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Second Edition

Textbook of PROSTHODONTICS

With Embedded Videos

V Rangarajan | TV Padmanabhan

ELSEVIER

Textbook of Prosthodontics

SECOND EDITION

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Foreword

Prof. (Dr.) Mahesh Verma Director – Principal, Maulana Azad Institute of Dental Sciences, New Delhi - 110002

"***It is the supreme art of teacher to awaken joy in creative expression and knowledge***". With this quote I laud the magnificent literary outcome of two of the most revered Prosthodontic educators and clinicians of the current era-***Dr.V. Rangarajan and Dr. T.V. Padmanabhan***. I am extremely delighted to introduce the product of their years of dedication to churn out a stupendously detailed and insightful "***Textbook of Prosthodontics" in its current form of 2nd edition***. The members of Prosthodontic fraternity collectively express gratitude to the stalwarts for their outstanding work.

Prosthodontics is a vast field and to acquire a complete understanding of all its branches is a ***complex and challenging task,*** for both dental students and practitioners alike. The current edition is an enriched resource of information and an exclusive version as it compiles the traditional views and philosophies pertaining to all the sub-specialties of Prosthodontics and merges them in a confluent manner with the contemporary, updated methods and techniques. The compiled book offers dental students and practitioners an excellent opportunity to understand the basic fundamentals and principles underlying the management of patients requiring Prosthodontic rehabilitative services in a comprehensive and user friendly manner.

The systematic manner in which the book presents each detail is extremely appealing to ***readers of all stages***, including those in the early phase of learning curve as well as the seasoned practitioners. The clarity of presentation acquaints the readers with the sequence of procedures in an explicable manner. The illustrations supporting the text further enhance the content presented. Of special mention are the ***video illustrations (22 in number)*** that help to clear the ambiguity associated with several clinical procedures. An additional feature that is earmarked for this issue is the accompanying ***power point presentations*** on important topics ***(15 in number)***. These topics can be used "***on-the-go***" by the readers to refresh themselves with the concepts and procedures at the click of a button!

The specialty of Prosthodontics has imbibed the avant-garde technologies and digitization in both the clinical and laboratory procedures. By encompassing both basic and advanced topics, the intent of this edition is to guide and inform the readers at various levels of learning and practice including undergraduates, postgraduate students and practicing clinicians.

This education resource gets through to the readers to offer "value care" to varied Prosthodontic scenarios. I wish the readers can take as much as possible from this enriched resource! Simply because "***Readers of today become leaders of tomorrow***".

Maheswari

Preface to the second edition

V Rangarajan

TV Padmanabhan

According to the Glossary of Prosthodontic Terms (GPT8), *Prosthodontics is the dental specialty pertaining to the diagnosis, treatment planning, rehabilitation and maintenance of the oral function, comfort, appearance and health of patients with clinical conditions associated with missing or deficient teeth and/or maxillofacial tissues using biocompatible substitutes—see Fixed Prosthodontics, Implant Prosthodontics, Maxillofacial Prosthetics, Removable Prosthodontics.*

Apart from throwing light on the speciality, the definition also informs the reader to go through its various branches to get a wholesome picture of the subject. It is very clear that to comprehend the subject it is essential to read all the sub-specialities in one book so that the fabrication of various types of prostheses can be elucidated. It is with this objective *Textbook of Prosthodontics* was conceptualised.

Over the many years that we have interacted with our undergraduate students and fellow general practitioners, we have most often got the impression that; to them the subject was always an unsolved puzzle. We were determined to demystify the subject and have endeavoured to make each topic follow a sequence or framework which is easy to comprehend and remember. We know that visual impact is better than words, hence numerous colour photographs on models and patients and line diagrams have been included to complement the written text. This will serve as a comprehensive textbook for the undergraduate student and a good basic platform for the postgraduate who can further utilize our Suggested Reading in Appendices Section to widen their knowledge. The step-by-step description of clinical procedures aided by photographs will be a ready-reckoner for the general practitioner as well.

Keeping in mind the various branches of Prosthodontics, the book has been divided into 4 sections: Complete Dentures, Removable Partial Dentures, Fixed Partial Dentures and Miscellaneous. The first three sections will deal with terminologies, planning and fabrication of the prototype prosthesis of that particular section. Prosthesis, which may not necessarily come under one of these three categories: Attachment Retained Dentures, Overdentures, Oral Implantology and Maxillofacial Prosthetics, have been categorized and detailed in the Miscellaneous section. Though we firmly believe that every aspect of Prosthodontics has a cosmetic component, we have included Porcelain Laminate Veneers and Smile Design in the Miscellaneous section for the benefit of the cosmetic dentist.

The second edition of the book will retain the same simplified textual content with an enhanced visual experience in the form of videos of important procedures to compliment the line diagrams and photographs. Lecture presentations on power point has also been incorporated for specific chapters to facilitate classroom lectures.

You can refer the front inner cover of the book to explore online additional reading material. Besides these, you will get access to the complimentary e-book also.

We deem it a privilege to share more than two decades of our experience in Prosthodontics, both didactic and clinical, with you.

Preface to the first edition

V Rangarajan

TV Padmanabhan

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Acknowledgements

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We are extremely grateful and indebted to the following persons who have helped us in this endeavour:

Dr Mahesh Verma, Principal-Director, Maulana Azad Institute of Dental Sciences, an academician and clinician par excellence, for having consented to write the Foreword for our Second edition also. He has been a great source of inspiration for many years and we are privileged and humbled by his gesture.

Shri VR Venkataachalam, the Chancellor of Sri Ramachandra University and the Dean of Faculties, Prof KV Somasundaram for their encouragement and providing great infrastructural facilities to work and study in the institution.

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The Lord Almighty for his blessings and giving us the mental fortitude to successfully complete the publication.

I would like to sincerely thank my PG teacher and former Head of Dept of Prosthodontics at Dr R Ahmed Dental College, Kolkata, late Prof PK Basu, who has been a tremendous positive influence on my professional development. I am eternally indebted to him for his guidance in the subject and words of wisdom. I am privileged to have fulfilled his dream of writing a book on Prosthodontics. I am also grateful to my former Dean at Annamalai University, Late Prof B Srinivasan for his valuable guidance during my formative years. I am indebted to Dr Lodd Mahendra, Principal of my current institution, for his unflinching support and co-operation. I am also grateful to all the faculty members of my institution for their affection and good wishes. I am extremely thankful to my wife Deepa for her patience,

tolerance and eternally supportive nature as such projects intrude a lot into family time. I am grateful to my daughter Hita for her valuable inputs as an undergraduate student of dentistry during the revision of this edition.

I would like to dedicate this book to my parents, particularly in memory of my mother Mrs TV Vijayalakshmi, who was the driving, determined force responsible for shaping my life and career. I would not be here if not for my brothers Mr TVL Narsimhan and Mr TVT Chari who have been a source of support and inspiration by themselves being rolemodels of hardwork and success. I thank my wife Sridevi and my daughter Harini for their patience and understanding. I would like to thank my teacher Prof TN Swaminathan, a man of principles and my postgraduate guide Late Prof Julian Ratnasamy. I am also grateful to my mentors Prof S Rangachari and Prof R Vishwanathan for all their blessings and guidance. I am also deeply indebted to my Japanese professors, Prof Yasunari Uchida and Prof Shin Ichi Masumi who are responsible for shaping me as an academician and refining my clinical skills. A special mention about Prof Ryuji Hosokawa, a researcher, academician, and an excellent clinician, a perfect gentleman and a very good friend who has been constantly motivating me for my professional betterment. I am also thankful to all my well wishers and friends from Sri Ramachandra University.

SECTION 1
Complete Dentures

OUTLINE

CHAPTER 1

Introduction

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Introduction

Complete dentures (CD) replace the entire dentition and restore the functions of aesthetics, mastication and speech. This is the last consideration for the patient after all the other tooth-supported options are exhausted. Hence, they must be designed with an emphasis on preservation of the remaining oral structures and an understanding of the psychological changes affected by the loss of all natural teeth. The complete edentulous situation is most often witnessed in the elderly, geriatric individual and changes associated with ageing also need to be considered. This section deals with the fabrication of the CD that is not supported by implants (implant-supported dentures are discussed in Chapter 49). This chapter will deal with the oral changes related to ageing, and the definitions, components, anatomic landmarks and procedures involved in the construction of a removable CD.

Effects of ageing

The success of endodontic and periodontal treatments has made the completely edentulous condition occur mostly in old age. The changes that occur in the oral cavity concomitant with age need to be understood in order to treat this condition successfully. Changes in the following structures are important for the construction of CD.

Bone

Generally bone quantity and quality decrease with age. This occurs due to decrease in efficiency of osteoblasts, less oestrogen production and reduction in calcium absorption from intestine.

Osteoporosis is common, especially in women.

Residual ridge resorption

Definition: The diminishing quantity and quality of the residual ridge after teeth are removed (GPT8).

The alveolar process of the jaws is dependent on the presence of teeth and hence changes in shape due to age are more marked in completely edentulous individual. This change in shape and size of the ridge occurs at varying rates in different individuals and at different times in the same individual. Due to this constant change, the treatment of the completely edentulous patient requires a 'maintenance phase' throughout the life of the individual.

Classification

Atwood classified the progression of residual ridge resorption (RRR) as follows (Fig. 1.1):

- **Order 1**: Pre extraction
- **Order 2**: Post extraction

- **Order 3**: High, well rounded
- **Order 4**: Knife-edged
- **Order 5**: Low, well rounded
- **Order 6**: Depressed

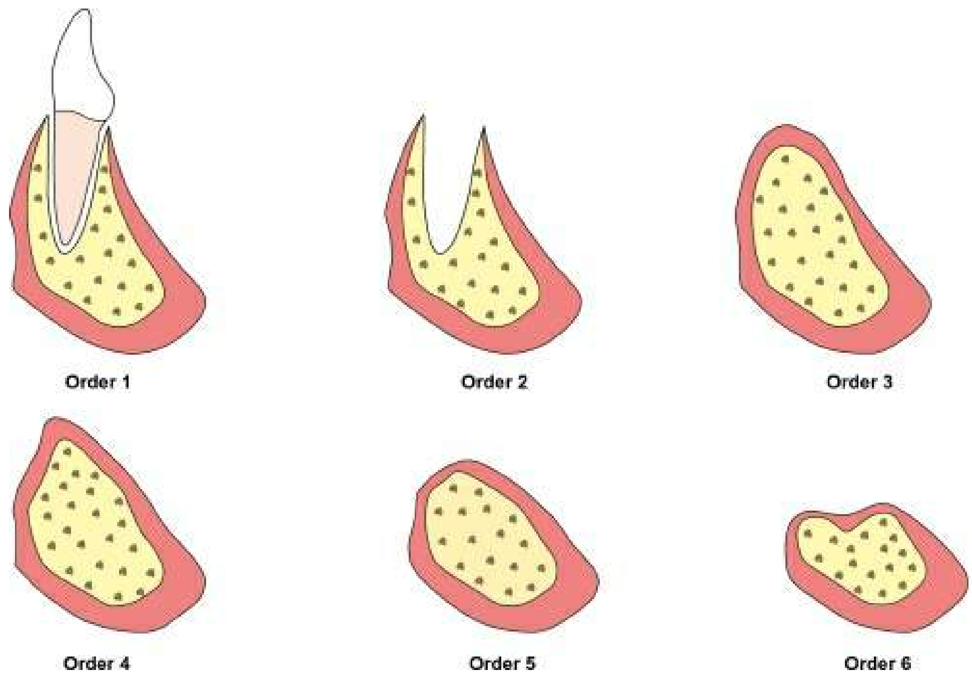


FIGURE 1.1 Atwood classification indicating progression of RRR: Order 1–6.

Resorption pattern

Generally women show more RRR than men.

During the first year following extraction, reduction in residual ridge height is 2–3 mm in maxilla and 4–5 mm for mandible. After this, the process will continue but with reduced intensity. Mandible shows 0.1–0.2 mm resorption annually, which is four times more than edentulous maxilla.

Aetiology

This is multifactorial and may be due to a combination of the following factors:

1. **Anatomic factors:** These are more pronounced in mandible than maxilla; associated more in patients with short and square face with increased masticatory forces. Large well-rounded ridges and broad palates are favourable anatomic factors for RRR.

2. **Metabolic factors:** RRR varies directly with bone resorption factors and inversely with bone formation factors.

a. *Bone-resorbing factors*: Factors causing periodontal disease and heparin.

b. *Bone-forming factors*: Circulating oestrogen, thyroxine, growth hormone, androgens, calcium, phosphorus, vitamin D, protein and fluoride.

3. **Mechanical factors**: Though RRR may be inevitable due to 'disuse atrophy', it can also be caused due to excessive force transmitted through dentures because of continuous denture wearing and unstable occlusal conditions.

Consequences of residual ridge resorption

1. Apparent loss of sulcus width and depth.

2. Displacement of muscle attachment closer to crest of the residual ridge.

3. Loss of vertical dimension of occlusion.

4. Reduction in the lower face height.

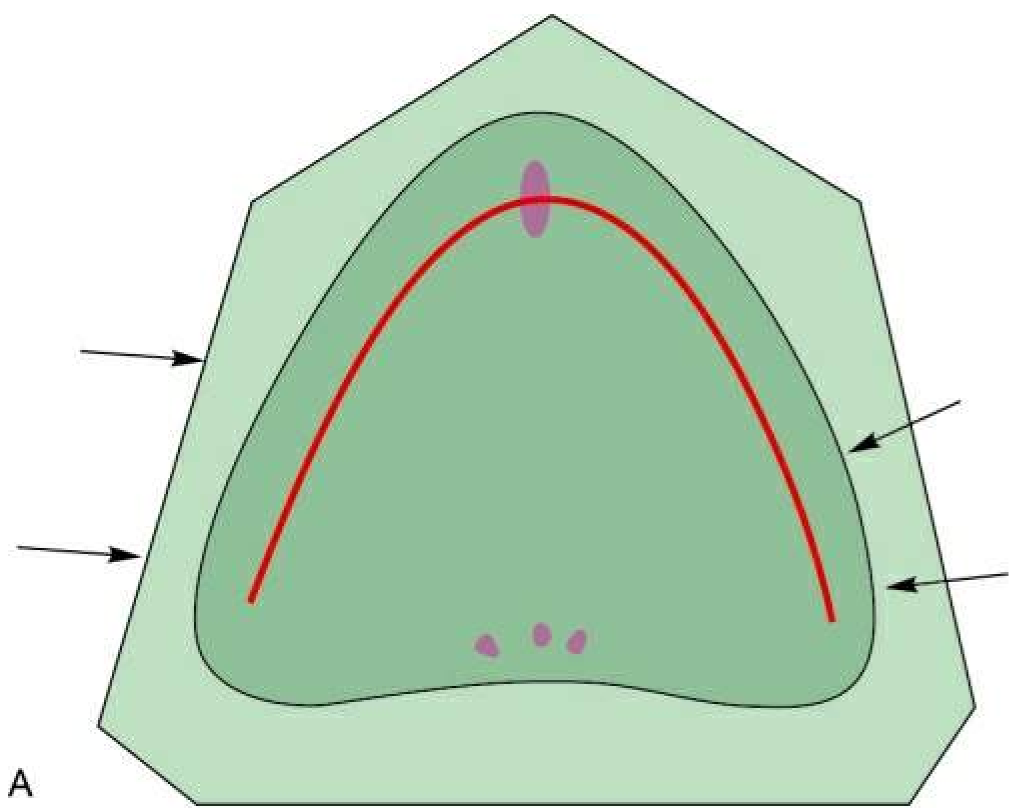
5. Anterior rotation of mandible and increase in relative prognathism.

6. Mental foramen may come to lie at or near the level of the upper border of the body of mandible.

7. The genial tubercles project above the upper border of the mandible in the symphyseal region.

8. Flattening of the vault of the palate.

9. Reduction in the height of both the maxillary and mandibular edentulous arches. While the maxillary arch resorbs buccally and labially with a concomitant reduction in perimeter or circumference of the arch, the mandibular arch resorbs in a labial and lingual direction resulting in widening of the arch posteriorly. This will lead to confinement of maxillary arch within the mandibular arch in long-standing edentulous situations, giving a pseudo-class 3 ridge relationship (Fig. 1.2 A and B).



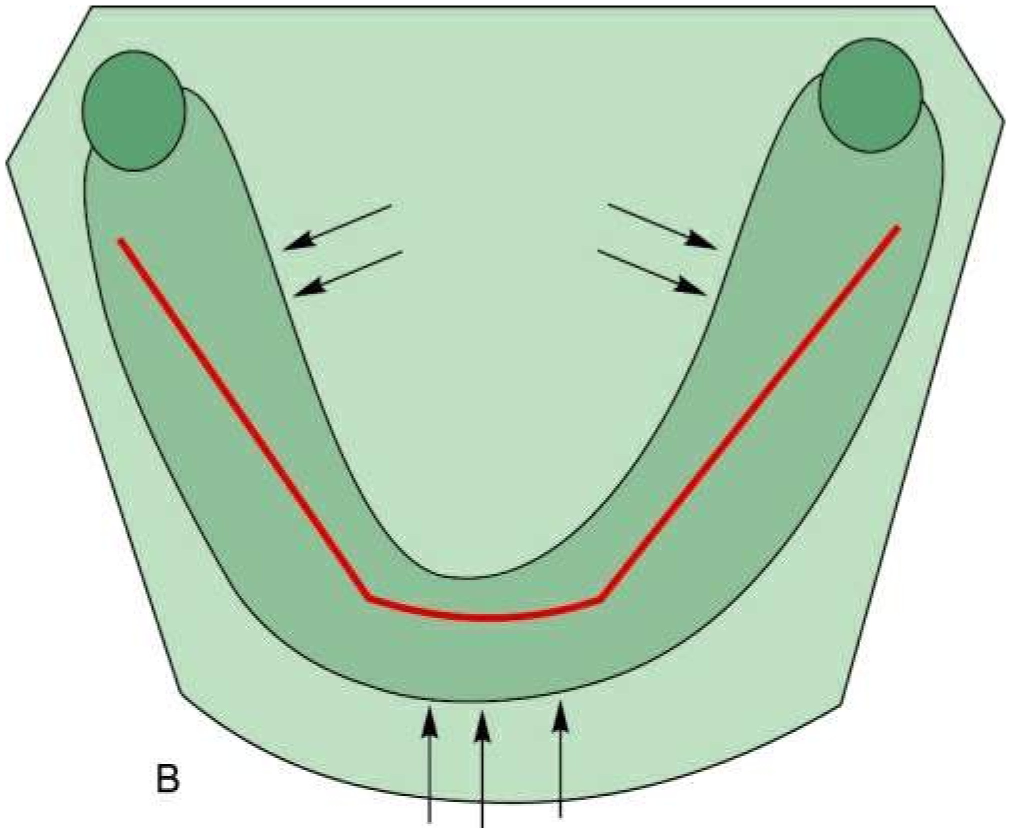


FIGURE 1.2 **(A)** Maxillary ridge resorbs buccally and labially which result in reduced arch size (red outline indicates the centre of the arch following resorption). **(B)** Mandibular arch resorbs labially (anteriorly) and lingually (posteriorly) resulting in widening of the arch.

Treatment

- Due to this continuous process, a maintenance phase comprising of relining and rebasing the dentures is essential throughout the life of a CD patient.
- Overdentures help in minimizing ridge resorption and contribute towards enhanced retention, stability, support of prosthesis along with preservation of proprioception. Clinicians must try to retain residual roots whenever possible.
- A severely resorbed ridge may require vestibuloplasty, but prosthetic rehabilitation with osseointegrated implants is the best

solution to prevent this process and preserve the bone.

Oral mucosa

The age changes seen in the oral mucosa are less acute than those seen in the skin because the moist environment of the mouth helps to maintain the turgor of the tissue. It can become thin and can be easily abraded.

Taste

There is a 60% reduction in taste buds by the age of 75–80 years. The threshold of basic taste modalities of salty and bitter is increased in older subjects, while the threshold for sweet and sour remains very similar to those of younger subjects.

Saliva

Salivary flow decreases and quality changes with age. It affects denture retention and may be caused more by the medications than age.

Mastication and deglutition

It has been observed that older adults are capable of fewer swallows in a 10-s period of time than younger adults. Even healthy older persons open their mouth less wide and chew with less power, which is related to loss of muscle bulk with age. This is worsened in edentulous patients.

Skin

Wrinkles, puffiness and pigmentation are associated with ageing. Philtrum is flattened and nasolabial grooves are deepened which lead to sagging of middle third of the face. Upper lip droops over the maxillary teeth. All these are accentuated with edentulousness and loss of vertical dimension.

Nutrition

- As age advances, there is a 30% reduction in energy needs and food intake. But, with the exception of carbohydrates, the requirement for other nutrients does not significantly reduce. As a consequence, the dietary intake by elderly individuals frequently shows some nutritional deficiencies.
- Malnutrition among the elderly denture wearers can be due to the following causes:

  - Low intake
  - Poor general health
  - Poor absorption and metabolic disturbances
  - Reduced salivary secretion rate
  - Condition of dentition
  - Socioeconomic factors

Nutritionally deficient denture-bearing tissues will be uncomfortable for the denture. It is essential to improve the nutritional status of the elderly patients through proper counselling and nutritional supplements, for prosthodontic treatment to be successful.

Nutritional requirements of the elderly

Recommended dietary requirements of geriatric individuals are

- Carbohydrates should comprise 45%–65% of total calories

- Fat should comprise 20%–35% of total calories
- Protein should comprise 10%–35% of total calories
- Fluid: 30 mL/kg/day or 1 mL/kcal intake

Factors affecting the nutritional intake

1. *Physiologic factors*

As age increases, following conditions persist among elders:

- Decreased physical activity—the lean body mass is replaced by fat.
- Decrease in gastrointestinal functioning.
- Decrease in taste and smell sensation.
- Dehydration due to decline in renal function and impaired thirst threshold.

All this leads to decreased metabolic rate and decreased caloric needs.

2. *Cognitive factors*

- Dementia—mastication increases cortical blood flow and widely activates various cortical areas of the somatosensory, supplementary motor and insular cortices. Blood oxygen levels in the prefrontal cortex and the hippocampus are increased by mastication, which may be essential for learning and memory processes. Decreased masticatory efficiency in edentulous patient consequently a poor nutritional status leads to loss of memory. Loss of teeth has been identified as one of the causes for Alzheimer disease.

3. *Oral factors*

- Xerostomia
  - Lack of self-cleansing by saliva—tongue is coated with epithelial debris.
  - Decreased taste sensation due to degeneration of taste buds.
  - Difficulty in chewing food.
- Dentate status
  - Masticatory ability is affected due to loss of dentition. Hence, the patient prefers soft diet which is rich in fats.

4. *Economic factors*

These determine the variety and nutritional adequacy of the diet.

5. *Psychological factors*

Depression, anxiety and loneliness all can undermine the desire to prepare and eat food.

6. *Pharmacological factors*

Prescribed drugs are the primary cause of anorexia, nausea, vomiting, gastrointestinal disturbances, xerostomia, taste loss and interference with nutrient absorption and utilization, e.g. digoxin, phenytoin, Ca^{++} channel blockers, H_2 receptor antagonists.

Impact of wearing dentures on dietary intake

- Greater number of chewing strokes are required for mastication.

- Due to decrease in masticatory ability, stringy food (including meat, which is a significant dietary source of protein and iron), crunchy food (including vegetables, a significant dietary source for vitamins and fibre) and dry solid food (including bread) are avoided. Patients select processed and softer diets rich in fat and carbohydrates, for ease of chewing.
- Decline in taste sensation due to palatal coverage of denture.

Dietary counselling

This involves:

- Obtaining a nutrition history and accurate record of food intake over a period of 3–5 days and evaluating the diet.
- Educating the patient regarding the importance of a balanced diet.
- Helping the patient to improve the diet.
- Follow-up to verify and support patient in changing food behaviours.

Complete dentures

Definitions

Denture: An artificial substitute for missing natural teeth and adjacent tissues (GPT8).

Complete denture: A removable dental prosthesis that replaces the entire dentition and associated structures of the maxilla or mandible (GPT8).

Complete denture prosthodontics: That body of knowledge and skills pertaining to the restoration of the edentulous arch with a removable dental prosthesis (GPT8).

Objectives

CD should satisfy the following functional objectives:

1. Compatibility with surrounding oral environment.

2. Restoration of mastication.

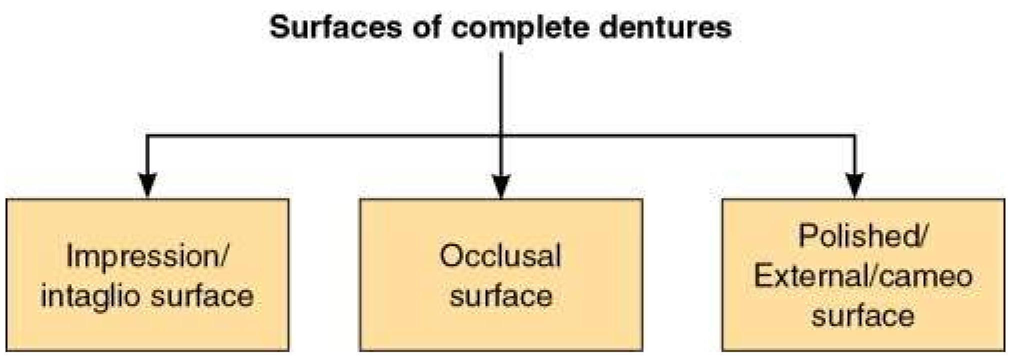
3. Harmony with functions of speech, respiration and deglutition.

4. Aesthetics.

5. Preservation of remaining oral tissues.

Surfaces of complete dentures

Sir Wilfred Fish (1948) described a denture as having three surfaces, with each surface playing an independent and important role in the overall fit, stability and comfort of the denture (Flowchart 1.1).



FLOWCHART 1.1 Three surfaces of complete dentures

Impression surface (intaglio surface) (fig. 1.3)

Definition: The portion of the denture surface that has its contour determined by the impression (GPT8).

- Part of the denture in contact with the tissues on which the denture rests.
- The fit of the denture depends on the accuracy of this surface.
- Contributes to retention, stability and support of the denture.

FIGURE 1.3 Impression surface of the denture. It is the surface that fits onto the tissues.

Occlusal surface (fig. 1.4B)

Definition: The surface that is intended to make contact with an opposing occlusal surface.

- Aids in mastication and directs forces of mastication to the supporting tissues.
- Contributes to the stability of denture.

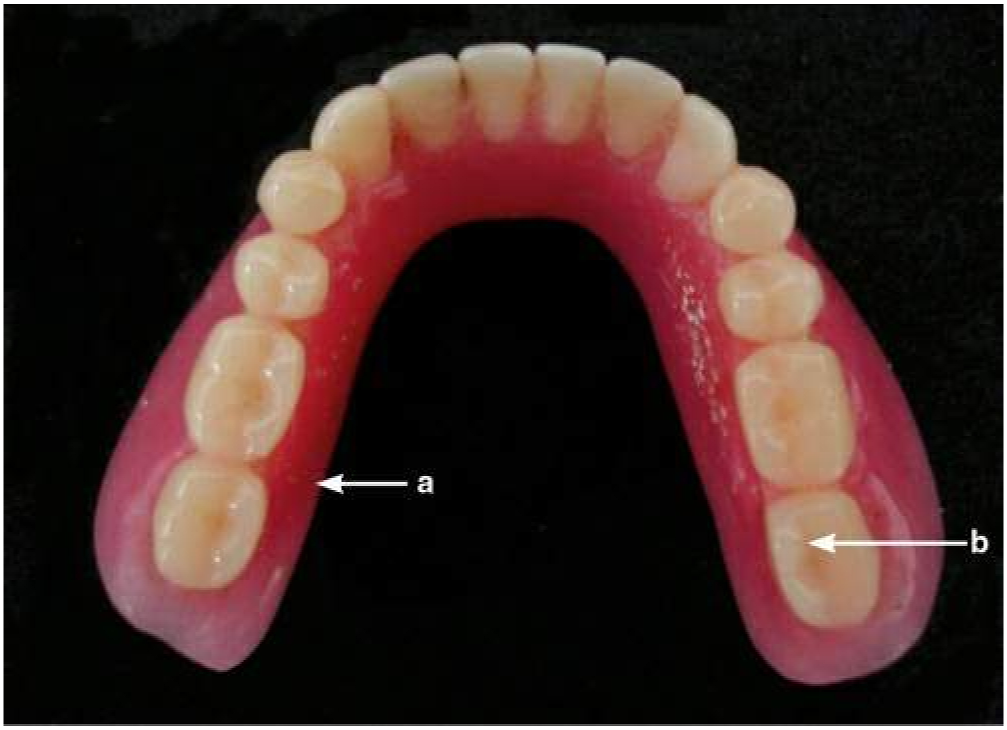


FIGURE 1.4 Polished surface extends both buccally and lingually (a). Occlusal surface aids in mastication (b).

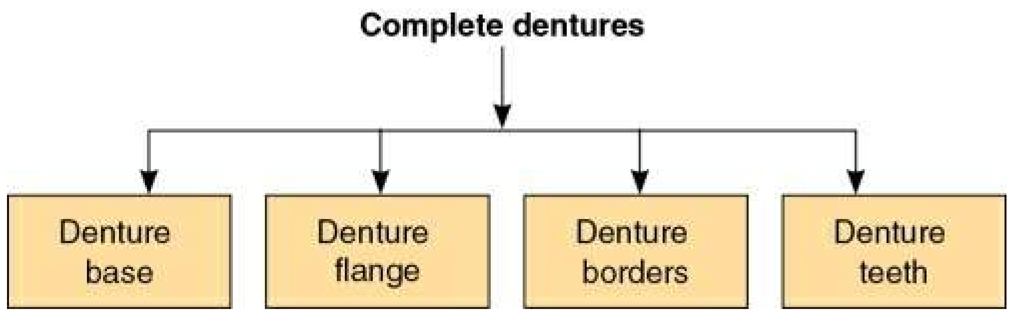
Polished or external surface (cameo surface) (fig. 1.4A)

Definition: That portion of the surface of a denture that extends in an occlusal direction from the border of the denture and includes the palatal surfaces. It is that part of the denture base that is usually polished, and it includes the buccal and lingual surfaces of the teeth (GPT4).

- It was termed by Fish (1948).
- It is the external surface of the denture without the teeth.
- Should correspond to the contours of the lips, cheek and tongue.
- Contributes to retention and stability of denture.

Component parts of complete dentures

The various components of the CD are explicated in Flowchart 1.2.



FLOWCHART 1.2 Component parts of complete denture

Denture base

Definition: The part of a denture that rests on the foundation tissues and to which teeth are attached (GPT8).

- Forms the foundation of the denture.
- Forces applied to the denture are distributed and transmitted to the basal seat through the denture base.
- Adequate extension of the denture base helps in providing retention and support.
- Denture bases are made of acrylic resin or metal (Fig. 1.5A and B).

FIGURE 1.5 **(A)** Denture base made of acrylic. **(B)** Denture base made of metal.

Denture flange

Definition: The part of the denture base that extends from the cervical ends of the teeth to the denture border (GPT8).

- Provides peripheral seal and horizontal stability.
- Classified according to the vestibule where it extends as—labial, buccal and lingual.

Labial flange

Definition: The portion of the flange of a denture that occupies the labial vestibule of the mouth (GPT8).

- Provides lip support.
- V-shaped notch is provided in the labial flange to accommodate the labial frenum (Fig. 1.6A).

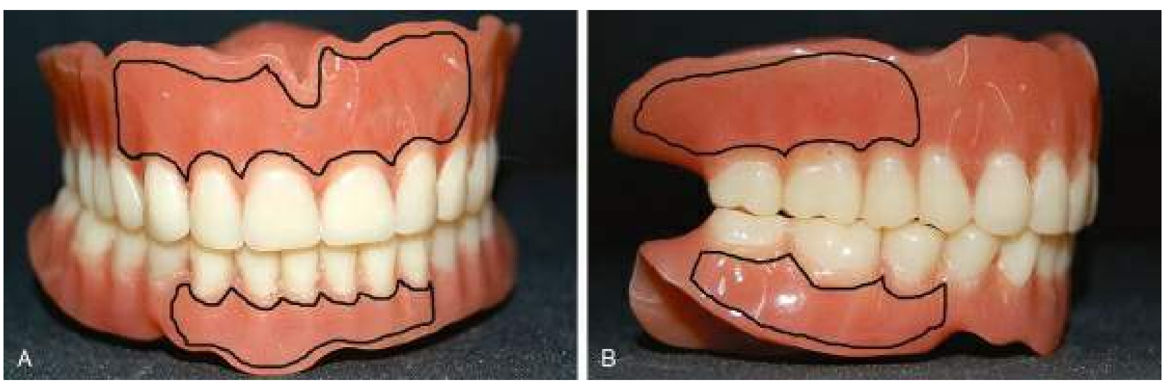


FIGURE 1.6 **(A)** Labial flange of the denture with V-shaped notch to accommodate the labial frenum. **(B)** Buccal flange of denture.

Buccal flange

Definition: The portion of the flange of a denture that occupies the buccal vestibule of the mouth (Fig. 1.6B).

- Provides the cheek support.
- Relief is provided to accommodate the buccal frenum.

Lingual flange

Definition: The portion of the flange of a mandibular denture that occupies the alveololingual sulcus (GPT8) (Fig. 1.7).

- Should maintain contact with the tissues of the floor of the mouth.

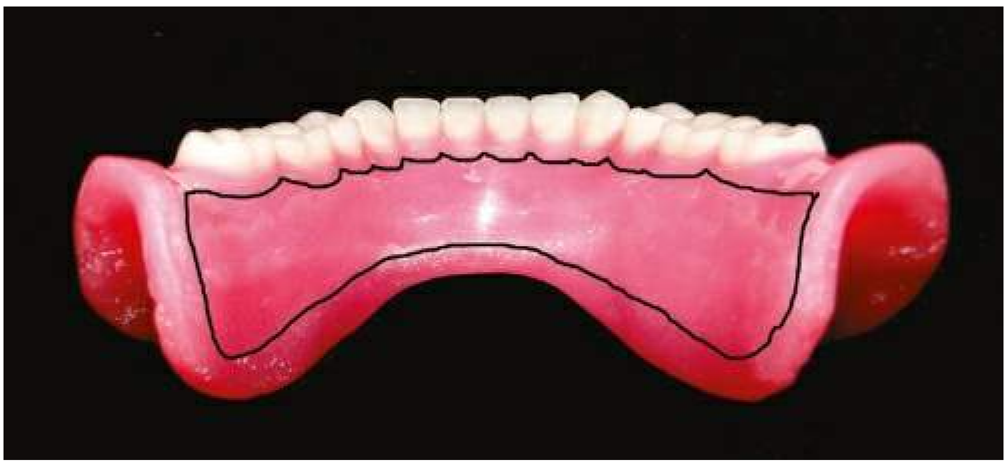
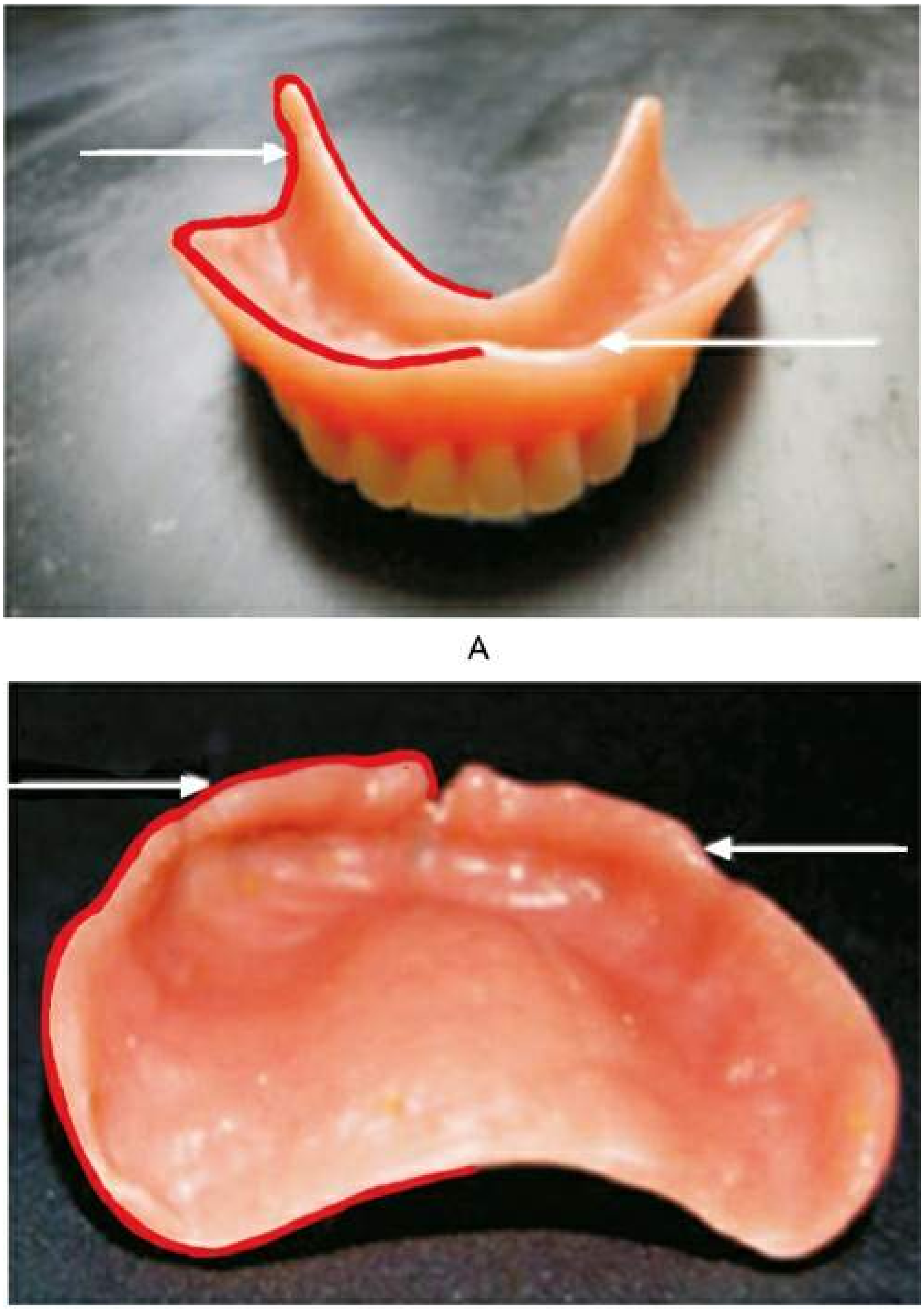


FIGURE 1.7 Lingual flange.

Denture border

Definition: The margin of the denture base at the junction of the polished surface and the impression surface (GPT8) (Fig. 1.8).

- Responsible for maintaining the peripheral seal.
- Should be smooth and polished.
- Overextended denture borders may cause ulcers and hyperplasia.
- Underextended borders result in loss of peripheral seal and compromise retention.



A

B

FIGURE 1.8 Denture borders. **(A)** Mandibular denture. **(B)** Maxillary denture.

Denture teeth

- Functions of denture teeth are to improve aesthetics, phonetics and mastication.

  They are classified as follows:

- Based on the type of material used:

  ○ Acrylic

  ○ Porcelain.

- Based on the morphology of teeth:

  ○ Anatomic (33 degree or more)

  ○ Modified anatomic (between 30 and 0 degrees)

Steps in fabrication of complete dentures

The various procedures involved in the fabrication of a CD can be divided into clinical and laboratory procedures and are summarized in Table 1.1.

Table 1.1

Sequential steps in the fabrication of complete dentures—clinical and laboratory

Clinical procedures	Laboratory procedures
1. Diagnosis and treatment planning	2. Making diagnostic casts
3. Mouth preparation	
4. Primary impressions	5. Primary cast 6. Fabrication of custom trays
7. Secondary impressions	8. Master cast 9. Fabrication of occlusal rims
10. Recording jaw relations	11. Articulation 12. Arrangement of artificial teeth
13. Try-in	14. Processing of denture
15. Denture insertion	
16. Postinsertion review and maintenance	

All these are discussed in detail in the subsequent chapters of this section.

CHAPTER 2

Diagnosis and treatment planning

CHAPTER CONTENTS

Diagnosis

Definition: Determination of the nature of a disease.

Diagnosis is the examination and evaluation of the physical and psychological state and understanding the needs of each patient to ensure a predictable result. Diagnosis involves patient evaluation, history and examination.

Patient evaluation

This process commences as the patient walks to the dentist's chair as well as during the introductory and history taking conversation. The following characteristics are observed:

Gait

Observations regarding the patient's walk, steadiness and the level of coordination can help in gaining an insight into the patients' motor skills and any systemic disease.

- Stooped shoulders—spinal changes.
- Tremor of head—Parkinson disease, tranquillizers.
- Dragging of one leg—stroke.
- Staggering—excessive alcohol and medication, hyperventilation, damage to brain and spinal cord.

Age

This refers to the physiologic age and provides information about the patient's expectations and care for the dentures. A young patient who appears old may indicate disinterest, while an old patient who appears young indicates willingness to adapt and look good.

Facial expression

This provides information about the mental attitude and presence of any disorders.

Absence of any expression indicates loss of muscle tone, trigeminal neuralgia, plastic surgery or disorders of central nervous system.

Complexion

It is used to select the colour of the teeth. It may also be indicative of the following conditions:

- Pale—anaemia, lack of nourishment.
- Ruddy—polycythaemia, chronic alcoholic.
- Bronze—radiation therapy, Addison disease.
- Bluish-purple—vitamin deficiency, cyanosis.
- Lemon-yellow—jaundice.

Speech

The fluency and quality of the speech should be noted, as it will help in arranging artificial teeth. If speech is altered due to poor denture construction, it should be rectified.

Speech can also be altered due to the following pathologies:

- Hypernasality—paralysis of palatal musculature.
- Hoarseness—paralysis of both vocal cords, excessive smoking.

Breathing pattern

Abnormal breathing patterns may indicate the following:

- Heavy sighing—emotionally disturbed

- Wheezing—asthma
- Shortness of breath—lung disease, heart failure
- Shallow breathing at rapid rate—pulmonary fibrosis
- Erratic breathing—continuous hyperventilation

Personality

The personality may be vigorous or delicate, and it guides teeth selection and arrangement.

Mental attitude

Dr M.M. House (1950) classified patients as philosophical, exacting, indifferent and hysterical. This is the most widely used classification.

Class I: Philosophical patients

- They are rational and composed in difficult situations.
- They desire treatment for maintenance of health and appearance and accept the complete denture treatment as a normal procedure.
- They learn to adjust rapidly.
- These patients have the best mental attitude for acceptance of the treatment.

Class II: Exacting patients

- They are very methodical, precise and accurate, making severe demands.
- They are comfortable when each procedure is explained and discussed with them in detail.

- They require extreme care, effort and patience on part of the dentist.
- The intelligent and understanding category in this class can be the best type of patient, but for those lacking the same, extra time should be spent in education and treatment started only after an understanding is reached.

Class III: Indifferent patients

- These patients are identified by their lack of concern and motivation and apathetic attitudes.
- They may not pay any attention to instructions, will not cooperate and are prone to blame others including the dentist for their poor health. In many cases, the lack of interest on part of the patient is the reason for their edentulousness.
- A patient education programme is recommended before treatment.
- If their interest cannot be stimulated, it may be best to refuse such patients.
- They present a questionable or unfavourable prognosis.

Class IV: Hysterical patients

- They are emotionally unstable, excitable and apprehensive.
- They may not be aware that their symptoms may be more related to their systemic health.
- They often present an unfavourable prognosis and additional psychiatric counselling is required prior to the treatment.

History

A record of all the information obtained from the patient must be made and kept for further study and later use. The health history is an extremely important part of the patient's overall diagnosis and treatment planning. It is best obtained by a combination of questionnaire and direct interrogation. It should include the following:

General information

Name

This is important for documentation and record maintenance.

Patients are more comfortable and confident when addressed by their names. Some systemic conditions are more common in certain communities.

Age

Younger patients usually show better healing ability. They also adapt easily to treatment and a new prosthesis. However, they can be exacting in nature and be very concerned about their appearances.

Older patients need more care and patience on part of the dentist. Systemic diseases and medications may be more relevant in older age. Their previous experiences may lead them to be very apprehensive of the treatment. Proper nutritional care is very important in geriatric patients. This is an important consideration in the selection and arrangement of artificial teeth.

Sex

Generally, appearance is a higher priority for women. Males may be more concerned about comfort and function of the dentures. Menopause and its associated hormonal and behavioural changes are a concern with women. This is also an important consideration in the selection and arrangement of artificial teeth.

Occupation/Social information

Particulars such as the occupation can help in setting up a convenient appointment for the treatment procedure and in tooth selection and arrangement.

Executives in high stress jobs may exhibit bruxism. People who work in places with high physical exertion and factories where abrasive dust abounds require rugged teeth which do not wear easily.

For professionals, appearance and retention may be more important than efficiency.

Public speakers and singers may need greater attention to palatal shape and thickness and perfect retention. Wind instrument players may require special positioning of anterior teeth. Patients in high socioeconomic groups may be more demanding and critical, while those of low economic status may show disinterest and poor hygiene maintenance.

Location/Address

Some endemic disorders may be confined to certain localities.

Habits

Pan chewing, smoking, chronic alcoholism may modify the systemic status and evoke concerns regarding the hygiene, maintenance and wear of the denture.

Habits like pencil biting and nail biting may cause denture instability.

Parafunctional habits like clenching and bruxism should also be verified as they affect teeth selection and prognosis.

Nutritional history

It is important to obtain a record of food intake of the patient over a 3–5 days period. This helps in evaluating the nutritional status of the patient. The ability of the oral tissues to withstand the stress of dentures is greater in a well-nourished patient. Dietary counselling is necessary in malnourished patients.

Medical history

No prosthodontic procedure should be commenced without evaluating the systemic status of the individual. The following need to be assessed:

Debilitating diseases

The most common is diabetes mellitus. Patients are at a higher risk of opportunistic infections such as candidiasis and show delayed wound healing. Salivary flow may also be impaired. Their medication and mealtime should be given due importance while scheduling appointments. Special emphasis on denture hygiene, recall and maintenance is also necessary for such patients.

Tuberculosis is contagious and necessary precautions are required. The therapy is also long term and the drugs can cause nausea. Patient with blood dyscrasia require specific precautions if preprosthetic surgery is contemplated. Mucosa is also more sensitive to denture pressure.

All patients with debilitating disease should be under medical control before commencing any dental treatment.

Diseases of the joints

Rheumatoid arthritis and osteoarthritis are common diseases affecting the joints. If fingers are affected, patient will find it difficult to insert and clean dentures. When the temporomandibular joint (TMJ) is affected, special impression trays are required due to poor mouth opening and frequent occlusal correction may be necessary as jaw relations are difficult to record due to painful mandibular movements.

Cardiovascular disease

Patients with stable cardiac problems under the regular care of a cardiologist are not contraindicated for procedures. Short appointments may help the patients to manage stress better. A consultation with the physician is required if any invasive preprosthetic procedure is contemplated, along with premedication and stoppage of anticoagulants.

Neurological conditions

Conditions like Bell palsy and Parkinson disease will present problems related to denture retention, maxillomandibular records and support for the musculature. Patients need to be educated regarding these anticipated problems.

Oral malignancies

Construction of CD may be commenced depending on the tumour prognosis, the healing of tissues following the treatment and the amount of radiation. After CD construction, the tissues should be evaluated constantly for any evidence of radiation necrosis. Patient should be advised to use the dentures on a limited basis.

Epilepsy

Patient may aspirate or break the denture during the seizure. It will influence the selection of denture base material and teeth. Patient and close relatives may also need to be educated on quick removal of the dentures prior to or during seizures.

Diseases of the skin

Dermatological diseases like pemphigus have painful oral manifestations like ulcers and bullae. Medical treatment may or may not provide relief to these patients. The constant use of dentures in such patients must be discouraged.

Menopause

This is an important consideration in women as they could undergo CD construction during this period. The period is characterized by bone changes like osteoporosis, burning mouth syndrome, mental disturbance ranging from mild irritability to complete nervous breakdown. They may require psychiatric counselling and medication. Patient must be made aware of this condition before treatment and the possible effect on denture adjustment.

Medications

It can be an indication of a systemic problem or dental treatment may be modified and influenced by the effect of the drug.

Xerostomia is a common side effect of antihypertensives and antidepressants. This can decrease denture retention and cause increased soreness.

Diuretics cause changes in tissue fluids which affect retention and stability of dentures.

Psychotropic drugs can cause uncontrollable tongue or facial movements.

Drugs can also act as synergists or antagonists to produce undesirable effects.

Hence, the dentist must be aware of all the patient's medications.

Dental history

This should include the following.

Chief complaint

The chief complaint is recorded in patient's own words. It should be determined if the complaint is justified and realistic.

Patient's desires and expectations

It is important to find out what the patient expects from the treatment. Unrealistic expectations will be detrimental to success of treatment. Patient education regarding what is possible is very important in such cases.

Past dental history

The following information should be elicited:

1. **Reason for tooth loss**: If periodontal disease was the reason, more bone loss is anticipated. It also helps in prognosis.

2. **Period and sequence of edentulousness**: Longer the period, more will be the bone loss. By understanding the sequence, bone resorption pattern can be identified.

3. **Previous dental and denture experience**: Traumatic experiences will affect the attitude of the patient towards dental treatment and they will require more counselling and education. Patient's experience

with previous dentures will give an insight into their attitude, desire and expectations.

Current denture

The examination and evaluation of the present prosthesis gives an insight into the patient's previous experience, patient tolerance and aesthetic values. It is evaluated for the following:

- Extension of denture is evaluated using vestibule, hamular notch and vibrating line as guides for maxillary denture; and vestibule, retromolar pad, retromylohyoid area and buccal shelf as guide for mandibular denture.
- The jaw relation—vertical and horizontal, is checked using appropriate methods.
- Occlusion is verified for balance and premature contacts.
- Artificial teeth are examined for type and wear or breakage. Considerable wear in a short time period is indicative of bruxism.
- Retention and stability.
- Aesthetics.
- Maintenance of the denture is checked which will provide information about patient's hygiene, interest and methods.
- Any previous prosthesis and the reasons for its change should also be evaluated.

Pre-Extraction records

This will include old diagnostic casts, radiographs and photographs.

- Old diagnostic casts aid in determining tooth size, position and arrangement.

- Old radiographs aid in determining tooth size and bony changes.
- Photographs give information about tooth size, position and tooth display.

Diagnostic casts

- They confirm and sometimes reveal new information obtained from intraoral examination. It may be of immense benefit to keep the cast ready during intraoral examination.
- Diagnostic casts should be mounted on an articulator following a facebow transfer. This allows for dynamic evaluation of interarch relations, most importantly the interarch space (interridge distance), which is very essential in determining if space exists to place artificial teeth.
- Undercuts and their significance can be evaluated with a dental surveyor.
- Preprosthetic surgeries can be planned and surgical templates can be made on the diagnostic cast.

Examination

Extraoral examination

- The patient's head and neck should be examined for the presence of any pathologic condition.
- Any nodules and ulcerations on the face are noted.
- Facial colour and tone, hair texture, eye clarity, symmetry and neuromuscular activity should be noted.
- Face and neck are palpated to check for enlarged nodes or masses.

Facial examination

Face form

Leon William has classified the facial form based on the approximate shape of the face as square, tapering, square–tapering and ovoid (Fig. 2.1).

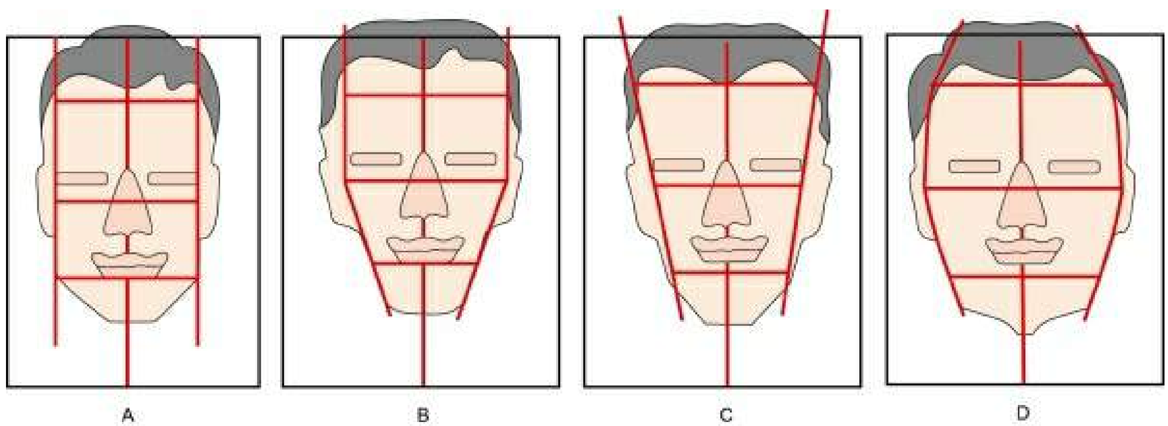


FIGURE 2.1 Facial form. **(A)** Square, **(B)** Square-Tapering, **(C)** Tapering and **(D)** ovoid. Points on Temporal, Zygomatic, Angle of the mandible are taken to form the lines on side of the face.

This helps in selecting the shape of the artificial tooth for the patient (also see Chapter 9).

Facial profile

The facial profile is classified as:

- Class I: Straight profile
- Class II: Retrognathic or convex profile
- Class III: Prognathic or concave profile. This helps in selection and arrangement of artificial teeth (Fig. 2.2) (also see Chapter 9).

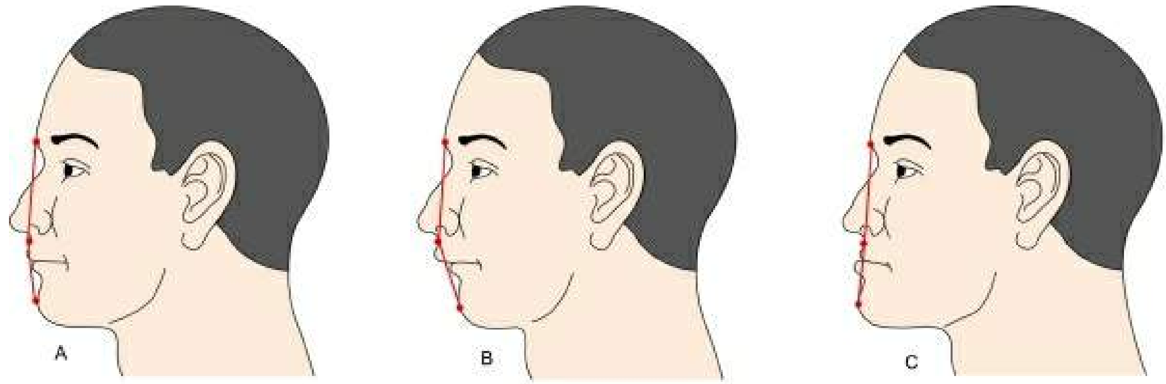


FIGURE 2.2 Facial profile. **(A)** Straight, **(B)** retrognathic and **(C)** prognathic. Forehead, base of nose and chin points are considered for the classification.

Colour of face, hair and eye

This helps in determining the tooth shade. Though there is no scientific evidence to associate this colour with a particular tooth shade, a harmonious relationship of all of these should exist.

Lip examination

Lip health

Fissures, cracking or ulcers at the corner of the mouth indicate vitamin B deficiency, candidiasis and loss of vertical dimension or neoplasm. The cause should be determined before denture construction.

Lip support

Lack of proper support can lead to wrinkling. If the same is caused due to age and health of the patient, it cannot be corrected with dentures. Correct placement of upper anterior teeth will provide adequate lip support to eliminate wrinkles around the modiolus.

Lip thickness

In patient with thin lips, even a slight change in the labiolingual tooth position makes an impact on lip fullness and support. Thick lips can tolerate more alterations in tooth position without visible changes.

Lip length

Length of the lips affects the amount of anterior tooth exposure and the anterior tooth size. They are classified as long, medium and short. Patients with short upper lip will expose all the upper anterior teeth and much of the labial flange of the denture base with any expression. Long lip will hide most of the tooth and denture base. Short lips will influence the selection of anterior tooth size and characterization of denture base.

Muscular examination

The musculature surrounding the mouth plays an important part in the stability of the prosthesis. The musculature can be classified according to House as:

- Class 1: Normal muscle function and tone or patients showing no degeneration. This is most commonly seen in patients with recent extractions.

- Class 2: Normal muscle function with mildly decreased muscle tone.

- Class 3: Decreased muscle tone and function, seen as drooping commissures, exaggerated nasolabial fold or loss of vertical dimension.

Temporomandibular joint

The TMJ and associated muscles should be examined for pain by palpation or mandibular movement. Range of opening, deviation, clicking and crepitus should be noted. It must be decided if CD construction will solve some of the problems associated with the TMJ and explained to the patient.

Intraoral examination

Teeth present

Teeth, if present, are examined for planning the following treatments:

1. Immediate denture
2. Overdenture
3. Single complete denture

These are discussed in separate chapters in this section.

Mucosa

The mucosa of the cheeks, lips, floor of the mouth, residual ridge, hard palate and soft palate is evaluated for colour and thickness and the condition is noted.

Colour

- Redness is a sign of inflammation, which could be due to ill-fitting dentures, infections, smoking and systemic diseases such as diabetes. It is important to eliminate the cause and allow the tissues to return to normal before impression making.
- White patches and brown/blue pigmented spots should be noted. If the cause is uncertain, a biopsy is indicated.

Thickness

M.M. House has classified mucosa thickness as follows:

- Class 1: Normal uniform density of mucosal tissue (approximately 1 mm thick). Investing membrane is firm but not tense and forms an ideal cushion for the basal seat of a denture.
- Class 2:
    - Soft tissues have thin investing membranes and are highly susceptible to irritation under pressure.
    - Soft tissues have mucous membranes twice the

normal thickness.

- Class 3: Soft tissues have excessively thick investing membranes filled with redundant tissues. At the very least, this requires tissue treatment. Such conditions may require surgical correction.

The quality of the mucoperiosteum may vary within each arch. Tissues may be extremely thin in one area where teeth have been missing for a long time and normal where teeth were removed recently. Other areas may be excessively thick with localized regions of redundant tissue. Such variations make it difficult to equalize pressure under the denture and to avoid soreness.

Condition

Classified by House as:

- Class I—healthy
- Class II—irritated
- Class III—pathological

Residual alveolar ridge

Residual alveolar ridge should be evaluated for the following.

Arch size

- Greater the arch size larger is the contact and support, hence greater is the retention.
- Discrepancy in the size of the maxillary and mandibular ridges can create problems with denture stability in the smaller arch due to poor relationship of the teeth. This discrepancy may be due to developmental causes, trauma and early loss of teeth in one of the arches, or from a severe class II or class III malocclusion.

• Size can be classified as—small, medium and large (Fig. 2.3).

FIGURE 2.3 Arch size. Left—small, right—large.

Arch form

• Influences support and tooth selection.

• If opposing arches do not have the same form, difficulty in tooth arrangement can be anticipated.

• Arch forms can be classified as—square, tapering or ovoid (Fig. 2.4).

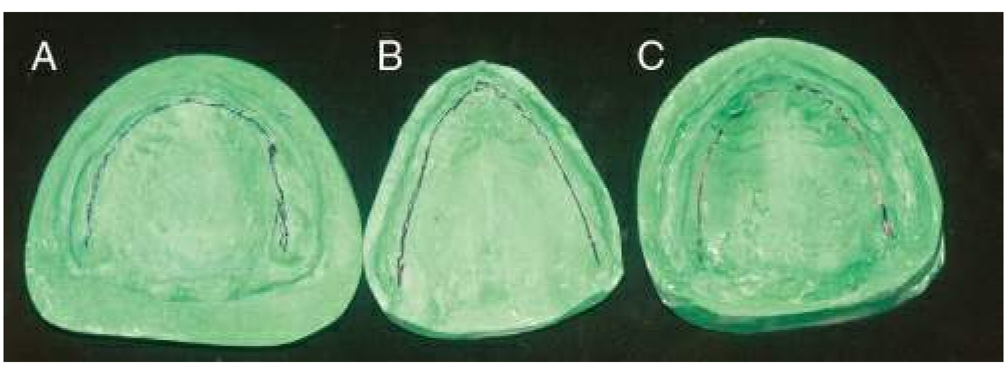


FIGURE 2.4 Arch form. **(A)** Square, **(B)** tapering and **(C)** ovoid.

Ridge contour

Influences support and stability of the dentures.

Atwood has classified residual ridges as:

- Order I: Pre-extraction
- Order II: Postextraction
- Order III: High well rounded
- Order IV: Knife-edge
- Order V: Low well rounded
- Order VI: Depressed (also see Fig. 1.1 in Chapter 1).

The ideal is a high ridge with a flat crest and nearly parallel sides. This offers maximum support and stability. A flat ridge lacking vertical height affords little resistance to horizontal movement leading to reduced stability. A knife-edged ridge offers the poorest prognosis because it cannot withstand much occlusal force and can easily become sore. Relief is necessary while making impressions.

Ridge relation

Ridge relation is evaluated for the following:

Interridge distance

- The interarch space is noted at normal occlusal vertical distance.
- Excessive space due to resorption will lead to poor denture stability and retention due to excessive leverage. Less space will make teeth setting difficult.
- Can be classified as normal, excessive and reduced (Fig. 2.5)

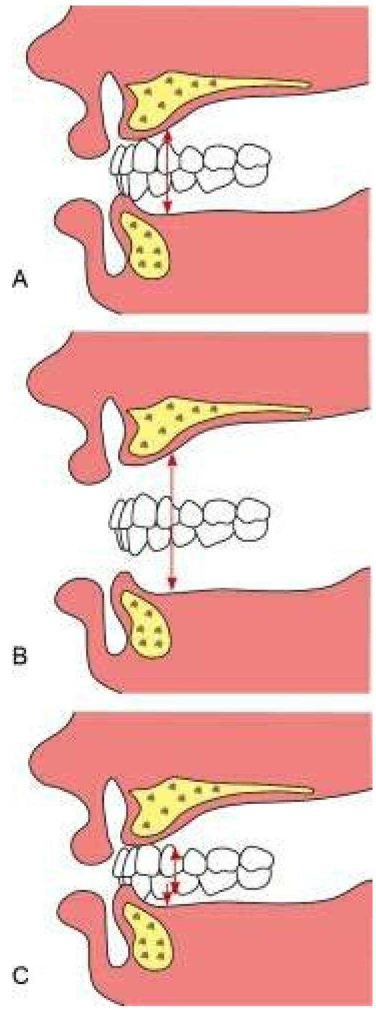


FIGURE 2.5 Interridge distance (interarch space). **(A)** Normal, **(B)** excessive and **(C)** reduced.

Parallelism

- This affects denture stability as nonparallel ridges will cause movement of the bases when teeth occlude due to unfavourable direction of forces.
- Classified as parallel, nonparallel.

Positional relation

- This affects tooth arrangement and denture stability.

- As maxilla resorbs, the crest appears to move upwards and inwards. As mandible resorbs, the crest appears to move downwards, forwards and laterally.

- The positional relation can be normal (class I), retrognathic (class II) and prognathic (class III) (Fig. 2.6).

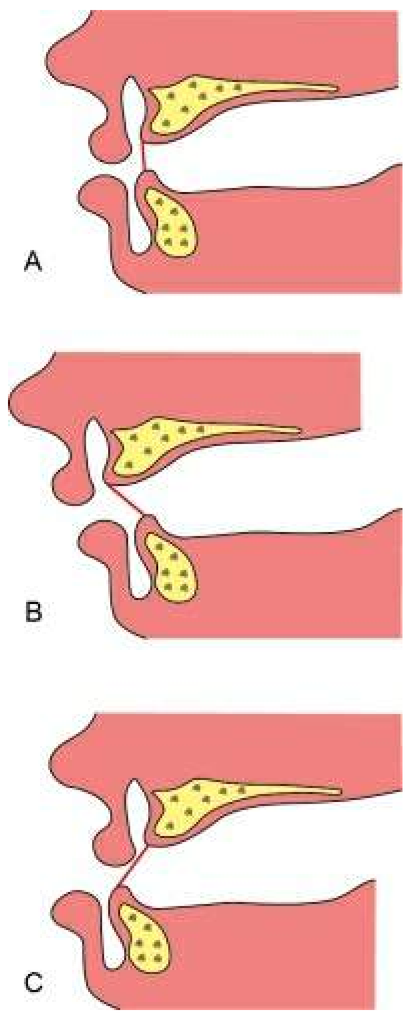


FIGURE 2.6 Positional ridge relation. **(A)** Normal (class I), **(B)** retrognathic (class II) and **(C)** prognathic (class III).

Flabby tissue

Both the arches should be examined for loose flabby tissue which can cause the denture bases as the foundations themselves are moving leading to poor stability and support. This may need surgical correction before impressions or special impression procedures are adopted to record the same.

Hyperplastic tissue

Hyperplastic tissues such as epulis fissuratum and papillary hyperplasia may result from an ill-fitting denture and need to be treated. The patient is advised to rest the tissues by not wearing the existing dentures, through proper oral hygiene and tissue massage, tissue conditioning and lastly, if necessary, by surgical correction.

Bony undercuts

These do not aid in retention but cause loss of border seal and retention; may be present in both maxillary and mandibular ridges.

Maxilla—present in anterior ridge and lateral to maxillary tuberosity. These may be selectively relieved without any surgery. Only if the undercuts are severe and previous denture attempts have failed, surgery should be considered.

Mandible—prominent sharp mylohyoid ridge produces undercut. Surgical reduction and reattachment may be beneficial.

Muscle and frenal attachments

The location of these attachments in relation to the crest of the ridge must be verified. In resorbed ridges, they can be near the crest of the ridge. This interferes with the border seal compromising retention of the dentures. In such cases, a surgical correction may be required. The attachments most often corrected surgically are the maxillary labial frenum and the mandibular lingual frenum; buccal frena rarely require surgical repositioning.

Relation with floor of the mouth

Relationship of the floor of mouth to crest of the ridge is important for prognosis of lower denture.

If the floor of the mouth is at the crest of ridge at rest, especially in the sublingual gland and mylohyoid areas, retention and stability of denture will be poor.

Palate

The following are evaluated.

Hard palate

It is classified according to the shape as:

- U-shaped: Provides good retention and stability
- V-shaped: Provides least retention
- Flat: Provides poor retention and stability (Fig. 2.7)

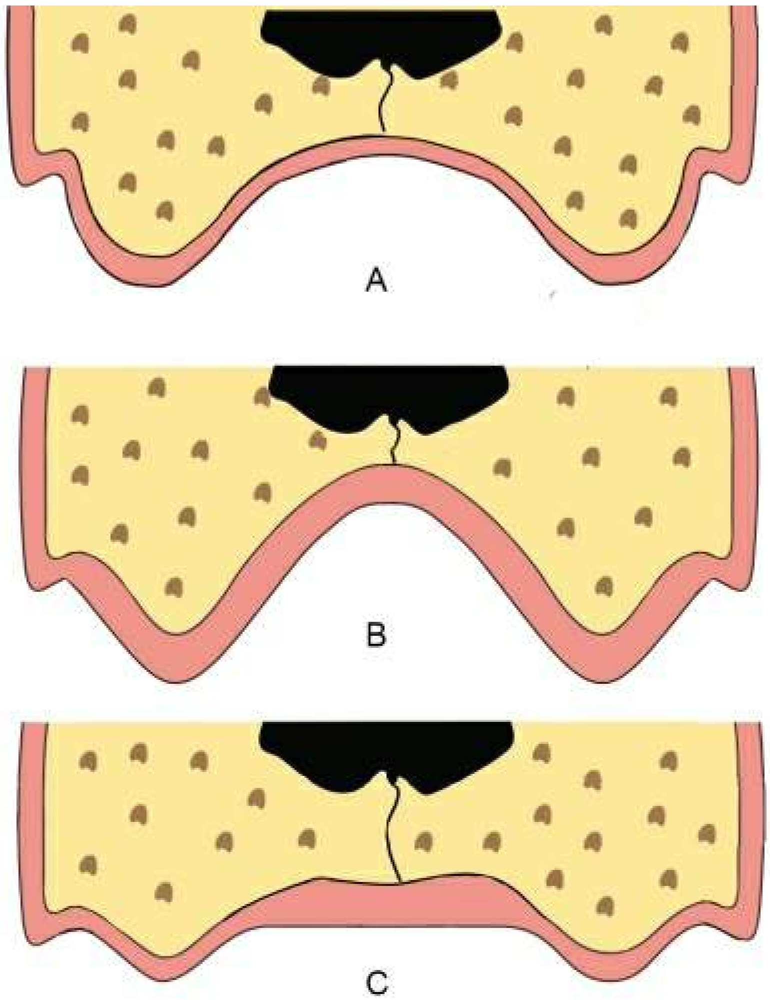


FIGURE 2.7 Hard palate. **(A)** U-shaped, **(B)** V-shaped and **(C)** Flat.

Soft palate

Based on the degree of flexure that the soft palate makes with the hard palate and the width of the palatal seal area, the soft palate configurations may be classified as:

- Class I: Almost horizontal with little movement making angle of less than 10° with hard palate; most favourable, as it allows best tissue coverage (more than 5 mm) and development of a wide posterior palatal seal.

- Class II: Makes a 45° angle with the hard palate. Tissue coverage is less than class I (3–5 mm).

- Class III: Makes a 70° angle with the hard palate; least favourable, as it allows least tissue coverage (less than 3 mm); usually associated with V-shaped palate (Fig. 2.8).

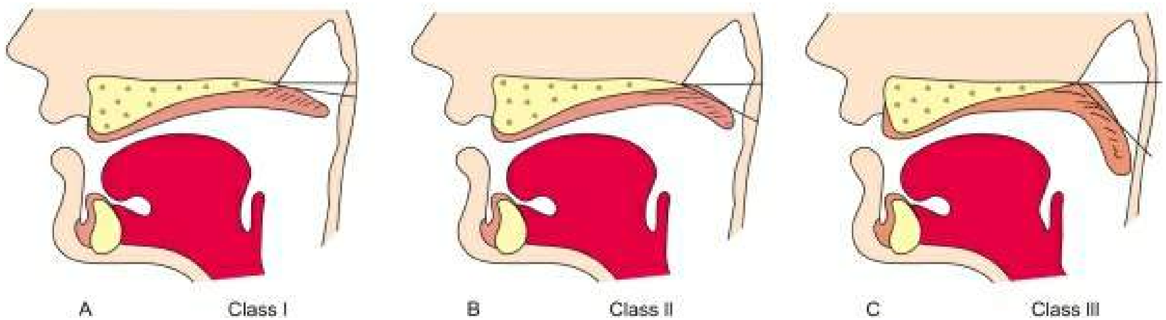


FIGURE 2.8 Classification of soft palate. **(A)** Less than 10 Degree movement, **(B)** 45 Degree movement and **(C)** 70° Degree movement.

Palatal sensitivity or gag reflex

- Gagging is a normal defence mechanism to prevent foreign objects from entering the trachea.

- An exaggerated gag reflex can compromise prosthodontic procedures like impression making.

- The cause of this can be systemic, psychological, physiologic and iatrogenic. The management of such patients may be clinical, psychological or pharmacological.

- House classified palatal sensitivity as:

○ Class I: Normal

○ Class II: Hyposensitive

○ Class III: Hypersensitive

Lateral throat form

The retromolar space can be partially or totally obliterated by tongue movement. This area is critical for lingual seal and lateral stability.

Neil classified lateral throat form (Fig. 2.9) according to the extent of anterior movement of retromylohyoid curtain as tongue is extended anteriorly. Checked by placing a finger in the area.

- Class I - Deep - Change in configuration, places heavy pressure on finger
- Class II - Moderate - Any position in between I & III
- Class III - Shallow - Minimal pressure

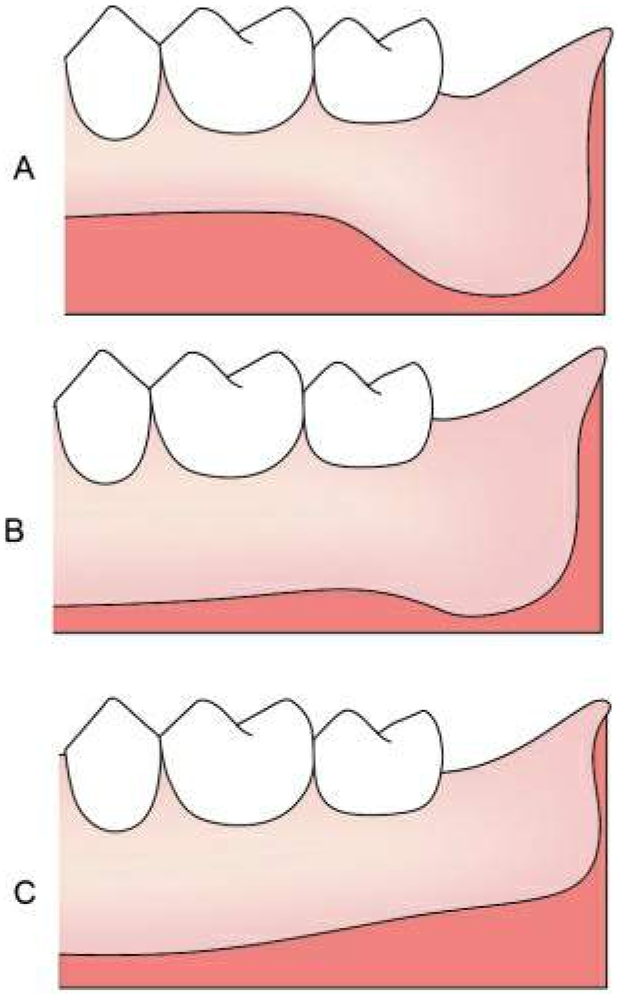


FIGURE 2.9 Classification of lateral throat form (lingual view). **(A)** Deep, **(B)** moderate and **(C)** shallow.

Tongue

Size

The size of the tongue may be normal, enlarged or small.

- If the patient has been without teeth for a long time, the tongue can become enlarged, which causes tongue biting, compromises impression making and also leads to denture instability. Small tongue compromises a lingual seal.

Position

Tongue movement, muscular coordination and position control the dentures during speech, mastication and deglutition.

- Wright has classified tongue positions as:

  - Class I: Tongue lies on the floor of the mouth with the tip forwards and slightly below the incisal edges of the mandibular anterior teeth.
  - Class II: Tongue is flattened and broadened but the tip is in normal position.
  - Class III: Tongue is retracted and depressed into the floor of the mouth with the tip curled upwards, downwards or assimilated into the body of the tongue (Fig. 2.10A–C).

- Class I position has the best prognosis because the floor of the mouth will be high enough to cover the lingual flange of the denture producing border seal. Class II and class III are unfavourable, as the level of the floor of the mouth drops and does not provide adequate seal.

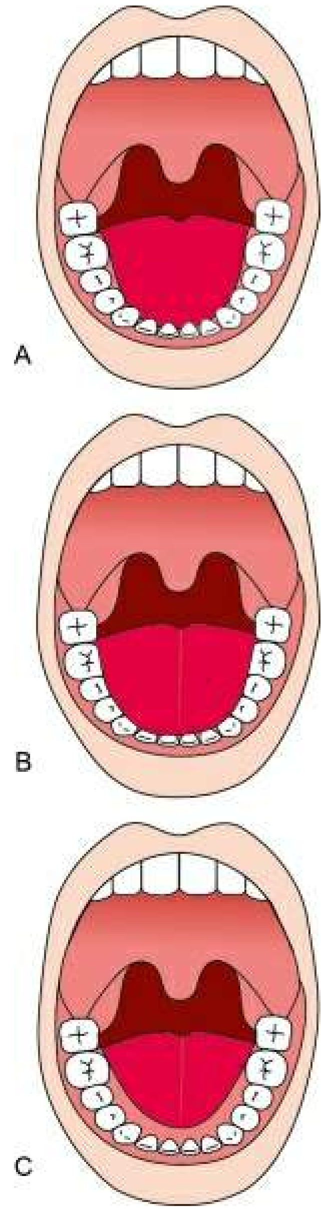


FIGURE 2.10 **(A)** Class I—tongue position. **(B)** Class II—tongue position. **(C)** Class III—tongue position.

Tori

These are bony prominences which may be present in the palate or lingual alveolar ridge.

Torus has an extremely thin mucous covering which can be traumatized during impression making and by the denture. Adequate relief must be planned. Tori can also act as a fulcrum to rock the denture and compromise denture stability.

Surgical removal is not indicated unless the tori are large.

Saliva

Major salivary glands orifices should be examined to ensure they are open.

The amount and consistency of saliva affects denture retention and construction.

Amount of saliva can be classified as:

- Class I: Normal
- Class II: Excessive
- Class III: Xerostomia

In xerostomia, denture will have poor retention and there is increased potential for soreness as lubricating action of saliva is lost. Excessive saliva will complicate impression making.

Consistency

It ranges from thin and serous to thick and ropy. Thick ropy saliva prevents intimate contact between the denture and the tissues and results in dentures.

Radiographic examination

- If some teeth are remaining, periapical and panoramic radiographs are essential to plan the treatment for immediate dentures, single complete dentures and overdentures.
- Panoramic radiographs are necessary for the completely edentulous patients. The aim is to screen the edentulous jaws for any pathology and determine the amount of ridge resorption.
- The screening gives information about the defects in jaw structure,

root fragments, unerupted teeth or retained roots, foreign bodies, sclerosis, tumours and cysts and TMJ disorders.

- Amount of bone resorption can be assessed using the method described by Wical and Swoope. According to this, the original alveolar ridge crest height is three times the distance from the inferior border of the mandible to the inferior margin of the mental foramen. The amount of bone resorption is classified as:

○ Class I: Mild resorption—loss of one-third of vertical ridge height.

○ Class II: Moderate resorption—loss of one-third to two-third of vertical height.

○ Class III: Severe resorption—greater than two-third loss (Fig. 2.11).

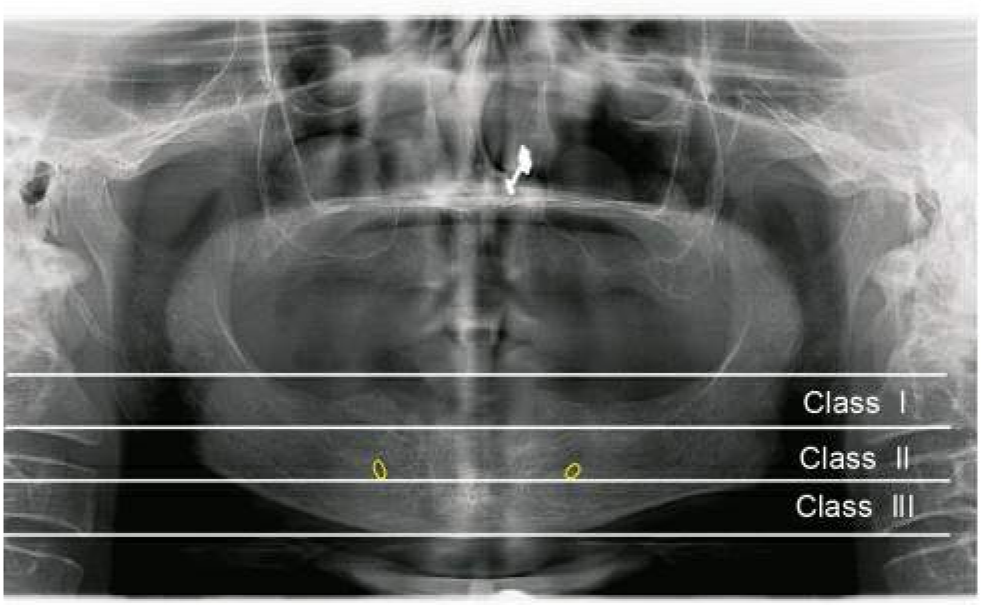


FIGURE 2.11 Classification of bone resorption. Class I—

third resorption class II—two-third resorption class III—more than two-third resorption.

Treatment planning

Treatment planning is the process of matching possible treatment options with patient needs and systematically arranging the treatment in order of priority but in keeping with a logical or technically necessary sequence (Zarb and Bolender *Prosthodontic Treatment for Edentulous Patients*, 12th edn).

It requires a wide knowledge of treatment possibilities, an idea of patient needs as determined by a thorough diagnosis, while taking into account prognosis, patient health, attitude and financial capability.

It will involve two processes:

Mouth preparation

Mouth preparation involves:

1. Elimination of infection

2. Elimination of pathology

3. Conditioning of tissues

4. Nutritional counselling

5. Preprosthetic surgery.

It is discussed in detail in Chapter 3.

Prosthodontic treatment

Patients with some teeth remaining:

1. Interim removable partial dentures (Chapter 30, RPD Section)

2. Immediate dentures (discussed in Chapter 17)

3. Single complete denture (discussed in Chapter 16)

4. Overdenture (discussed in Chapter 48).

Completely edentulous patient:

1. Conventional CD

2. Implant supported CD—fixed, removable (discussed in Chapter 49).

Prosthodontic diagnostic index for complete edentulism

It was developed by American College of Prosthodontics. This system classifies edentulous patient's treatment complexity using four diagnostic criteria:

- Mandibular bone height
- Maxillomandibular relationship
- Maxillary residual ridge morphology
- Muscle attachments

These four criteria identify patients as:

- Class I (ideal or minimally compromised)
- Class II (moderately compromised)
- Class III (substantially compromised)
- Class IV (severely compromised)

PDI for edentulous class I patient

A patient who presents ideal or minimally compromised complete edentulism and who can be treated by conventional prosthodontic techniques.

The class I patient exhibits:

- A residual mandibular bone height of at least 21 mm measured at the area of least vertical bone height.
- A maxillomandibular relationship permitting normal tooth articulation and an ideal ridge relationship.
- A maxillary ridge morphology that resists horizontal and vertical movements of denture base.
- Muscle attachment locations conducive to the stability and retention.

PDI for edentulous class II patient

A patient who presents moderately compromised edentulism and continued physical degradation of the denture supporting anatomy. The class II patient exhibits:

- A residual mandibular bone height of 16–20 mm measured at the area of least vertical bone height.
- A maxillomandibular relationship permitting normal tooth articulation and an appropriate ridge relationship.
- A maxillary residual ridge morphology that resists horizontal and vertical movements of the denture base.
- Muscle attachment that exerts limited compromise on denture base stability and retention.

PDI for edentulous class III patient

A patient who presents substantially compromised complete edentulism and exhibits:

- Limited interarch space.

- A residual mandibular bone height of 11–15 mm measured at the area of least vertical bone height.
- An Angle class I, II or III maxillomandibular relationship.
- Muscle attachment that results in compromised denture base stability and retention.
- Maxillary residual ridge morphology providing minimal resistance to movement of the denture base.

PDI for edentulous class IV patient

A patient who presents the most debilitated form of complete edentulism where surgical reconstruction is usually indicated, and specialized prosthodontic techniques are required to achieve an acceptable outcome.

The class IV patient exhibits:

- Residual mandibular bone height of 10 mm or less.
- An Angle class I, II or III maxillomandibular relationship.
- A maxillary residual ridge morphology providing no resistance to movement of denture base.
- Muscle attachment that significantly compromises denture base stability and retention.

Complete denture—case sheet

I. General information:

Name :...

Age :...

Sex :...

Occupation :...

Address :...

....

....

Habits: Pan-chewing/smoking/parafunctional/others

Nutritional history: Adequate/malnourished

II. History:

1. Medical history:

Disease	Tick if present
Debilitating diseases—diabetes	
TB	
Blood dyscrasias	
Diseases of joints	
Cardiovascular	
Neurological	
Oral tumours and malignancies	
Epilepsy	
Skin diseases	
Menopause	

Medications:

Name of medication	Purpose

2. Dental history:

i. Chief complaint ....

ii. Patient's expectations...

iii. Past dental history ....

a. Reason for loss of teeth

Maxillary: 1. Caries
2. Periodontal
3. Congenital
4. Others

Mandibular : 1. Caries
2. Periodontal
3. Congenital
4. Others

b. Sequence of loss of teeth/duration for which the teeth have been lost:

Maxillary : ☐ Anterior ☐ Posterior

Mandibular : ☐ Anterior ☐ Posterior

c. Duration of complete edentulousness

d. Previous dentures

Maxillary: Number ....Type: ...... C.D ....

Mandibular: Number ......Type: ...... C.D ......

iv. Current denture evaluation

Extension ....

Vertical dimension ....

Centric ....

Occlusion ....

Artificial teeth ....

Retention ....

Stability ....

Aesthetics ....

Denture hygiene ....

Patients comments on present denture

Comfort ....

Chewing efficiency ....

Aesthetics ....

Speech ....

Soreness ....

Others ....

v. Pre-extraction records

Diagnostic casts ....

Radiographs ....

Photographs ....

III. **Examination:**

1. **Extraoral examination:**

i. Facial examination:

Facial form:
☐ Square ☐ Tapering
☐ Square-tapering ☐ Ovoid

Face profile
☐ Straight ☐ Retrognathic (Convex) ☐ Prognathic (Concave)

Colour of face, hair, eyes:

ii. Lip examination:

Lip health: ☐ Normal ☐ Abnormal

Lip support: ☐ Supported ☐ Unsupported

Lip thickness: ☐ Normal ☐ Thick-thin

Lip length:
☐ Normal
☐ Long
☐ Short

iii. Temporomandibular joint

☐ Tenderness ☐ Discomfort ☐ None

Mandibular movement

☐ Normal

☐ Impaired

iv. Muscular examination:

☐ Class I ☐ Class II ☐ Class III

2. **Intraoral examination**

i. Mucosa

Buccal:
☐ Normal ☐ Irritated ☐ Pathological

Floor of the mouth:
☐ Normal ☐ Irritated ☐ Pathological

Palate:

Hard
☐ Normal ☐ Irritated ☐ Pathological

Soft
☐ Normal ☐ Irritated ☐ Pathological

ii Residual alveolar ridge:

Arch size: Maxilla
☐ Small ☐ Medium ☐ Large

Mandible
☐ Small ☐ Medium ☐ Large

Arch form:
☐ Square ☐ Tapering ☐ Ovoid

Contour:
Order ☐ 1 ☐ II ☐ III ☐ IV ☐ V ☐ VI

Ridge relation:
Interridge distance:

☐ Normal ☐ Excessive ☐ Reduced

Parallelism:

☐ Parallel ☐ Non-parallel

Positional relation:

☐ Class I ☐ Class II (Retrognathic) ☐ Class III (Prognathic)

Flabby tissue: ☐ Present ☐ Absent

Hyperplastic tissue: ☐ Present ☐ Absent

Bony undercuts:

Anterior maxillary ridge:
☐ Present ☐ Absent

Maxillary tuberosity: ☐ Present ☐ Absent,
if present type: ☐ Bulbous ☐ Pendulous
☐ Unilateral ☐ Bilateral

Prominent mylohyoid ridge:

☐ Present ☐ Absent

Frenal attachments:

Labial: ☐ Normal ☐ High

Buccal: ☐ Normal ☐ High

Lingua: ☐ Normal ☐ High

Floor of mouth:

☐ Normal ☐ Raised

iii. Palate:

Hard Palate: ☐ U-shaped ☐ V-shaped
☐ Flat

Soft Palate: ☐ Class I ☐ Class II ☐ Class III

Gag relex: ☐ Normal ☐ Exaggerated

iv. Lateral throat form: ☐ Class I ☐ Class II
☐ Class III

v. Tongue
☐ Class I ☐ Class II ☐ Class III

vi. Tori:
Palatal: ☐ Present ☐ Absent
Lingual: ☐ Present ☐ Absent

vii. Saliva:

☐ Normal excessive reduced

☐ Thin, serous

☐ Thick, ropy

3. **Radiographic examination:**

i. Resorption:
☐ Mild ☐ Moderate ☐ Severe

ii. Evaluation remarks:

4. **Patient evaluation:**

Trait	Remark
Gait	
Age	
Facial expression	
Complexion	
Speech	
Breathing pattern	
Personality	
Mental attitude	

Diagnosis:

Treatment plan:

Adjunctive:

Prosthodontic:

Definitive diagnosis

Prognosis

☐ Favourable ☐ Unfavourable

SUMMARY

Diagnosis and treatment planning are the most important parameters in the successful management of a patient. A major reason for prosthetic failure is the inadequate and inappropriate diagnosis and treatment planning. Therefore, care must be taken to elicit and record an informative case history to understand the patients' needs and expectations for a successful outcome.

CHAPTER 3

Mouth preparation

CHAPTER CONTENTS

Introduction

The oral tissues must be in a state of optimum health before commencing the fabrication of complete dentures. The denture foundation must be prepared to achieve all the functions of a complete denture. Patients who have been wearing complete dentures for a long time (old denture wearers) may undergo a number of adverse changes in the denture-bearing areas (sequelae of wearing complete denture). It is important to understand the nature of these changes to initiate effective treatment. Many dentures fail because impressions and jaw relations are made under distorted tissues. Even in new complete denture wearers, the denture foundation must be improved to obtain optimum comfort and function for the dentures. The possible sequelae of using complete dentures, and various procedures involved in preparing the mouth and restoring it to optimum health prior to complete denture fabrication are discussed in this chapter.

Sequelae of wearing complete dentures

Sequelae of complete denture wearing may be categorized as follows.

Direct sequelae

Mucosal reactions

Denture stomatitis

- It is a pathological reaction of the denture-bearing mucosa.
- It is also known as denture-induced stomatitis, denture sore mouth, inflammatory papillary hyperplasia or chronic atrophic candidiasis.

Classification (newton)

- Type 1: Localized simple inflammation or pin-point hyperaemia.
- Type 2: Erythematous or generalized simple type presenting a more diffuse erythema involving a part or the entire denture-covered mucosa (Fig. 3.1).
- Type 3: Granular type (inflammatory papillary hyperplasia) commonly involving the central part of the hard palate and the alveolar ridges. It is often seen associated with type 1 or type 2 (Fig. 3.2).

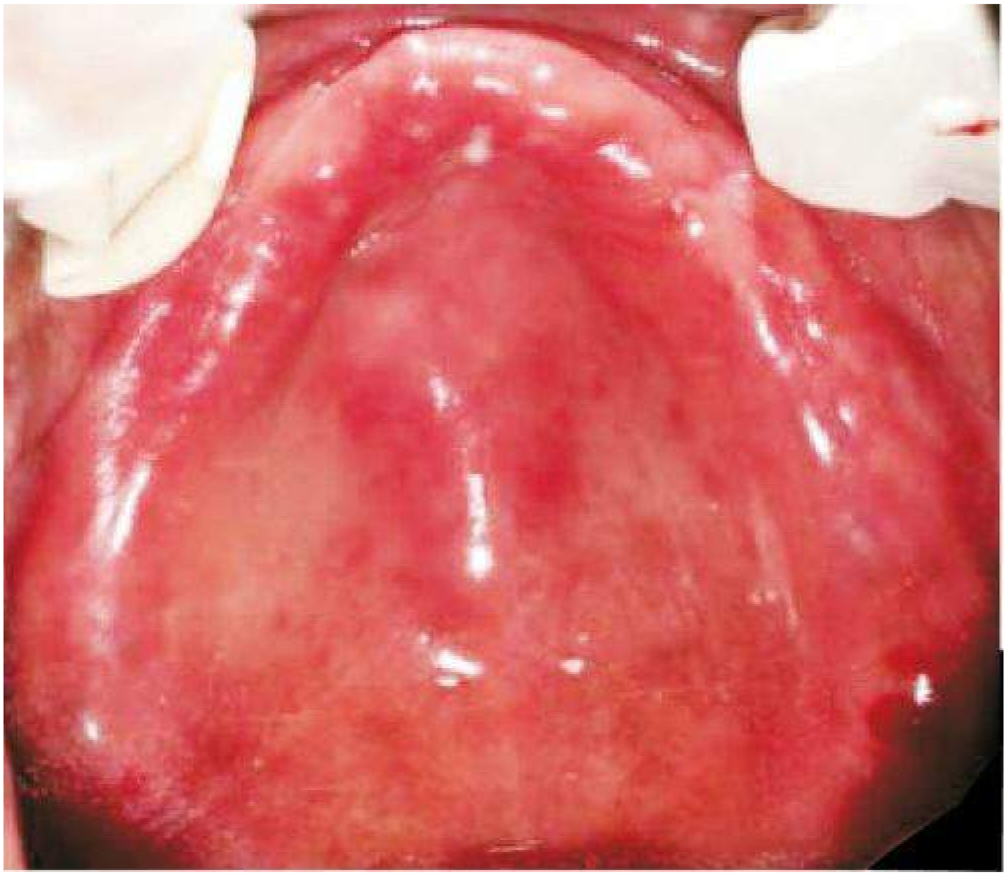


FIGURE 3.1 Type 2 denture stomatitis.

FIGURE 3.2 Type 3 denture stomatitis.

Type 1 is often trauma induced, whereas types 2 and 3 are associated with denture plaque.

Aetiology

- The main cause is the presence of denture in oral cavity and is associated with patients wearing dentures day and night.
- Denture plaque and trauma reduce the degree of keratinization and barrier function of the epithelium, allowing easy penetration of fungal and bacterial antigens.
- *Candida albicans* is most often associated with denture stomatitis along with the other causative factors. It is then termed as *Candida-associated denture stomatitis. The predisposing systemic and local factors for this type of denture stomatitis are listed in* Table 3.1.

Table 3.1

Predisposing factors for Candida-associated denture stomatitis

Systemic factors	Local factors
Old age	Dentures
Diabetes mellitus	Xerostomia
Nutritional deficiencies – iron, folate or vitamin B_{12}	High-carbohydrate diet
Malignancies – acute leukaemia, agranulocytosis	Broad-spectrum antibiotics
Immunosuppression due to disease or use of steroids	Smoking

Diagnosis

- The diagnosis of *Candida-associated denture stomatitis* is confirmed by the presence of mycelia or pseudohyphae in a direct smear and/or the isolation of *Candida* in high numbers from the lesion (>50 colonies).

Prevention and management

This involves the following measures:

- **Initiation of effective oral and denture hygiene**
  - The patient is instructed to scrub and clean dentures with soap after every meal, and massage the mucosa in contact with dentures with soft toothbrush.
  - The patient is advised against wearing the denture at night and the dentures should be soaked overnight in an antiseptic solution such as 0.2%–2% chlorhexidine or dilute sodium hypochlorite (10 drops of household bleach in a denture cup or container filled with tap water). If the denture base contains metal, the patient should avoid using hypochlorite because it causes metal to tarnish.

- Polishing of tissue surface of denture to facilitate cleaning.

- **Correction of ill-fitting dentures**

- Areas of denture causing trauma to the tissues are trimmed and polished.

- Generally rough areas on fitting surface are smoothed or relined with tissue conditioner.

- **Antifungal therapy**

Indicated when:

- Clinical diagnosis is confirmed by mycological examination.

- There is associated burning sensation from oral mucosa.

- Infection has spread to other parts of the oral cavity and pharynx.

- Patients are at increased risk of contracting systemic mycotic infections due to debilitating diseases, drugs or radiation therapy.

- Local therapy with nystatin, amphotericin B, miconazole or clotrimazole is preferred to systemic therapy with ketoconazole or fluconazole due to frequent drug resistance.

To prevent recurrence:

○ Antifungal treatment should continue for 4 weeks.

○ Patients are instructed to remove dentures during sucking when lozenges are prescribed.

○ Patient should follow meticulous oral and denture hygiene.

- **Surgical treatment**

○ Indicated in type 3 denture stomatitis to eliminate crypts and ensure effective mucosal hygiene. Cryosurgery is preferred.

Denture irritation hyperplasia (epulis fissuratum) (fig. 3.3)

This tissue hyperplasia of the mucosa is a consequence of trauma of ill-fitting dentures and occurs along the denture borders. It is also known as inflammatory fibrous hyperplasia, denture injury tumour or denture epulis.

FIGURE 3.3 Epulis fissuratum.

Aetiology

Chronic injury due to unstable dentures or thin overextended denture flanges.

Clinical features

- Proliferation takes place quickly but symptoms may be mild.
- Appears as single or multiple folds of hyperplastic tissue in the alveolar vestibule (Fig. 3.3).
- Inflammation varies from mild to severe ulceration with deep fissures. The severe form may mimic a neoplasm.
- The anterior portion of the jaw is more commonly affected than the posterior areas.

Management

- Surgical removal of lesion is followed by the adjustment of old dentures or replacement of denture. Recurrence is unlikely.

Fibroepithelial polyp

Fibroepithelial polyp is a less common form of fibrous hyperplasia. It is also known as leaf-like denture fibroma.

Aetiology

It occurs due to irritation or trauma of the maxillary denture.

Clinical examination

It appears as a flattened pink mass that is attached to the palate by a peduncle. It sits in a cupped out depression and is easily lifted up with a probe. They usually appear as single lesions, but may occasionally present as multiple lesions. They are a few millimetres in size.

Management

Treatment comprises surgical excision of the lesion and relining or remaking the ill-fitting denture.

Flabby ridge

- This is a mobile or extremely resilient alveolar ridge, which occurs due to the replacement of bone by fibrous tissue (Fig. 3.4).

- It is commonly seen in the anterior part of the maxilla, especially when there are remaining anterior teeth in the mandible.

- They provide poor support to the denture.

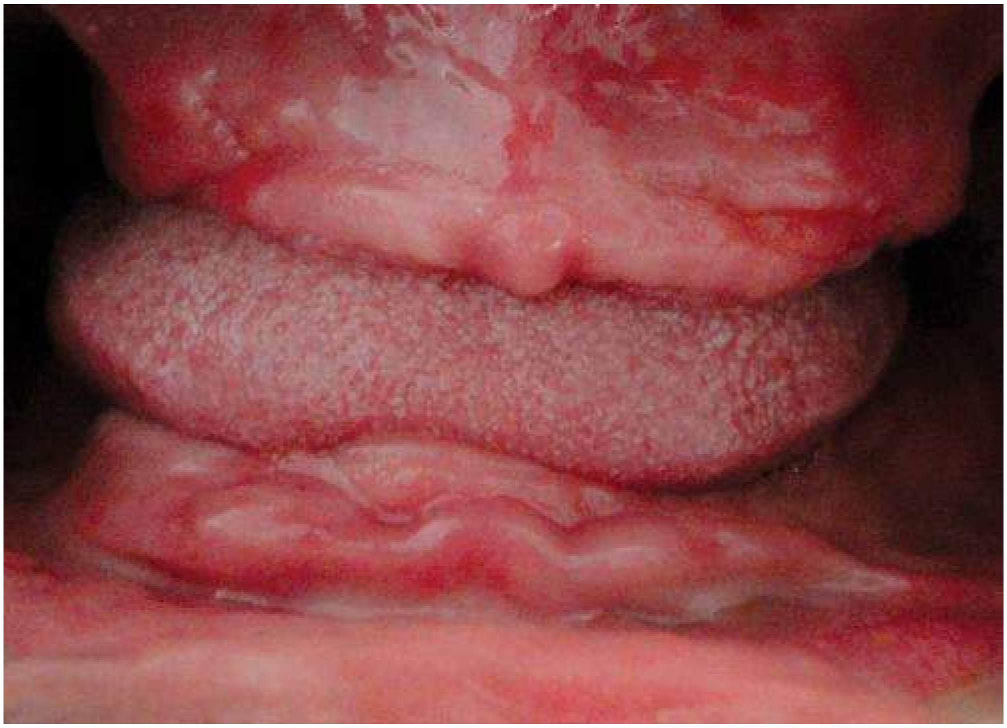


FIGURE 3.4 Flabby ridge.

Aetiology

Excessive load on the residual ridge caused by unstable occlusal forces from the remaining natural teeth.

Features

Histological examination shows marked fibrosis, inflammation and resorption of underlying bone.

Management

Though surgical removal is an option to improve stability and reduce ridge resorption, when severe resorption already exists, removing the flabby tissue will completely eliminate the vestibular area. Here, preserving the tissue will provide retention to the denture. Special impression techniques are indicated for flabby ridges (discussed in Chapter 4, p. 77).

Flabby ridge as a constituent of combination syndrome *(Kelly,*

1972) (**fig. 3.5**)

Definition

The characteristic features that occur when an edentulous maxilla is opposed by natural mandibular anterior teeth, including loss of bone from the anterior portion of the maxillary ridge, overgrowth of the tuberosities, papillary hyperplasia of the hard palate's mucosa, extrusion of the lower anterior teeth, and loss of alveolar bone and ridge height beneath the mandibular removable dental prosthesis bases – also called anterior hyperfunction syndrome (GPT8) (Figs 3.5 and 3.6).

FIGURE 3.5 Combination syndrome.

The cause for this problem is usually inadequate posterior occlusion (Fig. 3.6).

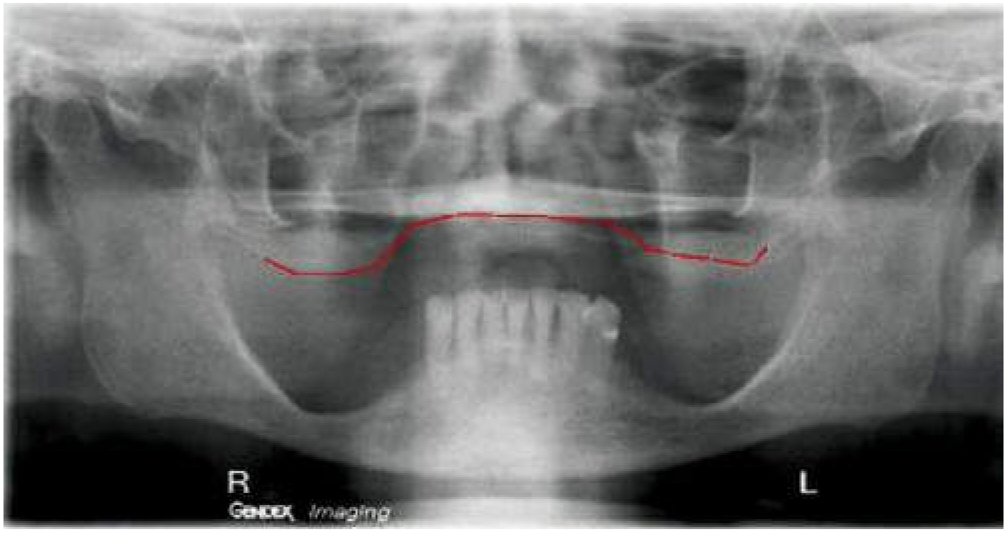


FIGURE 3.6 OPG showing features of combination syndrome – overhanging maxillary tuberosity, extensive mandibular ridge resorption, extrusion of lower anterior teeth.

Traumatic ulcers

Traumatic ulcers or sore spots are a breach in the surface epithelium (Fig. 3.7). They develop within 1–2 days after placement of new dentures.

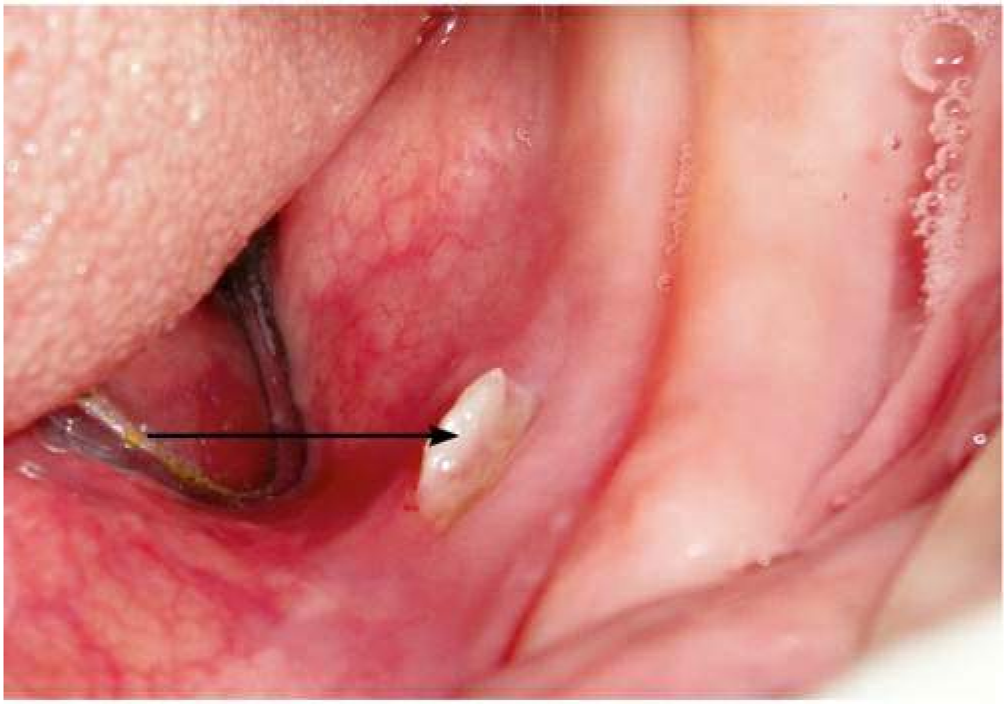


FIGURE 3.7 Lingual border overextension resulting in traumatic ulcer.

Aetiology

It is caused due to overextended denture flanges or unbalanced occlusion. Predisposing factors are conditions that reduce the resistance of the mucosa to mechanical irritation – diabetes, nutritional deficiencies, radiation therapy or xerostomia.

Clinical features

The ulcers are small, painful areas covered by a grey necrotic membrane and surrounded by an inflammatory halo with firm, elevated borders.

Management

Following correction of the offending denture problem, the ulcers will heal spontaneously in a few days. Symptomatic relief is provided with anaesthetic gels.

Oral cancer

Oral carcinoma associated with chronic irritation from dentures has been reported (Fig. 3.8).

FIGURE 3.8 Oral cancer.

Predisposing factors

Use of heavy alcohol and tobacco, uneducated and low socioeconomic status, which lead to poor dental health.

Prevention

- Any traumatic ulcer that does not heal following correction of the denture should be checked for malignancy.
- Denture patients should be recalled every 6 months for a clinical examination.

Burning mouth syndrome

Definition

Burning pain in the tongue or other oral mucous membrane associated with normal signs and laboratory findings lasting at least 4–6 months (International Association for the Study of Pain).

It is also known as stomatopyrosis, glossopyrosis, stomatodynia and glossodynia.

In this condition, the oral mucosa appears clinically healthy. It must be differentiated from 'burning mouth sensations' where the oral mucosa is inflamed due to mechanical denture irritation.

The symptoms often appear for the first time in association with the placement of new dentures. The symptoms may be so severe that the dentures cannot be tolerated for more than a few hours.

Aetiology

Burning mouth syndrome (BMS) has been associated with several causative factors which can be broadly classified under local, systemic and psychogenic factors.

- **Local factors**
  - Undue friction on mucosa from dentures
  - Instability of dentures
  - Prolonged period of masticatory muscle activity
  - Parafunctional tongue activity
  - Myofascial pain
  - Infection (oral candidiasis) and allergic reactions may mimic BMS, but are more related to burning mouth sensations.

- **Systemic factors**
  - Menopause – most common
  - Vitamin (B_{12}) and iron deficiencies
  - Xerostomia
  - Diabetes
  - Medication
  - Parkinson disease
- **Psychogenic factors**
  - Depression
  - Anxiety

Clinical features

- Female predilection specifically postmenopausal women.
- Symptoms appear for the first time after placement of new dentures.
- Gradual onset, pain begins in the morning and increases through the course of the day.
- Patients complain of a burning sensation associated with a feeling of dry mouth and persistent altered taste sensation. Burning sensations from supporting tissues or tongue are also common complaints.

- Other symptoms include headaches, decreased libido, insomnia, irritability and depression.
- Aggravating factors are tension, fatigue and hot or spicy foods while sleeping, distraction and eating reduce pain.

Management

- The symptoms of the patient should not be ignored and denture should be checked thoroughly for any local causes, and corrected.
- The patients need to be counselled to help them understand that their problems are benign and that the dentures are not the cause of their psychiatric disorders, with subsequent elimination of fears.
- Any comprehensive treatment may need the help of a psychiatrist.

Gagging or retching

- The gag reflex is a normal, healthy defence mechanism, which prevents foreign bodies from entering the trachea.
- It can be triggered by tactile stimulation of the soft palate, posterior part of the tongue and the fauces. Sight, taste, noise and psychological factors can also produce gagging.
- In sensitive patients, gagging is common immediately after placement of new dentures, but disappears in a few days as the patient adapts to them. Some patients start to retch weeks or months after the dentures have been satisfactorily fitted. Then the cause needs to be identified and corrected.

Aetiology

- Overextended denture borders (posterior part of maxillary denture and distolingual part of mandibular denture).

- Unstable occlusal conditions.
- Increased vertical dimension of occlusion.
- Restricted tongue space.
- Gastrointestinal tract disorders, adenoids or discharge from upper respiratory tract.
- Alcoholism and smoking.

Management

The cause has to be identified and corrected.

Residual ridge resorption

- Though residual ridge resorption (RRR) may be inevitable due to 'disuse atrophy', it can also be caused due to excessive force transmitted through dentures because of continuous denture wearing and unstable occlusal conditions.
- The various aspects of RRR are discussed in Chapter 1 of this section.

Altered taste

- A condition characterized by alterations of the sense of taste may range from mild to severe, including gross distortions of taste quality.

Aetiology

- Covering of taste buds in the hard palate by the dentures.
- Ill-fitting dentures – cause patients to choose foods which are easier to masticate. However, these foods may not be of proper nutritional

value. Decrease in the nutrients greatly affects the quality and rate of flow of saliva and saliva is required to provide an environment for optimal functioning of the taste buds.

- Poor oral and denture hygiene – debris is constantly covering the taste buds.

- Dental diseases, olfactory deficits, neurological deficits and other systemic disorders.

Management

The patient must be advised to maintain good oral as well as denture hygiene and any defect in the denture is corrected.

Altered speech

Difficulty is to be expected when the complete dentures are first worn. However, the adaptability of the patient is sufficient to attain adequate speech patterns.

Temporary alterations may be due to:

- Thickness of denture base covering the palate.

- Slightly altered tongue position.

- Copious salivary flow.

These difficulties can be overcome by asking the patient to practice speaking with the dentures by reading aloud.

Aetiology

Persistence of phonetic problems may be due to:

- An alteration of the position of the maxillary incisors and change in their palatal shape.

- Reduction in tongue space.

- Alteration of the occlusal plane.
- Defective palatal contour.
- Improper posterior extension of the dentures.

Management

Correction of offending problem, if possible, but most often a new set of dentures will have to be fabricated with a sound knowledge of the valving actions of speech and keeping in mind the principles of teeth arrangement.

Angular cheilitis

Angular cheilitis is a multifactorial disease affecting the commissure of the lips and is commonly seen in denture wearers (Fig. 3.9).

FIGURE 3.9 Angular cheilitis seen at the commissure of the lips.

It is also called perlèche when it is associated with nutritional deficiencies.

Aetiology

- Loss of vertical dimension or worn-out dentures – deep folds of skin are produced at the corners of the mouth. The skin becomes macerated and fissured, predisposing to infection – usually candidal or staphylococcal.
- Nutritional deficiencies such an iron deficiency, vitamin B.
- Other uncommon predisposing factors include AIDS, diabetes and neutropenia.

Clinical examination

- Deep fissures and cracks at the corners of the mouth that may be ulcerated. A superficial exudative crust may form.
- The fissures do not involve the mucosa on the inside of the mouth, but stop at the mucocutaneous junction.
- Associated burning sensation or dryness at the corners.

Management

- The primary cause should be treated first.
- The patient's vertical dimension should be restored.
- Antifungal agents and antibiotics can be given to treat the secondary infection.

Galvanism

- This is due to the presence of different types of dental materials (mostly metals) in the mouth which cause electrochemical corrosion. Bacterial plaque is also an important cofactor in the process.

- These galvanic currents may be a cause of BMS, oral lichen planus and altered taste perception.

Indirect sequelae of complete denture wearing

Atrophy of masticatory muscles

- Masticatory function depends on skeletal muscle force and coordination of oral functional movements by patient.

- In general, bite force decreases with age. A greater reduction has been demonstrated in complete denture patients, especially women. In fact, CD patients need seven times more chewing strokes than persons with natural dentition to achieve similar reduction in particle size.

- Retaining a few teeth to support overdentures and implant-supported dentures has improved the maximal occlusal force and masticatory efficiency of completely edentulous individuals.

Nutritional deficiencies

- Severe deficiencies are rare, except in hospitalized or chronically ill patients. In such patients, ill-fitting dentures, salivary gland hypofunction or altered taste perception may have a negative effect on the nutritional status and some improvement in nutritional intake can be expected following prosthodontic correction.

- In healthy individuals, there is no evidence that the nutritional intake is impaired in complete denture wearers or that the replacement of ill-fitting dentures with new ones will cause a major improvement in nutrition.

- Dietary counselling and mechanical preparation of food may be necessary to improve the nutritional status of the CD patients.

Mouth preparation

Mouth preparation involves the following procedures.

Elimination of infection

Infections arising from remaining carious teeth, periodontally weak teeth, ulcers and nonvital teeth should be eliminated. Fungal infections like candidiasis, viral infections like herpetic stomatitis and denture stomatitis must be treated prior to commencement of the treatment.

Elimination of pathology

Patients must be educated and informed about the danger involved if these lesions are left unattended. Tumours and cysts of the jaw should be treated or surgically excised.

Conditioning of tissues

Deformed tissues are allowed to return to normal by asking the patient to not wear the old dentures for some time and conditioning the tissues using soft liners (see Chapter 15).

Nutritional counselling

As already discussed, nutritional counselling is essential to prevent any nutritional deficiencies. This is more important for the patient whose metabolic and masticatory efficiency may be compromised.

Preprosthetic surgery

Definition

Surgical procedures designed to facilitate the fabrication of a prosthesis or to improve the prognosis of prosthodontic care (GPT8).

Classification

The conditions and procedures involving preprosthetic surgery can be classified as follows.

Conditions that prevent optimal prosthesis function

1. *Retained dentition*

- These are assessed through radiographic examination. A decision has to be made whether to retain or remove them.

- Generally, all retained roots and unerupted teeth are removed.

- Only those that are located deep within the bone, which are asymptomatic and removal would leave a large defect, are retained, but assessed regularly for any pathologies.

2. *Soft tissue abnormalities*

(i) Hypertrophic frenum

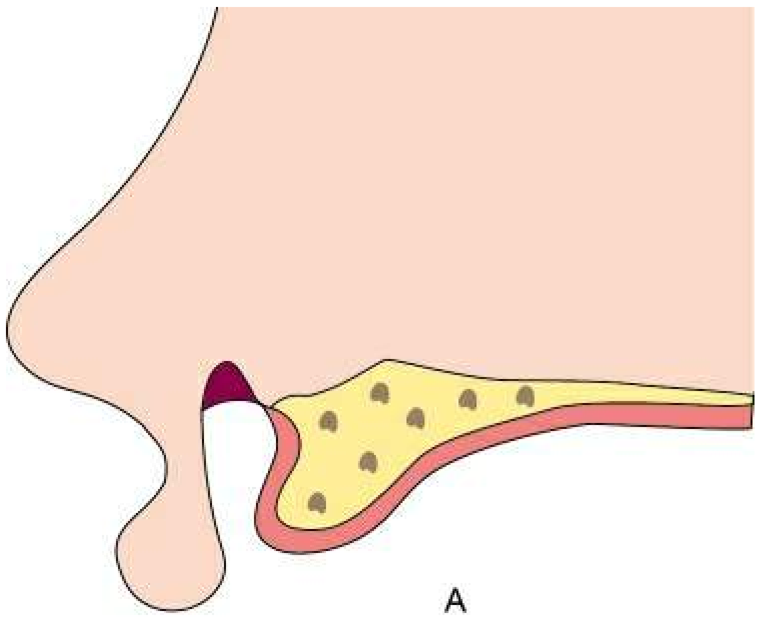
These are fibrous bands of tissue frequently attached superficial to the muscle attachments in mandible and maxilla.

- Hypertrophic maxillary labial frenum attached close to the ridge crest prevents ideal extension of denture borders and peripheral seal. They can also become prominent as a result of ridge resorption. Movement of the soft tissue adjacent to the frenum may also create discomfort and ulceration. Providing relief in the labial notch of denture can create loss of border seal and also midline fracture of denture. It needs surgical removal (Fig. 3.10).

- Hypertrophic lingual frenum can attach high on the residual ridge interfering with denture extension and stability. It can also attach high on the ventral surface of the tongue, restricting tongue movements, causing tongue-tie and speech impairment. In either case, surgical intervention is indicated (Fig. 3.11).

- Frenectomies can be performed before commencing prosthetic treatment or at the time of denture insertion when the new denture can act as a surgical template. The former is preferred.

- Prominent buccal frenum usually does not require any surgical correction because of its compressible and flaccid nature.



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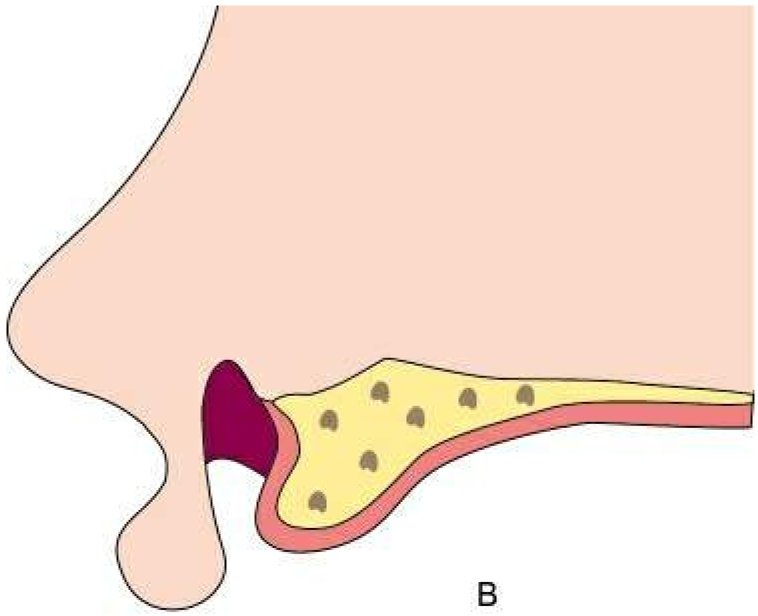
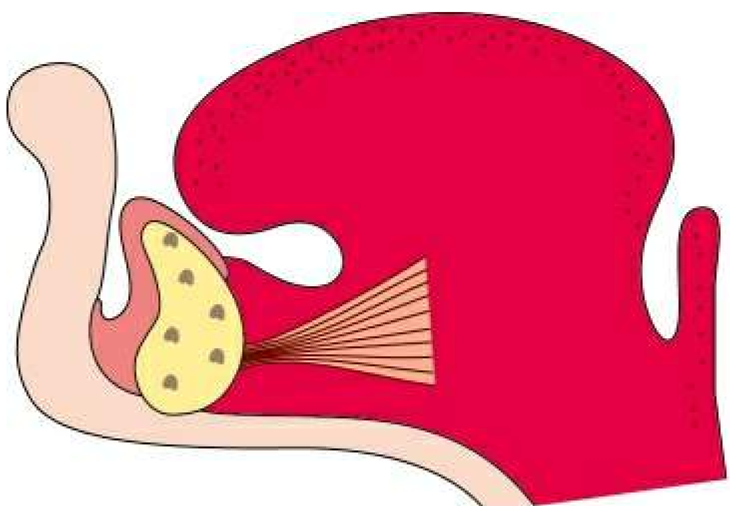
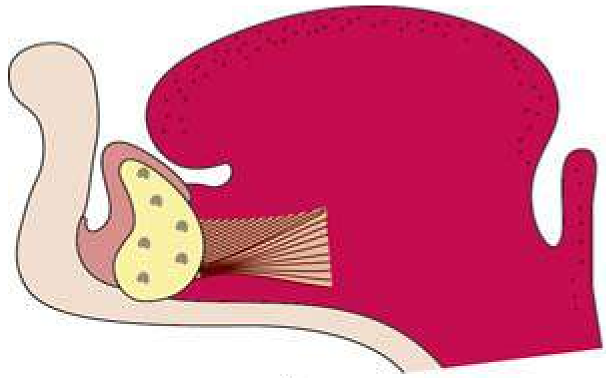


B

FIGURE 3.10 **(A)** Normal labial frenum. **(B)** Hypertrophic labial frenum resulting in frenum attached close to the crest.



A



B

FIGURE 3.11 **(A)** Normal lingual frenum. **(B)** Hypertrophic lingual frenum obliterating the lingual sulcus.

(II) Flabby tissue, inflammatory papillary hyperplasia (denture stomatitis), and denture irritation hyperplasia (epulis fissuratum)

These need to be surgically excised as indicated.

3. *Bony abnormalities*

(i) Extraction and alveoloplasty

- Irregularities of the alveolar ridge found either at the time of extraction (Fig. 3.12) or after healing (Fig. 3.13) require recontouring before final prosthetic construction.

- Alveoloplasty is the surgical smoothing and shaping of the alveolar ridge prior to denture placement.

FIGURE 3.12 Irregular alveolar ridge during extraction.

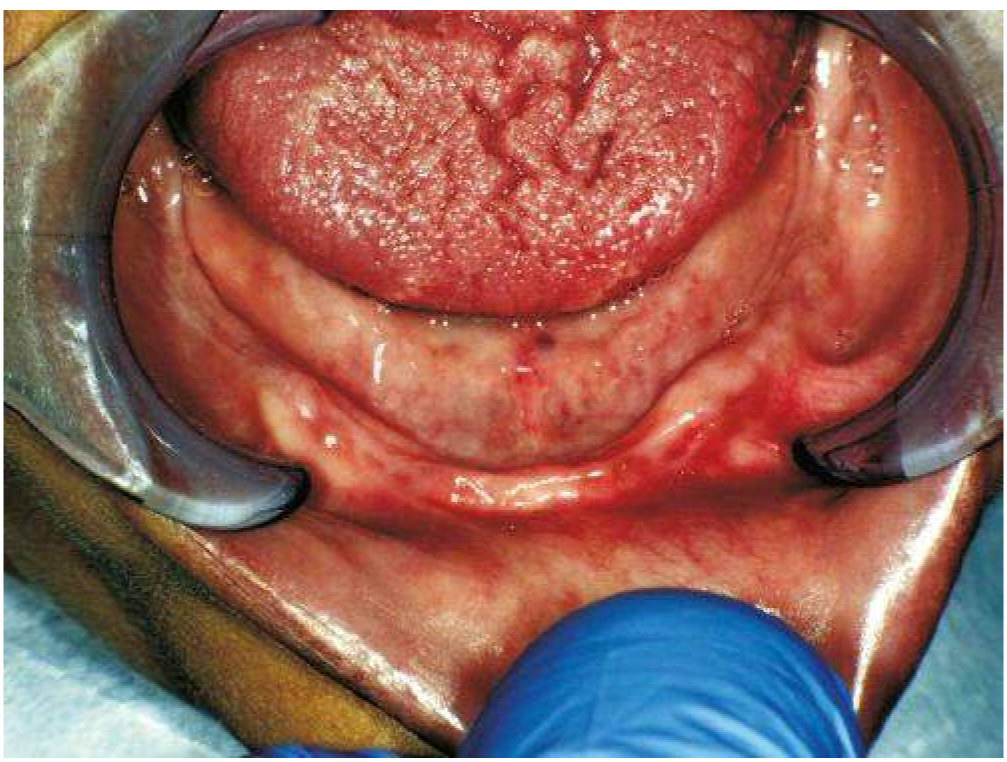


FIGURE 3.13 Irregular alveolar ridge postextraction.

(ii) Ridge undercuts

- Small undercuts from ridge crests and undercuts only in anterior labial region do not require any surgical intervention (Fig. 3.14A).
- If undercuts are present both anteriorly and posteriorly, reduction of posterior undercut is preferred.
- Bilateral undercuts need correction at least on one side (Fig. 3.14B).

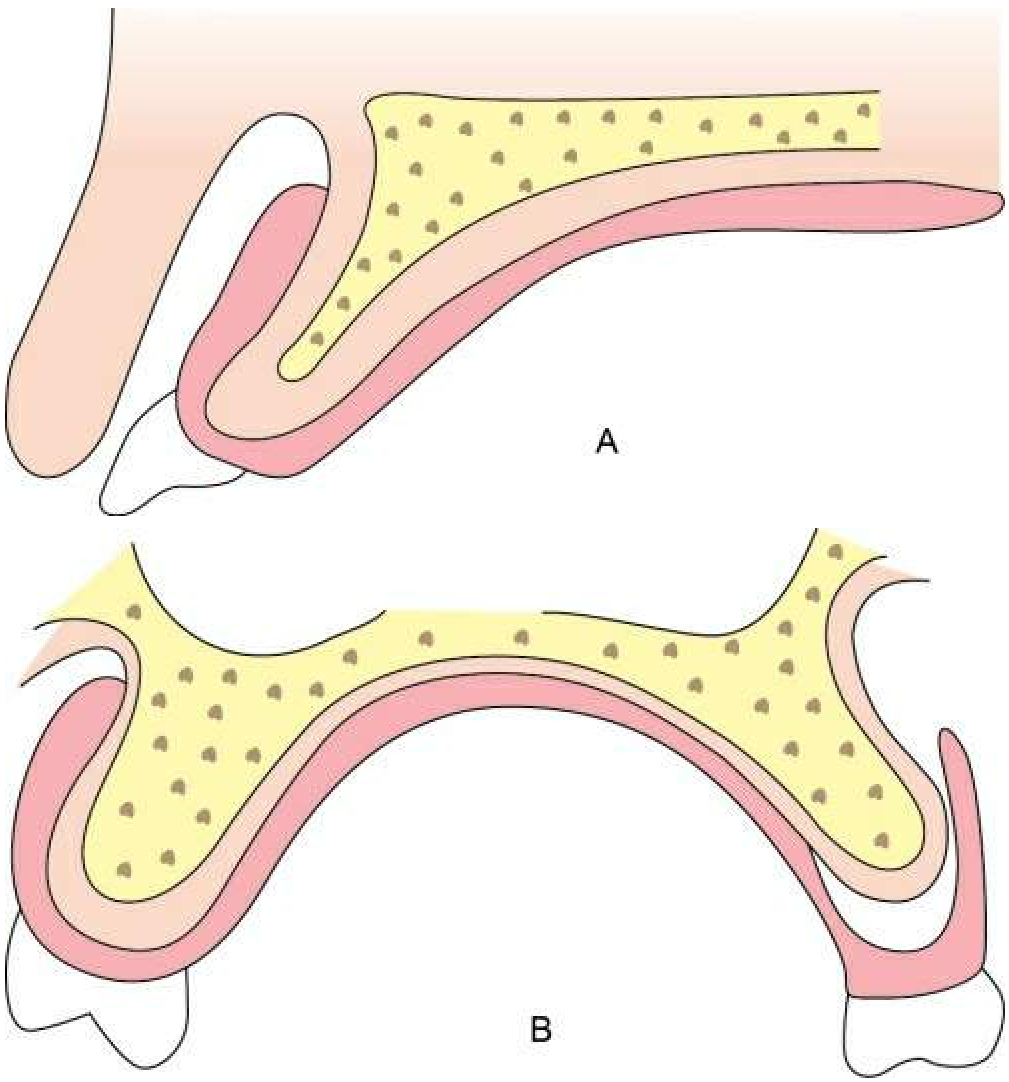


FIGURE 3.14 Ridge undercuts. **(A)** Undercut in anterior region can be tackled by changing the path of denture insertion. **(B)** Bilateral undercuts require surgical correction on

one side to enable comfortable denture insertion.

(iii) Prominent mylohyoid ridge

- In addition to the actual bony ridge, with its easily damaged thin mucosa covering, the muscular attachment in this area dislodges the denture. The sharp ridge produces pain in this area (Fig. 3.15).
- If so, surgical recontouring is done with bone files along with detachment of the posterior muscle insertion of mylohyoid muscle.

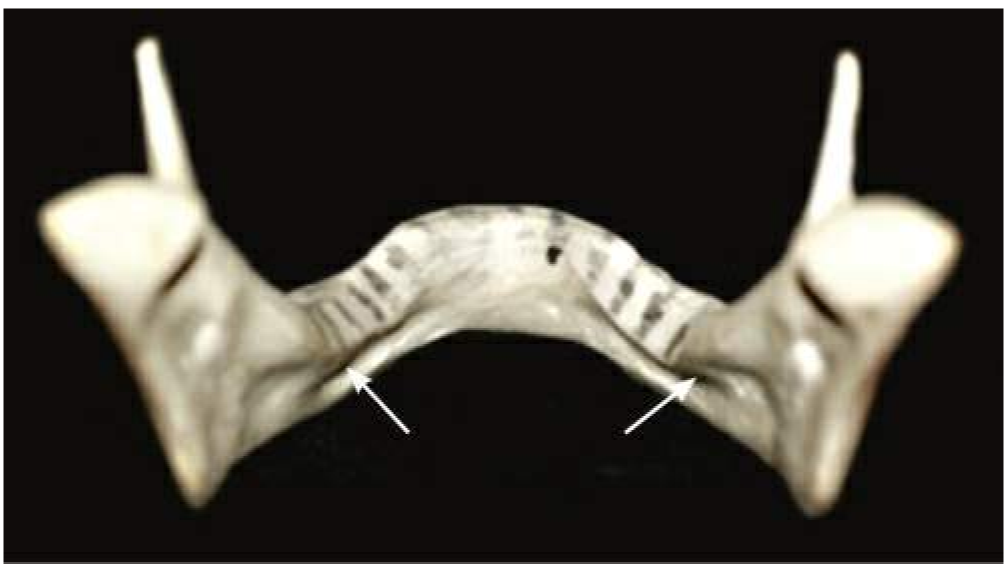


FIGURE 3.15 A mandible with prominent mylohyoid ridge.

(iv) Maxillary tuberosity interference

- Pendulous tuberosity with undercuts is encountered unilaterally or bilaterally. They interfere with interarch space, denture insertion and extension and mandibular movements. These require surgical correction if they interfere with the normal denture function (Fig. 3.16).
- Bilateral undercuts will require surgical recontouring at least

unilaterally.

- Maxillary sinus can expand into the tuberosity. Bone removal should be performed with caution guided by radiographs.

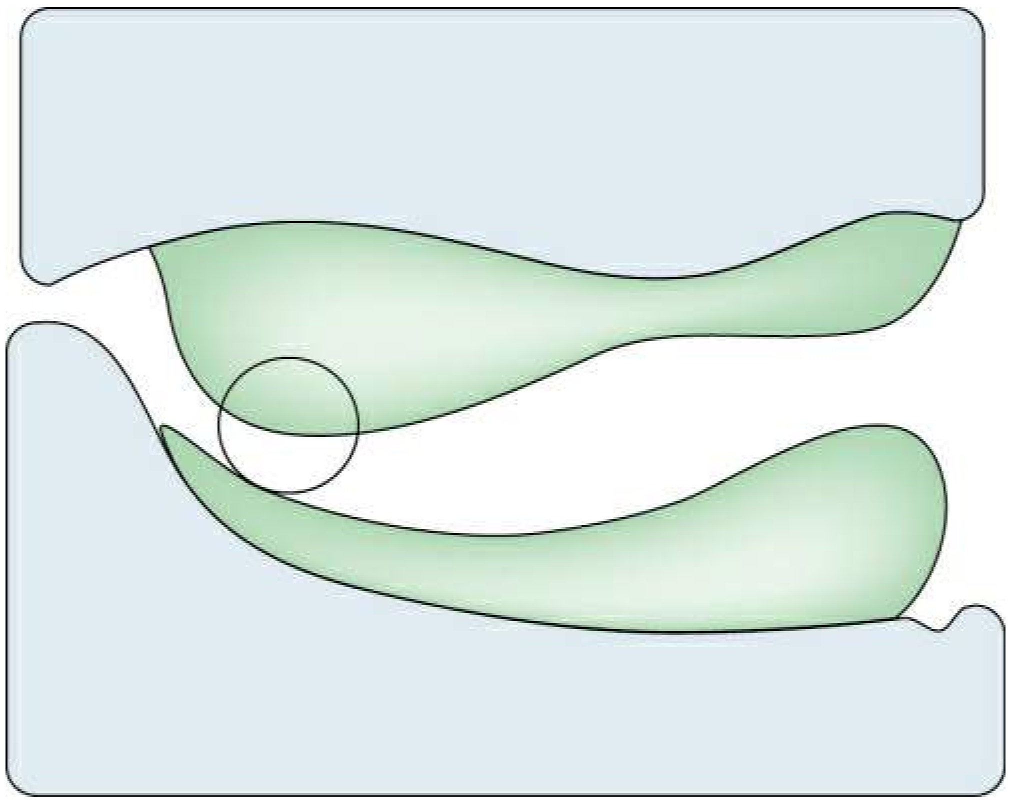


FIGURE 3.16 Prominent tuberosity interferes with interarch space, denture extension and mandibular movements.

(v) Sharp, spiny residual ridges

- These knife-edged ridges commonly occur in the lower anterior region due to rapid labial and lingual resorption. It leads to hypermobile tissue covering the ridge that gets trapped between the denture and the sharp bony ridge, causing denture soreness, discomfort and instability (Fig. 3.17).

- Meyer described three types of sharp ridges – saw-tooth, razor-like and discrete spiny projections.

- Surgical treatment involves recontouring of bone, reshaping of soft tissues and closure of epithelium with sutures.
- If surgery is contraindicated dentures can be made with:

○ Selective pressure impressions to reduce the pressure in this area.

○ Reduction of occlusal table with maximum denture base extension.

○ Permanent resilient liners.

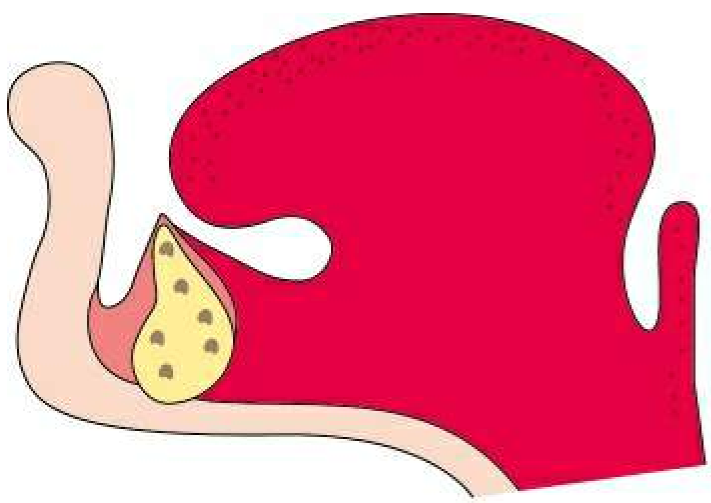


FIGURE 3.17 Sagittal section showing knife-edge ridge in mandibular anteriors.

(vi) Tori and exostoses

- They are relatively common, benign, slowly growing bony projections of maxilla or mandible. They attain their maximum size by the third decade and are of unknown aetiology. When it occurs in the midline of palate, it is called ‘torus palatinus’, and when it occurs in the lingual aspect of mandible, it is called ‘torus mandibularis’.

- The mucosa over the torus is thin and can be abraded easily.

Maxillary Tori (Fig. 3.18A)

- They occur in multiple shapes and configurations.
- Smaller tori require only to be relieved, because they do not interfere in prosthetic construction.
- Indications for removal:

  ○ Speech interference.

  ○ Affects posterior palatal seal.

  ○ Denture instability due to fulcrum effect.

  ○ Undercut torus that traps food debris.

Mandibular Tori

- They are bony protuberances on the lingual aspect of the mandible and usually occur in the premolar area (Fig. 3.18B).
- Constructing a denture over mandibular tori causes frequent mucosal irritation and sore spots, and prevents development of a border seal. Large tori also cause interference in speech.
- All mandibular tori need to be surgically removed.

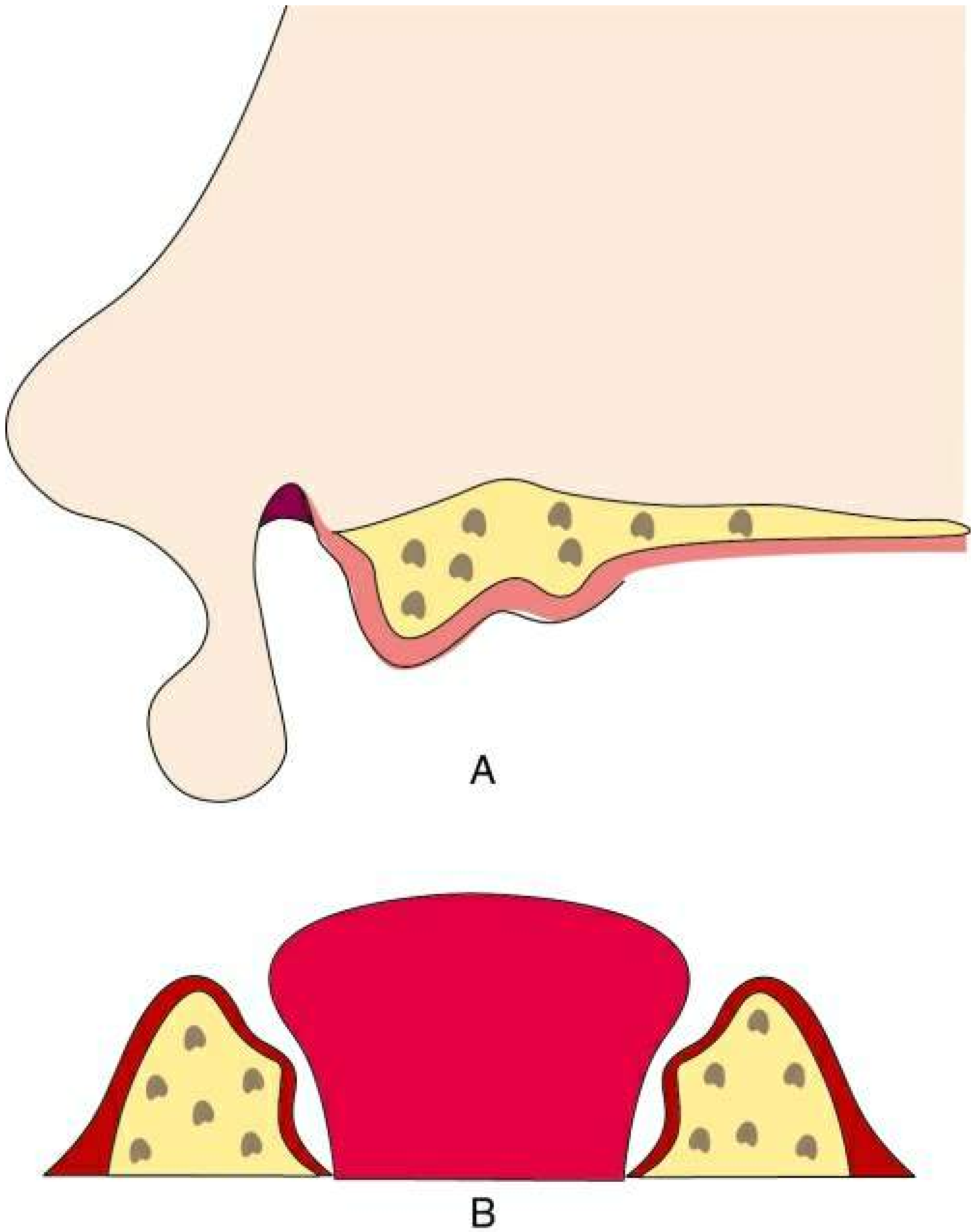


FIGURE 3.18 **(A)** Maxillary tori. **(B)** Mandibular tori.

Enlargement of denture-bearing areas

1. *Vestibuloplasty*

Definition: A surgical procedure designed to restore alveolar ridge height by lowering muscles attaching to the buccal, labial, and lingual

aspects of the jaws (GPT8).
Purpose:

- To obtain more denture extension.
- Reposition the muscle attachment to obtain better support for the prosthesis.

It can be done using one of the following procedures:

(i) Mucosal advancement

The subepithelial connective tissue is dissected and repositioned apically with the aid of a surgical stent. Mostly used in maxilla, it has potential for relapse.

(ii) Secondary epithelialization

’An apically repositioned flap is sutured to the periosteum at the desired depth. The area is allowed to heal by secondary intention. Overcorrection is usually necessary as there is 50% relapse. Hyperplastic and hypermobile tissues can be reduced at the same time.

(iii) Epithelial graft vestibuloplasty

A skin or oral mucous membrane graft is used to cover the exposed tissue following raising of a full thickness mucoperiosteal flap. It is allowed to heal by primary intention. This is the most successful method of vestibuloplasty.

2. *Ridge augmentation*

- Augmentation by bone grafts adds strength to an extremely deficient mandible or maxilla and improves the height and contour of the available bone.
- Autogenous grafts from an iliac or rib source are the most biologically acceptable but they require an additional and extensive

surgery at the donor site. The use of hydroxyapatite alloplastic material eliminates the donor site surgery but poses problems of resorption. The results with regard to predictable recovery of ridge height and morbidity are not encouraging.

- In general, grafting and just complete dentures are not recommended as they are a major consideration with respect to cost, success rate and procedure involved, especially for the elderly.

- Currently, grafts have been combined with osseointegrated implants and have shown promising results.

SUMMARY

Mouth preparation is an important step before we commence construction of complete denture prosthesis. Examination of hard and soft tissues of the oral cavity will provide information about the need for preprosthetic mouth preparation. The preparation may also be essential in existing denture wearers, due to tissue abuse. Most often it may be necessary for the patient to abstain from wearing the denture for at least a period of 48 hours before we start the impression procedures.

CHAPTER 4

Impressions and casts

CHAPTER CONTENTS

Introduction

Impression is a negative replica of the teeth and associated structures. Impression making is the first clinical working procedure in the fabrication of a complete denture. It helps the dentist in confirming the evaluation of patient, which was performed during diagnosis and treatment planning. It also helps in building confidence of the patient towards the dentist. A thorough understanding of the anatomy of the supporting and limiting structures is essential for proper extension and support of the denture. Impression techniques also vary depending on the clinical conditions. A preliminary impression is made following all the necessary mouth preparations and a preliminary cast is poured. If mouth preparation was not necessary, the diagnostic cast can be used as the preliminary cast. Hence, the procedures involved in making a diagnostic and preliminary impression, and in pouring a diagnostic and preliminary cast are similar. A custom tray is fabricated on the preliminary cast and a definitive (final) cast is made following final impressions. The clinical success of the complete denture depends largely on the accuracy and contours of the patient's definitive casts.

Definitions

Impression: A negative likeness or copy in reverse of the surface of an object, an imprint of the teeth and adjacent structures for use in dentistry (GPT8).

Preliminary impression: A negative likeness made for the purpose of diagnosis, treatment planning or the fabrication of a tray (GPT8); also referred to as 'primary impression'.

Preliminary cast: A cast formed from a preliminary impression for use in diagnosis or the fabrication of an impression tray (GPT8); also referred to as 'primary cast'.

Final impression: An impression that represents completion of registration of the surface or object, made for the purpose of fabricating a prosthesis; also referred to as 'secondary impression' or 'master impression'.

Definitive cast: A replica of the tooth surfaces, residual ridge areas and/or other parts of the dental arch and/or facial structures used to fabricate a dental restoration or prosthesis; called also final cast (GPT8); also referred to as 'master cast'.

Stock tray: A metal prefabricated impression tray typically available in various sizes and used principally for preliminary impressions (GPT8).

Custom tray: An individualized impression tray made from a cast recovered from a preliminary impression. It is used in making a final impression (GPT8); also referred to as 'special tray' or 'individualized tray'.

Principles and objectives of impression making

Principles

An impression must adhere to the following principles:

1. Tissues must be healthy, before impression making.

2. Proper space must be provided for selected impression material.

3. Tray and impression material should be dimensionally stable.

4. For correct positioning of tray, a guiding mechanism should be provided.

5. Impression should be adequately extended to include the entire basal seat area as dictated by limiting and supporting structures.

6. A border moulding must be performed in harmony with anatomical and physiological limitations of the oral structures.

7. Impression must be removed without damage to the oral structures.

8. The tissue surface of impression and intaglio surface of the denture must coincide.

Objectives

1. Retention

2. Stability

3. Support

4. Preservation of residual structures

5. Aesthetics

Retention

Definition: That quality inherent in the dental prosthesis acting to resist the forces of dislodgment along the path of placement (GPT8).

- It is related to forces that resist the forces of gravity, adhesiveness of food and opening of the jaws.

- The process of obtaining denture retention begins with impression making. Factors that attach the denture to the mucosa affect retention.

Factors affecting retention

1. *Anatomical factors*

(i) Size of the denture-bearing area

Retention increases with increase in the size of the denture-bearing area (Fig. 4.1). The average size of the maxillary denture-bearing area is around 24 cm^2 and that of the mandibular denture-bearing area is around 14 cm^2.

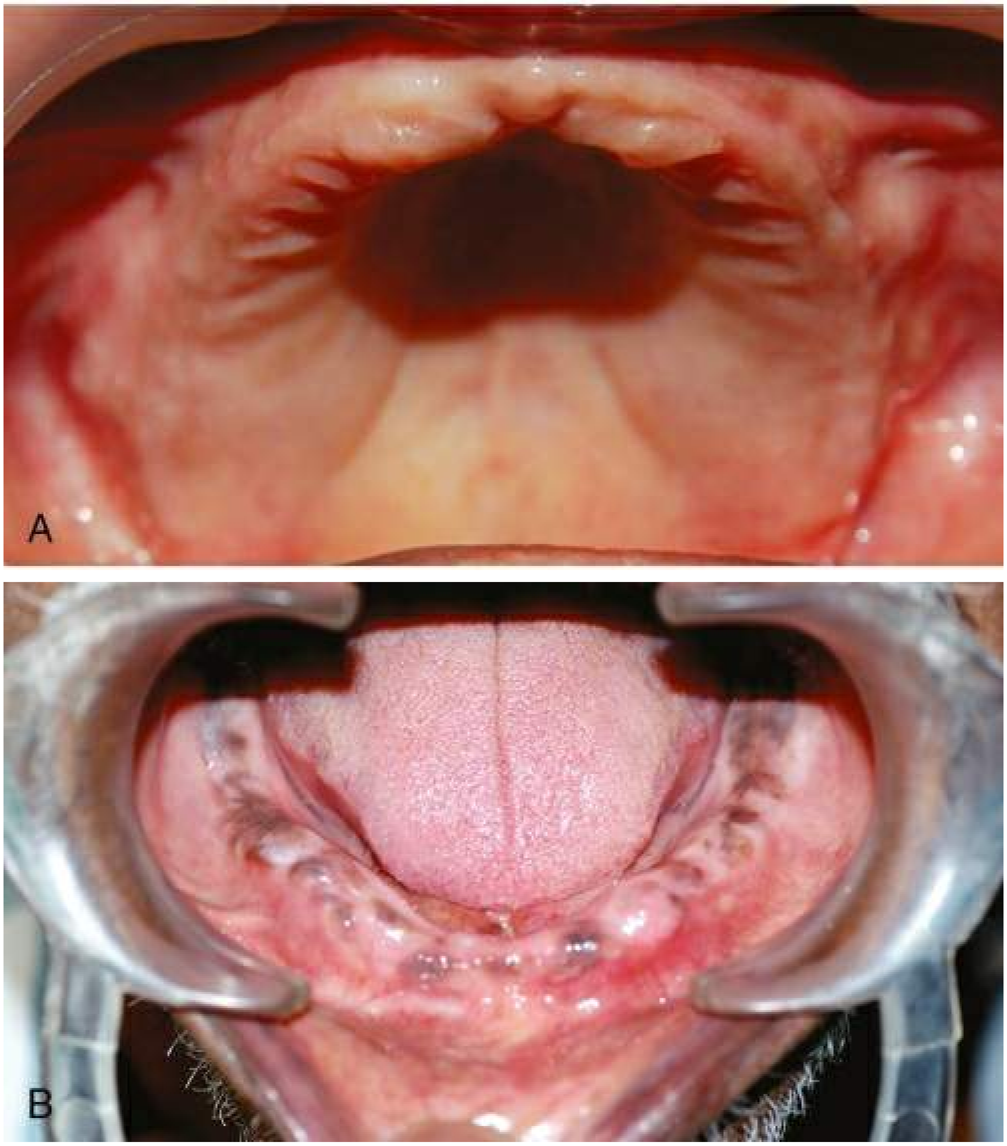


FIGURE 4.1 **(A)** Maxillary edentulous ridge and **(B)** mandibular edentulous ridge. Both ridges are well formed but size of denture-bearing area is smaller in the lower jaw.

(ii) Tissue displaceability

The displaceability of the tissues affects the retention of the denture. Tissues displaced during impression making will rebound during function and lead to loss of retention.

2. *Physiological factors*

- The amount and consistency of saliva affects retention.
- Thin, watery saliva affords best retention.
- Excessive saliva that is thick and ropy accumulates between the tissue surface of the denture and the palate leading to loss of retention.
- The absence of saliva (xerostomia) affects retention and can also cause irritation and soreness of the denture-bearing tissues.

3. *Physical factors*

(i) Adhesion

- Adhesion is defined as *the physical attraction of unlike molecules to one another*.
- Saliva is present in between the denture base and the mucosa, and its contact with both these surfaces creates adhesion. It is achieved by ionic forces between the salivary glycoproteins and surface epithelium or acrylic resin (Fig. 4.2A).
- It depends on:
  - Close adaptation of denture.
  - Size of denture-bearing area.
  - Type of saliva.
- Adhesion also takes place directly between the denture base and mucosa in case of xerostomia (lack of saliva), but this leads to ulcerations and abrasions in the mucosa.

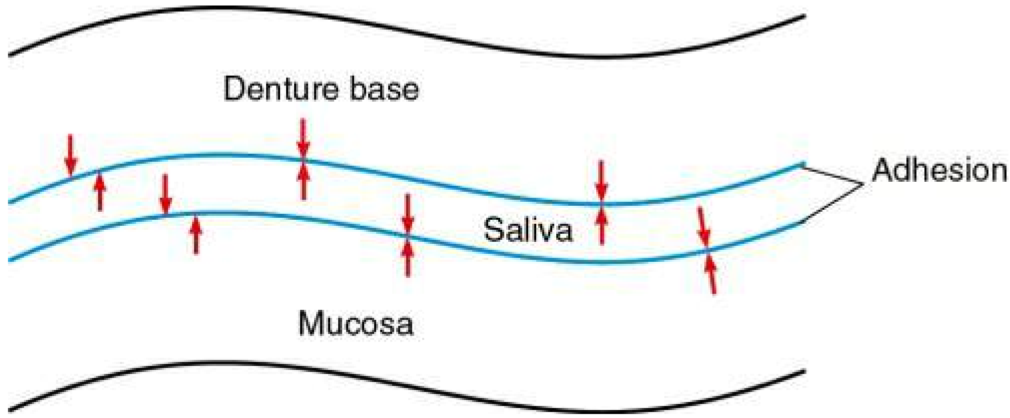


FIGURE 4.2A Adhesion (attraction of dissimilar molecules) takes place between saliva and denture base, and between saliva and mucosa.

(ii) Cohesion

- Cohesion is defined as *the physical attraction of like molecules to one another*.
- This occurs within the film of saliva and aids in retention (Fig. 4.2B).
- Normal saliva is not very cohesive; hence, retention from mucosa interface is more dependent on adhesion and surface tension.
- As viscosity of saliva increases, greater is the cohesion but very thick, mucous saliva can physically push the denture out, resulting in loss of retention.

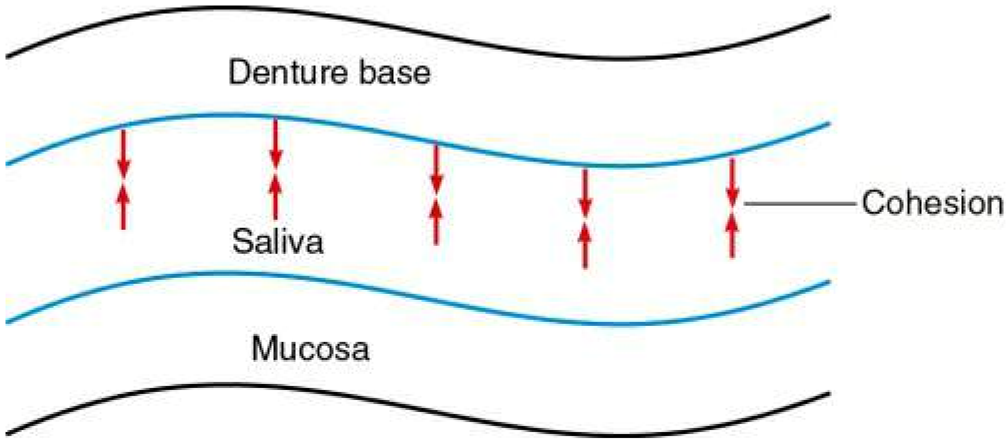


FIGURE 4.2B Cohesion (attraction between similar molecules) takes place within the molecules of saliva present between the mucosa and denture base.

(iii) Interfacial surface tension

- Interfacial surface tension is defined as *the tension or resistance to separation possessed by a film of liquid between two well adapted parallel surfaces*.

- It is dependent on the ability of the liquid to 'wet' the surfaces. The 'wettability' of the fluid is inversely proportional to the surface tension of the surfaces.

- These forces are found within the thin film of saliva that is present between the denture base and tissues. Saliva 'wets' the denture surface, to aid in retention. The oral mucosa has low surface tension and hence the saliva 'wets' it well, spreading out in a thin film. Denture base materials demonstrate less wettability than oral mucosa, with heat-cured resins showing better wetting than autopolymerized resins. But once coated with salivary pellicle, the surface tension of the denture base material decreases and contact increases. This is similar to trying to separate two glass plates with intervening liquid between them (Fig. 4.2C and D).

- Interfacial surface tension is also dependent on existence of a liquid/air interface at the boundary of the liquid/solid contact. If two plates with a fluid between them are immersed in the same fluid, then there is no interfacial surface tension and they can be separated easily. The external boundary of the mandibular denture is always filled (immersed) in saliva, thereby reducing the surface tension effect (Fig. 4.2E). Hence, interfacial surface tension plays a significant role in retention of only the maxillary denture.

- The interfacial surface tension can be calculated by Stephan's formula:
  - $$F = \frac{4.7 \times kr^4}{h^3} \times v$$

Where *F* is surface tension, *k* is viscosity of liquid, *r* is radius of the contacting surfaces, *v* is velocity of force, *h* is the space between the surfaces.

- This means the following:
  - Greater the space (h^3), interfacial surface tension (F) is less – closer the adaptation of the denture, greater is the interfacial tension and retention.
  - Greater the radius (r^4), greater is interfacial surface tension (F) – greater the area covered by the denture, greater is the interfacial tension and retention.
- Other factors that aid in obtaining maximum interfacial surface tension are

○ Thin and even layer of saliva.

○ Adequate adhesion and cohesion.

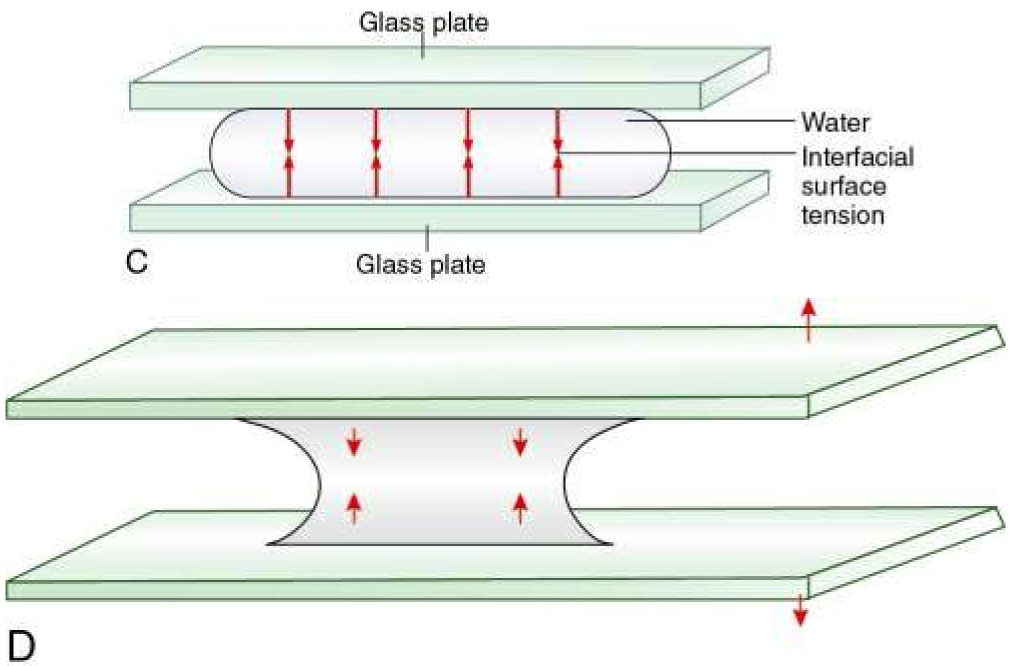


FIGURE 4.2C, D Interfacial surface tension acts only when the two glass plates are pulled apart. The cohesive forces between the molecules of the liquid, (intermolecular attraction) and the adhesive forces between the plate and the liquid will result in preventing the plates to move away from each other forming a concave meniscus.

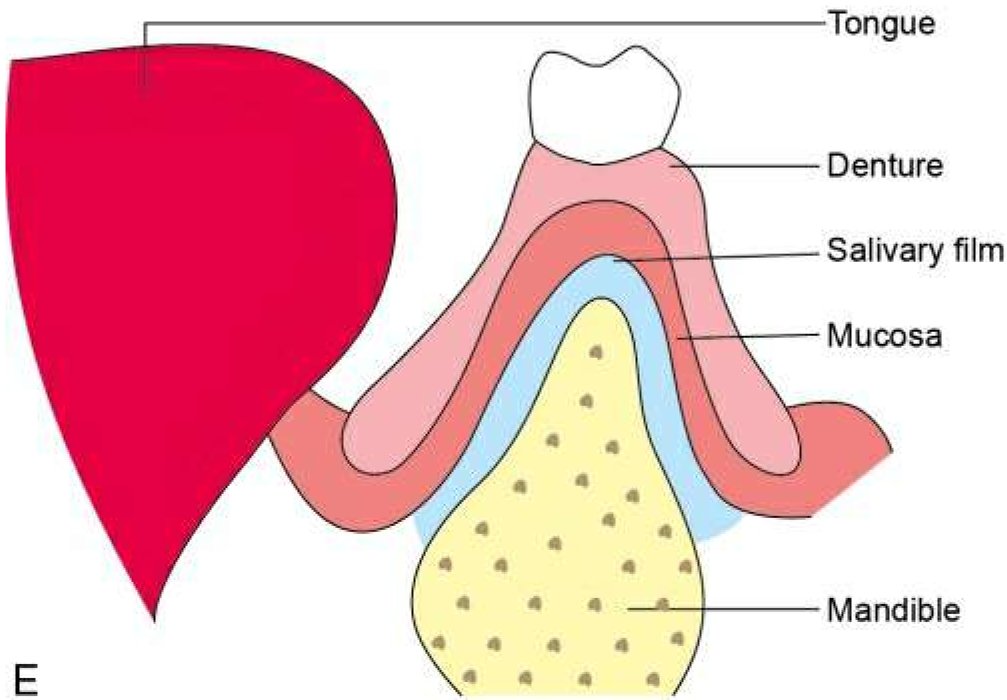


FIGURE 4.2E Surface tension lost in mandibular denture.

(iv) Capillarity

That quality or state, which because of surface tension causes elevation or depression of the surface of a liquid that is in contact with a solid.

- Capillarity causes the thin film of saliva to rise and increase its contact with the denture base and the mucosa.

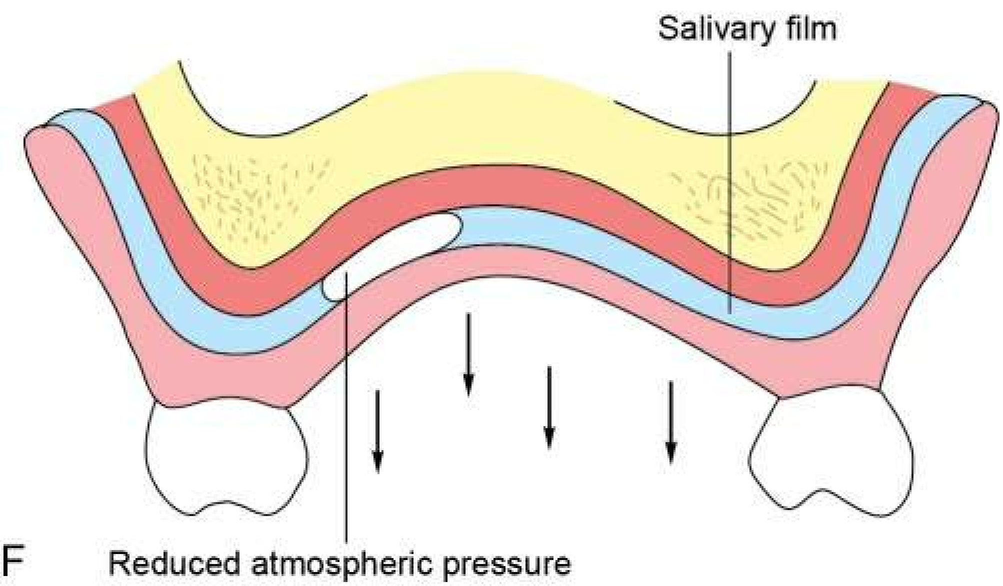
- Close adaptation of the denture base to mucosa is important for capillarity to provide effective retention.

(v) Atmospheric pressure

- This can help resist dislodging forces if the dentures have an effective border seal. Peripheral seal or border seal is defined as the contact of the denture border with the underlying or adjacent tissues to prevent the passage of air or other substances (GPT8).

- When a force is exerted perpendicular to and away from the basal seat of a denture which is properly extended and fully seated, pressure between the prosthesis and mucosa drops below the ambient pressure, resisting displacement. This has been previously referred to as ‘suction’ (Fig. 4.2F).

- Retention due to atmospheric pressure is proportional to the denture base area. Proper border moulding is essential for this retention mechanism to function.



F

FIGURE 4.2F When dislodging forces act on a properly extended denture, pressure between the prosthesis and mucosa drops, contributing to retention.

(vi) Gravity

This natural force can aid in the retention of the mandibular denture especially when there is more weight and other retentive forces and factors are marginal (Fig. 4.2G).

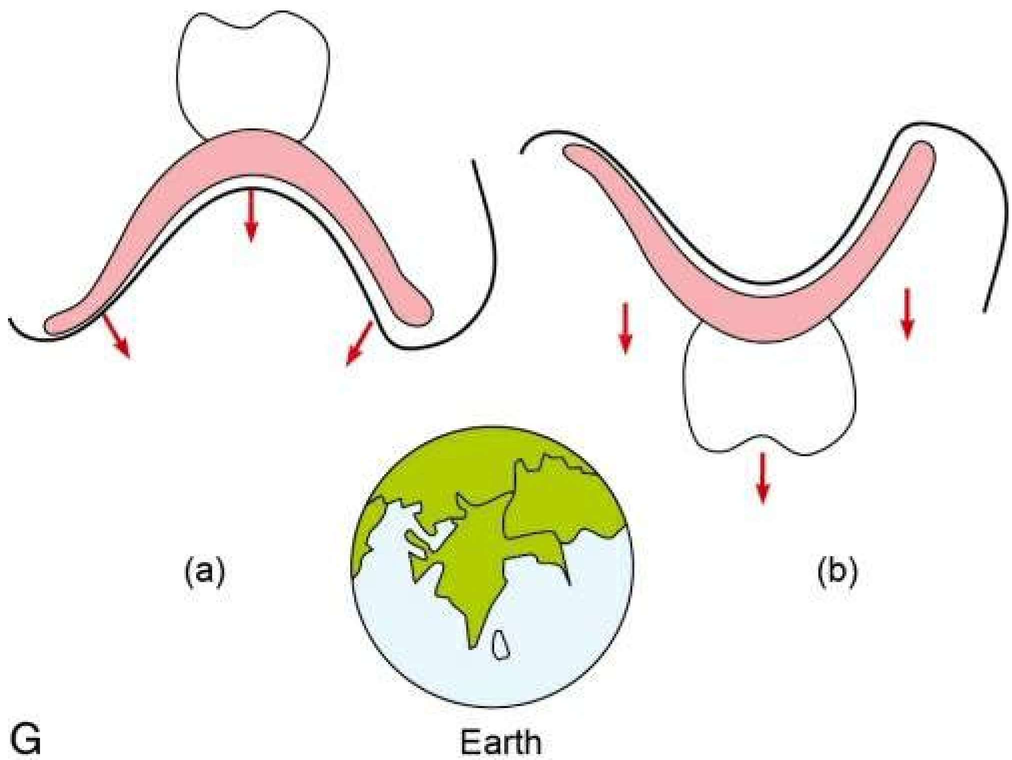


FIGURE 4.2G Gravitational force helps seat the mandibular denture (a), while it acts against the maxillary denture (b).

4. *Mechanical factors*

(i) Undercuts

- Moderate undercuts enhance retention because of the resiliency of mucosa. Examples are unilateral tuberosity undercuts, undercuts in maxillary premolar area, distolingual areas and lingual to the midline of mandible.
- Severe undercuts covered with thin mucosa compromise retention and need to be surgically eliminated. Undercuts like those present in the retromolar areas and maxillary anterior ridge allow insertion of denture with a rotational path with the undercut area seated first.
- They provide good resistance to displacement in a vertical direction (also see Fig. 3.14A).

(ii) Denture adhesives

These commercially available products enhance retention by increasing adhesive and cohesive properties and by eliminating voids between denture base and basal seat tissues (Fig. 4.3A). (These are discussed in Chapter 11.)

FIGURE 4.3A A commercially available denture adhesive powder applied on denture.

(iii) Suction chambers and discs

These have been used to create a negative pressure in the palatal surface of the maxillary denture, thereby enhancing retention. They are best avoided due to their potential to cause papillary hyperplasias (Fig. 4.3B).

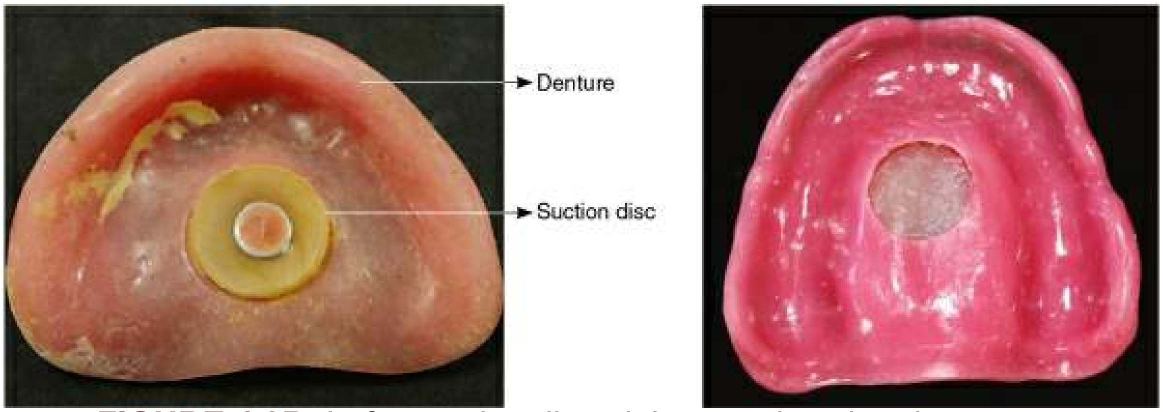


FIGURE 4.3B Left—suction disc, right—suction chamber.

5. *Muscular factors*

The oral and facial musculature and tongue supply supplementary retentive forces. For this to be effective:

- Teeth must be positioned in the 'neutral zone' between the tongue and cheeks.
- Polished surfaces of the dentures should be properly contoured.
- Denture bases must be extended to cover maximum area.
- Occlusal plane must be at correct level.
- The potential denture space or the neutral zone is explained in Chapter 10.

Stability

Definition: The quality of a removable dental prosthesis to be firm, steady, or constant, to resist displacement by functional horizontal or rotational stresses (GPT8).

Factors affecting stability

1. *Vertical height of the residual ridge*

• Stability deceases with loss of vertical height of the ridges (Fig. 4.4A–C).

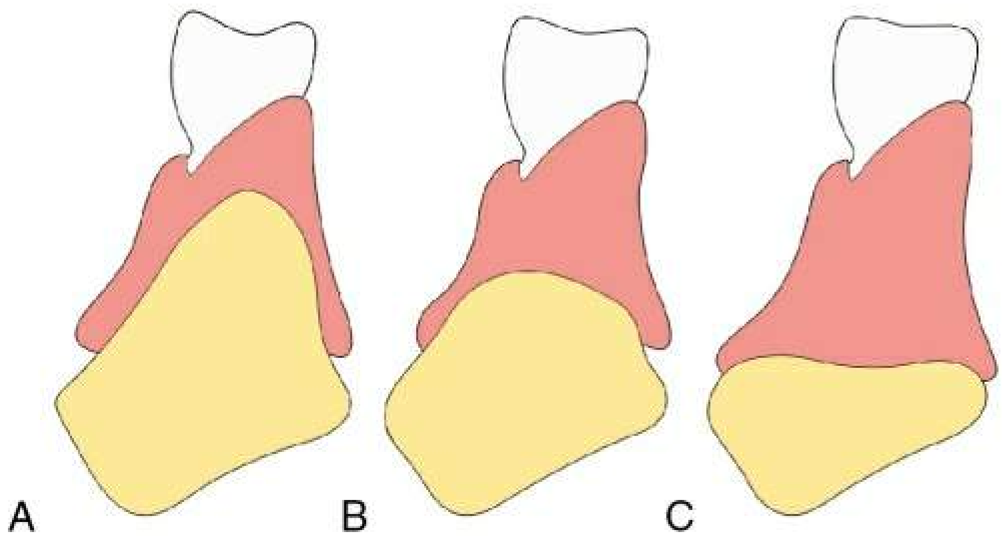


FIGURE 4.4 Stability: **(A)** good ridge height, **(B)** poor ridge height, **(C)** flabby ridge. Ridge with good vertical height contributes to better stability than poor ridges due to decreased leverage.

2. *Quality of soft tissue covering the ridge*

• Flabby ridges provide poor stability.

3. *Adaptation of denture to the tissues*

• Close adaptation of the denture to the basal seat tissues is very important to ensure proper stability. An accurate impression is essential to achieve this.

4. *Occlusal plane*

• The occlusal plane should be oriented parallel to the ridges and should divide the interarch space equally. Inclined occlusal planes will promote sliding forces and cause instability (Fig. 4.4D).

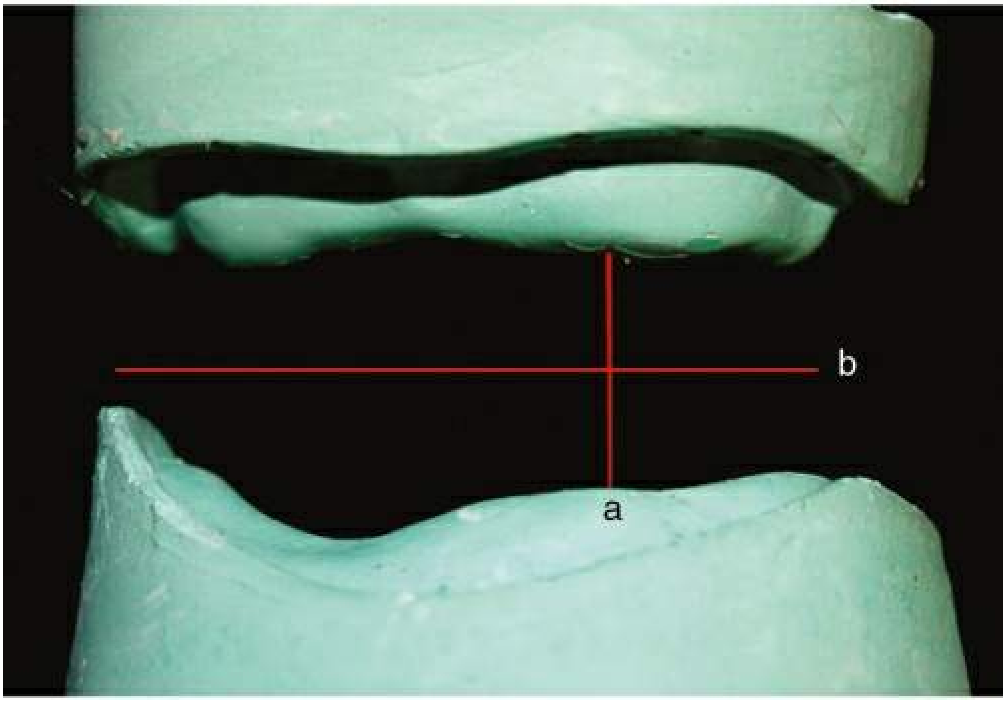


FIGURE 4.4D Occlusal plane (b) contributes to stability when the interarch space (a) is equally divided.

5. *Teeth arrangement*

- Setting teeth in 'balanced occlusion' and in the 'neutral zone' promotes stability.

6. *Contour of polished surface*

- The polished denture surface should be in harmony and with the functioning of oral muscles to promote stability.

Support

Definition: The resistance to the vertical forces of mastication, occlusal forces and other forces applied in a direction towards the basal seat tissues.

To provide adequate support, the denture base should cover as much denture-bearing area as possible. This distributes the forces over a large area and is known as *snowshoe effect* (Fig. 4.5).

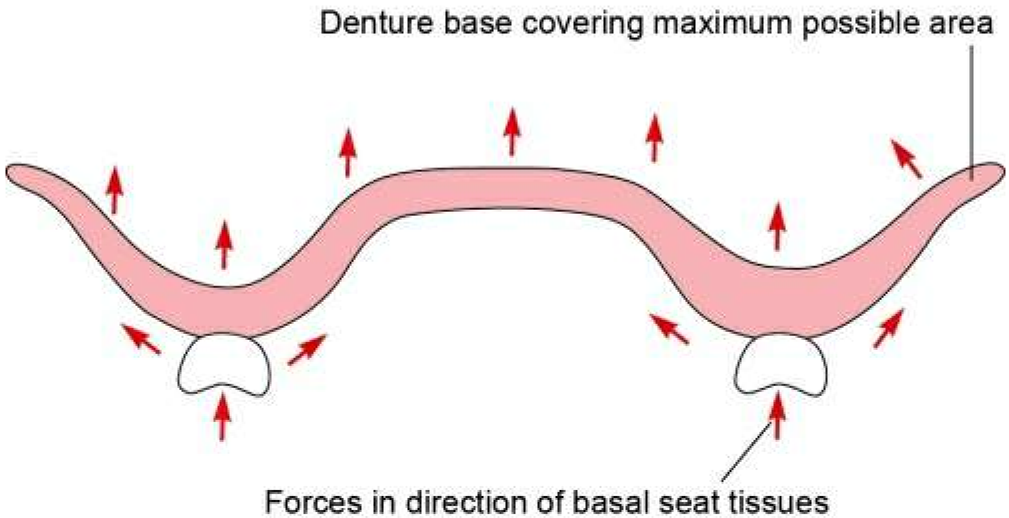


FIGURE 4.5 Forces distributed over a large area, by maximum extension of denture base, known as snowshoe effect.

The maxillary and mandibular 'supporting structure' and 'stress-bearing areas' are discussed further in this chapter.

Preservation of residual structures

- Preservation of remaining oral structures is vitally important to long-term success of the denture.
- Accurate impressions using a selective pressure impression technique that places pressure only on stress-bearing areas is important for this preservation.

Aesthetics

- Denture border and flange thickness are dependent on the amount of residual ridge loss and varies with each patient.
- Reducing or increasing the thickness of this area leads to poor aesthetics.
- Border moulding ensures adequate thickness in the region.

Classification of impressions

Impressions can be classified into the following types.

Depending on purpose of impression making

Diagnostic impression

- This is an impression made for the purpose of diagnosis, treatment planning and fabricating diagnostic casts (discussed in Chapter 2).
- Materials used for diagnostic impressions – irreversible hydrocolloids.

Primary/Preliminary impression

- This is made for the purpose of making a preliminary cast on which a special tray is constructed.
- Materials used for making preliminary impressions – irreversible hydrocolloids, impression compound, putty and heavy body elastomeric impression materials.

Final/Secondary/Master impression

- This is made for the purpose of fabricating a master cast, on which the prosthesis is fabricated.
- Materials used for final impressions—zinc oxide eugenol (ZOE) impression paste, impression plaster, medium and light body elastomeric impression materials.

Depending on theories of impression making

Mucostatic/passive/nonpressure/minimal pressure impression technique

- Proposed by Henry Page.
- In this technique, the oral mucosa is recorded in a resting state.
- Impression is made in an oversized impression tray with spacer.
- Border moulding is not performed; hence, flanges are shorter than other techniques.
- Impression material of choice for this technique is 'impression plaster'.
- It is best termed as 'minimal pressure' impression as it is impossible to record the mucosa with no pressure.
- Disadvantages:
  - Deprives the denture of maximum coverage within physiologic limits.
  - Results in closely adapted dentures but with poor peripheral seal thereby providing good stability but poor retention.

Mucocompressive/pressure impression technique

- This technique compresses the denture-bearing tissues during impression making.
- The proponents of this theory perceived that by recording the tissues in a compressed state, they would withstand functional

forces, which compress the tissues better.

- Pressure can be manually applied using high viscosity impression materials impression compound, irreversible hydrocolloids, putty and heavy body elastomeric impression materials. Closed mouth functional technique also produces mucocompressive impressions.
- Disadvantages:
    - Produces overextended impressions.
    - As the tissues are recorded in a compressed state, due to the rebound phenomenon of the oral tissues, there are chances that the dentures will dislodge when not in function (compression) – at rest or speaking.
    - Increased residual ridge resorption is seen as the ridges are constantly under pressure from the overlying dentures.
    - As the tissues are uniformly compressed, pressure is also transmitted to areas that are not capable to withstanding the stress.
    - This often results in good initial retention but eventual resorption and loose dentures.

Selective pressure technique

- It combines the principles of both pressure and minimal pressure techniques. Pressure is applied selectively on areas capable of resisting stress (stress-bearing areas), and reduced from areas incapable of tolerating stress (relief areas).

- This is achieved through the design of the custom tray, where nonstress-bearing (relief) areas are relieved and only stress-bearing areas contact the tray. (See section on ‘Custom Trays’ in this Chapter)
- The technique combines the principles of maximum coverage within physiologic limits, with intimate contact on the movable, loosely attached peripheral tissues, and light pressure on weak tissues.
- Disadvantages:
  - Some feel it may be impossible to record areas with varying pressure.
  - Some areas are still recorded under compression, which can rebound.

Depending on impression technique

Open mouth

- This records the oral tissues in a static state with displacement.
- The amount of displacement depends on the ability of the different oral tissues to withstand pressure, the amount of space provided for the impression material and the consistency of the impression material.
- With the patient’s mouth in open position, the dentist applies controlled pressure on the inserted tray to record the tissues in a

static form.

- Disadvantages:

    - The tissues are not recorded in a functional state.

Closed mouth

- In this technique oral mucosa is recorded in a functional, compressed form. It is assumed that the occlusal loading during impression making is comparable to occlusal loading during function.

- Occlusal rims or teeth are attached to the impression trays and impression is recorded, while patient applies pressure and performs functional actions like swallowing, grinning or pursing the lips. Thus, the peripheries of the dentures are established during function.

- Impression materials used for this technique are waxes and soft liners.

- Indicated for atrophic ridges.

- Disadvantages:

    - Difficult to control the amount of pressure leading to pressure spots.

    - Even occlusion is essential for recording, which may be difficult to establish.

    - Can produce distorted impressions.

Impression materials

The impression materials used for complete dentures may be classified as follows.

Rigid or inelastic and elastic

The impression materials under the classification rigid are as follows.

Impression plaster

- Type I dental plaster is used for this purpose.
- Potato starch is added to make it soluble and for easy removal of impression from the cast.
- It is mostly used with a custom tray as a ‘wash’ impression, but can be used with stock trays also.
- Used for making final impressions.
- It is mixed with water in appropriate ratio, loaded onto tray and inserted in patient’s mouth.
- Advantages:
  - Minimal tissue distortion—indicated for minimal pressure impressions
  - Good flow
  - Ease of manipulation.
- Disadvantages:

- ○ Pores must be sealed before pouring cast, which can result in inaccuracies.
- ○ It is brittle.
- ○ Not used for mandibular impressions as saliva washes the material and distorts the surface.
- ○ Cannot be used in the presence of undercuts.
- ○ Messy.

- This material is rarely used currently.

Impression compound

- These are reversible thermoplastic materials also called 'modelling plastic'.
- It is supplied as a tray material, impression material and sticks for border moulding (also called low fusing compound and tracing stick) (Fig. 4.6A). The tray material requires more heat to soften, while the stick material requires least heat.
- It is composed of a mixture of waxes, thermoplastic resins, filler and colouring agents.
- Indicated for making preliminary impressions with stock trays and border moulding.
- The impression compound is softened by immersion in warm water at about 65°C, while the stick material is softened over a flame.
- Advantages:

○ Low cost, easy to manipulate.

○ Material can be reused.

○ Impression can be corrected.

○ Easy to bead and box.

• Disadvantages:

○ Rigid, cannot be used to record undercuts.

○ Impression material cannot be used to make final impressions as ability to record surface detail is poor due to its high viscosity.

○ Tissue compression is high.

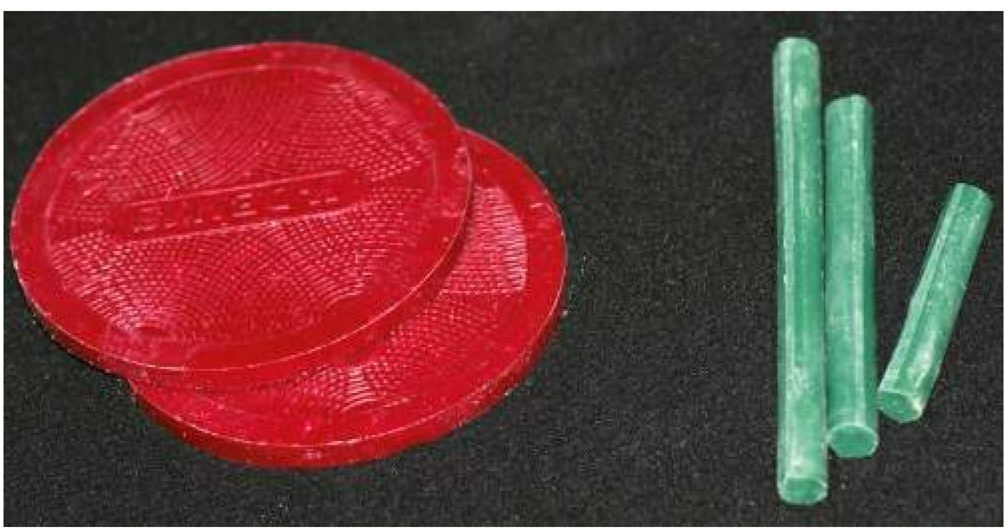


FIGURE 4.6A Impression compound (left) and tracing stick (right).

Zinc oxide eugenol (ZOE) impression paste (fig. 4.6B)

- Main constituents are ZOE to which plasticizers, fillers and additives are added.
- Supplied as base and catalyst paste.
- Used for making final impressions in a custom tray.
- Advantages:

  - Accurate recording of surface details due to high fluidity.
  - Minimal tissue compression can be used with minimal pressure technique.
  - Cost effective, easy to manipulate.
  - Easy to bead and box.
  - Dimensionally stable.

- Disadvantages:

  - Temperature and humidity affect setting time.
  - Rigid, so it can distort in the presence of undercuts.
  - Hydrophobic, does not absorb palatal secretions.

○ Untidy.

FIGURE 4.6B Base (white) and catalyst (red) paste of ZOE impression paste.

Impression waxes

- It not sufficiently accurate for final impressions.
- It is indicated as a corrective material to refine tray borders.

Elastic

Elastic impression materials are discussed in Chapter 37.

Anatomic and denture landmarks

A thorough understanding of the anatomic and denture landmarks in relation to the denture foundation is important for the following reasons:

- Selective placement of forces as determined by the stress-bearing potential of the anatomic structures.
- Maximum coverage of denture without interfering with the health or function of the tissues.
- Long-term success of the complete denture.

The anatomic landmarks of significance in relation to maxillary and mandibular complete denture impressions can be discussed as:

- Mucous membrane
- Supporting areas
- Limiting areas
- Stress-bearing areas
- Relief areas

Mucous membrane

- Covers or lines the oral cavity including the residual alveolar ridges and acts as an intervening cushioning material between the residual ridges and denture.
- Composed of mucosa and submucosa.
- Mucosa is classified as masticatory, specialized and lining.

Specialized mucosa covers the dorsal surface of the tongue and is keratinized. Lining mucosa is nonkeratinized and covers the lips, cheek, sulcus, soft palate, ventral surface of tongue and slopes of residual ridges.

- Mucosa covering the hard palate and crest of the residual ridge is termed as masticatory mucosa and is formed by keratinized stratified squamous epithelium and a thin layer of connective tissue, the lamina propria. Keratinization decreases in denture wearers. Removing dentures at night and massaging improves keratinization.

- The submucosa is formed by connective tissue and makes up the bulk of the mucous membrane. The submucosa varies in thickness and character from dense to loose areolar connective tissue. The support and stability offered by the mucosa to the denture depends on the thickness of submucosa and its attachment to the underlying bone. A dense, firmly attached submucosa will successfully withstand the pressure of the denture. A thin layer can be easily traumatized, while a loosely attached layer is easily displaceable.

Maxilla

1. **Supporting structures** (Fig. 4.7A and B):

○ Hard palate—rugae

○ Residual alveolar ridge—maxillary tuberosity

2. **Limiting structures** (Fig. 4.7A and B):

○ Labial frenum

○ Labial vestibule

○ Buccal frenum

○ Buccal vestibule

○ Hamular notch

○ Fovea palatine

○ Posterior palatal seal area

3. **Relief areas:**

○ Midpalatine suture

○ Incisive papilla

○ Torus palatinus

4. **Stress-bearing areas** (Fig. 4.7C and D):

○ Primary—horizontal slopes of hard palate lateral to median sutures

○ Secondary

▪ Crest of the residual alveolar ridge

▪ Rugae

▪ Maxillary tuberosity

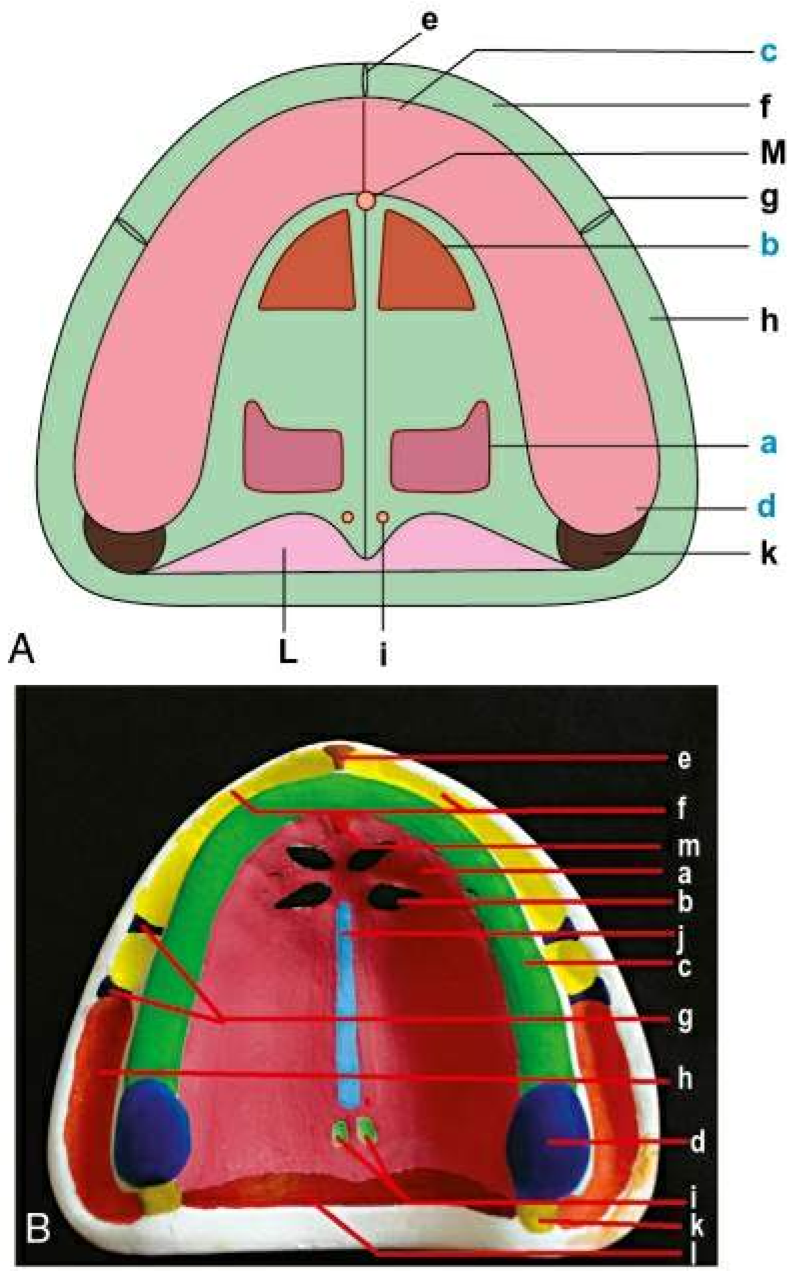


FIGURE 4.7 Supporting and limiting structures in maxilla: (a) palate, (b) rugae, (c) residual ridge, (d) maxillary tuberosity, (e) labial frenum, (f) labial vestibule, (g) buccal frenum, (h) buccal vestibule and (i) fovea palatine, (j) median palatine raphe, (k) hamular notch, (l) posterior palatal seal area and (m) incisive papilla. **(A)** Line diagram and **(B)** model.

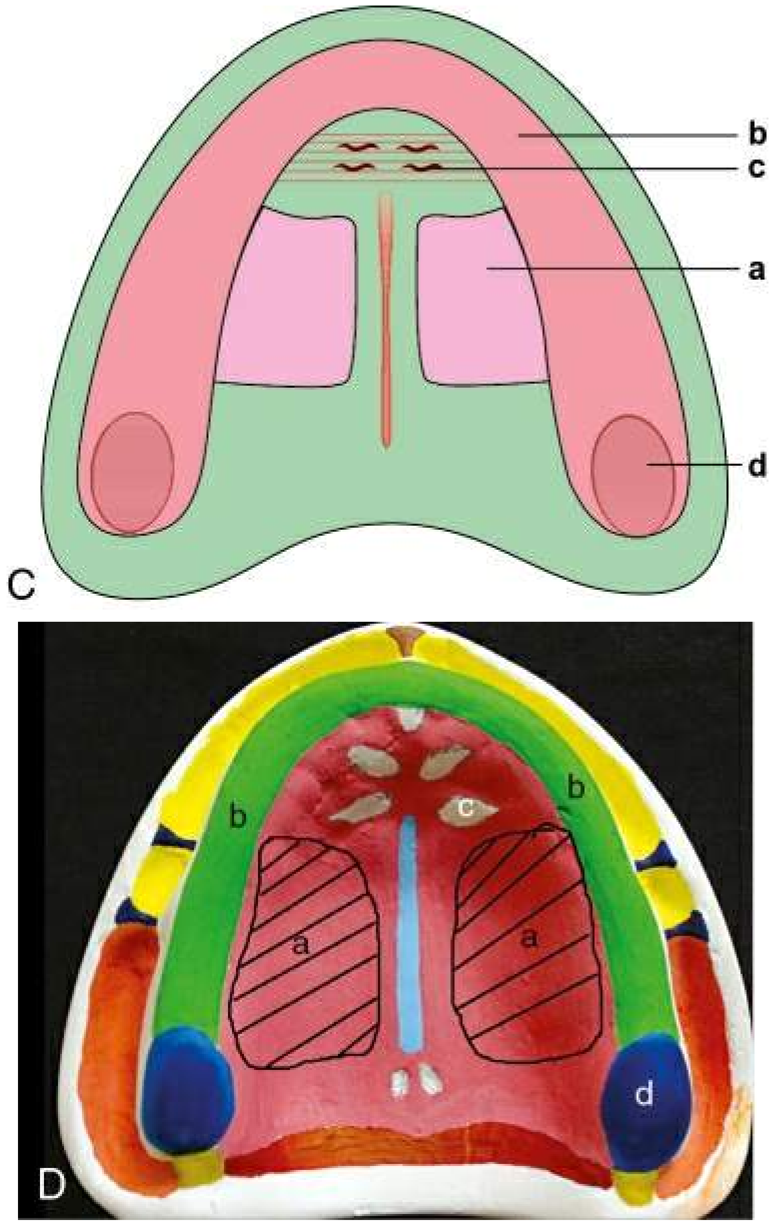


FIGURE 4.7C, D Stress-bearing areas in maxilla: (a) primary-horizontal slopes of hard palate, (b) secondary-crest of residual alveolar ridge, (c) secondary-rugae and (d) secondary-maxillary tuberosity.

Supporting structures

Hard palate

- It is made up of two maxillae and the palatine bone.
- The palatine process of the maxillae join together at the midline forming the median suture.
- The mucosa is keratinized throughout the hard palate.
- Posterolaterally, submucosa contains glandular tissue and the horizontal portion lateral to midline provides the primary support as it also undergoes least resorption (Fig. 4.7E).

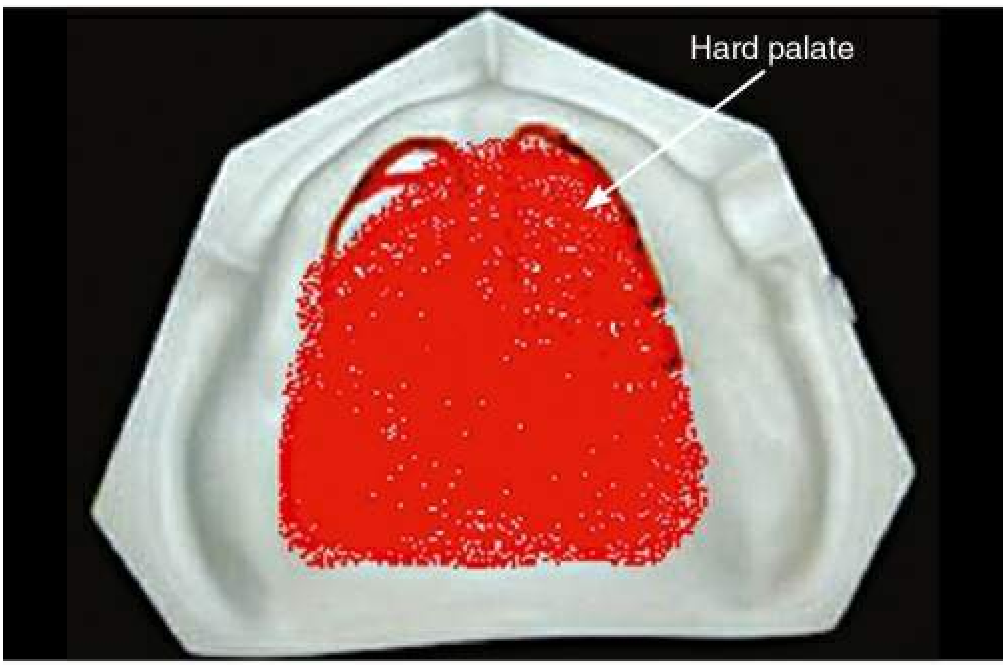


FIGURE 4.7E Hard palate.

Rugae

Raised areas of dense connective tissue present in the anterior one-third of the palate are at an angle to the residual ridge. This provides the secondary support to the maxillary denture as it resists anterior displacement of denture. It should not be distorted during impression making (Fig. 4.7F).

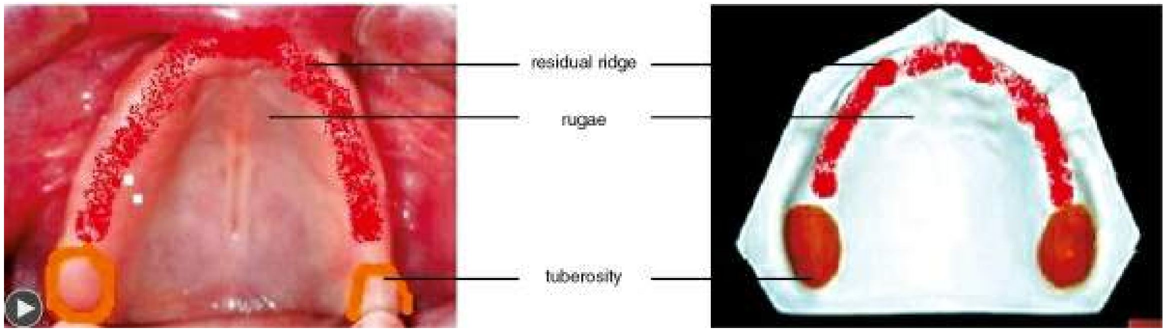


FIGURE 4.7F Rugae, residual ridge and maxillary tuberosity —intraoral and model.

Residual ridge

Definition: The portion of the residual bone and its soft tissue covering that remain after the removal of teeth (GPT8) (Fig. 4.7F).

- Residual alveolar ridge resorption is rapid immediately following extraction of teeth and continues throughout the life but at a reduced rate.
- The crest of the maxillary residual alveolar ridge provides good support, but as it is subject to resorption, it can be a secondary stress-bearing area.
- **Maxillary tuberosity** is a bulbous extension of the residual ridge in the second and third molar region. The posterior part of tuberosity rarely resorbs and therefore is among the most important areas providing support to the maxillary denture (Fig. 4.7F).

Limiting structures

Labial frenum

- It is a fold of mucous membrane present in the midline that extends from the labial aspect of the residual ridge to the lip (Fig. 4.7G).
- It has a configuration varying from single to multiple folds and is

fan shaped superiorly.

- It contains no muscle or action of its own and can be excised if attached close to the ridge crest.
- It inserts in a vertical direction.
- It is accommodated by providing a notch in the labial flange of the denture.

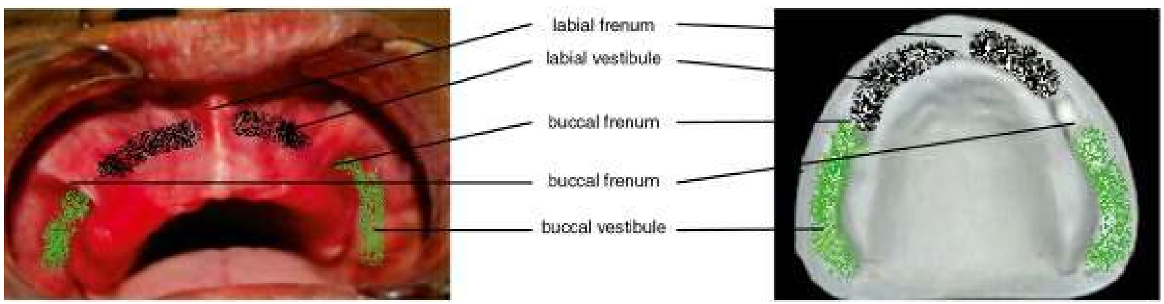


FIGURE 4.7G Labial frenum and vestibule, buccal frenum and vestibule—intraoral and model.

Labial vestibule

- **Definition**: The portion of the oral cavity that is bounded on one side by the teeth, gingiva, and alveolar ridge (in the edentulous mouth, the residual ridge) and on the other by the lips anterior to the buccal freni/frenum (GPT8) (Fig. 4.7G).
- Extends on both sides from labial frenum to buccal frenum and houses the labial flange of the denture.
- The mucous membrane lining the labial vestibule is relatively thin and classified as lining mucosa. The submucosa layer is thick and contains large amount of loose areolar tissue and elastic fibres.
- The main muscle of the lip, orbicularis oris forms the outer surface of the labial vestibule. Its tone depends on the support given by the

labial denture flange and position of teeth. As the fibres run horizontally, it only has an indirect effect on the impression extension and the denture base.

- The main support for the upper lip is obtained from the junction of acrylic to the teeth and not from the periphery.

Buccal frenum

It separates the labial and the buccal vestibule and overlies the levator anguli oris muscle (Fig. 4.7G).

- It also varies in configuration from single or double folds, to broad and fan-shaped.
- Its insertion is in an anteroposterior direction.
- Orbicularis oris pulls the frenum in a forward direction, while the buccinator pulls it in a backward direction.
- It requires more clearance in the denture than the labial frenum due to its muscle attachments.

Buccal vestibule

- It extends from the buccal frenum to the hamular notch and houses the buccal flange of the denture (Fig. 4.7G).
- Its mucosa is a lining mucosa and similar to that of labial vestibule.
- Its size varies with:

○ Contraction of buccinator

○ Position of mandible

○ Amount of bone lost from maxilla

- The size and shape of distal end of buccal flange must be adjusted to accommodate the movement of coronoid process of mandible and the masseter muscle. When the mandible is opened wide and moved laterally, the width and height of this area is reduced. The stability and retention of the denture is greatly increased when this area is recorded properly.

Hamular notch

- It is a depression present between the maxillary tuberosity and pterygoid hamulus (Fig. 4.7H).
- It is the distal termination of the denture. The denture should never extend onto the pterygoid hamulus as it is sharp and contains thin mucous membrane.
- The mucosa here contains a thick submucosa made up of loose areolar tissue. This can be safely displaced to achieve a posterior palatal seal.
- The pterygomandibular ligament is attached to the hamulus and provision must be made for its movement.

FIGURE 4.7H Hamular notch: (a) model and (b) intraoral.

Fovea palatinae

- These are two ductal openings into which the ducts of other palatal mucous glands open (Fig. 4.7I).
- They are present posteriorly in the hard palate on either side of midline.
- Not a constant finding in all individuals.
- They serve no specific function, but are a guide in identifying the posterior extent of the denture. The denture should extend 1–2 mm beyond the fovea.

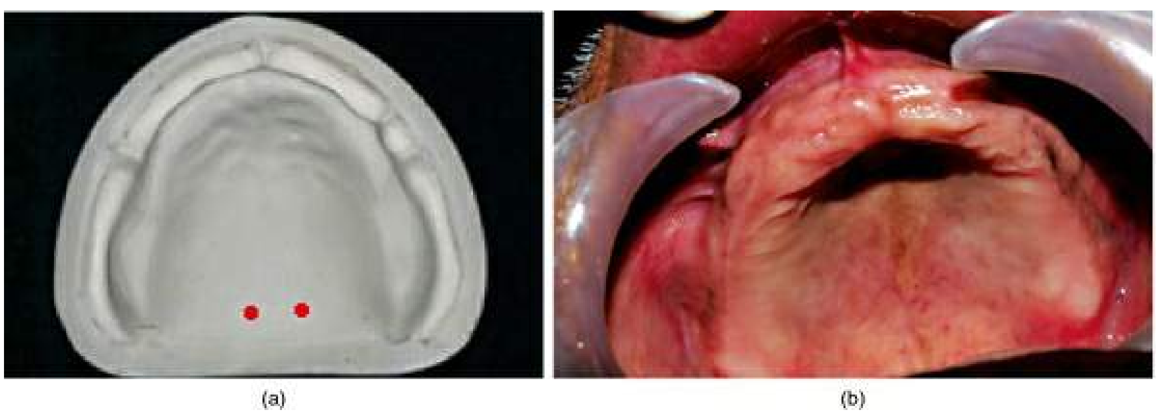


FIGURE 4.7I Fovea palatinae: (a) model and (b) intraoral.

Posterior palatal seal

- **Definition:** The soft tissue along the junction of hard and soft palates on which pressure within physiologic limits can be applied by the complete removable dental prosthesis to aid in retention of denture.
- The posterior palatal seal is identified as the area between the anterior and posterior vibrating lines (Fig. 4.7J).

Vibrating line: An imaginary line across the posterior part of the palate marking the division between the movable and immovable tissues of the soft palate; this can be identified when the movable tissues are functioning (GPT8).

It is divided into:

- *Anterior vibrating line* is an imaginary line at the junction of the attached tissue overlying the hard palate and the immediate movable tissue of the soft palate. It is always on soft palate. Due to the projection of the posterior nasal spine, the anterior vibrating line is not a straight line, but takes the shape of a cupid's bow. It is located by:

  - Valsalva manoeuvre—patient is asked to hold both nostrils and gently blow through the nose. This will place the soft palate inferiorly at the junction of the hard palate and the junction can then be marked.

  - It can also be located by instructing the patient to say 'ah' in short vigorous bursts.

- *Posterior vibrating line* is an imaginary line at the junction of the aponeurosis of the tensor veli palatini muscle and the musculature of the soft palate. It is the demarcation between the part of the soft palate that has limited movement during function and the remainder of the soft palate that is markedly displaced during function. It is a slightly curved line.

  - It can be located by instructing the patient to say 'ah' in short bursts but in a normal, unexaggerated manner.

- The seal also consists of two separate but confluent areas (Fig. 4.8A):

- Postpalatal seal extends medially from one tuberosity to another.
- Pterygomaxillary seal extends through the hamular notch for 3–4 mm anterolaterally approximating the mucogingival junction.

- The width and depth of the posterior palatal seal depend on the type and displaceability of soft palate (see Chapter 2).
- **Functions:** This can be divided into its importance when incorporated in the impression tray and complete denture.

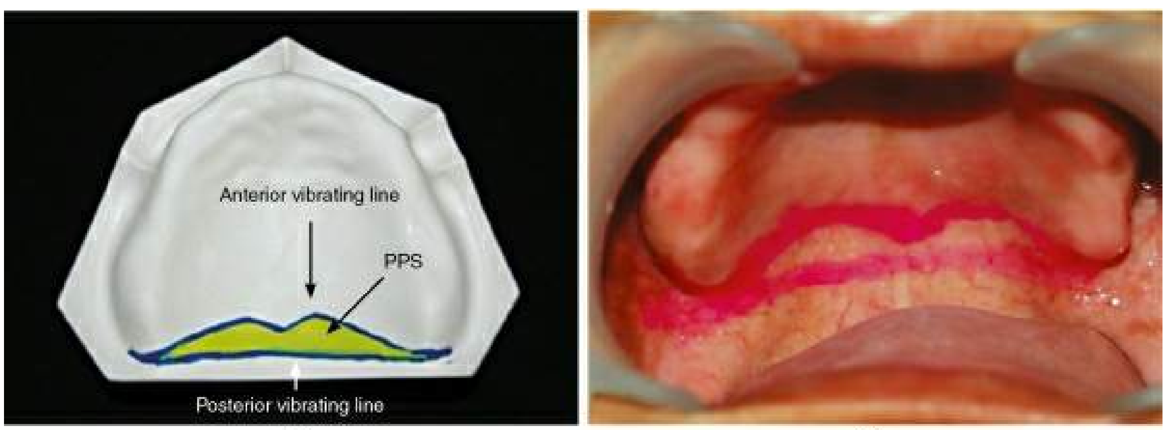
  - Impression tray
    - Establishes positive contact posteriorly and prevents impression wash material from sliding down the pharynx.
    - Guides the positioning of impression tray.
    - Creates slight displacement of soft tissues.
    - Helps verify retention and seal of potential denture border.
  - Complete denture
    - Primary function is retention of maxillary denture.

- Reduces gag reflex by reducing patient awareness of this area.

- Prevents food accumulation beneath the posterior aspects of the denture.

- Reduces patient's discomfort when contact occurs between dorsum of tongue and posterior part of denture.

- Compensates for volumetric shrinkage that occurs during polymerization of methyl methacrylate resin.



(a) (b)

FIGURE 4.7J Posterior palatal seal: (a) model and (b) intraoral.

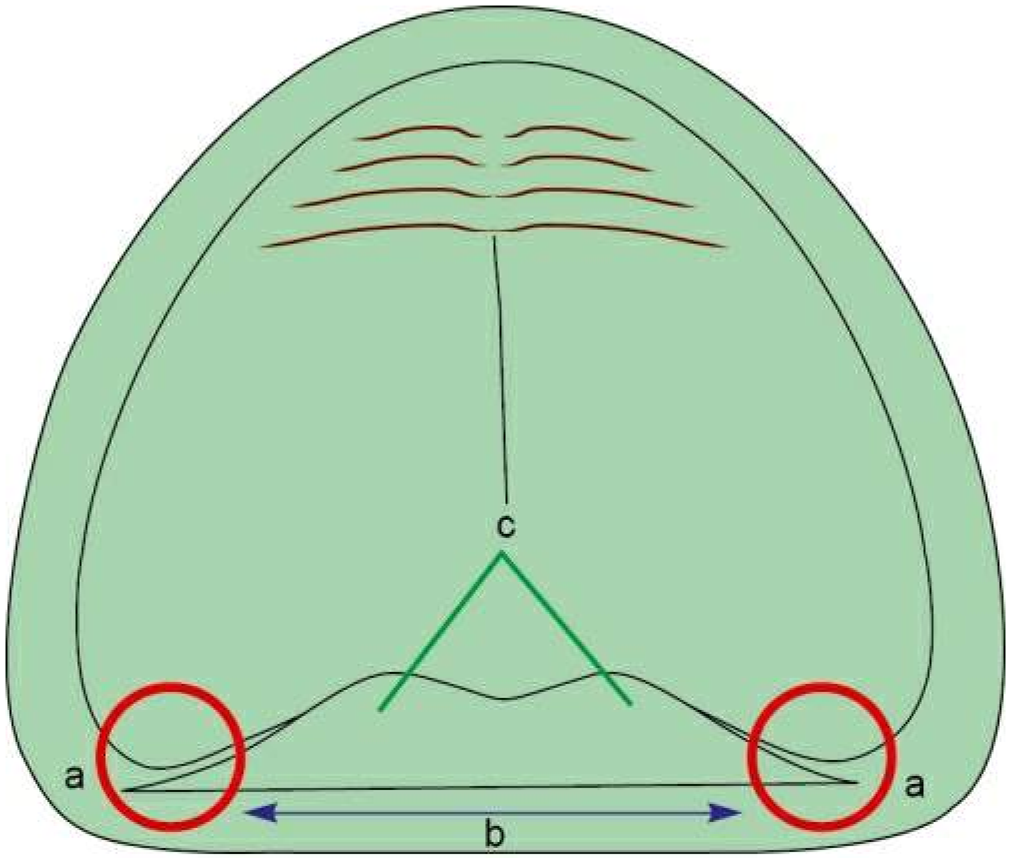


FIGURE 4.8A (a) Pterygomaxillary seal, (b) post palatal seal and (c) Posterior palatal seal area.

Recording the posterior palatal seal

This can be achieved by the following methods:

1. Scraping of cast

○ Functional

○ Arbitrary

2. Impression technique

○ Using fluid wax

○ Using low fusing compound.

1. Functional scraping of cast:

- This procedure is done on the trial denture base that is fabricated on the master cast (Fig. 4.8B).
- The patient is asked to sit in an upright position.
- After the posterior palatal area is wiped with gauze, a 'T' burnisher is used to locate the hamular notches by palpating posterior to the maxillary tuberosity on both sides, and marked with an indelible pencil. The posterior vibrating line is established and marked. Both these lines are connected to form the posterior border of the denture. The trial denture base is inserted into the patient's mouth and the line is transferred to the record base.
- The trial base is trimmed till the posterior border marking and seated on the master cast to transfer the recorded posterior border. The anterior vibrating line is marked in the patient's mouth by performing the Valsalva manoeuvre and transferred to the cast.
- Scraping the master cast functionally:

○ The deepest area of seal is located on either side of midline, one-third the distance anterior to posterior vibrating line. This is scrapped to a depth of 1–1.5 mm.

○ In the region of the midpalatine raphe, it should be only 0.5–1 mm in depth.

○ It should taper towards the hamular notches and anterior vibrating line, with minimal scraping.

- ○ It should also taper towards the posterior vibrating line but blends with the palatal tissues.

- After scraping the master cast, the postdam should be checked. The scrapped area of the cast is filled by readapting the shellac denture base or by adding autopolymerizing acrylic resin material.

- The modified record base is reinserted in the patient's mouth, and with a mouth mirror kept at the distal end, checked for any space as the patient says 'ah' in a short unexaggerated manner. Presence of a space between the record base and the soft tissues indicates under postdamming and the depth of the scraping should be increased. The procedure is repeated until no space exists.

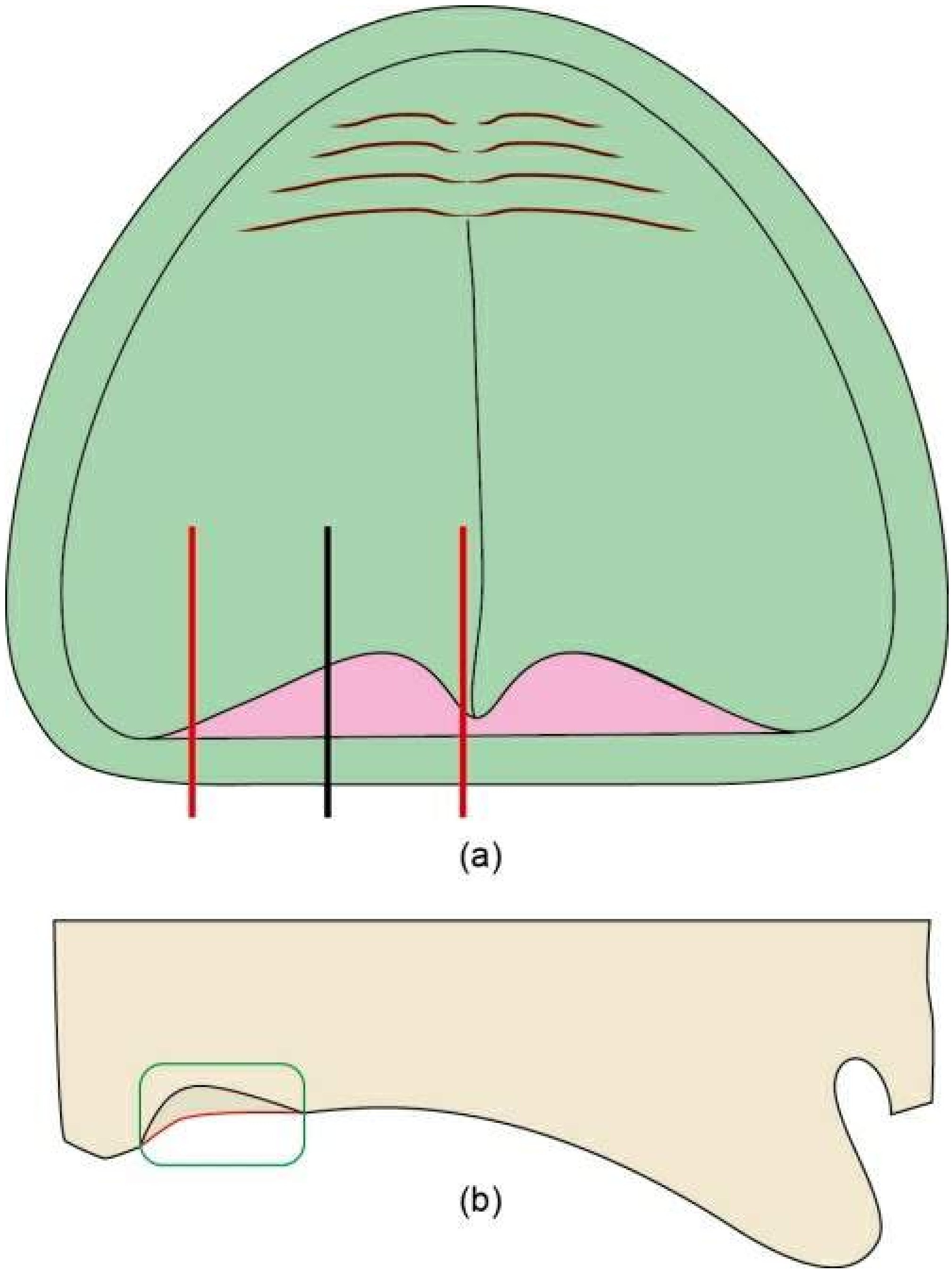


FIGURE 4.8B (a) Functional scraping of cast—sections made through the deepest portion (black line) and midpalatine suture and hamular notch (red lines). (b) Functional scraping—sagittal section showing depth of scraping in deepest portion (1–1.5 mm) and midpalatine suture and hamular notch areas (0.5 mm). (c) Functional scraping—enlarged view of section of deepest part. PVL, posterior vibrating line; AVL, anterior vibrating line.

Advantages:

- The trial base has increased retention due to this technique, thereby enhancing the accuracy of the jaw relation procedure.
- The patient can experience and is aware of the retentive qualities expected from the final denture.
- The dentist is also aware of the amount the retention denture will possess.
- Adjustment period with regard to the posterior extension of the denture is less for the patient.

Disadvantages:

- Not a physiological technique; hence, it is technique sensitive.
- Excessive scraping of the cast can lead to over postdamming.

2. Arbitrary scraping of the master cast:

- This is mostly done by the technician prior to processing the denture when the dentist fails to establish the seal clinically.
- It is an arbitrary notched line formed in the imaginary posterior vibrating line area extending to the hamular notches (Fig. 4.8C).
- It should be discouraged.

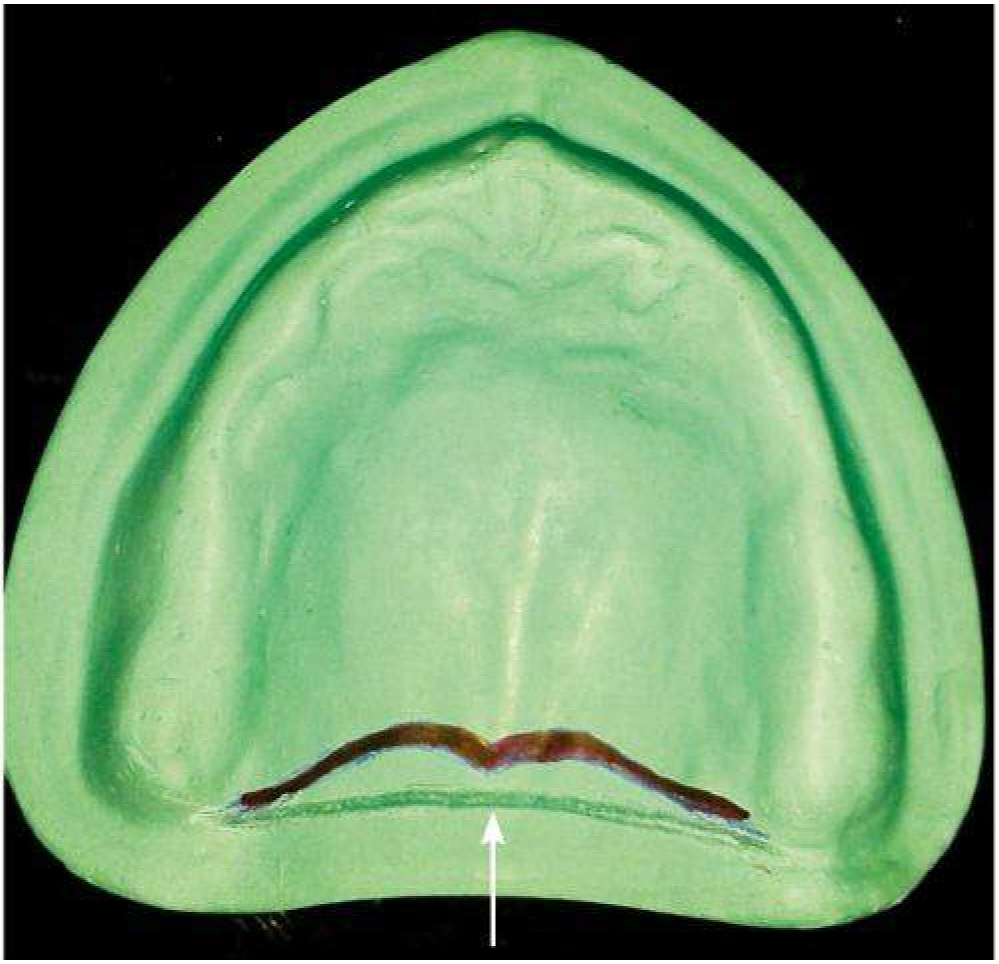


FIGURE 4.8C Arbitrary scraping of cast—a notch formed in the cast along the posterior vibrating line, which looks like a ledge in the denture.

3. Fluid wax technique:

- Any wax that is designed to flow at mouth temperature can be used.
- The seal is established after making final impressions but before pouring the master cast.
- ZOE and impression plaster are suitable impression materials for this technique as fluid wax adheres well to them.
- The anterior and posterior vibrating lines are marked as described in the conventional technique and transferred to the final

IMPRESSION in the mouth.

- The final impression is painted with fluid wax within the marked seal area. Usually it is applied in excess and cooled below mouth temperature so that it gains resistance to flow. This allows them to soften at mouth temperature and flow intraorally during impression making.

- The patient's head should be positioned such that the Frankfort's horizontal plane is 30° below the horizontal plane. It is only at this position that the 'soft palate' is at its maximal downward and forward functional position. Flexion of the head also helps to prevent excess impression material and saliva from moving down the throat.

- The patient's tongue should be positioned against the mandibular anterior teeth.

- The impression tray is inserted in the mouth and the patient is asked to periodically rotate the head so that all functional movements of the soft palate are recorded.

- The impression is removed after 4–6 min and examined. Glossy areas show tissue contact and dull areas represent lack of contact. Wax extending beyond the posterior vibrating line should be cut with a hot knife. Wax is added to areas that appear dull, and the procedure is repeated till the appropriate seal is achieved.

Advantages:

- It is a physiological technique.

- Overcompression of tissues is avoided.

- Increased retention of the record base and convenience in jaw relation.

• There is no need for mechanical scraping the master cast.

Disadvantages:

• Increase chairside time during patient appointment.

• Handling of material is difficult.

• Care needed while pouring master cast.

4. Low fusing compound:
Low fusing compound (greenstick compound) can also be used to make an impression of the seal area using a similar procedure as described for fluid wax.

Errors in establishing posterior palatal seal

Underextension

This is the most common cause for posterior palatal seal failure and leads to loss of retention.
Causes:

• Using fovea palatine as the limit for posterior denture extension results in loss of several millimetres of denture extension.

• Gag reflex of the patient, prompting the dentist to intentionally leave the posterior borders short.

• Incorrect delineation of the anterior and posterior vibrating lines.

• Asking technician to establish the seal on the cast arbitrarily.

Overextension

• Overextension of the denture base can lead to ulceration and painful deglutition.

• Covering of the hamular process can also lead to sharp pain in the region.

- These areas should be identified, trimmed and polished.

Under postdamming

- This can occur if the patient's mouth was wide open while making final impressions. The seal area becomes taut in this position and a space is created in other positions.

- Under postdamming can be verified by inserting a wet denture into a patient's mouth and inspecting the posterior border. If air bubbles are seen escaping under the posterior border, it indicates under damming.

- This is corrected by adding a new seal to the existing denture.

Over postdamming

- This commonly occurs due to excessive scraping of the master cast, especially in the hamular notch region.

- Mild overdamming in the hamular notch region can cause irritation of the mucosa and excessive postdamming displaces the denture.

Adding a seal to an existing denture

If all other functional and aesthetic requirements of the denture are fulfilled and it lacks only a proper seal, the same can be added in the denture as follows:

- An impression is made of the seal area on the denture, with fluid wax or low-fusing compound as described previously.

- The seal area is boxed separately and a cast is poured, or undercuts in the denture are blocked out and a cast of the entire fitting surface of denture is poured after applying separating medium in uninvolved areas.

- The cast is separated from the denture, wax or compound is removed from the cast and autopolymerizing denture base resin is added to the space occupied by the impression material using the sprinkle-on technique.
- As the resin polymerizes, the denture is attached firmly to the cast with rubber bands.
- It is then placed in a pressure pot for 20 min under 30 psi pressure. Denture is then separated from cast, excess trimmed and polished. It is stored in water for 24–36 h to eliminate any free monomer and then delivered.
- Light-activated resins can also be used.
- Direct intraoral correction with autopolymerizing resin is best avoided due to the exothermic heat and residual monomer.

Relief areas

Midpalatine suture

The submucosa underlying the **median palatal suture** is very thin making the overlying mucosa nonresilient. During intraoral examination, this area should be palpated to determine any tenderness. It may then be relieved during impression making (Fig. 4.9).

FIGURE 4.9A Relief areas in maxilla (model).

Incisive papilla

The submucosa covering the **incisive papilla** contains the nasopalatine vessels. It also gives an indication of the amount of resorption, as it comes to lie near the crest as resorption progresses. It may then need to be relieved to avoid pressure on the nerve and vessels (Fig. 4.9).

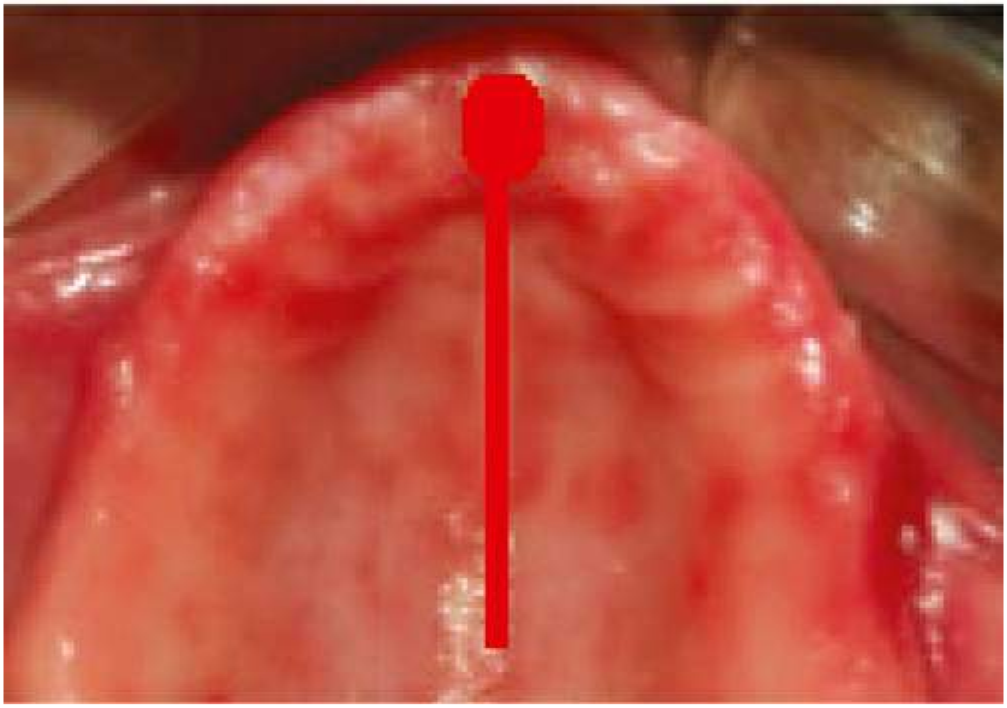


FIGURE 4.9B Relief areas in maxilla (intraoral).

Torus palatinus

This is a bony enlargement that occurs in the middle of the palate in 20% of the population. It is covered by a thin mucosa which can act as a fulcrum and is easily traumatized. Relief should be provided or surgical excision is planned (also see Chapter 3).

Mandible

1. **Supporting structures (**Fig. 4.10A and B):

- Buccal shelf area

- Residual alveolar ridge

2. **Limiting structures** (Fig. 4.10A and B):

○ Labial frenum

○ Labial vestibule

○ Buccal frenum

○ Buccal vestibule—masseteric notch

○ Retromolar pad

○ Alveololingual sulcus—retromylohyoid space

3. **Stress-bearing areas** (Fig. 4.10C):

○ Primary—buccal shelf area (Fig. 4.10D)

○ Secondary (Fig. 4.10E)

Labial and lingual slopes of the residual ridge

4. **Relief areas:**

○ Crest of the residual alveolar ridge

○ Mylohyoid ridge

○ Mental foramen

○ Genial tubercles

○ Torus mandibularis

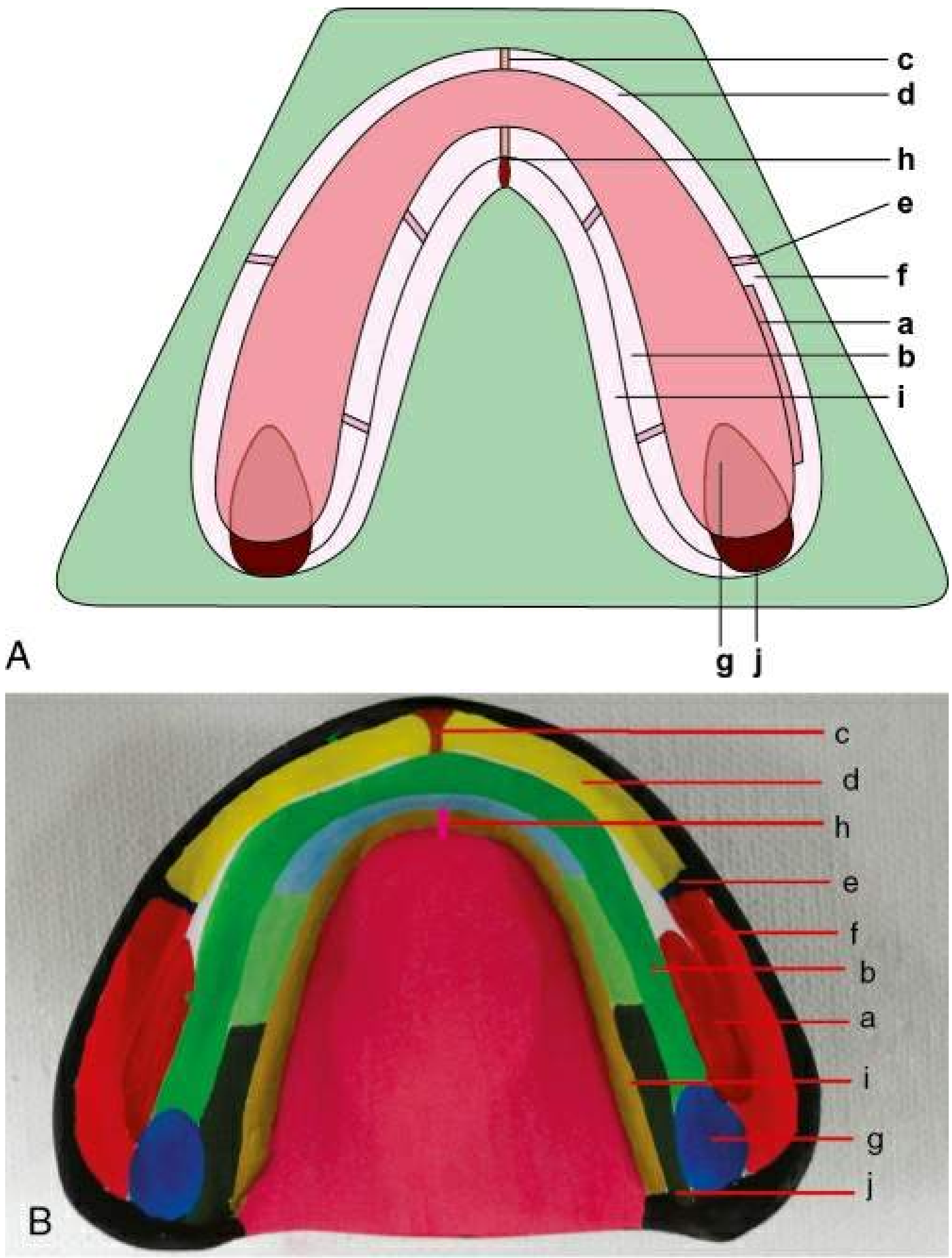


FIGURE 4.10A, B Supporting and limiting structures of the mandible: (a) buccal shelf area, (b) residual alveolar ridge, (c) labial frenum, (d) labial vestibule, (e) buccal frenum, (f) buccal vestibule, (g) retromolar pad, (h) lingual frenum, (i) alveololingual sulcus and (j) retromylohyoid space. **(A)** Line

diagram and **(B)** model

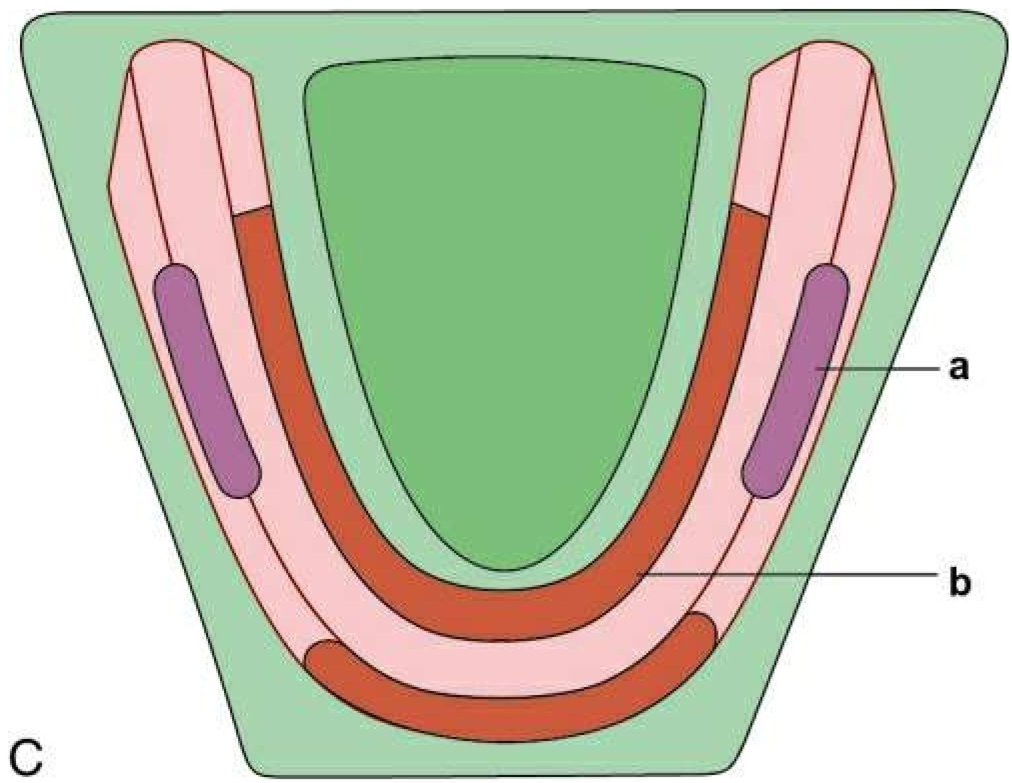
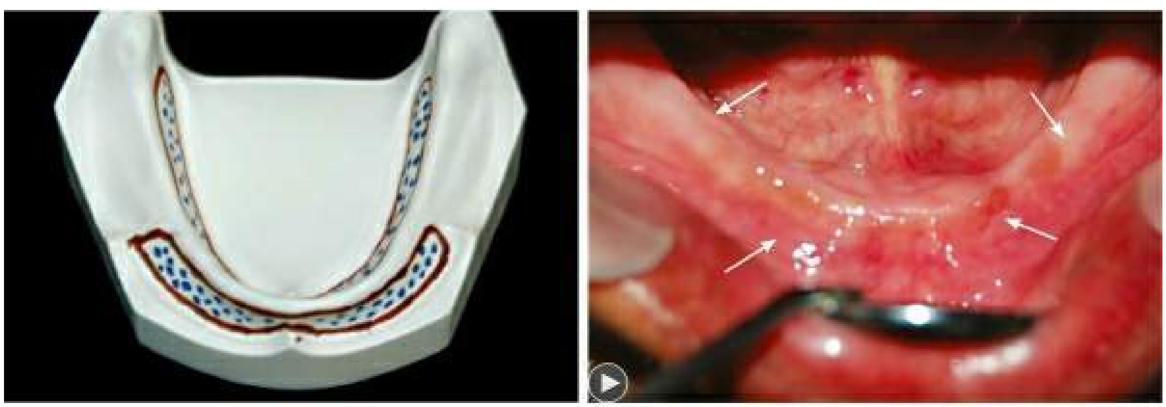


FIGURE 4.10C Stress-bearing area in mandible: (a) primary and (b) secondary.

FIGURE 4.10D Primary stress-bearing area in mandible – buccal shelf area.



(a) (b)

FIGURE 4.10E Secondary stress-bearing area in mandible – labial and lingual slopes of the residual ridge: (a) model (b) intraoral.

Supporting structures

Buccal shelf

- It is bounded by:

  ○ Medially—crest of the ridge

  ○ Laterally—external oblique ridge

  ○ Anteriorly—buccal frenum

  ○ Distally—retromolar pad

- The buccal shelf lies at right angles to the vertical occlusal forces and is covered with good smooth cortical bone. The total width of this region actually becomes greater with bone resorption. Hence, it is the primary stress-bearing area of the mandible even though the mucous membrane may not be histologically suitable for this (Fig. 4.10F).

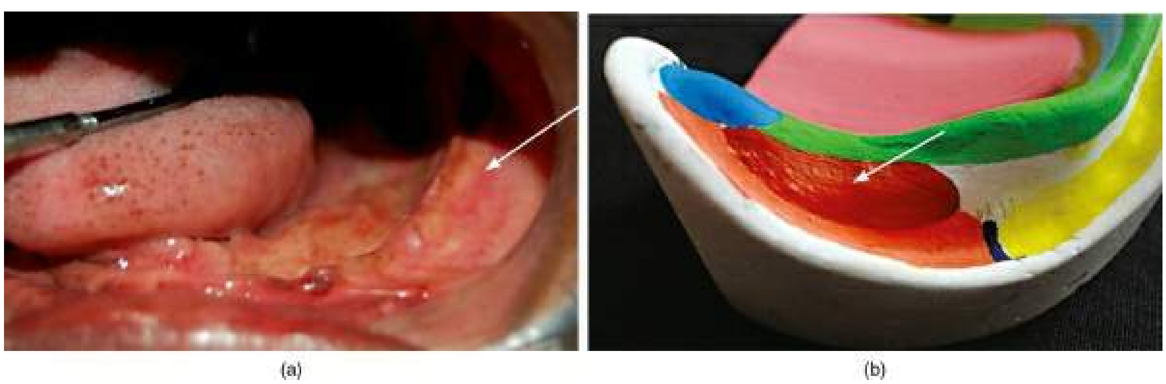


FIGURE 4.10F Buccal shelf area: (a) model and (b) intraoral.

Residual alveolar ridge

- The slopes of the residual alveolar ridge may provide more support than the crest in the mandible due to the nature of the underlying bone and the mucosa (Fig. 4.10G).

- The crest of the residual alveolar ridge is covered by fibrous connective tissue. But the underlying bone is cancellous made up of spongy trabeculae without a good cortical plate covering it. Though in the healthy mouth it is keratinized, the crest of the mandibular ridge is not suitable as a primary stress-bearing area.

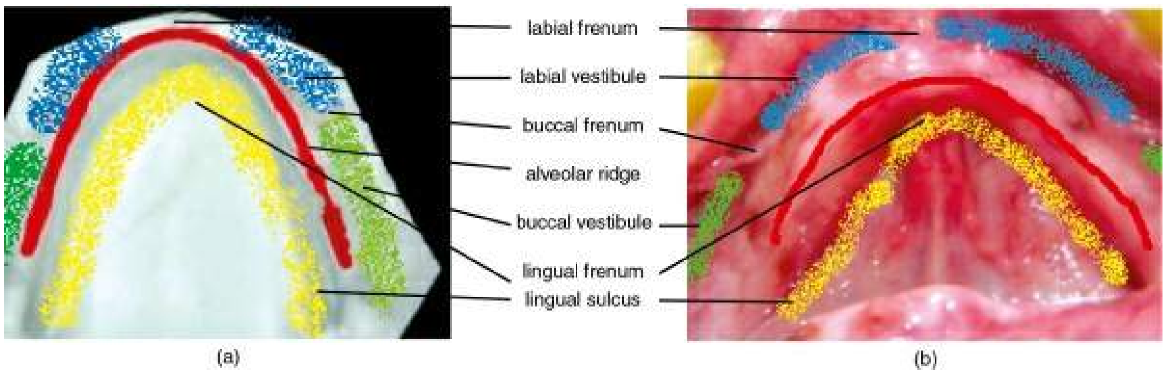


FIGURE 4.10G Residual alveolar ridge: (a) model and (b) intraoral.

Labial frenum

- The mandibular labial frenum contains a band of fibrous connective tissue that helps attach the orbicularis oris (Fig. 4.10G).

- It is quite sensitive and active vertically. It must be carefully accommodated by making a groove in the denture, to maintain a seal without causing soreness.

Labial vestibule

- Extends between the labial frenum to buccal frenum and houses the labial flange (Fig. 4.10G).

- Length of the labial flange of the denture is limited by muscles—orbicularis oris and incisive labii inferioris that are inserted close to the crest of the ridge.

- The thickness is restricted by orbicularis oris, which is stretched when asking patient to open mouth wide.

Buccal frenum

- Overlies depressor anguli oris and moves vertically and horizontally; needs wide clearance (Fig. 4.10G).
- Clearance must be provided in the denture, to avoid dislodgement.

Buccal vestibule

- Extends from the buccal frenum to the retromolar pad and houses the buccal flange. The buccinator muscle influences the extent of the flange (Fig. 4.10G).
- The distobuccal area of the buccal flange must converge rapidly to accommodate the anterior fibres of the masseter muscle which pass outside the buccinator in this region. When properly accommodated and recorded, this results in a notch in the denture called **masseteric notch**. Overextension in this region causes soreness and movement of denture.

Retromolar pad

This is a triangular pad of tissue at the distal end of the ridge (Fig. 4.10H).

- Its mucosa is composed of thin, nonkeratinized epithelium and submucosa contains loose areolar tissue, some glandular tissue, fibres of the buccinator (buccally), superior constrictor (lingually), pterygomandibular raphae (superoposteriorly) and tendon of the temporalis. This limits the pressure and extension in the pad.
- It should be covered by the denture as determined by the muscle attachments.

FIGURE 4.10H Retromolar pad: (a) model and (b) intraoral.

Lingual frenum

- Anterior attachment of the tongue and overlies genioglossus muscle (Fig. 4.10G).
- Extremely resistant and active.
- Usually occurs as a narrow, single band.
- It should be accommodated as a notch in the mandibular denture.

Alveololingual sulcus

- It is the space between the tongue and the residual ridge and extends posteriorly from the lingual frenum to the retromylohyoid curtain. It accommodates the lingual flange and is divided into three regions (Fig. 4.11A):

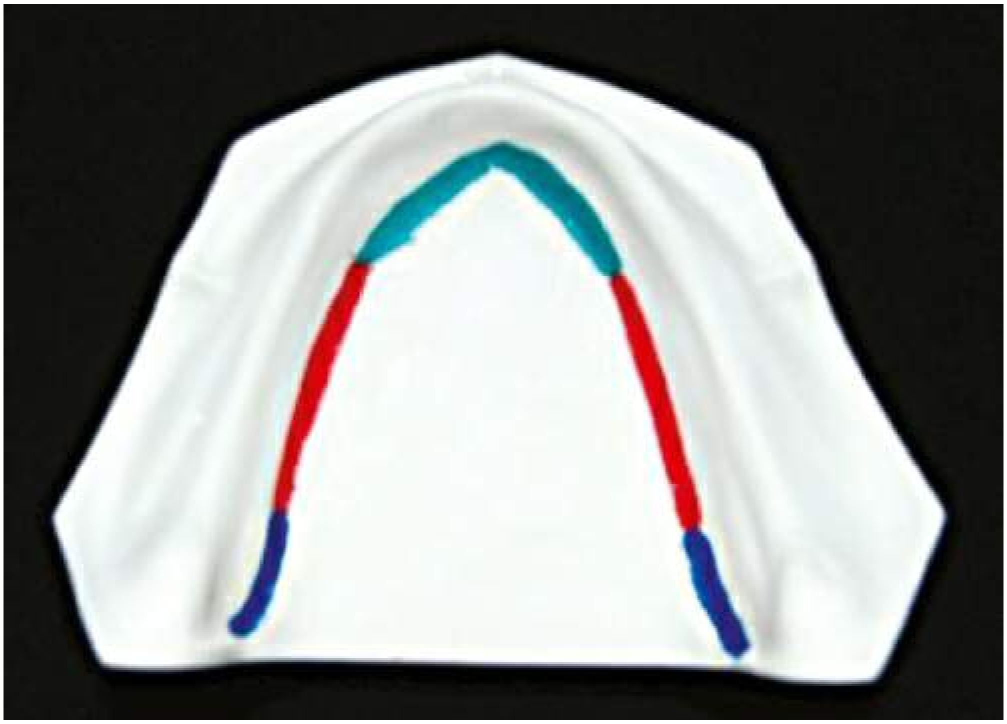


FIGURE 4.11A Alveolingual sulcus.

1. Anterior region

- Also called the sublingual crescent area or sublingual fold (Fig. 4.11B).
- It extends from the lingual frenum to the premylohyoid eminence (present in the impression).
- The lingual border of the denture in this region should extend down to make definite contact with the mucous membrane of the floor of the mouth, when the tip of the tongue touches the upper central incisors.

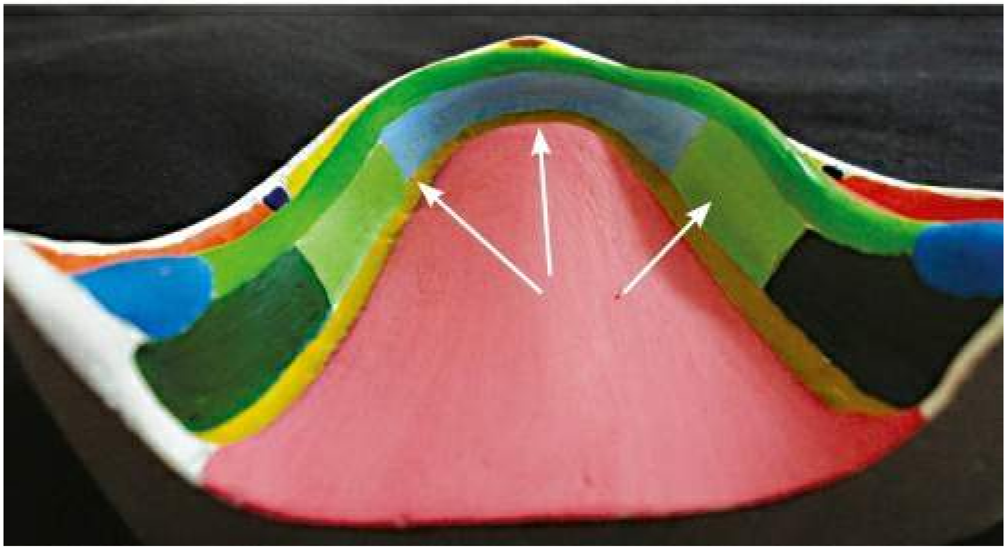


FIGURE 4.11B Anterior region (blue colour).

2. Middle region

- Extends from the premylohyoid fossa to the distal end of the mylohyoid ridge curving medially from the body of the mandible. This is due to the prominence of the mylohyoid ridge and action of the muscle (Fig. 4.11C).
- The lingual flange in this area is made to slope towards the tongue and can extend below the level of the mylohyoid ridge due to the following reasons:

○ Tongue rests on the flange stabilizing it.

○ Space is provided for raising the floor of the mouth during function without displacing denture.

○ Seal is maintained during function.

▪ If the ridge is flat, the denture border in this area may be made thicker (4–5 mm) to provide better stability and support.

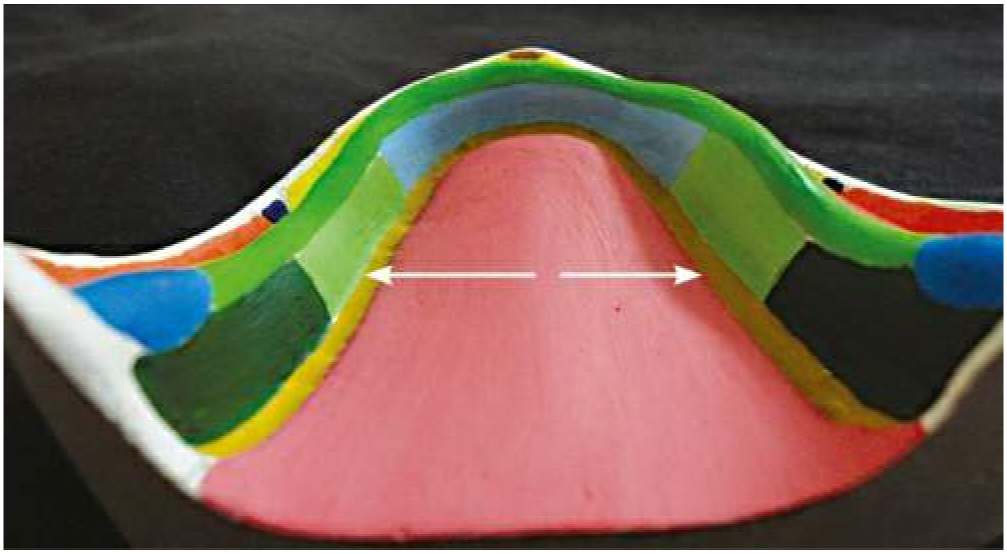


FIGURE 4.11C Middle region (green colour).

3. Distolingual region

- The flange passes into the retromylohyoid fossa and turns laterally towards the ramus. It is no longer influenced by mylohyoid muscle (Fig. 4.11D).
- The flange in this region completes the 'S' shape of the lingual flange as dictated by the combination of the arch form of the lingual side of the mandible, projection of mylohyoid ridge and retromylohyoid fossa.
- Denture border should be extended posteriorly to contact the retromylohyoid curtain when the tip of the tongue is placed against the front part of upper residual ridge.
- **Retromylohyoid space** is an anatomic area in the alveololingual sulcus just lingual to the retromolar pad bounded anteriorly by the

mylohyoid ridge, posteriorly by the retromylohyoid curtain, inferiorly by the floor of the alveololingual sulcus, and lingually by the anterior tonsillar pillar when the tongue is in a relaxed position (GPT8) (Fig. 4.11E).

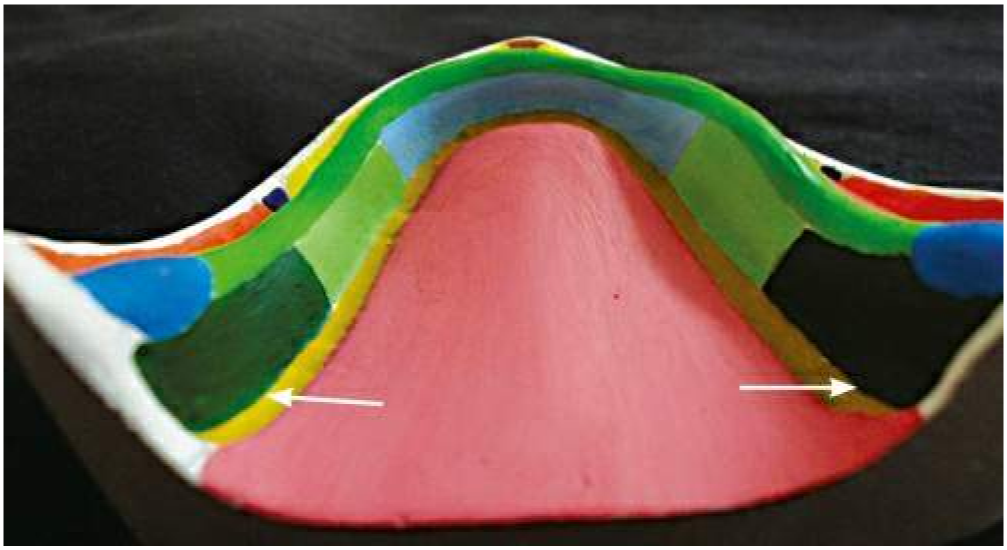


FIGURE 4.11D Distolingual region (black).

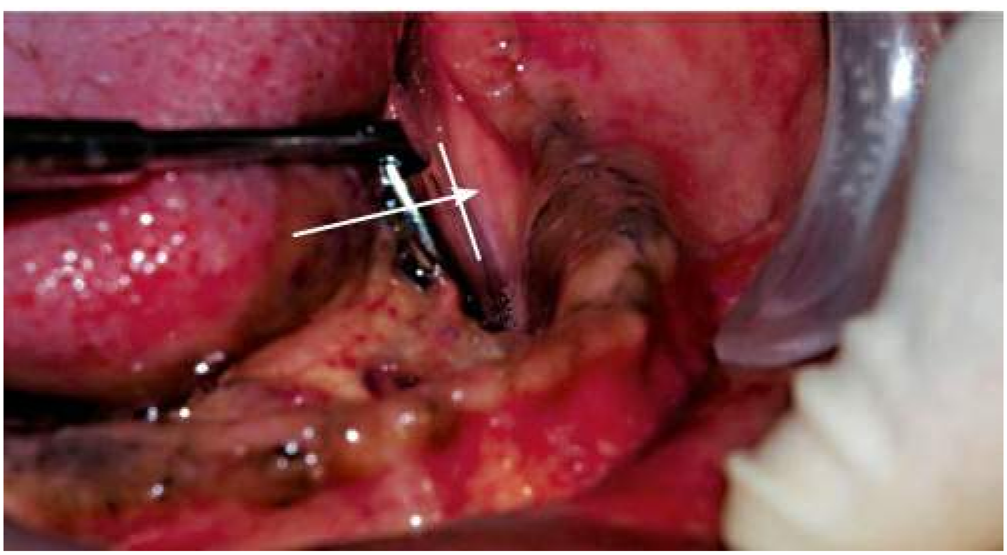
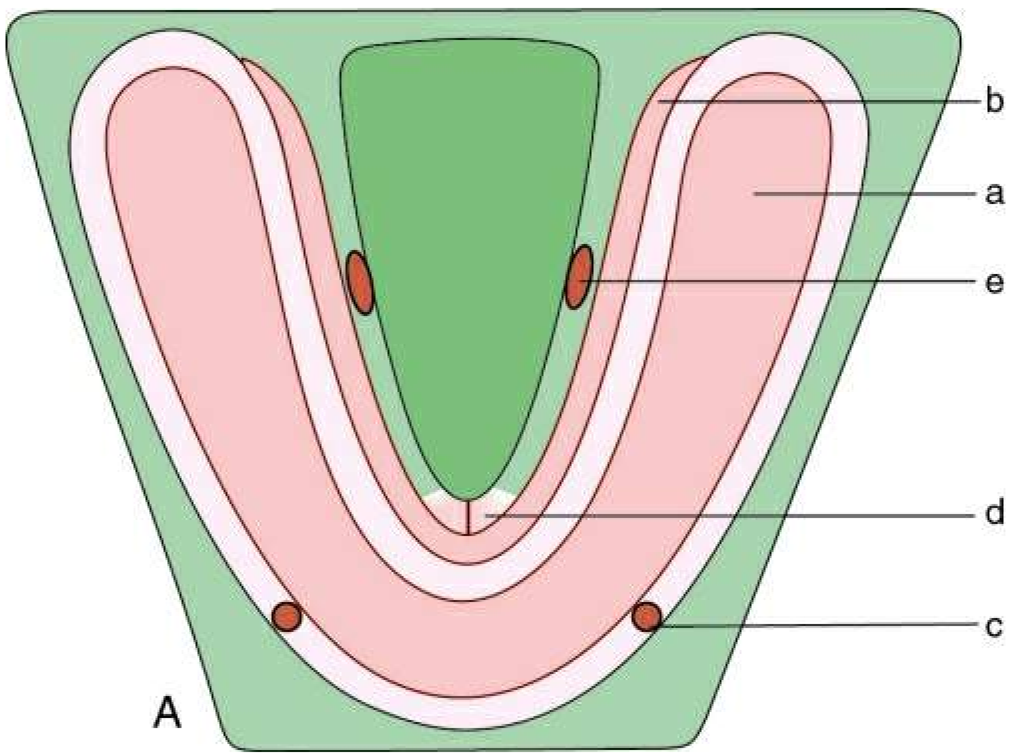


FIGURE 4.11E Retromylohyoid space.

Relief areas (fig. 4.12A and B)

Crest of residual alveolar ridge

This area can sometimes be present as sharp, spiny or knife-edged. Then it needs to be relieved.



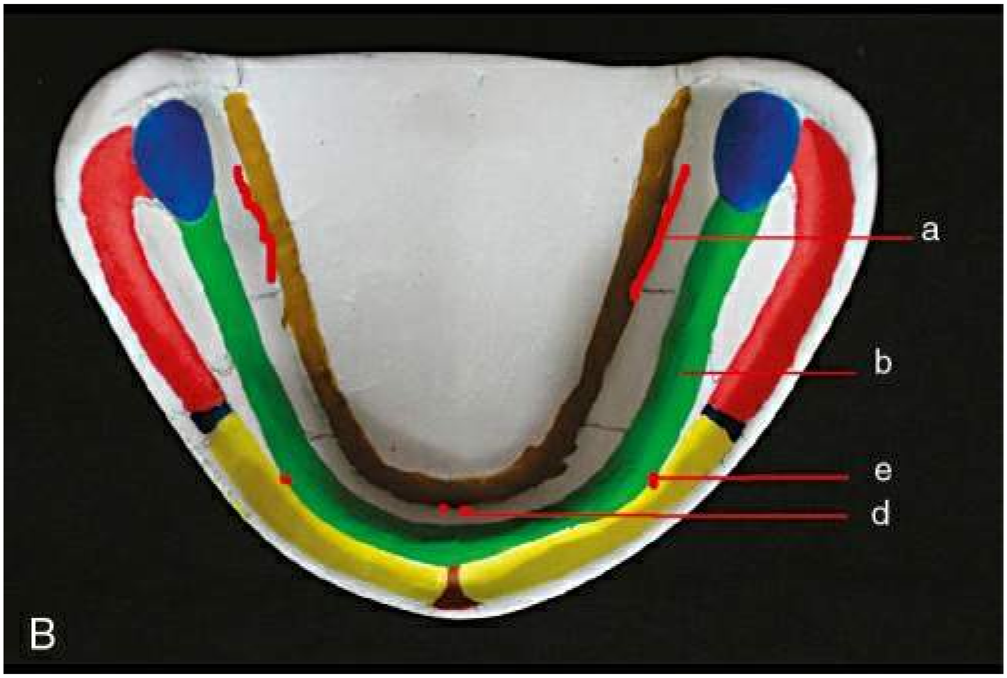


FIGURE 4.12A, B Relief areas in mandible: (a) mylohyoid ridge, (b) crest of residual alveolar ridge, (c) torus mandibularis (d) genial tubercles and (e) mental foramen. **(A)** Line diagram and **(B)** model.

Mylohyoid ridge

The shape and inclination of the **mylohyoid ridge** varies greatly among edentulous patients. Mylohyoid muscle attaches to this ridge. The denture flange should extend below the mylohyoid ridge. With resorption, the mylohyoid ridge can become prominent and sharp, and is easily traumatized by the denture base. Relief may be necessary in such cases.

Mental foramen

It may come to lie on the crest of the residual ridge when resorption is severe. The denture will then compress the mental nerves and blood vessels unless relief is provided. Pressure on the nerve can cause numbness of lower lip.

Genial tubercles

Present lingual to the anterior body of the mandible and can also become prominent with severe resorption. They may need to be relieved then.

Torus mandibularis

It is a bony prominence found bilaterally and lingually in the premolar region. Surgical removal is indicated mostly as relief may compromise on peripheral seal. Surgical contraindications may necessitate relief.

Preliminary impressions

The main objective of making preliminary impression is to fabricate a custom tray.

Requirements

- To obtain an accurate impression of the entire denture-bearing surface of each jaw.
- To record the full extent of the sulcus.
- To ensure all the anatomic landmarks are recorded.

Material selection

- Preliminary impressions are made with stock trays.
- An impression material with relatively high viscosity is selected allowing the material to compensate for any deficiencies in the tray.
- The preliminary impressions are generally overextended.
- The following materials are commonly used:

○ Impression compound

○ Irreversible hydrocolloids

○ Silicone putty

Tray

Definition: A receptacle or device used to carry the impression material to the mouth, confine the material in apposition to the surface to be recorded, and control the impression material, while it sets to form the impression.

Selection

A stock tray (prefabricated) is used for preliminary impressions.

- These are available in metal or plastic. Metal is preferred because of its rigidity (Fig. 4.13).
- They may be perforated or nonperforated – perforated trays are used with irreversible hydrocolloids for retention. Impression compound is used with nonperforated trays. Silicon putty requires a tray adhesive for retention.
- Size of the tray is selected by using a divider or calipers:
  - Measurement for the lower tray is made by placing the tips of the divider on the lingual aspect of the ridges just below the retromolar pad on the right and left sides. This must be comparable to the lingual flanges of the tray posteriorly (Fig. 4.14A and B).
  - In the upper jaw, the tips of the divider is placed in the buccal vestibule in the tuberosity region and compared to tray flanges in the corresponding area (Fig. 4.14C and D).
  - The tray should be 5 mm larger than the residual ridge. It should cover the tuberosity and the

retromolar pads.

- Modelling/beading wax is added to build up the tray contour if the tray is short. This is necessary only for irreversible hydrocolloid impressions.

FIGURE 4.13 Stock tray: metal nonperforated and perforated.

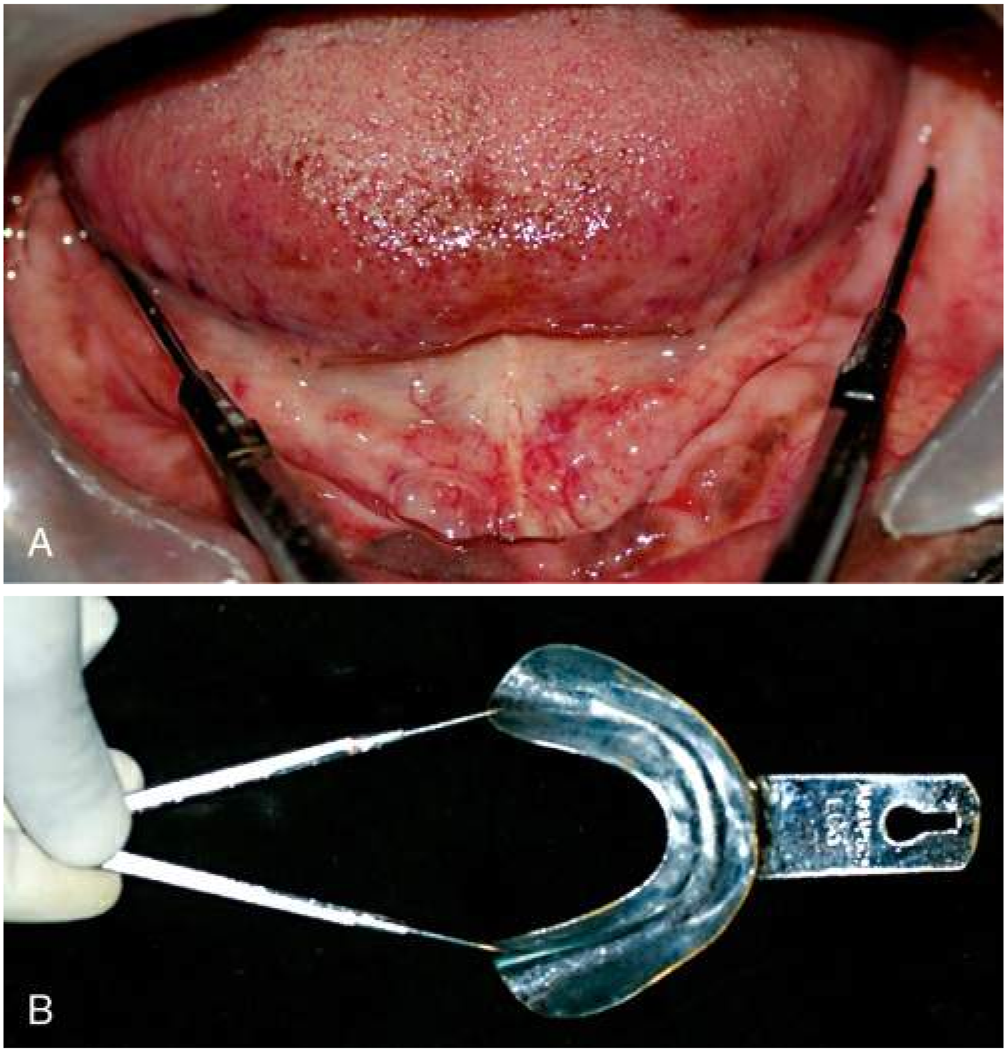


FIGURE 4.14 **(A)** Size of mandibular tray is selected by placing a divider lingual to retromolar pad on either side in the mouth. **(B)** This should conform to the lingual flange of the tray posteriorly.

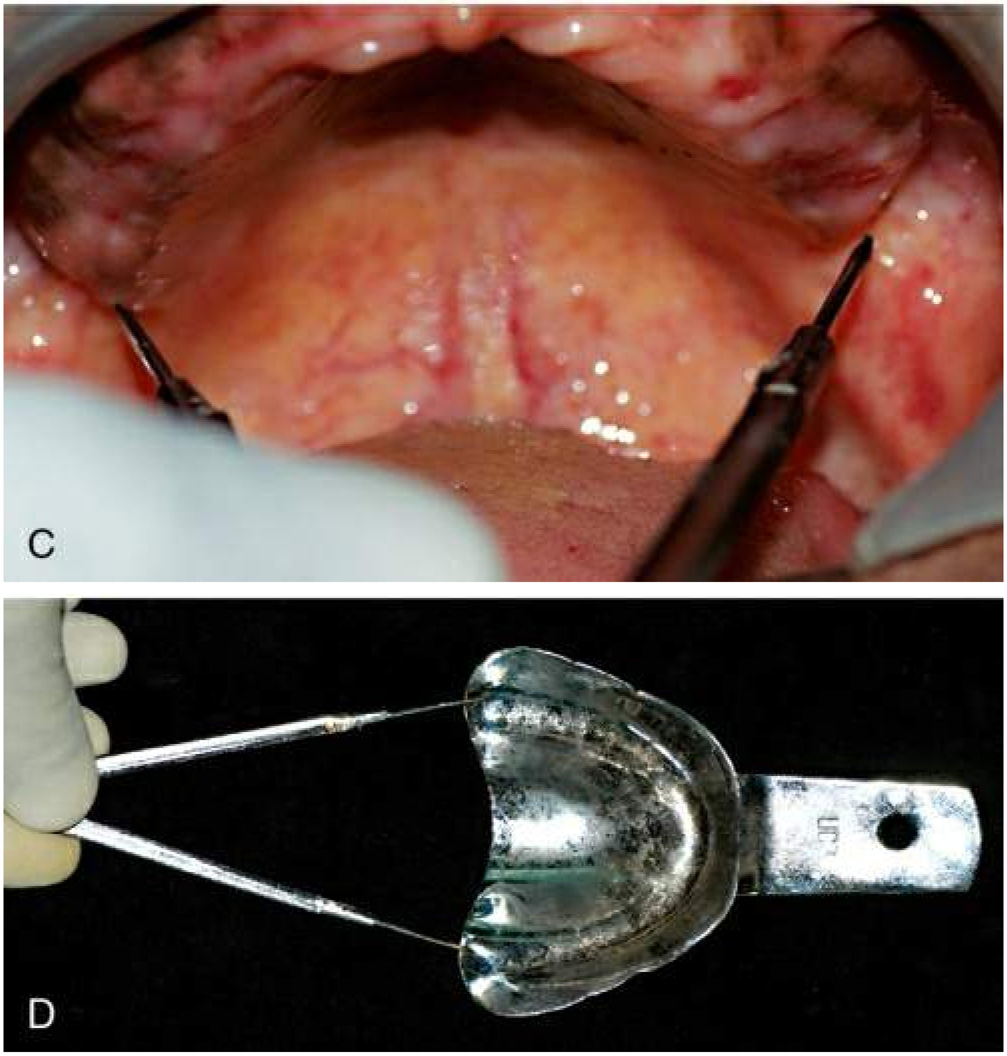


FIGURE 4.14 (**C**) Size of maxillary tray is selected by placing the divider buccal to tuberosity on either side **(D)** and comparing it to the tray.

Position of patient and operator

Maxillary impressions

The position of the patient and operator varies for maxillary and mandibular impressions. For maxillary impressions, the patient is seated upright with the operator in the rear. Patient's mouth is at the level of operator's elbow. The position is summarized in Table 4.1 and shown in Fig. 4.15A.

A

FIGURE 4.15A Patient and operator position for maxillary impression.

Table 4.1

Summary of patient and operator position for maxillary impressions

Patient position	Head and neck are in line with the trunk. Head is upright, occiput resting firmly on the headrest of the chair
Operator position	Right rear or rear position
Height of the chair	Patient's mouth should be in level with the operator's elbow

Mandibular impression

The position of the operator changes for mandibular impressions. The operator is positioned in front of the patient, on the right. Patient's mouth is at the level of operator's shoulder. The position is summarized in Table 4.2 and shown in Fig. 4.15B.

FIGURE 4.15B Patient and operator position for mandibular impression.

Table 4.2

Summary of patient and operator position for mandibular impressions

Patient position	Head and neck are in line with the trunk. Head is upright, occiput resting firmly on the headrest of the chair
Operator position	Right front position
Height of the chair	Patient's mouth should be in level with the operator's shoulder

Mandibular preliminary impressions

It is always preferable to make the lower impression first for the following, according to George Alexander Lamme

- If the patient is susceptible to gagging, it is more likely to occur when making the upper impression. The patient becomes more apprehensive and less cooperative when an attempt is made to make the mandibular impression after the maxillary impression.

- The effect of inserting an impression tray and material into the patient's mouth causes a reflex salivation, which is cumulative and after a period excess saliva pools in the floor of the mouth.

- Particles of some impression materials can become detached from the mass of impression material loaded into the tray. In the upper, such fragments may fall onto the lower alveolar ridge and these escape removal when the patient washes out the mouth. This is particularly liable to occur when the oral tissues are covered with a tenacious layer of mucous.

With impression compound

- The patient is usually asked to use an astringent mouthwash to reduce the viscosity of the saliva.

- Nonperforated stock tray is inserted in the patient's mouth to confirm its extension.

- Compound is placed in hot water (60°C) and is kneaded to achieve uniform consistency without wrinkles or folds.

- It is formed into a suitable size roll (1.5 cm in diameter) and placed in the tray with enough bulk extending beyond the flanges such that there is no restriction in flow when pressed over the ridge (Fig. 4.16 A and B).

- A trough is indented in the compound with a finger to receive the crest of the alveolar ridge (Fig. 4.16C). It should be deeper posteriorly and shallow anteriorly and moulding should begin from the midline and proceed distally.

- It is again placed in hot water, tempered and inserted in the patient's mouth.
- For insertion, the tray is first placed in the left side of the mouth at right angles to the final position, and then rotated in a clockwise manner to engage the right side after retracting the angle of the mouth on that side (Fig. 4.16D).
- Once the tray is in position, the patient is instructed to slightly close the mouth and raise the tongue, while vertical pressure is applied on the tray in the molar region (Fig. 4.16E).
- The cheeks are stretched to ensure that they are not trapped in the tray.
- Labial and buccal flanges are border moulded (see Border Moulding in the subsequent section) and patient is asked to move the tongue from side to side and then protrude it slightly.
- As the room temperature may be less than that intraorally, the material sets from the tray towards the tissues. Due to poor thermal conductivity, it will take longer time for the material in contact with the tissues to set as compared to those outside of tray. Sufficient time should be given after the external material sets to remove the tray, thereby, preventing distortion.
- To remove the tray, patient is asked to close the mouth partially, cheeks are retracted to break the seal, the handle of the tray is held between the thumb and index and middle fingers of the right hand, and an upward and backward force is applied.
- The impression (Fig. 4.16F) is evaluated for extension, reproduction of anatomical landmarks, tray exposure and wrinkles or voids.

- *Refining the preliminary impression*: Any excess material is trimmed, impression is again softened in warm water and refined by reseating the impression in the patient's mouth. Similarly, a deficient border can be added with low fusing compound.
- The impression should be poured within an hour to minimize warpage due to release of stresses.

FIGURE 4.16A Roll.

FIGURE 4.16B Placed on tray.

FIGURE 4.16C Troughing.

FIGURE 4.16D Insertion at right angles.

FIGURE 4.16E Final seating.

FIGURE 4.16F Completed lower impression.

With irreversible hydrocolloid (Alginate)

- Alginate requires support from the tray because of its poor tear-resistance. The tray should be extended if needed with modelling or boxing wax (Fig. 4.17A).
- A clearance of 2–3 mm is sufficient for alginates.
- The powder and liquid are mixed to a slightly thicker consistency and loaded onto a perforated stock tray up to the border. A small quantity is placed on the retromylohyoid area and labial vestibules to displace any air pockets and the impression is made (Fig. 4.17B).

- Tray is inserted and removed as described for impression compound. All elastic impressions should be removed in a snap. It is then rinsed in tap water, dried and evaluated for any deficiencies (Fig. 4.17B). The impression must be remade if any deficiencies exist.
- It should be poured immediately.

FIGURE 4.17A Tray extended with wax.

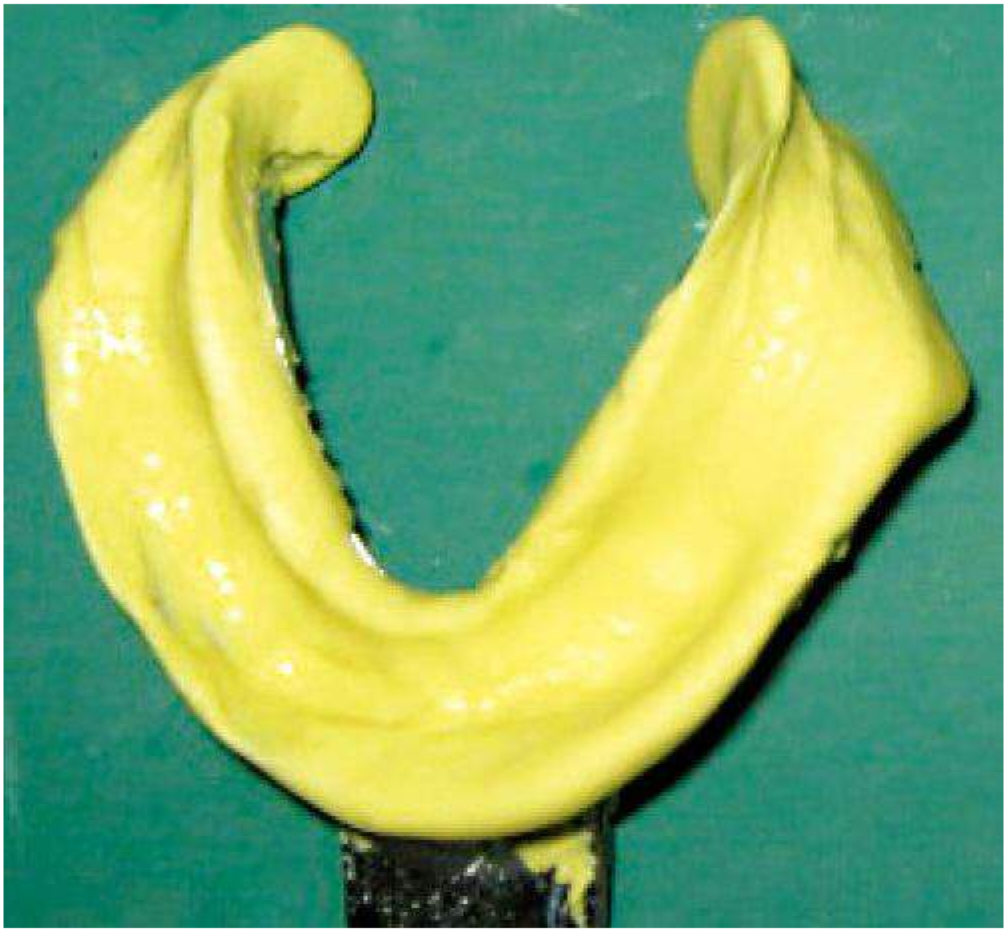


FIGURE 4.17B Completed irreversible hydrocolloid preliminary impression.

Impression with silicone putty

- The procedure is similar to impression compound except that the material is supplied as a base and catalyst, which is dispensed in equal quantities and kneaded. A nonperforated stock tray is used with a tray adhesive.

- The impression is removed in a snap. It is difficult to refine the impression, but pouring can be delayed (Fig. 4.18).

FIGURE 4.18 Completed mandibular putty impression.

Maxillary preliminary impressions

With impression compound

- Nonperforated stock tray is inserted in the patient's mouth to confirm its extension.
- Compound is placed in hot water (60°C) and is kneaded to achieve uniform consistency without wrinkles or folds.
- It is formed into a suitable size ball and placed over the centre of the tray (Fig. 4.19A).

- The compound is moulded and spread to fill the tray in order to develop a trough to accommodate the ridge crest (Fig. 4.19B). This is best accomplished by moulding the compound with both thumbs holding the tray from the rear end (Fig. 4.19C).
- For insertion, the tray should be held with the handle in the operator's right hand pointing towards the patient's right. The operator uses index and middle finger of left hand to retract the upper lip and tray is rotated into the mouth (Fig. 4.19D and E).
- The labial frenum is used as a guide to centre the tray.
- The patient is instructed to slightly close the mouth, while the upper lip is lifted upwards and forwards.
- Seat the tray anteriorly such that the alveolar process presses the compound and excess flows into the labial sulcus (Fig. 4.19F).
- Seat the tray posteriorly until the impression contacts the ridge.
- Apply an upward and backward force with index finger of each hand placed under the tray until the material flows into the vestibule and posteriorly (Fig. 4.19G).
- The lips and cheek are gently border moulded (as described in subsequent section) and patient is instructed to open the mouth wide and move the mandible from side to side (to mould the distobuccal flange). The material is then allowed to set.
- To remove the tray, patient is asked to close the mouth partially, cheeks are retracted to break the seal, the handle of the tray is held between the thumb and index and middle fingers of the right hand, and a downward and forward force is applied.
- The impression (Fig. 4.19H) is evaluated for extension, reproduction of anatomical landmarks, tray exposure and wrinkles or voids.

• It can be refined if needed and poured within an hour.

FIGURE 4.19A The compound is moulded into the shape of a ball and placed in centre of tray.

FIGURE 4.19B Moulding the compound with both thumbs

holding the tray from the rear end.

FIGURE 4.19C The material is spread out evenly creating a trough in the ridge areas.

FIGURE 4.19D Tray inserted from right side.

FIGURE 4.19E Tray rotated into mouth.

FIGURE 4.19F Tray seated anteriorly.

FIGURE 4.19G Final seating.

FIGURE 4.19H Completed maxillary impression.

With irreversible hydrocolloid

- The tray should be extended if needed with modelling or boxing wax. Wax can also be added to the vault area of the tray in case of high palatal vaults (Fig. 4.20A).
- A clearance of 2–3 mm is sufficient for alginates.
- The posterior palatal seal area is wiped with gauze to remove any excess saliva.
- The powder and liquid are mixed to a slightly thicker consistency and loaded onto a perforated stock tray up to the border. A small quantity is placed on the palatal vault and buccal vestibule.
- Tray is inserted as described for impression compound and as the material sets, the patient is instructed to keep eyes open, relax, breathe through the nose and bend the head down a little to prevent impression from running down the throat. All elastic impressions should be removed in a snap. It is rinsed in tap water, dried and then evaluated for any deficiencies (Fig. 4.20B). The impression must be remade if any deficiencies exist.
- It should be poured immediately.

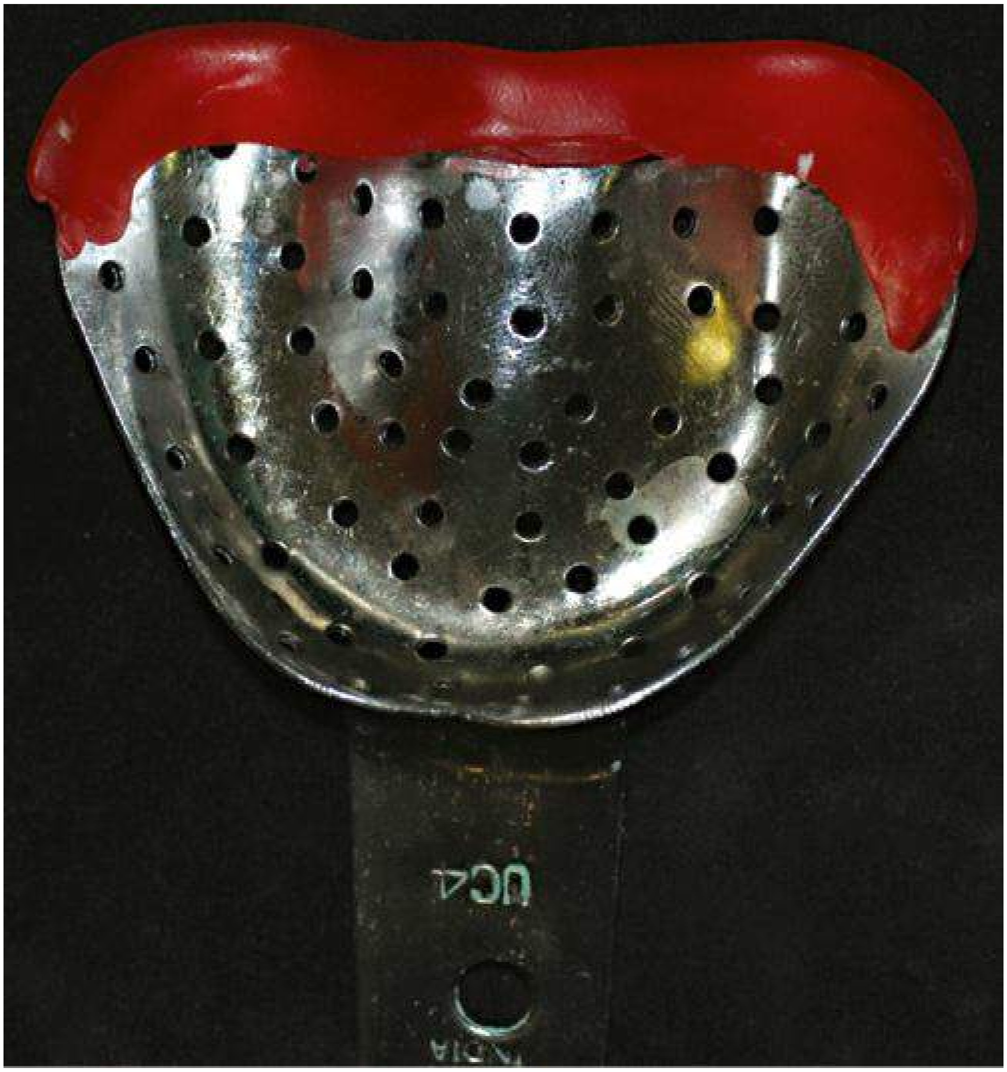


FIGURE 4.20A Correction with modelling/utility wax.

FIGURE 4.20B Completed irreversible hydrocolloid impression.

Impression with silicone putty

- Procedure of manipulation, insertion and making an impression is similar to impression compound, except that the putty is supplied as a base and catalyst paste.

- The impression is removed in a snap. It is difficult to refine the impression, but pouring can be delayed (Fig. 4.21).

FIGURE 4.21 Completed maxillary preliminary impression with silicone putty.

Preliminary/primary cast

- After making the preliminary impressions, the preliminary casts are poured with model plaster, irrespective of the impression material used.

- The recommended water, powder of plaster is dispensed in a rubber bowl and mixed.

- This is poured into the impression in small quantities from one posterior end, allowing it to flow into the other under vibration (Fig. 4.22A and B). After filling up the entire impression and initial set attained (Fig. 4.22C), a base former is filled with plaster and the poured impression is inverted onto it. Alternately, a block of plaster can be poured on a tile or glass plate and the poured impression is inverted onto it forming a base of 15 mm. The width should be 5–6 mm (Fig. 4.22D) beyond the impression. The ridge crests should be parallel to the glass plate or table top. The material in the tray should reach its initial set before it is inverted to form a base.

- The material should be allowed to set for about 45 min or follow manufacturers' recommendations and then it is removed. For irreversible hydrocolloids' impressions, a damp cloth can be used to cover the cast while it sets.

FIGURE 4.22C2 A block of plaster poured on a tile.

- To remove compound impressions, the cast with tray is immersed in warm slurry water at 65°C for 5 min. The impression is then easily separated once the material softens (Fig. 4.22E).
- The casts are trimmed as per recommended dimensions for the base and land areas (Figs 4.23–4.25).
- The impressions can also be poured after beading and boxing as described later in this chapter in the section 'Definitive Casts'.

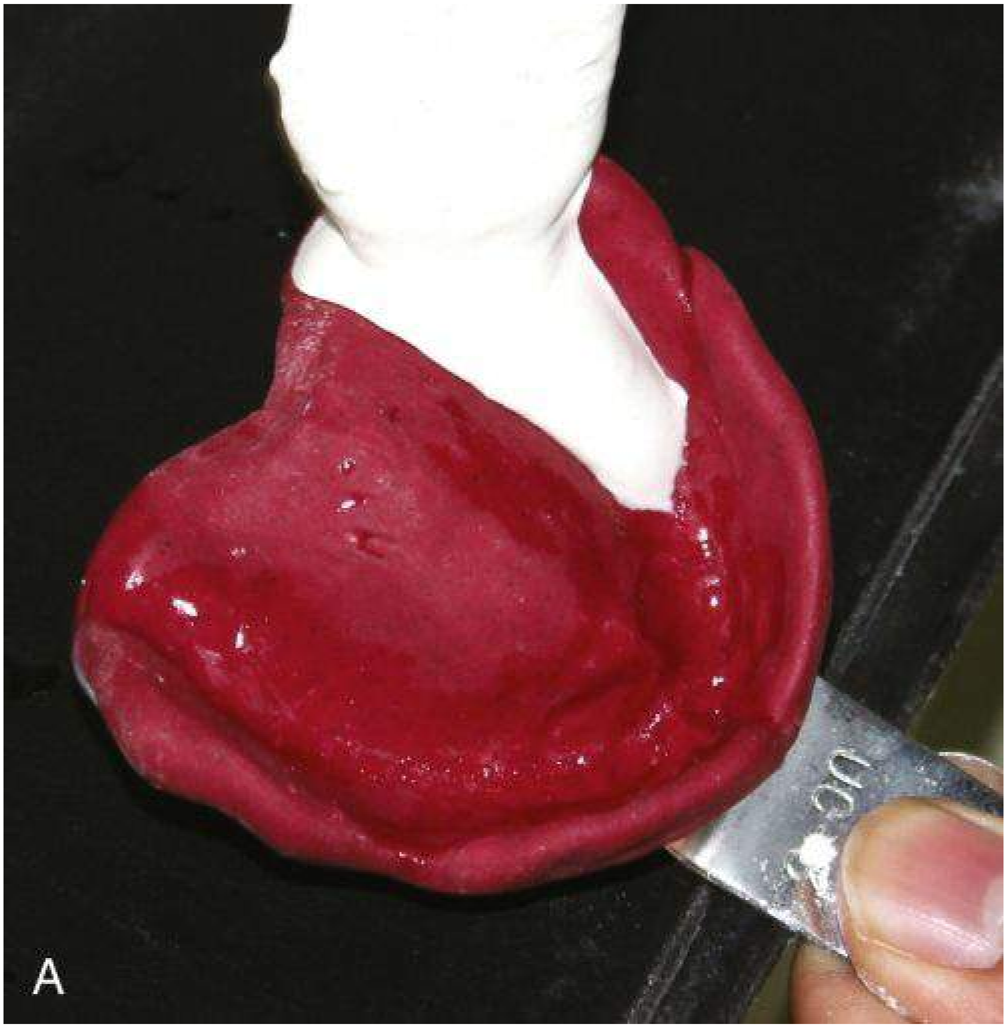

A

FIGURE 4.22 Showing pouring of cast from one posterior end and allowing to flow: **(A)** maxillary and **(B)** mandibular.

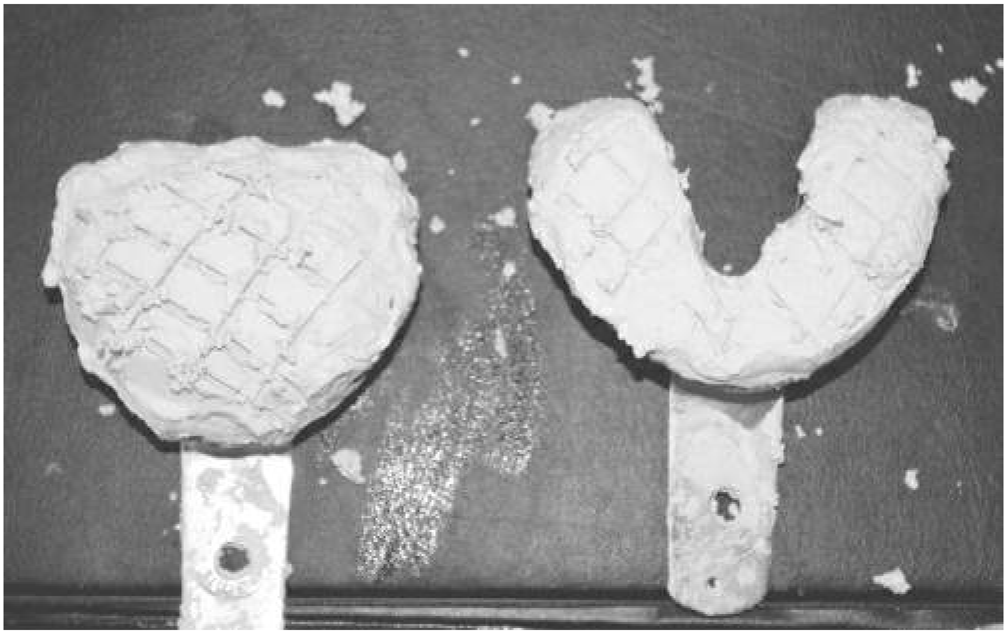


FIGURE 4.22C1 Poured maxillary and mandibular casts on initial setting, with grooves for retention to base.

(a) (b)

FIGURE 4.22D The poured cast is inverted onto the block of plaster: (a) maxillary and (b) mandibular.

FIGURE 4.22E The set cast is immersed in a bowl of warm water to retrieve the cast from the tray.

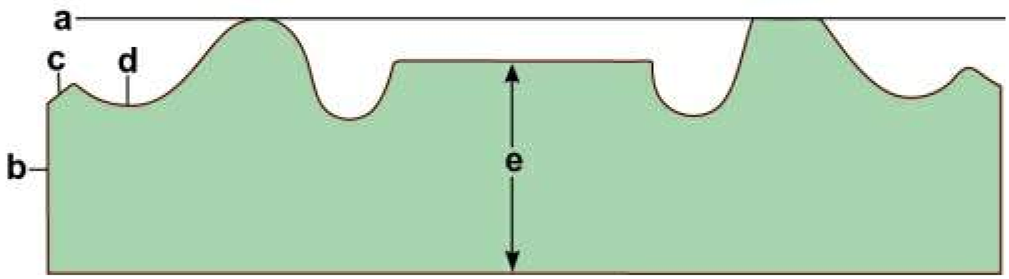


FIGURE 4.23A Cross section of a mandibular cast: (a) ridge is parallel to base, (b) sides are perpendicular to base, (c) land area 2–3 mm at 45º, (d) sulcus 2 mm depth below land area and (e) base of 10–15 mm.

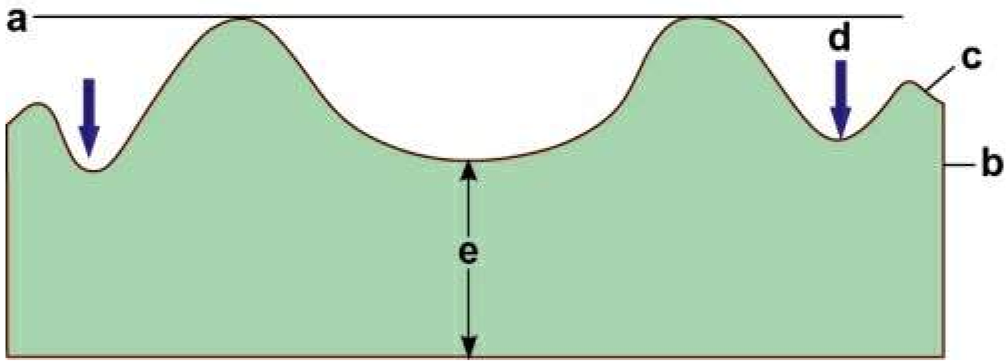


FIGURE 4.23B Cross section of a maxillary cast: (a) ridge is parallel to base, (b) sides are perpendicular to base, (c) land area 2–3 mm at 45º, (d) sulcus 2 mm depth below land area and (e) base of 10–15 mm.

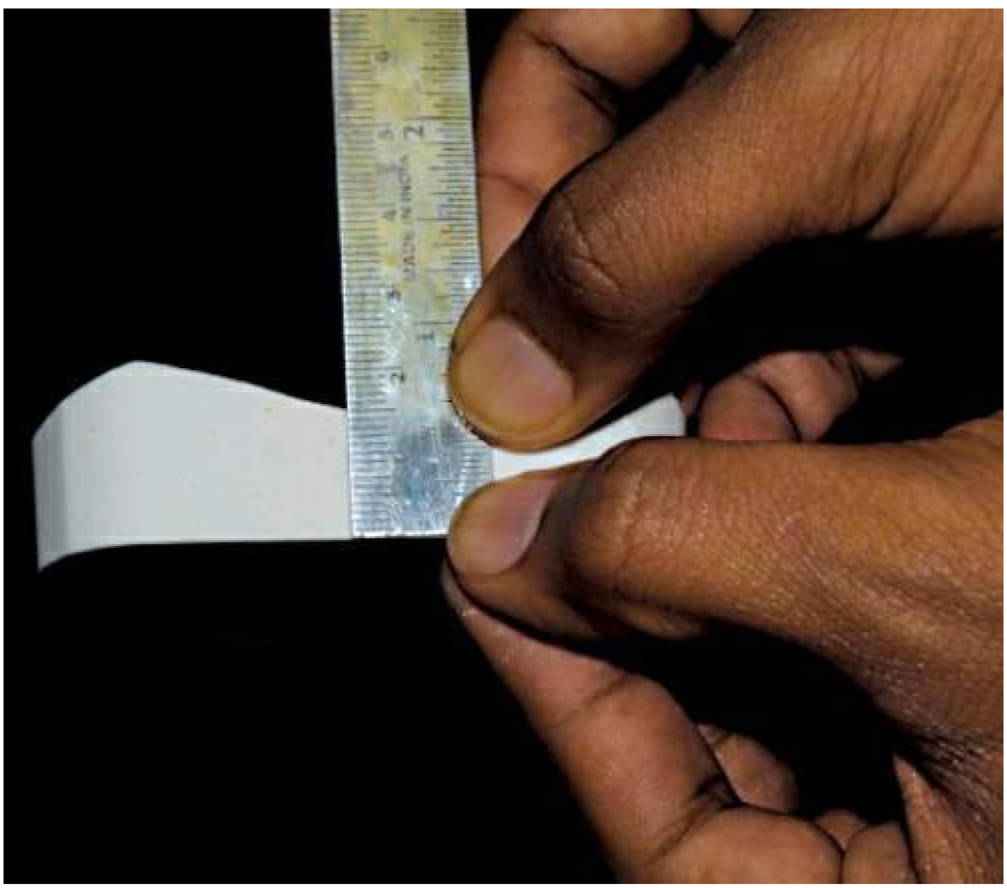


FIGURE 4.23C Base of the cast 10–15 mm.

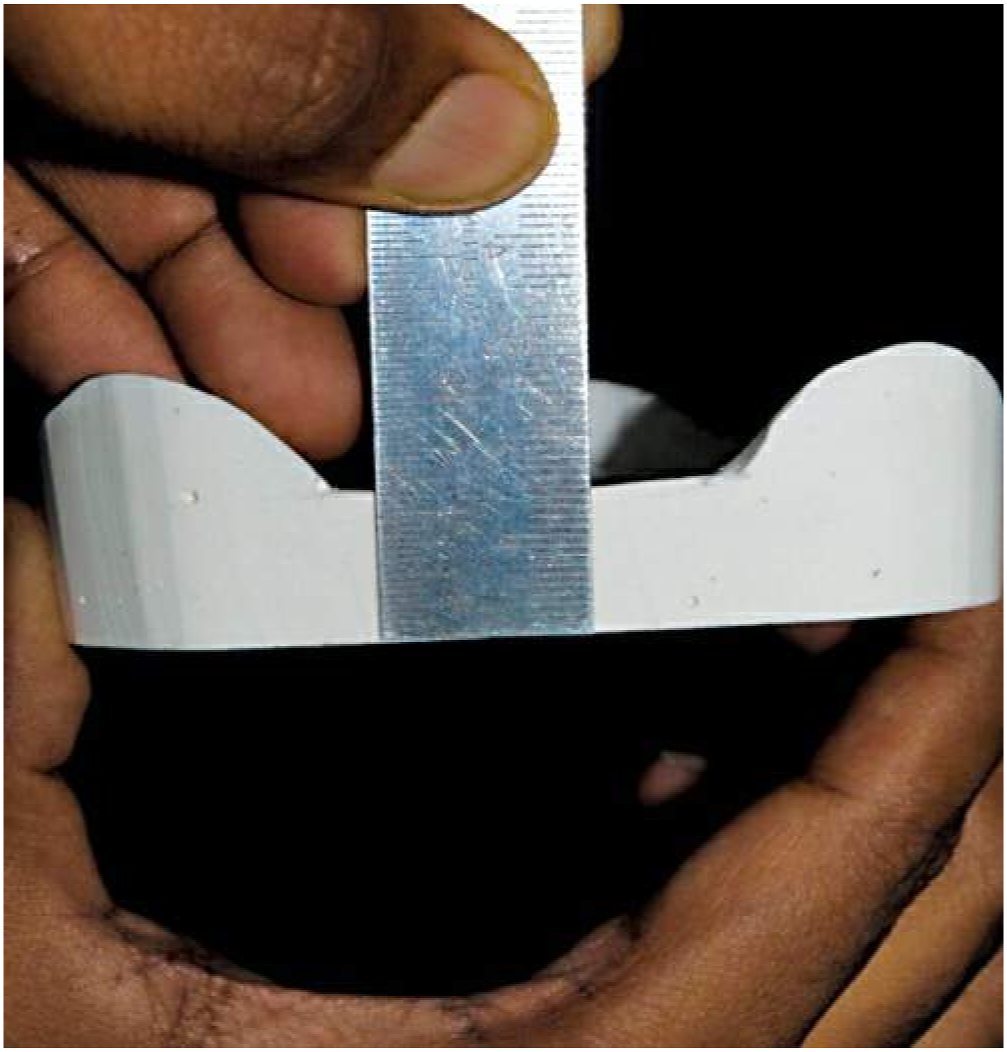


FIGURE 4.23D Height of base measured on the mandibular cast.

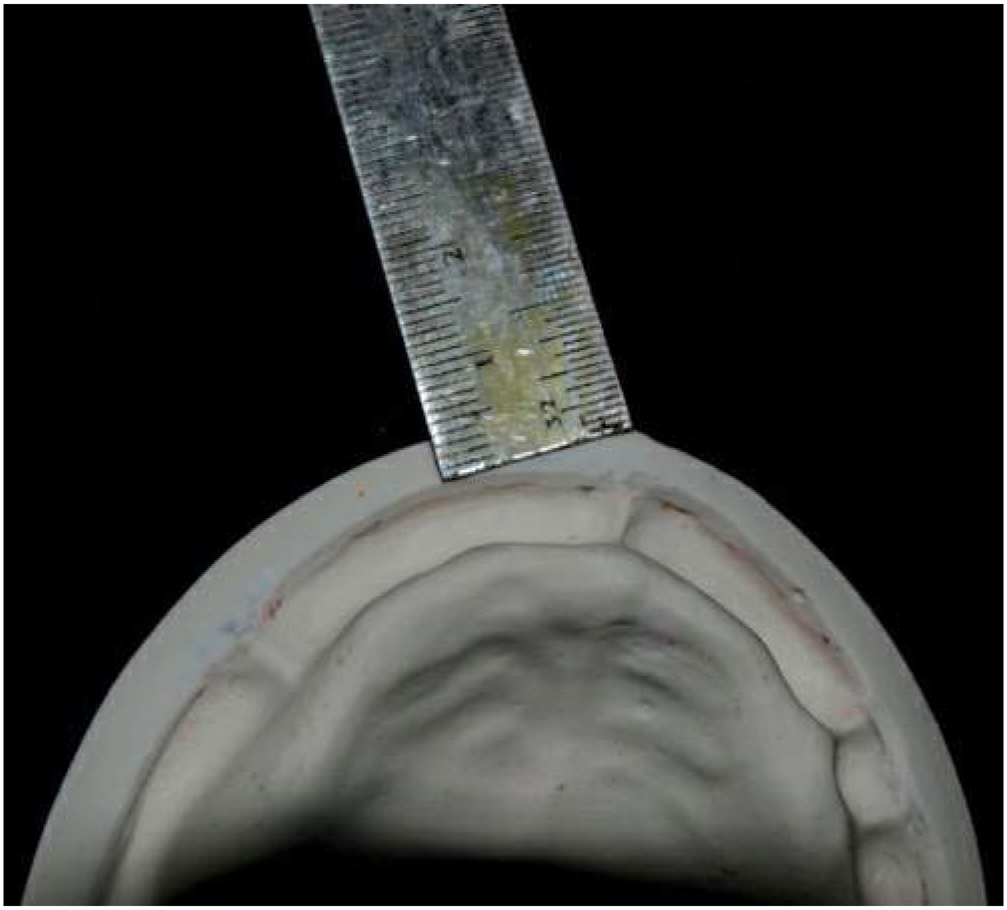


FIGURE 4.23E The width of the land area measured on the cast is 2–3 mm.

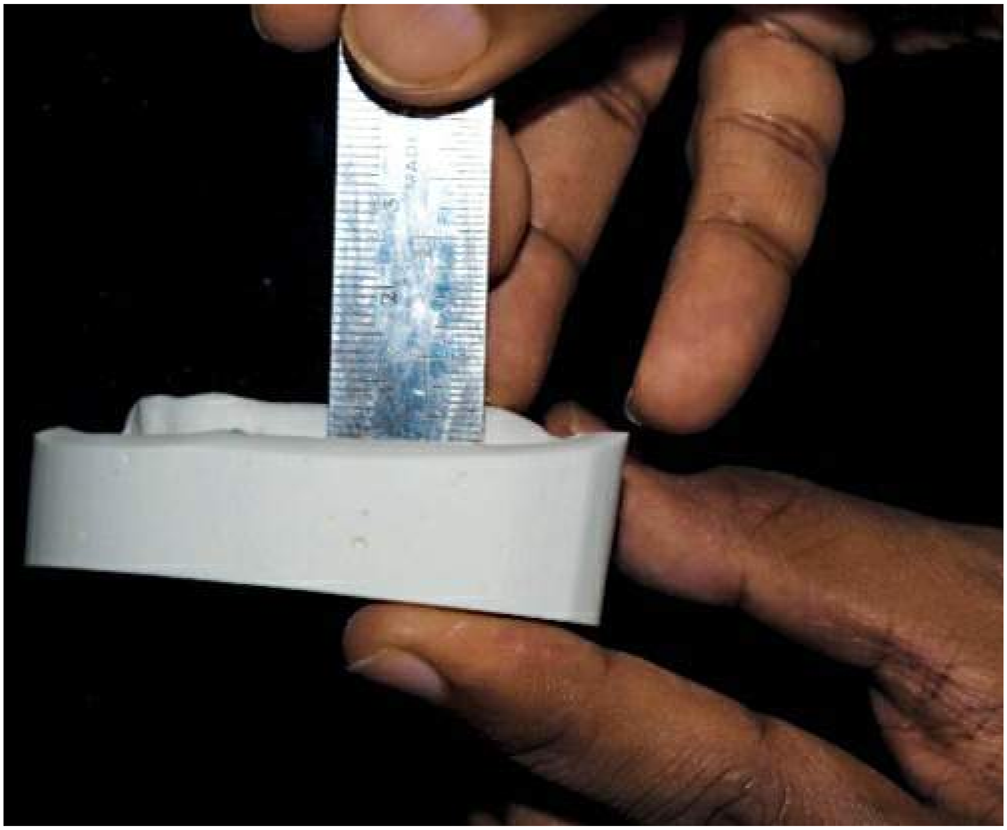


FIGURE 4.23F Height of the land area measured from the sulcus is 2 mm.

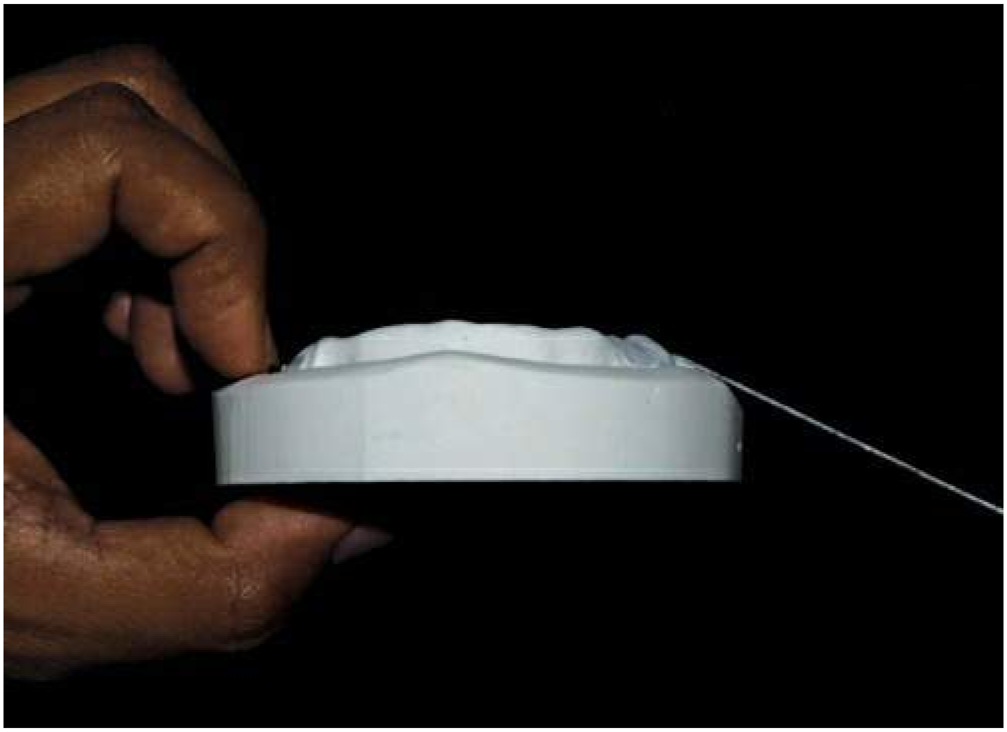


FIGURE 4.23G Land area at 45.

FIGURE 4.24 Completed preliminary maxillary cast.

FIGURE 4.25 Completed preliminary mandibular cast.

Custom trays

Definition: An individualized impression tray made from a cast recovered from a preliminary impression. It is used in making a final impression (GPT8).

Objectives

- To confine and control the final impression material
- To obtain minute details of denture-bearing area
- Development of border seal
- Ensure uniform distribution of final impression material
- Ensure planned distribution of pressure on the residual ridges

Requirements

The custom tray should be

- Rigid
- Dimensionally stable
- Easily adjusted
- Easy to construct
- Smooth without sharp edges

Design considerations

- It should include the entire denture-bearing area.

- Periphery should be such that impression material can flow without displacement of soft tissues.
- Appropriately relieved and spaced if necessary.
- Handle is designed to avoid displacing the lips.
- Allows free movement of muscle attachments.

Types

Custom trays are fabricated depending on the condition of the ridge:

Custom tray with spacer

- Indicated for ideal ridges where a uniform pressure can be given to the entire denture-bearing tissues and impression is made of the tissues in an undistorted state.
- Custom tray should extend 2 mm short of the vestibular reflection.
- Uniform spacer of 2 mm is provided using baseplate wax. The peripheral extension of spacer should be 2 mm short of the custom tray (Fig. 4.26). In maxilla, it should not cover the posterior seal area but should stop at the anterior vibrating line. In mandible, it should not cover the retromolar pad.
- Tissue stops are square or rectangular areas where the spacer is removed. The custom tray is in direct contact with the ridge in these areas. They function to correctly orient and stabilize the tray during impression making and ensure uniform thickness of impression material. Generally, four square stops are given, 2 mm in dimension, two in the canine region and two in the molar region, on the crest of the ridge (Fig. 4.27).
- Functions of spacer is to provide space for the final impression material.

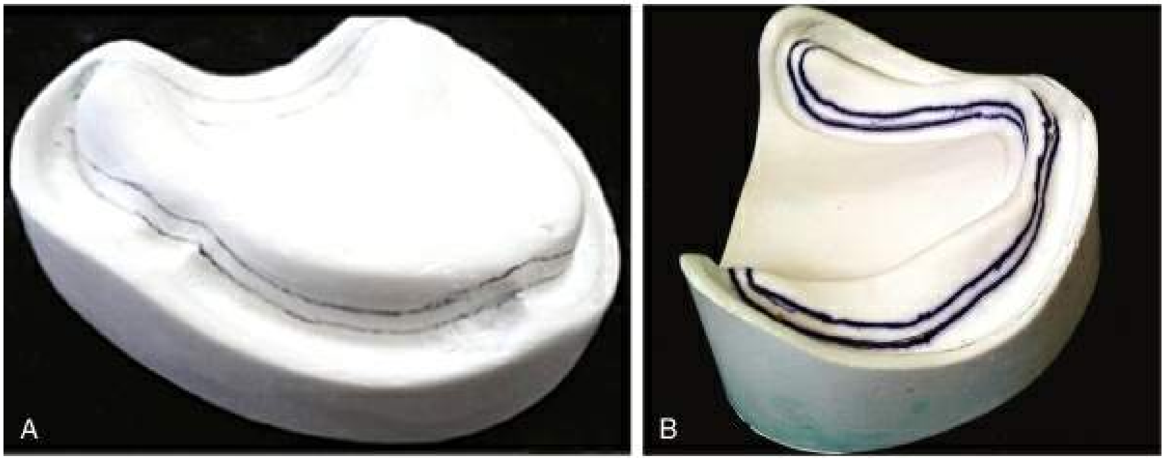


FIGURE 4.26 Spacer is outlined on the cast. Its extension should be 2 mm short of the custom tray: **(A)** maxillary and **(B)** mandibular.

FIGURE 4.27 Square wax stops of 2 mm are created by removing wax from spacer anteriorly and posteriorly: **(A)** maxillary and **(B)** mandibular.

Custom tray with relief

- Also termed as 'close fitting tray'.
- Areas such as the incisive papilla and midpalatine suture in maxilla and the crest of the residual ridge in the mandible, sometimes need to be relieved. This happens when an incisive papilla comes to lie on the crest of the ridge (due to resorption), mid palatine suture is tender on palpation due to very thin mucosal covering and a sharp, spiny ridge presents in a mandibular crest (see discussion on 'Relief Areas' in Anatomic and Denture Landmarks in this chapter).

- One thickness of baseplate wax is applied over the areas when relief is indicated, on maxillary and mandibular cast (Figs 4.28 and 4.29).
- A close fitting tray is made over these relieved areas without the use of a spacer. This produces a selective pressure impression distributing more load to the stress-bearing areas.

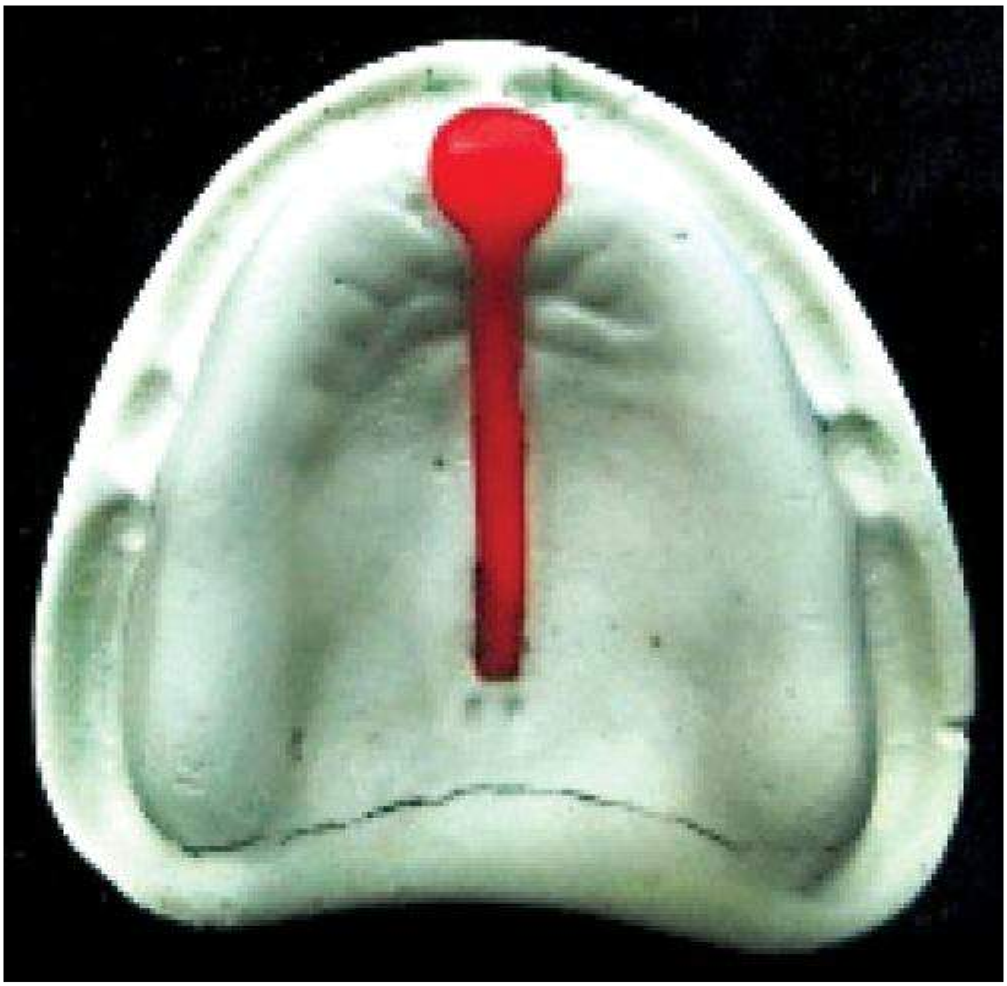


FIGURE 4.28 Midpalatine suture and incisive papilla relieved in maxillary cast.

FIGURE 4.29 Crest of the residual ridge relieved in mandibular cast.

Custom tray with window

- This is indicated with flabby and displaceable tissues.
- Usually the anterior ridges are affected.
- A minimal or controlled pressure impression is indicated for the displaceable tissue, while a normal impression can be made for the remainder of the arch. This is another example of a selective pressure impression.
- The affected area is marked and blocked out in the preliminary cast and a custom tray is constructed without involving this area (Figs 4.30 and 4.31).

- The rest of the custom tray can be prepared similar to a ‘close fitting tray’ or ‘custom tray with spacer’ as described before.
- The impression procedure is discussed in the section on ‘Final Impressions’ in this chapter.

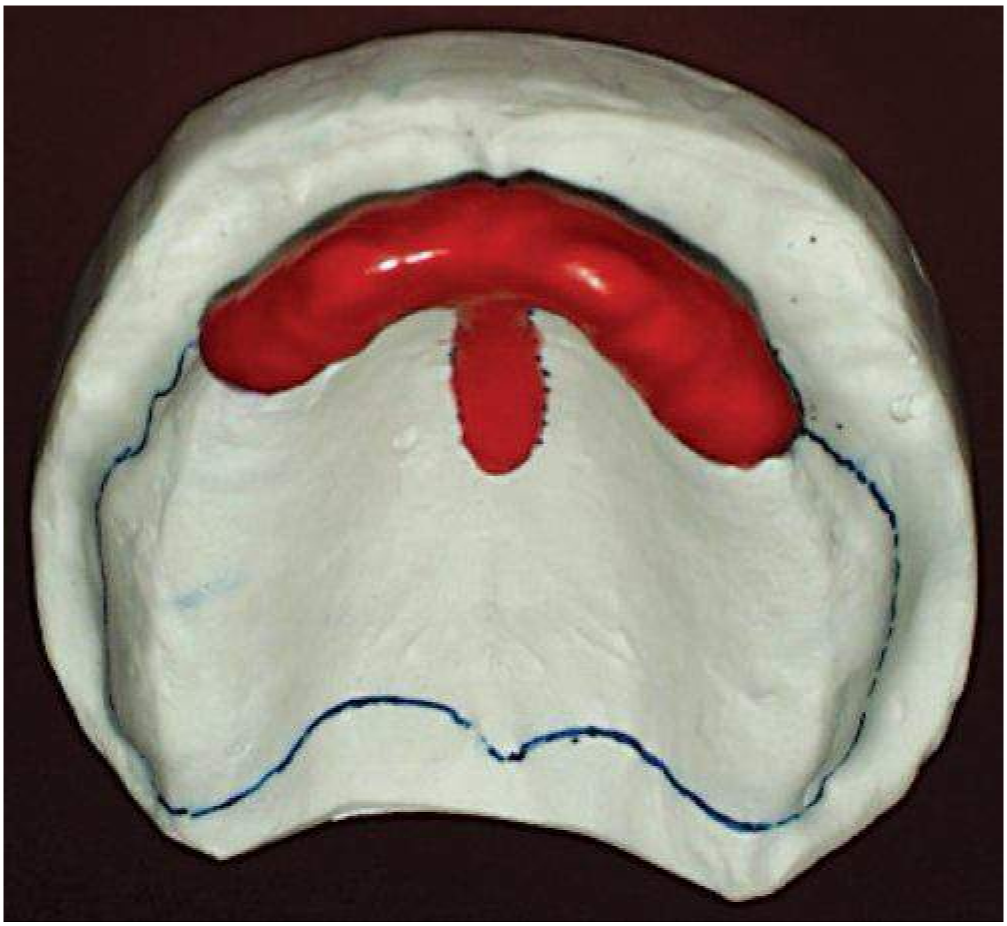


FIGURE 4.30 Maxillary anterior flabby ridge marked on preliminary cast.

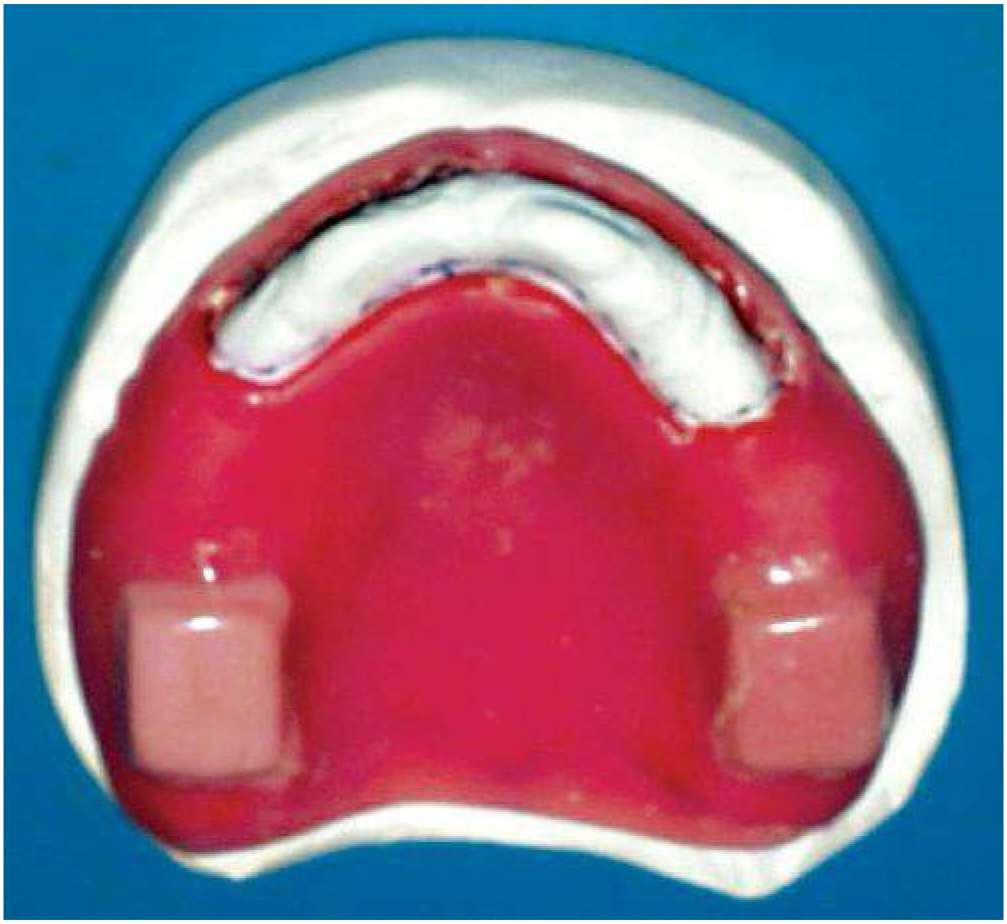


FIGURE 4.31 Custom tray with a window in the flabby ridge area.

Fabrication

Outlining and preparing the preliminary cast for making custom tray

- Preliminary impressions are overextended due to the material used and that was the purpose. The aim is to produce a tray, which is 2 mm short of the reflection of the mucosa when the tissues are at rest. This outline of the custom tray should be marked on the preliminary cast so that less chairside time is spent on trimming the borders while making final impressions.

- The outline or extension is similar for all types of custom trays. In both the casts, the outline should follow the area where the mucosa begins to turn outwards into the sulcus (tissue reflection point).
- In the maxilla, the distal termination should be a line joining the hamular notches passing 2 mm posterior to the fovea palatine. In the mandible, it should be just beyond the retromolar pad. In both arches, the outline in the frenum areas should be elevated (notched) by 1 mm to provide adequate space for this landmark (Figs 4.32 and 4.33).
- Undercut areas are blocked out with baseplate wax to ensure easy removal of tray from cast.
- Depending on the indication, relief and spacer are provided and tissue irregularities like flabby tissue are blocked out using baseplate wax.
- Separating medium is applied on the entire cast following provision of relief, spacer and block-out. Cold mould seal, vaseline (petrolatum) and tin foil are commonly used.


A

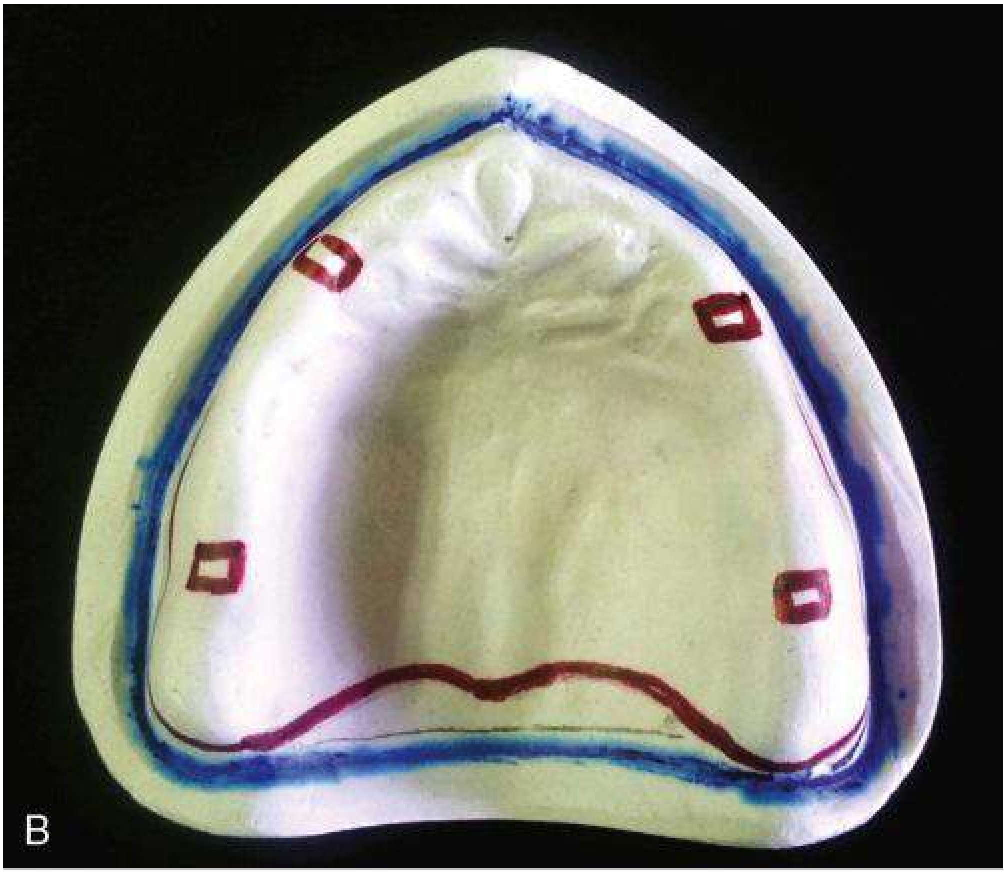


FIGURE 4.32A, B Outline of maxillary custom tray showing vestibular extension (blue), tray extension (black) and spacer with stops (brown).

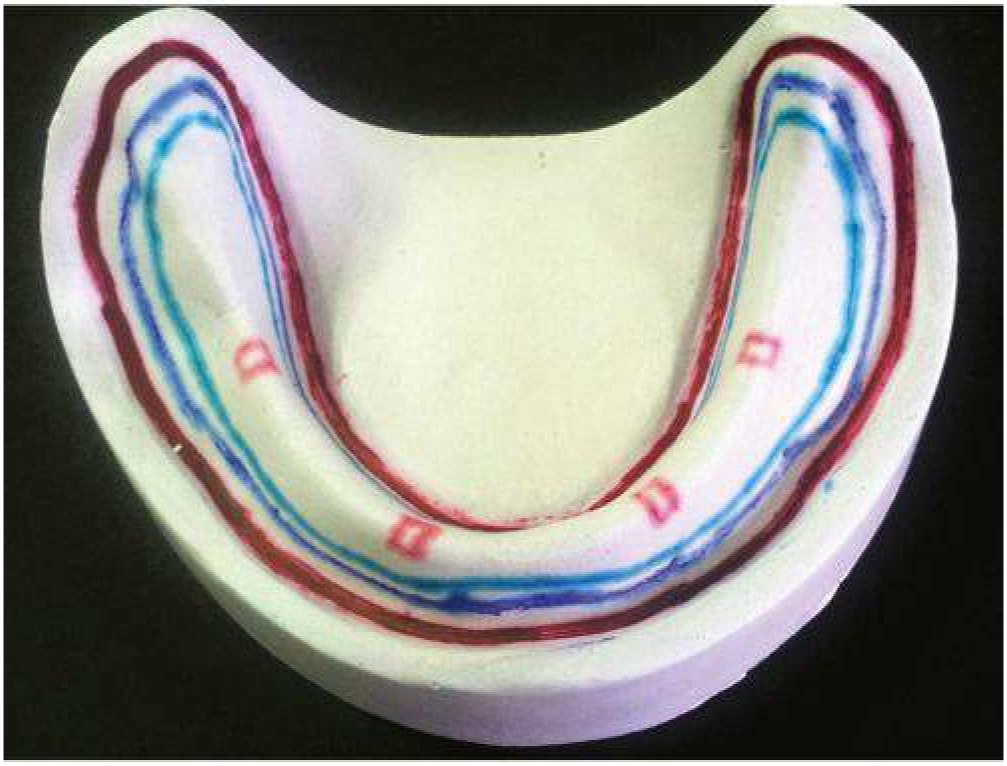


FIGURE 4.33 Outline of mandibular custom tray showing vestibular extension (brown), tray extension (blue), spacer extension (green), stops (red).

Custom tray materials and methods of fabrication

The following materials are commonly used for fabricating custom trays:

1. *Autopolymerizing resins*

- Autopolymerizing denture base acrylic resins are used. They are also termed as self-curing or chemically activated resins; dispensed as powder and liquid.

- The difference between this and the heat cure resins is in the method of activating the initiator-benzoyl peroxide. Here, a tertiary amine–dimethyl-para-toluidine is added to the liquid, which upon mixing with the powder, causes decomposition of the benzoyl peroxide and production of free radicals which initiates polymerization. Heat is the activator in heat curing resins.

Advantages:

- Rigid, easy to fabricate
- Easy to trim and adjust
- Inexpensive.

Disadvantages:

- Undergo dimensional changes for 24 h following fabrication. It is recommended for use only after this period.
- Potential sensitizer can produce allergic manifestations.

Various techniques used are

(i) Sprinkle-on method

- The powder is taken in a container with a perforated top like a salt and pepper dispenser, while the liquid is loaded in a syringe or taken in a dropper from a dappen dish.
  - Powder is shifted onto a particular area and is then saturated with monomer. This is continued until the area is built up to a thickness of 2.5 mm. The procedure is extended to cover the entire denture-bearing area with the resin (Fig. 4.34A–D).

FIGURE 4.34A Cast is tilted approximately at 45, polymer is shifted on one side of the cast and monomer is syringed on it.

FIGURE 4.34B Powder and liquid are alternately added until there is a uniform layer of resin approximately 2 mm thick.

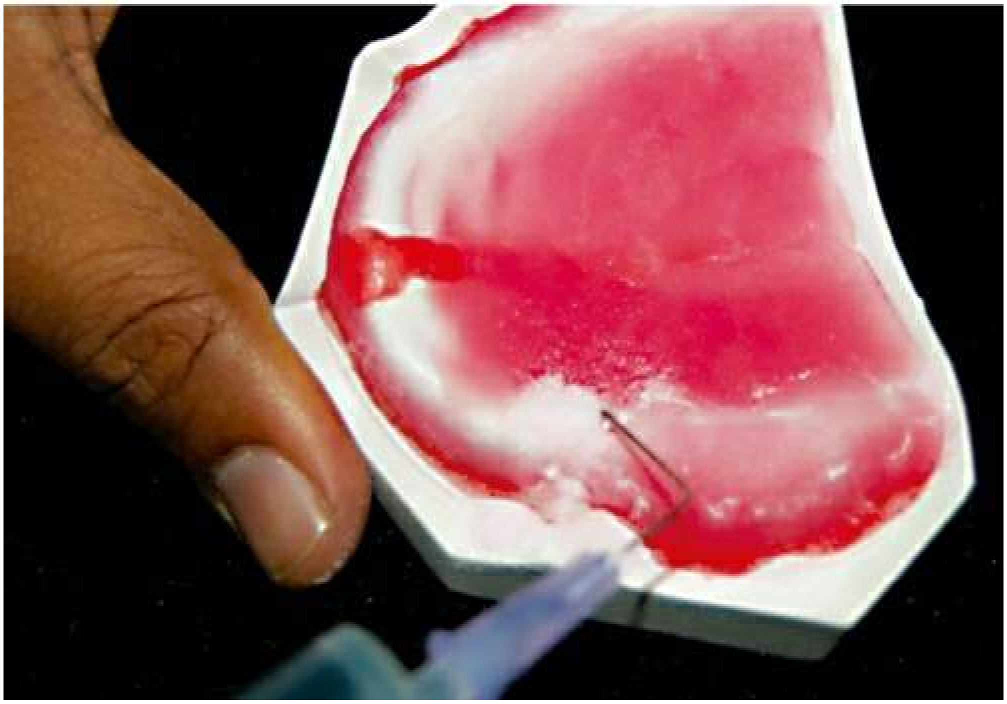


FIGURE 4.34C This is continued until rest of the denture-bearing area is covered with resin.

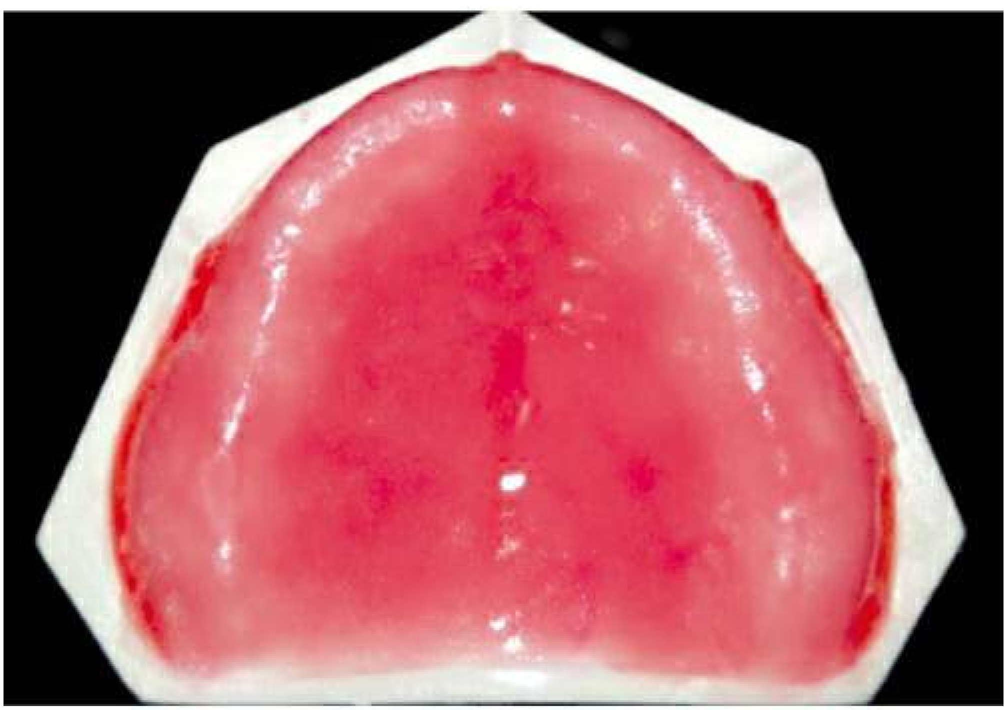


FIGURE 4.34D Completed tray.

Advantage:

- Wastage of material is minimal.

Disadvantages:

- Difficult to obtain uniform thickness throughout.
- Greater chances of porosity due to inadequate saturation of polymer.

(ii) Dough method

- The powder and liquid are mixed according to the manufacturer's instructions in a porcelain jar.
- When the mix attains the dough stage, it is kneaded into a ball and placed in the centre of a flat glass plate. Using another plate the dough is pressed down and flattened (Fig. 4.35A). Wet cellophane sheets are used as separating medium. This spreads and flattens the acrylic dough uniformly, making it in the form of a sheet of 2 mm thickness. Alternately, a rolling board and roller can also be used to flatten the resin dough.
- The sheet of tray material is gently lifted from the glass plate/roller board and placed over the lubricated cast.
- The resin is adapted to the cast using light finger pressure (Fig. 4.35B). The excess material is trimmed with a sharp knife.
- After the material has polymerized completely, it is removed from the tray and trimmed.

FIGURE 4.35 Dough method: **(A)** Acrylic dough placed in between two glass slabs. **(B)** The flattened dough is adapted on the cast with mild finger pressure until the material sets.

Advantages:

- Takes less time.
- Chances of porosity are less.

Disadvantages:

- Less working time, hence perfect adaptation in all areas will be difficult.
- Technique-sensitive.
- More wastage of material.

(iii) Fabrication of tray handle

- The handle should approximate the size and shape of the missing teeth to properly support the lips and cheek and must not distend or distort the lips or vestibules.
- It should be located in the space previously occupied by the teeth and alveolar bone.
- The handles ensure that the tray is positioned without disturbing the borders.
- The maxillary tray requires only a single handle placed in the midline. Its dimensions may be 8 mm in height, 8 mm in width and 4 mm in thickness. It should be slightly concave anteroposteriorly and mesiodistally to aid gripping and removal from the mouth (Fig. 4.36).
- The mandibular tray requires three handles, one in the anterior region similar to the maxillary, and two more on either side in the molar region. These two are called auxiliary handles and used for stabilization and orientation of the tray. The dimensions should be similar to that described for the maxillary handle (Fig. 4.37).
- Handle is fabricated using the dough method. The desired quantity of powder and liquid is mixed into appropriate shape and when the resin attains dough stage, it is placed in the area marked for the handle. Tray is roughened in the area of placement and a small amount of monomer sprinkled in the area, will help to retain the dough on the tray. Deficient areas at the junction of the handle and

tray are filled with resin using the sprinkle-on method.

FIGURE 4.36 Handle for maxillary tray.

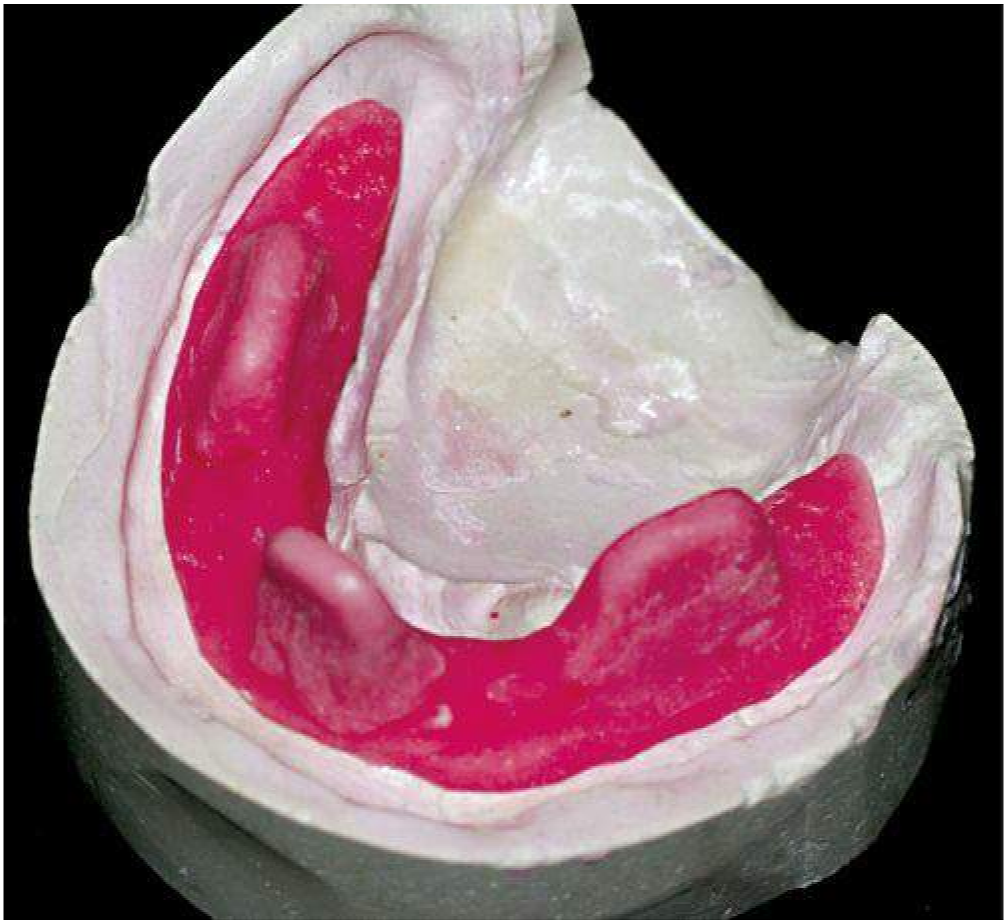


FIGURE 4.37 Handles for mandibular tray.

Light-polymerized resins

- Urethane dimethacrylate is used. They are available in sheet and gel forms. Sheet forms are used for tray fabrication.
- The sheet is adapted to the preliminary cast following provision of relief/spacer/block out and after application of separating medium.
- The cast with the adapted sheet is then placed in a light-curing chamber for 2 min, following which the tray is removed, inverted and cured again for 6 min.
- It is then trimmed, finished and handles are placed using the same material to the same dimensions as described previously.

Advantages:

- Easy to fabricate
- Dimensionally stable can be used immediately

Disadvantages:

- Brittle
- Produce fine particles during grinding
- Need special curing chamber

Thermoplastic resins

- They are made of vinyl or polystyrene materials; available in the form of sheets. As heat is used to adapt the materials, high fusing wax or tin foil can be used as spacer.
- They can be fabricated manually or using vacuum former.
- Manually: The material is softened in a water bath at 77°C and manually adapted to the cast. Easy tray is a commercially available example of this material.
- Vacuum formed: These are adapted using a vacuum-forming machine (see Chapter 38). The sheet is held in place over the cast, heated until it sags and adapted on the cast under vacuum.

Advantages:

- Adaptation is excellent.

Disadvantages:

- Strength is less than the acrylic resins.

- Expensive specialized equipment is needed.

Other materials used for custom trays

- Shellac has been used previously. They are brittle and distort easily. Hence, they are not recommended.

- Impression compound (tray compound) has been used to make a primary impression in a stock tray. The impression is trimmed to convert it into a custom tray and a final wash impression is made with appropriate materials.

Final impressions

Definition: The impression that represents the completion of registration of the surface or object.
Final impressions are made using the following methods:

1. Custom trays

2. Stock trays

3. Record bases with occlusal rims

Whichever method is used, old denture wearers are instructed to remove their dentures for 24 h prior to making the final impressions to enable distorted tissues to return to normal.

Using custom trays

Checking the custom trays intraorally

Before border moulding, the custom tray is placed in the mouth and checked for the following and trimmed, if necessary:

- The borders of the trays should be 2 mm short of the sulcus and should provide adequate clearance for the frenum.

- The posterior extension of the maxillary should cover the hamular notch and extend up to the posterior vibrating line. This is checked by palpating for the notch with a ball or 'T' burnisher, and drawing the posterior vibrating line in the mouth and transferring it to the tray.

- The mandibular tray should cover the retromolar pads posteriorly.

- If a spacer is placed, it should be removed only after border moulding.

Border moulding

It is also termed as 'peripheral tracing'.

Definitions

1. The shaping of the border areas of an impression material by functional or manual manipulation of the soft tissue adjacent to the borders to duplicate the contour and size of the vestibule.

2. Determining the extension of a prosthesis by using tissue function or manual manipulation of the tissues to shape the border areas of an impression material (GPT8).

Purpose

The main purpose of border moulding is to create a peripheral seal.

Methods of manipulating the peripheral tissues

There are two methods of manipulating the peripheral tissues to mould them.

1. **Active method**: The patient performs various functions related to the concerned areas to manipulate the borders.

2. **Passive method**: The dentist physically manipulates the tissues to mould them.

Either of these methods or a combination of both is used to mould the borders.

Techniques of border moulding

1. Incremental or sectional border moulding

In this method, sections of the periphery of the tray are refined individually, according to the anatomic landmark in that area. This is the better method for the beginner as it allows each section to be recorded, verified and refined. The material of choice for this procedure is greenstick compound (low fusing impression compound). Putty or heavy body elastomeric impression materials can also be used.

Method of adapting greenstick compound:

- Appropriate length of the stick corresponding to the length of the section to be moulded is softened over a flame till it begins to droop (Fig. 4.38A).
- The compound is placed on the border of the custom tray, rotated slightly and then quickly pulled away to prevent long strings from forming (Fig. 4.38B).
- The material should then be tempered in warm water (about 50°C) and formed into appropriate shape with fingers (make sure vaseline is applied to the gloved fingers) and inserted in the patient's mouth.
- After moulding the borders, the tray is removed and compound is chilled in cold water and any excess is trimmed.
- This sequence is followed for moulding every section and repeated until the moulding is seen to be accurate without over or under extension:

FIGURE 4.38A Method of softening greenstick compound.

FIGURE 4.38B The compound is placed on the border of the custom tray, rotated slightly and then quickly pulled away to prevent long strings from forming.

Soften – place – temper – form – insert – mould – remove – chill – trim.

Maxillary tray border moulding: The moulding can be accomplished using the following sections and sequences (Fig. 4.39):

(i) Labial flange:

a. *Passive:* The lips are elevated and then extended outwards, downwards and inwards.

b. *Active:* Patient is asked to pucker the lips and suck on the dentist's finger (Fig. 4.40).

(ii) *Buccal flange (buccal frenum area):* This may be performed unilaterally.

a. *Passive:* The cheek is elevated and pulled outwards, downwards and inwards and moved backwards and forwards.

b. *Active:* Patient is asked to pucker the lips and smile (Fig. 4.41).

(iii) *Distobuccal area:* This should be performed bilaterally.

a. *Passive:* The cheek is pulled outwards, downwards and inwards.

b. *Active:* Patient is asked to open the mouth wide, close and move the mandible from side to side. Opening the mouth wide delineates the depth and width of the distobuccal flange as governed by the muscle attachments, while moving the mandible from side to side, accommodates for the movement of the coronoid process (Fig. 4.42).

(iv) *Posterior palatal seal area:*

a. *Active:* The patient is asked to say 'ah' in short bursts to record this area (Fig. 4.43). The seal or 'postdam' can be developed as per the methods described earlier in this chapter.

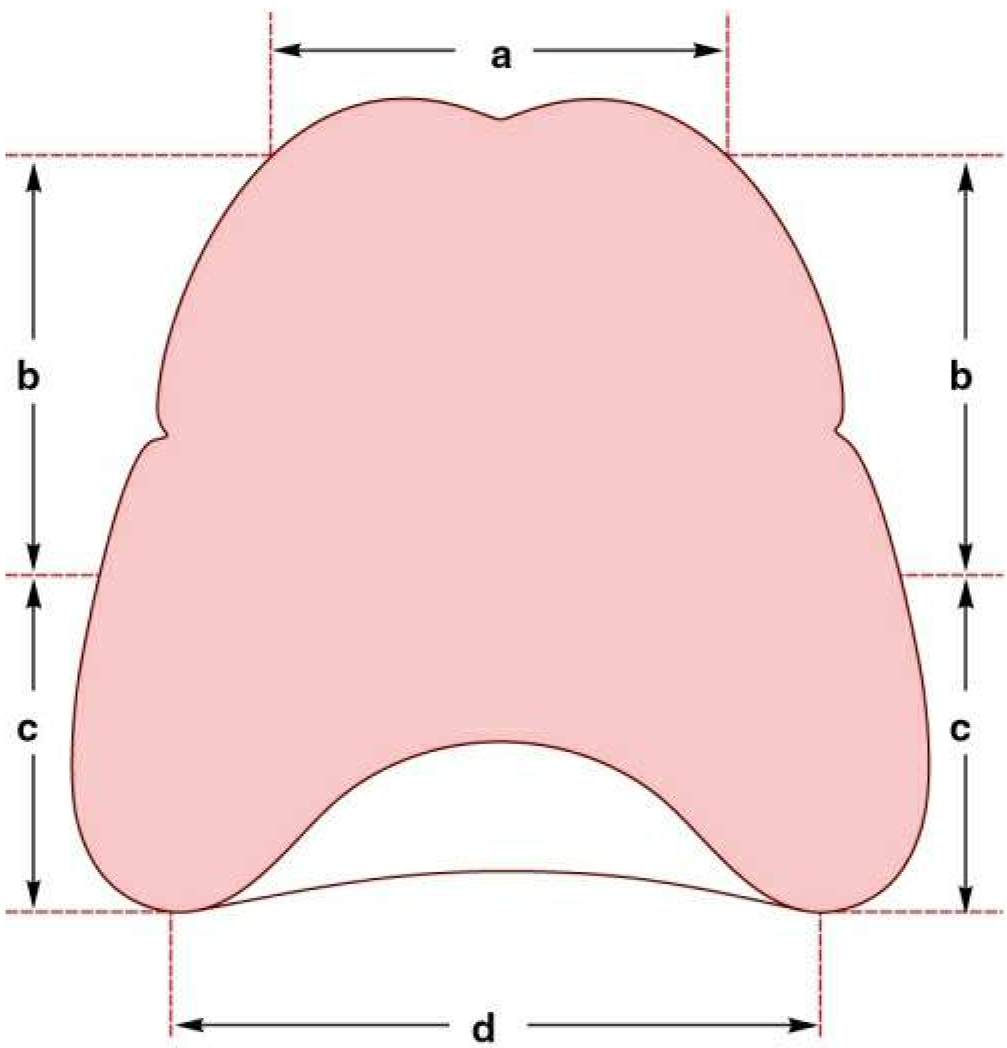


FIGURE 4.39 Sequence of border moulding: (a) labial flange, (b) buccal flange, (c) distobuccal flange and (d) posterior

palatal seal area.

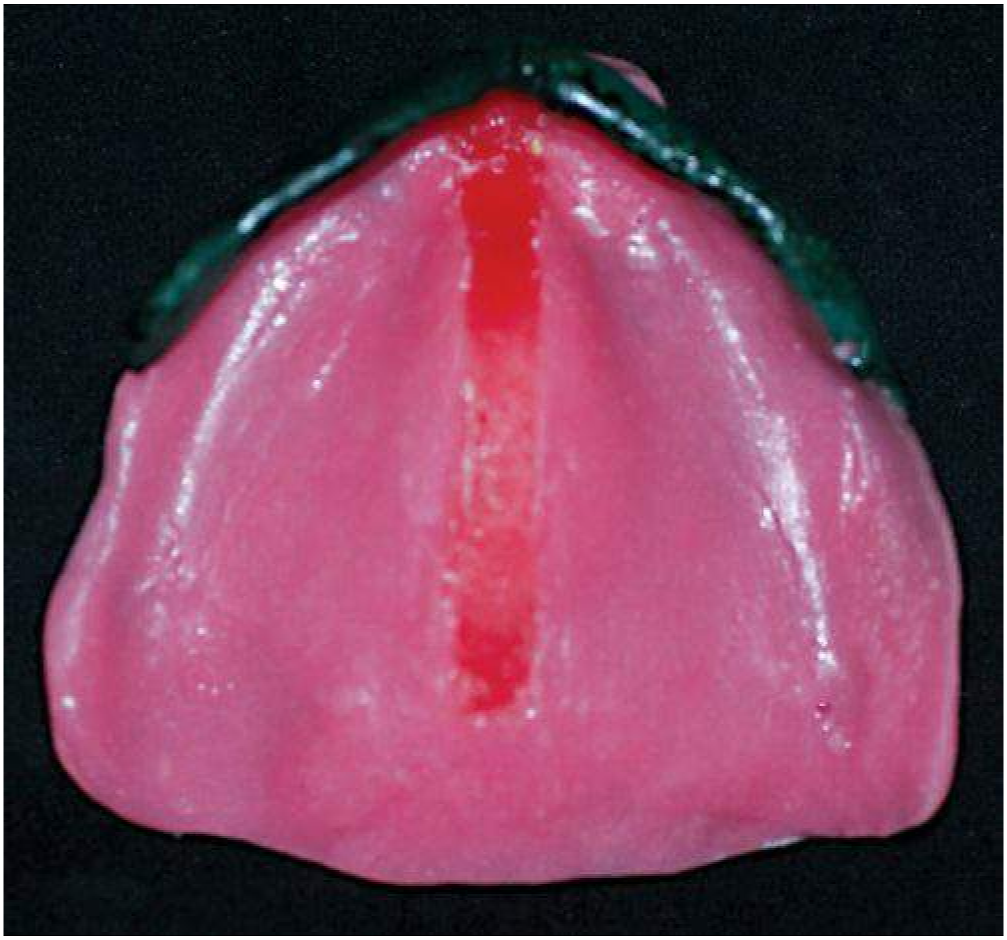


FIGURE 4.40 Custom tray with labial flange moulded.

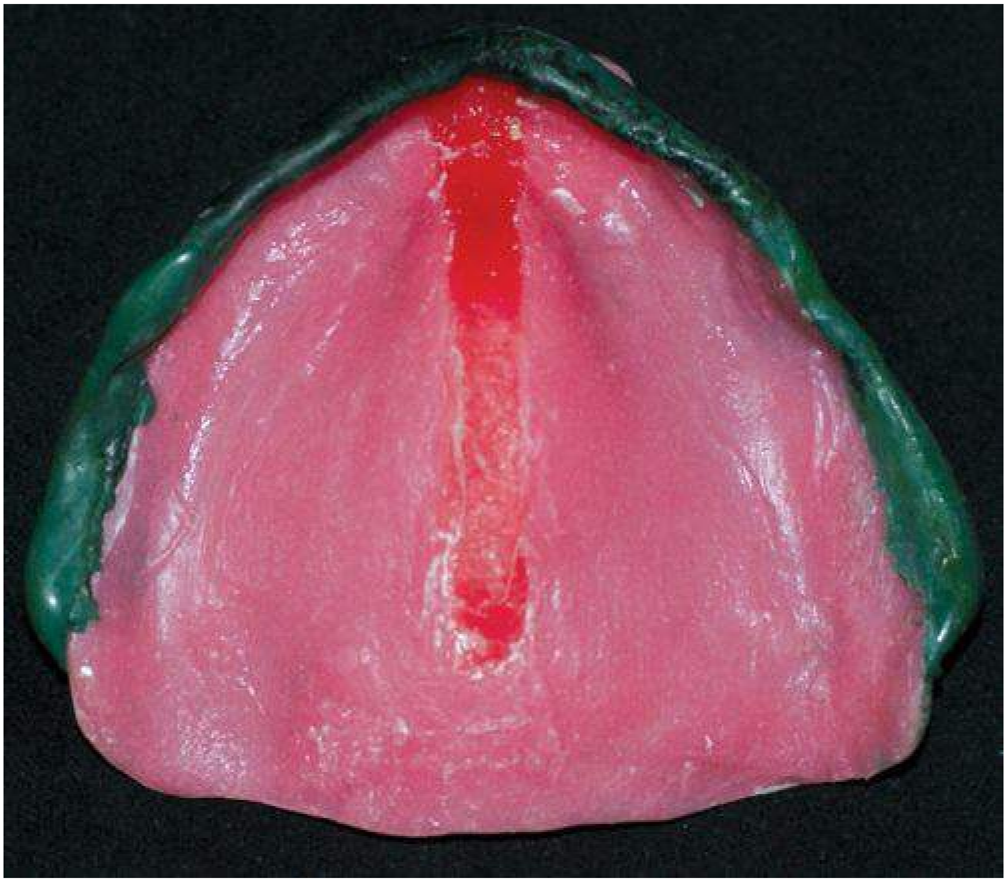


FIGURE 4.41 Custom tray with buccal frenum area of buccal flange moulded.

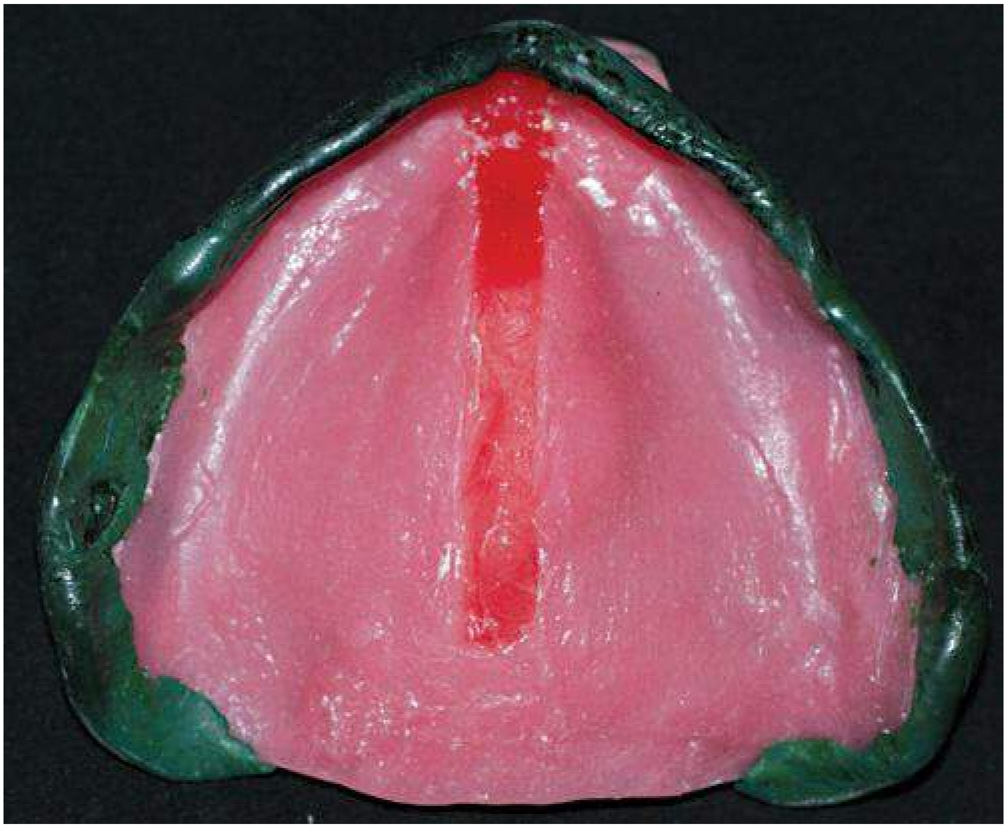


FIGURE 4.42 Custom tray with distobuccal area of buccal flange moulded.

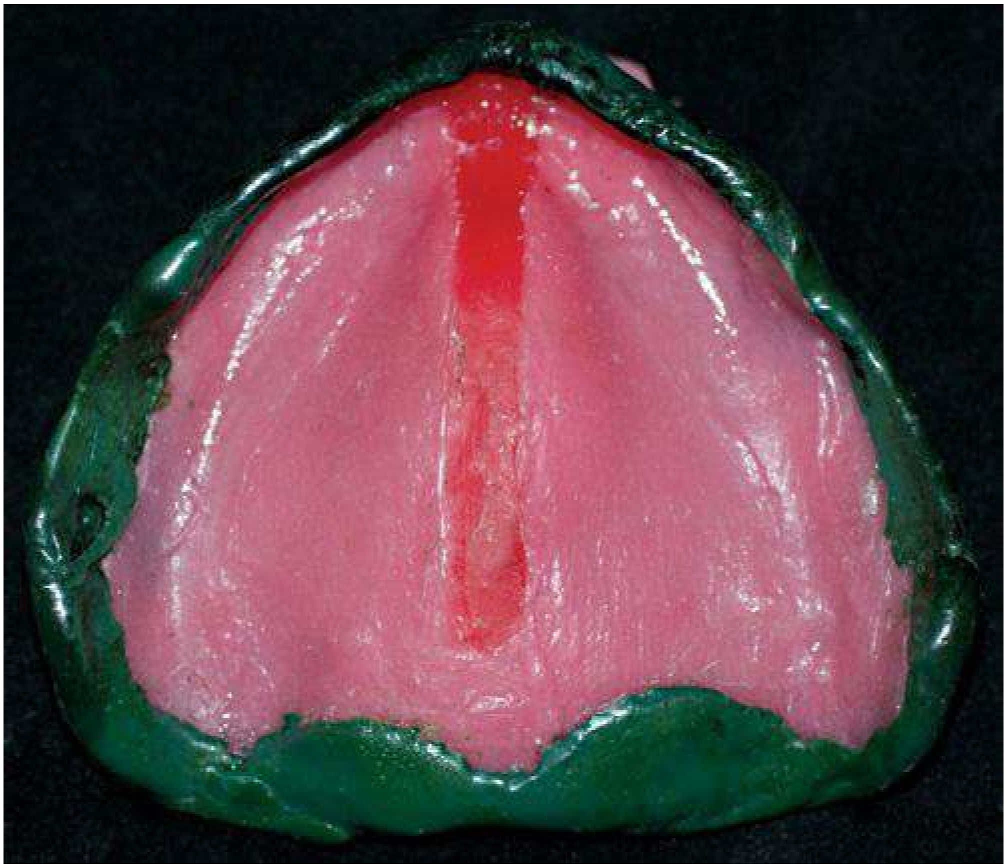


FIGURE 4.43 Custom tray with posterior seal area moulded.

Mandibular tray border moulding: The moulding can be accomplished using the following sections and sequence (Fig. 4.44):

(i) ***Labial flange:***

a. *Passive:* The lip is slightly lifted outwards, upwards and inwards (Fig. 4.45).

(ii) ***Buccal flange (buccal frenum area):*** Can be developed unilaterally.

a. *Passive:* The cheek is lifted outwards, upwards and inwards and moved backwards and forwards.

b. *Active:* Patient is asked to pucker and smile (Fig. 4.46).

(iii) Buccal flange (distobuccal area): Developed bilaterally.

a. *Passive:* The cheek is pulled buccally to ensure it is not caught in the tray and then moved upwards and inwards.

b. *Active and Passive:* The masseteric notch is recorded by asking the patient to close, while dentist exerts a downward pressure on tray (Fig. 4.47).

(iv) Anterior lingual flange

a. *Active:* Patient is asked to protrude the tongue and then push the tongue against the anterior part of the palate. This develops the length and thickness of the flange in this area, respectively (Fig. 4.48A).

(v) Middle portion of lingual flange: Developed bilaterally.

a. Active: Patient is asked to protrude the tongue and lick the upper lip from side to side (Fig. 4.48B).

(vi) Distolingual flange: Developed bilaterally.

a. Active: Patient is asked to protrude the tongue and then place the tongue in the distal part of the palate in the right and left buccal vestibules (Fig. 4.49).

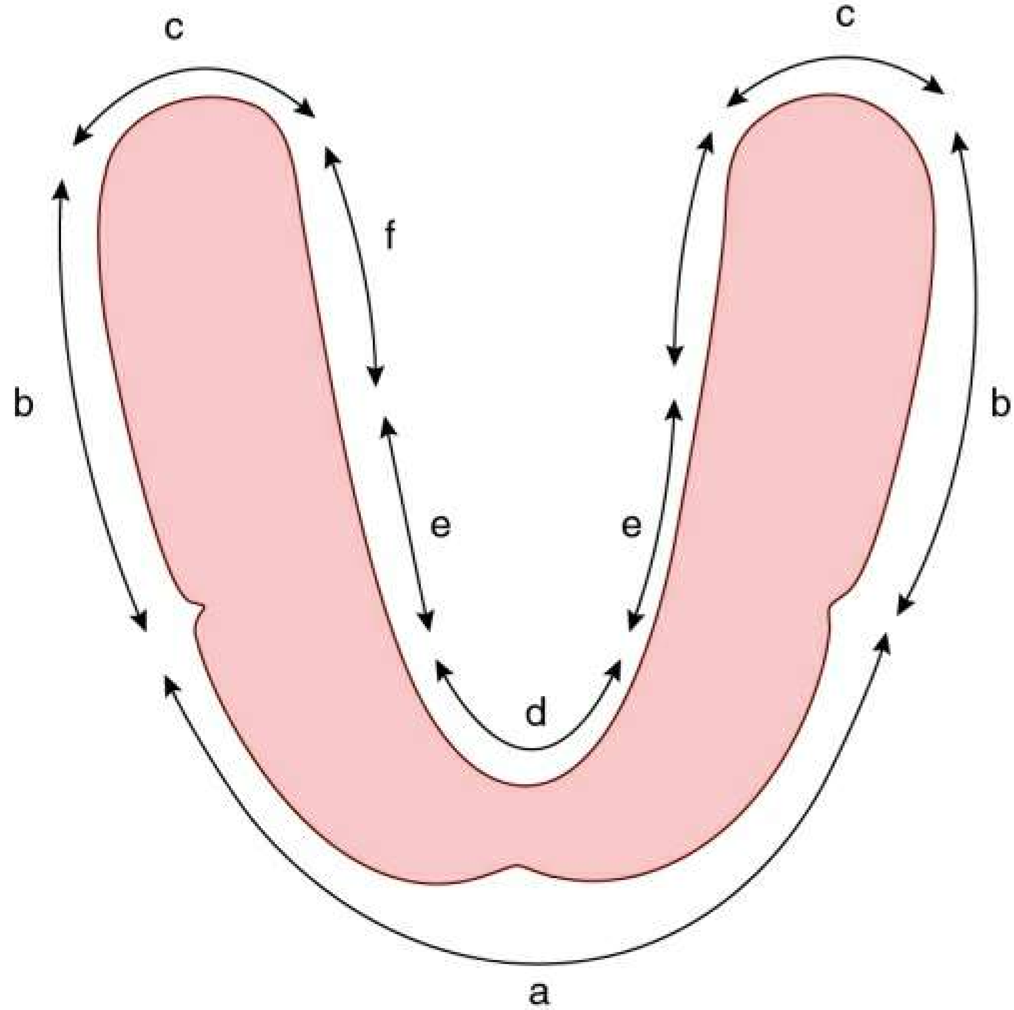


FIGURE 4.44 Sequence of border moulding mandible: (a) labial flange, (b) buccal flange, (c) distobuccal area including masseteric notches, (d) anterior lingual flange, (e) middle portion of lingual flange and (f) distolingual flange.

FIGURE 4.45 Labial flange moulded.

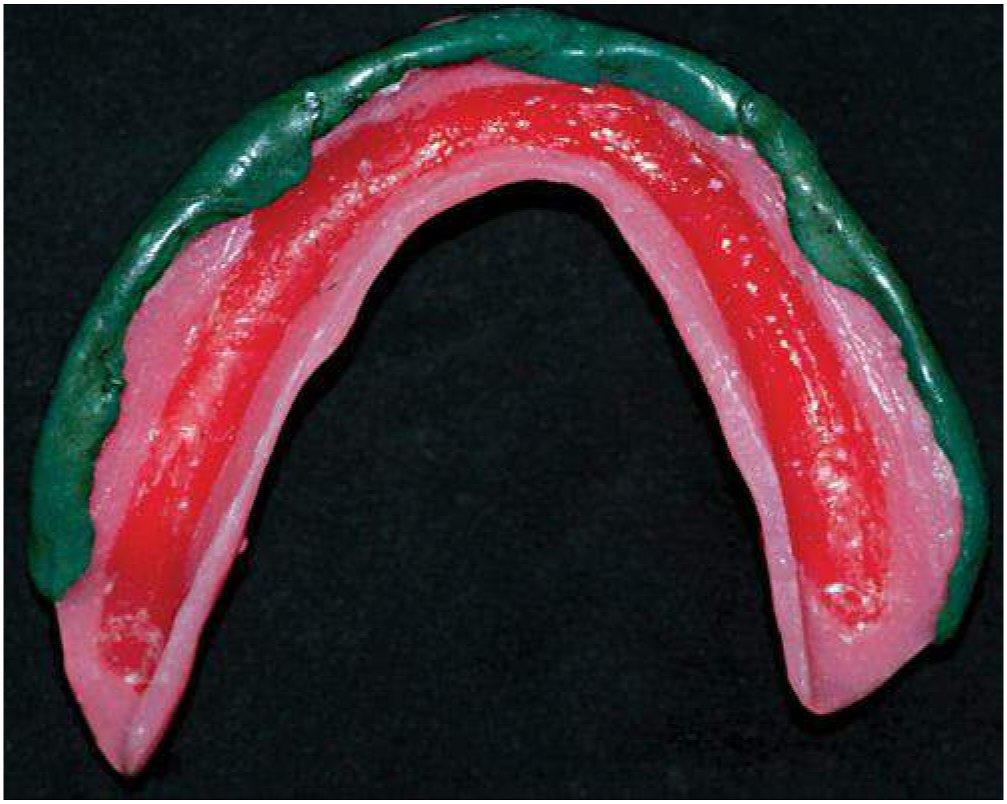


FIGURE 4.46 Buccal flange moulded.

FIGURE 4.47 Distobuccal flange moulded.

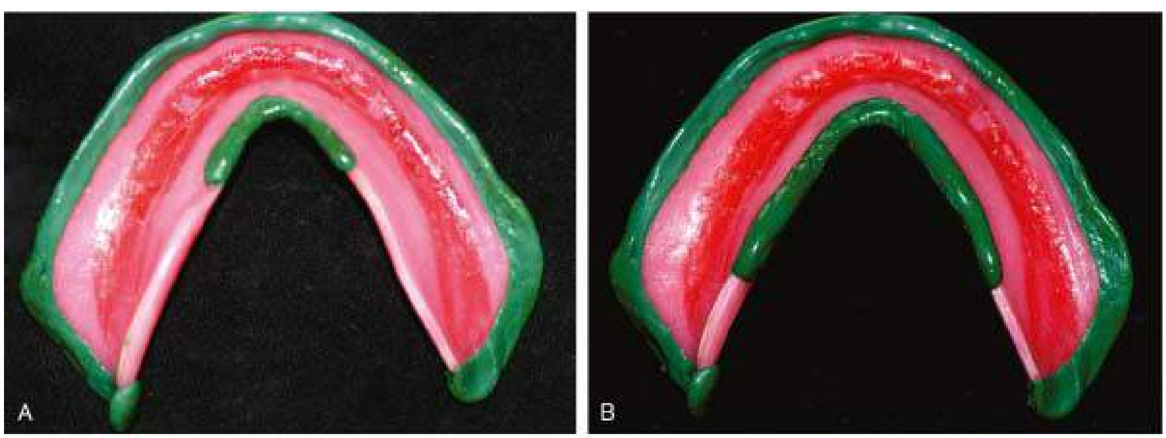


FIGURE 4.48 **(A)** Anterior portion of lingual flange moulded. **(B)** Middle portion of lingual flange moulded.

FIGURE 4.49 Distolingual flange moulded and border moulding completed.

Verification: The extension in retromolar pad is verified by asking the patient to open mouth wide. A notch in the area indicates interference from pterygomandibular raphae and should be adjusted. The patient is asked to wipe the tongue against the vermilion border of the upper lip. This should not displace the tray.

2. Single-step or simultaneous border moulding

In this method, the entire periphery of the tray is refined in a single step. The border moulding material is placed around the entire border in a single step and moulded similar to sectional technique all at once. Putty or heavy body elastomeric impression materials are ideal for this method (Figs 4.50–4.52). Greenstick compound is not recommended, as it is impossible to soften the material over the entire length of the border.

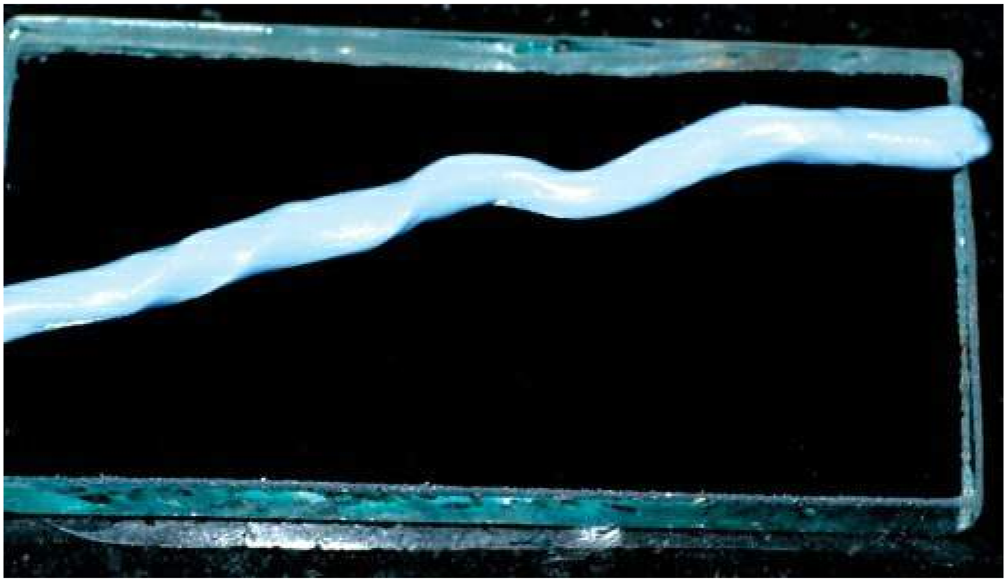


FIGURE 4.50A Putty addition silicone is kneaded and rolled into a rope of required length.

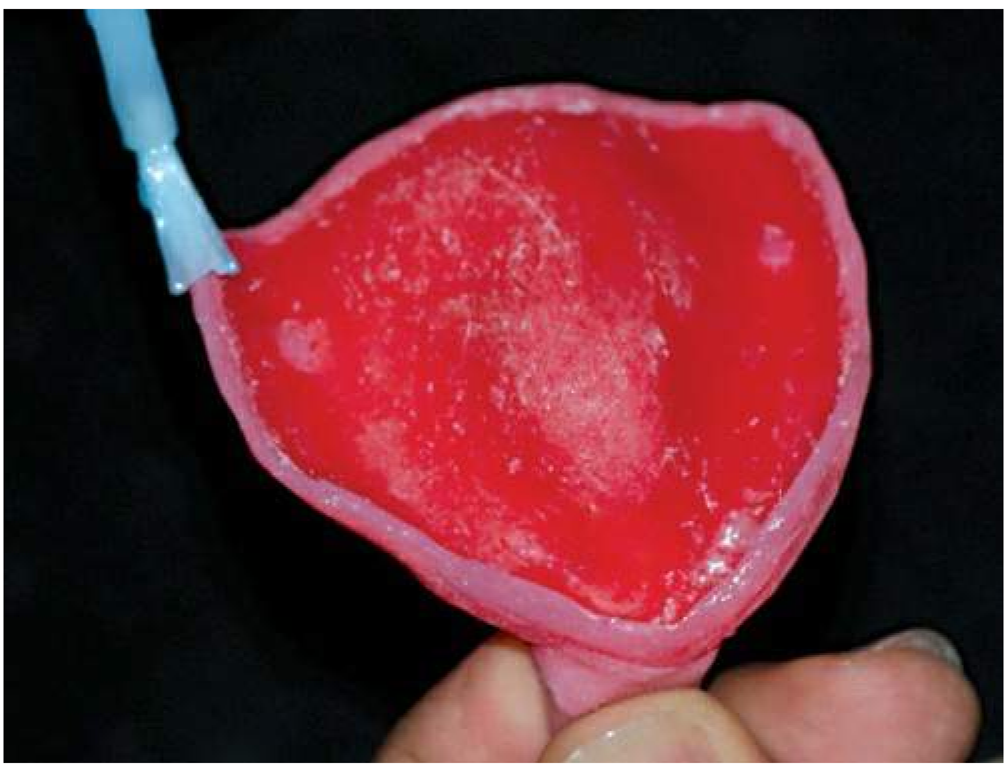


FIGURE 4.50B Tray adhesive applied on borders.

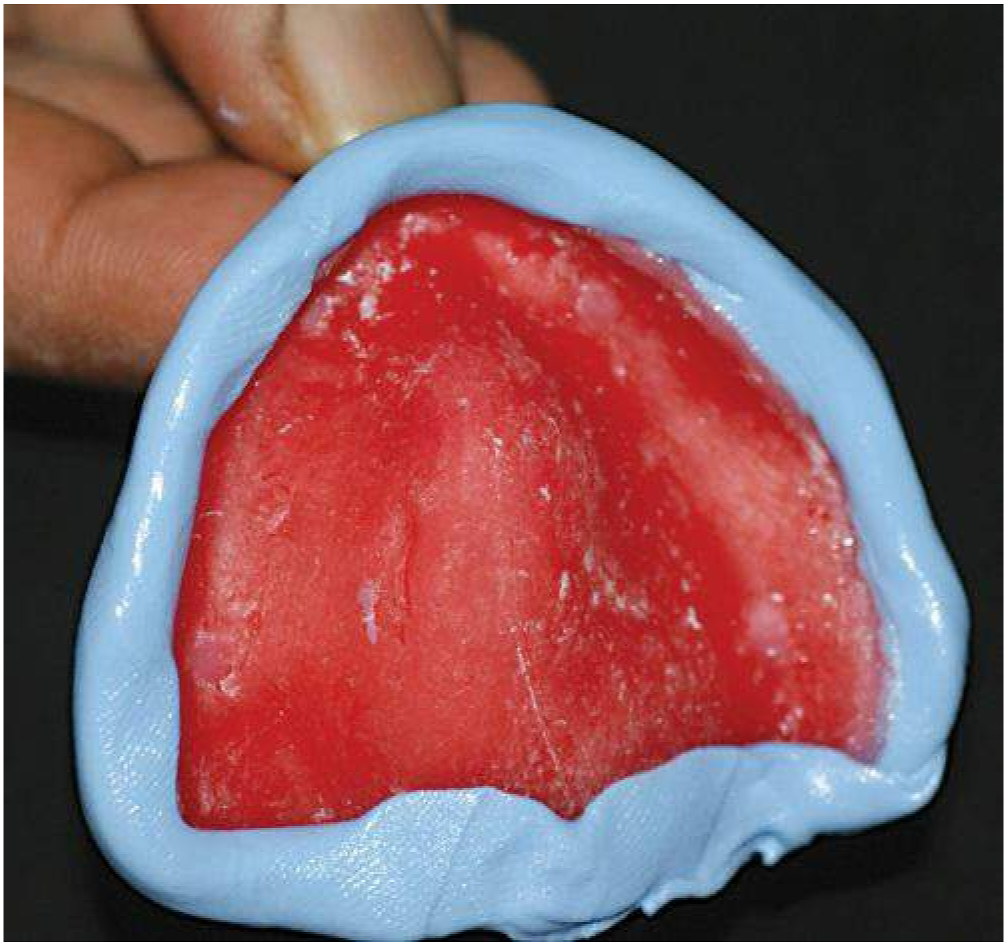


FIGURE 4.50C Putty placed around the borders.

FIGURE 4.51 After border moulding.

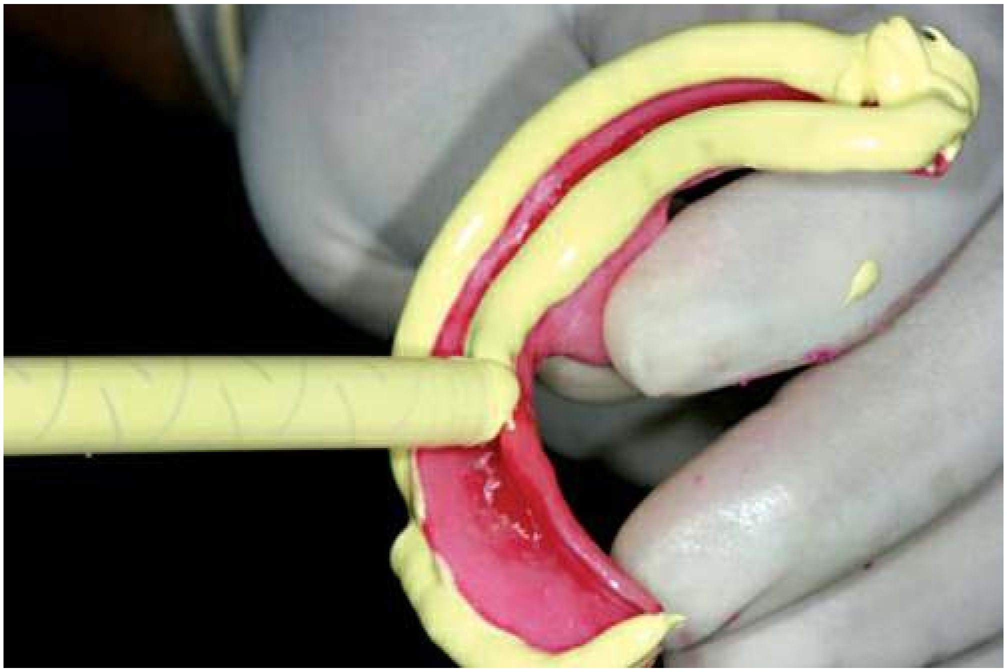


FIGURE 4.52A Alternately heavy body impression material can also be used. It is syringed around the borders of the mandibular tray using an automix syringe.

FIGURE 4.52B Showing mandibular tray after border moulding with heavy body impression material.

Advantages of technique:

- Number of insertions of tray in the mouth is reduced to one.
- Error in one section will not propagate the mistakes to the other segments.

Advantages of using elastomeric impression materials:

- Procedure is simpler no need to temper and chill.
- Less armamentarium – no water baths and flames.
- No fear of patient discomfort from heated stick compound.

Disadvantages of using elastomeric impression materials:

- They will not adhere to tray and require tray adhesive.
- They need good support from tray, not indicated with grossly underextended trays.
- Material is more expensive.

Preparing tray for final impressions

After border moulding, the maxillary and mandibular trays should be prepared before making the secondary impression.

- If a custom tray with spacer was used, the wax spacer is removed to provide space for the impression material.
- 0.5–1 mm of the tracing material is removed from inner, outer and top surface of the border. A scalpel blade is used for greenstick compound, while a scalpel or bur can be used with elastomeric impression material (Figs 4.53 and 4.54).
- The material over the posterior palatal seal is not removed because:
    - It enhances seal by slightly displacing the tissues.
    - It guides the positioning of the tray.
    - It prevents excess material from going into the throat.
- Holes are drilled in all the types of custom trays to provide escape ways for the final impression material. They can be drilled over the relief areas just to ensure an undistorted impression (Figs 4.55 and 4.56).

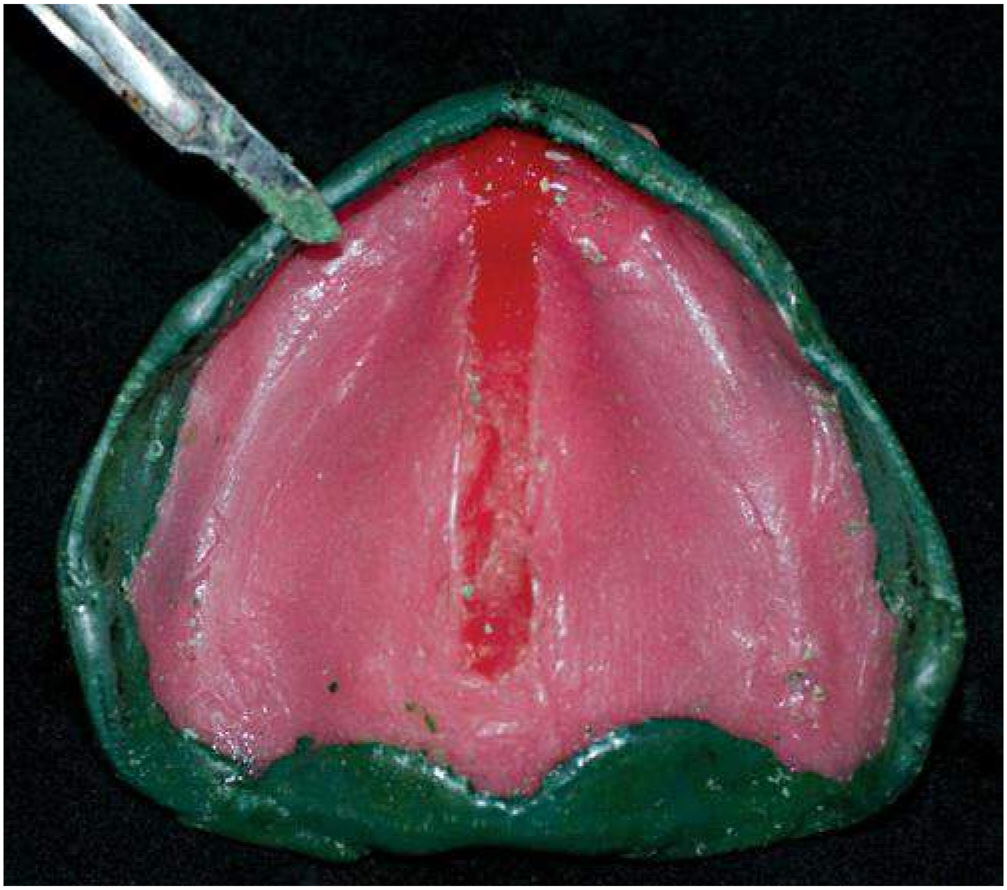


FIGURE 4.53 Trimmed maxillary tray.

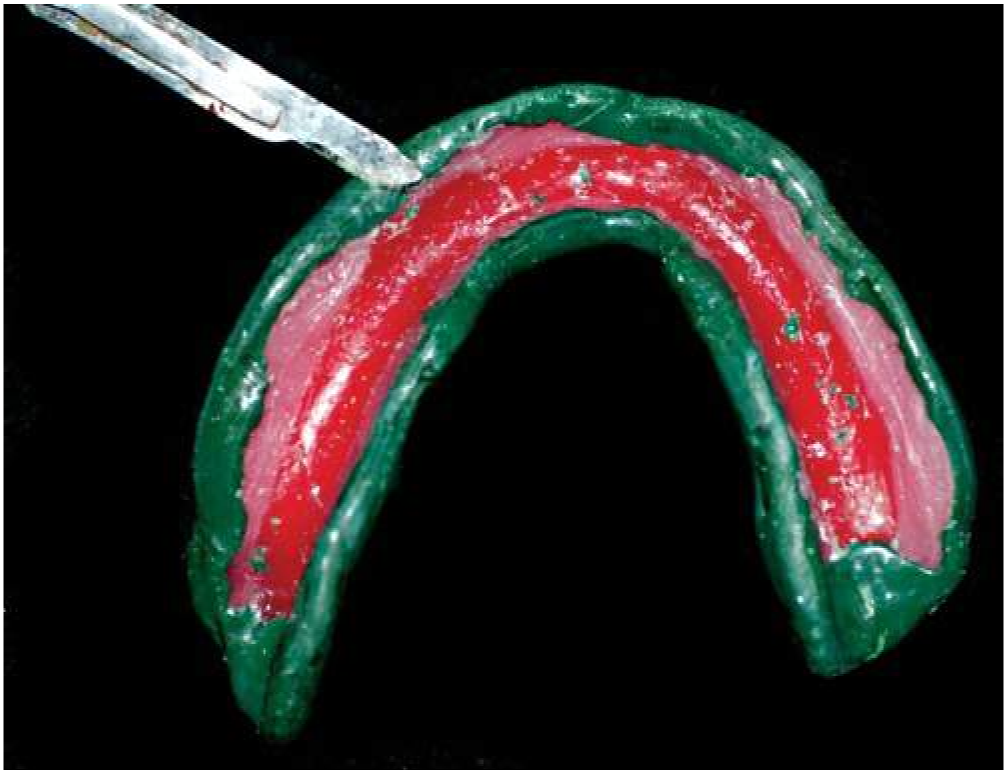


FIGURE 4.54 Trimmed mandibular tray.

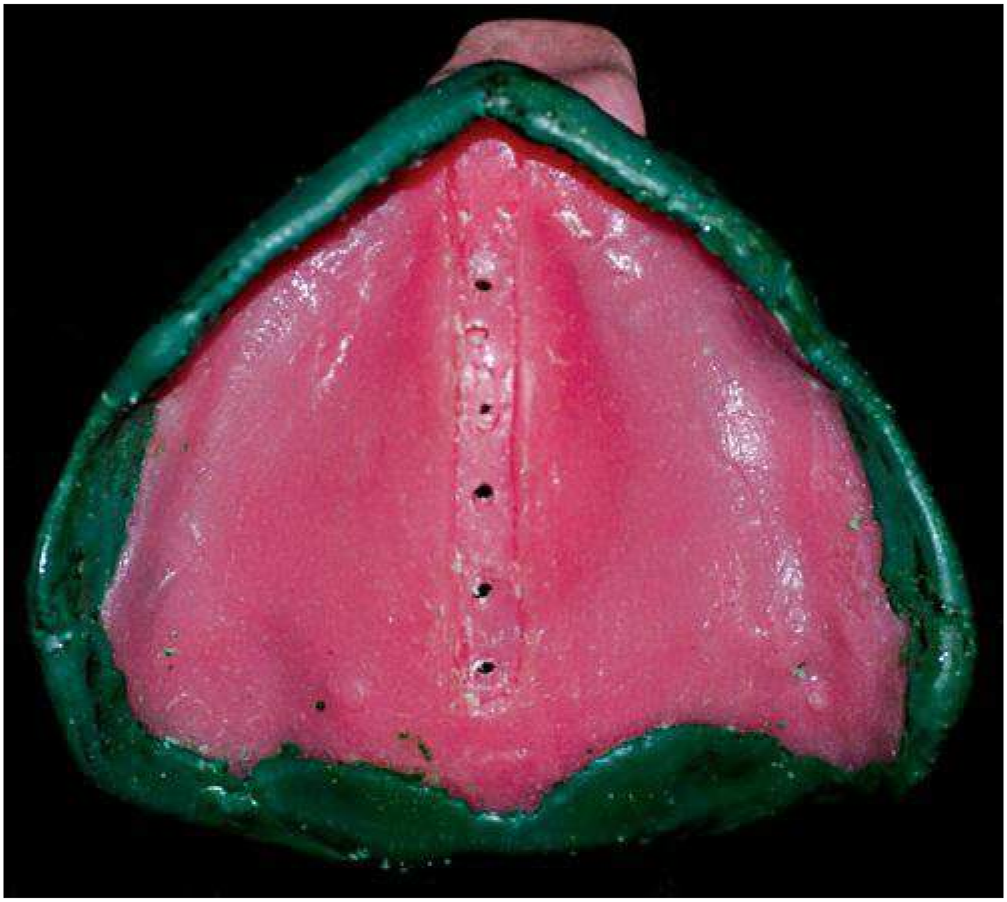


FIGURE 4.55 Holes placed in maxillary tray over relief areas.

FIGURE 4.56 Holes placed in mandibular tray over relief areas.

Making final impression

Material selection:

- When gross tissue undercuts exist, elastomeric impression materials are indicated.
- When using a custom tray with relief (close fitting tray), ZOE impression paste is preferred.
- When using a custom tray with spacer, medium/regular body or monophase elastomeric impression material is preferred.
- When using a custom tray with window, impression plaster is used for the displaceable tissues, in combination with ZOE paste. Light-body elastomeric impression material can also be used to record the

flabby tissues, in combination with medium body materials.

Making final impressions using custom tray with relief and custom tray with spacer

The procedures are similar using both types of trays. The spacer is removed prior to impression making.

Mandibular final impression

- Correct position of tray is essential and it is practiced before making the impression. It also enables the patient to be familiar with the procedure and what is expected.

- If ZOE paste is used, patient's lips and some part of the face are covered with vaseline as the material is sticky and will be hard to remove.

- The impression material of choice is mixed and evenly loaded onto the tray, covering the borders also.

- The tray is rotated and inserted into the mouth as discussed with preliminary impressions, asking the patient to lift the tongue slightly and centring it anteriorly. The index fingers of each hand are placed on the auxiliary posterior handles to apply gentle downward pressure such that buccal flanges come in contact with the buccal shelf.

- Border moulding, as described previously, is gently performed simultaneously on all the sections both passively and actively.

- Once this is done, the material is allowed to set with the patient's tongue touching the upper lip.

- After the material is set, the tray is removed and is inspected for deficiencies and voids (Fig. 4.57).

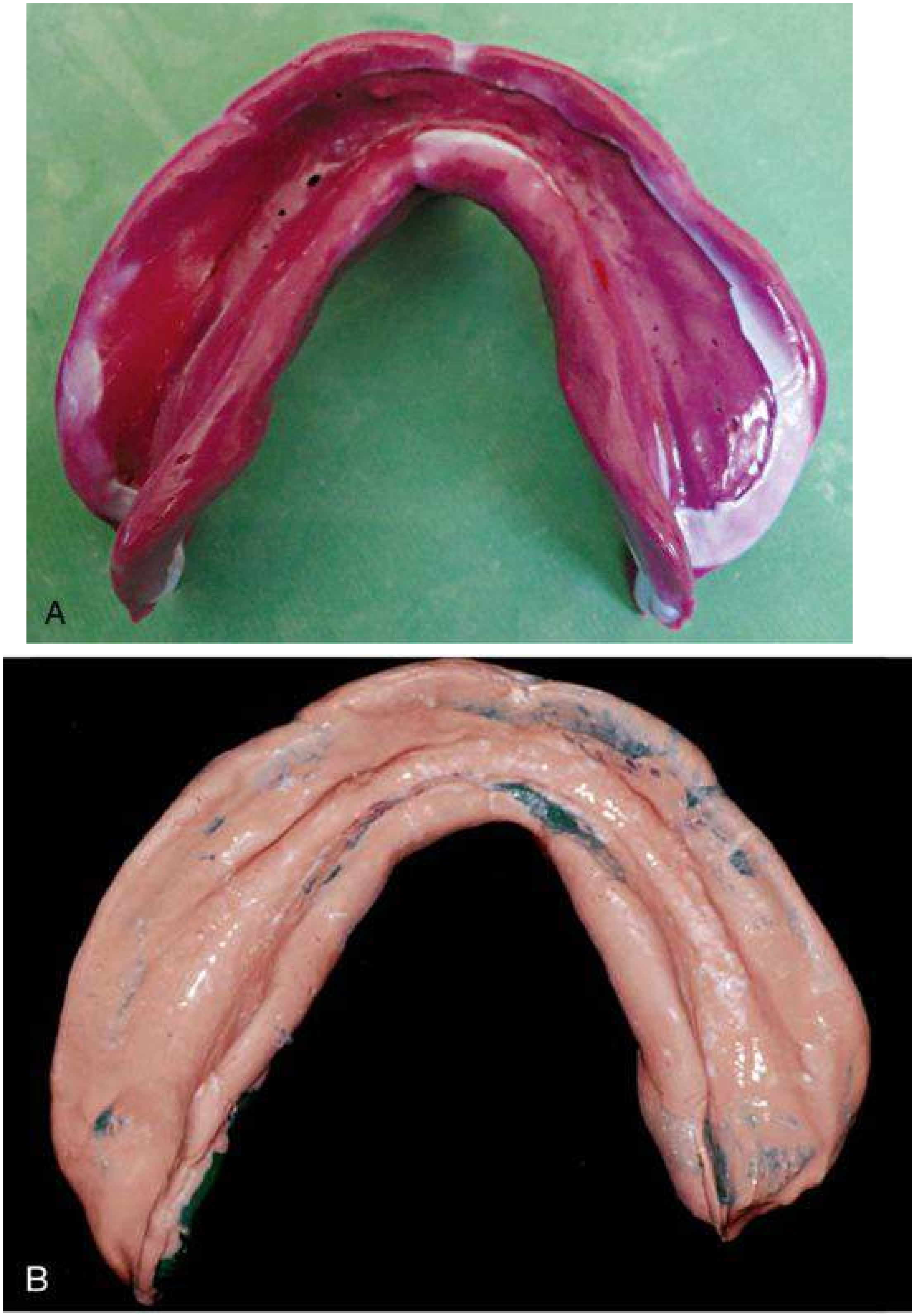


FIGURE 4.57 Completed mandibular final impression using **(A)** medium/regular body elastomeric impression material and **(B)** ZOE impression paste.

Maxillary final impression

- All the procedures prior to impression making are similar to mandibular impressions.
- After placing the material evenly on the tray and around the borders, the tray is inserted by centering and aligning the labial notch in the tray with the labial frenum.
- The index fingers of each hand are used to apply an upward pressure in the molar regions until the tray seats posteriorly in the hamular notches.
- The tray is then held in position with a finger in the hard palate just anterior to the posterior palatal seal area.
- Border moulding, as described previously, is gently performed simultaneously on all the sections both passively and actively.
- The material is allowed to set and then removed and inspected for any discrepancies (Fig. 4.58).

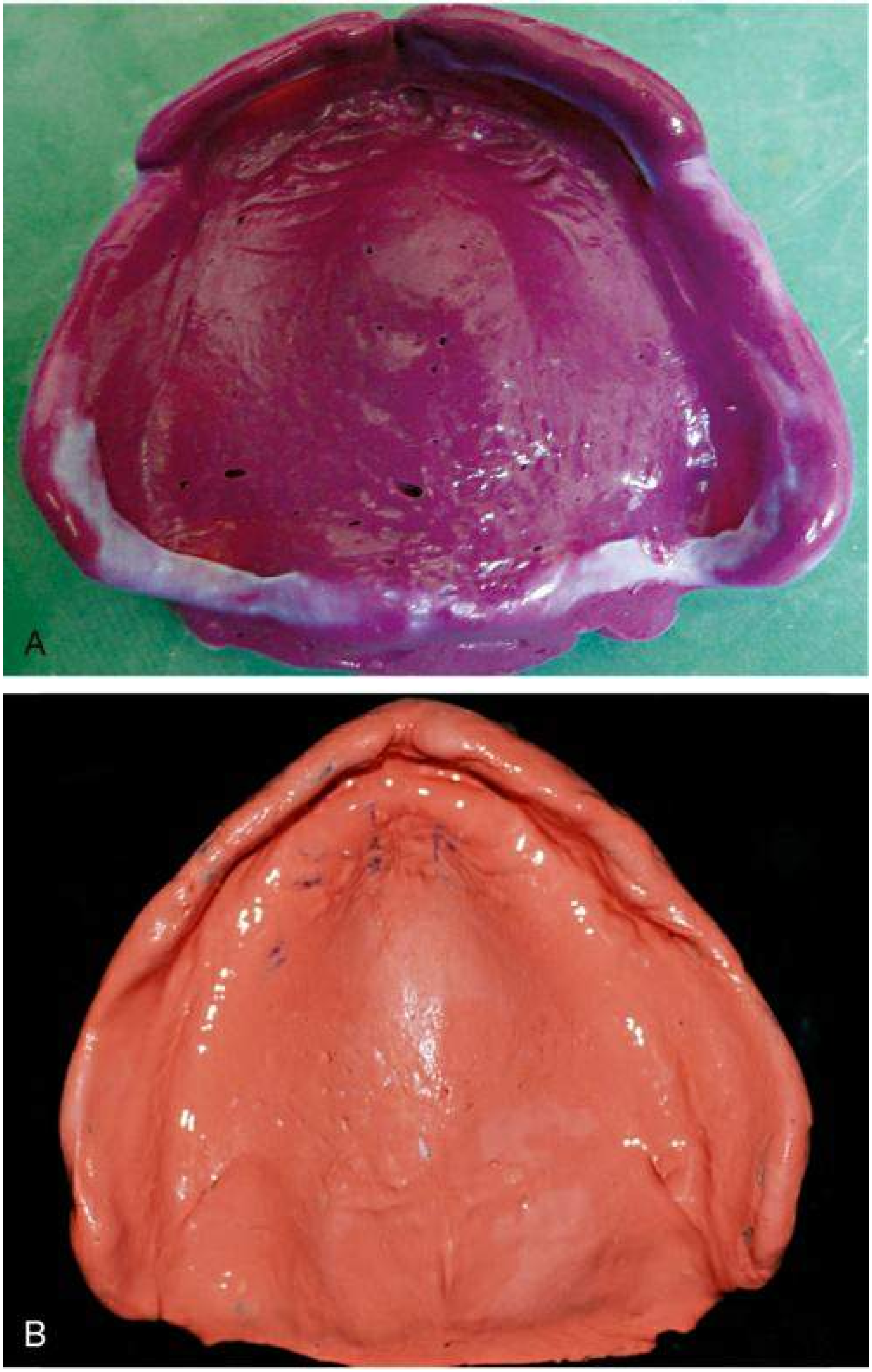


FIGURE 4.58 Completed maxillary final impression using **(A)** medium/regular body elastomeric impression material, **(B)** ZOE impression paste.

Final impression using custom tray with window

- This is indicated for flabby or displaceable tissues.
- A custom tray with a window in the displaceable area is made as described previously.
- Border moulding is completed as described previously with greenstick low fusing impression compound (Fig. 4.59).
- A final impression is made with ZOE impression paste (Fig. 4.60).
- The tray is reinserted and impression plaster is injected onto the window (Fig. 4.61A and B).
- The tray is removed after the plaster sets (Fig. 4.62), and the master cast is poured after applying appropriate separating medium on the plaster. The impression has recorded the displaceable tissues with minimal pressure, while controlled pressure is transferred to the other areas with a close fitting tray and impression with ZOE paste.
- Alternately, impression for flabby ridges can also be accomplished using a combination of medium body elastomeric impression material and light body elastomeric impression material (Fig. 4.63).

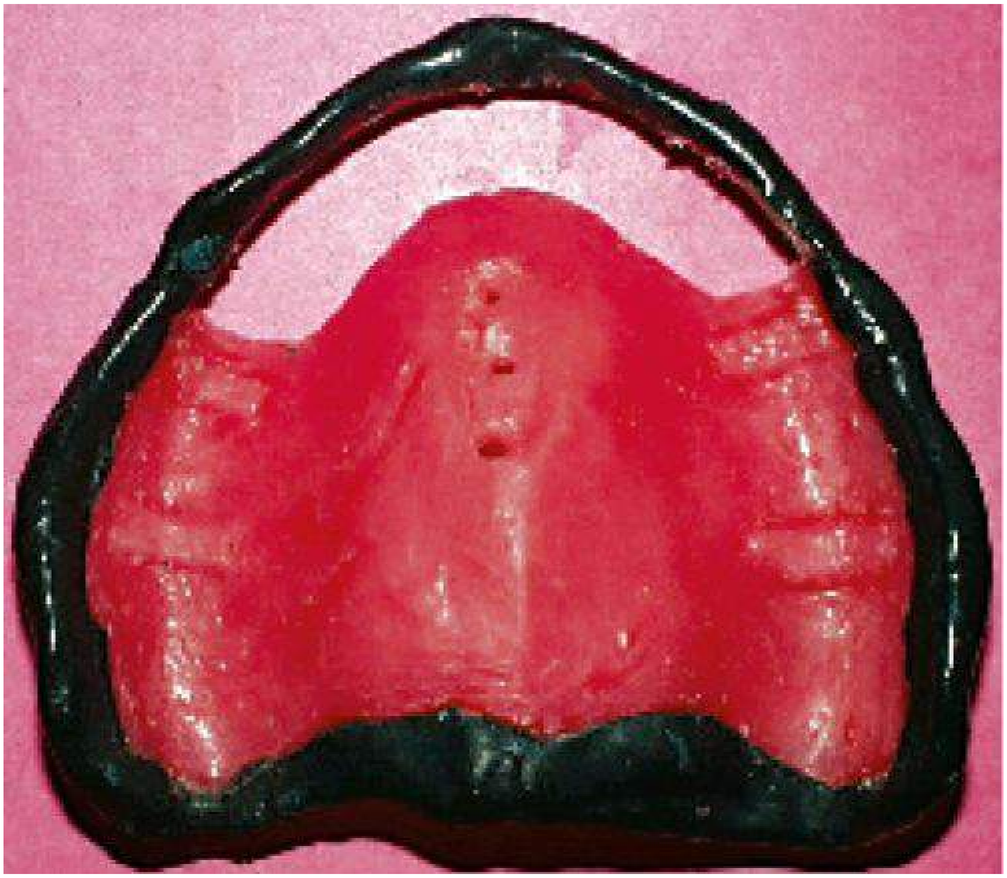


FIGURE 4.59 Border moulded custom tray with window.

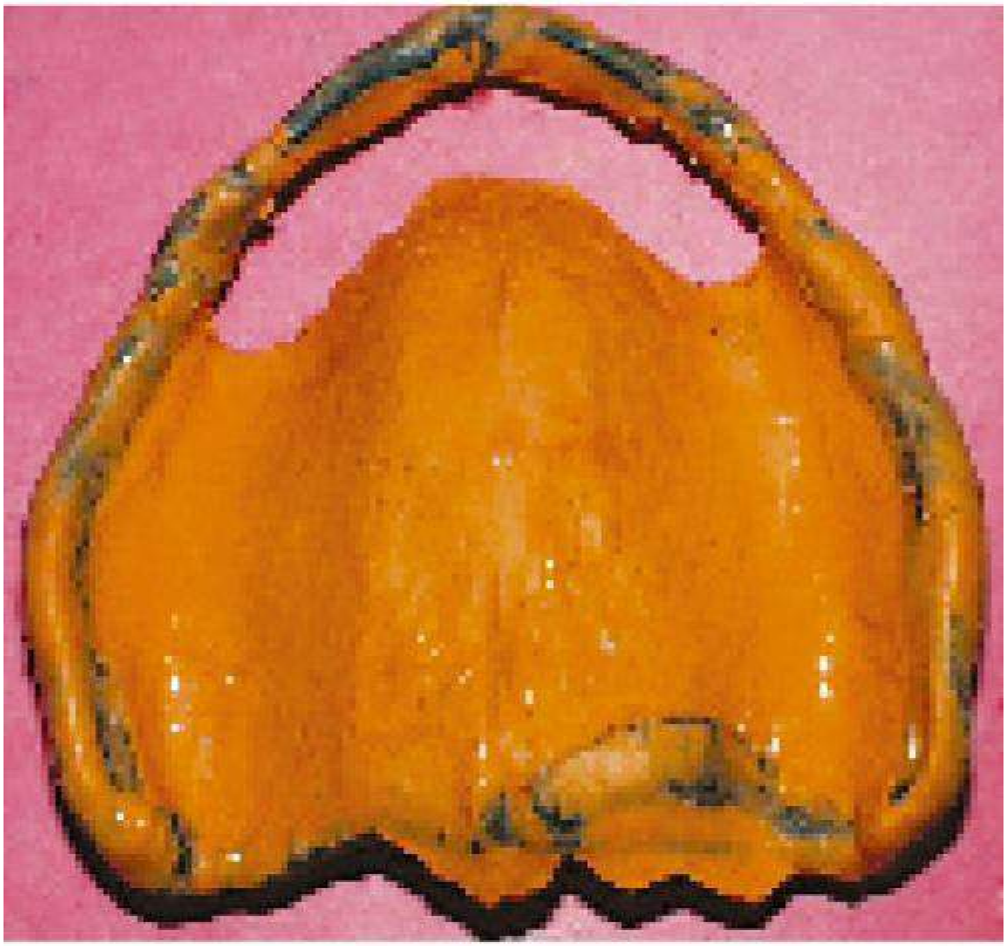


FIGURE 4.60 Impression made with ZOE paste.

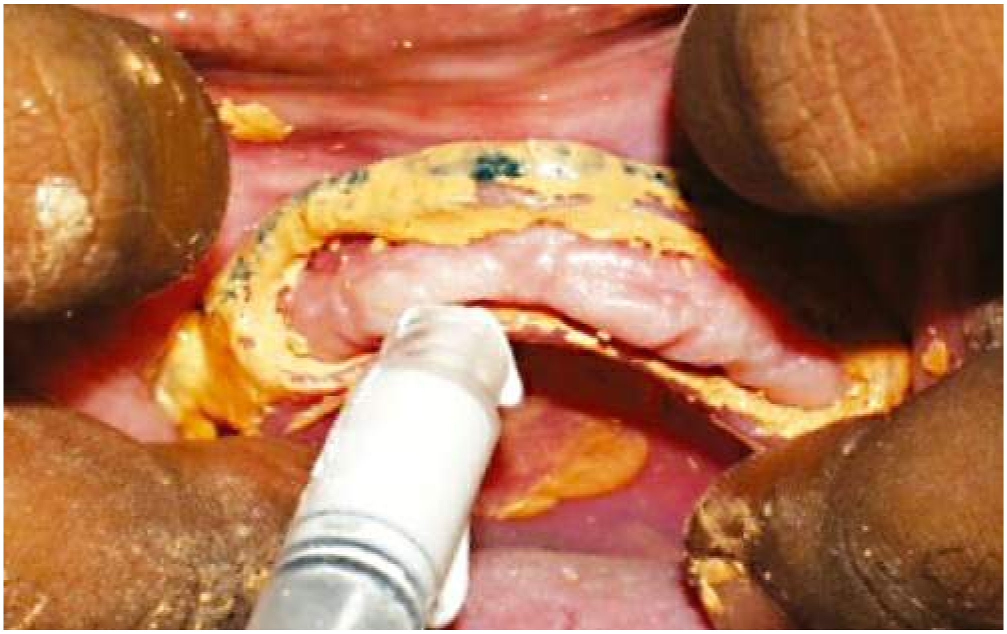


FIGURE 4.61A Impression plaster syringed onto flabby tissue.

FIGURE 4.61B Following setting of plaster.

FIGURE 4.62 Completed final impression (custom tray with window) – combination of ZOE paste and impression plaster.

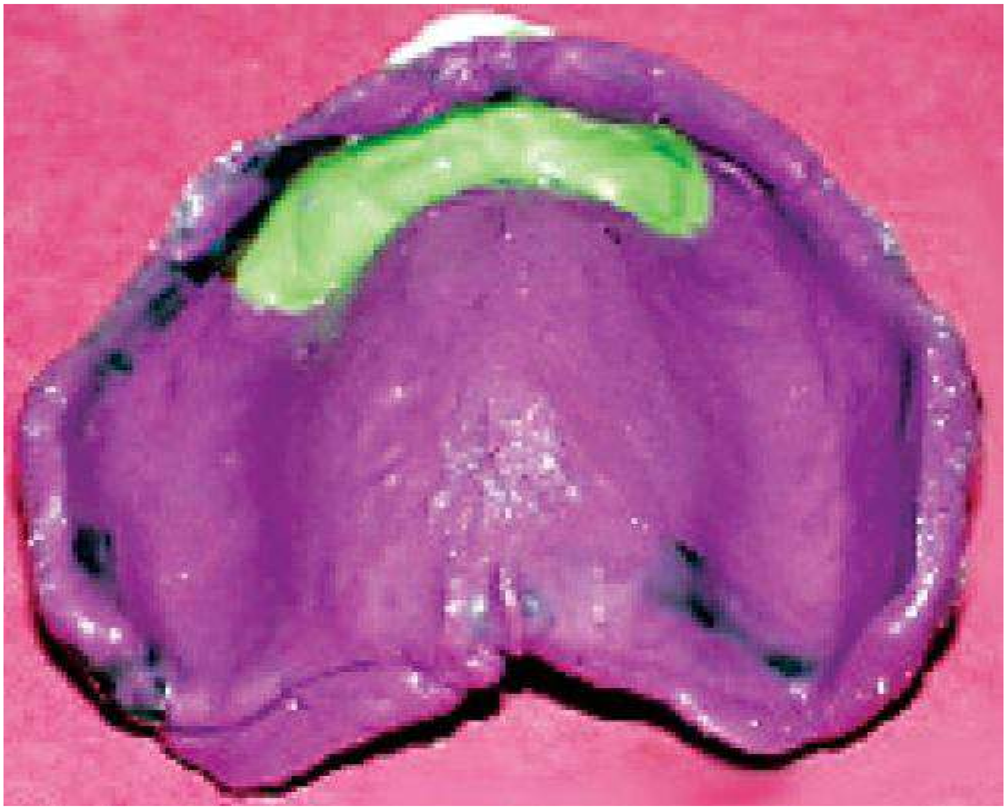


FIGURE 4.63 Completed final impression (custom tray with window). Light body used for flabby tissue and medium body for the remaining tissues.

Using stock trays

- This is used more frequently for making maxillary impressions than for mandibular.
- It is indicated for ideal ridge conditions and when patient does not have the time for additional impression procedures.
- An appropriate stock tray is selected ensuring adequate support for the borders. They may be modified with baseplate wax if needed.
- Preliminary impression is made using putty elastomeric impression material or tray compound material as described previously (Fig. 4.64). The putty material requires a tray adhesive.

- The borders of the preliminary impression are reduced by 0.5 mm and a final wash impression is made with light body impression material or ZOE paste depending on whether the primary impression was made with putty or compound, respectively (Fig. 4.65).
- If a compound impression is used, the compound can be separated from the stock tray and used as a custom tray, while borders are refined.
- During both preliminary and final impression procedures, simultaneous technique of border moulding is performed.

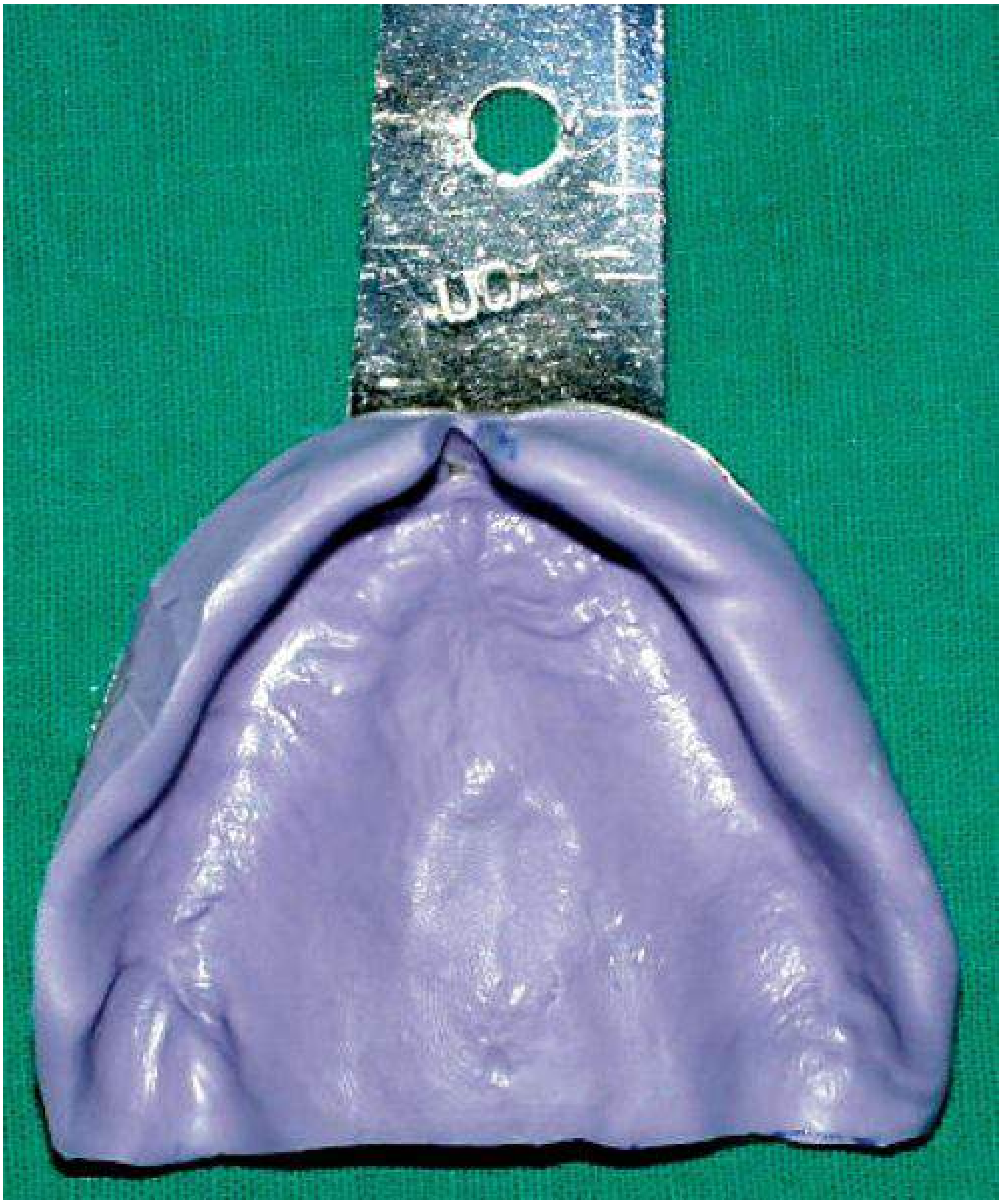


FIGURE 4.64 Preliminary impression made with silicone putty in stock tray.

FIGURE 4.65 Final wash impression made with light body material.

Using record bases with occlusal rims

- This is indicated for atrophic ridges and this condition is more common in edentulous mandibles.
- A functional closed-mouth impression is made using tissue conditioning materials and then an anatomic open-mouth final

wash impression is made using light body impression materials.

- Record base with occlusal rims are fabricated on a maxillary final impression and a mandibular preliminary impression.
- The occlusal rims are inserted intraorally and modified to appropriate vertical dimension.
- The lower record base is used as a tray and tissue-conditioning material is loaded and inserted. The lingual borders are developed with mouth open as described for border moulding of alveololingual sulcus. The patient is instructed to perform functional movements like talking, swallowing and smiling while biting on the occlusal rims. The record base is removed, pressure areas are relieved and overextensions trimmed. More material is added and similar movements are performed till an impression with appropriate borders without pressure areas is obtained. For each application, the conditioning material is left in the mouth for at least 10 min.
- A final wash impression is made with mouth open using standard border moulding methods. A cast is poured immediately (Fig. 4.66).
- The procedure takes up a lot of clinical time.

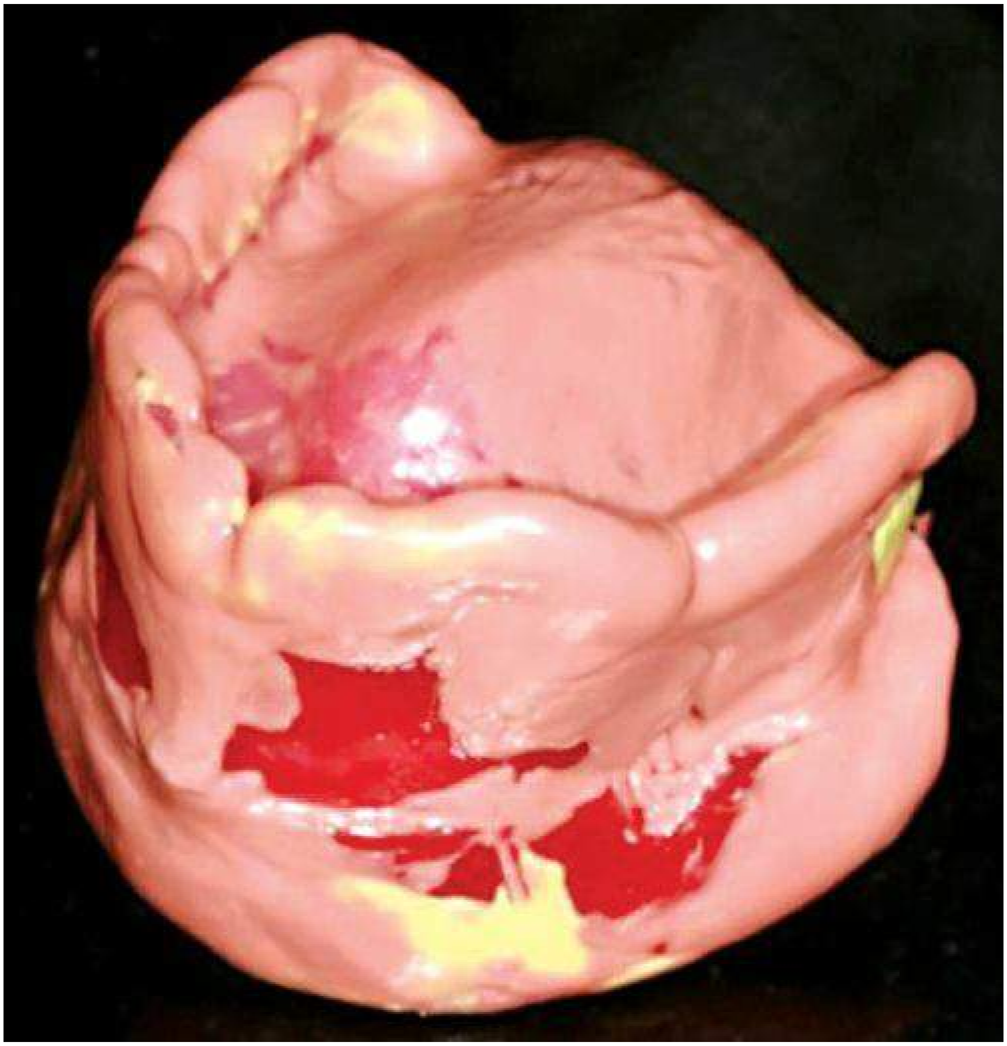


FIGURE 4.66 Completed maxillary and mandibular impressions using occlusal rims.

Inspecting impressions

Final impressions are inspected for air inclusions and voids. The surface is inspected to make sure that all the landmarks are recorded accurately. Small voids can be rectified by filling with wax.

Disinfecting impression

The impression may be disinfected by immersing in iodophor or 2% glutaraldehyde for 10 min.

Remaking impression

Causes:

- Improper positioning of the tray.
- Large voids.
- Improper consistency of impression material.
- Movement of the tray during the setting of the impression material.
- Inadequate scraping of the border moulding material.
- Quantity of the impression material used.

Definitive (final) cast

The final impression should be poured accurately, preserving the depth and width of the border tissues, which have been recorded assiduously. It is poured using dental stone. The cast obtained is termed as 'definitive cast' or 'master cast'.

Definition: Definitive cast is a replica of the tooth surfaces, residual ridge areas, and/or other parts of the dental arch and/or facial structures used to fabricate a dental restoration or prosthesis. It is also called 'final cast'.

This involves:

- Beading and boxing
- Pouring the cast
- Indexing the cast

Beading and boxing

Beading preserves the depth and width of the sulcus, while boxing produces the desired form and size of the base of the cast.

This is commonly accomplished using two methods:

Wax boxing

- Both beading and boxing is done using wax.
- This method is more suitable for final impressions made with ZOE impression paste. Elastomeric impressions are more difficult to bead with wax.
- Commercially available beading wax or baseplate wax can be used for beading, while boxing wax or baseplate wax can be used for boxing.

- Strips of 4 mm width are attached to the periphery of the impression (both maxillary and mandibular) such that it is placed 3–4 mm below the border of the impression and sealed with a spatula (Fig. 4.67A and B). The beading should run parallel and horizontal to the denture border.
- For the lower impression, the tongue space is also covered by attaching baseplate wax to the superior surface of the beading wax (Fig. 4.67B).
- The beaded impressions are placed on a table top, with the impression surface facing upwards, such that the ridges are parallel to the floor. For the upper impression, the handle can be used for anterior stabilization, while soft wax or modelling clay is added to the two posterior ends for stabilization. For the lower impression, the anterior and auxiliary tray handles can stabilize the tray anteriorly and posteriorly. Soft wax or modelling clay can be used to adjust the height to achieve parallelism of ridges (Fig. 4.67C).
- Boxing or baseplate wax is then attached (fused) to the outside of the beading wax all around the impression, to form a vertical enclosure. This should extend 10–15 mm above the highest point on the impression (Fig. 4.67D and E).
- ***Disadvantages:***
- Attaching the beading wax to impression and boxing wax to the beading is technique-sensitive and can cause spilling of wax on the impression.
- Detachment of beading while pouring cast is common.

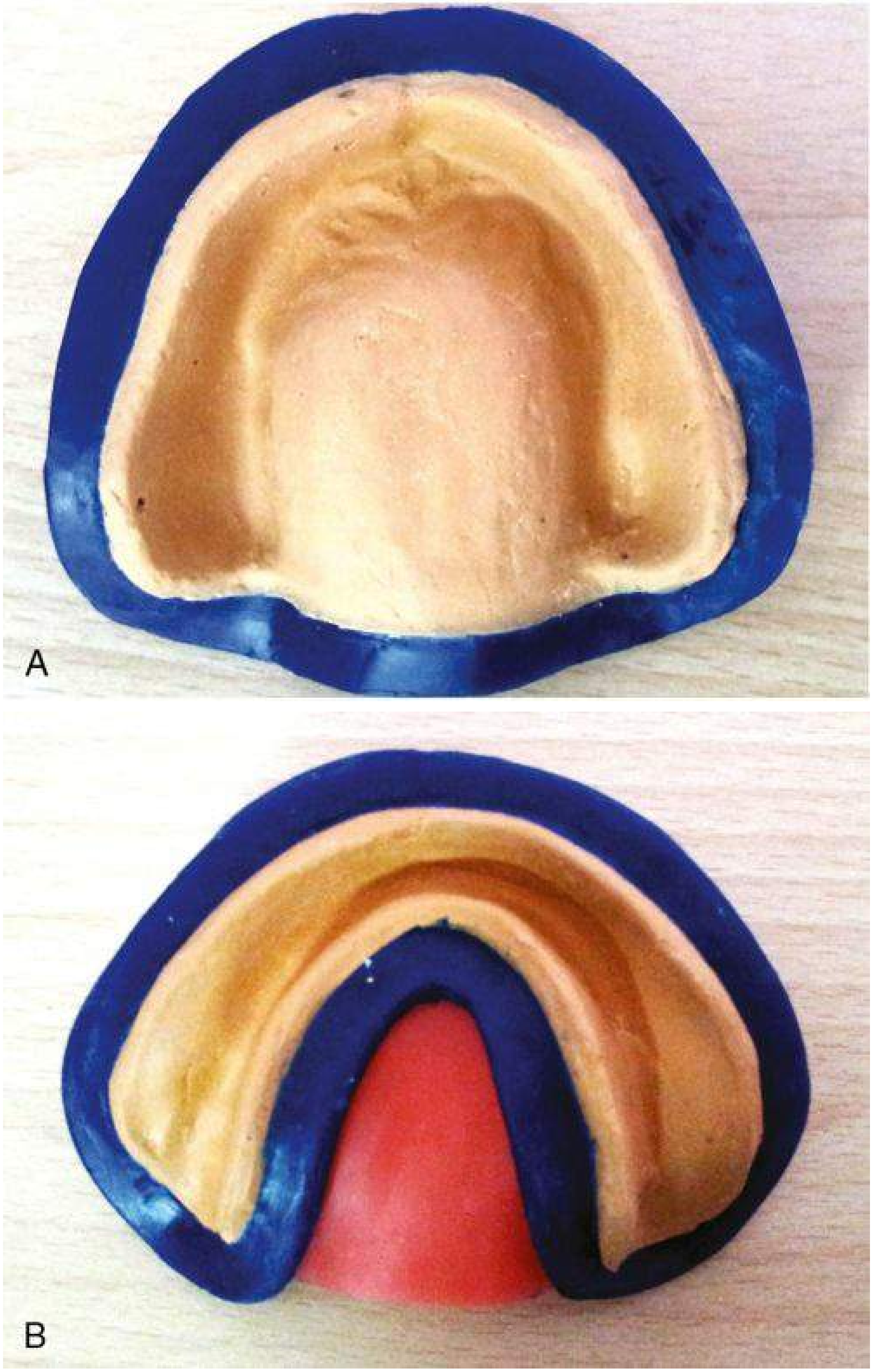


FIGURE 4.67 **(A)** Beading of maxillary impression using beading wax. **(B)** Beading of mandibular impression using beading wax and tongue space covered with baseplate wax.

FIGURE 4.67C Beading using baseplate wax placed 3–4 mm below, parallel and horizontal to impression borders: (a) Maxillary and (b) mandibular. They are stabilized on a table top using the tray handles and modelling clay such that the ridges are parallel to the floor.

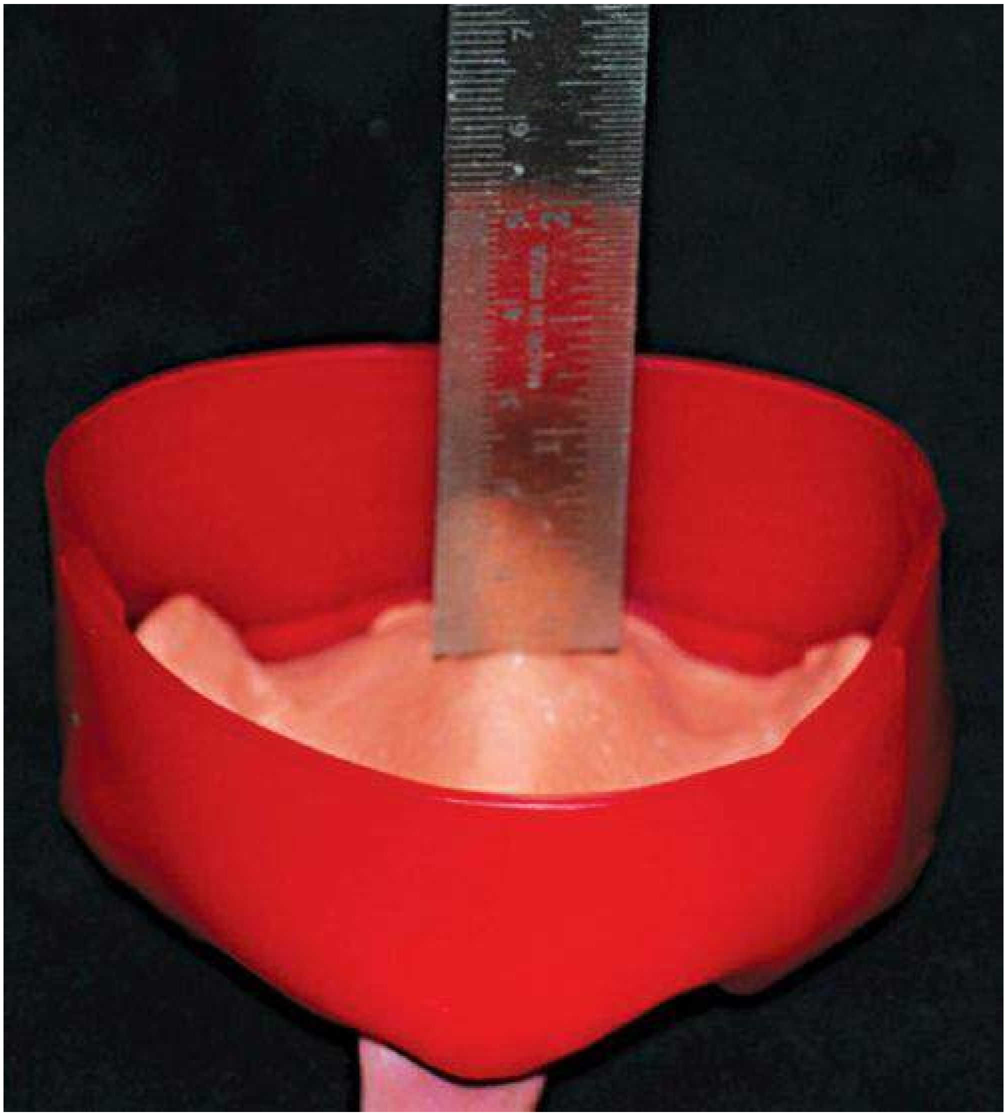


FIGURE 4.67D Boxing with wax all around the beading. The height should be 10–15 mm from highest point in the impression.

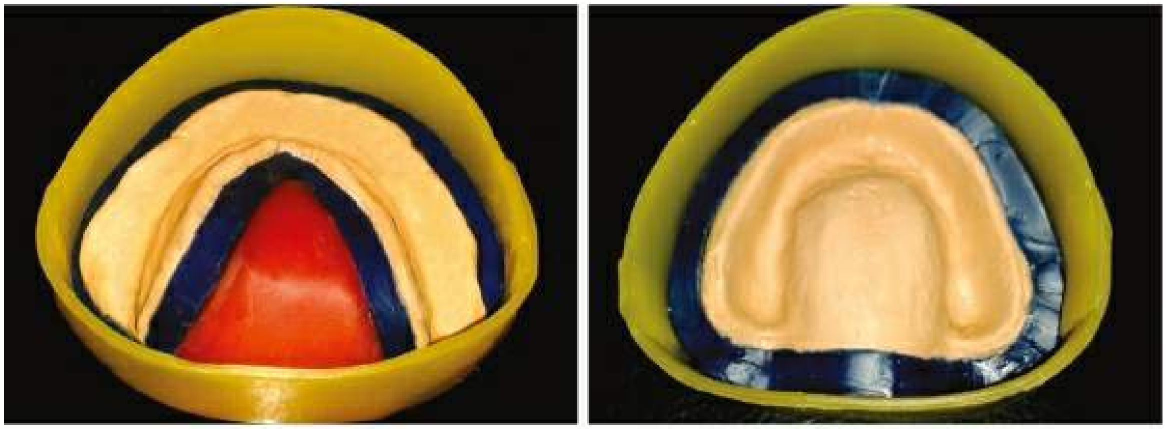


FIGURE 4.67E Beaded and boxed (using boxing wax): (a) mandibular and (b) maxillary impressions.

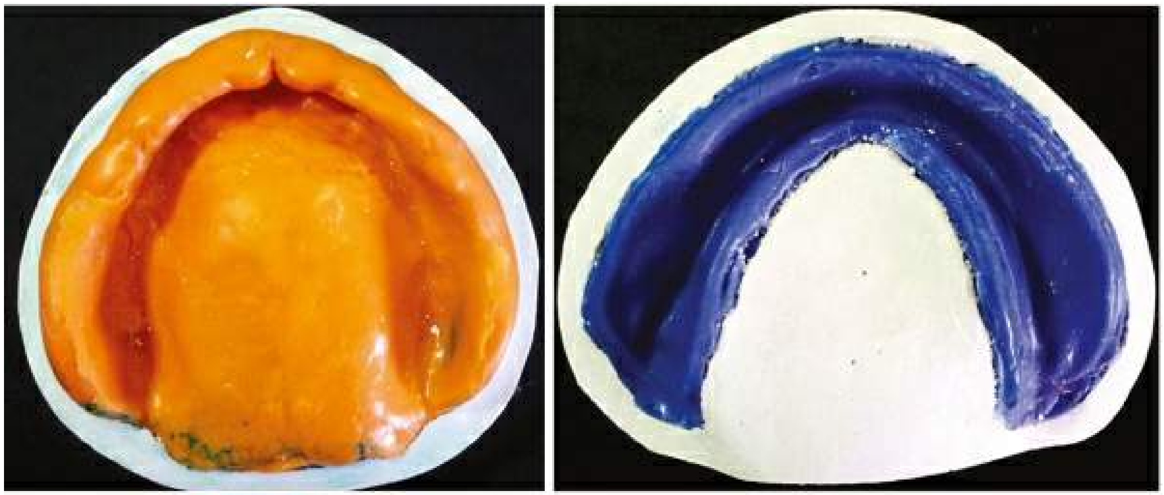
Plaster boxing

- This is the most common method and can be used with all impression materials.
- A 1:1 mixture of plaster of Paris and pumice is mixed uniformly. Pumice weakens the set plaster and facilitates separation from the definitive cast. A stiff mix is made of this mixture with appropriate amount of water and placed on a glass slab, such that it is 15 mm thick and larger than the impressions.
- The impression is now pushed into this mix (tray side down) (Fig. 4.68A) and the mix is manipulated such that the sides are approximately 5 mm below and outside the entire border. The ridges should also be parallel to the floor.
- The mixture is allowed to set and the sides are trimmed perpendicular to the base, leaving with a width of 3–4 mm surrounding the borders (Fig. 4.68B and C).
- Modelling clay is added on top of the plaster ledge and it is built up to a height of 2–3 mm short of the border uniformly all around. The advantage of using this material is that it can be easily modified and

separation of cast from the boxed plaster is easy (Fig. 4.68D).

- Boxing or baseplate wax is then attached to the outside of the plaster base all around the impression, to form a vertical enclosure. This should extend 10–15 mm above the highest point on the impression (Fig. 4.68E).

FIGURE 4.68A Maxillary impression immersed in plaster (tray side down).



(a) (b)

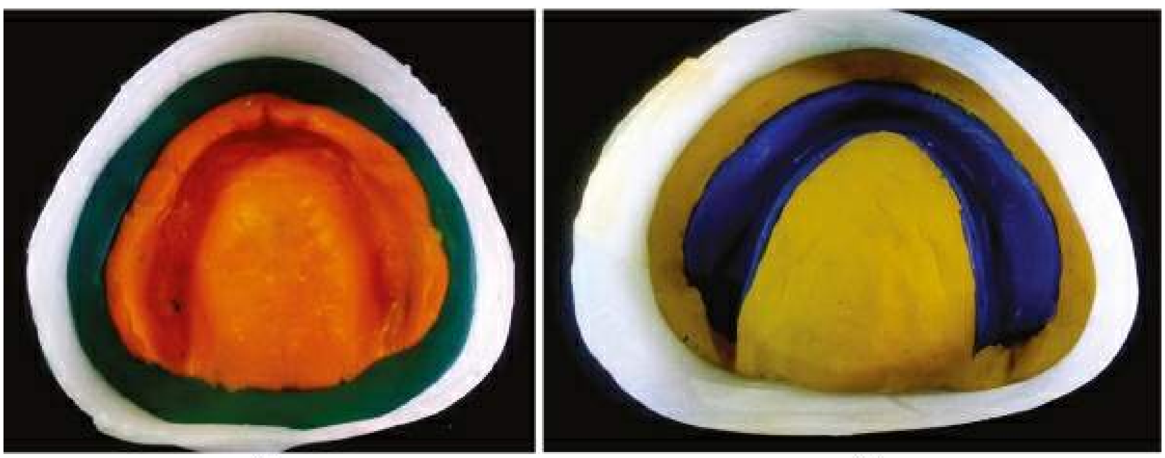
FIGURE 4.68B Excess plaster trimmed leaving a width of 4–5 mm all around: (a) maxillary and (b) mandibular.

(a) (b)

FIGURE 4.68C Plaster trimmed to 5 mm below the borders with the ridges parallel to the floor: (a) maxillary (b) and mandibular.

(a) (b)

FIGURE 4.68D Modelling clay added on top of plaster 2–3 mm short of borders: (a) maxillary and (b) mandibular.



(a) (b)

FIGURE 4.68E Boxing completed using boxing wax: (a) maxillary and (b) mandibular.

Pouring definitive casts

The dental stone should be mixed according to the recommended proportion with water. The mix is vibrated and poured into one posterior end of the boxed impression and allowed to flow onto the other. This is continued until the boxed impression is full.

The stone is allowed to set for 45 min and then it is separated. It is trimmed as described previously for preliminary impressions (Fig. 4.69).

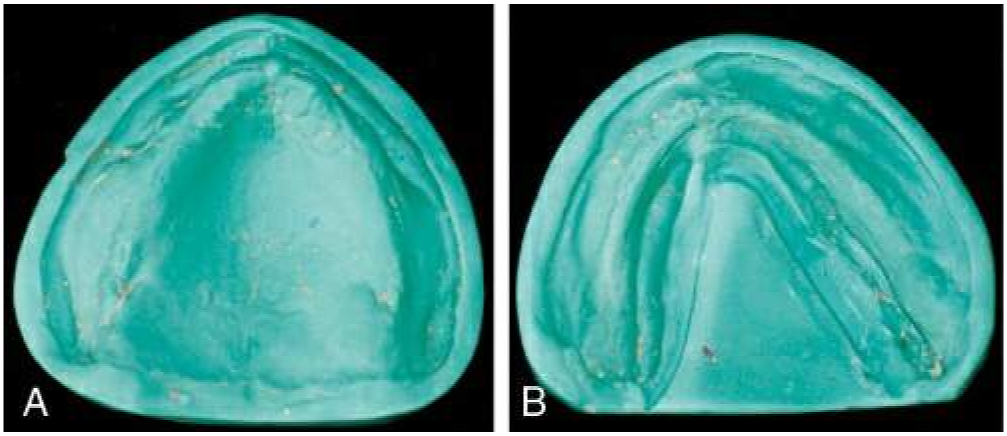


FIGURE 4.69A, B Trimmed maxillary and mandibular definitive casts.

Indexing the cast

- This permits removal and accurate replacement of definitive cast on an articulator.
- Purpose:
  - Verifying jaw relations – split cast method.
  - Checking processing errors – remounting.
- **Requirements:**
  - Should permit easy removal and accurate replacement without damage to cast or mounting.

- Should not weaken the cast.
- There should be no undercuts or mechanical locks.
- Should be functional even if cast size is reduced.
- Should provide a positive three-dimensional fit.
- Procedure should be simple and easily accomplished with readily available materials and equipment.

• It involves the following methods:

- Grooves
- Notches
- Remounting plates.

Groove indexing

This method involves placing 'V-shaped' grooves on the base of the cast for indexing.
Procedure:

• For maxillary casts, two lines that are perpendicular to each other are drawn through the centre of the base of the cast (Fig. 4.70).

• For the mandibular casts, the lines are marked under the thickest area (under the area of the ridges).

• The grooves, 5 mm in depth, are prepared using a lathe – mounted wheel which has been sharpened to make a V-shaped edge.

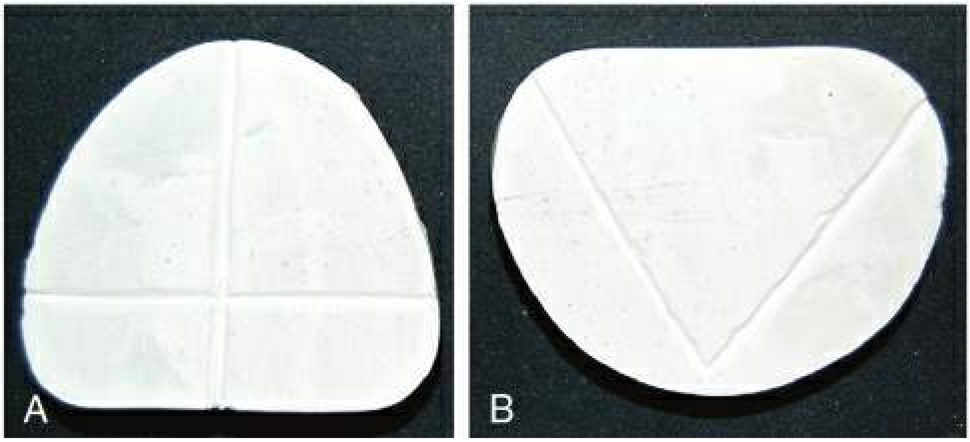


FIGURE 4.70A, B Groove indexing in maxillary and mandibular casts.

Notch indexing

- It is a simple method wherein three 'V/C -shaped' notches are marked on the three corners of the cast (one anterior and two posterior) (Fig. 4.71).
- The notches are created using a sharp knife or a lathe-mounted wheel.
- **Disadvantage:**
- If cast is trimmed to reduce the size, the indexing is lost.

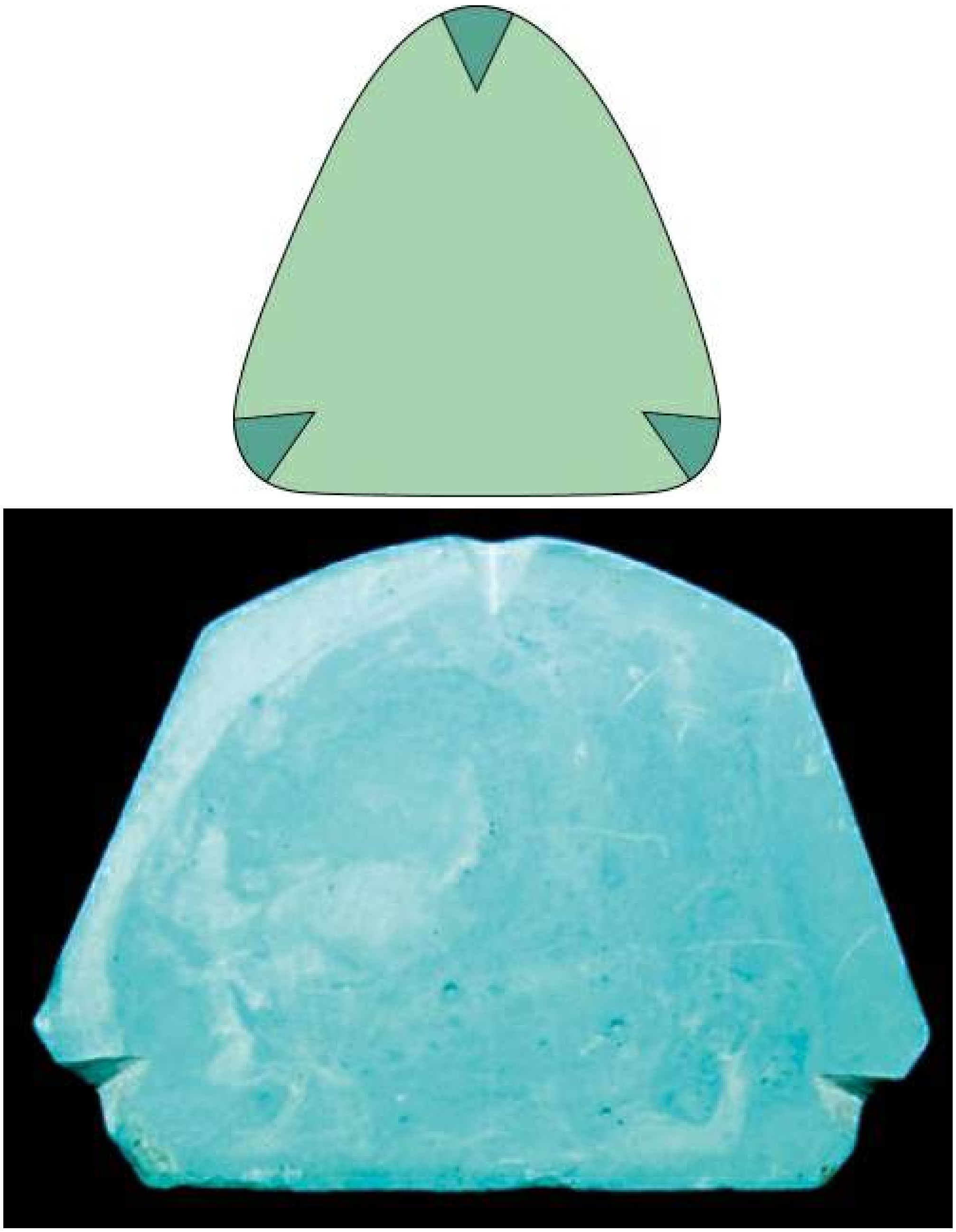


FIGURE 4.71 V-shaped notch indexing.

Split remounting plates

- These are commercially available, and consist of two plates (one male and one female), which precisely fit into each other and can be locked with a locking pin.

- **Advantages:**
  - Fit is precise.
  - Cast can be removed and remounted rapidly.
- **Disadvantages:**
  - Expensive.
  - More time is required to attach them to cast.
- **Procedure:**
  - The male mounting plate is fixed to a 0.5 inch thick sheet of plexiglass to avoid stone contact.
  - The female plate is locked to the male plate with a locking pin.
  - The master impression is poured and before the stone sets; the plexiglass with the remounting plates is inverted and placed over the stone.
  - The female component is allowed to fuse with the stone.
  - After the stone sets, the locking pin is removed and the male remounting plate is separated from the master cast.

○ During articulation, the male and the female parts are locked together and the mounting plaster is contoured over the male plate alone (Fig. 4.72A and B).

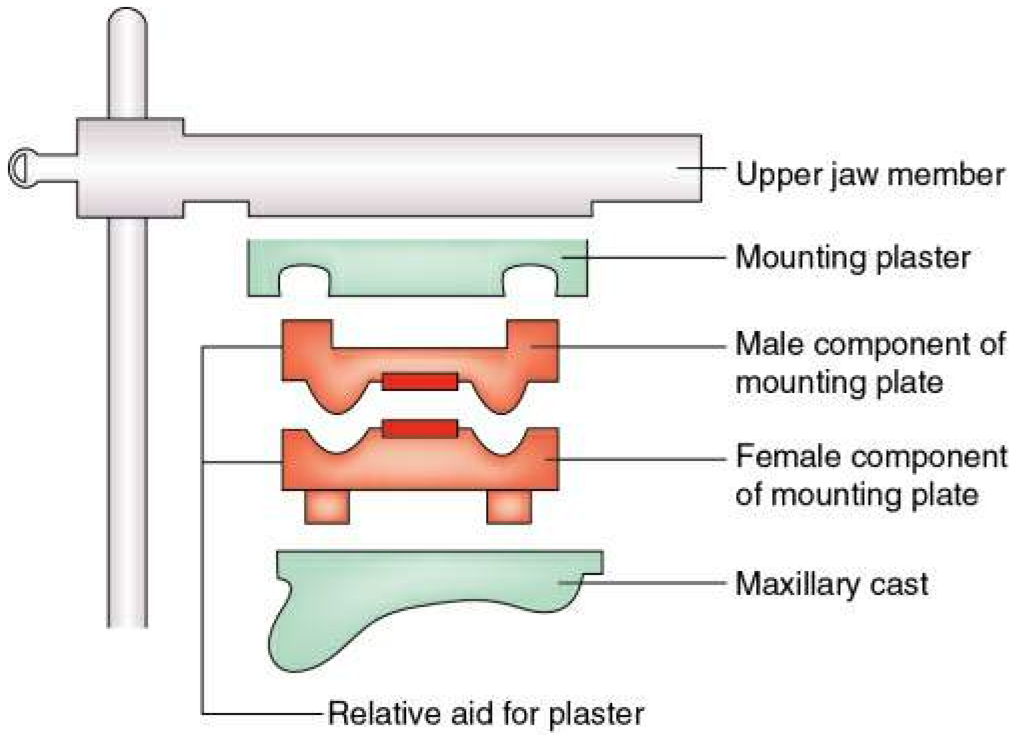


FIGURE 4.72A The female component of the mounting plate gets incorporated in the maxillary cast. The male component is attached to the female before mounting it to the articulator. The retentive mechanism of the plates engages the plaster.

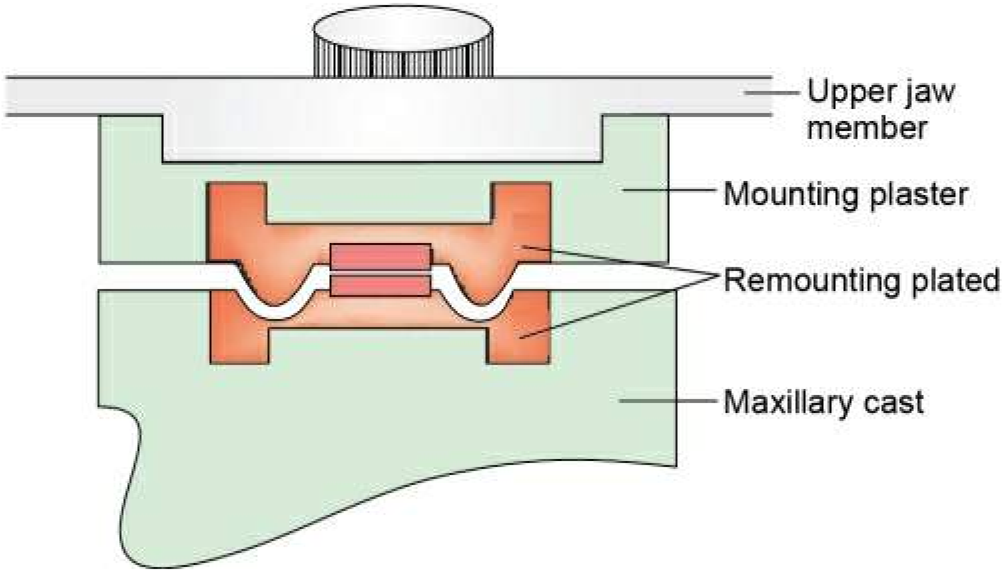


FIGURE 4.72B Schematic diagram of the mounting plate assembly, articulator and the cast.

SUMMARY

An impression is the primary reason for the success or failure of a denture. It is, therefore, extremely important to pay utmost attention to this step and create an exact replica of the patient's oral structures. There are various techniques and materials available for impressions. It is the duty of the operator to choose, based on the clinical findings and requirements and then make an ideal impression. As this procedure is the beginning of all the clinical steps, any mistake in this stage should be identified and corrected. Failure to correct will result in surmounting of mistakes, which will have profound impact on the prognosis of the treatment. However, most often it is safe to make a selective compression impression using low-fusing compound as material of choice for border moulding and ZOE as a final impression material.

CHAPTER 5

Record bases and occlusal rims

CHAPTER CONTENTS

Introduction

Following the fabrication of definitive casts, the next clinical procedure in the fabrication of a complete denture is to record the jaw relationship. For this, a record base and occlusal rims should be fabricated on the definitive cast. The record base should provide a stable foundation and occlusal rims should be contoured appropriately to enable accurate recording of jaw relations. Various materials can be used to fabricate record bases, their properties, advantages and disadvantages, and method of fabrication is discussed in this chapter. Occlusal rims are most commonly made in wax, and their dimensions and fabrication techniques are also discussed.

Definitions

Record base: An interim denture base used to support the occlusal/record rim material for recording maxillomandibular records.
Stabilized record base: A record base lined with a material to improve its fit and adaptation to the underlying supporting tissues.
Occlusal rim: Occluding surfaces fabricated on interim or final denture bases for the purpose of making maxillomandibular relation records and arranging teeth, also called record rim (GPT8).
Denture base: The part of a denture that rests on the foundation tissues and to which teeth are attached.

Record bases

Definition: An interim denture base used to support the occlusal/record rim material for recording maxillomandibular records (GPT8).

It is also known as baseplate, trial base or temporary base. It supports the occlusal rims and the artificial teeth for clinical procedures like recording jaw relations and try-in.

Requirements

• Should be rigid, accurate and stable.

• Borders should resemble that of the finished denture.

• Should be smooth, rounded and polished.

• Should not interfere with teeth arrangement.

• Should be easy to remove from the cast.

• Thickness should not be greater than 2 mm.

• Acceptable colour to blend with the mucosa.

Materials

The materials commonly used for making record bases are classified as:

1. **Temporary bases:** These are eliminated prior to processing the denture and are replaced with a new denture base material. These can be of the following types:

○ Autopolymerizing acrylic resin

○ Light-curing resins

○ Thermoplastic resins

○ Shellac

○ Baseplate wax

○ Stabilized bases

2. **Permanent bases:** The record base is also used as the denture base for the completed denture. Permanent bases can be of the following types:

○ Heat-curing acrylic resins

○ Fluid resins

○ Metal bases

Temporary bases

Autopolymerizing acrylic denture bases

They can be manipulated using the following techniques:

• Sprinkle-on technique

• Dough technique:

1. Finger-adapted

2. Confined dough methods

- Stone-mould method
- Wax-confined method
- Flask-confined method

The sprinkle-on technique and the finger-adapted dough technique have been described for making custom trays (Chapter 4) and the technique is similar. The main disadvantage of the finger-adapted method is that it is impossible to adapt and apply pressure throughout the tray during polymerization. This results in lift-off or rebound of the resin causing distortion. To overcome this, two techniques are described to apply pressure on the resin and confine it during polymerization.

Stone-mould method

- Described by Assadzadik and Yarmond (1975).
- One or two sheets of baseplate wax are adapted over the definitive cast (master cast). This should duplicate the record base in thickness and contour (Fig. 5.1A).
- Small, widely separated round indentations are made in the land area of the cast (Fig. 5.1A).
- Separating medium is applied over the cast.
- The cast is boxed to achieve a height of at least 15 mm, and the index is poured in dental plaster, and removed from the definitive cast after setting (Fig. 5.1B–D).
- The baseplate wax is removed from master cast, and separating medium is applied over both the index and cast.

- Autopolymerizing resin is mixed, kneaded and rolled into a sheet and placed on the cast (Fig. 5.1E). The index is placed on top of the cast to fit the indentations and the assembly is confined with heavy rubber bands (Fig. 5.1F).

- The resin is allowed to polymerize in a pressure pot for 20 min under 20 psi pressure to reduce porosities or bench cure.

- Once polymerization is complete, the baseplate is separated from the cast, trimmed and polished (Fig. 5.1G).

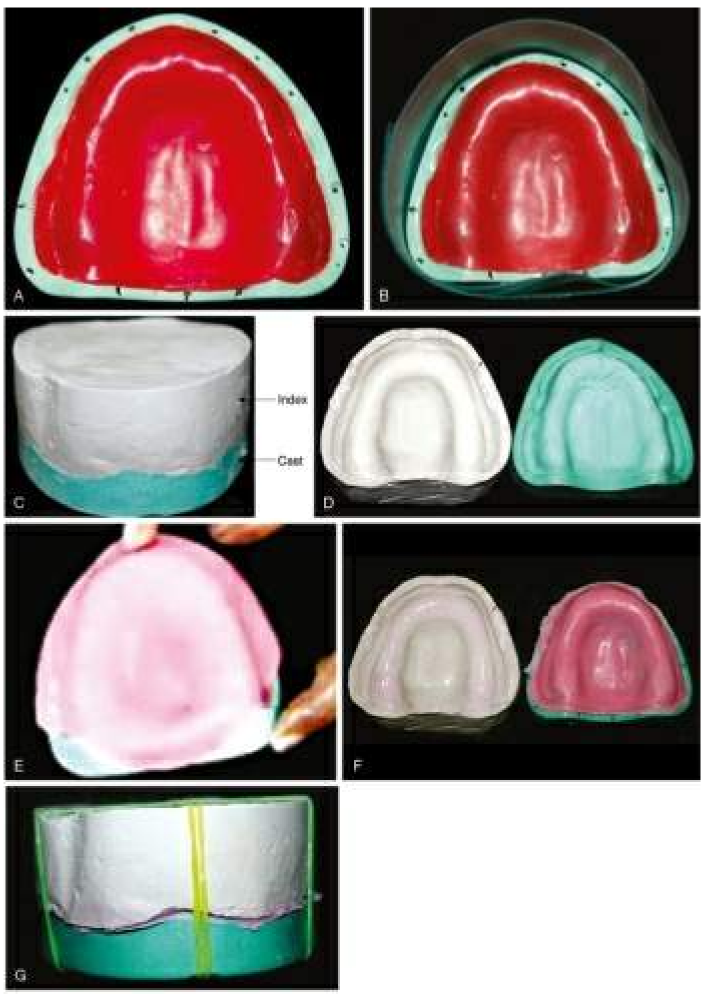


FIGURE 5.1 **(A)** Baseplate wax adapted and indentations made in land area of cast (black marks). **(B)** The cast is boxed and an index poured in plaster. **(C)** Cast with plaster

index. **(D)** Index separated from cast and baseplate wax is removed. **(E)** Autopolymerizing denture base acrylic resin is rolled into a sheet and placed on cast after application of separating medium in index and cast. **(F)** The index is placed on the cast and resin to fit the indentations, the assembly is secured with rubber bands and the resin is allowed to polymerize. **(G)** After polymerization, the assembly is separated, record base retrieved, trimmed and finished.

Wax-confined method

- Described by LaVere and Freda (1974).
- This combines baseplate wax and acrylic resin to form the record base. This may also be used as a method to obtain a stabilized record base of wax using acrylic resin.
- Undercuts are blocked out with wax.
- Three layers of separating medium are applied over the cast and allowed to set for 10 min.
- A sheet of baseplate wax is adapted over the entire cast short of the borders by 2 mm (Fig. 5.2).
- A thin mix of autopolymerizing resin is added along the borders to fill the sulcus.
- The resin is also added on the fitting surface of the adapted wax covering the entire surface by 2 mm (Fig. 5.3).
- After an initial set, the baseplate wax with the unpolymerized resin is inverted and placed on the cast and compressed evenly till the resin attains a thickness of 2 mm (Fig. 5.4A and B).
- The resin is allowed to cure, trimmed and polished.
- **Advantages:**

- Acrylic on fitting surface gives accuracy and rigidity.
- Wax on the outer surface allows better attachment to wax occlusal rim.

FIGURE 5.2 Sheet of baseplate wax is adapted over the entire cast.

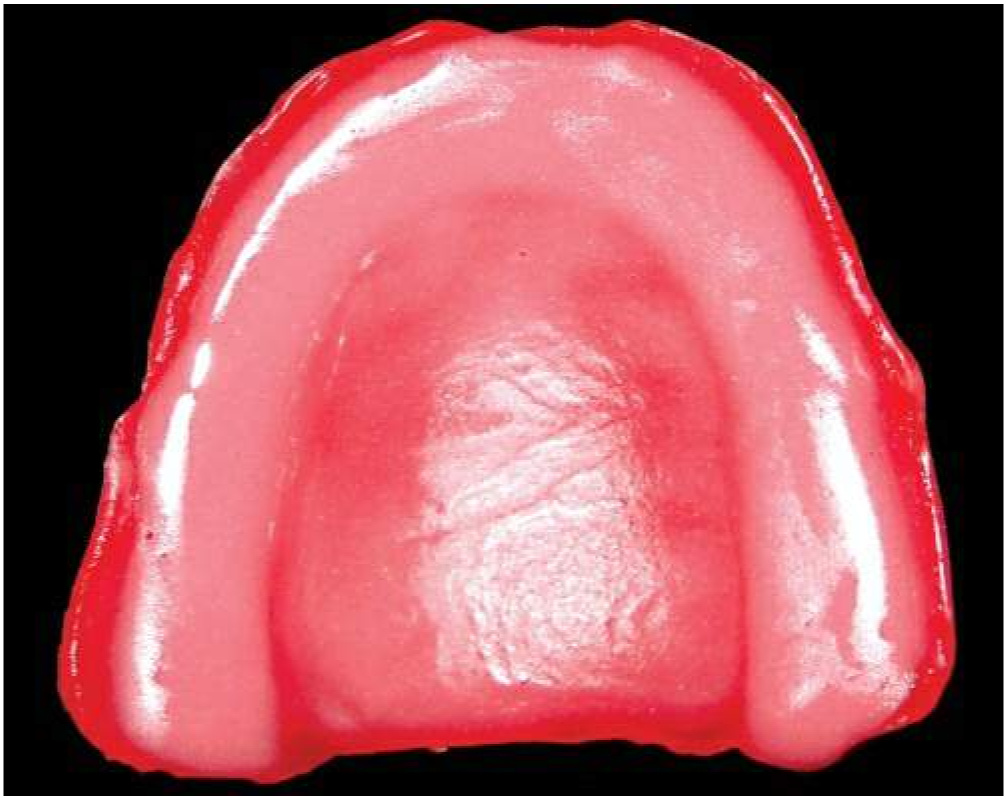


FIGURE 5.3 Resin is added onto the tissue surface of the adapted baseplate wax.

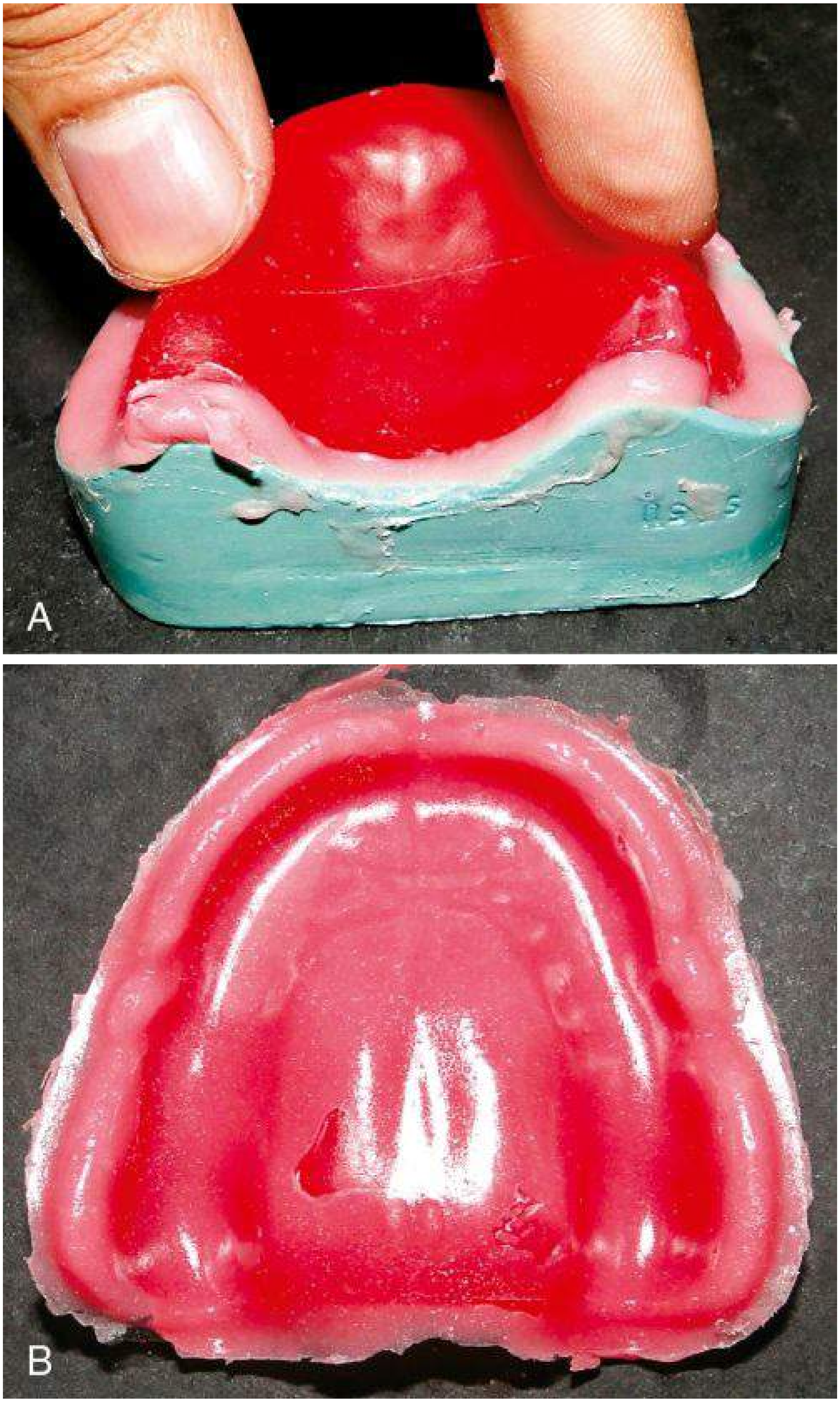

A
B

FIGURE 5.4 **(A)** Wax with the resin is inverted and placed on the cast and compressed. **(B)** Record base removed after the resin has polymerized. **(C)** Shellac base reinforced with wire.

Flask-confined method

- Baseplate wax shaped is adapted on the master cast and shaped to the final contour of the record base. This is then flasked and dewaxed as for making the permanent denture base in heat-cure acrylic resin.
- Following dewaxing, the autopolymerizing resin is mixed and kneaded to a dough-like consistency and packed. The flask is closed, clamp tightened and the resin allowed to cure under pressure.

Light cure and thermoplastic resins

These are discussed with fabrication of custom trays in Chapter 4 and are similarly used for making record bases.

Shellac bases

- Shellac is derived from the resinous exudates of a scale insect. It is thermoplastic and brown in colour, but can be bleached to other colours like pink. It is available in the shapes of the maxillary and mandibular arches.

- **Procedure:**

  - The cast is coated with powdered talc or dipped in slurry water to prevent shellac from sticking to cast when heated.

  - The baseplate is centred over the cast and flamed or it is softened and placed on the cast.

  - The shellac is adapted from the centre to the periphery using a wet cotton swab, thus preventing creases. The borders are adapted using a wax spatula.

  - While soft, the excess is trimmed with scissors.

  - The formed record base is gently tapped to check for rocking. Specific areas can be heated and readapted.

- The borders of the baseplate are smoothened using files or arbour band.
- Presence of glossy areas on tissue surface indicates improper adaptation and needs to be readapted.

- **Advantages:**
  - Easy to fabricate in less time.
- **Disadvantages:**
  - Can distort and break easily due to lack of rigidity.
  - Needs to be reinforced or stabilized.
- **Reinforcing shellac:** Orthodontic wires or paper clips can be used to reinforce shellac (Fig. 5.4C). They are placed in the posterior border of the maxillary cast and lingual to the crest of the ridge anteriorly in the mandibular cast.

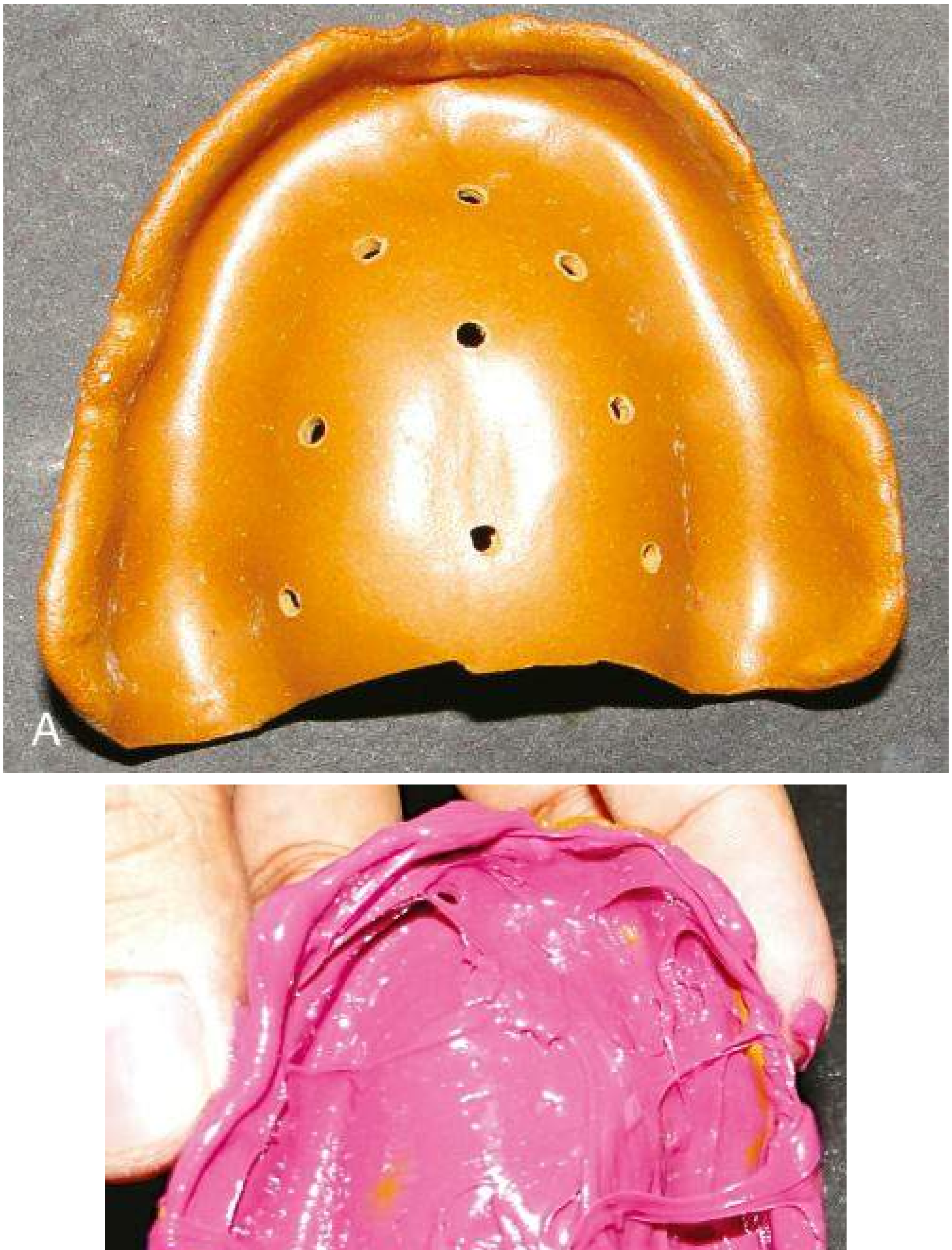
Wax record bases

- Hard baseplate wax is used, reinforced with wires as described previously.
- **Advantages:**
  - Easy to fabricate in less time.
- **Disadvantages:**

- ○ Lack of dimensional stability and rigidity.
- ○ Tend to distort easily.
- ○ Not recommended.

Stabilized bases

- **Definition:** A record base lined with a material to improve its fit and adaptation to the underlying supporting tissues.
- Shellac and wax bases are commonly stabilized but additional time must be spent on the procedure.
- **Materials used:**
  - ○ Zinc oxide eugenol (ZOE) impression paste.
  - ○ Elastomeric impression material (medium-body).
  - ○ Autopolymerizing resin.
- **Procedure:** Similar for all the materials. The shellac or wax is first adapted on the cast, removed and some relief holes placed (Fig. 5.5A). Separating medium is applied on the cast. The stabilizing material is mixed, loaded on the tissue surface of the record base and replaced on the cast, giving adequate pressure to maintain thickness and allowed to set (Fig. 5.5B–D).


A
B

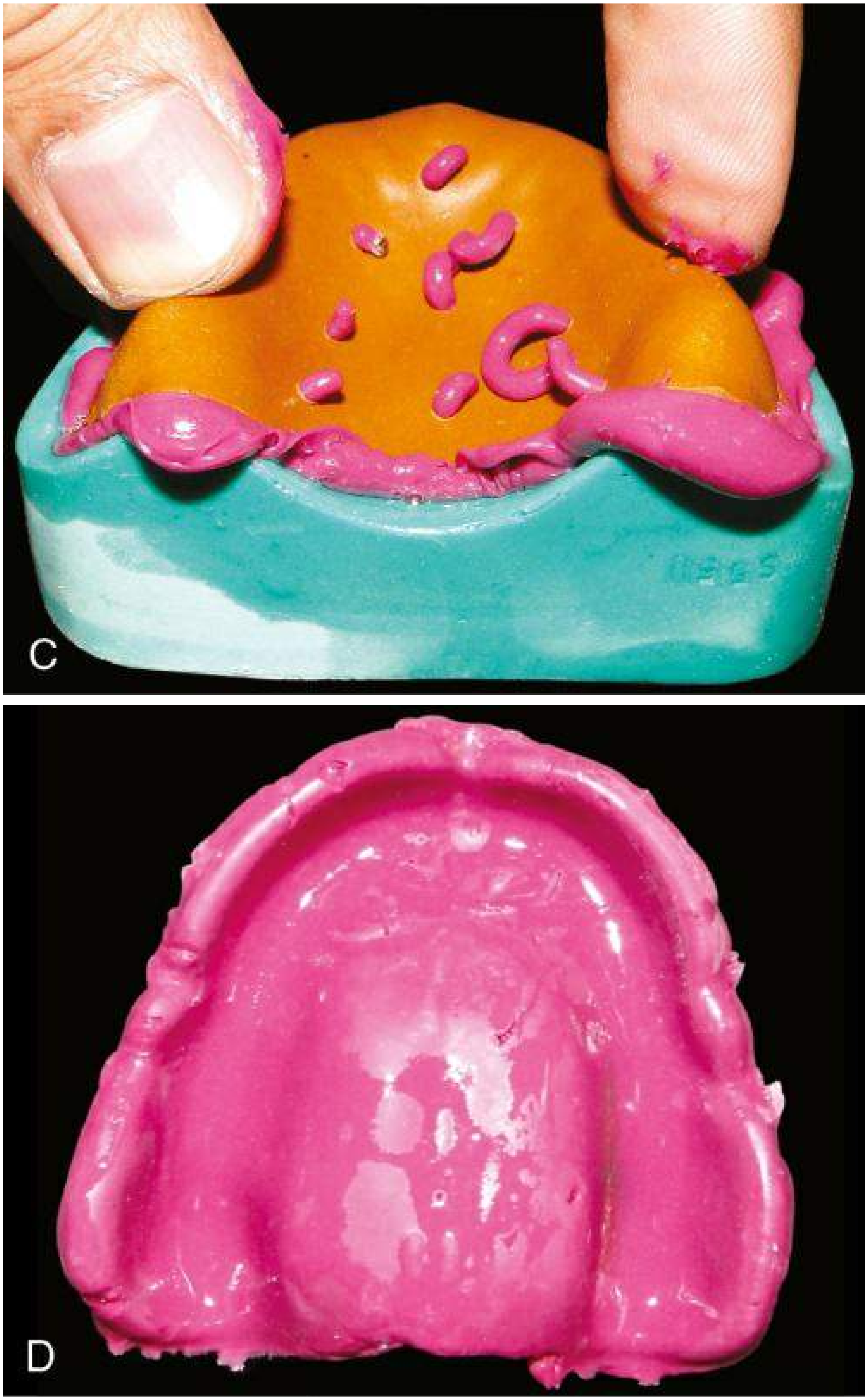


FIGURE 5.5 **(A)** Holes made in the shellac baseplate. **(B)** Medium body impression material applied on the tissue

surface of the baseplate. **(C)** The shellac baseplate is stabilized by applying pressure. **(D)** Stabilized record base (tissue surface).

ZOE impression paste

- **Disadvantages:**

○ Excessive thickness.

○ Undercuts need to be blocked out.

Elastomeric impression materials

The material can extend into undercuts.

- **Disadvantages:**

○ Material is expensive.

○ Excessive thickness.

Autopolymerizing resins

- **Disadvantage:**

○ The resin tends to warp the record base due to release of stresses.

Permanent bases

Heat cure resins

- These serve as record bases and subsequently become denture bases.
- **Procedure:**
    - A layer of baseplate wax is adapted over the definitive cast and contoured to the shape of record base.
    - The cast is invested and flasked using the three-pour technique.
    - Dewaxing is carried out and the wax is removed completely.
    - Heat-cure denture base acrylic resin is mixed and packed into the mould.
    - Compression moulding technique and heat are used for polymerization.
    - Alternately, an injection-moulding technique can also be used to process the heat-cure acrylic resin (described in Chapter 13).
- **Advantages:**
    - Strong and rigid.
    - Thickness can be controlled by manipulating wax.

○ Requires minimal finishing.

- **Disadvantages:**

○ Master cast can be damaged during flasking, hence, may need to be duplicated.

○ Time-consuming.

Fluid resin bases

- This employs a pourable, chemically activated acrylic resin for fabrication.
- It can be used as a denture base material.
- The waxed record base with the cast is placed in a modified duplicating flask with sprues and filled with reversible hydrocolloid.
- After chilling the hydrocolloid, the wax pattern of record base is removed, resin is mixed and poured into the mould and cured.
- **Advantages:**

○ Improved adaptation.

○ Simplified flasking procedure.

- **Disadvantages:**

○ Physical properties poor compared to conventional heat-processed resins.

○ Technique sensitive.

○ It can also be fabricated using injection moulded technique.

Metal bases

- It is used as a permanent denture base material.
- **Procedure:**

It is similar to fabricating a cast–metal partial denture. Master cast is duplicated and refractory cast is poured. Wax pattern is formed on the refractory cast, which is sprued, invested and cast with suitable alloy (Fig. 5.6).

- **Advantages:**

○ Rigid, accurate, dimensionally stable.

○ Easy to maintain.

○ Good thermal conductivity.

○ Adds more weight to mandibular dentures.

○ Less reaction with the mucosa.

○ More strength even at thin sections.

- **Disadvantages:**

○ Expensive.

○ Require more time for fabrication.

○ Alteration, relining and rebasing are difficult.

• **Materials used:**

○ Type IV gold alloys.

○ Chromium-based alloys.

○ Titanium and titanium alloys.

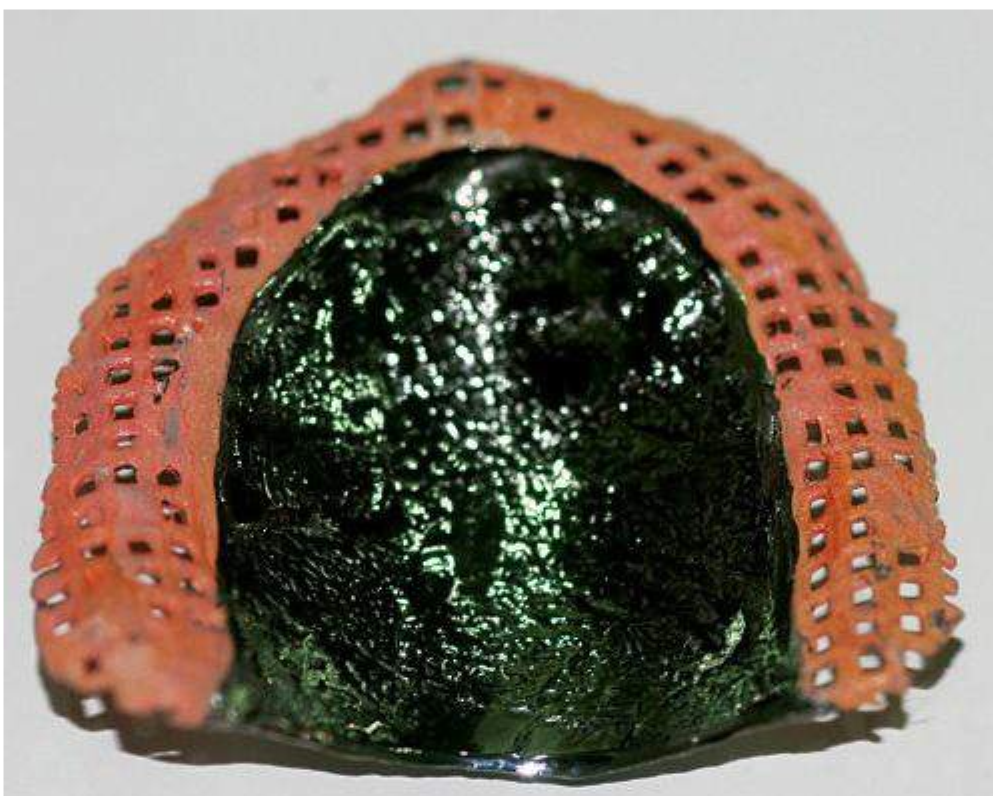


FIGURE 5.6 Record base made of cast metal.

Occlusal rims

Definition: Occluding surfaces fabricated on interim or final denture bases for the purpose of making maxillomandibular relation records and arranging teeth, also called record rim (GPT8).

Wax occlusal rims are most commonly used; compound rims may be used for specific purposes.

Purpose

1. To establish and record maxillomandibular relationships.

2. Arranging artificial teeth for try-in. Assists in determining the following:

○ Length and width of artificial teeth

○ Midline of arch

○ Proper lip support

○ Cuspid eminence

Dimensions of a standard occlusal rim

Maxillary occlusal rim

• Should be parallel to the long axis of the tooth to be replaced.

• Should follow the arch contour (Fig. 5.7).

• **Anterior:**

- *Height* – should be 22 mm from the highest portion of the labial flange to occlusal edge.
- *Width* – 4–6 mm.
- *Inclination* – the anterior border of the rim should be about 8 mm from the incisive papilla or a labial inclination of 5°.
- *Relation to ridge* – slightly labially.

• **Posterior:**

- *Height* – should be 18 mm from highest portion of buccal flange to occlusal edge.
- *Width* – 8–10 mm.
- *Inclination* – 5° palatal (buccal aspect), perpendicular to occlusal plane (palatal aspect).
- *Extension* – 1 cm anterior to hamular notch and angled down.
- *Relation to ridge* – slightly buccal.

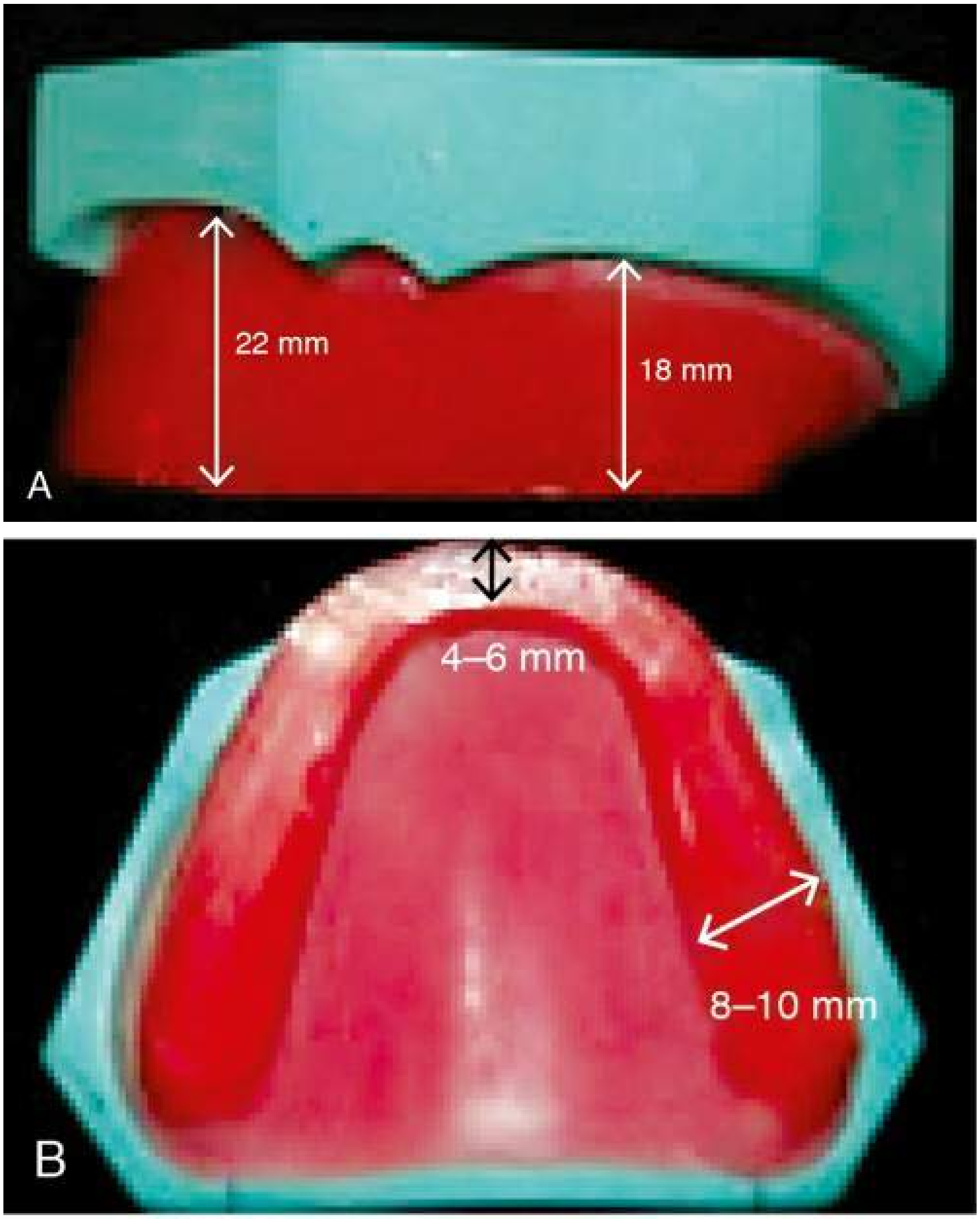


FIGURE 5.7 Dimensions for maxillary rims. **(A)** Height of 22 mm anteriorly measured from the highest point of labial flange and 18 mm posteriorly measured from highest portion of buccal flange. **(B)** Width of 4–6 mm anteriorly and 8–10 mm posteriorly.

Mandibular occlusal rim

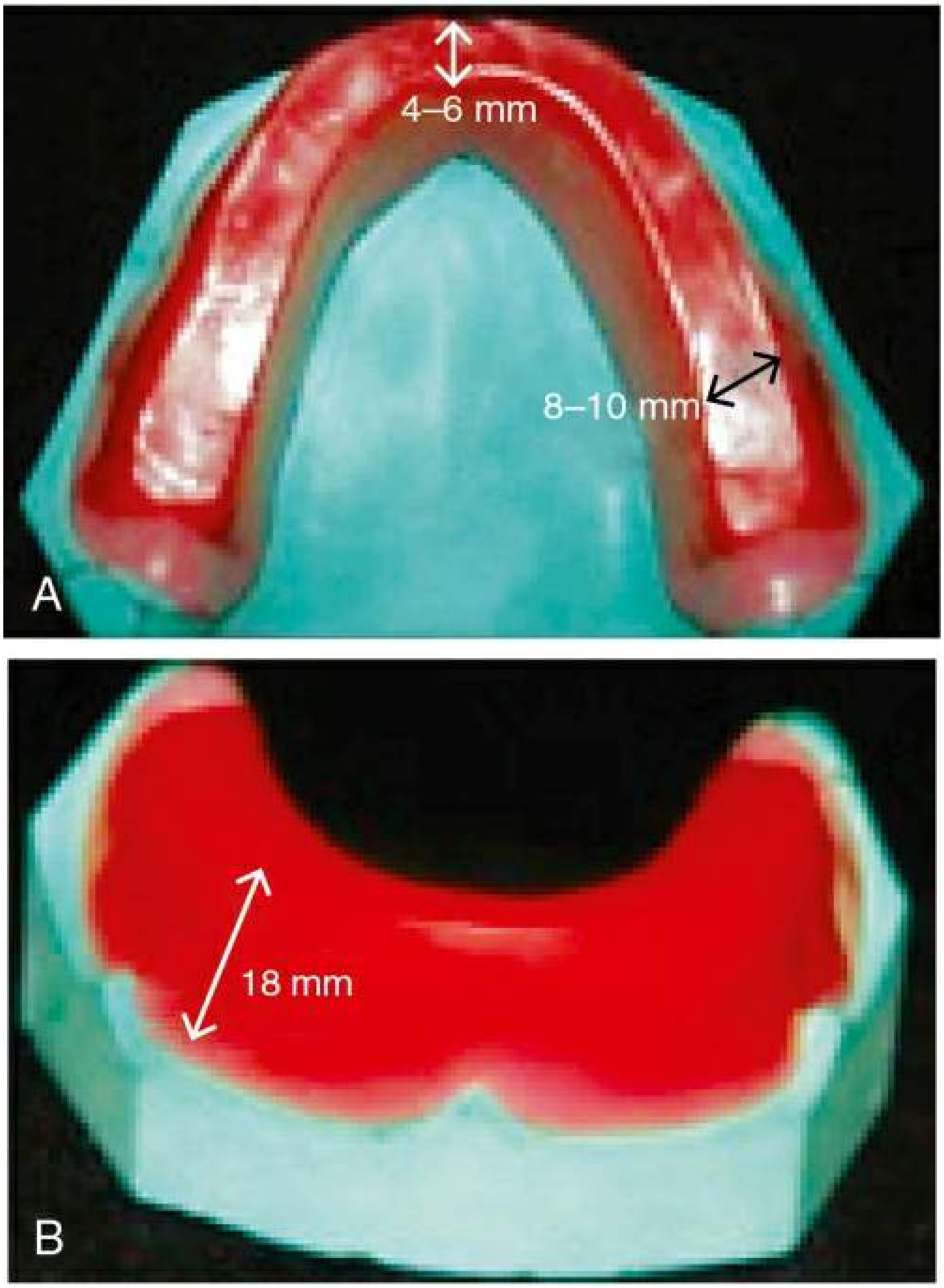
- Should be parallel to the long axis of the tooth to be replaced and follow the contour of the arch (Fig. 5.8).

- **Anterior:**

  - *Height* – should be 18 mm from the deepest portion of the labial flange to occlusal edge.
  - *Width* – 4–6 mm.
  - *Inclination* – labial inclination of 5°.
  - *Relation to ridge* – slightly labial.

- **Posterior:**

  - *Height* – up to retromolar pad.
  - *Width* – 8–10 mm.
  - *Inclination* – slight 5° lingual inclination of buccal aspect and buccal inclination of lingual aspect.
  - *Relation to ridge* – on crest of ridge.


4–6 mm
8–10 mm
A
18 mm
B

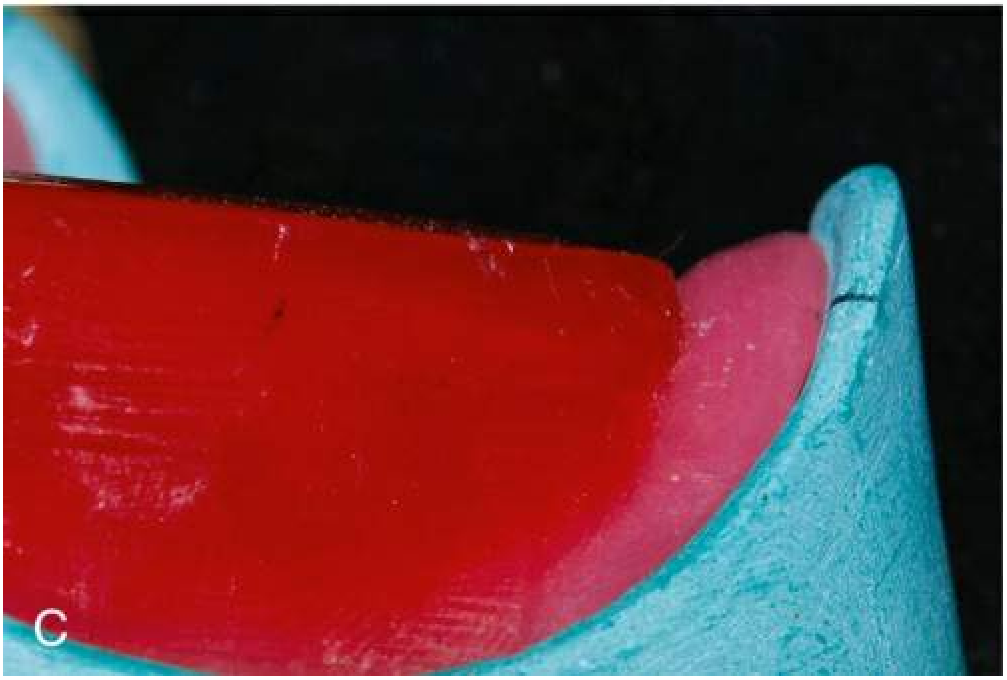


FIGURE 5.8 Dimensions for mandibular rims. **(A)** Width of 4–6 mm anteriorly and 8–10 mm posteriorly. **(B, C)** Height of 18 mm anteriorly measured from the deepest point of labial flange and extends posteriorly up to retromolar pad.

Fabrication of occlusal rims

Occlusal rims can be fabricated by one of the following methods.

Rolled wax technique

- A sheet of modelling wax is taken, heated, softened and rolled to a diameter of 1 cm (Fig. 5.9A).
- It should not be melted and should be continuously softened and rolled to prevent air bubbles.
- The roll is placed on the record base to follow the contour of the arch and downward pressure is given to extend it along the lateral borders (Fig. 5.9B).
- The adapted wax is sealed to the record base on the lingual/palatal

surface using a hot wax knife or wax spatula.

- Wax is added as required to fill up voids and spaces.
- The rims are contoured to appropriate dimensions using a hot plate (Fig. 5.9C).
- Polishing is done by gently flaming the rim, and rubbing with wet cotton or nylon.

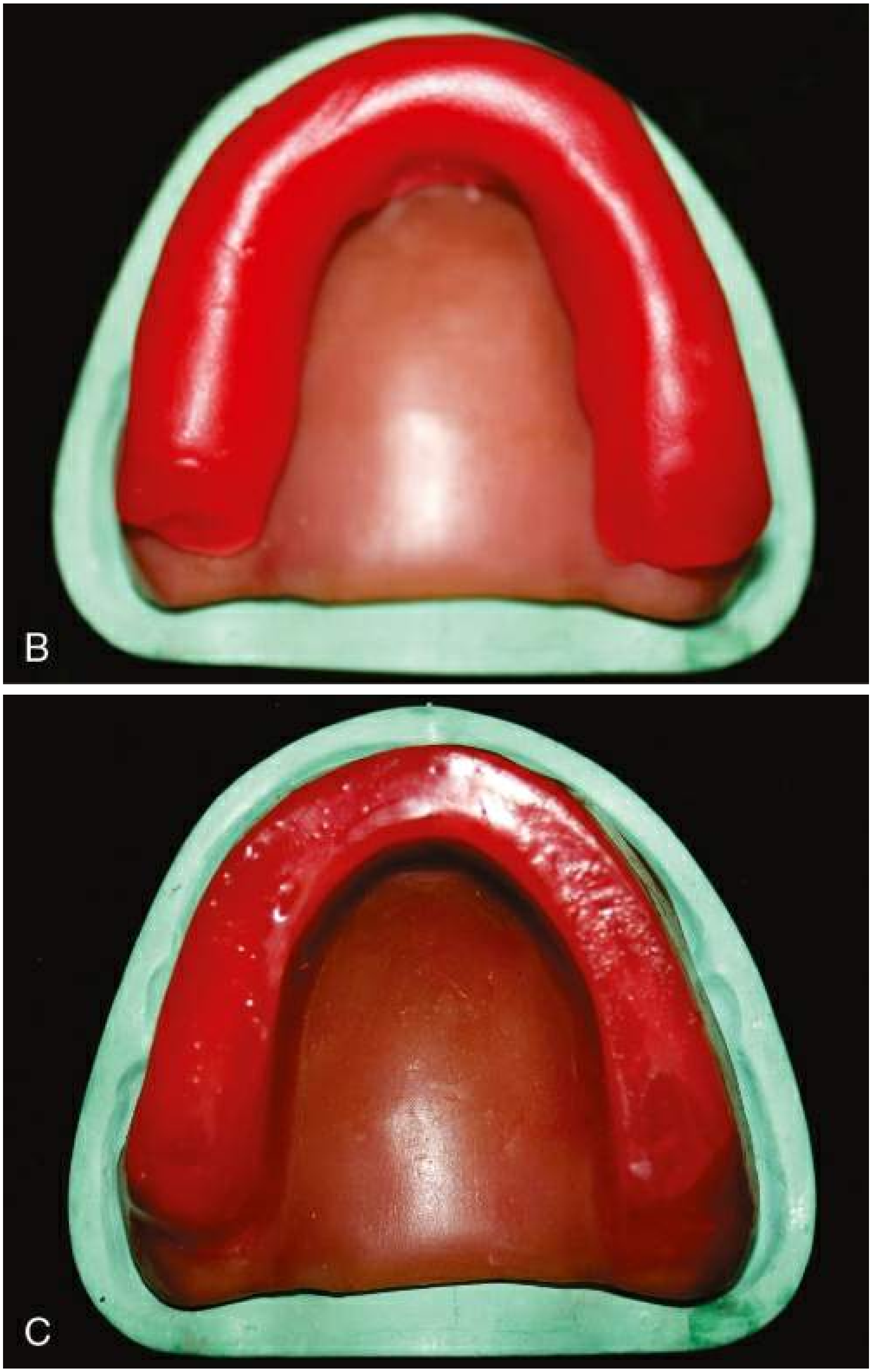


FIGURE 5.9 **(A)** Modelling wax sheet softened and rolled to a diameter of 1 cm. **(B)** Roll placed on record base along the contours of arch and extended laterally. **(C)** Contoured wax

occlusal rim.

Using metal occlusal rim formers

- Modelling wax or baseplate wax is rolled into a cylinder as described earlier.
- The cylinder of wax is then shaped using the rim formers and stored for later use (Fig. 5.10).
- When required, it is adapted over the record base, sealed and shaped.

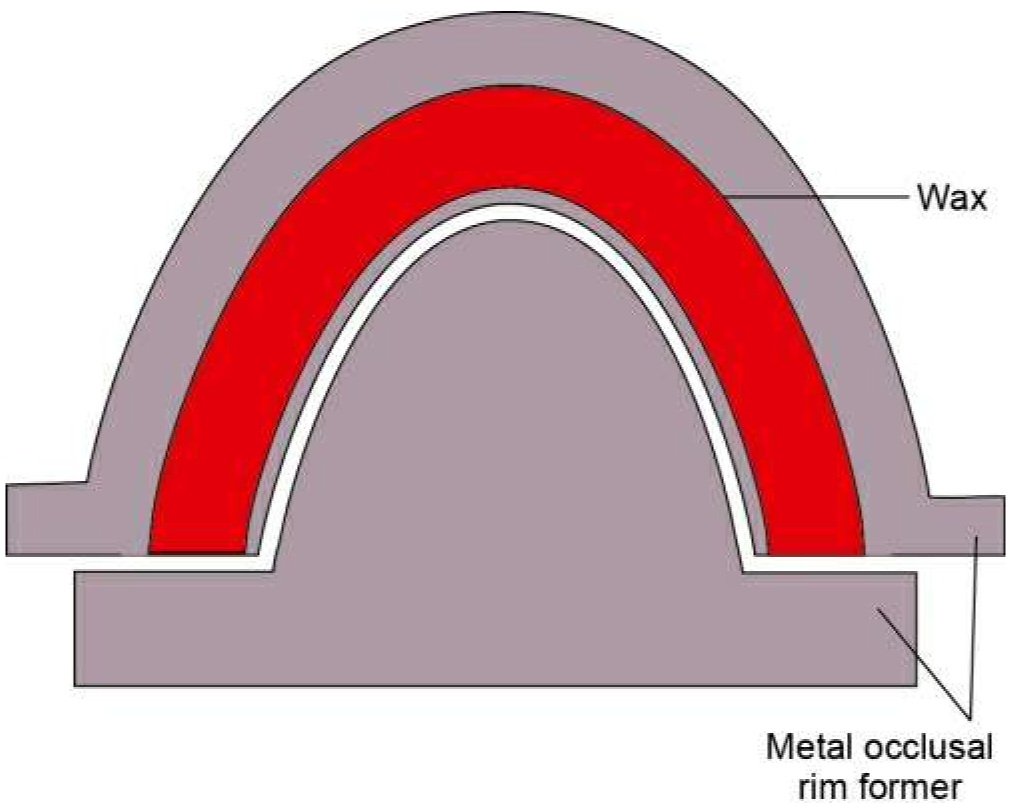


FIGURE 5.10 Metal occlusal rim formers used to form wax rims.

Preformed occlusal rims

- Preformed rims are commercially available wax rims (Fig. 5.11).
- They are designed separately for the maxillary and mandibular ridges.
- They are adapted over the record base, sealed and shaped.

FIGURE 5.11 Preformed occlusal rims.

Compound occlusal rims

- Apart from wax, occlusal rims are also fabricated in impression compound rarely.
- They record the jaw relationship using functionally generated techniques.
- The procedure of fabrication is similar to rolled wax technique.

Clinical contouring of occlusal rims

- The basic laboratory procedures involved in the fabrication of occlusal rims have been discussed previously.
- Final contouring is accomplished in chairside prior to recording the maxillomandibular relations. Some adjustments may also be required while recording jaw relations depending on the method used.

Maxillary rim

Labial extension or fullness

- Should be in harmony with facial profile.
- Nasolabial angle should be 90°.
- Nasolabial sulcus, philtrum and commissure of the mouth exhibit a distinct, normal appearance when proper lip support has been developed (Fig. 5.12A and B). If the rims are under extended labially, there is a deepening of the nasolabial sulcus, philtrum is flattened, nasolabial angle is obtuse and commissures drop. If the rims are overextended, the sulcus is distorted and shallow, philtrum is obliterated, nasolabial angle is acute and commissures are stretched laterally (Fig. 5.12C).
- The vertical length in the anterior region should be 2 mm below the relaxed lip or low lip line (Fig. 5.13).

FIGURE 5.12A Profile picture showing normal appearance of (a) philtrum and (b) mentolabial sulci and nasolabial line angle of 90.

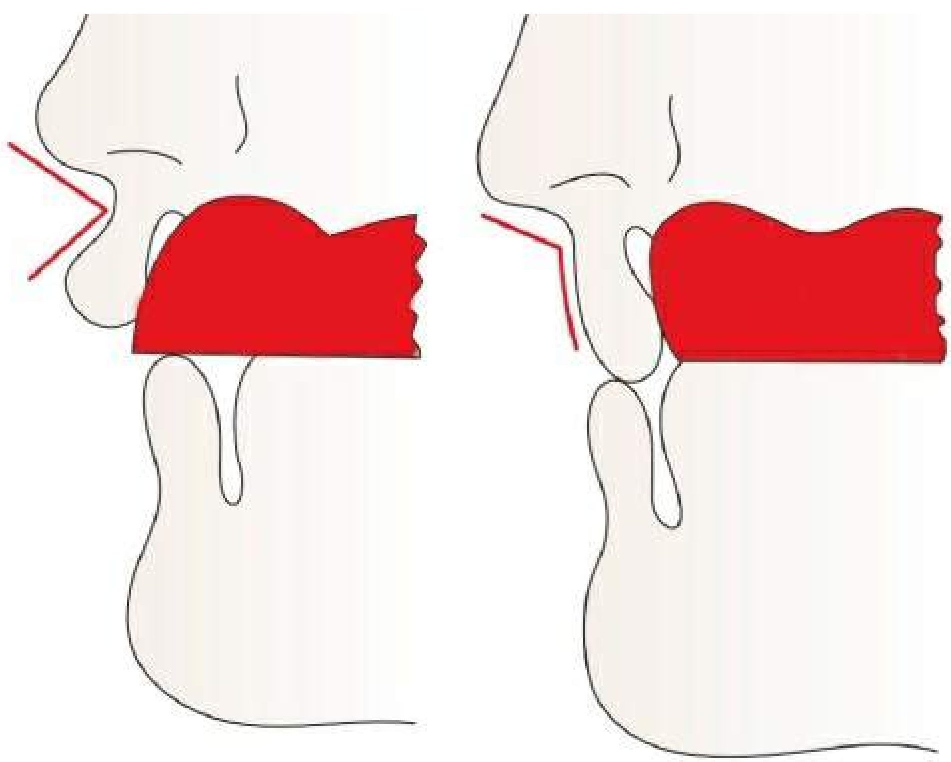


FIGURE 5.12C (a) Overextension of maxillary occlusal rim causes stretching of lip and acute nasolabial angle and (b) underextension causes flaccid lips and obtuse nasolabial angle.

FIGURE 5.13 Two-millimetre height of anterior maxillary rim in mouth showing 'low lip line'.

Buccal extension

- The contour of the buccal surface from just distal to the cuspid should slightly slant towards the palate to provide space for the buccal corridor (Fig. 5.14).

- The vertical length at the first molar region should be approximately 6 mm below the orifice of the Stensen's duct (Fig. 5.15). The height should also be in harmony with the occlusal plane.

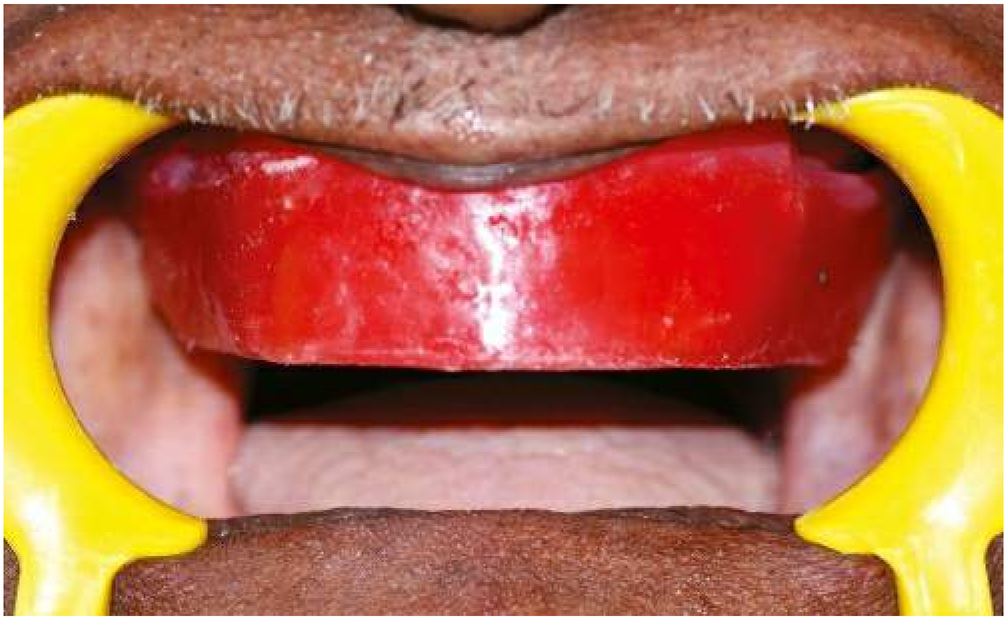


FIGURE 5.14 Slant and buccal corridor.

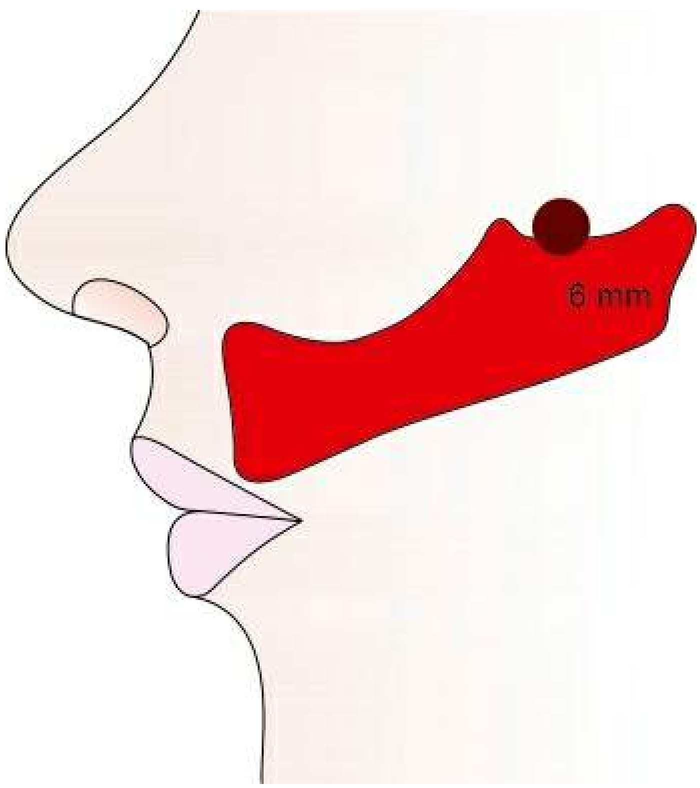


FIGURE 5.15 Vertical length at the first molar region should be approximately 6 mm below the orifice of the Stensen's

duct (marked as brown dot).

Occlusal plane

- In profile view, the occlusal plane should be parallel to the Camper's line (Fig. 5.16). This line is also called ala-tragal line and runs from the inferior border of ala of nose to superior border of tragus of the ear.
- In frontal view, the occlusal plane should be parallel to the interpupillary line (Fig. 5.17).
- A Fox plane (Fig. 5.18A) is used in conjunction with a scale or tongue blade outside, to check the parallelism (Fig. 5.18B).

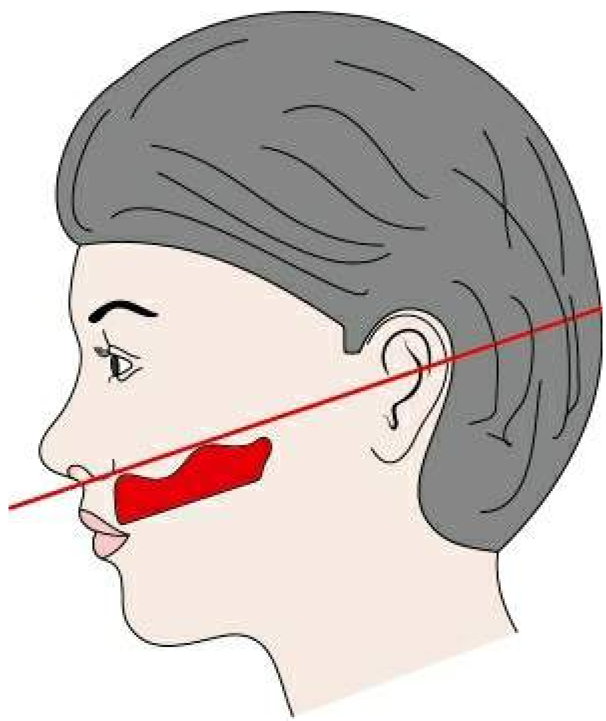


FIGURE 5.16 Profile view, the occlusal plane should be parallel to the Camper's line.

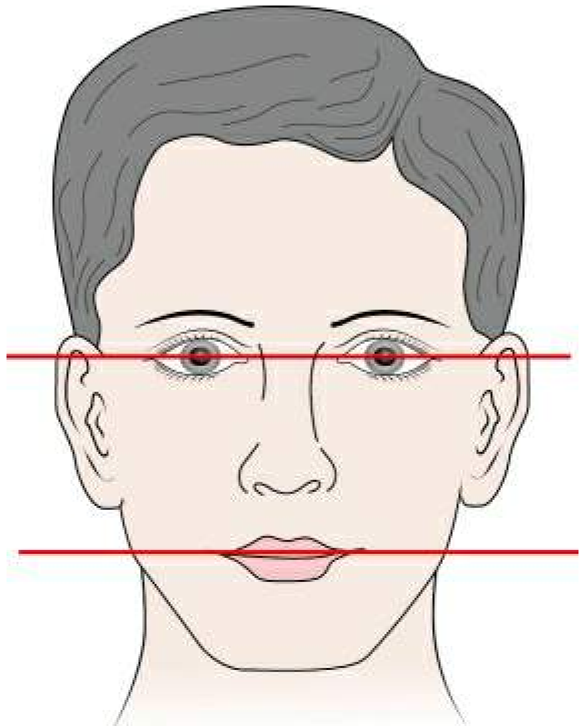
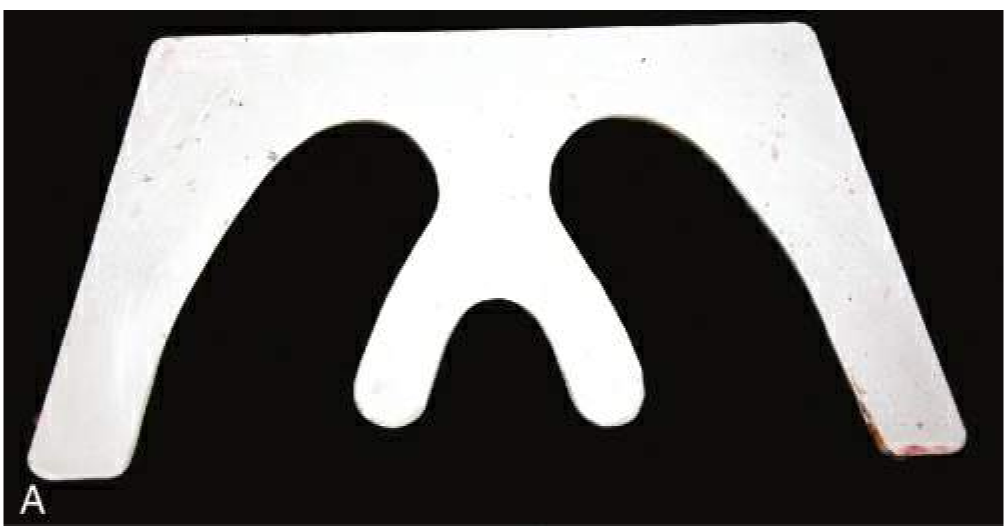


FIGURE 5.17 Occlusal plane parallel to interpupillary line.



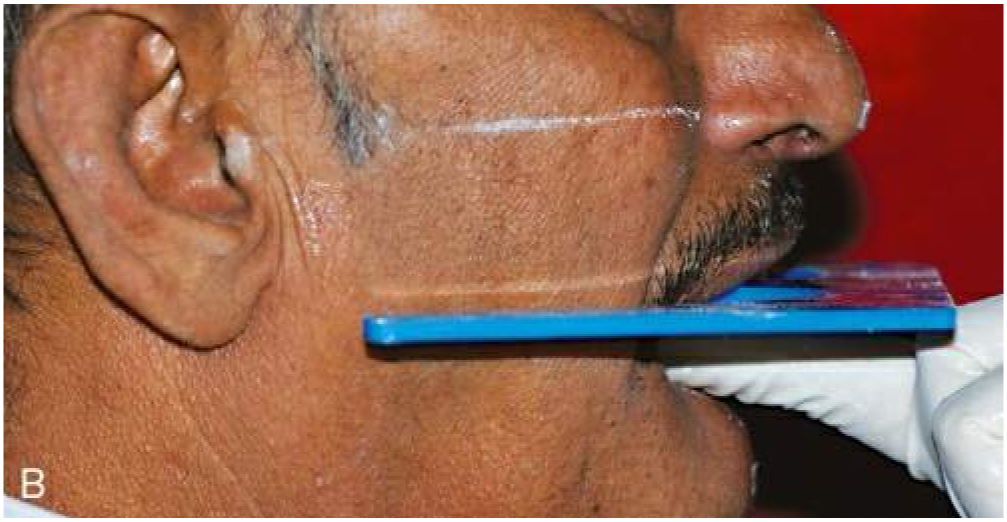


FIGURE 5.18 **(A)** Fox plane indicator. **(B)** Fox plane used to check parallelism.

Mandibular occlusal rim

- Labially, the lip should be unstrained, with vermilion border showing, with proper support of mentolabial sulcus (Fig. 5.12B).
- The anterior extension should be such that an overjet of 2 mm is present with the maxillary rim in position (Fig. 5.19A).
- The height of the rim anteriorly should be at the level of corner of the mouth (Fig. 5.19B).
- Buccally, the rim should contour slightly lingually from the cuspid region with provision for a buccal corridor (Fig. 5.20).

FIGURE 5.12B Showing normal appearance of (a) philtrum, (b) commissure of lips, (c) nasolabial sulcus and (d) lower vermilion border.

FIGURE 5.19 **(A)** Labial extension of mandibular rim should be such that there is an overjet of 2 mm. **(B)** Mandibular occlusal rim in place. When correctly contoured, lip should be unstrained labially and height should be in level with the corner of the mouth.

FIGURE 5.20 Mandibular occlusal rim tilting lingually posteriorly.

Guidelines

The following lines are placed on the occlusal rims for orientation purpose when recording maxillomandibular relations and arranging artificial teeth.

Midline

The following guides are used to record midline (Fig. 5.21):

a. Centre of philtrum of lip

b. Centre of forehead

c. Labial frenum

d. Midpalatine suture and incisive papilla

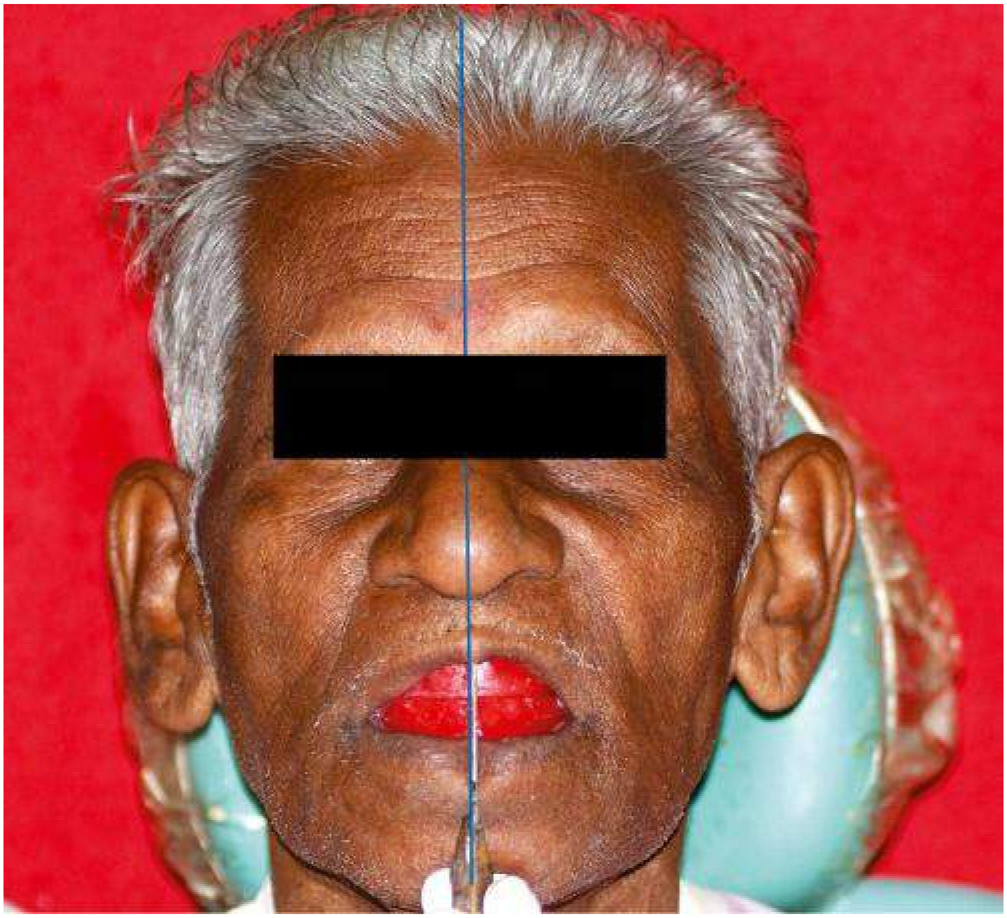


FIGURE 5.21 Midline oriented to the face using centre of forehead and philtrum as guides.

Low lip line

Definition: The lowest position of the inferior border of the upper lip when it is at rest (GPT8) (Fig. 5.22).

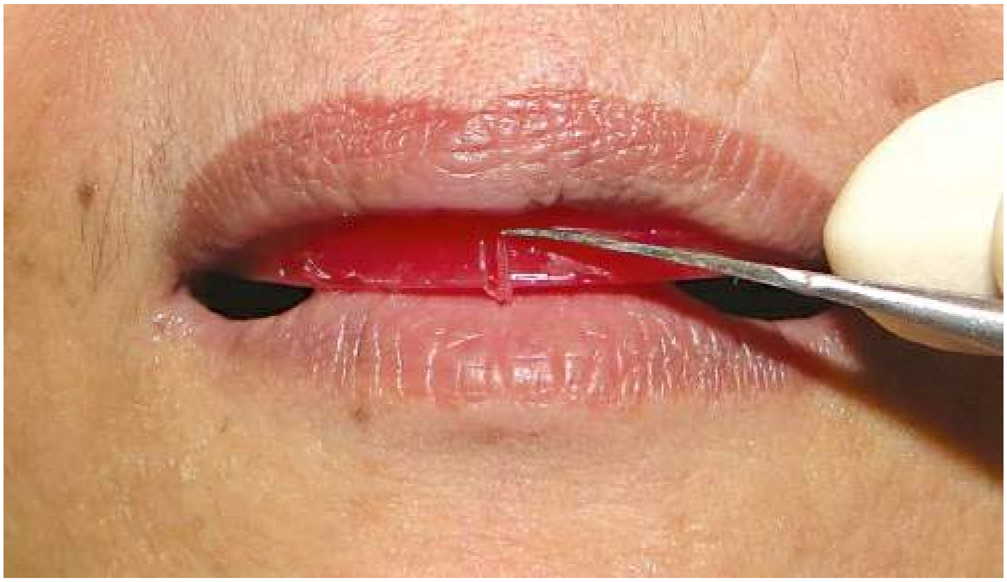


FIGURE 5.22 Low lip line – lip in rest position.

This helps to determine the vertical length of the incisors.

High lip line

Definition: The greatest height to which the inferior border of the upper lip is capable of being raised by muscle function (GPT8).

This is determined by asking the patient to smile and helps in determining the extent to which the teeth and gums are exposed superiorly and laterally when the patient smiles (Fig. 5.23).

FIGURE 5.23 High lip line marked.

Cuspid line

It marks the tentative position of maxillary canine teeth and is also used as a guide in teeth selection.

With the occlusal rims in the mouth, the pointed end of a No. 7 wax spatula is placed in the corners of the mouth and a line parallel to the pupils of the eye is marked. This marks the tentative distal extension of the maxillary canine teeth.

A line is marked from the inner canthus of the eye through the lateral border of ala of the nose and extended onto the maxillary occlusal rim. This marks the tentative cusp tip of the maxillary canine teeth (Fig. 5.24).

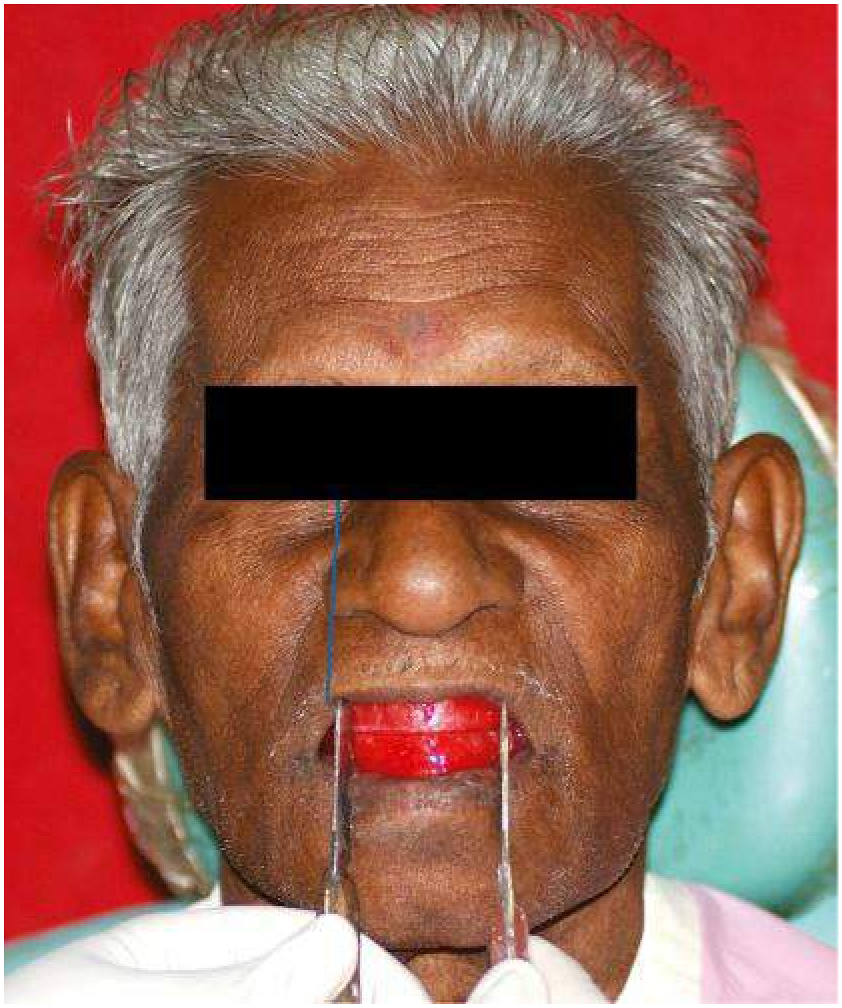


FIGURE 5.24 Cuspid lines are marked using the eye and nose as guides.

SUMMARY

Record bases and occlusal rims are essential to record jaw relations. A rigid, accurate and dimensionally stable record base is necessary to achieve the desired objectives, and autopolymerizing denture base acrylic resin is most commonly used. Appropriately contoured wax occlusal rims in the laboratory save a lot of clinical time, while verifying the occlusal rims intraorally prior to recording the jaw relations.

CHAPTER 6

Maxillomandibular relations

CHAPTER CONTENTS

Introduction

The relationship of the mandible to the maxilla and their orientation to the cranium is a very important consideration in prosthodontics. This is more so in completely edentulous individuals where there are no teeth to provide any reference. The maxillomandibular relationship is recorded following the fabrication and contouring of occlusal rims described in the previous chapter. The mandible moves to perform various functions like chewing, swallowing and speech. The constructed complete denture should function in harmony with the various mandibular movements. This will ensure a great deal of comfort and confidence to the denture wearer. The mandible moves as dictated by the movement of its condyle in the glenoid fossa and by the guidance of teeth. In a completely edentulous situation, the teeth should be arranged such that they do not interfere with the smooth, coordinated movement of the mandible during function. Hence, an understanding of the temporomandibular joint (TMJ) and mandibular movements is essential for understanding and recording maxillomandibular relations. The recorded jaw relations are then transferred to an articulator which can simulate these movements and assist in arranging the artificial teeth accordingly.

Definitions

Temporomandibular joint:

1. The articulation between the temporal bone and the mandible. It is a bilateral diarthrodial and bilateral ginglymoid joint.

2. The articulation of the condylar process of the mandible and the intra-articular disc with the mandibular fossa of the squamous portion of the temporal bone; a diarthrodial, sliding hinge (ginglymus) joint. Movement in the upper joint compartment is mostly translational, whereas that in the lower joint compartment is mostly rotational. The joint connects the mandibular condyle to the articular fossa of the temporal bone with the temporomandibular disc interposed (GPT8).

Glenoid fossa: The concavity in the temporal bone by the zygomatic arch that receives the mandibular condyle (GPT8).
Articular capsule: The fibrous ligament that encloses a joint and limits its motion. It is lined with the synovial membrane (GPT8).
Articular disc: A ring of fibrocartilage that separates the articular surfaces of a joint (GPT8).
Excursive movement: Movement occurring when the mandible moves away from maximum intercuspation (GPT8).
Christensen's phenomenon: Space that occurs between opposing occlusal surfaces during mandibular protrusion (GPT8).
Bennett angle: The angle formed between the sagittal plane and the average path of the advancing condyle as viewed in the horizontal plane during lateral mandibular movements (GPT8).
Early mandibular translation (early side shift): The translatory portion of lateral movement in which the greatest portion occurs early in the forward movement of the nonworking side condyle as it leaves centric relation (CR) (GPT8).
Progressive mandibular translation (progressive side shift): The translatory portion of mandibular movement as viewed in a specific body plane that occurs at a rate or amount that is directly proportional

to the forward movement of the nonworking condyle (GPT8).
Immediate mandibular lateral translation: The translatory portion of lateral movement in which the nonworking side condyle moves essentially straight and medially as it leaves the CR position (GPT8).
Envelope of motion: The three-dimensional space circumscribed by mandibular border movements within which all unstrained mandibular movements occur (GPT8).
Camper's line (ala-tragus line): The line running from the inferior border of the ala of the nose to some defined point on the tragus of the ear, usually considered to be the tip of the tragus (GPT8).
Maxillomandibular relationship: Any spatial relationship of the maxillae to the mandible; any one of the infinite relationships of the mandible to the maxillae (GPT8).
Maxillomandibular relationship record: A registration of any positional relationship of the mandible relative to the maxillae (GPT8).
Transverse horizontal axis: An imaginary line around which the mandible may rotate within the sagittal plane (GPT8); Also called the 'hinge axis' previously.
Interocclusal distance: The distance between the occluding surfaces of the maxillary and mandibular teeth when the mandible is in a specified position (GPT8).
Interocclusal rest space or freeway space: The distance between the occluding surfaces of the maxillary and mandibular teeth when the mandible is in its physiologic rest position (GPT8).
Vertical dimension at rest: The length of the face when the mandible is in the rest position (GPT8).
Physiologic rest position: The postural position of the mandible when an individual is resting comfortably in an upright position and the associated muscles are in a state of minimal contractual activity (GPT8).
Vertical dimension of occlusion or occlusal vertical dimension: The length of the face when the teeth are in contact in maximal intercuspal position (maximal intercuspation).
Centric relation: The maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their

respective discs with the complex in the anterior–superior position against the slopes of the articular eminencies. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superiorly and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis (GPT5).

Maximal intercuspal position (MIP): The complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position – called also maximal intercuspation (GPT8).

Eccentric relation: Any relationship of the mandible to the maxilla other than the CR (GPT8).

Central bearing tracing device: A device that provides a central point of bearing or support between the maxillary and mandibular dental arches. It consists of a contacting point that is attached to one dental arch and a plate attached to the opposing dental arch. The plate provides the surface on which the bearing point rests or moves and on which the tracing of the mandibular movement is recorded. It may be used to distribute occlusal forces evenly during the recording of maxillomandibular relationships and/or for the correction of disharmonious occlusal contacts. First attributed to Alfred Gysi, Swiss prosthodontist, in 1910 (GPT8).

Central bearing point: The contact point of a central bearing device (GPT4).

Central bearing tracing: The pattern obtained on the horizontal plate used with a central bearing tracing device.

Structure of TMJ

The TMJ is a 'ginglymoarthrodial joint'. 'Ginglymus' meaning a 'hinge' joint and 'arthrodia' meaning a joint permitting 'gliding' motion. Hence, it permits both hinge and gliding movements.

Components of TMJ (fig. 6.1)

Glenoid fossa

The glenoid fossa is a deep hollow on the under surface of the zygomatic process of the temporal bone. The condyle stays in the fossa during ordinary opening and closing (hinge) movements.

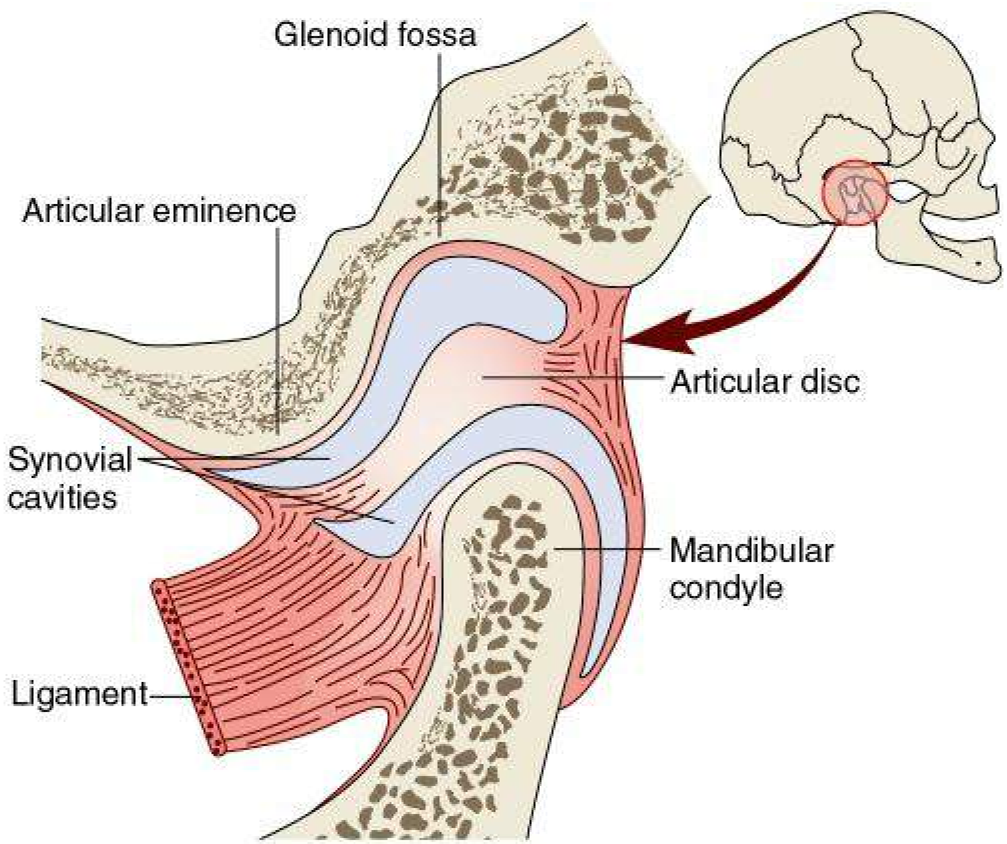


FIGURE 6.1 Structure and components of TMJ.

Articular eminence

The articular eminence is a ramp-shaped prominence which extends forwards and downwards from the anterior boundary of the glenoid fossa. During forward (protrusive) movements of the entire mandible, both condyles leave their fossa and move onto eminences. In lateral movements, one condyle usually stays in a fossa and the other condyle moves out of the fossa onto its eminence.

Condylar head of mandible

The condyle is an oval- or kidney-shaped structure found at the end of the condylar process. It consists of a head and a neck. The convex superior surface of the head articulates with the concave inferior surface of the articular disc.

Articular disc

The articular disc is a pad of tough, flexible fibrocartilage situated between the condyle and the glenoid fossa. The biconcave disc is a shock-absorbing mechanism. When the condyle moves out onto the articular eminence, the disc travels with it. It is also called meniscus. It is attached at its periphery to the capsule and divides the compartment into two spaces that contain synovial fluid – synovial spaces.

Synovial cavity

It contains the synovial fluid, which acts to lubricate the joint. It is divided into two:

1. **Upper synovial cavity:** Located between the glenoid fossa and the upper surface of the articulating disc.

2. **Lower synovial cavity:** Located between the lower surface of the disc and the condyle of the mandible.

TMJ ligaments

1. Articular capsule

The capsule is the 'major' ligament of the TMJ. This ligamentous sleeve or capsule originates from the entire rim of the glenoid fossa and articular eminence, attaches to the edges of the articular disc, and passes to insert around the rim of the condyle. The capsule holds the disc in place between the condyle and the fossa and it also retains the synovial fluid in the upper and the lower joint compartments. It acts to prevent the dislocation of the mandible and limits extreme lateral movements in wide opening of the mandible.

Some authors mention a separate temporomandibular ligament, while others describe it as an anterior thickening of the capsule, not a separate ligament (Fig. 6.2).

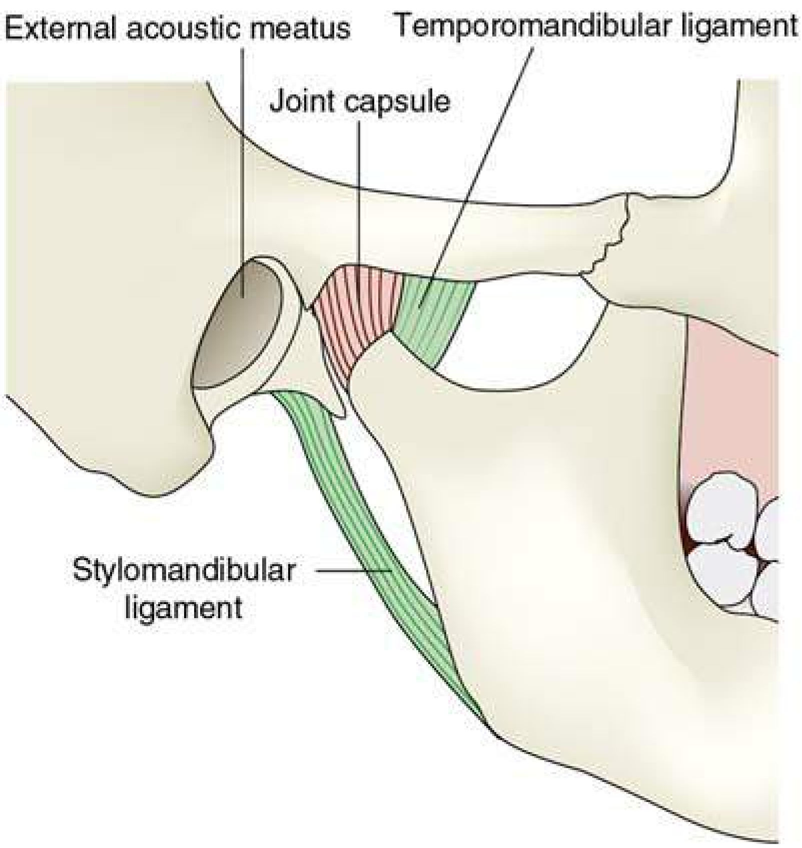


FIGURE 6.2 Ligaments of TMJ.

2. *Accessory ligaments* (fig. 6.3)

(i) **Stylomandibular ligament:** The stylomandibular ligament originates on the styloid process of the temporal bone and inserts on the posterior border of the ramus near the angle. This ligament becomes tense only in extreme protrusive movements.

(ii) **Sphenomandibular ligament:** The sphenomandibular ligament originates on the spine of the sphenoid bone and inserts on the anterior–superior of the mandibular foramen (lingula). This ligament is passive during mandibular movements.

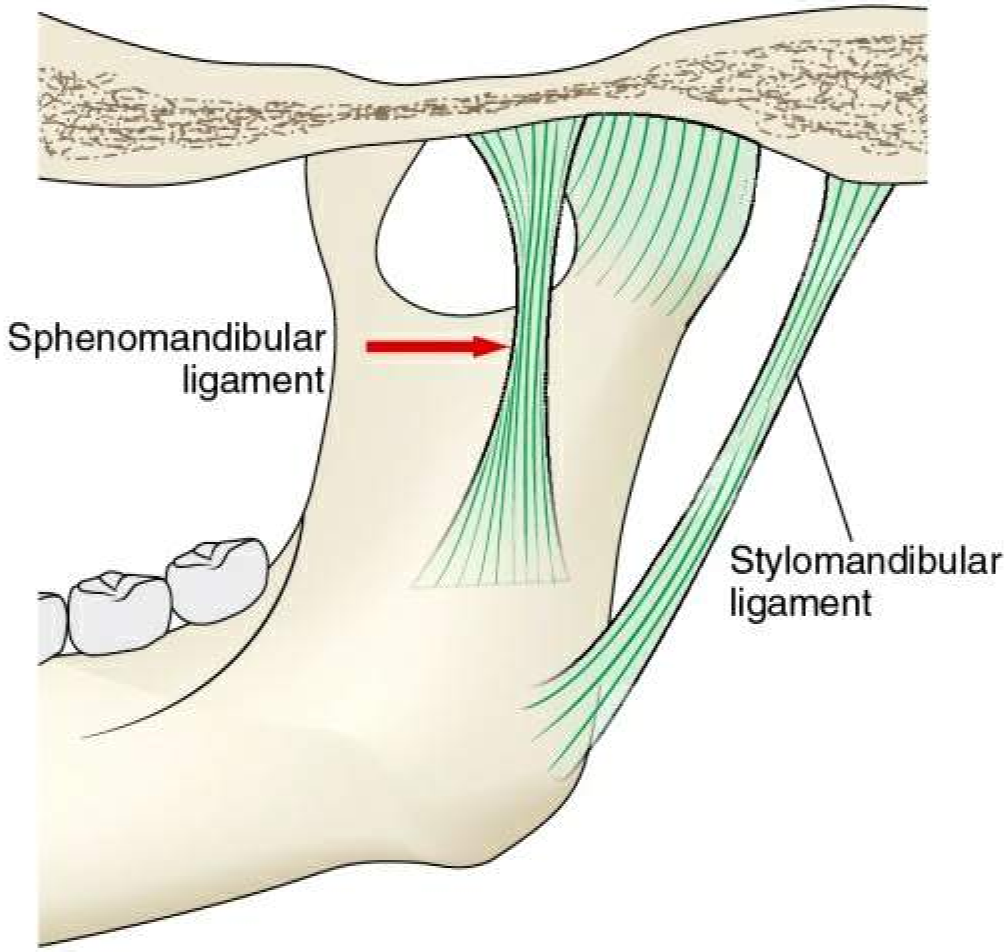


FIGURE 6.3 Accessory ligaments of TMJ.

Mandibular movements

These are complex and vary among individuals and also within each individual.

An articulator must simulate the mandibular movements so that the planned occlusal contacts will function properly. The less it simulates, more will be the occlusal discrepancy.

Factors regulating mandibular movements

The following factors regulate mandibular movements. They are also called ‘determinants or controlling factors’.

1. The condylar path.

2. The opposing tooth contact and anterior guidance.

3. Neuromuscular system.

The condylar path or guidance and the anterior guidance are called ‘end-controlling factors’. The condylar guidance is also termed as ‘posterior determinant’, while the anterior guidance is termed as ‘anterior determinant’.

Condylar path

This is the path travelled by the condyle in the TMJs during various mandibular movements. It is influenced by the following:

- Inclination of glenoid fossa.

- Tone of muscles responsible for mandibular movements and their nerve controls.

- Attached ligaments.

• Shape and movement of the articular disc.

• Teeth (when present).

The condylar path is not under the dentists' control and cannot be altered. The movements can be categorized into the following types:

1. Basic movements

2. Excursive movements

3. Border movements

4. Functional movements

5. Parafunctional movements

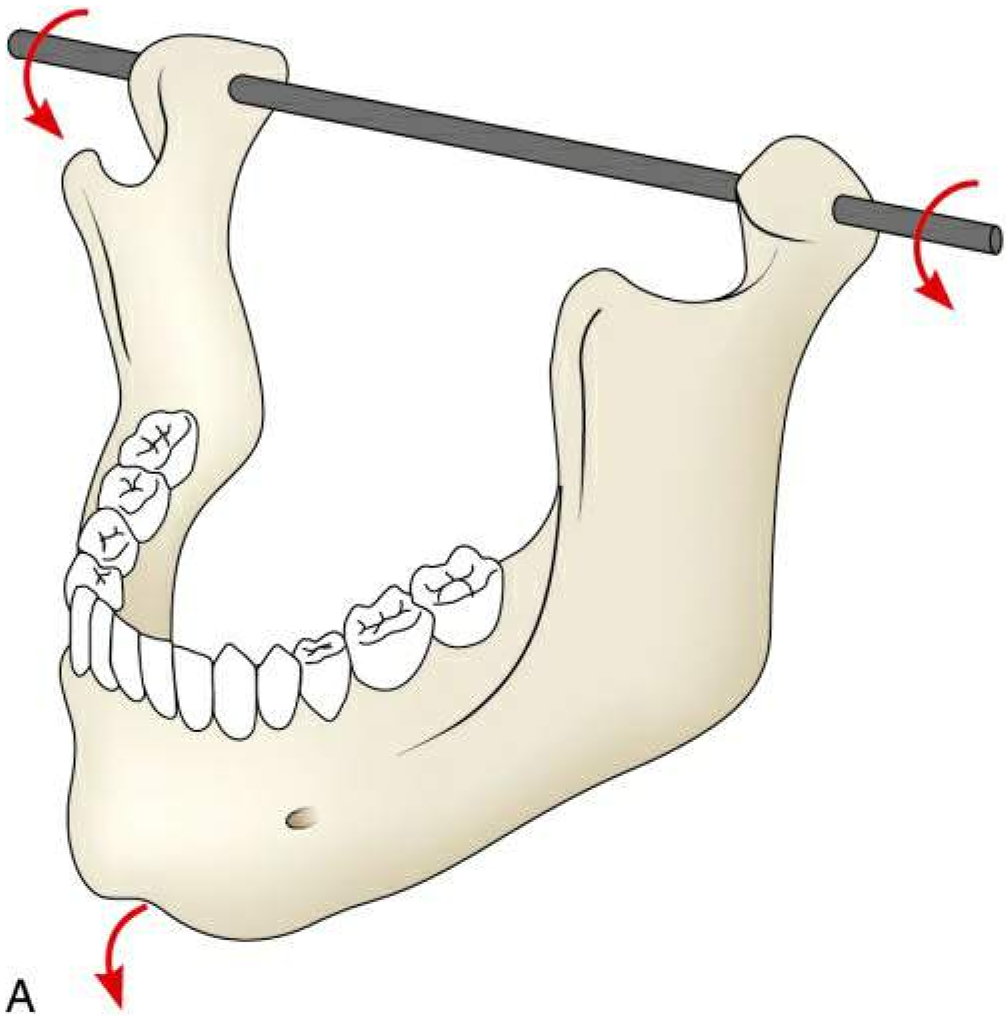
1. *Basic movements*

All the movements of the condyle can be categorized as:

(i) Rotation (hinge movement)

Definition: The action or process of rotating on or as if on an axis or centre (GPT8).

Movement is similar to a door hinge, and the condyle rotates without any bodily movement. It happens in the inferior joint cavity (lower compartment) between the superior surface of the condyle and the inferior surface of the articular disc. Rotation occurs around an axis – horizontal, frontal and sagittal and can be viewed in the three reference planes of the skull – sagittal, frontal or coronal and horizontal (Figs 6.4–6.6).



A

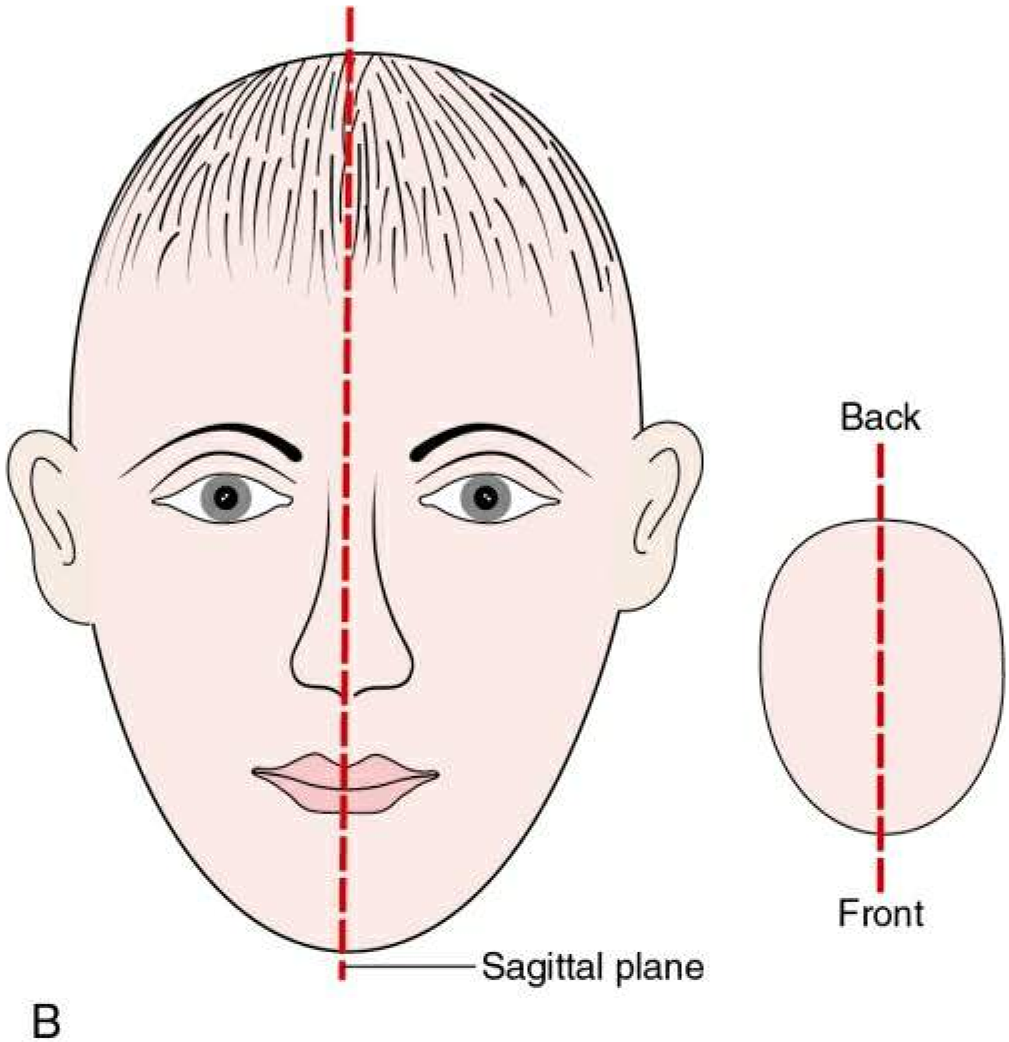


FIGURE 6.4 (**A**) Rotation in the transverse horizontal axis can be viewed in the sagittal plane **(B)** Sagittal plane divides the face into right & left parts.

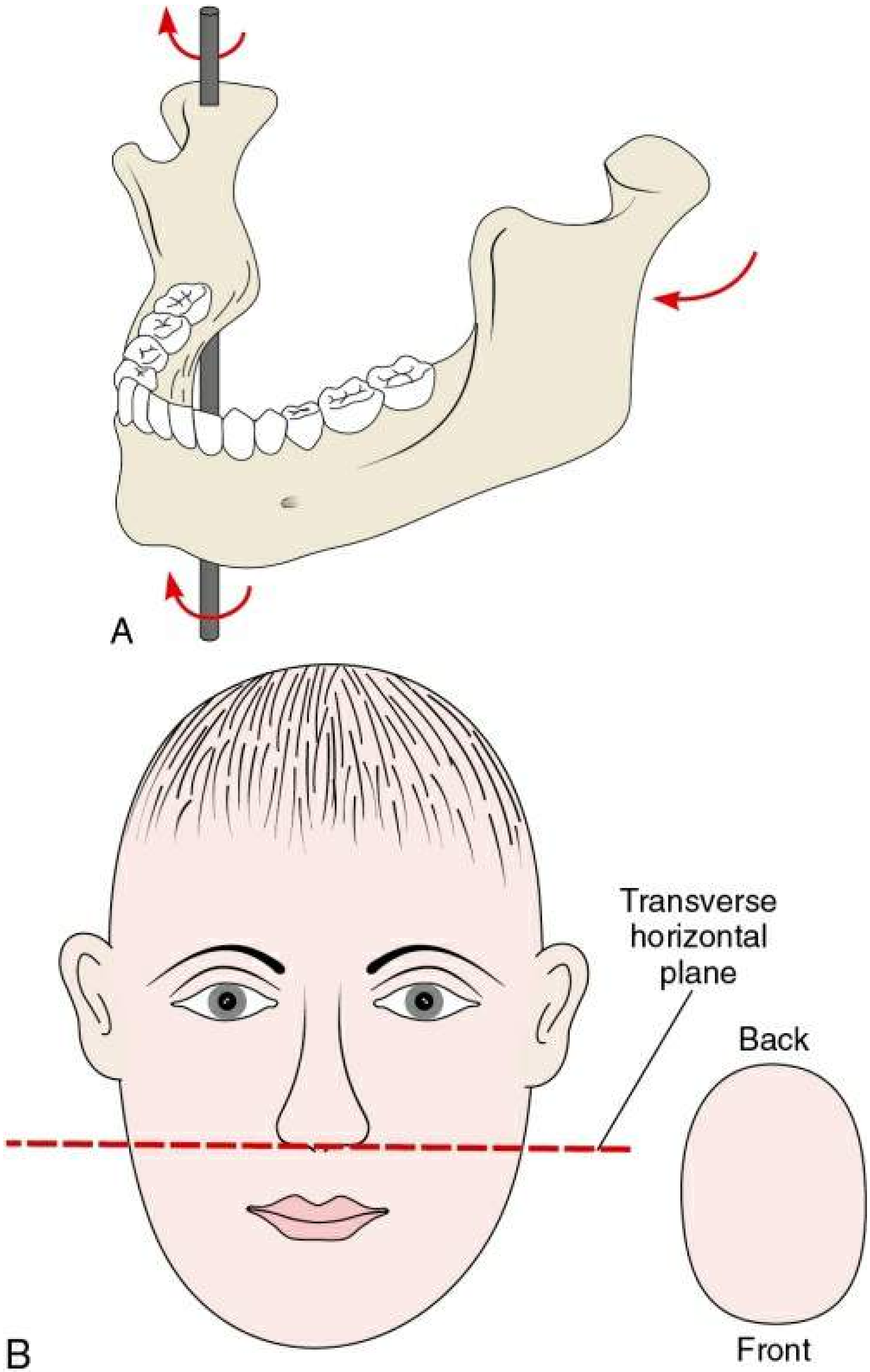
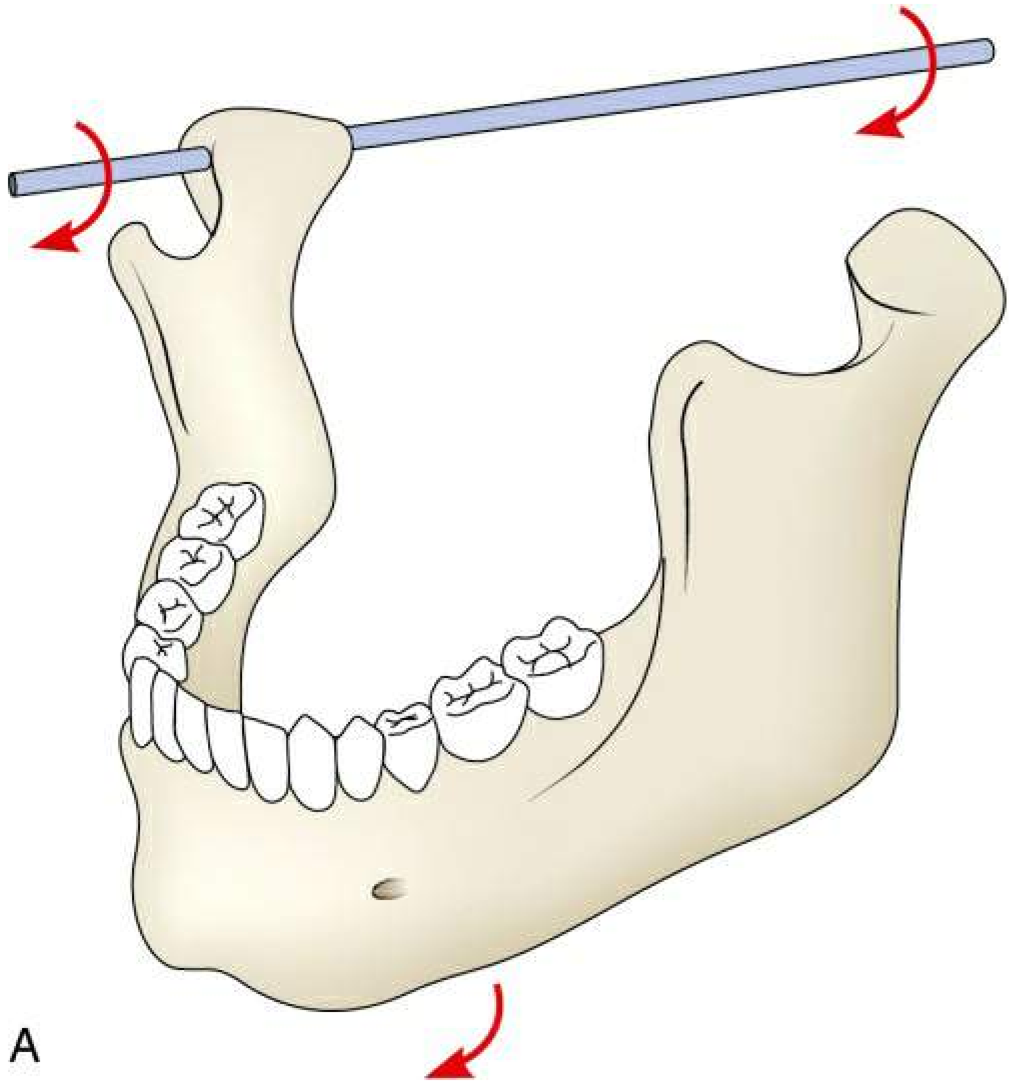


FIGURE 6.5 (**A**) Rotation around the frontal axis can be viewed in the horizontal plane, (**B**) Horizontal plane divides

the face into upper & lower parts.



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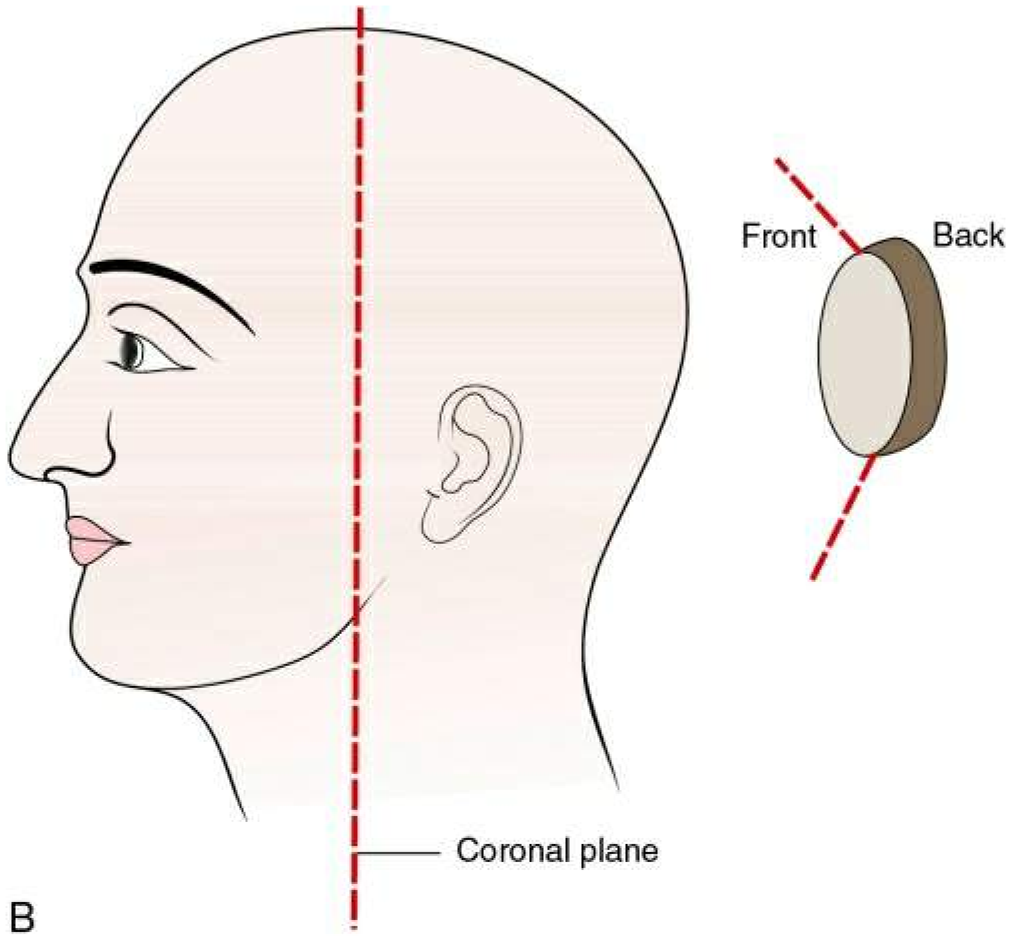


FIGURE 6.6 (**A**) Rotation in the sagittal axis can be viewed in the frontal or coronal plane, (**B**) Coronal plane divides the face into anterior & posterior parts.

Axis: It is a line around which a body may rotate or about which a structure would turn if it could revolve (GPT8).

Rotation in the horizontal axis (also called transverse horizontal axis) occurs during mouth opening and protrusion. It is also a posterior border movement.

Rotation in the frontal and sagittal axis occurs during lateral movements.

(ii) Translation

Definition: That motion of a rigid body in which a straight line passing through any two points always remains parallel to its initial position. The motion may be described as a sliding or gliding motion

(GPT8).

Translatory movement: The motion of a body at any instant when all points within the body are moving at the same velocity and in the same direction (GPT1).

This refers to bodily movement of the condyle. It occurs during all the excursive mandibular movements. Translation occurs in the superior joint cavity (upper compartment) between the superior surface of the articular disc and the inferior surface of the glenoid fossae.

2. *Excursive movements*

Definition: Movement occurring when the mandible moves away from maximum intercuspation.

In a completely edentulous situation, it can be assumed as any movement of the condyle from the CR position as it coincides with MIP. Excursive movements are a combination of rotation and translation.

The excursive movements are

(i) Opening and closing

- During mouth opening from CR position, initially for about 12 mm of opening, there is only rotation of condyles in the glenoid fossa. This is a posterior border movement. Then there is a translatory movement and the condyles move downwards and forwards until maximal opening. This can be viewed in the sagittal plane (Figs 6.7–6.9).

- This movement is used during introduction of food in the oral cavity and for crushing certain types of brittle food.

- The reverse movement occurs during mouth closure.

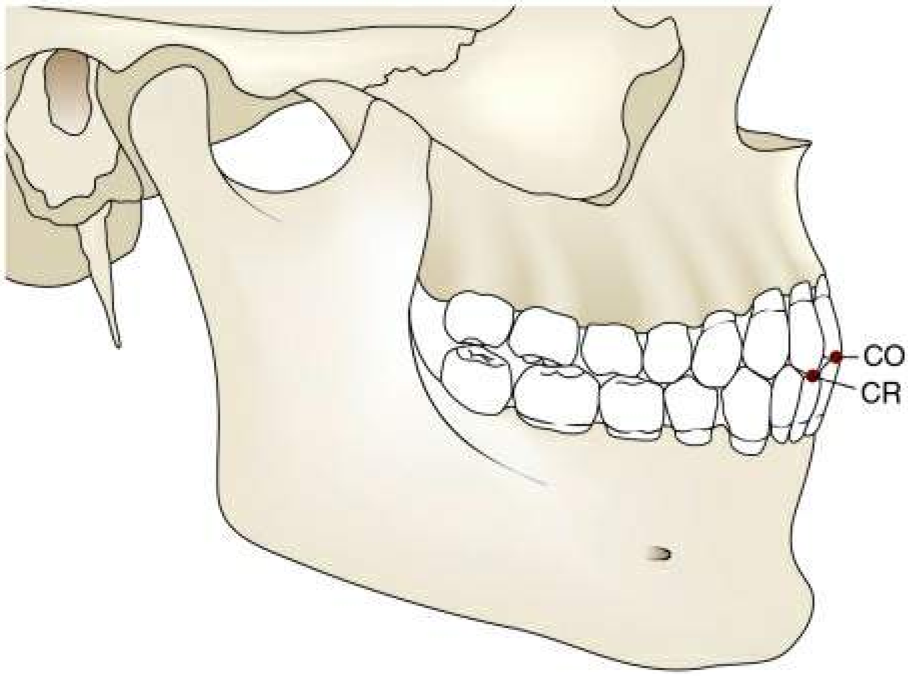


FIGURE 6.7 Opening movement begins from CR. Showing position of condyle during CR.

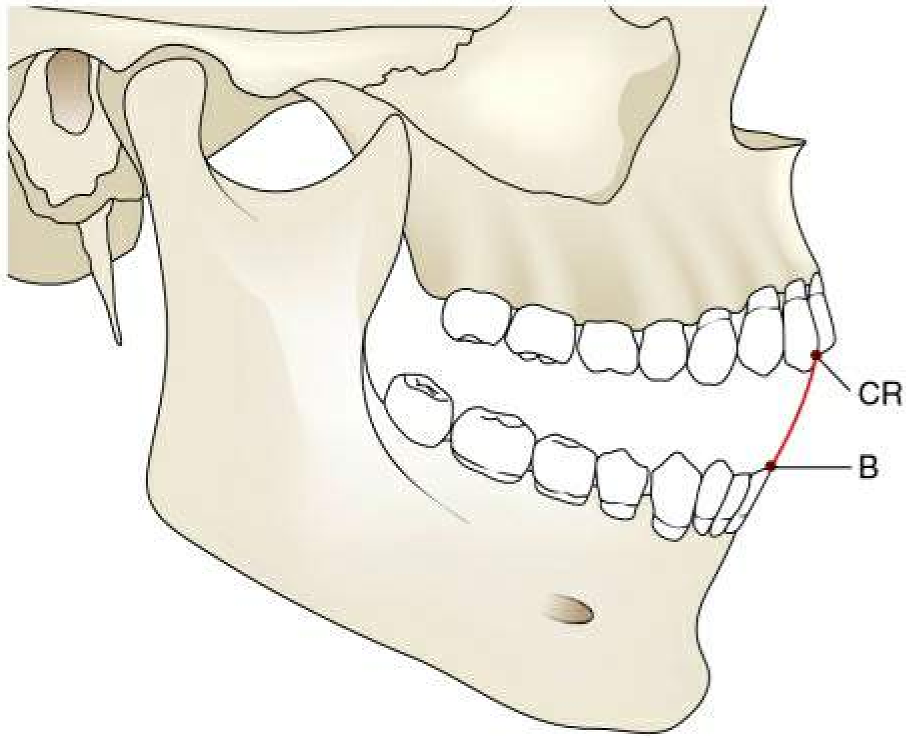


FIGURE 6.8 For 12 mm of opening (CR to B), there is only hinge or rotational movement in condyle.

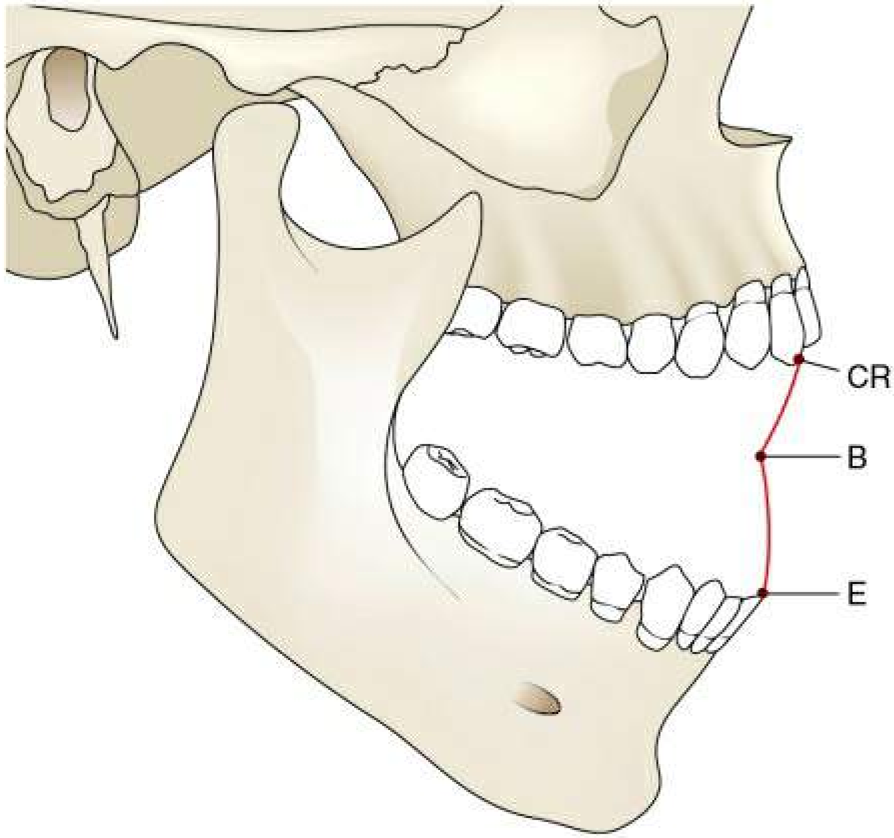


FIGURE 6.9 Showing position of condyle after maxillary opening, translation occurs.

(ii) Protrusion and retrusion

Protrusion: A position of the mandible anterior to CR (GPT8).

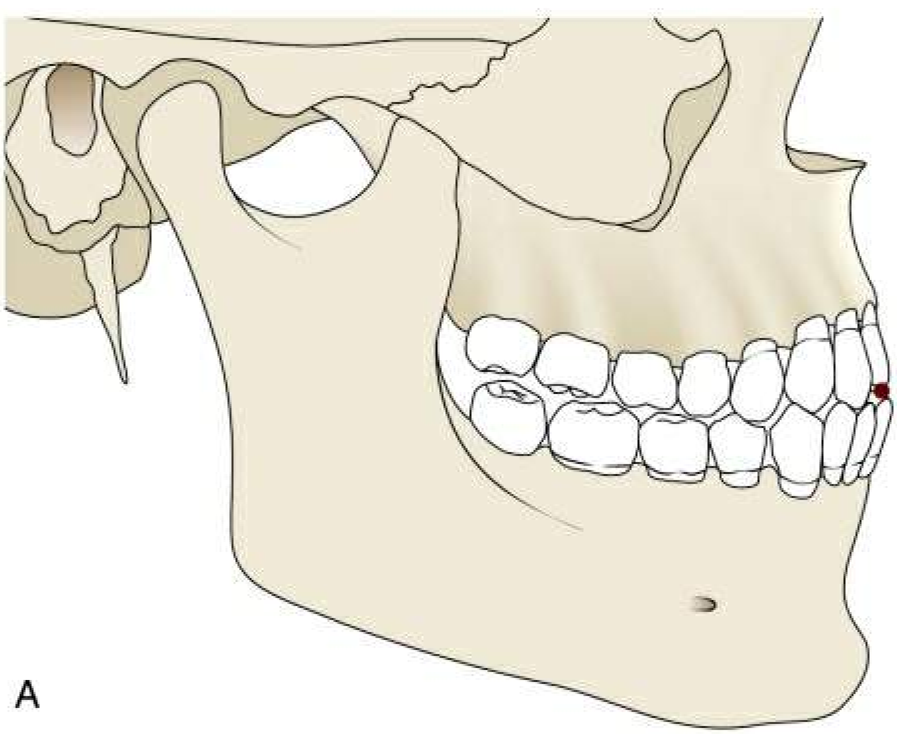
- This movement is used to grasp or incise food.
- The condyles translate downwards and forwards in the glenoid fossa depending on the degree of protrusion (Fig. 6.10A and B). The movement is not in a straight line and is dictated by the contour of the glenoid fossa.
- In a natural dentition, the edge-to-edge protrusive contact will create a gap between the posterior teeth (Fig. 6.11). This is called the

Christensen's phenomenon. While fabricating complete dentures, it is essential to eliminate this gap by allowing simultaneous contact of posterior teeth also, when the anterior teeth contact in protrusion (see 'Balanced Occlusion' in Chapter 9). This stabilizes the denture during protrusive movement.

- The average path of the advancing condyle makes an angle with the frontal plane called the 'protrusive condylar guidance angle/inclination' (Fig. 6.12). It is determined using protrusive records (also see Chapter 7).

Retrusion: Movement towards the posterior (GPT8).

- The reverse of the above occurs during retrusive movement.



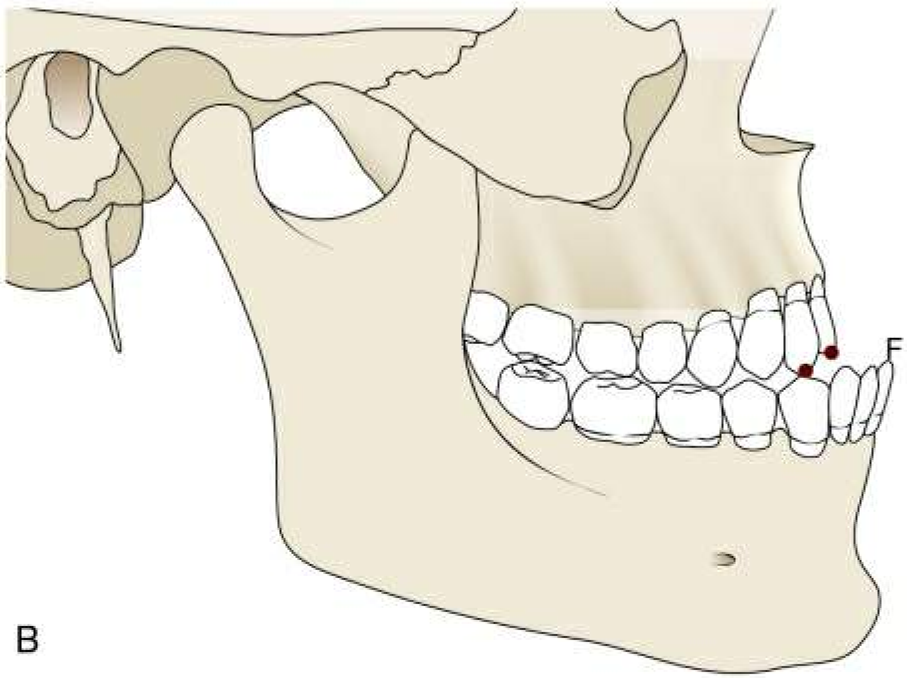


FIGURE 6.10 **(A)** Protrusive movement brings the anterior teeth edge-to-edge. Condyle translates downwards and forwards. **(B)** During maximal protrusion F, condyle shows maximal movement as dictated by the contours of glenoid fossa.

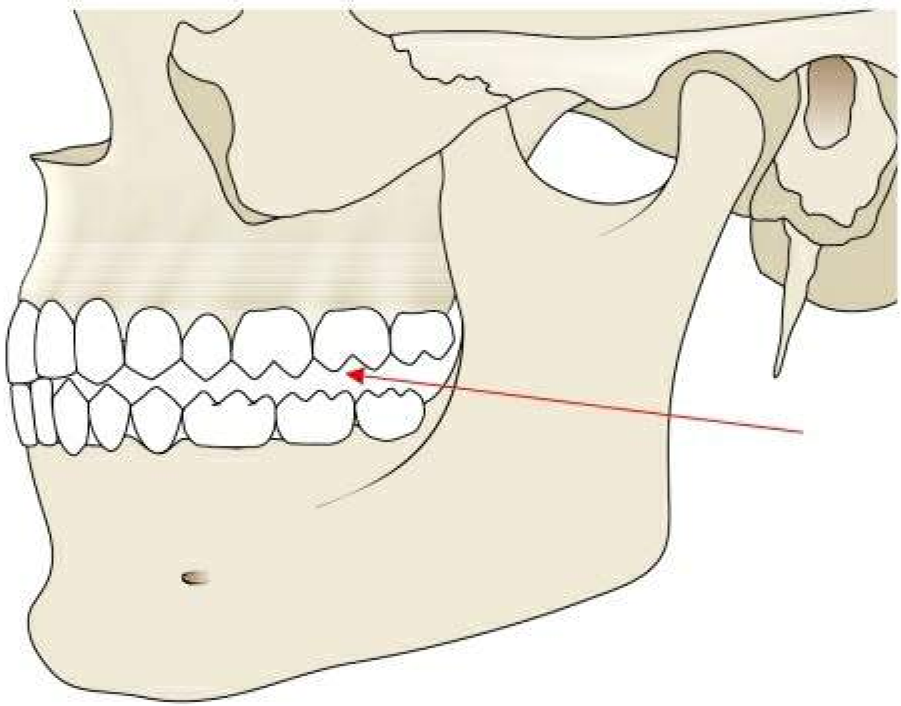


FIGURE 6.11 Christensen's phenomenon – gap between the upper and lower posterior natural teeth when the jaw is moved edge-to-edge.

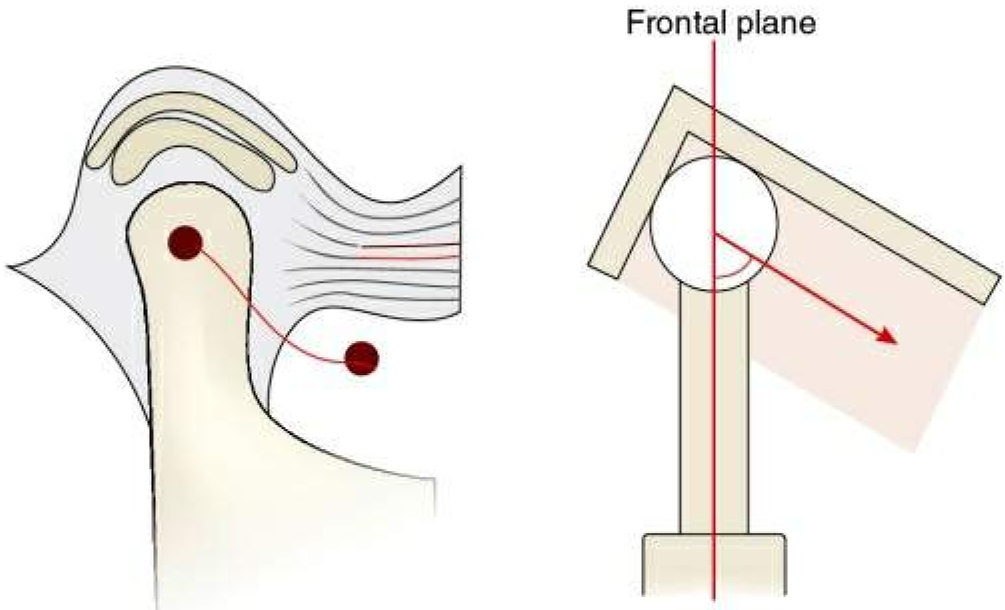


FIGURE 6.12 Protrusive condylar guidance angle/inclination. Angle formed by the average path of the condyle and the frontal plane.

(iii) Lateral excursion

- Movement produced when the mandible moves laterally (side to side or right and left). This movement is used for the reduction in fibrous and other types of foods while chewing.

- When the mandible moves laterally (side to side), the side to which it moves is termed as the 'working side' or 'functional side' and the other side is termed as the 'nonworking side', 'balancing side' or 'nonfunctional side'(Fig. 6.13).

- The condyle on the side to which the mandible moves (working side) is termed as the **working condyle** or **rotating condyle** and the condyle on the left side is termed as **orbiting condyle** or **nonworking condyle** (Fig. 6.13).

- The working side condyle can just rotate on its axis or move outwards and laterally (Fig. 6.13). This lateral movement is termed as the 'laterotrusion' or 'mandibular lateral translation' or 'Bennett movement'. It has also been termed previously as 'Bennett shift' or 'mandibular side shift'. *If the temporomandibular ligament of rotating condyle is very tight, there is no bodily side shift of the mandible and therefore no Bennett movement occurs*.

- The lateral movement can also have a superior, inferior, anterior or posterior component and this is termed as follows:

  - Superior – latero - surtrusion
  - Inferior – latero - detrusion
  - Anterior – latero - protrusion
  - Posterior – latero - retrusion
  - A definite timing may also be involved in Bennett movement. It can occur immediately, take place at the beginning, or be distributed throughout the lateral deflection. This is termed as immediate, early or progressive side shift respectively.

- The nonworking side condyle moves forwards, downwards and medially (inwards). The medial movement is termed as 'mediotrusion'. The average path of this advancing condyle forms an angle with the sagittal plane called the 'Bennett angle' or 'lateral condylar guidance angle' (Fig. 6.14). This angle is determined using lateral records or using the Hanau formula, L = H/8 + 12 (see Page 137, Chapter 7). It can range from 2° to 44° with a mean value of 16°.

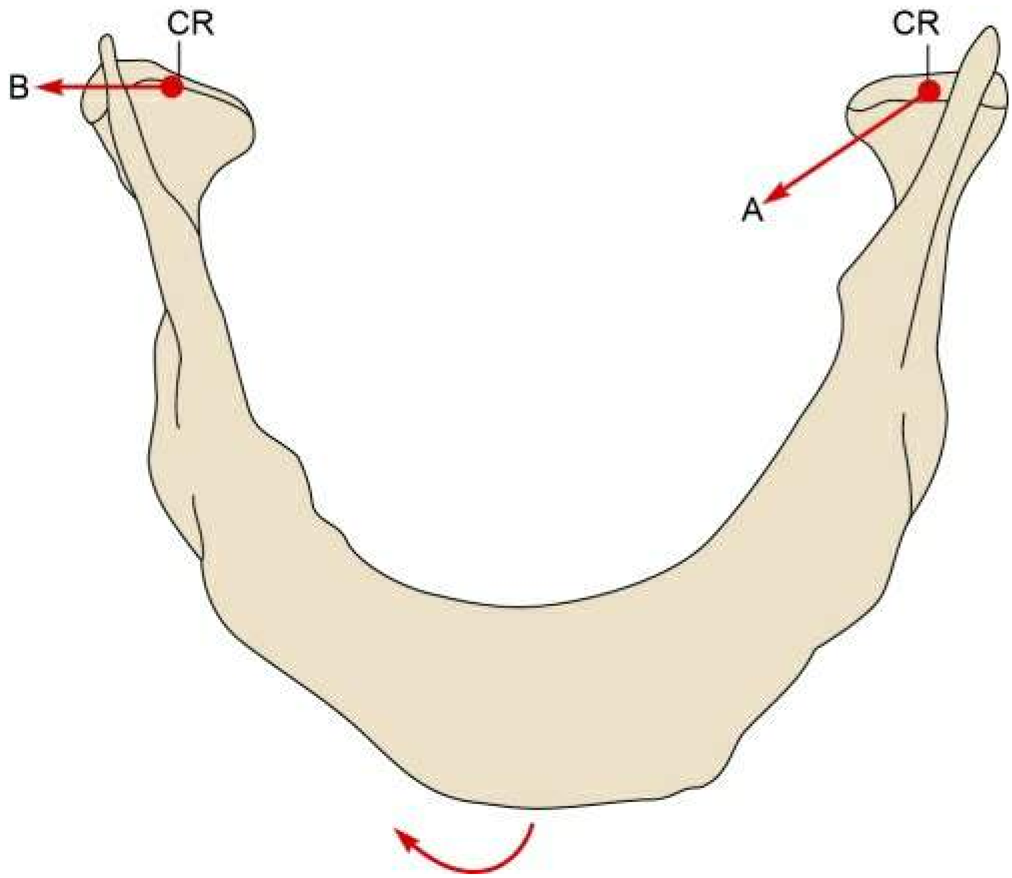


FIGURE 6.13 When the mandible is moved to the right, the right side condyle is the working condyle and the opposite condyle is the nonworking condyle. The working condyle rotates with or without a lateral shift (Bennett shift – CR to B), while the nonworking condyle translates forwards, downwards and medially (from CR to A).

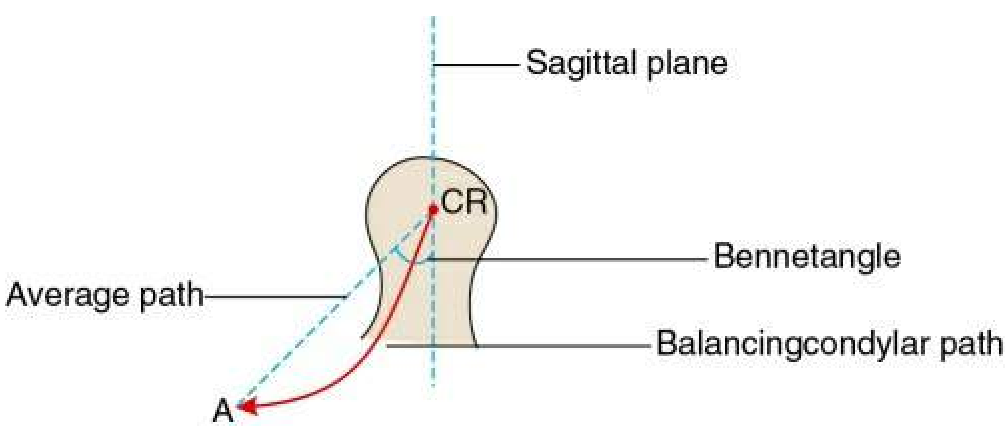


FIGURE 6.14 Bennett angle – angle formed by the average path of balancing condyle, with the sagittal plane when lateral movement is made. A, end of lateral movement; CR, centric relation.

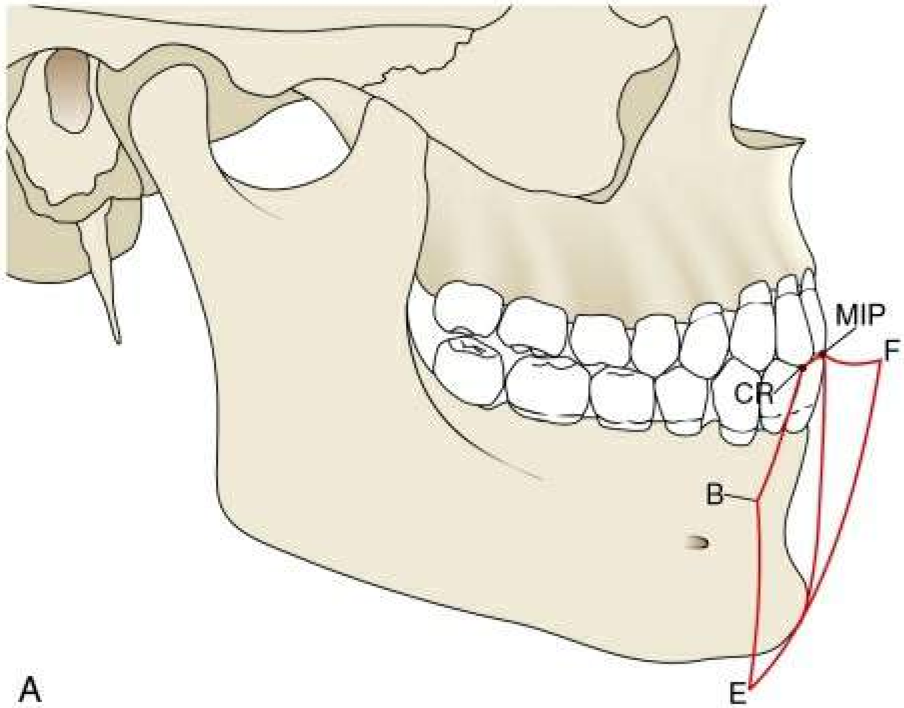
3. *Border movements*

Definition: Mandibular movement at the limits dictated by anatomic structures, as viewed in a given plane (GPT8).

- These are extreme positions of the mandible in any direction limited by nerves, muscles and ligaments.
- These positions can be recorded in the three anatomic planes with devices such as the pantograph.
- These border positions are invaluable in recording jaw relations, as they are consistently repeatable.
- Most mandibular movements occur as intraborder movements. Parafunctional activities such as bruxism or wide opening during yawning may occur in the borders.

Border movement in sagittal plane

This traces the movement as the mandible moves from centric occlusion (CO) to maximal protrusion (F) to maximal mouth opening (E) and then closing while returning to CO. While closing, condyle translates (EB) and then rotates (B-CO) as explained in 'opening movements'. The characteristic tracing in sagittal plane is shown in Fig. 6.15A and B. The last portion of the movement is basically a posterior border movement and depicts the transverse horizontal axis as the condyles only rotate in this position.



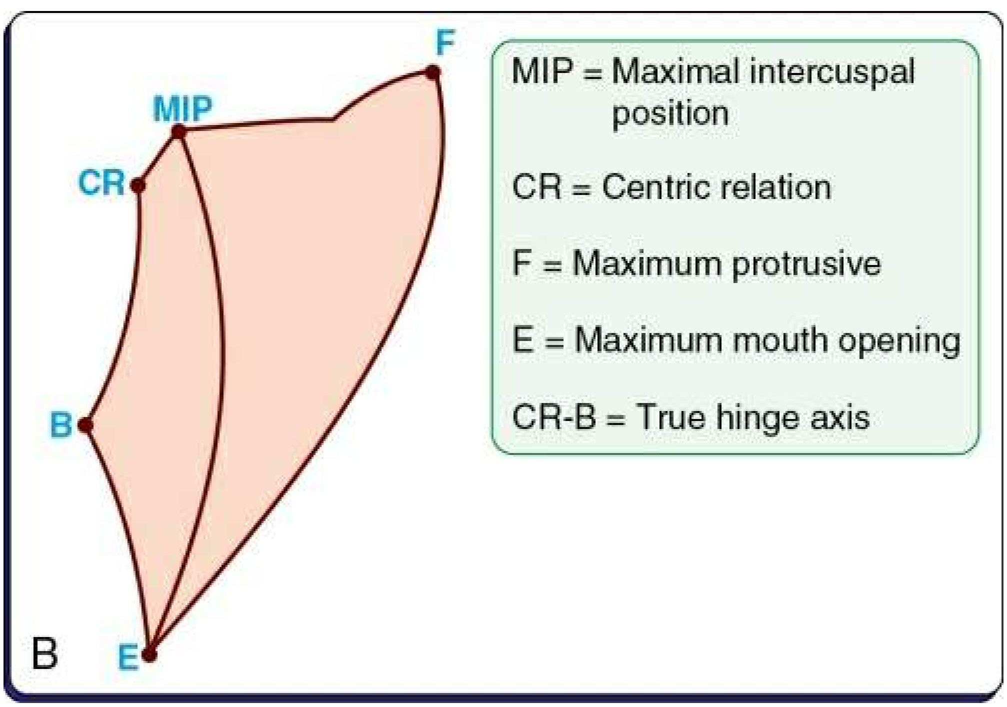


FIGURE 6.15A, B Border movement in the sagittal plane.

Border movement in horizontal plane

This traces the movement from CR to right and left extreme lateral movements, maximal protrusion and then returns to CR. This characteristic tracing forms the basis of 'gothic arch tracing' used to record centric and eccentric jaw relations (Fig. 6.16).

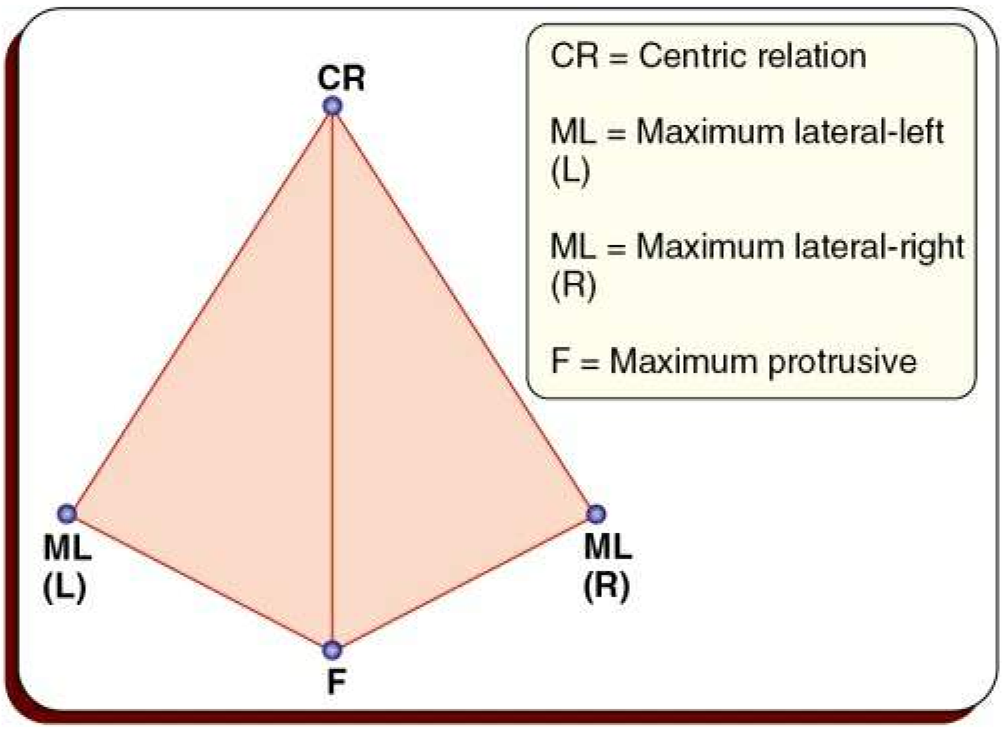


FIGURE 6.16 Border movement in the horizontal plane.

Border movement in frontal plane

This traces the movement from CR to right and left extreme lateral movements to maximal mouth opening and back. The characteristic tracing is shown in Fig. 6.17.

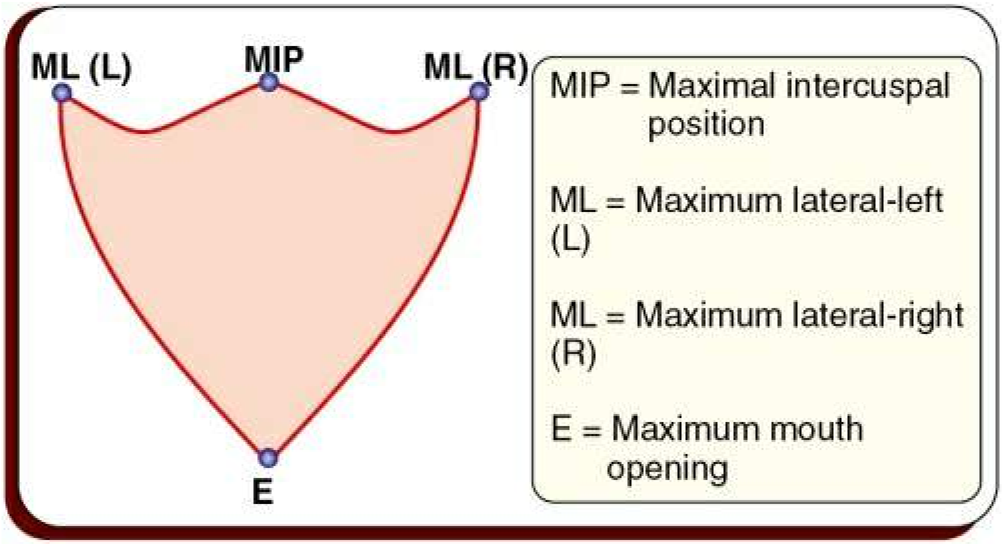


FIGURE 6.17 Border movement in the frontal plane.

Envelope of motion

This is the three-dimensional combination of all the border movements discussed above. It was first described by Posselt. All functional movements of the mandible occur within this envelope (Fig. 6.18).

Definition: The three-dimensional space circumscribed by mandibular border movements within which all unstrained mandibular movements occur (GPT8).

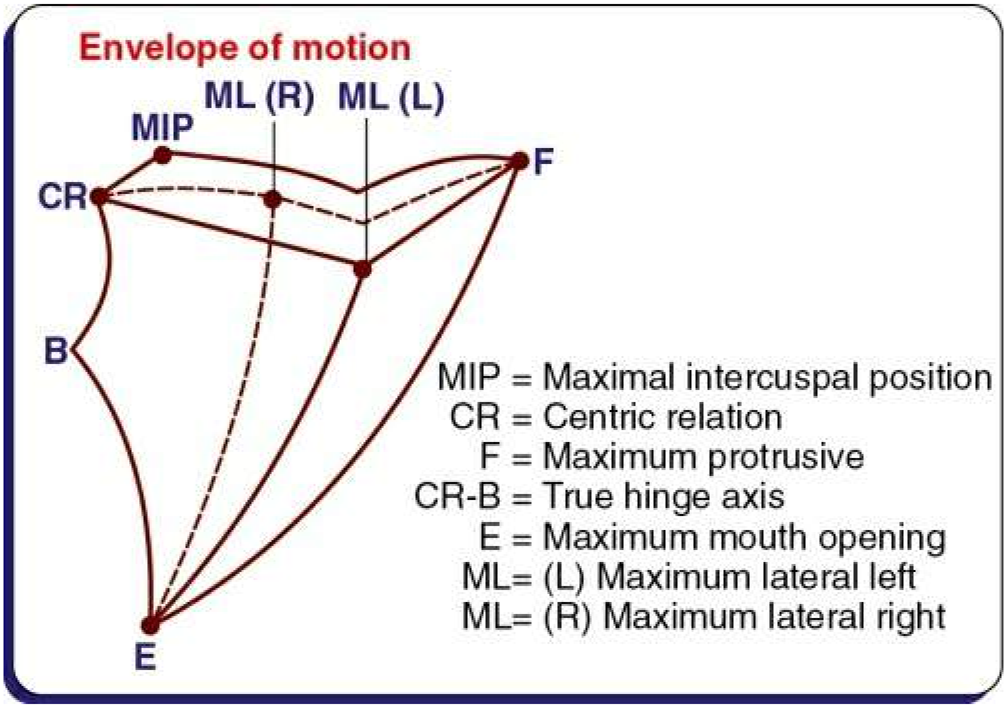


FIGURE 6.18 Envelope of motion as described by Posselt. A combination of border movements in all three planes.

4. *Functional movements*

Chewing, swallowing, speaking, yawning and associated movements constitute the functional movements of the mandible. These take place within the border movements. The envelope of motion recorded during chewing appears as a characteristic 'tear drop' and can be viewed in all three planes (Fig. 6.19). The movements are variable, within the borders and are influenced by:

- Consistency, bulk and type of food
- Size, number and form of teeth
- Excess or lack of saliva
- The musculature and force of chewing

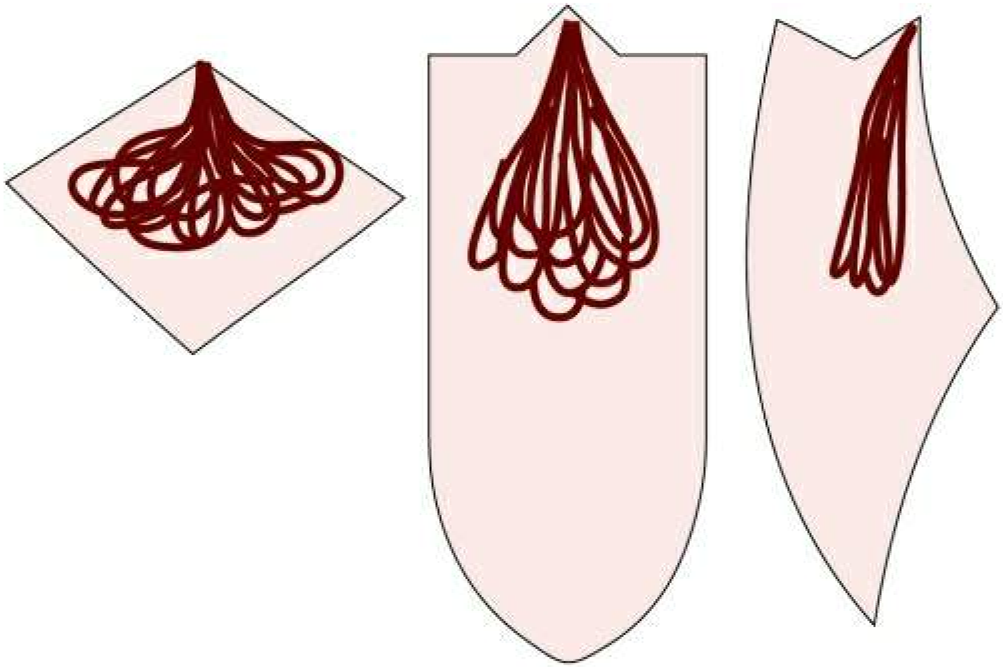


FIGURE 6.19 Characteristic tear drop pattern of movement recorded while chewing in all three planes.

The chewing cycle can be divided into opening and closing phases. Closing phase is further divided into crushing phase and grinding phase. While chewing, adults open their mouth to a comfortable distance and more at the mandible in a forward direction until the edges of maxillary and mandibular teeth meet. The food bolus is then transported to the centre and mandible goes to its original position. The mandible after moving sideways closes into the food until the guiding teeth contact.

Chewing cycle

The chewing cycle was divided into the following six phases by Murphy:

(i) **Preparatory phase:** The mandible deviates towards the chewing side and the tongue positions the food within the oral cavity.

(ii) **Food contact phase:** Sensory receptors are triggered due to food contact.

(iii) **Crushing phase:** Starts at a high velocity and slows down as the food gets crushed.

(iv) **Phase of tooth contact:** Reflex muscular adjustments for tooth contact are made. A slight change in the direction occurs without delay.

(v) **Grinding phase:** Maxillary and mandibular occlusal tables guide the grinding movement.

(vi) **Centric occlusion:** The cuspal inclines slice the food, as the mandible moves in an incline and then returns into a single terminal point before going into the preparatory phase. Usual masticatory frequency is one to two strokes per second. A tear drop tracing is obtained, when tracing is recorded for the chewing cycle in the sagittal plane (Fig. 6.19). When the mandible moves in an anterior incline, the churned food is dispersed along the sluiceways. Trituration of food occurs when the teeth are in a cusp to fossa relationship.

Mandibular movements occur during *speech* but are highly variable and cannot be practically recorded. Speech can be used as a guide to verify jaw relations and for an arrangement of artificial teeth as anterior teeth come very close together (discussed later in this chapter and in Chapter 10).

During **swallowing** (deglutition), mandible is generally stabilized against maxilla by contraction of masseter and temporalis muscle. This results in contact of the upper and lower teeth. Mandibular movement during swallowing can be used as a guide to verify jaw relations as described later in this chapter.

5. *Parafunctional movements*

These are sustained movements of the mandible that occur other than normal, manifested by long periods of increased muscle activity. They are almost impossible for the patient to control. The two most common parafunctional activities are bruxism and clenching (Table

6.1).

Table 6.1

Functional and parafunctional activities

Functional activities	Parafunctional activities
Chewing (mastication)	Bruxism
vallowing (deglutition)	Clenching
eech (phonation)	Habits (pipe smoking, pencil biting, bobby pin opening and other habits)
spiration	
wning	
cial expression	

Parafunctional movements of the mandible are activities that serve no useful function and are potentially harmful to the dentition and its contiguous structures. They can cause restricted mandibular movements. These have to be diagnosed and appropriate remedial measures need to be initiated, as they might affect jaw relation records and prognosis of the prosthesis.

Opposing tooth contact

In complete denture wearers, a balanced occlusion is essential (see Chapter 9) to prevent mandibular deflection and displacement of dentures. During mandibular movements, the inclined planes of teeth should not disrupt the influence of the condylar guidance posteriorly and incisal guidance anteriorly. The condylar and incisal guidance are also called 'end-controlling factors' in mandibular movement.

It has been shown that deflective contacts produce variations in mandibular movements. But the patients tend to avoid deflective and eccentric contacts by chewing on both sides at the same time during mastication, which may explain why they function well even in the absence of balanced occlusion.

The effect and adjustment of anterior (incisal guidance) guidance which is also called the 'anterior determinant' of mandibular movement is discussed in Chapter 9.

This factor can be altered by the dentist to achieve a balanced and smooth occlusion during various functional mandibular movements.

Neuromuscular system

This is another important factor in regulating mandibular movement. The muscles responsible show increased activity and may be associated with movement, fixation or stabilization of mandible such that there is a smooth and coordinated movement from one position to another.

The muscles perform their specific functions because they receive impulses from the central nervous system. The impulses may arise at the conscious or subconscious levels and result in voluntary or involuntary muscular activity respectively.

The muscles of mastication and suprahyoid muscles are involved in mandibular movements (Table 6.2).

Table 6.2

Muscles involved in mandibular movements

Muscles of mastication and suprahyoid muscles	Mandibular movements
Masseter	Closing and retrusion
Temporalis	Elevation and retrusion
Medial pterygoid	Closing and lateral movements
Lateral pterygoid	Opening, protrusion and lateral movements
Suprahyoid group of muscles	Depress (open the mouth) the mandible assisted by infrahyoid group

Significance of mandibular movements

A sound understanding of mandibular movements is essential for the following reasons:

- Recording jaw relations
- Designing, selection and adjustment of articulator
- Developing tooth form for dental restorations
- Understanding the basic principles of occlusion

- Diagnosis and treatment of TMJ disturbances
- Preserving periodontal health

Maxillomandibular relations and records

Maxillomandibular relationship: Any spatial relationship of the maxillae to the mandible; any one of the infinite relationships of the mandible to the maxillae (GPT8).
Maxillomandibular relationship record: A registration of any positional relationship of the mandible relative to the maxillae (GPT8).
Maxillomandibular relations can be classified as:

- Orientation relations: These establish the relationship of the maxilla to the cranium.

- Vertical relations: Vertical relations establish the degree of jaw separation or vertical height of the face. These are classified as:

  ○ Vertical relation (dimension) at rest

  ○ Vertical relation (dimension) in occlusion (occlusal vertical dimension)

- Horizontal relations: Horizontal relations establish the anteroposterior and side-to-side relationships of the jaws. These are classified as:

  ○ CR

  ○ Eccentric relations:

    ▪ Protrusive

▪ Lateral

The various jaw relations, their significance and methods of recording are discussed below.

Oriental jaw relation

This is the first jaw relation to be recorded. It establishes the relationship of the maxilla to the base of the skull or cranium. Basically, it establishes the angle or tilt of the maxilla in the three reference planes. The mandible moves against a fixed maxilla and to accurately reproduce mandibular movements, it is necessary to establish and record the tilt of the maxilla (Fig. 6.20A).

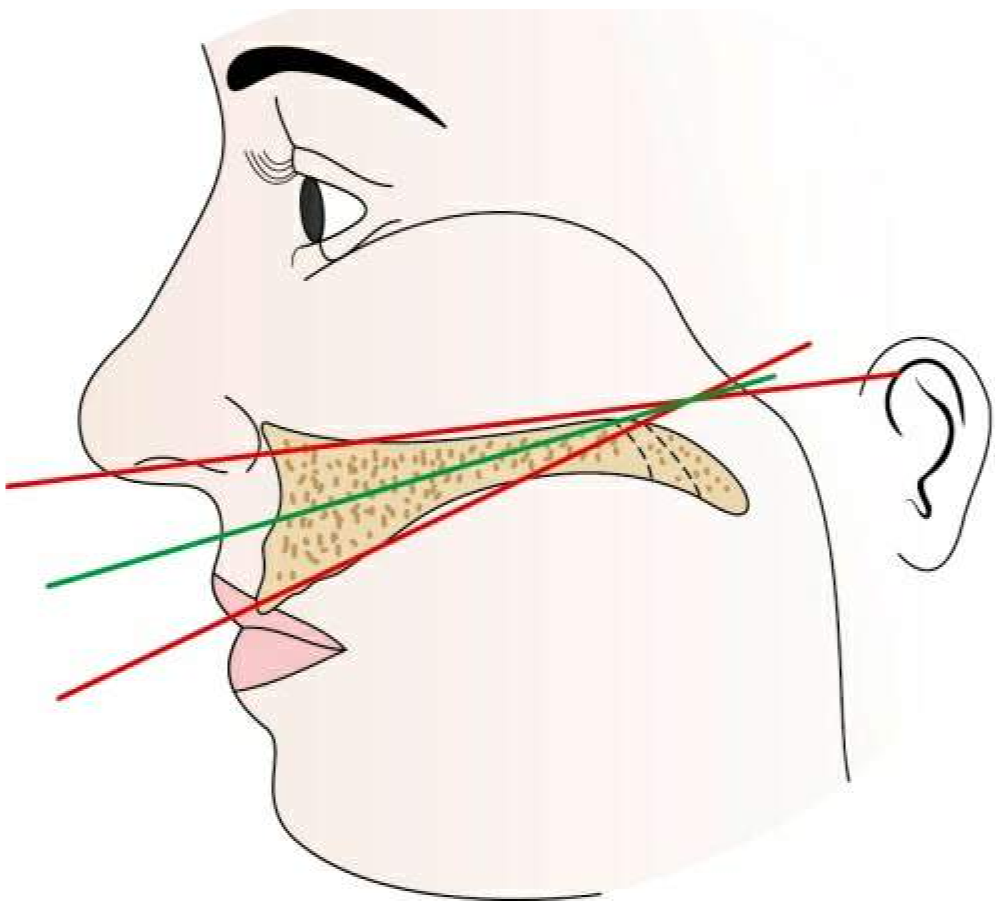


FIGURE 6.20A Tilt of maxilla – red lines show the existing tilt/inclination of the maxilla in relation to the cranium. The tilt

can vary with every individual (green line). This tilt needs to be recorded and transferred to the articulator to obtain accurate jaw relation records. This tilt is recorded using facebow.

To record the angulation of the maxilla, a plane should be formed with at least two posterior references and one anterior reference (Fig. 6.20B).

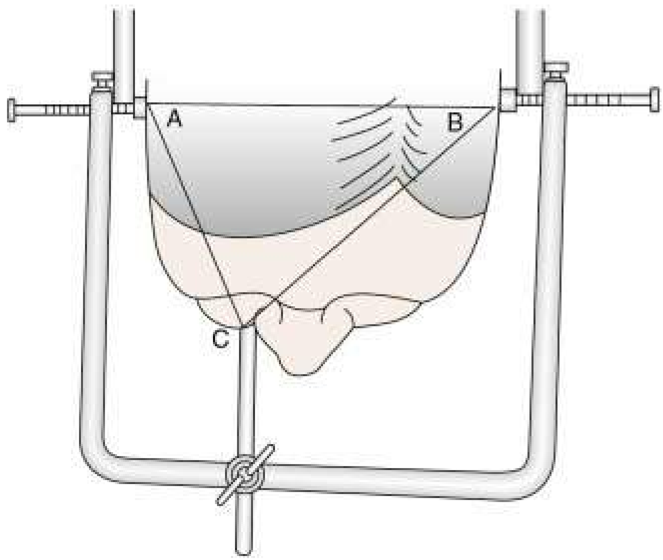


FIGURE 6.20B View of a head from top – to record the inclination of maxilla, a plane should be formed with two posterior (centre of both condyles A and B) and one anterior point – here infraorbital notch C is used as anterior reference point.

As the mouth opens and closes in CR, the movement of the condyles in the initial stages (up to about 12 mm) of opening and final stages of closing is a rotational movement in the horizontal axis, following an arc of a circle (as previously described in Mandibular Movements). The axis of the rotation or arc passes through the centre of both the condyles. The condyles are centred in the glenoid fossa during this rotational movement. If the centre of condylar rotation can be determined, it will correspond to the two posterior reference points necessary to form a plane for the maxilla, as the glenoid fossa is located just above the centre. This is a repeatable border position and can be located consistently. A third reference point located anteriorly in the maxilla – infraorbital notch or nasion – will complete the plane (Fig. 6.20C).

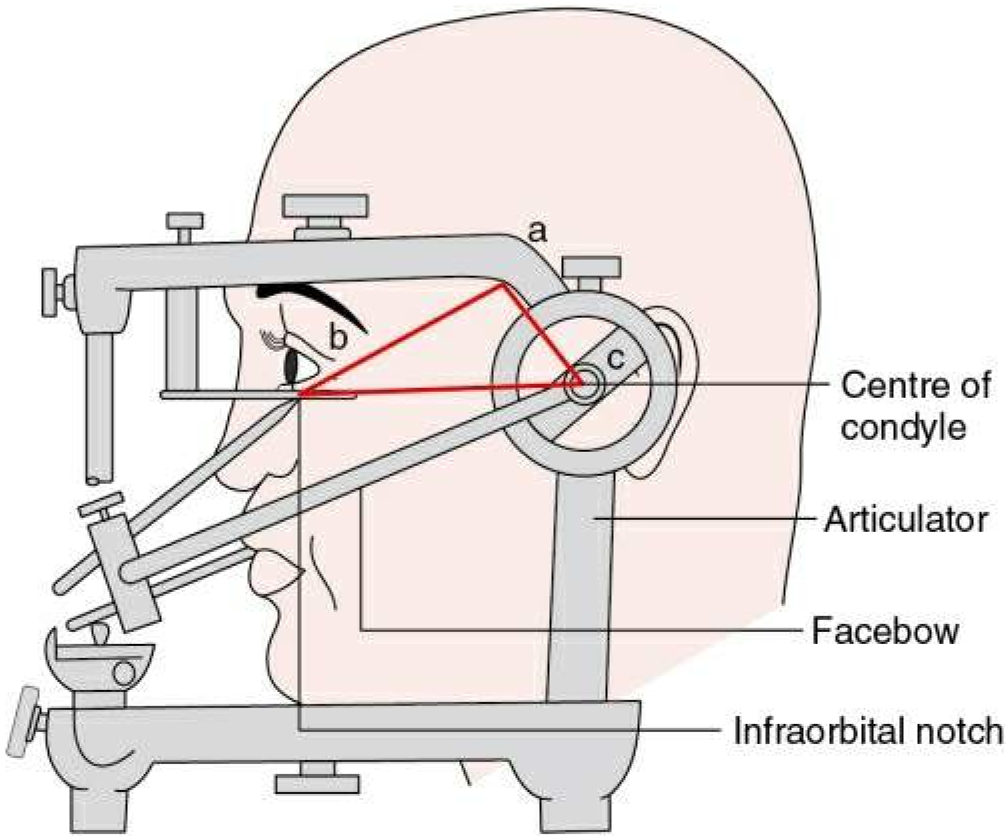


FIGURE 6.20C Facebow is used to determine the inclination of maxilla by forming a plane (a–c) using the centre of the two condyles (a and c) as posterior references and infraorbital notch (b) as anterior reference. Hence, the centre of condylar rotation is also determined and the same is transferred to the articulator. Once the maxilla is oriented, the mandible is oriented with the maxilla using centric and eccentric records.

The instrument that is used to record the centre of condylar rotation along with a third reference point, thereby forming a plane to record the orientation relationship of the maxilla to the cranium, is called facebow.

Facebow

Definition: A caliper-like instrument used to record the spatial relationship of the maxillary arch to some anatomic reference point or points and then transfer this relationship to an articulator; it orients the dental cast in the same relationship to the opening axis of the articulator. Customarily the anatomic references are the mandibular condyles, transverse horizontal axis and one other selected anterior point; also called hinge bow (GPT8).

Types of facebow

There are two types of facebows:

- Arbitrary facebows
- Kinematic/hinge facebows

The arbitrary facebow determines the approximate 'centre of rotation' of condyle, while the kinematic facebow establishes the centre accurately.

Arbitrary facebow

Definition: A device used to relate the maxillary cast to the condylar elements of an articulator using average anatomic landmarks to estimate the position of the transverse horizontal axis on the face (GPT8).

- Also called 'average axis facebow'.
- It is the most commonly used facebow and is preferred for complete denture construction.
- The hinge axis (transverse horizontal axis) is approximately located. It positions the rods within 5 mm of the true centre of rotation of condyle.
- This method does not locate the true hinge axis, but the clinical

impact of this inaccuracy is minimal and will lead to a mild error in the occlusion, which can be adjusted during insertion of the complete dentures.

- Arbitrary facebows are classified as:

  - **Earpiece type (ear bow):** In this type, the external auditory meatus is considered as reference point to determine the centre of condylar rotation. The condyles are located at an approximate distance in front of the meatus (Fig. 6.21) and this is compensated for in the articulator by mounting the facebow behind the condylar centre (Fig. 6.22). This type of facebow is easier to manipulate clinically.

  - **Facia type:** In the facia type of facebow, the centre of condylar rotation is arbitrarily marked as 13 mm anterior to the middle of the tragus of the ear, on a line drawn from the outer canthus of the eye to the middle of the tragus of the ear – **canthotragal** line (Fig. 6.23). The condylar rods of the facebow are placed on this point (Fig. 6.24). Unlike the earpiece type, this facebow is mounted by placing the condylar rods at the centre of the condyle in the articulator (Fig. 6.25).

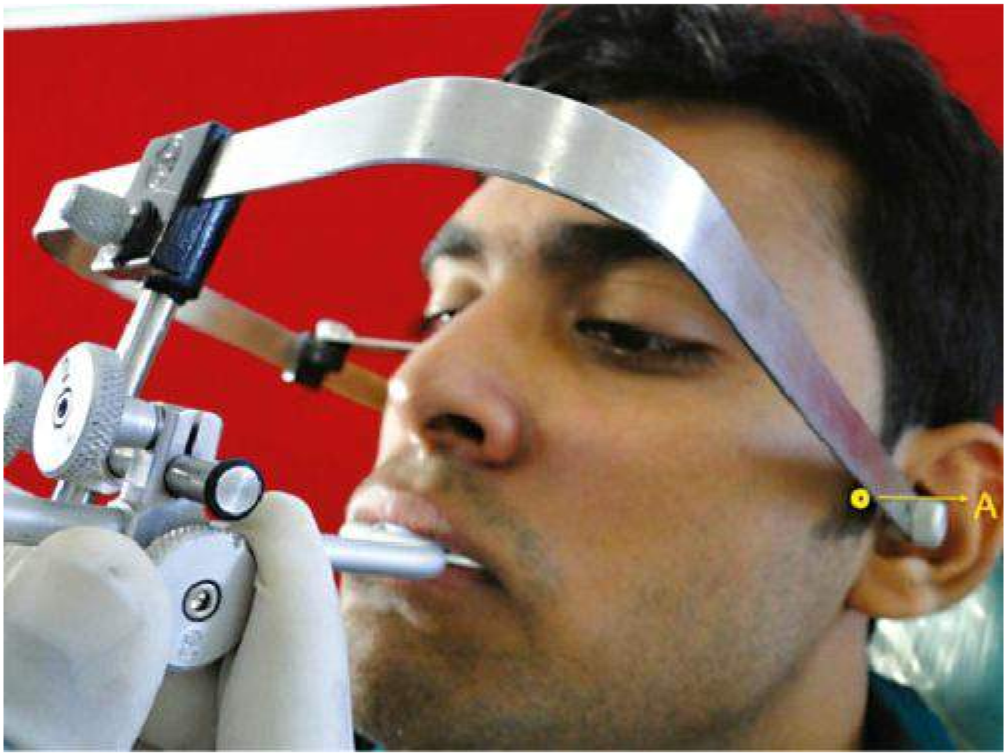


FIGURE 6.21 Ear pieces fit into the external auditory meatus which is located posterior to the centre of condyle (A).

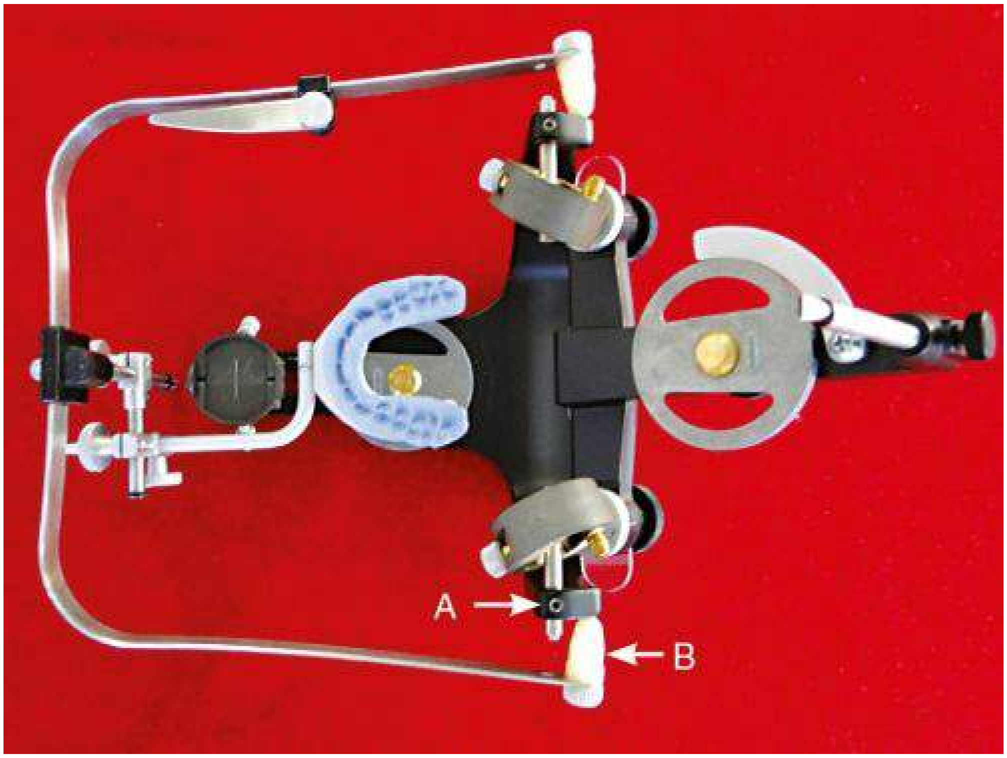


FIGURE 6.22 The ear piece (B) that fits into the external auditory meatus is fitted in a slot behind the centre of condyle (A) in the articulator similar to its position on the patient.

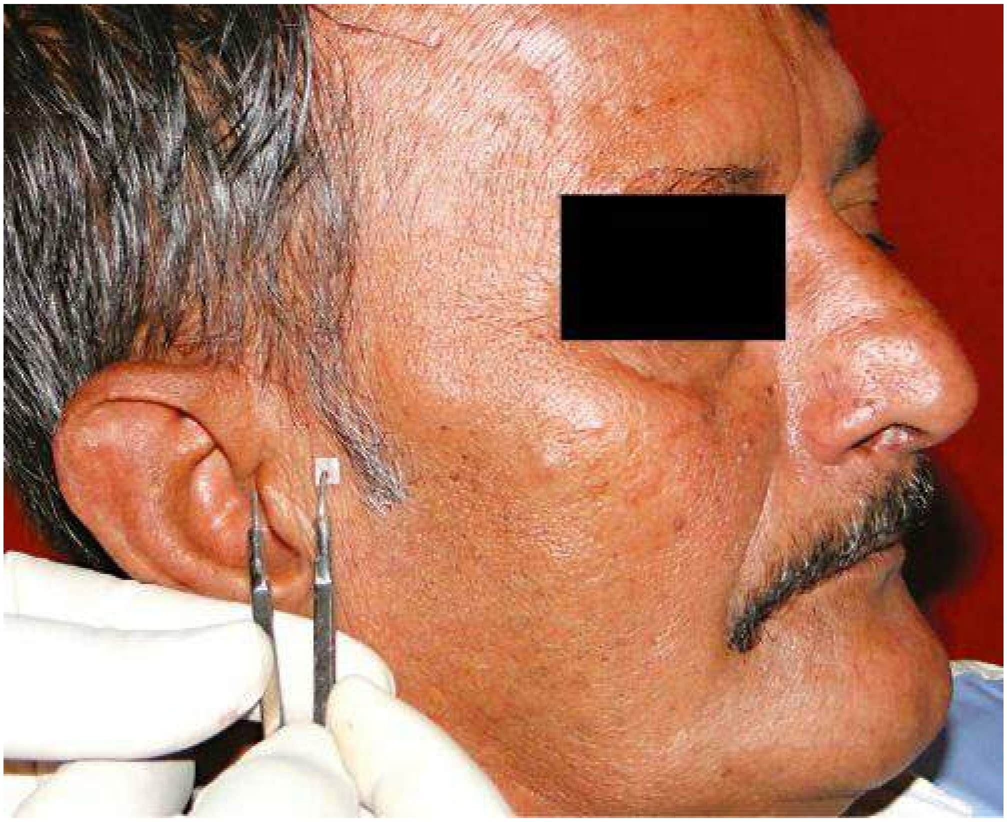


FIGURE 6.23 The condylar centre is located 13 mm from the middle of tragus of ear on the canthotragal line.

FIGURE 6.24 Placement of condylar rods at the marked point (centre of condyle).

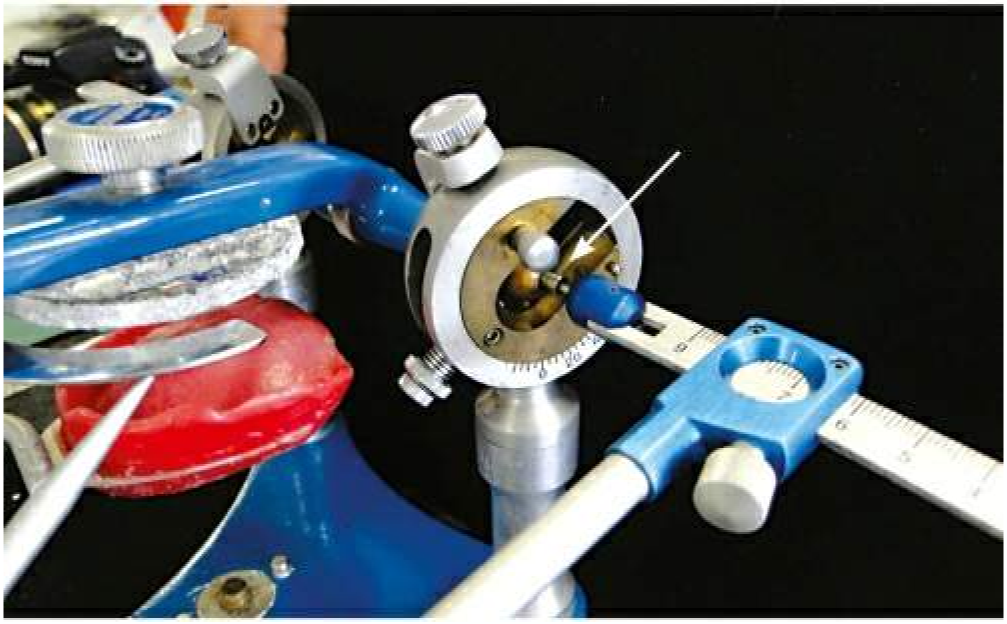


FIGURE 6.25 Facebow is mounted by placing the condylar rods at the centre of the condyle in the articulator.

Kinematic facebow

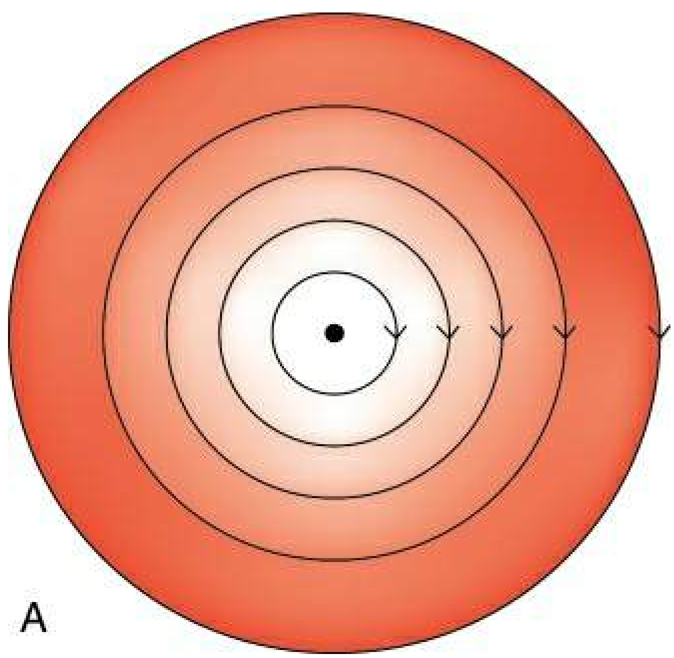
Definition: A facebow with adjustable caliper ends used to locate the transverse horizontal axis of the mandible (GPT8) (Fig. 6.26B).

- It locates the true (exact) centre of condylar rotation or transverse horizontal axis.
- It is preferred in full mouth reconstructions.
- It usually requires a fully adjustable articulator.
- When we consider the rotation of any circular object, only the central point rotates, any other **point within** the circle will show translatory movement (Fig. 6.26A). Similarly in the condyle, the centre alone will display pure rotation. This principle used to determine the true centre of rotation using kinematic facebow.

- The condylar rods are first positioned arbitrarily similar to facia type of facebow at a point 13 mm anterior to the auditory meatus on the canthotragal line.

- The patient is instructed to make opening and closing movements in CR. The opening should not be greater than 12 mm as then the condyle will then begin to translate instead of rotating.

- The position of the condylar rod is shifted around the arbitrary mark until it shows pure rotation. This is the centre of condylar rotation. This point is marked, the condylar rods are locked, the facebow assembly is removed and mounted on an appropriate articulator.



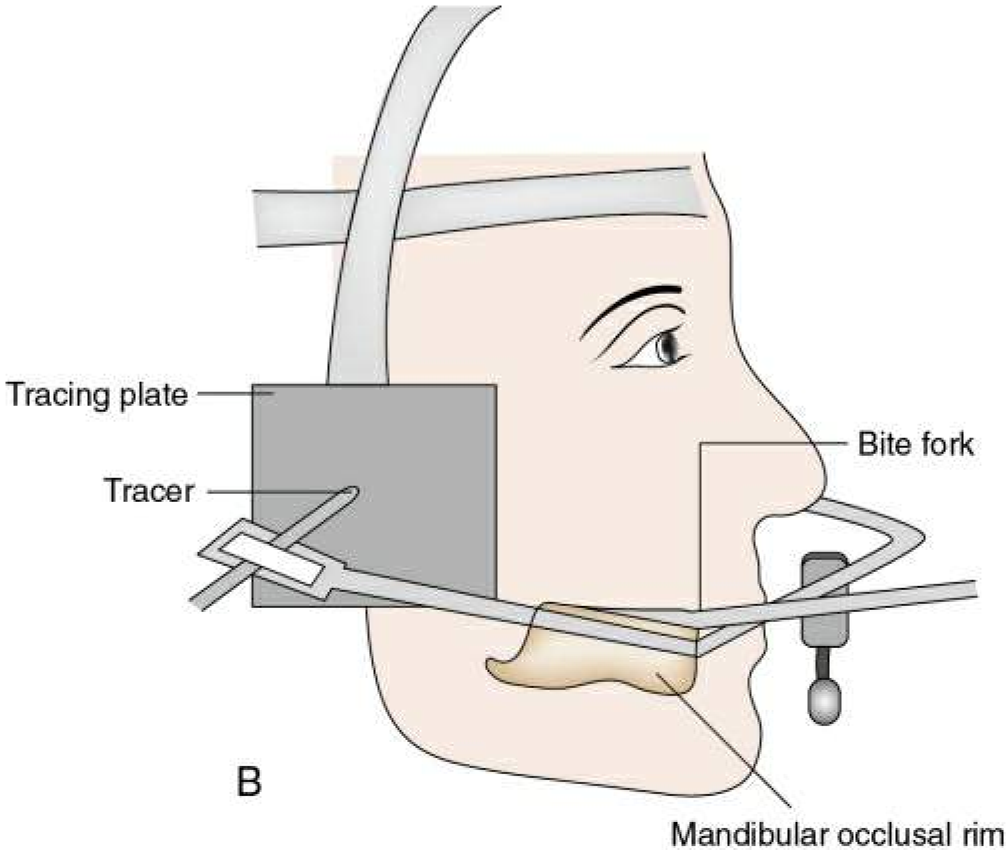


FIGURE 6.26 **(A)** Rotation of a circular object – only the centre rotates, other points translate. **(B)** Kinematic facebow. The bite fork/clutches are attached to the mandible which has the tracing stylus, and the tracing plates fixed to the skull, so that the tracers are in contact with the plates. During the mandibular opening and closing, the stylus makes the tracing on the plates.

Parts of a facebow

Slight modifications in the facebow may be seen in different types. The basic parts of a facia facebow are described as follows:

1. U-shaped frame

- It is a U-shaped metallic frame, to which all the other components of the facebow are attached (Fig. 6.27).
- It extends from the TMJ of one side to the TMJ of the other side, at

least 2–3 inches anterior to the face to avoid contact.

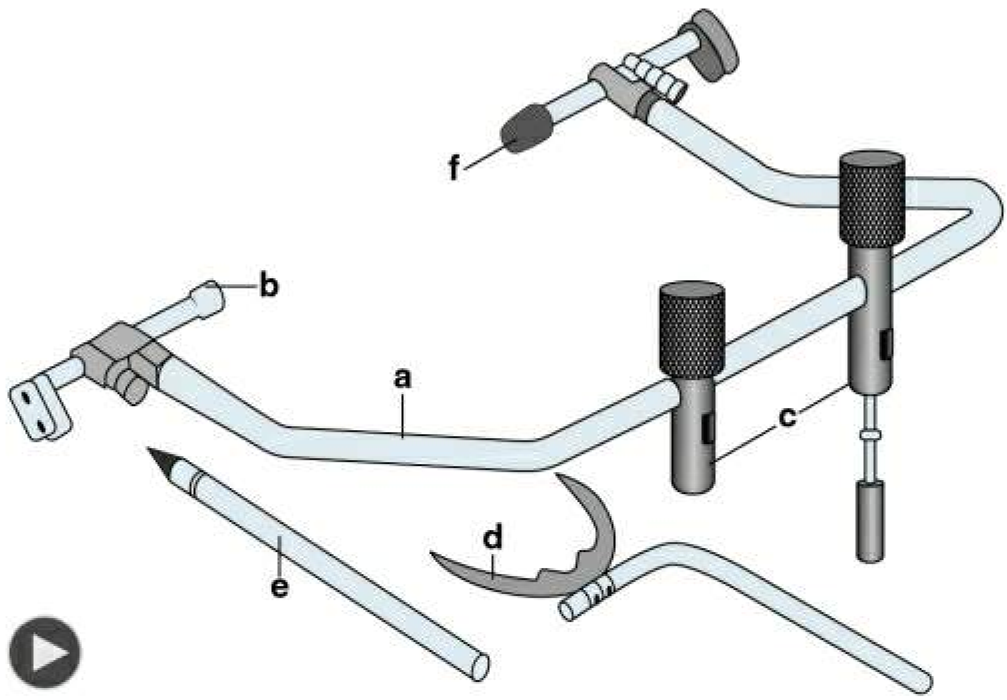


FIGURE 6.27 Parts of a facebow: (a) U-shaped frame, (b) condylar rod-facia facebow, (c) locking device (d) bite fork, (e) orbital pointer and (f) condylar rod-earpiece facebow.

2. Condylar rods

- These are two calibrated metal extensions fitted on either side of the free end of the U-shaped frame that are placed on the determined centre of condyle (Figs 6.27 and 6.28).
- The calibrations on either side are equalized (to centre the facebow) and then locked.

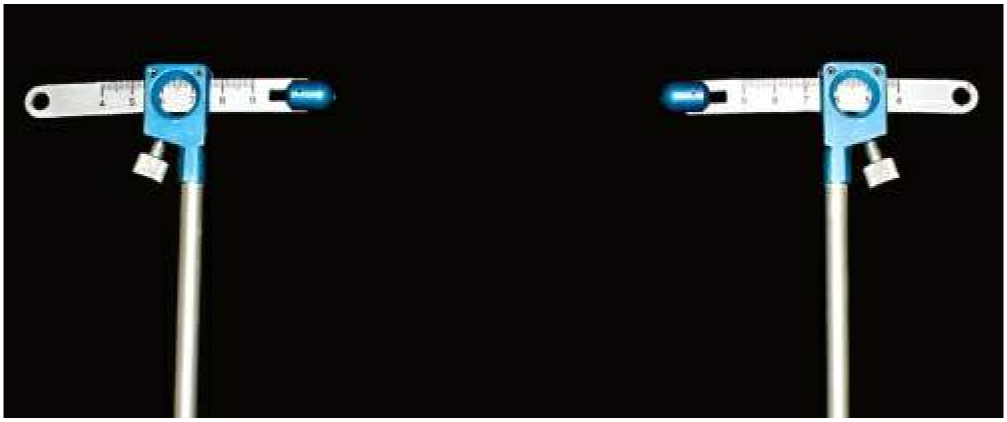


FIGURE 6.28 Condylar rods.

3. Bite fork

- It is a U-shaped rod which is attached to the maxillary occlusal rim while recording the orientation jaw relation (Figs 6.27 and 6.29).
- It is attached to the frame with the help of a metal rod called the 'stem'.
- The bite fork should be inserted about 3 mm above the occlusal surface into the occlusal rim.
- Sometimes the bite fork is attached to the occlusal surface of the occlusal rim with the help of impression compound. This is done in order to preserve the occlusal rim.

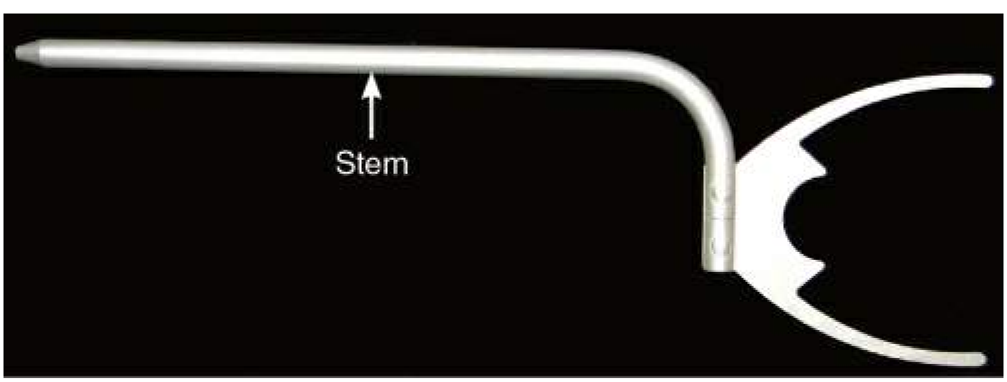


FIGURE 6.29 Bite fork.

4. Locking devices

There are three locking devices (Figs 6.27 and 6.30):

- **Locking clamp for bite fork:** It attaches the bite fork to the U-shaped frame.
- **Locking clamp for orbital pointer pin**: Locks the orbital pin onto the U-shaped rod.
- There is another locking screw for the condylar rods.

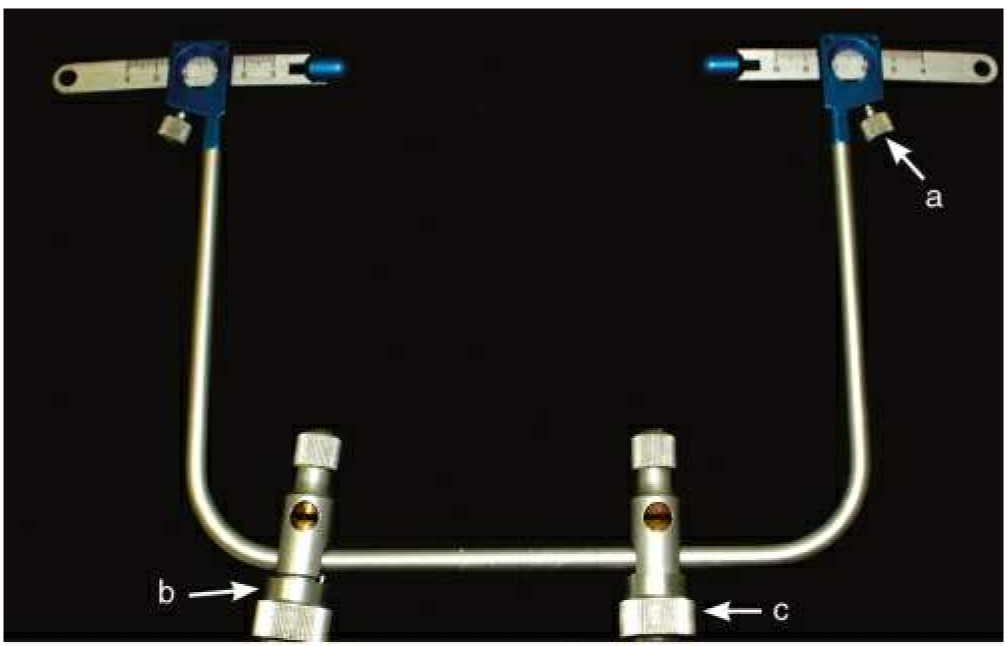


FIGURE 6.30 Locking device: (a) locking screws for condylar rods, (b) locking clamp for bite fork and (c) locking clamp for orbital pointer.

5. Orbital pointer pin

- It helps in marking the anterior reference point (Figs 6.27 and 6.31).

- It is adjusted after marking the anterior reference point on the patient. This enables the transfer of the third reference point.

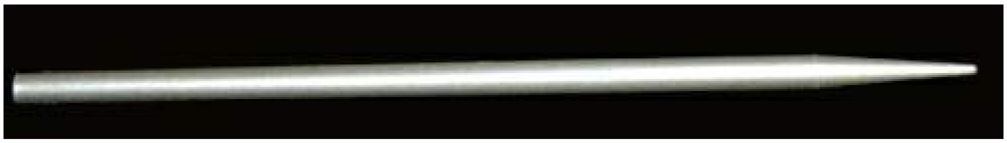


FIGURE 6.31 Orbital pin.

Facebow transfer

The procedure of transferring the orientation of the maxilla to the articulator involves:

- Facebow record
- Facebow mounting

Clinical procedure for recording orientation jaw relation (using facia type)

- The maxillary occlusal rim is inserted into the patient's mouth and contoured and all the required guidelines are marked as described in Chapter 5.
- A point 13 mm from tragus of the ear on the canthotragal line is marked on both sides (Fig. 6.23).
- The bite fork is flamed and attached anteriorly to the maxillary occlusal rim, 3 mm above the incisal plane and parallel to the occlusal plane (Fig. 6.32).The maxillary rim with the attached bite fork is inserted into the patient's mouth. The parallelism and centring of the attached bite fork are verified (Fig. 6.33).
- The U-frame is supported by two fingers and gently rotated and inserted into the stem of the bite fork in the patient's mouth (Fig.

6.34).

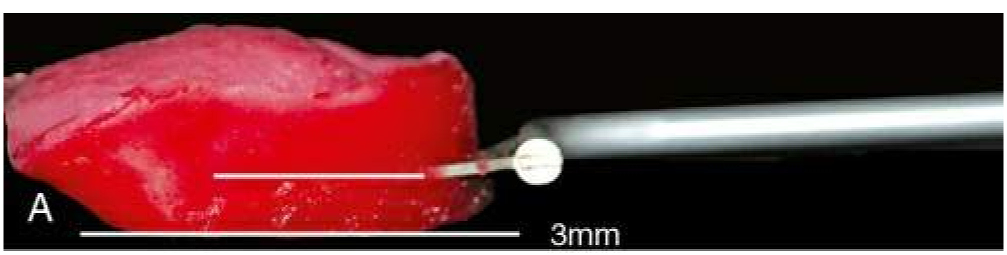
- The condylar rods are unlocked and the condylar heads are then placed in the patient's right and left condylar centres on the previously marked points (Fig. 6.35).

- The third point of reference (infraorbital notch) is palpated and the orbital pointer is set to the third point of reference (Fig. 6.36A and B).

- The condylar rod readings are equalized on both sides and the locking screws are tightened. Following this, the orbital pointer is also tightened in position (Fig. 6.37A and B).

- Once the entire apparatus is in position, the condylar rods, orbital pin and the bite fork are verified for any movement, alignment and parallelism.

- The contoured mandibular occlusal rim may be used during the transfer to stabilize the maxillary rim. The facebow record is removed from the patient by loosening only the condylar screws (Fig. 6.38). The record is now ready to be mounted on the articulator. This completes the facebow transfer and then it is transferred to the articulator.



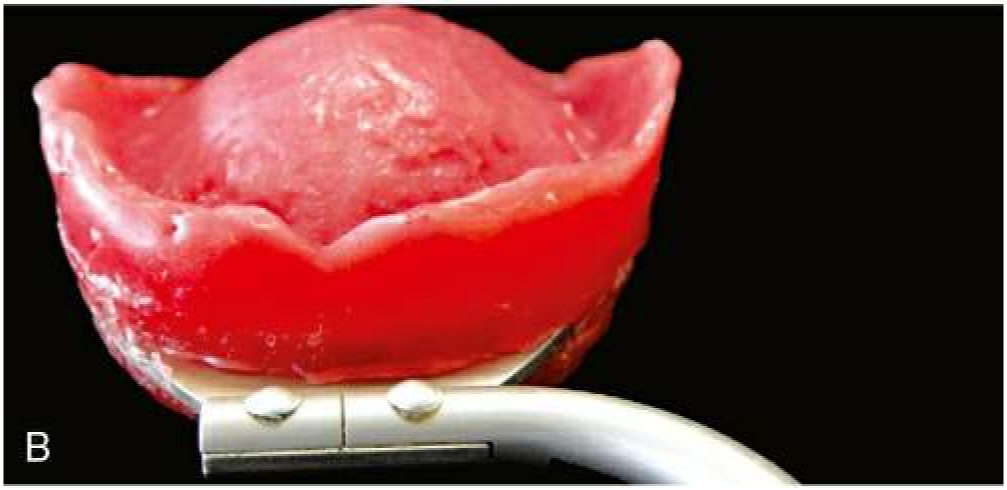


FIGURE 6.32 **(A)** The bite fork is mildly warmed on a burner and slowly inserted into the maxillary occlusal rim 3 mm above and parallel to the occlusal plane. **(B)** The centre of the fork should coincide with the patient's midline.

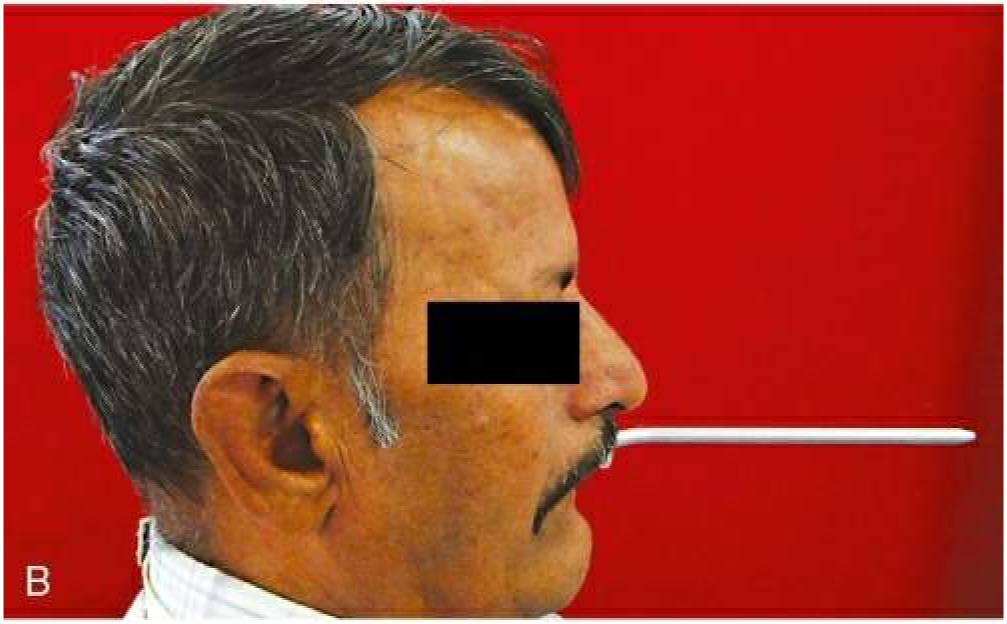


FIGURE 6.33A, B The occlusal rim with attached bite fork is inserted into the patient’s mouth and verified.

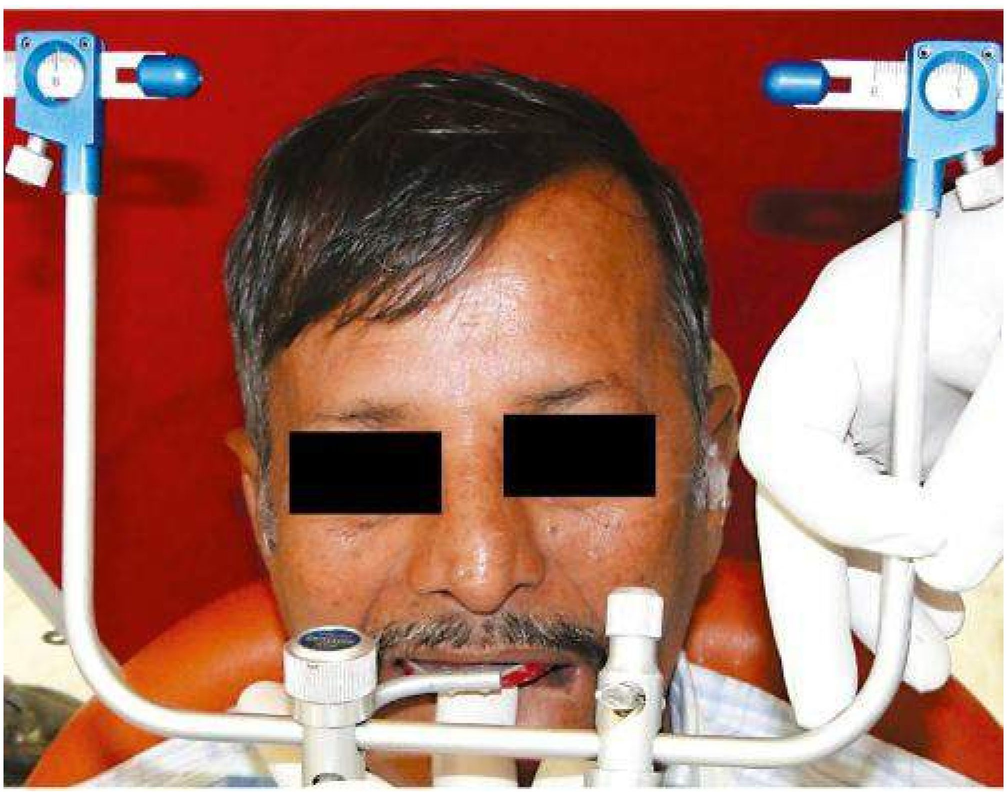


FIGURE 6.34 The U-frame is inserted into the bite fork stem.

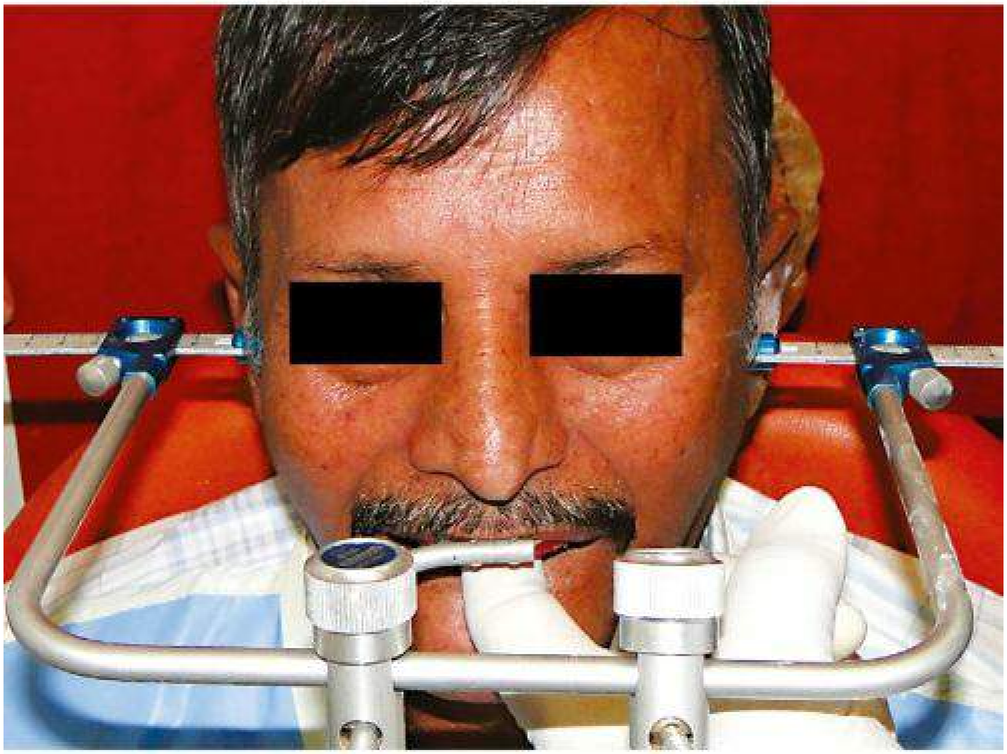
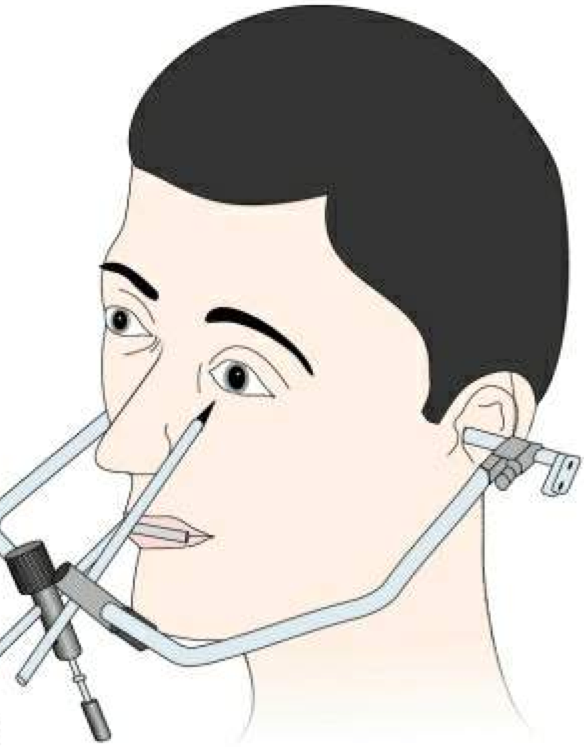


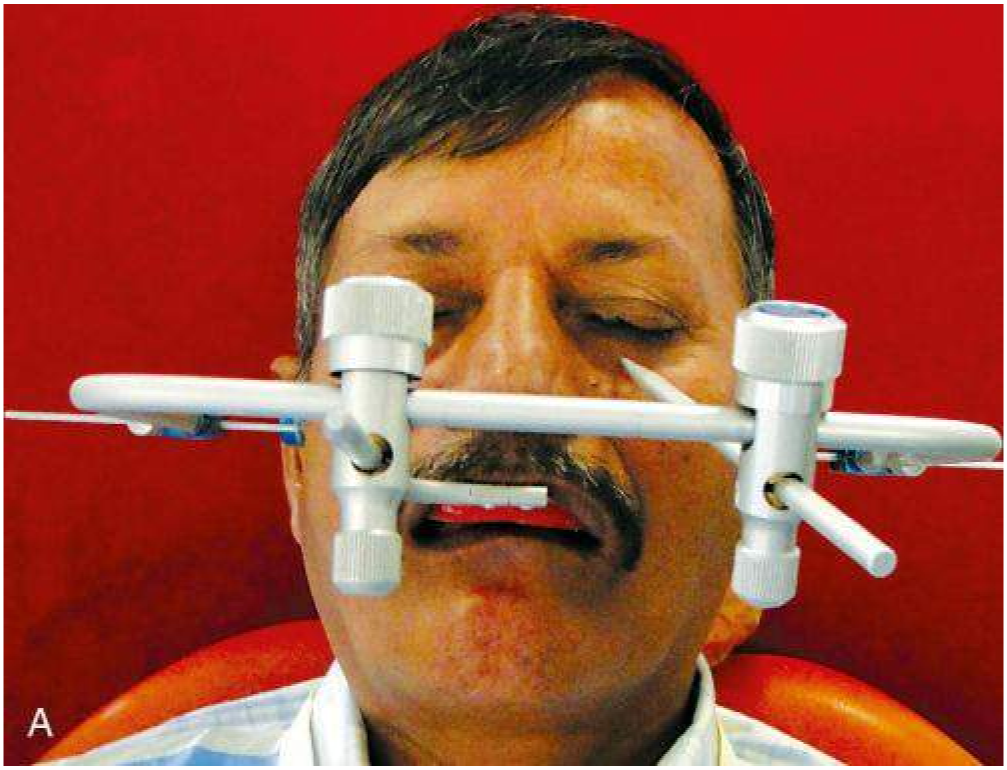
FIGURE 6.35 The condylar rods are placed on the predetermined condylar centres.


A



B

FIGURE 6.36A, B The infraorbital notch, which is the third point of reference is palpated.



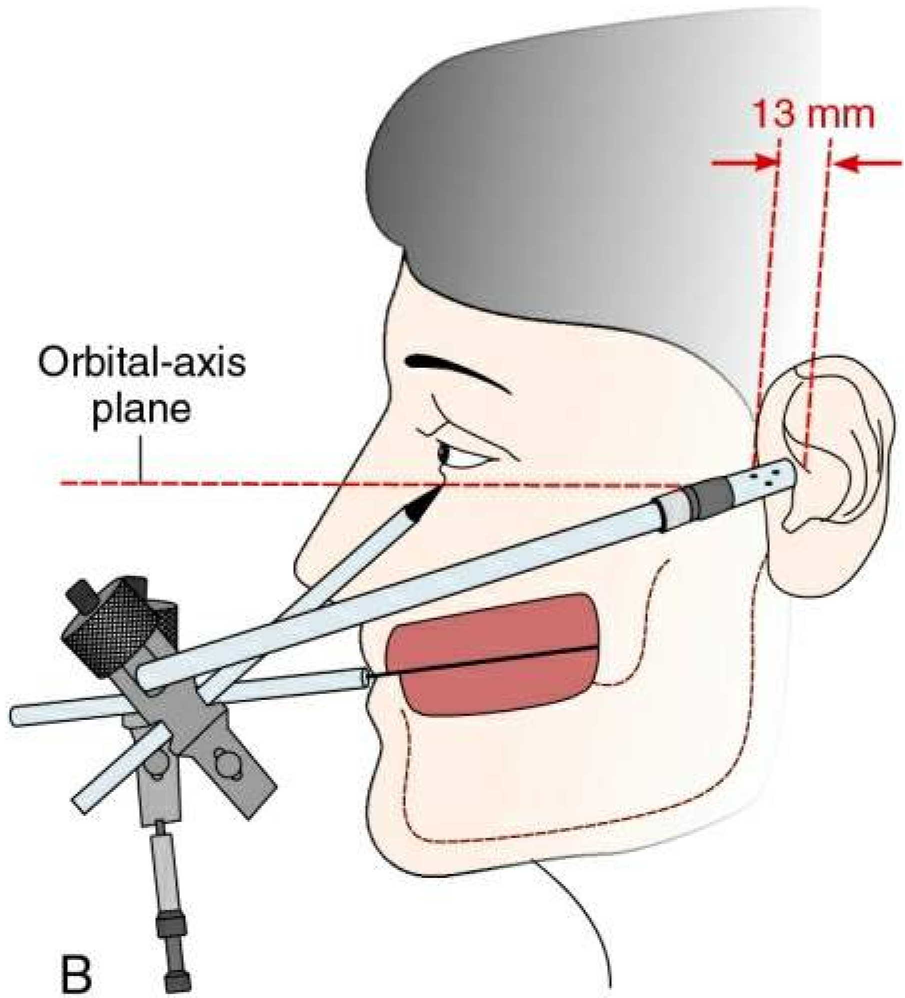


FIGURE 6.37A, B Completed facebow record.

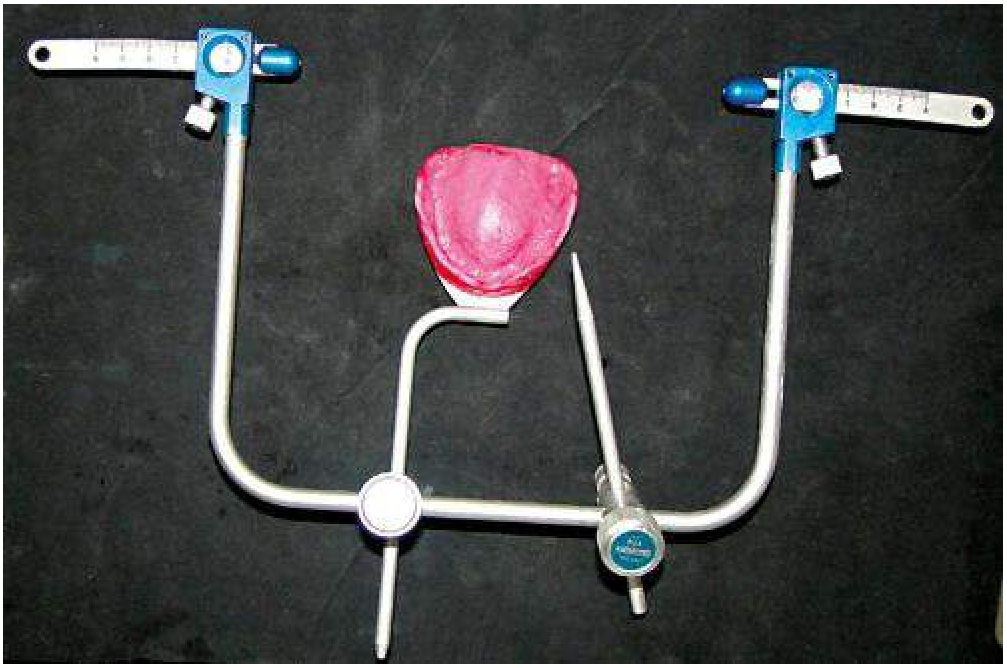


FIGURE 6.38 The entire assembly to be transferred to the articulator is carefully removed. Note the condylar rod calibration, position of maxilla and orbital pin.

Mounting on the articulator

- The articulator is programmed first (zeroing of articulator): The incisal guide pin is set to correct jaw separation and the anterior stop screws are tightened first. Next the horizontal condylar inclination is set at 40° and the Bennett angle at 20° (Figs 6.39 and 6.40).

- The facebow record is now mounted on the articulator as follows: The condylar rods are attached to the auditory pins. The bite fork is stabilized on the tilting support bar provided and the orbital pin is made to coincide with the orbital axis plane indicator.

- The incisal pin is locked with its lock screw at zero on calibration and the incisal table is set horizontally (Fig. 6.41).

- The upper member of the articulator is swung open, plaster is mixed and placed on the cast and the upper member is closed slowly, until the incisal pin fully touches the incisal table and upper mounting plate is covered with plaster.

- Excess plaster is trimmed once the plaster is set (Fig. 6.42). Facebow is now removed by loosening all the locking devices.

FIGURE 6.39 Programming articulator – horizontal condylar guidance set at 40.

FIGURE 6.40 Lateral condylar angle set at 20.

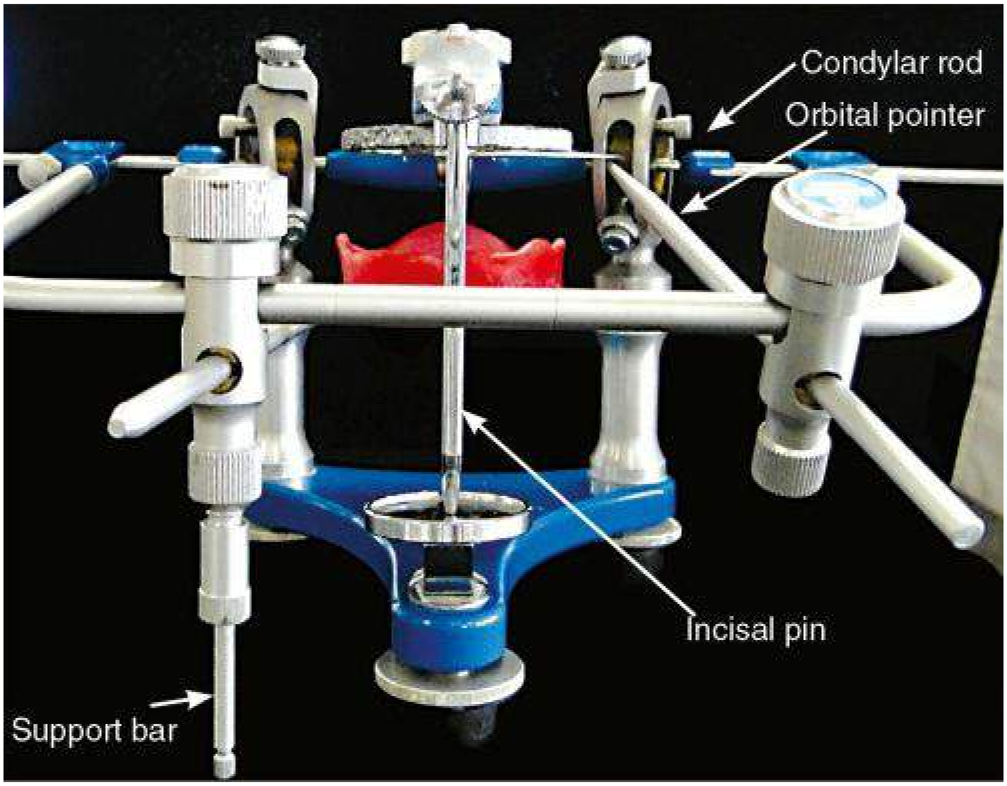


FIGURE 6.41 The U-shaped frame is supported by the base anteriorly.

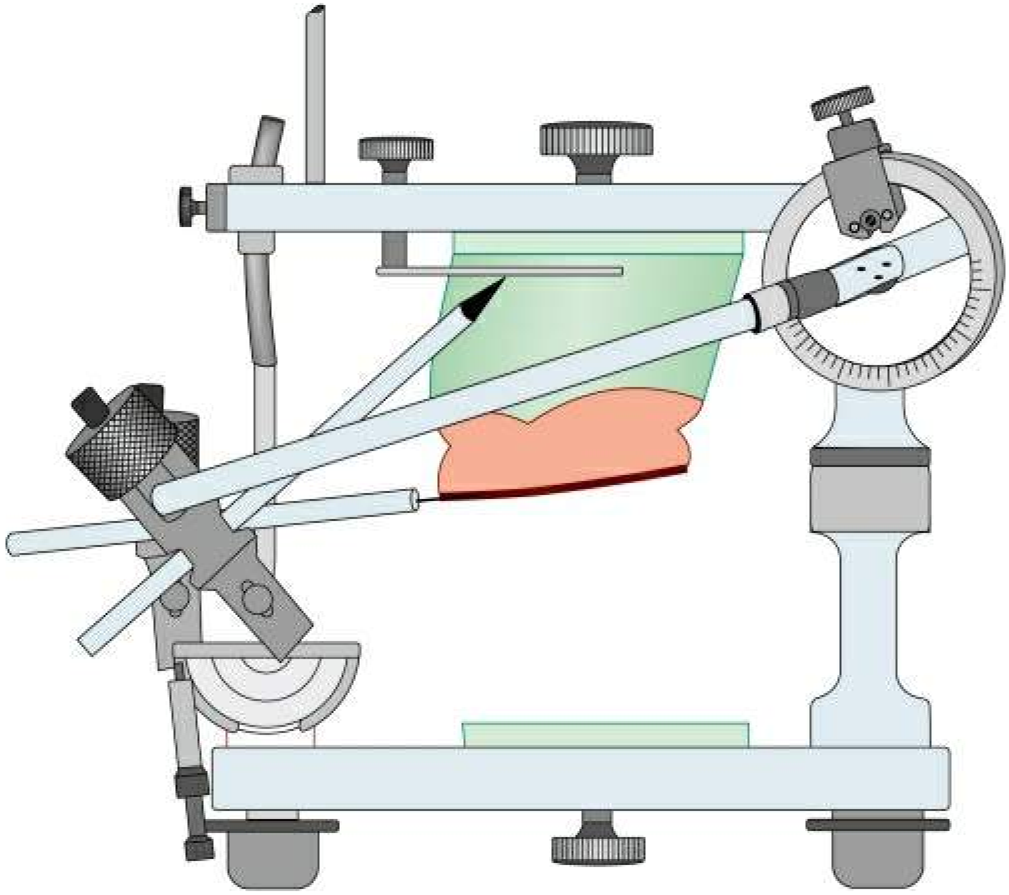


FIGURE 6.42 Mounted maxillary cast using facebow transfer.

Indications of facebow

The need to use a facebow in complete dentures has been debated with many dentists preferring not to use the same. It is seen that not using the facebow only leads to minor errors in occlusion, which can be corrected intraorally during the delivery of the denture. In fact, studies comparing the patient response to complete dentures with or without facebow transfer failed to show any significant clinical advantage with facebow use. In this context facebow may be indicated when:

- Balanced occlusion is desired.
- Vertical dimension is subject to change.

If a facebow is not used, the maxillary cast is mounted arbitrarily on the articulator using the occlusal plane as a guide.

Vertical jaw relations

- Following the orientation of the maxilla or maxillary cast, the mandible/mandibular cast is related to the maxilla using interocclusal records, which record the horizontal jaw relation. It is important to record the horizontal jaw relation at the appropriate vertical dimension that is normal for the individual. Hence, the vertical dimension should be determined first.
- The vertical jaw relation or vertical dimension is defined as *the length of the face as determined by the amount of separation of the jaws under specified conditions.*
- The correct vertical dimension should be established before recording horizontal relations as increasing or decreasing the vertical dimension can have deleterious effects.
- The vertical dimension is maintained by the occlusion of teeth or the mandibular musculature.
- Classification:

  - ○ Vertical dimension at rest.
  - ○ Vertical dimension of occlusion or occlusal vertical dimension.
  - ○ Vertical dimension in other positions of mandible.

Vertical dimension at rest and occlusion are the two measurable guides and need to be determined.

Vertical dimension at rest: The length of the face when the mandible is in rest position (GPT).

Physiologic rest position: The postural position of the mandible when an individual is resting comfortably in an upright position and the associated muscles are in a state of minimal contractual activity (GPT8).

Vertical dimension of occlusion or occlusal vertical dimension: The length of the face when the teeth are in contact in MIP (maximal intercuspation).

It is imperative that teeth should not contact at rest position and a space exists. This is important because the rest position is a comfortable position and the individual returns to this position most of the time that allows the supporting hard and soft tissues to rest. Contact of teeth in this position will be similar to a premature and constant contact of teeth and will lead to soreness of supporting tissues and bone resorption. The vertical distance between the teeth at rest position is termed as 'freeway space' or 'interocclusal rest space'. In the dentulous individuals this space varies from 1 to 10 mm with an average of 2–4 mm. The older the complete denture patient, more interocclusal rest space is provided.

As the rest position does not depend on the presence of teeth and is repeatable and recordable, the vertical dimension of occlusion in complete denture patients can be calculated by determining vertical dimension at rest and then subtracting 2–4 mm to allow for freeway space.

VD at occlusion = VD at rest – 2–4 mm

The most commonly used method of determining the occlusal vertical dimension – **Niswonger's method** (described later in this chapter) – employs this principle to determine the same.

Whatever method is used for determining the occlusal vertical dimension, the rest position is always used as a guide to ensure that interocclusal rest space or freeway space is present. This will ensure that the vertical dimension is not increased or decreased.

Methods of determining vertical dimension at rest

The following factors influence the rest position:

1. **The posture of the patient**: The rest position is affected by postural changes. The patient should be sitting upright or standing with the head erect and looking straight ahead, when the rest position is determined.

2. **A relaxed patient**: When a patient is nervous, tense, irritable or tired, the rest position may be inaccurate. It should be determined when the patient is relaxed.

3. **Neuromuscular disturbance**: It will be difficult to determine the rest position in patients with such problems. The dentist should be more considerate, patient and spend more time to establish the rest position in such individuals.

4. **Duration**: As it is a position in space, the patient cannot maintain the rest position for long periods. The dentist should make the measurement without delay when the patient assumes this position.

5. **Use of several methods**: Although the rest position is measurable and repeatable, there is no single scientific method of establishing the same. A combination of various methods is used to verify the position.

The following methods are commonly used to determine the vertical dimension of rest:

1. *Facial measurements*

The vertical dimension at rest is calculated by making facial measurements. The posture of the patient should be as described previously. Two marks are commonly placed, one on the tip of the nose and other on the chin directly below the nose marking. The markings can be made with an indelible marker or pieces of adhesive tape (Fig. 6.43).

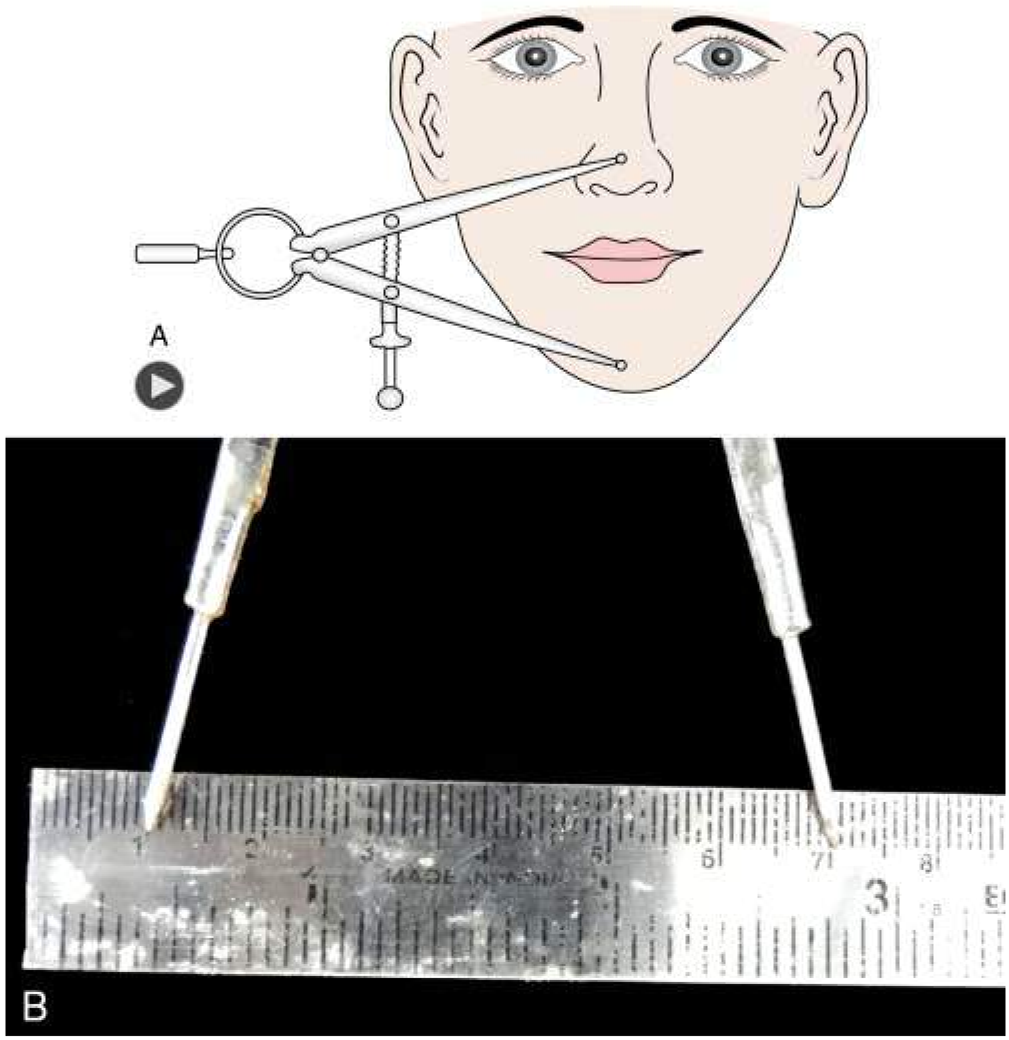


FIGURE 6.43 **(A)** Facial measurements can be made by marking points on chin and nose. **(B)** A divider can be used to measure the vertical dimension.

As the patient assumes rest position, the vertical distance between the two points is measured using a divider or scale. Measurements can also be made with special instruments made for the purpose like Willis gauge (Fig. 6.44) and Dakometer.

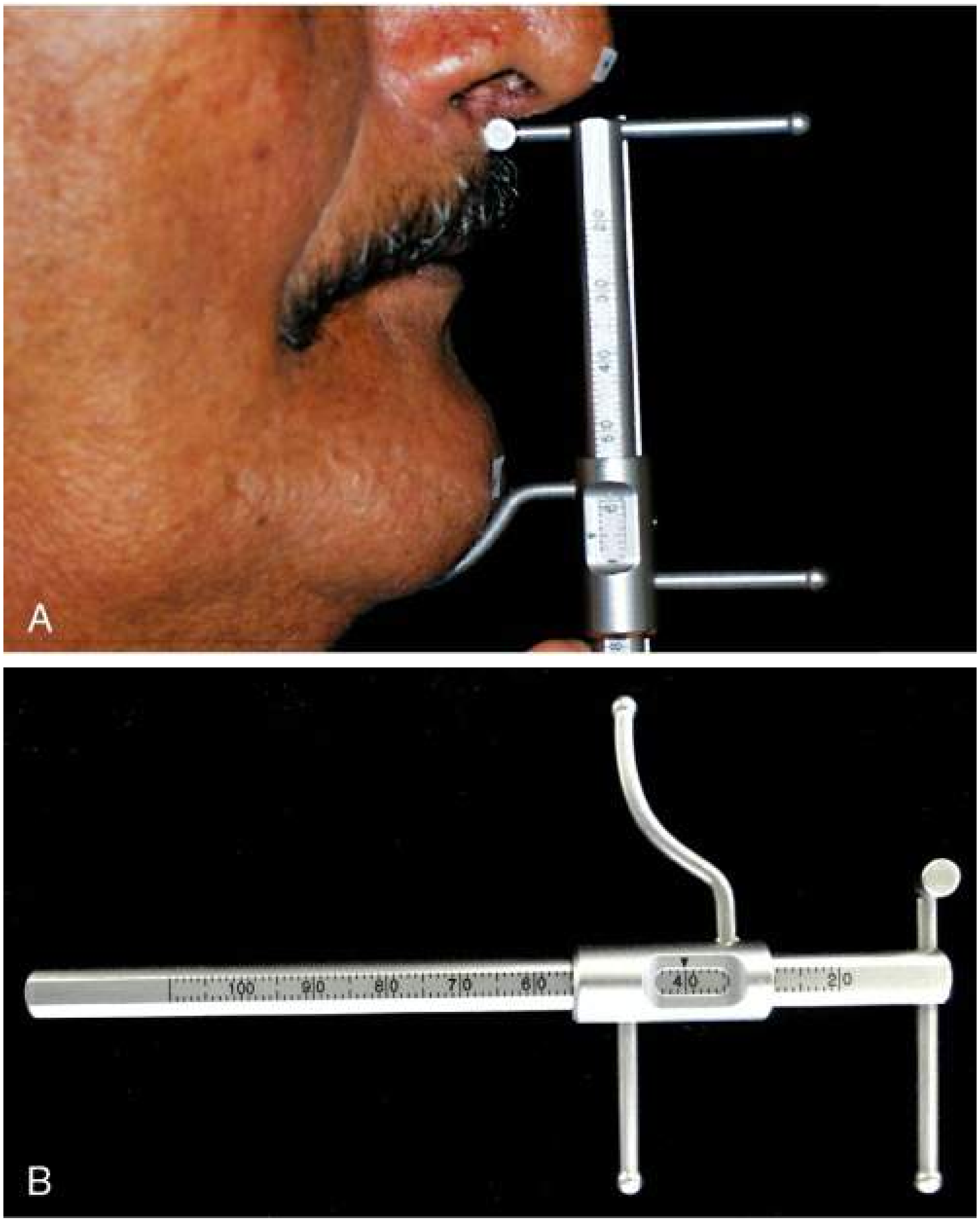


FIGURE 6.44A, B Willis gauge used to make facial measurements.

The following methods are used to make the patient assume the postural rest position:

(i) Swallowing: The patient is instructed to drop the shoulders, wipe his/her lips with tongue, swallow and close the mouth. This makes the mandible assume the rest position, which is immediately measured.

(ii) Tactile sense: The patient is instructed to open the mouth wide until strain is felt in the muscles (may be for 1–2 min). They are then asked to close the mouth slowly until they feel comfortable and relaxed. Measurement is made in this position.

(iii) Phonetics: The patient is instructed to repeatedly say words that contain the letter 'm'. The lips meet when this is pronounced and the patient is instructed to stop all jaw movements when this happens. Measurement is made between the two points of reference.

Alternately, the patient can be engaged in a conversation and measurement made when the patient pauses during the dialogue. The mandible assumes rest position at this point.

(iv) Facial expression: The following indicates rest position:

- Lips are even anteroposteriorly with slight contact.
- Skin around the eyes and chin is relaxed.
- Relaxation around the nostrils with unobstructed breathing.

With experience the dentist learns to recognize, these features depicting rest position and will make measurements accordingly.

2. *Measurement of anatomic landmarks*

The **Willis guide** states that the distance from the pupil of the eye to the rima oris (corner of mouth) should be equal to the distance from the anterior nasal spine to the lower border of the mandible, when the mandible is in its physiologic rest position (Fig. 6.45).

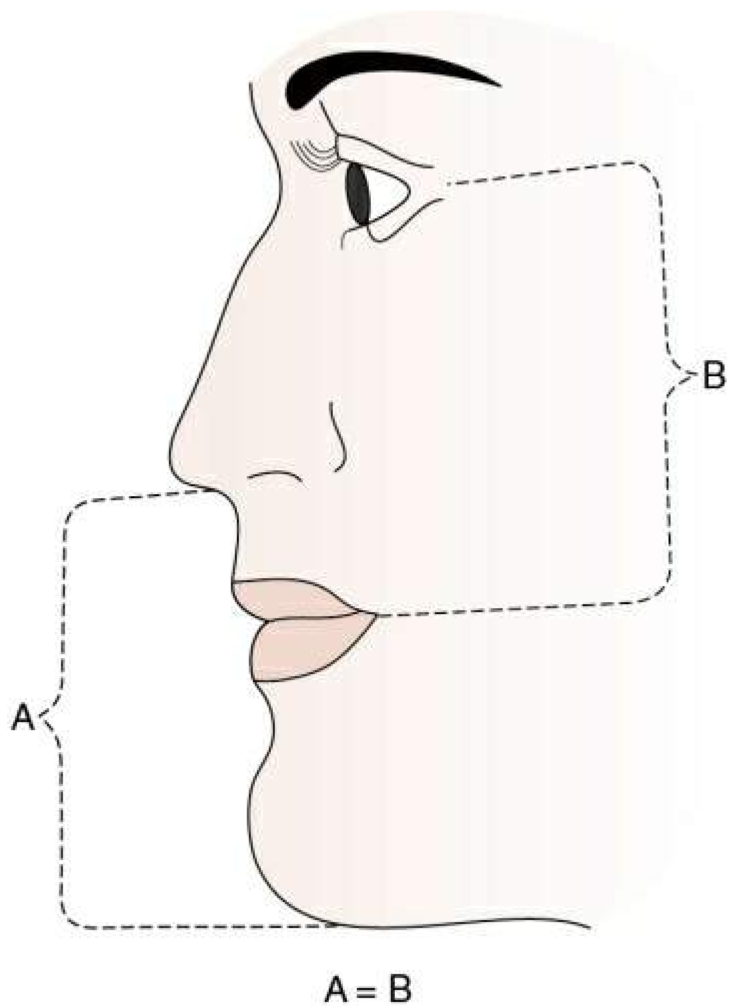


FIGURE 6.45 Willis guide – distance from pupil of eye to rima oris (B) should be equal to the distance from anterior nasal spine to the lower border of mandible (A), when the mandible is in physiologic rest position.

Methods of recording vertical dimension of occlusion

The methods employed to determine vertical dimension of occlusion can be classified as *physiologic* and *mechanical* methods. In dentate individuals, the occlusal vertical dimension may not be established at CR, but for the complete denture patient, it must be established at CR.

1. *Physiologic methods*

(i) Niswonger's method (physiologic rest position)

This is the most commonly used method to establish occlusal vertical dimension. It uses the physiologic rest position (vertical dimension at rest) to determine the occlusal vertical dimension. As discussed previously in this chapter, Niswonger stated that:

VD at Occlusion = VD at rest – freeway space (2–4 mm)

Hence, the physiologic rest position is first determined. The contoured maxillary occlusal rim is placed in the patient's mouth and the vertical dimension at rest is determined using facial measurements as discussed previously. The mandibular occlusal rim is then inserted and it is trimmed and contoured until it meets the maxillary rim evenly. The lower rim is adjusted till the facial measurement in occlusion is 2–4 mm less than that in rest position. This will provide for the necessary interocclusal space or freeway space (Fig. 6.46). The same can be verified by asking the patient to part the lips without moving the jaws at rest position, with the occlusal rims inserted.

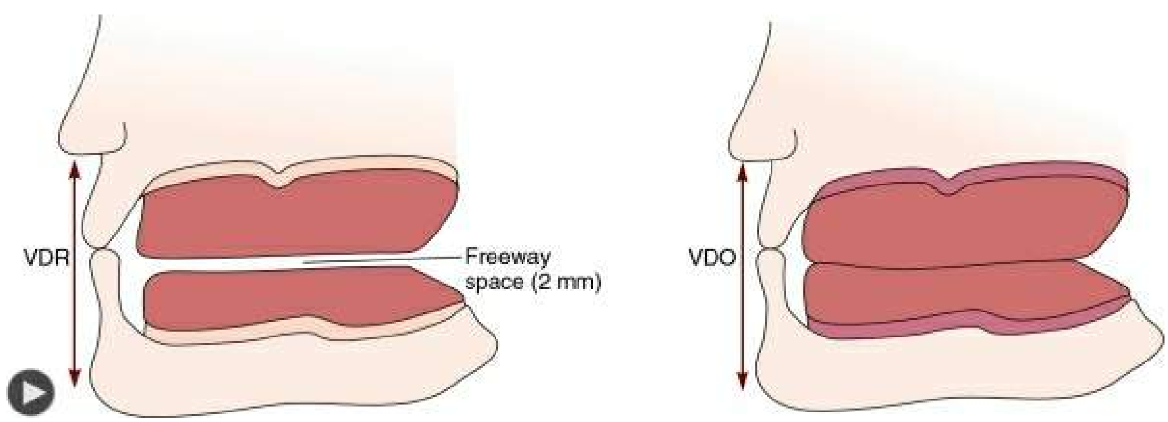


FIGURE 6.46 Niswonger's method: vertical dimension of occlusion (VDO) = vertical dimension at rest (VDR) – freeway space (2–4 mm).

(ii) Swallowing threshold

The concept that maxillary and mandibular teeth come into light contact at the beginning of the swallowing cycle is used as a guide to determine occlusal vertical dimension. The procedure involves building a cone of soft wax on the lower denture base in such a way that it contacts the upper occlusion rim when the jaws are open. Flow of saliva is stimulated by a piece of chocolate. The lower wax cone is softened and the patient is asked to repeat the action of swallowing. This will gradually reduce the height of the wax cone until it just touches the upper rim while swallowing. However, this method has not proven to be consistent.

(iii) Phonetics

This uses phonetics to determine the vertical dimension.

Closest speaking space: The space between the anterior teeth that, according to Dr Earl Pound, should not be more or less than 1–2 mm of clearance between the incisal edges of the teeth when the patient is unconsciously repeating the letter 's'. Dr Meyer M Silverman termed this speaking centric, which was defined as the closest relationship of the occlusal surfaces and incisal edges of the mandibular teeth to the maxillary teeth during function and rapid speech. This was later called closest speaking level by Dr Silverman and finally the closest speaking space (GPT8). The occlusal rims are inserted and height is adjusted until a minimum of 2 mm space exists when the patient pronounces the letter 's'.

The production of 'ch' and 'j' sounds also brings the anterior teeth close together. When correctly placed, the lower incisors should move forward to a position nearly directly under and almost touching the upper central incisors (Fig. 6.47).

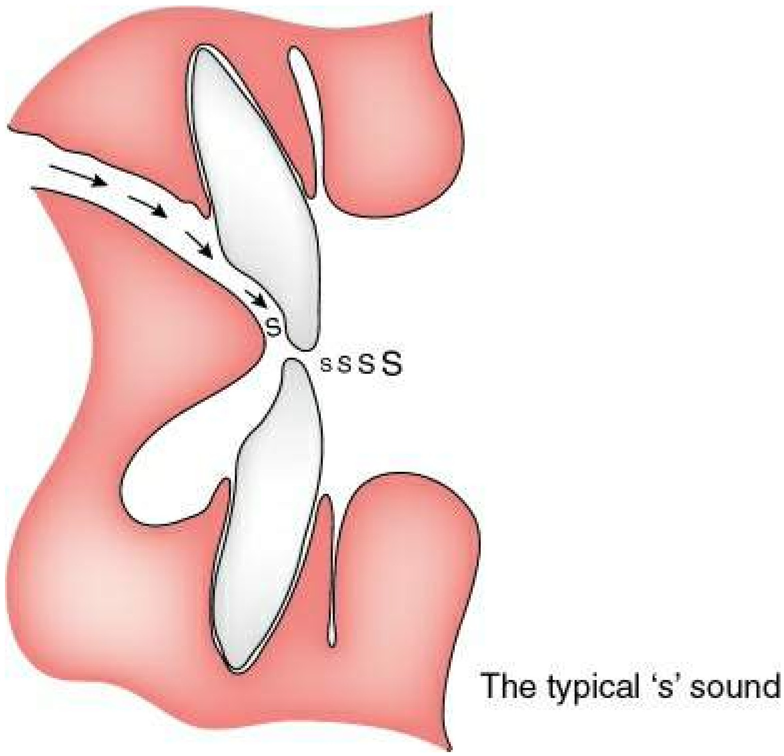


FIGURE 6.47 Closest speaking space. Position of the anterior teeth govern the vertical separation between them during pronunciation of ‘ch’, ‘s’ and ‘j’. Incorrect positioning will result in obliteration or opening of this space (closest speaking space) which will result in altered pronunciation of these words.

If the distance is too large with any of the above methods, it means that too small a vertical dimension of occlusion may have been established. If the anterior teeth touch or click together when these sounds are made, the VD is probably too great.

(iv) Neuromuscular perception

- **Central bearing device (tactile sense):** This utilizes the tactile sense of the individual to establish the vertical dimension. An adjustable central bearing screw is attached to one of the rims and a central bearing plate is attached to the other rim. The central bearing screw is first placed such that it is obviously too long or vertical dimension is increased. Progressively the screw height is reduced till the patient indicates that the jaws are overclosing (reduced vertical dimension). Finally the screw is adjusted until the patient indicates that the length is comfortable. The problem with this method is the presence of foreign objects in the palate and restriction of tongue space.

- **Power point (maximum biting force):** Boos (1940) demonstrated that the maximum biting force in an individual is registered at vertical dimension at rest. The method involved attaching a pressure indicating gauge which displayed the biting pressure, to a central bearing plate and screw on the occlusal rims as previously described. The device is called bimeter and the maximum biting point is termed as **power point**. The screw is adjusted to increase or decrease the vertical dimension and the bite force is recorded with each insertion (Fig. 6.48). Boos stated that the vertical dimension of occlusion is the rest position or maximum force minus 2 mm.

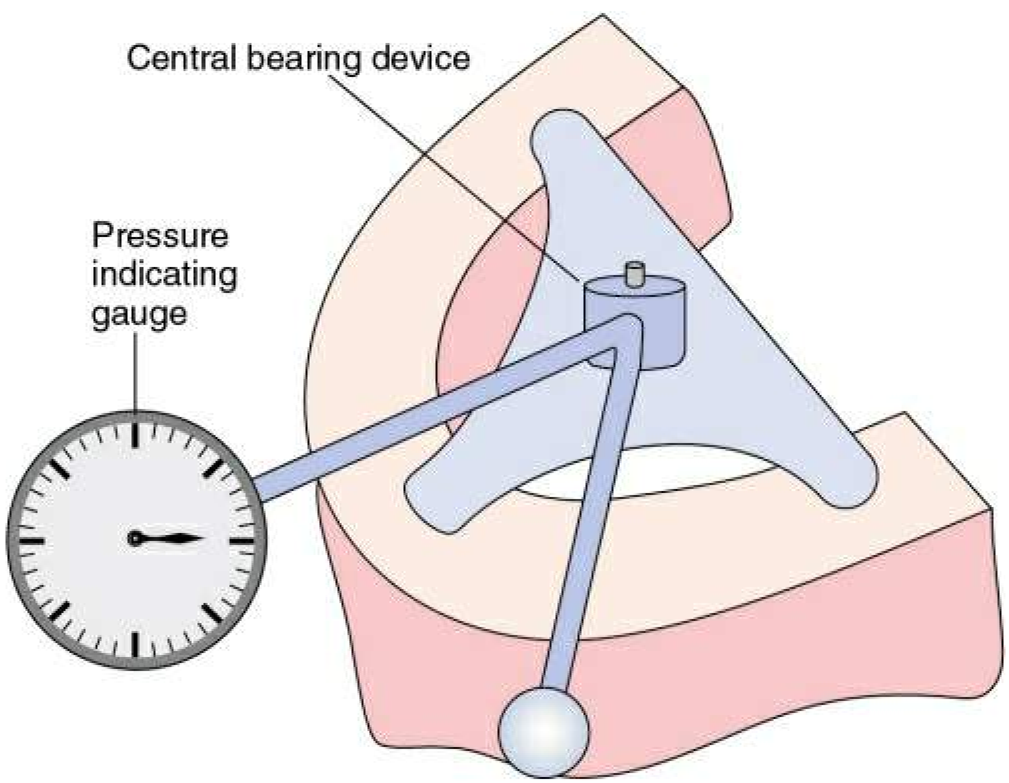


FIGURE 6.48 Bimeter used to determine the bite force and thereby the vertical dimension.

(v) Aesthetics

The vertical dimension also affects aesthetics. When the vertical dimension is increased, the skin of the lips appears stretched compared to the skin over other parts of the face (Fig. 6.49). The skin appears more flaccid with a decreased vertical dimension. The contour of the lips is also distorted with a change in vertical dimension. The same problems can also occur if the labial contour of the occlusal rims is incorrect. Hence, the labial contour of the occlusal rims should be first developed and verified individually before evaluating the vertical relations.

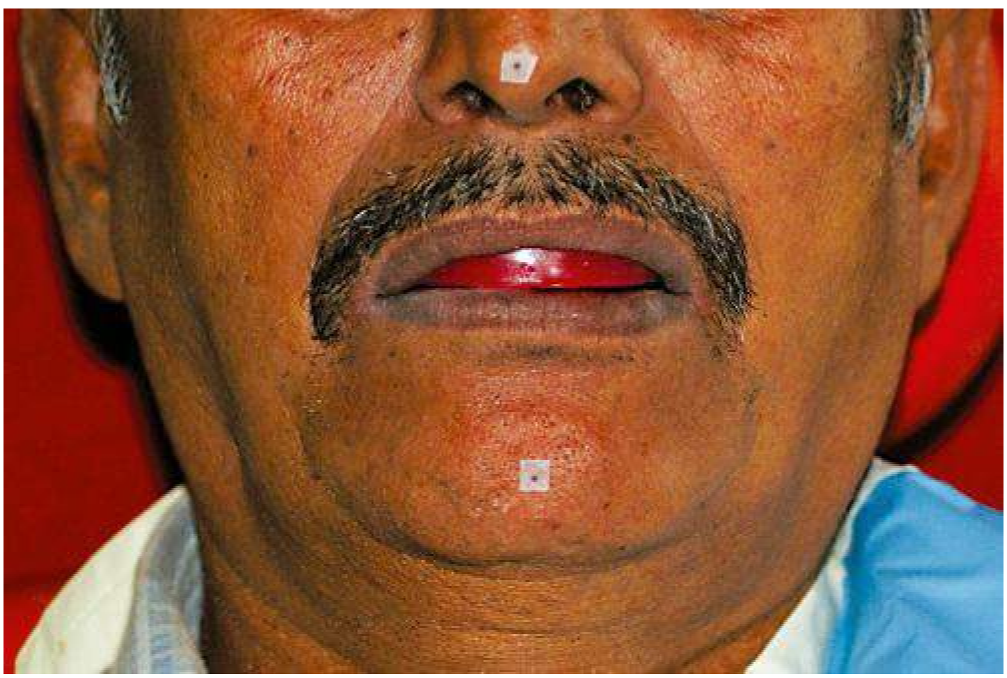


FIGURE 6.49 Aesthetics affected due to increase in vertical dimension. The same is also true for a decreased VD.

2. *Mechanical methods*

(i) Ridge relations

- **Incisive papilla to mandibular incisors:** The incisive papilla is a stable landmark whose position changes very little with resorption of the alveolar ridge. The distance of the papilla from the incisal edges of the mandibular anterior teeth should be on an average, approximately 4 mm in CO (Fig. 6.50). This is again just a guide to verify the vertical dimension and should be used with caution in patients with severe resorption.

- **Ridge parallelism:** Parallelism of the maxillary and mandibular ridges with a 5° opening in the posterior region provides a guide of appropriate vertical dimension. Since the clinical crowns of the anterior and posterior natural teeth have similar lengths, their removal makes the residual alveolar ridges nearly parallel to each other. However, in most people the teeth are lost at different times, and when a person finally becomes edentulous, the residual ridges may no longer be parallel.

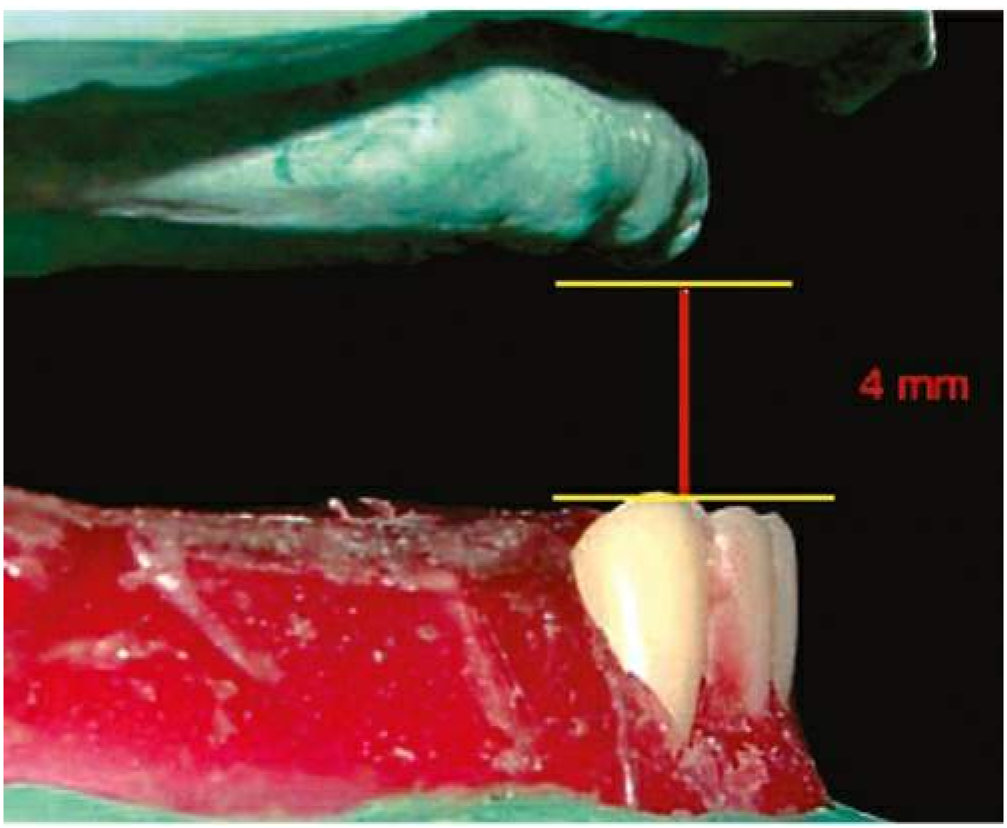


FIGURE 6.50 Maxillary and mandibular casts showing

relationship of incisive papilla to mandibular incisors.

(ii) Pre-extraction records

These records can be prepared prior to the extraction of teeth and can be used as a guide to verify the vertical dimension of occlusion during the fabrication of complete dentures.

- **Profile photographs:** Photographs are made of the facial profile when the teeth were present, in occlusion (Fig. 6.51). These are enlarged to a life size and similar photographs are made during recording of jaw relations with the rims in occlusion. Distance between similar anatomic landmarks on the photographs taken when the teeth were present and during jaw relation is compared. This allows verification of occlusal vertical dimension.

- **Profile silhouettes:** The facial profile of a patient with natural teeth in occlusion before extraction can be carved out in a cardboard or contoured in a wire. The same can be placed on the face when the occlusal vertical dimension is being recorded with occlusal rims in position. This also allows verification of the vertical dimension.

- **Radiographs:** Cephalometric radiographs and radiographs of condyles in fossa have been used similar to previous methods before extraction and during recording jaw relations to verify the vertical dimension. Because of radiation hazards and inaccuracies, they are now avoided.

- **Articulated cast:** Casts are mounted before extraction and following the recording of the edentulous jaw relation in CR. The interarch distance is compared between the two casts to verify accuracy of vertical dimension.

- **Facial measurements:** Tattoo marks are placed, one in the upper half and other on the lower half of the face (Fig. 6.52). The vertical distance between the marks is measured with the teeth in occlusion before extraction. The measurement is compared with the occlusal rims in position during jaw relation procedure to determine occlusal vertical dimension.

FIGURE 6.51 Profile photograph used for pre-extraction records. It is enlarged to a life size and compared to similar

photograph taken with occlusal rims in mouth.

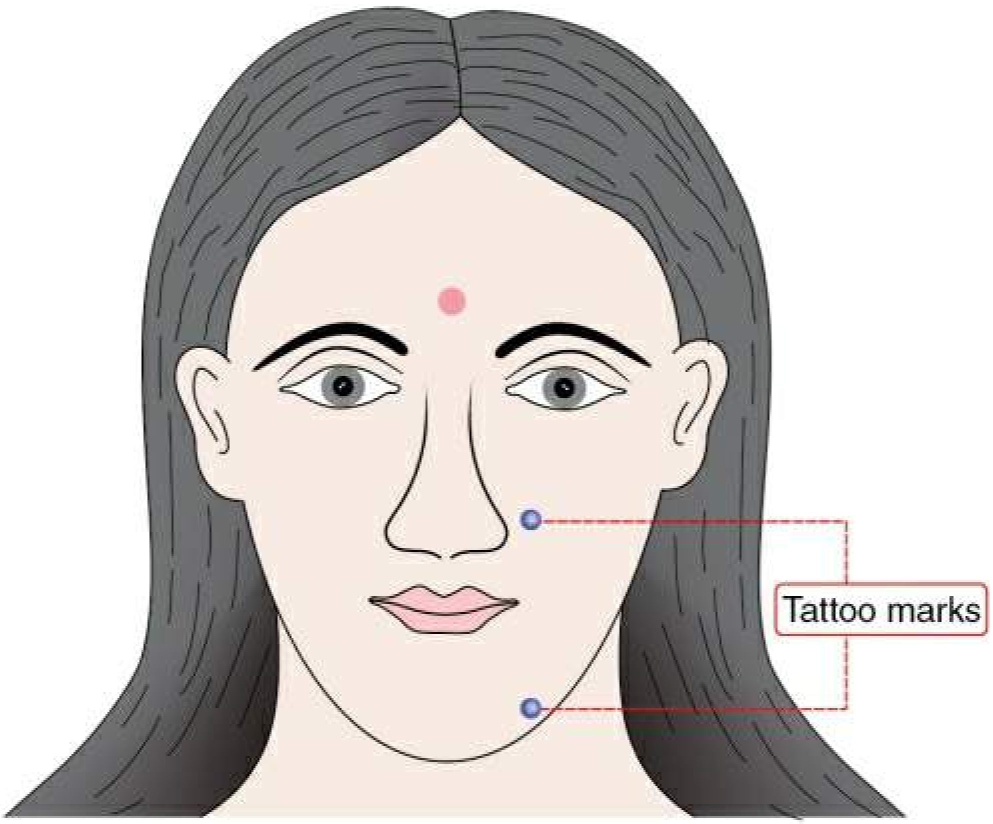


FIGURE 6.52 Tattoo marks placed in the upper and lower half of face before extraction of teeth enable verification of vertical dimension following extraction.

(iii) Measurement of former dentures

The old dentures are placed in the mouth and using facial measurements the vertical distance is measured. This can be done during the jaw relation appointment for the new dentures. This again can only be used as a guide to establish the vertical dimension for the new dentures as there could be loss of vertical dimension with the old dentures due to ridge resorption and wear of the artificial teeth.

Effects of increase in vertical dimension

1. **Discomfort**: Chewing is a muscular mandibular movement, acquired over a period of many years, which the patient performs automatically and unconsciously. Increasing the vertical dimension alters the environment in which these unconscious movements take place and until the original condition is restored, discomfort will result. The jarring effect of teeth coming into contact sooner than expected also causes discomfort.

2. **Trauma**: The sudden and frequent contacting of teeth causes trauma to the denture-bearing area, especially under the lower denture, where the area to resist pressure is less. Correcting the fitting surface of the denture will typically not solve the problem.

3. **TMJ problem**: The constant tooth contact will also affect the TMJ causing soreness and pain.

4. **Bone resorption**: The increased vertical height does not allow the muscles that close the mouth to complete their contraction. They will continue to exert force to overcome this obstruction and this will lead to resorption of supporting tissues.

5. **Muscular fatigue**: Due to the constant effort of the muscles to close the mouth, muscular fatigue will also occur.

6. **Clicking of teeth**: The premature contact of teeth sooner than what the individual is used to, will cause clicking of teeth.

7. **Facial distortion**: There will be an inability to close the lips, which will produce a strained expression and elongation of face.

8. **Difficulty in swallowing and speech**: The inability to close the lips will also cause difficulty in swallowing and speech.

Effects of decrease in vertical dimension

1. **Inefficiency**: The biting force exerted by the teeth in occlusion

decreases which causes inefficient mastication.

2. **Cheek biting**: The loss of muscle tone and reduced vertical height causes the flabby cheeks to become trapped during mastication.

3. **TMJ problem**: The patient has to often protrude the mandible to occlude the teeth and this causes pain and clicking in the TMJ.

4. **Facial distortion**: The following effects are seen:

- Nose appears closer to the chin
- Loss of lip fullness
- Loss of tonicity of muscles of facial expression
- Face appears flabby
- Patient appears older (Fig. 6.53)

5. **Angular cheilitis**: The corners of the mouth form deep folds, which are bathed in saliva. This becomes infected and sore (also see Fig. 3.9, Chapter 3).

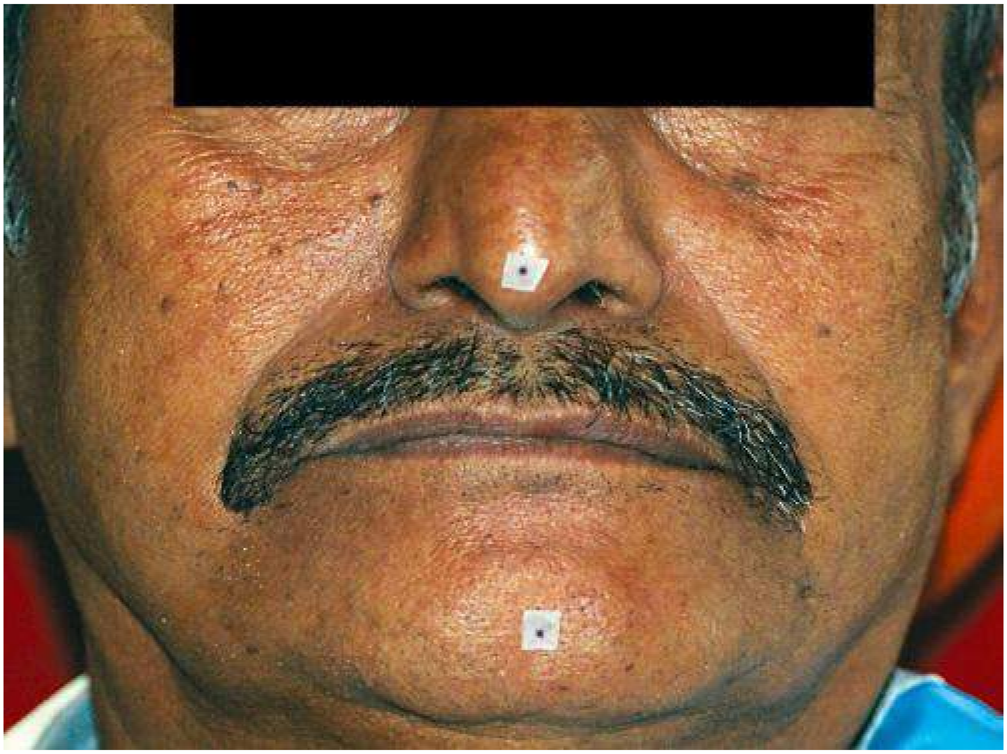


FIGURE 6.53 Effects of a reduced vertical dimension on facial appearance.

There is no single method to determine the vertical dimension. It has to be evaluated using the various methods as discussed. All determination of the vertical dimension must be considered tentative until the teeth are arranged. During try-in, the vertical relation should again be assessed.

Horizontal jaw relations

Following the orientation of maxilla and determination of vertical dimension, the final relation to be recorded is the horizontal relation. This is the anteroposterior relation of the mandible to the maxilla in the horizontal plane.

The horizontal relations can be classified as:

- Centric relation
- Eccentric relations – protrusive and lateral.

Centric relation

Definitions

1. The maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in the anterior–superior position against the slopes of the articular eminencies. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superiorly and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis (GPT5).

2. The most retruded physiologic relation of the mandible to the maxillae to and from which the individual can make lateral movements. It is a condition that can exist at various degrees of jaw separation. It occurs around the terminal hinge axis (GPT3).

Maximal intercuspal position (MIP): The complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position, is also called maximal intercuspation.
Centric occlusion (CO): The occlusion of opposing teeth when the mandible is in CR. This may or may not coincide with the MIP.

- CR is a bone-to-bone relation, while MIP and CO are tooth-to-tooth relation.

- Definitions of CR have been constantly modified in prosthodontic literature. The first definition given above is what is currently advocated. The second one has been used previously and various other definitions have also been documented (GPT8). The current definition throws light on the position of the condyle in the fossa, which is clinically not significant while recording CR. The most retruded position is also not acceptable as this position requires the operator to use force to obtain and may not be a comfortable position for the individual.

• It can be assumed that the CR is certainly a posterior border position or retruded position (may be not the most retruded), independent of tooth contact, which is comfortable, repeatable and recordable for the patient and allows easy access to all other eccentric positions of the mandible.

Significance of CR

CR is the most important record to obtain for complete denture construction because of the following reasons:

1. **CR and MIP:** In natural dentition, the MIP may not coincide with CR. But this does not create any damage as the proprioceptive receptors present in the periodontal ligament direct the mandible away from deflective occlusal contacts present in CR into MIP. So a memory pattern is established which allows the mandible to move from CR to MIP and back without any interference and damage.

In completely edentulous individuals, these receptors are lost along with the teeth. So they cannot avoid deflective contacts in CR. This will cause movement of denture base, displacement of supporting tissues and direct the mandible away from its path. *Hence, MIP must coincide with CR in completely edentulous individuals.*

2. **CR and transverse horizontal axis:** The maxillary cast is oriented to the hinge axis or transverse horizontal axis using a facebow transfer. As already discussed, this axis is a posterior border position and hence the facebow record was made in CR. *Hence, the mandibular cast will also be correctly oriented to the opening axis of the articulator only if it is mounted in CR.*

3. **CR and vertical relation:** CR position changes with variations in

vertical dimension. The deleterious effects of increase or decrease in vertical dimension have already been discussed. *Hence, the CR must be recorded at the established vertical dimension, which is normal for the individual.*

4. **Reproducible:** Since it is a border position, it can be recorded, reproduced and verified over a period of time. It is a learned position to which the patient can voluntarily and reflexly return.

5. **Comfortable:** The mandible returns to this position during all its functional movements, and hence it is convenient and comfortable.

6. **Easy excursion:** This posterior reference position allows easy access to all other excursive positions.

7. **Conducive to health:** Pain and lack of occlusal integrity and instability have been associated with complete dentures not fabricated with MIP in CR.

Retruding the mandible

Methods: To record CR, the mandible must be retruded. The various methods of retruding the mandible can be classified as:

Passive methods

The mandible is retruded by the patients themselves, following the dentist's instructions without any physical participation by the dentist. The patient is instructed to

1. Relax, pull the jaw back and close on the back teeth.

2. Get the feeling of pushing the upper jaw out and close on back teeth.

3. Touch the posterior part of the upper denture with tongue and close till the rims contact.

4. Swallow and close.

5. Tap the occlusal rims together repeatedly and rapidly.

6. Tilt the head back while performing the above exercises.

7. Protrude and retrude the mandible repeatedly holding his/her fingers lightly against the chin.

Active methods

The patient is guided to retrude the mandible with physical assistance from the dentist.

1. The dentist places his thumb and forefinger on the patient's chin to exert a mild but firm posterior force while patient closes on the rims. This will prevent the patient from moving the jaw anteriorly (Fig. 6.54A).

2. Dentist palpates the temporal and masseter muscles to relax them.

3. Dawson's bimanual palpation – the dentist stands behind the patient and places all four fingers of both hands on the lower border of the mandible on either side. The thumbs are placed over the symphysis such that they contact in the midline (Fig. 6.54B). The patient is instructed to open the mouth and then close slowly. As the patient closes, dentist applies an upwards lifting force with the fingers on the inferior border and simultaneously applies a downward force with the thumbs (Fig. 6.55). This guides the patient to close in CR.

Difficulty: Difficulties in retruding the mandible can be classified as:
Biological causes

• Lack of muscle coordination in opposing groups

• Patient closing habitually in a protruded relation

Psychological causes

• Patient unable to follow the dentist's instructions due to anxiety and stress

Mechanical causes

- Poor adaptation of record bases

FIGURE 6.54 **(A)** Active method of retruding mandible. **(B)** Dawson's bimanual palpation – position of fingers.

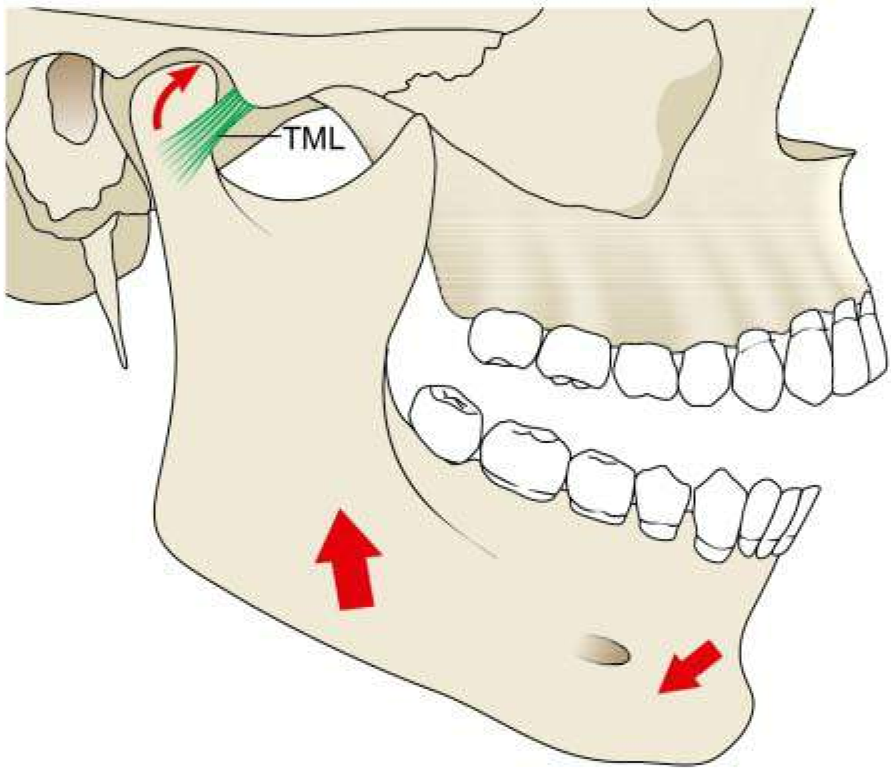


FIGURE 6.55 Dawson's bimanual palpation – direction of force application.

Recording the centric relation

After establishing the vertical dimension, the mandible is oriented to the maxilla in the horizontal relation using centric and eccentric records. The record is transferred to the articulator so that the artificial teeth can be arranged to harmonize with the patient's mandibular movements.

Requirements of CR record

1. To record correct horizontal relation of mandible to maxilla.

2. To exert equalized vertical pressure.

3. To remain undistorted till mounting on articulator.

Methods used to record CR

1. Static methods: These methods are employed without the use of functional or excursive mandibular movements. They have been referred to as 'tentative centric record'.
Advantages:

- Simple, no extra armamentarium or devices are required.
- Can be recorded in one appointment.

Disadvantages:

- Inaccuracy can result from lack of equalized pressure.
- Difficult to verify the accuracy of the record.
- Not as accurate as graphic method.

(i) Wax occlusal rims:

- One of the most commonly used methods to record CR.
- The wax occlusal rims are contoured (as described in chapter 5) and the vertical dimension of occlusion is established ensuring even contact of the maxillary and mandibular rims anteriorly and posteriorly.
- The patient is trained to retrude the mandible (using one of the methods previously described). The various 'guidelines' are marked (as described in chapter 5) and the patient is asked to close in centric and hold the position.
- The rims are joined or sealed in this position and then removed from the mouth and articulated.
- The following methods can be used to seal the rims:

○ *Heat:* A hot wax knife can be used to melt and flow the wax at the junction of the rims. Care must be taken to avoid heating the lips and cheeks by adequately protecting and retracting them. The knife should not be hot enough to cause the wax to run (Fig. 6.56).

- *Pinning:* The occlusal rims can also be sealed together using pins. Slightly warm metal staples can be used to join the sides of the rims (Fig. 6.57).

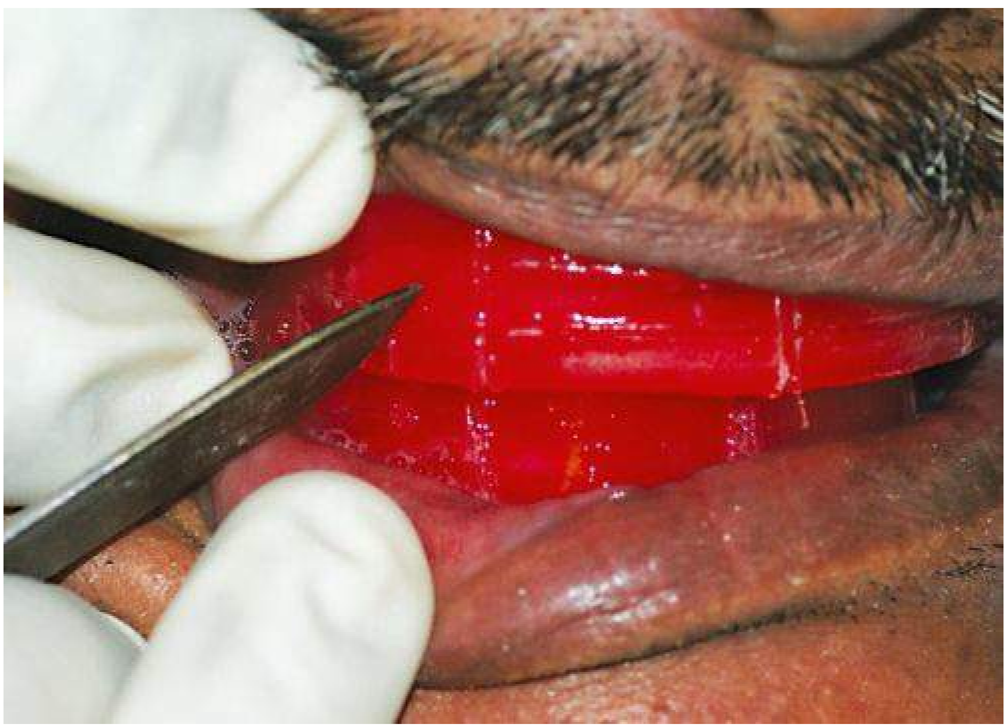


FIGURE 6.56 Heated wax knife used to fuse the occlusal rims.

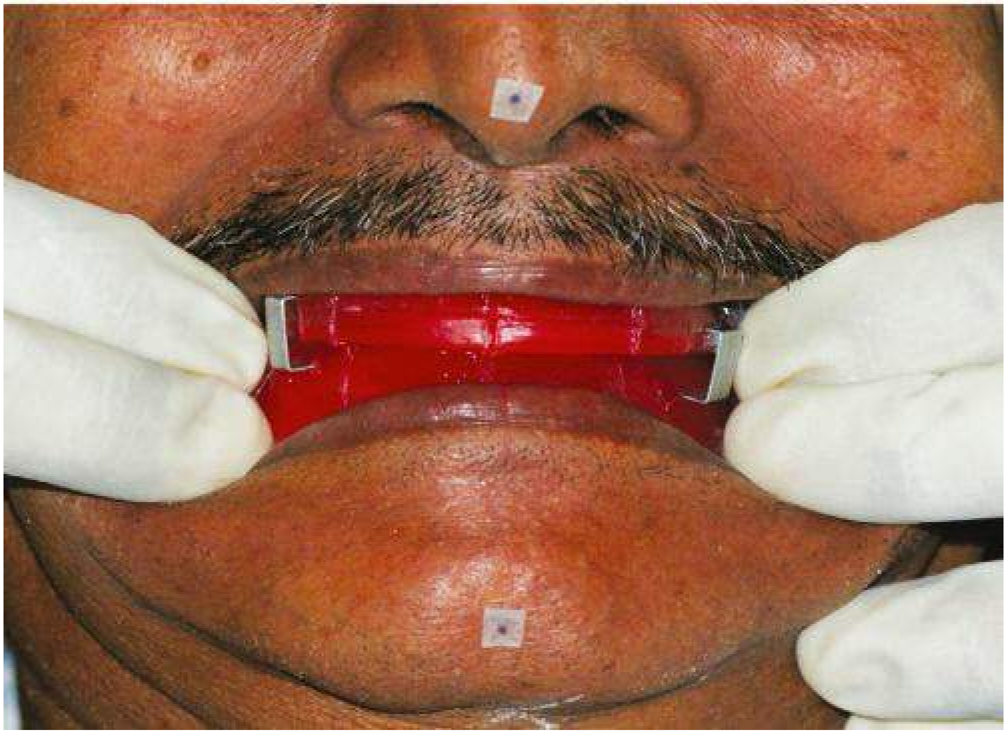


FIGURE 6.57 Stapler pins used on both sides to join the occlusal rims together.

In both the above methods, pins can also be placed on the mandibular rim in the premolar area protruding not more than 2 mm above the occlusal surface, to prevent movement of the bases while sealing.

○ The above methods of sealing are not recommended due to:

▪ Chances of burning and injuring lips and cheek.

▪ No equalization of pressure.

▪ Difficult to prevent movement of rims while sealing.

○ *Nick and notch method:* This is the recommended method for sealing the rims as there is less resistance to closure and the movement during sealing is tackled. After the rims are evened, V-shaped notches are then placed in the molar region of the maxillary occlusal rim to prevent anteroposterior movement. A nick is cut anterior to the notch in the premolar regions, not extending throughout the width of the occlusal rim, to prevent the lateral movement.

- A trough is created in the posterior regions of the mandibular occlusal rims (Fig. 6.58).
- The patient is trained to retrude and close at CR position.
- Soft wax, zinc oxide eugenol impression paste, quick setting plaster and elastomeric bite materials may be used as interocclusal record materials.
- The recording material is loaded in the trough created on the mandibular rim (Fig. 6.59A). Occlusal rims are inserted in the patient's mouth and the patient is instructed to retrude and close. Contact should be observed in the maxillary and mandibular rims anteriorly.
- Once the intervening recording material sets, the rims get sealed and are removed together (Fig. 6.59B).

(ii) Interocclusal check records:

- As the name suggests, these records are used to verify the centric jaw relation at the time of try-in or denture insertion. They are also used to check the occlusion of teeth in existing dentures.

- These are also called ‘physiologic’ methods as the patient’s proprioception and tactile sense is essential in the making of an accurate record.
- The same recording mediums used for static registrations can also be used for this procedure.
- After the occlusal rims have been articulated with a static record, the artificial teeth are arranged and a trial denture is fabricated.
- At the time of try-in (or denture insertion) if the dentist feels the need to verify the CR, then this procedure is adopted.

▪ Patient is asked to rehearse retruding the mandible.

▪ The maxillary trial denture is inserted in the patient’s mouth. The recording medium like aluwax is loaded onto the occlusal surface of the teeth in the mandibular occlusal rim (Figs 6.60 and 6.61).

▪ The patient is asked to slowly retrude the mandible and close on the wax till the tooth contact occurs (Fig. 6.62). They should not bite through the material. The recording material is allowed to set and the trial dentures are removed with the recording material.

▪ The maxillary trial denture is removed from the record and placed on the mounted maxillary cast in the articulator.

▪ The mandibular trial denture with the record is now returned to the mandibular cast on the articulator.

▪ The horizontal condylar guide locks in the articulator are released.

▪ The maxillary teeth are now seated over the record.

▪ If the previous recording of CR is the same as the check record, then both the condylar elements of the articulator will contact the centric stops, i.e. the articulated casts need not move to fit into the check records.

- If anyone or both of the condylar elements of the articulator does not contact the centric stops, it indicates that one of the records is inaccurate.

Indications: It may be advisable to make interocclusal check records to verify the CR in the following conditions:

- Abnormally related jaws
- Displaceable, flabby tissues
- Large tongue
- Uncontrolled mandibular movements

Factors affecting the success of interocclusal records:

- Uniform consistency of the recording material
- Accurate vertical jaw relation records
- Stability and fit of the record base

2. Functional method or chew-in method: These methods utilize the functional movements of the jaws to record the CR. The patient is asked to perform border movements such as protrusive and lateral excursive movements in order to identify the most retruded position of the mandible. All these methods require a static CR record mounted on the articulator to prepare the recording devices. The new occlusal rims with the recording devices are fabricated with an increased vertical height so that the correct dimension is established as patient performs functional movements and grinds down the recording medium. Very stable record bases are required. The functional methods are not very popular as graphic methods may be more accurate.

Advantages:

- Vertical dimension and CR can be determined.

Disadvantages:

- Inaccuracy can result from:
  - Displaceable basal seat tissues
  - Resistance of recording mediums
  - Lack of equalized pressure
- Patients must have very good neuromuscular coordination and be capable of following instruction.

(i) Needle–House method: Occlusal rims are fabricated from impression compound. Four metal balls or styli are embedded in the canine and molar areas of the maxillary occlusal rim. The occlusal rims are inserted and the patient is asked to perform various functional and excursive movements of the mandible with the styli contacting the lower rim. The vertical height is reduced as the styli cuts through the lower rim and the patient is stopped at the appropriate vertical dimension. The styli makes three-dimensional diamond-shaped tracings, which can be transferred to a suitable articulator (House articulator – discussed in Chapter 7) to duplicate the movements. The most anterior point of the marking denotes CR and can be used to mount on any articulator (Fig. 6.63).

(ii) Patterson method: Wax occlusal rims are fabricated. A trench or trough is made in the mandibular occlusal rim which is filled with equal mixture of carborundum paste and plaster (Fig. 6.64).

The occlusal rims are inserted and the functional mandibular movements will produce compensating curves in the plaster lower rim. As the vertical height reaches the appropriate level, the patient is asked to retrude his jaw and the occlusal rims are joined together with metal staples.

(iii) Meyer's method: Meyer used soft wax to generate the functional pathway and record CR.

3. Graphic methods: These methods are called so because they use graphs or tracings to record the centric jaw relation. Graphic methods are of two types namely:

- Gothic arch tracing
- Pantographic tracing

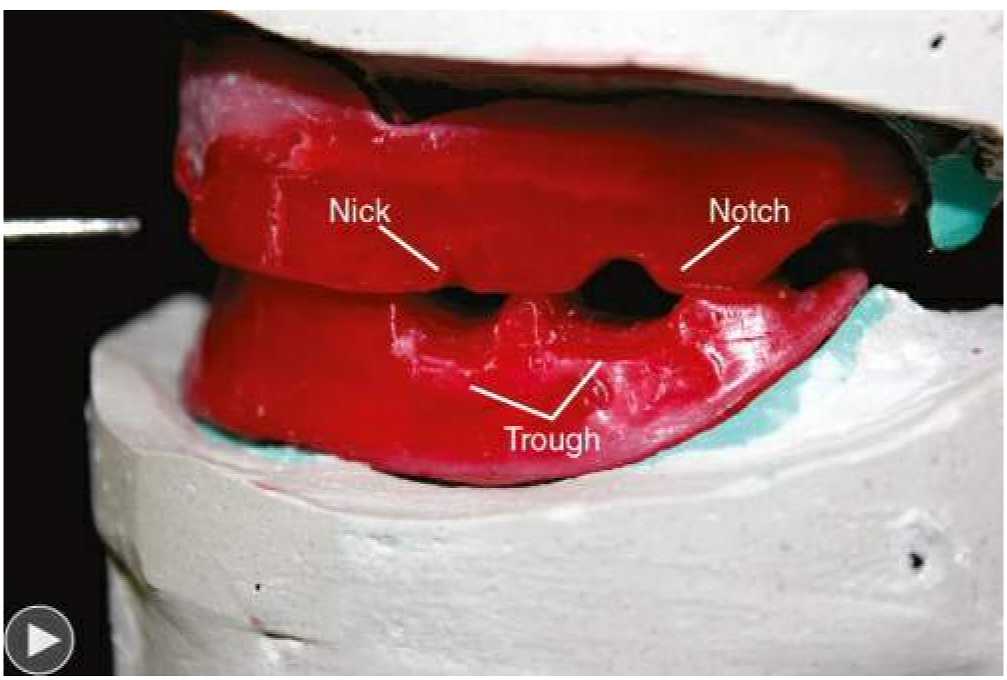


FIGURE 6.58 Nick and notch in the maxillary occlusal rim and a trough in the mandibular occlusal rim.

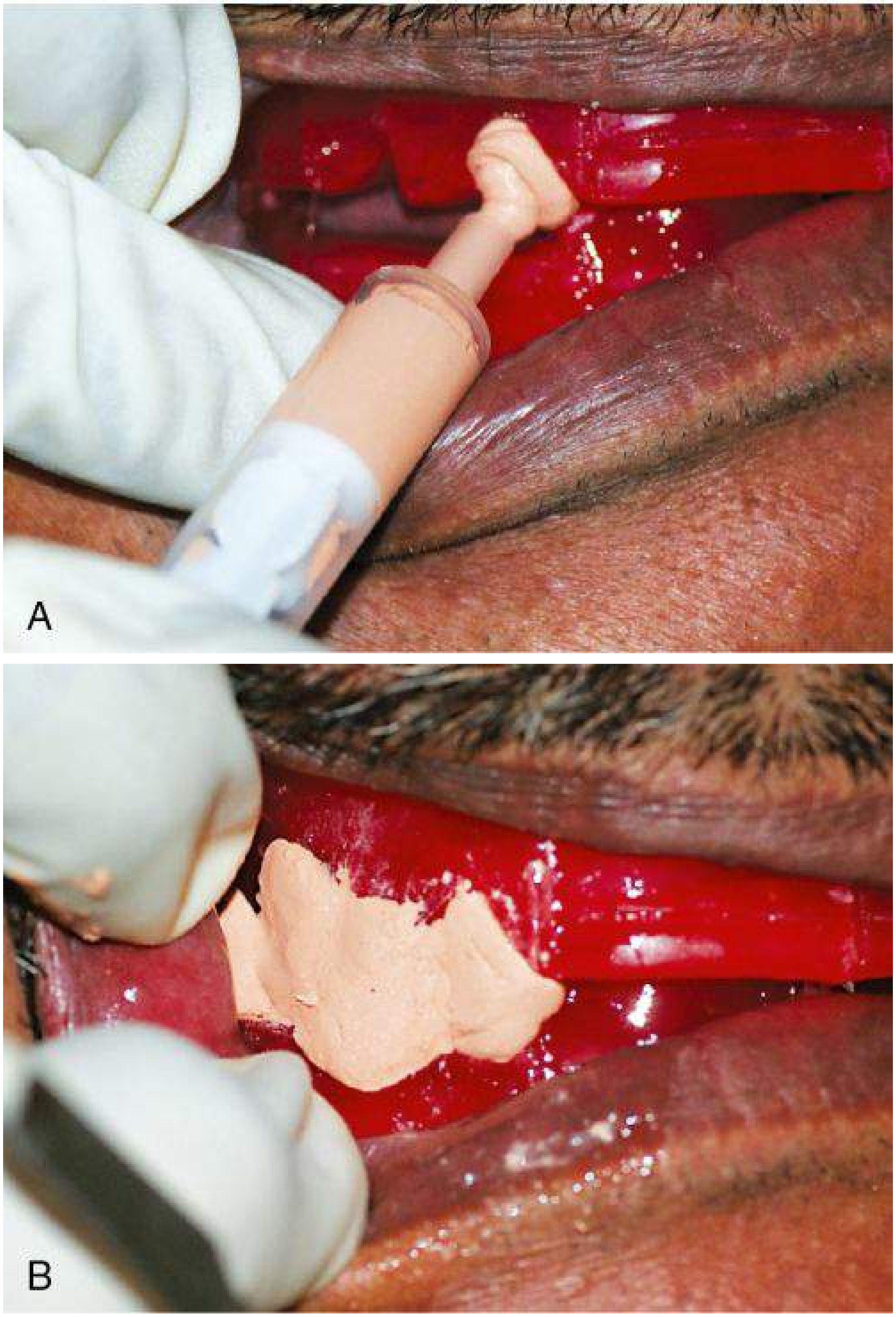


FIGURE 6.59 **(A)** Zinc oxide eugenol impression paste injected into the trough and nick and notch. **(B)** The occlusal rims are removed once the material sets.

FIGURE 6.60 Aluwax used to make the interocclusal check record.

FIGURE 6.61 Aluwax is softened and loaded on the occlusal surface of the mandibular trial denture.

FIGURE 6.62 The patient is asked to retrude the mandible and bite. Once the wax hardens, the assembly is transferred to the articulator and centric relation verified.

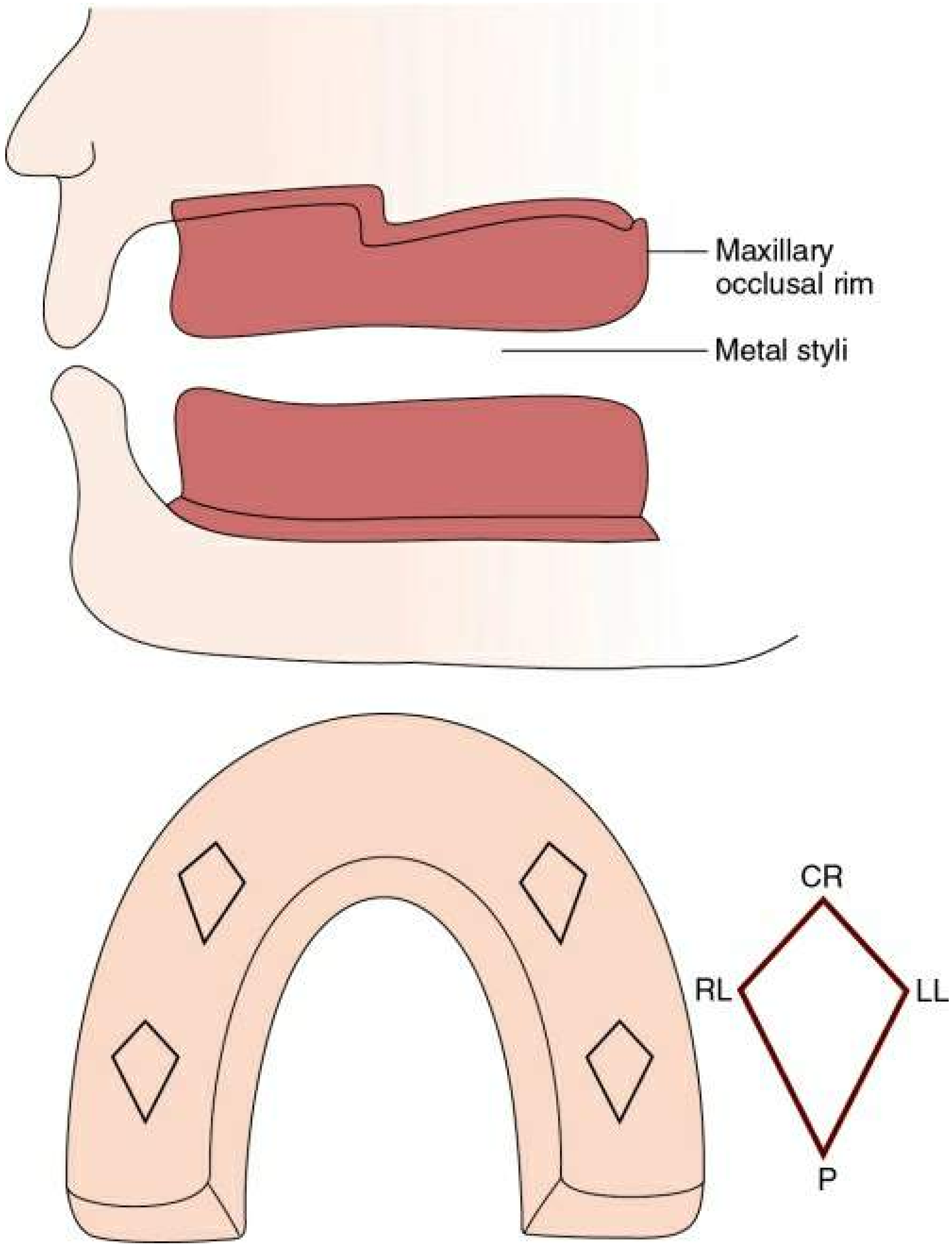


FIGURE 6.63 Needle–House technique: metal styli (on maxillary rim) cut diamond-shaped tracings on mandibular rim. P, protrusive; LL, left lateral; RL, right lateral; CR, centric relation.

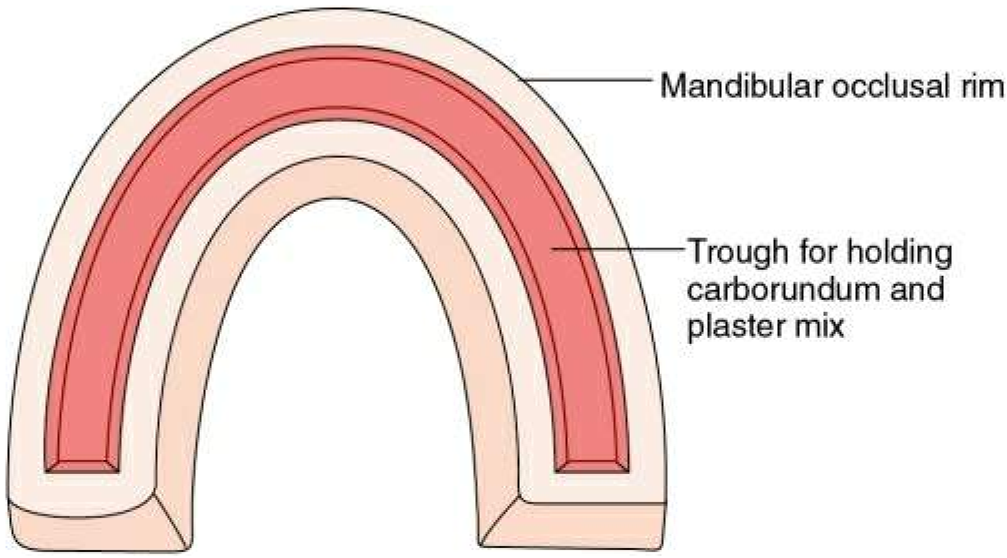


FIGURE 6.64 Mandibular occlusal rim with trough for holding carborundum and plaster mix.

Gothic arch tracings record mandibular movements in one plane (horizontal), while pantographs record it in all three planes.

(i) Gothic arch tracing:

- This concept was proposed by Hesse (1897) and popularized by Gysi (1910).
- This is also termed as 'arrow head tracing' or 'needle point tracing'.
- **Concept:** The concept consists of attaching a stylus (a writing device with a pointed end) to one occlusal rim and a plate to the other rim. The stylus traces or marks the path in the plate as the mandible performs excursive movements from the centric position. The tracing is typically in the shape of a 'gothic arch' or 'arrow head' if the patient is trained to move the mandible from centric to protrusive, right and left lateral positions (Fig. 6.65).
- **Components:** The tracing can be made intraorally or extraorally. The extraoral tracing device consists of a central bearing device and a tracing device. The central bearing device consists of a central bearing point and a central bearing plate. The tracing device

consists of a stylus and a recording plate. The stylus or stud and central bearing plate attached to the maxillary occlusal rim, while the central bearing point and recording plates are attached to the mandibular rim (Figs 6.66 and 6.67).

- In the intraoral tracer, the central bearing device also performs the function of a tracing device. So there is only one set of device (Fig. 6.68).

- Central bearing device is a very important aspect of the device. It should be placed in the geometric centre of the maxillary and mandibular arches to serve the following functions:

  - Maintains vertical dimension.

  - Equalizes the pressure by distributing the forces throughout the supporting tissues.

  - Allows mandibular movement to be dictated by the condyles.

- *Advantages:*

  - Documented to be the most accurate method of recording CR.

  - Allows equalization of pressure on the supporting tissues.

- Easily verifiable.
- Can also be used to record eccentric relations.

• *Disadvantages:*

- May be difficult to locate the centre of the arches which is very important for central bearing function and accuracy of tracing.
- More time consuming.
- Training patient in making mandibular movements is strenuous.

• *Indications:*

- Broad edentulous sides.
- Adequate interarch space.
- In patients with habitual centric (a more anterior position of the jaws due to prolonged edentulous period without tooth replacement), the use of the graphic method eliminates all occlusal contacts on the rims, thus breaking the neuromuscular reflex and allows the patient to record his true centric.

• *Contraindications:*

- Severely resorbed ridges and excessively flabby ridges as they lead to instability of denture bases.
- Decreased interarch space – difficult to place central bearing device without raising the vertical dimension.
- TMJ arthropathy.
- Abnormal jaw relations.

• *Procedure for extraoral tracing:*

- The maxillary cast is mounted on the articulator with a facebow transfer.
- The mandibular cast is oriented to the maxillary cast at the established vertical dimension with a static CR record.
- The condylar elements of the articulator are secured against the centric stops.
- The central bearing and tracing devices are mounted on the respective rims (Fig. 6.69).
- The patient is seated with head upright, in a comfortable position on the dental chair.

- The record bases with the attached devices are inserted in the patient's mouth. They are checked for stability, contact during mandibular movements and interference (Fig. 6.70).
- The stylus is retracted and patient is trained to make various excursive movements passively and actively (if needed). Patient is instructed to move the jaw forwards, right and left from centric position. The Ney Excursion Guide has been used as an aid in training the patient but patient responds better to specific locations than numbers (Fig. 6.71).
- When the patient is well trained in making the movements, the recording plate is coated with a thin coating of lacquer, precipitated chalk or dark coloured wax. The coating material should not provide any resistance to movement and produce a clearly visible tracing (Fig. 6.72).
- The stylus is made to contact the recording plate and the patient is instructed to make the specific movements.
- When an acceptable tracing is made with a single sharp apex, a centric record is obtained. The rims and tracing are prepared to receive the centric

record (Figs 6.73A and B). The patient is instructed to retrude the mandible such that the stylus contacts the apex of the tracing. Quick setting plaster is injected between the rims and allowed to harden (Fig. 6.74); thus, the centric record is obtained (Fig. 6.75A).

- ○ The rims are remounted on the articulator with the new record (Fig. 6.76).

- ○ The procedure with intraoral tracer is similar, but as the tracing is not visible while being made, a thin plastic disc with a central hole is fixed on the recording plate such that the hole is placed on the apex of the tracing. The patient closes with the tip of the stylus in the hole and this ensures that the patient closes in centric and maintains the position while the record is being made.

- *Troubleshooting:* The following are the commonly observed inaccuracies in tracings:

- ○ Apex absent/round:

- ▪ It indicates a weak retrusive movement.

- ▪ Patient needs more training in making the movements (Fig. 6.77).

○ Double arrow point:

▪ Indicates a habitual and retruded CR and an alteration in the vertical dimension during tracing.

▪ Patient requires training and vertical dimension should be checked and maintained by the central bearing device (Fig. 6.78).

○ Interrupted gothic arch:

▪ Usually due to posterior interference at the heels during movements (Fig. 6.79).

- Differences between extraoral and intraoral tracers are given in Table 6.3.

(ii) Pantographic tracings:

Pantograph: An instrument used to graphically record in, one or more planes, paths of mandibular movement and to provide information for the programming of an articulator (GPT8).
Pantographic tracing (pantogram): A graphic record of mandibular movement usually recorded in the horizontal, sagittal and frontal planes as registered by styli on the recording tables of a pantograph or by means of electronic sensors (GPT8).

- The pantograph is a device that records the movement in all three planes. The tracing is called a pantographic tracing or pantogram (Fig. 6.80A).

- To put it simply, it will consist of styli and recording plates placed in all three planes and the various jaw movements from centric position traced in all the planes (Fig. 6.80B). The recordings are transferred to a fully adjustable articulator, which is capable of accepting and reproducing these movements.

- This can also be used to record eccentric relations.
- Records are very accurate but procedure is complex.

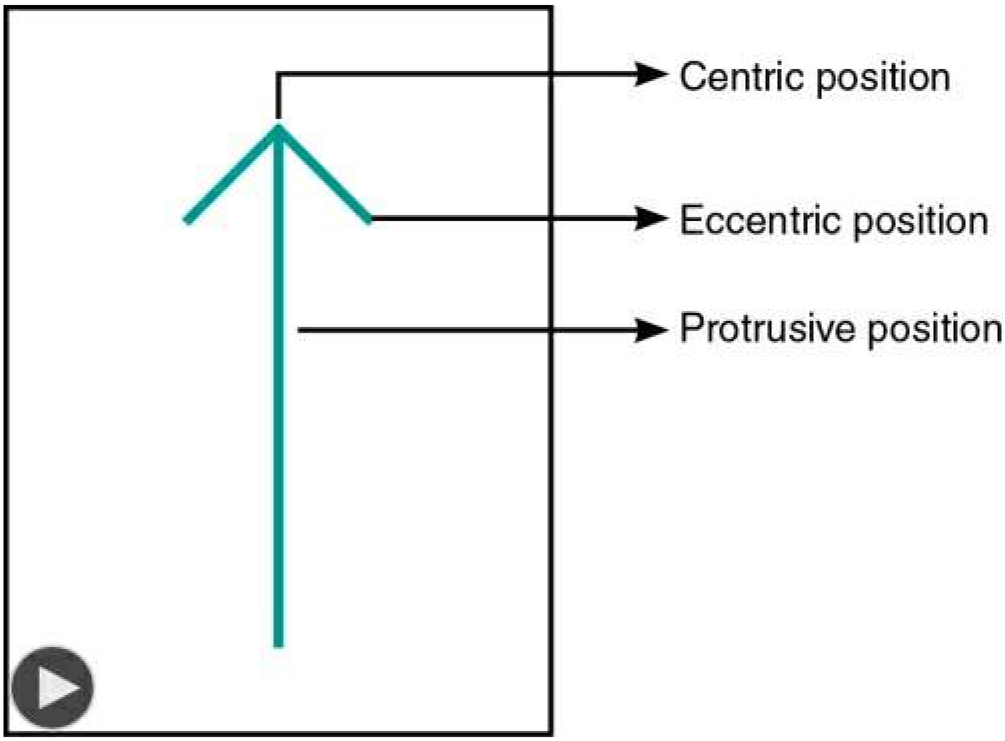


FIGURE 6.65 Drawing of the tracing showing centric and eccentric positions.

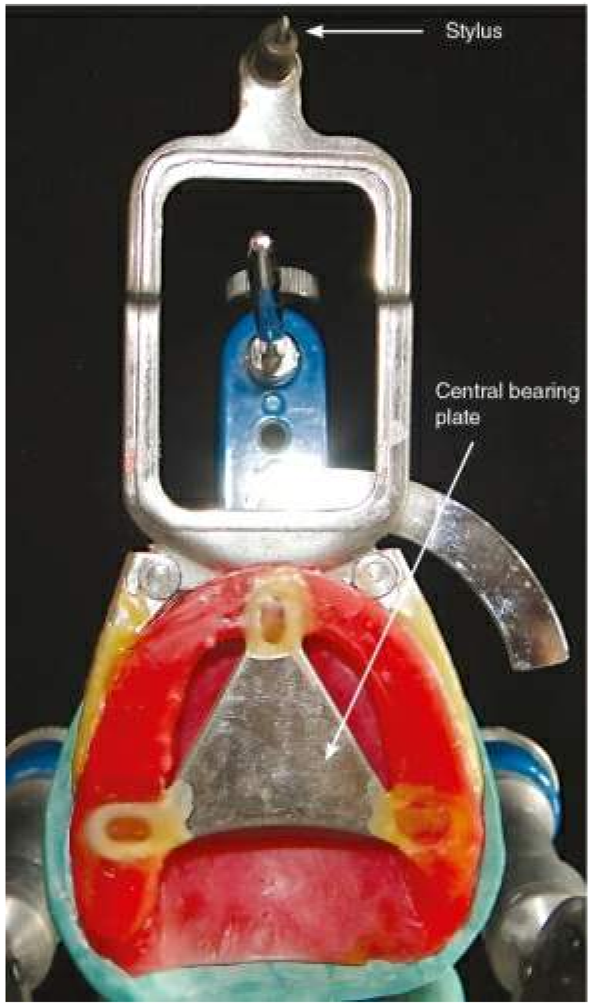


FIGURE 6.66 Extraoral tracer components – stylus (tracing device) and central bearing plate attached to the maxillary rim.

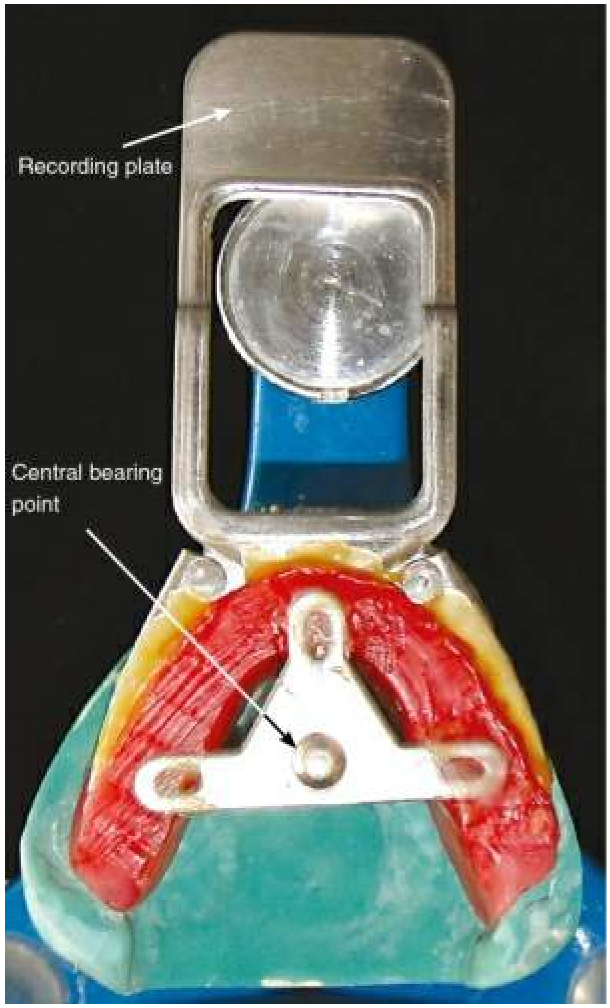


FIGURE 6.67 Extraoral tracer components – recording plate (tracing device) and central bearing point (central bearing device) is attached to the mandibular rim.

FIGURE 6.68 Intraoral tracer components: (a) Recording plate and central bearing plate are combined as one component and attached to maxillary rim. (b) The stylus and central bearing point are combined as one component and attached to the mandibular rim.

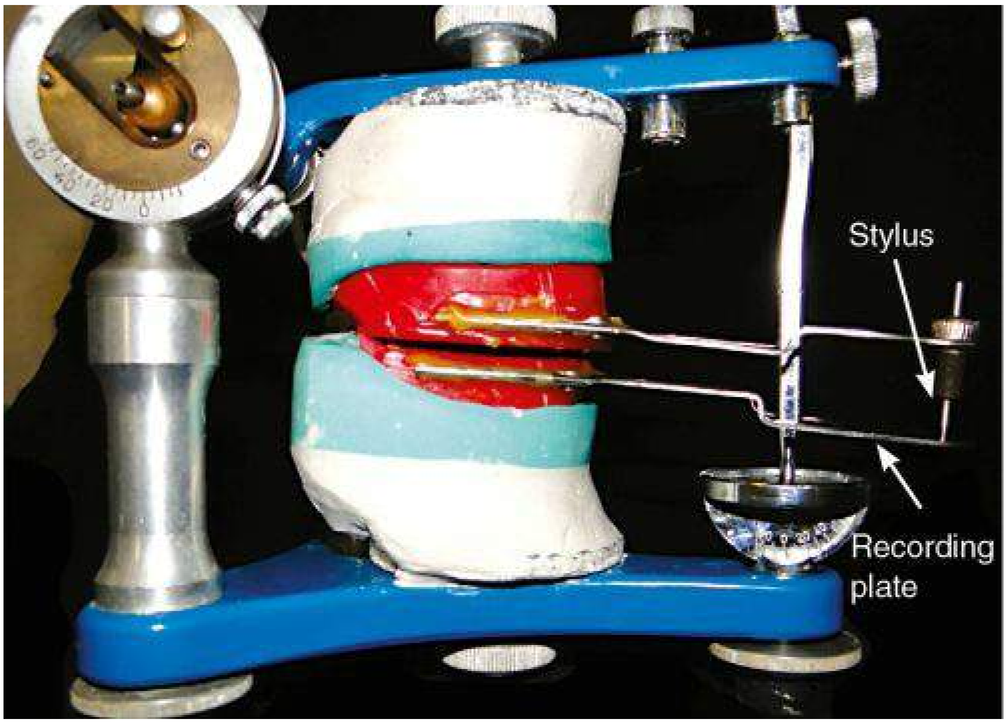


FIGURE 6.69 Extraoral tracers attached to articulated occlusal rims. The stylus must be in contact with the recording plate and the tracers must be mounted parallel to each other.

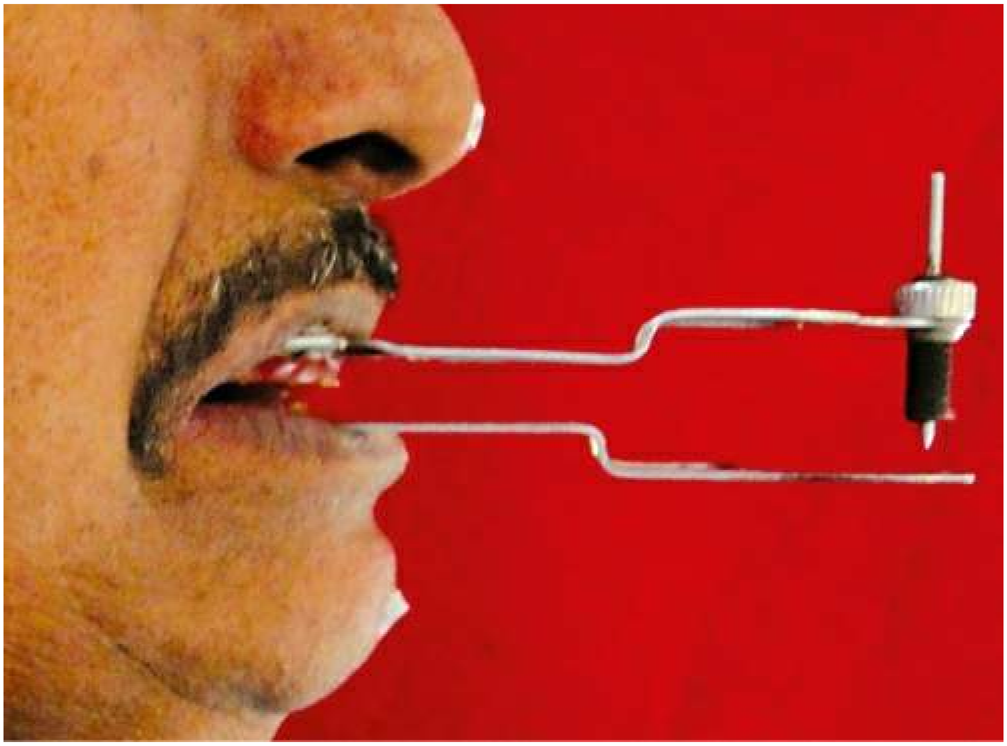


FIGURE 6.70 Occlusal rims with the extraoral tracer inserted in the patient's mouth.

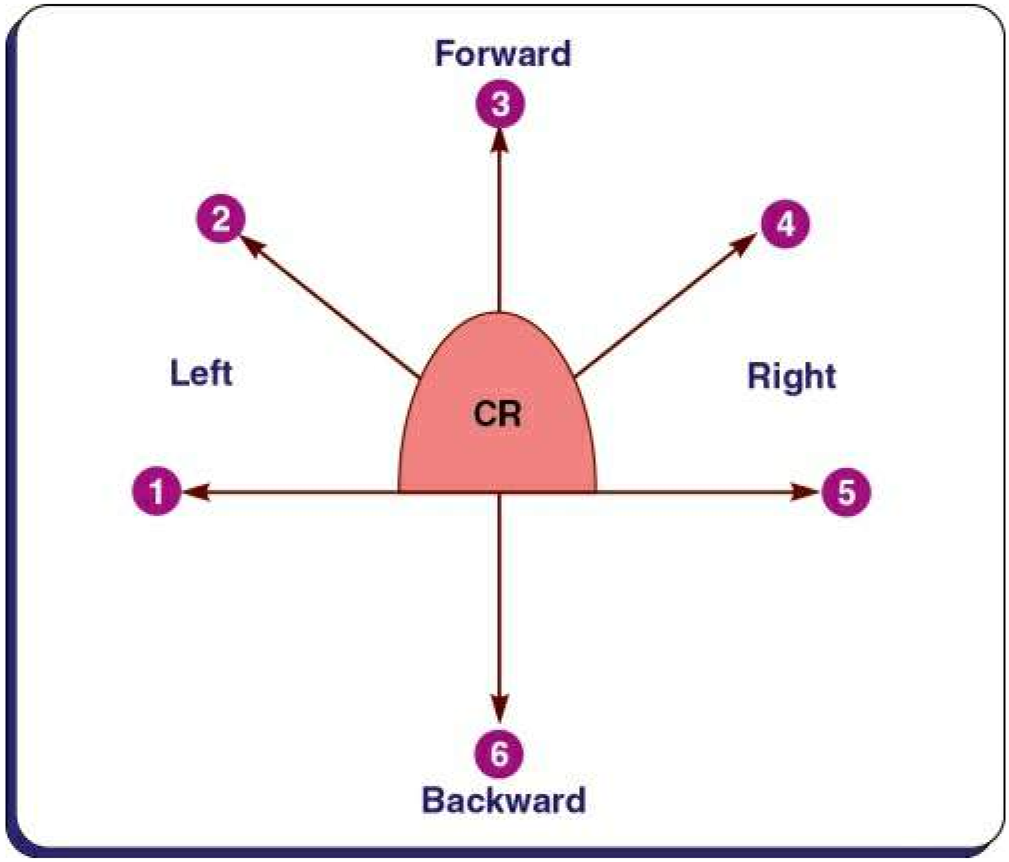


FIGURE 6.71 Ney Excursion Guide. The patient is trained to make the mandibular movements in the numerical order.

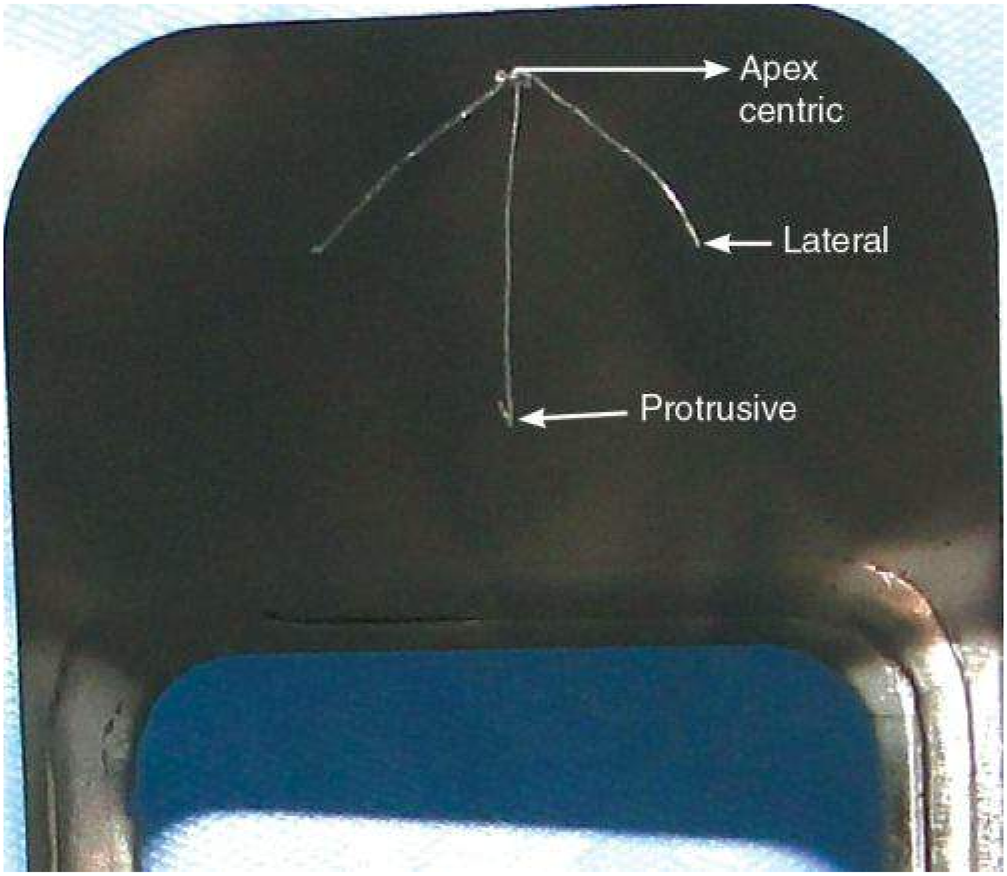


FIGURE 6.72 Characteristic arrow head tracing obtained in the recording plate coated with recording medium. For obtaining a centric record, patient is asked to close at the apex of the tracing.

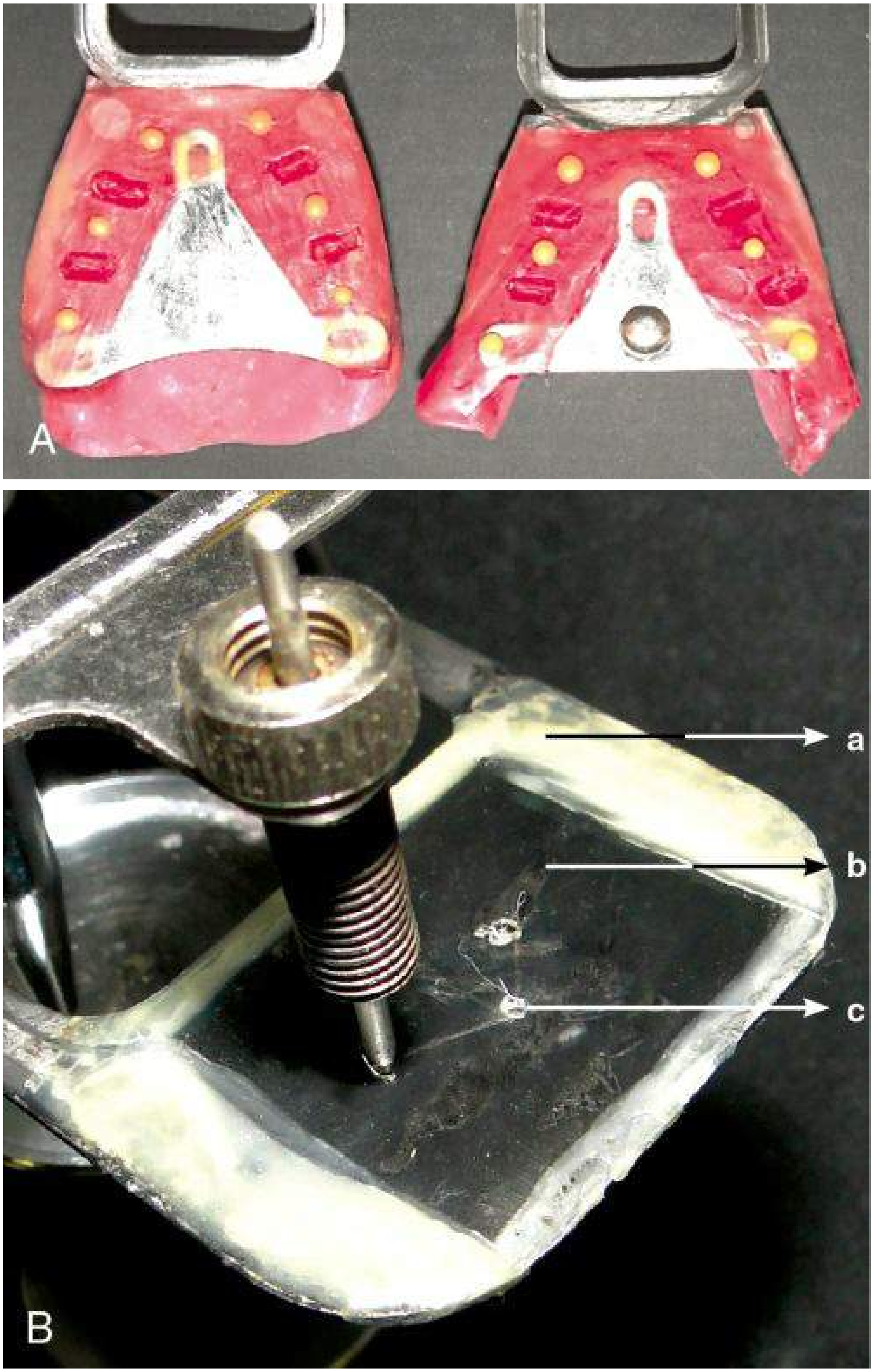


FIGURE 6.73 (A) Before making the records, the undercuts are blocked with wax and orientation grooves made in the wax. A repositioning guide can also be made with sticky wax.

(B) Before making the records, the tracing is protected by a transparent plastic film (b). This film is secured over the recording plate using sticky wax (a). The centric point of the arrow head is viewed and using a sharp heated needle, a hole is made (c) which will guide the needle in position while making records. 6 mm from the centric point, another slot is made, to stabilize the needle while making the protrusive record.

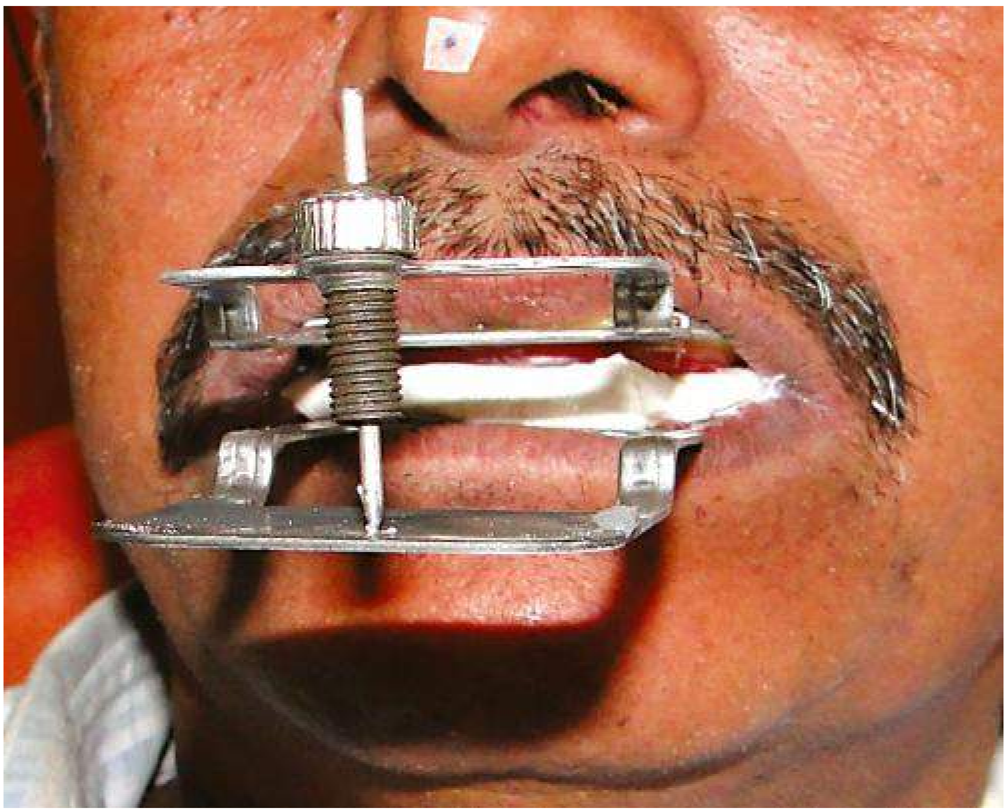


FIGURE 6.74 Patient is instructed to close in centric (contact of the stylus with the apex of the tracing is verified) and quick setting plaster is injected to make a centric record.

A B

FIGURE 6.75 Centric record **(A)** and protrusive record **(B)**.

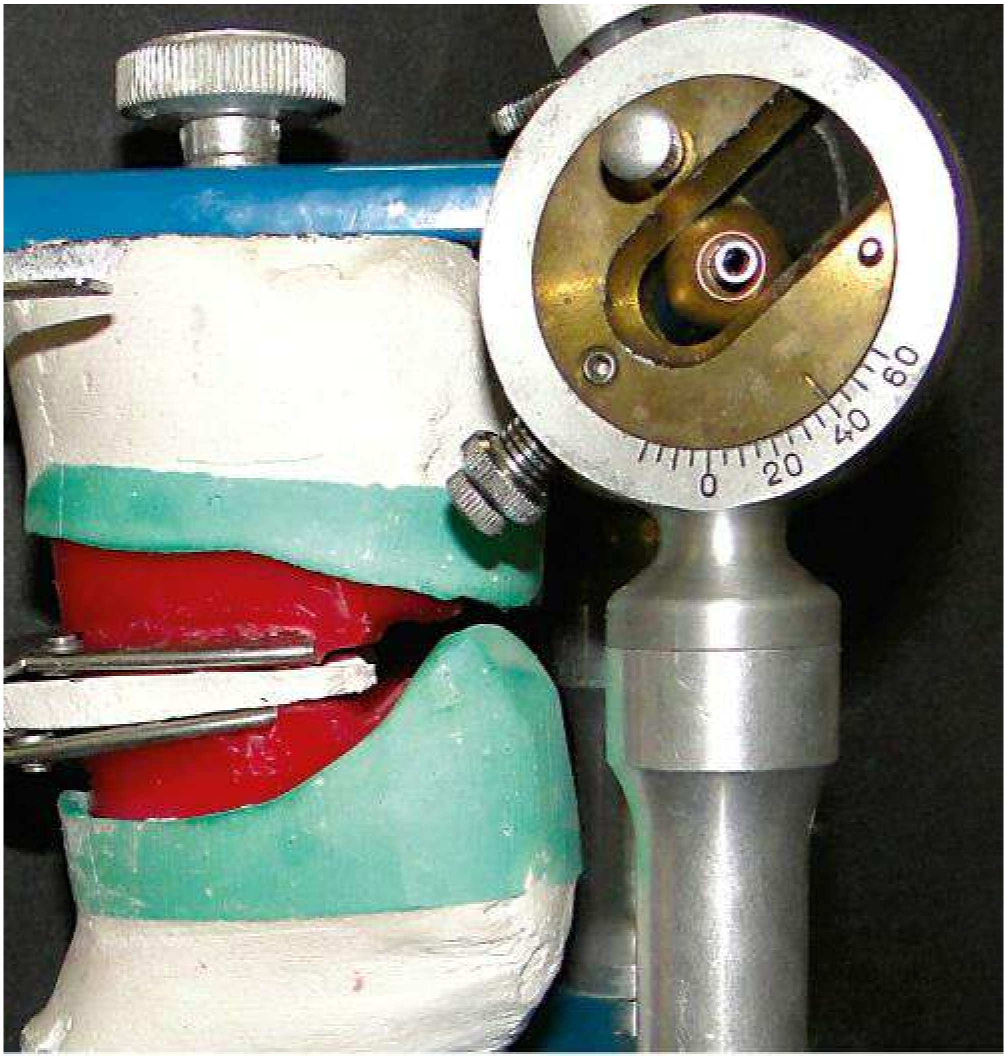


FIGURE 6.76 The occlusal rims are seated over the casts and with the centric record in place, and the mandibular cast is remounted with the new record.

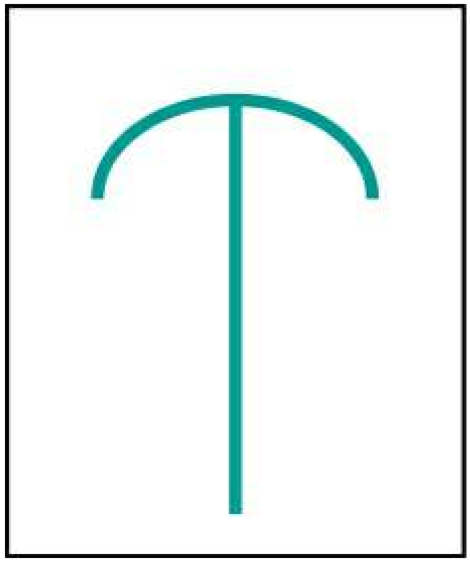


FIGURE 6.77 Gothic arch tracing with round apex.

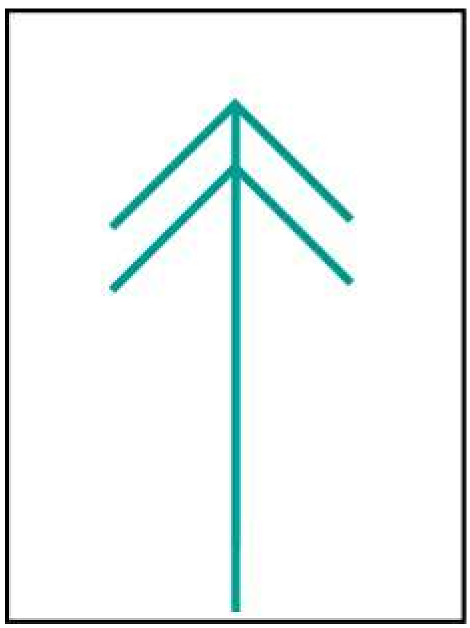


FIGURE 6.78 Double arrow point tracing.

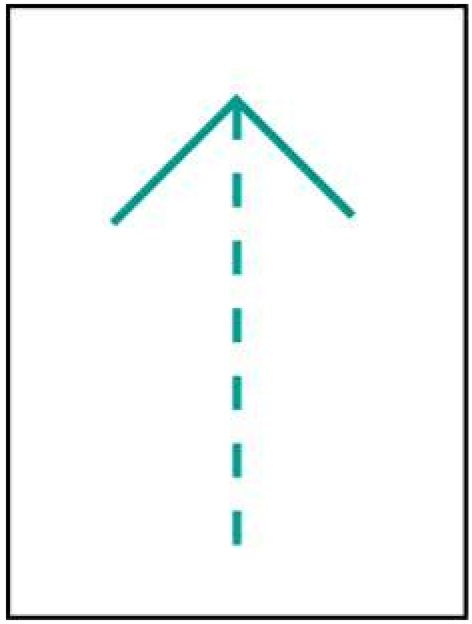
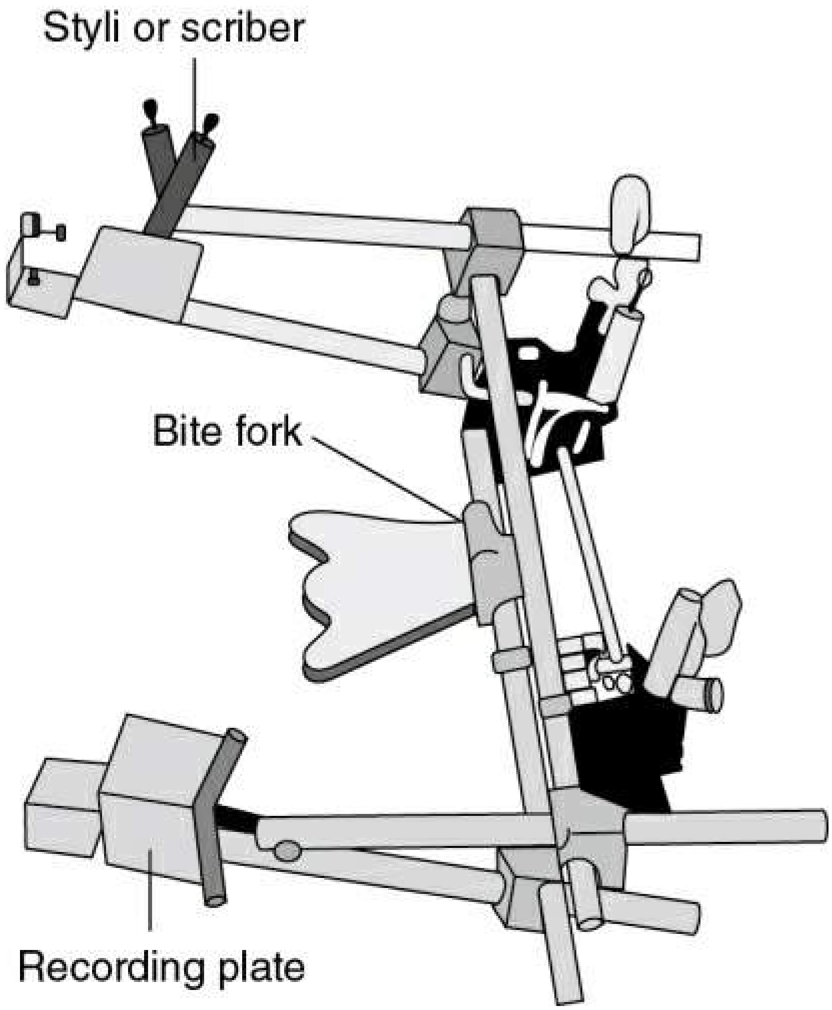


FIGURE 6.79 Interrupted arrow point tracing.



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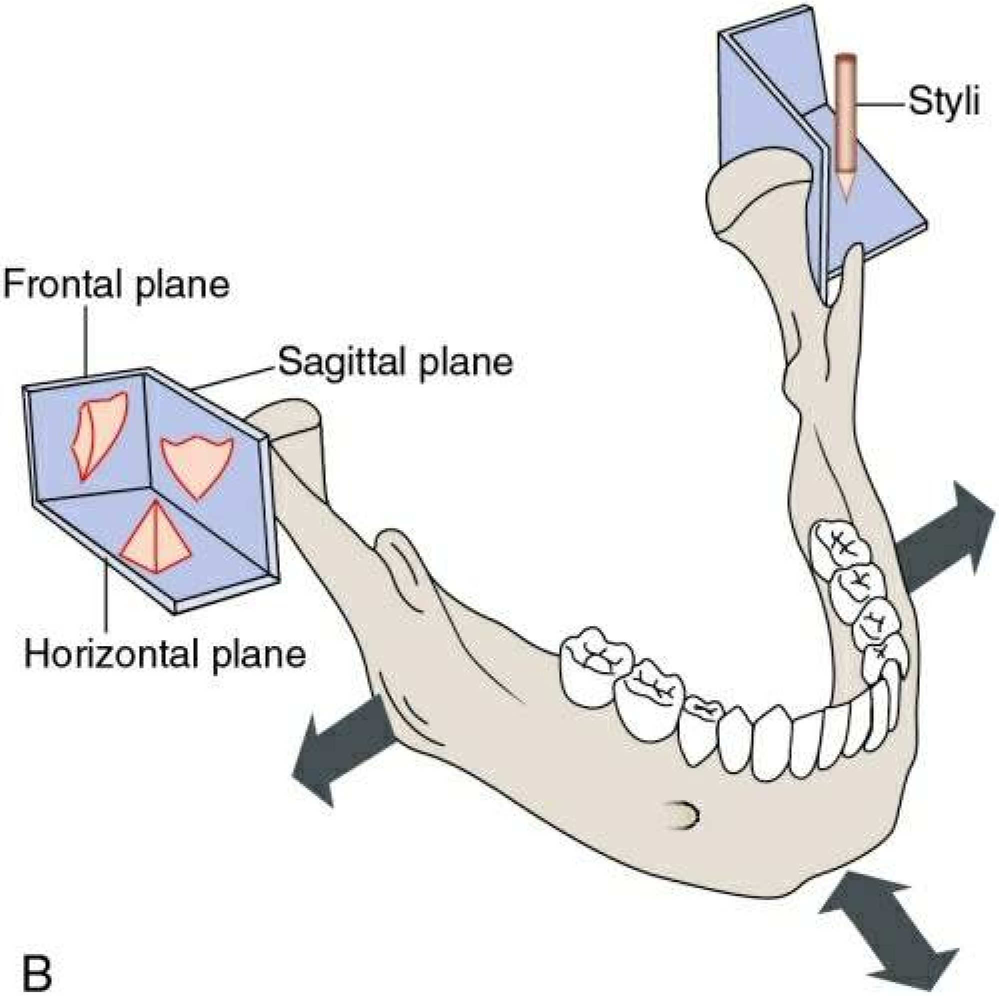


FIGURE 6.80 **(A)** Pantograph – traces the mandibular movement in three planes using a styli and recording plates attached to a facebow. **(B)** Pantogram – the tracings recorded in the three planes.

Table 6.3

Comparison of intraoral and extraoral tracers

Intraoral tracers	Extraoral tracers
Tracing not visible when being made – verification of mandibular movement and position is not possible	Tracing is visible, movement and position can be verified
Tracings are small – may be difficult to locate apex	Larger – apex is more discernible
As central bearing and recording device is the same and placed intraorally, movement is not interrupted by the position of lips and cheeks	The lips and cheek may interfere as recording device is placed extraorally
Example: Coble tracer	Example: It is Hight tracer

Eccentric relations

Definition: Any relationship of the mandible to the maxilla other than CR (GPT8). The eccentric relations that are recorded and used in complete denture construction are:

- Protrusive relations
- Lateral relations

These records are essential if a balanced occlusion is planned for the denture.

They are used to adjust the protrusive and lateral condylar inclinations of the articulator, which will help in reproducing the mandibular movements of the patient. The extent of reproducibility depends on the capabilities of the articulator. Hence, they can be used only with semi- and fully adjustable articulators (see Chapter 7).

Protrusive records

As the condyles move downwards and forwards during protrusion, these records help determine the protrusive condylar inclination of the articulator. The following methods are used.

Functional methods

- Similar to those described for recording CR.
- As the various mandibular movements are recorded with this procedure, the articulator is adjusted to the eccentric records after mounting the casts in CR.
- These can be used with both semi- and fully adjustable, to simulate the eccentric mandibular movements.

Graphic methods

Gothic arch tracing can be used as previously described to record protrusive relation also.

- The same central bearing and recording devices are reseated in the patient's mouth after casts are mounted with the CR record.
- A distance of 5–6 mm from the apex of the arrow point tracing is measured on the protrusive tracing and marked (Fig. 6.81).
- The patient is instructed to protrude until the stylus rests on this mark.
- Quick setting plaster is injected between the occlusal rims and allowed to harden.
- This plaster index is the protrusive record (Fig. 6.75B) and is later used to adjust the protrusive (horizontal) condylar inclination.
- Since the Gothic arch tracer records the movements in only one plane, it can be used only with semi-adjustable articulators.

FIGURE 6.81 Protrusive record is obtained by making the patient close on a mark 5–6 mm from the apex on the protrusive line.

Pantographic tracings

As previously described, these devices record the movements in three dimensions and the eccentric movements recorded can also be transferred to a fully adjustable articulator.

Static methods

- These are similar to those described for recording CR.
- Most commonly used method is interocclusal check record.
- As previously described, these records are made during try-in following arrangement of artificial teeth. Soft baseplate (4 mm) wax is placed over the mandibular teeth and sealed to the buccal/labial and lingual surfaces. Wax is softened and mandibular trial denture is inserted in the patient's mouth.
- The patient is instructed to protrude the lower jaw for 5–6 mm and close until all the upper teeth contact the wax. Midlines of the upper and lower teeth must coincide.
- The record with the trial denture is removed and used to adjust the condylar inclinations of the articulator. The interocclusal record can also be used only with semi-adjustable articulators.

Lateral records

- Lateral records are used to adjust the lateral condylar inclination of the articulator. Two records are required unlike the centric and protrusive records – one of right lateral and other of left lateral (Fig. 6.82). The lateral condylar inclination of the opposite side is adjusted with each record, respectively.
- The same functional, graphic and interocclusal check methods can be used to make lateral records. The patient is instructed to move the jaw laterally instead of protrude, to make the record.
- Some semi-adjustable articulators are not capable of accepting

lateral records. Hanau derived a formula to determine the lateral condylar inclination, if the protrusive (horizontal) condylar inclination was available through protrusive records.

$$L = (H/8) + 12$$

FIGURE 6.82 Lateral records. Note the position of the needle on the recording plate positioned to make a left lateral record.

Where L = lateral condylar inclination, H = horizontal condylar inclination.

- He opined that making a lateral record had no major advantages, and discrepancies because of this could be determined and corrected following denture insertion.

- The usefulness of this formula has not been proved or disproved.

SUMMARY

The mandible articulates with the maxilla through the TMJ. Mandibular movements are responsible for oral functions like mastication, deglutition and speech. To provide satisfactory oral function with complete dentures, it is desirable to have a reproducible mandibular position, which allows the denture teeth to meet evenly – maximum intercuspation at CR. This relation should be established at the appropriate vertical dimension so that sufficient interocclusal clearance is provided when the mandible is in the rest position. Although there is no conclusive scientific evidence that use of facebow is associated with a more acceptable clinical result, a significant relation is seen between accuracy of CR and presence of interocclusal space with comfortable wearing of dentures and chewing efficiently. Hence, establishing and recording the correct CR at the appropriate vertical dimension are a very important aspect of complete denture construction.

CHAPTER 7

Articulation

CHAPTER CONTENTS

Introduction

As can be inferred from the definitions, an articulator should perform the function of the TMJs of the patient so that the restorations that are developed on it do not interfere with mandibular function during mastication, speech and swallowing. Theoretically, if they represent the TMJs, they should also reproduce the mandibular movements of the patient, more so in a completely edentulous situation. Numerous articulators are available which range from simple to complex. Their capacity to reproduce the mandibular movements of the individual also varies. Selection of articulator for complete dentures depends on the type of occlusion planned.

After recording the maxillomandibular relations, the maxillary cast is attached to the articulator with a facebow transfer. The mandibular cast is then attached to the maxillary cast with a centric relation record. If balanced occlusion is planned, the condylar elements of the articulator are adjusted with eccentric records. Artificial teeth are then arranged on the articulator such that maximal intercuspation coincides with centric relation. It is made to coordinate with the various mandibular movements if balanced occlusion is planned.

It may be noted that ‘articulation’ is a dynamic relationship of the teeth compared to ‘occlusion’, which is a static relation.

Definitions

Articulator: A mechanical device which represents the temporomandibular joints and the jaw members to which maxillary and mandibular casts may be attached to simulate jaw movements (GPT8).

Articulation: The static and dynamic contact relationship between the occlusal surfaces of the teeth during function (GPT8).

Occlusion: The static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues (GPT8).

Articulators

Functions of articulators

1. To hold the maxillary and mandibular casts in a planned relation.

2. To simulate the patient's TMJs, mandible, maxilla and mandibular movements.

3. To open and close similar to patient.

4. To mount casts for diagnosis, treatment planning and patient presentation.

5. To fabricate occlusal surfaces of restorations.

6. To arrange artificial teeth.

7. To teach and study occlusion and mandibular movements.

Advantages of articulators

1. Providing a better view of the patient's occlusion, especially lingual side.

2. Refinement of complete denture occlusion is extremely difficult intraorally, because of movement of denture base and resiliency of supporting tissues. These problems are eliminated with articulators.

3. Patient cooperation is not a factor once casts are mounted on articulator with appropriate records.

4. Chairside time for the dentist and appointment time for the patient is decreased.

5. Some procedures can be delegated to technicians if an articulator is used.

6. Patient's tongue, saliva and cheeks are not factors of hindrance while using an articulator.

Limitations of articulators

1. The articulator is subject to errors in tooling and errors resulting from metal fatigue and wear.

2. No articulator can exactly duplicate the condylar movements of an individual.

3. It cannot compensate for any errors in jaw relation records.

Requirements

Minimal requirements

1. It should hold casts in the correct horizontal and vertical relationships.

2. It should provide a positive anterior vertical stop (incisal pin).

3. It should open and close in a hinge movement.

4. It should allow protrusive and lateral jaw motion.

5. The moving parts should move freely.

6. The nonmoving parts should be rigid.

Additional requirements

1. It should accept a facebow transfer record.

2. Adjustable condylar guide elements.

3. A terminal hinge position locking device.

4. Mounting plates that can be repositioned accurately.

5. An adjustable incisal guide table.

6. Adjustable intercondylar width of the condylar elements.

Classification

Articulators can be categorized as follows.

Based on adjustability

1. Nonadjustable: An articulator that does not allow adjustment to replicate mandibular movements (GPT8).
Example: Class I and II articulators.
2. Semi-adjustable: An articulator that allows adjustment to replicate average mandibular movements – also called class III articulator (GPT8).
3. Fully adjustable: An articulator that allows replication of three-dimensional movement of recorded mandibular motion – also called class IV articulator (GPT8).

Based on position of condylar elements

1. Arcon: An articulator that applies the arcon design; this instrument maintains anatomic guidelines by the use of condylar analogues in the mandibular element and fossae assemblies within the maxillary element (GPT8).
2. Nonarcon: Any articulator design in which the condylar element (analogue) is not part of the lower member of the articulator and may be used to simulate the three-dimensional motions of the left and right condylar compartments (GPT8).

- Bergstrom designed a semi-adjustable articulator in 1950 called 'Arcon'.
- He derived the word, ARCON from '**ar**ticulator' and '**con**dyle'.
- The condyle was attached to the lower member of articulator and the condylar guides were attached to the upper member similar to the natural jaws.
- Though this was not the first arcon articulator to be developed, Bergstrom was the first to coin the term. Also, though the term was coined for describing semi-adjustable articulators, it can be used with any type of articulator.
- The other articulators where the condyle is attached the upper member is called nonarcon.
- As condyles move in the articulator similar to natural glenoid fossa, visualization and understanding of condylar movements is better in arcon articulators. There seems to be no other advantage with regard to accuracy of movement or superiority in clinical evaluation of complete dentures when compared to nonarcon articulators.

Based on instrument function

The International Prosthodontic workshop on complete denture occlusion at the University of Michigan in 1972 proposed the following classification:

It was developed based on articulator's function:

- Instrument capability
- Intent
- Registration procedure
- Registration acceptance

This is now a widely followed classification which is also given as a definition for articulators in GPT8.

Class I

A simple holding instrument capable of accepting a single static registration; vertical motion is possible.

- Only opening and closing movement is possible. No eccentric motion is possible. Hence they are categorized as *nonadjustable articulators*.

- Examples: Slab articulator, hinge articulator, barn door hinge.

  Slab articulators:

- This was the first articulator to be conceptualized.

- It was formed by extending plaster indices from the back of the casts which were keyed to each other (Fig. 7.1A and B).

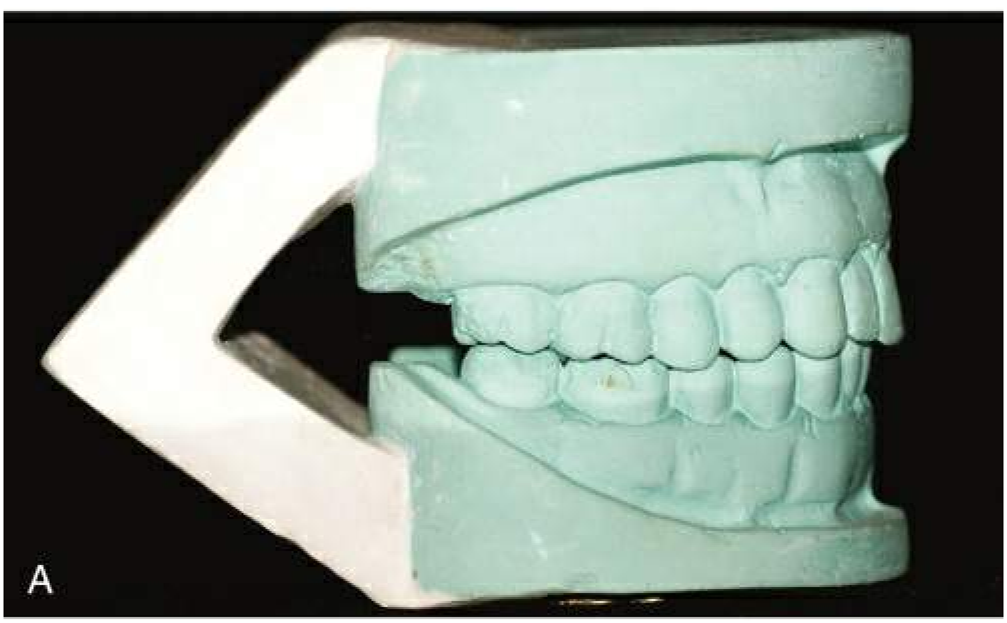


FIGURE 7.1 **(A)** Slab articulator formed by extending plaster from base of cast. **(B)** A model poured for a triple tray impression is also an example of slab articulator (discussed in Chapter 37).

Hinge articulator:

- Designed by J.B. Gariot in 1805.
- Consists of a simple hinge with a screw in the posterior region contacting the upper member to serve as a vertical stop (Fig. 7.2A).
- Barn door hinge: These are articulators that have a vertical stop (Fig. 7.2B).

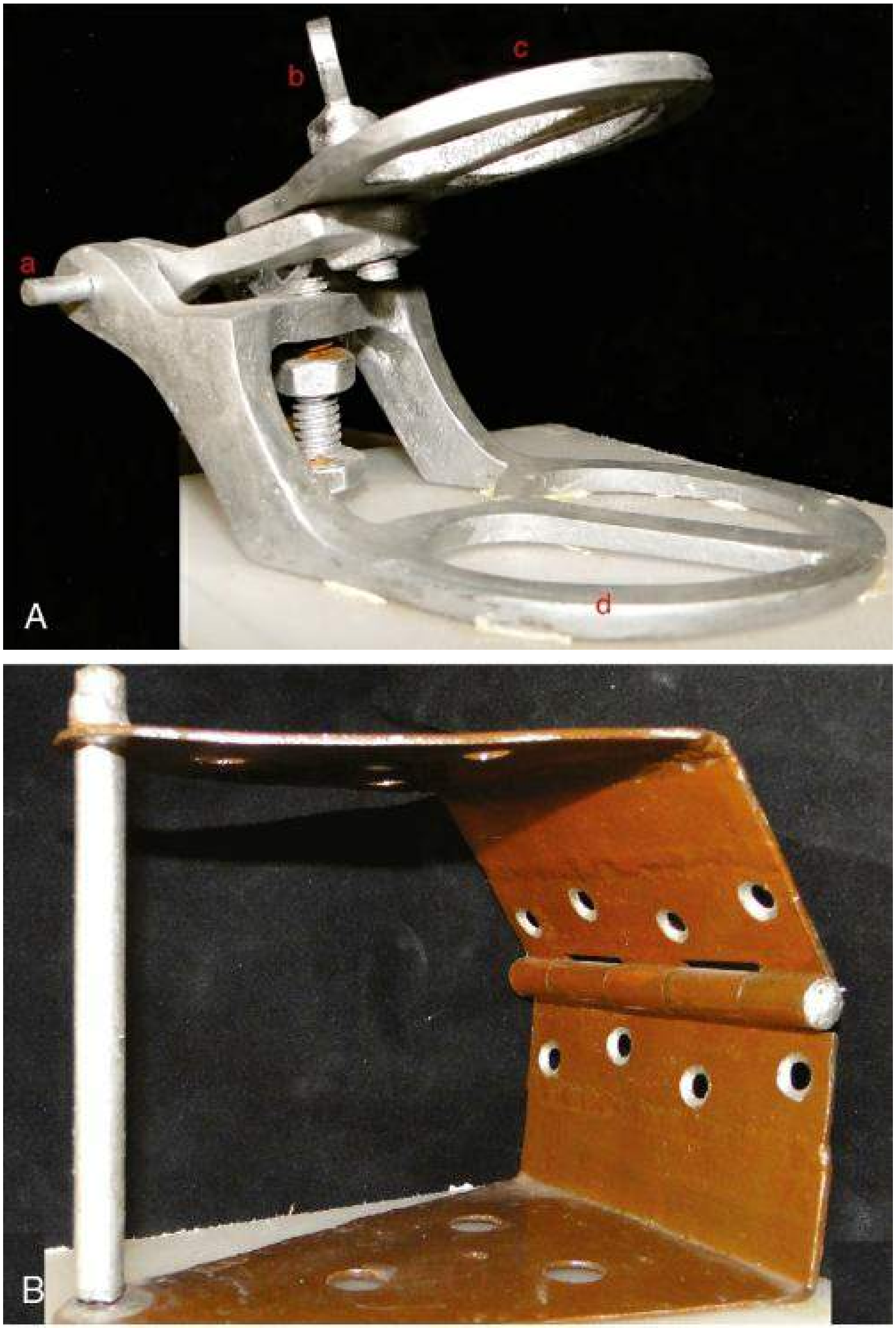


FIGURE 7.2 **(A)** Hinge articulator; (a) hinge, (b) set screw, (c) upper member, (d) lower member. **(B)** Barn door hinge articulator.

Class II

An instrument that permits horizontal as well as vertical motion but does not orient the motion to the temporomandibular joints.

- In this category, eccentric motion (protrusive and lateral) can be made, but these are not adjustable (cannot be replicated from the patient) and are based on average values and theories. Hence they are categorized as *nonadjustable articulators.*

- They cannot accept a facebow transfer.

- They are further subdivided into three categories depending on the method used for producing eccentric movement.

Class IIA

Eccentric motion permitted is based on average values.

Examples: Grittman articulator, Gysi simplex, mean value articulator.

Grittman articulator:

- Designed by Grittman in 1899.

- The condylar path is inclined at 15° – determined by measurements taken from a large number of patients.

Gysi simplex:

- Designed by Alfred Gysi in 1914.

- Condylar path is inclined at 30°, incisal guidance is fixed at 60°.

Mean value articulator is explained in detail later in the chapter.

Class IIB

Eccentric motion permitted is based on arbitrary theories of motion.

Spherical theory:

- This proposes that each cusp and incisal edge touches or conforms to a segment of the surface of a sphere 8 inch in diameter with its centre in the region of the glabella (Fig. 7.3A).

- Monson proposed this theory and designed an articulator the 'maxillomandibular instrument' based on this (Fig. 7.3B).

Bonwill theory:

- Also called 'theory of equilateral triangle'. It states that distance between the condyles and each condyle and incisal point is 4 inch forming an equilateral triangle (Fig. 7.4).

- Proposed by Bonwill, and 'Bonwill articulator' was desi'gned based on this theory (Fig. 7.5).

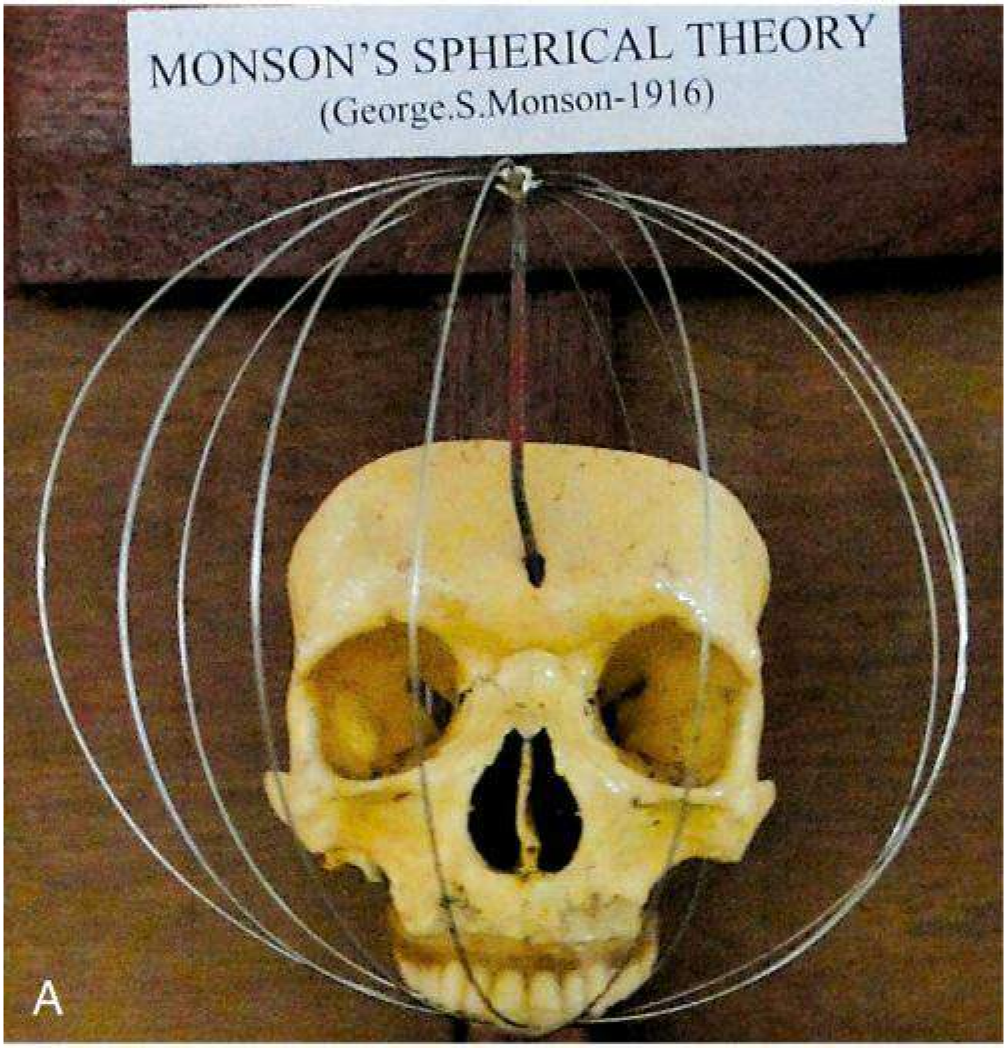

MONSON'S SPHERICAL THEORY
(George.S.Monson-1916)
A

FIGURE 7.3 **(A)** Monson's spherical theory sphere with 8-inch diameter, with the centre of circle in the glabella. **(B)** Maxillomandibular instrument.

FIGURE 7.4 Bonwill triangle. The sides of the triangle measure 4 inches each and form an equilateral triangle from the condyles to the incisal tip.

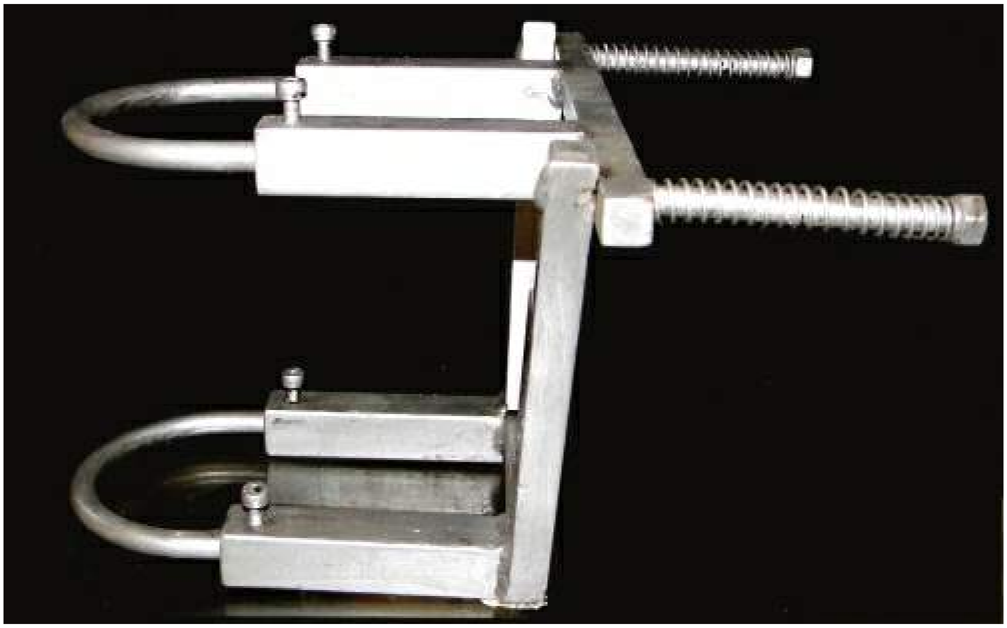
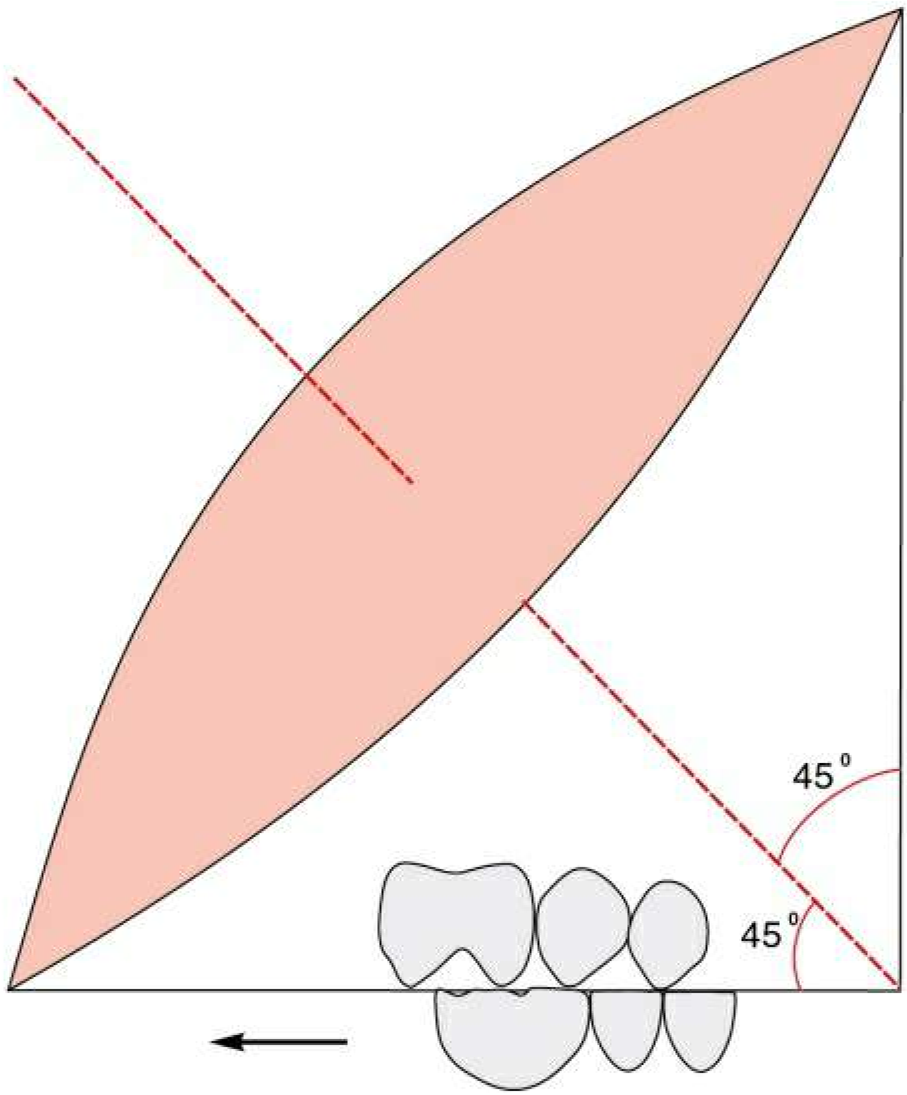


FIGURE 7.5 Bonwill articulator.

Conical theory:

- It states that the lower teeth move over the surfaces of the upper teeth as over the surface of a cone, generating an angle of 45° with the central axis of the cone tipped 45° to the occlusal plane. The teeth of the maxillary denture would conform to a segment of the inner surface of an 8-inch cone (Fig. 7.6A).

- Proposed by Hall in 1915. The Hall articulator is based on this theory (Fig. 7.6B).



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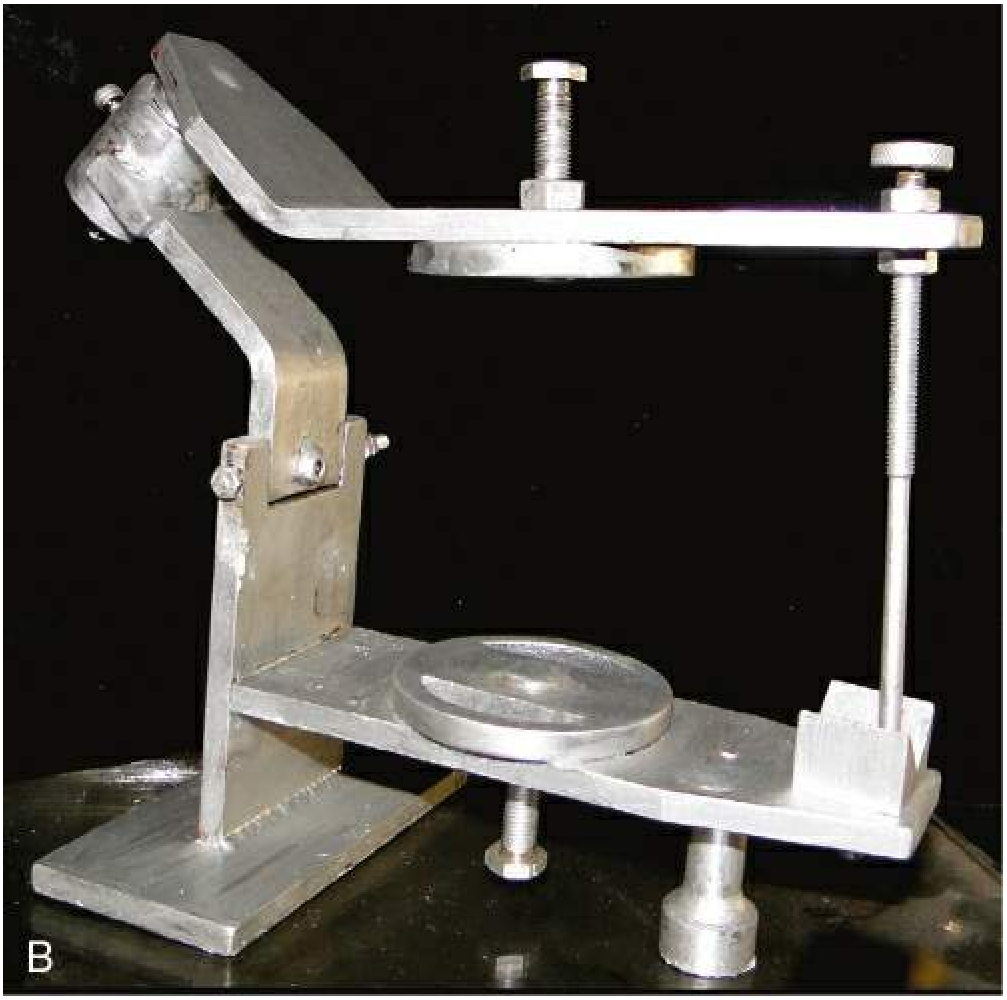


FIGURE 7.6 **(A)** Hall's conical theory. 45 angle generated when upper teeth glide over the surface of the lower teeth. **(B)** Hall articulator.

Class IIC

Eccentric motion permitted is based on engraved records obtained from the patient.

- The 'House articulator' was designed by M.M. House in 1927, based on this concept.
- The instrument is adjusted by using a CR record by the 'Needle–House' method (described in Chapter 6, Page 123).

Class III

An instrument that simulates condylar pathways by using averages or mechanical equivalents for all or part of the motion; these instruments allow for orientation of the casts relative to the joints and may be arcon or nonarcon instruments.

- These permit eccentric motion (protrusive and lateral) and also allow adjustment of the movements according to the patient. But only a part of the patient's condylar movement can be simulated and hence they are categorized as *semi-adjustable articulators*.
- They accept a facebow transfer.
- The classification of 'arcon and nonarcon' originated from this class of articulators but it can be applied to any articulator.
- They are further divided into two categories depending on the records they accept.

Class IIIA

Instruments accept only a protrusive record to adjust the protrusive condylar inclinations. The lateral condylar inclination is determined using the Hanau formula L = H/8 + 12.

Examples: Hanau Model H and H2, Dentatus (Fig 7.16), Bergstrom.

Class IIIB

Instruments accept both protrusive and some lateral records.

Examples: Hanau Kinoscope, Ney Articulator, Panadent.

Class IV

An instrument that will accept three-dimensional dynamic registrations; these instruments allow for orientation of the casts to the temporomandibular joints and simulation of mandibular movements.

They can simulate all the mandibular movements of the patient. Hence, they are categorized as *fully adjustable articulators*.

- They do accept a facebow transfer.

- All articulators in this class are 'Arcon' type with adjustable intercondylar distance.

- They are categorized into two types depending on the method used for recording the condylar movements.

Class IVA

The condylar pathways are engraved by the patient (stereographic recording) and the instruments will accept these three-dimensional dynamic engravings. Example: TMJ articulator (Fig. 7.7).

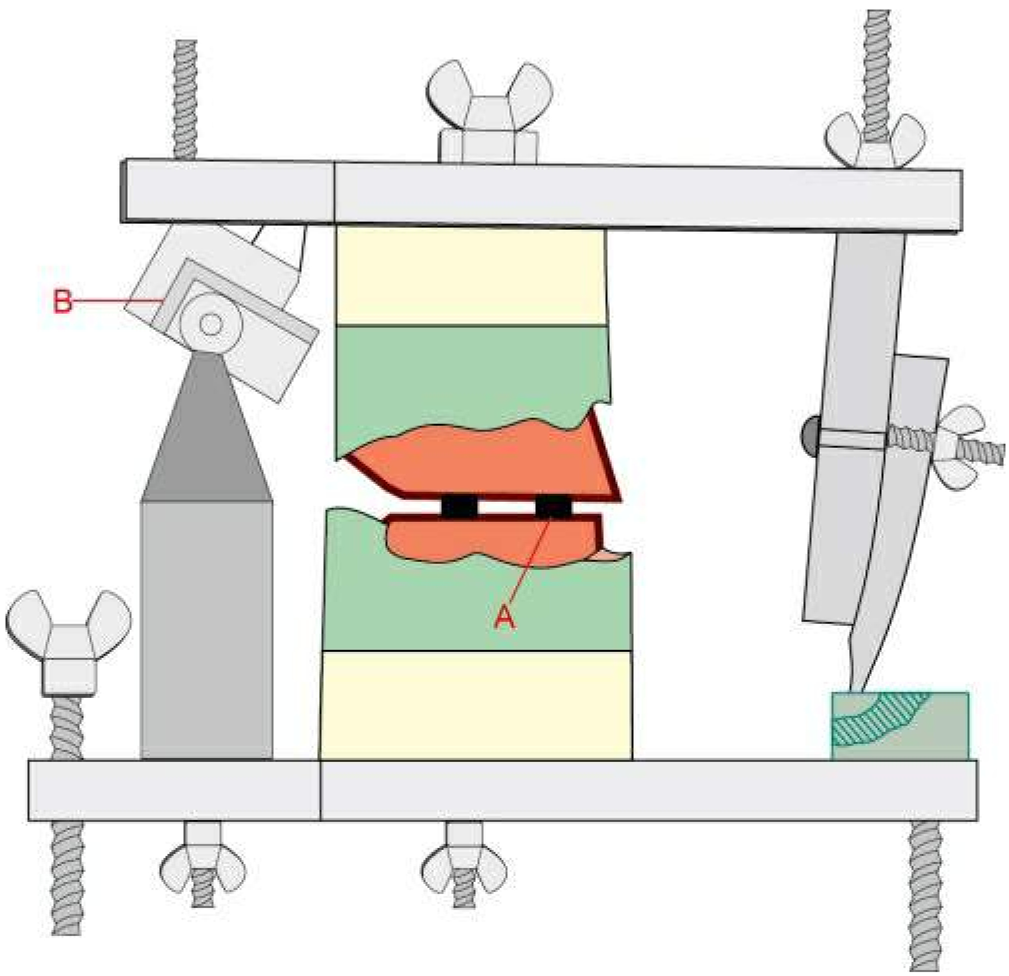


FIGURE 7.7 Swanson's TMJ articulator with fossa moulded (B) using studs (A).

An instrument that records mandibular movement in three planes. Engraving, milling or burnishing the recording medium by means of styli, teeth, abrasive rims or rotary instruments thus obtains the registrations (GPT8).

- The record of mandibular movement is obtained by engraving.
- The instrument used is termed as stereograph and recording is called stereographic record.
- The TMJ articulator was designed by Kenneth Swanson in 1965. An intraoral registration of the various jaw relations (centric and eccentric) is generated by studs in autopolymerizing resin similar to the 'Needle–House' technique. This is called 'stereographic' recording. This is placed on the articulator and is used to mould the condylar fossa in the articulator. This is claimed to produce an accurate replica of the patient's TMJ function.

Class IVB

The condylar pathways are obtained using three-dimensional tracings (pantographic recordings) and the instruments will accept these three-dimensional dynamic tracings.

Pantograph: An instrument used to graphically record in, one or more planes, paths of mandibular movement and to provide information for the programming of an articulator (GPT8). Example: Pantogragh.

- The record of mandibular movement is obtained by graphic tracing.
- The instrument used is termed as pantograph (see Fig. 6.80A) and tracing is called pantographic tracing or pantogram (see Fig. 6.80B).
- The tracings obtained are similar to gothic arch tracing, but are obtained in all three planes. So six styli and tracing tables are attached by means of facebows and clutches to maxilla and mandible (Fig. 7.8). The tracings of the various mandibular movements obtained in 3D are then transferred to the articulator in

the same relation as in the patient. The articulator is adjusted to follow these tracings.

- These are now also available in electronic form (Fig. 7.9).

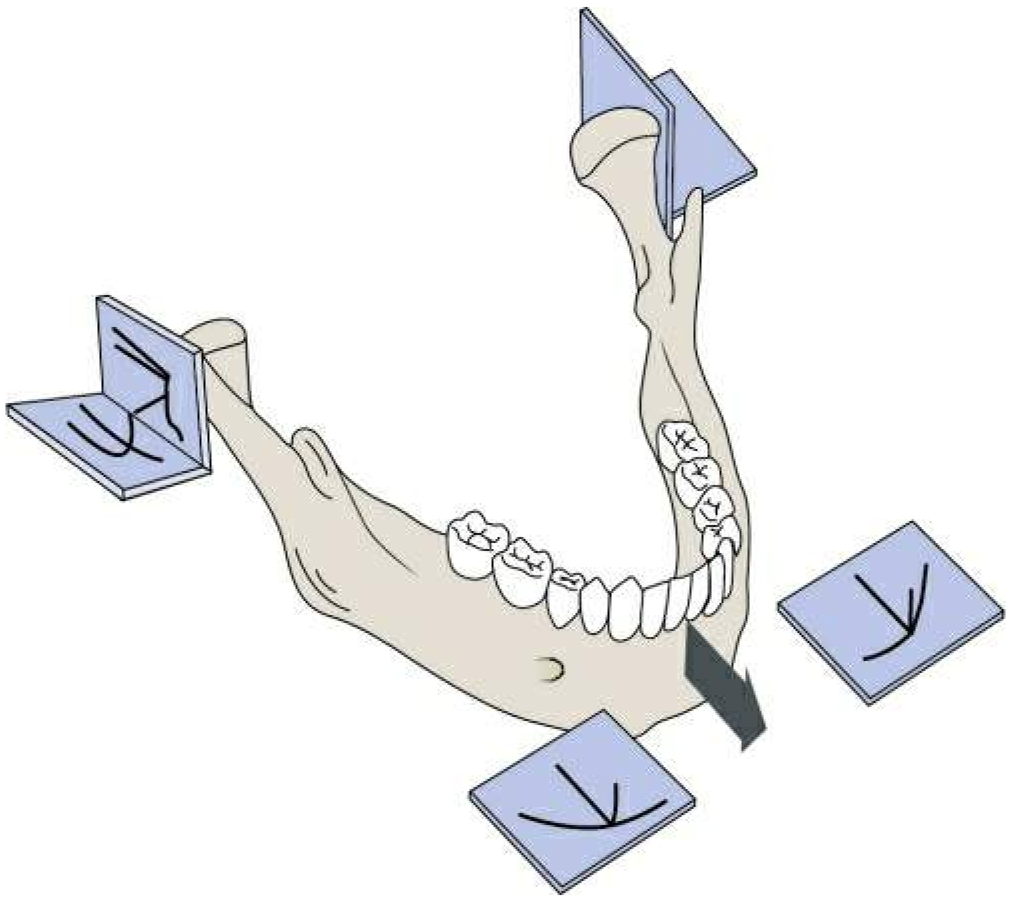


FIGURE 7.8 Tracings obtained in various mandibular movements is recorded in the three planes and transferred to the articulator.

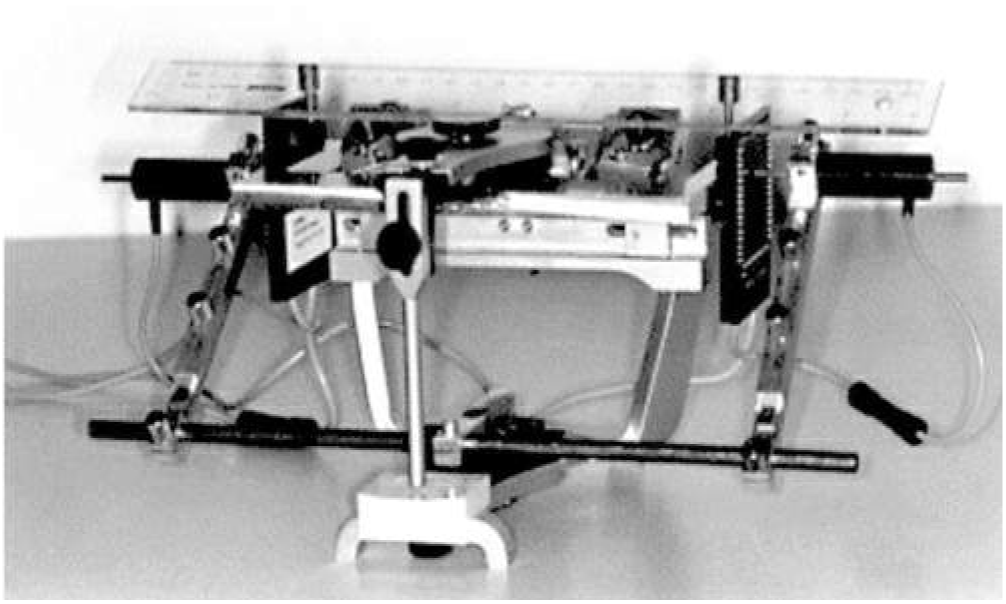


FIGURE 7.9 Electronic pantograph. Source: *Courtesy:* Chang WSW, et al. An in vitro evaluation of the reliability and validity of an electronic pantograph by testing with five different articulators. J Prosthet Dent 2004; 92(1): 83–89.

Articulation

Once the jaw relation is obtained or tracings are done, the casts are articulated using the records.

The most commonly used articulators are mean value articulator and semi-adjustable articulator. These are discussed here in detail.

Mean value articulator

Class II nonadjustable articulator

Used if occlusal contacts are to be oriented in centric occlusion only. It can open and close in a fixed horizontal axis and has a fixed incisal table and condylar path. It is also called three-point articulator.

Component parts (fig. 7.10)

1. Upper and lower member

2. Incisal table and pin

3. Midincisal pin

4. Condylar shafts and slots

5. Vertical supporting arms

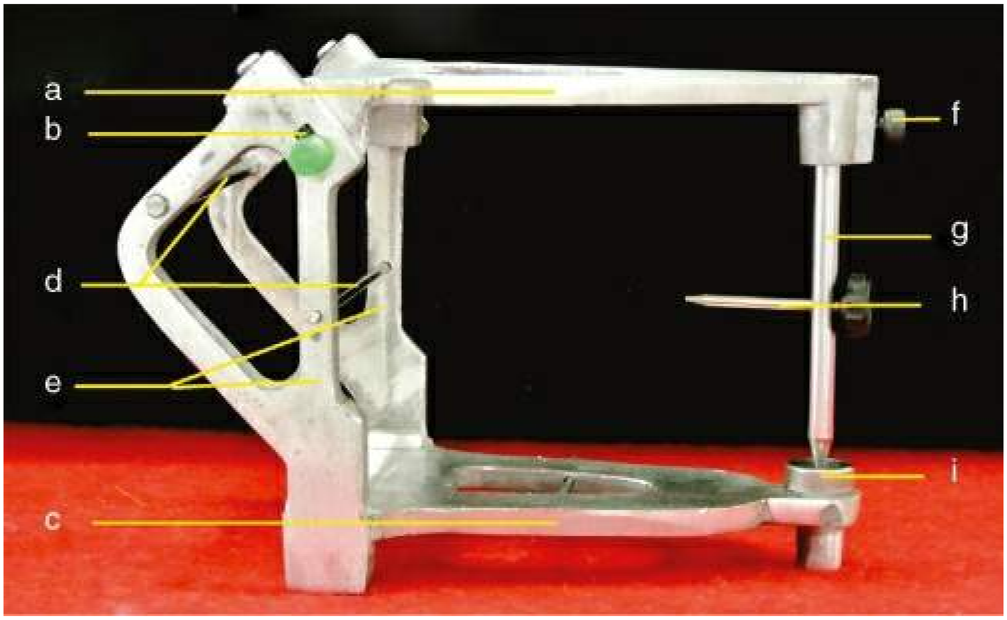


FIGURE 7.10 Mean value articulator. (a) Upper member. (b) Condylar shaft and slot with spring. (c) Lower member. (d) Two additional pins for orientation and support. (e) The two vertical arms on either side, hold the upper and lower members together. (f) Incisal adjustment screw. (g) Incisal pin. (h) Midincisal pin. (i) Incisal pin table.

Design

Designed using fixed dimensions derived from the average distance between the incisal and condylar guidance. The condylar shafts, placed at a distance of 110 mm from each other, are engaged within the condylar slots, which represent the glenoid fossa. The condylar slots are angulated at a 30° incline and have a spring mechanism, which helps to push the condylar rod into position (Fig. 7.11). Anteriorly, the incisal pin which rests on the incisal table (with a uniform 5° angulation on all sides of the table), maintains the vertical height and separation between the upper and lower members and acts as an anterior vertical stop. In the centre of the incisal pin, there is a smaller, thinner pin placed horizontally, known as the midincisal pin, which helps in the orientation of maxillary anterior teeth according to the midline and the occlusal plane (Fig. 7.12). All these components are supported on either end by two vertical supporting arms. These also have two additional horizontal arms running to either end, where one acts as an orientation guide and the other provides support (Fig. 7.13).

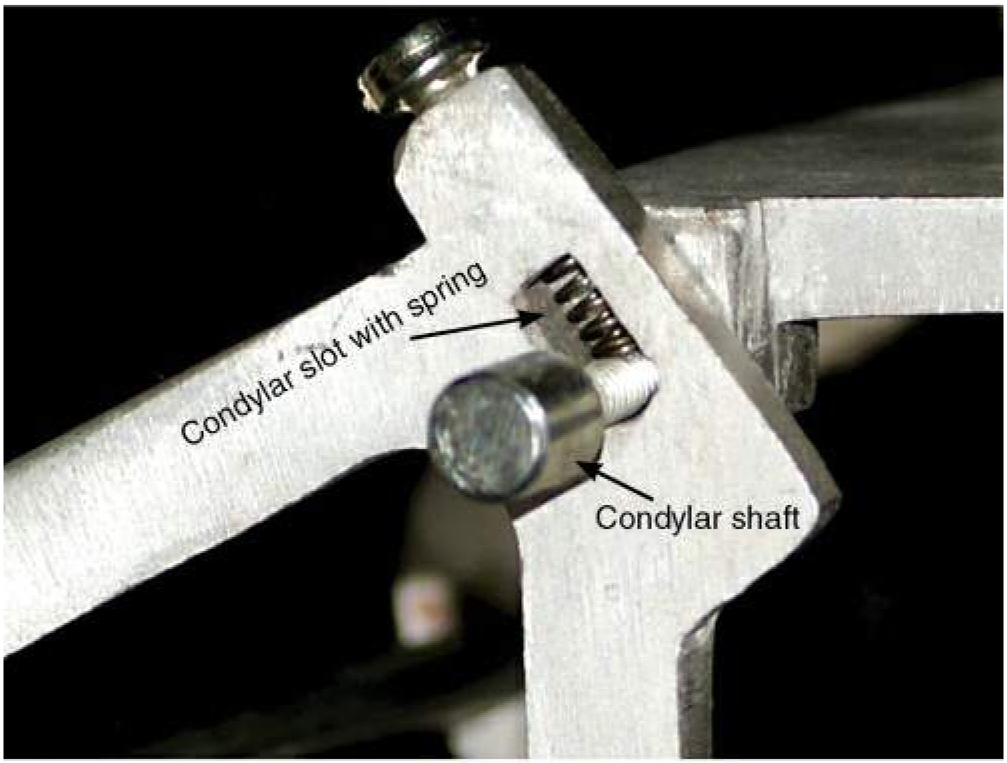


FIGURE 7.11 Condylar shaft and 30 slot with spring loaded mechanism.

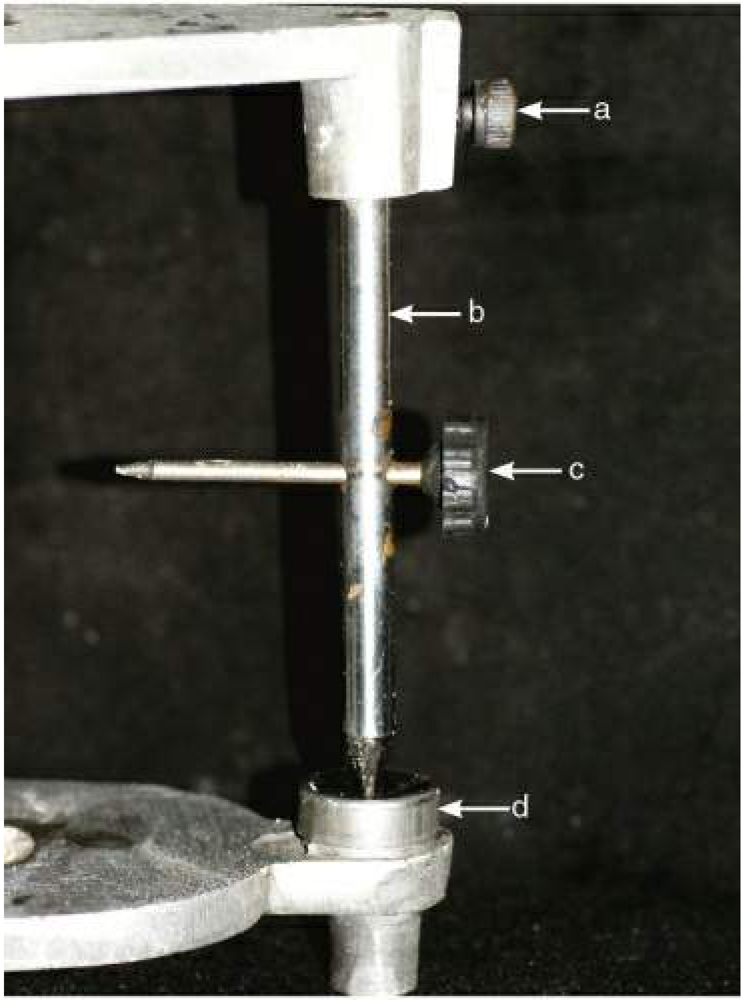


FIGURE 7.12 (a) Incisal pin adjustment screw. (b) Incisal pin. (c) Midincisal pin. (d) Incisal table.

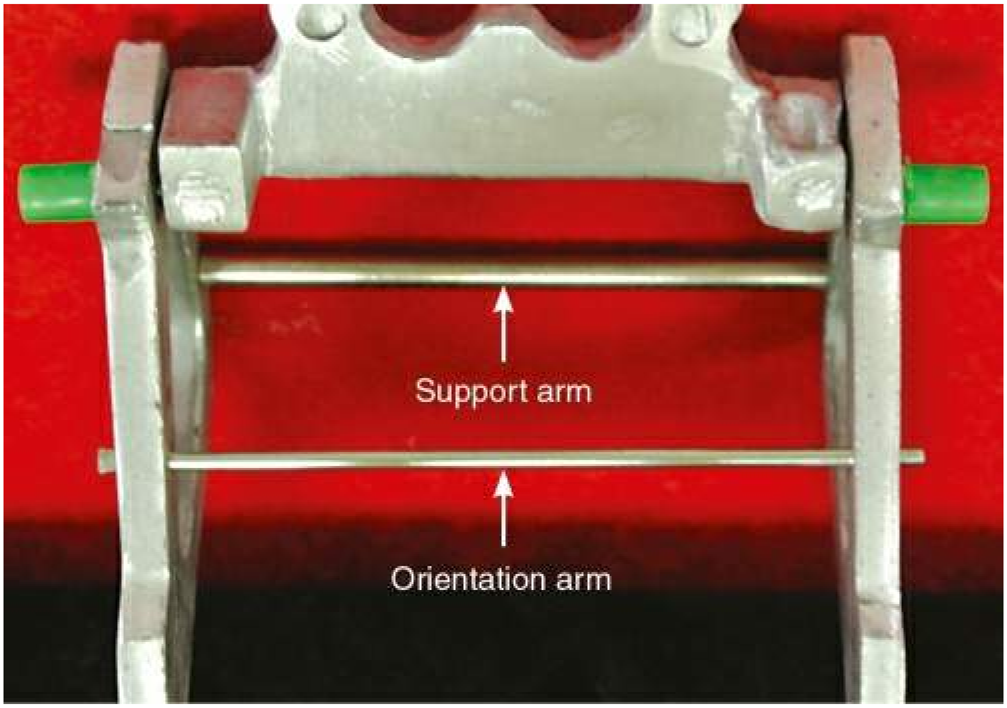


FIGURE 7.13 Support arm and orientation arm.

Articulation procedure

The occlusal rims fused with the centric record are placed over the respective casts. A thread is suspended all around the articulator, running anteriorly across the midincisal pin to the point where the posterior horizontal pin meets the vertical rod (Fig. 7.14). This thread line must coincide with the occlusal plane. Wax blocks are stabilized on the lower member – one anteriorly and two posteriorly (Fig. 7.15A) and the occlusal rims with cast is placed over the wax blocks. The height of the wax is reduced or increased as required, such that the reference plane of the thread coincides with the occlusal plane and the incisal pin meets the incisal table (Fig. 7.15B).

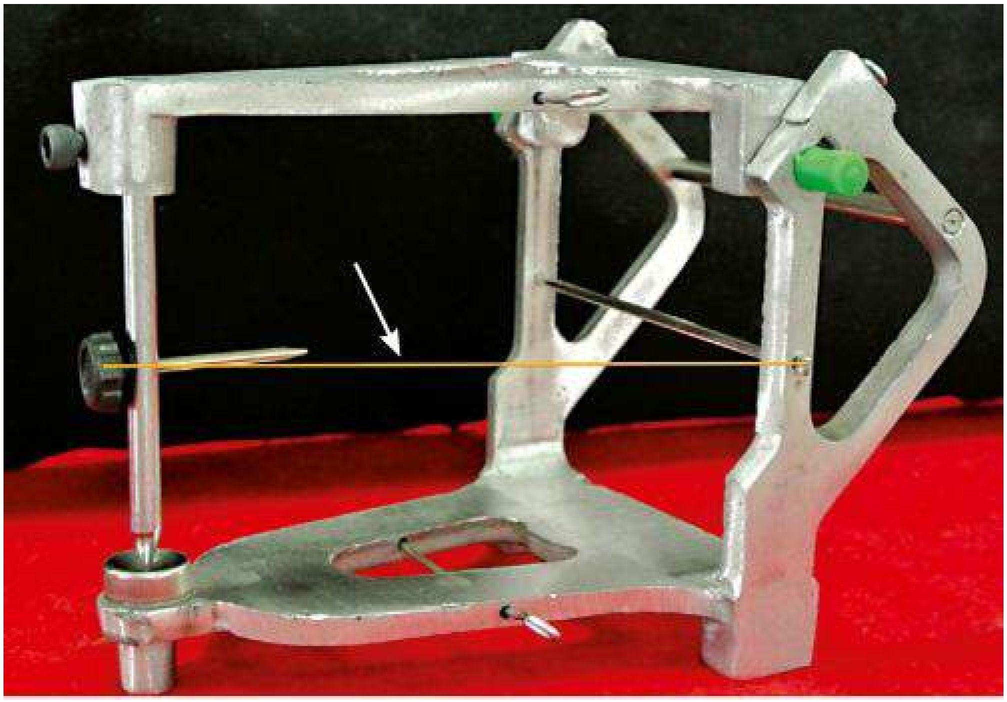
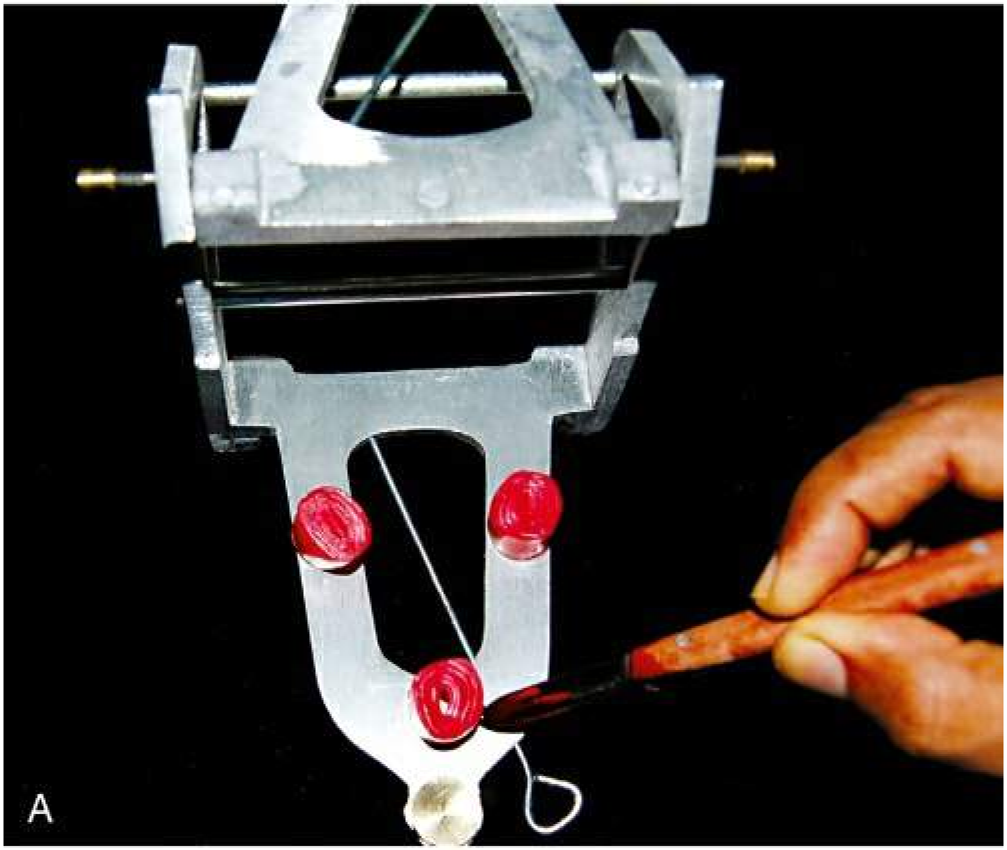


FIGURE 7.14 The horizontal orientation arm and the midincisal pin are joined with the help of thread to guide the occlusal plane orientation during articulation.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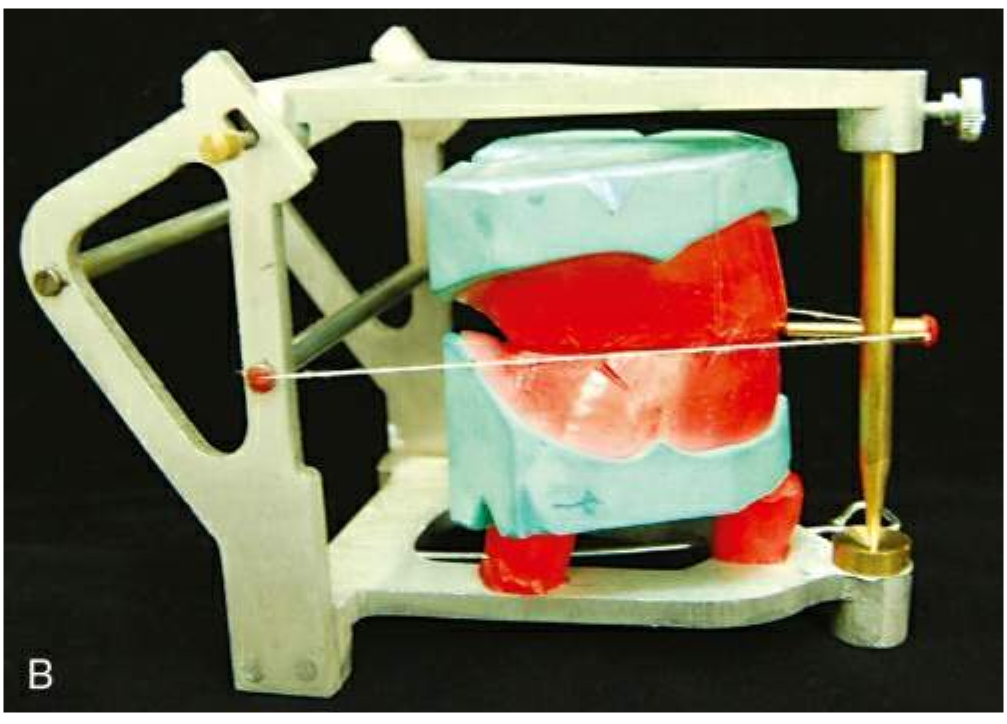
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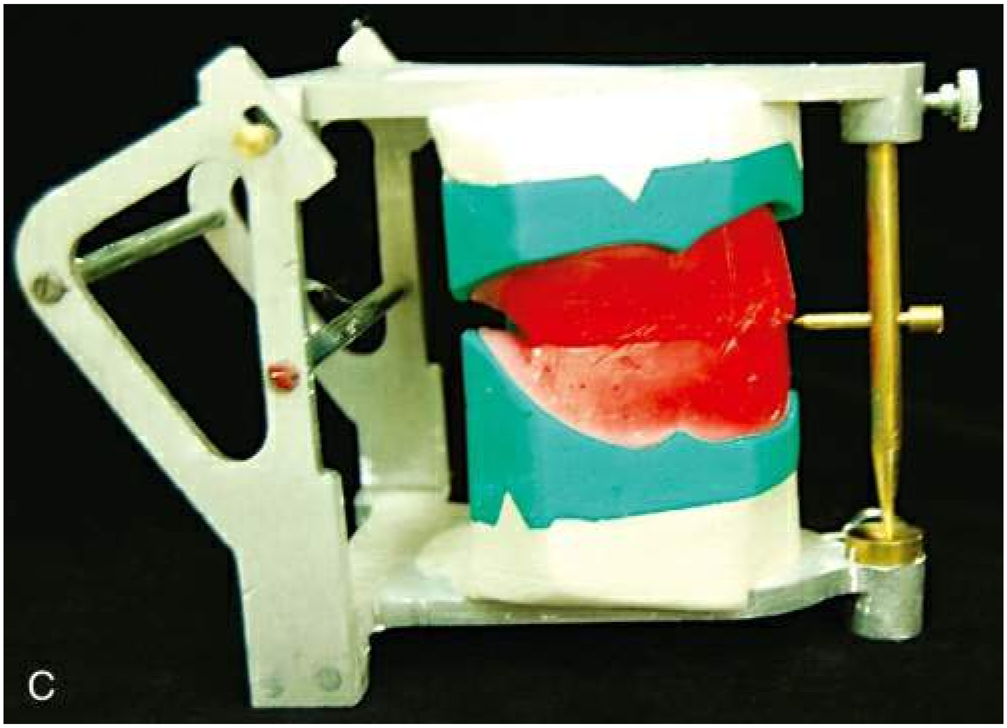


FIGURE 7.15 **(A)** Wax blocks are placed two posteriorly and one anteriorly to support the casts with occlusal rims. **(B)** Sealed maxillary and mandibular cast positioned in the articulator. The tip of the incisal pin is oriented to the midline at the junction of the occlusal rims anteriorly. The occlusal plane should run parallel to the attached thread connecting the incisal pin and horizontal orientation arm. **(C)** Completed articulation.

The upper member is swung open. Plaster is mixed and placed over the cast and the upper member is then gently closed, till the incisal pin touches the incisal table. Excess is removed.

Once the plaster is set, the articulator is now reversed. The lower member is swung open and the wax blocks are removed. The space between the lower cast and lower member is adequately filled with plaster, excess removed and finished.

The articulator (Fig. 7.15C) is then cleaned and once the plaster is set, it can be opened.

Semi-adjustable articulator

It is used if balanced occlusion in eccentric movement is desired.

Examples are Hanau wide vue articulator, Dentatus ARH and ARL.

The mounting of maxillary cast using a facebow transfer has been discussed in Chapter 6. The procedures used to mount the mandibular cast to the maxillary cast using centric record and setting the horizontal and lateral condylar guidance inclinations on the articulator using protrusive and lateral records respectively, will be discussed here. The semi-adjustable articulator used for explanation is a Dentatus articulator as the facebow of the same was used to mount the maxillary cast in Chapter 6.

The Dentatus articulator is a class IIIA type, which is a nonarcon type of semi-adjustable articulator. The parts of articulator are depicted in Fig. 7.16.

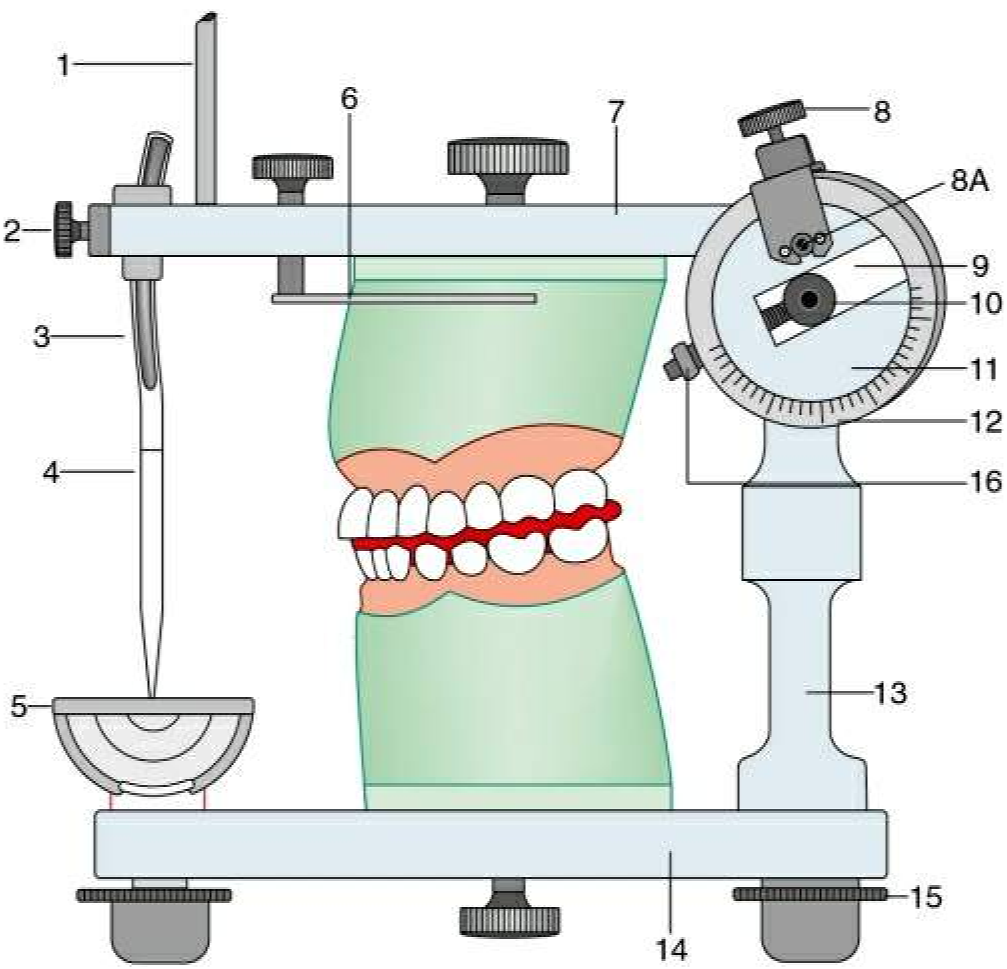


FIGURE 7.16 Parts of a Dentatus semi-adjustable articulator.

Parts of the Articulator

1. Support rod for upper member
2. Lock screw for incisal pin
3. Curved calibrated incisal pin
4. Midincisal groove
5. Incisal table (detachable)
6. Infraorbital plane indicator
7. Upper member
8. Lock nut for HCI, 8A – lock nut for condylar sphere
9. Condylar track or path
10. Condylar sphere
11. Condylar assembly
12. Calibration for horizontal condylar inclination (HCI)
13. Condylar post
14. Lower member
15. Lock nut for lateral condylar inclination (LCI)
16. Screw for moving condylar sphere
17. Calibration for lateral condylar inclination.

The instrument has the following features:

- Fixed intercondylar distance of 110 mm.
- Adjustable horizontal condylar inclination and lateral condylar inclination (Fig. 7.17).
- The incisal guide pin rests on an adjustable incisal table that can also be customized according to the patient's jaw movements. The incisal pin supplied with this articulator is calibrated and curved. The curve in the incisal pin is used to compensate the arc of closure, in dentate individuals, and also in post processing adjustment of complete dentures (Fig. 7.18).

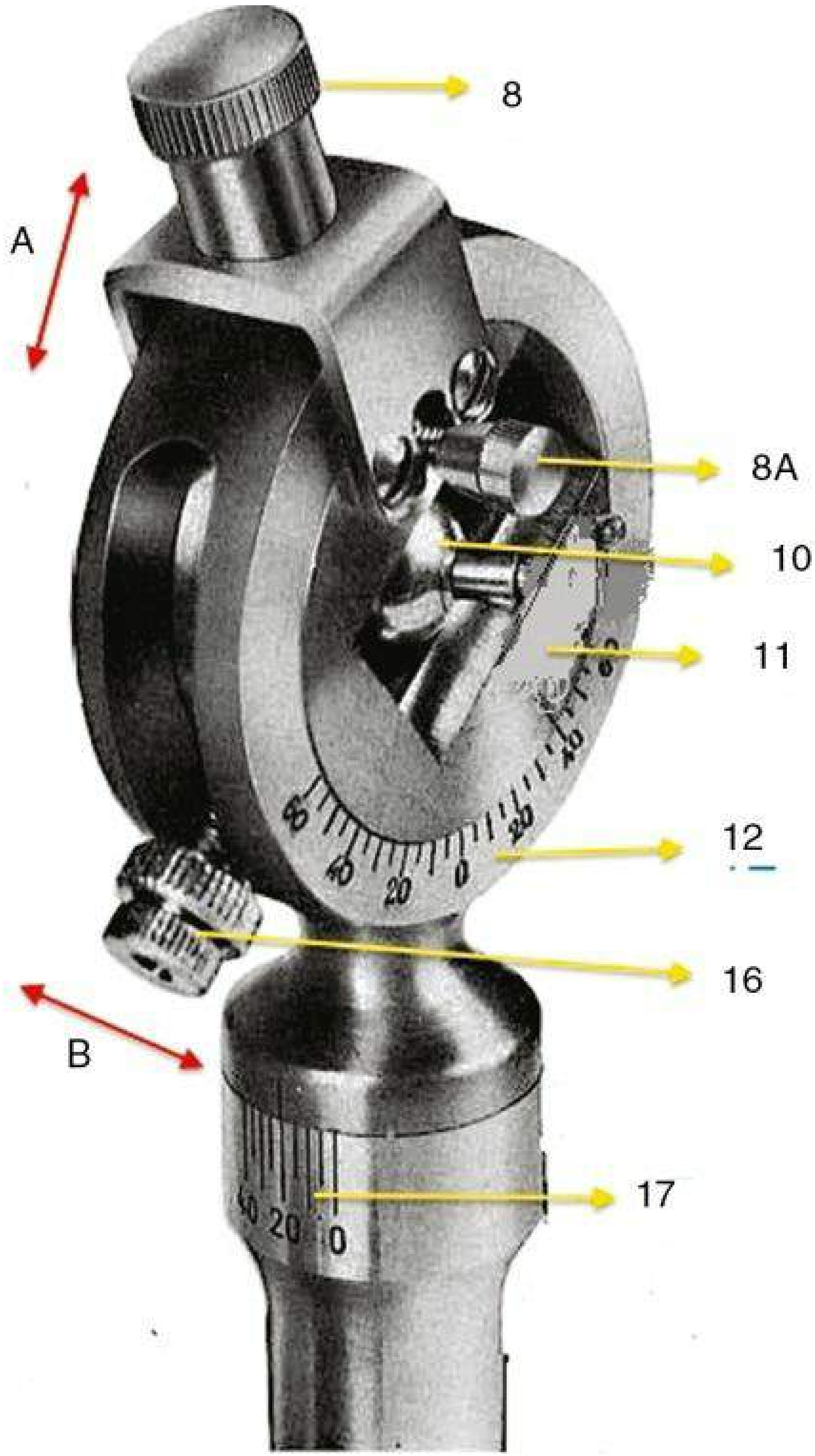


FIGURE 7.17 Condylar assembly showing the horizontal condylar calibration (12) and lateral condylar calibration (17). For adjusting HCI the condylar assembly is moved up and down as shown in arrow A. For adjusting the LCI the condylar

assembly is moved right and left as shown in arrow B. For zeroing of articulator the HCI and LCI angles are set at 40 and 20, respectively.

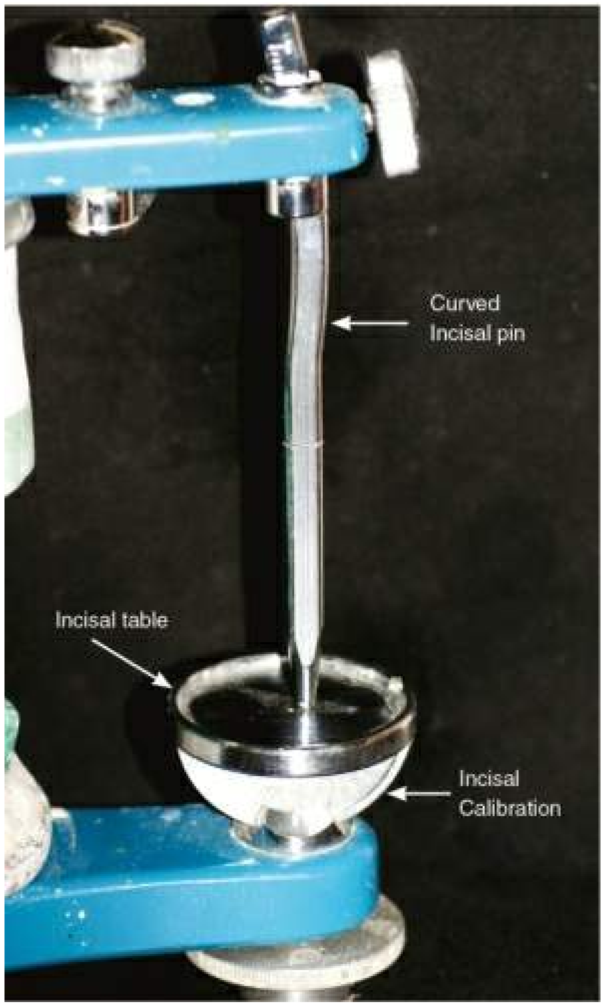


FIGURE 7.18 Incisal pin assembly – incisal pin adjustment screw, curved incisal pin, incisal table.

Laboratory procedures

The articulation using this semi-adjustable articulator starts with basic adjustment of the articulator controls. This is also called 'zeroing of the articulator' (as discussed in Chapter 6). The condylar element and the incisal tables are set at recommended positions (depending on the manufacturer) to prevent rotation of the movable parts of the articulator and the resultant errors during mounting procedure.

Recommended positions

Zeroing of the articulator on both sides.

1. The horizontal condylar inclination is set to 40° and the locknuts (8 and 8A in Fig. 7.17) are tightened.

2. The lateral condylar inclination is set to 20° and the locknut (15 in Fig. 7.16) is tightened.

3. Incisal pin is adjusted to align to the midline calibration on the incisal table.

4. The incisal guide table is set to zero degree and thumb nut is tightened.

Mounting of the maxillary cast

The facebow assembly is transferred to the articulator from the patient's mouth and the maxillary cast is mounted to the articulator using the obtained facebow records. This has been explained in detail in Chapter 6.

The following are verified after mounting the maxillary casts (Fig. 7.19):

1. Incisal pin should contact the midpoint of the incisal table.

2. The calibrated reading on both the condylar rods must be equal.

3. The midpoint of the wax rim, midpoint of the fork and the incisal pin should be in a straight line.

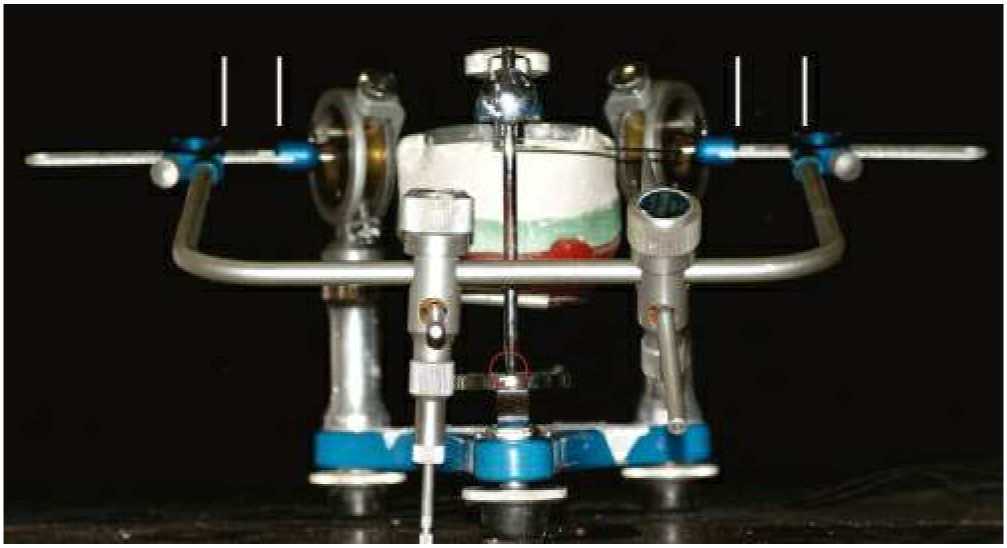


FIGURE 7.19 Check list after mounting the upper cast. (1) Incisal pin touching the incisal table. (2) Condylar rod reading equal on both sides. (3) Midline coincides with incisal pin.

Clinical procedure of recording the true centric will start with recording the tentative centric records by nick and notch method. The mandibular casts are mounted on the articulator and the gothic arch tracing devices are fixed to the wax occlusal rims. The tracings and the plaster record of the true centric is obtained as described in Chapter 6.

Using the centric plaster record from the tracings, the mandibular cast is rearticulated, i.e. the mandibular cast which was mounted using the nick and notch method will be disarticulated, and the cast will be articulated again.

Mounting of the mandibular cast

1. Maxillary and mandibular casts with their occlusal rims and tracers are assembled with the centric record. It is ensured no gaps exist between the wax rims and the centric record (Fig. 7.20). It is sometimes preferable to fasten this assembly with a rubber band.

2. The articulator is now inverted so that the maxillary jaw member of the articulator is in contact with the table (Fig. 7.21).

3. Place the wax rim assembly and also the mandibular cast. Close the

lower jaw member and make sure that there is enough space for the plaster (Fig. 7.22).

4. A well-proportioned mix of plaster is made and applied on the base of the mandibular cast (Fig. 7.23). The lower jaw member is slowly closed such that the incisal pin makes a contact with the table (Fig. 7.24). Secure the articulator in this position with the help of a rubber band.

5. After the plaster sets the excess of the plaster is trimmed and finished (Fig. 7.25A and B).

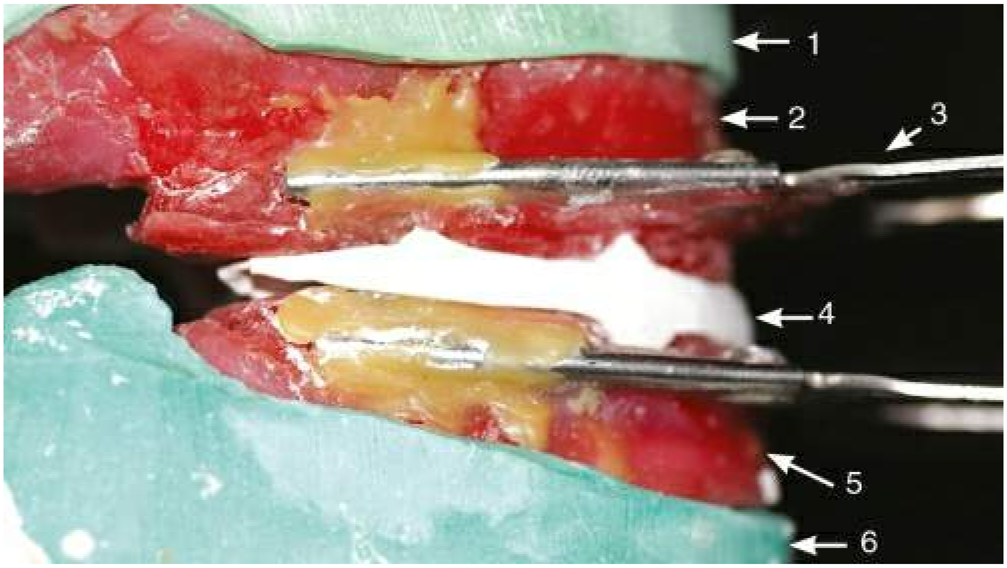


FIGURE 7.20 Interocclusal record. The assembly consisting of (1) maxillary cast, (2) maxillary occlusal rim, (3) tracers (4) interocclusal record – note there should be no gap between the wax and the record, (5) mandibular occlusal rim, (6) mandibular cast.

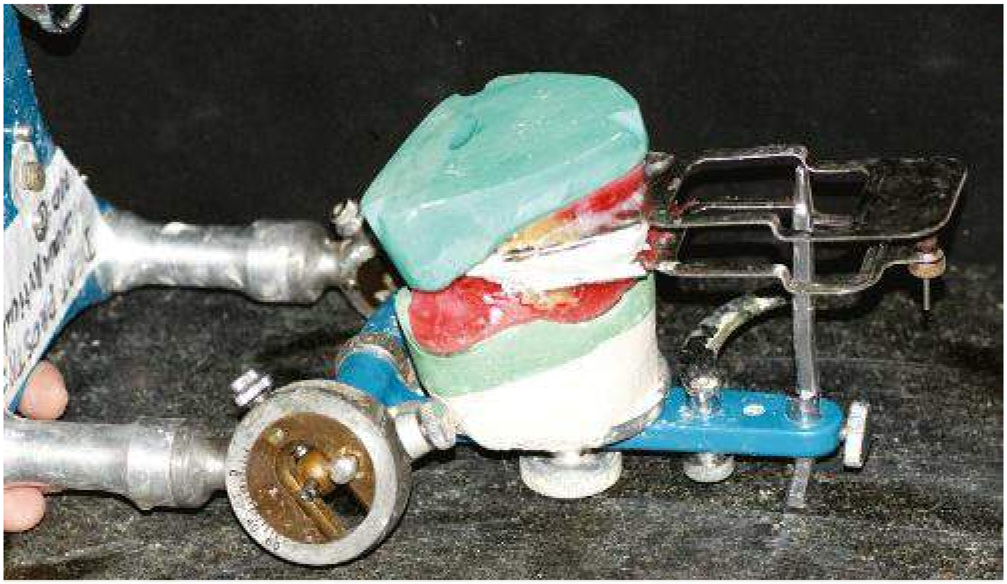


FIGURE 7.21 Mounting the mandibular cast. Articulator is inverted, occlusal rim with the records are secured in correct position.

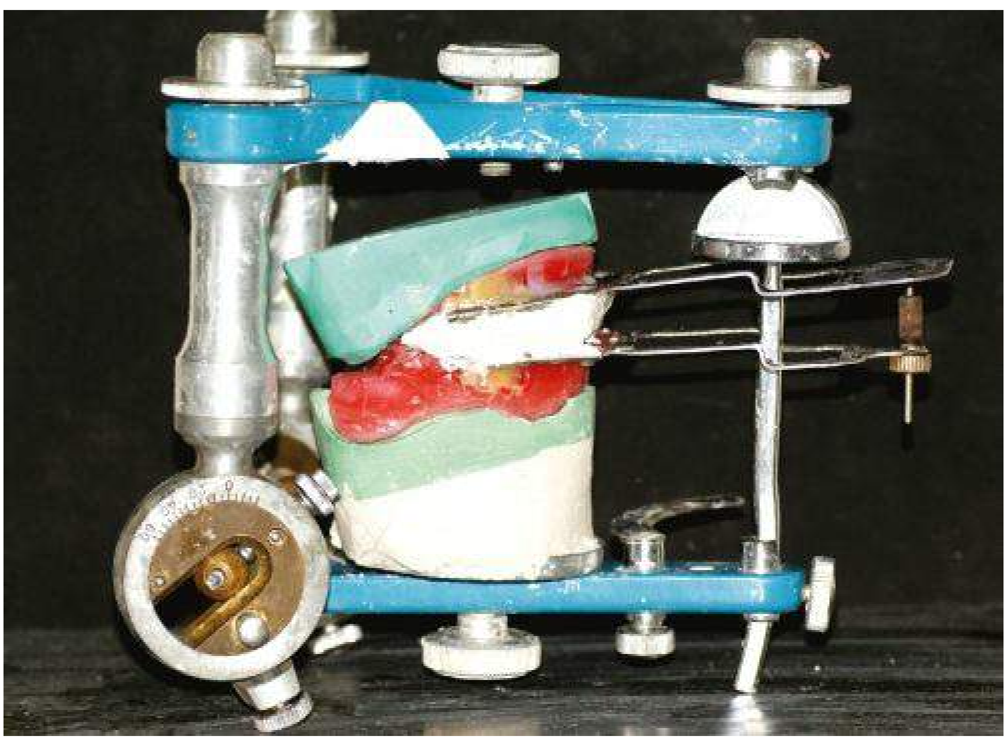


FIGURE 7.22 Lower member of the articulator in position to make sure that there is enough space for plaster.

FIGURE 7.23 Plaster placed on the base of the mandibular cast.

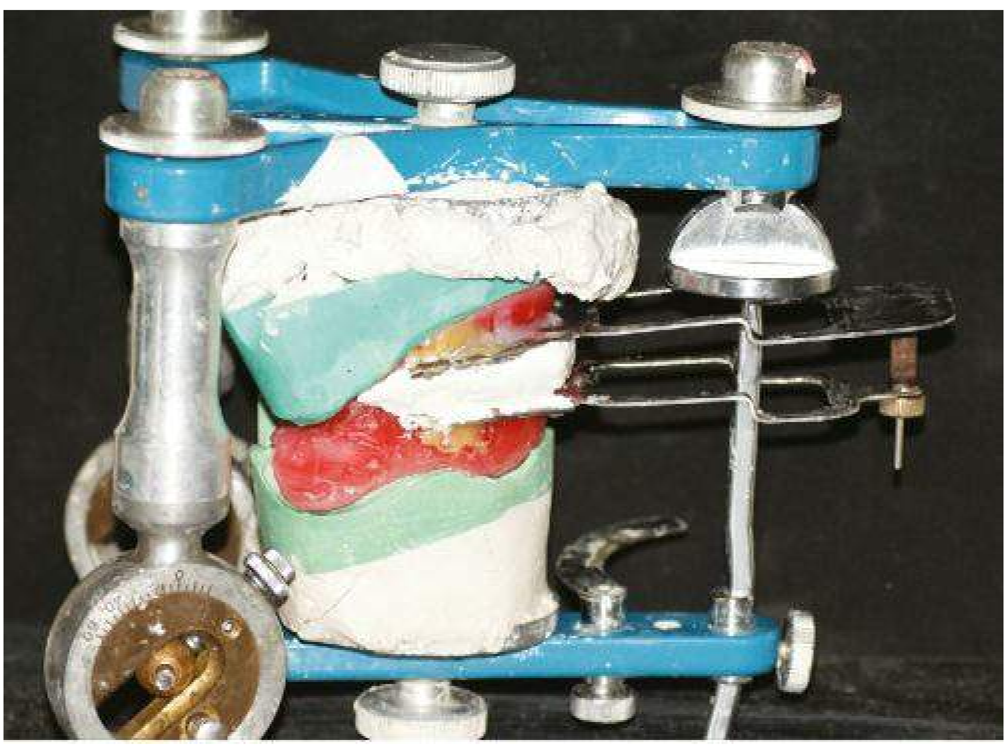
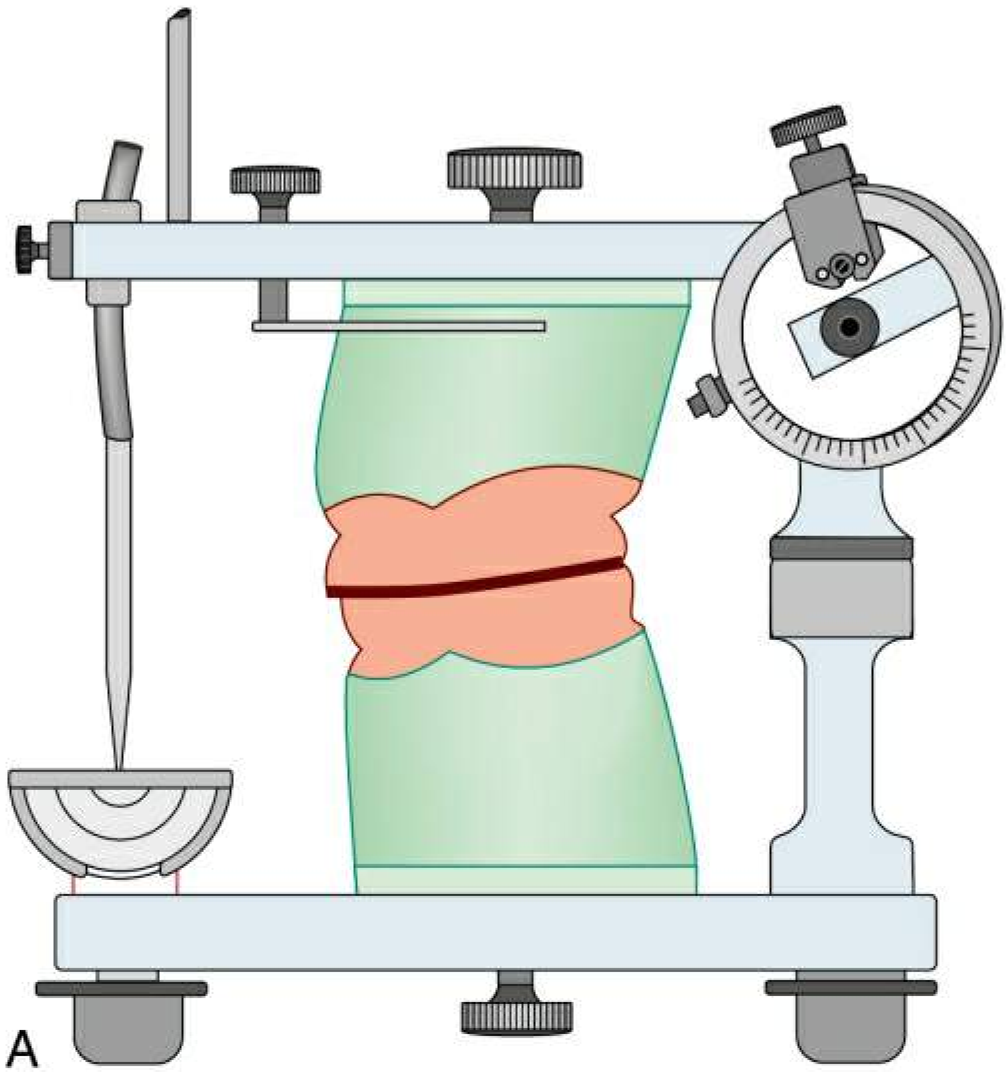


FIGURE 7.24 Lower member of the articulator closed, note the incisal pin touches the incisal table.



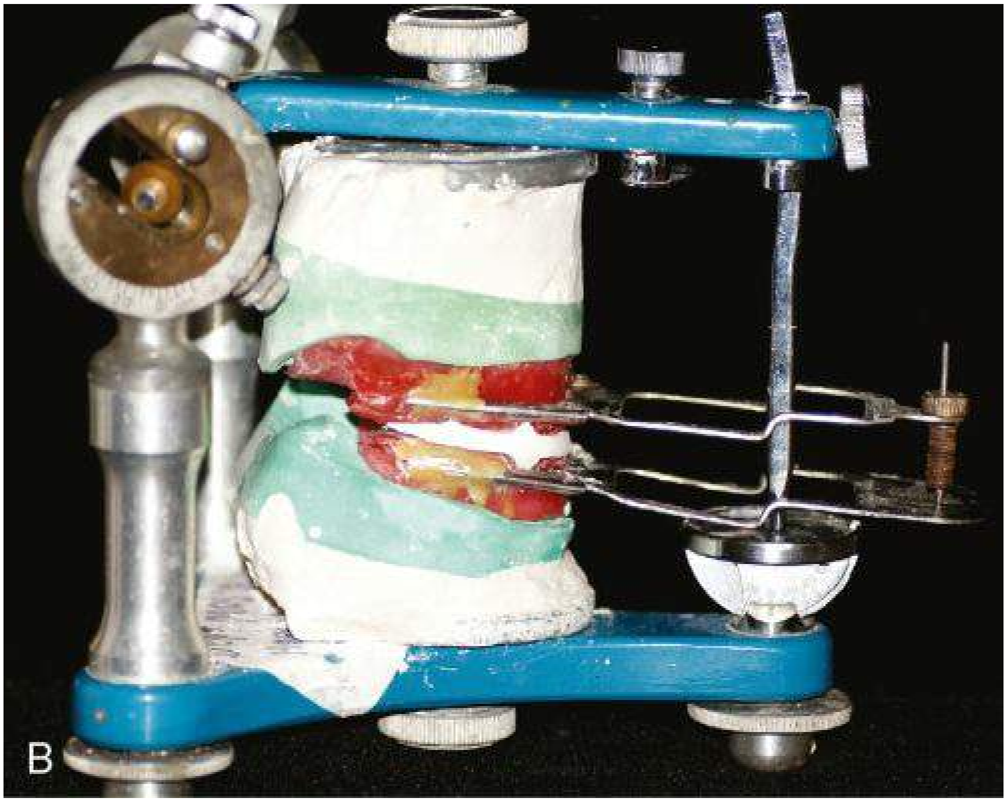


FIGURE 7.25 The excess plaster trimmed and articulation is completed **(A)** Line diagram **(B)** Picture.

Setting the horizontal condylar guidance

Once the mandibular cast is also mounted using the centric record, we have to set the protrusive horizontal condylar inclination (HCI) using the protrusive record. The protrusive record is now placed between the maxillary and mandibular rims but will not seat properly (Fig. 7.26). The following will be observed:

- The notches in the wax occlusal rims do not correspond to the elevations in the protrusive records.
- The incisal pin does not touch the incisal table.
- The stylus of the tracers do not contact the plates fixed in the mandibular occlusal rims.

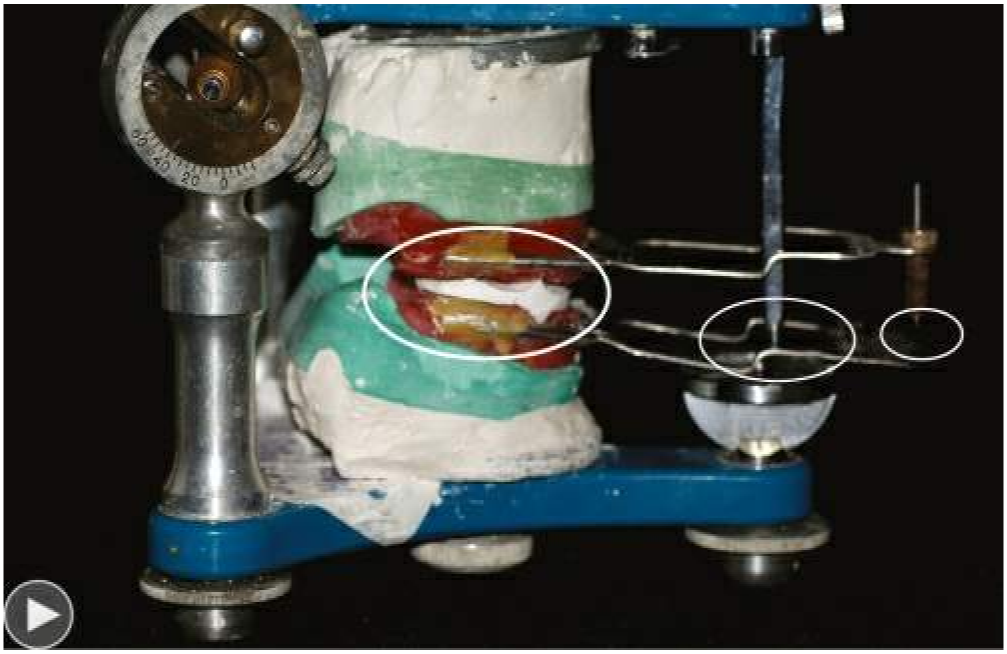


FIGURE 7.26 Protrusive record in place, before condylar adjustments. Note (1) the wax indentations do not coincide with elevations of the interocclusal record, (2) incisal pin not making contact with the incisal table, (3) stylus of the tracer not contacting the tracing table.

Now the lock nuts (Fig. 7.27) are loosened and the upper jaw member is adjusted till the maxillary and mandibular rims seat accurately over the record, incisal pin touches the incisal table and the stylus of the tracers coincide with the protrusive point of the gothic arch arrow head tracings. The angle which is now shown in the condylar assembly is the horizontal condylar guidance angle (Fig. 7.27).

FIGURE 7.27 After adjustment of the condylar angle note the protrusive record coinciding with the wax rims. Incisal pin and stylus of the tracer contacting their respective tables. The determined HCI is now 20° as shown.

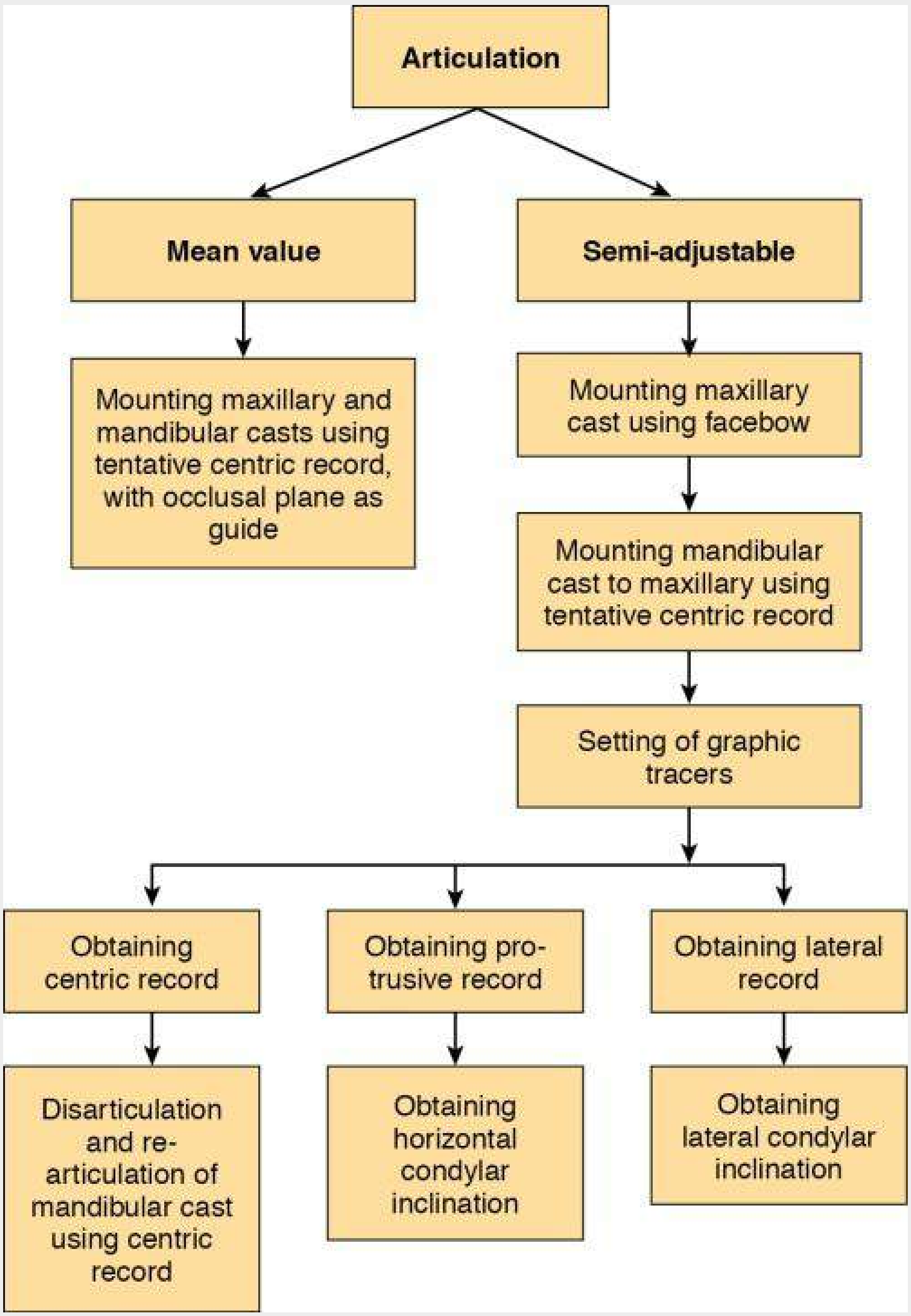
Setting the lateral condylar guidance

The lateral condylar guidance angle can be determined similarly using two lateral records (right and left) provided the articulator accepts the records (class IIIB). The right lateral record will set the condylar guidance for the left assembly and vice versa. Alternately, for class IIIA articulators, it can also be calculated using Hanau's formula: L = H/8 + 12, where L is the lateral condylar guidance angle and H is the horizontal guidance angle.

When these two angles are determined, the arrangement of artificial teeth can be commenced.

SUMMARY

Articulator is a device, which attempts to replicate the position of the condyle during various mandibular movements of the patient. The level of replication determines their adjustability. For complete dentures, the mean value articulator is used when occlusion with centric balance only is planned. The semi-adjustable articulators are used when eccentric balance is planned. When using a mean value articulator, articulation involves mounting the maxillary and mandibular casts with a tentative centric record using the occlusal plane as a guide. When using a semi-adjustable articulator, articulation involves mounting the maxillary cast using a facebow transfer, mounting the mandibular cast using a tentative centric record, attaching the tracers, obtaining centric, protrusive and lateral records, rearticulating the mandibular cast using the centric record, obtaining the horizontal condylar guidance angle using the protrusive record and obtaining the lateral condylar guidance angle using the lateral record (or using Hanau formula) (see Flowchart 7.1). These angles assist in determining the protrusive and lateral movements, which help in arranging the teeth in eccentric balance.



FLOWCHART 7.1 Steps involved in articulation using a mean value articulator and a semi-adjustable articulator.

CHAPTER 8

Occlusion

CHAPTER CONTENTS

Introduction

Occlusion: The static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues (GPT8).

Prior to selection and arrangement of the artificial teeth, the type of occlusal scheme is planned. It is important to understand the differences in occlusion between natural teeth and the complete dentures and their nature of transfer of forces. This chapter discusses the requirements of complete denture occlusion along with the various types and their influence on the tooth arrangement.

Difference between natural and complete denture occlusion

This is given in Table 8.1 and this forms the basis for developing occlusion for complete dentures such that they will function efficiently with least trauma to the supporting tissues.

Table 8.1

Differences in occlusion between natural teeth and complete dentures

Natural teeth	Complete denture
Incising with anterior teeth does not affect posteriors	Incising affects all the teeth
Presence of proprioception allows avoidance of prematurities and interferences and establishes a habitual occlusion	Interferences cannot be avoided due to lack of proprioception and the dentures will move on the bases
Second molar is the favoured area for mastication	Masticating in second molars will tilt the base; second premolar and first molar is the favoured area for mastication
Bilateral balanced occlusion does not exist	Balanced occlusion may be necessary to enhance stability
Teeth respond individually to forces of occlusion	All teeth respond as one unit and move on the bases
Malocclusion may not cause any damage for a long period	Malocclusion causes immediate damage
Nonvertical forces are well tolerated	Nonvertical forces are traumatic to supporting tissues

Requirements of complete denture occlusion

- Cutting and shearing efficiency of incisal and occlusal surfaces with sluiceways for escape of food.
- Minimal areas of contact for reduced force on ridges during mastication.
- Favourable tooth-to-ridge crest position for functional lever balance.
- Reduced posterior cusp height to control horizontal forces.
- Reduced buccolingual width of posterior teeth to decrease forces transmitted to residual ridge.
- Should have a surface to direct the forces of occlusion vertically.
- Occlusal forces should be directed towards the anteroposterior centre of the ridges.
- Occlusal plane parallel to the mean foundation plane.
- Allow settling of denture bases without interference or locking of cusps.
- No anterior teeth contact except during protrusion by providing adequate vertical and horizontal overlap and flat incisal guidance.
- Stability of occlusion in centric and eccentric relations.

Types of complete denture occlusion

These can be of three types.

Balanced occlusion

Definition: The bilateral, simultaneous, anterior and posterior occlusal contact of teeth in centric and eccentric positions (GPT8) (Figs 8.1–8.3).

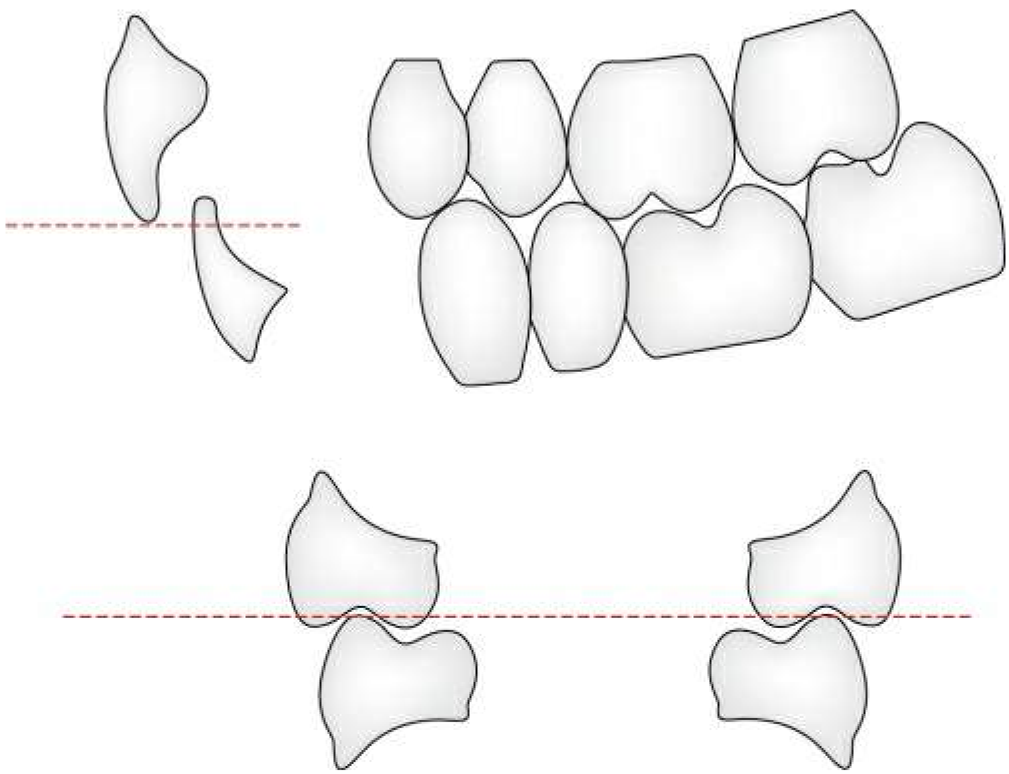


FIGURE 8.1 Balanced occlusion – showing posterior teeth contact in centric occlusion.

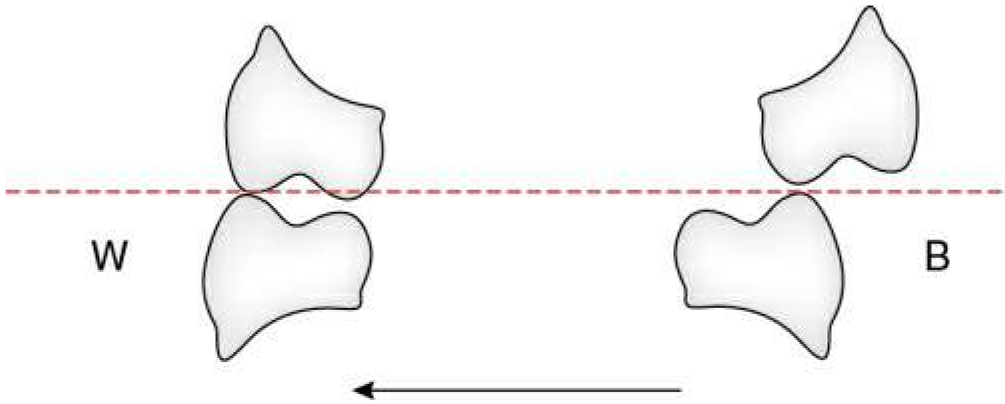


FIGURE 8.2 Balanced occlusion – showing posterior tooth contact on working and balancing side during lateral excursion.

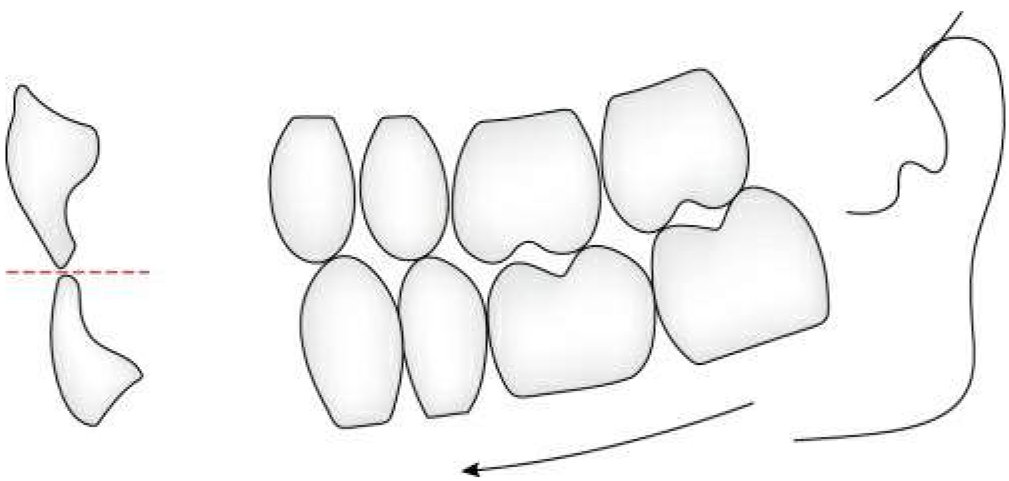


FIGURE 8.3 Balanced occlusion – showing anterior and posterior tooth contact in protrusion.

Balanced occlusion in complete dentures is unique as it does not occur with natural teeth. If it occurs in natural teeth, it is considered as a premature contact on the nonworking side and is considered pathologic. Usually anatomic teeth are used to arrange teeth in balanced occlusion. Nonanatomical teeth can be used with balancing ramps.

Importance

- It enhances the stability of the denture.
- The concept was originally put forth to enhance the retention of complete dentures during mastication. But it became apparent that even a grain of food on the working side eliminated balance on the nonworking side. It was aptly summarized as 'enter bolus, exit balance' by Sheppard. The rationale for balance was then altered. Balance is now deemed necessary during many excursive movements like swallowing saliva, closing to reseat dentures and bruxism, performed by patients in between meals. Mastication is performed only for about 10 min during the day, while the other eccentric contacts occur for hours during the day. Hence, if balance is not present, the bases could shift, tip or torque on their foundations during the eccentric movements and cause soreness and inflammation leading to accelerated bone resorption.
- Although some authors argue that these contacts other than mastication are not likely to be made with any great deal of force, it is seen that many patients enjoy comfort only when eccentric balance is present.
- Equal contact of all posterior teeth (centric occlusion) in centric relation is definitely essential to the health of the mucosa, though the same cannot be stated for contact in eccentric relations (balanced occlusion).
- **Lever balance**: This is the relation of the tooth to its base of support. It is important when a bolus of food is placed in between the teeth on one side and a space exists on the opposite side (Fig. 8.4). It is enhanced by the following:

  ○ Placing the teeth such that resultant direction of force on the chewing side is on the crest or slightly lingual.

○ Placing the teeth close to the ridge.

○ Denture base covering as wide an area as possible.

○ Reducing the buccolingual width of the teeth.

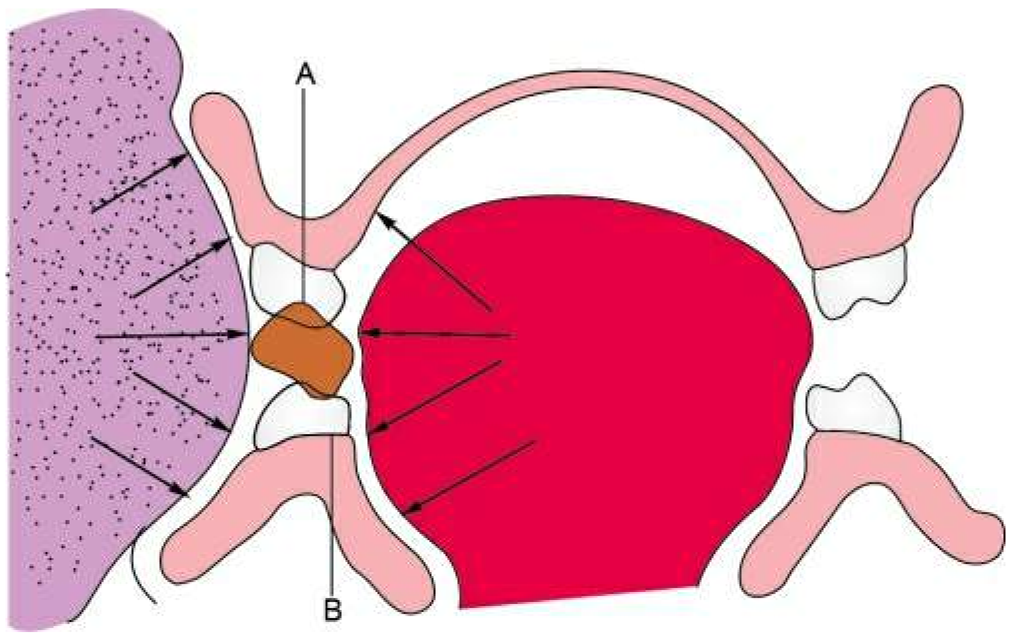


FIGURE 8.4 Bolus food (A) on one side creates a gap on opposite side. Lever balance is essential when this happens and resultant force (B) should be directed on the crest or slightly lingual.

Factors affecting balanced occlusion

The following five factors affect occlusal balance.

1. Condylar guidance

Definition: The mechanical form located in the upper posterior region of an articulator that controls movement of its mobile member (GPT8).
Condylar guide inclination: The angle formed by the inclination of a condylar guide control surface of an articulator and a specified

reference plane (GPT8).

- This is the mandibular guidance generated by the condyles traversing the contours of the glenoid fossa.
- It is duplicated in the articulator. The extent of duplication depends on the articulator's capability, whether it is semi-adjustable or fully adjustable (Fig. 8.5).
- Protrusive condylar guidance is obtained using protrusive records, while the lateral condylar guidance is obtained using Hanau's formula or lateral records (see Chapter 7).
- It is designated as an inclination or angle – condylar guidance angle or inclination – and is expressed in degrees.
- This is the only factor that is obtained from the patient and is not under the dentist's control.
- A shallow condylar guidance will cause less posterior tooth separation in protrusion and requires teeth with shorter cusps and flatter fossa to achieve balanced occlusion, than a steep guidance (Fig. 8.6A–C).

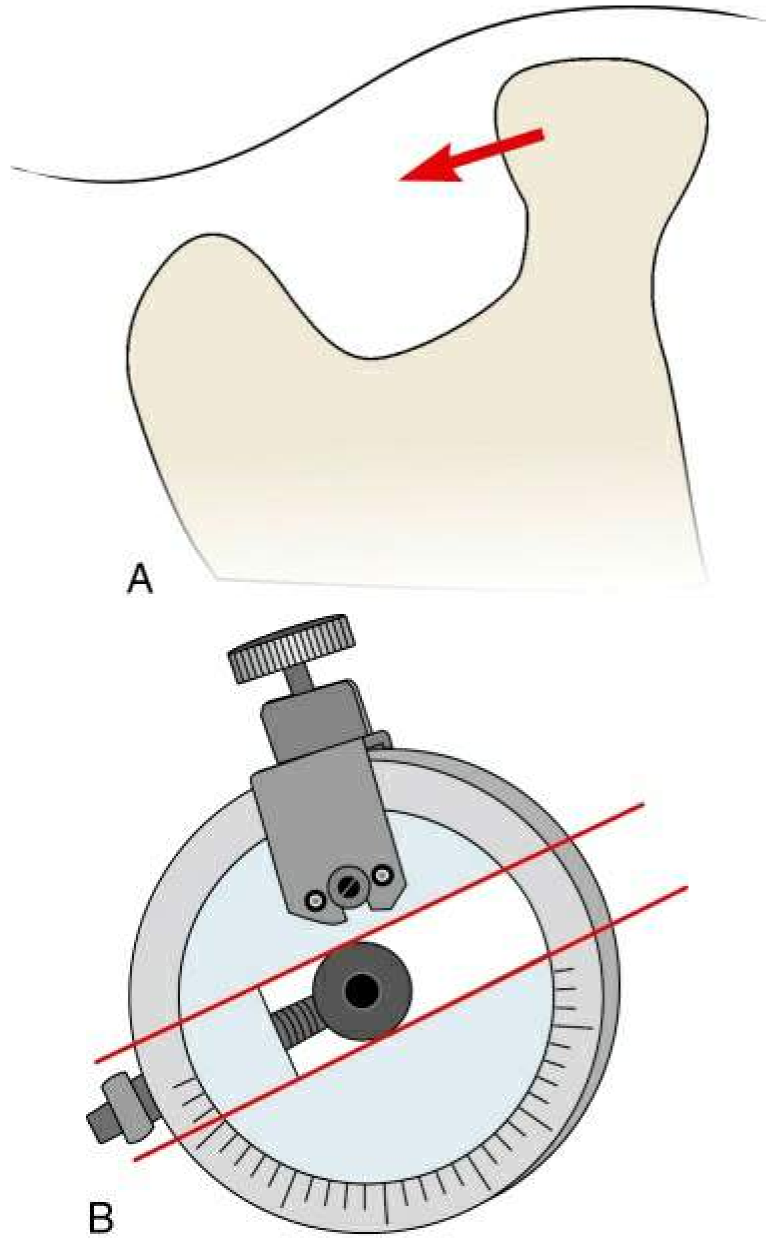
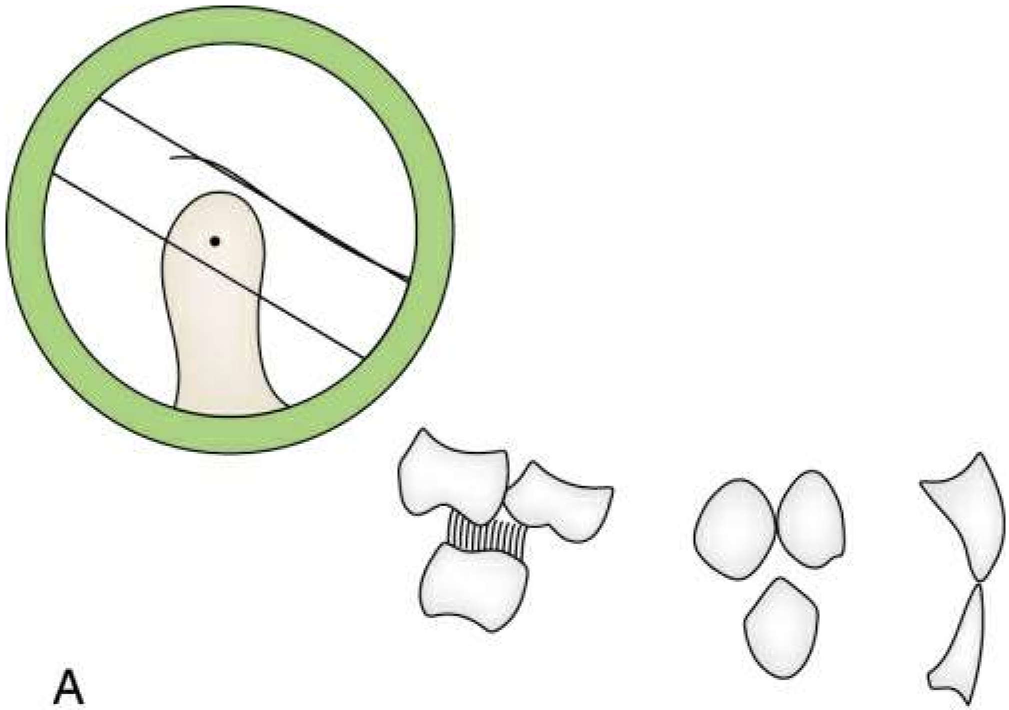


FIGURE 8.5 Simulation of condylar guidance in an articulator. **(A)** Movement of natural condyle. **(B)** Simulated by articulator.



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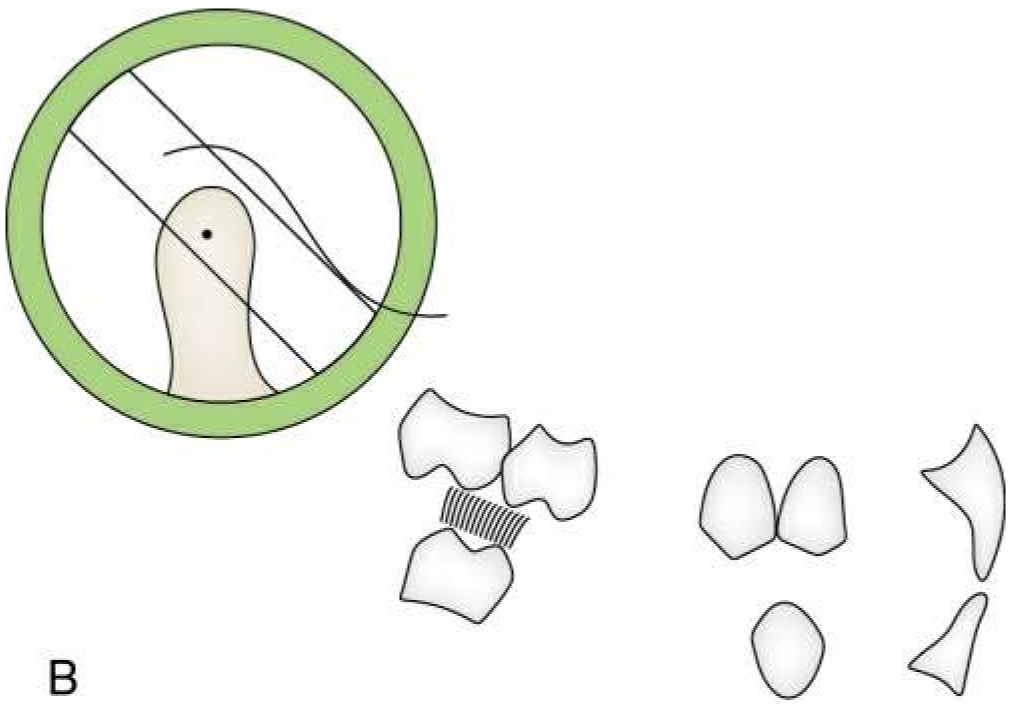

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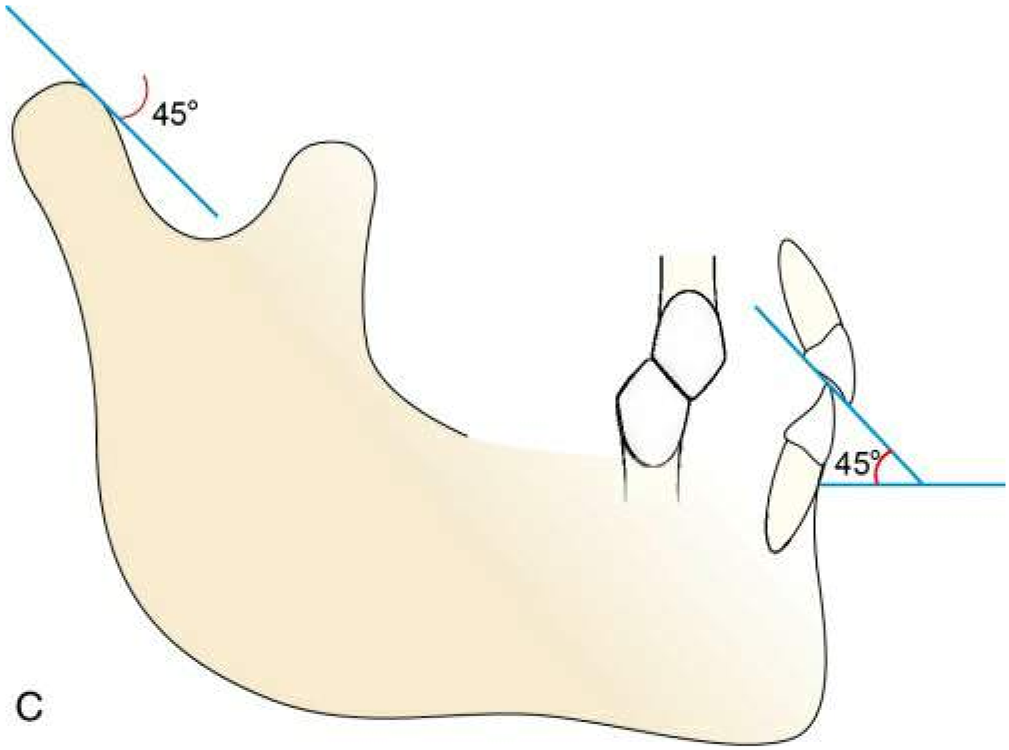


FIGURE 8.6 **(A)** Shallow condylar guidance causes lesser posterior tooth separation on protrusion. **(B)** Steep condylar guidance causes greater tooth separation on protrusion. **(C)** A steep condylar guidance requires teeth with longer cusps and deeper fossa to achieve balanced occlusion.

2. Incisal guidance

Definition: The influence of the contacting surfaces of the mandibular and maxillary anterior teeth on mandibular movements (GPT8).

Incisal guide angle: The angle formed between the horizontal plane of occlusion and a line drawn in the sagittal plane between the incisal edges of the maxillary and mandibular central incisors when teeth are in maximum intercuspation (Fig. 8.7).

- It is also expressed in degrees.
- It is established during try-in.
- If this angle is steep, it requires steep cusps, steep occlusal plane and a steep compensating curve to obtain occlusal balance. This is

detrimental to denture stability.

- Hence, it should be as flat (close to zero degrees) as aesthetics and phonetics will permit. It should never be greater than the condylar guidance.
- When a steep vertical overlap is required for the anterior teeth, a compensating horizontal overlap should be given to reduce the incisal guide angle (Fig. 8.8).

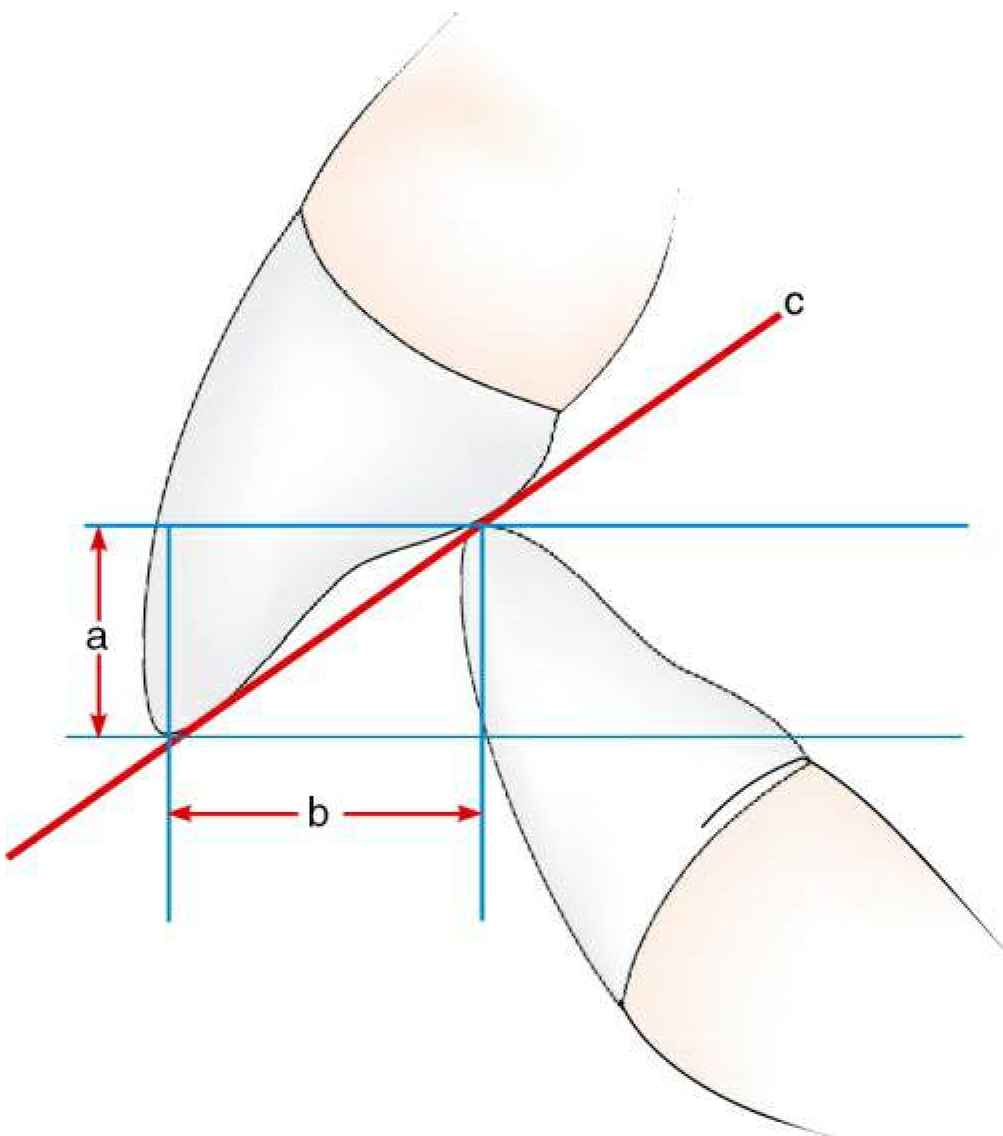


FIGURE 8.7 (a) Vertical overlap, (b) horizontal overlap, (c)

incisal guidance angle.

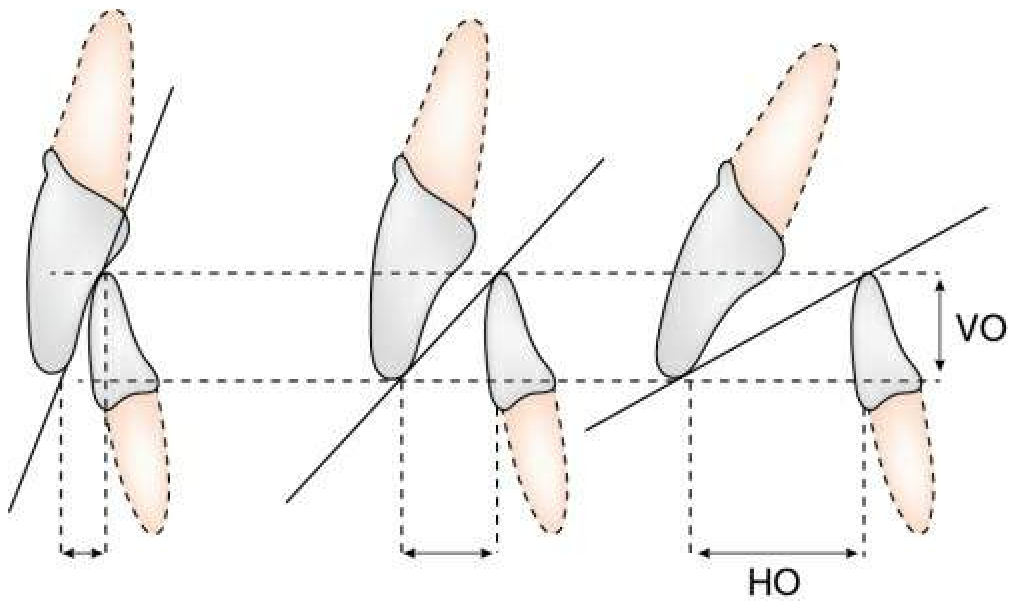


FIGURE 8.8 If a steep vertical overlap (VO) is required for aesthetics, a corresponding increase in horizontal overlap (HO) will help to decrease the incisal guidance angle.

3. Orientation of occlusal plane

Occlusal plane: The average plane established by the incisal and occlusal surfaces of the teeth. Generally, it is not a plane but represents the planar mean of the curvature of these surfaces (GPT8).

- It is established anteriorly by the height of the lower canine, which nearly coincides with the commissure of the mouth. Posteriorly it is established by the height of the retromolar pad.
- It is also related to the ala-tragus line (see Chapter 5).
- It must be oriented in the same relation as when natural teeth existed and hence there is not much scope to manoeuvre this factor.

4. Compensating curves

Definition: The anteroposterior and lateral curvatures in the alignment of the occluding surfaces and incisal edges of the artificial teeth that are used to develop a balanced occlusion (GPT).

- It is determined by the inclination of the posterior teeth and their vertical relationship to the occlusal plane. This results in a curve that is in harmony with the mandibular movements as dictated by the condylar guidance – both protrusive and lateral.
- A steep condylar guidance requires a steep compensating curve for occlusal balance otherwise it will lead to loss of balancing molar contact during protrusion and lateral excursion.
- The curves that assist in producing balanced occlusion are
  - Anteroposterior curve – run in anteroposterior direction and help in obtaining protrusive balance.
  - Mediolateral curves – run in a lateral direction from one side of the arch to the other and help in obtaining lateral balance.

Anteroposterior curve (curve of spee)

The anatomic curve established by the occlusal alignment of the teeth, as projected onto the median plane, beginning with the cusp tip of the mandibular canine and following the buccal cusp tips of the premolar and molar teeth, continuing through the anterior border of the mandibular ramus, ending with the anterior most portion of the mandibular condyle. First described by Ferdinand Graf Spee, German anatomist, in 1890 (GPT8) (Fig. 8.9).

- This curve assists in obtaining protrusive balance. Without this curve, it would be necessary to tilt the entire occlusal plane at an angle and raising it distally, to obtain balance. This will destabilize the upper denture and causes damage to the rugae area, increasing bone resorption in this area.

- The radius or steepness of the curve necessary to achieve balance is dependent on the incisal and condylar guidances. It is functionally and mechanically advantageous to keep it as modest or shallow as possible.

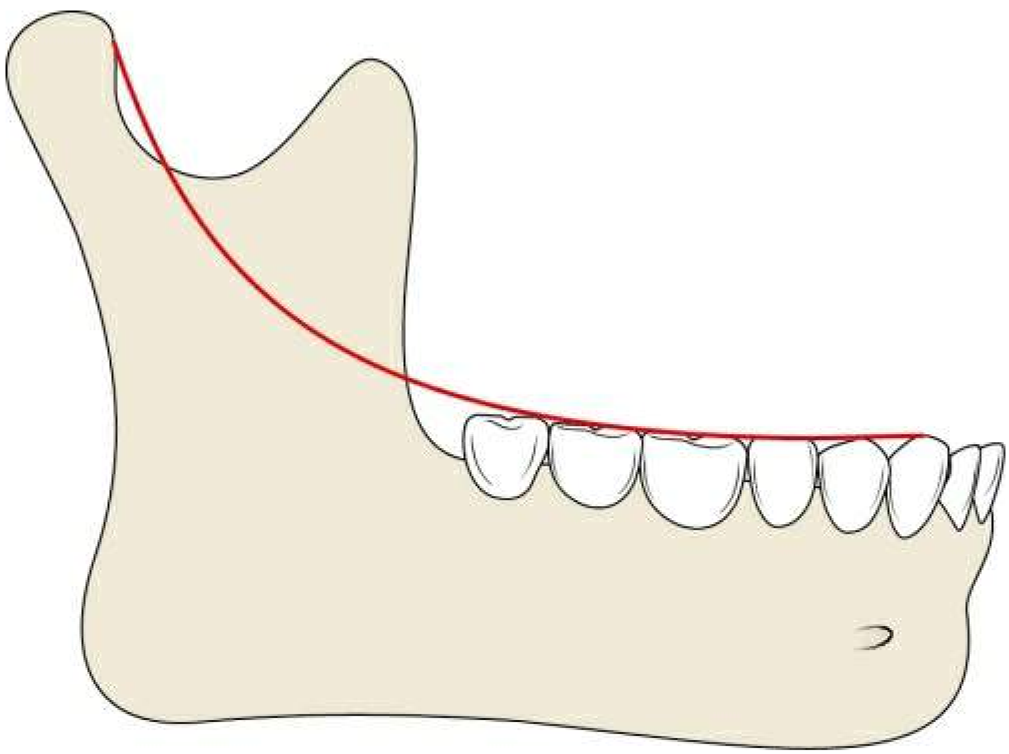


FIGURE 8.9 Curve of Spee.

Mediolateral curves

1. Curve of Wilson*:* This is a curve that is convex downwards. Wilson adopted this curve in setting the artificial teeth in balanced occlusion for complete dentures. It is used to arrange the molars. The lower teeth are inclined lingually, giving prominence to the buccal cusps and bringing them into heavy occlusal contact with the upper buccal cusp during lateral movements on the working side (Fig. 8.10). It is

named after George Wilson who described it in 1911.

2. Reverse curve or anti-Monson curve: A curve of occlusion that is convex upwards. This is usually used to arrange the first premolars (Fig. 8.11).

3. Curve of Monson: Curve of occlusion in which each cusp and incisal edge touches or conforms to a segment of the surface of a sphere 8 inches in diameter with its centre in the region of the glabella (GPT8).

It was described by George S. Monson, a US dentist. This curve in three dimensions is a combination of 'curve of Spee and curve of Wilson' (Fig. 8.12).

4. Pleasure curve: In excessive wear of the teeth, the obliteration of the cusps and formation of either flat or cupped-out occlusal surfaces, associated with the reversal of the occlusal plane of the premolar, first and second molar teeth (the third molars being generally unaffected), whereby the occlusal surfaces of the mandibular teeth slope facially instead of lingually and those of the maxillary teeth incline lingually (GPT8).

- This is a combination of Monson and anti-Monson curves. Hence, it is not a single curve but a combination of curves.
- It was used for arranging nonanatomic teeth in balanced occlusion.
- The premolars and the first molars are set in a reverse curve to prevent buccal tipping and seat the

denture.

○ Second molars are set in a conventional Monson's curve to provide eccentric lateral balance (Fig. 8.13).

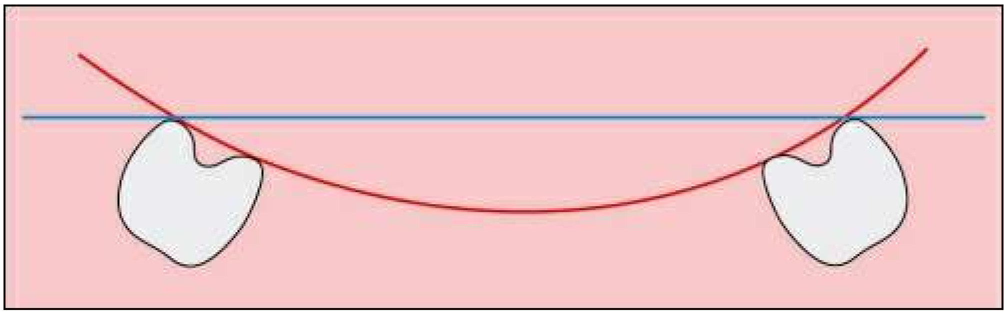


FIGURE 8.10 Curve of Wilson.

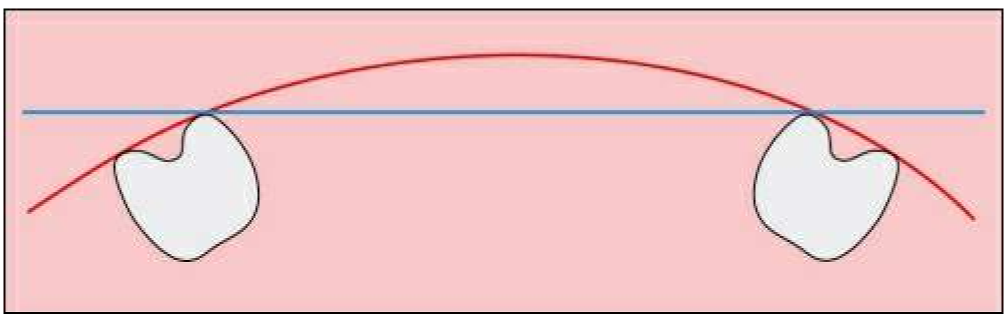


FIGURE 8.11 Reverse curve.

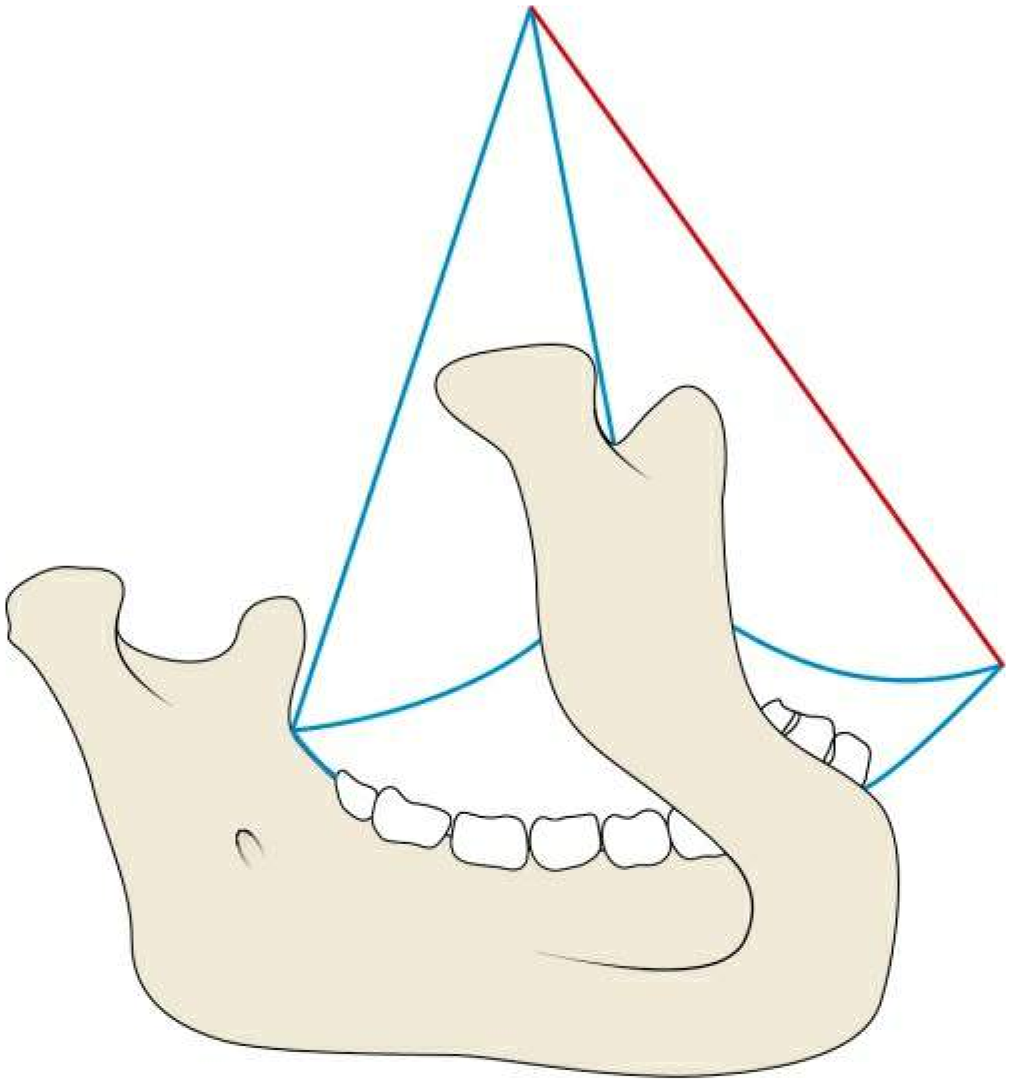


FIGURE 8.12 Monson's curves.

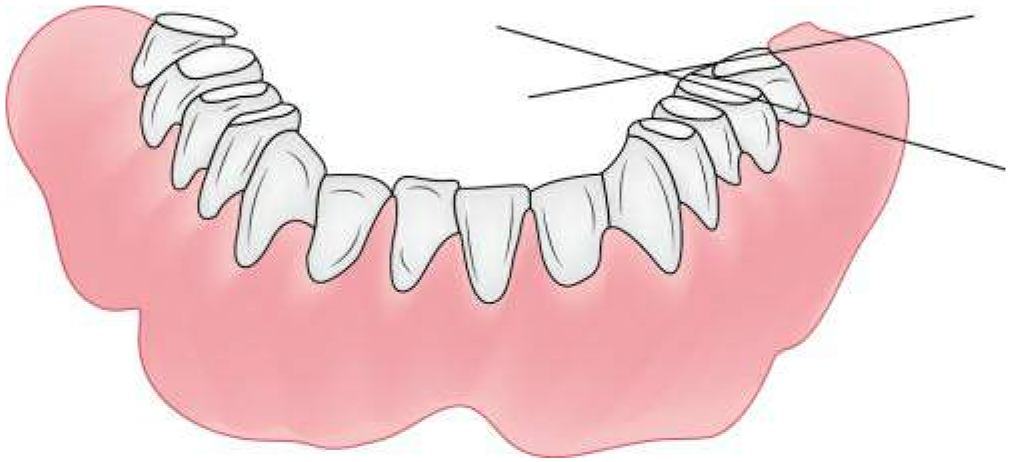


FIGURE 8.13 Pleasure curve. Premolars and I molar set in reverse curve, II molar set in Monson's curve.

5. Cuspal inclination

Definition: The angle made by the average slope of a cusp with the cusp plane measured mesiodistally or buccolingually; also called 'cusp angle' (GPT) (Fig. 8.14).

- This has effects on the occlusal plane and the compensating curves.
- The closer a tooth is located to incisal or condylar guidance, the more influence that guidance has on cuspal inclination of that tooth.
- In anatomic teeth, it is preferable to eliminate the mesiodistal cusp height, as then only the buccolingual inclines need to be considered for balanced arrangement.

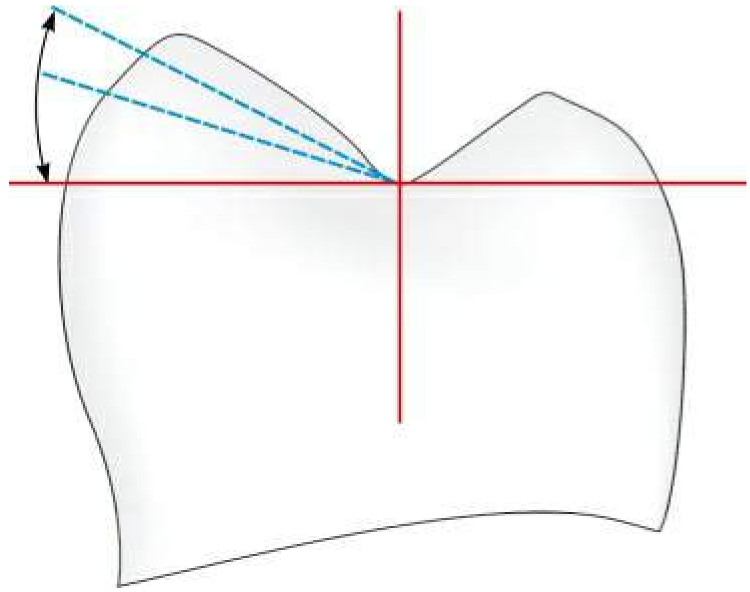


FIGURE 8.14 Cuspal angulations – determined by the angle which is formed by the incline of a cusp with the horizontal.

Hanau's quint

The above factors have also been described as Hanau's quint. Fig. 8.15 shows how each factor influences the other factors, thereby affecting balanced occlusion.

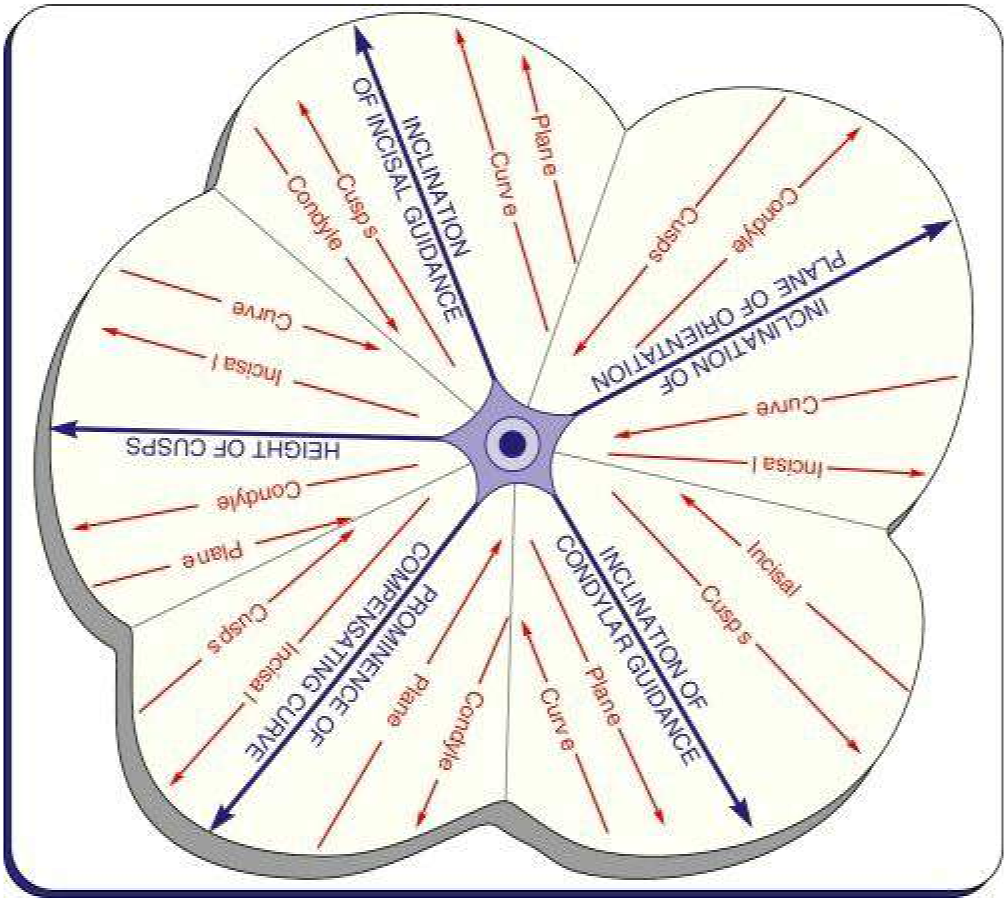


FIGURE 8.15 Hanau's quint.

Thielman's formula

This also describes the interrelationship of the 5 factors affecting balanced occlusion:

$$\text{Balanced occlusion (C)} = \frac{\text{Condylar Guidance} \times \text{Incisal guidance}}{\text{Occlusal plane} \times \text{Cuspal inclination} \times \text{Compensating curve}}$$

Monoplane occlusion

Definition: An occlusal arrangement wherein the posterior teeth have masticatory surfaces that lack any cuspal height (GPT8).

- This is an occlusal arrangement using nonanatomic teeth.
- This is based on the philosophy that by eliminating cusps, lateral forces on the denture will be reduced thereby enhancing denture stability.
- Anterior teeth are arranged with an overjet of 2 mm and no overbite.
- Although balanced occlusion in eccentric relations is not a part of the occlusal scheme, it may be developed using compensating curves and balancing ramps (Figs 8.16 and 8.17).
- To direct the force towards the centre of the ridge, the number of posterior teeth and their buccolingual width is reduced. Teeth are not placed on inclines in the second molar area (Fig. 8.18).
- **Advantages:**
  - Easy to arrange the teeth.
  - Simple nonadjustable articulator is sufficient.
  - Easier occlusal scheme to achieve especially in the following conditions:
    - Difficult to obtain accurate centric relation records (muscle incoordination)
    - Skeletal malocclusion
    - Severe residual ridge resorption

• **Disadvantages:**

○ Poor appearance (nonanatomic teeth)

○ Reported less chewing efficiency

○ Unstable dentures in patients with steep condylar guidance

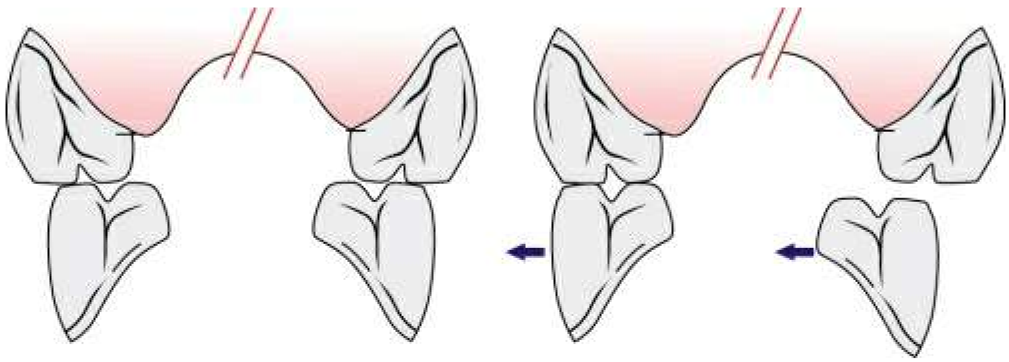


FIGURE 8.16 Monoplane occlusion. Left shows occlusion in centric, right shows occlusion in lateral excursion.

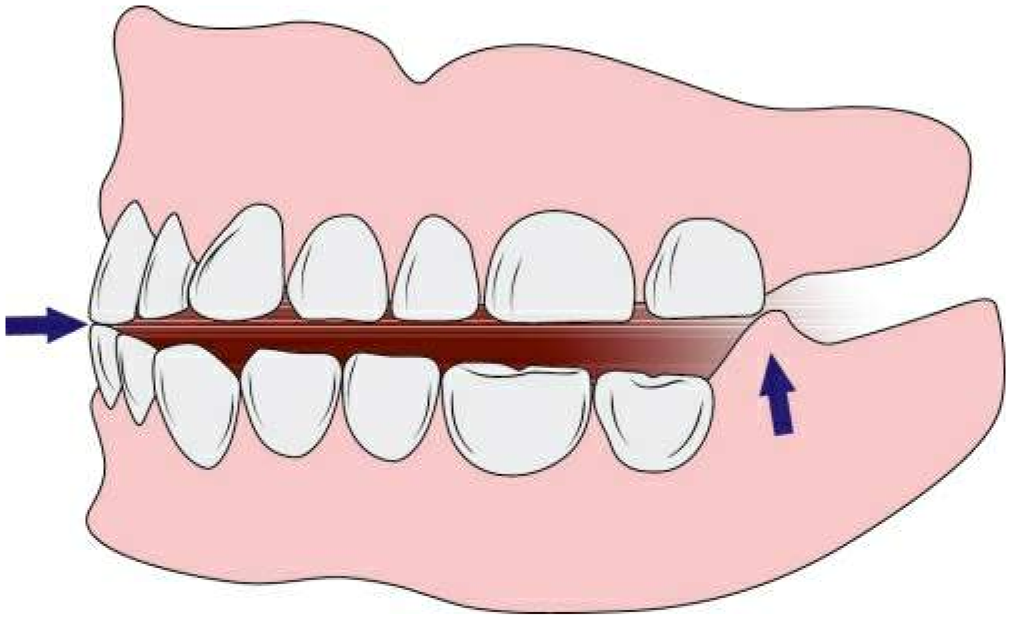


FIGURE 8.17 Balancing ramp used with monoplane teeth to achieve balance.

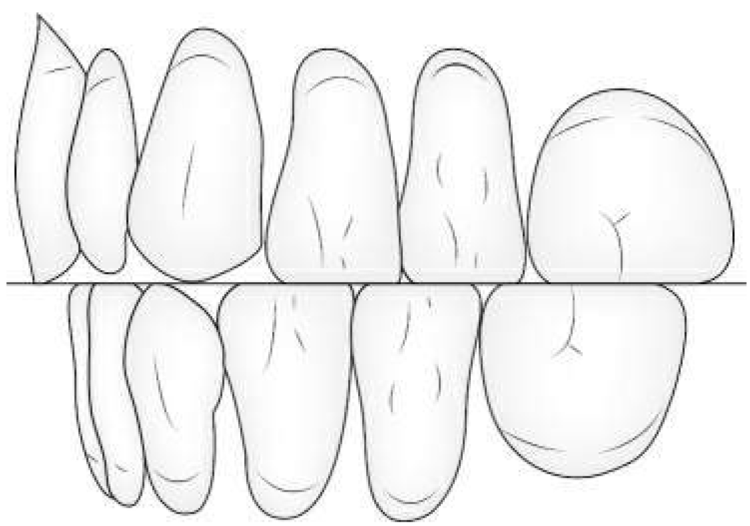


FIGURE 8.18 Reduced number of posterior teeth (buccal view).

Lingualized occlusion

Definition: This form of denture occlusion articulates the maxillary lingual cusps with the mandibular occlusal surfaces in centric working and nonworking mandibular positions. The term is attributed to Earl Pound and was first described by S. Howard Payne, in 1941 (GPT8).

- This combines the balanced occlusion and the monoplane concepts.
- Anatomic teeth are used in the maxillary arch and nonanatomic teeth are used for the mandibular arch.
- It differs from traditional fully balanced occlusal schemes by having only the palatal cusps of the maxillary teeth to contact the mandibular teeth in centric and eccentric relations (Fig. 8.19).
- All the five factors involved in balanced occlusion play a similar role in the arrangement of teeth with this scheme also.
- Manufacturers are now producing moulds for this concept specifically – Myerson Lingualized Integration (MLI).
- **Advantages:**

○ More natural appearance of upper premolar teeth.

○ Better chewing than monoplane occlusion.

- **Disadvantages:**

○ More challenging teeth arrangement than monoplane.

○ No scientific data to show improved stability.

○ Cannot be applied to difficult situations – muscular incoordination, severe ridge resorption and malrelated jaws.

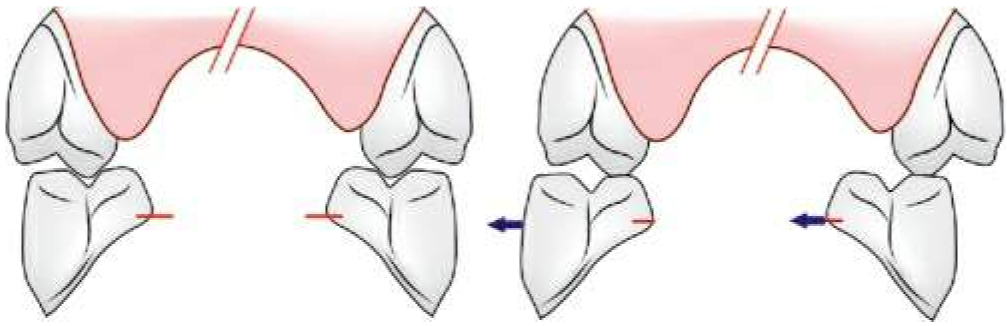


FIGURE 8.19 Lingualized occlusion. Left – centric contact, right – eccentric contact.

SUMMARY

The occlusal scheme selected should satisfy the aesthetic and functional needs of the patient. Anatomic teeth show slightly better chewing efficiency. The concept of bilateral balanced occlusion and its necessity has been debated for many years. Due to 'realeff' (resiliency like effect) of the mucosa and the ability of the patient to alter their chewing pattern to suit a centric balance, balanced occlusion in eccentric relations has not had many takers in general dental practice. Patients do seem to have more comfort with eccentric balance, though there is no documented evidence for this. Even a minimum of three point contact – one anteriorly and two posteriorly on either side, may provide some balance in eccentric relations to enhance denture stability. The basic requirement is certainly to provide even maximum intercuspal contact of all the posterior teeth in centric relation (centric occlusion), along with a no contact of the anterior teeth.

CHAPTER 9

Selection of artificial teeth

CHAPTER CONTENTS

Introduction

Following the mounting of casts on the articulator and determining the type of occlusal scheme, the next procedure in the fabrication of complete dentures is selection of artificial teeth. Anterior teeth are primarily selected for aesthetics, while the posterior teeth are selected for mastication. Both must function in harmony with each other and with the surrounding oral environment. The type of occlusal scheme planned also dictates the selection of posterior teeth.

Although there is again no single rule of the thumb to decide the selection, it certainly requires artistic skill in addition to scientific knowledge.

Objectives

The following are the main objectives in selecting artificial teeth:

- To establish harmony with surrounding tissue.
- Maintenance of vertical dimension.
- Aesthetic acceptability.
- Masticatory efficiency.

Selection of anterior teeth

The anterior teeth are selected according to the following factors.

Size

The following factors guide and contribute to anterior teeth selection.

Size of face and head

- The average combined width of the maxillary anterior teeth is determined by dividing the bizygomatic width by 3.3. (Pound stated that zygoma was mostly present 1–1.5 inches behind the lateral corner of the eyes.)
- The average width of the maxillary central incisor is determined by dividing the bizygomatic width by 16 (Fig. 9.1).
- The ratio of the cranial circumference (glabella to occiput) to the width of upper anterior teeth has been shown to be 10:1 (Fig. 9.2).
- The average length of the maxillary central incisor is determined by dividing the length of the face by 16. Length of the face is a measure of distance from the hairline to the lower edge of the bone of the chin, with the face at rest.

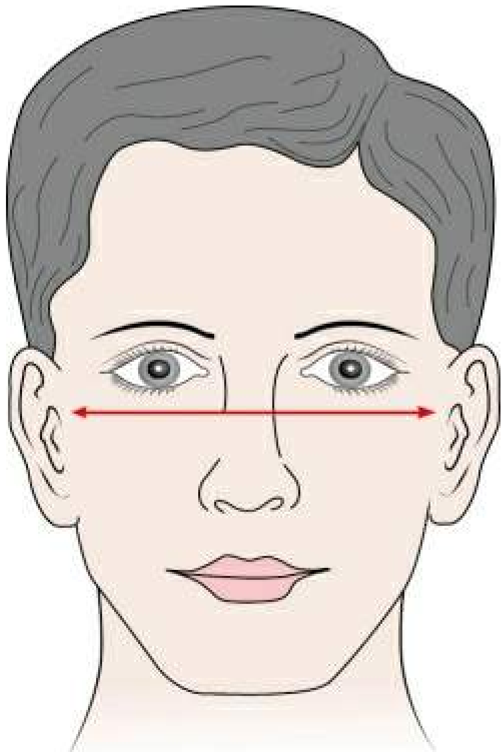


FIGURE 9.1 Bizygomatic width – used to determine the width of maxillary anterior teeth and the average width of maxillary central incisor.

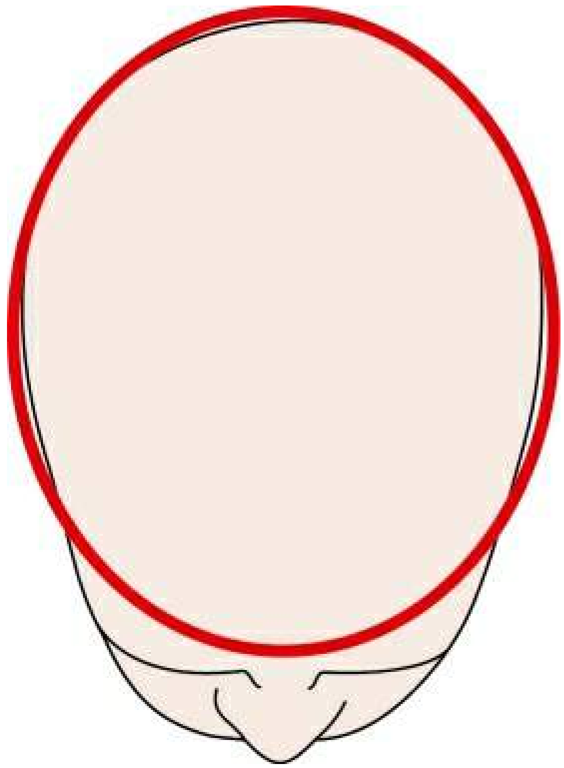


FIGURE 9.2 Cranial circumference – used to determine the width of upper anterior teeth.

Anatomical landmarks

- Mark or pin is placed at the *corners of the mouth* on the wax occlusal rims. The width of the maxillary anterior arch is determined by measuring the distance from the two marks with a flexible ruler (Fig. 9.3).

- Parallel lines are extended from the *lateral surface* of **the ala of the nose** onto the maxillary occlusal rim. This line tentatively gives the position of apex of canine teeth indicating the width of the maxillary anteriors (Fig. 9.4).

- Through the distal border of **incisive papilla** a line is drawn perpendicular to the midline of palate and continued onto the edge of master cast. The tips of the canine teeth should lie near the point of intersection of this line with the labial surface of the occlusal rim.

A flexible ruler can be used to measure this distance (Fig. 9.5).

- If the **cuspid eminences** are evident, a line placed at its distal termination in the cast gives a measure of the anterior maxillary arch. If the eminences are not evident, the **buccal frenum** can be used as a guide for the arch.

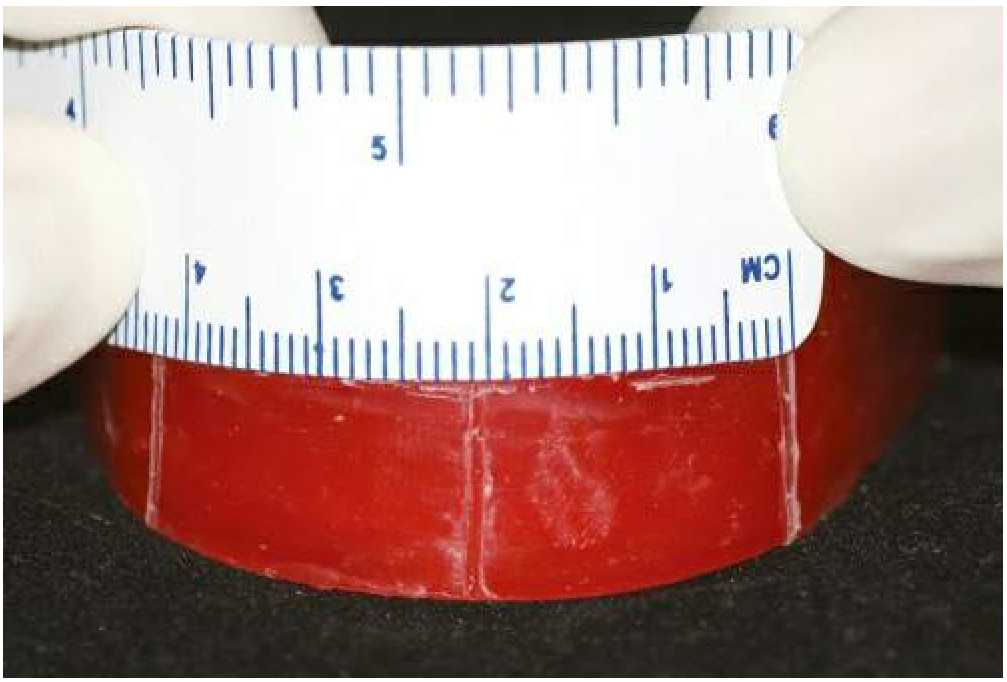


FIGURE 9.3 Corners of the mouth are marked on occlusal rims; this determines the width of maxillary anterior arch.

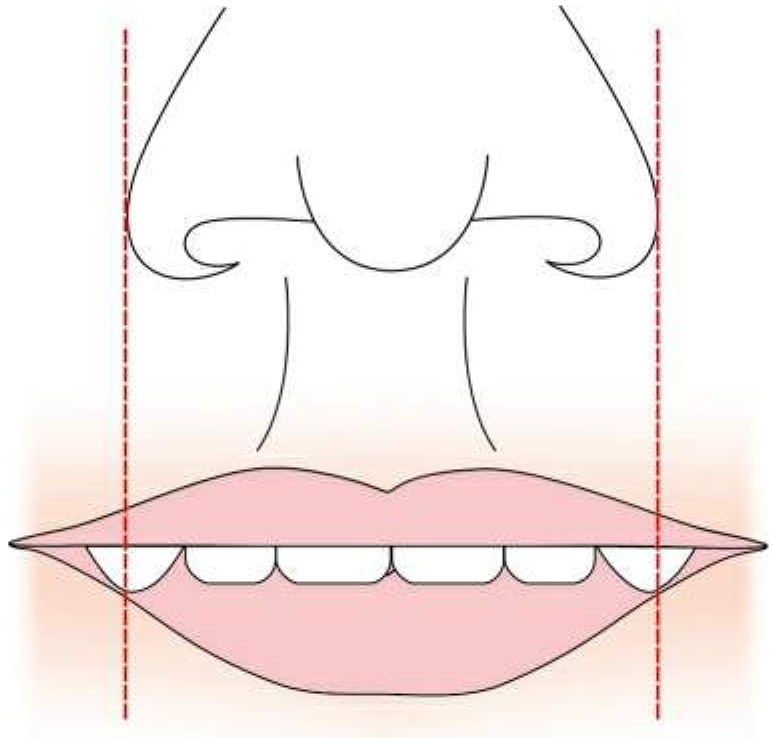


FIGURE 9.4 Positioning apex of the canine teeth on the parallel lines extending from ala of the nose.

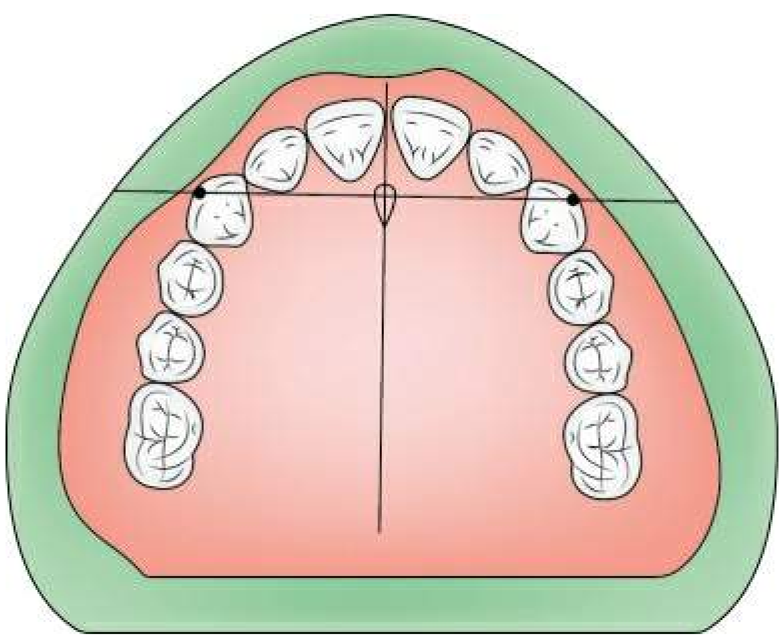


FIGURE 9.5 Tip of maxillary canine is positioned on the

intersection of a line drawn through distal border of incisive papilla and labial surface of occlusal rim.

Maxillomandibular relations

- In class III arches, the mandibular anterior teeth are selected larger than normal.
- In class II arches, the mandibular anterior are selected smaller than normal.

Contour of the residual ridges

- The artificial teeth should be placed to follow the contour of the residual ridges that existed when the natural teeth were present (Fig. 9.6). Thus the size of anterior teeth is selected according to this position. The loss of contour as a result of resorption, accident or surgery may make this a difficult task. Resorption of the maxillae anteriorly is in a vertical and palatal direction, while posteriorly it is in a vertical and medial direction. Resorption of the mandible anteriorly is in a vertical and lingual direction, while posteriorly it is in a vertical and slightly lingual direction (Fig. 9.6).
- There also may be a relationship between the form of the residual ridge and the form of the teeth – square, tapering and ovoid (Fig. 9.7).

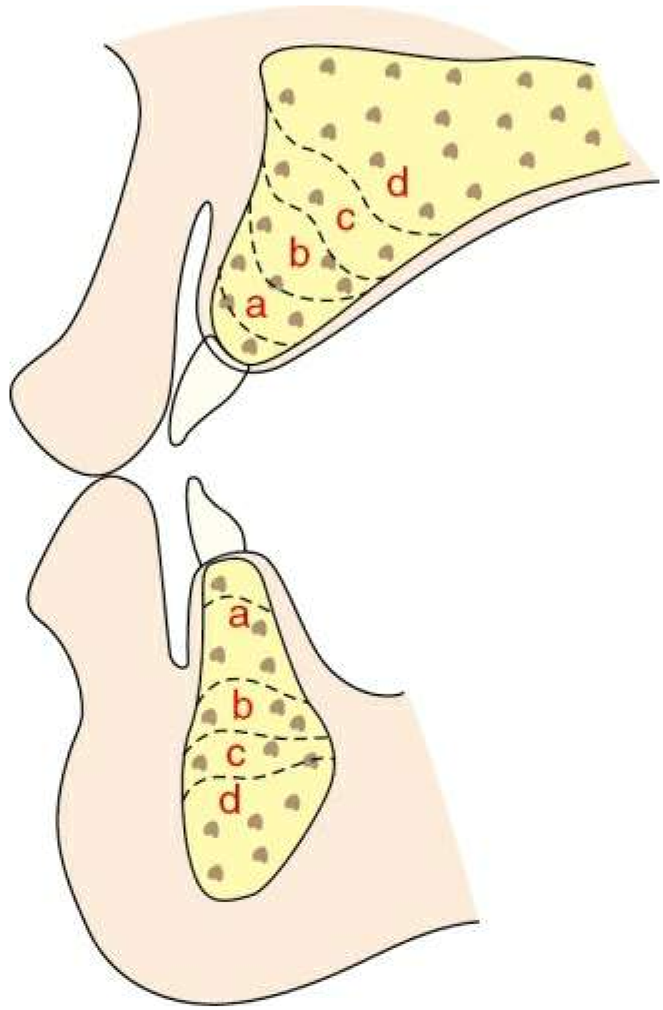


FIGURE 9.6 a–d show the resorption pattern. Irrespective of the amount of resorption, the artificial tooth should be set in the place where the natural teeth existed.

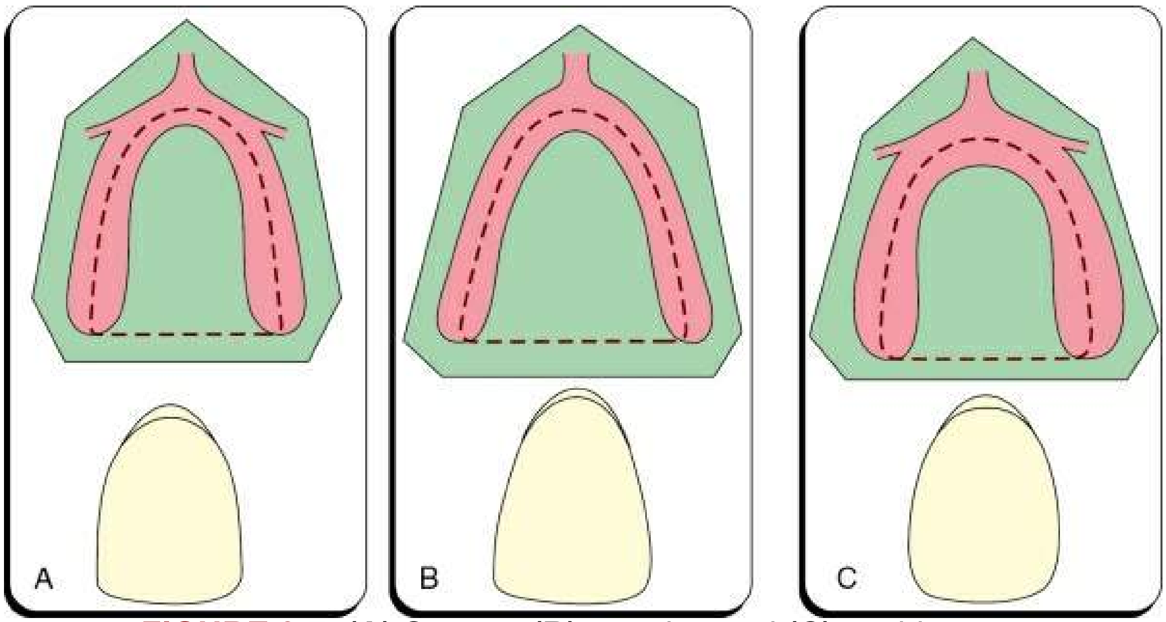


FIGURE 9.7 **(A)** Square, **(B)** tapering and **(C)** ovoid.

Vertical distance between the ridges

- This determines the length of the teeth. When space is available, it is more aesthetically acceptable to use teeth that are long enough to eliminate the display of denture base (Fig. 9.8 A and B).

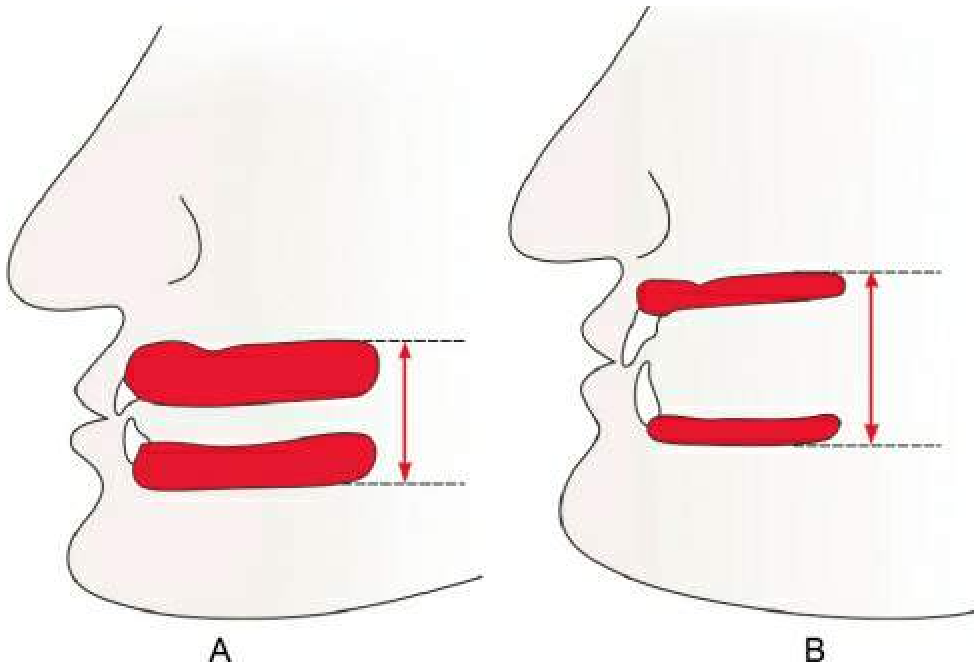


FIGURE 9.8 **(A)** When interridge distance is less, shorter teeth are used. **(B)** When interridge distance is more, longer teeth should be used so that display of denture base is less (more aesthetic).

Lips

- This again guides the selection of length of maxillary anterior teeth.
- At rest, the relationship of incisal edges of the central incisors to the lip line is given in Table 9.1 (Frush and Fischer, 1958). This depends on the age and sex of the individual (Fig. 9.9 A and B).
- In speech, the incisal edges of the maxillary anterior teeth should contact the lower lip at the junction of the moist and dry surfaces of the vermilion border, when the patient pronounces the letter ‘f’.


A

FIGURE 9.9 Amount of tooth visible below the upper lip should be more in **(A)** a young patient than **(B)** an elderly patient.

Table 9.1

Amount of tooth exposure depending on age and sex of individual

Type of individual	Amount of tooth exposure below lip line at rest
Young female	3 mm
Young male	2 mm
Middle aged	1–1.5 mm
Elderly	0–2 mm above lip line at rest

Pre-extraction records

These can provide information about the size and form of both anterior teeth. These include:

- **Facial photographs:** Provide general information about the width and outline form of anterior teeth through an algebraic proportion. By comparing, clearly visible factors like interpupillary distance of patient in photo and in person with the tooth width in photo, the actual width of the anterior tooth can be calculated.

- **Diagnostic casts:** Casts of patient's natural or restored dentition provide information, which is useful to select the size and form of anterior teeth.

- **Radiographs:** They can provide information about the size and form of teeth.

- **Teeth of close relatives:** Son's or daughter's tooth size, colour and arrangement can be effectively used in selecting and arranging artificial teeth for their parents.

- **Extracted teeth:** Provide information about the size and form; should not be used for selecting colour.

Form

The form or shape of the anterior teeth is selected according to

1. Form and contour of face

2. Dentogenic concept

3. Pre-extraction records.

Form and contour of face

• The form of a tooth should conform to the contour of the face as viewed from the front and side (profile) (Figs 9.10 and 9.11).

• According to Leon William's classification, facial forms can be categorized as square, square tapering, tapering and ovoid, when viewed from front. Three areas in the face are considered for this – temporal, zygomatic and angle of mandible. (See Fig. 2.1, Chapter 2.)

• To determine the facial profile, forehead, base of nose and chin points are considered. The profiles can be classified as – straight or convex and teeth are selected accordingly. (See also Fig. 2.2, Chapter 2.)

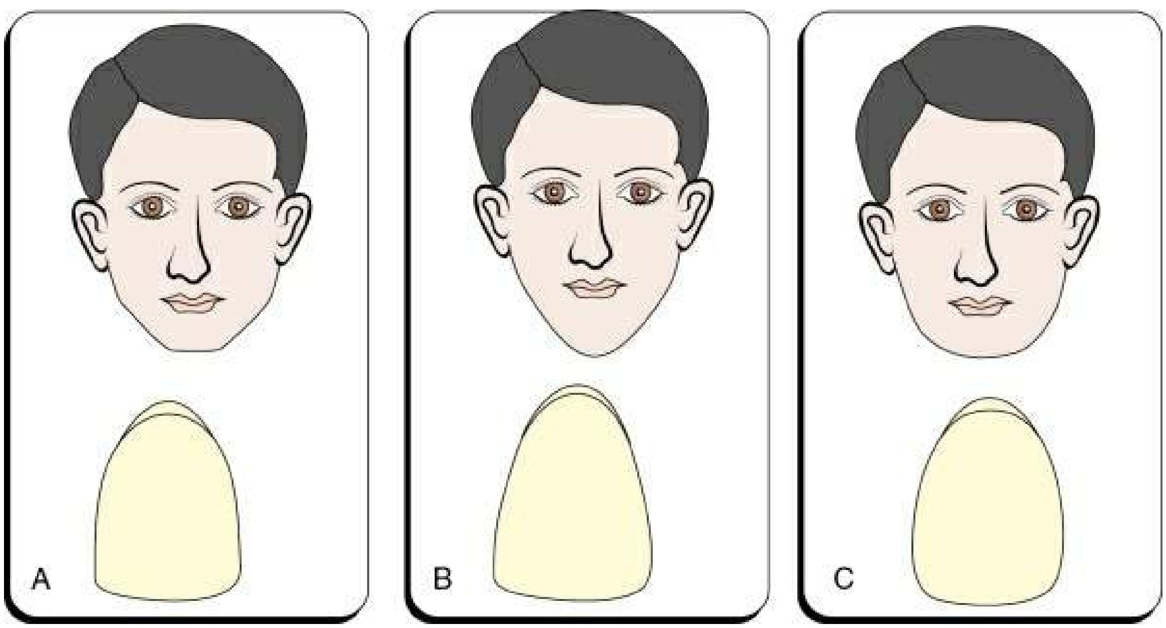


FIGURE 9.10 Form and shape of teeth are selected according to facial form. **(A)** Square, **(B)** Tapering and **(C)** Ovoid.

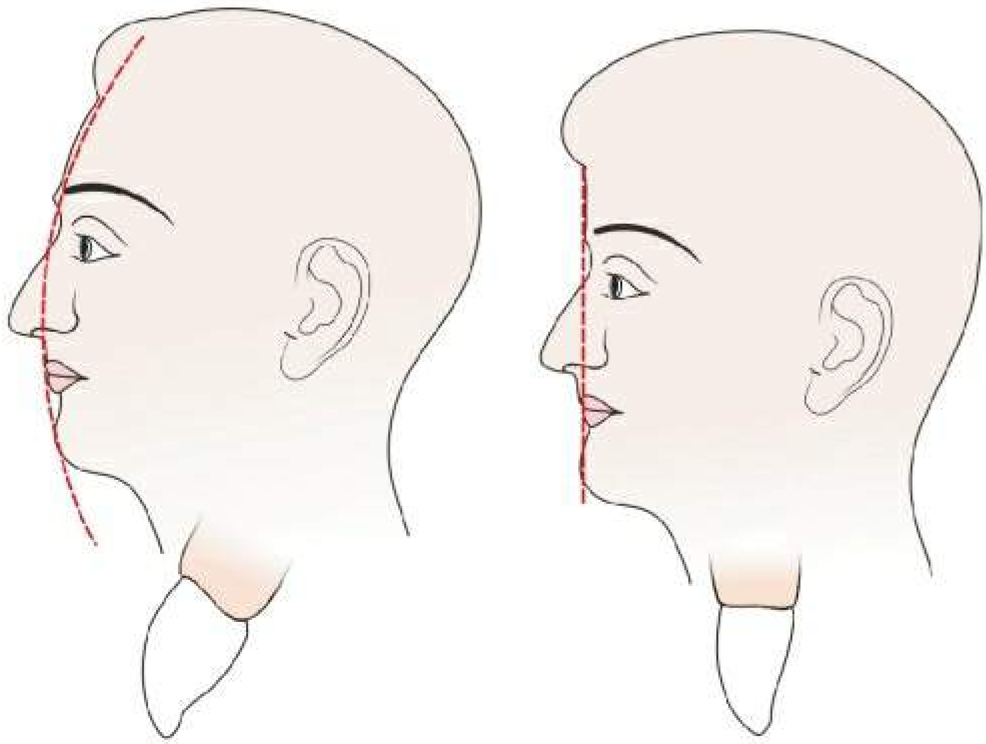


FIGURE 9.11 Form and shape of teeth selected according to facial profile.

Dentogenic concept

This concept was advocated by Frush and Fisher (1957). It was based on **s**ex, **p**ersonality and **a**ge of the patient (SPA concept or factors). The teeth were selected and arranged according to this concept.

- **Sex:** Curved facial features are associated with femininity and square with masculinity. To create harmony between the tooth form and face, teeth of females may be more ovoid or tapering than square as compared to males. The incisal edges may also be rounded for females. Square feature is associated with masculinity (Fig. 9.12).
- **Personality:** A vigorous personality requires square teeth with flat incisal edges, while a delicate personality will require ovoid teeth.

- **Age:** With age, the teeth wear at the incisal edges and interproximal surfaces. Labial surfaces seem flatter and form appears squarer. The same should be considered while selecting the teeth.

FIGURE 9.12 **(A)** Mould selected for male with sharp edges. **(B)** Mould selected for female with round edges.

Pre-extraction records

As previously described, these are useful in selecting the size and form of anterior teeth.

Colour

Definition: A phenomenon of light or visual perception that enables one to differentiate otherwise identical objects (GPT8).

Dimensions

Colour has three dimensions according to the Munsell system – hue, value and chroma. Translucency is a fourth dimension, which is the property of an object that permits the passage of light through it.

Factors

The following parameters assist in selecting the colour of the artificial teeth.

Colour of hair, eyes and skin

- Individuals with blue, green or light coloured eyes and fair skin are given teeth with lighter shade, while those with black or dark eyes and ruddy complexion are given darker teeth.
- Some authors have also suggested a relation between colour of the hair and tooth colour, but this is a very unreliable guide as the patient could be dyeing the same.
- Although there is no scientific correlation between the above factors and tooth colour, in general the selected artificial tooth colour or shade should be in harmony with these factors.

Age

- With increasing age, tooth colour becomes progressively darker.
- When young, the pulp chambers are large & the increased blood supply, lightens the tooth colour. With age,formation of secondary dentin reduces the size of the pulp chamber, making teeh appear more opaque & dark.
- As wear occurs on the teeth as a result of age, they also become smoother and reflect more light. But the attrition at the incisal edge contributes to decreased translucency with age.
- Teeth also pick up stains with age and acquire a brownish colour.

Sex

- Darker shade is generally selected for men and lighter shade for women.

Pre-extraction records

A record of the patient's tooth colour before extraction can be a useful guide in selecting the colour, but extracted teeth are unreliable as they dehydrate and become lighter.

Selecting colour

The colour or shade of the artificial teeth for complete dentures is selected by placing the shade tab in the following areas:

- Along the side of the nose – establishes the basic hue, chroma and value (Fig. 9.13).

- Under the lips with only the incisal edge exposed – reveals the effect of the colour of the teeth when the patient's mouth is relaxed (Fig. 9.14).

- Under the lip with only the cervical end covered and mouth open – simulates the exposure of the teeth as in a smile (Fig. 9.15).

FIGURE 9.13 Along the side of the nose.

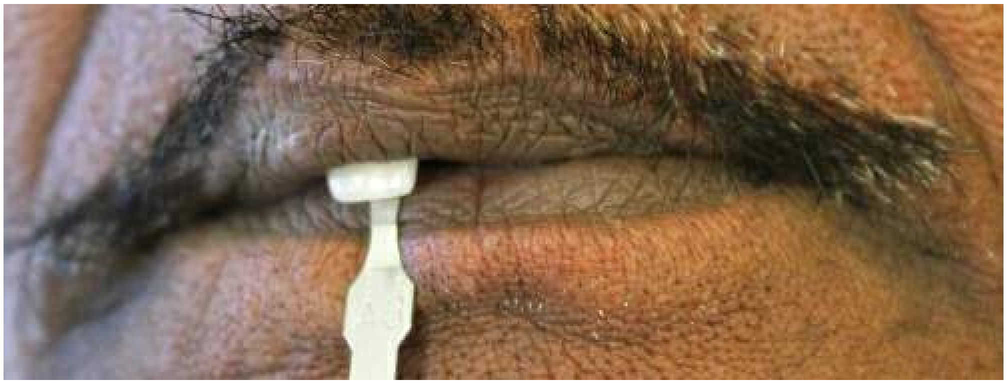


FIGURE 9.14 Under the lips with only incisal edge exposed.

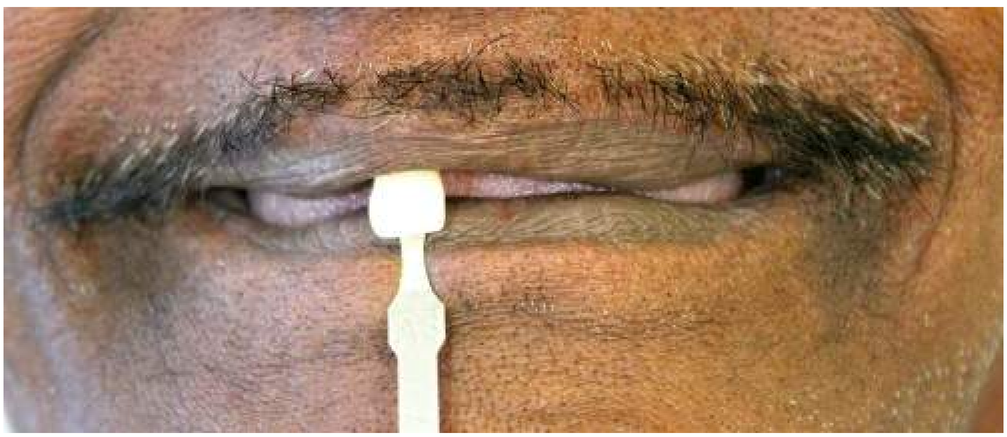


FIGURE 9.15 Under the lip with only the cervical end covered and mouth open.

The squint test may be helpful in evaluating the colour of teeth with complexion of face. With the eyelids partially closed to reduce light, the dentist compares the selected shade tabs by holding them along the face of the patient. The colour that fades from view first is the one that is least conspicuous and is in harmony with the colour of the face.

Colour and its selection for partially edentulous individuals are also discussed in Section III, Chapter 39.

Selection of posterior teeth

Posterior teeth are selected according to the following.

Size

Buccolingual width

- The buccolingual width should be sufficient to act as a table to hold food during trituration, to support cheeks and tongue and function in harmony with the musculature during swallowing, speaking and mastication (Fig. 9.16).

- Buccolingual width of the artificial posterior teeth should be less than the width of the natural teeth being replaced (Fig. 9.17A). But it should not be reduced such that support for cheeks is lost. It should also not be so large that it encroaches on tongue space and buccal corridor (Fig. 9.17B).

- Artificial teeth that are narrow in this dimension also enhance development of the correct form of polished surface of the denture, by allowing the denture to slope away from the occlusal surfaces. This also permits forces from the cheeks and tongue to stabilize the denture (Fig. 9.18).

- When the lower ridge is strong, well formed and covered by adequate thickness of attached masticatory mucosa, the entire buccolingual space available can be used to place the artificial teeth as the ridge has the capacity to tolerate the forces of mastication (Fig. 9.19).

- When the ridge is weak, resorbed and covered only by thin lining mucosa, the size should be smaller. This will limit the forces directed to the ridge.

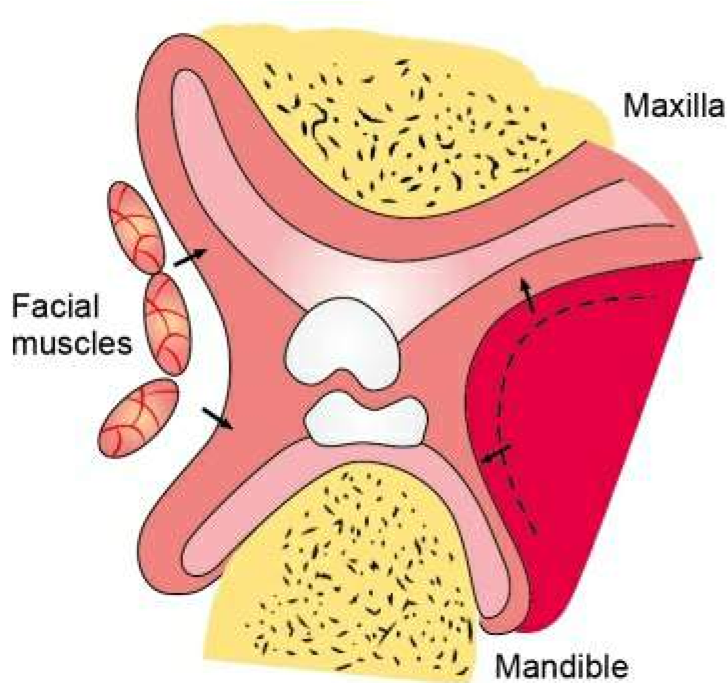
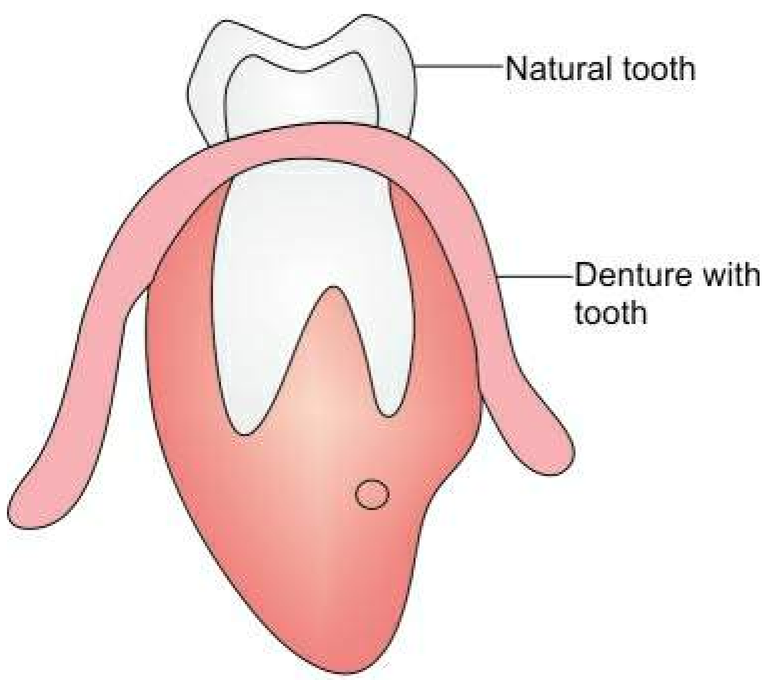


FIGURE 9.16 Buccolingual width should be in harmony with cheeks, tongue and musculature.



A

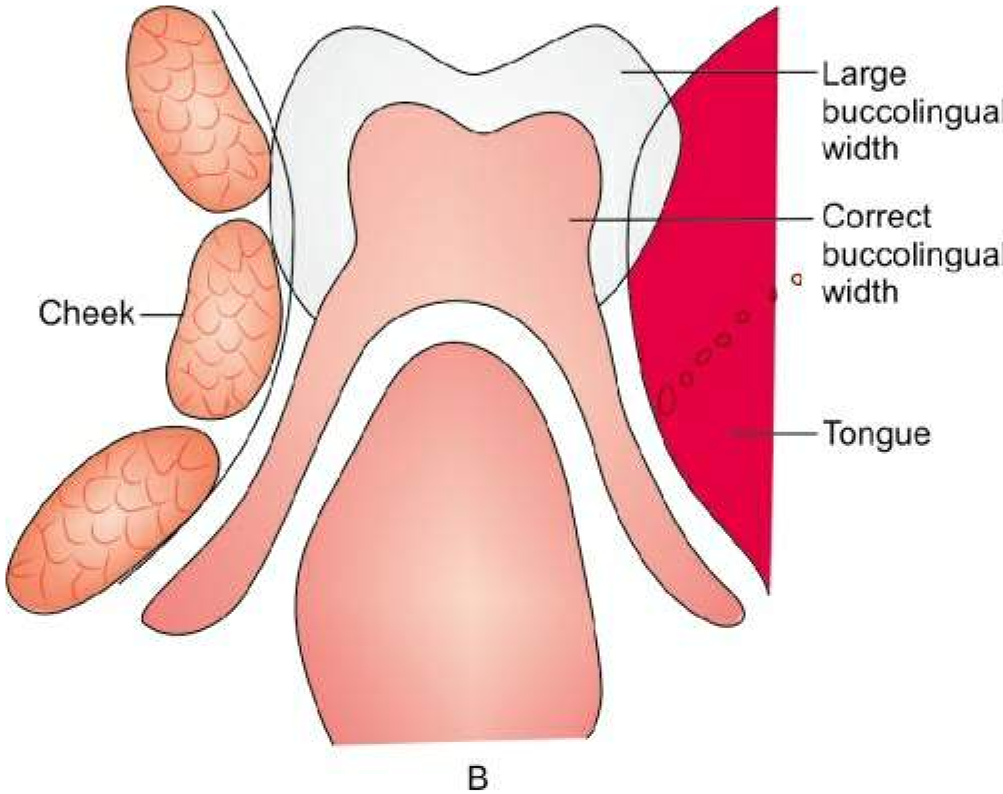


FIGURE 9.17 **(A)** The buccolingual width should be less than the natural tooth to be replaced. **(B)** Buccolingual width should not be too large to encroach on tongue and cheek.

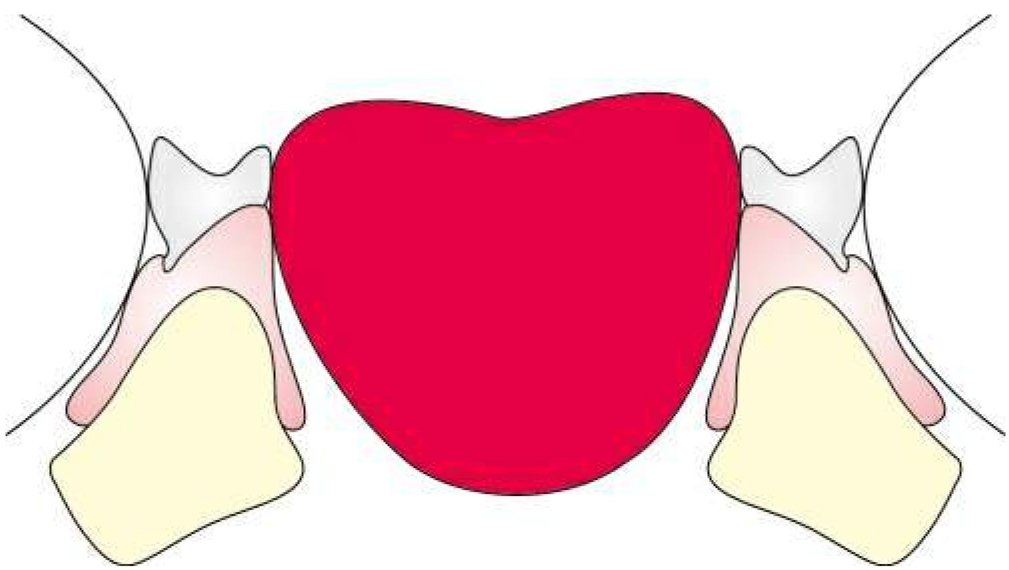


FIGURE 9.18 Correct selection of posterior teeth size also allows development of properly contoured polished surfaces

of the denture.

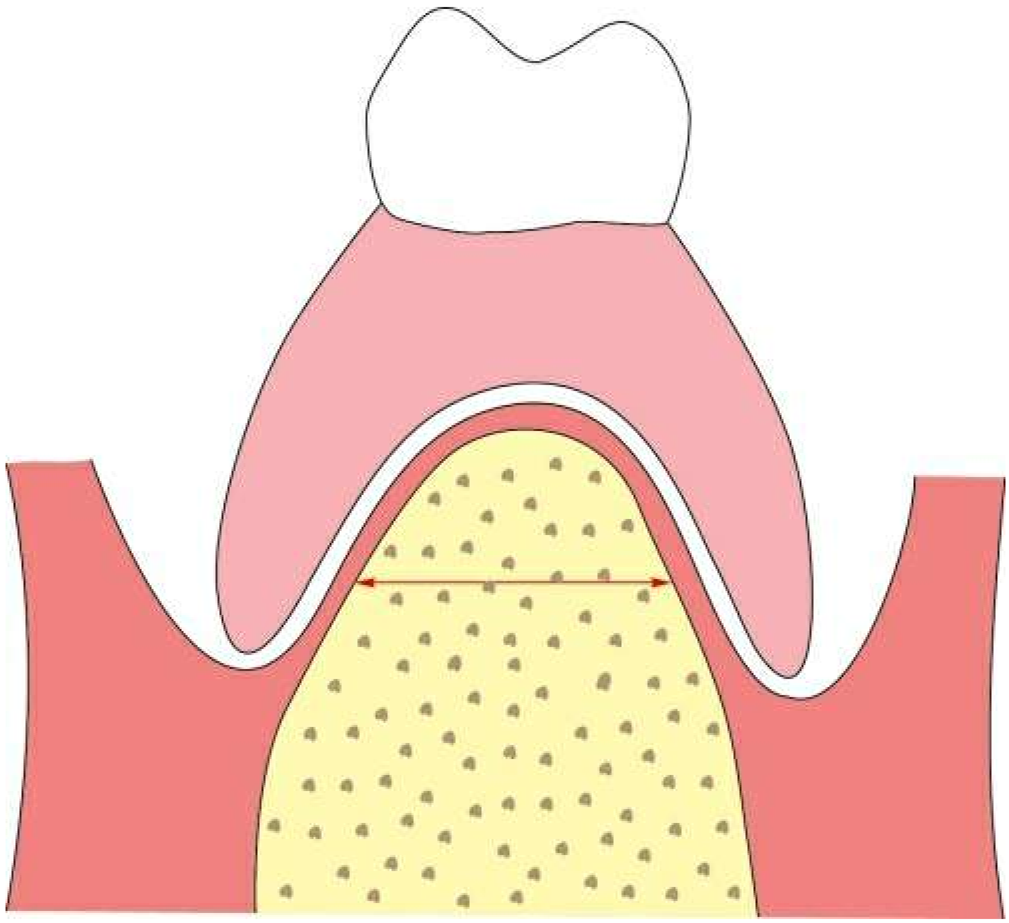


FIGURE 9.19 Entire buccolingual width of residual ridge is utilized for placement of artificial tooth when the ridge is well-formed.

Mesiodistal width

- This is determined by the edentulous space available from the distal of mandibular cuspids to the beginning of ascending area of mandible (Fig. 9.20).
- The ascending area is inclined and placing teeth here would direct forces at an inclined plane rather than at right angles to the support,

which will cause the lower denture to slide forward.

- The posterior teeth should also not be placed over the retromolar pad as it is soft and easily displaced. Placing teeth here would tip the denture during mastication.

- The posterior should be placed as far as possible posteriorly as otherwise forces of mastication will place a heavier load on the weaker anterior part of the residual ridge.

- This measurement may need to be modified for class II and class III arches.

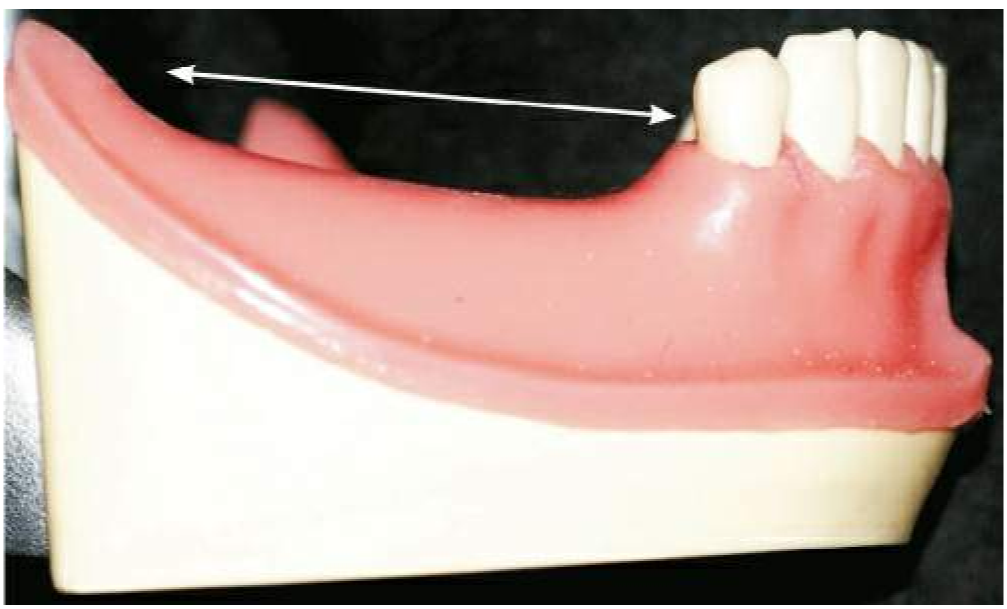


FIGURE 9.20 Mesiodistal length of edentulous ridge from distal of mandibular canine till the ascending ramus determines the mesiodistal space available for the posterior teeth.

Occlusogingival height (vertical)

This is determined by the available interridge space, occlusal plane and height of anterior teeth. Teeth with largest possible vertical length that can be used without grinding are preferred for aesthetics (Fig. 9.21).

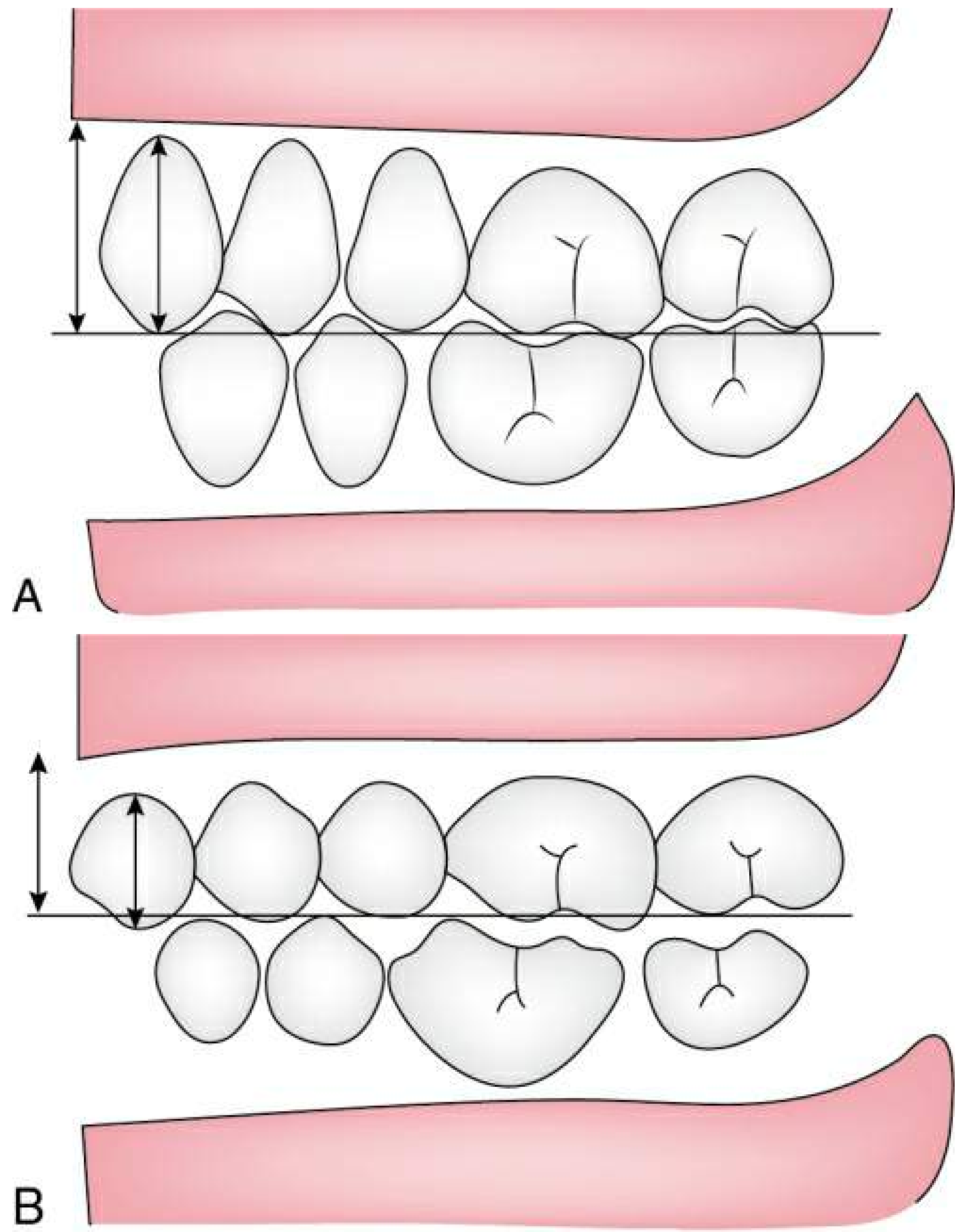


FIGURE 9.21 **(A)** Occlusogingival length. Long teeth are preferred when the interocclusal space is adequate. **(B)** Shorter teeth are selected when the interocclusal space is deficient.

Form

Artificial posterior teeth are available in two forms.

Anatomic teeth

- Also called ‘cusp teeth’ (Fig. 9.22).
- Designed to simulate the occlusal surface of the natural tooth.
- Available in varying degrees of inclinations – the standard is approximately 33°.
- The angle can be modified by grinding or purchased in a modified anatomic form. When the cusp incline is less than the conventional 33°, it is termed as **modified anatomic or semi-anatomic** teeth (Fig. 9.23).

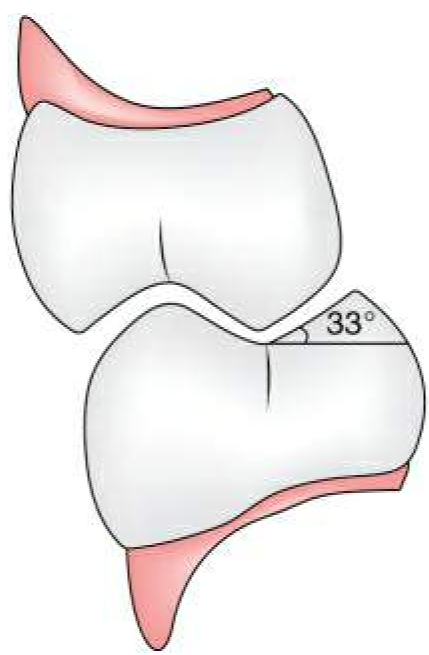


FIGURE 9.22 Cusp teeth (angulation of 33)

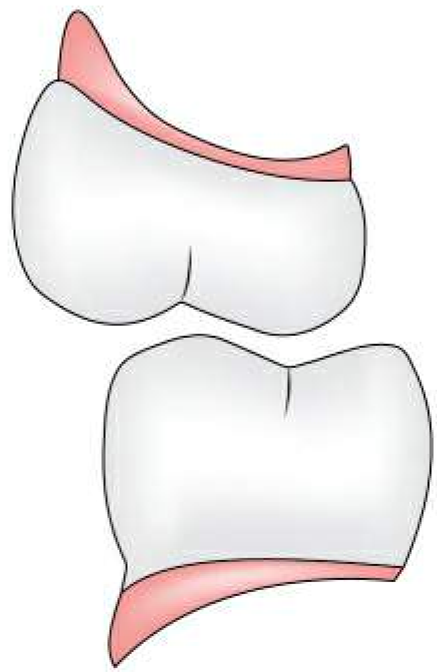


FIGURE 9.23 Semi-anatomic teeth – angulation of less than 33.

Advantages:

- Aesthetic, as they resemble natural teeth.
- More efficient in cutting food, thereby reducing the forces directed at the residual ridge.
- When cusps are making contact in fossa at centric relation, the position is comfortable, a definite point of return.
- Contours are more compatible with surrounding oral environment.
- Occlusion with cusp teeth is more organized and has depth; it is not a sudden closure of flat surfaces.
- They can be arranged in balanced occlusion in eccentric relations.

Disadvantages:

- The presence of cusps generates more horizontal force during function.

- Harmonious balanced occlusion is lost when settling of denture base occurs.
- The bases need prompt and frequent refitting to keep the occlusion stable and balanced.

Nonanatomic teeth

These are also called ‘cuspless’, ‘monoplane’ or ‘zero degree’ teeth. The occlusal surface is essentially flat and has no cusp heights (Fig. 9.24).

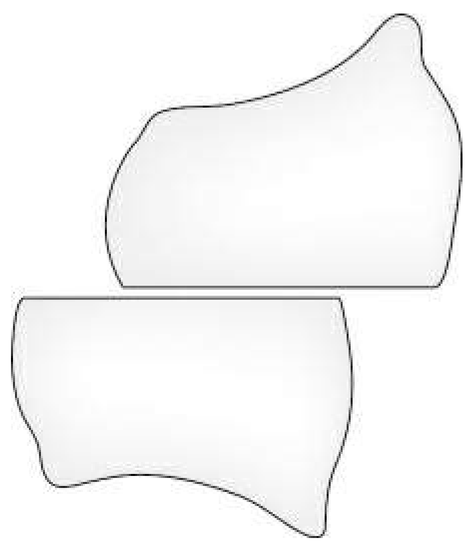


FIGURE 9.24 Monoplane teeth.

Advantages:

- They are less damaging than cusp teeth when teeth are not arranged in balanced occlusion.
- They offer less resistance to horizontal forces thereby causing less damage to the ridges in the following conditions:

- Bruxism
- Poor residual ridges
- Malrelated jaws – class II and class III
- Uncoordinated neuromuscular controls

Disadvantages:

- They occlude only in two dimensions (no height). Absence of this vertical component reduces the shearing efficiency of food.
- Any occlusal grinding further impairs their efficiency.
- Poor aesthetics.
- Obtaining lateral and protrusive balance of teeth is not possible.

Selection of material

Materials used for artificial denture teeth can be classified as:

1. Resin

   (i) Acrylic resin

   a. Monolithic

   b. Cross-linked

   c. IPN linked

   (ii) Composite resin

2. Porcelain

- Resin and porcelain are the materials used for fabricating preformed artificial denture teeth.
- The majority of resin teeth are made of acrylic resin – polymethyl methacrylate. Composite resin teeth are not commonly used due to greater wear than newer acrylics. The main disadvantage of traditional monolithic acrylic teeth has been their poor wear resistance, which led to the development of cross-linked acrylics, IPN (interpenetrating polymer network) resins and highly cross-linked

resins.

- The development of these high strength acrylic resin teeth with good wear resistance has considerably reduced the use of porcelain denture teeth.

- Although resin posterior denture teeth can be used in all situations, they are specifically indicated in the following conditions:

  - When opposing dentition consists of natural teeth or metal restorations.

  - Recently extracted residual ridges.

  - Limited interocclusal space.

  - If an immediate denture is being contemplated.

  - Poor ridges and mucosa.

  - Aged and debilitated patients.

  - When teeth are in contact with retainer of RPD.

- Porcelain teeth are rarely used, only when aesthetics are paramount. As they cannot be trimmed easily, they are used only when adequate interarch space is available.

- A combination of resin and porcelain teeth on opposing dentures can be used, as it softens the impact sounds, reduces friction and chipping. But porcelain can wear the resin faster and loss of vertical dimension occurs with anterior interference.

- Differences between resin and porcelain teeth are given in Table 9.2.

Table 9.2

Differences between resin and porcelain teeth

Resin	Porcelain
1. Wears easily with loss of VD	No clinically significant wear
2. Easy to grind and adjust	Difficult to grind and adjust
3. Chemical bonding to denture base	Mechanical bonding using pins (for anterior teeth) and diatoric holes (for posterior teeth)
4. Does not abrade opposing natural teeth and restorations	Abrades opposing natural teeth and restorations
5. Colour instability – can stain easily	Does not stain easily
6. Soft impact sound – no clicking sound when opposing teeth meet	Sharp impact sound – clicking present
7. Rebasing is a problem as it is difficult to separate the teeth from denture base	Easy to separate the teeth and rebase
8. No leakage	Marginal staining is possible due to capillary leakage
9. Good impact resistance – chipping is not a problem	Poor impact resistance – chipping of denture tooth is a problem

Diatoric: A channel placed in denture teeth to serve as a mechanical means of retaining the teeth in a chemically dissimilar denture base material (GPT8) (Fig. 9.25).

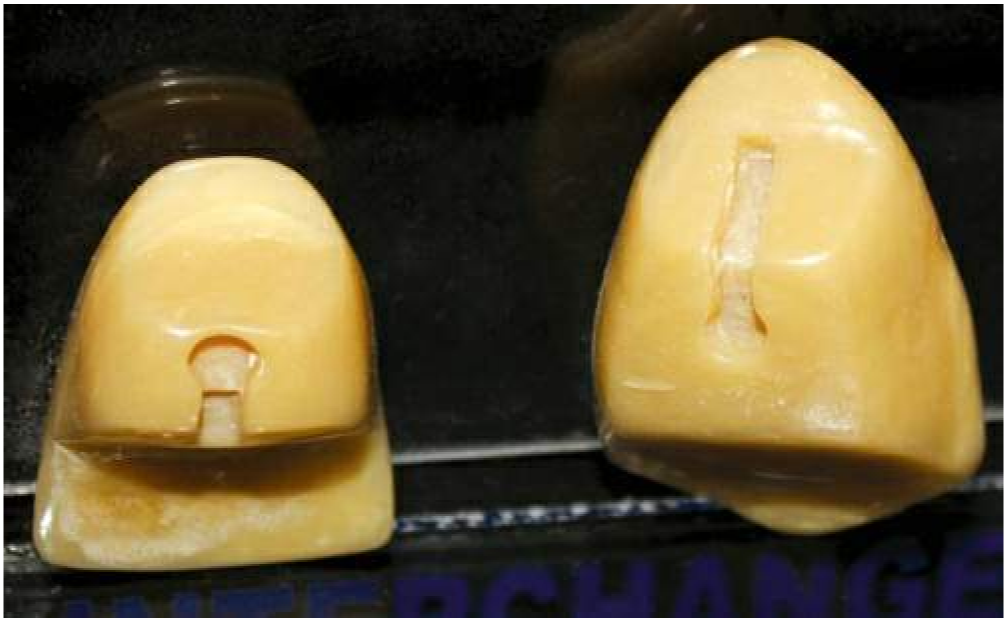


FIGURE 9.25 Diatoric channel made in artificial teeth for retention to denture base.

Posterior tooth forms

The historical development of posterior tooth forms can be categorized according to their morphology.

Anatomic teeth

• 1914 – **Trubyte teeth** – designed by Gysi.

These were the first 33° anatomic posterior teeth to be developed. They were made of porcelain and resembled natural teeth with transverse ridges intended for tight interdigitation. Crossbite situations were difficult to treat with these teeth (Fig. 9.26).

FIGURE 9.26 Trubyte teeth.

Modified anatomic teeth

• 1927: **Gysi crossbite teeth** – designed by Gysi.

Maxillary buccal cusp was eliminated. Palatal cusp occluded with anatomic lower posteriors. Occlusal surfaces of all posterior teeth were reduced and these were used for crossbite cases (Fig. 9.27).

- 1927: **Channel tooth** – designed by Sears.

Maxillary occlusal surfaces had a deep channel running mesiodistally along all four posterior teeth. Lower posteriors were like a single ridge, half the buccolingual width of normal anatomic teeth, which articulated with the upper channel. They permitted unlimited protrusive glide (Fig. 9.28).

- 1930: **Scissor bite teeth** – designed by Avery Brothers.

Posterior occlusal surfaces were ground-like steps with the angle determined by condylar guidance. There was freedom in lateral excursion (Fig. 9.29).

- 1932: Pilkington-Turner teeth – designed by Pilkington and Turner.

Resembled natural occlusal forms but had angle of 30°. Provided a small degree of freedom in protrusive excursions, but were interlocked in lateral excursions (Fig. 9.30).

- 1935: **Modified posteriors** – designed by French.

Upper posterior teeth were similar to ‘channel teeth’ but with very shallow buccolingual inclines. Lower teeth had a sloping buccal surface that was placed below the occlusion. Only lingual cusp contacted the grove in the upper. This was claimed to direct the forces lingually stabilizing the lower denture (Fig. 9.31).

- 1937: **Pleasure scheme** – designed by Max Pleasure.

Lower posterior occlusal surfaces were modified to produce a reverse curve by tilting the tooth buccally. This was also claimed to stabilize the lower denture by directing the forces lingually.

- 1942: **Metal insert in resin** – designed by John Vincent.

Circles of gold solder wire or stainless steel wire were inserted into maxillary posterior resin occlusal surfaces. They were set opposing French's mandibular posteriors. It was claimed that as the resin wore, the chewing force was concentrated in the centre of the denture (Fig. 9.32).

- 1961: **Crossblades** – designed by Sosin.

The occlusal surface of upper second premolar and first and second molars were covered with vitallium. During try-in, the lower posteriors were removed and denture processed. During insertion of denture, wax was placed on the lower permanent record base and the patient was asked to produce chewing movements. This lower occlusal pattern was converted to gold and processed onto lower denture (Fig. 9.33).

- In 1977, Levin modified these teeth by placing the vitallium only on the maxillary palatal cusps for aesthetic reasons. Both authors claimed increased masticatory efficiency with this 'functionally generated path' technique.

FIGURE 9.27 Gysi crossbite teeth.

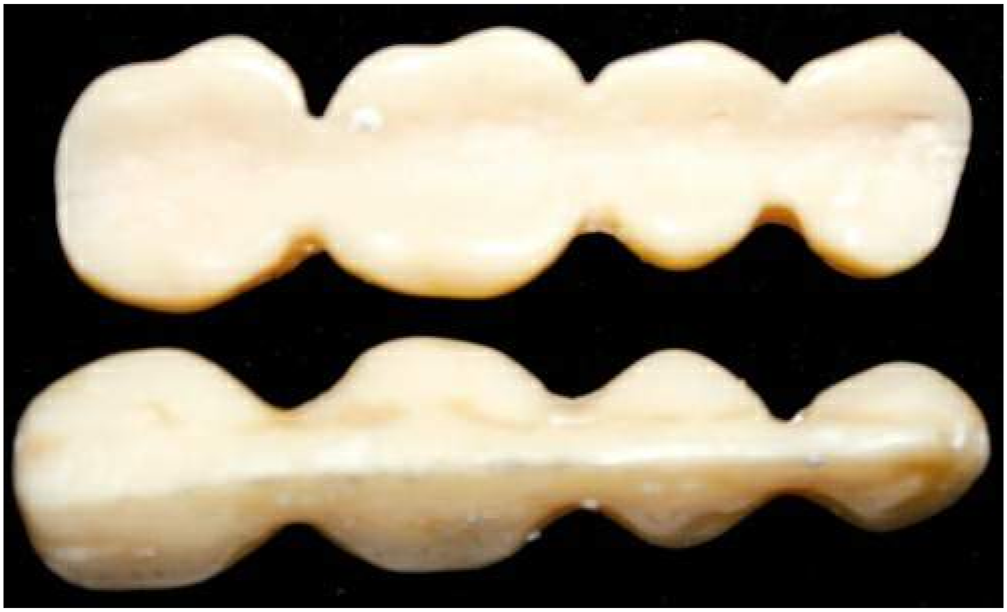


FIGURE 9.28 Sears channel tooth.

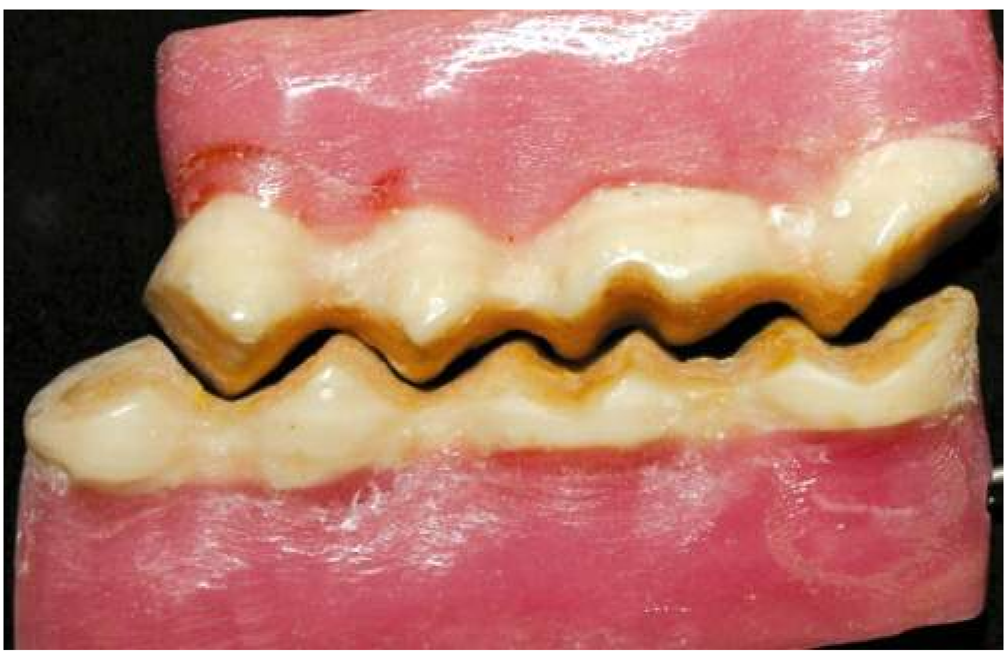


FIGURE 9.29 Scissor bite teeth.


FIGURE 9.30 Pilkington–Turner teeth.

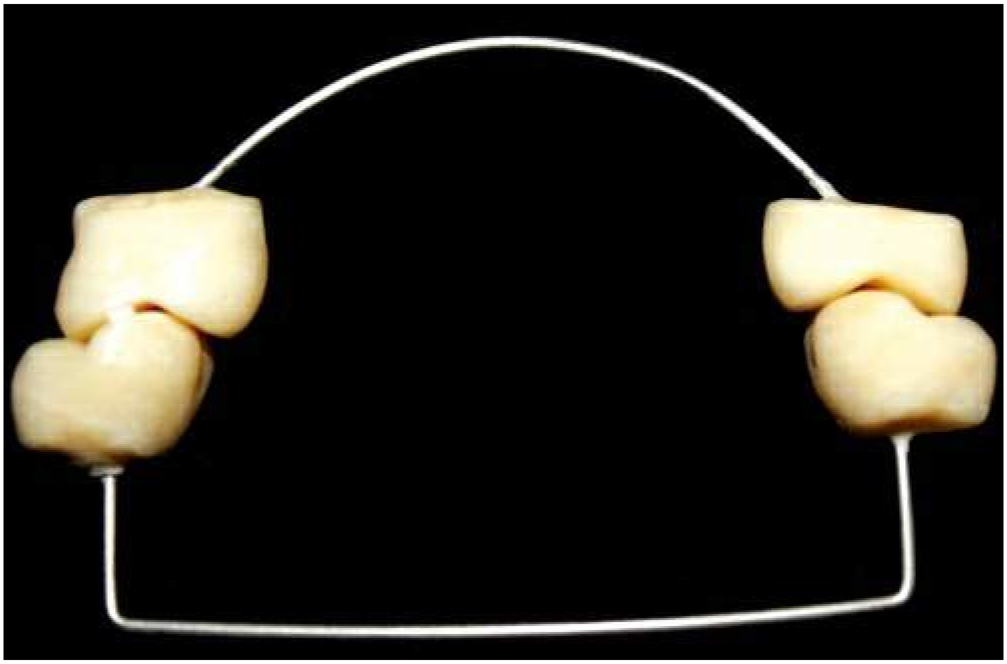


FIGURE 9.31 Modified posteriors.

FIGURE 9.32 Metal insert in resin.

FIGURE 9.33 Crossblades.

Nonanatomic teeth

- 1929: **Inverted cusp tooth** – designed by Hall.

This was one of the first nonanatomic designs. The occlusal surface of the teeth was flat with sharp concentric ridges around cup-like depressions (inverted cusp). Efficient mastication was claimed with this type. But actually the depressions became clogged with food and lost their efficiency (Fig. 9.34).

- 1929: **True-kusp** – designed by Myerson.

This was also a cuspless posterior that had a series of buccal–lingual ridges with sluiceways between them (Fig. 9.35).

- 1934: **Chopping block** – designed by Nelson.

Flat occlusal surface with ridges. Mandibular ridges were placed transversely, while maxillary ridges were mesiodistal. The perpendicular contact made by the ridges was claimed to have an efficient shredding and cutting mechanism (Fig. 9.36).

- 1939: **Nonlock** – designed by Swenson.

Flat occlusal surfaces with sluiceways for shredding and allowing food to escape from the occlusal table. They also provided some balancing contact as mild buccal and lingual incline was provided (Fig. 9.37).

- 1946: **'VO' (Vitallium Occlusal)** – designed by Hardy.

These were nonanatomic teeth, which contained metal inserts in the occlusal surface. The two premolars and first molar teeth were joined together but with separation evident buccally. Vitallium ribbon was embedded on the occlusal surface in a zigzag manner, slightly raised from the resin surface. The contact of the upper and lower teeth was on this metal ribbon and this improved the cutting efficiency. The Astenal Company manufactured the teeth (Fig. 9.38).

- 1951: **Shear-cusp tooth** – developed by Myerson Tooth Corporation.

These were the first cross-linked acrylic nonanatomic teeth to be developed. These cross-linked resin teeth were documented to be at least 30% more wear resistant than normal acrylics.

- 1952: **Coe masticators** – designed by Cook.

The mandibular second premolar and first molar were flat stainless steel castings with diagonal holes on the occlusal surface that sloped buccally. These occluded with flat upper porcelain teeth to grind the food. The force required for mastication was claimed to be reduced. Again, problems occurred with clogging of food in the holes (Fig. 9.39).

- 1957: **Cutter bars** – designed by Bader.

A cobalt–chromium metal cutting bar was placed on the occlusal surface of the lower posteriors – second premolar, first and second molars. They opposed flat upper porcelain teeth. Masticatory efficiency was claimed to be superior. This was similar to Sears channel teeth.

- 1967: **Linear occlusal concept** – designed by Frush.

A single mesiodistal ridge was placed on the lower posterior teeth opposing flat upper teeth.

FIGURE 9.34 Inverted cusp teeth.

FIGURE 9.35 Myerson's true-kusp teeth.

FIGURE 9.36 Nelson's chopping block teeth.

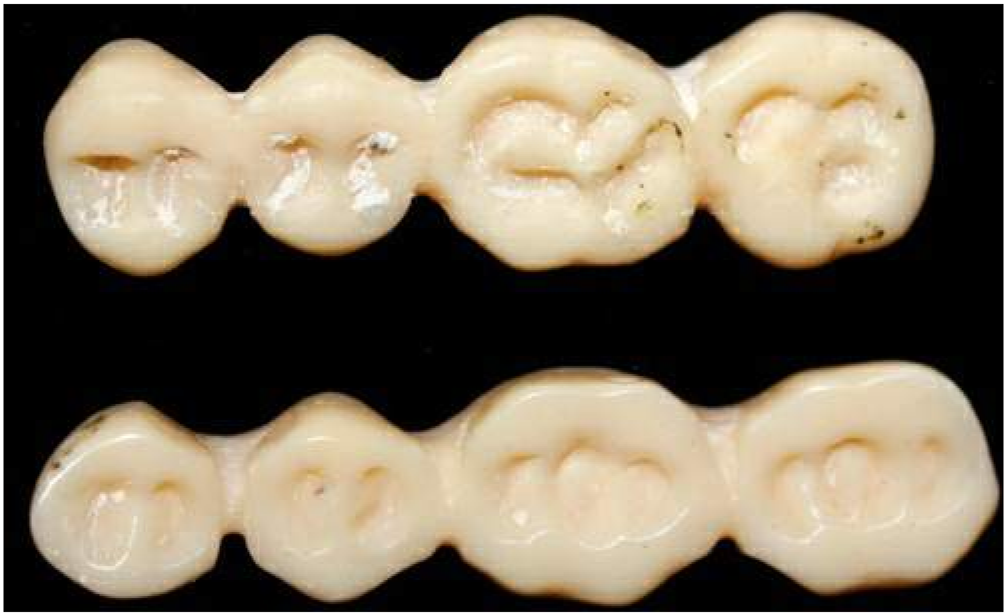


FIGURE 9.37 Swenson's nonlock teeth.

FIGURE 9.38 VO (vitallium occlusal) – Hardy's posteriors.

FIGURE 9.39 Coe masticators.

SUMMARY

Artificial teeth are selected for aesthetics and function. The size, form and colour play an important role in this selection. While aesthetics dictate the selection of anterior teeth, the type of occlusion planned dictates the posterior tooth selection. Anatomic teeth are usually used especially when balanced occlusion in eccentric relations is planned. Nonanatomic teeth may be used in specific conditions. With the advent of highly cross-linked resin teeth, the use of porcelain denture teeth has now become a rarity.

CHAPTER
10

Teeth arrangement

CHAPTER CONTENTS

Introduction

Following the selection of teeth and determining the type of occlusion, the artificial teeth are arranged. Arrangement of teeth is dictated by the setting principles of individual teeth, anatomical landmarks and dentogenic concept. The ridge relation and the need to arrange the teeth in balanced occlusion also influence the procedure. The teeth should occupy the potential denture space or neutral zone.

Factors influencing teeth arrangement

The various factors/guidelines involved in the arrangement of artificial teeth are discussed in this chapter. These are categorized into:

1. Anatomical landmarks

2. Dentogenic concept

3. Ridge relation

4. Balanced occlusion

5. Neutral zone

Anatomical landmarks

Residual ridge

Maxillary teeth are positioned labial to the ridge and mandibular teeth on the crest of ridge due to the resorptive pattern of the ridge (Fig. 10.1).The lingual cusp of the maxillary posterior teeth should be centred over the mandibular ridge and mandibular anterior teeth should not be set too far from the centre of the ridge to ensure denture stability (Fig. 10.2A).

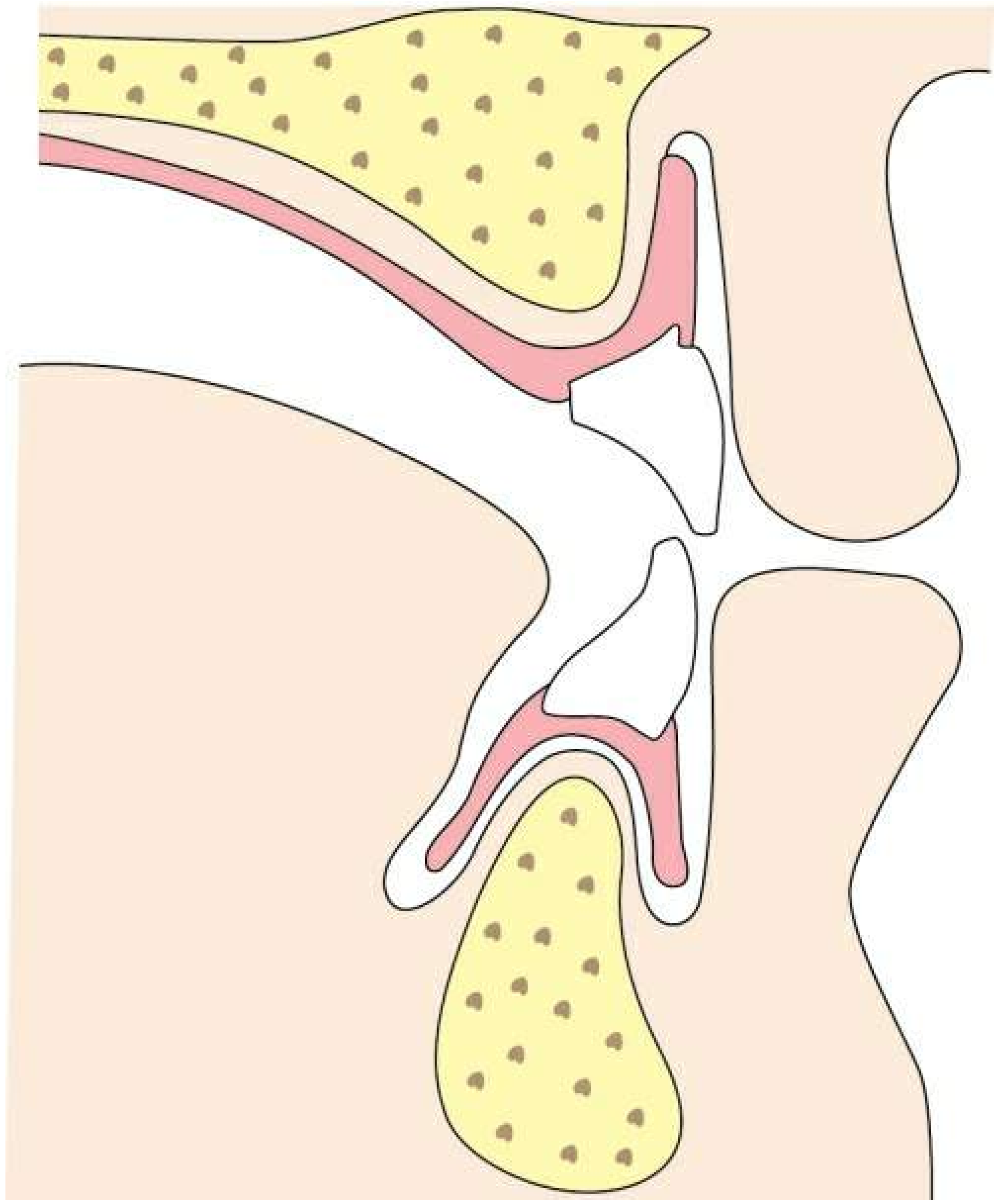
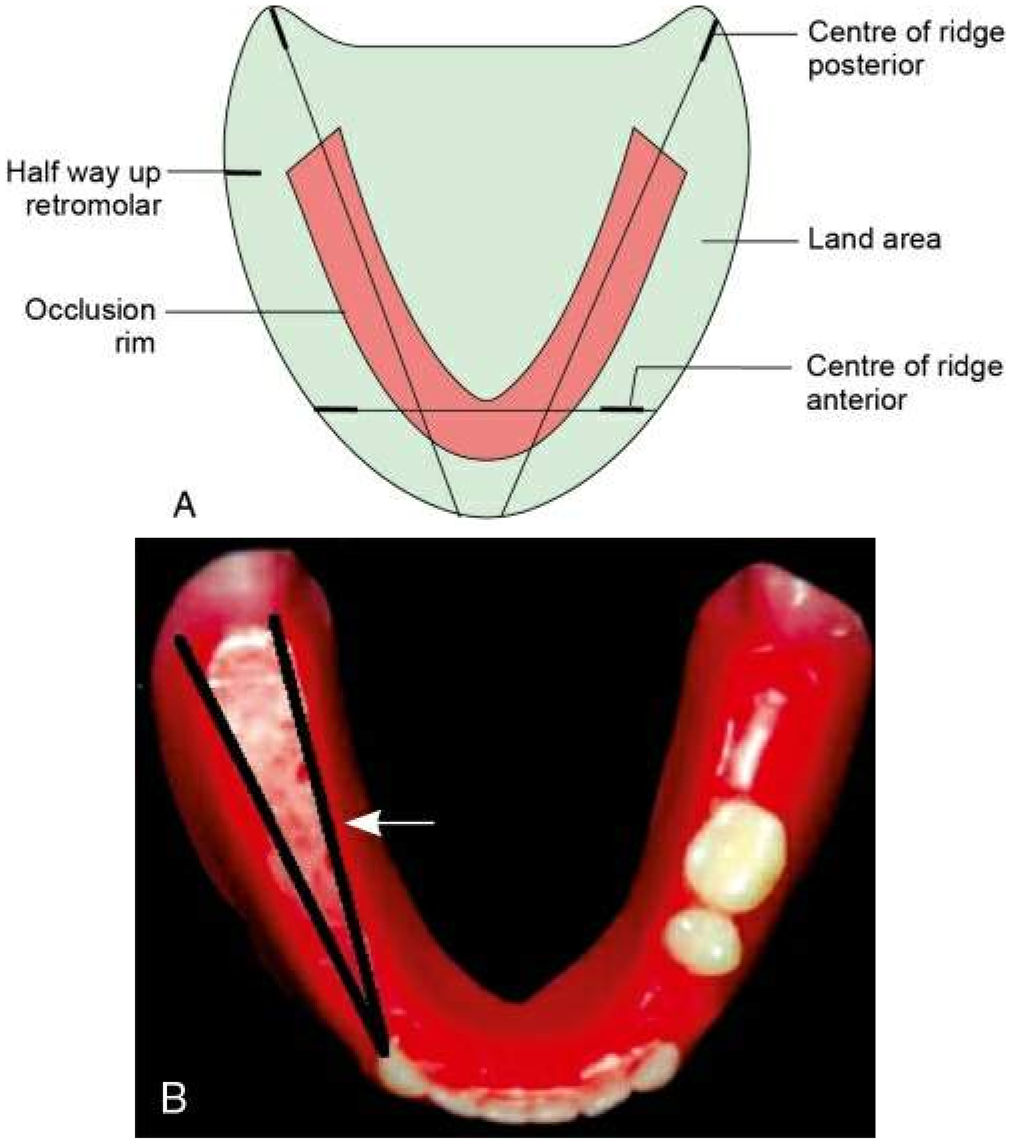
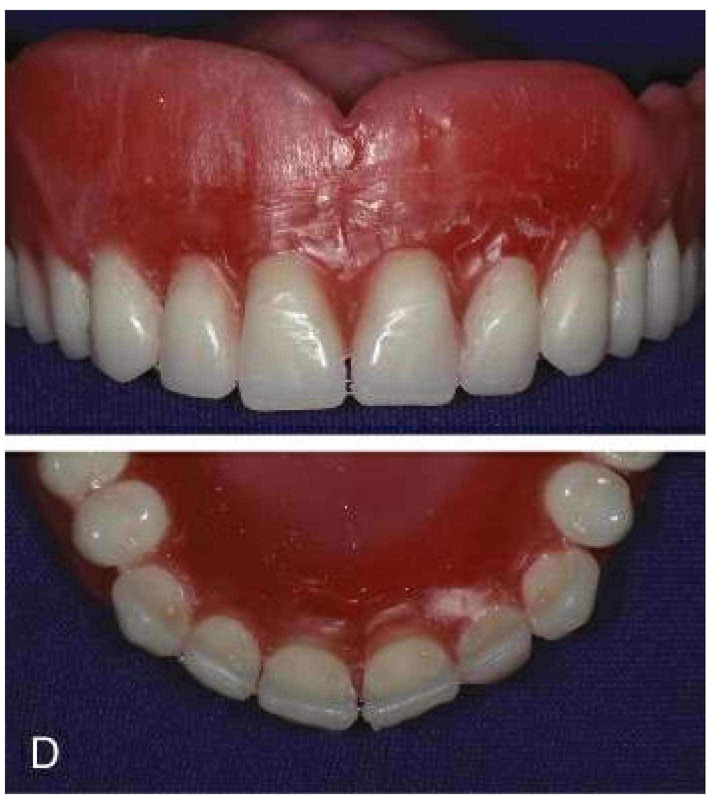


FIGURE 10.1 Position of anterior teeth in relation to ridge.


Centre of ridge posterior
Half way up retromolar
Land area
Occlusion rim
Centre of ridge anterior
A
B


C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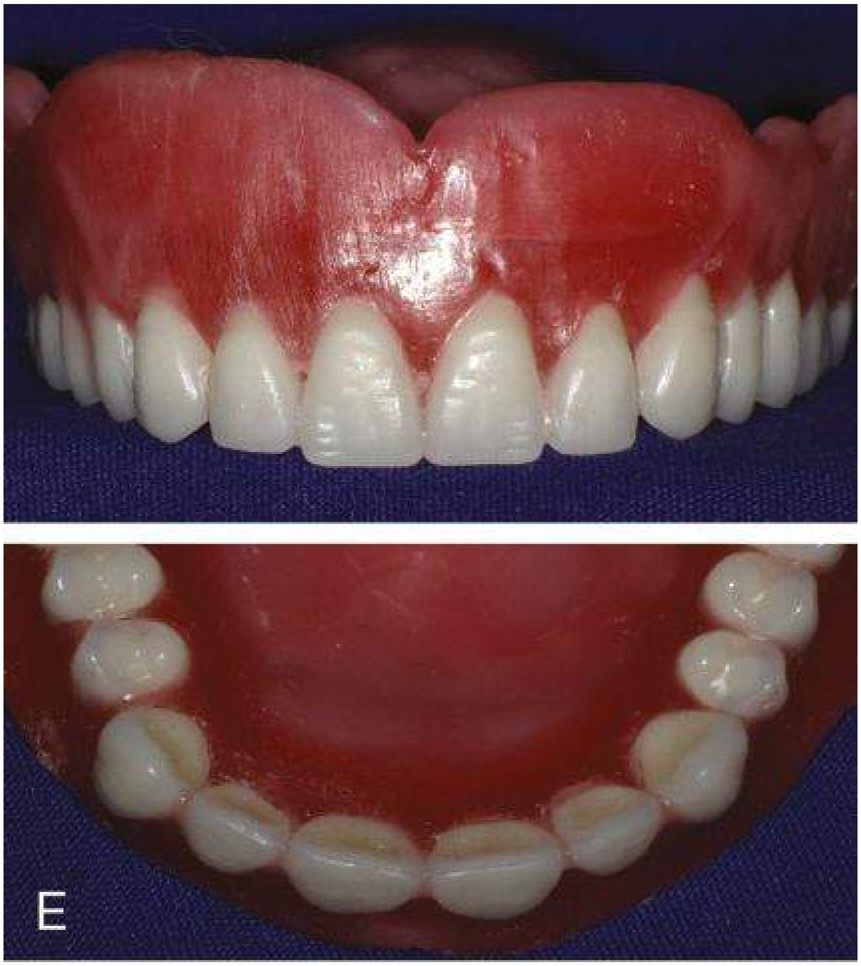


FIGURE 10.2 **(A)** Relation of denture teeth to the residual ridge. **(B)** The lingual position of the mandibular posteriors should not go beyond the pound line (marked). **(C)** Characteristics of a square arch. **(D)** Characteristics of a tapering arch. **(E)** Characteristics of an ovoid arch.

The lingual cusp of the mandibular posteriors should not encroach on the 'pound line' – an imaginary line from the lingual border of retromolar pad to the mesial angle of the canine, as it would restrict the tongue space (Fig. 10.2B).

Arch form

Teeth arrangement especially of the maxillary varies with arch form – square, tapering or ovoid, and the general rule is to follow the contour of the arch.

1. **Square arch:** The arrangement is almost on a straight line (slight curve) from canine to canine without much rotation. The full face of all the maxillary anteriors should be seen to give broad effect (Fig. 10.2C).

2. **Tapering arch:** The central incisors are placed much forward than canines and also rotated distally. Lateral incisors are also rotated, raised from occlusal plane and depressed at the gingival margin. Neck of canine teeth is prominent (Fig. 10.2D).

3. **Ovoid arch:** Arrangement has a definite curvature and central incisors are set forward of canines (not as much as a tapered arch). There is not much rotation and canines will not be very prominent (Fig. 10.2E).

Retromolar pad

The line extending from the tip of lower canine to the upper two-third of retromolar pad will determine the height of the lower posterior teeth (occlusal plane) (Fig. 10.3). If the occlusal plane is too low, it causes tongue biting or too high occlusal plane can cause instability and strain as tongue struggles to place the food bolus back on occlusal table.

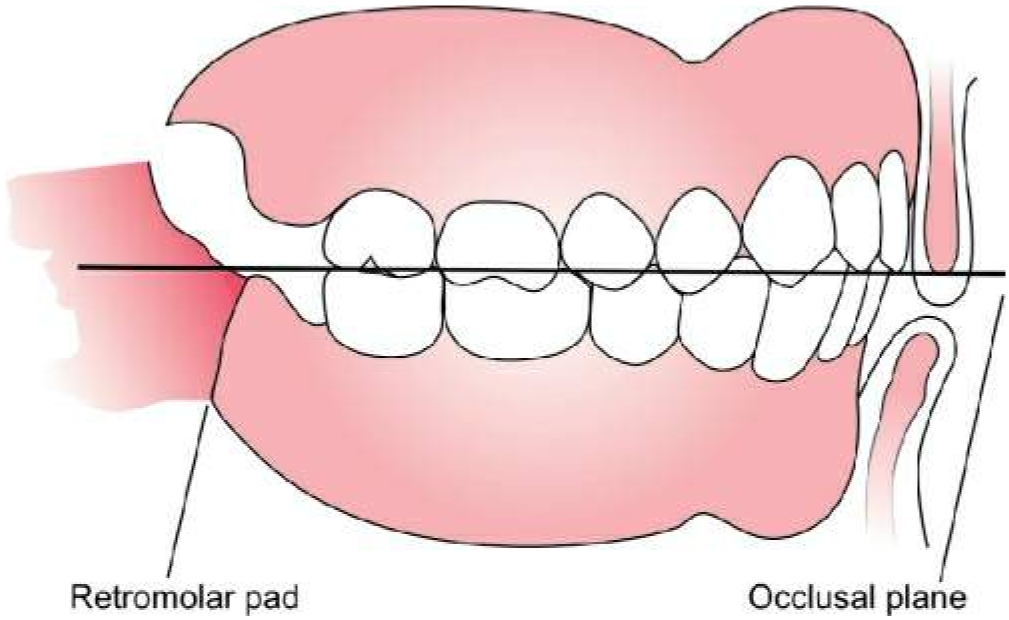


FIGURE 10.3 Relation of retromolar pad in determination of height of posterior teeth.

Parotid duct

Maxillary first molar should be placed below the orifice of the parotid gland (Fig. 10.4).

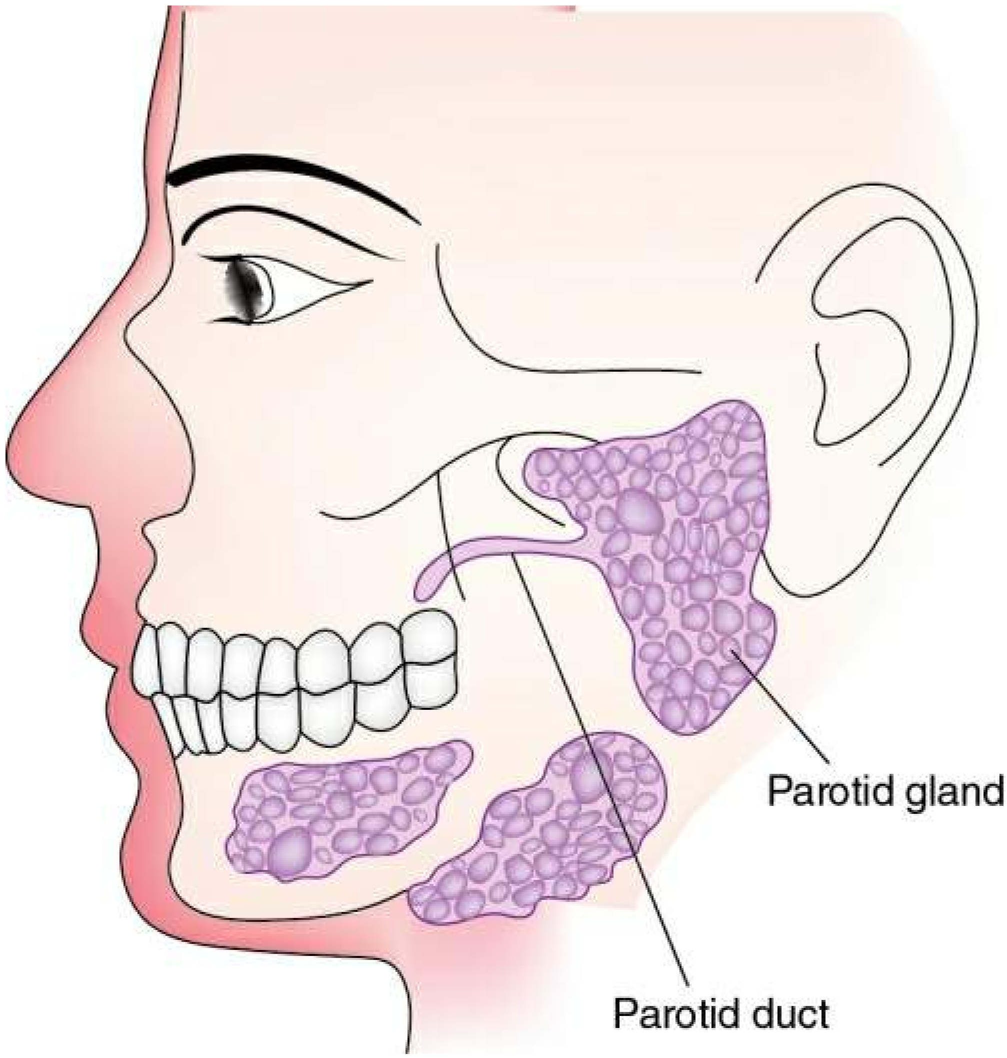


FIGURE 10.4 Relation of Stensen's duct to teeth position.

Rugae

The labial surface of the canine is normally 10.5 mm from the lateral aspect of the first large pair of anterior rugae (Fig. 10.5).

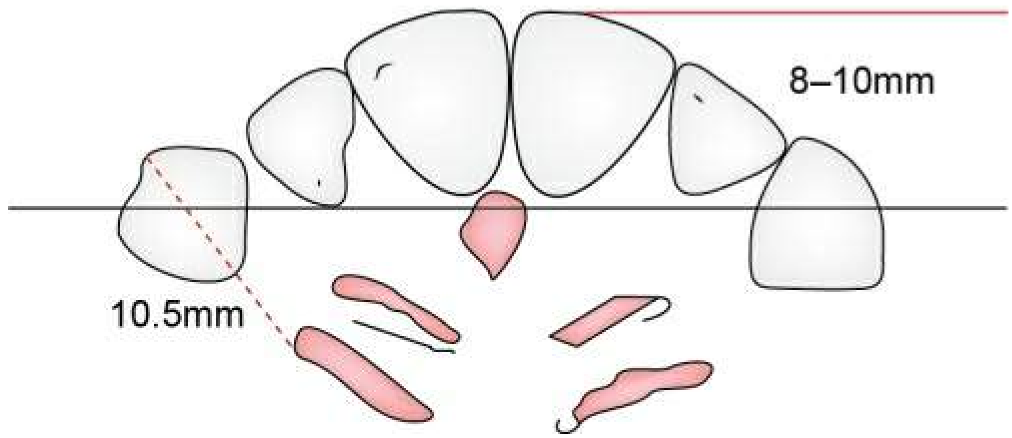


FIGURE 10.5 Relation of rugae to the denture teeth.

Incisive papillae (figs 10.5 and 10.6)

- A line through the incisive papilla and the midline of the raphae determine the midline of the denture teeth. The distance from the middle of the incisive papilla to the labial surface of the maxillary central incisor is typically 8–10 mm.

- A line drawn perpendicular to the midline of the palate, through the centre of the incisive papilla intersects the cusp tips of the canines.

- In young persons, a line connecting tips of canines transverses the incisive papilla.

- With advancing age due to increased alveolar ridge resorption, line moves posteriorly and may eventually pass through the distal extent of the papilla.

- Pterygomaxillary notch-incisive papilla plane tends to be more parallel to the occlusal plane that uses mesiolabial incisal edge of maxillary right central incisor as anterior reference point and mesiobuccal cusp tips of maxillary first or second molars as posterior reference point.

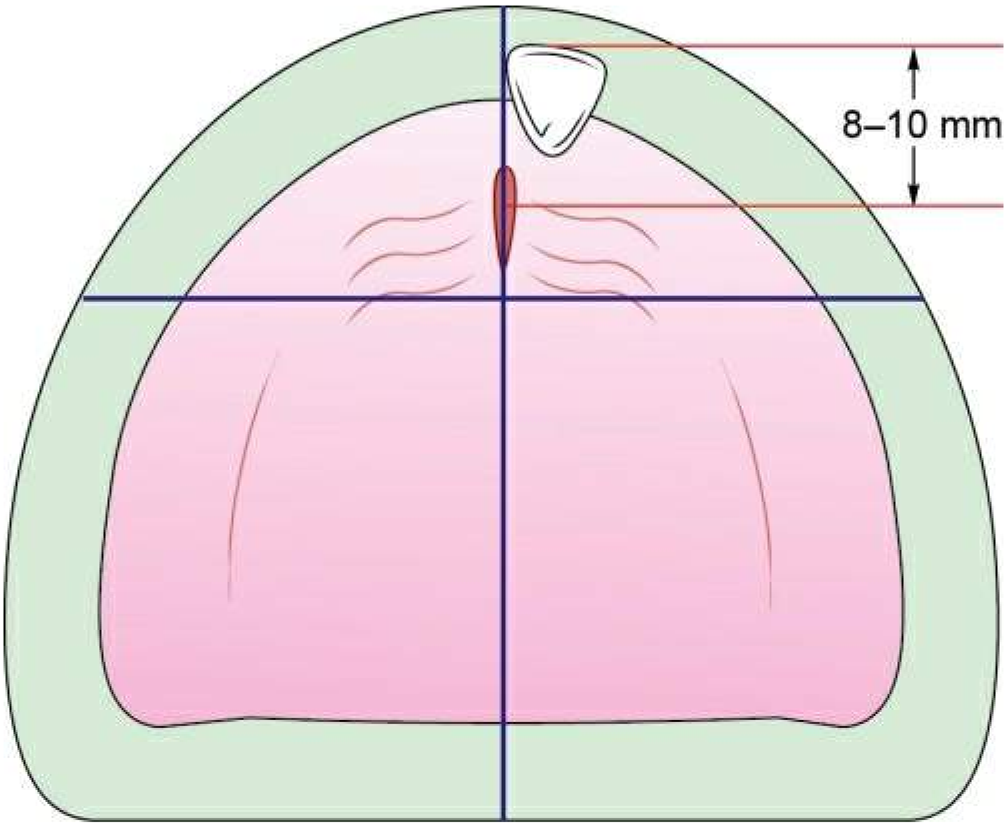


FIGURE 10.6 Relation of incisive papillae to the denture teeth.

Nose

The distance between the tips of the canines is the same as the width of the base of the nose. In order to visualize buccal corridor space, canines are positioned immediately inferior to the side of the nose (Fig. 10.7).

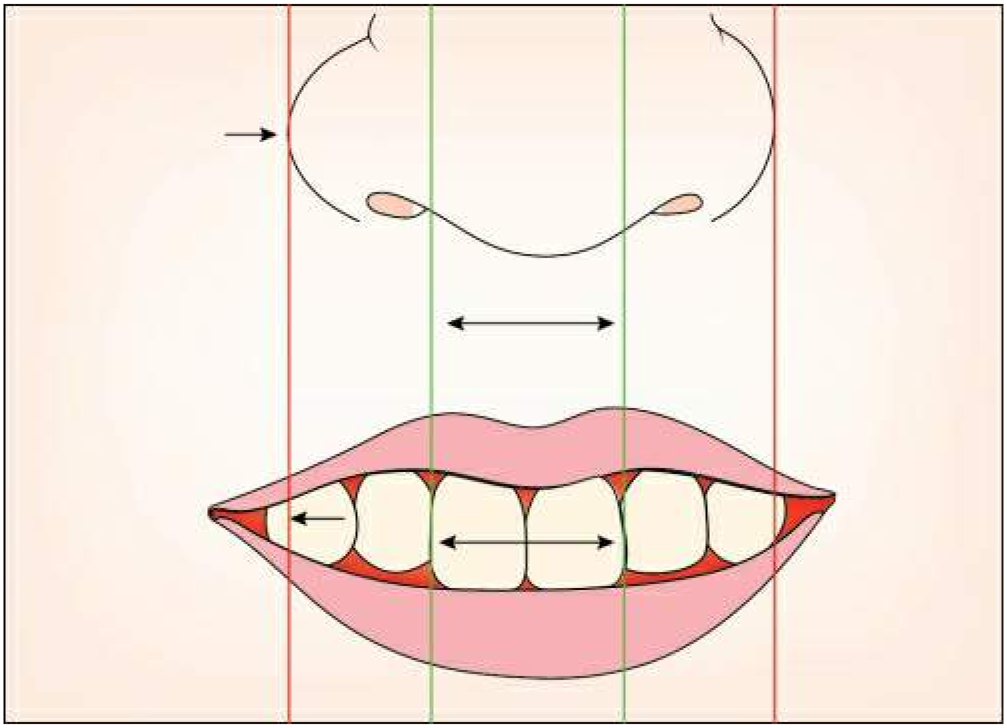


FIGURE 10.7 Philtrum and nose and their relation to the denture teeth.

Philtrum

The width of the central incisor approximates the width of the philtrum (Fig. 10.7).

Dentogenic concept

Sex factor

Feminine characteristic – softness

Central incisor

For softness, one of the central incisors is moved out at the base and the incisal edges are placed together (Fig. 10.8B).

FIGURE 10.8 Position of one central incisor bodily placed anteriorly **(A)**, rotation of the distal surface forwards to depict vigorous appearance.

Lateral incisor

The lateral incisor is rotated outward with asymmetric long axis between right and left lateral incisors (Fig. 10.9A).

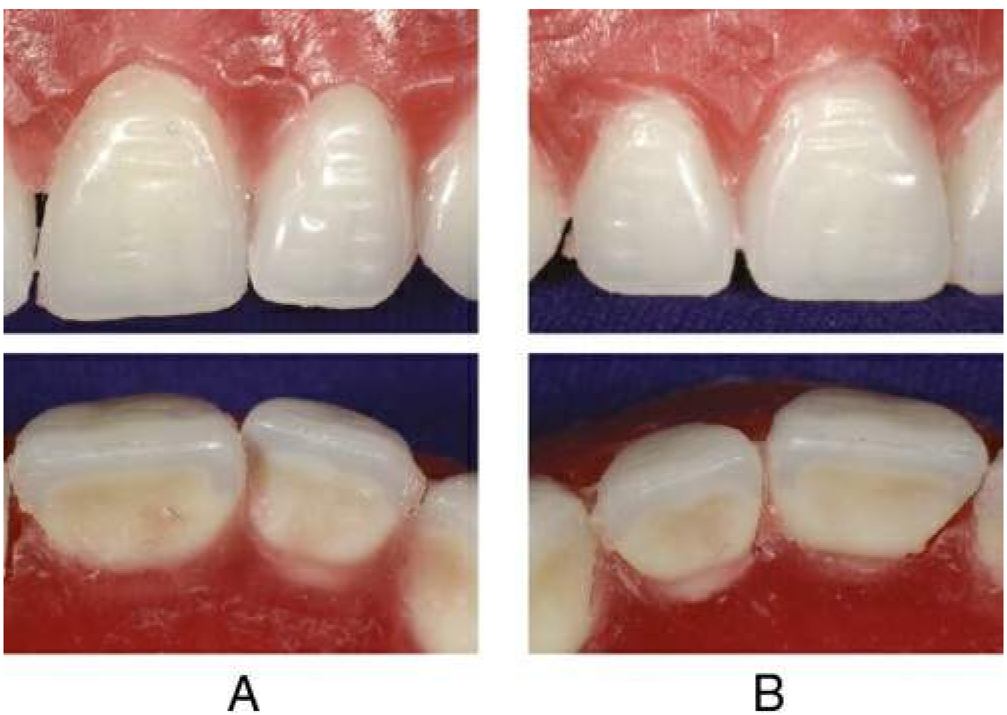


FIGURE 10.9 Lateral incisor position. Female characteristics. **(A)** Male characteristics **(B)**.

Masculine characteristic – boldness and hardness

Central incisor

The incisal edge of one upper central incisor can be brought anteriorly. For boldness, one of the central incisors is bodily placed anterior to the other (Fig. 10.8A) or combined rotation of the two central incisor with their distal surface forward having one incisor depressed at the cervical and the other depressed incisally (Fig. 10.8C).

Lateral incisor

The mesial line angle of the lateral incisors can be labially overlapped on the distal line angle of the central incisors to give a feminine characteristics (Fig. 10.9A). The mesial line angle of lateral if positioned palatally with prominent distal line angle of the central incisors, it depicts male characteristics (Fig. 10.9B).

Canine

A prominence in the canine tooth.

Personality factor

- Grouped into three categories: vigorous type – hard, aggressive, muscular; medium type – normal, robust, healthy; delicate type – fragile, frail appearance.

- Vigorous look is given by having wider central incisors, wearing of central incisors and canine with sharp line and point angle.

- Delicate look is created by rounded contours of the tooth with pale colour.

Age factor

Incisal edge

- Young patients – presence of mamelons and cuspid with pointed tip.

- Youth full adult – more incisal wear on central, lateral incisors, canine and the enamel incisal edge of visible depth and of bluish hue.

- Adults – central and lateral incisors abrade in straight line and cuspids abrade in a curve. This results in flattening of the arch (Fig. 10.10).

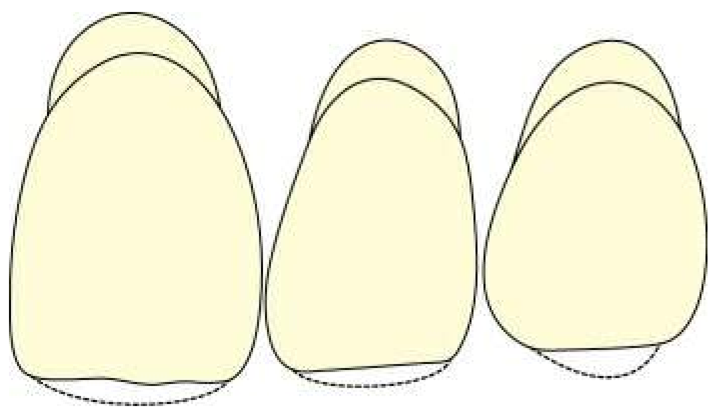


FIGURE 10.10 Age factor on the incisal edge. Dotted line – young age, darker line – as age advances.

Erosion: It is seen on the gingival third and the necks of the teeth. It is depicted by careful grinding and polishing effectively with variable shading effects.

Diastema: It is seen very frequently in youth.

Denture base

- Youth interdental papillae – freely stippled and pointed tight against the tooth.

- Advancing age – shortening the papillae and by raising gingival line, selecting long teeth, contouring the wax and positioning the teeth properly to suggest recession (Fig. 10.11).

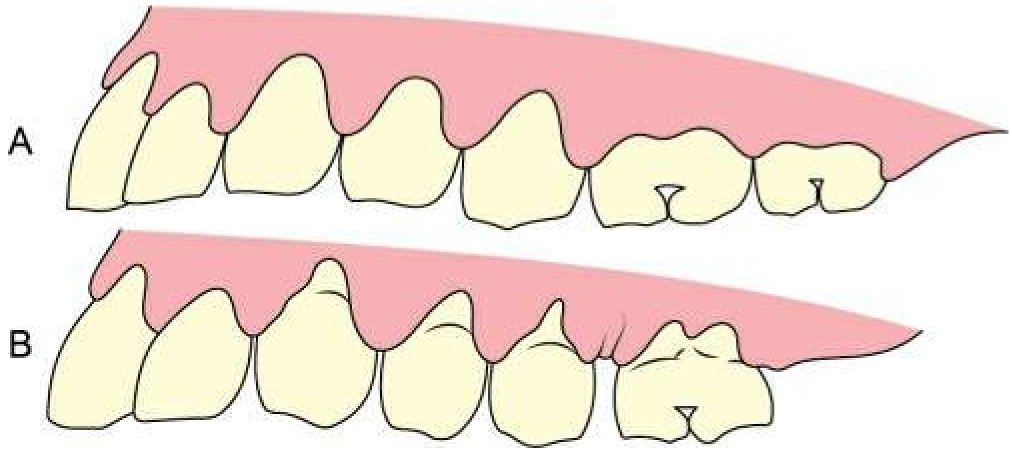


FIGURE 10.11 Age changes on denture base: **(A)** young adults and **(B)** advanced age.

Ridge relations

Principles of individual teeth arrangement according to ridge relations in centric occlusion can be classified into the following types:

1. Teeth relation for class I ridge relation
2. Teeth arrangement for class II ridge relation
3. Teeth relation for class III ridge relation

Teeth arrangement for class I ridge relation

Anterior teeth arrangement

Arrangement of maxillary central incisor

Its long axis inclines slightly towards the vertical axis when viewed from the front. The incisal edge contacts the occlusal plane (Fig. 10.12A).

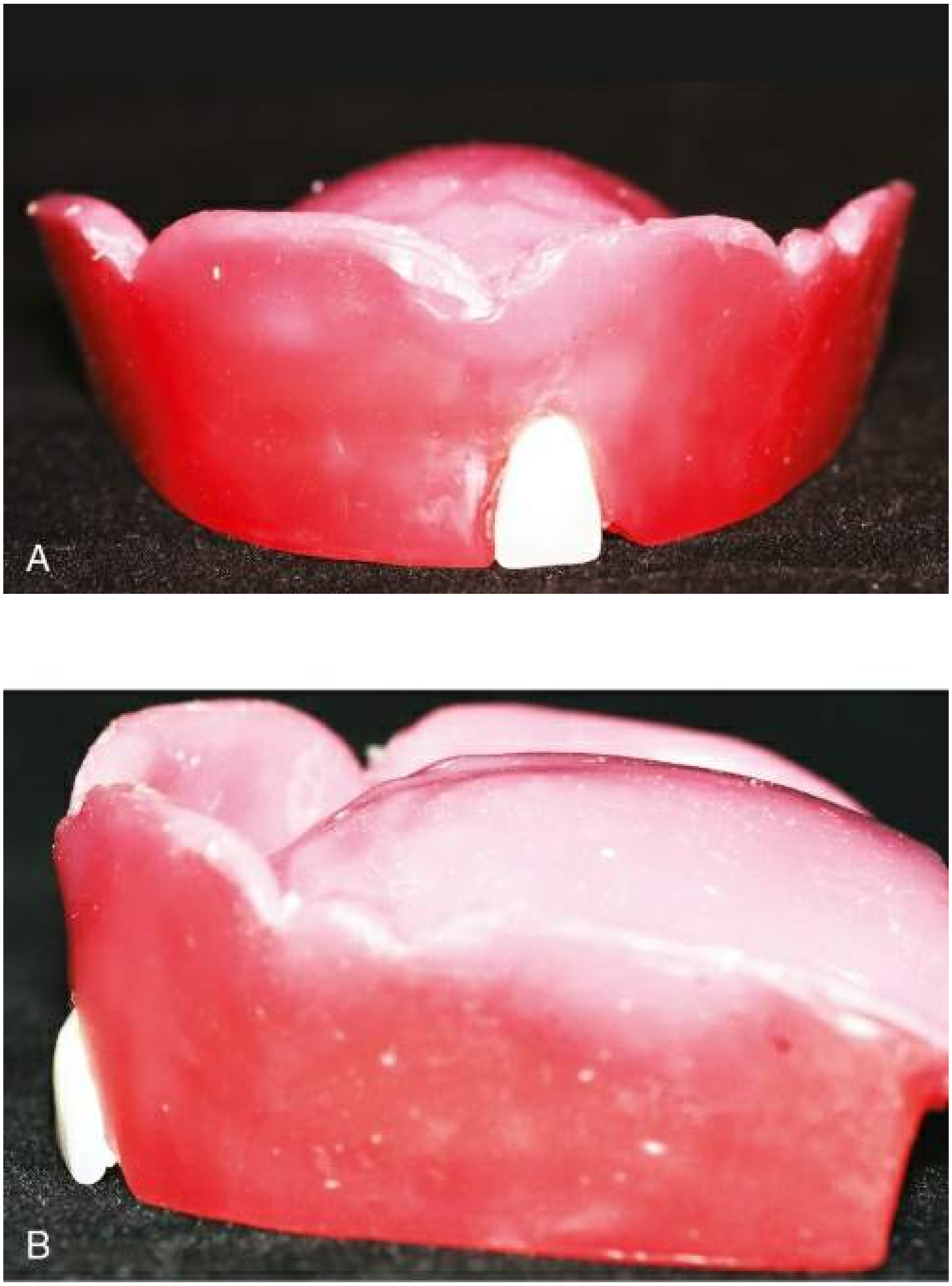

A
B

FIGURE 10.12 **(A)** Arrangement of maxillary central incisor (frontal view). **(B)** A 15° angulation of central incisor (side view). **(C)** Central incisor set along arch form (palatal view).

The maxillary teeth slopes labially about 15° when viewed from the side (Fig. 10.12B). The 15° angulation is more pronounced in the incisal half of the central incisor and the cervical margin should be within the occlusal rim. The position of the central incisor when viewed lingually (Fig. 10.12C) is not straight but follows the arch form.

Arrangement of maxillary lateral incisor

Its long axis slopes more towards the midline, when compared to the central incisor the incisal edge is about 1 mm short of the occlusal plane (Fig. 10.13A). A mesiolabial rotation usually looks good in a female or delicate patient and is called a 'soft' lateral. This makes the tooth look narrower and enlarges the embrasures.

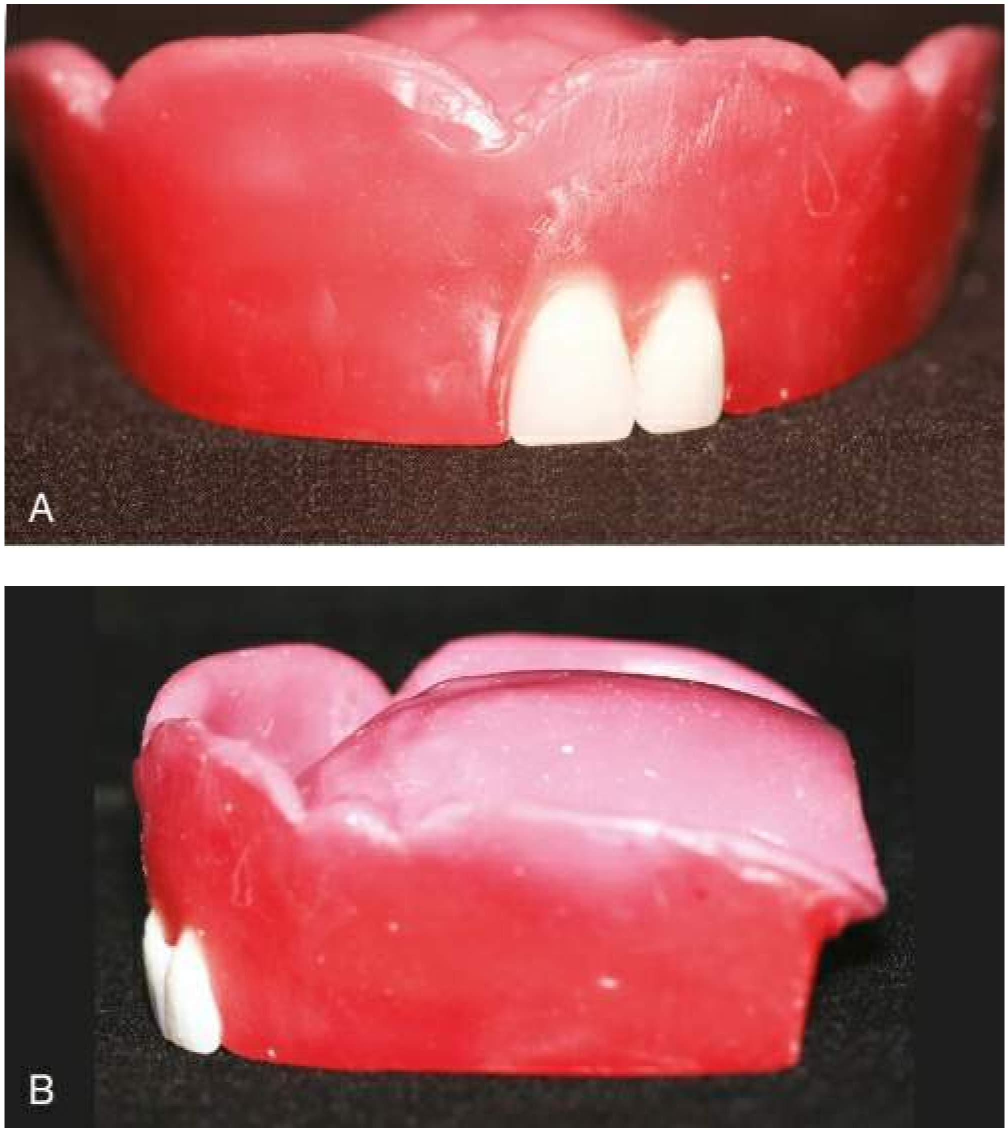


FIGURE 10.13 **(A)** Arrangement of maxillary lateral incisor (frontal view). **(B)** 20° angulation of lateral incisor (side view). **(C)** Lateral incisor set along arch form (palatal view).

For a man and for a more vigorous effect, try a mesiolingual rotation, called a 'hard' lateral. This makes the tooth look wider. Place the lateral incisors higher than the centrals depending on age. This begins the 'smile line'.

It is inclined labially about 20° when viewed from the side (Fig. 10.13B). The lingual view reveals distal margin overlap of the central incisor by the mesial surface of lateral incisor due to its inclination. The distal surface of lateral incisor follows the curvature of the arch (Fig. 10.13C).

Arrangement of maxillary canine

Its long axis is parallel to the vertical axis when viewed from both front and side (Fig. 10.14A). The cervical margin of the canine is more prominent when compared with central and lateral incisors. It is less for patient with a square face and more if the face is tapering. The tip of the canine contacts the occlusal plane. When viewed from front only the mesial slope of canine is visible.

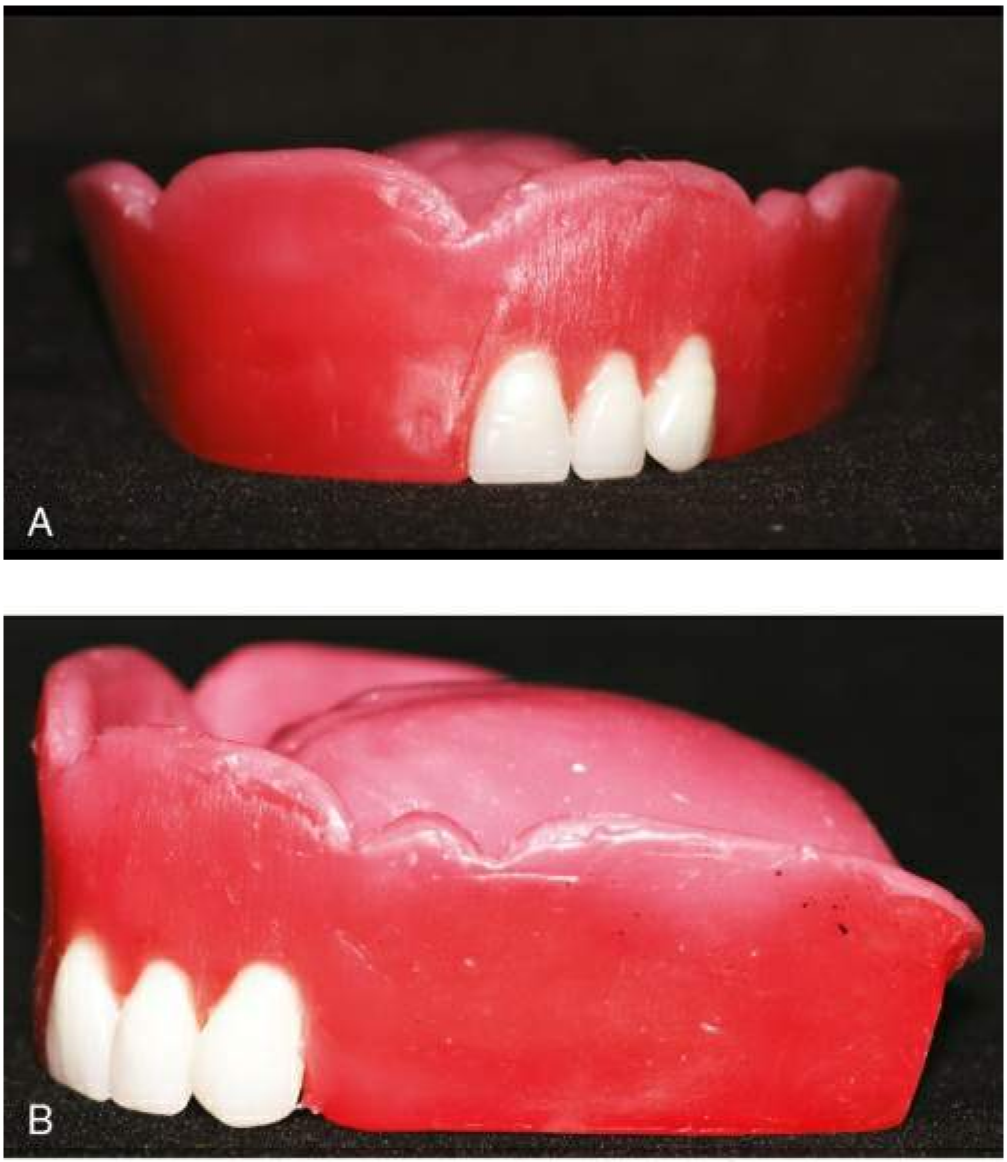
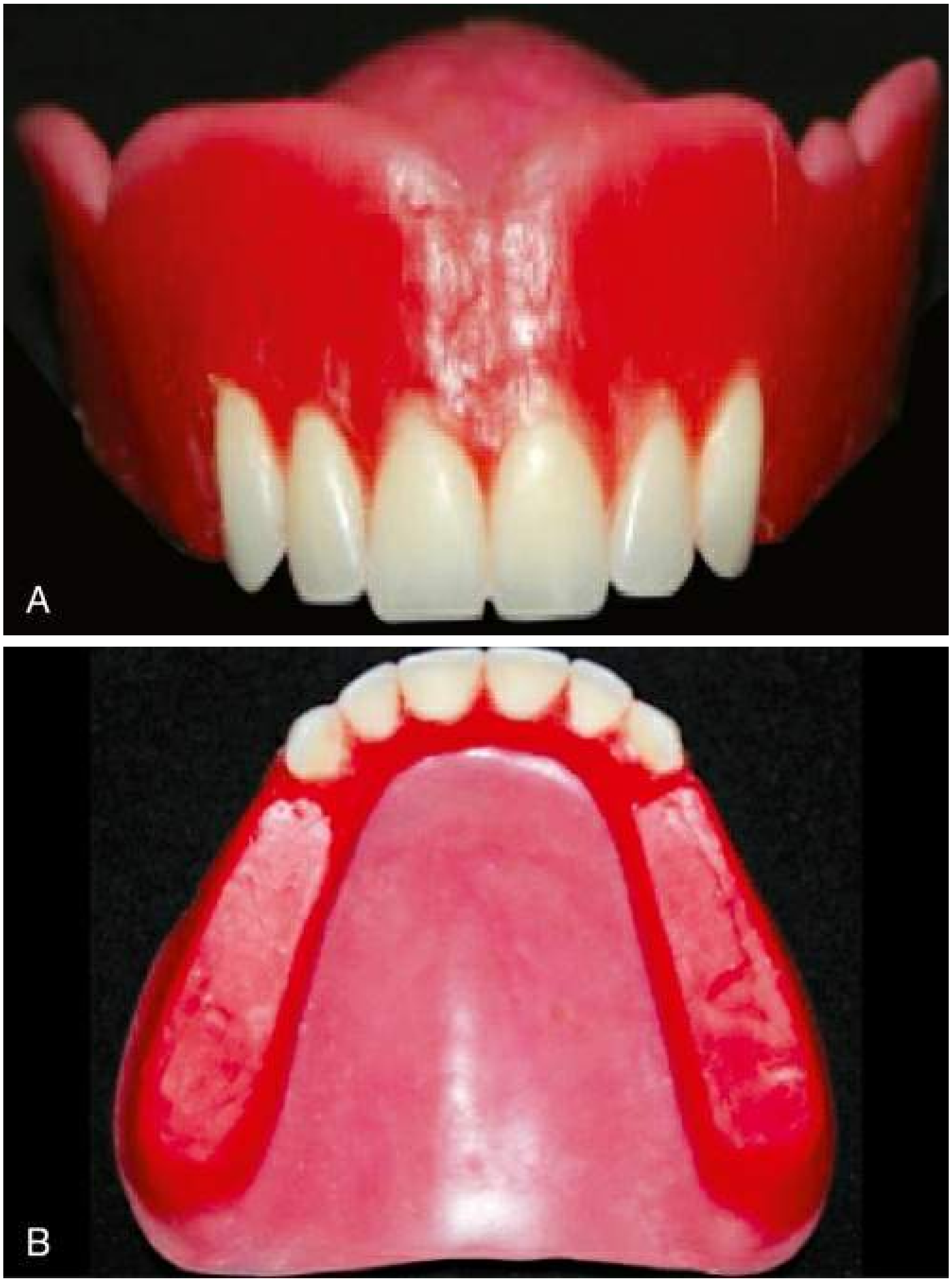


FIGURE 10.14 **(A)** Arrangement of maxillary canine (frontal view). **(B)** Parallel to vertical axis (side view). **(C)** Follows the arch form (palatal view).

It is parallel to the vertical axis when viewed from the side (Fig. 10.14B). The bulbous cervical half of the tooth provides its prominence. When viewed from the buccal side only the distal slope of the canine is visible. On palatal view, the arrangement follows the arch form (Fig. 10.14C).

Similarly the teeth are arranged on the opposite side of the rim (Fig. 10.15A). Maxillary anterior teeth arrangement is thus completed (Fig. 10.15B).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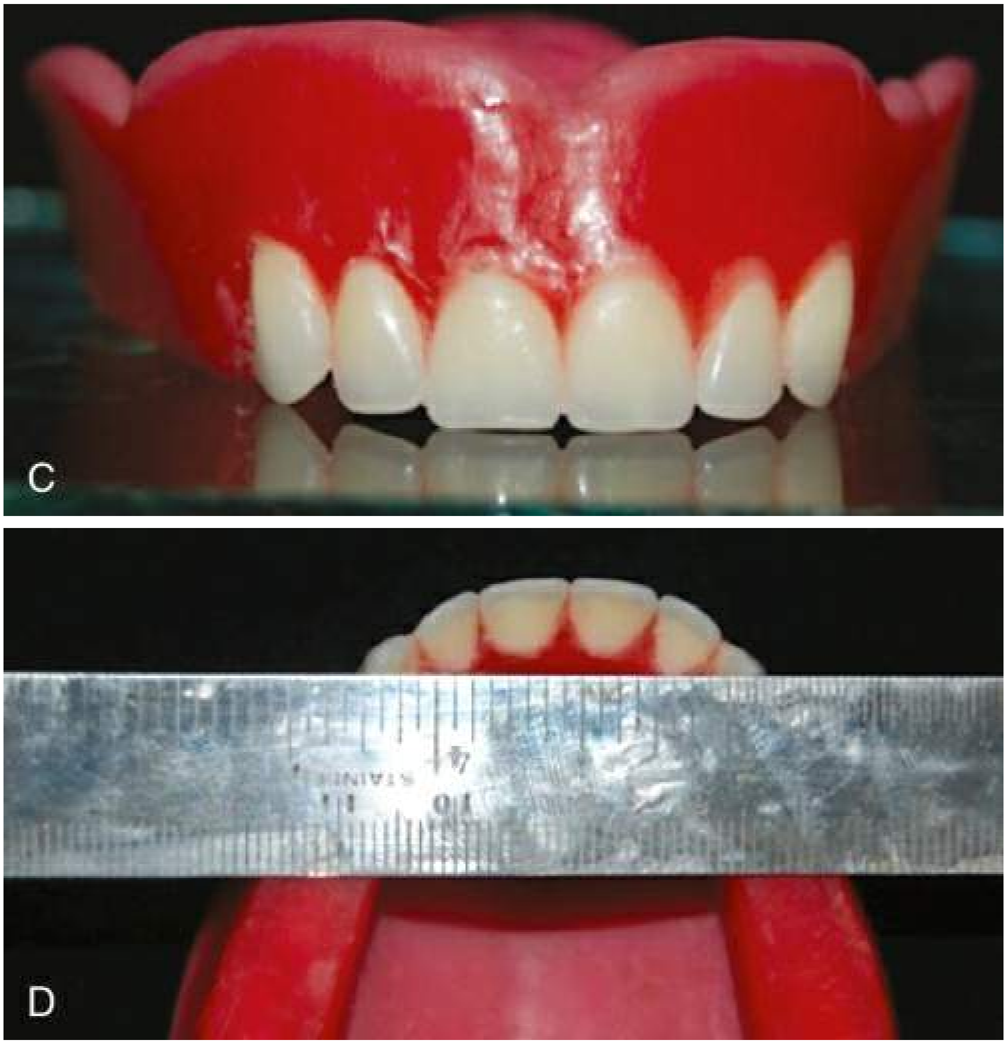


FIGURE 10.15 **(A)** Opposite side of maxillary rim is completed. **(B)** Completed maxillary anterior teeth arrangement. **(C)** Glass plate relation of maxillary anterior teeth. **(D)** Arch symmetry checked with a metal scale.

Glass plate relation of maxillary anteriors is shown in Fig. 10.15C. The cervical margin of the canine is higher than that of the central and lateral incisors. Arch symmetry is shown in the arrangement on either side of the midline (Fig. 10.15D).

Mandibular anteriors

Arrangement of mandibular central incisor

Its long axis also inclines slightly towards the vertical axis when viewed from the front (Fig. 10.16A). The incisal edge is about 2 mm above the occlusal plane.

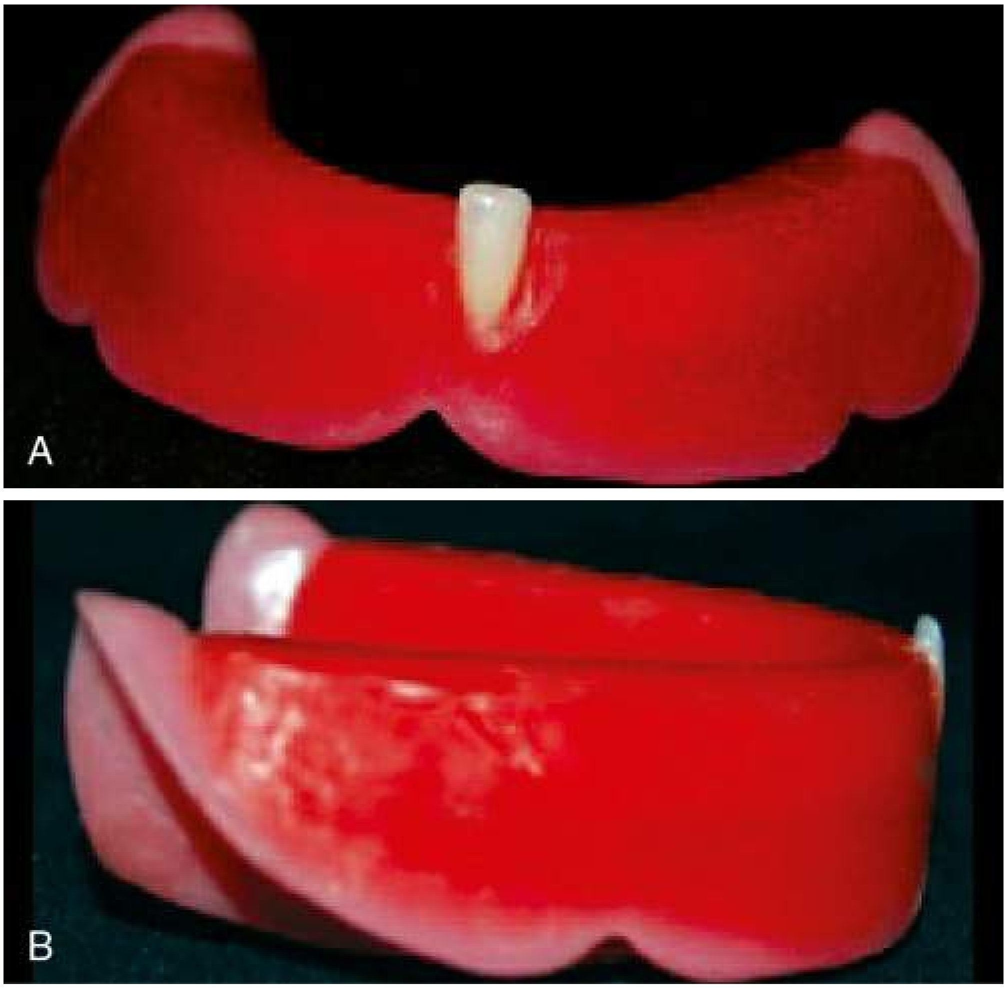
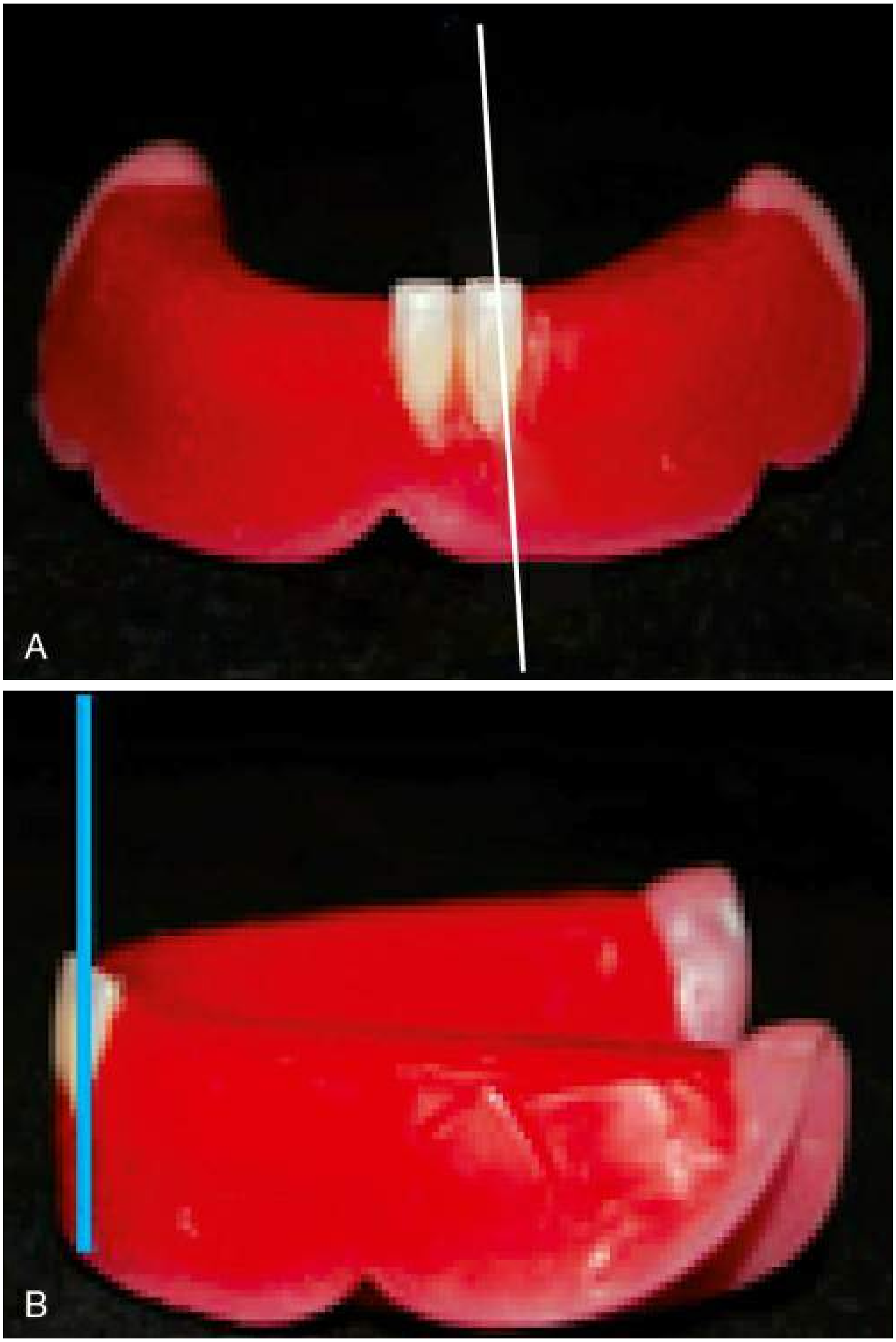


FIGURE 10.16 **(A)** Arrangement of mandibular central incisor (frontal view). **(B)** Mandibular central incisor slopes labially (buccal view). **(C)** Follows the arch form (occlusal view).

It slopes labially when viewed from the side (Fig. 10.16B).The inclination is more pronounced in the incisal half of central incisor and cervical region within the occlusal rim. From incisal view, it follows the arch form (Fig. 10.16C).

Arrangement of mandibular lateral incisor

Its long axis inclines to the vertical axis when viewed from the front. The incisal edge is 2 mm above the occlusal plane (Fig. 10.17A).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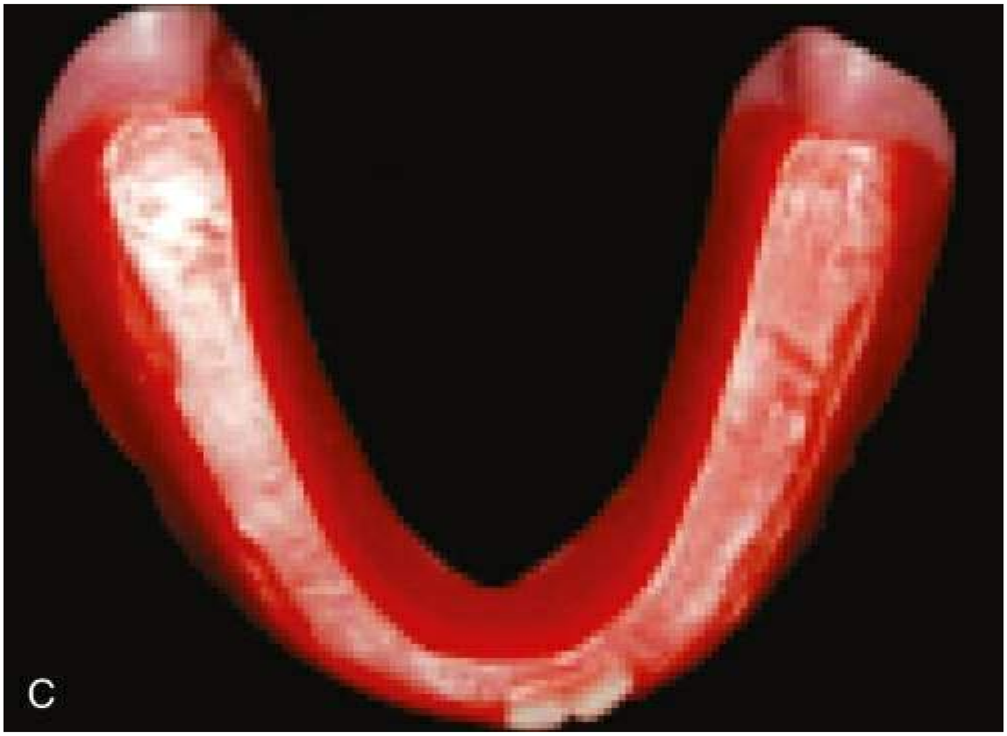
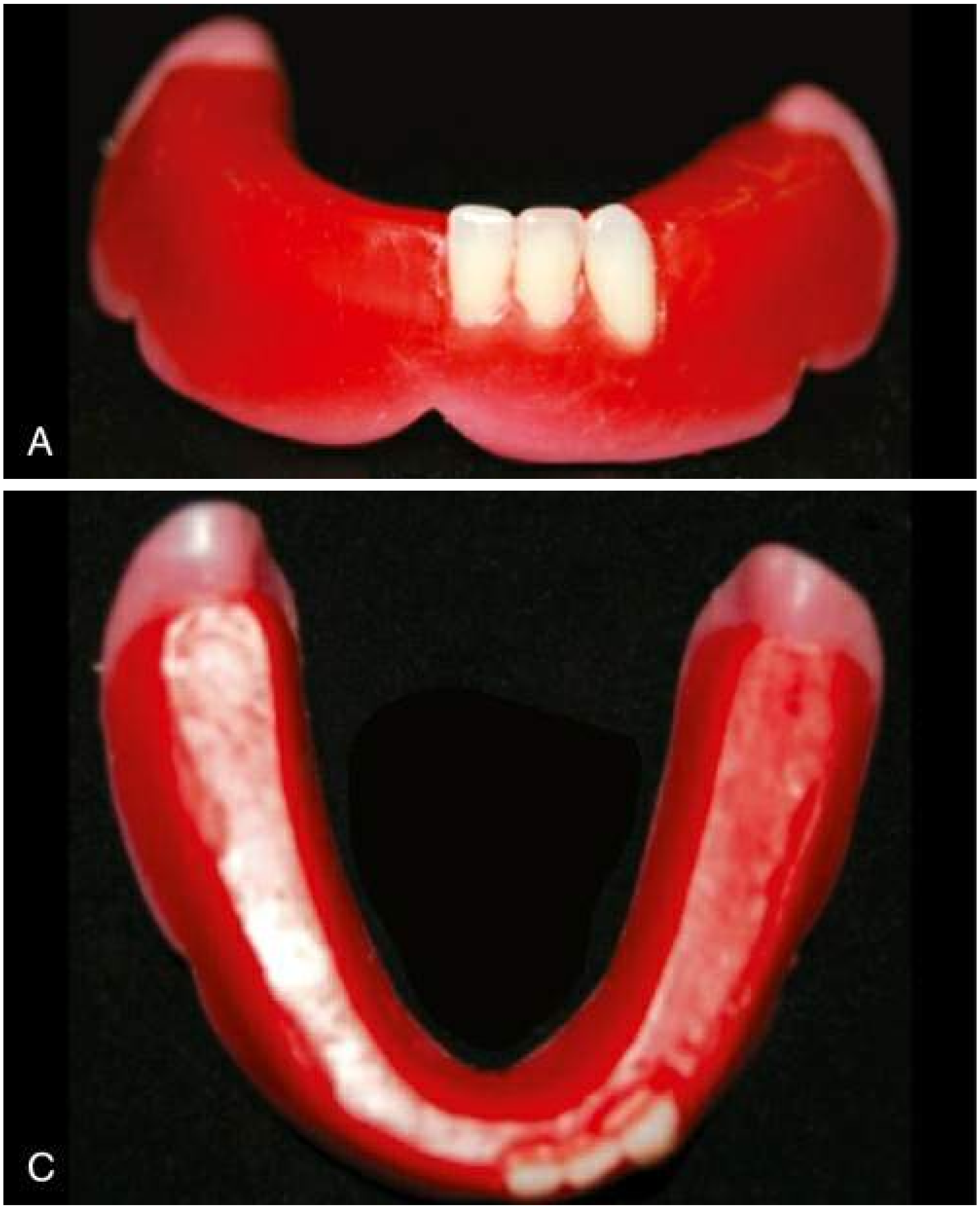


FIGURE 10.17 **(A)** Arrangement of lateral incisor (frontal view). **(B)** Mandibular lateral incisor slopes labially but less steep than centrals. **(C)** Follows the arch form (occlusal view).

When viewed from side its slopes labially (Fig. 10.17B) but not as steep as the central incisor. From incisal view, it follows the arch form (Fig. 10.17C).

Arrangement of mandibular canine

Its long axis leans slightly towards the midline when viewed from the front (Fig. 10.18A). The cervical margin is more prominent than incisors. The incisal margin is 2 mm above the occlusal plane.


A
C

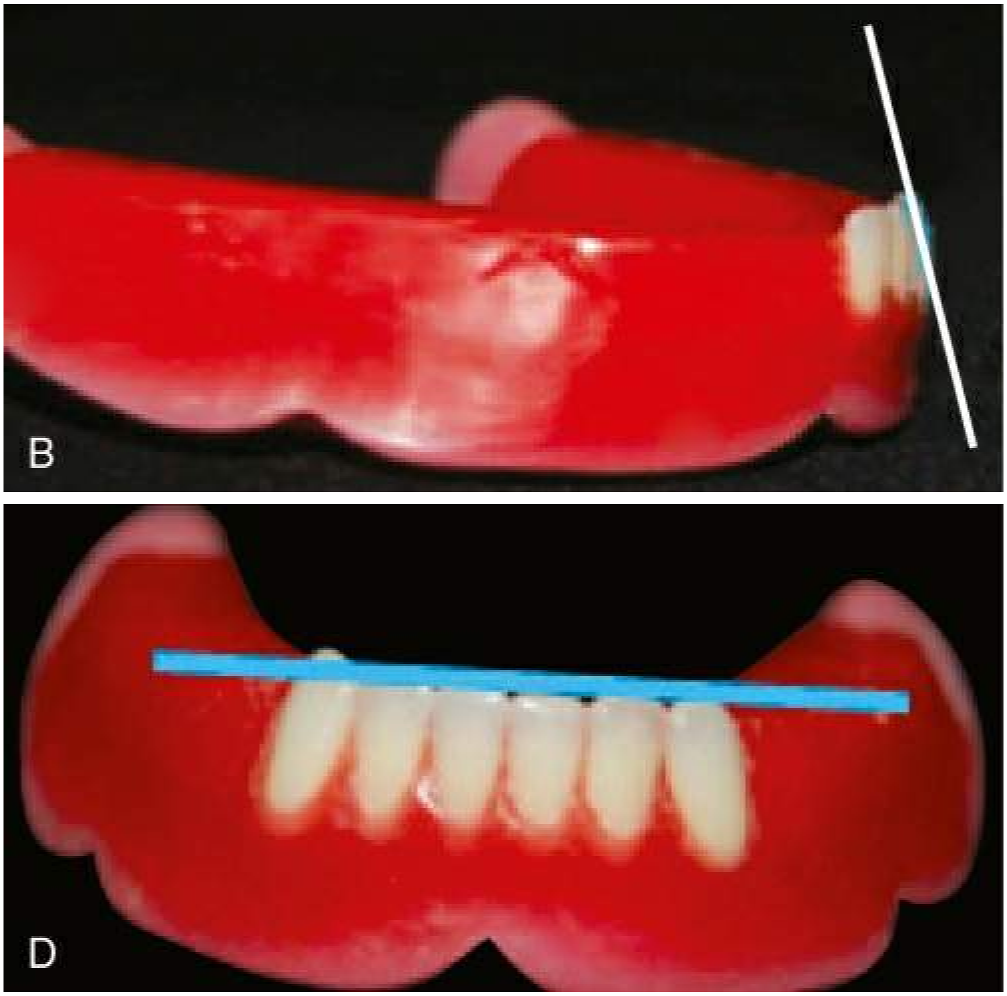

B
D

FIGURE 10.18 **(A)** Mandibular canine leans towards midline (frontal view). **(B)** The SPACE incisal half of the canine is slightly lingually tilted (side view). **(C)** Follows the arch form (occlusal view). **(D)** All the teeth are in the same plane except canines (frontal view). **(E)** All teeth curve along the arch (occlusal view).

From lateral view, the incisal half of the canine is slightly lingually tilted and the cervical half is more prominent when viewed from the side (Fig. 10.18B). From incisal view, the cusp is slightly more than 2 mm above the occlusal plane. The arrangement follows the arch form (Fig. 10.18C).

Similarly the teeth are arranged on the other side of the arch. The incisal edges of all the teeth from canine to canine are in the same plane (Fig. 10.18D).

From incisal view of the mandibular anteriors, the arrangement reveals the incisors follow the arch form. The incisors do not form a straight line but curve according to the curvature in the arch (Fig. 10.18E).

The overjet and overbite (Fig. 10.19A) are approximately 1–2 mm in class I. The canine relationship of the maxillary and mandibular teeth in case of class I arrangement is that the mesial slopes of maxillary canine comes in relation to the distal slopes of mandibular canine.


A

FIGURE 10.19 **(A)** Overjet (1–2 mm) of anterior teeth. **(B)** Complete arrangement of anterior teeth.

The completed frontal view of the anterior teeth arrangement is shown in Fig. 10.19B. This is followed by arranging the posterior teeth.

Posterior teeth arrangement

Arrangement of maxillary first premolar

The long axis is parallel to the vertical axis when viewed from the front and the side (Fig. 10.20A). Its buccal cusp contacts the occlusal plane. The palatal cusp is slightly above the occlusal plane. The buccal surface of the premolar is in line with the labial surface of the canine (Fig. 10.20B).

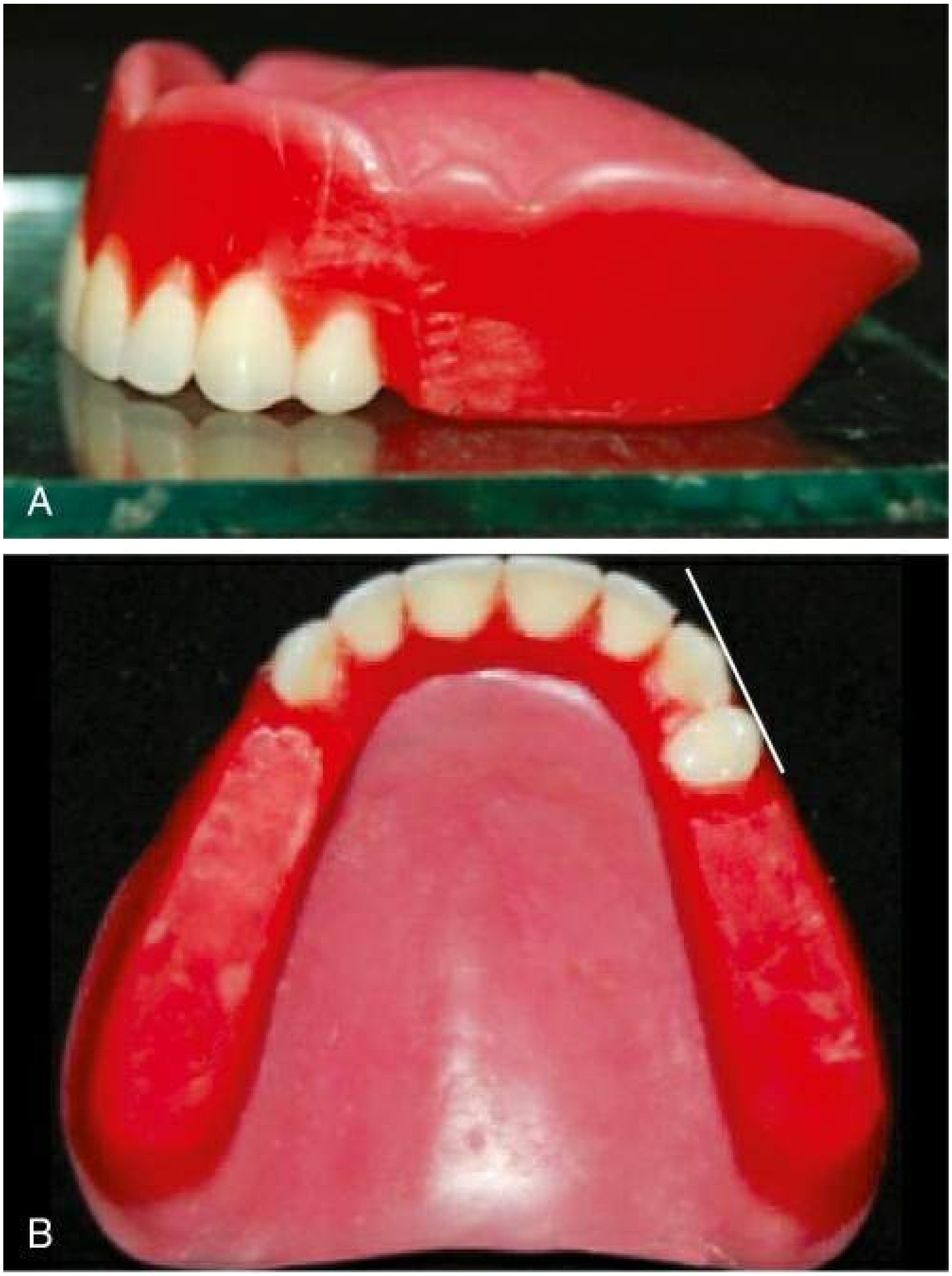


FIGURE 10.20 **(A)** Maxillary first premolar parallel to vertical axis (side view). **(B)** Buccal surface of the premolar is in line with labial surface of the canine.

Arrangement of maxillary second premolar

Its long axis is parallel to the vertical axis similar to first premolar. Both the buccal cusp and palatal cusp contacts the occlusal plane (Fig.

10.21A). From occlusal view, the buccal surfaces of the first and second premolars are in line with the labial surface of the canine (Fig. 10.21B).

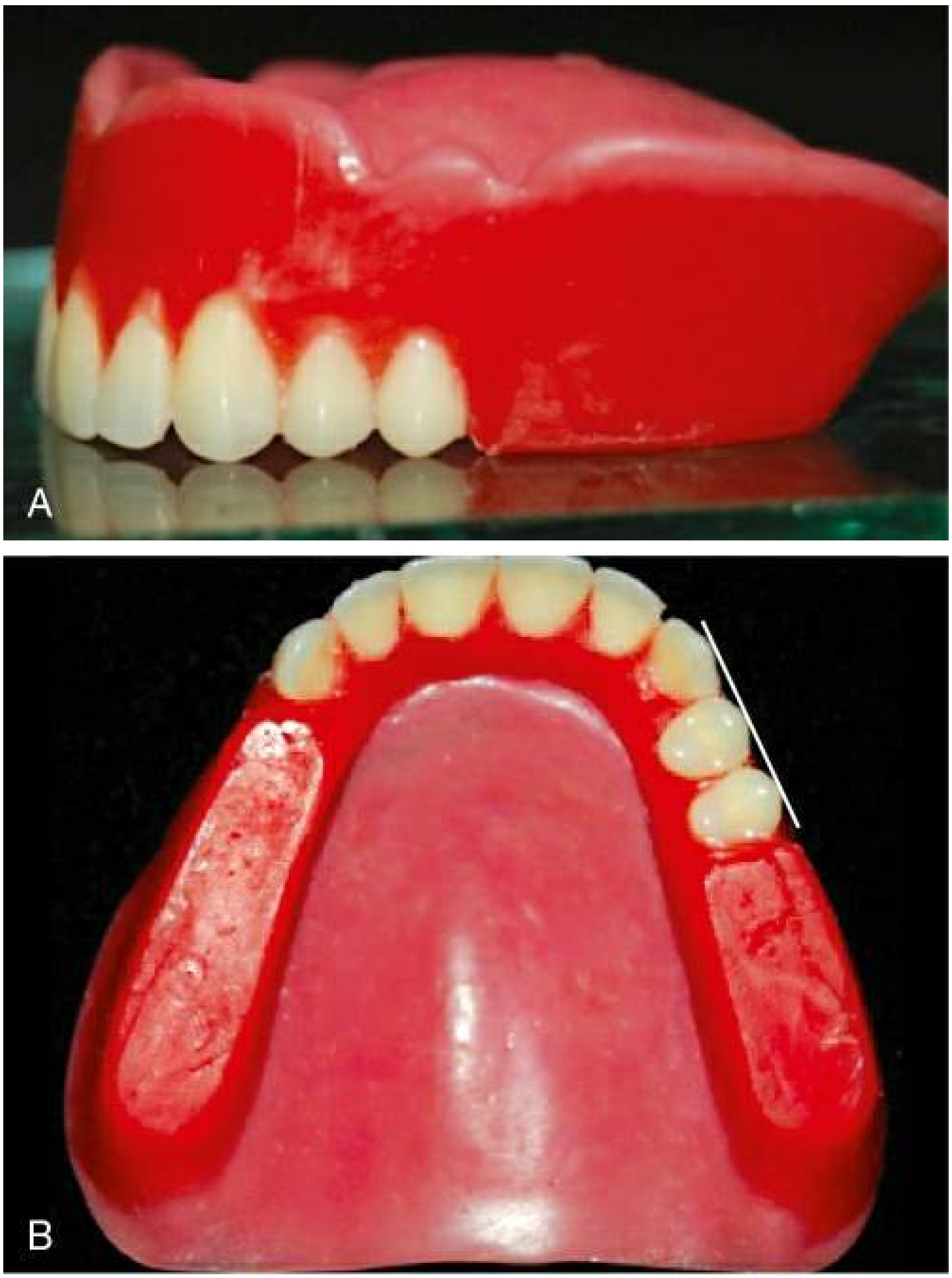


FIGURE 10.21 **(A)** Long axis is parallel to the vertical axis (side view). **(B)** The first and second premolars are in line

(palatal view).

Arrangement of maxillary first molar

When viewed from front, the long axis slopes buccally. When viewed from side, long axis slopes distally. Only the mesiopalatal cusp contacts the occlusal plane and mesiobuccal in close cusp is close to the occlusal plane (Fig. 10.22A). From occlusal view, the buccal surfaces of two premolars and first molar are in line with the labial surface of the canine (Fig. 10.22B).

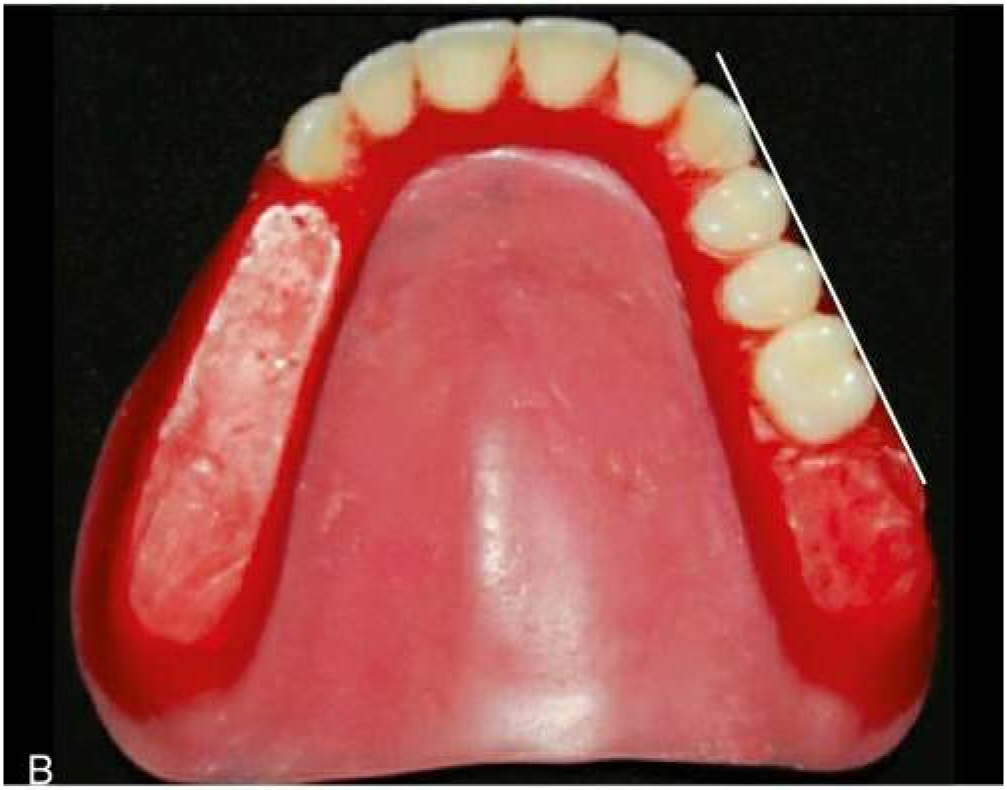
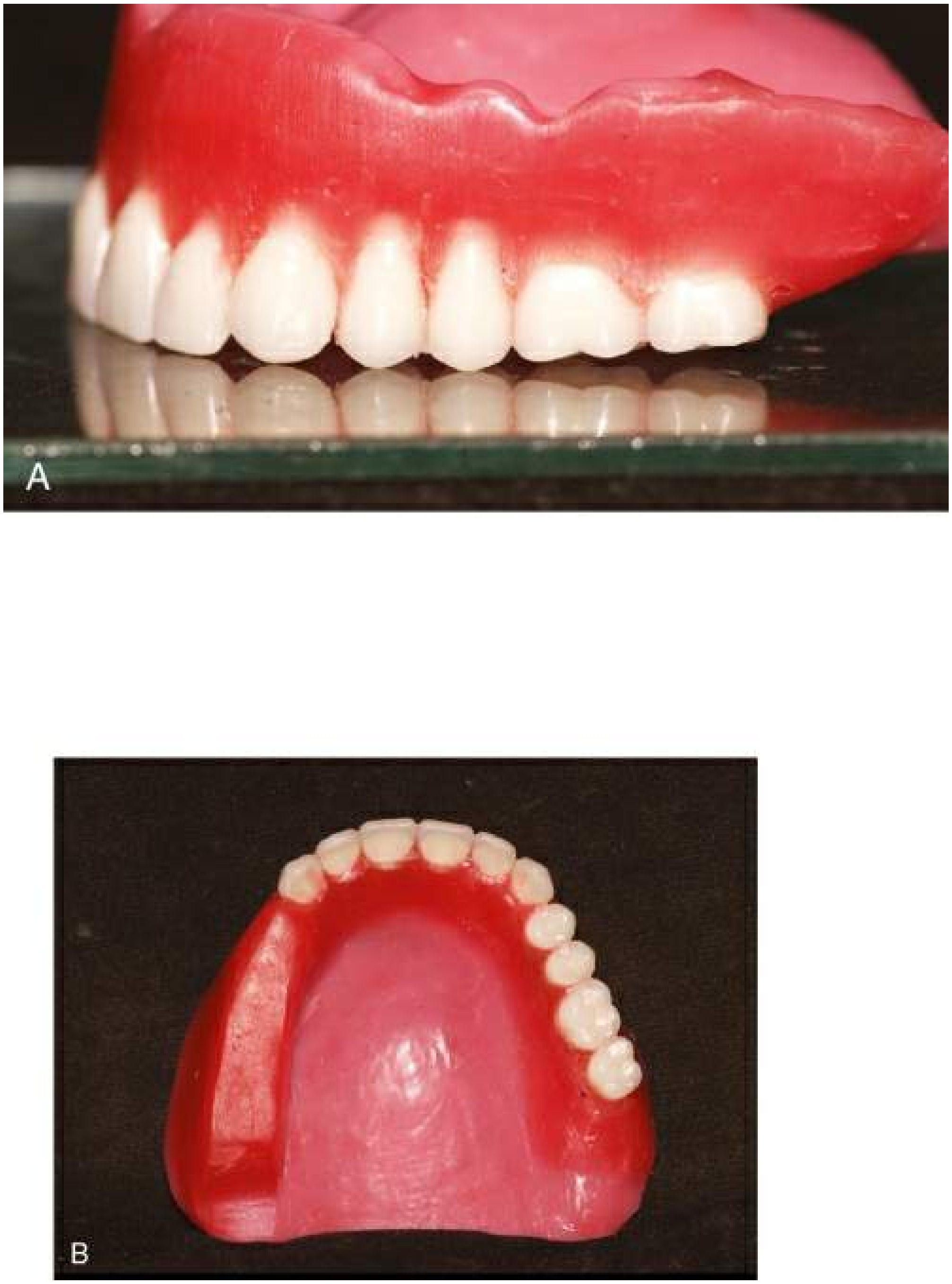


FIGURE 10.22 **(A)** Only the mesiopalatal cusp contacts the occlusal plane. **(B)** Buccal surfaces of two premolars and first molar are in line (occlusal view).

Arrangement of maxillary second molar

When viewed from the front, it slopes more buccally than first molar. When viewed from side it slopes more distally than first molar. None of the cusps is in contact with the occlusal plane but mesiopalatal cusp is close to the occlusal plane (Fig. 10.23A). The mesial surface of the second molar should be in line with the distal surface of first molar (Fig. 10.23B).



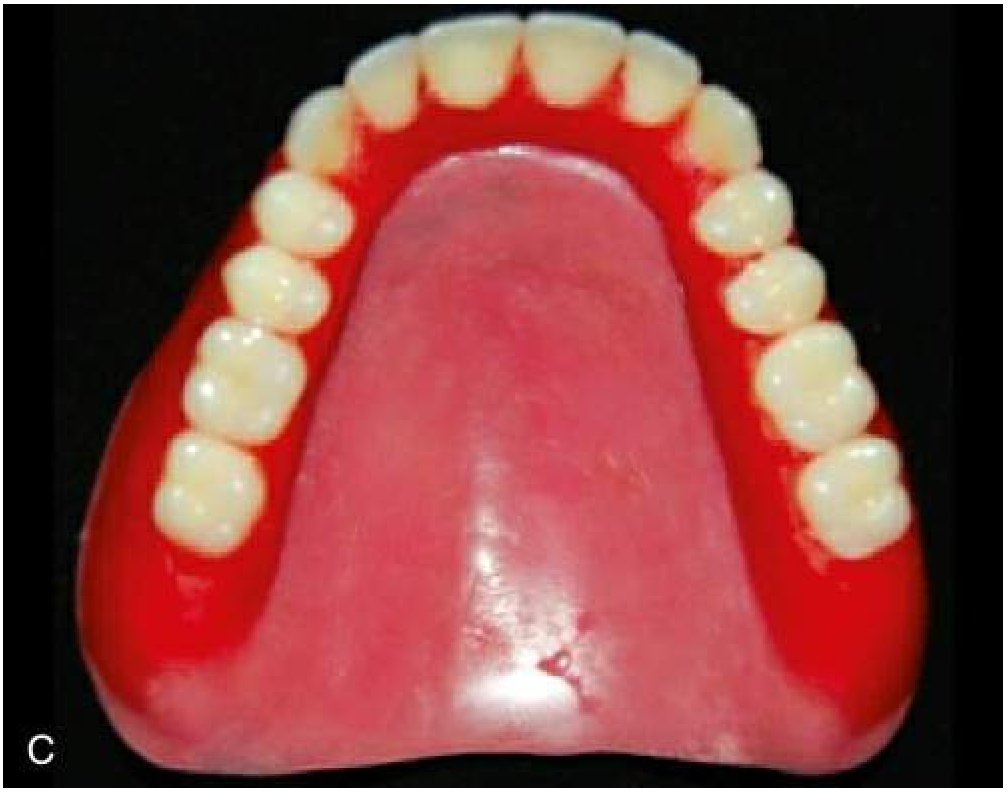


FIGURE 10.23 **(A)** None of the cusps is in contact with the occlusal plane for maxillary second molar. **(B)** Occlusal view reveals the buccal surface of maxillary posteriors in line with the distal slope of canine except the distobuccal cusp of the second molar. **(C)** Completed teeth arrangement of maxillary arch.

From occlusal view, the buccal surface of the maxillary posteriors is in line with the distal slope of canine except the distobuccal cusp of the second molar. The occlusal view of maxillary trial base after teeth arrangement is shown in Fig. 10.23C.

The glass plate relation of maxillary teeth showing the cuspal contact on the glass plate is shown in Fig. 10.24A and B.

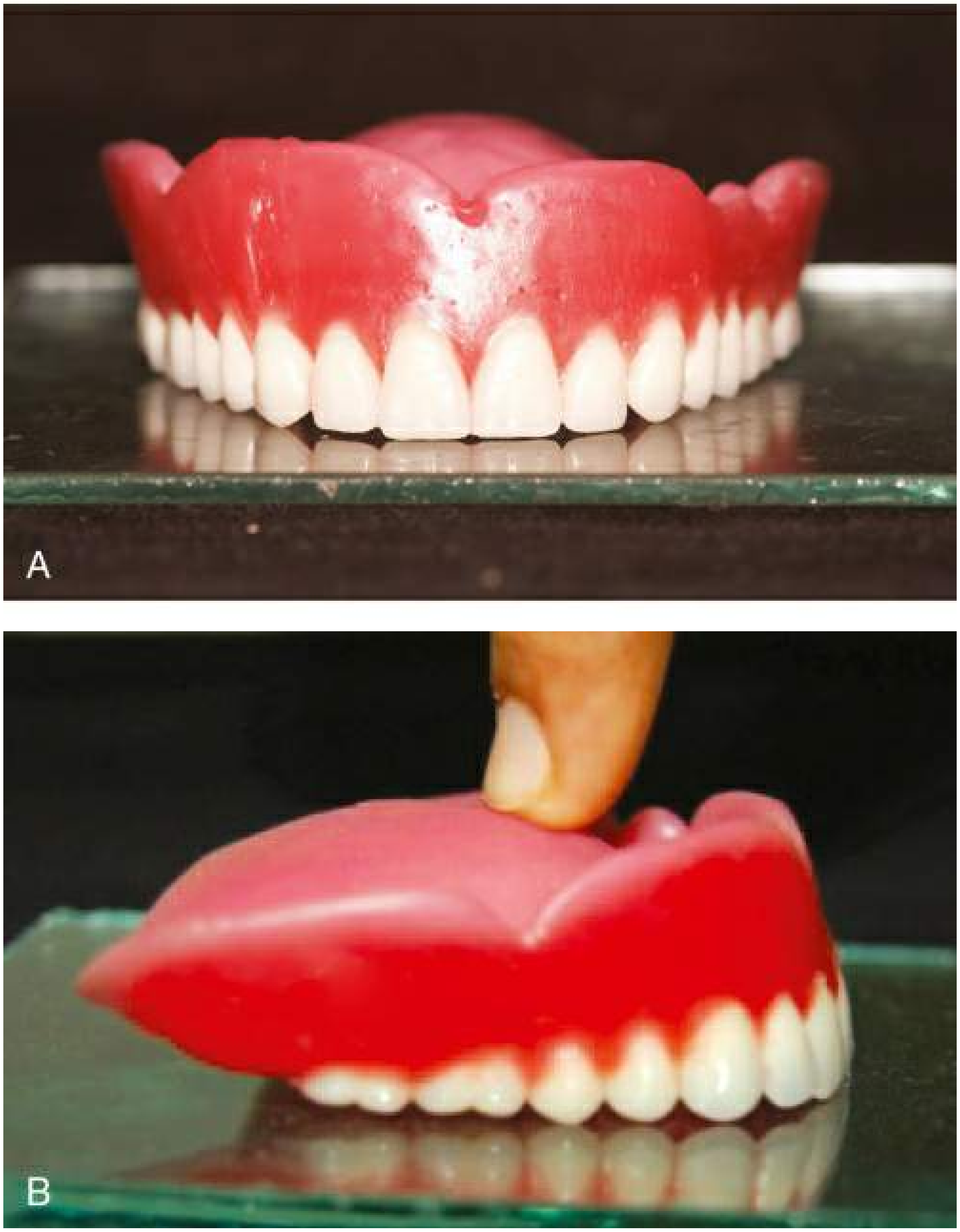


FIGURE 10.24 **(A)** Glass plate relation (frontal view). **(B)** Glass plate relation (side view).

The trial denture base with the maxillary teeth arranged is placed on the articulator with the frontal view revealing the correct placement of maxillary central incisor (Fig. 10.25A and B).

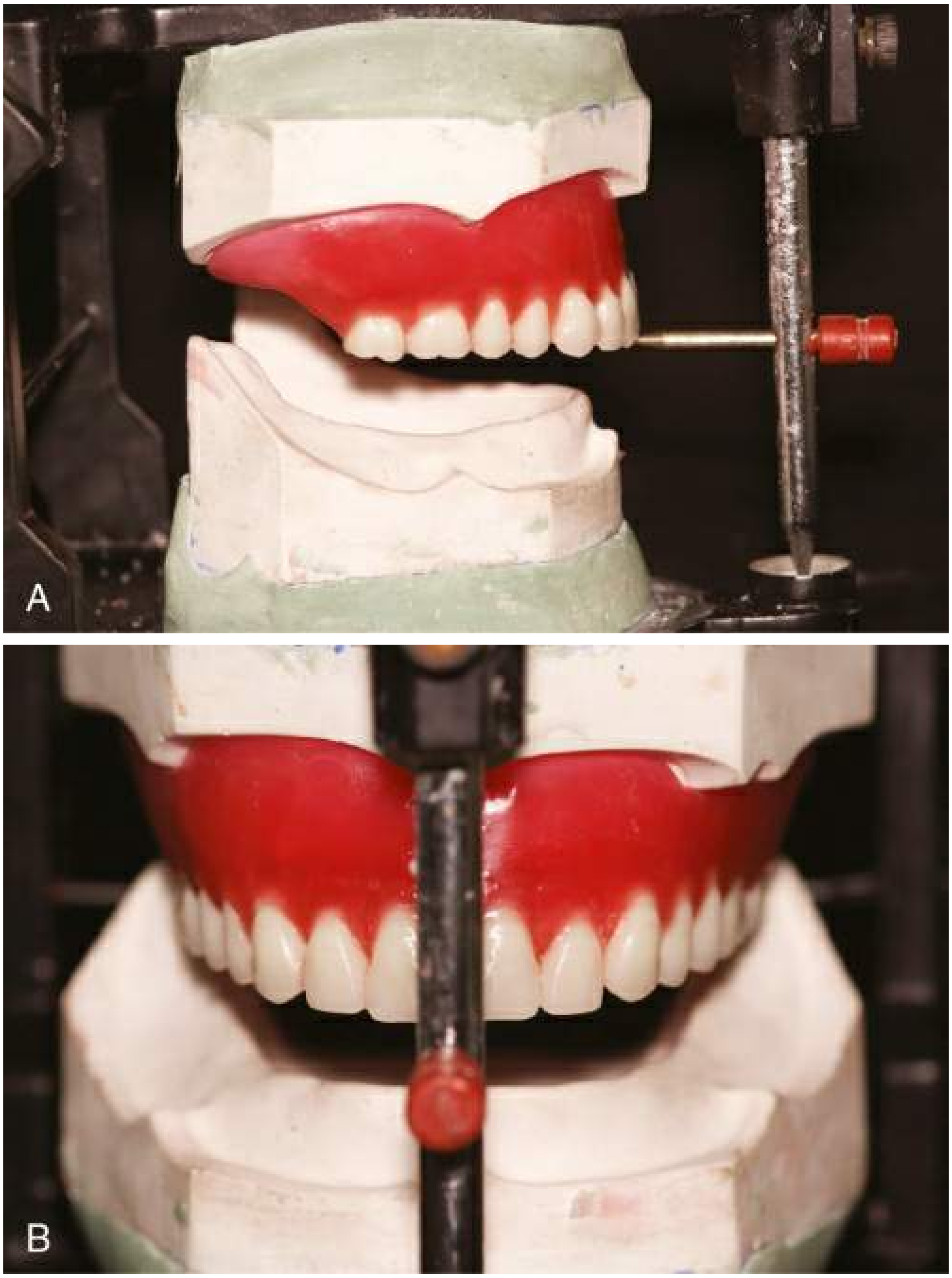
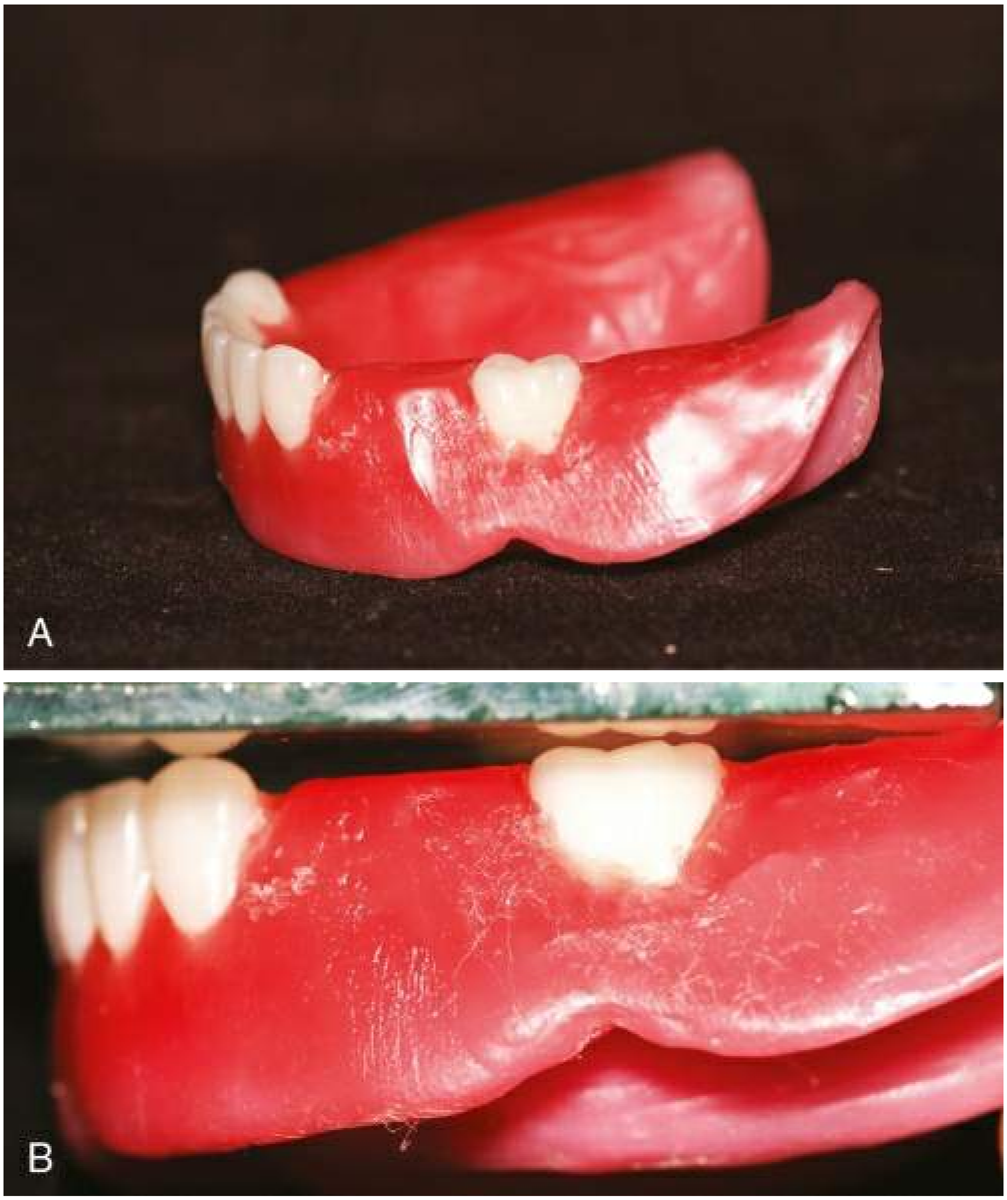


FIGURE 10.25 **(A)** Maxillary teeth arranged and placed on the articulator (side view). **(B)** Maxillary teeth arranged and placed on the articulator (frontal view).

Arrangement of mandibular first molar

Long axis leans lingually when viewed from the front view and mesially when viewed from the buccal side (Fig. 10.26A). All cusps are at a higher level above the occlusal plane than those of the second premolar. The distal cusp will be higher when compared with other cusps.



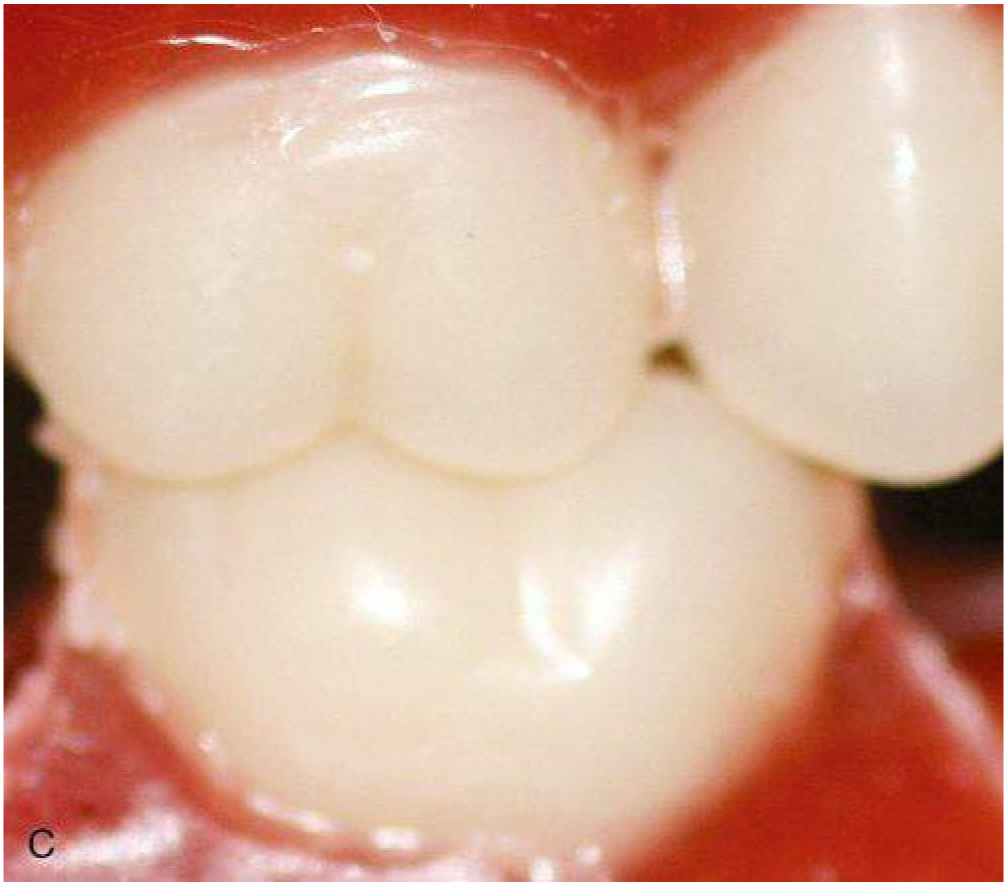


FIGURE 10.26 **(A)** Long axis leans mesially (buccal side view). **(B)** Buccal and distal cusps are higher for mandibular first molar. **(C)** Key of occlusion: mesiobuccal cusp of maxillary I molar resting on buccal groove of mandibular I molar.

The buccal and distal cusps are higher than the mesial and lingual because of the inclination (Fig. 10.26B).

Occlusion: The mesiopalatal cusp of maxillary should rest on the central fossa of the mandibular first molar to establish the buccal overjet. The mesiobuccal cusp of the maxillary first molar should rest on the buccal groove of the mandibular first molar (Fig. 10.26C). This is one of the 'keys of occlusion'.

Arrangement of mandibular second premolar

The long axis is parallel to the vertical plane when viewed from both the front and the side (Fig. 10.27A). Both cusps are about 2 mm above the occlusal plane and follow arch form (Fig. 10.27B).

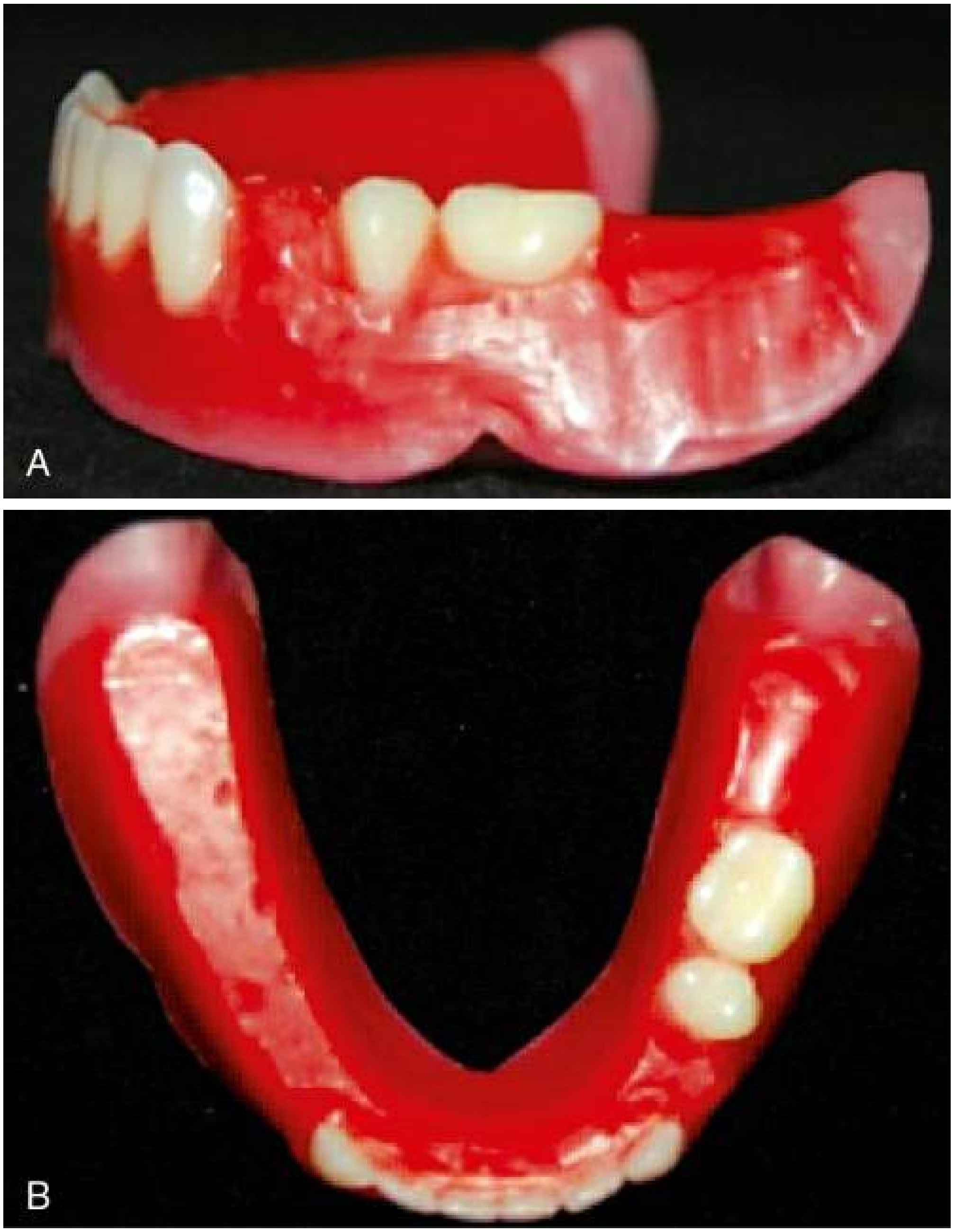

A
B

FIGURE 10.27 **(A)** Mandibular second premolar long axis parallel to the vertical plane. **(B)** Follows the arch form (occlusal view). **(C)** Mandibular second premolar in occlusion.

Occlusion: The buccal cusp tip contacts the mesial marginal ridge of the maxillary second premolar. The mesiolingual ridge contacts the distal slope of the lingual cusp of maxillary first premolar (Fig. 10.27C).

Arrangement of mandibular second molar

Lingual and mesial inclination of the long axis is more than that of the first molar. Inclination of the distal and buccal cusps is more than the mesial and lingual. Long axis is parallel to the vertical plane when viewed from the front and follows the arch form (Fig. 10.28A). Lingual cusp is below the horizontal plane.

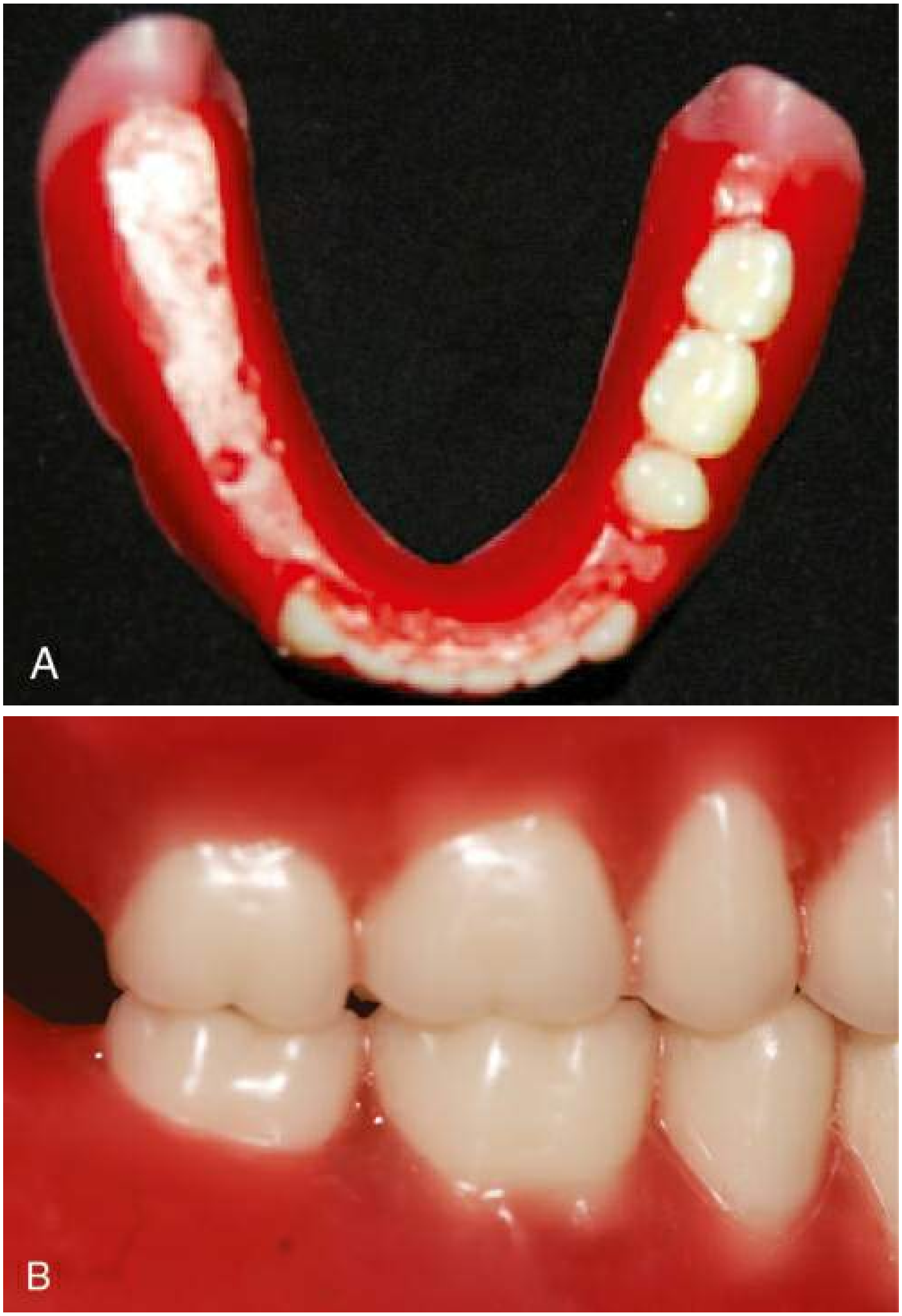
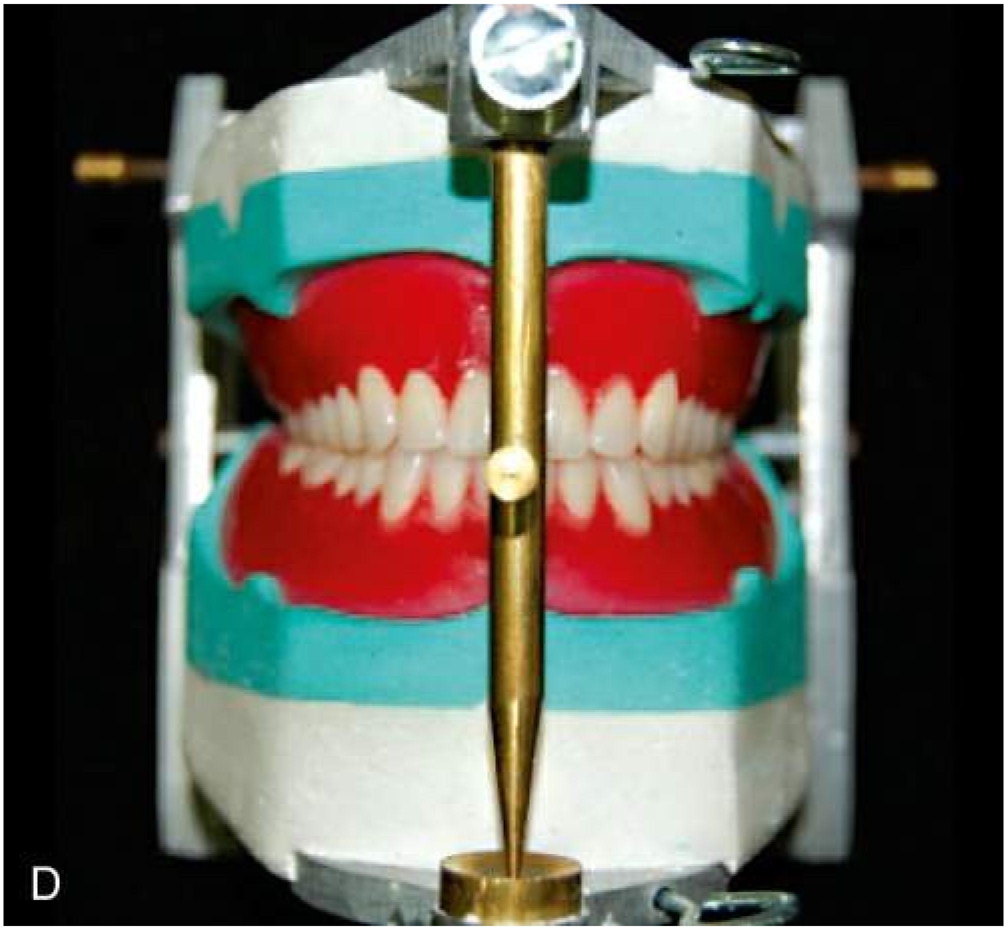


FIGURE 10.28 **(A)** All teeth follow the arch form (occlusal view). **(B)** Mandibular second molar in occlusion.

Occlusion: Contact with maxillary second molar is similar to occlusion between the first molars (Fig. 10.28B).

Arrangement of mandibular first premolar

The buccal cusps or the central groove of the mandibular posteriors should coincide with the crest of the residual alveolar ridge which is finally placed (Fig. 10.29A).


D


A

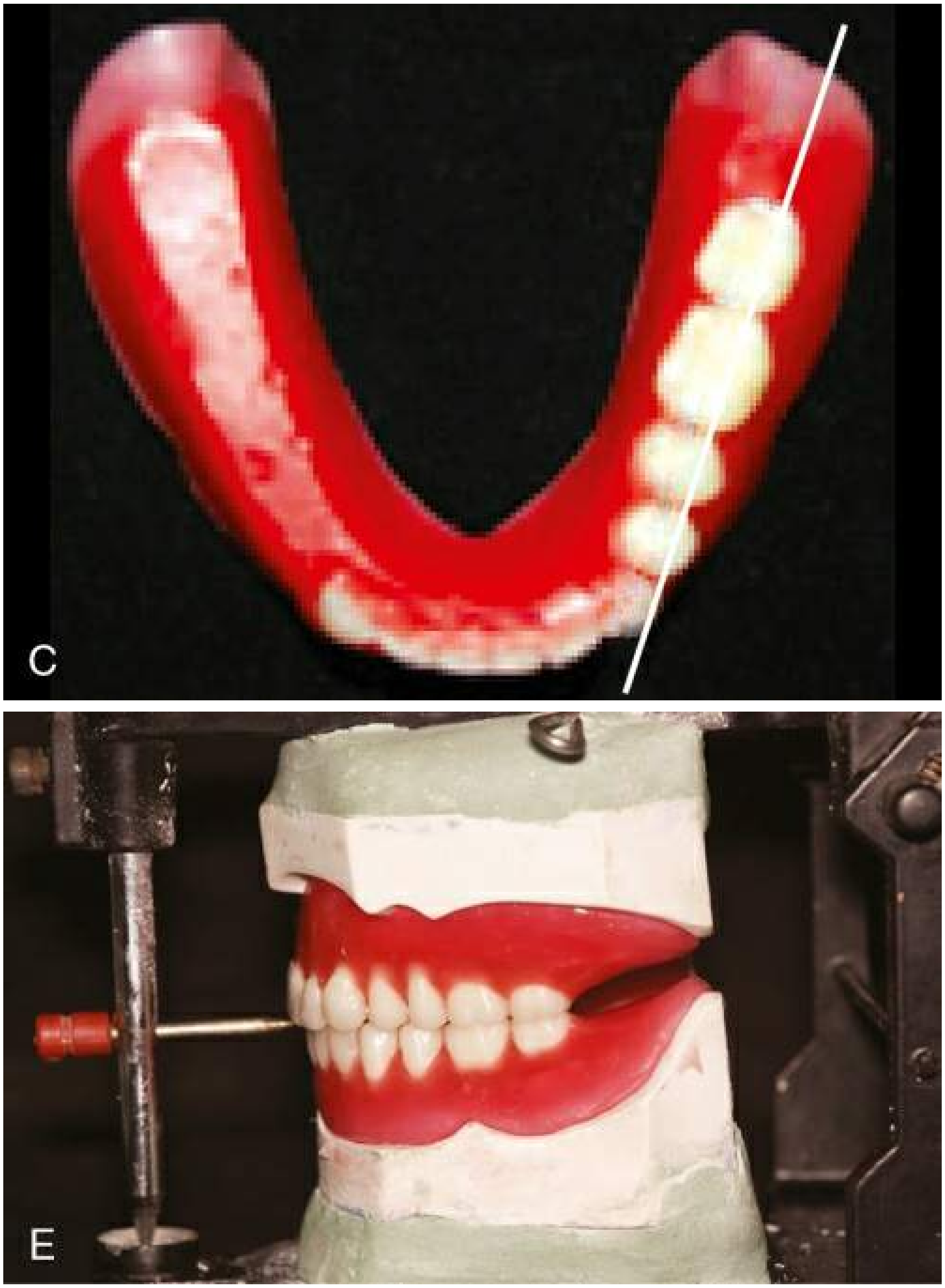


FIGURE 10.29 **(A)** Mandibular first premolar is finally placed. **(B)** Mandibular first premolar in occlusion. **(C)** All the posterior teeth are in a straight line. **(D)** Completed teeth arrangement. **(E)** Completed arrangement in occlusion.

Occlusion: Buccal cusp should contact the mesial marginal ridge of the maxillary first premolar (Fig. 10.29B).

The remaining mandibular posteriors are arranged in the similar fashion on the other quadrant. Note that the central fossae of all the posterior teeth are in a straight line on the ridge crest (Fig. 10.29C).

Fig. 10.29D and E shows the completed teeth arrangement in class I ridge relation.

Key of occlusion

The mesiobuccal cusp of maxillary first molar rests on the mesiobuccal groove of the mandibular first molar in centric occlusion.

Teeth arrangement for class II ridge relation

In class II the maxilla is prognathic or mandible is retrognathic with an increased overjet of 5–6 mm. The same principles of teeth arrangement is followed, with slight modifications.

1. The teeth arrangement principles for the maxillary anteriors (Fig. 10.30A) are similar for both classes I and II and are governed by the aesthetics and dentogentic concepts.

2. The mandibular anteriors are placed with increased overjet of 5–6 mm and overbite of 2 mm (Fig. 10.30B and C).

3. Due to retruded position of the mandibular ridge with less space for teeth, one premolar is removed in the mandibular arch (Fig. 10.31A), while all the teeth are arranged in the maxillary arch (Fig. 10.31B).

4. Fig. 10.32 A and B shows the completed teeth arrangement for a class II ridge relation.

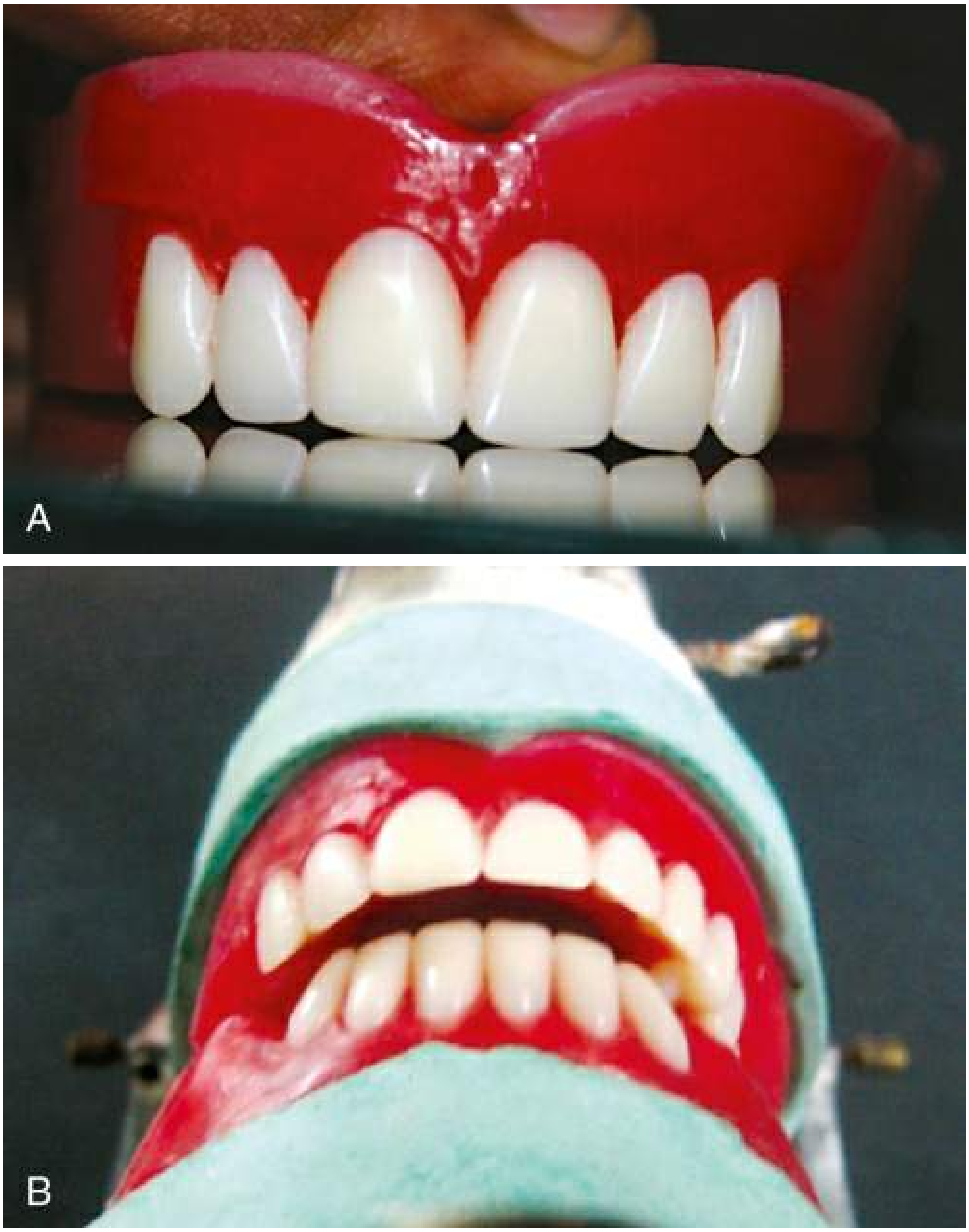

A
B

FIGURE 10.30 **(A)** Glass plate relation of maxillary anterior teeth. **(B)** Increased overjet (5–6 mm). **(C)** Increased overjet (5–6 mm).

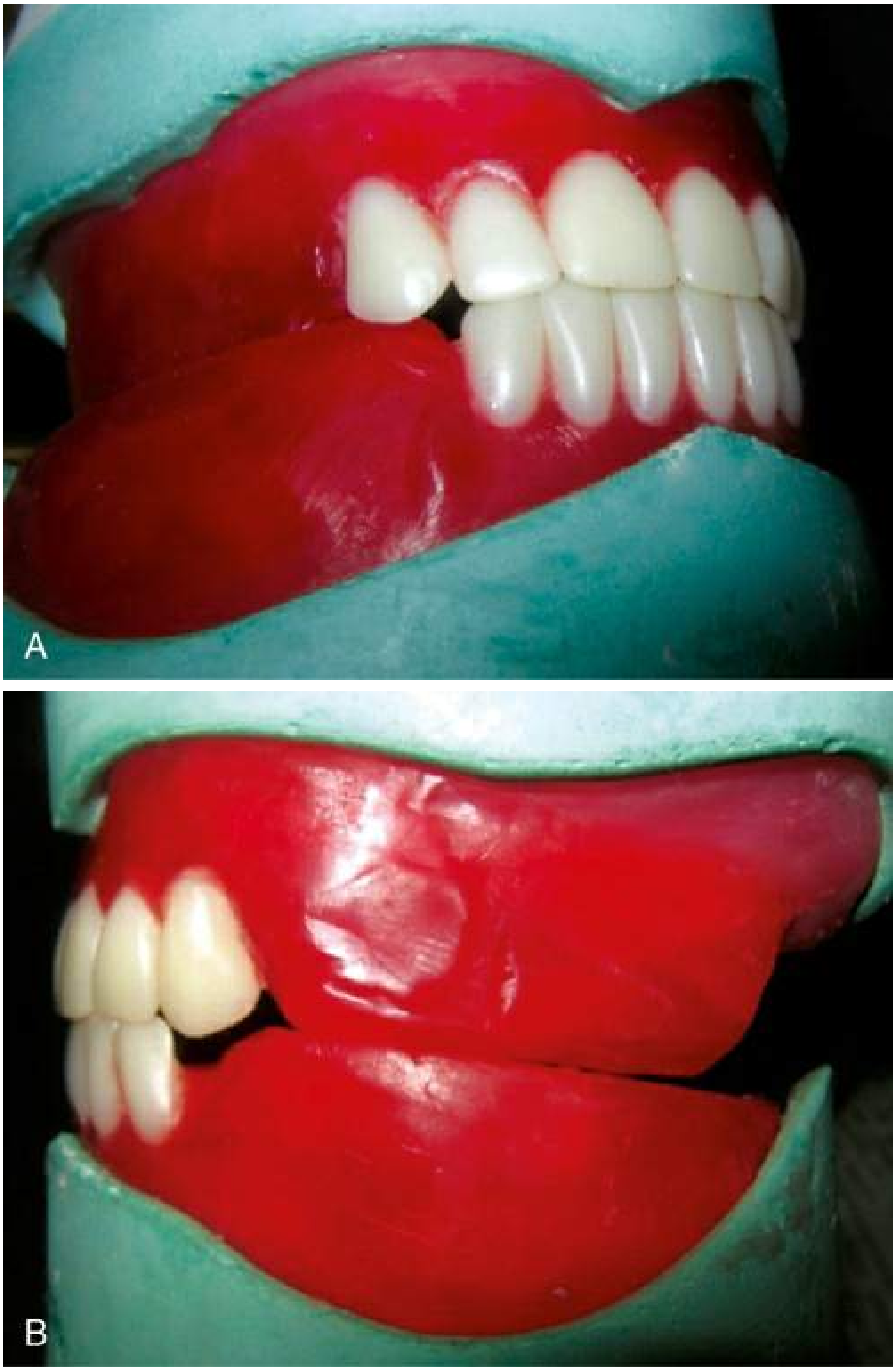
FIGURE 10.31 **(A)** Mandibular first premolar removed. **(B)** Glass plate relation of maxillary teeth.

FIGURE 10.32 **(A)** Completed teeth arrangement in class II. **(B)** Completed class II teeth arrangement showing the occlusion.

Teeth arrangement for class III ridge relation

In class III, the mandible is prognathic or the maxilla is retrognathic; thus, the overjet and overbite are reduced to almost 0–1 mm. The same principles of teeth arrangement is followed, with slight modifications.

In case of anterior teeth arrangement, the teeth arrangement principles are the same except for the overjet which is virtually eliminated (edge-to-edge bite) (Fig. 10.33A) and the overbite which is also minimized (Fig. 10.33B). In order to provide space for the maxillary posterior teeth, usually one premolar is trimmed mesiodistally or removed from the maxillary arch (Fig. 10.33C).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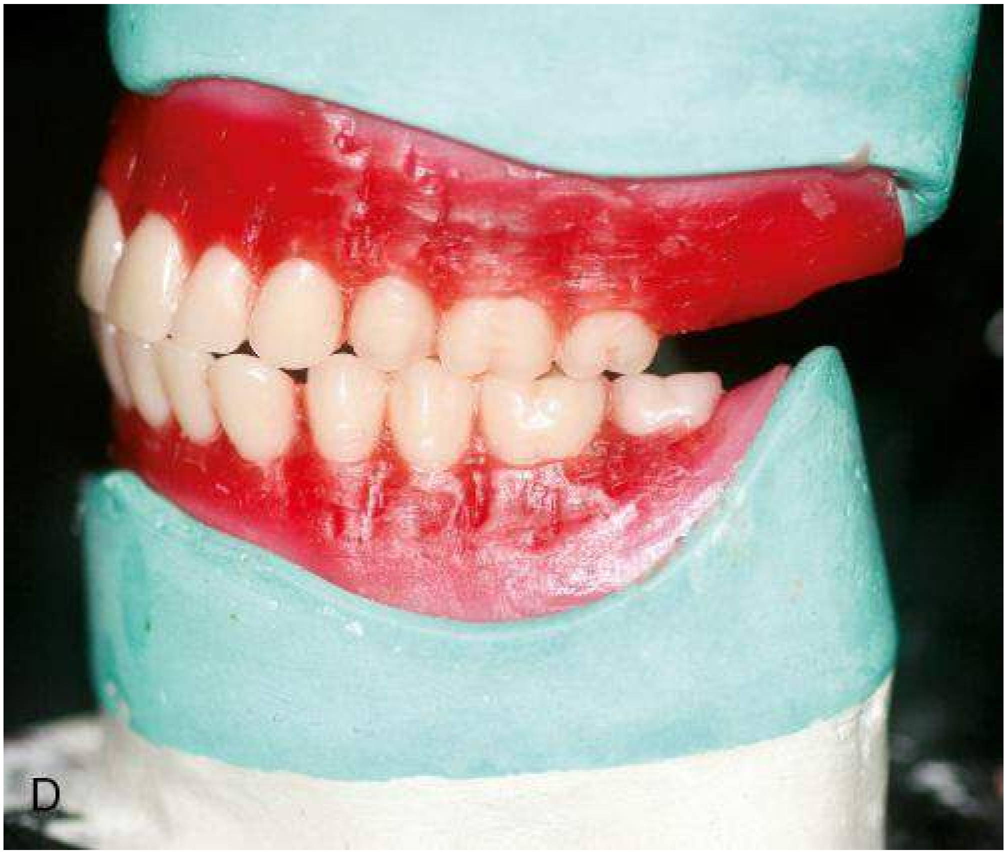


FIGURE 10.33 **(A)** Edge-to-edge relation of anterior teeth. **(B)** Minimized overbite. **(C)** Class III maxillary first premolar removed. **(D)** Completed class III teeth arrangement in occlusion.

Fig. 10.33D shows the completed arrangement for class III ridge relation.

Developing balanced occlusion

Once the centric balance is achieved using the basic setting principles as discussed before, the teeth arrangement is modified to achieve eccentric balance – protrusive and lateral. For this, it is essential to programme the articulator to set the horizontal condylar inclination (HCI) using protrusive records and the lateral condylar inclination (LCI) using lateral records or by using the Hanau formula. Hence, at least a semi-adjustable articulator is mandatory. This has been discussed in Chapters 6 and 7.

Developing balanced occlusion in protrusion

In a protrusive occlusion, the anterior teeth are edge-to-edge (this is done by releasing the locking screws and rotating the track forwards or backwards in semi-adjustable articulator – a working occlusion), and contacts should be simultaneously established in the posterior teeth (Fig. 10.34).

FIGURE 10.34 Protrusive balance – contact of both anterior and posterior teeth.

To achieve this, when we consider the factors affecting balance, HCI is obtained from the patient, hence it cannot be altered. As discussed in Chapter 8, the incisal guidance should be as flat (close to 0 degree) as aesthetics and phonetics will permit, so it can be manipulated limitedly. The occlusal plane is governed by anatomical and functional consideration and also cannot be altered. The other two factors – compensating curves and cuspal inclination need to be adjusted to achieve protrusive balance. The cuspal inclination also needs to be lesser than the condylar inclination. Cuspal inclination is predetermined by the selection of artificial teeth, but it can also be adjusted to a certain extent by grinding the teeth. The anteroposterior curve (curve of Spee) influences the protrusive balance. On protrusion, with anterior teeth in edge-to-edge contact, the mesial side of maxillary posteriors is tilted down while the distal side of mandibular posteriors is tilted up until contact is made to create the compensating curve (Fig. 10.35). This compensates for the Christensen's phenomenon. Steeper the condylar inclination, steeper should the compensating curve with low cuspal inclination. This achieves protrusive balance but care should be taken not to loose the centric contact in the process.

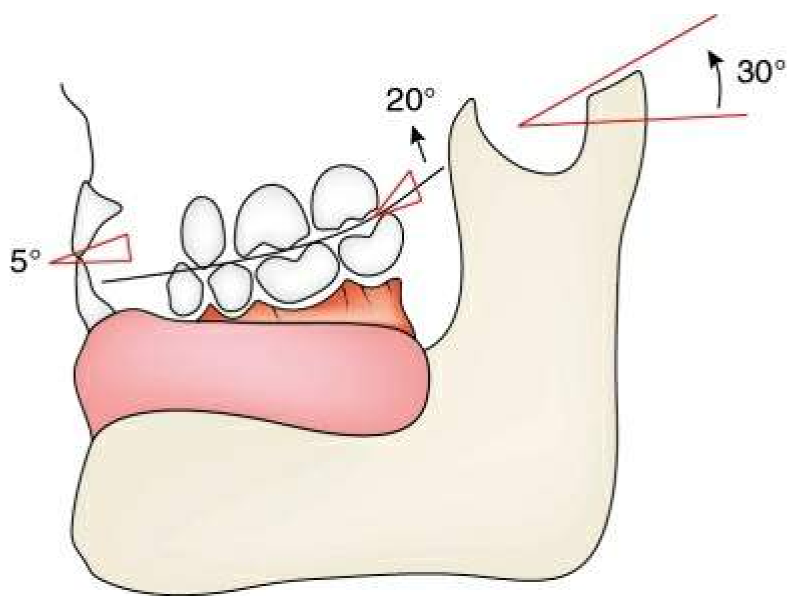


FIGURE 10.35 Protrusive balance achieved using incisal guidance, cuspal inclination and compensating curve.

Developing balanced occlusion in lateral excursions

To achieve lateral balance, buccal cusps of the maxillary and mandibular posterior teeth should contact on the working side, while the mandibular buccal and maxillary palatal cusps of the posterior teeth should contact on the nonworking side (Fig. 10.36).

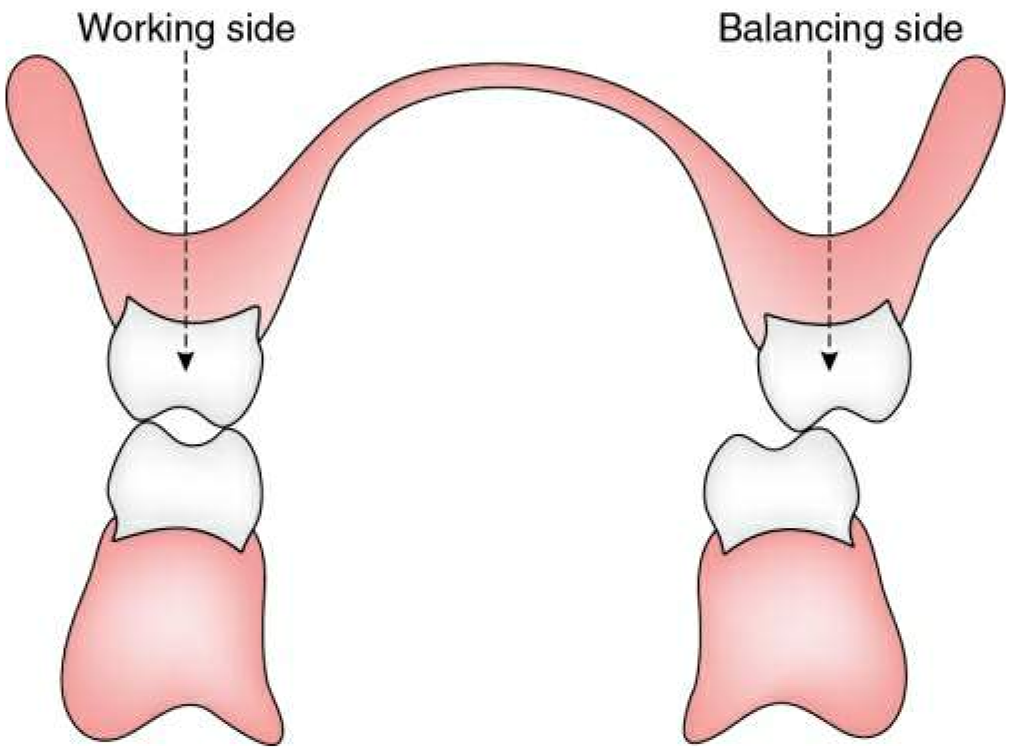


FIGURE 10.36 Lateral balance contacts.

Similar to achieving protrusive balance, the LCI is dictated by the joint morphology and is obtained by the patient, which cannot be altered. The factors that can be modified are compensating curve and cuspal inclination. The mediolateral curves are used to achieve lateral balance by tilting the posterior teeth buccolingually. Cuspal inclination can be grounded to incorporate the compensating curves and thereby achieve lateral balance.

Neutral zone technique

Definition: The potential space between the lips and cheeks on one side and the tongue on the other; that area or position where the forces between the tongue and cheeks or lips are equal (GPT8).

The loose and unstable mandibular complete denture is one of the most common and challenging tasks faced by the dentist. In order to overcome this, teeth need to be arranged such that the forces exerted by the tongue, cheek and lips are neutralized and the teeth along with the polished surfaces of the denture remain in a 'zone of equilibrium'. If the denture is fabricated outside this neutral zone, it will result in instability of the denture during functions like swallowing, speech and mastication. The neutral zone technique helps to minimize these displacing forces of the surrounding oral musculature on the mandibular complete denture.

Indications

- Atrophic mandibular ridge.
- Denture fabrication undertaken after a long period of edentulousness leading to tongue/cheeks/lips partially occupying the usual denture space.
- Enlarged tongue, e.g. Down syndrome.
- Abnormal anatomy, e.g. hemimandibulectomy.

Muscles involved

The muscles of the lower lips, cheeks and tongue are major displacing factors for mandibular denture instability. The major muscles involved are

1. Buccinator

The buccinator plays a major role in determining the neutral zone and extends from the pterygomandibular raphe anteriorly, and converges with the other muscles, at the modiolus. The main function of this muscle is to position food on the occlusal surfaces of the teeth during mastication, in coordination with the tongue.

2. Modiolus

The group of muscles converging at the angle of the mouth is known as modiolus. These are the orbicularis oris buccinator, risorius, zygomaticus major, and the levator and depressor anguli oris. It plays a vital role in positioning of the premolar teeth and establishing the contour of the polished denture surface in that region.

3. Orbicularis oris and mentalis

The movement of the lip and the tongue helps in determining the position of the mandibular anterior teeth. If the teeth are positioned too labially, lip contraction would cause posterior displacement of the denture. In highly resorbed ridges, the mentalis muscle may displace the neutral zone lingually.

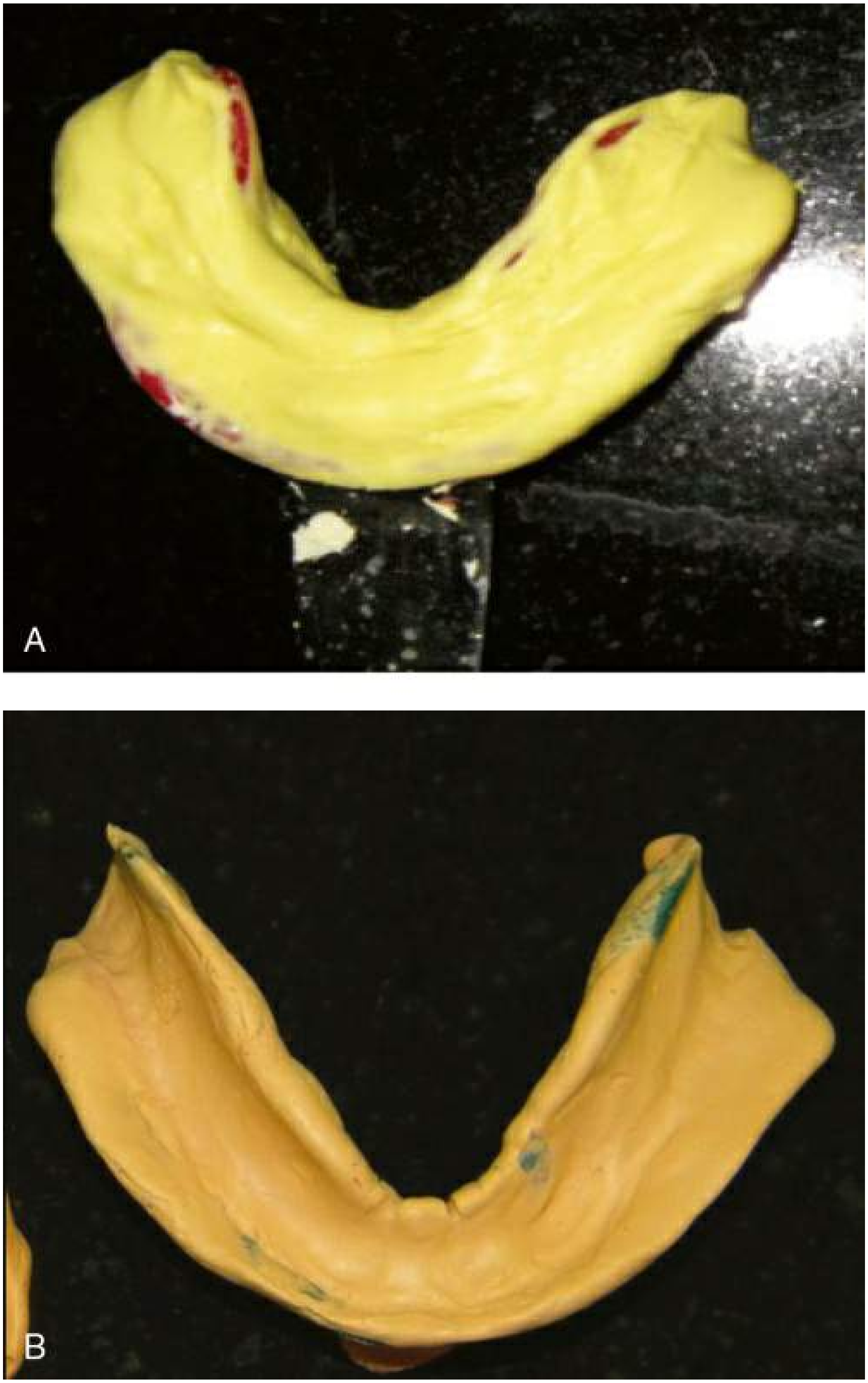
4. Tongue

The tongue is in constant contact with the mandibular denture at rest and function, and is composed of a powerful group of intrinsic and extrinsic muscles. If the teeth are positioned lingually, they will encroach the tongue space and the denture will be displaced during function. Appropriately contoured polished surface of denture is also important for normal tongue movement.

Clinical procedure

Impressions

The preliminary impressions are made in stock tray with a mucocompressive impression material like as impression compound or alginate (Fig. 10.37A). Secondary impression is made in a custom-made tray with a low viscosity mucostatic impression material like zinc oxide eugenol impression paste (Fig. 10.37B). The impression should be extended adequately to obtain maximum support and to record the functional depth and width of the sulcus that represents the activity of the muscles.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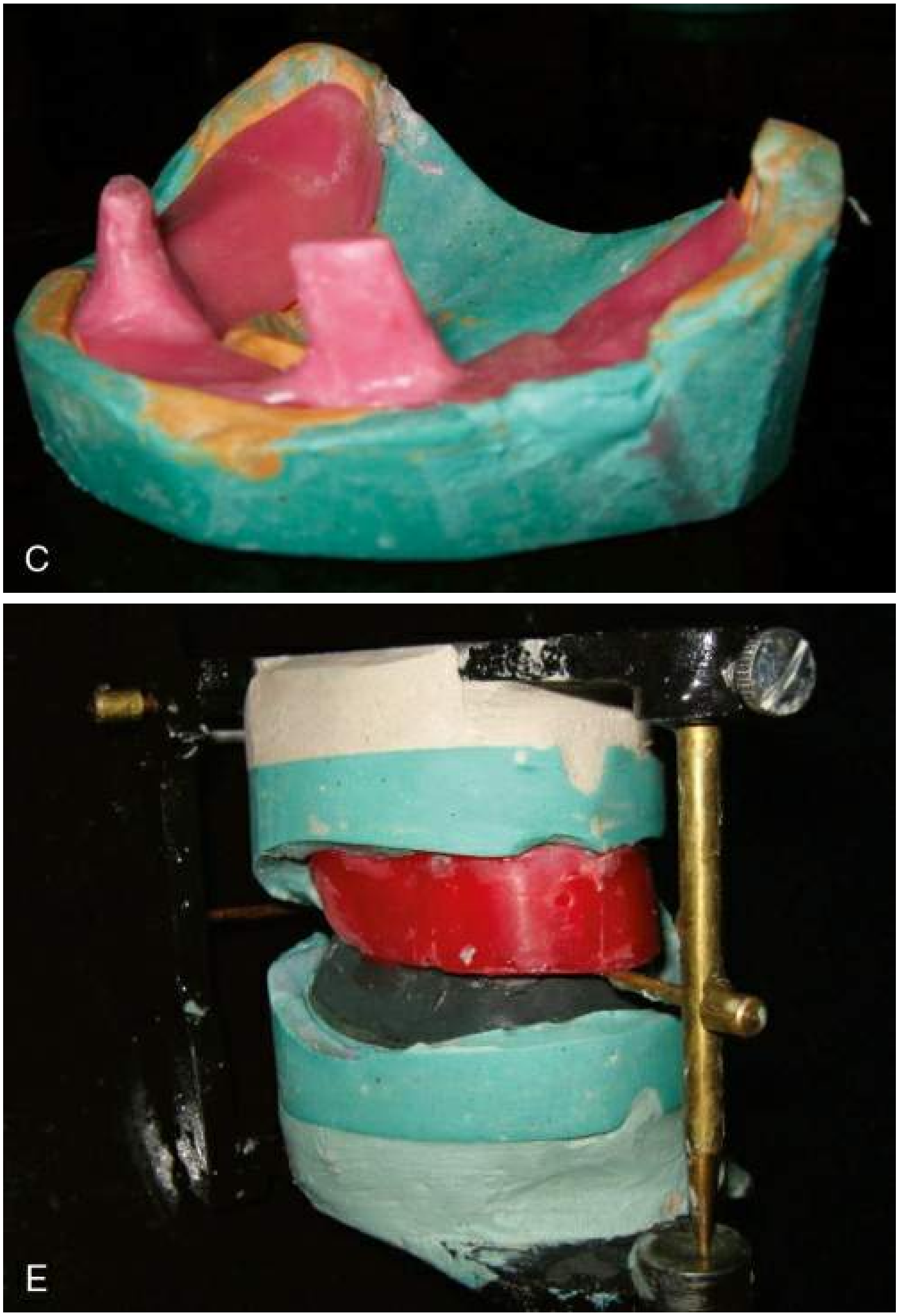
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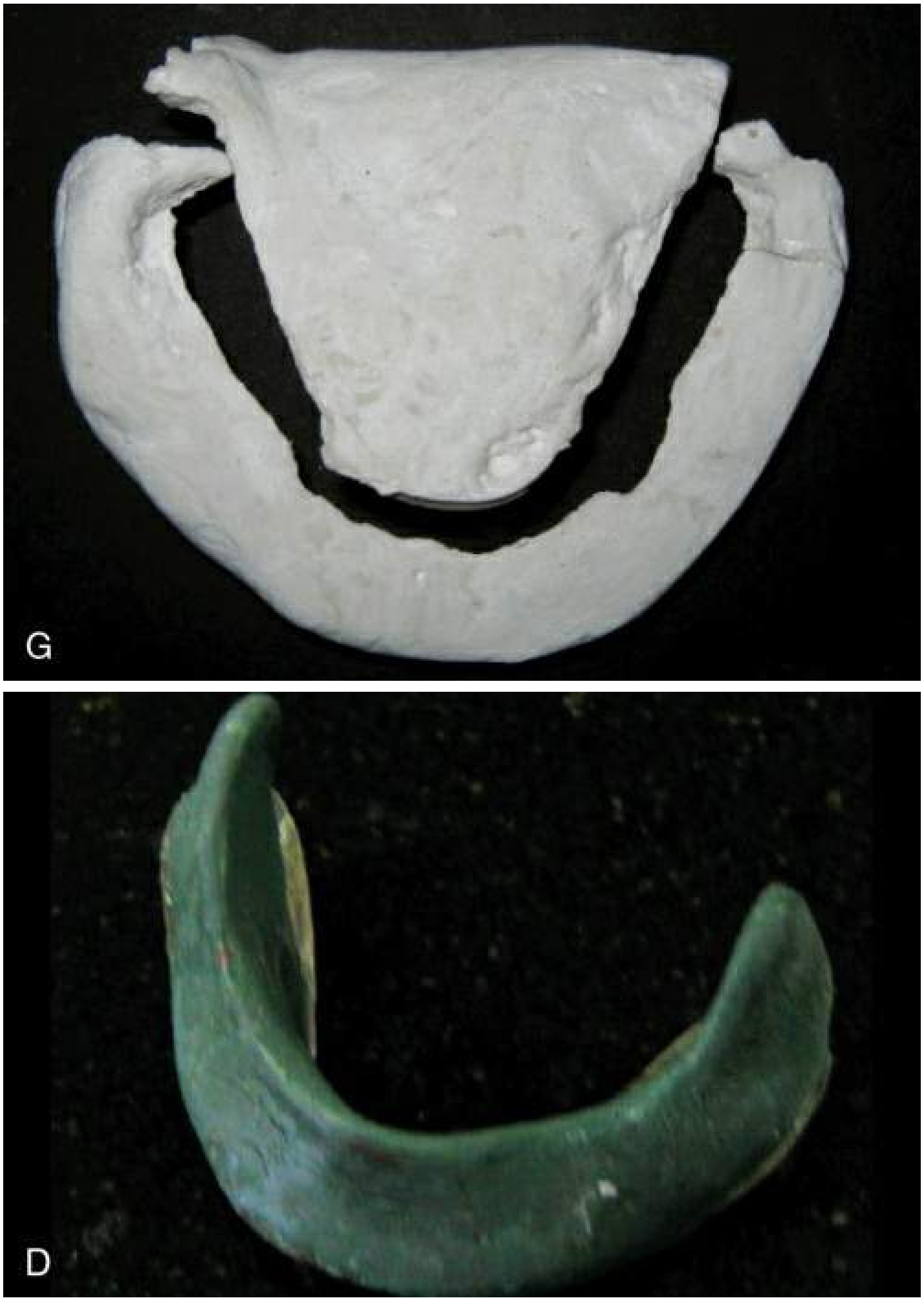
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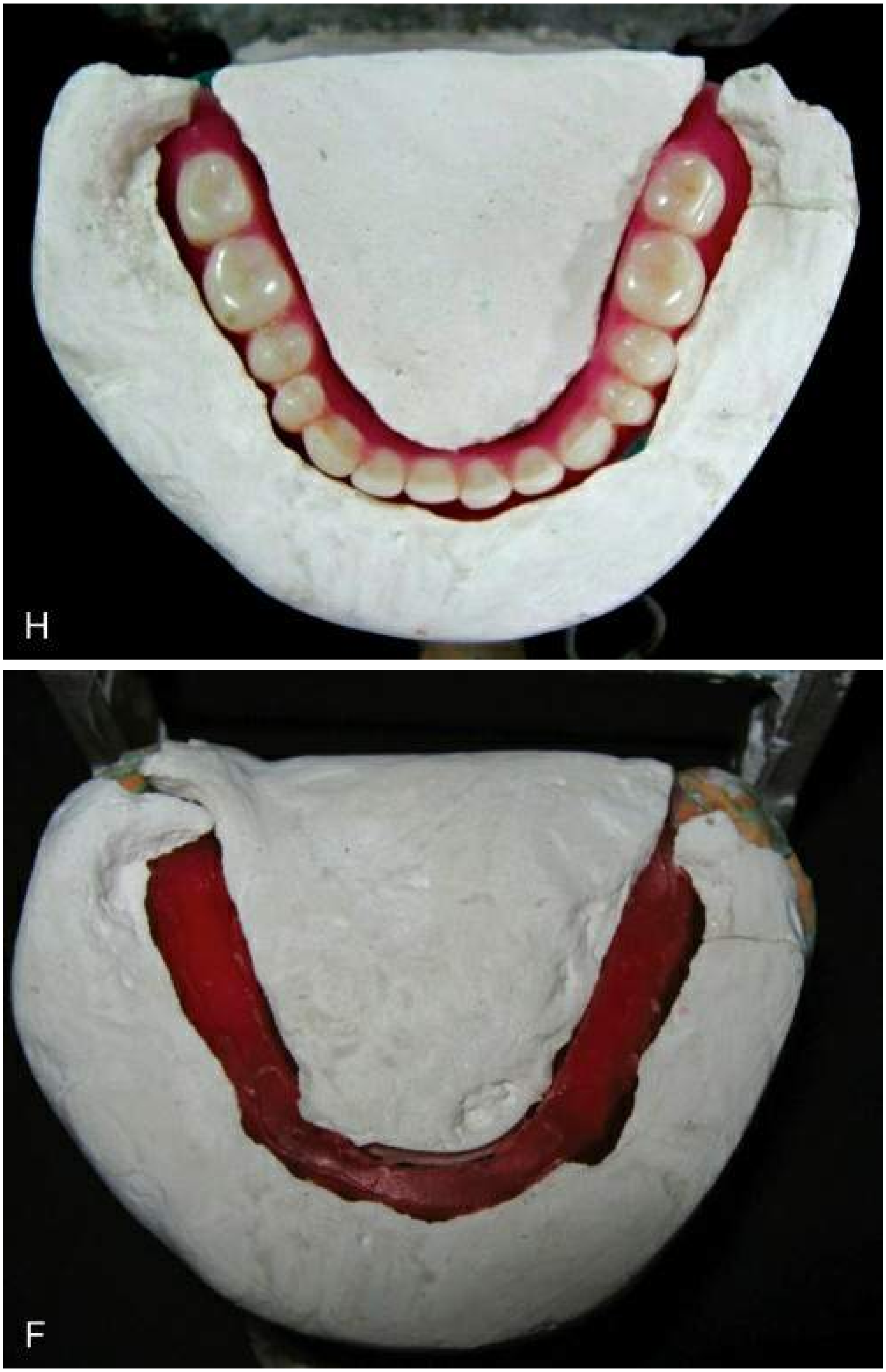


FIGURE 10.37 **(A)** Primary impression in alginate. **(B)** Secondary impression in zinc oxide eugenol impression paste. **(C)** Vertical projections in autopolymerizing resin. **(D)** Low-fusing compound moulded by muscle activity. **(E)**

Articulated mandibular neutral zone record. **(F)** Wax occlusal rim replacing the low-fusing compound record guided by plaster index. **(G)** Neutral zone index. **(H)** Processed dentures with teeth arranged and polished surface contoured using index.

Jaw relation record

Wax occlusal rims are fabricated using stabilized heat cured acrylic bases for improved stability. Wire loops can be embedded in the record base to facilitate retention of rim. These rims are evaluated for its extension, comfort and stability and a tentative jaw relation is recorded.

Recording the neutral zone

Following articulation, wax from the mandibular record base is removed. Vertical projections are fabricated in the premolar region using autopolymerizing denture base material. These provide occlusal stops at the established vertical dimension of occlusion and provide for the support of the neutral zone impression material (Fig. 10.37C). These vertical acrylic projections must be evaluated so that they do not interfere with the cheeks, lip or tongue. Various designs have been suggested for the projections and any design can be used provided they satisfy the objectives.

Prior to making the mandibular neutral zone impression, the maxillary occlusal rim is inserted to support the facial muscles and allow the tongue to be placed comfortably on the palatal contours during function. For recording neutral zone impressions, low-fusing impression compound is mostly used, as it can be moulded by functional muscle activity (Fig. 10.37D). Materials such as waxes, ZOE paste, Putty impression material, autopolymerizing acrylics and tissue conditioners, can also be used. A minimal quantity of the material required to achieve the purpose should be used so that the sulci are not distorted. The material is manipulated by hand and adapted onto the mandibular record base.

The rim is softened and patient is asked to perform a range of functional movements – smile, pout or purse lips, speak, swallow, slightly protrude the tongue and lick the lips. Following 10 min of this functional activity and allowing the material to set, the centric record is made and the casts are articulated (Fig. 10.37E).

Arranging artificial teeth in neutral zone

The neutral zone impression is then indexed by placing plaster or silicone putty around the impression material. The index will preserve the space of the neutral zone record. The low-fusing compound is then removed from the record base and replaced by wax to aid setting of the artificial teeth (Fig. 10.37F). Teeth can then be arranged guided by the index (Fig. 10.37G). The posterior teeth may require to be trimmed lingually so that they fit into the index space. The polished surfaces of the denture are also contoured to replicate the record.

Processing and insertion of the dentures

After completion of the wax try-in, the dentures are processed, trimmed and finished (Fig. 10.37H). Care should be taken while finishing to preserve the contours established by the neutral zone record. The final dentures will enhance the stability and retention during function.

SUMMARY

Arrangement of artificial teeth plays a pivotal role in the success of complete denture fabrication. It is not a mechanical process performed on devices, but needs to be correlated with biologic factors, function and aesthetics.

CHAPTER
11

Try-in

CHAPTER CONTENTS

Introduction

Definitions

Try-in: The process of placing a trial denture in the patient's mouth for evaluation (GPT8). It is also referred to as 'trial placement'.
Trial denture: A preliminary arrangement of denture teeth that has been prepared for placement into the patient's mouth to evaluate aesthetics and maxillomandibular relationships (GPT8).

The trial dentures need to be tried in the mouth following teeth arrangement and waxing. This is mandatory as it is very difficult and painstaking to make corrections in the processed denture.

Trial placement of waxed dentures can be evaluated as follows:

- The complete arrangement of artificial teeth is made in balanced occlusion and the trial dentures are evaluated.
- The anterior teeth are arranged and an aesthetic trial is performed followed by the arrangement of posterior teeth and a complete try-in.
- The artificial teeth are arranged in centric occlusion and after a try-in, eccentric check records are obtained during this stage and the teeth are arranged in balanced occlusion and only this aspect is verified later.

Whichever method is adopted, as there are many areas that need to be verified, a definitive systematic approach will ensure that all the essential attributes are checked. A methodical sequence of evaluation is described in the chapter.

Evaluation of mandibular trial denture

The mandibular denture is first evaluated individually for the following.

Peripheral extension

The periphery of the denture is checked for adequate extension – whether it is under- or overextended.

- Buccal and labial borders are checked by moving cheek and lips upwards and inwards, simulating chewing movement (Fig. 11.1). Overextension in this area should be trimmed if denture rises from the ridge.

- Lingual extension is evaluated by protruding the tongue to moisten the lips to check extension of lingual pouch (Fig. 11.2) and then to put the tip of the tongue at the back of the palate to evaluate lingual frenum (Fig. 11.3). The denture should not lift up during these movements.

- Posterior extension is evaluated by checking the extension of denture onto retromolar pad region.

- Underextension of the denture should also be evaluated for the presence of gap in between the denture and the tissue reflection.

FIGURE 11.1 Manipulation of cheek to evaluate extension of buccal flange.

FIGURE 11.2 Evaluation of lingual pouch.

FIGURE 11.3 Evaluation of lingual frenum.

Stability

To evaluate the stability of lower denture apply pressure on premolar and molar region on one side of arch, rise of denture on the other side indicates instability (Fig. 11.4).

FIGURE 11.4 Applying pressure on one side of arch to evaluate stability.

The causes could be:

- Teeth set outside the ridge or lack of adaptation of denture base on pressure side.
- Underextended flange on the nonpressure side.

Tongue space

The lower posterior teeth should be placed in the 'neutral zone' between the cheeks and tongue. Lack of tongue space is evaluated by asking the patient to raise the tongue after inserting the lower denture (Fig. 11.5).

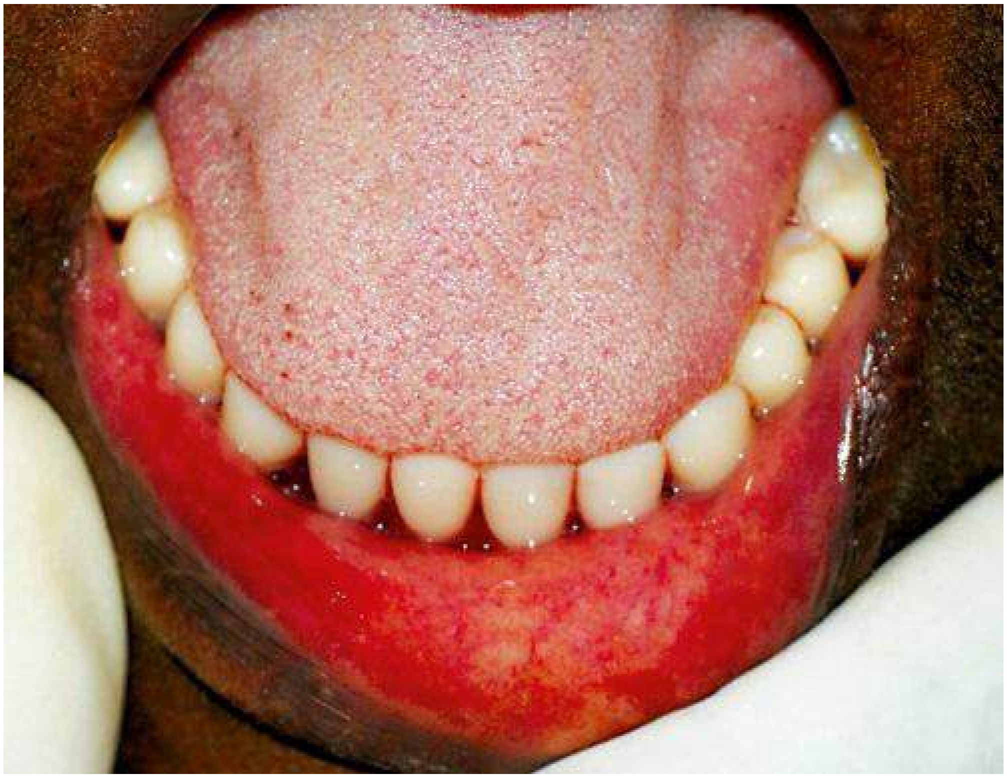


FIGURE 11.5 Lateral border of tongue making passive contact with the lingual surface of teeth and polished surface on insertion of trial denture.

Immediate movement of denture indicates lack of tongue space. This should be differentiated from lingual overextension where the movement occurs after tongue rises to some distance.

Causes

- Lower posterior teeth set lingual to the ridge (Fig. 11.6).
- Upper posterior teeth set on the ridge crest.
- Buccolingually broader molar teeth.
- Lingual tilting of mandibular molar teeth (Fig. 11.7).

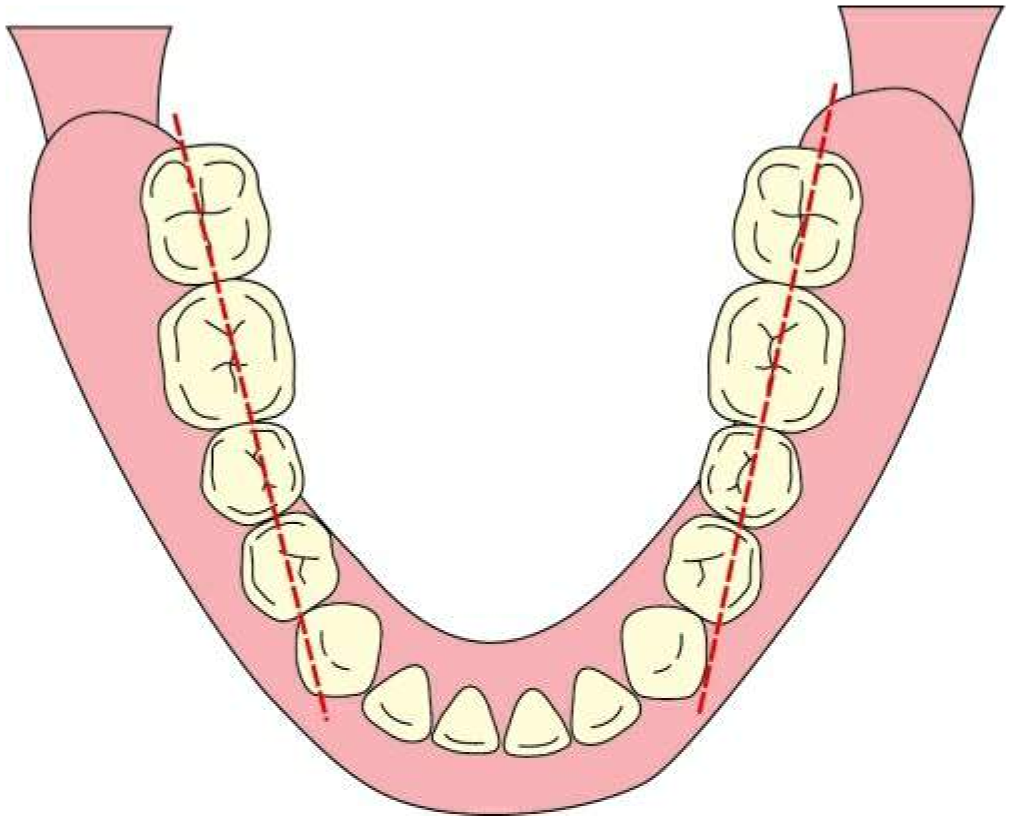


FIGURE 11.6 Lack of tongue space caused by placement of lower posteriors lingual to ridge crest.

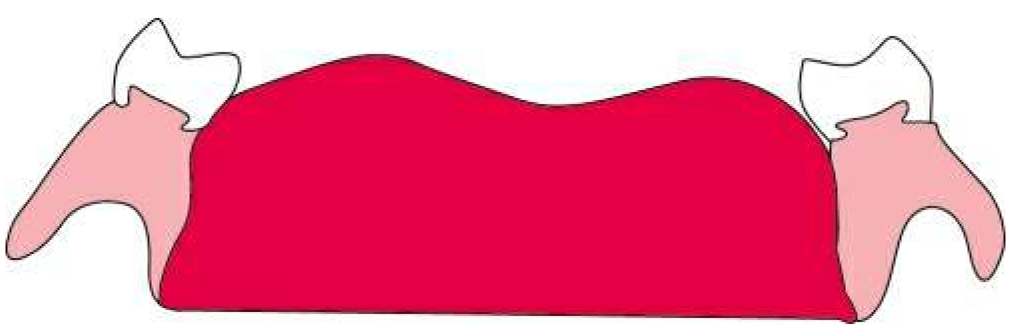


FIGURE 11.7 Lack of tongue space caused by lingual tilting of mandibular posteriors.

Height of occlusal plane

The height of the lower occlusal plane should be slightly below the tongue for stability. This must be evaluated. Fig. 11.8 shows pictures of incorrect and correct occlusal plane.

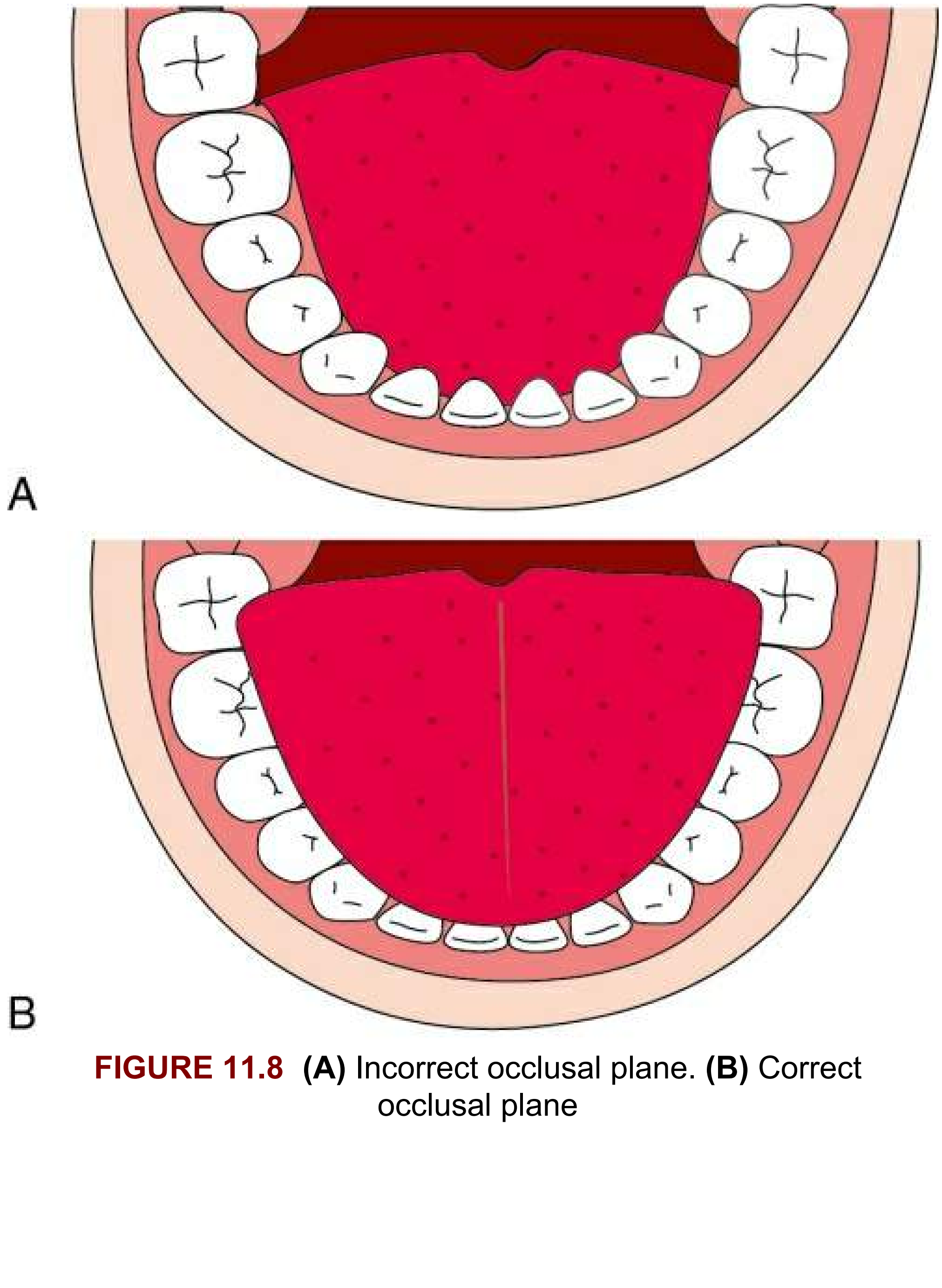


FIGURE 11.8 **(A)** Incorrect occlusal plane. **(B)** Correct occlusal plane

Evaluation of maxillary trial denture

The maxillary denture is evaluated individually for the following.

Peripheral Outline including posterior palatal seal

- Buccal and labial borders are checked by moving cheek downwards and inwards, simulating chewing movement (Fig. 11.9). Overextension in distobuccal flange area is evaluated by asking the patient to open mouth wide. Underextension is evaluated similar to the lower denture (Fig. 11.10).

- The posterior palatal seal area is then evaluated for extension by marking it intraorally. If the 'functional scraping technique' of recording the seal area is planned, it has to be developed during try-in. (Also see Chapter 4.)

FIGURE 11.9 Labial flange evaluation.

FIGURE 11.10 Underextension is evaluated by checking for space between the denture border and tissue reflection.

Stability

- Evaluated similar to lower denture.

Retention

Retention is evaluated as follows:

- Trying to pull down the denture vertically by holding the denture in the incisor region using thumb and forefinger (Fig. 11.11A).
- To check retention in posterior seal area, forefinger is placed on the palatal surface of the upper anterior teeth and an outward force is applied (Fig. 11.11B).
- Applying upward and outward force on canine region to check retentiveness of denture in the maxillary tuberosity and pterygomaxillary notch region of the opposite side (Fig. 11.12).

FIGURE 11.11 **(A)** Evaluating retention of maxillary denture by pulling denture down vertically by holding anterior part of denture between thumb and forefinger. **(B)** Posterior palatal retention is evaluated by applying an outward force with forefinger on palatal surface of anterior teeth.

FIGURE 11.12 Evaluating retentiveness of maxillary tuberosity region of opposite side by applying an upward and outward force on the canine.

Evaluating both dentures together

Occlusion and jaw relation

Horizontal relation

Patient is guided into centric relation using any method to retrude the mandible (Chapter 6). Error in centric relation is observed if:

- Space exists between upper and lower posterior teeth at first contact (Fig. 11.13).
- Lower teeth slide over upper teeth on first contact.
- Shift of lower midline from upper midline (indicating lateral shift of mandible while recording of centric) (Fig. 11.14).

FIGURE 11.13 Error in recording CR is evident when a space exists between the upper and lower posterior teeth when the patient closes in CR.

FIGURE 11.14 Error in CR is evident when upper and lower midlines do not coincide when the patient closes in CO.

Interocclusal check records can then be used to verify the relation or make a new centric relation record (see also Chapter 6).

Vertical relation

Vertical dimension is evaluated using the methods described in Chapter 6. In case of discrepancy, the posterior teeth are removed, replaced by wax occlusal rims and a new record is made.

Evenness of occlusal contact

Contact of teeth with equal pressure on either side of arch is essential for harmonious occlusion. This is evaluated as follows:

- Place Mylar strip on either side of the arch in the molar region and ask the patient to bite (Fig. 11.15). Try to remove the strip and observe whether the force required to remove the strip is similar bilaterally. Repeat the procedure in the premolar region.

- To observe whether anterior region of denture rises from ridge when posterior teeth are occluding, place wax knife between upper and lower incisor teeth and apply a wedging force as posterior teeth are contacting (Fig. 11.16A). Any definitive movement indicates excessive contact in molar region.

FIGURE 11.15 Using Mylar strip to check evenness of occlusal contact.

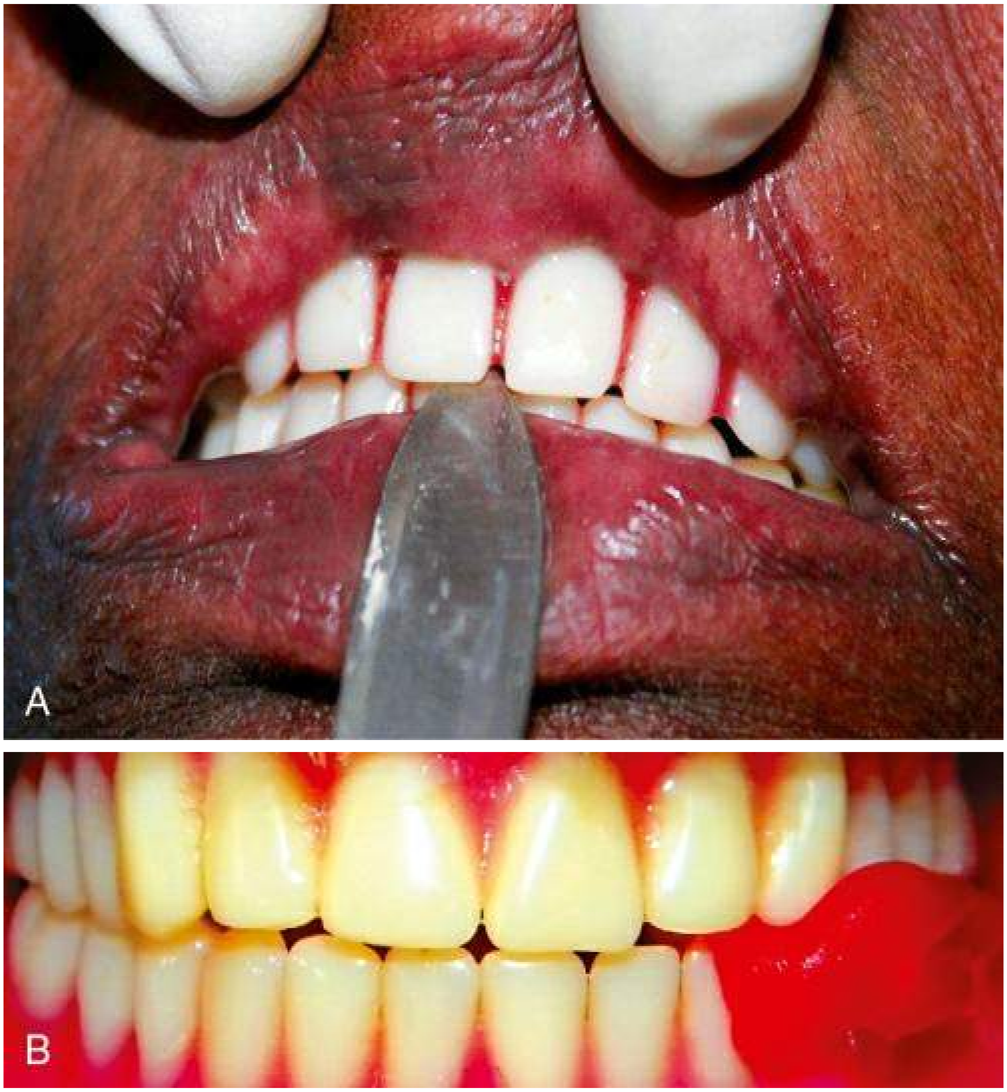


FIGURE 11.16 **(A)** Checking for excessive contact in molar region. **(B)** Correction of uneven contact by adding softened wax on the deficient side until there is even contact.

The unevenness is corrected by adding softened wax on deficient side until there is even contact on the opposite side of the arch (Fig. 11.16B).

Causes of uneven contact

- Resistant material used to record centric relation.
- Error when sealing the rims or during articulation.

- Warpage of record base.

Balanced occlusion

- This is verified following evaluation of all of the above.
- First it must be checked if the denture base lifts to create a balanced contact during protrusive and lateral movements.
- Causes for this problem may be:

○ Inaccurate facebow transfer.

○ Incorrect condylar path registration.

Then the balanced contacts are verified first in the articulator and then in the patient's mouth using articulating paper.

- If the errors are considerable, the eccentric records are repeated and casts remounted.
- If minor, it may be better to perform selective grinding during insertion of the processed denture.

Aesthetics

Midline

Coincidence of facial midline and dental midline of both arches evaluated. Long axis of anterior teeth should be parallel to the long axis of the face (Fig. 11.17).

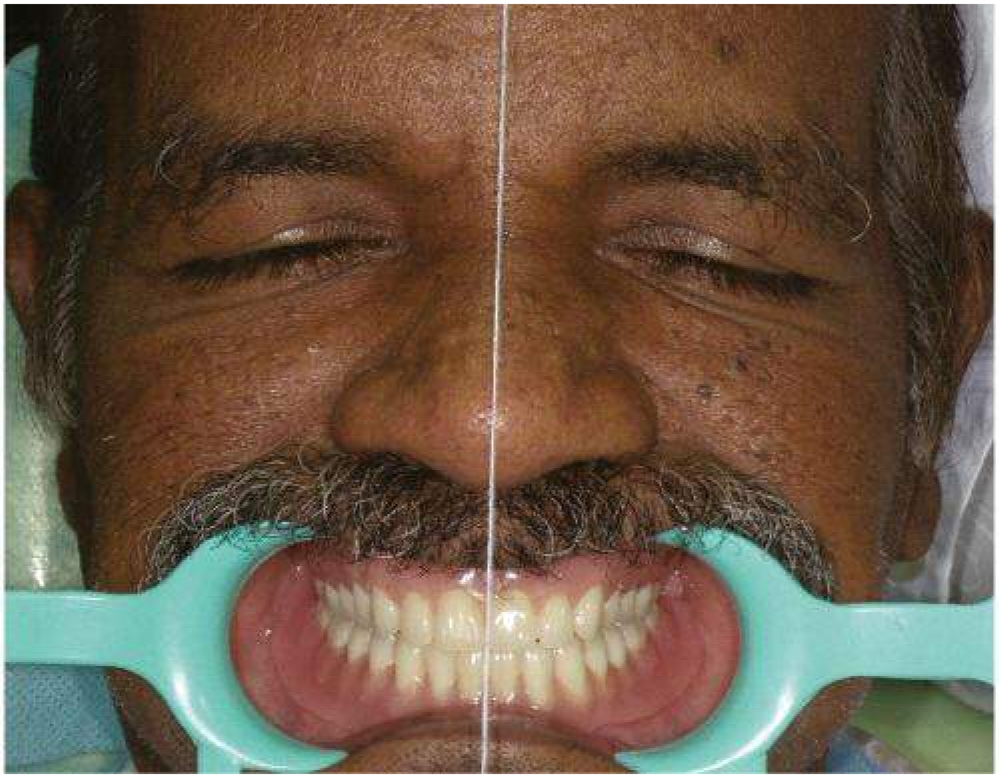


FIGURE 11.17 Coincidence of dental and facial midline.

Anterior plane

The incisal edges of the upper anterior teeth form a symmetrical curve which should be in harmony with lower lip when the patient smiles (Fig. 11.18).

FIGURE 11.18 Incisal edge of upper anterior following lower lip curvature.

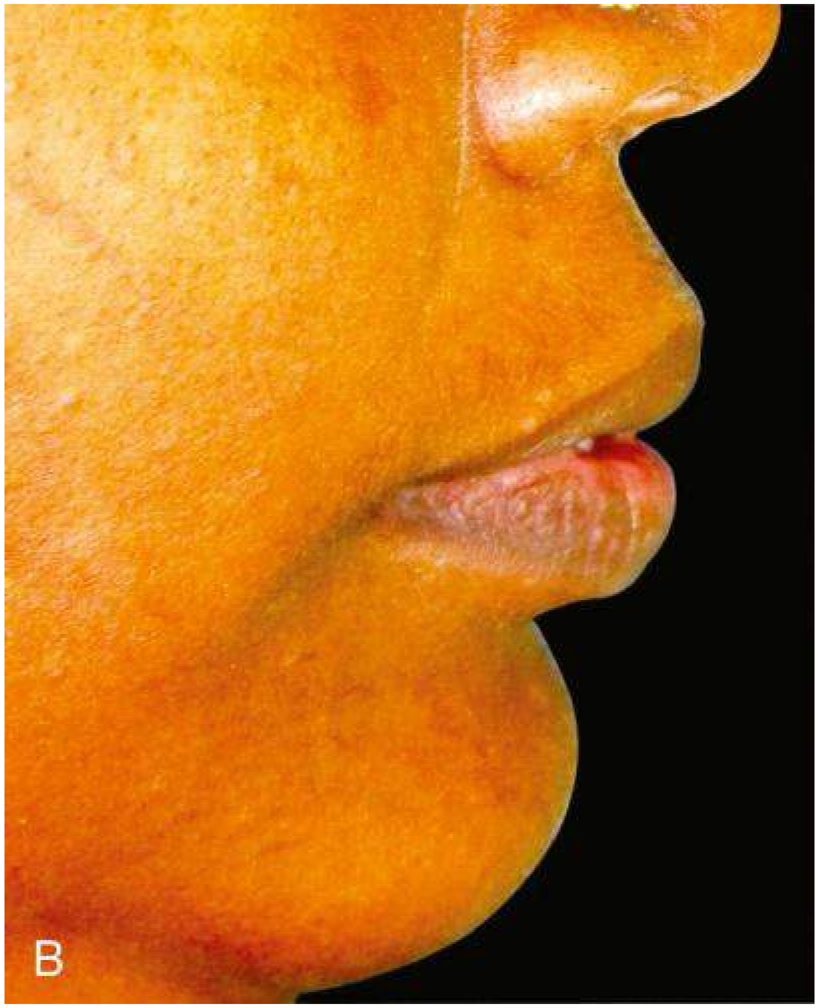
Shape, size and shade of teeth

These should conform to the guidelines discussed in Chapter 9. Independent judgment along with the patient's opinion should be taken into consideration.

Lip form in profile

This should be evaluated for excessively distended or sunken appearance. If distended remove some wax from the flange or check the position of front teeth whether it needs to be set further in. If sunken, consider resetting the anteriors further forward (Fig. 11.19A–C).


A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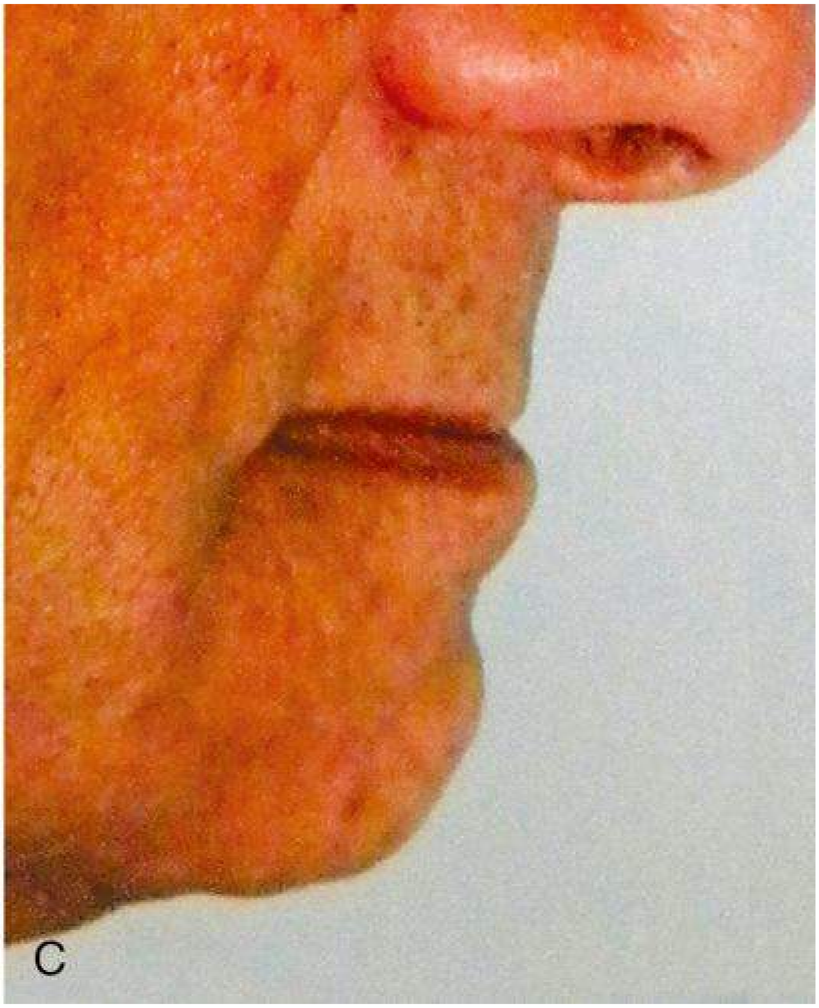


FIGURE 11.19 **(A)** Excessively distended lips. **(B)** Normal appearance of lips. **(C)** Sunken appearance of lips.

Amount of tooth visibility

The high and low lip lines should be in harmony with the amount of tooth visible (Fig. 11.20A and B).

FIGURE 11.20 **(A)** Low lip line. **(B)** High lip line.

Individualization

Patient's desire should be considered to provide any minor irregularities in tooth arrangement like overlapping or tilting. Characterization of dentures should also be planned now.

Phonetics

Phonetics is used to evaluate the position of the anterior teeth and the vertical dimension. The following sounds are evaluated:

- **Sibilant 's':** The upper and lower anterior teeth should be just out of contact as the patient pronounces 's' (Fig. 11.21).

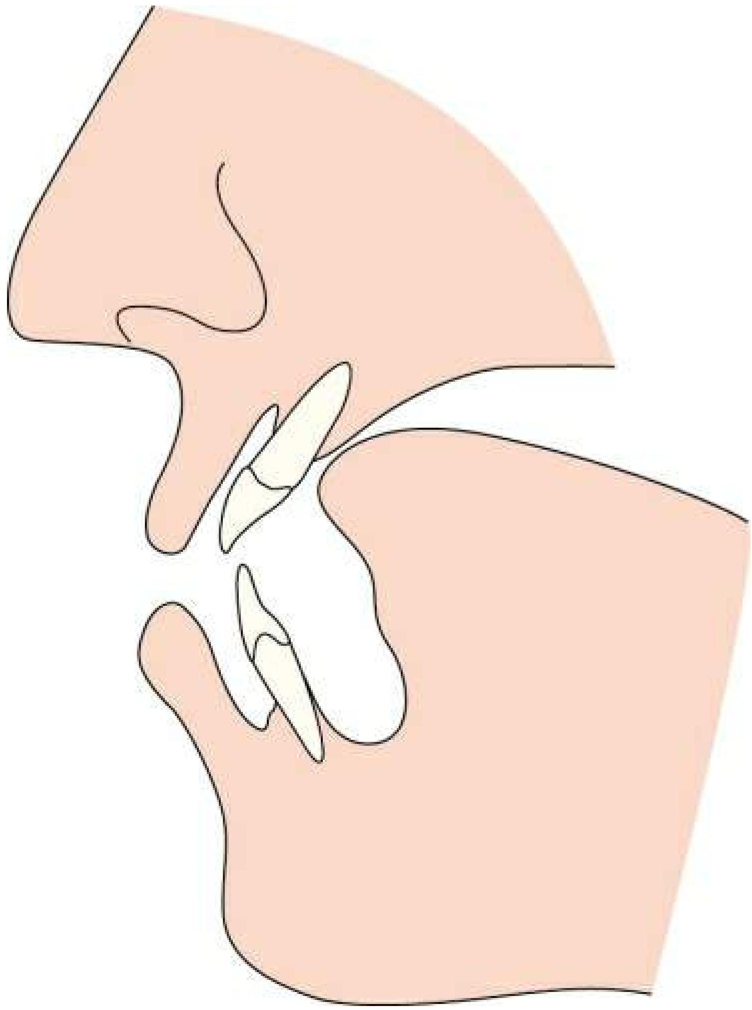


FIGURE 11.21 Verifying position of upper anterior teeth using phonetics. Correct position of the upper [5] anteriors when’s’ is pronounced.

Labiodental ‘f’ and ‘v’: The incisal edges of the maxillary central incisors should contact the vermilion border of the lower lip at the junction of moist and dry mucosa, without posterior tooth contact, when patient pronounces ‘f’ and ‘v’ (Fig. 11.22A).

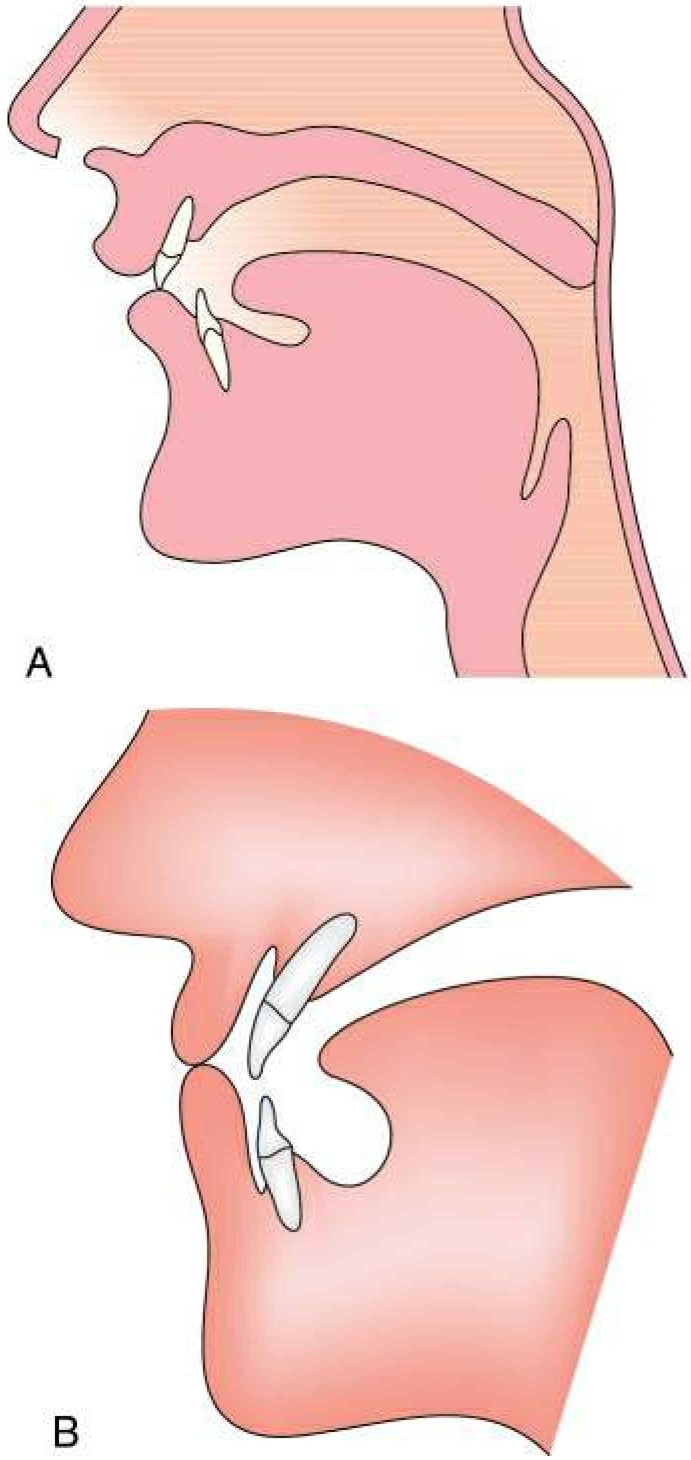


FIGURE 11.22 **(A)** Verifying position of upper anterior teeth using phonetics. Correct position of the upper anteriors when ‘v’ is pronounced. **(B)** Position of the anterior teeth (with space) when bilabial sounds are pronounced.

Bilabial 'p' and 'b': The lips should touch and there should be a space between the teeth when patient pronounces 'p' (Fig. 11.22B).

Approval of appearance by the patient

It is mandatory for the dentist to obtain patient's approval or consent for the appearance of the trial denture. It may be advisable to ask the patient to bring a close relative or friend during try-in and the approval and suggestions of this person can also be considered, if realistic and reasonable.

SUMMARY

Try-in is an important step in complete denture fabrication. It is usually neglected and restricted to evaluation of anterior teeth appearance in routine dental practice. Sequential and thorough evaluation is essential to avoid costly and time-consuming errors during denture insertion. Patient consent to appearance is also mandatory following the evaluation.

CHAPTER 12

Processing and remounting

CHAPTER CONTENTS

Definitions

Denture processing: (i) The means by which the denture base materials are polymerized to the form of a denture. (ii) The conversion of the wax pattern of a denture or a portion of a denture into resin or other material (GPT8).
Waxing: The contouring of a wax pattern or the wax base of a trial denture into the desired form (GPT1).
Festooning: Festooning is defined in dentistry as, carvings in the base material of a denture that simulate the contours of the natural tissues that are being replaced by the denture (GPT8).
Separating medium: A coating applied to a surface and serving to prevent a second surface from adhering to the first (GPT8).
Flasking: The process of investing the cast and a wax replica of the desired form in a flask preparatory to moulding the restorative material into the desired product (GPT8).
Packing: The act of filling a mould (GPT8).
Denture packing: The act of pressing a denture base material into a mould within a refractory flask (GPT8).
Remounting (remount procedure): Any method used to relate restorations to an articulator for analysis and/or to assist in development of a plan for occlusal equilibration or reshaping (GPT8).
Selective grinding: The modification of the occlusal forms of teeth by grinding at selected places marked by spots made by articulating paper (GPT). It can also be termed as 'occlusal reshaping', 'enameloplasty' and 'spot grinding'.
Finishing: The refinement of form prior to polishing (GPT8).
Polishing: The act or process of making a denture or casting smooth and glossy (GPT8).

Following try-in, the waxed dentures are converted to the desired denture base material by a series of laboratory procedures, which need to be sequential and performed with care to achieve consistent results minimizing errors. The most commonly used material is heat-polymerizing (curing) denture base acrylic resins. A 'compression moulding technique' is the most commonly employed method used to process the resin and it will be discussed in this chapter in detail. An 'injection moulding technique' may also be used. Following denture processing, a remounting and selective grinding is performed on the articulator to correct any occlusal error due to processing. The denture is then finished and polished.

The entire process involves various laboratory steps which are described here in detail.

Waxing

Waxing develops the polished surfaces of the denture. The polished surface influences retention, stability and tissue tolerance. Hence, the contour of the polished surface is an important consideration. The flange contour (polished surface) should be compatible with the contour and movement of cheeks, lips and tongue.

An adequately waxed denture also reduces the time required to finish and polish the processed denture.

Requirements of waxing

1. It should duplicate the covered soft tissue as accurately as possible.

2. The borders both labial and buccal should fill the vestibule to increase the retention and stability.

3. Notches should be provided to accommodate the frenum both in size and direction.

4. The contour of denture flanges should be compatible with the cheeks and lips.

5. The contour of lingual flanges should be compatible with the tongue.

6. The palatal section of the maxillary denture should be nearly the reproduction of the patient’s palate and rugae.

Procedure

Steps in waxing up the maxillary trial denture

Buccal surface

1. Adapt two sheets of softened wax on the facial and labial flanges. It should extend from the neck of the tooth to the flange of the trial base. The wax is added in slight excess so as to allow carving (Fig. 12.1A).

2. A thin roll of wax is added above the necks of the teeth to contour a gingival bulge simulating the attached gingiva (Fig. 12.1B). The bulge is more prominent posteriorly.

3. Add a little more bulk in the canine region to simulate the canine prominence. Molten wax is added to merge the prominences with the rest of the contoured portion and smoothened (Fig. 12.1C). It will be observed that wax would have spilled over the tooth structure also.

4. Gingival carving is done to remove the wax from the facial and buccal surfaces of the teeth. It will create the gingival margin and zenith. It is best achieved by holding the Lecron carver or No. 7 wax spatula at 60° to the anterior teeth and 45° to the posterior teeth (Fig. 12.1D).

5. The carver should penetrate the wax and contact the tooth, then follow the finish lines around the necks of the remaining teeth to create the gingival margin (Fig. 12.1E).

6. The interdental papilla is contoured by placing a wax spatula at 45° to the long axis of the tooth in this region. It should be convex in both dimensions, buccolingually and cervicoapically. The carving should also expose the entire contact area.

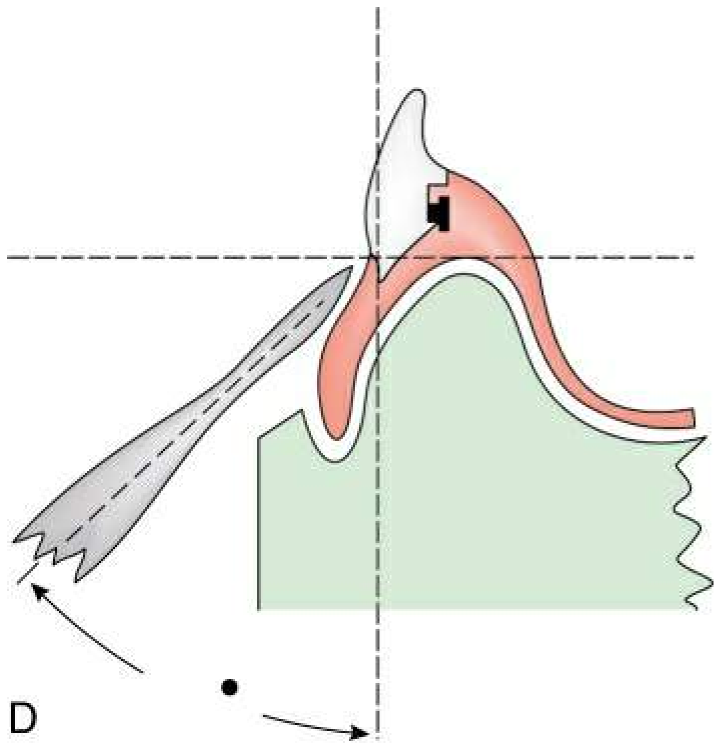
7. The waxed denture is now smoothened with a wet nylon cloth or Turkish towel and brought to a high gloss by running it over a flame, minimally softening the superficial wax and again polished (Fig. 12.1F). For most of the aged patients with poor inclination and ability to thoroughly clean the denture, this wax finishing would suffice.

8. For better aesthetics and characterization, it is necessary to create the root extensions (festooning) and also stippling.

9. Triangular markings are placed on the waxed denture in between the teeth to form the root extensions (Fig. 12.1G). The root extension carvings can be a little less prominent for premolars and least for molars. Merge the elevations and depressions to form a smooth surface (Fig. 12.1H).

10. Stippling can be done on the attached gingival portion, especially the interdental areas by using the periodontal brushes or toothbrush. Stippling is less pronounced in the posterior teeth. It is flamed to bring to a gloss polish (Fig. 12.1I).


C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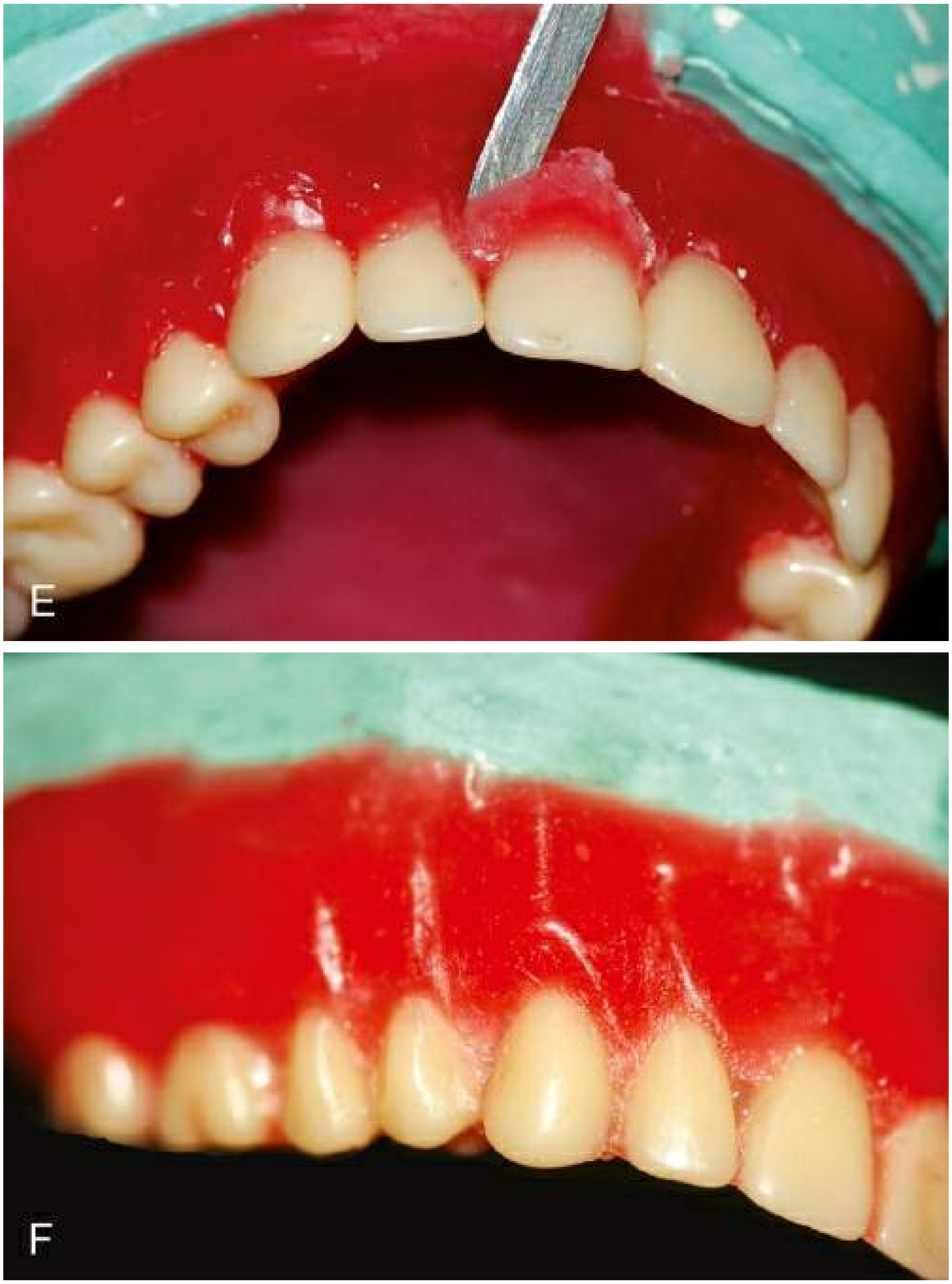
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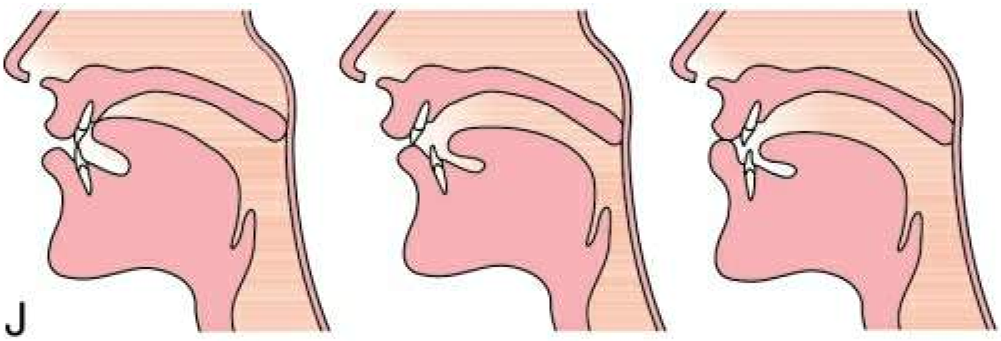

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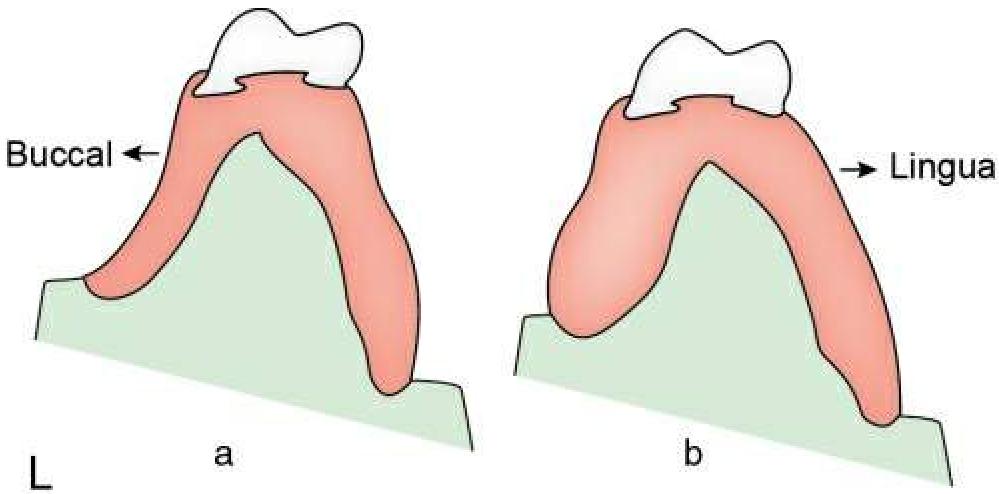

Buccal
Lingual
a
b
L

FIGURE 12.1 **(A)** Wax added on facial surface in excess. **(B)** Additional wax added above the margin to create the gingival roll. **(C)** Canine prominence added and the wax is blended. **(D)** Showing the angulation (45°) for gingival carving anteriorly. **(E)** Technique of wax removal to carve the margins. **(F)** Interdental papilla finished and wax polished. **(G)** Triangular markings on wax for carving root portion. **(H)** Root prominences carved. **(I)** Stippling with a brush. **(J)** Showing correct thickness and contour of the palatal and buccal surfaces. **(K)** The wax should blend smoothly with the teeth on the palatal surface with less prominent margins. **(L)** Showing correct (a) and incorrect (b) contour of the polished surfaces of a mandibular denture. **(M)** Finished wax up.

Palatal surface

1. The palatal surface of the maxillary denture should be contoured to accommodate the tongue, and should be about 2.5 mm in thickness. It should not be too thick as it can interfere with speech (Fig. 12.1J).

2. Wax is adapted on the palatal surface of the tooth and the flange so as to create a smooth curve and a least prominent margin (Fig. 12.1K).

Steps in waxing up the mandibular trial denture

Buccal surface

1. The waxing procedure for the mandibular denture is similar to the maxillary denture.

2. The gingival carving and the root extension carving is also similar but is less pronounced.

3. Stippling is normally restricted to anterior teeth only.

4. The distobuccal flange should be concave to accommodate the muscle and enhance retention (Fig. 12.1L).

Lingual surface

1. The lingual surface of the mandibular denture may be made slightly concave without the concavity being extended under the lingual surface of the teeth. A projection of the tooth beyond the polished surface acts as an undercut into which the patient's tongue will slip, thereby causing the denture to be unseated (Fig. 12.1L).

2. The polishing is done as for the maxillary trial denture.

Fig. 12.1M shows the completed waxing for the maxillary and mandibular trial dentures.

Once the wax try-in is completed, the trial dentures are ready for processing. Processing involves the following clinical steps:

1. Flasking

2. Dewaxing

3. Packing

4. Curing

5. Laboratory remounting

6. Trimming and polishing

Flasking

- The trial denture bases are sealed to the casts prior to dearticulation to avoid entrapment of dental plaster during flasking procedure.

- Wax strip of 2 mm width is adapted on the maxillary cast from the hamular notch area on one side to the other side. The wax strip is also adapted on the posterior palatal seal area. It is adapted within the confines of the land area. The wax strip is sealed to the cast and record base with a hot wax spatula (Fig. 12.2).

- In the mandibular cast, wax strips are adapted from the retromolar pad area on one side to the other side and also along the lingual border. A wax spatula is similarly heated and used to fuse the wax.

- The maxillary and mandibular casts are removed from their articulator mountings (dearticulated) by placing a wax knife at the junction of the cast and mounting and gently tapping with a hammer (Fig. 12.3). Care should be taken not to destroy the indexed portion of the plaster mount (Fig. 12.4). The index guides in reorientation of the master cast during laboratory remounting procedure. If remounting plates have been used for articulation, then dearticulation is a simple process.

- After the casts are dearticulated, they are ready to be flasked. A 2-pour or 3-pour technique is used for flasking depending on the number of layers of investing plaster. A 3-pour technique is recommended as it eases deflasking.

- The parts of a dental flask are base, body and lid (Fig. 12.5).

- A thin layer of Vaseline is applied on the base of the dental flask and base of the cast including indexed keys (Fig. 12.6). This is to facilitate easy retrieval of cast during deflasking procedure.

- The casts are soaked in clear slurry water for a few minutes for adequate wetting of dental plaster during flasking procedure.

- The base of the flask is filled with plaster and the cast is settled into the mix such that it is centred in the flask with occlusal plane parallel to the base. The dental plaster should merge along the land area and it slopes towards the rim of the flask (Fig. 12.7A and B). The outer rim of the flask base must be exposed for proper orientation of the body of the flask. This is the first pour.

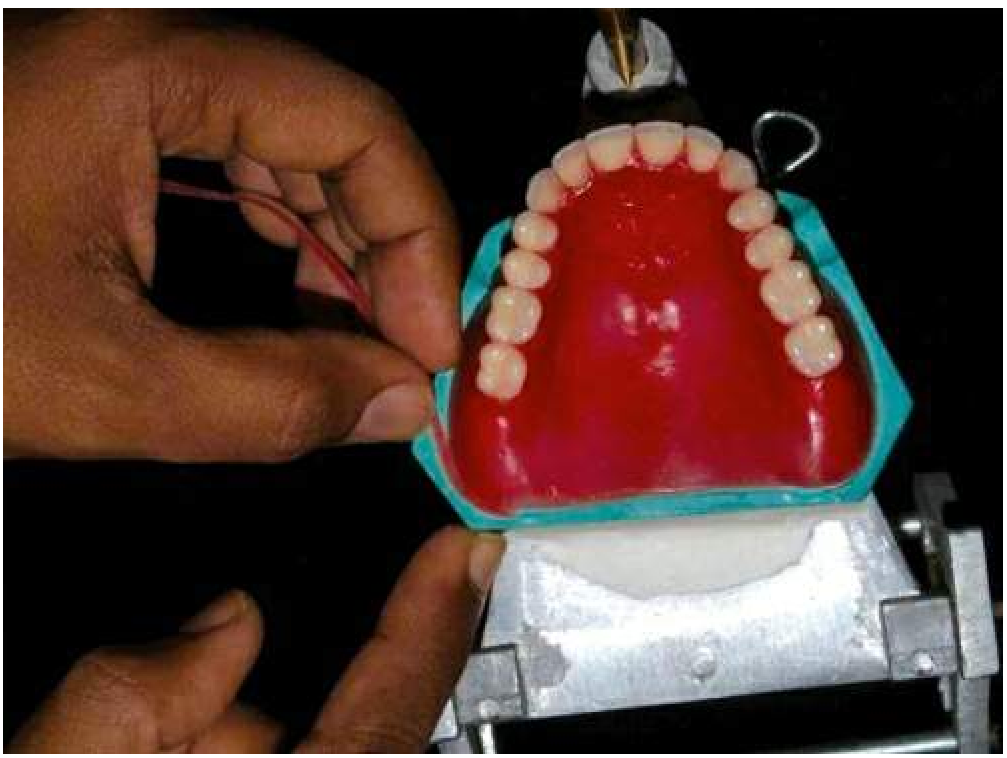


FIGURE 12.2 Wax strip used to seal the trial base to the cast.

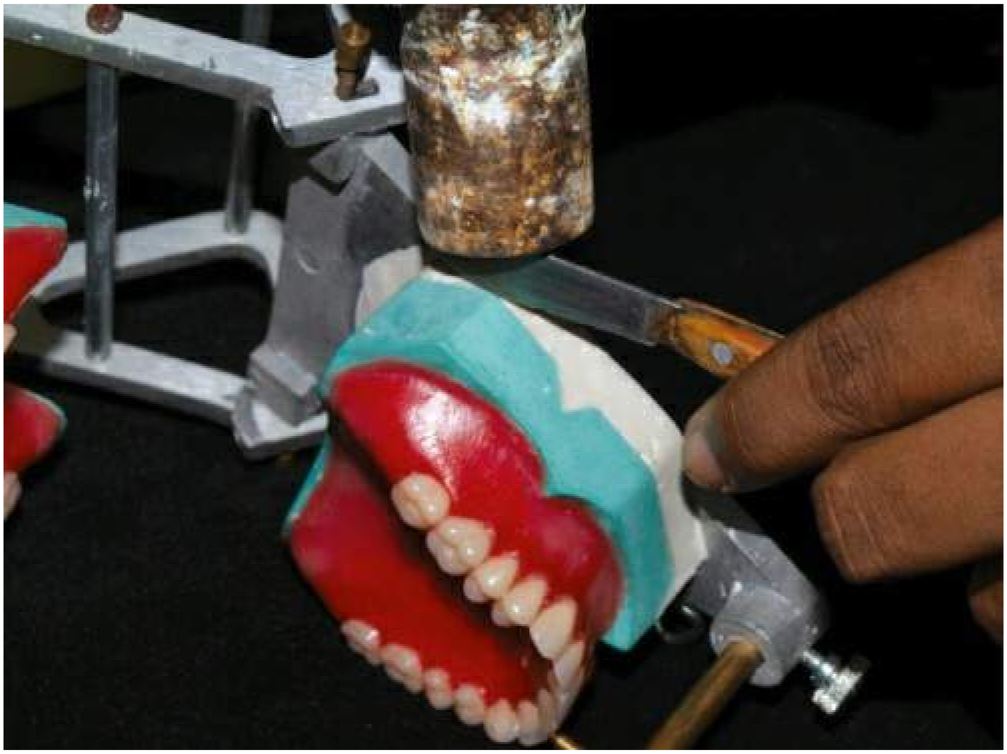


FIGURE 12.3 Dearticulation – to remove the cast from the mount, a wax knife is placed at the junction and tapped lightly with a hammer.

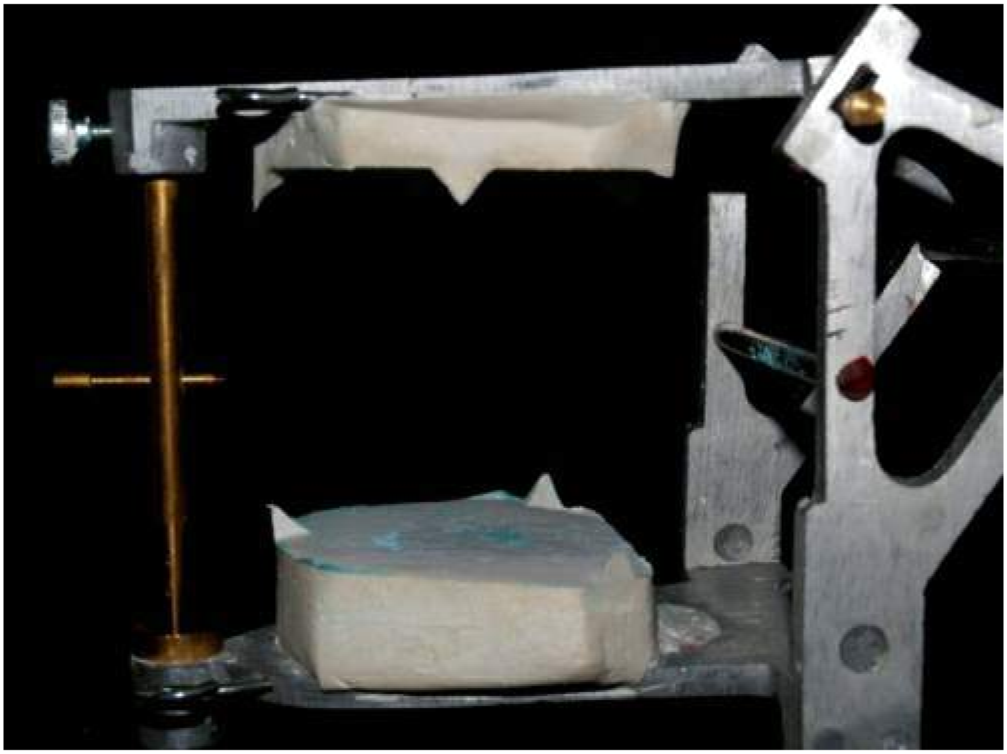


FIGURE 12.4 Indexing is preserved to enable remounting.

FIGURE 12.5 Parts of a flask: (A) body, (B) lid and (C) base.

FIGURE 12.6 Thin layer of Vaseline is applied only on the base and key areas of the cast.

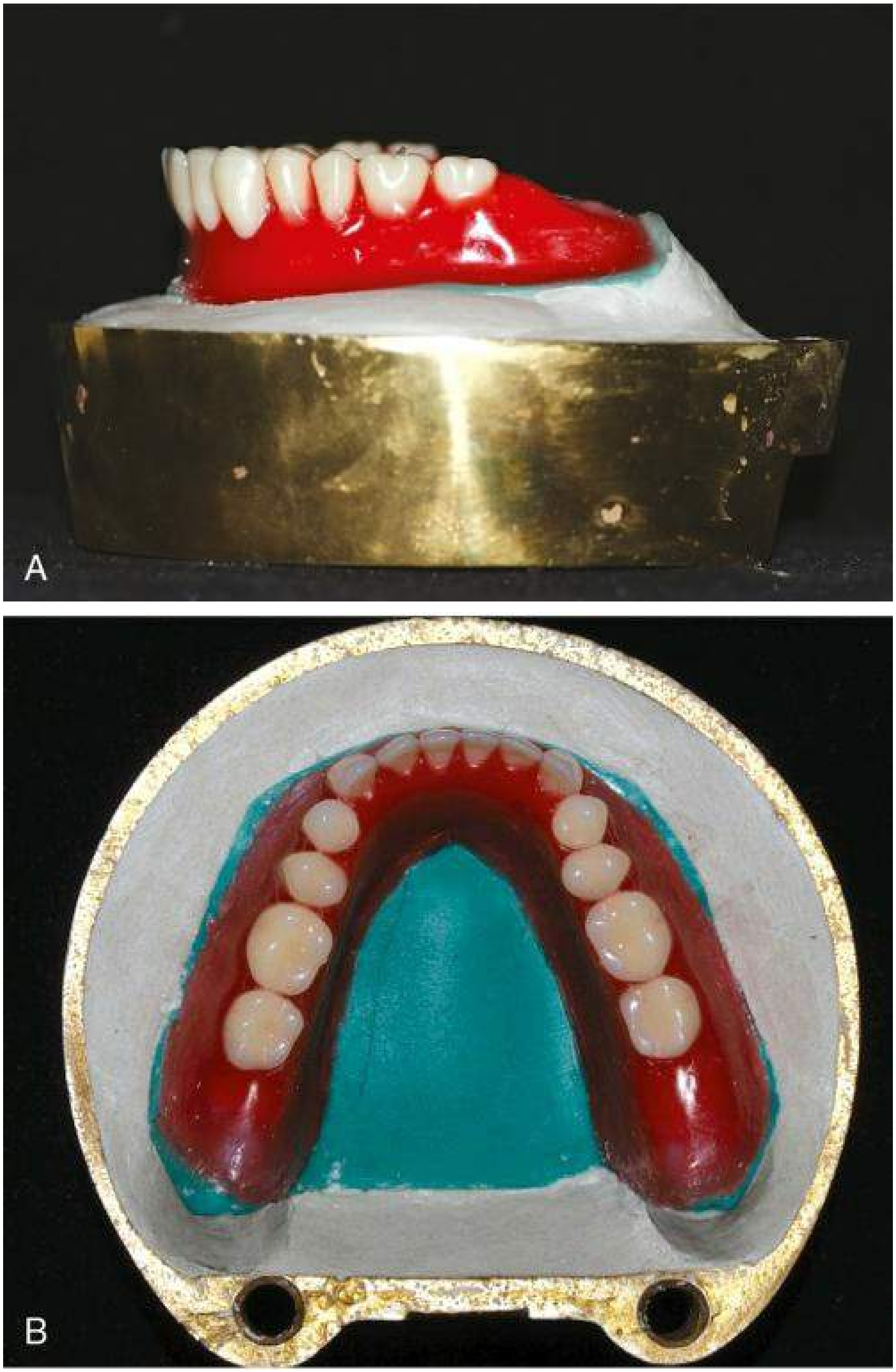


FIGURE 12.7 **(A)** Maxillary denture flasking (first pour). Plaster slopes from land area of cast to rim. **(B)** Mandibular denture flasking (first pour). Denture centred in the flask.

Separating medium

Definition: A coating applied to a surface and serving to prevent a second surface from adhering to the first (GPT8).

Purpose

- To enable easy separation of the cast and its mould for open dewaxing and then packing the resin.
- To prevent liquid monomer from penetrating the mould surface during processing – affects fit and appearance of denture.
- To prevent water from the mould surface to diffuse into the resin during processing – affects rate of polymerization, optical and mechanical properties of the denture.

Types

- **Tin foil:** Widely used in the past, but due to its time consuming manipulation and laborious technique, it has been replaced by tin foil substitutes.
- **Tin foil substitutes:** A variety of alternate separating medium were introduced instead of tin foil, hence they were called 'tin foil substitutes'.

○ Cellulose lacquers

○ Aqueous solutions of sodium silicate

○ Calcium oleate

○ Soaps and starches

○ Water-soluble alginate solutions: sodium and ammonium alginate. The alginate solutions are currently most popular and commonly used.

• Sodium alginate solution: also called ‘cold mould seal’.

Composition: 2% sodium alginate in water, glycerin, alcohol, sodium phosphate and preservatives.
Mode of action: When applied on gypsum surfaces, they react with the calcium sulphate to form a thin insoluble film of calcium alginate. This film prevents direct contact of denture base resins and the surrounding dental stone.
Manipulation: A small amount of separator is dispensed into a disposable container. A fine brush is used to spread the separating medium onto the exposed surfaces of a warm, clean stone mould. The separating medium is carefully guided into interdental regions. The mould is inspected to ensure that a thin, even coating of separating medium is evident on all stone surfaces. Subsequently, the mould sections are oriented to prevent ‘pooling’ of separator and the solution is permitted to dry.
Precautions:

• Separator should not contact exposed portions of acrylic resin teeth, since its presence interferes with chemical bonding between acrylic resin teeth and denture base resins.

• The film is fragile and can easily be scuffed off. If this occurs, remove the entire film and repaint.

• Place the acrylic resin to the cast within 1 h of painting the film on the cast to avoid deterioration.

Advantages over tin foil:

• Uniform film thickness permits closer adaptation of acrylic resin to gypsum cast.

- Easy to manipulate, takes less time.

- Separating medium (sodium alginate or cold mould seal) is applied with a paint brush on the plaster surface (Fig. 12.8) and exposed land areas of the cast after the first pour is completely set. Separating medium is not applied on the waxed surface and acrylic teeth of the trial denture base.

- A surface tension reducing agent may also be applied over the wax to enhance its wettability to the plaster.

- When the separating medium sets, the body of the flask is fitted on the lid. Dental stone is mixed and first painted or applied on the labial, buccal and palatal surfaces of the trial denture base (Fig. 12.9). This is done to avoid entrapment of air bubbles and for accurate reproduction of the waxed areas in complete denture prosthesis. The rest of the mixed stone is poured into the flask to cover the occlusal surfaces of the teeth. The occlusal surface should be exposed. This is the second pour (Fig. 12.10). When this sets, separating medium is applied again on the gypsum surfaces, and plaster is mixed and poured over the occlusal surfaces to completely fill the flask. This is the third pour (Fig. 12.11). If a 2-pour technique is used, then the 2nd and 3rd pours in this technique are combined into a single pour.

- Once the third pour is completed, the lid of flask is placed and the dental flask is checked for proper closure. Note excess dental plaster escaping outside the holes on the lid (Fig. 12.12). The excess plaster is removed and the dental flask is placed on the clamp and tightened to ensure complete closure (Fig. 12.13). The third pour is allowed to set and then dewaxing is commenced.

FIGURE 12.8 Application of separating medium on exposed gypsum surfaces.

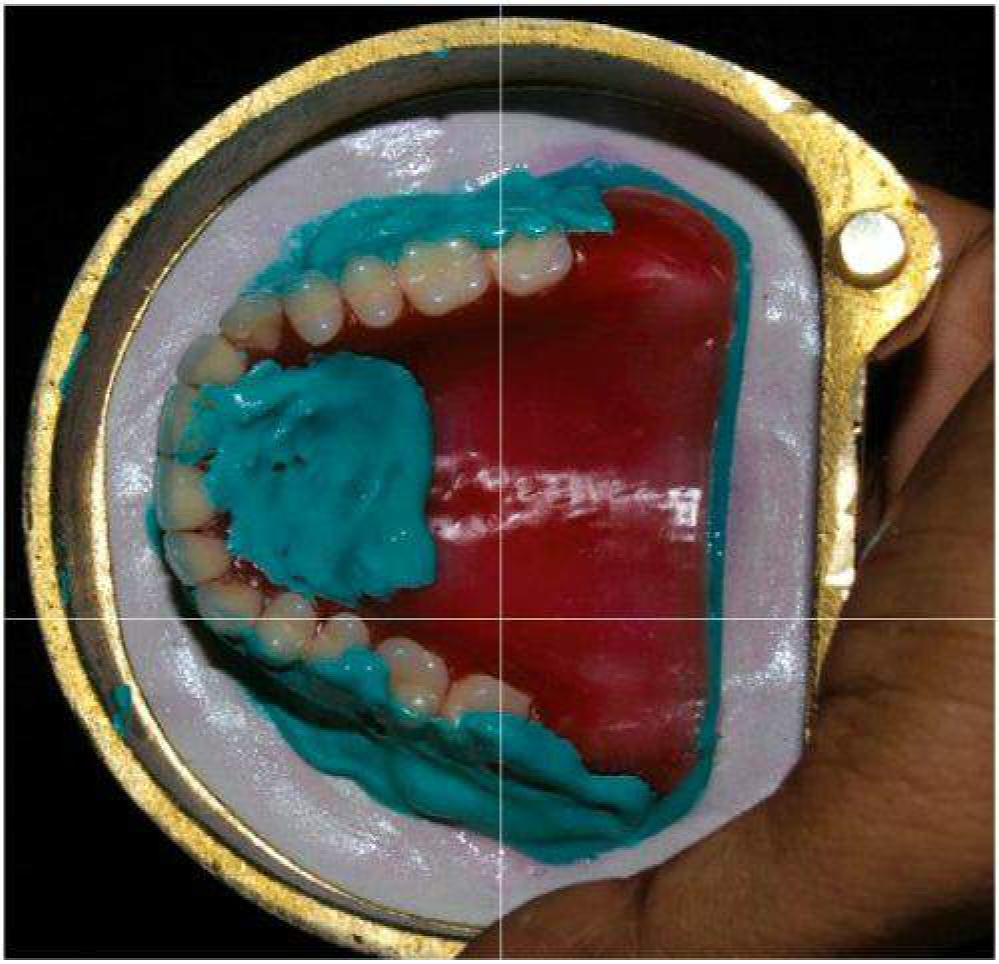


FIGURE 12.9 Dental stone applied on buccal and palatal surface.

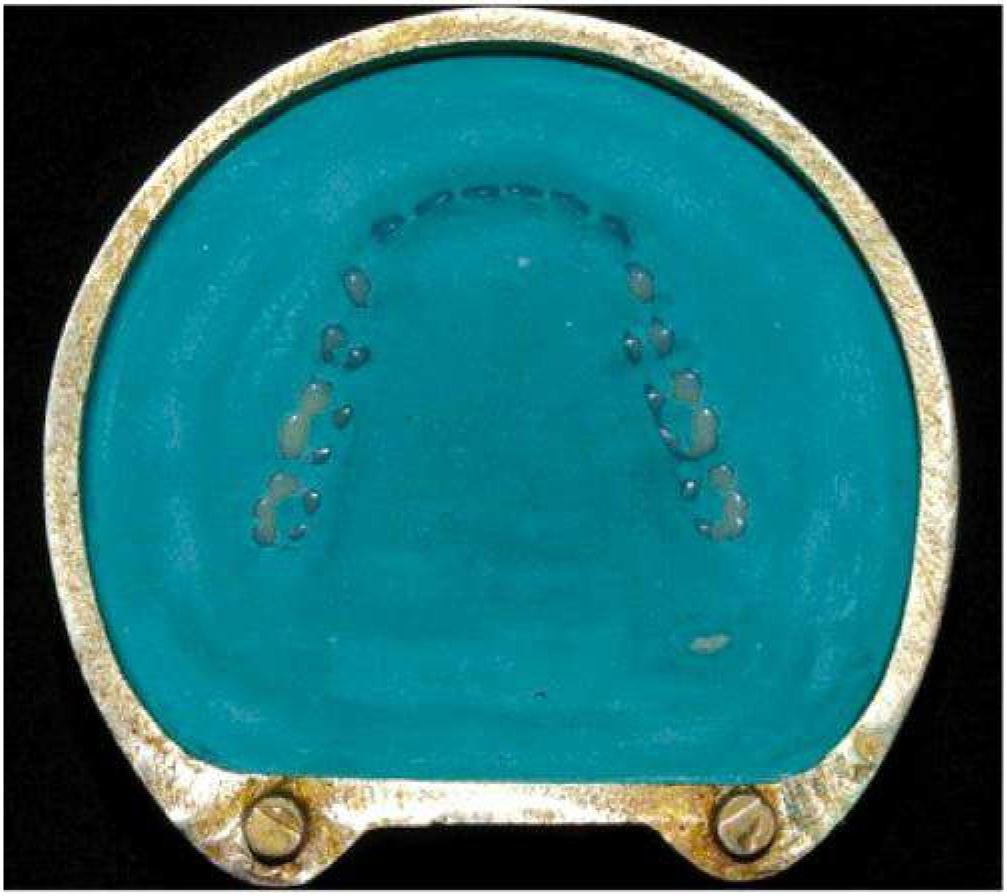


FIGURE 12.10 Second pour exposing the occlusal surfaces of the artificial teeth.

FIGURE 12.11 Third pour with dental plaster.

FIGURE 12.12 Excess plaster escaping through lid.

FIGURE 12.13 Flask tightened with clamp.

Dewaxing

- The flask is removed from the clamp and placed in boiling water for 5 min to soften the wax. The flask is then opened from the base and the softened wax and denture base are discarded.

- The mould is flushed with clean boiling water to which some detergent has been added. A brush is used with a detergent solution to completely clean the mould and cast surfaces (Fig. 12.14). Finally, the moulds are flushed with clean boiling water to remove all traces of the detergent (Figs 12.15A and B). During dewaxing, it must be ensured that the denture teeth remain in the flask and if any of them come loose, they can be kept aside until the procedure is complete and repositioned before packing the acrylic material. The flask is then allowed to cool.

- Failure to eliminate the wax completely will result in an incomplete polymerization between the denture base and teeth. As a result the teeth separate from the denture after processing. Also dewaxing for a prolonged period in boiling water will cause leaching of wax into the plaster.

- *Diatorics* may be made in the ridge lap portion of the artificial teeth to improve attachment with the denture base resin (see Fig. 9.25 in Chapter 9, Page 158). A No. 4 or 6 round bur is used for this preparation.

FIGURE 12.14 Detergent to remove impurities from mould surface.

FIGURE 12.15 **(A)** Maxillary cast and mould in flask after dewaxing. **(B)** Mandibular cast and mould in flask following dewaxing.

Packing

- Packing involves placement and adaptation of denture base resin within the dewaxed mould space. It is a very important procedure in the processing of the denture. Overpacking (too much material) leads to excessively thick denture base with shift in position of denture teeth. Underpacking (too little material) leads to porosity.

- Separating medium (soluble alginate solution) is applied with a paintbrush on the gypsum areas, while the mould is still warm. In the interdental areas it is applied with a thin brush.

- Heat cure acrylic resin consists of two components – powder (polymethylmethacrylate – polymer) and liquid (monomethylmethacrylate – monomer). The monomer is first dispensed in a porcelain jar and then the polymer is added in a ratio of 1:3 by volume (Fig. 12.16). The polymer is added slowly such that it is completely wetted by monomer. It is mixed homogenously and allowed to polymerize by closing the jar. This prevents monomer evaporation during polymerization. Use of too much monomer will increase the polymerization shrinkage of resin while use of less monomer will cause porosity.

- There are five stages of polymerization – as the material is polymerizing in a closed chamber, the stages can be verified by using a spatula to pick up the resin. In the first stage (sandy) the material is 'grainy', in the second stage (stringy) it is 'sticky' (Fig. 12.17A), while in the third stage (dough like) it is no longer tacky and becomes pliable (Fig. 12.17B). The material should be manipulated and inserted into the mould space (packed) in this stage. In the fourth stage (rubbery), material no longer flows freely and so cannot be moulded into the desired shape. In the fifth stage (stiff), material is dry and resists mechanical deformation. Hence, it cannot be manipulated in the 4th and 5th stages.

- Dough forming time – the time required for the material to reach a dough-like stage is less than 10 min for most heat-activated resins.

- Working time – the time for which a material remains in the dough-like stage is 5 min. It is affected by ambient temperature, less the temperature more is the working time.

- The material is best manipulated during late stringy stage or early dough stage and packed in the dough stage. Kneading is done using cellophane sheet to improve the handling characteristics (Fig.12.18).

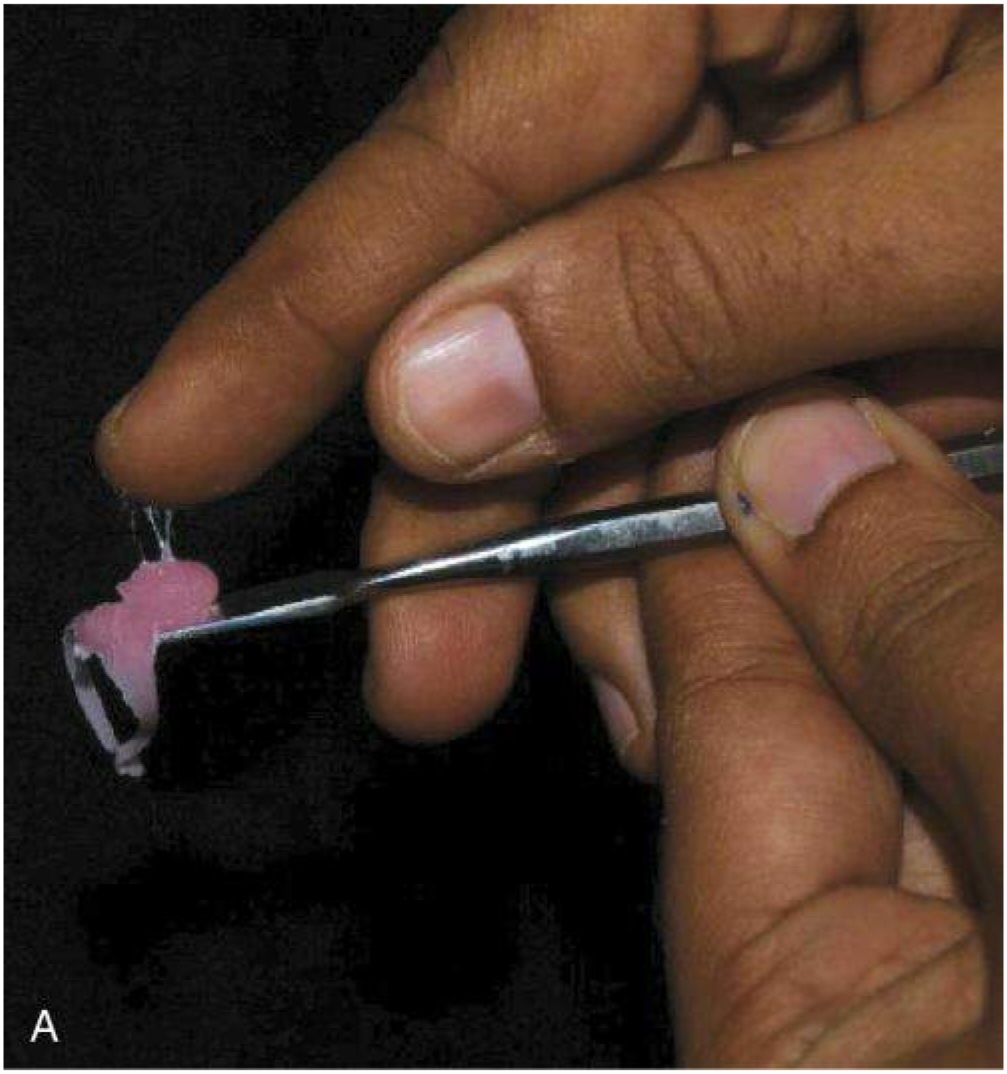
- The kneaded material is spread and placed in the mould space to fill it and a cellophane sheet is placed over the material (Fig. 12.19A and B).

- Trial closure – the body and base of the dental flask is then approximated, checked for rim-to-rim contact and tightened slowly in a bench press (Fig. 12.20). The excess resin flows along the rim of the dental flask. The flask is reopened, cellophane sheet is removed and the excess material is trimmed from the borders using a scalpel or carver (Fig. 12.21). The excess material is termed as *flash* and the procedure used to remove the excess material is termed as *trial closure*. This procedure is repeated until all the excess material is removed. When no flash is evident, final closure of the flask is done without any cellophane sheet. The flask is then clamped and allowed to bench cure at room temperature for 30 min.

- Bench curing – a stage of resin processing that allows a chemical reaction to occur under the conditions present in the ambient environment (GPT8). This is done to ensure uniform distribution of pressure in the mould space and to provide adequate wetting of resin teeth with monomer.

FIGURE 12.16 Polymer is added to the monomer in a

porcelain jar and mixed homogenously.



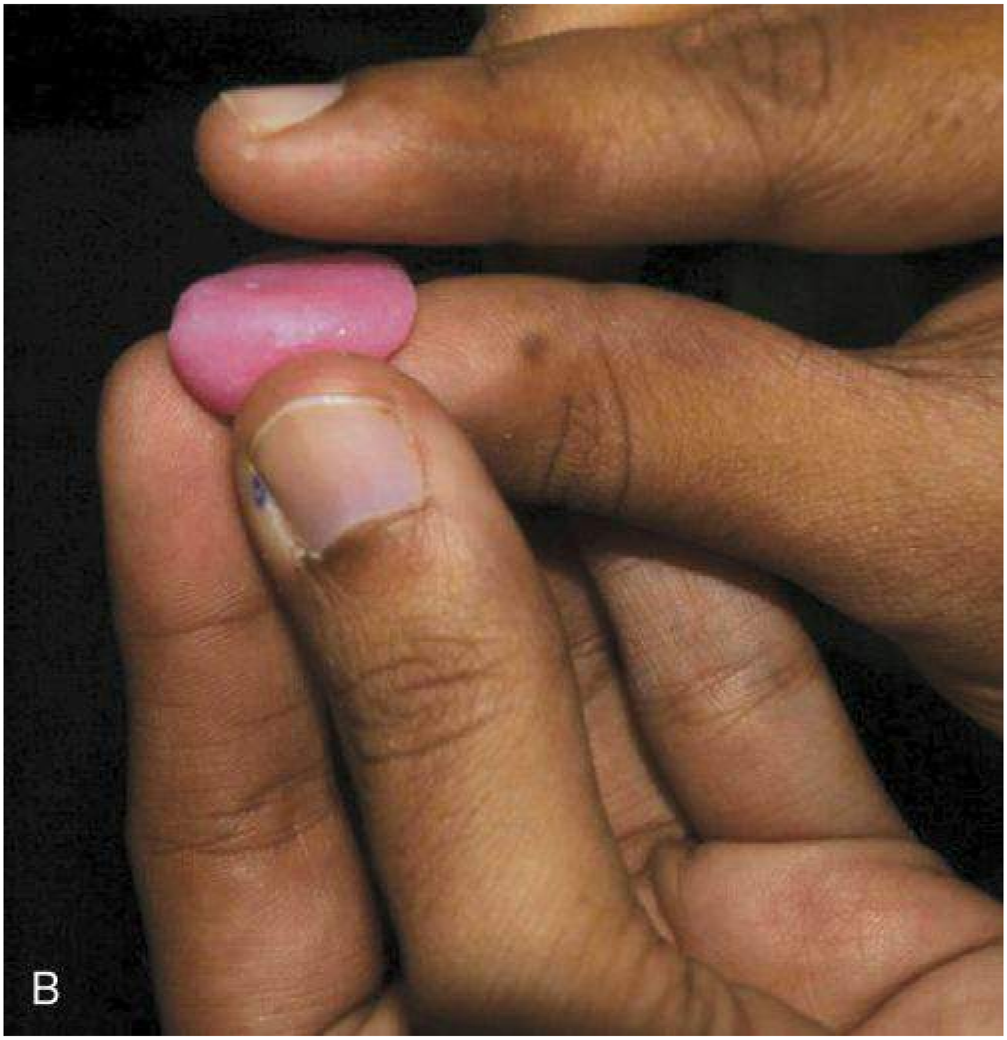


FIGURE 12.17 **(A)** Stringy stage – material sticks to the finger. **(B)** Dough-like stage – material is not sticky and can be moulded into a desired shape.

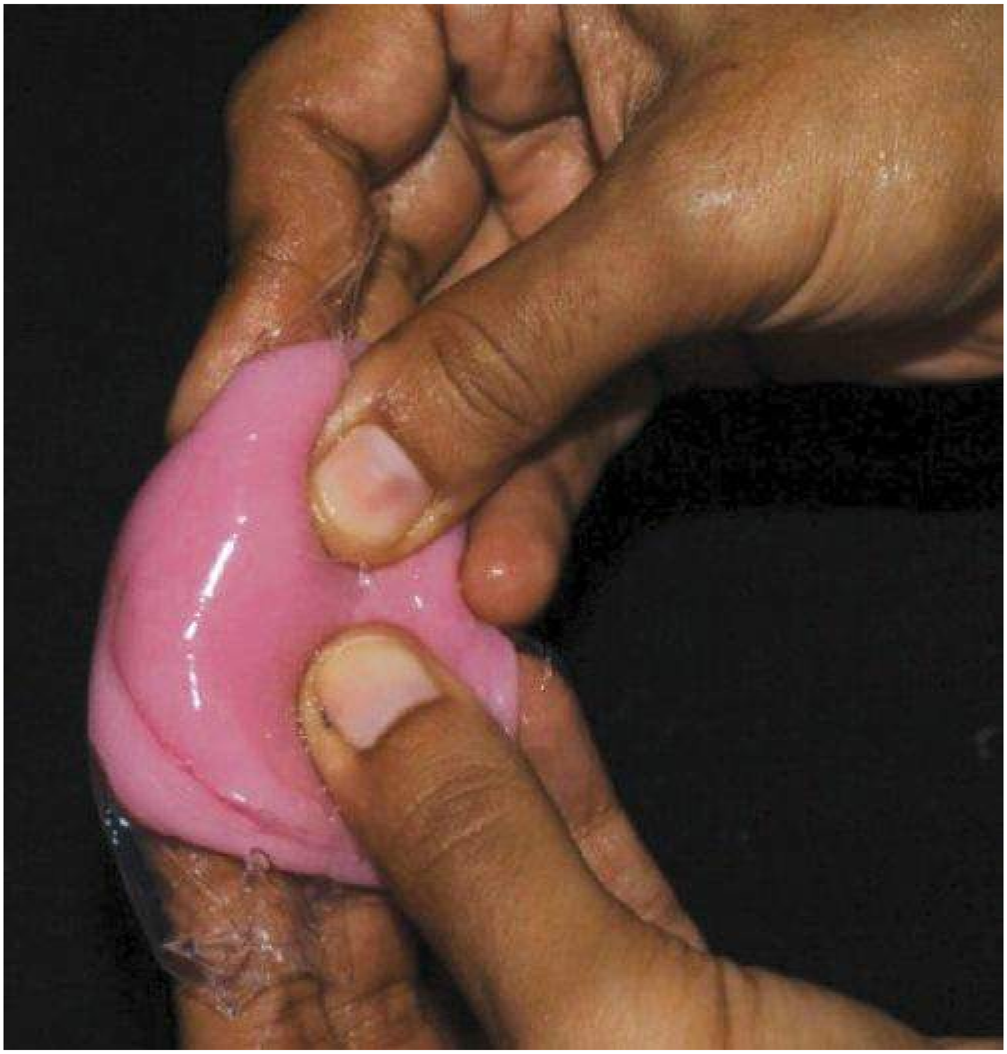
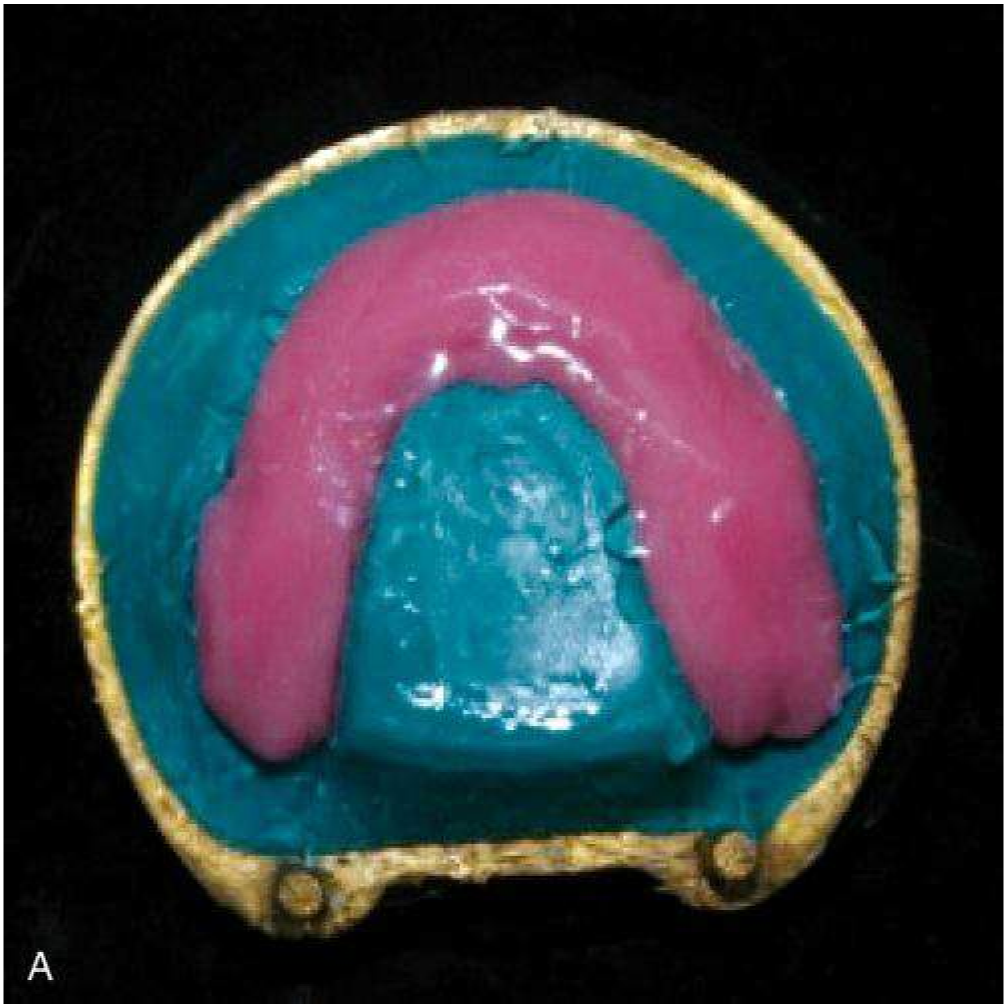


FIGURE 12.18 The material is kneaded using cellophane sheet.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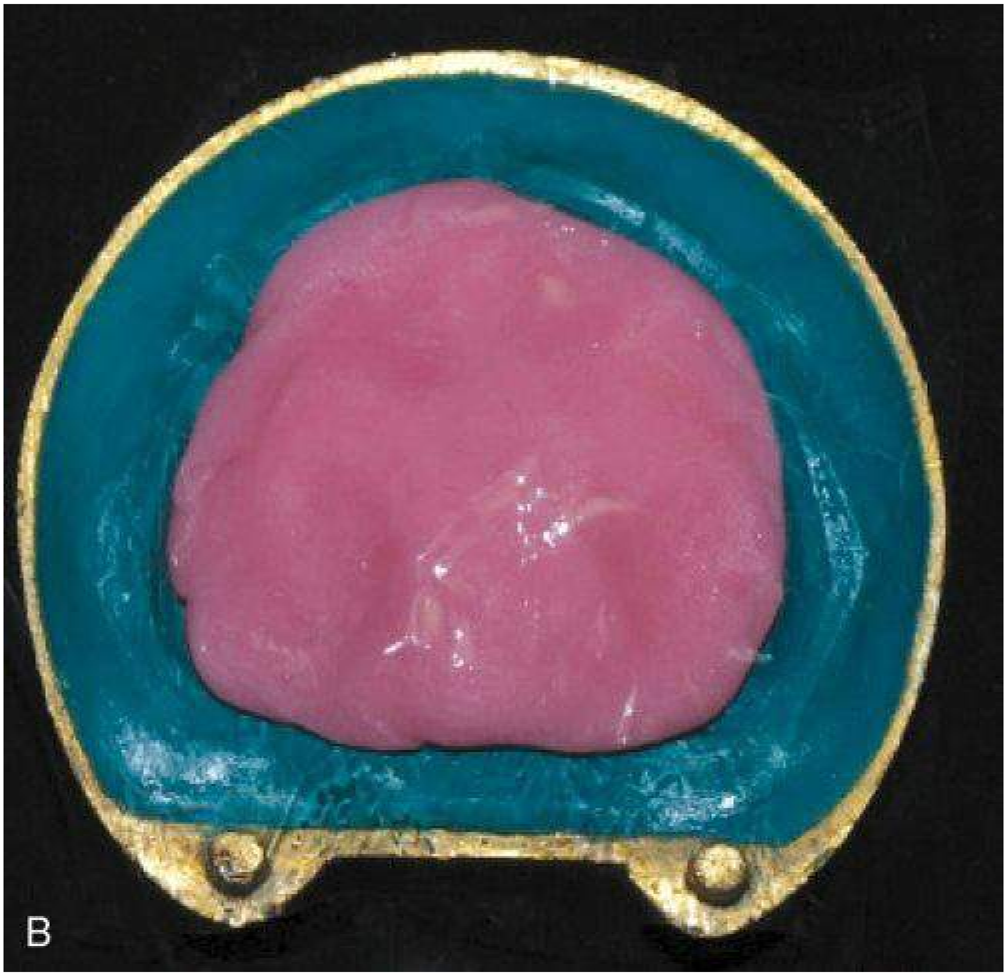


FIGURE 12.19 **(A)** Kneaded material placed in the mandibular mould space and covered with cellophane. **(B)** Kneaded material placed in the maxillary mould space and covered with cellophane.

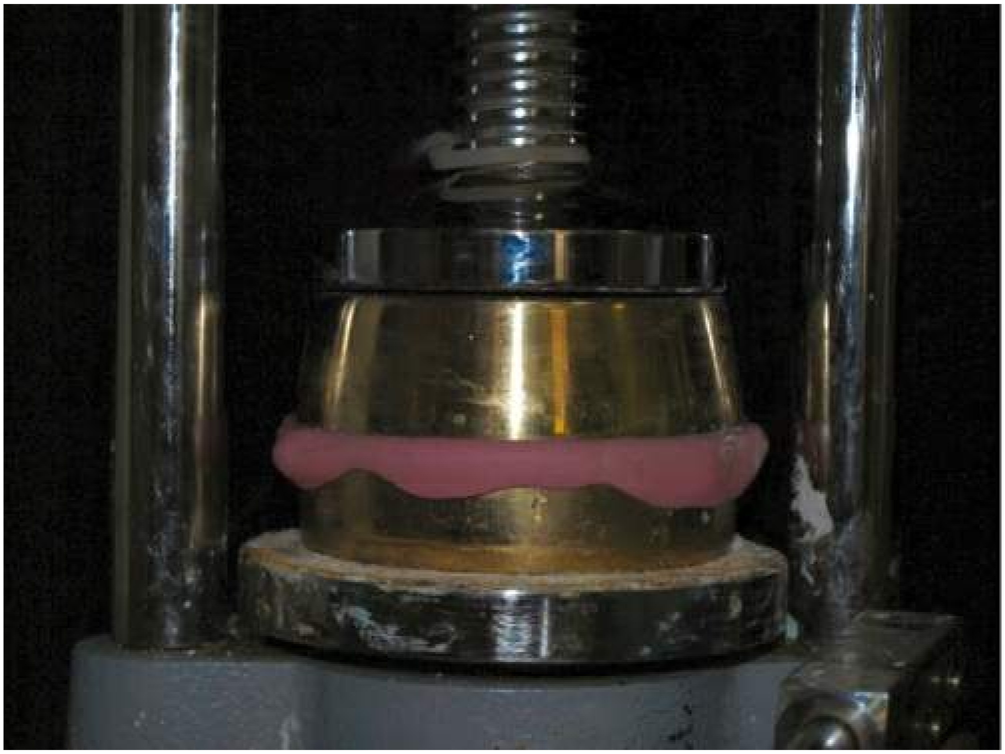


FIGURE 12.20 Flask tightened in bench press and excess material flowing out.

FIGURE 12.21 Flask opened and flash trimmed from the borders.

Curing (polymerization)

- The process by which the denture base materials are hardened to the form of a denture mould. Obviously in heat-activated resins, heat is used to polymerize the material. The heating process employed to control the polymerization is termed as *polymerization cycle* or *curing cycle*. The amount of heat and its rate must be controlled as the reaction is exothermic and the boiling point of monomer is 100.8°C. Uncontrolled temperature rise will lead to boiling of monomer and subsequently denture porosity. One of these two curing cycles can be used:

  ○ Heating at 70°C for 9 h.

  ○ Heating at 74°C for 2 h, raising the temperature to 100°C and processing for 1 h.

- Following polymerization the flask should be bench cooled slowly to room temperature. Rapid cooling can result in distortion of the denture. Ideally, the flask can be bench cooled for 30 min and then immersed in cool tap water for 15 min (Fig. 12.22). The processed denture is then deflasked.

FIGURE 12.22 Flasks immersed in tap water for cooling.

Deflasking

- The entire gypsum mould and cast containing the denture is first retrieved from the flask (Fig. 12.23). This is best achieved using a deflasker. The lid of the flask is removed using a wax knife. The flask is placed bottom side up in the deflasker, and thumbscrew is tightened till it contacts the plate. Pry bars are placed on either side to engage slots in the flask. The pry bars are pressed down and then up to separate the flask from the gypsum moulds. Alternately, the mould can be retrieved by prying out the base and lid of flask using a wax knife at their junctions with the body (Figs 12.24 and 12.25) and then lightly tapping on the top, bottom and sides of the mould using a wooden hammer. This runs the risk of damage to the flask and denture and should be done carefully.

- Once the mould is separated, a wax knife is placed at the junction of the 2nd and 3rd pours and tapped with a wooden or plastic hammer. This separates the 3rd pour from the rest of the mould exposing the occlusal surfaces of the denture teeth (Figs 12.26 and 12.27). Three cuts are made with a saw on the investing stone (where the 2nd pour was made) using a fretsaw, two on the distobuccal corners and one in the centre anteriorly (Fig. 12.28). A plaster knife is placed in the cuts to pry out the stone from the buccal, anterior and posterior sections. The stone is removed from the palate or tongue area by first removing the stone adjacent to the teeth and then gently lifting it away from the denture posteriorly (Fig. 12.29). The stone is also removed from the cast and the index grooves are cleaned. It is to be noted that at no point of time the denture is removed from the cast. The cast with the denture is now ready for remounting (Fig. 12.30).

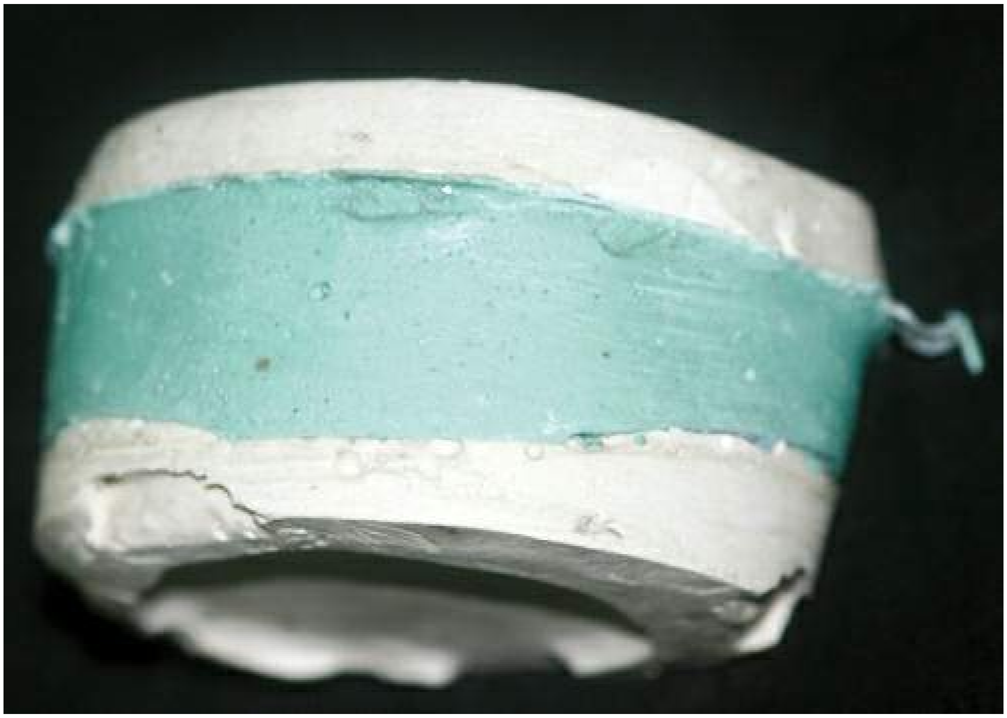


FIGURE 12.23 The entire gypsum mould and cast retrieved.

FIGURE 12.24 The lid is removed by prying with wax knife.

FIGURE 12.25 Base removed.

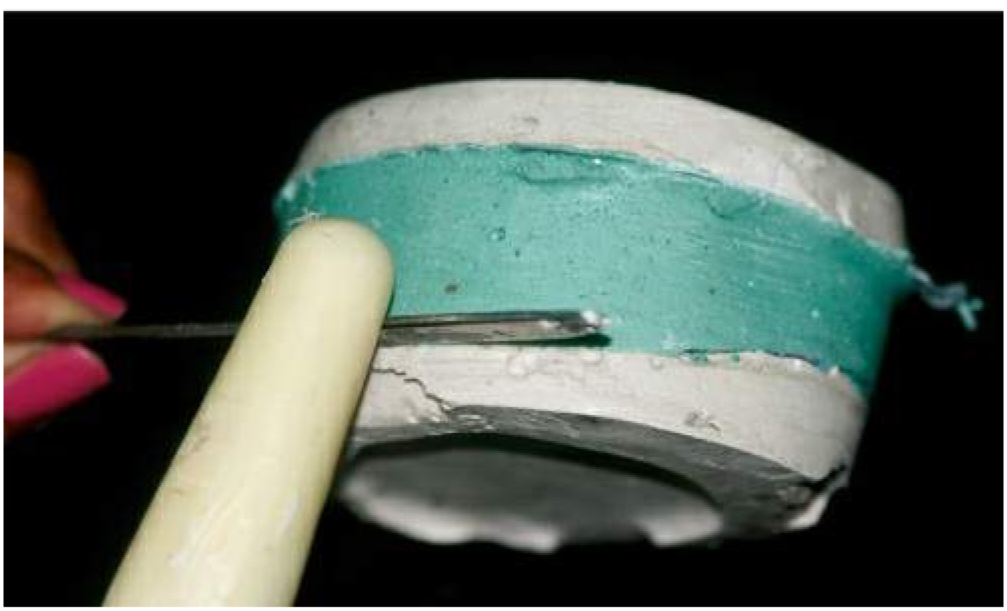


FIGURE 12.26 Tapping at junction of second and third pours.

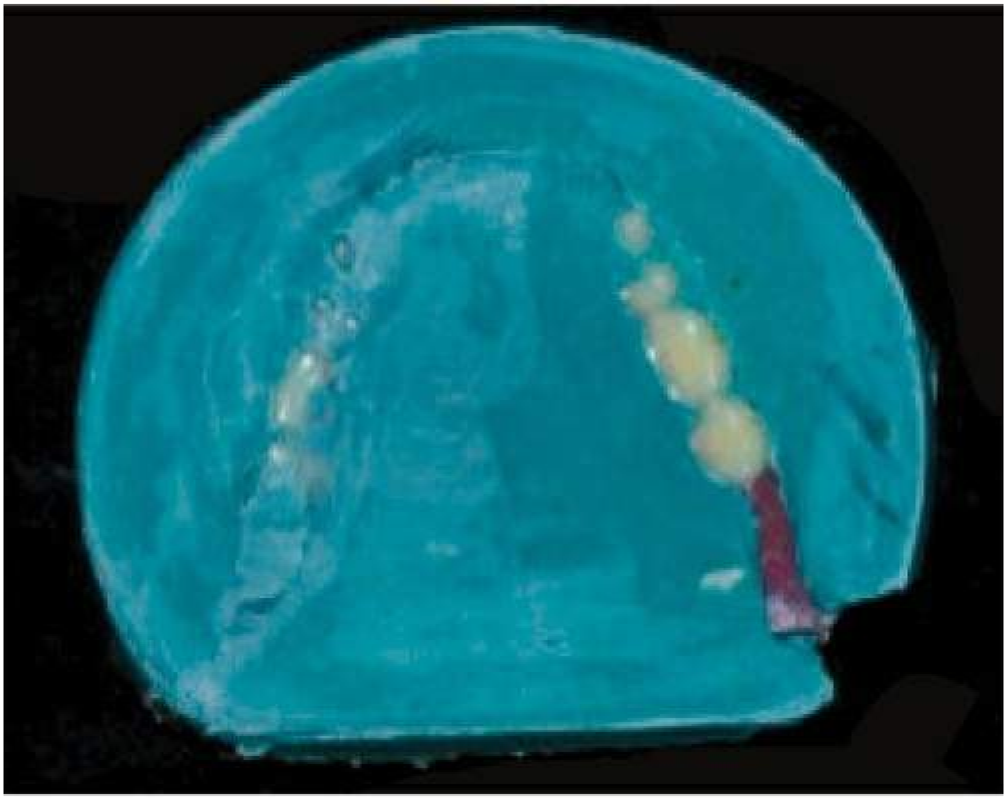


FIGURE 12.27 The third pour removed exposing the teeth.

FIGURE 12.28 Cuts made with saw, two on distobuccal corners and one anteriorly.

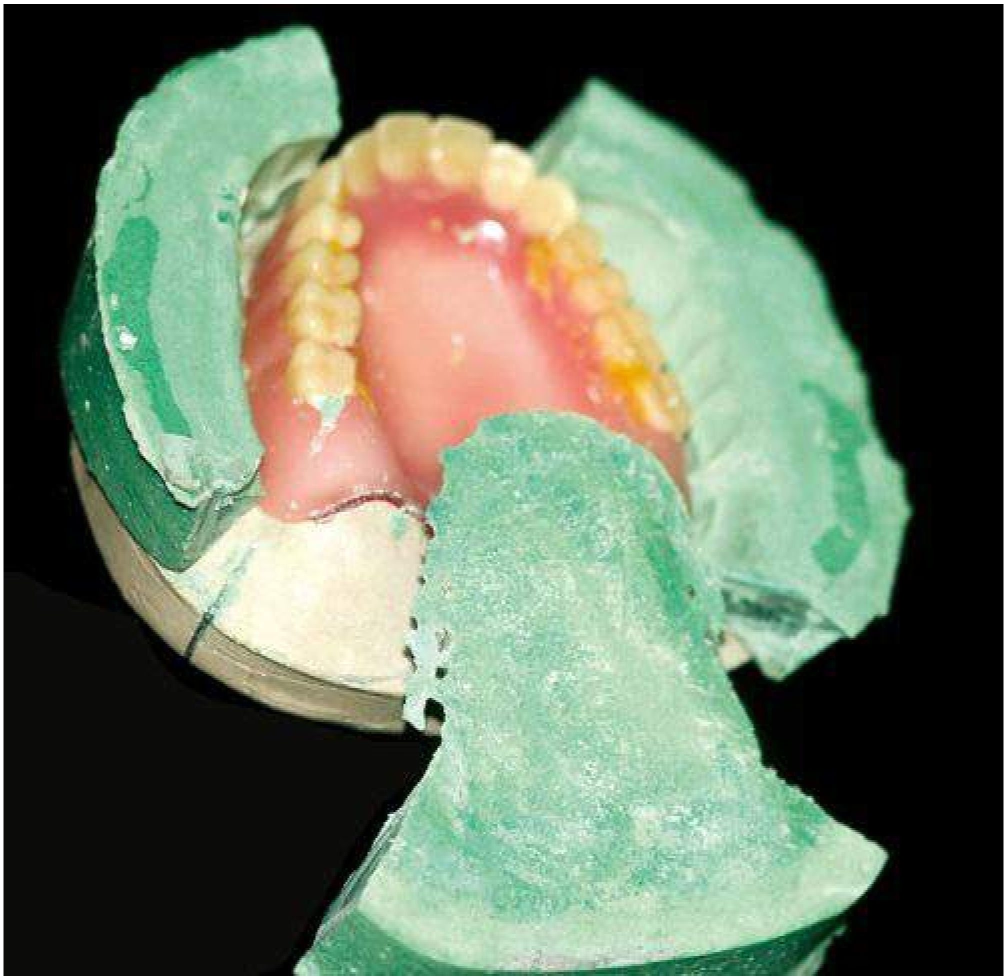


FIGURE 12.29 Denture with cast retrieved by prying the cuts with a plaster knife.

FIGURE 12.30 Deflasked denture attached to the casts.

Remounting

Remount procedure is any method used to relate restorations to an articulator for analysis and/or to assist in development of a plan for occlusal equilibration or reshaping (GPT8).

Remounting can be of two types:

- Laboratory remount
- Clinical remounting (discussed in Chapter 13).

Laboratory remounting

This should be routinely performed after the processing of complete denture and before they are finished, polished and inserted in the patient's mouth. Occlusal errors result from inevitable dimensional changes in the denture base material during processing due to polymerization shrinkage of the resin. The processing errors reflect an increase in vertical dimension with concomitant discrepancies in occlusion.

The deflasked dentures with their casts are mounted back on the articulator using the preserved index keys on the original plaster mounting. They can be attached with sticky wax (Fig. 12.31). If a semi-adjustable articulator is used the condylar elements are locked in centric. Now, when the articulator is closed, if the occlusal vertical dimension is increased, the incisal pin will not touch the incisal guide table (Fig. 12.32) and the vertical dimension has to be re-established by *selective grinding of occlusal surfaces of the teeth.*

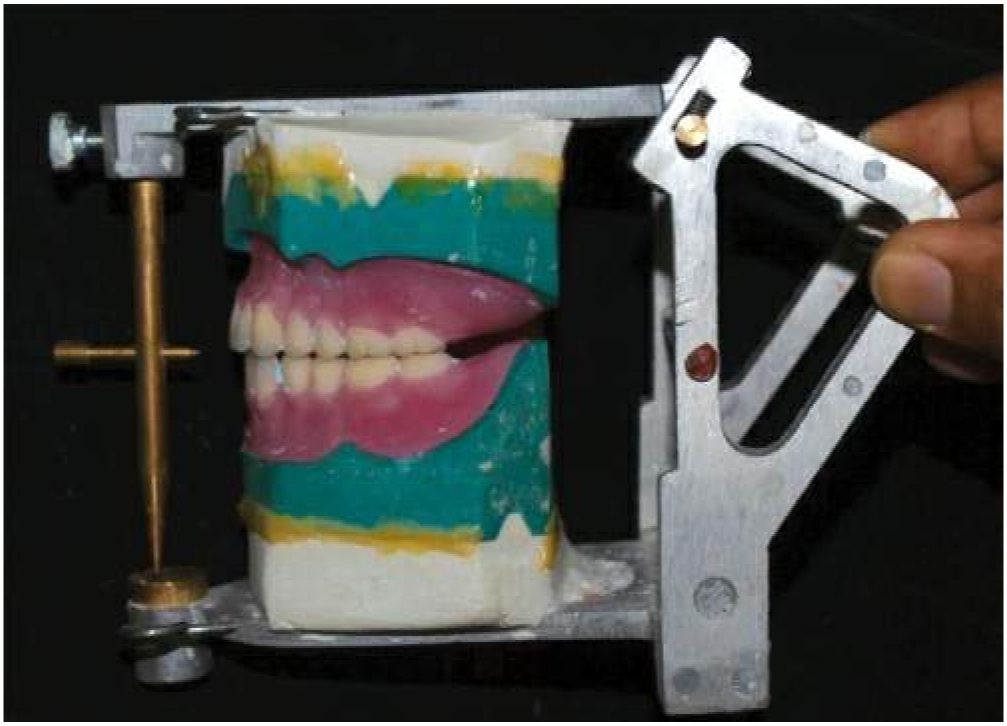


FIGURE 12.31 Casts remounted on articulator showing discrepancy in centric occlusion.

FIGURE 12.32 Incisal pin raised following remounting.

Selective grinding or occlusal reshaping

- This procedure is done to recover the desired form of the tooth and occlusion developed prior to processing.
- First errors in centric are corrected by locking the condylar elements of the articulator in centric (if a semi-adjustable articulator is used).
- Articulating paper is placed bilaterally on both sides and the prematurities are verified (Fig. 12.33) and corrected till the incisal pin contacts the centre of the incisal table (Fig. 12.34).
- If a balanced occlusion in eccentric positions has been provided, then the prematurities in protrusion and lateral excursions are verified. The incisal pin should smoothly and evenly contact the incisal table during these movements. Care should be taken not to grind the centric contacts by using articulating paper of a different colour for checking eccentric prematurities.
- In general, BULL rule (buccal upper, lingual lower) which advocates grinding of the mentioned cusps without modifying the functional cusps should be used while performing the corrections. More specific errors in centric and eccentric positions and their rectification are given below.

FIGURE 12.33 Articulating paper used to check the occlusal prematurities.

FIGURE 12.34 Centric occlusion re-established with selective grinding and incisal pin also touching the centre of incisal table.

Rectification of errors in centric occlusion (fig. 12.35)

Error 1

A pair of opposing teeth is too long, keeping the other teeth out of occlusal contact.

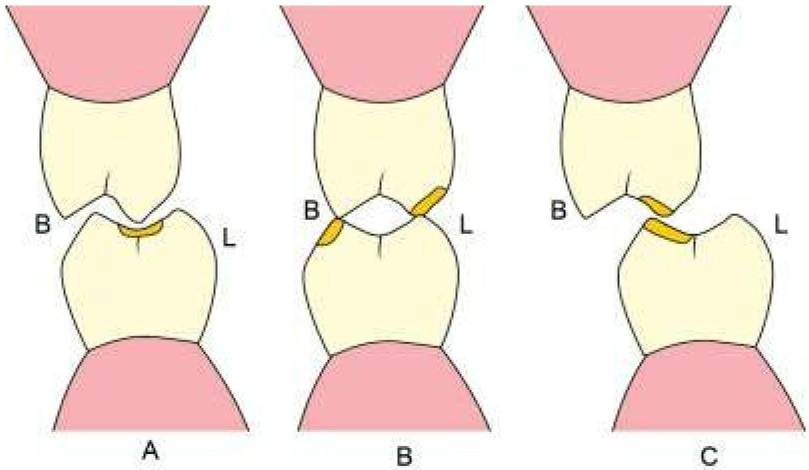


FIGURE 12.35 Centric errors, their rectification. **(A)** Error 1 – too long teeth, **(B)** Error 2 – edge-to-edge contact of the tooth and **(C)** Error 3 – greater horizontal overlap.

Rectification: Deepening of the fossa.

Error 2

Maxillary and mandibular posterior teeth are in edge-to-edge contact. **Rectification:** This error is corrected by grinding the inclines of the cusps in such a way to move upper cusps buccally and lower cusps lingually, broadening the central fossa. This is accomplished by grinding the lingual incline of palatal cusp of maxillary tooth and the buccal incline of the buccal cusp of the mandibular tooth. The cusps are not reduced in height.

Error 3

Buccal positioning of maxillary posterior teeth in relation to mandibular teeth.
Rectification: The maxillary palatal cusp is narrowed by widening of central fossae (grinding the buccal incline of the palatal cusp) and mandibular buccal cusp is moved buccally by grinding the palatal incline of the buccal cusp, thereby widening the central fossae.

Rectification of errors on working side

Occlusal errors on working side can be in sagittal and frontal plane. Following are the errors in frontal plane (Fig. 12.36).

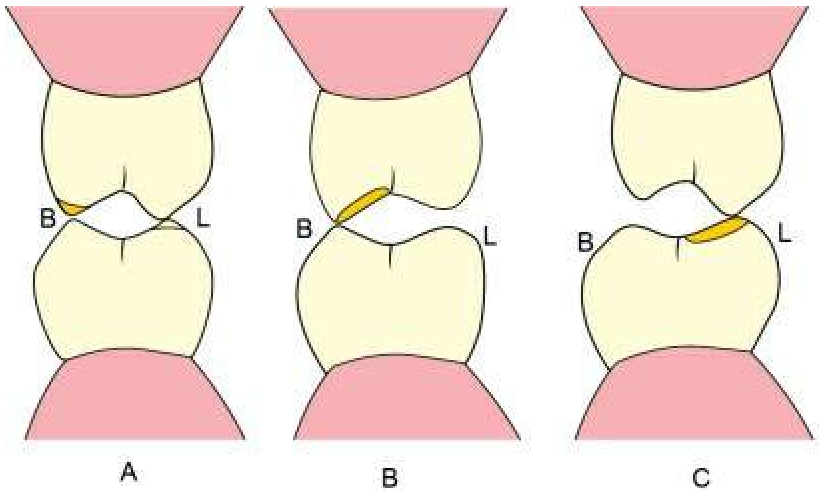


FIGURE 12.36 Working side errors in frontal plane and rectification. **(A)** Error 1 – longer buccal cusp of one tooth along with longer lingual cusp of its antagonist, **(B)** Error 2 – long buccal cusp and **(C)** Error 3 – long lingual cusp.

Error 1

Maxillary and mandibular posterior lingual cusps are too long.
Rectification: Maxillary buccal cusp and mandibular lingual cusps are reduced.

Error 2

Presence of only buccal cusp contact.
Rectification: Maxillary buccal cusp (palatal incline) is reduced.

Error 3

Presence of only lingual cusp contact.
Rectification: Mandibular lingual cusp is reduced by grinding their buccal incline.

Errors in sagittal plane (fig. 12.37)

Error 1

Maxillary buccal or lingual cusps are placed mesial to their maximal intercuspal position.

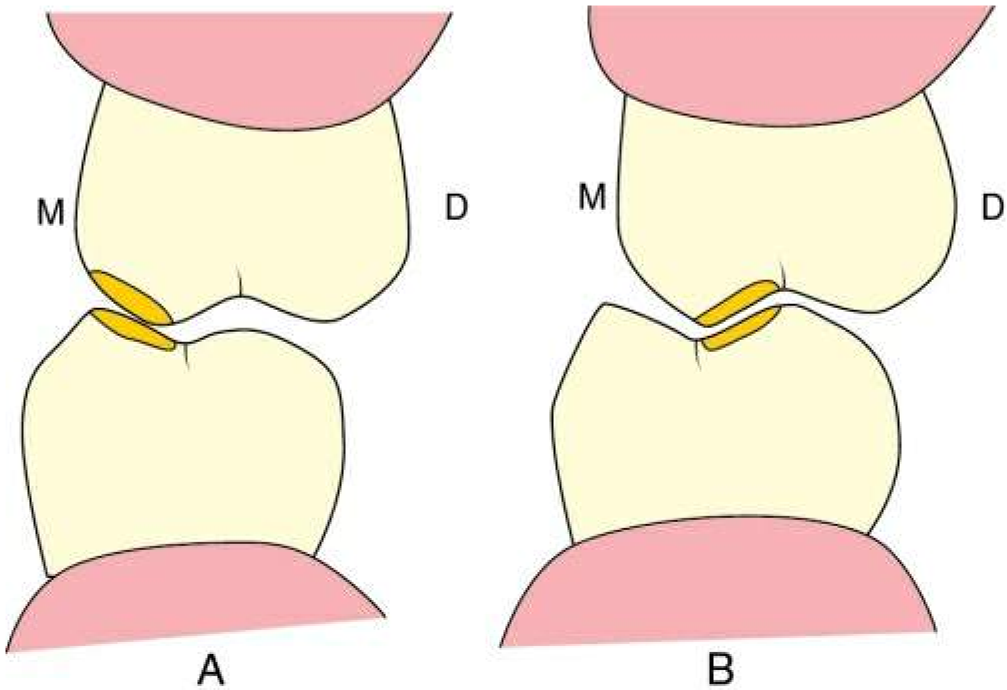


FIGURE 12.37 Working side errors in sagittal plane and its rectification **(A)** Error 1 – maxillary buccal and lingual cusp are mesial to maximum intercuspation, **(B)** Error 2 – maxillary buccal and lingual cusp distal to maximum intercuspation.

Rectification: Grinding the mesial inclines of the maxillary buccal cusp and the distal inclines of mandibular buccal cusp.

Error 2

Maxillary buccal and lingual cusps are placed distal to their maximal intercuspal position.

Rectification: Grinding of distal inclines of maxillary cusp and the mesial inclines of the mandibular cusp.

Error 3

No occlusal contact on the working side.
Cause: Excessive contact on the nonworking side.
Rectification: The paths are ground over the mandibular buccal cusp to reduce the incline of the part of the cusp that is preventing the tooth contact on the working side.

Rectification of nonworking side errors

This can be due to a lack of contact or excessive contact preventing contact on working side. This is when working side errors are corrected as explained previously.

Rectification of errors in protrusion

Reducing distolingual inclines of maxillary buccal cusps and mesiobuccal inclines of mandibular lingual cusps.

Recovering denture from the cast

- A saw is used to make cuts on the base of the cast in several directions (Fig. 12.38). Care should be taken to avoid damaging the borders of the denture. A plaster knife is inserted into the cuts to gently separate and remove the stone sections (Fig. 12.39).

- Alternately, a shell blaster, which uses crushed walnut shells under air pressure to blast the stone without affecting the acrylic, can also be used.

FIGURE 12.38 Cuts made on cast base.

FIGURE 12.39 Cast separated from denture.

Finishing

Finishing involves the following procedures:

- Removing excess acrylic resin (flash) in the borders – using an arbor band on a lathe or a large bur mounted on lab micromotor (Fig. 12.40).
- Removing gypsum around the teeth – using a round bur mounted on a straight handpiece or chisel (Fig. 12.41).
- Removing acrylic nodules from the impression surface – using a round bur mounted on a straight handpiece or small acrylic stones (Fig. 12.42).
- Frenal relief – provided with a straight fissure bur (Fig. 12.43).
- Smoothening the denture surfaces and borders – using large acrylic stones and rubber points (Fig. 12.44). Sandpaper mounted on a mandrel is then used to remove the finer scratches (Fig. 12.45).

FIGURE 12.40 Flash from borders removed with a large bur

mounted on a lathe.

FIGURE 12.41 Plaster is removed with a round bur.

FIGURE 12.42 Acrylic nodules removed with small acrylic stones.

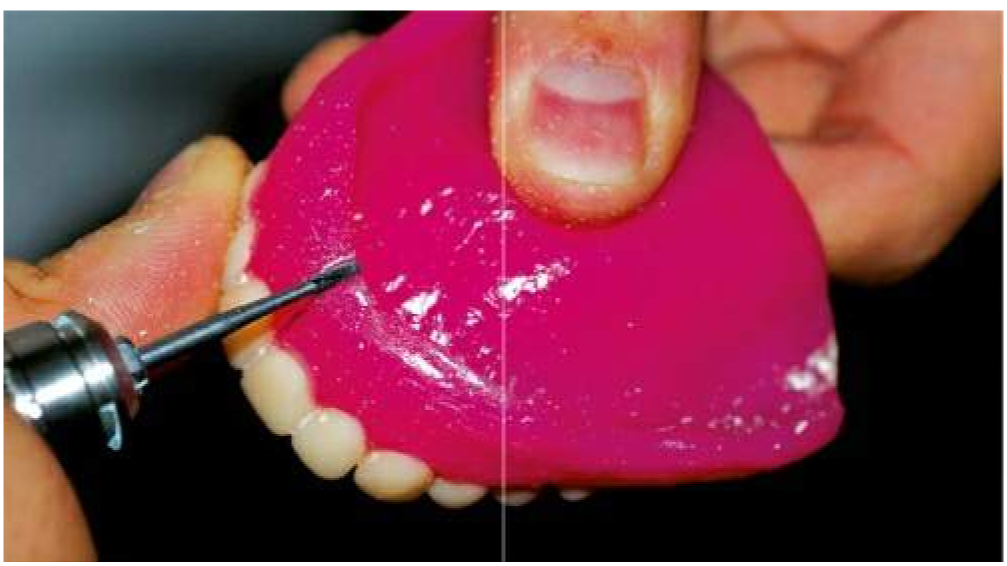


FIGURE 12.43 Frenal relief with a straight fissure bur.

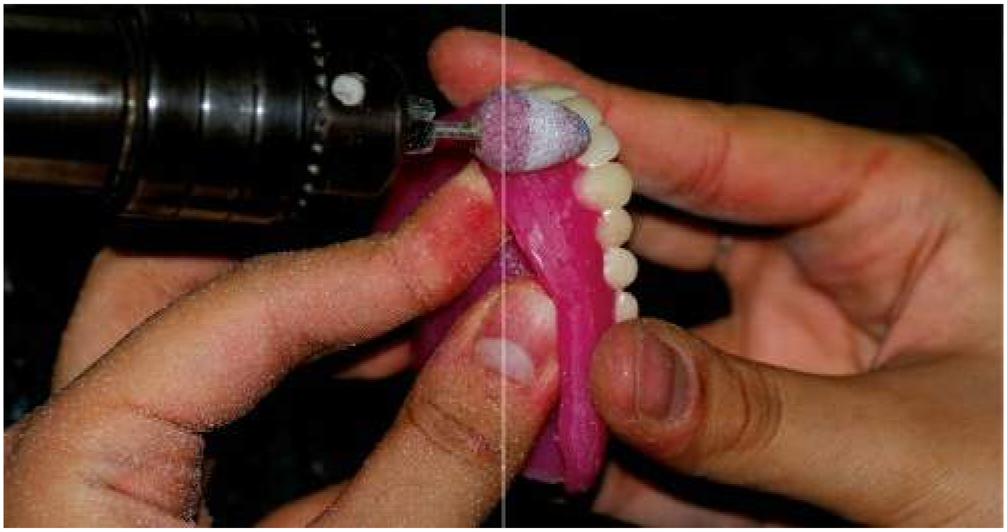


FIGURE 12.44 Smoothening using large acrylic stones.

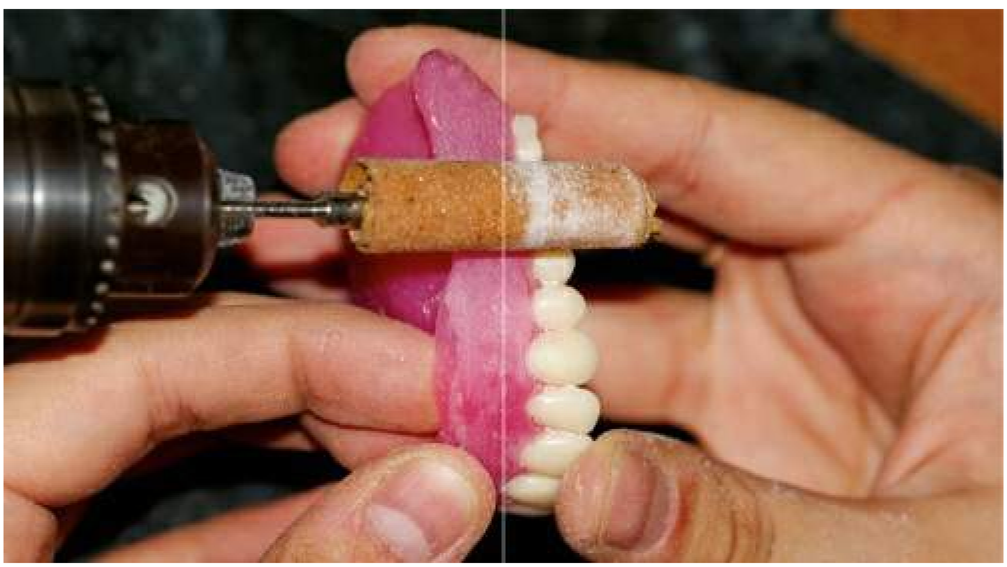


FIGURE 12.45 Smoothening with sandpaper mounted on a mandrel.

Polishing

- A rag wheel is used with a slurry of pumice and water to polish the denture (Fig. 12.46).
- Areas not accessible by the rag wheel (palate) are polished using prophy cup or brush with pumice (Fig. 12.47).
- Stippling the denture may be done using a round finishing bur at slow speed using random circular movements. The stippled area is then pumiced (Fig. 12.48).
- Denture is polished to a high shine using a soft chamois wheel and gold rouge (Fig. 12.49).
- The denture surface is cleaned with soap to remove the polishing material and stored in a container in water.

FIGURE 12.46 Polishing using a rag wheel with pumice and

water.

FIGURE 12.47 Prophy cup and pumice for polishing inaccessible areas.

FIGURE 12.48 Stippling can be created with round bur.

FIGURE 12.49 Dry polishing with a woollen buff.

SUMMARY

The processing of complete dentures is a very important procedure to ensure correct application and transfer of clinical procedures. The sequence of procedures mentioned should be followed diligently to minimize errors. Gross errors during this step will be expensive and time-consuming to rectify.

CHAPTER
13

Denture insertion

CHAPTER CONTENTS

Introduction

This is probably the most eagerly anticipated appointment for the patient in complete denture fabrication. The physical, physiologic and psychological needs of the patient should be addressed. Again, a planned sequence of procedures will help to verify all the aspects. This appointment involves not only clinical procedures but also counselling of the patient in the use and care of the dentures. A sequential approach to denture insertion is discussed in the chapter.

Denture inspection

The following aspects of the denture are inspected before the insertion appointment:

1. **Tissue or fitting surface:** For imperfections, nodules, sharp edges and plaster.

2. **Borders:** Rounded with no sharp angles (Fig. 13.1).

3. **Polished surface:** Smooth without scratches and no plaster on gingival crevice.

FIGURE 13.1 Denture inspection. Fitting surface – checked for imperfections. Borders – rounded, polished surface – smooth.

Denture insertion

During the insertion appointment the completed dentures are evaluated using a sequence of procedures as follows.

Adaptation

- The adaptation of the dentures to the tissues is verified individually. The dentures are inserted and the patient is queried for any pain or discomfort during insertion. Pressure indicating paste (PIP) is painted onto the tissue surface of the denture with a stiff-bristled brush, and seated by applying pressure in the first molar areas on either side.

- It is removed after 1 min and the surface is inspected for the following (Fig. 13.2):

  - Complete removal of paste – indicates pressure spot and needs to be trimmed.

  - Brush streaks remaining – no contact, other areas may have more pressure.

  - Paste remaining with no streaks – proper contact.

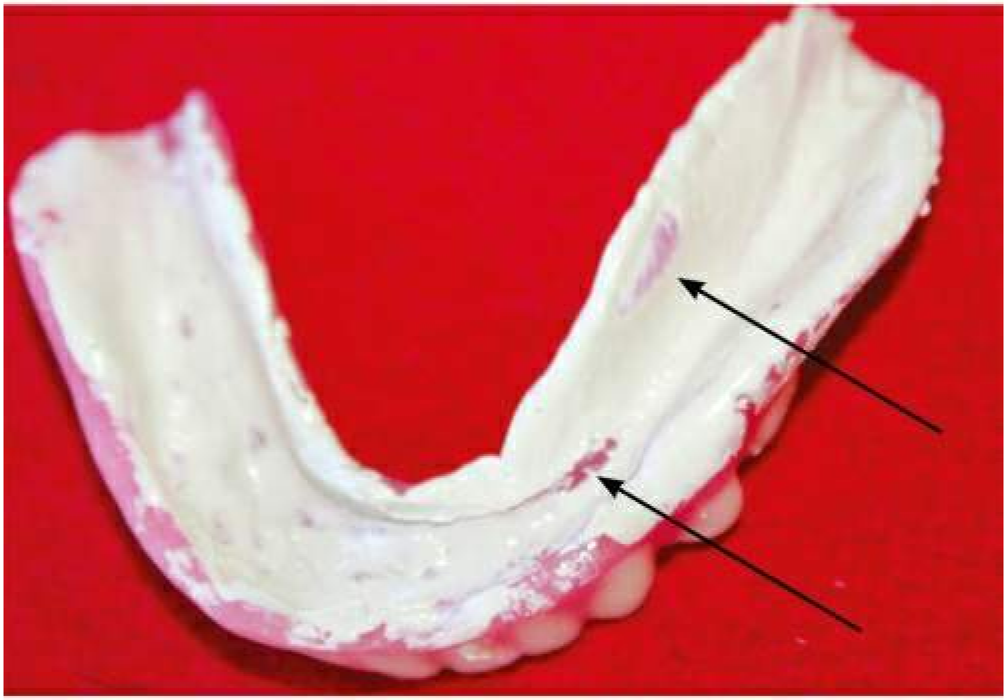


FIGURE 13.2 Pressure spots in mandibular denture detected using pressure indicating paste (PIP).

Borders and peripheral extensions

After ensuring adaptation of the dentures individually, the borders are evaluated and corrected for overextension. The same procedure is adopted using PIP. The frenal areas are checked for relief and the posterior palatal seal area is also verified (Fig. 13.3).

FIGURE 13.3 Frenal areas are checked for relief.

Retention and stability

The dentures are checked individually for retention and stability as described for try-in. It must be kept in mind that generally the lower denture will not be as retentive as the upper. Also, retention can improve after the patient has worn the denture for a few days due to better soft tissue adaptation.

Aesthetics

As discussed during try-in, the various factors affecting aesthetics are verified again and patient consent is again taken.

Occlusion

Occlusal harmony is important for the complete denture to function efficiently, be comfortable and to preserve the tissues.

Causes of occlusal discrepancy

Even after lab remounting and selective grinding can be due to:

- Errors in jaw relation records.

- Errors in mounting casts on articulator.
- Changes in supporting tissues since impressions were made.
- Differences in tissue adaptation between record bases and processed denture bases.
- Realeff (resiliency like effect)

- When a passive recording material is used for impression making the maxillomandibular relation changes in the final denture leading to occlusal discrepancy (premature contact).

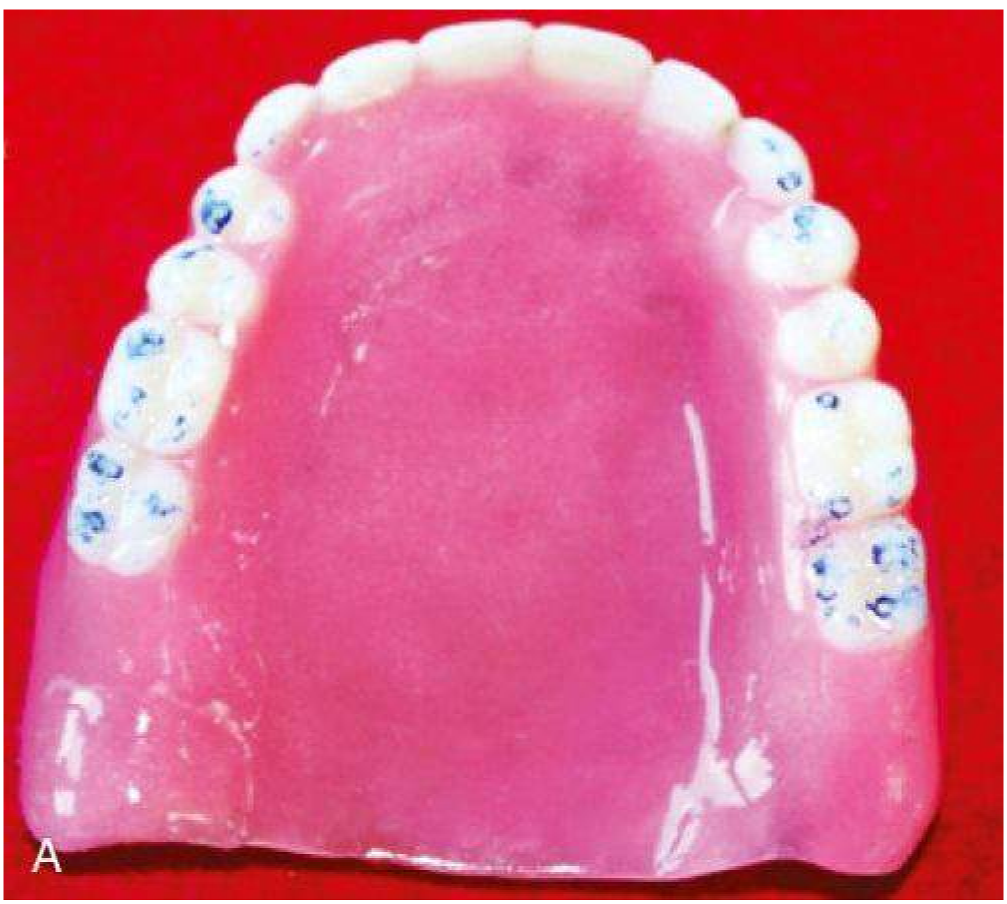
Occlusal correction can be done:

- Intraorally
- Extraorally (clinical remounting)

Intraoral correction

Articulating paper can be used to check the occlusion intraorally. It should be placed bilaterally (Fig. 13.4), as placement on one side may induce the patient to close away from that side and high points checked both in maxillary (Fig. 13.5A) and mandibular denture (Fig. 13.5B).

FIGURE 13.4 Articulating paper placed bilaterally.



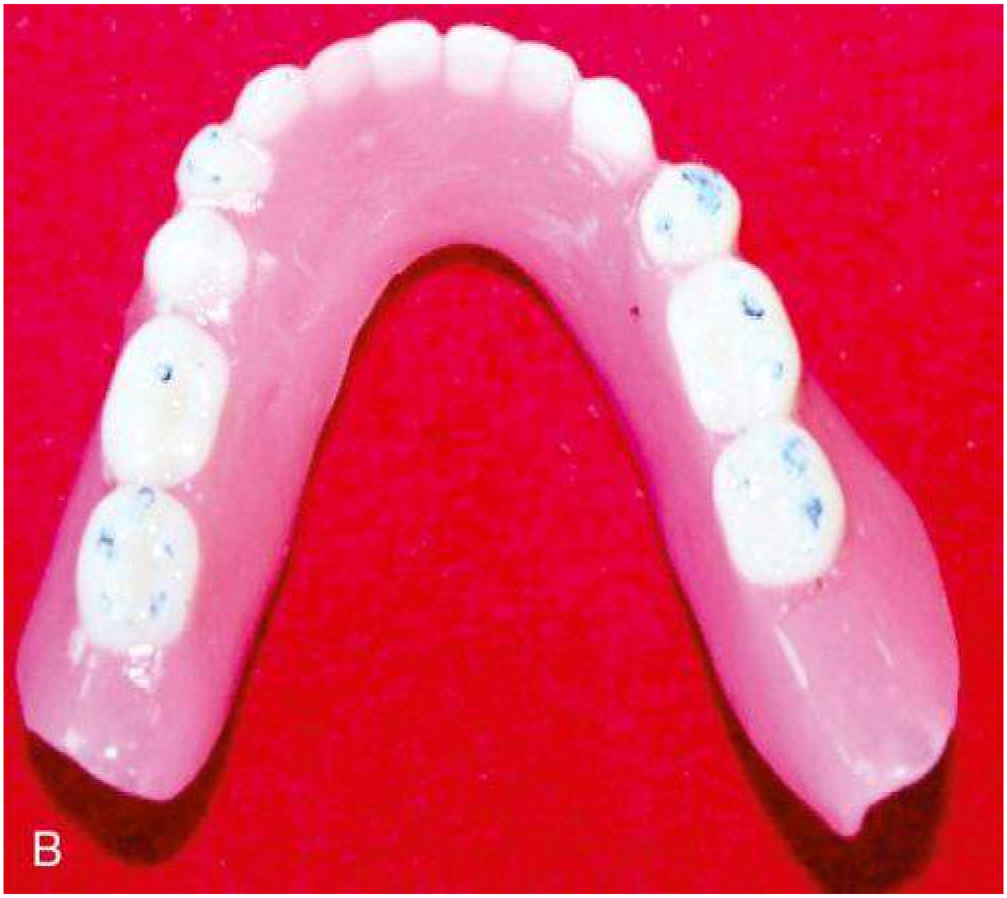


FIGURE 13.5 **(A)** High points in maxillary denture. **(B)** High points in mandibular denture.

Disadvantages of articulating paper

- It will colour a tooth even if it only touches it – areas which are not in occlusion tend to get marked.
- The fossa fail to be marked, cusps are marked better.
- Difficult to place bilaterally and at the same time ensure dentures do not shift.

○ Occlusal wax is a better choice for checking occlusion. Strips are placed bilaterally and patient is instructed to close in centric (Fig. 13.6A). Points of wax penetration are marked with pencil and relieved (Fig. 13.6B and C).

- Whichever material is used, it must be ensured that there is simultaneous and even contact of all the posterior teeth in centric occlusion after the correction. The eccentric occlusion is then verified.

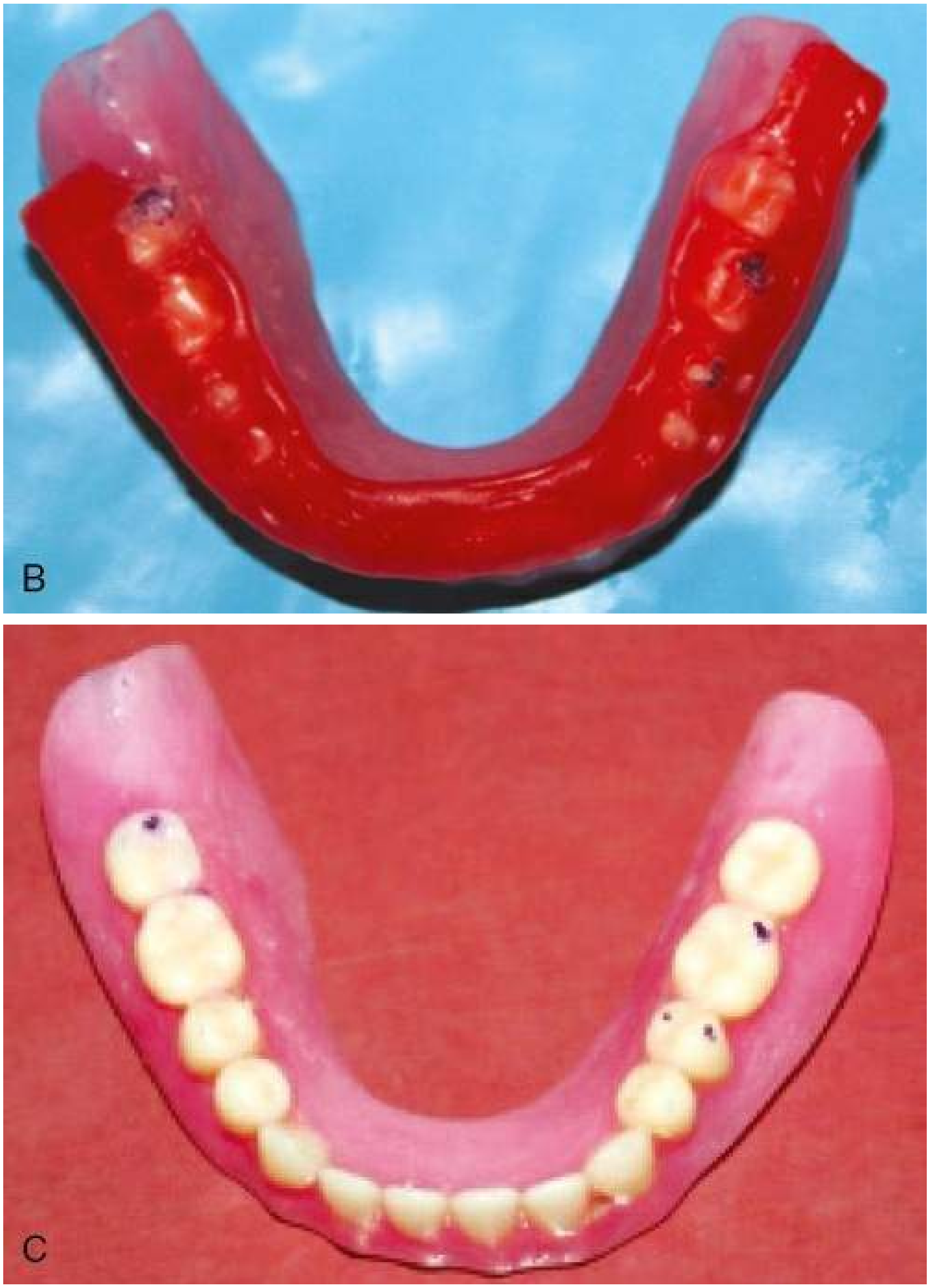


FIGURE 13.6 **(A)** Occlusal wax placed bilaterally. **(B)** Points of wax penetration. **(C)** High points marked and relieved.

Disadvantages of intraoral correction

• The resiliency and displaceability of the supporting soft tissues will mask the premature contacts.

- It is impossible to observe the discrepancy from all aspects with the dentists' naked eye.
- Patients also do not identify and quote the problem immediately.
- Occlusal interferences can cause pain which makes the patient avoid the same, giving false markings.

Extraoral – clinical remounting

- Clinical remounting is the better method for checking occlusal errors. This involves remounting the processed denture on an articulator and adjusting the occlusion extraorally.
- **Advantages:**

○ Permits dentist to view occlusion better from all sides including lingual.

○ Reduces patient participation.

○ Provides a stable foundation without shifting bases.

○ Absence of saliva makes the markings more accurate.

○ Clinical time and adjustment appointments are reduced.

- **Procedure:**

- The clinical remounting is performed using interocclusal check records (as described in Chapter 6).
- If the original final casts are intact, the dentures are just remounted on the articulator with the new interocclusal check record and the centric relation is verified by adjusting the condylar controls (as described in Chapter 6). If necessary, the lower cast is mounted again on the articulator in the new position.
- If the original final casts are destroyed, then remount casts are made.

Remount cast

A cast formed on prosthesis for the purpose of mounting the prosthesis on an articulator (GPT8).

Procedure of fabricating a remount cast

The undercuts present in the tissue surface of the dentures are blocked (Fig. 13.7) out with plasticine or wax.

FIGURE 13.7 Undercuts blocked in the denture.

The tissue surface of the denture is coated with a separating medium like petroleum jelly. Quick setting plaster is vibrated onto the tissue surface, such that it captures the peripheral roll, but it should not cover the external surface as it may become difficult to remove the denture from the cast (Fig. 13.8).

FIGURE 13.8 Plaster vibrated onto tissue surface without extending over external surface.

The maxillary cast can be mounted with a remounting jig (if fabricated after laboratory remount and selective grinding). Alternately, it can be mounted on the articulator using a new facebow transfer (Fig. 13.9).

- The mandibular cast is mounted using the interocclusal check record (Fig. 13.10).
- Selective grinding procedures using BULL law (buccal cusp of upper [Fig. 13.11A] and lingual cusp of lower [Fig. 13.11B]) are performed to correct occlusal discrepancies using articulating paper, as described in Chapter 12.
- Any area of the denture that is trimmed during denture insertion should be polished.

FIGURE 13.9 Maxillary cast is mounted using facebow transfer.

FIGURE 13.10 Mandibular cast mounted using interocclusal check record.


A

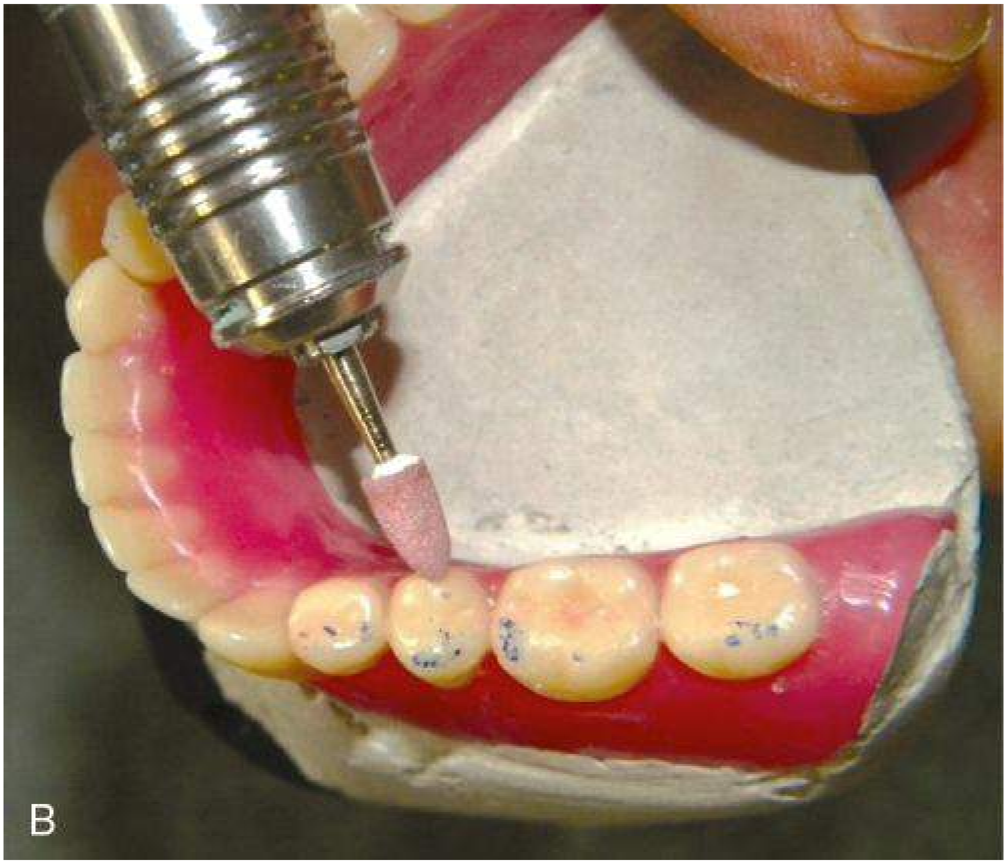


FIGURE 13.11 **(A)** Buccal cusp of maxillary teeth trimmed. **(B)** Lingual cusp of mandibular teeth trimmed.

FIGURE 13.12 Correct tongue position.

Instructions to patient

This is more important for patients who are having dentures inserted for the first time. It consists of instructions regarding:

- Denture insertion and removal
- What to expect from dentures
- How to use dentures
- Care for dentures

Denture insertion and removal

The patient is taught to insert and remove the denture. It is usually preferable to wear the upper denture first followed by the lower denture as upper is more retentive and larger. Again for the same reason, it is preferable to remove the lower denture followed by the upper denture.

What to expect from dentures

The patient should be instructed that dentures are artificial substitutes and can have limitations. The following are initial normal reactions to a new denture and these will get better as the tissues adapt:

- Awkward feeling in the beginning.
- Appearance seems changed.
- Speech seems altered.
- Feeling of mouth being full.
- Excessive salivary flow.

- Lower denture may be dislodged during speech and eating.

How to use dentures

Tongue position

- The tongue position needs to be trained to stabilize the dentures, particularly the mandibular denture. The patient must practice mouth opening and closing with the tongue in forward position resting against the inside of the denture flange and lower front teeth (Fig. 13.12). The same position should be maintained while opening the mouth to receive any food. This is important to prevent a retracted tongue position, which can destabilize the lower denture.

- If the maxillary denture feels loosened, patient should be advised to close the mouth and swallow which will elevate the tongue and reseat the denture.

FIGURE 13.13 **(A)** Denture brush with tapered bristles on one end to reach deep areas. **(B)** Cleaning of denture with a vessel filled with water below to prevent breakage.

Eating

Patient should be advised that eating efficiently requires training and patience and it usually requires 6–8 weeks to chew comfortably.

The following methods are adopted initially:

- Food should be cut into small pieces, placed on the back teeth and chewed slowly using both sides simultaneously.
- They should begin with soft, nonsticky food rather than fibrous food.

- Biting with front teeth is avoided till chewing with posterior teeth is mastered.

Speech

Patients can expect speech problems initially, due to the presence of palatal plate, initial feeling of bulk and excessive saliva. But the adaptability of tongue is such that patients overcome this problem quickly. They should be encouraged to read loudly and repeat words that give trouble.

Sneezing and coughing

Patients should be instructed that extreme and sudden movements like sneezing and coughing can dislodge the dentures and cause embarrassment. This can be avoided by covering the mouth with a handkerchief.

Tissue rest

- They should be advised to remove the dentures at night to provide rest to the tissues from the stresses during the day. Failure to do this can lead to soreness, irritation, increased chances for candidiasis and bruxism.

- In case of any pain, patient should not be encouraged to wear the dentures and should get back to the dentist at the earliest.

Care for dentures

- Dental plaque is a cause for denture stomatitis, candidiasis, inflammatory papillary hyperplasia, bad odour and bone loss. It must be removed.

- Patients should be instructed to rinse their mouth and dentures after every meal, if possible.

- At night, the dentures should be brushed gently using a soft denture brush (Fig. 13.13A) to remove the plaque. While brushing, the dentures should be held over a container of water (Fig. 13.13B) so that the water cushions the impact if they slip out of the hand and fall.

- Then they are soaked in any commercial denture-cleansing agent (Fig. 13.14) and allowed to remain overnight. *Hot water should never be used as it will distort the denture.*

- A simple denture cleanser can be made with the following:

  - Sodium hypochlorite (household bleach) (15 cc) – provides a bleaching and germicidal action.

  - Water softener like Calgon (4 cc) – softens and loosens food deposits.

  - Water (115 cc).

- Sonic cleaners can also be used for cleansing.

- Again in the morning, the dentures should be brushed and worn. The surface of the residual ridges should also be brushed gently or massaged with a washcloth. This will increase the circulation and help in removing plaque. It greatly reduces tissue inflammation.

- To remove calculus, dentures can be soaked overnight in white vinegar, which contains acetic acid to decalcify calculus deposits. Occasional soaking in the solution can prevent calculus formation.

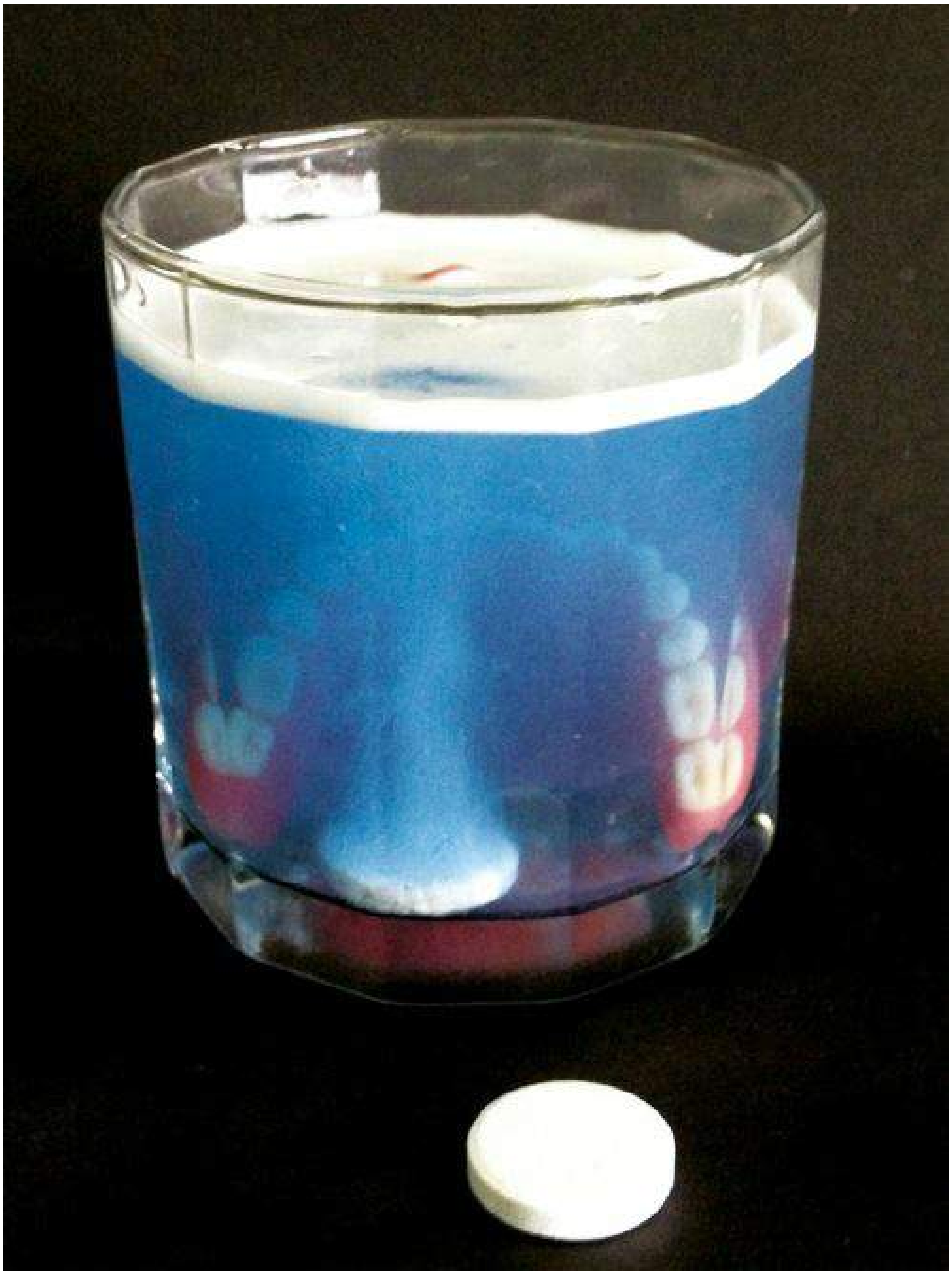


FIGURE 13.14 Dentures soaked in a commercially available denture-cleansing tablet.

Recall and maintenance

Recall appointments may be scheduled as follows:

First recall : 1–3 days

Second recall : 1 week after first visit

Third recall : 3–4 months after second visit

Maintenance : Every 1 year

This is a general recall programme, which may need to be modified depending on the postinsertion problems, after the first recall appointment.

Denture adhesives

Denture adhesives are an important adjunct in providing retention to dentures. The patient must be educated in the appropriate use of the material so that they understand their limitations.

Definition: A material used to adhere a denture to the oral mucosa (GPT8).

Mechanism of action

They enhance retention by:

- Increasing the adhesive and cohesive properties and viscosity of the saliva between the denture base and tissues.
- Eliminating voids between the denture base and tissues.

Composition

- Previously denture adhesives were based on vegetable gums like Karaya. These were highly water soluble and retained their adhesive properties only for a short time and had allergic potential.
- Currently synthetic materials are used. The main ingredient is a mixture of salts of short-acting and long-acting polyvinyl methyl ether maleate. Other ingredients are given in Table 13.1.

Table 13.1

Composition of denture adhesives

Ingredient	Function
Petrolatum, mineral oil, polyethylene oxide	Binder
Silicon dioxide, calcium stearate	Minimize slumping
Menthol, peppermint oil	Flavouring
Sodium borate and methylparaben	Preservatives
Red dye	Colouring agent

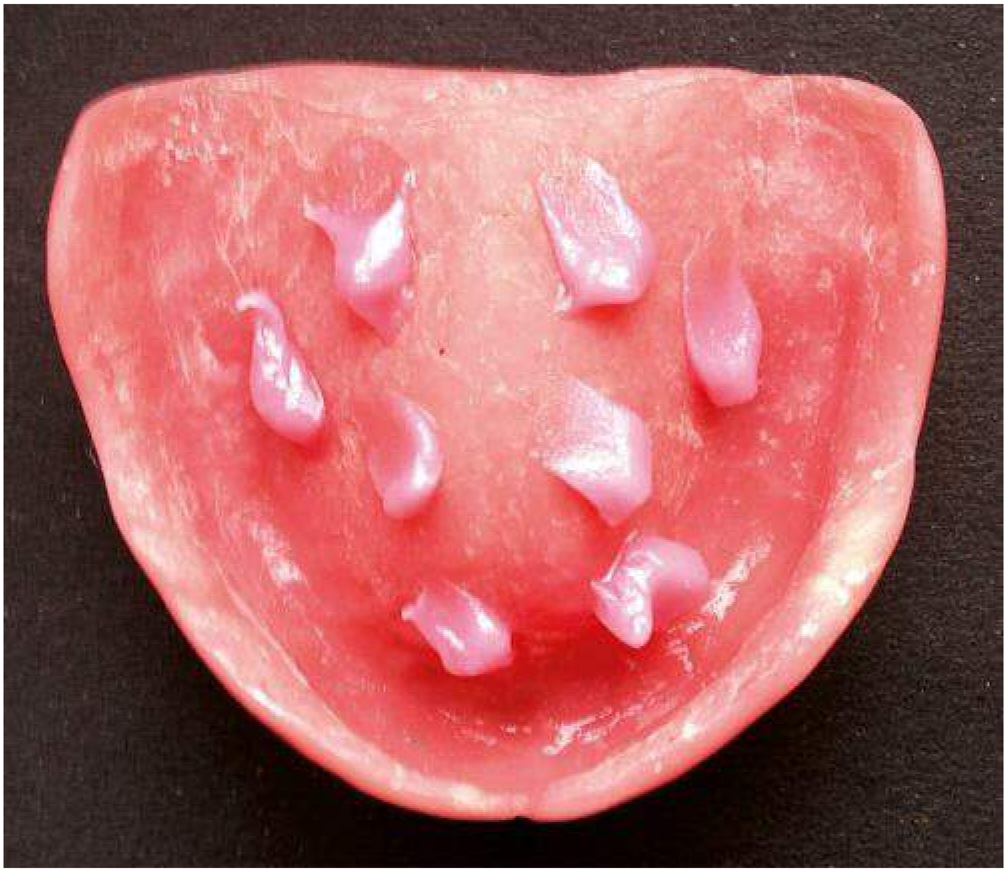


FIGURE 13.15 A commercially available denture adhesive paste applied on denture.

Indications

- Patients with conditions which compromise retention like:

○ **Xerostomia** – denture should be moistened with water after application of adhesive

○ Neurological disorders like facial paralysis

○ Orofacial dyskinesia

○ Resective oral surgery

○ Extremely resorbed ridges

- Patients with well-made complete dentures that do not satisfy their perceived expectations.
- To stabilize record bases while recording jaw relations and during try-in.
- To train an apprehensive new denture wearer.
- To provide a sense of security for high profile patients.

Contraindications

- Not indicated for improperly fabricated or poorly fitting dentures.
- Patients allergic to adhesive – some patients have reported allergic reactions to adhesives using Karaya.

Advantages

- Increased incisal bite force.
- Decreased frequency of denture dislodgement while chewing.
- Decreased movement of the denture during mastication and speech.
- Increased security and confidence while chewing.

Disadvantages

- Can increase vertical dimension and occlusal discrepancies with improper use.
- Cannot be used as a remedy for pain and discomfort.
- May be messy, grainy and difficult to remove for some patients.

Usage

- They are dispensed as soluble powders or creams/gels. (The various insoluble materials available commercially like paper cloth and pads, cushions and home repair kits are not recommended and are not considered here.)
- Powders are less retentive and effect is not as lasting as creams. But powders can be used in small quantities, easier to clean, not messy and initial retention is achieved sooner.
- For both, the least amount of material that will offer effective retention is used.
- While using powders, the dentures are cleaned, moistened and a thin, even coating of adhesive is applied on the entire tissue surface of denture. The excess is shaken off and denture is seated firmly.
- While using creams, the dentures are dried and then 1 cm beads of adhesive are dispensed in the incisor, molar and midpalatal areas. Alternately, small spots of cream are applied at 5 mm intervals throughout the denture (Fig 13.5). The denture is again seated firmly.
- Patients must be instructed to remove the adhesive daily using a brush or gauze under running water.
- Patient should be advised that denture discomfort would not be corrected by using adhesives. They should seek professional consultation in this regard.
- An increase in the quantity of adhesive used by patients, suggests that they need professional help.

SUMMARY

The denture insertion appointment is very important in delivering a functional and aesthetic denture to the patient. More important is the need for the patient to understand the limitations of denture service, and to comprehend the use and care of dentures. The dentist is solely responsible to educate the patient in this regard. Time spent by the dentist in this appointment will go a long way towards the successful use of dentures by the patient.

CHAPTER
14

Postinsertion problems

CHAPTER CONTENTS

Introduction

Recall appointments postinsertion of the complete denture is important for the purpose of eliminating problems faced by the patient in the wearing of the dentures. The dentist must *listen, examine* and *treat* the condition. The patient generally states the problems and hence it is only appropriate that they be categorized in the words of the patient. This chapter will deal with all the common complaints seen following denture insertion and their treatment.

Causes for postinsertion problems

Even though we take enough care in each and every step of complete denture fabrication, problem arises because of the inaccuracies in each step.

Border moulding in open mouth technique

In this technique, the vertical dimension and support to the muscles are not established. It will reduce the force of the muscle acting on the impression material during border moulding. So, the denture flanges tend to be overextended.

Jaw relation recording

The recording can be at fault, if (i) inaccurate record bases are used, (ii) tissue over the ridge is flabby and displaceable, (iii) use of existing dentures deforming and traumatizing the tissues, (iv) excessive or unequal pressure during registering of jaw relations or (v) the patient may not be in a position to give proper registration due to TMJ problems, age or decreased muscle tone.

Mounting

Mounting errors can be due to (i) record bases not properly seated in position, (ii) interferences in the heel of casts and (iii) occlusal rims are not properly keyed in correct orientation position.

Laboratory processing

Of all the phases, more errors occur during the processing stage, like (i) displacement of teeth during processing, (ii) incomplete closing of flask resulting in distortion, (iii) overheating during polishing causing warpage and (iv) shrinkage of the acrylic.

Postinsertion complaints (denture complaints)

Postinsertion complaints can be broadly categorized as follows:

- Looseness
- Discomfort
- Poor appearance
- Miscellaneous

Looseness

Loose dentures can elicit the following symptoms:

- Speech is affected, falls on speaking
- Falls while opening mouth, laughing
- Food entrapment under denture
- Pain

Causes for loose dentures

- Decreased retentive forces
- Increased displacing forces
- Support problems

Decreased retentive forces

Causes

- Lack of seal
- Air beneath impression surface
- Xerostomia
- Poor neuromuscular control

Lack of seal

Causes

- Underextended borders (depth or width)
  - Due to improper border moulding, the accurate depth of sulcus is not recorded (Fig. 14.1).
  - Border underextension in width is due to improper tooth arrangement and usually affects the distobuccal of maxilla and lower buccal shelf areas (Fig. 14.2A and B).
- Incorrect posterior palatal seal
  - Underextension – loose denture.
  - Overextension – denture becomes loose while talking.
  - Insufficient depth – denture becomes loose while eating. This can be checked by wetting the denture and inserting. Shows egress of air bubbles posteriorly.
- Inelasticity of cheeks – may be due to ageing, scleroderma or submucous fibrosis, which can lead to lack of seal if the borders were moulded using passive methods.

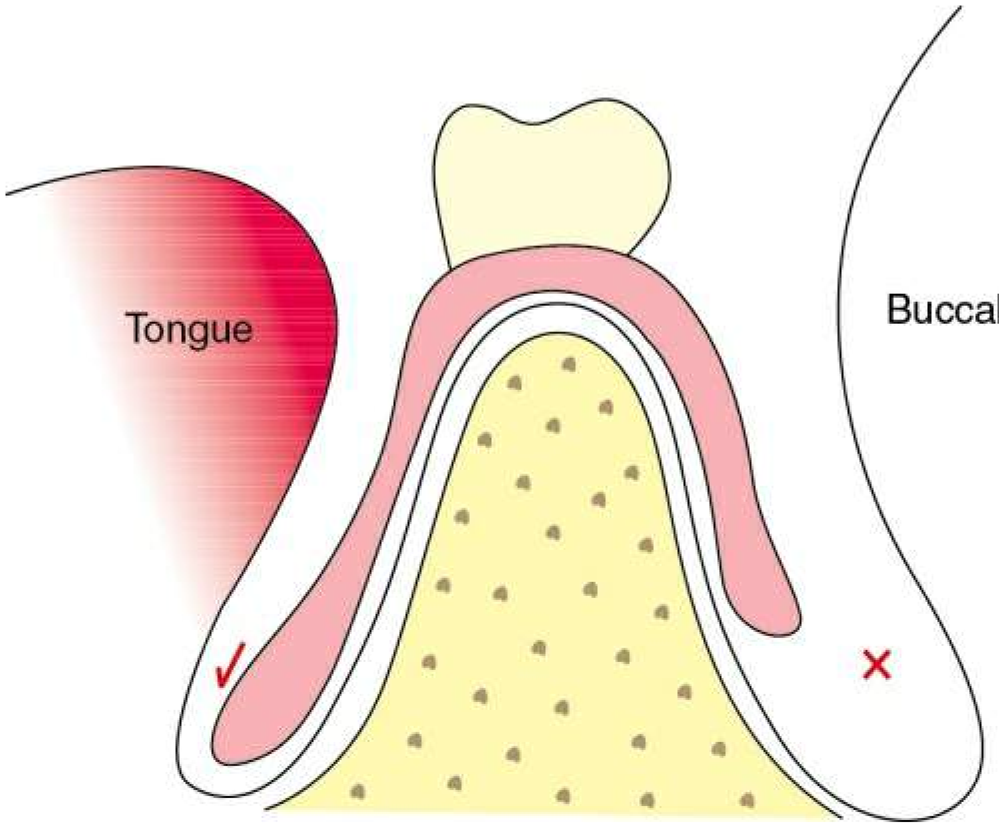
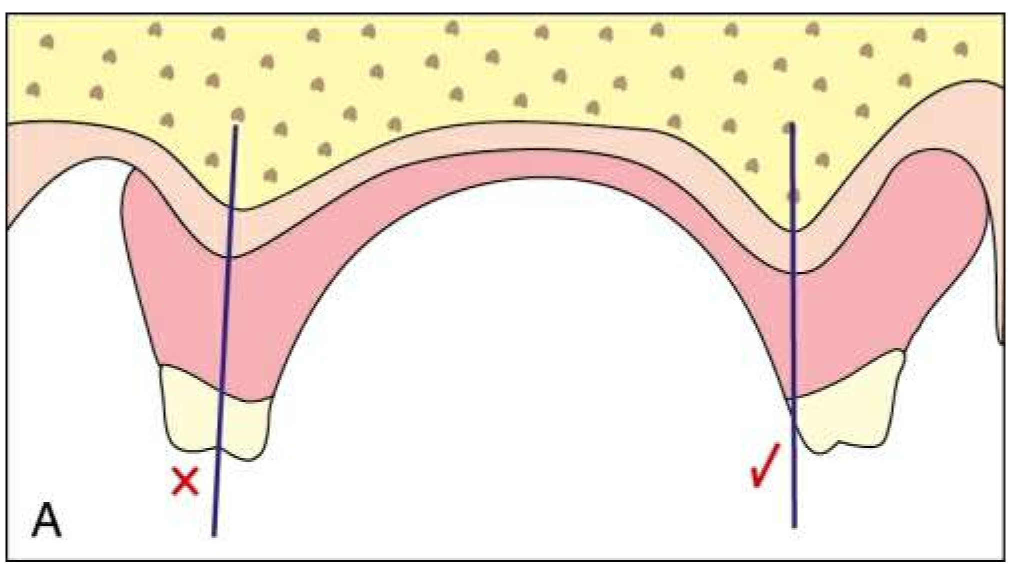


FIGURE 14.1 Underextended borders.



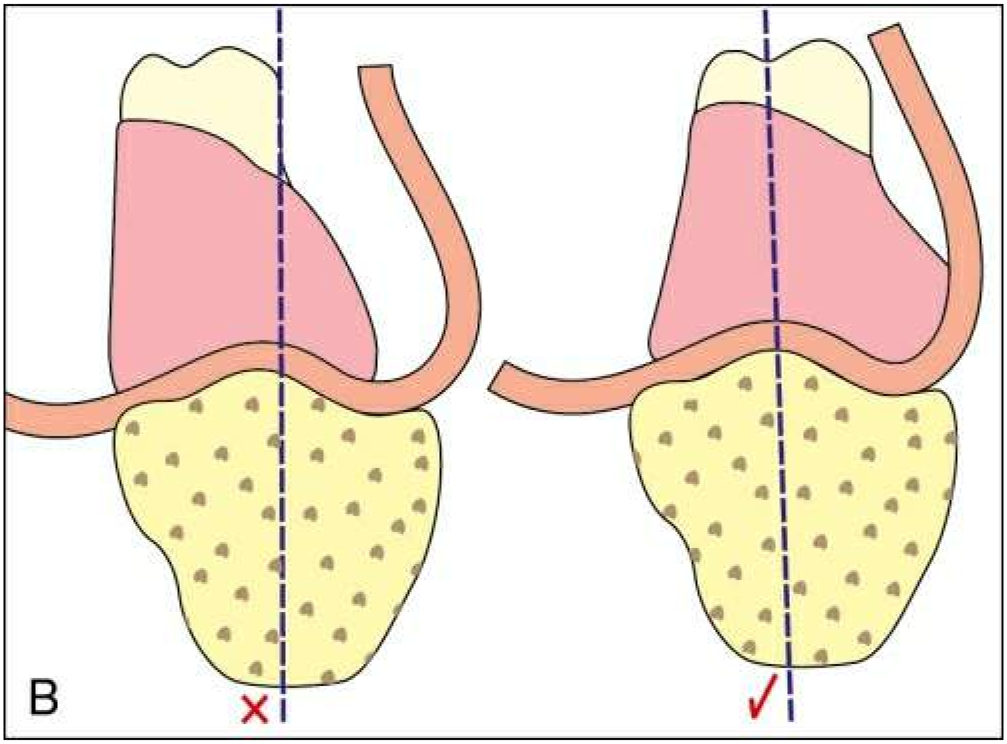


FIGURE 14.2 **(A)** Upper distobuccal area – left shows improper teeth setting (maxillary posteriors placed on crest of ridge) and subsequent underextension in width of upper distobuccal flange. Right shows correct arrangement (slightly buccal to ridge crest). **(B)** Lower buccal shelf area – left shows improper teeth setting (lingual to crest) and subsequent underextension in width of lower buccal shelf area. Right shows correct arrangement (crest of ridge).

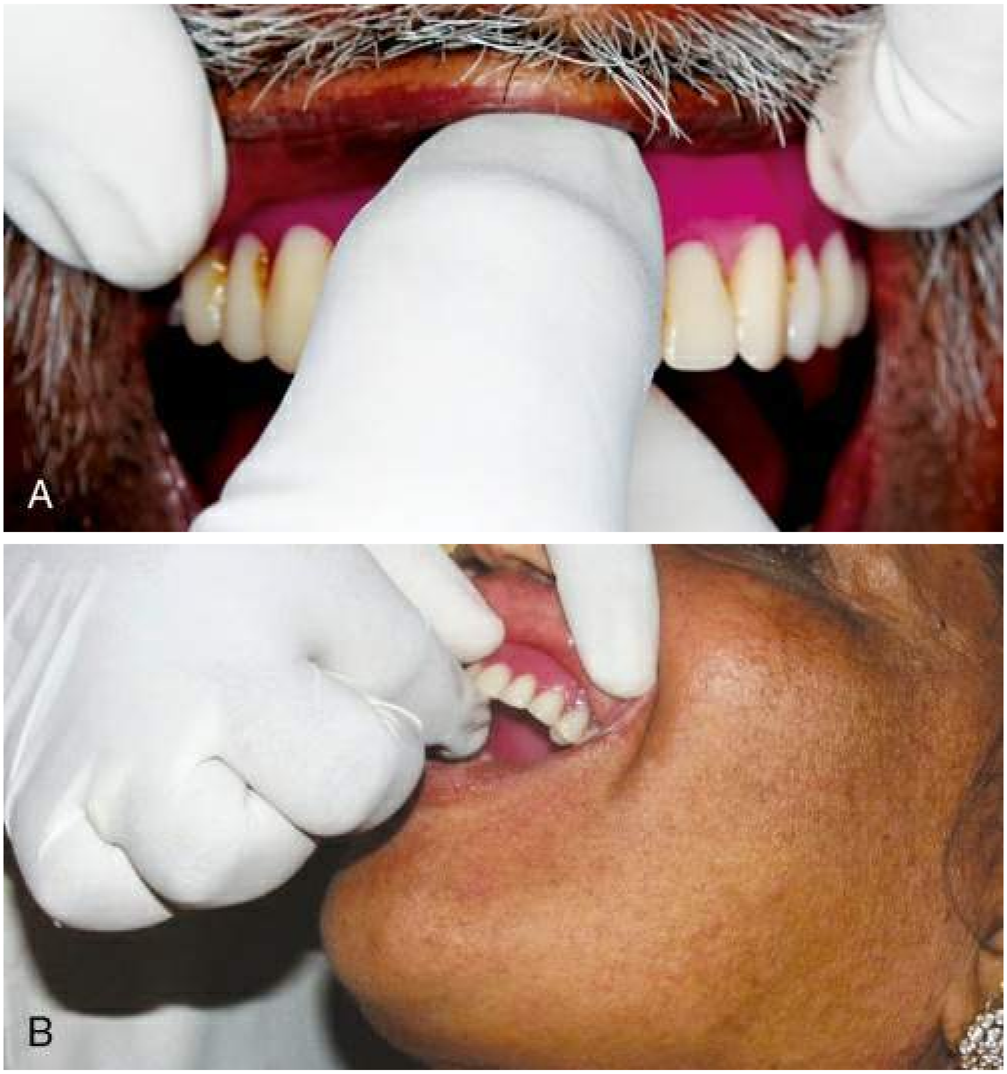
Treatment

Lack of seal can be checked as follows (Fig. 14.3A–D):

- For underextended borders – soft tracing compound is added to relevant border and processed with new resin material (Fig. 14.4).

- For incorrect posterior palatal seal – check the border for its correct placement at junction with mobile tissue of soft palate. Border moulding should be done in PPS and are processed with new material.

- For inelasticity of cheeks – border moulding should be done in increments as the functional movements are performed.



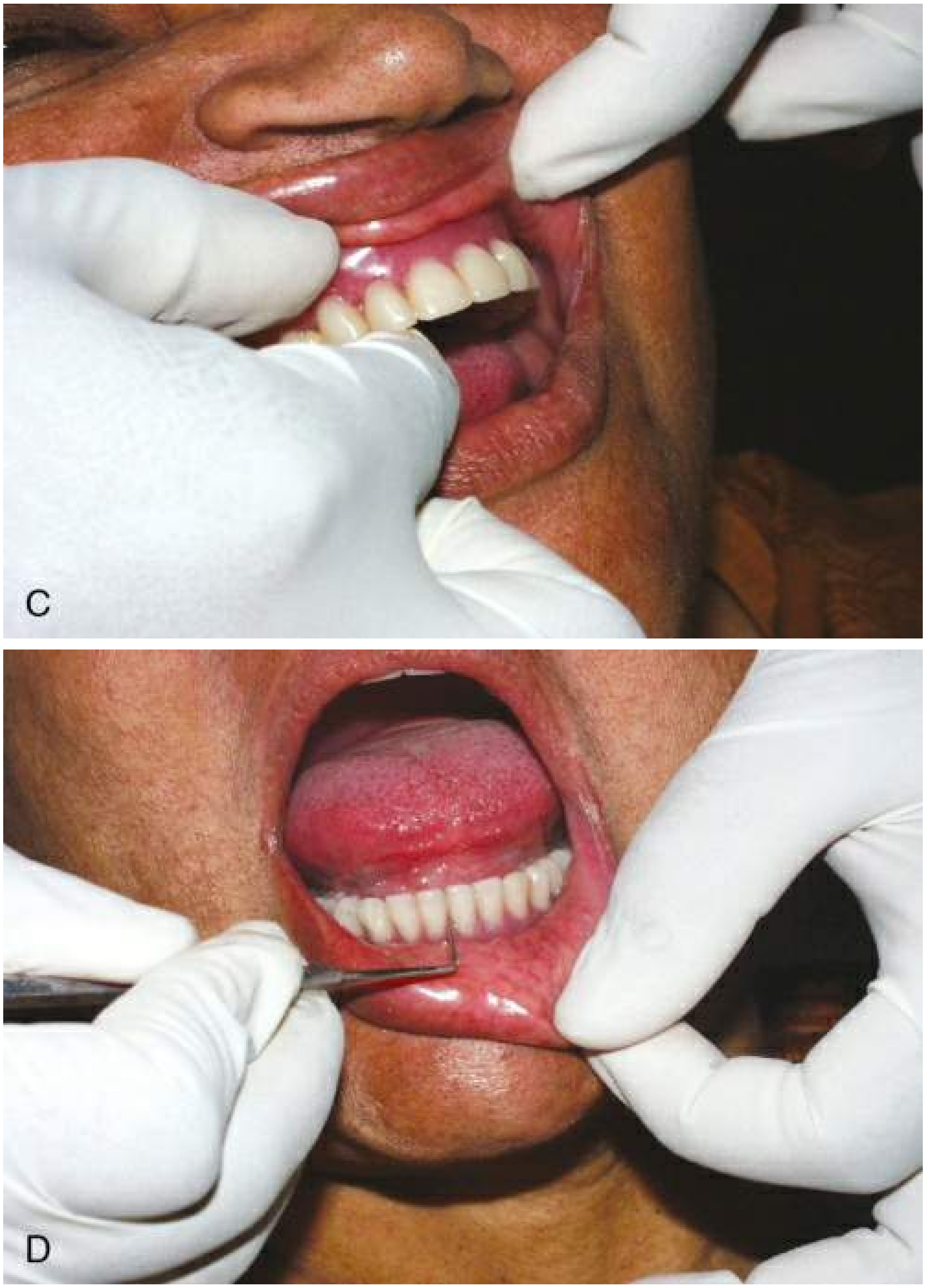


FIGURE 14.3 **(A)** Checking seal in the maxillary labial area. **(B)** Checking seal in the posterior palatal area. **(C)** Checking seal in the maxillary canine region. **(D)** Checking seal of the lower denture.

FIGURE 14.4 Adding material to an underextended border in depth.

Air beneath impression surface

Causes

- Poor fit.

○ Deficient impression

○ Damaged cast

○ Warped denture

○ Overadjustment of impression surface (Fig. 14.5)

- Undercut ridge – dentures are overtrimmed for insertion. Hence, impression surface is not closely adapted (Fig. 14.6).

- Excessive relief

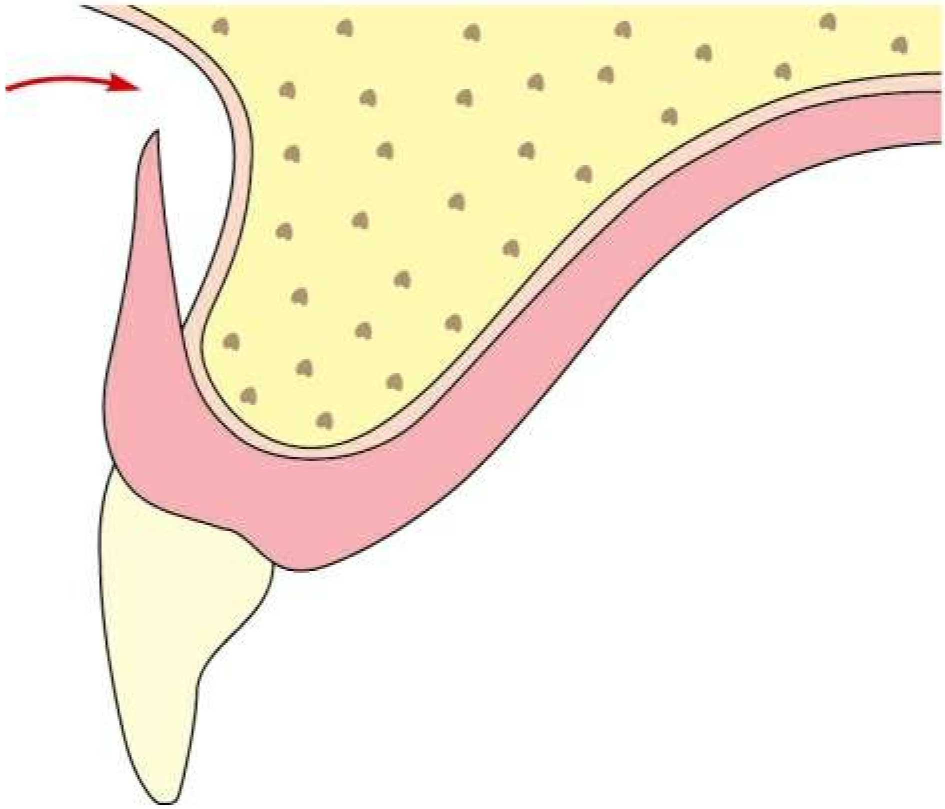


FIGURE 14.5 A gap seen between the mucosa and impression surface due to overtrimming.

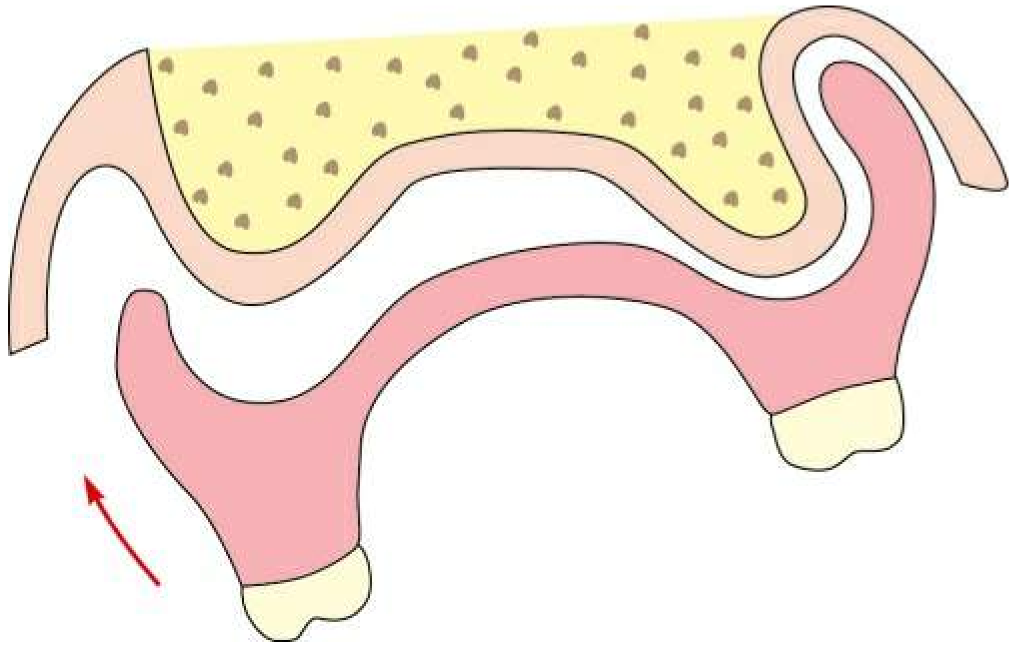


FIGURE 14.6 Undercut present on left side (unilateral). A rotational path is used to inert denture avoiding trimming the denture to relieve the undercut.

Trapped air expands as denture moves away from supporting tissues until it reaches the borders and eventually the seal is broken leading to loss of retention.

Treatment

- For poor fit – the area should be identified using pressure indicating paste (PIP) and relined if possible. Denture may need to be remade if there is too much correction involved.
- With undercut ridges – a rotational path of insertion will prevent this problem if undercut is present unilaterally (Fig. 14.6); otherwise, soft liners may be used.
- Providing excessive relief in the relief areas can also cause loss of retention. The area may need to be relined.

Xerostomia

Causes

- Diabetes
- Drugs (e.g. atropine, phenothiazine, ephedrine, chlorpromazine)
- Menopause
- Irradiation
- Vitamin deficiency (vitamins A, B_{12}, B_2 and folic acid)
- Sialolithiasis

Treatment

Treatment depends on the presence or absence of glandular function.

No glandular function

- Artificial saliva substitutes, soups, intermittent sips of water and coating of the tissue surface of the denture with tissue conditioners may also help.

Some glandular function

- Pilocarpine hydrochloride, sucking on sour candy.

Poor neuromuscular control

Causes

- Incorrect denture shape.
- Tongue unable to control denture.
- Change in shape relative to old dentures.

- Upper/lower motor neuron disorder.

Treatment

- The polished surface should occupy the neutral zone between the cheeks and tongue (Fig. 14.7). Thus active muscular forces double the retention provided by physical forces. The contour of the polished surface is described in Chapter 12. This should be verified and corrected appropriately.

- The position of the tongue is important to control the denture as described in Chapter 13. This should be verified and if necessary, patient should be trained to position the tongue.

- In rare instances, patients may be unable to adapt to the shape of new dentures, as they are accustomed to the old one for a long time. This generally happens due to advanced age. Duplication of old dentures may be necessary, provided occlusion and vertical dimension do not need to be changed.

- Patients suffering from upper or lower motor neuron disorders may also face problems in neuromuscular control. Denture adhesives can be used to augment retention.

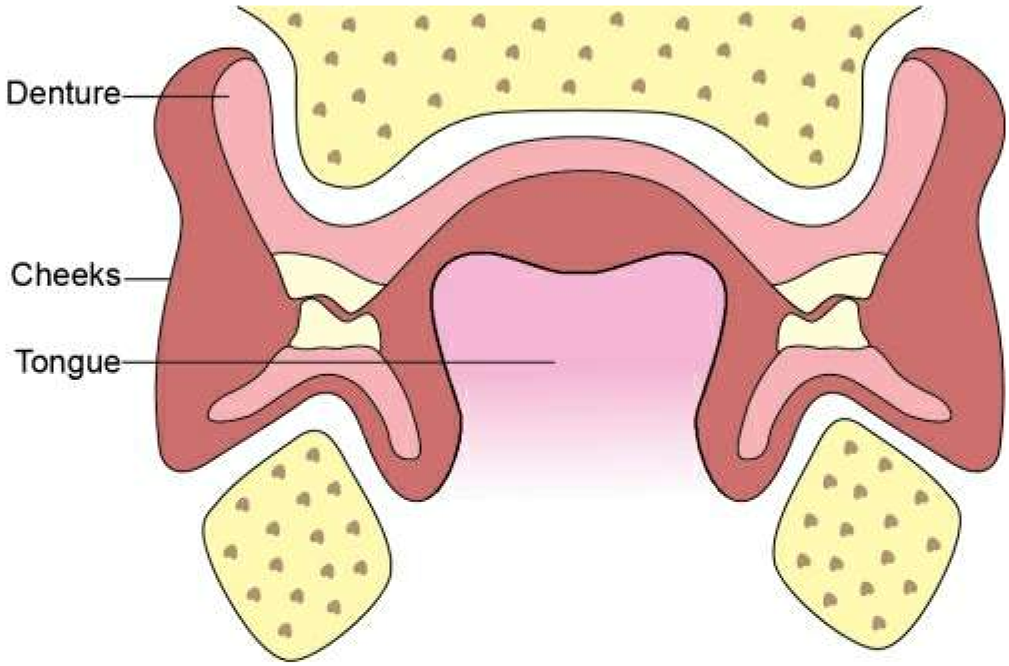


FIGURE 14.7 Denture should occupy the neutral zone.

Increased displacing force

Causes

• Overextended borders (Fig. 14.8).

• Poor fit.

• Denture not in optimal position.

• Occlusal problems.

○ Anterior and posterior prematurities (Fig. 14.9).

○ Maximum intercuspal position (MIP) not coinciding with CR in the following situations:

▪ Patients unable to control mandibular movement

- ▪ Poor ridge
- ▪ Skeletal class II
- ▪ Nonanatomic teeth

- ○ Last tooth placed too far posteriorly – last tooth can be removed.
- ○ Lack of occlusal balance.
- ○ Incorrect plane of occlusion – dentures move while eating. Commonly associated with large tuberosities (Fig. 14.10).

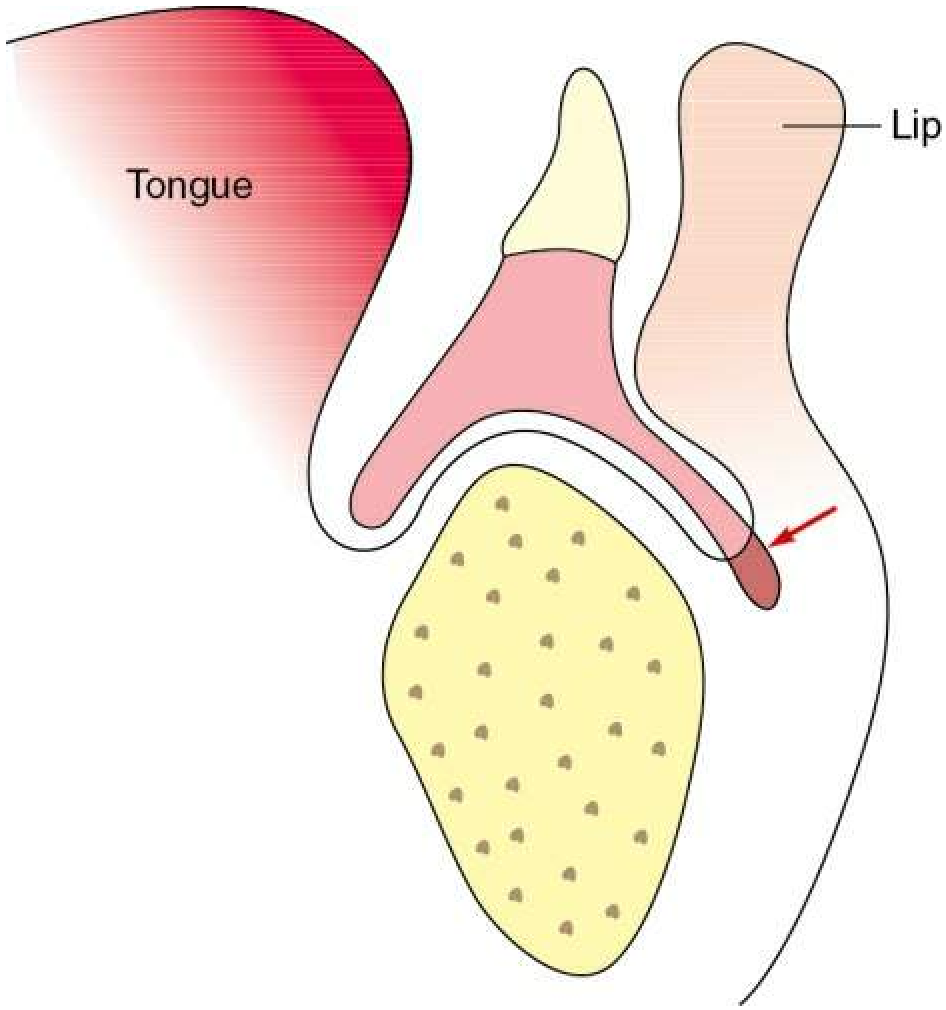


FIGURE 14.8 Overextension of the labial flange, encroaching on the lip and displacing the denture.

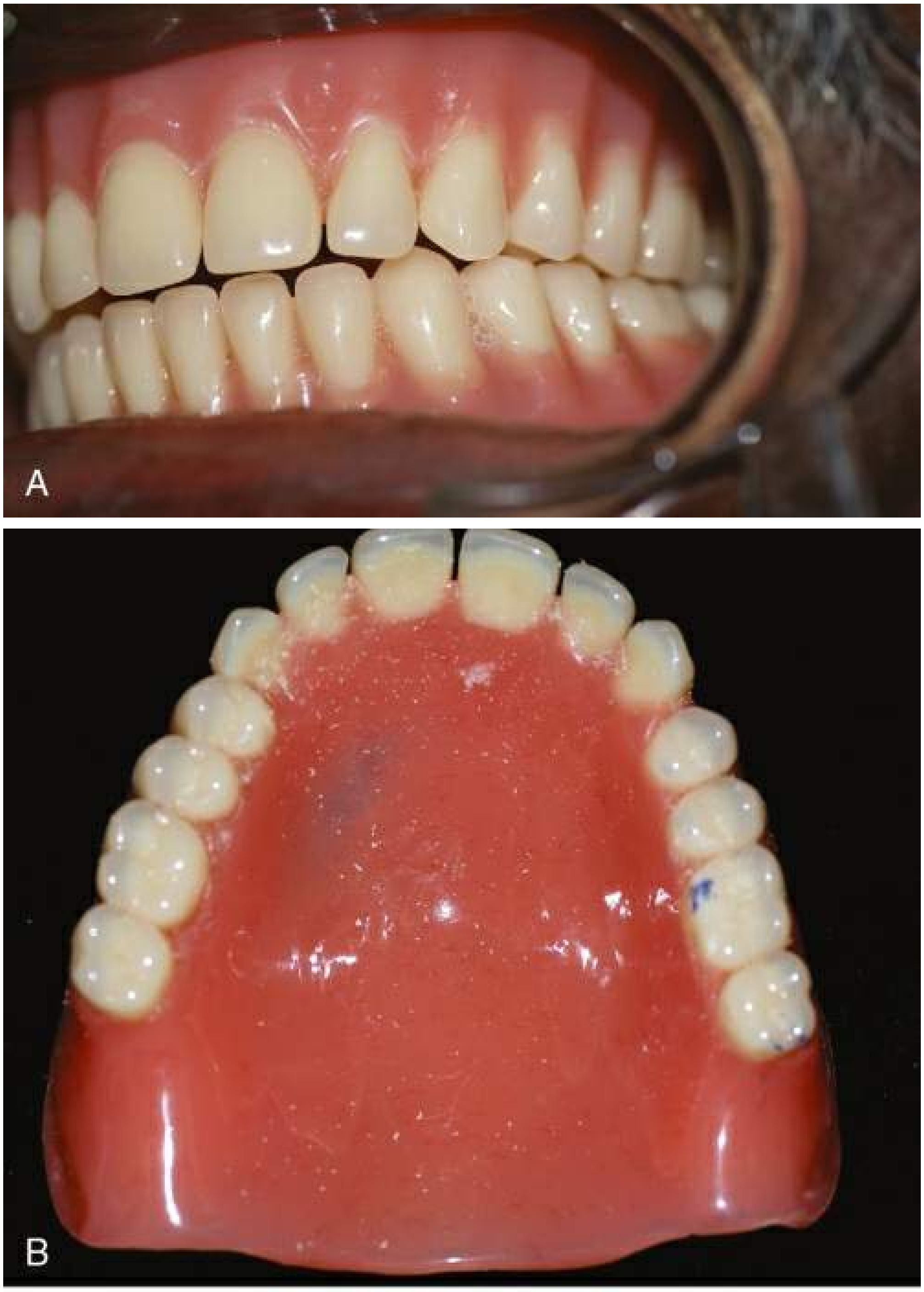


FIGURE 14.9 Occlusal premature contacts. **(A)** Improper occlusion causing increased displacing force. **(B)** Prematurity detected. **(C)** After correction. Note approximation of molars and canines.

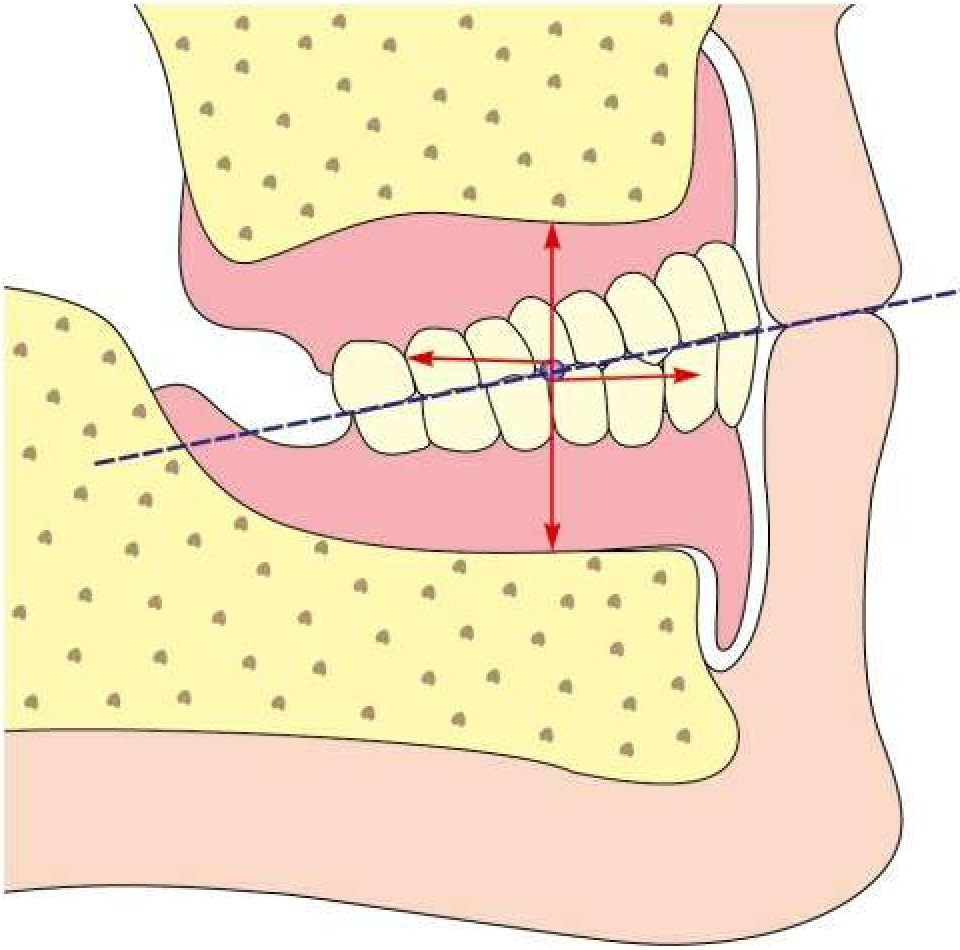


FIGURE 14.10 Incorrect occlusal plane causes instability.

Treatment

- As discussed in Chapter 11, PIP is applied to the borders and appropriate correction is made (Fig. 14.11).
- Poor fit and position of dentures were discussed under decreased retentive forces.
- Intraoral correction or correction using clinical remount procedures are recommended to correct occlusal problems as described in Chapter 13.
- Incorrect occlusal plane due to larger tuberosities may be corrected

by removing the second molars.

FIGURE 14.11 PIP showing the overextension borders in mandibular denture.

Support problems

Lack of support can also cause displacement of dentures.

Causes

- Fibrous displaceable ridge
- Lack of ridge

- Bony prominence

Treatment

Areas of bony prominence can be relieved. Denture adhesives can be recommended with poor ridge situations.

Discomfort

Discomfort while using complete dentures can elicit the following symptoms:

• Pain

• Altered sensation

• Difficulty in swallowing

• Difficulty in chewing

Causes for discomfort can be classified as:

• Related to impression surface

• Related to polished surface

• Related to occlusal surface

Related to impression surface

Causes

• Sharp acrylic nodule on fitting surface.

• Undercut areas and attachments not relieved.

• Overextension.

• Deep postdam – sore throat, difficulty in swallowing.

• Lower knife-edged ridge.

Treatment

These can be corrected by using PIP (pressure indicating paste) to identify the area causing the problem and trimming the same. In case of a lower knife-edged ridge, a permanent soft liner may be considered to cushion the impact (see Chapter 15).

Related to polished surface

Cause

Thick distobuccal flange of upper denture – coronoid process interferes while opening, yawning and moving mandible from side to side.

Treatment

PIP is applied to this area and the patient is asked to make the concerned movements. The area is trimmed (Fig. 14.12A and B).

FIGURE 14.12 **(A)** Thick distobuccal flange. **(B)** Area identified with PIP by actively border moulding the area.

Related to occlusal surface

Causes

- Pain on eating is usually due to premature contacts present anteriorly and posteriorly, and sometimes due to lack of balanced occlusion.
- Pain/ulceration lingual to lower anterior ridge is due to CR and MIP not coinciding, resulting in a slide from CR to MIP.
- Pain/ulceration on labial aspect of lower ridge and incisive papilla is due to insufficient incisal overjet.
- Excessive vertical dimension.

- Cheek/lip biting is due to insufficient overjet in anteriors and posteriors respectively or decreased VD.
- Tongue biting is due to teeth placed lingual to lower ridge.

Treatment

- Pain on eating is corrected using articulating paper or occlusal wax to identify the offending area (see Chapter 13).
- Pain/ulceration lingual to lower anterior ridge: CR to MIP should be made to coincide with the help of selective grinding.
- Pain/ulceration on labial aspect of lower ridge and incisive papilla: If not due to undercut or sharp acrylic, the labial aspect of lower anteriors are trimmed.
- The problems of excessive VD have been discussed in Chapter 6. If the VD is increased by greater than 2 mm, it is better to remake the dentures.
- Cheek or lip biting: posteriorly the buccal cusps are rounded or reset and anteriorly the lower incisors are corrected to give better incisal guidance.
- Tongue biting: Remove lower lingual cusps, or reset teeth, rearrange the teeth.

In the presence of pain and ulceration, the best method to heal the ulcer following correction of the cause, is to advise the patient against wearing the denture for one day.

Poor appearance

Problems with appearance will usually be related to:

- Insufficient or too much tooth visibility
- Creases at corner of mouth

Insufficient or excessive tooth visibility

Causes

- Improper orientation of occlusal plane.
- Improper vertical dimension.
- Improper labiolingual and labiopalatal positioning of anterior teeth.

Treatment

It is very difficult to correct the appearance without remaking the dentures. Minor corrections in vertical dimension can be made but the scope for extensive changes is not available. This reiterates the need to verify and take patient consent for aesthetics at the time of try-in.

Creases at corner of mouth

Causes

- Decreased labial fullness.
- Decreased vertical dimension.

Treatment

These causes are again difficult to correct and should have been checked during try-in; may be necessary to remake the dentures.

Miscellaneous

Speech problems

It will take some time, usually a few days for the patient to get accustomed to speaking with new dentures. This should be kept in mind before starting any correction.

Problems with sibilants ‘s’

- If there is tooth contact when patient pronounces ‘s’ it can be due to:
  - Increased vertical dimension
  - Excessive overbite
- Difficulty in pronouncing ‘s’ can be due to excessive overjet (Fig. 14.13).

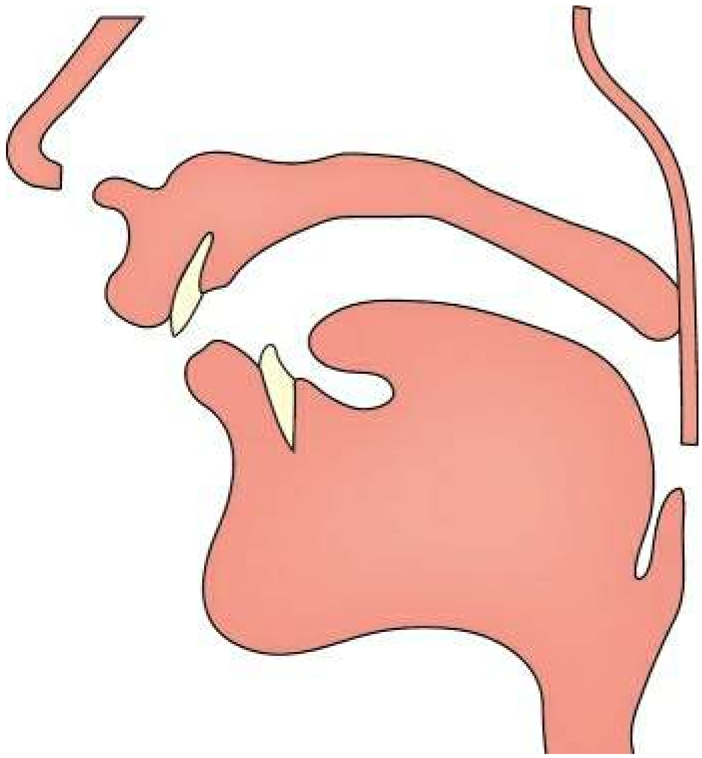


FIGURE 14.13 Increased overjet causes difficulty in pronouncing ‘s’.

Problems with bilabial sounds ‘p’ and ‘b’

- Incorrect vertical dimension and incisor position (Fig. 14.14).

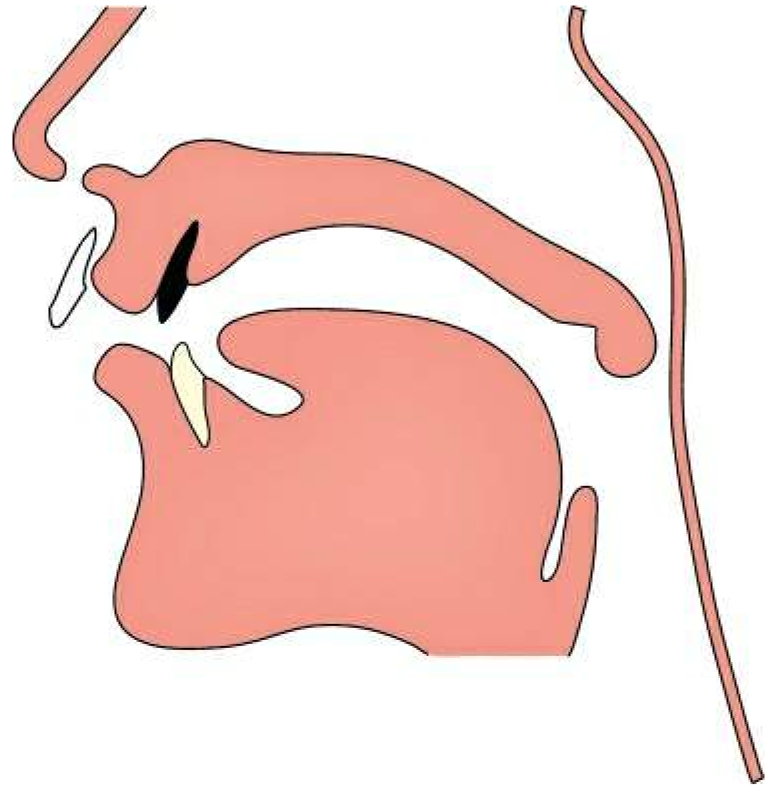


FIGURE 14.14 Incorrect VD causes difficulty in pronouncing bilabial and labiodental sounds.

Problems with labiodental ‘f’ and ‘V’

- Incorrect vertical dimension and incisor position (upper anteriors placed too far back [Fig. 14.14]).

It is very difficult to correct these problems, most of the time dentures have to be remade if problem persists.

Difficulty in eating

Causes

- Instability.
- Posterior teeth trimmed too much.

- Increased and decreased vertical dimension.

Treatment

The cause is identified and corrected if possible.

Clattering of teeth while eating and speaking

Causes

- Increased vertical dimension.
- Increased incisor overlap.
- Loose dentures.
- Cuspal interference and lack of balance.
- Use of porcelain teeth.

Treatment

The cause is identified and corrected if possible.

Altered taste

- The denture actually does not cover many taste buds; hence, there is no physiological basis for this problem.
- It may be due to the nature of the acrylic itself which has to be made thick and has reduced thermal conductivity.
- Denture can be remade with a metal base to enhance the conductivity.

Nausea and gagging

Causes

- Loose dentures.
- Poor occlusion.
- Thick distal termination of upper denture.
- Palatal placement of upper posteriors.
- Low occlusal plane.
- Overextended retromylohyoid area.
- Underextended denture borders.
- Psychogenic – refusing to swallow for fear of aspirating dentures. Saliva accumulates and triggers gag reflex.

Treatment

- Correction of cause.
- Prescribing a combination of atropine and a mild sedative during initial period of denture use.
- Referring patient to a psychiatrist if condition persists, all other factors being normal.

SUMMARY

It is very important to identify and correct postinsertion problems in complete dentures as it will boost the confidence of the patient once the problem is solved. The first time, denture wearer is already apprehensive regarding the function of the prosthesis and it is important to allay his/her fears and restore confidence. The patient should not be made to wait with the problem and recall. Appointments should be scheduled at close intervals till the problems are corrected.

CHAPTER

15

Refitting and repair

CHAPTER CONTENTS

Refitting

Introduction

Refitting the tissue surface of the denture may involve several reasons and procedures. All these are aimed at prolonging the life of the denture without making new ones. The following materials and procedure are commonly used in complete denture fabrication for varying reasons to resurface the tissue surface of the denture. These are

- Tissue conditioners
- Resilient liners
- Relining and rebasing

Tissue conditioners

The most effective method of treating abused tissues under complete dentures is to discontinue use of dentures for a period of time. But for social reasons it may not be possible for a number of patients to do this. Tissue conditioning materials basically accomplish this purpose of rehabilitating abused and compromised tissues without continuous removal of patient's dentures.

Rationale

- Tissue conditioners are soft, resilient materials, which flow under pressure.
- They form an intervening cushion between the denture base and basal seat tissues.
- Thereby transmission of masticatory forces to the mucosa is

equalized eliminating isolated pressure spots.

- Only as long as material remains soft, it will have a rehabilitating effect. Hence, prolonged use may cause trauma.
- Their use is limited to reversible tissue changes like tissue abrasion, ulceration, displacement and swelling.
- They do not have any direct effect on irreversible changes like tissue hyperplasia and hypertrophy.
- Occlusal disharmonies and improperly extended borders should be corrected before initiating tissue conditioning.

Composition

- Powder: poly(ethylmethacrylate)
- Liquid: mixture of aromatic ester and ethyl alcohol

The powder dissolves in the liquid to form a gel. The gelation is essentially a physical process, without polymerization.

Uses

Their main use is to treat chronic soreness due to dentures.

Adjunct uses

1. Conditioning the tissues during fabrication of new complete dentures

Tissue conditioners can be used with the old dentures to relieve and equalize pressure, and allow tissues to recover.

They can also be used in old dentures while making new denture for patients with the following conditions:

- Bruxism

- Papillary hyperplasia
- Depressed areas associated with suction cups and discs
- General debilitating disease and avitaminosis

2. Temporary obturator

Tissue conditioners may be used as a temporary obturator by adding them to an obturator following surgery. Temporary obturation is usually required for 7–10 days after surgery and it is important that the obturator produce minimal pressure and no irritation during this period. The use of these materials protects the tissues and enhances healing.

3. Stabilize surgical splints or stents

Tissue conditioners may be used to line surgical stents or splints after maxillary or mandibular vestibuloplasties or resections. They provide close adaptation to the healing tissues and prevent trauma to the tissues.

4. Stabilization of record bases

They can be added to undercut areas of record bases to prevent breakage of cast and to enhance the stability, retention and comfort of recording bases during registration of jaw relations. This will minimize errors during this procedure.

5. As an impression material

As described in Chapter 4 Page 77, they can be used to make closed-mouth functional impressions for atrophic ridges.

6. To help determine the potential benefits of a permanent resilient liner

At times, patients with well-fitting dentures cannot wear them comfortably due to chronic soreness. By using a tissue conditioner temporarily, it can be determined if the patient will benefit from the use of a permanent resilient liner or not.

Procedure

The procedure is described for the main use of tissue conditioner – conditioning traumatized denture-bearing tissues.

Preparation of denture

The following should be ensured in the denture prior to conditioning:

- Adequate extension
- No occlusal discrepancy
- Correct horizontal and vertical relations

All undercuts are removed from the tissue surface and this surface is reduced to a depth of 1 mm. The borders should not be trimmed and are retained as vertical stops. Basically space is provided for the conditioning material in the denture to allow recovery of the traumatized tissues.

Manipulation and placement

- If both maxillary and mandibular arches need to be conditioned, each should be treated separately. The arch with the most stable denture is used as a guide and the other is treated first.
- The armamentarium required for the procedure is shown in Fig. 15.1A. A lubricant may be applied on denture areas where the conditioning material is not supposed to contact, to ease removal of the material later (Fig. 15.1B).
- The powder and liquid are mixed in a glass jar according to the manufacturer's instructions.
- While the material is creamy and fluid, it is poured into the denture, covering the entire denture base area (Fig. 15.2).
- When material stops flowing and reaches a dough stage, it is

inserted in the patient's mouth and the patient is instructed to close in centric, maintaining vertical dimension. This position is maintained for 5–7 min, following which active and/or passive border moulding is performed.

- The denture is removed and excess trimmed (Fig. 15.3).
- Small amount of material can be added if required and procedure is repeated till the entire surface is covered.
- The patient is asked to use the denture with the conditioning material.

FIGURE 15.1 **(A)** Armamentarium. (1) Mixing spatula. (2) Dropper for monomer. (3) Mixing jar. (4) Powder measure. (5) Polymer. (6) Monomer. (7) Lubricant. **(B)** Application of lubricant on polished and occlusal surface.

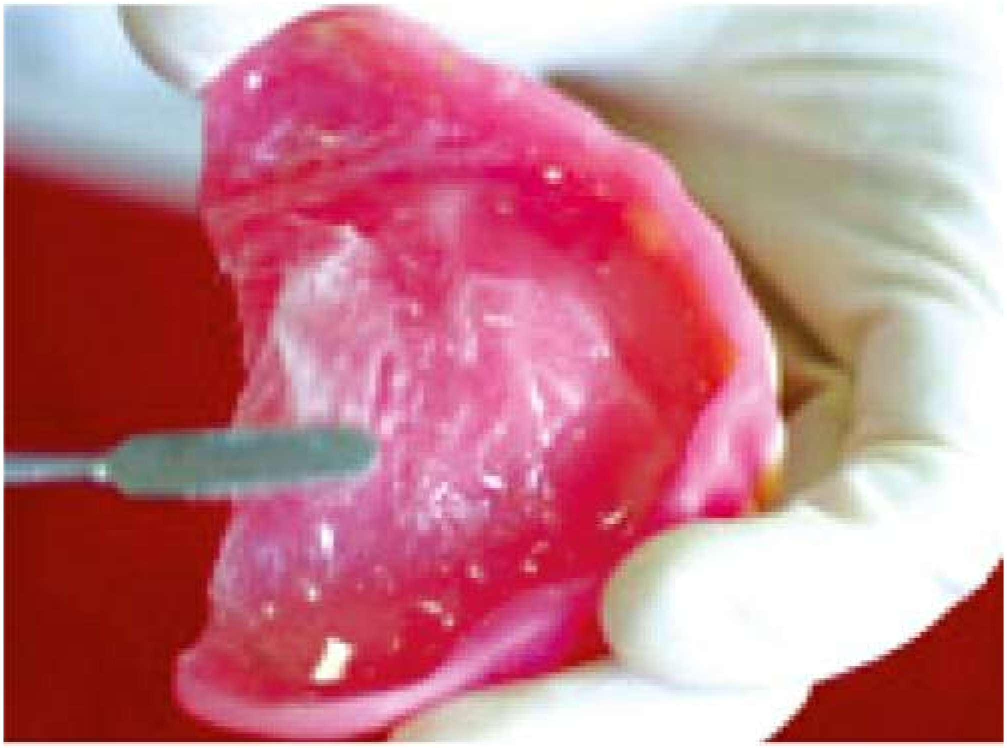


FIGURE 15.2 Entire impression surface of denture is covered with the mixed conditioning material.

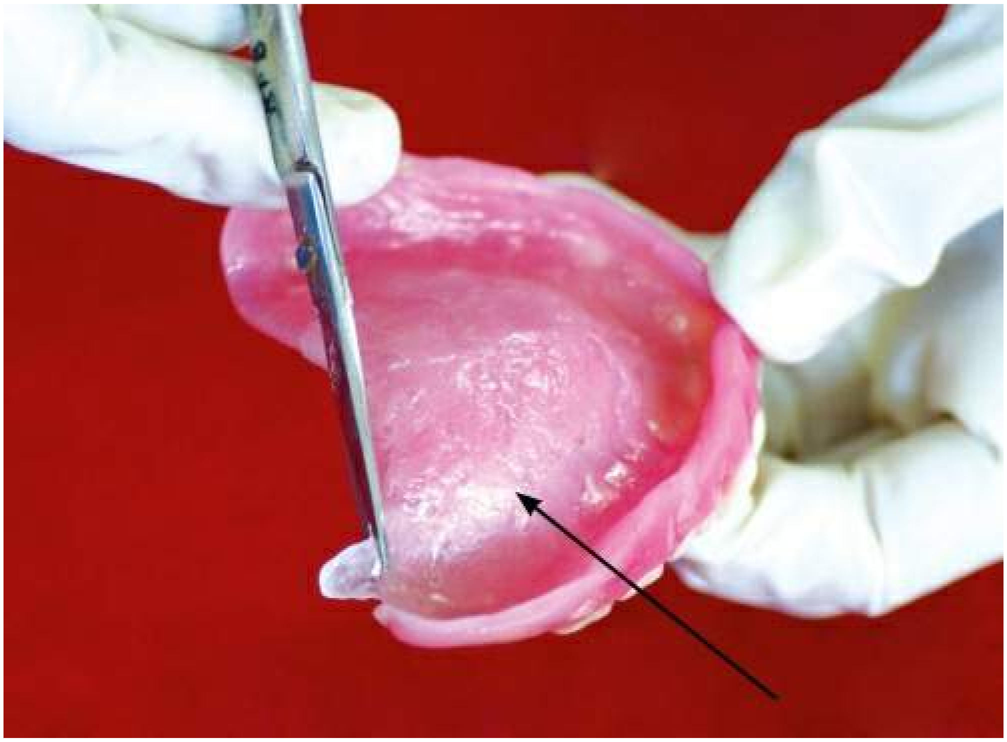


FIGURE 15.3 Tissue conditioner covers the impression surface uniformly and the excess is trimmed.

Recall and maintenance

- Patient should be instructed to avoid hard food for the first 8 h and is instructed to come the next day for inspection and correction of any pressure areas.
- The procedure has to be repeated every 3–4 days till the tissues have fully recovered.
- A soft brush is used to clean the material under cold running water. It should not be scrubbed with a hard brush and should not be soaked in denture cleanser.

Commercial examples

- COE comfort

- GC Soft liner
- Viscogel

Resilient liners

Definition

They are elastomeric polymers used in the prevention of chronic soreness from dentures and preservation of supporting structures (Winkler).

- These are also called soft liners or permanent liners.
- They are heat processed to the hard denture bases.
- Duration of use ranges from 6 months to 5 years depending on need and material.
- Their usage is to prevent denture soreness while tissue conditioners are used to treat denture soreness.

Requirements

- Biologically inert.
- Resilient and capable of maintaining this characteristic – the average period of satisfactory service for a denture is 7 years.
- Dimensionally stable and insoluble in oral fluids to maintain proper tissue contact.
- Colour stable.
- Resist abrasion and thereby allow the practice of proper hygiene of the surface.

• Maintain their bond to the denture base without damaging it.

• Relatively easily to work.

Composition

Two categories of materials are used as resilient soft liners:

• Acrylics (plasticized acrylics)

• Silicones (siloxane polymers)

The acrylics are generally referred to as temporary reline materials and are used as ‘tissue conditioners’. They have been discussed earlier.

The silicones are referred to as ‘permanent soft liners’ and are added to the denture base during processing. They are more durable and suitable for long-term use. Commercial example is Molloplast B.

Uses or indications of permanent soft liner

Permanent soft liners provide comfort by reducing the impact of forces during function and are used to prevent chronic soreness from the dentures and preserve the supporting structures. They have been used in the following situations:

1. Ridge atrophy or resorption

2. Bruxism

3. Undercut areas

4. Restoration of congenital or acquired oral defects

5. Xerostomia

6. Edentulous arch opposing natural teeth

It is important to understand that these materials should not be used to compensate for inadequacies in complete denture fabrication.

Limitations

- Not easy to clean and maintain.
- Difficult to trim and adjust.
- Lack bonding to the denture base.
- Ineffective in thin sections, thickness should be at least 1.5–2 mm, hence cannot be used in maxillary dentures.

In *conclusion*, soft liners have good application as 'tissue conditioners' on a temporary basis. To use them as a definitive denture base for prolonged period of time has not been successful as patients continue to experience discomfort and the properties of the current materials are far from ideal for use in these situations.

Relining and rebasing

Resorption of the residual ridge is inevitable and progressive. Additionally, the denture base changes over time due to distension and abrasion of the acrylic resin. The net result is a denture that becomes unstable and eventually loosens to the point where the denture wearer feels uncomfortable and inconvenienced.

These changes cannot be entirely avoided, and the need for servicing complete dentures to keep pace with the changing foundations becomes mandatory which involves a refitting of the impression surface of the denture by means of a reline or rebase procedure.

Definitions

Reline: The procedures used to resurface the tissue side of a removable dental prosthesis with new base material, thus producing

an accurate adaptation to the denture foundation area (GPT8).
Rebase: The laboratory process of replacing the entire denture base material on an existing prosthesis (GPT8).

Hence relining is performed for minimal or moderate tissue changes and a thin layer of acrylic is added to existing denture base following impression procedures.

Rebasing is performed for more extensive tissue changes and the entire denture base is changed following impression procedures. The clinical and laboratory procedures involved in both relining and rebasing is similar and they will be considered together.

Indications

Indications for relining or rebasing in general:

- Adaptation of the denture bases to the ridges is poor due to resorption of the residual alveolar ridges.
- Patients with complaint of looseness or instability of dentures following a long-standing history of comfort and satisfaction with the dentures.
- Three to 6 months after construction of immediate dentures.
- For geriatric or chronically ill patients when the construction of new dentures can cause physical or mental stress.
- When the patient cannot afford the cost of new denture.
- Porous and discoloured denture base (rebasing is indicated).
- With porcelain artificial teeth rebasing is indicated.

Contraindications

- Excessive ridge resorption – make new dentures.

- Presence of abused soft tissues – relining/rebasing is not indicated until the tissues recover and return as closely as possible to normal form.

- Temporomandibular joint problems – until accurate diagnosis and treatment of the problem has been accomplished, relining or rebasing is contraindicated.

- Dentures with poor aesthetics or unsatisfactory jaw relationships.

- Dentures with major speech problem.

- Presence of severe osseous undercuts.

Preparatory phase

Tissue preparation

- Oral mucosa should be free of any irritation.

- The dentures should be left out of the mouth at least 2 or 3 days before making the final impression.

- Any excessive hypertrophic tissue should be surgically removed.

- Removal of dentures at night and massaging of soft tissues, though recommended (see Chapter 13), should be reiterated.

Denture preparation

- Border extension is checked and corrected.

- Undercuts are relieved.

- Occlusal disharmony is corrected by selective grinding.

- Pressure spots are adjusted.

- Accurate posterior palatal seal is established.

Procedure

The procedure for relining and rebasing involves the following processes.

Impression making

- The static and functional methods of relining and rebasing involve impression making clinically using the existing denture followed by conversion of the impression material to denture base material in the laboratory.
- Static methods can be open- or closed-mouth techniques, where the existing denture is used as a custom tray to make the impressions, with border moulding and final impressions using conventional static methods. In closed-mouth technique, the patient is made to bite or close in centric while the impression is made, whereas in the open-mouth technique, they are not asked to close while impressions are made.
- The functional technique involves using tissue-conditioners to make functional impressions for the reline.
- Rarely, when time is a constraint, autopolymerizing acrylic resin is used to reline the denture directly in the mouth. This is called chairside technique.
- Whichever method is used, it is recommended to make maxillary and mandibular reline impressions separately.

Static methods

Open-mouth techniques

- Proposed by Boucher in 1973.

- Dentures are used as special tray for making the final impression.
- Tissue stops are prepared in the denture using low-fusing compound to maintain vertical dimension, occlusal plane and aesthetic position of anterior teeth.
- The tissue surface and borders of the denture are trimmed by 1 mm (Fig. 15.4).
- Borders are moulded with low-fusing green stick compound (Fig. 15.5).
- Final impression is made with ZOE impression paste.
- Impression of maxillary denture is made followed by mandibular.
- New CR record is made using interocclusal check methods.

FIGURE 15.4 Denture border marked for trimming.

FIGURE 15.5 Open-mouth technique – border moulding with green stick compound.

Advantages

- Selective pressure impression is made without any occlusal interference.
- Operator need not worry about jaw relation while making impressions, as a separate record is made.
- The CR record is verifiable.

Disadvantages

- Chances of increase in vertical dimension even though tissue stops are provided.
- High possibility of denture moving forward.

- Demanding and laborious technique.
- Requires more clinical and laboratory time.

Closed-mouth techniques

- Dentures are used as special tray for making the final impression.
- The tissue surface and borders of the denture are trimmed by 1–2 mm, except for posterior border of maxillary denture (similar to described in open-mouth technique).
- Borders are moulded with low-fusing green stick compound.
- Final impression is made with ZOE impression paste.
- The patient closes in centric occlusion on the opposing denture during border moulding and impression making (Fig. 15.6).

FIGURE 15.6 Closed-mouth impression technique.

Advantages

- Less chances of increased vertical dimension as patient closes in centric occlusion.

- Takes less time.
- Chances of denture moving forward during impression are less.

Disadvantages

- Existing errors in centric occlusion can produce pressure points and an inaccurate impression.
- Hydrostatic pressure in palate during impression making and packing of acrylic can still cause increase in vertical dimension.

To alleviate the above disadvantages, the following modifications were suggested:

1. Making a new CR record before making the impressions and then asking the patient to close in the CR record as the impressions are made.

2. Palatal portion is modified to reduce hydrostatic pressure during impression making and packing (a section of palatal portion is prepared to be removed during processing. Outline of the area is grooved on polished surface – holes are drilled at 5–6 mm intervals on the groove) (Fig. 15.7).

3. Labial and buccal flanges of denture are perforated which will decrease pressure during impression making and packing.

4. Use of impression wax instead of ZOE impression paste has been suggested to make final impression, but wax is difficult to work with and there is possibility of distortion.

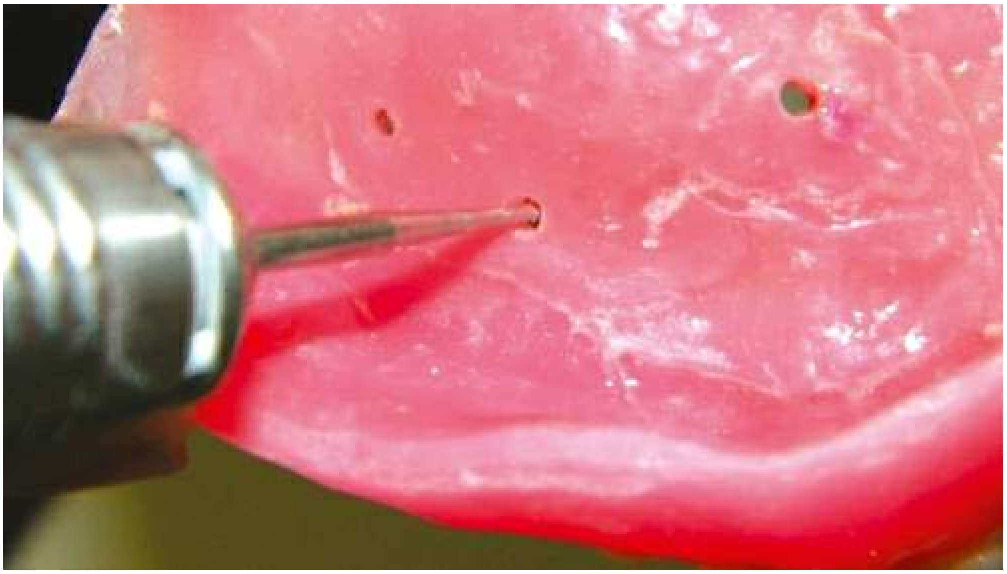


FIGURE 15.7 Perforation of denture.

Functional technique

- Simple, practical and popular method.
- Tissue conditioners are used as an impression material. The method is similar to that described for tissue conditioners.
- The areas of the denture (like occlusal surface), which are not to be contacted by the fluid resin, are painted with a lubricant (Fig. 15.1B).
- The powder and liquid of the soft liner are mixed according to the manufacturer's instructions and allowed to polymerize in the mixing cup.
- While the material is creamy and fluid, it is poured onto the tissue surface of the denture, covering the entire denture base area (Fig. 15.4). When material stops flowing and reaches a dough stage, it is inserted in the patient's mouth and the patient is instructed to close in centric, maintaining vertical dimension. Active and passive methods of border moulding are performed and the patient is also

instructed to perform functional movements like swallowing, speaking, smiling until the impression reaches a more stable rubber-like state, which will normally take about a minimum of 15 min.

- After removal from the mouth, the excess tissue conditioner is trimmed, voids are corrected with new material and procedure is repeated (Fig. 15.3).
- The patient is asked to use the denture with the conditioning material. This will further functionally mould the material.
- Recall and maintenance is similar to that described for 'tissue conditioners'.
- When the patient returns after 3–5 days, the underextensions, denuded areas and pressure spots are corrected by trimming and/or adding new material.
- The material is changed periodically till the tissues return to a state of health and then the patient is scheduled for final impressions.
- A ZOE impression paste or light-body wash impression is then made over the conditioning material and verified. This method is similar to the 'functional reline technique' of making complete denture impressions.

Chairside technique

Autopolymerizing acrylic resins are used for relining dentures directly in the mouth. They are added to the denture base after necessary trimming, and allowed to polymerize in the mouth. This is called instant chairside reline.

Disadvantages

- Material is porous and has an unpleasant odour.
- The excess monomer that leaches out may also irritate the mucosa.

- The exothermic heat produced can burn the mucosa.
- Poor colour stability.
- If not positioned correctly, it can lead to gross discrepancies.

Because of all these problems, this technique is not recommended except for replacing a very small part of the denture.

Laboratory procedures

The process of replacing the impression material with acrylic resin is the same for either the static or the functional approach.

The difference in relining (Fig. 15.8A and B) and rebasing is in the amount of old denture base removed and replaced. For rebasing (Fig. 15.9), the entire denture base is eliminated excepting the teeth and may be 2 mm of adjoining denture base.

FIGURE 15.8 **(A)** Showing trimming of borders for relining. **(B)** Flasked denture for relining with intact denture base.

FIGURE 15.9 Trimming of the entire denture-bearing surface except for teeth for rebasing.

One of the following methods can be used:

- Flask method
- Articulator method
- Jig method

Flask method

- The relined impression is poured with dental stone.
- The master cast is poured around the impression similar to the

original master cast made by beading and boxing (Fig. 15.10A and B).

- This cast provides the surface against which the denture is relined by embedding it in a processing flask (Fig. 15.11).
- The flask is warmed to soften the impression compound before opening it to remove the impression material (Fig. 15.12).
- Separating medium is applied on the plaster and stone moulds, and heat-polymerized denture base resin is packed into the mould. The flask is closed and clamped to ensure maintenance of occlusal vertical dimension. The acrylic is then processed.
- After processing, the flask is cooled slowly and the denture is retrieved from the stone mould, finished and polished (Fig. 15.13).

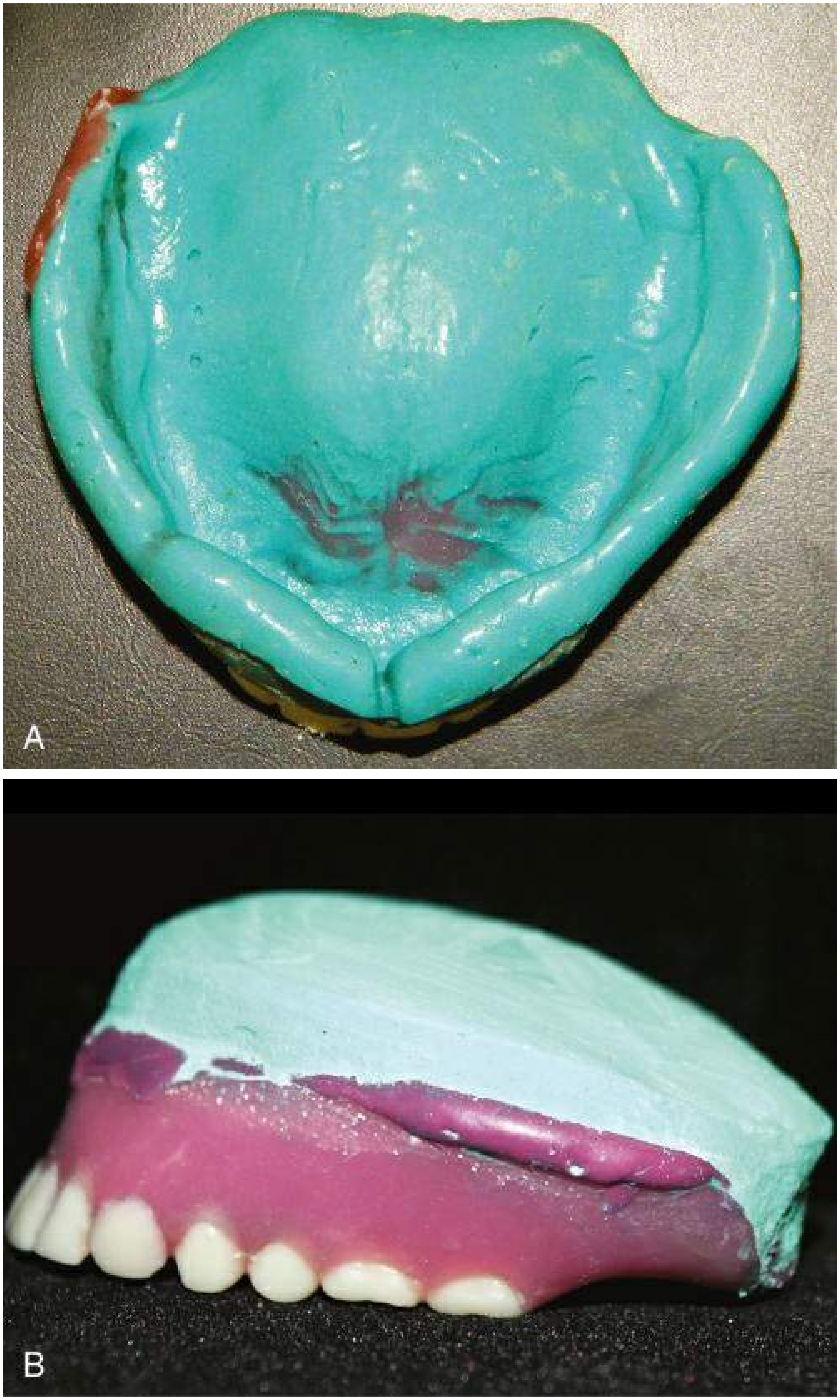

A
B

FIGURE 15.10 **(A)** Relined impression. **(B)** Master cast poured on the relined impression.

FIGURE 15.11 Flask method. Right – master cast embedded in flask, left – relined impression with denture.

FIGURE 15.12 Flask method. Left – impression softened and removed.

FIGURE 15.13 Relined denture after processing.

Articulator method

- A master cast is poured similar to the previous method. The cast is not separated from the impression.
- A layer of plaster is arranged in platform fashion on the lower member of the articulator.
- As the plaster is setting, the cast with the relined impression is placed on the wet plaster platform such that the teeth penetrate the plaster surface to a depth of 2 mm and the occlusal plane is parallel to the floor (Fig. 15.14). This forms an index or key of the teeth on the plaster platform which allows repositioning of the teeth maintaining the distance and relation with the cast (Fig. 15.15). Once the plaster platform sets, additional plaster is placed on the base of the cast and it is mounted on the upper member of articulator (Fig. 15.16).

• When the mounting sets, the articulator can be opened and the denture with impression is separated from the cast.

• At this point one may elect to rebase or reline the denture. It differs only in the amount of trimming of denture (Figs 15.8A and 15.17).

• The denture base is waxed (Fig. 15.18), cast and denture are removed from the mounting, flasked and processed with heat-cure denture base acrylic resin (Fig. 15.19).

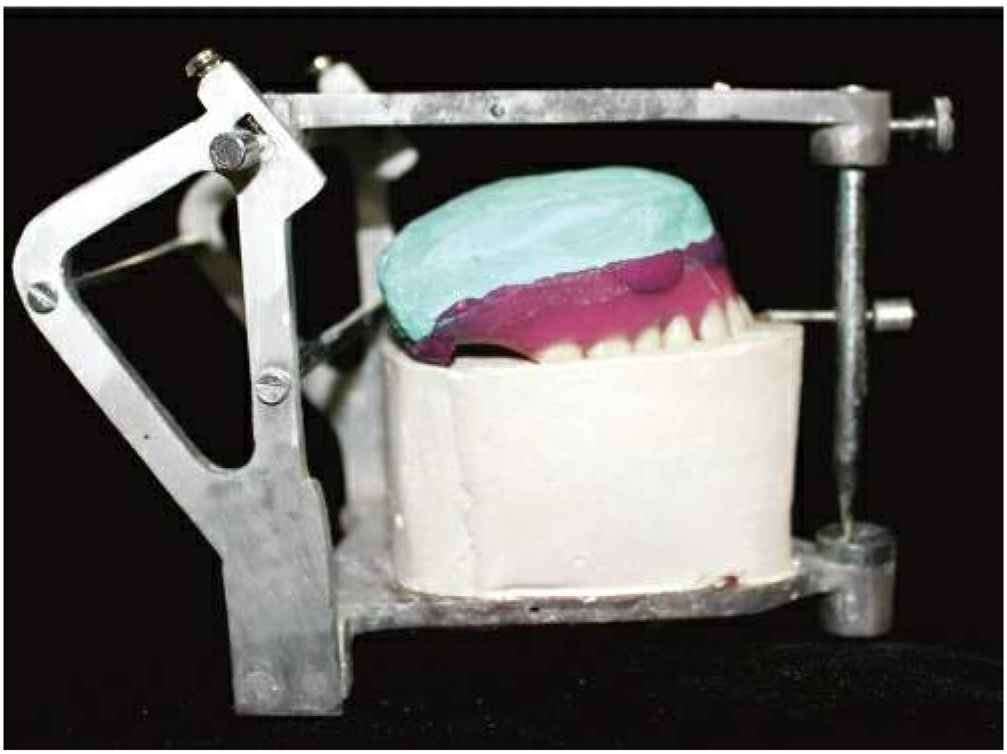


FIGURE 15.14 Relined denture with cast stabilized on a platform of plaster to form an index.

FIGURE 15.15 Key or index of denture teeth.

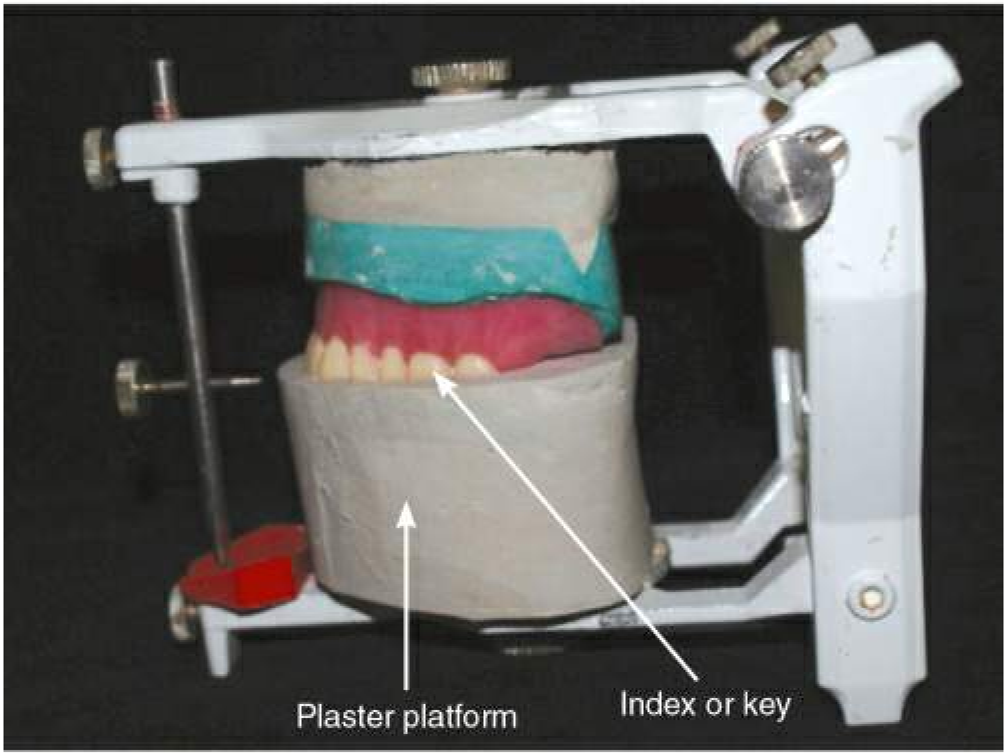


FIGURE 15.16 Completed mounting of relined impression with cast on the articulator with formation of index for the denture teeth.

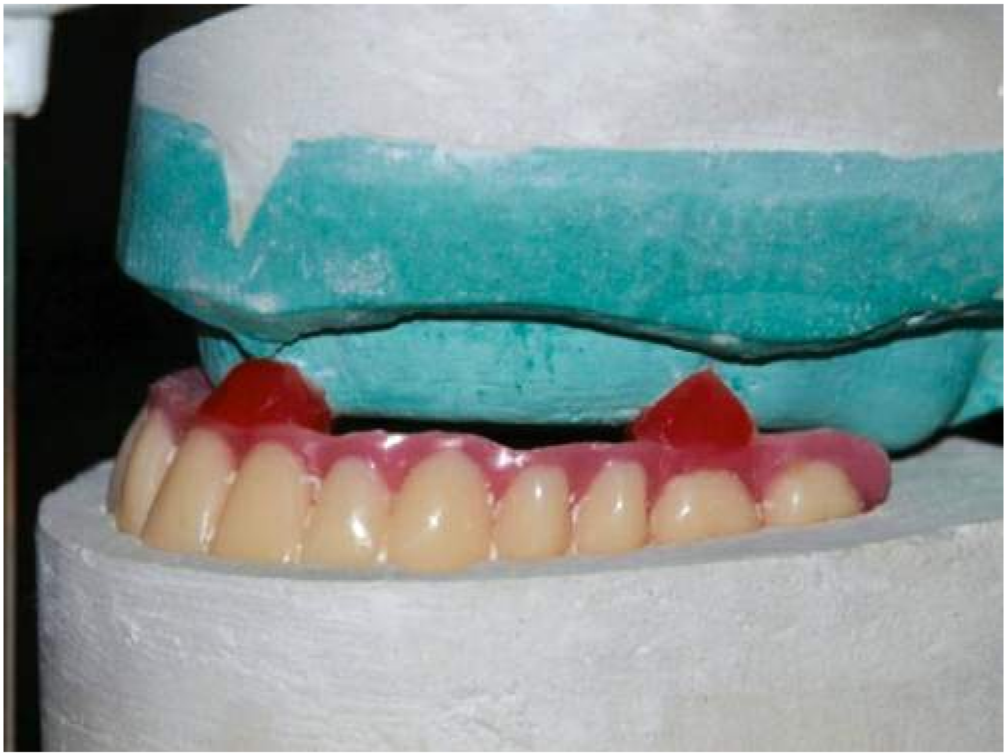


FIGURE 15.17 Showing trimmed denture for rebasing.

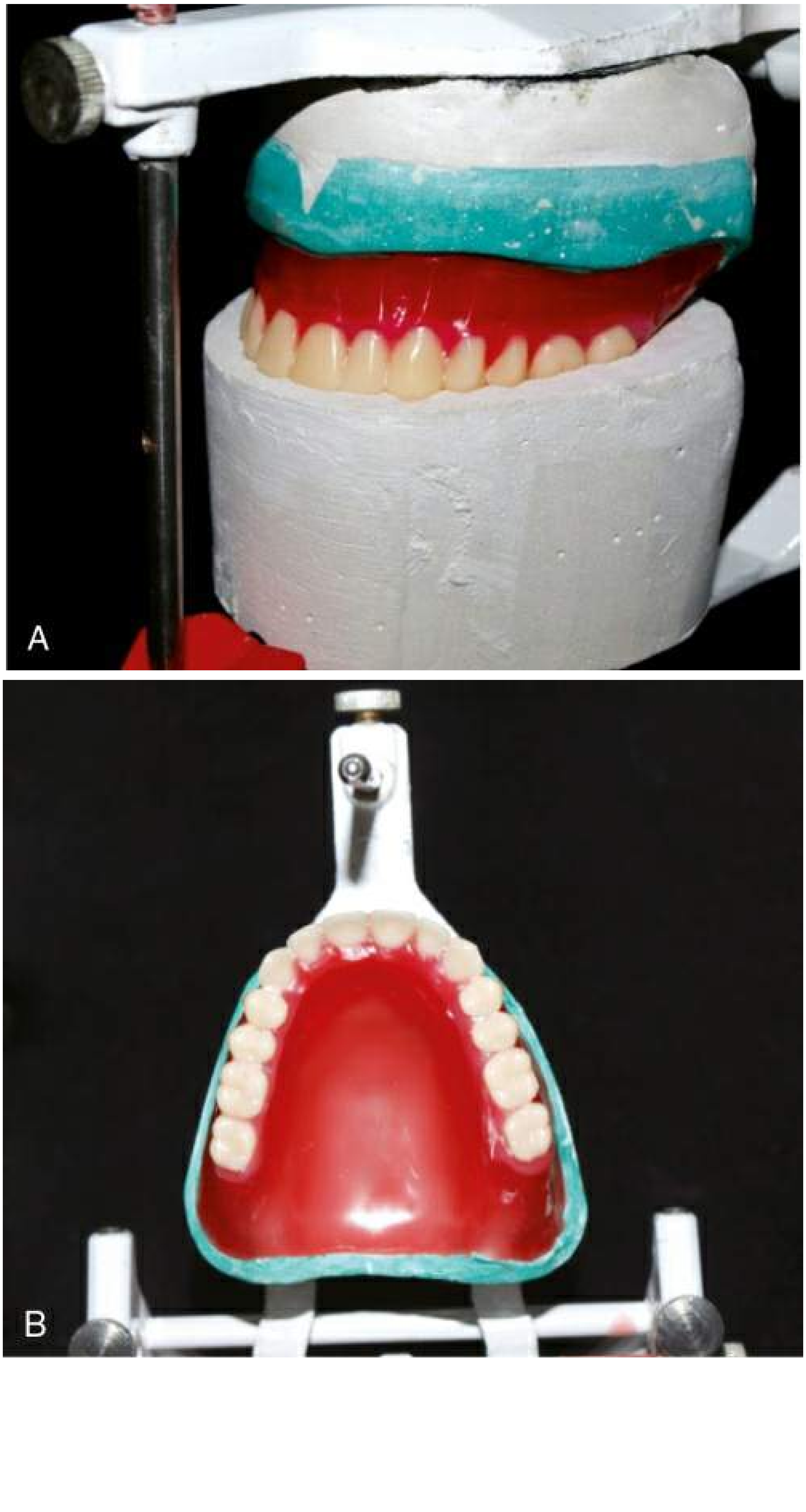

A
B

FIGURE 15.18A, B Waxing of denture.

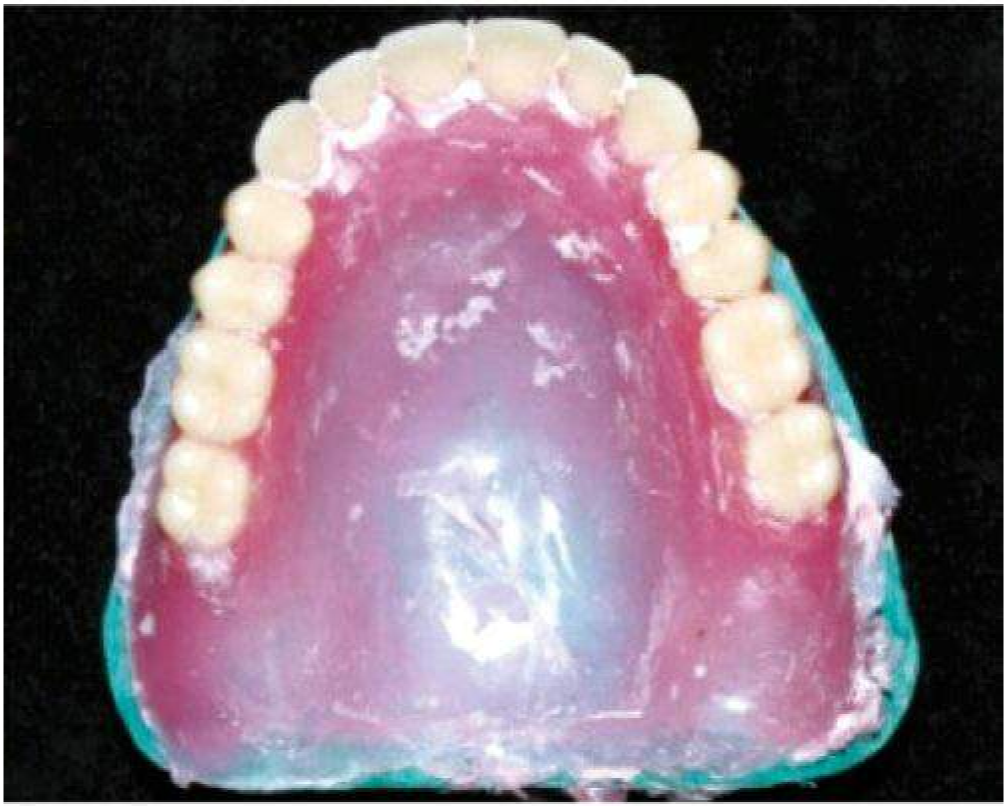


FIGURE 15.19 Processed denture.

Jig method

Definition: Jig – a device used to maintain mechanically the correct positional relationship between a piece of work and a tool or between components during assembly or alteration (GPT8).

- Procedure is similar to that using an articulator. Seat the occlusal surface of the denture on the plaster platform on lower member of relining jig.
- After the stone index is made, mount the denture with the cast to the upper member in reline jig similar to articulator method (Fig. 15.20).

- Open the jig, remove the teeth from denture base and adapt baseplate wax on the cast and wax the denture.
- After processing, replace the cured denture, check and correct occlusion using the indentation made in the jig during mounting of denture.
- Alternatively a Hooper's duplicator can also be used. It is similar to the Jig method.

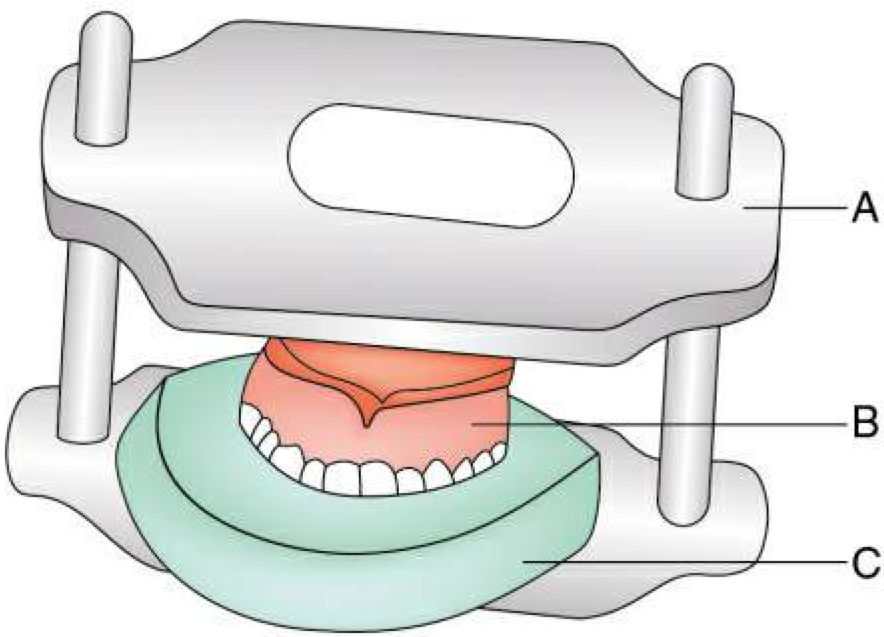


FIGURE 15.20 (A) Upper member of reline jig. (B) Relined denture mounted. (C) Plaster platform.

Insertion, recall and maintenance

The insertion procedure for a relined or rebased denture is similar to evaluating any new complete denture during its insertion. Since patient is an old denture wearer, much time need not be spent on patient instructions. Recall and maintenance is also similar.

Repair

Introduction

Fractured dentures are commonly encountered in clinical practice. Though the most common cause is due to patient dropping the dentures, some dentures break in the mouth. Repair of the denture without determining the cause of the breakage, results in repeated breakage, which is more common when the dentures break within the mouth. The most common reasons for denture repair are fracture of maxillary denture in midline and debonding of teeth. The various causes and the procedure for repair are discussed in this chapter.

Causes

Fractures or cracks can be categorized as:

1. Denture factors

   (i) Fracture of the denture base

   (ii) Fracture of a tooth or teeth on the denture

2. Patient factors

   (i) Accident

   (ii) Anatomical factors

   (iii) High occlusal load

Causes for these fractures are as follows.

Denture factors

Fracture of the denture base

The denture base can fracture due to two main reasons:

1. Poor fit

The following factors contribute to poor fit and fracture of dentures:

(i) Alveolar resorption

The alveolar resorption will cause the denture to be unevenly supported and cause fracture. This is especially true for dentures which have been worn for some considerable time, or which were made shortly after the extraction of the teeth.

(ii) Warpage

Dimensional changes in acrylic resin of repaired dentures cause poor fit and fracture.

(iii) Relief

Both inadequate and excessive relief can cause fracture. Failure to relieve bony prominences like tori and thin mucosa can cause denture to flex and fracture. Excessive relief can make the denture thin and fracture.

(iv) Inaccurate impression or cast

Inaccurate impressions or cast can induce considerable stresses in the denture base during mastication owing to the unevenness of its support, and eventually the base will crack. The length of time before this happens depends on the stresses induced and also on the physical properties and thickness of the material used.

(v) Inclusions in denture

Inclusions such as porosity, plaster dust, nylon filaments and metal meshes contribute to stress concentrations and rapid growth of crack.

2. Incorrect tooth position

The most common cause is setting upper teeth outside the ridge, which will lead to midline fracture of upper denture. This is because the force of mastication is applied outside the axis of the ridge and the ridge becomes a fulcrum point, causing a large component force to be transmitted to the midline of the denture.

The problem can be countered by:

- Wide extension of the denture base to ensure a retentive force on the contralateral side, which shifts the fulcrum and distribute the load more evenly.
- Arranging teeth in balanced occlusion.
- Use of metal denture base.

Fracture or debonding of a tooth or teeth

Fracture or debonding of a tooth or teeth happens due to the following reasons.

Cuspal interference

- Where the pressure is heavier on one tooth than elsewhere, it will frequently cause the tooth to split, especially when it is confined to one tooth.
- An anterior tooth may fracture if there is excessive overbite with insufficient overjet.
- In old dentures, upper anteriors are often chipped– due to ridge resorption, the lower denture shifts forwards resulting in traumatic anterior contact.

Excessive grinding of a tooth

- Excessive and incorrect grinding of the artificial teeth can also cause teeth to come off from the denture due to reduced area for attachment with denture base.

Patient factors

Accident

Accidental dropping of the denture by the patient is the most common cause of fractured denture due to impact.

Anatomical factors

Anatomical problems like high labial frenum will require a deep labial notch, which can result in stress in the area leading to midline fracture of upper denture.

High occlusal loads

This is present in patients with powerful muscles of mastication, bruxers and single complete dentures.

Procedure

Denture base repair

- Reassemble the individual pieces carefully and lute them with sticky wax reinforced with wooden sticks (Fig. 15.21A and B).
- Pour stone cast into reassembled denture (Fig. 15.22).
- After the cast is set, place grooves and dovetails to strengthen the repair joints (Fig. 15.23).
- Bevel the cut outward to increasing the bonding area.
- Place wire to strengthen the fracture joint (Fig. 15.24).
- Paint the cast with separating medium, replace the denture carefully on the cast, and mix and flow autopolymerizing acrylic resin into

the groove (Fig. 15.25).

- Secure the denture to the cast with rubber band and cure it for 30 min in pressure container. The denture is removed from the cast, finished and polished (Fig. 15.26).

FIGURE 15.21 **(A)** Fractured denture. **(B)** Stabilized with wooden stick and sticky wax.

FIGURE 15.22 Stone is poured on the impression surface of the reassembled denture.

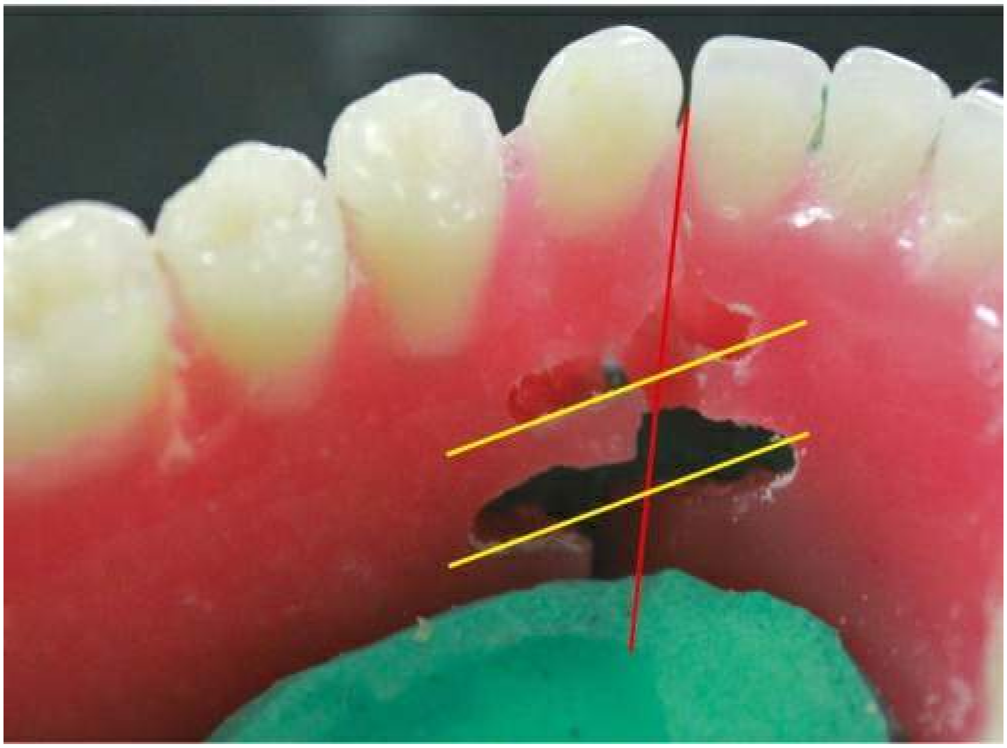


FIGURE 15.23 Grooves (yellow lines) are placed perpendicular to fracture site (red line).

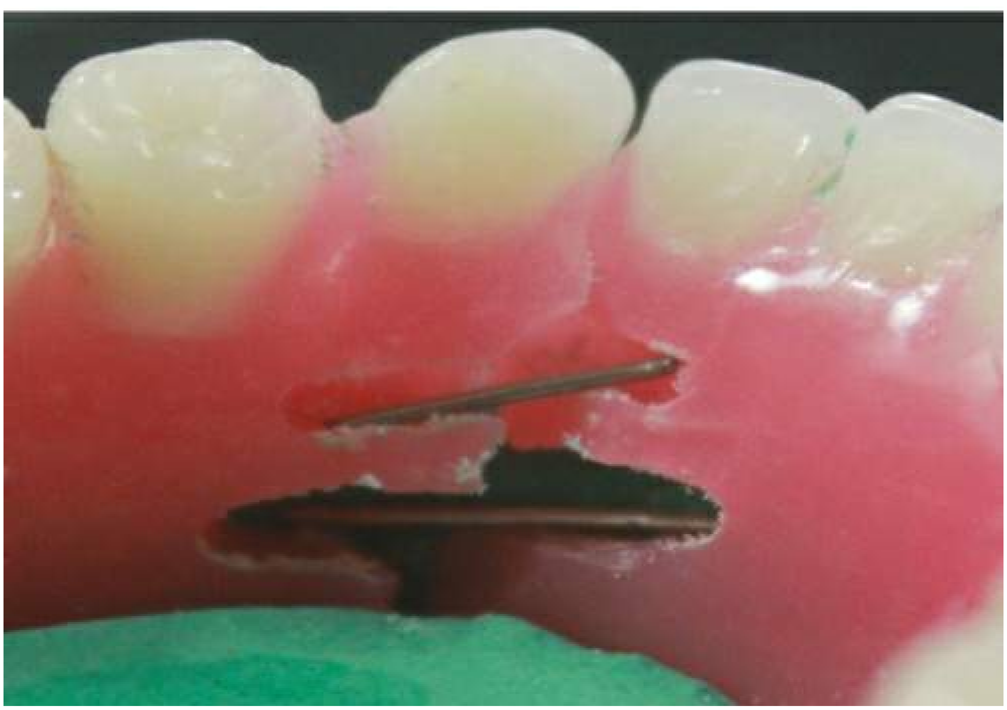


FIGURE 15.24 Wires can be placed for reinforcement.

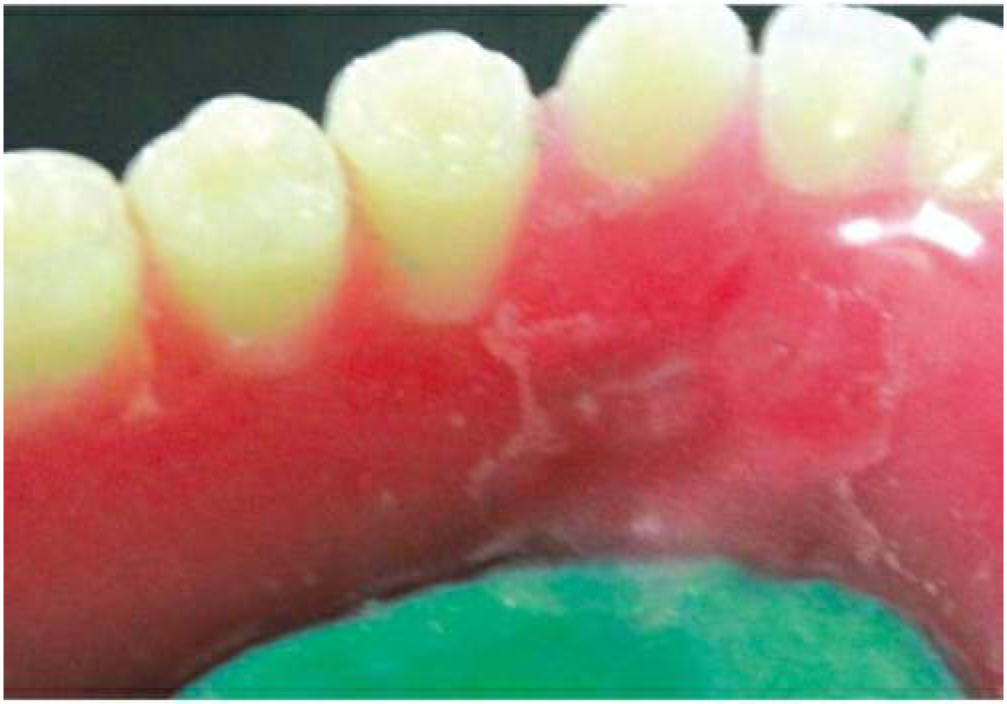


FIGURE 15.25 The groove is filled with autopolymerizing resin.

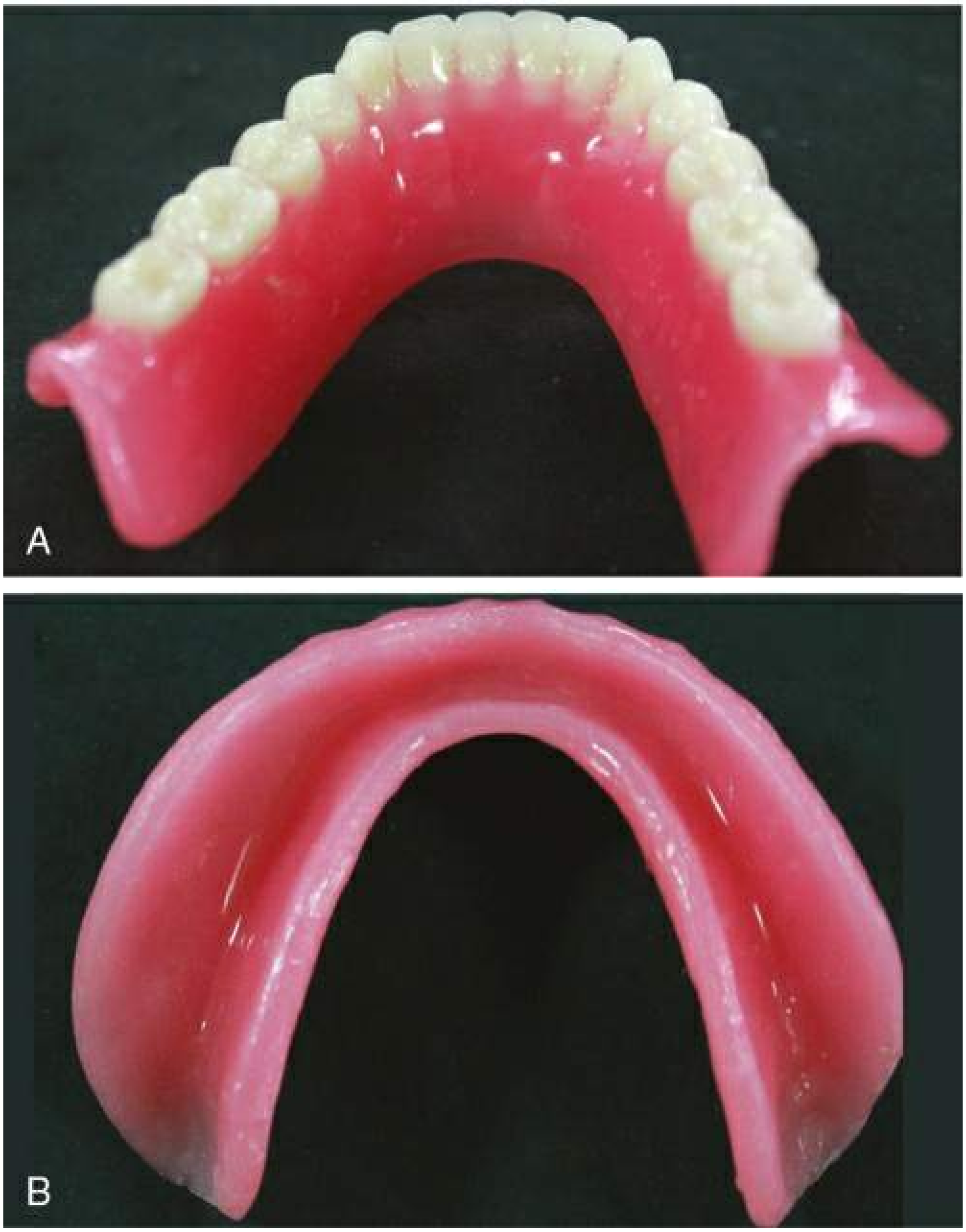


FIGURE 15.26A, B Repaired denture finished and polished.

Refixing broken teeth

- Grind out any remaining portion of broken tooth from the denture base to enable the bonding of resin (Fig. 15.27).
- In case of anterior teeth, trim the replacing teeth and stabilize with

sticky wax at the incise edge (Fig. 15.28A and B) and make plaster index of the tooth along with adjacent teeth (Fig. 15.29).

- In case of posterior teeth, articulate the denture, so that occlusal discrepancy is avoided.
- Replace the index (Fig. 15.30) and tooth on denture and paint autopolymerizing resin from lingual or palatal side (Fig. 15.31A and B).
- Secure the denture to the index with rubber band and cure it for 30 min in pressure container (Fig. 15.32). The denture is removed from the index, excess trimmed and polished.

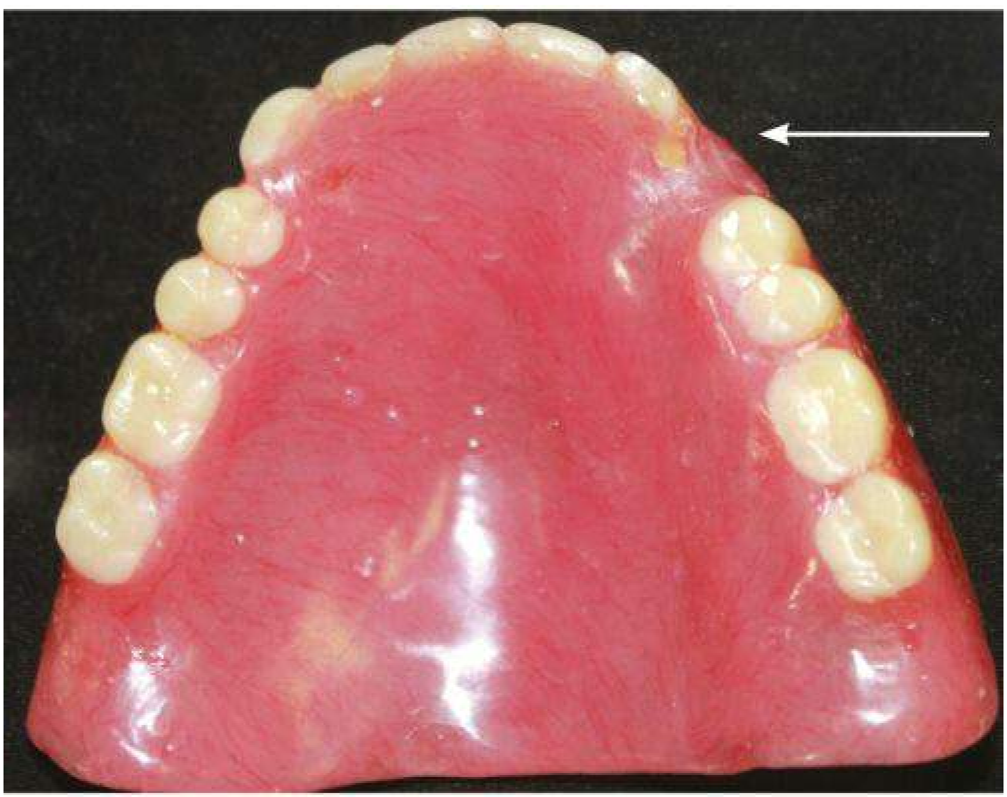


FIGURE 15.27 Remaining portion of broken teeth ground out from denture base.


A

FIGURE 15.28 Replacing denture tooth is selected and trimmed to fit the space **(A)** stabilized with sticky wax **(B)**.

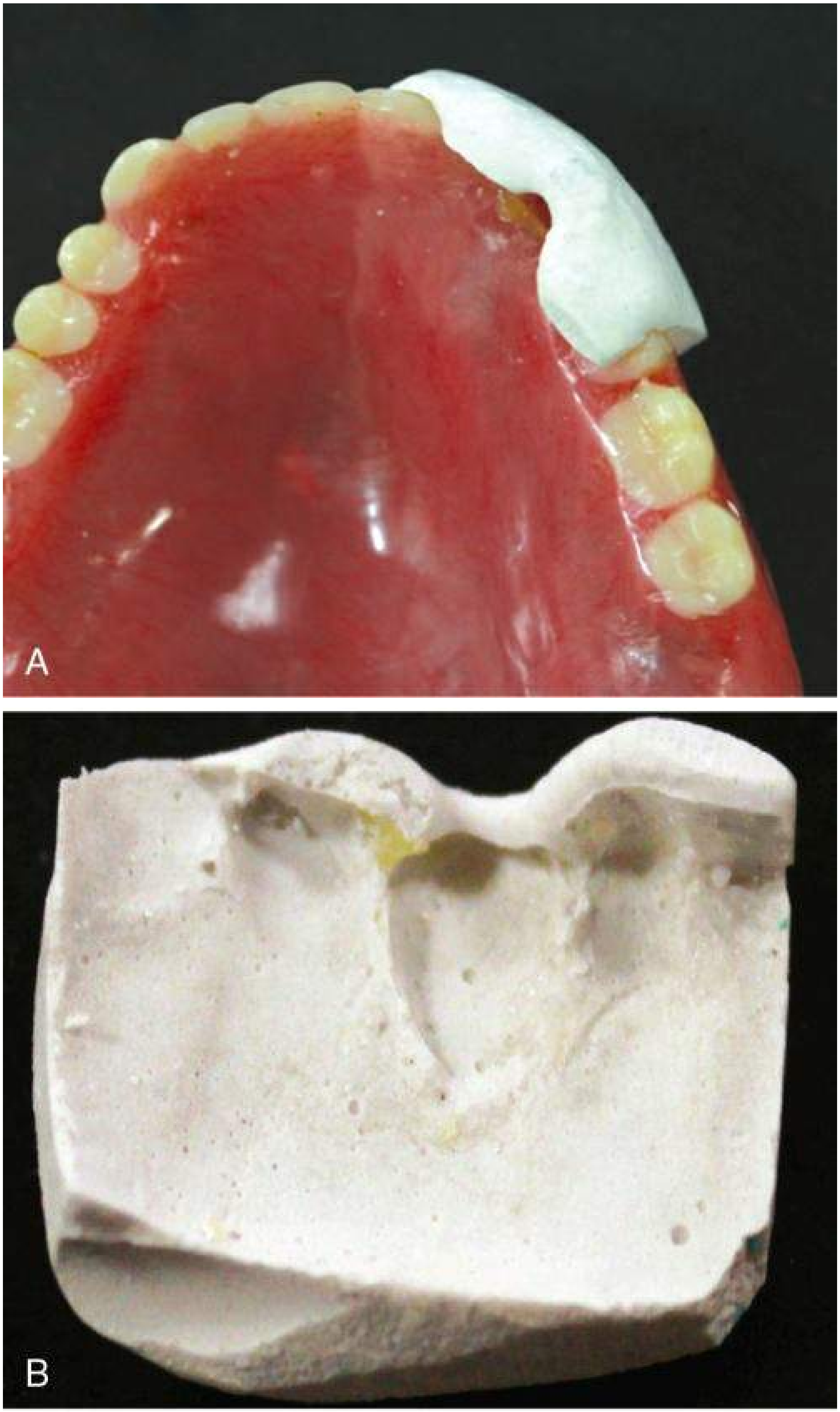

A
B

FIGURE 15.29 **(A)** Plaster index on denture. **(B)** Plaster index.

FIGURE 15.30 Replacing teeth placed in index and placed in denture.

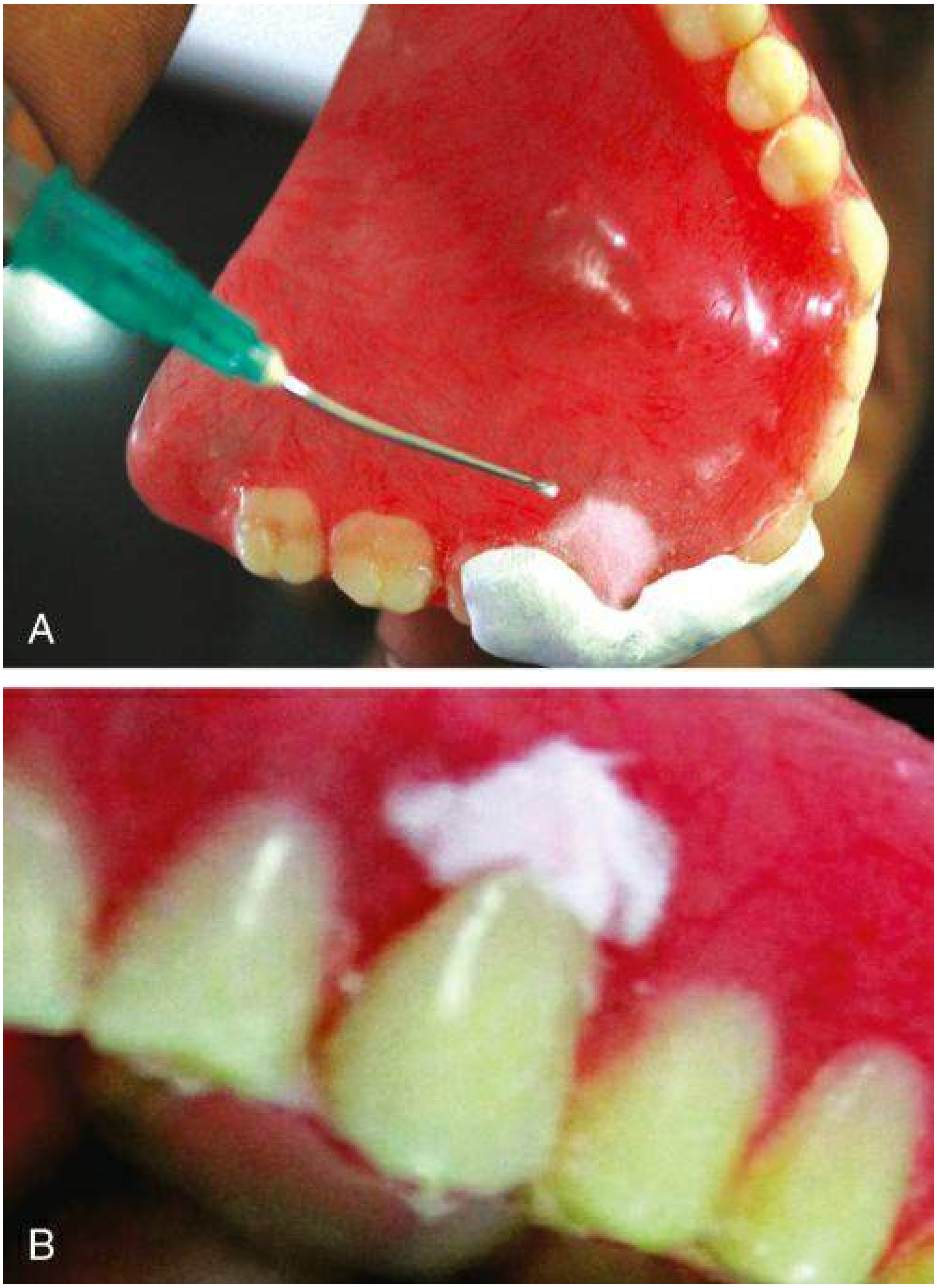


FIGURE 15.31 **(A)** Acrylic applied from palatal aspect. **(B)** Defect in labial aspect applied with acrylic resin.

FIGURE 15.32 Finished denture.

SUMMARY

Residual ridge resorption is an inevitable process with complete dentures. It is very important that the patient is educated on this aspect and the need for constant refitting of the denture over a period of time. Relining is done when the tissue changes are mild to moderate, while rebasing is done for more extensive changes. Various techniques are employed to make reline impressions, but the functional reline method is most commonly used as it also heals the abused tissues. Cracked denture and debonded teeth are common denture repair problems and the clinician should be aware of the causes and the procedure for correcting the same since, these can be performed in a routine clinical setting.

CHAPTER
16

Single complete denture

CHAPTER CONTENTS

Introduction

Definition: A single complete denture is a complete denture that occludes against some or all of the natural teeth, a fixed restoration, or a previously constructed removable partial denture or a complete denture.

The primary consideration for a single complete denture is preservation. By opposing the natural teeth, the magnitude of force transmitted to the denture and arrangement of artificial teeth will be the major considerations while planning the denture. These will be discussed in this chapter.

Disadvantages

The unfavourable force distribution by the natural teeth can cause the following adverse changes:

1. Extensive morphological changes in denture foundation.

2. Jaw relationship extremes which make it difficult to arrange artificial teeth for the denture along the line of support (Fig. 16.1).

3. Excessively displaceable denture-bearing tissue (flabby ridges).

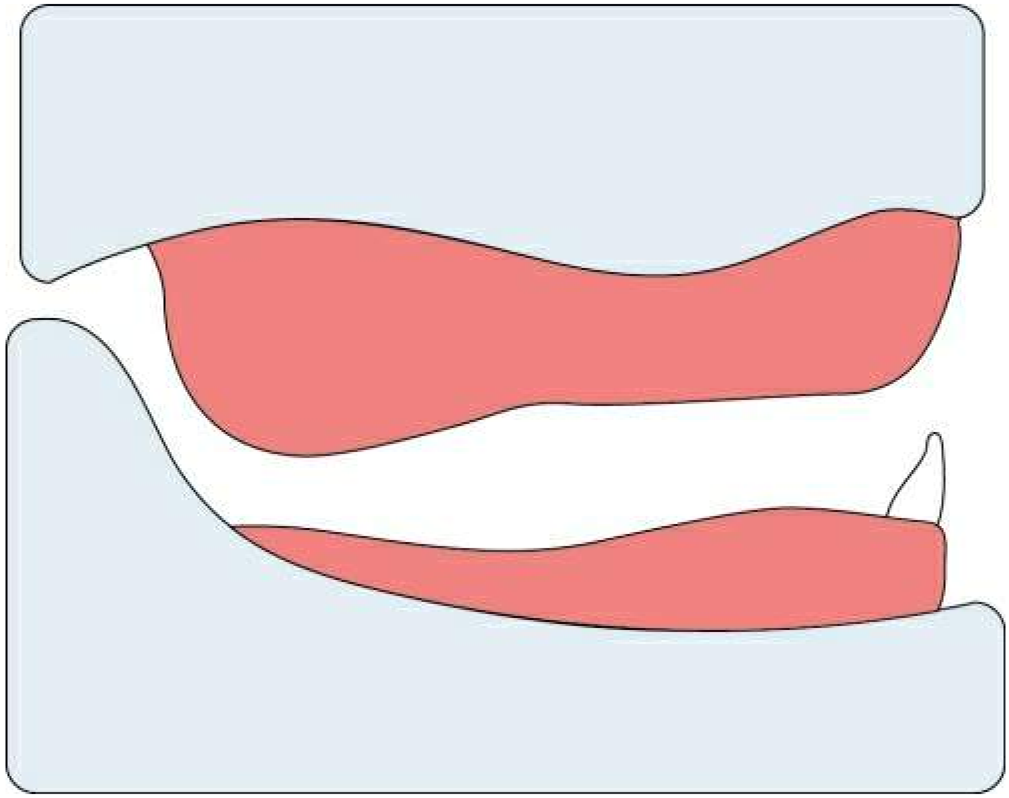


FIGURE 16.1 Insufficient interocclusal space due to enlarged tuberosities with resultant altered occlusal plane and jaw relationship.

Indications

A single complete denture may be desirable when it is to oppose any one of the following conditions:

- Natural teeth sufficient in numbers not to necessitate a fixed or removable partial denture.
- A partially edentulous arch in which the missing teeth have been or will be replaced by the fixed partial denture.
- A partially edentulous arch in which the missing teeth have been or will be replaced by a removable partial denture (Fig. 16.2).
- An existing complete denture.

FIGURE 16.2 Single complete denture opposing natural teeth and removable partial denture.

Prevalence

The mandibular canines are documented to be retained for the longest time followed by the mandibular incisors (Fig. 16.3). Hence, the maxillary single complete denture opposing lower natural teeth is a more frequent occurrence and will be discussed in detail.

FIGURE 16.3 Longest time retained mandibular canine and incisors.

Maxillary single complete denture

Diagnosis and treatment planning

Edentulous arch: This is evaluated similar to any complete edentulous situation.
Dentulous arch: The teeth are evaluated for the following:

- Number of teeth present.
- Position and condition of teeth to assess, endodontic, restorative and periodontal condition.

Mouth preparation

Apart from treating the natural teeth, the occlusal plane is assessed and corrected by selective grinding to achieve a harmonious occlusion with the artificial teeth.

Occlusal plane correction

Indications

- Malposed teeth
- Severely tipped teeth
- Supraerupted teeth (Fig. 16.4)
- Irregular occlusal plane
- Less space for teeth

FIGURE 16.4 Supraerupted premolars deranging the occlusal plane.

Methods

Swenson's technique

- Maxillary and mandibular casts are mounted at an acceptable VD with a CR record.
- The teeth are arranged and the occlusal discrepancies are corrected and marked with pencil on the diagnostic cast.
- With this as a guide, the natural teeth are modified.

Yurkstas technique

- A 'U'-shaped metallic occlusal template, which is slightly convex on the lower surface, is placed on the occlusal surfaces of the remaining natural teeth and cusps to be adjusted are identified (Fig. 16.5).

- The stone cast is modified to a more acceptable occlusal relationship and the modifications are marked with a pencil.
- Necessary alterations are done on the natural teeth using this as a guide.

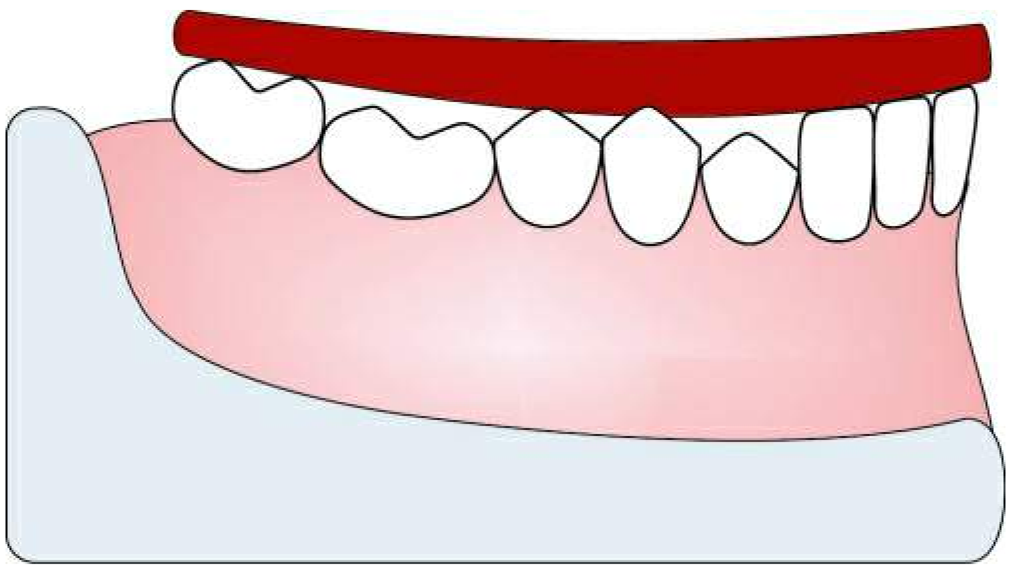
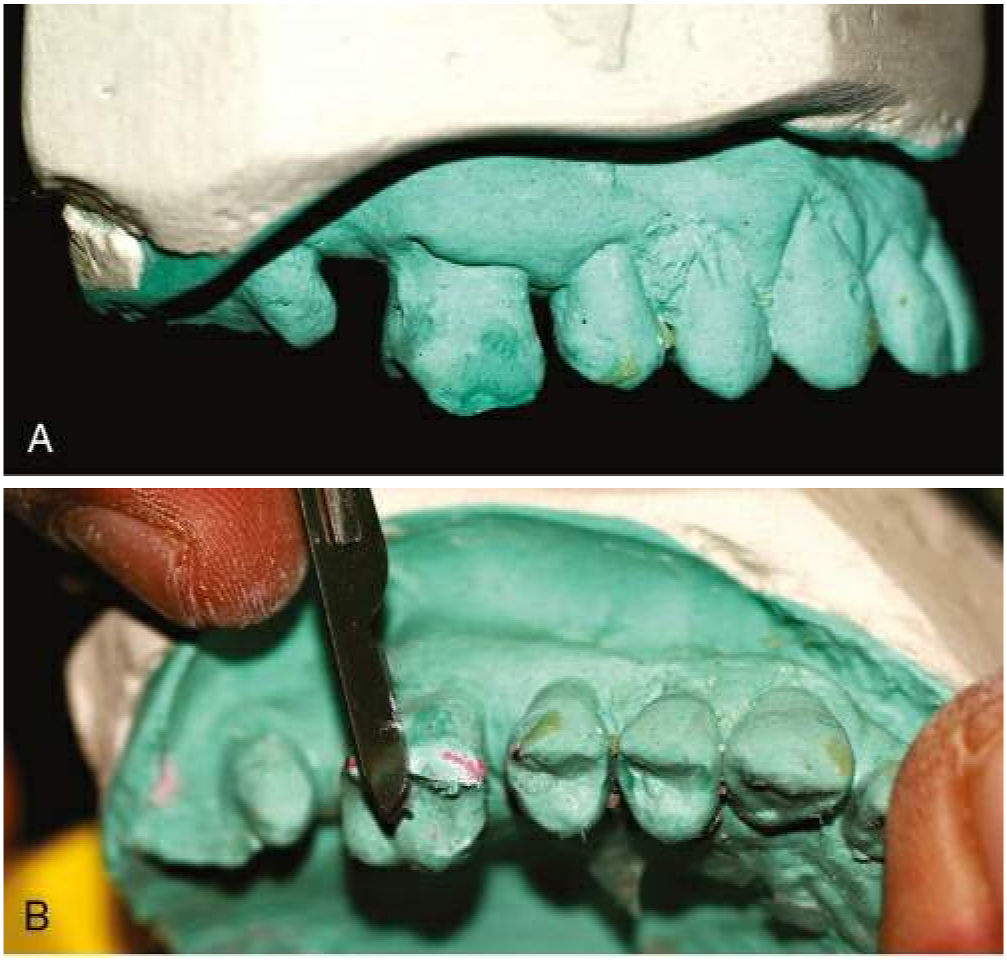


FIGURE 16.5 Occlusal plane correction – Yurkstas technique.

Bruce technique

- Maxillary and mandibular casts are mounted at an acceptable VD with a CR record.
- Necessary modifications are made on the stone cast.
- Acrylic resin template fabricated on the stone cast (altered).
- The natural teeth are modified accordingly till the template seats properly (Fig. 16.6).


A
B


C


D

FIGURE 16.6 Occlusal plane correction – Bruce technique. **(A)** Stone model with occlusal discrepancies. **(B)** Reduction of occlusal discrepancies in the cast. **(C)** Acrylic template made from altered stone model. **(D)** Try-in of template in patient mouth. **(E)** Reduction of natural teeth using template as a guide.

Boucher's technique

- Artificial porcelain teeth are arranged on the maxillary edentulous cast in centric occlusion establishing occlusal plane, after maxillary and mandibular casts are mounted at an acceptable VD with a CR record.

- The porcelain teeth are moved over the mandibular teeth in stone and occlusal interferences are ground by the porcelain teeth (Fig. 16.7).

- The ground areas are marked on the cast, and the natural teeth altered using this as a guide.

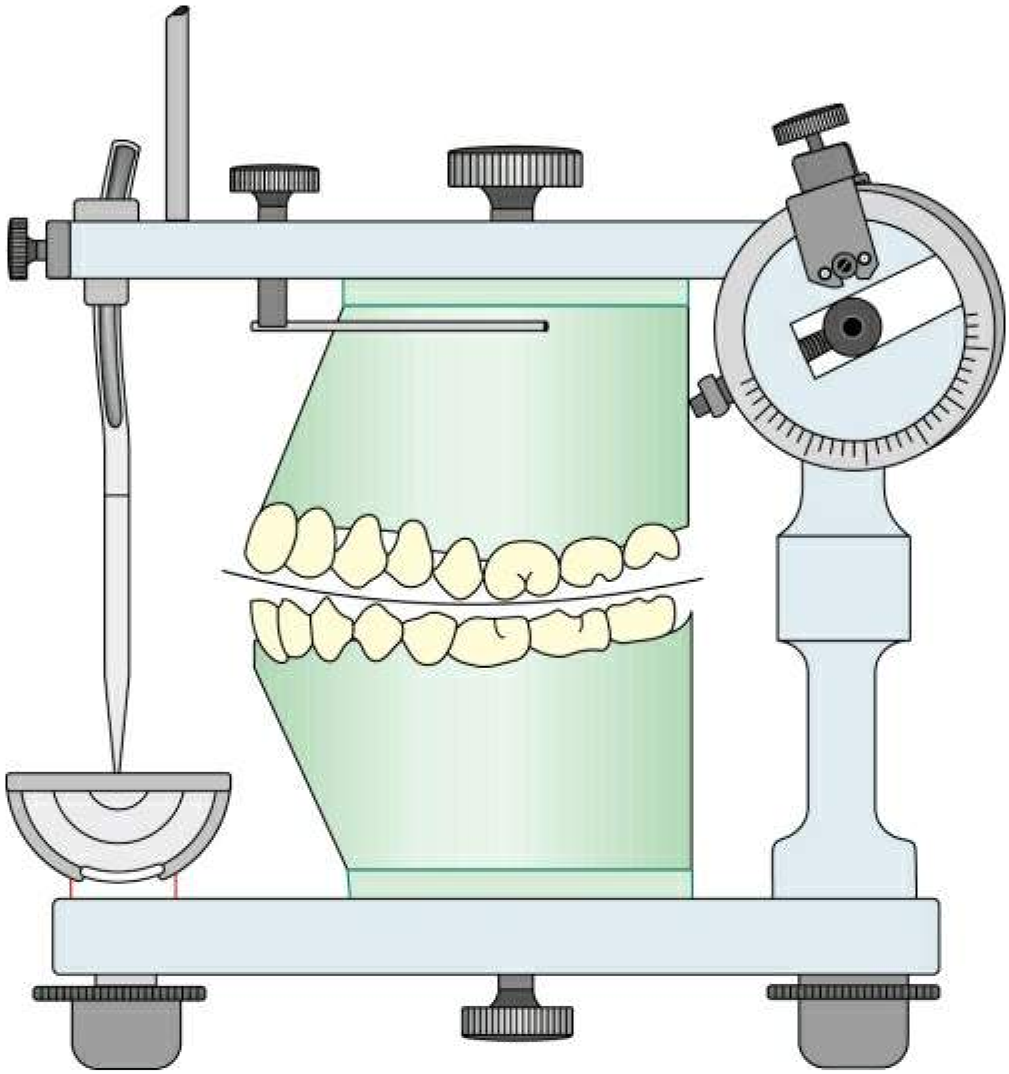


FIGURE 16.7 Occlusal plane correction – Boucher's technique, the maxillary porcelain teeth will remove the interferences of the mandibular natural teeth.

Impressions and jaw relations

- For the edentulous arch, the condition of the residual ridge and philosophies of complete denture impression making dictate the method used.
- For the dentulous arch, impressions are made with irreversible hydrocolloid, following occlusal plane correction if needed.

- Jaw relations are recorded using the techniques described for complete dentures – vertical dimension of occlusion is recorded using Niswonger method and a static registration is used to record the centric relation.

Teeth selection

Materials available for occlusal posterior tooth forms to oppose natural teeth are as follows:

1. *Porcelain*

Advantages

- Maintains vertical dimension.
- Wears very slowly.

Disadvantages

- Fracture, wearing and chipping of natural teeth.
- Difficult to equilibrate.
- Cannot be used when interocclusal distance is less.

2. *Acrylic resin*

Advantages

- Does not wear opposing natural teeth.
- Easy to equilibrate.

Disadvantages

- Loss of vertical dimension.

• Poor wear resistance.

3. *Gold occlusals*

Advantage

• Best to oppose natural teeth.

Disadvantage

• More time consuming and expensive.

4. *Acrylic resin with amalgam stops*

• Recommended by Winkler.

• After the acrylic teeth have been balanced, occlusal preparations are made in the acrylic teeth, extending to include as much of the articulating paper tracing as possible. Amalgam is condensed into the preparations and eccentric movements are made. Thus, the centric holding area and some of the excursions are recorded in amalgam by the articulator (Fig. 16.8).

• Has better wear resistance than acrylic.

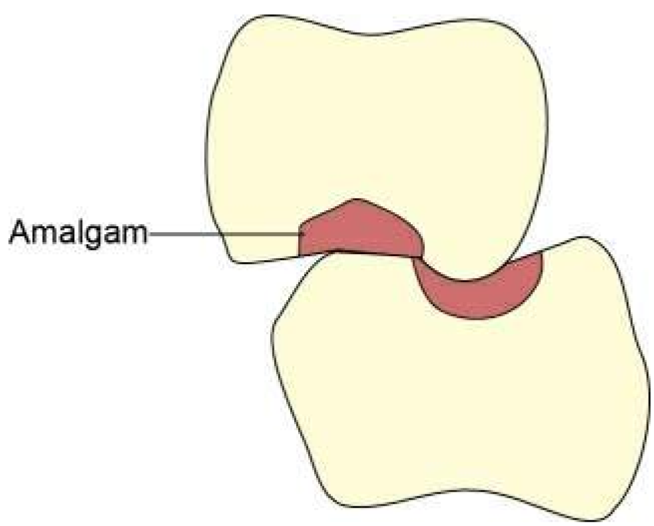


FIGURE 16.8 Acrylic resin teeth with amalgam stops.

5. *Interpenetrating (IPN) resin*

- Consists of an unfilled highly cross-linked, interpenetrating polymer network.
- Has good wear resistance.

Balanced setting

The following methods are used to achieve eccentric balance.

Functional chew-in technique

- Most accurate method of recording occlusal patterns.
- Record bases should have good stability.
- Patient should have good neuromuscular control.

The following techniques are suggested:

1. *Stansbury's technique (1928)*

This was the first functional chew-in technique.

- Compound maxillary occlusal rim is trimmed buccally and lingually so that occlusion is free in lateral excursions.
- Carding wax is added buccally and lingually and the patient is instructed to perform eccentric chewing movements.
- Carding wax gets functionally moulded, whereas the compound rim in the central fossa maintains the vertical dimension.
- Stone is vibrated onto the wax record occlusally, and the stone

record is secured to the lower member of the articulator.

- The denture teeth are first arranged to the lower cast of the patient's teeth.

- After aesthetics is approved at the try-in, the stone record of lower is secured and balance in eccentric positions is obtained.

2. *Vig's technique (1964)*

- It is similar to Stansbury's technique, except that a fin of acrylic resin is maintained at the vertical dimension instead of the compound rim (Fig. 16.9).

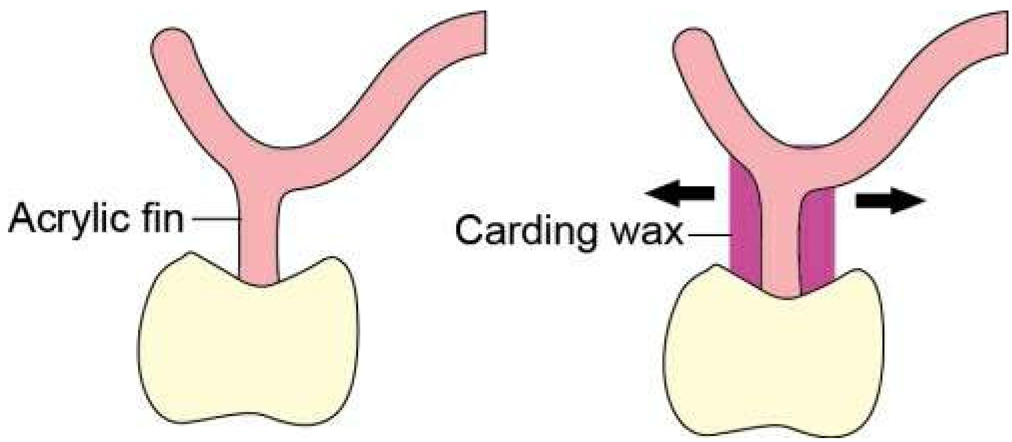


FIGURE 16.9 Vig's technique.

3. *Sharry technique*

- Uses softened wax rim in increased vertical dimension.

- Eccentric chewing movements are made such that wax is abraded generating the final paths of the lower cusps.

- It is continued until the correct vertical dimension is achieved.

4. *Rudd's technique*

- This technique is similar to Stansbury's technique.
- Uses a combination of baseplate wax and red counter wax instead of carding wax to make eccentric registration.
- But suggests using two maxillary bases, one for recording the generated path and the other for setting the teeth. It decreases the number of appointments.

Articulator equilibration method

- Most commonly used as it is similar to obtaining balance with conventional complete dentures.
- Used when denture bases are not stable and neuromuscular control of the patient is poor.
- After mounting the casts, teeth are arranged in centric occlusion. It has to be decided if the lower buccal or lingual cusp is the centric holding cusp depending on the relationship of the upper arch.
- During try-in, eccentric records are obtained to adjust the condylar settings on the articulator and teeth are arranged in eccentric balance. The cusps are modified depending on the centric holding cusp.

Try-in, insertion, recall and maintenance

These procedures are similar to conventional complete dentures.

Mandibular single complete denture

- Causes:
  - Irradiation therapy
  - Trauma
- Greater challenge than maxillary single denture due to the following:
  - Difficult to stabilize lower denture
  - Mandible is the movable member
  - Proximity to tongue
  - More resorption than maxilla
  - Limited availability of good quality mucosa
- Osseointegrated implants supported prosthesis is best in this situation.
- If patient cannot afford, conventional single denture is made, where the procedure is similar to that described for maxilla (Fig. 16.10). Patient should be educated about the potential problems.
- Some clinicians recommend use of resilient liners (see Chapter 15) in this situation to prevent soreness.

FIGURE 16.10 Mandibular single complete denture.

Complications of single complete denture:

- Combination syndrome
- Wear of natural teeth
- Fracture of denture

Combination syndrome

Definition: The characteristic features that occur when an edentulous maxilla is opposed by natural mandibular anterior teeth, including loss of bone from the anterior portion of the maxillary ridge, overgrowth of the tuberosities, papillary hyperplasia of the hard palate's mucosa, extrusion of the lower anterior teeth and loss of alveolar bone and ridge height beneath the mandibular removable dental prosthesis bases – also called anterior hyperfunction syndrome (GPT8).

It was described by Kelly in 1972.

Features

The above definition can be broken down to elicit the features (Fig. 16.11).

- Loss of bone in anterior maxilla with subsequent replacement by flabby fibrous tissue.
- Down growth of the tuberosities.
- Papillary hyperplasia of the hard palate.
- Supraeruption of lower anterior teeth.
- Bone loss under the lower distal extension removable prostheses.

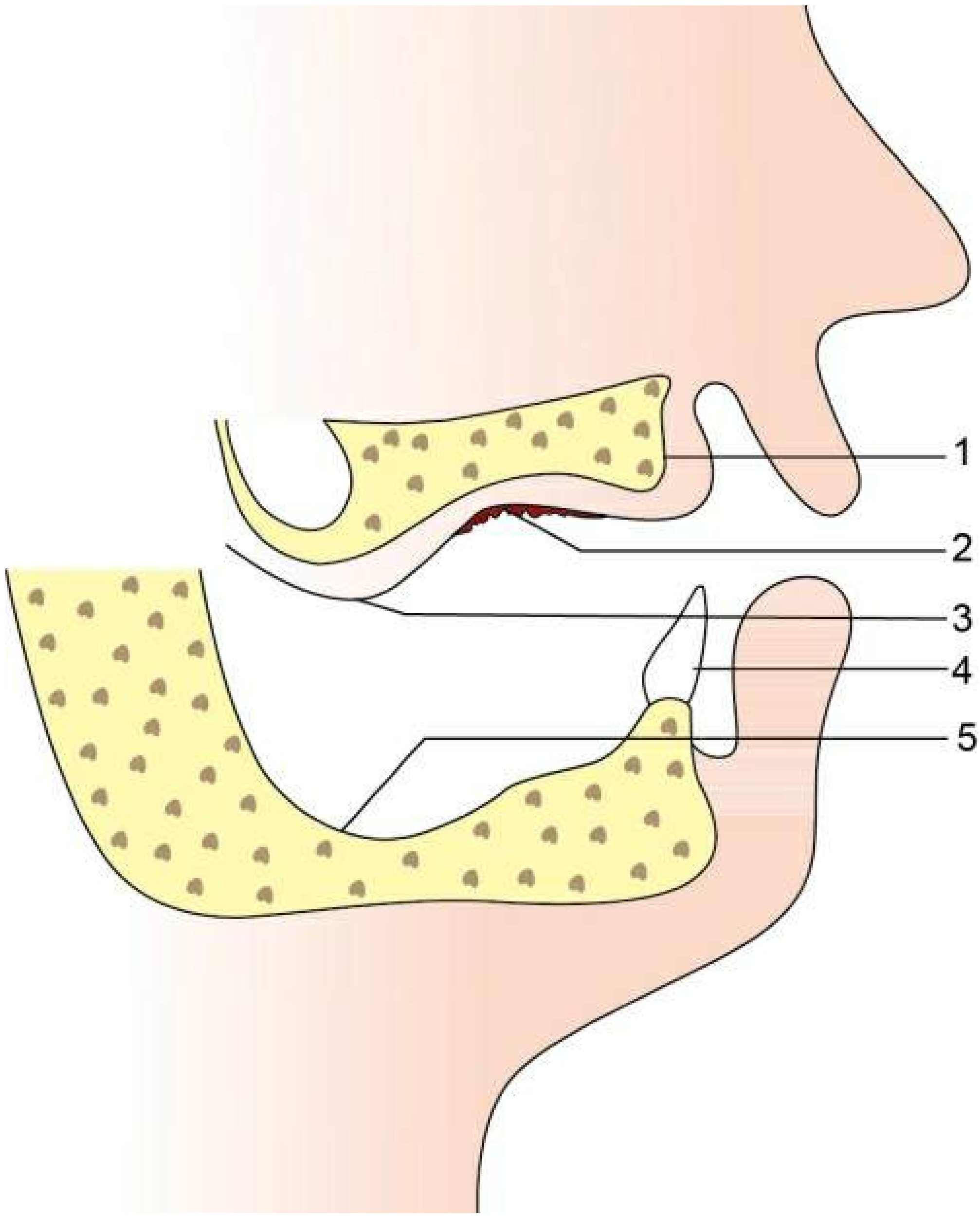


FIGURE 16.11 Combination syndrome. (1) Bone resorption in anterior maxilla. (2) Papillary hyperplasia of hard palate. (3) Enlarged maxillary tuberosities. (4) Supraeruption of lower anteriors. (5) Bone loss under distal extension prosthesis.

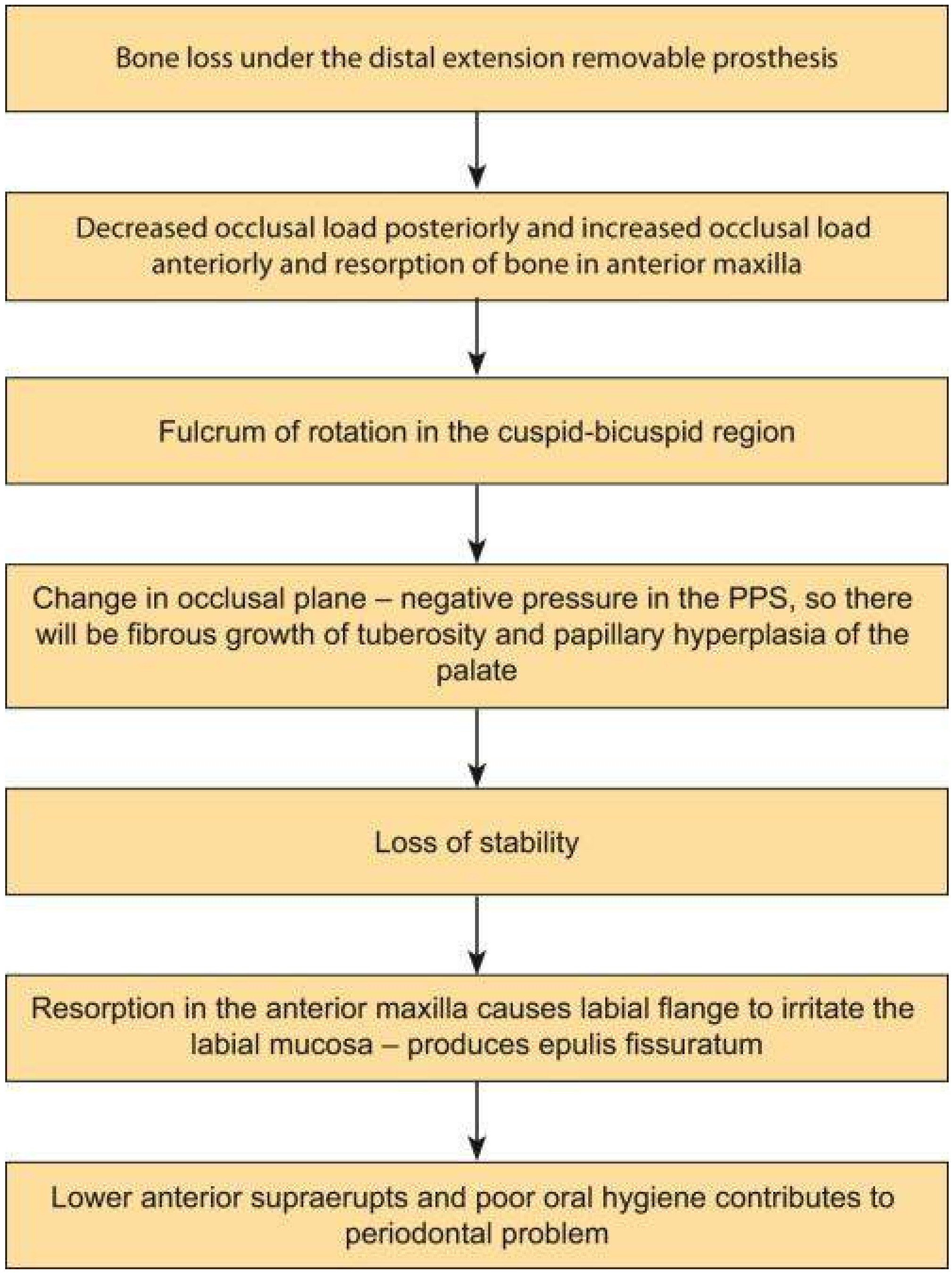
Saunders et al. (1978) added six more additional features:

- Loss of vertical dimension.
- Occlusal plane discrepancy.

- Anterior spatial repositioning of the mandible.
- Loss of stability and refabrication of the existing dentures.
- Epulis fissuratum.
- Periodontal problems of the remaining teeth.

Sequence

The sequence has been described in Flowchart 16.1.



FLOWCHART 16.1 Sequence of combination syndrome

Treatment planning

Systemic and dental considerations

1. *Systemic factors*

Systemic factors like diabetes and osteoporosis increase the rate of resorption of the bone.

2. *Dental factors*

- In case of class III jaw relationships, there will be increased pressure in the anterior maxilla.
- When lower anteriors are retained for a long time, the patient is accustomed to biting in the anterior region.
- Presence of parafunctional habits increases bone resorption.
- Type of occlusal scheme also has direct effect on the development of the syndrome.

Rationale

- Prevention of rapid resorption of the bone under the lower removable prosthesis by increasing stability through extension up to retromolar pad.
- Prevention of excessive load in the anterior region by providing a stable occlusal scheme.

○ Posterior occlusion free of interfering contacts during centric and eccentric movements.

○ Minimum contact in the anterior region even in protrusive movement.

○ Anterior teeth to be used only for phonetics and aesthetics.

- Education of the patient.

Prevention

- Retaining weaker posterior teeth by using combined endodontic and periodontal techniques.
- Fabricating a fixed prosthesis in the lower posterior region using endosseous implants.
- Planning for tooth-supported overdenture in the lower arch.
- Regular recall visits and checks with frequent relining to compensate for the resorption especially in the lower distal extension prosthesis.

SUMMARY

The single complete denture opposing natural or restored arches is a greater challenge than the conventional complete denture for the clinician. This is mainly due to the differences in support mechanisms of the natural and artificial teeth. The problems must be recognized and appropriate treatment should be provided to ensure a stable and comfortable prosthesis, which will preserve the supporting tissues. The patient should also be educated regarding the uniqueness of this treatment modality.

CHAPTER 17

Immediate dentures

CHAPTER CONTENTS

Introduction

Patients who have extracted all of their natural teeth in one or both jaws have to wait for at least 6–8 weeks after teeth are extracted before a conventional complete denture can be fabricated. The extraction sites heal during this period accompanied by a rapid period of alveolar bone remodelling. Consequently, the patient suffers the social indignity and functional difficulty of going without teeth for several weeks. The immediate denture offers a solution to this problem because it is constructed before and placed immediately following the extraction of natural teeth. It is more challenging than conventional dentures because a try-in is not possible to verify the arrangement of anterior artificial teeth.

Definition and types

Two types of immediate dentures are recognized:

- Conventional immediate denture
- Interim immediate denture

Immediate denture: Any removable dental prosthesis fabricated for placement immediately following the removal of a natural tooth/teeth (GPT8).

Interim denture: A removable dental prosthesis designed to enhance aesthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive prosthesis.

The conventional immediate denture is indicated when only the anterior teeth remain and posterior residual ridges are well healed. Following extraction of anterior teeth an immediate denture is provided, which only needs to be relined after the healing period.

The interim immediate denture is indicated when both anterior and posterior teeth are to be extracted at the same time and immediate dentures are provided. New complete dentures are fabricated after the healing period.

Advantages and disadvantages

The following are the advantages and disadvantages of any immediate complete denture.

Advantages

- Maintenance of patients' appearance as they are not without teeth even for 1 day.
- Acts as a bandage or splint to control bleeding.

- Less postoperative pain as extraction site is protected.
- Vertical dimension, jaw relationship, muscle tone, face height and tongue position is maintained.
- Speech and chewing habits and digestive function are not compromised and nutrition is maintained.
- Adjustment to the new dentures is quicker than with conventional complete dentures.
- Patient's social, professional and psychological status is not hampered.
- Artificial teeth can be arranged in same position occupied by the natural teeth.
- There is less resorption and better preservation of residual ridges as they are subjected to early function. The ridges are better adapted to support a denture.

Disadvantages

- Anterior try-in not possible, patient has no idea how the denture will look on the day of insertion.
- Requires more chairside time, additional appointments and cost.
- Bone resorption and shrinkage of unhealed soft tissues is greater and faster than the changes in healed tissues. These changes may require frequent relining.
- As the jaw relations are recorded with the natural teeth in varying numbers and locations, inaccurate centric and vertical records are possible.
- Cannot restore the stimulation that was supplied to bone by the

natural teeth.

- Anterior ridge undercut, commonly present when only anterior teeth remain, may produce inaccurate impressions.
- There will be a temporary impairment in speech and mastication.

Indications

- A dentulous or partially edentulous patient, whose remaining natural teeth are indicated for extraction.
- Patients for whom complete extractions are required and aesthetics cannot be compromised even for a short period due to social and professional commitments.

Contraindications

- Patients with poor general health or debilitating disease.
- Patients who are poor surgical risks – multiple extractions might be unwise because of systemic conditions like cardiac disease, uncontrolled diabetes, blood dyscrasias and those with slow healing potential.
- Emotionally disturbed individuals with psychological disorders.
- Uncooperative patients.

Conventional immediate denture

Diagnosis and treatment planning

- Similar to any complete denture patient.
- Posterior teeth are extracted and impression procedures are started after a healing period of 6–8 weeks.
- To ensure optimal aesthetics and occlusion, if upper and lower immediate dentures are planned, they should be fabricated simultaneously.

Impressions

- Preliminary impressions are made with irreversible hydrocolloid.
- Preliminary cast is poured (Fig. 17.1) and custom tray is fabricated.
- Final impressions can be made using two methods:
  - Single impression technique using a custom tray covering the teeth and edentulous ridges.
  - Dual impression technique using a custom tray covering only the edentulous space and lingual surface of anterior teeth.

FIGURE 17.1 Preliminary cast.

Single impression technique

- Custom tray is fabricated in autopolymerizing acrylic resin as follows:

○ **Spacer:** One sheet of baseplate wax (2 mm) covers the edentulous ridges, while two sheets of wax (4 mm) cover the natural teeth (Fig. 17.2).

○ **Stops:** One anteriorly and two posteriorly on either side – in first molar area (Fig. 17.3).

○ Peripheral extension – 2 mm short of vestibule.

• Border moulding of the entire border is performed using low fusing green stick compound.

○ The interdental spaces between the anterior teeth are blocked out with wax.

○ Final impression is made with regular/medium body elastomeric impression material (Fig. 17.4A and B).

FIGURE 17.2 Preliminary cast with spacer.

FIGURE 17.3 Stops placed in the wax.

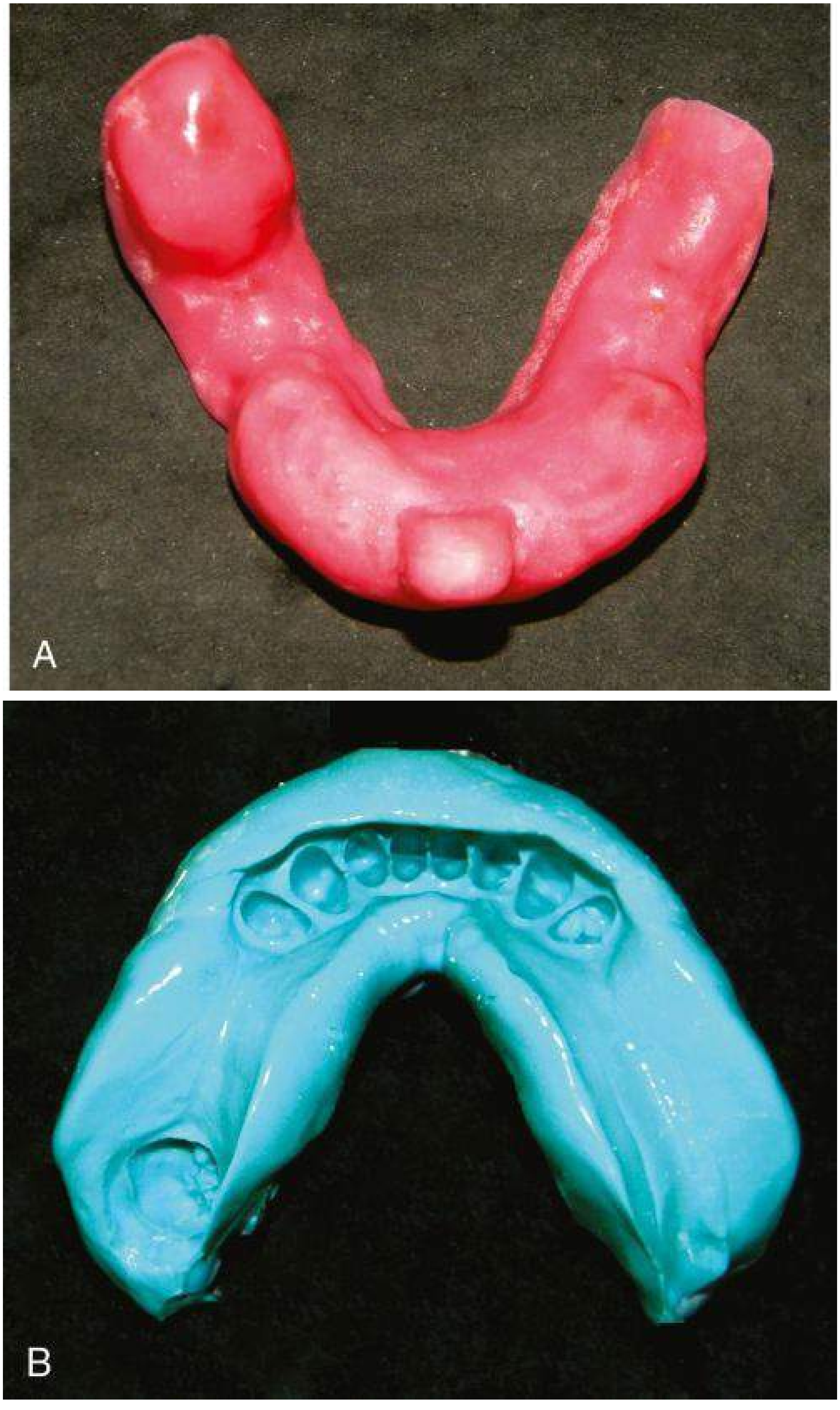

A
B

FIGURE 17.4 **(A)** Custom tray fabrication. **(B)** Final impression.

Dual impression technique

- Similar to the pick-up impressions described for removable partial dentures.
  - Custom tray is fabricated covering only the edentulous space and lingual surface of anterior teeth (Fig. 17.5).
  - Custom tray is inserted and only the edentulous section is border moulded with green stick low fusing compound (Fig. 17.6).
- Final impression is made of the edentulous area and lingual part of the anterior teeth with zinc oxide eugenol (ZOE) impression paste or regular/medium body elastomeric impression material (Fig. 17.7).
- After this material sets, the impression is removed from the mouth and the tray handle is cut off:
  - The impression is reseated in the mouth and a second impression is made over the edentulous impression and anterior teeth with a stock tray using irreversible hydrocolloid (Fig. 17.8).
- A master cast is made and record base with occlusal rim is fabricated for the edentulous posterior regions.

FIGURE 17.5 Custom tray for edentulous area.

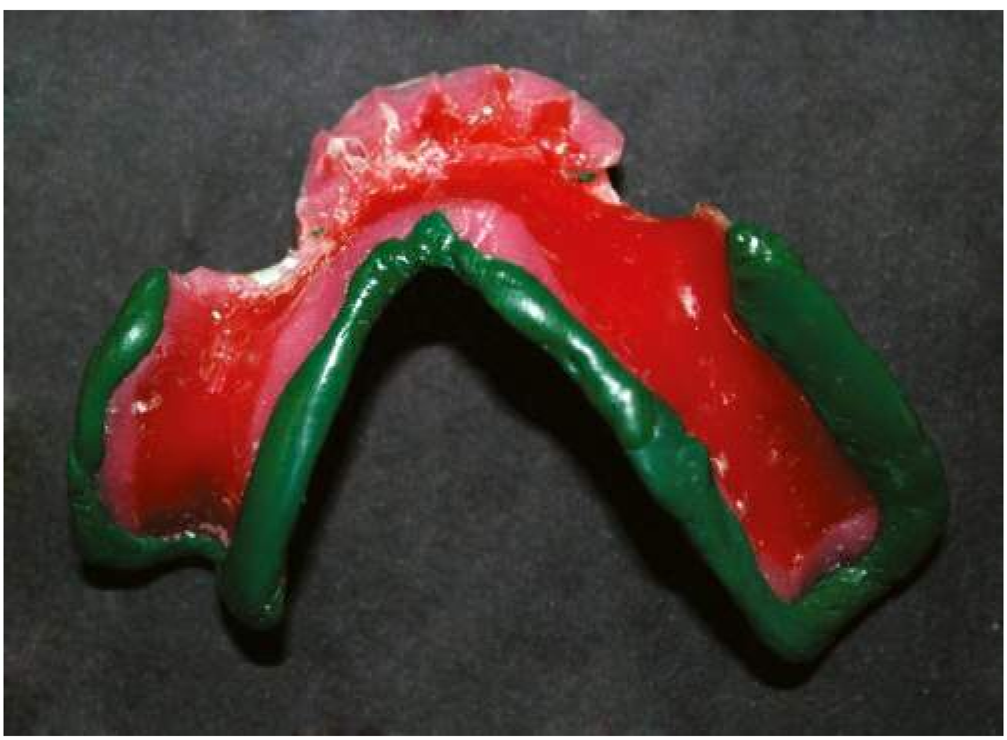


FIGURE 17.6 Border moulding of edentulous ridge.

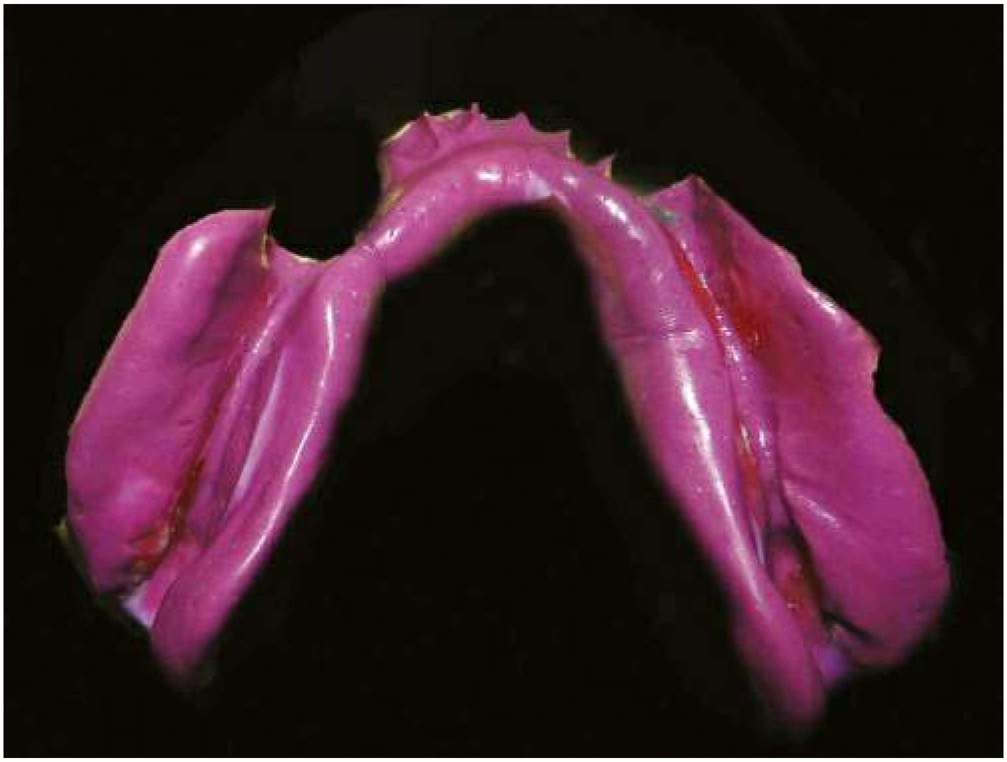


FIGURE 17.7 Impression of edentulous area.

FIGURE 17.8 Impression of teeth using irreversible hydrocolloid.

Jaw relation records

- Similar to conventional CD.
- Facebow transfer used to mount maxillary cast.
- A static centric record is obtained at vertical dimension of occlusion and lower cast is articulated (Fig. 17.9).
- Eccentric records as applicable are also obtained to adjust the condylar guidance on an articulator.

FIGURE 17.9 Articulated casts using centric record.

Teeth selection and posterior teeth arrangement

- The teeth are selected using the existing teeth as guide for size and shape. Acrylic resin denture teeth are indicated as they are easier to trim and adjust.

○ Posterior teeth are arranged with tight, multiple centric contacts in centric relation. Bilateral balancing contacts are given in eccentric movements (Fig. 17.10).

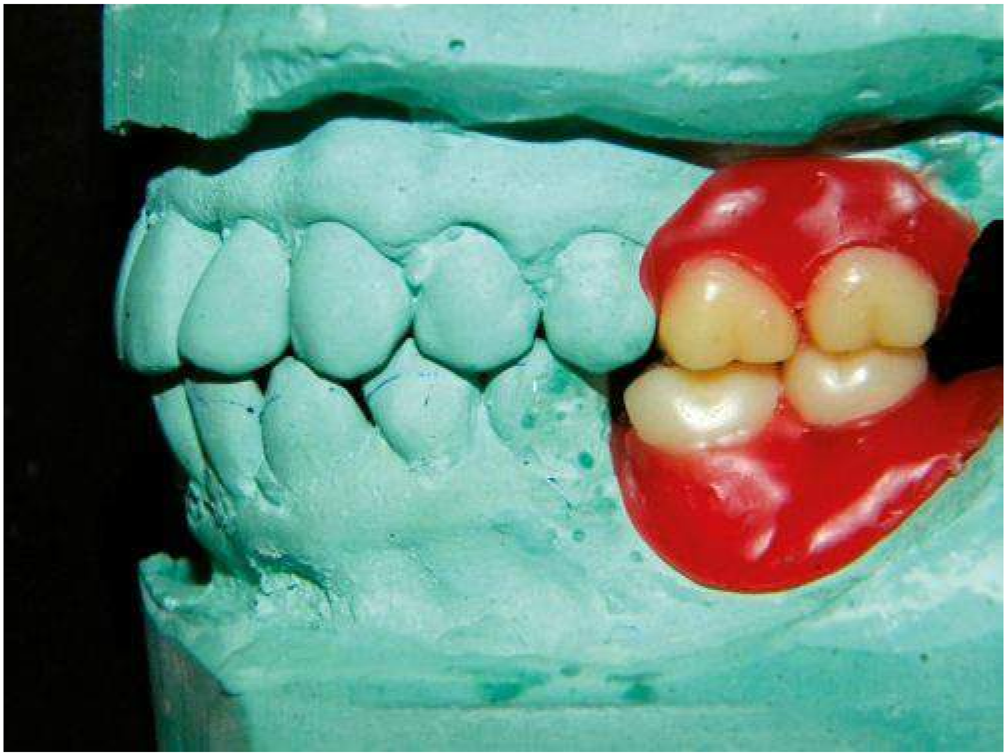


FIGURE 17.10 Posterior teeth setting.

Try-in

- A try-in of the posterior teeth is scheduled. Centric relation, vertical dimension and occlusion are verified.

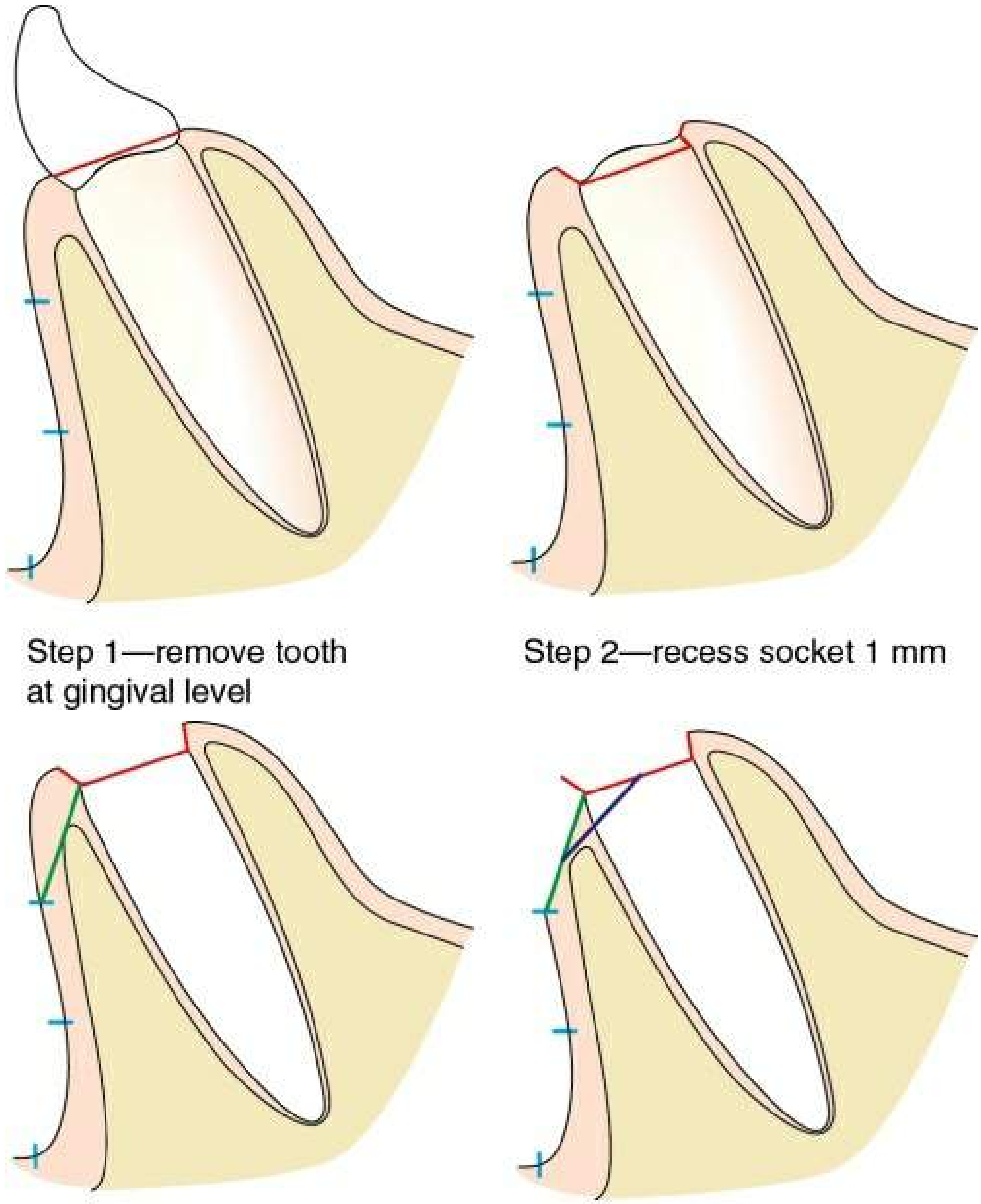
Arranging the anterior teeth

- Depends on whether the patient wants to duplicate the existing arrangement or not.

- If the patient desires to have his anterior teeth in the original position, alternate teeth are cut away on the cast and the labial portion of each root is excavated to a depth of 1–2 mm on the labial side and flush with the gingival margin of the lingual or palatal side. The selected teeth are placed in their specific positions and modified. By removing only one tooth at a time, the dentist can position the teeth in its original position.

- If the existing arrangement is not required, the casts are made edentulous and the desired tooth arrangement is created irrespective of where the natural teeth were (Fig. 17.11).
- The method of removing the existing natural teeth on the cast is shown in Fig. 17.12.

FIGURE 17.11 Completion of maxillary anterior teeth setting after removing maxillary teeth from cast.



Step 1—remove tooth
at gingival level

Step 2—recess socket 1 mm

Step 3—labial edge recess to
incisal third mark

Step 4—midpoint recess to
midwidth labial cut

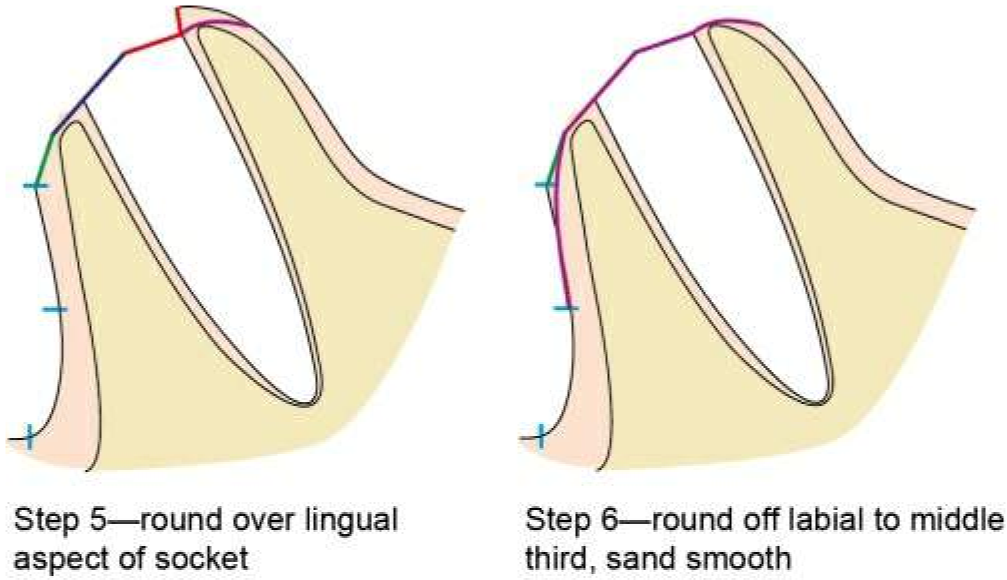


FIGURE 17.12 Steps in removing existing natural teeth from cast. Source: *Courtesy:* Jerbi FC. Trimming the cast in the construction of immediate dentures. J Prosthet Dent 1966;16(6):1047–53.

Waxing and processing the denture

- The waxing is completed (Fig. 17.13A) and the dentures are processed, and resultant changes in occlusion are corrected before removal of the dentures from their casts for final finishing. The dentures are then finished and polished.

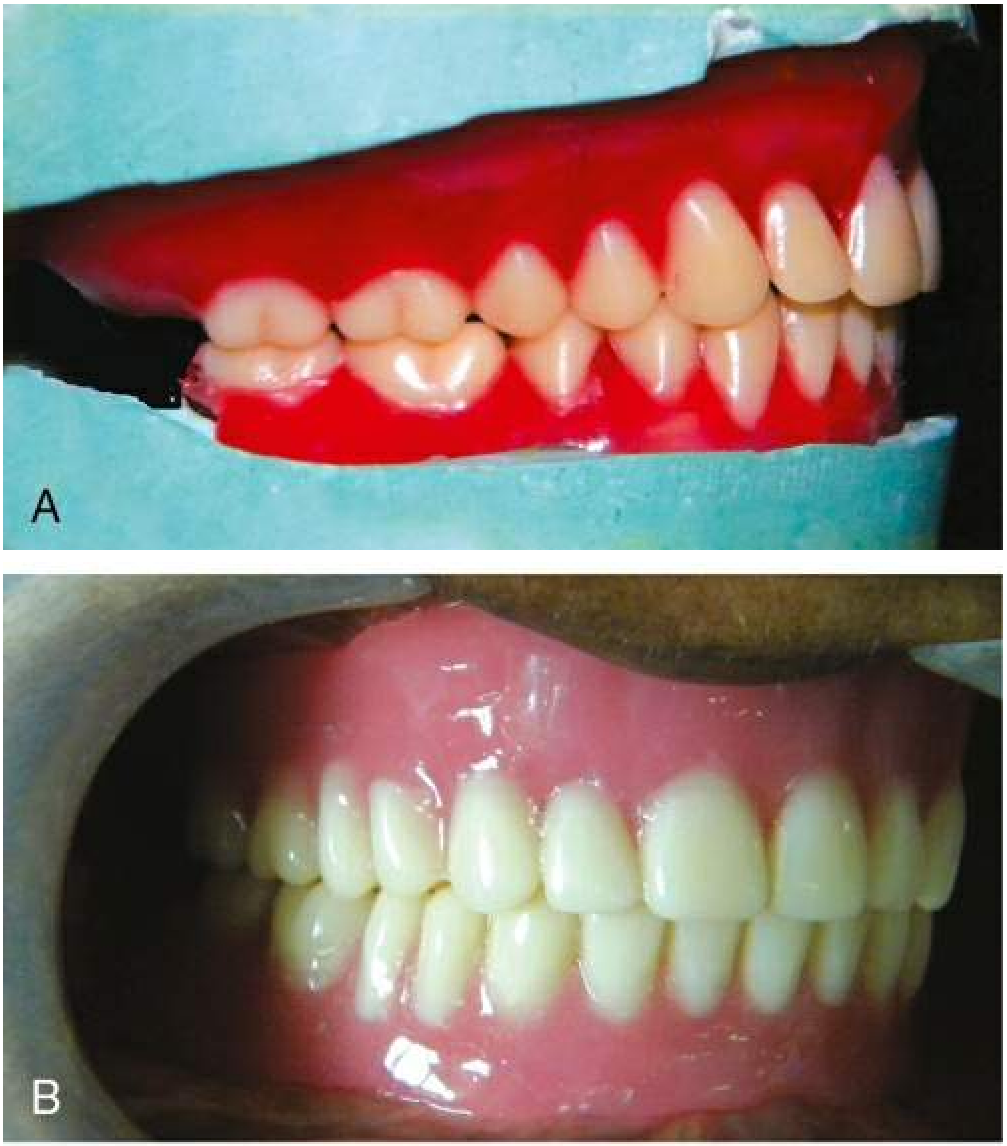


FIGURE 17.13 **(A)** Waxing completed. **(B)** Denture inserted immediately following teeth extraction.

Insertion of dentures

- The teeth are extracted with a minimum of trauma.
- A clear acrylic surgical guide fabricated on a duplicated model of the master cast after removing the existing teeth can be used to evaluate the surgical site and demonstrate areas of pressure. Areas

that require adjustment will be shown as blanched tissue through the guide, so that the denture can be adjusted or the alveolar bone and soft tissue modified surgically if necessary to accommodate the denture.

- After the surgical procedures are completed, the denture is inserted (Fig. 17.13B). Denture borders are checked for overextension and corrected. Gross occlusal irregularities are then corrected. Final correction is done after initial healing at recall appointments. Tissue conditioners can be used if the retention or adaptation is poor, after protecting the surgical site.

- The patient is instructed to wear the denture for next 24 h and is recalled the next day. If denture is removed during this period, tissue inflammation and oedema will prevent reinsertion of denture for several days.

- Patient is also instructed to avoid expectorating, gargling, smoking, hot liquids and alcohol. Cold packs are suggested with soft diet and cold drinks for that day.

- Appropriate medications are prescribed.

Postinsertion care

- The patient is seen 24 h after the denture insertion.

- The denture is removed and cleaned. The patient is asked to rinse with a mouth wash. The denture is evaluated for overextension and pressure spots, which are corrected. Again, only gross occlusal discrepancies are corrected. Patient is shown how to insert and remove the denture and instructed to rinse after every meal and clean the dentures. They are advised to wear the denture during night for 1 week till the postoperative swelling subsides.

- The patient is next seen after 1 week and now definitive occlusal correction is done. Tissue conditioners are used to reline the denture and are replaced every week.

- Patient is then recalled after 1 month and a clinical remount can be done to refine the occlusion and subjective complaints are addressed.

- Usually it takes 8–12 months for complete healing following extraction. Practically, it is possible to reline the denture in 6 months, but patient should be made aware that areas will continue to remodel and further relining may be needed.

- A functional technique (see Chapter 15) is used to perform a definitive relining.

Interim immediate dentures

Usually indicated with periodontally involved natural teeth which can be removed without any surgical trauma.

Advantages

- Similar to advantages of conventional immediate dentures.
- Can be worn during the construction of new dentures.
- Patient has the benefit of having a spare denture.
- Provides information about jaw relations and aesthetics during construction of conventional complete dentures.
- The procedure is quick as patient's existing teeth or old partial dentures are used to replicate the artificial teeth.

Procedure

- Maxillary and mandibular impressions are made using irreversible hydrocolloid after blocking out the interdental spaces with wax.
- Two sets of casts are poured.
- Baseplate wax is melted and poured into the impressions of the teeth up to gingival margin. After the wax hardens, the rest of the impression is poured in dental stone (Fig. 17.14A). This cast will be used to process the denture maintaining the shape of the patient's original teeth.
- After the first cast sets (Fig. 17.14B), it is carefully removed from the impression and a second cast is poured entirely in dental stone. This is used to make record base for jaw relations and also as a reference

cast while making the new dentures.

- As most of the natural teeth may be present anteriorly and posteriorly, sometimes hand articulation of cast may be sufficient. If not, record bases are made with occlusal rims and static centric record is obtained similar to that for removable partial dentures (Fig. 17.15).

- The casts are articulated and missing teeth are arranged using denture acrylic teeth.

- Waxing is done using baseplate wax to cover the flanges up to the vestibule and the palate. Gingival margins of the wax teeth are sharply demarcated (Fig. 17.16) so that tooth colour resin can be clearly delineated from the pink denture base resin during packing.

- The casts are flasked and dewaxed. All the teeth will be made with tooth coloured acrylic resin. So if any denture teeth are present, they are removed and tooth coloured resin of appropriate shade is mixed and poured into the space provided by the wax teeth up to the margin (Fig. 17.17A). The pink denture base resin is now packed into the mould and cured (Fig. 17.17B).

- The denture is deflasked, undercuts are trimmed and borders shortened, thinned but rounded. The dentures are finished and polished (Fig. 17.18).

- Extraction of all teeth is done atraumatically and the dentures are inserted at the same time. Relining with tissue conditioner may be necessary.

- All other instructions are similar to conventional immediate dentures

- A new set of complete dentures is fabricated after 4–6 months.

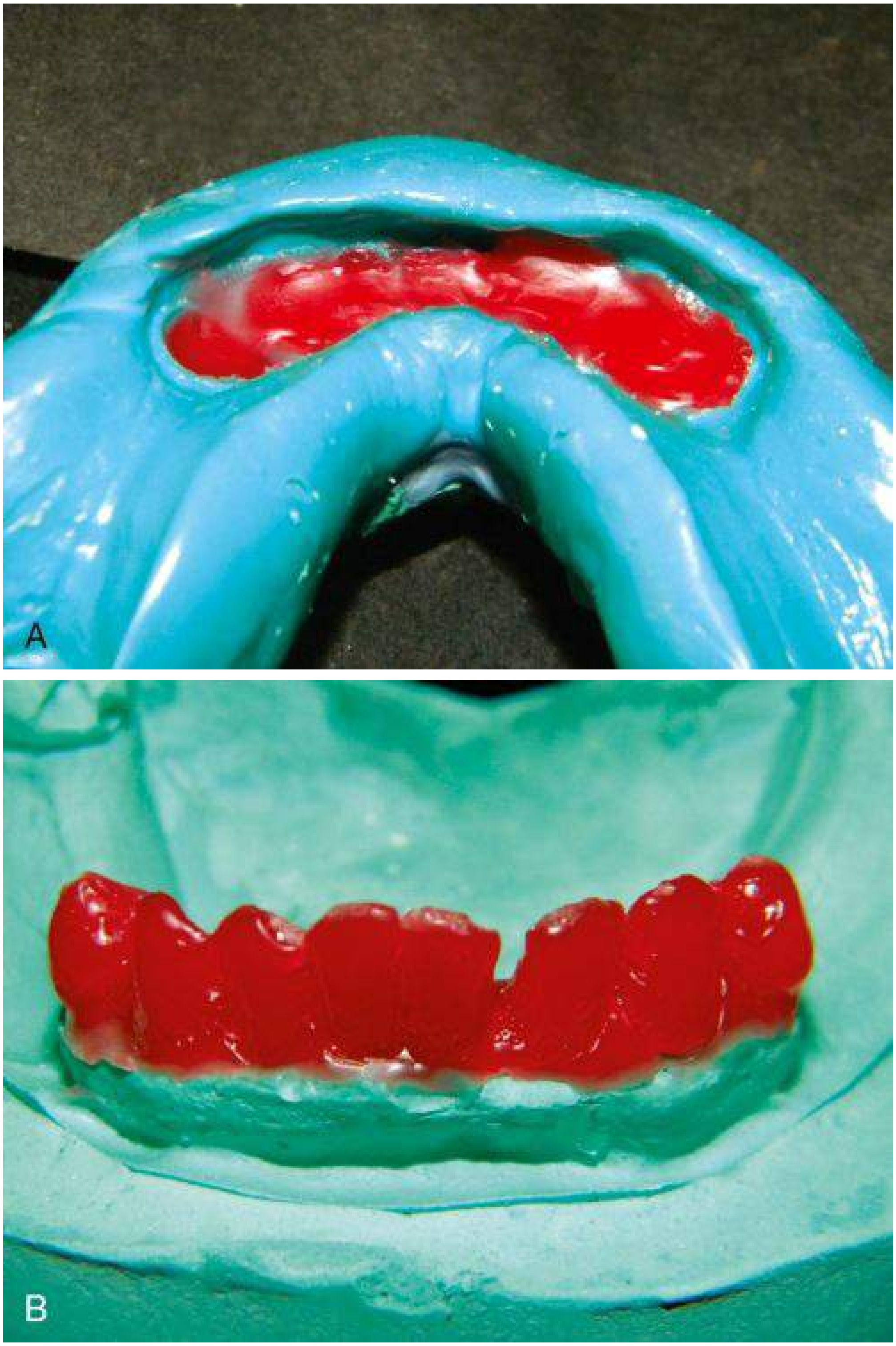


FIGURE 17.14 **(A)** Teeth areas filled up with wax in the impression. **(B)** Replica of patient teeth in wax following retrieval of cast from impression.

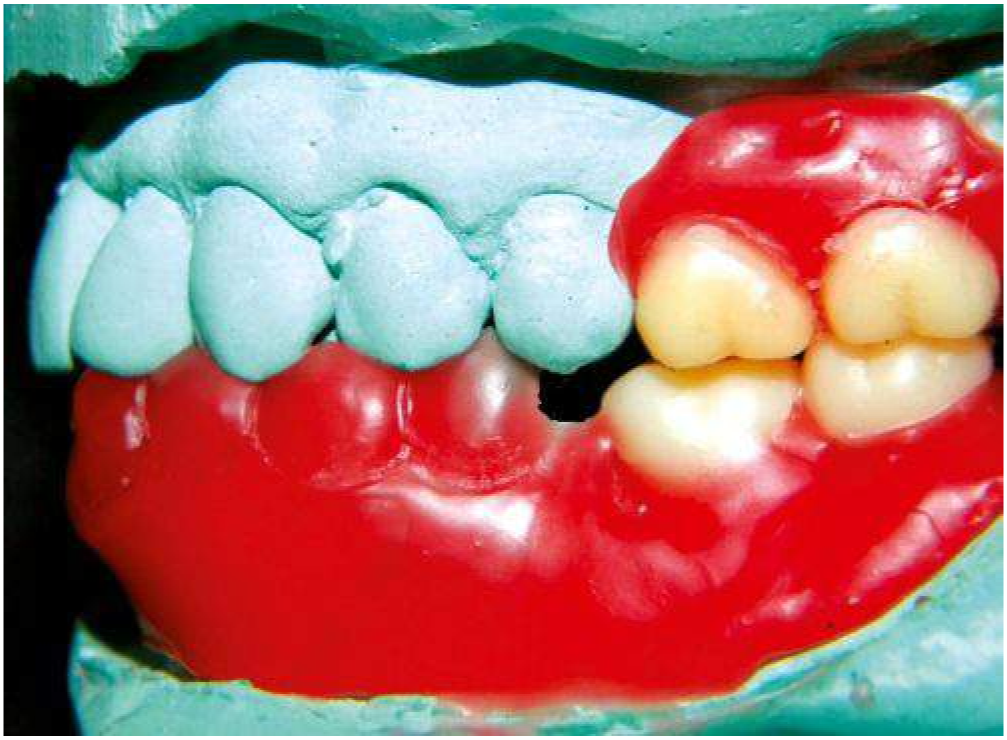


FIGURE 17.15 Articulation of cast and arranging missing teeth.

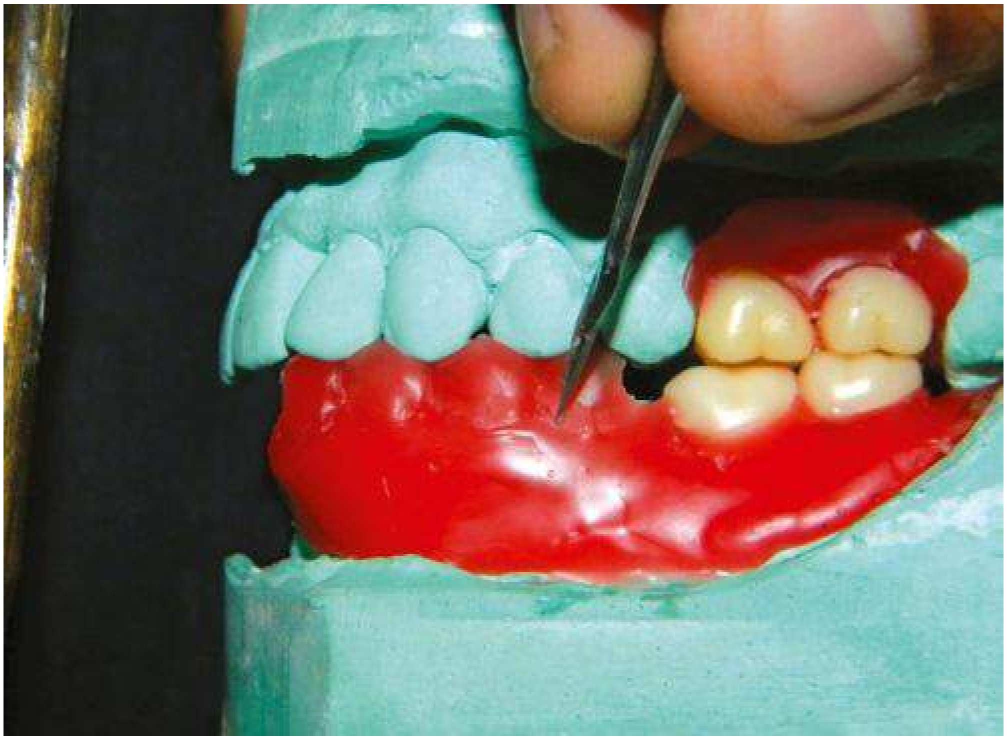


FIGURE 17.16 Waxed up models, and gingival carving being done to demarcate pink and tooth coloured acrylic.


A

FIGURE 17.17 **(A)** Tooth coloured heat cure acrylic resin of appropriate shade is poured on the dewaxed teeth portion. The denture teeth will be replaced with resin. **(B)** Pink heat cure acrylic is packed over the tooth coloured material.

FIGURE 17.18 Completed immediate denture made with custom acrylic teeth.

Comparison of conventional and interim immediate dentures

Table 17.1 compares the conventional immediate denture with the interim immediate denture.

Table 17.1

Differences between conventional and interim immediate dentures

Conventional immediate denture	Interim immediate denture
Definitive or long-term prosthesis, as it is only relined after healing	Transitional or short term – new dentures are made after healing
Costs less – denture and relining	Costs more – two dentures
Time to provide immediate denture is longer as posterior teeth if present have to be extracted and area is healed	Less time as all teeth are extracted in the same time
Aesthetics cannot be changed	Aesthetics can be changed as a new denture is made
Vertical dimension may not be maintained as posterior teeth are removed	Vertical dimension is maintained as posterior teeth are not removed
At the end of treatment, the patient has one denture	At the end of treatment, the patient has two dentures

SUMMARY

Immediate dentures are an important treatment modality as they provide instant aesthetics and function to the patient after extraction of all natural teeth. More importantly, they provide a psychological support to the patient at the time of this debilitating loss. It is time consuming and expensive and patient should also understand the limitations of this service.

SECTION 2
Removable Partial Dentures

OUTLINE

30. Forms of removable partial dentures

CHAPTER
18

Introduction

CHAPTER CONTENTS

Introduction

The study of removable partial denture is not just about the fabrication of restorations but more importantly about promotion of oral health, preservation of remaining oral structures and restoration of oral function with an aesthetically pleasing result. There are various types of removable partial dentures and the clasp retained cast partial denture will be discussed in detail in this section as it is commonly used and meets the objectives. Some of the introductory terminologies along with indications and steps in the fabrication of this type of denture are dealt within this chapter.

Definitions

Removable prosthodontics: The branch of prosthodontics concerned with the replacement of teeth and contiguous structures for edentulous or partially edentulous patients by artificial substitutes that are readily removable from the mouth (GPT8).

Removable partial denture (RPD): It is defined as any prosthesis that replaces some teeth in a partially dentate arch. It can be removed from the mouth and replaced at will – also called *partial removable dental prosthesis* (GPT8).

Basically there are two types of RPDs:

1. **Acrylic partial dentures**: These are made of acrylic resin with clasps of wrought wire. They are commonly referred to as 'flippers'. They are entirely tissue supported and cause gingival recession with long-term use. Hence, they are commonly termed as *'gum strippers' and* should be used only as temporary dentures (Figs 18.1 and 18.2).

2. **Cast partial dentures**: These are mainly fabricated by the lost wax casting method and hence the name. The teeth and denture base are made of acrylic resin. These are of two types.

   i. **Clasp retained –** uses cast metal clasps for retention (Fig. 18.3).

   ii. **Attachment retained partials –** uses prefabricated attachments for retention (Figs 18.4 and 18.5).

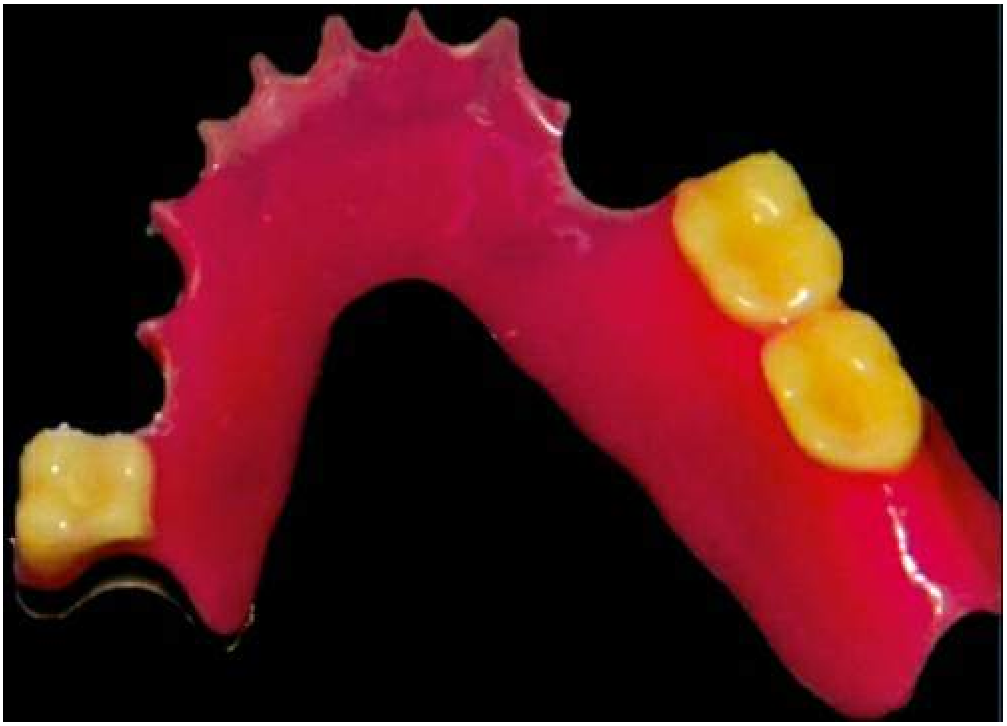


FIGURE 18.1 Acrylic partial denture without clasps.

FIGURE 18.2 Acrylic partial denture with clasps.

FIGURE 18.3 Clasp retained cast partial denture.

FIGURE 18.4 Attachments placed on 14 and 25 crowns.

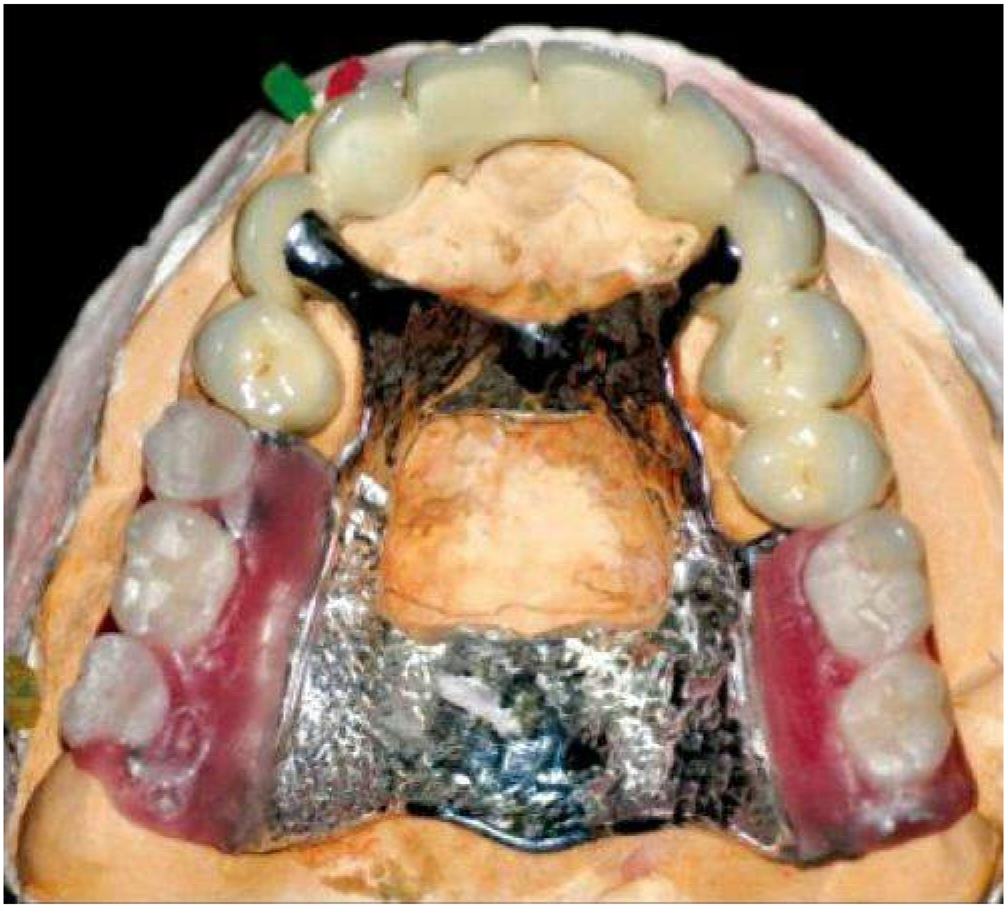


FIGURE 18.5 Attachment-retained cast partial denture.

An RPD may be intracoronal or extracoronal depending on its type of retention. This is discussed in Chapter 21.

Temporary RPD: They are used where tissue changes are imminent. They may be of three types:

1. **Interim denture:** Used to enhance aesthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive dental prosthesis.

2. **Transitional denture:** A removable dental prosthesis serving as an interim prosthesis to which artificial teeth will be added as natural teeth are lost and that will be replaced after postextraction tissue changes have occurred.

3. **Treatment denture:** A dental prosthesis used for the purpose of

treating or conditioning the soft tissues that have been abused by ill-fitting prosthesis. May also be used after surgery to protect a surgical site or reposition soft tissues. These are discussed in Chapter 30.

Tooth-supported RPD: A dental prosthesis or part of a prosthesis that depends entirely on the natural teeth for support (Fig. 18.6).

FIGURE 18.6 Tooth-supported removable partial denture.

Distal extension base RPD: A removable dental prosthesis that is supported and retained by natural teeth only at one end of the denture base segment and in which a portion of the functional load is carried by the residual ridge (Fig. 18.7).

FIGURE 18.7 Distal extension removable partial denture.

Appliance: Refers to devices (such as splints, orthodontic appliances and space maintainers) worn by the patient in the course of treatment (Fig. 18.8). This is often incorrectly used interchangeably with the term *prosthesis* that is an artificial replacement of a missing body part.

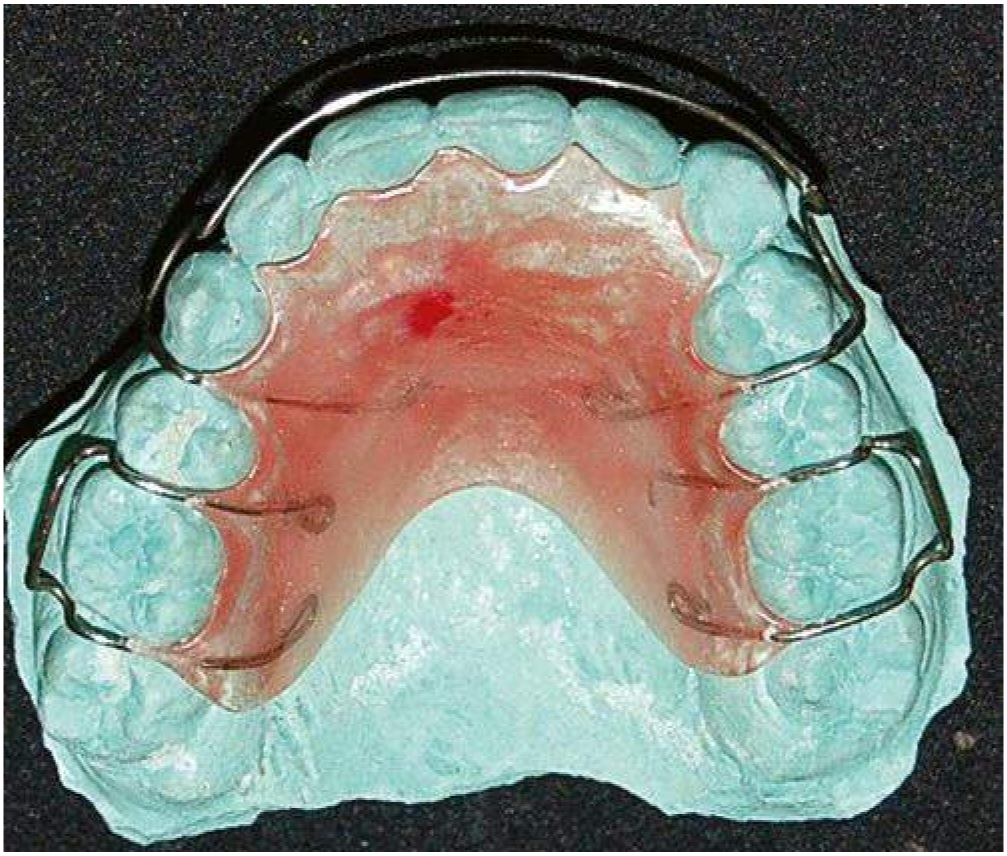


FIGURE 18.8 Removable orthodontic appliance with labial bow and clasps.

Abutment: Any tooth or a portion of a tooth that serves to support and/or retains prosthesis. A fixed partial denture (FPD) is cemented over the abutments, whereas the RPD is attached to abutment by clasp assembly (direct retainers).

Retainer: The fixation device, or any form of attachment applied directly to an abutment tooth and used for fixation of prosthesis. Example: direct retainer.

Retention: Is the quality inherent in denture that resists the vertical forces of dislodgement (e.g. the forces of gravity, the adhesiveness of foods or the forces associated with the opening of the jaws).

Support: The resistance to displacement towards the basal tissue or underlying structures.

Stability: Defined as the quality of the prosthesis to be firm, stable or constant and to resist displacement by functional, horizontal or rotational stresses.

Cast: An accurate reproduction of maxillary or mandibular dental arch.

Model: It is the reproduction for demonstration or display purposes, accuracy is not implied.

Cross-arch stabilization: Resistance against dislodging or rotational forces obtained by using a partial removable dental prosthesis design that uses natural teeth on the opposite side of the dental arch from edentulous space to assist in stabilization (Fig. 18.9).

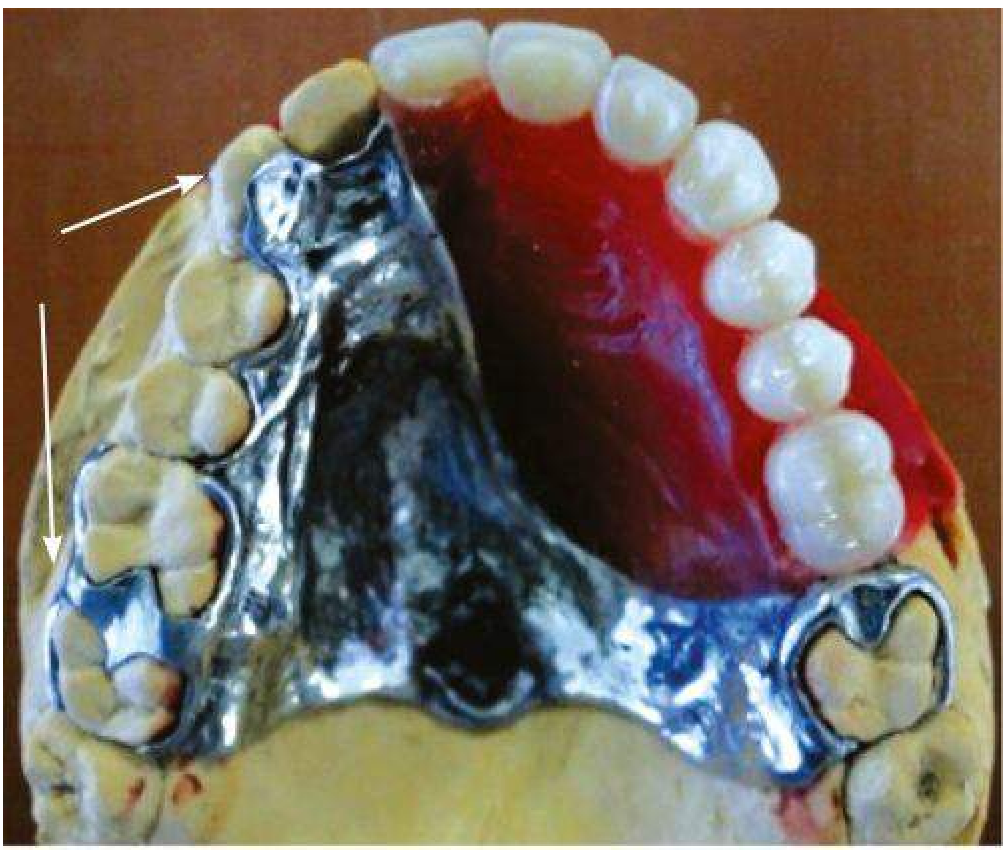


FIGURE 18.9 Cross-arch stabilization – teeth on opposite side of edentulous space used for stabilization of prosthesis.

Indications and contraindications

The treatment of choice for the partially edentulous patient when all factors are favourable is normally an FPD. However, certain situations necessitate the use of RPDs. With the advent of dental implants combined with the success and comfort of fixed restorations, generally the RPDs may not be the first line of treatment for partial edentulism.

Indications

They can be divided into extraoral and intraoral factors and are summarized in Table 18.1.

Table 18.1

Indications for removable partial dentures

Extraoral factors	Intraoral factors
Age	Distal extension situations
Sex	Long edentulous span
General health	Reduced periodontal support
Occupation and economic status	Cross-arch stabilization
Patient desires and attitude	Excessive residual ridge resorption
Time factor	Aesthetics
	Immediate replacement of teeth
	Obturation of intraoral defects
	Alteration of vertical dimension
	Poor prognosis for complete dentures

Extraoral factors

Age

The teeth of patients under the age of 17 have large pulp chambers and lack clinical crown height. Tooth preparation runs the risk of exposing the pulp and less crown height decreases retention, thereby contraindicating an *FPD*. Similarly in an old patient with frequent health problems an expensive FPD that requires tedious procedures like tooth preparation may not be indicated. RPD is indicated in these conditions.

Sex

In general, women tend to have a greater vanity index, i.e. to place greater values on the aesthetic excellence of the prosthesis, than does the male. Generally, it is said that the female is more apt to equate loss of teeth with the process of ageing or the state of old age. Accordingly, she may insist on retaining the natural teeth of dubious value long after her male counterpart has accepted and grown accustomed to his complete dentures.

General health – physical and emotional

Patient who is in poor health should be spared the trauma of long dental procedures required for FPD. Radical disruption of the oral status should be avoided until the health of such a patient can be returned to a normal status. Interim partial denture is the prosthesis of choice in preference to the complete denture and the temporary partial denture instead of the FPD, in these situations.

Occupation and economic considerations

Patients with lower occupational levels, i.e. labourers and housemaids, may prefer RPDs due to their financial condition. Immaterial of occupational levels an RPD is indicated in patients with poor oral hygiene until normalizing their condition and giving appropriate oral hygiene instructions. Similarly, individuals who engage in contact sports should be given special consideration when prescribing a prosthetic service, because swallowing or aspirating prosthesis, as a result of sudden impact, has been known to occur and is fraught with serious implications. The removable prosthesis has the advantage of readily being removed from the mouth, while the person is engaged in the sport.

Patient desires and attitude

Generally individuals with scant respect for remaining teeth with poor oral hygiene status should be treated with removable prostheses.

Sometimes patients may insist on RPDs instead of FPD to avoid preparation of sound healthy teeth and economic reasons.

Time factor

If time is the factor dictating prosthodontic services, interim partial denture is the treatment of choice until the patient can afford to spend the time required for definitive prostheses.

Intraoral factors

Distal extension situations

In distal extension situations when a patient cannot afford dental implants, an RPD is indicated, as there are no posterior abutments for support. In selected instances, a cantilever FPD may be planned when only one tooth is to be replaced posteriorly and opposing occlusion is also made of artificial teeth.

Long edentulous span

In such situations, an RPD is indicated as the partial denture derives support from both the abutment teeth and the underlying soft and hard tissues. This also dissipates forces over a wider area minimizing damage to abutment teeth and soft tissues. Ante's law is generally used to assess the periodontal support available for replacement with FPD.

Reduced periodontal support of remaining teeth

In patients with reduced periodontal support of the existing teeth, an RPD is indicated as the support can then be distributed between the teeth and the ridge.

Cross-arch stabilization

Wherever anteroposterior and lateral stabilization is required especially after treatment of advanced periodontal disease, an RPD is indicated. FPD only provides limited lateral stabilization.

Excessive residual ridge resorption

Whenever there is excessive bone loss of the edentulous ridge, may be due to trauma, the replacement of all the lost tissues is difficult to achieve with FPD. Also the teeth may look very lengthy and ideal buccolingual position cannot be achieved. So an RPD is an ideal alternative with the flange of denture base establishing normal facial contours by providing necessary support to the cheeks and lips.

Aesthetics and replacement of multiple anterior teeth

Denture teeth more often provide a more lifelike appearance than the flat and dull look of an FPD pontic as it looks to emerge from the gingiva, like natural teeth. They can also be arranged more easily to satisfy phonetic and support requirements.

Immediate replacement of teeth following extraction

Immediately after extraction of natural teeth an interim partial denture is a better option, as it will simulate the natural contour and appearance of the lost portion. It will also act as a splint and facilitate healing of the underlying residual ridge. Further, relining is possible as resorption occurs with healing. After healing is completed, the definitive prostheses can be planned depending on the existing clinical condition.

Obturation of intraoral defects

Any intraoral defect, e.g. palatal cleft, is better closed with removable prostheses. Most of the patients with defects have compromised dentition, which requires salvaging. A partial denture in these patients not only provides support (tooth–tissue borne) and cross-arch stabilization but also obturates the defect thereby preventing regurgitation of food and also provides better aesthetics and phonetics.

Abutments with questionable prognosis

In some patients abutment teeth with questionable prognosis requiring extraction may have to be retained either due to health or financial reasons. In these patients, removable prostheses in the form of transitional prostheses depending on the clinical situation are preferred.

Alteration of vertical dimension

Vertical dimension has to be altered gradually. The required change has to be accomplished in two or three increments. So this is better accomplished by making a removable prosthesis giving the necessary time to the patient to adjust to each increment. Better control can be achieved with removable prostheses in adjusting the required vertical dimension and also in subsequent alterations.

Poor prognosis for complete dentures

This is most often seen in patients with retrognathic jaw relation. Retaining some mandibular teeth and giving RPD to patient are of extreme importance, as a CD will pose more problems.

Contraindications

There are no contraindications for an RPD and this type of prosthesis can be given in almost all clinical situations, but wherever possible fixed prostheses are preferred. However, an RPD may be avoided in the following situations:

1. Patients who lack the dexterity to insert prosthesis.

2. Patient who do not care to maintain oral hygiene.

3. Epileptic patients where there is a danger of swallowing the denture during an attack.

Steps in fabrication of a clasp-retained cast removable partial denture

The following clinical and laboratory procedures are required to fabricate a clasp-retained cast RPD. Each of these is explained in detail in the relevant chapters of this book in the subsequent chapters.

1. **Examination**: This usually requires two appointments. It involves collection of diagnostic data, patient details – attitude and expectations, general health, intra- and extraoral examination, radiographic examination and making diagnostic impressions. Irreversible hydrocolloid is the material of choice for making this impression (Fig. 18.10A and B).

2. **Diagnostic casts – survey and design:** Diagnostic casts are poured and analysed by mounting on surveyor (Fig. 18.11A). The most favourable path of insertion is determined by considering guide planes, retentive undercuts, interferences and aesthetics. The type of denture that best suits the needs of the patient is designed and planned (Fig. 18.11B).

3. **Preparation of mouth**: These include all procedures to eliminate pain, interferences and those which act as an adjunct to the success of the prosthesis. Procedures include extractions and surgeries, restorations and endodontic treatment, periodontal treatment, interim prosthesis and FPDs. It would be appropriate to wait for at least 6 weeks if any surgical preprosthetic procedures have been performed before making preliminary impressions and casts to fabricate custom trays. If no procedures are indicated for preparing the mouth, the diagnostic casts will serve as the preliminary casts and custom trays (if needed) are fabricated on this. If some procedures have been performed, a preliminary impression is made, casts poured and custom trays are fabricated (as indicated).

4. **Preparing the abutment teeth**: The abutments are prepared to receive rests, guide planes and other planned modifications (Fig. 18.12A and B).

5. **Secondary impressions and master cast**: Following abutment preparation, secondary impressions are made and master cast is poured (Fig. 18.13A and B). Generally, custom trays are indicated for functional impressions. Putty-wash impressions using stock trays can be used for anatomical impressions. *A tentative jaw relation is recorded to ensure that framework does not interfere with the opposing dentition.*

6. **Survey of master cast – design transfer, relief, blockout and beading**: The planned design of the partial denture is transferred from the diagnostic cast to the master cast by surveying. Appropriate relief, blockout and beading (only indicated for maxillary dentures) are performed on master cast (Fig. 18.14A).

7. **Duplication of master cast**: The master cast is duplicated using reversible hydrocolloids (material of choice) (Fig. 18.14B) and a refractory cast is poured.

8. **Refractory cast**: The refractory cast is obtained by duplicating the master cast and it is made of a material (usually investment material) which can withstand the high heat involved in casting procedures (Fig. 18.15).

9. **Waxing of framework**: The planned design of the partial denture framework is waxed on the refractory cast (Fig. 18.16). The wax pattern is sprued and then invested.

10. **Casting of framework:** The invested wax pattern is burnt out in a burnout furnace and cast with appropriate metal. Induction casting is preferred for these large castings. The cast metal framework is fitted on the master cast, trimmed and polished (Fig. 18.17).

11. **Try-in of framework**: The framework is tried in the patient's mouth to verify fit and any interferences (Fig. 18.18).

12. **Jaw relation record:** A jaw relation is obtained to articulate the casts (Fig. 18.19).

13. **Trial denture**: The artificial teeth are arranged and the trial denture is checked in the patient's mouth (Fig. 18.20).

14. **Denture insertion**: The waxed denture is processed in acrylic resin, finished and polished and then inserted in the patient's mouth (Fig. 18.21).

15. **Maintenance and recall:** Patient is instructed regarding the maintenance of the denture and appropriate recall appointments are scheduled.

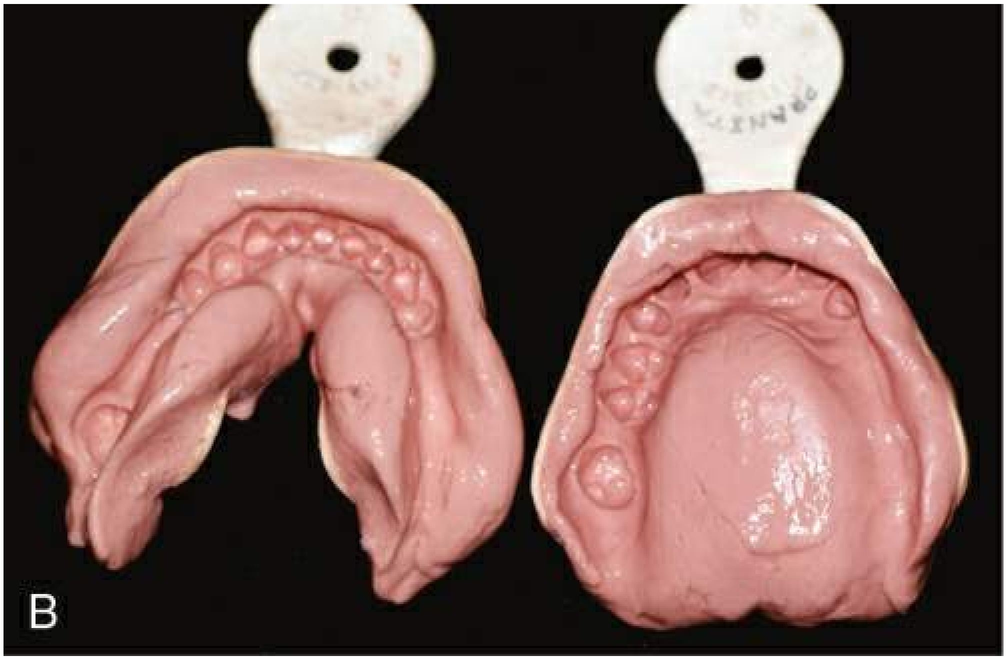
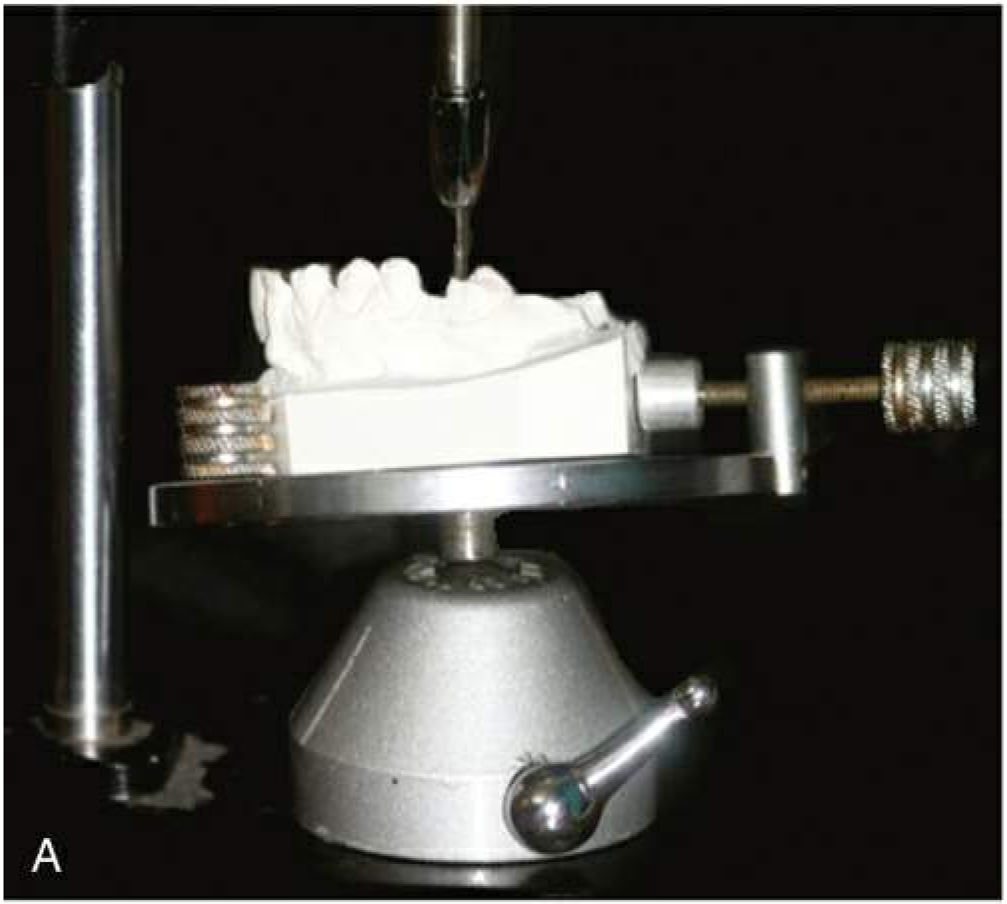


FIGURE 18.10 **(A)** Examination of the clinical situation. **(B)** Diagnostic impressions (preliminary impressions).



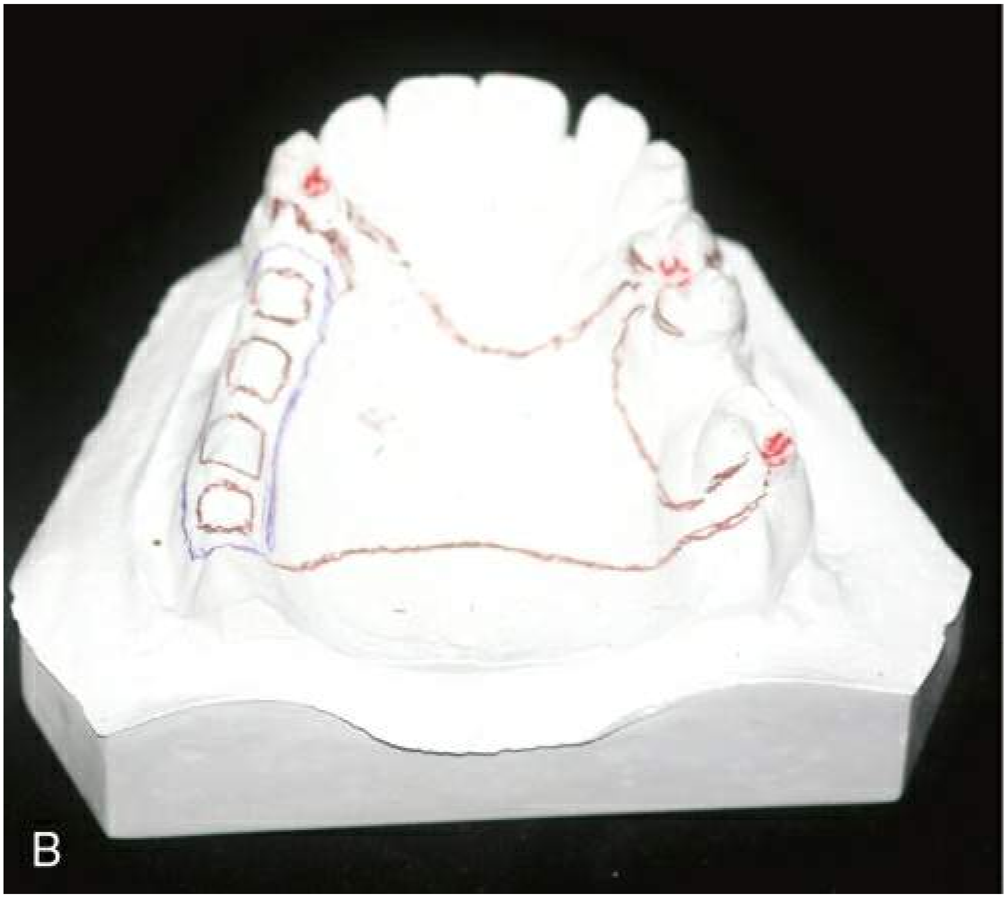


FIGURE 18.11 **(A)** Diagnostic cast mounted and analysed on a surveyor. **(B)** Designed diagnostic cast.

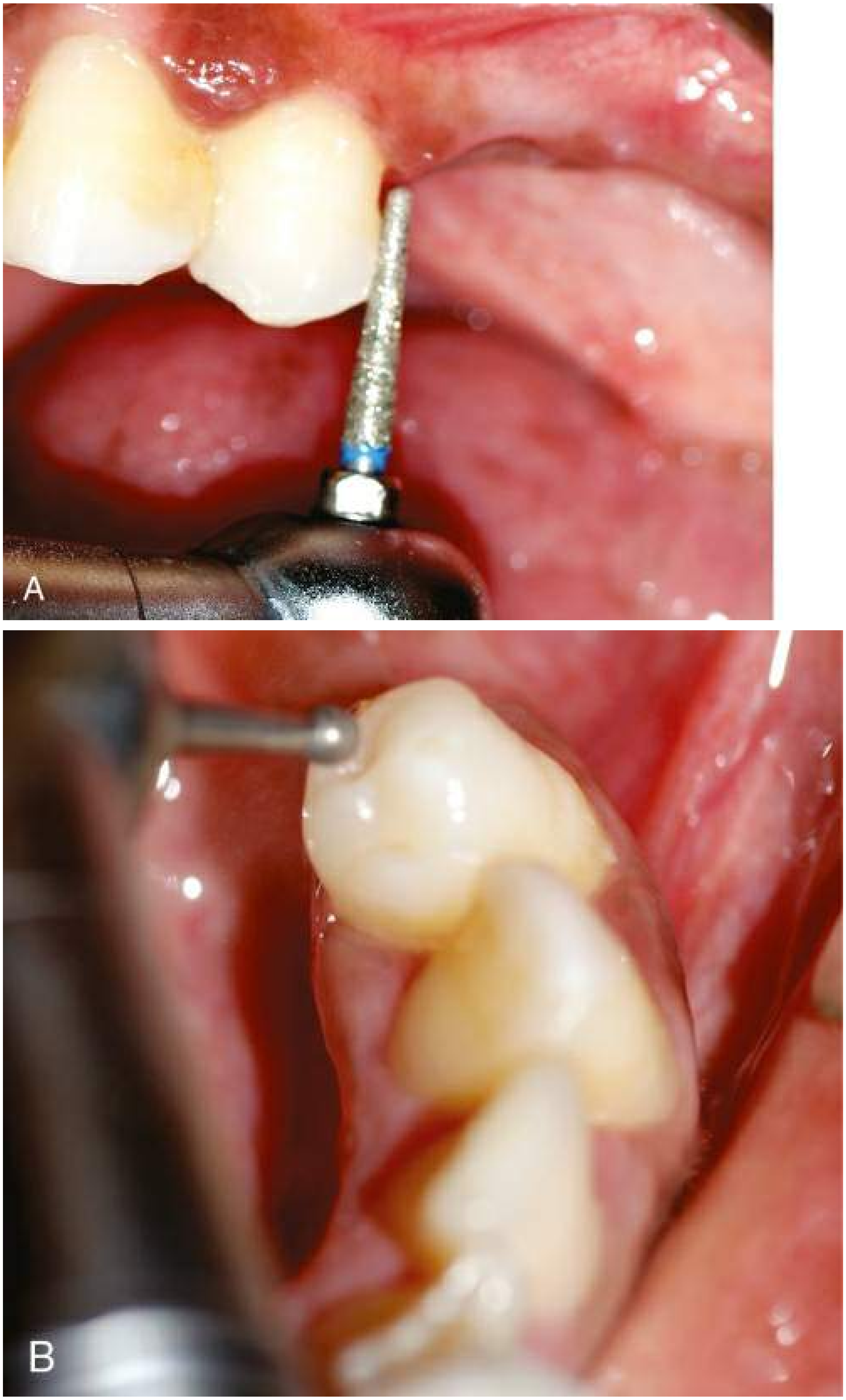
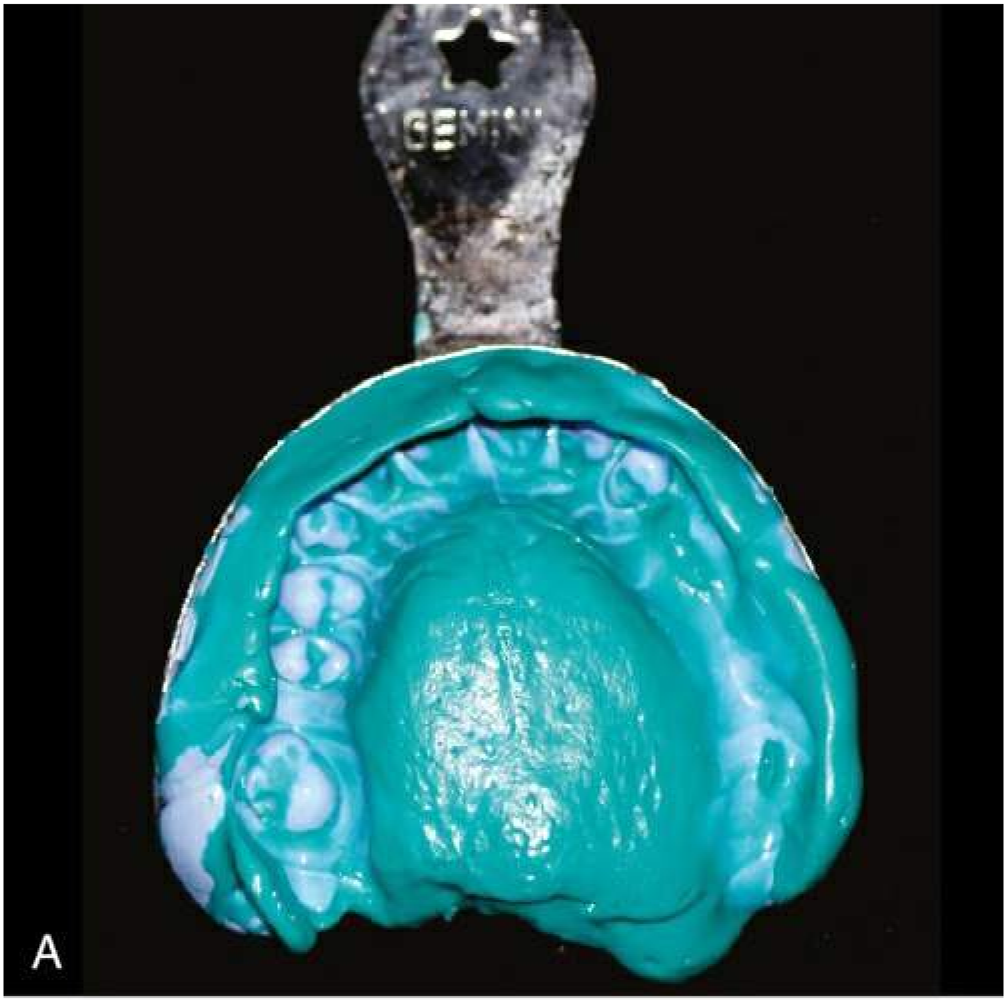


FIGURE 18.12 **(A)** Preparation of abutment teeth – making

guide planes. **(B)** Rest seat preparation.



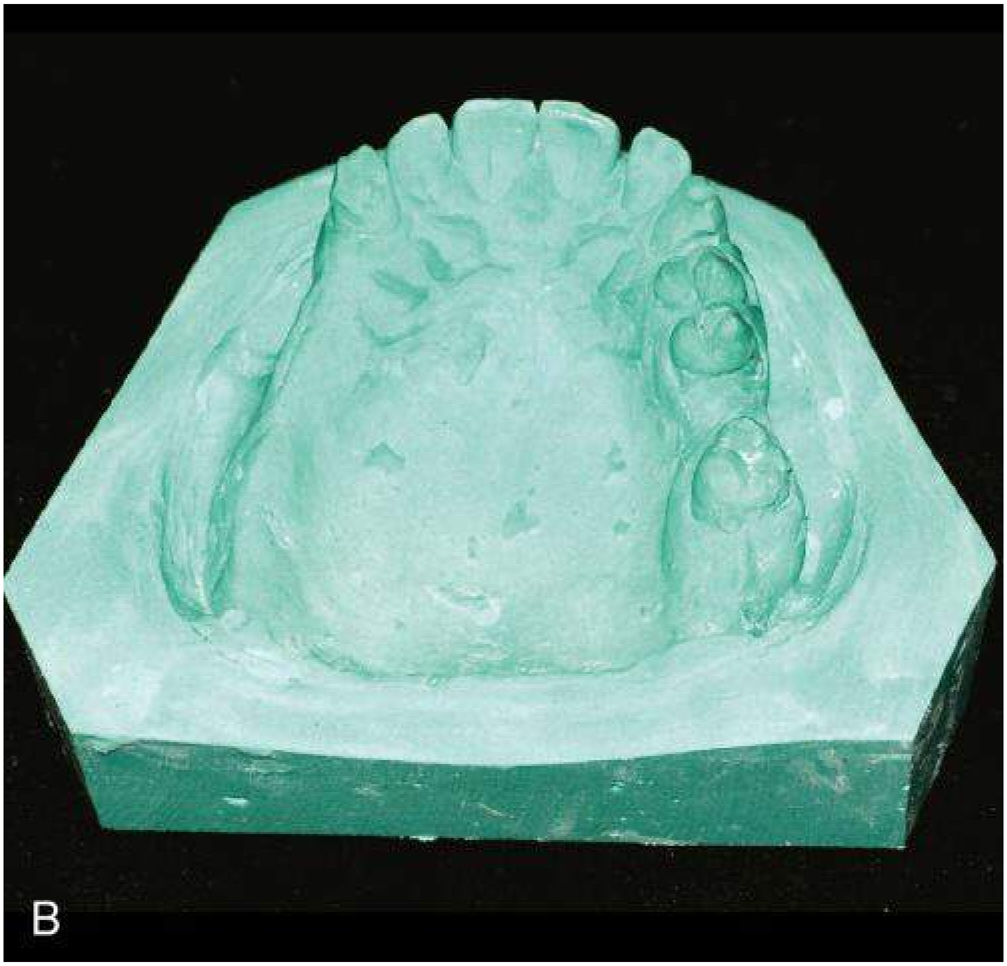


FIGURE 18.13 **(A)** Secondary impressions. **(B)** Master cast.

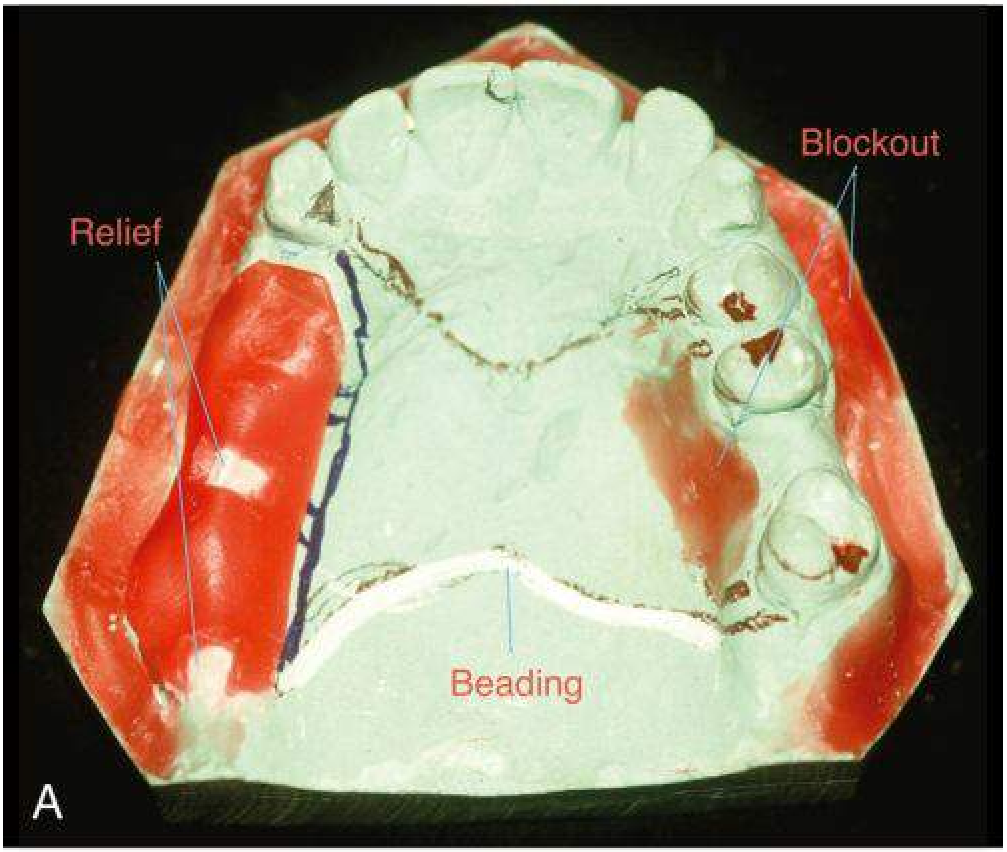

Blockout
Relief
Beading
A

FIGURE 18.14 **(A)** Design transferred to master cast with surveyor followed by relief, blockout and beading. **(B)** Master cast duplicated with agar.

FIGURE 18.15 Refractory cast.

FIGURE 18.16 Waxed framework.

FIGURE 18.17 Finished framework.

FIGURE 18.18 Try-in of framework.

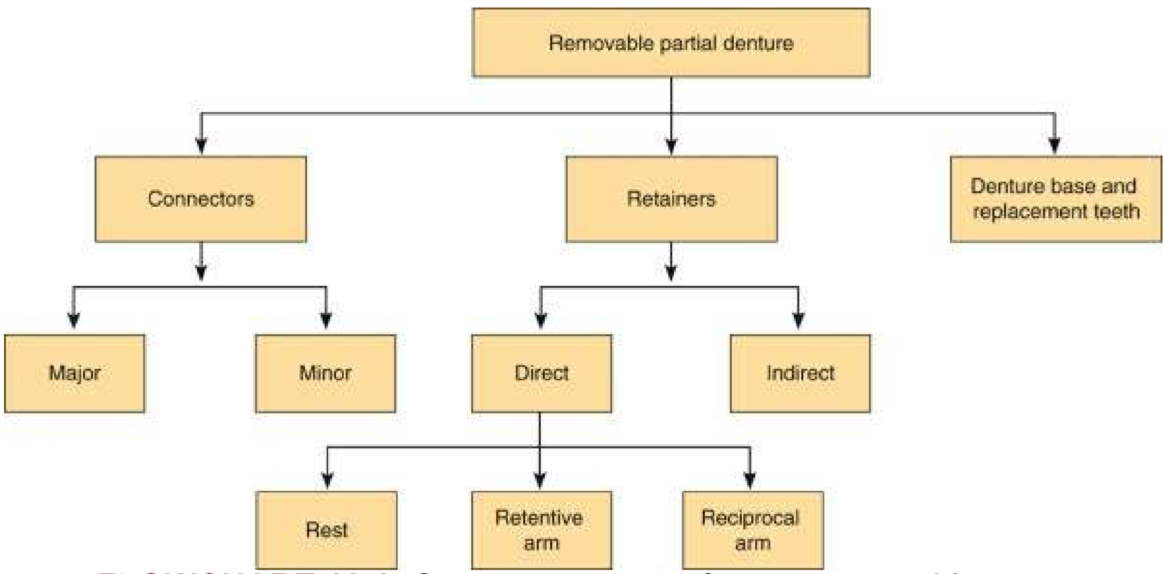
FIGURE 18.19 Jaw relation recorded.

FIGURE 18.20 Artificial teeth arranged and trial denture verified.

FIGURE 18.21 Denture inserted.

Component parts of removable partial denture

Flowchart 18.1 enumerates the component parts of a cast RPD. Also see Fig. 18.22.



FLOWCHART 18.1 Component parts of a cast removable partial denture

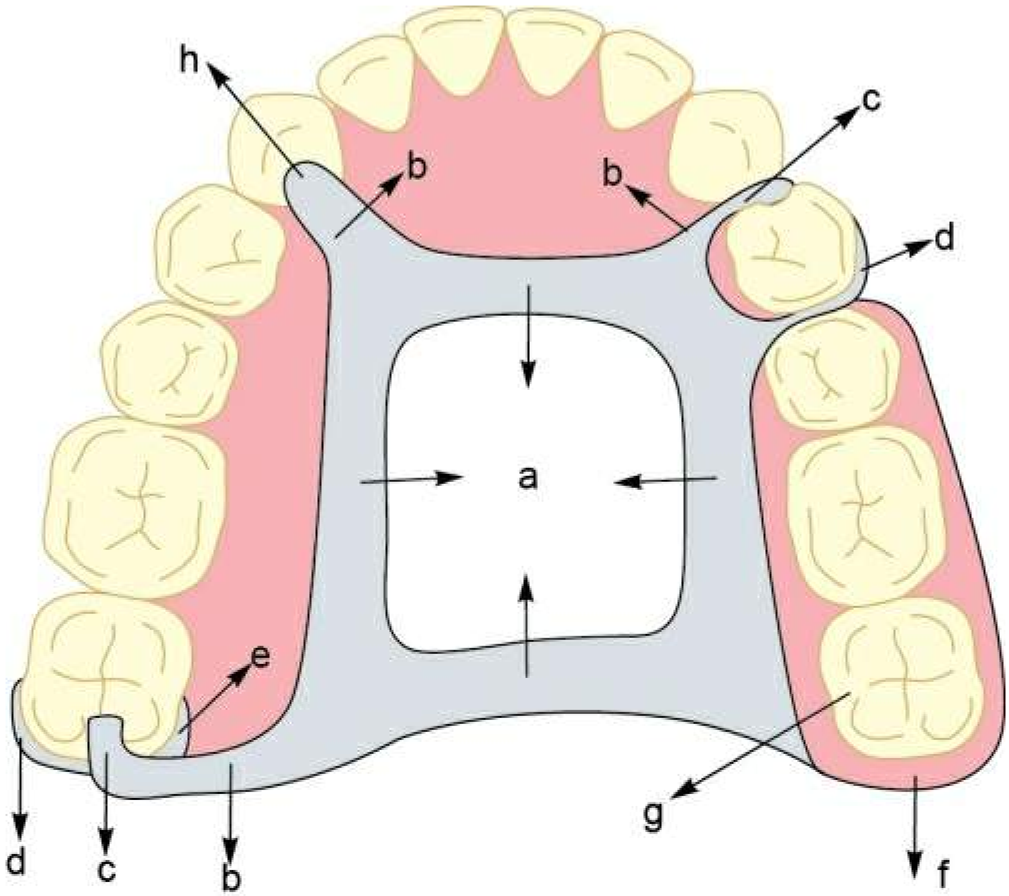


FIGURE 18.22 Component parts: a, major connector; b, minor connector; c, rest; d, retentive arm; e, reciprocal arm; f, denture base; g, replacement teeth; h, indirect retainer.

SUMMARY

This chapter familiarizes us with the different types of cast partial dentures and individual components which go into the making of a removable prosthesis and also shed light on the laboratory procedures and various steps involved in the construction of the same, thus providing a solid foundation for a successful treatment.

CHAPTER

19

Sequelae of partial edentulism

CHAPTER CONTENTS

Introduction

Edentulism is the condition of being toothless to at least some degree; it is the result of tooth loss. Loss of some teeth results in *partial edentulism.* Tooth loss is normal with baby teeth, where at some point in a child's life, a tooth becomes loose and then falls off, but is later replaced by an adult tooth. Otherwise losing a tooth is unfavourable and if it happens with adult teeth, it is the result of injury, tooth decay or disease. It directly affects self-esteem as tooth loss not only impinges on smile and the way the face looks but also affects speech and mastication.

Some of the consequences of partial teeth loss are

1. Aesthetics

2. Speech

3. Drifting and tilting

4. Supraerupted teeth

5. Overloading of remaining teeth

6. Loss of masticatory efficiency

7. Loss of vertical dimension

8. Mandibular deviation

9. Loss of alveolar bone

10. Combination syndrome

Sequelae of partial edentulism

Aesthetics

There is a significant aesthetic impact due to the loss of the teeth especially in the anterior region of the mouth. It is the most frequent cause of patients seeking treatment. This will depend on the value placed on the appearance of missing teeth in a given community or society.

Loss of teeth causes the cheeks to exhibit a 'sunken-in' appearance and wrinkle lines to form at the commissures. Additionally, the anterior teeth, when present, serve to properly support the lips and provide for certain aesthetic features, such as an acute nasolabial angle. Loss of muscle tone and skin elasticity due to old age, when most individuals begin to experience edentulism, tends to further exacerbate this condition (Fig. 19.1A and B).


A


B

FIGURE 19.1 **(A)** Lack of upper lip support without maxillary anterior partial denture. **(B)** Upper lip support restored with denture.

Speech

The teeth play a major role in speech. Phonation of some alphabets requires the lips and/or tongue to make contact with the teeth for proper pronunciation of the sound, and lack of teeth will obviously affect the way in which an edentulous individual can pronounce these sounds. The problem of anterior tooth loss affects a variety of speech sounds. Sibilant sounds ('s', 'sh') and labiodental sounds ('f', 'v') are the most obvious of these.

Drifting and tilting of adjacent teeth

Teeth on either side of an edentulous space may tilt towards the gap; teeth opposing may continue to erupt into the gaps (Fig. 19.2). When the teeth move, there will be a considerable disruption in normal function of the system. Replacement of lost teeth may be difficult when there is discrepancy in occlusal scheme.

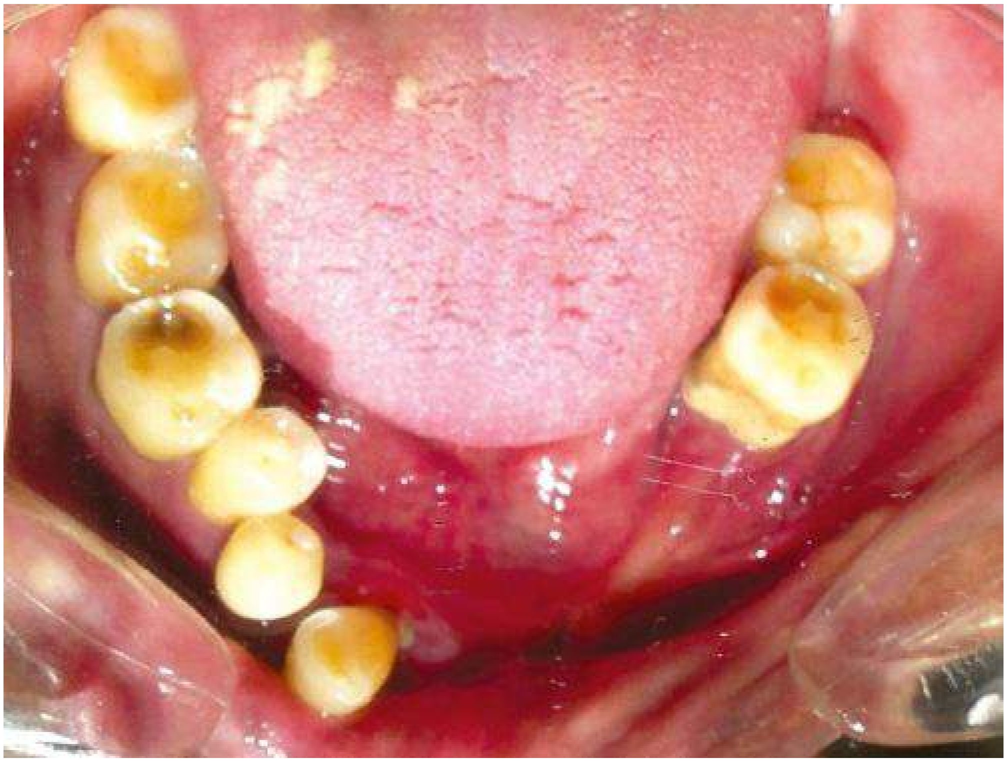


FIGURE 19.2 Drifting and tilting of adjacent teeth due to tooth loss.

Tipped molars

Presence of tipped molars poses a variety of problems in designing RPD (Fig. 19.3). They interfere in the placement of major and minor connectors, particularly mandibular lingual bar, and placement of clasp assembly and create food trap. The problem is directly proportional to the degree of severity of tipping. They are often tipped mesially and provide a high mesial survey line. Undercuts located mesially in tipped molars go for an assembly which approaches the undercut distally. Maxillary molars are generally tipped buccally; mandibular molars have a lingual tilt. The design requires the selective grinding of teeth 5–10° for moderately tilted teeth, 15° or more for severe tilted teeth. Severely tilted molars can be orthodontically best repositioned.

FIGURE 19.3 Tipped molars.

Supraerupted teeth

Extruded teeth cause defect in occlusal plane when posterior teeth are lost (Fig. 19.4) and affect aesthetics when anterior teeth are lost. The problems encountered by supraerupted teeth are insufficient space in positioning the opposing teeth and occlusal trauma.

FIGURE 19.4 Supraerupted teeth.

Classification of supraerupted teeth

Class I

Supraerupted teeth pose no appreciable problems in positioning the teeth in opposing arch and no potential for creating occlusal trauma. Hence, no treatment is needed.

Class II

Supraerupted tooth poses definite problem but can be successfully managed by enameloplasty to reduce height of crown (incisal edge, cusp tips).

Class III

Supraerupted tooth poses moderately severe problems which can be successfully managed by altering the teeth to such a degree that enamel is penetrated and teeth require a cast restoration.

Class IV

The tooth is severely extruded. Extraction is permissible if tooth is nonessential or useless to success of RPD. In *class IV(E)*, if the tooth is nonessential for bracing or retention but desirable for support, endodontic therapy is indicated and tooth may be used as abutment for removable partial overdenture. Extruded teeth are considered nonessential for support in eliminating distal *extension RPD. In class IV(O), tooth is considered essential for bracing, retention and support, its repositioning by means of surgery or surgical orthodontics is indicated.*

Overloading of remaining teeth

If there is advanced loss of periodontal support or if only a few teeth are remaining to withstand functional and parafunctional demands, the remaining periodontium can be overloaded. Excessive wear and mobility of remaining teeth may occur (Fig. 19.5).

FIGURE 19.5 Overloading of remaining teeth.

Loss of masticatory efficiency

Physiologically, teeth provide for greater chewing ability. They allow us to masticate food thoroughly, increasing the surface area necessary to allow for the enzymes present in the saliva, as well as in the stomach and intestines, to digest our food. An index of food reduction is known as 'masticatory efficiency'. It is strongly correlated with the occlusal contact. Loss of molar teeth has more impact on the masticatory performances, so the efficiency with which the food is broken up deteriorates and patient tends to swallow larger particles, which leads to digestive system problems.

Loss of vertical dimension

Loss of contacts because of loss of teeth changes the vertical dimension. This is commonly seen when posterior teeth are lost (Fig. 19.6). The height can be maintained by the anterior teeth in some patients, who manage to compensate for the loss of posterior support without wearing down the remaining teeth excessively.

FIGURE 19.6 Loss of vertical dimension.

Mandibular deviation

Disruption of normal occlusal scheme can result in mandible to take a pathway to avoid deflective occlusal contacts (Fig. 19.7). This deviation and loss of occlusal support lead to pain and discomfort in masticatory system, which manifest as pain in muscles of mastication and in temporomandibular joint (TMJ). Extraction of teeth leads to loss of periodontal ligament and alveolar bone. Loss of residual bone continues throughout the life at varying rates in different individuals. In partially edentulous state, this continuous resorption causes problems in placing the components of denture in edentulous areas that have different heights and different capacities to support loads.

FIGURE 19.7 Mandibular deviation.

Loss of alveolar ridge

Extraction of teeth leads to loss of periodontal ligament and alveolar bone (Fig. 19.8). Loss of residual bone continues throughout the life at varying rates in different individuals. In partially edentulous state, this continuous resorption causes problems in placing the components of denture in edentulous areas that have different heights and different capacities to support loads.

FIGURE 19.8 Loss of alveolar ridge.

Combination syndrome

Specific oral destructive changes are often seen in patients with a maxillary complete denture and a mandibular distal extension partial denture. These changes have been referred to as the 'combination syndrome' and identified by Kelly in 1972. It is discussed in detail in Chapter 16.

SUMMARY

Failure to replace a missing posterior tooth is assumed to disrupt the balance of the stomatognathic system and trigger a host of adverse consequences. These consequences which include extrusion of opposing teeth, tilting of adjacent teeth and disturbances in the health of the supporting structures – also are thought to hasten the loss of remaining teeth. Extrusion of an unopposed tooth into the edentulous space may disrupt occlusion and complicate replacement of the missing tooth. Tilting or 'collapse' of the teeth adjacent to the edentulous space may lead to periodontal problems or heightened risk of caries development. It may also complicate restoration of the space; it could prompt the need for orthodontic uprighting or necessitate increased reduction in abutment teeth with corresponding negative effects on pulpal health and prosthesis retention, if a fixed partial denture was placed.

CHAPTER
20

Classification of partially edentulous arches

CHAPTER CONTENTS

Introduction

Classification of partially edentulous arches is essential for diagnosing, conveying, writing or discussing the existing clinical condition precisely and to arrive at an optimum design or treatment plan for that specific condition for the rehabilitation of the patients. A number of classification systems have been proposed by different authors some of which are simple and some relatively complicated. Most of the classification systems could not identify or diagnose underlying conditions nor could they help in designing or treatment of specific conditions due to wide range of partially edentulous combinations in the partially edentulous patients. Till date Kennedy's system of classification is the most simple and widely used system.

Need for classification

Partially edentulous arches need to be classified for the following reasons:

1. To communicate the condition of the oral cavity.

2. To create an order from innumerable possible combination of teeth present and the edentulous spaces.

3. To contribute to learning the fundamentals of design and to anticipate the difficulties that commonly occur for that particular design.

4. To design a denture according to the occlusal load usually expected for a particular group.

5. To formulate a good treatment plan.

Requirements of classification

Any classification should satisfy the following requirements:

1. Should allow visualization of the type of partially edentulous arches being considered.

2. Should permit differentiation between tooth-supported and tooth–tissue-supported partial dentures.

3. Serve as a guide to the type of design to be used.

4. The classification should be simple and universally acceptable.

Classification systems

Though the Kennedy's system is most commonly used, an overview of other systems gives an insight into the development of classification systems. Relevant systems are discussed below.

Kennedy's classification system

This is the most commonly used classification system which was proposed by Edward Kennedy in 1923. It is based on the relationship of the edentulous spaces to the abutment teeth. He divided all partially edentulous arches into four main types.

1. Class I: Bilateral edentulous areas located posterior to the remaining natural teeth (Fig. 20.1).

2. Class II: Unilateral edentulous areas located posterior to the remaining natural teeth (Fig. 20.2).

3. Class III: Unilateral edentulous area with natural teeth both anterior and posterior to it (Fig. 20.3).

4. Class IV: Single, bilateral edentulous area located anterior to the remaining natural teeth (Fig. 20.4).

FIGURE 20.1 Kennedy's class I.

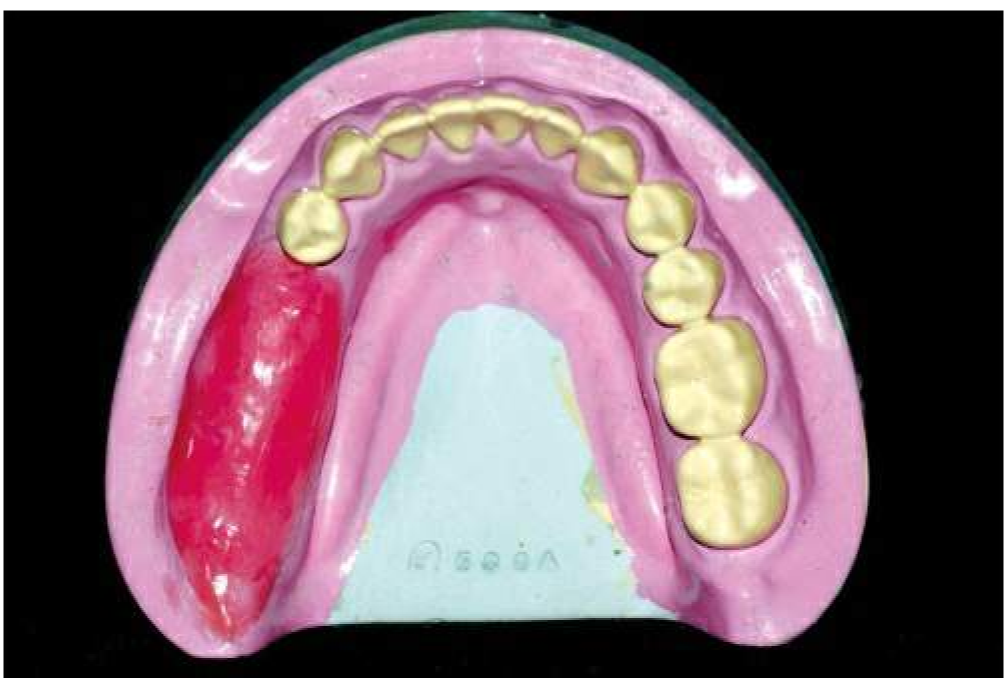


FIGURE 20.2 Kennedy's class II.

FIGURE 20.3 Kennedy's class III.

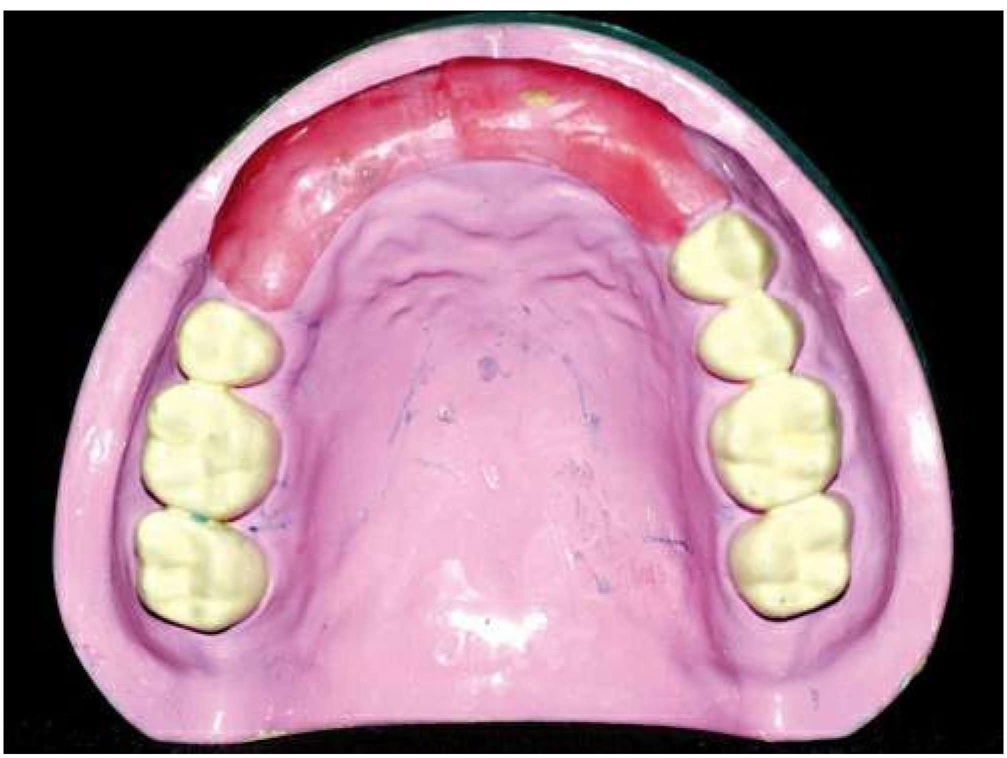


FIGURE 20.4 Kennedy's class IV.

The sequence of the classification is partly based on the frequency of occurrence – class I is most common and class IV is least common. The sequence is also based on design principles – class I, class II and long-span class IV are designed as tooth and tissue supported prosthesis, class III is designed as fully tooth-supported prosthesis.

Applegate's rules for Kennedy's classification

It would be difficult to apply the Kennedy's classification to every clinical situation. Applegate provided the following eight rules to govern the application of Kennedy's system.

1. Rule 1: Classification should follow rather than precede any extractions of teeth that might alter the original classification.

As shown in Fig. 20.5, if extractions of all the molars on left side are planned and executed, a class III situation becomes a class II.

2. Rule 2: If a third molar is missing and not to be replaced, it is not considered in the classification (Fig. 20.6).

3. Rule 3: If a third molar is present and is to be used as an abutment, it is considered in the classification (Fig. 20.7).

4. Rule 4: If a second molar is missing and is not to be replaced, it is not considered in the classification (Fig. 20.8) (e.g. if the opposing second molar is likewise missing and is not to be replaced).

5. Rule 5: The most posterior edentulous area (or areas) always determines the classification.

As shown in Fig. 20.9, the most posterior edentulous area is a class I on the right side, which will determine the classification. The other will be a modification space.

6. Rule 6: Edentulous areas other than those determining the classification are referred to as modification spaces and are designated by their number (Fig. 20.10A and B).

7. Rule 7: The extent of the modification is not considered, only the number of additional edentulous areas (Fig. 20.11A and B).

8. Rule 8: There can be no modification areas in class IV arches. The other edentulous will have to be posterior to this edentulous space and will hence determine the classification (rule 5) (Fig. 20.12).

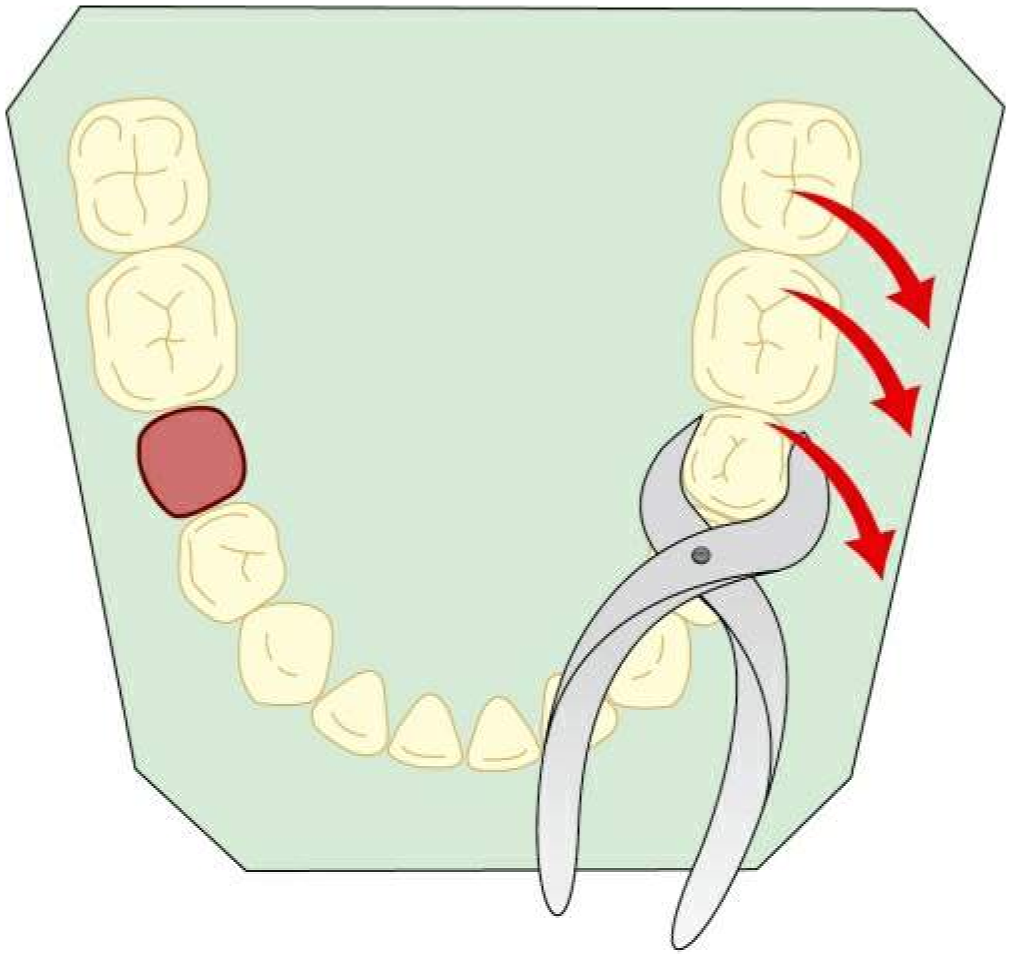


FIGURE 20.5 Applegate's rule 1 – extractions can change the classification.

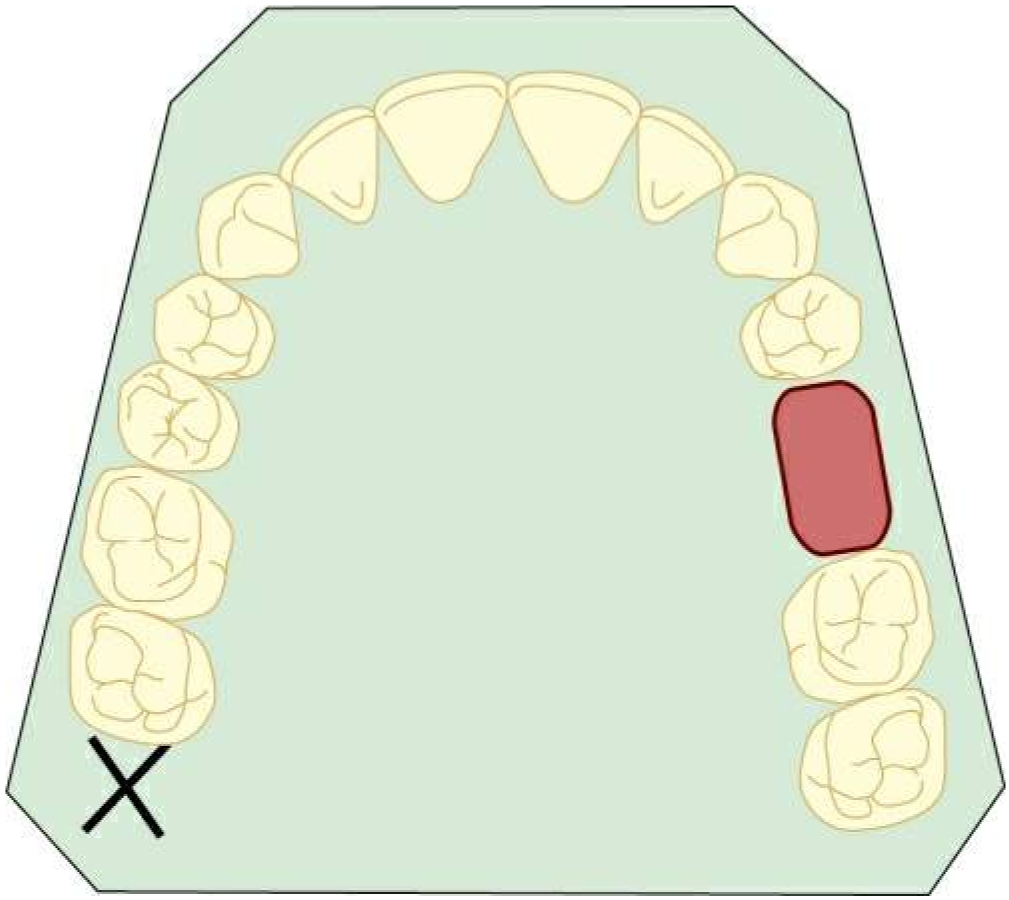


FIGURE 20.6 Applegate's rule 2 – missing third molar need not be considered.

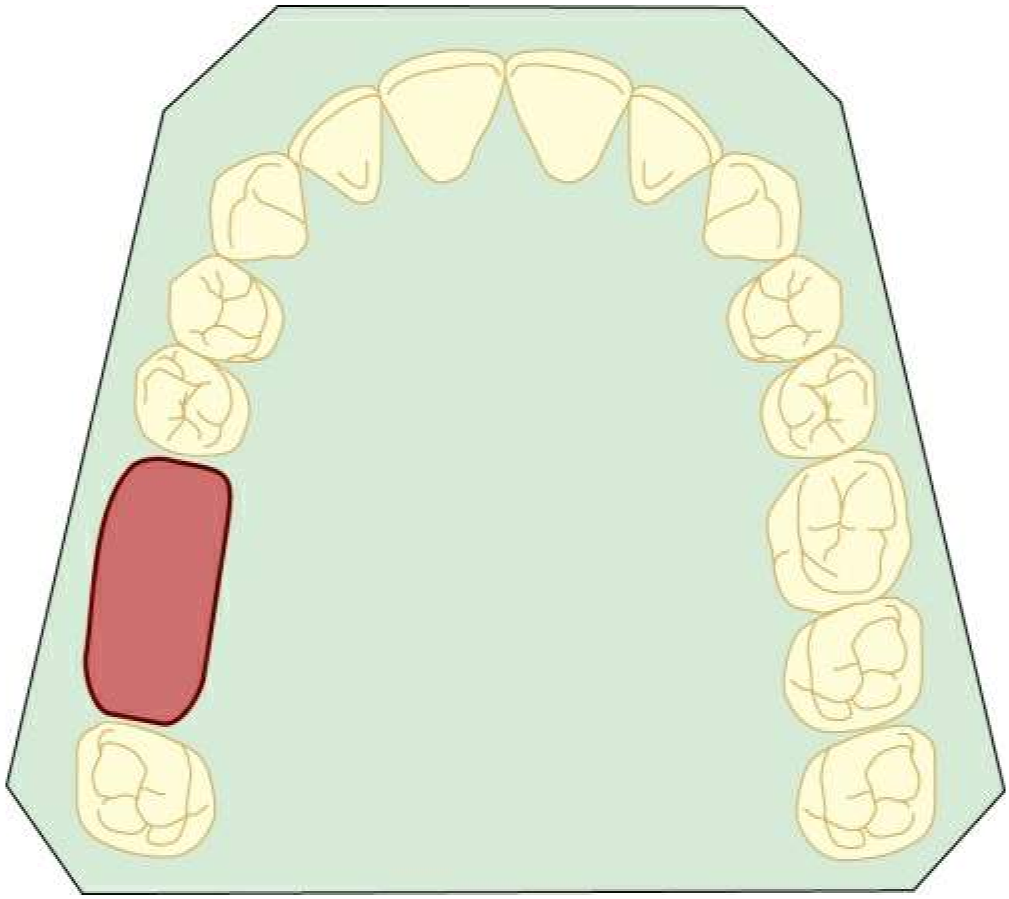


FIGURE 20.7 Applegate's rule 3 – third molar to be used as abutment is considered.

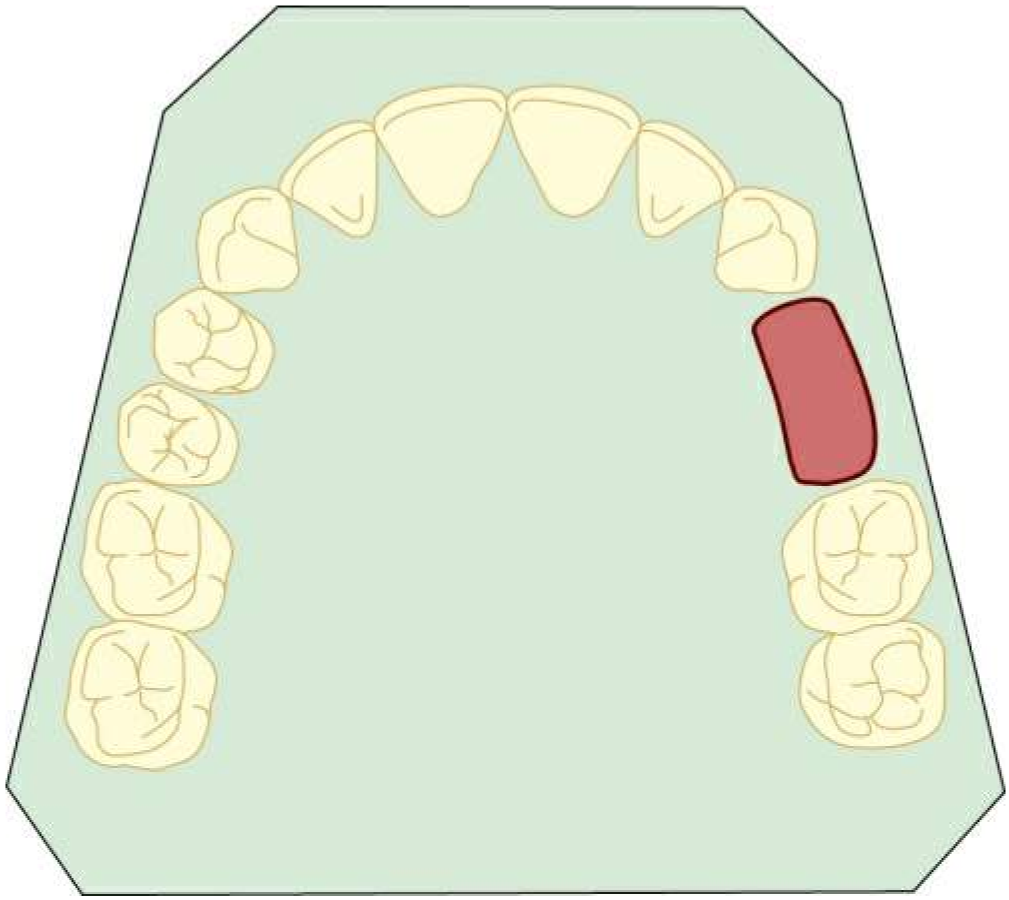


FIGURE 20.8 Applegate's rule 4 – missing second molar not being replaced is not considered.

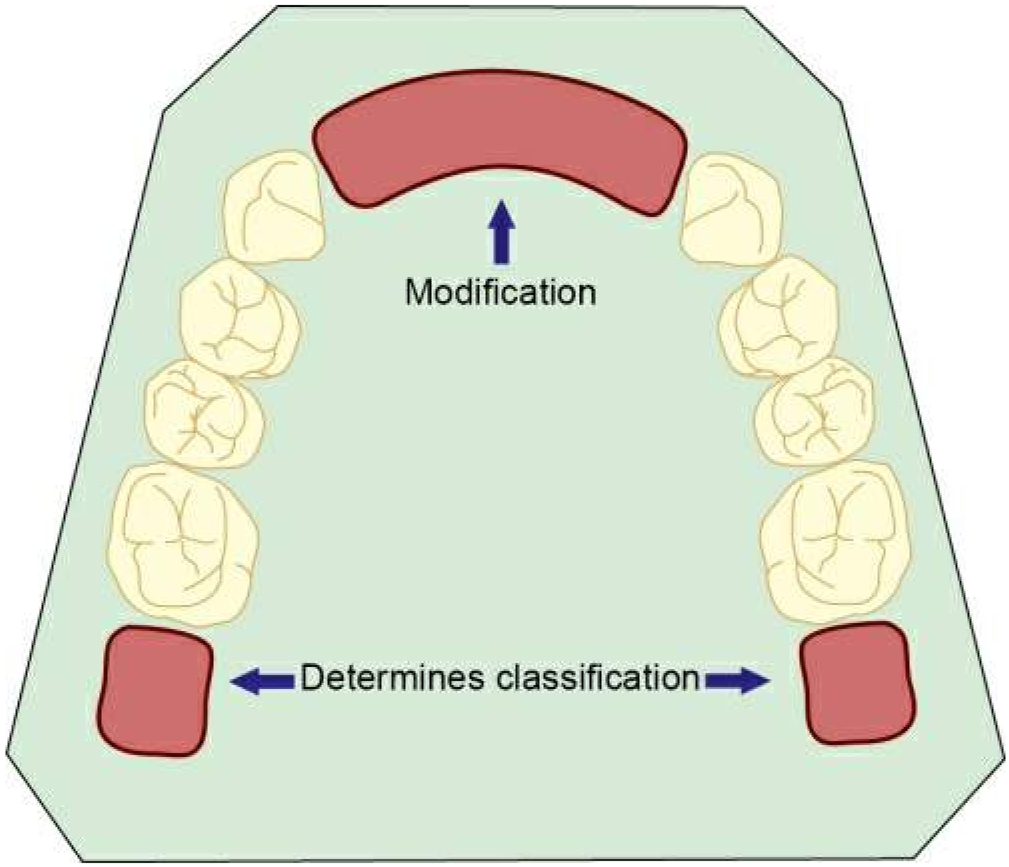
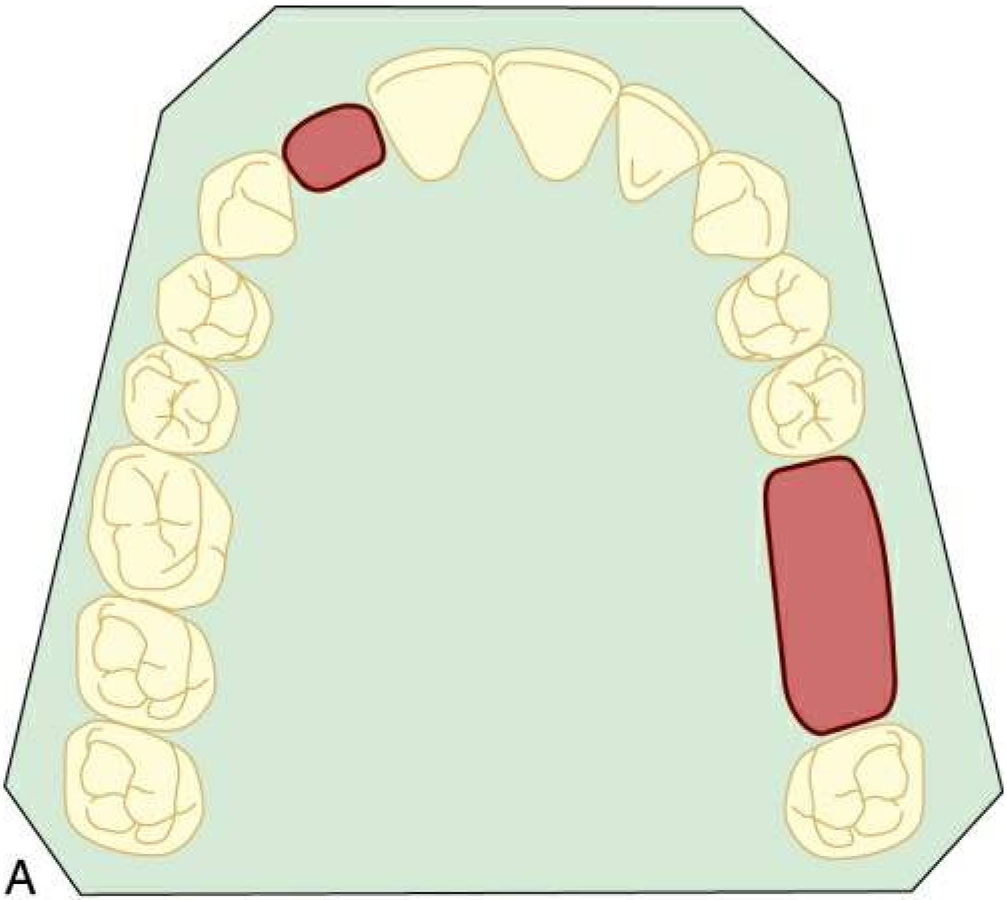


FIGURE 20.9 Applegate's rule 5 – most posterior space always determines the classification.



A

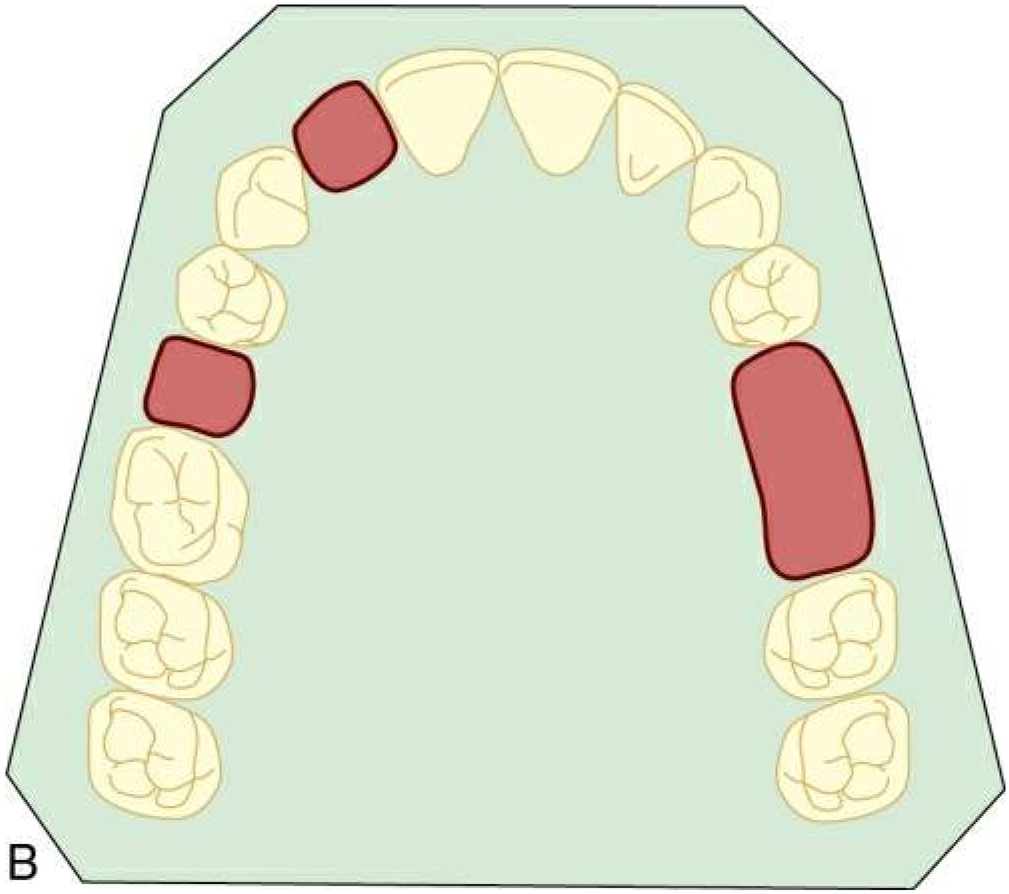
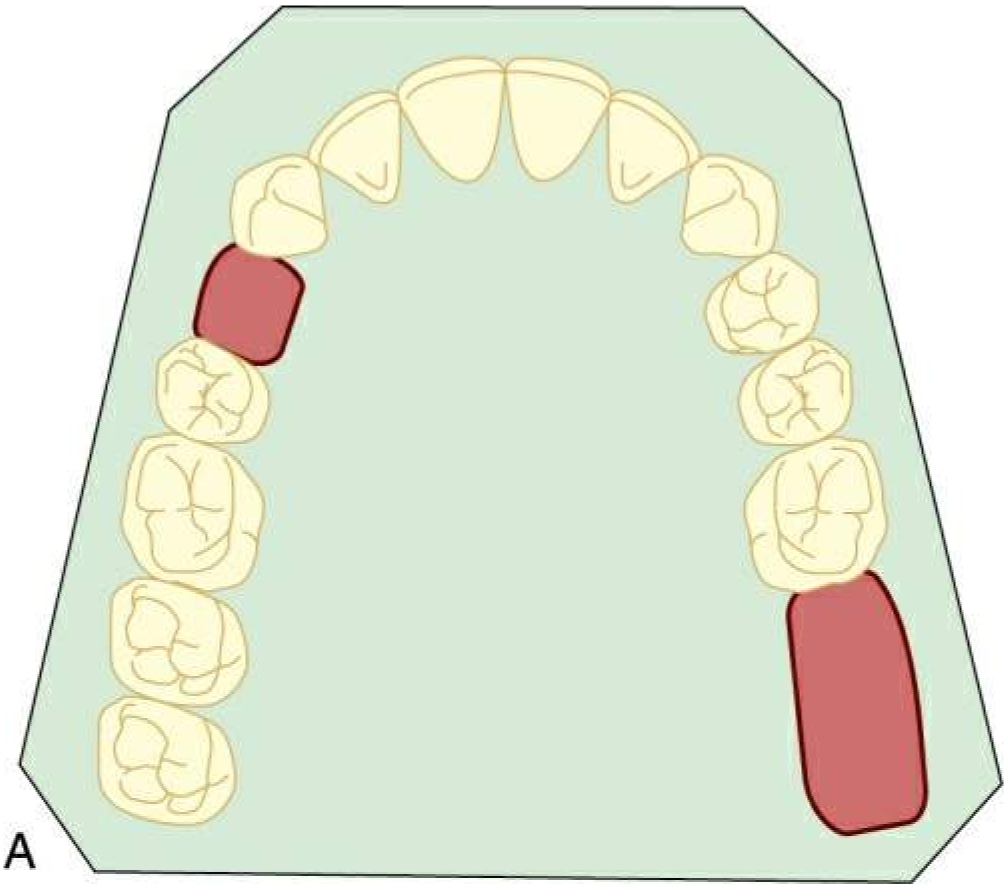
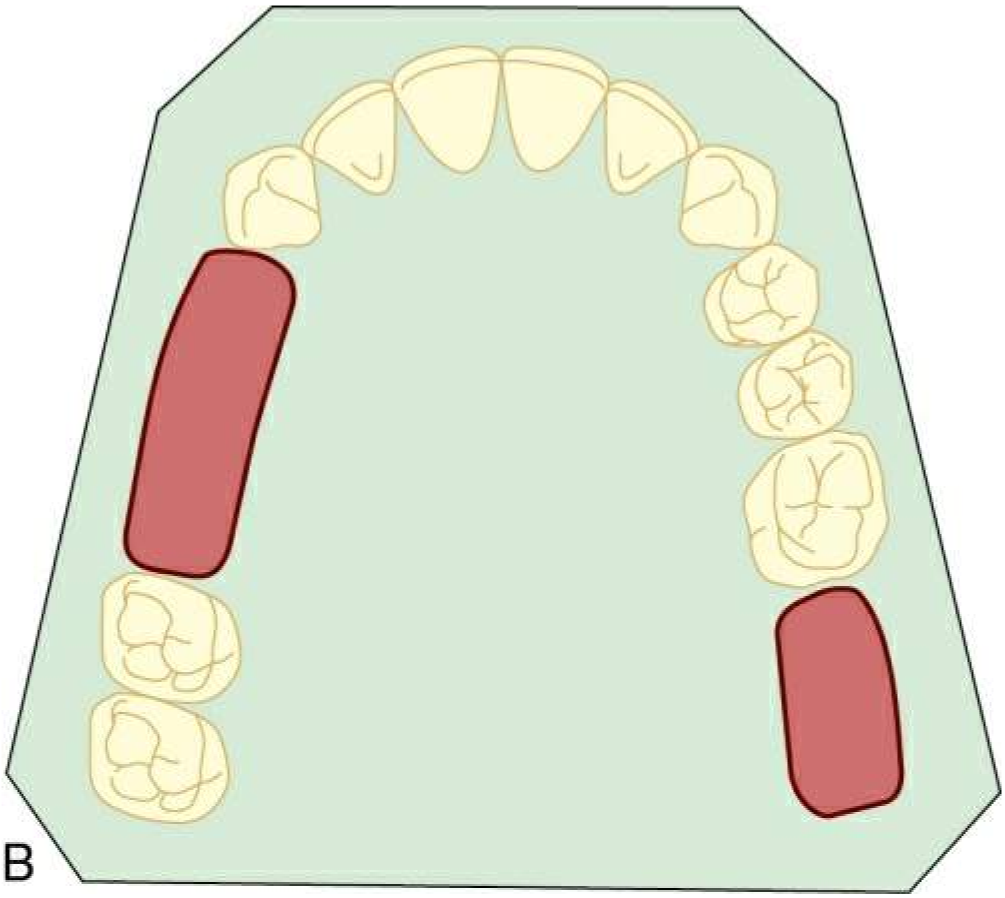


FIGURE 20.10 **(A)** Class III mod 1 – there is only one edentulous space other than that determining the classification. **(B)** Class III mod 2 – there are two edentulous spaces other than that determining the classification.


A



B

FIGURE 20.11 **(A)** Class II mod 1(one missing tooth). **(B)** Class II mod 1 (multiple missing tooth). For modifications, only the number of edentulous spaces (areas) is considered, not the number of missing teeth.

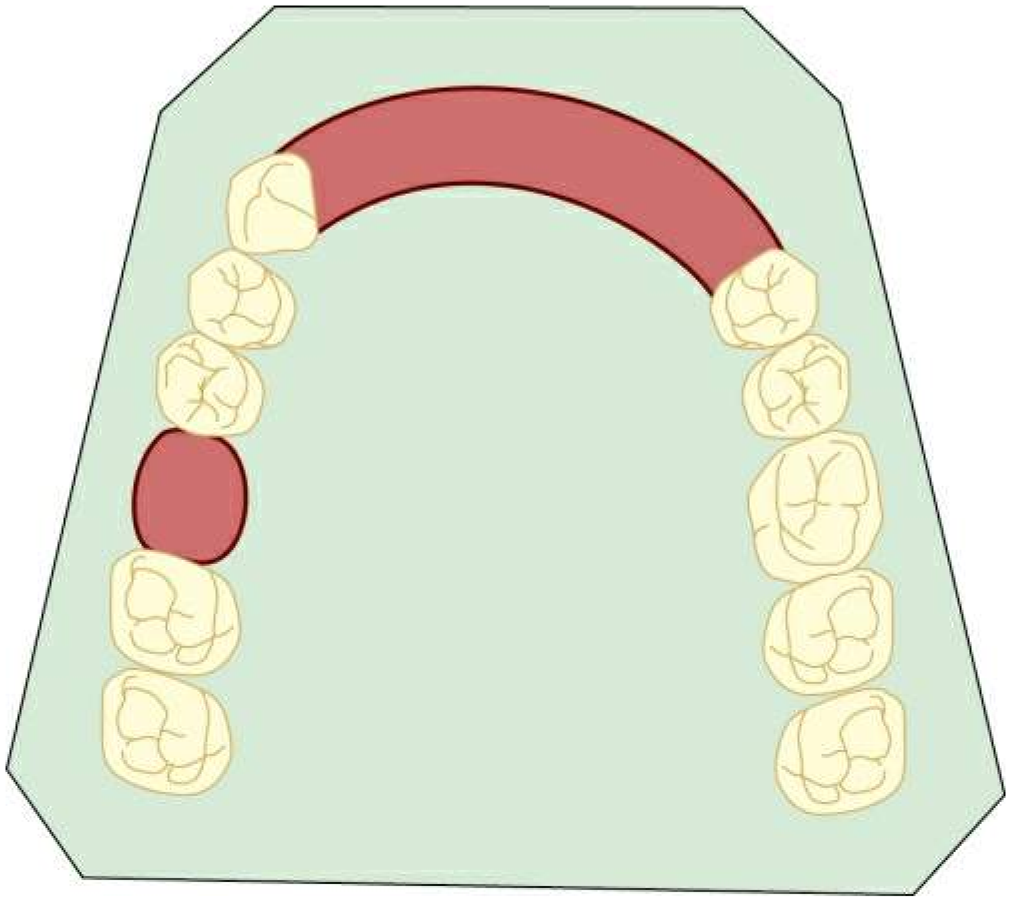


FIGURE 20.12 Class III mod 1.

Merits

1. The classification is simple and universally acceptable.

2. It allows to clearly communicate, to write or to diagnose the condition of the oral cavity in which missing teeth are to be replaced.

3. It permits visualization of the type of partially edentulous arches being considered.

4. Classification is based on the relationship of the edentulous spaces to the abutment teeth so type of support can be easily determined.

5. The number and location of edentulous spaces can be identified but

does not indicate the number of missing teeth in each edentulous area.

6. This classification provides design for each class. Guidelines and principles for each class have been proposed.

Demerits

1. Does not assess the choice, number, location and condition of the abutment teeth.

2. Assessment of the hard and soft tissue status not possible.

3. Does not indicate the position of individual tooth.

4. Does not permit assessment of occlusion.

Applegate–Kennedy classification

Applegate (1960) attempted to expand the above classification based on the condition of abutments. He added two more groups – class V and class VI. Acceptance to this has not been universal.

Class V: An edentulous area bounded anteriorly and posteriorly by natural teeth but in which the anterior abutment (e.g. lateral incisor) is not suitable for support (Fig. 20.13).

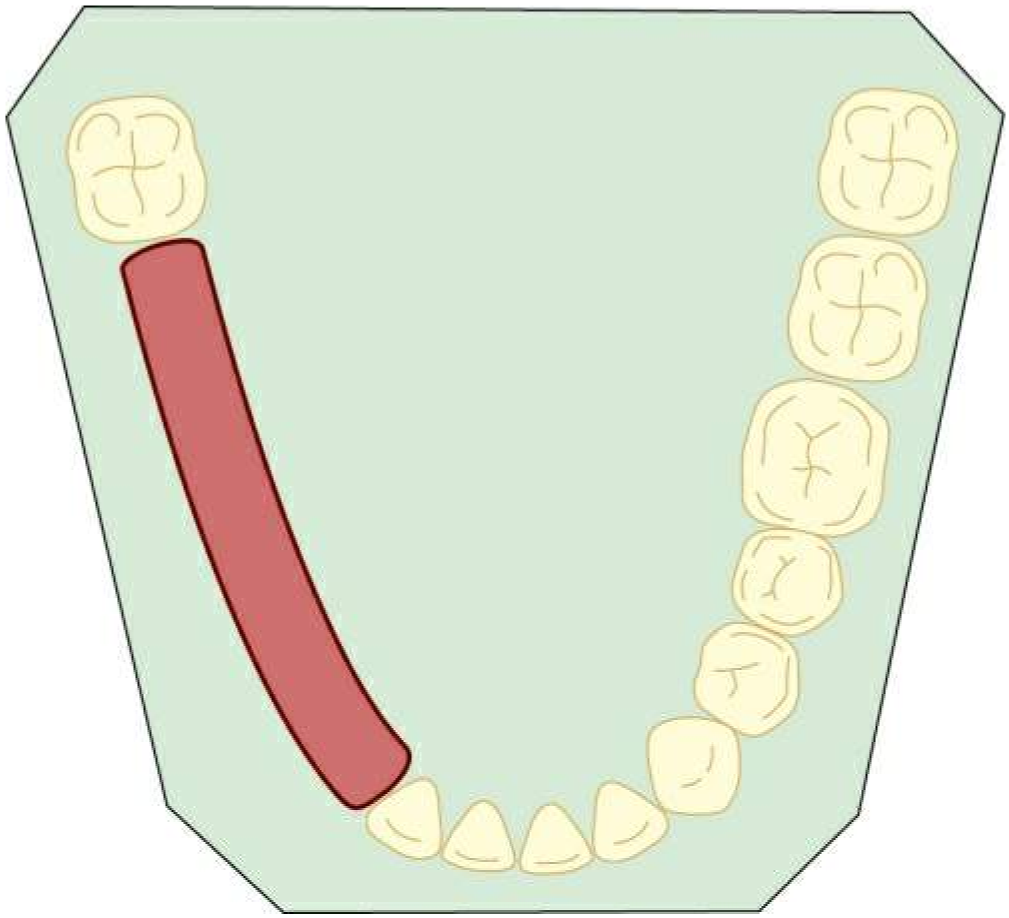


FIGURE 20.13 Applegate's class V.

Removable prosthesis with bilateral design with a free end base which extends anteriorly is planned in this situation.

Class VI: An edentulous area in which the teeth adjacent to the space are capable of total support of the required prosthesis. This does not require any tissue support. It would occur most frequently in a young adult for whom a fixed partial denture is indicated but possible damage to the dental pulp might occur if crown preparation were attempted (Fig. 20.14).

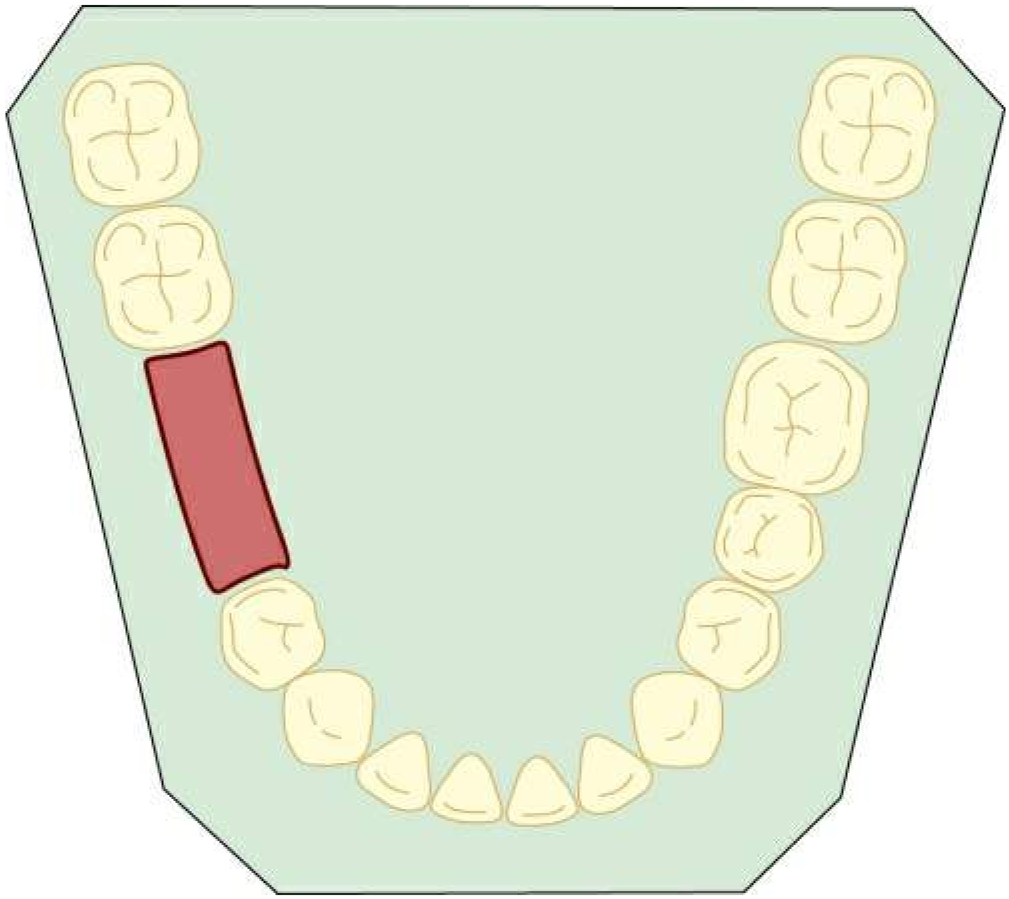


FIGURE 20.14 Applegate's class VI.

Some of the other classifications are given below. Each had its own merits and demerits and was not universally accepted.

Cummer's classification

This classification was proposed by Cummer in 1920; this was the first system to receive recognition. He classified partially edentulous arches into four classes based primarily on the position of the direct retainers.

1. **Class I (diagonal):** A partially edentulous arch in which two diagonally opposite teeth are chosen as abutment teeth for the attachment of direct retainers with an indirect retainer as an auxiliary attachment (Fig. 20.15).

2. **Class II (diametric):** A partially edentulous arch in which two diametrically opposite teeth are chosen as abutment teeth for the attachment of the direct retainers with an indirect retainer as an auxiliary attachment (Fig. 20.16).

3. **Class III (unilateral):** A partially edentulous arch in which one or more teeth on the same side are chosen as abutment teeth for the attachment of the direct retainers with or without an indirect retainer. This class includes most fixed and removable partial denture designs (Fig. 20.17).

4. **Class IV (multilateral):** A partially edentulous arch in which three or more teeth are chosen as abutment teeth for the attachment of the direct retainers in a triangular or quadrilateral relationship (Fig. 20.18).

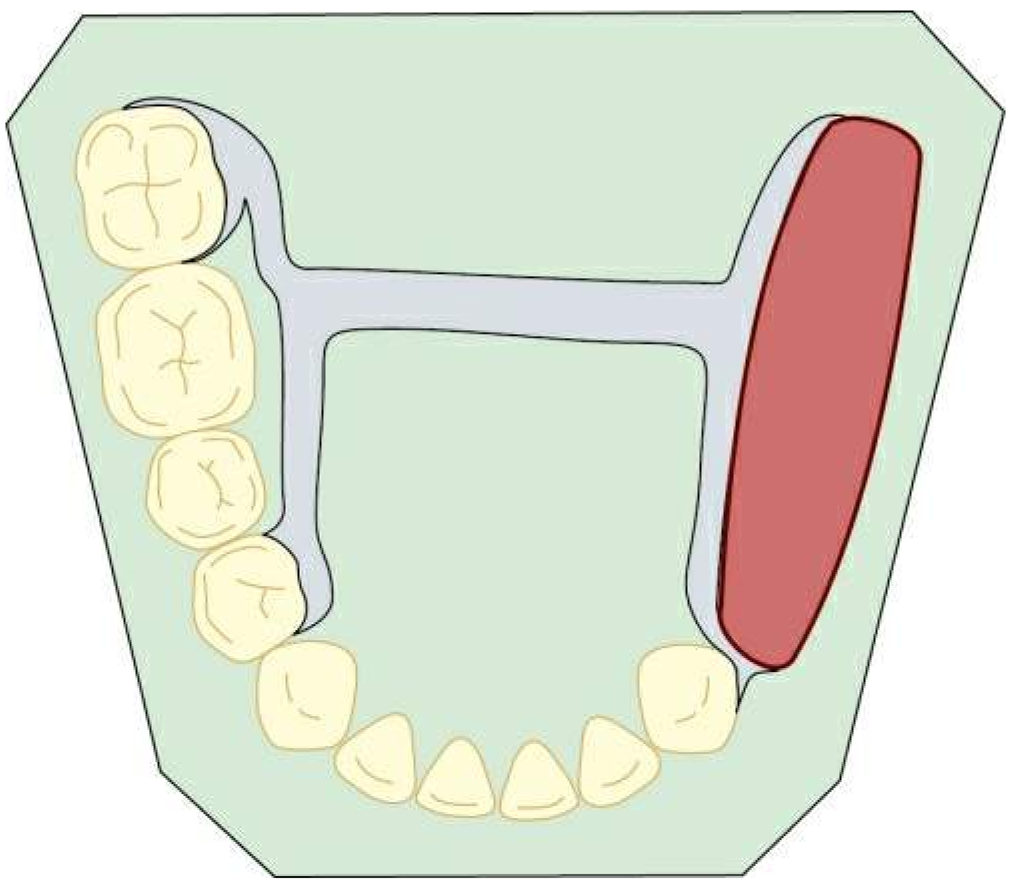


FIGURE 20.15 Cummer's class 1 (diagonal).

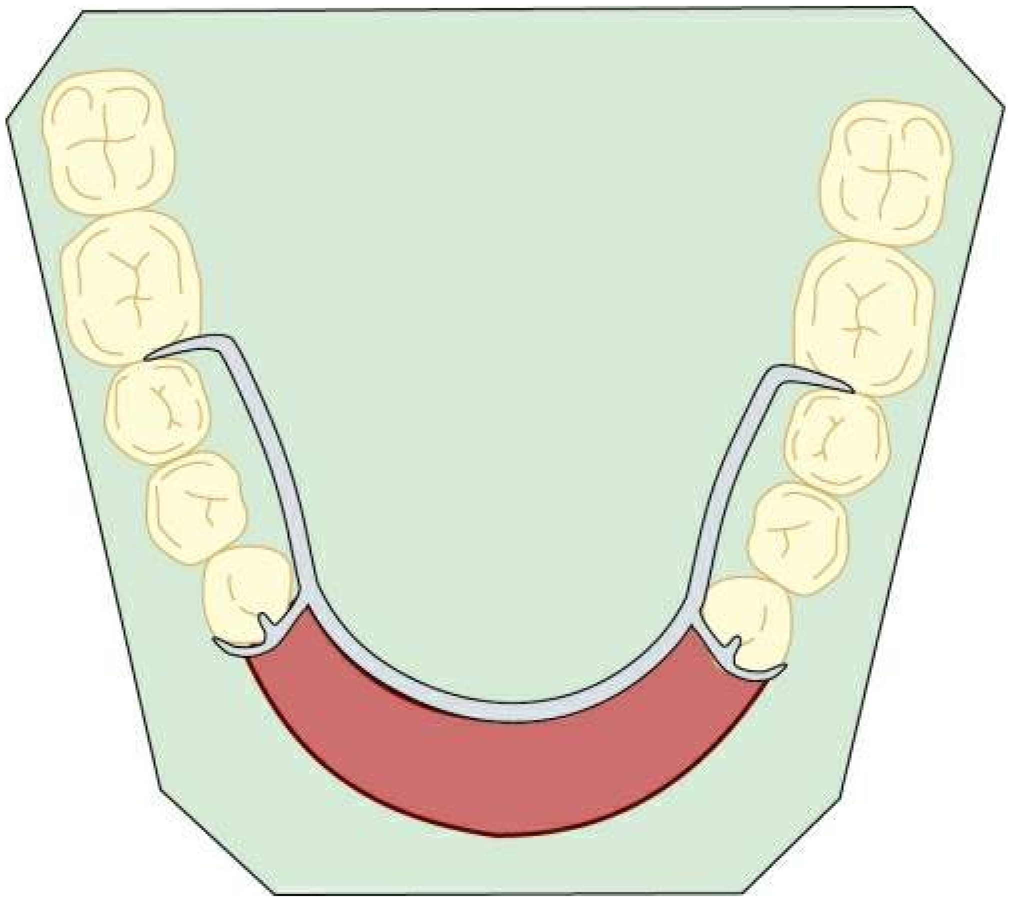


FIGURE 20.16 Cummer's class II (diametric).

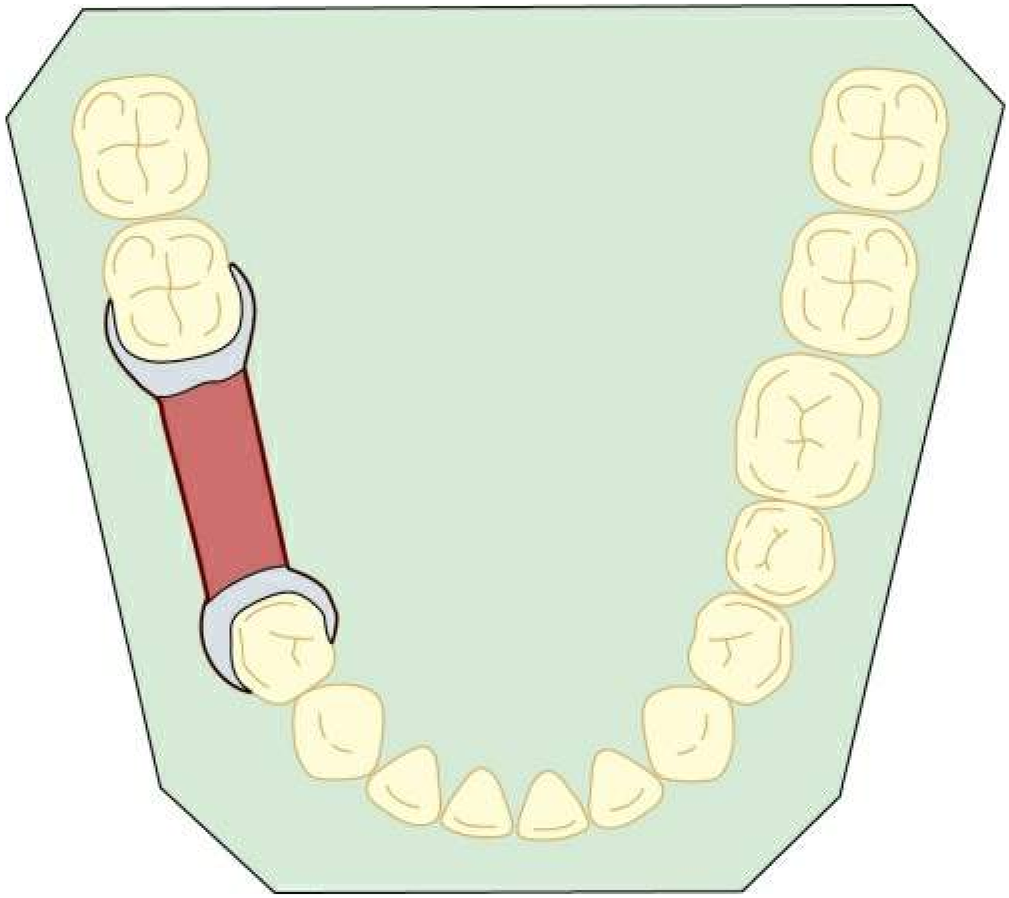


FIGURE 20.17 Cummer's class III (unilateral).

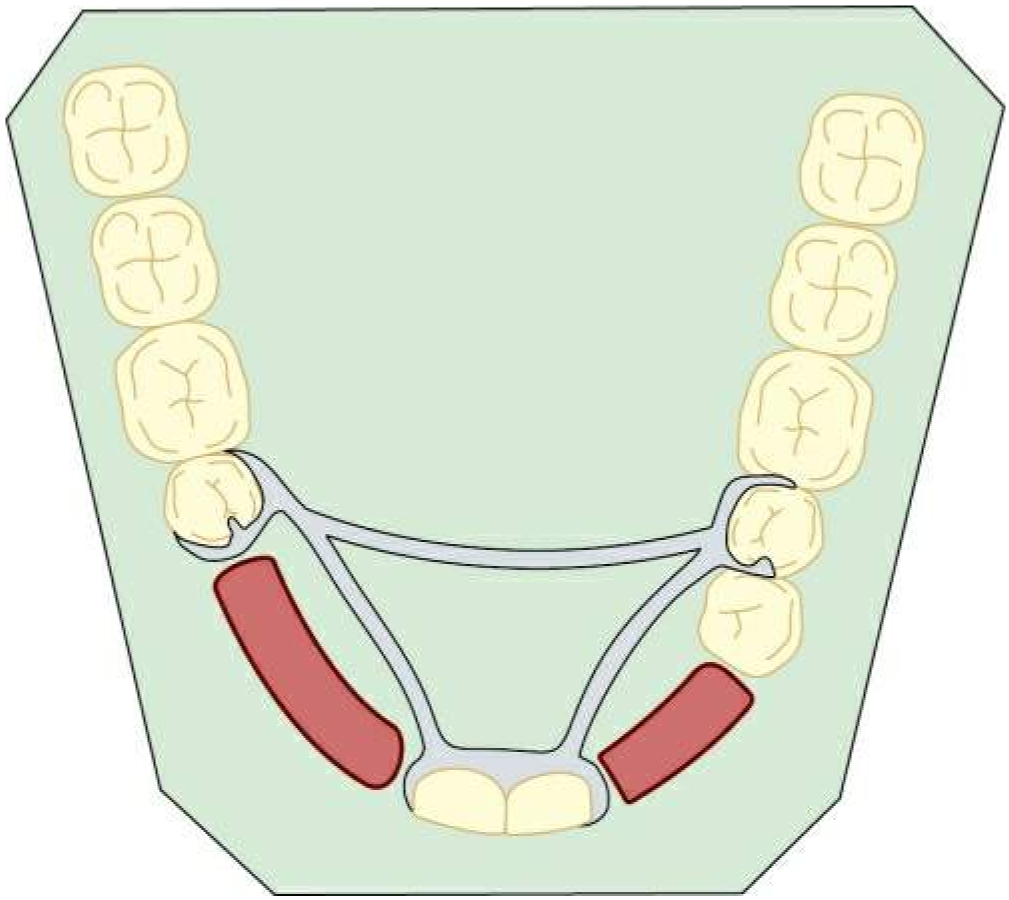


FIGURE 20.18 Cummer's class IV (multilateral triangular).

Bailyn's classification

This classification was proposed by Bailyn in 1928; this classification system is based on support – whether the prosthesis is tooth-borne, tissue-borne or combination. He divided all removable partial dentures into:

1. Anterior restorations (A) where saddle areas (denture bases) are anterior to the first bicuspids.

2. Posterior restorations (P) where saddle areas (denture bases) are posterior to the cuspids.

These were divided into three classes:

1. **Class I:** Bounded saddle, replacing not more than three teeth – tooth supported.

2. **Class II**: Free end saddle, no posterior abutment – tooth–tissue supported.

3. **Class III**: Bounded saddle, replacing more than three teeth – tooth–tissue supported.

The designations could be AI PII, AII PI, AI PII depending on the combination of available edentulous spaces (Figs 20.19–20.24).

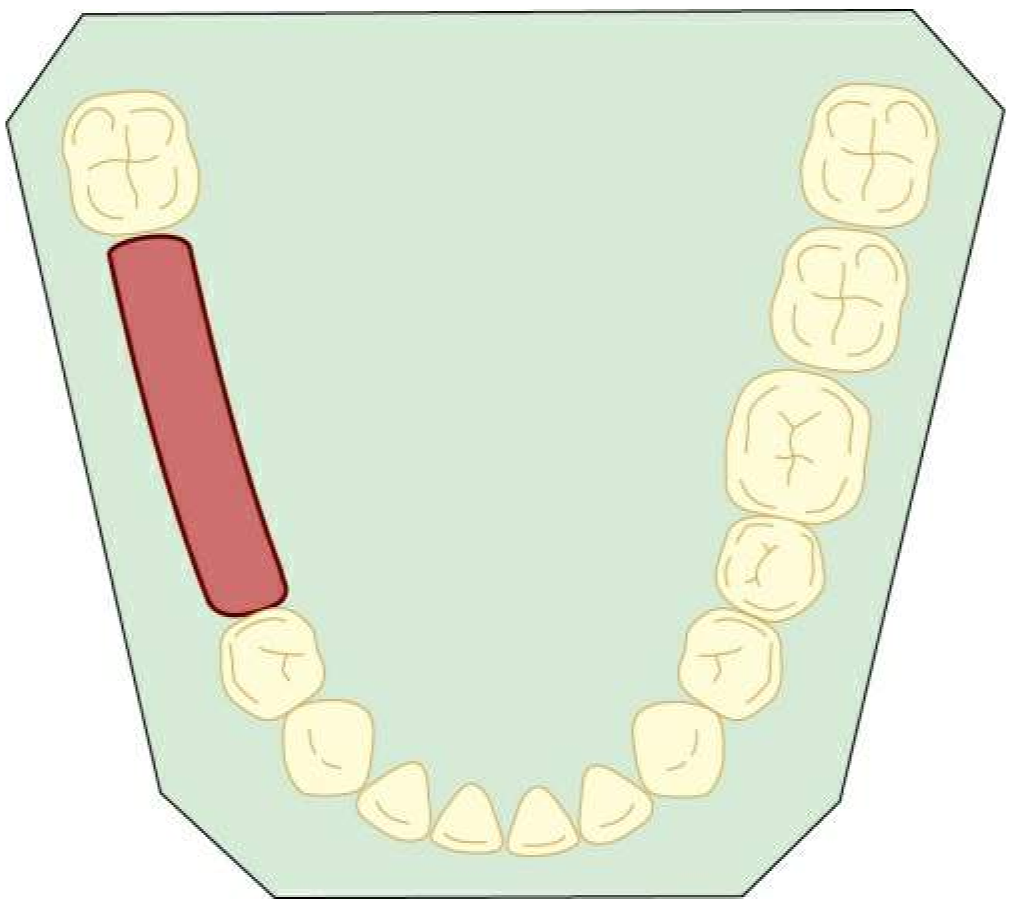


FIGURE 20.19 Bailyn's class PI.

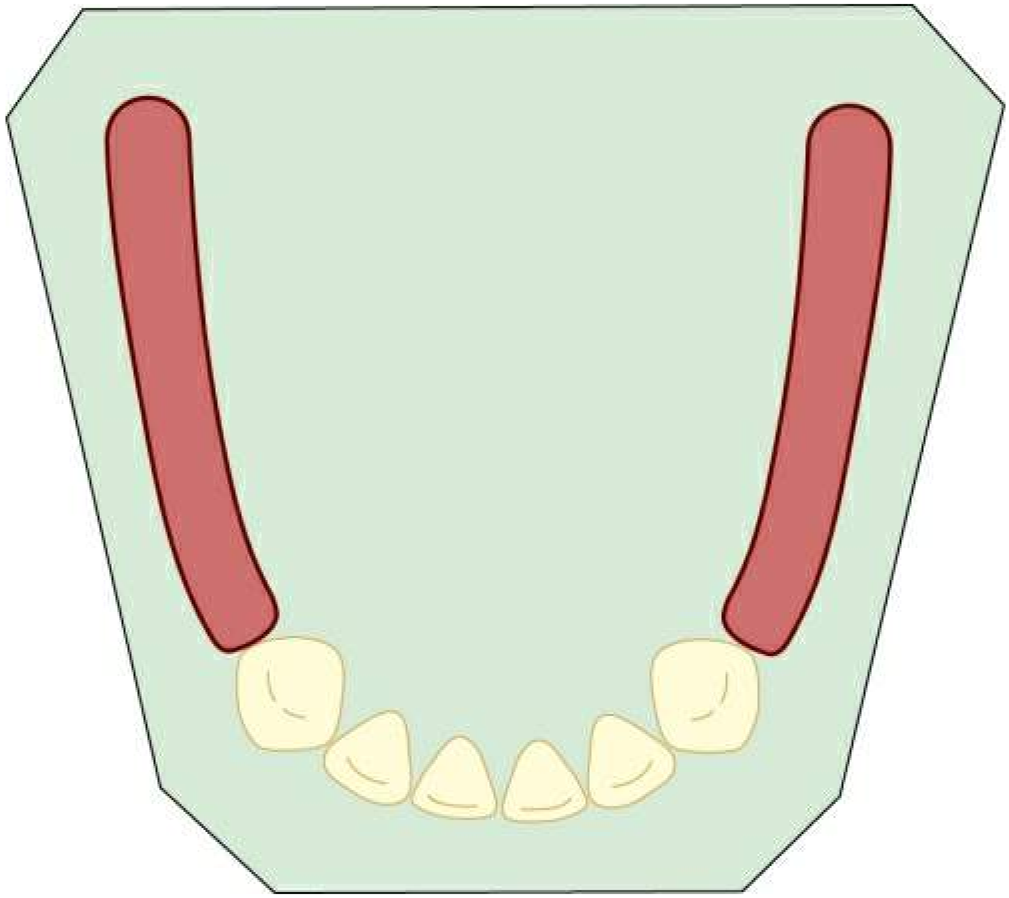


FIGURE 20.20 Bailyn's class P II.

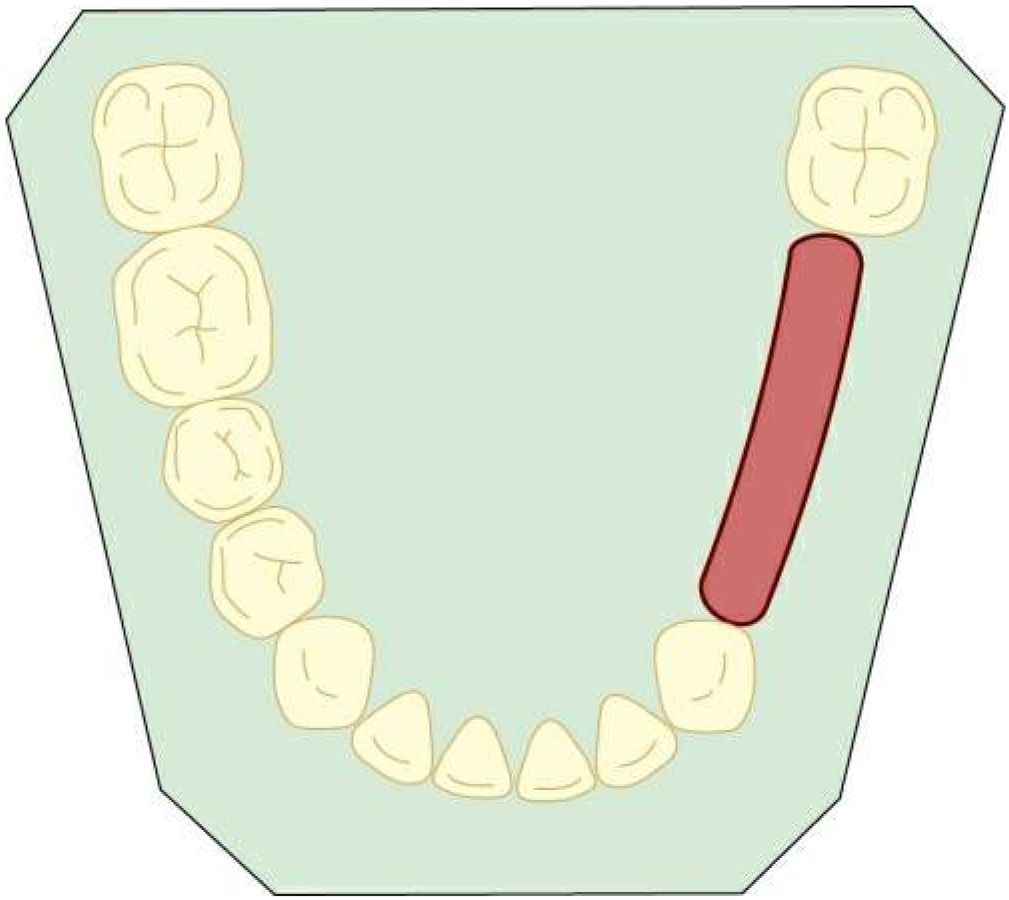


FIGURE 20.21 Bailyn's class P III.

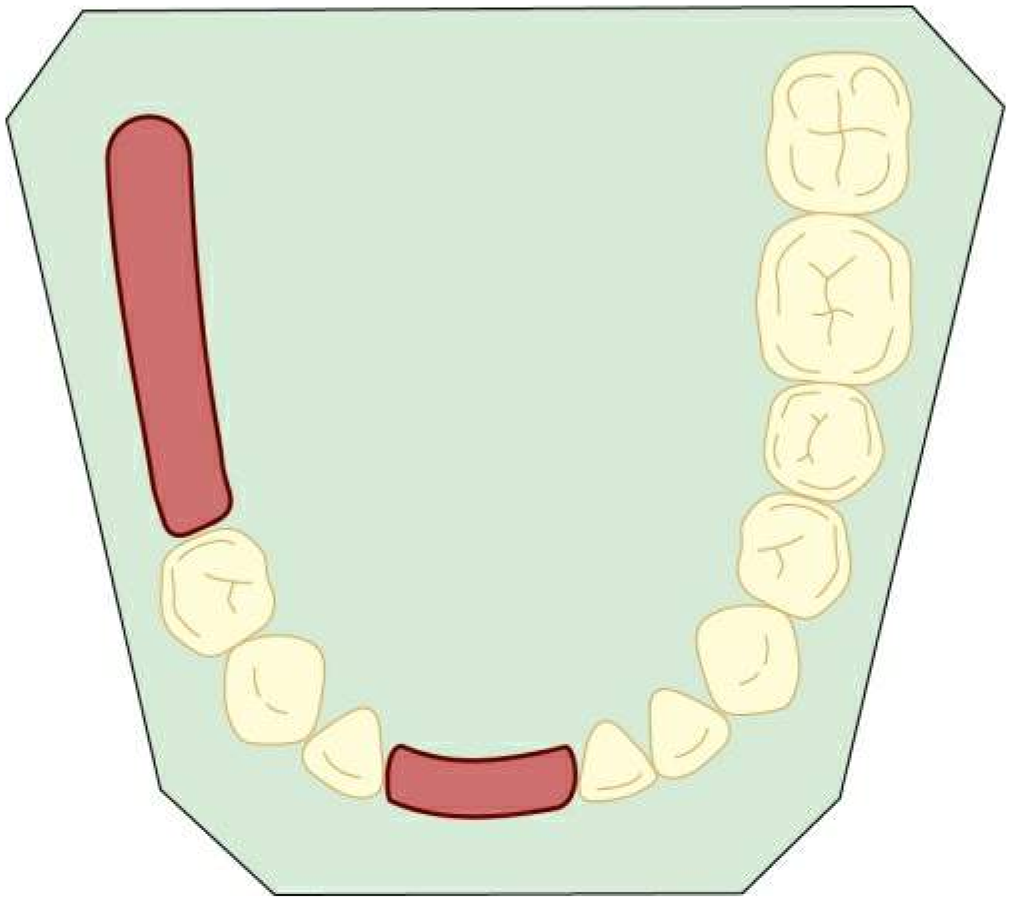


FIGURE 20.22 Bailyn's class AI, PII.

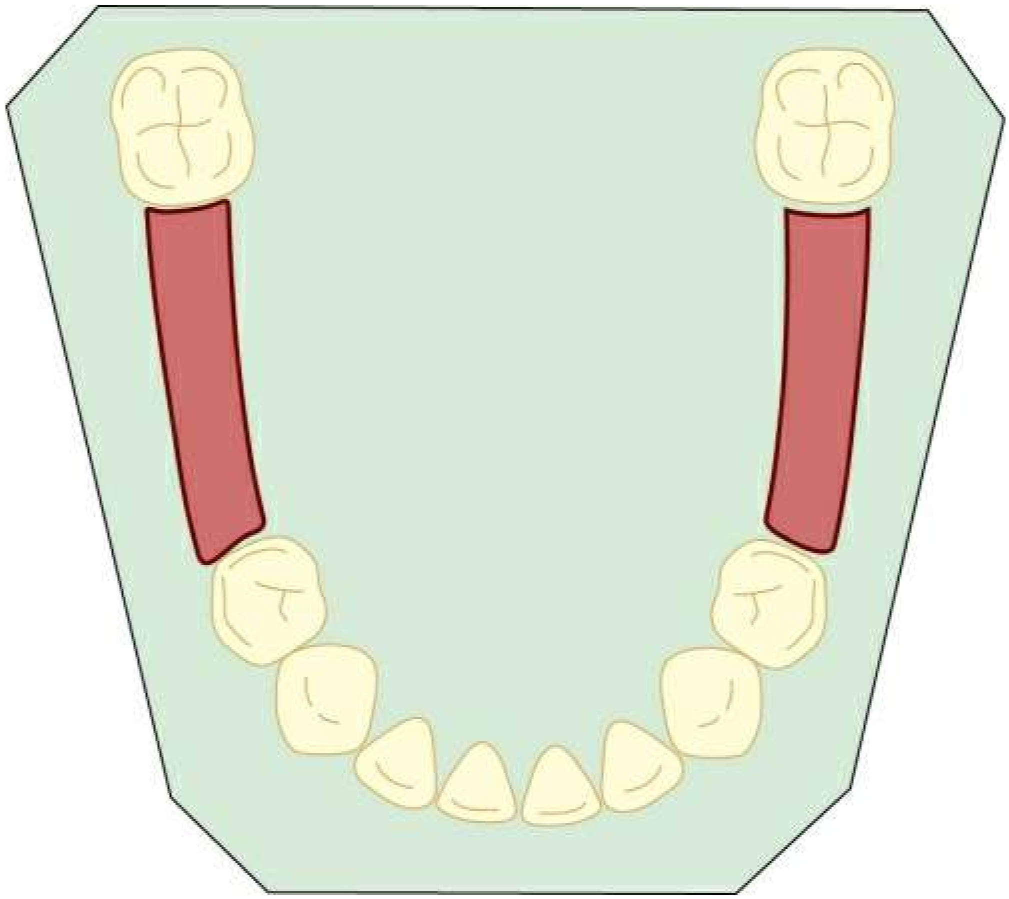


FIGURE 20.23 Bailyn's class PI, PII.

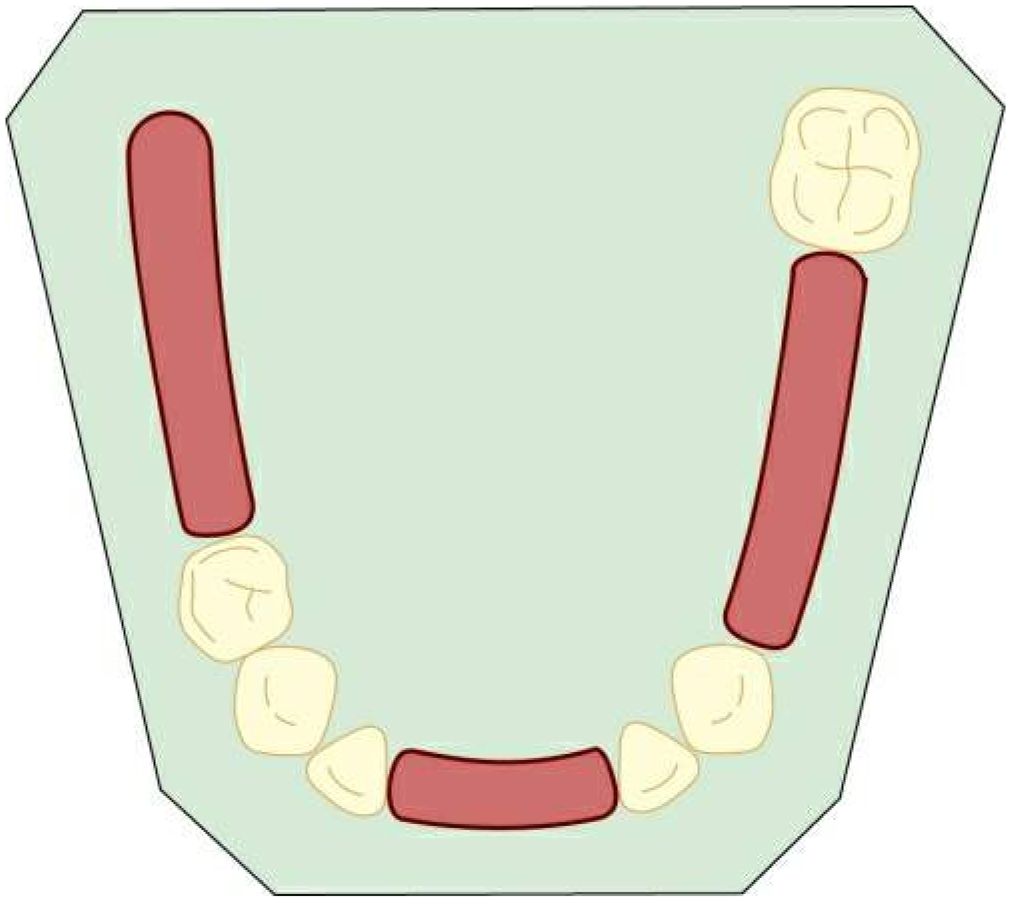


FIGURE 20.24 Bailyn's class AI, PI, PII.

Neurohr's classification

This classification was proposed by Neurohr in 1939; this classification was also based on the type of support. Because of its complexity, it is not commonly used.

Class I: Tooth bearing

A unilateral or bilateral case falls under this classification when there are teeth present posterior to all spans, and when there are no more than four teeth missing in any space.

There could be two variations in this class:

1. **Variation 1:** Missing posteriors predominate.

A. Posterior teeth are missing, anteriors are present (Fig. 20.25).

B. Posterior teeth are missing, and some anteriors are also missing (Fig. 20.26).

2. **Variation 2:** Missing anteriors predominate.

A. Anterior teeth are missing and posteriors are present (Fig. 20.27).

B. Anterior teeth are missing, and some posteriors are also missing (Fig. 20.28).

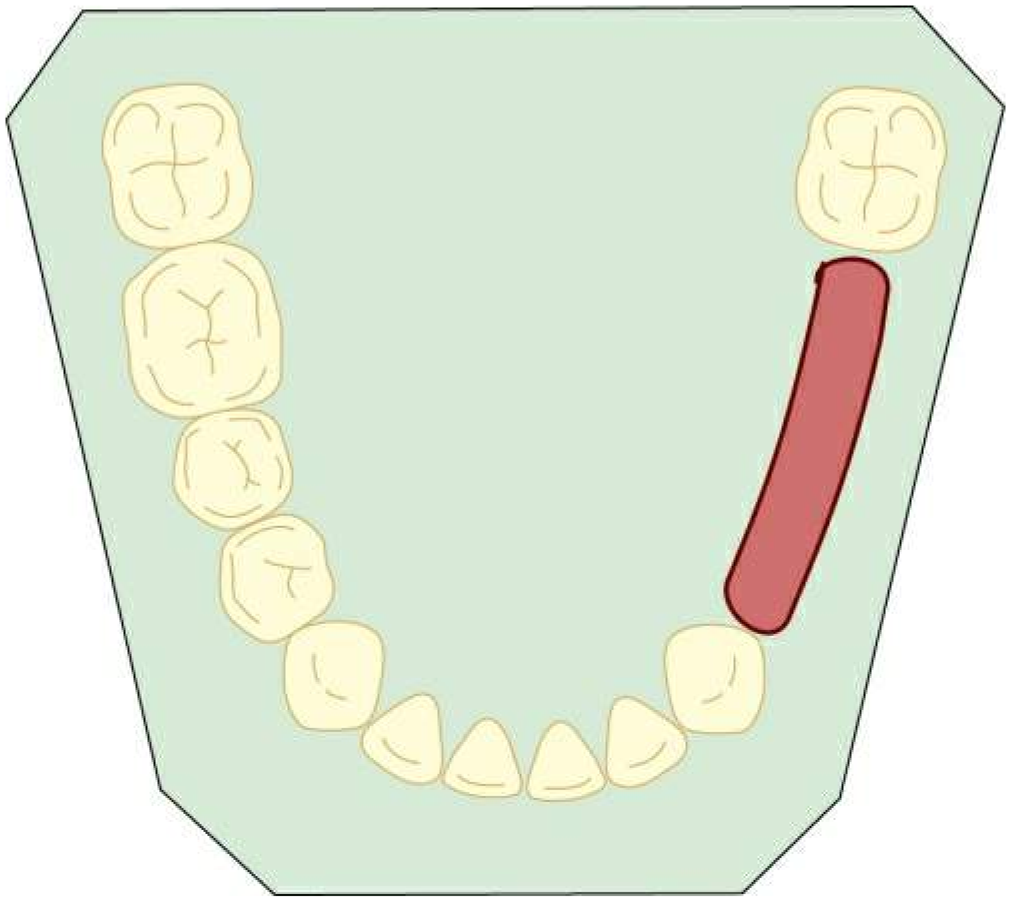


FIGURE 20.25 Neurohr's class I, variation 1A.

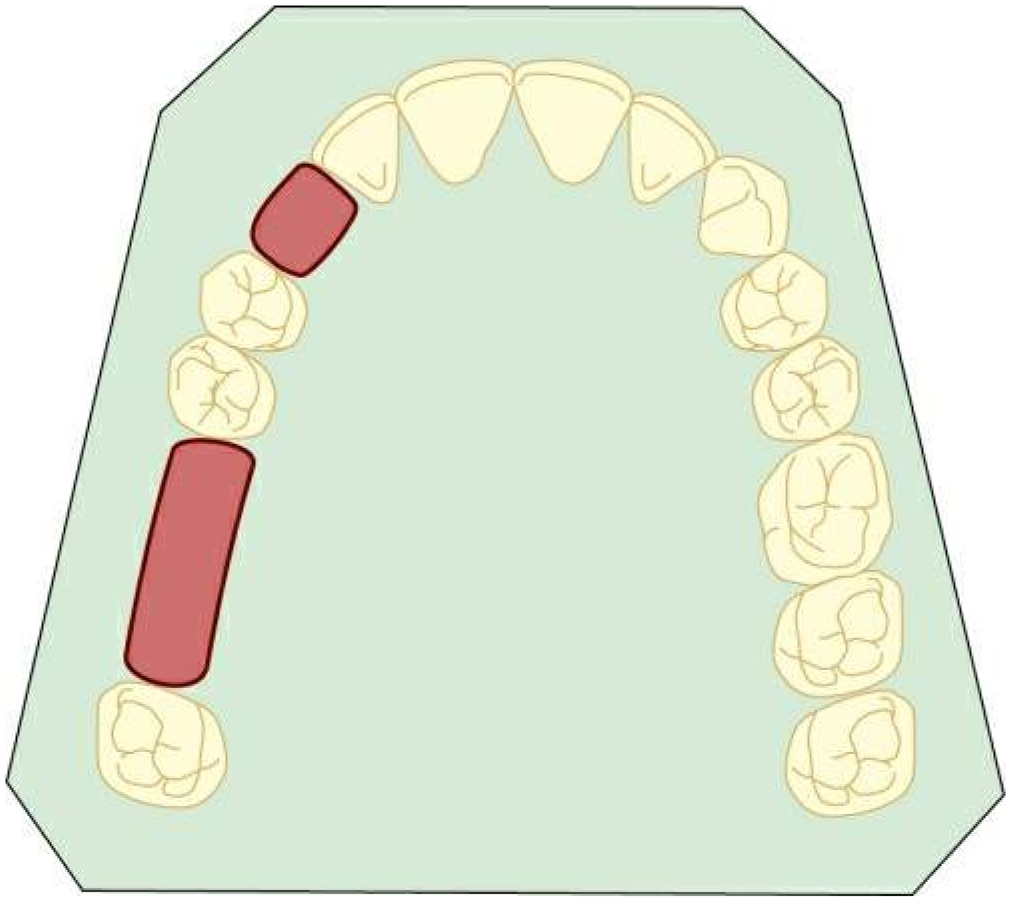


FIGURE 20.26 Neurohr's class I, variation 1B.

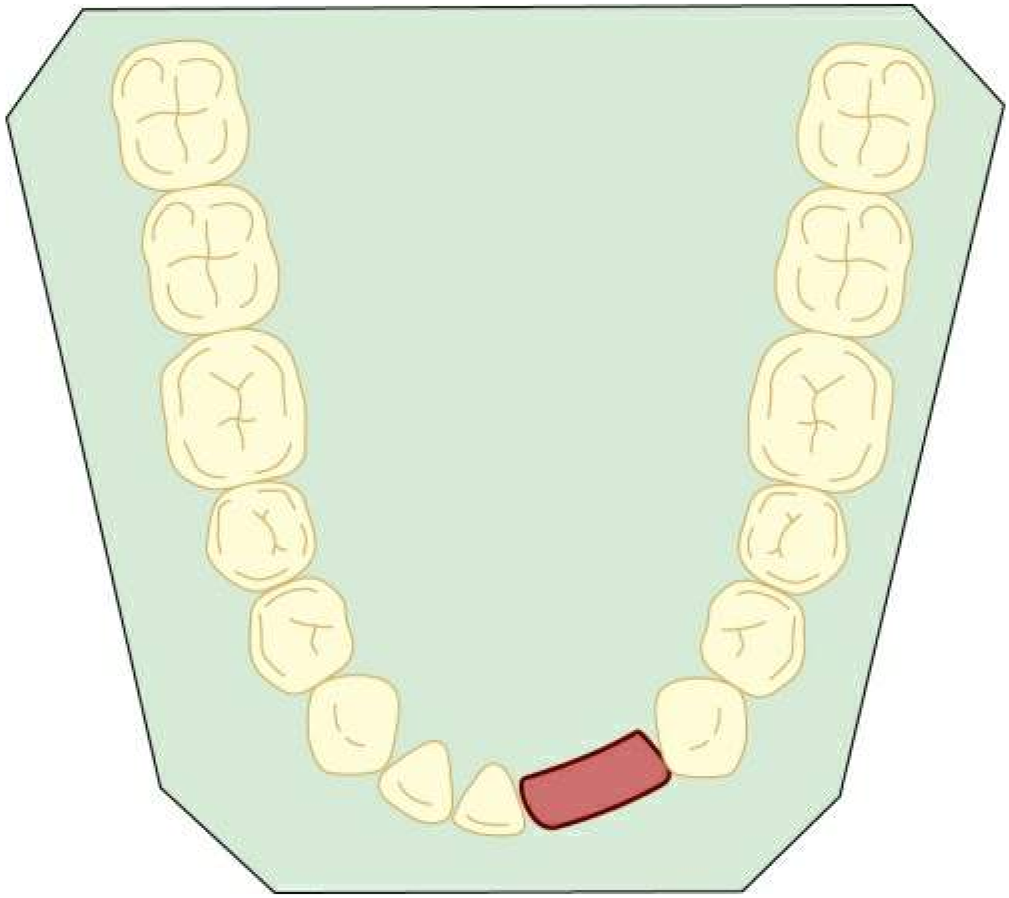


FIGURE 20.27 Neurohr's class I, variation 2A.

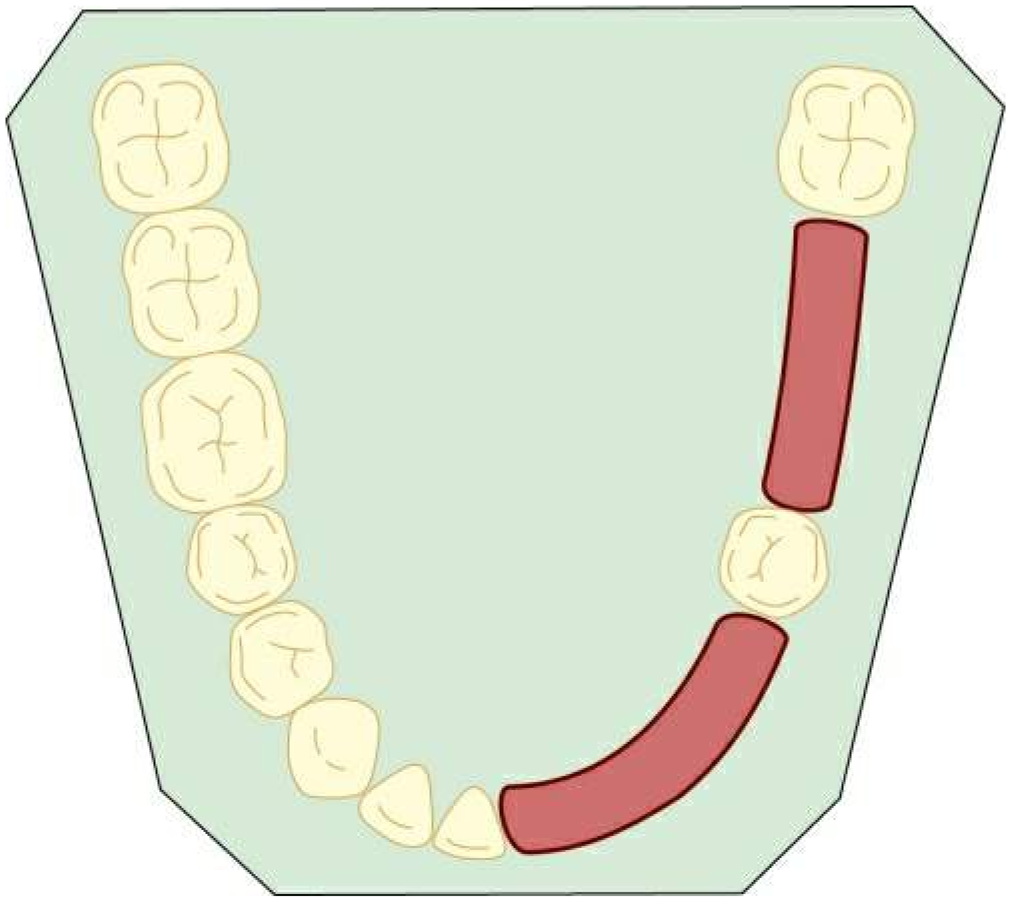


FIGURE 20.28 Neurohr's class I, variation 2B.

Class II: Tooth and tissue bearing

A unilateral or bilateral partial denture situation falls under this classification when there are no teeth posterior to one or more spans or when there are more than four teeth (including a cuspid) in one or more spans.

This is further subdivided into divisions with variations in each.

1. **Division I:** When there are no teeth posterior to one or more spans:

   i. **Variation 1:** Missing posteriors predominate:

   A. Posterior teeth are missing, anteriors are present

(Fig. 20.29).

B. Posterior teeth are missing, and some anteriors are also missing (Fig. 20.30).

ii. **Variation 2:** Missing anteriors predominate:

A. None (Fig. 20.31).

B. Anterior teeth are missing, and some posteriors are also missing (Fig. 20.32).

2. **Division II:** Has teeth posterior to all spans, but there are more than four teeth missing (including a cuspid) in one or more spans.

i. **Variation 1:** Missing posteriors predominate:

A. None (Fig. 20.33).

B. Posterior teeth are missing, and some anteriors are also missing (Fig. 20.34).

ii. **Variation 2:** Missing anteriors predominate:

A. Anteriors missing, posteriors are present (Fig. 20.35).

B. Anterior teeth are missing, and some posteriors are also missing (Fig. 20.36).

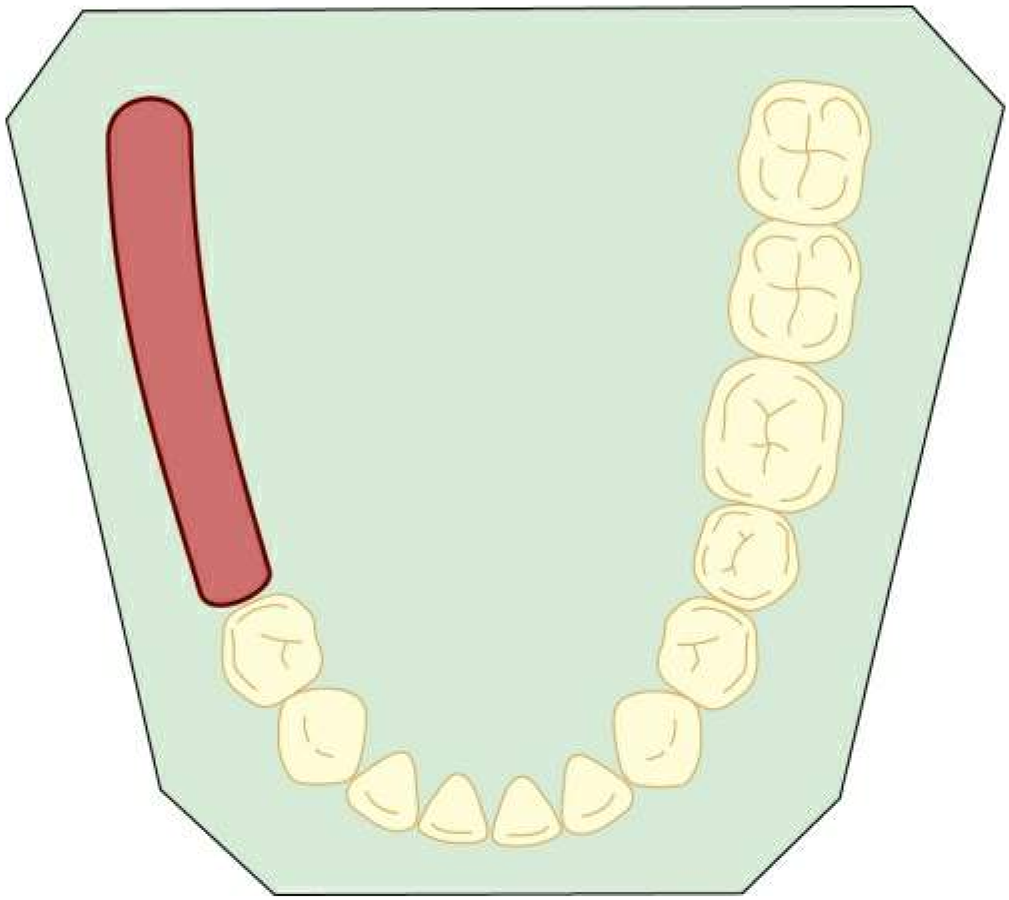


FIGURE 20.29 Neurhor's class II, division I, variation 1A.

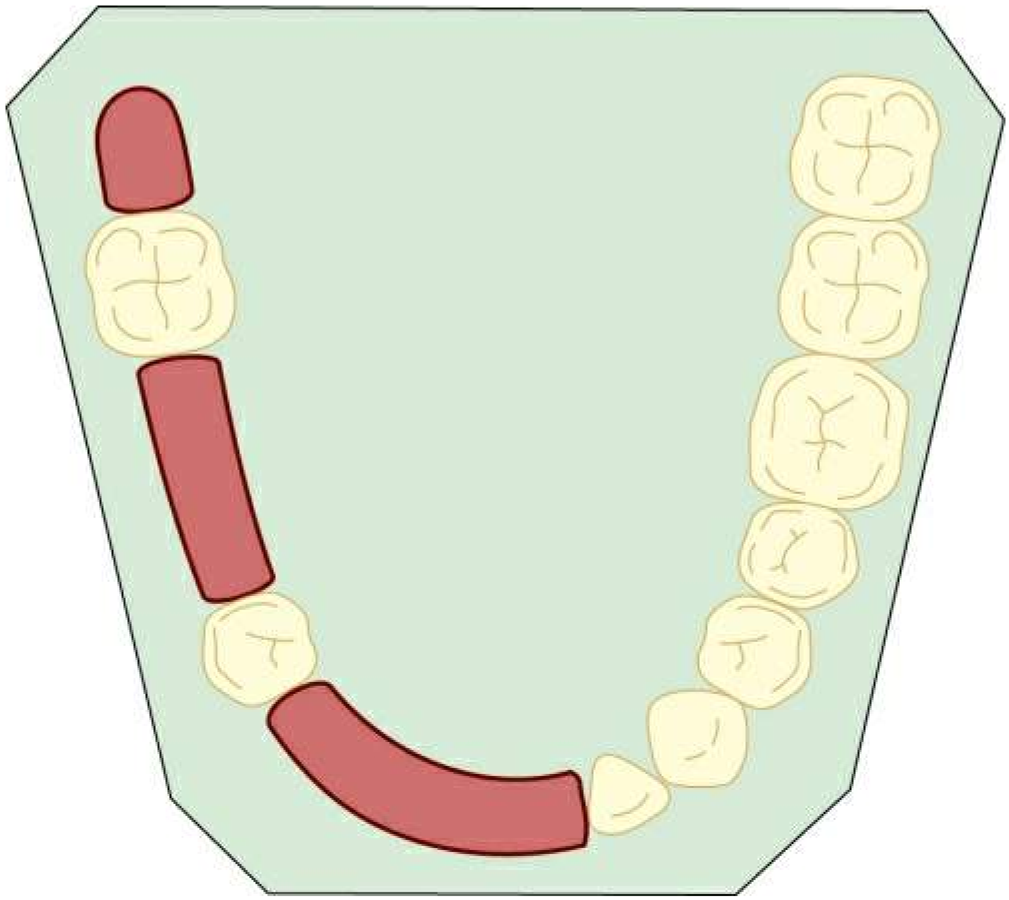


FIGURE 20.30 Neurhor’s class II, division I, variation 1B.

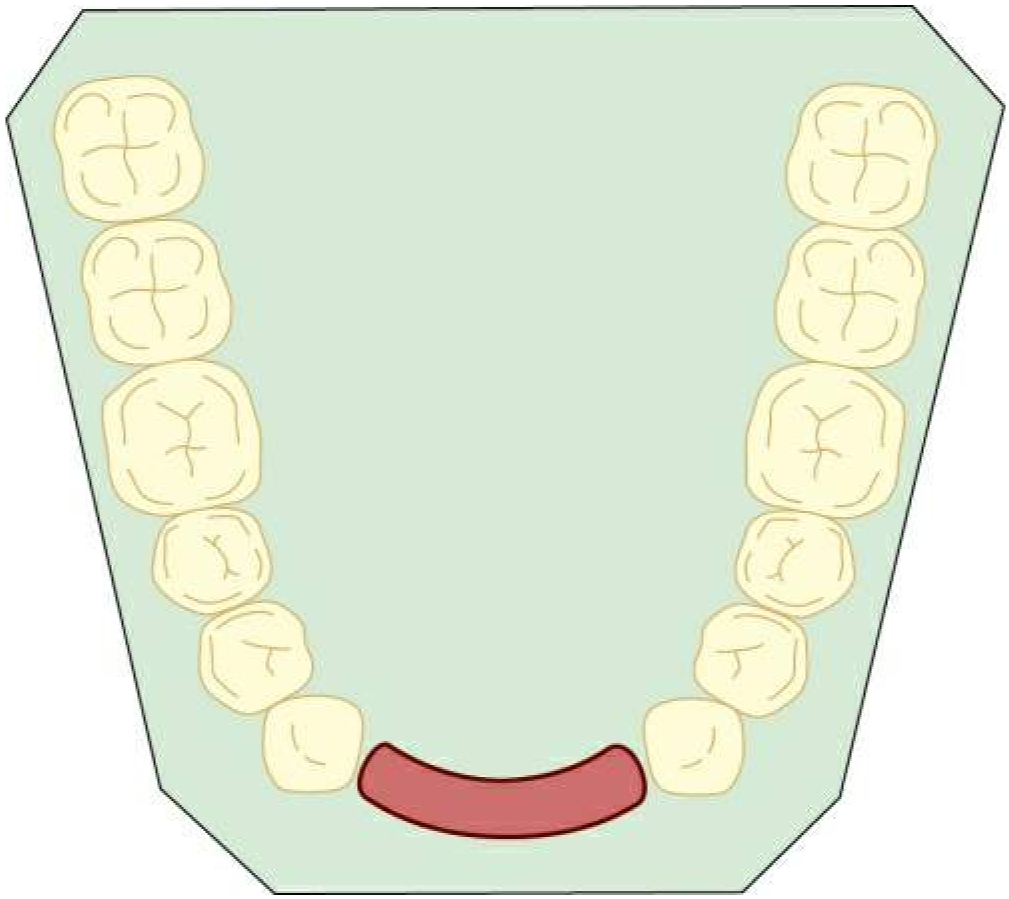


FIGURE 20.31 Neurhor's class II, division 1, variation 2A.

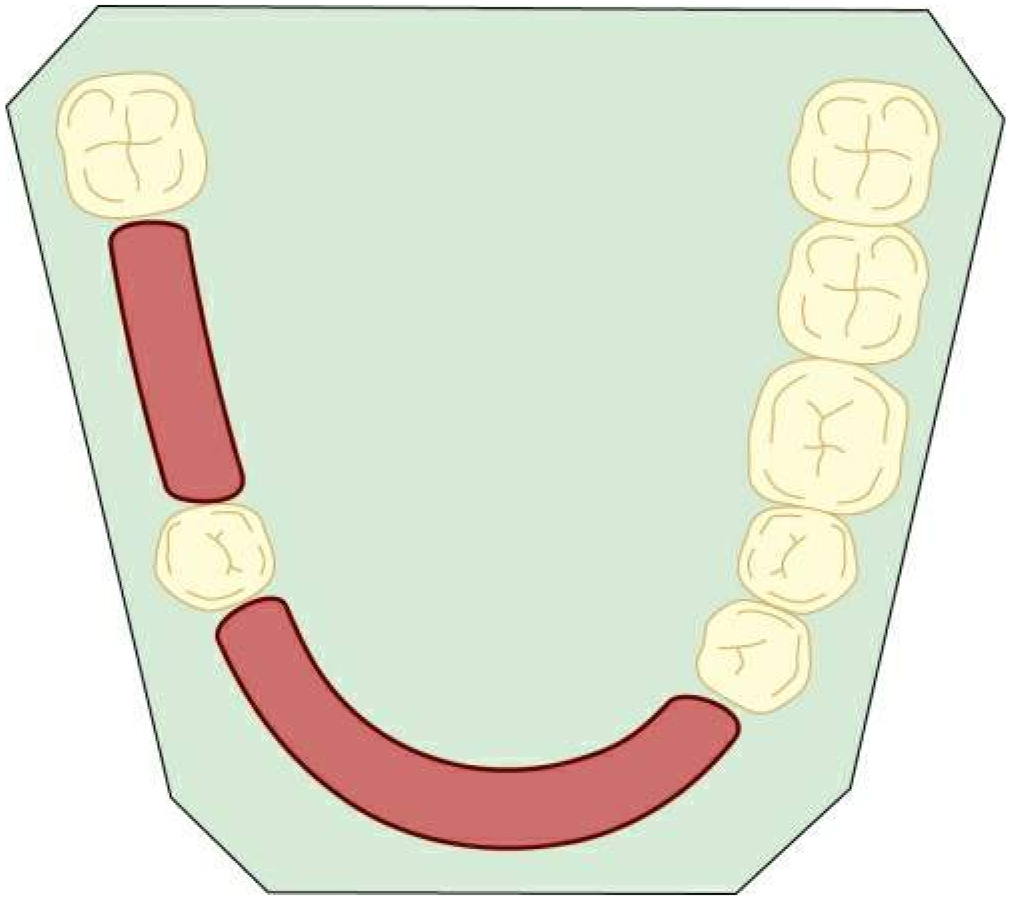


FIGURE 20.32 Neurhor's class II, division 1, variation 2B.

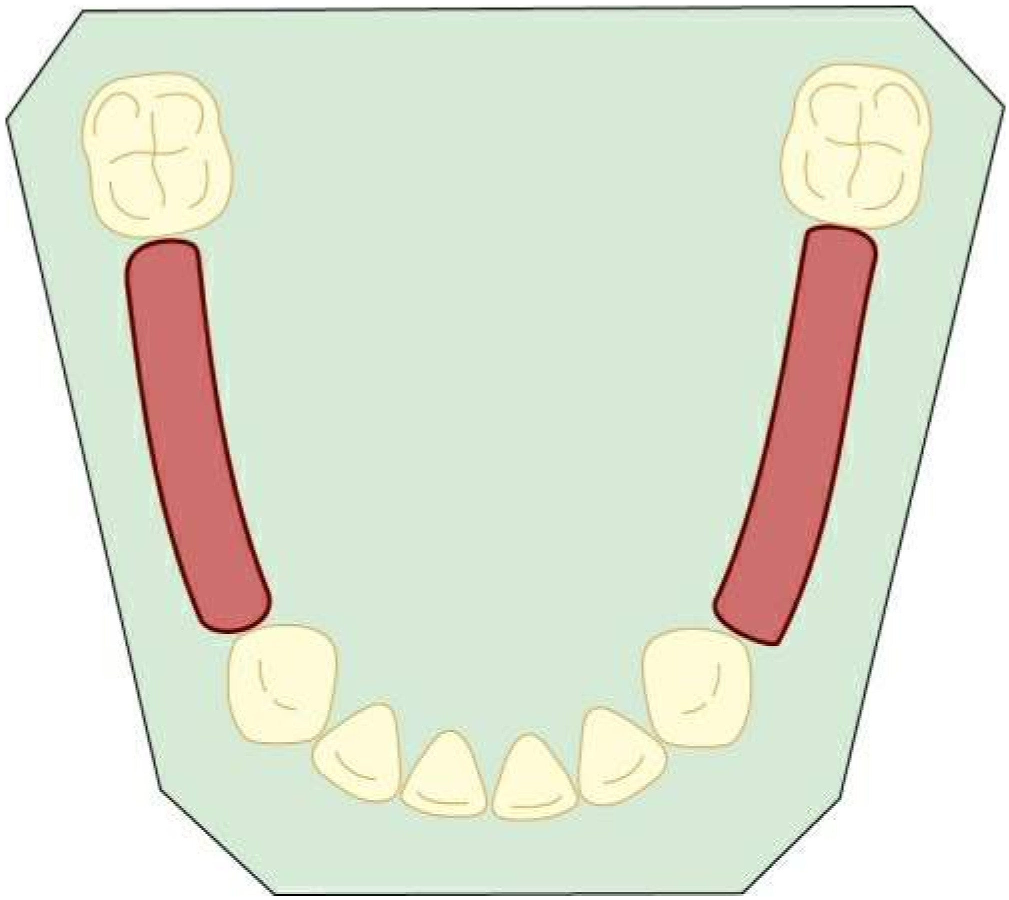


FIGURE 20.33 Neurhor's class II division II, variation 1A.

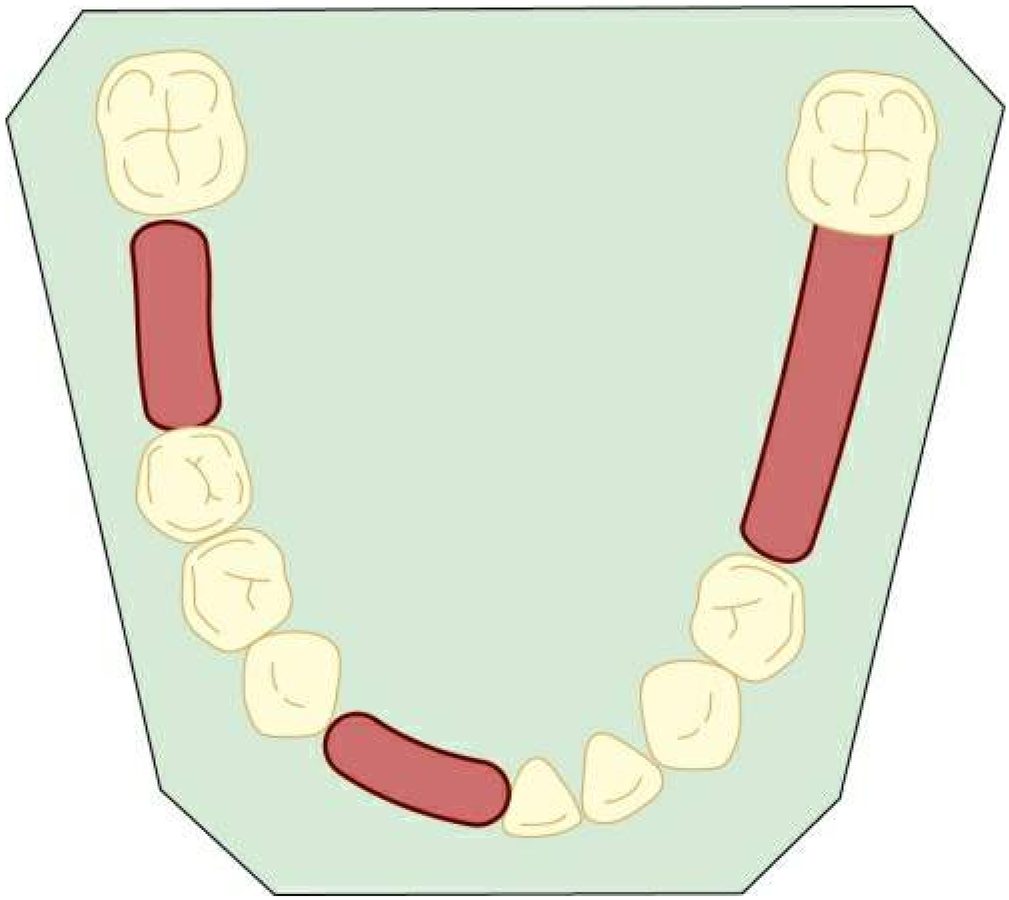


FIGURE 20.34 Neurhor’s class II division II, variation 1B.

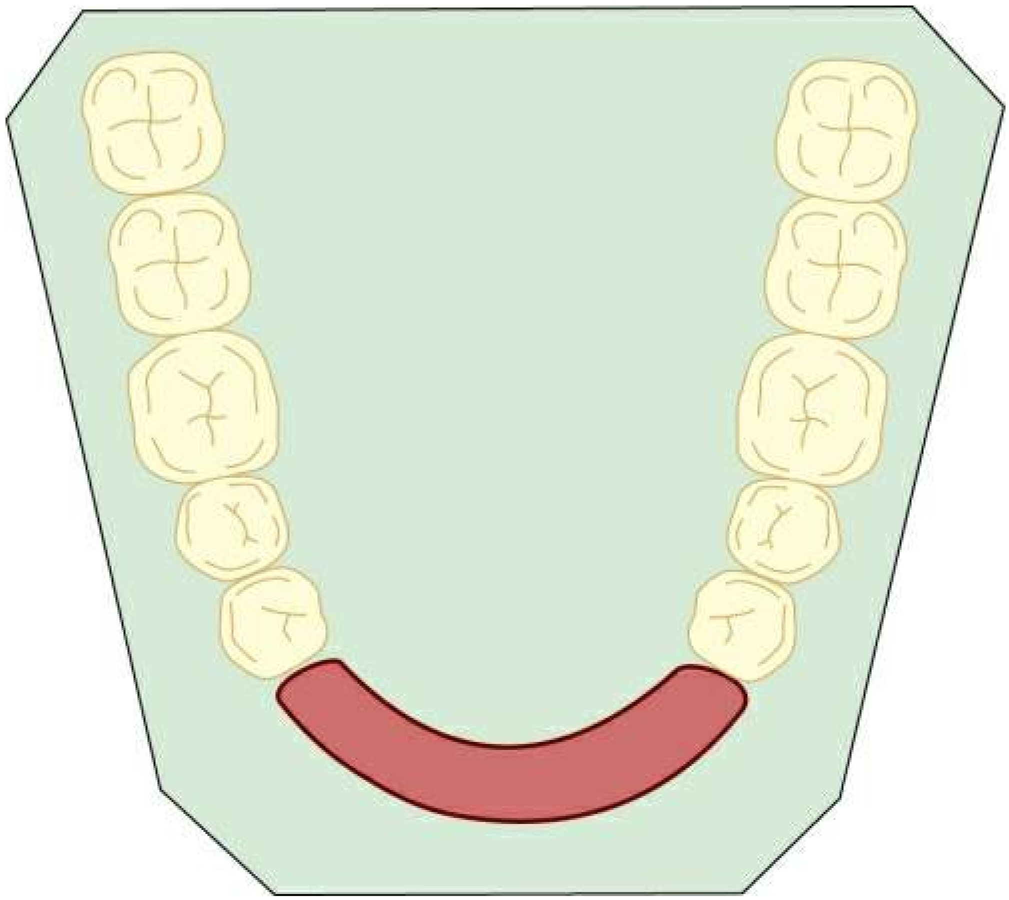


FIGURE 20.35 Neurhor's class II division II, variation 2A.

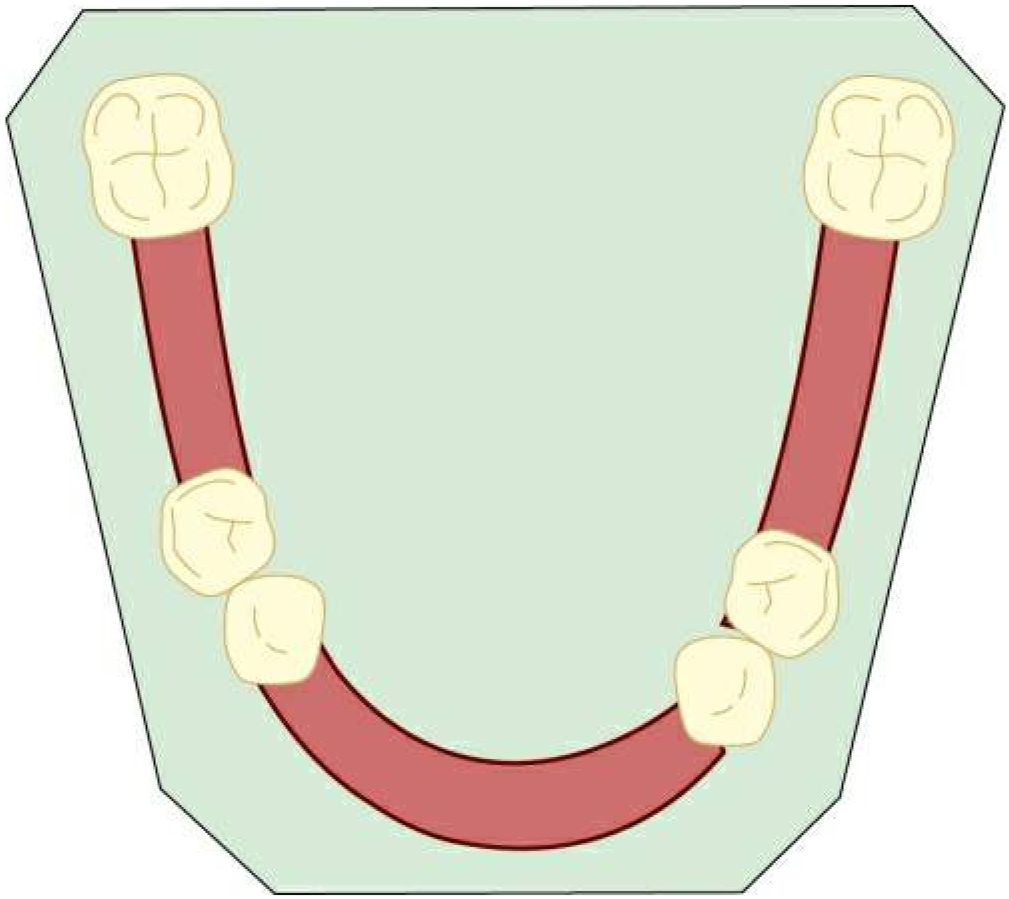


FIGURE 20.36 Neurhor's class II division II, variation 2B.

Class III: Tissue bearing complete dentures

Mauk's classification system

This was proposed by Mauk in 1942 and was based on the following:

- Number, length and position of the spaces.
- The number and position of the remaining teeth.

1. **Class I:** Bilateral posterior spaces and teeth remaining in a segment in the anterior region (Fig. 20.37).

2. **Class II:** Bilateral posterior spaces and one or more teeth at the

posterior end of one space (Fig. 20.38).

3. **Class III:** Bilateral posterior spaces and one or more teeth at the posterior end of both spaces (Fig. 20.39).

4. **Class IV:** A unilateral posterior space with or without teeth at the posterior end of the space. The arch is unbroken on the opposite side (Fig. 20.40).

5. **Class V:** An anterior space only. The posterior part of the arch is unbroken on either side (Fig. 20.41).

6. **Class VI:** Irregular spaces around the arch. The remaining teeth are single or in small groups (Fig. 20.42).

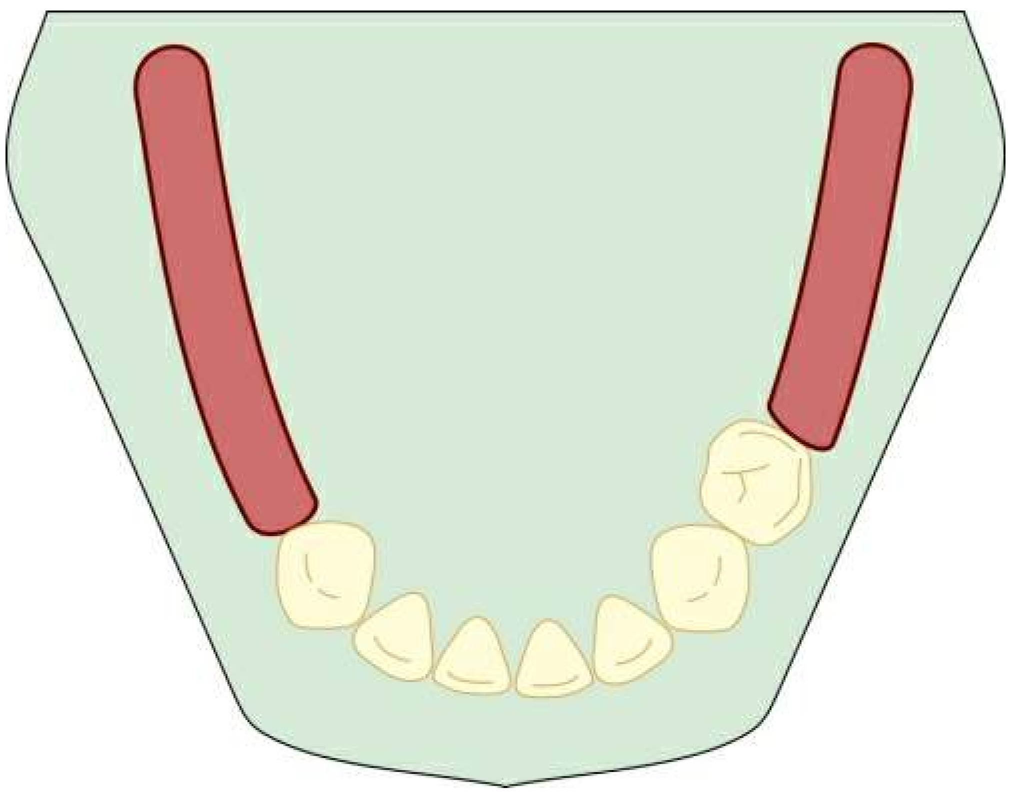


FIGURE 20.37 Mauk's class I.

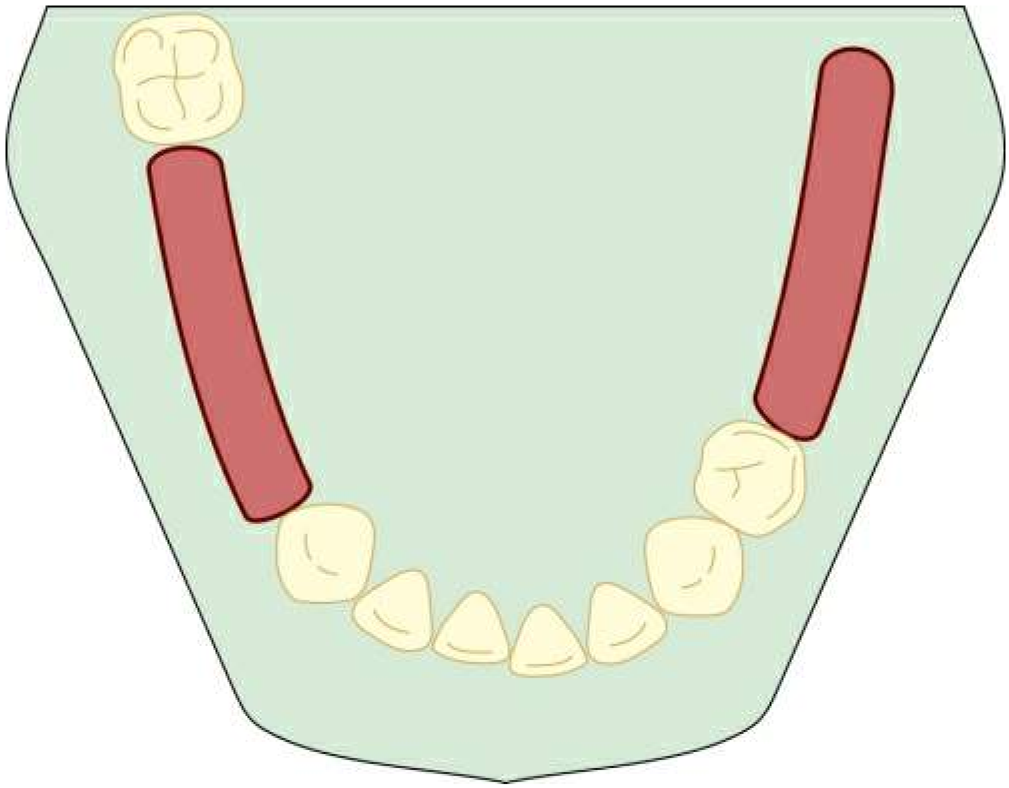


FIGURE 20.38 Mauk's class II.

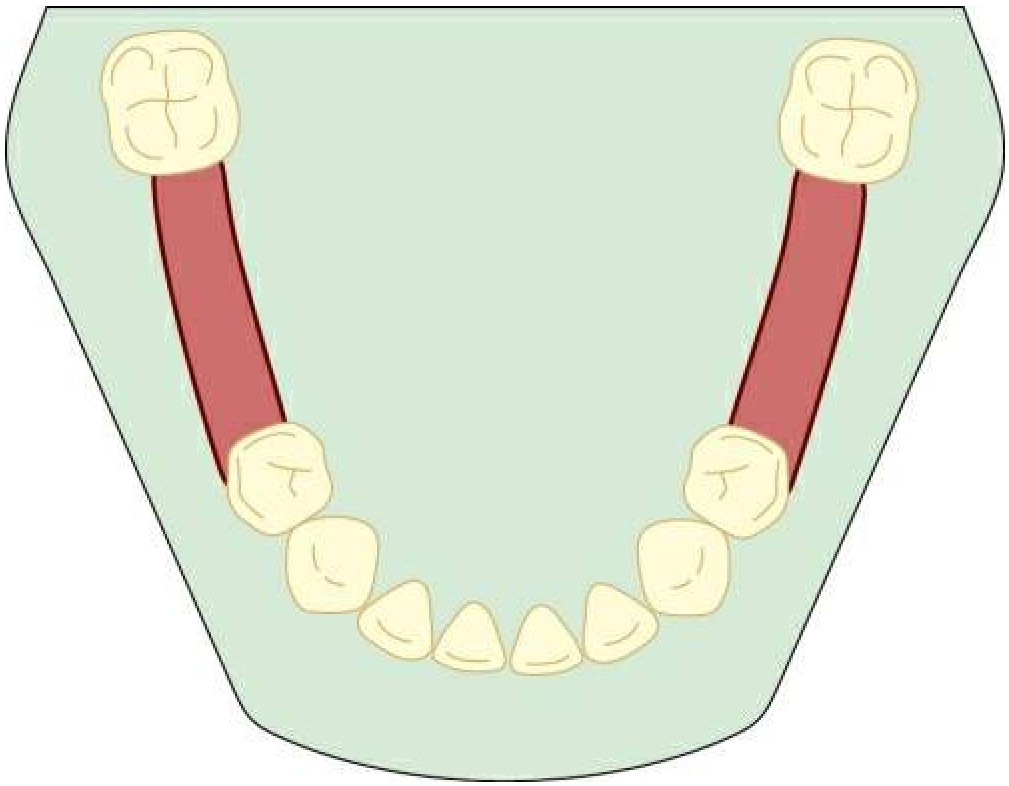


FIGURE 20.39 Mauk's class III.

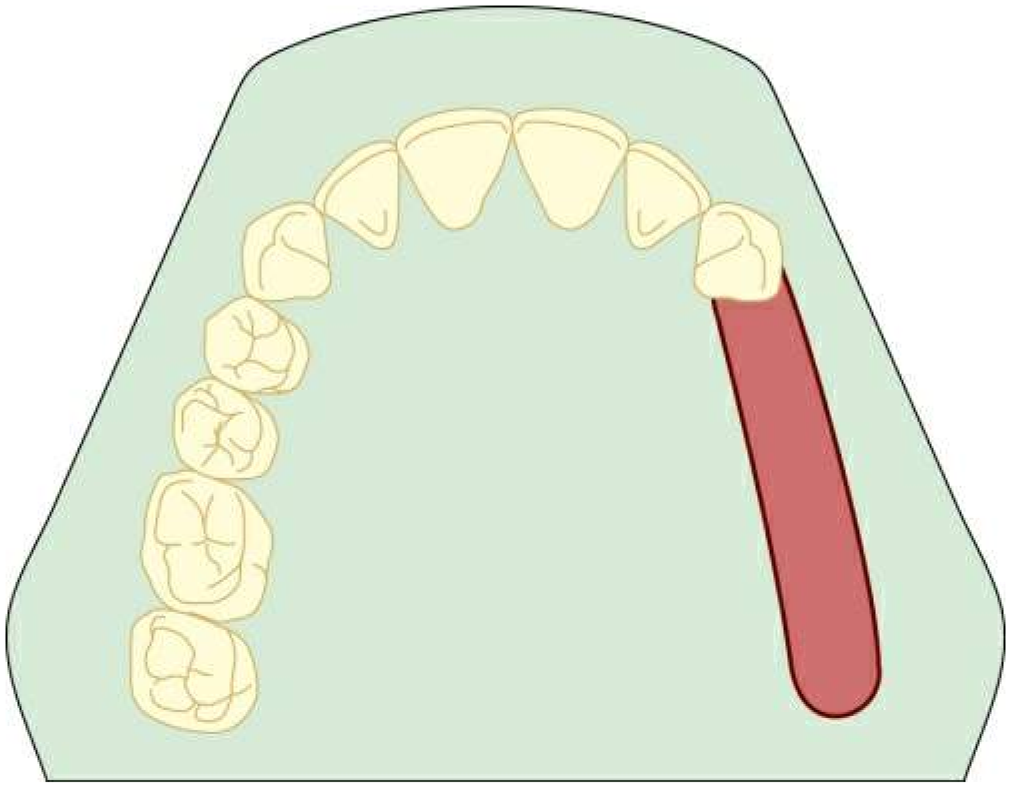


FIGURE 20.40 Mauk's class IV.

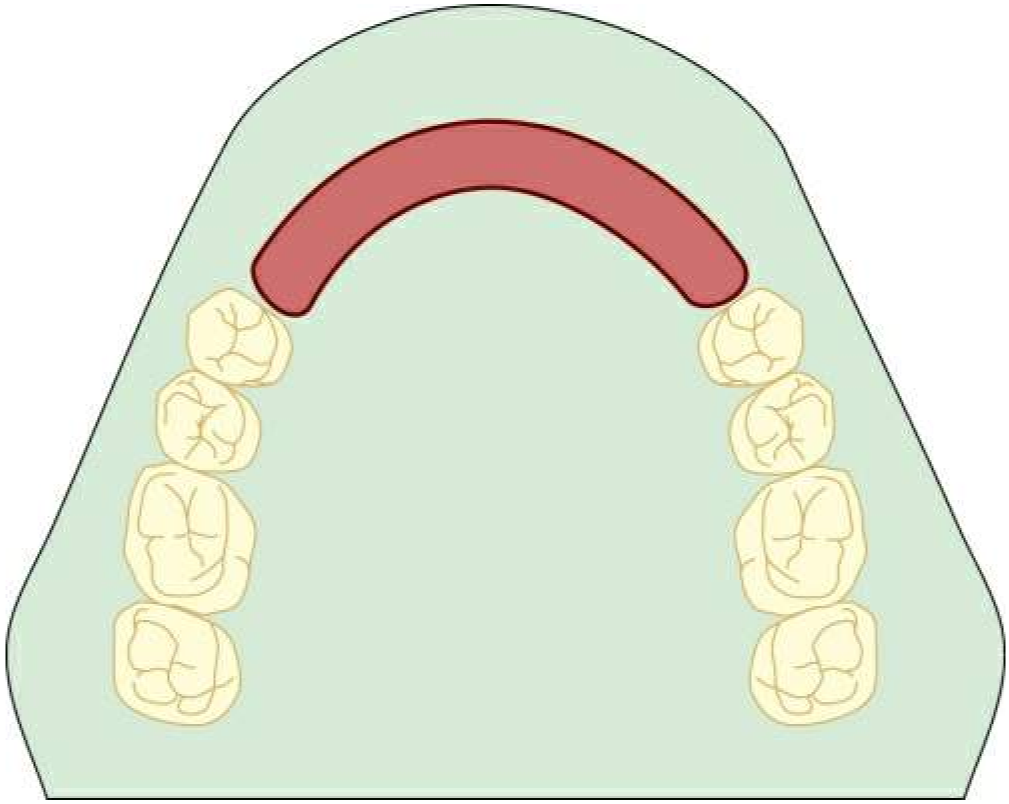


FIGURE 20.41 Mauk's class V.

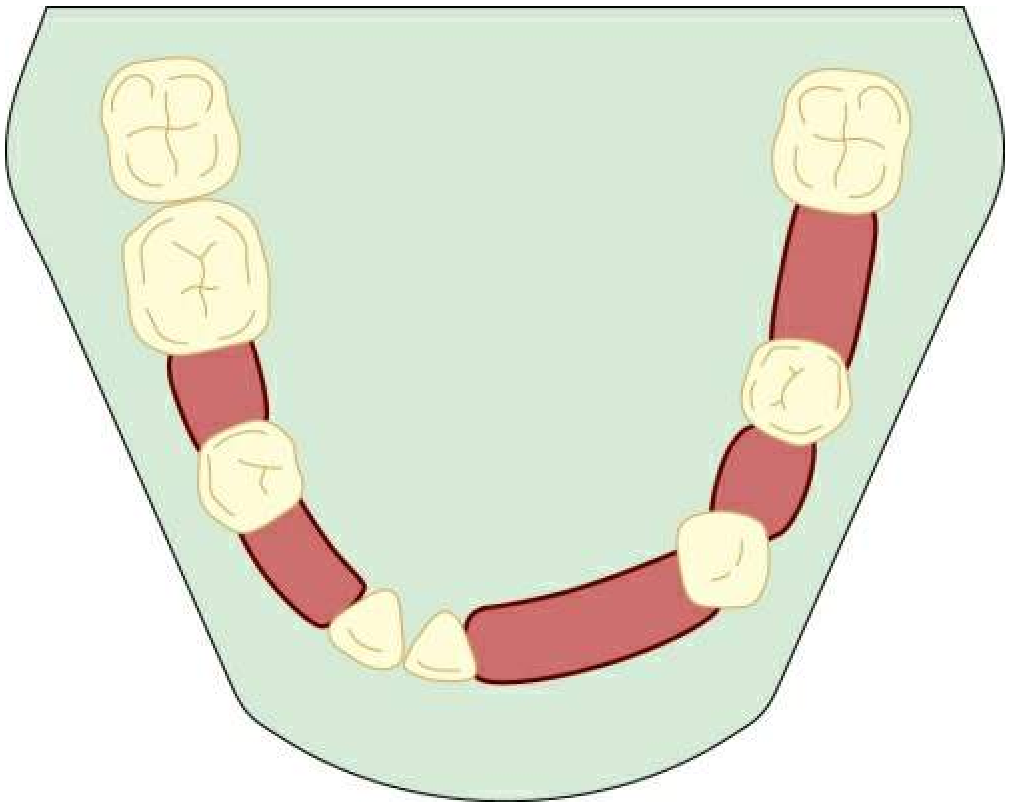


FIGURE 20.42 Mauk's class VI.

Godfrey's classification

This classification was proposed by Godfrey in 1951; it was based on location and extent of the edentulous spaces. The main classes have no subdivisions or modifications.

1. **Class A:** Tooth-borne denture bases in the anterior part of the mouth. It may be an unbroken five-tooth space, broken five-tooth space or an unbroken four-tooth space (Fig. 20.43).

2. **Class B:** Mucosa-borne denture bases in the anterior part of the mouth. It may be an unbroken six-tooth space, unbroken five-tooth space or a broken five-tooth space (Fig. 20.44).

3. **Class C:** Tooth-borne denture bases in the posterior part of the mouth. It may be an unbroken three-tooth space, a broken three-tooth

space, an unbroken two-tooth space or a broken two-tooth space (Fig. 20.45).

4. **Class D:** Mucosa-borne denture bases in the posterior part of the mouth. It may be an unbroken four-tooth space, a three-tooth, two-tooth, or single-tooth space (Fig. 20.46).

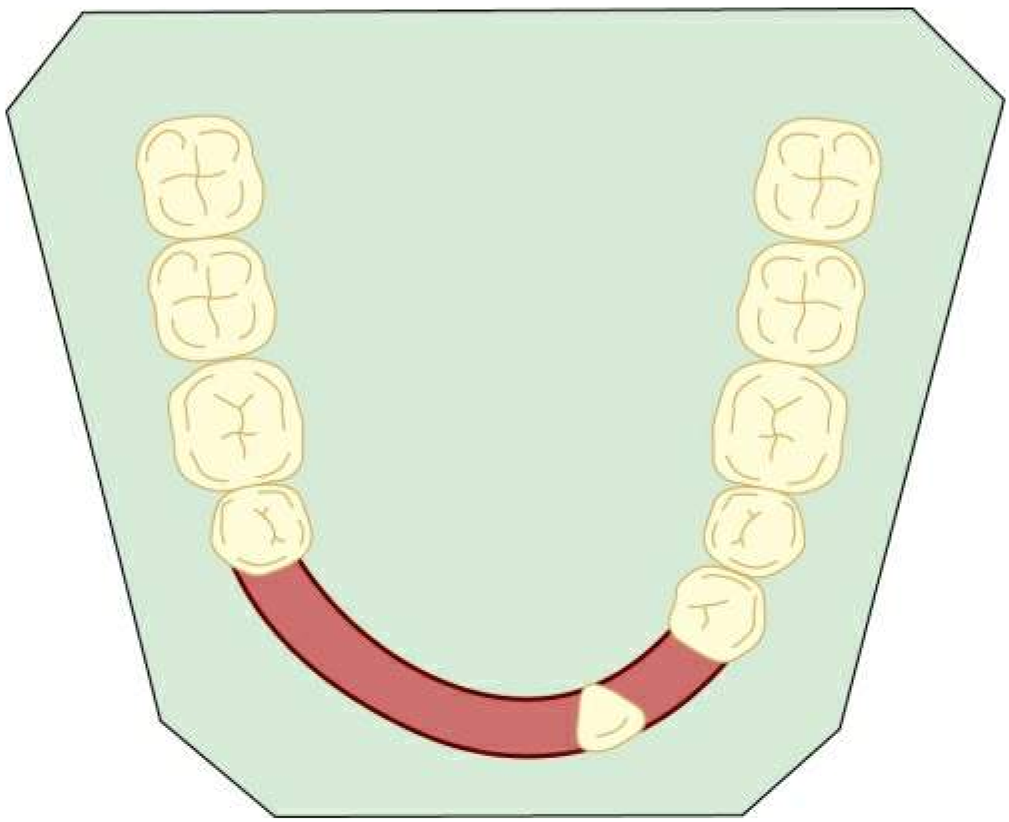


FIGURE 20.43 Godfrey's class A.

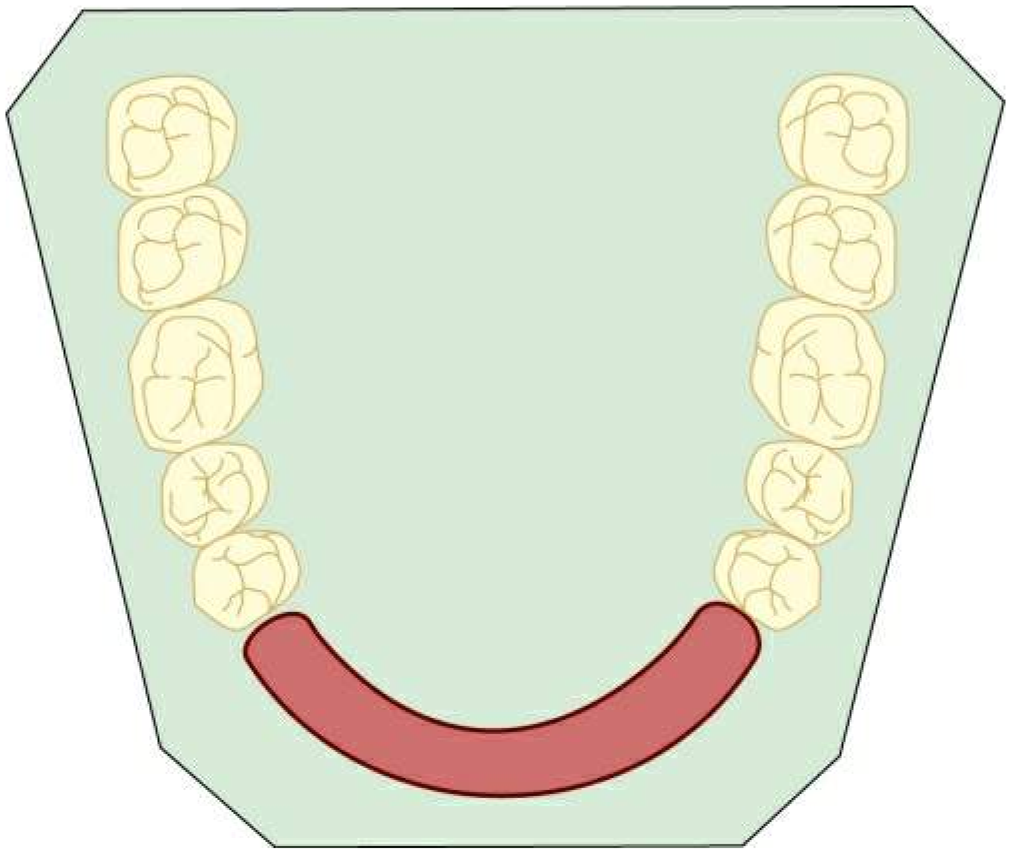


FIGURE 20.44 Godfrey's class B.

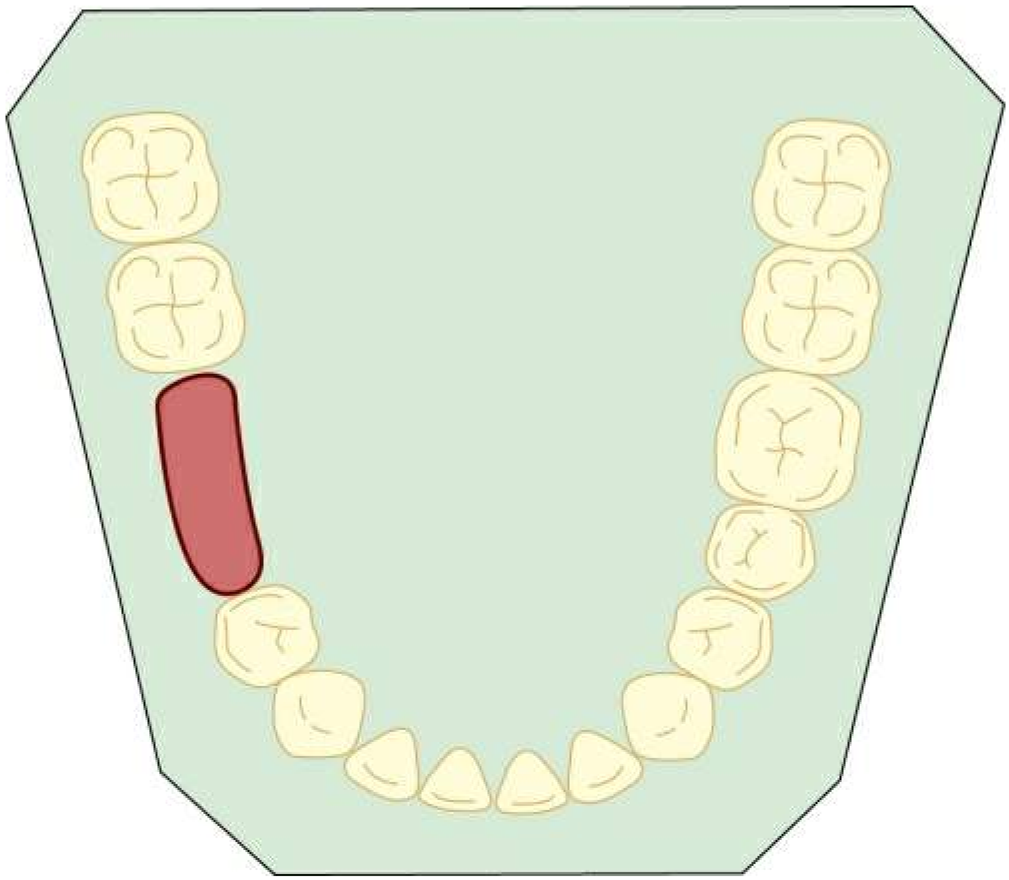


FIGURE 20.45 Godfrey's class C.

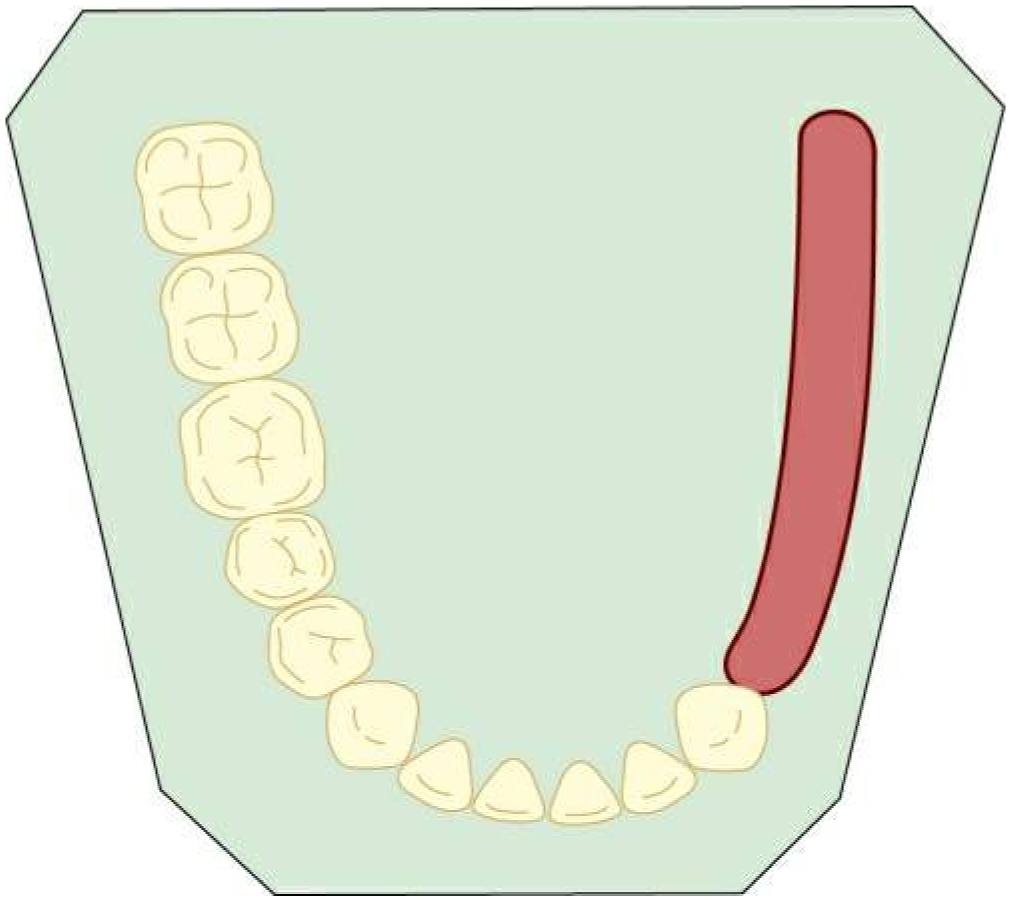


FIGURE 20.46 Godfrey's class D.

Beckett's classification

Beckett's classification was proposed by Beckett in 1953 based on Bailyn's classification. He considered the following factors to determine the proportionate amount of support provided by the teeth and tissue:

1. The quality of abutment support.

2. The magnitude of occlusal support.

3. The harmony of the occlusion.

4. The quality of the mucosa and residual ridge.

Class 1

Saddles (denture bases) that are entirely tooth supported. These are bounded saddles with sound abutment teeth which can completely support the prosthesis (Fig. 20.47).

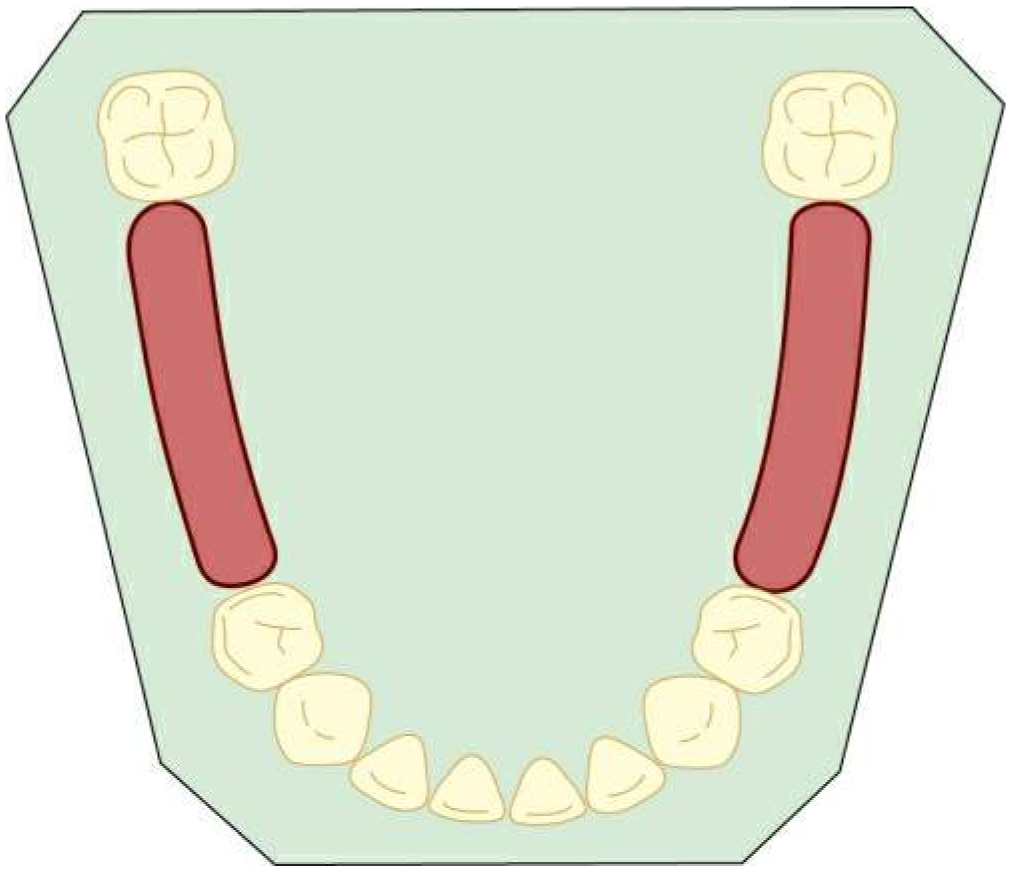


FIGURE 20.47 Beckett's class I.

Class 2

Saddles that are entirely mucosa supported. These may be of two types:

1. Free end saddle.

2. Bounded saddle where the length of the saddle or condition of the

abutment teeth contraindicates a tooth-borne saddle.

Class 3

Saddles that are tooth-borne but abutment teeth are not capable of providing total support (Fig. 20.48). This may be due to poor health of the abutments, long edentulous spans and poor mucosal and alveolar bone condition.

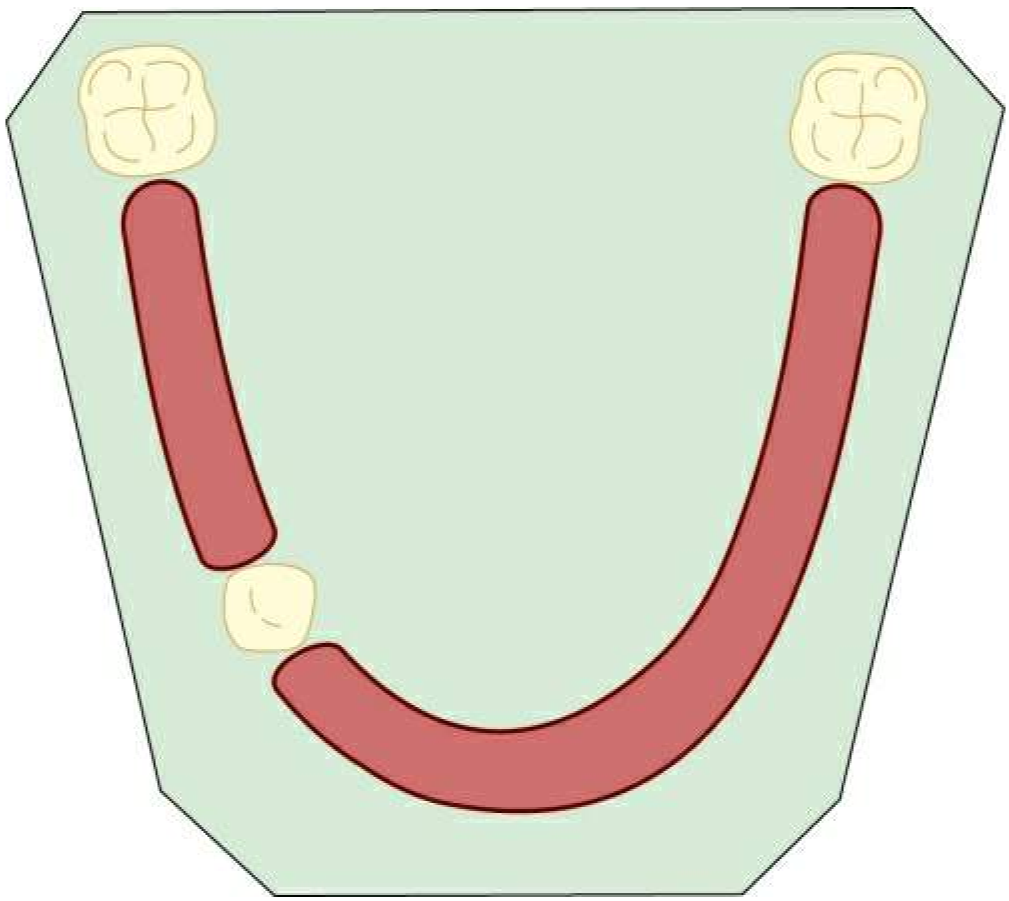


FIGURE 20.48 Beckett's class 3.

Beckett stated that these three basic classes of saddles frequently appeared in combination. Thus, partial dentures which would contain both class I and class II denture bases were designated as class 1.2 dentures. Similarly, there were class 1.3 dentures, class 2.3 dentures and class 1.2.3 dentures. Thus, partial dentures could be classified into seven groups from a functional point of view.

Friedman's classification

In 1953, Friedman introduced the ABC classification system based on three essential segment types occurring either as discrete or continuous segments (Fig. 20.49). These areas are designated as:

1. Anterior space

2. Bounded posterior space

3. Cantilever situation (posterior free-end).

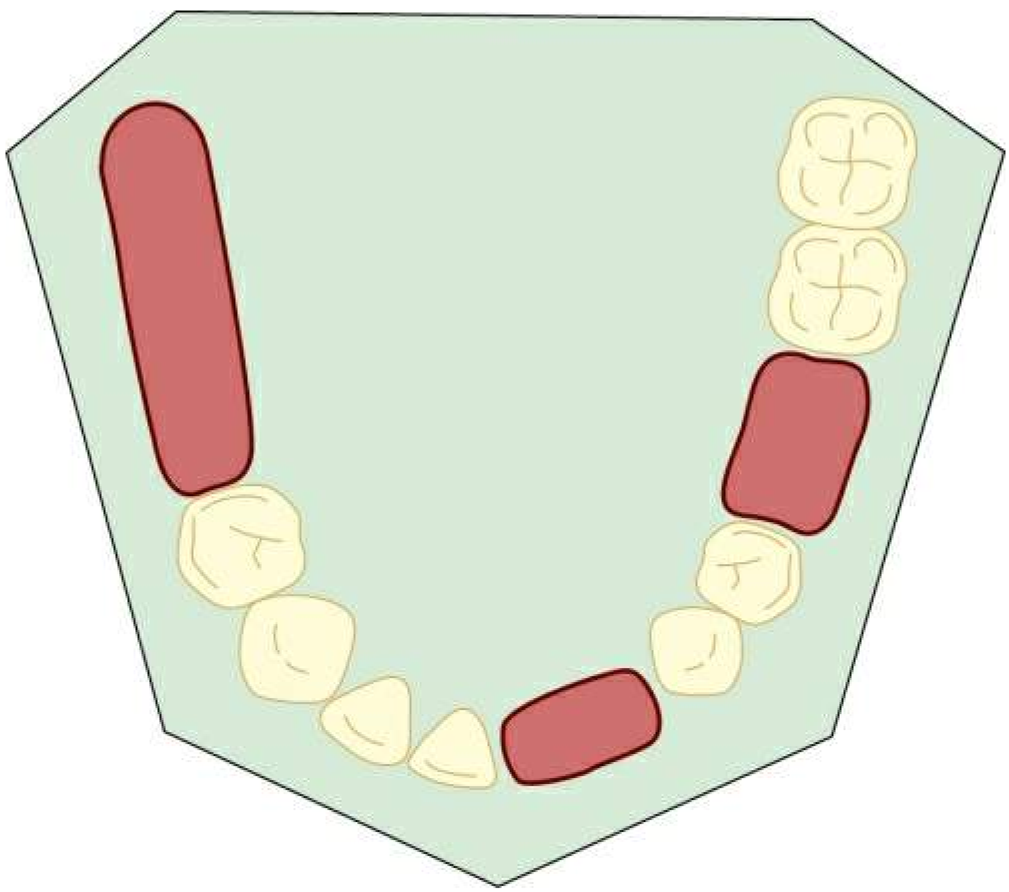


FIGURE 20.49 Friedman's classification – combination of all three C-A-B space.

Each of these is further subclassified into:

1. Single missing tooth

2. Two or more continuous missing teeth.

Austin–Lidge classification

This classification was proposed in 1957 by Austin and Lidge. Based on the position of the teeth, they designated partially edentulous spaces as:

1. Anterior space or spaces (A)

2. Posterior space or spaces (P)

3. Bilateral spaces (Bi)

A combination of any of these could be present in a given clinical situation.

Skinner's classification system

This classification system was proposed in 1957 by Skinner, based on the relationship of the abutment teeth to the supporting residual alveolar ridge. He reasoned that the value of a removable partial denture was directly related to the quality and degree of support which it received from the abutment teeth and the residual ridge. He stated that there were 131,072 possible combinations of partially edentulous arches.

1. **Class I**: Abutment teeth are present anterior and posterior to the edentulous space (Fig. 20.50). May be unilateral or bilateral, constituting 14% of all classes.

2. **Class II:** All the teeth are present posterior to the denture base which functions as a partial denture unit (Fig. 20.51). May be

unilateral or bilateral, constituting 8.5% of all classes.

3. **Class III**: All abutment teeth are anterior to the denture base which functions as a partial denture unit (Fig. 20.52). May be unilateral or bilateral, constituting about 72% of all classes.

4. **Class IV:** Denture bases are located anterior and posterior to the remaining teeth (Fig. 20.53). May be unilateral or bilateral, constituting about 3% of the total classification.

5. **Class V:** Abutment teeth are unilateral in relation to the denture base, constitute about 2.5% of the total classification (Fig. 20.54).

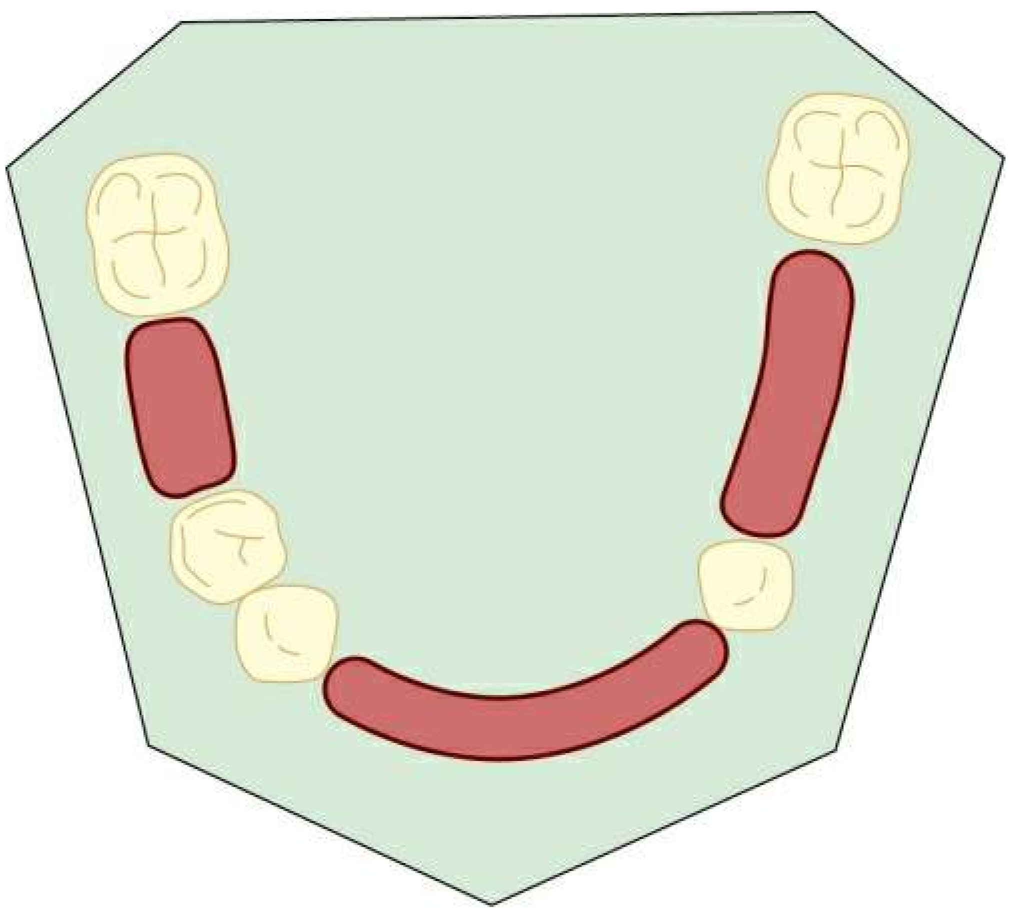


FIGURE 20.50 Skinner's class I.

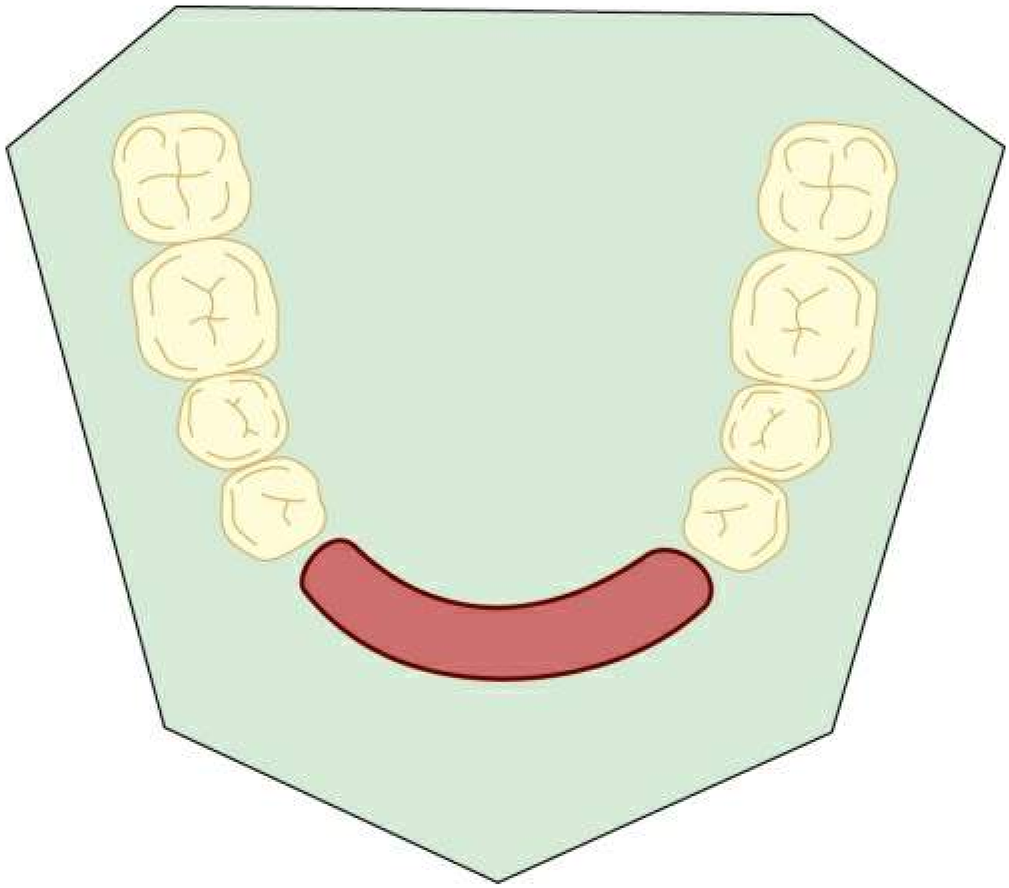


FIGURE 20.51 Skinner's class II.

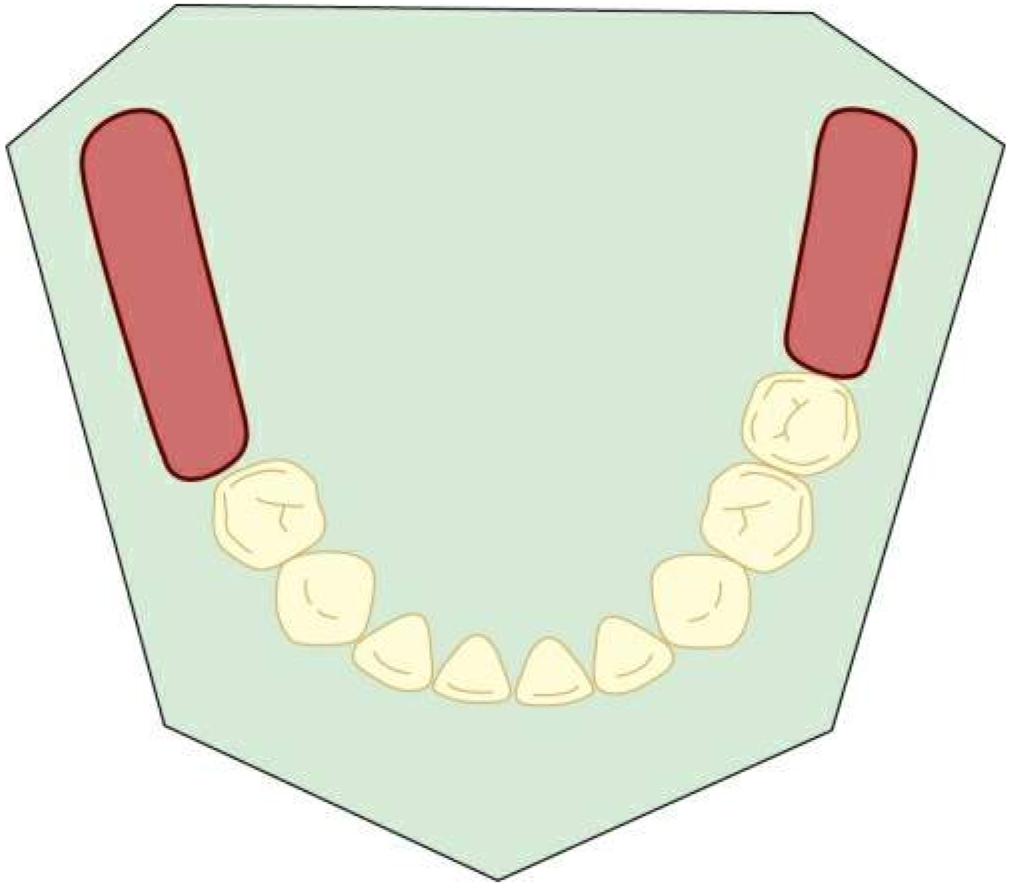


FIGURE 20.52 Skinner's class III.

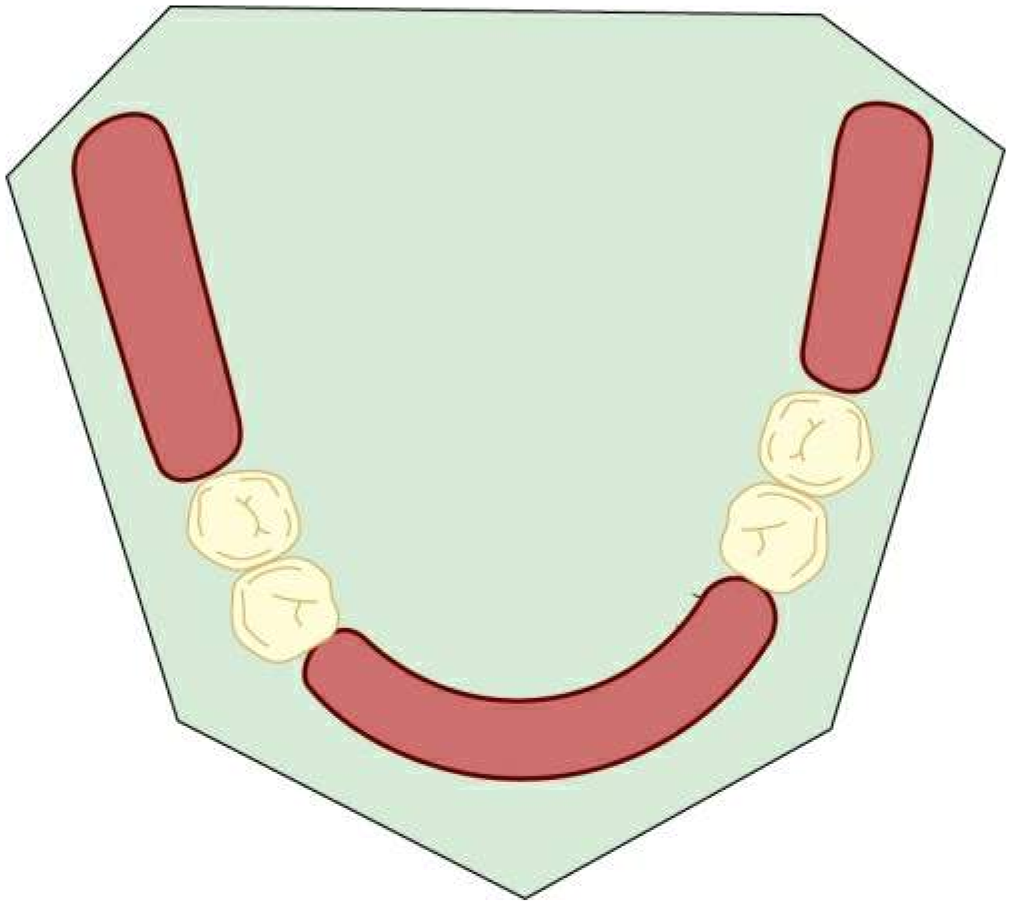


FIGURE 20.53 Skinner's class IV.

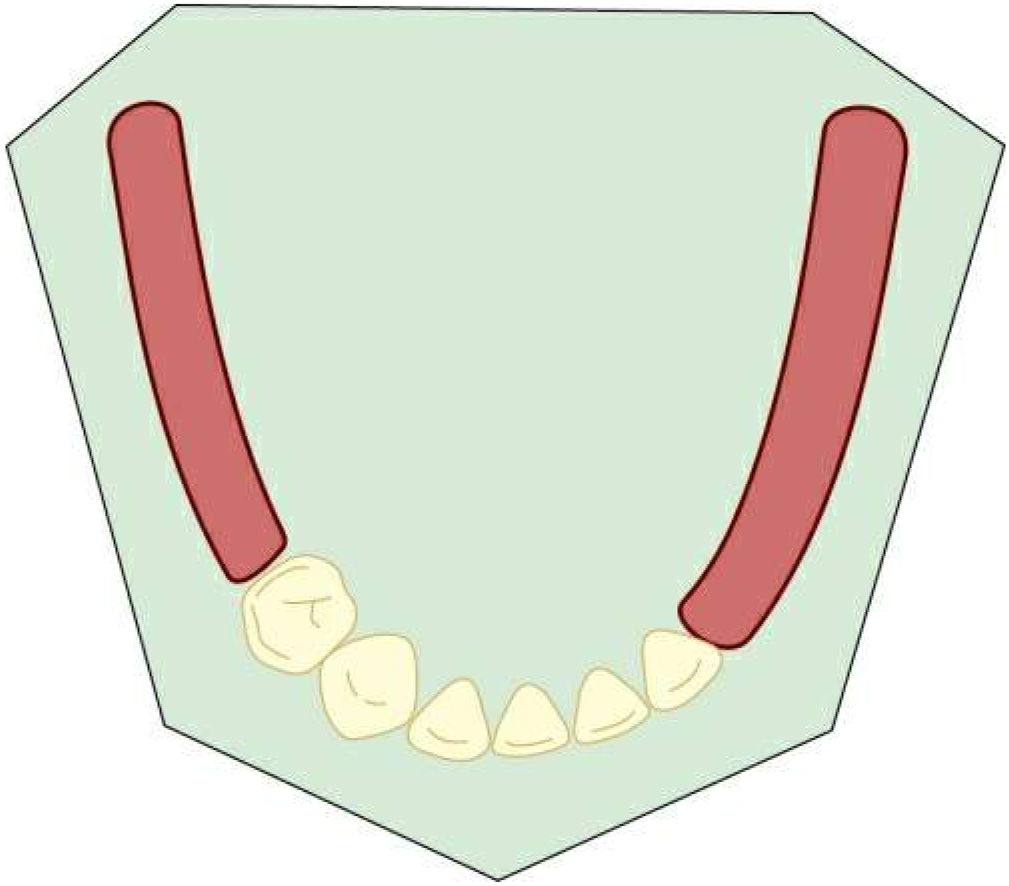


FIGURE 20.54 Skinner's class V.

Swenson's classification

This classification was proposed by Swenson and Terkla in 1955. The four primary classes represent only slight modifications of the Kennedy's system, whereas the modifications of these four primary classes were changed more drastically.

1. **Class I:** An arch with one free-end denture base.

2. **Class II:** An arch with two free-end denture bases.

3. **Class III:** An arch with an edentulous space posteriorly on one or both sides of the mouth but with teeth present anteriorly and posteriorly to each space.

4. **Class IV:** An arch with an anterior edentulous space and with five or more anterior teeth missing.

Subdivisions: The four main classes are subdivided without denoting the exact missing tooth (Figs 20.55–20.57).

1. Anterior region (A)

2. Posterior region (P)

3. Anterior and posterior (AP)

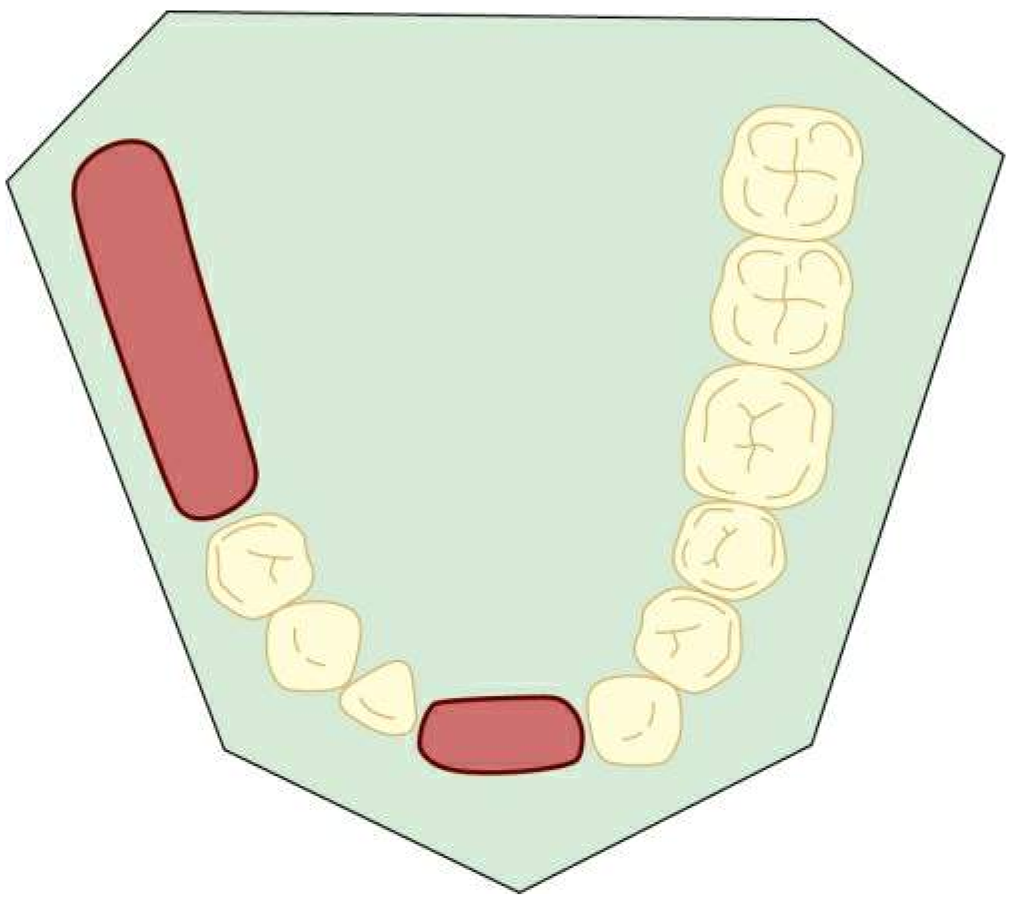


FIGURE 20.55 Swenson's class IA.

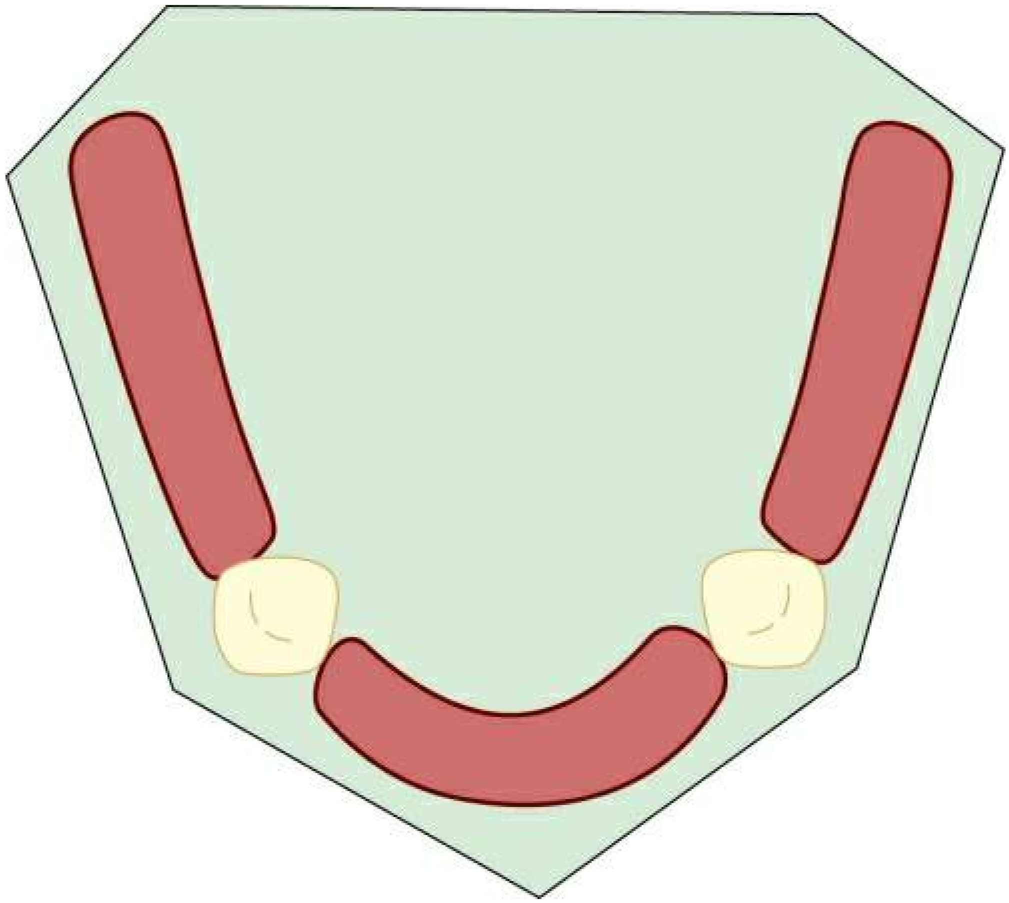


FIGURE 20.56 Swenson's class IIA.

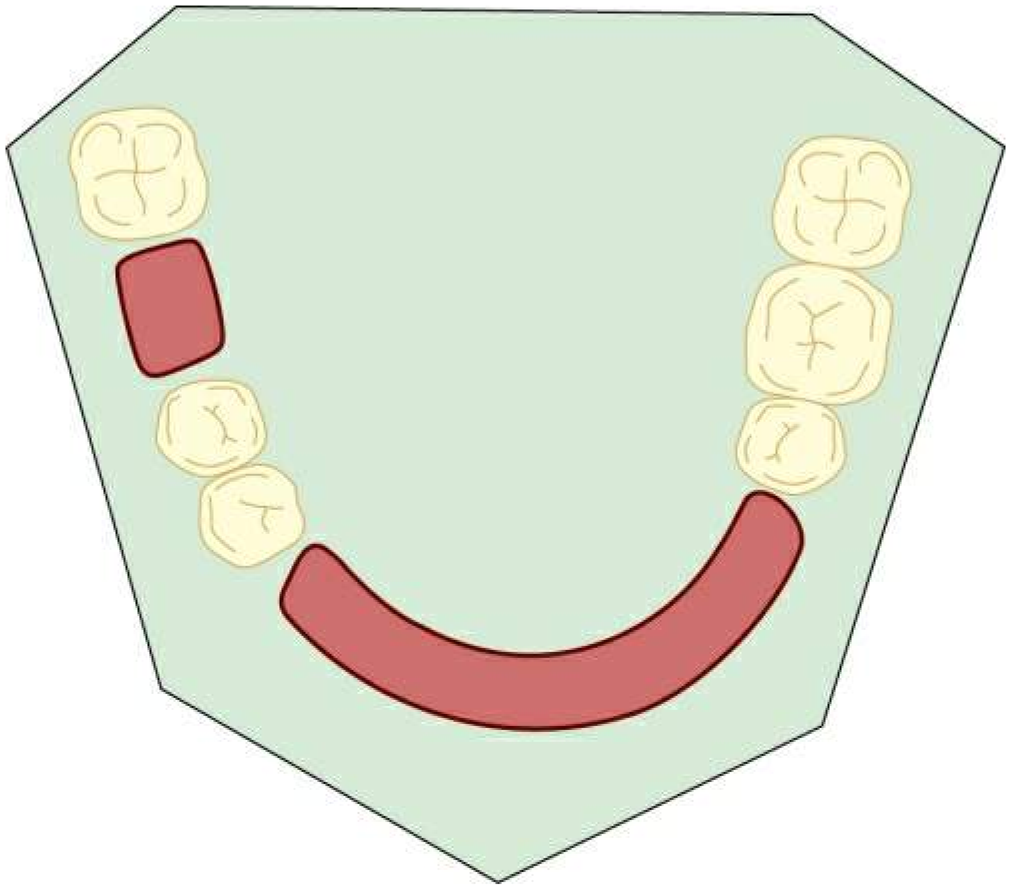


FIGURE 20.57 Swenson's class IVP.

ACP classification

In 2002, the American College of Prosthodontics (ACP) proposed a classification system based on diagnostic findings. Four categories of partial edentulism are defined, class I to class IV, with class I representing an uncomplicated clinical situation and class IV representing a complex clinical situation. Each class was differentiated by specific diagnostic criteria. These guidelines were intended to help determine appropriate treatments for patients.

Diagnostic criteria to be evaluated for the classification of partially edentulous patients were:

1. Location and extent of the edentulous area(s)

2. Condition of abutments

3. Occlusion

4. Residual ridge characteristics

The above criteria with subclassifications are organized into an overall classification system for partial edentulism as follows.

Class I

It is characterized by ideal or minimal compromise in the diagnostic criteria which are favourable (Fig. 20.58):

1. The location and extent of the edentulous area are ideal or minimally compromised. The edentulous area is confined to a single arch. The edentulous area does not compromise the physiologic support of the abutments. The edentulous area may include any anterior maxillary span that does not exceed two incisors, any anterior mandibular span that does not exceed four missing incisors, or any posterior span that does not exceed two premolars or one premolar and one molar.

2. The abutment condition is ideal or minimally compromised, with no need for preprosthetic therapy.

3. The occlusion is ideal or minimally compromised, with no need for preprosthetic therapy; maxillomandibular relationship. Class I molar and jaw relationships. Residual ridge morphology conforms to the class I complete edentulism description, i.e. residual bone height of 21 mm measured at the least vertical height of the mandible on a panoramic radiograph. Residual ridge morphology resistant to horizontal and vertical movement of the denture base; type A maxilla. Class I maxillomandibular relationship.

FIGURE 20.58 ACP class I – ideal or minimally compromised edentulous area, abutment condition, and occlusion. There is a single edentulous area in one sextant. The residual ridge is considered type A.

Class II

It is characterized by moderately compromised location and extent of edentulous areas in both arches, abutment conditions requiring localized adjunctive therapy, occlusal characteristics requiring localized adjunctive therapy, and residual ridge conditions (Fig. 20.59).

1. **The location and extent of the edentulous area are moderately compromised**: Edentulous areas may exist in one or both arches. The edentulous areas do not compromise the physiologic support of the abutments. Edentulous areas may include any anterior maxillary span that does not exceed two incisors, any anterior mandibular span that does not exceed four incisors, any posterior span (maxillary or mandibular) that does not exceed two premolars, or one premolar and one molar or any missing canine (maxillary or mandibular).

2. **Condition of the abutments is moderately compromised**: Abutments in one or two sextants have insufficient tooth structure to retain or support intracoronal or extracoronal restorations. Abutments

in one or two sextants require localized adjunctive therapy.

3. **Occlusion is moderately compromised**: Occlusal correction requires localized adjunctive therapy. **Maxillomandibular relationship:** Class I molar and jaw relationships.

4. **Residual ridge morphology conforms to the class II complete edentulism description:** Residual bone height of 16–20 mm measured at the least vertical height of the mandible on a panoramic radiograph. Residual ridge morphology is resistant to horizontal and vertical movement of the denture base; type A or B maxilla. Class I maxillomandibular relationship.

FIGURE 20.59 ACP class II – edentulous areas in two sextants in different arches.

Class III

It is characterized by substantially compromised location and extent of edentulous areas in both arches, abutment condition requiring substantial localized adjunctive therapy, occlusal characteristics requiring reestablishment of the entire occlusion without a change in the occlusal vertical dimension, and residual ridge condition (Fig.

20.60A–C).

1. **The location and extent of the edentulous areas are substantially compromised:** Edentulous areas may be present in 1 or both arches. Edentulous areas compromise the physiologic support of the abutments. Edentulous areas may include any posterior maxillary or mandibular edentulous area greater than three teeth or two molars, or anterior and posterior edentulous areas of three or more teeth.

2. **The condition of the abutments is moderately compromised:** Abutments in three sextants have insufficient tooth structure to retain or support intracoronal or extracoronal restorations. Abutments in three sextants require more substantial localized adjunctive therapy (i.e. periodontal, endodontic or orthodontic procedures). Abutments have a fair prognosis.

3. **Occlusion is substantially compromised:** Requires reestablishment of the entire occlusal scheme without an accompanying change in the occlusal vertical dimension. **Maxillomandibular relationship:** Class II molar and jaw relationships.

4. **Residual ridge morphology conforms to the class III complete edentulism description:** Residual alveolar bone height of 11–15 mm measured at the least vertical height of the mandible on a panoramic radiograph. Residual ridge morphology is with minimum influence to resist horizontal or vertical movement of the denture base; type C maxilla. Class I, II or III maxillomandibular relationship.

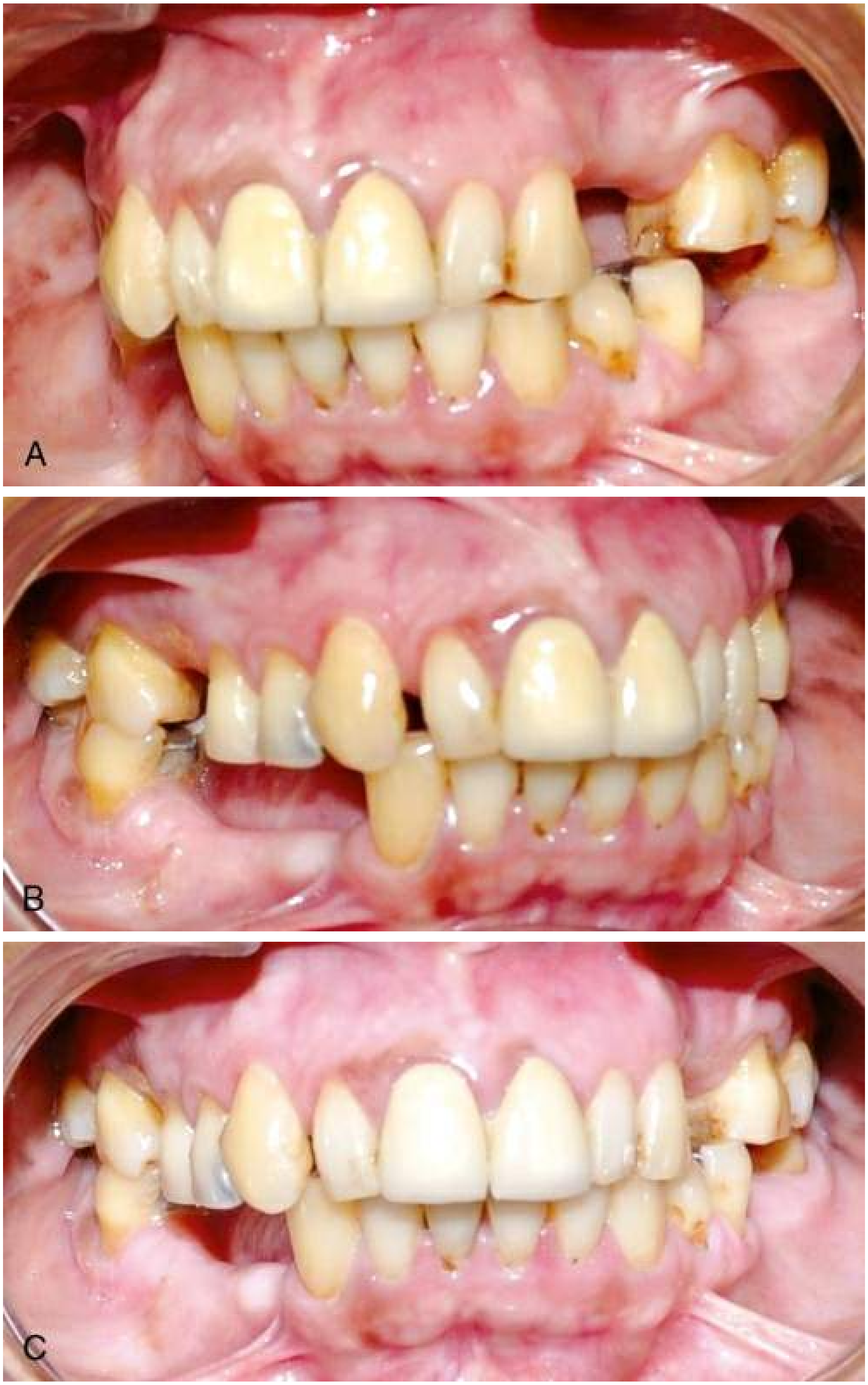


FIGURE 20.60 ACP Class III – the edentulous area(s) are located in both arches and multiple locations within each arch.

There are teeth that are extruded and malpositioned. The occlusion is substantially compromised because reestablishment of the occlusal scheme is required without a change in the occlusal vertical dimension: **(A)** frontal view, **(B)** right lateral view and **(C)** left lateral view.

Class IV

It is characterized by severely compromised location and extent of edentulous areas with guarded prognosis, abutments requiring extensive therapy, occlusion characteristics requiring reestablishment of the occlusion with a change in the occlusal vertical dimension and residual ridge conditions (Fig. 20.61A–C).

1. **The location and extent of the edentulous areas results in severe occlusal compromise:** Edentulous areas may be extensive and may occur in both arches. Edentulous areas compromise the physiologic support of the abutment teeth to create a guarded prognosis. Edentulous areas include acquired or congenital maxillofacial defects. At least one edentulous area has a guarded prognosis.

2. **Abutments are severely compromised:** Abutments in four or more sextants have insufficient tooth structure to retain or support intracoronal or extracoronal restorations. Abutments in four or more sextants require extensive localized adjunctive therapy. Abutments have a guarded prognosis.

3. **Occlusion is severely compromised:** Reestablishment of the entire occlusal scheme, including changes in the occlusal vertical dimension, is necessary. **Maxillomandibular relationship:** Class II division 2 or class III molar and jaw relationships.

4. **Residual ridge morphology conforms to the class IV complete edentulism description:** Residual vertical bone height of 10 mm measured at the least vertical height of the mandible on a panoramic radiograph. Residual ridge offering no resistance to horizontal or

vertical movement; type D maxilla. Class I, II or III maxillomandibular relationships.

FIGURE 20.61 ACP class IV edentulous areas are found in both arches, and the physiologic abutment support is compromised. Abutment condition is severely compromised, necessitating adjunctive therapy. The occlusion is severely compromised, necessitating reestablishment of occlusal vertical dimension and a proper occlusal scheme: **(A)** frontal view, **(B)** right lateral view and **(C)** left lateral view.

SUMMARY

This chapter explains about the various classification systems for partial edentulism which is based on the most objective criteria available to facilitate uniform use of the system. Such standardization may lead to improved communications among dental professionals and third parties.

CHAPTER 21

Component parts

CHAPTER CONTENTS

Introduction

Each of the component parts of a removable partial denture contributes to specific functions of the prosthesis and the name is most often descriptive of its function. The names are the same for maxillary and mandibular removable partial dentures. They come in different forms or types as indicated for varying clinical situations. This chapter will describe all the component parts, their types, structural requirements and function.

Major connectors

Definition

The part of a partial removable dental prosthesis that joins the components on one side of the arch to those on the opposite side (GPT8).

All other components of the partial denture are attached to it either directly or indirectly.

Classification

1. Maxillary and mandibular – depending on where it is used

2. Acrylic and metal – depending on the material used

3. Rigid and non-rigid – depending on the movement of denture base

Requirements

1. **Should be rigid:** This allows stresses that are applied to any part of partial denture to be distributed over entire supporting area. Other component parts can be effective only if major connector is rigid.

2. **Must avoid impingement of free gingival margin**: This is a highly vascular area which can get injured by pressure. Definitive distance must be maintained between the border of the major connector and the free gingival margin. It should be at least 6 mm for the maxillary major connector and 3 mm for the mandibular major connector (Fig. 21.1A–D). In case of difficulty in obtaining this clearance, the major connector could cover the free gingival margin with adequate relief, e.g. lingual plating.

3. **The border of major connector should run parallel to gingival margins** (Fig. 21.2A and B): If margin must be crossed, the crossing should be at right angles to produce least contact and relief must be provided (Fig. 21.2C and D).

4. Provide vertical support and hence protect the soft tissue.

5. Provide indirect retention where indicated.

6. Provide for positioning of denture bases where needed.

7. Should be self-cleansing and not cause food entrapment.

8. Maintain patient comfort and should not interfere with speech and phonation – the following factors should be considered to achieve this:

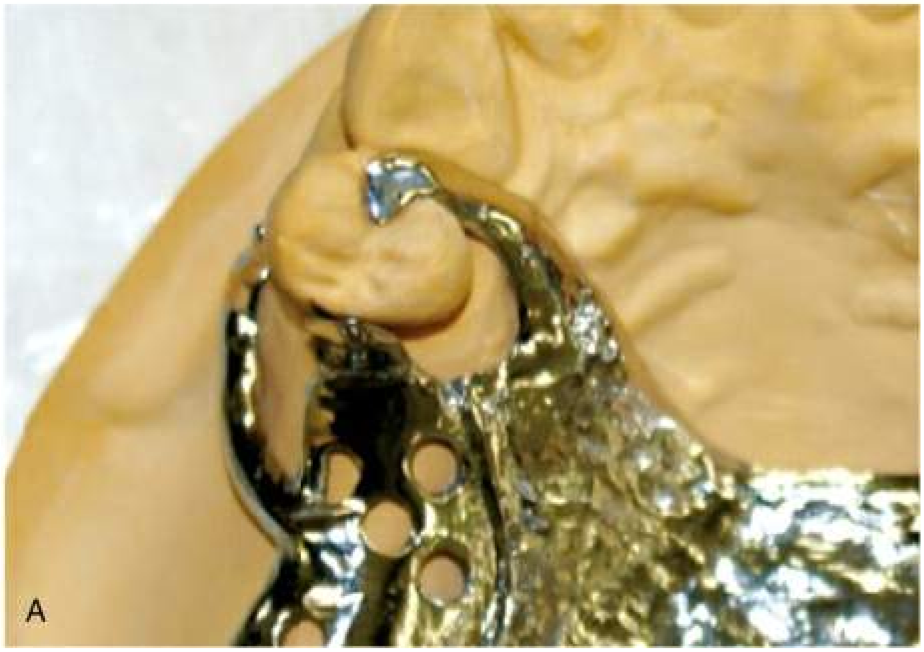
i. Edges should be rounded and tapered towards the tissues. The anterior border of a maxillary major connector should end in the valley between rugae crests and not on the crest (Fig. 21.3A–C).

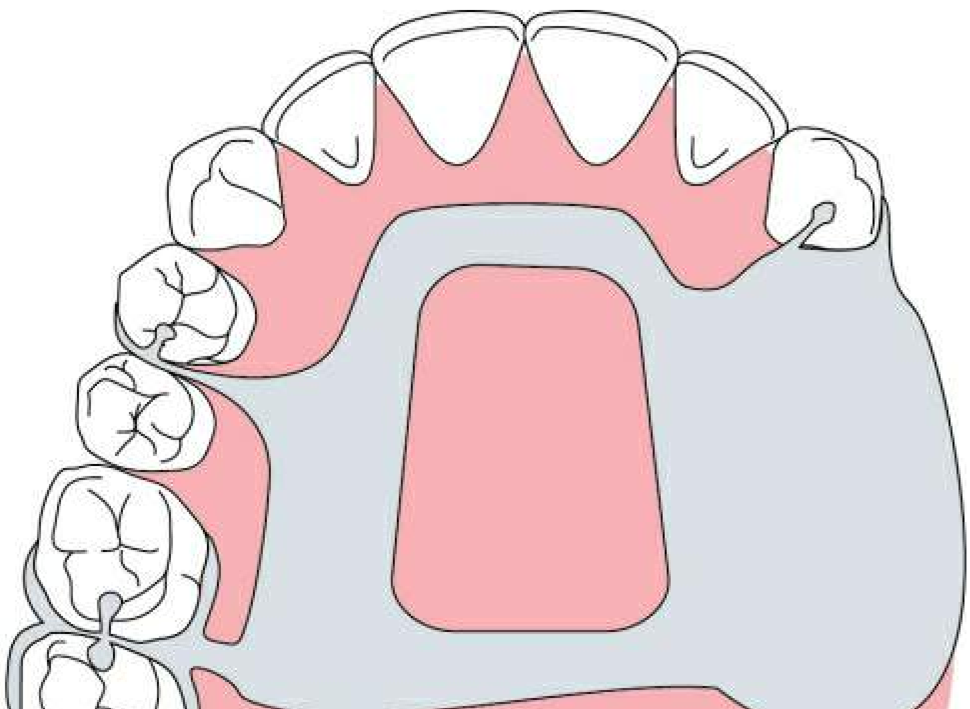
ii. Border outlines should be inconspicuous to tongue and hence should be curved and rounded (Fig. 21.4A and B).

iii. Tooth embrasures should be used to hide metal extension onto teeth from major connectors (Fig. 21.5).

iv. It should be symmetrical and cross the palate in a straight line (Fig. 21.6A and B).

v. Should not cross or cover bony prominences like tori. Relief could be given if small, otherwise surgical excision. Design can also avoid the tori (Fig. 21.7).





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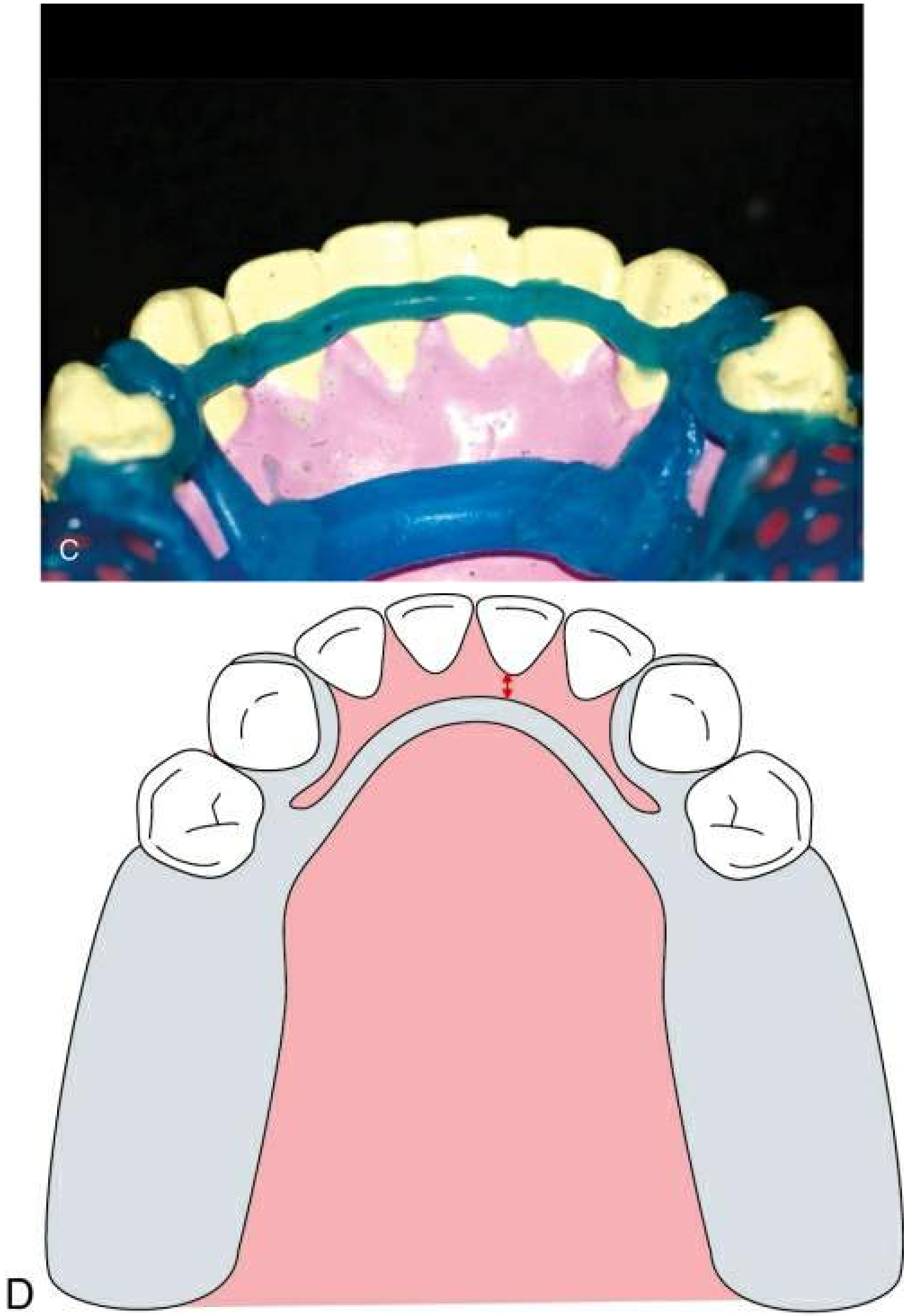
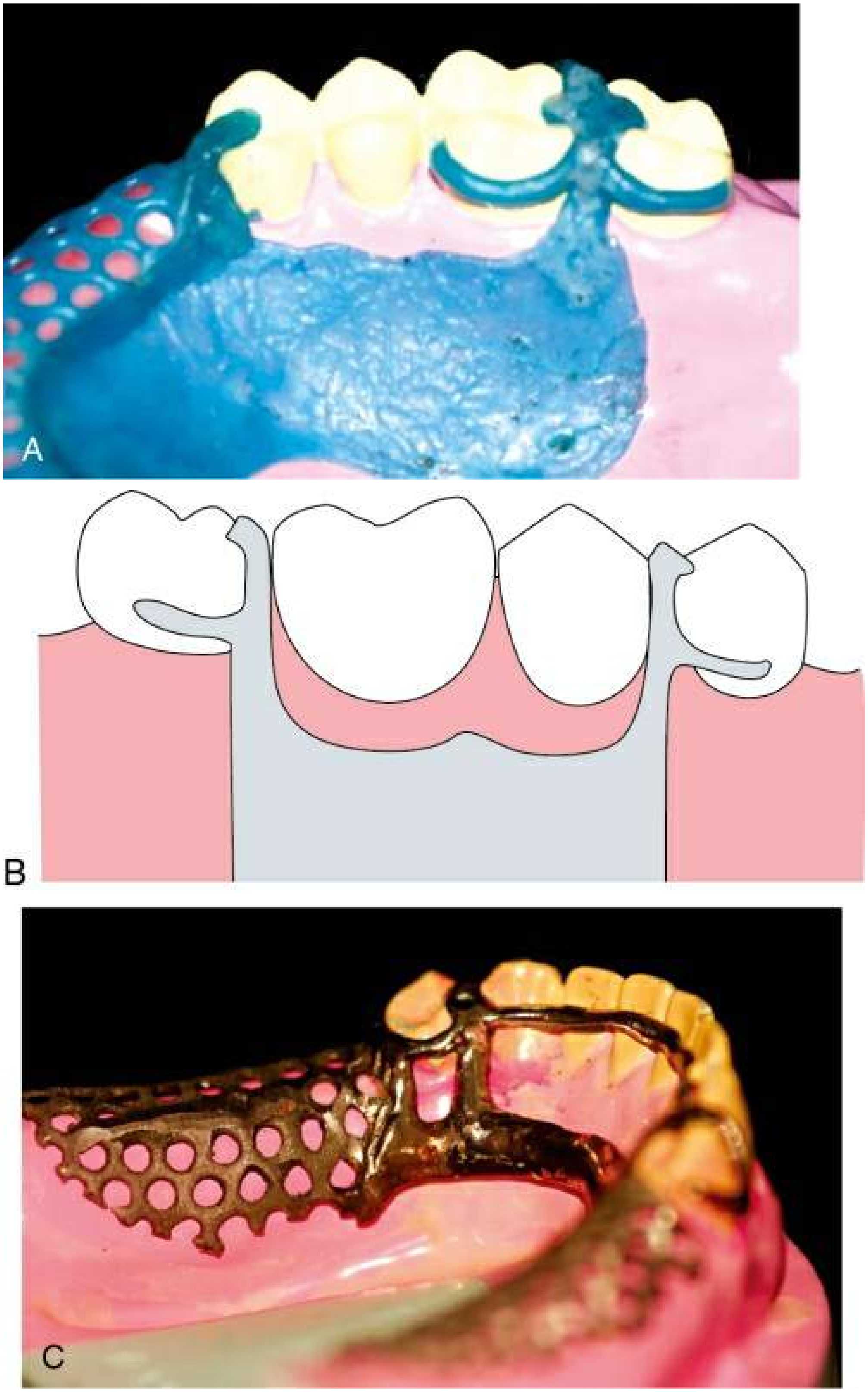


FIGURE 21.1 (A and B) Maxilla – minimum 6 mm distance between border of major connector and free gingival margin. **(C and D)** Mandible – minimum 3 mm distance between border of major connector and free gingival margin.


A
B
C

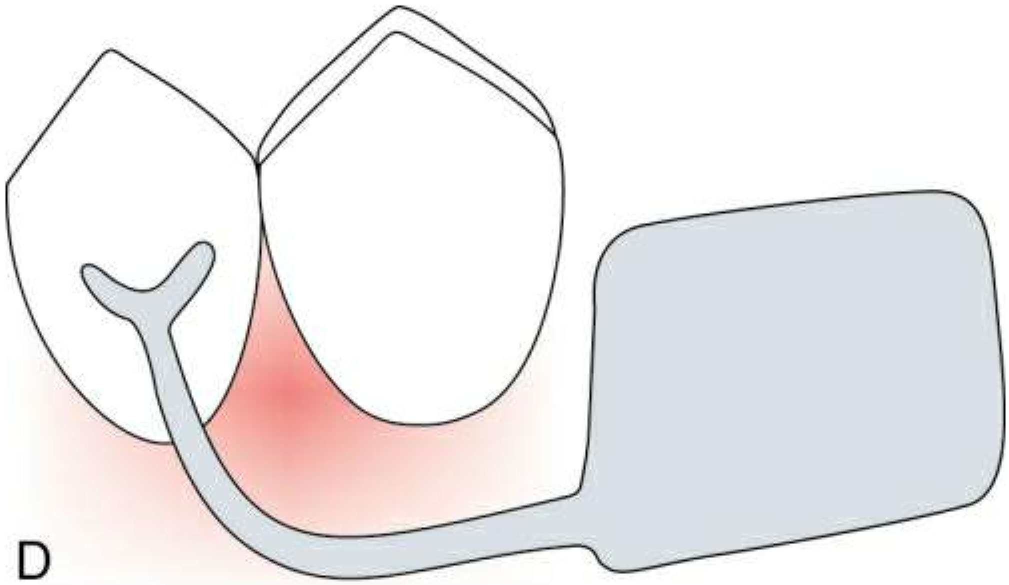


FIGURE 21.2 **(A and B)** Borders of a major connector should run parallel to the gingival margins. **(C and D)** Major connector should cross the gingival margin at 90.

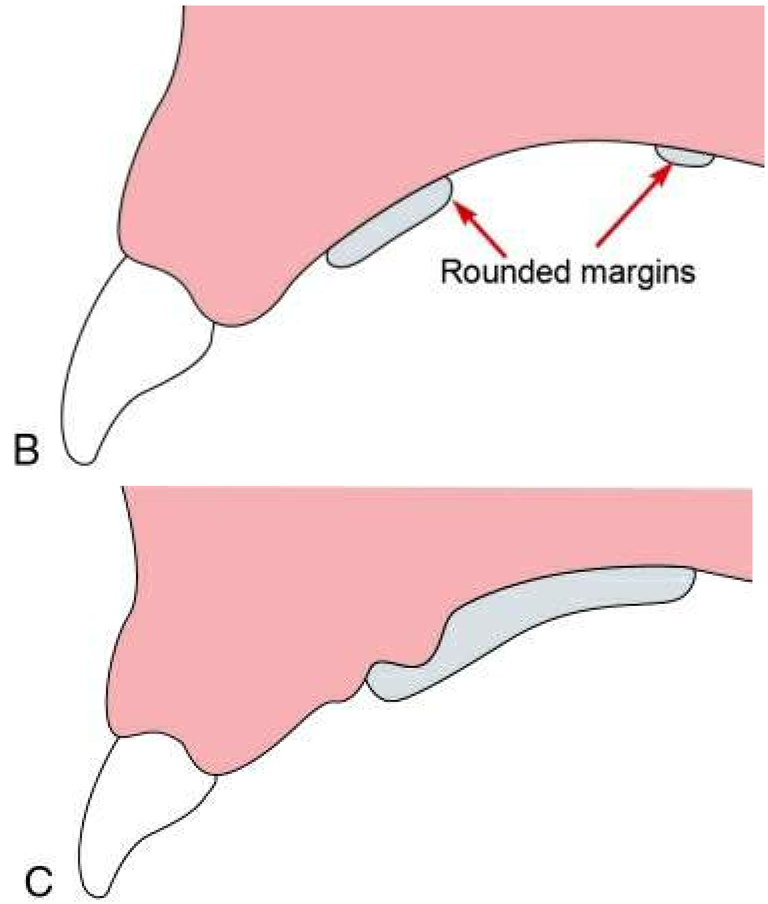


FIGURE 21.3 **(A)** Margins should taper towards the tissues, **(B)** rounded margins **(C)** should end in the valleys of rugae.

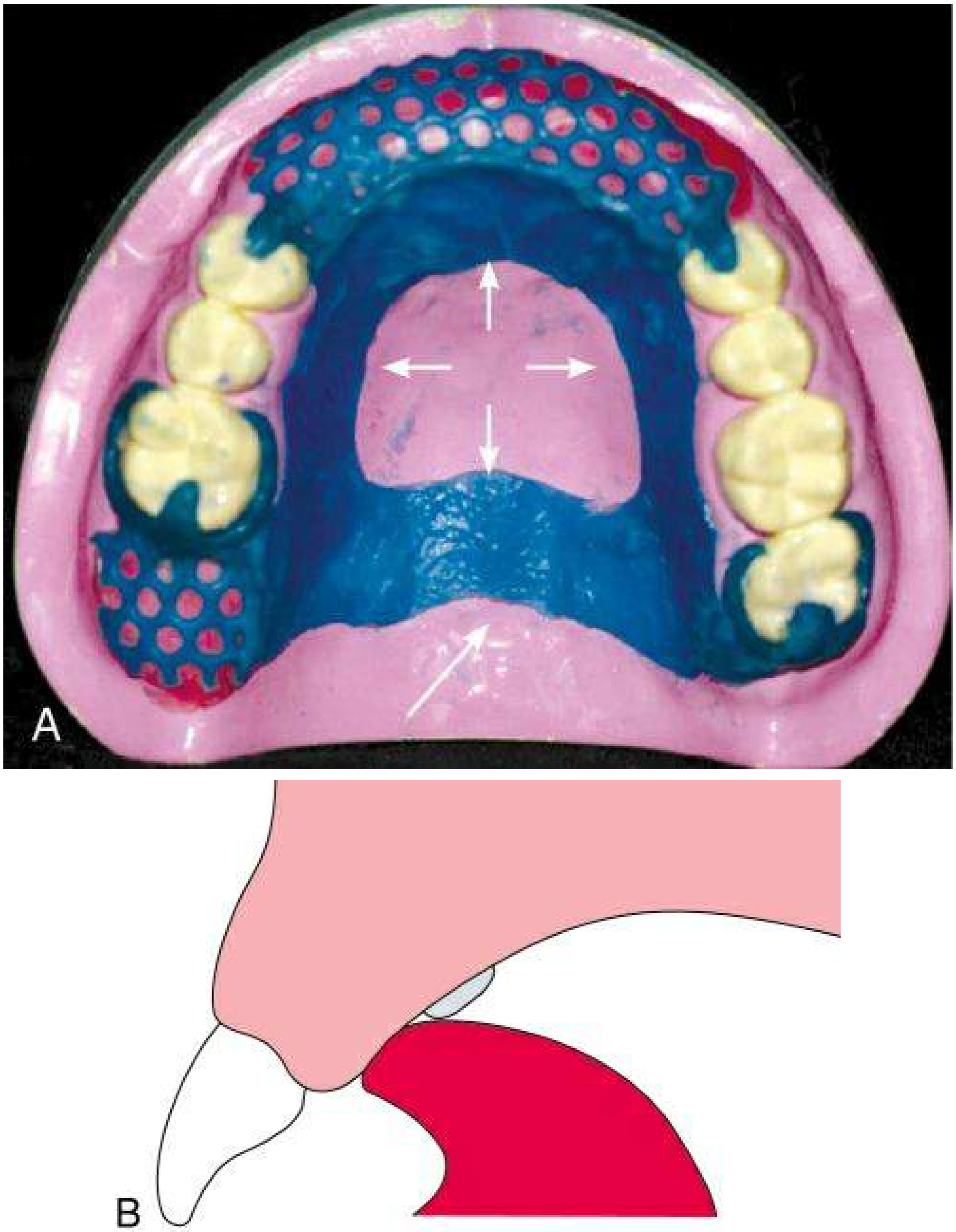


FIGURE 21.4A, B Borders should be curved and inconspicuous to tongue.

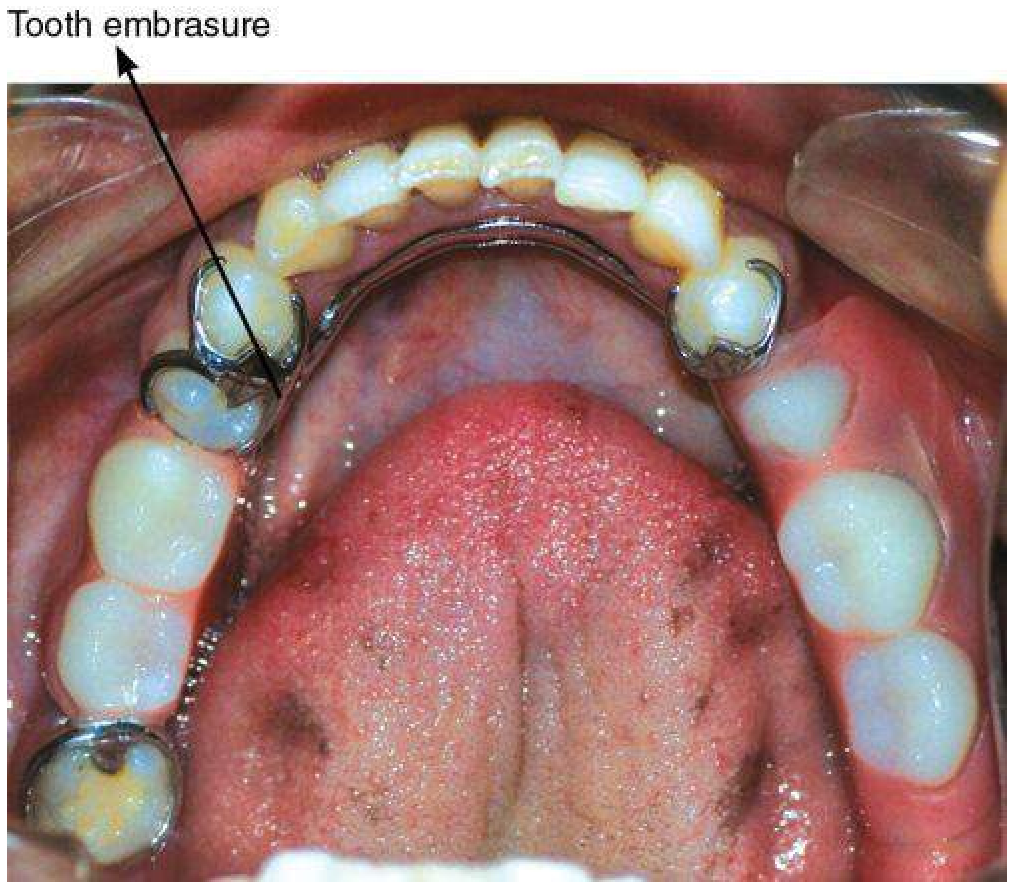


FIGURE 21.5 Tooth embrasures used to hide metal extension onto teeth.

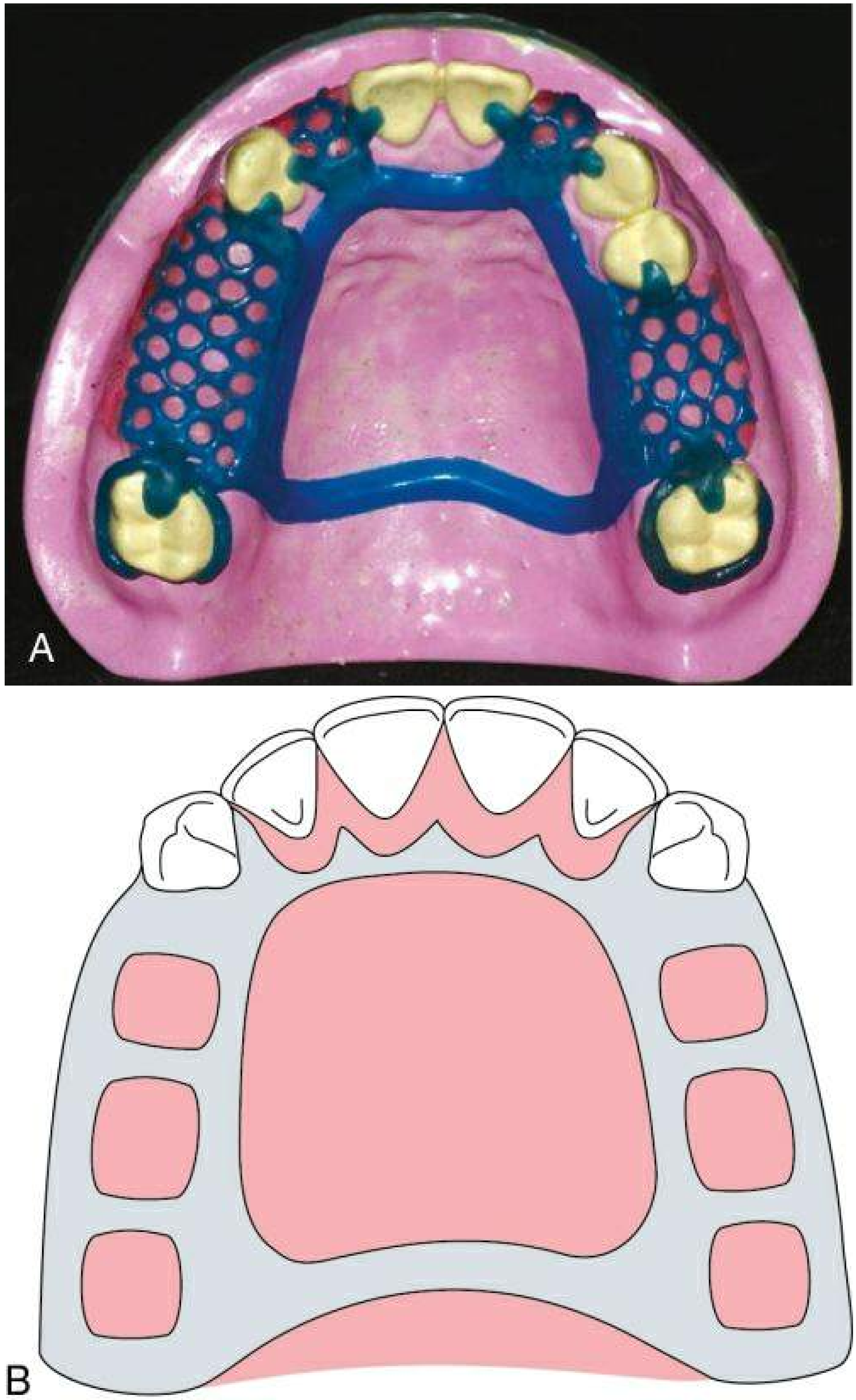


FIGURE 21.6A, B Major connector should be symmetrical

and cross the palate in a straight line.

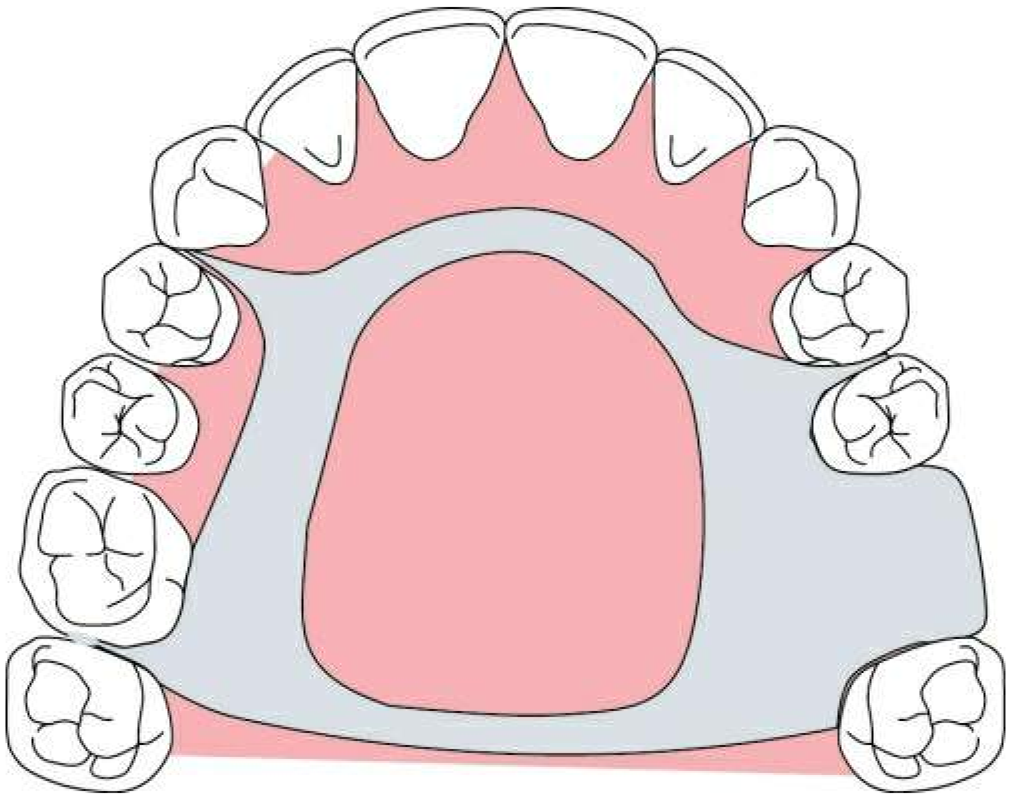


FIGURE 21.7 Maxillary major connector can be designed to avoid the tori.

Maxillary major connectors

These are major connectors used in the fabrication of maxillary partial dentures. They should satisfy the following additional requirements.

Beading

The maxillary major connector should be beaded along the posterior border to form a seal that contacts the soft tissue with a slight displacement of the tissue (Fig. 21.8). This prevents the entry of food under the denture from the posterior aspect, provides a visible finish line for technician to finish and polish the framework and makes the junction of metal and soft tissue less noticeable to tongue. The beading is done on the master cast before duplication and should have a width and depth of 0.5–1.0 mm. The depth should be reduced in the areas where the tissues are thin and it should fade out 6 mm away from the gingival margin. Spoon excavator or small round bur is used for making beading on the master cast.

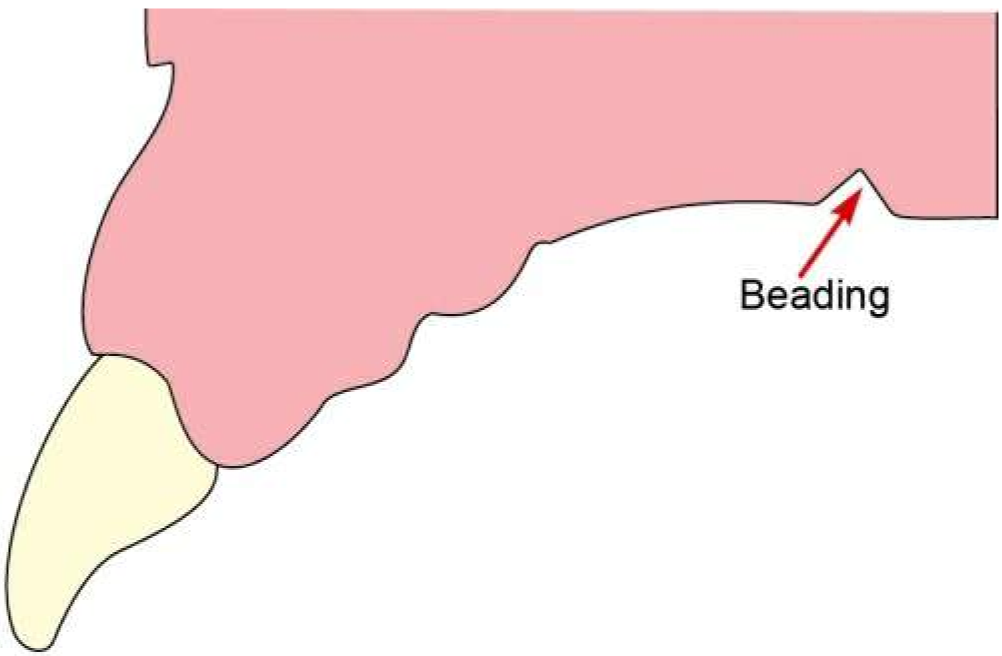


FIGURE 21.8 Beading.

Relief

This is not provided in maxillary major connectors except in the presence of small palatal tori and a prominent midpalatine suture. Close adaptation of connector to soft tissue is necessary for retention and stability and for the same reason tissue side of the major connector is not polished.

Types of maxillary major connectors

- Palatal bar

- Palatal strap
- Anteroposterior, or double palatal bar
- Horseshoe-shaped, or U-shaped connector
- Closed horseshoe, or anteroposterior palatal strap
- Complete palate

Palatal bar

It is a bar running across the palate which is a narrow half oval in cross-section with its thickest point in the centre (Fig. 21.9).

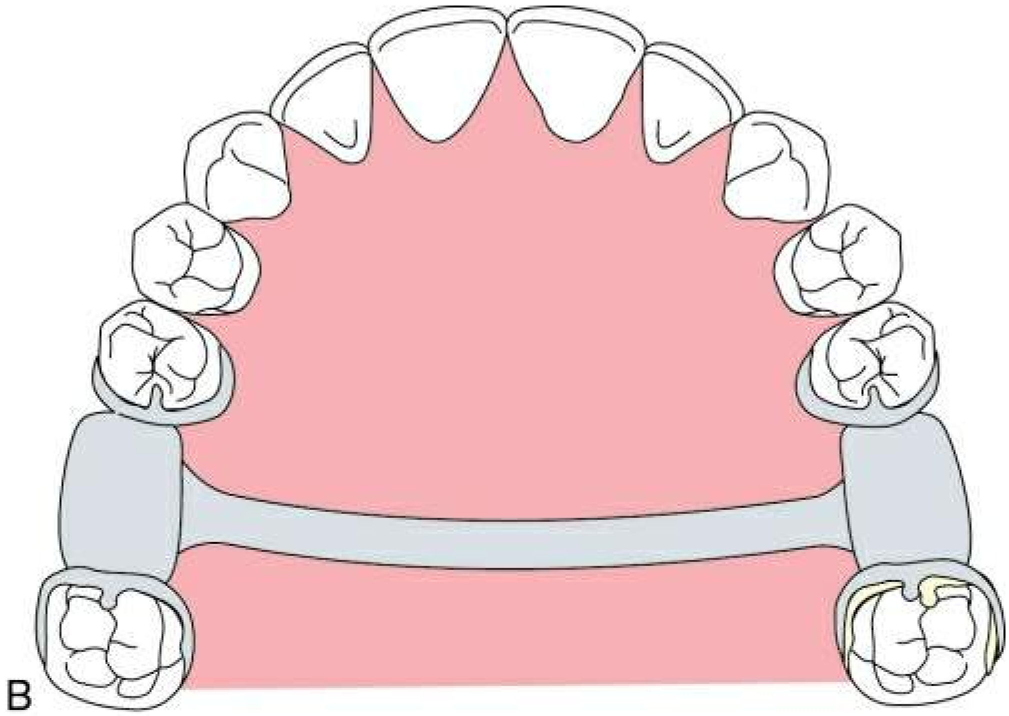


FIGURE 21.9A, B Palatal bar.

Indication

1. Interim partial denture.

2. Kennedy's class III limited to replacing one or two teeth on each side of arch.

Disadvantages

1. Most difficult for patient to get adjusted as to maintain rigidity it has to be bulky.

2. Narrow anteroposterior width derives little support from palate; hence, it should be positively supported by rests on remaining teeth.

3. Should be placed no further anteriorly than second premolar position due to tongue interference.

4. Should never be used in a distal extension situation or in class IV.

Palatal strap

It is a wide, thin band of metal that runs across the palate unobtrusively (Fig. 21.10A and B). A minimum width of 8 mm is essential to derive the palatal support and for maintaining the rigidity of the connector. It is the most versatile major connector.

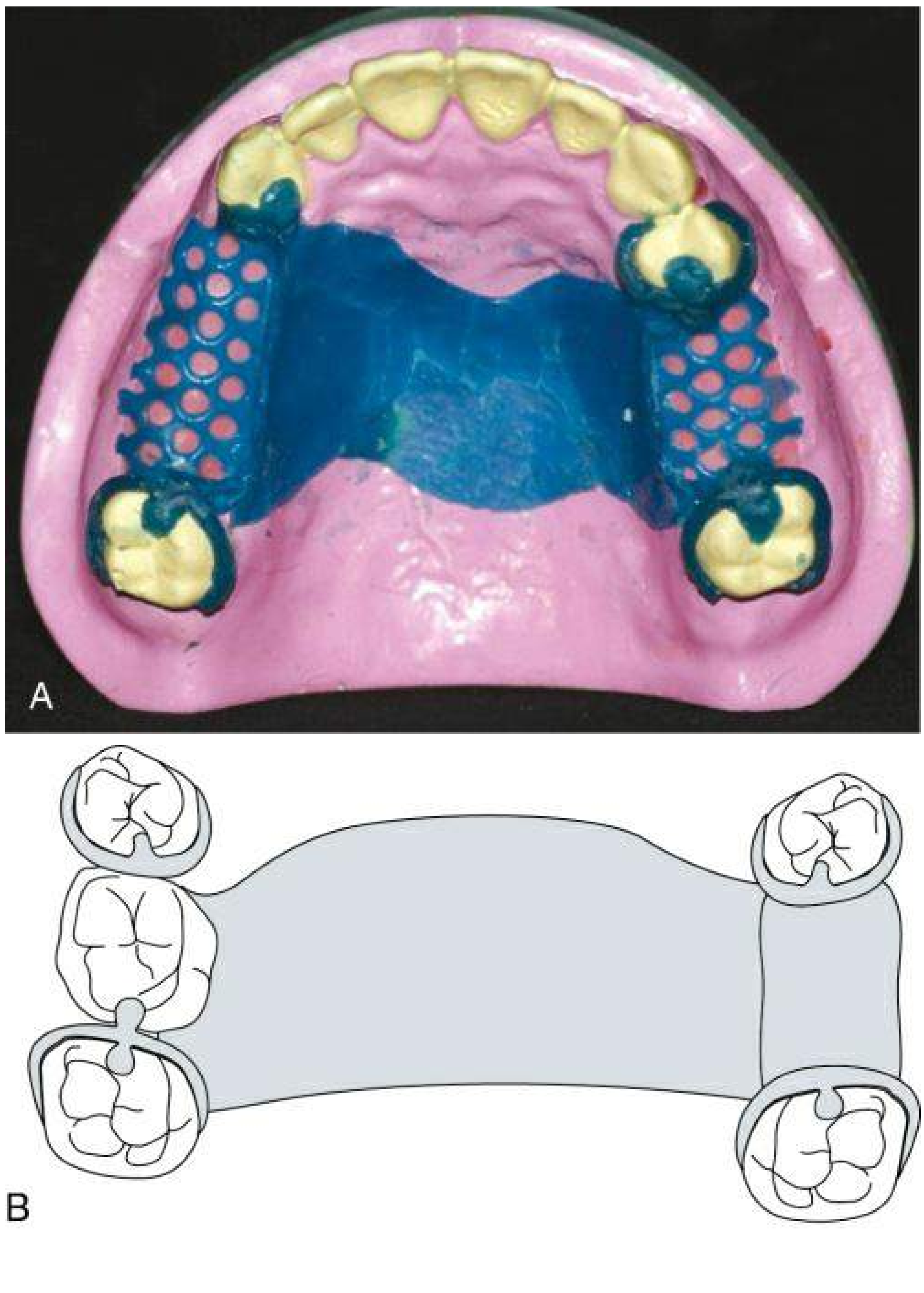


FIGURE 21.10A, B Palatal strap.

Indications

1. Unilateral distal extension partial dentures (class II).

2. Tooth-supported short-span bilateral edentulous areas (class III).

Advantages

1. Offers great resistance to bending and twisting forces because it is located in three planes (**horizontal –** palatal vault; **vertical –** lateral slopes of palate; **sagittal –** anterior slope of palate).

2. Produces greater rigidity with less bulk of metal.

3. It can be kept thin, increasing patient comfort.

4. Retention through adhesion and cohesion is enhanced by intimate contact.

5. Also contributes some indirect retention.

Disadvantages

1. Patient may complain of excessive palatal coverage – borders should be properly placed to avoid this.

2. Strap must avoid crossing a torus or a prominent midpalatine suture.

3. Can cause papillary hyperplasia.

Anteroposterior or double palatal bar

It has basically two bars – one placed anteriorly and the other posteriorly, connected by flat longitudinal elements on each side of lateral slope of palate (Fig. 21.11A and B). The flat anterior bar is narrower than palatal strap and should be positioned in the rugae valleys. The posterior bar is similar to palatal bar but less bulky.

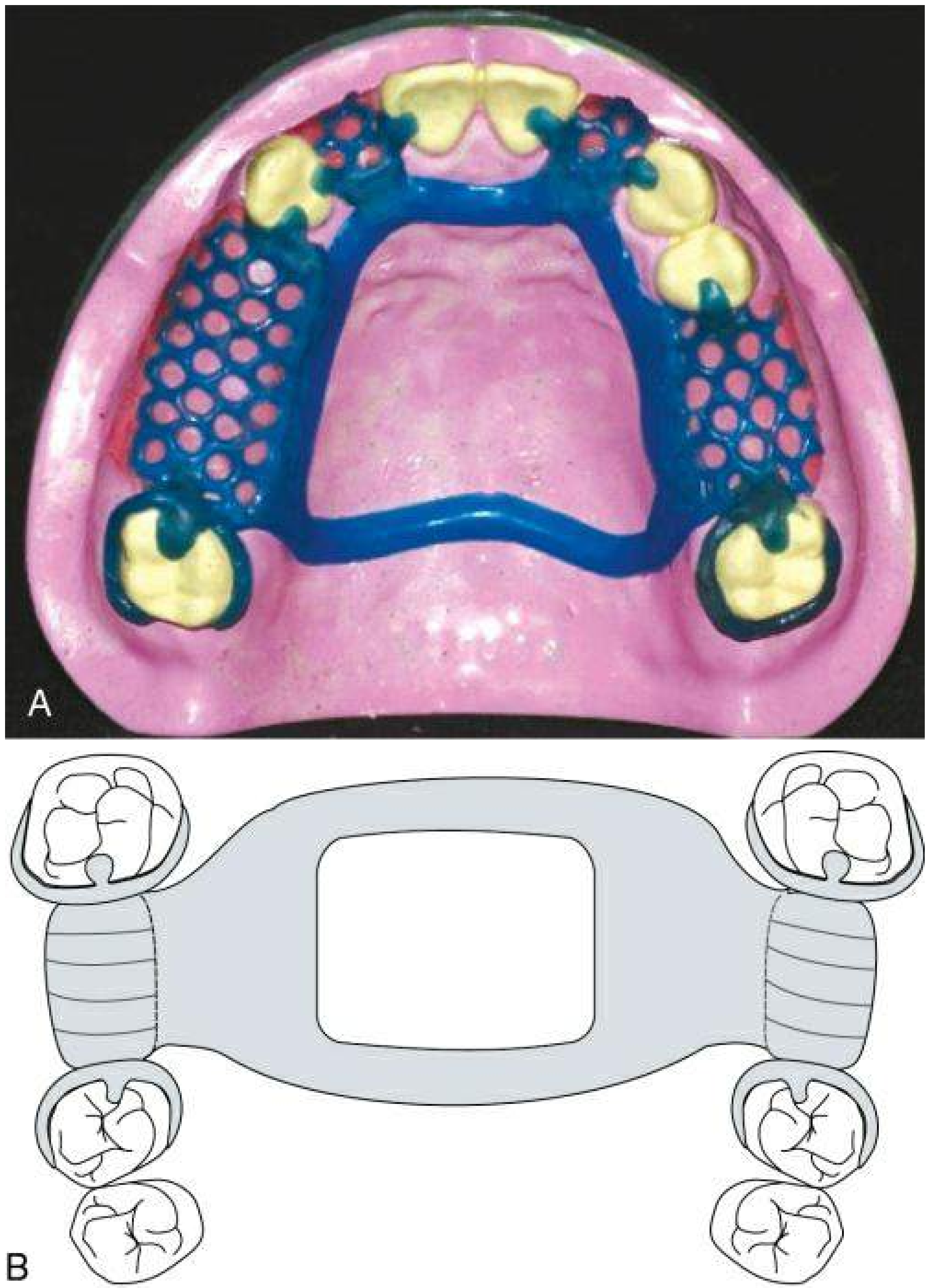


FIGURE 21.11A, B Double palatal bar.

Indications

1. Patients with large inoperable tori.

2. Anterior and posterior abutments are widely separated.

3. Patients who want less palatal coverage.

4. Class II and class IV.

Advantages

1. Rigidity.

2. Limited soft tissue coverage.

3. Strong L-beam effect contributes to good resistance.

Disadvantages

1. Less palatal support, hence cannot be used when periodontal support of remaining teeth is poor.

2. Not indicated with high narrow palatal vault as anterior bar interferes with phonetics.

3. Multiple borders make it uncomfortable for patient.

Horseshoe or u-shaped connector

It is a thin band of metal running along the lingual surface of posterior teeth. Anteriorly it covers the cingula and posteriorly it extends 6–8 mm onto the palatal tissues. The lateral borders should be at the junction of the horizontal and vertical slopes of the palate (Fig. 21.12).

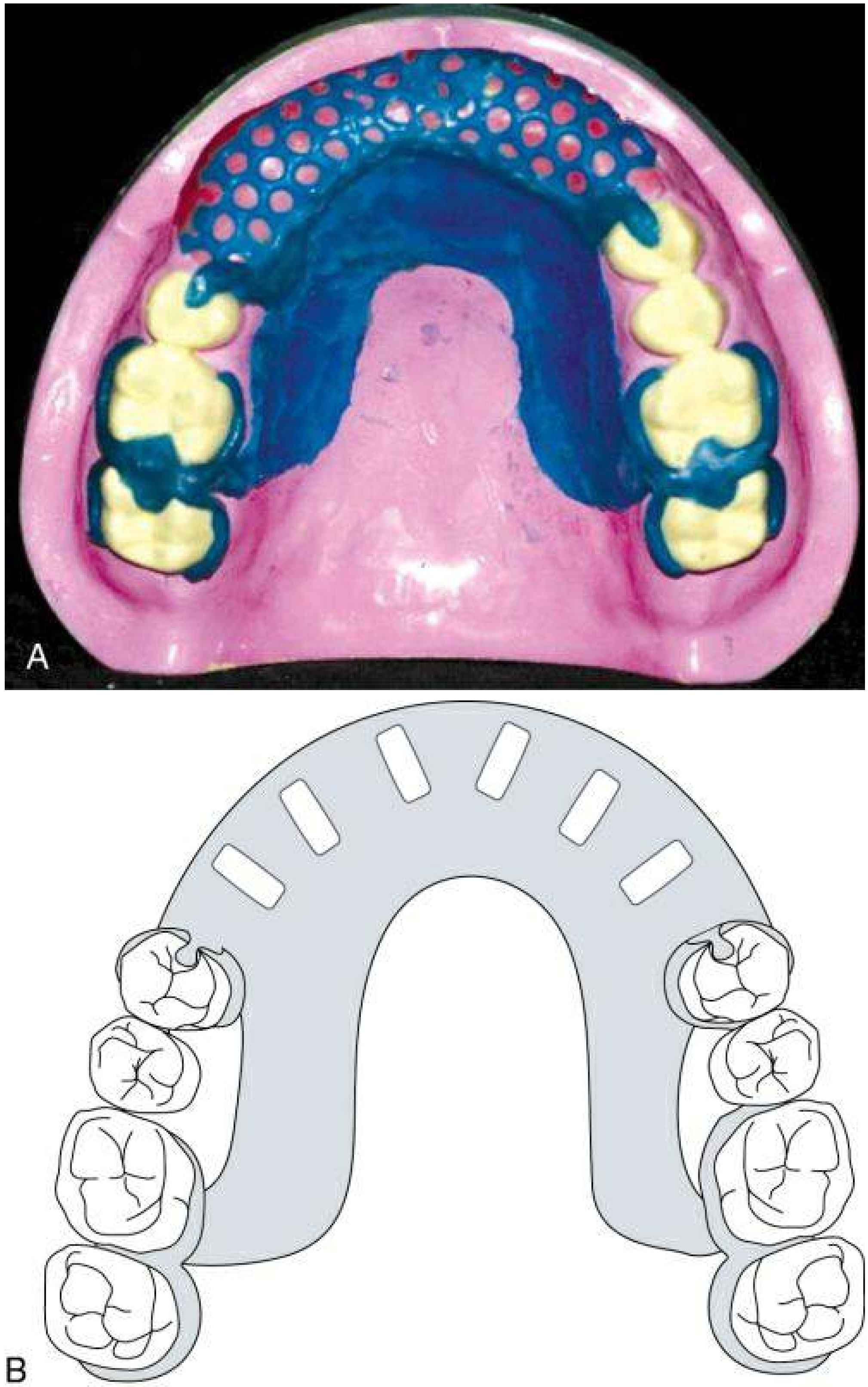


FIGURE 21.12A, B Horseshoe-shaped connector.

Indications

1. Anterior teeth replacement (class IV).

2. In patients with tori and prominent mid palatine suture.

3. Excessive vertical overlap of anterior teeth.

4. Need to stabilize anterior teeth.

Advantages

1. Reasonably strong.

2. Derives some vertical support and indirect retention from palate.

Disadvantages

1. Less resistance to flexing and movement at open end – hence cannot be used in distal extension bases and for providing cross arch stabilization.

2. Greater bulk in anterior part is required to avoid flexing – interference in phonetics and patient comfort.

Closed horseshoe or anteroposterior palatal strap

Basically two palatal straps – one anterior and the other posterior, connected by flat longitudinal elements on each side of lateral slope of palate (Fig. 21.13A and B). The thickness of metal in the straps should be uniform. All the requirements for placing borders anteriorly, posteriorly and laterally, are applicable.

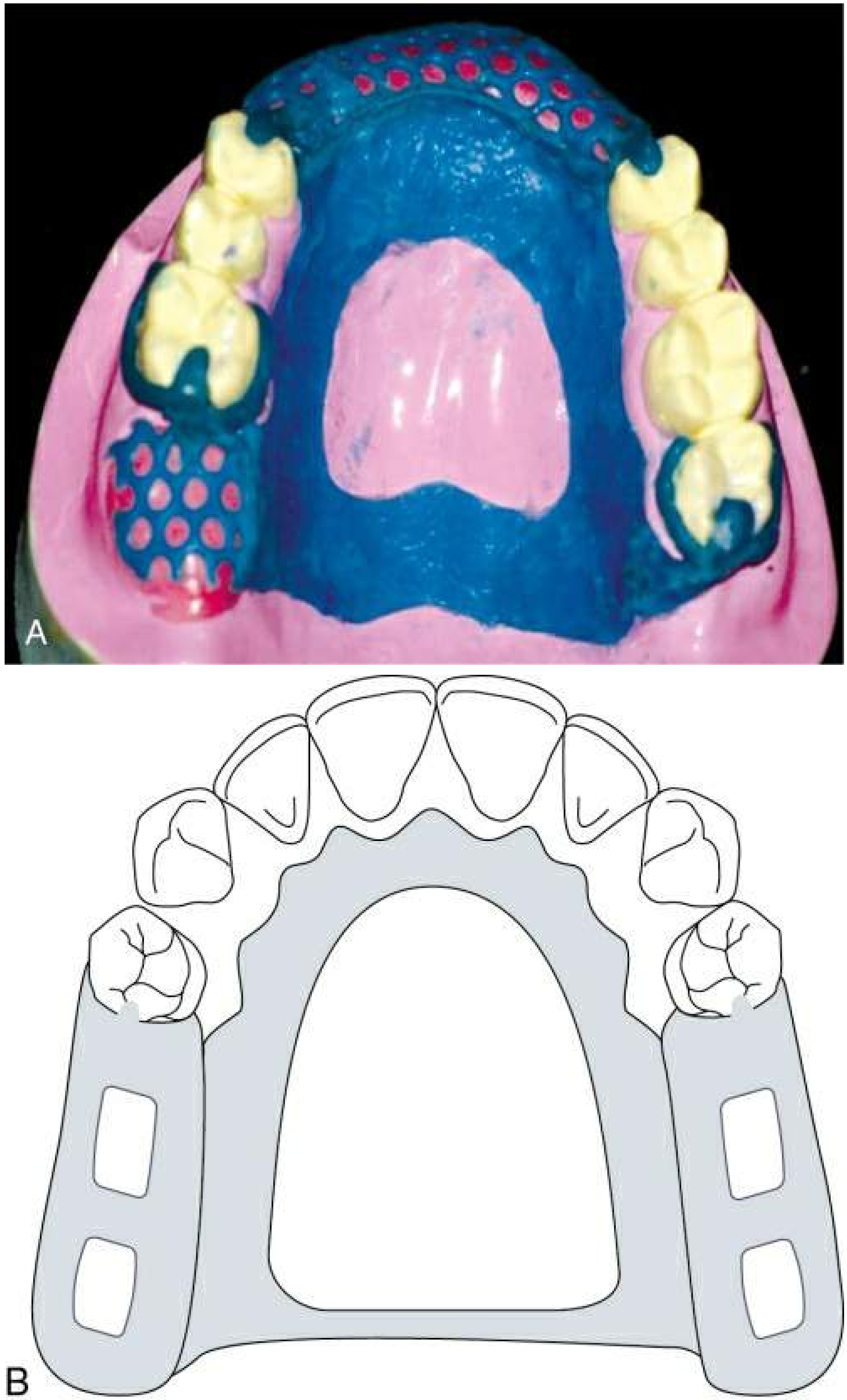

A
B

FIGURE 21.13A, B Anteroposterior palatal strap.

Indications

1. When numerous teeth are to be replaced and torus is present.

2. Kennedy's class I and II with anterior tooth replacement.

Advantages

1. Rigid with less thickness.

2. Good palatal support.

3. Strong, L-beam effect.

Disadvantages

Interference with phonetics and patient comfort in some cases.

Complete palate

The uniform metal coverage extends over the entire palate or simulating the anatomic replica of hard palate. Posterior border extends to junction of soft and hard palate (Fig. 21.14). *The posterior palatal seal that is used in complete dentures should not be used in removable partial dentures* as it is not effective. Beading of posterior borders as with all maxillary major connectors is sufficient.

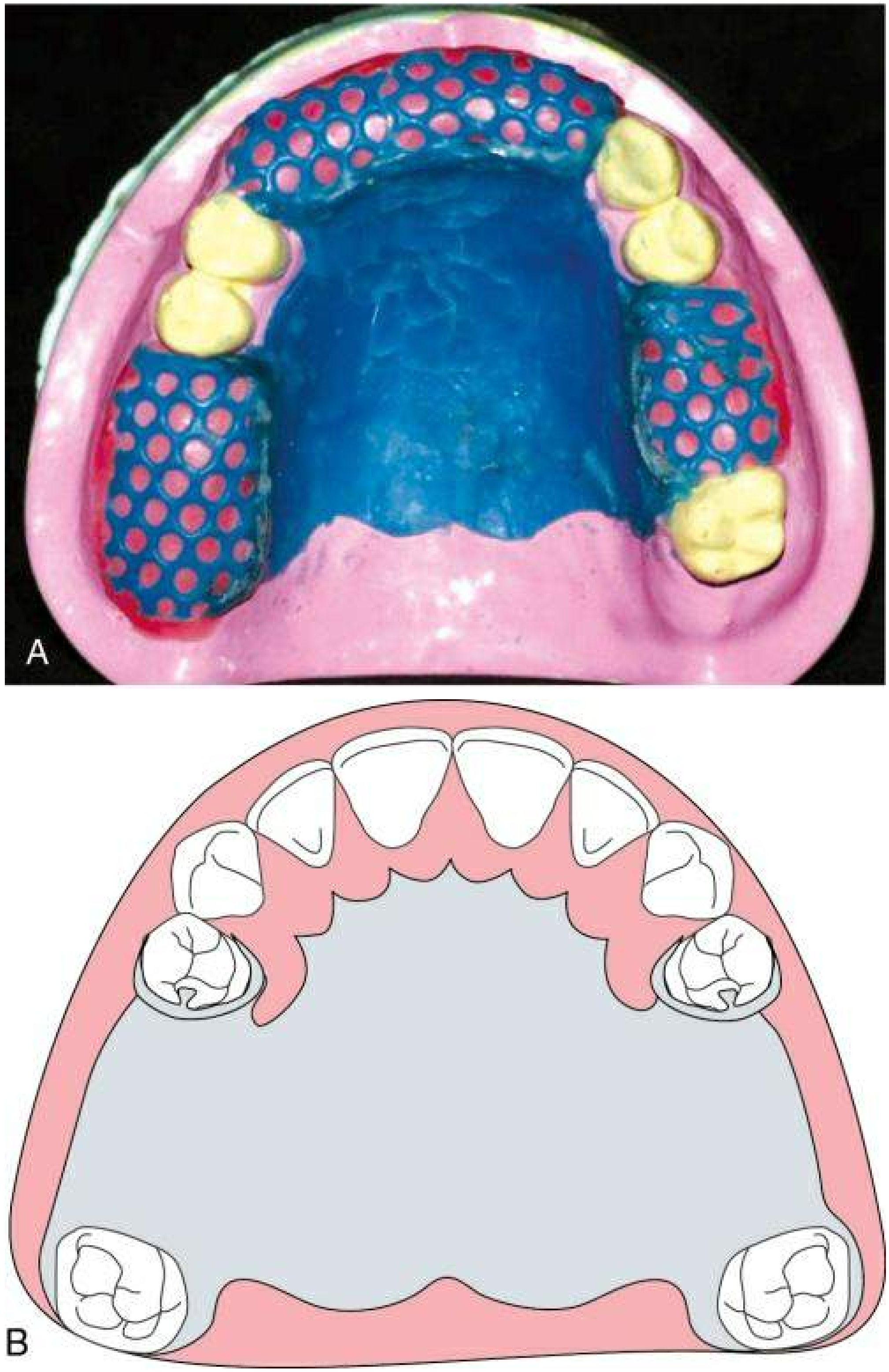


FIGURE 21.14A, B Complete palate.

Indications

1. Kennedy's class I where length of span is long with anterior modification.

2. Kennedy's class II with anterior and posterior modification spaces.

3. When opposing arch consists of a full complement of mandibular teeth and patient has well-developed muscles of mastication, complete palate provides the needed extra support against vertical displacement.

4. Flat, flabby ridges or shallow palatal vault, complete palate provides best stabilization.

5. Cleft palate patients with narrow, steep palatal vault.

Advantage

Best rigidity, support and strength.

Disadvantages

1. Adverse soft tissue reactions because of extensive coverage.

2. Problem with phonetics.

If the palatal coverage is made with acrylic resin instead of metal, the removable partial denture is a temporary, transitional or interim prosthesis, used to get the patient accustomed to complete palatal coverage or as surgical stents when future relining is predicted.

Maxillary major connectors indicated for kennedy's classification

The following major connectors are generally used for the given Kennedy's classification:

1. **Class I:** Closed horseshoe, complete palate

2. **Class II**: Palatal strap, closed horseshoe

3. **Class III:** Palatal strap, palatal bar

4. **Class IV:** Horseshoe, closed horseshoe, complete palate

Mandibular major connectors

These are major connectors used for mandibular removable partial dentures. Apart from the general consideration for major connectors, they should satisfy the following additional specific requirements for mandibular major connectors:

1. They should be rigid without being bulky as they have to be long and narrow because of space limitations caused by floor of mouth, lingual frenum, tongue and mandibular tori.

2. Relief is always given. It is more for distal extension bases than for tooth-supported partial dentures as they tend to rotate more. More relief is also given if lingual soft tissues slope towards the tongue than if they are vertical (Fig. 21.15). Because of the need for relief, beading is not indicated in mandibular major connectors.

3. The inferior border should not impinge on the tissues in the floor of the mouth. The available space is measured as follows:

  i. Patient is asked to touch the vermilion border of the upper lip with tongue, when height of the floor of the mouth is measured with a periodontal probe in relation to lingual margins of adjacent teeth (Fig. 21.16). These readings may then be transferred to diagnostic or master cast (Fig. 21.17).

ii. The second method is to make a custom tray with its lingual borders 3 mm short of elevated floor of the mouth and then use an impression material to record the area as the patient licks the lips. The resultant cast will give the available space. Of the two, the first method is more consistent and clinically acceptable.

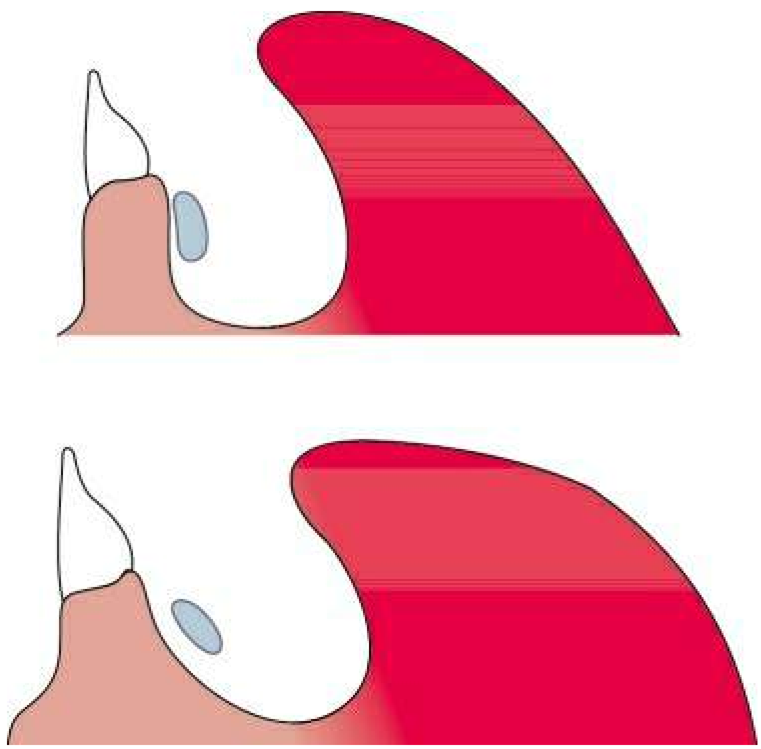


FIGURE 21.15 More relief given when soft tissues slope towards tongue (bottom) than when they are vertical (top).

FIGURE 21.16 Height of floor of the mouth is measured intraorally.

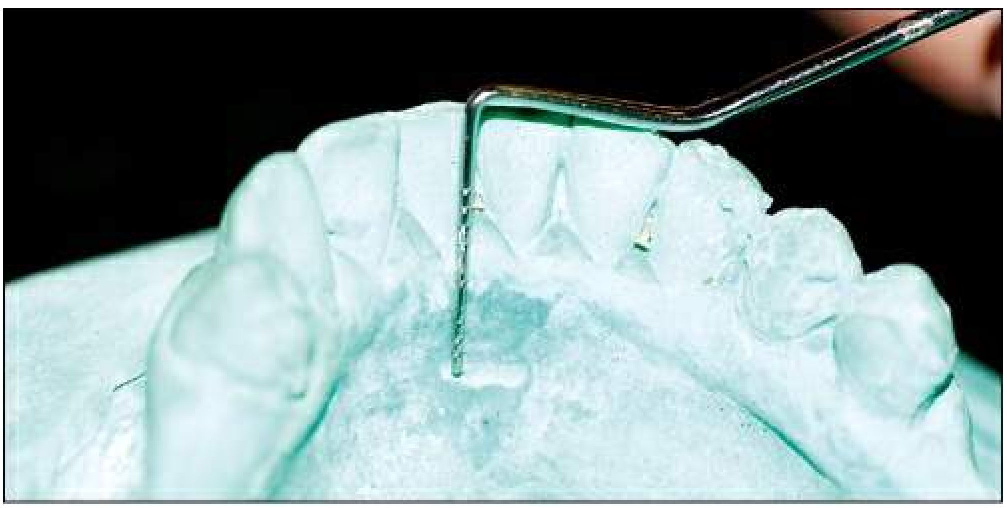


FIGURE 21.17 Transferred to cast.

Lingual bar

It is the most commonly used mandibular major connector. It is a half-pear shaped bar with the superior border located below the gingival border and the gingival margin (Figs 21.18 and 21.19).

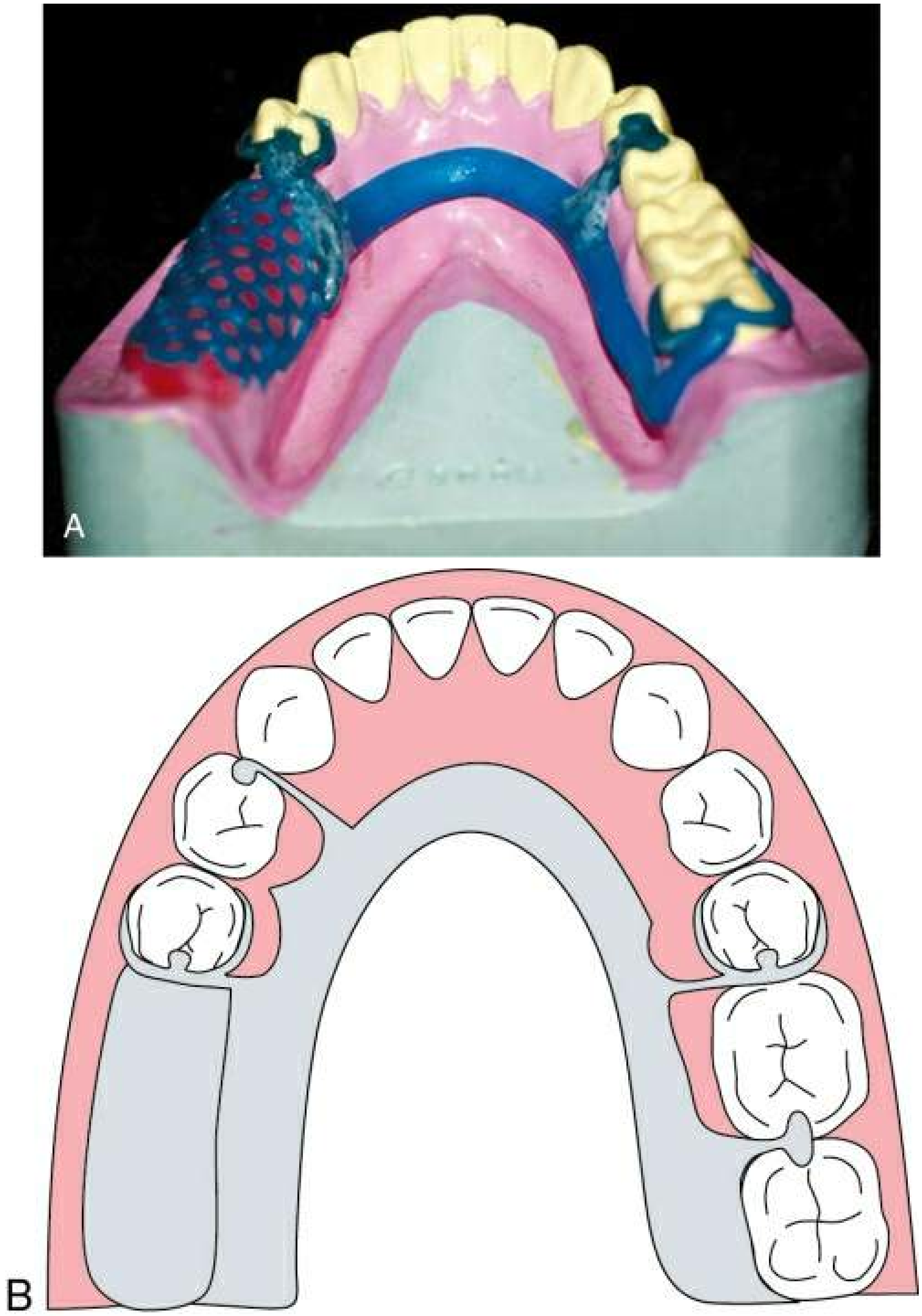


FIGURE 21.18A, B Lingual bar.

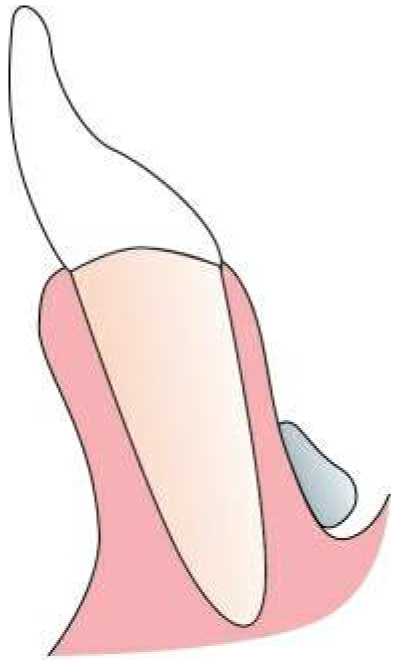


FIGURE 21.19 Lingual bar – half-pear shaped in cross-section.

It requires at least 8 mm of vertical space between the floor of the mouth and gingival margins of the teeth (5 mm for the connector and 3 mm space between the superior border and the gingival margin).

Indications

It is always used unless others offer a definite advantage for a given situation.

It is indicated in Kennedy's class III situation and its modifications.

Advantages

1. Simple, easy to design and fabricate.

2. Has minimal contact with oral tissue.

3. No contact with teeth, so no decalcification of teeth.

Disadvantages

1. Causes food entrapment and patient discomfort if it is placed over

an undercut.

2. Cannot be used when tori are present.

3. Chances of making it thin and flexible in cases of insufficient vestibular depth.

Sublingual bar major connector is a modification of lingual bar. It is kidney-shaped, placed deeper into the anterior lingual sulcus when adequate space is not available for lingual bar (Fig. 21.20).

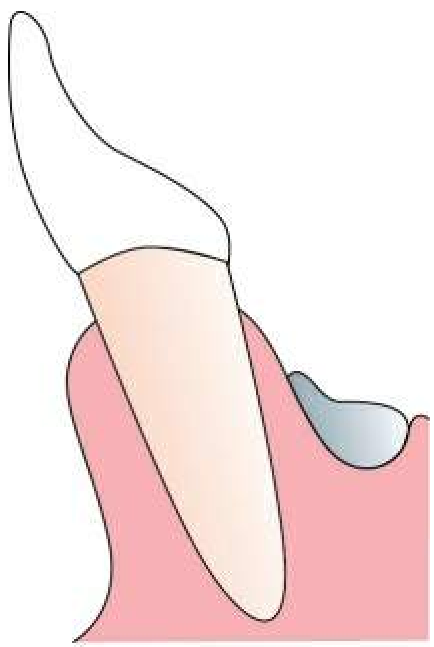


FIGURE 21.20 Cross-section of sublingual bar.

Lingual plate

Also termed linguoplate, it is basically a pear-shaped lingual bar with superior border extending onto the lingual surfaces of teeth as a thin solid plate of metal. The superior border is scalloped, with intimate contact on teeth above the cingula and knife-edge margins (Fig. 21.21A and B). This reduces the wedging effect on teeth and prevents food from packing into the area.

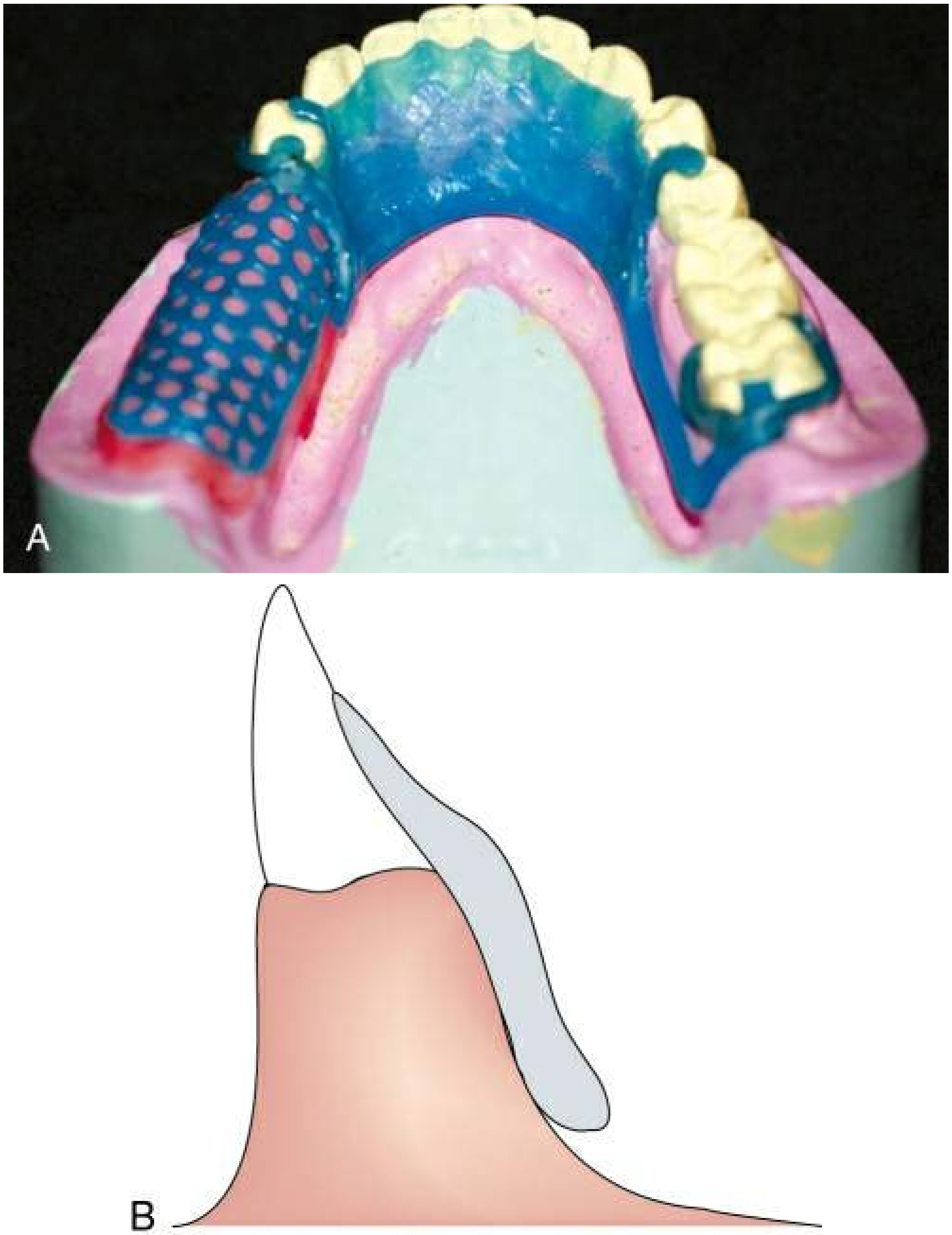


FIGURE 21.21 **(A)** Lingual plate. **(B)** Cross-section of lingual plate.

In case of gingival recession and spacing in the anteriors, cut back or step back of the plate can be done to prevent visibility of metal (Fig. 21.22).

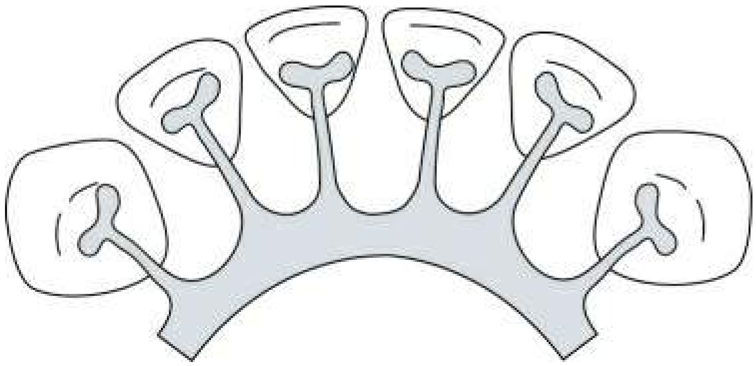


FIGURE 21.22 Cut back of plate.

The anterior lingual plate must always be supported at each end by rests no further posterior than mesial fossa of first premolars, whether indirect retention is needed or not (Fig. 21.23).

FIGURE 21.23A, B Mesial rests on first premolars.

Indications

1. When lingual frenum is high or space available for lingual bar is insufficient.

2. Kennedy's class I where residual ridges have undergone excessive vertical resorption.

3. For stabilizing periodontally weak teeth.

4. When future replacement of one or more anterior teeth is predicted, addition of retention loops to lingual plate will facilitate this.

5. Presence of inoperable mandibular tori.

6. To help prevent supraeruption of mandibular anteriors in retrognathic jaws by placement of incisal rests.

Advantages

1. Most rigid and provides good support and stabilization.

2. Provides indirect retention with rests on premolars.

3. Better patient comfort and phonetics.

Disadvantages

1. Extensive coverage of teeth may cause decalcification.

2. Soft tissue irritation.

Double lingual bar

It is also termed as Kennedy's bar or continuous bar retainer.

It differs from lingual plate in that the middle portion is removed and the remaining is a superior and inferior bar (Fig. 21.24). The lower bar is similar to a lingual bar, pear-shaped in cross-section. The upper bar should be half-oval in cross-section, 2–3 mm high and 1 mm thick (Fig. 21.25).

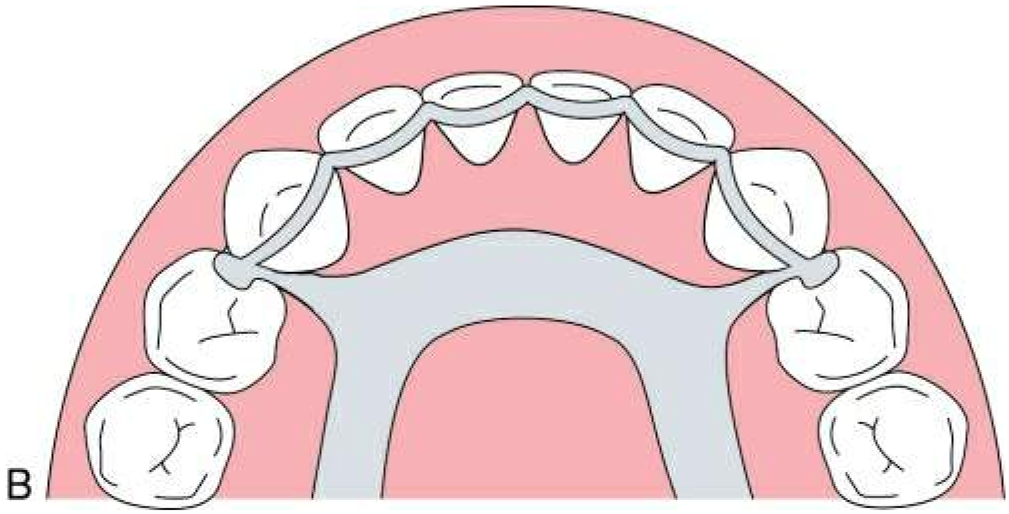


FIGURE 21.24A, B Double lingual bar.

FIGURE 21.25 Cross-section of double lingual bar.

Just like the lingual plate, the upper bar should dip into the embrasures and if a diastema is present, a step-back design is used (Fig. 21.26).

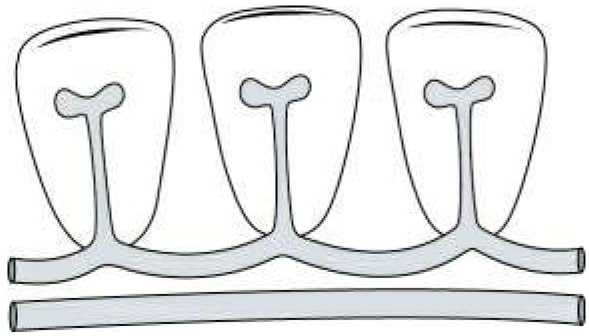


FIGURE 21.26 Double lingual bar with step back design.

The two bars are joined by minor connectors placed between canine and premolar. Rests must be placed at each end of upper bar, no posterior than mesial fossa of premolars (Fig. 21.27).

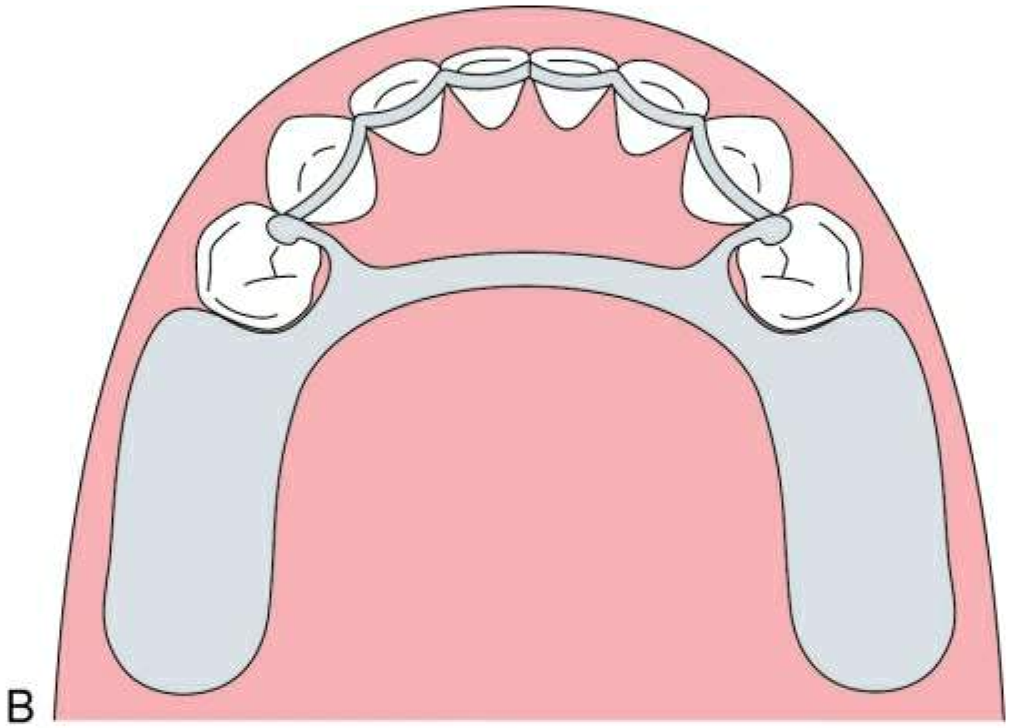


FIGURE 21.27A, B Rests on mesial surface of premolars.

Indications

1. When a lingual plate in otherwise indicated but axial alignment of anterior teeth entails excessive blockout, e.g. crowding.

2. Periodontal disease resulting in large interproximal embrasures.

3. Wide diastemas in lower anteriors.

Advantages

1. Provides good indirect retention.

2. Horizontal stabilization.

3. As gingival tissues are not covered, marginal gingiva receives natural stimulation.

Disadvantages

1. More annoyance to tongue than lingual plate.

2. Food entrapment.

Labial bar

It is half-pear shape in cross-section similar to lingual bar, but running across the labial or buccal mucosa (Fig. 21.28). The height, thickness and length of the labial bar are greater than the lingual bar.

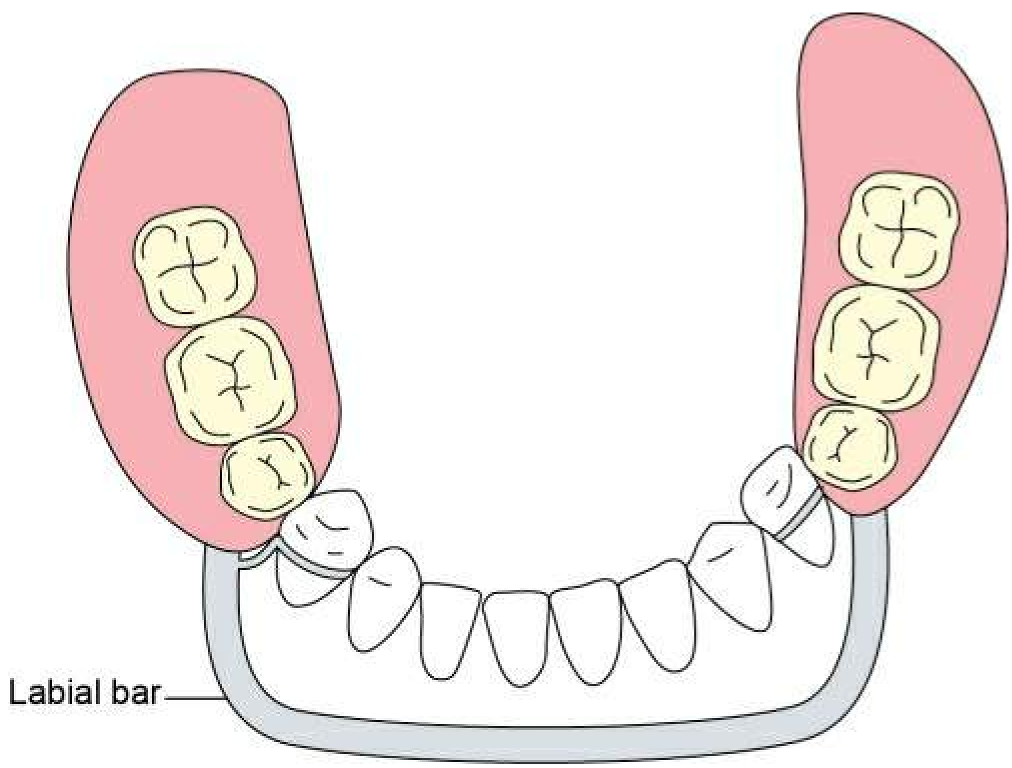


FIGURE 21.28 Labial bar – major connector placed labially.

Indications

1. Malposed and lingually inclined teeth (Fig. 21.29).

2. Severe and abrupt lingual tissue undercuts.

3. Large inoperable mandibular tori.

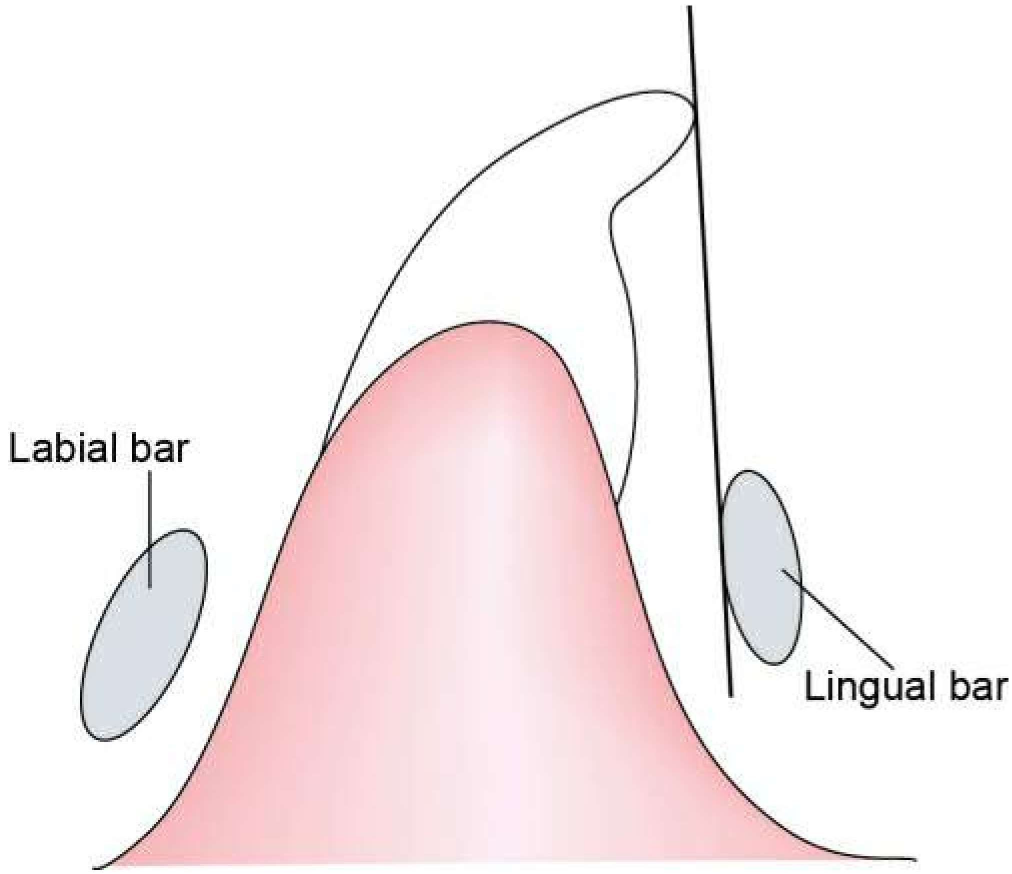


FIGURE 21.29 Labial bar is indicated when mandibular anterior teeth are lingually inclined preventing the use of lingual major connectors.

Advantages

The only choice of major connector when lingual tissues do not support the prosthesis design.

Disadvantages

1. Unaesthetic

2. Distortion of lower lip

3. Patient discomfort

A modification of the labial bar is the 'hinged continuous labial bar' incorporated in the 'swing-lock' partial denture. It is discussed in Chapter 30.

Major connectors are summarized in Tables 21.1 and 21.2.

Table 21.1

Maxillary major connectors

Type	Shape	Advantages	Disadvantages	Indications	Contraindications
Palatal bar	Narrow half oval shape	Minimalism in design Effort lessness in fabrication	Bulky Little vertical support Interferences	Interim partial denture Rarely, in Kennedy's class III	Kennedy's class I, class II, class IV situations
Palatal strap	Wide strap	Good rigidity and strength Distribute stresses Improved retention	Tissue reactions	Kennedy's class II and III Strong abutments	Bony interferences
Anteroposterior palatal bar	Flat anterior bar, oval shaped palatal bar, connected by two lateral bars	Relieved for bony exostosis Stiffness	Less palatal support Discomfort Decreased bulk of metal	Kennedy's class II and IV Inoperable tori Teeth with good periodontal support Patient complaining of extensive coverage	High arch palate Compromised periodontal support
Anteroposterior palatal strap	anterior and posterior palatal strap, connected by two lateral bars	Good palatal support The central opening provides taste sensation	Distress in speech Tissue reactions	Multiple saddles All possible Kennedy situationsIn presence of tori or bony exostosis in palate	In replacements one or two missing teeth
Horseshoe shape palatal bar	Thin band extending in the anterior and posterior lateral surfaces of palate	Beneficial in restoring anterior teeth	More lateral forces produced	Kennedy's class IV	Avoided mostly
Complete palate	Uniform metal extending over entire hard palate	Rigid Simple design Good support Temperature changes are transferred to tissues Gingival margin can be uncovered First choice of connector in distal extension	Tissue reactions Posterior palatal seal cannot be altered Weight of prosthesis may dislodge prosthesis	Distal extension conditions and its modifications Cleft palate situations Heavy occlusal forces	Smaller partially edentulous area

Table 21.2

Mandibular major connectors

Types	Shape	Advantages	Disadvantages	Indications	Contraindications
Lingual bar	Half-pear shaped bar with superior and inferior border	Ease of design and construction Less tissue coverage Decreased decalcification and tissue reactions	Food impaction Patient discomfort	Used in all situations where a minimum of 8mm space required in lingual anterior region	Lack of sufficient space lingually Tori
Lingual plate	Pear-shaped bar with superior and inferior border. The superior border extends as thin plate to the lingual surfaces of anterior teeth	Indirect retention Good rigidity, support and stabilization	Decalcification of tooth Soft tissue reactions	All possible situations	Conditions where lingual bar is used
Double lingual bar	Superior and inferior bar, connected by two lateral bars	Stabilization to horizontal forces Indirect retention	Complex design Food entrapment Tongue annoyance	Crowded lower anterior teeth Diastemas in lower anteriors Compromised periodontal support	Ideal situations
Labial bar	Half-pear shaped bar in labial or buccal surface	Labial support	Distorts lip support Patient discomfort Difficulty in fabrication	Severe lingual inclinations Inoperable tori Severe lingual undercuts	Last choice of connector
Sublingual bar	Kidney shaped, extending sublingually	Less obstructive than lingual bar Increased rigidity than lingual bar	Sublingual extension is critical	Similar to lingual bar	Similar to lingual bar

Minor connectors

Definition

The connecting link between the major connector or base of a partial removable dental prosthesis and the other units of the prosthesis, such as the clasp assembly, indirect retainers, occlusal rests, or cingulum rests (GPT8).

Functions

1. Joins major connector with other component parts.

2. Transfers and distributes functional stress to the abutment teeth and residual ridge.

3. Transfers effect of retainers, rests and stabilizing components to the remainder of the denture.

Classification

It is classified into four basic types:

1. Clasp assembly – minor connector

2. Indirect retainer or auxiliary rest minor connector

3. Denture base minor connector

4. Approach arm minor connector

Clasp assembly minor connector

This connects the clasp assembly to the major connector.

It must be rigid with sufficient bulk, but the bulk must be concealed. May be of two types:

1. Located in the proximal surfaces of the teeth adjacent to the edentulous area. Here it should be broad buccolingually and thin mesiodistally. The thickest portion should be at lingual line angle of the tooth and it should taper evenly to its thinnest portion at buccal line angle area (Fig. 21.30).

2. If clasp assembly is not placed adjacent to edentulous area, minor connector is placed in the embrasure between two teeth (Fig. 21.31).

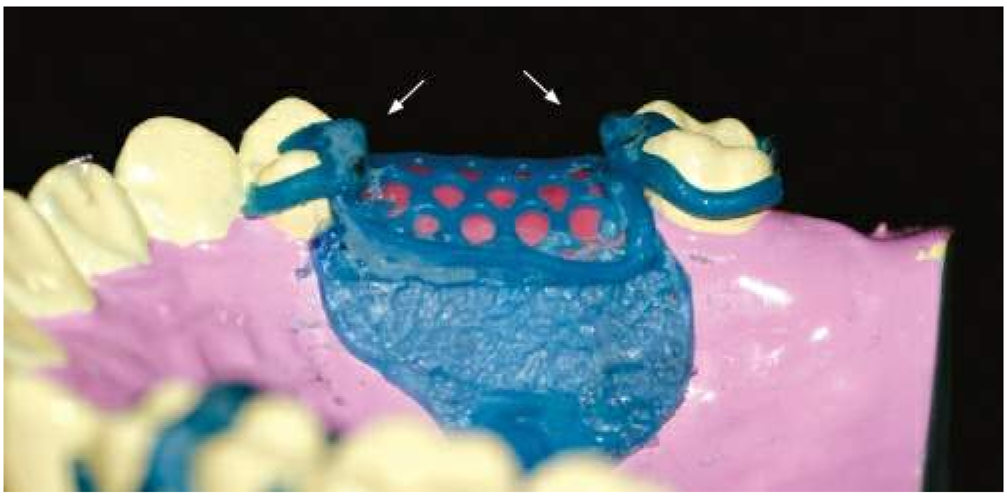


FIGURE 21.30 Minor connector adjacent to edentulous space.

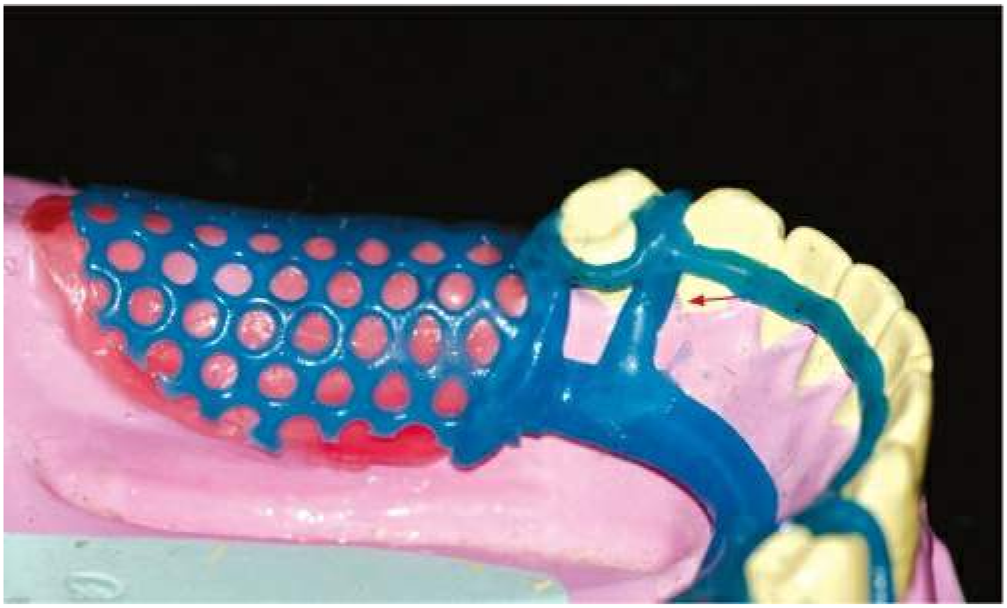


FIGURE 21.31 Minor connector in embrasure.

Minor connector should never be placed on the convex lingual surface of the tooth.

Indirect retainer or auxiliary rest minor connector

It connects the indirect retainer and auxiliary rest to the major connector (Fig. 21.32).

FIGURE 21.32 Indirect retainer minor connector.

It should form a right angle with major connector, but junction should be gentle curve. It is designed to lie in the embrasures so as to make it inconspicuous.

Denture base minor connector

This joins the denture base to the major connector, i.e. provides a mechanism of retention for the denture base made of acrylic resin.

It must possess sufficient strength and rigidity to anchor the denture base securely and must not interfere with tooth arrangement.

In maxillary distal extension bases, it must extend to cover the tuberosity, and in the mandibular distal extension bases, it should extend two-thirds the length of residual ridge.

This is of the following types:

1. Latticework construction
2. Mesh construction
3. Bead, wire or nail head construction

Latticework construction

It consists of two struts of metal running longitudinally along the edentulous space, with smaller struts running across the crest of the ridge connecting the longer struts (Fig. 21.33).

FIGURE 21.33 Latticework denture base minor connector for mandibular arch.

In the mandibular arch, there will be two longitudinal struts – one buccal and other lingual (Fig. 21.33), whereas in the maxillary arch, the border of the major connector palatally acts as second strut (Fig. 21.34). The longitudinal strut should not be placed on the crest of the ridge, as it will interfere with tooth arrangement and also set up a splitting action on denture base which can ultimately fracture the base.

- The connecting or cross struts should be positioned such that there is no interference in tooth arrangement. Generally one cross strut is placed between each of the teeth to be replaced.
- Relief is given between the struts and underlying ridge, so acrylic could flow around and through the latticework to provide retention of the denture base.
- The latticework construction provides the strongest attachment of acrylic resin denture base compared to all other denture base minor connectors.

- It is also the easiest to reline if required.
- It is indicated when multiple teeth need replacement.

FIGURE 21.34 Maxillary latticework – border of major connector acts as a longitudinal strut.

Mesh construction

- Consists of a thin sheet of metal with multiple small holes extending similar to latticework construction. It also requires relief (Fig. 21.35).
- Indicated when multiple teeth need replacement.
- Does not provide a strong attachment for the acrylic resin as holes are smaller.

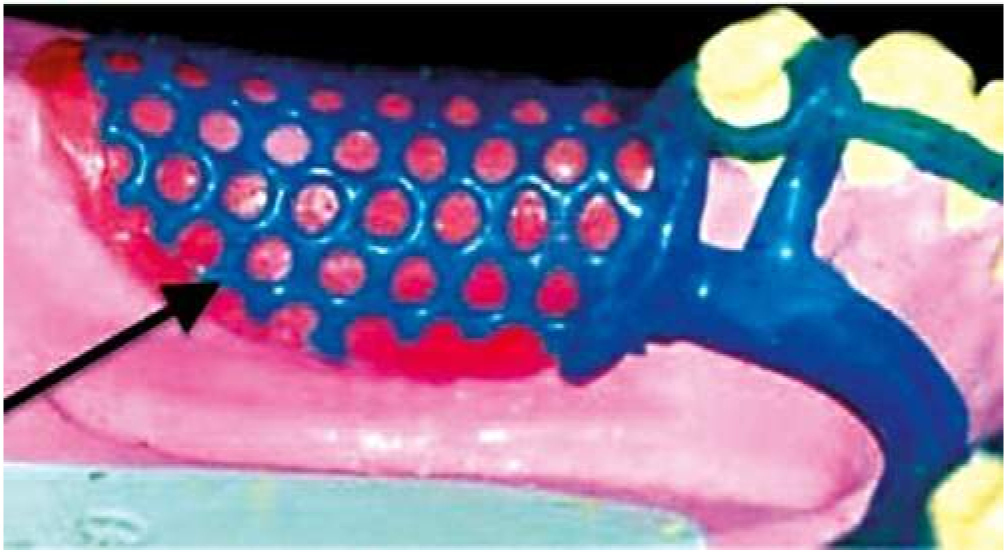


FIGURE 21.35 Mesh.

Both of the above minor connectors require acrylic resin to flow around and through the construction with space also provided underneath the connector in the form of relief. A tissue stop is necessary to achieve this objective as discussed below.

Tissue stop

- Used in all distal extension partial dentures using latticework or mesh retention.
- Provide stability and prevent distortion to framework during packing and curing of acrylic resin.
- Made by removing 2 mm square of relief wax where the posterior end of minor connector crosses centre of the ridge (Fig. 21.36).
- It is waxed as a projection of the framework and will contact the ridge after casting (Fig. 21.37).

FIGURE 21.36 Tissue stop.

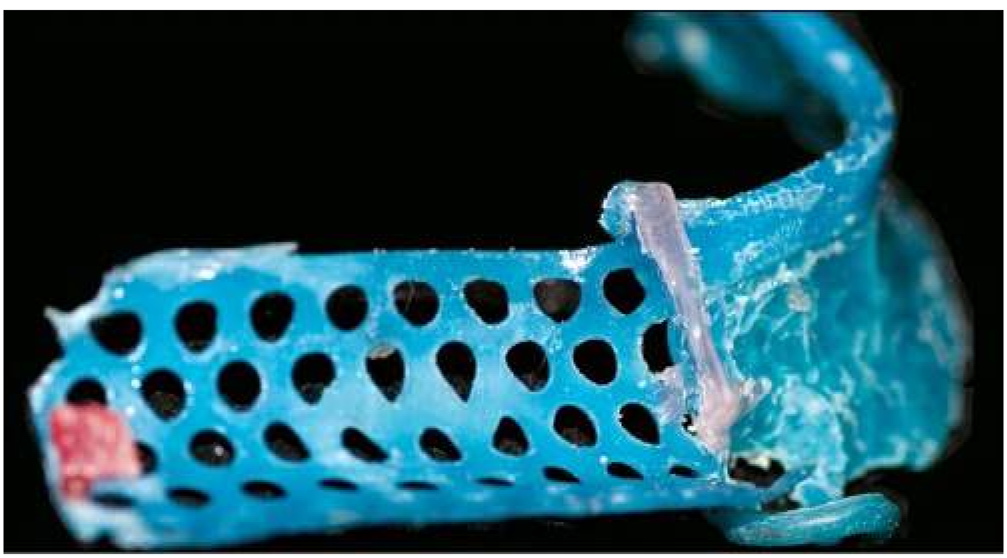


FIGURE 21.37 Waxed projection of tissue stop under the denture base minor connector.

Bead, wire or nail head

These are used with a metal denture base. No relief is provided. The acrylic resin is attached only to the superior surface of metal base and retention is achieved by projections in the form of beads, wires or nail heads (Fig. 21.38). As metal directly contacts the soft tissue instead of acrylic, there is better tissue response to this major connector.

- It is indicated on tooth-supported well-healed ridges where relining is not anticipated.
- **Disadvantage:** It has the weakest attachment to denture base and cannot be relined.

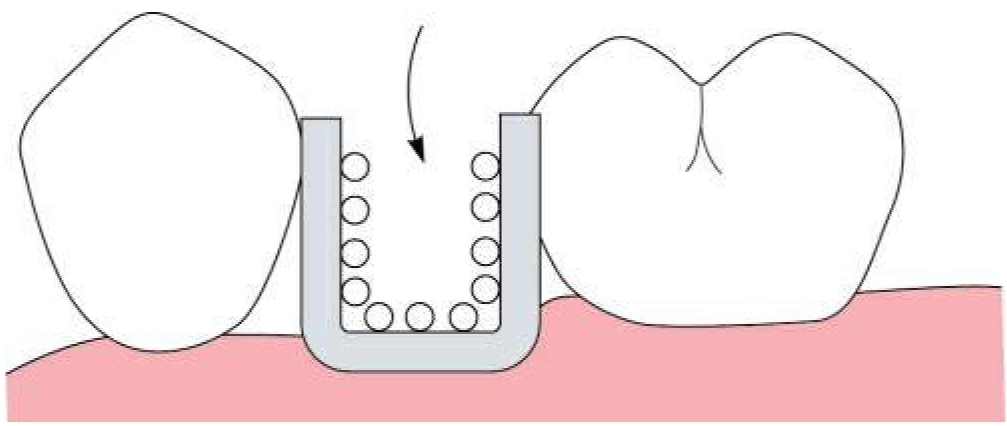


FIGURE 21.38 Bead minor connector.

The above-mentioned minor connectors – latticework, mesh and bead – support and retain the acrylic resin of denture base. It is important that the resin is not finished to a thin edge and must join the major connector in a smooth, even, butt joint. These butt joints are referred to as *finish lines*.

Finish lines

The planned junction of different materials (GPT8). In the context of removable partial dentures, it denotes the junction of acrylic resin denture base and metal major connector. It may be internal or external.

Internal finish line

Wax is used to provide relief (space for acrylic resin) in the master cast made for framework fabrication. The margin of the relief wax becomes *the internal finish line* and the ledge thus created must be sharp and definite (Fig. 21.39). It is the junction of acrylic with the fitting surface of the major connector. There is no internal finish line for bead, wire or nail head minor connector as acrylic resin is not present under the connector and contact of ridge is only by metal.

FIGURE 21.39 Internal finish line – blue line.

External finish line

This is the junction of acrylic resin with the polished surface of major connector. It is formed while making the wax pattern of framework on refractory cast. It should also be sharp and definite, but should be slightly undercut – less than 90°, to help lock acrylic to major connector. It extends from the lingual aspect of the rest seat and continues along the minor connector on the proximal tooth surface (Figs 21.40 and 21.41).

FIGURE 21.40 External finish line on cast metal framework.

FIGURE 21.41 External finish line – after processing of acrylic resin.

Approach arm minor connector

This serves as an approach arm for a bar clasp (vertical projection clasp), supports the direct retainer and engages the undercut from the gingival margin (Fig. 21.42).

- It is the only minor connector that is not required to be rigid.
- It should have a smooth even taper from start to finish.
- It must not cross a soft tissue undercut.

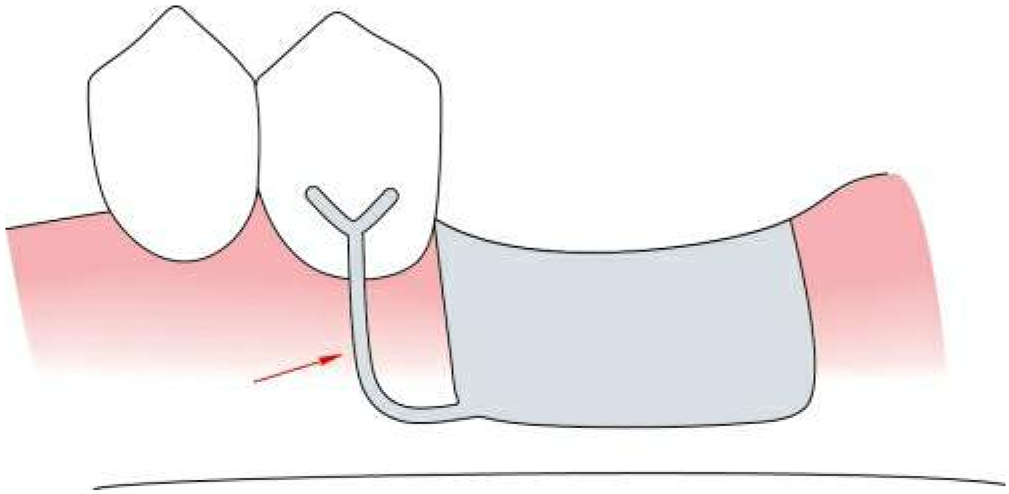


FIGURE 21.42 Approach arm minor connector.

Rests and rest seats

Definition

Rest: It is a rigid extension of a removable dental prosthesis that prevents movement towards the mucosa and transmits functional forces to the teeth (GPT8).

Rest seat: The prepared recess in a tooth or restoration created to receive the occlusal, incisal, cingulum, or lingual rest (GPT8).

Functions

1. **Support:** The primary function of the rest is to provide support to the removable partial denture, thereby preventing movement of denture towards the tissues.

2. **Force transfer:** The rest aids in transferring the forces along the long axis of the teeth.

3. **Indirect retention:** The rests are positioned anterior or posterior to the axis of rotation to prevent the unsupported distal extension denture base from lifting away from the edentulous ridge.

4. **Positional maintenance:** The rigidity of the rest helps in maintaining the clasp assembly in position for proper function of the other components of removable partial denture.

5. **Stability:** The thickness and position of rest reciprocates horizontal forces generated during function and thus assist in stability of the denture with other components of removable partial denture. In distal extension partial denture, the rest seat should be shallow and saucer shaped so that the rest can move slightly like a ball and socket joint, allowing the horizontal forces to be dissipated.

6. **Establishing occlusal plane:** Rest helps in establishing occlusal plane in situations like tipped molar. An occlusal onlay rest is designed to establish a more acceptable occlusal plane.

7. **Prevent food impaction:** The proximal surface of the abutment teeth close to the edentulous space is prone for food impaction. The rest placed closed to the edentulous space prevents food impaction in the abutment minor connector interface.

8. **Prevent tooth migration:** The smaller partially edentulous spaces which are difficult to restore cause discontinuity of arch and cause tooth migration problems. The rest placed on the proximal surface of teeth adjacent to edentulous space prevents tooth migration and thus maintains small edentulous spaces.

9. **Reciprocation:** Planned design of rest along with the minor connector aids in reciprocating stresses generated by the retentive arm of clasp assembly on the abutment teeth.

Classification

Based on relation to direct retainer

1. **Primary rests**: These are attached to the clasp assembly and aid in support.

2. **Secondary rests:** These are placed away from the clasp assembly and primarily aid in indirect retention.

Based on area of placement

Based on the surface of the tooth where the rest is placed, they can be of the following types:

1. **Occlusal rests**: Placed on occlusal surface of posterior teeth.

2. **Lingual or cingulum rests:** Placed on lingual surface of tooth in

cingulum area, usually canine.

3. **Incisal rests**: Placed on incisal edge of anterior teeth.

Occlusal rest

Definition

A rigid extension of a partial removable dental prosthesis that contacts the occlusal surface of a tooth or restoration, the occlusal surface of which may have been prepared to receive it (GPT8).

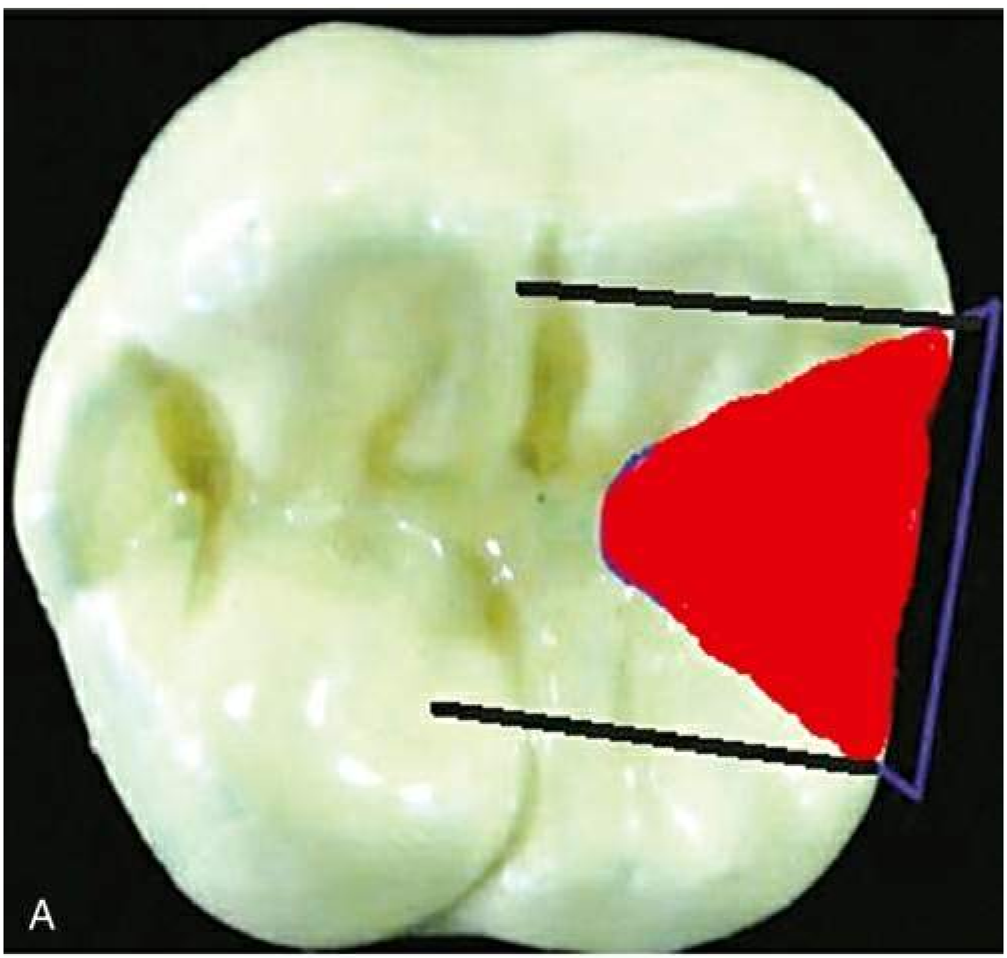
Characteristics

The outline form is rounded triangular in shape with the base of triangle towards the marginal ridge and the rounded apex towards the centre of tooth. It should follow the shape of the mesial or distal fossa of the tooth and be smooth with gentle curves (Fig. 21.43).

- The size should be:
  - **Mesiodistal:** One-third to one-half the mesiodistal diameter.
  - **Buccolingual:** One-half the buccolingual width between the cusp tips.
  - **Depth:** Deepest part should be in centre of preparation with base rising gradually to join the occlusal surface (Fig. 23.44A and B), making it spoon-shaped or saucer-shaped in cross-section. It should have a minimum thickness of 0.5 mm and at least 1–1.5 mm near the marginal ridges (Fig. 21.45).
- The angle formed by the occlusal rest and the minor connector from

which it originates must be less than 90° to direct the occlusal forces along the long axis of the tooth (Fig. 23.46A and B). An angle greater than 90° will also produce slipping of prosthesis away from abutment and cause orthodontic movement of tooth due to inclined plane effect (Fig. 21.47A and B).

- Preparing rests on restorations like amalgam, composite or glass ionomer may best be avoided as they do not possess sufficient strength and may fracture. It could be done for an interim prosthesis. Rests on cast restorations – inlays, onlays and crowns – are indicated and the preparation should be done along with wax pattern fabrication.



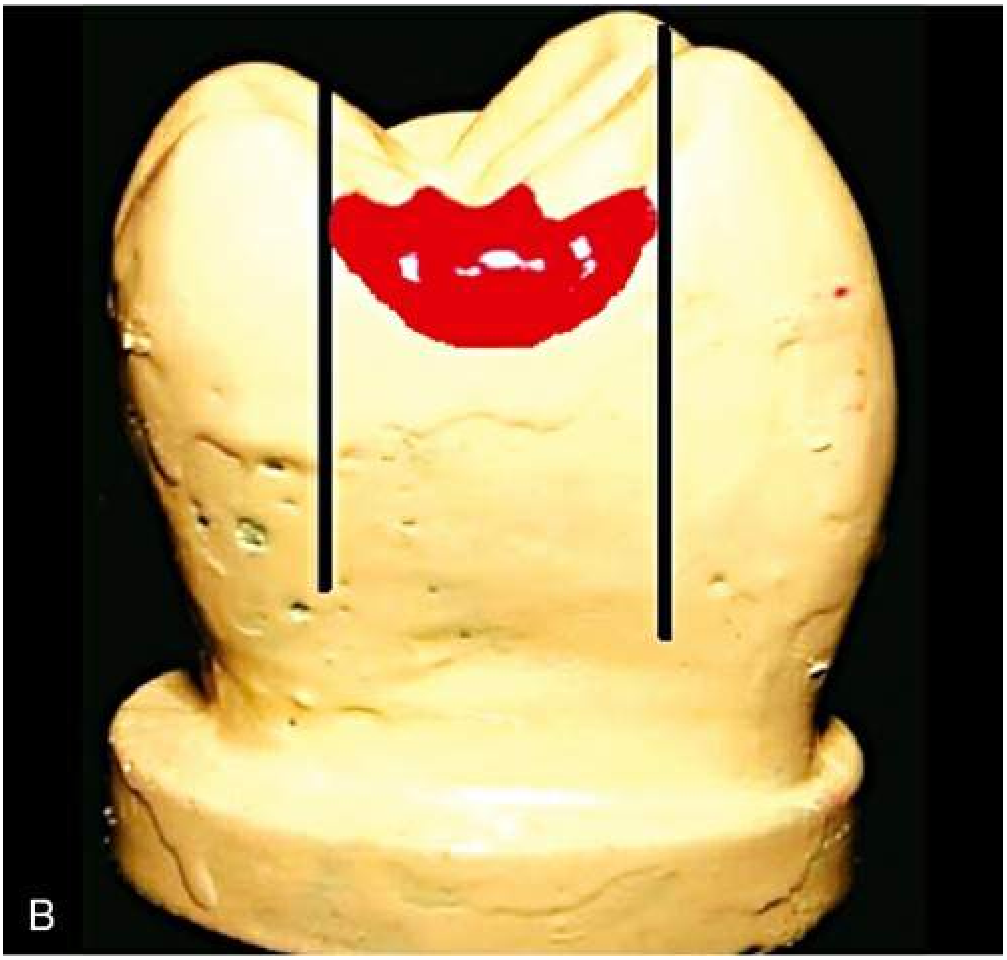


FIGURE 21.43 Outline of occlusal rest: **(A)** occlusal view, **(B)** proximal view.


A

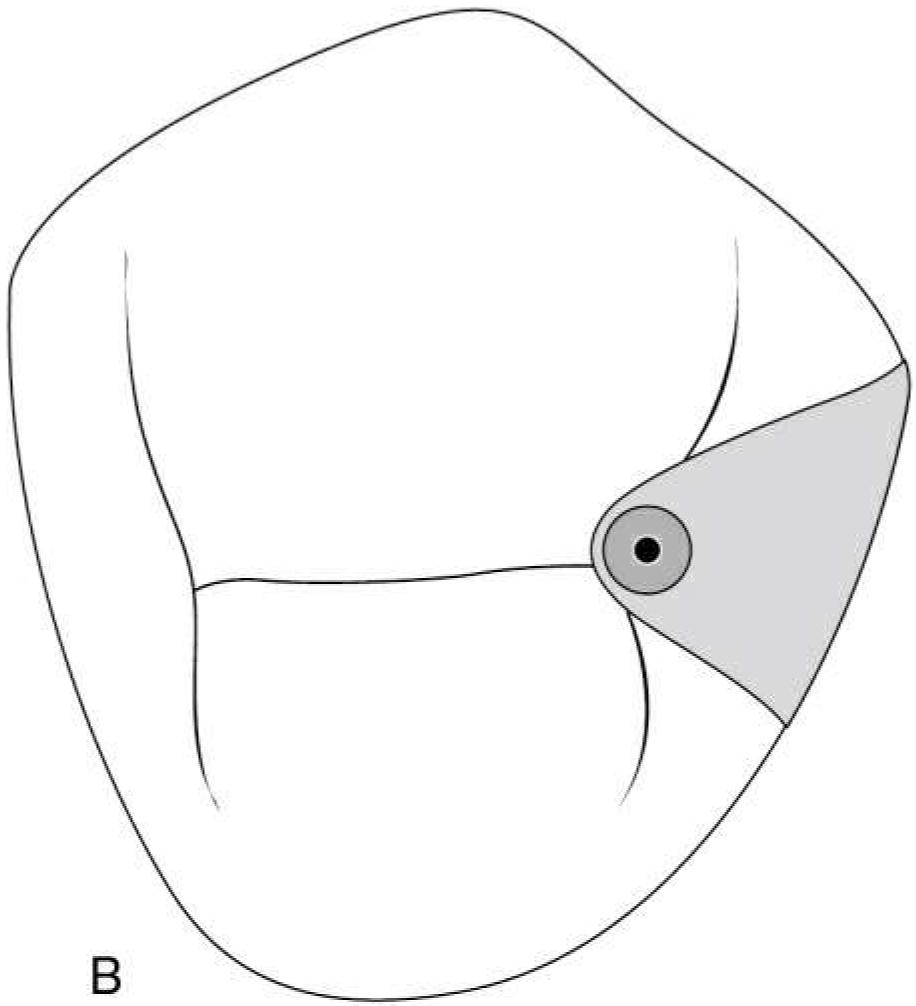
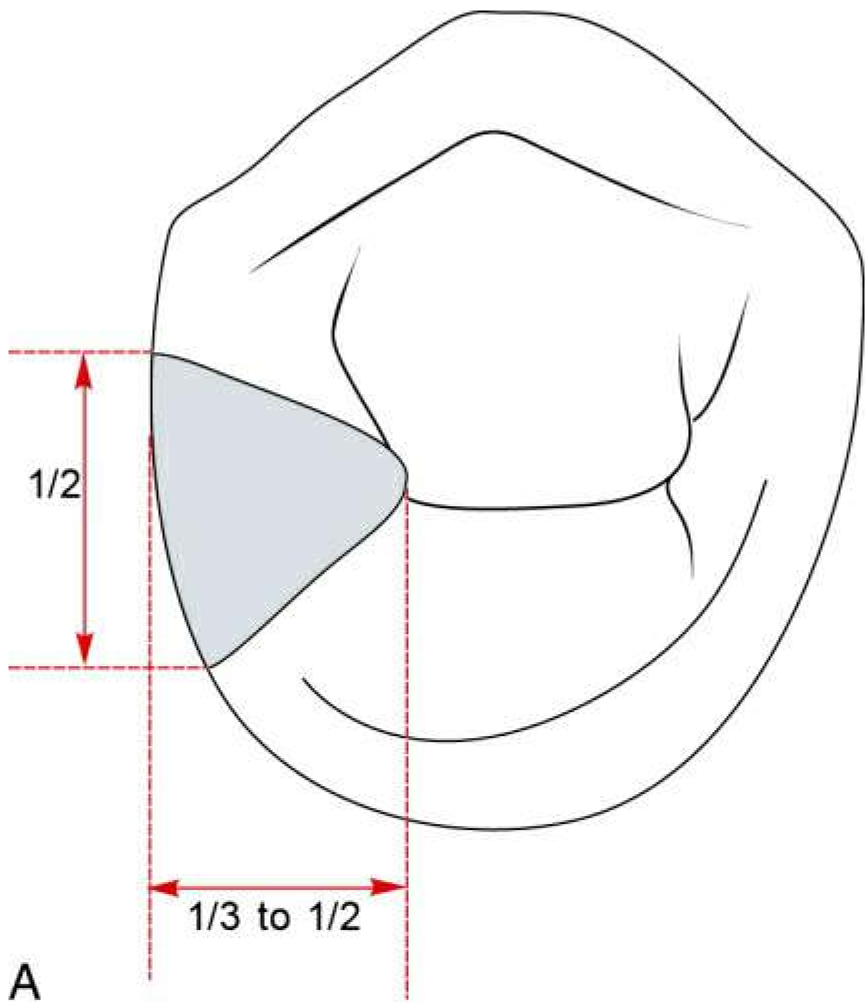


FIGURE 21.44A, B Deepest point in centre.



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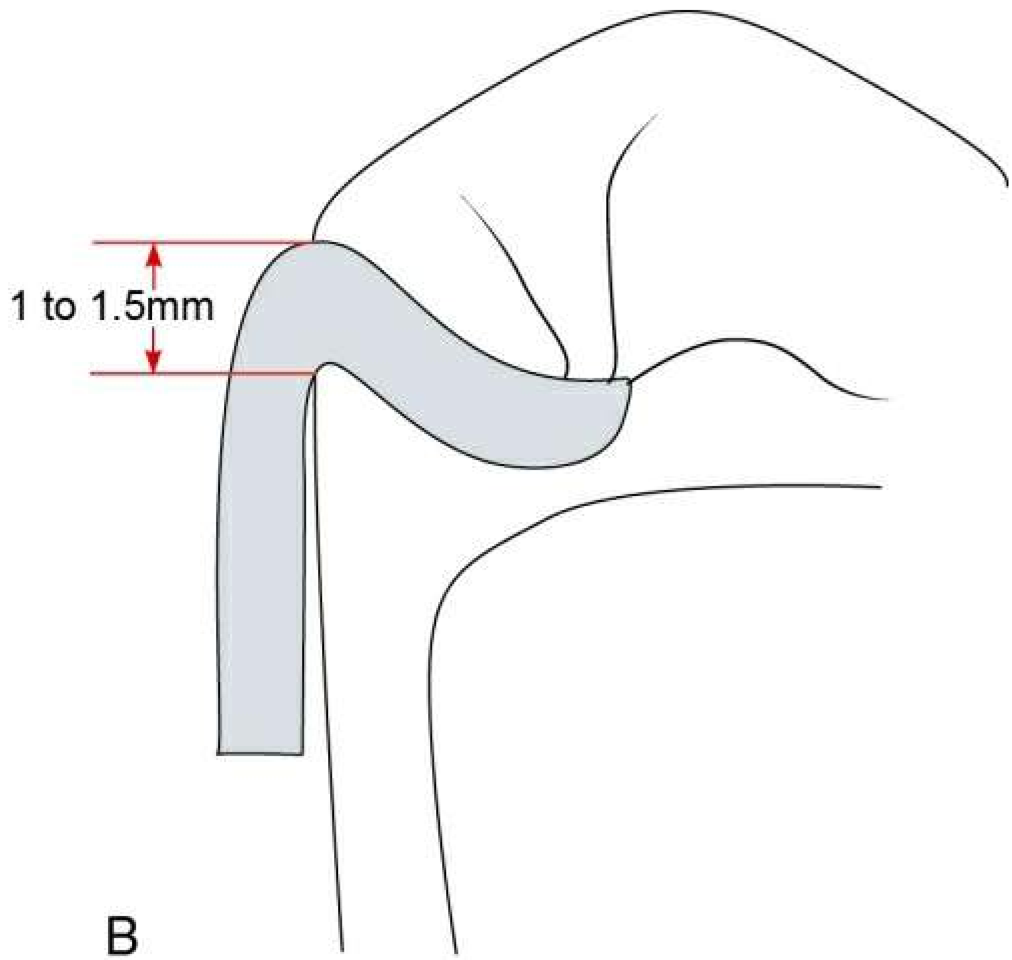
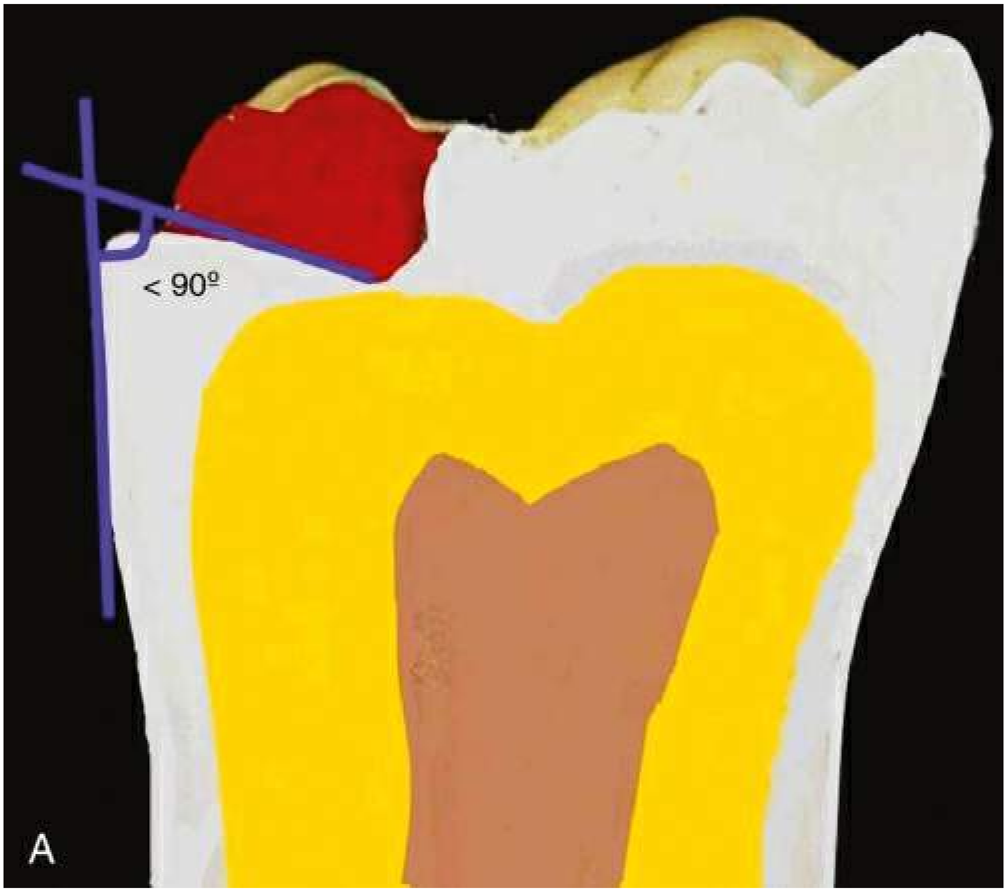


FIGURE 21.45A, B Size of rest seat.



< 90º
A

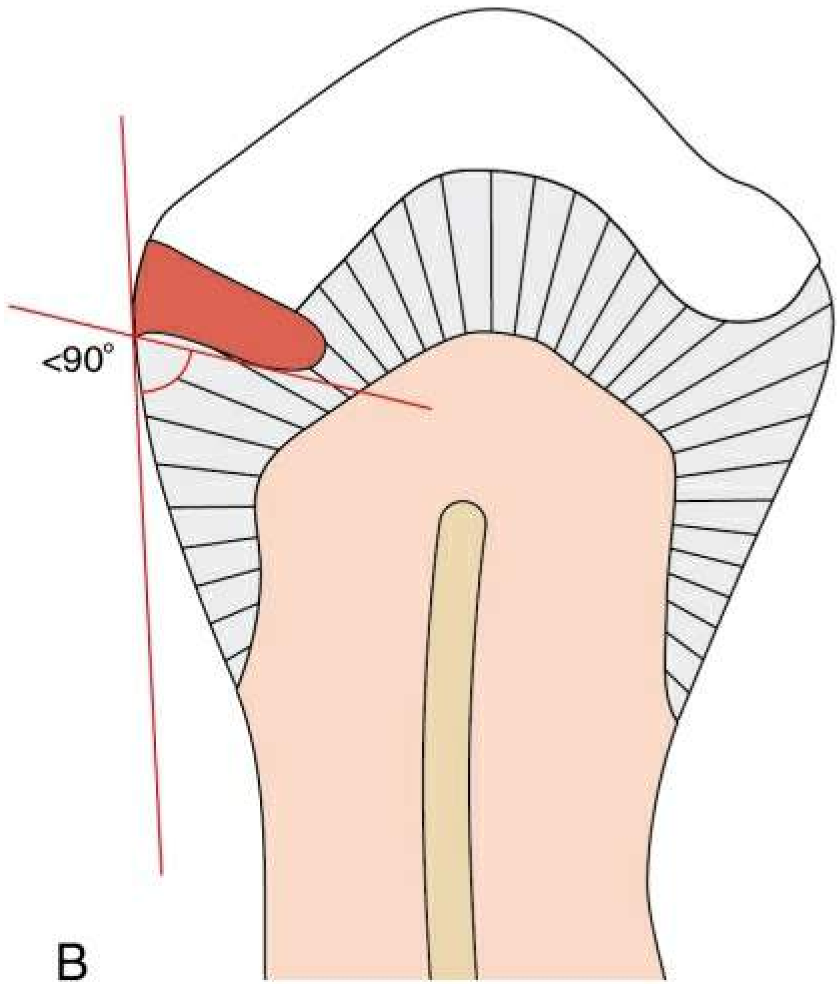


FIGURE 21.46A, B Angulation of rest.

> 90º
A

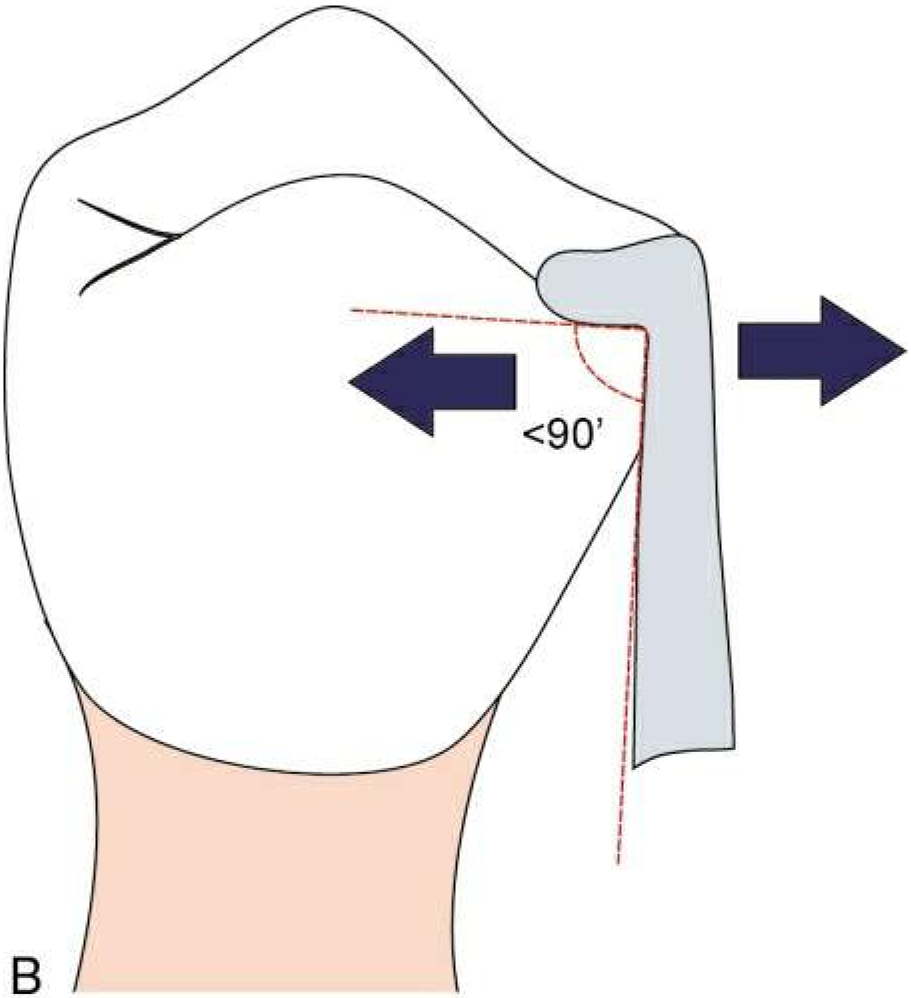


FIGURE 21.47A, B Inclined plane effect will cause tooth movement if angle is greater than 90°.

Lingual or cingulum rest

Definition

A metallic extension of a partial removable dental prosthesis framework that fits into a prepared depression within an abutment tooth’s lingual surface (GPT8).

Characteristics

- Indicated if an anterior tooth has a gradual lingual slope rather than perpendicular (Fig. 21.48A and B). Hence, it is used most often on maxillary canines than on incisors or mandibular canines. Lingual rests on incisors are indicated only in case of missing canines but in this instance multiple incisor teeth must receive rests to distribute the stresses. To successfully place lingual rests on enamel (natural teeth), patients' caries index should be low and they should maintain good oral hygiene.

- Lingual rest is preferred to an incisal rest for the following reasons:

  - It is placed nearer the centre of rotation of supporting tooth and so does not tip the tooth (Fig. 21.49A and B).

  - More aesthetic.

  - Less breakage and distortion.

- But whenever possible an occlusal rest is preferred to a lingual rest because of its mechanical advantages.

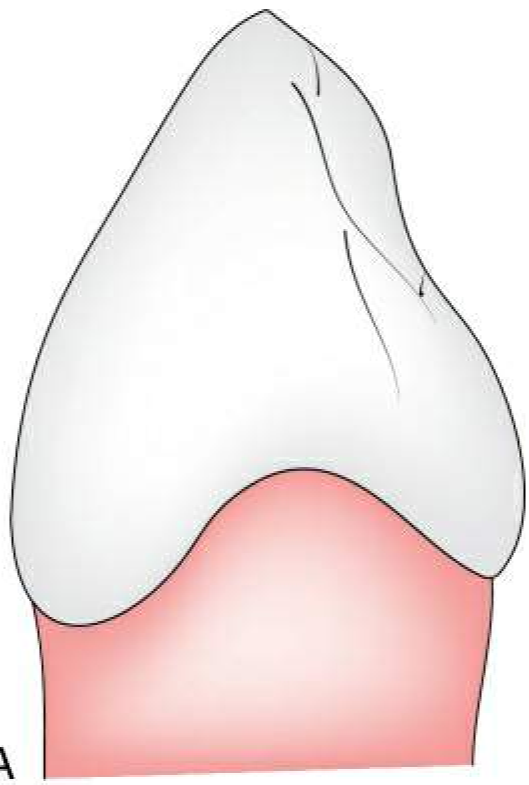
- The outline form of lingual rest is half-moon shaped, making a smooth curve from one marginal ridge to the other, crossing the centre of the tooth above the cingulum, with the deepest point over the cingulum (Fig. 21.50A and B).

- The rest seat is V-shaped and has two inclines. The labial incline is parallel to the labial surface of tooth, while lingual incline begins at the top of cingulum and converges labiogingivally towards the centre of the tooth, to meet the labial incline at the apex of rest seat.

- The lingual view shows a 'broad inverted V' following the contour of the cingulum (Fig. 21.50).

- Incisal view shows the rest seat to be broadest at the centre and tapering towards the proximal surfaces (Fig. 21.51).

- Proximal view shows the floor of the seat inclined towards the cingulum (Fig. 21.52).
- Lingual rests can be placed on cast restorations with great success by just accentuating the cingulum during wax pattern fabrication.



A

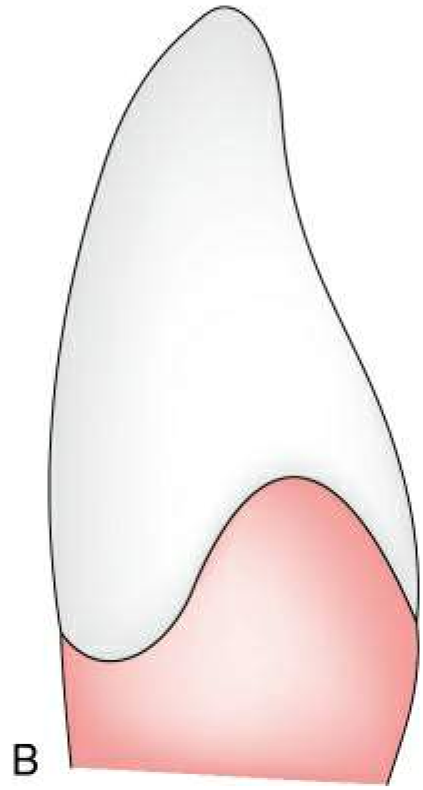


FIGURE 21.48 **(A)** Gradually sloping lingual surface. **(B)** Perpendicular lingual surface.

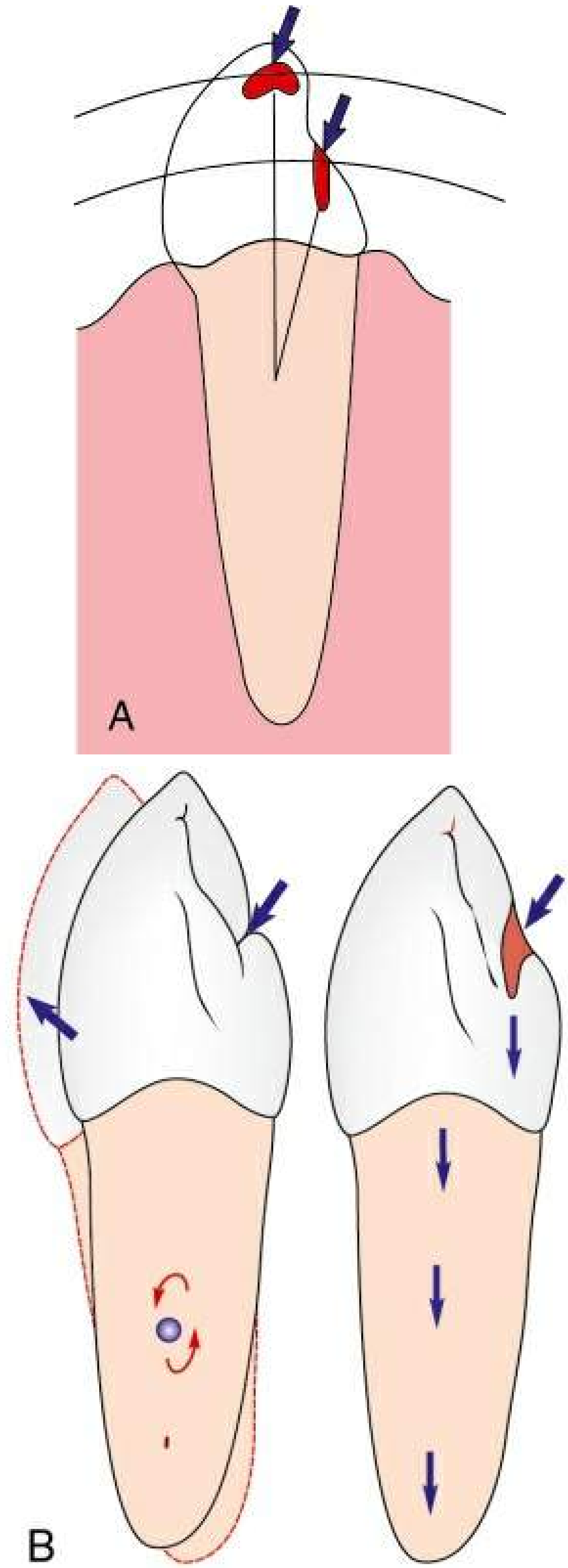
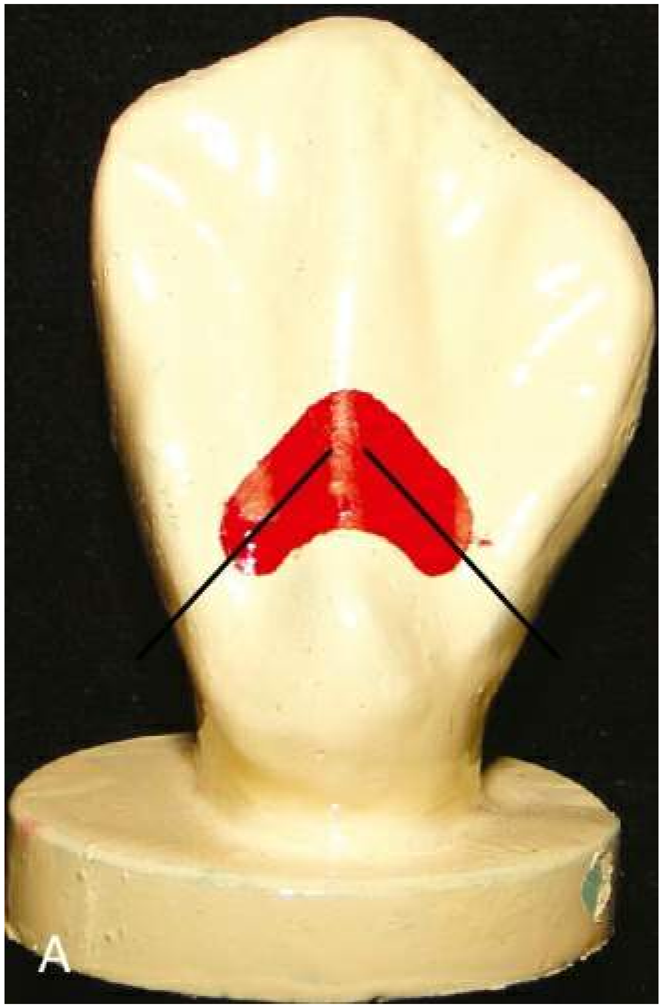


FIGURE 21.49A, B Lingual rest placed nearer the centre of rotation of supporting tooth and so it does not tip the tooth.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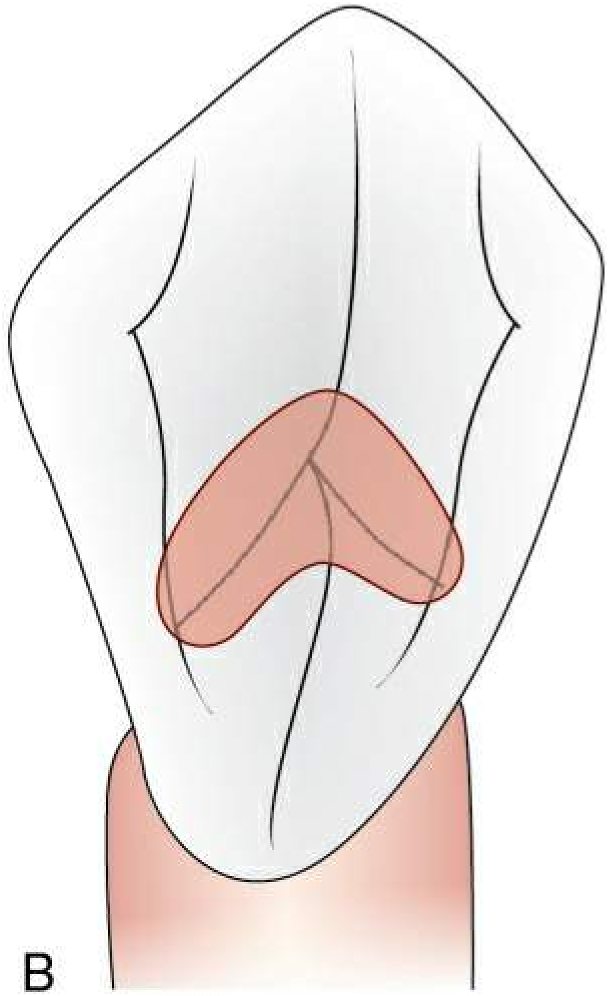


FIGURE 21.50A, B Lingual rest outline form.

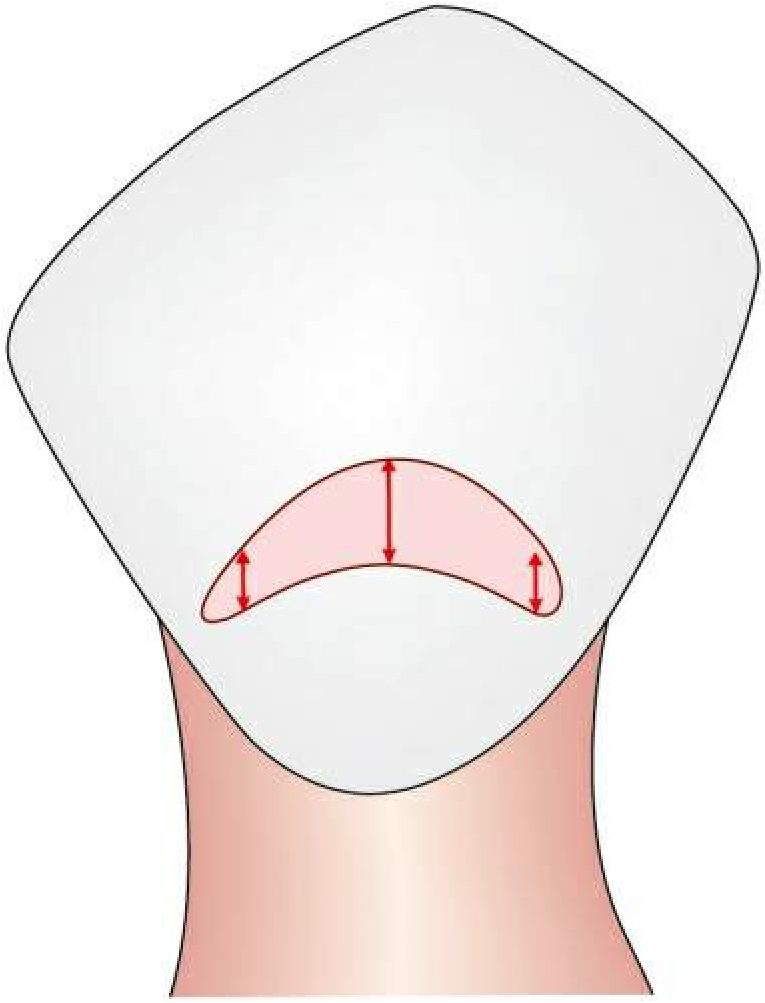


FIGURE 21.51 Rest seat broadest at the centre and tapers towards the proximal.

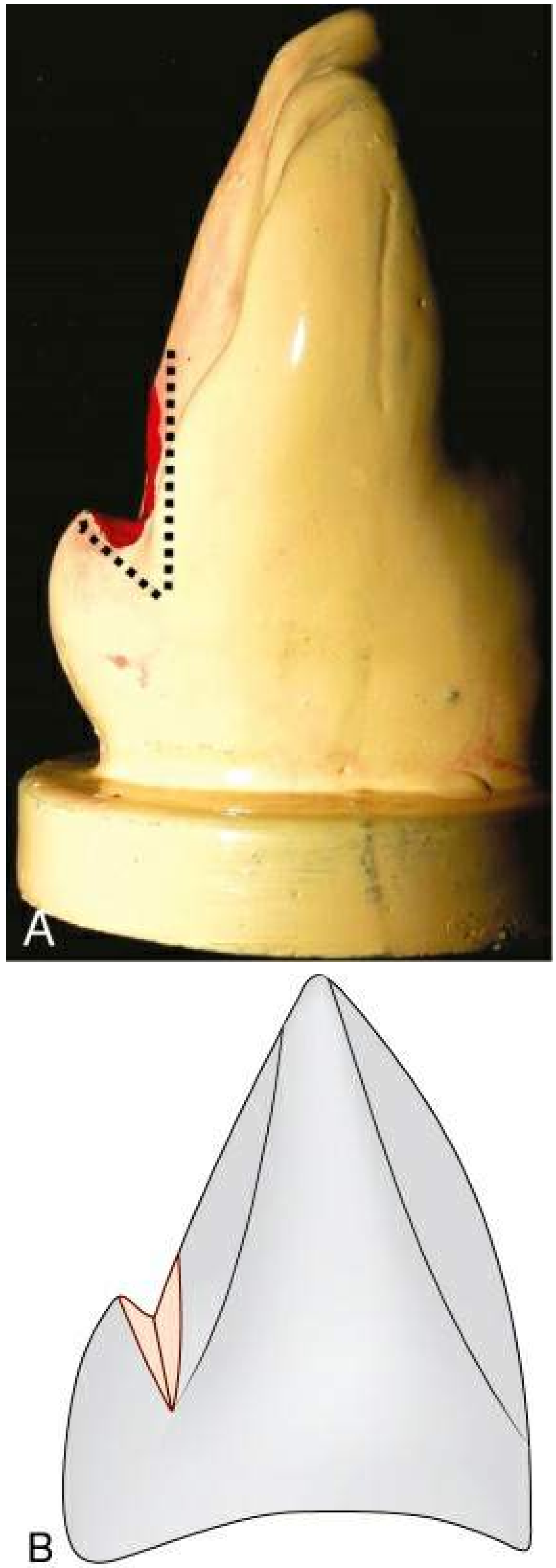


FIGURE 21.52A, B Floor of seat inclined towards cingulum.

Incisal rests

Definition

A rigid extension of a removable partial denture that contacts a tooth at the incisal edge.

Characteristics

- Least desirable position for rest placement. Used on sound tooth and never on cast restorations as lingual rest is preferred.
- They are mainly used as indirect retainers.
- They are frequently used on mandibular canines, rarely on maxillary canines if aesthetics is not a problem. In incisors, they are generally not used, but if required multiple incisal rests are placed to support the abutments.
- They are placed on the mesioincisal or distoincisal angle of the tooth depending on whether the tooth is to be clasped. If it is not clasped, rest is placed on distoincisal angle for aesthetic reasons. If a cast circumferential clasp is planned on the tooth, rest is placed on distoincisal angle. If a bar clasp is planned on the tooth, incisal rest is placed on mesial incisal angle.
- It is a small 'V-shaped' notch located 1.5–2 mm from proximoincisal angle of the tooth (Fig. 21.53). It should extend onto the facial surface to provide a positive seat for the rest. It should be bevelled labially and lingually and lingual enamel should be shaped to accommodate the minor connector.
- It should be 2.5 mm wide and 1.5 mm deep (Fig. 21.54). The deepest part should be towards the centre of tooth mesiodistally and it should be smooth.

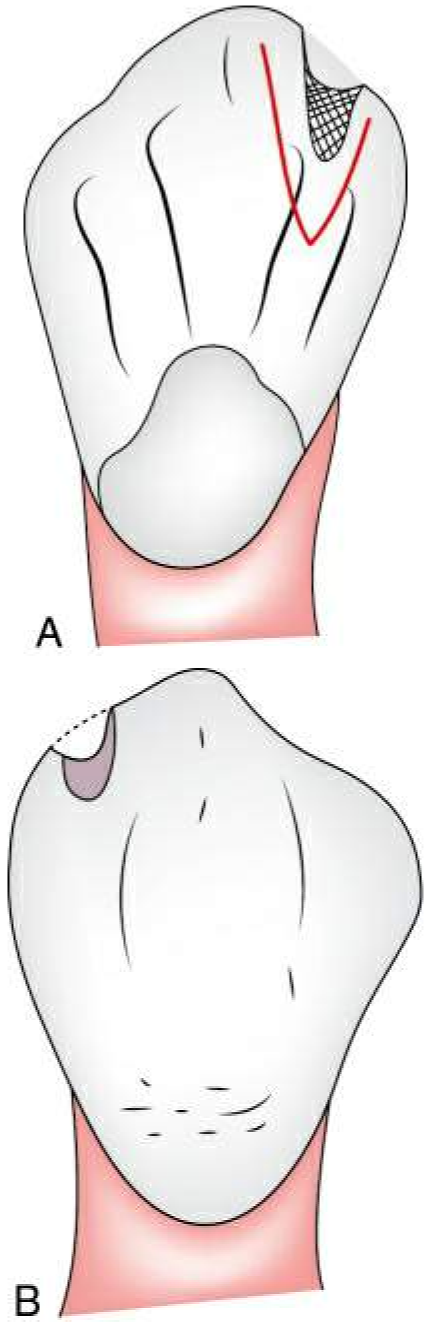


FIGURE 21.53 **(A)** Lingual view showing V-shaped rest. **(B)** Labial view.

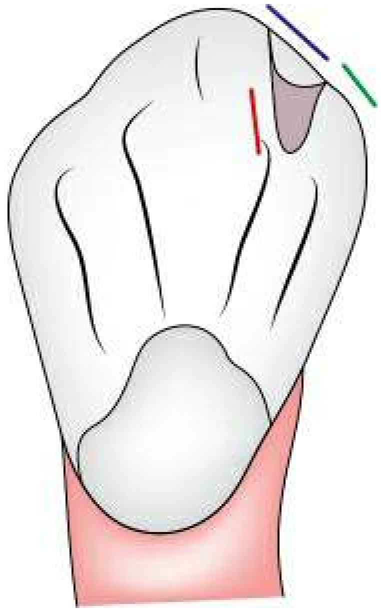


FIGURE 21.54 Dimensions of incisal rest. Depth (red line) 1.5 mm, width (blue line) 2.5 mm, distance from line angle (green line) 1.5–2 mm.

The sequence and technique of tooth preparation for all the types of rest seats is described in Chapter 25.

Direct retainers

This component engages the abutment tooth and basically prevents dislodgement of the denture or provides retention.

Definitions

Direct retainer: That component of a partial removable dental prosthesis used to retain and prevent dislodgment, consisting of a clasp assembly or precision attachment (GPT8).

Direct retention: Retention obtained in a partial removable dental prosthesis by the use of clasps or attachments that resist removal from the abutment teeth.

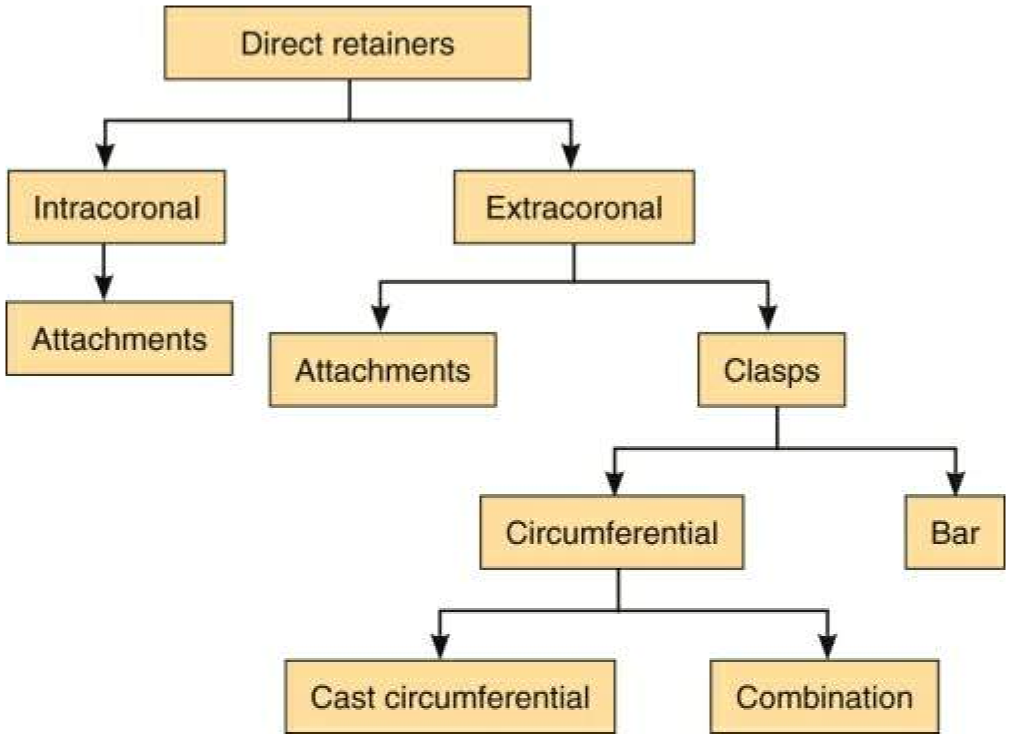
Classification

Direct retainers can be broadly classified as:

1. Intracoronal

2. Extracoronal

Depending on their placement inside (within) the abutment tooth or outside (surrounding) the abutment (Flowchart 21.1).



FLOWCHART 21.1 Classification of direct retainers

Intracoronal direct retainer

These provide retention through components placed inside (within) the normal contour of the abutment tooth.

Definition

A retainer consisting of a metal receptacle (matrix) and a closely fitting part (patrix); the matrix is usually contained within the normal or expanded contours of the crown on the abutment tooth/dental implant and the patrix is attached to a pontic or the removable dental prosthesis framework, precision attachment or internal attachment (GPT8).

Intracoronal attachments

Any prefabricated attachment for support and retention of a removable dental prosthesis. The male and female components are positioned within the normal contour of the abutment tooth (GPT8).

- These are prefabricated (manufactured) attachments positioned within the normal contour of the abutment tooth.
- These are also called ‘internal attachments’ or ‘precision attachments’.
- These were developed by Dr Herman E.S. Chayes in 1906.
- Intracoronal attachment consists of a male and female component. The female part, also called ‘matrix’, is a receptacle placed in the abutment tooth, while the male part (patrix) is an insert which is processed into the denture. The precise fitting of the patrix into the matrix creates frictional resistance to removal which contributes to retention of the prosthesis (Figs 21.55 and 21.56).
- Examples: Beyeler (Fig. 21.57), Biloc, Interlock attachments.

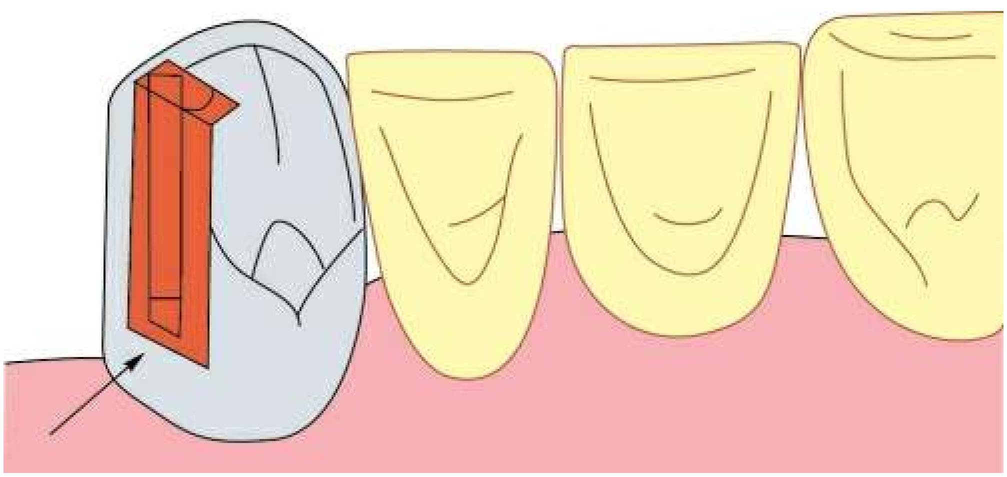


FIGURE 21.55 Placement of matrix (female part) into the abutment.

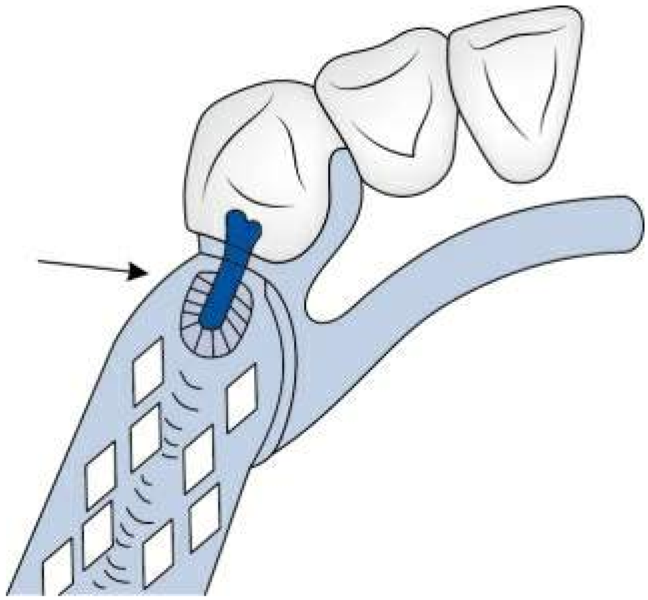


FIGURE 21.56 Patrix (male part) in denture.

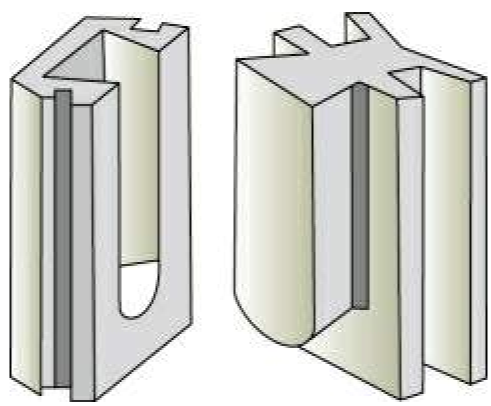


FIGURE 21.57 Beyeler intracoronal attachment. Matrix – female part on left, patrix – male part on right.

Advantages

1. Elimination of visible retentive component.

2. Elimination of visible vertical support (rest seat).

3. Provide some horizontal stabilization, but additional stabilization is

desirable.

4. Greater stimulation to underlying tissues because of intermittent vertical massage.

Disadvantages

1. Require preparation of abutment tooth and castings.

2. Complicated clinical and lab procedures.

3. Loss of retention due to wear.

4. Repair and replacement is difficult.

5. Difficult to place completely within the tooth.

6. Cost.

Contraindications

1. Presence of large pulp – related to age, placement may cause pulp exposure.

2. Short or abraded teeth – as they are prefabricated, length may be insufficient.

3. Distal extension bases – as they do not permit horizontal movement, all tipping and rotational forces are transmitted directly to abutment teeth. They require a ‘stress-breaker’ to transfer some forces to the residual ridge (discussed in Chapter 24) which also has its own limitations.

Attachments are discussed in greater detail in Chapter 47.

Extracoronal direct retainers

These provide retention through components placed outside the normal contour of the abutment tooth.

They are classified as:

1. Prefabricated attachments

2. Clasp

Extracoronal prefabricated attachments are discussed in detail in Chapter 47.

Clasps

This is the most commonly used extracoronal direct retainer. The dentures are referred to as 'clasp retained partial dentures' to differentiate them from 'attachment retained partial dentures'.

Definitions

Clasp assembly: The part of a removable dental prosthesis that acts as a direct retainer and/or stabilizer for a prosthesis by partially encompassing or contacting an abutment tooth-usage. Components of the clasp assembly include the clasp, the reciprocal clasp, the cingulum, incisal or occlusal rest and the minor connector.

Clasp: The component of the clasp assembly that engages a portion of the tooth surface and either enters an undercut for retention or remains entirely above the height of contour to act as a reciprocating element. Generally, it is used to stabilize and retain a removable dental prosthesis.

Undercut: The portion of the surface of an object that is below the height of contour in relationship to the path of placement.

Height of contour: A line encircling a tooth and designating its greatest circumference at a selected axial position determined by a dental surveyor; a line encircling a body designating its greatest circumference in a specified plane.

Characteristics

1. Operates on the principle of 'resistance of metal to deformation' by engaging an undercut (infrabulge) area of the abutment at a given path of insertion and removal for the prosthesis (Fig. 21.58).

2. Dislodging forces like sticky foods or force of gravity act perpendicular to the plane of occlusion. An undercut must be present in this position for the clasp to engage and resist dislodgement (Fig. 21.59).

3. The basis of clasp retention originated from 'Prothero cone theory' in 1916. He described the crown shape of posterior teeth to be like two cones sharing a common base. The part of the clasp that ends on the cervical cone would resist movement in an occlusal direction as it would be forced to deform to come out of the undercut (Fig. 21.60). The degree of resistance to deformation determines the clasp retention.

4. The line at which the two cones meet is called *height of contour* – coined by Kennedy. The height of contour will change if the vertical position of the tooth changes, similar to tipping or tilting a cast.

5. Devan (1955) referred to the surface occlusal to the height of contour as *suprabulge* area, and the surface below as *infrabulge*.

6. Clasps can be of two types:

i. Circumferential or Akers' clasp – approaches an undercut occlusally

a. Cast circumferential clasp – all components are made up of cast alloy (Fig. 21.61).

b. Combination clasp – retentive arm only is made of wrought alloy, rest of the clasp is made of cast alloy.

ii. Vertical projection or bar or roach clasps – approach the undercut gingivally (Fig. 21.62).

These are discussed in detail in the coming sections.

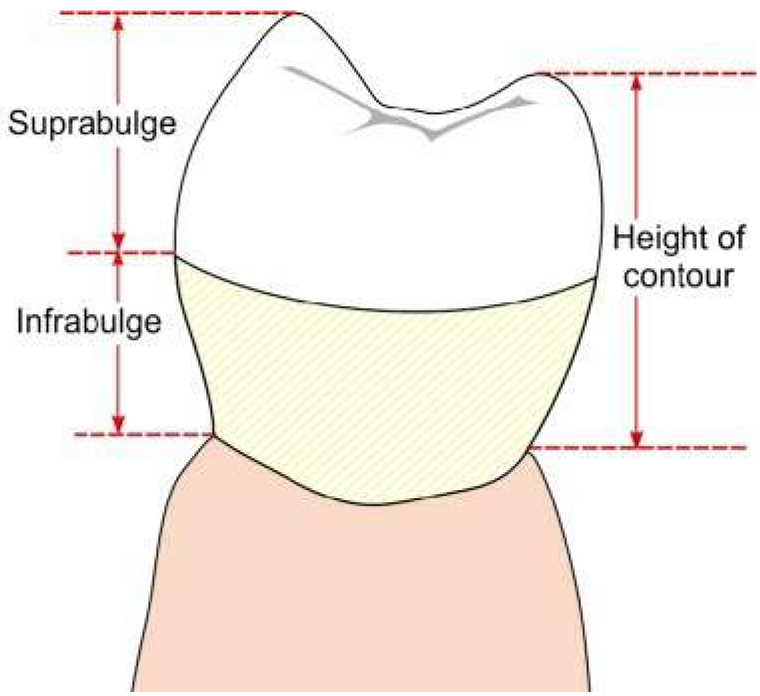


FIGURE 21.58 Principle of clasp retention.

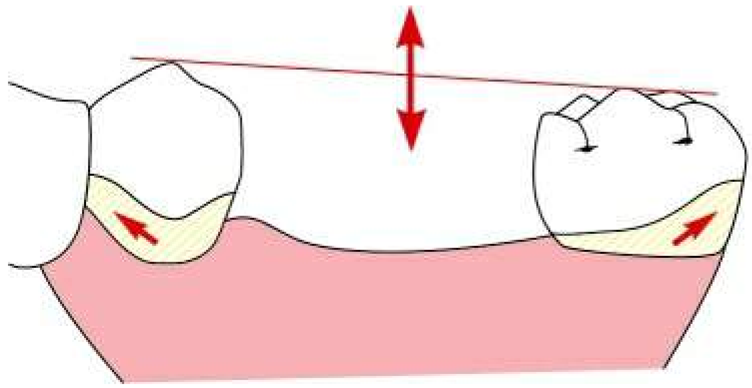


FIGURE 21.59 Dislodging forces like sticky foods or force of gravity act perpendicular to the plane of occlusion. An undercut must be present in this position for the clasp to engage and resist dislodgement.

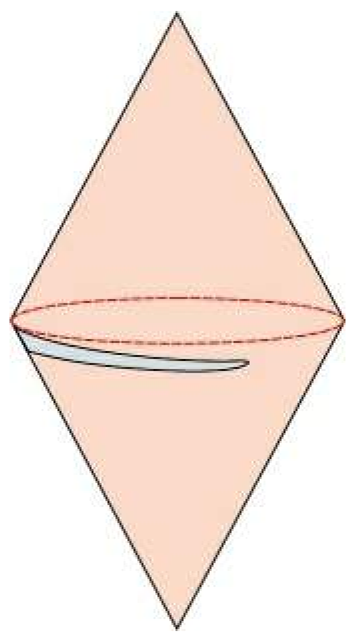


FIGURE 21.60 Prothero cone theory.

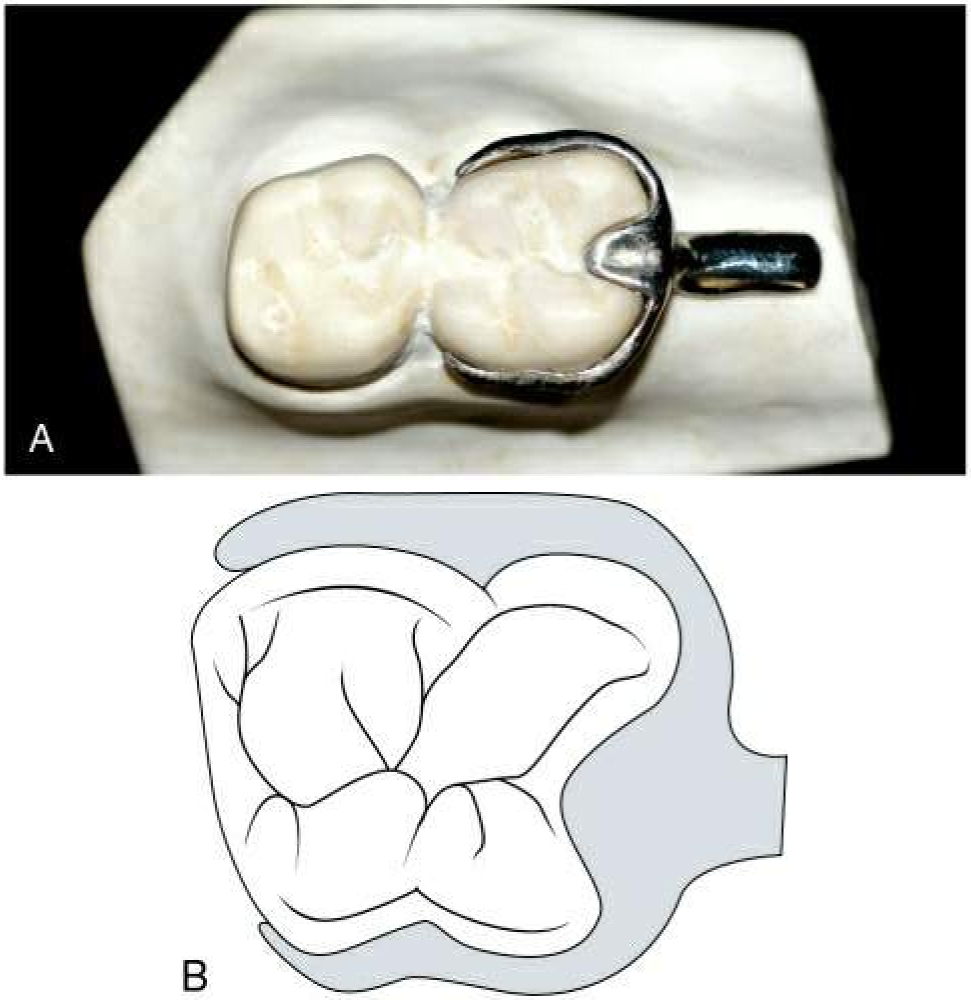


FIGURE 21.61A, B Circumferential clasp.

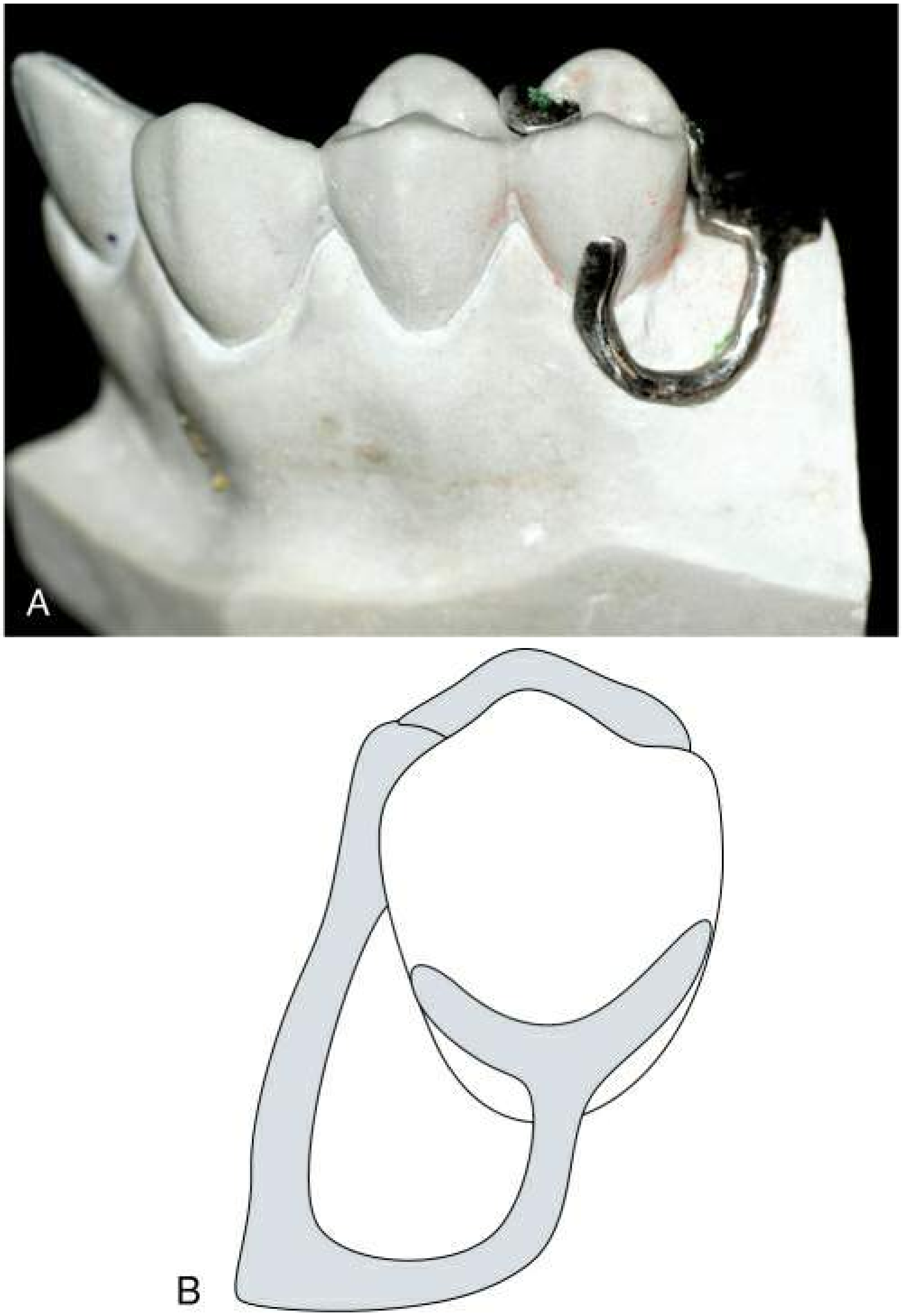


FIGURE 21.62A, B Bar clasp.

Component parts of a clasp assembly

1. Rest

2. Retentive arm:

   i. Retentive terminal

   ii. Body

   iii. Shoulder

3. Reciprocal arm

4. Minor connector

1. Rest

Provides vertical support or prevents tissue ward movement of the prosthesis. This ensures that the retentive tip of the clasp remains in the planned depth of undercut (Fig. 21.63). Rests were discussed in detail in the previous section.

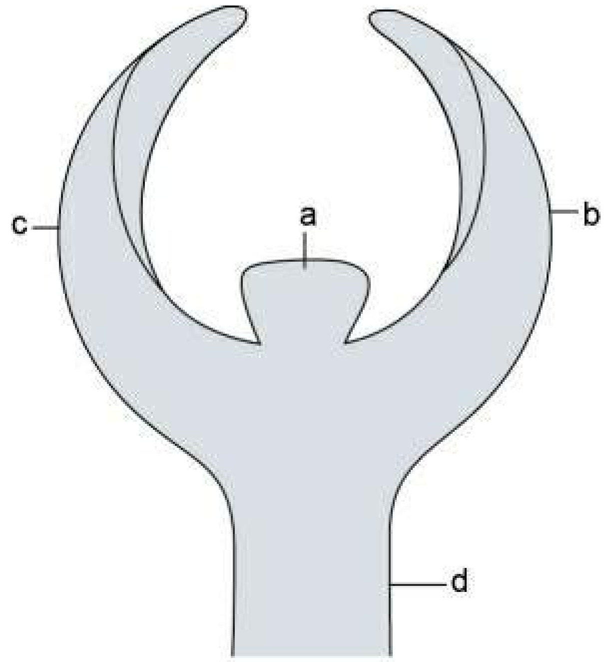


FIGURE 21.63 Component parts of a clasp assembly: (A) rest, (B) retentive arm, (C) reciprocal arm and (D) minor connector.

2. Retentive arm

Part of clasp assembly (Fig. 21.63) comprising of three parts – the terminal third (retentive terminal) is flexible and engages the undercut area, middle third (shoulder) which has limited flexibility and may engage minimal undercut and the proximal third or body, which is not flexible and is placed above the height of the contour.

i. Retentive terminal

This is the distal third of the retentive arm (Fig. 21.66). It is the only component that is placed below the height of the contour; hence, it is also the only flexible component.

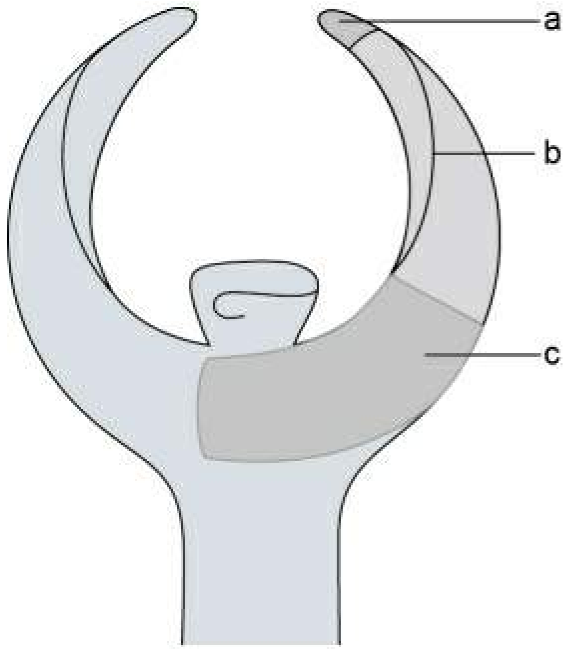


FIGURE 21.66 Parts of the retentive arm: (A) Retentive terminal, (B) shoulder, (C) body.

ii. Body

The body connects the rest and shoulder to the minor connector (Fig. 21.66). It contacts the guide plane during insertion and removal of denture.

iii. Shoulder

It connects the body to the clasp terminal (Fig. 21.66). Also provides some stabilization against horizontal forces.

3. Reciprocal arm

Clasp arm is placed above the height of the contour on the surface of the tooth opposing the retentive arm (Figs 21.63 and 21.64). It resists lateral forces exerted by retentive terminal as it passes over the height of the contour during removal and insertion of the partial denture. To perform this function, it should contact the tooth before the retentive arm does and should remain in contact till the retentive terminal passes over the height of the contour into the undercut (Fig. 21.65). It has the following functions:

i. Reciprocation against action of retentive terminal.

ii. Stabilization against horizontal forces.

iii. Contributes also to vertical support and indirect retention.

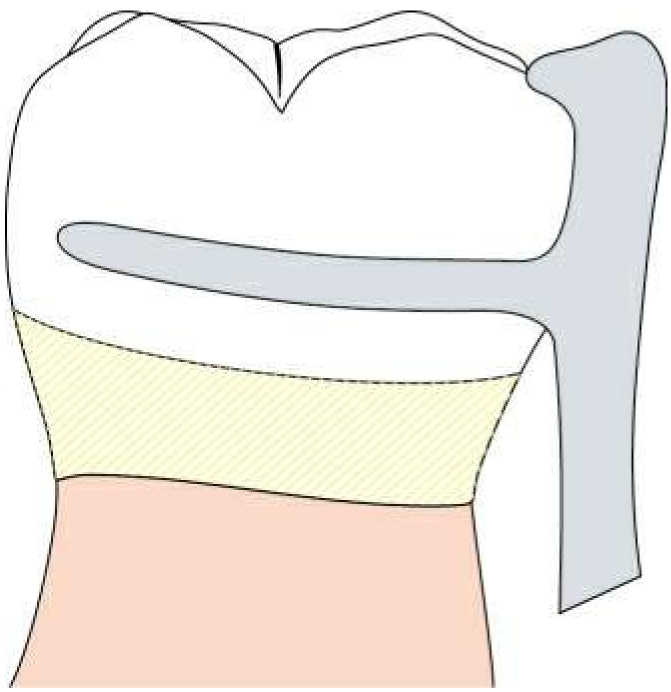


FIGURE 21.64 Reciprocal arm should be positioned above the height of contour.

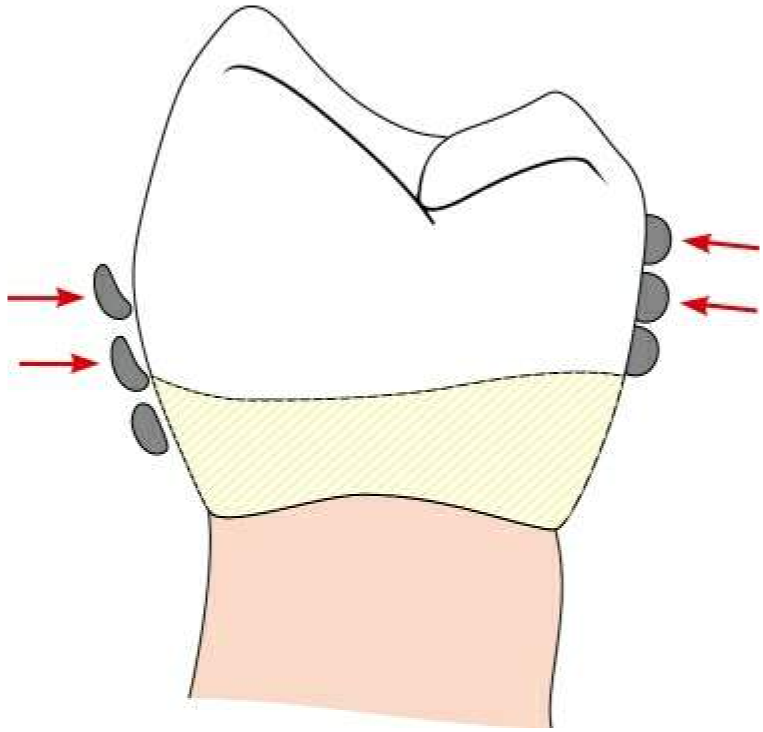


FIGURE 21.65 Reciprocal arm should contact the tooth before the retentive terminal passes into the undercut.

Features

- It should be rigid and not tapered.
- Should be positioned on a tooth surface reasonably parallel to the denture's path of insertion.
- Placed at the junction of gingival and middle thirds of the tooth above but as close to the height of contour as possible.
- If the height of the contour is present in occlusal third of tooth and cannot be changed by reshaping, a lingual plate will provide a better reciprocation.

4. Minor connector

Minor connector joins the body to the remaining part of the framework (Fig. 21.67). In the gingivally approaching clasp, it is called 'approach arm' (Fig. 21.68). It has been discussed in this chapter under section 'Minor Connectors'.

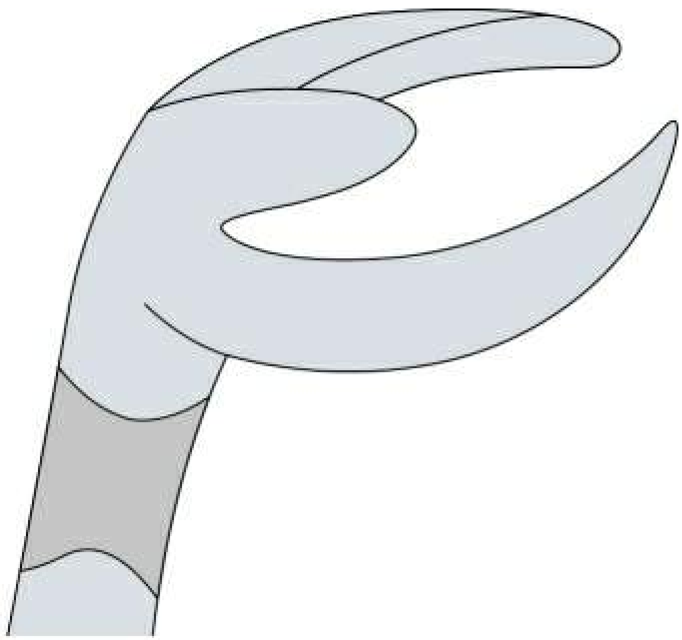


FIGURE 21.67 Minor connector of circumferential clasp.

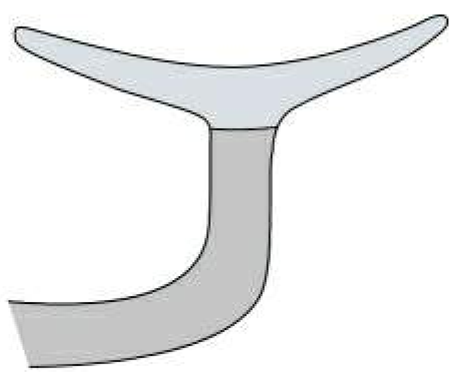


FIGURE 21.68 Minor connector (approach arm) of bar clasp.

Requirements of clasps

All clasps must be designed to satisfy the following six functional requirements:

1. Retention

2. Stability

3. Support

4. Reciprocation

5. Encirclement

6. Passivity

1. Retention

Definition: Retention is the quality inherent in denture that resists the vertical forces of dislodgement. Example: forces of gravity, the adhesiveness of foods or the forces associated with the opening of the jaws.

The most important function of the clasp is to provide retention to the prosthesis. Retentive arm of the clasp assembly provides retention.

Factors affecting retention

Amount of retention provided by the clasp depends on:

i. *Dimension of retentive undercut*

Retentive undercut has three dimensions:

a. **Buccolingual depth:** It is measured by the undercut gauge of surveyor and is called *angle of gingival (cervical) convergence*. It is the angle formed by the tooth surface below the height of the contour with the vertical plane, when the occlusal surface of the tooth is oriented parallel to the horizontal plane (Fig. 21.69). The lesser this angle, the greater the distance between the height of the contour and retentive tip to achieve same amount of retention.

b. **Distance between survey line (height of contour) and retentive tip:** It affects the clasp arm length which in turn affects flexibility (Fig. 21.70). This factor may not be important practically.

c. **Mesiodistal length:** The longer is mesiodistal length more flexible will be clasp and more important is buccolingual dimension (Fig. 21.71).

ii. *Flexibility of clasp arm*

Flexibility of clasp arm depends on the following factors:

a. **Length of clasp:** Greater the length of the clasp greater is the flexibility as the flexure is directly proportional to the cube of length (Fig. 21.72). To achieve this, a clasp should engage the undercut in a curved manner rather than a straight line. Increasing the flexibility also reduces the stresses transmitted to abutment by retentive tip, but flexibility should also be not so great that the clasp's retentive capability is lost.

b. **Diameter of clasp:** Flexibility is inversely proportional to the diameter. A uniform taper in thickness and width is essential. It should be half as thick at the tip as at the origin (Fig. 21.73).

c. **Cross-sectional form:** A clasp that is round in cross-section has greater flexibility than a half round as it flexes in all planes. Hence, a wrought wire clasp (round) clasp will have greater flexibility than a cast clasp.

d. **Clasp material:** Chrome alloys have a higher modulus of elasticity than gold alloys and are therefore less flexible. Wrought wire (combination clasp) has best flexibility. To obtain the same degree of retention, a chrome alloy should engage 0.010 inch undercut, whereas the gold alloy should engage 0.015 inch and wrought wire engages 0.020 inch undercut.

iii. *Type of clasp*

Gingivally approaching clasp produces better retention (push type) than occlusally approaching (pull type) clasps.

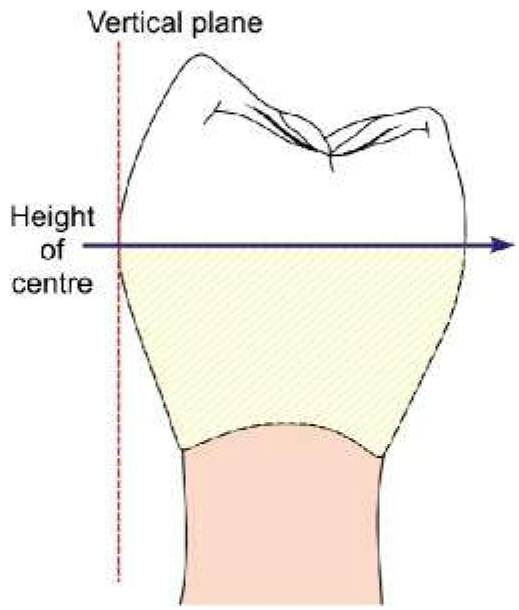


FIGURE 21.69 Angle of gingival (cervical) convergence determines the buccolingual dimension of the retentive undercut.

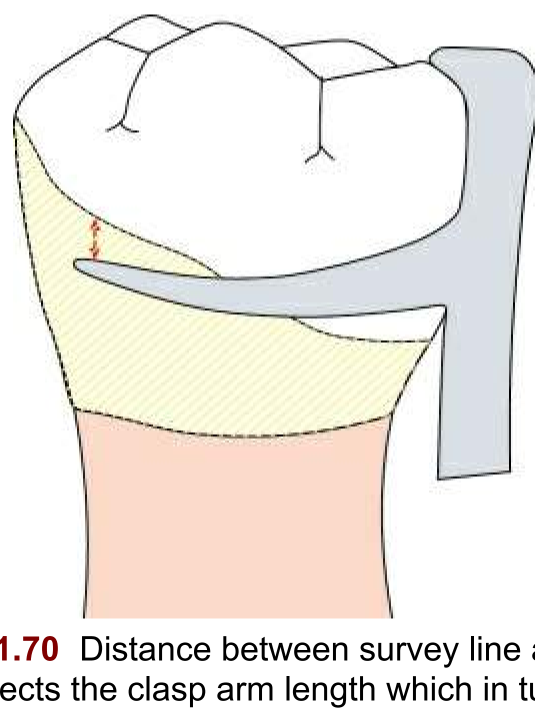


FIGURE 21.70 Distance between survey line and retentive tip. It affects the clasp arm length which in turn affects flexibility.

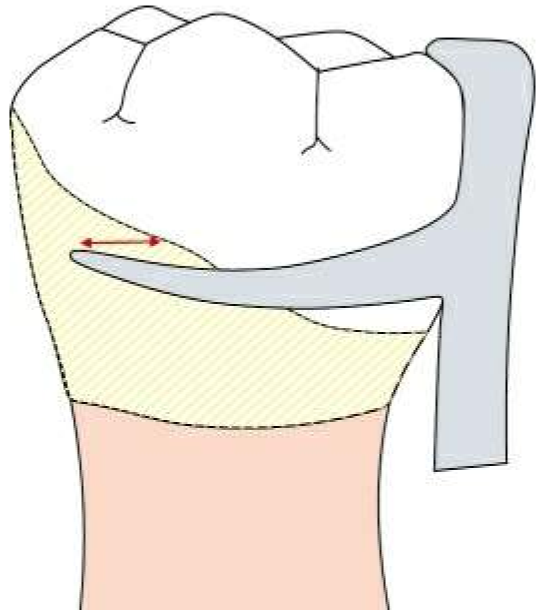


FIGURE 21.71 Mesiodistal length. The longer this length, more flexible will be the clasp.

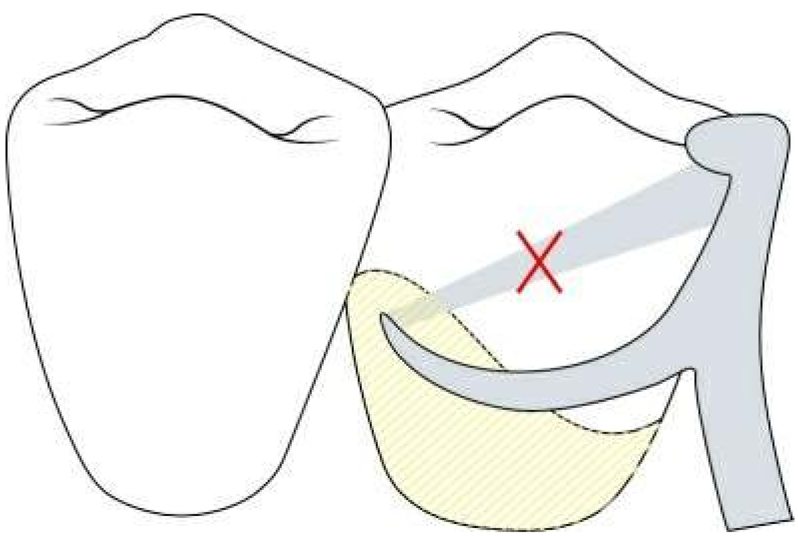


FIGURE 21.72 Length of clasp.

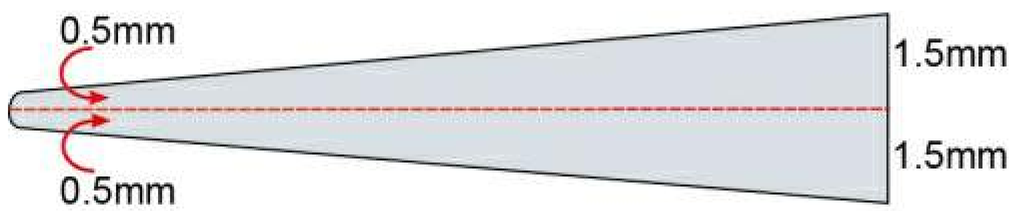


FIGURE 21.73 Diameter of clasp – the clasp should be half as thick at tip compared to the origin.

2. Stability

Definition: The quality of the prosthesis to be firm, stable or constant and to resist displacement by functional, horizontal or rotational stresses.

- All clasp components except retentive terminal contributes to this.
- Cast circumferential clasp with its rigid shoulder provides greatest stability compared to combination clasp (wrought wire) and bar clasp (no shoulder).

3. Support

Definition: The resistance to displacement of prosthesis towards the basal tissue or underlying structures.

Provided by the occlusal, lingual or incisal rests.

4. Reciprocation

Definition: The mechanism by which lateral forces are generated by a retentive arm passing over a height of contour is counterbalanced by a reciprocal arm passing along a reciprocal guiding plane.

It is described in the section on ‘reciprocal arm’.

5. Encirclement

Definition: Property of the clasp assembly to encompass more than 180° of the abutment tooth either by continuous or broken contact to prevent dislodgement during function.

• Continuous contact provided by circumferential clasp (Fig. 21.74).

• Broken contact provided by bar clasp – here clasp assembly must contact at least three different tooth areas – retentive terminal, occlusal rest and reciprocal terminal (Fig. 21.74).

• Also prevents tooth from moving out of the confines of the clasp assembly during function.

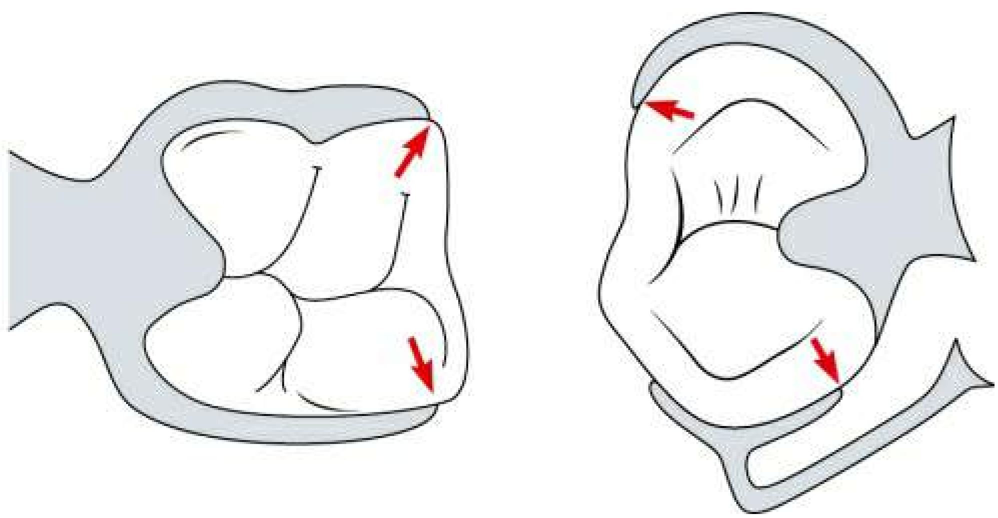


FIGURE 21.74 Encirclement of clasp: Left – circumferential clasp provides continuous contact of greater than 180°. Right – bar clasp provides broken contact of 180°.

6. Passivity

Definition: The quality or condition of inactivity or rest assumed by the teeth, tissues and denture when a removable dental prosthesis is in place but not under masticatory pressure.

• Retentive function of clasp should be activated only when dislodging forces are applied. At all other times, the clasp should be completely passive.

• If clasp is not seated completely, retentive terminal cannot reach undercut depth as planned and a constant force is applied on the tooth, producing pain.

Types of clasps

1. *Circumferential clasp*

Definition: A retainer that encircles a tooth by more than 180°, including opposite angles, and which generally contacts the tooth throughout the extent of the clasp, with at least one terminal located in an undercut.

Its basic form consists of a buccal (retentive) and lingual (reciprocal) arm arising from a common body and engages a tooth undercut from an occlusal direction.

It has a 'pull type' retention compared to 'push type' retention of bar clasps.

I. Cast circumferential clasp

- It is also called Akers' clasp.
- All components of the clasp assembly are made of cast alloy.
- Retentive terminal should originate above height of contour and terminate below it.
- Retentive terminal should point towards the occlusal surface, never towards gingival (Fig. 21.75).
- The retentive tip should only terminate in mesial or distal line angle of the tooth, never in the middle of facial or lingual surface (Fig. 21.76).
- Clasp arm should be kept as low as possible to gain mechanical advantage against any lever action on tooth (Fig. 21.77).

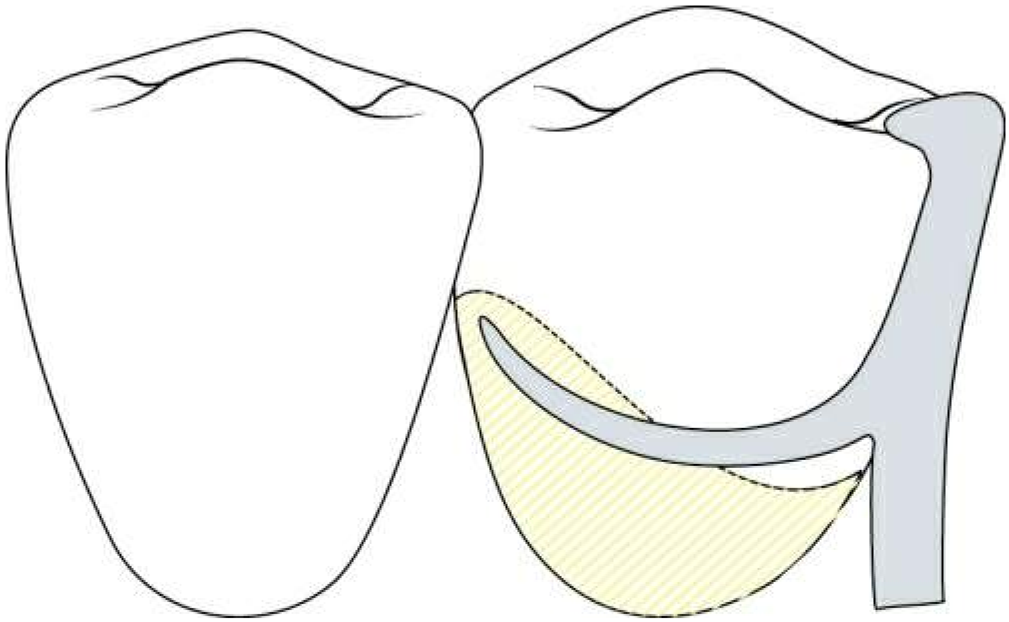


FIGURE 21.75 Retentive tip should point occlusally.

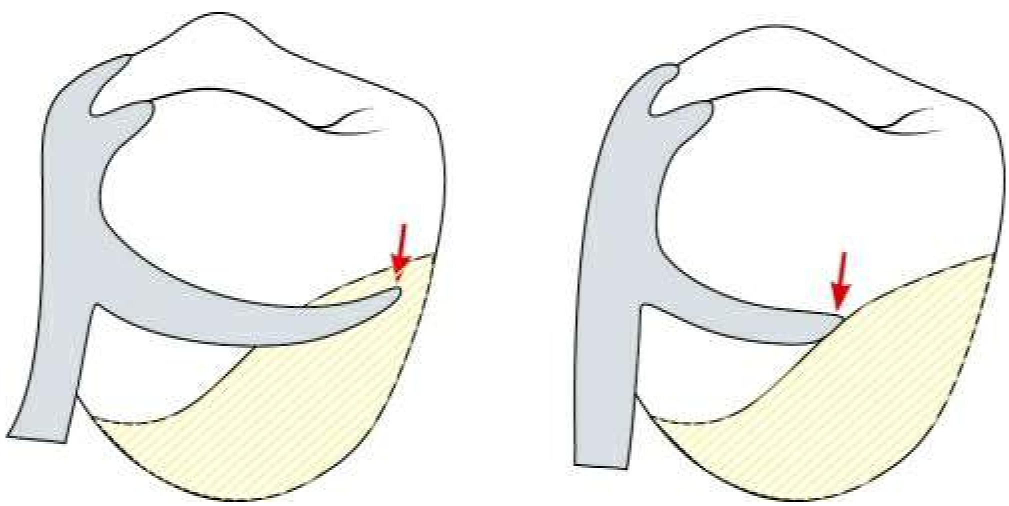


FIGURE 21.76 Retentive tip should not end in middle of the tooth (Right). It should end near the proximal line angle (left).

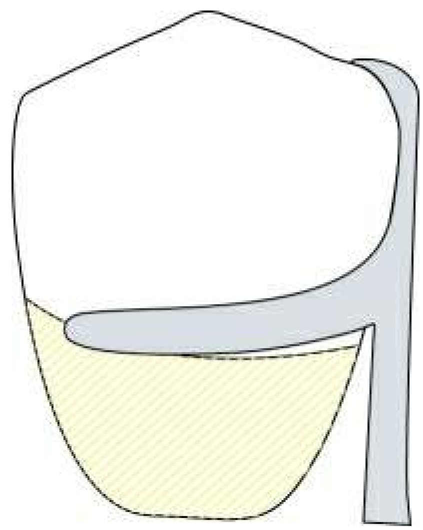


FIGURE 21.77 More effort is required to exert lever like forces on abutment if clasp is placed low.

Advantages

1. Easiest to design, construct and repair.

2. Excellent support, bracing and retentive qualities.

3. Most logical choice for tooth-supported removable partial dentures.

4. Causes less food retention.

5. Many types available so can be used in most situations.

Disadvantages

1. More coverage of tooth surface which may lead to decalcification and/or caries of enamel.

2. Alters the morphology of abutment which affects normal food flow pattern and can lead to damage of gingival tissues due to lack of physiologic stimulation.

3. If positioned high on abutment, they can increase the width of

occlusal table which can cause greater occlusal forces to be exerted on tooth.

4. Difficult to adjust with pliers as with all cast clasps (half round) as they can be adjusted only in one plane.

Types of cast circumferential clasps

The following are the various types of cast circumferential clasps. The common features, advantages and disadvantages are applicable to all. The specific features are discussed here.

1. Simple circlet clasp

- Most versatile and widely used.
- Approaches the tooth undercut from the edentulous area and engages the undercut remote from the edentulous space (Figs 21.78 and 21.61).
- Clasp of choice for tooth-supported (class III) removable partial dentures.
- Contraindicated for distal extension partial dentures as it can only engage mesiobuccal undercut.

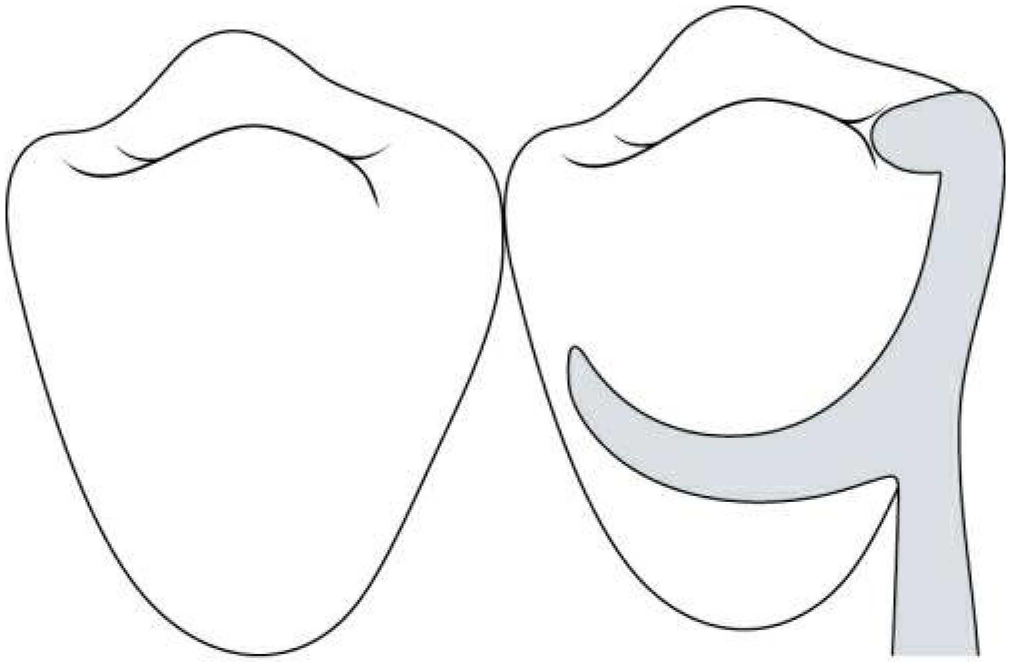


FIGURE 21.78 Simple circlet clasp.

2. Reverse circlet clasp

- Engages the undercut adjacent to edentulous space (distobuccal) by approaching from mesioocclusal rest (Fig. 21.79).
- Indicated for distal extension situations when bar clasp is contraindicated. In distal extensions it will move further into undercut when a force is applied on the denture base just like bar clasp and when dislodging forces (sticky food) are applied, it engages the undercut and denture is retained.

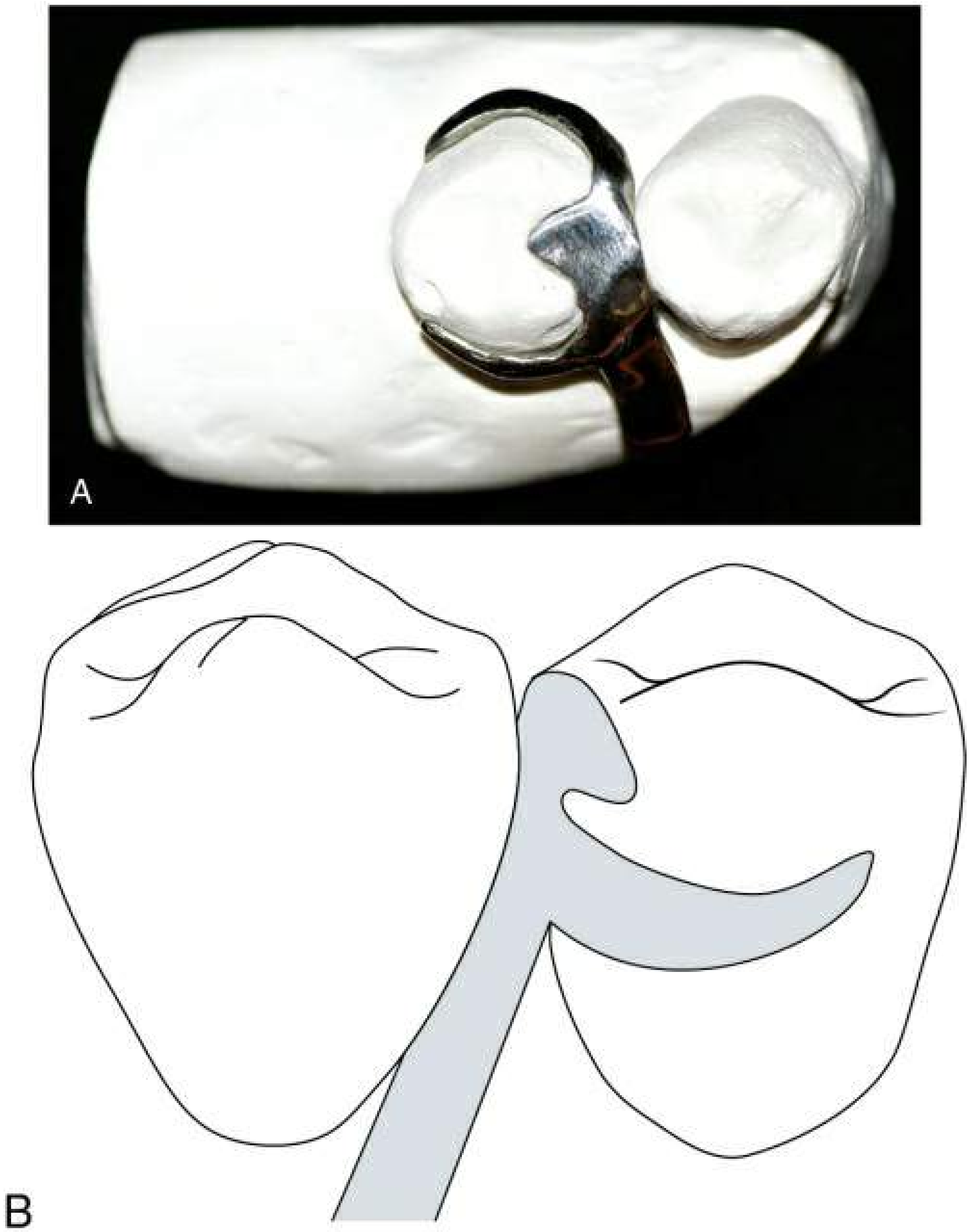


FIGURE 21.79A, B Reverse circlet clasp.

Disadvantages

1. Poor aesthetics as clasp runs from mesial to distal side of facial surface, hence is not the choice in premolars.

2. Obtaining sufficient clearance for the rest to be placed between teeth is difficult.

3. To protect the marginal ridge, an additional rest must be placed adjacent to edentulous space, which will decrease the releasing action of the clasp tip.

4. Wedging may occur between the abutment and adjacent tooth, if occlusal rest is not well prepared.

3. Multiple circlet clasp

- This is a combination of two opposing simple circlet clasps joined at terminal end of reciprocal arms (Fig. 21.80).
- When principal abutment has lost some of its periodontal support, this clasp is used to share retention responsibilities among other teeth.
- It is used in periodontally compromised abutment teeth in distal extension situations.

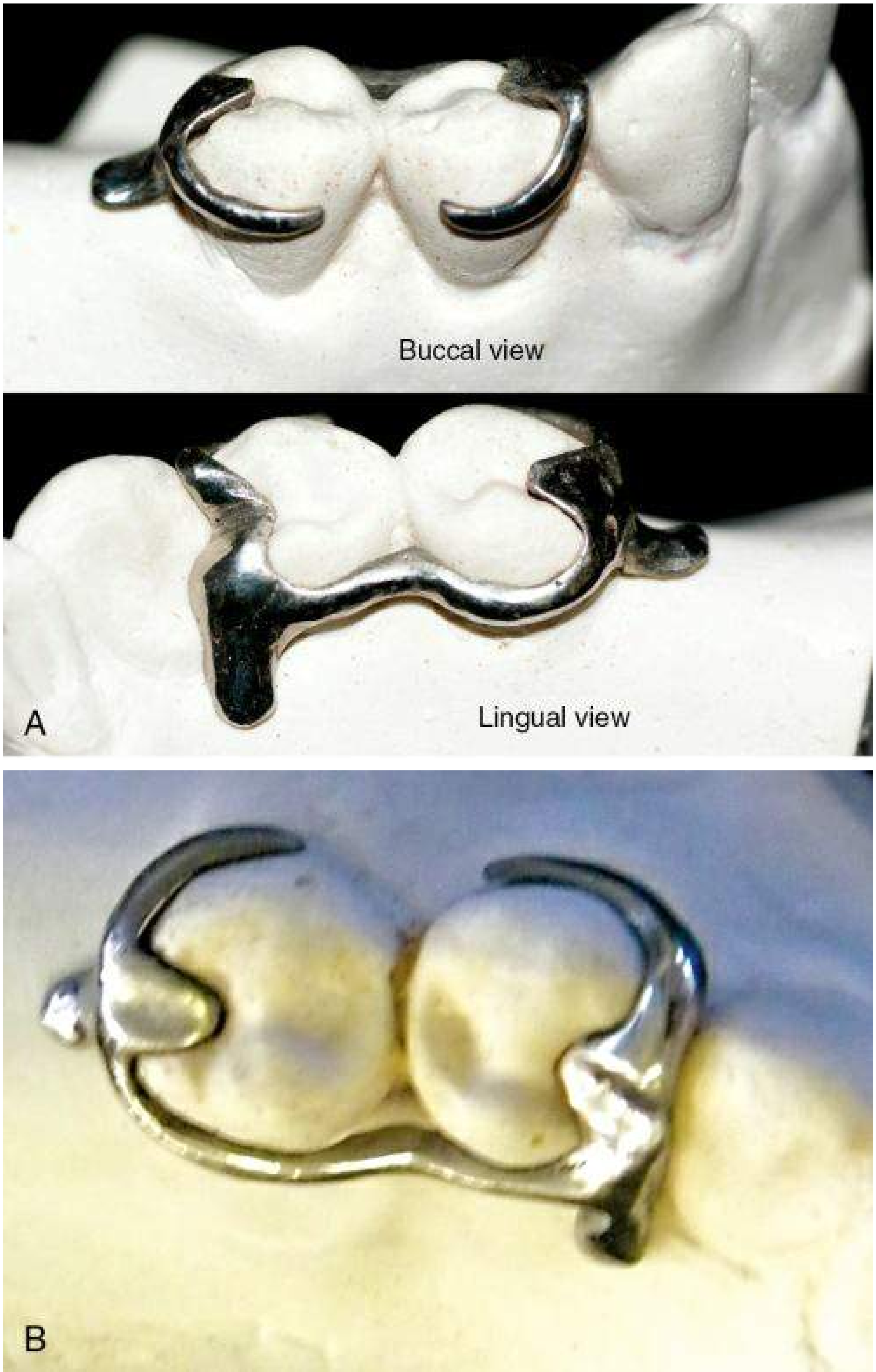
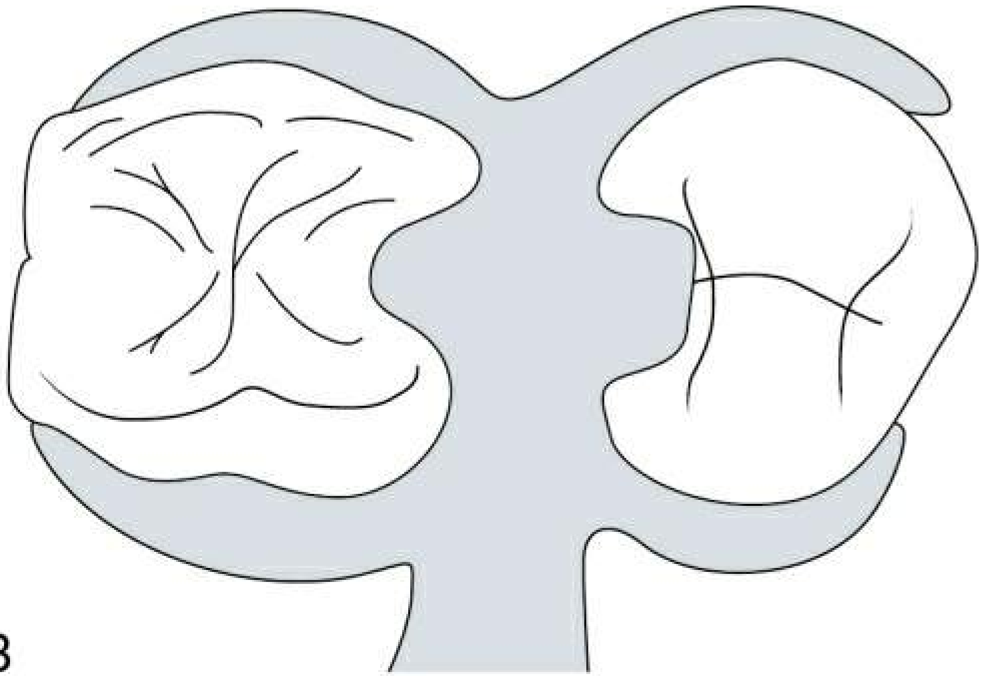


FIGURE 21.80A, B Multiple circlet clasp. Axial and occlusal views.

4. Embrasure clasp or modified crib clasp

- Two simple circlet clasps joined at the body (Fig. 21.81).
- Used on the side of the arch where there is no edentulous space.
- It is indicated in Kennedy's class II and class III without any modifications. As this is a mechanical disadvantage, embrasure clasp is used to make the design bilateral by providing cross arch stabilization.
- It crosses both marginal ridges and engages undercut on opposing line angles. The occlusal rest must be prepared on both the adjacent teeth and buccal inclination of cusp is reduced to get the required strength and rigidity for the clasp.
- If tooth preparation is insufficient, breakage of clasp is common.



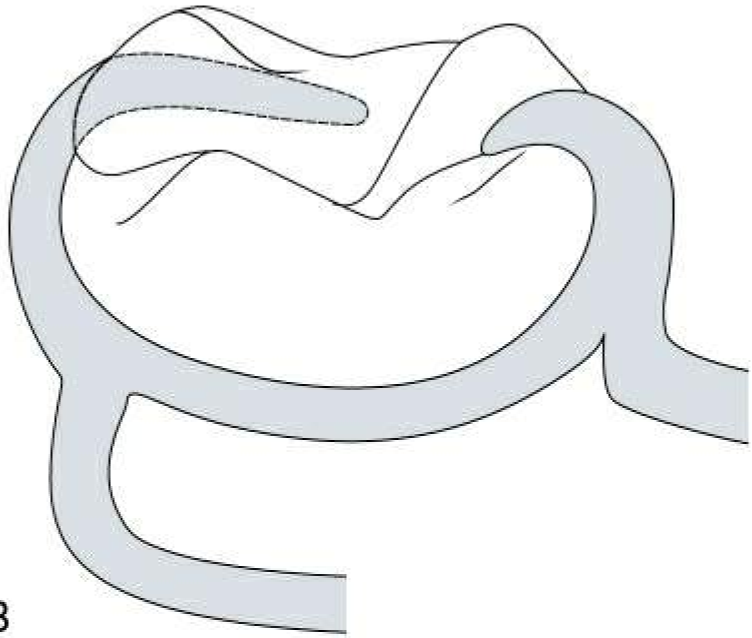
B

FIGURE 21.81A, B Embrasure clasp.

5. Ring clasp

- It starts on the opposite side of the undercut adjacent to edentulous space and engages the undercut by encircling the entire tooth almost from its origin. The retentive arm is an extension of reciprocal arm (Fig. 21.82).
- Indicated on tipped molars where undercut is present adjacent to edentulous space. Mandibular molars tip mesiolingually and maxillary molars tip mesiobuccally. Hence, the clasp engages mesiolingual undercut on mandibular molars and mesiobuccal undercut on maxillary molars.
- Because of great length of the clasp, it is usually supported by an auxiliary bracing arm from the minor connector of denture base to the centre of reciprocal arm. This is essential for proper reciprocation and stabilization.

- An auxiliary occlusal rest on the opposite side prevents further tipping of the molar.



B

FIGURE 21.82A, B Ring clasp.

Contraindications

- Buccinator attachment lies close to mandibular molar such that auxiliary bracing arm encroaches on it.
- Bracing arm will have to cross a soft tissue undercut.

6. Back action clasp

- It is a modification of ring clasp.
- Minor connector is attached to the clasp arm on the lingual surface unlike other clasps where the minor connectors are attached to the occlusal rest (Fig. 21.83). If placed on the buccal surface, it is called reverse back action clasp.
- Indicated in Kennedy's class I and class II where only a mesiobuccal undercut is present.
- Its use is not justified as lack of support to occlusal rest can make it

ineffective.

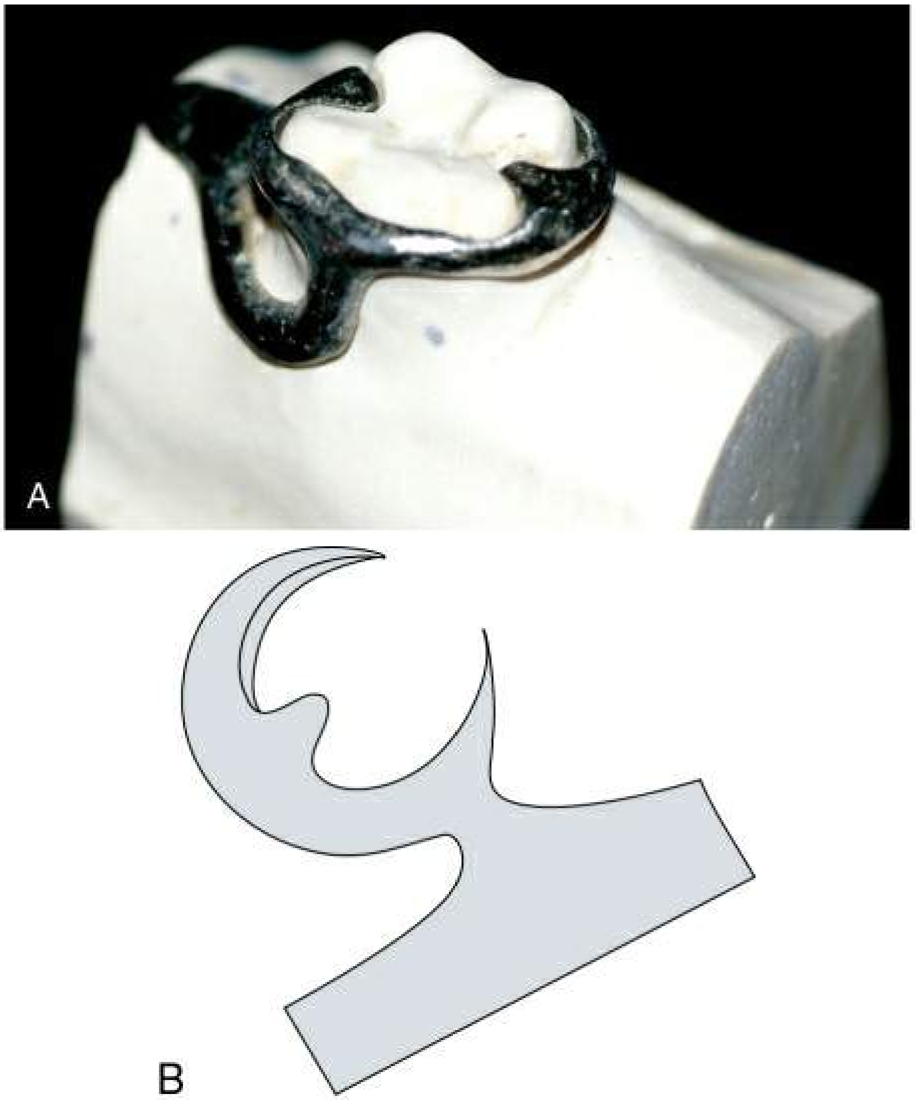


FIGURE 21.83A, B Back action clasp.

7. Fish hook or hairpin clasp

- This ‘C’ clasp is essentially a simple circlet clasp where the retentive arm, after crossing the facial surface, loops back in a hairpin turn to engage the proximal undercut below its point of origin (Fig. 21.84).

- The upper retentive arm is rigid, while the lower part is flexible and tapered because it engages the undercut.
- The abutment should have sufficient crown height to accommodate the two arms. There should also be sufficient space between the arms for finishing and polishing and to prevent food accumulation.
- It is indicated in distal extension base abutments where distobuccal undercut is present, and bar clasp and reverse circlet clasp are contraindicated, because of soft tissue undercut and lack of occlusal space, respectively.

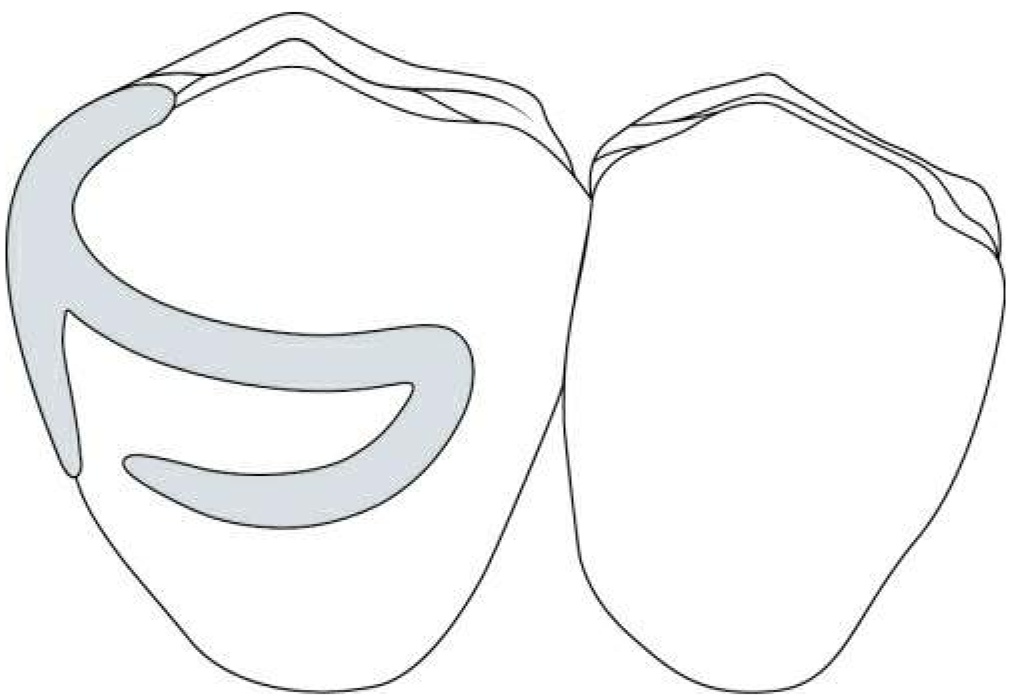


FIGURE 21.84 Hairpin clasp.

Disadvantages

- Can trap food and cause tooth decay.
- Poor aesthetics.

8. Onlay clasp

- It is an extension of occlusal rest with buccal and lingual clasp arms (Fig. 21.85).
- Indicated when occlusal surface of abutments is below occlusal plane and the onlay will restore the same.
- As it covers a large amount of tooth, it may lead to enamel breakdown. Hence, used only in caries free mouth and alloy of choice is gold alloy (margins can be burnished).
- Metal occlusal surfaces can be lined with tooth coloured acrylic resin to reduce the wear of opposing teeth.

FIGURE 21.85A, B Onlay clasp.

9. Half and half clasp

It consists of a circumferential retentive arm arising from one direction and reciprocal arm arising from another. Since second arm must arise from a second minor connector, this could be a bar clasp with or without an auxiliary rest (Fig. 21.86).

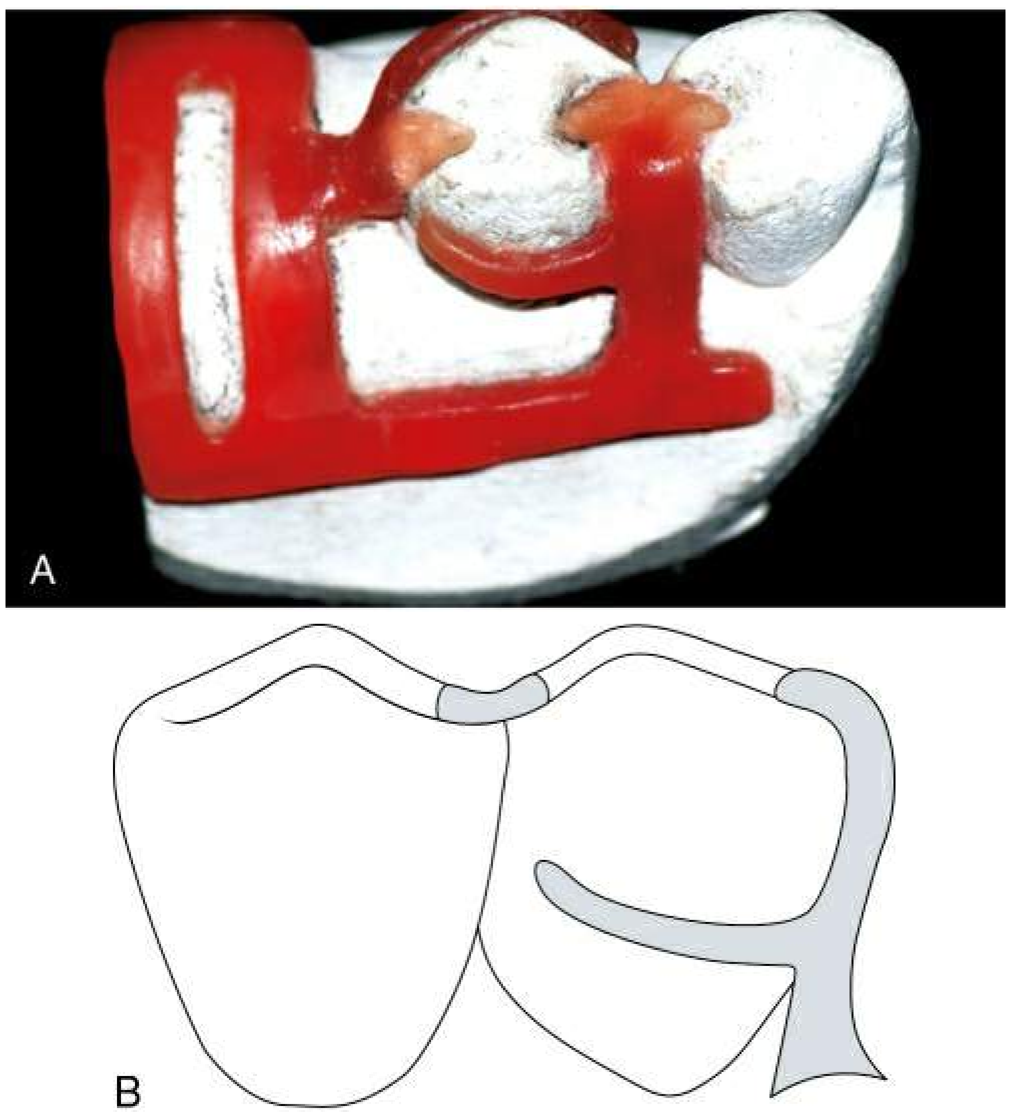


FIGURE 21.86A, B Half and half clasp.

It is originally intended to produce dual retention in unilateral dentures.

II. Combination clasp

Definition: A circumferential retainer for a removable dental prosthesis that has a cast reciprocal arm and a wrought wire retentive clasp (GPT8).

It consists of a wrought wire retentive arm and a cast reciprocal arm (Fig. 21.87). The combination of a wrought alloy and cast alloy gives it the name 'combination clasp'. In fact all other parts of the denture framework are made of cast alloy except the retentive arm.

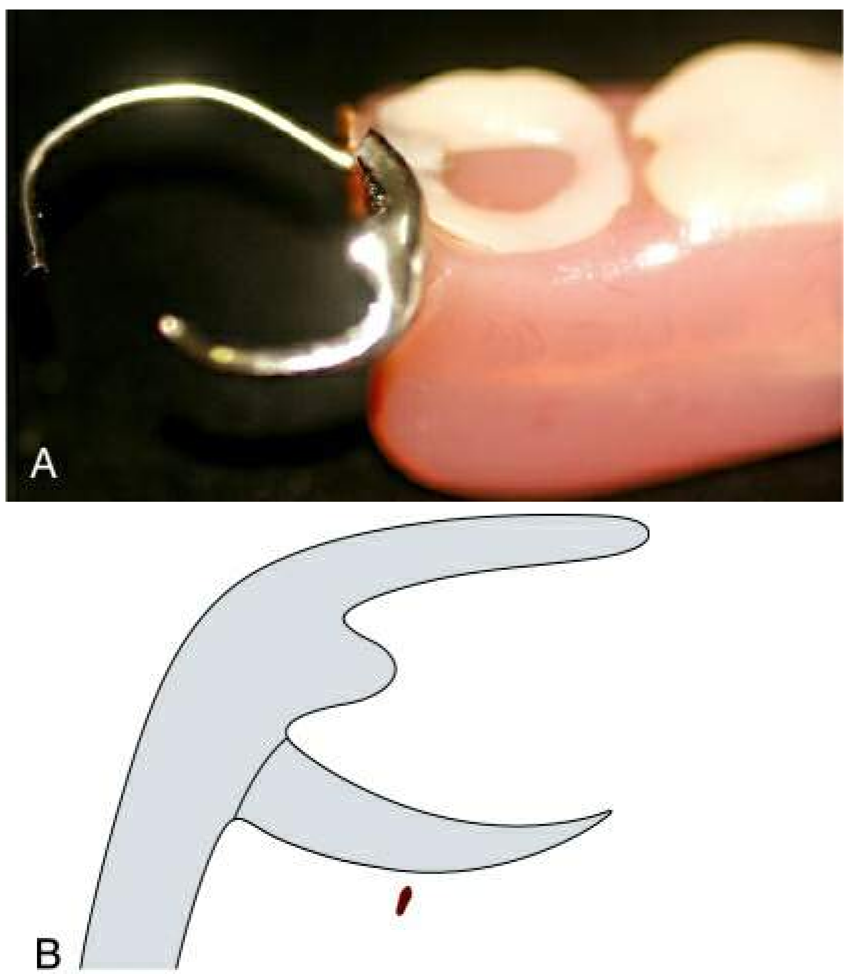


FIGURE 21.87A, B Combination clasp – wrought retentive

arm and cast reciprocal arm.

The wrought wire can flex in all three planes and has greater flexibility than a cast arm.

It is indicated on an abutment adjacent to a distal extension base where a mesiobuccal undercut is present. A simple circlet clasp or bar clasp should never be used to engage this undercut in distal extension situations as any downward (masticatory) force on the denture base will make the retentive terminal come out of undercut and create excessive stresses on the abutment. The use of flexible wrought wire clasp will help dissipate this functional stress better.

The wrought wire can be incorporated into the framework of low-heat alloys during the waxing procedure or can be soldered to the completed framework of high-heat alloys.

Advantages

1. Good flexibility – helps dissipate stresses on abutment.

2. Easy to adjust the clasp as it can flex in all planes.

3. More aesthetically acceptable as it can be placed in gingival third of facial surface – can be used in premolars and canines.

4. Makes only a line contact with tooth surface and hence collects less food and is easy to maintain.

Disadvantages

1. Extra lab procedures.

2. Can be easily distorted by careless handling.

3. Poor resistance to horizontal stabilization.

2. Bar clasp

Definition: A clasp retainer whose body extends from a major connector or denture base, passing adjacent to the soft tissues and approaching the tooth from a gingivo-occlusal direction (GPT8).

It is also called vertical projection, Roach and gingivally approaching clasp.

Arises from denture base minor connector and approaches the undercut from a gingival direction resulting in 'push type' retention (Fig. 21.88). This is more effective than the 'pull type' retention of circumferential clasp.

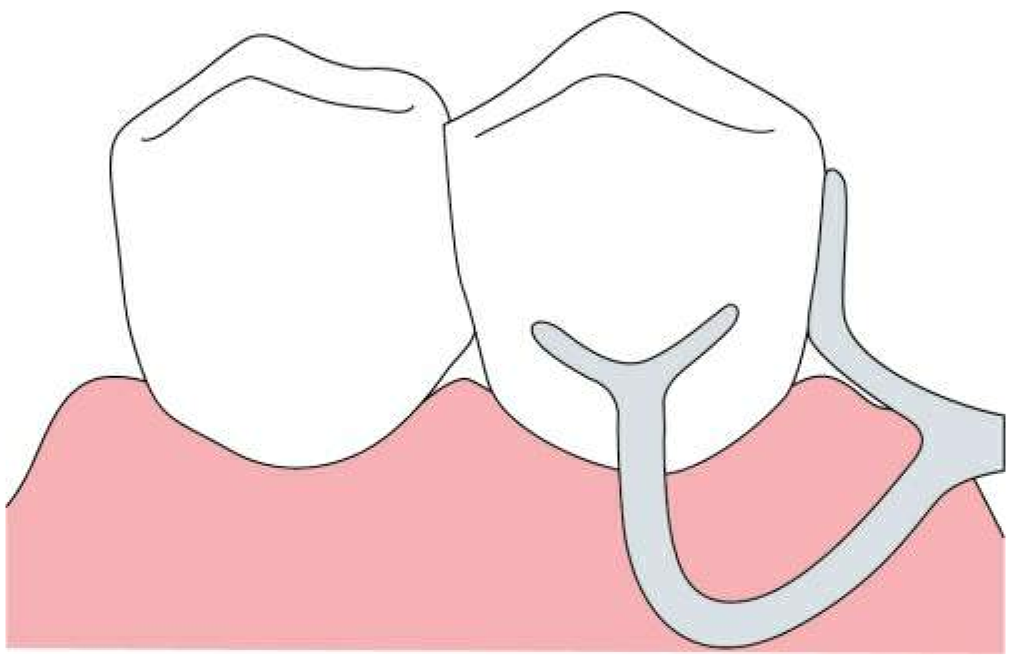


FIGURE 21.88 Bar clasp.

The retentive terminal is connected to denture base minor connector by the 'approach arm'. Both these have already been discussed in the section on 'Minor Connectors' in this Chapter.

Flexibility of the clasp can be controlled by the taper and length of approach arm.

Indications

1. Small undercut (0.01 inch) existing in cervical third of abutment (Fig. 21.89).

2. Distal extension abutments to engage a distobuccal (adjacent to edentulous space) undercut.

3. Most tooth-supported partial dentures including modification spaces where aesthetics is a concern.

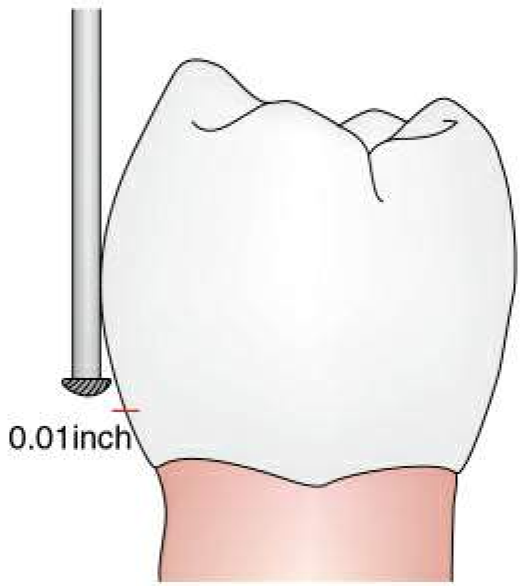


FIGURE 21.89 Indication for bar clasp – small undercut (0.01 inch) existing in cervical third of abutment.

Contraindications (fig. 21.90)

1. Severe tissue undercut.

2. Deep cervical undercut in abutment.

3. Severe buccal or lingual tilt of abutment.

4. Shallow vestibule.

5. Never used to engage mesiobuccal undercut of abutment.

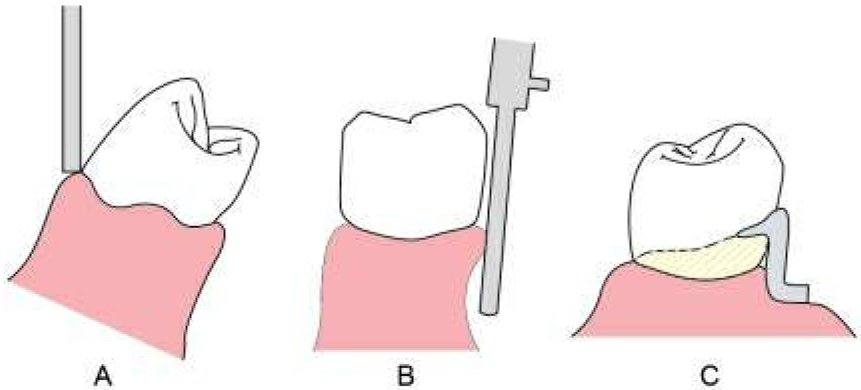


FIGURE 21.90 Contraindications of bar clasp: **(A)** Tilted abutment, **(B)** soft tissue undercut, and **(C)** shallow vestibule.

Advantages

1. Easy to insert and difficult to remove.

2. It is more aesthetic because of its gingival approach.

3. Variety of bar clasps gives it a wide range of adaptability.

Disadvantages

1. Tends to collect food.

2. Contributes less to bracing and stabilization because of its flexibility.

Design considerations

1. Tissue side of approach arm should be smooth and polished and should not impinge on the soft tissue it crosses.

2. Approach arm should cross the gingival margin of abutment at 90°.

3. Minor connector that joins the occlusal rest to framework should be strong and rigid and provide some bracing.

4. Retentive terminal should point towards the occlusal surface.

5. Clasp should be placed as low as possible on abutment to prevent leverages.

Types

Primarily four types depending on the shape formed by the terminals as they join the abutment:

1. T-clasp

2. Modified T-clasp

3. Y-clasp

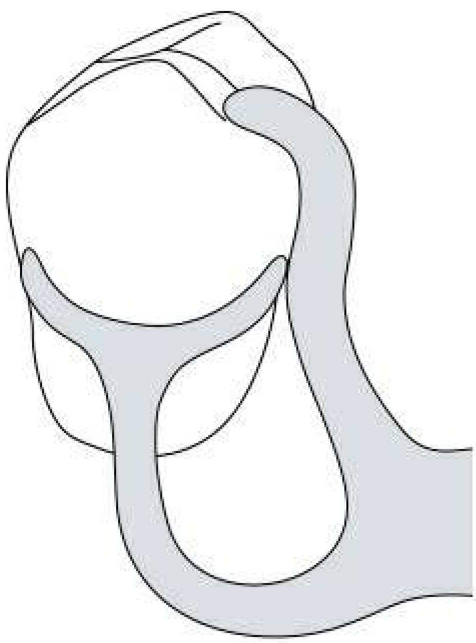
4. I-Clasp

The common features, advantages and disadvantages are applicable to all. The specific features applicable to each type are discussed here.

1. T-clasp

Approach arm extends till the height of contour at which point the retentive terminal leaves approach arm and engages an undercut (Fig. 21.91). The other terminal is positioned above the height of the contour.

A



B

FIGURE 21.91A, B T-clasp.

2. Modified T-clasp

- Essentially a T-clasp without the nonretentive (usually mesial) finger of the T-terminal (Fig. 21.92).

- It has better aesthetics and is used on canines and premolars.
- It does not possess 180° encirclement.

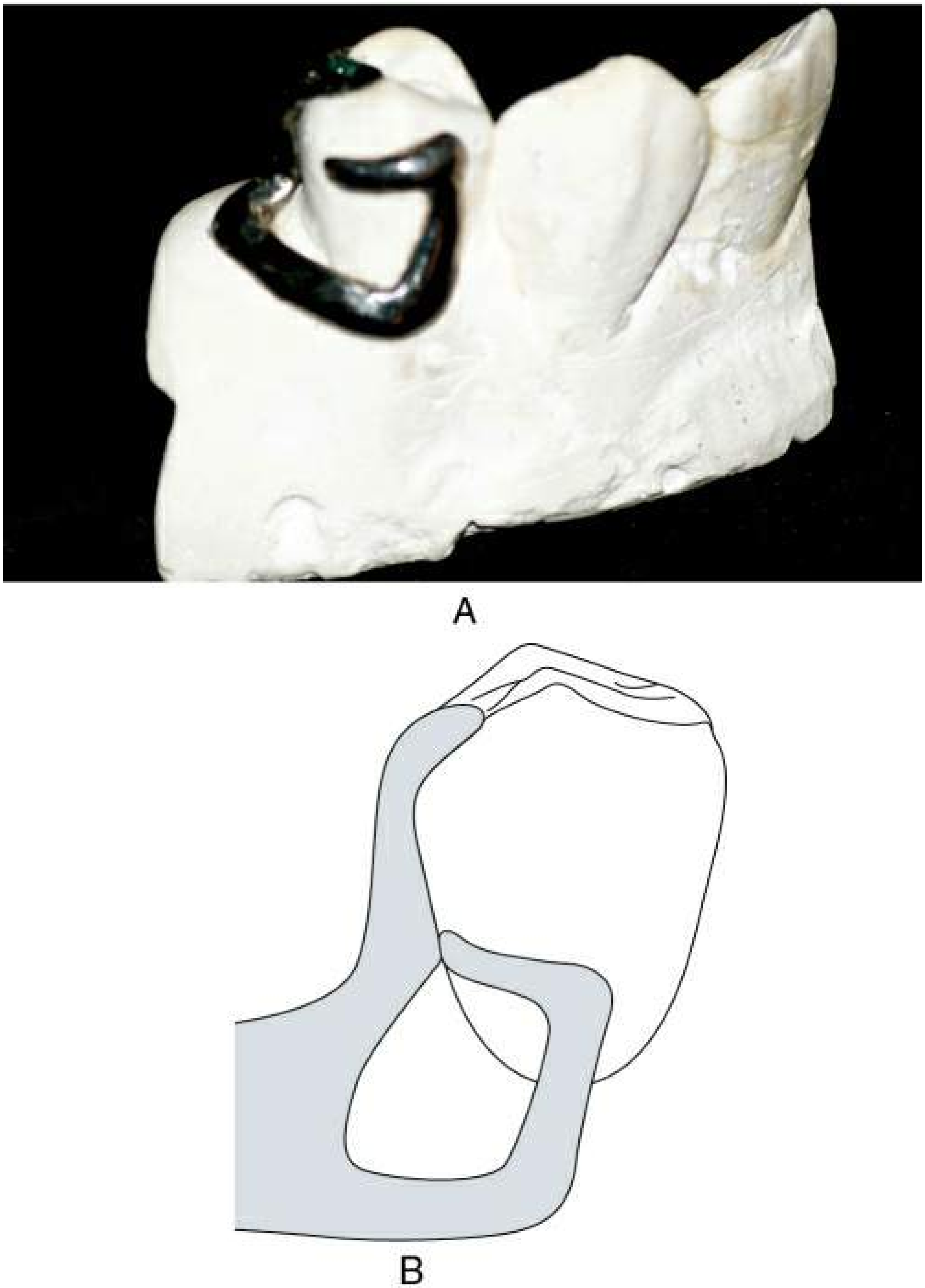


FIGURE 21.92A, B Modified T-clasp.

3. Y-clasp

It is used when the height of contour on the buccal surface of abutment is high near the mesial and distal line angles, but low at the centre (Fig. 21.93).

A

B

FIGURE 21.93A, B Y-clasp.

4. I-clasp

- Used on distobuccal surface of maxillary canines for aesthetics (Fig. 21.94).
- Compromise on encirclement and horizontal stabilization.
- This is also used in the RPI concept which is discussed in Chapter 30.

A

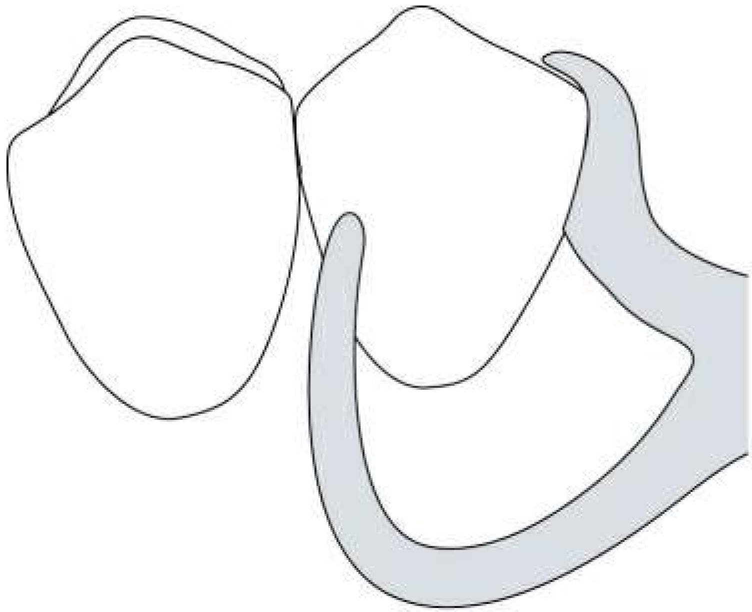


FIGURE 21.94A, B I-bar clasp.

Summary of extracoronal direct retainers

The clasp should conform to the existing undercut and design should be kept simple. Less desirable clasp forms can be avoided by changing the form of abutment by recontouring or crowning. Clasp selection is critical only when abutment tooth is adjacent to distal extension base. If mesiobuccal undercut is present – combination clasp is used, if distobuccal undercut is present – bar clasp is used. If bar clasp is contraindicated, a reverse circlet clasp is used. The differences between bar clasp and circumferential clasp are summarized in Table 21.3.

Table 21.3

Differences between bar clasp and cast circumferential clasp

	Cast circumferential clasp	Bar clasp
1.	Occlusally approaching	Gingivally approaching
2.	Push-type retention less effective	Pull-type retention more effective
3.	Retentive arm attached to a rigid minor connector	Approach arm minor connector is more flexible
4.	Removal is easy	Removal difficult, easy to place
5.	Less aesthetic	More aesthetic

6.	Better stabilization	Poor stabilization
7.	Less food accumulation	More food accumulation
8.	More occlusal load on abutment due to increase in width of occlusal table	Occlusal load not an issue
9.	Easy to repair	Difficult to repair
10.	Can be used in tilted abutments	Cannot be used with tilted abutments
11.	Can be used in presence of soft tissue undercut	Cannot be used in presence of soft tissue undercut
12.	Can be used where there is no edentulous space (embrasures)	Cannot be used where there is no edentulous space (embrasures)
13.	More tooth coverage can cause decalcification	Less tooth coverage

Indirect retainers

Definitions

Indirect retainer: The component of a partial removable dental prosthesis that assists the direct retainer(s) in preventing displacement of the distal extension denture base by functioning through lever action on the opposite side of the fulcrum line when the denture base moves away from the tissues in pure rotation around the fulcrum line.

Indirect retention: The effect achieved by one or more indirect retainers of a partial removable denture prosthesis that reduces the tendency for a denture base to move in an occlusal direction or rotate about the fulcrum line.

Fulcrum line: A theoretical line around which a removable dental prosthesis tends to rotate (GPT8).

Forces acting on partial denture

A removable partial denture is subject to the following forces during function. In a tooth-supported situation (Kennedy's class III), movement of denture towards the tissue is prevented by occlusal rests, movement away from the tissues is prevented by retentive arm of direct retainers and horizontal movements are prevented by stabilizing components like minor connector and reciprocal arm of direct retainer. Hence, all forces are well resisted by components on the abutments itself and will not rotate or dislodge the prosthesis.

In distal extension bases, Kennedy's class I and II and to a certain extent in class III and IV that do not have adequate abutment support, the same forces cannot be adequately resisted by components present on abutment teeth alone as they are not completely tooth supported. Hence, we need to look at other mechanisms to control these forces. The forces acting on a distal extension partial denture and mechanisms to control these forces are discussed in detail in Chapter 24.

The distal extension partial denture is subject to rotation around three principal fulcrum lines. To discuss indirect retainers, it is important to consider the fulcrum line on the horizontal plane which runs through the retentive terminal of the abutments. It produces a rotational movement on the sagittal plane, towards or away from the tissues, basically an up and down movement (Fig. 21.95).

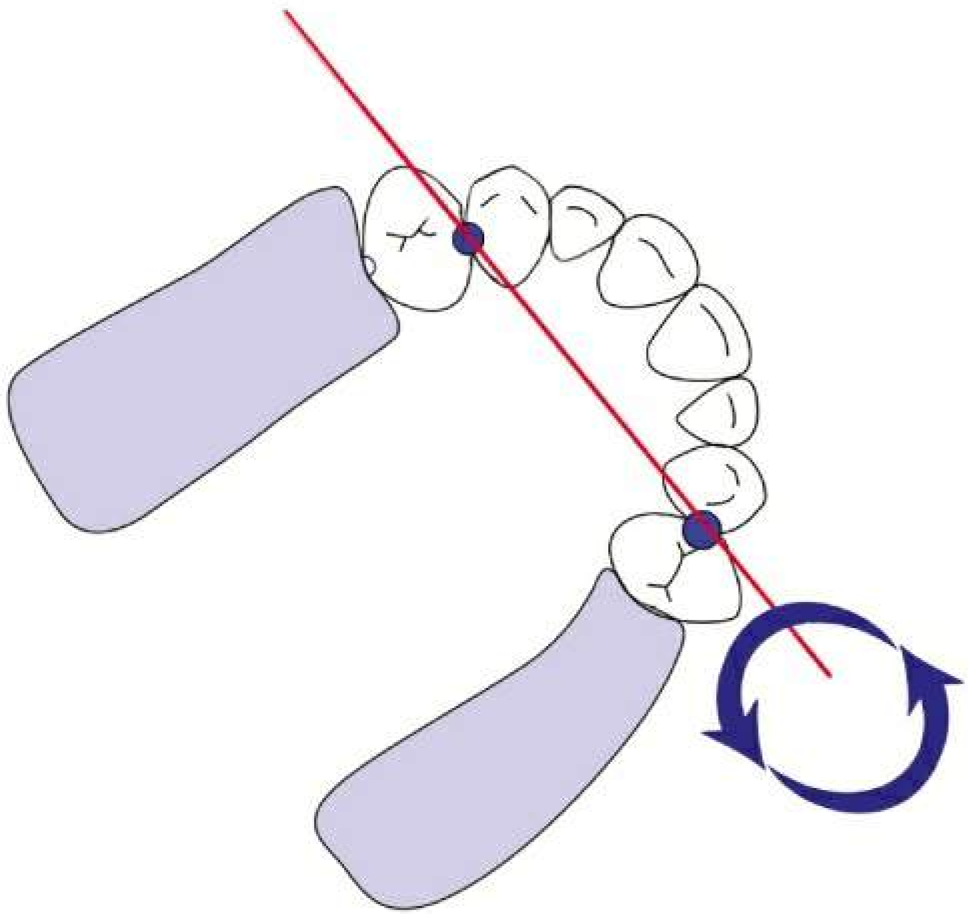


FIGURE 21.95 Fulcrum line on sagittal plane showing rotation towards and away from the ridge.

The downward movement of denture base towards the edentulous ridge is countered by the occlusal rest and the denture base in contact with the alveolar ridge (Fig. 21.96).

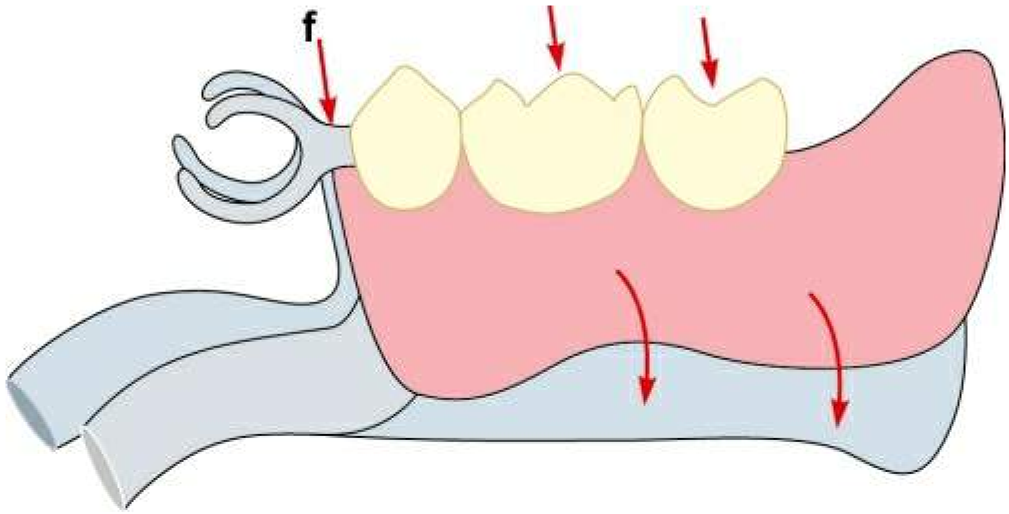


FIGURE 21.96 Tissueward force resisted by alveolar ridge.

The upward force that tends to dislodge the denture away from the supporting ridge is due to sticky food, tissues adjacent to denture base like tongue or buccinator's muscle when activated by speech, chewing or swallowing and gravity in case of maxillary prosthesis. The direct retainer is basically used to counter this force and is assisted by the indirect retainer in this resistance.

Principle of indirect retainer

Consider a beam or bar which is supported (fulcrum) at one point along its length. A lifting force will displace the entire beam in the absence of retainers. With direct retainers at fulcrum, lifting force will elevate the end where force is applied and depress the other end. If there is another support at the opposite end (indirect retainer), lifting force will not displace beam (Figs 21.97–21.100).

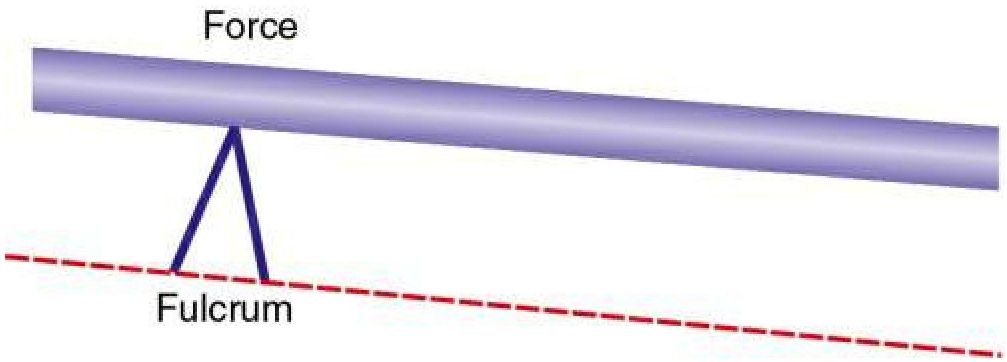


FIGURE 21.97 Beam supported at one point.

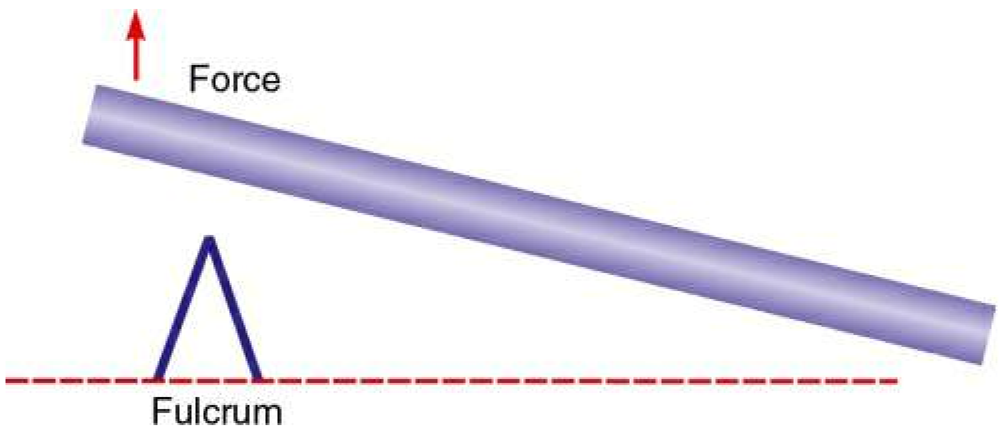


FIGURE 21.98 Beam lifts from point of support (fulcrum) in the absence of any retainer.

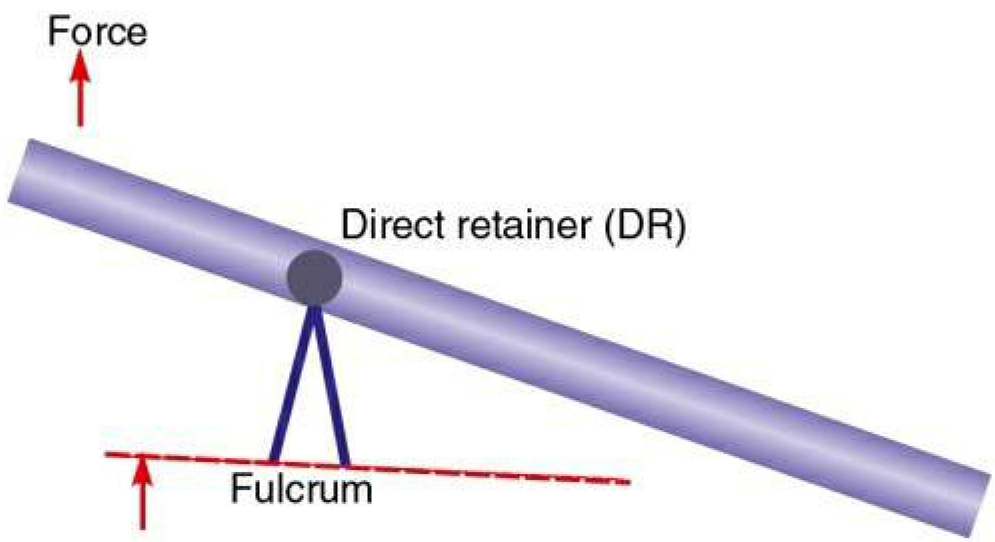


FIGURE 21.99 With direct retainer one end is depressed and the other elevated.

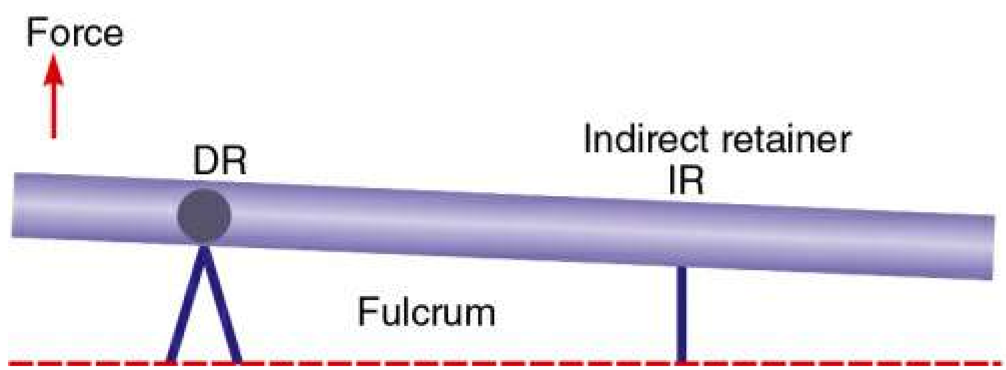


FIGURE 21.100 No displacement when indirect retainer is placed along with direct retainer.

In distal extension bases, the indirect retainer in the form of an occlusal rest uses this same lever principle to move the fulcrum line farther from the force and prevents displacement of denture away from the basal seat tissues (Figs 21.101 and 21.102).

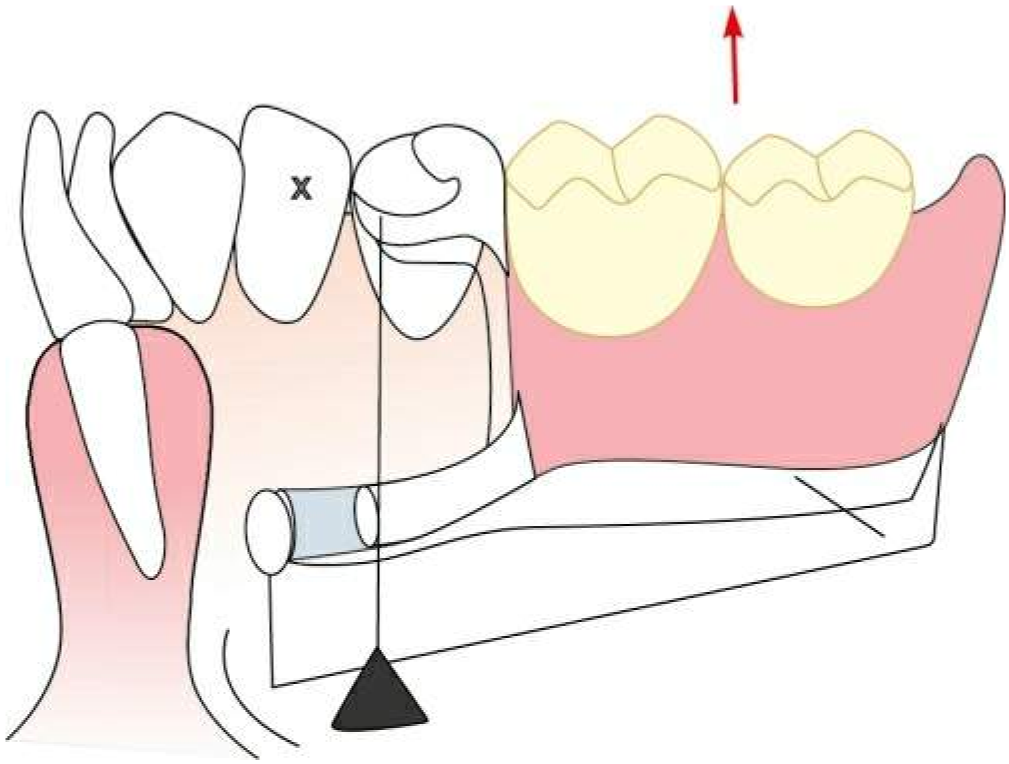


FIGURE 21.101 Lifting of denture without indirect retainer.

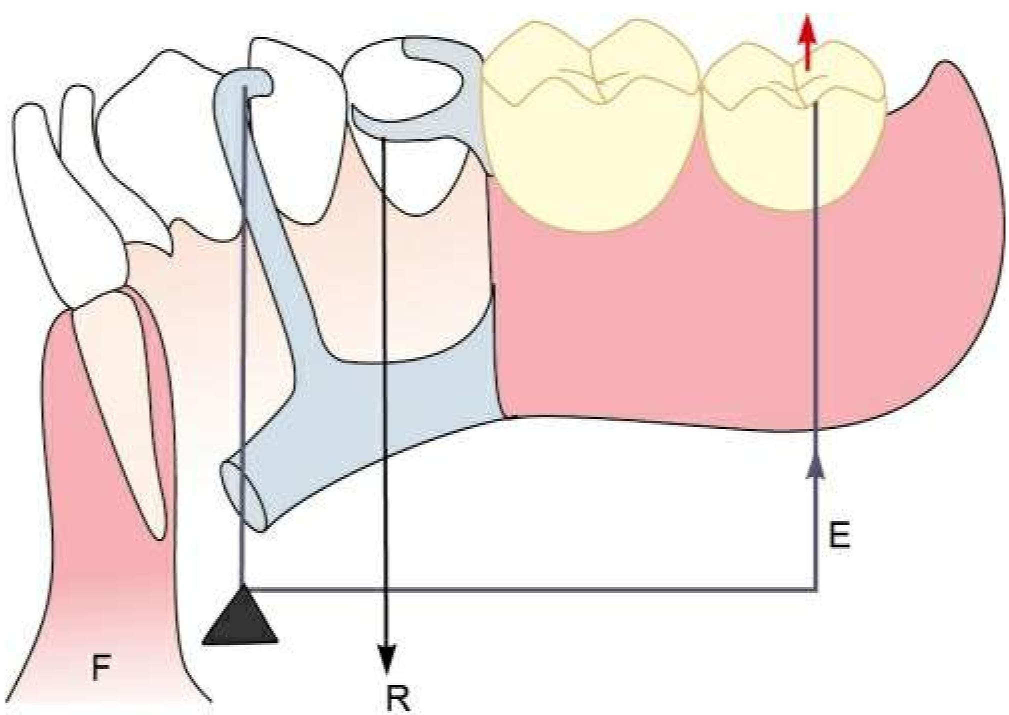


FIGURE 21.102 Lifting resisted by indirect retainer.

Factors influencing the effectiveness of indirect retainers

1. **Effectiveness of direct retainer:** The direct retainer must first prevent denture base and rest from being lifted out (displacement), for the indirect retainer to function properly. The indirect retainer can only prevent rotation, not displacement. Hence, effective direct retention is essential for indirect retainer to be effective.

2. **Distance from fulcrum line:** The greater the distance between the fulcrum line and indirect retainer, more effective it will be. This depends on length of distal extension base, location of fulcrum line and how far beyond fulcrum line the indirect retainer is placed (Fig. 21.103).

3. **Rigidity of connector**: Minor connector connecting the indirect retainer to the major connector should be rigid to get the desired functions of the indirect retainer.

4. **Effectiveness of supporting tooth structure:** The indirect retainer should not be placed on weak teeth or cuspal inclines and should occupy a definitive rest seat (Fig. 21.104).

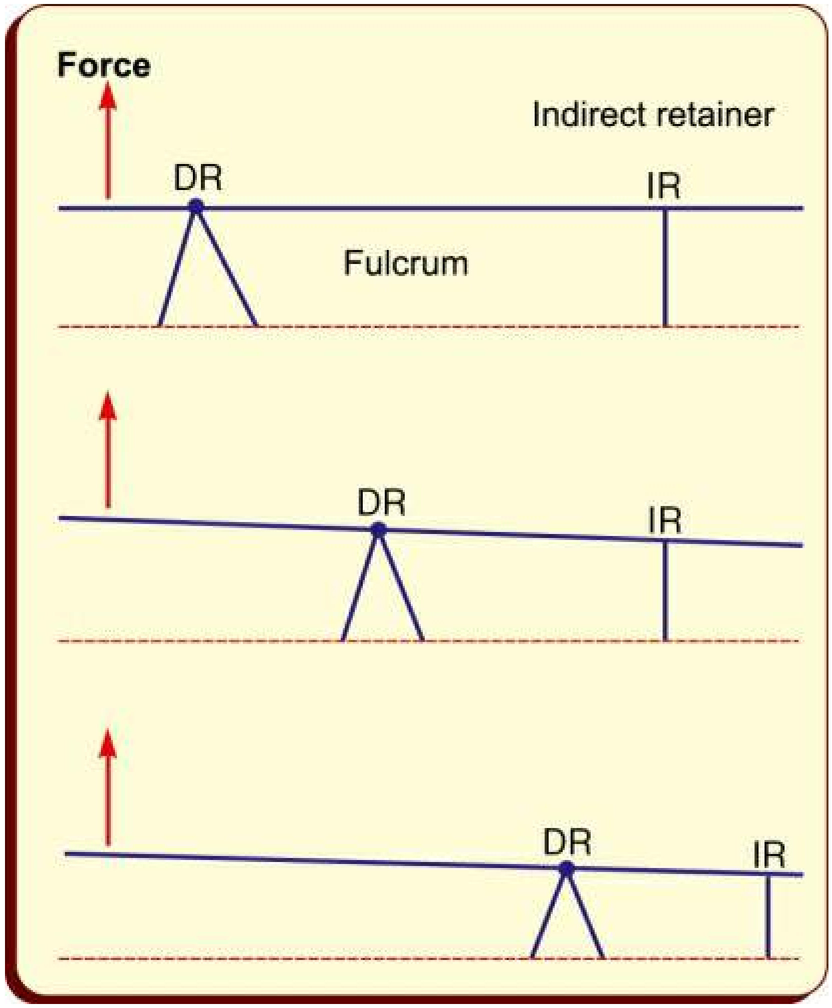


FIGURE 21.103 Indirect retainer should be placed as far away from fulcrum line as possible for maximum effect.

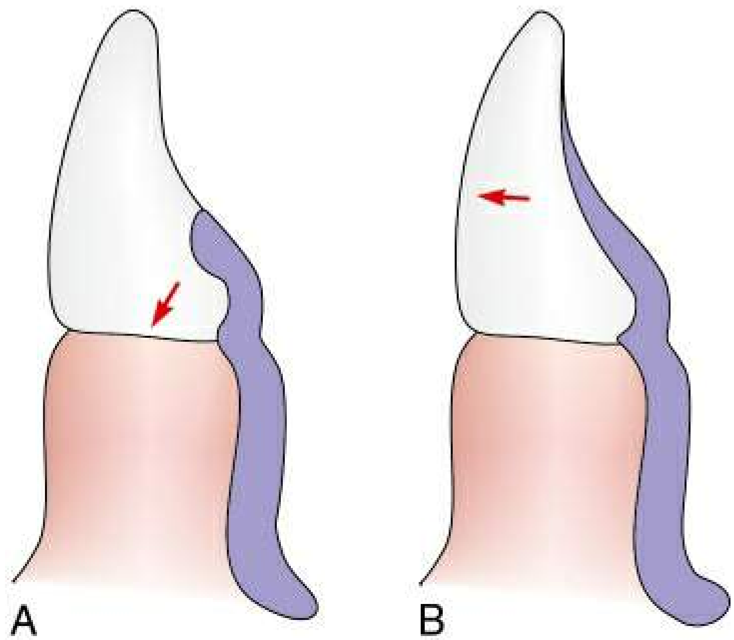


FIGURE 21.104 Rest placement: **(A)** definite rest seat perpendicular to movement which is best and **(B)** placement on incline – not desirable.

Functions of indirect retainers

1. The primary functions of indirect retainer are to assist the direct retainer in preventing displacement of denture away from the tissues.

2. Other auxiliary functions are:

i. Reduces anteroposterior tilting, leverages on the principal abutments.

ii. Contact of its minor connector with axial tooth surfaces aids in stabilization against the horizontal forces. Such tooth surfaces when parallel to path of placement may also act as auxiliary guide planes.

iii. Acts as an auxiliary or secondary rest to support the major connector.

iv. Anterior teeth may be splinted against lingual movement by the supporting indirect retainers.

v. Dislodgement of indirect retainer when denture base is depressed provides the first indication for the need to reline distal extension prosthesis.

Types of indirect retainers

Auxiliary occlusal rest

- Commonly used and located on occlusal surface as far away from denture base as possible. It is placed perpendicular to midpoint of fulcrum line. In Kennedy's class I, the perpendicular from fulcrum line would fall on an incisor tooth, which is weak and has a vertical lingual surface that cannot support a rest. Hence, bilateral rests on mesial marginal ridge of first premolar on either side will be effective as indirect retainer even though they are closer to fulcrum line (Fig. 21.105).

- In Kennedy's class II, indirect retainer is placed on the first premolar of the opposite side, perpendicular to fulcrum line (Fig. 21.106).

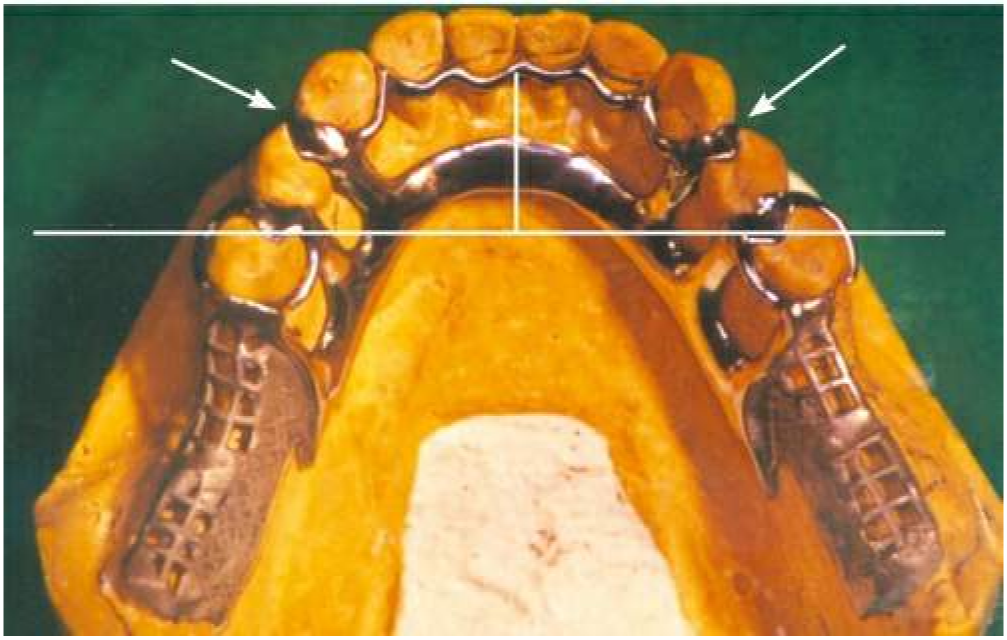


FIGURE 21.105 Indirect retainers placed in first premolars for class I.

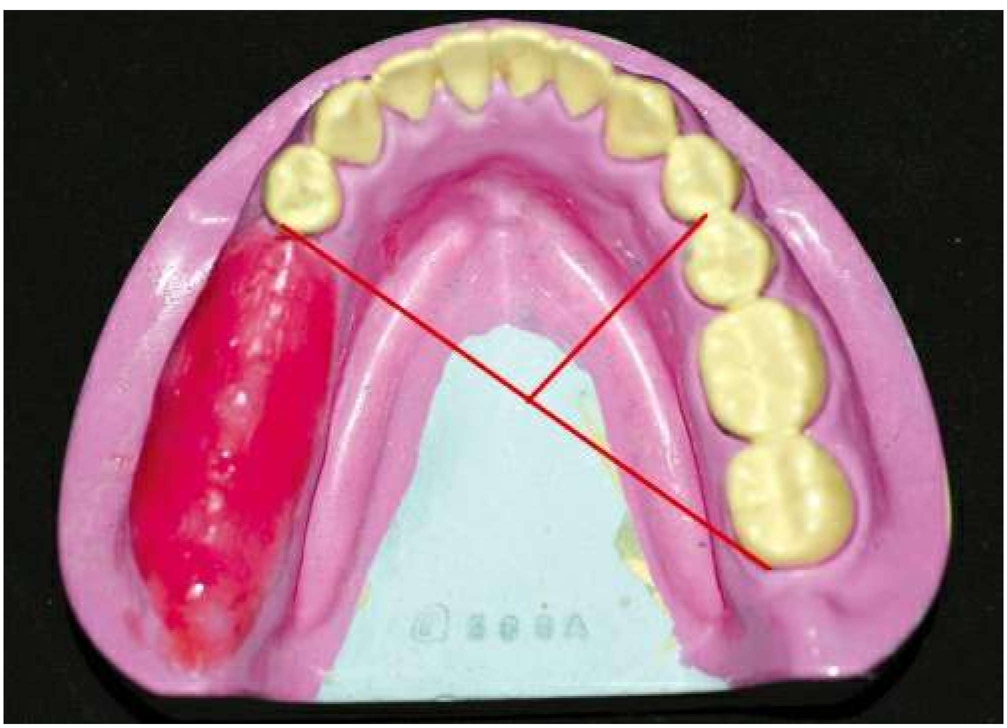


FIGURE 21.106 Indirect retainer placement in class II.

Canine extension from occlusal rest

It is a finger extension from a premolar rest placed on the prepared lingual slope of the adjacent canine tooth. It produces indirect retention by increasing the distance of a resisting element from fulcrum line (Fig. 21.107).

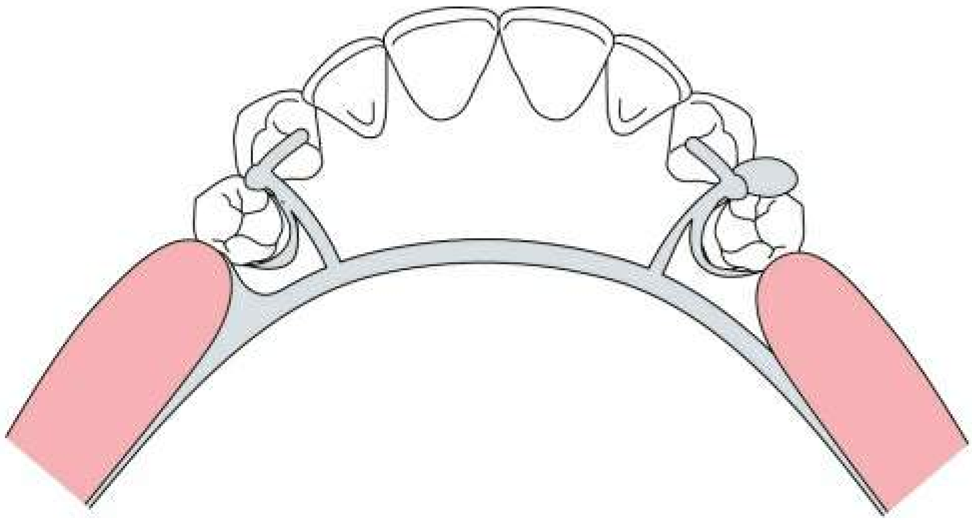


FIGURE 21.107 Canine extension.

Indicated in Kennedy's class I where the first premolar is the primary abutment.

Canine rests

Indicated when mesial marginal ridge of first premolar is too close to fulcrum line or when teeth are overlapped and fulcrum line is not accessible.

Continuous bar retainers and linguoplates

The terminal occlusal rests, which are present at either end, function as indirect retainers. The major connector itself does not perform this function as they rest on unprepared lingual inclines of anterior teeth (Fig. 21.108).

FIGURE 21.108 The auxiliary rests at either end function as indirect retainers.

When used for distal extension bases, these major connectors (continuous bar retainer and linguoplate) should never extend above the middle third of the anterior teeth, to avoid orthodontic forces on these teeth which may cause them to move.

Modification areas

In a class II with modification space on the opposite side, the occlusal rest of the direct retainer of the anterior abutment in that side will act as indirect retainer. The perpendicular from the fulcrum line falls in the vicinity of this tooth, and hence it is an ideal direct retainer in this situation (Fig. 21.109).

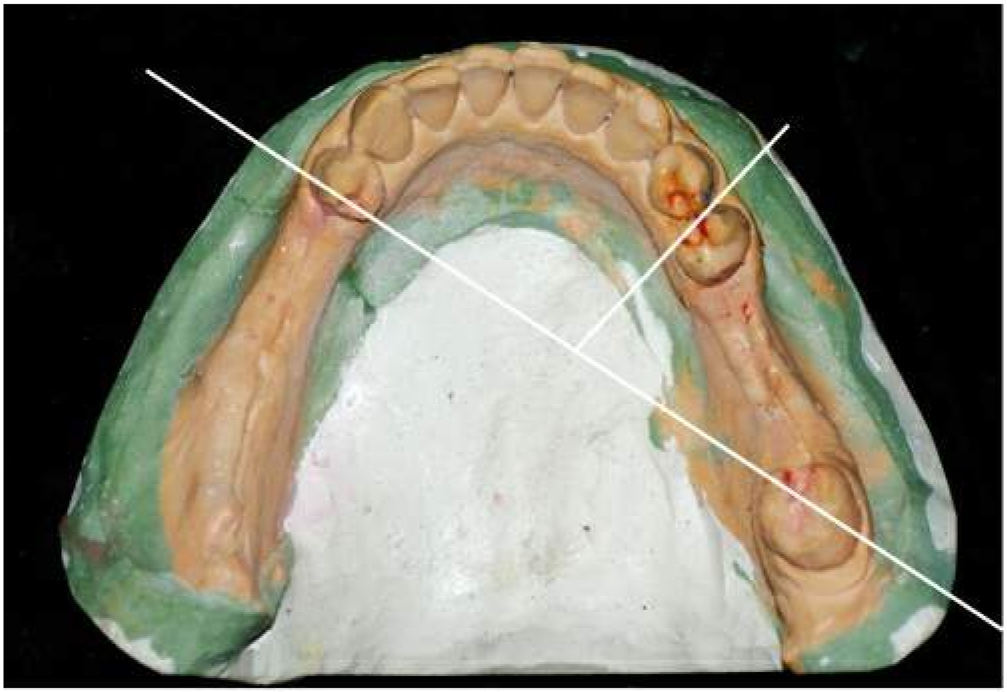


FIGURE 21.109 Placement in class II with modification.

If only one tooth is missing on the modification side, then the second premolar is too close to the fulcrum and then first premolar is used for indirect retention.

Rugae support

The rugae are firm and positioned well to provide indirect retention for a Kennedy's class I denture. This can be specifically utilized while using a horseshoe major connector as it lacks adequate posterior retention. But this support is less effective than indirect retention obtained by positive tooth support with rests.

Direct–indirect retention

In the maxillary arch where only the six anterior teeth remain, complete palatal coverage is usually necessary. This not only provides some direct retention by close adaptation to the tissues, it also provides some indirect retention by covering the anterior tissues.

Denture base

Definition

The part of a removable partial denture that rests on the basal seat and to which the teeth are attached (GPT8).

Functions:

1. Supports artificial teeth.
2. Transfers occlusal forces to supporting oral structures.
3. Stimulation of underlying tissues of residual ridge.
4. Adds to the cosmetic effect.

Ideal requirements:

1. Accurate adaptation to the tissues with less change in bulk.
2. Light weight.
3. Sufficient strength.
4. Self-cleansing.
5. Maintain a good finish and polish.
6. Thermal conductivity.
7. Aesthetic.
8. Low cost.
9. Potential for relining.

Types of denture bases

There are three types of dental bases depending on the type of material contacting the tissue:

1. Acrylic

2. Combination of metal–acrylic

3. Metal

Acrylic

A denture base made only of *acrylic resin* is indicated only for interim or temporary dentures and will carry all the inherent problems of acrylic resins.

Combination of metal–acrylic

It is the most commonly used dental base. A denture base minor connector is used to retain the acrylic. Acrylic resin only contacts the ridge and soft tissues. It is also discussed in the section on 'Minor Connectors'.

Indications

1. Distal extension partial dentures, but can be used with any classification.

2. When denture teeth are indicated as replacement teeth.

Advantages

1. Aesthetic appeal as it can be characterized especially in the anterior region.

2. Artificial teeth can be placed at their original position regardless of the amount of ridge resorption, thus restoring the normal contours of

the ridge.

3. Can reestablish the normal contours of lips and cheek.

4. Can be relined.

Disadvantages

1. More strength in bulk, so space for artificial teeth may be reduced. Cannot be used when interarch space is less.

2. Less fatigue and abrasion resistant so may break with use.

3. Can distort due to internal strain release.

4. More plaque accumulation.

5. Can irritate soft tissues.

6. Poor thermal conductivity.

Metal

The fitting surface of this dental base is entirely metal.

Indications

1. Tooth-supported dentures.

2. Reduced interocclusal space.

3. High occlusal forces – deep bite.

4. Acrylic allergy.

Advantages

1. Accurately adapts to ridge and maintains this accuracy

permanently.

2. Intimacy of contact contributes to retention.

3. Resistant to abrasion.

4. Good soft tissue response due to its high density and bacteriostatic activity.

5. Less plaque accumulation and hence more clean.

6. Better strength, can be made thinner and does not break easily.

7. Excellent thermal conductivity contributes to stimulation of oral tissues and patient acceptance.

Disadvantages

1. Difficult to reline.

2. Trimming is difficult and hence overextension must be avoided.

3. Difficult to correct underextensions.

4. Less aesthetic.

5. Cannot be used to support lips, cheek and make up for lost bone.

Tooth replacements

The various types of artificial teeth that can be used in a removable partial denture are as follows:

1. Denture teeth – porcelain and plastic (acrylic)

2. Facings

3. Tube teeth

4. Reinforced acrylic pontics (RAPs)

5. Metal teeth.

Denture teeth

These may be made up of porcelain or acrylic resin.

Porcelain

Porcelain is not commonly used.

Advantages

1. Excellent aesthetics – available in variety of shades.

2. High wear-resistance and hence maintains vertical dimension.

3. Impervious to stains – high colour stability.

Disadvantages

1. Brittle.

2. Grinding and shaping is difficult, and make it weaker.

3. Mechanical retention to acrylic using pins (anteriors) and diatoric holes (posterior).

4. Wear of opposing natural teeth especially if unglazed.

5. Used only if partial denture opposes a complete denture and if adequate interarch space exists.

6. Difficult for single tooth replacements.

Acrylic

It is the most commonly used material for denture artificial teeth (Fig. 21.110).

FIGURE 21.110 Acrylic denture teeth.

Indications

1. Most anterior spaces.

2. Any replacement where adequate space is present.

3. To restore facial contours.

Advantages

1. High impact strength and adequate strength in small sections.

2. Good aesthetics.

Disadvantages

1. Poor wear and abrasion resistance – anteriors wear labially, posteriors wear occlusally, causing decrease in vertical dimension.

2. Tendency to stain.

3. Difficult for single tooth replacements.

Facings

These are also made of porcelain or acrylic resin. The teeth are also waxed along with the partial denture framework, and only the labial part which is tooth coloured and made of acrylic or porcelain is cemented to these metal backings (Fig. 21.111).

FIGURE 21.111 Metal palatal part with acrylic facing (anteriors).

Indications

1. Single tooth anterior replacements.

2. Limited interocclusal space – deep bite.

Advantages

1. Strongest and most durable.

2. Can be replaced if needed.

Disadvantages

1. Poor aesthetics as it is backed by metal.

2. Cannot be relined.

3. Cannot be used on resorbed ridges.

4. Metal occlusal surface can wear opposing teeth.

5. Derive little or no support from ridge.

Tube teeth

Denture teeth made of porcelain or acrylic are prepared by drilling a channel on the base upwards (Fig. 21.112). During waxing of framework, tooth is positioned and waxed is added in the channel. Tooth is then removed and the channel (post) is cast as part of framework. After finishing and polishing, the tooth is cemented onto the post in the framework.

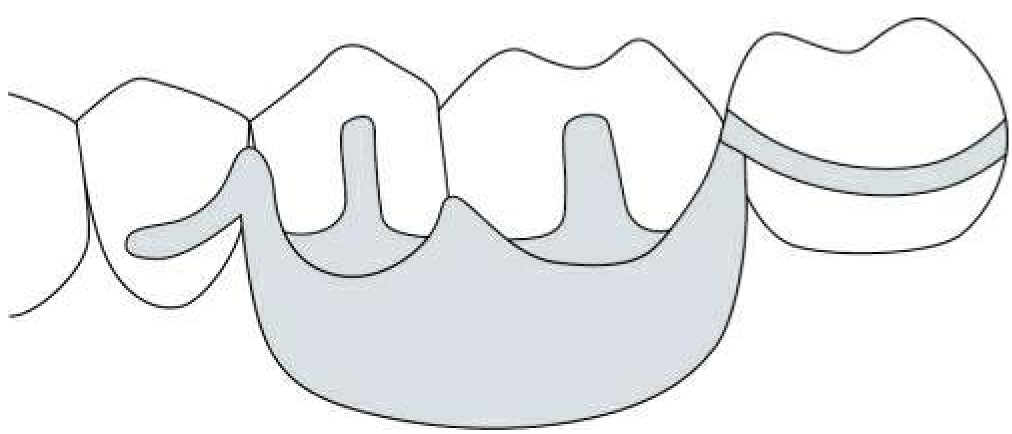


FIGURE 21.112 Tube teeth.

Indication

Single tooth replacements, especially premolar.

Advantages

1. Better aesthetics than facings.
2. Opposing teeth occlude with resin.
3. Reduced lab time.

Disadvantages

1. Must have adequate proximal and occlusal space.
2. Require a well-healed nonresorbed ridge.
3. Cannot be relined.
4. Not used for multiple adjacent teeth replacement.
5. Derives little or no support from ridge.

Reinforced acrylic pontics

Similar to facings and tube teeth. The artificial tooth made of acrylic resin is processed on projection or loops of metal arising from gingival half of lingual surface (Fig. 21.113). They are processed after framework fabrication.

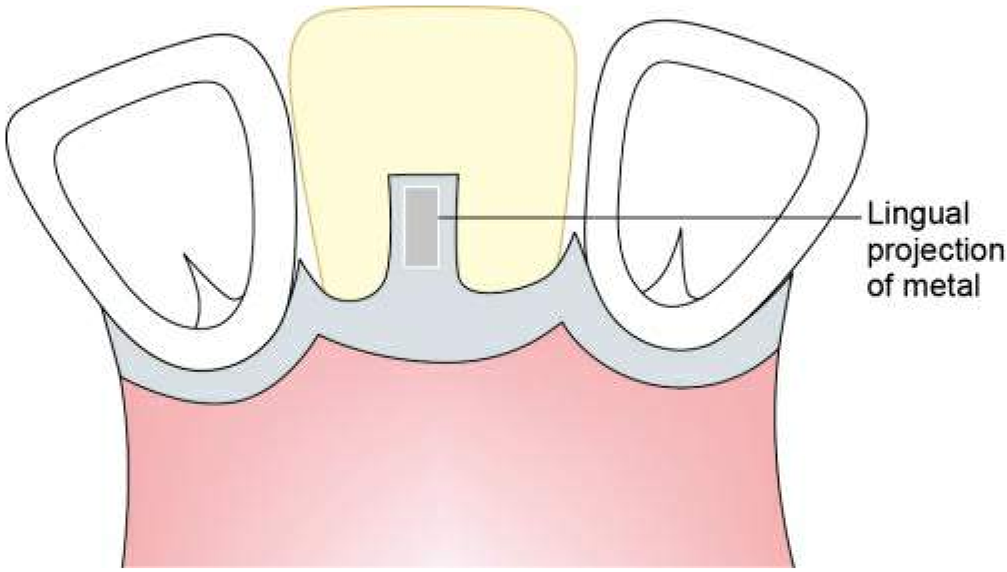


FIGURE 21.113 Reinforced acrylic pontics.

Indication

Single anterior teeth and maxillary first premolars.

Advantages

1. Excellent strength and aesthetics.

2. Occlusion confined to plastic.

3. Used in restricted space.

Disadvantages

1. Requires a well healed nonresorbed ridge.

2. Derives little or no support from ridge.

3. Cannot be relined.

Metal pontic

Usage restricted to posteriors teeth. Normally, it is made of same metal from which framework is fabricated. If chrome alloy is used, occlusal surface should be covered with tooth coloured resin, as otherwise the alloy will wear out the opposing natural teeth. If gold alloy is used, then there is no problem, but it is expensive (Fig. 21.114).

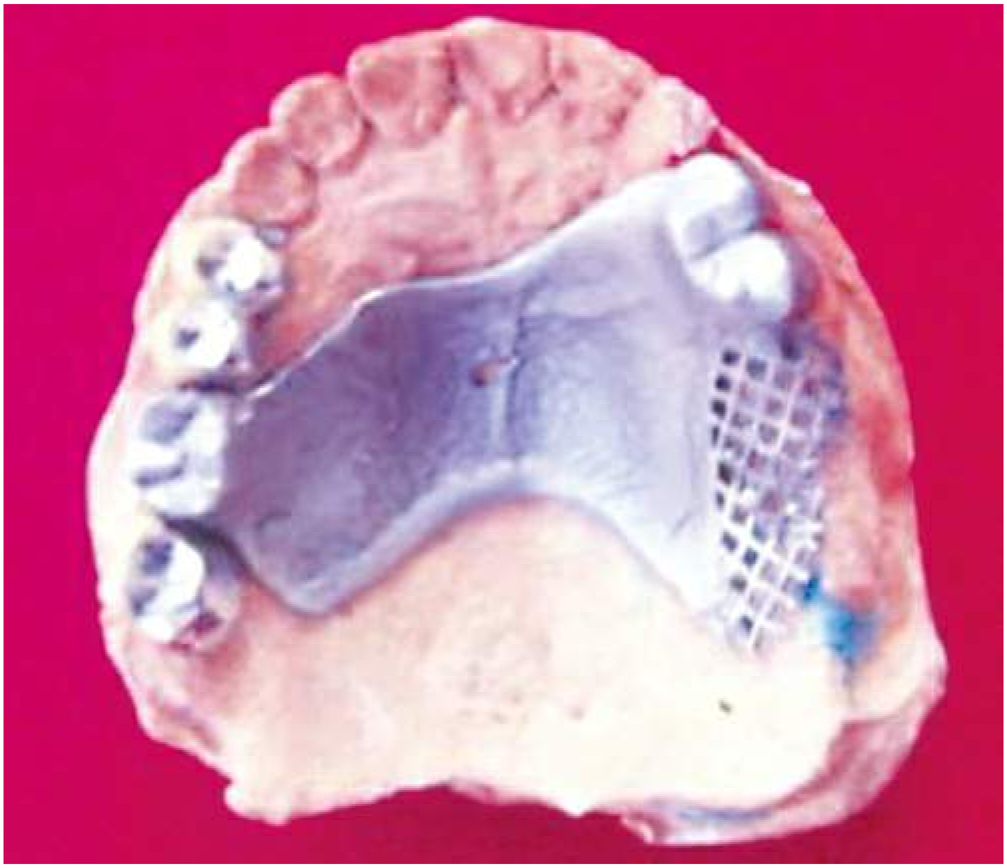


FIGURE 21.114 Metal pontics – made of same metal as framework.

Indications

1. Reduced interocclusal space.

2. Reduced mesiodistal space.

Advantages

1. Good wear-resistance.

2. Good strength.

Disadvantages

1. Poor aesthetics.

2. Restricted to posteriors.

3. Can wear opposing teeth.

Metal pontic with acrylic window, where the buccal surface of pontic is cut and filled with tooth coloured acrylic resin, can be used where aesthetics is a concern.

SUMMARY

The component parts of the cast partial denture perform specific roles in providing retention, stability and support for the prosthesis. Their judicious use also helps to preserve the health of the tissues. Except the indirect retainer, all the other components are an integral part of almost every cast partial denture. Hence, the role of each component should be thoroughly understood to help design the partial denture for different clinical situations. Indirect retention is mandatory only in distal extension situations.

CHAPTER 22

Diagnosis and treatment planning

CHAPTER CONTENTS

Introduction

Diagnosis and treatment planning for oral rehabilitation of partially edentulous mouths is an important step and must take the following into consideration – control of caries and periodontal disease, restoration of individual teeth, provision of harmonious occlusal relationships and the replacement of missing teeth by fixed (natural teeth/implants) or removable prosthesis.

The uniqueness of the ultimate treatment of a partially edentulous patient occurs through recording patient history and diagnostic clinical examination including radiographs, mounted and surveyed diagnostic casts, a definitive oral examination, including periodontal probing, percussion and vitality test and appropriate medical and dental consultations. This includes four distinct processes (i) understanding the patient's chief complaints/concerns, (ii) ascertaining the patients' dental needs through a diagnostic clinical examination, (iii) developing a treatment plan that reflects the best management of the desires and needs and (iv) execution of the treatment plan with follow-up.

History

The general, medical and dental history is obtained.

General history

Age

- Provides a reference for the physiological status of patient.
- Neuromuscular skills diminish with age and ability to adapt to new situations is decreased. With age, oral epithelium becomes dehydrated and loses its elasticity resulting in decreased resistance to trauma.
- Salivary flow decreases with age leading to greater risk of caries.

Sex

- In females, menopause may be associated with hormonal imbalances which can cause osteoporosis and atrophy of oral epithelium.
- Pregnancy can have a bearing on the type of prosthesis.

Occupation

Interim and immediate partial dentures may need to be considered depending on the occupation.

Medical history

The systemic health and the drugs taken by the patient may affect removable partial denture treatment.

Systemic diseases

Common systemic disturbances that can have a significant effect on the treatment of the patient include the following:

1.*Diabetes*

Uncontrolled diabetes is characterized by xerostomia, macroglossia and rapid periodontal breakdown (Fig. 22.1). They also bruise easily and heal slowly. This significantly reduces the ability of the patient to wear prosthesis with comfort and increases the possibility that caries will occur.

FIGURE 22.1 Rapid periodontal breakdown due to diabetes can affect treatment plans.

2. *Arthritis*

If arthritic changes occur in the temporomandibular joint, recording jaw relation can be difficult and changes in the occlusion may occur.

3. *Anaemia*

These patients have a pale mucosa, sore tongue, xerostomia and gingival bleeding. Wearing a removable prosthesis will be more difficult for them.

4. *Epilepsy*

Any seizure may result in fracture and aspiration of the prosthesis, and possibly the loss of additional teeth. Consultation with the patient's physician is essential before treatment is initiated. The construction of removable partial dentures is usually contraindicated if the patient has frequent, severe seizure with little or no warning. All material used in the construction of a prosthesis for an epileptic patient must be radiopaque so that any part of the prosthesis that is accidentally aspirated or swallowed during a seizure can be located radiographically. If the patient's medication includes diphenylhydantoin (dilation), one must take particular care to ensure that the removable partial denture does not irritate the gingival tissues, or hypertrophy of these tissues may result.

5. *Cardiovascular disease*

Patients with the following symptoms require medical approval before any dental procedures:

i. Acute or recent myocardial infarction

ii. Unstable or recent onset of angina pectoris

iii. Congestive heart failure

iv. Uncontrolled arrhythmia

v. Uncontrolled hypertension

6. *Cancer*

Oral complications are also common side effects of radiation and chemotherapy for malignancies in areas other than the head and neck (oral malignancy). The most common oral complications are mucosal irritations, xerostomia, and bacterial and fungal infections. These symptoms will complicate the construction and wear of a removable partial denture.

7. *Transmissible disease*

Hepatitis, tuberculosis, influenza and other transmissible disease pose a particular hazard for the dentist, patients and dental auxiliaries. These diseases may be transmitted by contact with the patient's blood or saliva, contaminated dental instruments and aerosol from the handpiece. Contaminated impression trays, materials, polishing wheels, pumice as well as grindings from the patient's prosthesis may cause aerosol contamination of both the laboratory and the dental office.

Drugs

Some of the frequently prescribed drugs that can affect prosthodontic treatment are discussed.

1. *Anticoagulants*

Postsurgical bleeding could be a problem for patients receiving anticoagulants who undergo extractions or soft tissue or osseous surgery. These patients should be referred to an oral surgeon for the management of the surgical phases of treatment.

2. *Antihypertensive agents*

The most significant side effect of the antihypertensive drugs is orthostatic, or postural, hypotension, which may result in syncope when the patient suddenly assumes the upright position. Therefore, care must be taken when the patient gets up from dental chair. Another fact to consider is that treatment for hypertension usually includes prescription of a diuretic agent, which can contribute to a decrease in saliva and an associated dry mouth.

3. *Endocrine therapy*

Patients receiving endocrine therapy may develop an extremely sore mouth. If the patient is wearing prosthesis, it could incorrectly be blamed for causing the discomfort.

4. *Saliva-inhibiting drugs*

Methantheline bromide (Banthine), atropine and their derivatives are sometimes used to control excessive salivary secretion, particularly when it is necessary to make accurate impression. They are generally contraindicated for use in patients with cardiac disease because of their vagolytic effect. Other contraindication for this disease includes prostatic hypertrophy and glaucoma. Saliva should be controlled by mechanical means in these patients.

Dental history

Dental history provides the following information:

1. **Reason for tooth loss:** If teeth were lost due to periodontal disease, prognosis of remaining teeth is not as favourable than if they were lost due to caries. If the teeth were lost because of caries, special emphasis will have to be placed on improving the patient's dietary intake and oral hygiene procedures.

2. Details of previous prosthesis, patient's views about the old prosthesis and reason for seeking new prosthesis give an idea about the design of prosthesis that best suits the patient.

3. **Patient expectations**: If too high, may be impossible to fabricate a removable prosthesis satisfactorily.

Examination

Examination consists of:

1. Oral examination

2. Radiographic examination

Oral examination

Preliminary oral examination

This is performed in the first appointment. It helps determine the need for the management of acute conditions and whether a prophylaxis is required to conduct a thorough oral examination.

Definitive oral examination

This is performed in the second appointment with the aid of radiographs and mounted diagnostic casts. The following should be evaluated:

1. *Caries evaluation*

- The remaining natural teeth are evaluated for the presence of any caries (Fig. 22.2) and restored teeth (Fig. 22.3) are evaluated with regard to their number, signs of recurrent caries and evidence of decalcification.

- The selection of abutment teeth to receive rest seats must be made before restorative treatment has begun. Amalgam and tooth-coloured restorative materials are more likely to fail under forces of occlusion than a cast metal restoration or porcelain, when rest seats are incorporated.

FIGURE 22.2 Decayed teeth are evaluated.

FIGURE 22.3 Restorations are evaluated.

2. *Periodontal evaluation*

- To assess pocket depths, attachment levels, furcation involvement, mucogingival problems and tooth mobility (Figs 22.4–22.6).

- Mobility may be due to trauma from occlusion, periodontitis and loss of support. Mobility due to trauma from occlusion can be reversed if the occlusion is corrected.

- The periodontal health of the remaining teeth should be restored to optimum health by performing appropriate treatment like root planning, gingivectomy, flap surgery and free gingival grafts. Splinting of abutment teeth is considered when the remaining teeth have reduced support and when only few widely spaced abutments remain. This should be done only after restoration of periodontal health.

FIGURE 22.4 Periodontal evaluation – gingivitis.

FIGURE 22.5 Periodontal evaluation – gingival recession.

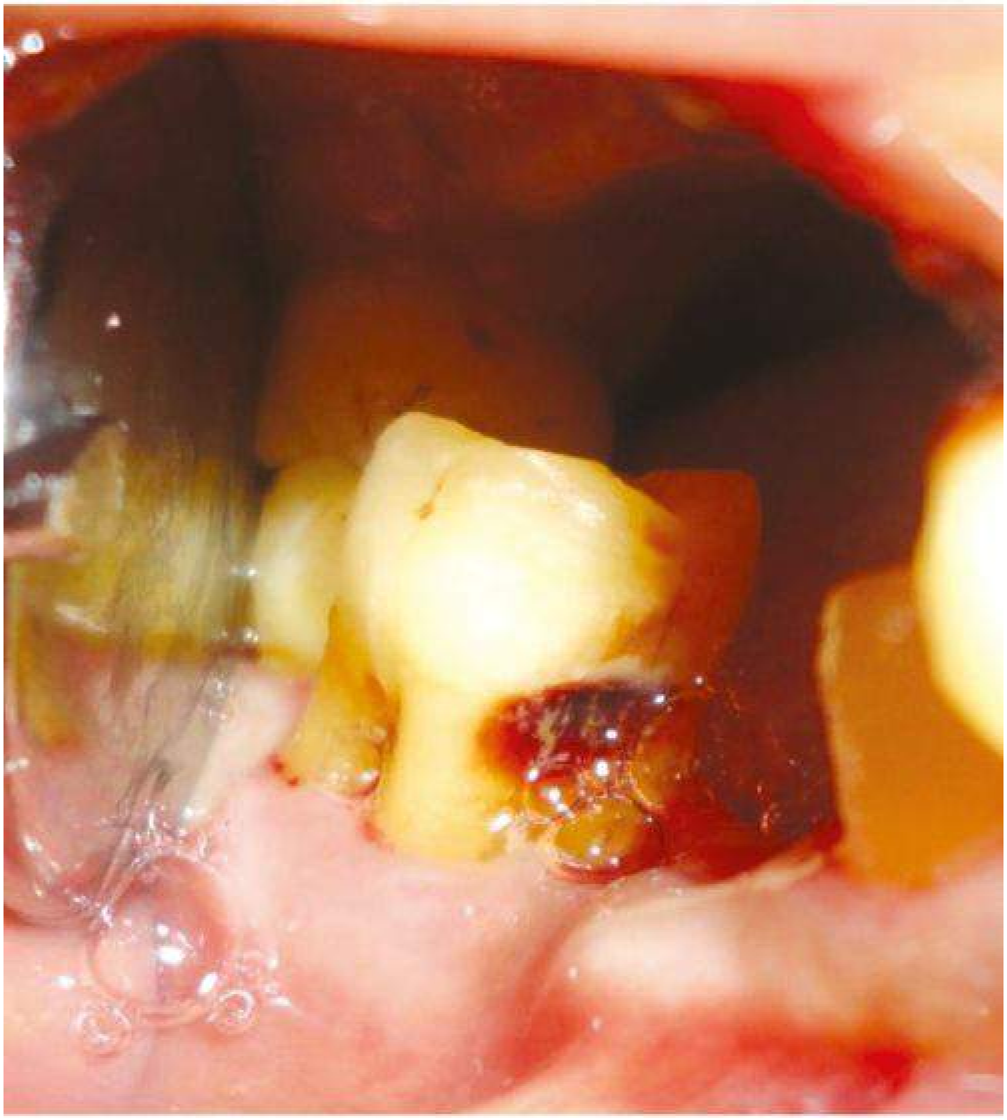


FIGURE 22.6 Periodontal evaluation – furcation involvement.

3. *Residual ridges, soft and hard tissues*

- The residual ridge is examined to assess the contour, quality and load-bearing capacity especially in distal extension base situations.

- The soft tissues are checked for any reactions to the wearing of a prosthesis like denture stomatitis (Fig. 22.7), papillary hyperplasia, and for any other pathological changes. The frena are checked for their location and if positioned too high a surgical correction is contemplated.

- The hard tissues are examined for torus, bony exostoses and undercuts, especially in the mylohyoid ridge and maxillary tuberosity area. Any surgical correction, relief or change in major connector design is planned.

FIGURE 22.7 Denture stomatitis.

4. *Mounted diagnostic cast*

The mounted diagnostic cast (Fig. 22.8) is analysed for the following along with intraoral examination:

- Interarch space
- Occlusal plane
- Occlusion is checked for any interference and trauma from occlusion

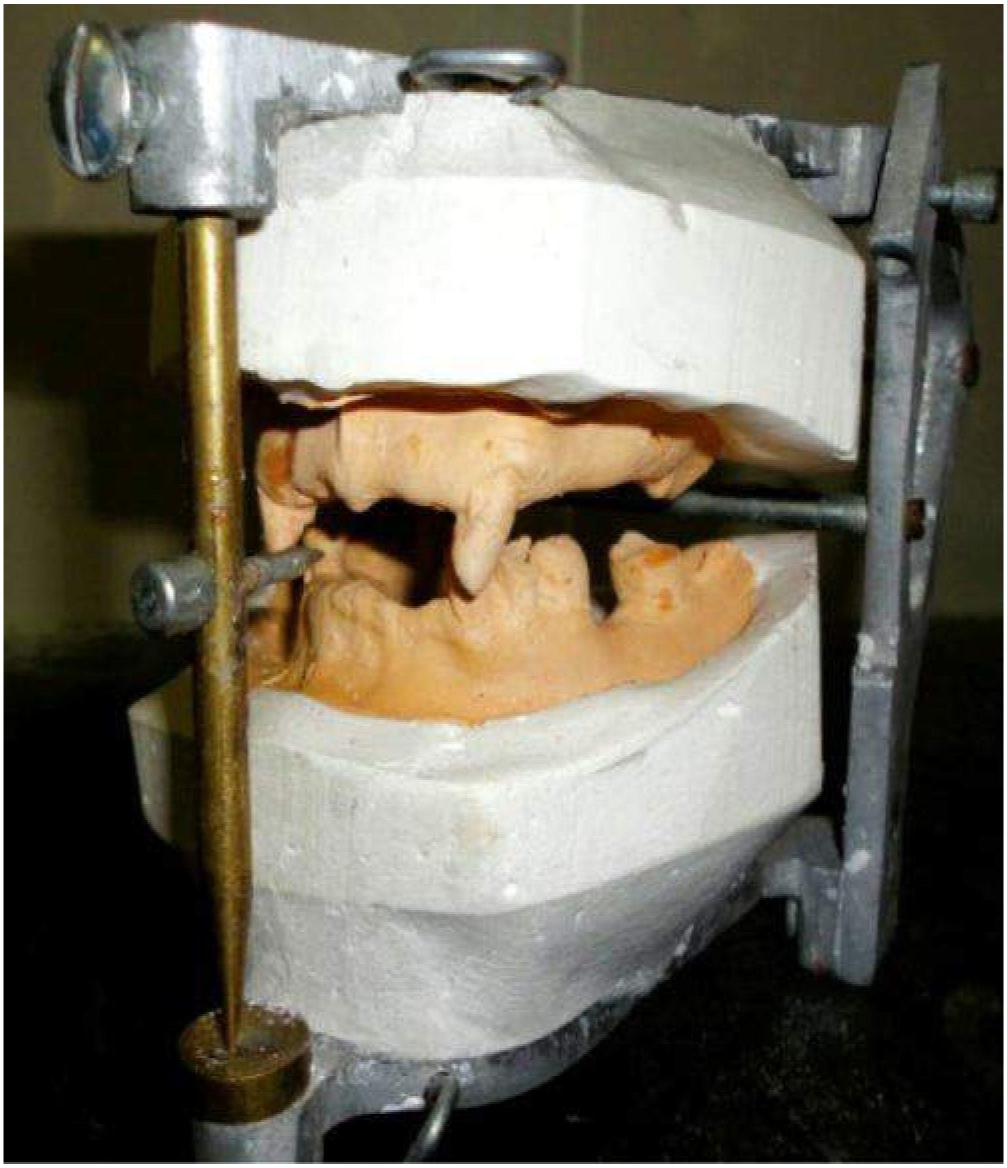


FIGURE 22.8 Mounted diagnostic cast.

Radiographic examination

- This will include panoramic and periapical radiographs (Figs 22.9–22.11). The objectives of radiographic examination are as follows:

○ Locate areas of infection and any other pathology.

- Reveal the presence of root fragments, foreign objects, bone spicules and irregular ridge formations.
- Display the presence and extent of caries.
- Evaluate existing restorations with respect to marginal leakage and overhanging gingival margins.
- Evaluate root canal fillings.
- Evaluate periodontal condition, alveolar support of abutment teeth, the length and morphology of roots.

FIGURE 22.9 Orthopantomograph (OPG) showing presence of root fragments and alveolar support of abutment teeth and

existing restorations.

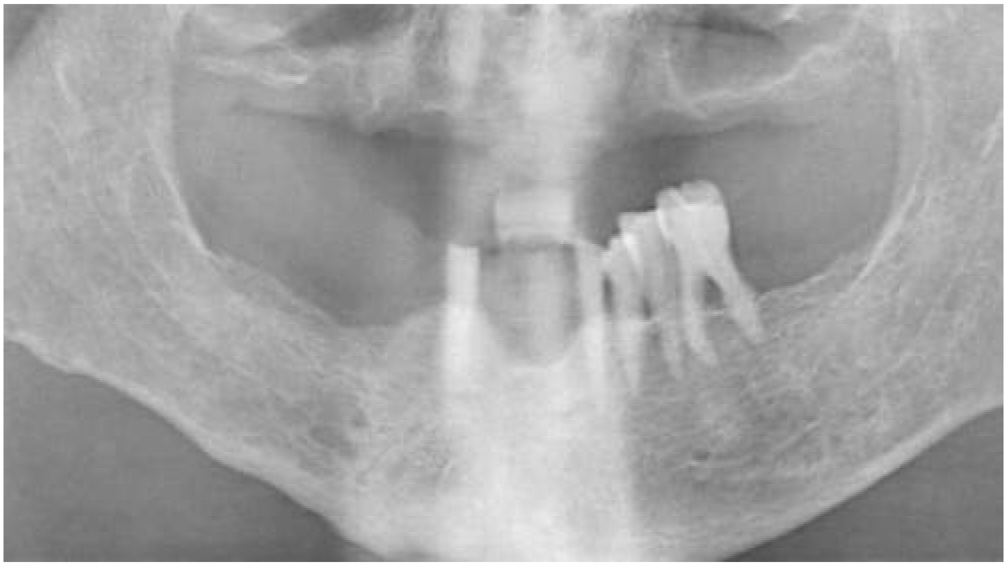


FIGURE 22.10 OPG to evaluate the alveolar support and periodontal condition of remaining teeth.

FIGURE 22.11 Periapical radiograph will provide information on status of restorations in abutments.

Diagnostic impressions and casts

Purpose of making diagnostic casts

1. Analysis of the contour of both the hard and soft tissues of the mouth.

2. Determination of the types of restorations to be placed on the abutment teeth.

3. Determination of the need for surgical correction of exostoses, frena, tuberosities and undercuts.

4. Survey and design of diagnostic cast (Fig. 22.12).

5. Analysis of occlusion and interarch space.

6. Presentation of the proposed treatment plan to the patient.

7. Fabrication of special tray.

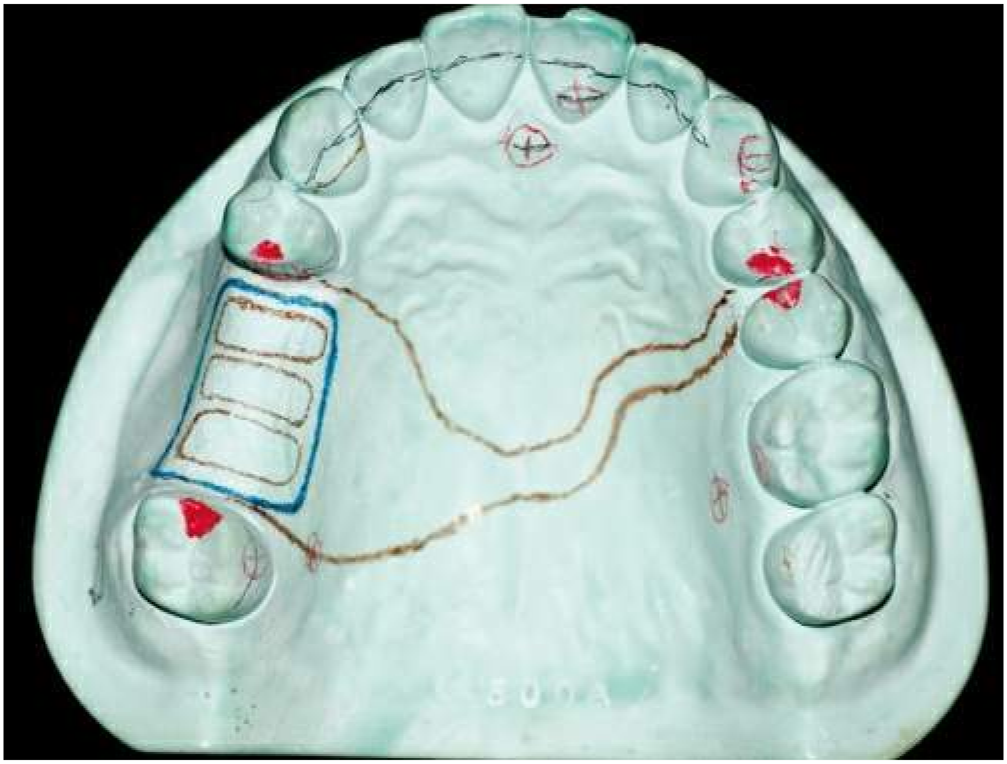


FIGURE 22.12 Designed diagnostic casts.

Impression material

The impression material of choice for making diagnostic or preliminary impressions is 'irreversible hydrocolloid' or 'alginate'.

They are accurate for diagnostic purposes, easy to manipulate, have pleasant taste and odour and are nontoxic and inexpensive. However, they provide less surface detail than some other impression materials and are not dimensionally stable. They must be poured immediately. If this is not possible, the impressions must be stored in 100% humidity for not more than 1 h. They can be disinfected using 2% acid glutaraldehyde solution.

Composition and chemistry

The composition of irreversible hydrocolloid is given in Table 22.1.

Table 22.1

Composition of irreversible hydrocolloid impression material

Component	Function	Weight (%)
Potassium alginate	Soluble alginate	15
Calcium sulphate	Reactor	16
Zinc oxide	Filler	4
Potassium titanium fluoride	Accelerator	3
Diatomaceous earth	Filler	60
Sodium phosphate	Retarder	2

When the soluble potassium alginate is mixed with water, it reacts with calcium sulphate forming an insoluble calcium alginate gel.

Water:Powder – 38 mL:16 g

Setting time: 3–4.5 min, it can be increased by cooling the water

Trays

Stock trays are used for making diagnostic impressions with alginate.

Stock trays are of three types:

- Rim-lock trays (Fig. 22.13)
- Perforated metal trays
- Plastic disposable trays

FIGURE 22.13A, B Rim-lock trays.

Rim-lock trays and perforated trays are commonly used because they are rigid an ensure confinement of the impression material. Disposable plastic trays are too flexible, thus accuracy of the impression and cast may be compromised.

Extension of maxillary tray

There should be a buccal clearance of 5–7 mm between the inner flange of the tray and the buccal/facial surfaces of the teeth and residual ridges. It should extend up to and cover the maxillary tuberosity (Fig. 22.14).

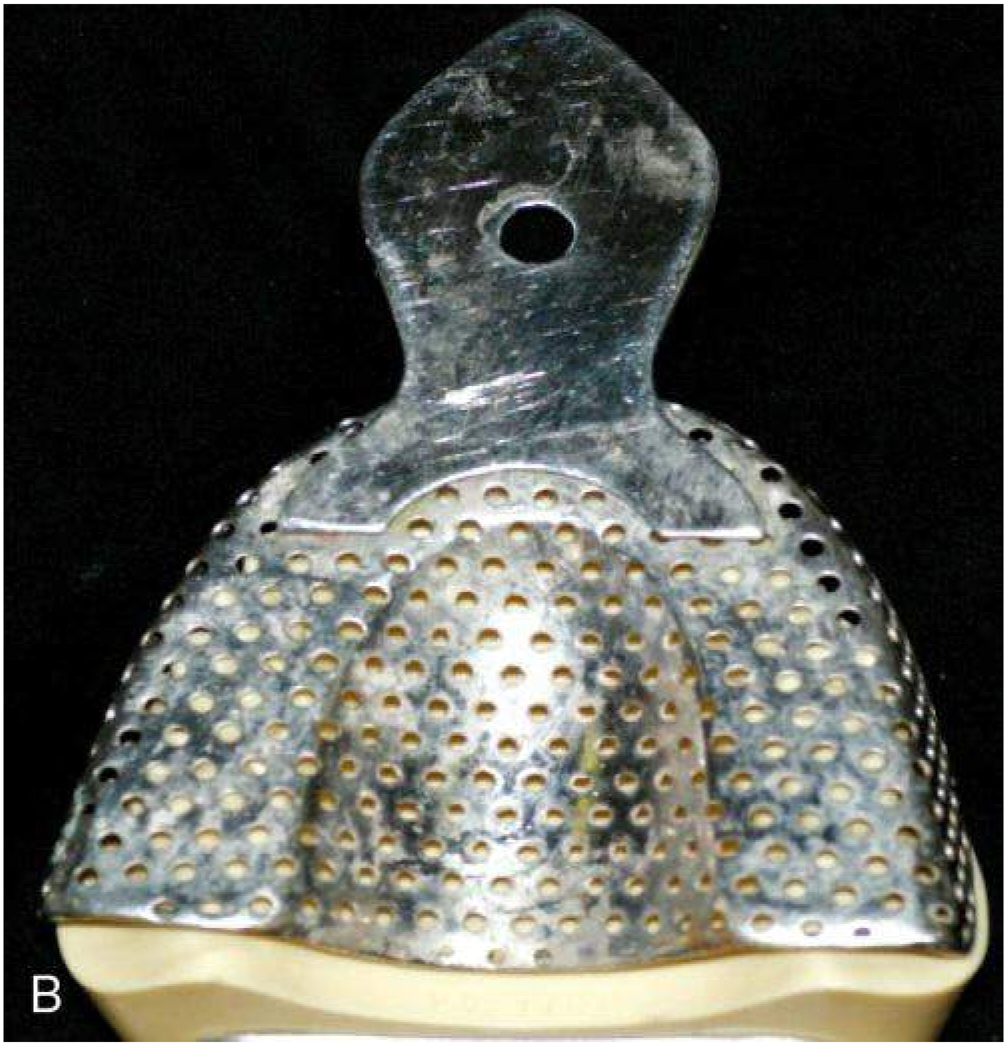


FIGURE 22.14 Extension of maxillary tray. **(A)** Clearance of 5–7 mm from the facial surfaces of teeth and ridges. **(B)** Should cover maxillary tuberosity.

This space is necessary so that in case of undercuts, the impression can spring over the undercuts.

The drawbacks of selecting a tray that is too large is that it may be difficult to insert in the patient's mouth and it may interfere with the coronoid processes of the mandible.

Extension of mandibular tray

There should be a clearance of 5–7 mm on the buccal and lingual sides of the remaining teeth and residual ridge. It should cover the retromolar pad distally (Fig. 22.15).

FIGURE 22.15 Extension of mandibular tray.

If the tray extends too lingually, it may interfere with the tongue and floor of the mouth. This can be overcome by bending the lingual flanges of the stock tray.

The stock tray which has a correct width can be extended to cover the desired area by using green stick compound or baseplate wax (Fig. 22.16).

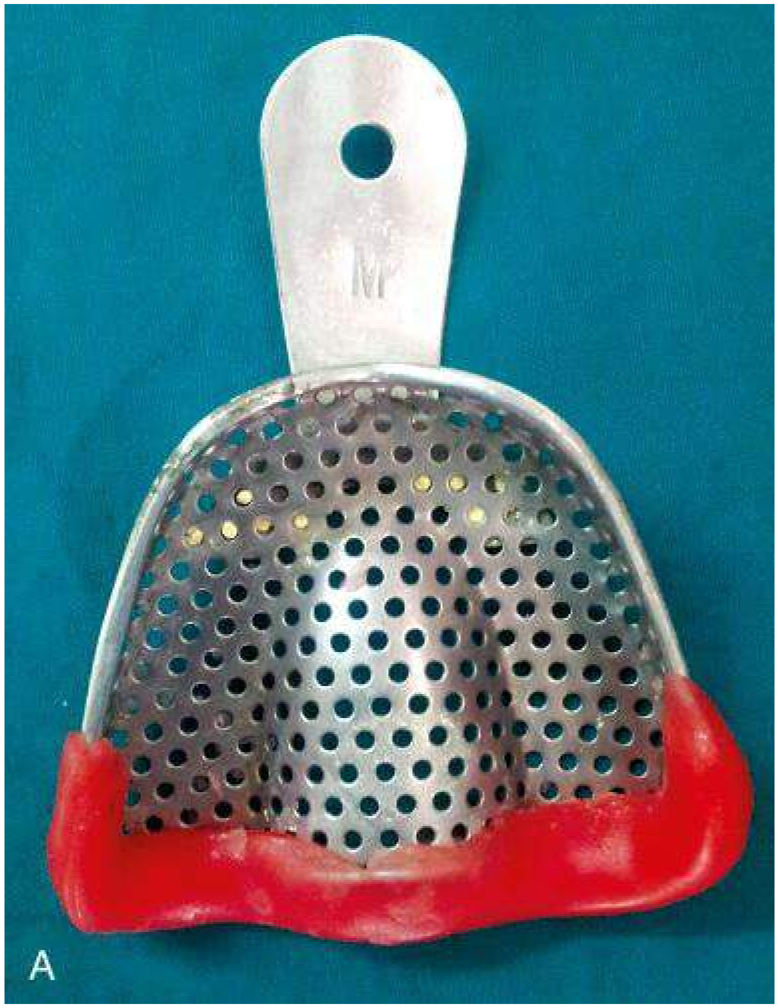

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FIGURE 22.16 **(A)** Stock tray extended with baseplate wax. **(B)** Stock tray extended with green stick compound.

Impression making

Position of patient and operator

The dentist should be standing and the patient is made to sit in an upright position. The chair height should be adjusted such that the patient's mouth is at the level of the dentist's elbow.

When the patient's mouth is open, the occlusal plane of the arch for which the impression is being recorded should be parallel to the floor.

For a right-handed operator:

- When the maxillary impression is being made, the operator should stand at the right rear of the patient. This allows the operator's left arm to encircle the patient and manipulate the patient's mouth and cheek of the left side (Fig. 22.17).
- When the mandibular impression is being made, the operator should stand in front of the patient, holding the impression tray in the right hand. Using the left hand the operator can manipulate the patient's lip and cheek of the right side (Fig. 22.18).

FIGURE 22.17 Position of patient and operator for maxillary impression.

FIGURE 22.18A, B Position of patient and operator for mandibular impression.

Procedure

Select a suitable, perforated or rim-lock impression tray and extend it if required.

Water is taken in a clean, dry rubber bowl and the alginate powder is added according to the recommended water powder ratio. Mixing may be by hand or mechanical using an alginate mixer. If done by hand, mixing should begin slowly using a stiff, broad blade spatula. The spatula should compress the material against the sides to ensure complete mixing. A figure of eight motion is used. *Spatulation time is 45 s.*

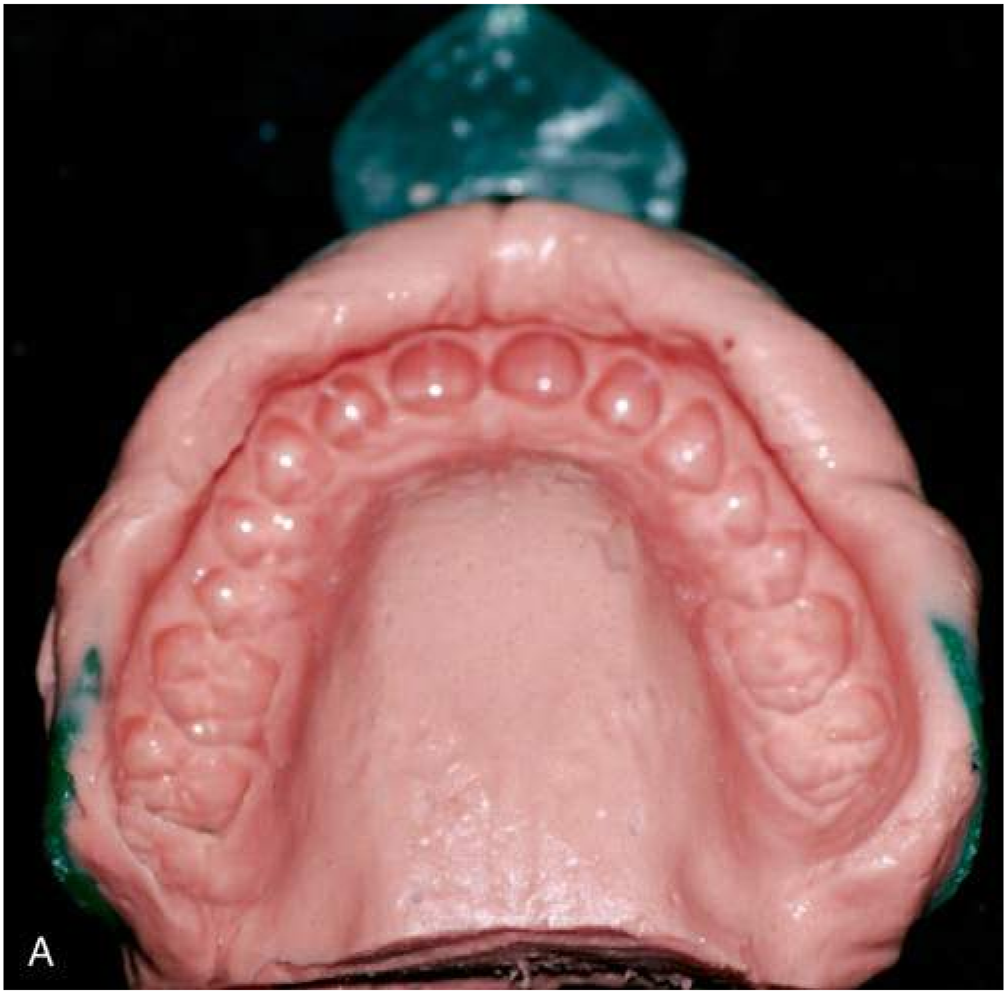
The material is loaded onto the tray in small increments and forced under the rim lock or perforations. The tray is filled up to the flanges.

Place some impression material with a syringe on critical areas such as abutment teeth, rest preparations and the palatal vault.

The tray is first seated on the side away from the operator, then in the anterior region, followed by the near side, ensuring that the lip and cheek are retracted at all times.

Hold the tray in position in the premolar regions, without allowing movement, until the material sets.

The impression is removed quickly, along the long axis of the teeth ensuring that it does not tear or distort. Fig. 22.19 shows completed maxillary and mandibular diagnostic impressions using irreversible hydrocolloid.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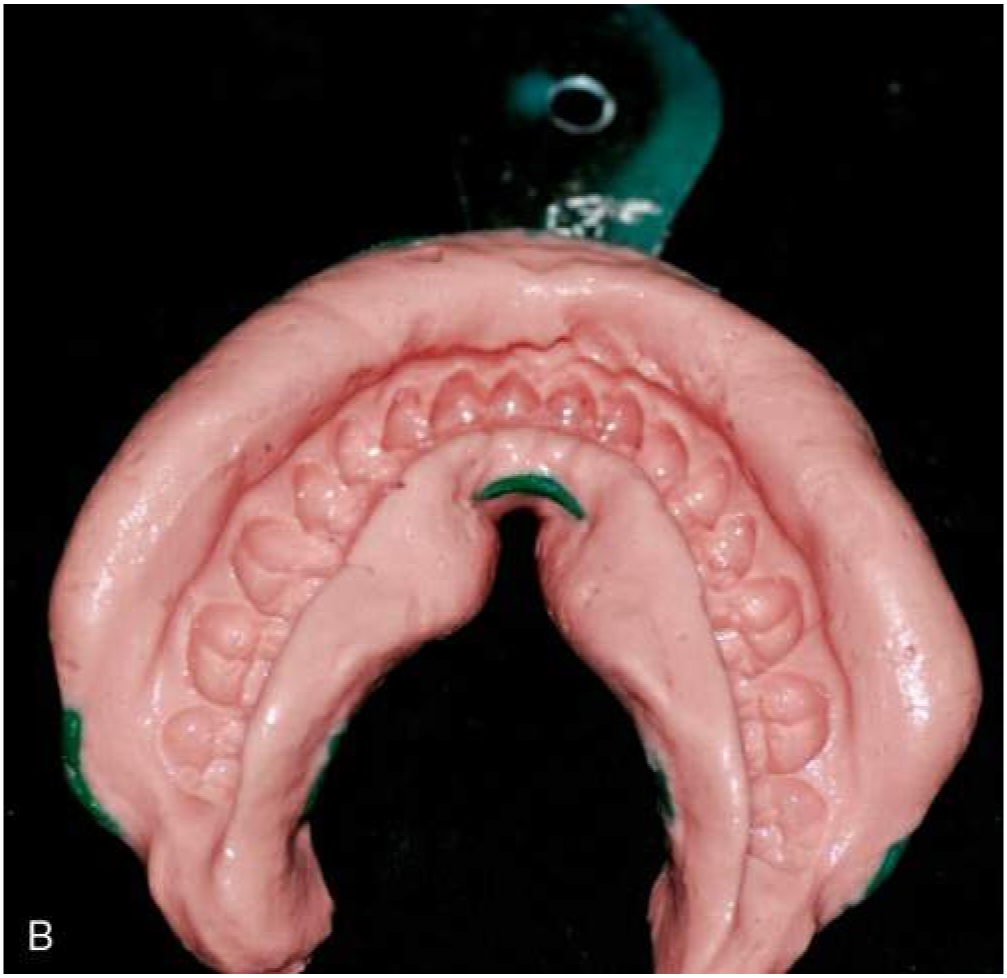


FIGURE 22.19 Diagnostic impression using alginate **(A)** Maxillary **(B)** Mandibular

Rinse the impression and spray with a suitable disinfectant.

Inspecting the impression: This should be done under a good light source and magnification. The impression should not be dried with compressed air as it causes a loss of moisture. It should be verified if all the anatomic landmarks have been recorded accurately. It should be repeated if voids are present; tears, trapping of lips, cheeks and tongue are seen; inadequate extension of the impression and granular appearance.

It is best to pour the cast immediately. If it is not going to be poured immediately, place it in a humidor to prevent dehydration.

Diagnostic cast

Pouring the diagnostic cast

The tray is suspended by its handle in a tray holder or a slightly open drawer. Laying the tray on the table may displace the alginate from the tray or cause distortion of the alginate.

The pour must begin within 12 min after the impression is removed from the mouth. A 'two-pour technique' is used.

Dental stone, 150 g, is gently sifted into a mixing bowl containing 42 mL of water and hand mixed for 1–2 min or mechanically spatulated under vacuum for 20–30 s. It is then placed on a vibrator until no air bubbles rise to the surface. Stone is added in small increments to one of the posterior extension of the impression, and the impression is tipped slightly to allow the motion of the vibrator to cause the stone to flow slowly over to the other side of the impression. This is done until the entire impression is covered by 6–8 mm of stone.

The surface of the poured stone should be left rough to provide locking undercuts for the second pour.

After allowing an initial set of 10–12 min, impression is placed in a bowl of clear slurry water for 4–5 min to thoroughly wet the first pour of stone.

A second mix of stone with the same water–powder ratio is mixed. The stone is placed on a glass slab and formed into the approximate shape of the impression. Remaining stone is vibrated onto the roughened surface of the first mix of stone. The impression is then inverted and placed into the stone on glass slab and the base is shaped with a plaster spatula.

The impression is separated from the cast 45–60 min after the first pour.

Trimming the diagnostic cast

The base of the cast is trimmed such that the occlusal surfaces of the teeth are parallel to the base. The base should be trimmed until it is 10 mm thick at its thinnest point, usually the centre of the hard palate for the maxillary cast and the depth of the lingual sulcus for the mandibular cast.

The posterior border of the cast should be perpendicular to the base and to a line passing between the central incisors.

The sides of the casts should be perpendicular to the base of the cast and parallel to the buccal surface of the posterior teeth.

A land area of 2–3 mm should be maintained around the entire cast. The sides and the posterior borders are joined by trimming just posterior to the hamular notch or retromolar pad (Fig. 22.20).

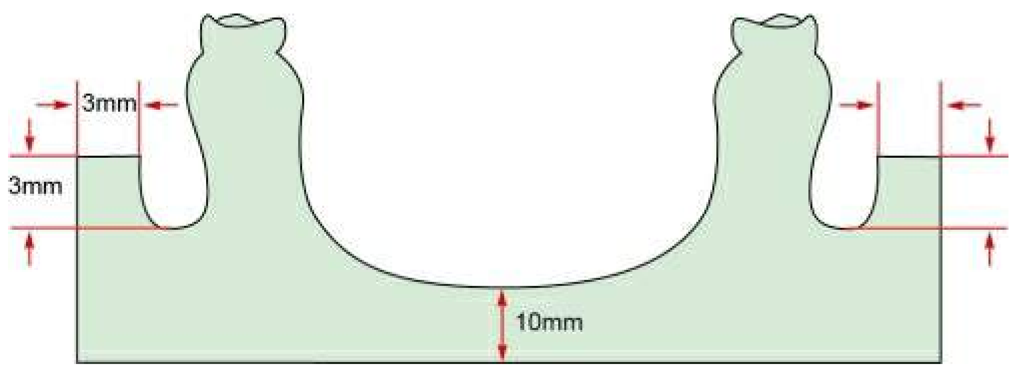


FIGURE 22.20 Cross-sectional dimensions of a diagnostic cast and its base.

The anterior borders of the maxillary cast are trimmed differently from those of the mandibular cast. The anterior borders of the maxillary cast are formed by trimming from the canine area on each to a point anterior to the interproximal area of the central incisors. The anterior border of the mandibular cast is formed by creating a curving wall from the canine on one side to the canine on the other (Fig. 22.21).

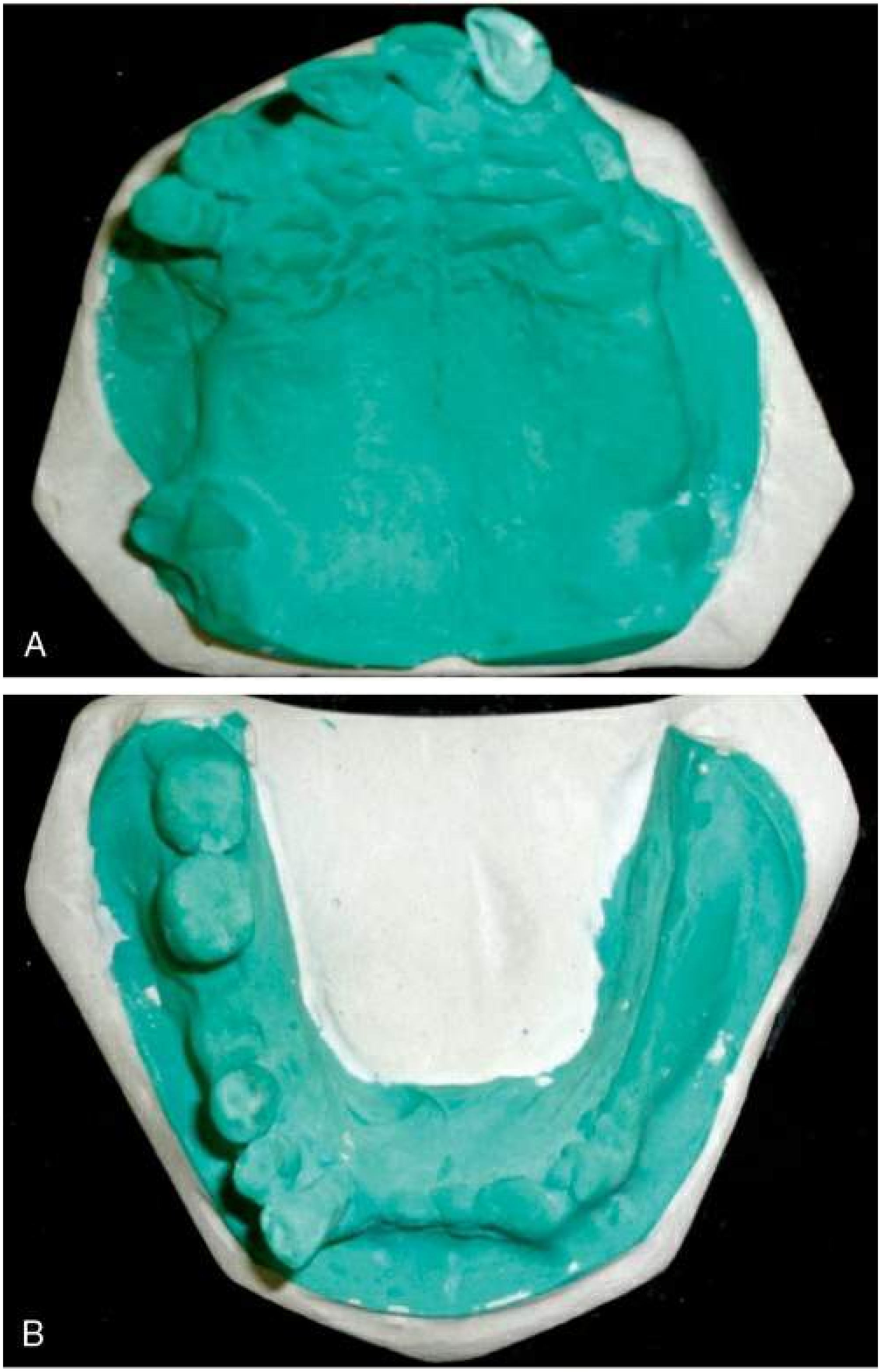


FIGURE 22.21 Diagnostic casts: **(A)** maxillary and **(B)** mandibular.

Tongue space should be trimmed flat while preserving the lingual frenum and alveololingual sulcus.

Nodules of stone caused by voids in the impression can be scraped from noncritical areas.

Mounting of diagnostic cast

The diagnostic cast is mounted on an appropriate articulator using jaw relation records. A facebow transfer is indicated when a semi-adjustable articulator is used.

The use of facebow and procedures involved is described in detail in the section on CD (Chapter 7).

After mounting the maxillary cast on the articulator with a facebow transfer, the mandibular cast is mounted with the jaw relation records.

If most natural posterior teeth remain – and if no evidence of temporomandibular joint (TMJ) disturbances, neuromuscular dysfunction, or periodontal disturbances related to occlusal factors exists – the proposed restorations may safely be fabricated in the maximal intercuspal position (MIP). However, when most natural centric stops are missing, the proposed prosthesis should be fabricated such that the maximum intercuspal position is in harmony with centric relation.

The procedure for recording jaw relations is described in Chapter 27.

The diagnostic cast is surveyed and the design of the partial denture is drawn on the diagnostic cast (refer to Chapter 23) along with the procedures required for 'preparation of mouth' (refer to Chapter 25).

Differential diagnosis

Following assimilation of all the diagnostic data, a decision has to be made whether the partially edentulous condition is to be rehabilitated with a fixed or removable partial denture. The indications and contraindications for these two treatment modalities have been discussed in Chapter 31 and Chapter 18, respectively.

When only a few teeth remain, a decision is to be made regarding removal of all teeth and construction of complete dentures.

A complete denture may be indicated for the following reasons:

- Poor prognosis of remaining teeth.
- Only anterior teeth remain and they are unaesthetic.
- Patient desires to extract the remaining teeth.
- Malalignment of remaining teeth.
- Economic reasons.

Treatment planning

The treatment of partially edentulous patient can be divided into six phases.

Phase I

- Emergency treatment to control pain or infection.
- Collection and evaluation of the diagnostic data – diagnostic casts and radiographs.
- Developing a design and formulating a treatment plan.

Phase II

- Preparation of mouth.

Phase III

- Preparation of abutment teeth.
- Final impressions and fabrication of master cast.

Phase IV

- Fabrication of removable partial denture.

Phase V

- Denture insertion.
- Postinsertion instructions.

Phase VI

- Maintenance and recall.

SUMMARY

The actual construction of the removable partial denture is only the last of many complex procedures, all requiring the dentist to have knowledge and skill in almost every phase of dental practice. Many failures in removable partial dentures can be traced to an inadequate diagnosis leading to an inappropriate or incomplete treatment plan. Hence, the time spent on patient interview to record history, ascertaining patient psychology and expectations and collecting the diagnostic data, is invaluable and forms the most important phase in the construction of a removable partial denture.

CHAPTER
23

Surveying

CHAPTER CONTENTS

Introduction

A standard dental arch for which a removable partial denture is to be constructed is made of remaining natural teeth in varying angulations and edentulous space/s of varying width and length. The challenge is to design and fabricate a prosthesis that can be placed smoothly on the teeth and edentulous ridge, and once in place will resist removal. Everyone is aware of the difficulty in trimming and fitting acrylic temporary partials, the same procedure is impossible with cast partials as it involves metal. In a more definitive prosthesis, such guesswork will create uncontrolled forces on teeth and ridge. Until 1950s most of the removable partial dentures were designed and constructed by the time-honoured method of 'eye balling', which was arbitrary. The advent of 'surveyor' has made this procedure more scientific and controlled. Dr A.J. Fortunati is thought to be the first person to employ a mechanical device to determine the relative parallelism of tooth surfaces. The first commercial dental surveyor was manufactured by J.M. Ney Company in 1923 (Ney Surveyor).

Definitions

Survey: The procedure of locating and delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture.

Surveying: An analysis and comparison of the prominence of intraoral contours associated with the fabrication of a dental prosthesis.

Surveyor: A paralleling instrument used in construction of a dental prosthesis to locate and delineate the contours and relative positions of abutment teeth and associated structures.

Height of contour: A line encircling a tooth and designating its greatest circumference at a selected axial position determined by a dental surveyor.

Survey line: A line produced on a cast by a surveyor marking the greatest prominence of contour in relation to the planned path of placement of a restoration.

Path of placement: Defined as the specific direction in which a prosthesis is placed on the abutment teeth (GPT8).

Guiding planes: Vertically parallel surfaces on abutment teeth oriented so as to contribute to the direction of the path of placement and removal of a removable dental prosthesis (GPT8).

Surveyor

Types

The most commonly used surveyors are

1. **Ney surveyor**: Horizontal arm is fixed.

2. **Jelenko (Wills) surveyor**: Horizontal arm can swivel.

3. **Williams surveyor**: Horizontal arm is split and jointed.

Parts

1. **Surveying platform:** It is a metal base parallel to the floor onto which a cast holder and vertical arm are attached (Fig. 23.1).

2. **Surveying table:** This consists of a base and cast holder. The base sits on the platform and cast holder is attached to it (Fig. 23.1). The cast to be surveyed can be secured to this holder. The holder is attached to the base with a ball and socket joint that permits the cast to be oriented in various horizontal planes so that the axial surfaces of the teeth and soft tissue areas of the cast can be analysed in relation to the vertical plane.

3. **Vertical arm:** This is attached to the platform and supports the horizontal arm (Fig. 23.1).

4. **Horizontal arm**: This extends at right angles to the vertical arm and the surveying arm is attached to it (Fig. 23.1). The Ney, Jelenko and Williams surveyors differ in this aspect as mentioned.

5. **Surveying arm**: It drops vertically from the free end of the horizontal arm (Fig. 23.1). It can be moved vertically up and down. The Mandrel, which holds the surveying tools, is attached to its lower

end. This arm is spring loaded in Jelenko surveyor, while it is passive in the Ney surveyor.

6. **Surveying tools**: These are held by the mandrel attached to surveying arm (Fig. 23.1). The tools are analysing rod, carbon marker, undercut gauges and wax trimmer.

- **i. Analysing rod:** It is the first tool used in surveying. It is a cylindrical metal rod that contacts the convex surface of the teeth to be analysed, like a tangent contacting a curve, thereby locating the *height of contour* (Fig. 23.2). It helps determine the relative parallelism of one surface to another and hence is also called as *paralleling tool*. It also makes an initial assessment of the path of insertion.

- **ii. Carbon marker:** It is similar to lead points in a pencil. It is used to draw the 'survey line' by contacting the teeth similar to the analysing rod (Fig. 23.3). They are circular in cross-section in Ney surveyors and triangular in Jelenko surveyors.

- **iii. Undercut gauges:** Used to determine the amount and location of retentive undercut on the surface of an abutment tooth. It consists of a vertical rod attached to the centre of a circular metal plate. While the rod contacts the height of contour, the circular projection contacts the undercut (Fig. 23.4). The size of projection can vary giving the exact amount of undercut. Generally, it comes as 0.010, 0.020, 0.030 inch gauge.

iv. **Wax trimmer:** Used to trim excess wax from block out areas to make them parallel to path of insertion and to trim waxed crown restorations to desirable path of insertion (Fig. 23.5).

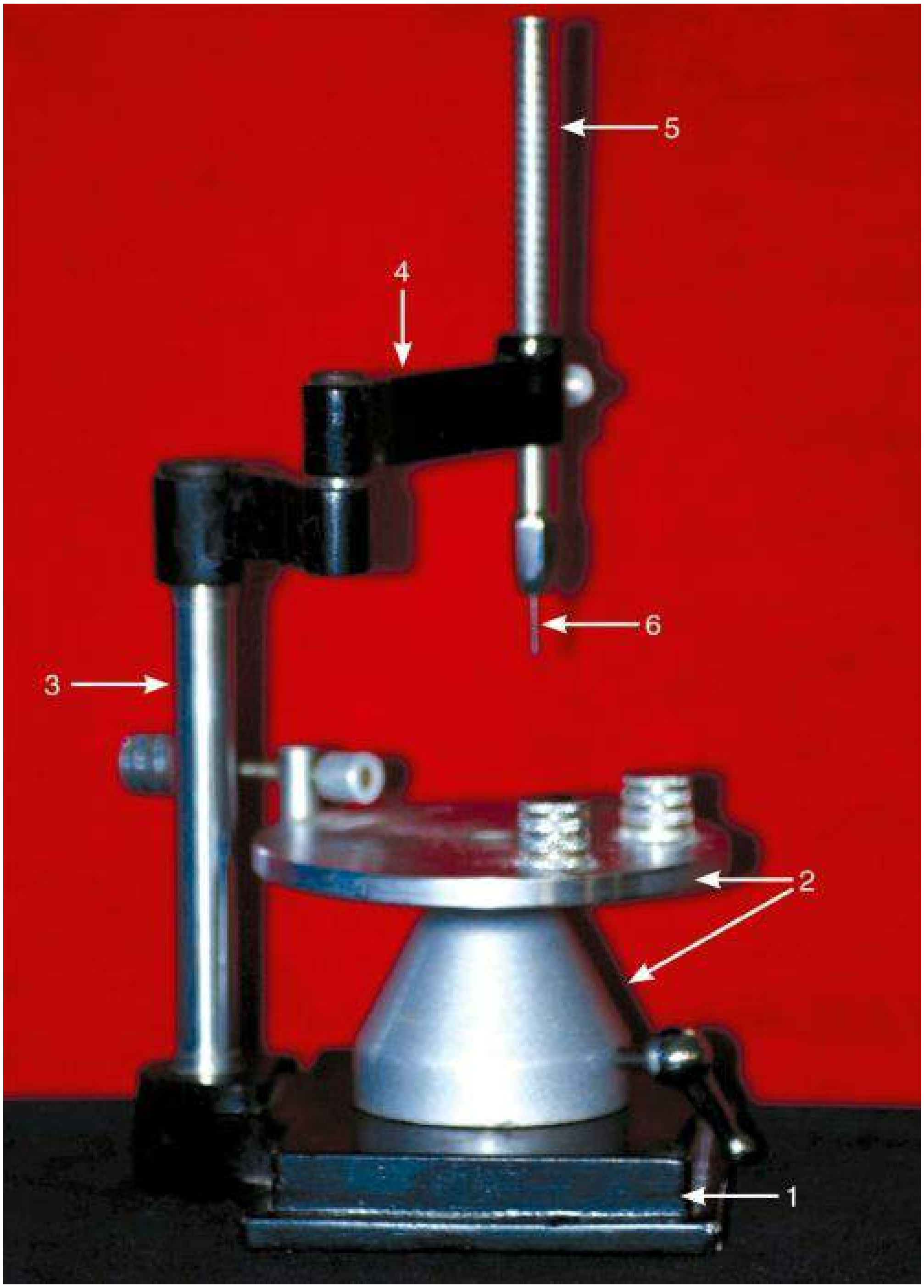


FIGURE 23.1 Parts of a surveyor: (1) surveying platform, (2) surveying table, (3) vertical arm, (4) horizontal arm, (5) surveying arm and (6) tools.

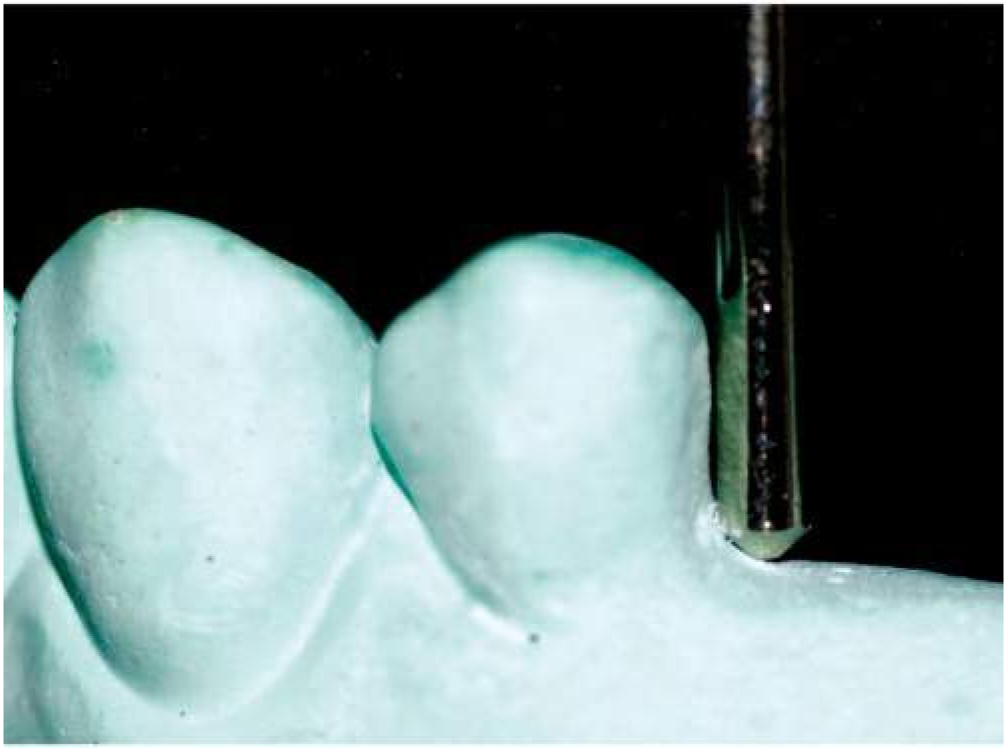
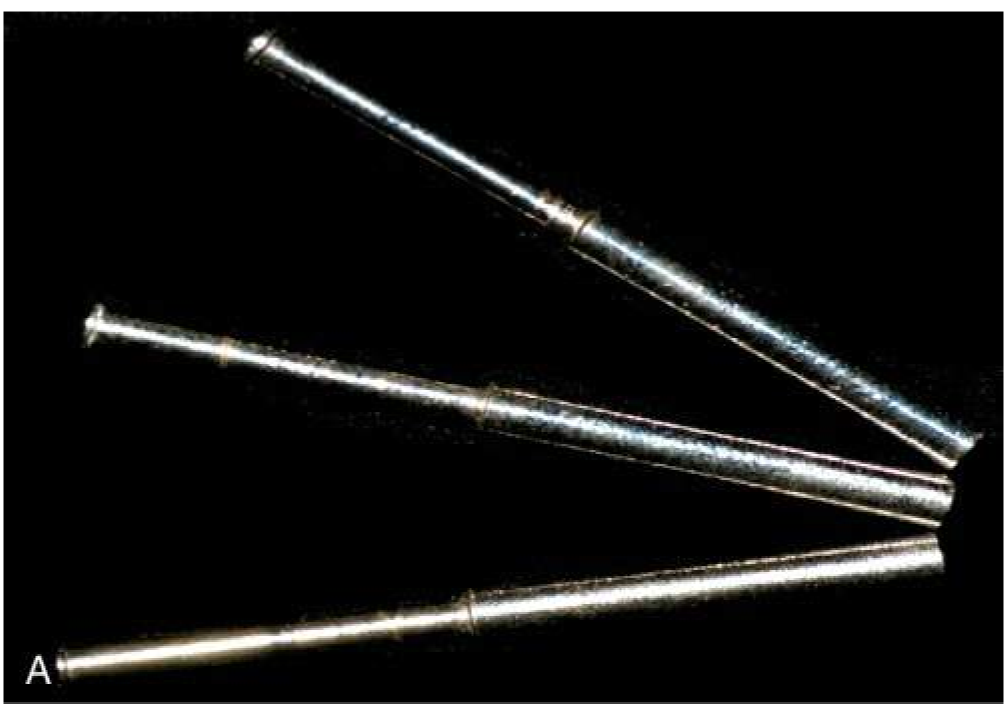


FIGURE 23.2 Analysing rod.

FIGURE 23.3 Carbon marker – used to mark the height of contour.



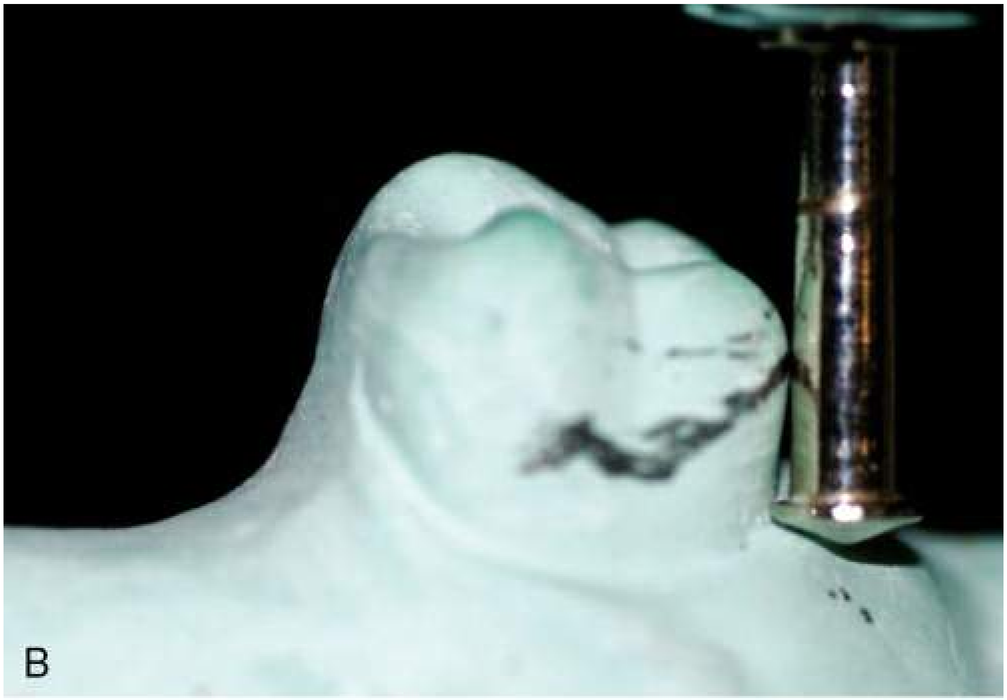


FIGURE 23.4 Undercut gauges. **(A)** Available in different sizes. **(B)** Used to measure the undercut.

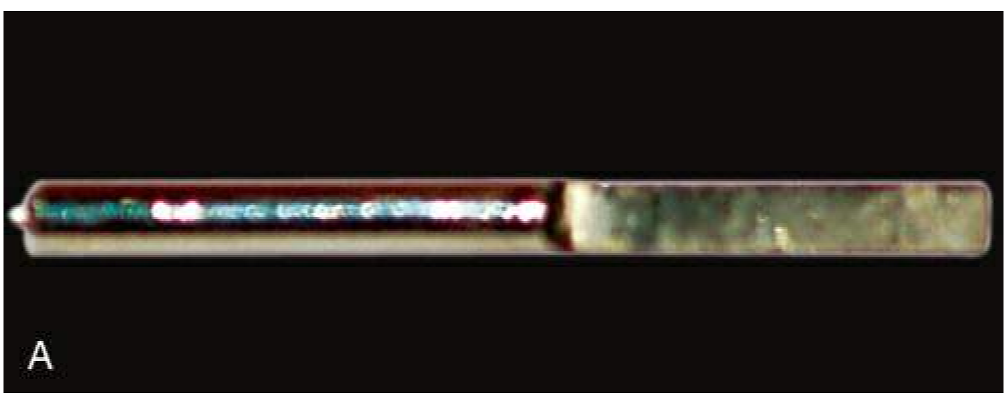


FIGURE 23.5A, B Wax trimmer in use.

Uses/purposes of surveyor

1. Surveying the diagnostic cast

2. Tripoding

3. Surveying the master cast

4. Contouring wax patterns

5. Contouring crowns

6. Placing internal attachments

7. Placing internal rests

Surveying the diagnostic cast

First the diagnostic cast is surveyed to basically determine 'the path of insertion' or the most favourable tilt. The factors that influence this are

1. Retentive undercuts

2. Interferences

3. Aesthetics

4. Guide planes

Tripoding

After the path of insertion or final tilt of cast is selected, it must be recorded on the diagnostic cast. This enables the cast to be oriented back on the surveyor in the same position. This procedure of recording the position is called tripoding. The tripod marks are also transferred to the master cast, so that it can also be positioned similarly.

Surveying the master cast

The master cast is tripoded in the same position as diagnostic cast by tripoding. It is surveyed to perform the following procedures:

1. Beading

2. Block out

3. Relief

Contouring wax patterns

- This is performed by the surveying tool – the wax trimmer.

- Indicated when the proposed abutment needs to be crowned.

- When the wax pattern of the crown is prepared, the working cast is placed on the surveyor in the same position as diagnostic cast, using tripoding.

- Guiding planes on all proximal surfaces of wax patterns adjacent to edentulous areas should be made parallel to the determined path of insertion.
- The height of contour of the wax pattern may also be adjusted to get the right amount of undercut for the placement of retention and reciprocal clasp arms.

Contouring crowns

- The established contours on wax patterns undergo some degree of change following casting procedures and ceramic application. To re-establish the original height of contour and guide plane as developed in the wax pattern, the working cast with the metal crown or unglazed ceramic crown is returned to the surveyor in the same orientation using tripoding and the contour is refined.
- This is performed by attaching a handpiece holder to the surveying arm. This holder then suspends a straight handpiece onto which mounted cylindrical stones are attached. The guiding planes can be refined by moving the surveying table so that the mounted stone contacts the guiding plane of crown or restoration. Final finishing and polishing or glazing is performed after this.

Placing internal attachments

- The surveyor may be used to position intracoronal retainers or internal attachments along the path of insertion in the wax crown pattern of abutment teeth, as the patterns are being formed (Fig. 23.6A and B). Absolute parallelism among the attachments is necessary.
- The surveyor is first used to verify the space available in the abutment by making a recess in the stone abutment teeth on diagnostic cast. If space is adequate (without any pulpal

encroachment), a recess is carved in wax pattern and attachment is placed. The path of insertion is again verified after casting by using the surveyor.

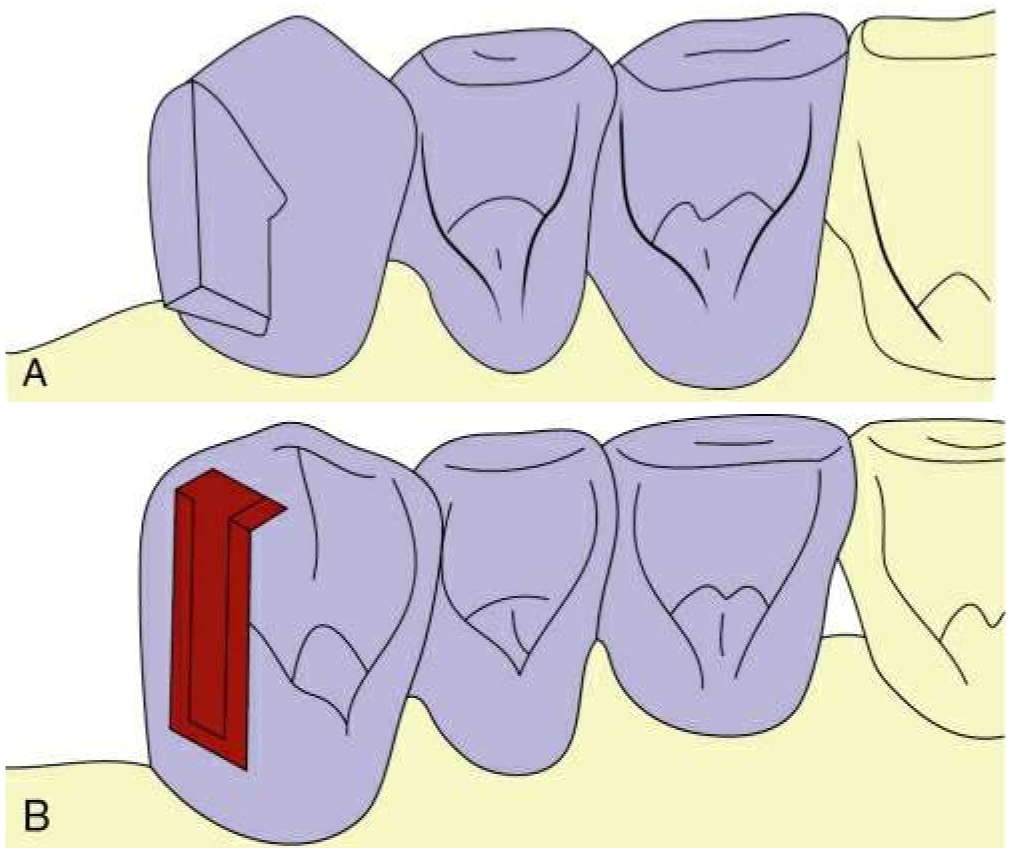


FIGURE 23.6 **(A)** Recess carved in wax pattern. **(B)** Attachment placed.

Placing internal rests

- These are box-shaped exaggerated occlusal rests with vertical walls and flat floors. They can be created in the wax patterns of abutments crowns, in harmony with the path of insertion, by using the straight handpiece of surveyor with appropriate tools.

- It provides good support and stabilization. Depending on the taper of the walls, retention can be controlled. It is contraindicated with distal extension base partial dentures as more torque is applied to the abutment using this interlocking rest.

Surveying

The surveying procedure usually involves the following procedures.

Surveying diagnostic cast

This is done before the treatment plan is formulated.

Objective

The main objective of surveying the diagnostic cast is to determine the most desirable *path of placement* (insertion) that will eliminate or minimize the interference to the placement and the removal of prosthesis.

This basically involves determining the *most favourable tilt* of the cast with respect to various factors involved in determining the path of placement.

Mounting of cast

The cast to be designed, whether maxillary or mandibular, is first attached to the cast holder such that occlusal plane is parallel to the base. The anterior teeth should face the vertical arm of the surveyor and cast is locked in this position. This is called horizontal tilt or 0° tilt and is the starting point for the surveying procedure (Fig. 23.7).

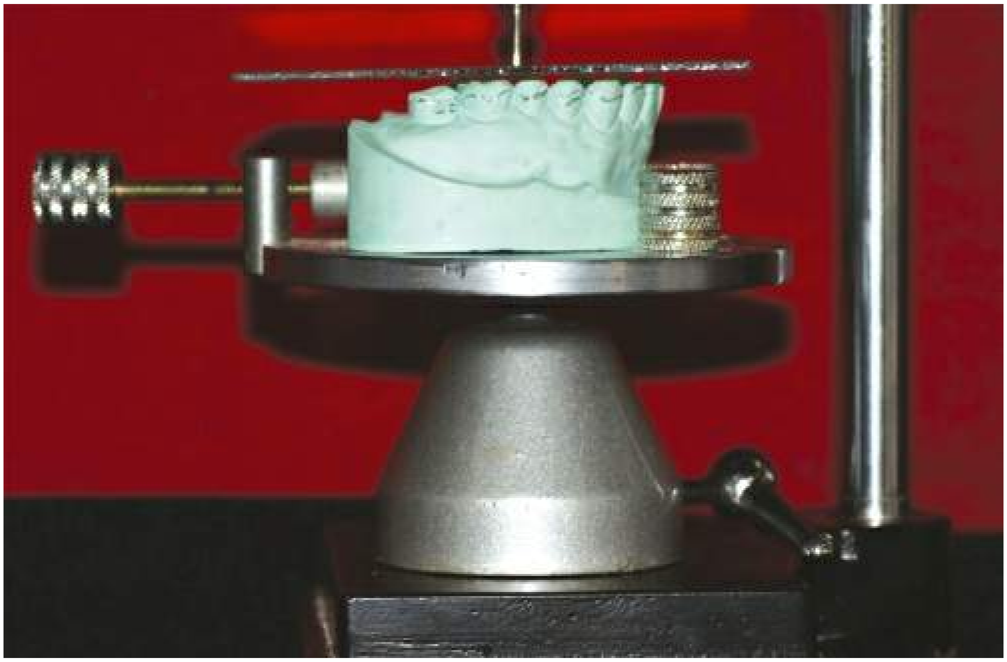


FIGURE 23.7 Correct position of cast while mounting on surveyor – horizontal or zero tilt.

Tilting

Tilting changes the position of the cast, which in turn changes the long axis of each tooth on the cast relative to the horizontal plane. Tilt is seen from the view of a person looking at the cast from the rear. Thus, if anterior part of cast is lowered, it is called anterior tilt. Similarly the cast can be tilted posterior, right, left or a combination of these (Figs 23.8 and 23.9). Tilting more than 10° from the horizontal should be avoided as the patient would be unable to open the mouth sufficiently to accommodate this exaggerated tilt. The final tilt determined after considering the factors affecting the same will give the final path of placement of the prosthesis.

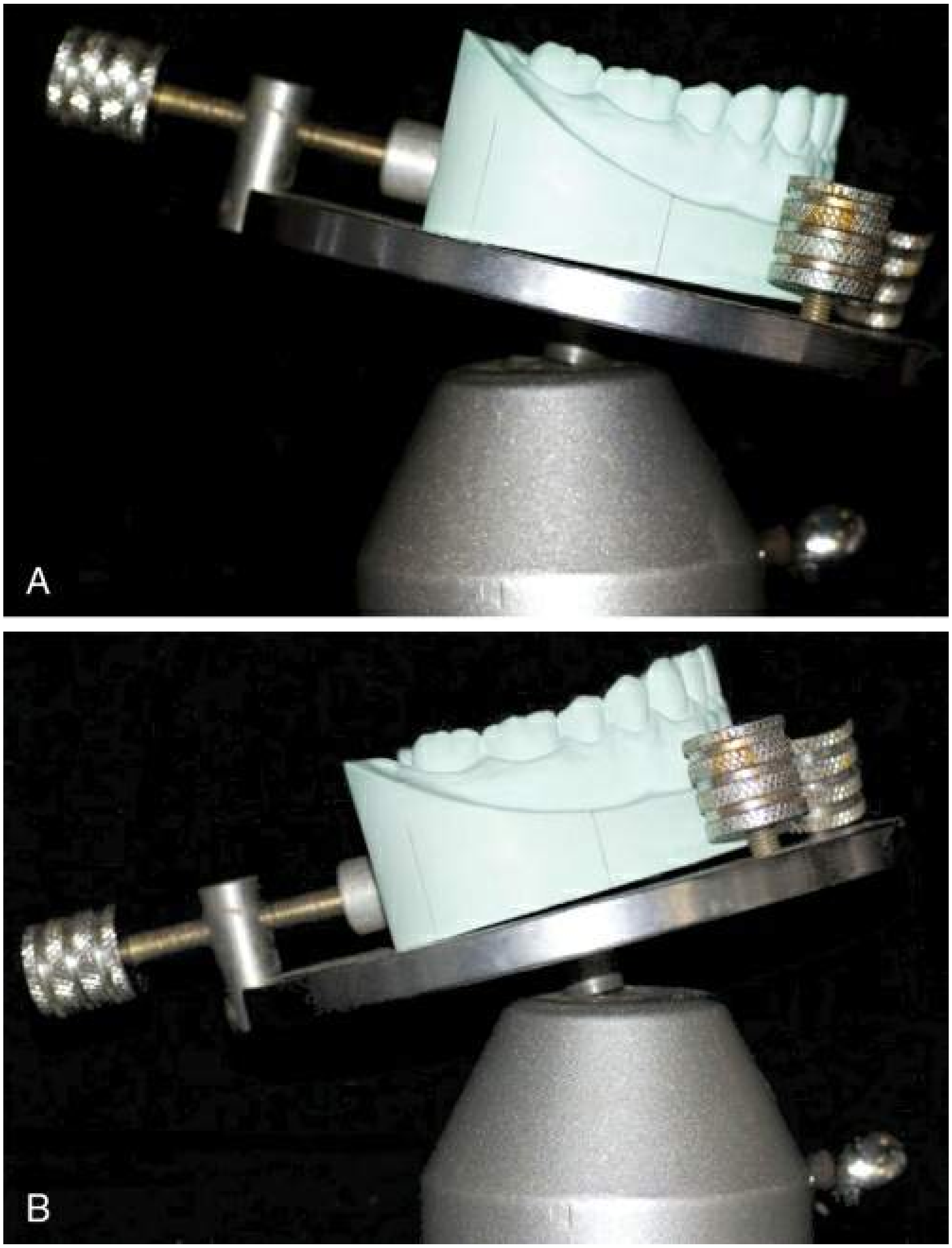


FIGURE 23.8 **(A)** Anterior tilt. **(B)** Posterior tilt.

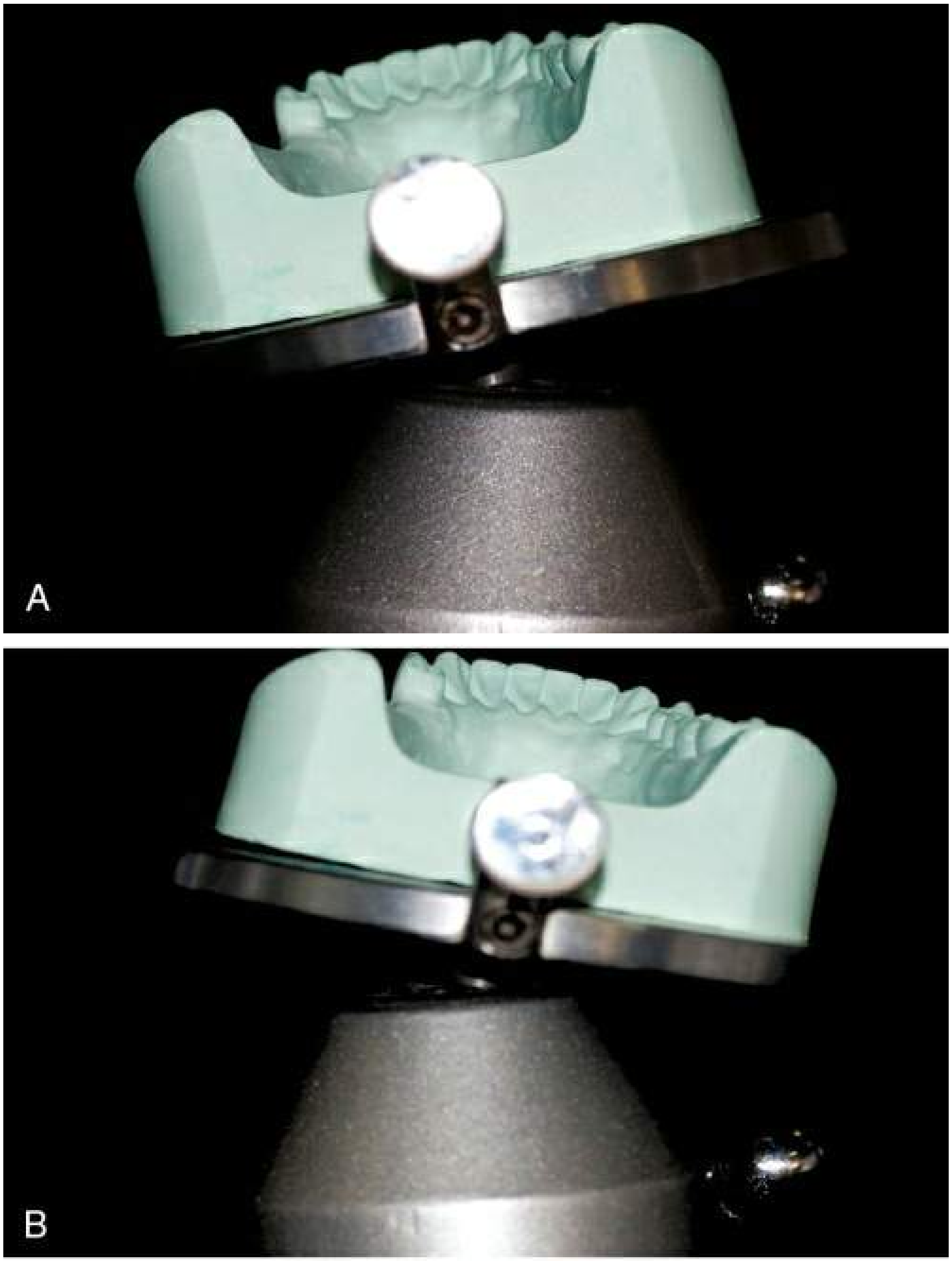


FIGURE 23.9 **(A)** Left tilt. **(B)** Right tilt.

In general, anteroposterior tilts will influence the guiding planes, while the right and left lateral tilts will change amount of the retentive undercuts, which in turn will affect placement of retentive and reciprocal arms.

Path of placement or insertion

As previously noted, the tilt of the cast determines at what angle the partial denture will seat over the remaining teeth. This angle is referred to as the path of placement. All the various factors that influence this seating of the restoration should be considered to determine the final path. It will always be parallel to the vertical arm of surveyor (Fig. 23.10).

- The number of paths of placement may be single or multiple depending on whether the edentulous space is tooth borne or distal extensions. If it is completely tooth borne like a class III situation, then the prosthesis will have a single path of placement (Fig. 23.11). In case of Kennedy's class II with a modification on the opposite side, again there will be a single path as the same is controlled by the guide planes on the tooth bound side (Fig. 23.12).

- In a class I situation, there will be multiple paths of entry and exit of prosthesis on the abutments and additional guide planes on lingual surfaces of other teeth may be needed to restrict the number of paths (Fig. 23.13). The class IV situation will usually have a single path parallel to the proximal surface of abutment teeth (Fig. 23.14).

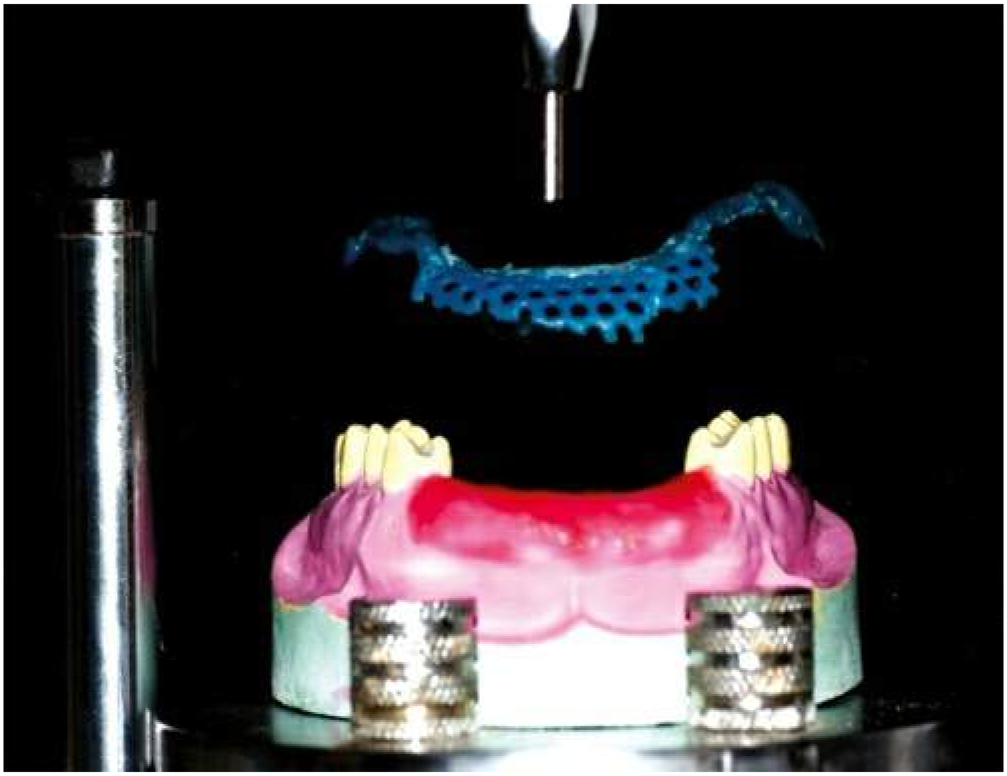


FIGURE 23.10 Path of placement or insertion.

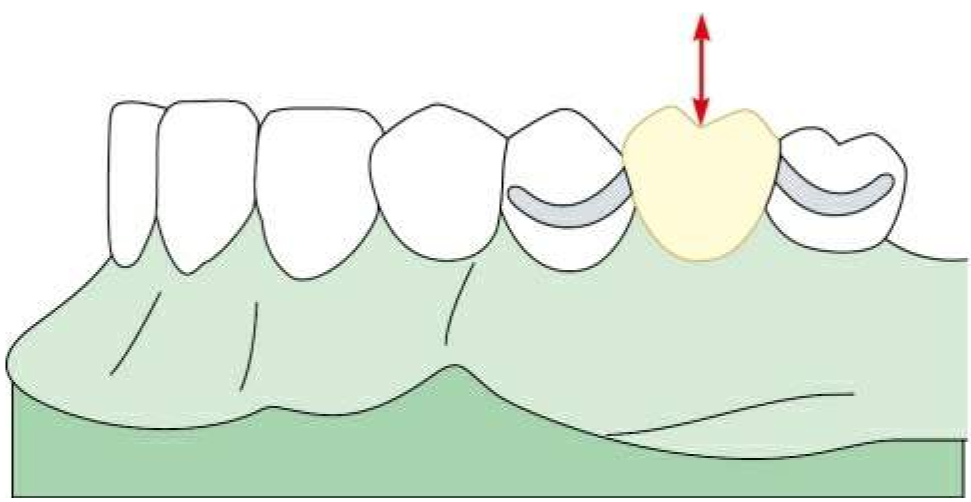


FIGURE 23.11 Class III – single path of insertion.

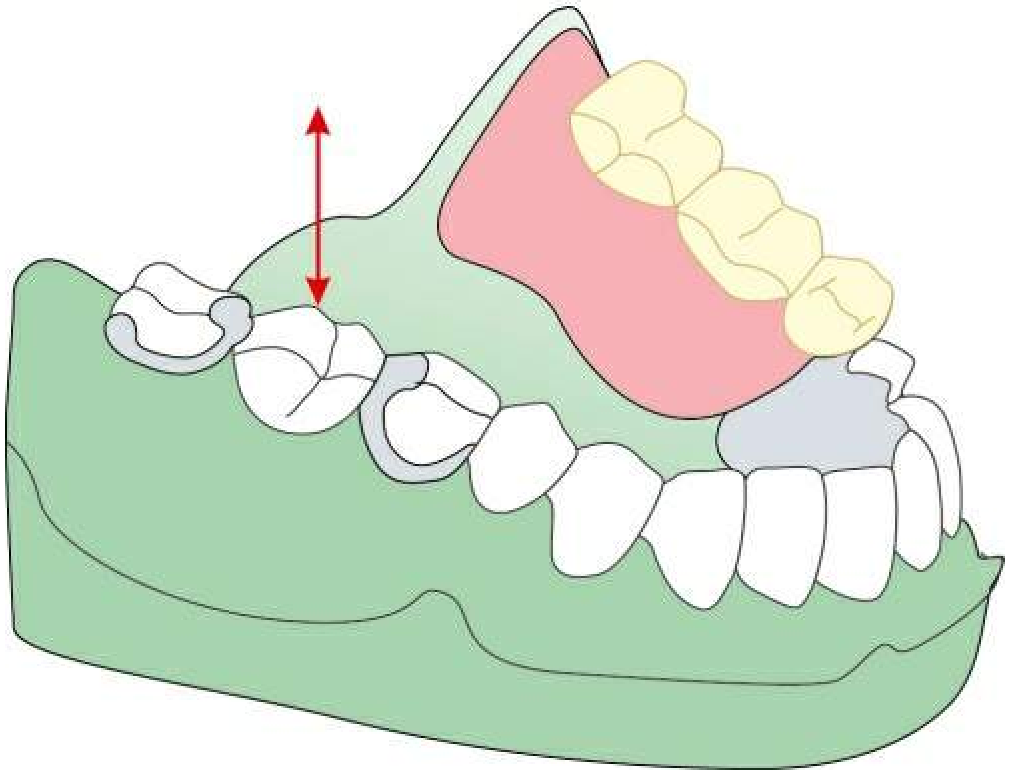


FIGURE 23.12 Modified class II – single path of insertion.

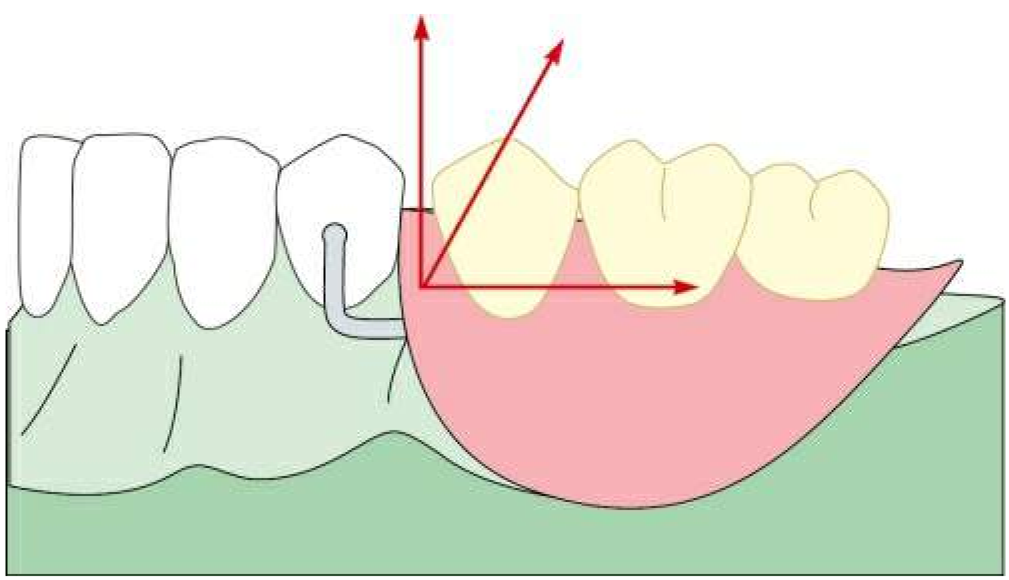


FIGURE 23.13 Class I – multiple path of insertion.

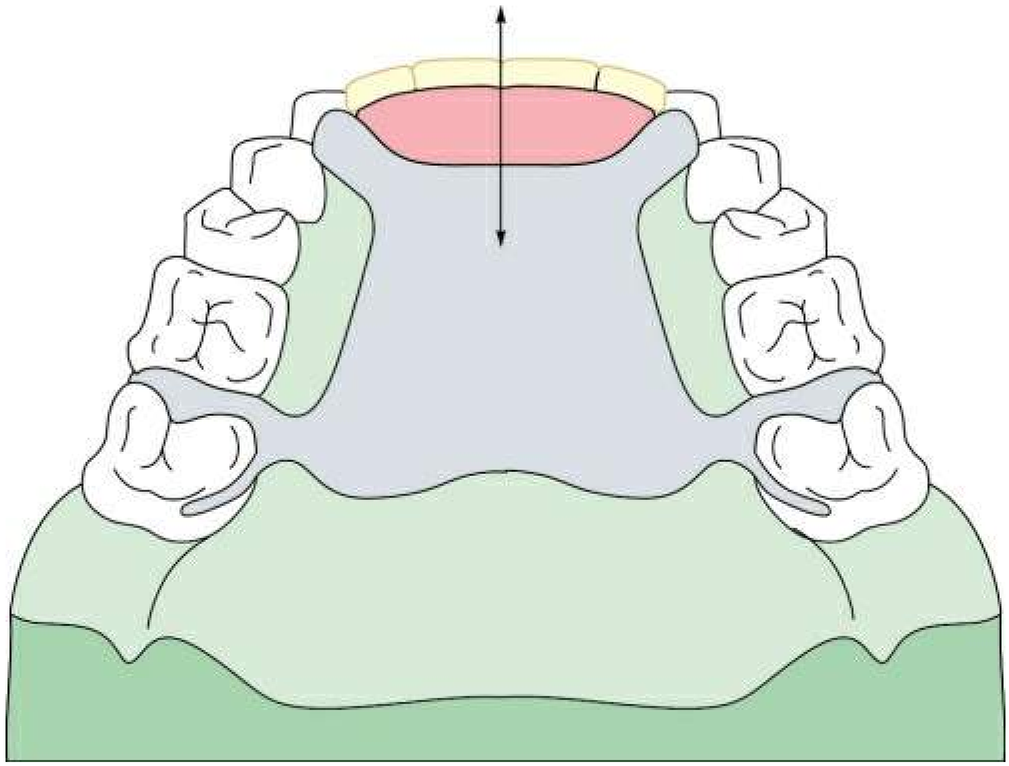


FIGURE 23.14 Class IV – single path of insertion.

Factors affecting the path of insertion:

It may be impossible to achieve the optimum among all factors which affect the path of insertion as one or other may need to be compromised. It is only clinical judgment which finally dictates and may be compromised without sacrificing the quality of service.

The following four factors should be considered before final path of placement is selected.

1. Retentive undercuts

- The most important rule to consider is that retentive undercuts must be present on the abutment teeth at the horizontal or 0° tilt (Fig. 23.7). As dislodging forces are always perpendicular to the horizontal plane, even if cast is tilted to create undercuts on the abutments (Fig. 23.15), there will still be no resistance to forces in this direction. This is first checked using the analysing rod attached to the vertical arm and examining the buccal surface of the abutments (Fig. 23.16).

- If undercuts are not present, they must be created. This can be done by recontouring the buccal surface if only slight modification is needed. Otherwise a crown is made on the abutment with the desired undercut.

- When retentive undercuts are found at horizontal tilt, it may be changed to alter the amount of undercut on abutments (Fig. 23.17). Tilting is also used to increase the desirable undercuts and to decrease undesirable undercuts on abutments. The available undercuts could be distributed to obtain uniform retention (Fig. 23.18). The right lateral tilt increases undercuts on buccal surfaces of teeth on right side and vice versa (Fig. 23.9).

- Tilting can also lower the height of contour such that the retentive arm is placed at the gingival thirds of the abutment and not further occlusally (Fig. 23.19). As already seen, this position of retentive arm enhances aesthetics and reduces the rotational forces transmitted by clasp on the abutments.

- The undercut gauge is then used to get the desired amount of undercut after the survey line is scribed on the abutment (Fig. 23.4B). A 0.010 inch undercut is ideal for chrome alloys. For gold alloys and wrought alloys, more undercut can be utilized as already discussed. The retentive terminal should be placed either at the distobuccal or mesiobuccal line angle in the gingival third of the clinical crown of abutment.

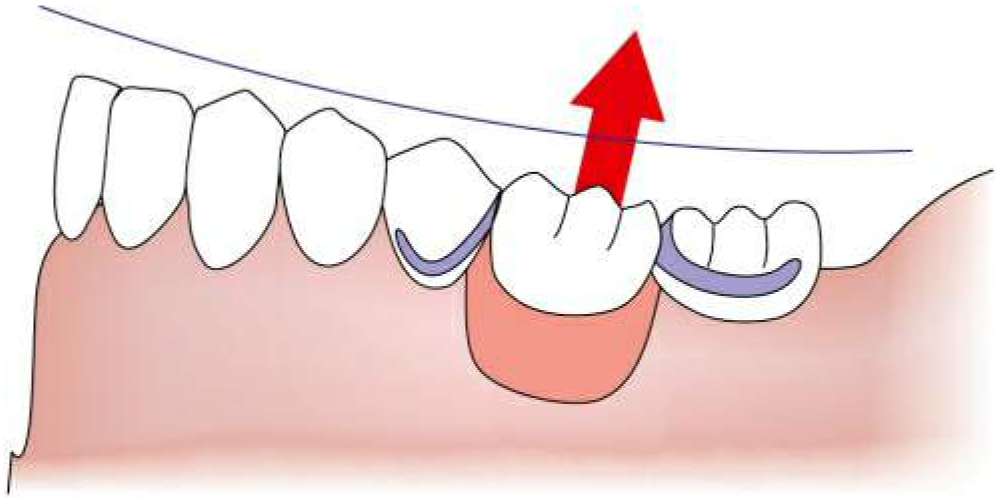


FIGURE 23.15 Dislodging forces are perpendicular to horizontal plane. So undercuts must be present at horizontal tilt on the abutments.

FIGURE 23.16 Analysing rod used to check for undercuts at horizontal tilt.

FIGURE 23.17 Altering the tilt to increase or decrease the amount of undercut.

FIGURE 23.18 Tilting the cast can also ensure uniform distribution of undercuts on the abutments.

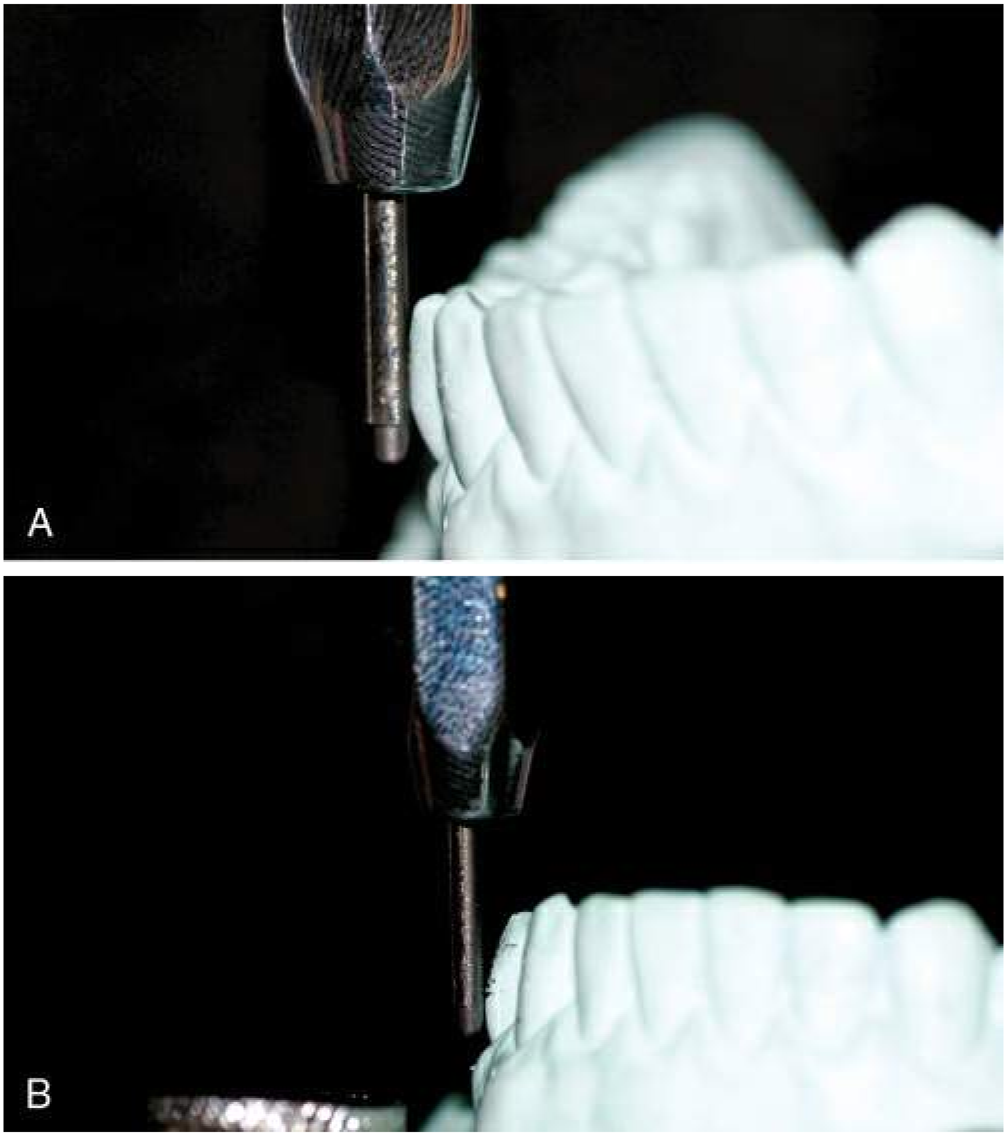


FIGURE 23.19 **(A)** Position of retentive tip more needs to be placed more occlusally without tilting. **(B)** Position of retentive tip placed more gingivally after tilting.

2. Interferences

Interferences to insertion of partial denture are mainly caused by:

i. Teeth

ii. Soft tissue undercuts

iii. Bony prominences or exostoses

They have to be eliminated either by tilting the cast or rarely by surgery.

Interferences in mandible

1. **Lingual tori:** If possible, relief can be provided under the major connector to minimize pressure on tori, but this can lead to compromise in thickness of major connector and tongue interference. The only other practical option is surgery to remove tori (Fig. 23.20).

2. **Lingual tilt of posterior teeth:** Remaining teeth in the mandible are frequently lingually inclined and tend to drift mesiolingually (Fig. 23.21). If unilateral, cast may be tilted to get better path of insertion and undercut usage. If bilateral, major connector would have to be placed away from the lingual mucosa to be able to insert the prosthesis. This results in undesirable tongue interference and food entrapment. Solutions may be use of labial bar, lingual retention, recontouring, crowning and orthodontic uprighting of abutment teeth depending on severity of problem and patient compliance.

3. **Area lingual to retromolar pad:** If unilateral, lateral tilting of cast will solve problem (Fig. 23.22). If bilateral, acrylic denture base can be trimmed to insert the denture or rarely surgery is indicated.

4. **Bony prominence or undercuts:** Undercuts buccal to premolars and canine are not uncommon (Fig. 23.23). These interfere with denture base and placement of bar clasp. If mild – tilting, if severe – surgery.

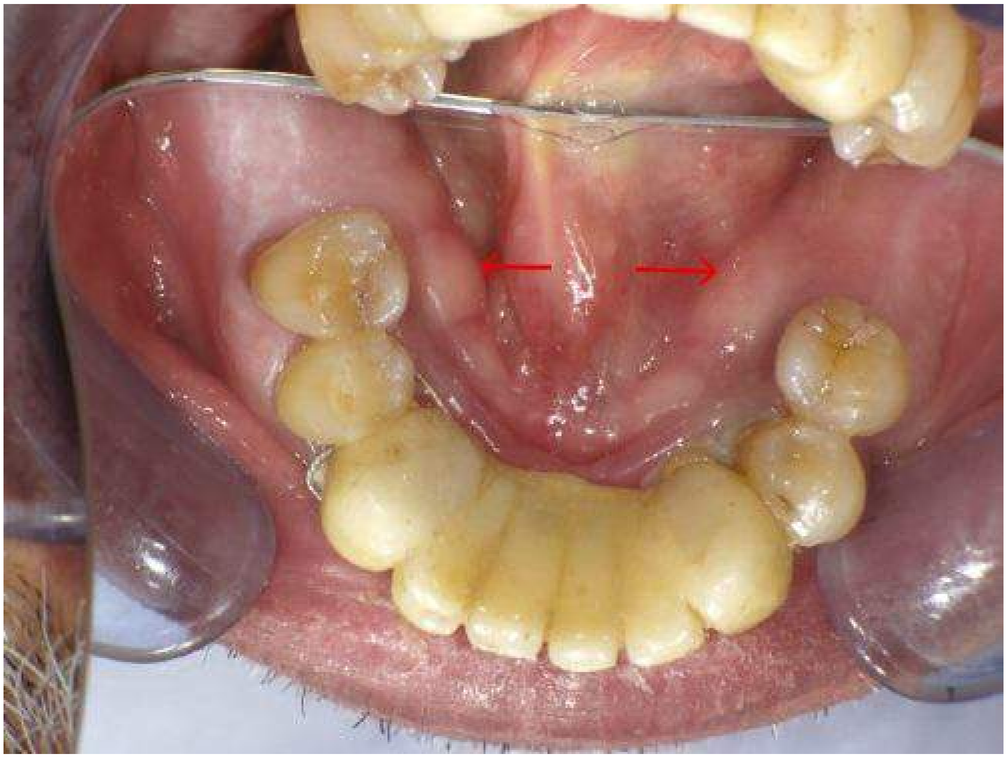


FIGURE 23.20 Lingual tori.

FIGURE 23.21 Lingual tilting of posterior teeth.

FIGURE 23.22 Interference lingual to retromolar pad.

FIGURE 23.23 Bony prominences.

Interferences in maxilla

1. **Palatal torus:** Change of major connector design to avoid the torus or surgery is indicated when interference with a palatal torus occurs (Fig. 23.24).

2. **Bony prominence and undercuts:** These occur buccal to posterior edentulous ridges. If these are relieved, it can lead to food entrapment in the space created under the denture base and decreased denture stability (Fig. 23.25). They can be corrected surgically.

3. **Facial tipping of posterior teeth:** This raises the height of contour to a more occlusal level, making placement of retentive buccal clasp arms unaesthetic and at a mechanical disadvantage, increasing forces on the abutment (Fig. 23.26). Gingival tissues are also undercut in this

situation contraindicating the use of bar clasp. If the (Fig. 23.27) tipping is unilateral, titling will lower the height of contour (Fig. 23.28). If bilateral, recontouring of enamel can be performed if tipping is slight (Fig. 23.29). If severe, crowning may be the only option.

4. **Anterior ridge undercut:** When an anterior ridge is undercut, posterior tilting will reduce the same and also help in more aesthetic positioning of anterior teeth (Figs 23.30 and 23.31). The denture flange can also be eliminated by placing teeth directly on ridge – 'gum fit' denture (Fig. 23.32).

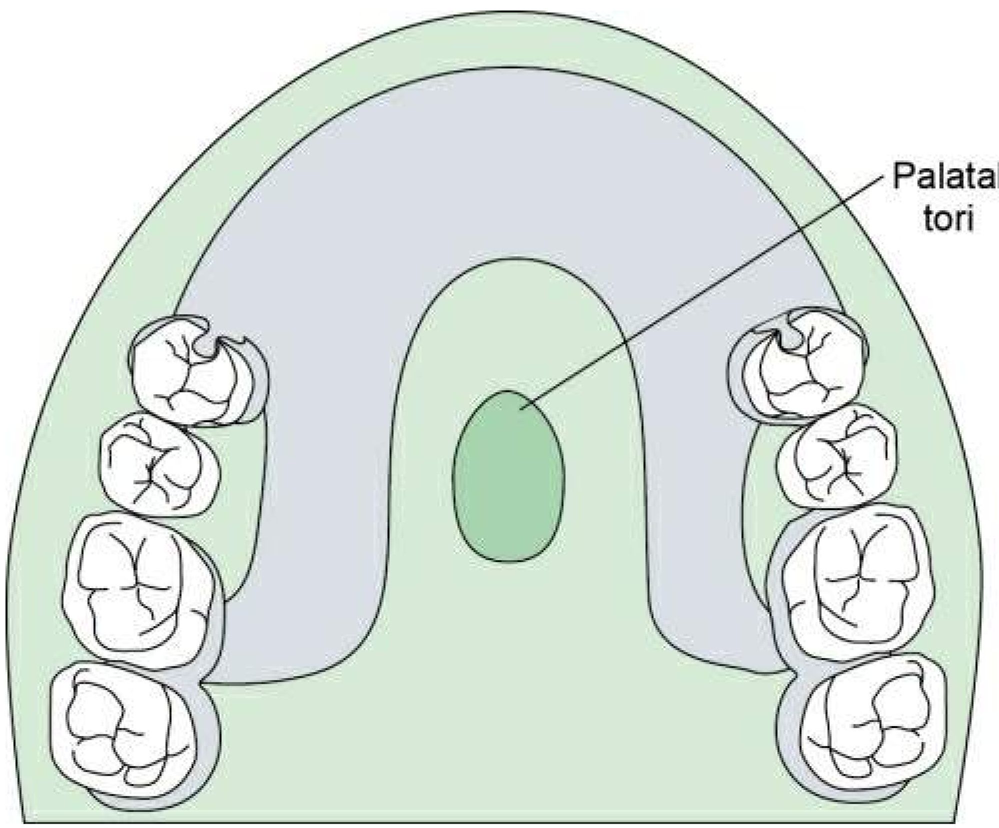


FIGURE 23.24 Palatal torus avoided by use of horseshoe major connector.

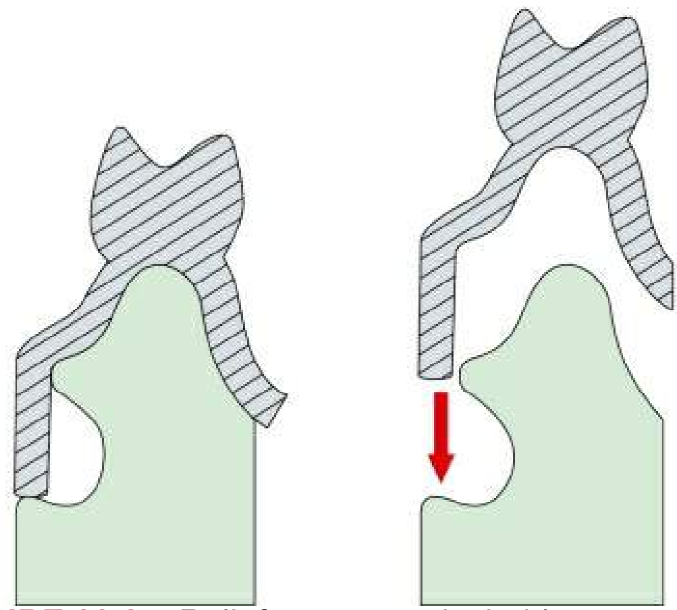


FIGURE 23.25 Relief causes undesirable space.

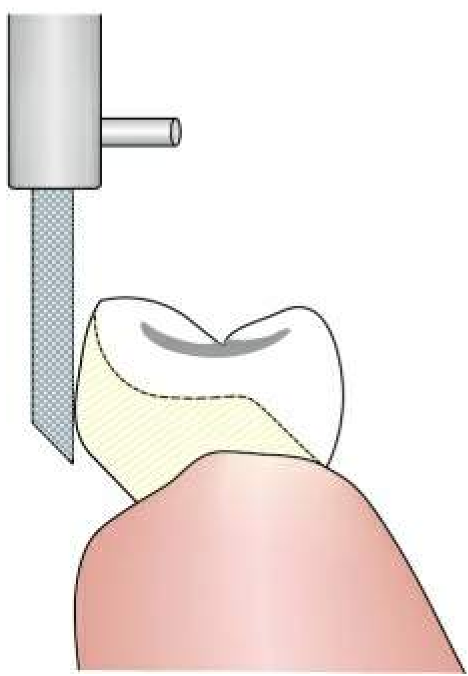


FIGURE 23.26 Buccal tilting of maxillary posteriors causing high survey line.

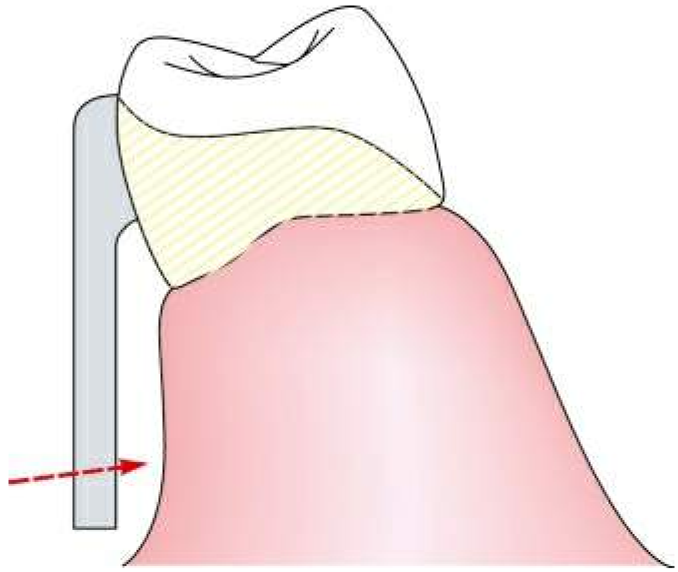


FIGURE 23.27 A high survey line is contraindicated for bar clasp due to presence of soft tissue undercut.

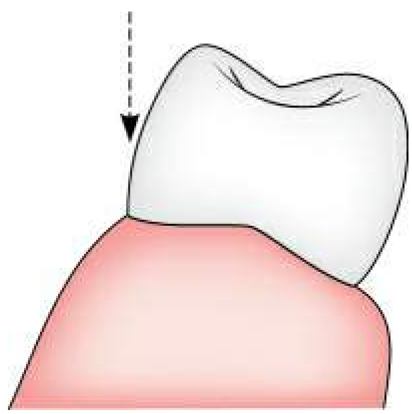


FIGURE 23.28 High survey line can be lowered by tilting.

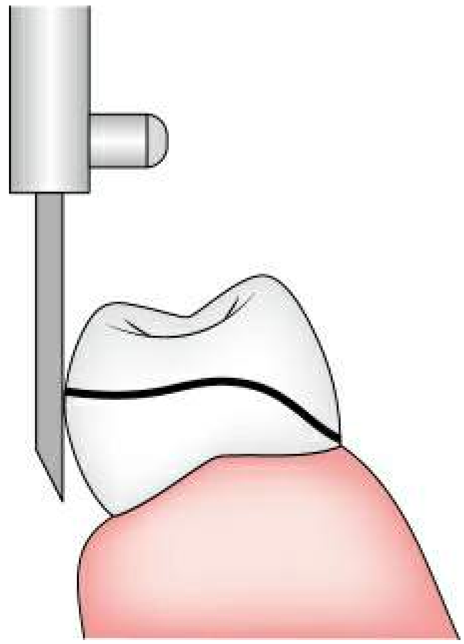


FIGURE 23.29 Buccal surface can also be recontoured to lower the survey line.

FIGURE 23.30 Anterior undercut ridge.

FIGURE 23.31 Eliminated by tilting to change the path of insertion.

FIGURE 23.32 Placing teeth directly on ridge without denture flange (gum fit) can also overcome anterior undercut ridge problems.

3. Aesthetics

To optimize aesthetics the following should be considered:

i. Metallic clasp arms should be concealed as much as possible. This can be achieved by:

a. Tilting cast to lower the height of contour so retentive tip could be placed in gingival third of abutment (Fig. 23.33).

b. Selection of clasp with less metal display – I-bar clasp (Fig. 23.34).

ii. Anterior artificial teeth should be placed in most natural position:

a. Mesial drifting or inclination of remaining anterior teeth occurs when lost anterior teeth are not replaced immediately. The replacement teeth will be smaller than the original. The original size can be restored by recontouring or disking the proximal surfaces adjacent to edentulous space with a surveyor. This not only enhances aesthetics but also creates guide planes to allow only a single path of insertion. Alternately crowns can also be planned if recontouring is not possible.

b. Large undercuts may be seen anteriorly on proximal surfaces of teeth adjacent to edentulous space (Fig. 23.35). If path of insertion is vertical, removable partial denture will be made with this space visible (Fig. 23.36). This is unaesthetic and also causes food entrapment. A posterior tilt will make the path of insertion more labial and will eliminate the space making the prosthesis more aesthetic (Figs 23.37 and 23.38).

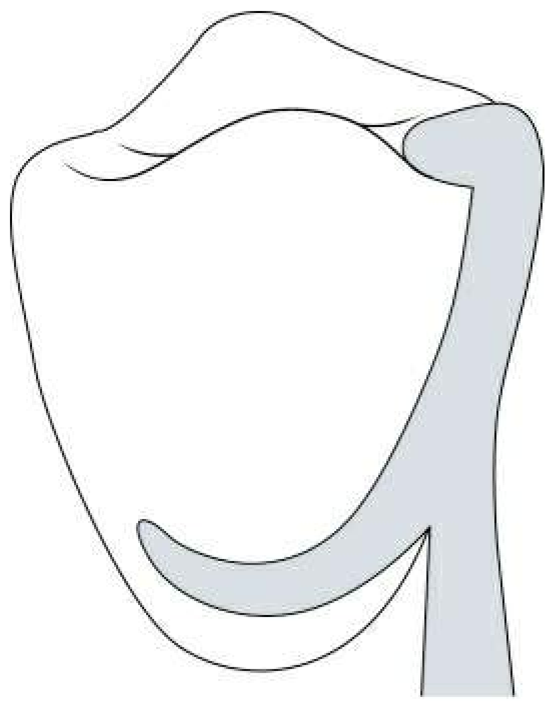


FIGURE 23.33 Placing retentive tip in gingival third will conceal the clasp, enhancing aesthetics.

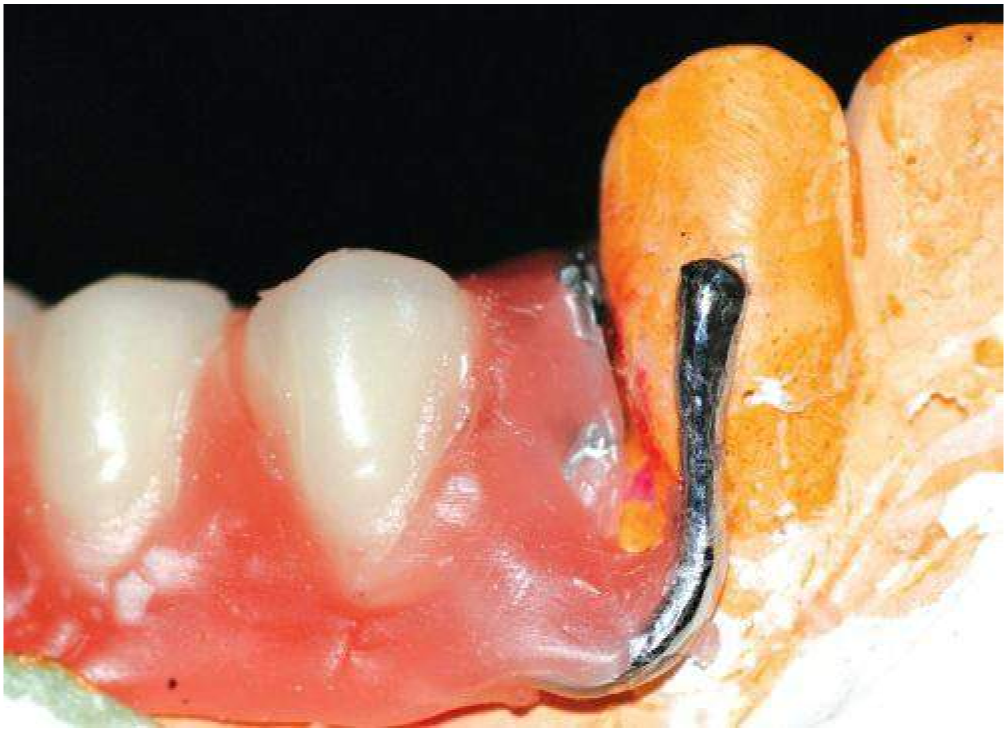


FIGURE 23.34 I-bar clasp: displays less metal, hence more aesthetic.

FIGURE 23.35 Large anterior undercut.

FIGURE 23.36 RPD made as such will show an unsightly mesial space.

FIGURE 23.37 Posterior tilt eliminates undercut.

FIGURE 23.38 Better aesthetics with no space.

4. Guiding planes

- These are prepared on the proximal or axial tooth surfaces of the teeth (Fig. 23.39).
- They are created by the contact of the minor connectors and other rigid components of the partial denture against the prepared proximal tooth surface.
- They help in insertion and removal of prosthesis without any undesirable forces on the abutments. Hence, it should be parallel to the path of insertion.
- Using the analysing rod of surveyor, the proximal surfaces of the abutments that can be made parallel to each other are identified by anteroposterior tilting of the cast. The guide planes are then prepared by recontouring the proximal enamel surface. Rarely crowning of the abutment may be necessary to create guide planes.
- Sometimes the lingual surface of crowns is made parallel to the path of placement by creating a ledge in wax pattern. This contact of the reciprocal component will also create a guiding plane.
- **Form:** Width should be two-third the distance between the buccal and lingual cusp tips or one-third the buccolingual width of tooth. Height should be about two-third the length of the crown from the marginal ridge cervically. In general, it should be 2–3 mm in height occlusogingivally.
- **Functions:**

  ○ Make insertion and removal of prosthesis easier for patient.

- ○ Provide resistance to horizontal forces.
- ○ Minimize wedging forces on abutments.
- ○ Aid in stabilising individual teeth.
- ○ Minimize space between prosthesis and abutments and reduce food entrapment.
- ○ Contribute to retention of prosthesis.

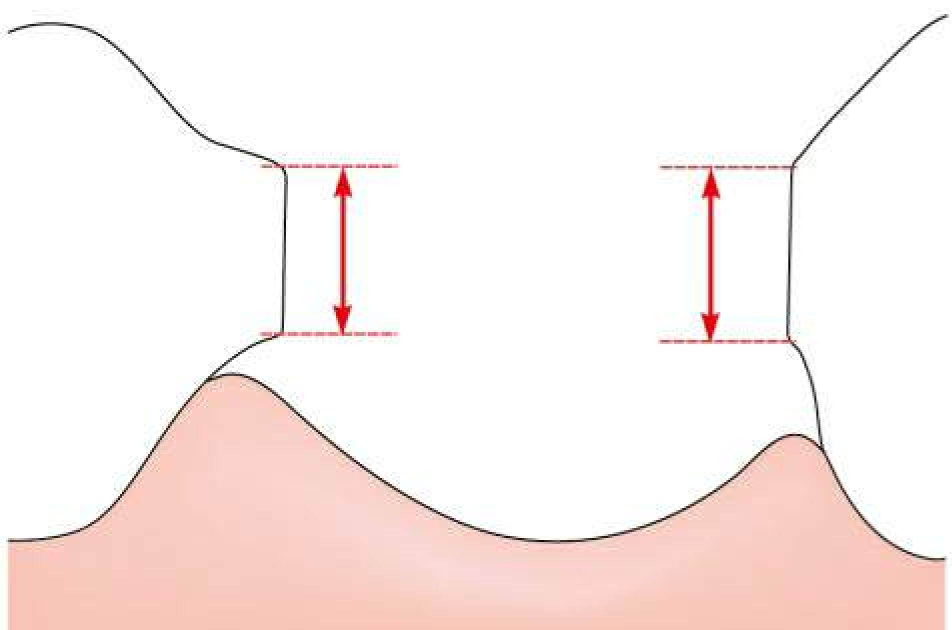


FIGURE 23.39 Guiding planes.

Tripoding or tripod marking

Definition: Those marks or lines drawn on a cast in a single plane perpendicular to the survey rod to assist with repositioning the cast on a dental surveyor in a previously defined orientation.

The final position (tilt) of the cast in relation to the horizontal plane has to be recorded so that the cast could be placed back on the surveyor for any later analysis if necessary. This is called 'tripoding'. This can be achieved by the following two methods:

Tissue surface indexing

Cast with determined final tilt is locked on surveyor table (Fig. 23.40). The vertical arm of surveyor is also locked (Fig. 23.41) such that it contacts the tissue surface of the cast. Horizontal arm can be moved.

FIGURE 23.40 Cast is locked.

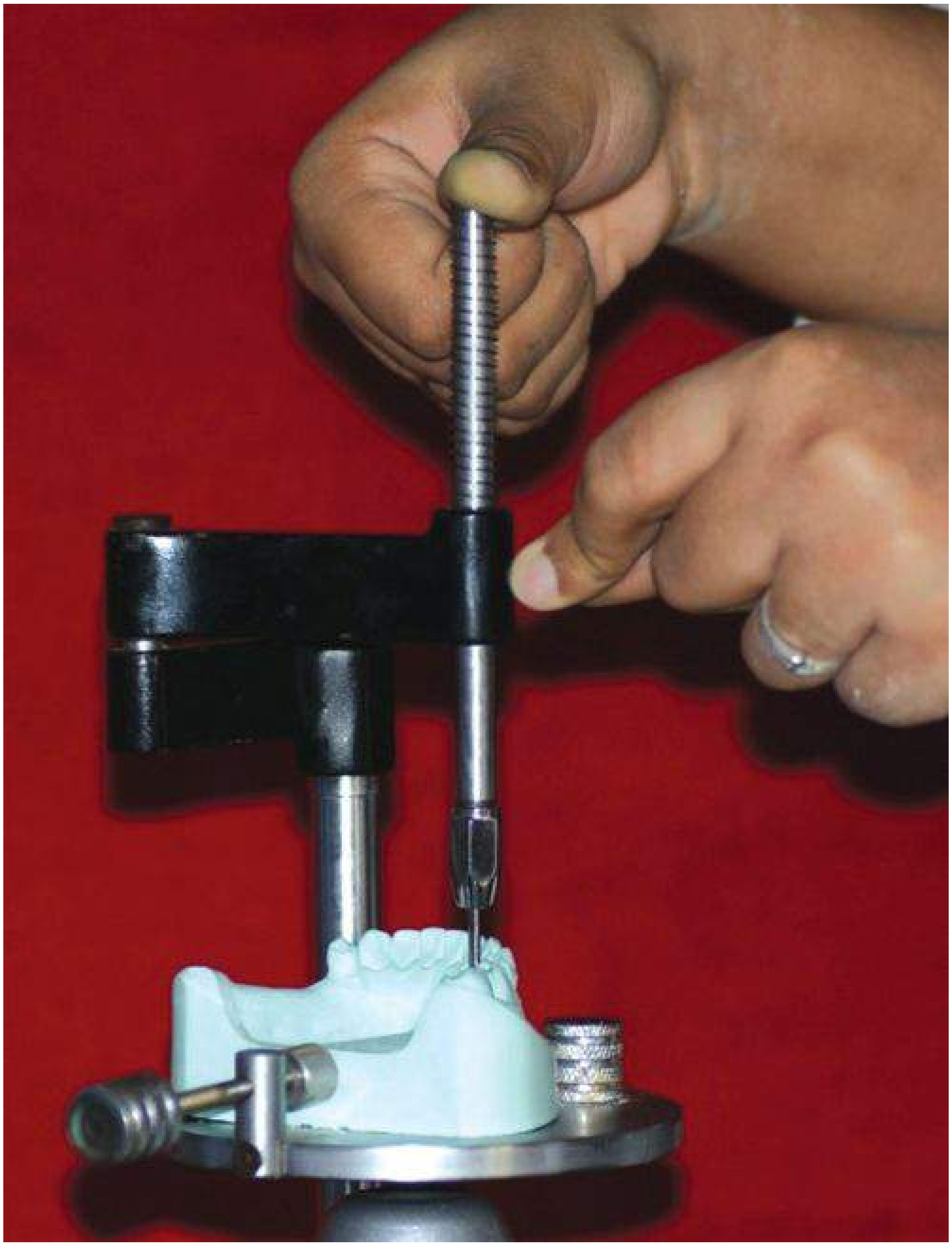


FIGURE 23.41 Vertical arm is locked.

Undercut gauge is attached to the mandrel, and three widely divergent marks are created on the tissue surface by pressing the gauge against the cast (Fig. 23.42). These marks are then highlighted in pencil by making a cross and circling it (Figs 23.43 and 23.44). These marks should not be placed on areas of cast involved in framework design (Fig. 23.45). This will establish three points in the same horizontal plane and permit the cast to be repositioned precisely (Fig. 23.46).

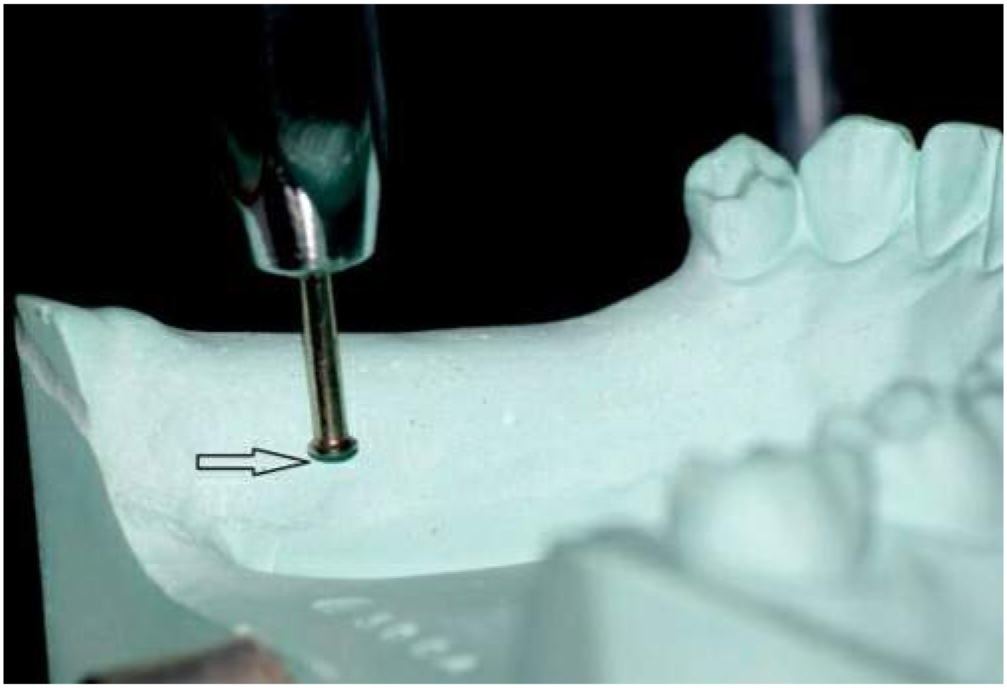


FIGURE 23.42 Undercut gauge scribes a mark.

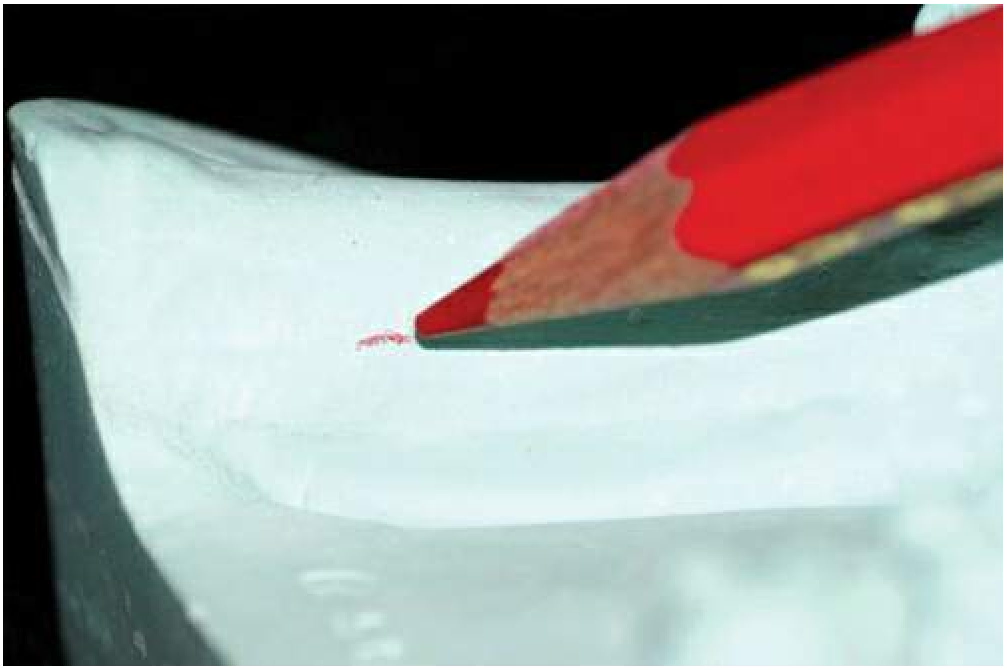


FIGURE 23.43 Mark highlighted with pencil.

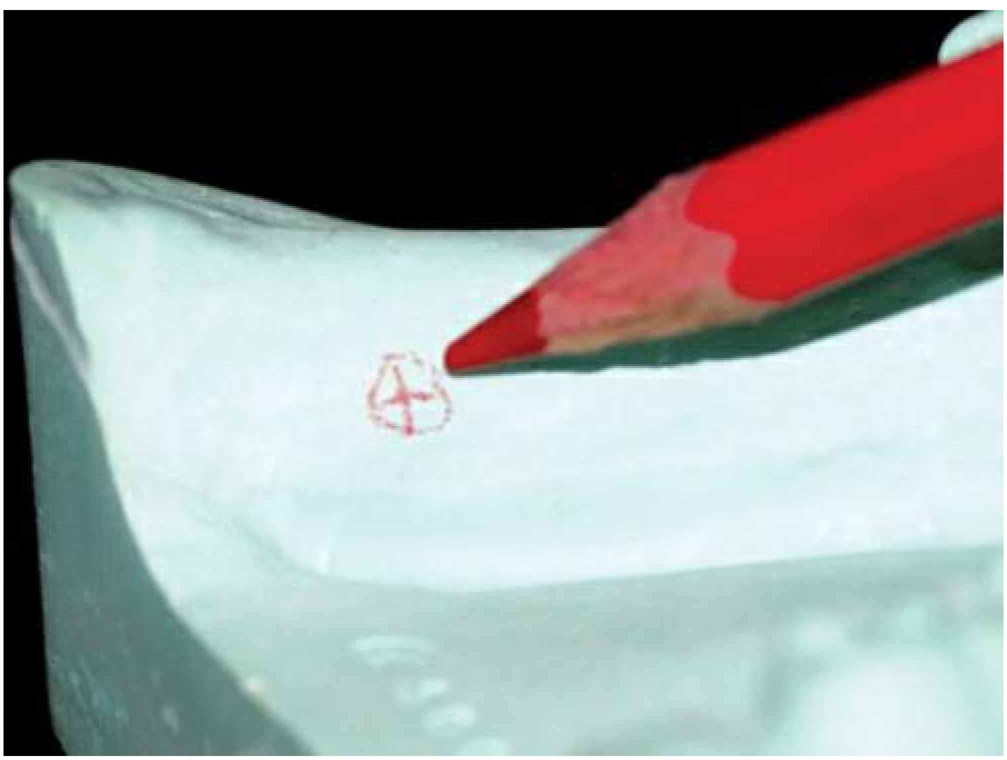


FIGURE 23.44 Mark crossed and circled.

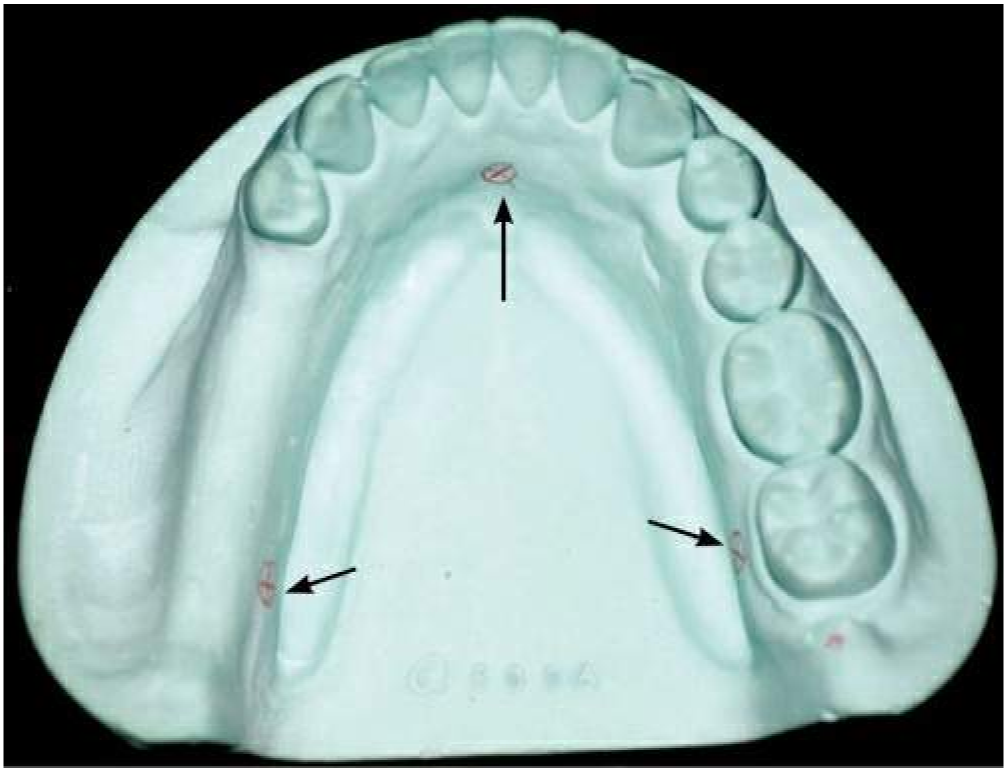


FIGURE 23.45 Placement of three widely divergent marks on areas of cast not involved in framework design.

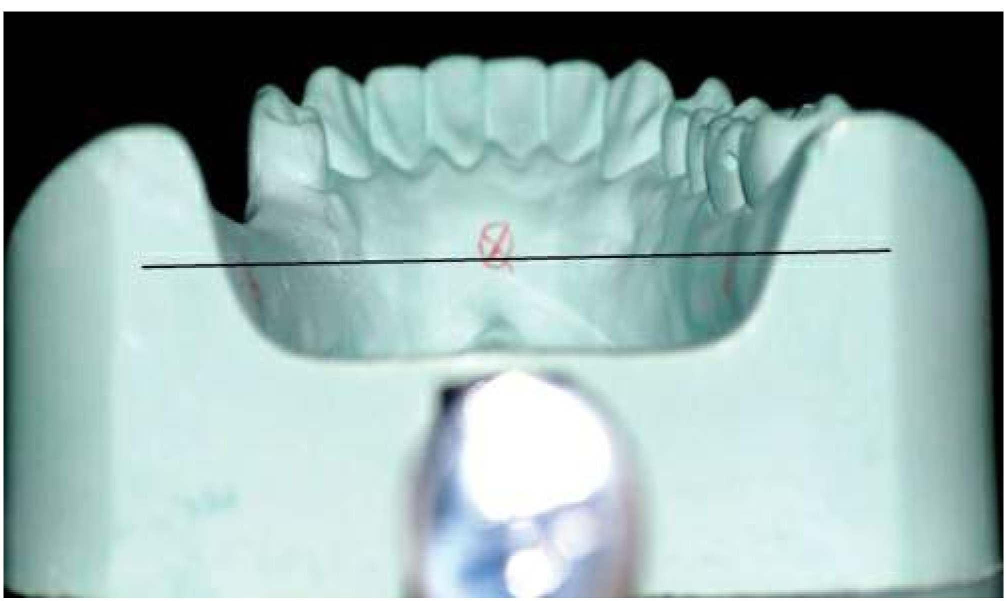


FIGURE 23.46 Three marks in same horizontal plane.

Alternately, the carbon marker can also be used to make the marks but may cause smudges on the cast (Fig. 23.47).

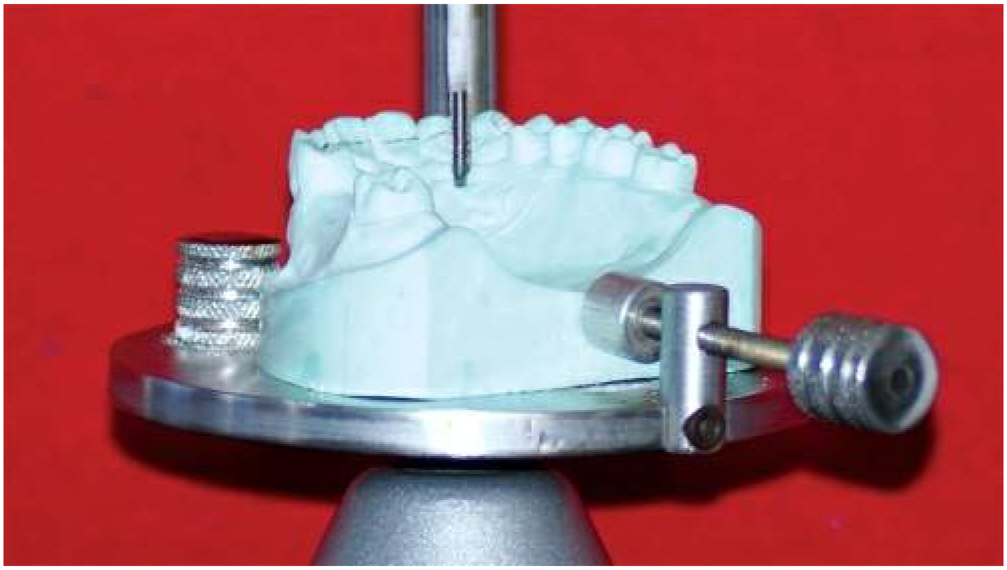


FIGURE 23.47 Carbon marker used to make the marks.

Art portion indexing

This is the second method to tripod the cast.

Three lines and marks are scribed, one on the posterior, and one each on the lateral surface of the art portion or base of the cast. This is done by holding the analysing rod against the side of the cast and making a mark with a sharp instrument (Fig. 23.48). All other procedures are the same as before. By tilting the cast until all three lines are again parallel to the surveyor blade, the original cast position can be re-established.

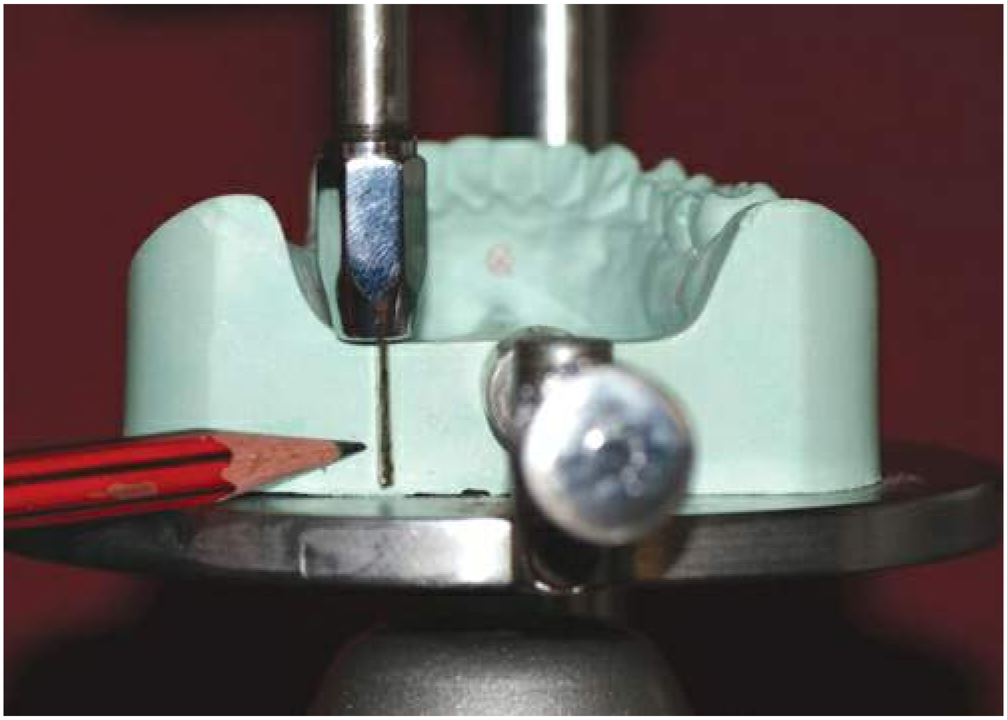


FIGURE 23.48 Art portion indexing.

Transferring tripod marks to another cast

In both the above methods, scoring (making a mark) the cast rather than just drawing the marks with pencil or carbon marker, has the advantage that if the cast is duplicated, the marks will also be transferred from one cast to another. It is thus possible to transfer the tripod marks from a master cast to a refractory cast.

If the marks successfully are to be transferred from the diagnostic cast to a master cast, as there is no duplication done here, the diagnostic cast is first repositioned on the surveyor by using the tripod markings. Three additional marks are placed on cast on distinct anatomic landmarks (Fig. 23.49). The commonly used landmarks are:

1. Distal marginal ridge of first premolar on one side.

2. Lingual cusp tip of first premolar of opposite side.

3. Incisal edge of lateral incisor.

FIGURE 23.49 Additional anatomic landmarks used for tripoding.

Since these points can be easily marked on any other cast of the same patient (master cast), it can be repositioned in the same orientation as diagnostic cast.

Once final path of placement of prosthesis is determined and the same is tripoded for future reference, the survey line is marked on the cast by the surveyor.

Survey lines

Definition: A line produced on a cast by a surveyor marking the greatest prominence of contour in relation to the planned path of placement of a restoration.

Blatterfein divided the abutment tooth into two halves by a vertical line through the centre of the tooth. The area adjacent to edentulous space was termed as *near zone* and the other area was called *far zone* (Fig. 23.50).

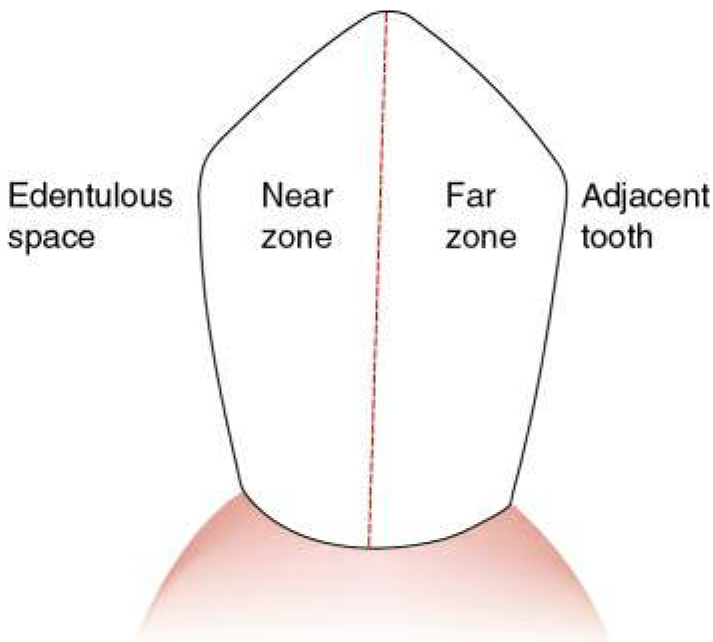


FIGURE 23.50 Near zone and far zone.

Blatterfein's Classification of Survey Lines

Medium survey line

It passes from middle third of the tooth in the near zone to the gingival third of the tooth in the far zone (Fig. 23. 51). Preferable to tilt and produce this survey line whenever possible. Both circumferential and bar clasps can be used with this survey line.

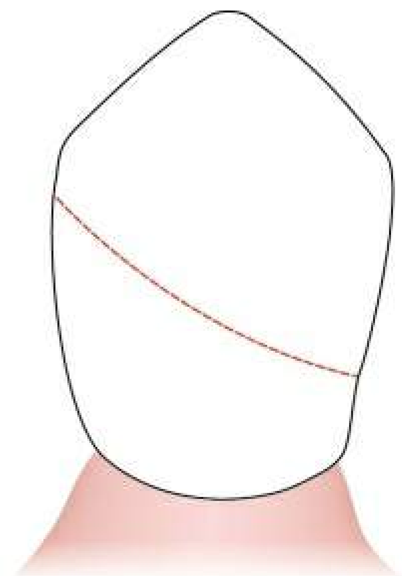


FIGURE 23.51 Medium survey line.

Diagonal survey line

It passes from near the occlusal third in the near zone to the gingival third in the far zone (Fig. 23.52). Commonly found on buccal surface of canines and premolars. Circumferential reverse circlet and hair pin clasps can be used or 'T' and 'modified T-bar' clasp can be used.

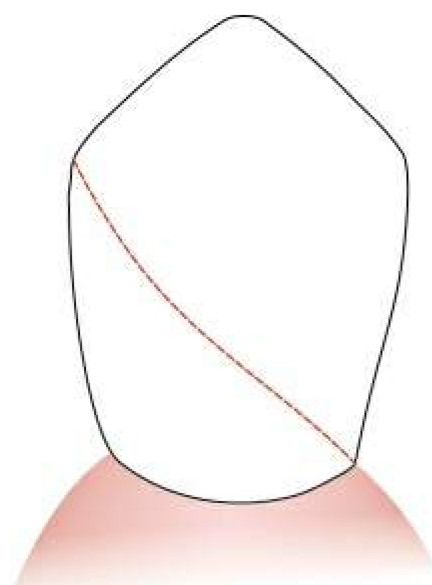


FIGURE 23.52 Diagonal survey line.

High survey line

It is placed in the occlusal third in both near and far zones (Fig. 23.53). Inclined teeth produce this survey line. A wrought wire combination clasp can be used to engage this deep undercut. Ring clasp can also be used on lone-standing abutments which are tilted and have high survey line. It can be changed to a medium survey line by tilting, recontouring or crowning.

FIGURE 23.53 High survey line.

Low survey line

It is placed in the gingival third of both near and far zones (Fig. 23.54). It occurs on the opposite side of a tilted tooth with high survey line. It is difficult to place any retentive arm. Reciprocal arm can be placed, better to change contour by tilting, recontouring or crowning.

FIGURE 23.54 Low survey line.

Following tripoding, the survey line is marked on all the remaining teeth by fixing the carbon marker on the surveying arm of surveyor (Fig. 23.55).

FIGURE 23.55 Marking of survey line by carbon marker.

After the survey line is marked, *the diagnostic cast is designed* taking into consideration the various components, principles and philosophies. These are described in Chapter 24.

The designed diagnostic cast is used as a guide for mouth preparation and *after the same is completed, the master cast is made. The master cast with the designed diagnostic cast is then sent to laboratory for surveying the master cast.*

Survey of master cast

The following procedures are performed by surveying the master cast.

Retripoding master cast

The master cast is tripoded in the same relation as diagnostic cast using the procedures previously discussed under 'tripoding'.

Design transfer to master cast

With the master cast tripoded and locked in the surveyor, the same procedure used previously to design the diagnostic cast is now used to transfer the design to the master cast.

Block out

Definition

The process of applying wax or another similar temporary substance to undercut portions of a cast so as to leave only those undercuts essential to the planned construction of prosthesis (or) elimination of undesirable undercuts on a cast.

Material

The following can be used as block out material:

1. Combination of one sheet of baseplate wax and one stick of green inlay wax.

2. 4½ sheets of baseplate wax, 4½ sticks of gutta percha, 3 sticks of sticky wax, ½ tsp kaolin and ½ tube lipstick (colour).

3. Any commercially available block out material.

Technique

The wax is added to the area to be blocked out by a wax spatula and trimmed parallel to path of placement by attaching the wax trimmer to the surveying arm. Trimming is facilitated by slightly warming the wax trimmer.

Types

Depending on use, it is classified into three types:

1. Parallel block out

It could be made with 0°, 2°, 4° tapered styli (trimmer) (Fig. 23.56). The selection of the parallel (0°) or tapered styli (2/4°) depends on the need for increased freedom of movement of prosthesis in function. For tooth bound partial dentures (class III), 0° is indicated. Tapered block out is indicated for distal extension partials to allow some movement in function.

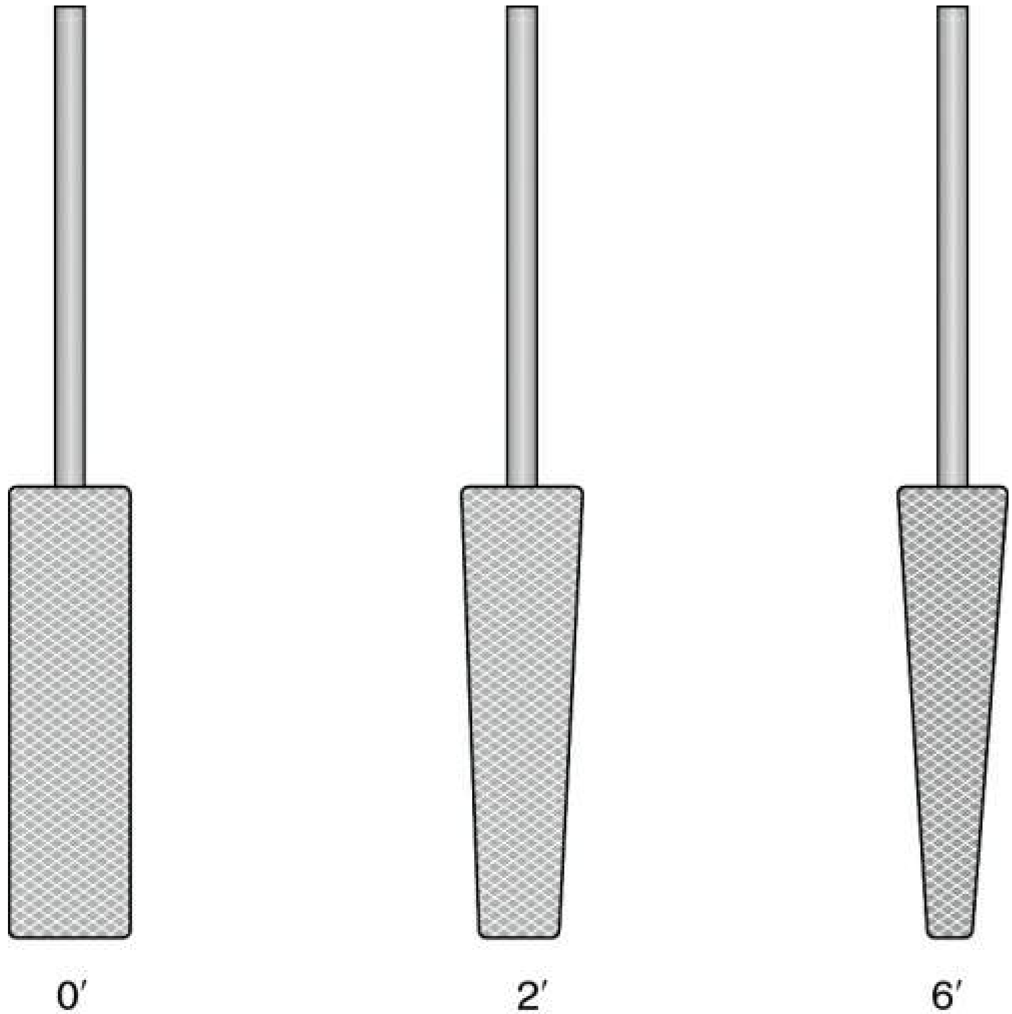


FIGURE 23.56 Different taper of styli.

Generally, this block out is done cervical to guiding plane surfaces and all undercut areas that will be crossed by major or minor connector (Fig. 23.57). It will include the following:

- Proximal tooth surfaces.
- Beneath all minor connectors.
- Tissue undercuts crossed by rigid connectors, origin of bar clasps.
- Deep interproximal spaces to be covered by minor connectors or linguoplates.

• Beneath bar clasp arms to gingival crevice.

FIGURE 23.57 Block out cervical to guiding planes.

2. Arbitrary block out

Areas of undercut not involved with framework should also be blocked out with wax (Fig. 23.58). This minimizes distortion during duplication. This is termed arbitrary as it is not contoured with block out instrument. It includes the following areas:

• All gingival crevices.

• Gross tissue undercuts situated below areas involved in design of framework.

• Tissue undercut distal to cast framework.

• Labial and buccal tooth and tissue undercuts not involved in denture design.

FIGURE 23.58 Arbitrary block out.

3. Shaped block out

These are ledges made on buccal and lingual surfaces to help place plastic or wax patterns for clasp arms (Fig. 23.59). Following duplication, this ledge which is created in refractory cast will help guide easy placement of retentive clasp patterns. This is not an essential step and need not be performed by the surveyor.

FIGURE 23.59 Shaped block out.

Relief

Definition: The reduction or elimination of undesirable pressure or force from a specific region under a denture base (GPT8). This is also used for the creation of space for a material.

It involves addition of wax to make framework stand away from master cast.

As already discussed in Chapter 22 in Section 'components parts of removable partial denture', relief is provided under the denture base in case of lattice and meshwork constructions to provide space for acrylic resin and help in its attachment (Fig. 23.60).

FIGURE 23.60 Relief areas.

Relief is also provided to reduce the pressure from a component part on the mucosa as follows:

- Beneath lingual bar and bar of linguoplate.
- Areas in which 'major connector' will contact thin tissue – mandibular lingual ridges and median palatal raphae.

SUMMARY

The surveyor is an essential tool in the diagnosis and treatment planning of removable partial dentures. Surveying helps design a removable partial denture such that the rigid and nonrigid components of the prosthesis will go into the mouth as a single unit, free from interferences, and in the mouth, will resist dislodging forces. The procedure involves surveying the diagnostic cast and master cast. The diagnostic cast is surveyed to determine the path of placement while considering the factors that influence the same. The design of the prosthesis is made on the diagnostic cast, and after all the necessary mouth preparations are performed, the master cast is surveyed to provide block out and relief. The laboratory procedures involved in the construction of the framework are continued after this survey of master cast.

CHAPTER 24

Principles and design

CHAPTER CONTENTS

Introduction

In a properly constructed fixed partial denture, all forces against the prosthesis are directed towards the long axis of the abutment teeth and the prosthesis itself does not move in function. This is in direct contrast to the removable partial denture, where only in a short span tooth supported or class III edentulous arch most forces are transmitted down the long axis of the abutment teeth and limited movement of the prosthesis occurs during function. In class I, II and IV edentulous arches, the removable prosthesis combines the support derived from the abutment teeth and soft tissue resulting in greater stresses during function. These forces need to be controlled by maximum coverage of the soft tissues and the proper use and placement of components in the most favourable positions.

The design of the removable partial denture must originate on the diagnostic cast so that all mouth preparations may be planned and performed with a specific design in mind. Proper design of the removable partial denture will contribute to the preservation of remaining natural teeth, aid in the maintenance of tooth position and occlusion and will restore mastication, improve phonation and enhance appearance.

Biomechanical considerations

Machines are classified as 'simple' and 'complex'. There are six simple machines – lever, wedge, screw, wheel and axle, pulley and inclined plane. Complex machines are a combination of simple machines (Fig. 24.1).

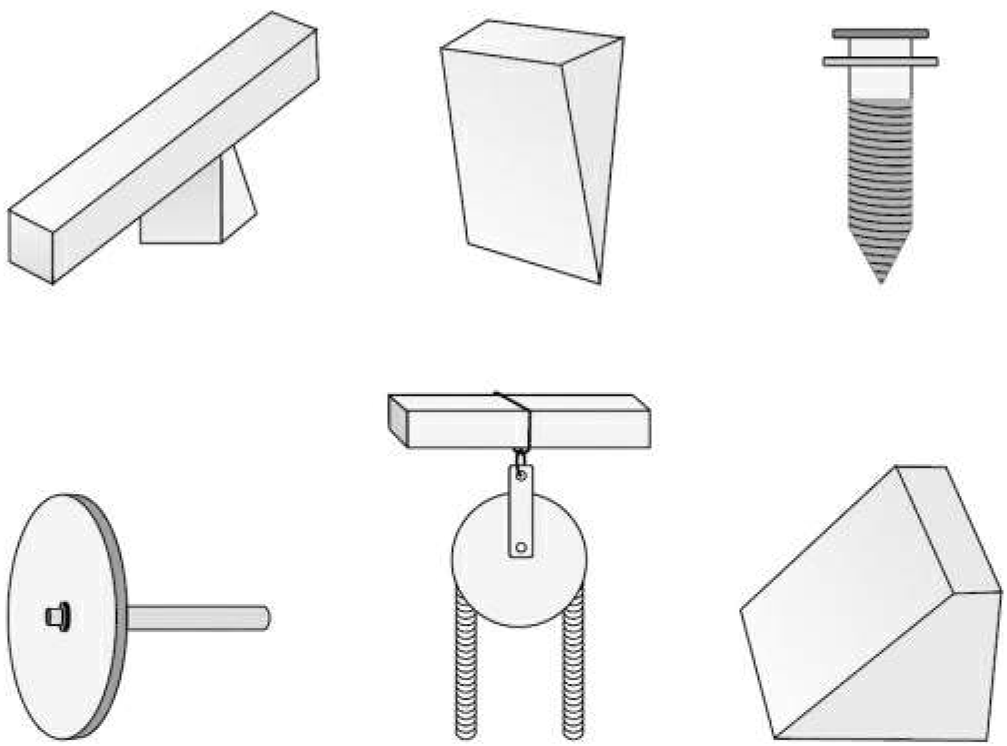


FIGURE 24.1 Simple machines.

The removable partial denture in the mouth performs the action of two simple machines – lever and inclined plane. We have to avoid or reduce the effect of these two machines while designing the prosthesis.

Lever is a rigid bar supported somewhere along its length (Fig. 24.2). Support point of the lever is called the fulcrum and lever can move around the fulcrum.

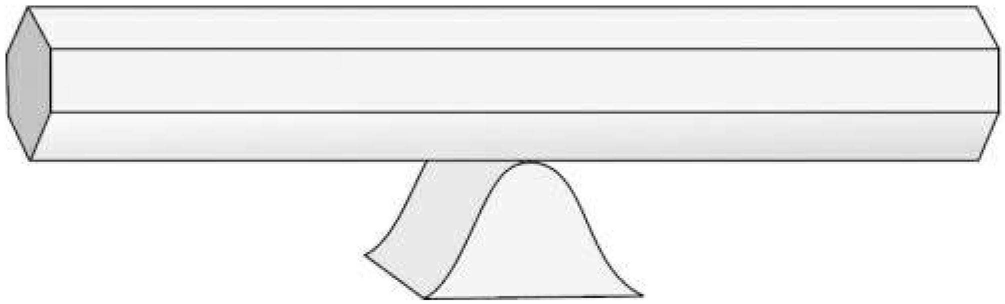


FIGURE 24.2 Lever and fulcrum.

There are three classes of levers: class I, II and III (Fig. 24.3).

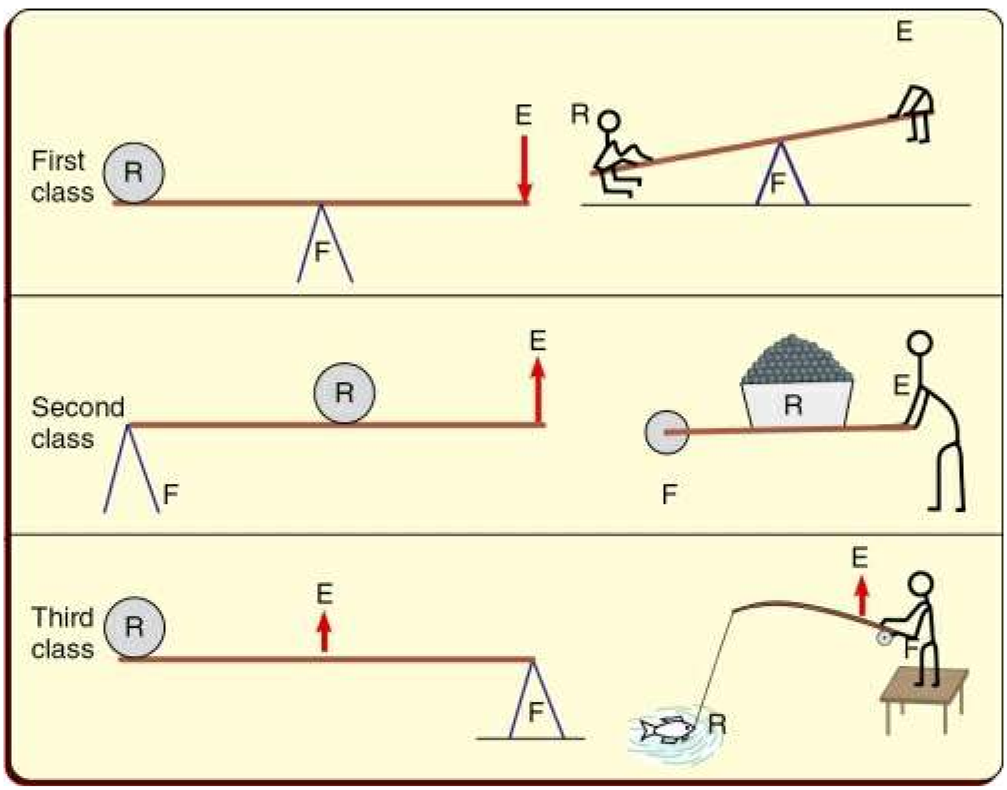


FIGURE 24.3 R, resistance; F, fulcrum; E, effort.

The distal extension removable partial denture acts as a class I lever (Fig. 24.4). As downward forces act on the denture base (effort), the clasp (resistance), supported by occlusal rest (fulcrum) tries to come out of the undercut due to rotational forces at the fulcrum. This creates deleterious forces on the abutments and needs to be controlled by our design. This is the most efficient and easily controlled lever.

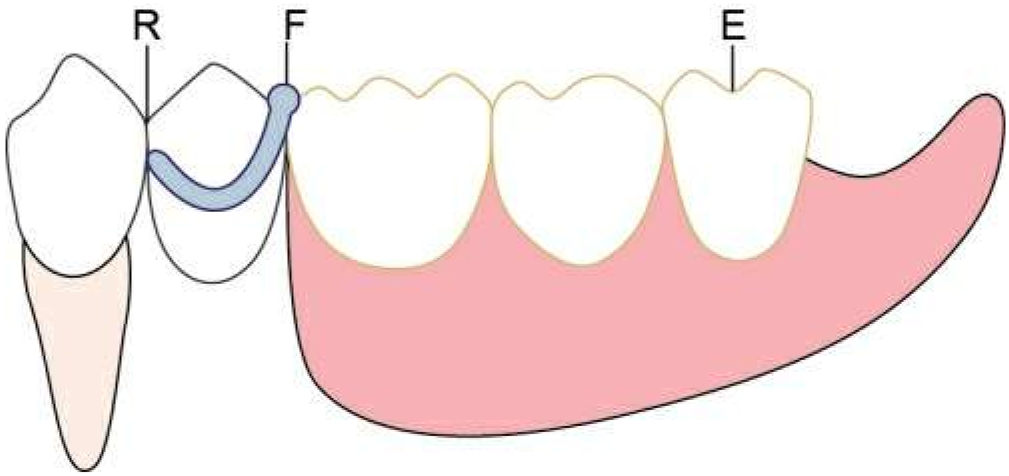


FIGURE 24.4 Class I lever in distal extensions.

The class II lever is seen in indirect retention in removable partial denture, while the class III lever is not encountered.

The inclined plane effect is typically seen in the movement of minor connectors and direct retainers against the guiding planes, and with occlusal rests and their rest seats, if these are incorrectly prepared. Forces applied in an inclined plane may cause deflection of part applying the force (denture base), or result in movement in the plane itself (abutment tooth) (Fig. 24.5).

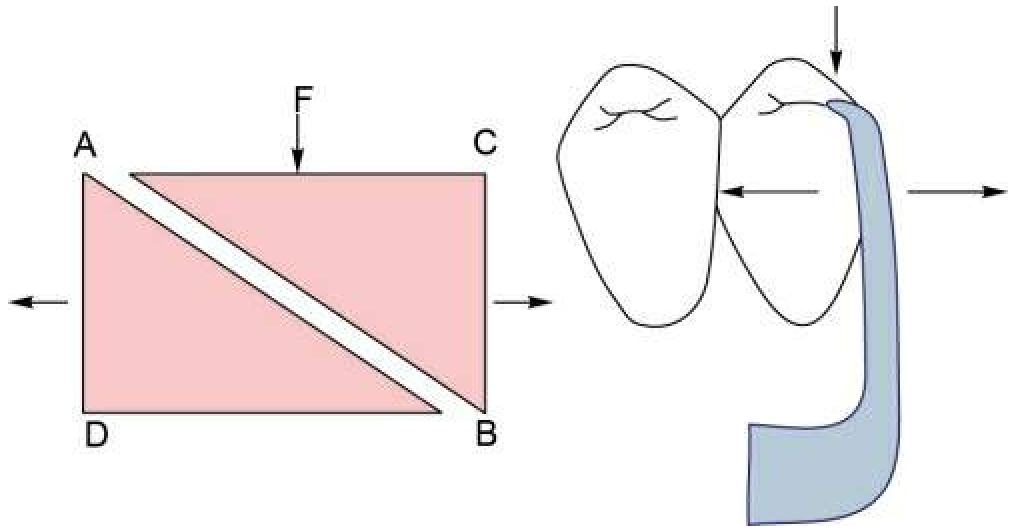


FIGURE 24.5 Inclined plane effect.

Forces acting on the partial denture

The tooth-supported partial denture is rarely subject to rotational stresses. The distal extension prosthesis is subjected to a composite of forces arising from three principal fulcrum lines.

Horizontal fulcrum line

This fulcrum occurs along the horizontal line joining the rests on the two main abutments on either side of the arch (Fig. 24.6).

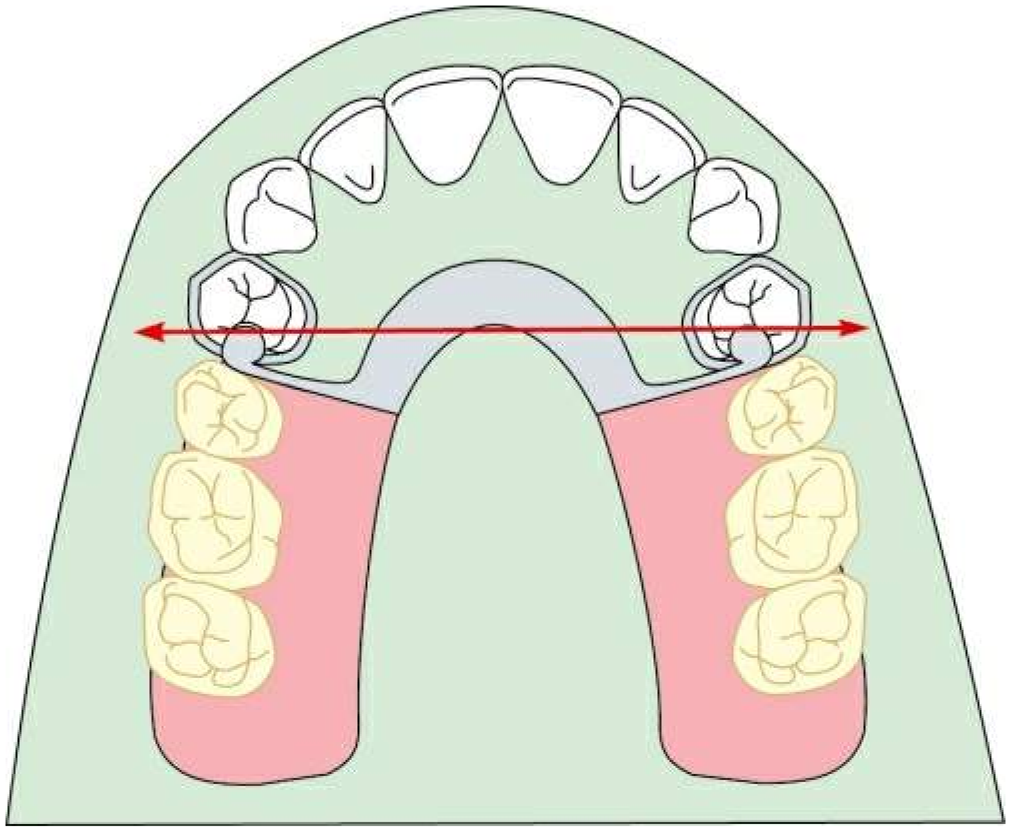


FIGURE 24.6 Horizontal fulcrum line – fulcrum on horizontal plane and movement on sagittal plane.

Movement around this fulcrum line occurs in the sagittal plane resulting in rotation of the denture base away from or towards the residual ridges. It is difficult to control the movement around this fulcrum line.

Magnitude of rotational movement is greatest around this fulcrum but not the most damaging because these are vertical forces on the abutment teeth directed apically (Fig. 24.7). Fibres of periodontal ligament are better equipped to resist vertical forces than horizontal forces.

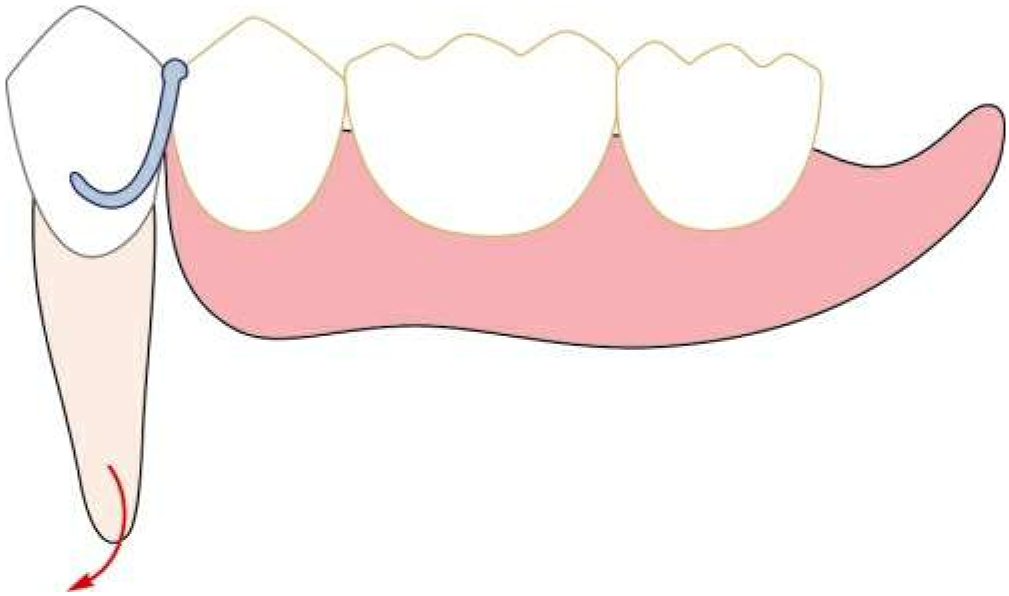


FIGURE 24.7 Resultant forces directed apically.

Sagittal fulcrum line

This fulcrum extends from the occlusal rest on the terminal abutment along the crest of the alveolar ridge on one side of the arch (Fig. 24.8). In a class I arch, there would be two such fulcrums on either side.

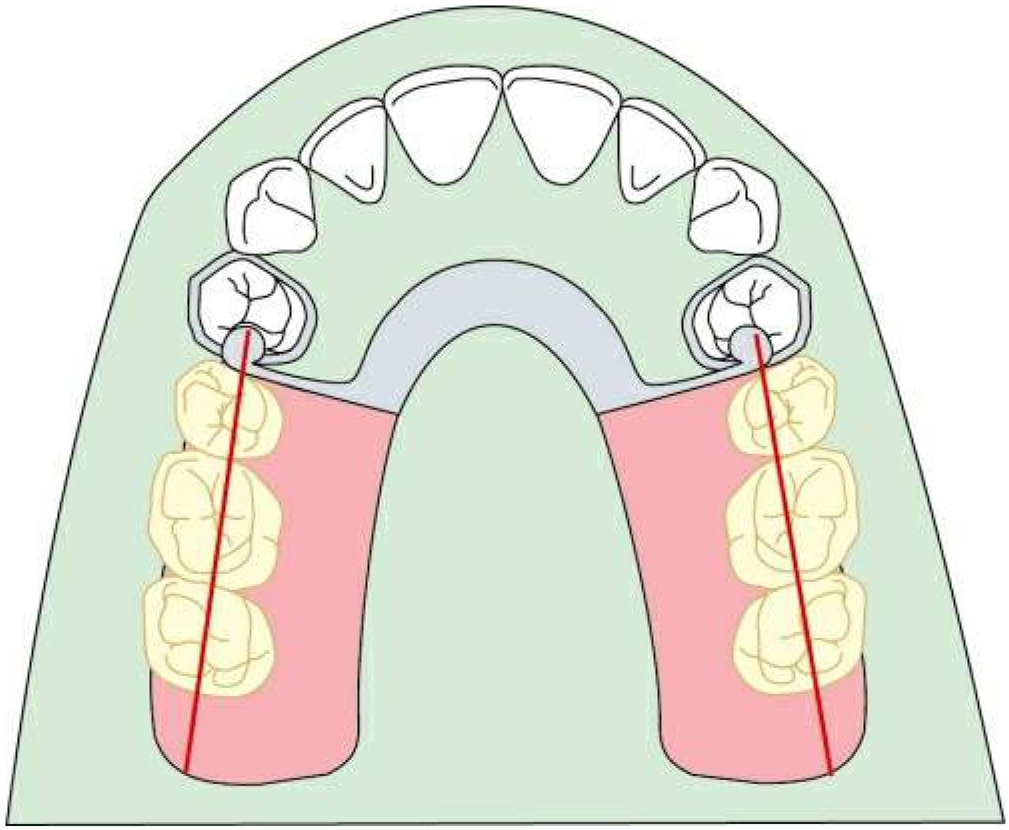


FIGURE 24.8 Sagittal fulcrum line – fulcrum on sagittal plane and movement on vertical plane.

Movement around this fulcrum occurs in the vertical plane resulting in rocking or side-to-side movement of denture base. It is easier to control this movement.

Though this movement is not of great magnitude, the direction of the resultant force is more nearly horizontal and not well resisted by the tissues.

Vertical fulcrum line

This is a vertical fulcrum line located in midline, lingual to anterior teeth (Fig. 24.9).

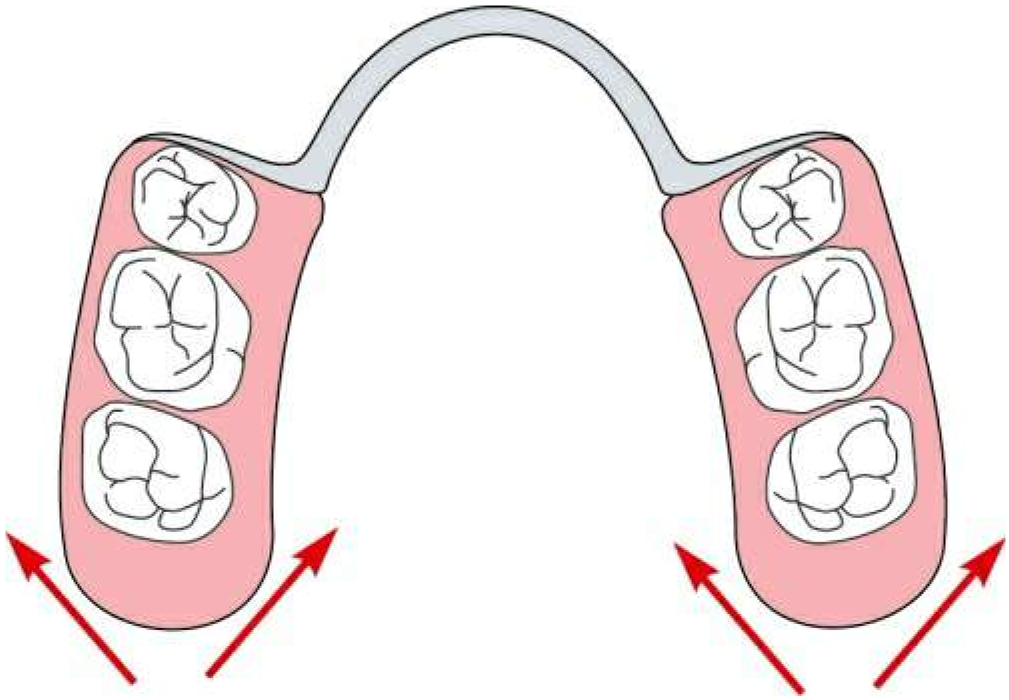


FIGURE 24.9 Vertical fulcrum line – fulcrum on vertical plane and movement on horizontal plane.

It controls rotational movements of the denture in horizontal plane (flat circular movements of the denture).

Factors influencing the magnitude of stresses transmitted to abutment teeth

1. Length of span

2. Quality of support of ridge

3. Clasp

   i. Qualities

   ii. Design

   iv. Length

v. Material

4. Abutment tooth surface

5. Occlusal harmony

Length of span

The longer the edentulous span (more missing teeth), (Fig. 24.10) greater will be the force transmitted to the abutment teeth. Every effort must be made to preserve posterior teeth so the span length is less.

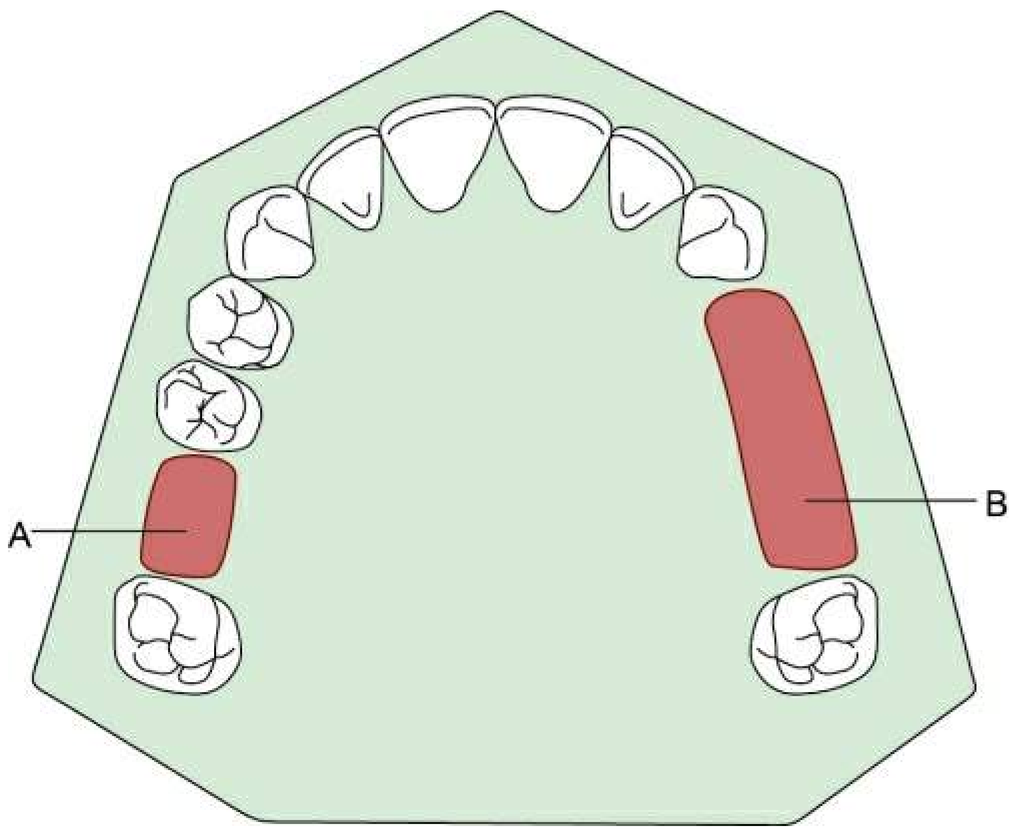


FIGURE 24.10 Less force will be transmitted to the abutments supporting edentulous space (A) than (B).

Quality of support of ridge

Large well-formed ridges are capable of absorbing greater amounts of stress and also provide good stability. Flat ridges give good support but poor stability. Sharp spiny ridge provides poor support and poor to fair stability. Soft, flabby displaceable ridges provide poor support and poor stability (Fig. 24.11).

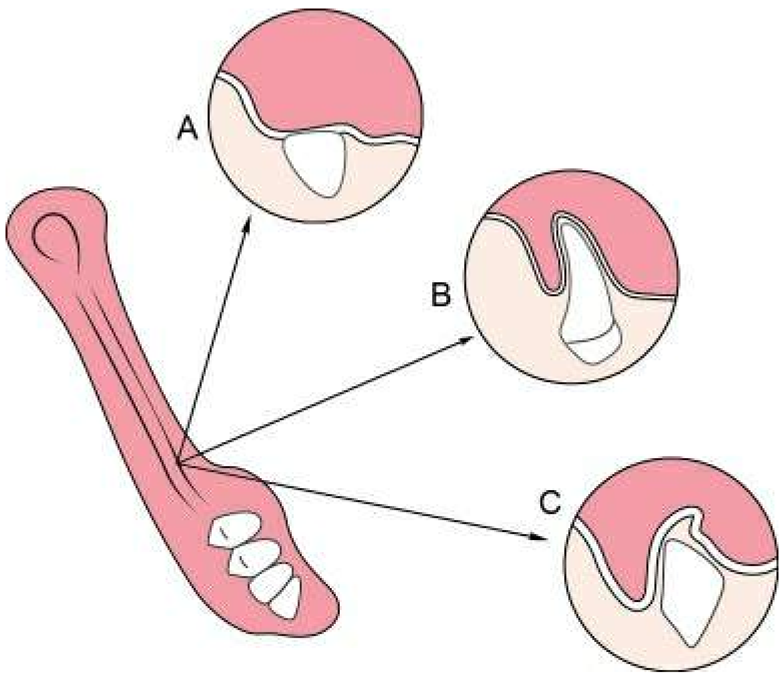


FIGURE 24.11 (A) Flat ridge, (B) sharp spiny ridge and (C) displaceable tissue.

Type of mucoperiosteum also influences the magnitude of stresses transmitted to abutment teeth. Healthy mucosa, 1 mm thick, absorbs forces better than a thin atrophic mucosa.

Clasp

1. *Qualities of clasp*

More flexible the clasp less stress is transmitted to the abutment tooth, but more force is transferred to the edentulous ridge.

A wrought wire combination clasp because of its flexibility will transfer less stress to the abutment tooth, but has poor horizontal stabilization.

Selection of clasp will depend on whether the abutment or ridge needs protection. If abutment tooth is periodontally sound, a less flexible clasp like bar clasp is indicated. If abutment is weak, then a combination clasp can be used.

2. *Clasp design*

A clasp should be designed such that it is passive on complete seating, and during insertion or removal of the prosthesis the reciprocal arm should contact the tooth before the retentive tip passes over the greatest bulge of the abutment tooth (Fig. 24.12).

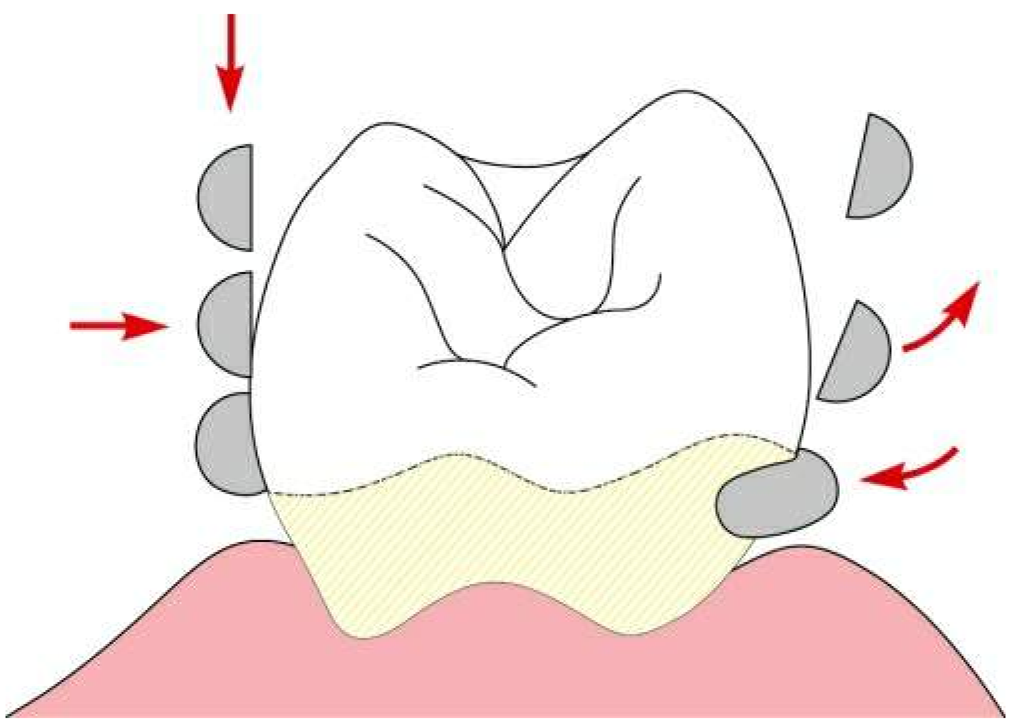


FIGURE 24.12 Reciprocal arm should contact abutment first to counteract the force created by the retentive terminal passing over the undercut.

3. *Length of clasp*

As already seen, more flexible the clasp less stress it will exert on the abutment tooth. Flexibility can be increased by lengthening the clasp. Clasp length may also be increased by using a curved rather than a straight path on an abutment tooth (Fig. 24.13).

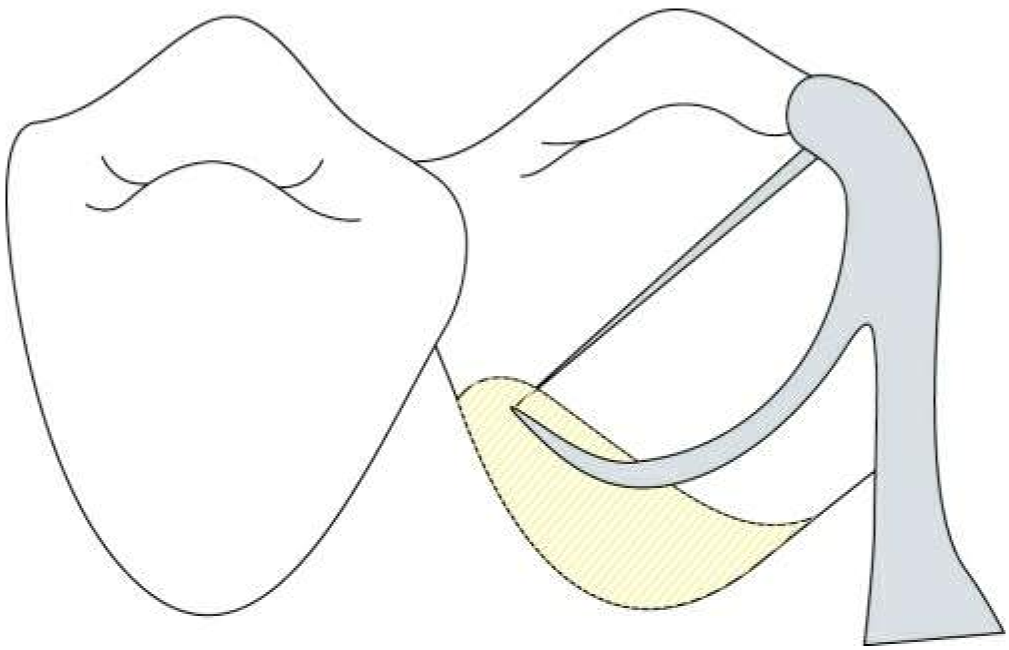


FIGURE 24.13 Increasing length by curving path of clasp to engage same undercut.

4. *Material*

Chrome alloy being more rigid will exert greater stress on the abutment tooth than noble alloys. Clasp arm of chrome alloys is constructed with a smaller diameter than a gold clasp and will also engage smaller undercut (Fig. 24.14).

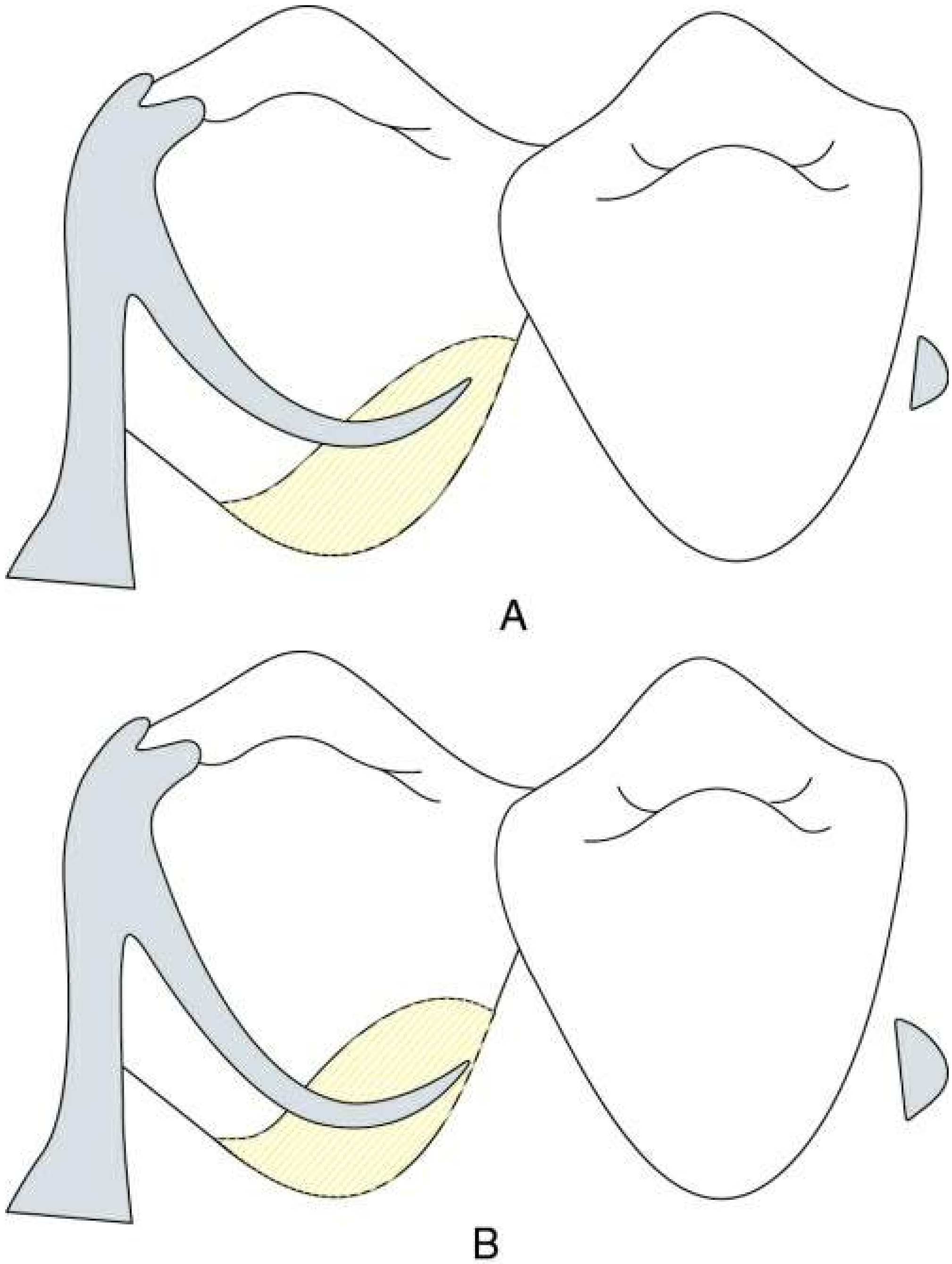


FIGURE 24.14 **(A)** Clasp of chrome alloy is of smaller diameter and engages a smaller undercut than clasp of noble alloy **(B)**.

Abutment tooth surface

Surface of gold crown or any restoration offers more frictional resistance to clasp arm movement than does the enamel surface of the tooth.

Greater stress is exerted on a tooth restored with gold than on a tooth with intact enamel.

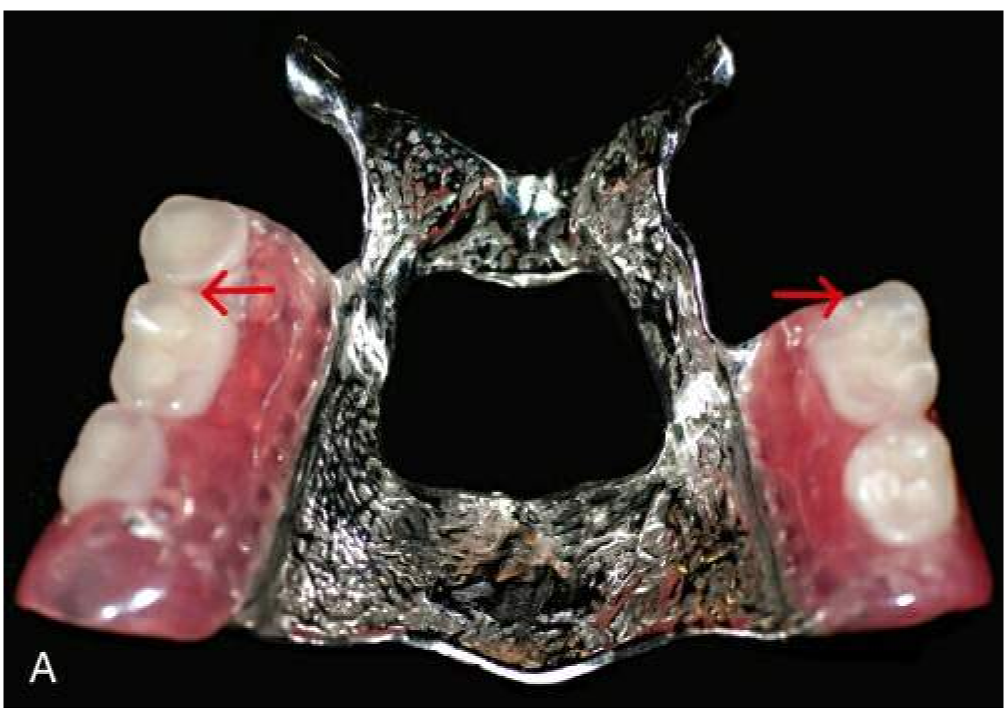
Occlusal harmony

A disharmonious occlusion with deflective occlusal contacts transmits destructive horizontal forces to the abutment and ridge.

Partial denture constructed opposing a complete denture will be subjected to a much less occlusal stress than one opposed by natural dentition.

Occlusal load applied to the distal end of denture base will result in more stress transmitted to the abutment teeth than load applied adjacent to abutment tooth.

Ideally masticatory load should be applied in the centre of the denture-bearing area, both anteroposteriorly and buccolingually, i.e. in the second premolar–first molar region (Fig. 24.15).



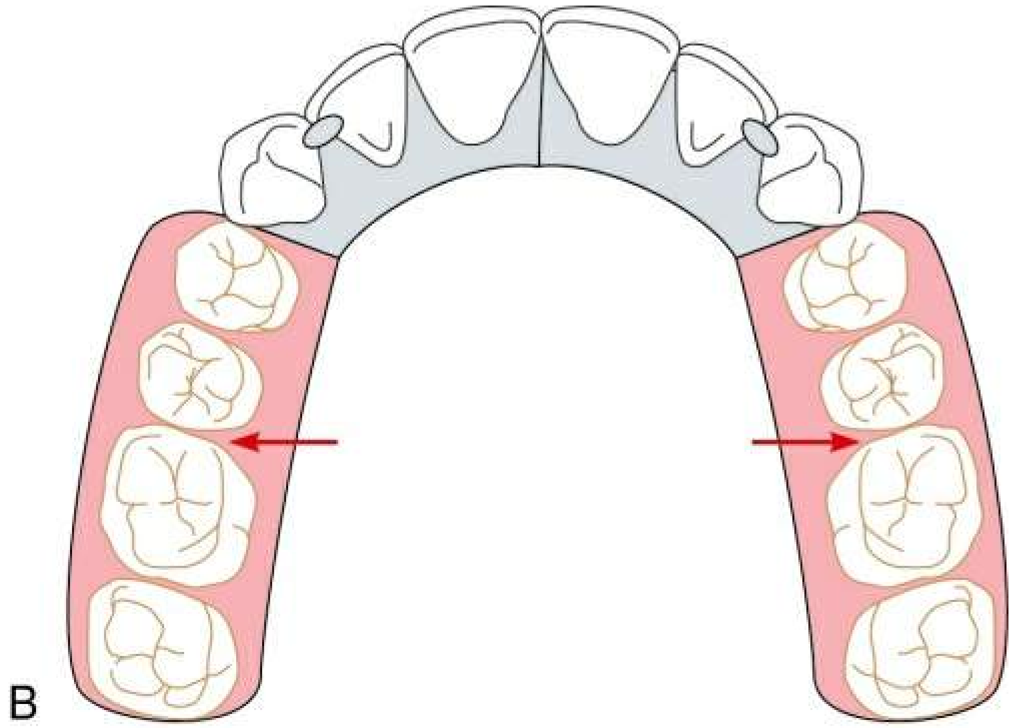


FIGURE 24.15A, B Ideally load should be applied in second premolar–first molar area.

Controlling stress by design considerations

We have seen the forces acting on a distal extension partial denture and the factors that influence these forces. Every effort must be made to minimize or control these forces through the design of component parts of the prosthesis as discussed below.

Direct retention

The retentive clasp arm is responsible for transmitting most of the destructive forces to the abutment teeth.

Clasp retention should be kept at the minimum yet provide adequate retention to prevent dislodgement of the denture.

Other factors should be used to contribute to retention so that the amount of retention provided by clasp can be reduced. The factors are explained as follows:

1. *Adhesion and cohesion*

Adhesion is the attraction of unlike molecules for one another – attraction of saliva to the denture on one side and tissues on the other.

Cohesion is the attraction of like molecules to each other – internal attraction of molecules of saliva for each other.

To obtain the maximum use of forces of adhesion and cohesion, the denture base must cover maximum area and must be accurately adapted to the mucosa.

2. *Atmospheric pressure*

This may also contribute to retention, especially when a maxillary complete palatal plate major connector is used and posterior margins are sealed by beading.

3. *Frictional control*

Properly prepared guiding planes enable the minor connectors to contribute substantially to retention as a result of frictional contact with adjacent tooth surfaces. Guiding planes should be created on as many teeth as possible.

4. *Neuromuscular control*

A properly contoured denture base significantly contributes to the ability of the patient to retain the denture through the action of the lips, cheeks and tongue.

Any overextension of denture will impinge on the patient's neuromuscular control and lead to loss of retention and increased stress on abutments.

Clasp position

The position of retentive clasp is more important than the number of retentive clasp used in any design.

The number of clasps used and their location is determined by classification. It can be of the following three configurations:

1. *Quadrilateral configuration*

Indicated in class III arches particularly when modification space exists on the opposite side (Fig. 24.16). A retentive clasp is positioned on each abutment tooth adjacent to the edentulous spaces.

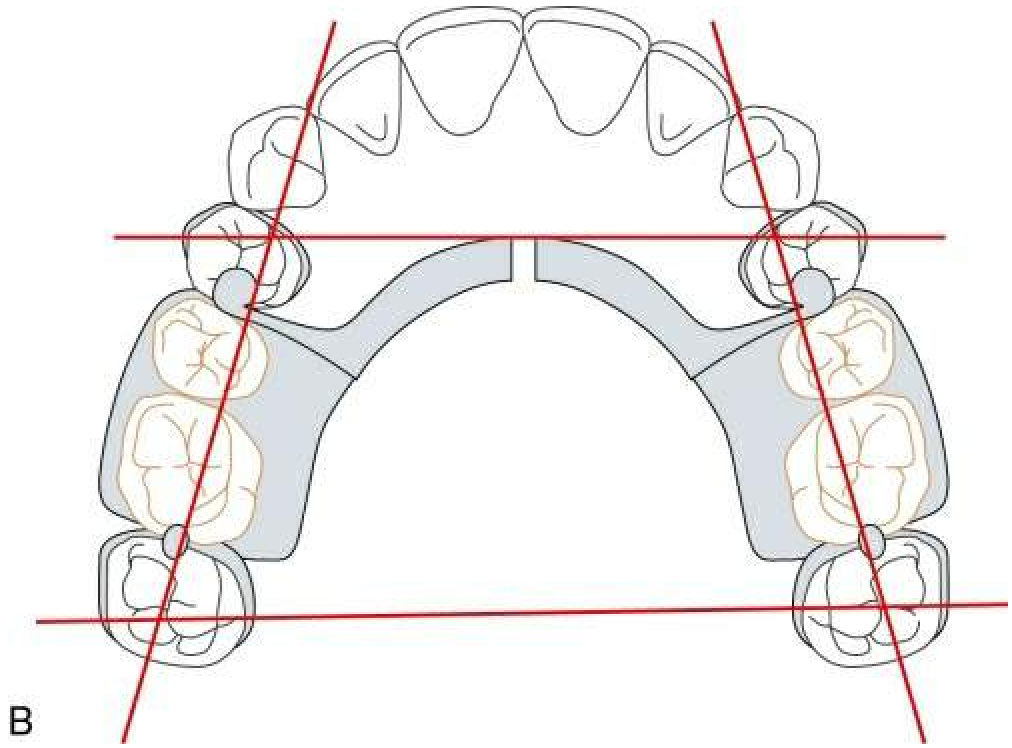


FIGURE 24.16A, B Quadrilateral clasp position.

When no modification space exists, the goal should be to place one clasp as far posterior on the dentulous side as possible and one as far anterior as space and aesthetics permit.

In this design, leverage is most effectively neutralized.

2. *Tripod configuration*

Indicated in class II arches. When modification exists, all teeth adjacent to edentulous space are clasped resulting in this configuration (Fig. 24.17A).

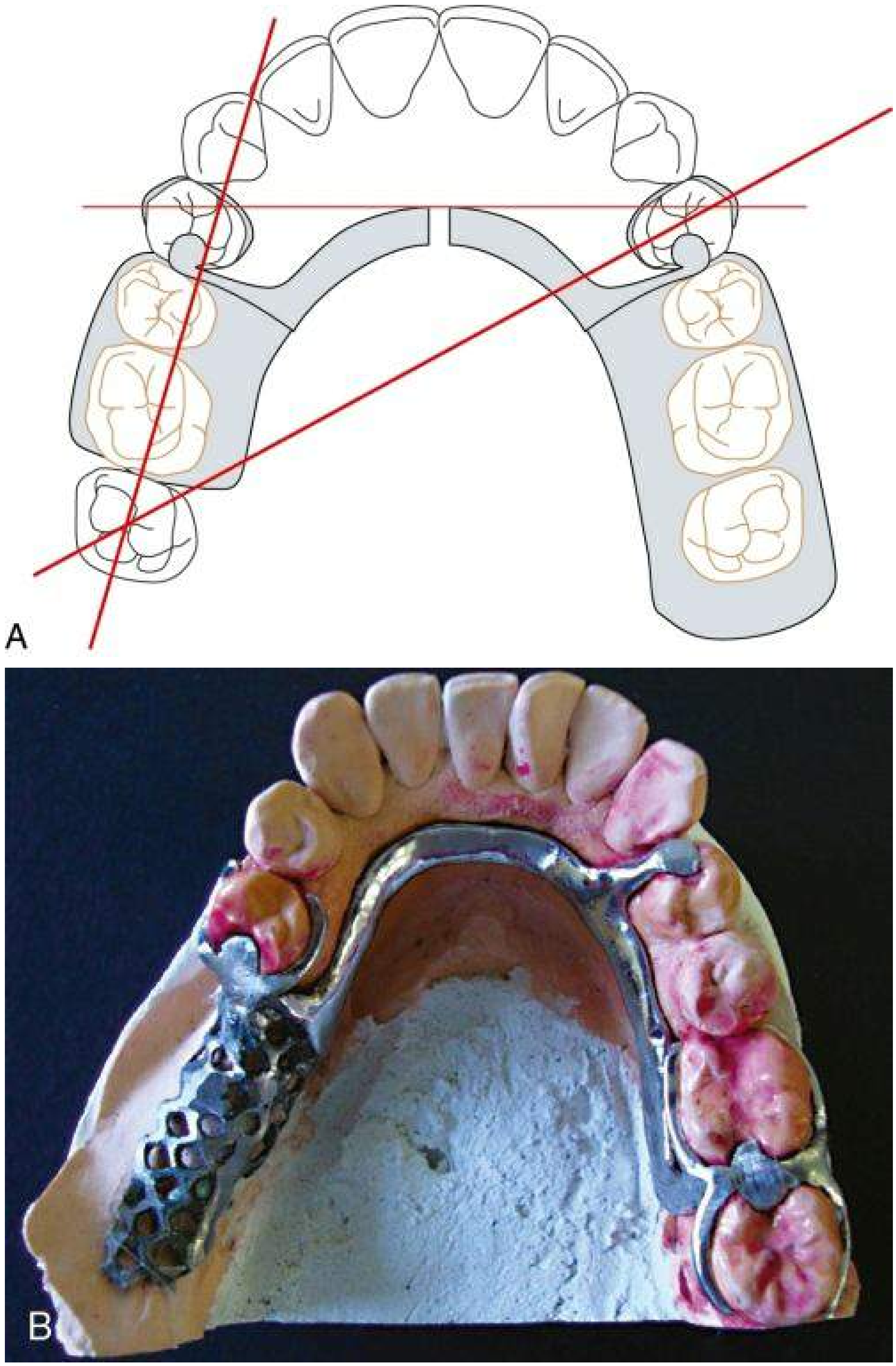


FIGURE 24.17 **(A)** Tripod configuration in class II with modification space. **(B)** Tripod configuration in class II without modification.

If there is no modification space present, one clasp on the dentulous side of the arch should be positioned as far posterior, and the other, as far anterior as factors such as interocclusal space, retentive undercut and aesthetics will permit (Fig. 24.17B).

This design is not as effective as quadrilateral, but is most effective in neutralizing leverage in class II situations.

3. *Bilateral configuration*

It is used in class I situations (Fig. 24.18).

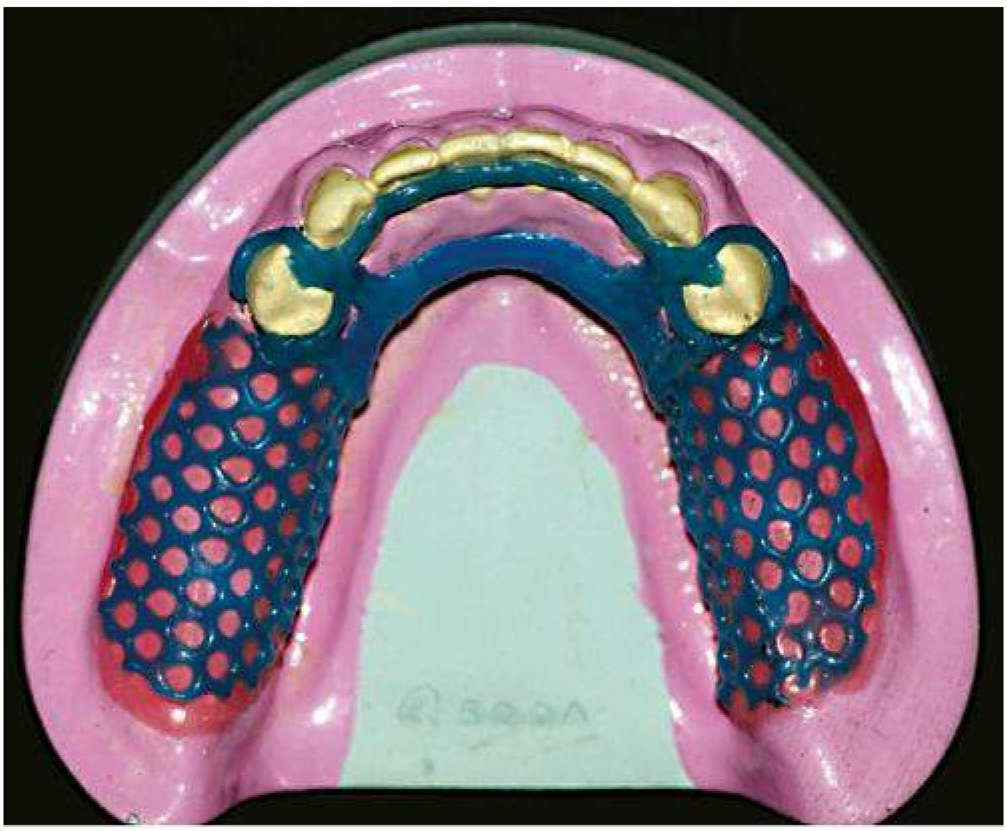


FIGURE 24.18 Bilateral configuration.

The terminal abutment tooth on each side of the arch must be clasped regardless of where it is positioned.

In this configuration, the clasps exert little neutralizing effect on the leverage-induced stresses generated by the denture base. These stresses must be controlled by other means.

Clasp design

1. *Cast circumferential clasp*

Conventional simple circlet cast circumferential clasp originating from distal rest and engaging mesiobuccal retentive undercut should be avoided in distal extension removable partial denture. Every time the denture base moves down on mastication, the retentive tip will try to come out of the undercut causing torquing forces on the abutment (Fig. 24.19).

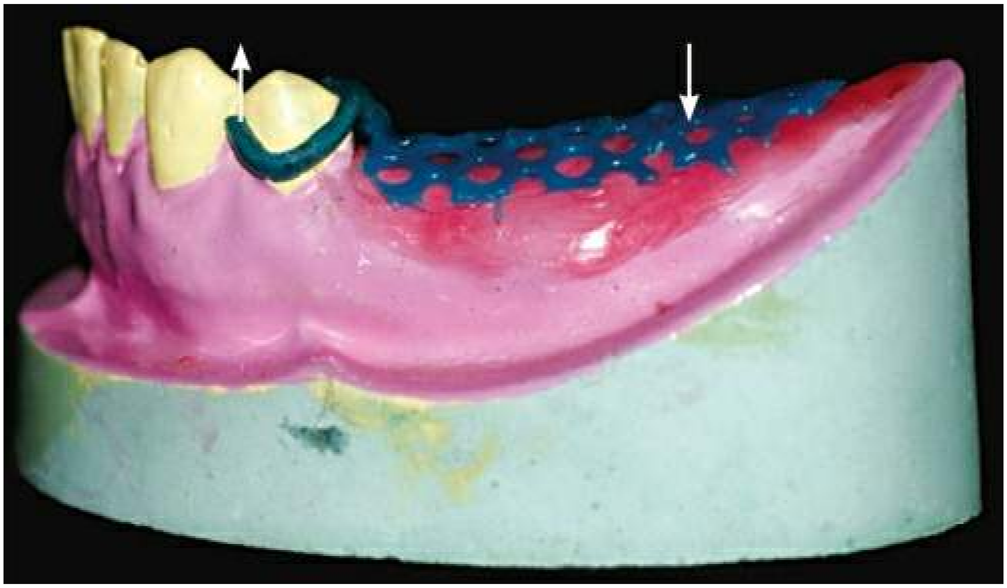


FIGURE 24.19 Simple circlet clasp causing undesirable forces on abutment if used in distal extensions.

The reverse circlet clasp engaging a distobuccal undercut is the preferred cast circumferential clasp in this situation (Fig. 24.20). As the denture base moves down, the clasp moves further gingivally into the undercut without contacting the abutment. The clasp may produce wedging force between the abutment and the adjacent tooth, which can be countered by preparing a distal occlusal rest on the adjacent teeth also (Fig. 24.21).

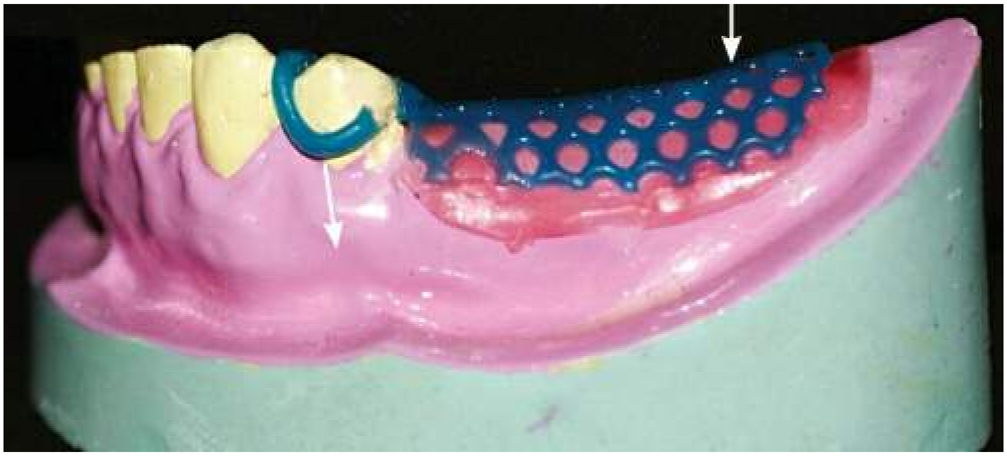


FIGURE 24.20 Reverse circlet clasp indicated in distal extensions when distobuccal undercut is present.

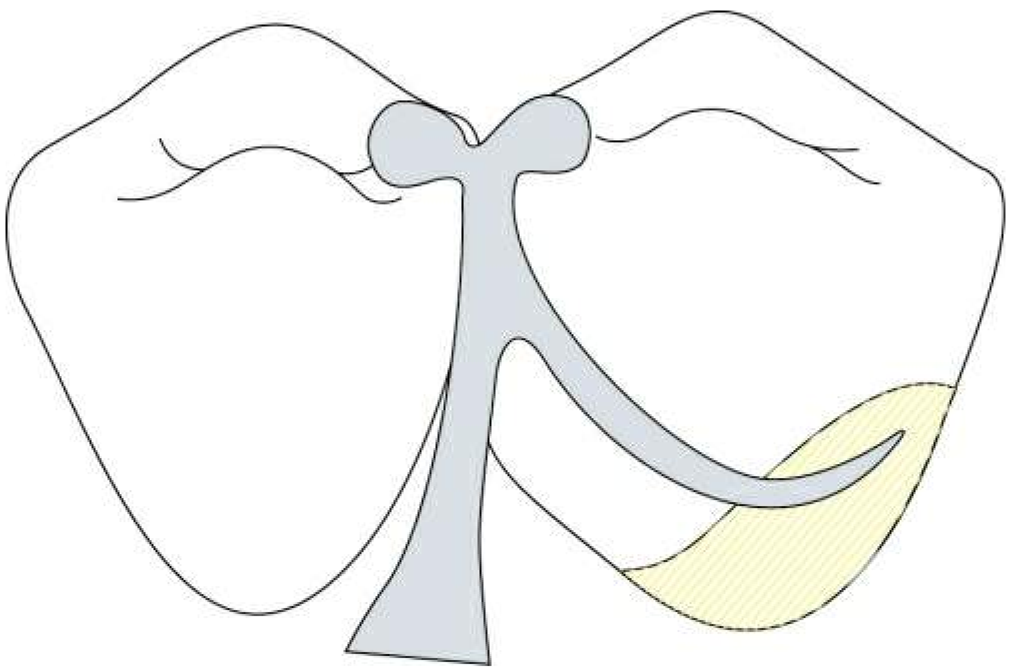


FIGURE 24.21 Occlusal rest should be prepared on the adjacent tooth to prevent wedging of reverse circlet clasp.

2. *Bar clasp*

Bar clasp functions similar to reverse circlet clasp by engaging the distobuccal undercut as the retentive terminal moves gingivally (Fig.

21.91, Chapter 21). T-bar clasp with a distal–occlusal rest and rigid circumferential arm causes least stress on abutment.

Bar clasp is not indicated with mesiobuccal undercut as then it will function similar to simple circlet clasp.

Some clinicians use a mesial rest instead of distal as they feel moving fulcrum anteriorly will direct forces more vertically, but this can cause food impaction adjacent to edentulous space (Fig. 24.22).

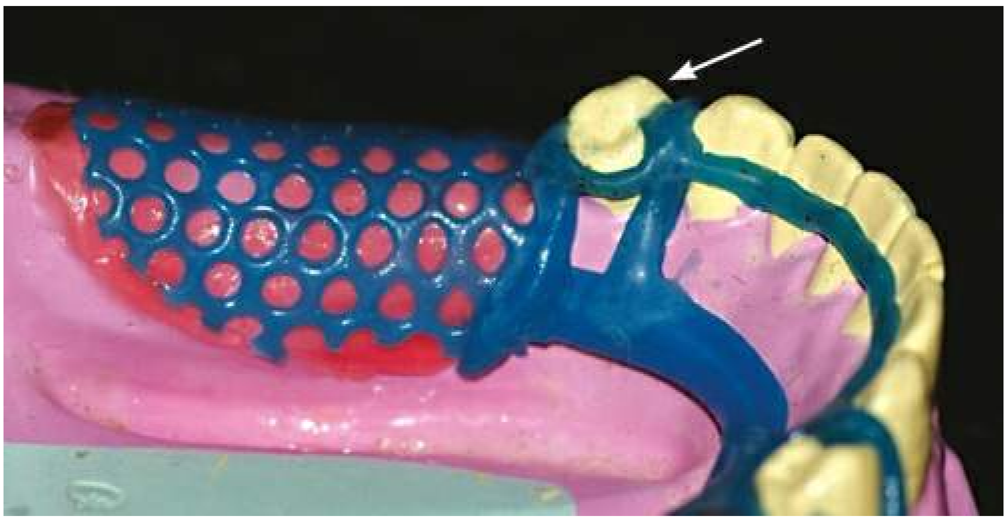


FIGURE 24.22 Mesial rest can cause food impaction.

3. *Combination clasp*

It is used in distal extension bases when mesiobuccal undercut exists on an abutment tooth (Fig. 24.23).

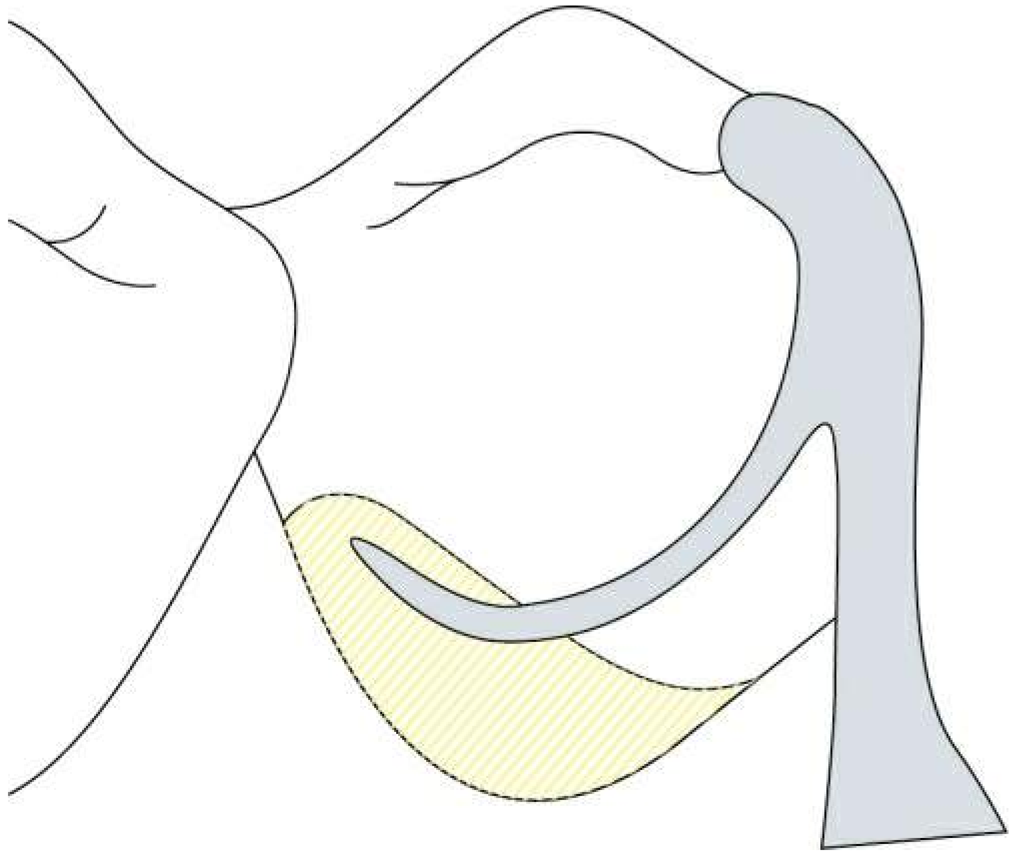


FIGURE 24.23 Wrought wire retentive arm (combination clasp) indicated when a mesiobuccal undercut exists.

Wrought wire retentive arm being more flexible will exert less stress on the abutment.

Splinting

Splinting can be fixed or removable.

Fixed splinting

Adjacent teeth may be splinted to increase the periodontal ligament attachment area and distribute the stress over a larger area of support. This is achieved by crowning the two teeth and is called *fixed splinting* (Fig. 24.24).

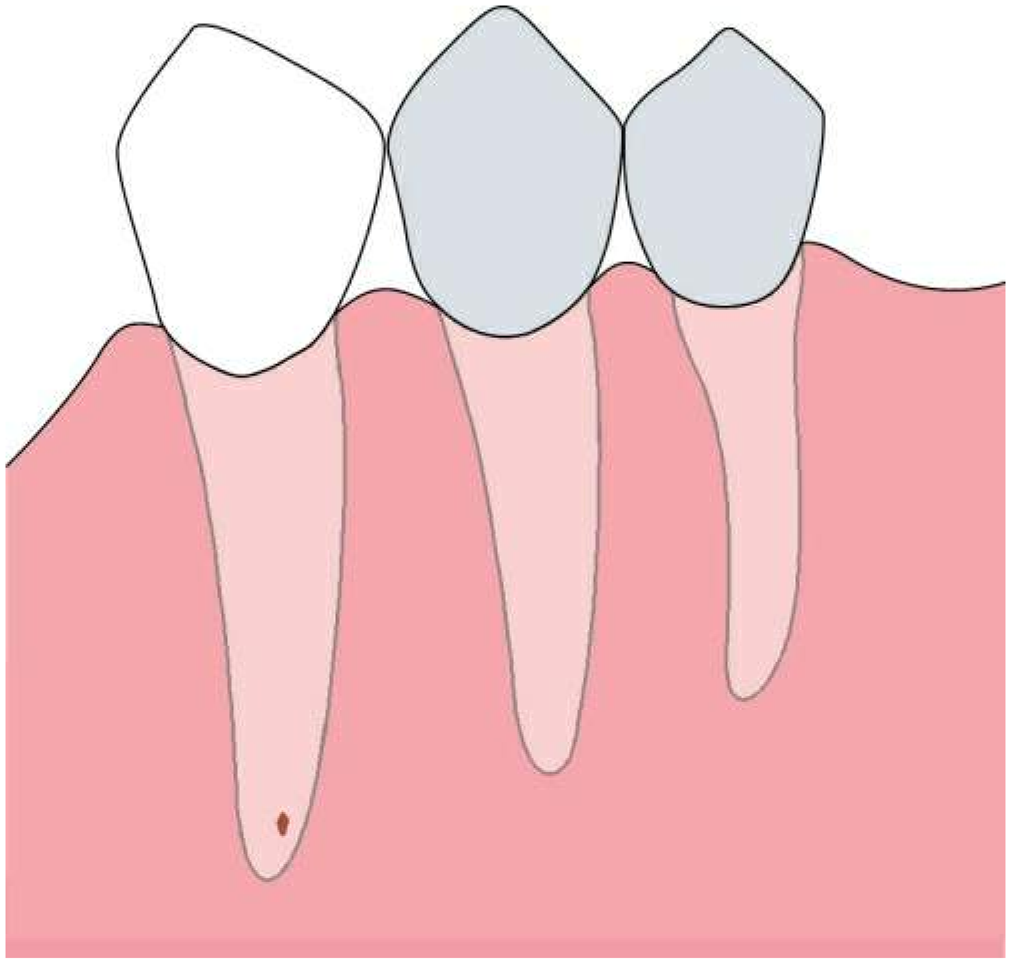


FIGURE 24.24 Fixed splinting with crowns.

An extremely week tooth should not be splinted with a strong tooth.

Indications for fixed splinting

1. Loss of periodontal attachment by disease or therapy.

2. Abutment has tapered or short roots.

3. When terminal abutment stands alone (Fig. 24.25): Edentulous space distal to canine and lateral incisor is also missing. The canine is splinted to central incisor by making a three unit fixed partial denture replacing lateral incisor. The distal space is replaced with removable partial denture.

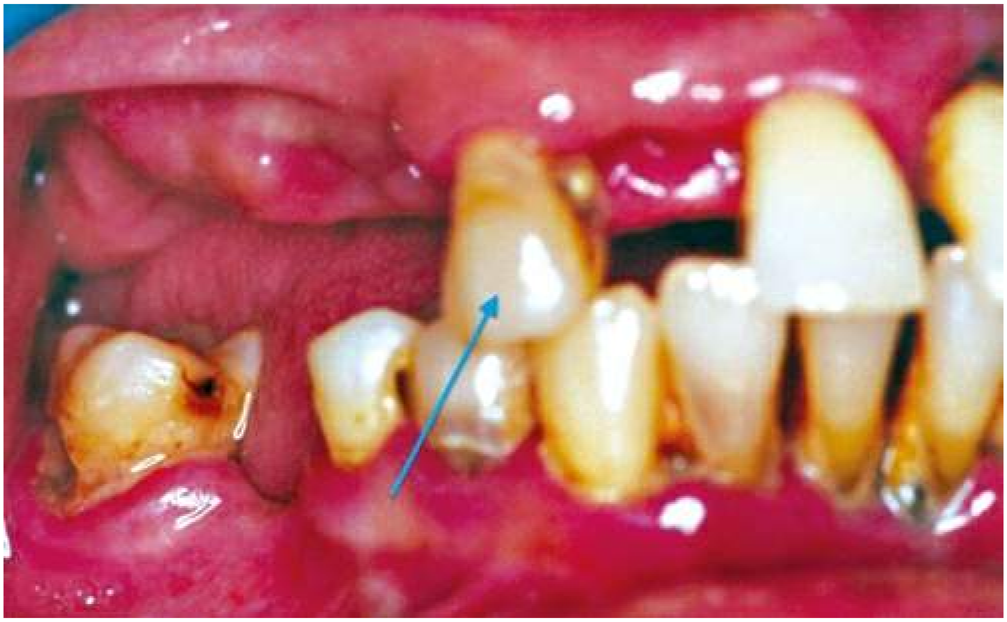


FIGURE 24.25 Lone-standing abutment (maxillary canine) should be splinted to central incisor with fixed partial dentures.

Removable splinting

This is achieved by clasping more than one tooth on each side of the arch, using a number of rests for additional support and stabilization of the teeth and prosthesis (Fig. 24.26). Most of the clasp arms will not be retentive.

FIGURE 24.26 Removable splinting with clasps.

The main advantage of removable splinting is cross-arch stabilization.

It should not be attempted if fixed splinting is possible because it is a compromised treatment.

Indirect retention

It basically assists the direct retainer in preventing displacement of denture away from the tissues by moving the fulcrum farther from the force. This is discussed in detail in Chapter 21.

In Kennedy's class I arches, indirect retainer is mandatory. One on each side of arch is placed as far anteriorly as possible (Fig. 24.27).

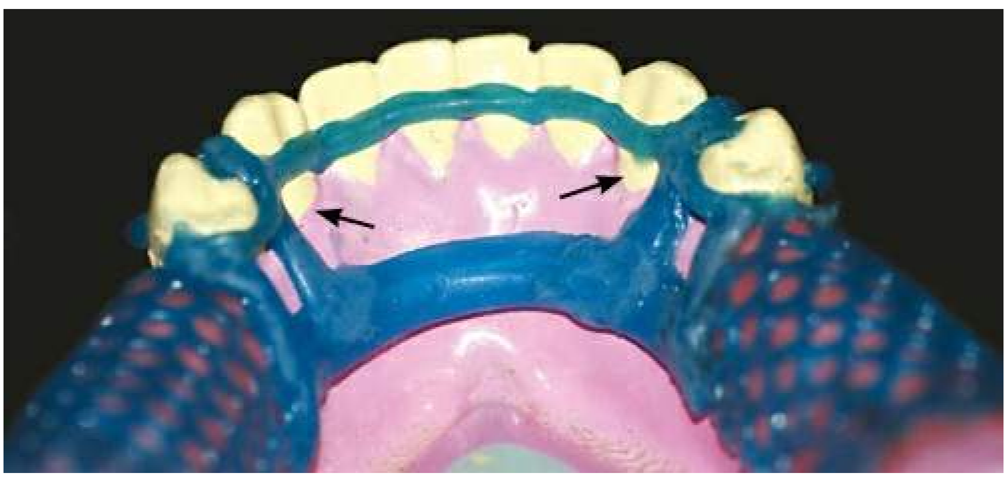


FIGURE 24.27 Indirect retainer in class I arch.

In class II arch, it is not critical as anyway the opposite arch will be clasped to make a tripod configuration and the most anterior clasp with its rest will function as indirect retainer (Fig. 24.28). If modification space exists on the opposite arch, the mesial abutment on the tooth-supported side, with its rest and clasp assembly will serve as indirect retainer (Fig. 24.29). If that mesial abutment is not far enough anteriorly, then another rest seat positioned further anterior may be used as indirect retainer (Fig. 24.30).

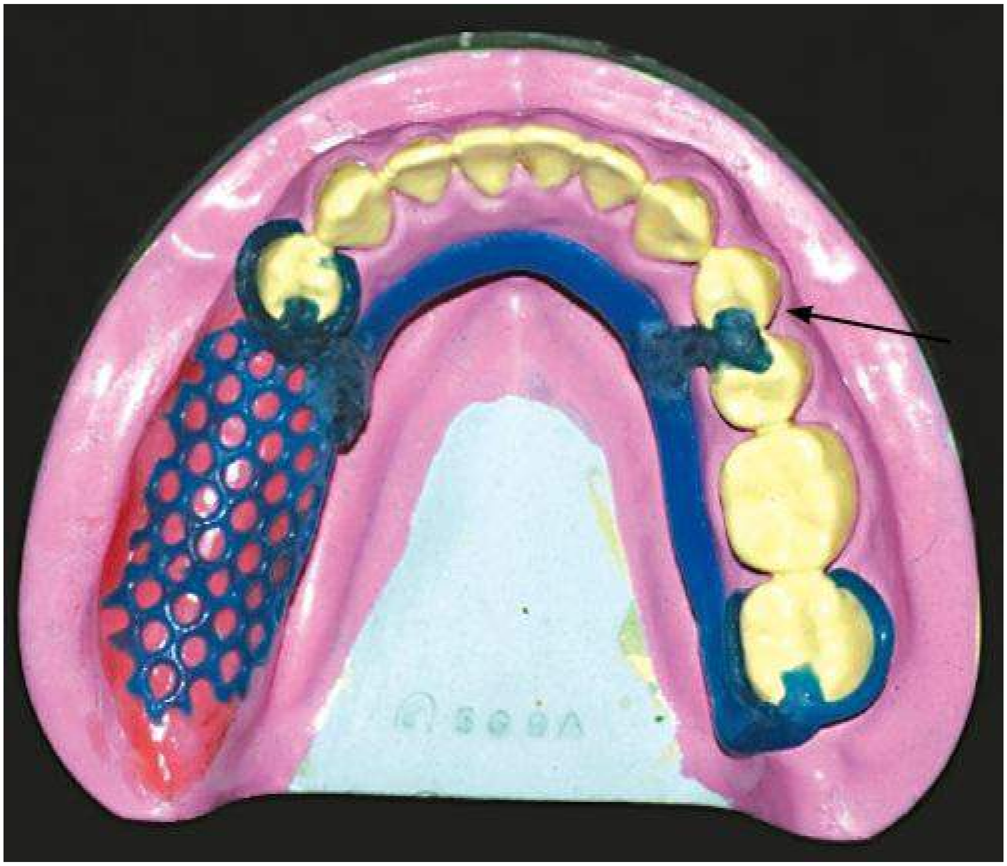


FIGURE 24.28 Class II – opposite arch will be clasped to make a tripod configuration and the most anterior clasp with its rest will function as indirect retainer.

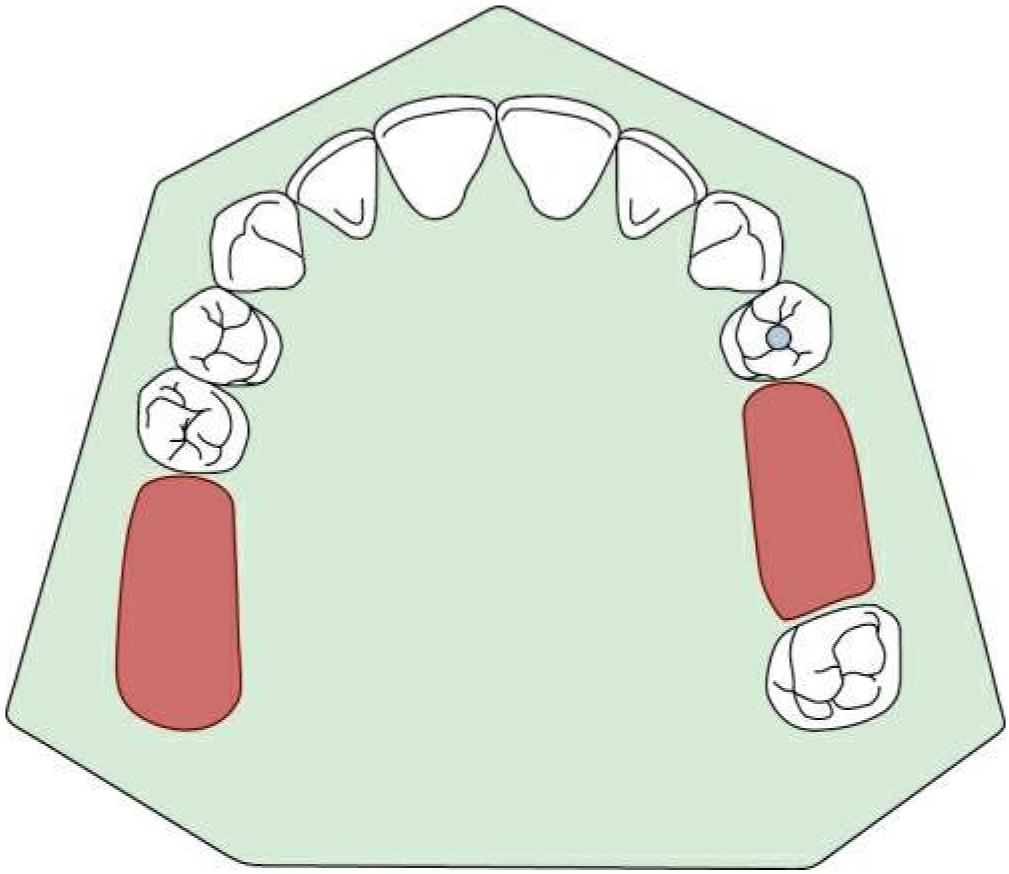


FIGURE 24.29 Class II with modification – the mesial abutment on the tooth-supported side, with its rest and clasp assembly will serve as indirect retainer.

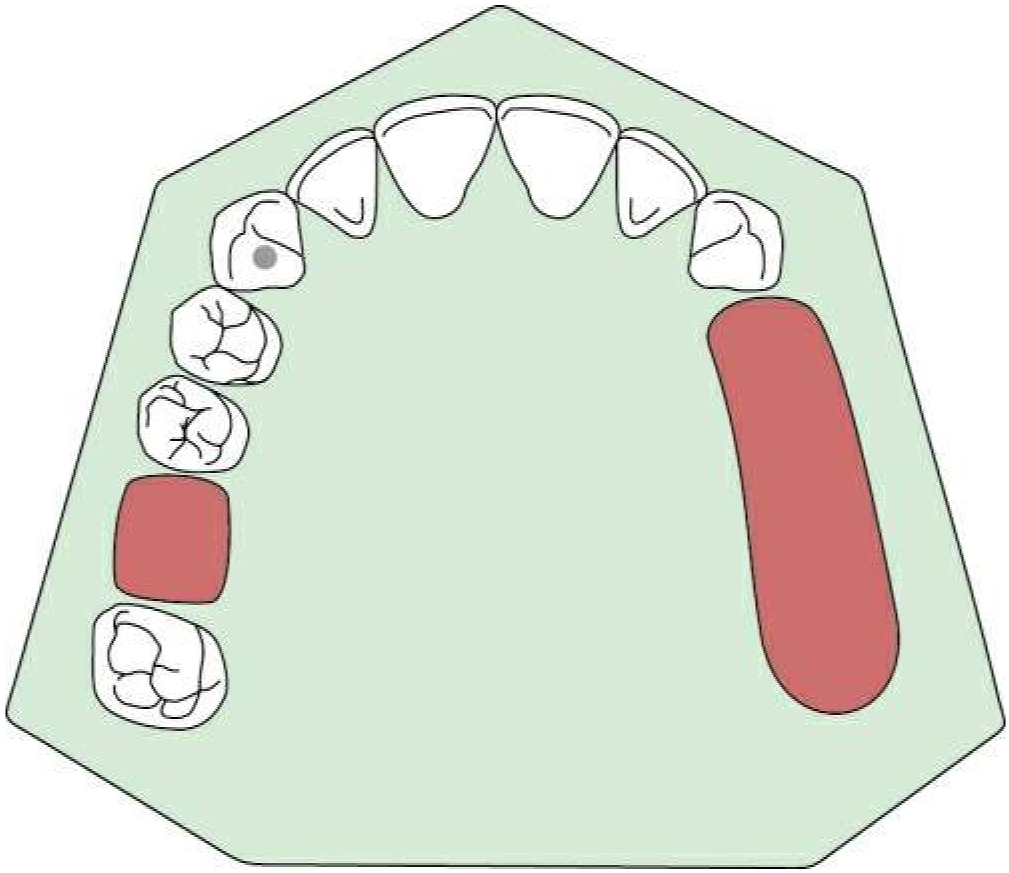


FIGURE 24.30 Class II with modification – another rest seat positioned further anterior, may be used as indirect retainer if mesial abutment of modification is not located too far anteriorly.

In class III, indirect retainer is not necessary as there are no rotational forces.

In class IV, the consideration is reverse of class I and II. The indirect retainer is placed as far posteriorly as possible on either side (Fig. 24.31).

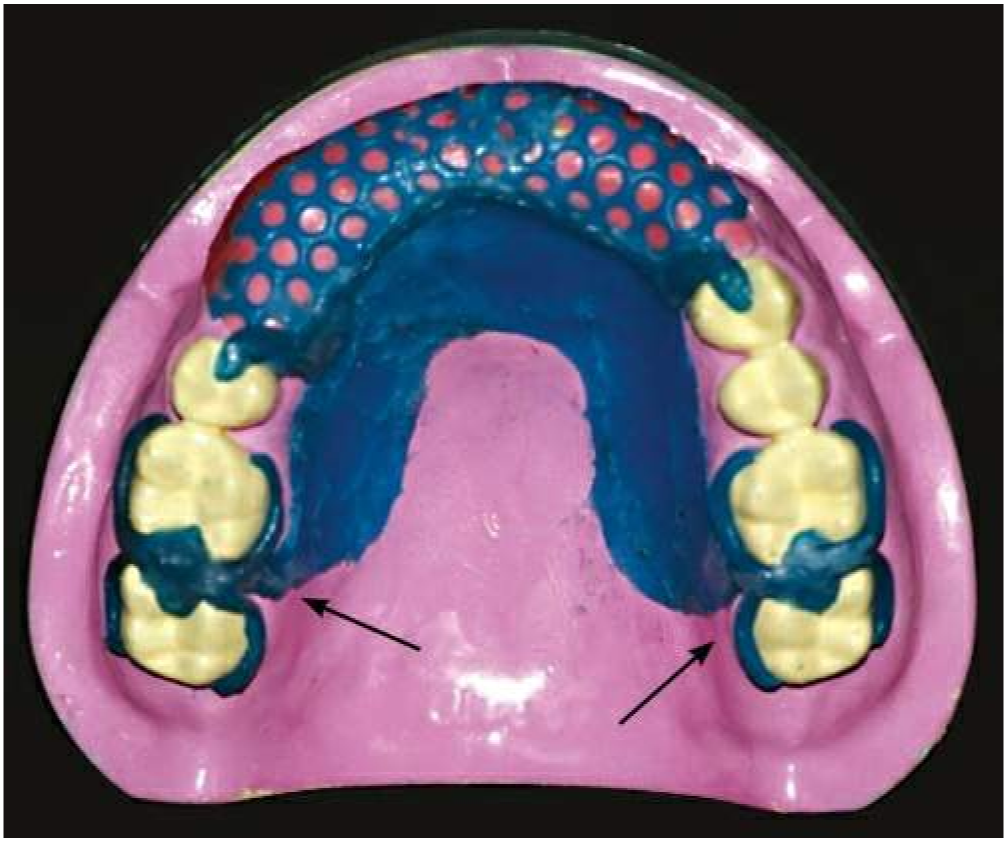


FIGURE 24.31 Indirect retainer placed bilaterally as far posteriorly as possible in class IV.

Occlusion

Occlusion should be in harmony with movements of temporomandibular joint and neuromusculature to minimize the stress transferred to the abutment teeth and residual ridge.

The initial occlusal contact should always be in the remaining natural teeth. Mandible should not be guided into protrusive or lateral movements by the metal or artificial teeth. Contact of the natural teeth should be same whether denture is in mouth or not.

Reducing the buccolingual width and the number of teeth being replaced will also reduce the stress transmitted.

Sharp cutting surfaces and sluiceways can help relieve some unnecessary force during mastication. Steep cuspal inclines on the artificial teeth should be avoided because they tend to set up horizontal forces detrimental to the abutment.

Denture base

It should cover maximum area of the supporting tissue as possible and flanges should be as long as possible to help stabilize against horizontal movements. Overextension should be avoided.

Distal extension denture base should cover the retromolar area and tuberosity of maxilla as these structures absorb stress better.

Accurate adaptation of denture base also lessens movement of the same and reduces stress.

Contour of the polished surfaces in harmony with the cheeks, lips and tongue also helps in reducing the stress transmitted.

Major connector

Some major connectors can control stress effectively.

In the mandibular arch, the *lingual plate* major connector properly supported by rests aids in distribution of functional stress. It also supports periodontally weakened anterior teeth. Added rigidity provided by lingual plate also helps in distributing stress created on one side of the arch to the other side – *cross-arch stabilization*.

In the maxillary arch, *broad palatal* major connector can distribute stress over a large area by covering hard palate and contributing to support, stability and retention of the prosthesis.

Minor connector

Intimate tooth to partial denture contact is brought about by contact of minor connectors with tooth (guiding planes). It offers horizontal stability to partial denture and abutment tooth against lateral forces.

Rests

These control stress by directing forces down the long axis of abutment teeth. Periodontal ligament is better suited to withstand vertical rather than horizontal forces.

The floor of rest seat must form an angle less than 90° to the long axis, to hold the tooth in position and to prevent its migration.

In distal extensions, the rest seat should be saucer shaped to allow some movement of the rest, so that forces are not transmitted to the abutment.

Principles of design

These principles were developed by A.H. Schmidt in 1956. While designing removable partial dentures, the following instructions should be adhered to:

1. Dentist must have a thorough knowledge of both the mechanical and biologic factors involved in removable partial denture design.

2. The treatment plan must be based on a complete examination and diagnosis of the individual patient.

3. Dentist must correlate the pertinent factors and determine a proper plan of treatment.

4. The prosthesis should restore form and function without injury to the remaining oral structure.

5. A removable prosthesis is a form of treatment and not a cure.

Philosophy of design

Of the various schools of thought, none is backed by scientific research or statistics.

They are ideas of dentists who by extensive clinical experience have formulated rules by which they produce a design.

If the physiologic limits of the supporting tissues are respected, then almost any design can be successful.

The challenge is primarily in designing class I and II arches and to some extent in class IV arches and distributing the forces acting on the removable partial denture between the soft tissues and teeth.

There are three philosophies that drive the design process of removable partial dentures:

1. Stress equalization

The proponents of this theory state that resiliency (movement) of the tooth secured by the periodontal ligament in an apical direction is not comparable to the greater resiliency and displaceability of the mucosa covering the edentulous ridge. So if a load was applied to the denture base, the greater movement of the mucosa would cushion the force, while the lesser movement of abutment tooth would generate more stress on the tooth. Therefore, it is believed that a type of stress equalizer is needed to replace the rigid connection between denture base and direct retainer and transfer the load from the abutment to the ridge.

These are also called *stress breakers* or *articulated prosthesis*. These can be of two types and are described as follows:

1. **Stress equalizer having a movable joint between the direct retainer and denture base** (Fig. 24.32). They may be hinges, sleeves and cylinders or ball and socket joints. They allow vertical movement and hinge action of the distal extension denture base and help transfer load from the abutment to the ridge. Examples: Dalbo, Crismani and ASC 52 attachments.

2. **Stress equalizer having a flexible connection between the direct retainer and denture base.** They may be wrought wire connectors and divided major connectors (Fig. 24.33).

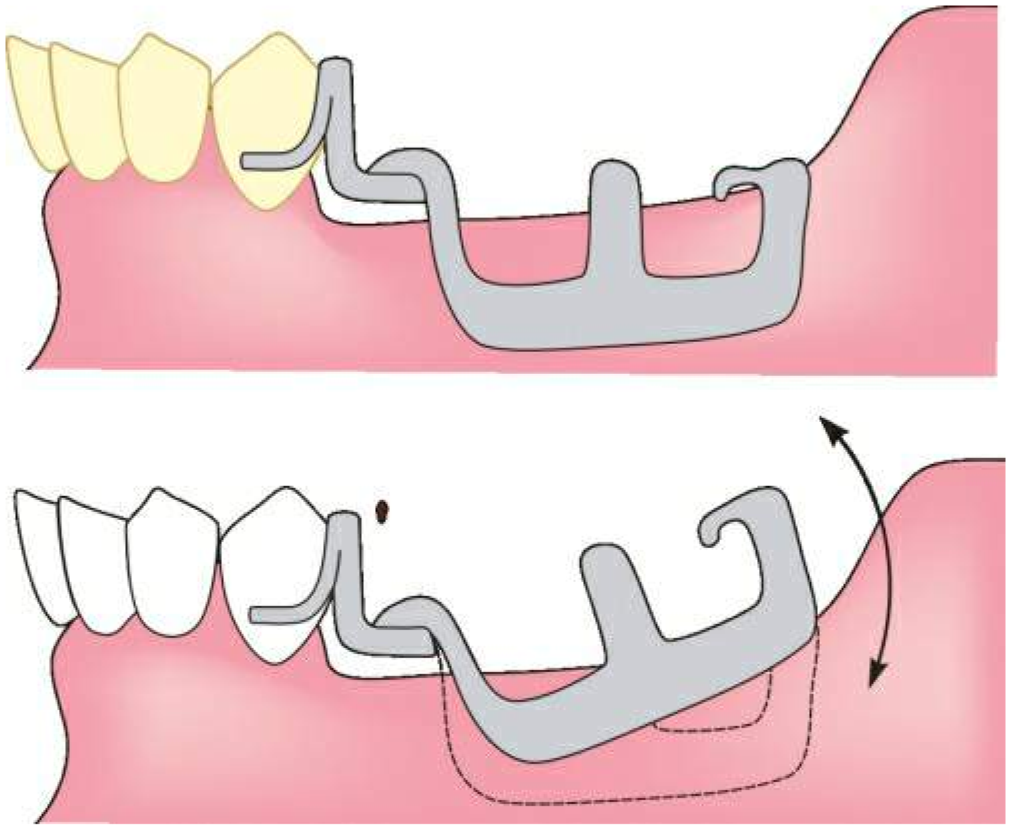


FIGURE 24.32 Hinge attachment allowing movement of denture base.

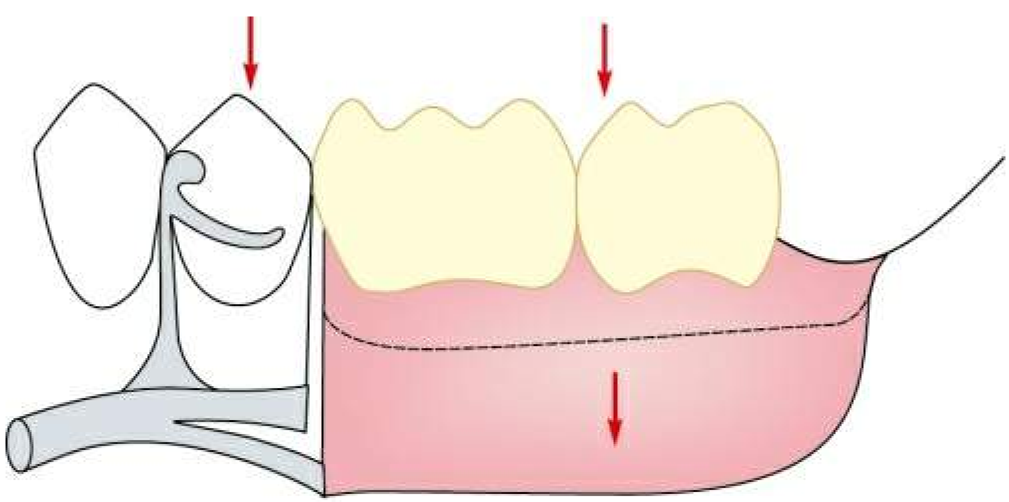


FIGURE 24.33 Divided major connector – will allow denture base to move interdependently without creating stress on the direct retainer, thereby the abutment.

Advantages

1. Minimal direct retention is required as denture base acts more independently.

2. Minimize tipping forces on abutments thus preserving its alveolar bone support.

3. Proposed that force is evenly distributed between abutment and ridge.

4. Intermittent movement of denture base against mucosa has a massaging or stimulating effect on the soft tissues.

5. Splinting of weak teeth possible.

6. If relining is not done when needed, abutment is not damaged as quickly.

Disadvantages

1. Construction is complex and costly.

2. Constant maintenance is required and it is difficult or impossible to repair.

3. Vertical and horizontal forces are concentrated on ridge which leads to rapid resorption of the ridges.

4. If relining is needed but not done, there will be excessive ridge resorption.

5. Effectiveness of indirect retainer is lost.

6. More food entrapment in the joint and spaces.

7. Can easily distort if not handled properly.

2. Physiologic basing

The proponents of this theory also believe that there is relative lack of movement in abutment teeth in an apical direction compared to the ridge. They advocated distributing the stress by displacing or depressing the ridge mucosa during the impression making procedure or by relining the denture base after it has been constructed. So when an occlusal load is applied on denture base, it will adapt better and will withstand the force.

The tissue surface is recorded in functional form and not anatomic form.

Prosthesis constructed from tissue displacing impression will be above the plane of occlusion when the denture is not in function (Fig. 24.34). To permit vertical movement from rest position to functional position, the retentive clasps need to have minimum retention and also their number has to be less.

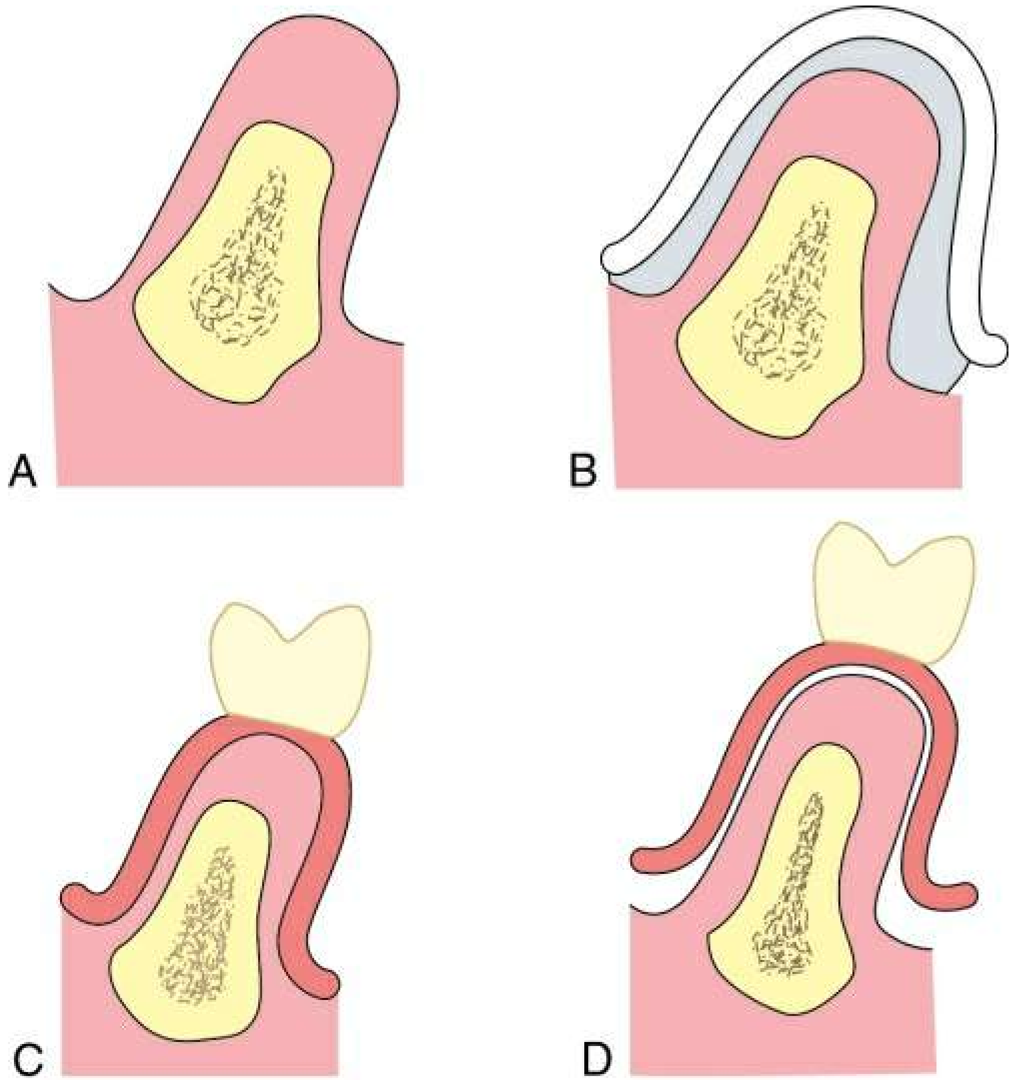


FIGURE 24.34 **(A)** Anatomic position of mucosa. **(B)** Functional impression made by depressing mucosa. **(C)** Denture in functional position. **(D)** Denture will rest above occlusal plane when not in function.

Advantages

1. Intermittent base movement has a physiologically stimulating effect on the underlying bone and soft tissue.

2. Less need for relining and rebasing.

3. Simple in design and construction with minimal maintenance and

repair.

4. The looseness of the clasp on the abutment tooth reduces the functional forces transmitted to the tooth.

Disadvantages

1. Denture is not well stabilized against lateral forces.

2. There will be always premature contact when mouth is closed, which is uncomfortable for the patient.

3. It is difficult to produce effective indirect retention.

3. Broad stress distribution

The proponents of this philosophy advocated distributing the forces of occlusion over as many teeth, and as much of the available soft tissue area as possible. This is achieved by means of additional rests, indirect retainers, clasps and broad coverage denture bases.

Advantages

1. Teeth can be splinted.

2. Prosthesis is easier and less expensive to construct.

3. No flexible or moving parts so less danger of distorting the denture.

4. Indirect retainers and other rigid components provide excellent horizontal stabilization.

5. Less relining required.

Disadvantages

1. Greater bulk may cause prosthesis to be less comfortable.

2. Increased amount of tooth coverage can lead to dental caries if oral hygiene is not maintained properly.

Out of these three philosophies, stress equalization has few advocates. Broad stress distribution is the most widely used philosophy and will be followed in the design procedure.

Essentials of design

A summary of the various components and considerations for all the Kennedy's classification types is discussed below. Class I and II will be considered together as their principles are similar. All the factors have already been discussed under 'Controlling Stress by Design Consideration' in the previous sections of this chapter and in Chapter 21, and are indicated as such.

Class I and II

1. *Direct retention*

i. Retention should *not* be the prime objective.

ii. Proper contour and close adaptation of an adequately extended denture base, accurate fit of the framework and properly prepared guide planes should be used to help in retention.

2. *Clasps*

Simplest type of clasp should be used.

i. Class I prosthesis usually requires two retentive clasp assemblies – one on each terminal abutment. The type of clasp depends on the location of undercut, distobuccal – reverse circlet and bar clasp, mesiobuccal – combination clasp as already discussed in 'Clasp design'. Reciprocal arms should fulfil all its requirements.

ii. Class II should have three retentive clasp arms. Type and location on distal extension side are similar to class I. On the other side if modification is present, simple circlet clasp is on the teeth anterior and posterior to edentulous space. If there is no modification, then one anterior and one posterior embrasure clasp (Fig. 24.35). Reciprocal arms should fulfil all the requirements.

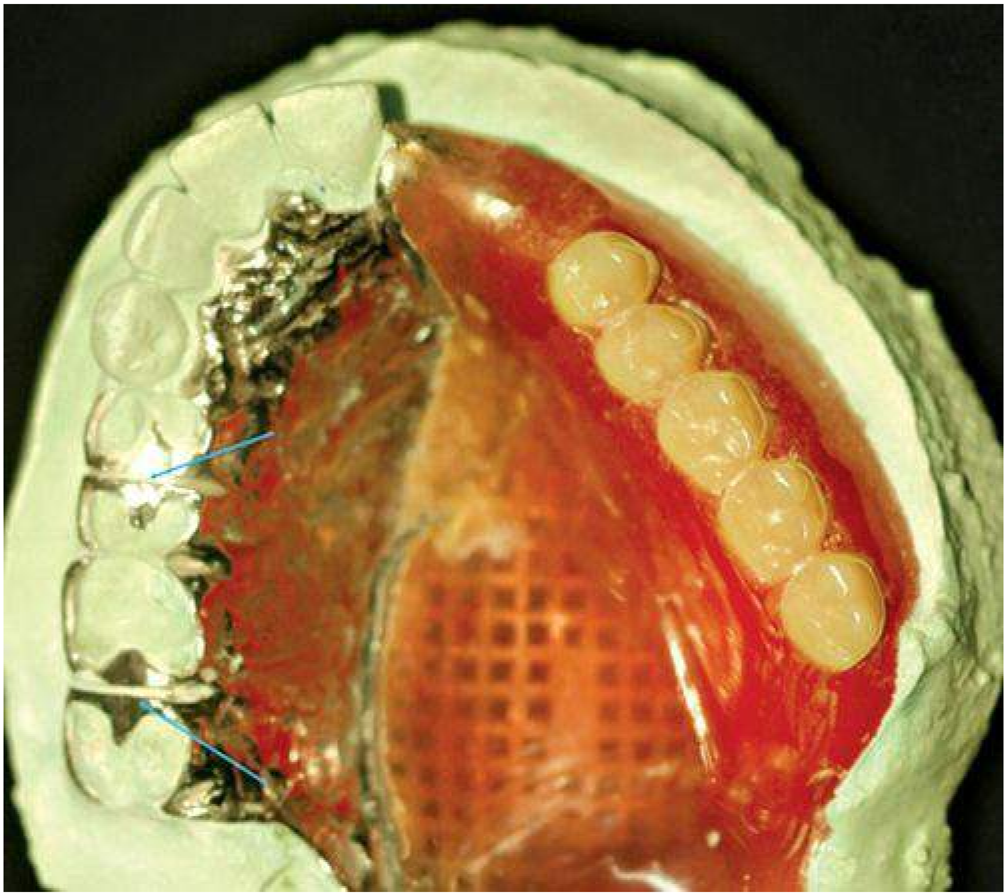


FIGURE 24.35 In class II with no modifications, two embrasure clasps are placed, one anteriorly and other posteriorly.

3. *Rests*

Teeth selected for rest preparation should provide maximum possible support for the prosthesis. Rests should be placed next to the edentulous space with few exceptions. All other requirements are already discussed.

4. *Indirect retention*

Number, location and type are already discussed in this chapter under 'Controlling Stress by Design'.

5. *Major connectors*

These fulfil all the requirements and specifically the requirements for distal extensions.

6. *Minor connectors*

These must fulfil all the requirements.

7. *Occlusion*

If there are sufficient centric stops, then MIP (Maximal Intercuspal Position) is utilized. If there are insufficient centric stops, then centric occlusion is given (MIP at centric relation). All other parameters are already discussed in this chapter.

8. *Denture base*

Selective pressure technique is used to record ridge in a functional form. All other criteria are already discussed.

Class III

1. *Direct retention*

Retention can be achieved with much less potential harmful effect on the abutment teeth than with the class l or II arch. The position of the retentive undercut on abutment teeth and type of clasp is not critical.

2. *Clasp*

Quadrilateral positioning of clasp arms is ideal. Tooth and tissue contours and aesthetics should be considered, and the simplest clasp possible is selected.

3. *Rests*

Should fulfil all the requirements and are placed adjacent to edentulous space when possible.

4. *Indirect retention*

Indirect retention is not required.

5. *Major connectors*

These fulfil all the requirements and are used as per indication.

6. *Minor connectors*

These fulfil all the requirements.

7. *Occlusion*

Given in MIP and all other parameters are already discussed in this chapter.

8. *Denture base*

A functional type impression is not required.

Class IV

Design considerations are unique. To satisfy aesthetics, artificial teeth may need to be placed anterior to the crest of the residual ridge, resulting in potential tilting leverages. Planning should begin to reduce these stresses even before extraction is planned by considering the following:

i. Preservation of labial alveolar process.

ii. Retaining teeth to serve as an intermediate abutment or as an overdenture abutment.

iii. Shorter the edentulous span, less will be the tilting leverage.

The quadrilateral configuration, with the anterior clasps placed as far anterior and the posterior clasps placed as far posterior as possible, would be the ideal. The major connector should be rigid and broad palatal coverage should be used in the maxillary arch.

Indirect retention should be used as far posterior to the fulcrum line as possible. An ideal quadrilateral configuration of clasping may preclude the need for an additional indirect retainer. A functional type of impression may be indicated if the edentulous area is extensive.

Design procedure

Armamentarium

1. Surveyor with its tools.

2. Articulator – plasterless if possible or any simple hinge or mean value articulator.

3. Colour pencils – red, blue, black, brown.

Colour coding

Colour coding allows for easy understanding of the design marked on the diagnostic models by the technician and improves the communication between the dentist and laboratory.

At present no universally accepted colour coding system exists. Commonly red, black, blue and brown colours are used.

- **Red**: Means 'required action' or the teeth require some preparation. It marks the teeth and soft tissues which are to be prepared, recontoured and relieved. Solid red shows where occlusal rest is to be prepared. Diagonal red lines show where recontouring is necessary. Tripod marks are also marked in red.

- **Black**: Denotes survey lines on teeth and soft tissues. Instructions on cast base on type of tooth replacement, type of clasp, depth of undercut are also written in black.

- **Blue**: Denotes portions that will be made of acrylic – mostly denture bases and acrylic teeth.

- **Brown**: Denotes all metallic portions.

Procedure

1. *Occluded diagnostic casts*

The following procedures are performed on occluded diagnostic casts:

i. Proposed rest areas are marked on the cast base below the tooth with a short line (Fig. 24.36).

ii. Any cuspal relief needed to provide adequate occlusal clearance for the rest is marked in red on the tooth to be prepared (Fig. 24.37).

iii. Line marked on lingual surface of upper anterior teeth demarcates incisal limits of metal extensions and gingivo-occlusal limits of proposed rests and indirect retainers (Figs 24.38 and 24.39).

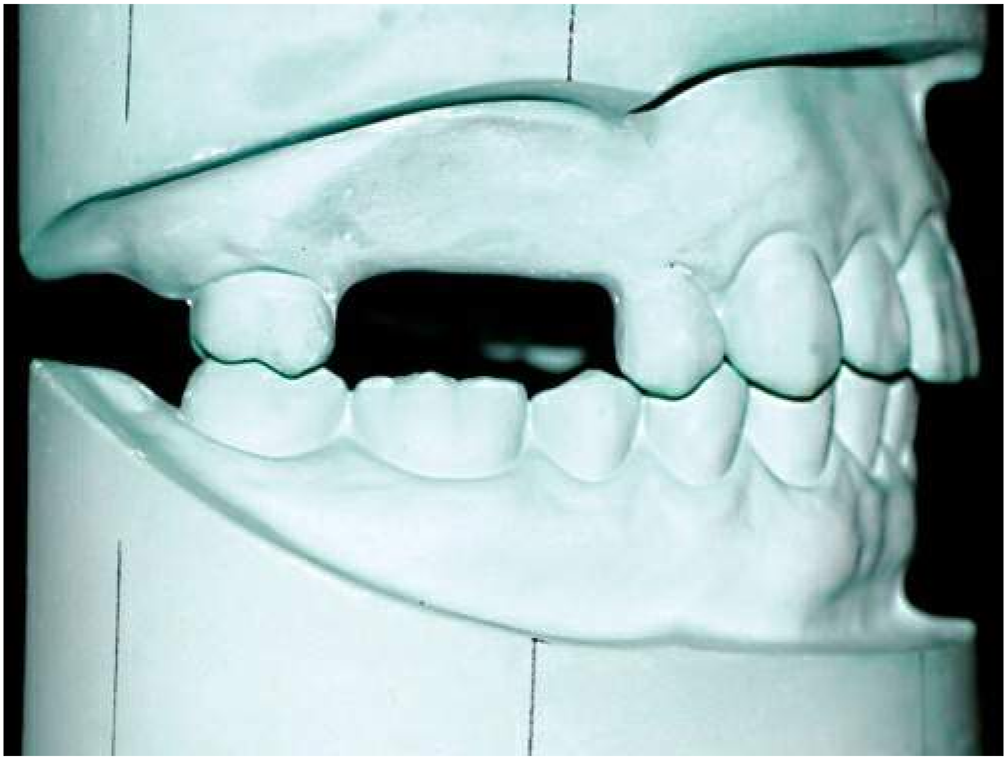


FIGURE 24.36 Proposed rest areas are marked on the cast base.

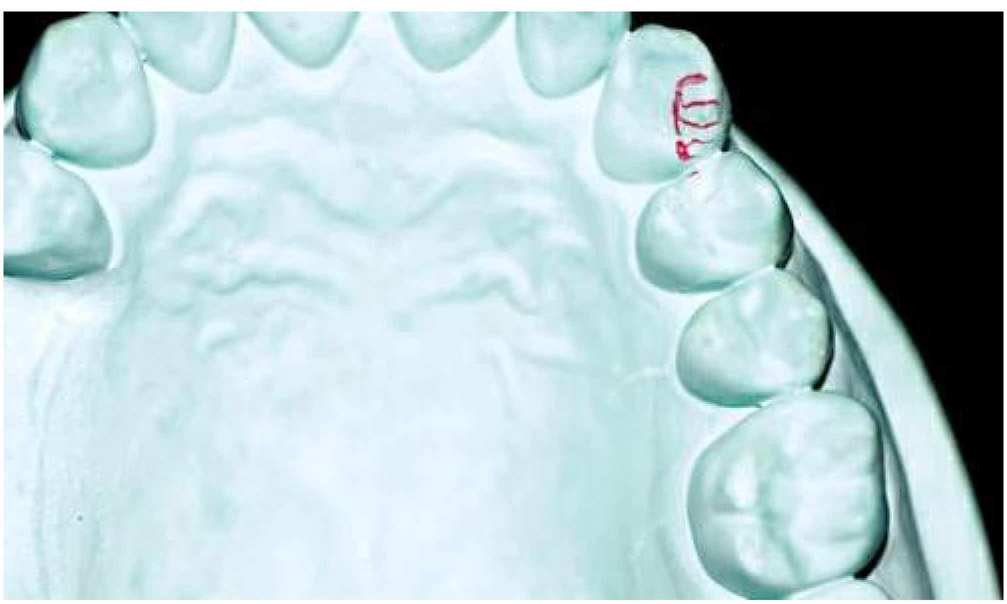


FIGURE 24.37 Cuspal relief needed is marked on tooth.

FIGURE 24.38 Incisal limits of metal extensions.

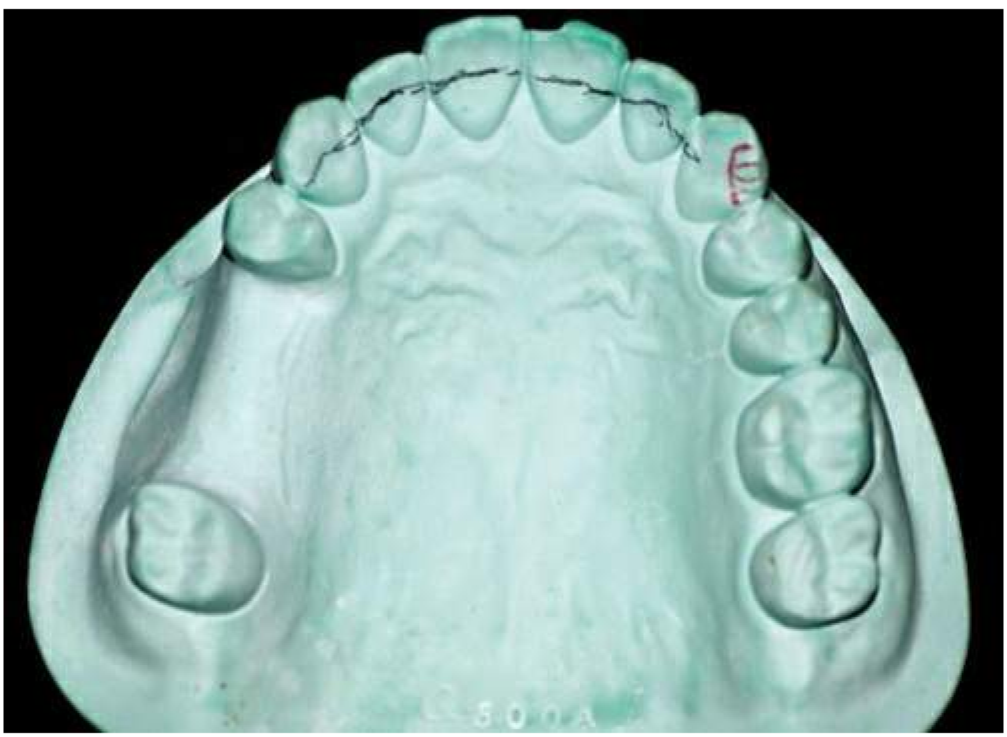


FIGURE 24.39 Gingivo-occlusal limits of proposed rests and indirect retainers.

2. *Type of tooth replacement*

This is indicated by marking the type of replacement on the labial side of ridge of the missing tooth (Fig. 24.40). The following symbols are used:

I. Denture tooth – No symbol

II. Tube tooth – T

III. Facing – F

IV. Metal pontic – M

V. Reinforced acrylic pontic – RAP

FIGURE 24.40 Type of tooth replacement marked on the labial side of ridge of the missing tooth.

3. *Select the final tilt of cast*

The final tilt is selected by placing the cast on surveyor at horizontal tilt and tilting the cast to consider – retentive undercuts, interferences, aesthetics and guiding planes. The cast is locked in position once the final tilt is determined. This is discussed in Chapter 23. The areas that require modification are marked in red.

4. *Tripod the cast*

The tilt of cast is recorded by tripoding for future reference (Fig. 24.41).

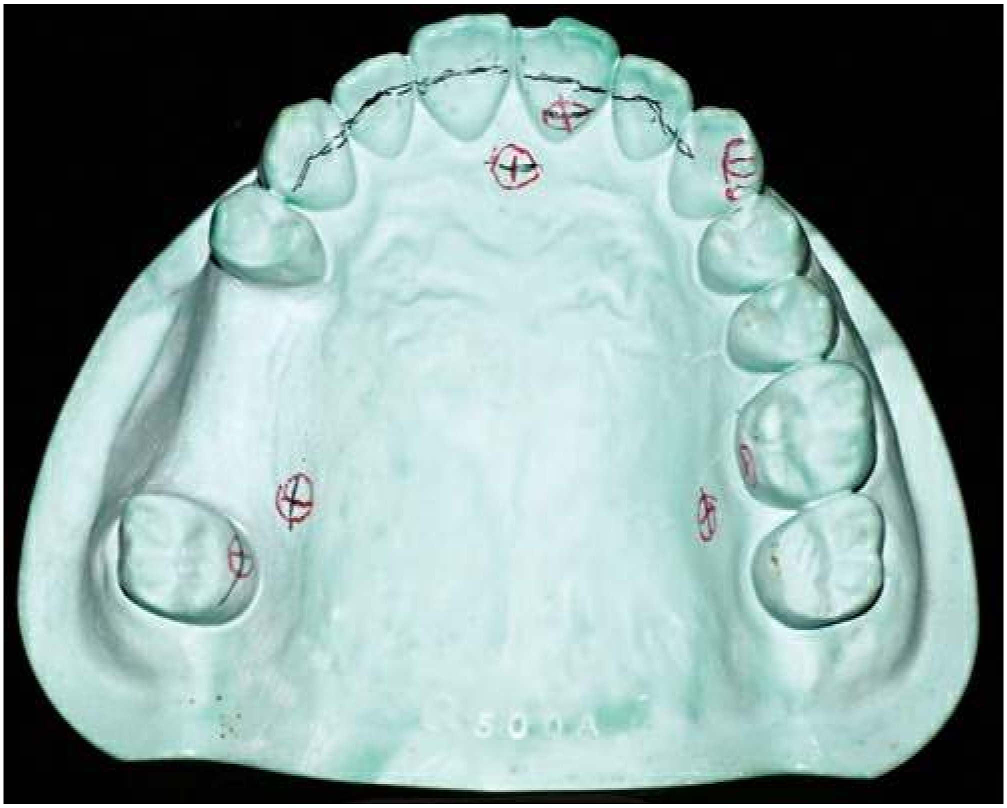


FIGURE 24.41 Tripoding the cast.

5. *Mark the survey lines and soft tissue undercuts*

The carbon marker is placed and survey line is marked in black on all the teeth (Fig. 24.42). Soft tissue undercuts are also scribed for designing bar clasps (Fig. 24.43).

FIGURE 24.42 Survey line marked.

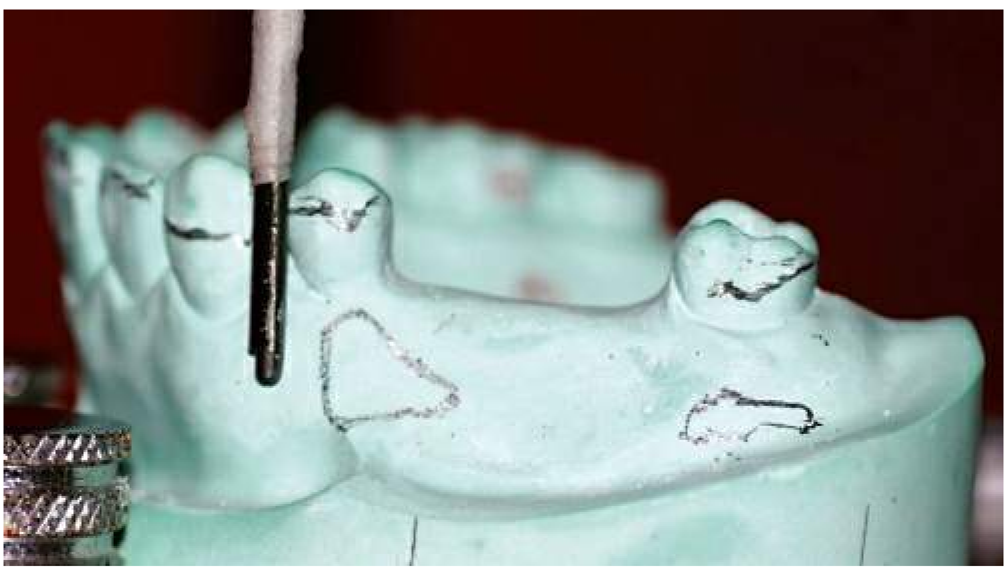


FIGURE 24.43 Soft tissue undercut marked.

6. *Mark the areas to be prepared in the mouth*

Rests and indirect retainers are then marked in red (Fig. 24.44). Areas to be recontoured are also marked in red as evenly spaced diagonal lines (Fig. 24.45).

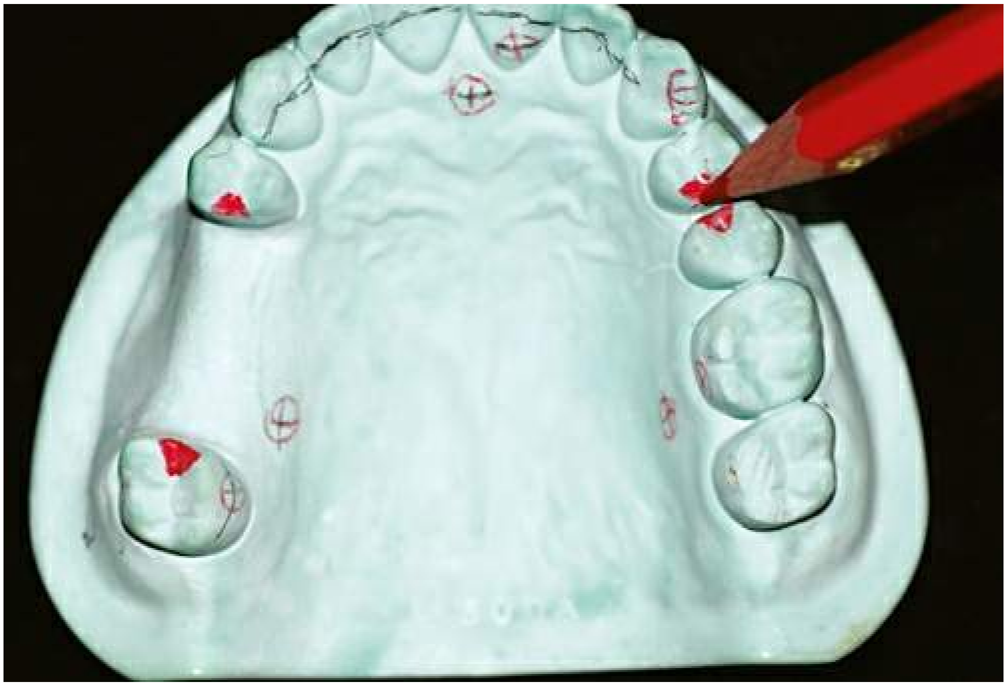


FIGURE 24.44 Rests and indirect retainers marked.

FIGURE 24.45 Areas to be recontoured.

7. *Mark the denture base area*

Outline the exact position and extent of the denture base area in blue

(Fig. 24.46).

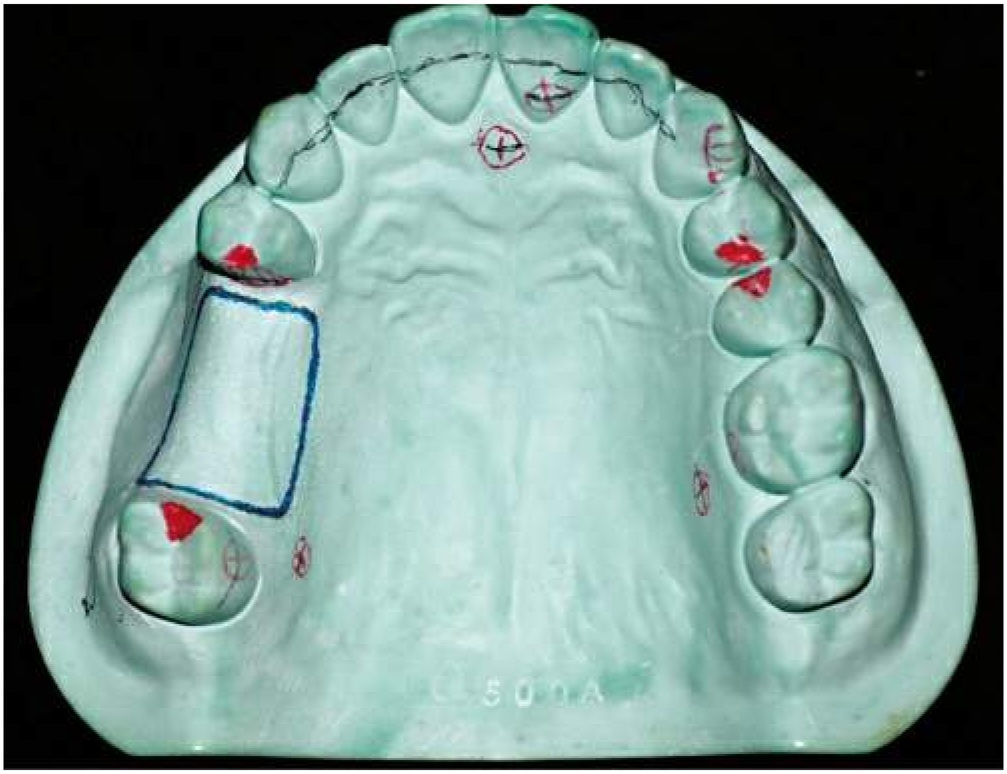


FIGURE 24.46 Extent and position of denture base area marked.

8. *Mark the major and minor connectors*

The framework with major and minor connectors is marked in brown to join the already marked rests, indirect retainers, denture base and replacement teeth (Fig. 24.47).

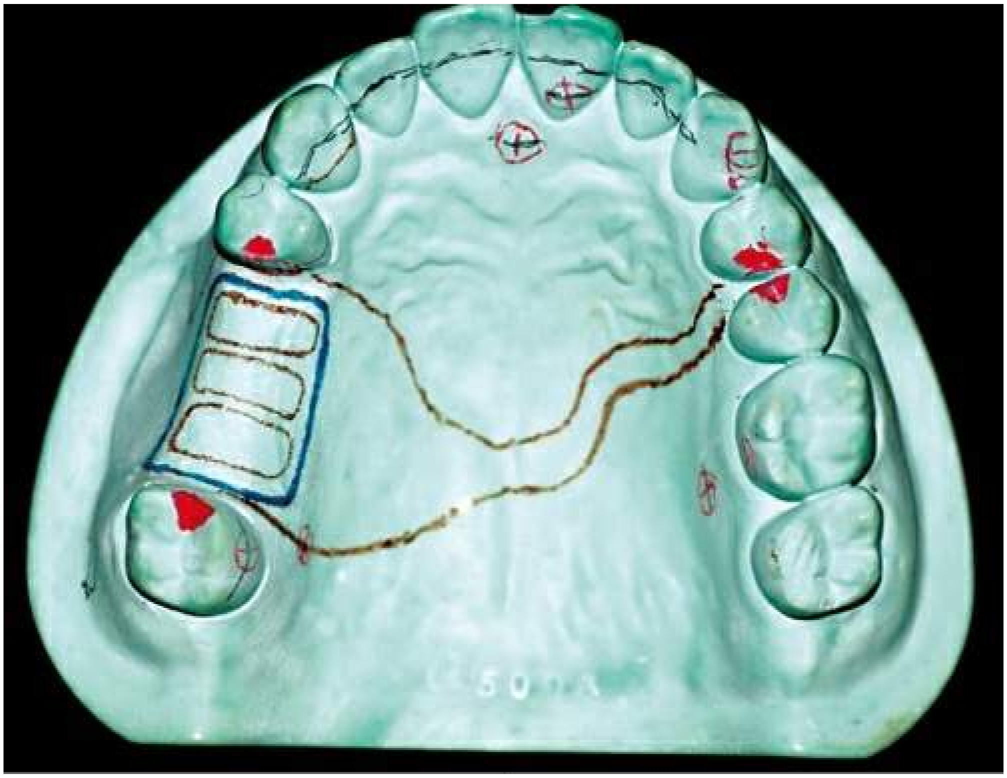


FIGURE 24.47 Major and minor connectors marked.

9. *Mark the retentive terminal*

Desired undercut is measured with undercut gauge and location of retentive terminal is marked as a red line of 2 mm (Fig. 24.48).

FIGURE 24.48 Retentive terminal marked.

10. *Draw the clasp arms*

With a brown pencil, the clasp arms are drawn to the correct size, shape and location and are connected to the other components (Fig. 24.49). If wrought wire clasp is used, the symbol WW is marked on the cast base (Fig. 24.50).

FIGURE 24.49 Clasp arm marked.

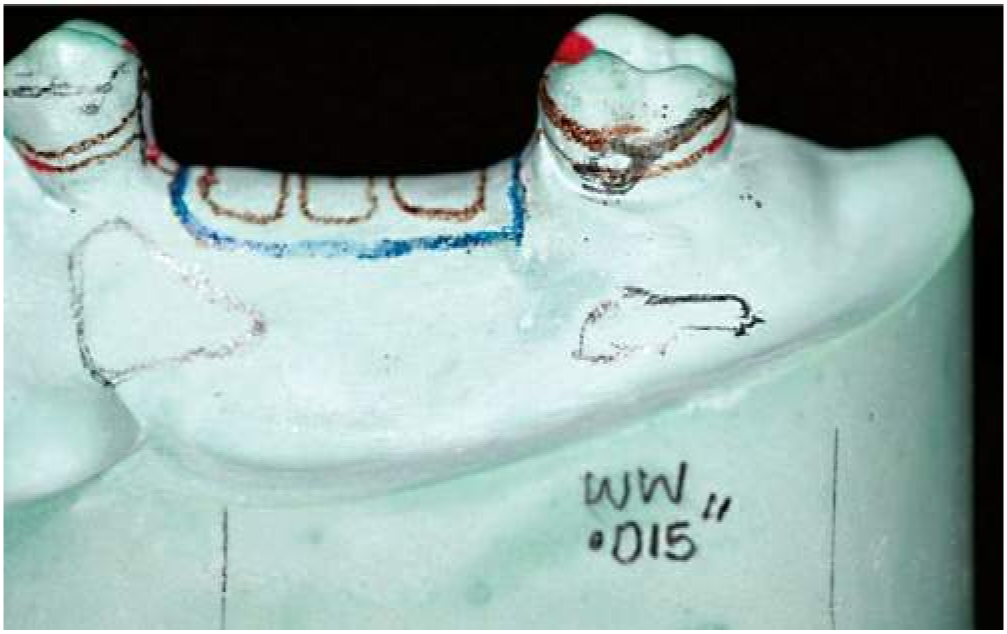


FIGURE 24.50 Wrought wire arm marked.

11. ***Designed diagnostic cast*** (fig. 24.51)

SUMMARY

Biomechanical principles guide the design of cast partial dentures depending on the forces acting on the denture. These forces transmit deleterious forces to the abutment teeth which will affect the prognosis and can destroy the tissues. Every effort must be made to select the component parts judiciously to mitigate these forces and allow the prosthesis to function adequately in the long term. Broad stress distribution to transfer and share the stress is the design philosophy of choice.

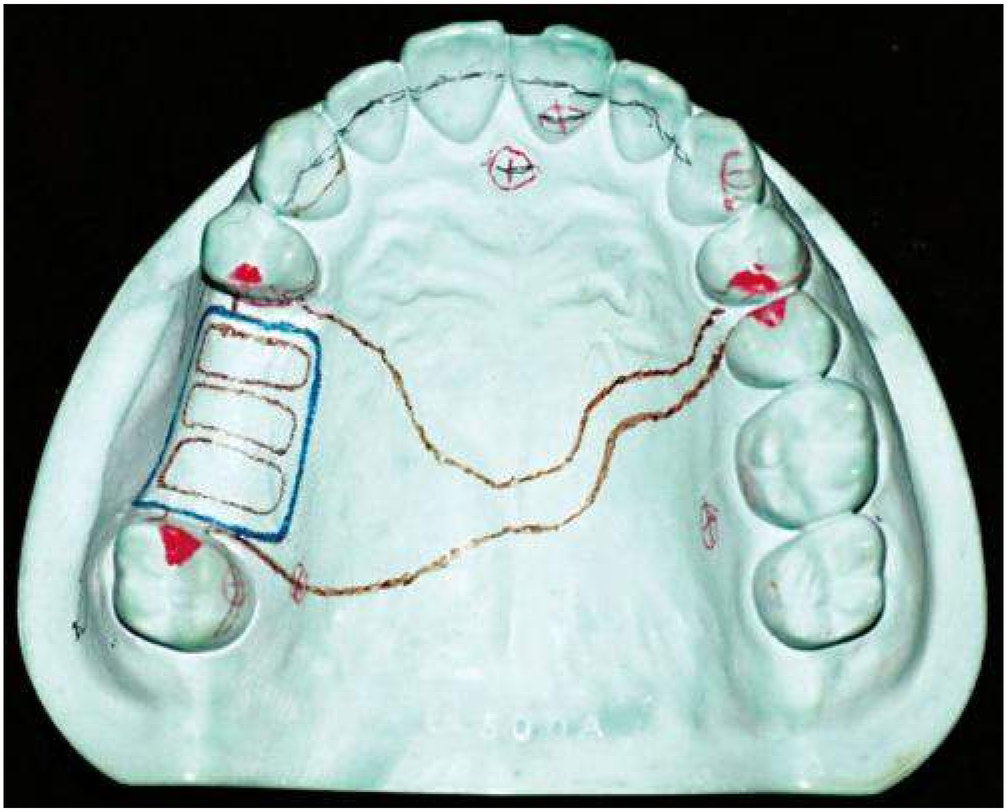


FIGURE 24.51 Designed diagnostic cast.

CHAPTER

25

Mouth preparation

CHAPTER CONTENTS

Introduction

Mouth preparations are procedures that change or modify existing oral structures or conditions, to facilitate placement and removal of prosthesis for its efficient physiologic function and long-term success. This step contributes to the philosophy that prosthesis must not only replace what is missing but also preserve what is remaining. Mouth preparation follows preliminary diagnosis and development of tentative treatment plan and design. Following this, the master cast is made.

Definition: Mouth preparations are identified as those procedures that are accomplished to prepare the mouth for the reception of prosthesis – Renner Boucher.

Objectives

- Establishing state of health in supporting and contiguous tissues.
- Eliminating interferences or obstructions.
- Establishing acceptable occlusal plane.
- Alteration of natural tooth form for the requirements of form and function of prosthesis.

Classification

Mouth preparation may be classified basically into two parts:

1. General preparation of the mouth which involves nonprosthodontic preparation (where no prosthetic procedure is performed) and prosthodontic preparation (which may involve some prosthetic procedures like crowns).

2. Specific preparation of abutment teeth to create guiding planes, retentive undercuts and occlusal rests.

Mouth preparation should be completed before impression procedures for master cast on which denture is to be constructed.

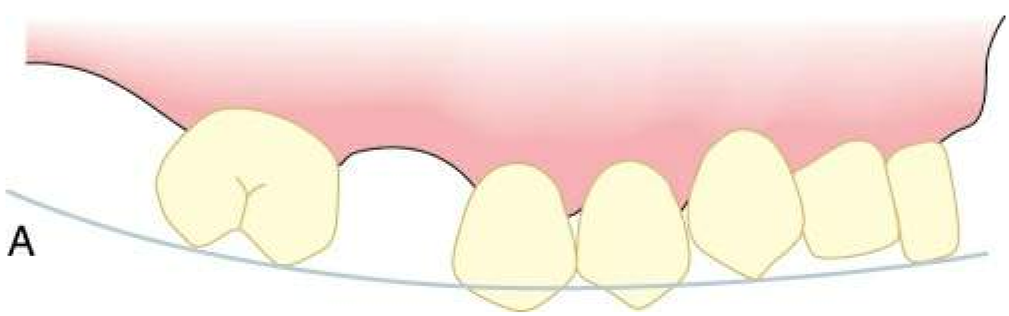
Oral surgical and periodontal procedures should precede abutment preparations to allow healing period.

A period of 6 weeks, but preferably 3 months, should be provided between surgical and restorative procedures.

Preparation of mouth

Procedures involved in mouth preparation are summarized in Flowchart 25.1.

A



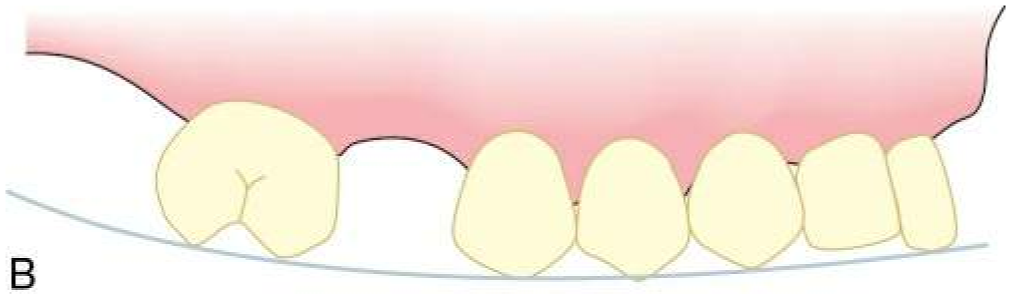
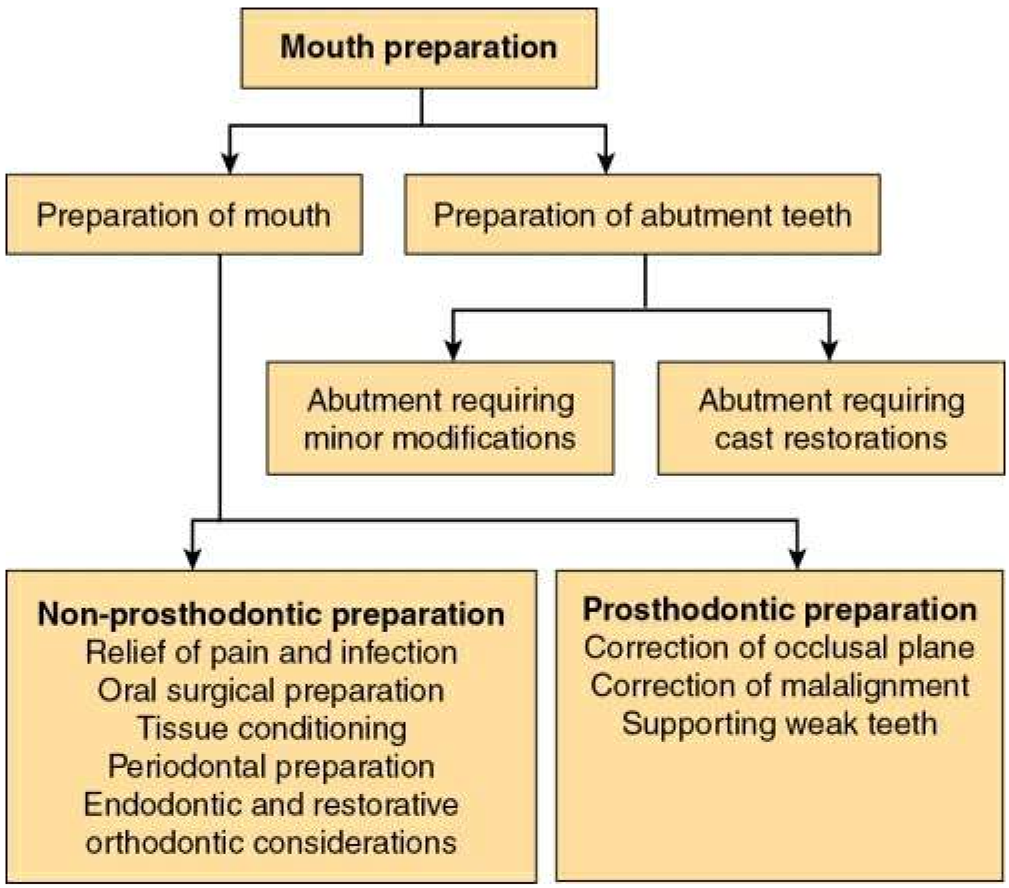


FIGURE 25.1 **(A)** Irregular occlusal plane. **(B)** Enameloplasty done to correct the occlusal plane.



FLOWCHART 25.1 Classification of procedures involved in mouth preparation

Nonprosthodontic preparation

It includes procedures which do not involve any kind of prosthodontic treatment.

1. Relief of pain and infection

Teeth that are causing pain or discomfort due to caries or defective restoration and infection should be treated to eliminate pain.

Large carious lesion which is asymptomatic should be restored with an intermediate restoration to prevent possibility of any acute pain during treatment.

Gingival tissues should also be treated early to eliminate acute infections like abscesses.

2. Oral surgical procedures

Conditions requiring oral surgical procedures should be treated first. This includes the following processes:

i. Extraction

Regardless of its condition each tooth must be evaluated for its strategic importance and saved if possible. At the same time, no heroic attempts should be made to save a seriously affected tooth, which would contribute little to the success of removable partial denture (RPD).

Extraction of nonstrategic teeth that are detrimental to the design of RPD should be part of the treatment plan.

ii. Removal of residual roots

Generally, all retained roots should be removed especially those that are close to the tissue surface, those associated with pathologies and those adjacent to abutment teeth.

Removal is accomplished from facial or palatal surfaces to preserve the ridge height.

iii. Impacted teeth

All impacted teeth should be removed to avoid acute and chronic infection with extensive bone loss later.

iv. Malposed teeth

Loss of teeth may lead to extrusion, mesial drifting or combinations of malpositioning of remaining teeth. Alveolar bone supporting the extruded teeth is also carried occlusally in some instances.

Surgical repositioning of these teeth is contemplated only after orthodontic treatment is ruled out.

v. Cysts and odontogenic tumours

Panoramic radiographs should be taken for ruling out unsuspected pathology. Radiolucencies and radiopacities noted in the radiograph should be investigated, and the diagnosis should be confirmed through biopsy.

Surgical removal should be done.

vi. Exostoses and tori

Mucosa covering these bony protuberances is usually thin and liable to ulcerate. Exostoses approximating gingival margins may complicate the maintenance of periodontal health and may lead to the loss of abutment teeth.

Denture design may be modified to accommodate the exostosis but could result in additional stress to the supporting elements and compromised function. If so, surgical removal of exostosis and tori is done.

vii. Hyperplastic tissue

This presents as fibrous tuberosities, soft flabby ridges, folds of tissues in the vestibule or floor of the mouth and palatal papillomatosis.

Removal of this excess tissue provides a firm base for the denture and reduces stress on supporting teeth and tissues.

viii. Muscle attachments and freni

With loss of alveolar bone height, muscle attachments may occur near the alveolar crest. Mylohyoid, buccinator, mentalis and genioglossus muscles are likely to produce this problem. Ridge extension procedures can be performed to reposition these attachments.

Maxillary labial and mandibular lingual freni most commonly interfere with denture design. These can be easily modified using surgical procedures.

ix. Bony spines and knife-edge ridges

Sharp bony spicules should be removed and knife-edge ridges should be rounded. If insufficient ridge support results, then vestibular deepening should be done.

x. Abnormal lesions

All abnormal soft tissue lesions like polyps, papillomas and haemangiomas should be excised and pathological investigation should be done before fabrication of denture.

Investigation of white, red or ulcerative lesions like hyperkeratosis, erythroplasia and ulcerations should be done regardless of their relationship to proposed denture. All these lesions should be excised.

xi. Dentofacial deformities

Patients with these deformities have multiple missing teeth and malocclusion as part of the problem. Correction of the deformity should form part of the treatment plan to replace teeth and develop a harmonious occlusion.

xii. Alveolar bone augmentation

Ridge augmentation is done for atrophic ridges, flat palatal vault and mild-to-moderate anteroposterior ridge relation discrepancy. It is done with synthetic graft materials like hydroxyapatite and autogenous bone grafts. It enhances the support and stability of the denture.

3. Conditioning of abused and irritated tissues

Conditioning of the tissue is required if:

i. Denture-bearing mucosa is irritated or inflamed.

ii. Anatomical structures like rugae, incisive papilla and retromolar pad are distorted.

iii. Burning sensation in tongue, ridge area, cheeks and lips.

These are usually associated with ill-fitting dentures, prosthesis with poor occlusion, bruxism, diabetes, nutritional deficiencies, endocrine imbalances and blood dyscrasias.

If denture is the problem, patient is advised against wearing them till the tissues return to normal. If this is not possible, tissue conditioners are used to provide a soothing and cushioning effect on the irritated mucosa till mucosa becomes normal. Recommended home care during this period would include patients rinsing with saline solution three times in a day, massaging the soft tissues, using multivitamins and a high protein, low carbohydrate diet.

4. Periodontal preparation

Periodontal preparation usually follows or is performed simultaneously with oral surgical procedures and is completed before restorative procedures.

The success of the prosthesis depends on the health and integrity of the periodontal tissues of the remaining teeth and the following procedures are performed to achieve this objective.

i. Initial disease control therapy

Initial disease control therapy includes the following procedures:

- Oral hygiene instructions.
- Scaling and root planning.
- Elimination of local irritating factors other than calculus-like overhanging margins of restorations and open contacts leading to food impactions.
- Elimination of gross occlusal interferences.

- Temporary splinting of mobile teeth to allow any periodontal procedures to be performed.

- Use of night guard as a temporary splint and to stimulate any unopposed teeth.

ii. Definitive periodontal surgery

After the initial therapy if periodontal problems persist, then gingivectomy, periodontal flap and reconstructive surgical procedures, as indicated, may be planned to eliminate periodontal disease.

iii. Recall maintenance

This is very important in maintaining periodontal health. It includes reinforcement of oral hygiene measures and thorough scaling and root planning. The frequency of recall varies with each patient but in general patients with moderate to severe periodontitis should be placed on a 3–4 months recall system.

5. Endodontic and restorative treatment

Teeth with pulpal involvement and root end pathology are candidates for endodontic therapy. Restorative therapy like – crowns, inlays, onlays, restoration of carious lesions and replacement of defective restorations should be integrated with endodontic treatment.

6. Orthodontic treatment

Orthodontic preparation is carried out to achieve the following:

- Reduce the need for prosthetic teeth as much as possible.

- Position the teeth to allow the most natural prosthetic replacement of teeth.

- Create sufficient vertical height to allow room for placement of artificial teeth.

- Allow sufficient occlusal guidance on natural teeth.

Unfortunately in many patients a large number of teeth are missing so there may not be enough remaining teeth to serve as an anchor from where the moving force can be applied.

Prosthodontic preparation

These procedures may involve prosthodontic treatment in certain areas of the mouth. It may or may not involve the abutment teeth.

1. Correction of occlusal plane

Uneven occlusal plane is common in partially edentulous situations due to:

- Supraeruption and infraeruption
- Mesial migration
- Tipping of teeth
- Malrelationship of jaws

To correct the plane of occlusion, one of the following procedures which range from simple to complex may be employed:

i. Enameloplasty

Definition: The intentional alteration of the surfaces of teeth to change their form (Fig. 25.1).

Amount of correction that can be achieved by this technique is limited as complete penetration through enamel is contraindicated except for the elderly with more secondary dentin.

Anatomy of the tooth should be maintained including grooves and sluiceways after procedure.

The enamel is contoured using high-speed tapered diamonds and polished with carborundum wheels or points. Fluoride treatment of the tooth surface increases its resistance to caries.

ii. Onlay

It is a conservative method of correcting occlusal plane as minimal tooth preparation is required compared to a full veneer crown. It maintains the natural contours of facial and lingual enamel surfaces as only occlusal surface is prepared.

The occlusal surface of the tooth being prepared should be free of pits and fissures.

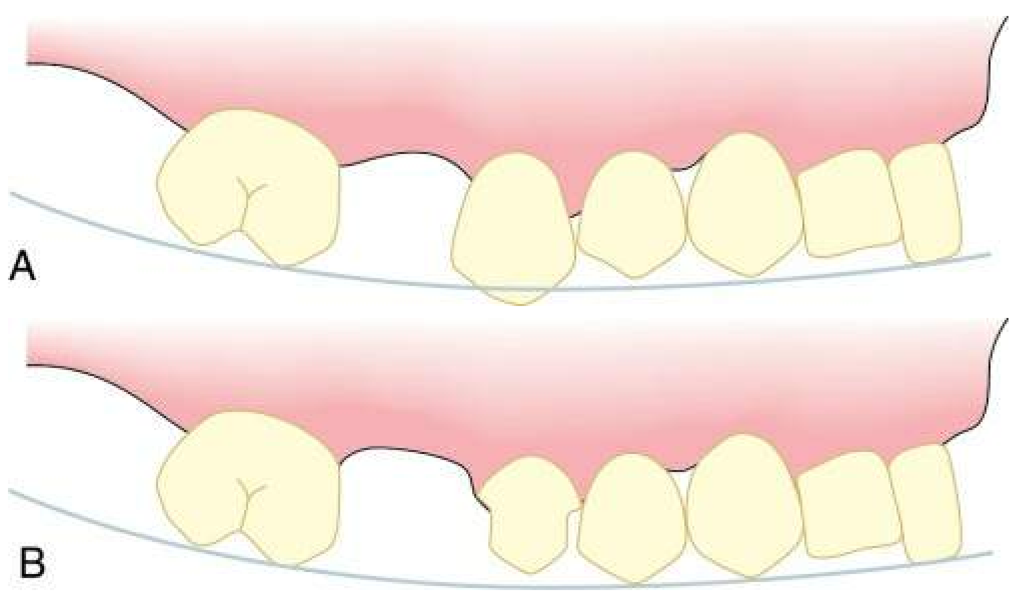
It can be made of chrome or gold alloy. If chrome alloy is used, the occluding surface should be processed with tooth coloured acrylic resin to prevent attrition of opposing tooth.

Disadvantages:

- Less retention
- More metal display

iii. Crowns

When the height of contour, retentive undercut or guiding plane needs to be altered, a full veneer crown is preferred to an onlay to change the occlusal plane (Fig. 25.2).



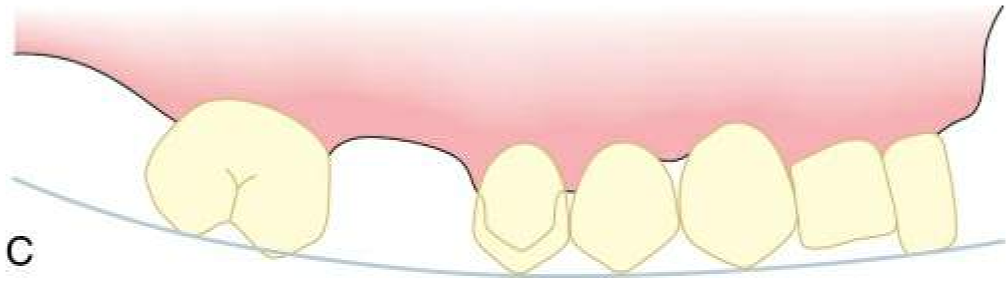


FIGURE 25.2 **(A)** Irregular occlusal plane with need to change height of contour in tooth number 15. **(B)** Tooth preparation in 25. **(C)** Crown fixed will correct occlusal plane & alter height of contour.

A mounted diagnostic cast will be required to gauge the amount of tooth preparation required so as to decide the need for endodontic treatment.

iv. Endodontics with crown or coping

Retaining teeth in strategic positions will greatly improve the prognosis of the partial denture:

Retaining mandibular second or third molars to serve as posterior abutments will support the prosthesis and will prevent it from being a more complicated distal extension situation (Fig. 25.3).

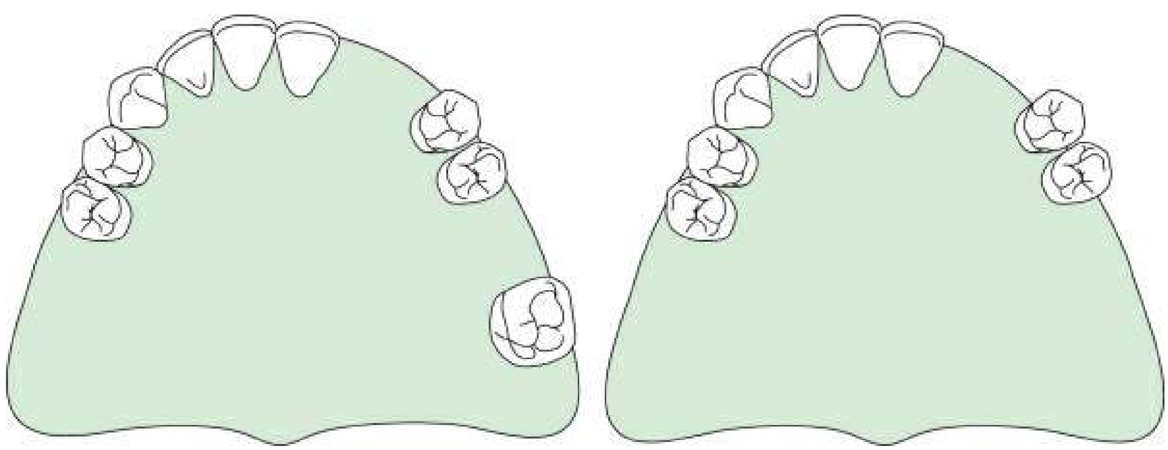


FIGURE 25.3 Retaining a distal abutment (left) will prevent a distal extension situation (right).

Retaining a tooth in the centre of a long anterior edentulous span will reduce the vertical movement of the denture.

These important teeth are mostly supraerupted with loss of periodontal support. Endodontics followed by crown or overdenture coping will restore occlusal plane and allow the teeth to be retained.

v. Extraction

Although it is desirable to retain teeth as much as possible, some conditions like severely malposed teeth and teeth interfering with placement of major connector require extractions to correct occlusal plane as they compromise the success of treatment.

vi. Surgery

Surgical repositioning of one or both jaws, fully or partly, can be contemplated to correct occlusal plane. These include osteotomies and repositioning procedures.

2. Correction of malalignment

Malaligned teeth create the following difficulties:

- Maintenance of oral hygiene.
- Determining a simple path of insertion.
- Establishing guiding planes.
- Placement of clasp arms of direct retainers.

Teeth which are malposed facially or lingually are more difficult to correct than supraerupted teeth. The following methods can be adopted for their correction:

i. Orthodontic realignment

- It is the treatment of choice.
- With multiple missing teeth, anchorage may be difficult.

ii. Crown

- Partial or full veneer crowns may be used.
- Indicated to correct buccal or lingual tipping.
- If tipping is extensive, endodontic treatment followed by a post will correct the same. However, long axis of crown and root should not be too dissimilar, as undesirable horizontal forces will occur on tooth. Hence, severe malposition cannot be corrected by crowning.

iii. Enameloplasty

- This is always considered first, but amount of correction that is possible is limited.
- Enameloplasty can be used to recontour buccal or lingual surfaces to eliminate the interferences to the path of placement of major connector.

3. Provision of support for weakened teeth

It is necessary to provide additional support to teeth with poor periodontal support by splinting them or using them as overdenture abutments. Splinting is discussed in Chapter 24.

Overdenture abutments

Teeth strategically positioned in the arch with more than 50% bone loss can be retained as overdenture abutments. They resist the tissueward forces and provide support.

Retaining such a tooth distal to edentulous space will convert a potential distal extension base into a tooth supported situation, improving the function of denture and patient acceptance.

Preparation of abutment teeth

Objectives

- Direct stress along the axis of the tooth.
- Eliminate interferences by recontouring of teeth.
- Create retention by simple alteration procedures.
- Allow placement and removal of prosthesis without transmitting wedging types of stress against teeth with which it comes in contact.

Classification of abutment teeth

1. Abutment teeth that require only minor modifications to their coronal portions

The following sequence of mouth preparation is followed:

1. Preparation of guiding planes
2. Modification of height of contour
3. Preparation of retentive undercuts
4. Rest seat preparation

The first three preparations require only minor modifications or reshaping of enamel. The procedure is called ‘enameloplasty’. This is a conservative procedure as it involves only modification of enamel surface. If extensive preparations are necessary to accomplish the desired contours, indirect restorations like crowns are better options. As already discussed, whenever the enamel is reshaped or contoured, the procedure involves use of high speed diamonds, polishing with carborundum wheels or points and fluoride treatment of the tooth surface to increase its resistance to caries.

i. Preparation of guiding planes

Surfaces of the proximal or lingual surfaces of abutment teeth are made parallel to each other and to the path of insertion of RPD. They can be prepared on abutments as follows:

a. Abutments adjacent to tooth supported segments

The procedure for preparation is as follows:

- Diagnostic cast mounted on surveying table at the desired tilt should be placed on tray in front of operator. Handpiece with cylindrical diamond point is positioned over abutment tooth on cast to visualize the correct angulation. The same is reproduced in the mouth (Fig. 25.4A and B).
- Tooth is prepared using gentle light sweeping stroke from buccal line angle to lingual line angle.
- Flat surface created should be 2–4 mm in occlusogingival height (Fig. 25.5A).
- Reduction should follow curvature of proximal surface (Fig. 25.5B).
- All prepared surfaces are polished as described for enameloplasty.

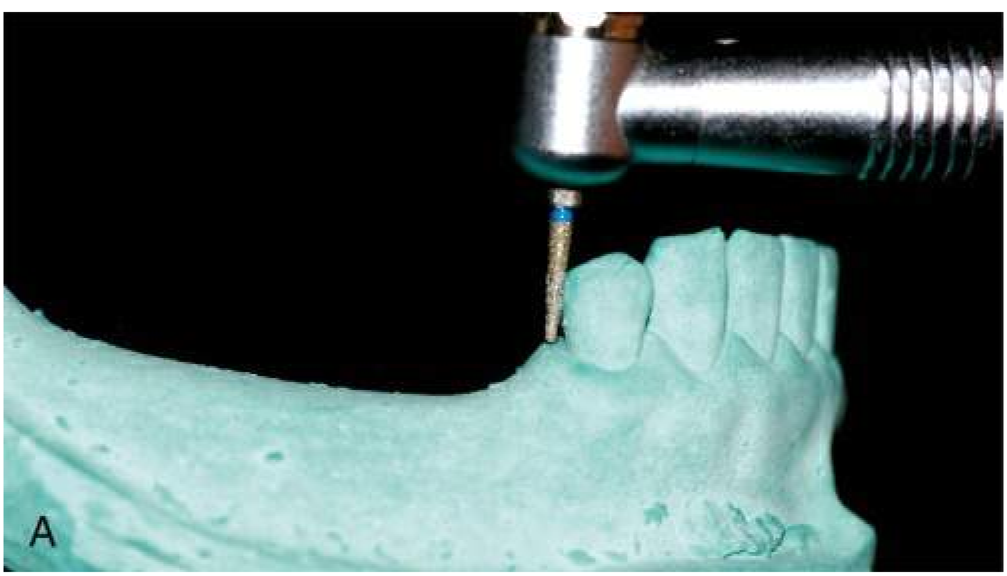
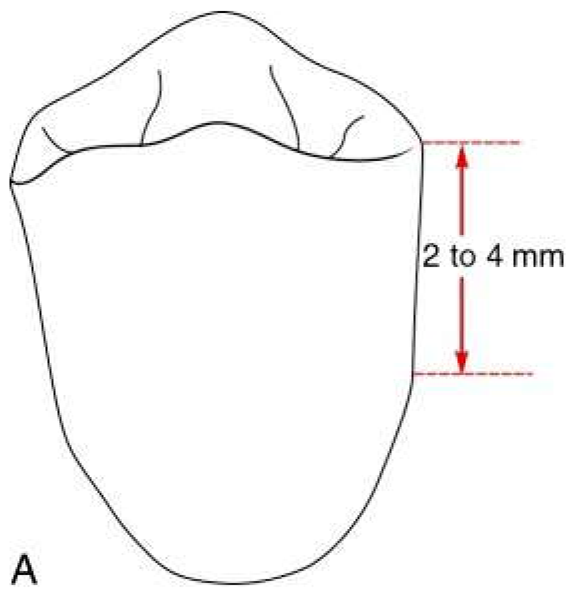


FIGURE 25.4 **(A)** Required angulation is checked on cast.
(B) The same is transferred to the mouth.



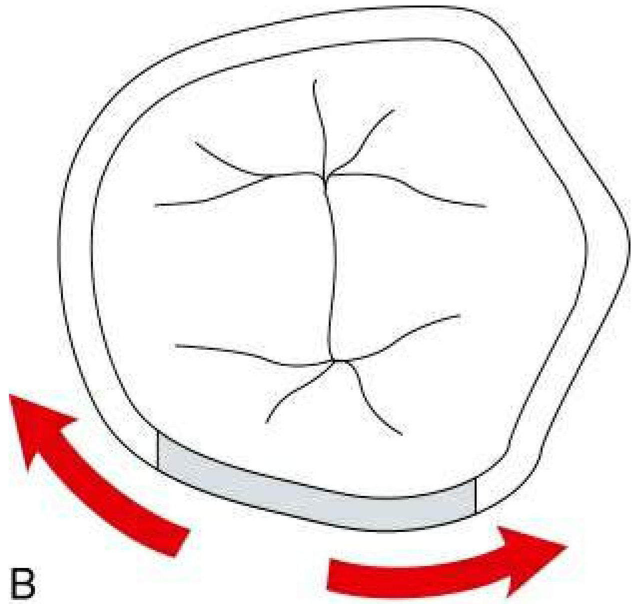


FIGURE 25.5 **(A)** Flat surface created should be 2–4 mm in occlusogingival height. **(B)** Reduction should follow curvature of proximal surface.

b. Abutments adjacent to distal extension bases

- Occlusogingival height of preparation is 1.5–2 mm (Fig. 25.6A).
- This permits slight rotation around the distal occlusal rest, which avoids torquing forces on distal abutment tooth (Fig. 25.6B).

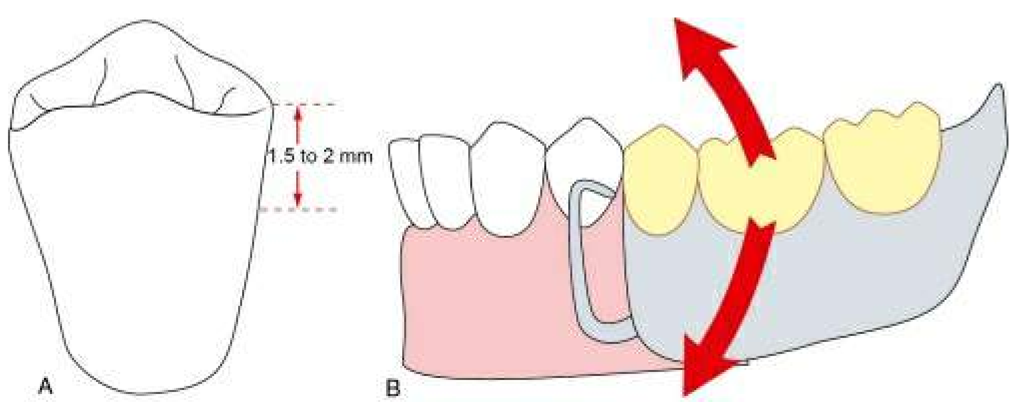


FIGURE 25.6 **(A)** Occlusogingival height of preparation is 1.5–2 mm. **(B)** Slight rotation around the distal occlusal rest, which avoids torquing forces on distal abutment tooth.

c. Lingual surface of abutments

- This is done to provide maximum resistance to lateral stresses.
- Occlusogingival height of preparation is 2–4 mm, located in the middle third of the crown (Fig. 25.7).
- Contour of gingival third should not be changed because it can cause damage to marginal gingiva due to improper food deflection.

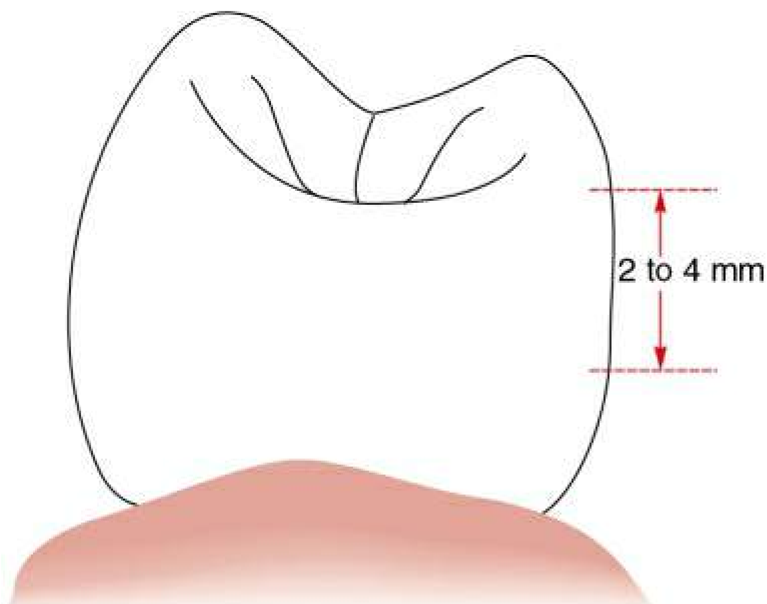


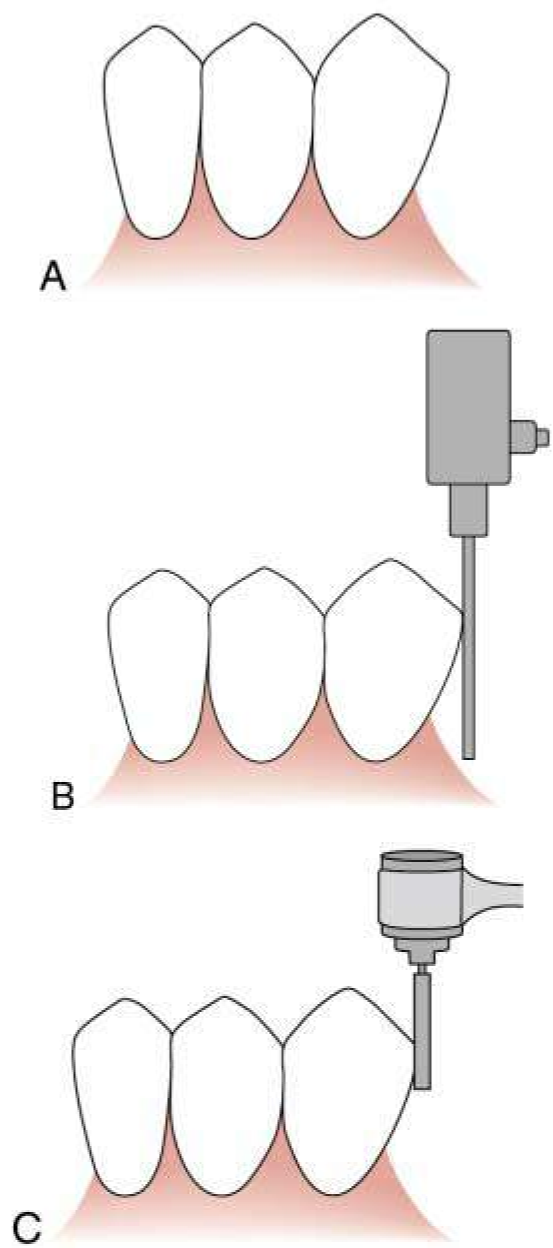
FIGURE 25.7 Occlusogingival height of preparation is 2–4 mm, located in the middle third of the crown.

d. Anterior abutment teeth

Preparation is similar to that described for any guiding plane and achieves the following:

- Provides parallelism ensuring stabilization.
- Minimizes wedging action.

- Reduces undesirable space between denture and abutment teeth and enhances aesthetics (Fig. 25.8).
- Increases retention through frictional resistance.
- Restores normal width of edentulous space.



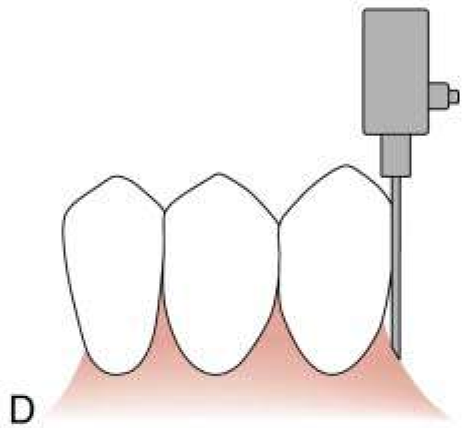


FIGURE 25.8 Guiding planes in anterior teeth reduce undesirable space between denture and abutment teeth and enhance aesthetics.

ii. Modification of height of contour

- Enameloplasty to change height of contour is performed to provide ideal placement of clasp arms and remove interferences for placement of major connectors.
- Maxillary posterior teeth tend to tip buccally making placement of retentive terminal unaesthetic. Mandibular posteriors tip lingually making it difficult to place reciprocal arm and lingual major connectors (Figs 25.9 and 25.10). In both these situations, height of contour will be near occlusal surface.
- Amount of correction depends upon thickness of enamel. If dentine is exposed, placement of restoration is considered.
- Preparation is best done with tapered diamond stones.

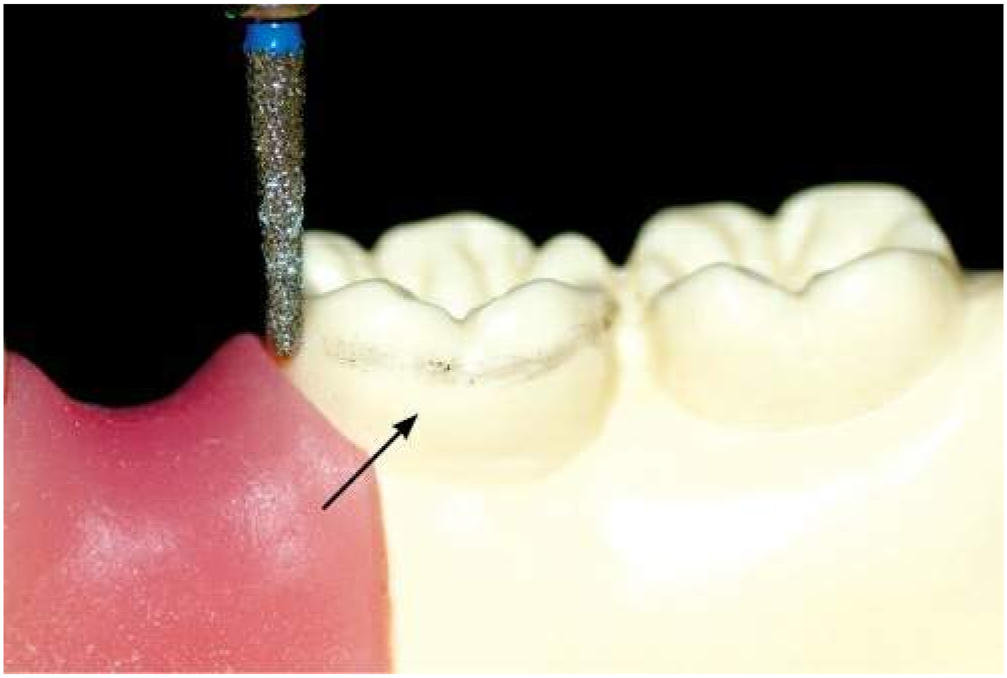


FIGURE 25.9 Height of contour placed occlusally on lingually tipped molar.

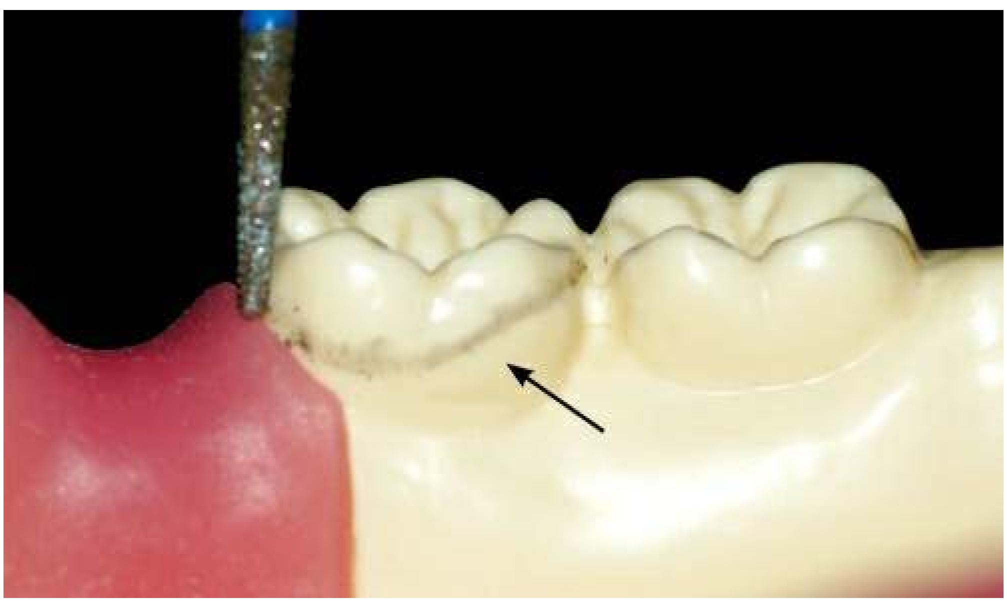


FIGURE 25.10 Level of height of contour decreased after preparation with tapered diamond.

iii. Preparation of retentive undercut (dimpling)

Enameloplasty to modify retentive undercuts is termed 'dimpling'.

- Performed to increase a less than adequate retentive undercut. Should be avoided if other undercuts exist and can be utilized to provide adequate design.

- Procedure is successful only when the buccal and lingual surfaces of abutment are nearly vertical (Fig. 25.11A and B).

- The prepared retentive undercut is in the form of a gentle depression – dimpling. It should be 0.010 inch deep measured from a line parallel to the path of insertion. It is placed parallel and close to gingival margin (Fig. 25.12).

- Preparation is done using small round end tapered diamond stone. End of stone is moved in an anteroposterior direction near line angle of tooth. Depression should be 4 mm in mesiodistal length and 2 mm in occlusogingival height. It should be highly polished.

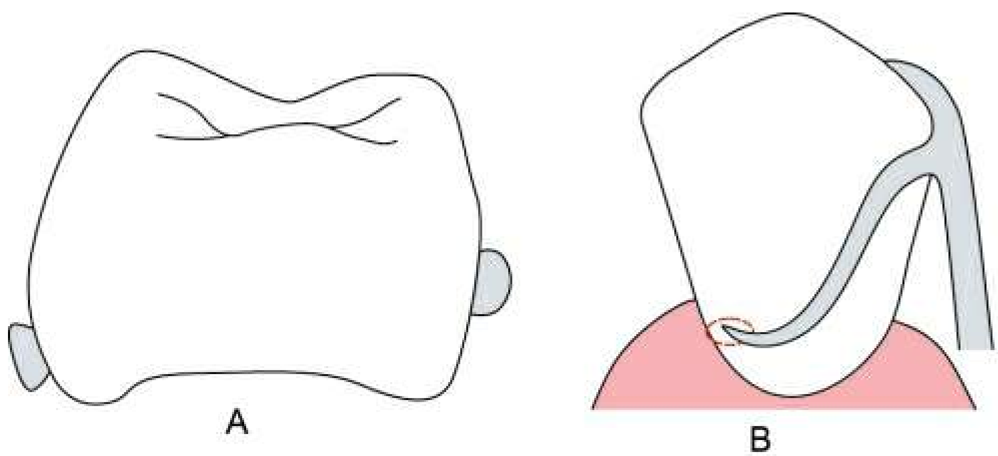


FIGURE 25.11 **(A)** Vertical buccal and lingual sides lacking undercuts. **(B)** Retentive tip engaging the dimple.

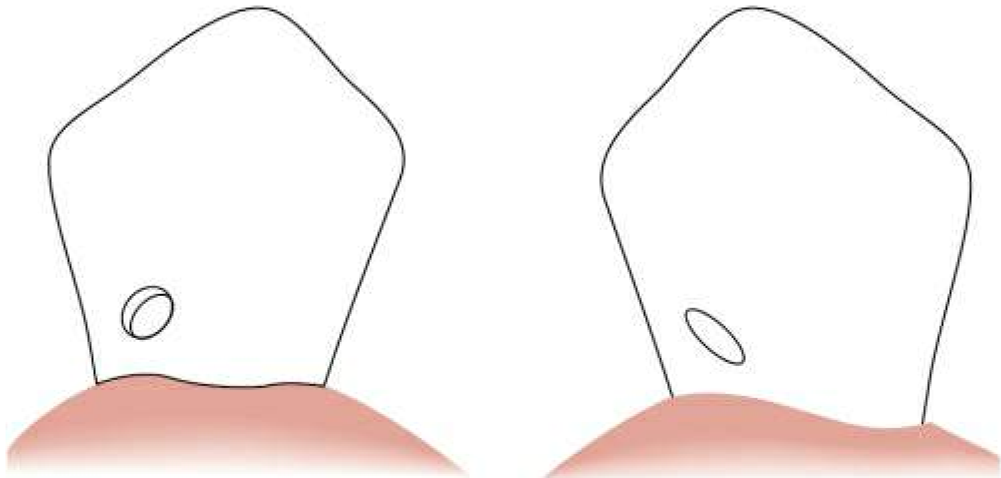


FIGURE 25.12 Dimpling: right side figure gives correct shape and position, a pit should not be created like figure on the left.

iv. Preparation of rest seats

The form, functions and types of rests are described in Chapter 21. Rest seats must always be prepared after preparation of guiding planes.

Procedure for preparation of rests on enamel and restoration is described below:

a. Occlusal rest seat in enamel

- Outline form of occlusal rest is triangular with base of triangle at marginal ridge and apex towards the centre of the tooth (Fig. 25.13).
- A channel of correct depth and desired outline of preparation is created by small round diamond stone, diameter similar to No. 8 round bur (Fig. 25.14).
- Lower the marginal ridge at either buccal or lingual extent of rest seat to continue inward towards centre of tooth and then return to marginal ridge.
- Island of enamel which remains within outline form is then removed and the floor is spoon shaped or saucer shaped.

- Deepest portion of rest seat is towards the centre of tooth preparation and raises gradually towards marginal ridge (Fig. 25.15).
- Adequacy of occlusal rest seats can be checked by:
  - Visual inspection.
  - Direct tactile contact.
  - Asking patient to bite on softened bite wax and verifying the imprint (Fig. 25.16).
  - Making a check cast.
- Sharp line angles are removed with a No. 4 round steel bur at slow speed.
- The preparation is smoothed with a rubber disc and polished with pumice. Fluoride treatment is recommended.

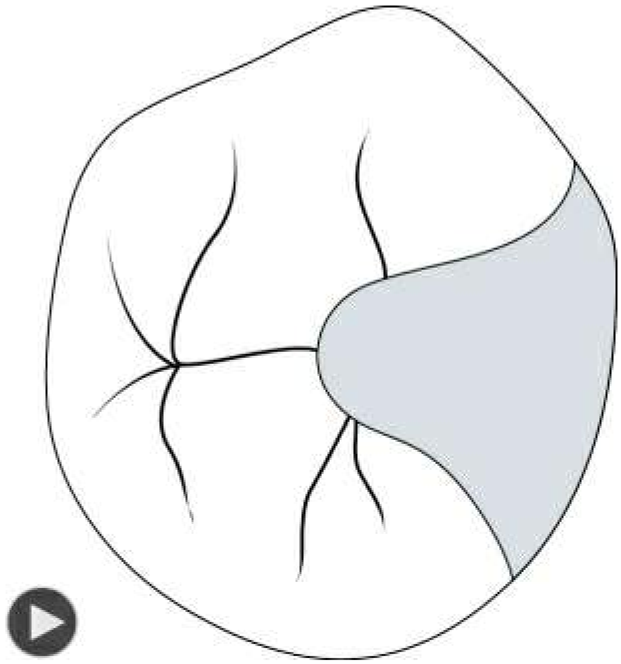


FIGURE 25.13 Outline form of occlusal rest.

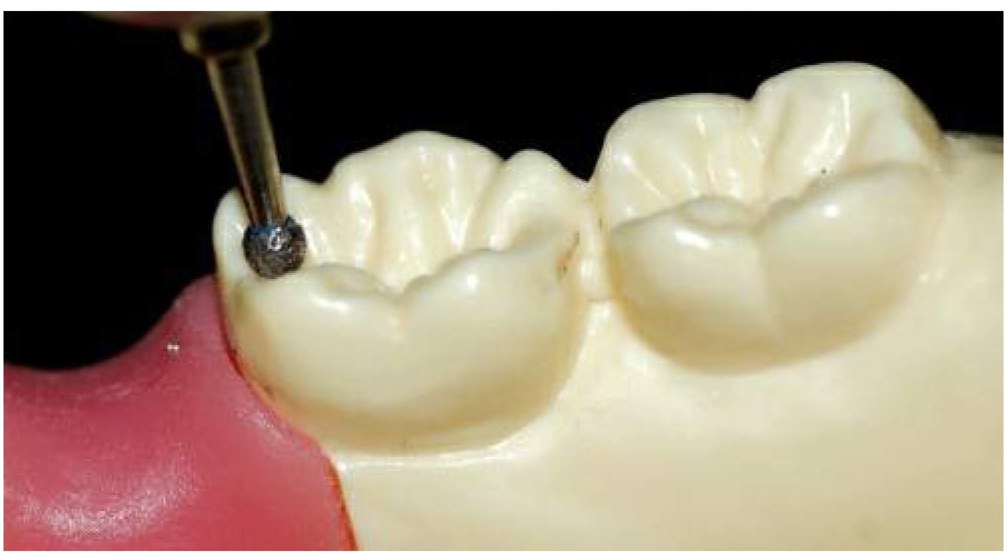


FIGURE 25.14 Preparation with small round diamond.

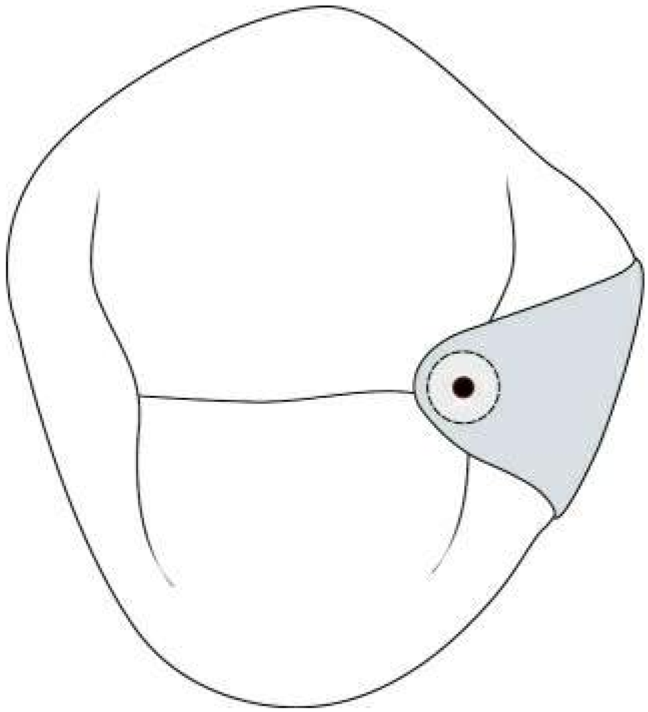


FIGURE 25.15 Outline and deepest part.

FIGURE 25.16 Imprint on bite wax checked.

b. Occlusal rest seat in new cast crown restoration

- Should always be placed while making wax patterns.

- Sufficient occlusal clearance should be created for rest and restoration.

- A depression is added to the preparation to accommodate rest seat (Fig. 25.17).

- Rest seat in wax pattern prepared by using No. 4 round steel bur and then cast.

FIGURE 25.17 Tooth preparation for crown with depression for rest seat.

c. Occlusal rest in existing crown restoration

- Due to economic reasons, it may be necessary to prepare occlusal rests on existing crowns. It must be ensured that crown restoration has adequate marginal integrity and occlusal harmony.

- If perforation of crown occurs during preparation, new restoration must be made. Patient must be warned of this possibility.

- Procedure similar to rest preparation on enamel.

d. Occlusal rests in amalgam restorations

- Less desirable, as amalgam alloy tends to flow under constant pressure.
- Rest seats are prepared using No. 4 round bur, not diamond.
- Proximal portion of amalgam restoration and isthmus should have sufficient width after preparation to resist fracture.
- Preparation is similar to rest preparation on enamel.
- Polishing is similar to any amalgam restoration.

e. Occlusal rests for embrasure clasps

Embrasure clasps are described in Chapter 21.

- Preparation extends over occlusal embrasures of two adjacent posterior teeth from mesial fossa of one tooth to distal fossa of other tooth (Fig. 25.18).
- Small round diamond stone is used to prepare the outline form for a normal occlusal rest in both the teeth. Marginal ridges should be reduced equally.
- Contact point between teeth should not be broken.
- Same round diamond stone is used to prepare the buccal and lingual extension of occlusal rests over buccal and lingual embrasures (Fig. 25.19). Obtaining sufficient clearance in the embrasures is important.
- Buccal clearance can also be obtained by using a cylindrical diamond stone. It is held horizontally from buccal surfaces of teeth pointing towards lingual surface (Fig. 25.20).
- Clearance can be checked by placing two pieces of 18 gauge side by

side in embrasure and patient should be able to close mouth without contacting metal. Clearance can also be checked by making patient close on soft bit wax and measuring thickness with wax calipers.

- Preparation should be 1.5–2 mm wide and 1–1.5 mm deep.
- Procedures for finishing and polishing are similar to occlusal rests.

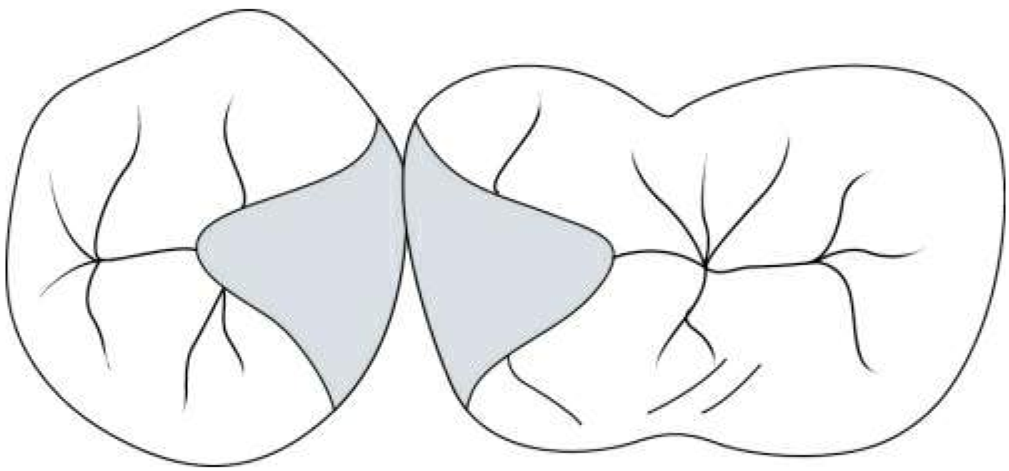


FIGURE 25.18 Preparation extends over occlusal embrasures of two adjacent posterior teeth from mesial fossa of one tooth to distal fossa of other tooth.

FIGURE 25.19 Same round diamond stone is used to prepare the buccal and lingual extension of occlusal rests over buccal and lingual embrasures.

FIGURE 25.20 Buccal clearance can also be obtained by using a cylindrical diamond stone. It is held horizontally from buccal surfaces of teeth pointing towards lingual surface.

f. Lingual or cingulum rest

The characteristics of the rest are described in Chapter 21.

- Using flat end large diamond cylinder preparation should begin low on one marginal ridge, pass over cingulum and pass gingivally to contact opposite marginal ridge (Fig. 25.21A and B). For a safe side, 0.25 inch diamond disc can also be used for preparation if space permits.
- Rest seat must be gingival to contact level of opposing tooth.
- Occlusion should be checked for adequate clearance even before tooth preparation.
- Polishing is done with carborundum-impregnated rubber wheels and points.
- Cingulum rests on cast crown restorations are preferred to those on enamel as they can be easily made on wax patterns.


A

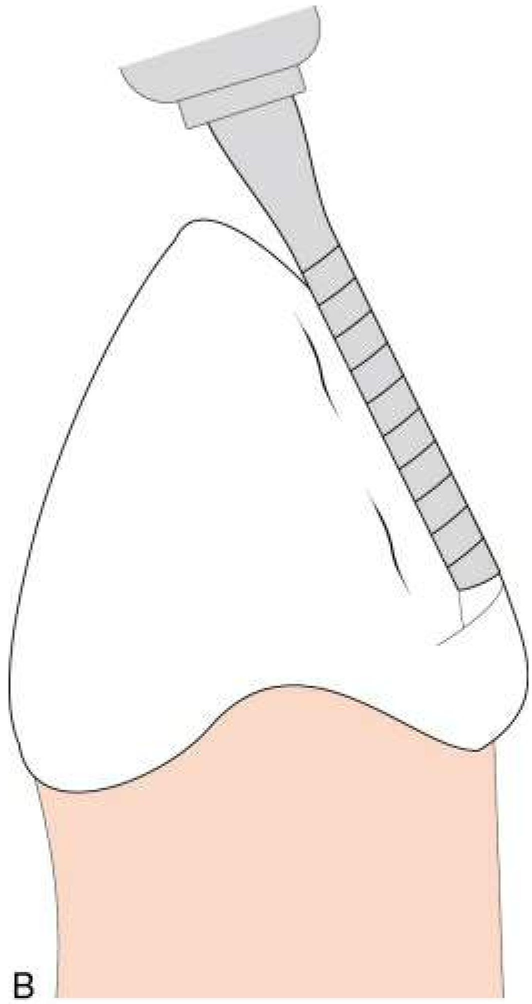


FIGURE 25.21 **(A)** Outline form of cingulum rest. **(B)** Prepared with cylindrical diamond, showing correct position of bur.

g. Incisal rest seat preparation

The characteristics of the rest seat are described in Chapter 21.

- It is prepared only on enamel surfaces. If a cast restoration is planned, cingulum rest is preferred.
- Preparation is made using small safe-sided diamond disc or tapered cylindrical diamond, parallel to path of insertion (Fig. 25.22).
- First cut is made vertically 1.5–2 mm deep in the form of a notch and

2–3 mm inside the proximal angle of the tooth. Enamel walls and base of notch are rounded with small flame-shaped diamonds (Fig. 25.23).

- The groove must be carried slightly over to labial surface to prevent facial tipping. Groove must be continued part way down the lingual surface as indentation to accommodate minor connector (Fig. 25.24).

- Preparation is finished and polished with carborundum-impregnated rubber wheels and points.

FIGURE 25.22 Preparation is made using small safe-sided diamond disc or tapered cylindrical diamond, parallel to the path of insertion.

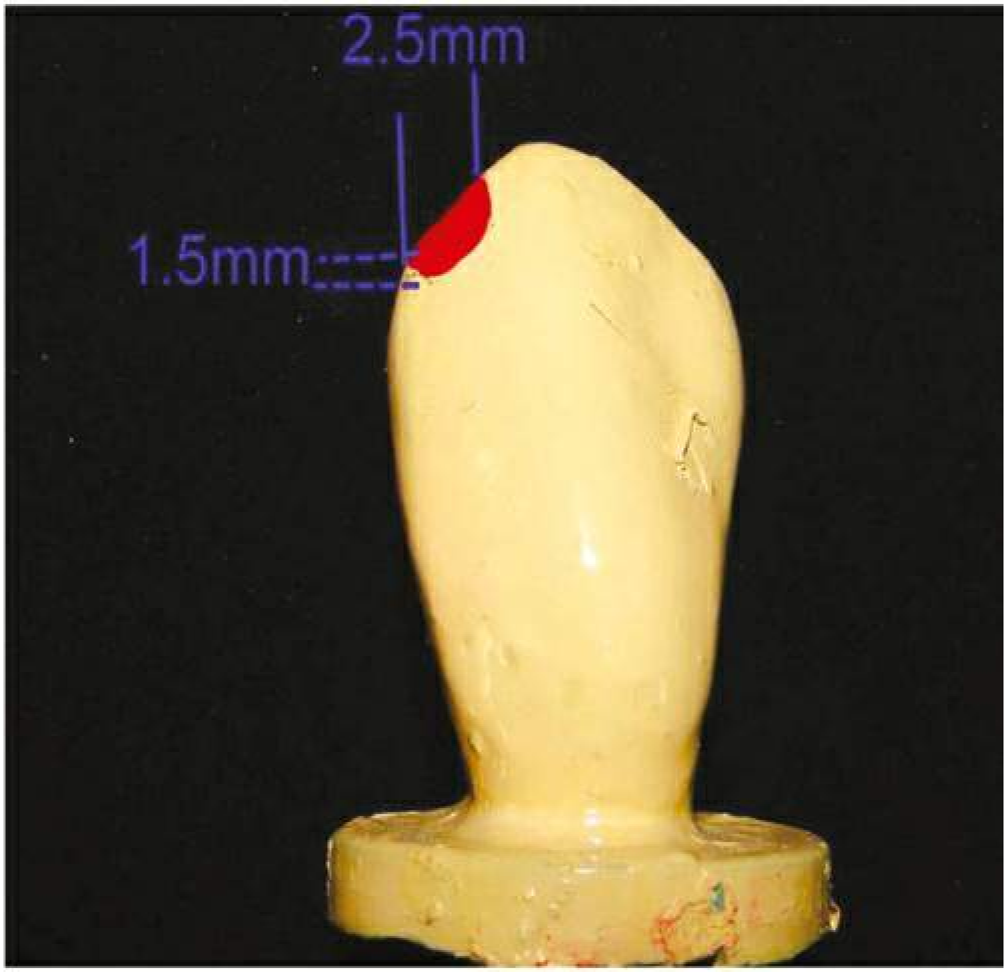


FIGURE 25.23 First cut is made vertically 1.5–2 mm deep in the form of a notch and 2–3 mm inside the proximal angle of the tooth.

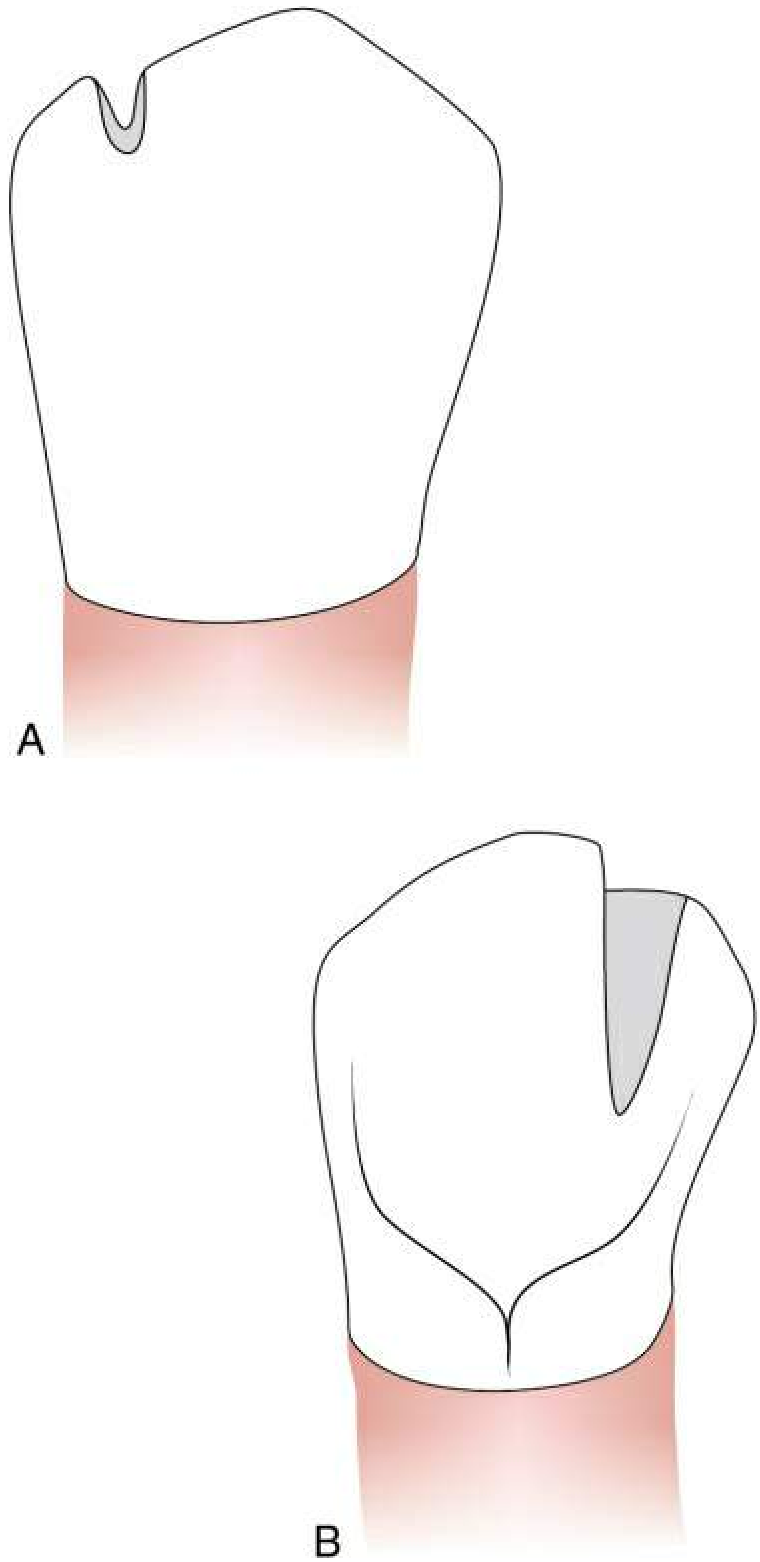


FIGURE 25.24 **(A)** Labial view and **(B)** lingual view of preparation.

2. Abutment teeth that are to have cast restorations

Cast restorations like inlays, onlays and crowns are planned on abutments in the following situations:

- If enameloplasty does not achieve usable natural contours, as in tipping, rotation, malalignment, supra- and infraeruption of abutment.

- Presence of caries, defective restorations, tooth fracture and endodontic treatment in abutment tooth.

- The guiding planes, height of contour, retentive undercuts and occlusal rests are prepared on the wax patterns of these restorations with mounted casts on the surveyor.

Inlays

- When inlay is the restoration of choice, proximal and occlusal surface that support minor connectors and occlusal rests require modification in preparation.

- Buccal and lingual proximal margins must be extended well beyond line angles of tooth (Fig. 25.25).

- Axial wall is carved to confirm with external proximal curvature of tooth (Fig. 25.26).

- There should be 1–1.5 mm of restorative material between occlusal rest and inlay margin (Fig. 25.27).

- The rest is made on the wax pattern of inlay.

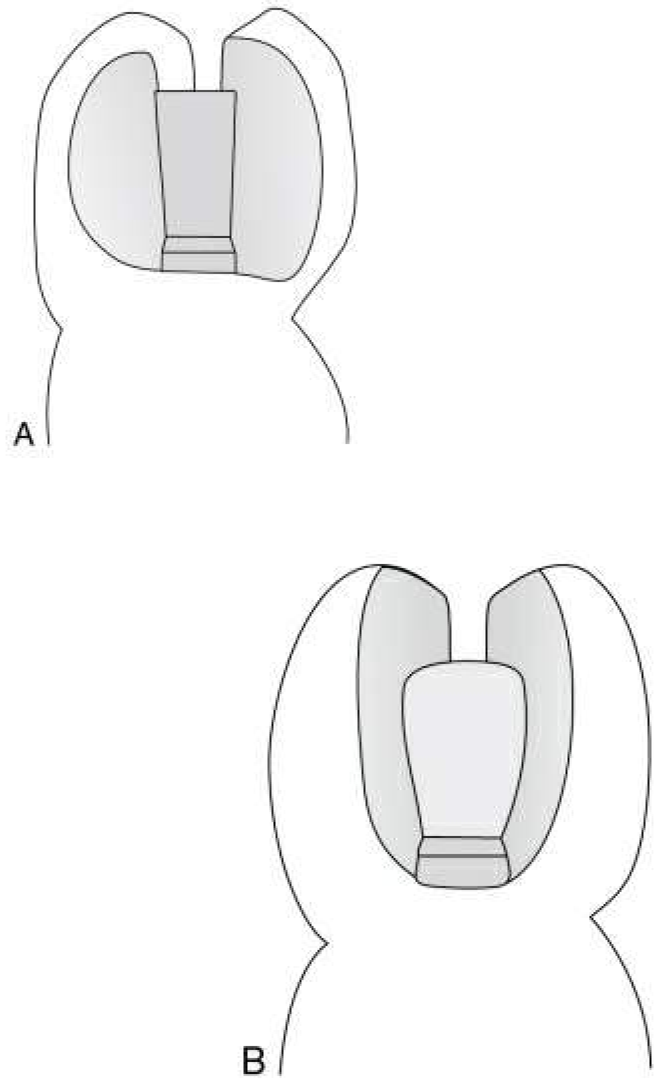


FIGURE 25.25 **(A)** View of distal surface of MOD onlay preparation for lower left second premolar showing broad extension of box, where occlusal rest with minor connector will be placed. **(B)** View of mesial surface, not as broad where there is only contact with adjacent tooth with no rest.

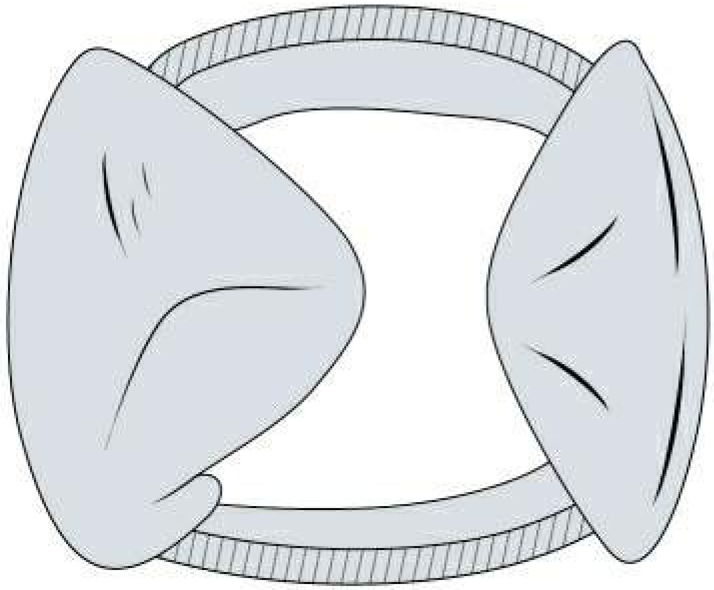


FIGURE 25.26 Occlusal view showing axial wall curvature in conformity with external proximal tooth curvature.

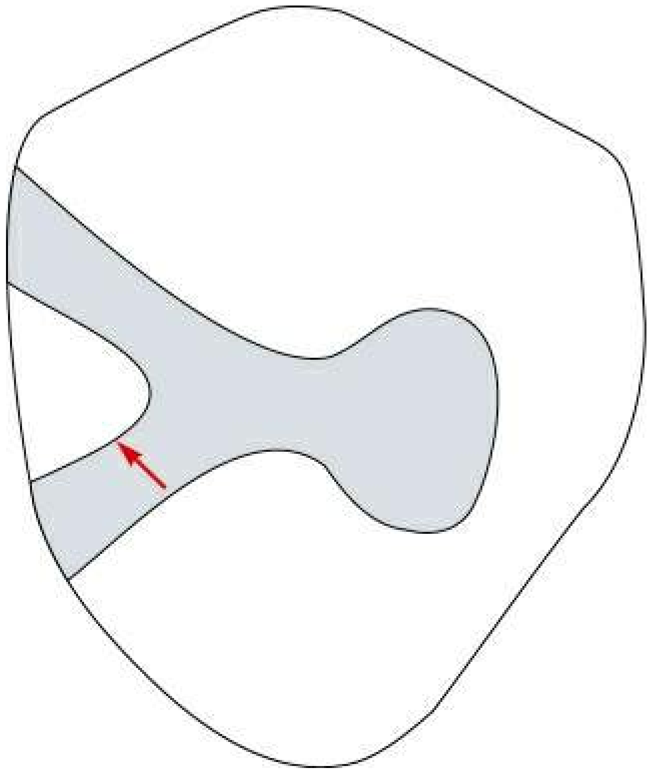


FIGURE 25.27 There should be 1–1.5 mm of restorative material between occlusal rest and inlay margin.

Crowns

- Three quarter crowns, complete coverage cast crowns and porcelain veneer crowns can be used. Ideal for partial denture is complete coverage crown.
- Preparation should be made to accommodate the depth of occlusal rest, which is seen as a depression in the prepared tooth, in the rest area.
- If crowns are to be veneered with acrylic resin or porcelain, they are surveyed again after veneering to confirm the established contours. With resin veneers, it is better to place the retentive terminal on metal due to poor abrasion resistance of resin.

SUMMARY

The success or failure of a RPD depends on how well the mouth preparations are accomplished. It is only through intelligent planning and competent execution of mouth preparations that the partial denture can satisfactorily restore lost dental functions and contribute to the health of the remaining oral tissues. Table 25.1 summarises & lists the various procedures for preparing the mouth to receive a cast partial denture.

Table 35.1

Summary of clinical procedures involved in mouth preparation in their order of priority.

Oral surgical procedure	Periodontal procedure	Occlusal plane correction	Correction of malalignment	Reshaping of teeth	Rest seat preparation
Extraction	Oral prophylaxis	Enameloplasty	Orthodontic realignment	Guide plane adjacent to tooth-supported segments	Occlusal rest
Tori/bony undercuts	Flap surgery	Onlay	Crowns	Adjacent to distal extension spaces	Rest for embrasure clasp
Vestibuloplasty		Crown	Enameloplasty	Lingual surfaces	Lingual/cingulum rest
Ridge augmentation		Endodontic therapy		Anterior abutments	Incisal rest
Tuberosity reduction		Extraction		Changing height of contourModifying retentive undercuts	

CHAPTER

26

Secondary impressions and master cast

CHAPTER CONTENTS

Introduction

In tooth-supported removable partial dentures (class III and many class IV partially edentulous arches), the occlusal forces transmitted to the abutment teeth are directed vertically along the long axis of the teeth through the occlusal, incisal or lingual rests. The edentulous ridges do not contribute to the support of the partial denture. Since abutment teeth are the sole support of the tooth-supported prosthesis, they can be constructed on a master cast made from a single, pressure-free impression that records the teeth and the residual ridge in their anatomic form *(anatomic impressions).*

A tooth- and tissue-supported removable partial denture (class I and class II) obtains support from both the abutment and the residual ridge. If the prosthesis is constructed on an anatomical impression, it will exert excess pressure on the abutments as the soft tissue under the denture base is compressed and moves under occlusal loading. A dual impression technique is used to distribute the forces to the abutment teeth and the residual ridge such that support is provided by both. The impression of the teeth should be made with a material that captures the teeth in the anatomic form, as teeth do not change position under function. The impression of the soft tissue, on the other hand, is made in such a manner so as to record the tissues in their functional state (*functional impressions*).

Anatomic impressions

Anatomic form is the surface contour of the ridge when it is not supporting an occlusal load.

These are indicated for tooth-supported partial dentures and most class IV. Most maxillary distal extension bases can also be recorded with this technique.

A single impression with medium body/regular body/monophase elastomeric impression material using a custom tray is the preferred technique. Putty with light body wash in a stock tray can also be used. Irreversible hydrocolloid – alginates, may also be used. Addition silicones are preferred.

Procedure

Fabrication of custom tray

1. Outline of the tray is marked on the primary cast. It should extend up to the vestibule (Fig. 26.1).

2. A wax spacer 2 mm in thickness is adapted on the cast and at least three tissue stops (one anteriorly and two posteriorly on either side) are created in noncritical areas to provide space for the impression material (Fig. 26.2).

3. A custom tray is fabricated with autopolymerizing acrylic resin (Fig. 26.3).

FIGURE 26.1 Outline of the tray on the primary cast.

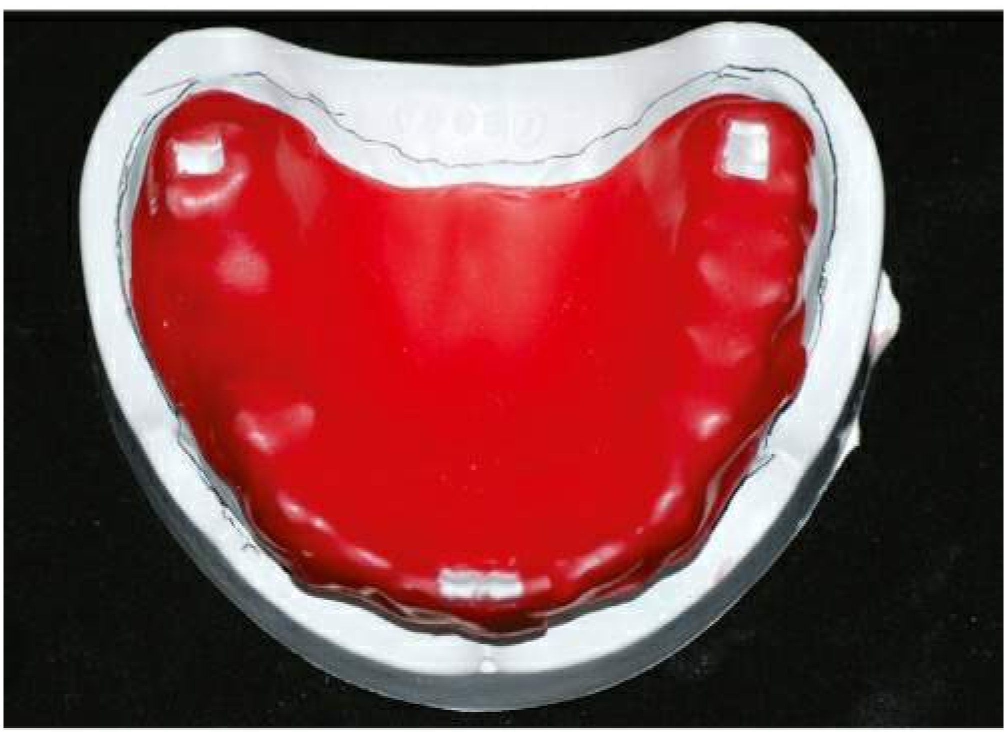


FIGURE 26.2 A wax spacer on the cast.

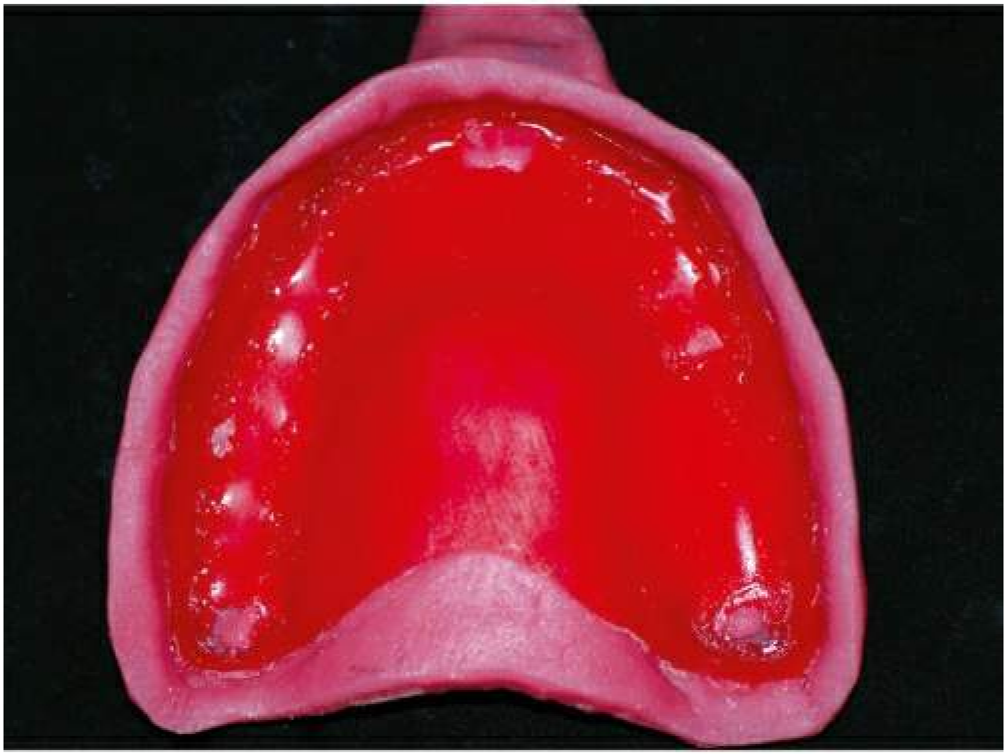


FIGURE 26.3 Custom tray fabrication.

Impression making

1. Evaluate the custom tray in the mouth and correct the extension.

2. Impression material is mixed and loaded onto the tray after application of tray adhesive. In case of alginate, perforations in tray provide retention.

3. Tray is seated in the mouth and held steady till material sets.

4. Impression is removed, washed and checked for any imperfections (Fig. 26.4).

5. A master cast is poured after beading and boxing (Fig. 26.5).

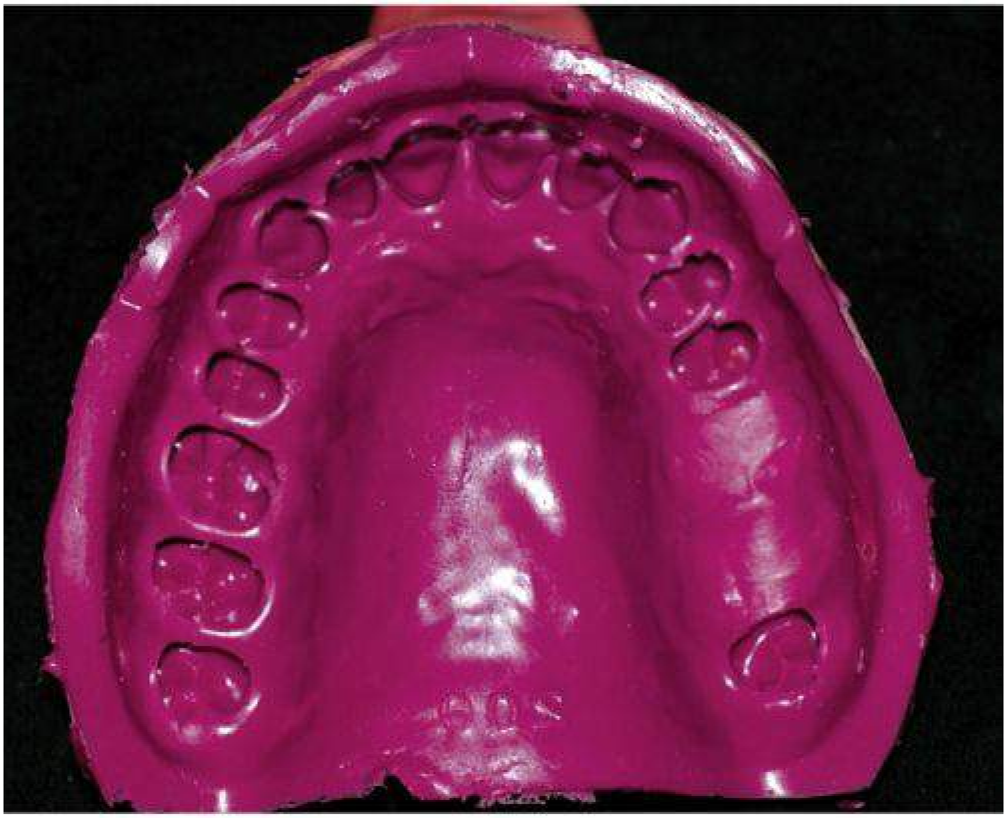


FIGURE 26.4 Evaluate the impression.

FIGURE 26.5 Master cast.

Functional impressions

Functional form is the form of the residual ridge recorded under some loading or compression. This could be achieved by occlusal loading, finger loading, specially designed individual trays or consistency of recording medium.

It is indicated for distal extension bases (class I and class II), especially in the mandibular arch. Maxillary distal extension ridges are covered by firm mucosa, stress is borne by crest and slopes of the ridge and hence a functional impression may not be needed.

Another indication for this type of impression is a long span anterior edentulous ridge (class IV).

A dual impression technique is used along with a combination of impression materials – one that records the teeth in anatomic form and the other that records the residual ridge in functional form.

Requirements

1. Record the tissues under the same loading as the teeth.

2. Distribute the occlusal load over a large area.

3. Demarcate accurately the extent of the denture base.

Factors influencing support of distal extension base

The following factors determine the extent of displacement of the residual ridges thereby indicating the support.

Quality of soft tissue covering edentulous ridge

- A firm, tightly attached thick mucosa will offer the greatest support.

- The more displaceable tissue is present over the edentulous ridge, less is the support.
- Surgical removal of flabby tissue is indicated to increase the support.

Type of bony architecture of denture-bearing area

- Cancellous bone has less ability to resist vertical forces compared to cortical bone. This is due to its irregular surface which acts as an irritant to overlying soft tissue when stress occurs. This results in chronic inflammation of soft tissues which leads to resorption of the cancellous bone.
- The crest of the maxillary and mandibular ridge is composed mainly of cancellous bone and hence should not be considered as a prime source of support.

Design of partial denture

- Rotational forces on the ridges in distal extension bases can be controlled by our design considerations (see Page 354, Chapter 24).
- The most efficient method to control rotational stress is by using indirect retainers.

Amount of tissue coverage of denture base

- The broad stress distribution design philosophy demands that the denture base must cover the maximum amount of surface area of the edentulous ridge to effectively distribute the functional stresses.
- Overextension must be avoided, as it can cause soft tissue irritation, ulceration and even lifting or dislodgement of the base leading to leverage forces on the clasped abutment teeth.

Amount of occlusal force

- Greater the occlusal load on a denture base, greater should be its support.
- A denture base that is opposed by a full complement of natural teeth requires more support than that opposed by a complete denture.
- Narrowing the food table of the artificial teeth will help reduce the load transmitted to the denture base.
- Supplemental grooves and sluiceways on artificial teeth increase the masticatory efficiency thereby reducing the load transmitted.

Support from denture-bearing area

In the maxillary edentulous ridge:

- Crest of the ridge provides the maximum support and is the primary stress-bearing area.
- The buccal slopes of the ridge, though covered by a layer of cortical bone, is not placed perpendicular to the vertical forces, so it offers little resistance to them. It will, however, resist lateral forces, reducing the total force.
- Hard palate also provides some resistance to vertical displacement.

In the mandibular edentulous ridge:

- Buccal shelf area, composed of very dense cortical bone, bordered by the external oblique ridge, is an excellent primary stress-bearing site. The soft tissue covering the cortical bone in this region is also firm and dense. It is also positioned perpendicular to the vertical occlusal stresses.

- The slopes of the residual ridge contribute to resisting horizontal forces.

Fit of denture base

To derive optimum support from stress-bearing areas, accurate fit of denture is mandatory.

Type of impression registration

Impression plaster and zinc oxide eugenol impression paste are best suited to record the ridges in the resting or anatomic state because of their low viscosity, though it can also be recorded by other materials like elastomeric materials and hydrocolloids. This largely depends on the fit of the tray and the thickness of the spacer.

Functional impressions to compress the tissues are better made with higher viscosity materials like waxes, impression pastes and elastomers.

Classification

Functional impression procedures can be classified as follows:

1. **Physiologic impressions:** Those impressions which record the residual ridge under generalized compression.

i. Pick-up impressions

a. Mclean’s technique

b. Hindels’ technique

ii. Functional reline impressions

iii. Ridge correction technique using fluid wax

2. **Selective pressure impressions:** Those which selectively compress the stress-bearing tissues.

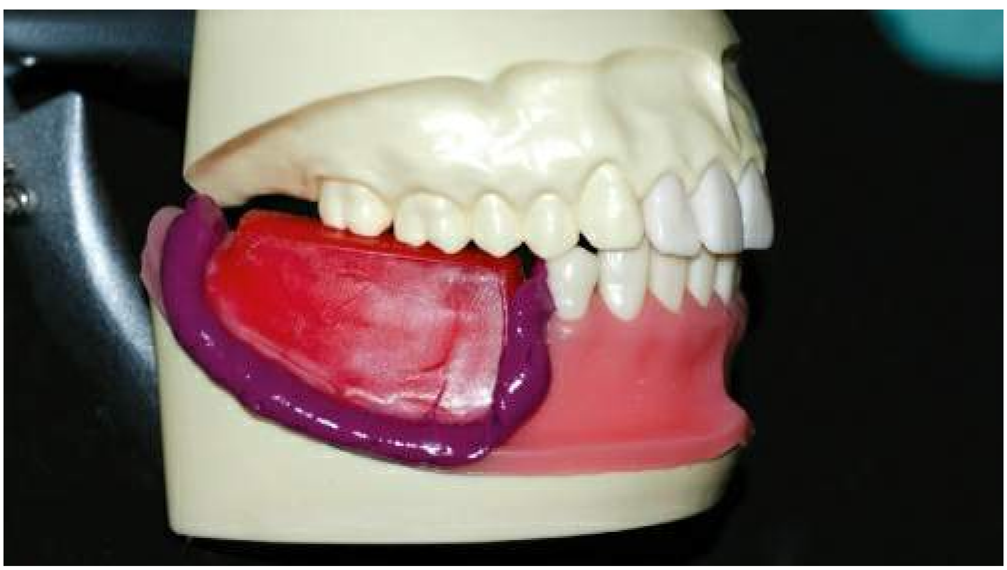
Impression procedures

Pick-up impressions

1. Mclean's technique

- Custom tray is fabricated only for the distal extension base area with wax occlusal rims (Fig. 26.6).
- Functional impression is made of the residual ridges with zinc oxide eugenol impression paste or polyvinylsiloxane (PVS), by recording the impression with patient biting on the occlusal rims (Fig. 26.7).
- After this impression has set, without removing the same, a second impression is made over the functional impression and the teeth, in a stock tray with alginate. It is called as *overimpression* or *pick-up impression* as the first impression made with custom tray is contained in it. While making the overimpression, finger pressure is applied posteriorly to push the first impression down towards the ridge, to its functional biting position (Figs 26.8 and 26.9).
- A master cast is poured after beading and boxing.
- **Disadvantage:** Finger pressure on second impression will not produce the same amount of functional displacement of the tissue that biting forces produced in the first impression. Hence compression of the tissues will not be the same and the functional impression will not be recorded as per the patient's biting force.

FIGURE 26.6 Custom tray fabrication.



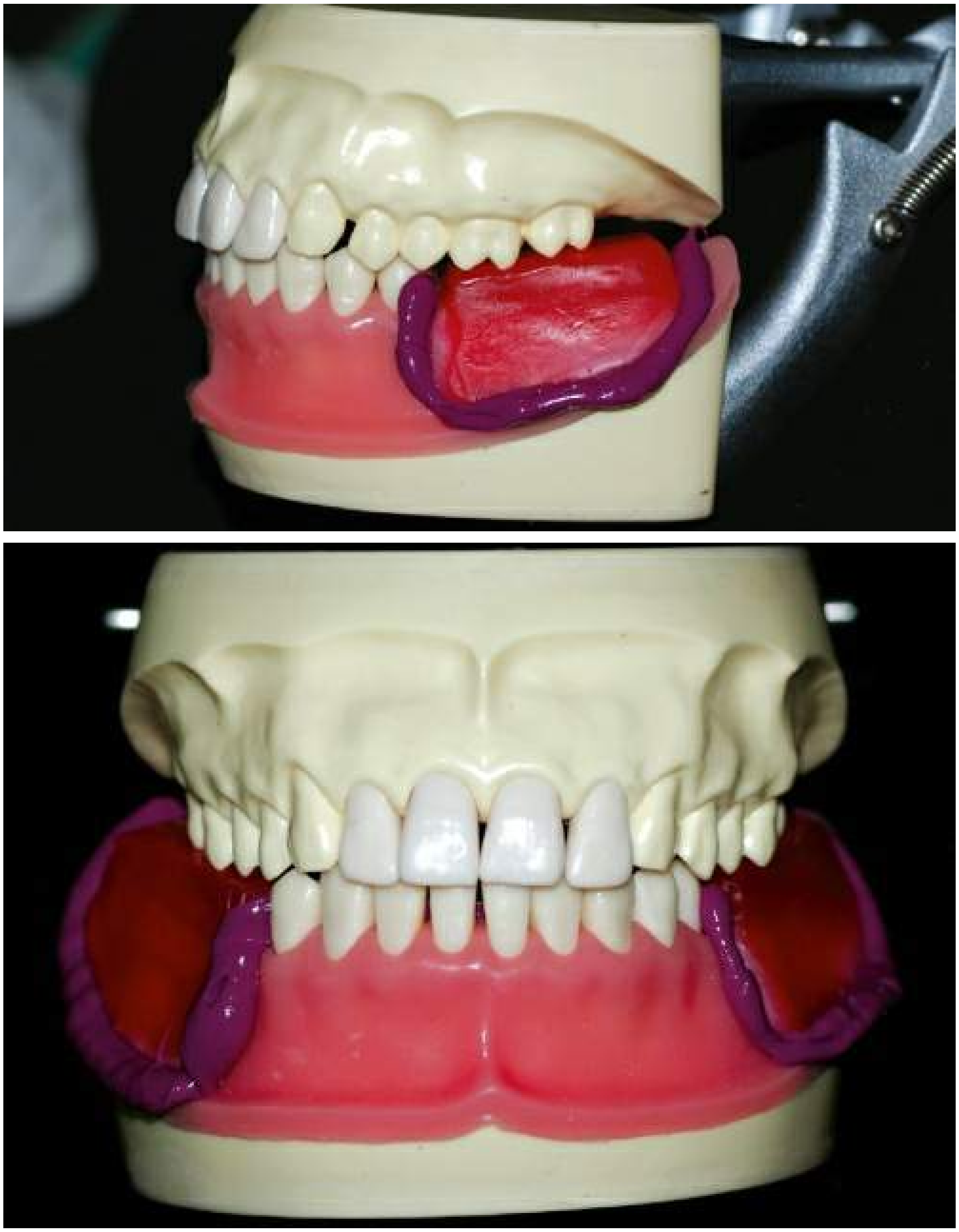


FIGURE 26.7 Simulated functional impression made of the residual ridge, by recording the impression with patient biting on the occlusal rims.

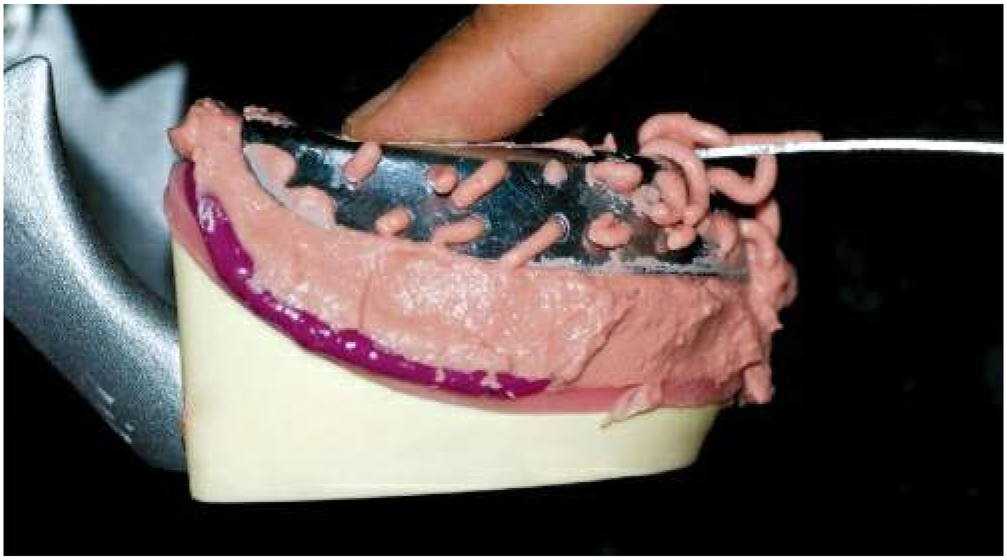


FIGURE 26.8 Overimpression or pick-up impression making.

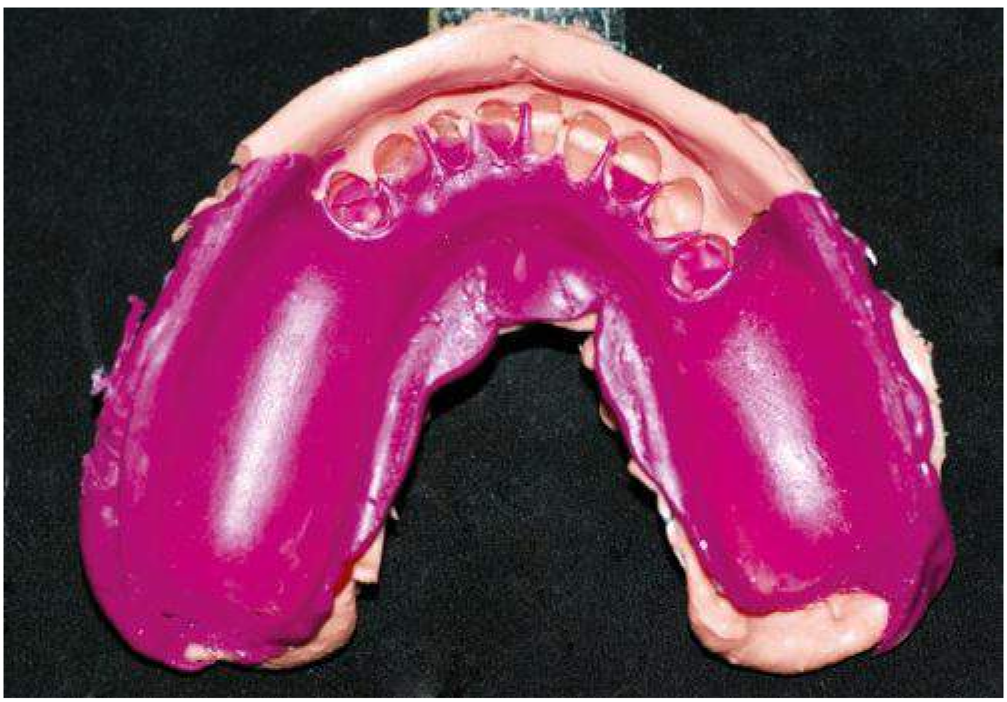


FIGURE 26.9 Showing pick-up impression.

2. Hindels' technique

- Hindels and coworkers developed this technique to overcome the disadvantage of Mclean's technique.
- The first impression of the edentulous ridge was an anatomic impression made in a custom tray with tissue stops so that pressure could not be applied to the ridge. The impression was made with zinc oxide eugenol impression paste.
- Hindels and coworkers developed stock trays with a large hole on either side posteriorly so that finger pressure could be directly applied to the first impression through the holes on the tray (Fig. 26.10). With the set anatomic impression in the mouth, the second overimpression was made in the specially designed stock tray with alginate, maintaining finger pressure till the material sets.
- It was contended that the finished impression is related to the teeth and the ridge as if masticatory forces were taking place on denture base.
- A master cast is poured after beading and boxing.
- **Disadvantages of both Mclean's and Hindels' technique:**
  - As tissues are recorded in compressed state, if clasp retention is good, even at rest position (when patient is not biting) the soft tissues are constantly displaced as the clasps will maintain the denture in this position. This will lead to interruption of blood supply to the ridges and bone resorption.
  - If clasp retention is not adequate, the denture will always remain slightly occlusal to the functionally recorded position. Hence the artificial teeth will

first come into contact with the opposing teeth, when patient applies biting force. This will produces premature contacts which is uncomfortable to the patient.

FIGURE 26.10 Hindels' stock tray with a large hole on either side posteriorly for application of finger pressure.

Functional reline technique

- This is done after fabrication of the metal framework and denture base. It consists of adding a new layer to the fitting or tissue surface of the denture base.

- The procedure may be performed before the insertion of the partial denture, or it may be done at a later date to any cast partial denture, if because of bone resorption, the denture base no longer fits the ridge adequately and relining is necessary. The first method is discussed here.

- A cast partial denture is fabricated using an anatomic impression as described before. To allow some space for the reline material, a layer of relief metal (ash metal), is added to the ridge area of the cast prior to packing the acrylic resin denture base material. Space can also be provided by trimming the tissue surface of the denture base, but metal spacer provides a uniform thickness. After processing, the metal spacer is attached to the acrylic resin.

- The partial denture is tried in the mouth and once the fit is confirmed, the metal spacer is removed and functional reline impression procedure carried out.

- Low-fusing green stick impression compound is flowed onto the tissue surface of denture base, tempered and placed in the patient's mouth. This procedure is performed several times along with border moulding so that an accurate impression of the ridge as compressed by the impression compound is obtained. The tissue surface of the low-fusing compound impression is trimmed uniformly by 1 mm and final impression is made with zinc oxide eugenol impression paste, fluid wax or medium body elastomeric impression materials. It is like making a primary impression with green stick compound and a final wash impression with the other materials. If fluid wax is used to produce a functional reline, green stick compound is eliminated and only wax is used for making the impressions.

- The amount of soft tissue displacement can be controlled by the amount of relief given to the green stick compound before the final impression is made. The greater the relief, the less will be the tissue displacement.

- Patient must keep the mouth half open during the impression procedure to:

○ Control the border tissues, cheek and tongue.

○ Enable the operator to ensure proper placement of framework on teeth during the procedure.

- Master cast is poured using the altered cast technique, as described later in the chapter, and the reline area is processed in heat cure denture base acrylic resin.

Disadvantages

1. Occlusion may be altered by reline procedure and needs adjustment.

2. A visible junction may be created between new acrylic and old denture base.

3. May be difficult to maintain correct position of framework on teeth during impression making.

Ridge correction technique using fluid wax

This impression of the ridge is made after fabrication of the framework, but before denture base is processed.

Following fabrication of framework using an anatomic impression, special tray is made for the distal extension segment attached to the denture base major connector (Fig. 26.11).

FIGURE 26.11 Special tray made for distal extension segment.

Fabrication of special tray

Framework is placed on master cast after checking in the mouth. Outline of tray is marked on cast and uniform relief of 1–2 mm is provided with a spacer of baseplate wax.

Cast is coated with separating medium and autopolymerizing acrylic resin is mixed to a dough consistency and adapted over the edentulous ridge and denture base minor connector.

The tray is trimmed 2 mm short of its estimated functional length. In the mandible, it should cover retromolar pad and extend onto buccal shelf, and in maxilla it should extend up to hamular notches.

Impression technique using fluid wax

Fluid wax: These are waxes that flow at mouth temperature and are firm at room temperature. Frequently used are Iowa Wax – developed by Dr Smith and Korrecta Wax No. 4 – developed by Drs O.C. and S.G. Applegate. Korrecta wax has more fluidity than Iowa wax.

Tray extension is checked for any overextension by manipulating the border tissues. Wax in a container is placed in a water bath maintained at 51–54°C, which makes it fluid. The fluid wax is uniformly painted onto the tissue surface of a dry special tray with a brush.

The tray is placed in the mouth and border moulding is performed. At all times correct positioning of framework on teeth is ensured by finger pressure on the abutments. The wax is allowed to remain for 5 min with mouth half open.

Framework is removed and impression is dried and inspected. Areas in good functional contact with tissues will appear glossy, while insufficient contact will be dull. Wrinkled areas indicate insufficient time for wax to flow, and areas of tray exposure need to be relieved.

After all the corrections are made and impression shows complete tissue contact, the prosthesis is reinserted and left in the mouth for 12 min to ensure that wax has completely flowed and released any internal strains.

The final cast is poured using the altered cast technique.

The procedure can also be performed by using low-fusing green stick compound for border moulding and making final impression with zinc oxide eugenol impression pastes and medium body elastomeric impression materials. The amount of tissue compression depends on the thickness of spacer provided and viscosity of impression material.

Selective pressure impressions

This technique directs forces to areas of ridge capable of withstanding stress and protects areas of ridge unable to absorb stress by relieving them.

As discussed earlier, only mandibular distal extension ridges require functional impressions. The buccal shelf area is the primary stress-bearing area, but the crest of the ridge is not a stress-bearing area and hence needs to be relieved (Fig. 26.12).

FIGURE 26.12 Stress-bearing areas and relief areas in mandible are outlined.

This procedure is similar to the ridge correction technique described previously, except for the spacer provided for the special tray. In this technique no spacer is provided and a close fitting special tray is fabricated on the distal extension ridge on the denture base minor connector.

The tissue surface of the tray is relieved in the ridge crest area by trimming the tray by 1 mm. The buccal shelf area of special tray is trimmed very slightly so direct contact will be maintained and more pressure can be transferred here. The lingual slope of ridge should be trimmed similar to buccal shelf as it may offer some support. If the soft tissue covering the ridge is very soft and displaceable, relief holes may be made in the special tray to dissipate the pressure even more.

After border moulding with low-fusing green stick compound (Fig. 26.13), final impression can be made with a free flowing impression material like zinc oxide eugenol impression paste. This is the material of choice when residual ridge is free from undercuts and when soft, flabby tissue is involved.

FIGURE 26.13 Border moulding of distal extension segment with green stick compound.

Other impression materials like medium body elastomeric materials can also be used to make the final impression (Fig. 26.14). These are indicated for patients with undercuts in the edentulous ridges. They have higher viscosity than impression pastes.

FIGURE 26.14 Final impression with medium body elastomeric impression material.

The amount of pressure placed on the ridge will depend on the viscosity of the impression material and relief should be given accordingly.

Master cast

Pouring the cast for anatomic and pick-up impression is similar to making a cast with dental stone for diagnostic casts and master cast for complete dentures. This has been discussed in Chapter 4.

For the functional reline, ridge correction and selective pressure impressions, an altered cast technique is desirable which is discussed here.

Altered cast technique

This involves altering only the distal extension part of the master cast after a functional impression is made of the residual ridges.

As discussed previously, the framework is fabricated on an anatomic impression in a refractory cast duplicated from the first master cast. The framework fitted to the master cast is sent to the dentist by the laboratory (Fig. 26.15).

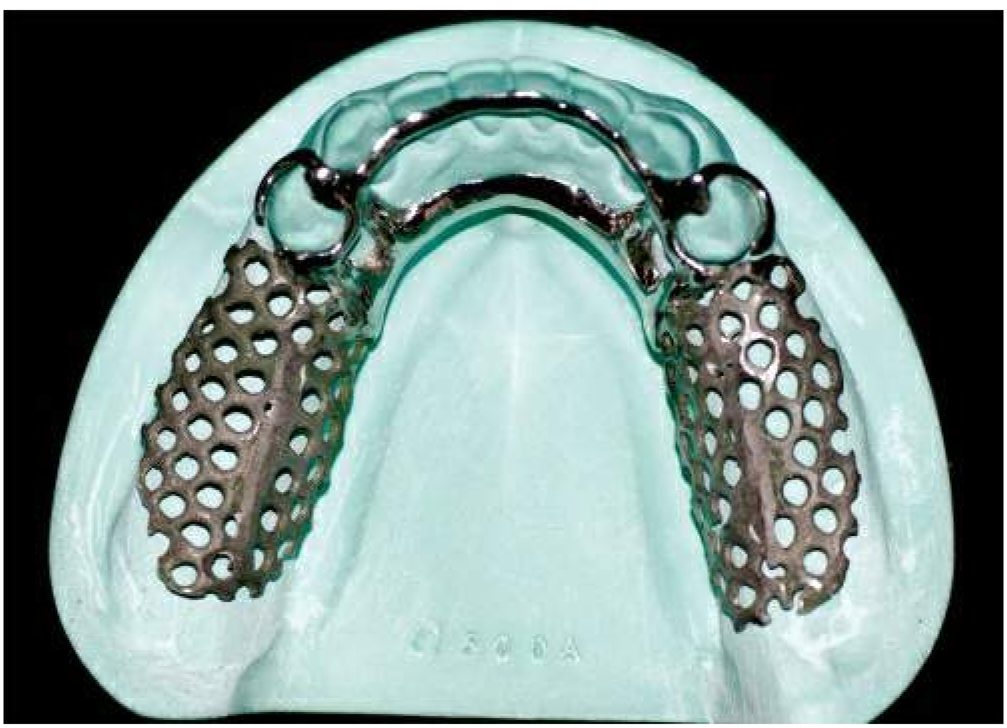


FIGURE 26.15 Framework fitted on master cast.

A special tray is made for the distal extension segment attached to the denture base major connector (Fig. 26.11). A functional impression is then made of the ridge area. The master cast is then altered to accommodate the functional impression as follows:

The area to be altered is outlined on the master cast. It consists of two lines one buccolingual and other anteroposterior along each distal extension ridge.

The buccolingual line is made 1 mm posterior to the distal abutment at right angles to the long axis of the ridge. The anteroposterior line is drawn at right angles to the first, just lingual and parallel to the lingual sulcus. The outlined area is cut and removed with a handsaw (Fig. 26.16).

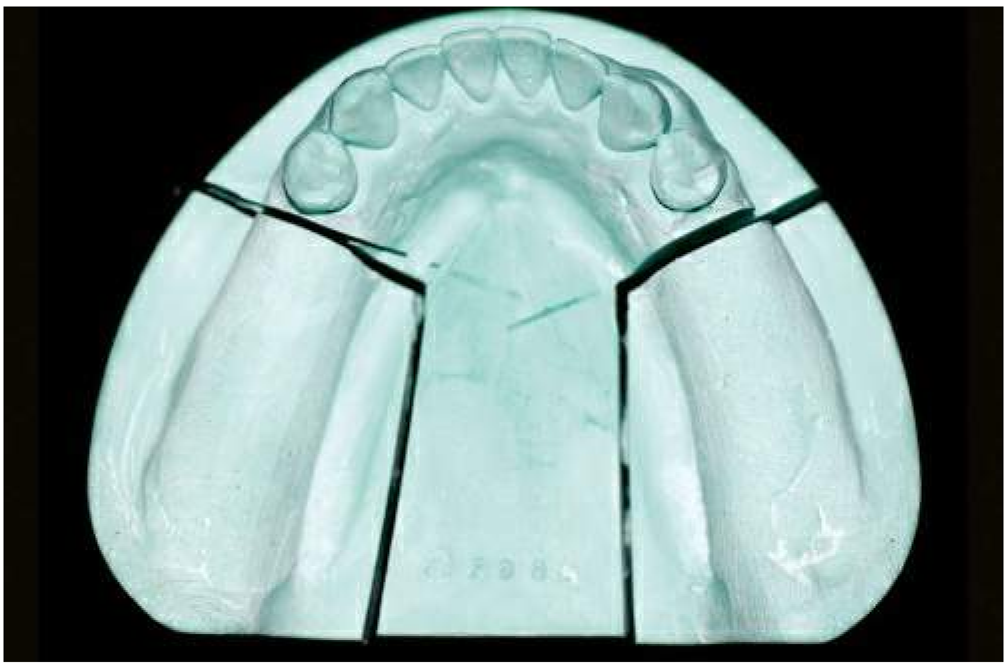


FIGURE 26.16 Portions of master cast to be removed are outlined and cut with a handsaw.

Longitudinal retention grooves are made on the cut surface of the cast to provide mechanical retention for the attachment of new stone to the old (Fig. 26.17).

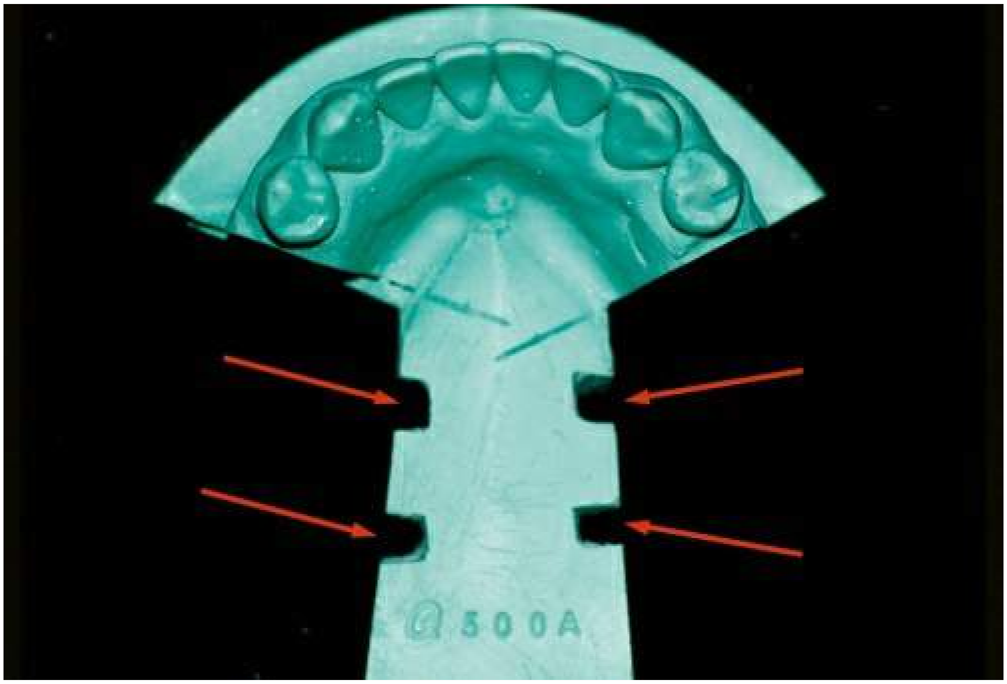


FIGURE 26.17 Retention grooves on cast.

The framework with the functional impression is placed on sectioned master cast (Fig. 26.18). Impression must not have any contact on the cast.

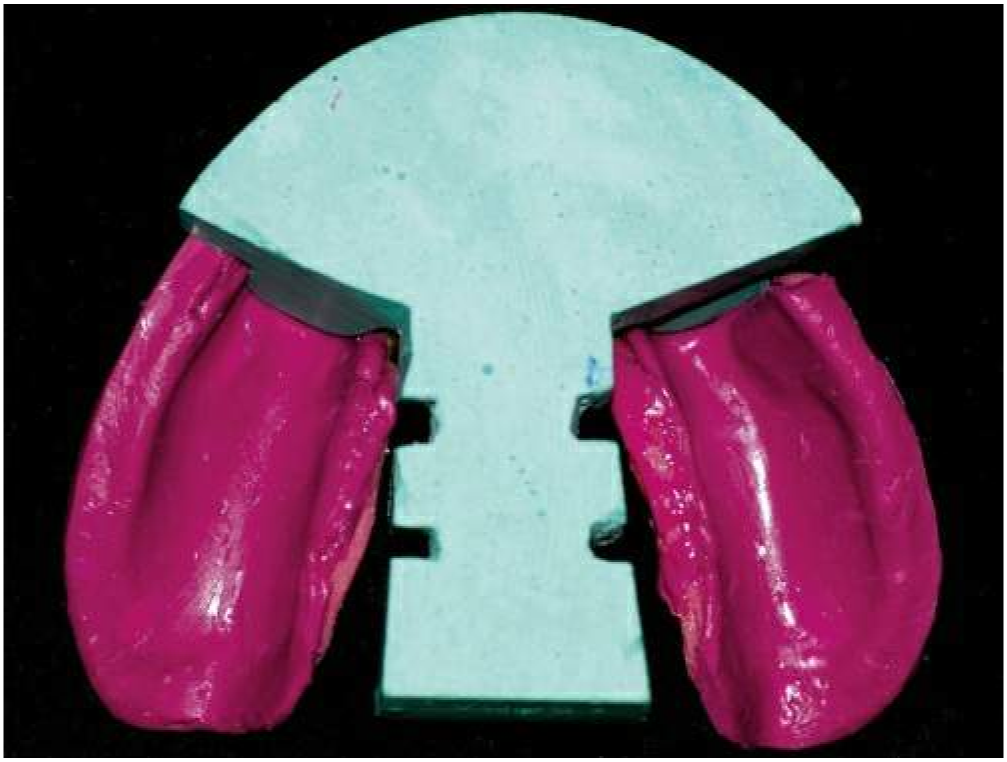


FIGURE 26.18 Framework with functional impression seated on cast.

The framework is secured firmly to the cast with sticky wax after ensuring correct position of all components on the cast (Fig. 26.19).

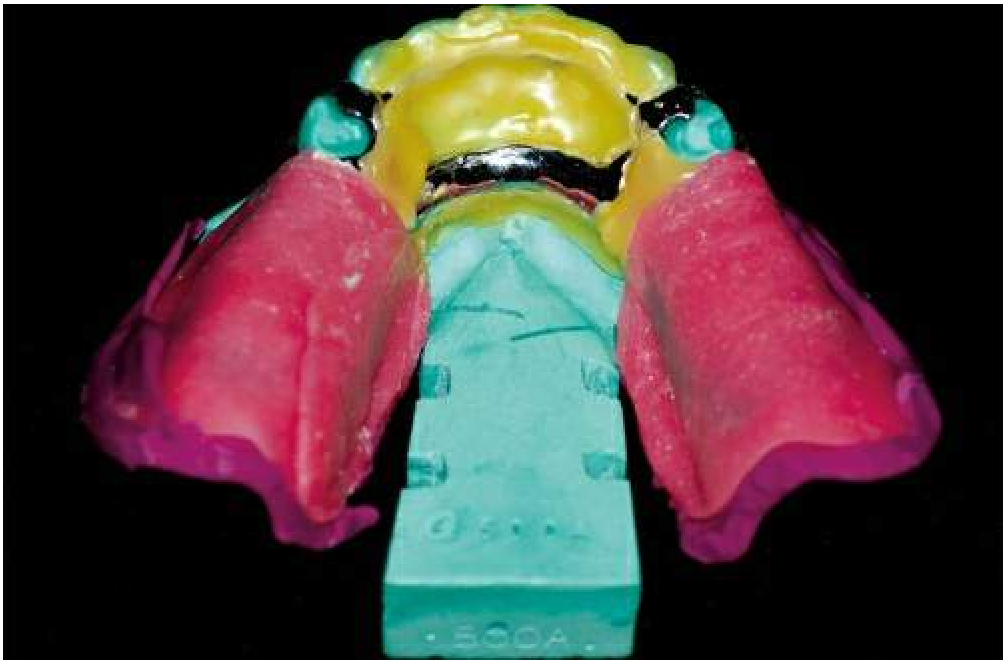


FIGURE 26.19 Framework secured with sticky wax.

The impression area is beaded with utility wax and boxed with boxing wax (Fig. 26.20). The cast is immersed in slurry water for 10 min to provide saturation of dry stone.

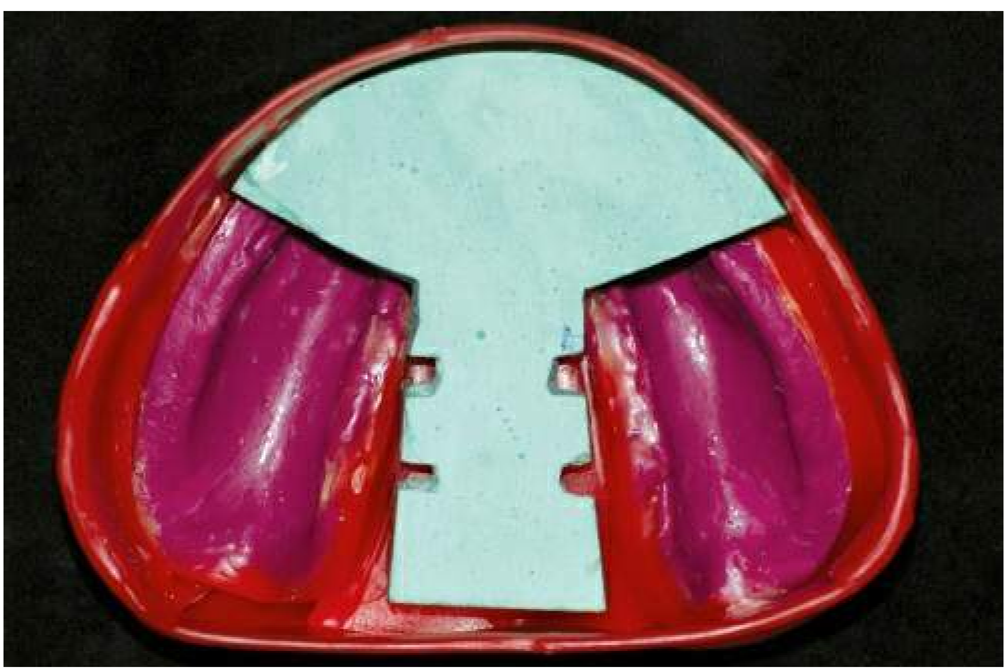


FIGURE 26.20 Impression beaded and boxed.

The functional impression is poured with low-expansion dental stone without much of vibration so that the framework is not disturbed.

After final set, cast is trimmed and is ready for completion of the denture base part of the cast partial denture (Fig. 26.21).

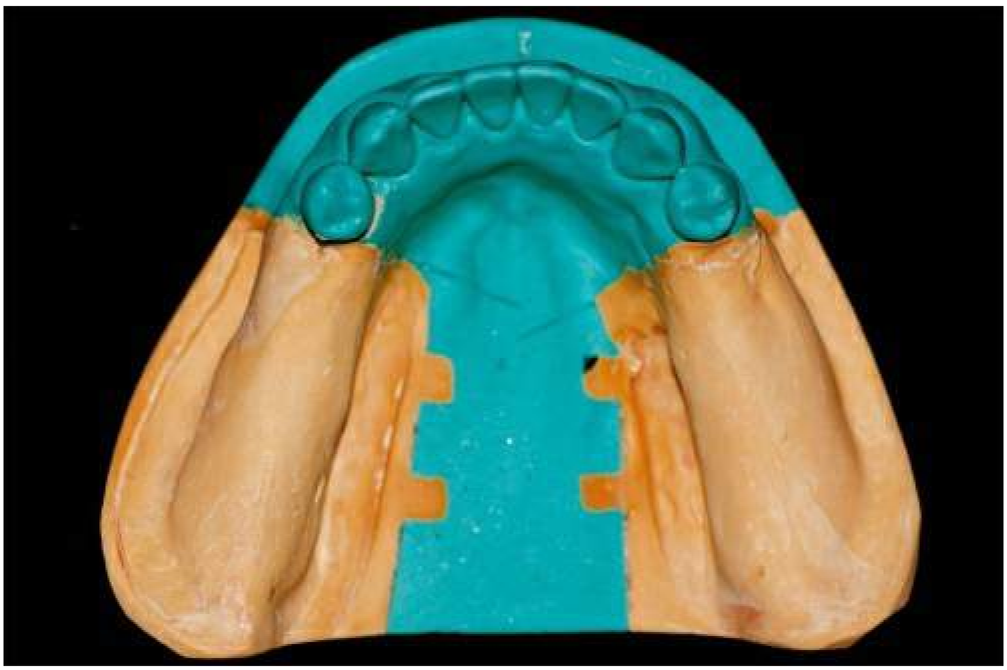


FIGURE 26.21 Showing final altered cast.

SUMMARY

Impression making is an important aspect of any prosthesis as the tissues need to be recorded accurately to ensure proper fit. In cast partial dentures, an anatomic impression will suffice in most clinical situations. When the load on the abutments needs to be transferred to the residual ridges, a functional impression is essential, in long-span edentulous spaces and distal extensions. Altered cast technique is the method of choice to make master casts with functional impressions. Once the master cast is poured, the prosthesis design is transferred and fabrication of the framework is commenced.

CHAPTER 27

Fabrication of removable partial denture

CHAPTER CONTENTS

Introduction

After making the master impression, it is sent to the laboratory along with a tentative jaw relation record. The framework, as designed on the master cast is fabricated in metal alloy of choice, by the lab and sent back to the clinician to try-in the framework and record the jaw relation. After articulation, the lab then arranges the artificial teeth. A clinical trial is performed in the patient's mouth; the denture base is processed and inserted. The various procedures involved in this process are discussed in this chapter.

Framework fabrication

The following procedures are performed after fabricating the master cast.

Survey of master cast

The following procedures are performed by surveying the master cast:

- Retripoding master cast
- Design transfer to master cast
- Blockout
- Relief

All of the above procedures are discussed in the Chapter 23.

Beading

Definition: Scribing of a shallow groove on the maxillary master cast to provide intimate contact between the prosthesis and soft tissues.

Purpose

1. To transfer the design to the refractory cast.
2. To provide a visible finish line for casting.
3. To ensure intimate tissue contact of major connector.

Beading is performed only for maxillary major connectors and never for mandibular, as the mucosa in mandible is thin and cannot take the pressure. The procedure is discussed under the section 'Major Connectors' in Chapter 21.

Duplication and fabrication of refractory cast

After the above procedures are performed on the master cast, it is duplicated. An impression is made of the master cast and a new cast is poured in a different material. This is done because, while casting the wax pattern for a removable partial denture, the entire cast along with the wax pattern is invested, unlike the fixed partial denture where the wax pattern is removed from the master cast or die and then invested separately. So the cast on which the RPD wax pattern is made and invested should be of a material which can withstand high temperatures. Hence, the master cast is duplicated and poured in refractory material (withstand high temperature). On this refractory cast the wax pattern of framework is fabricated and the entire cast along with wax pattern is invested for casting the metal.

Definition: The procedure of accurately reproducing a cast is termed as duplication.

Duplicating material

Reversible hydrocolloids (agar), silicones and irreversible hydrocolloids (alginate) can be used for duplication.

Reversible hydrocolloid (agar) is the material of choice as it can be reused and is accurate. But it needs to be poured immediately due to syneresis. Silicones are expensive, but very accurate and multiple models can be poured. Alginates are rarely used.

Duplicator

An equipment that is used for mixing the duplicating material is called duplicator.

In case of agar, this equipment consists of an upper compartment where the material is heated to its sol state and stored at a specific temperature. This liquefied material is poured into a flask containing the cast to be duplicated by opening a nozzle attached to the upper compartment. The flask with the cast is placed under the nozzle on a horizontal platform attached to the base of the duplicator (Fig. 27.1).

FIGURE 27.1 Agar duplicator.

For silicones, the base and catalyst liquids can be mixed manually (Fig. 27.2) or an equipment similar to any automixer is used, which mixes the base and catalyst and again dispenses it through a nozzle.

FIGURE 27.2 Silicone duplicating base material (pink) is mixed with the catalyst (white) in equal amount in a clean bowl and mixed.

Duplicating flask

The original duplicating flasks were designed for agar duplication. They are used to support the cast and confine the hydrocolloid, since it aids in controlling shrinkage. It is a simple design, consisting of three pieces – the base, the body and the reservoir ring. Holes in the top surface of the body permit air to escape as the duplicating material fills the flask. The reservoir ring helps in compensating for shrinkage. Duplicating flasks can be made of metal, formica or plastic.

The modern agar duplicating flask is shown in Fig. 27.3.


FIGURE 27.3 On the left is a plastic flask and on the right is an aluminium flask for agar duplication.

Procedure

- Immerse the cast in slurry water at room temperature (30°C) for 4 min prior to duplication.
- Centre the cast on the base of the flask, and secure it with three small pieces of modelling clay (plasticine). There should be at least 0.25 inch clearance in all directions (Fig. 27.4).
- Place the body on top of the base and the reservoir ring on the body of the flask (Fig. 27.5).

- The new hydrocolloid material is chopped or cut into small pieces (Fig. 27.6). Any material being reused should also be treated similarly.
- The agar can be liquefied using the following methods:
  - Heating in a double boiler.
  - Heating in a microwave oven using a ceramic pressure pot.
  - Heating in a duplicator.

In any method, the agar is liquefied at 100°C (Fig. 27.7), and the temperature is brought down to about 50–60°C, to pour the agar into the flask. In case of the duplicator, this is done automatically with the storage unit (Fig. 27.8).

- Fill the duplicating flask with agar hydrocolloid duplicating material (Fig. 27.9). If the storage unit is used, centre the duplicating flask under the nozzle, and open the valve.
- After covering the teeth of the cast with the material, the flask is filled within 3 mm of the top. If the modern agar duplicating flasks are not used, the reservoir ring is placed on the body and the material is poured up to the top of the ring (Fig. 27.10).
- The material is then allowed to cool and set in the flask. In the duplicator, a fan placed below the base of the unit enables cooling. If other methods of liquefying the agar have been used, the flask can be placed in a tray filled with cool running water such that it covers only the base of the flask.

- After the agar cools, the flask is inverted and base of the flask is removed, exposing the base of the cast (Fig. 27.11). The cast is loosened from the material with gentle blasts of air, and then removed from the set duplicating material (Figs 27.12 and 27.13).

- The refractory cast is poured immediately into the space created by the master cast in the duplicating material (Fig. 27.14). The investment material used for making the refractory cast depends on the alloy to be used for fabricating the cast partial denture. Generally, gypsum-bonded investments are used for type IV gold alloys, while phosphate-bonded investments are used for chrome–cobalt and other base metal alloys.

- The set refractory cast is removed from the duplicated mould by breaking the mould. The cast should neither be trimmed on a model trimmer nor should be rinsed at all. It should be hand trimmed and dried in an oven or preheating furnace at 80–90°C for 60–90 min. It is then removed and lightly sprayed with a plastic model spray. Instead of model spray, it could also be dipped in beeswax at 138–149°C for 15 s. This produces a smooth, dense surface on the refractory cast, allows better adherence of wax pattern and helps prevent damage to the cast during handling (Fig. 27.15).

FIGURE 27.4 Cast secured with plasticine on base of cast.

FIGURE 27.5 Body placed on the base.

FIGURE 27.6 Agar cut into small pieces.

FIGURE 27.7 Agar heated in a polymerizing bath.

FIGURE 27.8 Agar heated in storage bath of duplicator.

FIGURE 27.9 Flask being filled with agar.

FIGURE 27.10 Agar allowed to cool.

FIGURE 27.11 Base of flask is removed exposing cast.

FIGURE 27.12 Cast is removed from the material.

FIGURE 27.13 Impression of master cast on the duplicating material.

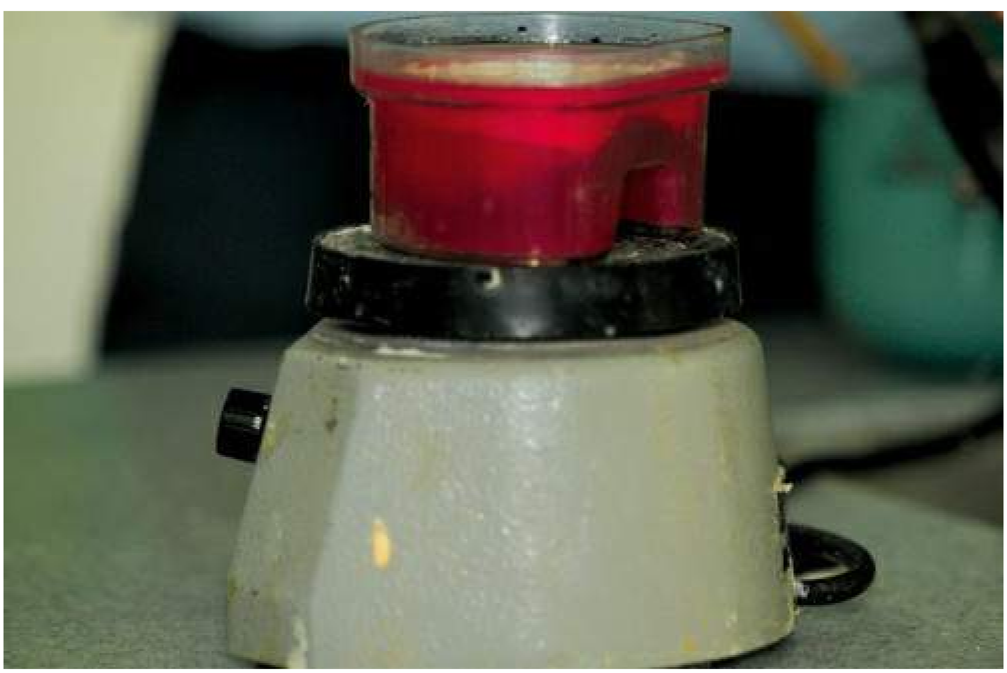


FIGURE 27.14 Refractory material mixed and poured into the duplicated mould.

FIGURE 27.15 Refractory cast.

The master cast is thus duplicated and on the refractory cast the wax pattern is fabricated.

Waxing the framework

Design transfer: The framework design on the master cast is transferred to the refractory cast even without surveyor. A common soft lead pencil can be used. The relief, blockout and beading on the refractory cast will guide the design transfer.

Materials: Prefabricated patterns for waxing the framework are available in wax and plastic, in a variety of shapes, sizes and thickness (Fig. 27.16). The thickness is measured as 'gauge'. Table 27.1 gives the approximate value of gauges in millimetres. The sheets are available in adhesive and nonadhesive varieties and also in soft and hard types.

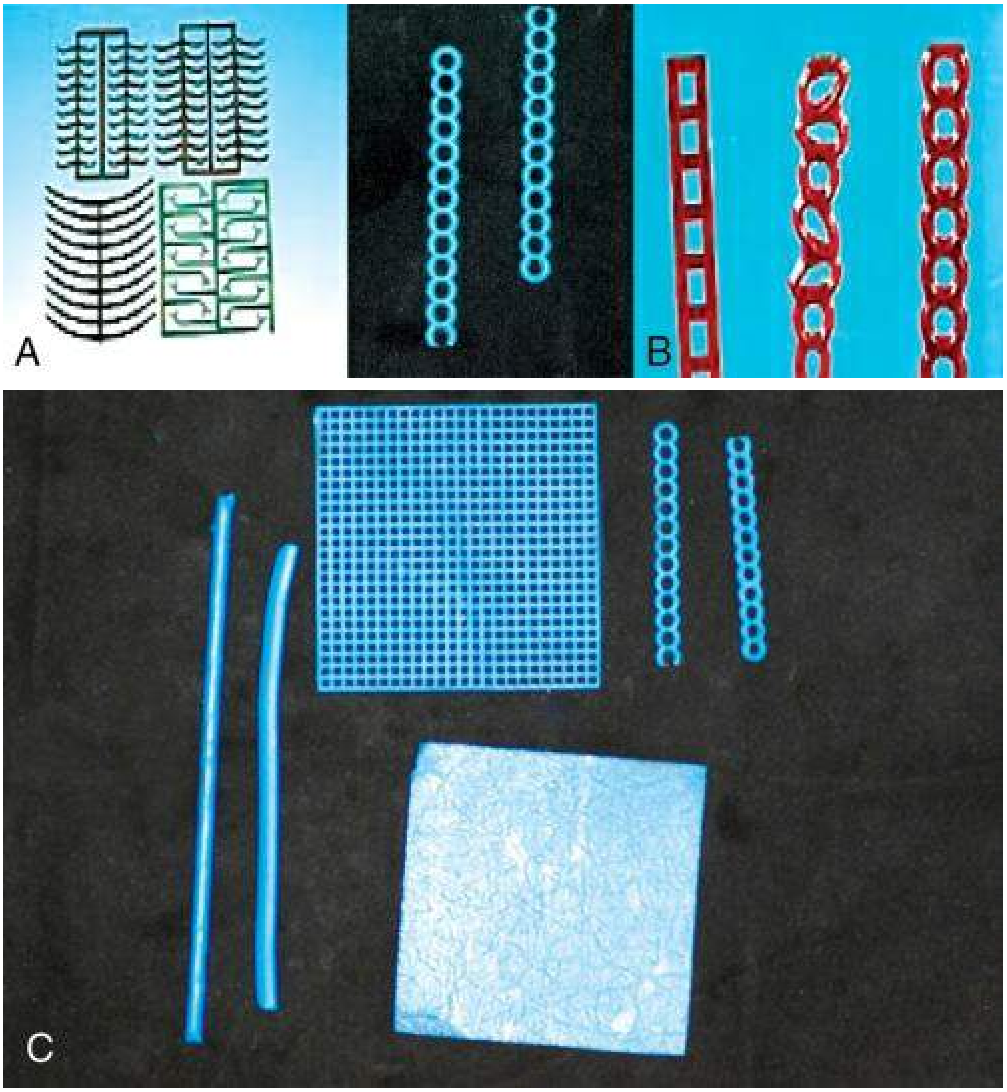


FIGURE 27.16 **(A)** Prefabricated clasp patterns. **(B)** Prefabricated denture base minor connectors. **(C)** Wax sheets and bars.

Table 27.1

Gauge conversion in millimetre

Gauge	mm (approx.)
34	0.16
32	0.20
30	0.25
28	0.32
26	0.40
24	0.51

22	0.64
20	0.81
18	1.02
16	1.29
14	1.62
12	2.05

Procedure

Maxillary framework

One sheet of casting wax or plastic with the required thickness is cut and adapted to the approximate outline of the major connector (Fig. 27.17). Soft blue casting wax is flowed along the borders to seal the sheet to the outline. The wax is finished to a thin edge when it goes onto the teeth, and is left slightly rounded on the border of the major connector (Fig. 27.18).

FIGURE 27.17 Wax sheet adapted to the major connector outline.

FIGURE 27.18 Sealing the borders.

The tissue stops are then waxed (Fig. 27.19), following which the denture base minor connector is then waxed. This is made depending on the type of the connector. For making a latticework design, the outer strut is waxed first using a 12- or 14-gauge half round wax. After sealing, the cross struts are waxed using 16- or 18-gauge half round wax. For meshwork design, prefabricated mesh wax is adapted to the desired area (Fig. 27.20).


FIGURE 27.19 Tissue stops being waxed.


FIGURE 27.20 Meshwork type of minor connector adapted.

The clasp is then adapted and waxed. It should be placed over the clasp outline, guided by ledging. Tip of the clasp is positioned first, followed by the body and shoulder of the clasp (Fig. 27.21).

FIGURE 27.21 Placement of clasp pattern.

The occlusal rests and other minor connectors are then filled by flowing casting wax according to the requirements of the components (Fig. 27.22).

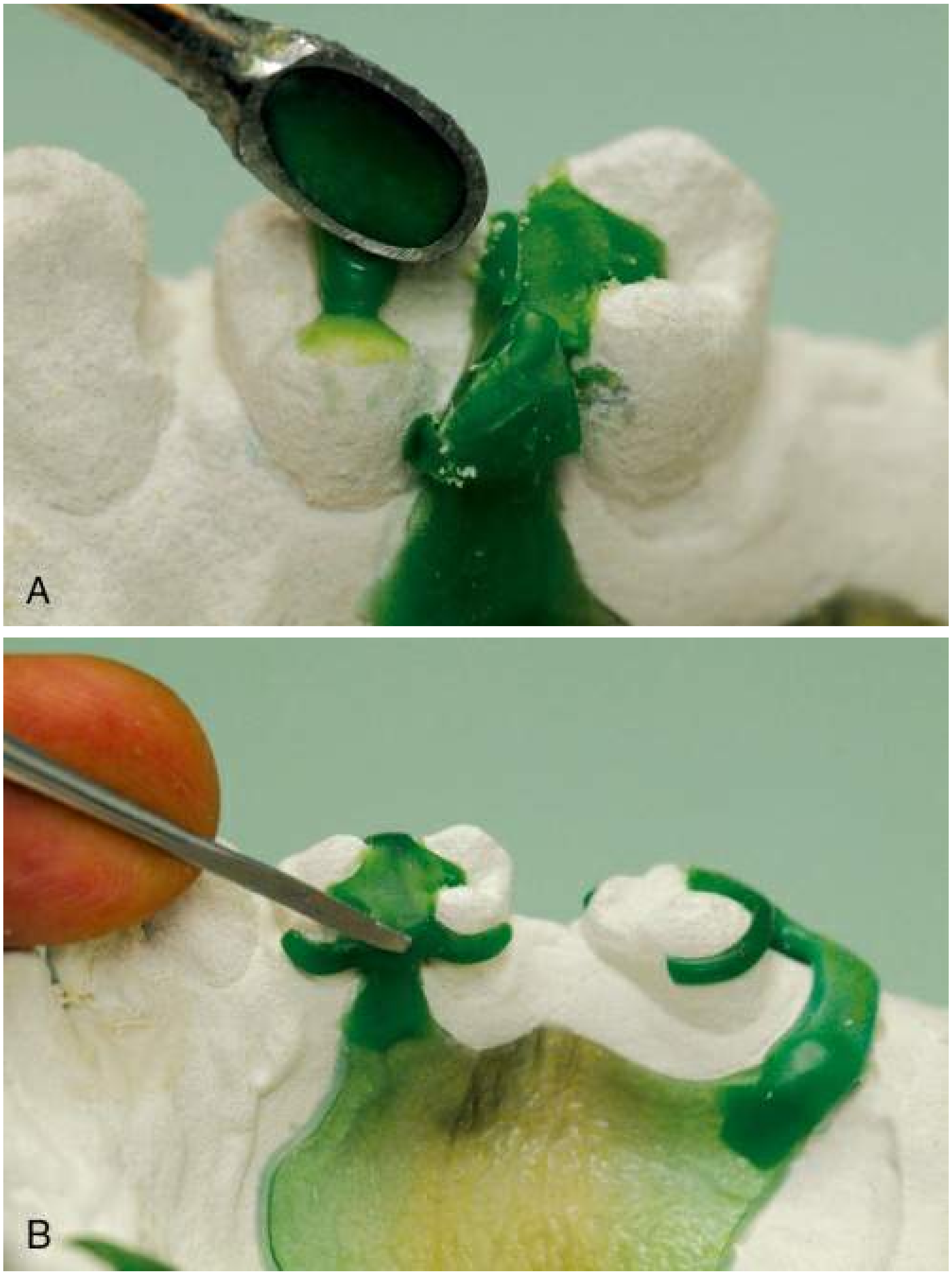


FIGURE 27.22 Waxing of occlusal rests **(A)** and minor connectors **(B)**.

The external finish lines are then developed with half round wax wire and the wax pattern is smoothed, polished and completed (Fig. 27.23).

FIGURE 27.23 External finish lines developed and wax pattern completed.

A similar sequence is followed to make a wax pattern for a mandibular cast partial denture (Fig. 27.24).

FIGURE 27.24 Photo of a waxed up lower denture.

Spruing

After the wax pattern is fabricated on the refractory cast, it is sprued to enable casting procedure. The actual spruing technique depends on the instructions provided by the manufacturer of the alloy system. A commonly used technique will be discussed here.

Sprue: The channel or hole through which plastic or metal is poured or cast into a gate or reservoir and then into a mould (GPT7).

Sprue former: A wax, plastic or metal pattern used to form the channel or channels allowing molten metal to flow into a mould to make a casting (GPT7).

Basically the channel that is formed is termed as sprue and the material that is used to form the channel is called the sprue former.

Purpose

1. To direct the molten metal into the mould space or cavity.

2. To provide a reservoir of molten metal which compensates for solidification shrinkage of casting.

General rules of sprue attachment

1. Sprues should be large enough so that they do not solidify before the casting.

2. Sprues should leave the crucible from a common point and should always be attached to bulky sections of the wax patterns.

3. They should be as short and as direct as possible. Abrupt changes in direction and T-shaped junctions should be avoided.

4. All sprue junctions should be reinforced and rounded.

Types

1. **Single sprue:** Limited to maxillary frameworks with palatal plate, disadvantage is use of extra long investment ring.

2. **Multiple sprues:** Most often used, main sprue should be 8- to 12-gauge round wax wire; auxiliary sprue should be 12–18 gauge. Auxiliary/secondary sprues are placed in areas separated from the bulk of the framework by long spans of retentive meshwork and to support heavy metal pontics.

Procedure

Multiple spruing procedure is similar for all mandibular and maxillary castings apart from palatal plate.

1. The cast base is trimmed to 12 mm thickness and tapered towards the base.

2. A 9 mm hole is drilled through the cast centrally on a line joining the distal ends of the major connector on each side.

3. A roll of pink baseplate wax is inserted into the hole and is projected into the tissue surface of the cast by 10 mm (Fig. 27.25A). The auxiliary sprues are attached about 5 mm below the tip of this main sprue to dissipate the turbulence from molten metal. The portion of rolled wax projecting from the underside of cast will serve as a handle during investing.

4. Three pieces of 8-gauge round wax is attached to the main sprue. They are extended radially to the lower border of lingual bar major connector. Direct one piece centrally and other two anterior to the finish lines on either side. Other 12-gauge round wax is attached to the body of each direct retainer assembly (Fig. 27.25B).


A

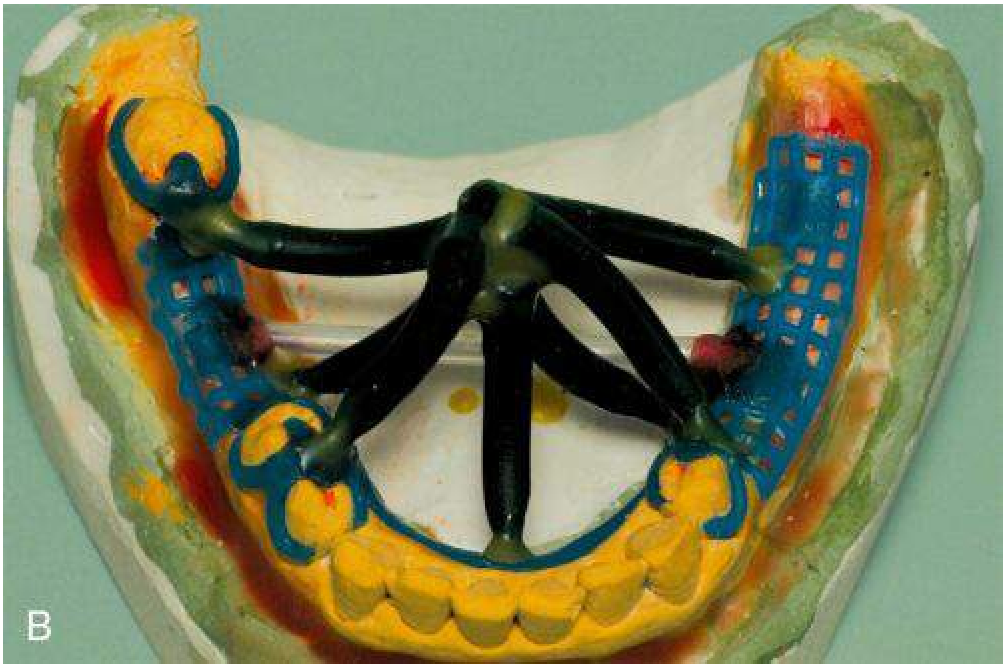


FIGURE 27.25 **(A)** Baseplate wax inserted into hole in base of cast and sprues are attached to it. **(B)** Multiplesprues placed on the mandibular wax pattern.

Investing

The sprues are attached; the refractory cast with the wax pattern and sprue is invested with an investment material. As in spruing, the investment procedures are also dependant on the alloy used and is hence controlled by the alloy manufacturer. A general procedure will be discussed.

Definition: The process of covering or enveloping wholly or in parts an object such as a trial denture tooth, wax pattern or crown with an investment material before curing, soldering or casting is called investment.

Purpose

1. Provides the required strength to withstand forces from the entry of molten metal till it solidifies.

2. Provides a smooth surface for the mould space.

3. Provides an escape route for gases entrapped in mould space by the entering molten metal.

4. Provides compensation for casting shrinkage of metal.

Types of investing flasks

Metal, ringless (Fig. 27.26).

FIGURE 27.26 Investment flask.

Procedure

1. Before placement in the casting/investment ring, the refractory cast is soaked in room temperature slurry water for 4 min to ensure good bonding with investment material. The wax pattern is then sprayed with wetting agent (debubblizer) to reduce the surface tension of wax thereby enhancing the adherence of investment to pattern.

2. Investment material is selected according to the alloy to be used and manufacturer's instructions. First the material is painted onto the waxed refractory cast for a thickness of about 6 mm and allowed to set for 10 min.

3. The casting/investing ring large enough to hold the refractory cast and painted investment is selected depending on the alloy and manufacturer's instructions. A ring liner is used to line the inner surface in case a metal casting ring is used. The liner is soaked in water after placement and it allows escape of hot gases.

4. Place the waxed refractory cast in the ring, make a fresh mix of investment in a vacuum mechanical mixer and pour the investment slowly until it completely fills the ring.

5. Allow the investment to set for an hour.

Burnout

This is also called *wax elimination*. The invested waxed refractory cast is placed in a furnace and heated to a specified temperature to eliminate the wax and create a mould space for casting.

Definition: The removal of wax from a mould, usually by heat.

Purpose

1. Removes moisture from mould.

2. Eliminates wax pattern.

3. Expands the mould to compensate for casting shrinkage of metal.

Furnace

The burnout furnace (Fig. 27.27) can be electric or gas and should be vented to allow the resulting gases to escape. Modern furnaces are electronically controlled such that time–temperature relationship can be set according to the alloy manufacturers requirements.

FIGURE 27.27 Burnout furnace.

Procedure

The time and temperature needed to eliminate the wax is dependent on the expansion required for the alloy and the type of investment. It is controlled by the alloy manufacturer's specifications.

Generally the procedure is as follows:

1. The mould should be moist when placed in furnace to ensure uniform heating. Hence, if burnout is not carried out immediately after investing, the mould could be placed in a plastic bag to prevent

them from drying or they could be soaked in water for a few minutes prior to placement in furnace.

2. The mould should be placed in the furnace with the sprue hole down.

3. Burnout should begin with a nearly cold furnace.

4. For low-heat gypsum-bonded investments, the mould should be heated slowly to a temperature of 1250°F/680°C over a period of 2 h. This temperature should be maintained for 30 min to ensure uniform heat penetration, also called 'heat-soaking'. More time should be given for plastic patterns.

5. Insufficient burnout time will not allow the moisture to be eliminated completely and result in porosities in casting. Overheating will result in mould breakdown and loss of expansion.

Casting

Induction casting is now most commonly used for removable partial dentures. Although the machine is expensive, the ease of procedure and safety (lack of open flame) make it a method of choice. It also works on the same centrifugal casting principle, but the metal is heated electrically instead of using a flame.

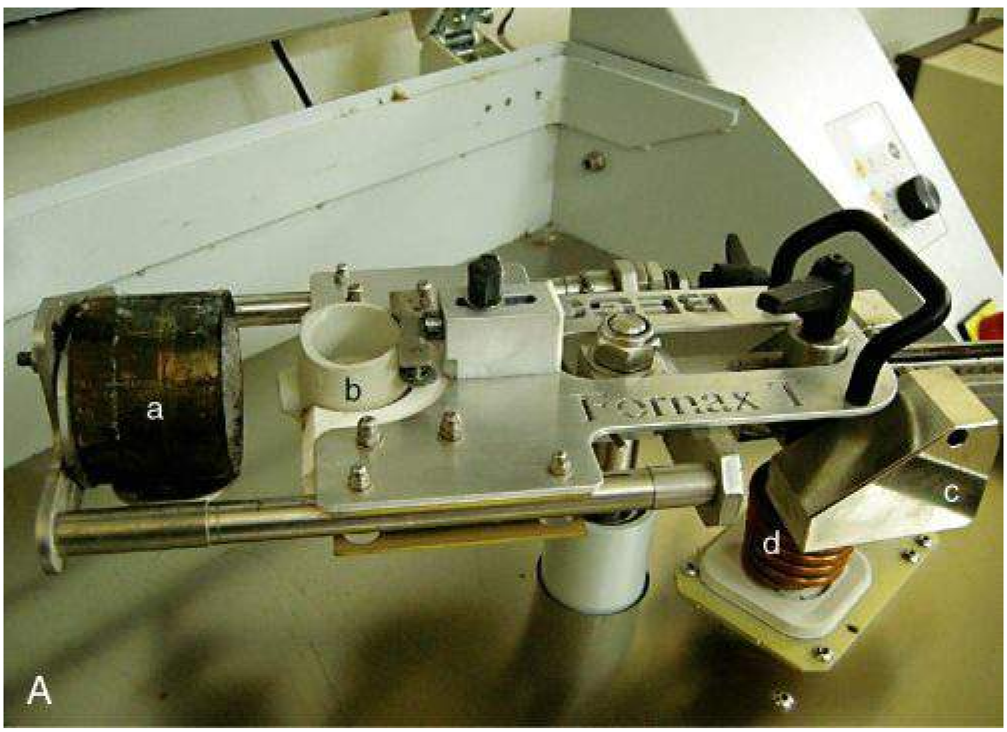
Procedure of induction casting

1. Alloy manufacturers' instructions are followed for deciding the amount of alloy and the heat required.

2. The mould is placed in the casting machine following burnout and balance of casting arm must be ensured by placing counter weights on the opposite end of the mould (Fig. 27.28A). The number of revolutions of the centrifugal casting machine is set according to the alloy manufacturer's instructions. Most machines revolve at 600 rpm.

3. The alloy pellets are placed in the crucible and is heated electrically by a coil of copper tubing around it. The heating of metal is viewed through a dense blue lens and each alloy has its own distinctive appearance when it is ready to cast (Fig. 27.28B). When it is ready to cast, a lever is manually released to start the rotation of centrifuge.

4. After the casting is completed, it is allowed to cool for 8–12 min according to manufacturer's instructions. The coil in the machine is cooled automatically by a flowing water source running through it.



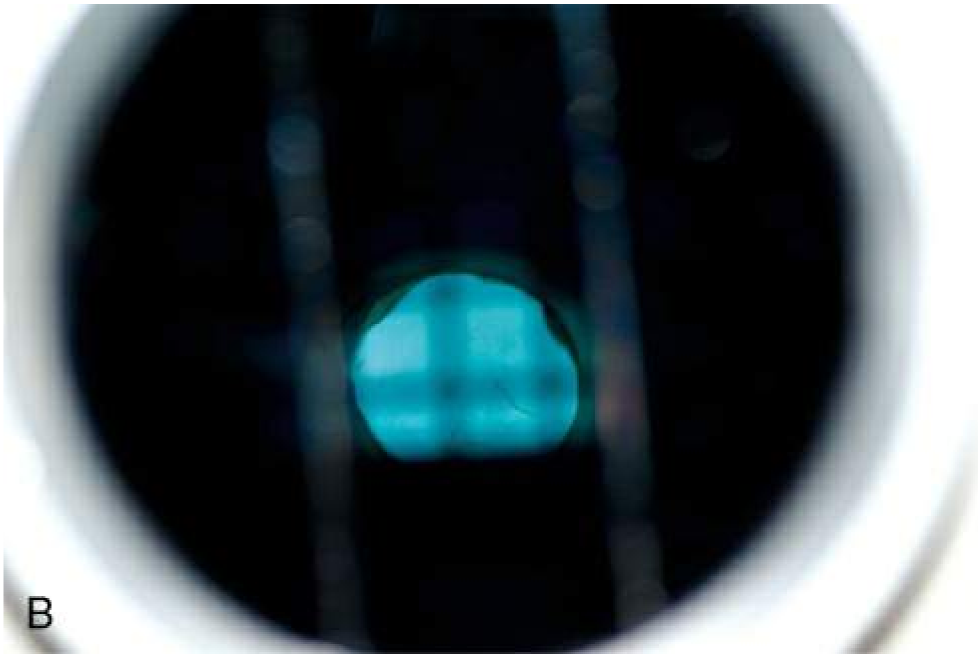


FIGURE 27.28 **(A)** Induction casting machine: (a) Casting ring with mould, (b) crucible where metal is heated, (c) weights for counter balance, (d) heating element (coil of copper). The centrifuge is rotated to place the crucible under the heating element before commencement of casting. **(B)** The heating of metal is viewed through a dense blue lens.

Casting with centrifuge using flame for melting alloy is described under the FPD section in Chapter 40; the metal is melted using a gas – oxygen or oxyacetylene blow torch depending on the melting temperature of alloy.

Recovery of framework

The bulk of the investment is removed by tapping with a wooden mallet or by using a devesting machine. Gold alloys are quenched in water to break surface investment, cleaned and then pickled, while for base metal alloys like cobalt–chromium, sandblasting with aluminium oxide is used to remove the investment adhering to the surface.

Finishing and polishing

Framework finishing consists of smoothening the metal with progressively finer abrasive agents to remove scratches and rough areas to give a high lustre.

1. The sprues are cut using carborundum discs on a high speed lathe.

2. Surface irregularities are removed with tungsten carbide burs.

3. Coarse to fine stone are used to finish the framework, followed by rubber wheels and points.

4. The framework is then placed on master cast to check the fit. To determine areas causing the interference commercially available special powdered sprays or liquid disclosing media are used. The disclosing medium will be removed from the interfering areas, allowing exact trimming of such portions. The trimming is done using appropriately shaped carbides and the checking and grinding is continued till the rests seat completely on the cast.

5. Occlusal interference with opposing arch especially on occlusal and incisal rests is checked after mounting the casts with a jaw relation record.

6. The final polishing is done with polishing compounds recommended for the particular alloy, and with rag and felt wheels on high speed lathe. Wire brush works well to shine bead retention and nail heads.

Framework try-in

The finished framework is sent to the clinician to be tried in the patient's mouth (Fig. 27.29). The clinician will check the frame as follows.

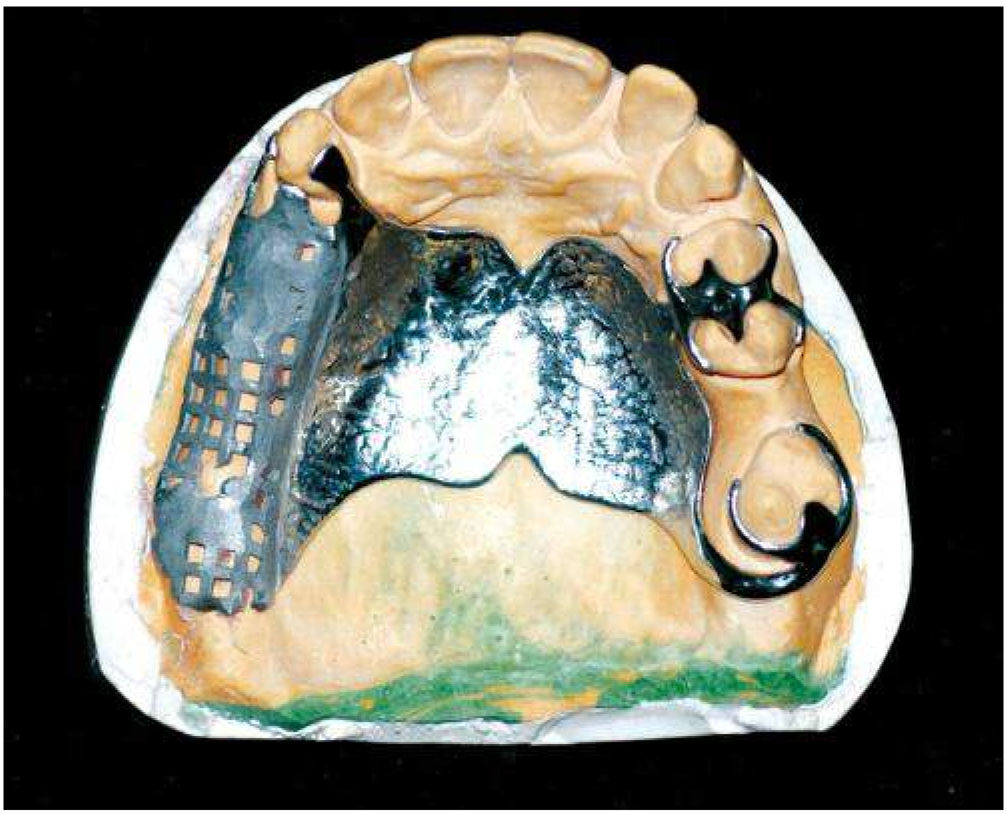


FIGURE 27.29 The framework is examined on the master cast.

Examination of framework

On the master cast, the framework is examined for the following:

1. Design

2. Fit

3. Occlusion

4. Finishing and polishing

Framework fits cast but not mouth

This may be due to:

1. Incorrect impression.

2. Improperly poured cast.

3. Cast has been abraded during fitting of framework in laboratory.

4. Teeth have changed position after making master impression – can happen if adequate time has not be given following any surgery or extractions.

Clinical try-in

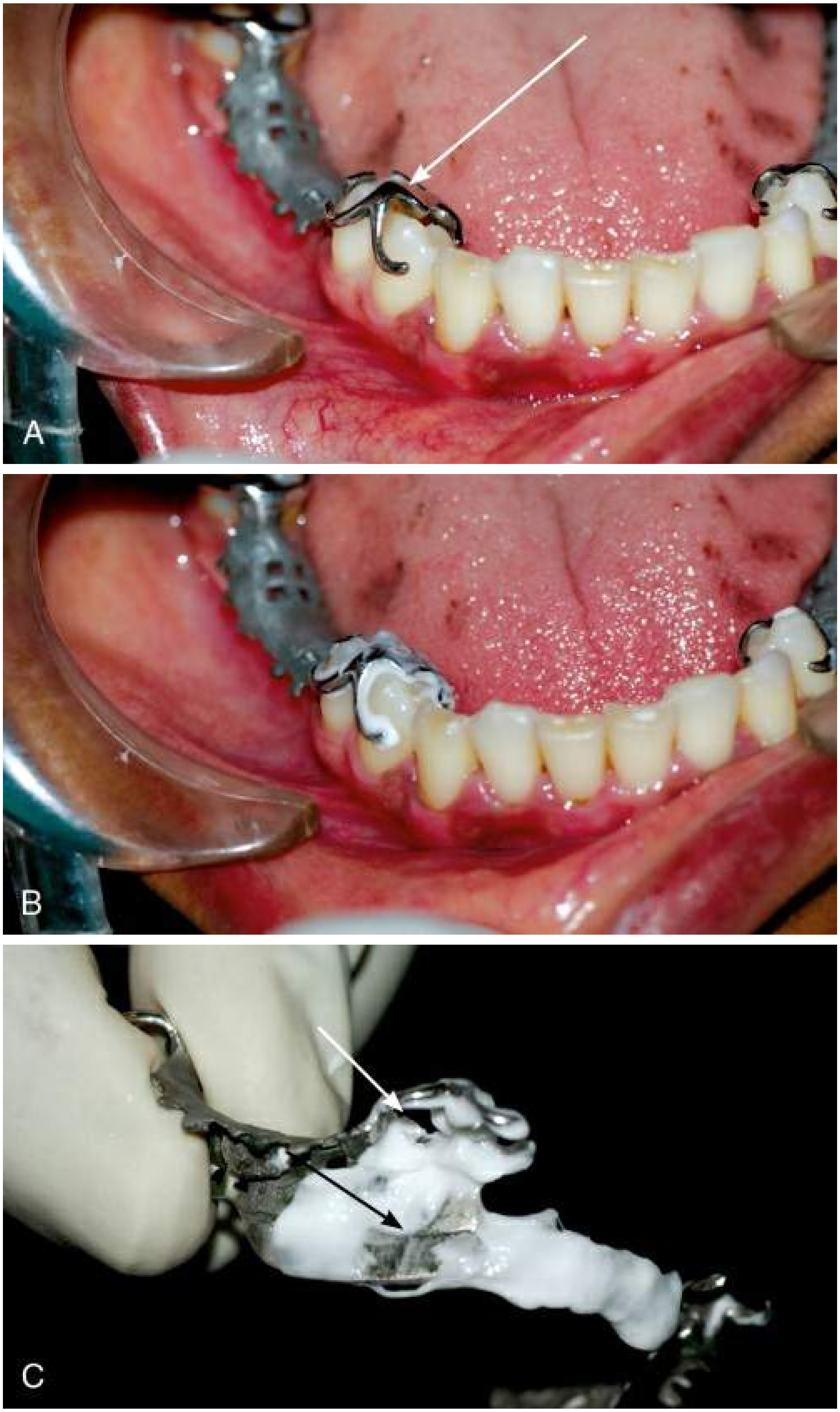
This involves three steps: The framework is first adjusted to fit in the patient's mouth, then the occlusion is checked and corrected and lastly the ground areas are finished and polished.

Fitting framework

1. The fitting surface of the framework is painted with commercially available pressure indicating paste or disclosing wax and tried in the mouth. Framework is aligned over the abutments and mild finger pressure applied along the planned path of insertion. Areas where the disclosing medium is eliminated indicate interference, and is trimmed appropriately. The procedure is repeated till the occlusal rests seat accurately on the rest seats (Fig. 27.30A–E).

2. Sometimes the retentive clasp may need to be adjusted to remove an obstruction or increase retention. Pliers with smooth beaks should be used as otherwise the clasp arm may be scratched and weakened. In case of cobalt–chromium alloys, the desired position of clasp is achieved by a series of minute bends by application of moderate controlled force.

3. If the discrepancies in fit are such that suitable adjustment will not correct the same, a new impression must be made and the framework should be repeated.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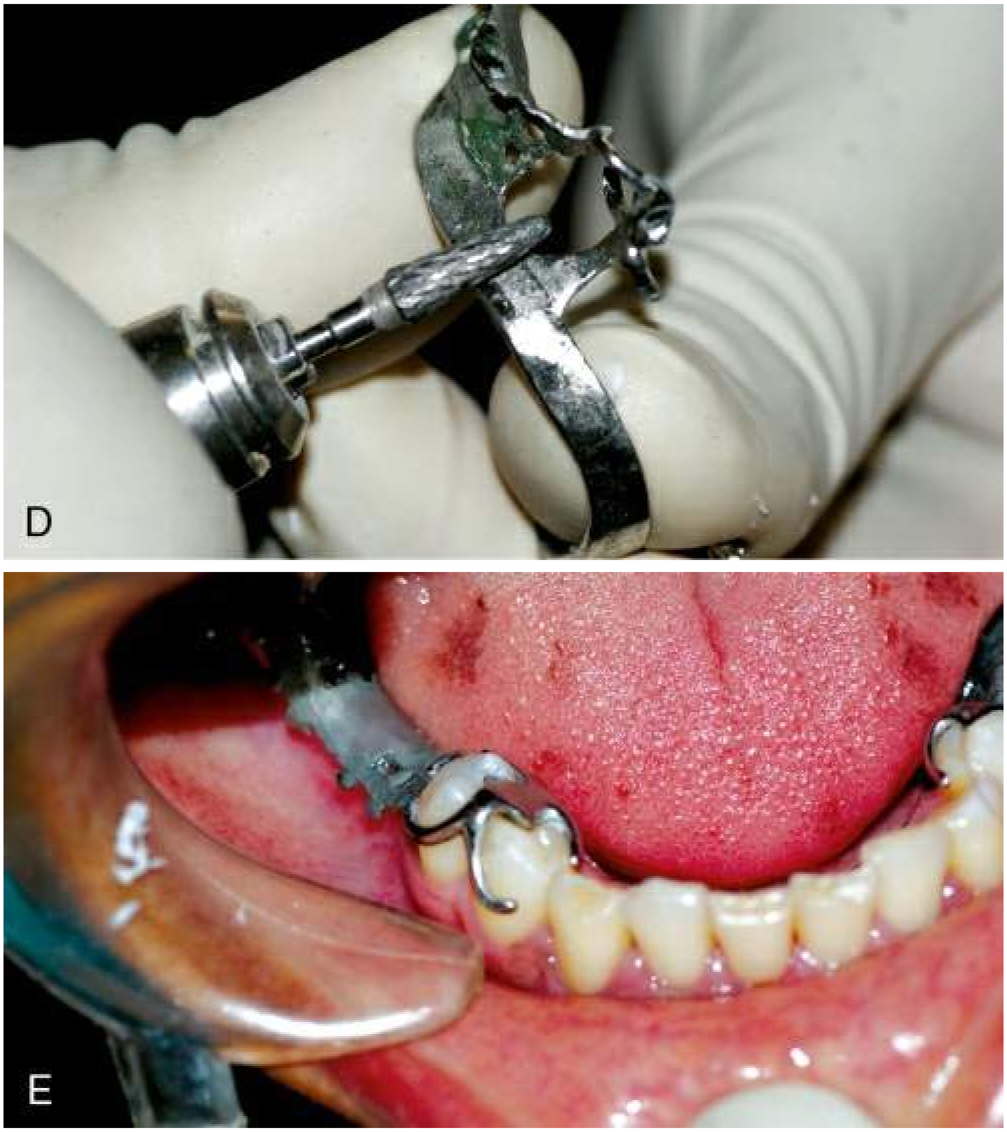


FIGURE 27.30 **(A)** Framework tried in the mouth reveals improper fit – occlusal rests not seating fully. **(B)** Framework tried in after applying pressure indicating paste. **(C)** Areas where the disclosing medium is eliminated indicate interference. **(D)** The interfering areas are trimmed appropriately. **(E)** Occlusal rests seat accurately ensuring proper framework fit.

Correcting occlusion

1. It must be ensured that natural teeth contact first and guide the occlusion in centric and eccentric closures. The framework is first

checked for centric occlusal interference. If partial dentures are being constructed for both upper and lower arches, the frames should be checked for occlusal discrepancy, one at a time, and then together.

2. The occlusion of natural teeth without the framework is first noted. Framework is positioned in the mouth and articulating paper held with holder or forceps is placed over the teeth on one side of arch. Patient is asked to gently tap on the teeth with vertical force. This is repeated on the opposite side. Mark produced by the paper on framework shows interference and should be trimmed outside the mouth. After correcting centric occlusal discrepancies, lateral and protrusive interferences are checked similarly (Fig. 27.31).

FIGURE 27.31 Metal framework should not interfere with the natural dental occlusion during centric as well as eccentric positions. **(A)** Right lateral view, **(B)** Frontal view and **(C)** Left lateral view.

Finishing and polishing

The corrected (ground) parts of the framework should be finished and polished as previously described.

The checked framework is then returned to the laboratory for fabrication of record base and occlusal rims. In distal extension situations which require altered cast impressions, the framework is sent for appropriate modification depending on the technique planned and following the impression making, the record base and occlusal rims are fabricated.

Record bases and occlusal rims

Record bases

The record base is fabricated over the saddle area on the denture base minor connector. The most commonly used material is autopolymerizing acrylic resin as it is stable.

Procedure

1. Outline of record base is marked on cast.

2. Undercut on the ridge part of cast is blocked out with modelling clay or baseplate wax.

3. Tin foil substitute or any suitable separating medium is applied on the cast.

4. After the separating medium has dried, the framework is placed on cast.

5. A sprinkle-on method is used to mix the monomer and polymer and a uniform thickness of 2 mm is obtained (Fig. 27.32). After polymerization, the base is trimmed and polished.

FIGURE 27.32 Record base made with self-cure acrylic resin.

Occlusal rims

Most commonly used material is medium baseplate wax. Modelling plastic may also be used. They should be so shaped that they represent the lost teeth and supporting structures. It should be centred over the crest of the ridge (Fig. 27.33).

FIGURE 27.33 Metal framework with occlusal rims.

Detailed description of making occlusal rims is given in Chapter 5.

Jaw relations and articulation

If only few teeth are to be replaced, especially in class III removable partial dentures, hand articulation is sufficient to establish jaw relation.

In most situations, however, a jaw relation record is essential. It is determined twice during the construction of the partial denture.

First, a jaw relation record is obtained following secondary impression and construction of master cast to begin the fabrication of denture framework. The record base and occlusal rims are constructed on the master cast as described in Chapter 5.

A second jaw relation record is obtained after fitting the framework in the mouth by constructing a record base and occlusal rim on the saddle area of the framework as previously described.

There are two methods used to record the jaw relation thereby establishing occlusal relationship of artificial teeth:

1. Functionally generated path technique

2. Static method

Functionally generated path

This technique records all possible functional movements of the teeth opposing the edentulous span, and the artificial teeth are set accordingly so that they remain in harmony with their antagonist in all times. The pathways are generated by the patient on a wax occlusal rim.

Procedure

1. A hard wax occlusal rim attached to an acrylic resin record base is constructed on the metal framework slightly higher than the normal, approximately 0.5–0.75 mm. The buccolingual width of the rim should be more than that of the opposing tooth.

2. It is then inserted in the patient's mouth and the patient is instructed to simulate chewing movements for a period of 20–30 min. Alternately, the patient is instructed to take the framework home and wear it continuously for 24 h except when eating and consuming hot or chilled drinks.

3. Whichever method is used, patient will invariably perform all possible jaw movements that will be recorded in the form of indentations and pathways on the wax rim.

4. The wax pattern thus obtained from the patient is then boxed and poured in dental stone. This provides a record of the opposing teeth with the functionally generated pathways.

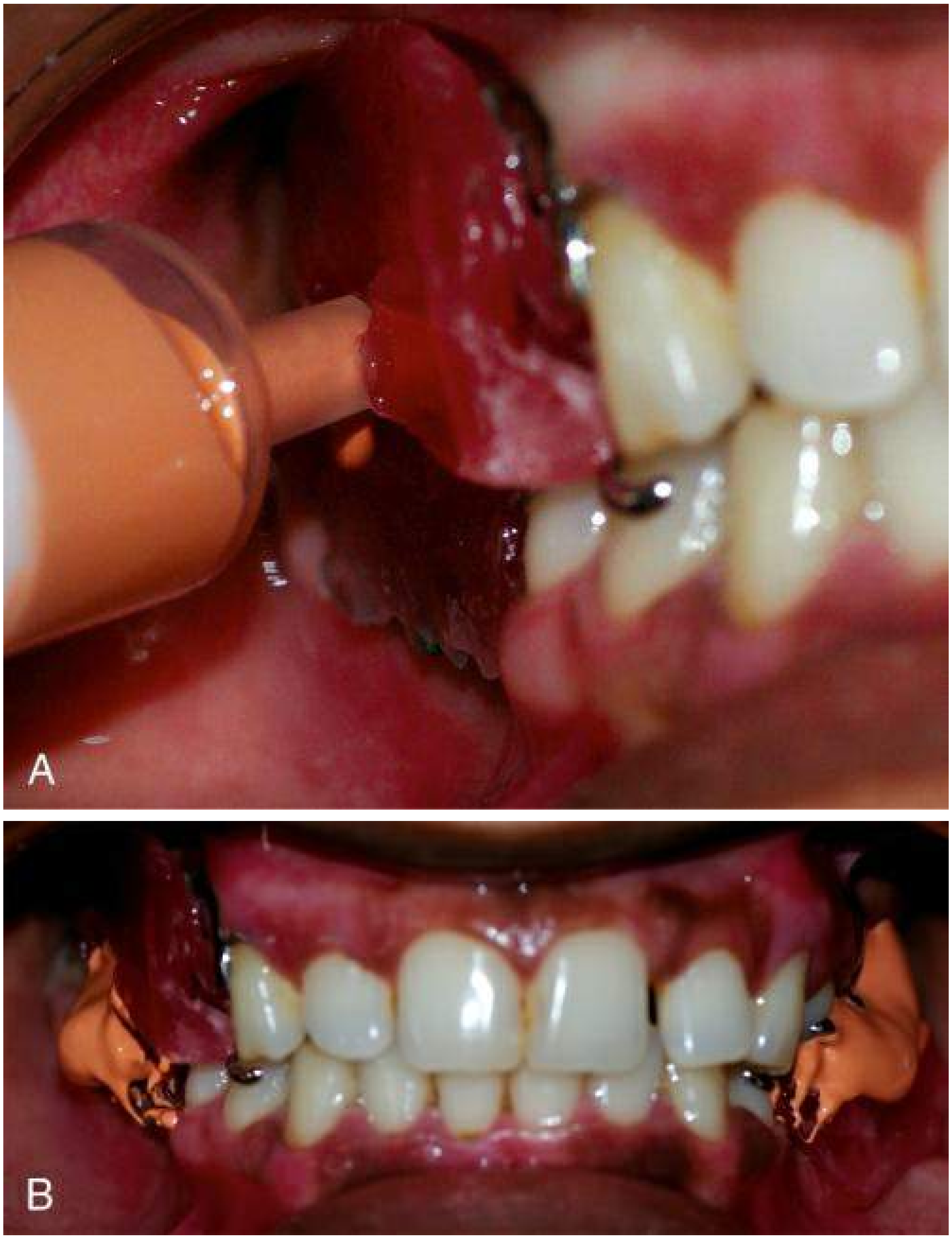
5. The stone record with the opposing wax pathway on the framework is then mounted on an articulator and the artificial teeth are set accordingly.

Static method

1. Most widely used and preferred method.

2. The occlusal rims fabricated on the framework as previously described are inserted in the patient's mouth.

3. The patient is instructed to close in maximal intercuspal position. The rims are reduced in height until it is just out of occlusal contact. The jaw relation record is made by injecting a recording material between the occlusal rim and opposing natural teeth (Fig. 27.34A and B). This material should be uniformly soft on placement and set to a hard state. The recommended material is zinc-oxide eugenol impression paste. Other materials that can be used are impression plaster, modelling plastic and soft baseplate wax.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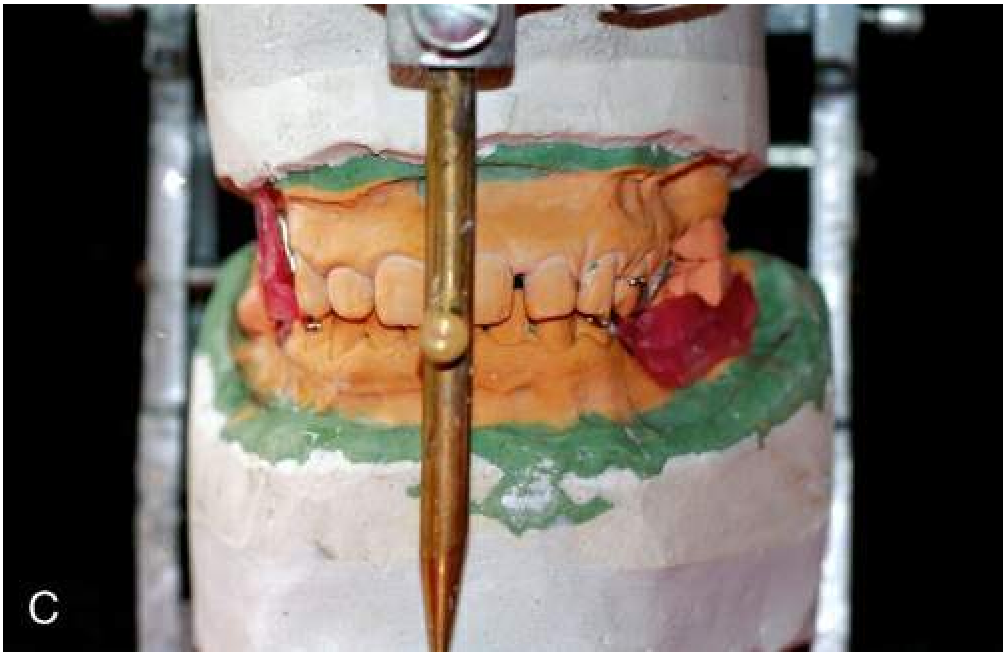


FIGURE 27.34 **(A)** Zinc oxide eugenol impression paste being injected between the occlusal rims. **(B)** Jaw relation recorded at maximum intercuspal position (MIP). **(C)** Articulation of casts.

When no occlusal contact exists between the remaining natural teeth, such as a complete denture opposing a removable partial denture, the procedure of recording is similar to that described for complete dentures.

Articulation

1. The casts with the jaw relation record is then mounted on an articulator (Fig. 27.34C).

2. The simplest articulator to accomplish the desired purpose is selected.

3. A simple hinge or nonadjustable articulator is sufficient for class III arches. For most of the other situations, a semi-adjustable instrument is indicated. Facebow transfer is performed depending on the articulator selected.

The procedure for facebow record and articulation is described in Chapter 7.

Selection of teeth and denture base

The various types of artificial teeth and denture base are described in Chapter 21. A selection is made depending on their indications. The most commonly used artificial teeth are the denture teeth made of acrylic resin. Most commonly used denture base is the combination of metal and acrylic.

Arrangement of artificial teeth and occlusion

Following teeth selection, the artificial teeth are arranged. The general setting principles are similar to those for complete dentures as discussed in Chapter 10. Specific considerations for a partial denture are discussed below.

Anterior teeth arrangement

It is directly associated with aesthetics of the prosthesis and hence very important. Denture acrylic teeth are the most aesthetic tooth type, available in any shade, size or contour.

Mould and shade selection

- The selected teeth should be in harmony with the patient's features and remaining natural teeth.
- The opposing and adjacent teeth are also considered.
- Preferably, shade guide of the manufacturer of the artificial teeth that is selected, should be used (Fig. 27.35A and B).
- Shade guide tooth is moistened and selection is made in natural light if possible. Colour corrected light can also be used.
- Shade should be taken quickly as first impression will be most accurate.
- In cases of long standing edentulousness, there is diminished mesiodistal space for setting the teeth due to the mesial migration/tilting of the adjacent natural teeth. To overcome this problem, if narrower teeth are chosen it will produce an artificial appearance. Proximal contouring of the teeth to regain space should

be considered during mouth preparation. Overlapping the artificial teeth should also be considered. Sometimes if the patient possesses diastemas before extraction, more space may be present for the teeth. Slightly large sized teeth can be chosen or the diastemas can be recreated.

- The temporary denture bases constructed on the framework for jaw relation should be removed before setting teeth.

- If the missing teeth cross the midline, it is essential that the central incisors be set first to re-establish the midline. The fullness and lip support should be verified.

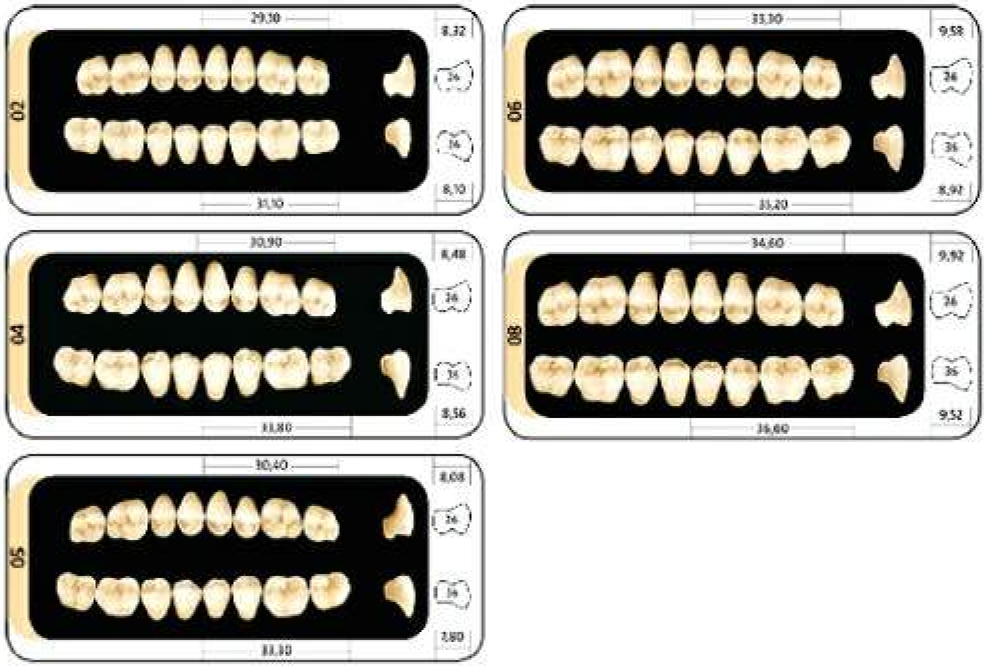
- It is almost always necessary to reshape the ridge-lap portion of an artificial tooth to position it over the acrylic resin retentive minor connector. An anterior denture tooth should be positioned as nearly as possible where the original natural tooth was located.

- As an anterior denture tooth is positioned adjacent to a natural tooth, the proximal surface of the artificial tooth may be recontoured for better and close adaptation with the natural tooth.

- The denture base flanges should be contoured and smoothened to give a natural pleasing appearance.

- An aesthetic try-in phase should be scheduled to verify the appearance in patient's mouth.

A



B

FIGURE 27.35 **(A)** Shade guide (courtesy VITA Zahnfabrik). **(B)** Mould guides.

Posterior teeth arrangement

- The universal teeth setting principles should be applied to set these teeth also.
- Posterior teeth must not only fit into the available space, they should also be in harmonious occlusion with the opposing teeth.
- Denture acrylic teeth are most commonly used.

Mould selection

1. The tooth size or mould is dictated by the length of the edentulous span.

2. Posterior denture teeth are selected on the basis of measurement from the distal surface of the canine to the beginning of the upward

incline of the ramus of mandible.

3. The occlusogingival height also plays a major role. Aesthetics is compromised if the artificial tooth with little occlusogingival height is placed adjacent to a natural tooth with long clinical crown. To correct this, it may be necessary to trim and place the teeth directly butting against the mucosa.

- As a general rule the classic pattern of intercuspation of maxillary and mandibular teeth should be followed. However, these rules although cannot be accurately followed because of the presence of natural opposing teeth. To obtain a good interocclusal anatomy, it may be necessary to set the teeth around 0.5–0.75 mm higher than the correct vertical dimension. The excessive vertical height can then be corrected by selective grinding to achieve a harmonious occlusion.

Positioning tooth adjacent to the clasp

Artificial tooth adjacent to the clasp has to be in harmony with the opposing teeth, the residual ridge and the clasp. The tooth should be first adjusted in proper occlusion with the opposing teeth and then adapted to the alveolar ridge. This is done best by removing the framework from the cast and contouring the ridge-lap portion of the tooth in accordance with the ridge. A small space, 2 mm should be left between the denture tooth and the adjacent abutment tooth (Fig. 27.36). The minor connector supporting the clasp will occupy this space.

- In a class III mandibular relationship, lower artificial buccal cusps should be placed on the crest of ridge, rather than central groove.

• Occlusal surfaces should have adequate grooves, ridges and sluiceways to function effectively.

• Attrited natural teeth should not be opposed by flat artificial teeth. Cutting edges and sluiceways should be provided.

• Final occlusal correction should be performed in the mouth.

FIGURE 27.36 Tooth adjacent to clasp is first trimmed to fit the edentulous space and placed 2 mm away from abutment tooth.

Occlusion

1. The existing natural teeth should guide the occlusion.

2. For a class III partial denture, the existing natural teeth occlusion should be maintained – canine protected or mutually protected.

3. For a mandibular class I or class II patient, simultaneous working

side contact of natural and artificial teeth on edentulous side is preferred.

4. For a maxillary class I, simultaneous working and balancing contact is preferred.

5. For a maxillary class II, only working side contact on edentulous side is preferred.

6. For a maxillary class IV, light contact with lower anterior natural teeth in centric occlusion is preferred to prevent supraeruption. Contact in eccentric relations is not desirable.

7. Generally, contact of opposing posterior teeth in protrusive relation for any class of partial denture is not desired.

8. For a removable partial denture opposing a complete denture, bilateral balanced occlusion in eccentric relations is preferred.

Try-in

Indications

1. Replacement of anterior teeth.

2. Verification of jaw relation records.

Aesthetic (anterior) try-in

The artificial teeth are verified for the following:

1. Anteroposterior position.

2. Tooth length in relation to lip length and existing natural teeth.

3. Width.

4. Overjet and overbite.

5. Midline and vertical alignment.

6. Shade – in a variety of light sources.

Only when the dentist is satisfied with the trial, the patient should be allowed to view the same. Patient should stand at least 2–3 feet away from a wall mirror to examine the appearance. Patient approval is mandatory to proceed beyond this step (Fig. 27.37).

FIGURE 27.37 Try-in.

Verification of jaw relation records

This is done in the following situations:

1. Class I and class II arches.

2. Problems existed while recording jaw relations.

3. Partial denture opposing complete denture.

4. No opposing natural teeth in contact and vertical dimension need to be verified.

Verification can be visual or by using interocclusal check records. The same is discussed in Chapter 11.

Waxing and processing the denture base

The procedure is similar to that described for complete dentures in Chapter 12. Any specific requirements for a partial denture are only mentioned below:

1. When waxing to an external finish line, excess bulk of wax is added so that after processing and finishing it will be at the level of finish line.

2. On minor connectors and approach arm of bar clasp, the metal can be slightly roughened for acrylic attachment and bulk should be adequate.

3. Gingival height of the replacement teeth should be compatible with the adjacent natural teeth.

4. Polished surfaces should be waxed similar to a complete denture.

5. Investing, dewaxing, processing and deflasking is similar to complete dentures.

6. Remounting is done when a large number of posterior teeth are being replaced. It is again similar to that described for complete dentures. Till this is completed, the denture is not removed from the master cast.

7. The master cast is removed from the denture either by cutting with a saw or trimming with a fissure bur.

8. The final finishing and polishing is similar to complete dentures (Fig. 27.38).

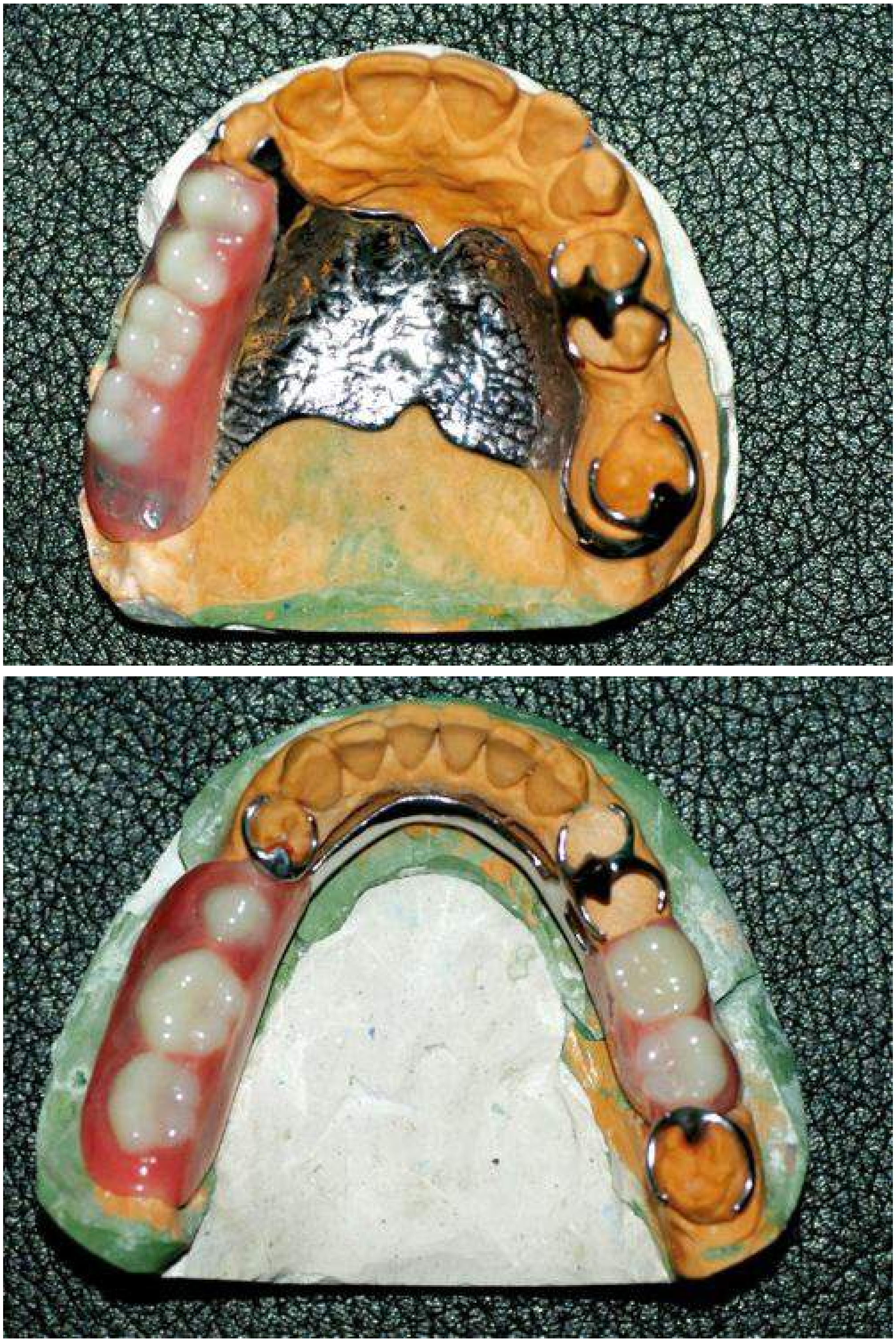


FIGURE 27.38 Processed maxillary and mandibular dentures.

SUMMARY

The fabrication of the removable partial denture involves a series of complex lab procedures combined with clinical aspects. A methodical process should be followed including a trial of the metal framework so that each step is evaluated. Though most clinicians may not be much involved in the lab procedures, it is imperative for them to understand the process so that errors can be identified and rectified easily.

CHAPTER 28

Denture insertion

CHAPTER CONTENTS

Introduction

This is the last step in the lengthy process of partial denture fabrication. It should be a scheduled appointment with proper time allocation. All aspects of the denture as discussed below should be thoroughly evaluated. That a patient could go through a period of discomfort and adjustment following denture insertion should be emphasized. This helps the patient to be mentally prepared for the same. The patient should be reminded of the various functions of the denture and the importance of follow-up and maintenance.

Objectives

1. To make the prosthesis comfortable to the patient.

2. To teach the patient how to use and care for the prosthesis.

3. To instruct the patient on how to maintain and preserve the remaining teeth.

4. To fit the denture base to the edentulous ridge.

5. To correct occlusal discrepancies.

6. To adjust retentive clasps if necessary.

7. To teach the patient to place and remove the prosthesis.

8. To instruct the patient in home care and in care of the prosthesis.

Appointment

Before scheduling the appointment the following points should be considered:

1. The appointment should be fixed in the first half of the day when the patient is mentally fresh. It also allows the patient to get back to the dentist later in the day if required.

2. The appointment should not be at the end of the week as the patient should be evaluated after 24 h.

3. Patient should not be in a position to transact an important business or attend social engagements immediately after the insertion.

Insertion procedure

The following sequence of procedures is practiced.

Inspection of prosthesis

1. The intaglio (tissue surface) of the prosthesis should be examined for blebs, bubbles, plaster and sharp ridges (Fig. 28.1).

2. The borders should be smooth and not knife-edged.

FIGURE 28.1 Inspection of prosthesis. Check the tissue surface and borders of the prosthesis.

If any of the above observation is detected, it should be corrected.

Checking fit of denture base

The denture should be seated gently in the patient's mouth along the determined path of placement. If any resistance to seating is felt, the prosthesis should be reinserted after application of pressure indicating paste to determine the area of resistance. The problem usually is with the acrylic resin base area as all other parts were checked during try-in of framework.

Pressure indicating paste

Commercially available pressure indicating pastes generally consist of zinc oxide powder combined with a medium consistency vegetable oil and other ingredients to improve odour and taste. The base paste of zinc oxide eugenol impression paste can also be used.

The tissue surface of denture base is completely dried and a thin coating of the paste is painted with stiff brush and denture inserted (Fig. 28.2). Paste is displaced from those parts of denture base in contact with soft tissue indicating the area of interference. Vulcanite burs are used to relieve these areas, a little at a time (Fig. 28.3). The process is repeated till the prosthesis goes into place without causing any discomfort to the patient.

FIGURE 28.2 Application of pressure indicating paste.

FIGURE 28.3 Trimming of interferences.

Common areas of interference

Maxilla: Lateral surface of tuberosity and labial plate of bone (if covered by denture base).

Mandible: Mylohyoid ridge area and areas buccal to premolars.

Checking extension

As has been seen in Chapter 24, denture base extension is important in providing retention, stability and support to the prosthesis. Hence, the peripheral extensions should not be arbitrarily reduced but should cover as much ridge as possible.

In class I and class II partial dentures, the extension of the peripheral borders is determined by performing border-moulding movements and checking for lifting of denture. In class III, the peripheral border should extend enough to ensure tissue contact so that food impaction is prevented under the denture base. To define area of overextension more accurately, disclosing wax is flowed over flange periphery and checked. Appropriate frenum relief should be provided.

All borders of the posterior denture base are well-rounded. The only areas where the flange is deliberately made thin are the distolingual extension of mandibular class I or II (to provide tongue space), distobuccal extension over the tuberosity of a maxillary class I or II (to provide freedom of movement of the coronoid process), and the leading edge of a maxillary or mandible posterior denture base flange.

In class IV dentures, after checking extension as above, margins of anterior flange are bevelled superiorly and laterally to blend into supporting soft tissue. The frenum should be relieved appropriately.

Occlusal correction

The aim of occlusal correction is to restore natural tooth contacts and establish the planned occlusal relationship. This can be accomplished by the following methods.

Intraoral correction

The contact of two opposing natural teeth is noted when patient closes in maximal intercuspation with partial dentures out of mouth. After insertion of the denture, the patient is instructed to close and the contact on the same natural teeth is verified using a Mylar strip (Fig. 28.4). If the strip can be pulled out easily, there is no contact on the natural teeth because of interference in the artificial teeth. The same is then identified using an articulating paper or tape, occlusal indicator wax or thin sheet of casting wax.

FIGURE 28.4 Mylar strip used to check interferences.

When articulating paper is used, the area of interference or high point will appear as a small bull's eye. A normal contact will appear as a solid mark of articulating paper's colour (Fig. 28.5). Same principles are followed as for complete dentures.

FIGURE 28.5 Articulating paper marks on occlusal surfaces of teeth showing bull's eye mark and a solid mark.

After interferences in centric occlusion are adjusted, interferences in eccentric relations must be corrected. After all corrections are made, fine Mylar strip/tape is used again to verify occlusal contacts between natural teeth (Fig. 28.6).

FIGURE 28.6 Mylar strip used to check interferences in eccentric relations.

The disadvantages of this method are difficulty in guiding the mandible into desired positions and giving a clear view of the interference especially posteriorly. The alternative is to remount the denture on an articulator and perform the occlusal correction.

Correction by remount procedures

Irreversible hydrocolloid impression is made in a slightly oversized impression tray with the partial denture seated in mouth. On removal of impression, the denture comes with it or it should be repositioned in the impression accurately. A cast is poured in dental stone. An interocclusal check record is used to record the jaw relation in centric. The cast is mounted using a facebow transfer, as the arc of closure of articulator should be the same as that of the patient. Occlusal correction procedures are carried out as before on the articulator (Fig. 28.7A and B).

FIGURE 28.7 **(A)** Impression made with denture and cast is poured, after which the prosthesis is remounted on the articulator. **(B)** Occlusal correction done using articulating paper.

Adjusting retentive clasps

Retention provided by clasps should be just adequate to maintain the denture in position and should not exert undesirable forces on the abutment. After all the other corrections are completed, the clasps are adjusted finally. Many patients find it difficult to insert and remove a prosthesis; hence, the clasp can be adjusted for maximum retention even after the initial adjustment phase.

Adjusting wrought wire clasps

Wrought wire clasps are adjusted to increase contact with tooth. Plier No. 139 is used for this purpose (Figs 28.8 and 28.9). A tapered cylindrical beak is opposed by flat surface of a triangular beak. The round beak of plier is placed on inner aspect of clasp at point marked where adjustment is needed. Denture is rotated with opposite hand towards round beak of pliers. Small adjustments are made at a time and denture is returned to mouth for observation and process is repeated until complete contact between tooth and clasp has been re-established.

FIGURE 28.8 Adjusting wrought clasp using a plier No. 139.

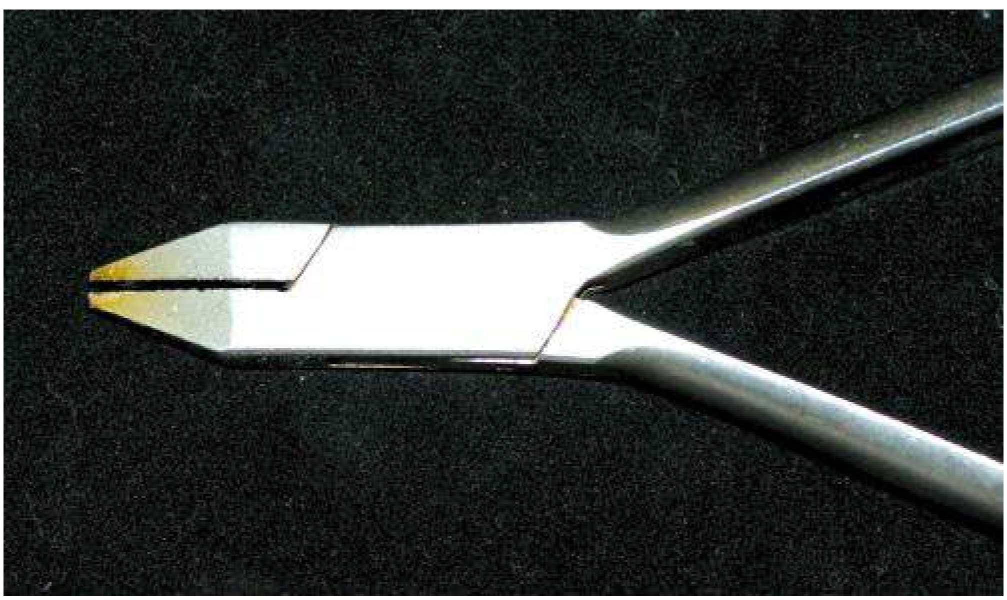


FIGURE 28.9 Plier No. 139.

Adjusting cast circumferential clasps

This clasp can be adjusted in one plane only – inward perpendicular to the flat surface of clasp or in the opposite direction. Technique is similar to that for wrought wire clasp and same pliers are used (Fig. 28.10).

FIGURE 28.10 Adjusting cast circumferential clasp using a plier No. 139.

Adjusting vertical projection clasps

Vertical projection clasps can be adjusted inward or outward perpendicular to flat side of approach arm. Procedure is again similar to the above two clasps and the same pliers are used (Fig. 28.11). The retentive finger of a 'T' or modified 'T-clasp' should rarely be adjusted to increase retention. The plier used for this is No 200, which is three beaked (Fig. 28.12).

FIGURE 28.11 Adjusting T-bar clasp using a plier No. 200.

FIGURE 28.12 Plier No. 200.

Instruction to patients

1. **Oral hygiene:** The importance of this should be emphasized. Home care measures like brushing and flossing should be demonstrated. Use of disclosing tablets to identify plaque may be demonstrated to enhance awareness. Brushing of teeth and prosthesis should be done after every meal and snack.

2. **Denture care:** It is very similar to the process described for complete dentures as explained in Chapter 13. A combination of soaking the denture in cleansing solution is recommended.

3. **Night wear:** To give opportunity for soft tissues to rebound and recover from constant pressure, the denture should be removed at night. Only in bruxers less damage is done to teeth with the dentures, but again a night guard is preferred.

4. **Placement and removal of denture:** This should be demonstrated. The patient is positioned in front of a wall mirror, while dentist inserts the denture. Dentist should explain how the clasps of the denture are placed on the appropriate abutments and then gentle seating pressure is applied. If the path of insertion is designed with a tilt, the same should be demonstrated. The patient should be warned about trapping of soft tissue of cheek or tongue between clasp and tooth, and how to prevent it. They should be advised against placing denture in mouth and seating it with biting pressure, as this damages the denture, teeth and soft tissues.

For removal of denture with cast circumferential clasp, the patient is instructed to place a fingernail or thumbnail under a buccal clasp arm on each side and push occlusally. In case of wrought wire clasp, this procedure will damage clasp. Hence, the patient is advised to hold the saddle area of denture between thumb and forefinger and again push occlusally. For bar clasp, pressure should not be given below approach arm. Instead the nonretentive tip of ‘T’ or modified ‘T-clasp’ is engaged and occlusal pressure given.

Written instructions should also be provided to the patient.

Postinsertion appointments

A follow-up after 24 h should be scheduled. Additional adjustments are performed every 72 h till the patient is comfortable. Maintenance visits should be scheduled every 6 months. The patients who are susceptible to dental caries and/or periodontal disease should be examined every 3 months.

Postinsertion problems

These can be categorized into the following.

Pain or discomfort

This can be due to the following reasons.

Soft tissue laceration or ulceration

This is due to:

1. Overextension of denture border

On examination, the affected area shows increased redness and translucency. The degree of overextension is checked by performing border moulding movements with denture in position.

Area of soft tissue irritation is circled with indelible pencil after drying with gauze (Fig. 28.13). Partial denture is seated in mouth, and the pencil mark is transferred to denture base (Fig. 28.14). Correction is done using vulcanite trimmers and arbour bands.

FIGURE 28.13 Area of irritation marked with indelible pencil.

FIGURE 28.14 Mark transferred onto denture.

Pain should reduce in 24 h after adjustment. The patient should be advised to use a hot saline mouthwash every 4 h till symptoms subside. If ulceration is severe, the prosthesis should not be worn until pain subsides.

2. Bruising of tissue by rubbing movement of denture during function

This is manifested as redness or erythema and may be due to:

1. **Roughness or blebs on tissue surface of denture base:** This is corrected and checked using pressure indicating paste.

2. **Occlusal prematurities:** This can be corrected intraorally or by using remount procedures as described earlier.

3. **Bony protuberances:** The denture base can be relieved under this area.

Tooth irritation

This may be due to:

1. Pressure caused by component of the prosthesis

The affected tooth is identified by applying pressure using finger. The most common component causing this problem is a clasp and can be corrected by adjusting the clasp as previously described. Other components can be checked by using disclosing wax and corrected accordingly.

2. Occlusal interference

This is the most common cause of discomfort to a tooth opposing a partial denture. As explained in this chapter, the same can be checked using articulating paper or occlusal indicator wax and corrected intraorally or using remount procedures.

Cheek and tongue biting

Cheek biting is due to:

1. Teeth positioned posteriorly with insufficient horizontal overlap.

2. Artificial teeth may have been set facially to the edentulous ridge.

3. Another contributing factor is when the natural posterior teeth have been missing for a long period, the buccinator muscle tends to sag into space created by the missing teeth and may cause cheek biting. After the prosthesis is worn for a time, the muscles will regain its normal tone and resume its original position and cheek biting will subside.

If teeth are positioned correctly, the problem can be solved by rounding the buccal cusps of the lower posterior denture teeth. Resetting the teeth may be necessary if teeth are not positioned correctly.

Tongue biting is due to placing the artificial teeth too far lingually which results in decreased tongue space. Recontouring the lingual surfaces of the mandibular posterior teeth is attempted, if tongue biting continues after the teeth have been reshaped, the artificial teeth will have to be reset.

Problems with phonetics

Although this is not frequently encountered with partial dentures, it may occur due to

1. Change in the contour of the anterior part of the palate.

2. Anterior teeth being positioned palatally.

3. Maxillary or mandibular premolar teeth positioned too far lingually or buccally.

The patient should be given 1–2 weeks to adapt to the denture. Reading aloud is one of the best methods to adapt. If patient does not adapt in this time, repositioning of the anterior teeth and recontouring of the anterior palate should be considered.

Problems with eating

Most patients, who complain of inability to eat, have had missing posteriors for a long time. Hence, the neuromuscular skills required to chew with posteriors are lost or get diminished. This generally requires only a period of time to return to normal. The patient should be reassured that the chewing pattern will eventually be reestablished. The patient should also be advised to avoid extremely tough, stringy, or sticky food during the early period of adjustment.

If the occlusal anatomy of acrylic resin or plastic teeth is not established correctly, additional sluiceways and grooves should be added to the occlusal surface to increase the cutting efficiency.

Food accumulation under denture

This is due to:

1. **Underextended denture flange:** This can be corrected by addition of autopolymerizing acrylic resin to the area.

2. **Flange covers an undercut:** Undercuts need to be blocked out to allow the denture base to fit. This leaves a space where food can accumulate. This is very difficult to correct and alveoloplasty during mouth preparation would be a better option.

Gagging

This is due to:

1. **Failure of maxillary major connector to adapt closely to hard palate:** The main cause for this is an improper impression or cast. If the major connector is made of acrylic resin, it can be relined. If it is made of metal, then the framework is repeated.

2. **Posterior overextension of maxillary major connector:** The posterior vibrating line is verified and the connector is trimmed accordingly.

3. **Alteration in vertical dimension:** Both an increase or decrease in vertical dimension can cause gagging. It needs to be verified and corrected.

4. **Overextended mandibular denture base:** Overextension both in length and thickness can cause gagging.

Loose dentures

The causes for loose dentures are as follows:

1**. Ill-fitting prosthesis:** A prosthesis which is not well adapted to the tissues is the most common cause. Prosthesis is repeated.

2. **Clasps not adapting properly:** Sometimes adjusting the clasp may solve the problem. If the clasp does not engage the undercut even

after adjustment, new clasp will need to be added.

3. **Deflective occlusal contacts:** This produces torsional stress which dislodges the denture. Correcting occlusion will correct the problem.

Summary

Denture insertion is an important appointment which establishes confidence in the patients that they can successfully function with a removable partial denture. Hence, sufficient time should be allocated for this step and an established sequence of procedures should be followed to make the denture comfortable for the patients. Postinsertion appointments should be scheduled without much delay to correct any problem. Otherwise the patients may lose interest in wearing the denture if they have problems which are not attended. Long-term recall and maintenance is also very important to preserve the existing tissues.

CHAPTER
29

Refitting and repair

CHAPTER CONTENTS

Introduction

These are procedures performed to restore an existing partial denture to its original function following wear, breakage or resorption. The decision to refit or repair must be made only after ensuring that the fit of the framework is not compromised as otherwise a new framework and denture must be made.

Refitting

The residual alveolar ridge undergoes resorption in response to the stress applied by the denture base. This results in a space between the denture base and the alveolar ridge. The impact of this is more pronounced in distal extension partial denture as the denture begins to rotate around the abutment teeth causing damage to the abutment and the tissues. In the tooth-supported partial denture, generally less resorption occurs as the support is more from teeth and the stress transmitted to the ridge is less. So the rotational stresses following resorption are also reduced. Also the mandibular partial dentures are more frequently relined as the stresses in the maxillary distal extension denture base are distributed over a greater area of support. Hence, in mandibular classes I and II, refitting the denture base is done routinely and the same should be informed to the patient even at the time of denture insertion so that they are prepared for the changes.

Need for refitting

This is determined by the following methods:

- Placing a thin mix of alginate in the denture base area, seating the denture in the mouth and maintaining its position until the alginate sets. The denture is removed from the mouth and evaluated. Two or three millimetres of alginate under the denture base are a good indication for the need to reline.

- Apply a seating force on the extreme distal end of the denture base and watch an anterior indirect retainer lift off its rest preparation. If the indirect retainer lifts two or more millimetres the patient can be considered a candidate for reline or rebase.

Depending on the severity of resorption and the amount of correction needed in the denture base, the following refitting procedures can be adopted.

Relining

Definition: The procedures used to resurface the tissue side of a removable dental prosthesis with new base material, thus producing an accurate adaptation to the denture foundation area.

Indications

1. Moderate loss of fit.

2. Loss of occlusion which is correctable.

3. Framework fit is good.

4. Denture base is in good condition and extension is adequate.

5. Teeth are not worn or excessively deteriorated.

Procedure

Two methods can be employed:

1. Conventional or laboratory reline

In this method, an impression is made of the residual ridge using the partial denture that needs to be relined. Heat cure acrylic resin is added in the laboratory using the conventional flasking method or the reline jig.

i. The resin denture base is prepared for reline impression by removing a uniform layer of resin from the tissue surface of the denture base as well as all the undercut areas. The resin is removed for two reasons:

- To create space in order to prevent displacement of the soft tissues by the impression material.

- To create an uncontaminated interface between new and old resin.

This is used as a special tray to make an impression of the residual ridge.

ii. The choice of impression material depends on the type of soft tissue:

- Zinc oxide eugenol impression material is used when mobile tissue is present on the crest of the ridge.

- Polysulphide rubber, silicones or mouth temperature wax is used on dense firm edentulous ridge.

- Tissue conditioners may also be used in both situations but can distort easily.

iii. The impression material is mixed, loaded onto the trimmed denture base and inserted in the patient's mouth. Maintenance of the tooth-framework relationship during the setting of the impression material is very important. The framework must be held against the abutment teeth until the material sets. Thin extensions of impression material must be removed as soon as the impression is removed from the mouth. Small defects in the impression can be corrected with mouth temperature wax.

iv. The impression is now sent to the laboratory where heat cure acrylic resin replaces the impression material using the flasking technique or reline jig as described for complete dentures in Chapter 15.

2. Chairside reline

In this method, autopolymerizing acrylic resin is used to reline the denture base directly in the mouth.

i. The denture base is prepared as described in the previous technique. Autopolymerizing acrylic resin is mixed according to the manufacturer's instructions. Care must be taken to shift polymer into the monomer to prevent trapping air into the mixture which will result in a porous resin base.

ii. The external surface of the denture base is covered with an adhesive tape to prevent the resin from adhering to the outer surface and teeth. The inner surface is coated with monomer and the resin is applied with a spatula. Again care must be taken not to trap.

iii. The denture is held in the mouth and removed after the initial set as recommended by the manufacturer. Resin extending beyond internal finishing line must be trimmed while the resin is still in dough stage.

iv. The denture is reseated while the resin is still plastic and held in place, again as per the time recommended by the manufacturer.

v. It is then removed and placed in a pressure pot for final curing.

vi. Mouth curing resins will completely polymerize in 12–15 min from the start of mix. Regular finishing and polishing of acrylic resin is done.

Advantages

It is a one-step procedure, hence performed quickly.

Disadvantages

1. The autopolymerizing resin is porous and not colour stable; therefore, it is indicated for use in temporary situations only.

2. Patient discomfort due to exothermic heat if material is not handled properly.

Rebasing

Definition: The laboratory process of replacing the entire denture base material on an existing prosthesis (GPT7).

Indications

1. Moderate loss of fit.

2. Loss of occlusion which is correctable.

3. Framework fit is good.

4. Teeth are not worn or excessively deteriorated.

5. Denture base has deteriorated or flanges need alteration due to:

   i. Underextension of denture flange

   ii. Fracture of denture base

   iii. Staining or discolouration of denture base

Procedure

Rebasing is always only a laboratory technique as bulk of the denture base material is replaced by a new resin.

- The denture base is relieved and trimmed 2 mm short of borders.

- Modelling plastic/green stick compound is added in small increments and borders are moulded.

- After the border moulding, a final impression is made with a suitable impression material – zinc oxide eugenol impression paste, regular body or monophase elastomeric impression material or fluid wax, ensuring that the framework is related to the teeth as for relining.

- The impression is corrected for defects and cast poured.
- Flasking is done in a conventional manner as for the reline procedure and subjected to a brief boil out procedure to soften the modelling plastic and ease separation of the flask.
- When the flask is opened, the remaining denture resin can be ground away just short of the denture teeth to allow the majority of the rebase to be in new resin. When anterior teeth are involved, the junction of old and new resin should not be visible when patient smiles. Shaping the old denture border to finish in a butt joint with the new, will greatly reduce this visible junction
- The denture is packed, cured, finished and polished.

Reconstruction

Here the entire denture base along with the teeth is replaced. The framework should have a clinically acceptable fit.

Indications

1. Denture base is extensively damaged.

2. Denture teeth have lost their functional and aesthetic value due to wear and/or breakage.

3. Occlusal plane is completely lost involved in a repair situation and the framework has an acceptable fit, the partial denture can be reconstructed.

Procedure

- The denture base and teeth are completely removed by heating the resin from the tissue side while holding the framework in a cotton or artery forceps. It is then sandblasted to remove all traces of resin and polished.

- The framework is seated in the mouth and an alginate impression made over it. The framework must be picked up by the impression and a cast is poured in dental stone.
- After the impression is separated from the cast, the framework is carefully removed from the cast by prying it along the inferior border of the major connector, clasp arms as purchase points.
- The edentulous area in the cast is examined to determine the need for an altered cast impression (Chapter 26).
- The partial denture is then articulated and completed routinely.

Repair

It can be classified into two types:

1. Simple – accomplished without the need for impressions.

2. Complex – requires an impression and cast.

Simple

Denture base repairs

- If the broken denture segments can be accurately positioned, they are cleaned, dried and joined with sticky wax while held in original relationship. Dental stone is poured against the tissue surface to preserve the relationship.

- The denture is removed after the stone has set and the sticky wax eliminated.

- The broken segments are dovetailed along the fracture line to provide retention for the new resin (Fig. 29.1).

- Cast is painted with separating medium, pieces of denture reassembled and held in position with sticky wax.

- Autopolymerizing resin is added to the prepared fracture line by sprinkle on technique and placed in a pressure pot to complete the curing.

- If the broken segments are lost or cannot be approximated, procedure described for rebasing should be followed.

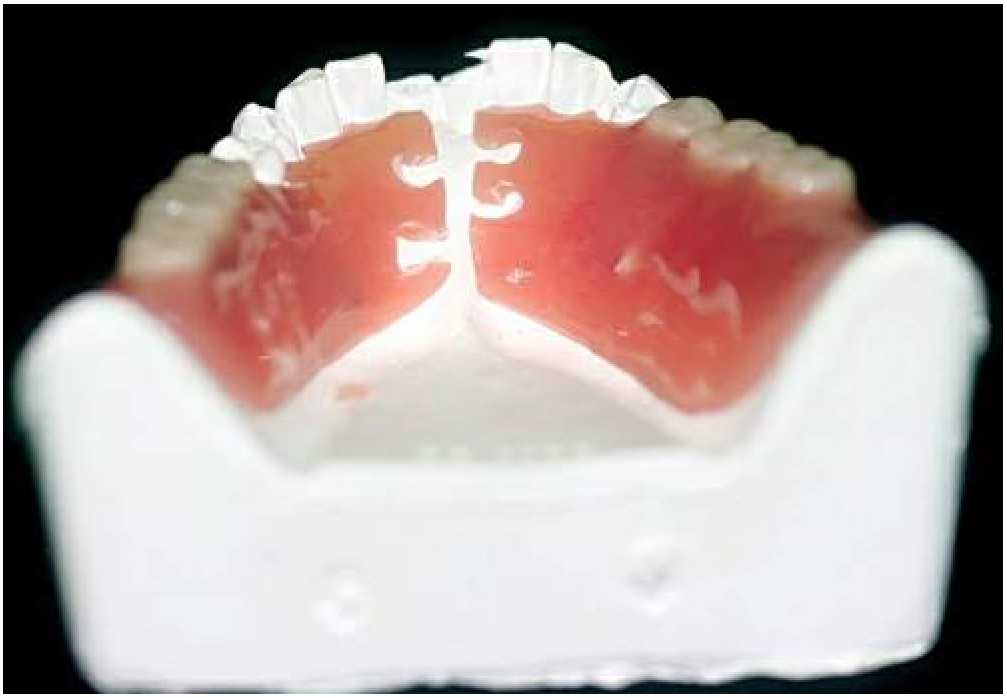


FIGURE 29.1 Denture base repair. Broken fragments joined, cast poured, dovetailed and repaired with autopolymerizing resin.

Replacement of denture teeth

- An accurate opposing cast is needed and a jaw relation record is made if required (Fig. 29.2).
- Acrylic denture tooth of same mould and shade is selected and fitted into the missing tooth space.
- Trimming of denture base to create space is made from the lingual aspect and the labial (or buccal) surface is not touched. The ridge lap area is relieved to allow at least 2 mm of repair resin to attach the tooth to the base.
- The tooth is attached to the adjacent denture teeth or framework with sticky wax.
- Autopolymerizing denture resin is added to the gingival repair

space using a brush in small increments. The repair is completed by curing in a pressure pot followed by finishing and polishing.

- The completed repair is articulated with the opposing cast and occlusal adjustments are performed.
- If a number of teeth need replacement or associated denture base areas are also missing, procedure described for rebasing should be followed.

FIGURE 29.2 Denture teeth replacement. Tooth articulated and acrylic denture tooth fixed with autopolymerizing resin.

Repair of porcelain facings

Broken porcelain facings are completely replaced by cementing a new facing of the same shade and mould intraorally. If chairside time is to be reduced, a cast can be made with the framework and the facing is cemented to the backing in the laboratory.

Repair of tube tooth

- Broken tube tooth is replaced by waxing a replacement onto framework, flasking the mould with appropriate shade of acrylic resin and curing it. The new tooth is then cemented on the denture.

- Acrylic denture tooth can also be hollowed out to fit the post and cemented with thin mix of autopolymerizing resin.

Complex

Metal repair

Metal repair can be discussed as the repair of the following:

1. Clasp repair

- The most common metal repair is the addition of a retentive clasp arm.

- To perform the repair, the framework is picked up with an alginate impression and a repair cast is poured to get the exact framework-to-tooth relation.

- To repair the retentive arm of a cast circumferential clasp or bar clasp, the simplest method is to contour and attach a wrought wire to the denture base acrylic. A more complex procedure will be to electric solder the wrought wire to the framework minor connector.

- A more definitive method is to remake the entire clasp assembly using the same procedures for making any framework, and attaching the cast clasp to the frame by soldering.

2. Major and minor connector

- Breakage of major connector happens rarely, except for the lingual bar major connector which breaks at its junction with retentive latticework. A new segment is cast and attached to framework with solder. The same can be done following breakage of minor connector.

- Major and minor connectors also need repair when the denture has been distorted and does not completely and passively seat on the abutment teeth.

- The framework is sectioned with a carborundum disc and the sections are seated in the mouth. The sections should have adequate fit or the entire framework should be remade.

- A plaster or resin index is used to record the relationship of the sectioned parts in the mouth. The sectioned denture with the index is sent to the laboratory where they are soldered and finished.

- Following loss of number of teeth, denture base minor connector may need to be added to the framework. An accurate repair cast with the existing partial denture is made along with an opposing cast for articulation. Loops of 18 gauge wire can then be soldered to the framework for fabricating the minor connector. Alternately, sections of standard retentive mesh or latticework can also be soldered to the framework. An internal and external finishing line is mandatory.

3. Occlusal rest

- Insufficient space provided during the rest seat preparation is the main cause of fracture of occlusal rest.

- A repair cast is poured with the existing framework after preparing the tooth with adequate space for the rest. The new rest is then waxed and soldered to the framework.

Adding teeth to denture following loss of natural teeth

- A repair cast of the remaining teeth is obtained by making an alginate impression over the partial denture after the base is redefined with modelling plastic in the area of the missing teeth. An opposing cast with a centric occlusion record (if required) is also made.

- If the extracted tooth is adjacent to the denture base, it can be simply attached to the resin base without any metal retention.

- If the extracted tooth is not adjacent to resin base but adjacent to a major connector, a wire loop or retentive mesh can be soldered to the connector to provide retention.

- If the major connector does not involve the area of the tooth to be added, the repair cast should be duplicated, major connector extended by waxing and the extension is soldered to the existing framework. Remaking the entire framework may be ideal instead of this complicated repair.

- If an abutment tooth is extracted, usually a new design and framework is needed. Temporarily, however, a rest is prepared in the adjacent tooth and a repair cast is made after removing the old clasp. A new clasp is waxed to the prepared abutment and soldered to the existing framework. A denture tooth is added to restore the missing tooth.

Replacing a restoration under a clasp

- Direct restorations can be fabricated under a clasp provided the damage to abutment is minor.

- Mostly indirect restorations like an inlay or crown may be needed to restore the abutment.

- Tooth preparation is similar to any routine crown preparation with additional preparation in the occlusal rest area.

- An impression is made using elastomeric impression material, with the denture in the mouth, and a repair cast is fabricated.
- Wax pattern for crown is fabricated to conform to the clasp assembly of the partial denture. The same is cast and veneered with porcelain as indicated.

SUMMARY

Whenever prosthesis is damaged or needs refitting, the decision to remake the same should always be kept in mind. The time, effort and economy of any refitting repair procedure must be compared to that required to make a new denture and an appropriate decision should be taken. Some of the simple procedures mentioned can provide adequate extension to the life of the prosthesis and should always be considered first.

CHAPTER 30

Forms of removable partial dentures

CHAPTER CONTENTS

Introduction

The conventional extracoronal clasp-retained removable partial dentures have been described previously in this section. Other forms are also available depending on the indication, material and method of fabrication. These can be discussed under the following six categories:

1. Temporary

2. Immediate

3. Variations of conventional

4. Removable partial overdentures

5. Implant supported

6. Attachment retained

7. Miscellaneous

Temporary removable partial dentures

These are to be worn only until a more definitive prosthesis can be constructed. These are of three types according to their indication for use:

1. Interim

2. Transitional

3. Treatment

Interim partial denture

Definition: A prosthesis designed to enhance aesthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive dental prosthesis (GPT7).

Indications

1. Young patients with anterior tooth loss when fixed partial denture cannot be given because of large pulp chambers of the abutment teeth.

2. Young patients with posterior tooth loss, to maintain the space before definitive treatment.

3. When poor health limits lengthy appointments needed for definitive prosthesis, especially in geriatric patients.

4. For financial reasons.

5. Patients who do not have time at the moment for definitive prosthesis.

Fabrication

Interim removable partial dentures are constructed with acrylic resin denture base (with no metal) and acrylic resin denture teeth. The following procedures are involved in fabricating an interim removable partial denture.

Impressions, master casts and jaw relations

- Accurate irreversible hydrocolloid impressions are made for both the arches using conventional methods (Fig. 30.1). Extension to record the peripheral roll of the border at least in the edentulous areas is necessary.
- Impressions are poured in dental stone using double pour technique – described in Chapter 22 (Fig. 30.2).
- The shade and teeth should be selected using the remaining natural teeth as reference.
- A temporary record base is made in baseplate wax or shellac baseplate and occlusal wax rims are attached to the edentulous areas. If the casts cannot be hand articulated in maximal intercuspation, a tentative jaw relation record is made (Fig. 30.3) and the casts are mounted on a nonadjustable articulator (Fig. 30.4).
- The temporary record base is not fabricated if jaw relation record and try-in is not required and the denture is to be processed in autopolymerizing acrylic resin. We can then directly proceed with clasp forming followed by arrangement of artificial teeth and processing.

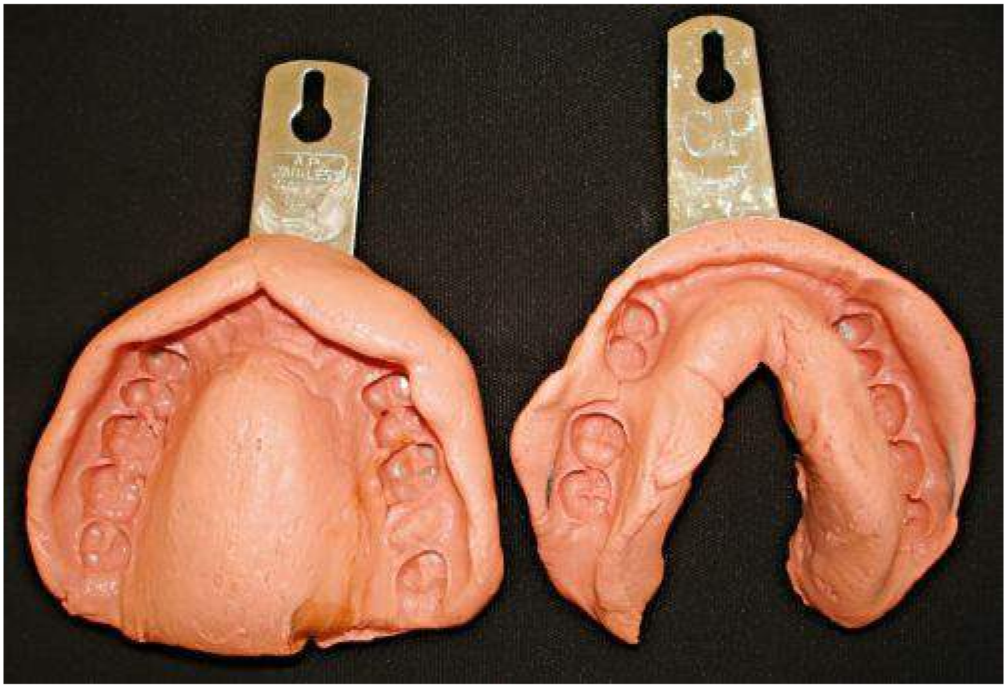


FIGURE 30.1 Impressions made with irreversible hydrocolloid.

FIGURE 30.2 Master casts poured in dental stone. **(A)** Maxillary and **(B)** mandibular.

FIGURE 30.3 Jaw relation recorded in MIP (maximal intercuspal position).

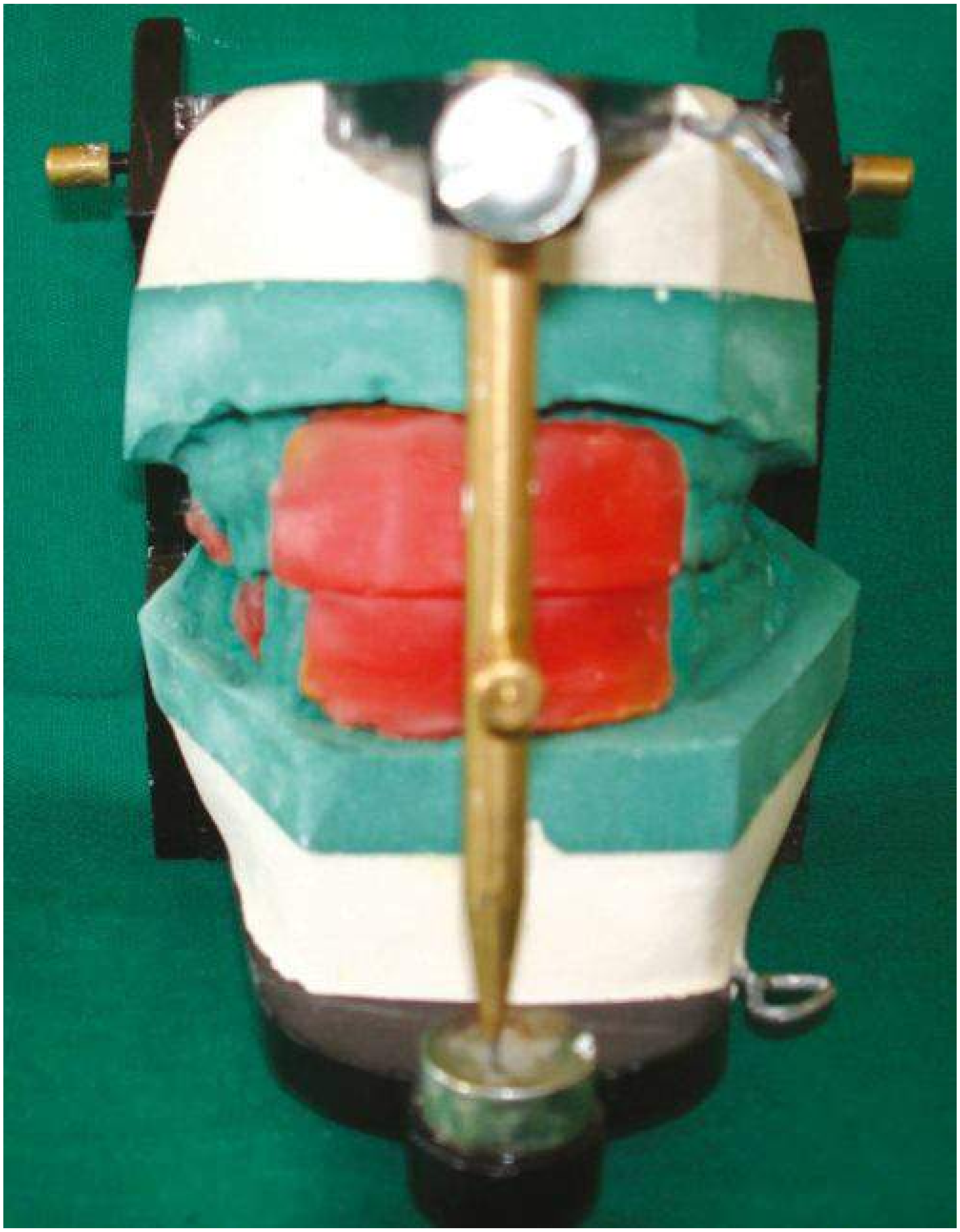


FIGURE 30.4 Casts articulated.

Retention

Natural retentive factors present in the patient's mouth should be considered first and only if this is inadequate clasp retention should be planned.

Following are some of the natural sources of retention:

1. **Frictional resistance between the denture and tooth surface:** Lingual surface of posterior teeth and interproximal embrasures.

2. **Interfacial surface tension obtained by close adaptation of the denture to the tissues:** It is directly proportional to the area covered by the denture.

3. **Contour of palatal vault:** Deep vault, more retention.

4. **Occlusion:** Deep bite may reduce the stability of removable partials replacing maxillary anterior teeth.

5. A well-fitting labial flange.

6. Neuromuscular coordination of patient's tongue, cheek and lips.

Only if the natural retentive factors are extremely unfavourable, clasps are considered.

Fabrication of retentive clasps

- Cast should be surveyed to locate the desired undercuts (Fig. 30.5).
- Wrought wire of 0.040 inch diameter is used. The clasp is fabricated using orthodontic pliers.
- An appropriate length of the wire is cut from the spool. One end is adapted onto the abutment tooth engaging the undercut as desired (Fig. 30.6). The nonretentive end to be inserted into the denture base is coiled upon itself so that it will be slightly out of contact with the lingual or palatal surface of the cast (Fig. 30.7). This allows the denture base acrylic resin to flow beneath the wire and secure it.
- Occlusal clearance should be checked so that grinding the natural teeth to accommodate the clasp later can be avoided (Fig. 30.8).
- If undercuts are not present for conventional clasp, ball clasp can be

used.

- The clasp is then attached to the buccal surface with sticky wax so it is not disturbed during further procedures involved in denture fabrication (Fig. 30.9).

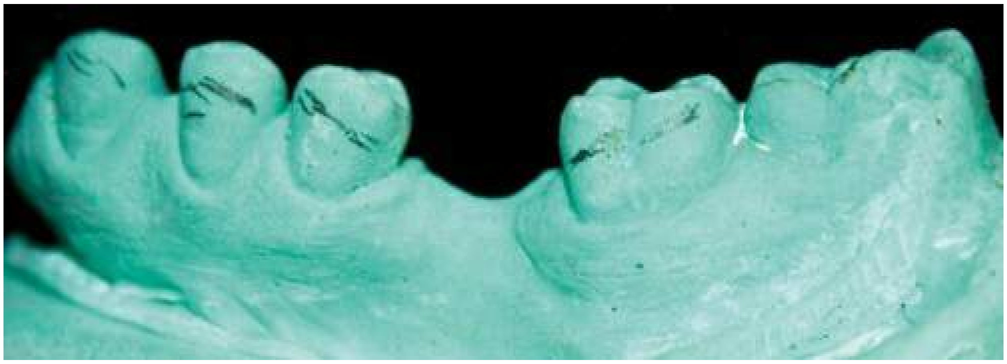


FIGURE 30.5 Retentive undercuts marked on abutments.

FIGURE 30.6 One end adapted on abutment engaging undercut.

FIGURE 30.7 Other end, coiled, slightly out of contact with lingual surface to provide space for denture base.

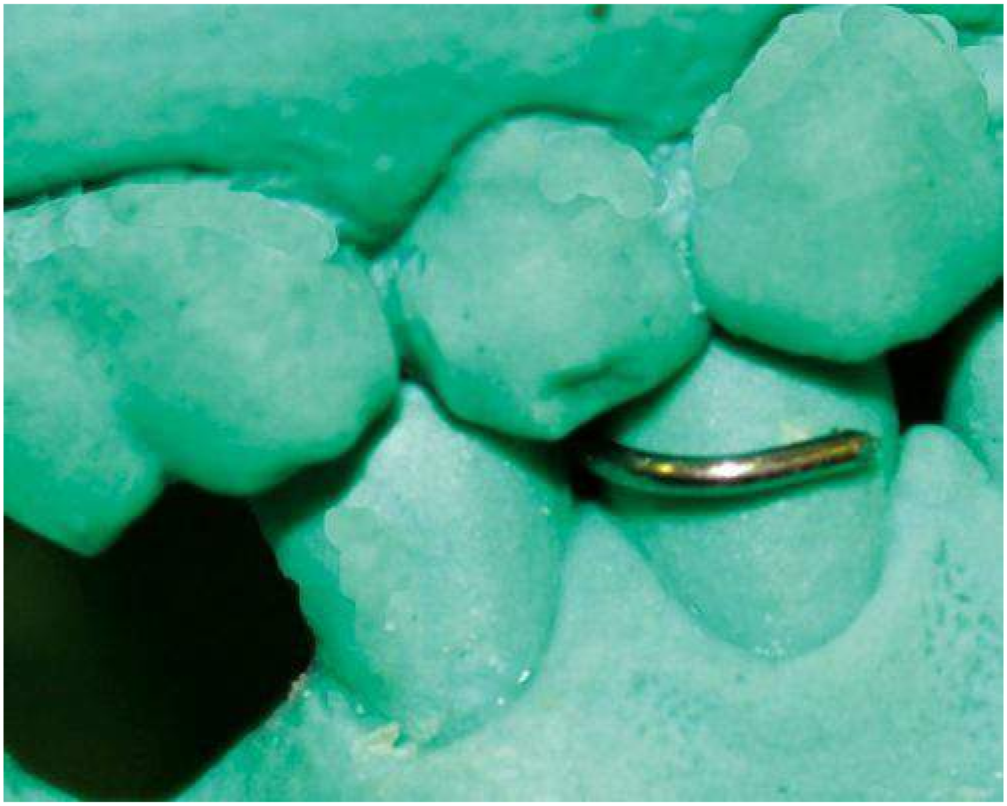


FIGURE 30.8 Occlusal clearance verified.

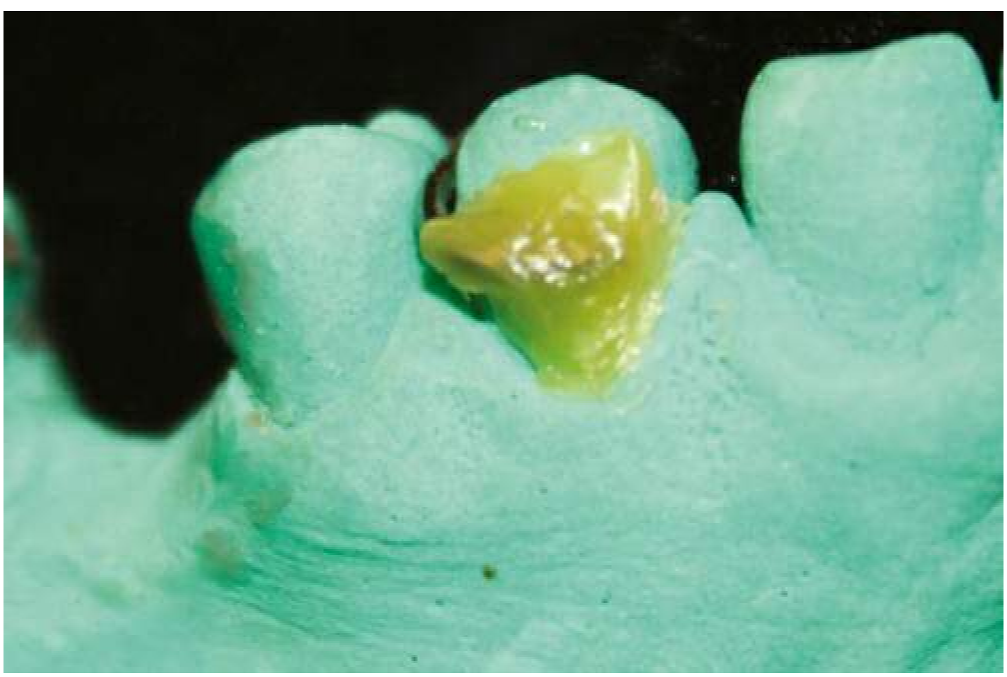


FIGURE 30.9 Clasp attached with sticky wax.

Arranging the artificial teeth

- Artificial denture teeth are selected by considering the available mesiodistal and occlusogingival space and by comparing the same teeth on other side. The advantage of using plastic teeth is that it can be reshaped easily. If all anterior teeth are to be replaced, selection of teeth as for complete denture is followed and it is important to maintain the midline. In selecting the posterior teeth, consideration should be given to restoring occlusion and function.

- If there is minimum or no resorption of the edentulous ridge, the neck of the artificial teeth is contoured to fit directly on the labial aspect of residual ridge with no labial flange. To ensure intimate contact, the crest and labial flange of cast can be trimmed lightly. Such a denture is called 'gum fit denture'.

- If there is adequate space due to resorption of residual ridge, the ridge is covered with the denture flange and the cast need not be trimmed.

- Once the teeth are set (Fig. 30.10), an aesthetic try-in is performed if anterior teeth are involved (Fig. 30.11).

- Following teeth arrangement and try-in, if retention by clasp is desired the same should be formed on the cast after removing the temporary record base and artificial teeth. The temporary denture base is then modified to fit the clasp.

- The denture is then processed using an autopolymerizing or heat cure acrylic resin as denture base material.

FIGURE 30.10 Artificial teeth arranged.

FIGURE 30.11 Try-in.

Autopolymerizing acrylic resin as denture base

- When autopolymerizing acrylic resin is to be used as the denture base material for the temporary denture, a stone matrix of 8–10 mm thickness is formed to maintain position of artificial teeth during processing (Fig. 30.12).
- V-shaped notches are made in the master cast, to ensure that matrix can be repositioned accurately (Fig. 30.13).
- Master cast is soaked in slurry water and a gypsum separating medium is painted over the cast where the matrix will contact the cast. A thick mix of dental stone is placed over the labial surface of the cast and teeth. After setting, the matrix is gently removed from the cast.
- Temporary record base used to support the denture teeth is removed and cast flushed with boiling soap water. Separating medium is painted on warm cast.
- Retention holes or diatorics are drilled in ridge lap portion of acrylic

resin denture tooth to provide mechanical retention to the denture base (Fig. 30.14).

- Matrix and teeth are reassembled on the cast and fixed with sticky wax (Fig. 30.15). Undercuts to path of insertion are blocked with wax.
- Autopolymerizing acrylic resin is added using the sprinkle on technique to form the denture base (Fig. 30.16).
- The extension of the base for maxillary temporary partial denture should be limited to a horseshoe configuration with acrylic resin contacting the lingual surfaces of the remaining natural teeth. If anterior teeth are to be replaced, the denture base is extended till first molar to enable sufficient soft tissue contact.
- For mandibular temporary partial dentures, the denture base is extended lingually without encroaching the movable soft tissue. Posterior extension should be up to the first molar area to enhance stability and distribute forces. After the complete denture base is formed, it should be allowed to polymerize in a pressure pot under 20 pounds of pressure for 20 min.
- If a pressure pot is not available, the cast is placed in a closed container or a rubber bowl inverted over the cast during polymerization, to prevent porosity.
- After polymerization, the occlusion is checked without removing denture from the cast as described in Chapter 10.
- Following occlusal correction, the denture base is removed from the cast, finished and polished as described in Chapter 27.
- This procedure is normally done only if 1 or 2 teeth are to be replaced.

FIGURE 30.12 Stone matrix fabricated to maintain position of artificial teeth.

FIGURE 30.13 V-shaped notch on cast.

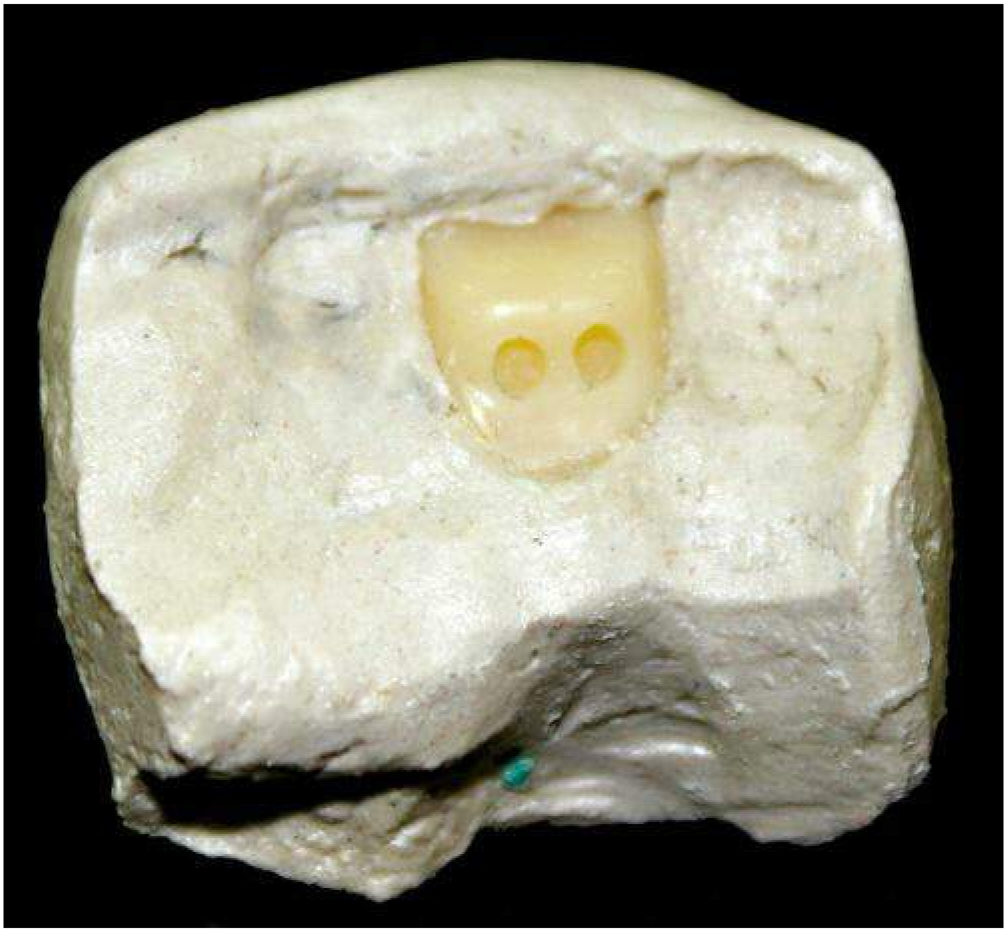


FIGURE 30.14 Diatoric holes drilled in ridge lap portion of artificial teeth.

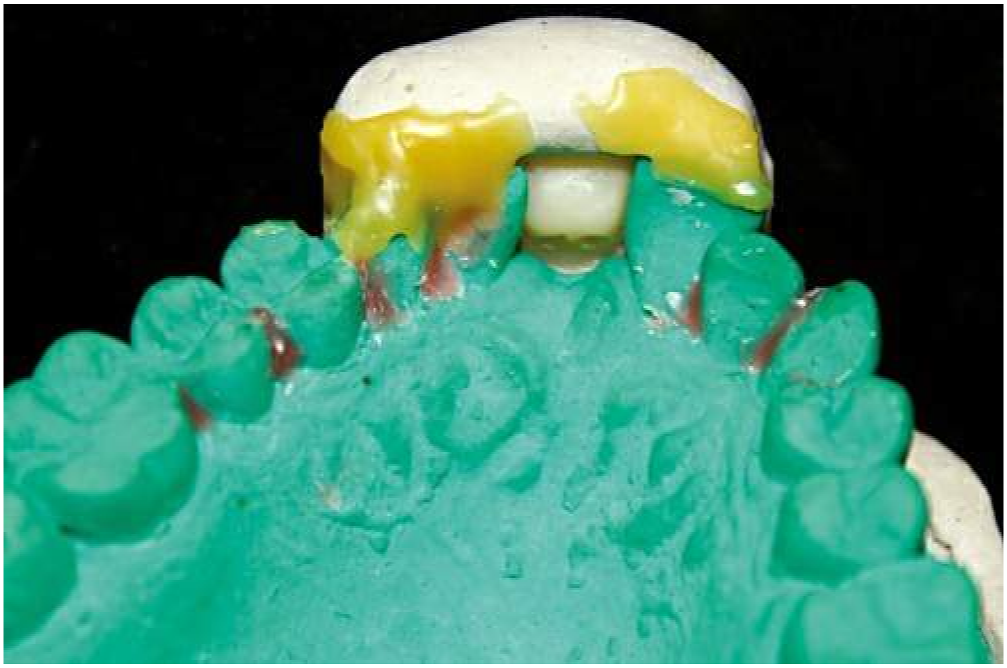


FIGURE 30.15 Sticky wax used to position the matrix and artificial teeth.

FIGURE 30.16 Autopolymerizing resin added to form the

denture base.

Heat cure acrylic resin as denture base

- A matrix is not required if a heat curing acrylic resin is used as denture base material.
- Following try-in and fabrication of clasps, the denture base is waxed, master cast is flasked and processed with heat cure resin, as described for complete dentures (Figs 30.17–30.20).

FIGURE 30.17 Flasking.

FIGURE 30.18 After dewaxing.

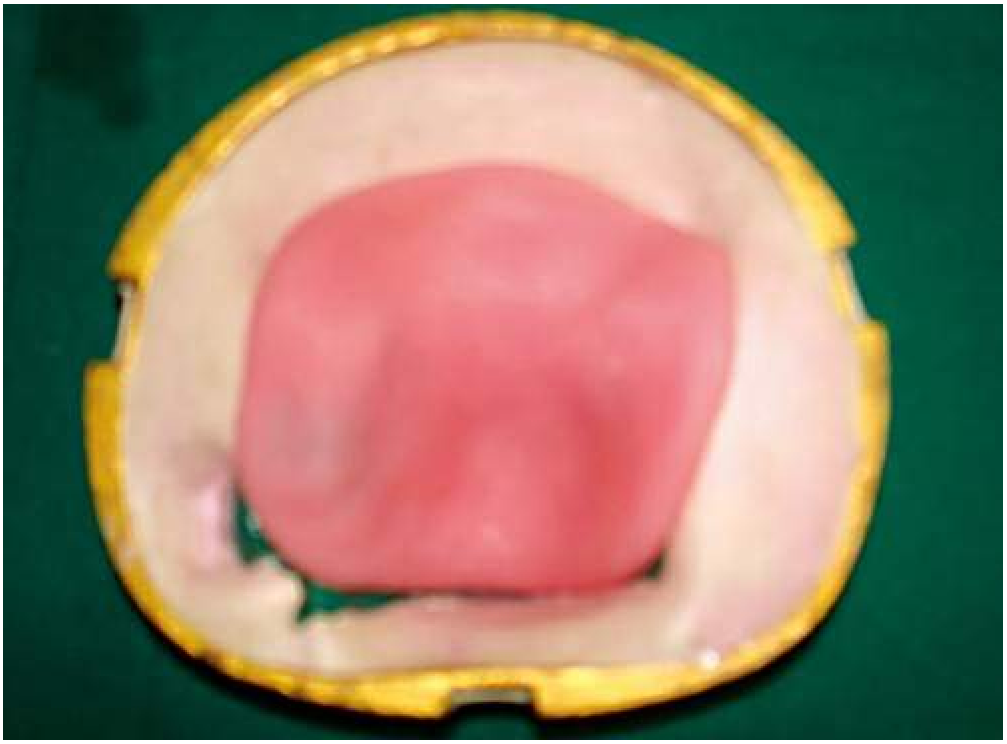


FIGURE 30.19 Packing heat-cured acrylic.

FIGURE 30.20 Finished interim partial dentures.

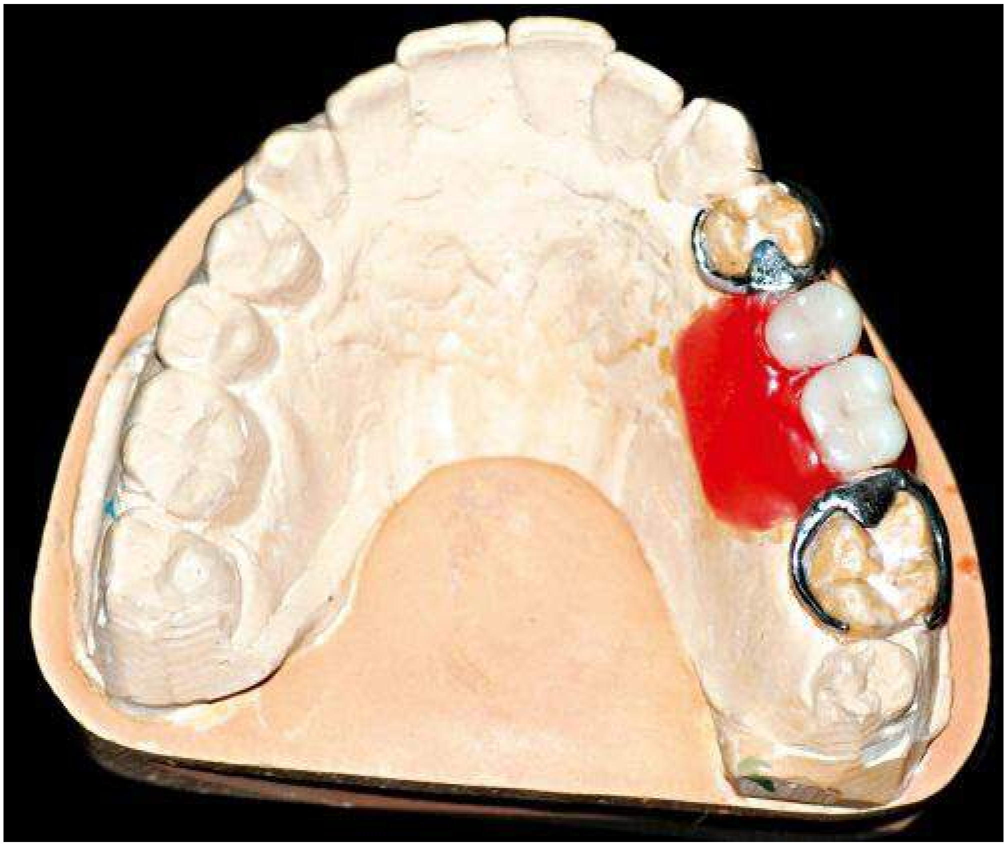


FIGURE 30.21 Unilateral denture.

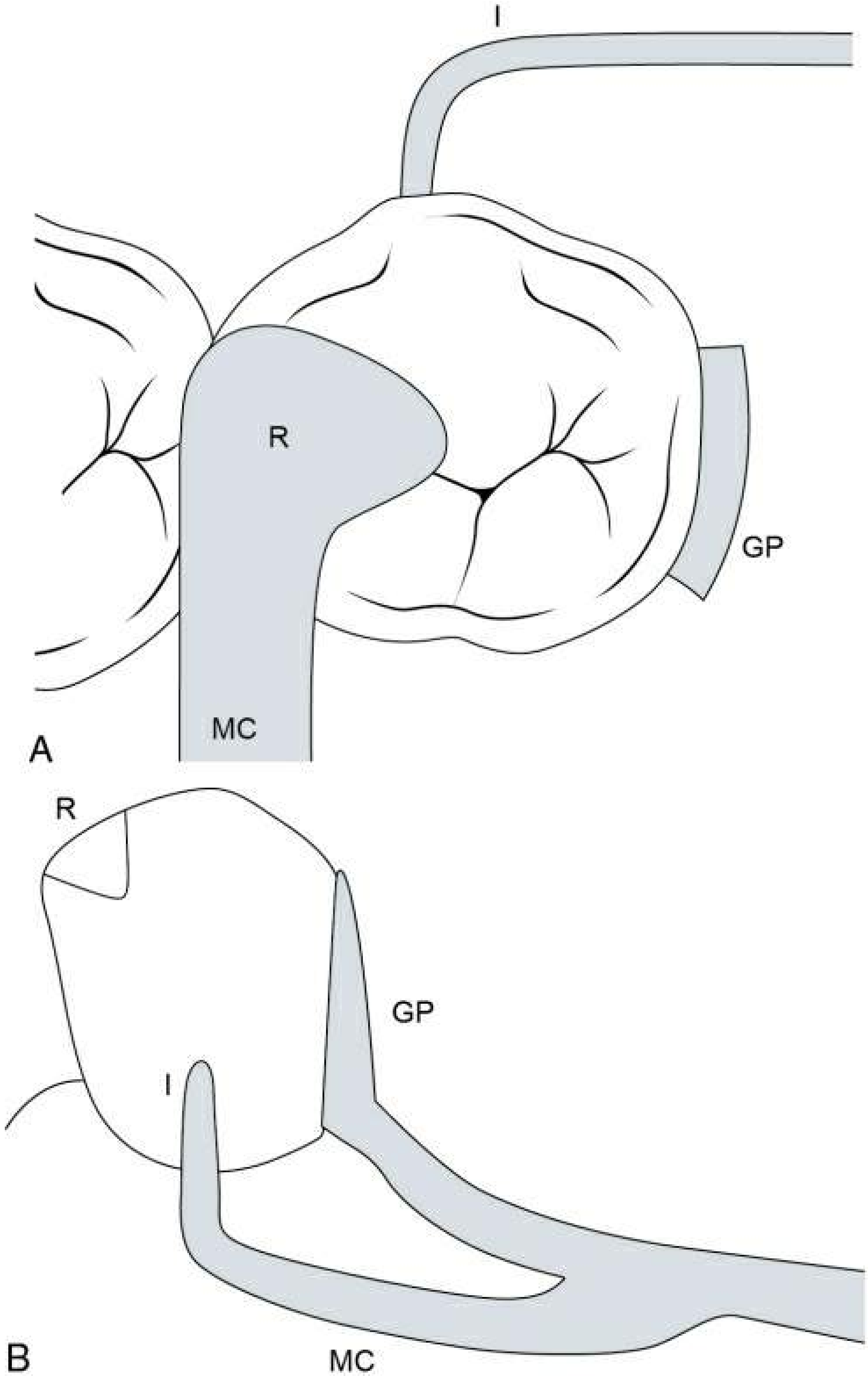


FIGURE 30.22 I-bar removable partial denture. R, rest; MC, minor connector; GP, guiding plane (proximal plate); I, I-bar clasp. **(A)** Occlusal view and **(B)** buccal view.

Denture insertion

- Pressure indicating paste is painted on the fitting surface of the denture and complete displacement of the paste indicates the areas to be relived. When checking for interference during seating, the denture should be inserted with light pressure. If heavy pressure is applied, the denture will be forced into the undercuts and removal may become difficult. The interfering areas are trimmed minimally with vulcanite burs or acrylic stones and the process is repeated until the denture seats without interference.

- When anterior teeth are replaced, the goal of occlusion should be to keep the teeth free of occlusal contact in centric occlusion and have light contact in eccentric relations.

- In posterior replacements, light contact of the artificial teeth in centric is preferred, with the natural teeth contact guiding the occlusion.

Instructions to patient

- Denture should not be worn continuously and should be removed during sleep.

- Care and cleaning is similar to complete dentures.

- Recall appointments and plan for definitive prosthesis should be outlined.

Transitional partial denture

Definition: A removable dental prosthesis serving as an interim prosthesis to which artificial teeth will be added as natural teeth are lost and that will be replaced after postextraction tissue changes have occurred (GPT7).

Indications

In periodontally affected teeth or teeth with poor prognosis, where immediate extraction of all the affected teeth is not indicated for physiological or psychological reasons.

Teeth may be extracted as symptoms arise and the extracted teeth are added to the denture to provide adequate function.

Fabrication

- The denture base is normally made of acrylic resin and the procedures involved are similar to that of interim denture.

- If the denture is planned to serve for a long period of time, a cast metal denture base is planned. Procedures are similar to fabricating any cast partial denture. The major connector should be designed such that teeth may be added to the existing denture. For this, metal retention loops may need to be soldered to the major connector as teeth are extracted and artificial denture teeth are processed on the loops. Lingual plate major connector is recommended for the mandibular arch.

- For adding teeth to an existing denture, refer to the section on 'Adding teeth to denture following loss of natural teeth' in Chapter 29.

Treatment partial denture

Definition: A dental prosthesis used for the purpose of treating or conditioning the tissues that is called upon to retain it (GPT7).

Indications

1. Tissue conditioning

- The partial denture is used as a vehicle or tray to carry tissue treatment material for treating abused tissues.

- Excessive forces on the soft tissues caused by pressure from denture base can cause adverse soft tissue reaction. The soft tissue reacts in the form of erythema, marginal gingivitis or hyperplasia. The condition is usually exacerbated by the presence of poor oral hygiene.
- Tissue treatment material is also referred to as tissue conditioner. It is a soft material applied temporarily to the tissue surface of the denture. Its elasticity lasts for a week, so it should be replaced in 4–5 days. For more details refer to Chapter 15 in the section on Complete Dentures.
- Mode of action:

○ Evenly distributes the occlusal load over the tissues.

○ Produces an intimate tissue contact massaging the soft tissues.

○ Reduces the inflammation by increasing blood flow to the abused tissues.

- Preparing the treatment partial denture:

○ If an existing partial denture is to be used, the tissue surface over the affected area is trimmed 2 mm to provide space for the tissue treatment material.

○ If a new partial denture is to be made, the procedure is similar to that of an interim denture, except that a spacer of 2 mm is created over the affected region by adapting spacer wax before acrylizing the denture base.

- Procedure for using tissue conditioner:

  - A separator (supplied by the manufacturer) is applied to the external surface of denture.

  - Tissue conditioner is mixed to a creamy consistency and applied to the tissue surface of denture base evenly with a cement spatula. Working time is usually 1 min.

  - Denture is seated in the mouth maintaining light pressure and border moulding is performed.

  - Patient is asked to occlude by gently biting on the posterior teeth and this is maintained for 4–5 min.

  - Denture is removed, voids filled with new material. The exposed denture base areas are trimmed, space created, new material added and inserted in mouth.

  - Once a smooth layer of the conditioning material is obtained, denture is washed under cool running water.

  - Excess material is trimmed with a scalpel blade or scissors and smoothed.

- ○ Patient is advised to use the denture at all times except while cleaning after meals. Details of care are described in the section on Complete Dentures.

2. To establish a new vertical dimension

- When an increase in vertical dimension is planned with restorations, resin occlusal rims and overlays on remaining natural teeth can be added to an existing metal partial denture or new acrylic denture to determine the acceptable level of increase for the patient. The resin can be readily altered to increase or decrease the height of occlusion till the clinically acceptable level is established for the patient.
- Procedure:

- ○ A facebow transfer is used with a semi-adjustable articulator.
- ○ The maxillary and mandibular casts are articulated with an interocclusal wax record at the established vertical dimension.
- ○ Wax occlusal rims are added to the edentulous spaces and the remaining natural teeth are waxed in the form of overlays, attached to the denture base. It is then processed in acrylic resin.
- ○ The denture is inserted and vertical dimension is checked and corrected till the appropriate vertical

dimension is established for the patient.

○ A full mouth rehabilitation is with definitive fixed or removable prosthesis is then planned at this vertical dimension.

3. As a surgical splint

- Denture base of removable partial dentures can be used as surgical splint to protect postoperative surgical sites in the oral cavity and promote healing.

- Most often it is used following surgical removal of palatal and lingual tori.

- The base may be lined with tissue conditioning material to provide intimate contact and act as a soothing surgical dressing.

- Procedure:

○ Impression is made with irreversible hydrocolloid. A mock surgery is performed on the cast to replicate the contour of the site after surgery by scraping to the desired contour.

○ Sprinkle-on method is used to fabricate an autopolymerizing acrylic resin splint.

○ Retention is obtained by clasp or holes are provided in the interproximal extension to suture the denture to the remaining natural teeth.

4. Creating interridge space

- A partial denture similar to a bite plane appliance may be fabricated to create interocclusal space and improve the occlusal plane. This may be used in the following cases:

  - Loss of mandibular posteriors followed by supraeruption of maxillary posteriors may sometimes be so severe that there is no space even for a denture base. Use of acrylic resin base in the mandibular arch, may select young patients, allow intrusion of the maxillary posteriors to provide space for a definitive denture base.

  - Edentulous maxillary anterior space may cause lower anteriors to supraerupt such that they contact the mucosa of the maxillary ridge. A bite plane type of partial denture in younger patients, will allow some intrusion of lower anteriors and some extrusion of posteriors to provide space for definitive treatment later.

Immediate partial dentures

Definition: Any removable dental prosthesis fabricated for placement immediately following the removal of a natural tooth/teeth (GPT).

The denture is inserted immediately, in the same appointment, following extraction of tooth/teeth.

Advantages:

1. Anterior replacements provide immediate aesthetics and help patient psychologically.

2. Posterior replacement prevents migration of teeth into the edentulous space.

3. Acts as a splint and controls haemorrhage and swelling.

Classification:

They are of two types:

- Definitive – framework made of cast metal.
- Temporary – made entirely of acrylic resin.

Definitive immediate partial denture

Indication

Prognosis of remaining natural teeth is good.

Fabrication

Procedures are similar to the construction of any cast partial denture with some differences. A try-in of the framework can be performed, but a try-in with artificial teeth cannot be done.

Mouth preparation

All the routine mouth preparations are done. While preparing guiding planes, the teeth that are to be extracted and present adjacent to the abutments are also sliced proximally to allow framework try-in.

Impressions are made as for any cast partial denture and master cast poured.

Scraping the teeth on the master cast: The teeth to be extracted are scraped in the cast up to the gingiva. The centre of the space is made deeper to resemble a shallow tooth socket. The cast is scrapped on the facial surface for 4–5 mm and 1 mm depth. This is will help in compressing the tissue and act as a splint. Also see fig 17.12 in Chapter 17

The prepared master cast is then duplicated and framework is fabricated. The denture base framework should be amenable for future relining after healing.

Framework fabrication

Two techniques can be adopted:

1. Denture base can be fabricated using wrought wire loops which can be bent backwards to allow framework try-in. They are bent back to the normal position before placing the artificial teeth.

2. Lattice-type denture base minor connector is fabricated independent of the rest of the framework. It is then soldered to the framework following try-in of framework used for fabrication of the denture.

The artificial teeth are arranged and the denture base polymerized, without an aesthetic try-in. The denture is trimmed, finished and polished. During the insertion appointment, the teeth planned for extraction are removed with least trauma to surrounding tissues. Following haemostasis, disclosing wax can be used to detect areas of interference and the denture delivered.

Immediate dentures are usually made for anterior teeth replacement. Since an aesthetic try-in cannot be performed and considering the cost factor, the permanent type of immediate denture is rarely indicated with all its limitations.

Temporary immediate partial denture

This is most commonly used. The fabrication is similar to an interim partial denture. Scraping of teeth from the cast is similar to that described previously. Relining is done as healing occurs, and a definitive prosthesis fabricated following complete healing.

Variations of conventional cast partial dentures

Guide plane denture

Indication

They are used as splints to stabilize periodontally weak remaining natural teeth.

Design

- Broad stress distribution concept – stress is distributed through rigid connectors and multiple rests and clasps.
- Not more than two clasps on either side of arch will be retentive. The rest will only provide buccolingual stabilization by not engaging the undercut.
- Framework should be completely passive.
- Multiple parallel guide planes are prepared.
- Disadvantages:
  - Aesthetics will be a problem due to large metal display.
  - The alternative to this treatment is only total extraction followed by a complete denture or overdenture, if residual ridge preservation is planned.

- The lingual plate major connector can also be used effectively to splint and stabilize periodontally weak mandibular anterior teeth. Mesial and distal rests are prepared on these teeth and engaged by projections from the lingual plate. Interproximal spaces are closed completely lingual to contact point.

- The procedure of fabrication and fitting the denture is similar to conventional cast partial dentures.

- This type of denture is very effective in stabilizing weak teeth.

Swing-lock denture

The swing-lock removable partial dentures were first described by Dr Joe J. Simmons in 1963. It consists of two major connectors – a conventional major connector like a lingual plate and a labial bar. Such a configuration will be impossible to insert together. Hence, the labial bar consists of a hinge on one end and a latch (lock) on the other. It is locked in position after insertion of the denture. Because of this locking mechanism the denture is termed 'swing-lock' denture. Small vertical projection clasps attached to the labial bar contact the labial or buccal surfaces of the teeth gingival to the height of contour providing retention and stability.

Indications

- Too few remaining natural teeth.

- Remaining teeth too mobile to serve as abutments.

- Location of remaining natural teeth is unfavourable for a conventional removable partial denture.

- Unfavourable tooth and soft tissue contours.

- To provide retention and stability for maxillofacial prosthesis such as obturators.

- For retention of prosthesis in cases of loss of large segments of teeth and alveolar ridge due to traumatic injury.

Contraindications

- Shallow vestibule.
- High labial frenal attachment.
- Unaesthetic – too much metal display due to short lower lip.
- Poor oral hygiene.

Advantages

- All or most of the remaining teeth can be used for the retention and stabilization of prosthesis.
- A natural tooth can be removed and added to the major connector of a swing-lock prosthesis through a simple laboratory procedure.
- Construction of a swing-lock removable partial denture is relatively simple and inexpensive.

Disadvantages

- Relatively poor aesthetics result for patients with short lips.
- Tipping of remaining anterior teeth in case of long-span distal extension bases.

Design and fabrication

- The major connector of choice is linguoplate in the mandible and complete palate in maxilla. Closed horseshoe can also be used in maxilla.

- A gingival resin veneer can be processed on the labial bar if aesthetics is compromised due to loss of gingival tissue.

- Alginate is the material of choice for final impressions as it may be difficult to remove elastomeric impressions where gingival embrasures exist due to bone loss.

- **Surveying:** Path of insertion should be from lingual direction with the labial arm open.

- Chrome alloy is used for the framework. Gold alloy is contraindicated as lock mechanism wears quickly with use and lot of bulk is needed to provide sufficient rigidity and strength.

- Rest of the component design and the fabrication is similar to conventional cast partial dentures.

Unilateral dentures

It may also be called 'clasp bridge' (Fig. 30.21).

Definition: A removable dental prosthesis which restores lost or missing teeth on one side of the arch only (GPT8).

Disadvantages

This type of denture is not normally recommended as the danger of aspiration of denture by patient is high because of its small size and less retentive and stabilizing features.

Design

- Clinical crown of the abutments must be sufficiently long to resist rotational forces.

- Buccal and lingual surfaces of the abutment should be parallel/nearly parallel to each other to resist tipping forces.

- Retentive undercuts should be available both buccally and lingually.
- The artificial tooth is normally a tube tooth supported by a cast metal denture base.
- The base must have intimate contact with the tissues to prevent food accumulation.

I-bar removable partial dentures

These were introduced by Kratochvil in 1963. The concept emphasizes three components – mesial occlusal rest, I-bar retainer and long guide planes (Fig. 30.22).

The design philosophy and components are discussed with reference to distal extension bases.

Mesial occlusal rest

The occlusal rest is placed in the mesial fossa of the primary abutment instead of distal fossa for the following reasons:

1. Directs tipping forces mesially (Fig. 30.23).
2. Wrenching action of retentive arm avoided (Fig. 30.24).
3. Forces on mucosa more perpendicular (Fig. 30.25).
4. Firm resistance to distal displacement (Fig. 30.26).

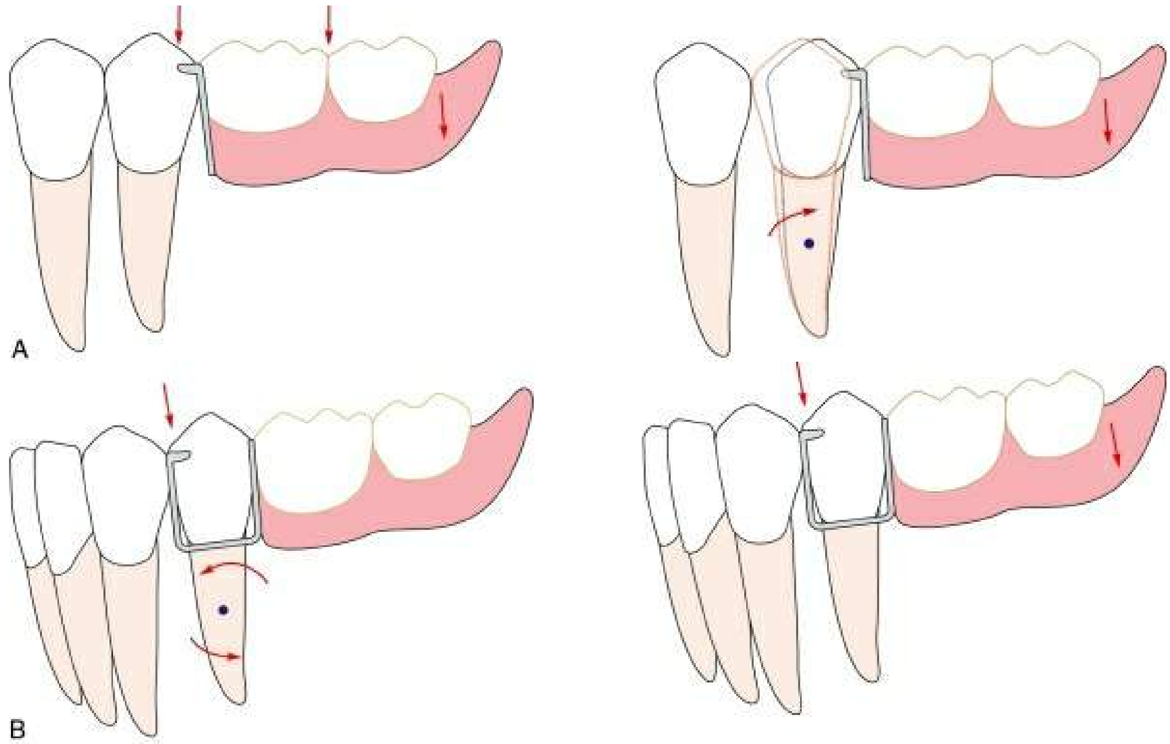


FIGURE 30.23 **(A)** A rest adjacent to edentulous space of a distal extension partial denture (distal rest) rotates the abutment distally and opens the contact area on the mesial side. **(B)** When the rest is located on the mesial surface, the contact area remains closed as abutment tooth is supported by the other natural teeth anterior to it.

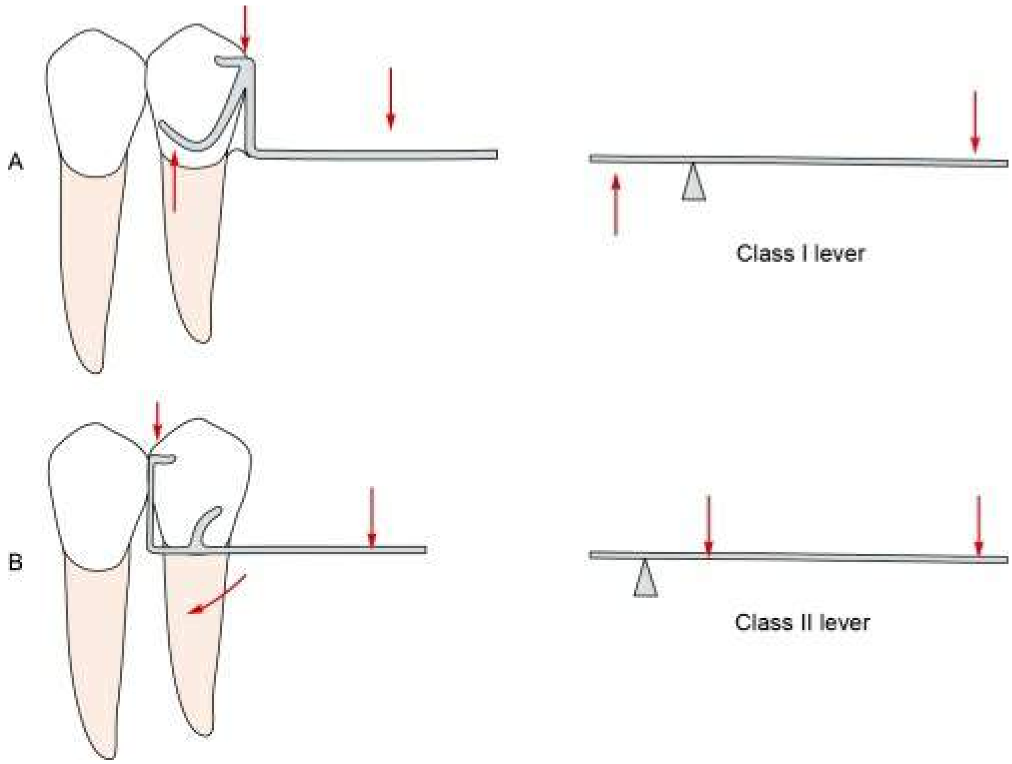
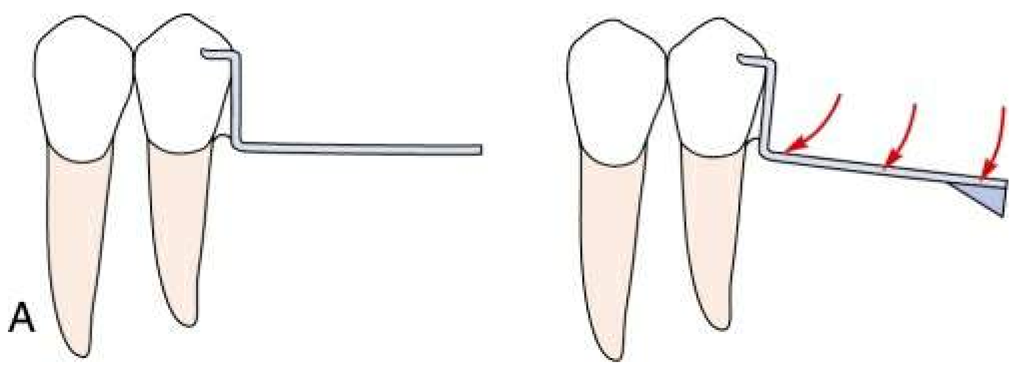


FIGURE 30.24 **(A)** With distal occlusal rest, RPD behaves as a Class I lever, wrenching action of retentive arm is anterior to point of rotation, force tends to pull the tooth out **(B)** With a mesial rest, the forces on the abutment tooth changes from a class I to class II type of lever action. Therefore, the wrenching action of the retentive arm anteriorly to point of rotation is avoided.



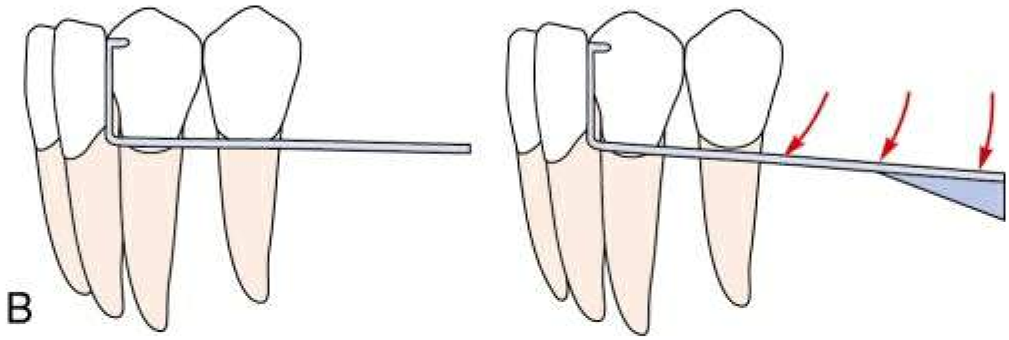


FIGURE 30.25 **(A)** With a distal rest, forces not perpendicular to ridge, **(B)** With a mesial rest, as the distance between the fulcrum point and the extension base is increased (fulcrum line shifts anteriorly), the arc of rotation at any given point on the base becomes flatter and its direction becomes more perpendicular to the ridge. This force is better tolerated.

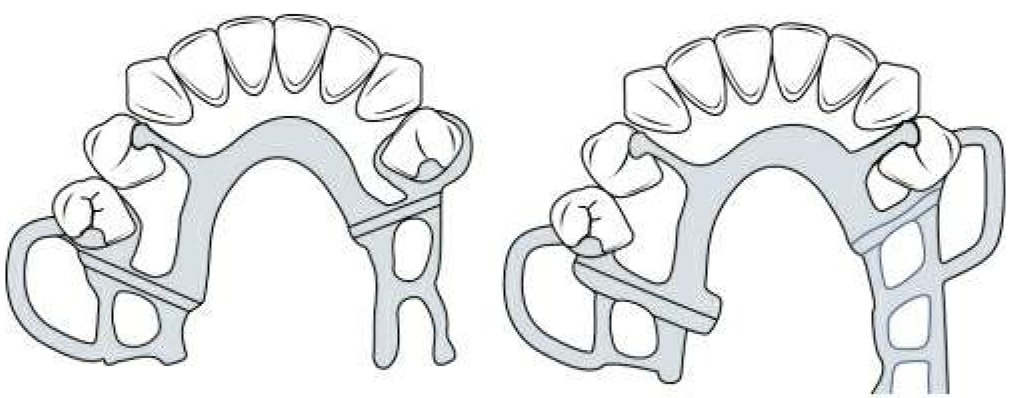


FIGURE 30.26 Mesial rest with rigid minor connector tends to resist distal displacement of the denture. The clasp assembly is solidly anchored on the tooth, and the clasp tips or recessed rest seats are not relied upon to prevent slippage distally.

Preparation of rest seat is similar to that described for conventional cast partial dentures.

Direct retainer

1. I-bar clasp is indicated. It is located in a mid-buccal position where it is free to disengage from the tooth when rotation occurs around the

mesially placed rest. I-bar must contact the tooth at or slightly anterior to the point of greatest buccolingual diameter for such rotation to occur (Fig. 30.27). It must lie far enough from the gingival margin (minimum of 2.5–3 mm) to avoid food impaction. There is no reciprocal arm, reciprocation is provided by proximal plate.

FIGURE 30.27 **(A)** I bar clasp in a maxillary cast partial denture, **(B)** I bar clasp in a mandibular cast partial denture

Advantages

1. Freedom to disengage.

2. Minimal tooth contact.

3. Minimum distortion of tooth contours thereby minimal food accumulation.

4. Maximum gingival stimulation.

5. Adequate retention with minimal undercut.

Disadvantages

Retention and resistance to horizontal stabilization is less compared to other retentive elements.

Proximal plate (long guide planes)

According to this design philosophy, an extended guide plane is prepared on the distal surface of the abutment. It extends from the marginal ridge to the tooth-tissue junction and extends onto the attached gingiva for 2 mm (Fig. 30.28). This extended guide plane of metal is called 'proximal plate'.

FIGURE 30.28. Proximal plate.

Advantages

1. A highly polished metal, rather than resin, contact with the marginal gingiva protects the area.

2. Intimate metal-to-tooth contact distally between the denture and the natural tooth to minimize or eliminate food impaction.

3. Better retention and horizontal stabilization.

4. Provides reciprocation.

5. Distributes occlusal forces.

Disadvantages

Contact of the abutment with parallel vertical elements mesially and distally grips the tooth tightly and prevents the rotation of the extension bases.

Minor connectors, major connectors, indirect retainers and denture base

These components complete the I-bar denture. The design philosophy is similar to that for routine cast partial dentures.

In keeping with the minimal coverage philosophy, anteroposterior palatal strap is the recommended maxillary major connector and lingual bar for the mandible.

Variations

1. RPI concept

Developed by Krol (1973), this concept advocated reduction in the amount of tooth preparation and coverage involved with the previously described I-bar system.

RPI denotes – rest, proximal plate and I-bar clasp. The emphasis was on stress control with minimal tooth and gingival coverage.

The following changes were advocated with regard to the mesial rest, proximal plate and I-bar clasp compared to Kratochvil's system:

1. **Rest:** Preparation is less extensive, extends only to the triangular fossa, just concave depressions are prepared on mesial marginal ridge.

2. **Proximal plate:** The prepared guide plane is only 2–3 mm and contacts only 1 mm of the gingival portion (Fig. 30.29A). Relief is provided at the tooth-tissue junction to allow plate to disengage into undercut under occlusal loading.

3. **I-bar retentive terminal:** It is pod-shaped with more tooth contact. It is placed more towards the mesial embrasure space for effective reciprocation from the short proximal plate (Fig. 30.29B). There is no separate reciprocal arm similar to the previously described I-bar partial denture.

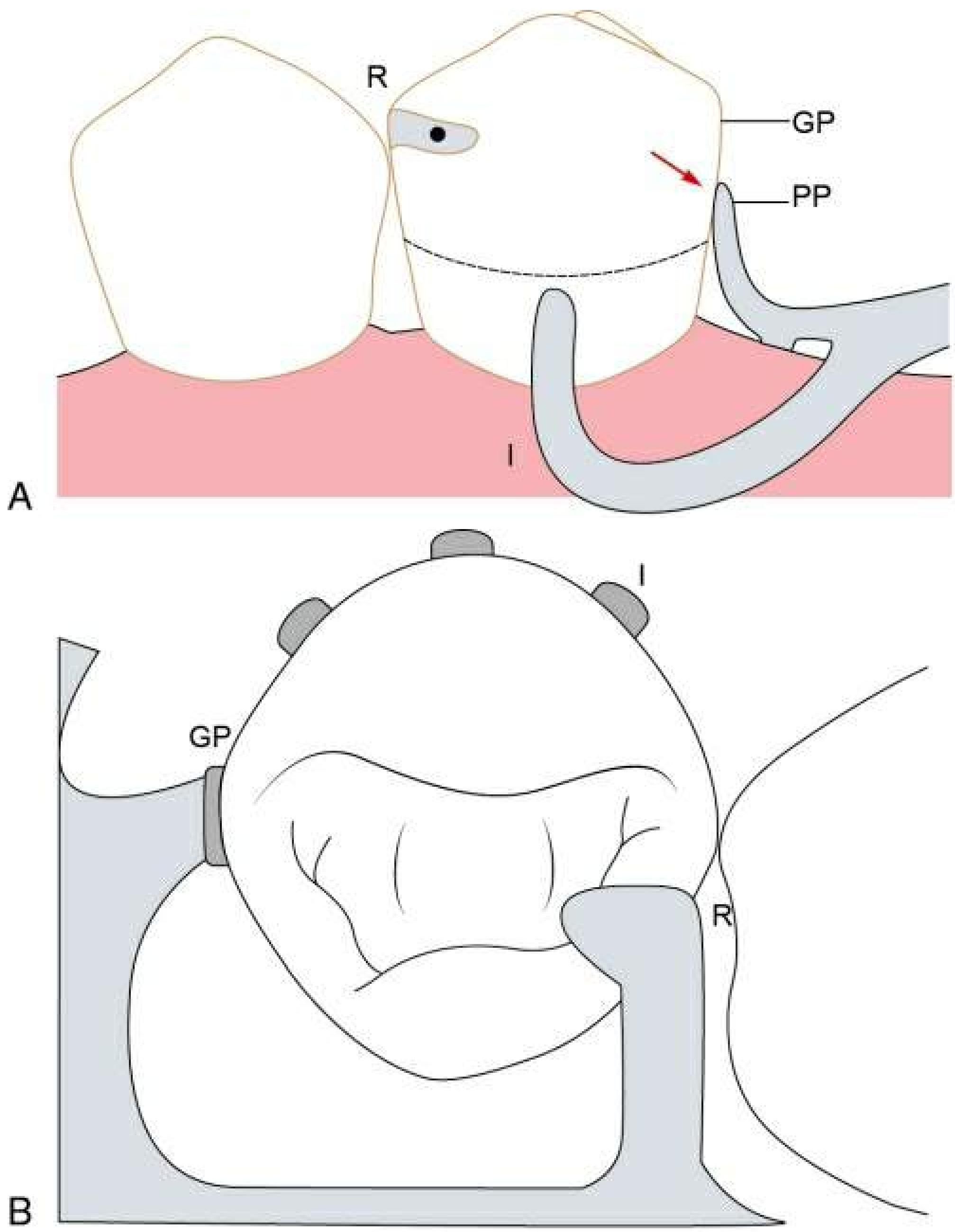


FIGURE 30.29 **(A)** Proximal plate of RPI concept, 2–3 mm guide plane contacts only 1 mm of gingiva. R, rest; GP, guide plane; PP, proximal plate; I, I-bar clasp. **(B)** I-bar retentive terminal of RPI concept is placed towards the mesial embrasure than centre.

The rest of the components are designed similar to conventional cast partial dentures.

2. RPA concept

It was described by Krol (1976). When RPI system cannot be used in cases of tipped abutments and soft tissue undercuts, RPA concept is advocated.

In this case use of distal rest and a wrought wire circumferential clasp (Akers' clasp) is indicated (Fig. 30.30). Although the clasp will not release during functional movement, its flexibility will create a stress breaking affect.

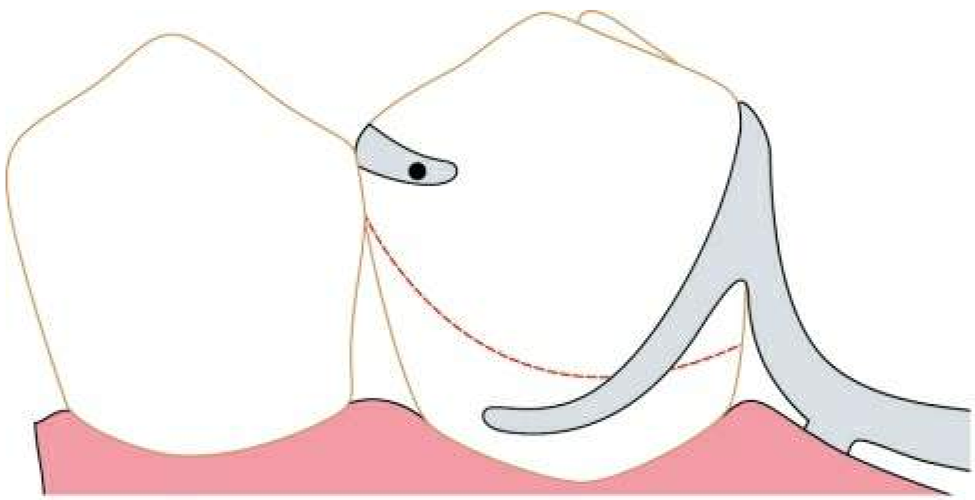


FIGURE 30.30 RPA concept: R – rest, P – proximal plate, A – Aker's clasp.

The distal rest eliminates any space between occlusal aspects of the proximal surfaces of the abutment and the artificial tooth and the gingival portion of the guide plate can be relieved without creating any area for food impaction.

Removable partial overdentures

Definition: A removable partial denture that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants; a prosthesis that covers and is partially supported by natural teeth, natural roots and/or dental implants (GPT8).

It may also be known as – overlay denture, overlay prosthesis, superimposed prosthesis or hybrid prosthesis. Teeth which support the RPD are known as overdenture abutments.

Advantages

1. Enhances denture support.

2. Reduces the stresses on partial denture abutments.

3. Decreases residual ridge resorption.

4. Denture base extension can be reduced.

Indications

A natural tooth can be retained as an overdenture abutment to produce better support and reduce the stresses on the partial denture abutments in the following situations:

1. Distal extension bases – retaining a posterior tooth provides better support and reduces stresses.

2. Long-span anterior edentulous areas – retaining an anterior tooth provides better support and reduces residual ridge resorption.

3. Weak partial denture abutment.

4. Number of remaining teeth is less.

5. Interim partial denture.

Criteria for overdenture abutment selection

The teeth to be selected as overdenture abutment should be evaluated for the following:

1. Positional considerations

i. Selection depends on the position of the abutment and the length of the edentulous span. The selected tooth should help in reducing stress to the partial denture abutment and residual ridge.

ii. Presence of labial or buccal tissue undercut does not change treatment planning as the flange extension can be reduced with retention being provided by clasps.

2. Periodontal considerations

i. Periodontium must be healthy.

ii. Excessive periodontal pocket depth must be eliminated.

iii. Oral hygiene must be maintainable.

iv. Two millimetre of attached gingiva must be present.

v. Mobility is not important as it will decrease after crown height is reduced.

3. Endodontic considerations

i. All overdenture abutments require to be treated endodontically to reduce the crown height to 2–3 mm. Only teeth with calcified pulp chambers may not require endo treatment.

ii. If a single-rooted tooth can be used as effectively as a multirooted tooth, the former should be selected for ease and economic reasons.

4. Caries considerations

i. The abutment is covered with a coping if there is extensive caries and tooth is susceptible to fracture.

ii. Root caries on the crown root junction may be of concern as it may interfere with the margin of the coping.

iii. Rampant caries is a contraindication for teeth being selected as overdenture abutments.

5. Oral hygiene considerations

This treatment modality is successful only if the patient can maintain oral hygiene effectively.

Design

The design is essentially the same as for the conventional cast partial dentures. A few considerations regarding selection of the replacement teeth, choice of retentive clasps and design of the denture base are necessary in some situations.

Teeth selection

Acrylic resin teeth are preferred over porcelain as they are easier to modify and are less susceptible to fracture.

Clasp design/selection

If the abutment tooth is in the middle of the edentulous space it may act as the fulcrum point on application of occlusal forces distally. A wrought wire clasp may be indicated.

Denture base

The denture base can be supported by using the following methods:

1. Using an attachment to provide better retention and vertical support (discussed in Chapter 47).

2. Providing a metal to tooth/coping contact with the use of a metal denture base on the prepared overdenture tooth or coping. The disadvantage of this design is that the prosthesis cannot be functionally fitted to the abutment tooth and later placement or replacement of coping is difficult.

3. The best and most commonly used design is the development of resin to tooth contact. Acrylic resin retained by the denture base minor connector covers and contacts the overdenture abutment. This allows the denture to be functionally fitted and modified if needed.

Preparation of overdenture abutment

Sufficient reduction is important to allow for the artificial tooth to be seated in the same position as the natural tooth. Strength, aesthetics and retention are influenced by amount of tooth preparation.

- A hole is prepared through the clinical crown and dental floss is threaded to secure the crown during sectioning. It is then sectioned 3 mm above the crest of the ridge.

- The occlusal surface is rounded to remove unsupported enamel and prevent fracture.

- The labiolingual taper must be 25–35°. Proximal taper must be 10–15°.

Clinical and laboratory procedures

The clinical and laboratory procedures for fabricating the overdenture are the same as for the conventional cast partial dentures. During mouth preparation, the overdenture abutments are prepared and final impressions are made. While making altered cast impressions, elastomeric impression materials are preferred if there are undercuts adjacent to abutment.

Denture insertion

- Prosthesis is adapted to the abutment tooth during insertion for best clinical results.
- The tissue surface of the denture where it contacts the overdenture abutment is trimmed and relieved. It is shaped in the form of a butt joint to retain the autopolymerizing acrylic resin.
- A hole is drilled through the lingual side to provide an escape channel for the excess resin.
- All other aspects are checked for fit and occlusion is corrected.
- Tooth coloured autopolymerizing acrylic resin is mixed and placed in the concavity created in denture base. The prosthesis is placed in the mouth while partial polymerization occurs. It is then removed and placed in warm water until polymerization is complete. Excess resin is trimmed and polished.
- By making the patient bite on the denture or by applying finger pressure while the resin polymerizes in the mouth, the desirable contact between the denture base and overdenture abutment can be obtained under occlusal loading.

Postinsertion care

- Similar to any conventional cast partial denture.
- Fluoride application on abutment will prevent caries. Fluoride is applied chairside during insertion and recall appointments, and patient is also advised to use a fluoride gel on a daily basis during home care procedures.

Prognosis

- The ultimate prognosis depends on the fit of the prostheses, occlusion and oral hygiene and denture maintenance.

Overdentures are also discussed in Chapter 48 under the section 'Miscellaneous'.

Implant-supported removable partial dentures

Removable partial dentures that use the support of a surgically placed implant are known as implant-supported RPDs. The implant may be used by two means either as an overdenture abutment (Figs 30.31–30.33) or as a partial denture abutment after the placement of the crown.

FIGURE 30.31 Partially edentulous situation rehabilitated with two implants supported by a bar (courtesy Dr D. Arunachalam).

FIGURE 30.32 Impression surface of overdenture showing clip to attach to bar.

FIGURE 30.33 Implant-supported partial bar-retained overdenture.

Indicated in patients with poor neuromuscular control and parafunctional habits such as tongue thrusting which may cause poor retention or stability of the RPD. A long-span distal extension base can be converted to a class III situation to make the leverage forces more favourable (Fig. 30.34).

FIGURE 30.34 Implants placed distally will convert a class I situation into a class III.

Implant prostheses is discussed in Chapter 49 under the section Miscellaneous.

Attachment-retained partial dentures

See Chapter 47 Section 4: Miscellaneous section of the book which discusses the same.

Miscellaneous

Spoon denture

These are completely tissue-/mucosa-borne denture (Fig. 30.35).

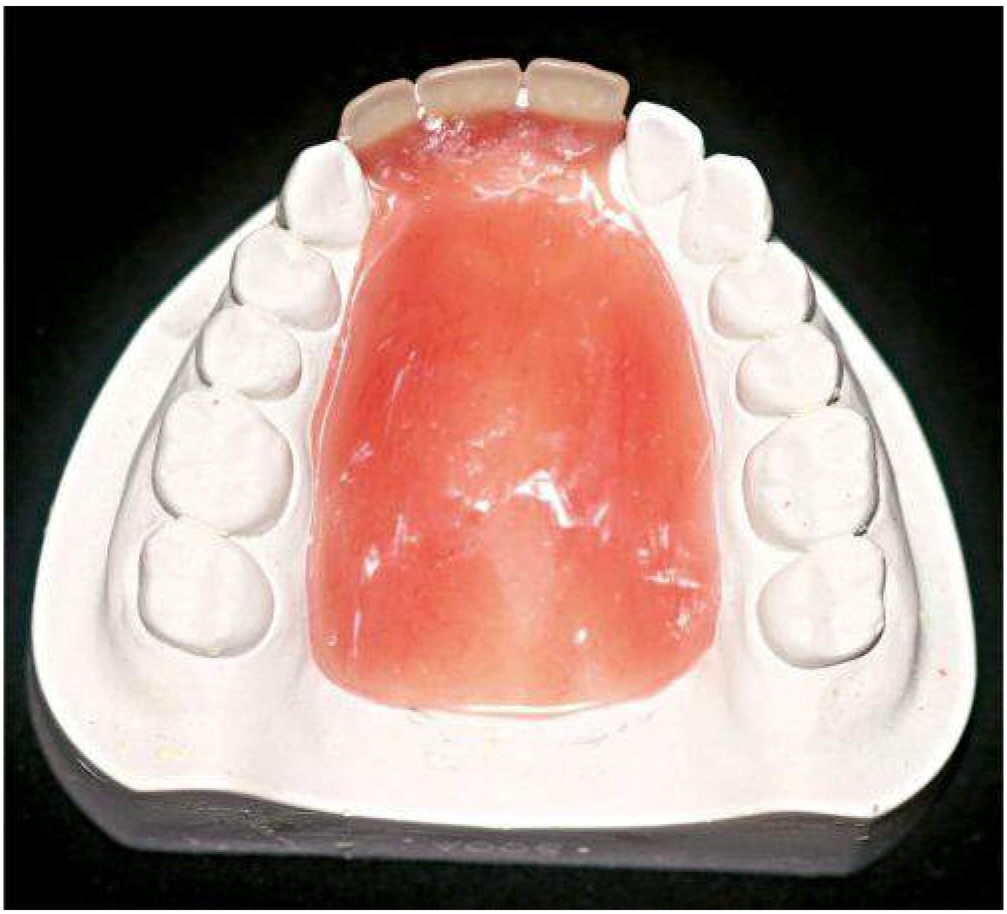


FIGURE 30.35 Spoon denture.

Indication

- They are mostly used in children in class IV situations as a temporary denture.

Advantages

- Less time required to fabricate.
- Caries incidence is decreased because there is no extensive tooth contact.

Disadvantage

- Poor retention.

Design

- Palatal vault should be high with steep sides.
- They are fabricated using acrylic resin or chrome metal.
- Should cover the palate but the gingival margins should not be covered.
- Denture borders are 3–4 mm away from the gingival margin.

Every denture

It is also called 'precision plastic partial upper denture' (Fig. 30.36).

FIGURE 30.36 Every denture.

Indication

- For restoring multiple bounded edentulous areas in maxillary jaw, in Kennedy class III with modifications.

Advantages

- Caries incidence is decreased because there is no extensive tooth contact.
- Economical.

Disadvantage

- Poor strength.

Design

- The supporting tissues of remaining teeth immediately surrounding the denture are kept free of any acrylic part.
- Connector borders are kept 3 mm away from the gingival margins.
- Point contact between artificial teeth and abutment teeth also reduces the lateral stress.
- Wire stops are placed posteriorly to prevent distal drift of posterior teeth. Retention is obtained by atmospheric pressure through a modified peripheral seal and by accuracy of fit between the denture base and the mucosa.
- Flanges on the labial and buccal border are included to assist bracing of dentures.

Two part denture

This is also known as 'sectional denture' (Fig. 30.37). It is made of two parts each with a different path of insertion which is joined in the centre.

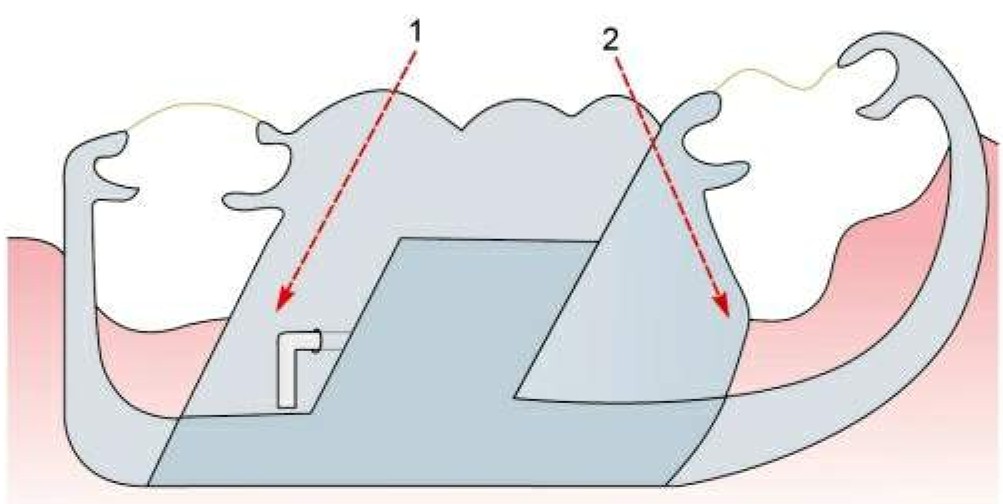


FIGURE 30.37 (1) Involving mesial undercut, (2) distal undercut.

Indications

- Unilateral partial dentures including single tooth replacements.
- Maxillectomy and mandibulectomy cases, where a single path of insertion is not possible.

Advantages

- Overcomes the problem of opposing proximal undercut in relation to unilateral partial denture.
- No visible retentive component.

Disadvantages

- Complex in design and fabrication.
- Requires more manual dexterity by the patient for insertion of denture.

Characteristics

- Each part of the denture has individual path of insertion. First part of denture engages the mesial undercut on the distal abutment and second part of denture engages the distal undercut of the mesial abutment.
- After both parts of denture are inserted, they are locked together in the centre using an attachment device like a bolt.
- The denture also contains bracing components which prevent

movement of abutment teeth.

Disjunct denture

The disjunct principle of partial dentures design joins differently supported parts of a denture – tooth borne and tissue borne – connecting bar acts as stress breaker (Figs 30.38 and 30.39).

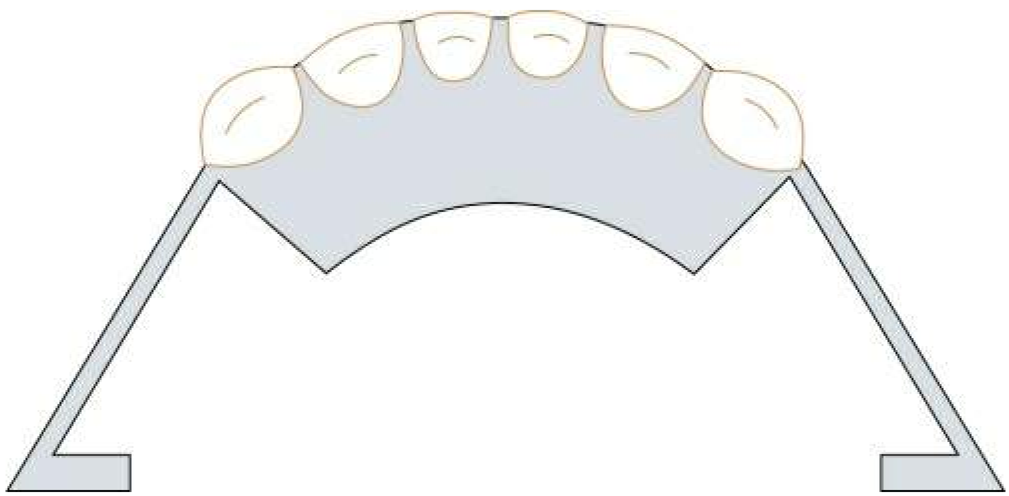


FIGURE 30.38 Anterior part with bar extending posteriorly.

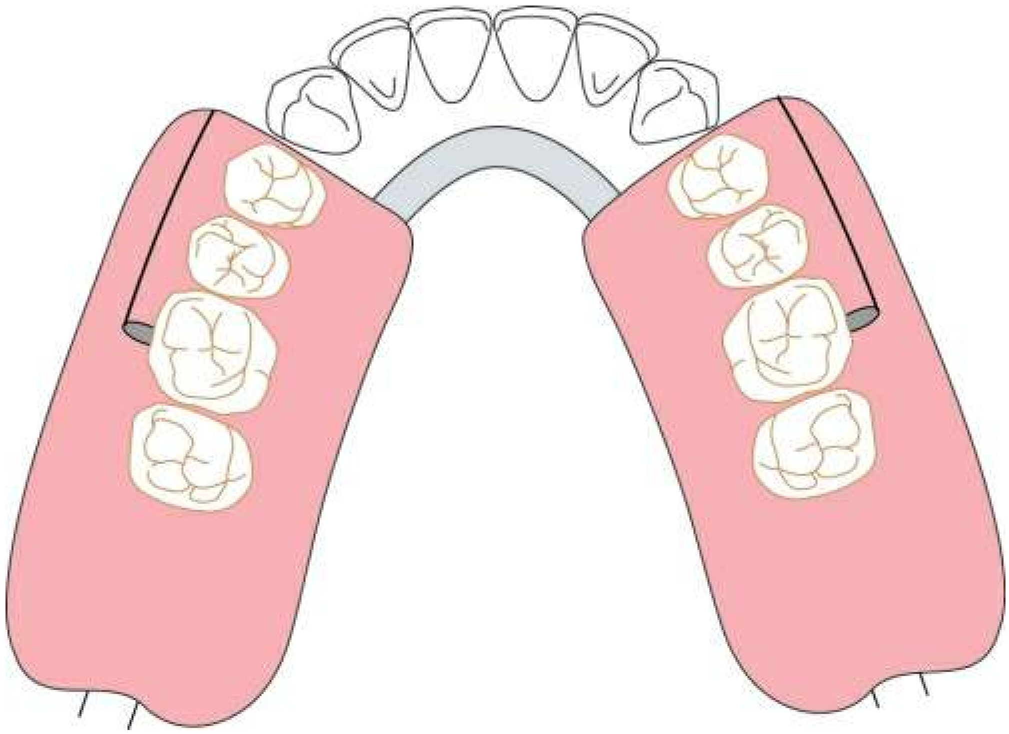


FIGURE 30.39 Posterior (mucosa-borne part) attached to the bar with pins and sleeves.

Indication

- Mandibular class I and class II when remaining natural teeth are periodontally weak.

Advantages

- By varying the pin/sleeve movement, the overall load can be shared proportionately between mucosa and abutment teeth, the proportion on each depending on the clinical findings in any particular case.
- Periodontally weak teeth are preserved.

Disadvantages

- Complex design.
- Discomfort to the patient as there is movement of both parts.

Design

- In a lower denture, the anterior tooth-borne part is made in cast alloy. Bar extends distally from the last abutment tooth on each side (Fig. 30.38).
- Mucosa-borne part is attached to the bars by means of pins and sleeves which allow vertical movement when a load is applied to the denture (Fig. 30.39).
- The movement of the sleeves on the pins can be adjusted so that when the mucosa is compressed (and therefore accepting a load) any further load is directed forward, via the buccal bars, to the tooth-borne part of the denture.

SUMMARY

Apart from conventional cast partial dentures, other types of partial removable dentures are also discussed. Each has its own indication, material and method of fabrication which should be followed. The temporary removable dentures are often used as a definitive prosthesis. This is not recommended as it will not preserve the health of the remaining tissues.

SECTION 3
Fixed Partial Dentures

OUTLINE

43. Metal-free ceramic restorations

44. Resin-bonded fixed partial dentures

45. Restoration of endodontically treated teeth

CHAPTER 31

Introduction

CHAPTER CONTENTS

Introduction

The nature of fixed prosthodontic treatment can vary from restoration of a single tooth to the rehabilitation of the entire dentition. These restorations are the best practice builders for any clinician and can instantly restore the image and confidence of the patient. They are more technique sensitive than removable prosthodontics and require more precise clinical skills. As it involves tooth preparations and fixed restorations, it is irreversible and can cause considerable damage if not properly executed. The basic terminologies and uses of fixed partial dentures in general are discussed in this chapter.

Definitions

Fixed prosthodontics: The branch of prosthodontics concerned with the replacement and/or restoration of teeth by artificial substitutes that are not readily removed from the mouth (GPT8).

Fixed partial denture (FPD) or fixed dental prosthesis: A dental prosthesis that is luted, screwed or mechanically attached or otherwise securely retained to natural teeth, tooth roots and/or dental implant abutments that furnish the primary support for the dental prosthesis. They are commonly referred to as *bridges* and cannot be removed by the patient.

The supporting teeth are termed as *abutments*, the restorations that are cemented onto the abutments and retain the FPD in place are called *retainers* and the artificial replacement tooth is a *pontic*. The retainers are joined to the pontic by *connectors* (Fig. 31.1).

Crown: An artificial replacement that restores missing tooth structure by surrounding part or all of the remaining structure with a material such as cast metal, porcelain, or a combination of materials such as metal and porcelain (GPT8).

It is basically a cemented extracoronal restoration that covers, or veneers, the outer surface of the clinical crown. It should reproduce the morphology and contours of the damaged coronal portions of a tooth and also protect the remaining tooth structure from further damage. If it covers all the surfaces of the clinical crown it is called *complete* or *full veneer crown* (Fig. 31.2). If only a portion of the clinical crown is covered, the restoration is called a *partial veneer crown* (Fig. 31.3).

Laminate veneer: A thin bonded restoration that restores the facial surface and part of the proximal surfaces of teeth requiring aesthetic restoration (GPT8). They are fabricated from resin or dental porcelain and are bonded (adhesively cemented) to etched enamel with a composite resin luting agent (Fig. 31.4).

Resin-bonded restorations: It is a fixed dental prosthesis that is luted to the tooth structure, primarily enamel, which has been etched to provide mechanical retention for the resin cement (GPT8) (Fig. 31.5A and B). Tooth preparation is limited to the lingual/palatal surface and is minimal. This prosthesis is discussed in detail in Chapter 44.

Radicular retained restorations: It consists of a post or dowel with an attached core. The post is in the prepared radicular space of the endodontically treated tooth. The core offers support to the crown (Fig. 31.6). These restorations are discussed in detail in Chapter 45.

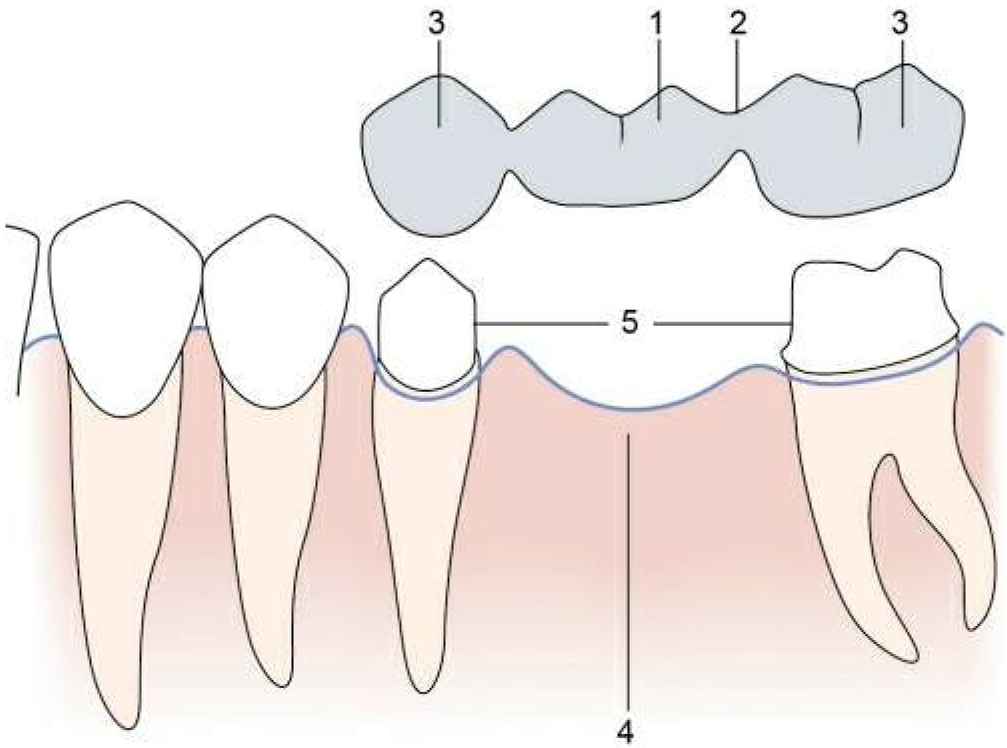


FIGURE 31.1 Schematic diagram of the fixed partial denture assembly and the supporting anatomical structures: (1) pontic, (2) connector, (3) retainer, (4) edentulous space and (5) abutment.

FIGURE 31.2 Full veneer crown covering all the surfaces of the tooth.

FIGURE 31.3 Partial veneer crown (seven-eighths) covering all surfaces except mesiobuccal.

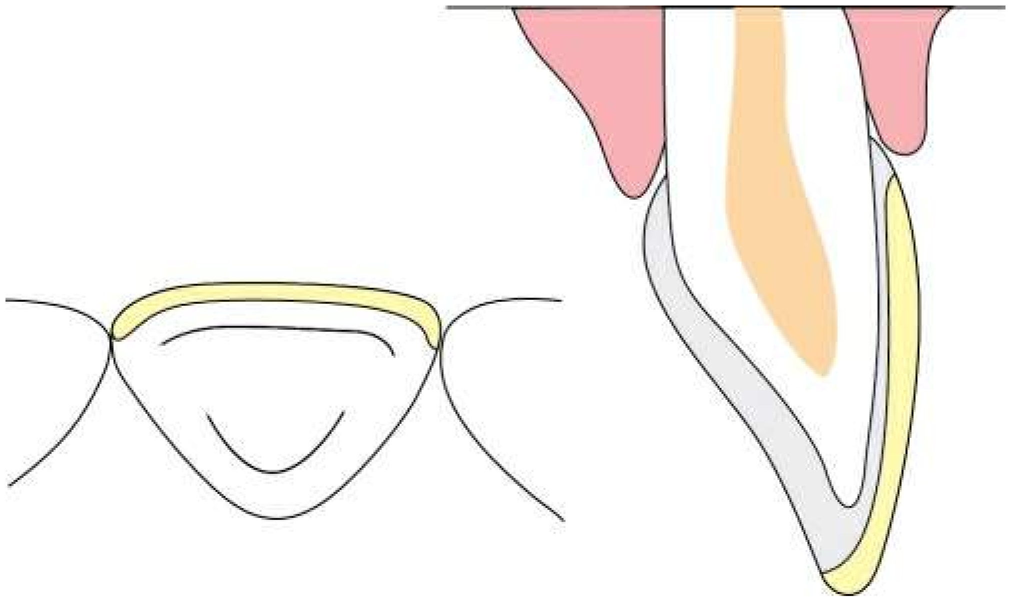


FIGURE 31.4 Laminate veneer on the labial surface of the tooth.

FIGURE 31.5 **(A)** Showing missing 41 (mandibular central incisor – tooth number 41) and mirror image of lingual preparation on abutments 42 and 31. **(B)** Resin-bonded prosthesis bonded to abutments 42 and 31.

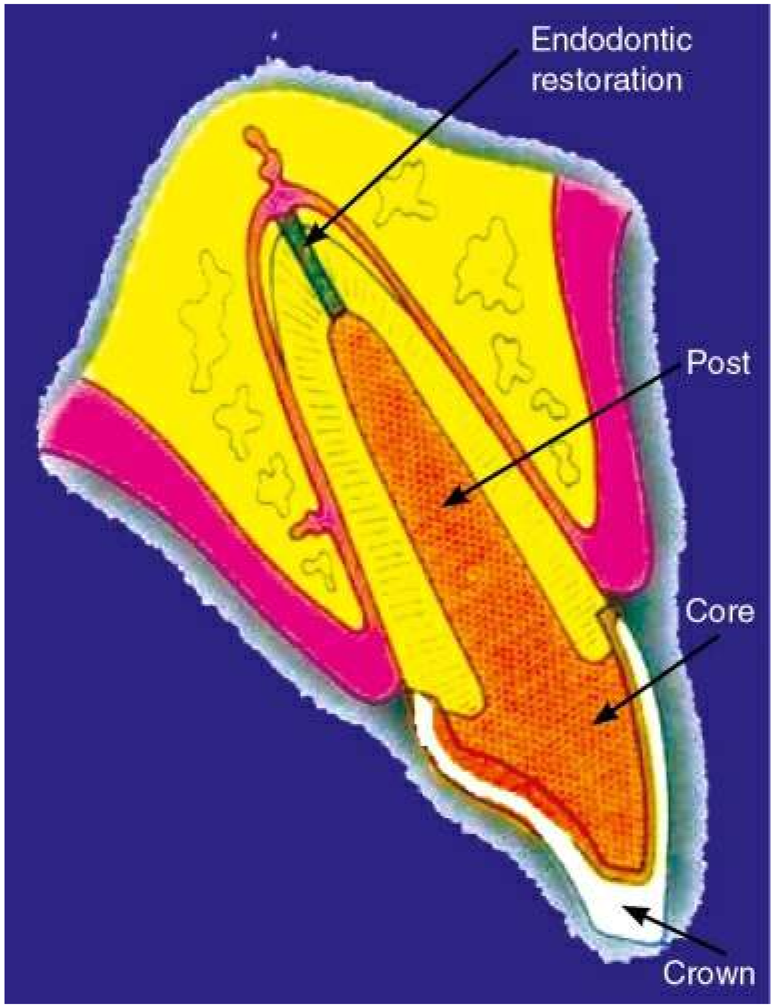


FIGURE 31.6 Radicular retained restoration.

Indications for fixed partial denture

The fixed partial denture prosthesis is indicated in general when one or two adjacent teeth are missing. The abutment teeth and its supportive tissue namely the periodontium should be healthy. It is commonly indicated for the following situations:

1. In short edentulous spaces.

2. Abutment teeth and supporting tissues are healthy.

3. To harmonize dental occlusion in temporomandibular joint

disorders.

4. To stabilize and splint the dentition after advanced periodontal therapy.

5. When the patient desires a fixed prosthesis.

6. The patient has the skills and motivation to maintain good oral and prosthetic hygiene.

7. When removable prosthesis is not indicated as in mentally and physically challenged patients.

Contraindications

Fixed partial dentures are generally avoided in the following situations:

1. Edentulous space with no distal abutment.

2. Long edentulous spaces.

3. Bilateral edentulous spaces with more than two teeth missing on either side require cross arch stabilization.

4. Presence of periodontally weakened abutments.

5. Teeth with very short clinical crown like congenitally malformed teeth.

6. Severe loss of tissue in the edentulous ridge because of surgery or trauma.

7. The patient has poor oral hygiene.

8. Very young patients with wide pulp chambers.

9. Very old patients, because of brittle teeth.

10. Medically compromised patients.

Advantages

The advantages over the removable dentures are the following:

1. Aesthetics.

2. Patient feels more secure than with RPD.

3. Capable of directing forces along the axis of the tooth.

4. Superior strength.

5. Provide proper occlusal function.

6. Maintain arch integrity/tooth position.

7. Maintain occlusal relationships.

8. Protect and preserve the remaining structures.

Disadvantages

Since preparation of the teeth is involved, it may have adverse and irreversible effects on the pulp and periodontium. A few disadvantages of fixed partial dentures are

1. Involves irreversible preparation of abutment teeth.

2. Abutments susceptible to recurrent decay.

3. Preparation may injure pulp and periodontium.

4. Cost for remake if it needs to be replaced.

5. Creation of diastema difficult.

Classification of fixed partial dentures

Fixed partial dentures can be classified based on the following criteria.

Location of the edentulous space

1. **Posterior:** Fixed partial denture confined to the posterior region, e.g. replacement of missing first molar (Fig. 31.7).

2. **Anterior:** Fixed partial denture confined to the anterior region, e.g. replacement of missing central incisors (Fig. 31.8A and B).

3. **Combination:** Fixed partial denture extending both anteriorly and posteriorly, e.g. replacement of single/multiple teeth involving the turn of the arch, as in cases of replacement of missing canine, premolars (Fig. 31.9).

FIGURE 31.7 Posterior FPD replacing mandibular first molar.

FIGURE 31.8 **(A)** Missing maxillary central incisors – abutments 12 and 22 prepared. **(B)** Anterior FPD cemented.

FIGURE 31.9 FPD extending both anteriorly and posteriorly.

Location of abutment

1. **Conventional:** Abutment is located adjacent to the edentulous space and pontic is supported on both sides. This is the design for majority of fixed partial dentures.

2. **Cantilever:** Abutment is located adjacent to edentulous space but pontic is supported on one side only. This is discussed in detail in Chapter 33.

3. **Spring cantilever:** Abutment is not located adjacent to edentulous space and pontic receives support from one side only. A posterior abutment, generally premolar, is used to replace an anterior tooth and a bar is used to connect the abutment and pontic. The bar is rigid and is termed 'loop connector' (Fig. 31.10). It is most often indicated in replacing missing maxillary central incisor when a diastema is desired. Not used with mandibular replacements as the connector can cause tongue interference.

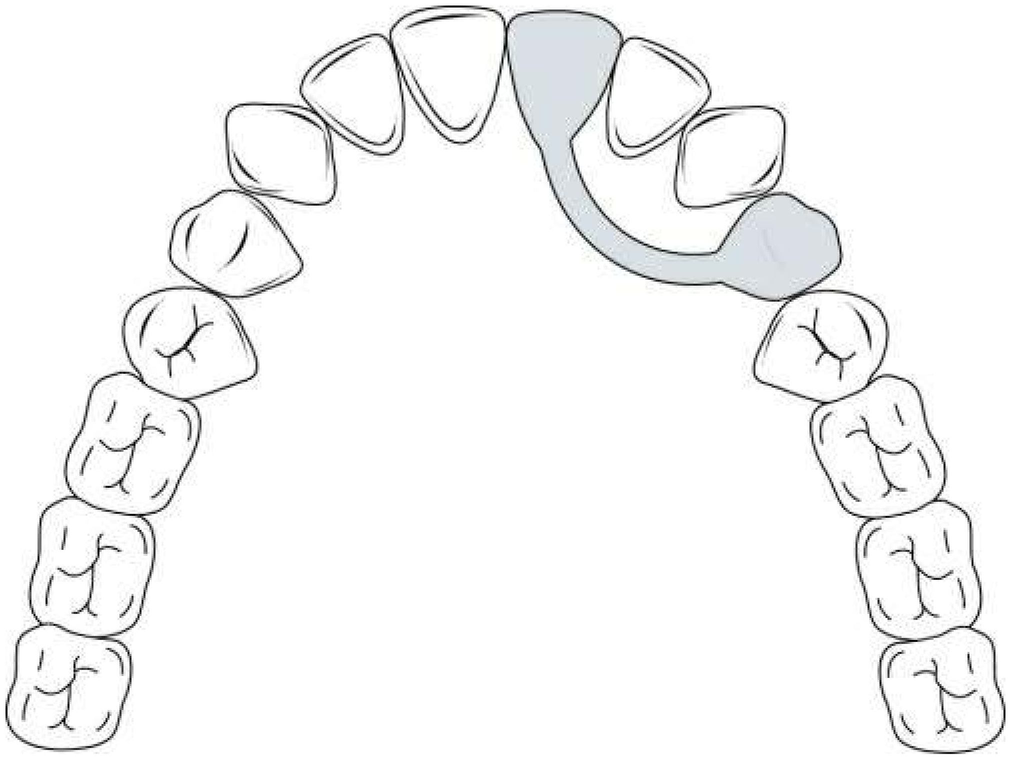


FIGURE 31.10 Spring cantilever FPD replacing 21 using 24 as abutment and a loop connector.

Indications

Replacement of missing maxillary central incisor when diastema is to be maintained.

Disadvantages

1. Bar interferes with speech and can cause food entrapment.

2. Not indicated in mandibular arch as bar causes tongue interference.

Types of connector

1. **Fixed-fixed:** Connectors on both sides of the pontic are rigid with no scope for any movement. The connector is either soldered to the pontic and the retainer or all the components are cast as a single piece (Fig. 31.8A and B).

2. **Fixed-movable:** One of the connectors of the FPD assembly is nonrigid (not in the literal sense, it is called so because it allows some movement between the pontic and abutment) and is made of a precision or semiprecision attachment which allows some vertical movement (Fig. 31.11). This is normally indicated in case of a pier abutment, tilted abutments or periodontally weak abutments. The nonrigid connectors are discussed in detail in Chapter 33.

3. **Fixed-removable:** This prosthesis was developed by Dr James Andrews and is called 'Andrews Bridge'.

- The fixed portion consists of two abutment retainers adjacent to an edentulous space splinted by a bar. The retainers attached to the bar are cemented on the abutments (Fig. 31.12A). The removable portion consists of the artificial teeth (pontics) and a denture flange with a sleeve which clips onto the bar (Fig. 31.12B).

- This technique possesses the advantage of flexibility in placing denture teeth as well as the stabilizing qualities of a fixed prosthesis. This is mainly indicated for patients with extensive supporting tissue (bone) loss. Replacing the teeth for such patients with a conventional FPD will result in unaesthetically long pontics with no lip support.

- Also indicated with long edentulous spans (Figs 31.13–31.15).

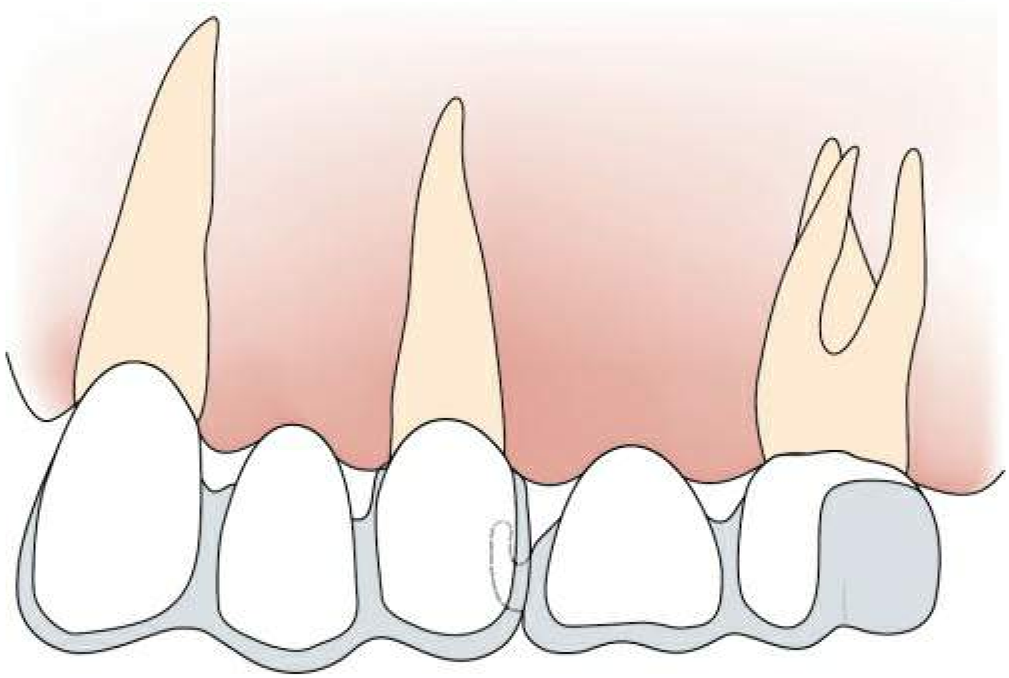
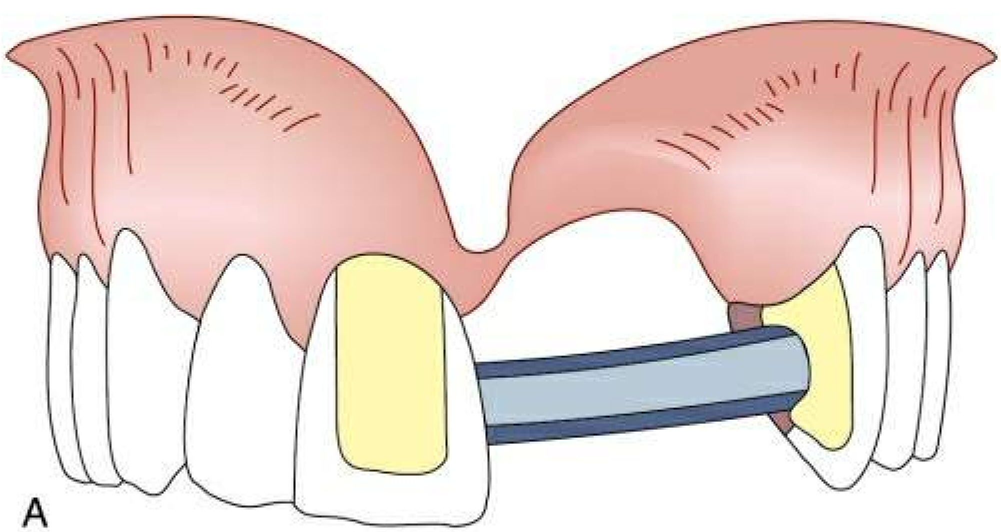


FIGURE 31.11 Tooth number 15 – a pier abutment, is supporting a rigid connector on the left and a key–keyway attachment on the right which allows some movement to distribute the load.



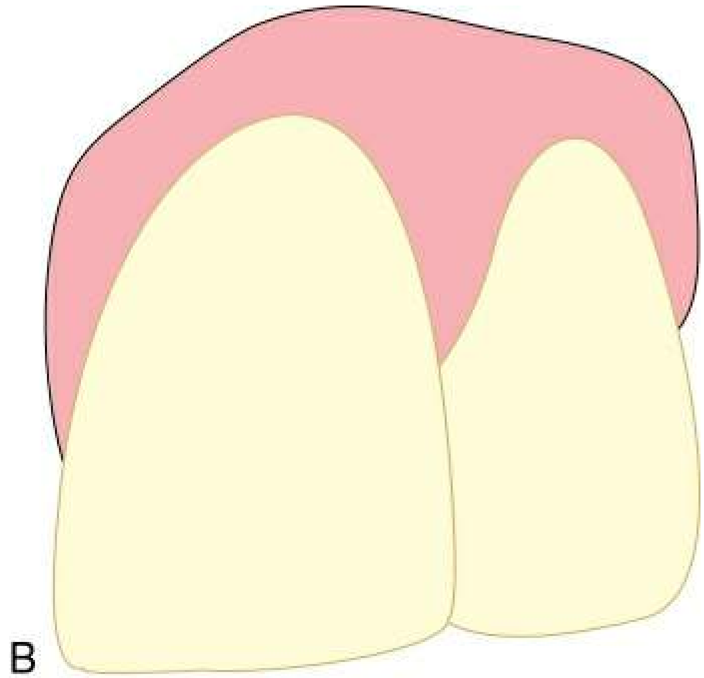


FIGURE 31.12 **(A)** Retainers on 11 and 23 connected by a bar and cemented on the abutment teeth. **(B)** Removable part consists of the pontics with denture flange and the fitting surface contains the sleeve which clips onto the bar.

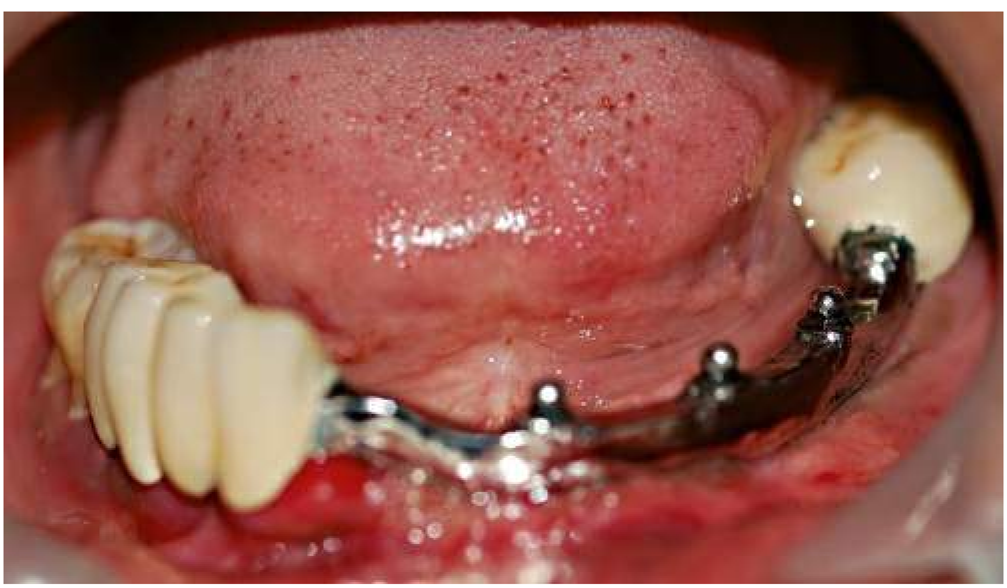


FIGURE 31.13 Long edentulous span restored with fixed part of Andrews bridge with crowns on 45, 44, 43 and 37 connected by a bar with stud attachments.

FIGURE 31.14 Removable denture with matrices to fit on the studs for retention.

FIGURE 31.15 Removable denture in mouth attached to the bar.

Classification based on type of materials used

1. **All metal:** These are used only to replace posterior teeth as they are not aesthetic.

2. **Metal ceramic:** These are also termed as 'porcelain fused to metal' (PFM) crowns/retainers. These may be of two types:

   (i) **Metal with complete ceramic coverage:** In this there is a core of metal which fits on the abutment and is completely covered by ceramic both facially and lingually/palatally (Fig. 31.16A–C).

   (ii) **Metal with ceramic facing:** In this restoration, though all the surfaces are formed by metal, ceramic covers the metal in the labial/buccal surface alone (Fig. 31.17A and B).

3. **All ceramic:** These are fabricated using only ceramics with no metal component. They are also called 'metal-free ceramic' restorations. This is discussed in detail in Chapter 43.

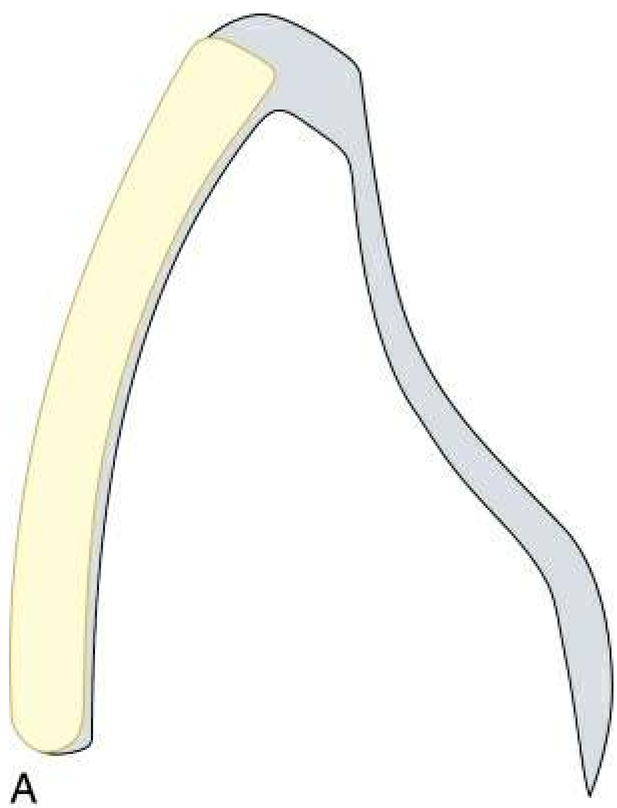
4. **Metal with resin facings:** This is similar to metal with ceramic facings except that instead of ceramic, acrylic or composite resin is used. Unlike ceramics, resins do not bond chemically to metal. Hence, retention should be obtained mechanically by using small wire loops or retention beads on the labial surface of metal which is then cast. An opaque resin supplied by the manufacturer is applied on the labial surface prior to processing the resin to mask the metal. The other difference with metal with ceramic facing is that the veneered resin should not cover the incisal edge and all contact must occur on metal (Fig. 31.18A and B).

Disadvantage: Resin facings wear easily and also do not possess good colour stability.

5. **All acrylic, composite and fibre-reinforced composite:** These are only used as provisional restorations. They are discussed in Chapter 38.

FIGURE 31.16 **(A)** Labial view, **(B)** palatal view and **(C)** fitting surface showing metal core.

FIGURE 31.17 **(A)** Occlusal view of metal with ceramic facing crown showing ceramic covering the incisal edge. **(B)** Labial view of metal with ceramic facing crown.



A

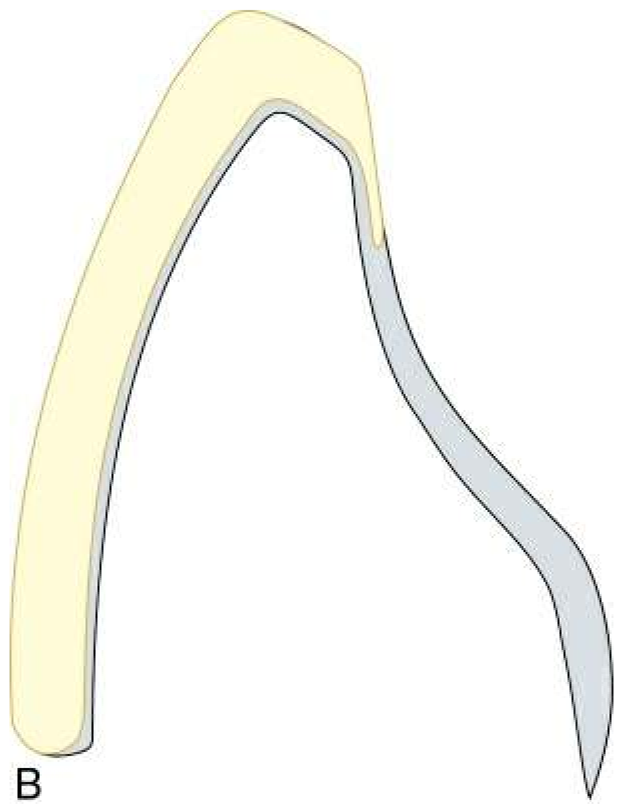


FIGURE 31.18 **(A)** Metal with acrylic facing – metal is indicated by brown and acrylic by blue, acrylic does not cover incisal edge and needs metal on the gingival seat to support the acrylic. **(B)** Metal with ceramic facing –ceramic covers the incisal edge and can also cover the gingival seat without metal support.

Duration of use

1. **Provisional or temporary FPD:** Usually made of acrylic resins and are intended for use for a short period of time. It is fabricated soon after the preparation and is expected to serve the patient till the definitive prosthesis is fabricated. It is cemented using temporary cements.

2. **Long-term temporary FPDs:** The prosthesis is indicated in situations where definitive treatment plan is not finalized as in cases of periodontally week teeth, and during healing period after periodontal therapy. They are fabricated with special acrylic resins

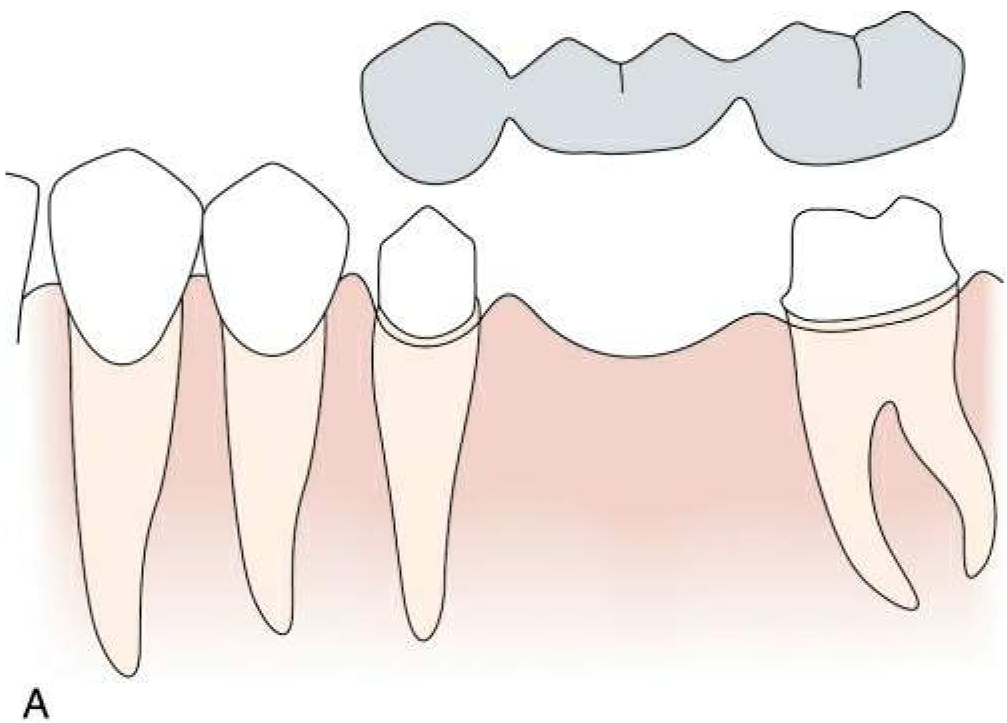
which have additional strength or can be reinforced with metal inserts.

3. **Definitive FPD:** These are fabricated with materials like ceramics and metals and are expected to serve the patient for longer period of time.

Span length

1. **Short span:** When the FPD replaces one/two adjacent teeth and is confined to 3–4 units, it is called short-span FPD (Fig. 31.19A).

2. **Long span:** When the FPD replaces more than two adjacent teeth, it is termed as long-span FPD (Fig. 31.19B).



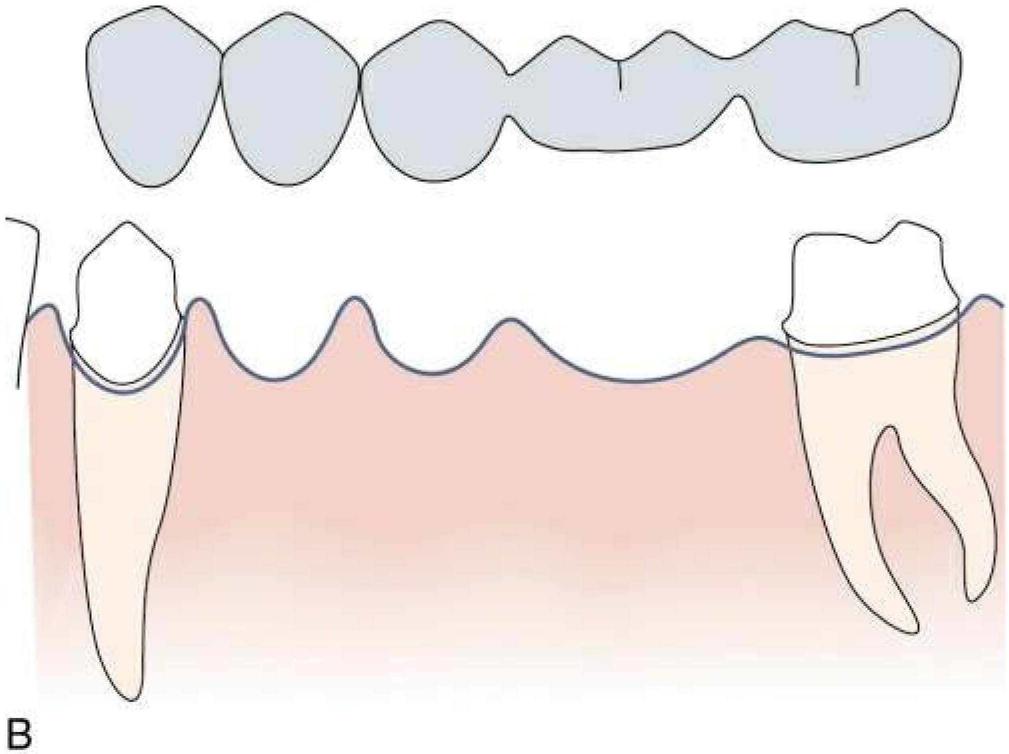


FIGURE 31.19 **(A)** Short-span FPD replacing single tooth. **(B)** Long-span FPD replacing three teeth.

Classification based on type of retention

1. **Frictional resistance:** All the conventional fixed partial dentures are retained because of the frictional resistance offered by the parallel walls of the prepared tooth and the restoration, assisted by the cement.

2. **Microretention:** The retention of the resin-bonded, etched cast restorations depend on the bonding ability of the resin and the surface irregularities of the tissue surface of the restoration.

Type of support

1. **Tooth supported:** Conventional FPDs taking support of natural teeth only (Fig. 31.8A and B).

2. **Implant supported:** FPDs using osseointegrated implants as abutments (Fig. 31.20A and B). These are discussed in section Miscellaneous of Chapter 49.

3. **Combination:** FPDs taking support of both natural teeth and implants (Fig. 31.21A and B). These are discussed in section Miscellaneous of Chapter 49.

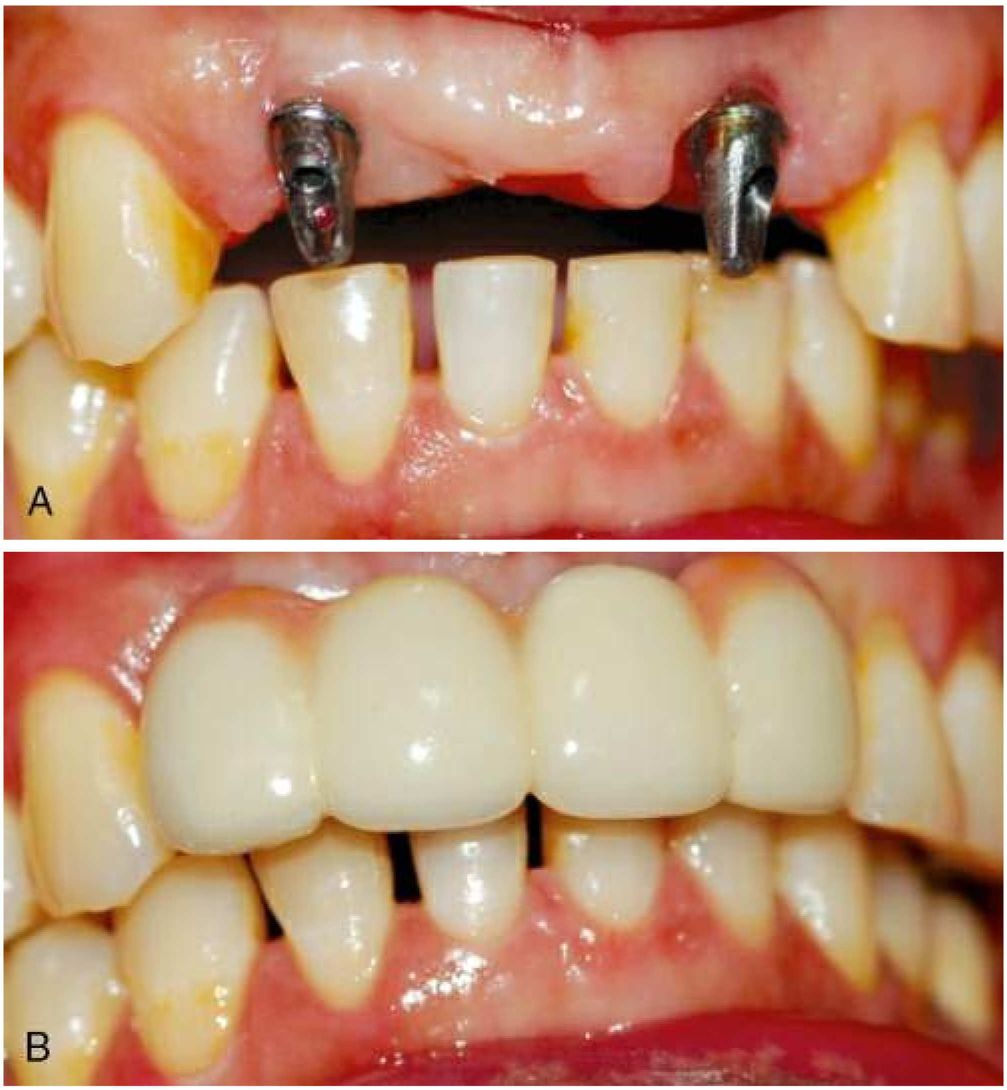


FIGURE 31.20 **(A)** Implant abutments placed in 12 and 22 region. **(B)** Implant-supported FPD.

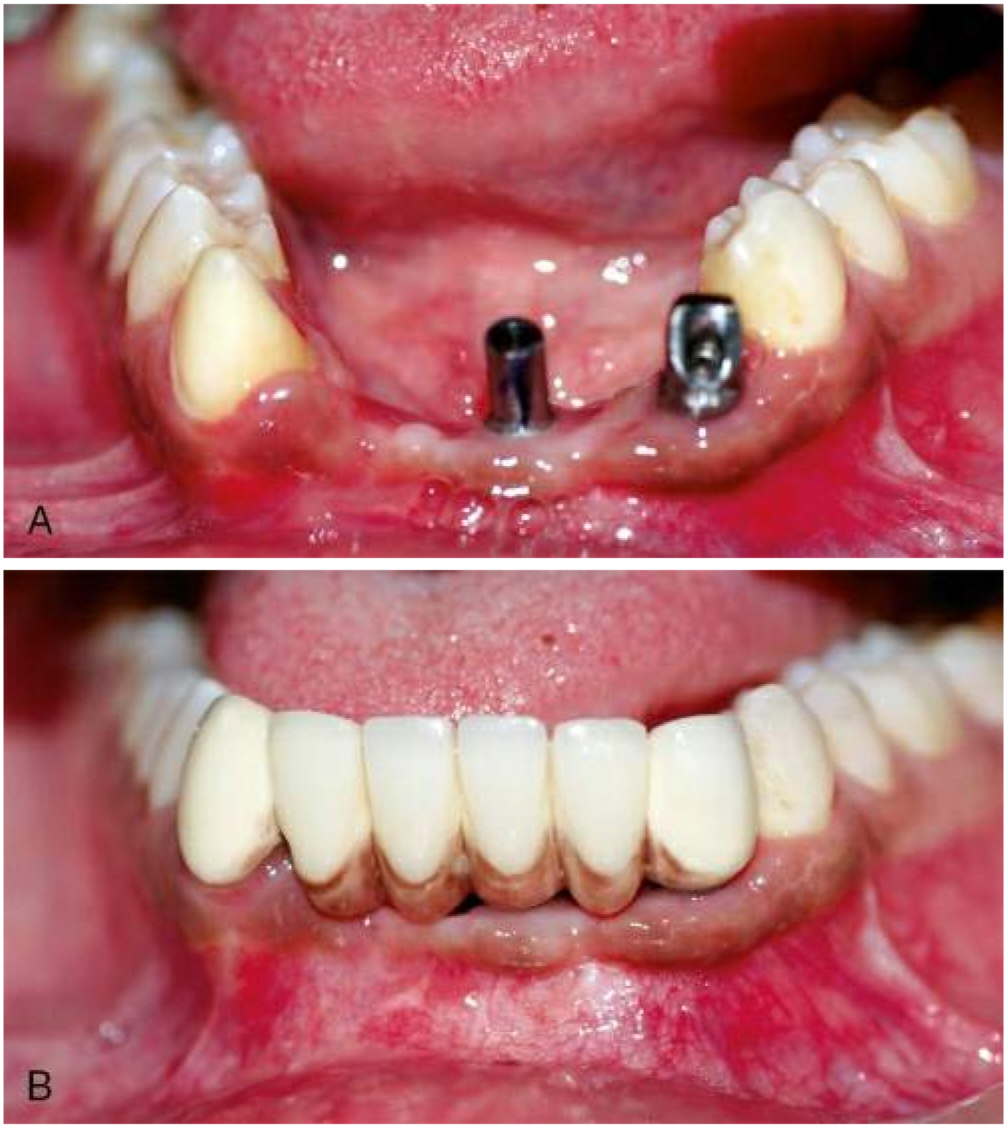


FIGURE 31.21 **(A)** 43 (natural tooth) and implant in 31 and 33 area used to support FPD. **(B)** Combination FPD taking support of natural tooth and implant.

SUMMARY

This introductory chapter gives an overall view of the indications and the advantages of fixed partial dentures. The classification presented, covers almost all possible combinations of fixed prosthodontic treatment. The subsequent chapters deal in detail with the components and fabrication of a fixed partial denture.

CHAPTER
32

Component parts

CHAPTER CONTENTS

Introduction

A fixed partial denture is commonly fabricated by preparing the teeth present on either side of the missing tooth or teeth. These supporting prepared teeth are the *abutments* onto which the prosthesis is cemented. Fixed partial denture is made up of three elementary components – *retainer*, *pontic* and *connector*.

Retainer: The part of a fixed dental prosthesis that unites the abutment(s) to the remainder of the restoration (GPT8).

Pontic: An artificial tooth on a fixed dental prosthesis that replaces a missing natural tooth, restores its function, and usually fills the space previously occupied by the clinical crown.

Connector: The portion of a fixed dental prosthesis that unites the retainer(s) and pontic(s).

Retainer

This is used for the stabilization or retention of prosthesis. It is cemented to the abutment.

Classification

The retainers can be classified on the following criteria.

Amount of tooth coverage

1. Complete coverage or full veneer retainers

- They cover all the surfaces of the abutment tooth and are ideal retainers as they provide maximum retention.
- Most commonly used retainers for FPDs and are the retainers of choice for extensively damaged abutment teeth (Fig. 32.1A–C).

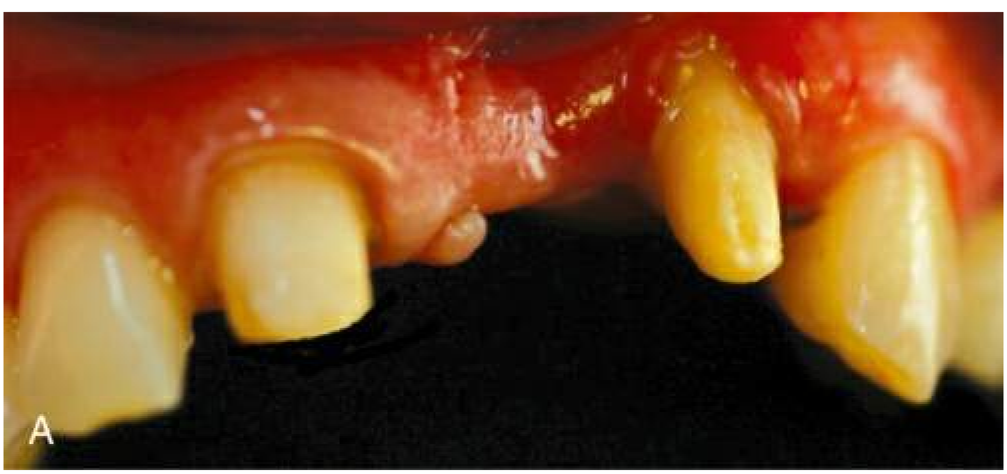


FIGURE 32.1 **(A)** Prepared abutments 11 and 22. **(B)** FPD with full veneer all ceramic retainers. **(C)** All ceramic FPD cemented.

2. Partial coverage or partial veneer retainers

- These retainers do not involve all the surfaces of the abutment.
- Compared to full veneer retainers, they require less amount of tooth preparation and have superior aesthetics but are less retentive.
- Depending on the surface and area covered they are termed as three-fourth crown, reverse three-fourth crown, four-fifth crown, seven-eighths, one-half crown, pinlays and pinledges (Fig. 32.2A and B). They are discussed in detail in Chapter 35.


A
B

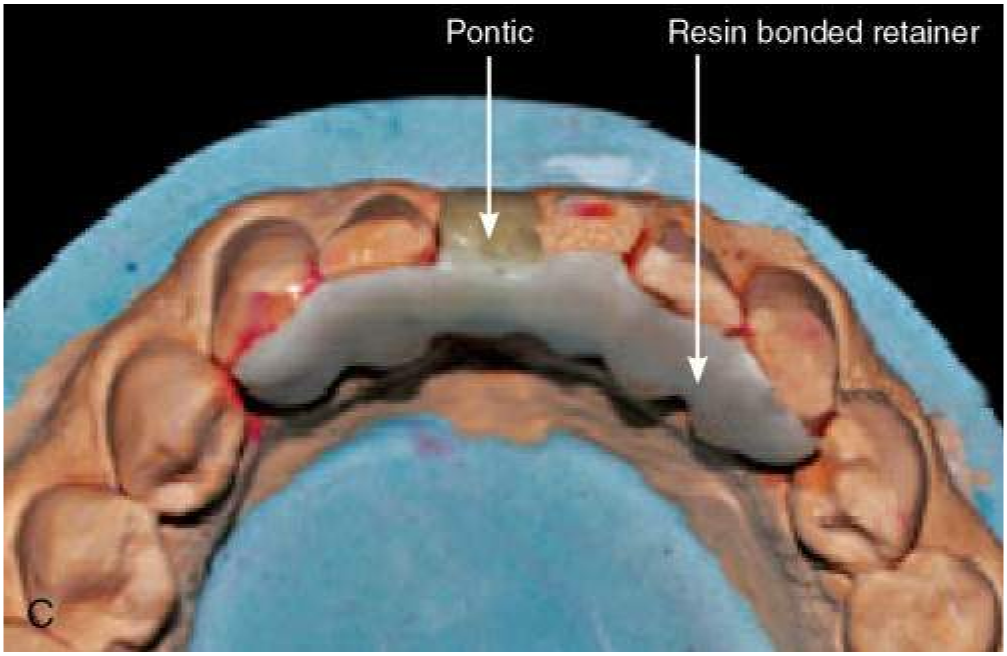


FIGURE 32.2 **(A)** Partial coverage retainer – seven-eighths crown. **(B)** Partial coverage retainers – proximal half crown. **(C)** Resin-bonded fixed partial dentures.

3. Conservative retainers

- These retainers require minimal tooth preparation and are primarily indicated for anterior teeth.
- They cannot accept heavy occlusal load, for example resin-bonded fixed partial dentures (Fig. 32.2C).

Mechanism of retention

1. Extracoronal retainers

Obtain retention from the external surface of the coronal part of the abutment teeth; examples are full veneer crowns and partial veneer crowns.

2. Intracoronal retainers

Obtain retention from within the coronal tooth structure; examples are inlays, onlays (Fig. 32.3).

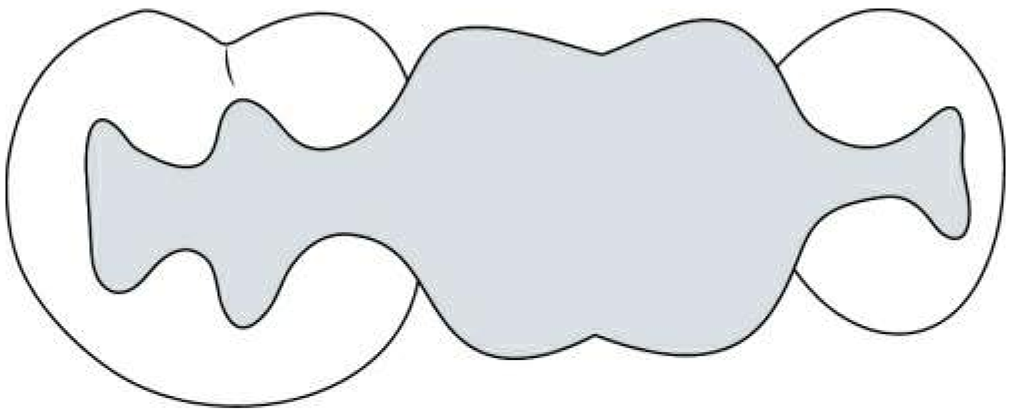


FIGURE 32.3 FPD retained by inlays.

3. Radicular retainers

Obtain retention from within the root of the abutment. Posts are discussed in detail in Chapter 45.

Material used

1. All metal retainers

- Can be either partial or full coverage.
- They possess good strength and are used commonly with posterior abutments.
- They require minimal tooth preparation (Fig. 32.4).

FIGURE 32.4 Metal with ceramic facing retainer on left and full metal retainer on right.

2. Metal-ceramic retainers

- Most commonly used; indicated in both anterior and posterior teeth.
- Ceramic can be either a facing or full coverage.
- They require more tooth preparation than the all metal type (Fig. 32.4).

3. All ceramic retainers

- Most aesthetic and need maximal tooth preparation.
- Also provide the best aesthetics but strength in long-span FPDs is still questionable (Fig. 32.1B).

4. Acrylic retainers

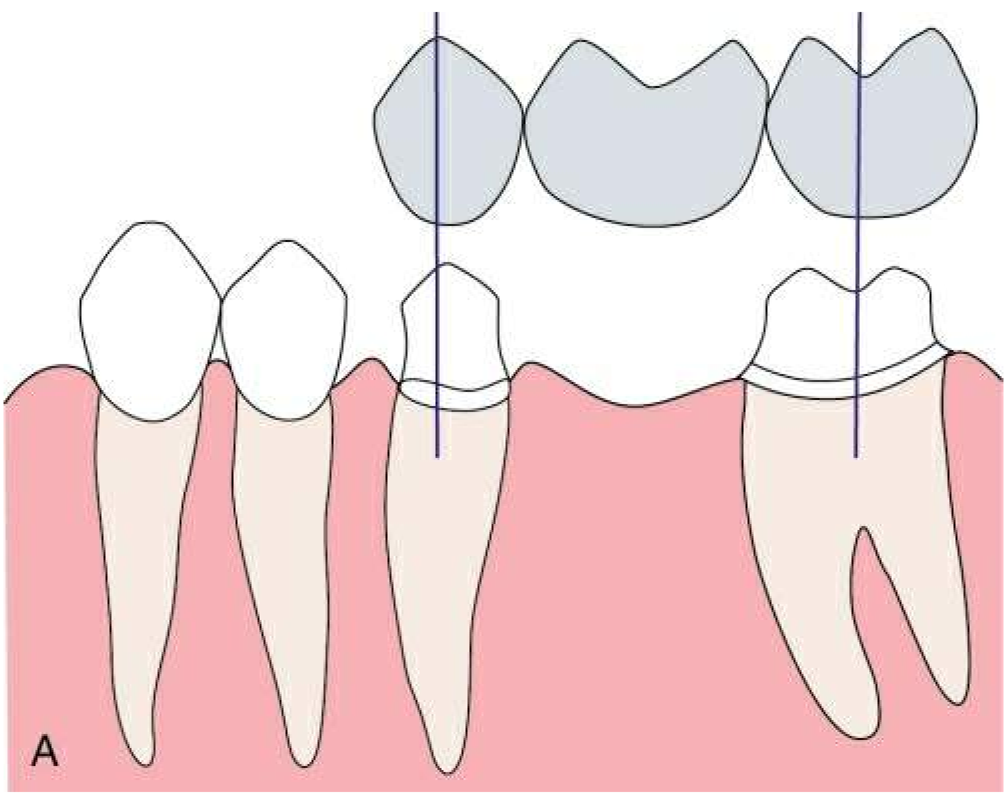
- Used for temporary fixed partial dentures.
- They are not used for definitive FPDs because of their poor strength, colour instability, inadequate wear resistance and poor tissue response.

Criteria for selection of retainers

Various factors governing the selection of retainers are as follows.

Abutment angulations

- In case the abutments are parallel to each other, a full veneer retainer can be planned and a single path of insertion can be obtained (Fig. 32.5A).
- If the abutments are nonparallel owing to unfavourable tooth positions, a partial veneer retainer along with another partial or full veneer retainer can be used to get a single path of prosthesis insertion (Fig. 32.5B).



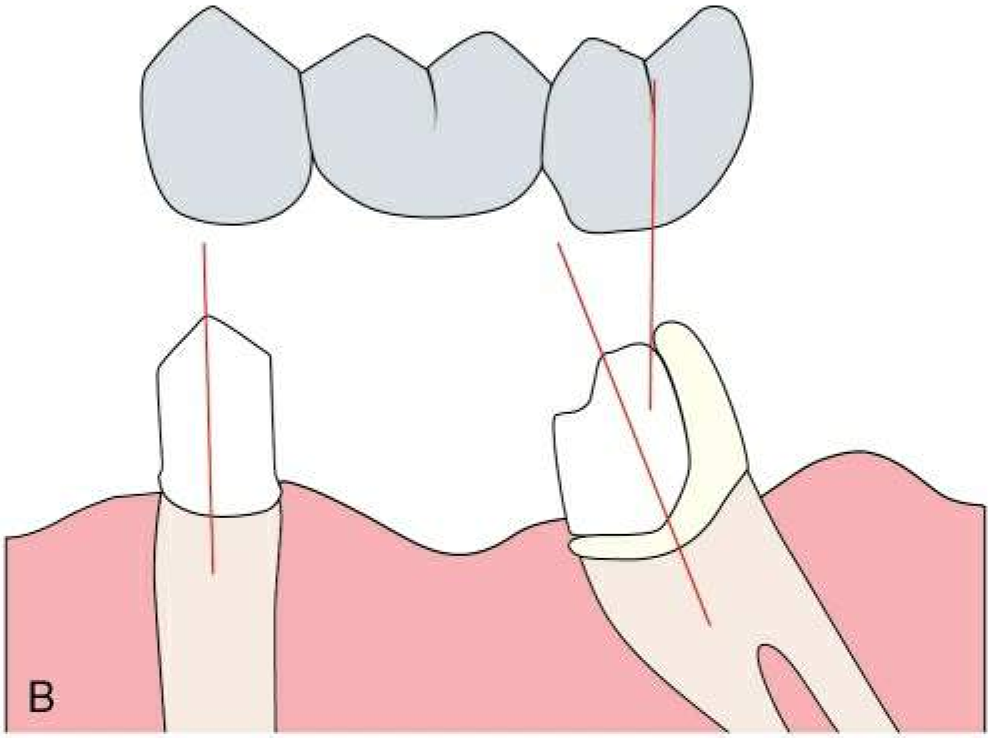


FIGURE 32.5 **(A)** Full veneer retainers used when abutments are parallel. **(B)** Proximal one half crown used in distal abutment to create parallelism.

Condition of the abutment

- If the abutment teeth are in good health, in terms of both periodontium and caries, a partial veneer retainer can be considered as a treatment option.
- In case the abutment is endodontically treated or extensively damaged, a full veneer retainer is recommended.
- If abutments are periodontally weak with exposure of the root surface, conservative resin-bonded retainers are indicated.

Aesthetics

Though partial veneer retainers may not involve the facial surface, their use in aesthetic zones can be questionable when the teeth are thin and metal may be reflected. Secondary caries is also a possibility because of open margins. In such circumstances, full veneer retainers are preferred with either facing or full ceramic coverage.

In case of inadequate pontic space, a full veneer retainer can help better in managing the space to get better aesthetics (Fig. 32.6).

FIGURE 32.6 Inadequate pontic space can be better corrected with full veneer retainers after preparing the teeth to distribute the space.

Preservation of tooth structure

- Partial veneer preparations are more conservative than full veneer preparations.
- The buccal/facial surfaces of the teeth should be preserved for natural aesthetics. Choice should be made depending upon all the factors so that the longevity of the prosthesis is not compromised.
- Even etched cast retainers can be thought of a conservative alternative.

Retention

A molar exerts more force when compared to a premolar, thus it requires more retention. Longer the span, greater is the retention required. In both cases, full coverage retainers offer better retention.

Cost

- Full veneer all ceramic retainers are recommended in cases of anterior tooth replacements. But they are more expensive than metal ceramic and facing retainers.

- Hence if cost is a factor, metal-ceramic restorations can be considered for anterior region and all metal restorations for posteriors.

Pontics

Pontic is the artificial tooth replacing the missing natural tooth. The name is derived from the Latin word *pons* meaning bridge.

Definition: An artificial tooth on a fixed partial denture that replaces the missing tooth restores its function and usually fills the space previously filled by the natural crown.

Ideal requirements of pontics

Following are the ideal requirements of a pontic:

1. Restore function of the replaced tooth.

2. Provide aesthetics and comfort.

3. Should be biologically acceptable.

4. Permit effective oral hygiene.

5. Preserve the underlying residual ridge and mucosa.

6. Have adequate strength to withstand occlusal forces.

Classification of pontics

Pontics can be classified on the basis of mucosal contact, material used and method of fabrication.

i. Mucosal contact

1. With mucosal contact

i. Ridge lap or saddle pontic

ii. Modified ridge lap

iii. Ovate pontic

iv. Conical pontic

2. Without mucosal contact

i. Sanitary/hygienic pontic

ii. Modified sanitary pontic/perelpontic/arc-shaped FPD

ii. Material used

1. All metal pontics

2. All ceramic pontics

3. Metal-ceramic pontics

4. Metal with resin facing pontiffs

5. Fibre-reinforced composite pontics

iii. Method of fabrication

1. Custom-made pontics

2. Prefabricated pontics

Mucosal contact

Depending on the amount of contact the pontic makes with the underlying mucosa it is further classified into the following types.

1. With mucosal contact

Those that contact the mucosa are

i. Ridge lap or saddle pontic

Design

- This pontic derives its name from its shape. It overlaps both the buccal and lingual surfaces of the ridge; hence it is called ‘ridge lap’. It forms a large concave contact with the ridge.
- It simulates the emergence profile of the missing tooth.
- It must not displace the soft tissues or cause blanching, but it should make a snug contact (Fig. 32.7).

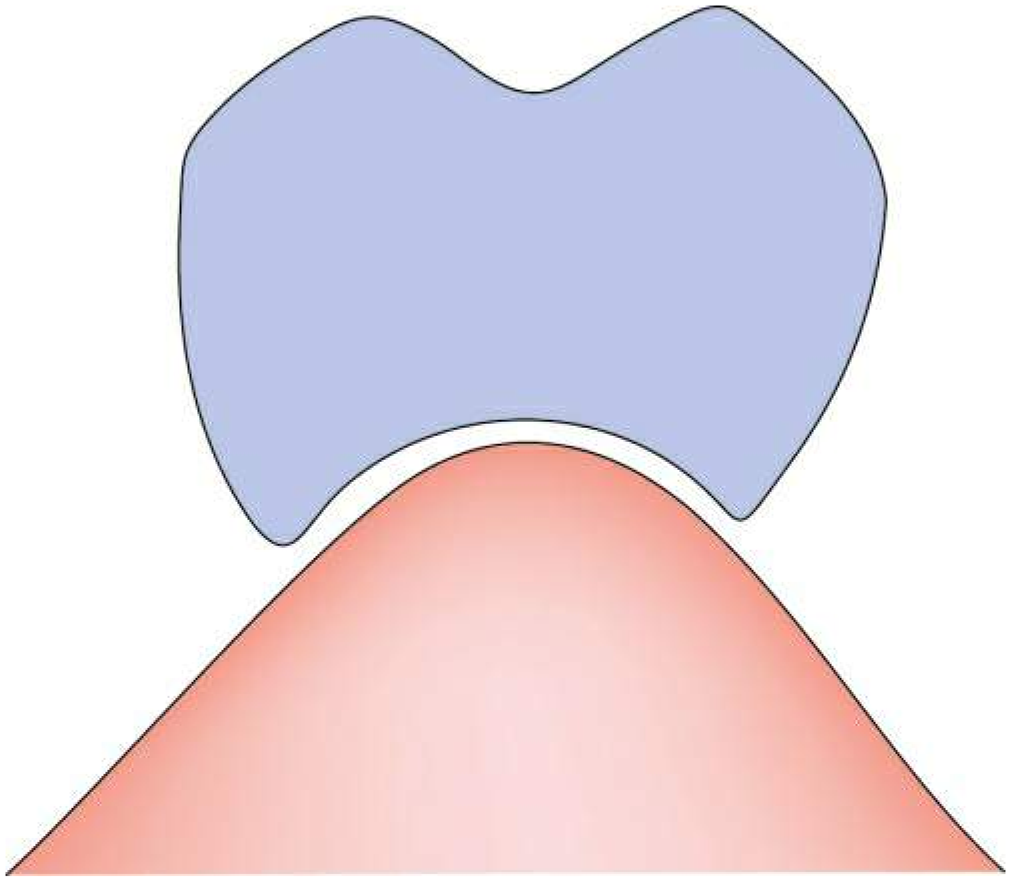


FIGURE 32.7 Ridge lap pontic – proximal view.

Advantage

- The emergence profile of a pontic simulates the adjacent natural tooth; thus, it is aesthetically superior.

Disadvantages

- The gingival surface of the pontic is not accessible by the patient, making it difficult to clean.
- As the gingival surface of the pontic is in contact with the ridge it may sometimes cause tissue inflammation.

Due to the above-mentioned disadvantages, this type pontic is rarely used. It is also recommended that the tissue contacting area of the pontic should be made of highly polished metal or glazed porcelain to facilitate cleansing.

ii. Modified ridge lap

Design

- The pontic does not contact the lingual aspect of the ridge, while facially it is in contact with the ridge and hence simulates the emergence profile of the adjacent teeth.
- It is called 'modified ridge lap' because the gingival surface of the pontic overlaps only the buccal surface of the ridge. To enable optimal plaque control, the gingival surface of the pontic should have no depression or hollow. It should be as convex as possible from mesial to distal. Greater the convexity, the easier it is to clean.
- When viewed from the gingival aspect, the tissue contact should resemble a letter 'T' whose vertical arms end at the crest of the ridge.
- This is most commonly used in areas that have high visibility (Fig. 32.8).

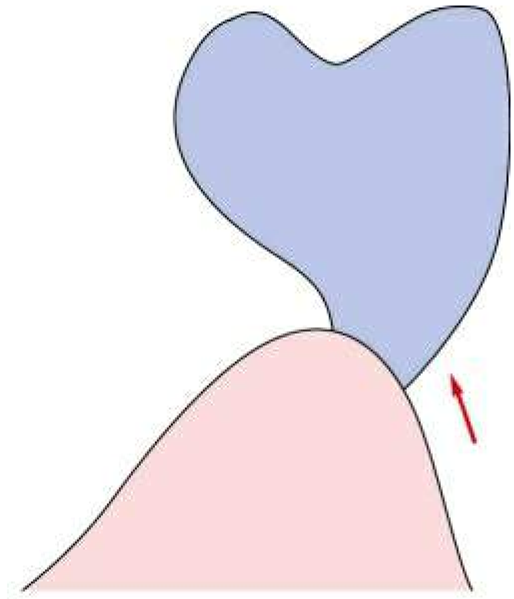


FIGURE 32.8 Modified ridge lap pontic.

Advantages

- Superior aesthetics.
- Lingually, the pontic does not make any contact with the gingival tissue and the contacting surface is convex. This enables the patient to maintain hygiene.

Disadvantages

- Hygiene is inferior to sanitary.

Recommended location

- Appearance zone.

iii. Ovate pontic

An ovate pontic is one of the most aesthetically appealing designs.

Design

- Convex tissue surface of ovate pontic resides within the ridge, which appears as if the pontic is emerging from the ridge.
- The tissue contacting surface of the pontic is bluntly rounded and is set into the concavity within the ridge.
- Concavity in ridge can be created by placing a provisional restoration similar in shape immediately after extraction. It can also be surgically created (Fig. 32.9).

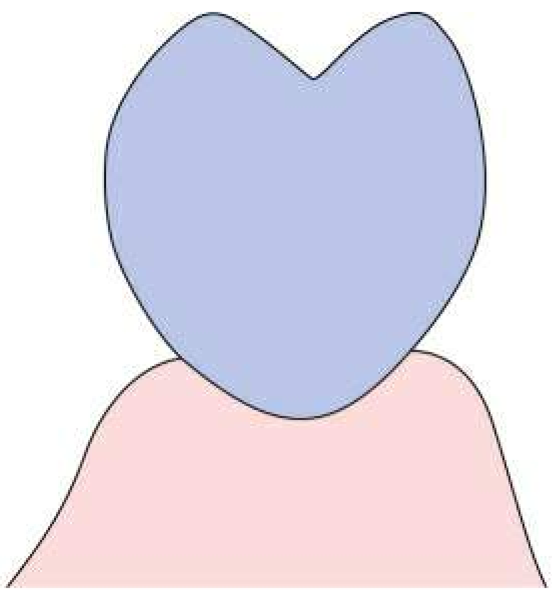


FIGURE 32.9 Ovate pontic.

Indications

- Fresh extraction sockets.
- Anterior missing teeth where aesthetics is of prime concern.
- Broad flat ridges.

Advantages

- Emergence profile of a pontic simulates that of the adjacent natural tooth.
- Pleasing appearance.
- Broad convex geometry is stronger than modified ridge lap pontic.
- As tissue surface is convex in all directions, it is accessible while flossing.

Disadvantages

- Requires surgical preparation.
- Though it can be flossed, meticulous oral hygiene is required to prevent tissue inflammation resulting from large area of tissue contact.

iv. Conical pontic

It is also known as ‘egg-shaped’, ‘bullet-shaped’ and ‘heart-shaped’ pontic. This design is related to the ‘sanitary dummy’ described by Tinker in 1918.

Design

- The conical pontic is rounded with a small tip in relation to the overall size of the pontic.
- It should be made as convex as possible, with only one point contact at the centre of the ridge.
- The facial and lingual contours are dependent on the width of the residual ridge. A knife-edged residual ridge requires flatter contours with a narrow tissue contact area (Fig. 32.10).

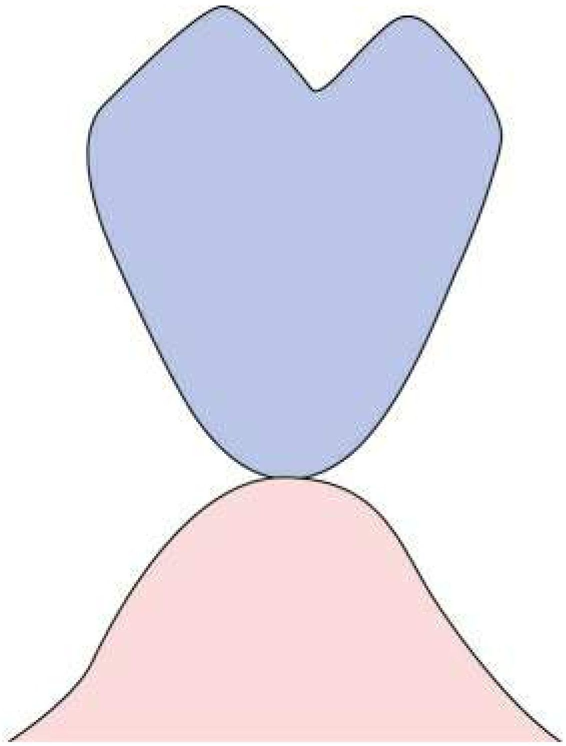


FIGURE 32.10 Conical pontic.

Advantage

- Good access for the oral hygiene.

Disadvantage

- Poor aesthetics.

Indications

- Knife-edged posterior ridges.
- Molars that do not require much aesthetic attention.

Contraindications

- Broad residual edentulous ridge.

- Aesthetic zone as the emergence profile is compromised.

2. Without mucosal contact

i. Sanitary/hygienic pontic

Sanitary pontic is called so because this design allows easy cleansing, as the tissue surface of the pontic remains clear of the residual ridge.

Design

- This design makes no contact with residual ridge thus there are minimal chances of inflammation.
- Occlusogingival thickness of the pontic should be greater than 3 mm and there should be adequate space under it to facilitate cleansing.
- It is frequently made in convex configuration in both faciolingually and mesiodistally.
- The conventional type is called 'the fish belly' design where the undersurface of the pontic is rounded without angles for easier cleansing/flossing because it is difficult to get the floss to pass over a flat undersurface evenly (Fig. 32.11).

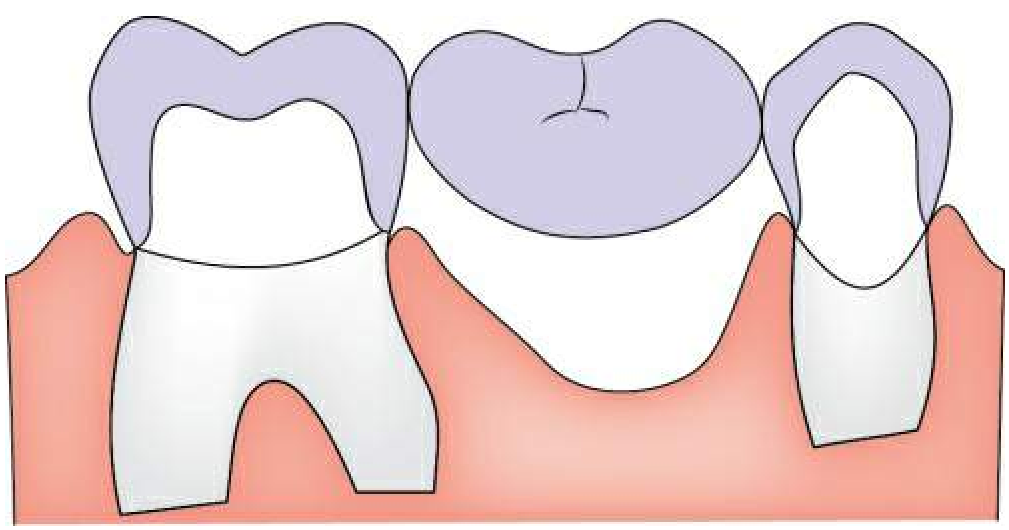


FIGURE 32.11 Sanitary pontic.

Advantages

- Good access for oral hygiene.
- Minimal tissue inflammation.

Disadvantage

- Poor aesthetics.

Recommended location

- Nonappearance zone (usually in the region of mandibular molars) when occlusogingival space is high.

Contraindications

- Appearance zone.
- Less vertical dimension will result in connector failure.

ii. Modified sanitary pontic/perelpontic/arc-shaped fpd

This is an alternative design in which there is a mesiodistal concavity. The undersurface is convex faciolingually and it gives a configuration of the hyperbolic parabolic. This design provides an added strength to the connecters and at the same time allows space for easier cleansing (Fig. 32.12).

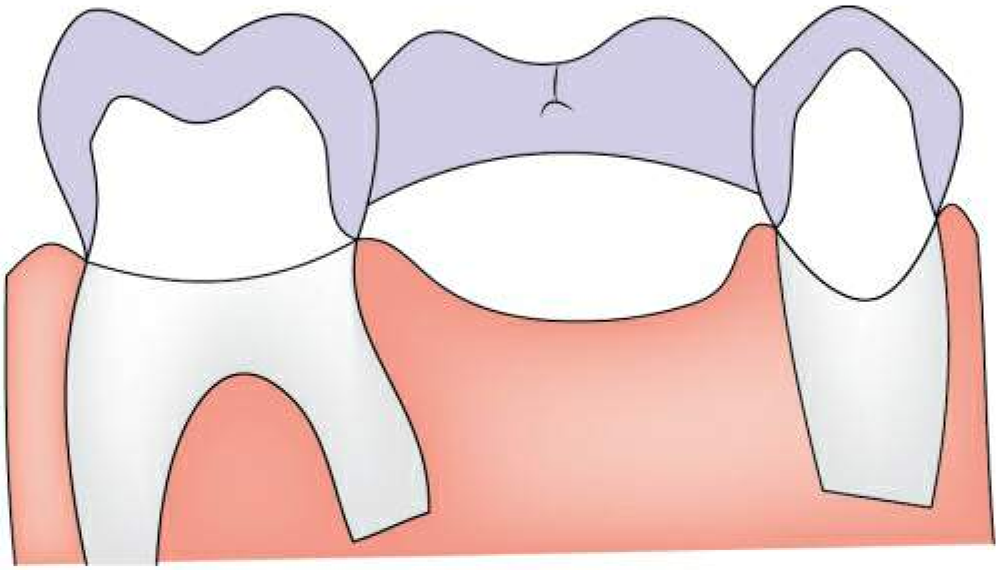


FIGURE 32.12 Modified sanitary pontic.

The various pontic designs along with their respective characteristics are summarized in Table 32.1.

Table 32.1

Summary of pontic types with their characteristics

Pontic design	Figure	Ideal location	Indications	Contraindications	Advantages	Disadvantages
Sanitary/hygienic	32.11	Nonappearance zone – mandibular molars	Nonaesthetic zone and ease of maintenance	Appearance zone Less vertical dimension	Good accessibility for oral hygiene	Poor aesthetics
Saddle/ridge lap	32.7	Not recommended	High aesthetic demands	Patients with poor oral hygiene maintenance and periodontal problems	Aesthetically superior	Gingival surface inaccessible to patient thus difficult to clean Pontic must be highly polished
Conical	32.10	Molars where aesthetics not of concern	Knife-edged posterior ridges or molar teeth	Broad residual edentulous ridge Aesthetic zone	Ideal oral hygiene	Compromised aesthetics
Modified ridge lap	32.8	Appearance zone	Anterior teeth, premolars and sometimes maxillary molars where aesthetic requirements are high	Poor oral hygiene and mandibular posterior teeth	Good aesthetics. Lingual surface is convex and does not contact gingival tissue, enabling hygiene maintenance	Oral hygiene inferior when compared to sanitary pontic
Ovate	32.9	Maxillary teeth – incisors, cuspids and premolars	Fresh extraction sockets Anterior missing teeth or flat broad ridges	Posterior teeth	Most aesthetically appealing, least food entrapment and thus easy to clean	Surgical preparation required Meticulous oral hygiene required

Material used

1. All metal pontics

These pontics are fabricated completely of cast metal with no ceramic or acrylic veneering (Fig. 32.13).

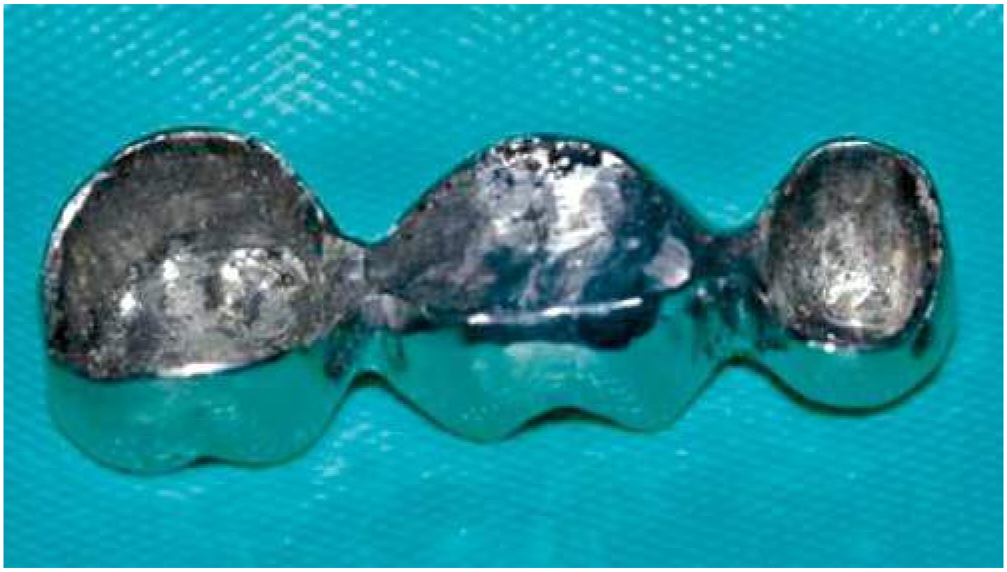


FIGURE 32.13 All metal pontic.

Indications

- Areas that are not of aesthetic concern.
- High stress-bearing teeth like mandibular molars.
- Patients with parafunctional habits like bruxism.

Contraindication

- Cannot be used if aesthetics is of prime concern.

Advantages

- High strength.
- Easy to fabricate and less technique sensitive.
- Can be used if pontic space is inadequate.

Disadvantages

- Poor aesthetics.
- Permeable to oral fluids.
- Galvanism, if two different metals are used in the mouth.

2. All ceramic pontics

These are metal-free pontics that make use of an alternative high strength material like alumina or zirconia instead of metal, around which the ceramic is built (Fig. 32.1B).

Indications

- Areas of prime aesthetic concern like maxillary anteriors.
- Exacting patients who are highly motivated towards quality dental treatment.

Contraindications

- Patients with parafunctional habits like bruxism.
- Reduced interarch pontic space.
- Long-span bridges.

Advantages

- Highly aesthetic.

- Good strength.

Disadvantages

- High cost as it is highly technique-sensitive.
- Lesser strength than porcelain fused to metal pontics.

3. Metal-ceramic pontics

These are pontics that have a metal substructure over which ceramic buildup is done, covering the metal fully or partially (Fig. 32.14A and B).

FIGURE 32.14 **(A)** Metal-ceramic pontic – metal with complete ceramic coverage. **(B)** Metal with ceramic facing pontic.

Indications

- It is indicated in most clinical cases.
- Most commonly used pontic type.

Advantages

- Can be used in almost all clinical situations.
- ***Good aesthetics.***
- ***Adequate strength.***
- ***Biocompatible.***

Disadvantages

- More extensive lab procedure than all metal pontics.
- Difficult to fabricate if the retainers are not metal ceramic.

4. Metal with resin facing pontics

Here, instead of ceramic, acrylic/composite resin is veneered to the facial/buccal surface of the underlying metal.

Indication

- Long term provisional restorations.

Contraindication

- Definitive restorations.

Advantages

- Cost-effective procedure as conventional gold can be used as substructure.
- Easy fabrication.
- Fairly good aesthetics can be achieved.

Disadvantages

- Lower strength as compared to any other permanent restoration.
- Lesser abrasion resistance.
- Easily discoloured over a period of time.
- Permeable to oral fluids.

5. Fibre-reinforced composite pontics

They are composite pontics that are fabricated around a resin fibre that provides strength to the prosthesis.

Indications

- Resin-bonded fixed prosthesis.

- Good oral hygiene.
- Anterior single missing tooth situations.
- Short-span bridges.
- As temporary restorations in young adults till a permanent prosthesis is fabricated.

Contraindications

- Replacement of posterior missing tooth.
- Long-span bridges.
- Deep bite cases.

Advantages

- Easy chair side fabrication procedure.
- Acceptable aesthetics and shade matching.
- Minimal tooth preparation required.
- Can be used in young patients where the pulp chambers are big and full crown preparation may cause pulpal damage.

Disadvantages

- Less strength.
- Cannot be used in cases of multiple missing teeth.

Method of fabrication

1. Custom-made pontics

Most commonly used type of pontics. Each pontic is fabricated according to the patient's ridge contour. Wax patterns are first made which are then cast to obtain the final metal pontic substructure.

Advantage

- They provide superior aesthetics and adaptation of the prosthesis.

Disadvantage

- Extensive fabrication procedure.

2. Prefabricated pontics

- They are commercially available prefabricated porcelain pontics.
- They are used along with a metal backing (usually gold), that is individually customized according to the patient's ridge contours.
- The facing is then glazed and adapted to fit the metal backing to finish the prosthesis.
- Examples are trupontic, sanitary facings, Steele's facings, harmony and Trubyte facings (Fig. 32.15A and B).
- The increased use of custom-made pontics has greatly decreased the commercial making of manufactured facings.

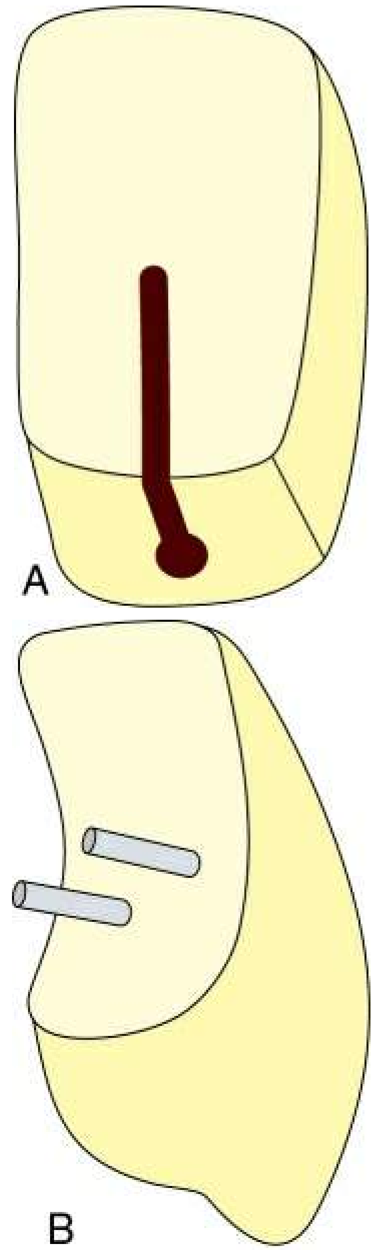


FIGURE 32.15 **(A)** Prefabricated pontic – slot back. **(B)** Prefabricated pontic – harmony pin facing pontic.

Pontic design

The success of the fixed partial denture depends on pontic design. We have to make a substitute tooth that compares favourably in form, function and appearance with the tooth it replaces.

Factors influencing pontic design

1. Edentulous space

Adequate edentulous space must be available to fabricate a pontic. In some cases this space can be reduced because of tilting of adjacent teeth and supraeruption of opposing teeth caused by a prolonged edentulous period. Some space can be regained while preparing the adjacent teeth, but in severe cases orthodontic uprighting and intentional endodontic treatment of opposing tooth may be necessary to get adequate space (Fig. 32.16).

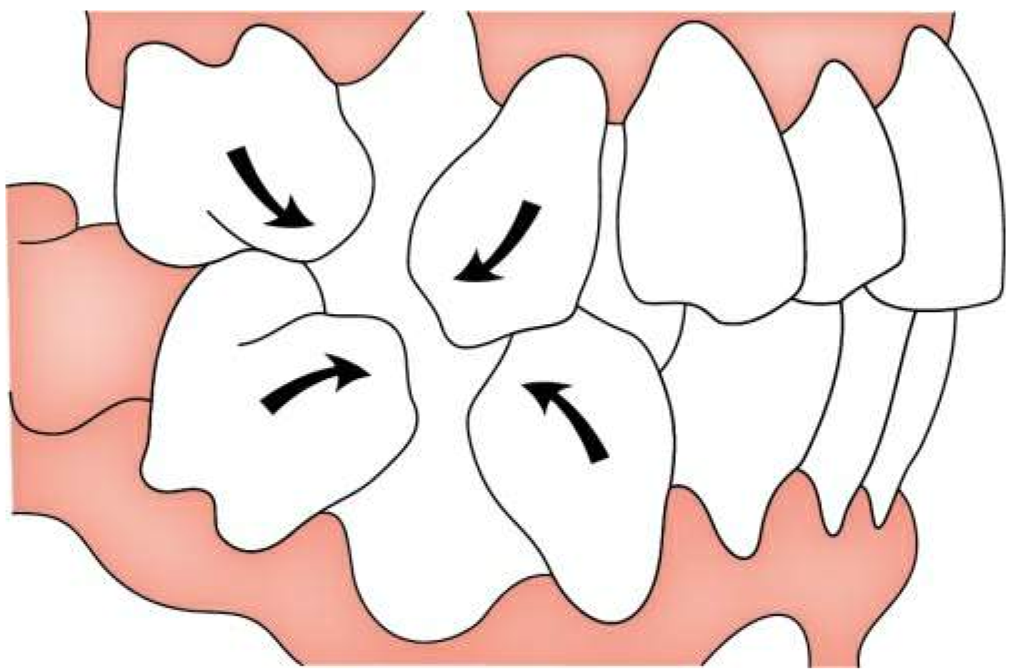


FIGURE 32.16 Tilting and supraeruption reduce the space available for a pontic.

2. Ridge contour

The edentulous ridge should be examined carefully. The amount of destruction will determine the pontic design and indicate the necessity for surgical correction of the ridge. An ideal ridge should be well formed and rounded.

Ridge deformities have been classified into three types by Siebert (Fig. 32.17A–C):

1. Class I: Loss of faciolingual ridge width, normal apicocoronal height.

2. Class II: Loss of height, normal width.

3. Class III: Loss of height and width.

FIGURE 32.17 **(A)** Class I – loss of bone width. **(B)** Class II – loss of bone height. **(C)** Class III – loss of height and width.

A deficient ridge can be masked to a certain extent by adding 'pink gingival porcelain' to simulate interdental papilla, but most often surgical correction with augmentation techniques will produce the best results aesthetically (Fig. 32.18).

FIGURE 32.18 Pink gingival porcelain added cervically to mask deficient ridge.

Design

Analysing each pontic surface will aid in determining the design.

Gingival surface

- This is influenced by the material, location of space and degree of tissue contact.
- Finish of the material is more important than the material itself although highly glazed porcelain has been advocated as the material of choice. Rough surfaces accumulate plaque and cause irritation.
- Aesthetics and hygiene require different gingival shapes of pontic depending on the location:
  - In mandibular posteriors, aesthetics is not a major factor, hence *spheroidal (conical) pontic* is indicated. In the presence of excessive bone loss, a *hygienic pontic* can be utilized. In such cases there should be at least 3 mm of space between the ridge and pontic.
  - In maxillary posteriors *modified ridge lap* design satisfies both aesthetics and function.
  - In the anterior region generally a *modified ridge lap* pontic is indicated.
- A pontic should have only minimum passive contact with the ridge. Excessive pressure causes inflammation, ulceration or tissue proliferation. It should also allow easy cleansability of the tissue

surface (Fig. 32.19).

FIGURE 32.19 Gingival surface should be easy to clean.

Occlusal surface

- The most important factor in determining the design of this surface is provision of a stable vertical stop by suitable placement of functional cusps (maxillary palatal cusps and mandibular buccal cusps).
- Although reduction of size of the occlusal table of pontic has been suggested to decrease the forces on the abutment, it is very clear that since proprioceptive impulses control these forces, this reduction will not help.
- The positions of maxillary buccal cusps and mandibular lingual cusps should not be altered as they prevent cheek biting and protect the tongue, respectively (Fig. 32.20).

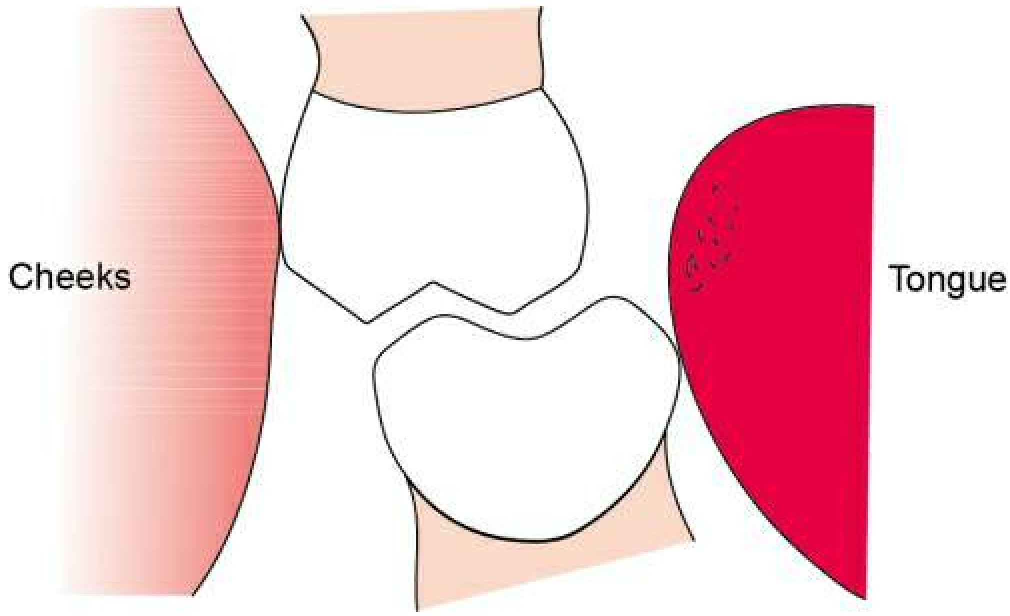


FIGURE 32.20 Proper positioning of maxillary buccal and mandibular lingual clasps prevent cheek biting and protect tongue, respectively.

Interproximal surface

Contoured according to the following considerations:

- Vertical space must be sufficient for interproximal tissues and permit physiologic contour of pontic.
- Maxillary anterior embrasures are minimal for aesthetics should allow sufficient space to prevent papillary impingement (Fig. 32.21).
- Posteriorly, size of embrasure gradually increases to facilitate hygiene.

FIGURE 32.21 Buccal embrasure.

Buccal and lingual surfaces

Buccal and lingual surfaces are determined by aesthetic, functional and hygienic requirements (Fig. 32.22).

- The facial contour should meet aesthetic requirements by maintaining normal contour, alignment and length in coordination with adjacent teeth.
- Lingual contour should meet functional and hygienic requirements. It should harmonize with adjacent teeth from cusp tip to height of contour, and then recedes smoothly and convexly to the facial or buccal tissue contact area.
- Embrasures on lingual are wider than the buccal or facial.

FIGURE 32.22 The labial contour should meet aesthetic requirements by maintaining normal contour, alignment and length in coordination with adjacent teeth.

A pontic design must be intelligibly chosen and precisely made, fulfilling all the requirements, such that the prosthesis will have a long-term favourable prognosis.

Connectors

A connector is that portion of the fixed partial denture that unites the retainer(s) and the pontic(s).

Types of connectors

Fixed partial denture connectors can be broadly divided into two types:

1. Rigid connectors
   - i. Cast connectors
   - ii. Soldered connectors
   - iii. Loop connectors
2. Nonrigid connectors
   - i. Tenon-mortise connectors
   - ii. Split pontic connector
   - iii. Cross-pin and wing connector

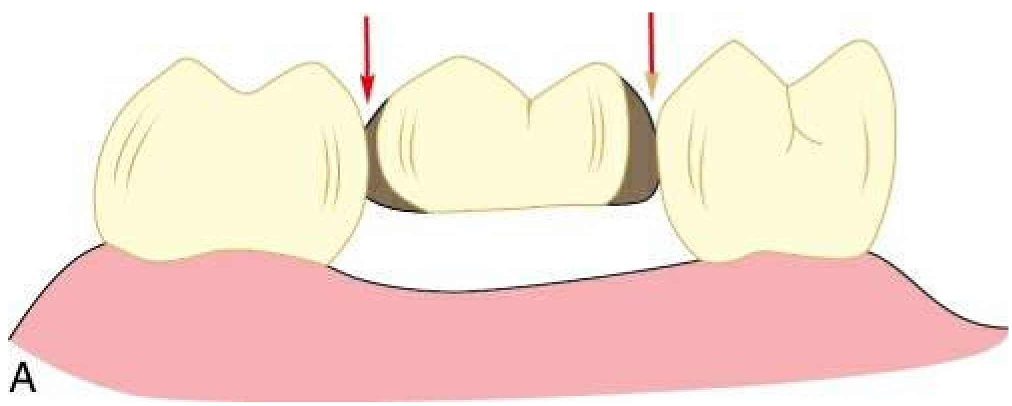
Rigid connectors (fig. 32.23A)

- These connectors do not allow any movement and are indicated when the entire masticatory load is to be transferred onto the abutments.

- They can be directly cast as a part of a multiunit fixed partial denture, or different units can be joined together by means of soldering.

- A loop connector is used in case an existing diastema is to be maintained in the fixed partial denture (Fig. 32.23B). It is mainly cast and care should be taken that the tissue contour is followed during the fabrication of the wax pattern of the connector (see also 'spring cantilever bridge' in Page 438, Chapter 31).

- **Design:** The size, shape, and position of rigid connectors all influence the success of the prosthesis. An ideal connector will enhance ease of cleansing, should have adequate strength and be aesthetically acceptable (Table 32.2 and Fig. 32.24).



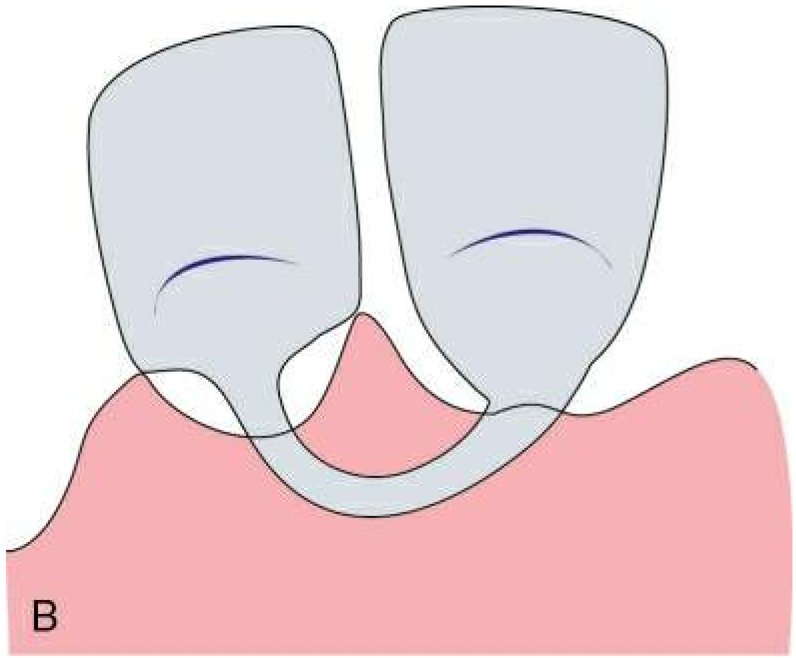


FIGURE 32.23 **(A)** Rigid connector. **(B)** Loop connector.

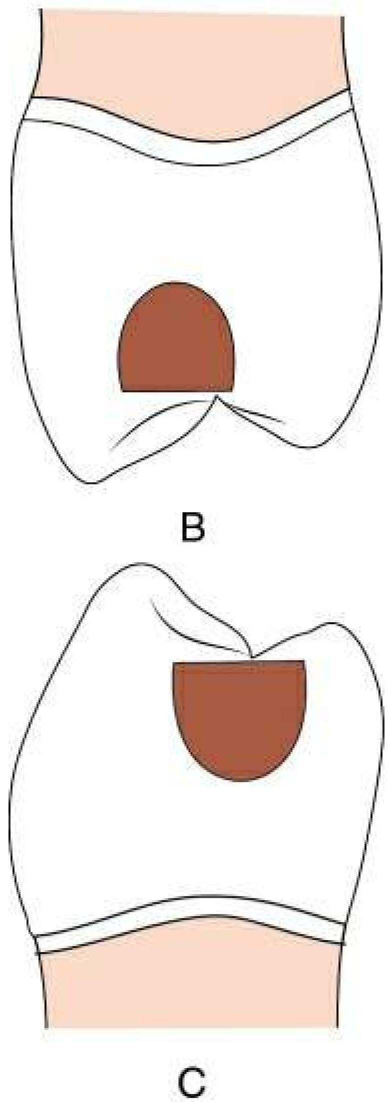


FIGURE 32.24 Configuration and location of connector in **(A)** anteriors, **(B)** maxillary posteriors, **(C)** mandibular posteriors.

Table 32.2

Characteristics of rigid connectors

Connector design	
Size	Large enough to prevent distortion or fracture during function; too large leads to ineffective plaque control and is unaesthetic
Tissue surface	Curved faciolingually for efficient cleaning
Buccolingually	Elliptical
Mesiodistally	Shaped to create a smooth transition from one FPD component to the other, similar to a meniscus
Anterior connector	Placed towards lingual embrasure for aesthetics

Nonrigid connectors

- These connectors allow limited movement between the retainer and the pontic and have little amount of flexibility.
- **Indications:**

  ○ When a parallel path of insertion cannot be achieved in the preparations.

  ○ Pier abutment.

  ○ Periodontally unfavourable abutments to reduce the amount of stress to the tooth. Here, it is called stress breaker.

- **Types:** Almost all of them will consist of a male and a corresponding female component. The shape and configuration of the male and female differ to accommodate the movement between the pontic and the retainer required.

  ○ **Tenon-mortise connector:** The tenon (male component) is attached to the pontic and the mortise (female component) is attached to the retainer. Their alignment must be parallel to the path of placement. They can be made free hand or milled or prefabricated plastic patterns can be used (Fig. 32.25A and B).

- ○ Split pontic connector is used in case of pier abutment situations where a minimal amount of movement is required to maintain abutment health. The pontic is split into mesial and distal halves, which are attached to their respective retainers. A shoe/key is incorporated into the mesial half and the keyway in the distal half. This assembly engages when the FPD is seated in position (Fig. 32.26A and B).
- ○ Cross-pin and wing connectors are similar to the split pontic connector and are used for tilted abutments. The wing is attached to the distal retainer, which is cemented first and pontic to the mesial retainer (Fig. 32.27A–C).

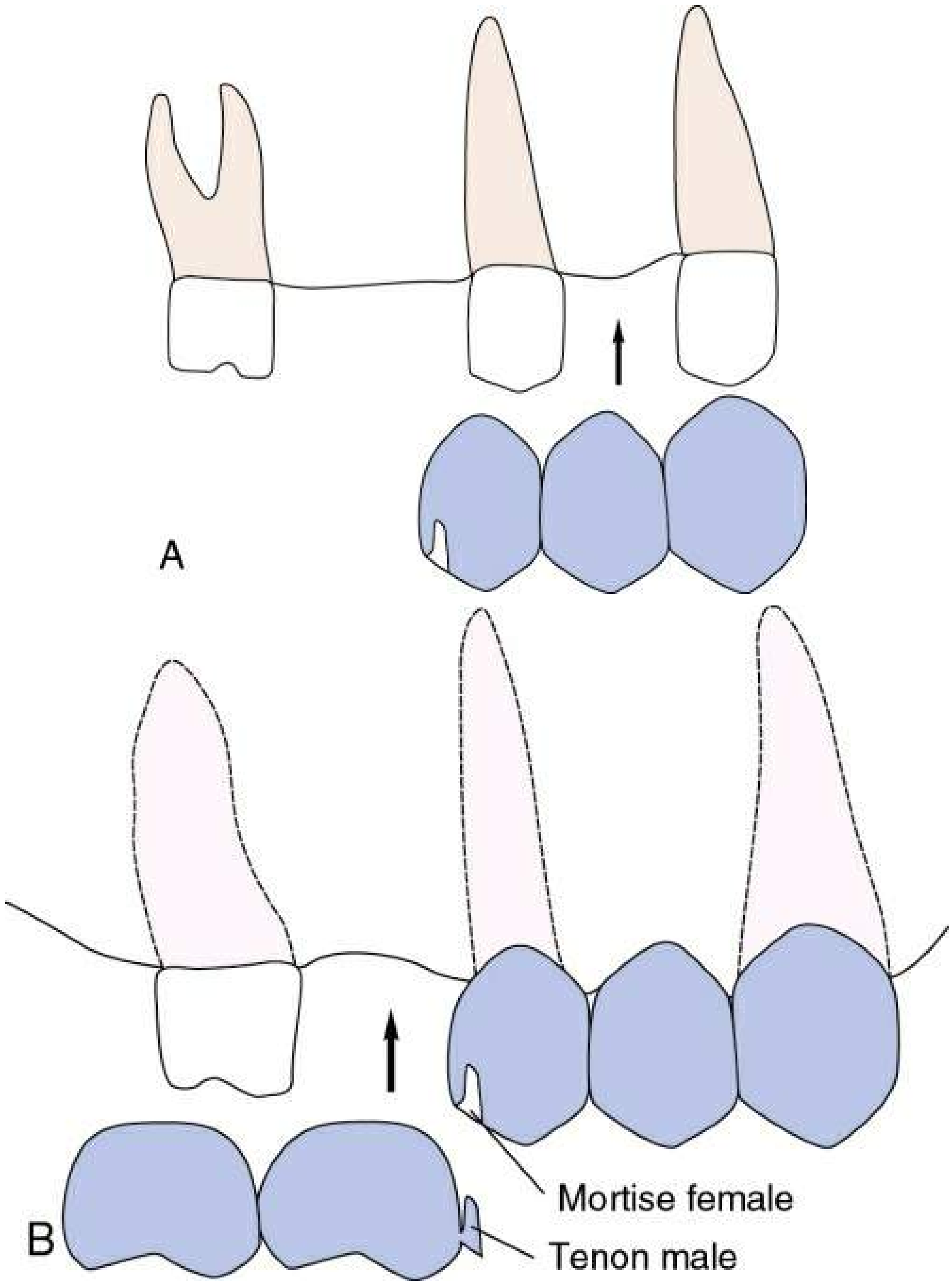


FIGURE 32.25 **(A)** Tenon-mortise connector. Three-unit FPD containing mortise is cemented first. **(B)** Other FPD component containing tenon is cemented next.

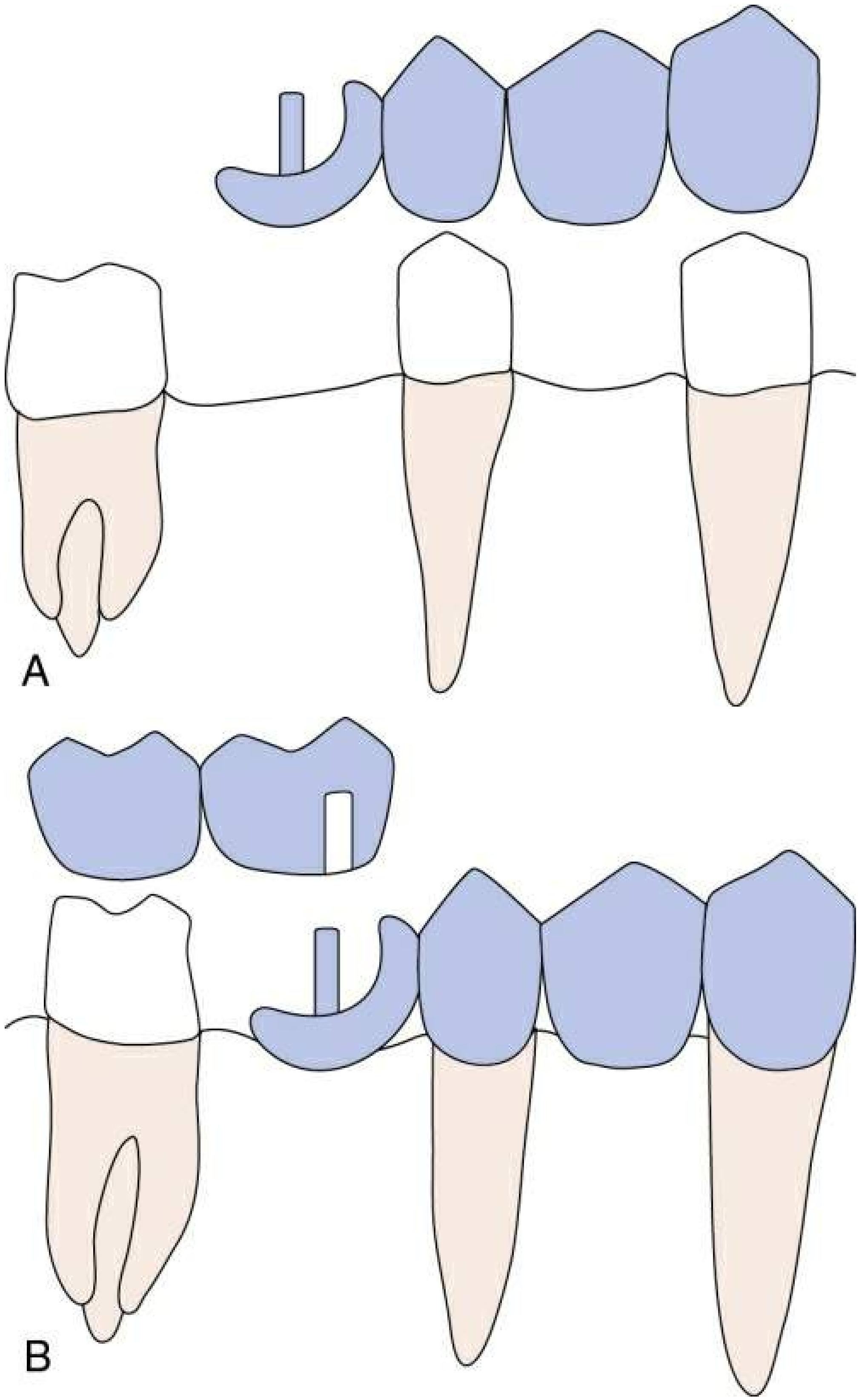
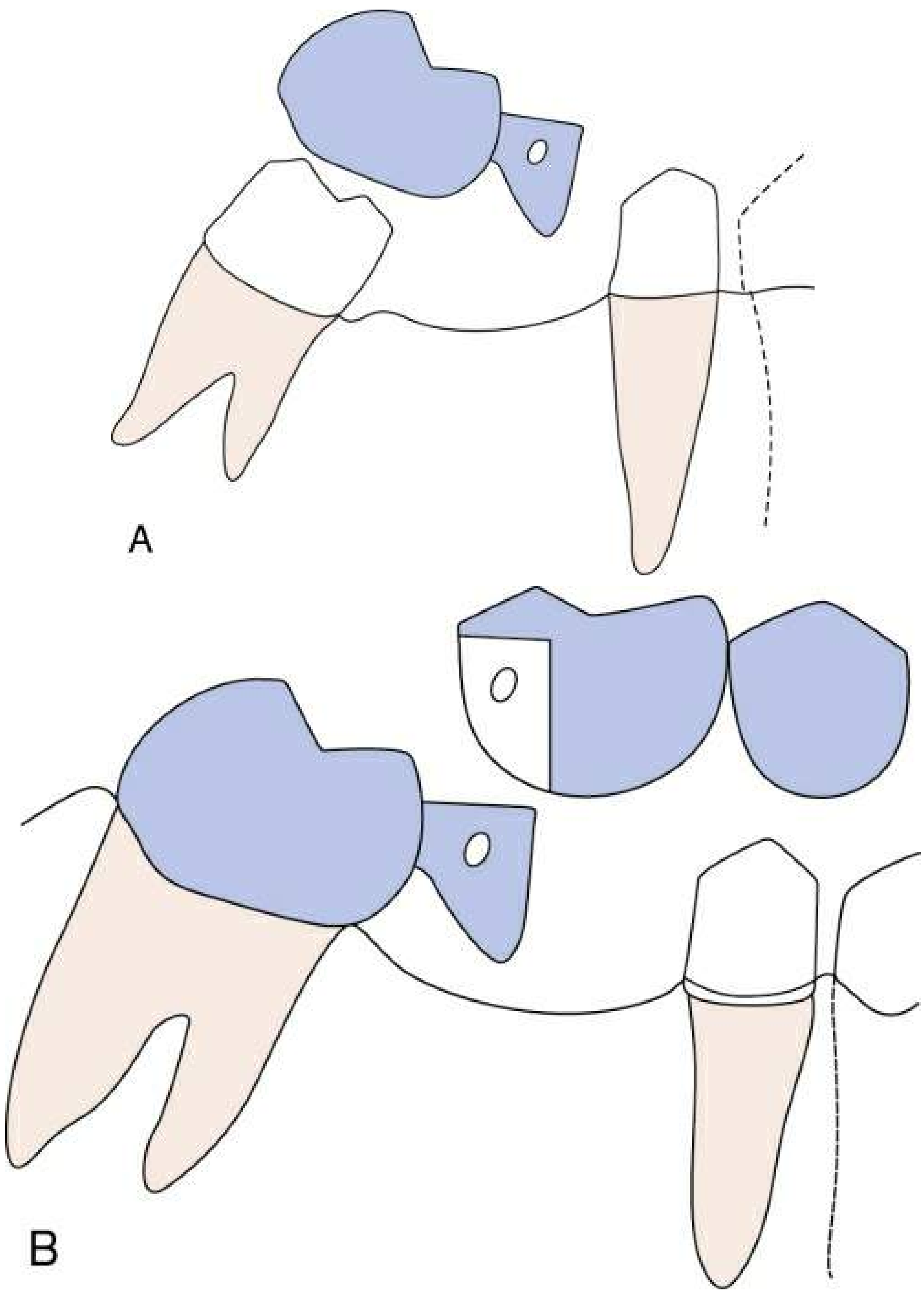


FIGURE 32.26 **(A)** Split pontic connector. Mesial segment

with distal shoe is cemented first. **(B)** Distal segment is cemented next.



A

B

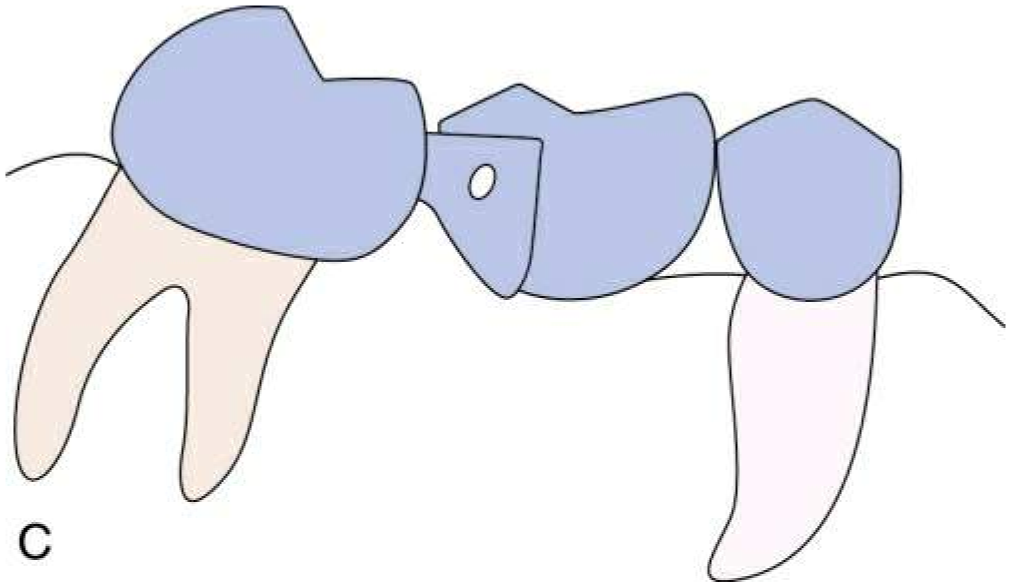


FIGURE 32.27 **(A)** Cross-pin and wing connector. Distal retainer and wing cemented first. **(B)** Retainer pontic segment seated finally. **(C)** Final cementation of cross-pin and wing.

SUMMARY

Components of a fixed partial denture need to be designed within the context of the whole bridge, in harmony with all the principles and fulfilling all the requirements for each part. In the case of pontics it sometimes becomes necessary to compromise with aesthetics for cleansability. Thus, after a thorough examination, the type of prosthesis is determined such that it has a long-term favourable prognosis.

CHAPTER
33

Diagnosis and treatment planning

CHAPTER CONTENTS

Introduction

The objective of any oral rehabilitative procedure is to increase masticatory efficiency, retain the remaining teeth and preserve their supportive tissues, and to achieve the best possible aesthetic result. To achieve these objectives, a treatment plan must be derived from a thorough and accurate diagnosis. Diagnosis aims at the determination of the nature of a disease process. Treatment is any measure designed for the remedy of a disease. An evaluation is made from data obtained from the history, examination, mounted diagnostic casts and evaluation of abutment teeth.

History

This should include the following aspects.

Chief complaint

- Chief complaint should be recorded in the patient's own words.
- The patient perceives the chief complaint as the major problem, hence when proposing a comprehensive treatment plan; special attention should be given to the chief complaint.

  The complaints usually belong to one of the following categories:

1. **Comfort** – in terms of pain, sensitivity or swelling.
2. **Function** – difficulty in mastication or speech.
3. **Social** – brought about by bad odour and taste.
4. **Appearance** – compromised aesthetics in terms of fractured or unattractive teeth, restorations or discolourations.

Personal details

The patient's name, age, sex, occupation, marital status and financial status are noted. These details not only help in developing a rapport with the patient but also provide information regarding the patient expectations and economic status.

Medical history

Obtaining a medical history helps to reveal any underlying systemic condition that may influence the treatment plan. Some common problems are

1. **Cardiovascular:** It may limit treatment appointments, as these patients cannot tolerate long appointments. They may need prophylactic medications before and/or during treatment. Electrosurgical procedures are avoided in patients with pacemaker.

2. **Hypertension:** Adrenaline may be avoided in local anaesthetic and during retraction procedures.

3. **Diabetes mellitus:** If uncontrolled, they are predisposed to periodontal breakdown. This affects the prognosis. Stress of dental appointment can also affect them.

4. **Xerostomia:** Dry mouth patients are prone to caries which can affect the restoration margins. Common causes are drugs and radiation. It affects prognosis.

5. **Medications:** Medications, that the patient is currently taking, are noted to obtain any history of drug allergy or adverse drug reactions. Anticoagulants may need to be discontinued if any surgical procedure is contemplated.

6. **Infectious diseases:** To prevent cross-contamination with dental clinical and laboratory personnel.

7. **Sensitivity to dental materials:** Impression materials and nickel are the most common causes. This may modify treatment plan.

Dental history

Obtaining a dental history provides information about previously rendered dental treatment and highlights the following:

- Genetic predisposition to periodontal disease, malocclusion and facial deformities.
- Cause for tooth loss.

- Complications following dental procedures.
- Patient attitude towards oral hygiene measures.

Clinical examination

General examination

The patient’s general appearance, gait and weight are assessed. Vital signs – body temperature, pulse, blood pressure, respiratory rate are assessed. Any signs of anaemia or jaundice are also checked.

Extraoral examination

- This involves head and neck examination for size, shape and symmetry of head and facial profile and any signs of palpable lymph nodes.
- TMJ evaluation and evaluation of the muscles of mastication are also essential to rule out disease of TMJ. A prerequisite to fixed prosthodontic treatment is a healthy joint and supporting skeletal musculature.

Intraoral examination

Reveals the following information regarding soft tissues, teeth and supporting structures:

- Any pathology of tongue, lips, floor of the mouth, vestibule, cheeks, hard and soft palate.
- Patient’s oral hygiene and periodontal status.
- Restorative status – presence of caries, abrasion wear, erosion and previous restorations.
- Edentulous spaces and residual ridge resorption.
- Evidence of bruxism or parafunctional habits.

- Type of occlusion.

Radiographic examination

- Both panoramic and intraoral radiographs are taken (Fig. 33.1).
- The objectives of radiographic examination are to fulfil the following:
  - Locate areas of infection and any other pathology.
  - Reveal the presence of root fragments, foreign objects, bone spicules and irregular ridge formations.
  - Display the presence and extent of caries.
  - Evaluate the existing restorations with respect to marginal leakage and overhanging gingival margins.
  - Evaluate root canal fillings.
  - Evaluate periodontal condition, alveolar support of abutment teeth, the length and morphology of roots.

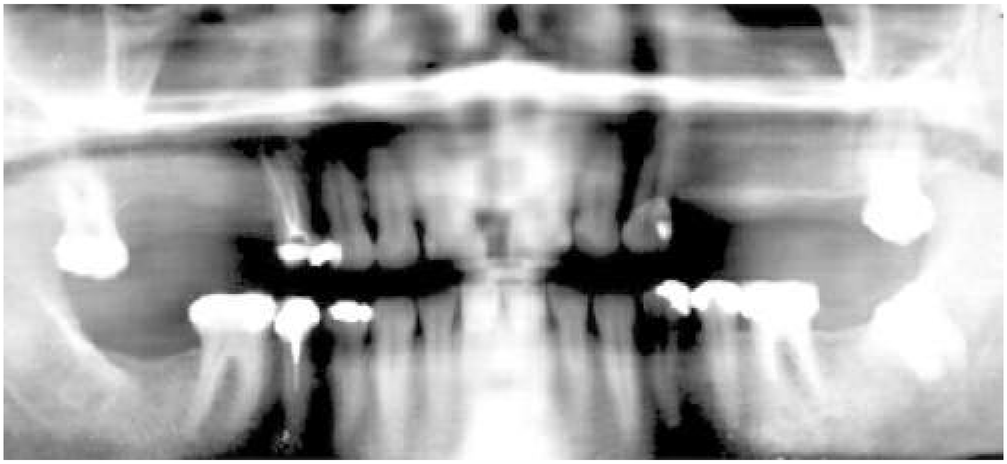


FIGURE 33.1 The picture of OPG showing impacted tooth, endodontic status, restorative status and periodontal status of the teeth.

Diagnostic casts

Importance of mounted diagnostic casts

Diagnostic cast allows assessment of the following:

1. Static and dynamic relationship of teeth without neuromuscular interference.

2. Occlusion from all sides (including lingual).

3. Centric relation and maximum intercuspation.

4. Dimensions of edentulous space.

5. Alignment and angulations of abutment teeth.

6. Occlusal plane.

7. Final outcome of proposed treatment through 'diagnostic waxing'.

Impression making and pouring

The procedure for impression making and fabricating a diagnostic cast is described in detail in Chapter 22. The same is adopted for fixed partial dentures also.

Facebow transfer

The procedure for mounting diagnostic casts using a facebow transfer and interocclusal records on a semi-adjustable articulator is described here using a Hanau spring-bow. This is an earpiece type of arbitrary facebow. The component parts of the facebow are given in Fig. 33.2A–C. Description of facebows and transfer using facia type of facebow has been described in Chapter 6.

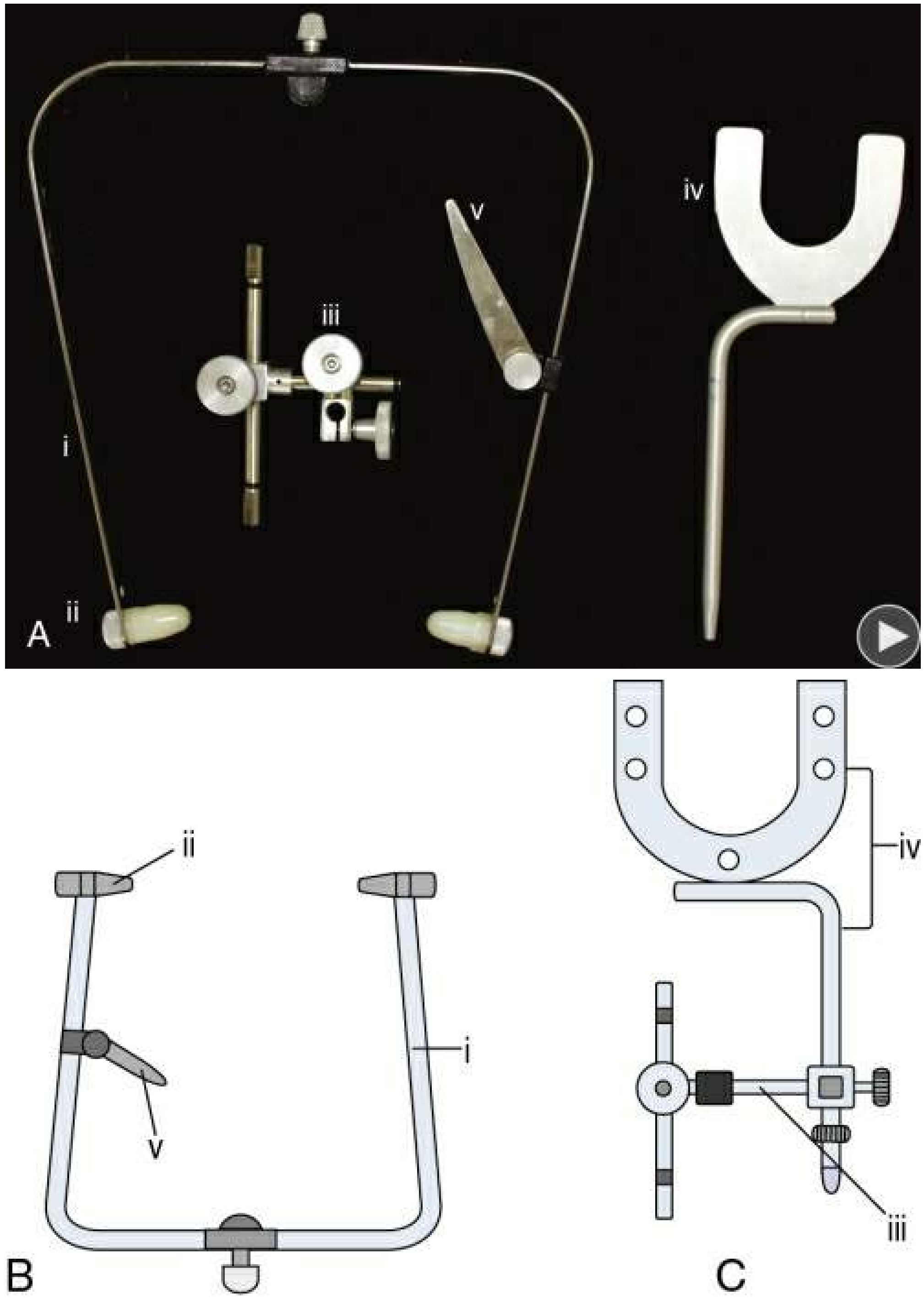


FIGURE 33.2A–C Components of Hanau spring-bow: (i) U-shaped frame, (ii) earpiece, (iii) locknuts (thumbscrews), (iv) bite fork with shaft and (v) orbital pointer.

Transfer using a hanau spring-bow (earpiece type of facebow)

Putty impression material is mixed and adapted over the bite fork, after applying a tray adhesive (Fig. 33.3). Alternately, baseplate wax can also be softened and adapted over the bite fork.

- Position the putty on the bite fork against the maxillary teeth such that the midline coincides and the shaft of the fork is on the patient's left side. The patient is then asked to close the mouth (Fig. 33.4).

- The maxillary putty record is removed once the material sets (Fig. 33.5).

- Insert the vertical rod of the thumbscrew assembly into the facebow frame with the flat side facing the operator (Fig. 33.6A and B). The bite fork with maxillary record is positioned on the maxillary teeth and the shaft is inserted into the thumbscrew assembly and frame, ensuring that the shaft is positioned to the operator's right. The thumb screw is tightened while the patient is gripping the fork with the teeth.

- Open the bow by pulling outward on the arms and swing it down into position with the earpiece placed into the external auditory meatus (Fig. 33.7).

- Locate the infraorbital notch, i.e. the anterior reference point and mark it (Fig. 33.8).

- Position the orbital pointer such that it is at the plane of the anterior reference point (Fig. 33.9).

- Tighten the three thumbscrews in order from left to right (Fig. 33.10).

- Ask the patient to slowly open the mouth and remove the entire assembly from the head. Have a firm hold over the bow while removing it as the bow is made of spring steel and could snap back (Fig. 33.11).

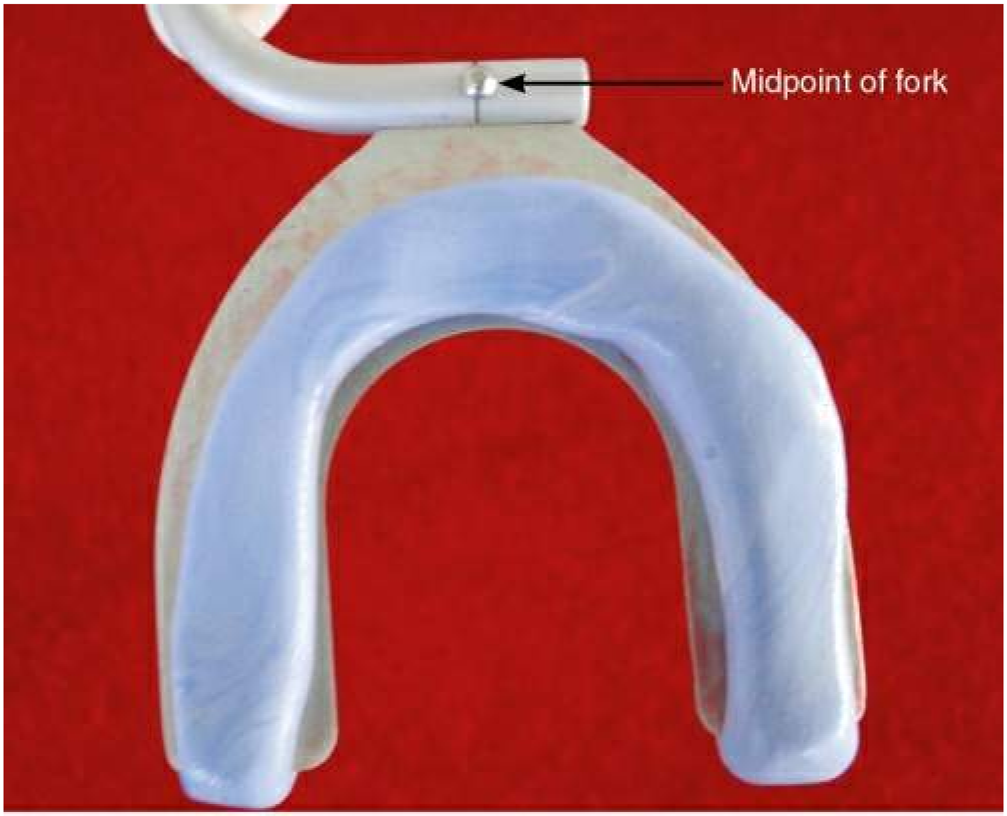


FIGURE 33.3 Putty impression material adapted on bite fork.

FIGURE 33.4 Bite fork with putty material is centred against the maxillary teeth with midpoint coinciding with midline 7 shaft on the patient's left.

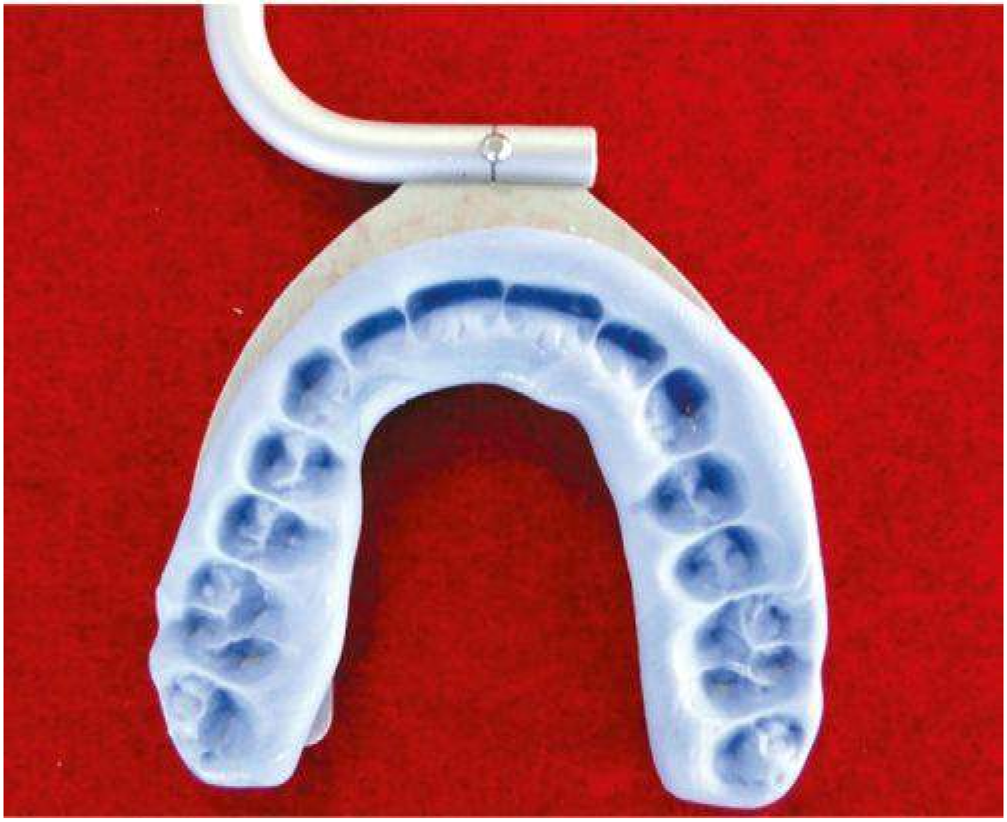


FIGURE 33.5 Maxillary record on the bite fork.

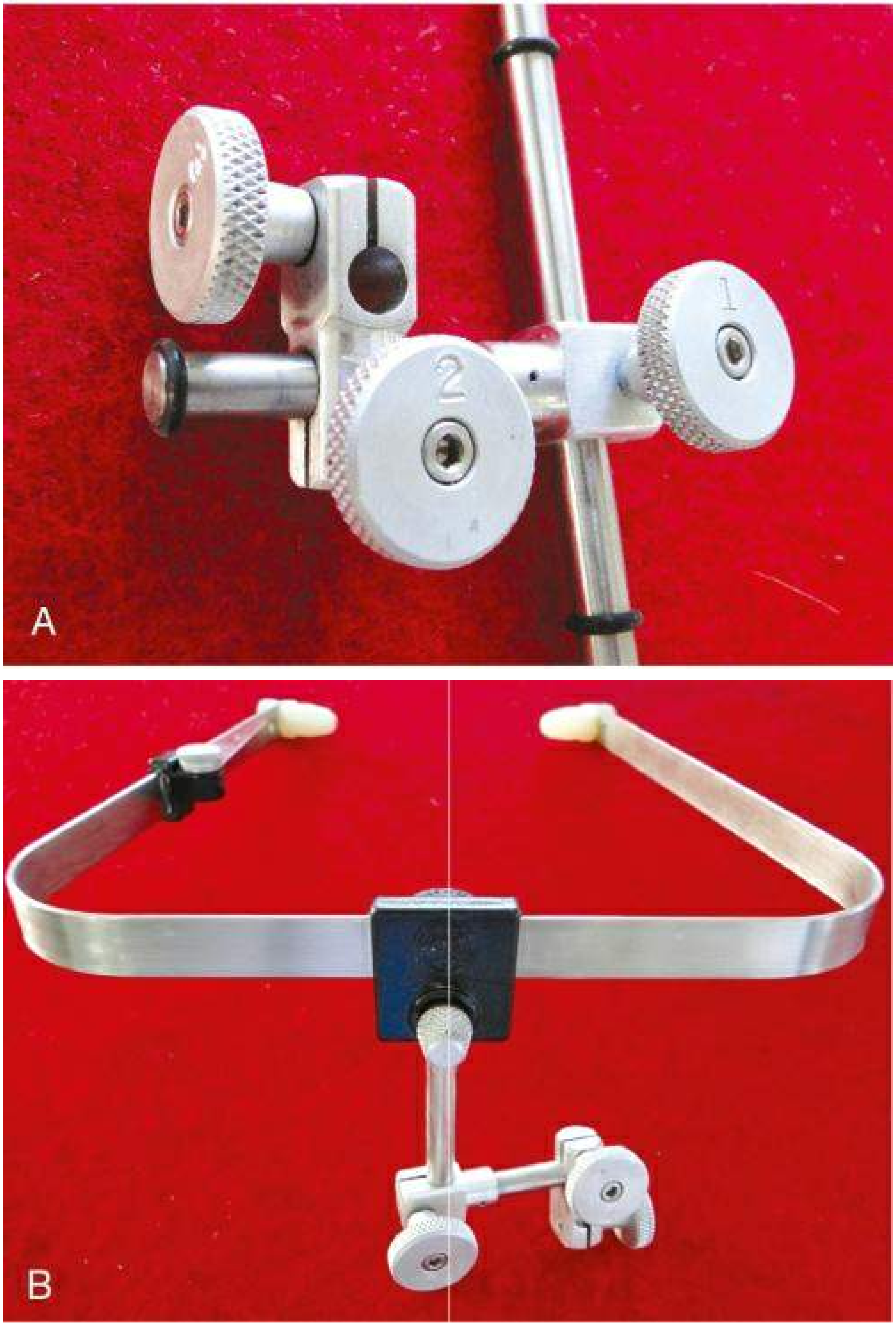
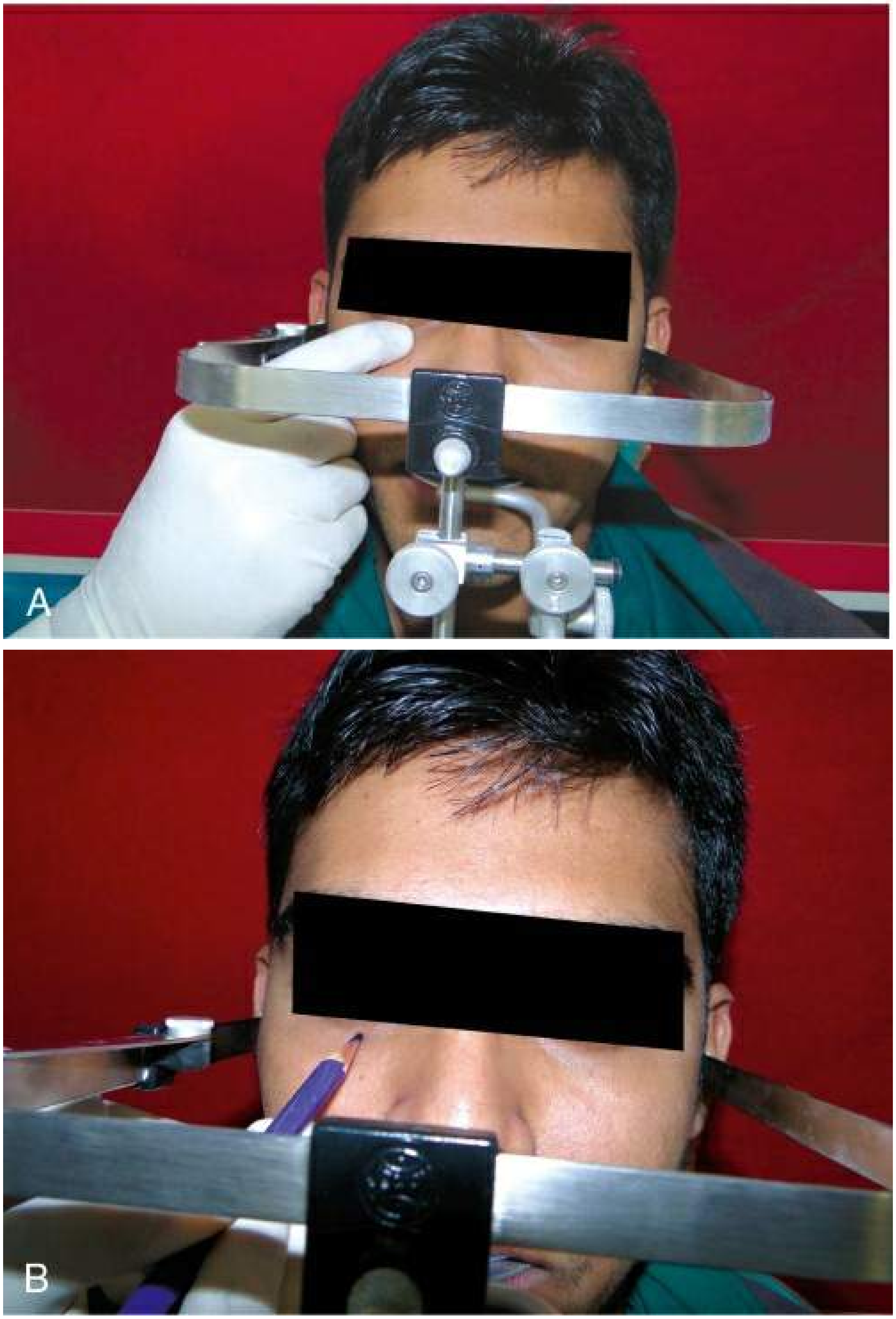


FIGURE 33.6 **(A)** Thumbscrew assembly. **(B)** Vertical rod of thumbscrew assembly positioned into facebow frame.

FIGURE 33.7 Bite fork inserted into frame and ear pieces placed in external auditory meatus.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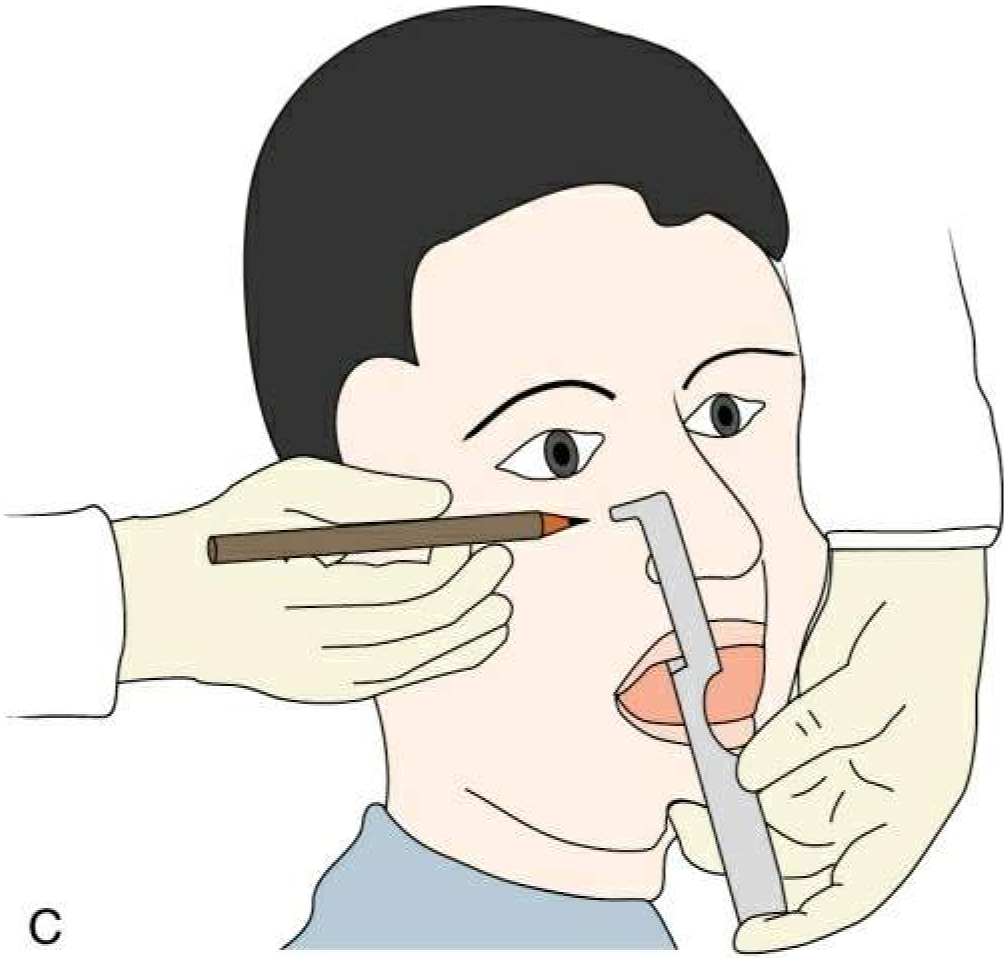


FIGURE 33.8 **(A)** Locating the infraorbital notch by palpation. **(B and C)** Marking the anterior reference point

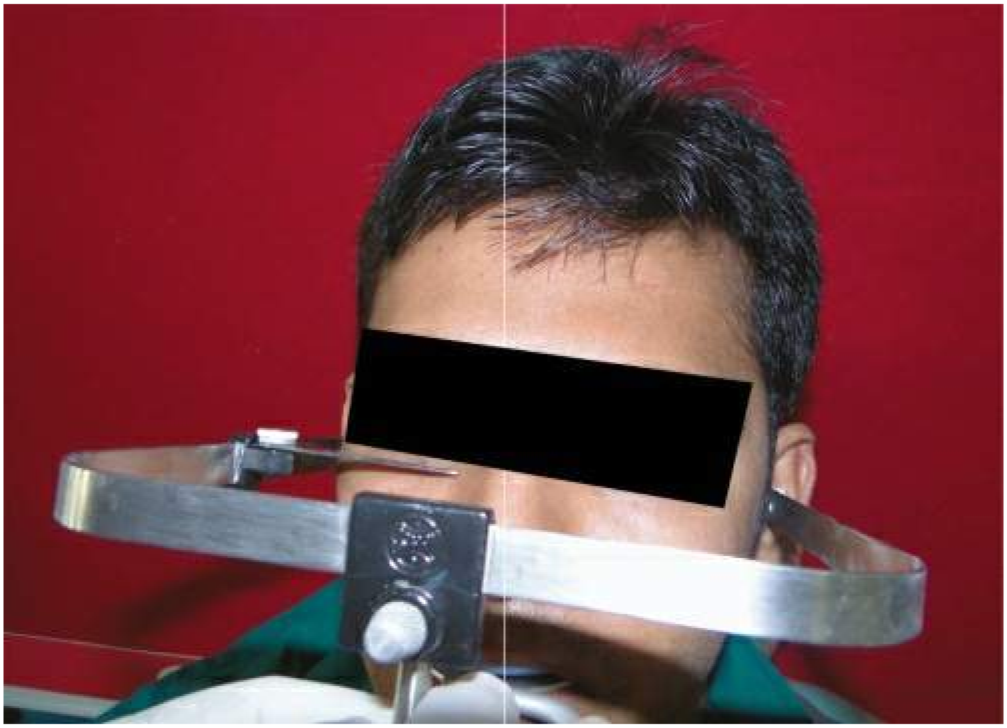


FIGURE 33.9 Positioning the orbital pointer.

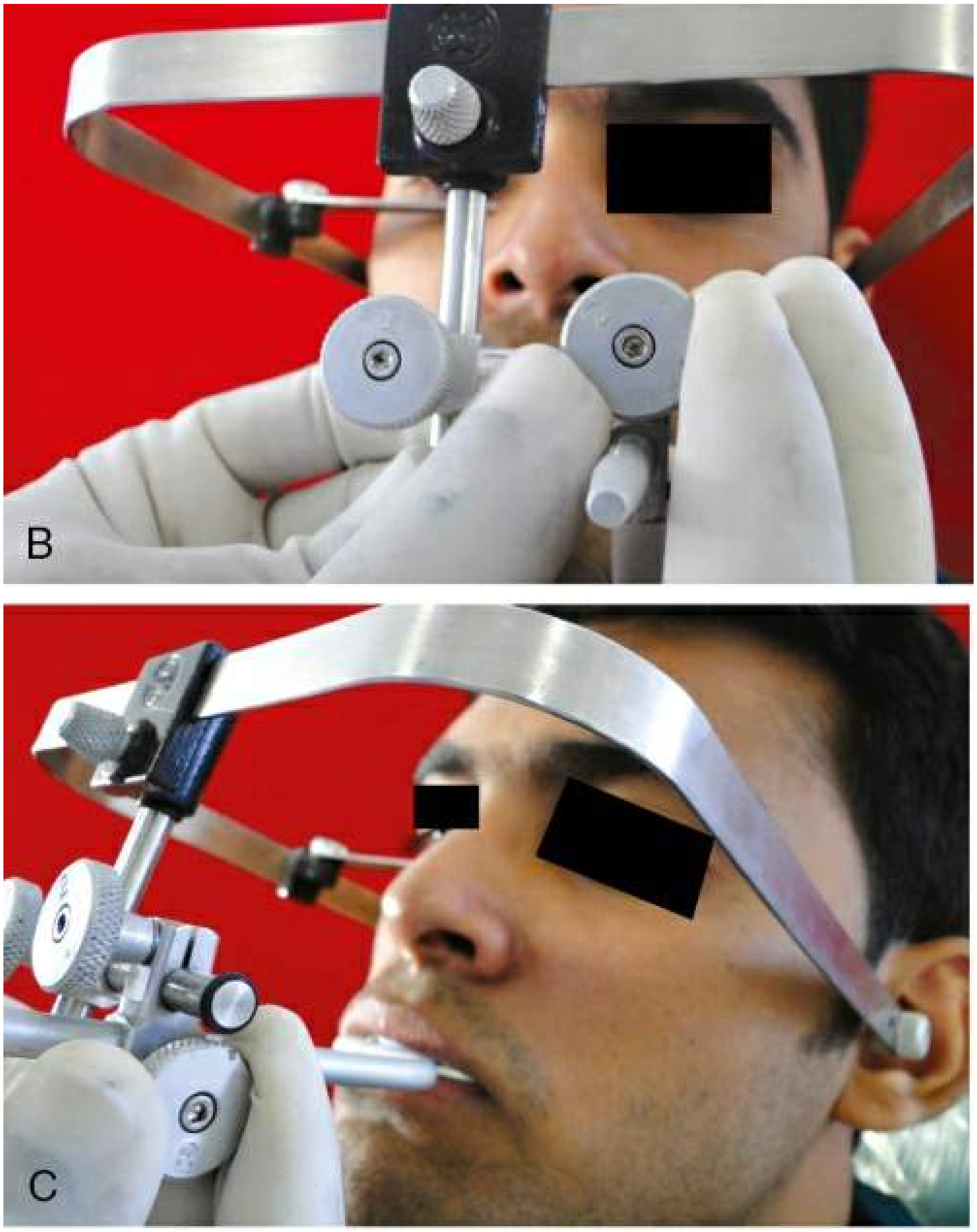


FIGURE 33.10A–C Tightening thumbscrews in order.

FIGURE 33.11 Completed facebow record following removal from mouth.

The maxillary cast is attached to the articulator with the facebow transfer.

Interocclusal records

- The maxillary cast is attached to the articulator by using a facebow, while the mandibular cast is oriented to the maxillary cast using interocclusal records.
- Interocclusal records are used to replicate, on the articulator, the relationship between the maxillary and mandibular arches.
- For diagnostic casts, this helps in determining tooth relationships

and identifying deflective contacts and/or other occlusal discrepancies from the casts on the articulator.

- Interocclusal records are also used for fabricating the final restorations.
- Interocclusal records may be classified as:

  - Centric relation records
  - Maximum intercuspation records
  - Eccentric interocclusal records

Interocclusal registration materials

Ideal requirements

Ideal requirements for interocclusal registration materials are

1. Easy to manipulate.
2. Limited resistance before setting and rigid or resilient after setting.
3. Accurate.
4. No reaction with tissues involved.
5. Minimal dimensional change after setting.
6. Verifiable.

Materials

1. Plaster:

○ Impression plaster is used.

○ Records are accurate, rigid and do not distort.

○ Difficult to handle and brittle.

2. Waxes:

○ Thermoplastic waxes like hard baseplate wax and aluwax are used.

○ Easy to manipulate.

○ Inaccurate, unstable and interfere with mandibular movement.

3. Zinc oxide eugenol pastes

○ ZOE impression paste is used.

○ Accurate, rigid, fluid before setting (minimal interference with mandibular closure) and adheres to carrier.

○ Prolonged setting time, brittle, accurate seating of cast may be prevented by better detail reproduction in record than cast.

4. Elastomers:

○ Silicones and polyether are used.

○ Accurate, fluid, stable after setting, does not require carrier.

○ Difficulty in seating of plaster casts due to resistance to compression and accurate seating of cast may be prevented by better detail reproduction in record than cast.

5. Acrylic resins:

○ Autopolymerizing acrylic resin is used as a single-stop registration.

○ Accurate and rigid after setting.

○ Dimensional instability, strength and rigidity can damage plaster casts.

Records

Three types of records may be obtained to mount the maxillary and mandibular cast with their own indications.

1. Centric relation records

• Used for diagnosis and treatment planning.

• To record jaw relation when:

○ Posterior occlusal stops are absent.

○ Significant occlusal restoration is required.

○ Vertical dimension is subject to change.

Methods of retruding the mandible

To obtain a centric relation record, the mandible has to be manipulated (retruded) into the appropriate position. These have been discussed in Chapter 6.

Techniques

i. Bite wafer technique

- A thermoplastic wax wafer is made with hard baseplate wax. It is warmed and a centric relation record is obtained after manipulating the mandible appropriately. After verification of record, ZOE paste, impression plaster or light-bodied elastomeric impression material is flowed on the indentations and recording is repeated.

- ZOE paste or a bite-registration elastomer can also be used alone with or without a carrier.

- When sufficient number of teeth is not present to provide bilateral stability, the jaw relation is recorded on stabilized bases with occlusal rims as described for RPD.

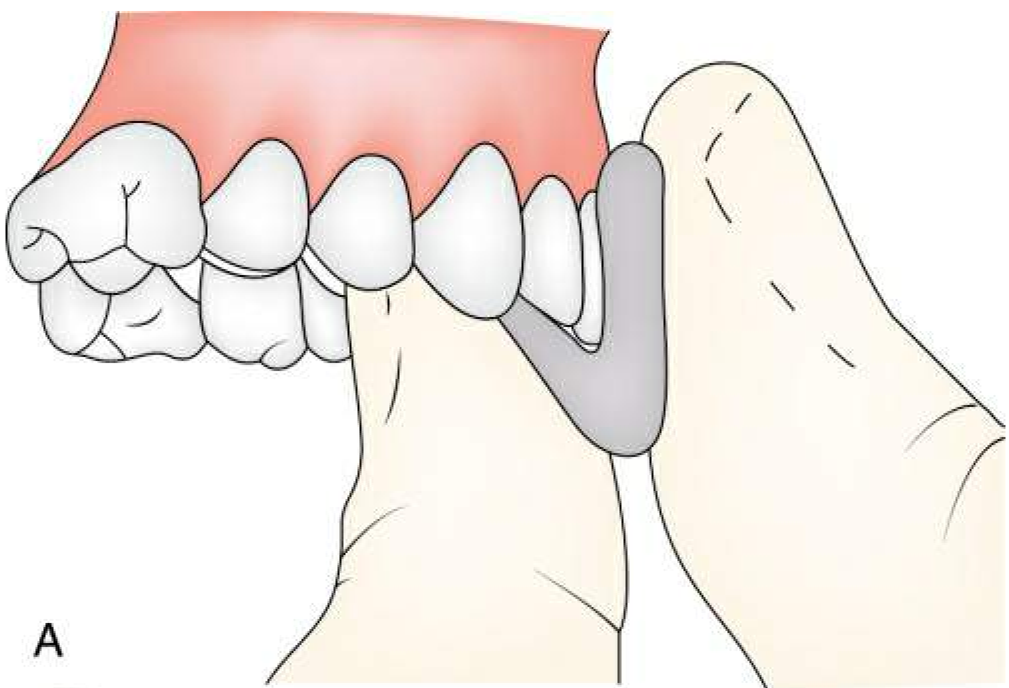
ii. Anterior stop technique

- Accomplished with an anterior deprogramming appliance.

- An anterior jig placed on the maxillary anterior teeth contacts the mandibular anterior teeth thereby deprogramming the influence of the posterior teeth by establishing a predetermined stop to vertical closure with condyles in the optimum position. The jig can be made with autopolymerizing acrylic resin (indirect method on cast) or green stick compound (directly in the mouth).

- Acrylic resin or green stick compound of 2 mm thickness is adapted over the maxillary central incisors in a 'J' shape and is extended to cover the palatal surface (Fig. 33.12A). The patient is made to close in centric and the jig is trimmed till 1 mm of space exists between the posterior teeth (Fig. 33.12B). It should also allow the patient to make smooth eccentric (protrusive and lateral) movements.

- Bite registration material – wax, elastomer, ZOE or a combination of wax and elastomer/ZOE is placed in the posterior space with the jig in position and the patient is again instructed to close in centric or in the indentations created on the palatal surface of the jig (Fig. 33.12C). When set, the record is removed from the mouth and excess trimmed. The maxillary and mandibular casts are placed on the record and mounted. This produces a centric relation record without influence of the teeth.



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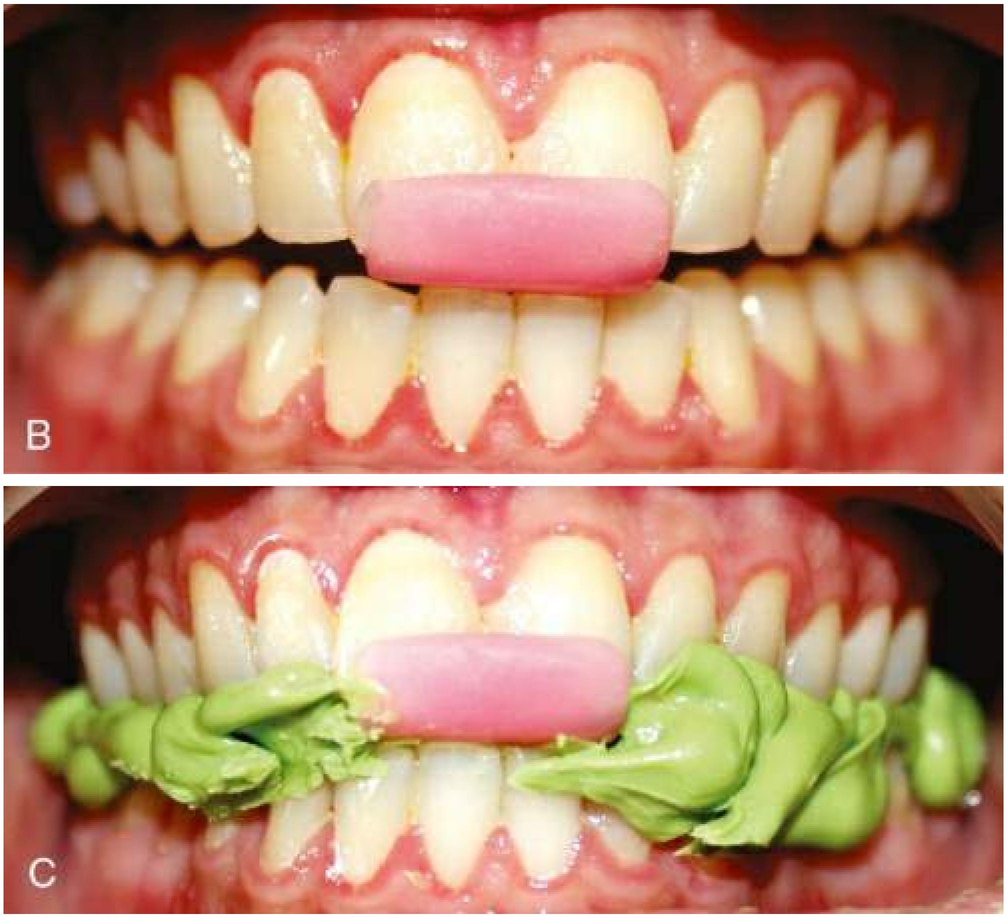


FIGURE 33.12 **(A)** Acrylic resin (or green stick compound) adapted on the maxillary central incisors. **(B)** Anterior resin jig positioned on maxillary central incisors and the jig trimmed until a separation of 1 mm is obtained in the posterior teeth. **(C)** Centric jaw relation recorded with bite registration material.

2. Eccentric records

- These are also called 'check bites' and used for and setting the articular fossa elements on a semi-adjustable articulator.
- Two types – protrusive and lateral, help to adjust the horizontal condylar inclination and lateral condylar inclination respectively. (These are discussed in detail in the section on Complete Dentures.)
- To obtain protrusive record, a bite wafer is placed in the mouth and

the patient is asked to bring the mandibular anterior teeth in an edge to edge position with the maxillary anteriors (Fig. 33.13A).

- To obtain a lateral record, a bite wafer is placed in the mouth and the patient is asked to move the mandibular canine in an edge to edge position with the maxillary canine (Fig. 33.13B). Repeat this for the other side also.

FIGURE 33.13 **(A)** Protrusive record. **(B)** Lateral record.

3. Maximum intercuspation records

- This records the relationship of maxillary and mandibular teeth in maximum intercuspation.
- Indicated for fabricating single crowns and fixed partial dentures with occlusal position and tooth form within normal physiological

limits.

- Hand articulation of casts is usually sufficiently accurate to mount these casts. For this, patient must have at least three interocclusal contacts – two posterior on either side and one anterior.
- But if the distal molar is to be prepared, then a record is obtained. This can be made unilaterally only for the side where the tooth is prepared.
- Any of the previously mentioned bite-registration materials or a combination can be used with/without a carrier to record this position.
- The material is placed in the mouth and the patient is instructed to close in maximum intercuspation (Fig. 33.14). Once set, the record is removed and the casts are articulated.
- The uses or indications of the different types of interocclusal records are given in Table 33.1.

FIGURE 33.14 Maximal intercuspation record.

Table 33.1

Indications of various interocclusal records

Centric relation records	Maximum intercuspation records	Eccentric interocclusal records
For diagnosis and treatment planning hen adjustment or reorganization of occlusion is required such as increasing the vertical dimension r restoration of a significant portion of occlusion	Casts that are used for the fabrication of restorations for a small portion of the occlusion are attached to the articulator in a position of maximum intercuspation Mounting them in centric position could result in a restoration with built-in interference	Includes protrusive and lateral interocclusal records Used to set the condylar guides of a semi-adjustable articulator close to the anatomic limits of the temporomandibular joints.

Selection of articulator

Articulator selection depends on the complexity of the restoration being planned. Table 33.2 summarizes the indications of various articulator types.

Table 33.2

Types of articulators and their indications in fixed partial dentures

Articulator	Indications
Nonadjustable articulator (classes I and II)	Single-tooth restorations
Semi-adjustable articulators (class III)	Diagnostic assessment Most fixed partial denture patients
Fully adjustable articulator (class IV)	No anterior guidance Full mouth rehabilitation Extensive occlusal pathology

Mounting of diagnostic cast

Diagnostic casts are mounted on a semi-adjustable articulator with a facebow transfer. The maxillary cast is first mounted with the facebow record, then the mandibular cast is attached to the maxillary cast with the interocclusal record. Procedure for mounting the casts on Hanau Wide-Vue articulator is described below. To understand the various terminologies, please refer to Chapter 6.

Mounting of maxillary cast with facebow transfer on articulator

The facebow record made with Hanau spring-bow is attached to the articulator; however, before mounting the facebow, the articulator must be zeroed.

Steps in zeroing of articulator

1. Set the horizontal condylar inclination at 30° on each side (Fig. 33.15).

2. The 'Bennett angle' set at 30° (Fig. 33.16).

3. Adjust the incisal pin to align the midline marking of the upper member of the articulator (Fig. 33.17): The incisal pin serves as the forward control of the articulator, maintaining the vertical stop.

4. Adjust incisal guide table to zero degrees and slide the incisal table such that the chisel end of the incisal pin aligns with the zero indicating line on the centre of the table (Fig. 33.17).

5. Attach the mounting plates to the articulator.

FIGURE 33.15 Horizontal condylar inclination is set at 30°.

FIGURE 33.16 Bennett angle is at 30°.

FIGURE 33.17 Incisal pin and table adjusted.

Transferring the facebow assembly to the articulator

After zeroing the articulator the obtained facebow record is transferred to the articulator.

Following are the steps in transferring facebow assembly to articulator:

1. The earpiece, representing the external auditory meatus is inserted into the auditory pin, on either side of the articulator (Fig. 33.18A and B). As discussed in Chapter 6, this is behind the condylar centre to compensate for placing the ear piece in the external auditory meatus.

2. The facebow is attached to the articulator (Fig. 33.19).

3. The orbital pointer (anterior reference point) is aligned with the orbital indicator or to the bottom of the mounting plate (Fig. 33.20).

4. The bite fork is adequately supported with a cast support accessory provided along with the spring bow (Fig. 33.21A and B).

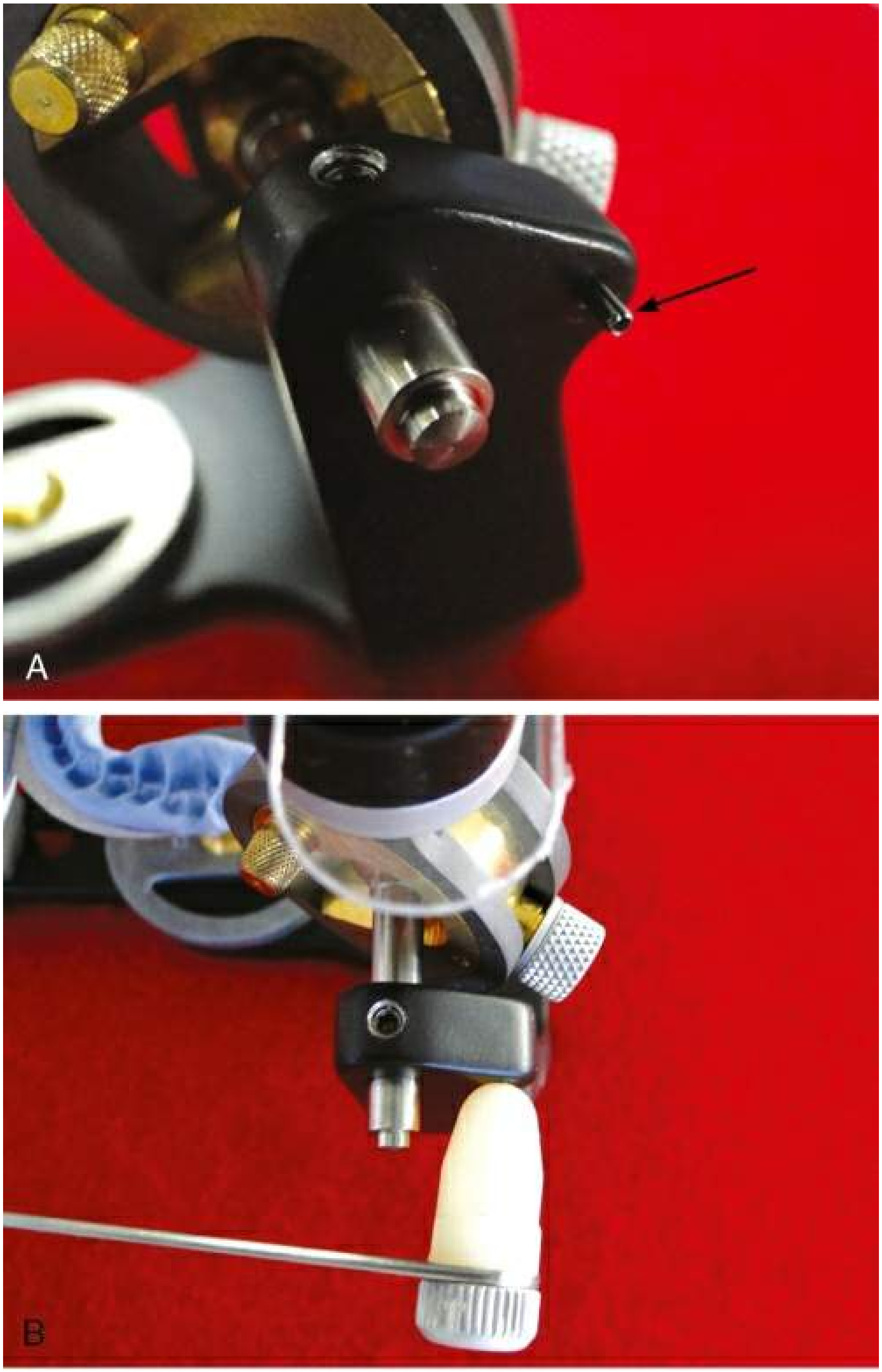


FIGURE 33.18 **(A)** Auditory pin. **(B)** Earpiece inserted into auditory pin.

FIGURE 33.19 Facebow is attached to the articulator.

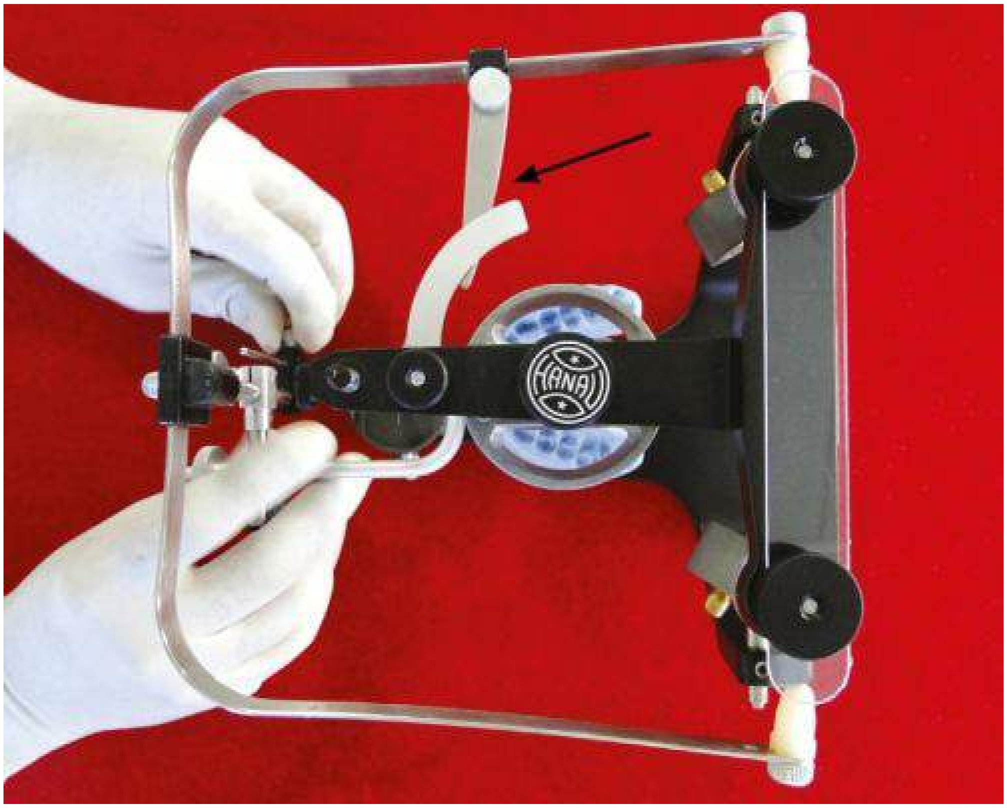


FIGURE 33.20 Orbitale pointer aligned with orbitale indicator.


A

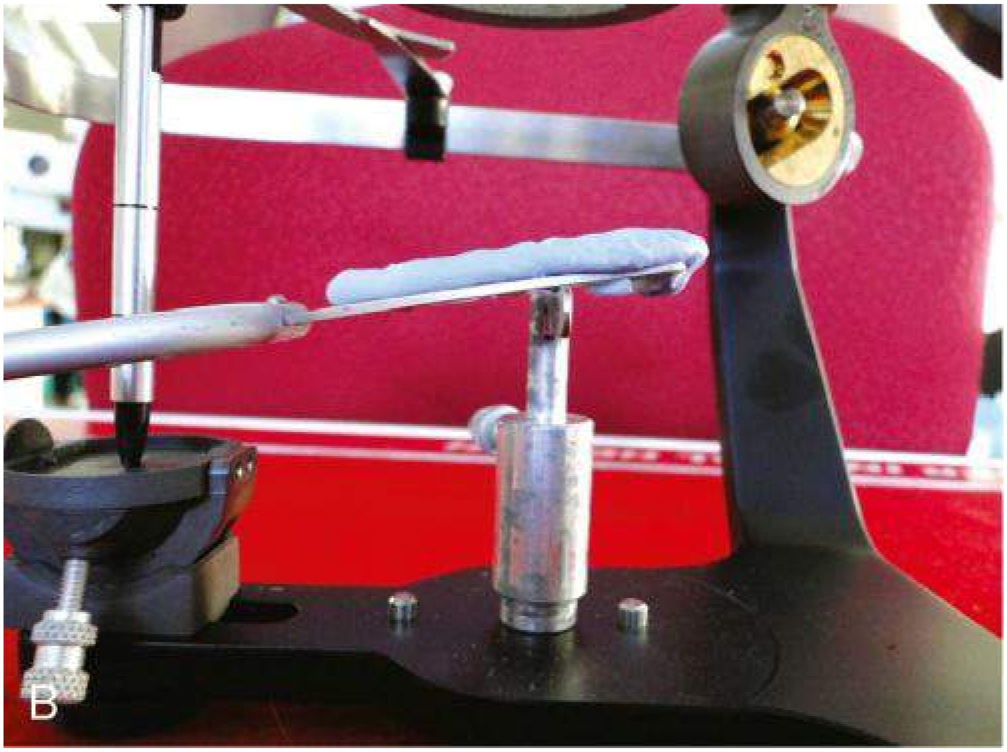


FIGURE 33.21 **(A)** Cast support accessory. **(B)** Bite fork is adequately supported with a cast support accessory.

This maintains the position of the bite fork and supports its weight while mounting.

Mounting and securing the maxillary cast

After attaching the facebow to the articulator, the maxillary cast is then mounted on the upper member as follows:

- Detach the facebow frame from the bite fork assembly and articulator (Fig. 33.22).
- Place the vertical rod of the assembly into the hole at the front of the mounting guide. Seat the maxillary cast into the indentations of the record on the fork (Fig. 33.23).
- The upper member of the articulator is swung open. Mix plaster and place it on the base of the cast (Fig. 33.24A and B).
- Immediately closed down the upper member until the incisal pin is

resting on the mounting guide or the anterior table (Fig. 33.25).

- Remove the bite fork assembly and mounting guide after the stone sets. Attach the lower mounting plate to the articulator (Fig. 33.26).

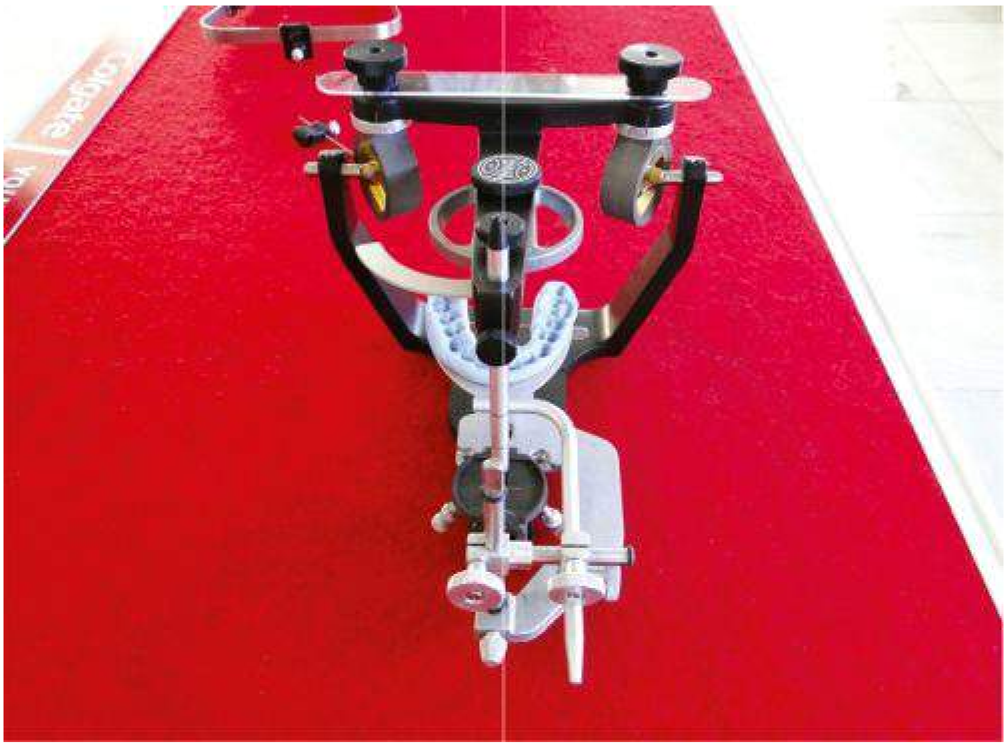


FIGURE 33.22 Frame is detached from the bite fork assembly.

FIGURE 33.23 Vertical rod positioned into slot on the mounting guide.

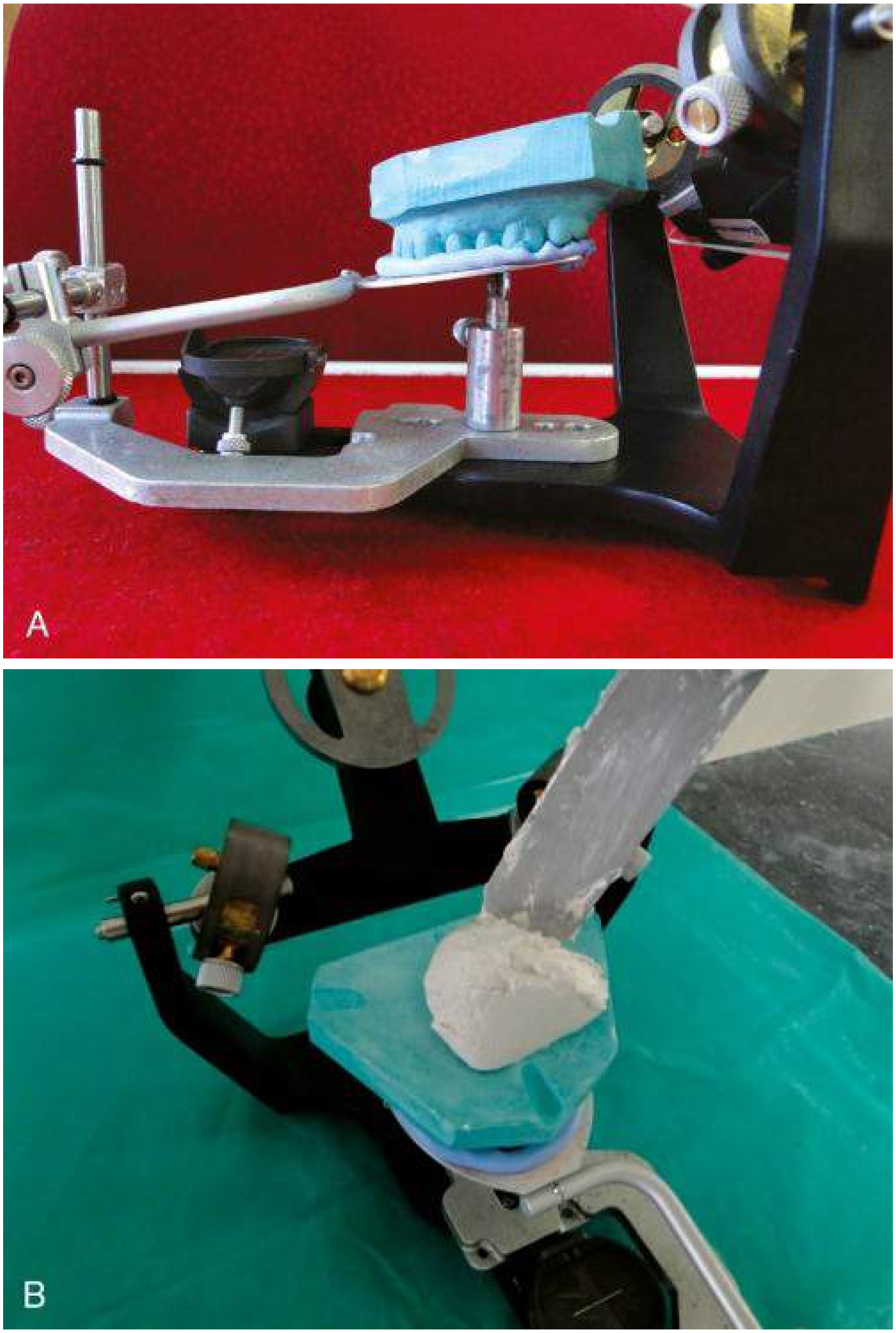


FIGURE 33.24 **(A)** Maxillary cast is seated into the record indentations. **(B)** Plaster is mixed and placed on the base of the cast.

FIGURE 33.25 Upper member is closed into the soft stone until the incisal pin rests on the anterior table.

FIGURE 33.26 Bite fork assembly is removed from the facebow after mounting stone is set.

Mounting of mandibular cast

After mounting the maxillary cast on the upper member, the mandibular cast is mounted on the lower member.

Steps in mounting mandibular cast:

- Raise the incisal guide pin by 1–2 mm to compensate for the thickness of the interocclusal record.
- Invert the articulator on the benchtop. Place the wax maximal intercuspal or centric record on the maxillary cast. Then position the mandibular cast into the record (Fig. 33.27).
- Mix and place plaster on the base of the cast and the mounting plate (Fig. 33.28).
- Hinge the lower member into the soft mounting stone until the incisal guide pin rests firmly against the incisal guide. Allow plaster

to set, trim the excess and complete the mounting. (Fig. 33.29).

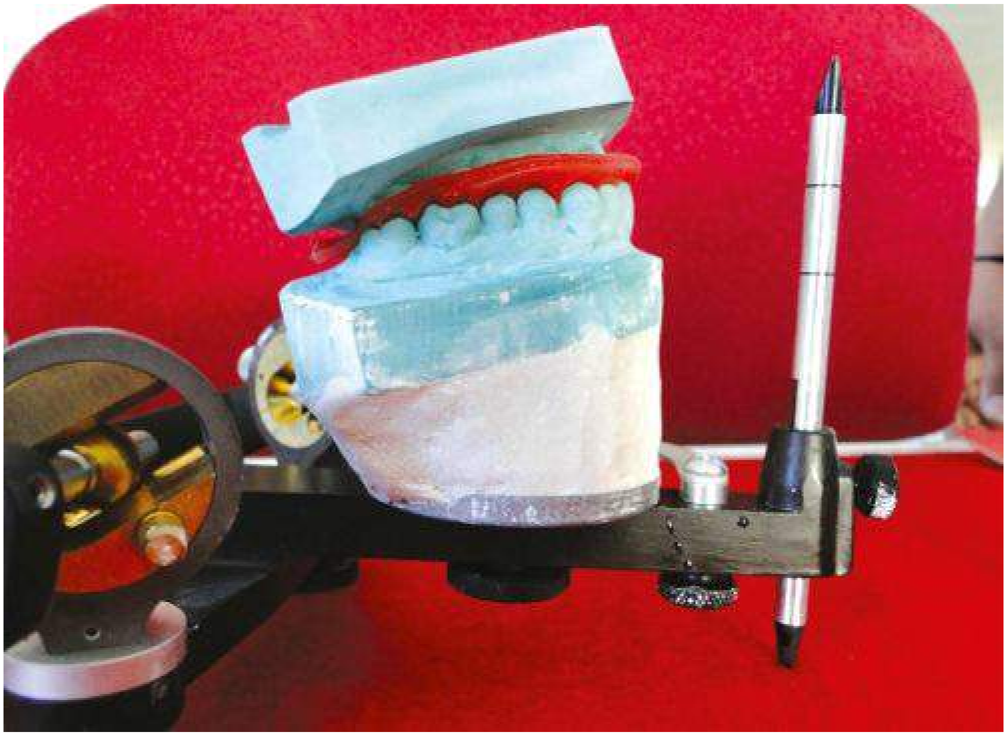


FIGURE 33.27 Wax interocclusal record is placed on the maxillary cast and mandibular cast is positioned into the record.

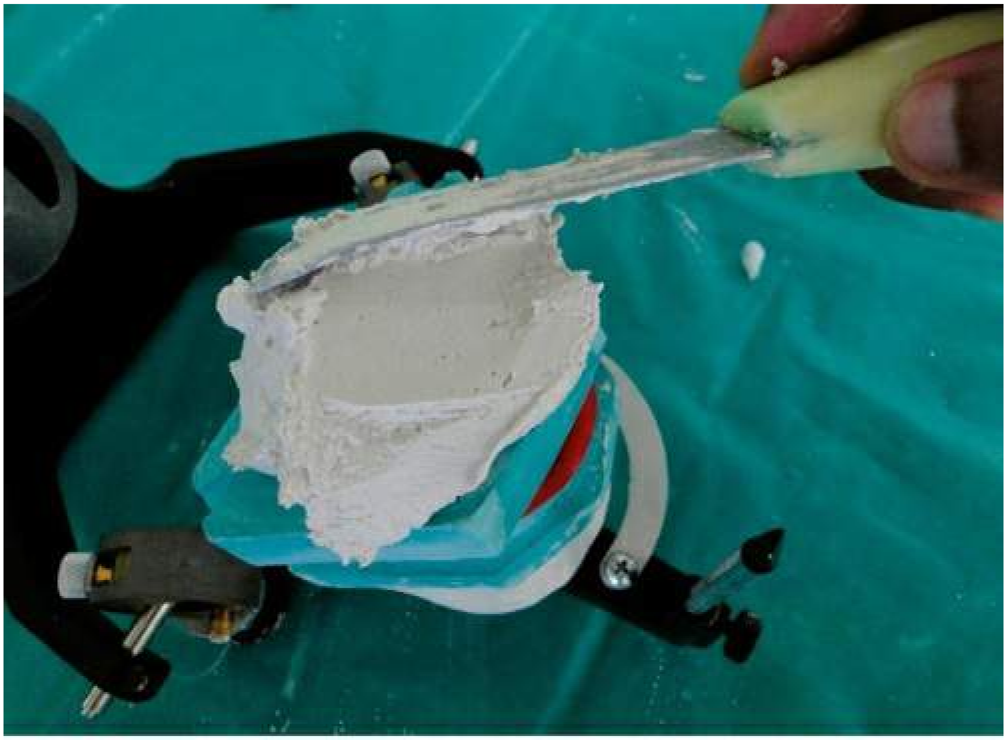


FIGURE 33.28 Mounting stone plaster placed on the base of the inverted mandibular cast.

FIGURE 33.29 Completed mounting of maxillary and mandibular cast.

Setting condylar guidance using interocclusal records

The procedure is similar to that described for the complete dentures in Chapter 7. A protrusive record is used to adjust the horizontal condylar inclination while lateral records are used to adjust the lateral condylar inclination. Either one of the records may be sufficient and the other condylar guidance can be calculated using Hanau formula.

Anterior guidance

Custom anterior guidance

- A customized anterior guidance is made by moulding acrylic resin by the end of the incisal pin.
- Incisors and canines influence the occlusion during excursive movements. The guidance given to the mandibular movements by the anterior teeth can be recorded in acrylic resin on the incisal guide block and used to set the articulator.
- The mounted casts are examined and any nonworking interferences on the casts are removed. This enables the articulator to move freely while maintaining contact between the anterior teeth.
- Raise the incisal guide pin so that it does not contact the plastic incisal guide by at least 1.0 mm in all excursions (Fig. 33.30).
- Mix tray acrylic resin and place it on the incisal guide table. Add additional material until there is approximately 6.0 mm of resin on the plastic incisal guide.
- Close the articulator into full occlusion so that the guide pin penetrates into the soft resin (Fig. 33.31).

- Move the articulator through all excursions, making sure that the anterior teeth remain in contact at all times.
- Trim off excess resin after it has polymerized. This forms the **anterior guidance record.**

Mechanical anterior guidance

- A mechanical incisal guide table can also be used with this instrument to record the anterior guidance (Fig. 33.32).
- Examine the casts and remove any interference that prevents the anterior teeth from remaining in contact in all excursions. The incisal pin should be in contact with the incisal table. Loosen the lock nut under the incisal table.
- Gently move the casts into a protrusive relationship by moving the upper member back to bring the maxillary and mandibular teeth into an end on position. The incisal pin gets lifted off the incisal table. Increase the angulations of the guide table to contact the pin and lock it in this position.
- Similarly, the casts are moved into a right lateral excursion and the left wing of the incisal table is

raised to contact the pin. Repeat the process for left lateral excursion.

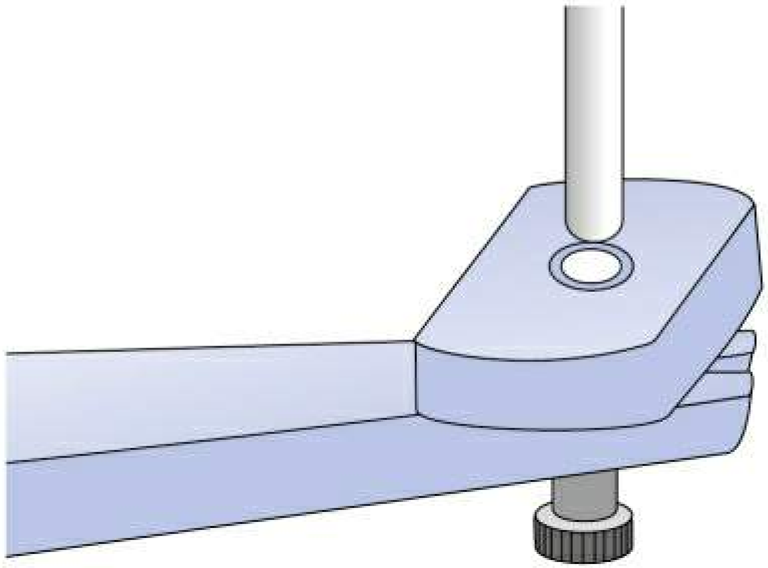


FIGURE 33.30 Incisal pin is raised by at least 1.0 mm.

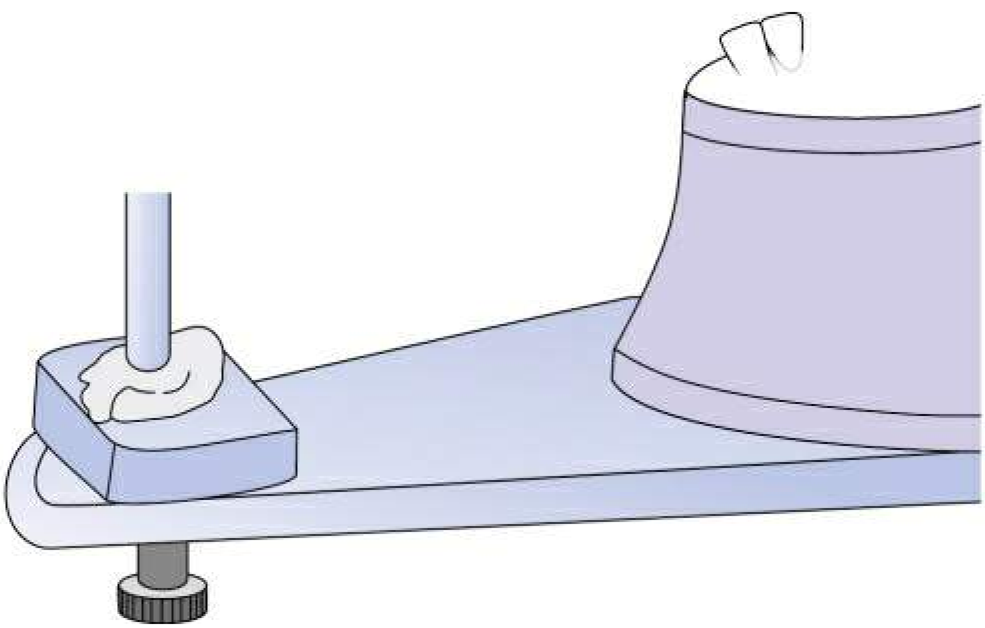


FIGURE 33.31 Articulator is closed into full occlusion so that

guide pin penetrates into the soft resin.

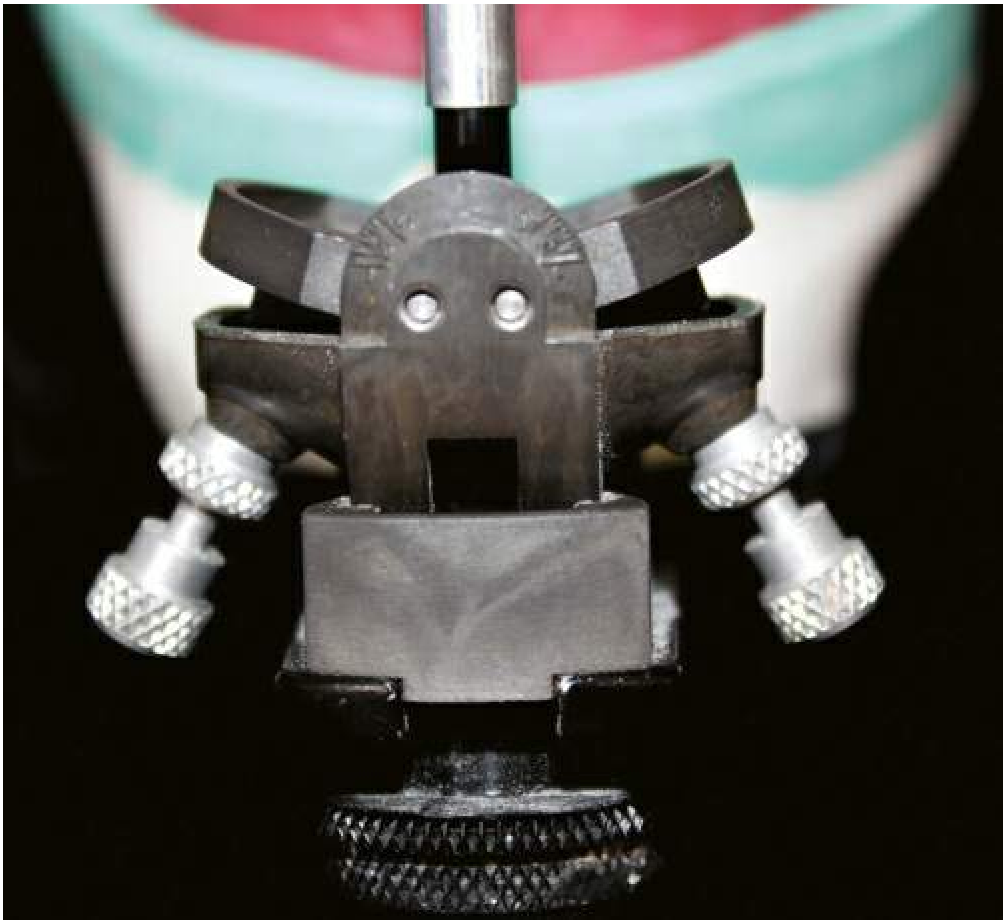


FIGURE 33.32 Mechanical adjustable incisal guide table.

Treatment planning

Treatment planning for a fixed partial denture involves the following.

Selection of type of prosthesis

A partially edentulous condition can be treated as follows depending on the indications:

1. Removable partial denture

The indications for a removable partial denture are discussed in Chapter 18.

2. Tooth-supported fixed partial denture

The indications for a fixed partial denture are discussed in Chapter 31.

3. Implant-supported fixed partial dentures

These are indicated in the following situations:

i. Inadequate number and strength of abutment teeth to support conventional FPD.

ii. Distal extension situations.

iii. Excessive span length.

iv. Single-tooth replacements as otherwise adjacent teeth need preparation to support conventional FPD.

v. Pier abutment.

vi. Better in patients with 'dry mouth'.

vii. If prospective natural abutment tooth requires extensive treatment.

4. No treatment

If patient is present with a long standing edentulous space with no evidence of any drifting/migration of teeth, patient does not have any complaints regarding aesthetics or function, and patient does not desire a prosthesis, no treatment is better than forcing patient to have a prosthesis.

Abutment evaluation and selection

The following are evaluated while selecting an abutment for fixed partial dentures.

Crown

1. Crown length

- The abutment teeth must have adequate occlusocervical crown length to achieve sufficient retention.

- Full coverage restorations and crown lengthening are considered with short clinical crowns to ensure adequate retention (Fig. 33.33).

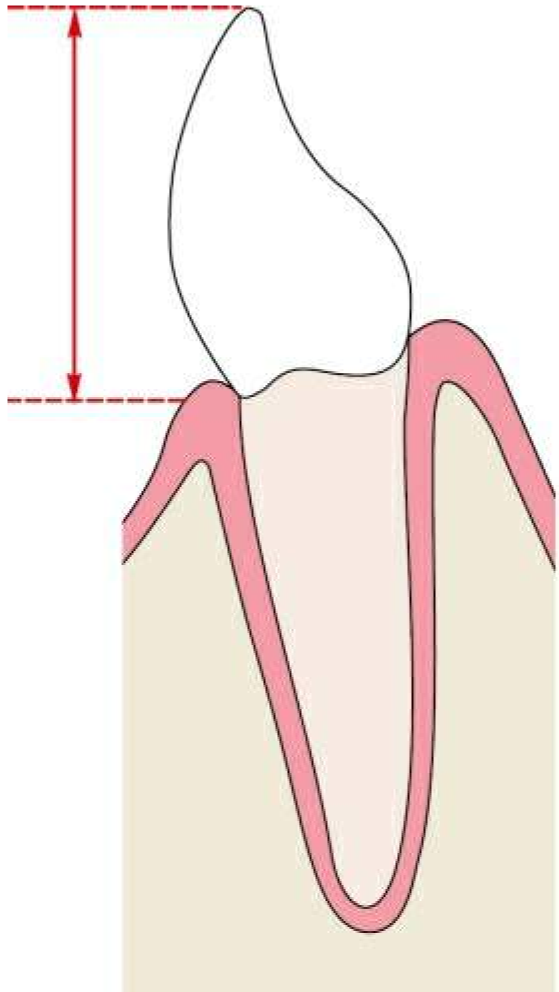


FIGURE 33.33 Adequate occlusocervical crown length.

2. Crown form

- Some teeth have tapered crown form that interferes with the preparation parallelism, necessitating full coverage crowns to improve aesthetics and retention (Fig. 33.34).
- Examples: Peg laterals, anterior teeth with poorly developed cingula and short proximal walls, mandibular premolars with poorly developed lingual cusps and short proximal surfaces and thin incisors (Fig. 33.35).

FIGURE 33.34 **(A)** Short clinical crown. **(B)** Increase in axial length after surgical crown lengthening.

FIGURE 33.35 Peg-shaped laterals do not provide adequate retention as the taper of the preparation may be compromised.

3. Degree of mutilation of crown

The size, number and location of carious lesions or restorations in a tooth will influence the type of retainer on an abutment (Fig. 33.36).

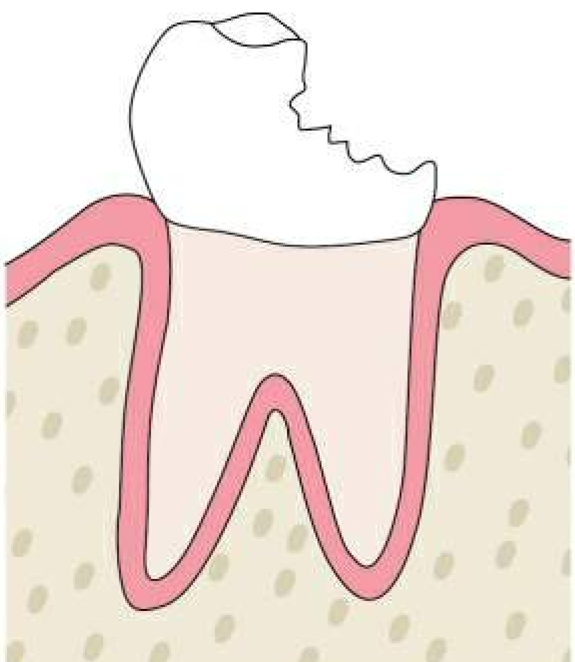


FIGURE 33.36 Amount of coronal structure present in a mutilated tooth influences the selection of abutment.

If the mutilation/fracture is severe, removal of that tooth is necessary which will alter the design of the original prosthesis.

Root length and form

- Abutment teeth should possess adequate root anchorage in the bone to effectively resist and transmit the occlusal load.

- The length of the abutment root is directly proportional to the stability and strength of the prosthesis (Fig. 33.37).

- Roots with parallel sides and developmental grooves are better able to resist additional occlusal force than smooth sided conical roots.

- Roots that are broad labiolingually are preferred over ones that are round in cross-section (Fig. 33.38). Multirooted teeth provide greater stability and resistance to force than single rooted teeth (Fig. 33.39).

- A single-rooted tooth with irregular configuration or with some curvature in the apical third of the root is preferred, than to the tooth that has a nearly perfect taper.

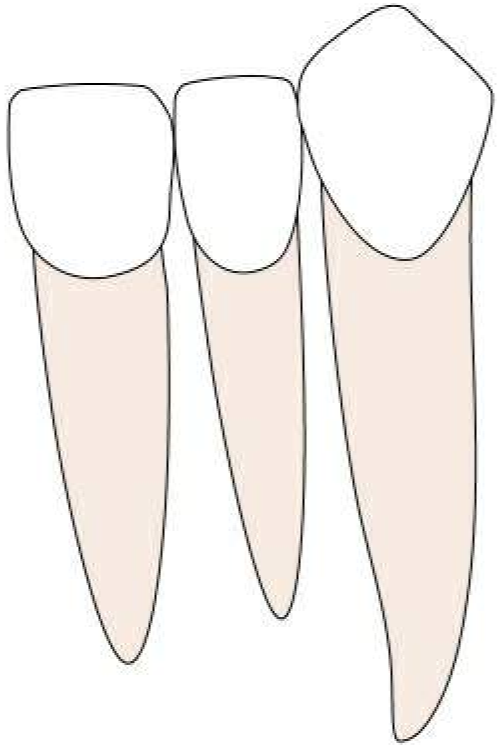


FIGURE 33.37 Longer roots provide stronger attachment to supporting bone.

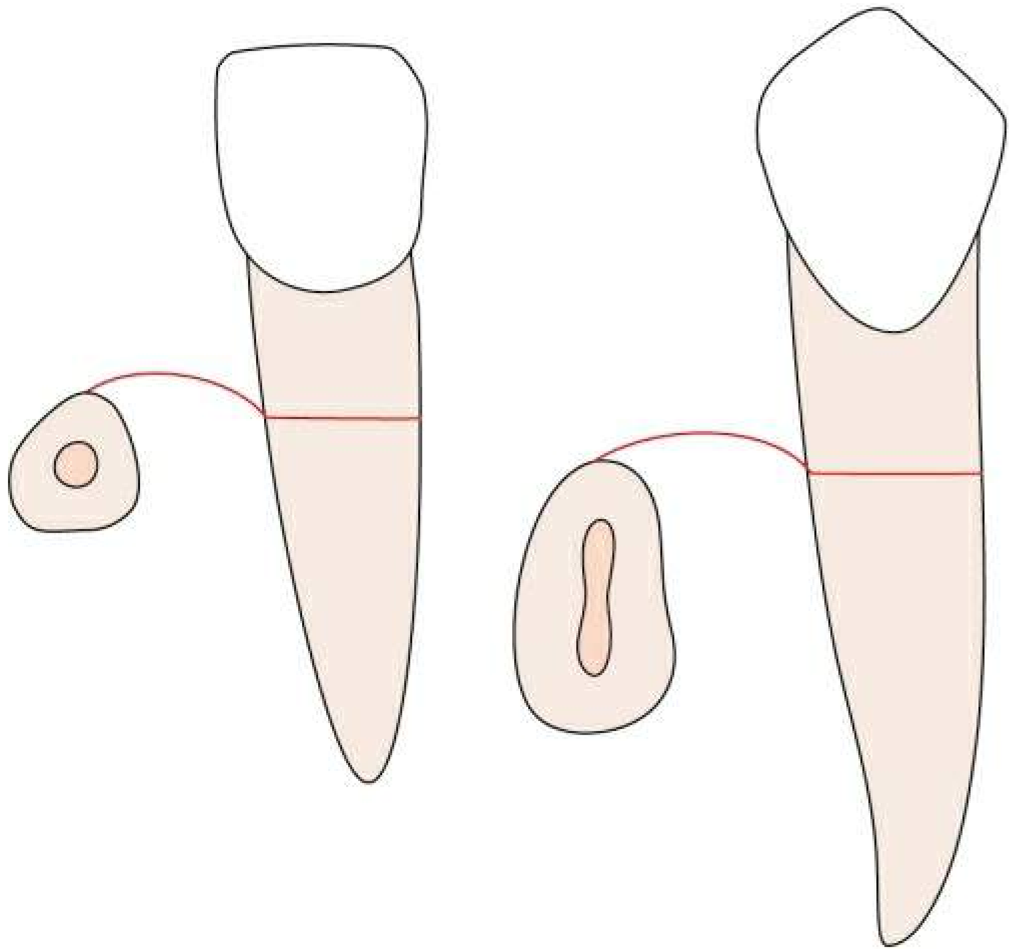


FIGURE 33.38 Roots that are broad buccolingually in cross-section are preferred over roots that are round.

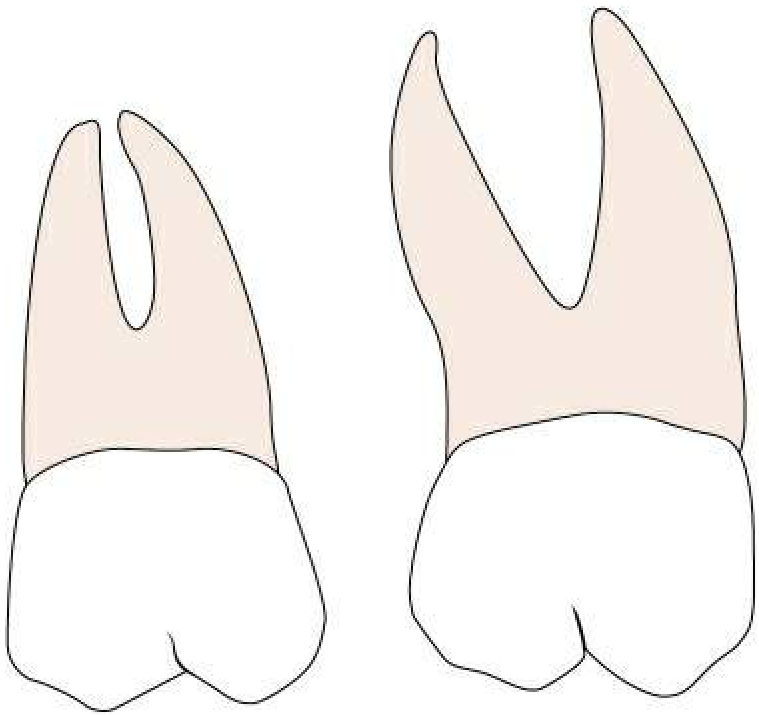


FIGURE 33.39 Teeth with diverging roots have more stability and resistance when compared to teeth with converging roots.

Root proximity

- There must be adequate clearance between the roots of proposed abutments to permit the development of physiologic embrasures in the completed prosthesis.
- Malpositioned anterior teeth and mesiobuccal roots of maxillary molars often present unfavourable root proximities.
- Selective extraction or root resection procedures may be the only solution.

Crown–root ratio

This ratio is the measure of the length of tooth occlusal to the alveolar crest of the bone, to the length of the root embedded in the bone.

- If the ratio is high, it is less likely that the tooth will be able to withstand additional occlusal forces. The problem is even greater when nonaxial (faciolingual) forces act on the prosthesis.
- The ideal crown–root ratio for a fixed partial denture abutment is 2:3 (Fig. 33.40A), while 1:1 (Fig. 33.40B) may be acceptable if:

○ Opposing occlusion is a removable prosthesis.

○ Opposing teeth are periodontally weak.

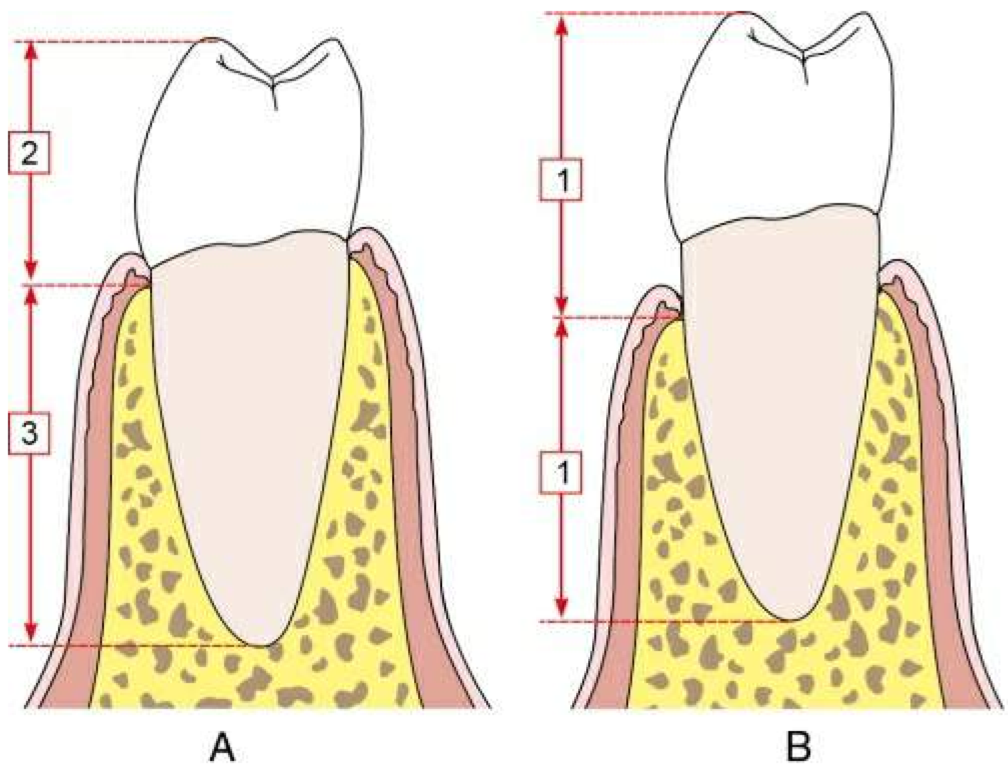


FIGURE 33.40 **(A)** Ideal crown–root ratio of 2:3. **(B)** Crown–root ratio of 1:1 can be adequate in certain conditions.

In both the cases, the forces exerted on the prosthesis are less compared to sound natural teeth.

Periodontal health

- Periodontal disease must be eliminated before any prosthesis is given.
- Retainers and pontics must be planned to promote effective oral hygiene.

Mobility

- Teeth with greater than normal mobility can be used as abutments depending on the degree of mobility and the cause (Fig. 33.41).
- A Miller mobility value of one is generally acceptable.
- A mobility value of two requires consideration of other factors before a treatment option is finalized. If the cause is deflective occlusal contact and a short-span prosthesis is planned, the tooth can be used as an abutment after occlusal correction. If the mobility is caused by periodontal problems, then the tooth may need to be splinted to the adjacent tooth and then used as abutment. It may not be used as abutment for a long-span prosthesis.
- Tooth with a mobility value of three is not suitable as an abutment.

FIGURE 33.41 Clinical procedure for tooth mobility examination.

Ante's law

- Ante's law states that 'the combined pericemental area of the abutment teeth should be equal to or greater than the pericemental area of the tooth or teeth to be replaced'.

- According to this law one missing tooth can be successfully replaced by taking two abutments for support. If two teeth are missing, they can be replaced taking support of two abutments, but the limit is being reached. It is unacceptable to replace three teeth with two abutments (Fig. 33.42A–C).

- To make this a mathematical calculation, average values for root surface area of permanent teeth were given by Jepson (1963) (Table 33.3). With this, the root surface area of missing teeth and abutments could be calculated and a decision could be made as to the number of abutments required for supporting the pontics.

- But this is not just a simple calculation. It has been shown that provided periodontal disease is treated, periodontal health maintained and occlusal forces evenly distributed, fixed partial dentures can be successful with as little as ¼ of the support advocated by Ante.
- Hence, Ante's law is a safe and useful guideline for abutment selection, when employed with other factors involved in evaluating abutment capabilities.

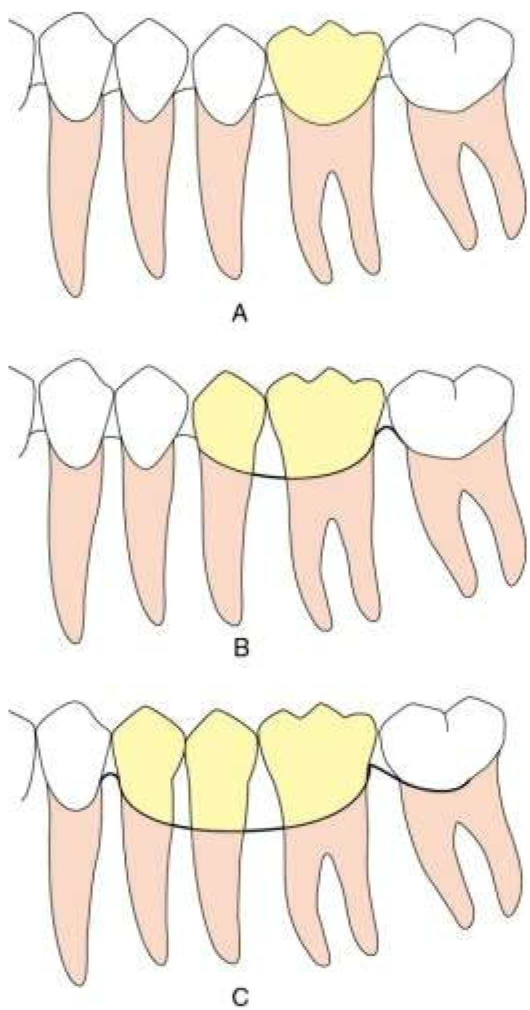


FIGURE 33.42 **(A)** One missing tooth (I molar) can be successfully replaced taking the adjacent teeth (II premolar

and II molar) for support. **(B)** Two missing teeth (II premolar and I molar) can also be replaced by taking two adjacent teeth (I premolar and II molar) for support. **(C)** Three missing teeth (I and II premolar and I molar) cannot be replaced by taking only two adjacent teeth for support.

Table 33.3

Root surface area of various natural teeth

Maxillary	Root surface area (mm^2)
Central	204
Lateral	179
Canine	273
First premolar	234
Second premolar	220
First molar	433
Second molar	431
Mandibular	
Central	154
Lateral	168
Canine	268
First premolar	180
Second premolar	207
First molar	431
Second molar	426

Caries

- Caries on enamel, dentin and root surfaces of abutments should be checked. If it is deep, vitality testing must be done. Some authors have even suggested the removal of existing fillings and checking for extent of damage previously caused by lesion.

- When in doubt, an intentional root canal treatment should be done to ensure predictable results.

- Abutments should also be evaluated for wear facets, abrasions and hypoplasia.

Endodontic status

- Abutment teeth with poor pulpal health need endodontic treatment prior to tooth preparation.
- Endodontically treated teeth can successfully function as abutments.
- Full coverage retainers are mandatory when endodontically treated teeth are used as abutments to minimize the possibility of fracture.
- A post and core may also be necessary depending on the amount of tooth destruction.
- These teeth are contraindicated as abutments to support cantilever FPDs.
- Elective endodontic treatment may be necessary for a supraerupted or malaligned teeth to improve the arch relationship (Fig. 33.43).
- The prognosis is poor for a pulpless tooth with an extremely short root or with a canal that cannot be negotiated (Fig. 33.44).

FIGURE 33.43 Supraerupted teeth indicated for intentional endodontic treatment to provide adequate height for pontic and improve arch relationship.

FIGURE 33.44 Poor prognosis if abutment teeth have short root with non-negotiable canal.

Tilt

- Could happen to any tooth adjacent to an edentulous space if not replaced for a long period of time. The most common situation is that of mandibular second molar tilting mesially into the space created by a missing first molar (Fig. 33.45).

- It is impossible to prepare the abutment teeth for a fixed restoration along the long axes of the respective teeth to achieve a common path of insertion.

- There is further complication if third molar is present. It will drift mesially, along with the second molar. Since the path of insertion is determined by the smaller premolar abutment, the mesial surface of the tipped third molar will encroach on the path of insertion, thereby preventing the placement of the prosthesis (Fig. 33.46).

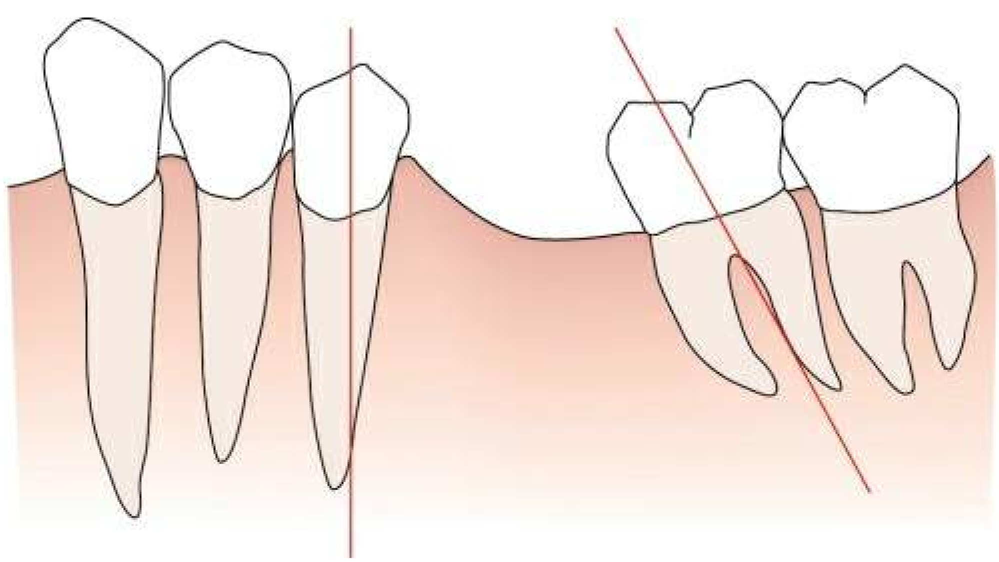


FIGURE 33.45 Second mandibular molar abutment tilts mesially into space formally occupied by first molar.

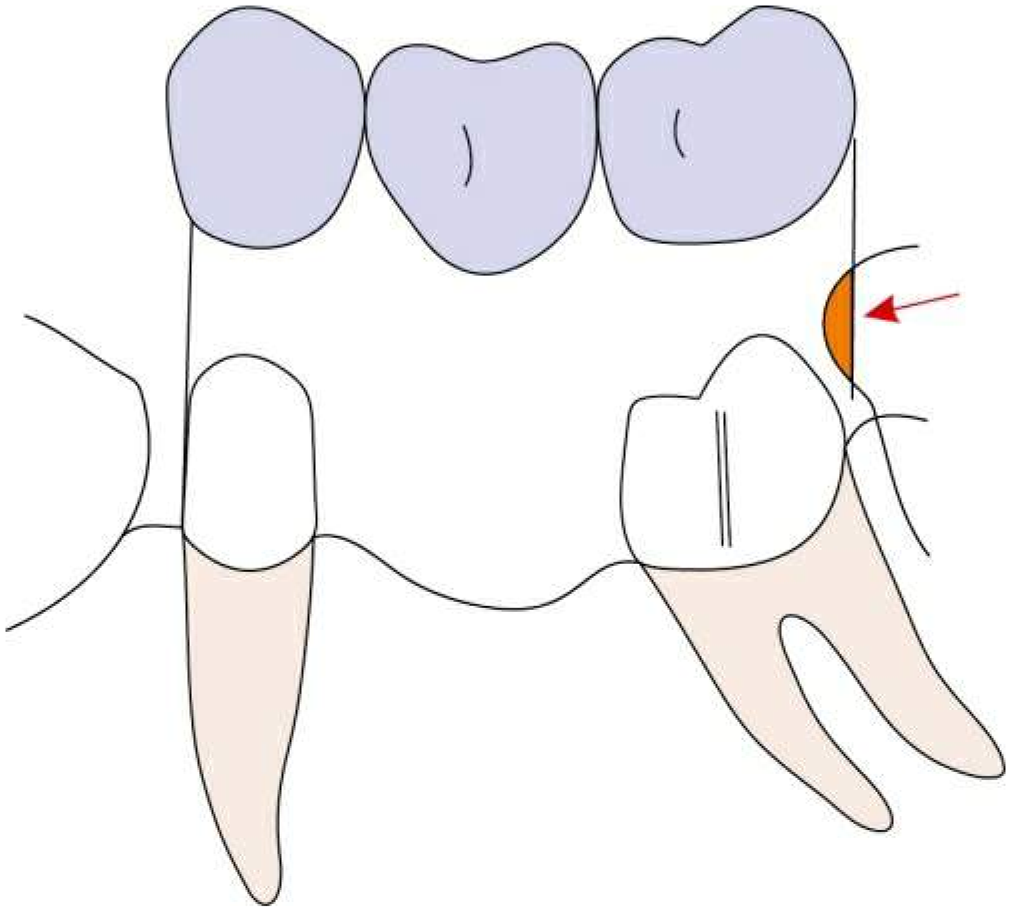


FIGURE 33.46 Mesial surface of the tipped third molar encroaches on the path of insertion of the fixed prosthesis. If tipping is slight, proximal stripping will correct the problem and ensure seating of restoration. Retention is enhanced by placing facial and lingual grooves.

Treatment

Proximal stripping

If the encroachment is minimal, slight recontouring of the mesial surface of the third molar can be done to facilitate the placement of the prosthesis (Fig. 33.46). However, the over tapered second molar must have its retention improved by the addition of facial and lingual grooves.

Orthodontic treatment

The treatment of choice is to upright the molars using orthodontics. In addition to placing the abutment in a better position for preparation and for distribution of occlusal forces, it also helps to eliminate bony defects along mesial surface of the root (Figs 33.47 and 33.48).

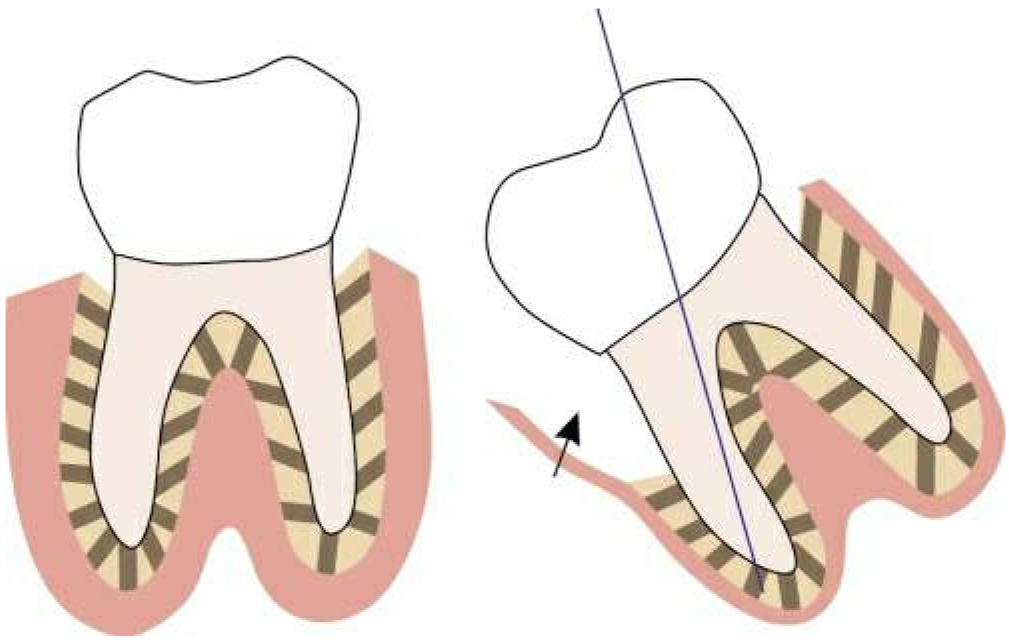


FIGURE 33.47 Mesial loss of bone because of mesial tilting.

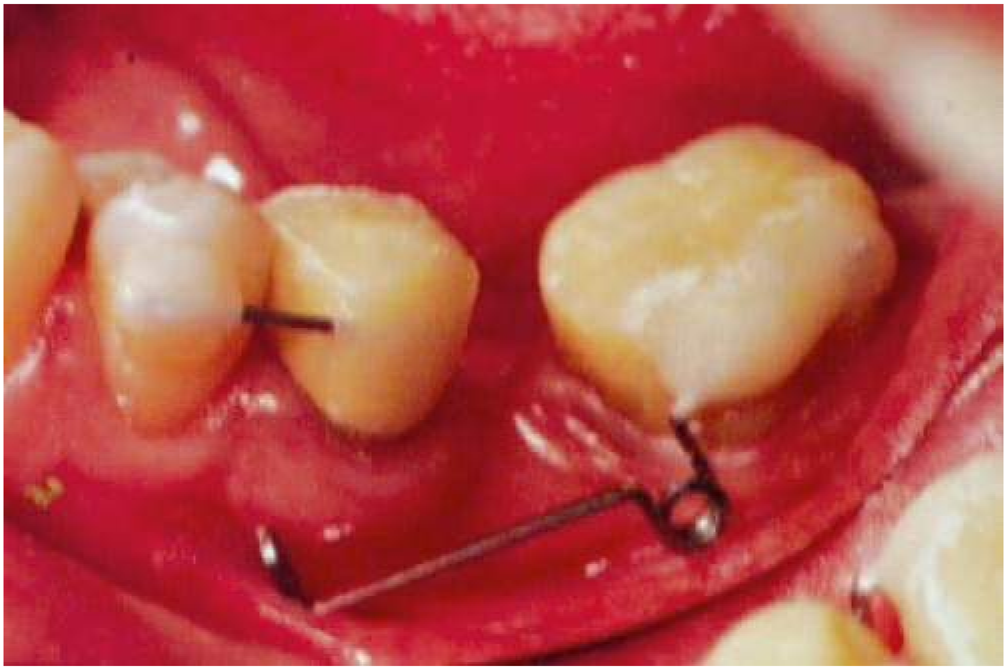


FIGURE 33.48 Simple orthodontic forces used to correct the tilt.

If orthodontic correction cannot be performed, and if the long axis of prospective abutments converge by no more than 25–30°; a proximal half crown, telescopic crown and nonrigid connectors can be used to fabricate a fixed partial denture.

Proximal one half crown

- A proximal half crown is used as a retainer on distal abutment (Fig. 33.49). This is discussed in Chapter 35, FPD section.
- This is contraindicated when there is a severe marginal ridge height discrepancy between the distal surface of second molar and the mesial surface of third molar as a result of tipping.

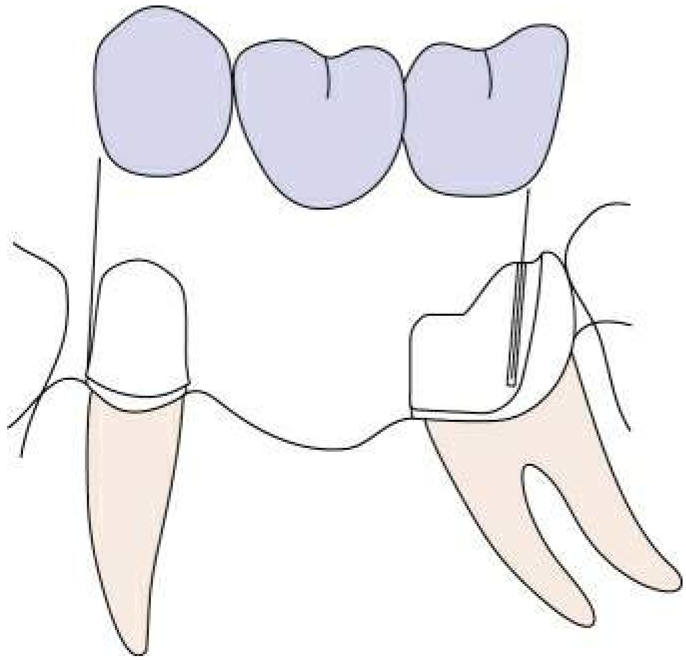


FIGURE 33.49 Proximal half crown used as retainer for the tilted tooth will prevent excessive tooth preparation.

Telescopic crowns

- Telescopic crowns (Fig. 33.50) and coping can be used as retainers on distal tilted abutment.
- A full veneer crown with heavy reduction is prepared following the long axis of the tilted abutment.
- On this preparation, a coping with the shape of a prepared proximal one half crown is fabricated and cemented. As previously described, the proximal one half crown will parallel the long axis of the other abutment.
- A proximal one half crown is used as the retainer for the tilted tooth and a fixed partial denture is fabricated and cemented over the coping. The proximal one half crown (any crown) which fits over the coping is called 'telescopic crown' (Fig. 33.51).

FIGURE 33.50 Schematic diagram of prepared tooth, inner thimble and secondary crown.

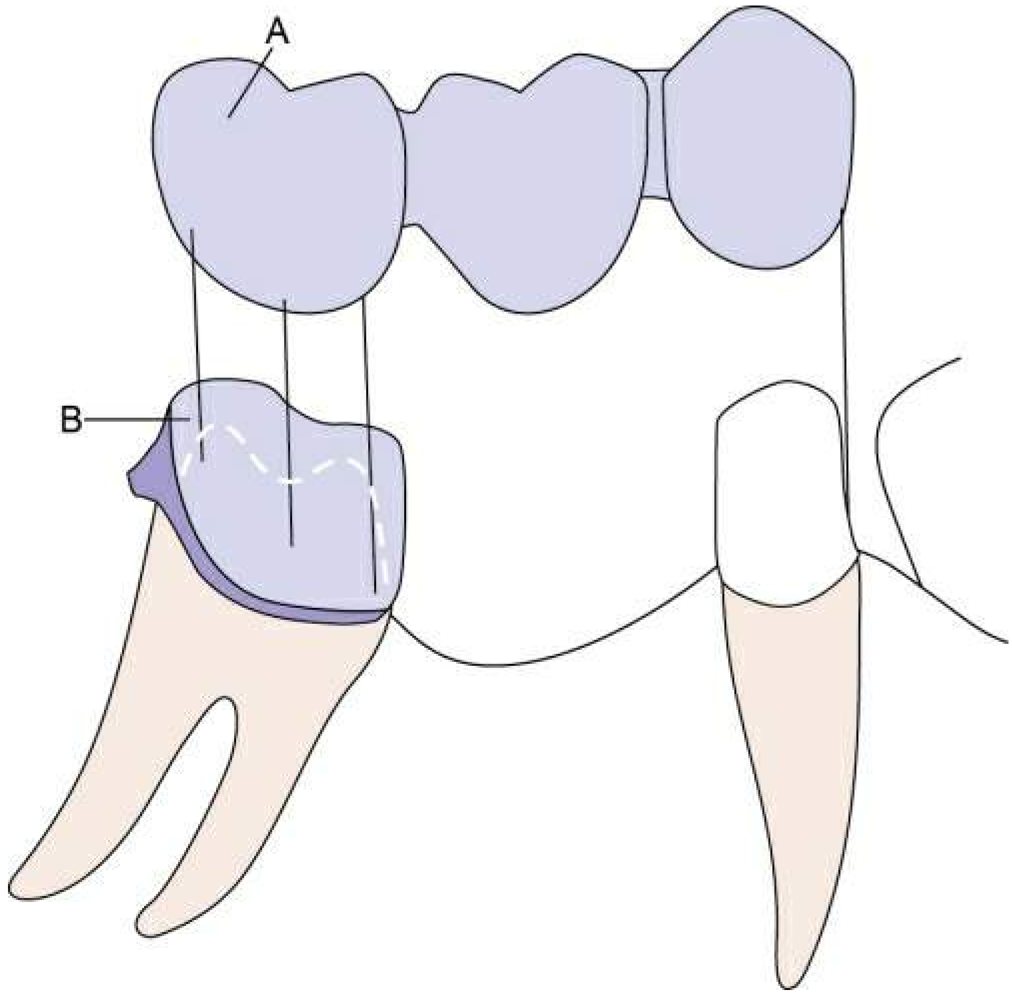


FIGURE 33.51 FPD (A) retained using a telescopic crown (B).

Nonrigid connector

- The tilted molar is prepared for a full veneer crown with path of insertion parallel to its long axis.
- A box form is placed on the distal surface of the premolar to accommodate a key way in the premolar crown parallel to the long axis of the tilted abutment preparation (Fig. 33.52).
- Nonrigid connectors are indicated on molars with a severe lingual and mesial inclination, as a routine FPD would lead to a drastically over tapered preparation with no retention. The presence of a dowel

core or distal restoration on premolar would favour placement of a nonrigid connector on that tooth, while extensive facial and/or lingual restorations in the tilted molar would call for the use of a telescope crown.

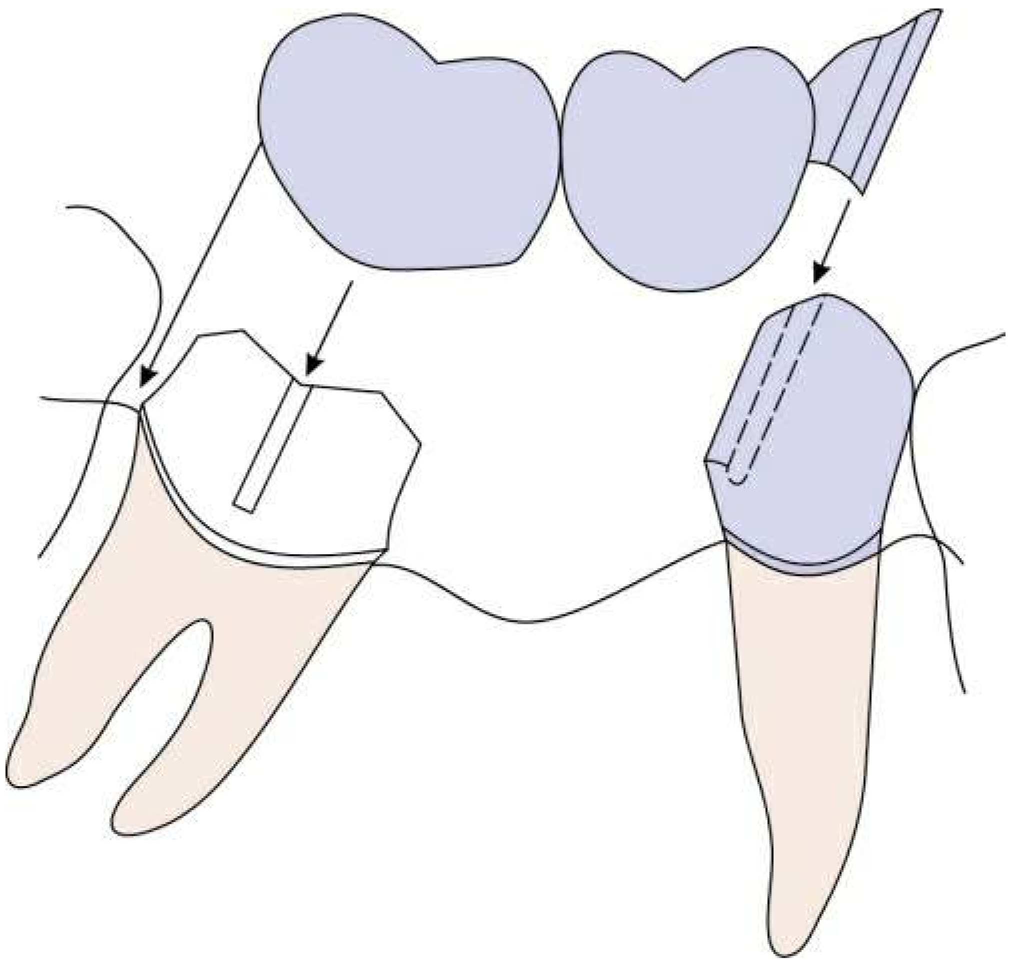


FIGURE 33.52 Key way in the distal of premolar showing mesial path of insertion of FPD.

Occlusal forces

- The forces exerted on the fixed partial denture depend on the opposing dentition, muscular activity of the patient and parafunctional habits.

- Average values for force exerted against a fixed prosthesis is 26 pounds by a removable prosthesis, 54 pounds by a fixed prosthesis and 150 pounds by sound natural dentition.
- This will directly affect the selection of the type of retainer, material used and the number of abutments.

Biomechanical design considerations

Biomechanical design consideration depends on the following factors.

Span length

- As the length of the edentulous span (number of teeth being replaced) increases, there is an increased load on the abutments and the FPD also flexes more.
- The flexure is directly proportional to the cube of length and inversely proportional to the cube of occlusogingival thickness of pontic. That is, an FPD with three pontics will flex 27 times (3 × 3 × 3) times more than an FPD with one pontic (Fig. 33.53A and B). Also if the thickness of the pontic is halved, the FPD flexure will be eight times greater (Fig. 33.54).
- Double abutments can be used to distribute the load by reducing leverage forces in long spans (Fig. 33.55).
- To reduce flexure in long-span FPDs, pontics could be chosen with greater occlusogingival dimension. Alloys such as nickel-chromium which have high rigidity also reduce the flexure.

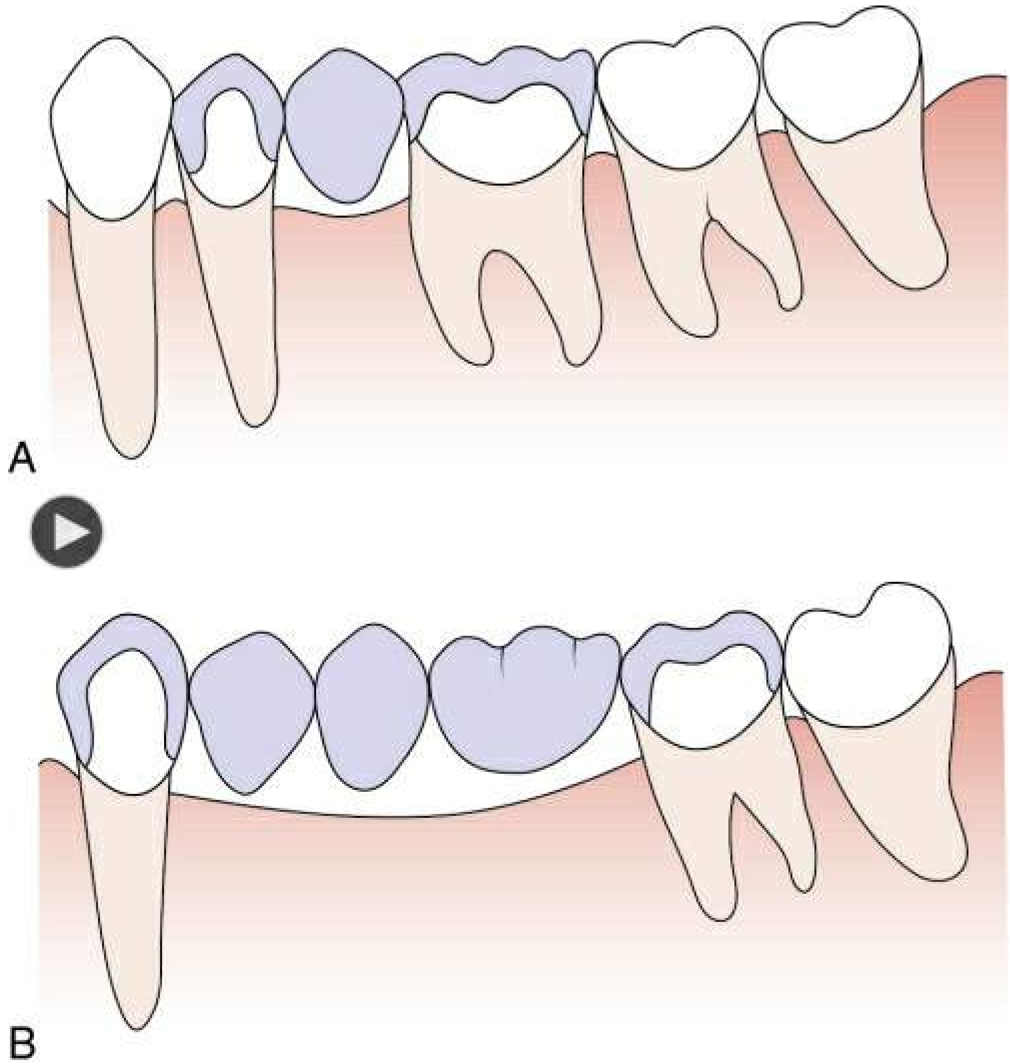


FIGURE 33.53 **(A)** A single pontic FPD will deflect less when subjected to force. **(B)** A three pontic can deflect up to 27 times as much when subjected to the same amount of force – directly proportional to cube of length.

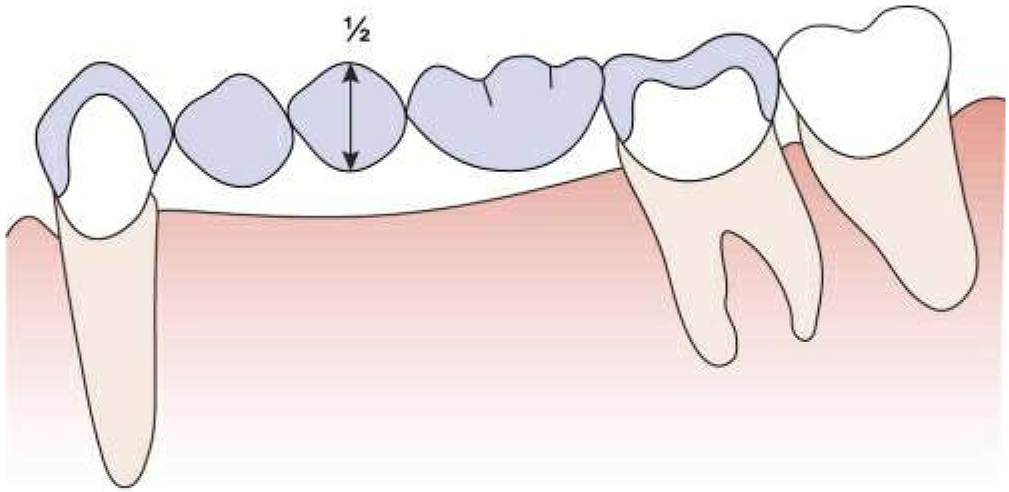


FIGURE 33.54 Reducing thickness of pontic to minimize leverage will also lead to increased flexure.

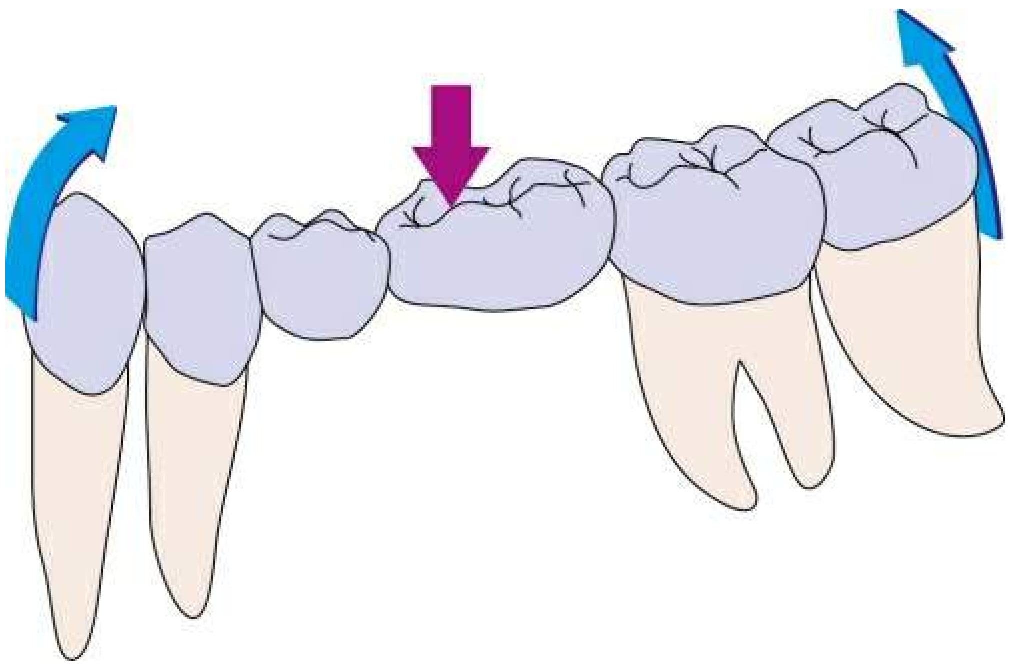


FIGURE 33.55 Double abutment teeth in cases of long-span bridges.

Arch form

- The curvature of the arches often places pontics facially to a straight line *(fulcrum line)* drawn between the teeth immediately adjacent to the edentulous span. This relationship creates a lever arm that can exert excessive torquing forces on the abutment teeth (Fig. 33.56).
- The length of this lever arm will be more in a tapered arch than in a square arch.
- It is commonly seen when all four anterior teeth are being replaced. Double abutments must be used to provide additional retention so as to offset the lever arm length.

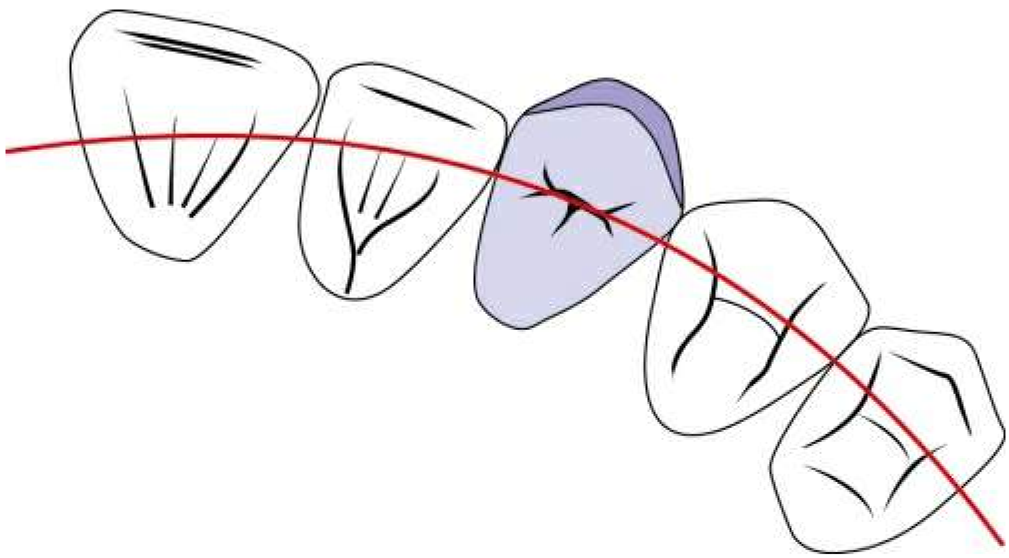


FIGURE 33.56 Pontic placed facially to the fulcrum line creates a lever arm that can exert excessive forces on the abutments.

Dislodging forces

- All fixed partial dentures flex due to forces applied to the pontics. This flexure causes the retainers to dislodge from the abutments.
- These dislodging forces on fixed partial dentures act in a mesiodistal

direction as opposed to a single restoration where such forces are buccolingual.

- Hence, retentive grooves to counter these forces are placed buccally and lingually in a fixed partial denture, while it is placed proximally for a single crown (Fig. 33.57).

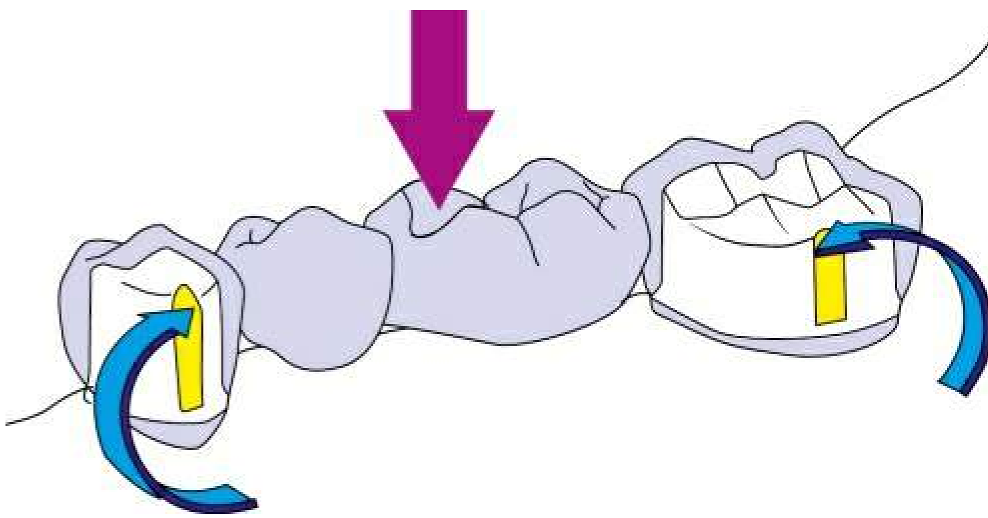


FIGURE 33.57 Retentive grooves placed to counter the forces.

Double abutments

- This refers to the use of two adjacent teeth at one or both ends of the FPD as abutments (Fig. 33.55). The abutment adjacent to edentulous space is termed as 'primary abutment' and the adjacent abutment is termed as 'secondary abutment'.

- Indications:

1. To increase retention of restoration.

2. To increase area of supporting periodontal

ligament and bone.

3. Unfavourable crown–root ratio.

4. Long-span FPDs.

5. Splint and stabilize periodontally compromised teeth.

- The secondary abutment must meet the following criteria:

  - It must have as much root surface area as favourable for a crown–root ratio and similar retention as the primary abutment.

  - Sufficient crown length and space should be present between the adjacent abutments to prevent impingement of the gingiva under the connector.

Selection of material

The materials available for construction of the fixed prosthesis are as follows:

1. All metal

2. All ceramic

3. Porcelain fused to metal

4. Resin veneered to metal

5. Fibre reinforced composite.

The criteria for selection are discussed in Chapter 32.

Special considerations

Pier abutment

Definition: A natural tooth located between terminal abutments that serve to support a fixed or a removable prosthesis (GPT8).

It is also called 'intermediate abutment' (Fig. 33.58).

- In this situation, if a five-unit rigid FPD is planned by using all the natural teeth adjacent to the edentulous areas as abutments, forces are transmitted to terminal retainers as a result of the intermediate abutment (pier) acting as fulcrum, causing failure (loosening) of a weaker retainer (anterior). Some authors suggested that tension between the terminal retainers and their respective abutments rather than a pier fulcrum caused intrusion of the weaker abutment which lead to failure (loosening) of a weaker retainer (anterior) (Fig. 33.59). These loosened castings will cause marginal leakage and secondary caries.

- Hence, physiologic tooth movements, arch position of the abutments and a disparity in the retentive capacity of the retainer can make a rigid connector in a five-unit fixed prosthesis, a less ideal treatment of choice in case of pier abutments.

- The use of a *nonrigid* connector has been advocated to overcome this problem. It is a broken stress mechanical union of retainer and pontic, the movement in it is enough to prevent the transfer of stress from the segment being loaded to the rest of FPD. It consists of a T-shaped key attached to the pontic, and a dovetail key way placed within a retainer. (Fig. 33.60).

- The location of this device is important. It is usually placed on the middle abutment, since placement on the terminal abutments could result in pontic acting as a lever arm. The key way should be placed within the distal contour of pier abutment and key, on the mesial side of distal pontic. This seats the key more solidly into the keyway as forces usually are mesially directed due to the mesial inclination of posterior teeth.

- Another simple treatment option would be to cantilever the premolar pontic provided the periodontal support of the abutments is adequate (Fig. 33.61).

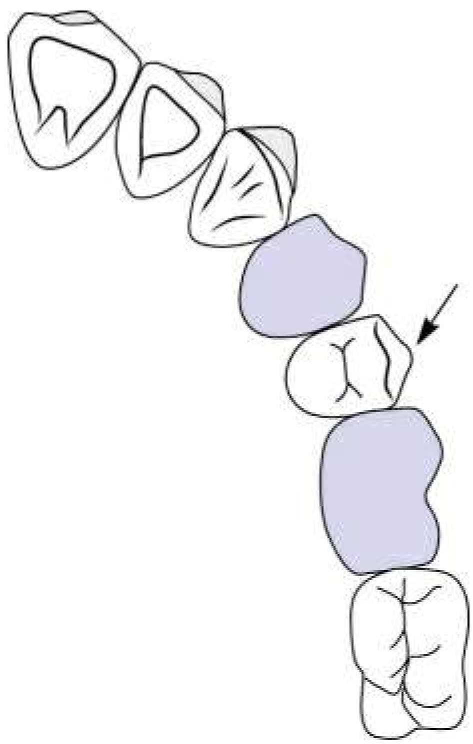


FIGURE 33.58 Pier abutments having edentulous spaces on either side.

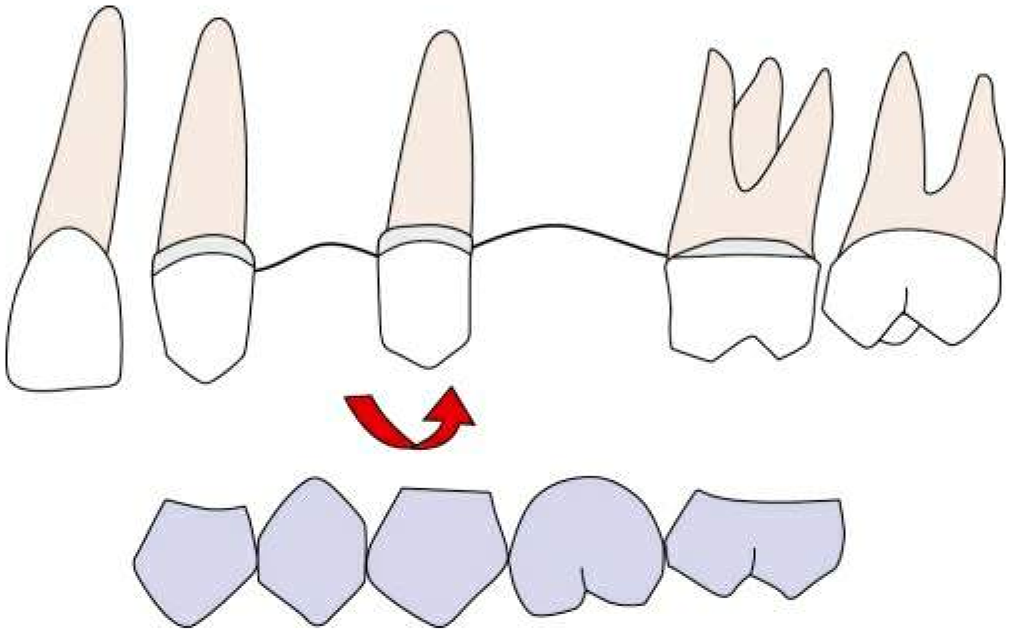


FIGURE 33.59 Forces are transmitted to terminal retainers as a result of the pier abutment, causing failure of a weaker anterior retainer.

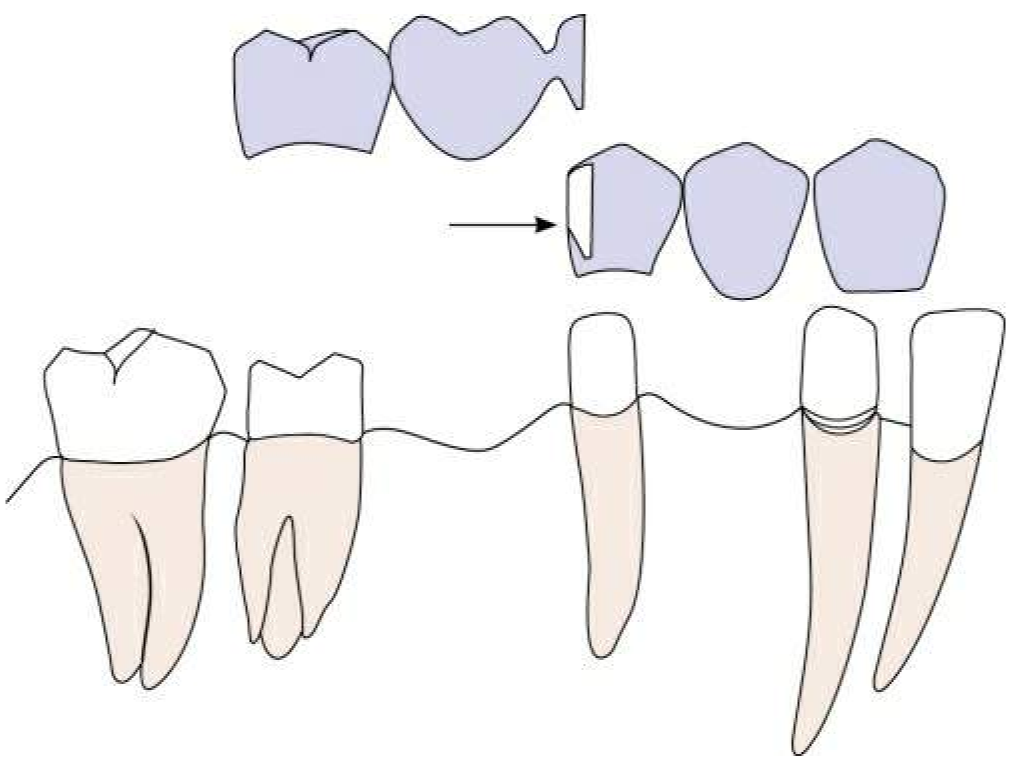


FIGURE 33.60 A nonrigid connector can be used as

breaker.

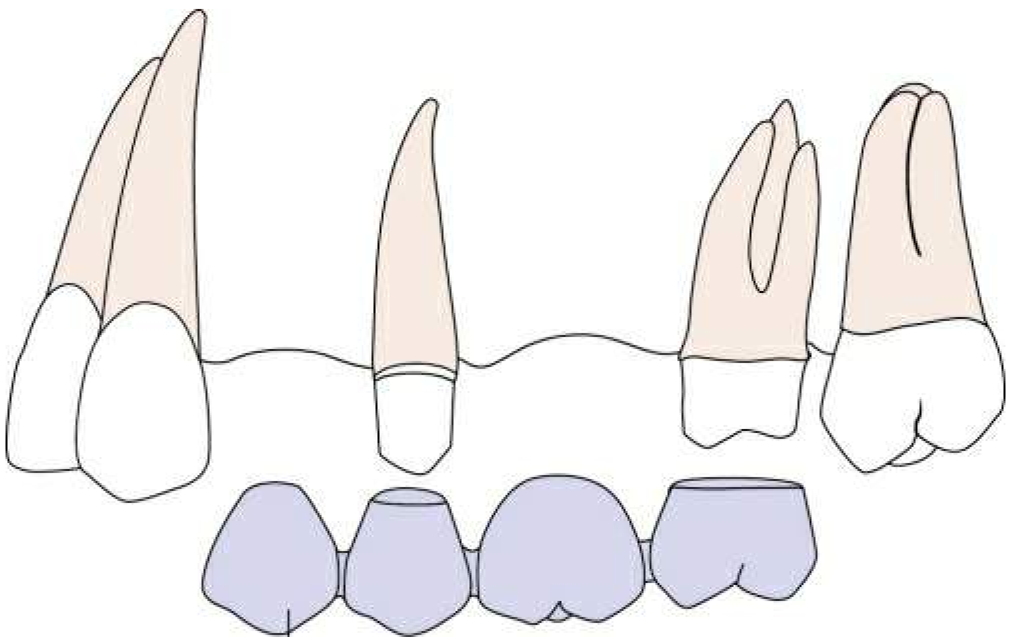


FIGURE 33.61 Cantilever pontic.

Cantilever fixed partial dentures

Definition: A fixed dental prosthesis in which the pontic is cantilevered, i.e. is retained and supported only on one end by one or more abutments (GPT8).

- In a conventional FPD supported by abutment on either side of edentulous space, forces on the pontic are distributed evenly to both the abutments (Fig. 33.62).

- In a cantilever FPD, forces applied to the pontic tend to depress and tip the pontic. This is a potentially destructive design with the lever arm created by the pontic (Fig. 33.63).

- Prospective abutment teeth for cantilever FPDs should satisfy the following requirements:

- ○ Lengthy roots with favourable configuration.
- ○ Long clinical crowns.
- ○ Good crown root ratios.
- ○ Healthy periodontium.
- ○ Should be used to replace only one tooth.

• Indications:

1. Missing maxillary lateral incisors using canine for support.

○ There should be no occlusal contact on the lateral incisor pontic in centric and eccentric relations.

○ A distal rest prepared on the central incisor will support a mesial extension from the lateral pontic to prevent rotation.

2. Missing first premolar using II premolar and I molar as abutments (Fig. 33.64).

3. Missing I molars when there is no distal abutment, using I and II premolar as abutments (Fig. 33.65).

○ Pontic should be similar in size to a premolar.

○ Only light occlusal contact on pontic with no contact in eccentric.

○ Pontic should possess maximum occlusogingival height.

4. Periodontally compromised teeth as they have extremely long

clinical crowns.

5. Pier abutment situations.

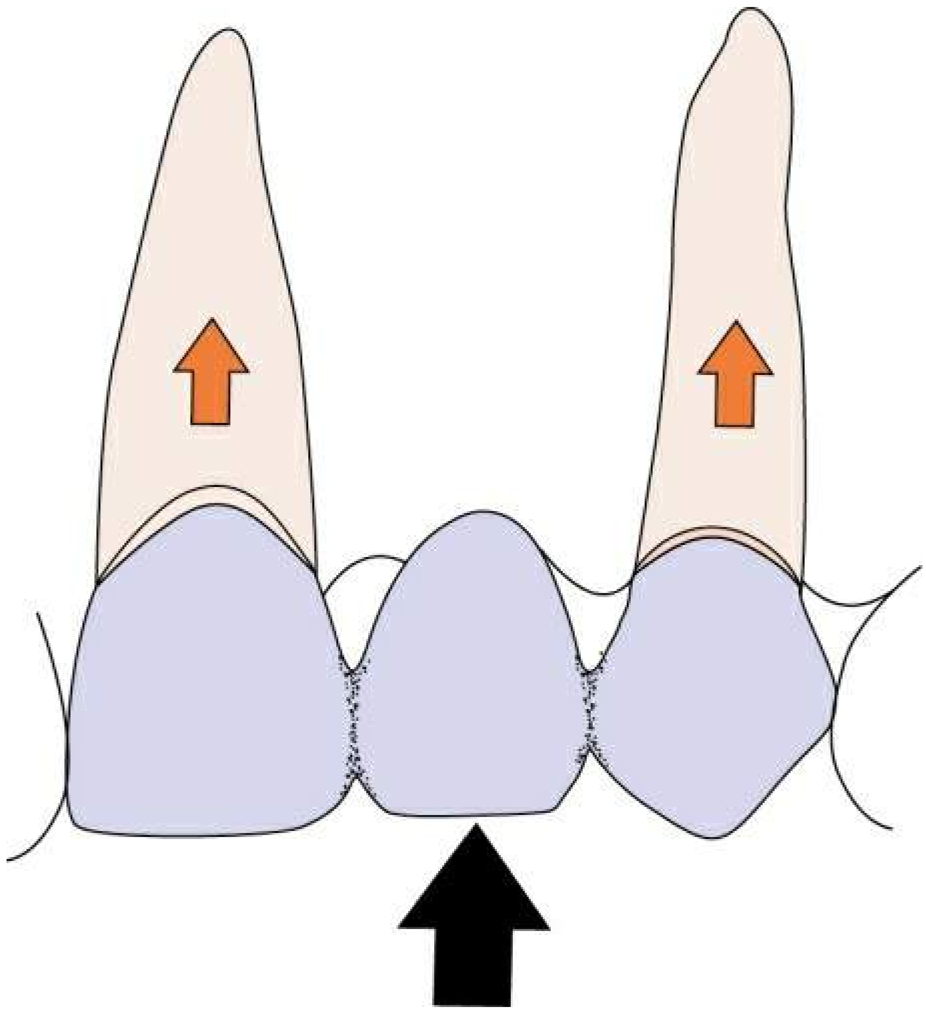


FIGURE 33.62 Equal distribution of forces on abutments in conventional FPD.

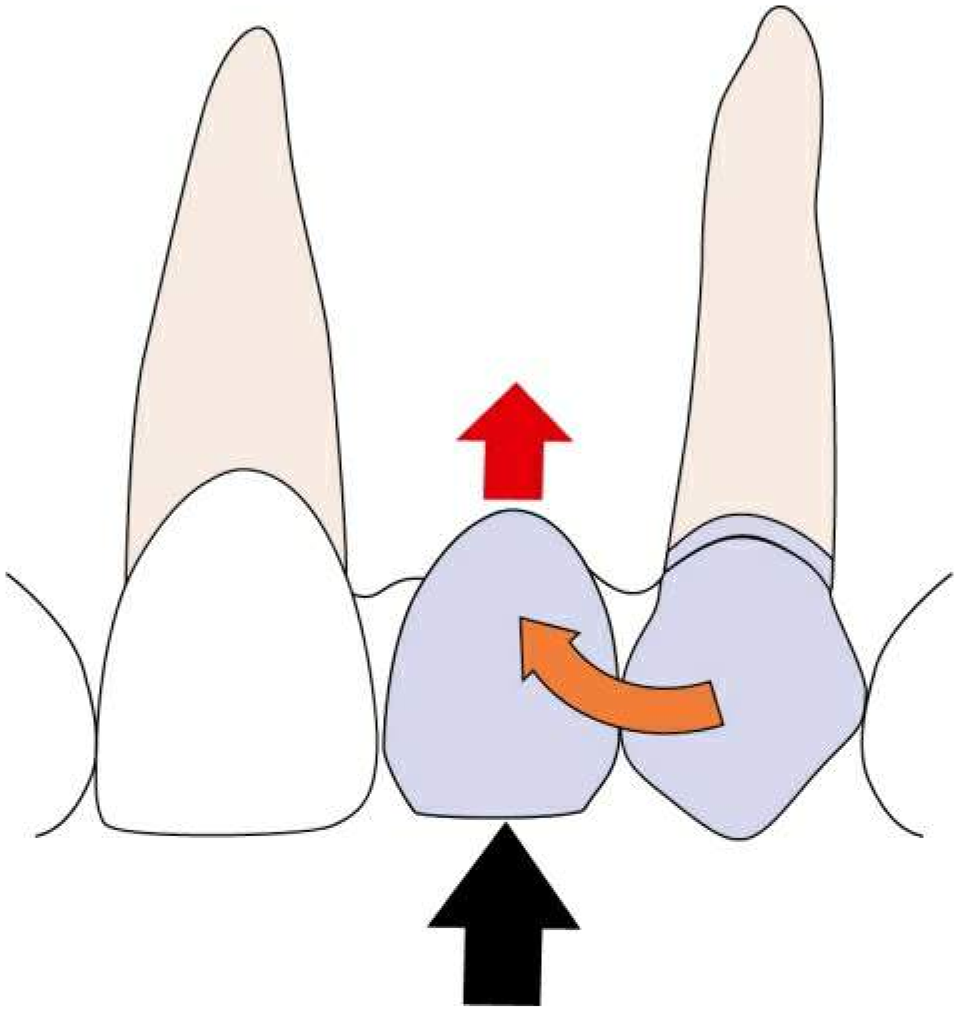


FIGURE 33.63 Forces applied to the pontic tend to depress and tip the pontic in cantilever FPDs.

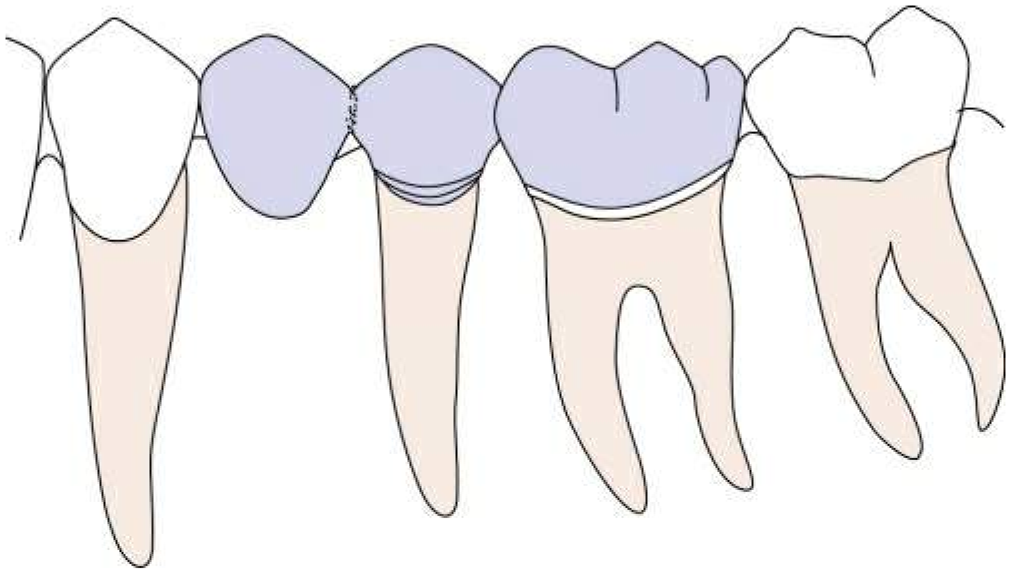


FIGURE 33.64 Second premolar and first molar used as abutments to replace missing first premolar.

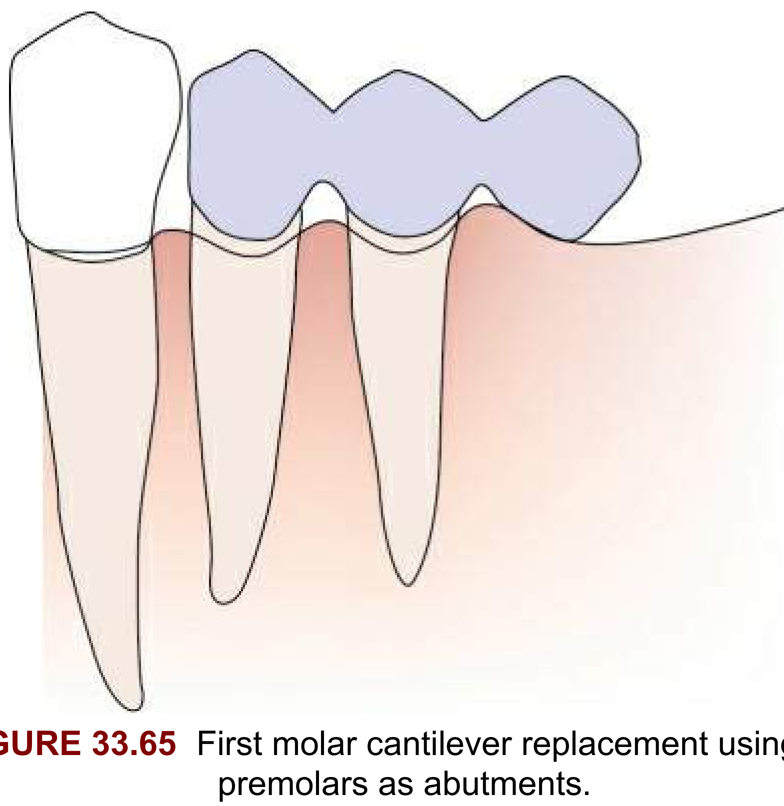


FIGURE 33.65 First molar cantilever replacement using the premolars as abutments.

Canine replacement fixed partial dentures

- Replacing canine with a fixed partial denture is often difficult as the canine lies outside the interabutment axis and as described earlier, the fulcrum line is labial to the arch circumference. Hence, the abutments are subjected to increased stresses (Fig. 33.66).
- The prospective abutments are the lateral incisor, weakest tooth in the arch and the first premolar, weakest posterior tooth.
- The forces acting on the maxillary canine act outward, labially, subjecting it to a greater stress, as compared to the mandibular canine where the forces act lingually.
- No FPD replacing a canine should replace more than one additional tooth.

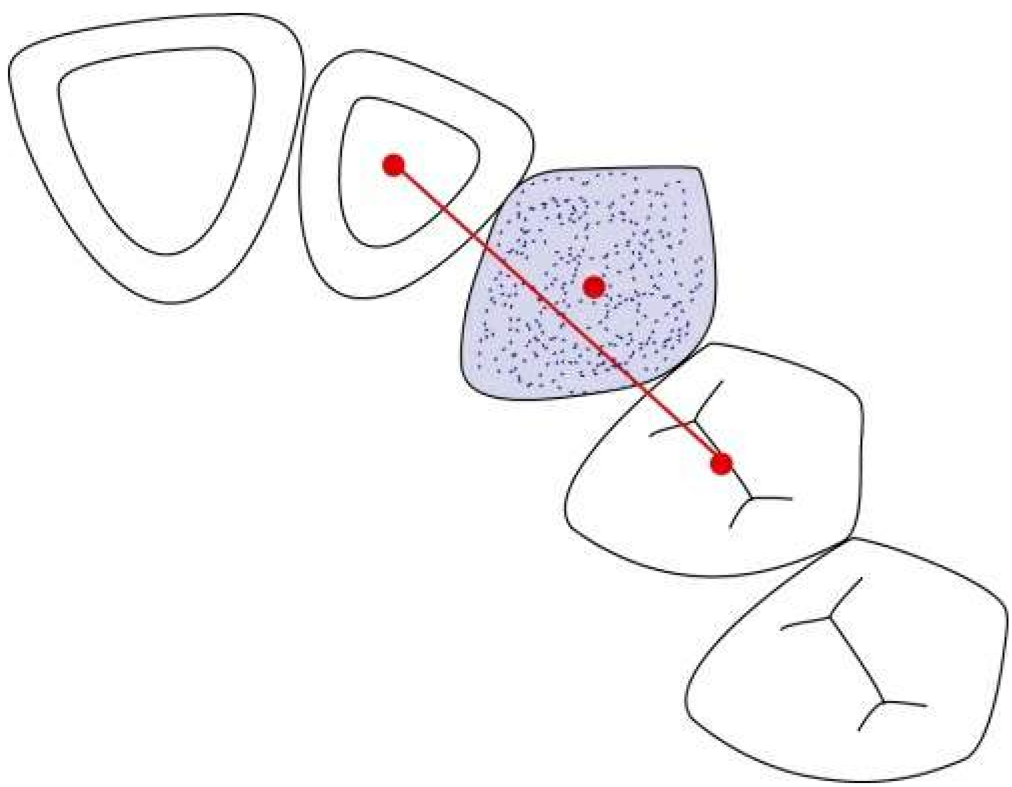


FIGURE 33.66 Canine replacement – canine is positioned outside the interabutment axis.

Mouth preparation

Once the treatment plan is finalized after considering the above-mentioned factors, the patient's oral cavity is prepared to receive the fixed prosthesis keeping in mind long-term prognosis and preservation of oral health.

The following could be a practical sequence of procedures:

1. Preliminary assessment
2. Emergency treatment of presenting symptoms
3. Oral surgery
4. Caries control and replacement of existing restorations
5. Endodontic treatment
6. Periodontal therapy
7. Orthodontic treatment
8. Definitive occlusal treatment
9. Fixed prosthodontics
10. Removable prosthodontics
11. Follow-up care

Although all the procedures are self-explanatory and have also been dealt with in Chapter 25, 'definitive occlusal treatment' or 'occlusal correction' is discussed here.

Occlusal correction

This involves eliminating occlusal interferences and getting the 'maximal intercuspal position' (MIP) to coincide with centric relation (CR).

This may be performed for two reasons:

1. Therapeutically, to relieve symptoms of occlusal dysfunction.

2. Diagnostically, before extensive restorative treatment.

This should be performed before definitive prosthodontic rehabilitation and is first executed on mounted diagnostic casts and then transferred to the patient. The interferences are discussed in Chapter 34, and the same are corrected accordingly.

SUMMARY

The objectives of any successful treatment planning should begin with identification of existing disease, the aetiology, pathogenesis and the ideal treatment planning. The process of treatment should include prevention of future disease, restoring function and improving appearance also. This should be planned after identifying the patient's needs which is very important for the successful treatment or prognosis. Throughout, the extent of treatment is modified by the attitude of and objectives for the patient.

CHAPTER

34

Occlusion

CHAPTER CONTENTS

Introduction

Occlusion: The static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues (GPT8).

In simple terms, it is the static contact relationship of maxillary and mandibular teeth in any given position.

Articulation: The static and dynamic contact relationship between the occlusal surfaces of the teeth during function (GPT8).

Compared to occlusion this is a contact relationship of maxillary and mandibular teeth in function.

The contact of the maxillary and mandibular teeth in various functional movements (mandibular movements) is an important relationship that should not be traumatic to the supporting tissues and should allow an even load distribution throughout the dental arch. It is interrelated with the TMJ and the associated muscles. It is important to understand what is normal so that any deviation can then be assessed for diagnosis and treatment.

Anatomy of TMJ

It is important to know the anatomy of the TMJ as it is one of the determinants of mandibular movement during which occlusal contacts take place. This is discussed in detail in Chapter 6.

Centric relation

Centric relation (CR): The maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in the anterior-superior position against the slopes of the articular eminences. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superior and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis (GPT8).

Maximal intercuspal position (MI): The complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position – called also *maximal intercuspation* (GPT8).

Centric occlusion (CO): The occlusion of opposing teeth when the mandible is in centric relation. This may or may not coincide with the maximal intercuspal position (GPT8).

- It is clear from the definitions that in natural dentition, MI position **need not** coincide with CR.

- When fixed and removable prosthesis are fabricated with existing natural teeth, they may be made to coincide with the existing normal MI position, if sufficient natural teeth are present to guide the occlusion. MI position is made to coincide with CR only when there are insufficient occlusal contacts existing to guide the occlusion.

- This is different from complete dentures where MI position is given at CR.

Mandibular movement and occlusal contact

Movements and the occlusal contacts

Basic movements

Mandibular movement is divided into two basic components:

1. Rotation: The action or process of rotating on or as if on an axis or centre (GPT8).

2. Translation: The motion of a body at any instant when all points within the body are moving at the same velocity and in the same direction. This refers to a bodily movement.

Excursive movements

1. Opening movement

On opening, initially up to 12 mm of incisor separation there is only rotation of the mandible (Fig. 34.1) which is then followed by a forward translation to maximal opening (Fig. 34.2).

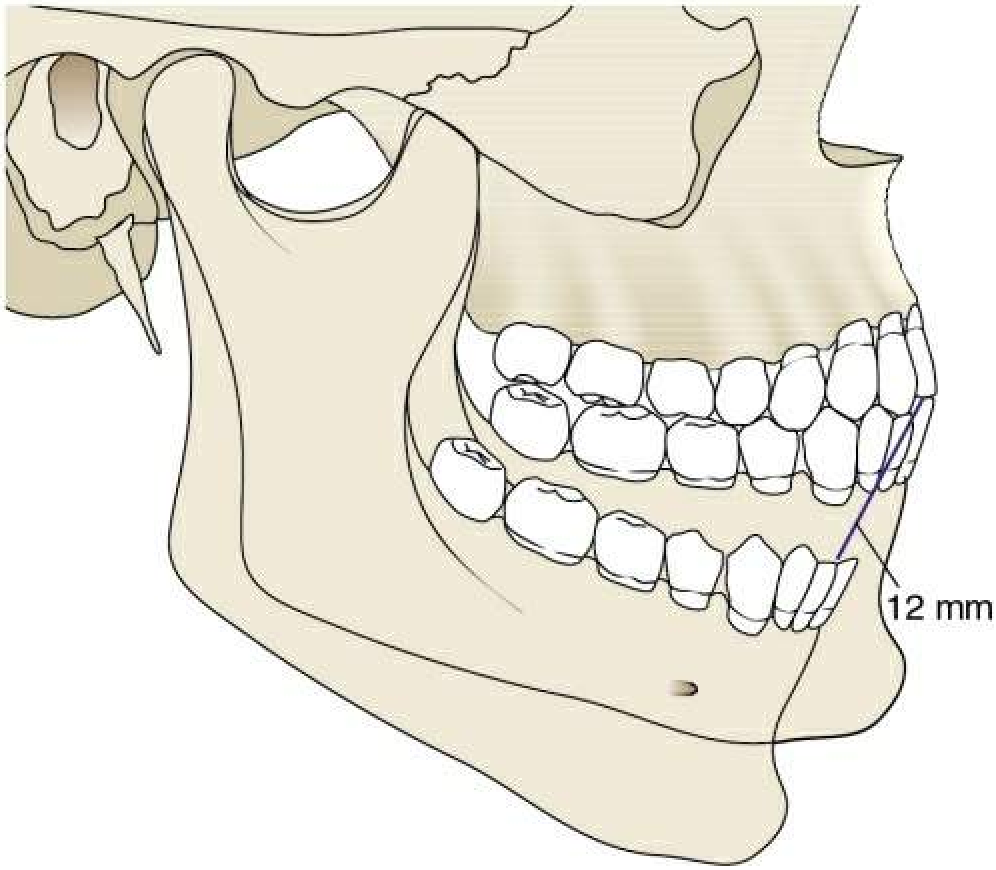


FIGURE 34.1 Rotation up to 12 mm of opening.

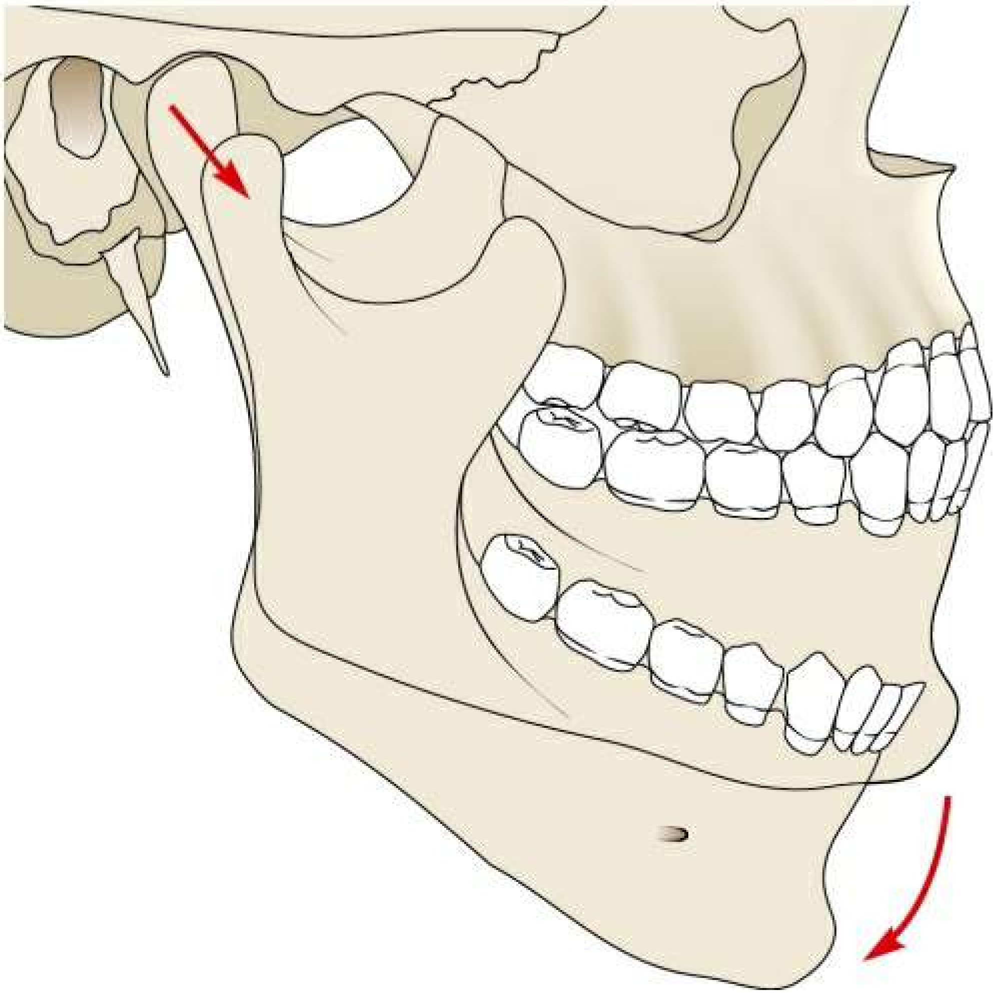


FIGURE 34.2 Translation on opening greater than 12 mm.

The rotation occurs around the horizontal axis and can be observed in the sagittal plane.

2. Protrusion

This is a translatory movement as the mandible slides downward and forward for the anterior teeth to meet edge to edge (Fig. 34.3).

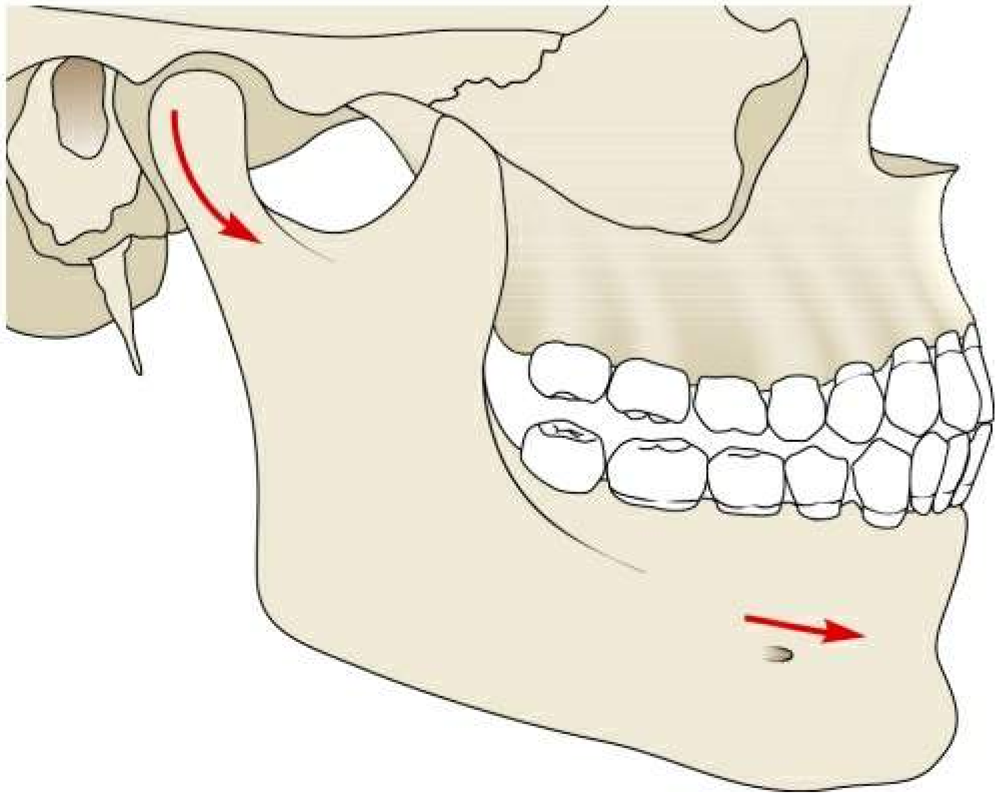


FIGURE 34.3 The mandible moves forward in a protrusive mandibular movement. Note the contact of the anterior teeth only; the posterior teeth are in disocclusion.

Occlusal contact in protrusive mandibular movement

- A protrusive mandibular movement occurs when the mandible moves forward from the intercuspal position. Any area of a tooth that contacts an opposing tooth during protrusive movement is considered to be protrusive contact.

- In a normal occlusal relationship the predominant protrusive contacts occur on the anterior teeth, between the incisal and labial edges of the mandibular incisors against the lingual fossae areas and incisal edges of the maxillary incisors. These are considered the guiding inclines of the anterior teeth.

- On the posterior teeth the protrusive movement causes the mandibular centric cusps (buccal) to pass anteriorly across the occlusal surface of the maxillary teeth. Posterior protrusive contacts occur between the distal inclines of the maxillary lingual cusps and the mesial inclines of the opposing fossae and marginal ridges. Posterior protrusive contacts can also occur between the mesial inclines of the mandibular buccal cusps and the distal inclines of the opposing fossae and marginal edges. These posterior cuspal contacts are considered pathological if the anterior teeth are present in normal class 1 relationship.

3. Retrusion

The movement is just the opposite of protrusion.

Occlusal contact in retrusive mandibular movement

- A retrusive movement occurs when the mandible moves posteriorly from the intercuspal position.

- Compared to the other movements, the distance of a retrusive movement is quite small as it is restricted by the ligamentous structures.

- Retrusive contacts occur on the reverse inclines of the protrusive contacts, since the movements are exactly opposite.

- This movement is of less clinical importance.

4. Lateral excursion

Movement produced when the mandible moves side to side – right and left. Rotation in vertical and sagittal axis during lateral movements on the working side (side to which the mandible moves) with a little translation called Bennett movement or mandibular side shift (Fig. 34.4).

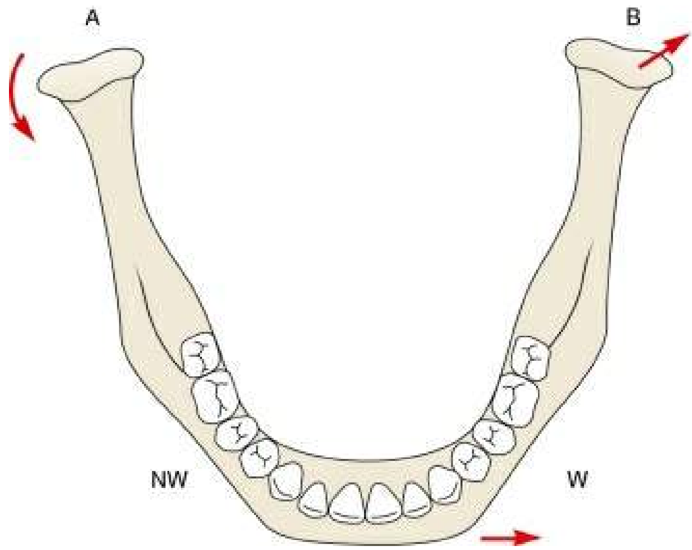


FIGURE 34.4 When the mandible moves into a left lateral excursion, the right condyle (A) moves forward and inward, and the left condyle (B) shifts slightly in a lateroposterior direction. The left side is the working side (W), and the right side is the nonworking side (NW).

Translation on the nonworking side – downward, forward and medially.

Occlusal contacts in laterotrusive mandibular movement

- In the posterior teeth on the left side during a left lateral movement (working side) contact can occur on two incline areas (Fig. 34.5).

○ Between the inner inclines of the maxillary buccal cusps and the outer inclines of the mandibular buccal cusps.

○ Between the outer inclines of the maxillary lingual cusps and the inner inclines of the mandibular lingual cusps. Both these contacts are termed **laterotrusive or working contact.**

- During the same left lateral movement the right mandibular posterior teeth (balancing/nonworking side) are passing in a medial direction across their opposing teeth. Normally, there should be no contact.

○ The potential sites for occlusal contacts are between the inner inclines of the mandibular buccal cusps and the buccal inclines of the palatal cusps of the maxillary teeth. These are called **mediotrusive** or nonworking contacts. If present, it is an interference.

- If the mandible moves laterally to the right, the potential sites of contact are identical with but reversed from those occurring in left lateral movement.

- The anterior teeth play an important guiding role during left and right lateral mandibular movement. In a normal occlusal relationship the maxillary and mandibular canines contact during the lateral movements and therefore have laterotrusive contacts. These occur between the labial surfaces and incisal edges of the mandibular canines and the lingual fossae and incisal edges of the maxillary canines.

○ During lateral movement of the mandible, if the contact is only in the palatal slopes canine, and the rest of the dentition is disoccluded, it is termed as **canine-guided occlusion** (Fig. 34.6).

○ However due to wearing-off, of the incisal edges of the canines, multiple posterior teeth may come into contact on the working side, with the nonworking side teeth in disocclusion. This is termed as **group function occlusion** (Fig. 34.7).

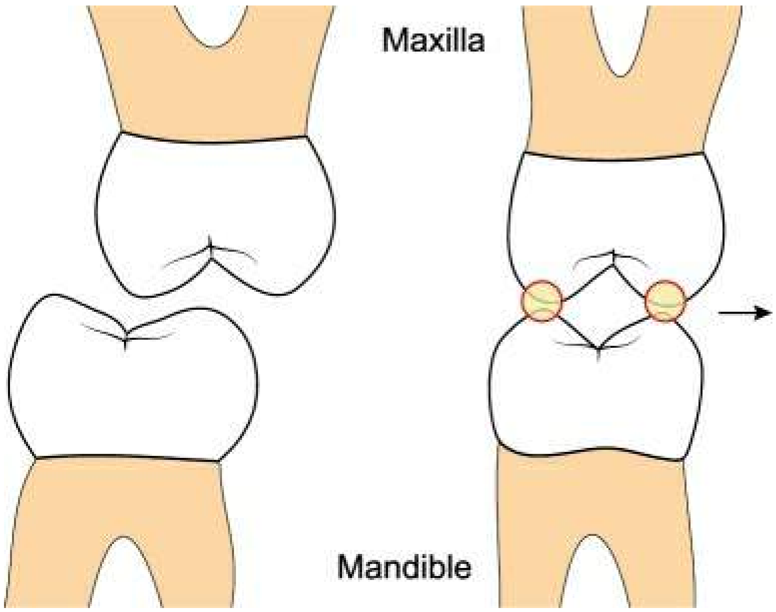


FIGURE 34.5 When the mandible moves laterally, there are two laterotrusive contacts.

FIGURE 34.6 In canine-guided occlusion only canines come to contact during lateral movements.

FIGURE 34.7 In group function occlusion, teeth posterior to canines also come into contact as a group, normally seen in older individuals.

Border movements

Posselt described the extremes of mandibular movement as limited by anatomic structures and the teeth. Also termed as 'envelope of motion'.

Envelope of motion: The three-dimensional space circumscribed by mandibular border movements within which all unstrained mandibular movement occurs (GPT8).

He described the mandibular movement as seen from the incisal edge of the mandibular central incisor (Fig. 34.8). The mandibular movement in the sagittal plane is traced beginning with contact in centric relation and moving through maximal protrusion followed by maximal mouth opening, and finally returning to centric relation position (Fig. 34.9).

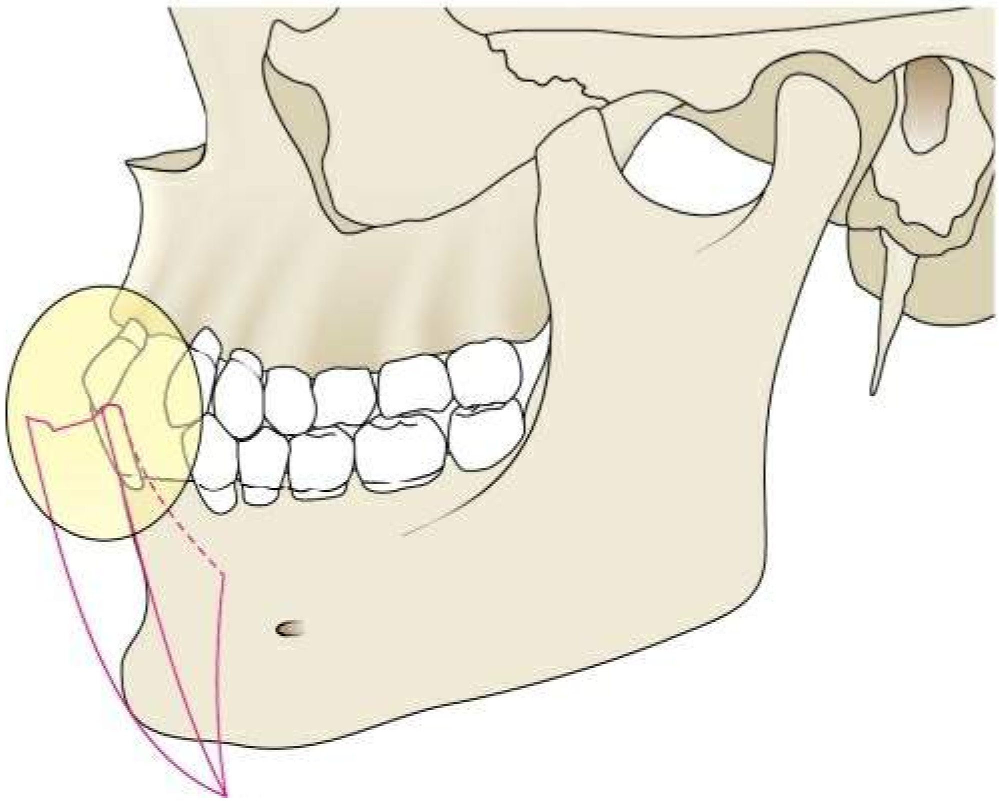
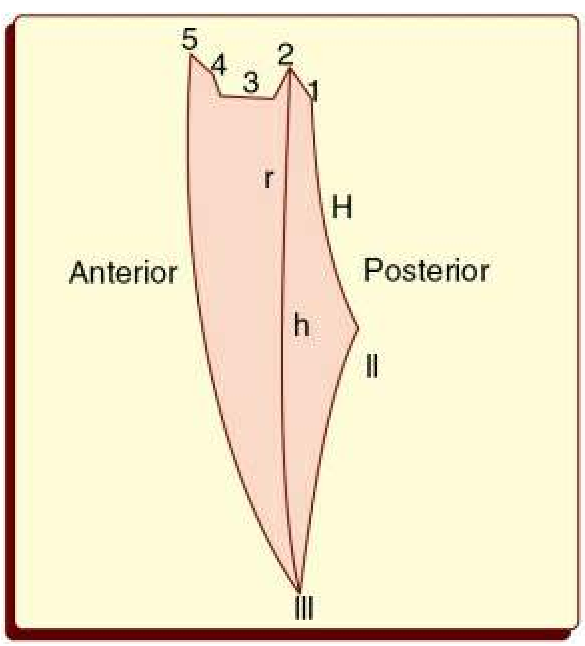


FIGURE 34.8 Border movement through incisor in sagittal plane.



1: Contact in CR
2: MIP contact
3: Edge-to-edge contact
4: Contact with protruded reversed overlap of anterior teeth
5: Contact in maximal protrusion
h. Habitual closing
r. Rest position
H. Terminal hinge opening
II. Transition from hinge opening to opening combining rotation and translation
III. Maximal opening

FIGURE 34.9 Envelope of motion.

A similar border movement is traced through the extreme right and left lateral positions which can be best viewed in the horizontal plane.

All possible functional mandibular movements occur within this boundary.

The upper part of the envelope is guided by the teeth. The movements along all other borders and within the borders are guided by the TMJ and muscles.

Occlusal contacts not properly created by natural growth and development, and faulty contacts created by dental restorations, produce deflection in the mandibular movement which may interfere with the anatomic control (TMJ and condyles), such that smooth condylar function is disturbed. This may produce TMJ dysfunction.

Functional movements

Chewing, swallowing, speaking, yawning and associated movements constitute the functional movements of the mandible. These take place within the border movements (Fig. 34.10).

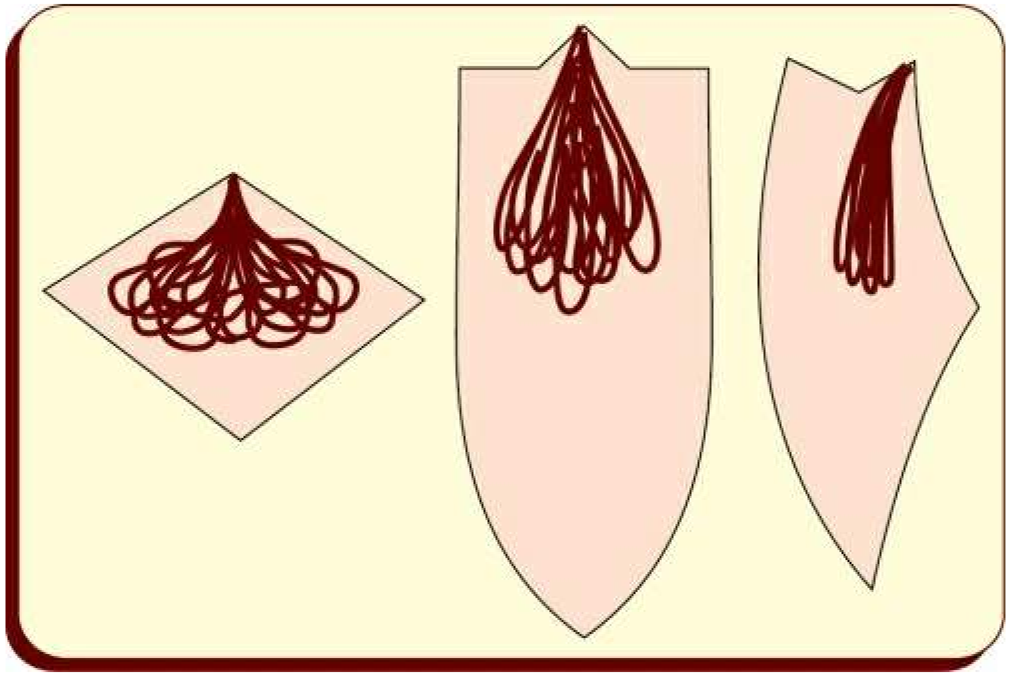


FIGURE 34.10 Multiple tear drop chewing cycles in the three planes all within the border movements.

In chewing, the direction of mandibular closure is influenced by the orientation of occlusal plane and the occlusal guidance. The occlusal form of the tooth influences the character of the chewing cycle (Fig. 34.11).

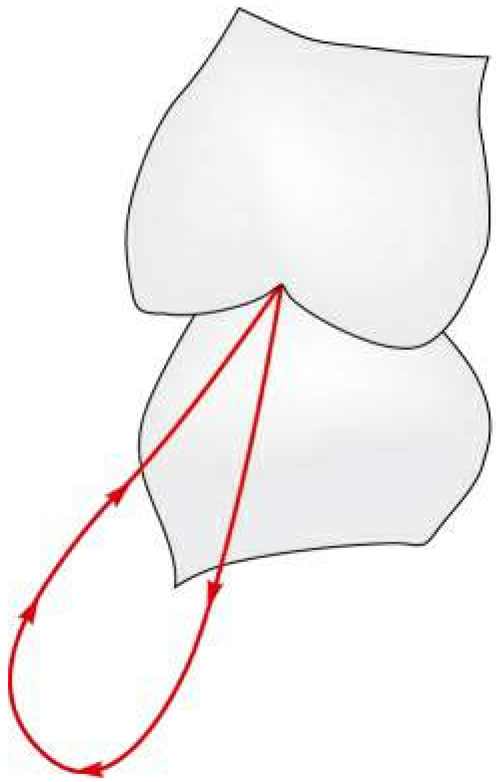


FIGURE 34.11 Occlusal form of tooth influencing chewing cycle.

Any interference may prevent a smooth cyclic function of the joint and muscles (Fig. 34.12).

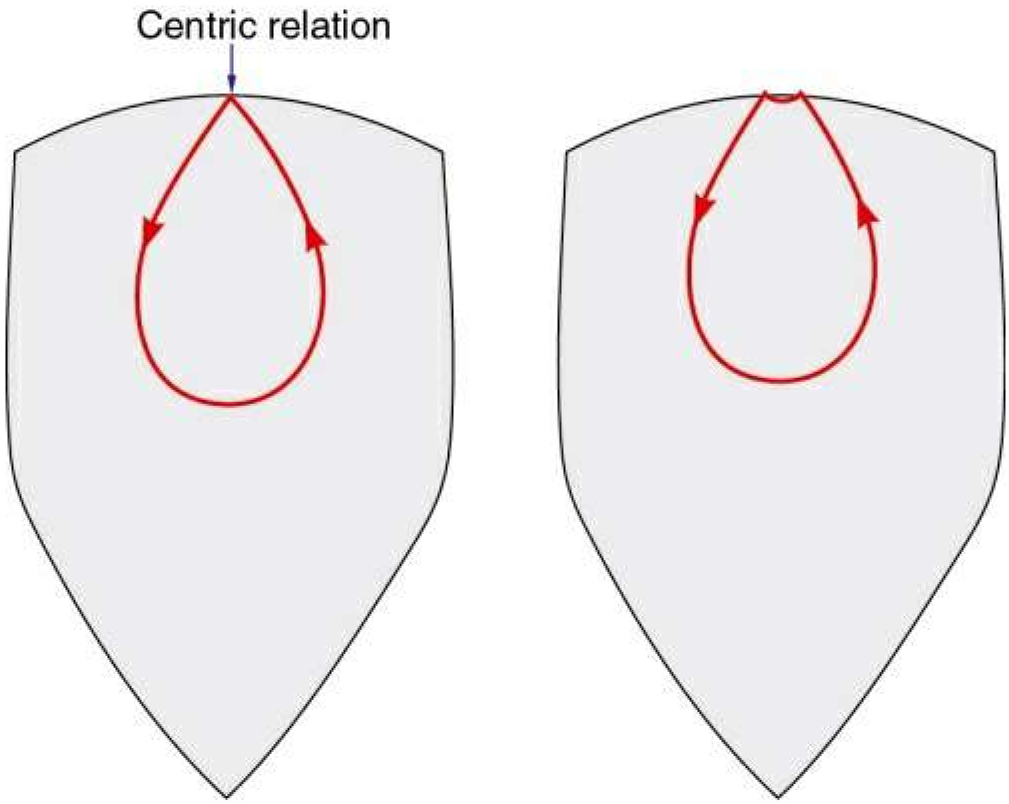


FIGURE 34.12 Left – smooth cycle, right – showing interference.

Dental occlusion should also be developed so as not to interfere with normal speech as described in the section on Complete Dentures.

Parafunctional movements

These are sustained movements of the mandible that occur other than normal, manifested by long periods of increased muscle activity. They are almost impossible for the patient to control.

The two most common parafunctional activities are bruxism and clenching.

Bruxism: An oral habit consisting of involuntary rhythmic or spasmodic nonfunctional gnashing, grinding, or clenching of teeth, in other than chewing movements of the mandible, which may lead to occlusal trauma – called also tooth grinding, occlusal neurosis (GPT8).

- It may be diurnal, nocturnal or both.
- Probable cause:

  ○ Subconscious reflex in response to emotional stress and occlusal interference.

- Consequences:

  ○ Extensive wear of teeth due to increased occlusal forces with prolonged tooth contact. Anterior teeth wear first to avoid a posterior interference, followed by posterior wear also.

  ○ Pain in joint and muscles around TMJ as there is increased muscle activity.

  ○ Widening of periodontal ligament space and mobility of posterior teeth.

Clenching: The pressing and clamping of the jaws and teeth together frequently associated with acute nervous tension or physical effort (GPT8).

- Occlusal disorder may not be a cause for this and clenching may not cause damage to the teeth except for abfractions.
- Commonly muscular pain is seen along with damage to the periodontium.

Determinants of mandibular movements

These are classified as anterior and posterior determinants and influence the development of occlusal scheme. The posterior determinants are the TMJ and their associated structures which cannot be controlled by the dentist, while the anterior determinants are the teeth. They influence occlusal schemes as follows:

Posterior determinants

1. **Inclination of articular eminence:** The greater the angle, greater is the allowable cusp height and deeper is the fossa of the teeth and vice versa (Fig. 34.13).

2. **Intercondylar distance:** This is the distance between the two rotational centres of the condyle. A larger than average distance requires more distal positioning of the oblique ridges and grooves on mandibular teeth, and a more mesial positioning on the maxillary teeth and vice versa.

3. **Side shift:** Greater the immediate side shift, shorter is allowable cusp height and vice versa (Fig. 34.14A and B). Greater the laterosurtrusion (outward and upward movement of working condyle), shallower the grooves and less cusp height. Greater laterodetrusion (outward and downward), deeper the grooves and greater the cusp height and vice versa.

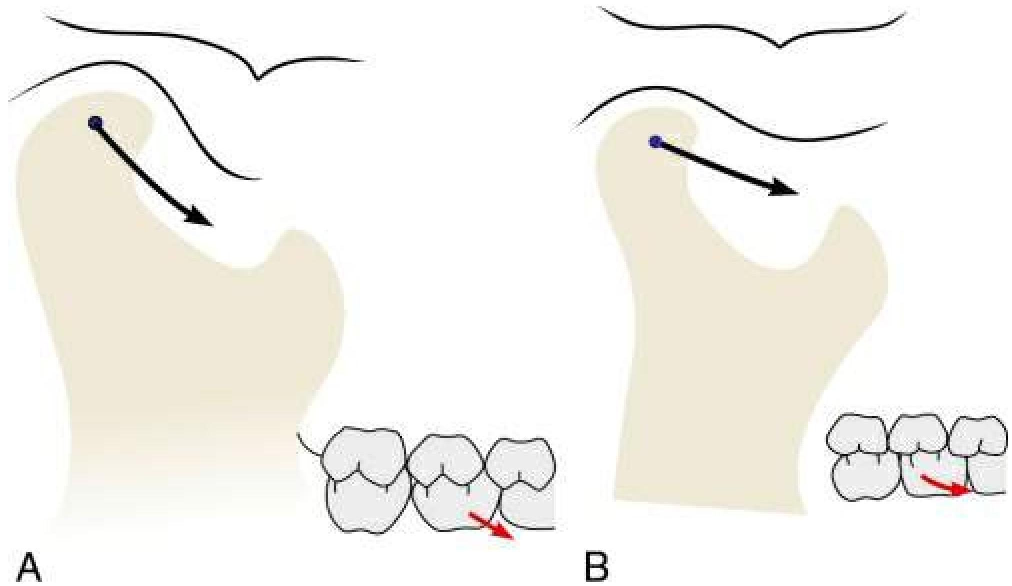


FIGURE 34.13 **(A)** Steep, **(B)** shallow.

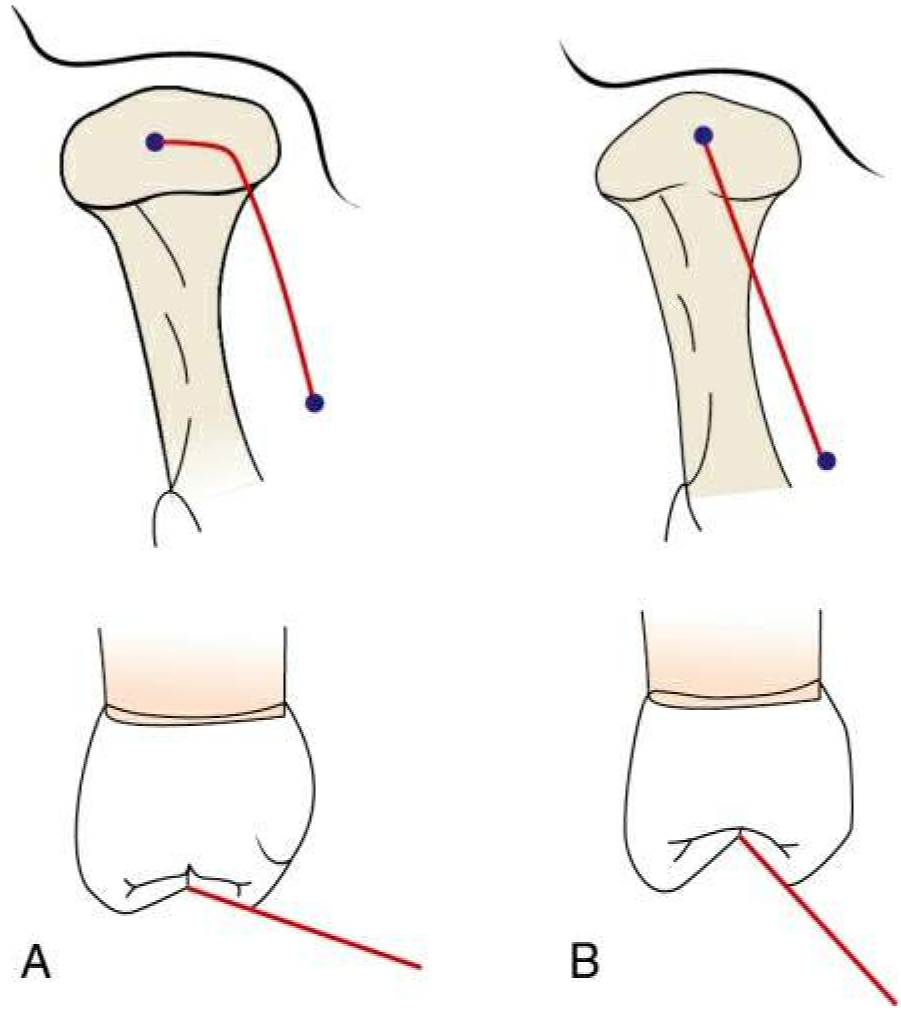


FIGURE 34.14 **(A)** Pronounced immediate lateral translation requires the cusps to be short. **(B)** Gradual lateral translation allows the cusps to be longer.

Anterior determinants

1. **Vertical overlap:** Greater the vertical overlap of anterior teeth, greater is the allowable cusp height and vice versa.

2. **Horizontal overlap:** Greater the horizontal overlap, shorter is the allowable cusp height and vice versa (Fig. 34.15).

3. **Occlusal plane:** When the plane is more parallel to the condylar guidance, allowable posterior cusp height is shorter and vice versa

(Fig. 34.16).

4. **Curve of Spee:** More convex the curve (lesser radius), allowable cusp height is lesser and vice versa (Fig. 34.17).

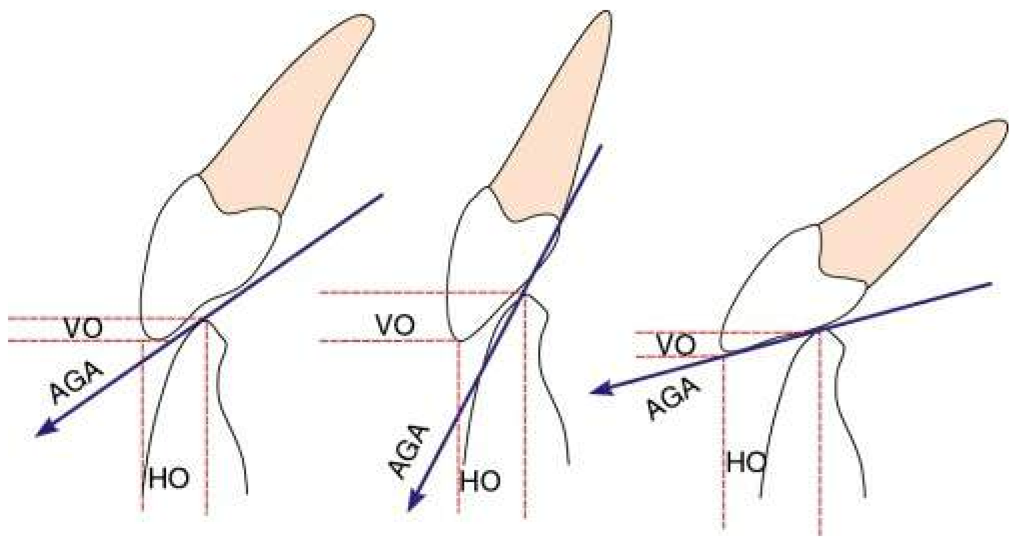


FIGURE 34.15 Anterior guidance has effect on occlusal scheme.

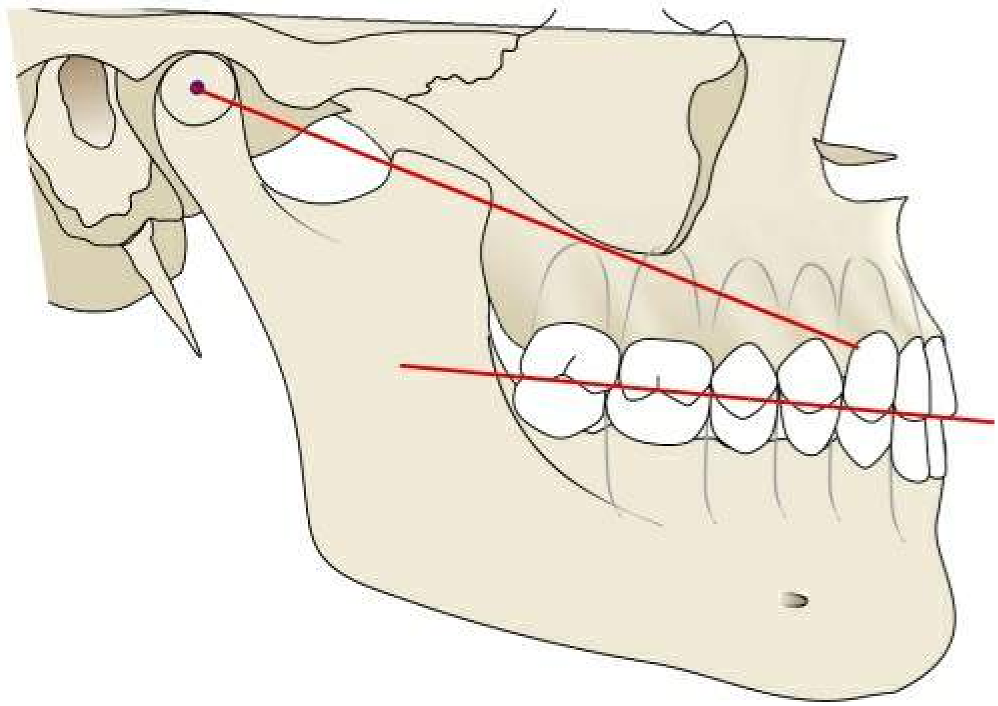


FIGURE 34.16 Occlusal plane.

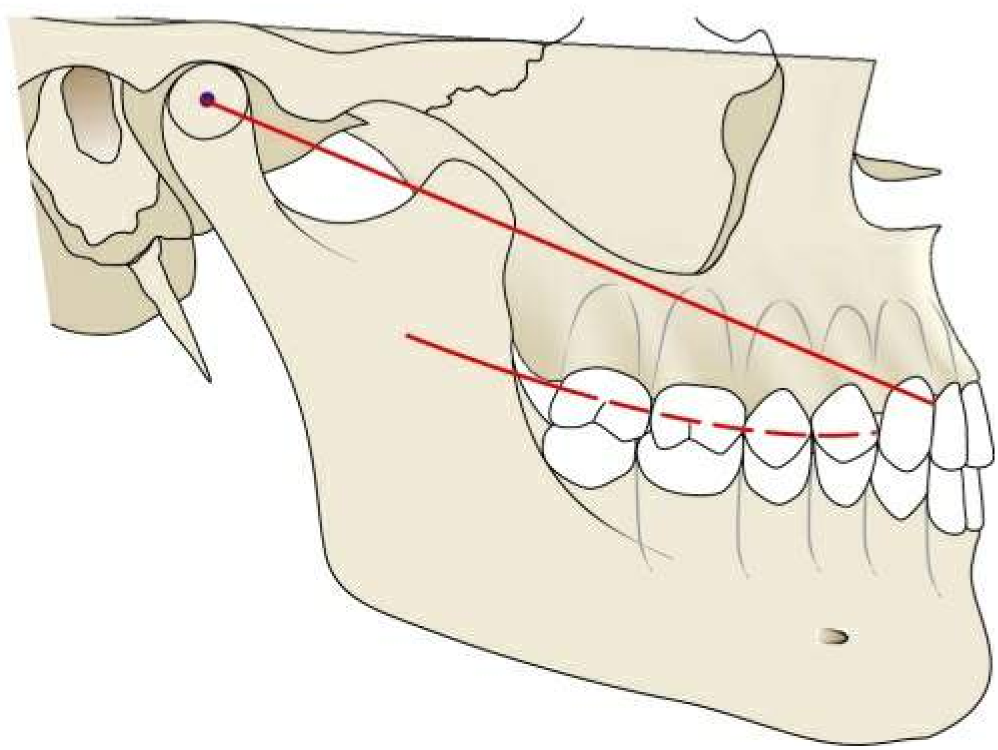


FIGURE 34.17 Curve of Spee.

Concepts of occlusion

Following are the three recognized concepts.

Bilateral balanced occlusion

This is a concept used in the construction of complete dentures and is discussed in detail in Chapter 8.

Unilateral balanced occlusion

Unilateral balanced occlusion also known as 'group function occlusion' (Fig. 34.7). It is based on Schuyler's concept.

Characteristics

- There is excursive contact on all posterior teeth on the working side during lateral movement. This distributes the occlusal load.
- Eliminates any tooth contact on the nonworking side.
- In protrusive movement no posterior tooth contact is seen.
- Prevents excessive wear of functional cusps.
- Functionally generated path technique is used for producing restorations in unilateral balanced occlusion.

Long centric

- Proposed by Schuyler; also known as 'freedom in centric'.
- Evolved with the unilateral balanced occlusion concept.
- The mandible is able to move anteriorly for a short distance in the

same horizontal and sagittal plane while maintaining centric tooth contact.

- Advocated as centric relation rarely coincides with maximal intercuspal position in natural dentition.
- At a given vertical dimension, it ranges from 0.5–1.5 mm in length.

Mutually protected occlusion

- Also termed as organic occlusion.
- Proposed by D'Amico, Stuart, Stallard and Lucia.
- Anterior teeth protect the posterior teeth in all excursive movements and posterior teeth protect the anterior teeth in the maximal intercuspal position (mutual protection). Frictional wear of teeth is reduced.

Characteristics

- Only anterior teeth contact in lateral and protrusive excursions in harmony with functional jaw movements. No posterior contact.
- Stable posterior tooth contacts with vertically directed resultant forces in maximal intercuspal position. There is only light or no contact in anterior teeth.
- The lack of contact is termed as 'disclusion'.
- Centric relation coincides with maximal intercuspation.
- Periodontally sound anterior teeth are required for this type of occlusion.

Advantages

- Patient tolerance.
- Ease of construction.

Disadvantages

Mutually protected occlusion cannot be used with:

- Periodontally weak anterior teeth.
- Missing canines.
- Class II and class III situation.
- Crossbite situations.

Canine-Guided/Protected occlusion

Definition: A form of mutually protected articulation in which the vertical and horizontal overlap of the canine teeth disengage the posterior teeth in the excursive movements of the mandible (GPT8) (Fig. 34.6).

Ideal occlusion

'Mutually protective occlusion' forms the basis for 'ideal occlusion' in natural dentitions.

Characteristics

1. Stable posterior contact with vertically directed resultant forces.

2. MIP coincident with CR along with freedom in centric.

3. No posterior contact in eccentric mandibular movements.

4. Contact of anterior teeth in harmony with functional jaw movements.

5. Occlusion in Angle's class I.

Occlusion can only be judged from the reaction it produces in the tissues of the system in which it coexists. This reaction varies infinitely between individuals and may also vary within an individual with time. Hence, some patients are capable of tolerating gross malocclusions without obvious discomfort, while others are unable to tolerate even minor occlusal deficiencies.

Factors determining a patient's reaction to an occlusion

The application of force from the muscles through occlusal contacts, results in load. Whether that load produces damage to tissues will depend on several factors:

1. The resistance of the tissues and/or restoration.

2. The magnitude of the force being applied.

3. The frequency of the force being applied.

4. The direction of the force being applied.

5. The number of contacts transmitting that force.

Importance of ideal occlusion

As previously discussed, every patient need not possess an 'ideal occlusion' to function comfortably. But it is important to know what is 'ideal' for the following reasons:

1. Use it as a benchmark for assessment of pretreatment records and examination (diagnostic casts).

2. Correcting of TMD and occlusal interference (if they exist) before commencing restorative procedures.

3. For final prosthodontic rehabilitation – to accomplish this **a conformative approach** (where patient's pretreatment occlusion is retained for the prosthodontic rehabilitation), or a **reorganized** approach (where a change in occlusal scheme is planned) is utilized.

Occlusal interferences

Interferences are undesirable occlusal contacts that may produce mandibular deviation during closure to maximum intercuspation or may hinder smooth passage to and from the intercuspal position.

When the teeth are not in harmony with the joints and the mandibular movements, interference is said to exist. There are four types of interferences.

Centric interference

Mandible is closed in centric relation until initial tooth contact occurs. If increasing the closing force deflects the mandible, premature contact or interference exists.

This leads to deflection of the mandible which can be in a posterior, anterior and/or lateral direction.

Interference occurs between the mesial inclines of maxillary posterior teeth and distal inclines of mandibular posterior teeth (Fig. 34.18).

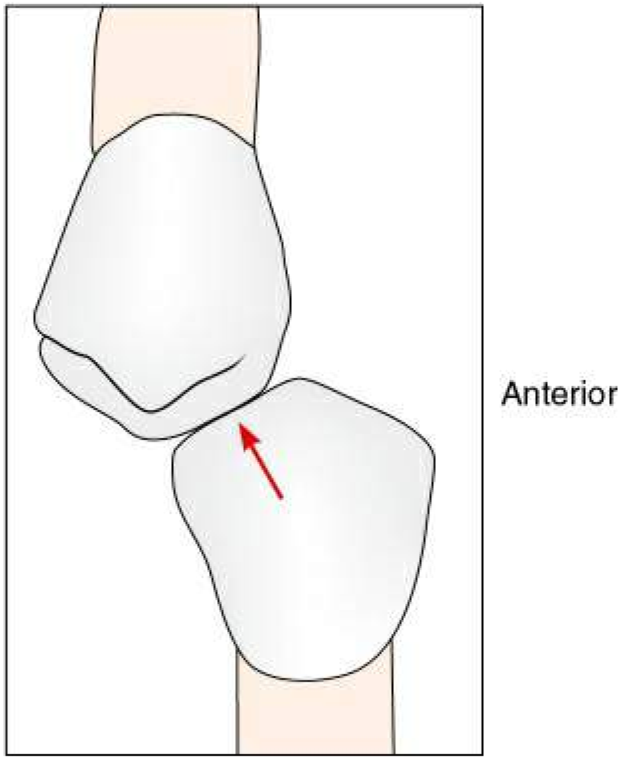


FIGURE 34.18 A centric occlusal interference often occurs between maxillary mesial-facing cusp inclines and mandibular distal-facing inclines, as a result the mandible is deflected anteriorly.

Working interferences

Occurs when there is contact between the maxillary and mandibular posterior teeth on the working side and this causes anterior teeth to disocclude.

Interference occurs on the maxillary lingual facing cusp inclines and mandibular buccal facing cusp inclines (Fig. 34.19).

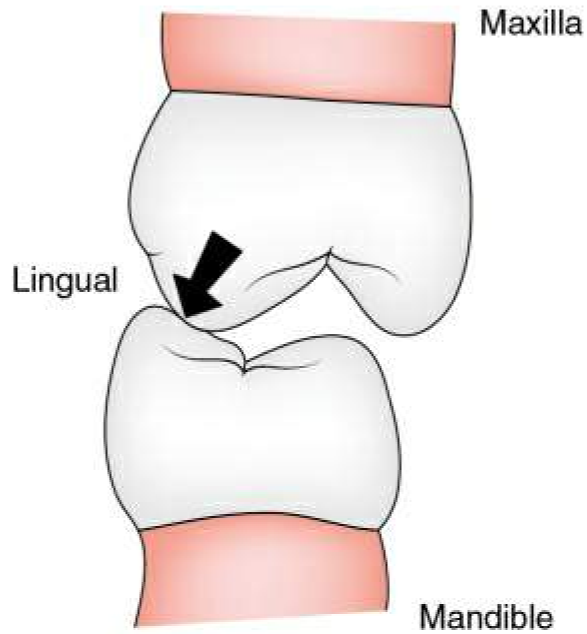


FIGURE 34.19 A working interference may occur between maxillary lingual-facing cusp inclines and mandibular buccal-facing inclines on the working side.

Nonworking interferences

Nonworking interference is an occlusal contact between the maxillary and mandibular teeth on the nonworking side when the mandible moves in a lateral excursion.

Interference occurs on the maxillary buccal facing cusp inclines and mandibular lingual facing cusp inclines (Fig. 34.20). It is destructive in nature because of nonaxial nature of forces causing leverage of mandible.

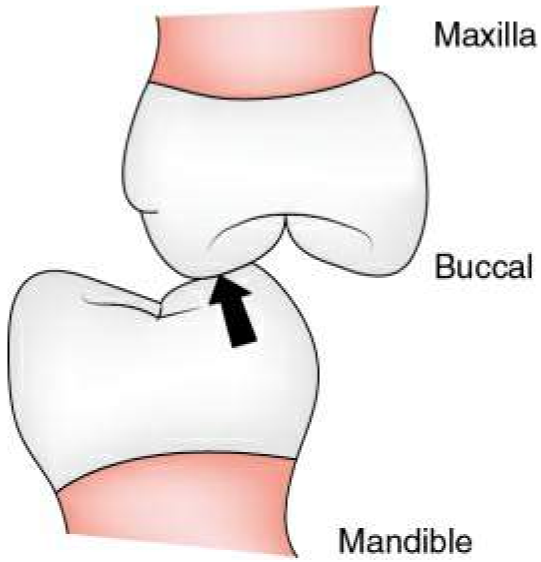


FIGURE 34.20 A nonworking interference may result when there is contact between maxillary buccal-facing inclines and mandibular lingual-facing cusp inclines on the working side.

Protrusive interference

Occurs when distal facing inclines of maxillary posterior teeth contacts the mesial facing inclines of mandibular posterior teeth during a protrusive movement (Fig 34.21).

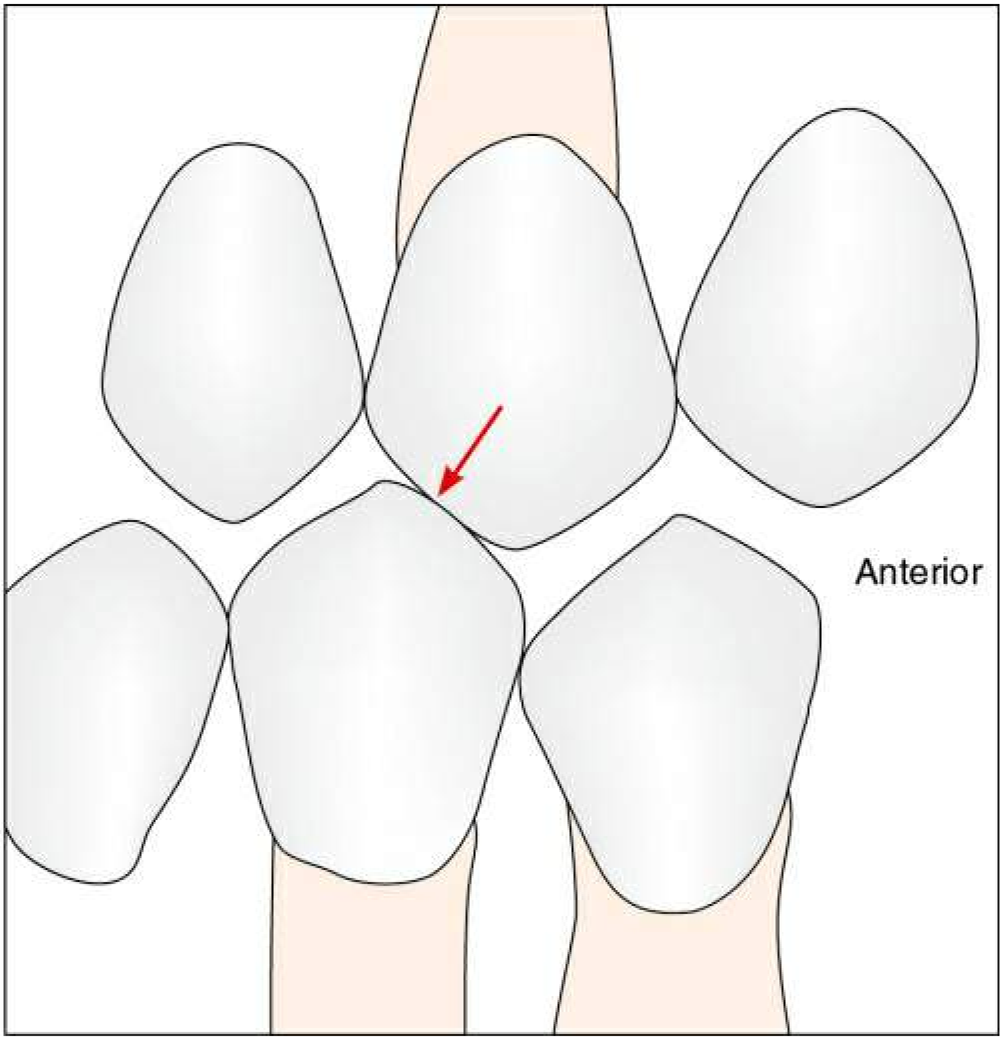


FIGURE 34.21 A protrusive interference occurs when during a protrusive movement distal-facing inclines of maxillary posterior teeth contact mesial-facing inclines of mandibular posterior teeth.

These are destruction forces due to closeness of teeth to the muscles, nonaxial nature of forces and inability of patient to incise food.

Interferences may lead to pathologic occlusion and should be assessed and corrected if needed, with the aid of mounted diagnostic casts before prosthetic rehabilitation is commenced.

Pathogenic occlusion

Definition: An occlusal relationship capable of producing pathologic changes in the stomatognathic system (GPT8).

Signs and symptoms

1. Teeth

    i. Mobility

    ii. Open contacts

    iii. Abnormal wear like fracture or chipping of incisal edges

2. Periodontium

    i. Chronic periodontal disease

    ii. Widened periodontal ligamant space (radiographically)

    iii. Tooth movement and a compromised C:R ratio

3. Musculature

    i. Chronic muscle fatigue leading to muscle spasm and pain

ii. Restricted opening or trismus

iii. Myositis

4. TMJ

i. Pain, clicking or popping in the TMJ

Treatment

This would include the following depending on the cause for occlusal interference.

Short-term treatment

This is accomplished with occlusal splints/devices. They are used only for a short period and provide the following benefits:

1. Serve to deprogram the occlusion such that future restoration in centric relation is easily accomplished.

2. Act as a diagnostic tool in determining if a proposed change in occlusal scheme will be tolerated by the patient.

3. They have also been beneficial in relieving myofacial pain.

Definitive treatment

Definitive treatment may be comprising the following individually or in combination:

1. Orthodontic treatment to correct malalignment.

2. Elimination of deflective occlusal contacts through selective grinding of interfering inclines.

3. Replacement of missing teeth to produce a more favourable distribution of force.

This is attained by either occlusal equalization procedures or appliances like occlusal splint.

SUMMARY

Occlusion of fixed partial denture with the antagonist should be achieved favourably in order to fulfil the requirements of mastication, aesthetics, speech, support for orofacial structures and prevention of TMJ dysfunction. Information about the existing occlusal scheme can be derived from intraoral examination, radiographic survey and evaluation of mounted diagnostic casts.

The TMJ and associated musculature permit the mandible to move in three planes – sagittal, horizontal and frontal. The three basic eccentric movements are protrusive, laterotrusive and retrusive. When the teeth are not in harmony with the joints and the mandibular movements, interference is said to exist.

Interferences are undesirable occlusal contacts that may produce mandibular deviation during closure to maximum intercuspation or may hinder smooth passage to and from the intercuspal position.

CHAPTER 35

Tooth preparation

CHAPTER CONTENTS

Introduction

Teeth do not possess the regenerative ability found in most other tissues. Therefore, restorative materials are required to replace the lost enamel or dentine as a result of caries, wear or trauma. Hence, teeth require preparation to receive such restorations. Teeth also require preparation to support a fixed partial denture. The longevity of all such restorations depends predominantly on the preparation. So every effort must be made to prepare the tooth such that it retains the restoration and does not harm the tooth or the surrounding structures. This chapter will detail the basic principles of preparation of the tooth to receive the restoration.

Definition: Tooth preparation is defined as the process of removal of diseased and/or healthy enamel, dentine and cementum to shape a tooth to receive a restoration (GPT8).

Principles of tooth preparation

The principles of tooth preparation are classified in Table 35.1.

Table 35.1

Classification of principles of tooth preparation

Biologic	Mechanical	Aesthetic
1. Prevention of damage i. Adjacent teeth ii. Soft tissue iii. Pulp	Retention form: i. Magnitude of dislodging forces ii. Geometry of preparation iii. Path of insertion iv. Roughness of fitting surface of casting v. Materials being cemented vi. Type of luting agent	1. Partial veneer restorations 2. Metal-ceramic restorations 3. All-ceramic restorations
2. Conservation of tooth structure	Resistance form: i. Magnitude of dislodging forces ii. Geometry of preparation iii. Type of luting agent	
3. Margin integrity i. Placement ii. Geometry iii. Adaptation	Structural durability i. Occlusal reduction ii. Functional cusp bevel iii. Axial reduction	

Biologic principles

These affect the health of oral tissues.

Prevention of damage during tooth preparation

Adjacent teeth

Iatrogenic damage to the adjacent tooth during tooth preparation is a common error. A damaged proximal contact area even if reshaped and polished will be more susceptible to dental caries. This is because the original surface enamel contains higher fluoride concentrations and hence the damaged layer is more prone to plaque retention.

Methods of prevention

1. A metal matrix band placed around the adjacent tooth may be used for protection (Fig. 35.1). The thin band can also be perforated and enamel damaged.

2. Use of proximal enamel of the tooth that is being prepared. This is the preferred method to avoid damage to the adjacent tooth.

FIGURE 35.1 Metal matrix band used to protect adjacent tooth.

Teeth are 1.5–2 mm wider at the contact area than at the cementoenamel junction. A thin, tapered diamond can be passed through the interproximal contact area to leave a slight lip of enamel without resulting in excessive tooth reduction (Fig. 35.2).

FIGURE 35.2 Thin tapering diamond used to produce a lip of enamel for protection.

Soft tissues

Damage to the soft tissues of the tongue and cheeks can be prevented by careful retraction with an aspirator tip, mouth mirror or flanged saliva ejector (Fig. 35.3).

FIGURE 35.3 Mouth mirrors used to retract cheek and tongue.

Pulp

Tooth preparations must not involve or irritate the pulp chamber. Pulp size is more in young and adolescent individuals and decreases with age. Up to 50 years of age, the decrease is more occlusocervical than faciolingual.

Pulpal damage during preparation may be due to:

(i) Increased depth of preparation – use of depth orientation grooves, appropriate selection of size of diamond point (diameter), and use of finish line as indicated, will prevent this.

(ii) Extreme temperatures caused by excessive pressure and high rotational speeds, condition of cutting instrument and improper application of coolants. Use of high speed handpiece intermittently with a feather touch, sharp diamonds and directing water spray to the area of contact between bur and tooth (Fig. 35.4A and B), will prevent this.


A

FIGURE 35.4 **(A)** Proper use of water spray directed towards the tip of the diamond. **(B)** Improperly directed water spray.

Conservation of tooth structure

Tooth structure can be conserved by:

- Using partial-coverage than complete-coverage restorations when possible.
- Preparation of teeth with the minimum practical taper (Fig. 35.5A and B).
- Preparation of occlusal surface following the anatomic planes (Fig. 35.5C).

- Selection of a conservative finish line compatible with the type of restoration.

- Avoidance of subgingival margins unless indicated.

- Preparing axial surfaces evenly using depth orientation grooves and proper width of diamond points as indicated for the restoration so that excessive preparation is avoided.

FIGURE 35.5 **(A)** and **(B)** Teeth prepared with more taper will not be conservative. **(C)** Tooth prepared following the anatomic planes will be conservative.

Margin integrity

Margin: The outer edge of a crown, inlay, onlay or other restoration (GPT8).

Finish line: Terminal portion or peripheral extension of the prepared tooth (GPT8) (Fig. 35.6).

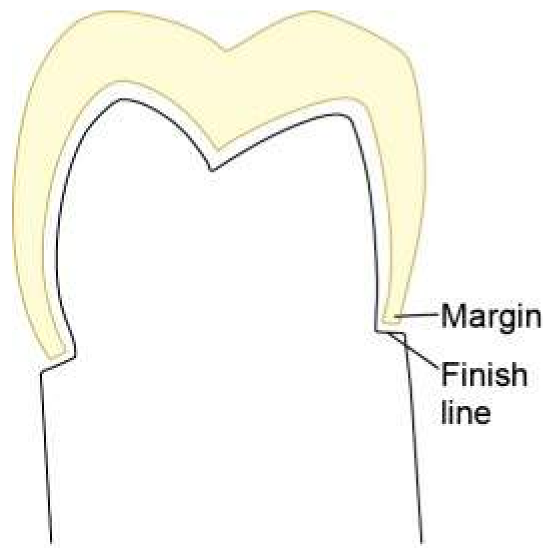


FIGURE 35.6 Appropriately placed margin.

The margins of a restoration lie on the prepared finish line of the tooth. The junction is in the form of a space or gap and is the most vulnerable part of the restoration as the cement joining the restoration to the tooth is exposed to the oral environment only in this area. Hence every effort must be made with our preparation design and fabrication, to reduce this space.

This integrity of the margin is determined by the following:

1. Margin placement

Margins can be placed by:

i. **Supragingival (at or above the gingival crest):** Margins placed at the level of gingival crest are referred to as *equigingival margins* (Fig. 35.7B, C).

ii. **Subgingival** (below the gingival crest) (Fig. 35.7 A).

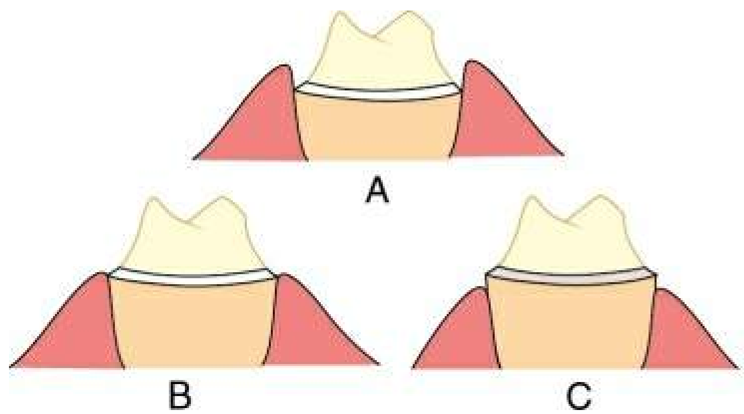


FIGURE 35.7 **(A)** Subgingival. **(B)** Equigingival. **(C)** Supragingival margins.

i. Supragingival margins

Margins should be placed supragingivally whenever possible.

Advantages

- Placed on enamel.
- Easy to prepare without trauma to soft tissues.
- Can be easily finished.
- Impression making is also less traumatic to soft tissues and easy to reproduce.
- Fit of the restorations can be easily evaluated.
- Can be maintained easily by the patient.

ii. Subgingival margins

- Subgingival margins have been described as a major aetiologic factor in periodontitis. The deeper the restoration margin is in the sulcus, greater is the inflammatory response. They are best avoided unless indicated.

- Placed at least 2 mm above the alveolar crest so that the biologic width is not encroached.

Indications for subgingival margins

- Caries, erosion or restorations extending subgingivally.
- Aesthetics – when metal-ceramic restorations are used.
- Additional retention – in case of short crowns.
- Root sensitivity.
- Modification of axial contour.
- Proximal contact extending to gingival crest.

2. Margin geometry

This refers to the shape or configuration of the prepared finish line. It should possess the following characteristics:

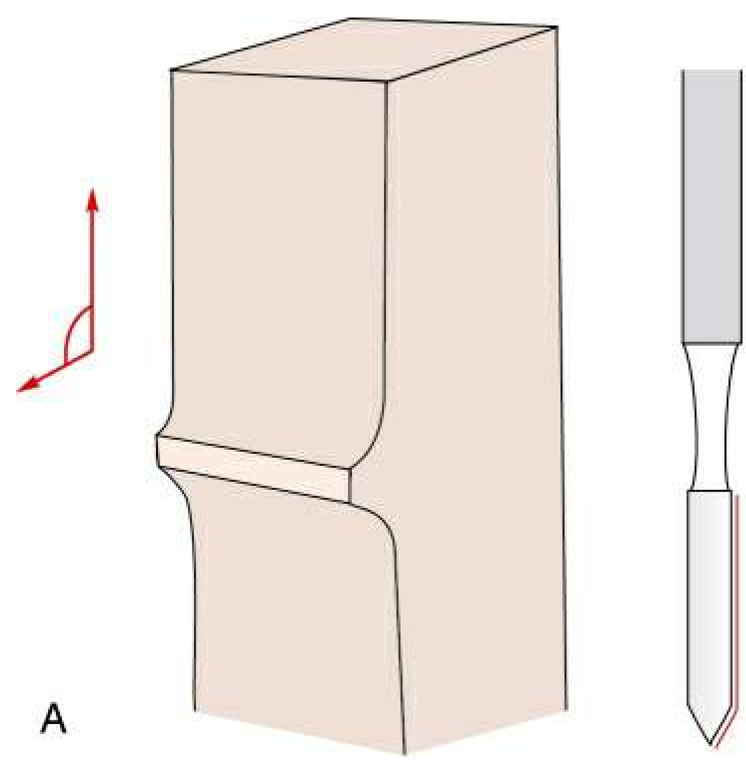
- Ease of preparation
- Ease of identification
- Distinct boundary
- Sufficient strength
- Conservation of tooth structures

The shape of the diamond point/bur determines the finish line configuration and the taper.

Finish line configurations

i. Chamfer

- It is an obtuse-angled finish line.
- It is distinct.
- Exhibits least stress.
- Most conservative.
- Indicated where metal forms the margin of a restoration, e.g. complete metal crown. Should not be given for porcelain restorations as the obtuse angle produces shearing forces which is not well tolerated by porcelain.
- It is prepared using a round-end tapering diamond. This is produced by sinking in half the diamond into the tooth. The tip produces the chamfer while the sides give the necessary taper to the axial surface (Fig. 35.8A and B).



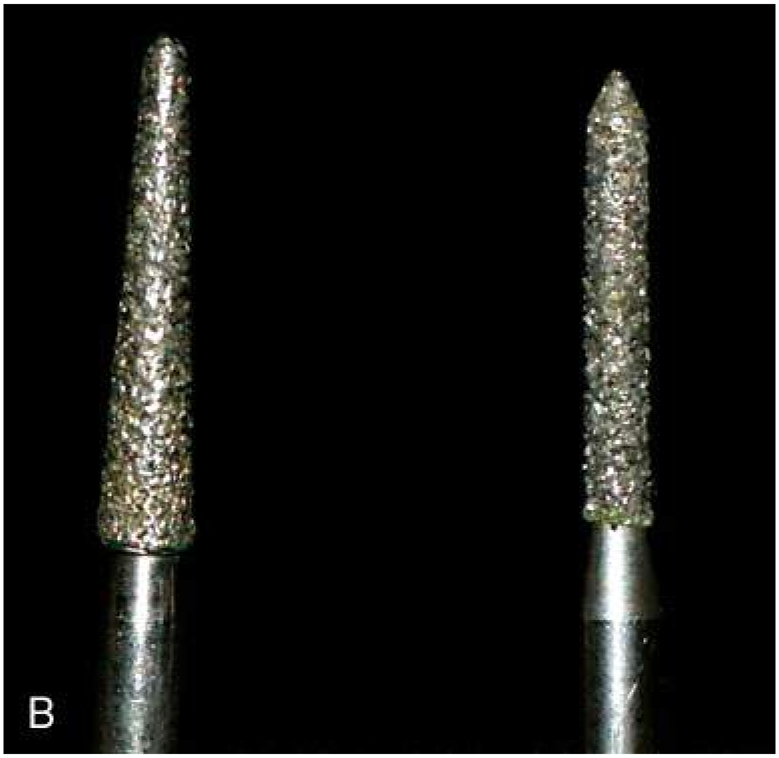


FIGURE 35.8 **(A)** Chamfer finish line – obtuse-angled finish line obtained by sinking half the width of rotary. **(B)** Round-end tapered diamond and chamfer diamond.

ii. Heavy chamfer

- Similar to chamfer but prepared with a diamond of greater diameter than that used to produce the chamfer **(**Fig. 35.9**)**.
- Indicated for all-ceramic crowns.
- Can produce an unsupported lip of enamel.

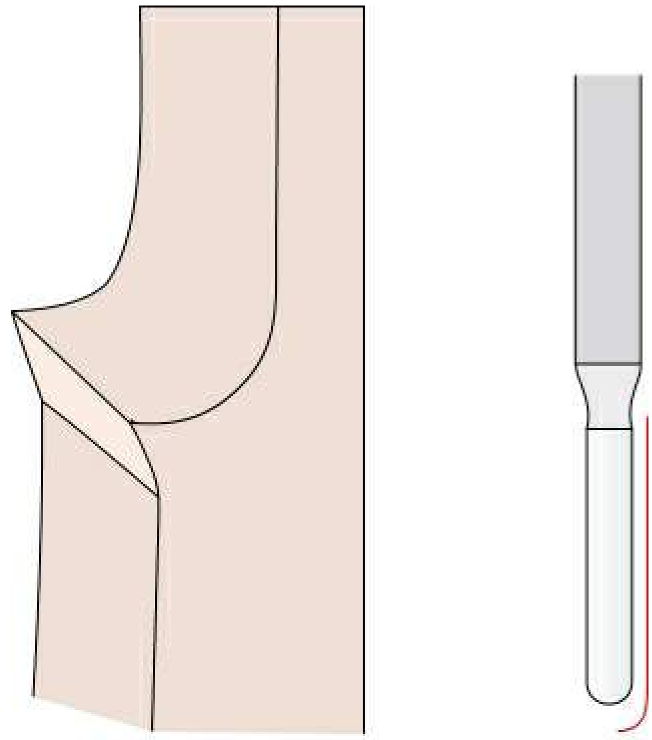


FIGURE 35.9 Heavy chamfer with diamond.

iii. Shoulder

- It is a right-angled finish line **(**Fig. 35.10A**)**.
- Produces a wide ledge which resists compressive occlusal forces.
- Requires more preparation, hence it is not conservative.
- Indicated for ceramic restorations – all ceramic and metal ceramic (where ceramic forms the margin).
- It is prepared using a flat-end tapering diamond (Fig. 35.10B). This is produced by sinking in the entire diamond into the tooth. The tip produces the shoulder while the sides give the necessary taper to the axial surface. End-cutting diamond is used to finish the shoulder. It has a cutting tip and noncutting sides (Fig. 35.10B).
- Sharp internal line angle can produce stresses in all-ceramic crowns.

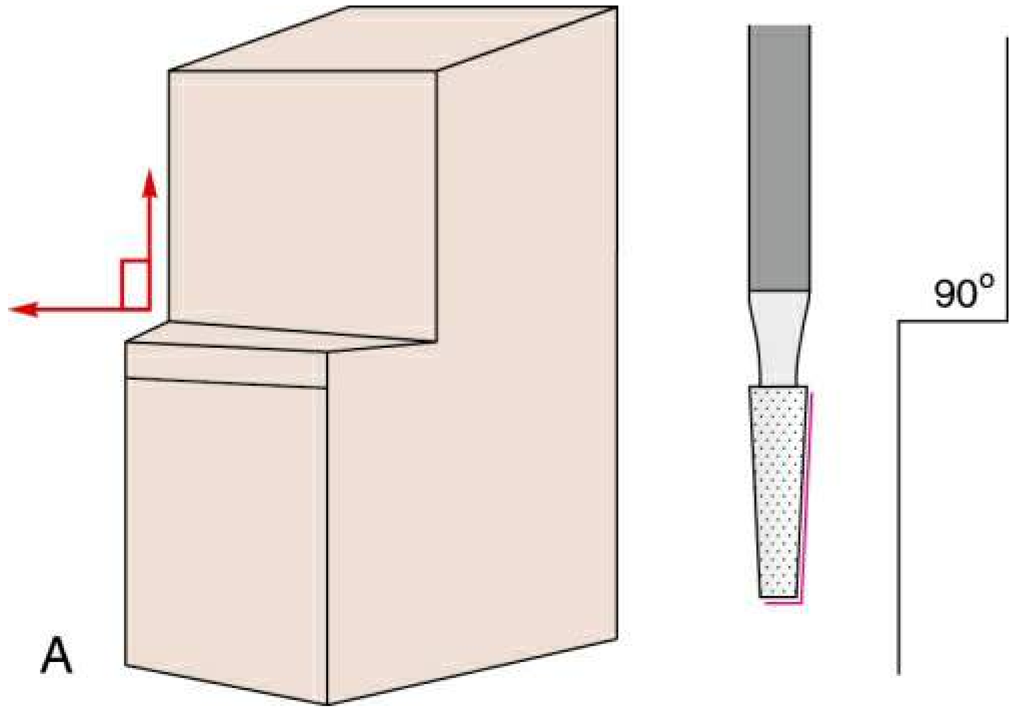

A
90°

FIGURE 35.10 **(A)** Shoulder finish line – right-angled finish line. Produced by sinking the entire rotary into the tooth. **(B)** Flat-end tapered diamond and end cutting diamond, arrow showing the tip which is the only cutting/abrasive area.

iv. Shoulder with bevel

- It is a shoulder with a bevel on the external edge **(**Fig. 35.11A**)**.
- It reduces the marginal discrepancy of the restoration as it can be burnished; however, only gold alloys can be burnished.
- Protects the edge of finish line preventing chipping.
- Primarily indicated to hide the supragingival facial metal margin of

metal-ceramic restorations (Fig. 35.11B). It is also used as the gingival finish line on inlays and onlays, and as occlusal finish line for onlays and partial veneer crowns.

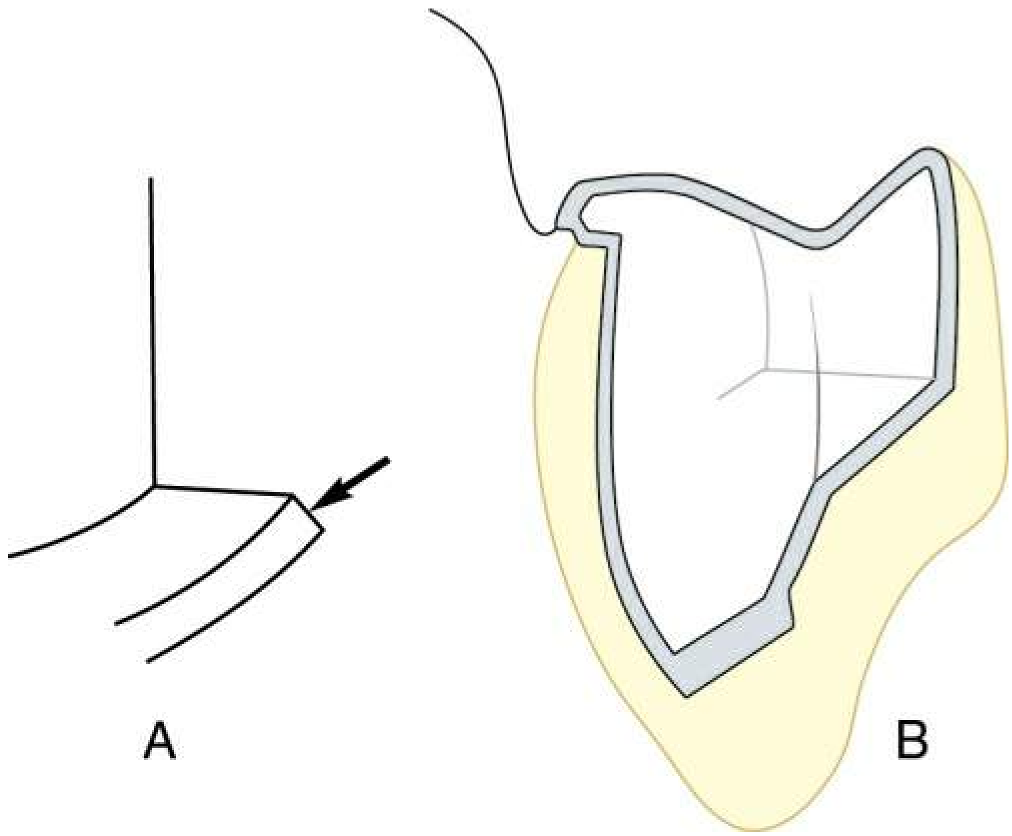


FIGURE 35.11 **(A)** Shoulder with bevel. **(B)** Metal on the bevelled portion is placed subgingivally in metal-ceramic restorations.

v. Radial shoulder

- It is a shoulder finish line with rounded internal line angle **(**Fig. 35.12**)**.
- The internal angle is rounded using an end-cutting diamond and finished with a bin-angle chisel.
- Indicated for all-ceramic crowns.

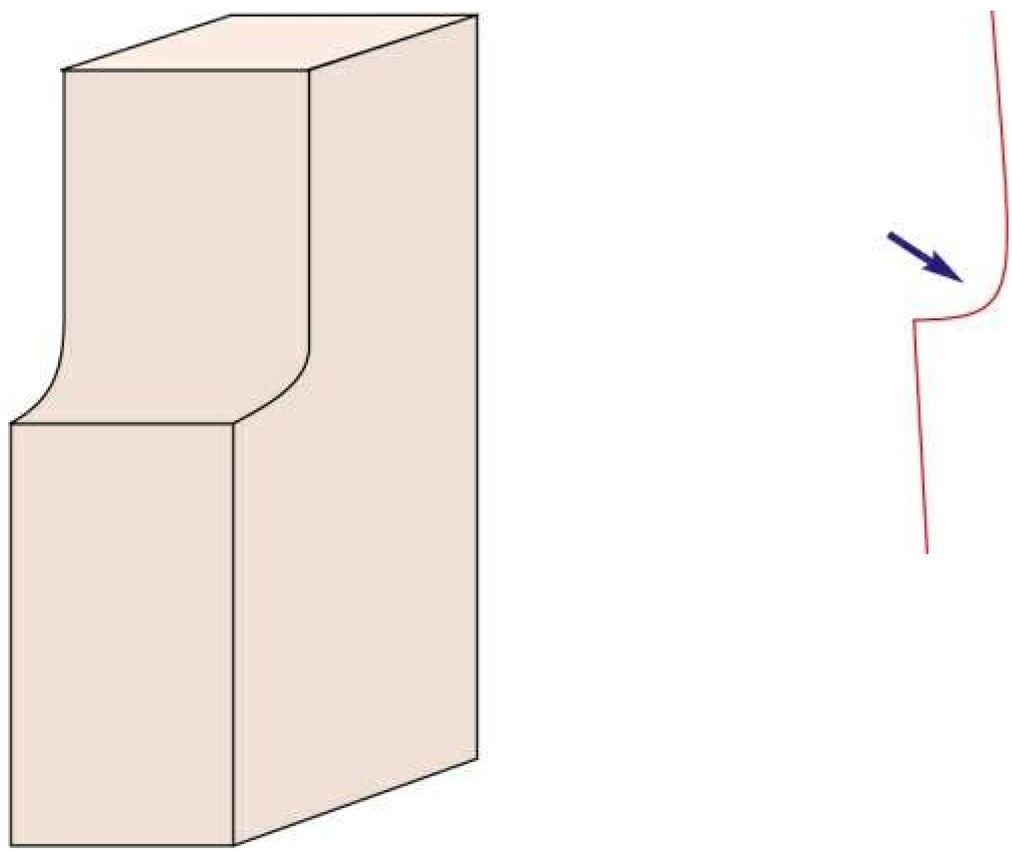


FIGURE 35.12 Radial shoulder.

vi. Sloped shoulder

- Similar to shoulder but with an obtuse angle (Fig. 35.13).
- Indicated for facial margin of metal-ceramic crowns.

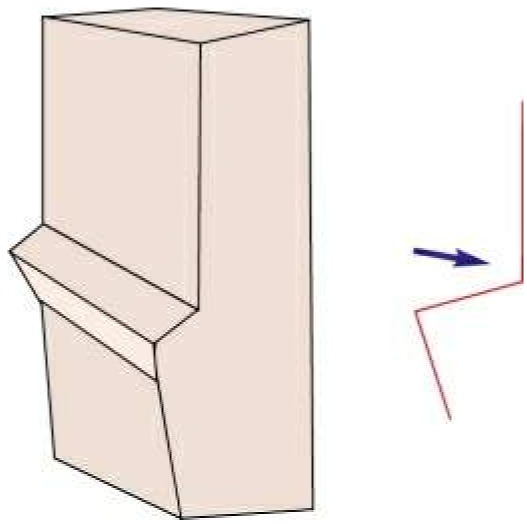


FIGURE 35.13 Sloped shoulder.

vii. Knife-edge

- It is a thin finish line (Fig. 35.14).
- Highly conservative.
- It is difficult to wax and cast and susceptible to distortion.
- It can lead to overcontoured restorations.
- May be used for metal restoration in adolescent patients, lingual surface of mandibular posteriors, very convex axial surfaces and tilted teeth where preparation is minimal.
- Rarely used.

Chisel edge and feather edge are similar to knife edge and they are rarely used. Finish line configurations are summarized in Table 35.2.

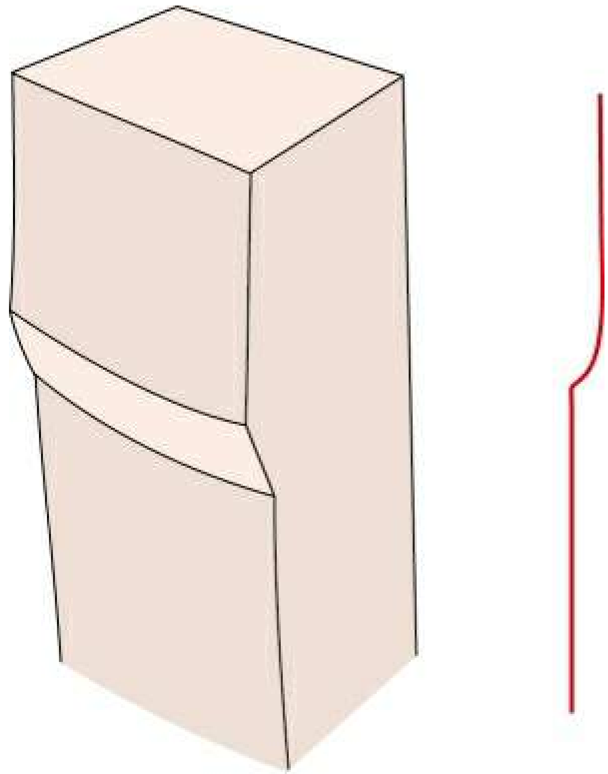


FIGURE 35.14 Knife-edge.

Table 35.2

Summary of various finish line configurations

Finish line	Advantages	Disadvantages	Indications
Chamfer	Distinct margin, adequate bulk, easy to control	Cannot be used for ceramic restorations	Cast metal restorations, lingual margins of metal ceramic crowns
Heavy chamfer	Distinct margin, adequate bulk, easy to control	Care needed to avoid unsupported lip of enamel	All-ceramic crowns
Shoulder	Provides for bulk of material	Not conservative	Facial margins of metal-ceramic crowns, full ceramic crowns
Shoulder with bevel	Provides for bulk of material	Not conservative	Facial margin of metal-ceramic crown, gingival margin of inlays and onlays, occlusal margin of partial veneer crowns
Radial shoulder	Provides for bulk of material	Not conservative	All-ceramic crowns
Sloped shoulder	Provides for bulk of material	Not conservative	Facial margins of metal-ceramic crowns
Knife-edged	Highly conservative	Not distinct	Metal restorations for adolescent patients, lingual surface of mandibular posteriors, very convex axial surfaces and tilted teeth

3. Margin adaptation

- The junction/space between a cemented restoration and tooth is always a potential site for recurrent caries or periodontal disease because of dissolution of luting agent and inherent roughness.

- Hence, preparing a smooth and even margin is the beginning of various steps – tissue displacement, impression making, die formation, waxing finishing, casting, involved in making a restoration fit better with least space.

- Clinically acceptable marginal gap is 10 microns for cast metal and up to 50 microns for ceramic restorations. The discrepancy in adaptation can have a horizontal and vertical component which determines whether the margin is over- or underextended which determines whether the margins are overextended or underextended.(Fig. 35.15).

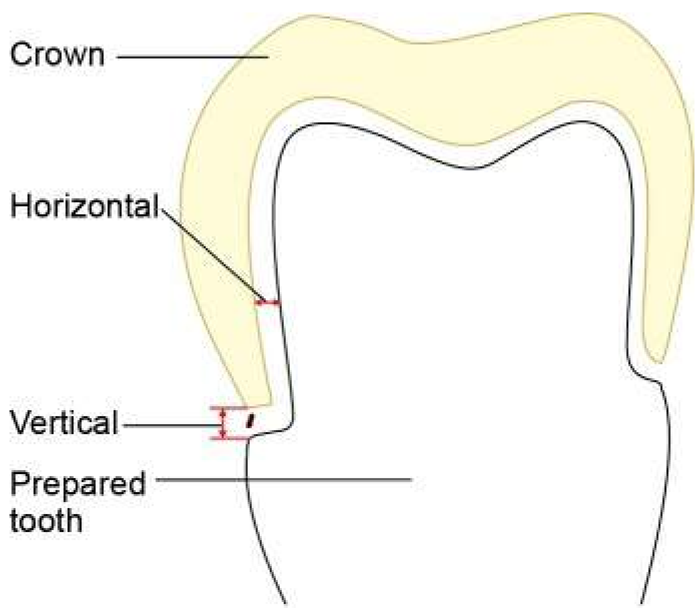


FIGURE 35.15 Vertical and horizontal margin opening.

Mechanical considerations

Tooth preparation design for fixed prosthodontics must adhere to certain mechanical principles; otherwise, the restoration may become dislodged or may distort or fracture during service.

The mechanical principles are

1. Retention form

2. Resistance form

3. Structural durability

Retention form

Definition: The feature of a tooth preparation that resists dislodgment of a crown in a vertical direction or along the path of placement (GPT8).

Sticky foods and chewing gum have been known to remove restorations in the line of draw. Only dental caries and porcelain failure are more common cause of failure of fixed partial dentures than lack of retention.

Retention is determined by:

1. Magnitude of dislodging forces

- Forces that tend to remove a cemented restoration along its line of draw are small and rare. This can happen with sticky food and by pulling with floss under connector.

- The magnitude of these forces depends on stickiness of food, surface area of contact and texture of restoration being pulled.

2. Geometry of preparation

- Fixed dental prosthesis depends on geometry of the preparation rather than adhesive nature of cement for retention. This is because no cement has a specific adhesion to the commonly used restorative materials – metal and ceramic.

- The grains of the cement only prevent two surfaces from sliding, although they do not prevent one surface from being lifted from another. Also cement is effective only if the restoration has a single path of withdrawal. Hence, the geometric configuration of tooth preparation must place the cement in compression to provide necessary retention and resistance.

- The relationship between two bodies, one (prepared tooth) restraining movement of the other (a cemented restoration), has been studied and the relevant sliding pair is formed by two cylindrical surface sliding along one another. A tooth preparation will be cylindrical if the axial surfaces are prepared by a cylindrical bur held at a constant angle.

Factors affecting geometry of preparation:

i. Taper

Definition: Taper is the convergence of two opposing external walls of a tooth preparation as viewed in a given plane. The extension of those average lines within that plane form an angle described as the angle of convergence (GPT8).

- Theoretically *the more nearly parallel the opposing walls of a preparation, greater should be retention*. This was first demonstrated by Jorgensen in 1955 when he cemented brass caps on Galalith cones of different tapers and measured retention with a tensile testing machine. The relationship was found to be hyperbolic, with retention rapidly becoming less, as taper increased (Fig. 35.16).

- **Need for taper:** Parallel walls are impossible to produce in the mouth without creating preparation undercuts. A taper enables the operator to:

○ Visualize the preparation walls

- Prevent undercut
- Compensate for the inaccuracy of the fabrication procedure
- Permit more nearly complete seating of the restoration during cementation

- **Degree of taper:** A taper of 2.5–6.5° has been suggested as optimum to minimize the stress in the *cement* interface between the preparation and restoration. But there is only a slight increase in the stress as taper is increased from 10 to 15°. However at 20°, the stress concentration was found to increase sharply. Hence, a taper of up to 15° is clinically acceptable.

- **Preparation of taper:** Teeth are prepared with a rotary instrument of desired taper. The instrument should be held parallel to the long axis of the tooth and moved through a cylindrical path as the tooth is prepared. The taper of instrument produces the desired axial wall taper (Fig. 35.17).

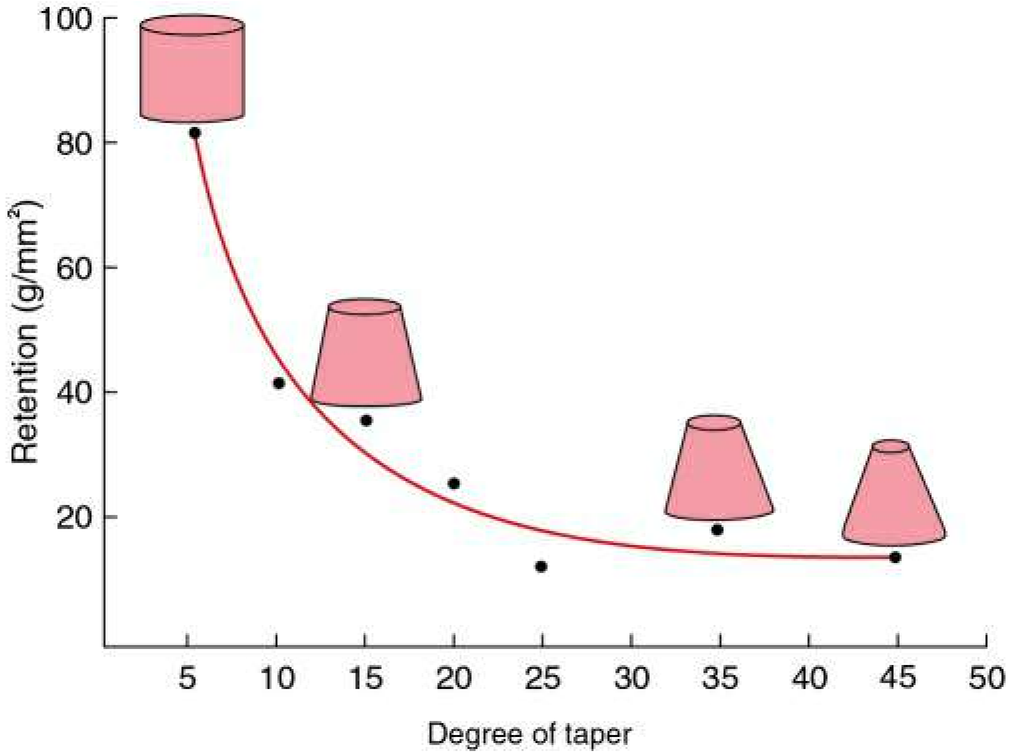


FIGURE 35.16 The relation between degree of taper and retention. Source: *Courtesy:* Jorgensen KD: The relationship between retention and convergence angle in cemented veneer crowns. Acta Odontol Scand 1955; 13:35–40.

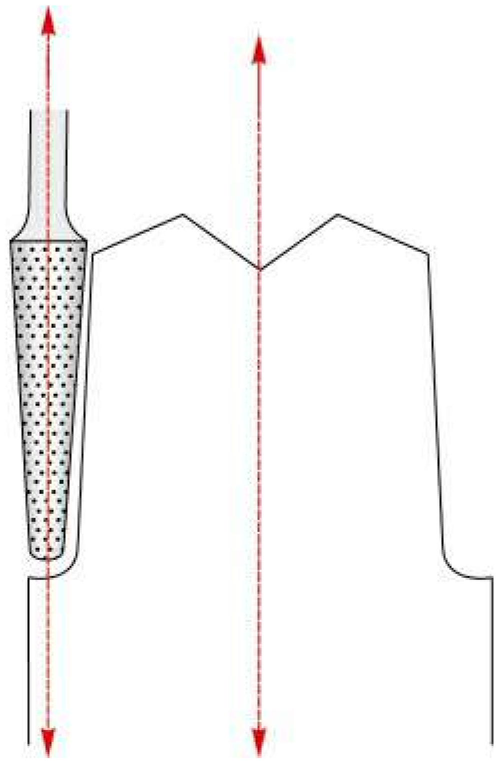


FIGURE 35.17 Bur held parallel to the long axis of the tooth.

ii. Surface area

- Greater the surface area greater is the retention.
- Preparations on large teeth are more retentive than preparation on small teeth. Molar crowns are more retentive than premolar crowns of similar taper (Fig. 35.18).
- Surface area can be increased by adding boxes and grooves. However, they may be actually limiting freedom of movement than increasing surface area.

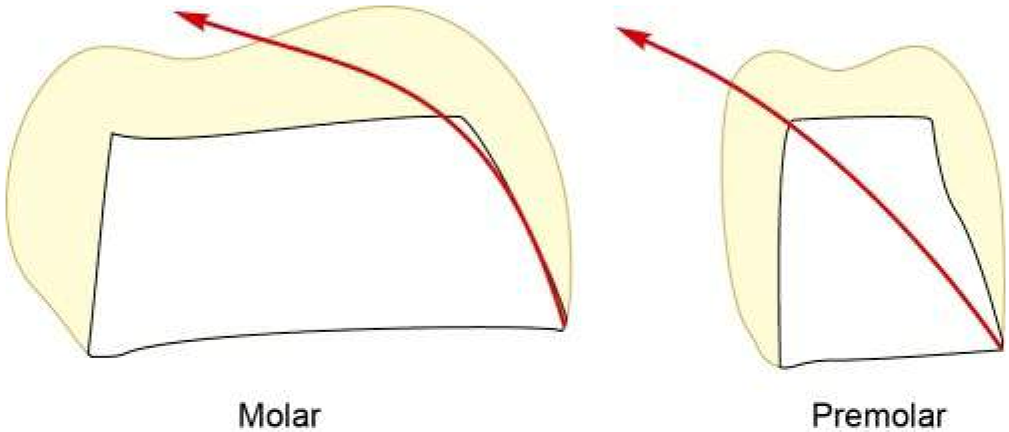


FIGURE 35.18 Preparations on molars are more retentive than on premolar because of greater surface area.

iii. Freedom of displacement

- Retention is improved by geometrically limiting the paths along which the restoration can be removed from the prepared tooth. Maximum retention is achieved when there is only one/single path of removal (Fig. 35.19).

- Grooves and proximal boxes can be used to increase retention by limiting the freedom of displacement in overtapered preparation and in the absence of opposing axial wall.

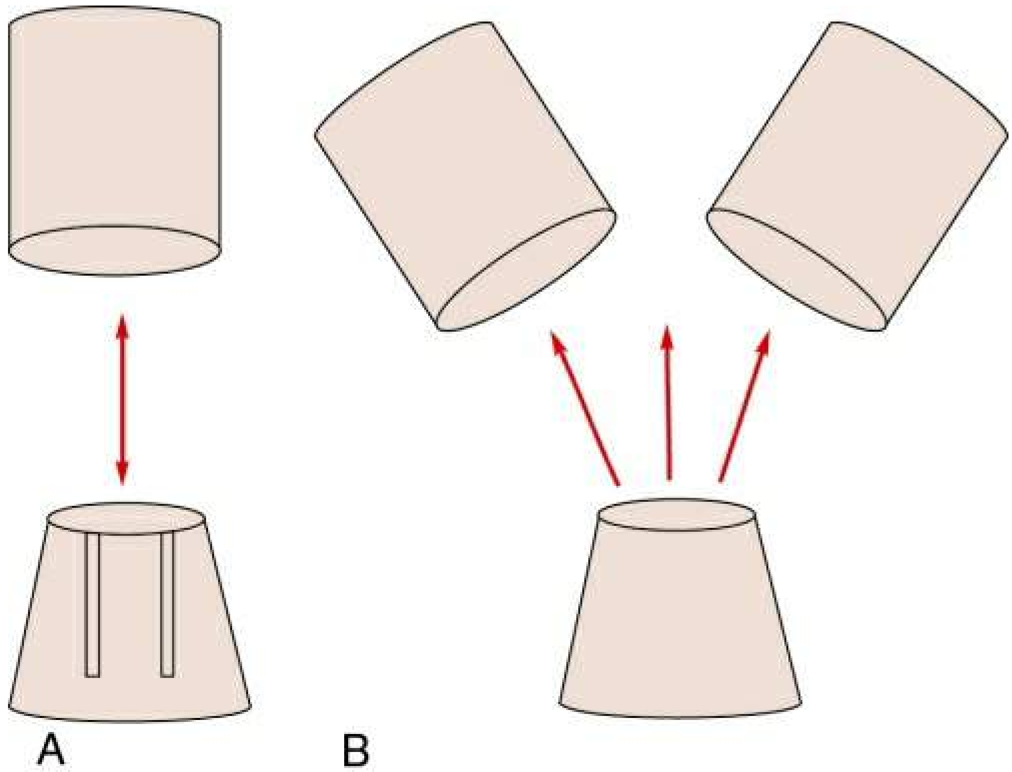


FIGURE 35.19 Freedom of displacement. **(A)** Limiting the paths of withdrawal by the use of grooves, improves retention. **(B)** Unlimited paths of withdrawal leading to poor retention.

iv. Stress concentration

Retentive failure begins at junction of axial and occlusal surfaces where stress is concentrated. This then results in cohesive failure of the entire cemented area. Thus, rounding of line angles will reduce stress concentration and enhance retention.

v. Type of restoration

Preparations on different restoration designs have different retentive values when other factors are kept constant. Thus a complete crown is more retentive than partial-coverage restorations (Fig. 35.20).

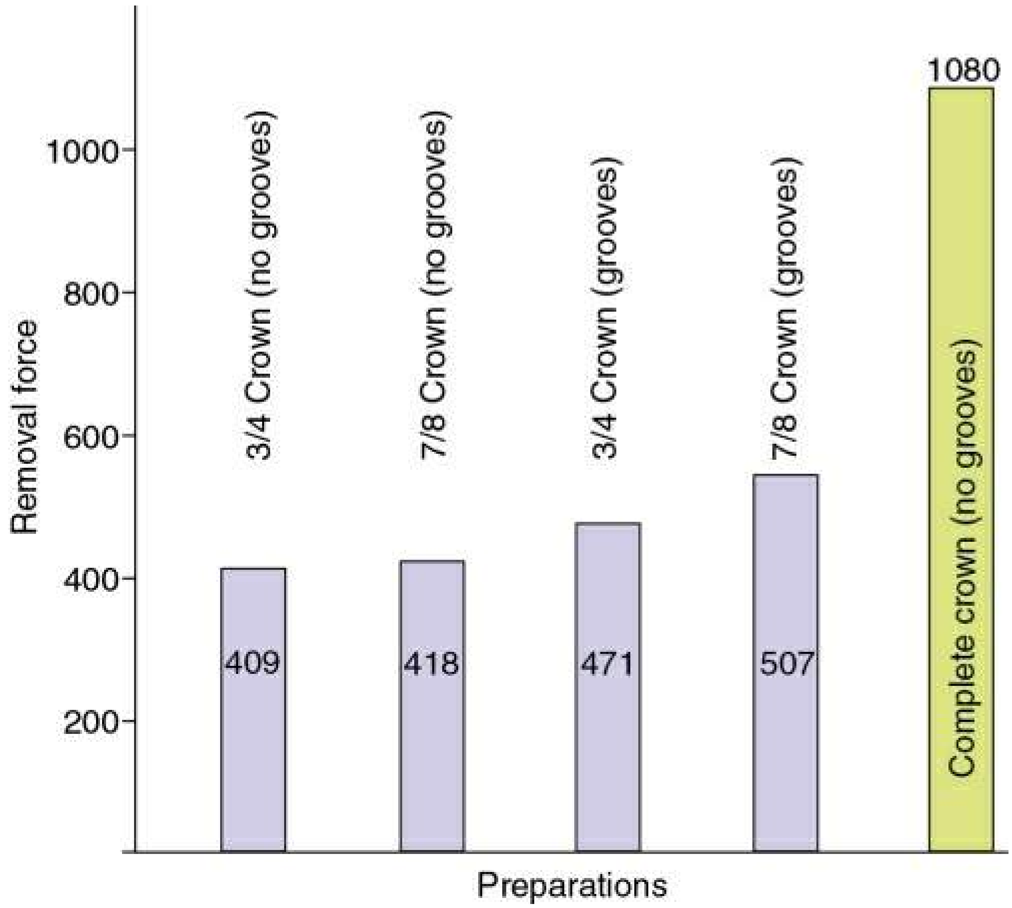


FIGURE 35.20 Retention for different types of restorations. Source: *Courtesy: Potts RG, et al. Retention and resistance of preparations for cast restorations, J Prosthet Dent 43(3):303–08, 1980.*

3. Path of insertion

Definition: The specific direction in which prosthesis is placed on the abutment teeth (GPT8).

- Path of insertion is an imaginary line along which the restoration will be placed onto or removed from the preparation; also called *path of placement*. It is determined before beginning the preparation and the preparation is then planned to coincide with that imaginary line. In case of fixed partial dentures, it is important to keep the paths of all the abutments parallel to each other and the path of insertion to ensure a smooth fit of the restoration.

- The path of insertion must be considered in two dimensions – faciolingually and mesiodistally.

  - Faciolingual orientation can affect the aesthetics of the metal-ceramic crown or partial veneer crowns. For metal-ceramic crowns, it should be parallel to the long axis of the teeth (Fig. 35.21). For partial veneer crowns, it should be parallel to the incisal half of the labial surface.

  - The mesiodistal inclination should parallel the contact areas of adjacent teeth (Fig. 35.22).

- To visually check a preparation for undercuts and taper, the centre of occlusal surface of the preparation is viewed with one eye from a distance of 30 cm or 12 inch. If it is viewed with both eyes open, undercuts will be not be seen (Fig. 35.23A and B).

- In the mouth, a mouth mirror is held at an angle 0.5 inch above the preparation and preparation viewed with one eye (Fig. 35.24). To view multiple abutments as in fixed partial dentures, the mirror is moved without changing the angulation from one abutment to another, after establishing a firm finger rest.

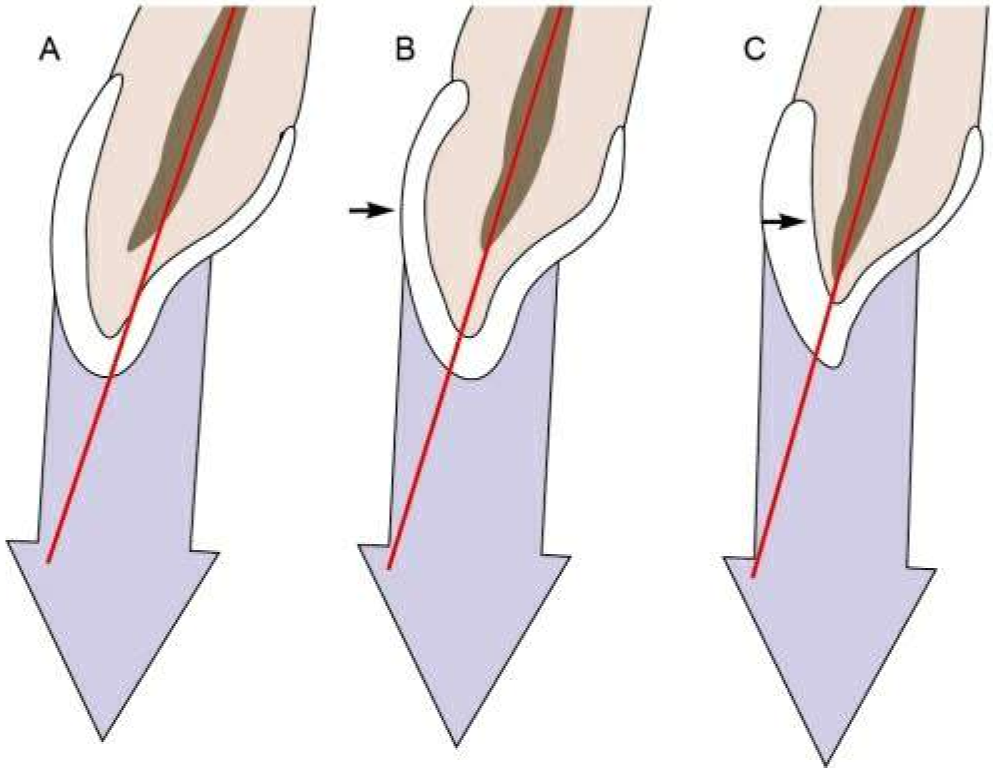


FIGURE 35.21 The path of insertion of a preparation for metal-ceramic crown should parallel the long axis of the tooth. (A) If the path is directed facially the prominent facioincisal angle may create aesthetic problems of overcontouring or opaque show-through. (B) If the path is directed lingually the facial surface will intersect the lingual surface, creating a shorter preparation. (C) It also may encroach the pulp.

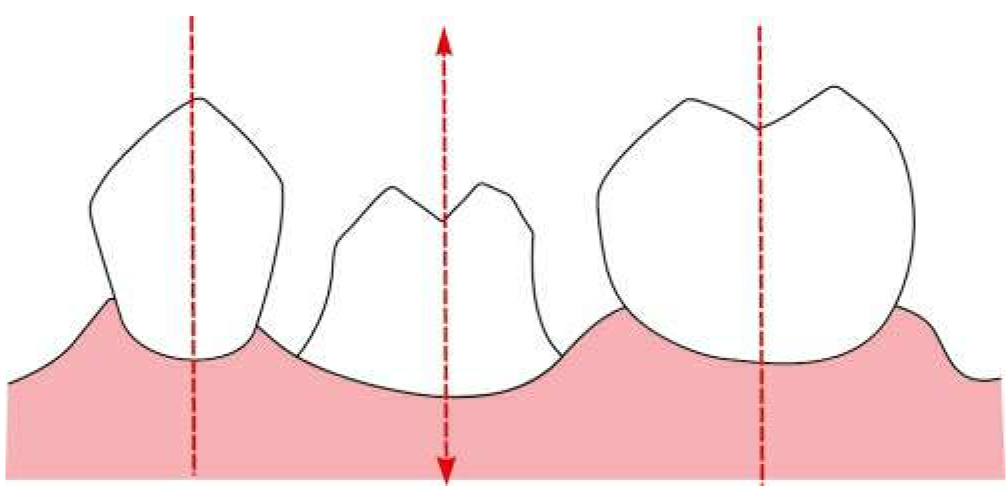
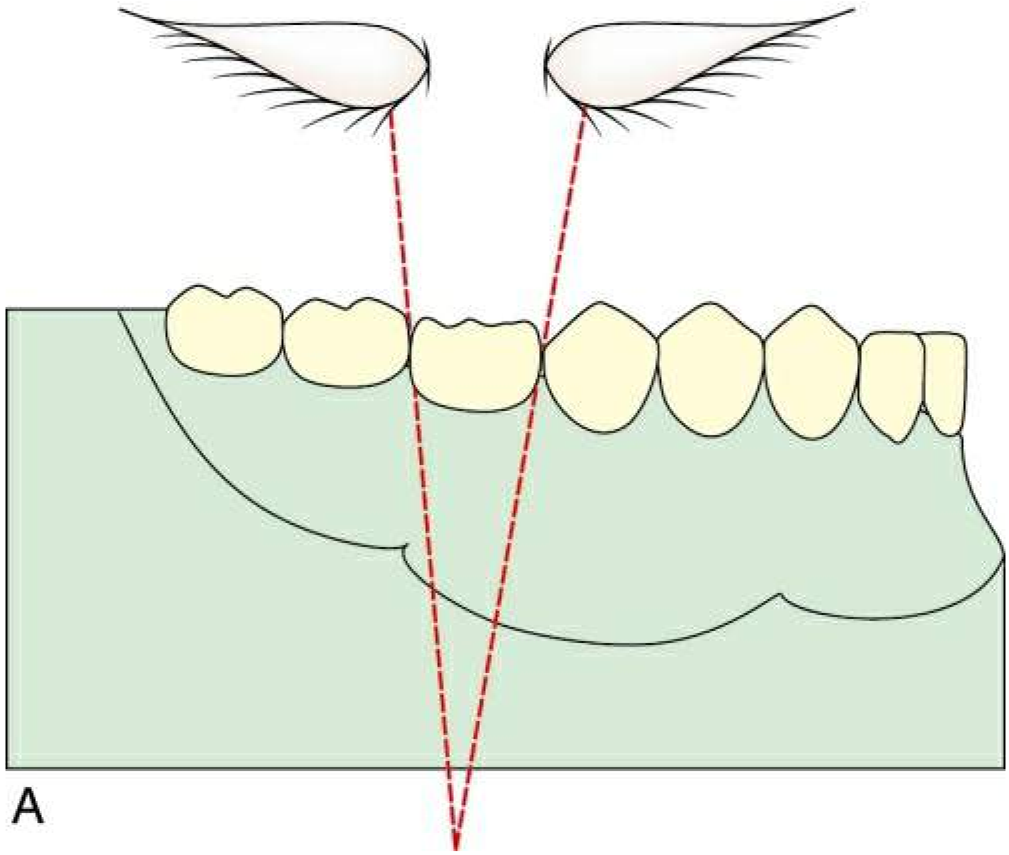


FIGURE 35.22 Path of insertion should be parallel to the adjacent teeth.



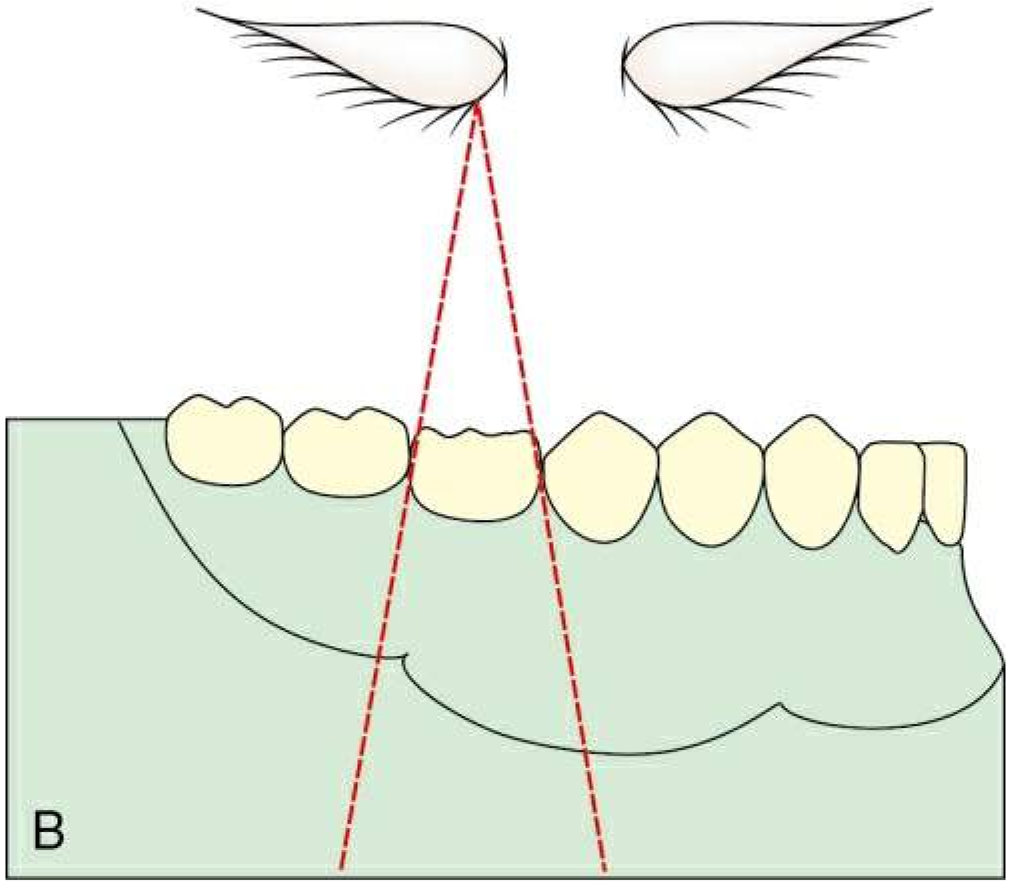


FIGURE 35.23 **(A)** Improper technique to view tooth preparation. **(B)** Correct technique to view tooth preparation.

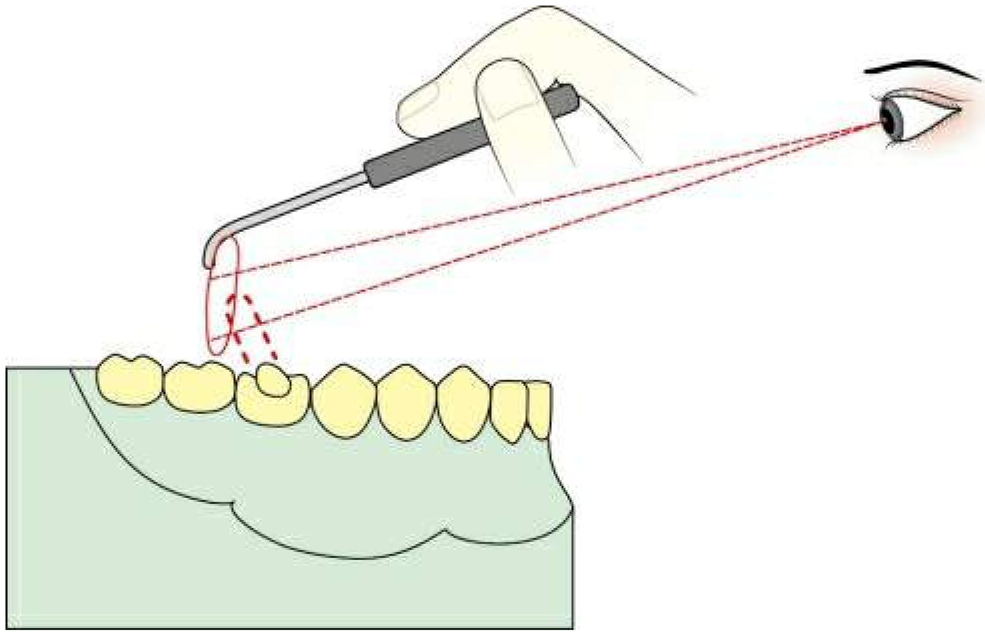


FIGURE 35.24 Preparation in the mouth is viewed through the mouth mirror using one eye.

4. Roughness of the surfaces being cemented

- The internal surface of casting is most effectively roughened by air-abrading with 50 microns of alumina. It has been seen that this increases retention by 64%. Acid-etching the fitting surface can also improve retention with certain luting agents.
- But the tooth should not be roughened during preparation as this makes it difficult to make impressions and fabricate the prosthesis.

5. Materials being cemented

- More reactive the alloy better is retention. Hence, base metal alloys are better retained than gold alloys.
- Effect of retention to different core buildup materials is not consistent.

6. Types of luting agent

In decreasing order, cement retention is best obtained with adhesive resin followed by glass ionomer, polycarboxylate, zinc phosphate and zinc oxide eugenol. However, the decision regarding which agent to use is also based on other factors.

Resistance form

Definition: The feature of a tooth preparation that enhances the stability of a restoration and resists dislodgment along an axis other than the path of placement (GPT8).
Factors affecting resistance form:

1. Magnitude and direction of dislodging forces

This varies with different individuals and a pipe smoker or bruxer can produce very large oblique forces. These should be considered while preparing the teeth so that sufficient resistance to these forces is planned.

2. Geometry of tooth preparation

i. Occlusogingival length

Short tooth preparations with large diameters were found to have very little resistance form. The length must be great enough to interfere with the arc of the casting pivoting about a point on the margin on the opposite side of the restoration (Fig. 35.25). Teeth with short diameter and short walls have better resistance than teeth with larger diameter but short walls. The preparation on the smaller tooth will have a short rotational radius for the arc of displacement, and the incisal portion of axial wall will resist displacement. The larger rotational radius on the larger preparation allows for a more gradual arc of displacement, and the axial wall does not resist removal (Fig. 35.26).

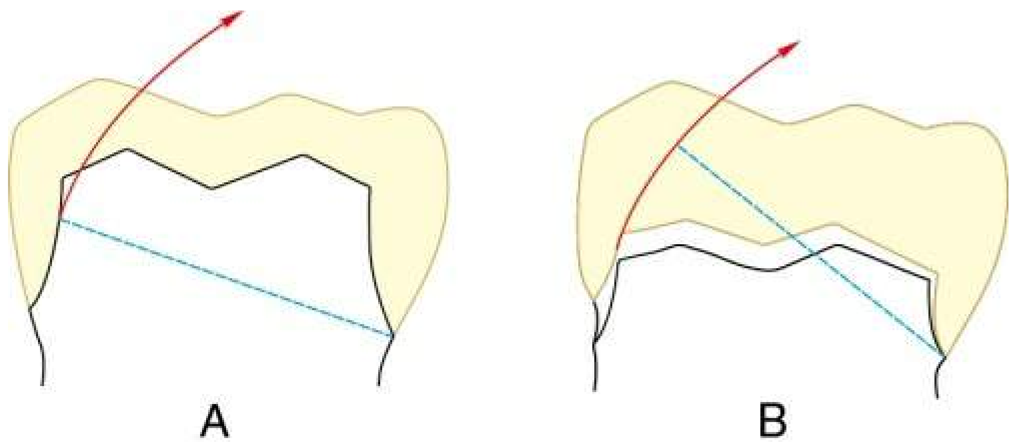


FIGURE 35.25 Preparation with longer walls **(A)** interferes with the tipping displacement of the restoration better than the short preparation **(B)**.

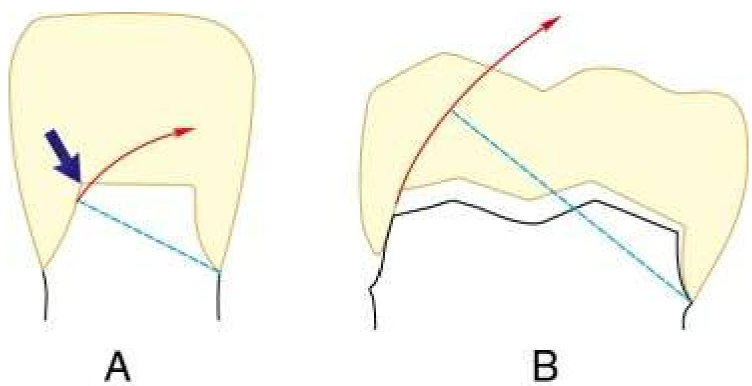
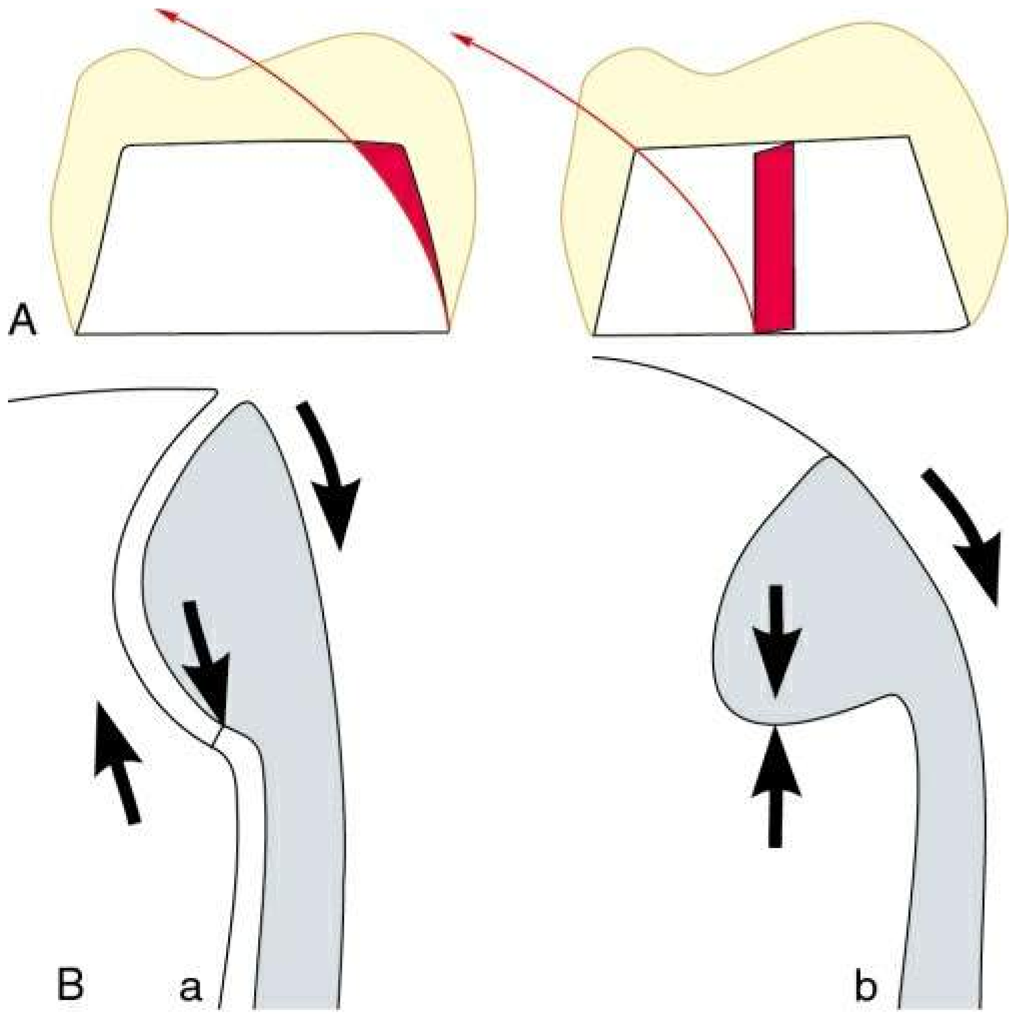


FIGURE 35.26 A preparation on a tooth with a smaller diameter **(A)** resists pivoting movements better than a preparation of equal length on a tooth of larger diameter **(B)**.

ii. Grooves, proximal boxes and pinholes

- Resistance to displacement for a short walled preparation on a tooth with large diameter can be improved by placing grooves, proximal boxes and pinholes in the axial walls. This reduces the rotation radius, and the portion of the groove near the occlusal surface of the preparation will resist displacement (Fig. 35.27A).

• Grooves and proximal boxes also limit the freedom of displacement from torquing or twisting forces in a horizontal plane and enhance the resistance of the restoration. The walls of the groove and proximal box must be perpendicular to rotating forces to provide resistance (Fig. 35.27B and C).



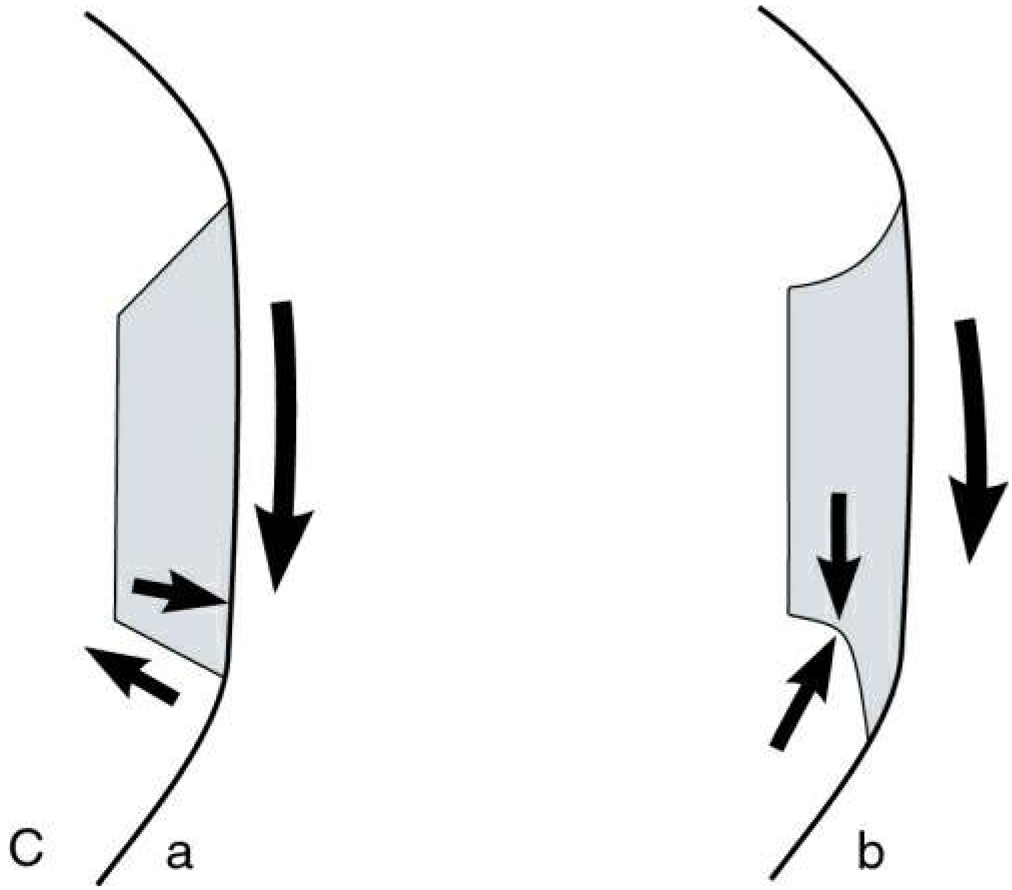


FIGURE 35.27 **(A)** Reduction of radius of rotation by using proximal boxes. **(B)** The walls of a groove that meet the axial wall at an oblique angle (a) do not provide necessary resistance. The walls of a groove must be perpendicular to rotating forces to resist displacement (b). **(C)** The buccal and the lingual walls of a box will not resist rotational displacement if they form oblique angles with the pulpal wall (a), they must meet the pulpal wall at angles near 90° (b).

iii. Type of luting agent

This depends on the compressive strength and modulus of elasticity of luting agent. Similar to the cements providing retention, but zinc phosphate cements show better resistance than zinc polycarboxylate. In decreasing order, cement resistance is best obtained with adhesive resin followed by glass ionomer, zinc phosphate, polycarboxylate and zinc oxide eugenol.

Structural durability

This is the ability of the restoration to last long without damage, under occlusal forces. For this, the tooth preparation must provide adequate space for the restorative material thereby enhancing strength and preventing wear.

Factors affecting structural durability:

1. Occlusal reduction

- Providing occlusal clearance is an important factor. The amount of occlusal reduction in the preparation depends upon the material used for restoration.
  - For metal alloys, there should be 1.5 mm clearance on the functional cusps, and around 1 mm on the nonfunctional cusps.
  - Metal-ceramic crowns will require 1.5–2 mm on the functional cusps and 1–1.5 mm on the nonfunctional cusps.
  - There should be 2 mm clearance on preparations for all-ceramic restorations.
  - For malposed teeth, only minimal preparation may be required to obtain clearance.
- The preparation should duplicate the pattern of the occlusal surface existing in the patient. If an inclined plane pattern exists with cusps and fossa, the same should be replicated in the preparation to avoid pulpal damage (Fig. 35.28). Flat plane may be acceptable when interocclusal relationships are worn out in older patients.

- If the patient's occlusion is disrupted by supraerupted or tilted teeth, considerable preparation of tooth is often needed to compensate for this supraeruption of abutment or opposing teeth. Intentional endodontic treatment may also be required sometimes to provide adequate space (Fig. 35.29). Compromising the principle of conservation of tooth structure is preferable to the potential harm from a traumatic occlusal scheme. Diagnostic wax up helps determine the exact amount of preparation required to develop an optimum occlusion and provide adequate space for the restorative material.

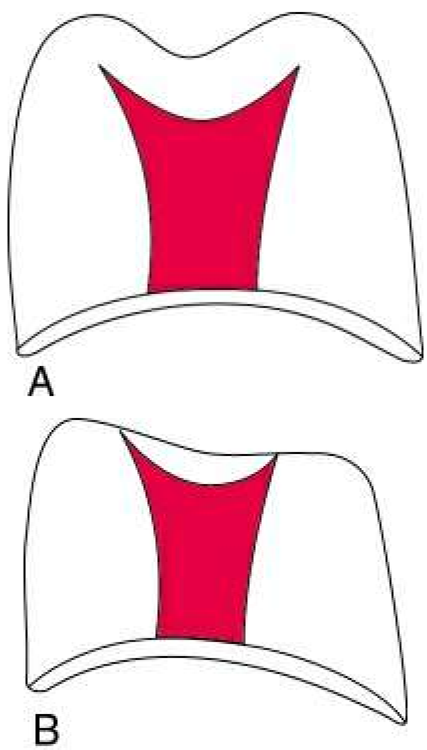


FIGURE 35.28 **(A)** Correct occlusal reduction as it reproduces the basic inclined planes. **(B)** Incorrect occlusal reduction as the occlusal surface has been reduced to a flat plane.

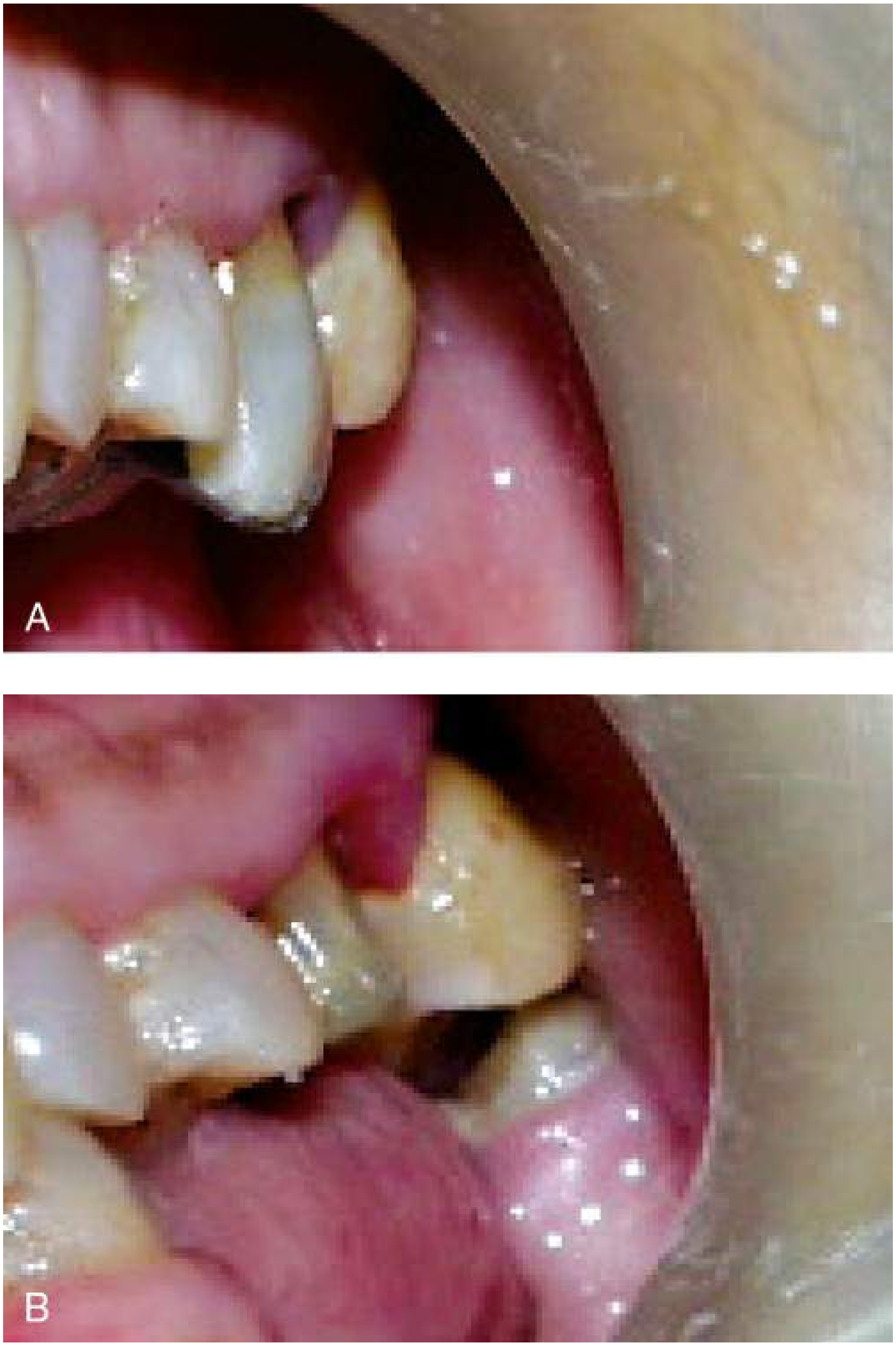
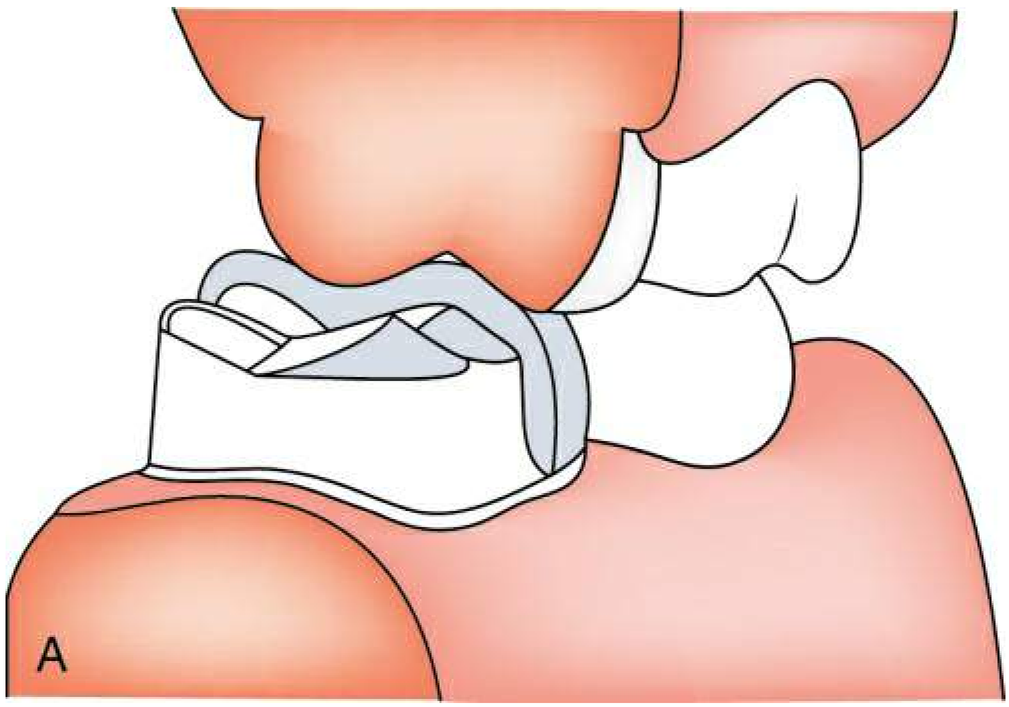
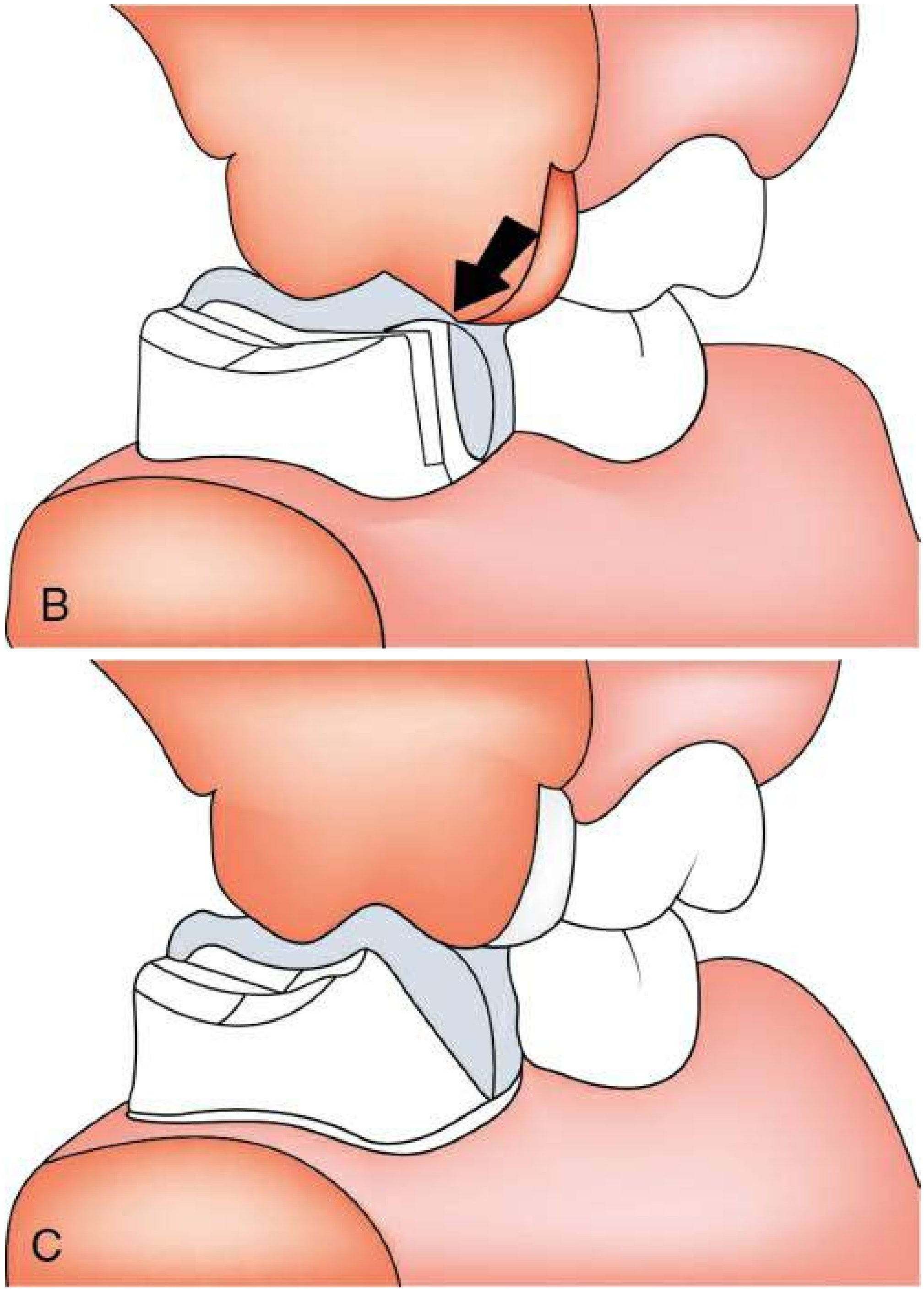


FIGURE 35.29 Supraerupted molar tooth. Intentional RCT done to provide adequate space.

2. Functional cusp bevel

A functional cusp bevel provides space for an adequate bulk of restoration in an area of heavy occlusal contact. A wide bevel is placed on the functional cusps – palatal cusps of maxillary posterior teeth and buccal cusps of mandibular posterior teeth. Lack of this may lead to perforation, overcontouring with deflective contact or overinclination of axial surface (Fig. 35.30).

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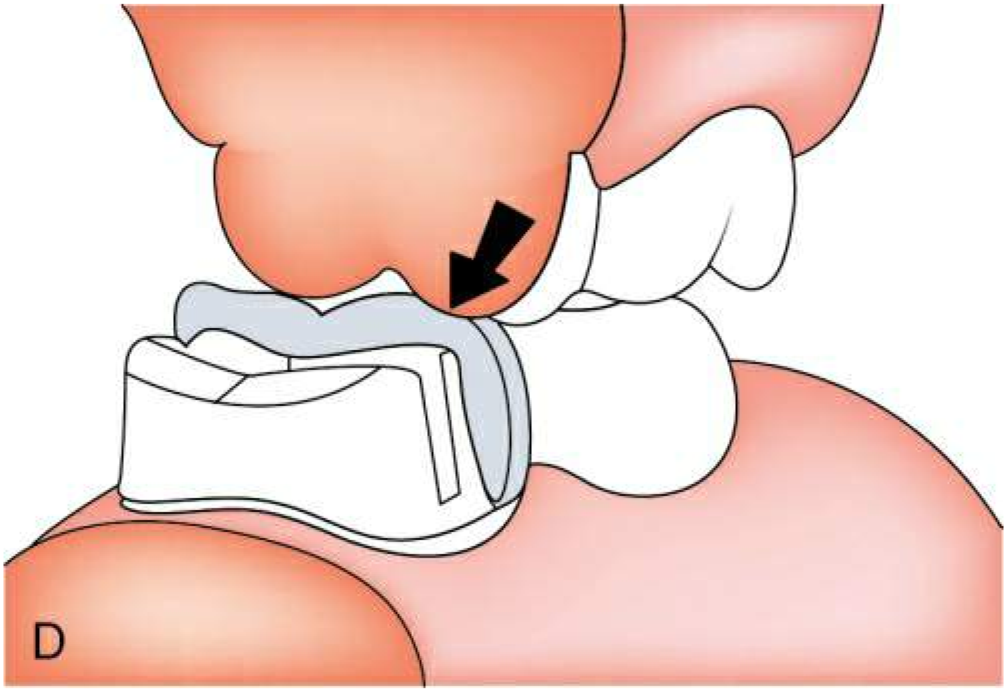


FIGURE 35.30 **(A)** Functional cusp bevel is an integral part of occlusal reduction. Lack of functional cusp bevel can cause **(B)** a thin area or perforation in the casting. **(C)** Overinclination of axial surface. **(D)** Overcontour of crown with deflective contact.

3. Axial reduction

This is important in securing space for an adequate thickness of restorative material.

If axial reduction is inadequate:

- Fabricating a restoration with normal contours will make the walls thin which will then be subject to distortion. It may even be difficult to fabricate such a restoration.

- More commonly, to achieve adequate thickness, the restoration needs to be overcontoured, which will then cause gingival inflammation as it becomes difficult to maintain plaque control around the gingival margins (Fig. 35.31).

Particularly in interproximal and furcation areas, sufficient tooth

structure must be removed to allow development of correct axial contours, as periodontal disease often begins in these areas.
Other features incorporated in tooth preparations that also enhance structural durability are offset, groove, occlusal shoulder, isthmus and proximal box.

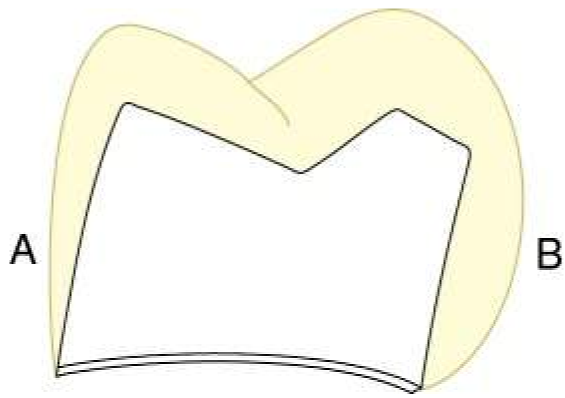


FIGURE 35.31 Inadequate axial reduction can lead to **(A)** Thin walls leading weak restoration. **(B)** Bulbous, overcontoured restoration.

Aesthetic considerations

Most patients prefer their dental restorations to look as natural as possible and the dentist should aim to fulfil this objective. However, aesthetic considerations should not be pursued at the expense of the prognosis of the patient's long-term oral health or function.

Aesthetic restorations are

- Partial veneer crowns with intact labial surface.
- Metal-ceramic restorations with ceramic coverage facially.
- All-ceramic restorations.

Armamentarium

The following are the general considerations for the instruments used in tooth preparation:

- Tooth preparation is performed with high speed airotor rotary instruments.
- Water cooling is extremely important with a well-directed spray.
- Rotary cutting instruments can be categorized as – stones (diamond), carbides (burs) and drills (twist) (Fig. 35.32). Although in general the term 'bur' is used for any rotary instrument, it should be specifically used only to denote 'carbides'.
- Diamond stones (also termed as diamond points) and tungsten carbide burs are most commonly used for tooth preparation. Twist drills are only used for making small diameter holes.
- 'Coarse' diamonds are used for making depth orientation grooves and gross reductions, while finishing is done with carbide burs or fine diamonds.
- The diameter and shape of the rotary used is determined by the required depth of preparation and the required configuration of the prepared surface.
  - If the entire instrument is to be sunk in to produce the required configuration, then the diameter of the rotary should be nearly the same as the depth of preparation, e.g. shoulder finish lines are provided by sinking in a flat-end tapering rotary (Fig. 35.33B). Hence, if the required depth of preparation

is 1 mm then the instrument should also have 1 mm diameter.

- If only half the instrument is to be sunk in to produce the required configuration, then the diameter of the rotary should be double that of the depth of preparation, e.g. chamfer finish lines are provided by sinking in half of round-end tapering rotary (Fig. 35.33A). Hence, if the required depth of preparation is 1 mm then the instrument should be 2 mm diameter to produce a 1 mm depth of preparation as only half of the rotary is sunk in.

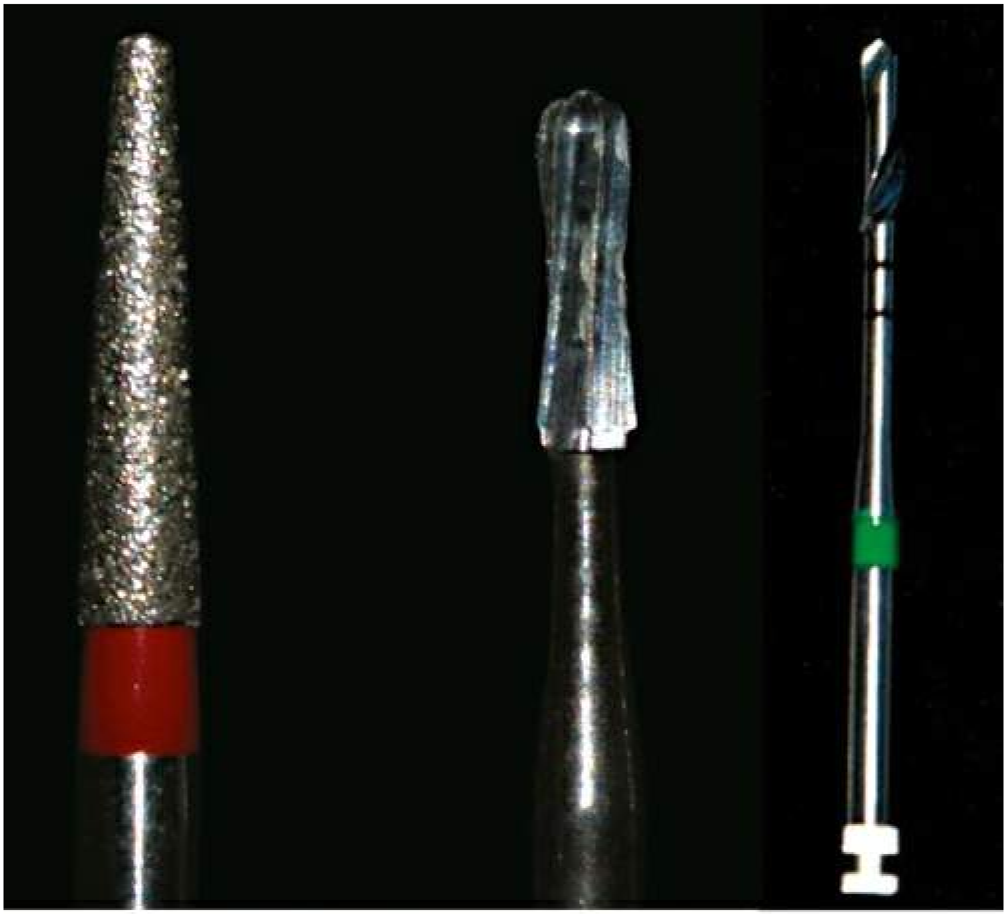


FIGURE 35.32 Diamond stone, carbide bur and twist drill.

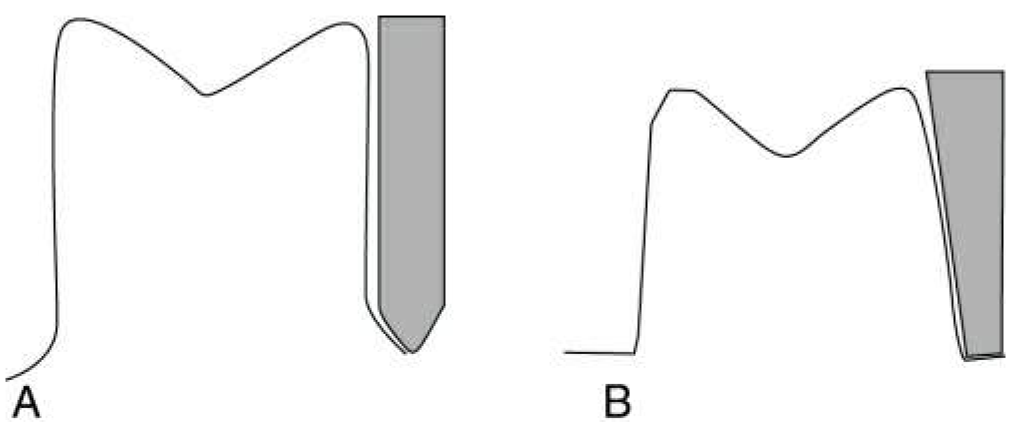


FIGURE 35.33 **(A)** Chamfer finish lines are provided by sinking in half of round-end tapering rotary. **(B)** Shoulder finish lines are provided by sinking in a flat-end tapering rotary.

A standard tooth preparation kit should contain at least the following five rotary instruments:

1. Round-end tapering diamond (Fig. 35.34).

2. Flat-end tapering diamond.

3. Long thin tapering diamond (also termed as long needle diamond).

4. Short thin tapering diamond (also termed as short needle diamond).

5. Wheel diamond.

FIGURE 35.34 Standard tooth preparation kit. (L–R: Round-end tapering diamond, flat-end tapering diamond, long thin tapering diamond, short thin tapering diamond, wheel diamond).

Complete crowns (full) veneer crowns

Definition: A restoration that covers all the coronal tooth surfaces (mesial, distal, facial, lingual and occlusal) (GPT8).

- It is also termed as 'full veneer crowns' though practically only all-metal complete crowns are 'veneers' or thin coverings.
- The complete crown is the restoration that replaces lost tooth structure and imparts some measure of structural support to the tooth.
- It covers all the coronal surfaces of the tooth.
- It can be all-metal, all-ceramic or combination of metal and ceramic.
- It can be used as a single-unit restoration or as a retainer for fixed partial denture.

Advantages

- Most effective retention and resistance.
- Alteration in tooth form and occlusion possible.

Disadvantages

- Extensive tooth preparation.
- Margins are close to gingivae and need meticulous maintenance.

Indications

Crown

- Presence of extensive caries.
- Large defective restorations.
- Endodontically treated teeth.
- Fractured tooth.
- Need to change contour for removable partial denture retention.

Retainer for FPD

- Short abutment.
- Long-span fixed partial dentures.
- Abutment alignment needs correction.
- Greater than average occlusal forces.

Contraindications

- Poor oral hygiene.
- Young adults where pulp chambers are large.

Tooth preparation for the following complete-coverage restorations is discussed:

1. All metal
2. Metal with ceramic facing

i. Anterior

ii. Posterior

3. All ceramic

All-metal full veneer crown preparation

This preparation is usually done for a posterior crown or fixed partial bridge.

Tooth preparation on a mandibular molar:

Armamentarium

- Airotor handpiece.
- Round-end tapered diamond.
- Short thin tapering/needle diamond.
- Chamfer diamond/torpedo diamond/bur.
- Baseplate wax sheet – 2 mm thick.

Preparation of a putty index

Before the preparation is begun an index is made.
Purpose: To have a positive check on the amount and configuration of tooth preparation. This is good guide for the beginner.
Procedure: Half a scoop of base of elastomeric putty impression material is kneaded with its catalyst paste or activator and adapted over the tooth to be prepared, covering the entire tooth structure and at least one adjacent tooth. Once set, index is removed and cut into a labial and lingual half with a BP blade. Each of these is again divided into an occlusal and gingival half. Once tooth preparation is completed, the index is used to verify the amount of reduction (Fig. 35.35A–C).
The steps in preparing a tooth for a full-coverage metal crown are

1. Occlusal reduction

2. Axial reduction

3. Proximal reduction

4. Finishing

5. Buccal seating groove

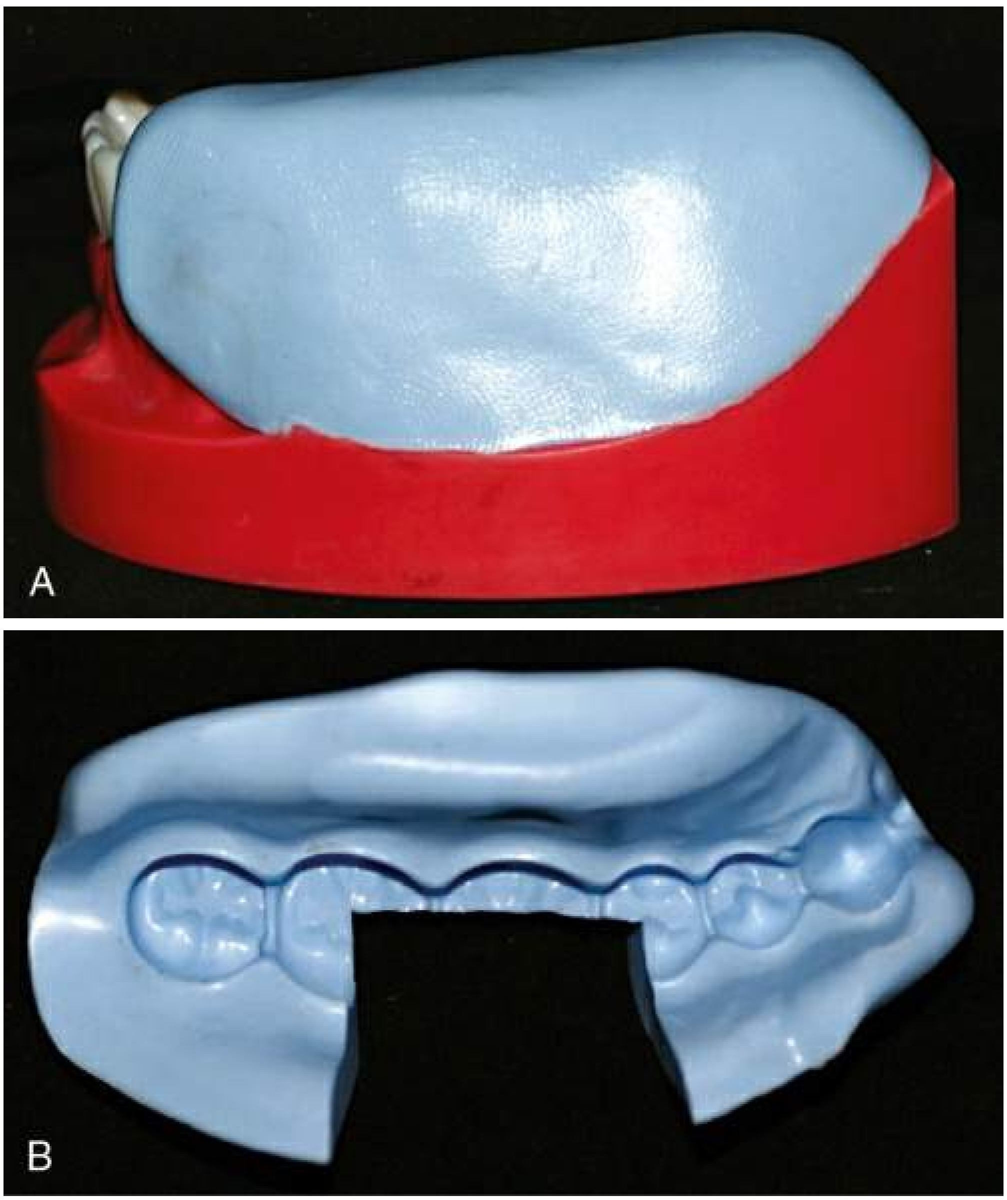


FIGURE 35.35 **(A)** Adaptation of a putty for index. **(B)** Cut putty index along the incisal/occlusal edges. **(C)** Verification of the preparation with the use of the index.

1. Occlusal reduction

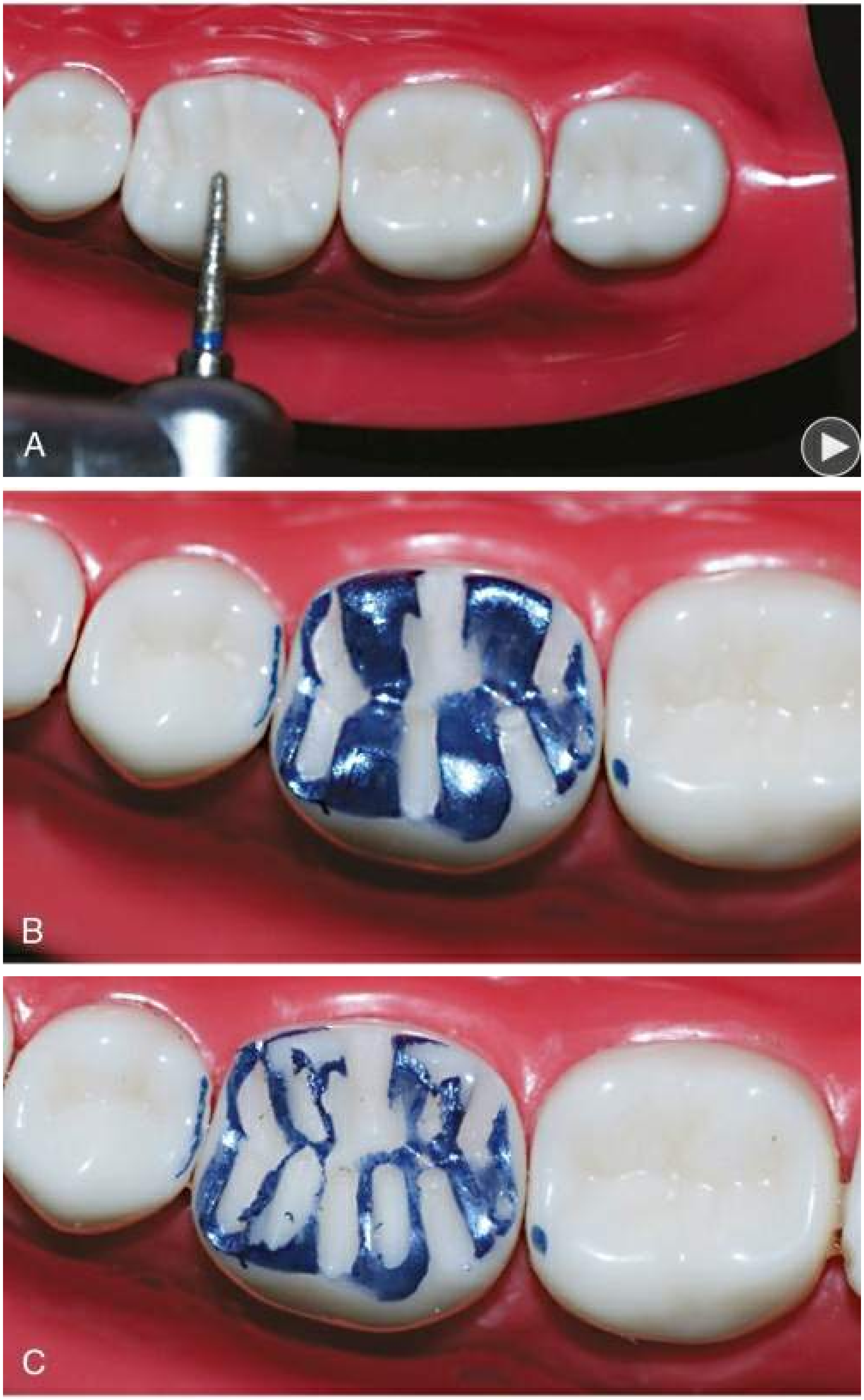
This prepares the occlusal surface.

Depth of preparation: 1 mm on nonfunctional and 1.5 mm on functional cusp.

Rotary instrument: Round-end tapering diamond.

Procedure:

- The depth cuts of 1 mm are first placed on the occlusal grooves following the anatomic contour of the occlusal surface (Fig. 35.36A and B).
- Depth cuts are then placed in the triangular ridges from cusp tip to the base again following the anatomic contour (Fig. 35.36C).
- It should be 1 mm on nonfunctional cusps and 1.5 mm on functional cusp.
- The remaining tooth structure between the depth cuts is then removed uniformly to complete the occlusal reduction (Fig. 35.36D and E).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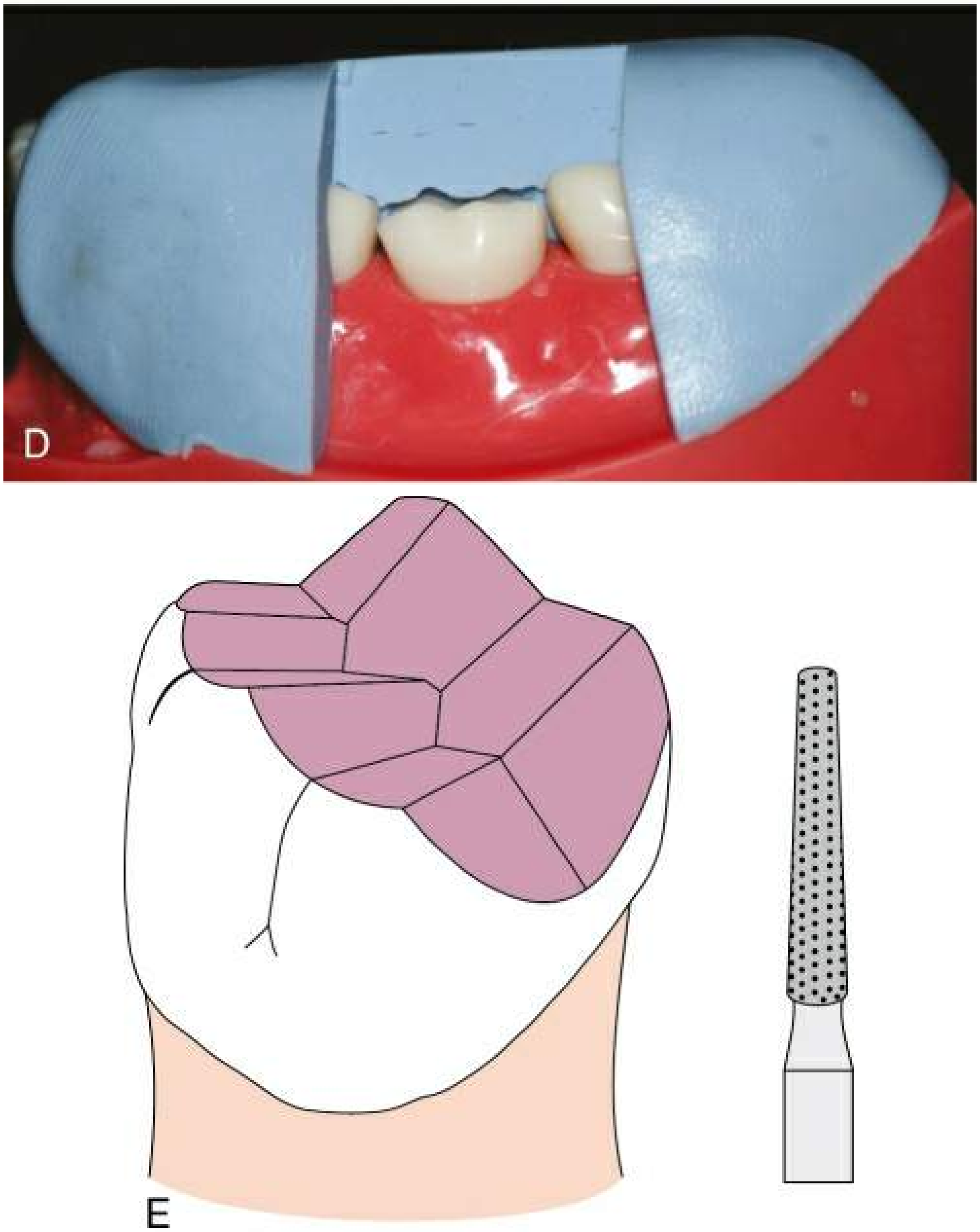
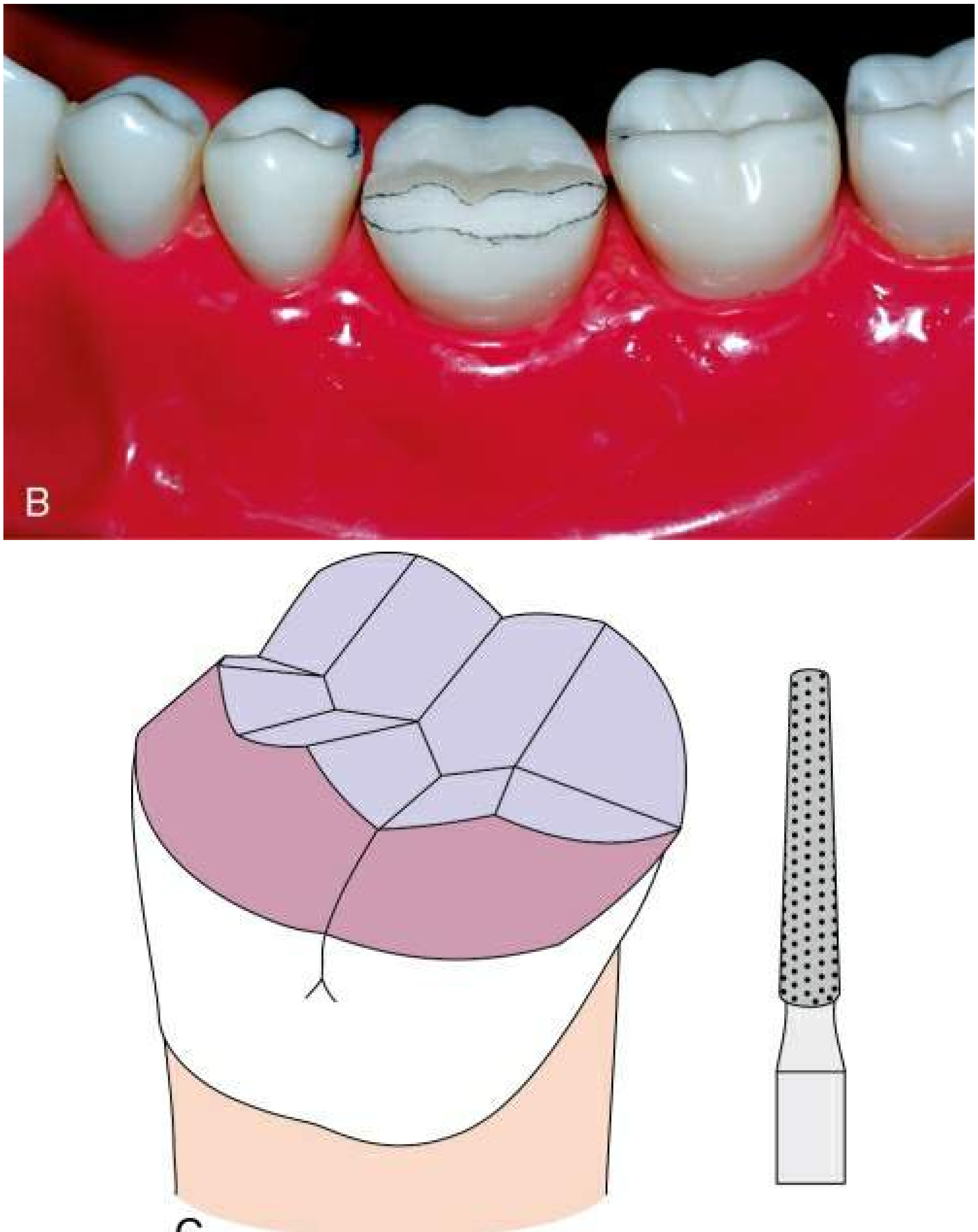


FIGURE 35.36 **(A)** Depth cuts are placed on the occlusal grooves. **(B)** Depth cuts should follow anatomic contour of tooth. **(C)** Depth cuts placed in the triangular ridges. **(D)** Completed occlusal preparation checked with index. **(E)** Completed occlusal reduction using round-end tapering diamond.

Functional cusp bevel

A wide bevel is then placed on the functional cusp using the end tapered diamond. It is placed on the buccal cusps of the mandibular teeth and palatal cusps of the maxillary teeth. The bevel is desired to be at an angle of 45° and an approximate width of 1.5 mm (Fig. 35.37A–C). The same round-end tapering diamond is used for this.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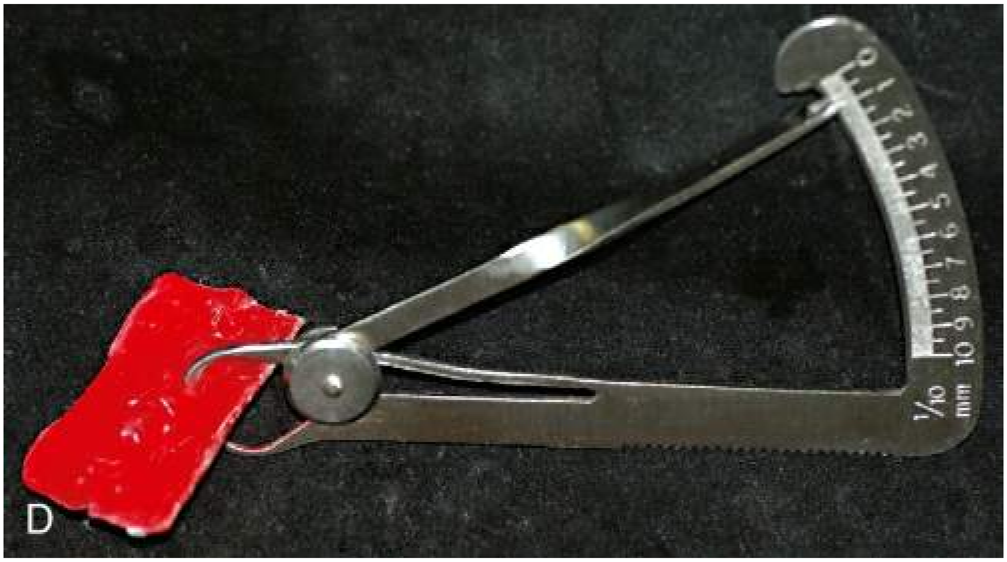


FIGURE 35.37 **(A)** A round-end tapered diamond is used to give a functional cusp bevel at an angle of 45. **(B)** Functional cusp bevel at an approximate width of 1.5 mm. **(C)** Completed functional cusp bevel using a round-end tapering diamond. **(D)** Checking occlusal clearance with a wax caliper.

Checking occlusal clearance

This is verified by asking the patient to bite on 2 mm thick baseplate wax (Fig. 35.37D). Thin spots in wax indicate inadequate clearance and the thickness is checked with a wax caliper. The area is again prepared till adequate clearance is achieved.

2. Axial reduction

This prepares the facial and lingual/palatal surface.
Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Round-end tapering diamond.

- As the preparation is accomplished when half the diamond sinks into the tooth, a round-end tapering diamond of 2 mm diameter is selected to prepare a depth of 1 mm. The round-end produces the required chamfer finish line.

- A metal caliper is used to check the diameter of the diamond.

- The necessary taper of 3–5° is provided in the tapering diamond.

Procedure:

- Depth orientation grooves/depth cuts are placed on the buccal surface following the existing contour of the respective surfaces. The tapering diamond half sunk in will reduce 1 mm occlusally and 0.5 mm cervically (Fig. 35.38A and B). These act as a guide to ensure that adequate and uniform reduction is achieved.

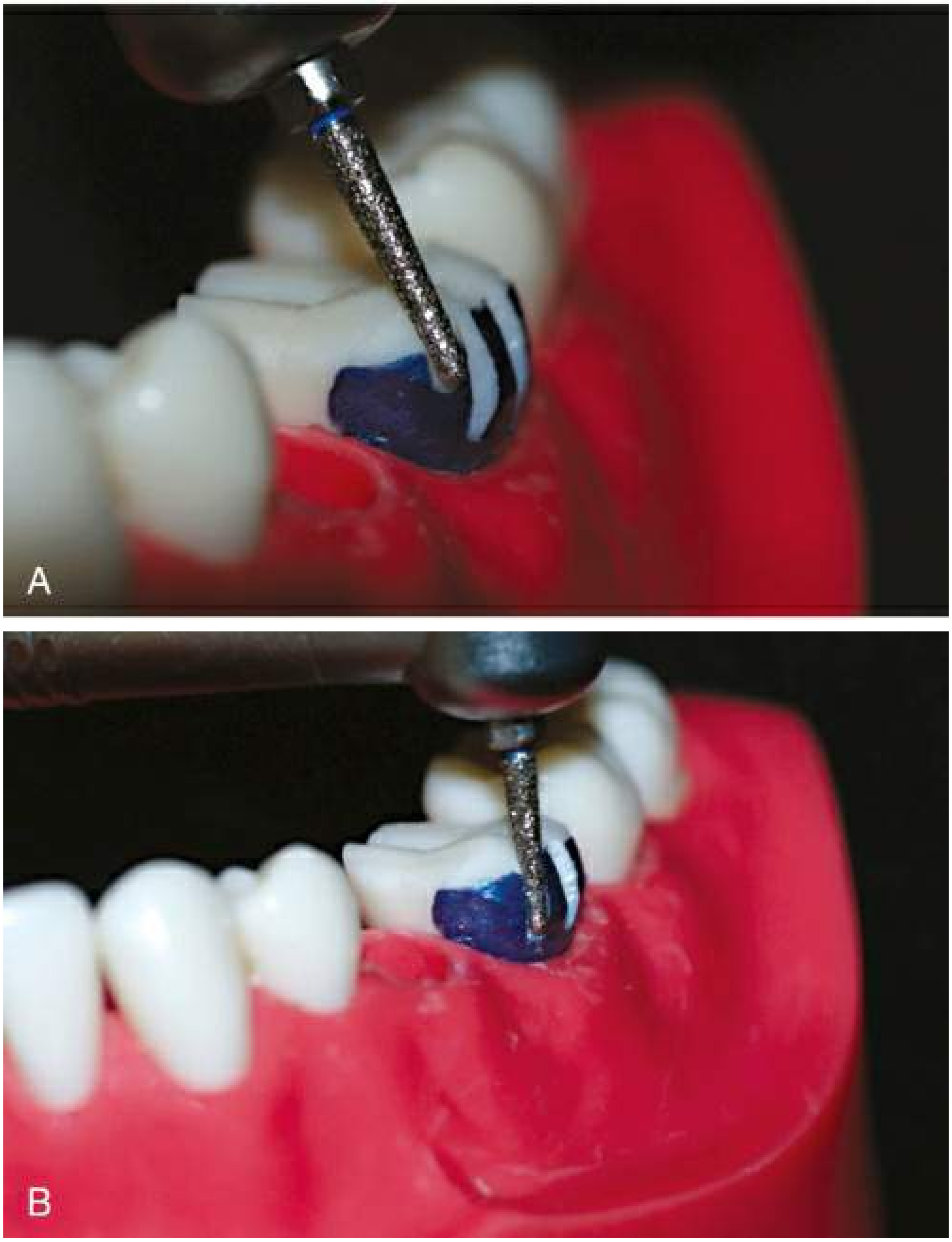
- The cervical part provides the retention form and should be parallel to the path of insertion.

- Two to three such grooves are placed equally spaced along the facial and lingual surface. The gingival termination should be established with the depth cut and it should be placed supragingivally on enamel (Fig. 35.38C and D).

- The remaining tooth structure between the depth cuts is then removed using the round-end tapering diamond and preparation extended till the junction of facial and proximal surface (Fig. 35.38E and F).

- The preparation is verified using the putty index (Fig. 35.38G).

- A similar procedure is adopted for preparing the lingual surface (Fig. 35.38H–K).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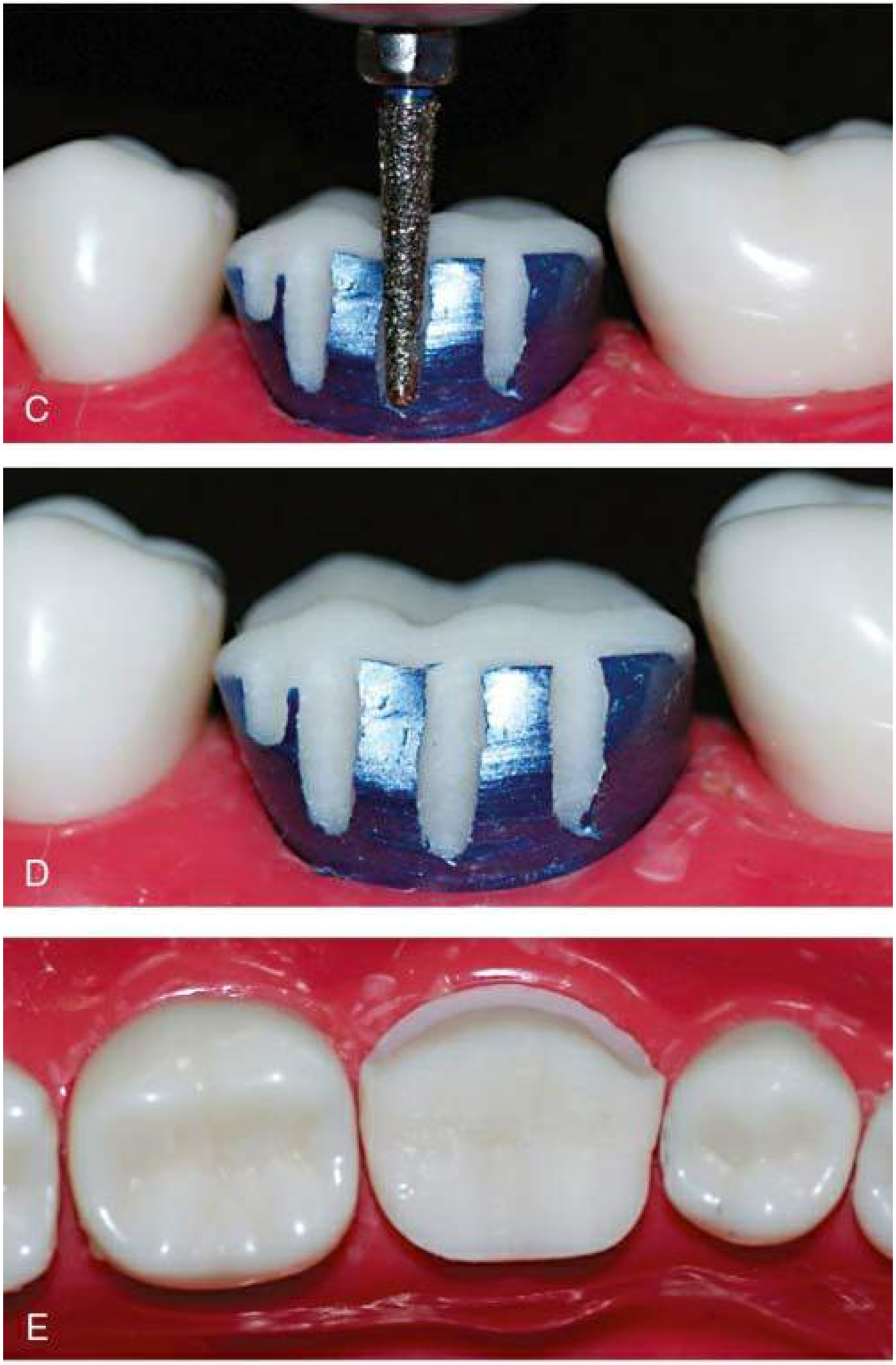
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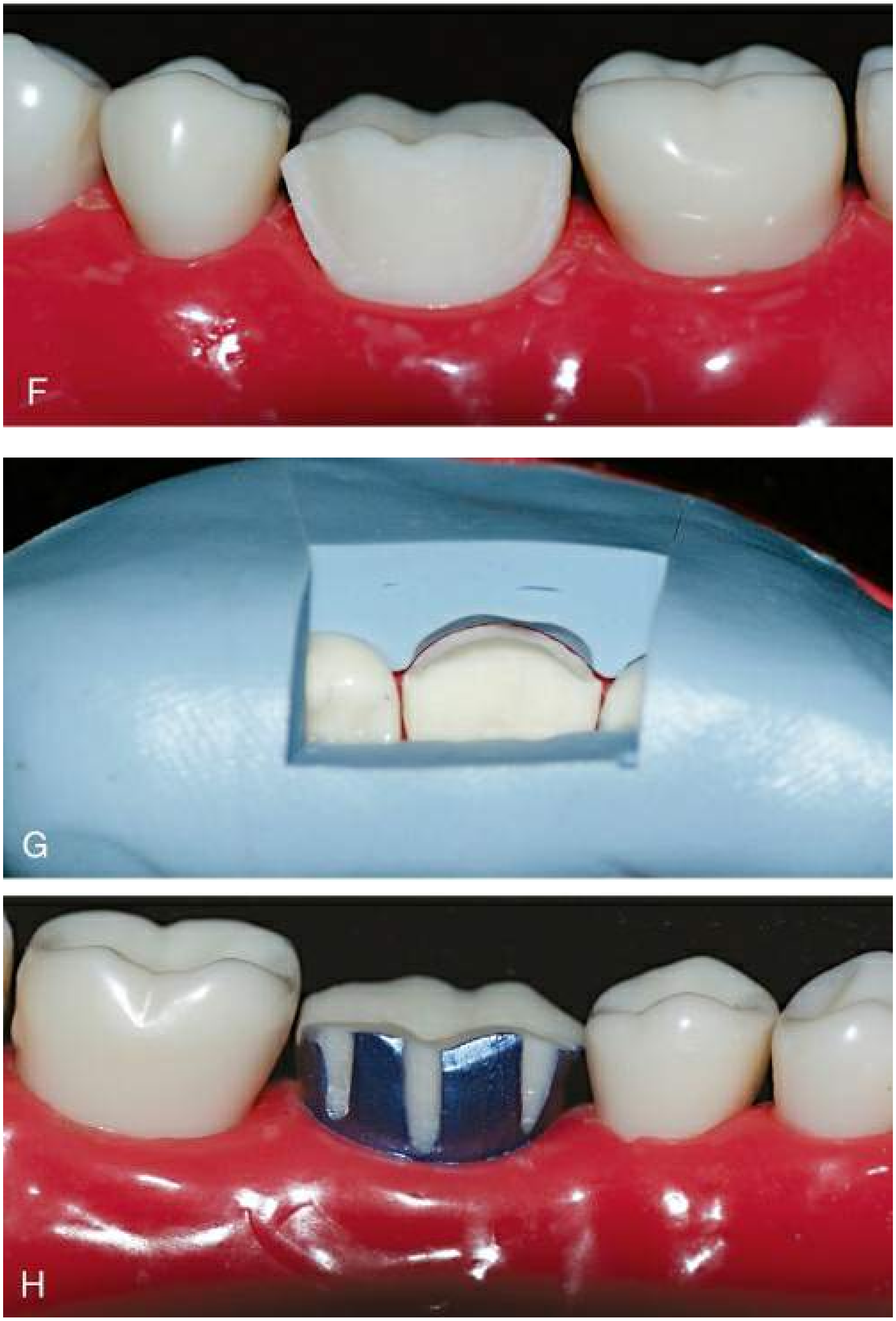
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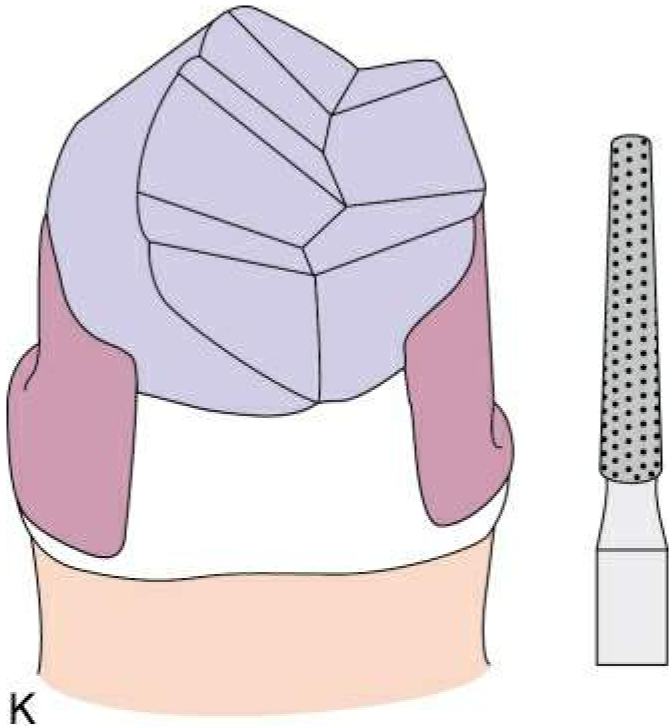


K

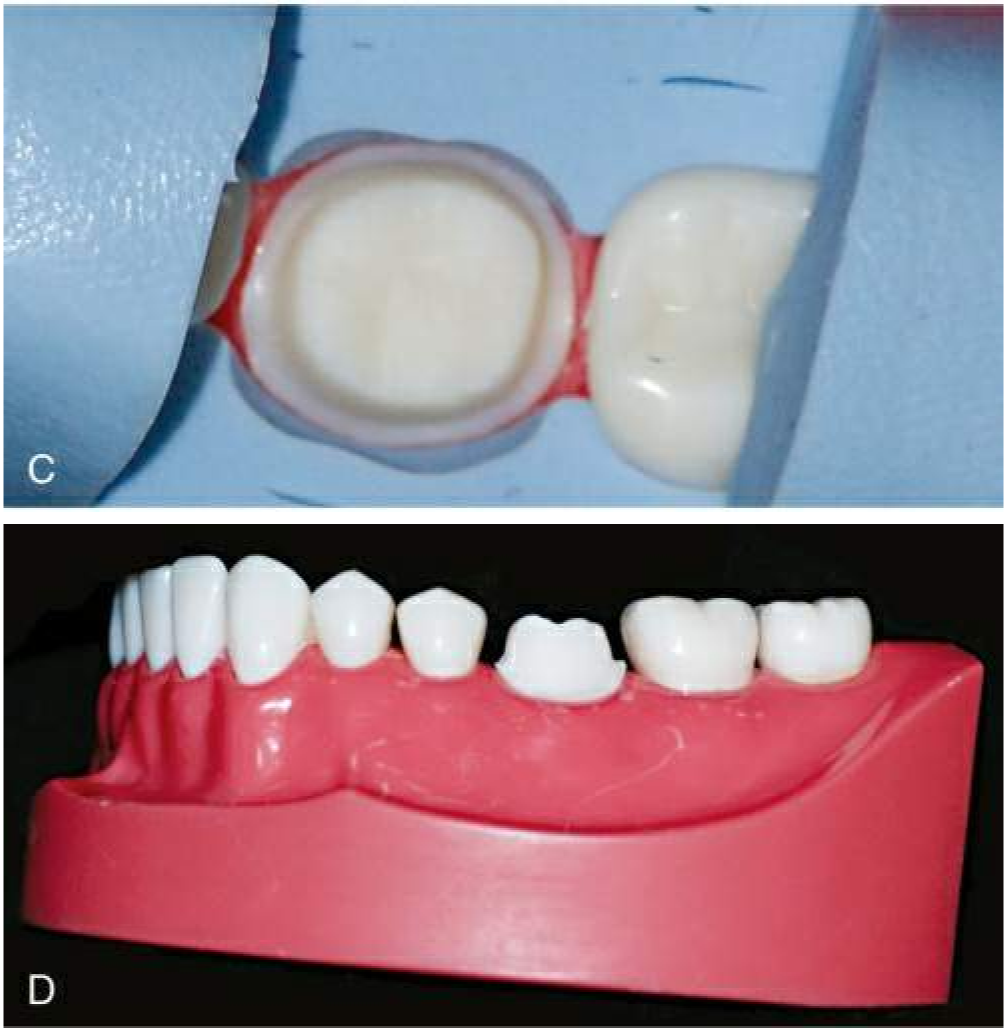
FIGURE 35.38 **(A)** Depth cut occlusal contour. **(B)** Depth cut following cervical contour showing half diamond sunk in, parallel to path of insertion. **(C)** Preparation parallel to path of insertion. **(D)** Completed depth cuts showing supragingival placement. **(E)** Completed buccal reduction – occlusal view. **(F)** Buccal view. **(G)** Facial reduction checked with putty index. **(H)** Depth orientation grooves on lingual surface. **(I)** Completed lingual preparation – lingual view. **(J)** Completed facial and lingual preparation – occlusal view with putty index. **(K)** Completed axial reduction using round-end tapering diamond.

3. Proximal reduction

This prepares the mesial and distal surfaces.
Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Short thin tapering diamond/needle diamond followed by round-end tapering diamond.
Procedure:

- Care should be taken to protect the adjacent teeth. A matrix band can be used as described previously in this chapter. It is best to use the proximal lip of enamel for protection.

- Thin tapering diamond is used in a 'vertical sawing motion' in an occlusogingival direction, from the facial to the lingual surface, placing the diamond parallel to long axis of the tooth and keeping a lip of enamel for protection to the adjacent teeth. This portion can later be removed with a probe (Fig. 35.39A and B).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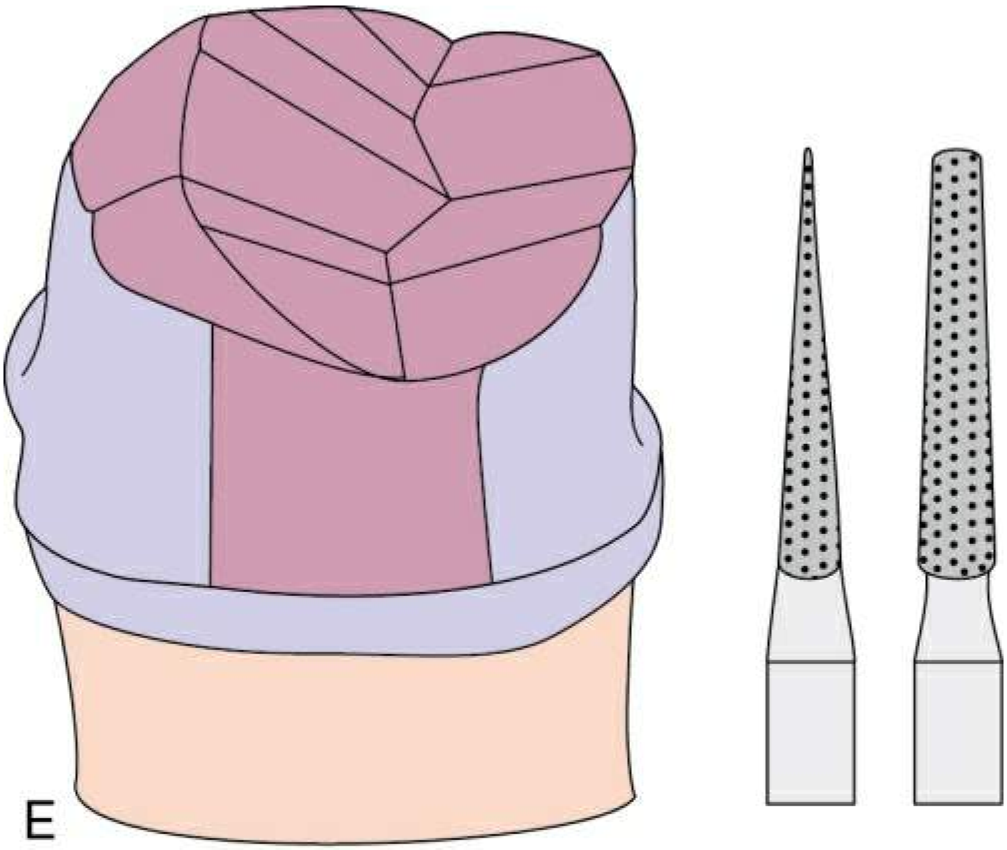


FIGURE 35.39 **(A)** Proximal tooth preparation using thin tapering diamond leaving a lip of enamel for protecting adjacent tooth. **(B)** The lip of enamel can be removed with a probe. **(C)** Completed proximal preparation – occlusal view. **(D)** Facial view. **(E)** Completed proximal reduction using short thin tapering diamond and round-end tapering diamond.

Now there is adequate space proximally to use the round-end tapering diamond and the surface is prepared to its required dimensions with a 0.3–0.5 mm chamfer. Fig. 35.39C–E shows completed proximal reduction.

4. Finishing

The axial surfaces are finished using a torpedo diamond of fine grit or torpedo bur (Fig. 35.40A).

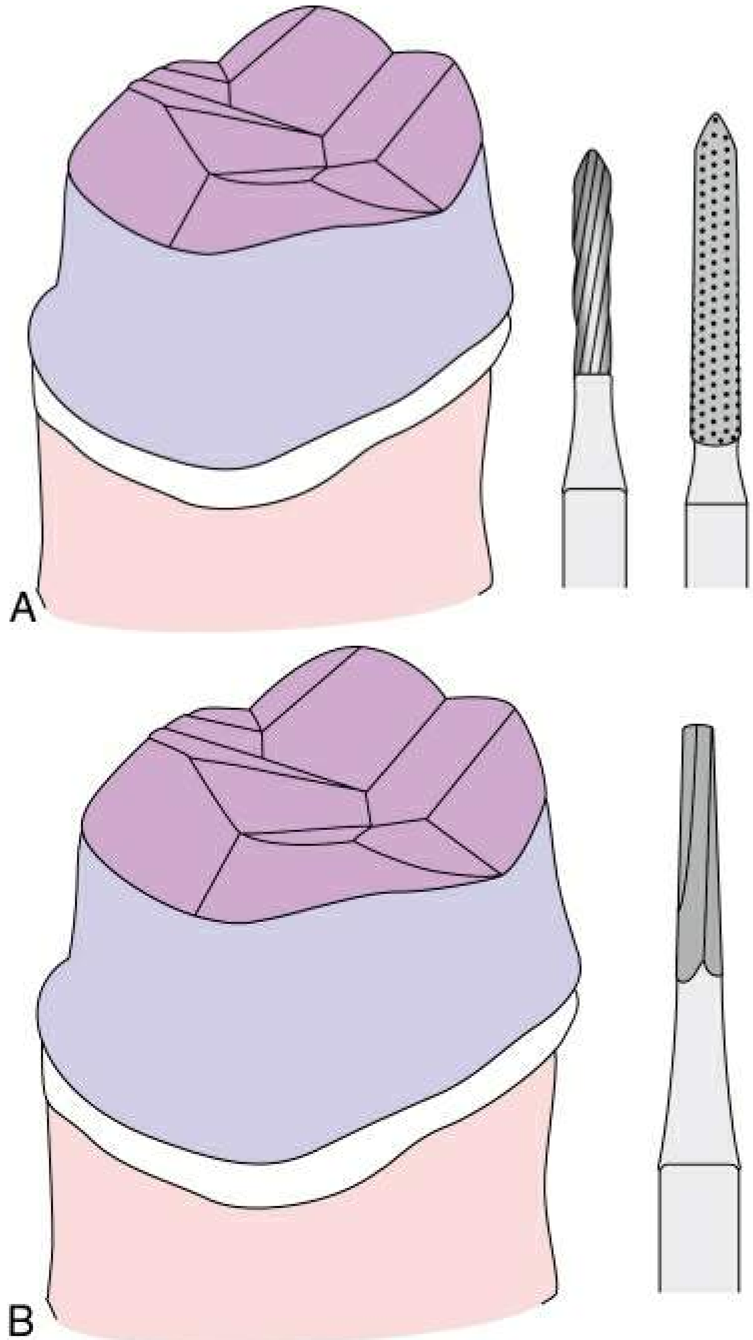


FIGURE 35.40 **(A)** Axial finishing with fine torpedo bur/diamond. **(B)** Occlusal finishing – flat-end tapering fissure bur.

The occlusal surface is finished using flat-end tapering fissure bur (Fig. 35.40B).

Buccal seating grove

It prevents rotation of crown during cementation and acts as a guide during placement. When opposing walls are excessively tapered, in tipped teeth and long-span fixed partial dentures, additional grooves may be placed.

Depth of preparation: 1 mm.

Rotary instrument: Flat-end tapering fissure bur.

Procedure: It is placed in the centre of the facial surface parallel to the path of insertion (Fig. 35.41A–D).

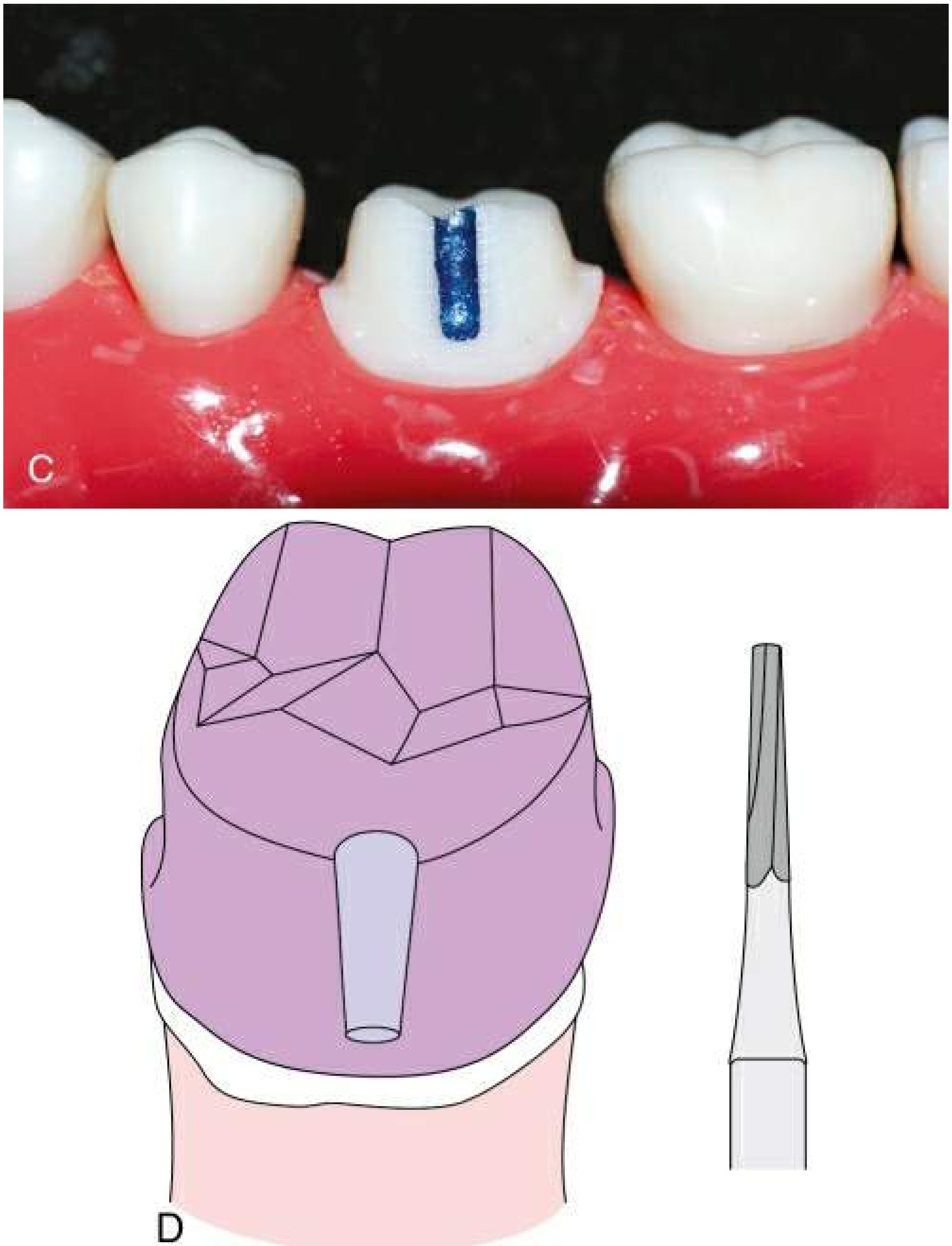


FIGURE 35.41 **(A)** Seating groove parallel to path of insertion. **(B)** Prepared seating groove – occlusal view. **(C)** Prepared seating groove – buccal view. **(D)** Completed buccal seating groove using a flat-end tapering fissure bur.

Metal-ceramic full veneer crown preparation

This restoration combines the strength of metal and the aesthetics of ceramics.

As discussed in Chapter 31, metal-ceramic crowns may be of two types:

1. Metal with complete ceramic coverage

2. Metal with ceramic facing

The tooth preparation for ‘metal with complete ceramic coverage’ is similar to all-ceramic crowns (metal-free ceramics). Hence, the preparation for ‘metal with ceramic facing’ will be considered here.

Anterior metal with ceramic facing crown

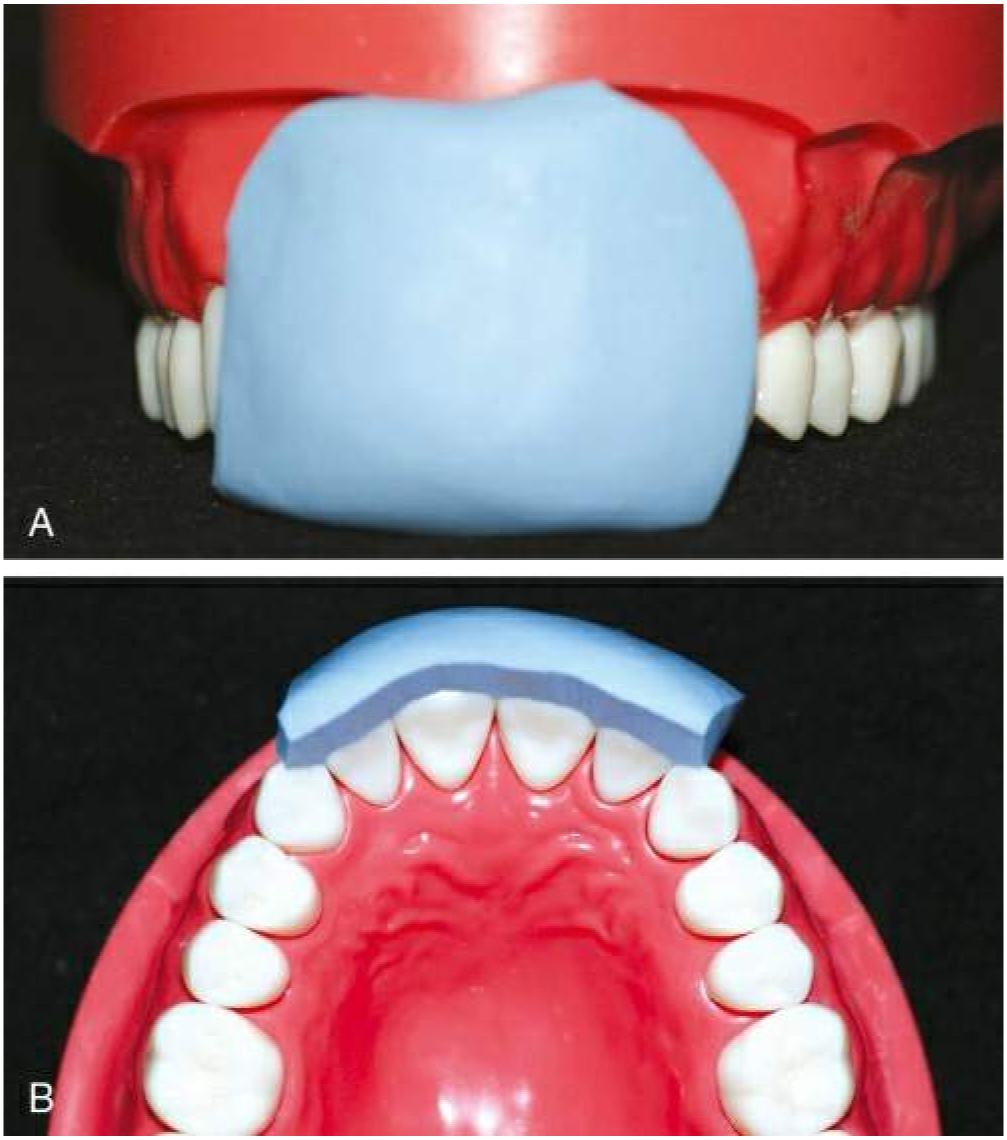
Tooth preparation on a maxillary central incisor

Armamentarium

- Airotor handpiece
- Flat-end tapered diamond
- Round-end tapering diamond
- No. 2 round bur
- Small wheel diamond
- Long thin tapering diamond/needle diamond
- End cutting diamond
- Chamfer diamond/torpedo bur
- Flat-end tapering fissure bur/radial fissure bur
- Baseplate wax sheet – 1 mm thick.

Preparation of putty index

The index is prepared as discussed for 'metal crowns'. The index is cut for the purpose of explanation (Fig. 35.42).



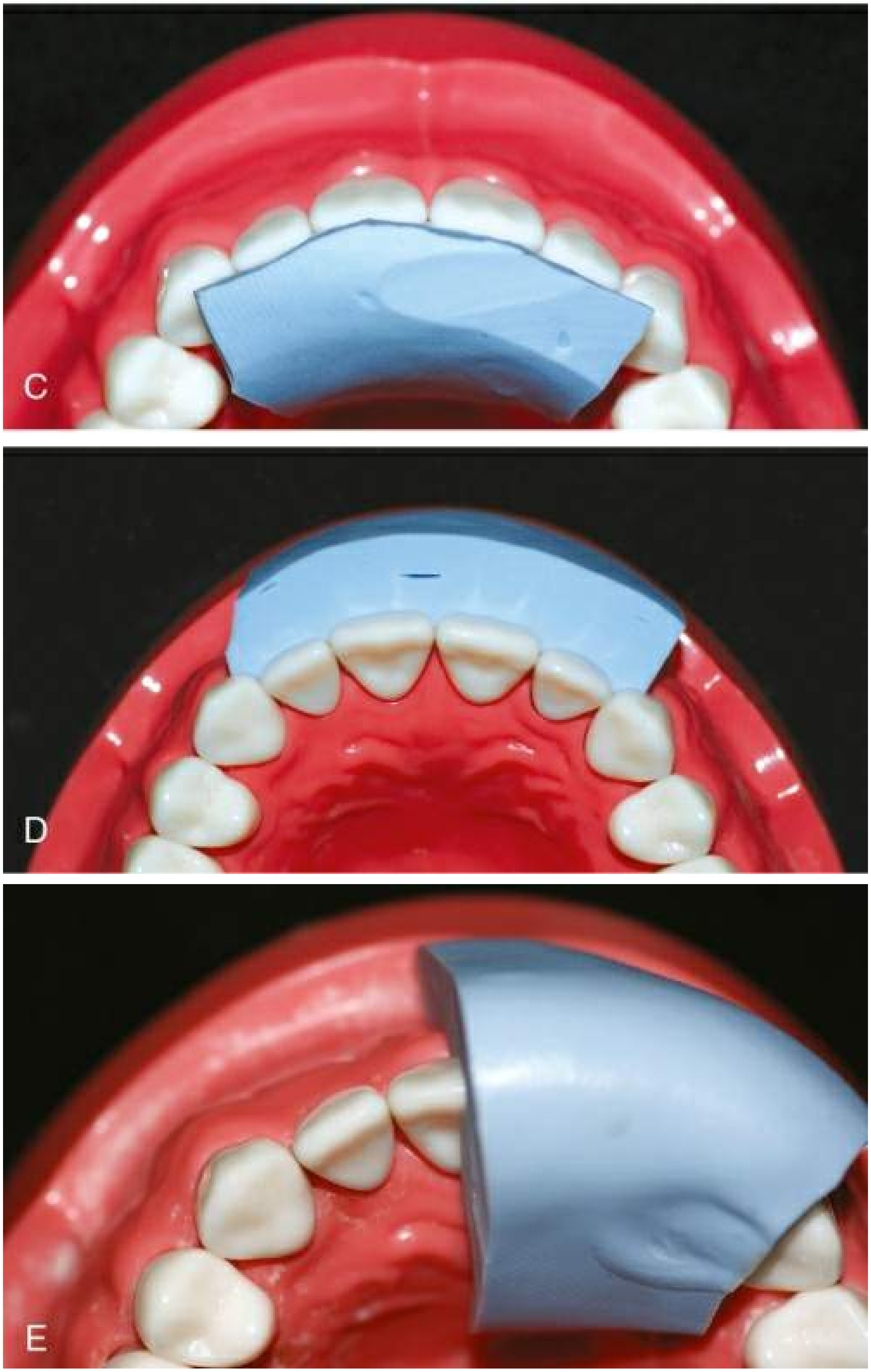

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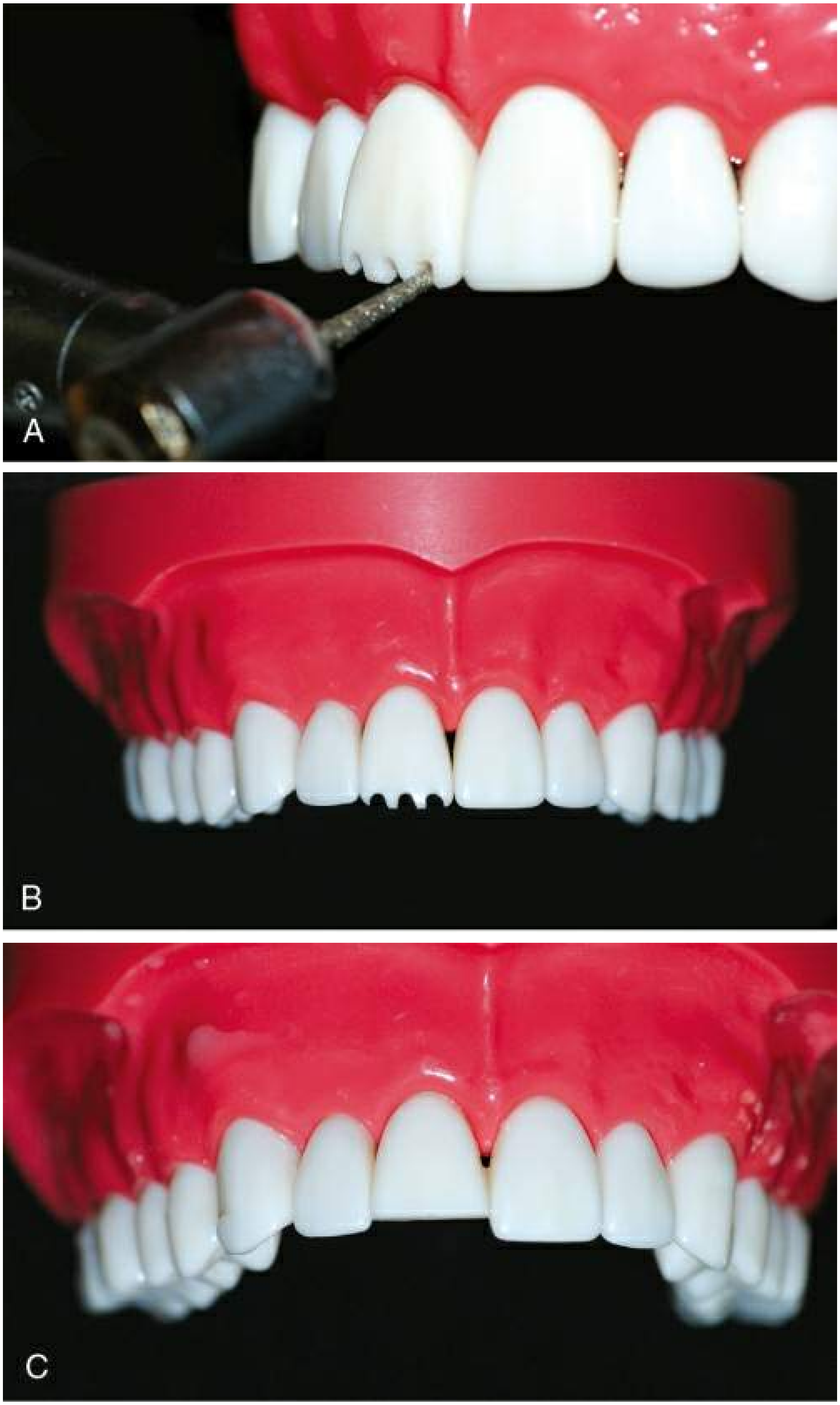
FIGURE 35.42 **(A)** Putty index made. **(B)** Labial half in place. **(C)** Lingual half in place. **(D)** Labiogingival half in place. **(E)** Mesial half. **(F)** Distal half.

Incisal reduction

Depth of preparation: 2 mm
Rotary instrument: Flat-end tapering diamond
Procedure:

- Depth cuts are placed on the incisal edge perpendicular to the direction of loading by the mandibular teeth (Fig. 35.43A). They are normally placed at mid-incisal and at the junction of each proximal surface (Fig. 35.43B).

- The remaining tooth structure is then removed maintaining the same angulation (Fig. 35.43C and D). Inadequate incisal reduction results in poor incisal translucency of the finished restoration.



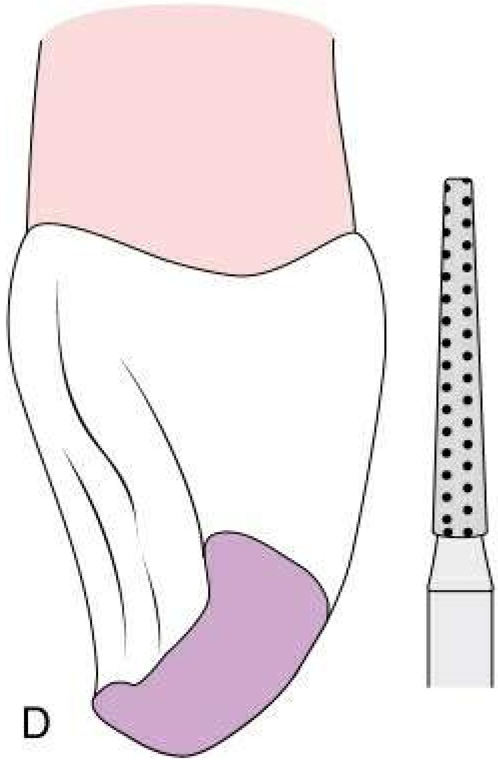


FIGURE 35.43 **(A)** Depth cuts are placed perpendicular to the direction of mandibular teeth. **(B)** Depth cuts placed at mid-incisal and at the junction of each proximal surface. **(C)** Completed incisal reduction. **(D)** Incisal reduction with flat-end tapered diamond.

Labial reduction

Depth of preparation: 1.2–1.5 mm
Rotary instrument: Flat-end tapering diamond

- As the preparation is accomplished when the entire diamond sinks into the tooth, a flat-end tapering diamond of 1.2 mm diameter is selected to prepare a depth of 1.5 mm after finishing. The flat-end produces the required shoulder finish line.

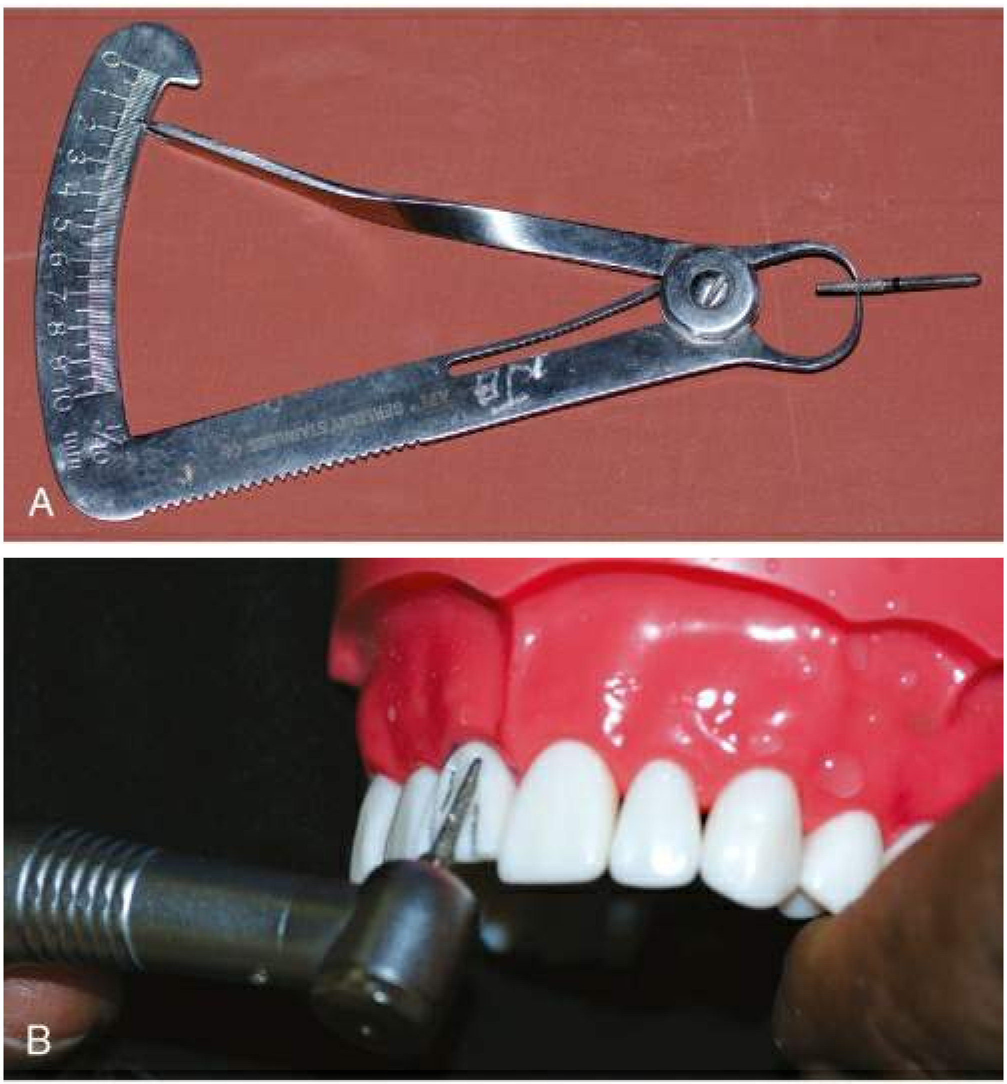
- A metal caliper is used to check the diameter of the diamond (Fig. 35.44A).

- The necessary taper of 3–5° is provided in the tapering diamond.

Procedure:

- The surface is prepared by placing depth orientation grooves/depth cuts by sinking the entire flat-end tapering diamond into the tooth. They are placed in two planes – one set within the gingival half is parallel to long axis or gingival half of labial surface and the incisal portion to follow the labial/facial contour (Fig. 35.44B–E).
- Labial surface should be reduced following the anatomic (two) planes only:
  - If preparation follows gingival contour only, it leads to insufficient preparation in the incisal half which produces lack of incisal translucency or a protruded labial–incisal edge in the finished restoration.
  - If the preparation follows the incisal contour only, it can encroach upon the pulp.
- Inadequate reduction of facial surface leads to:
  - Less space for ceramic and poor aesthetics
  - Overcontour – poor aesthetics and associated gingival problems.
- The remaining tooth structure between the depth cuts is then removed using the flat-end tapering diamond and preparation extended proximally 1 mm beyond contact point.
- A shoulder finish line is obtained as the labial surface will have ceramic.

- Preparation should parallel the gingival contour to avoid damage to interdental papilla and excessive extension into the gingival crevice (Fig. 35.44F).
- The putty index is used to verify the adequacy of the preparation (Fig. 35.44G).

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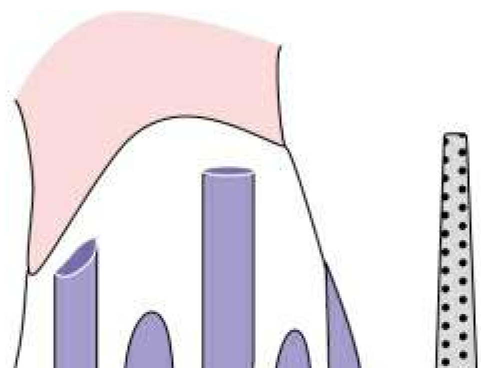
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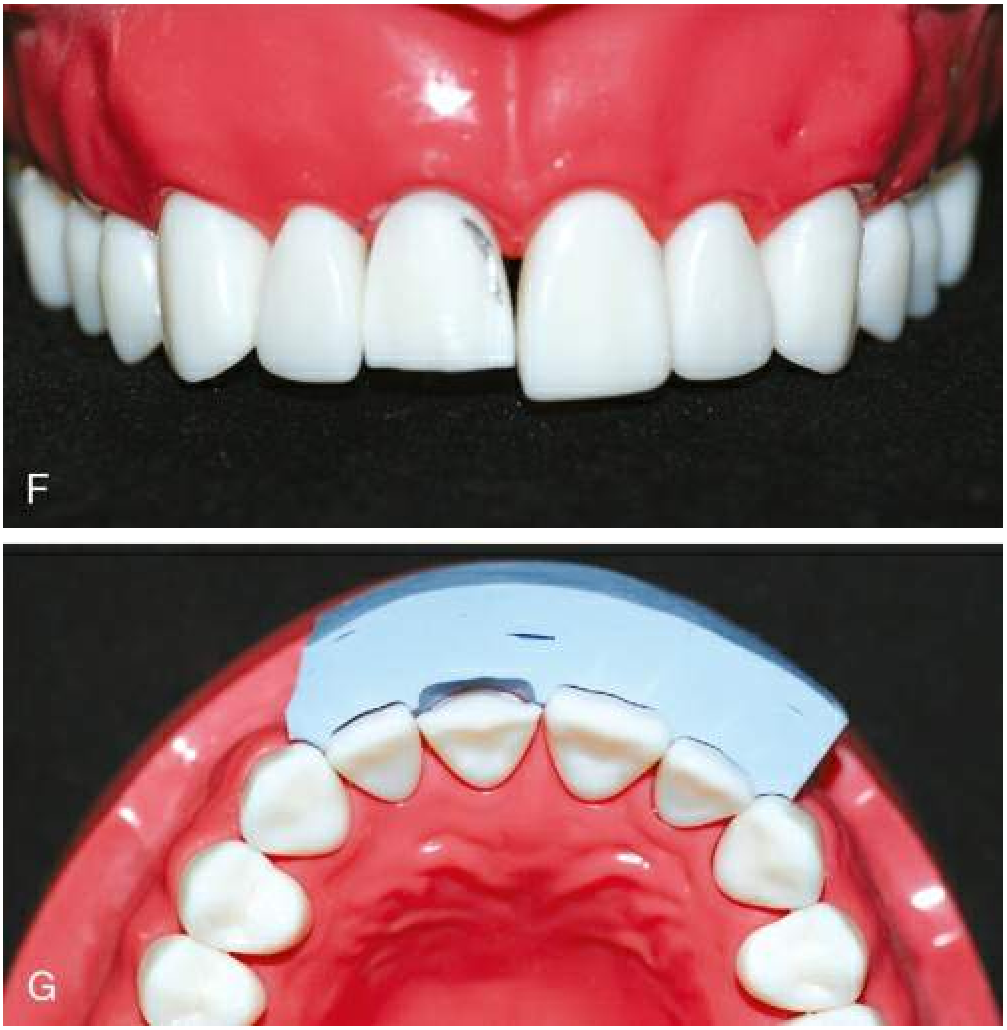
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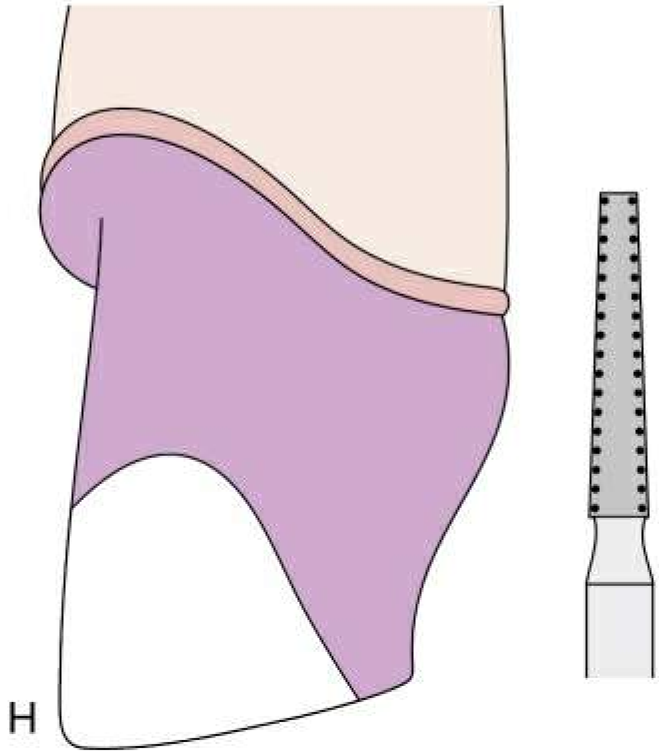
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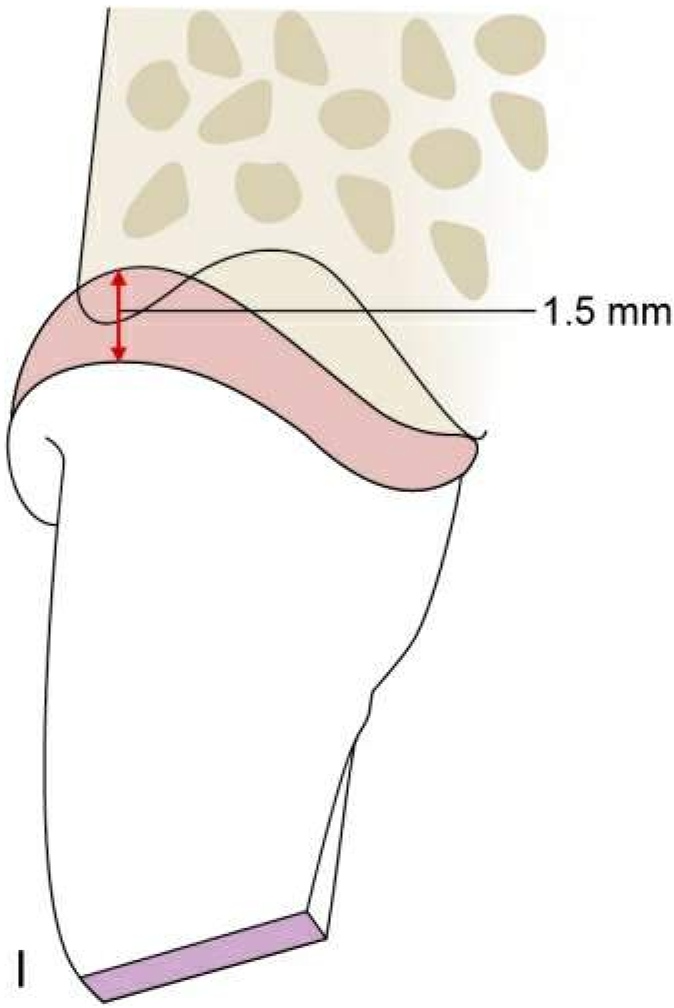


FIGURE 35.44 **(A)** A metal caliper is used to check the diameter of the diamond. **(B)** Depth orientation groove in two planes – first plane following gingival contour of labial surface. **(C)** Depth orientation groove – second plane following incisal contour of labial surface. **(D)** Completed depth orientation grooves. **(E)** Depth orientation grooves in two planes prepared with flat-end tapered diamond. **(F)** Preparation should follow the gingival contour to avoid damage of interdental papilla and excessive extension into the gingival crevice. **(G)** The putty index is used to verify the adequacy of the preparation. **(H)** Completed labial reduction using a flat-end tapering diamond. **(I)** Subgingival margin should be at least 1.5 mm away from alveolar crest.

Labial margin placement

- Supragingival margins are preferred.

- Subgingival margins may be indicated for aesthetic reasons. Preparation for this should begin when the depth cuts in the cervical region are placed. They should be placed 0.5 mm apical to the crest of free gingival, so that after final finishing they will be 1 mm deep.

- The margin should follow the contour of the free gingiva, being further apical in the middle of the tooth and further incisal interproximally (Fig. 35.44H).

- Margin should not be placed so far apically that they encroach on the attachment; extension to within 1.5 mm of the alveolar crest leads to bone resorption (Fig. 35.44I).

Lingual reduction

This can be divided into two parts:

Lingual axial reduction:

Depth of preparation: 0.3–0.5 mm
Rotary instrument: Round-end tapering diamond
Procedure:

- This prepares the cervical portion of the lingual surface. It should be parallel to the path of insertion and produce a taper of 3–5° with the cervical portion of the labial surface.

- Maintaining this angle, a round-end tapering diamond is used to prepare the surface producing a chamfer finish line and this is extended proximally to meet the shoulder preparation.

- A chamfer finish line is recommended as the lingual surface is covered only by metal (Fig. 35.45A–C).


A
B

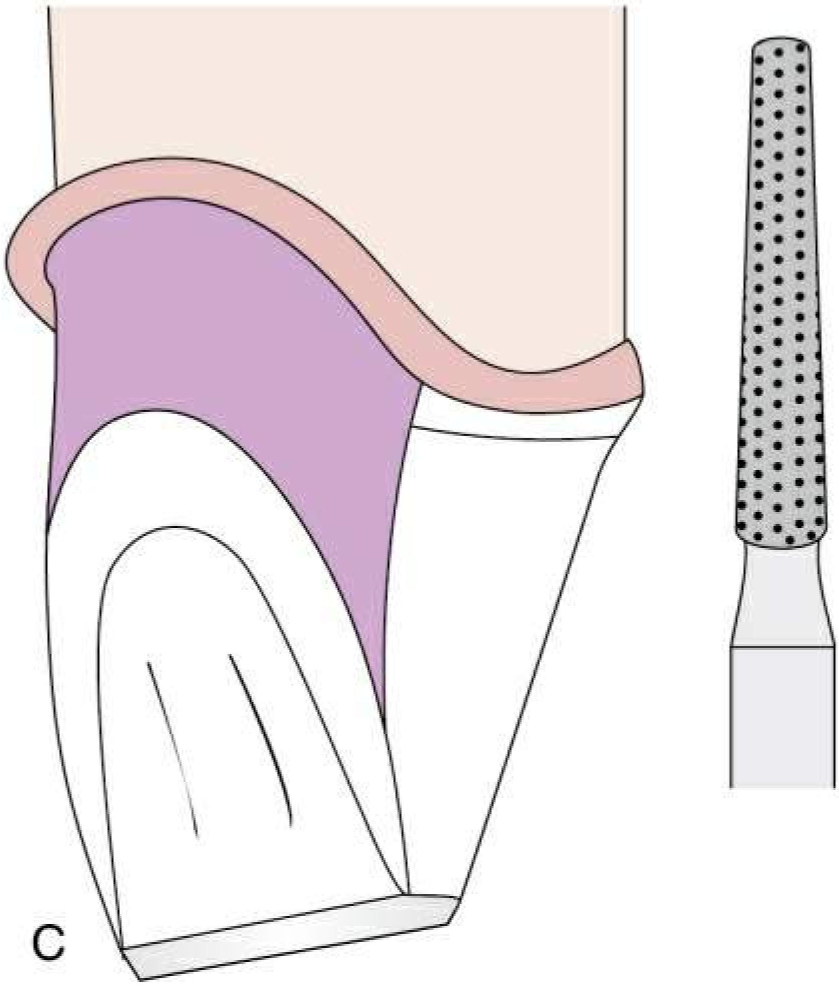


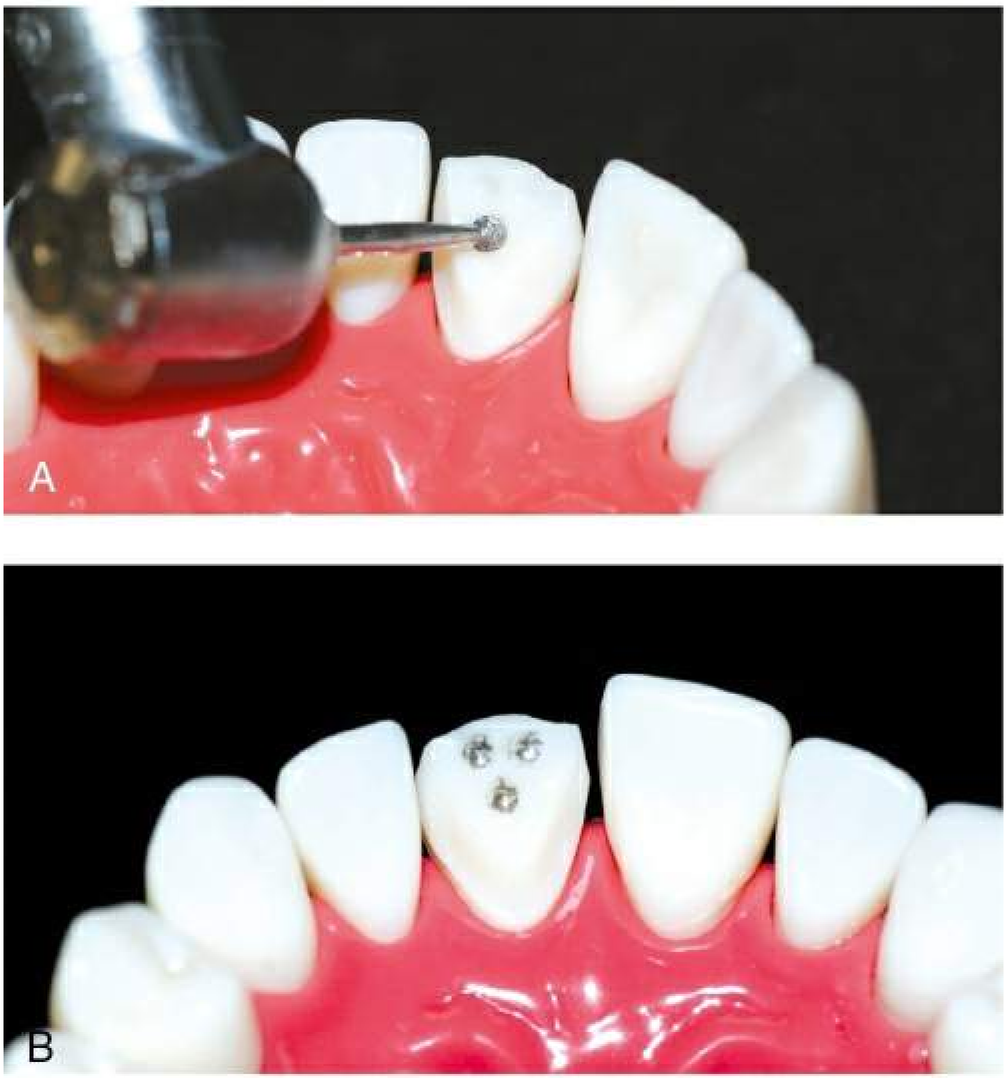
FIGURE 35.45 Lingual axial reduction – lingual view. Lingual axial reduction – occlusal view. Lingual axial reduction using a chamfer bur or round-end tapered diamond.

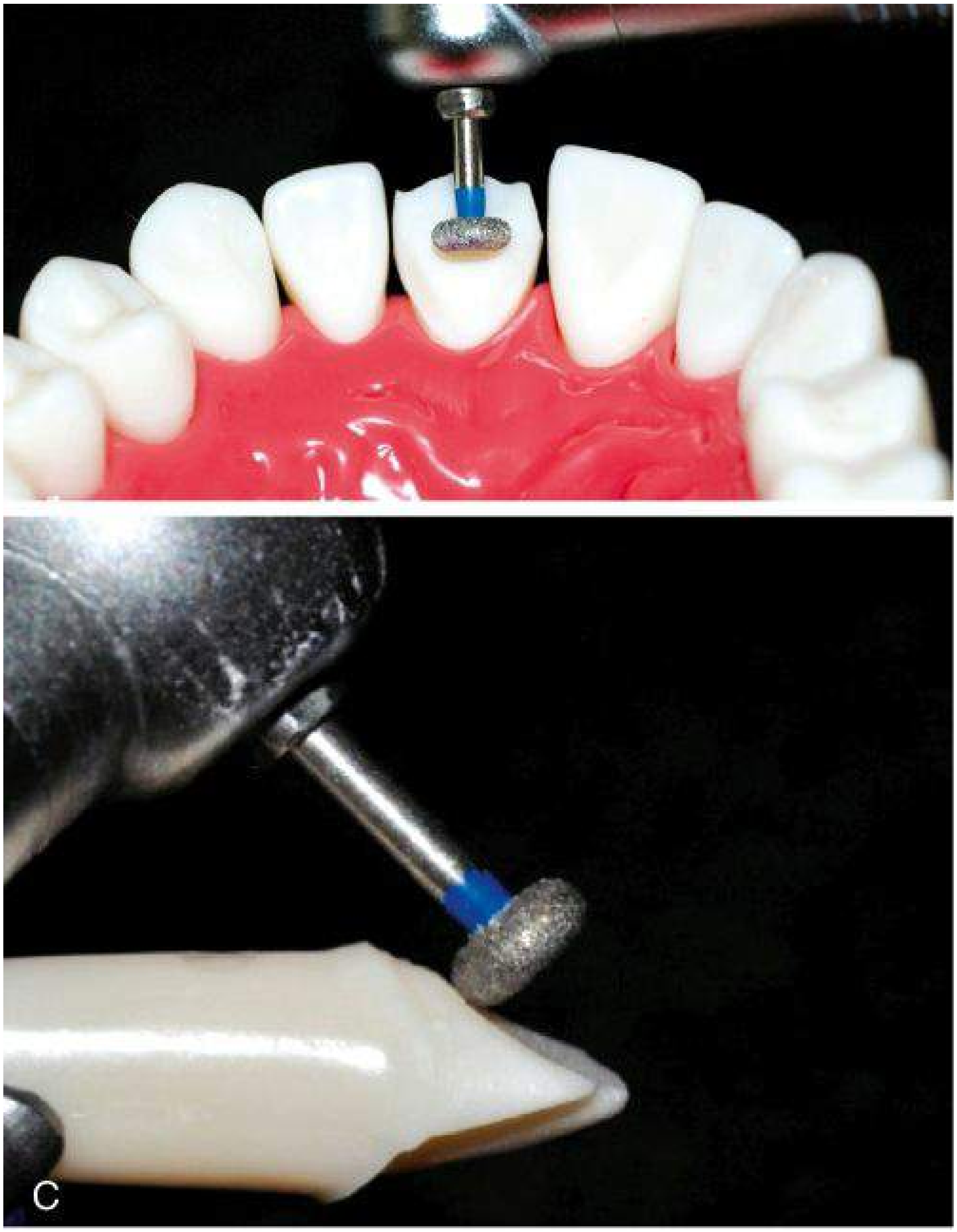
Lingual fossa reduction:

Depth of preparation: 0.8–1 mm
Rotary instrument: No. 2 round bur and wheel diamond/football diamond
Procedure:

- Depth cuts like pot holes are placed on the lingual fossa with a No. 2 round bur which has a diameter of 1 mm. With this depth cuts of 0.5 mm are produced which after finishing will provide the required depth (Fig. 35.46A and B).

- The remaining tooth structure is removed with a wheel diamond or a football diamond (Fig. 35.46C–F).
- The clearance is checked using baseplate wax of 1 mm thickness, as described for complete metal crown preparation.

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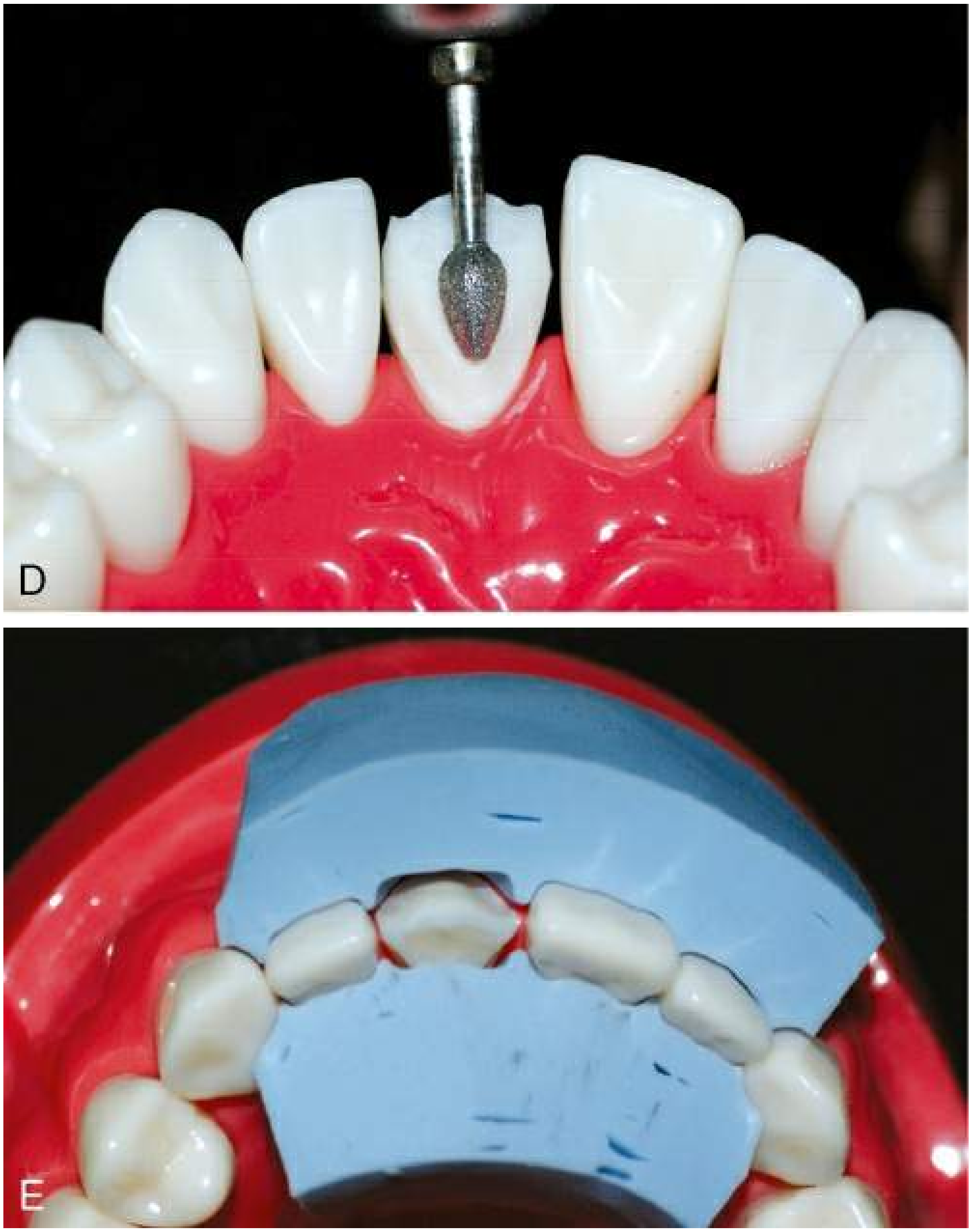
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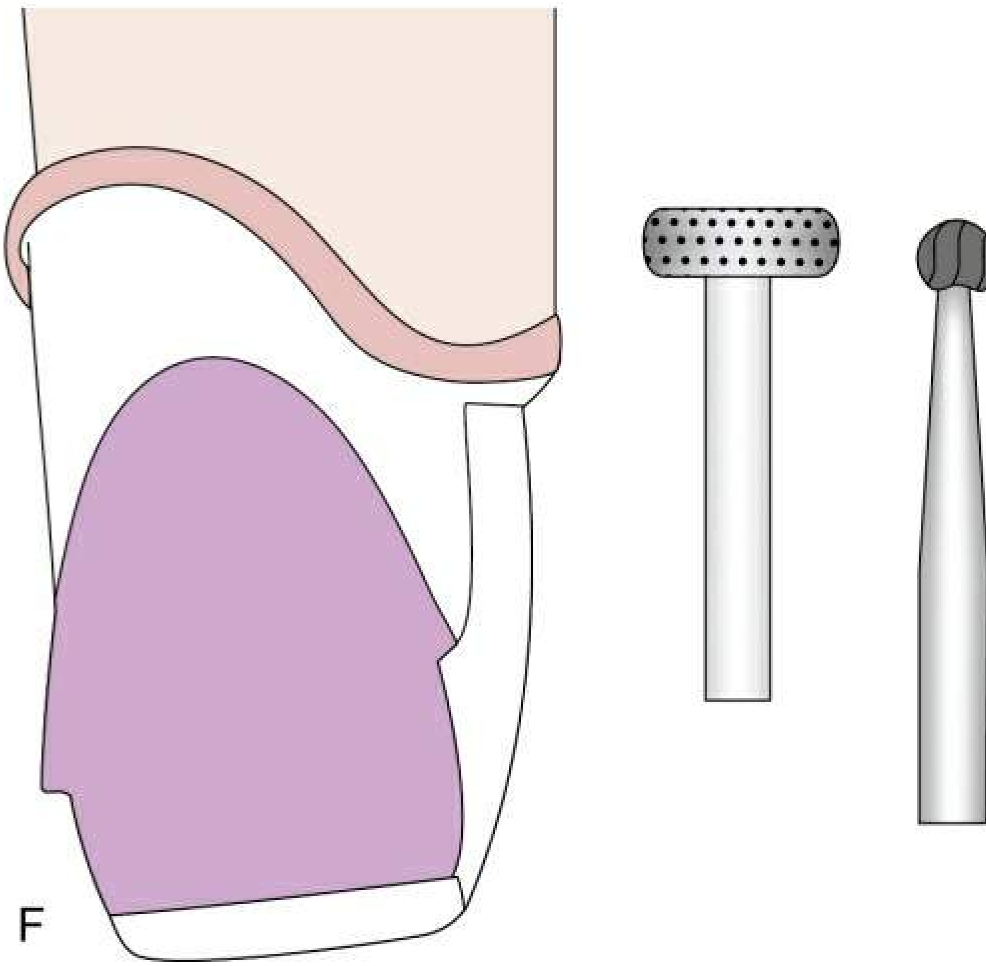


FIGURE 35.46 **(A)** Depth cuts placed on lingual fossa with round bur. **(B)** Completed depth cuts of 0.5 mm depth. **(C)** Removal of remaining tooth structure with small wheel diamond. **(D)** Football diamond bur can also be used for lingual reduction. **(E)** Completed facial and lingual reduction checked with putty index. **(F)** Lingual fossa reduction using round bur/diamond and wheel diamond.

Proximal reduction

Depth of preparation: Varies with formation of wing.
Rotary instrument: Long thin tapering diamond/long needle diamond and round-end tapering diamond.
Procedure:

- Long thin tapering diamond is used to provide access through the proximal surface (Fig. 35.47A). The access is prepared using a 'vertical sawing motion' in an incisogingival direction.

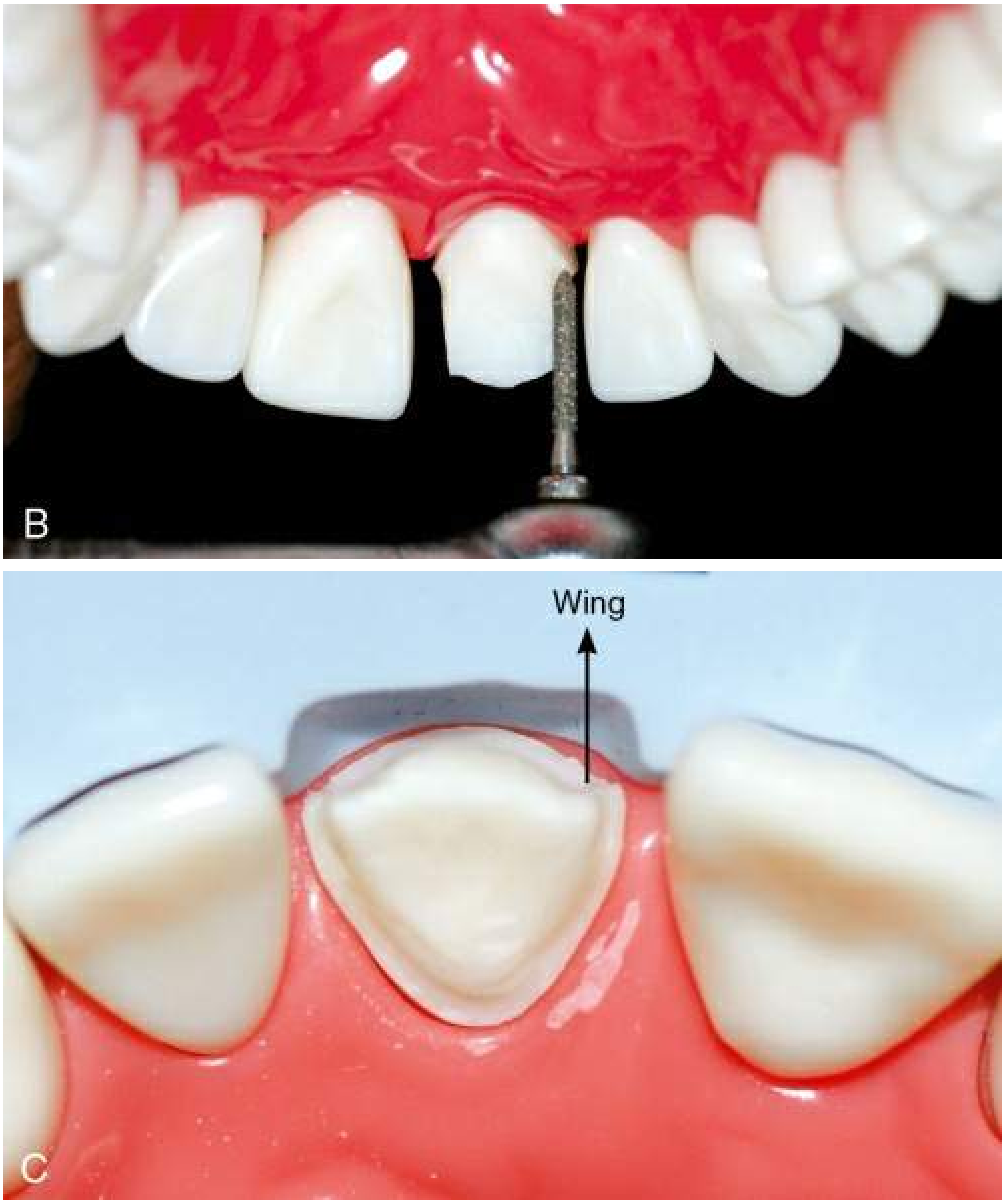
- The lingual axial preparation is now continued onto the proximal surface using the round-end tapering diamond which will produce the chamfer. A taper of 3–5° is produced by the reduced proximal surfaces (Fig. 35.47B).

- The final preparation has a labial shoulder and a lingual chamfer which meet proximally. The junction is called 'wing' as their depth of preparation varies. The shoulder will have a 1–1.5 mm cervical depth while the chamfer will have a 0.3–0.5 mm depth (Fig. 35.47C).

Finishing:

- Finishing of the labial axial surface is done using a flat-end tapering fissure bur (Fig. 35.47D). The shoulder is finished using end-cutting diamond which has noncutting smooth sides with diamond points impregnated only at the tip (Fig. 35.47E and F).

- The lingual axial surface is finished using fine grit torpedo diamond/bur.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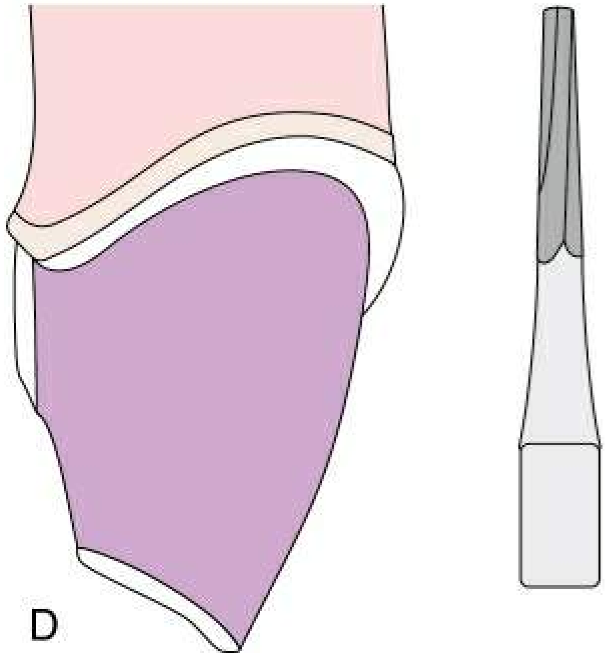

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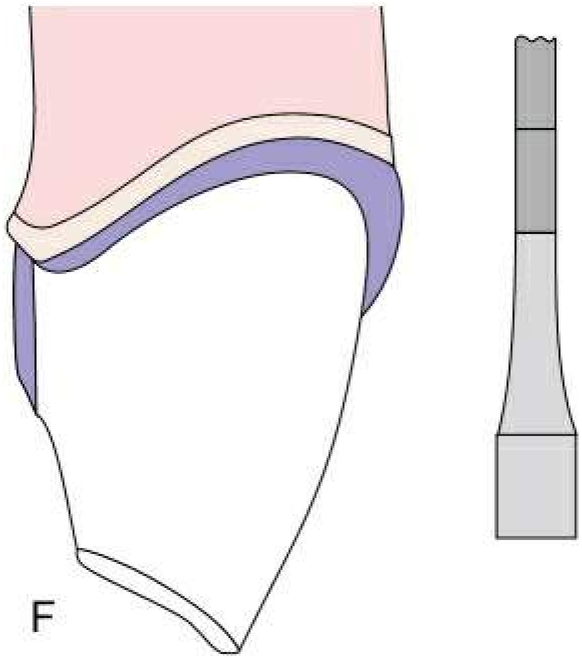


FIGURE 35.47 **(A)** Thin tapering diamond used to gain access to the proximal surface. **(B)** Round-end tapering diamond used to provide a chamfer finish line. **(C)** Finished preparation with 'wing'. **(D)** Labial axial finishing – flat-end tapering fissure. **(E)** Shoulder finishing using end cutting diamond. **(F)** Shoulder finishing – end cutting diamond.

Posterior metal with ceramic facing crown

This is generally used in maxillary premolars, maxillary first molars and mandibular premolars.

Advantages

- Combines the aesthetics of ceramics and a less abrasive metal occlusal surface.
- More conservative and less expensive than metal with complete ceramic coverage crown and all-ceramic crown.

Disadvantages

- More tooth preparation and more expensive than all-metal crowns.

- Risk of ceramic fracture.

Tooth preparation on a maxillary premolar

Armamentarium

- Airotor handpiece
- Flat-end tapered diamond
- Round-end tapering diamond
- No. 2 round bur
- Small wheel diamond
- Long thin tapering diamond/needle diamond
- End cutting diamond
- Chamfer diamond/torpedo bur
- Flat-end tapering fissure bur/radial fissure bur
- Baseplate wax sheet – 1 mm thick.

Preparation of putty index

The index is prepared as discussed for 'metal crowns'.

Occlusal reduction

This prepares the occlusal surface.
Depth of preparation: 1.5 mm.
Rotary instrument: Round-end tapering diamond.
Procedure:
The depth cuts are placed on the occlusal surface following the anatomic contour with round-end tapering diamond. It should be 1.5 mm on palatal cusps (covered by metal but it is a functional cusp, if it

is a nonfunctional cusp 1 mm is sufficient) and 1.5 mm on buccal cusps (as it is covered by metal and ceramic).

The remaining tooth structure between the depth cuts is then removed uniformly to complete the occlusal reduction (Fig. 35.48A and B).

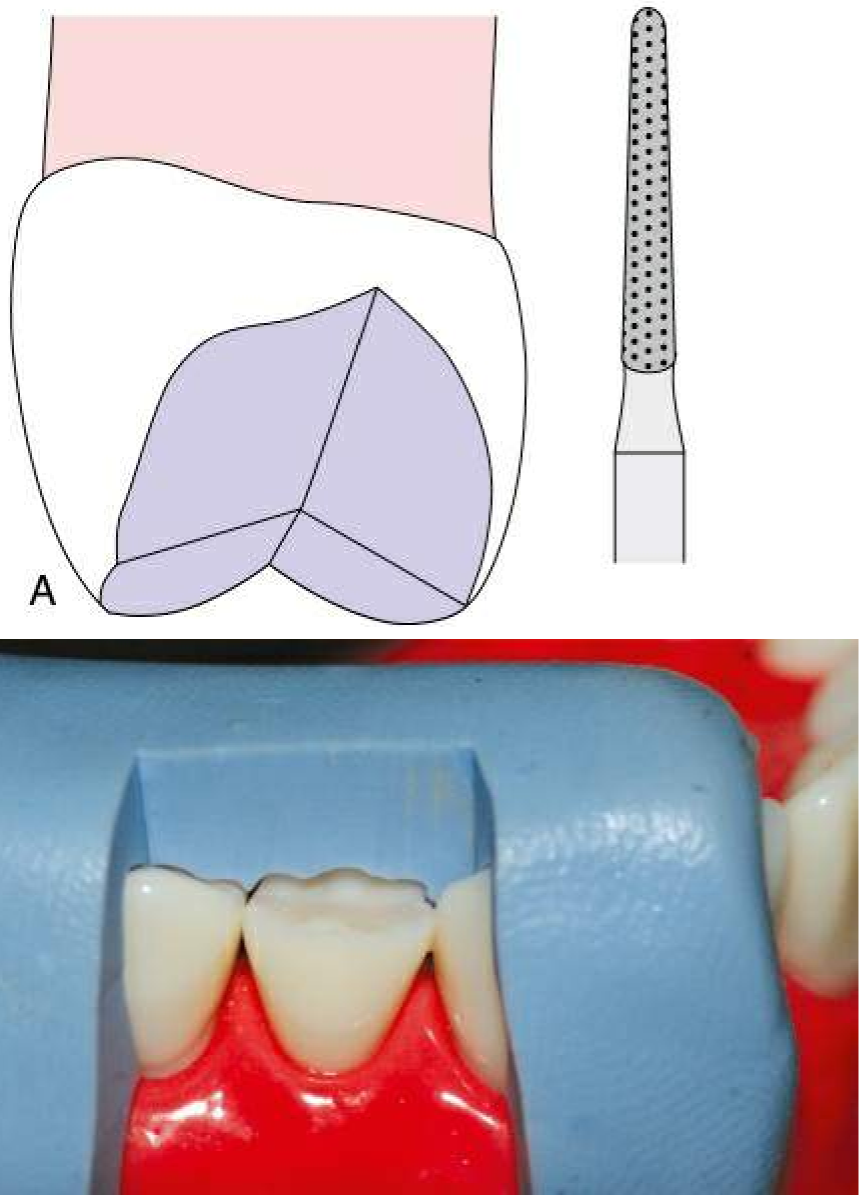


FIGURE 35.48 **(A)** Planar occlusal reduction using round-end tapering diamond. **(B)** Occlusal reduction checked with putty index.

Functional cusp bevel

A wide bevel is then placed on the functional cusp (palatal) using the round-end tapered diamond. The bevel is desired to be at an angle of 45° and an approximate width of 1.5 mm (Fig. 35.49A and B).

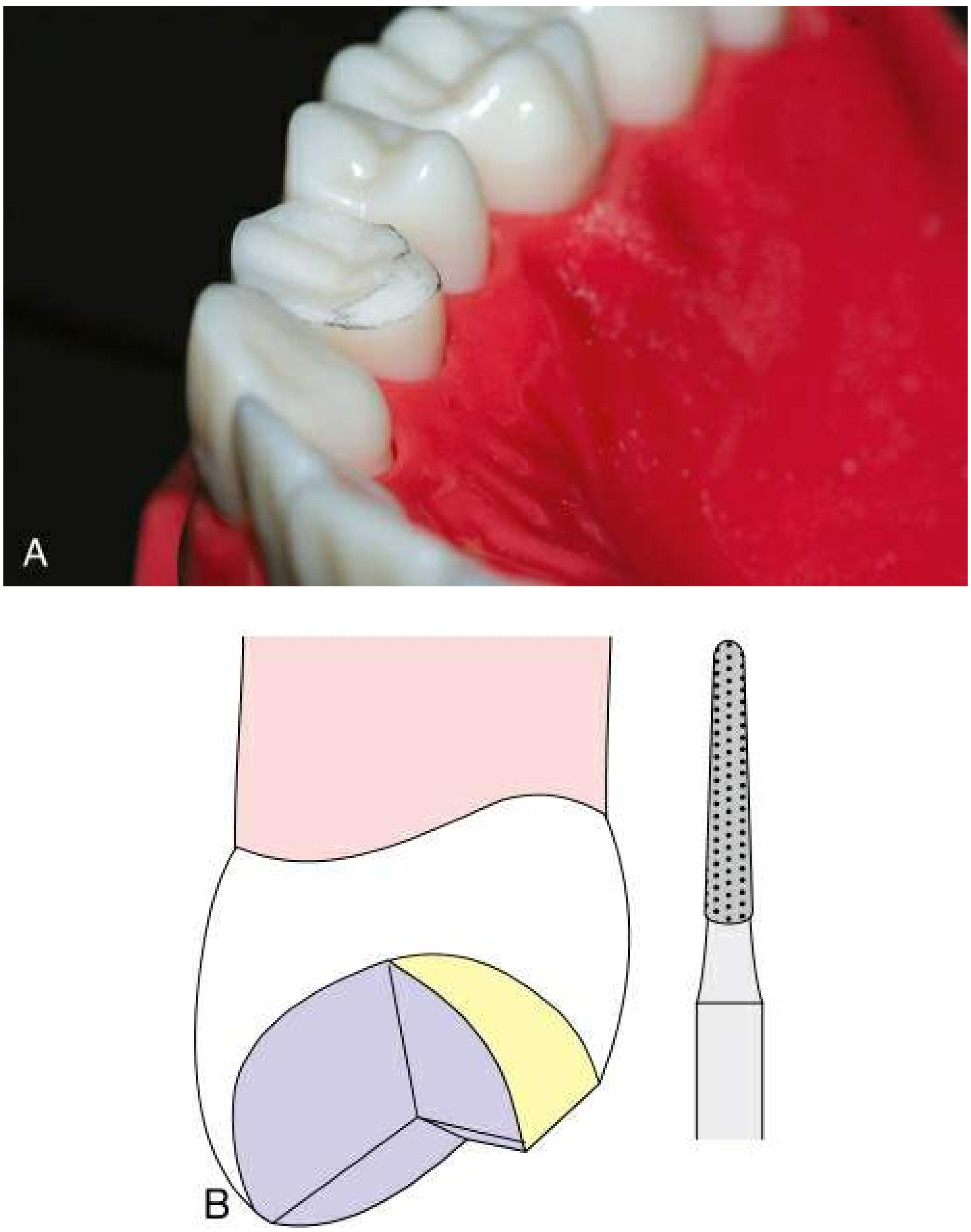


FIGURE 35.49 **(A)** Functional cusp bevel. **(B)** Functional

cusp bevel using round-end tapering diamond.

Checking occlusal clearance

This is verified by asking the patient to bite on baseplate wax of appropriate thickness (1–1.5 mm). Thin spots in wax indicate inadequate clearance and that area is again prepared till clearance is achieved.

Facial reduction

This prepares the facial surface.
Depth of preparation: 1.2–1.5 mm.
Rotary instrument: Flat-end tapering diamond.
Procedure:

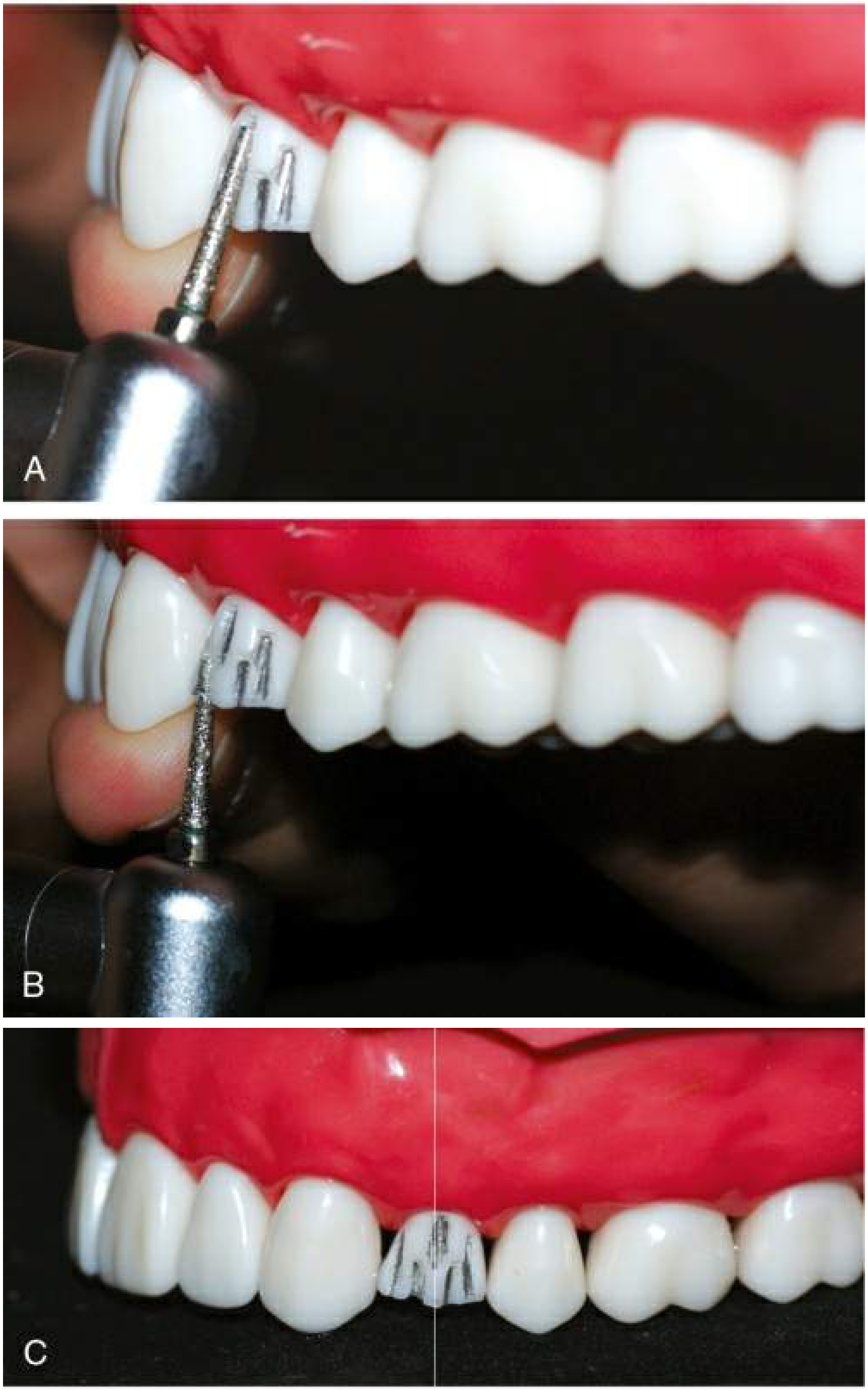
- Depth orientation grooves/depth cuts are placed on the facial surface following the existing contour of the respective surfaces. Two to three such grooves are placed equally, spaced incisally and cervically following the anatomic planes (Fig. 35.50A–C).

- The cervical part provides the retention form and should be parallel to the path of insertion.

- The gingival termination should be established with the depth cut and it should be placed equigingivally on enamel.

- The remaining tooth structure between the depth cuts is then removed using the flat-end tapering diamond and preparation is extended 1 mm beyond contact point on the proximal surfaces (Fig. 35.50D and F).

- The preparation is verified using the putty index (Fig. 35.50E).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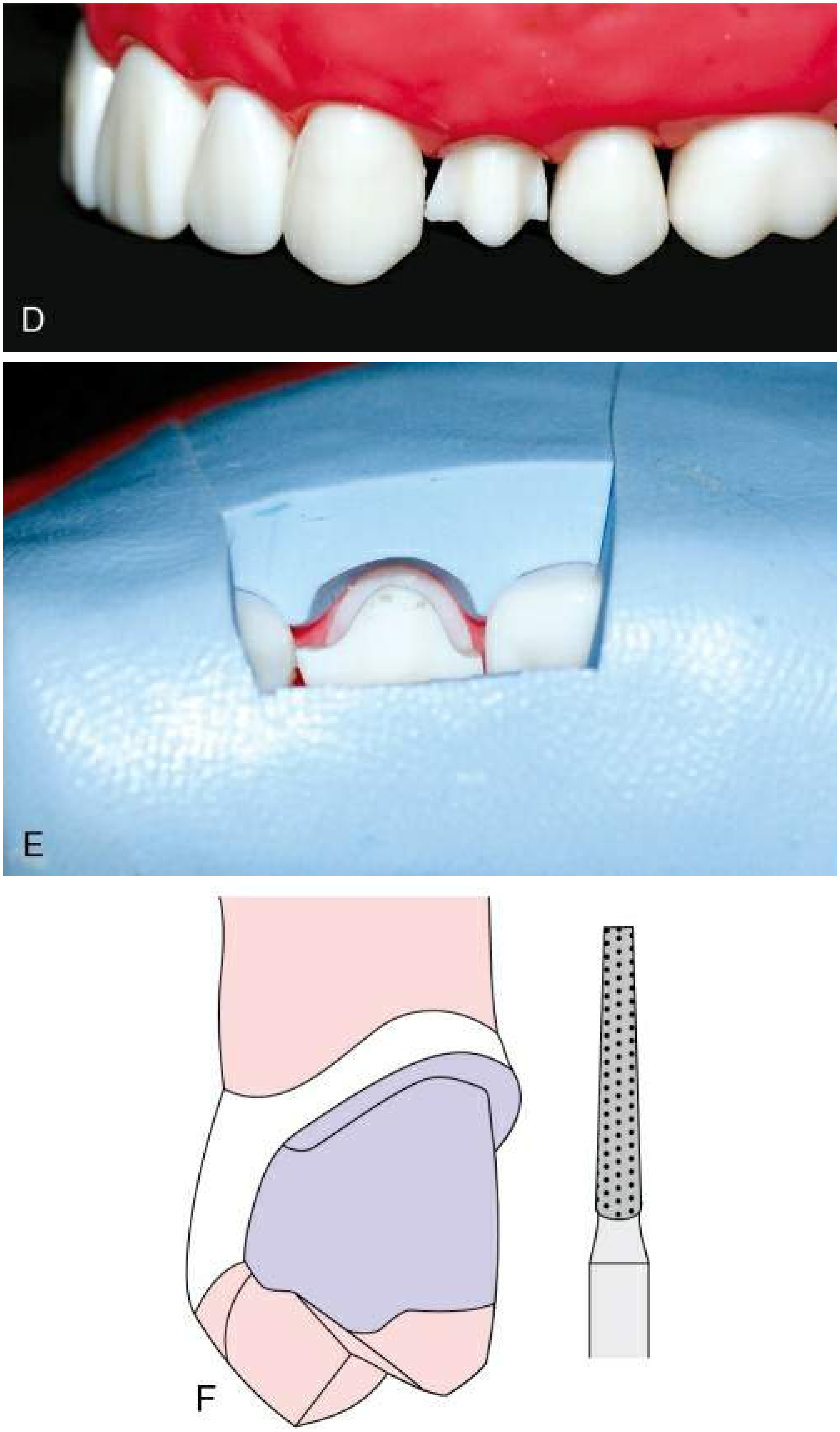
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FIGURE 35.50 **(A)** Depth cuts placed cervically. **(B)** Depth cuts placed incisally. **(C)** Depth orientation grooves placed. **(D)** Remaining tooth structure between the depth cuts is removed. **(E)** Facial reduction is verified using the putty index. **(F)** Facial reduction with flat-end tapering diamond.

Lingual reduction

Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Round-end tapering diamond.
Procedure:

- It should be parallel to the path of insertion and should produce a taper of 3–5° with the cervical portion of the labial surface. It should follow the contour of the lingual surface (two-plane reduction).
- Maintaining this angle, a round-end tapering diamond is used to prepare the surface producing a chamfer finish line and this is extended proximally to meet the shoulder finish line.
- The chamfer finish line is recommended as the palatal surface is covered only by metal (Fig. 35.51A and B).

Proximal reduction
Depth of preparation: Varies with formation of wing.
Rotary instrument: Long thin tapering diamond/long needle diamond and round-end tapering diamond.
Procedure:

- Long thin tapering diamond is used to provide access through the proximal surface. The access is prepared using a 'vertical sawing motion' in an occlusogingival direction.
- The palatal preparation is now continued onto the proximal surface using the round-end tapering diamond which will produce the chamfer. A taper of 3–5° is produced by the reduced proximal surfaces.

- A ‘wing’ is produced at the junction where the chamfer meets the shoulder as their depth of preparation varies (Fig. 35.52). The shoulder will have a 1–1.5 mm cervical depth while the chamfer will have a 0.3–0.5 mm depth.

Finishing:

- A shoulder with bevel could also be used as a finish line for the facial surface. This is produced by the tip of a flame-shaped diamond/bur with a width of 0.3 mm and at an angle of 45° to the shoulder (Fig. 35.53A and B).
- Occlusal surface is finished using a flat-end tapering fissure bur.
- Facial surface is finished using a flat-end tapering fissure bur. The shoulder finish line is finished using end-cutting diamond.
- The lingual surface is finished using fine torpedo diamond/bur.

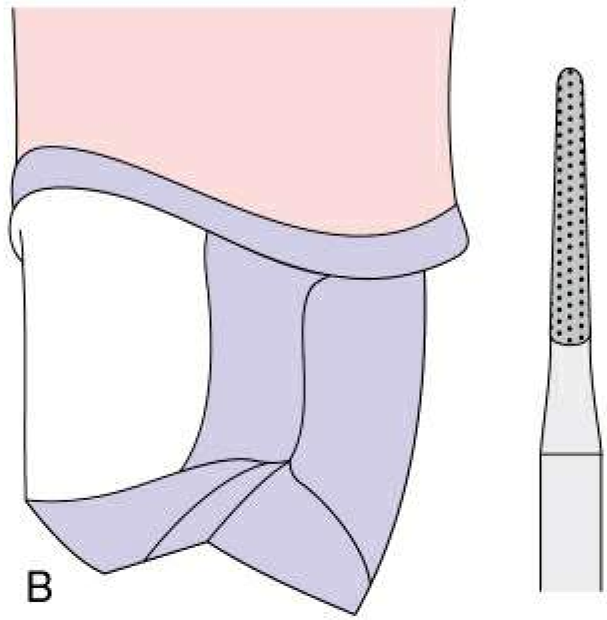


FIGURE 35.51 **(A)** Lingual axial reduction – chamfer finish line. **(B)** Lingual axial reduction with round-end tapering diamond.

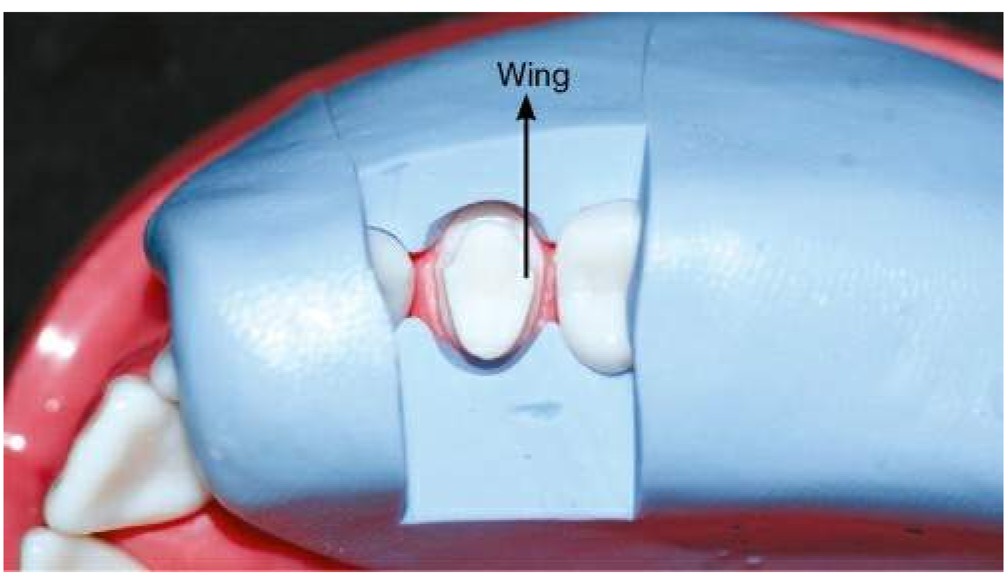
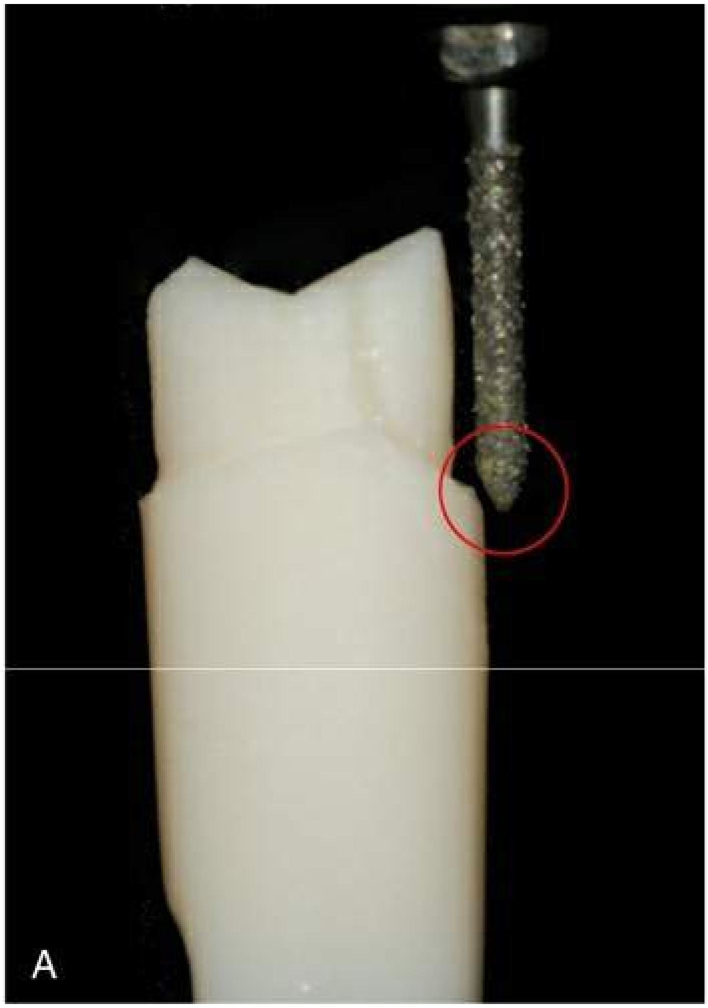


FIGURE 35.52 Wing produced at the junction where the chamfer meets the shoulder.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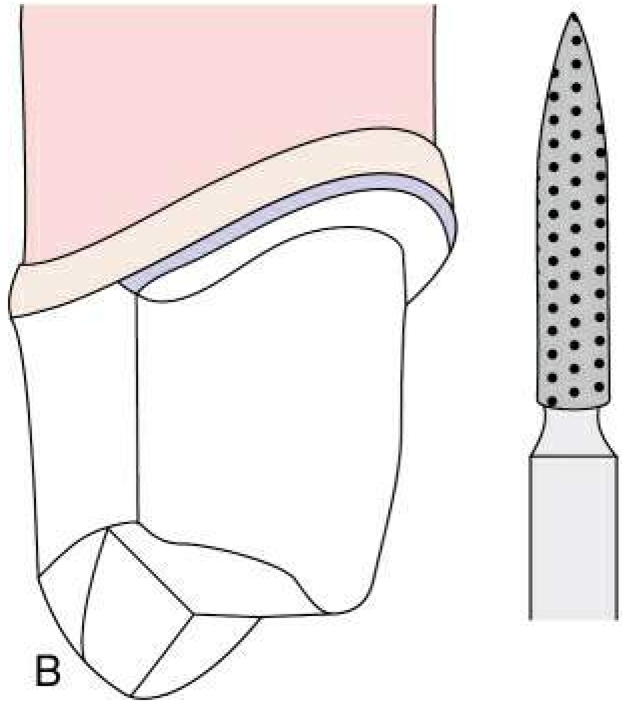


FIGURE 35.53 Shoulder with bevel produced by the tip of a flame-shaped diamond. Shoulder with bevel using a flame-shaped diamond.

All-ceramic crowns (metal-free ceramic crowns)

This is discussed in detail in Chapter 43. Only tooth preparation for the same will be discussed here.

Tooth preparation on a maxillary central incisor

Armamentarium

- Handpiece
- Flat-end tapered diamond
- No. 6 round bur
- Small wheel diamond

- Flat-end tapering fissure bur
- End-cutting diamond
- Binangle chisel
- Baseplate wax sheet – 2 mm thick.

Incisal reduction

Depth of preparation: 2 mm.
Rotary instrument: Flat-end tapering diamond.
Procedure:

- Depth cuts are placed on the incisal edge perpendicular to the direction of loading by the mandibular teeth. They are normally placed at mid-incisal and at the junction of each proximal surface (Fig. 35.54A).
- The remaining tooth structure is then removed maintaining the same angulation (Fig. 35.54B and C).

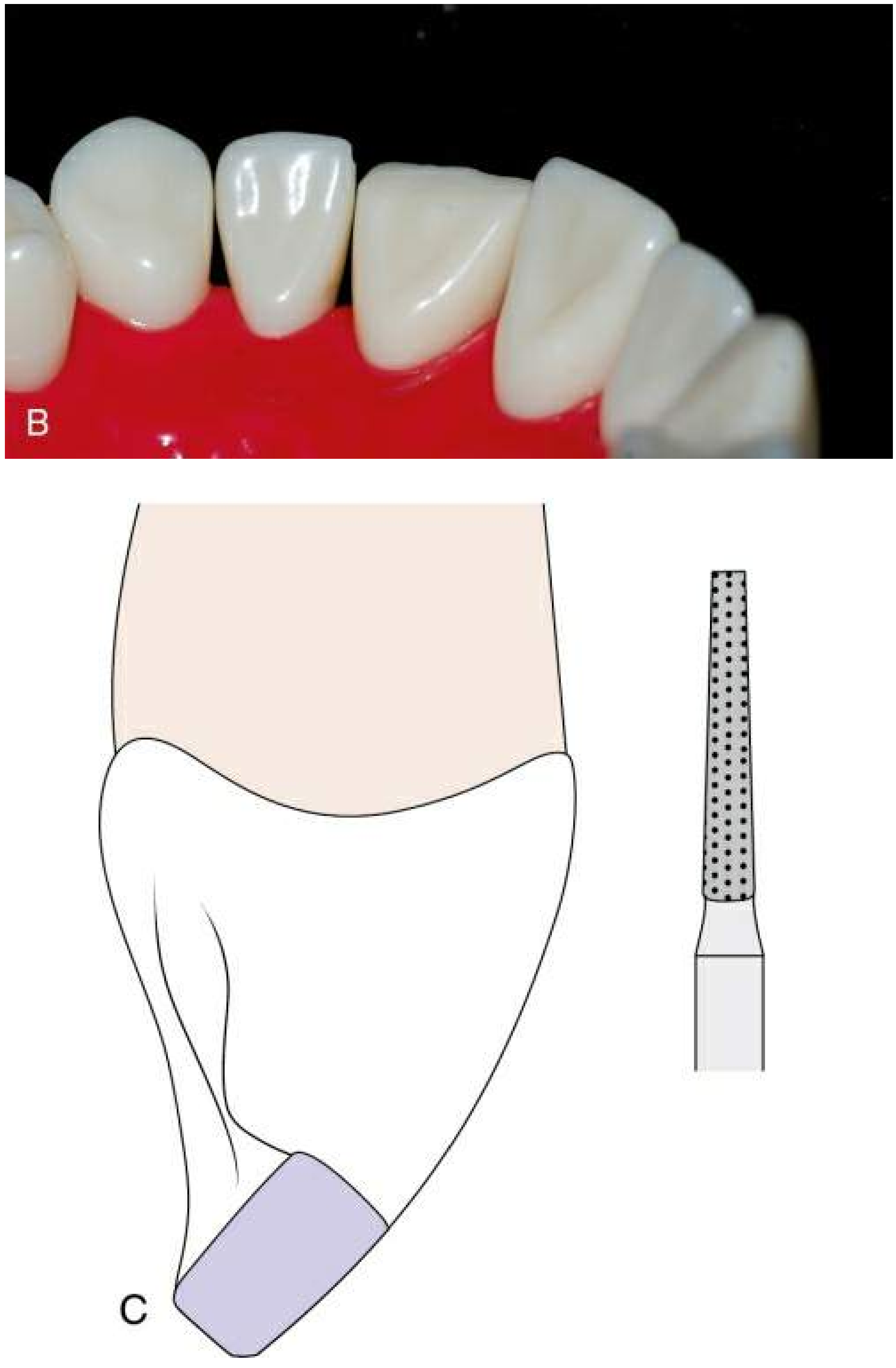


FIGURE 35.54 **(A)** Depth cuts placed at mid-incisal and at the junction of each proximal surface. **(B)** Completed incisal reduction. **(C)** Incisal reduction with flat-end tapering diamond.

Labial reduction

Depth of preparation: 1.5 mm.
Rotary instrument: Flat-end tapering diamond.
Procedure:

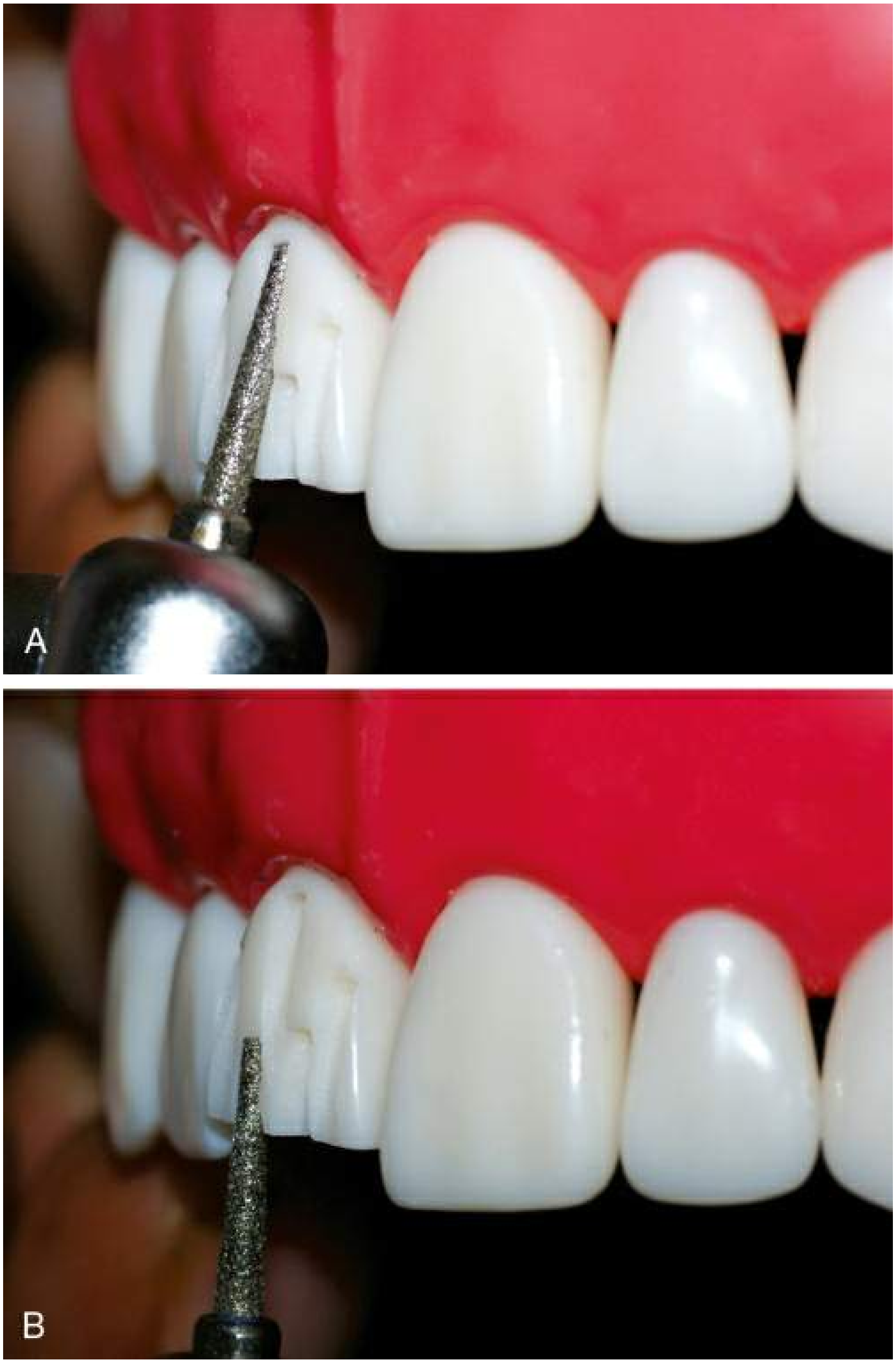
- The surface is prepared by placing depth orientation grooves/depth cuts 1.2 mm deep which after finishing will produce a depth of 1.5 mm. This is done by sinking the entire flat-end tapering diamond or appropriate diameter into the tooth. They are placed in two planes – one set within the gingival half is parallel to long axis or gingival half of labial surface and the incisal portion to follow the labial/facial contour (Fig. 35.55A and B).

- The remaining tooth structure between the depth cuts is then removed using the flat-end tapering diamond and preparation extended to the facioproximal line angle (Fig 35.55C and D).

- A shoulder finish line is produced by the flat-end tapered diamond.

- Preparation should parallel the gingival contour to avoid cutting of interdental papilla and excessive extension into the gingival crevice.

- Supragingival/equigingival margins are preferred.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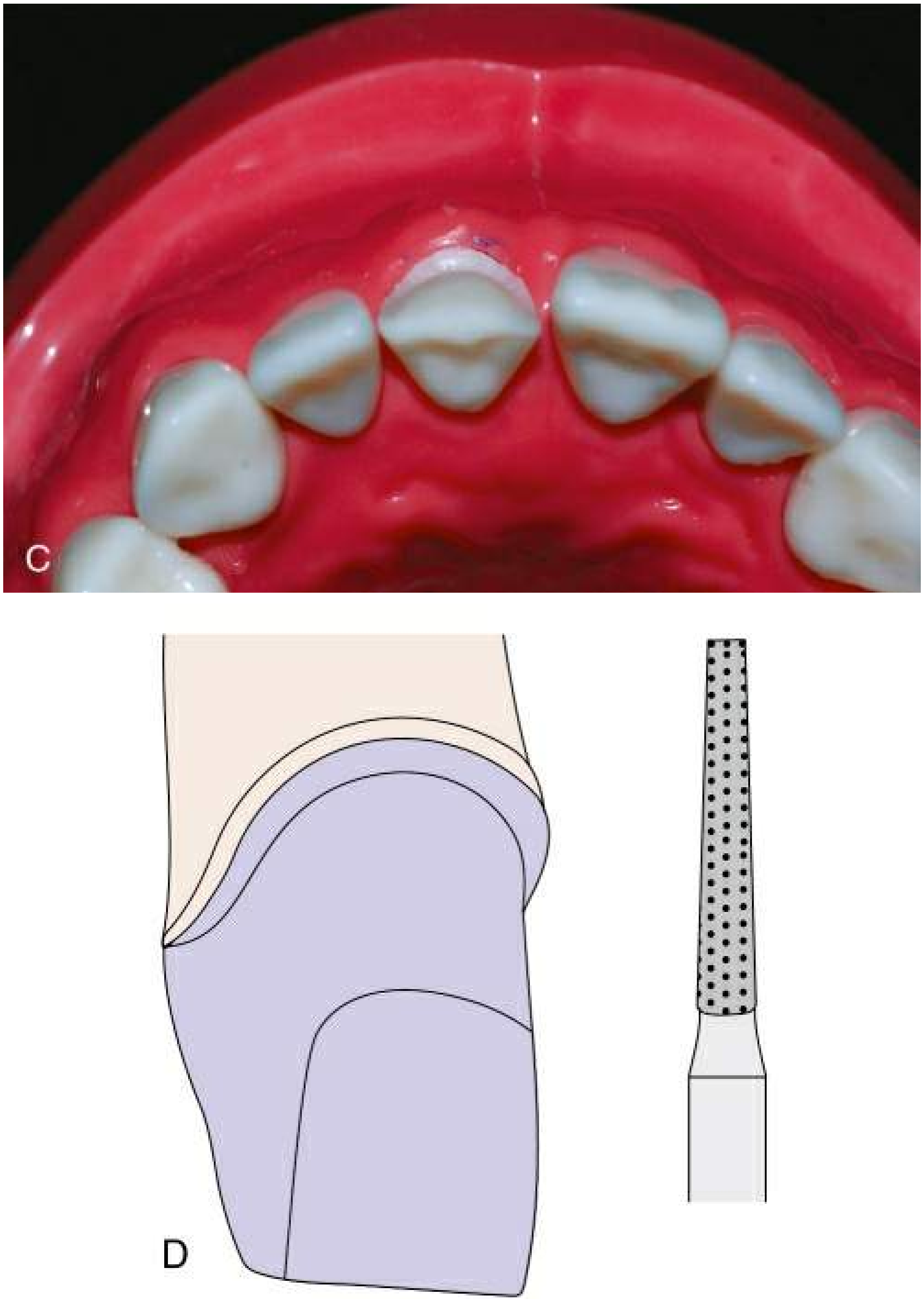


FIGURE 35.55 **(A)** Depth cuts placed gingivally by sinking the entire bur. **(B)** Depth cuts placed incisally following the facial contour. **(C)** Completed labial reduction. **(D)** Labial reduction with flat-end tapering diamond.

Lingual reduction

Lingual axial reduction

Depth of preparation: 1.5 mm.
Rotary instrument: Flat-end tapering diamond.
Procedure:

- This prepares the cervical portion of the lingual surface. It should be parallel to the path of insertion and should produce a taper of 3–5° with the cervical portion of the labial surface.
- Maintaining this angle, a flat-end tapering diamond is used to prepare the surface producing a shoulder finish line and this is extended proximally to meet the labial preparation (Fig. 35.56A and B).
- A shoulder finish line is recommended as the lingual surface is covered by ceramic. This is then converted to 'radial shoulder' while finishing.

FIGURE 35.56 **(A)** Lingual axial reduction – lingual view. **(B)** Lingual axial reduction – occlusal view.

Lingual fossa reduction

Depth of preparation: 1.5 mm.
Rotary instrument: No. 6 round bur and wheel diamond/football diamond.
Procedure:

- Depth cuts like pot holes are placed on the lingual fossa with a No. 6 round bur which has a diameter of 1.8 mm. With this depth cuts of approximately 1 mm are produced, which after finishing will give the required depth (Fig. 35.57A).

- The remaining tooth structure is removed with a wheel diamond or a football diamond (Fig. 35.57B).

- The clearance is checked using baseplate wax of 2 mm thickness, as described for complete metal crown preparation (Fig. 35.57C).

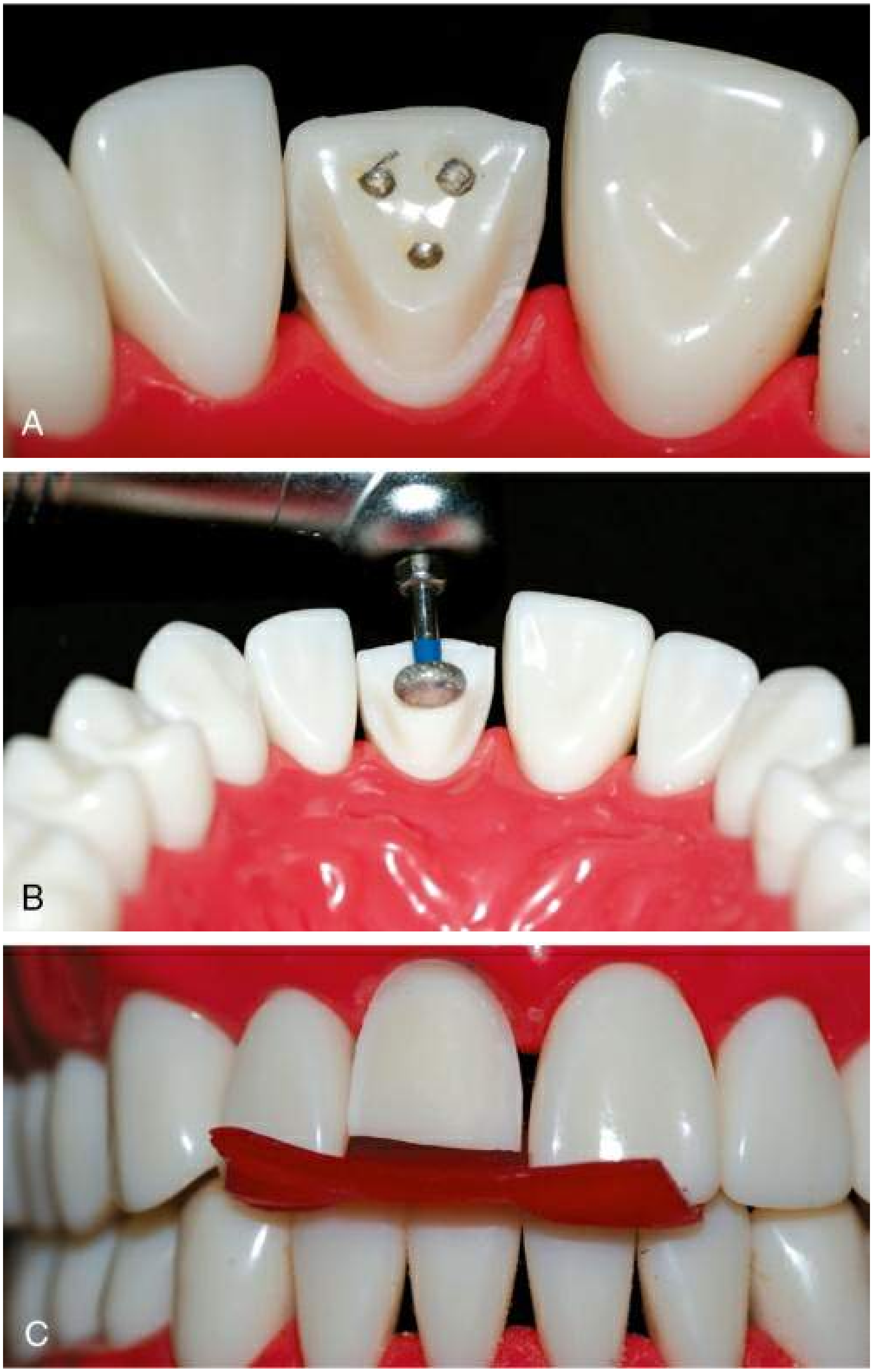


FIGURE 35.57 **(A)** Depth cuts placed on lingual fossa. **(B)** The remaining tooth structure is removed with a wheel diamond. **(C)** Clearance is checked using baseplate wax of 2

mm thickness.

Proximal reduction

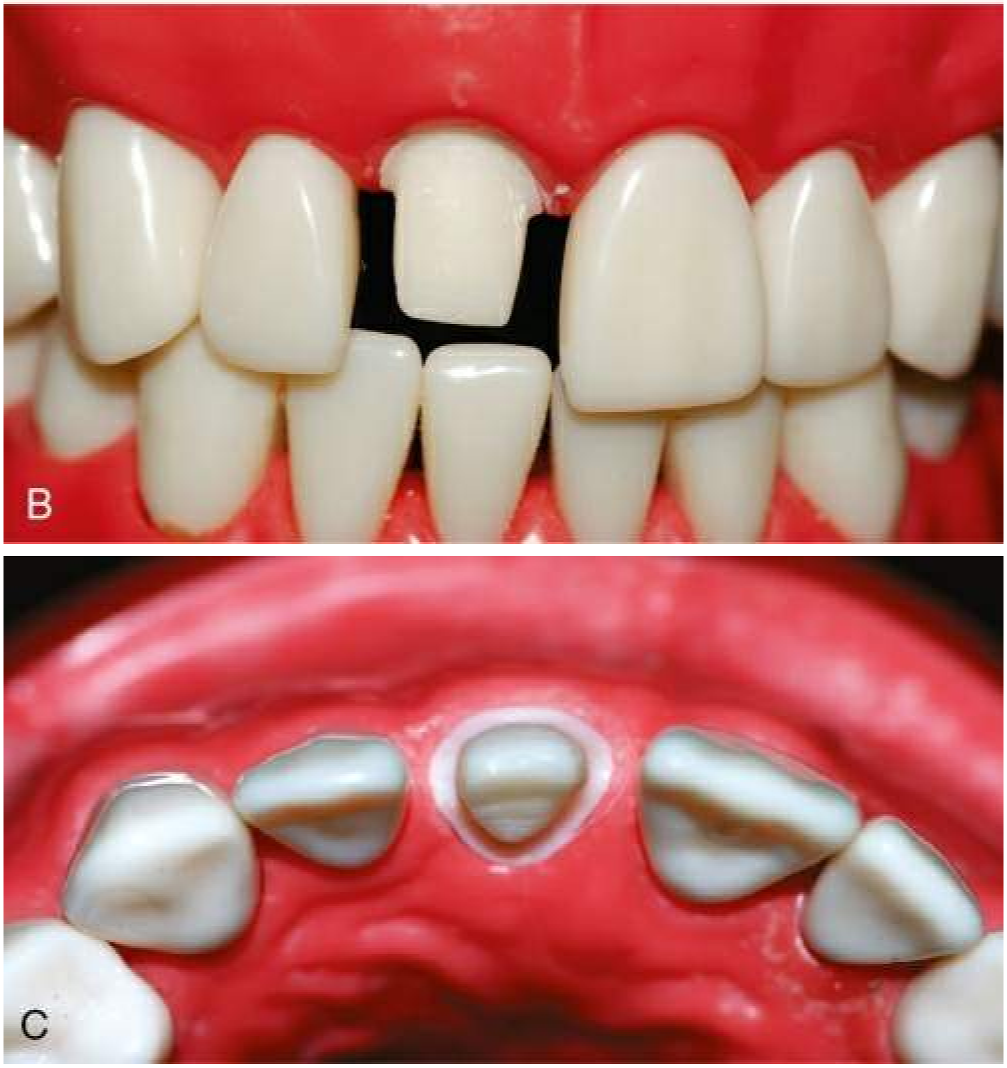
Depth of preparation: 1.5 mm.
Rotary instrument: Long thin tapering diamond/long needle diamond and flat-end tapering diamond.
Procedure:

- Long thin tapering diamond is used to provide access through the proximal surface. The access is prepared using a 'vertical sawing motion' in an incisogingival direction (Fig. 35.58).

- The axial preparation is now continued onto the proximal surface using the flat-end tapering diamond which will produce the shoulder. A taper of 3–5° is produced by the reduced proximal surfaces.

Finishing:
Axial surface is finished using a flat-end tapering fissure bur. The shoulder is finished with an end-cutting diamond where the sides are noncutting and smooth and only the tip has fine diamonds stones (Fig. 35.59A–C).
A heavy chamfer finish line can also be given instead of the shoulder finish line for all-ceramic crowns (Fig. 35.59D). In that case, a 3 mm diameter round-end tapering diamond is used for the axial reductions and the same is finished with a fine grit chamfer diamond/torpedo bur.

FIGURE 35.58 Proximal reduction with thin tapering diamond.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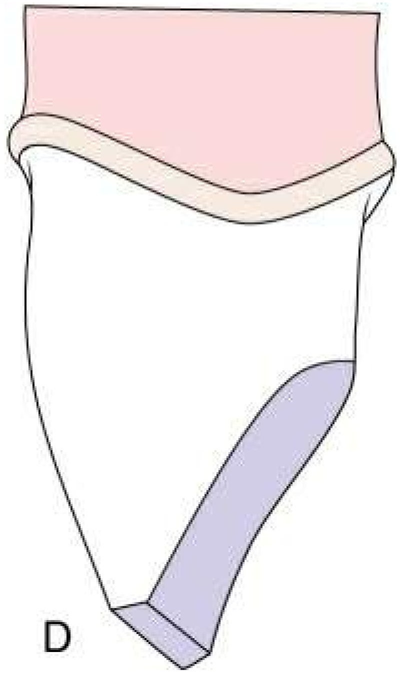


FIGURE 35.59 **(A)** The shoulder is finished with an end-cutting diamond. **(B)** Completed preparation – facial view. **(C)** Completed preparation – incisal view. **(D)** Completed preparation using a heavy chamfer.

Partial veneer crowns/partial-coverage restorations

Definition: A restoration that restores all but one coronal surface of a tooth or dental implant abutment, usually not covering the facial surface (GPT8).

- Commonly buccal/facial surface is left intact for better aesthetics.
- It is called three-quarter crown as traditionally it was used in anterior teeth and it involved preparing three out of four surfaces and incisal edge was not considered. In the posterior teeth it should be called four-fifth crown as it involves preparing a definite occlusal surface.
- It is usually made of cast metal and gold alloys are preferred as they can be burnished.
- It can be used as a single-unit restoration or as a retainer for fixed partial denture.

Advantages

- Conservation of tooth structure.
- Margins are accessible by the patient to maintain and operator to finish.
- Better periodontal response as there is limited contact between the restoration and gingiva.
- Cementation is easy as there is open margin for the excess cement to escape.
- Seating of the restoration can be verified.

- Pulp testing can be performed through the unrestored portion.

Disadvantages

- Lesser retention as compared to full veneers
- There can be some display of metal and it requires high skill to hide the same.
- May not have adequate rigidity as retainer for a fixed prosthesis.
- Tooth preparation more complicated.

Indications

Teeth with:

- Intact or minimally restored coronal tooth structure.
- Normal crown form.
- Average or greater crown length.

Teeth in aesthetic zone where conserving the buccal/facial surface of the tooth will be aesthetically advantageous.

As a retainer for:

- Short-span fixed prosthesis.
- Resin-bonded fixed partial dentures.
- Average or below average occlusal forces.

Contraindications

- Short clinical crown.
- Extensively damaged tooth.

- Endodontically treated tooth.
- Retainer for long-span fixed partial dentures.
- Poorly aligned abutments.
- Dentitions with active caries or periodontal disease.

Partial veneer preparations for posterior teeth on maxillary premolar

Armamentarium

1. Handpiece
2. Round-end tapered diamond
3. Short thin tapering diamond/needle diamond
4. Fine grit Chamfer diamond/torpedo
5. Flat-end tapering fissure bur
6. Flame-shaped diamond and bur
7. Enamel hatchet

Steps in preparation

1. Occlusal reduction
2. Lingual reduction
3. Proximal reduction
4. Proximal groove
5. Facial flare of proximal groove

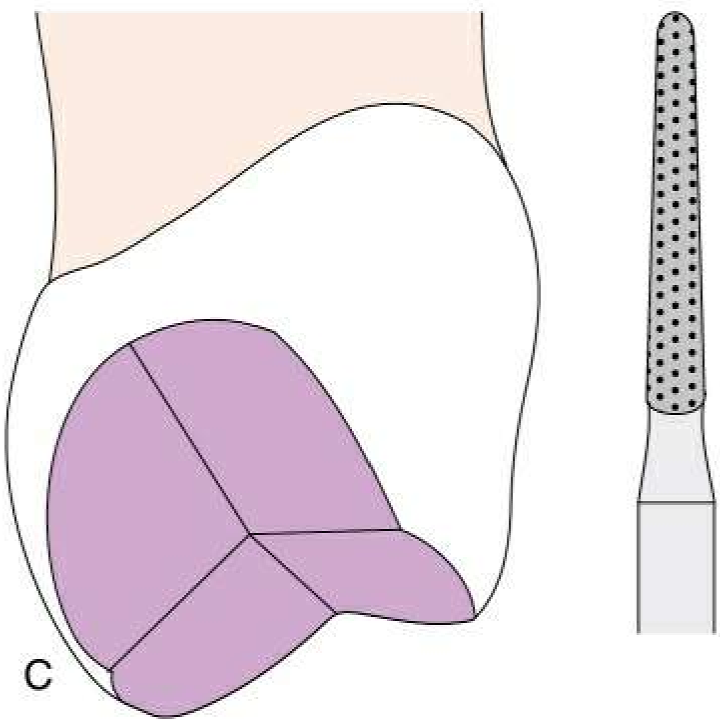
6. Occlusal offset

7. Buccal bevel

1. Occlusal reduction

This prepares the occlusal surface.
Depth of preparation: 1 mm on nonfunctional cusps (buccal) and 1.5 mm on functional cusps (palatal).
Rotary instrument: Round-end tapering diamond.
Procedure:
The depth cuts are placed on the occlusal surface following the anatomic contour of the occlusal surface with round-end tapering diamond (Fig. 35.60A). The depth should be 1 mm on nonfunctional cusps (buccal) and 1.5 mm on functional cusps (palatal). The depth should decrease to 0.5 mm at the occlusobuccal line angle to minimize display of metal.


B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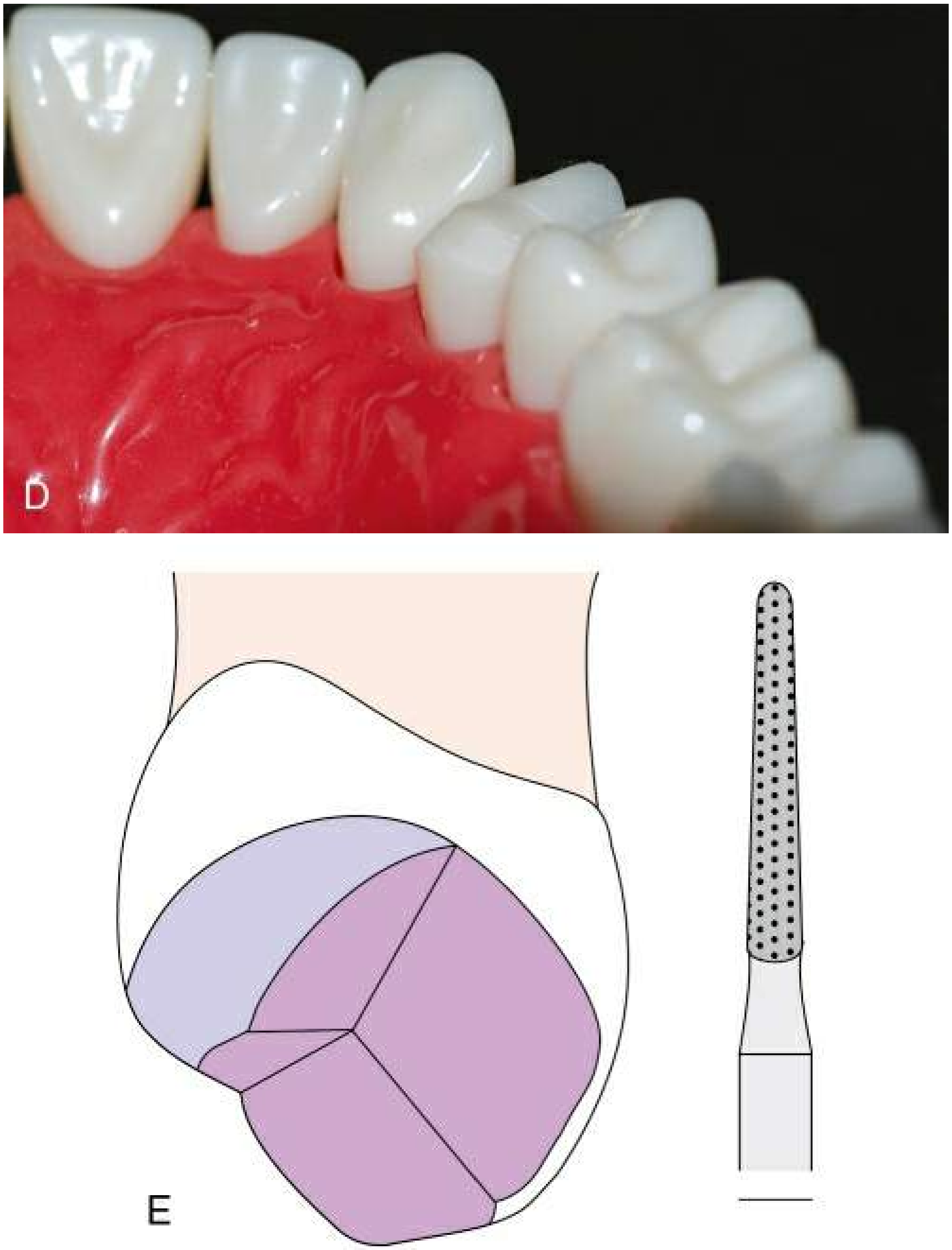


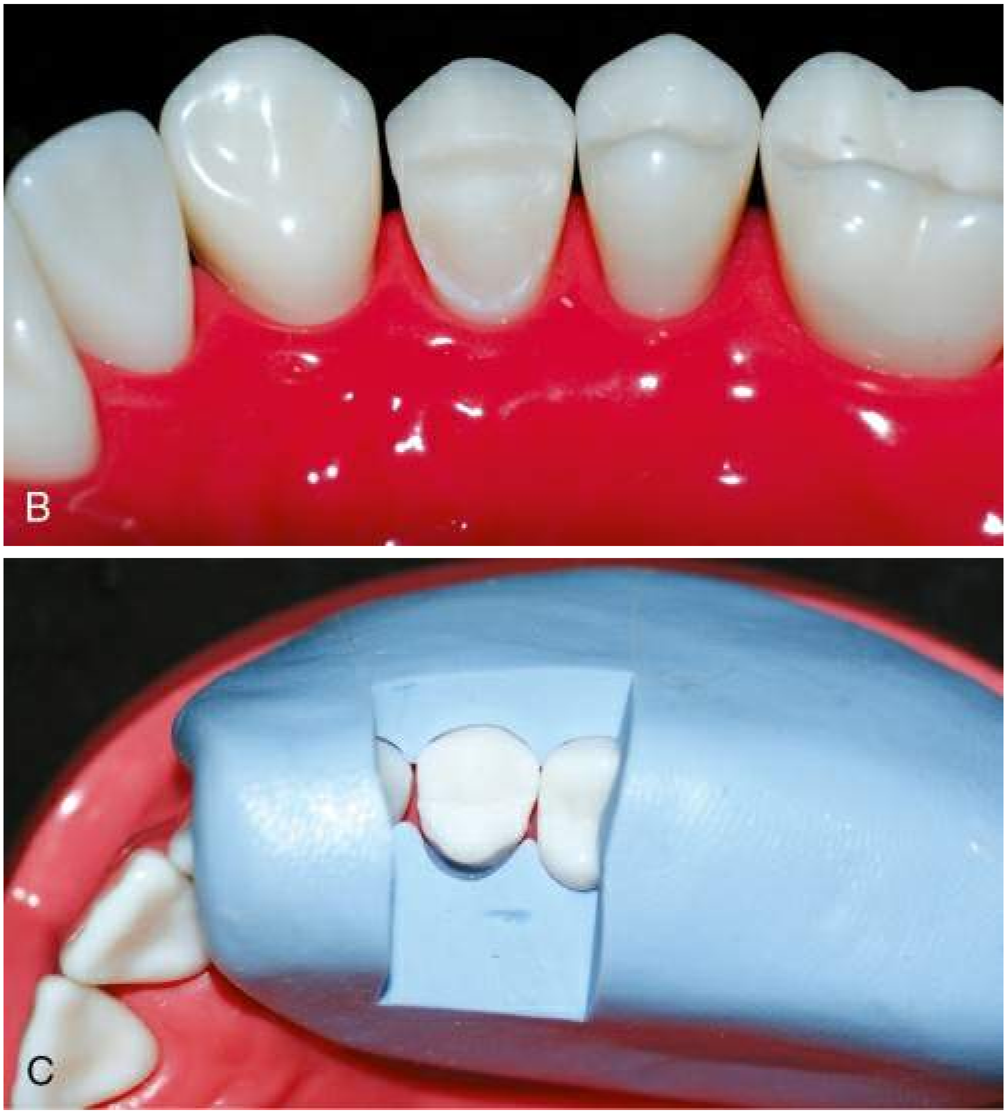
FIGURE 35.60 **(A)** Depth cuts for occlusal reduction. **(B)** Completed occlusal reduction. **(C)** Occlusal reduction using round-end tapering diamond. **(D)** Functional cusp bevel. **(E)** Functional cusp bevel using round-end tapering diamond.

The remaining tooth structure between the depth cuts is then removed uniformly to complete the occlusal reduction (Fig. 35.60B and C).

Functional cusp bevel: A wide bevel is then placed on the functional cusp (palatal) using the round-end tapered diamond. The bevel is desired to be at an angle of 45° and an approximate width of 1.5 mm (Fig. 35.60D and E).
Checking occlusal clearance: This is verified by asking the patient to bite on baseplate wax of appropriate thickness (1.5 mm). Thin spots in wax indicate inadequate clearance and that area is again prepared till clearance is achieved.

2. Lingual reduction

Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Round-end tapering diamond.
Procedure: Depth orientation grooves are placed in the centre of the lingual surface and in the linguoproximal line angles with round-end tapering diamond (Fig. 35.61A). It should be parallel to long axis of the tooth. The remaining tooth structure is removed and preparation is carried into the proximal embrasure producing a chamfer finish line (Fig. 35.61B–D).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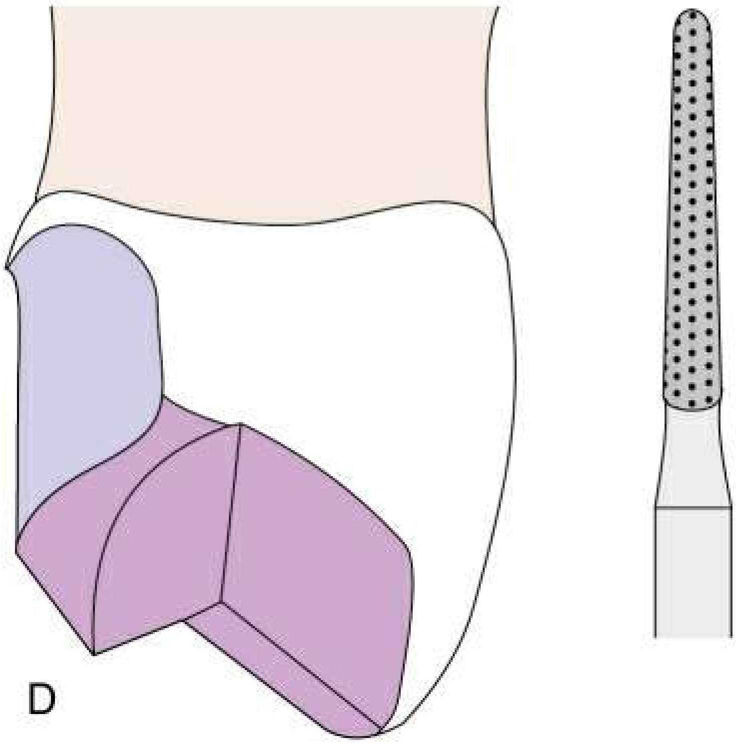


FIGURE 35.61 **(A)** Depth cuts placed in the centre of the lingual surface. **(B)** The remaining tooth structure is removed and chamfer finish line is given. **(C)** Preparation verified with putty index. **(D)** Lingual reduction completed using round-end tapering diamond bur.

3. Proximal reduction

Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Thin tapering diamond/needle diamond and round-end tapering diamond.
Procedure:

- The proximal contacts are first broken using a thin tapering diamond in a vertical sawing motion.
- The round-end tapering diamond is used to then prepare the surface producing a chamfer finish line (Fig. 35.62A and B).
- The gingivofacial angle of the preparation should not be underextended as this can cause failure of restoration.

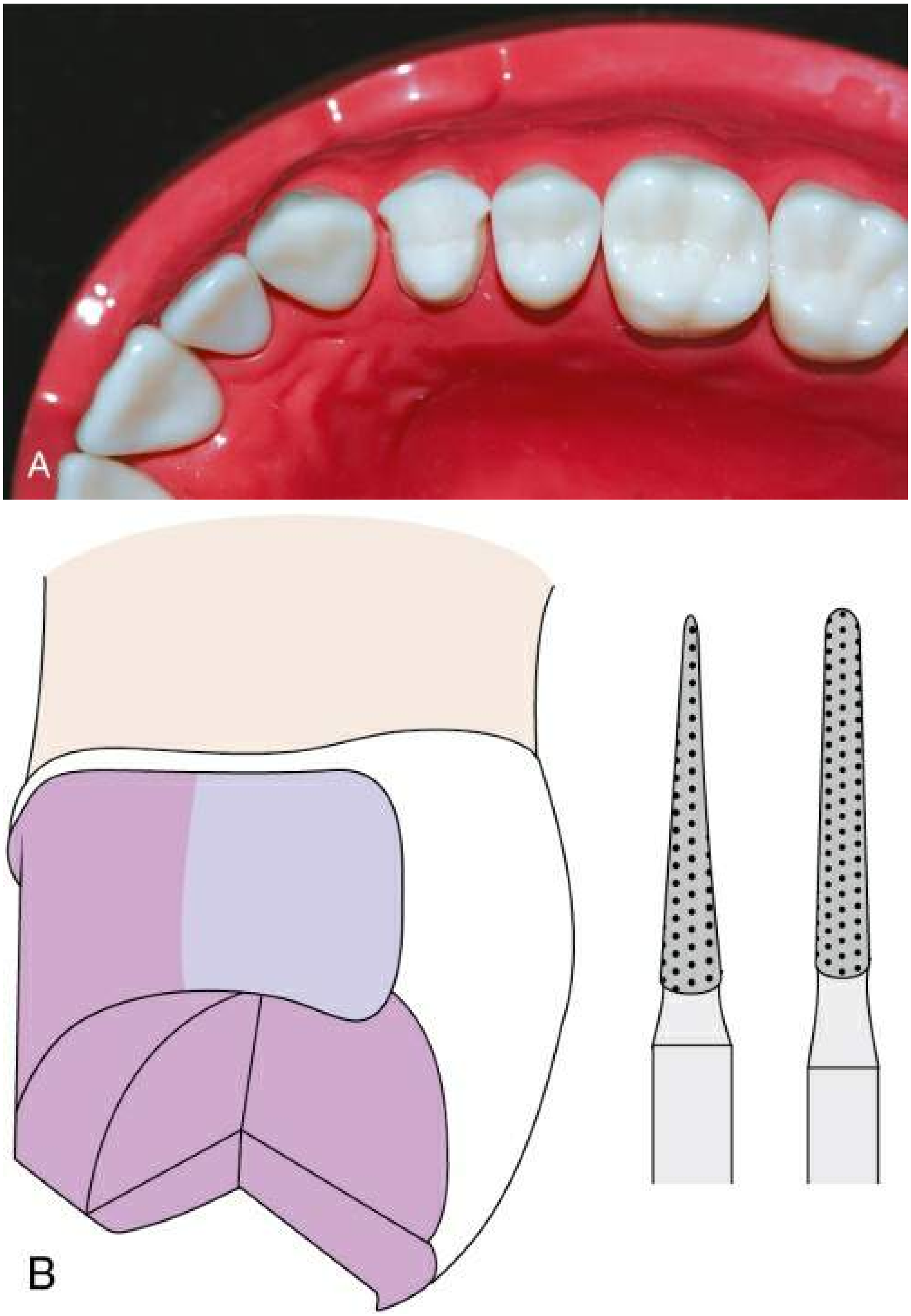


FIGURE 35.62 **(A)** Completed proximal reduction. **(B)** Proximal reduction using thin tapering diamond followed by round-end tapering diamond.

4. Proximal groove

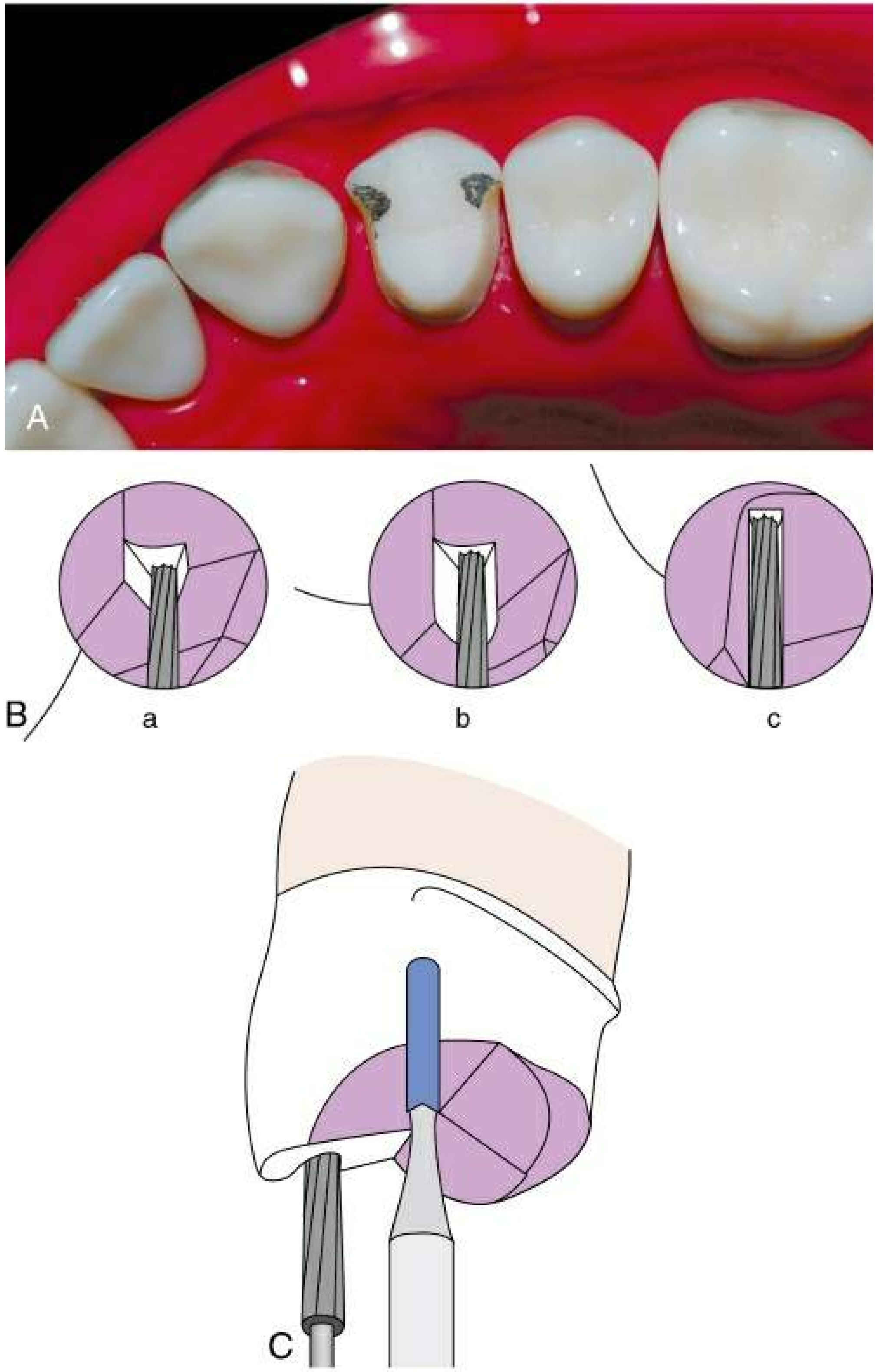
Depth: 0.3–0.5 mm cervically after proximal reduction.
Width: 1 mm.
Angulation: Parallel to path of insertion.
Rotary instrument: 1 mm diameter flat-end tapering fissure bur.
Procedure:

- They are placed mesially and distally in the facial half of the crown, parallel to path of insertion or long axis of the tooth. It should be 0.3–0.5 mm deep and should terminate cervically at the beginning of chamfer. Faciolingual width should be 1 mm. They are designed to create a definite lingual wall that resists lingual displacement.

- The outline form of the groove is first drawn with a sharp pencil (Fig. 35.63A). It is then prepared in stages starting with a 1 mm deep cut, extending to half its length and then finishing to its full length after verifying the alignment and shape (Fig. 35.63B). The cutting instrument used is a flat-end tapering diamond with a tip diameter of 0.8 mm.

- The second groove on the other proximal surface is placed using first as a guide to maintain parallelism. A bur may be held in the first groove using baseplate wax to act as a paralleling guide (Fig. 35.63C).

- In general the more important or difficult groove is prepared first like distal surface of molars and mesial surface of premolars (aesthetics). A problem in this first groove can be rectified by aligning the second groove from a more accessible area or without affecting aesthetics. The completed grooves are shown in Fig. 35.63D and E.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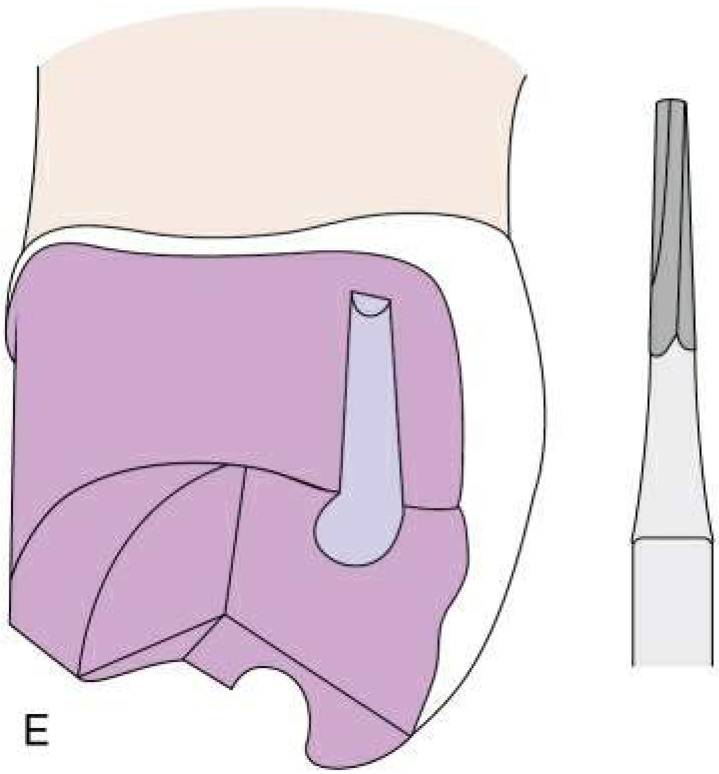


FIGURE 35.63 **(A)** Proximal groove outline is drawn with pencil. **(B)** Groove is prepared in stages. **(C)** Second groove is placed parallel to the first groove. **(D)** Completed proximal groove. **(E)** Proximal groove prepared using a flat-end tapering fissure bur.

5. Facial flare of proximal groove

- The facial surface of the groove is flared (prepared in a flat plane) to meet the labial surface of the tooth (Fig. 35.64A–C).
- Flaring is done with a flame-shaped diamond using short, crisp strokes in an outward direction and finished with a bur of similar shape (Fig. 35.64B).
- When facial extension is critical for aesthetics, enamel chisel is used for flaring.
- Purpose of flaring:

  - Smooths facial wall of groove.
  - Eliminates lip of enamel in contact with adjacent tooth.
  - Creates a facial margin that meets the unprepared tooth structure at 90°.

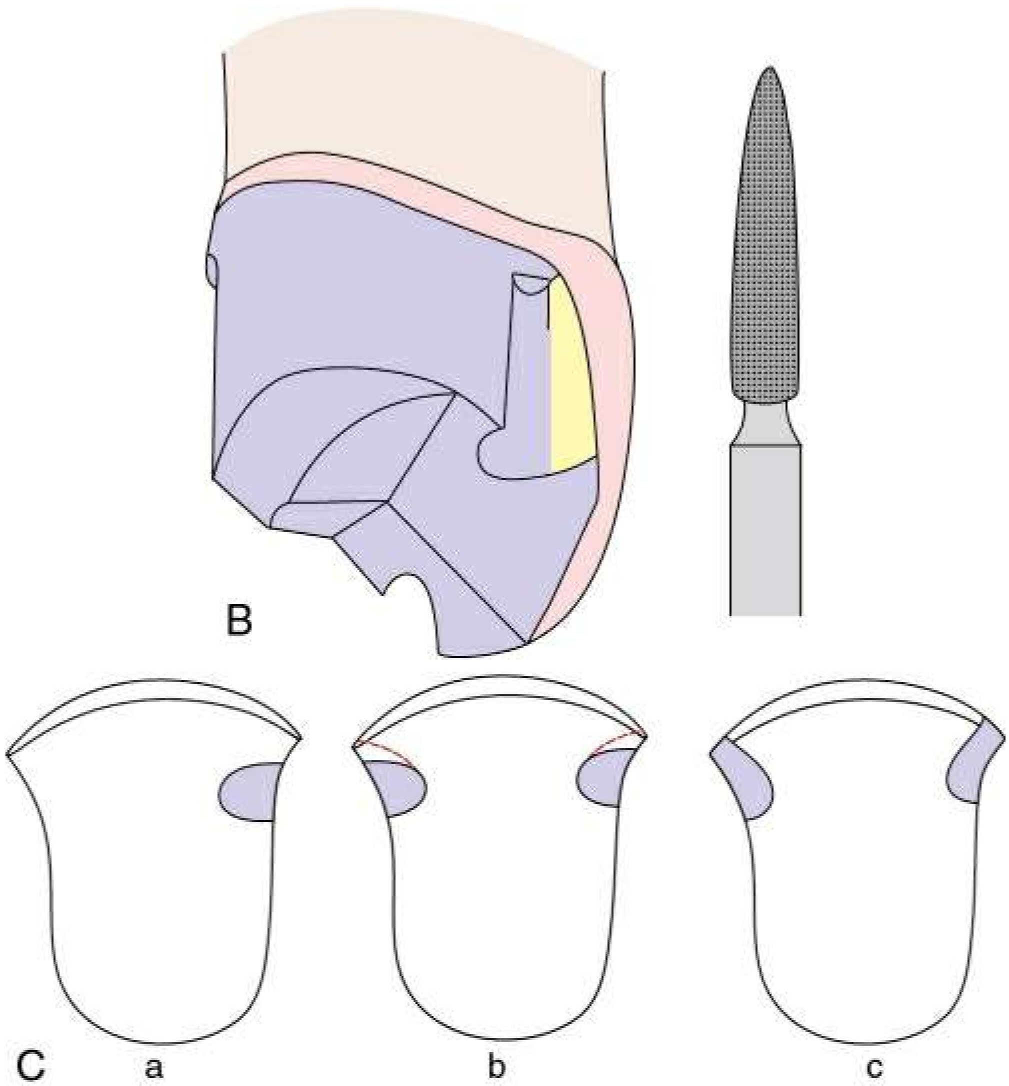


FIGURE 35.64 **(A)** Flaring of the facial groove. **(B)** Proximal groove with flare completed with flame-shaped bur. **(C)** (a) Before flaring of the groove, (b) outlined, (c) after flaring of the groove.

6. Occlusal offset

Depth: 0.3–0.5 mm lingually, tapers out facially.
Width: 1 mm.
Angulation: 90° to lingual surface.
Rotary instrument: 1 mm diameter flat-end tapering fissure bur.
Procedure:

- It is an 'inverted V-shaped' ledge, 1 mm wide, placed on the lingual incline of facial cusp. Joins the two proximal grooves and lies at a uniform distance from finish line labially.
- It is prepared using a flat-end tapering fissure bur (Fig. 35.65A and B).
- It increases the resistance form by providing bulk which prevents distortion of restoration (structural durability).

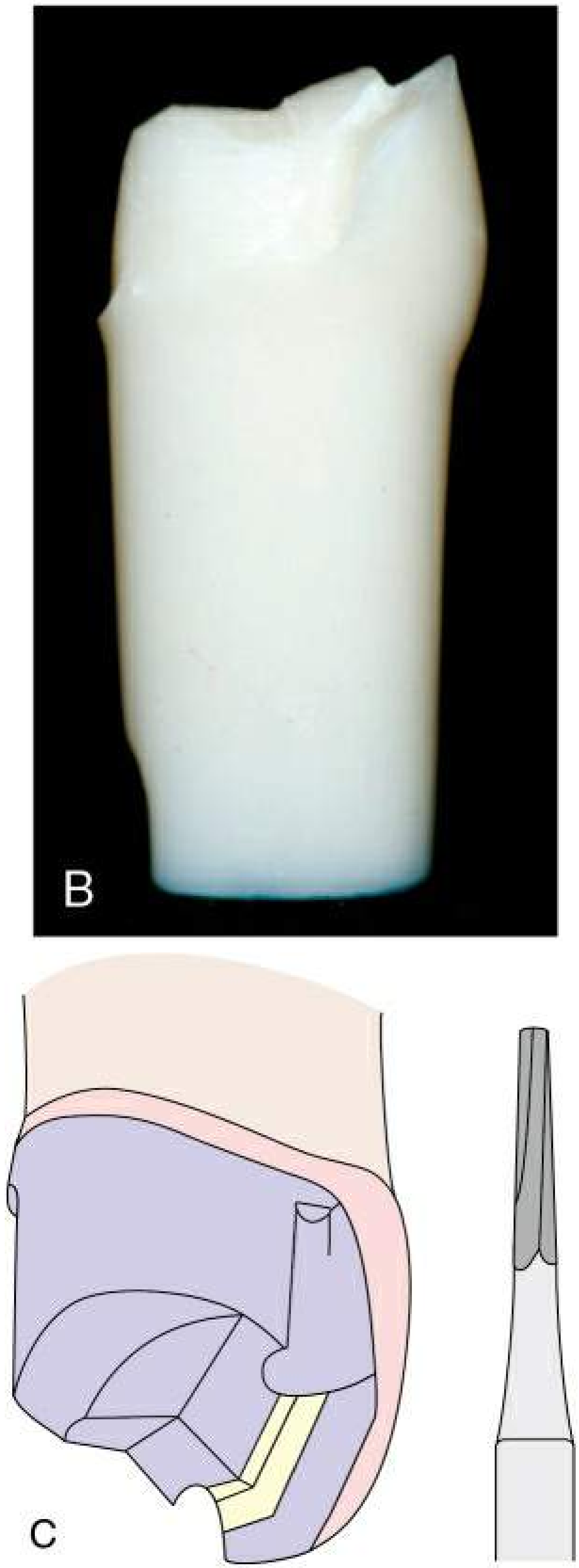


FIGURE 35.65 **(A)** An inverted V-shaped ledge placed on the

lingual incline of facial cusp. **(B)** Occlusal offset completed. **(C)** Occlusal offset prepared with flat-end tapering fissure bur.

7. Buccal bevel

Width: 0.5 mm.
Rotary instrument: Flame-shaped diamond.
Procedure:

- A 0.5 mm bevel is placed on the bucco-occlusal finish line perpendicular to the path of insertion.
- It is prepared using a flame-shaped diamond.
- It extends over the mesial and distal corners and blends into the proximal flares (Fig. 35.66A and B).

Finishing:

- Axial surface – fine grit chamfer diamond/torpedo bur.
- Occlusal surface – flat-end tapering fissure bur.
- Occlusal offset – end-cutting diamond.

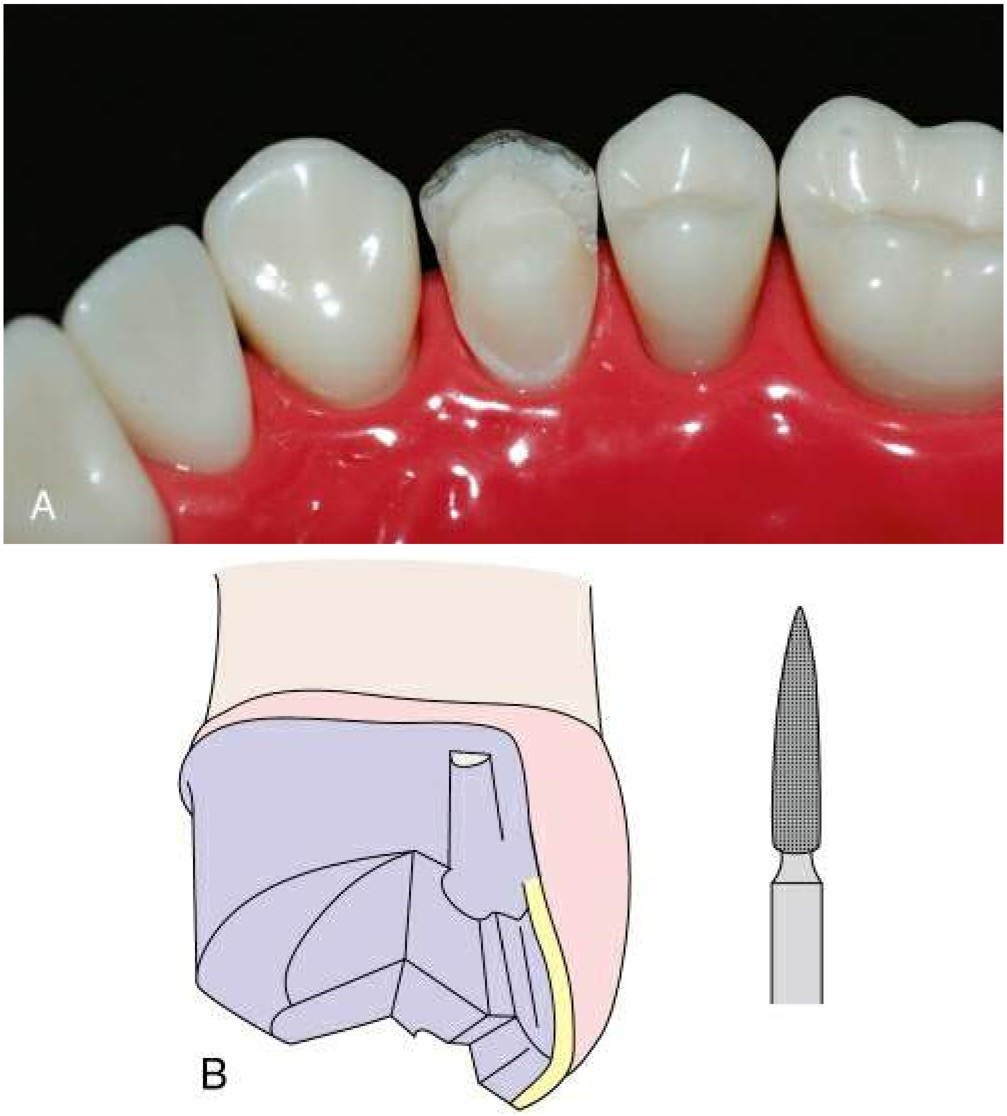


FIGURE 35.66 **(A)** Bevel of 0.5 mm is placed on the bucco-occlusal finish line. **(B)** Buccal bevel placed with flame-shaped diamond bur.

Modifications of posterior partial veneer crown

Depending upon the tooth and its angulations, there are various modifications that can be incorporated in a posterior partial veneer crown preparation:

Partial veneer crown with proximal boxes

- Proximal boxes may be used instead of proximal grooves in case the proximal surfaces of the tooth are extensively damaged or if the restoration demands additional retention (Fig. 35.67).
- They are less conservative and hence not preferred.

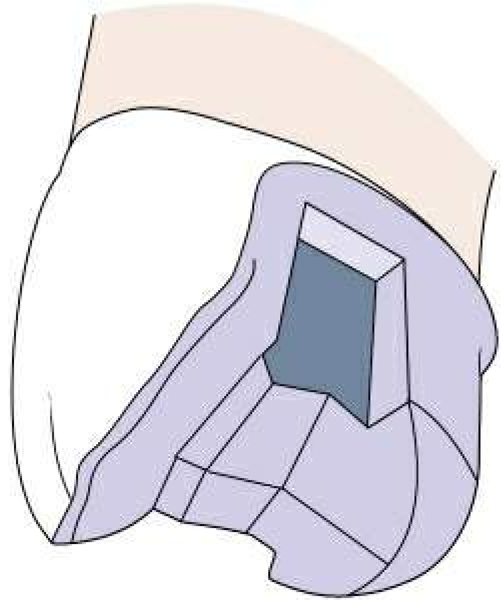


FIGURE 35.67 Proximal box placed instead of a groove.

Features

Depth: 0.5 mm after proximal reduction, total 0.8–1 mm.
Width: 1.3–1.7 mm.
Form: Tapered occlusally 3–5°.
Location: In facial half of the crown.
Angulation: Parallel to the path of insertion.
Rotary instrument: 1 mm diameter flat-end tapering fissure bur.

Partial veneer crown for mandibular posteriors

This preparation varies from the preparation for maxillary posteriors in the following aspects:

- The buccal cusps should be covered by the restoration as it is the functional cusp. Hence, an occlusal finish line is placed on the facial surface, cervical to the occlusal contact.

- Occlusal shoulder is prepared on the buccal incline of the buccal cusps connecting the proximal grooves and providing strength to the restoration, and not on the lingual inclines (Fig. 35.68).

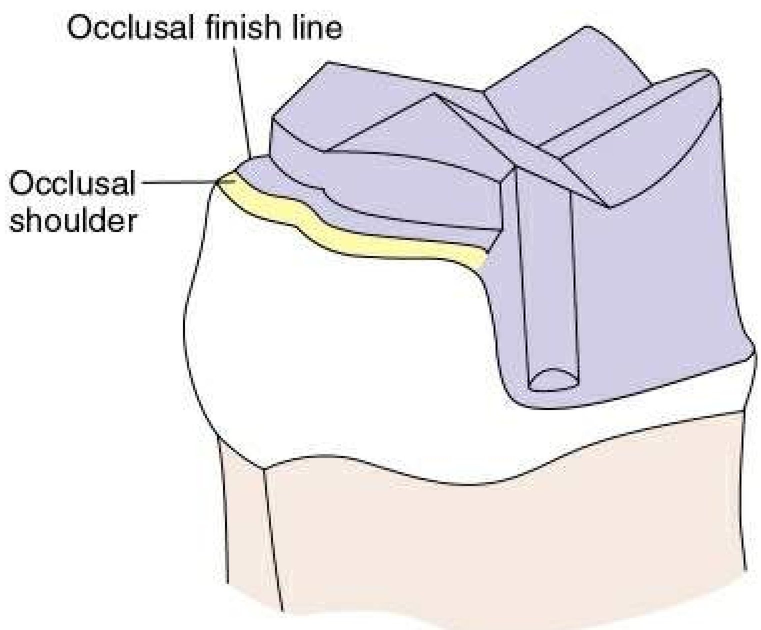


FIGURE 35.68 Mandibular posterior three-fourth crown.

Reverse three-quarter crown

- It is a partial veneer crown that does not cover the lingual surface instead of buccal.

- Indicated as a retainer for fixed partial dentures when the abutment has severe lingual inclination. A full veneer crown in this situation would need extensive preparation and the reverse three-fourth crown will be more conservative.

- Proximal grooves are placed at the linguoproximal line angles and occlusal offset is placed on the buccal incline of lingual cusp (Fig.

35.69).

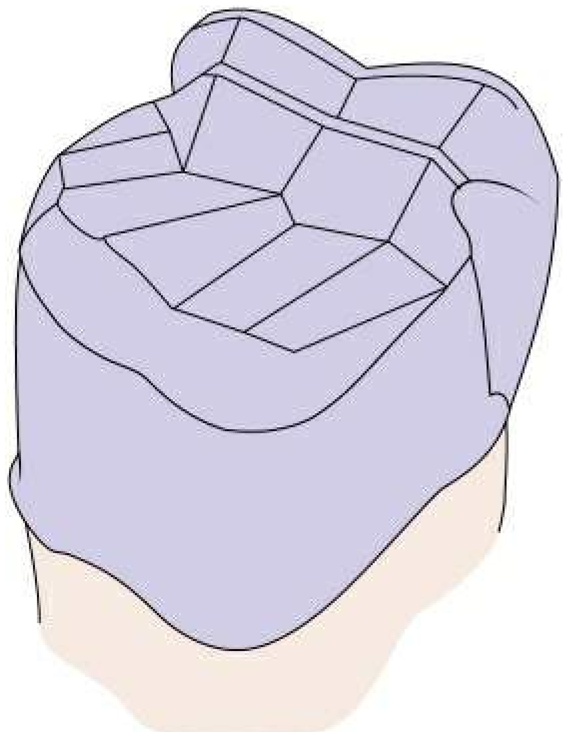


FIGURE 35.69 Reverse three-fourth crown. Proximal grooves are placed at the linguoproximal line angles and occlusal offset is placed on the buccal incline of lingual cusp.

Seven-eighths crown

- All surfaces except half of buccal surface (usually mesiobuccal cusp) are covered by the restoration (Fig. 35.70A–C).
- It is usually used in maxillary molars but can also be employed in mandibular molars and premolars.
- It is indicated when the distal buccal cusp or distal aspect of buccal surface must be covered due to the presence of any restoration, caries, decalcification or fracture.
- It is also aesthetically acceptable as intact mesiobuccal cusp hides

the distobuccal cusp.

- It has much better retention than a three-fourth crown and is used instead of the three-fourth crown as a retainer for fixed partial denture when short clinical crown height and when span exceeds one pontic.

- The two grooves are placed – one in the centre of facial surface and other in the buccoproximal line angle mesially, and they are joined by an occlusal offset.

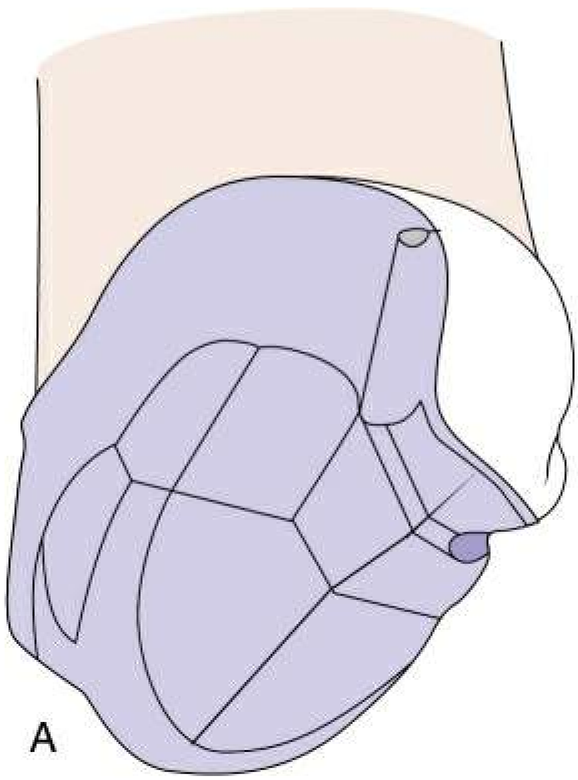


FIGURE 35.70 **(A)** The two grooves are placed – one in the centre of facial surface and other in the buccoproximal line angle mesially, and they are joined by an occlusal offset. **(B)** Completed seven-eighths crown preparation. **(C)** Restored seven-eighths crown.

Proximal half crown

- It is a partial veneer crown that does not cover the distal part of the tooth.
- It is indicated in mesially tilted mandibular molars. It can be used only in patients with excellent oral hygiene and low caries incidence. Distal surface must be caries free.
- Preparation parallels the mesial abutment (also see Fig. 33.49 in Chapter 33).
- Occlusal reduction gives a clearance of 1.5 mm and terminates on distal marginal ridge. As the mesial cusps are already below the occlusal plane, they require little or no reduction.
- Grooves are placed parallel to the path of insertion, on the distal end of buccal and lingual surface and connected by the occlusal offset.
- An occlusal isthmus (like an inlay preparation) enhances the retention and rigidity.
- A countersink on the distal fossa resists mesial displacement (Fig. 35.71).

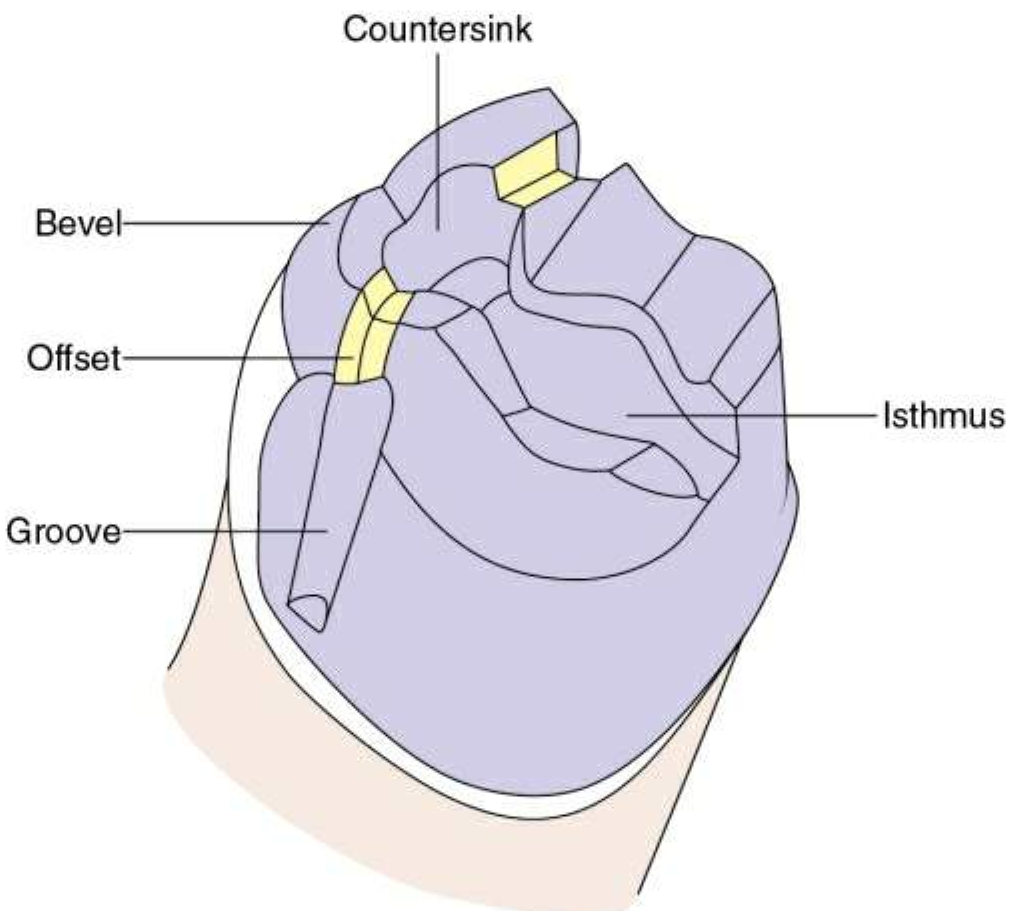


FIGURE 35.71 Proximal half crown.

Anterior partial veneer crowns

- Preparation does not involve the facial surface of the tooth.
- Preparation design differs from posterior partial veneers as given below:

○ The path of insertion of the restoration must be parallel to the incisal one-third to two-third of the labial surface of the tooth and not long axis of axial surface. This requires slight lingual inclination of the grooves.

○ The proximal extensions must be made carefully using thin diamonds and hand instruments to minimize metal display.

Partial veneer preparations for anterior teeth – maxillary canine

Armamentarium

1. Airotor handpiece

2. Round-end tapered diamond

3. Short thin tapering diamond/needle diamond

4. Fine grit chamfer diamond/torpedo

5. Flat-end tapering fissure bur

6. Flame-shaped diamond and bur

7. Enamel hatchet

Step-by-step procedure

The steps in preparation of an anterior crown for a partial veneer restoration are as follows:

1. Incisal reduction

2. Lingual reduction

    i. Lingual fossa

    ii. Lingual axial

3. Proximal reduction

i. Proximal groove and flare

4. Incisal offset

5. Incisal bevel

1. Incisal reduction

Depth of preparation: 0.7 mm at linguoincisal junction.
Rotary instrument: Round-end tapering diamond.
Procedure:

- It follows the contour of the incisal edge maintaining a flat plane for incisors and mesial and distal inclines for canines.
- The depth of the reduction is 0.7 mm at the linguoincisal junction and tapers to barely break through the labioincisal line angle (Fig. 35.72A and B).

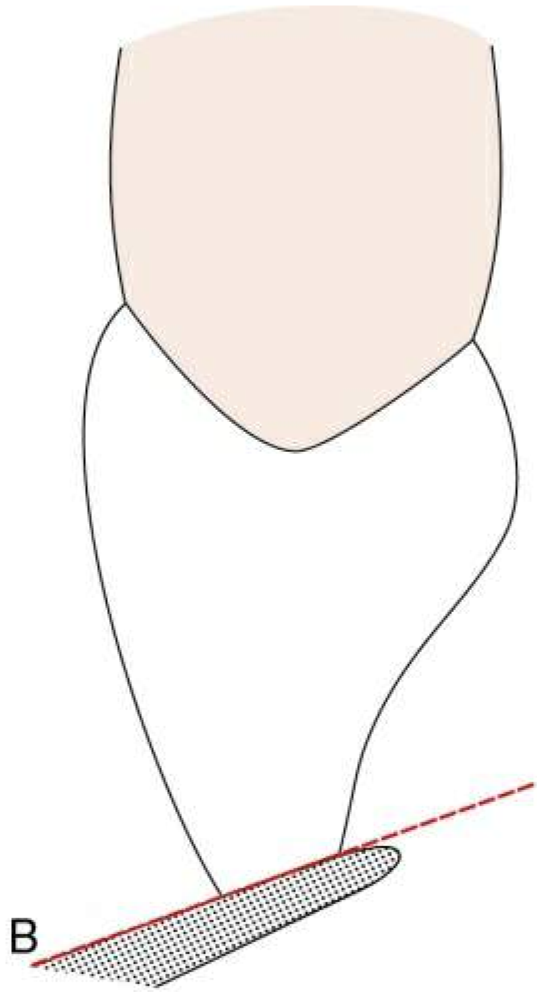


FIGURE 35.72 **(A)** Incisal reduction of depth 0.7 mm at linguoincisal junction. **(B)** Incisal reduction at linguoincisal junction.

2. Lingual reduction

This can be divided into two parts:

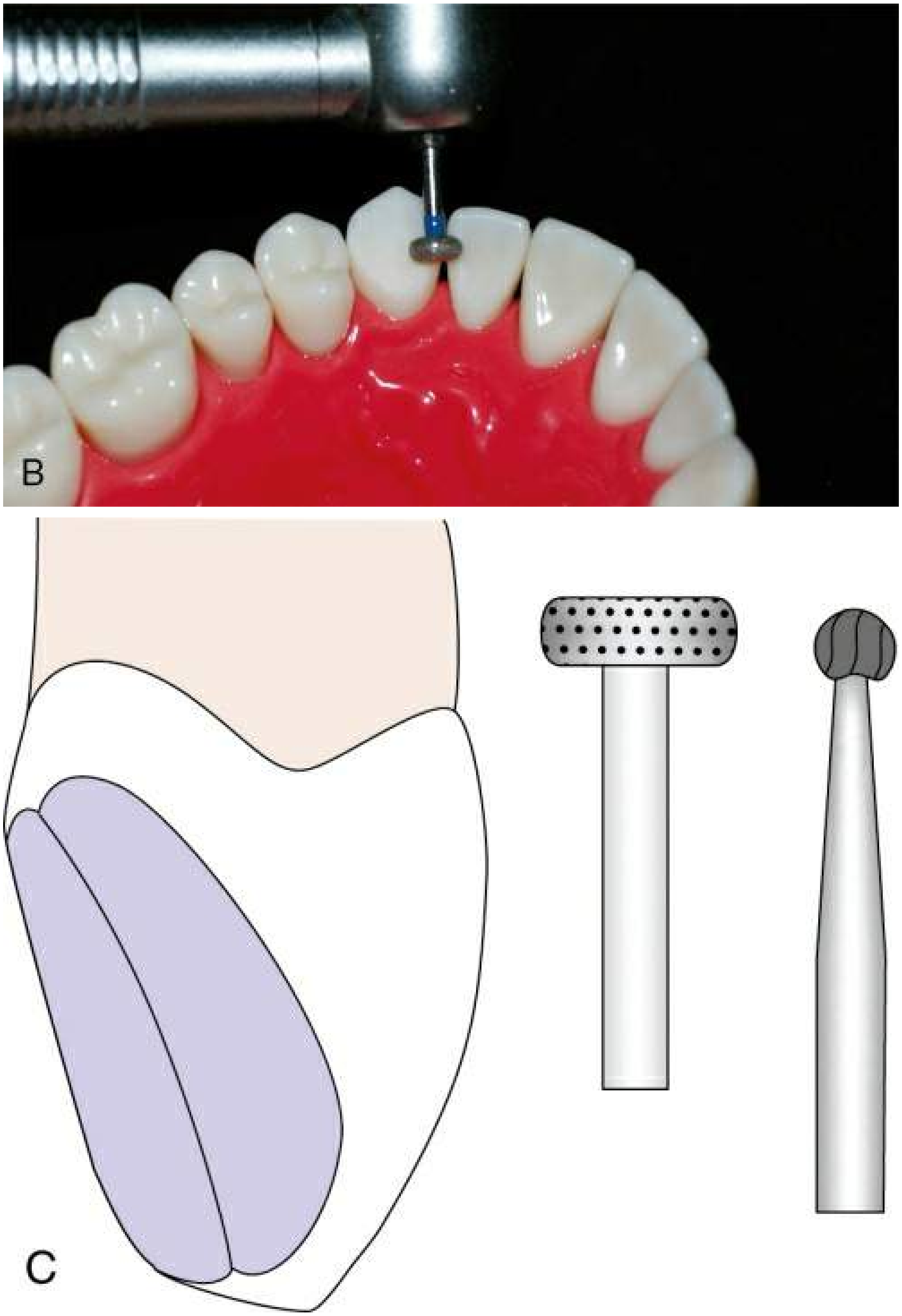
Lingual fossa reduction

Depth of preparation: 0.8–1 mm.
Rotary instrument: No. 2 round bur and wheel diamond/football diamond.
Procedure:

- Depth cuts like pot holes are placed on the lingual fossa with a No. 2

round bur which has a diameter of 1 mm. The entire bur is sunk in (Fig. 35.73A).

- The remaining tooth structure is removed with a wheel diamond or a football diamond (Fig. 35.73B).
- Preparation must follow the anatomic planes. Hence, a slight ridge will be seen for canines along the centre of the surface running incisocervically (Fig. 35.73C).
- Overpreparation of cingulum will shorten the lingual axial wall decreasing retention.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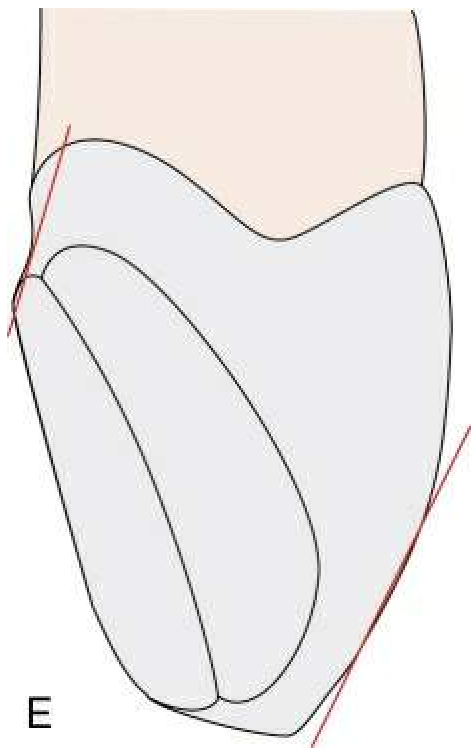
D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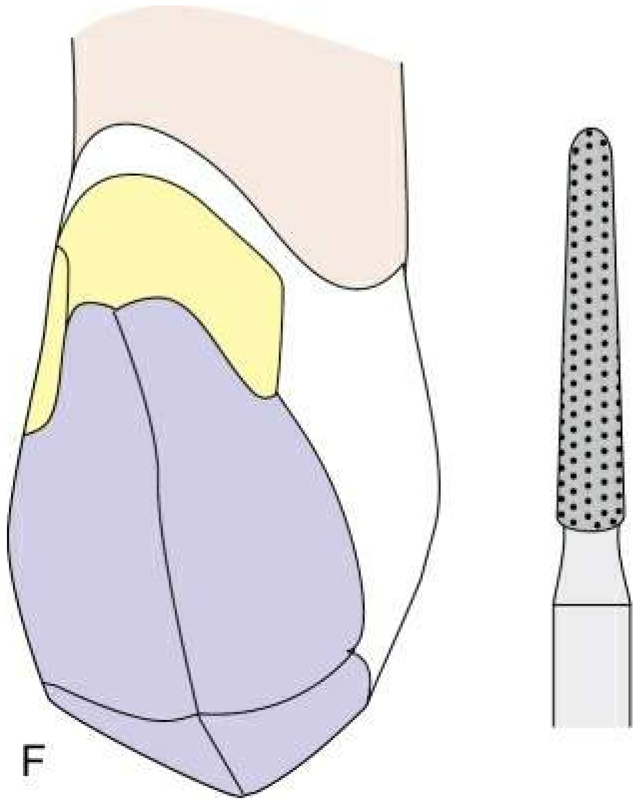


FIGURE 35.73 **(A)** Depth cuts are placed on the lingual fossa of 1 mm diameter. **(B)** Remaining tooth structure removed. **(C)** Lingual fossa reduction completed following anatomic planes using round bur and wheel diamond. **(D)** Lingual axial reduction completed with round-end tapering diamond. **(E)** The prepared cervical portion should be parallel to the path of insertion – incisal two-thirds of labial surface. **(F)** Lingual axial reduction using roundend tapering diamond.

Lingual axial reduction

Depth of preparation: 0.3–0.5 mm.
Rotary instrument: Round-end tapering diamond.
Procedure:

- This prepares the cervical portion of the lingual surface. It should be parallel to the path of insertion – incisal two-thirds of the labial surface.

- Maintaining this angle, a round-end tapering diamond is used to prepare the surface producing a chamfer finish line and is extended to the proximal line angles (Fig. 35.73D–F).

- In case of teeth with short lingual axial wall, a shoulder with bevel or a pinhole at the cingulum can be incorporated to improve retention.

3. Proximal reduction

Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Thin tapering diamond/needle diamond and round-end tapering diamond.
Procedure:
A long thin tapering diamond is used in a vertical sawing motion to create space for the proximal reduction up to the contact point. The contact should be broken with an enamel hatchet and not the diamond.

The round-end tapering diamond is then used to prepare the surface producing a chamfer finish line (Fig. 35.74A and B).

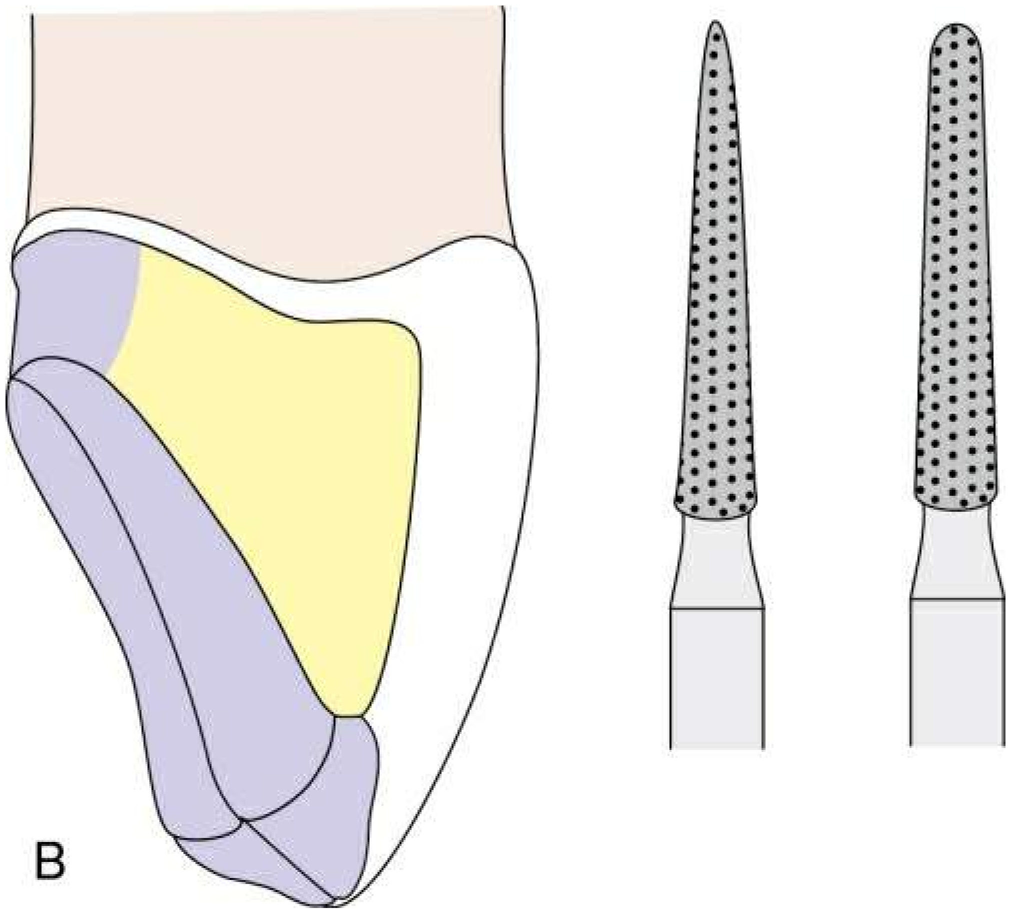


FIGURE 35.74 **(A)** Proximal reduction completed with round-end tapering diamond and a chamfer finish line given. **(B)** Proximal reduction completed with round-end tapering diamond.

i. Proximal groove

Depth: 0.3–0.5 mm cervically after proximal reduction.
Width: 1 mm.
Angulation: Parallel to the path of insertion.
Rotary instrument: 1 mm diameter flat-end tapering fissure bur.
Procedure:

- They are placed mesially and distally in the facial half of the crown, parallel to the path of insertion which is ideally parallel to the incisal two-thirds of the labial surface.

- It should be 0.3–0.5 mm deep and should terminate cervically at the beginning of the chamfer. Faciolingual width should be 1 mm. They are designed to create a definite lingual wall that resists lingual displacement (Fig. 35.75).
- The grooves are prepared by a flat-end tapering fissure bur using a template and procedure similar to that described for posterior three-fourth crowns.

FIGURE 35.75 A proximal groove placed mesially and distally in the facial half of the crown.

ii. Facial flare of proximal groove

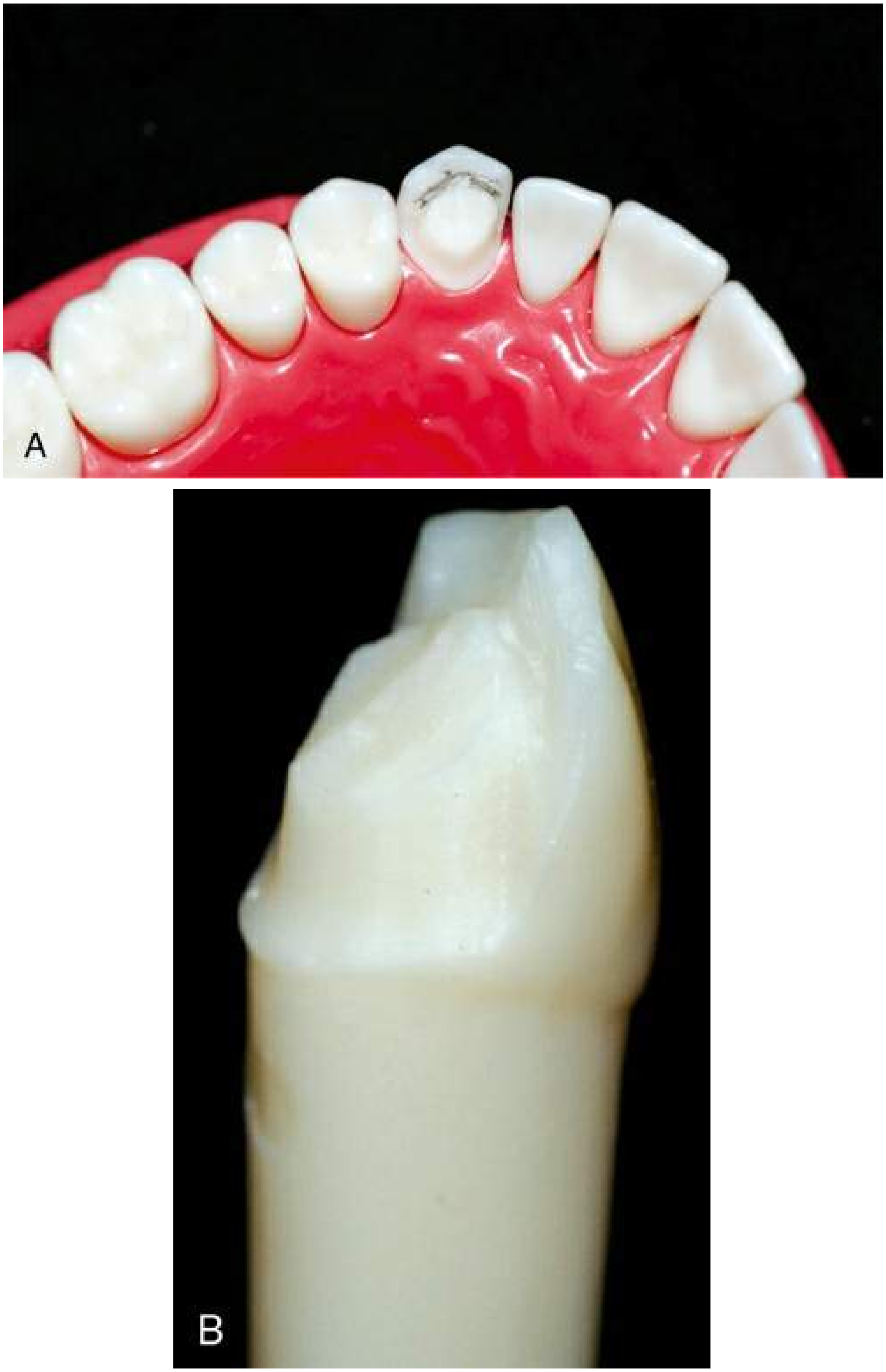
- The facial surface of the groove is flared (prepared in a flat plane) to meet the labial surface of the tooth (Fig. 35.76).
- Flaring is done with a flame-shaped diamond using short, crisp strokes in an outward direction and finished with a bur of similar shape.
- When facial extension is critical for aesthetics, enamel chisel is used for flaring.

FIGURE 35.76 Proximal groove with facial flaring.

4. Incisal offset

It is also referred to as *incisal groove*.
Depth: 0.3–0.5 mm lingually, tapers out facially.
Width: 1 mm.
Angulation: 90° to lingual surface.
Rotary instrument: 1 mm diameter flat-end tapering fissure bur.
Procedure:

- It is an 'inverted V-shaped' ledge, 1 mm wide, placed on the lingual incline of facial cusp. Joins the two proximal grooves and lies at a uniform distance from finish line labially. Hence, on canine it will form a 'V' but on incisors it will be a straight line.
- It is prepared using a flat-end tapering fissure bur (Fig. 35.77A–C).
- It increases the resistance form by providing bulk which prevents distortion of restoration (structural durability).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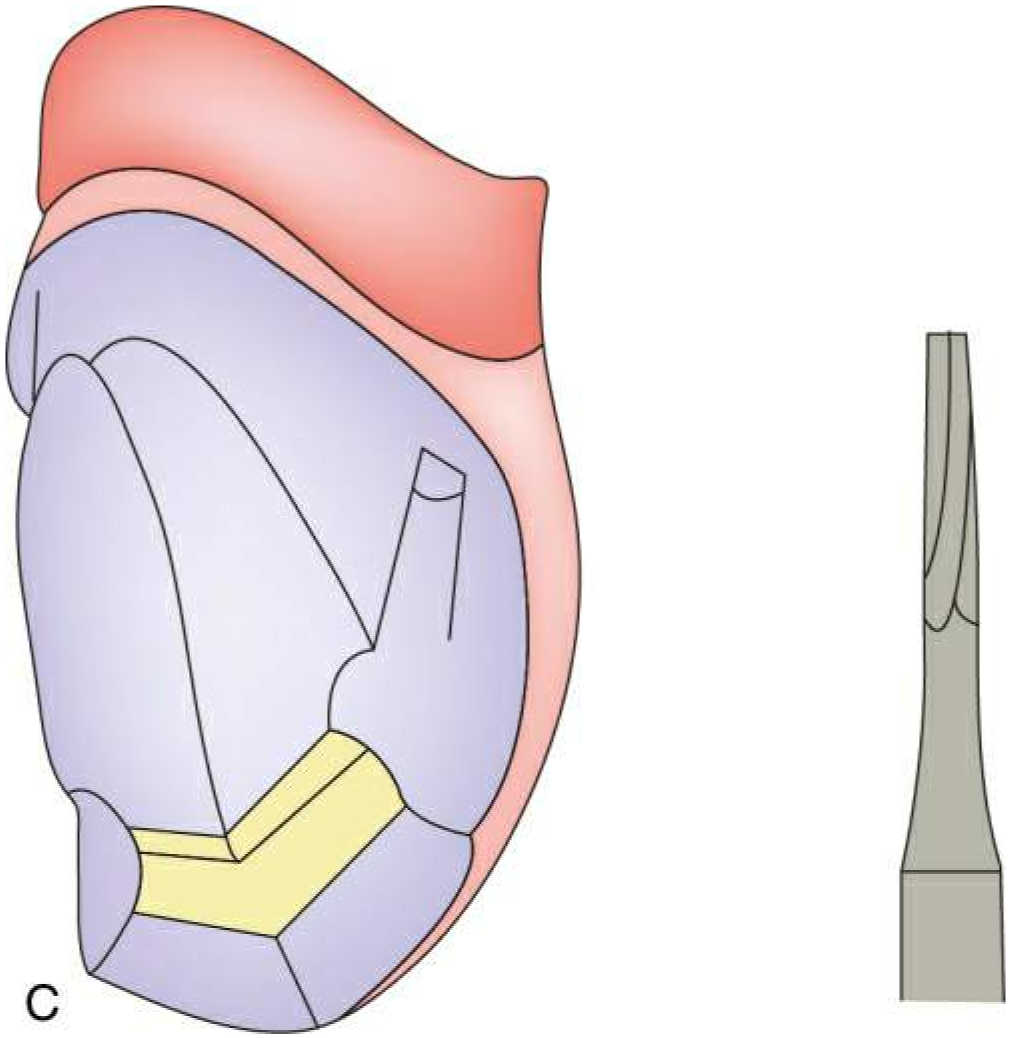


FIGURE 35.77 A–C Incisal offset – prepared with flat-end tapering fissure bur.

5. Incisal bevel

Width: 0.5 mm.
Rotary instrument: Flame-shaped diamond.
Procedure:

- A 0.5 mm bevel is placed on the bucco-occlusal finish line perpendicular to the path of insertion on mesial incline.
- It is prepared using a flame-shaped diamond.
- It extends over the mesial and distal corners and blends into the

proximal flares (Fig. 35.78A and B).

Finishing:

- Axial surface – fine grit chamfer diamond/ torpedo bur.
- Incisal offset – end-cutting diamond.

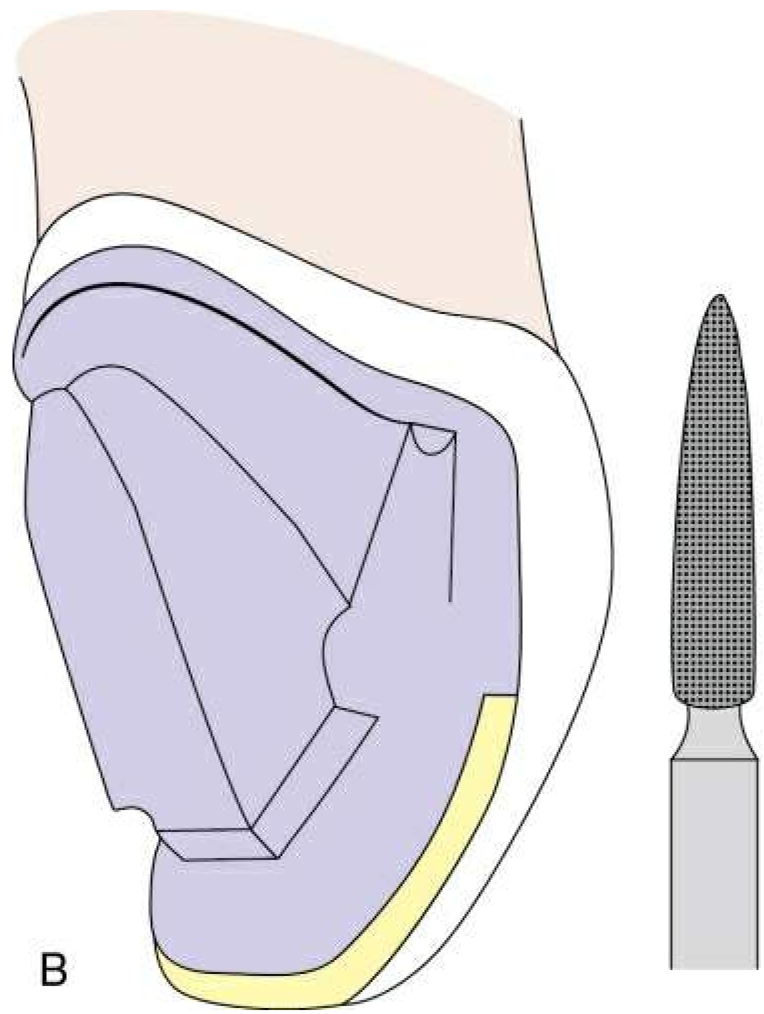
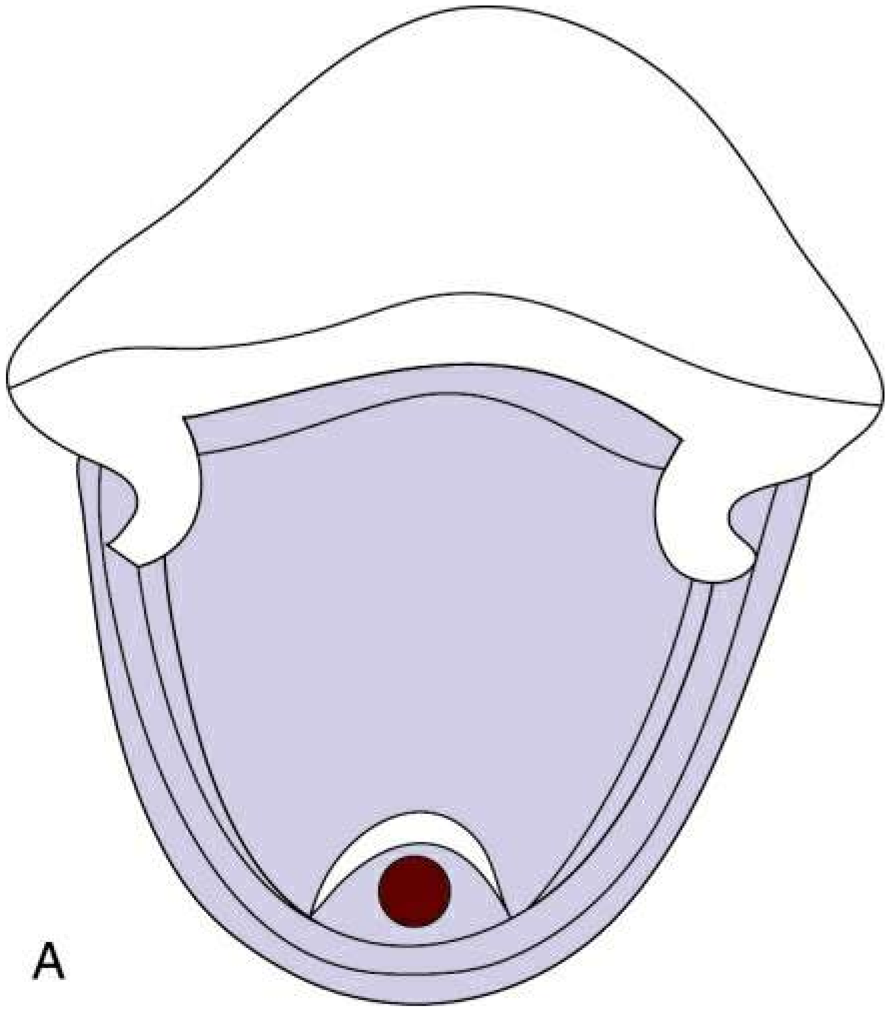


FIGURE 35.78 **(A)** 0.5 mm bevel is placed on the bucco-occlusal finish. **(B)** Incisal bevel completed with flame-shaped diamond.

Pin-modified anterior three-fourth crown

To improve retention and resistance of the anterior three-fourth crown, a pinhole is placed in the cingulum area (Fig. 35.79A). This can be placed in the centre or off-centre (Fig. 35.79B) (increases resistance).



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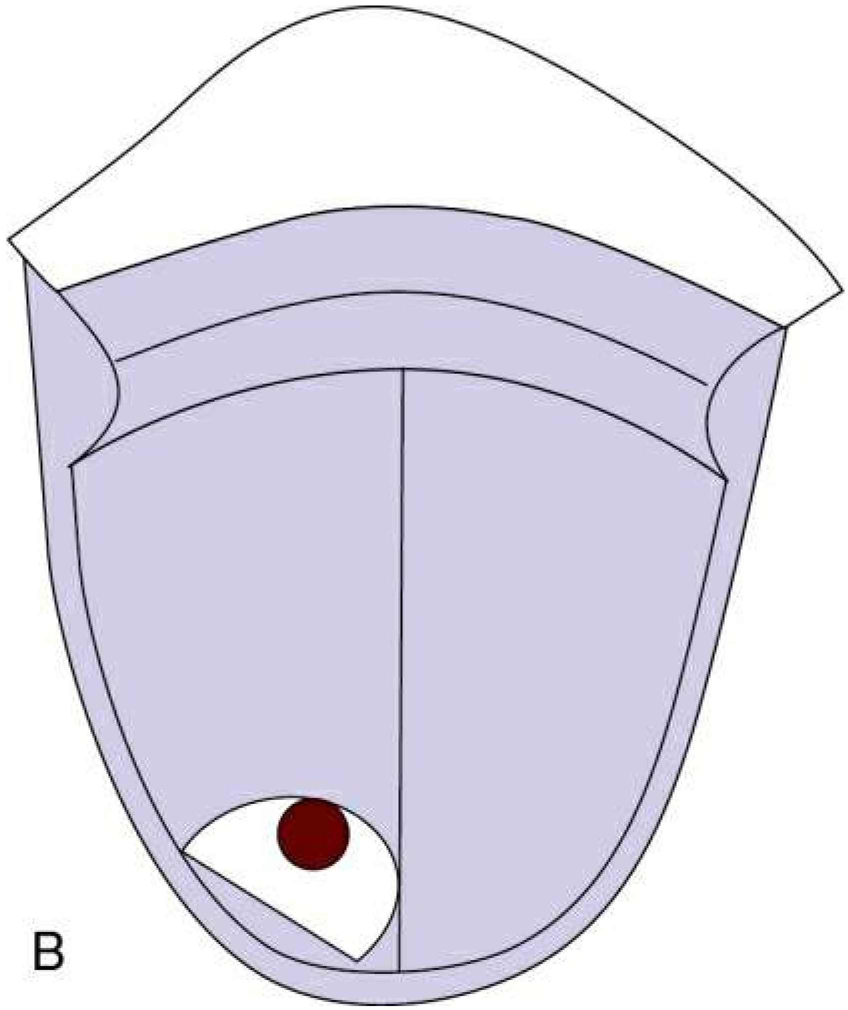

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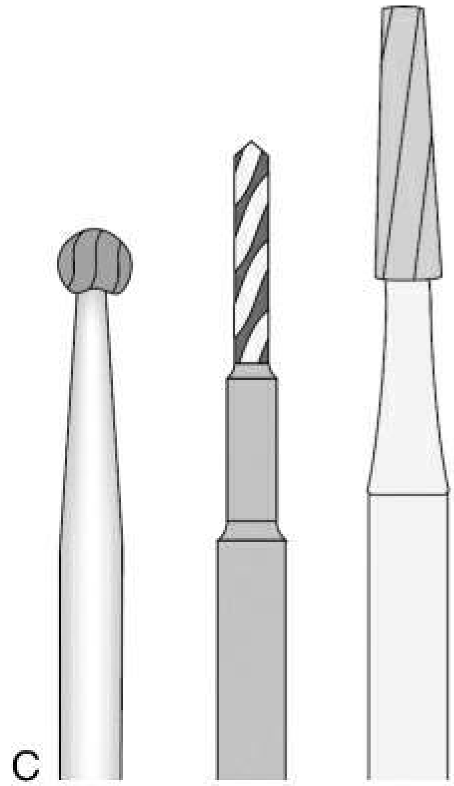


FIGURE 35.79 **(A)** Pinhole and ledge placed in centre in cingulum area. **(B)** Off-centre ledge and pinhole. **(C)** Instruments used for preparing pinhole round bur, twist drill and flat-end tapering fissure bur.

This requires the following steps:

1. A half-moon-shaped ledge is prepared in the centre of the cingulum using a flat-end tapering fissure bur. It is 2 mm wide mesiodistally and 1 mm wide faciolingually.

2. A slight 'dimple' is placed in the centre of the ledge by a No. 1/2 round bur to position the pinhole.

3. A pilot hole is prepared by a 0.6 mm twist drill to a depth of 1 mm (Fig. 35.79C).

4. The pinhole preparation is completed with a flat-end tapered fissure bur with a tip diameter of 0.6 mm.

5. A 1 mm diameter round bur is used to ‘countersink’ or bevel the junction between the pinhole and ledge.

Pinledge partial veneer preparations

Definition: Pinledge is a partial veneer retainer preparation incorporating pinholes to provide retention (GPT8).

These are partial veneer restorations limited to the anterior teeth where the labial surface and one or both proximal surface are not prepared. Retention is augmented by making pinholes on ledges.

Advantages

- Less tooth structure is prepared, hence more conservative.
- Optimal periodontal response as finish line is supragingival.
- Optimal aesthetics.

Disadvantages

- Less resistance to distortion.
- Tooth preparation is complex, needs greater than average skill and care.
- Limited application.

Indications

- Unrestored anterior teeth with low caries activity.
- As a single restoration to re-establish the anterior guidance.
- Retainers for short-span fixed partial dentures.
- Splinting of periodontally compromised teeth.
- Lingual abrasion of incisors and canines.

Contraindications

- Poor oral hygiene and high caries rate.
- Young adults with large pulp chambers.
- Nonvital teeth.
- Restorations demanding high retention like long-span FPDs.
- Crown exhibits abnormal form or is thin labiolingually.

Preparation designs

There are three preparation designs depending upon the placement of pinhole:

1. Conventional pinledge
2. Pinledge with a proximal slice
3. Pinledge with a proximal groove

The conventional preparation is indicated for single tooth restorations while the other two are indicated as retainers for fixed prosthesis.

1. Conventional pinledge preparation on maxillary central incisor

Armamentarium

- Airotor handpiece
- No. 1/2 round bur
- Small wheel diamond
- Long thin tapering diamond
- Fine grit chamfer diamond/bur

- Flat-end tapering fissure bur
- Flame-shaped diamond
- Enamel hatchet
- No. 2 round bur
- 0.6 mm drill
- Nylon bristle

Steps in preparation

1. Lingual reduction
   i. Lingual fossa reduction
   ii. Lingual incisal bevel
   iii. Lingual axial reduction
2. Ledges
3. Indentations
4. Pinhole placement

1. Lingual reduction

i. **Lingual fossa**

Depth of preparation: 0.8–1 mm
Instrument: No. 2 round bur and wheel diamond/football diamond
Procedure:

- A 1.4 mm diameter round bur is sunk to half its depth to create depth orientation grooves. The remaining tooth structure between the grooves is gently removed to get an even 0.7 mm reduction, which after finishing will be about 0.8–1 mm.
- Small wheel diamond is used to remove the remaining tooth structure (Fig. 35.80).

ii. **Lingual incisal bevel**

- It is prepared using a wheel diamond.
- The bevel is placed parallel to the unprepared incisal surface with an approximate width of 1.5 mm.
- It should stop lingual to the incisal edge so as to prevent the incisal display of metal (Fig. 35.80).

iii. **Lingual axial reduction**

- Lingual axial surface is prepared using a round-end tapering diamond, creating a chamfer finish line (Fig. 35.81).
- The inclination of the diamond point should be kept parallel to the path of insertion.

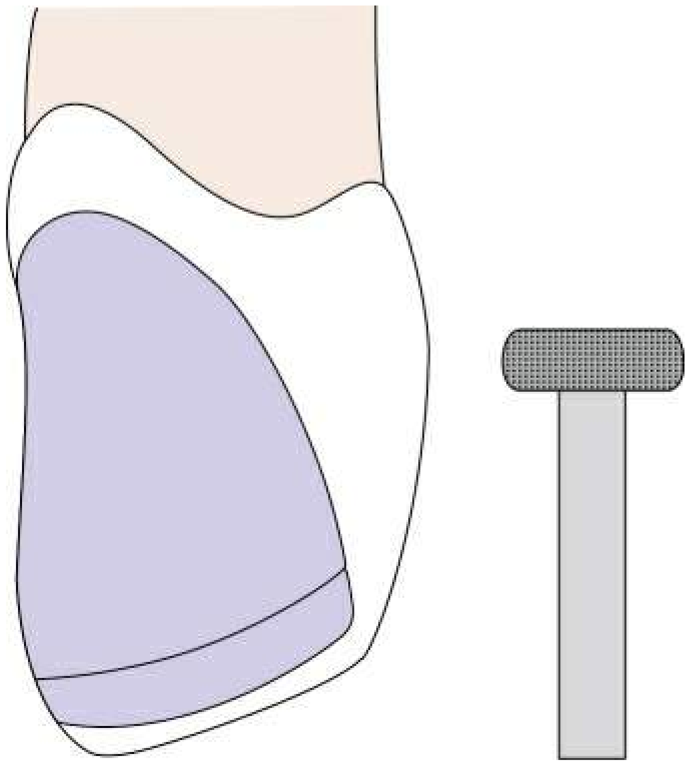


FIGURE 35.80 Lingual fossa reduction with lingual incisal bevel completed with wheel diamond bur. Bevel should stop lingual to incisal edge to prevent display of metal incisally.

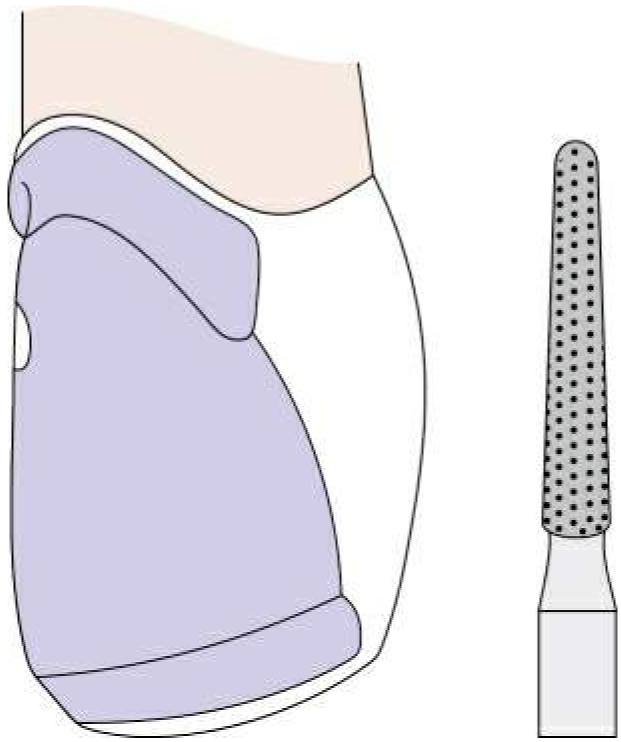


FIGURE 35.81 Lingual axial reduction completed with round-end tapering diamond bur.

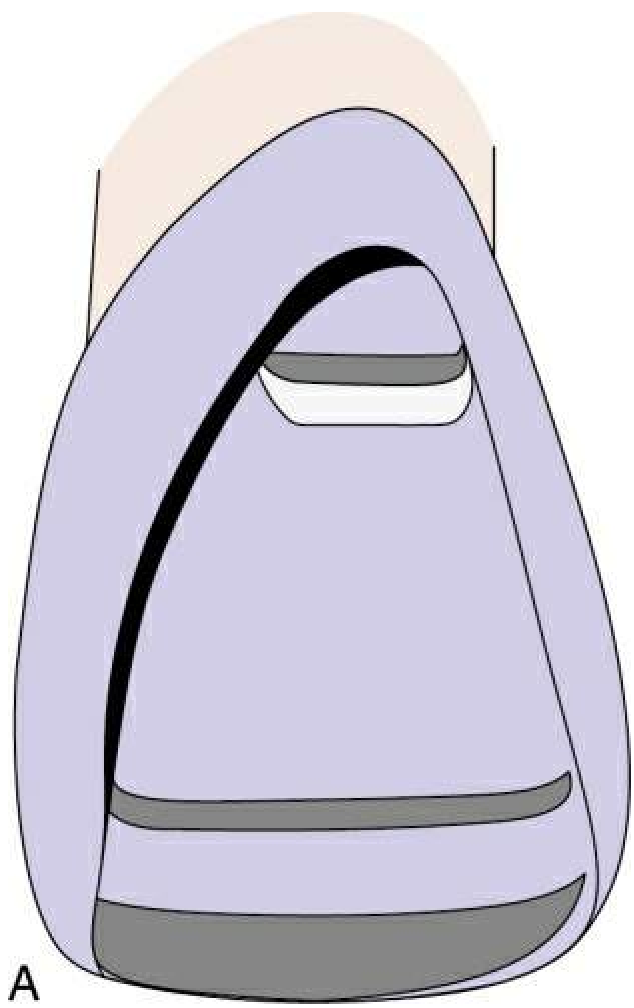
2. Ledges

Depth of preparation: 0.3–0.5 mm.
Instrument: Flat-end tapering fissure bur.
Procedure:

- Two ledges are prepared across the reduced lingual surface – incisally and cervically. They extend from one proximal marginal ridge to the other (Fig. 35.82A).
- The ledges are prepared parallel to the incisal edge and to each other. The facial wall of the ledge is parallel to the incisal two-thirds of the labial surface, while the cervical wall is parallel to the incisal edge. The ledges are prepared using a flat-end tapering fissure bur (Fig. 35.82B).
- The incisal ledge is prepared 2–2.5 mm cervical to the incisal edge, or one-fourth of the total height of the preparation from the incisal

edge.

- The cervical ledge is placed on the crest of the cingulum at the centre of the cervical one fourth of the preparation.
- Ledges provide rigidity to the casting and create flat surfaces in which pinholes can be drilled to provide positive seating of restoration.



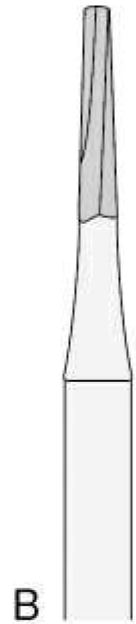


FIGURE 35.82 **(A)** Two ledges placed across the reduced lingual surface incisally and cervically. **(B)** Incisal and cervical ledges placed with flat-end tapering fissure bur.

3. Indentations

Depth of preparation: 0.3–0.5 mm
Instrument: Flat-end tapering fissure bur.
Procedure:

- They create additional space to locate pinholes and stabilize the restoration.
- Three indentations are placed with flat-end tapering fissure bur – two located on incisal ledge and one on cervical ledge. Incisal indentations are spaced as far apart as possible, 0.5–1 mm medial to the lingual outline form. The cervical one is also placed (off-centre) 0.5–1 mm medial to the lingual outline form to enhance resistance (Fig. 35.83).
- The vertical walls must be parallel to the path of insertion and each other. The floor of the indentation is at the level of the ledge.

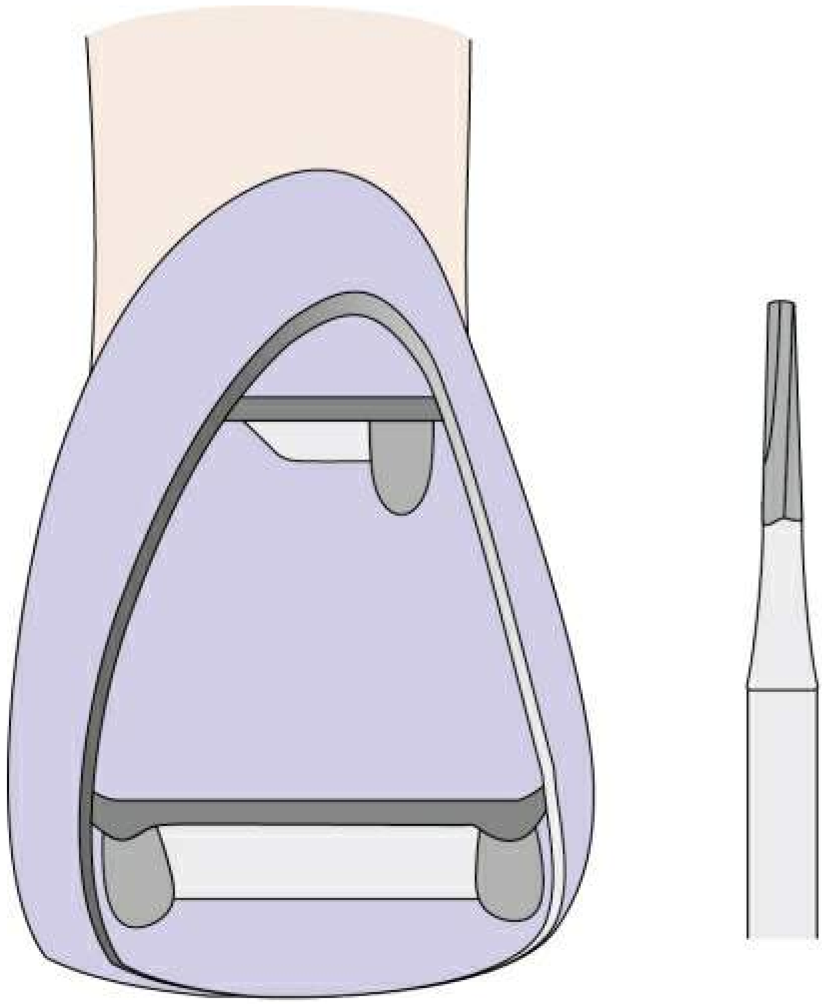


FIGURE 35.83 Three indentations are placed with flat-end tapering fissure bur – two located on incisal ledge and one on cervical ledge.

4. Pinhole placement

Depth of preparation: 2 mm.
Instrument: No. 1/2 round bur, 0.6 mm twist drill and flat-end tapering fissure bur.
Procedure:

- A slight 'dimple' is placed in the centre of the ledge by a No. 1/2 round bur to position the pinhole.
- A pilot hole is prepared by a 0.6 mm twist drill to a depth of 1 mm.

- The pinhole preparation is completed with a flat-end tapered fissure bur with a tip diameter of 0.6 mm.
- A 1 mm diameter round bur is used to 'countersink' or bevel the junction between the pinhole and ledge.
- A nylon bristle is now placed in the prepared pinhole. Using this as a guide, the second pinhole is drilled at the opposite end. The third pinhole is drilled in the cervical ledge (Fig. 35.84).

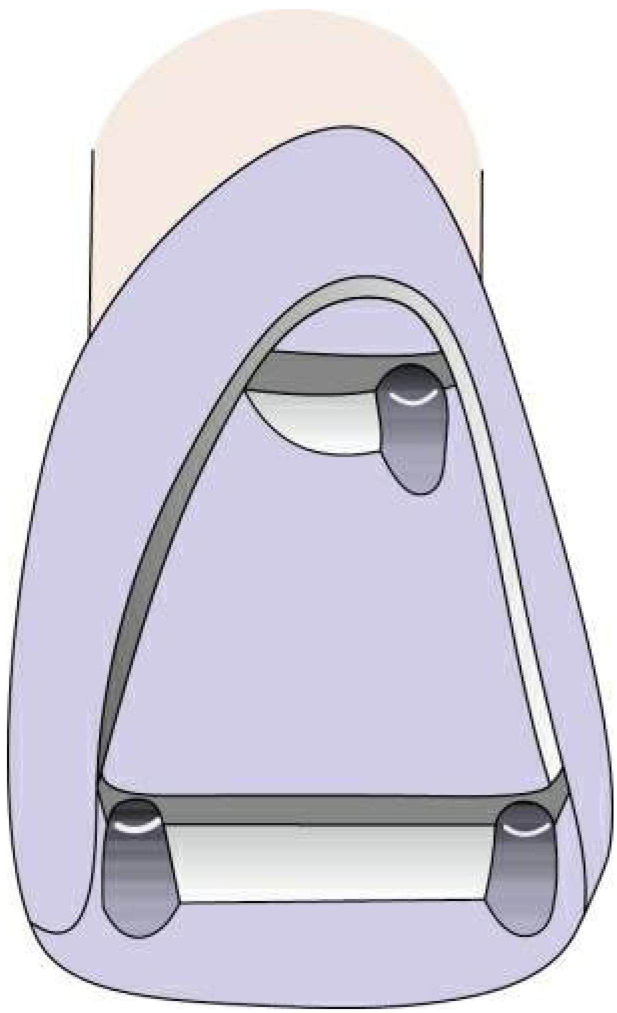


FIGURE 35.84 With pinholes.

2. Pinledge with proximal slice

The overall preparation of the tooth remains same as conventional pinledge preparation. A proximal slice is prepared along with the incisal and cervical pinholes. This is indicated when the preparation is being used as a retainer for fixed partial denture.

The slice is placed in the proximal surface adjacent to the edentulous space while the other proximal surface is not prepared.

The proximal slice is prepared first followed by the rest of the preparation similar to that described for conventional pinledge (Fig. 35.85).

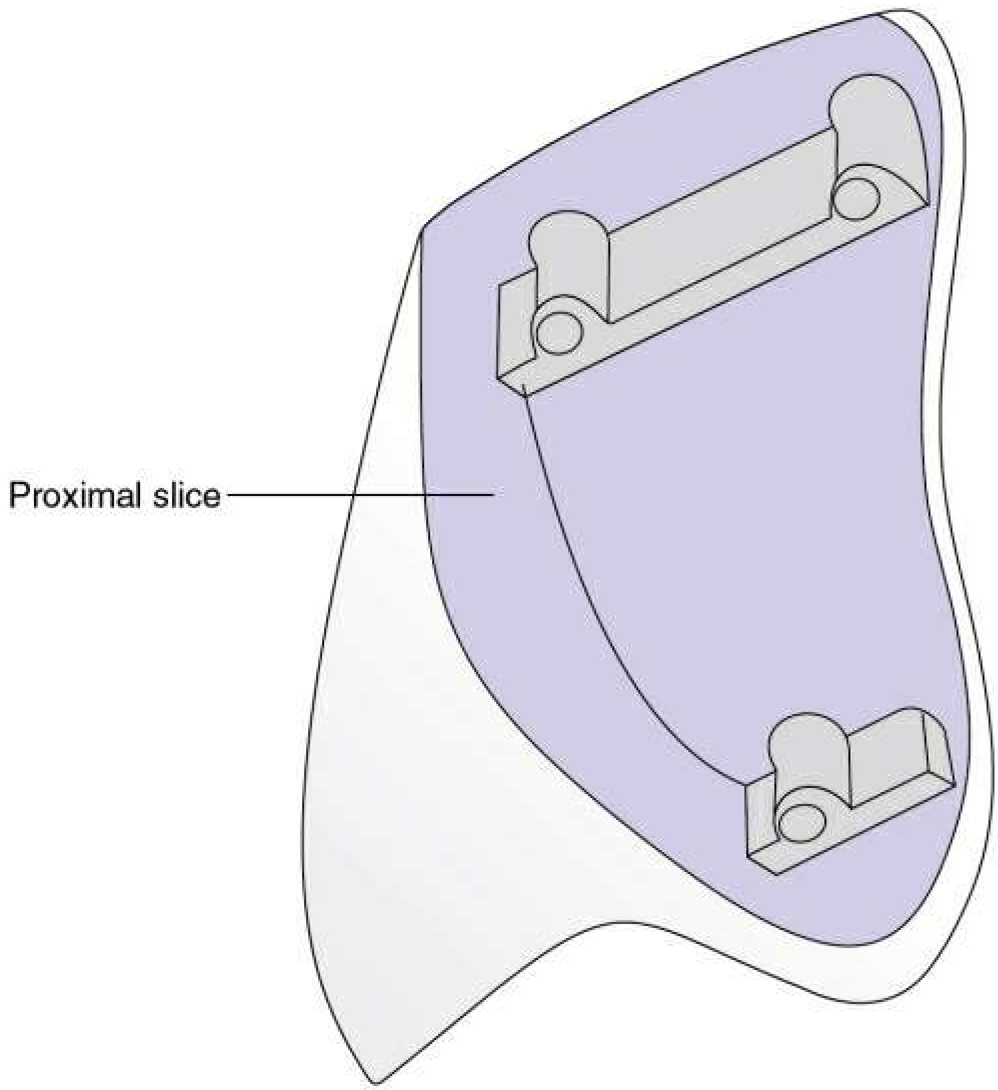


FIGURE 35.85 Pinledge with proximal slice.

Proximal reduction (slice)

Instrument: Flat-end tapering fissure bur.
Procedure:
It is prepared parallel to the path of insertion (incisal two-thirds of labial surface). The preparation provides space for the connector. It is extended facially to include the contact area but should not extend onto labial surface for aesthetics.

3. Pinhole with proximal groove

- Instead of one of the pinholes on the incisal ledge – either mesial or distal, one/two proximal grooves are incorporated on the proximal surface adjacent to the edentulous space. The other proximal surface is not prepared.

- The path of insertion of the prosthesis should be parallel to the proximal groove as well as the pinholes prepared.

- This is indicated in retainers for fixed partial dentures when increase of retention is required.

Armamentarium

- Airotor handpiece

- No. 1/2 round bur

- Small wheel diamond

- Long thin tapering diamond

- Fine grit chamfer diamond/bur

- Flat-end tapering fissure bur

- Flame-shaped diamond

- Enamel hatchet
- No. 2 round bur
- 0.6 mm drill
- Nylon bristle

Steps in preparation

i. Lingual reduction

Similar to the conventional pinledge preparation.

ii. Proximal reduction

Depth of preparation: 0.8–1 mm and 0.3–0.5 mm cervically.
Rotary instrument: Thin tapering diamond/needle diamond and round-end tapering diamond.
Procedure:
A long thin tapering diamond is used in a vertical sawing motion to create space for the proximal reduction up to the contact point. The contact should be broken with an enamel hatchet and not the diamond.
The round-end tapering diamond is then used to then prepare the surface producing a chamfer finish line (Fig. 35.86).

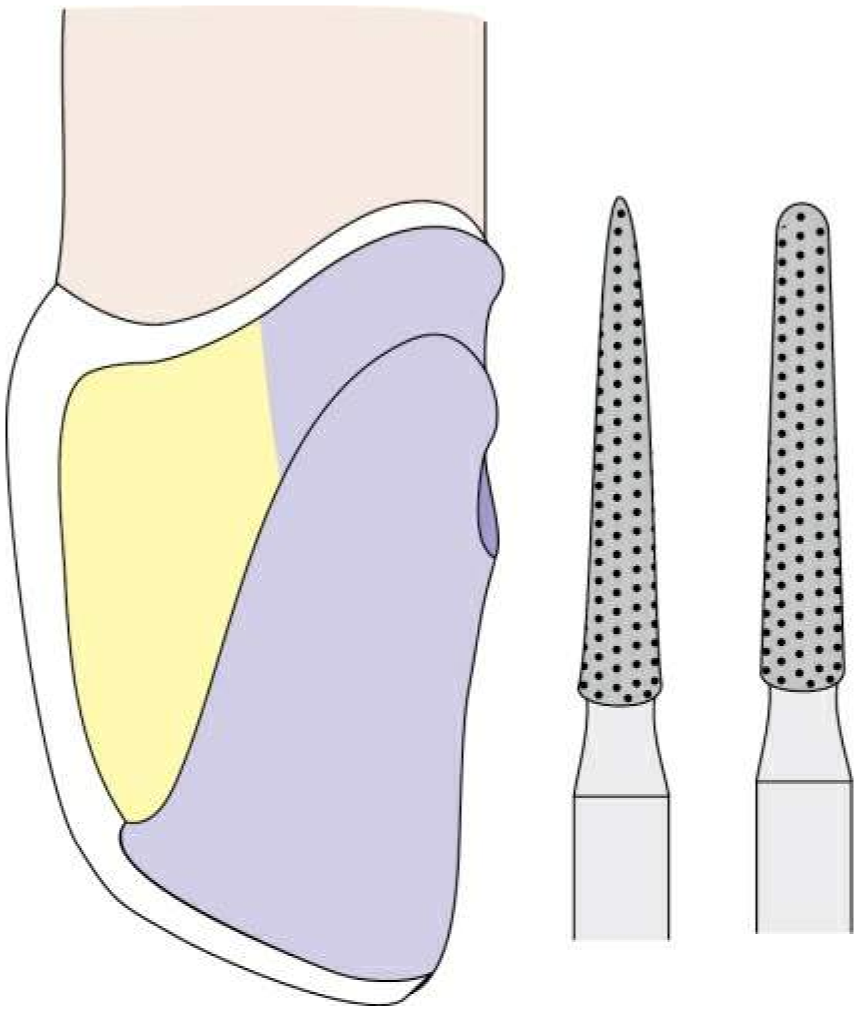


FIGURE 35.86 Proximal reduction completed and a chamfer finish line given using thin tapering diamond followed by round-end tapering diamond.

iii. Grooves

a. **Proximal**

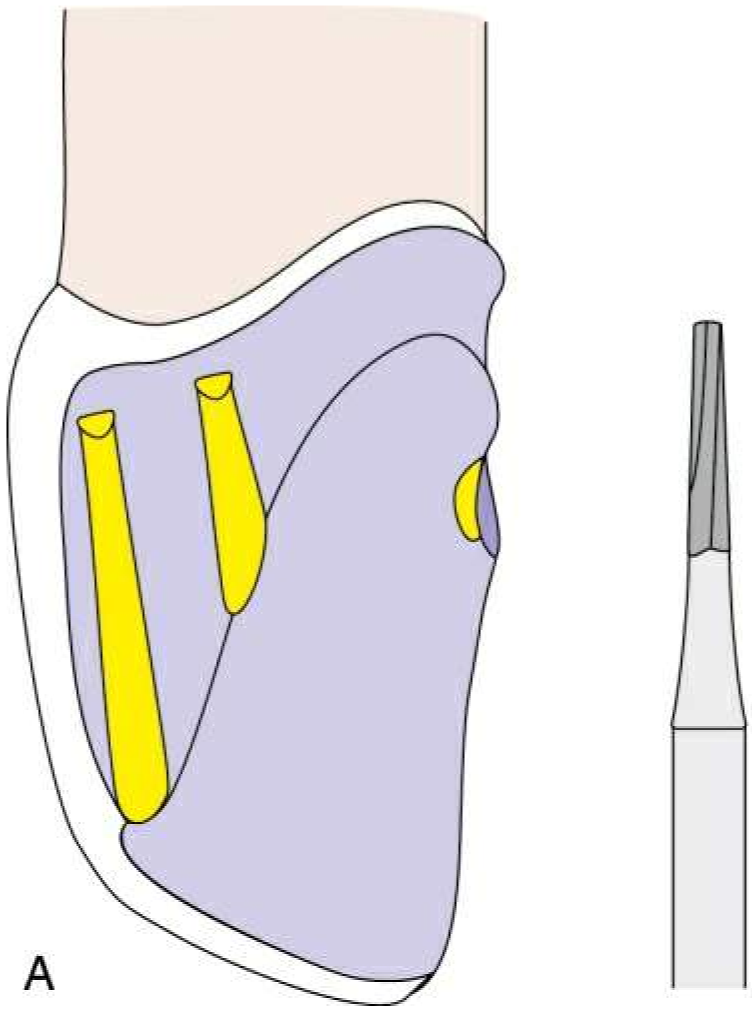
- This is the primary axial retentive feature.
- Two grooves are placed next to the edentulous space. One is placed facial and the other little lingual at the same proximal surface (Fig. 35.87A). Care should be taken that these grooves are parallel to each other and to the path of insertion.

- In case the region is carious, a proximal box form may be prepared, but two grooves are preferred as they are conservative and retention is same.

b. **Lingual**

- A third groove, much shorter than the previous ones is placed on the opposite side of cingulum near the vertical finish line on the lingual surface (Fig. 35.87B).This groove enhances the resistance of the restoration and accommodates bulk of metal to reinforce the margin.

- All the grooves are prepared similar to that described for anterior partial veneer crowns.



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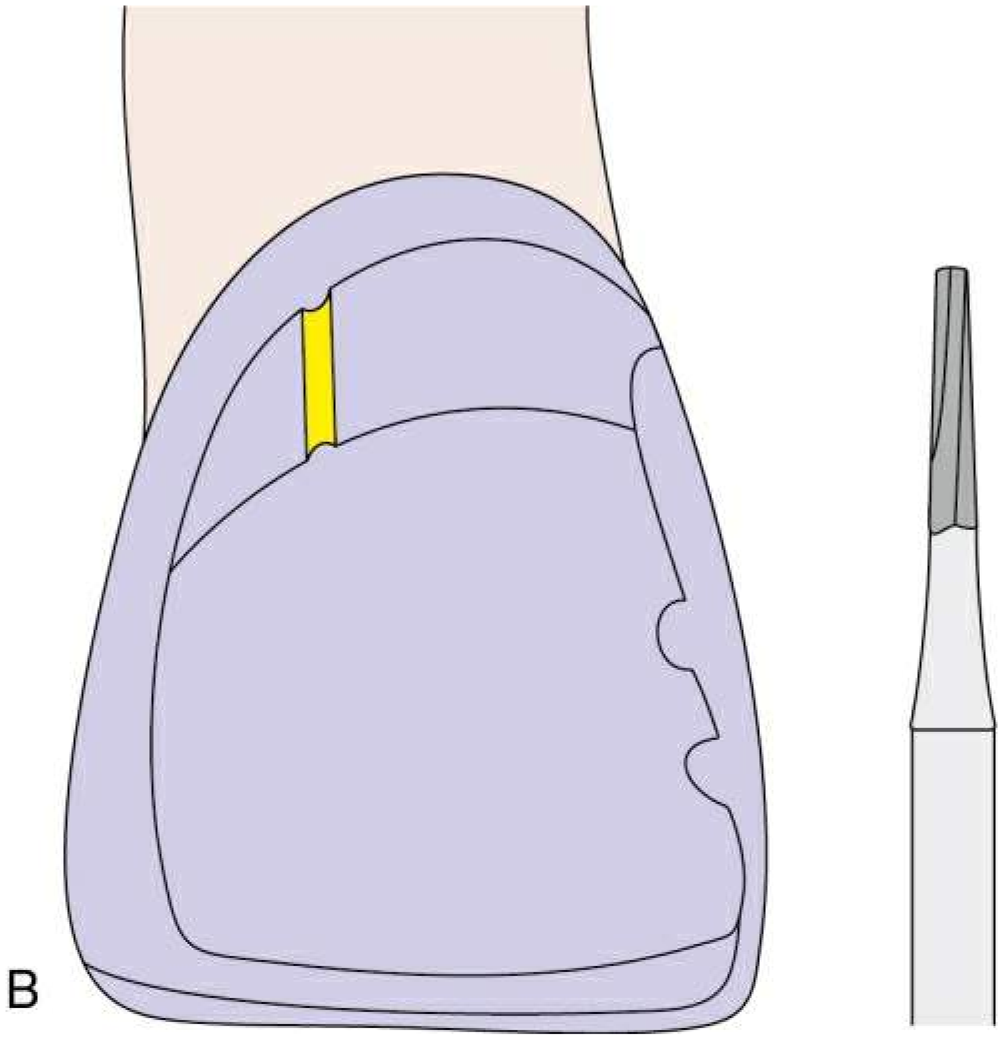


FIGURE 35.87 **(A)** Two grooves placed proximally are parallel to each other and to the path of insertion using a flat-end tapering fissure bur. **(B)** Third groove placed on the opposite side of the cingulum.

The facial proximal groove and the lingual grooves are flared as described for anterior partial veneer crowns, with a flame-shaped diamond (Fig. 35.88).

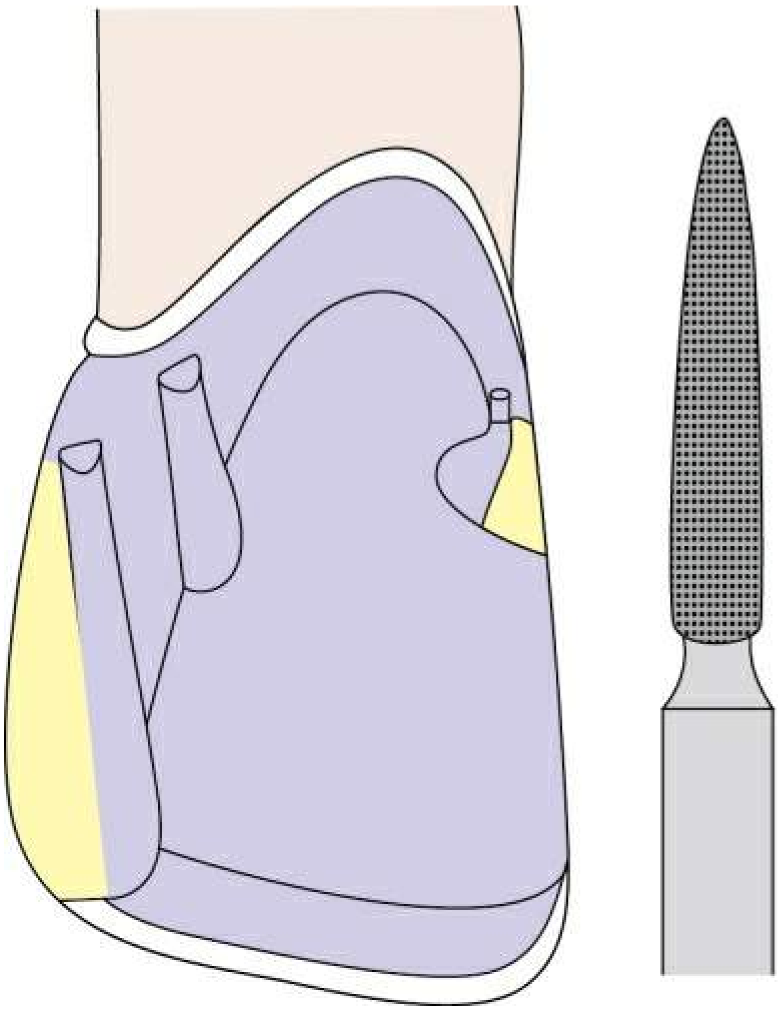


FIGURE 35.88 Flaring of proximal groove (facial) and lingual groove using flame-shaped diamond opposite side.

iv. Ledges

- Half-moon-shaped incisal and cingulum ledges are prepared with a flat-end tapering fissure bur (Fig. 35.89).
- Incisal ledge is prepared in the incisal corner opposite to the site of proximal grooves. It must be gingival to the incisal edge, in dentine, and lingual to the finish line.
- A ledge is also placed in the middle of the cingulum.

• These flat areas on the sloping lingual surface provide good platform for the placement of the pinholes.

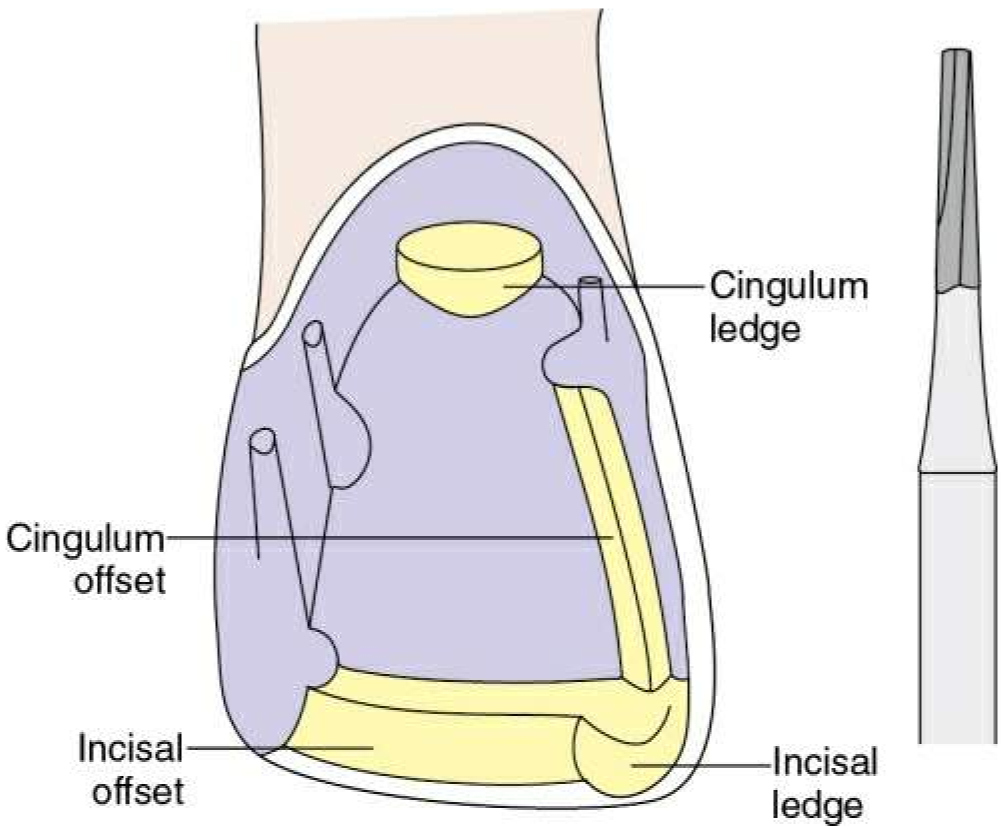


FIGURE 35.89 Ledges and offsets.

v. Offset

a. **Incisal**

• Connects the incisal ledge and facial proximal groove (Fig. 35.89).

• It is narrow and flat, perpendicular to the path of insertion. It is prepared with a flat-end tapering fissure bur.

b. **Lingual**

• Connects the incisal ledge and the lingual groove (Fig. 35.89).

• It is a V-shaped trough which reinforces the linguoproximal margin.

vi. pinhole placement

This is prepared as described for pin-modified anterior partial veneer crowns and conventional pinledge (Fig. 35.90).

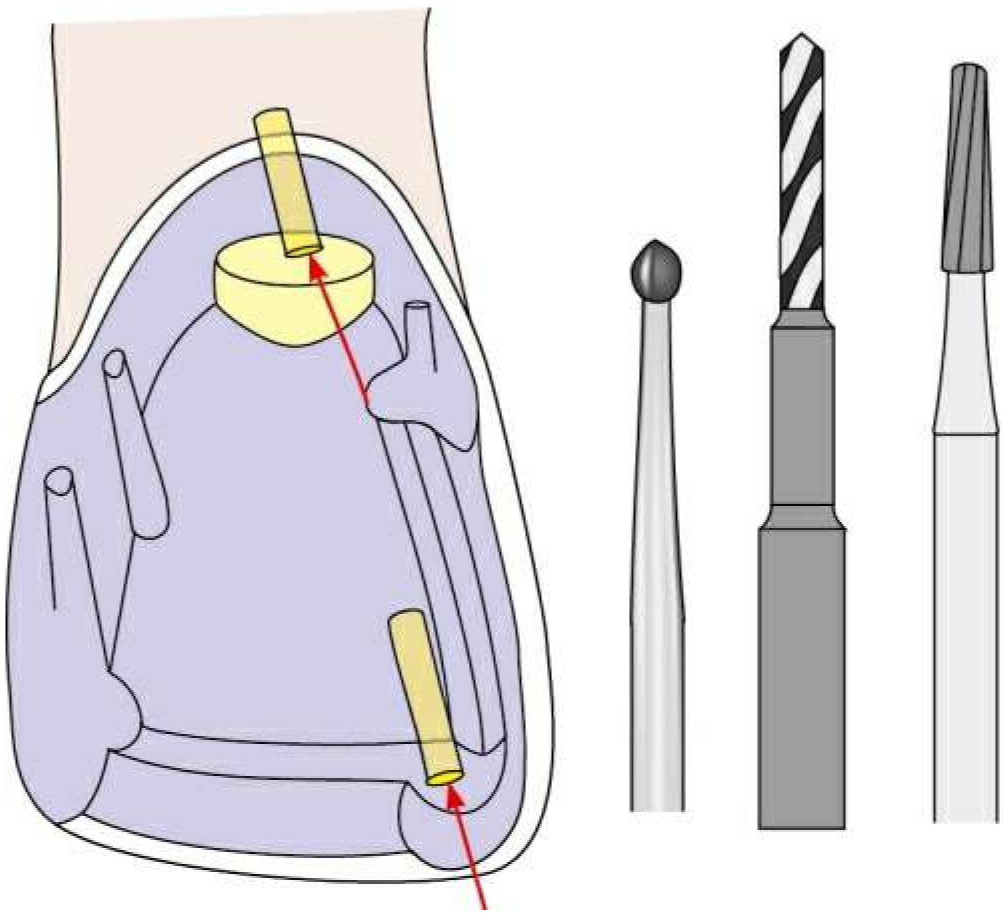


FIGURE 35.90 Pinhole placed using round bur, twist drill and flat-end tapering fissure bur.

vii. Bevels

The junction of the incisal and lingual offsets and their corresponding outer surface (incisal and proximal) are bevelled with a flame-shaped diamond (Fig. 35.91).

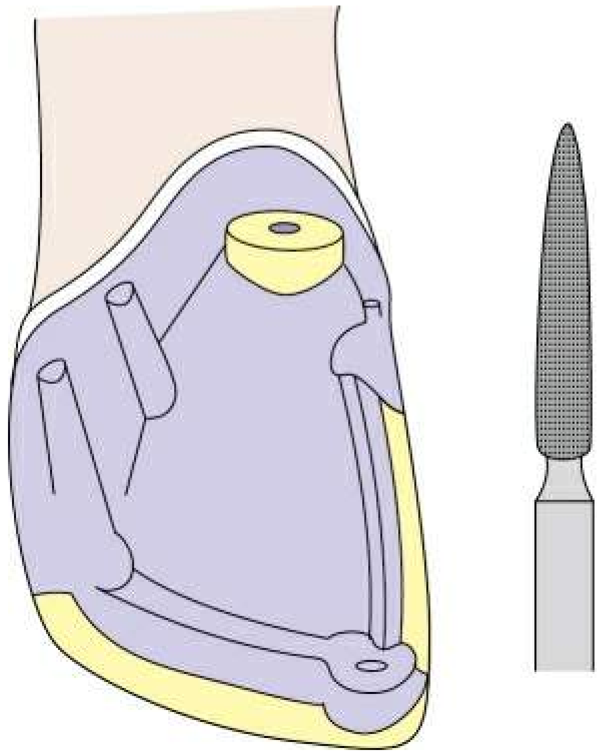


FIGURE 35.91 Incisal proximal grooves are bevelled with flame-shaped diamond bur.

The various features of tooth preparation in general and the function served by each of them are summarized in Table 35.3. The commonly used rotary cutting instruments and their uses are summarized in Table 35.4.

Table 35.3

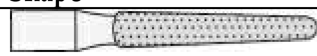
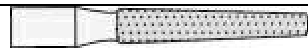
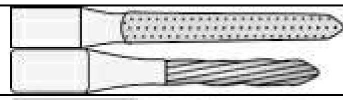
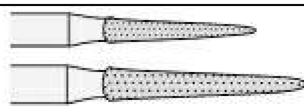
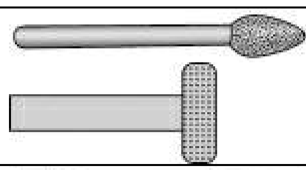
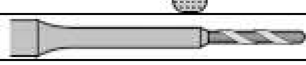
Tooth preparation feature and the function/principle served by them

Feature	Function (principle)
Axial reduction – buccal, lingual and proximal	Retention, resistance, structural durability
Occlusal, incisal and lingual fossa reduction	Structural durability
Finish lines – chamfer, shoulder and shoulder with bevel	Marginal integrity
Proximal groove	Retention, resistance, structural durability
Buccal seating groove	Retention, resistance
Flare	Marginal integrity
Any bevel	Marginal integrity
Any offset	Structural durability
Ledge and pinhole	Retention and resistance
Wing	Retention, resistance and conservation of tooth

	structure
Isthmus	Retention, resistance, structural durability
Countersink	Retention, resistance, structural durability

Table 35.4

Rotary cutting instrument and their functions

Instrument	Shape	Functions
Round-end tapering diamond		Axial reductions to produce chamfer finish line Occlusal reduction
Flat-end tapering diamond		Axial reductions to produce shoulder finish line
Torpedo diamond (fine)/bur		Finish axial surfaces where finish line is chamfer
Flat-end tapering fissure bur		Finish axial surfaces where finish line is shoulder Finish occlusal surfaces Make grooves, boxes and ledges Prepare offsets
Thin tapering/needle diamond – short and long		Short thin – proximal reduction on posterior teeth (short clinical crowns) Long thin – proximal reduction on anterior teeth (long clinical crowns)
Flame-shaped diamond and bur		To produce bevels and flares the diamond is used initially and finishing is done with bur
End-cutting diamond/bur		To finish the shoulder
Round bur		Depth orientation grooves (lingual fossa) Preparation of pinholes Countersink for pinholes
Wheel diamond and football diamond		Reduction of lingual fossa of anterior teeth
Twist drills		Prepare pinholes

SUMMARY

The chapter provides an exhaustive description of different types of preparations, indications, contraindications and the armamentarium to be used. A prudent reader will be able to differentiate between the different configuration of burs and the resultant finish lines. Although some of the preparations are not very often used or practiced, they have their own place and indication in crown and bridge prosthodontics.

CHAPTER

36

Fluid control and gingival displacement

CHAPTER CONTENTS

Introduction

Control of fluids and appropriate displacement of the gingiva are essential during tooth preparation to obtain accurate impressions, and for cementation. They enhance the operator visibility, increase patient comfort and aid in extracting optimum benefits from the impression and cementation procedures. The various procedures used in control of fluids and gingival displacement are discussed in this chapter.

Fluid control

Objectives

- Primarily to remove fluids, isolate and retract oral tissues.
- To enhance operator visibility and patient comfort during tooth preparation.
- To prevent injury to the patient's oral tissues.
- To prevent aspiration of fluids along with restorative debris.
- Isolate specific areas of the oral cavity and ensure a dry operating field in preparation for impression and cementation procedures.

Methods

The methods employed may perform the task of fluid control, isolation and retraction of oral tissues, singly or in combination.

Rubber dam

- It is used to isolate the tooth during restorative procedures.
- Some authors indicate its use during preparation, impression and cementation of indirect restorations.
- When used with elastomeric impression materials, it should be lubricated and clamp removed. It should not be used with polyvinyl siloxane (addition silicones) as its polymerization will be inhibited.

Cotton rolls

- Simplest method of fluid control and isolation.
- Used during impression and cementation procedures.
- For isolating maxillary arch, single cotton roll in the buccal vestibule adjacent to maxillary first molar where the parotid duct opens is sufficient (Fig. 36.1).
- For isolating the mandibular arch, multiple cotton rolls are placed on the buccal and lingual side of the prepared tooth (Fig. 36.2).
- An alternative to multiple cotton rolls is a single long roll placed in the maxillary and mandibular mucobuccal folds.
- A saliva ejector is usually placed in the lingual sulcus for fluid removal whenever cotton rolls are used for isolation (Fig. 36.3).
- An absorbent card may also be placed buccally in conjunction with cotton rolls for isolation and fluid control.

FIGURE 36.1 Isolation using a single cotton roll in maxillary arch.

FIGURE 36.2 Isolation of mandibular arch using multiple cotton rolls.

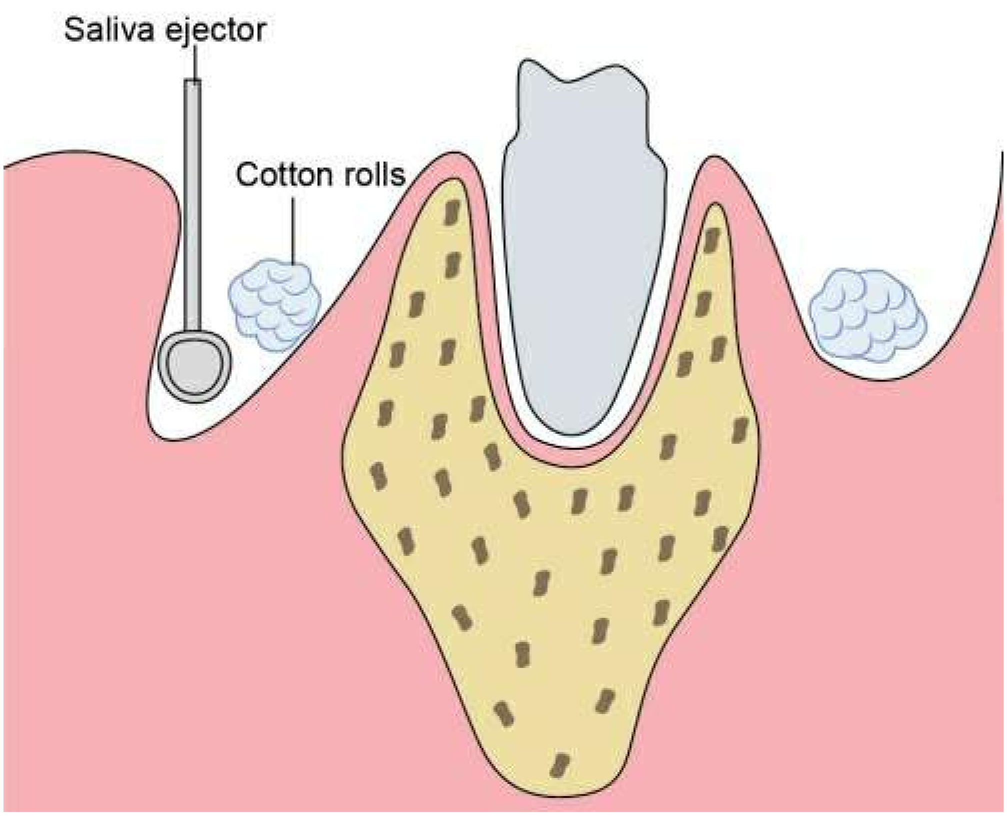


FIGURE 36.3 Saliva ejector is placed in lingual sulcus while using cotton rolls.

High vacuum suction

- Used for fluid and saliva removal during tooth preparation.
- It is a powerful suction equipment used with an assistant.
- It may also be used to retract the lip simultaneously (Fig. 36.4 A and B).

FIGURE 36.4 **(A)** High vacuum suction tube, **(B)** High vacuum suction may also be used to retract lip.

Saliva ejector (low vacuum suction)

- Used for fluid removal during impression and cementation procedures.
- May be used during tooth preparations in maxillary arch by placing it in the corner of the mouth opposite the side being prepared, with the patient's head turned towards that side. It is not as effective as high vacuum suction (Fig. 36.5 A and B).
- Can be used without any assistance.

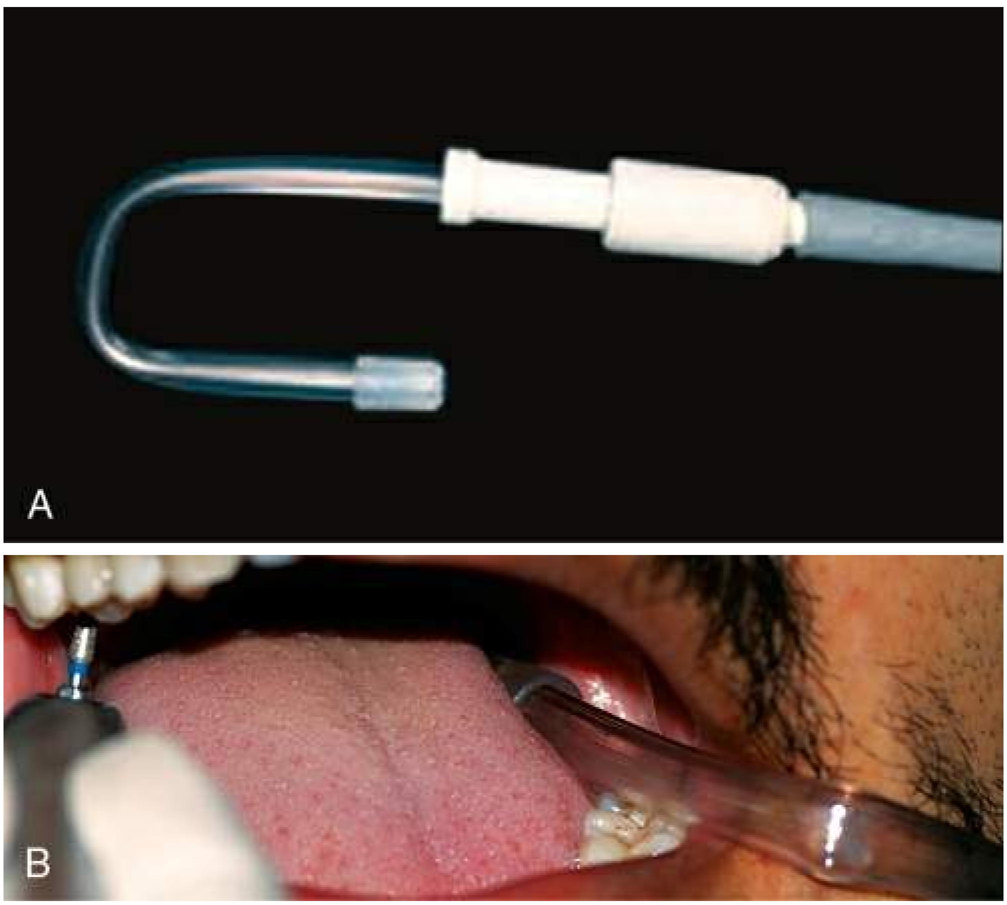
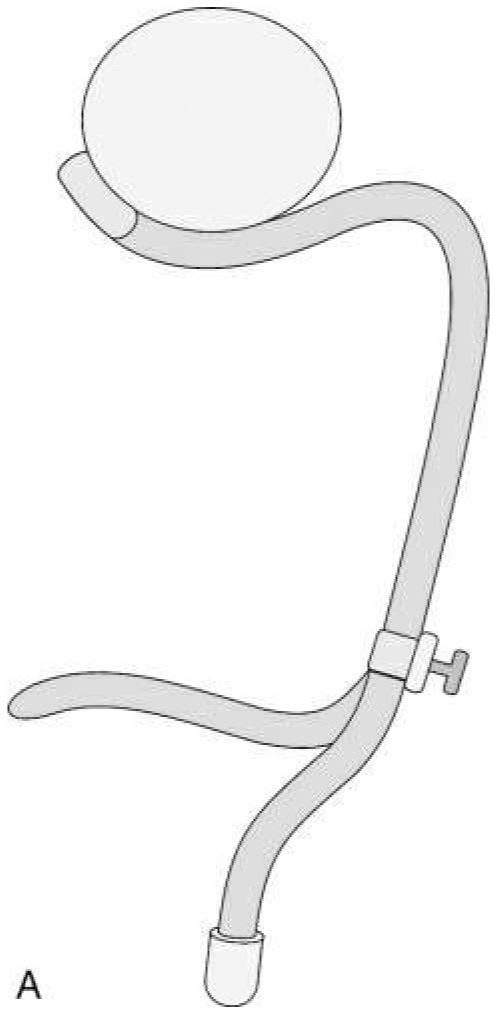


FIGURE 36.5 **(A)** Low vacuum suction tube. **(B)** Can be used without assistance by placing it opposite to the side of tooth preparation.

Svedopter

- It is a flange type of saliva ejector made of metal.
- Used for fluid removal and tongue retraction during tooth preparation on mandibular arch, and isolation during impression and cementation (Fig. 36.6 A and B).
- Can be used with patient in an upright position, without assistance.



A

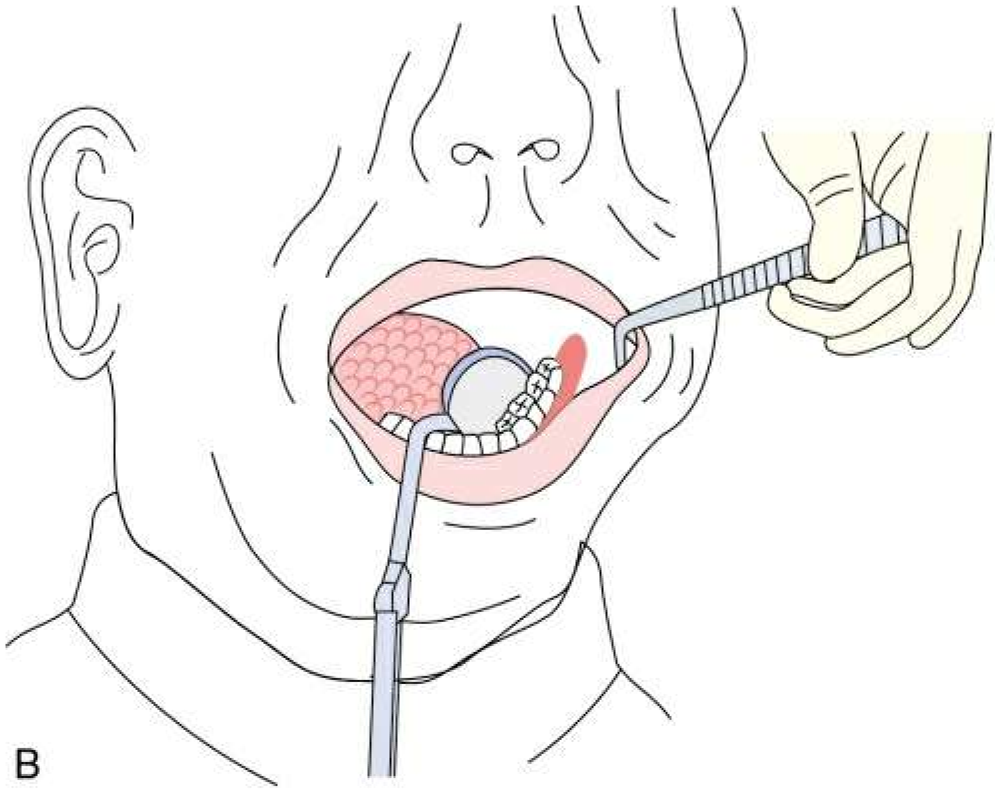


FIGURE 36.6 **(A)** Svedopter. **(B)** Used for fluid removal and tongue retraction.

Disadvantages

- Access to lingual surface of mandibular teeth may be limited.
- May injure the floor of the mouth if not used carefully, as it is made of metal. Cotton roll placed between the blade and mylohyoid ridge may reduce this problem.
- Contraindicated in the presence of mandibular tori.

Antisialogogues

- Drugs may be used to provide fluid control by reducing salivary flow. This is especially beneficial during impression making.
- Anticholinergic drugs – atropine, dicyclomine and propantheline

may be used. They are given 1 h prior to commencement of dental procedure. They are contraindicated in patients having hypersensitivity to the drug, glaucoma, asthma, obstructive conditions of the gastrointestinal tract and congestive cardiac failure.

- Clonidine, an antihypertensive drug may also be used. It is safer than anticholinergics but should be used with caution with other antihypertensives. It can cause drowsiness which may not be desirable.

- Drugs used and their recommended dosages are given in Table 36.1.

Table 36.1

Drugs used for fluid control and their dosage

Drug	Dose
Atropine sulphate	0.4 mg
Dicyclomine HCl	10–20 mg
Propantheline bromide	7.5–15 mg
Clonidine	0.2 mg

Local anaesthetic

- In addition to pain control, local anaesthetics also reduce salivary flow during impression making.

- They act by blocking nerve impulses from the periodontal ligament that regulate salivary flow.

Gingival displacement

Definition: The deflection of the marginal gingiva away from a tooth (GPT8).

- Also called *gingival retraction* or *tissue dilation*.
- It is essential that the gingiva is in a healthy state before the tooth preparation.

Indications

1. To provide adequate reproduction of finish lines.
2. To accurately duplicate subgingival margins.
3. To provide the best possible condition for the impression material, fluid control.
4. To fabricate accurate restorations thereby preventing periodontal disease.

Objectives

- To expose the prepared finish line.
- To control the gingival crevicular fluid.
- To evaluate the depth and uniformity of finish line.
- Allows refinement of finish line without laceration of soft tissues.
- Provides access for the impression materials to record accurately the finished margins and a part of the unprepared tooth beyond the finish lines.

- Helps to obtain accurate marginal fit which will reduce the marginal leakage and subsequent deterioration of the tooth.

Methods

Methods for gingival displacement are classified as follows.

Mechanical

This method physically displaces the gingiva. This can be achieved with the help of:

1. Copper band

- It carries the impression material and displaces the gingiva. Impression compound and elastomeric materials have been used.

- One end of a copper band is trimmed to follow the contours of gingival margins. The top part is plugged with resin or compound. A vent is placed to allow escape of excess impression material. Dental floss is threaded through the vent to ease band removal (Fig. 36.7). The tube is filled with impression material and is seated parallel to the long axis of the prepared tooth such that the contoured metal margins coincide with the free gingival margin gently displacing them.

- Though it is no longer used routinely, it may be indicated with multiple abutments and when full arch impressions of multiple abutments have not recorded one/two teeth properly (Fig. 36.8A and B).

- It can cause injury to the gingiva and retraction is also minimal.

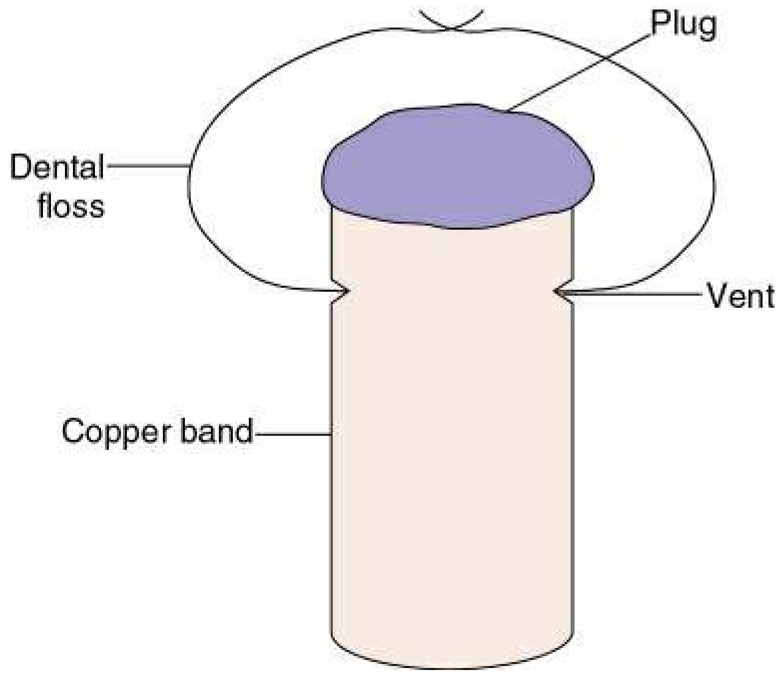


FIGURE 36.7 Dental floss is threaded through the vent to ease band removal.

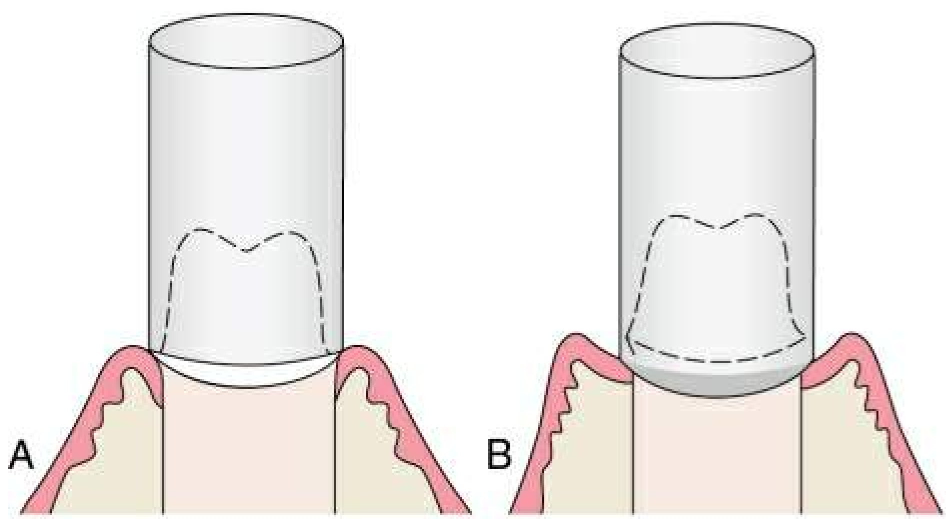


FIGURE 36.8 **(A)** Oversize copper band 2 mm wider than the mesiodistal width of the tooth. **(B)** Gingiva is trimmed and contoured inward to allow the band to clear the preparation margin during impression procedure.

2. Rubber dam

- It is used when limited number of teeth in one quadrant are being restored and when preparations do not have to extend subgingivally.

- Clamp should be blocked out and addition silicones should be avoided as rubber interferes with its setting.

3. Cotton threads

- Plain cotton threads have also been used to produce mechanical gingival displacement.

- The retraction achieved is purely physical without any haemostasis, very less and transient.

4. Magic foam

This is a recent development. It consists of 'Comprecap' – a hollow cotton and 'Magic Foamcord' – a polyvinyl siloxane material. Prior to impression making, a desired size of the Comprecap is selected (Fig. 36.9). Magic Foamcord is injected around the preparation and inside the Comprecap and is placed over the prepared tooth (Fig. 36.10). The patient is instructed to gently bite to hold the Comprecap. After about 3–4 min the Comprecap is removed along with the Magic Formcord (Fig. 36.11).

FIGURE 36.9 Different size of Comprecap.

FIGURE 36.10 Injection of Magic Formcord.

FIGURE 36.11 Patient is instructed to bite and hold the Comprecap and it is removed after 3–4 min.

Advantage

- Easy to use with less trauma.

Disadvantages

- Less retraction than cord.
- Haemostasis must be established prior to retraction.

Mechanical–chemical

A displacement/retraction cord is used for mechanically separating the tissue from the prepared margin and is impregnated with a chemical for astringent action and/or haemostasis as impressions are made. Cord displaces the gingival tissue both laterally and vertically.

Ideal requirements of cords

1. Dark in colour and never red.

2. Be made of absorbent material.

3. Strong enough to resist placement and should not snap.

4. It should be available in different diameters to accommodate the varying morphologies of the gingival sulcus.

Chemicals used

Cord is supplied impregnated with the chemical or cord may be dipped in specific chemical agents before packing into the gingiva. These cause a transient ischemia thereby shrinking the tissue, help control gingival fluids and provide haemostasis.

The most commonly used chemicals are ferric sulphate ($Fe_2(SO_4)_3$) 20%–25%, and aluminium chloride ($AlCl_3$) 15%–29%. Racemic epinephrine 8% is also used though not commonly as it causes tachycardia.

Classification

1. Plain or impregnated

2. Lubricated or nonlubricated

3. Twisted, braided or knitted (Figs 36.12–36.14)

4. According to thickness – 00, 0, 1, 2 (Fig. 36.15)

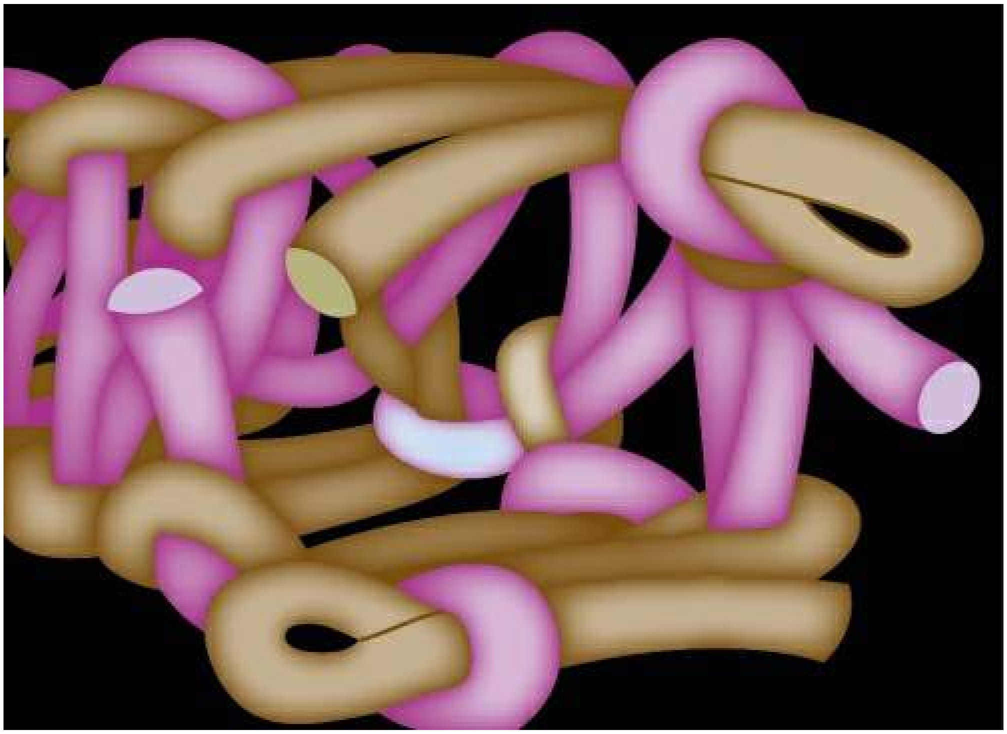


FIGURE 36.12 Knitted cords.

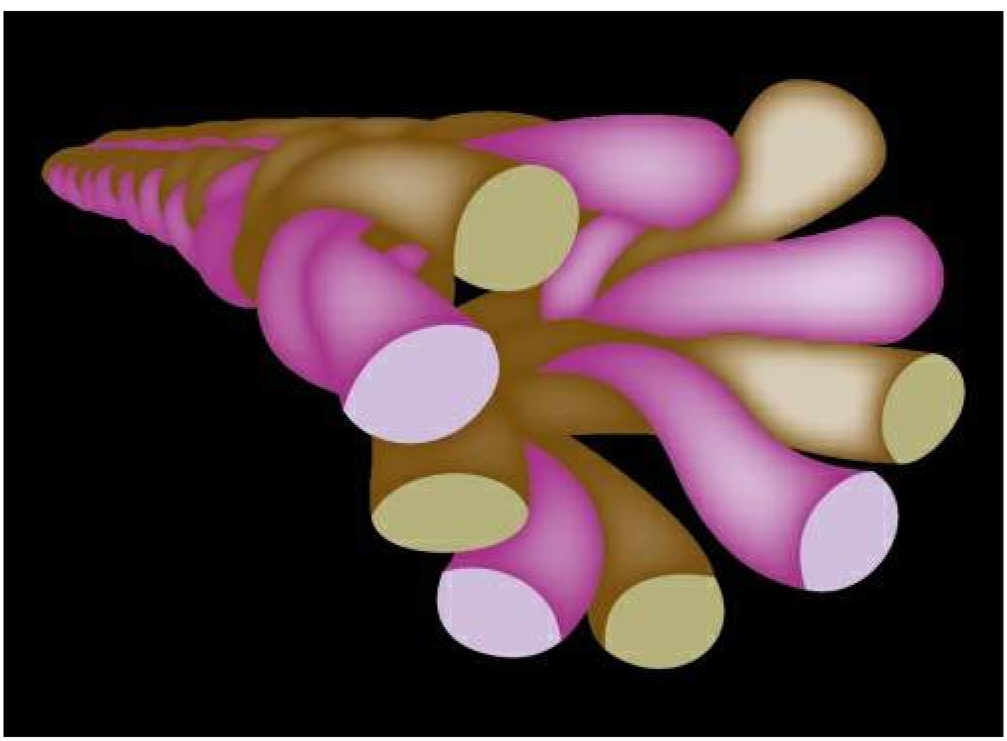


FIGURE 36.13 Braided cords.

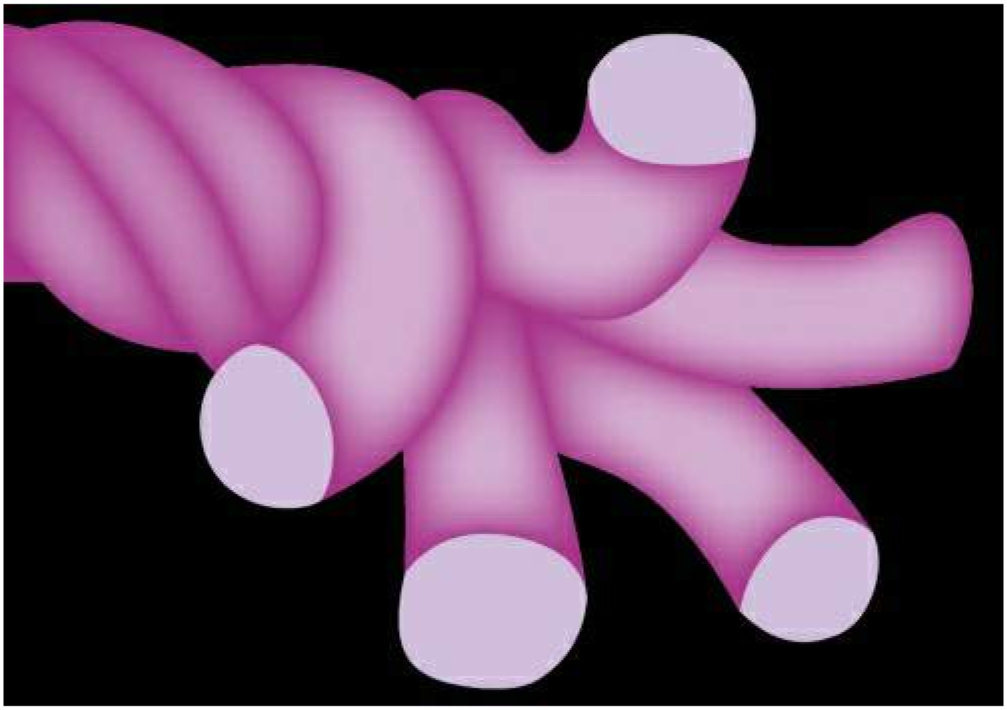


FIGURE 36.14 Twisted cords.

FIGURE 36.15 Different thickness of retraction cord.

Knitted cords are made up of compressible interlocking chains which transport greater amount of chemical agent. Braided cords do not separate easily and do not unravel while they are being inserted. Knitted and braided cords are preferred.

Instrument

Instrument used for packing the cord is called 'Fischer's cord packer' (Fig. 36.16).

FIGURE 36.16 Cord packer.

It should be thin enough to be placed in the gingival sulcus without damaging the tissues, and the angle of the instrument should allow packing of the cord all around the tooth. The tip may be serrated to enhance grip of instrument on cord.

Displacement techniques

Two methods may be employed:

1. **Single-cord technique:** One cord is placed in the sulcus and the impression is made immediately following retraction after removing the cord.

2. **Double-cord technique:** Two cords are used; one thin cord is first packed deep into the sulcus and left there during impression making to provide haemostasis. The second cord is placed over the first cord to provide retraction, and is removed immediately prior to impression making.

Method

Single-cord technique

- This is the most commonly used method.
- Indicated for making impression of one to three prepared teeth with healthy gingiva tissues.
- It is relatively simple and efficient.
- The operating field must be dry, isolated with cotton rolls and fluid removed with saliva ejector.
- Cut appropriate length of cord to encircle the tooth 2 inches approximately (Fig. 36.17).
- If impregnated, moisten cord intraorally, or dip cord in appropriate chemical agent placed in a dappen dish (Fig. 36.18).
- Form a 'U' shape and loop it around the prepared tooth so that the cut ends are on the lingual side (Fig. 36.19).
- From the lingual side grasp the cut ends of the cord between the thumb and forefinger and apply tension very slightly in an apical direction. This apical tension would result in the cord getting tucked in both the proximal and labial surfaces (Figs 36.19 and 36.20).
- Use the cord packing instrument to secure the cord in the proximal area first (Fig. 36.21). Instrument should be angled towards the tooth (Figs 36.22 and 36.23).
- Proceed to the lingual surface and facial surfaces beginning with the mesiolingual line angle.
- Cut off the excess length of cord protruding from lingual sulcus

leaving a small tag (Figs 36.24 and 36.25). This tag can be grasped for easy removal.

- After 10 min, moisten the cord with saline or sterile water and remove the cord slowly to avoid bleeding. If active bleeding persists ferric sulphate chemical can be applied to the gingiva (Fig. 36.26).

FIGURE 36.17 Two inches piece of retraction cord is cut off.

FIGURE 36.18 Retraction cord may be dipped in appropriate chemical agent (haemostatic) prior to placement.

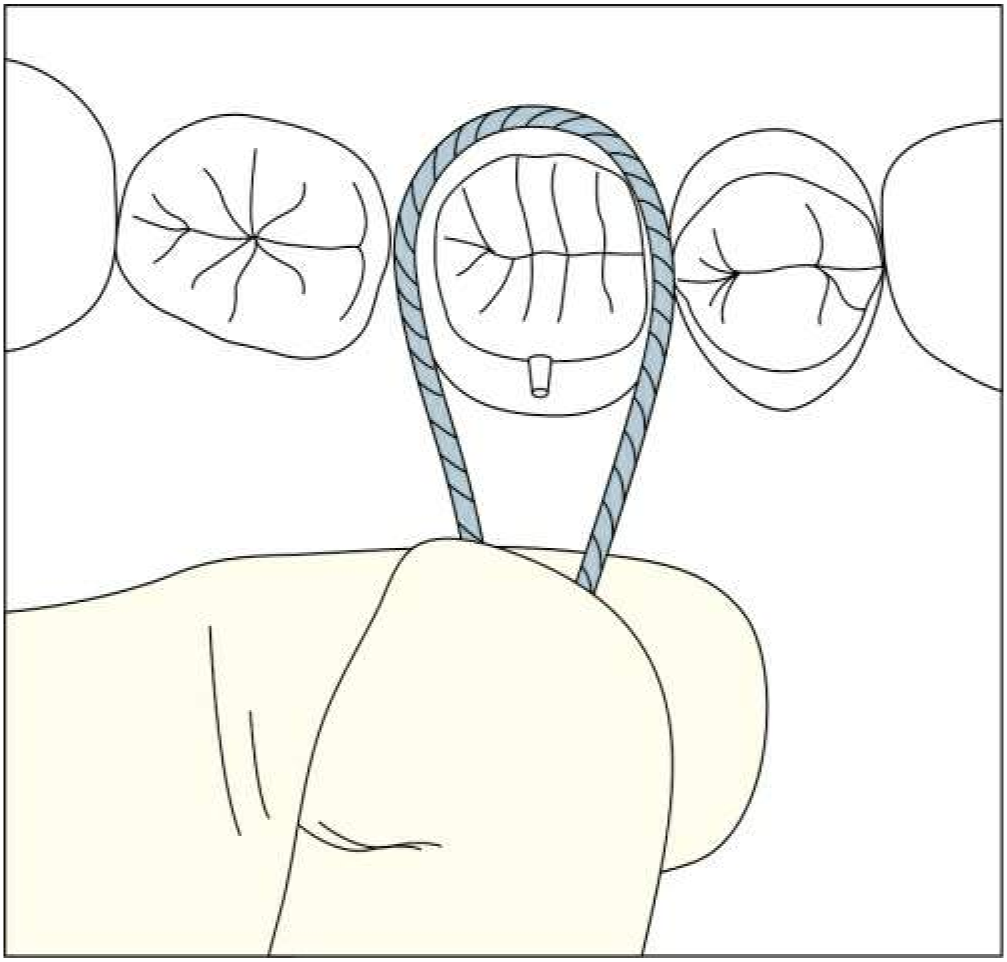


FIGURE 36.19 A loop of retraction cord is formed around the tooth and held tautly with the thumb and forefinger.

FIGURE 36.20 Cord grasped from the lingual side.

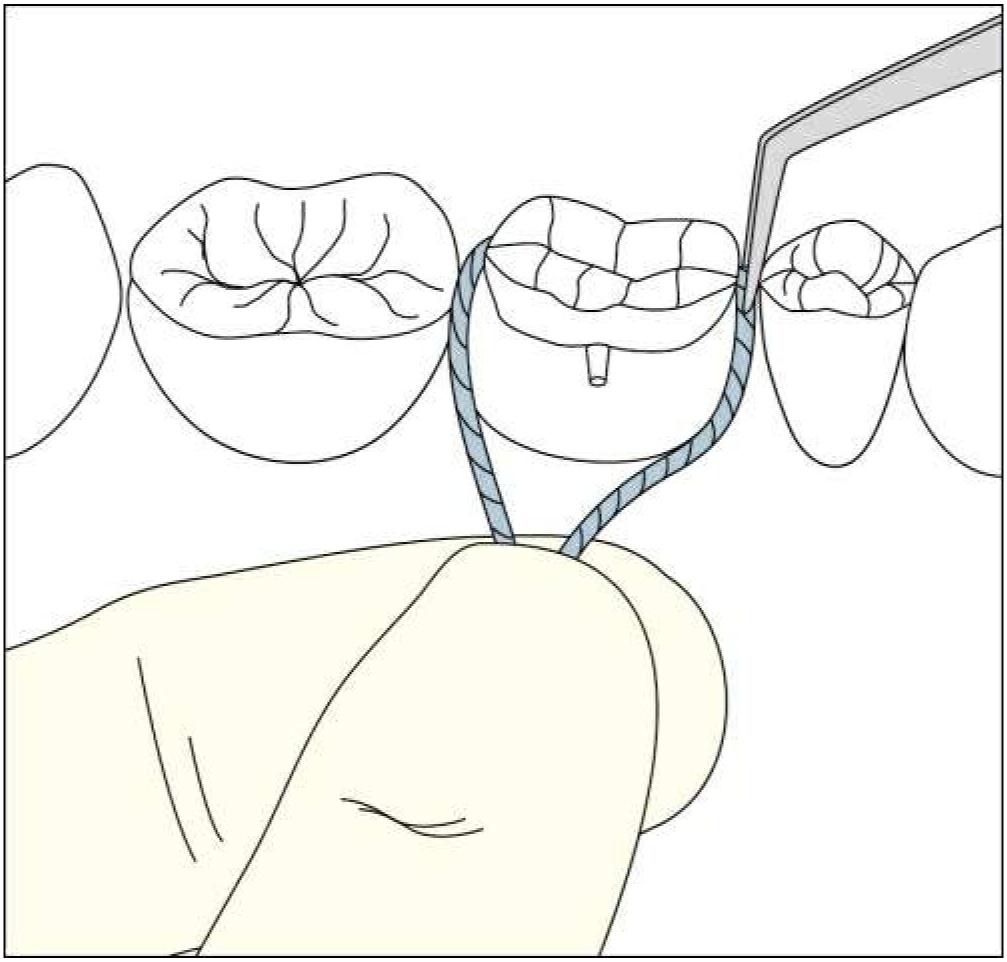


FIGURE 36.21 Placement of the retraction cord is begun by pushing it into the sulcus on the mesial surface of the tooth.

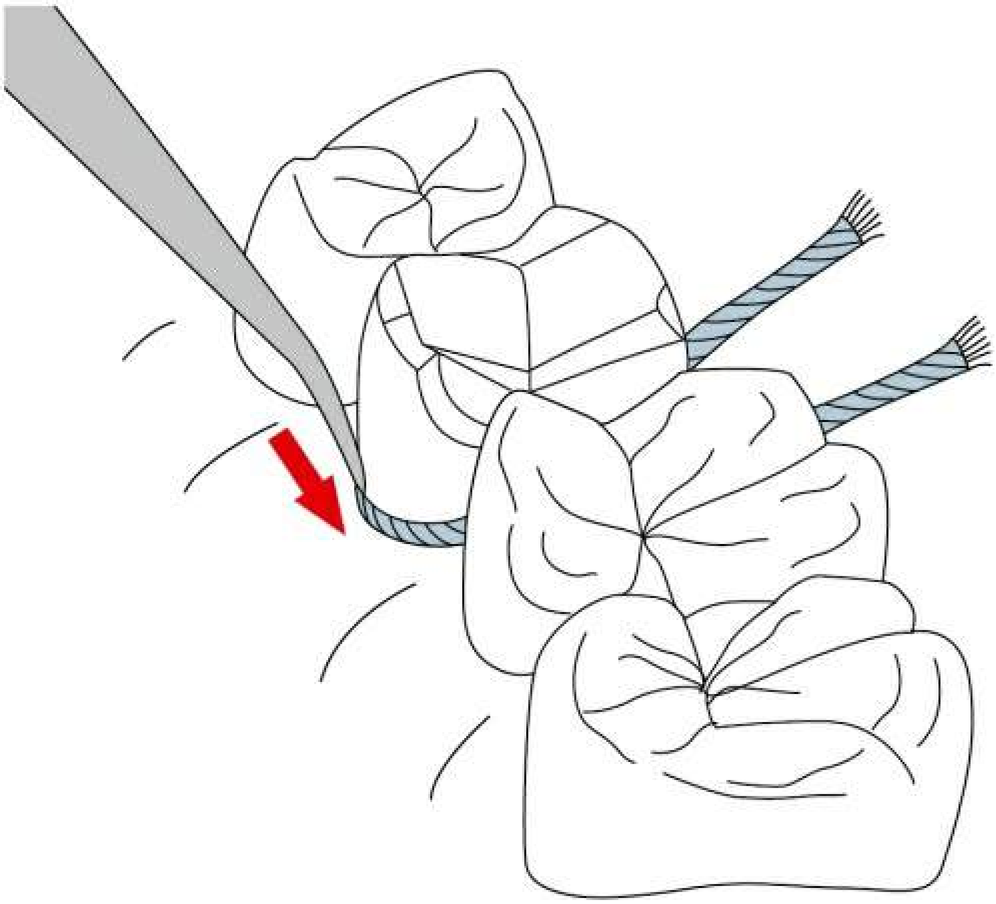


FIGURE 36.22 The instrument must be angled slightly toward the root to facilitate the subgingival placement of the cord.

FIGURE 36.23 Cord packer angled towards the tooth.

FIGURE 36.24 Excess cord is cut off in the mesial interproximal area.

FIGURE 36.25 Excess cord will facilitate easy removal.

(Fig. 36.27A).

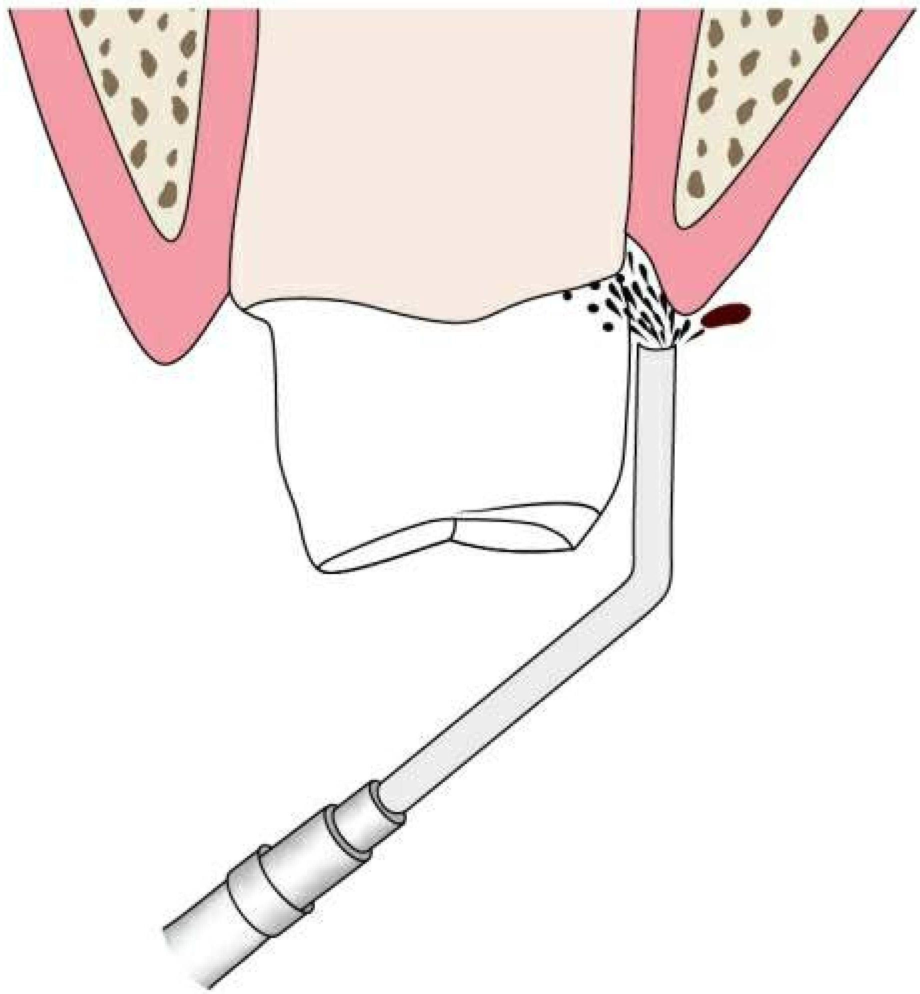


FIGURE 36.26 Application of ferric sulphate with infusion tip to arrest bleeding.

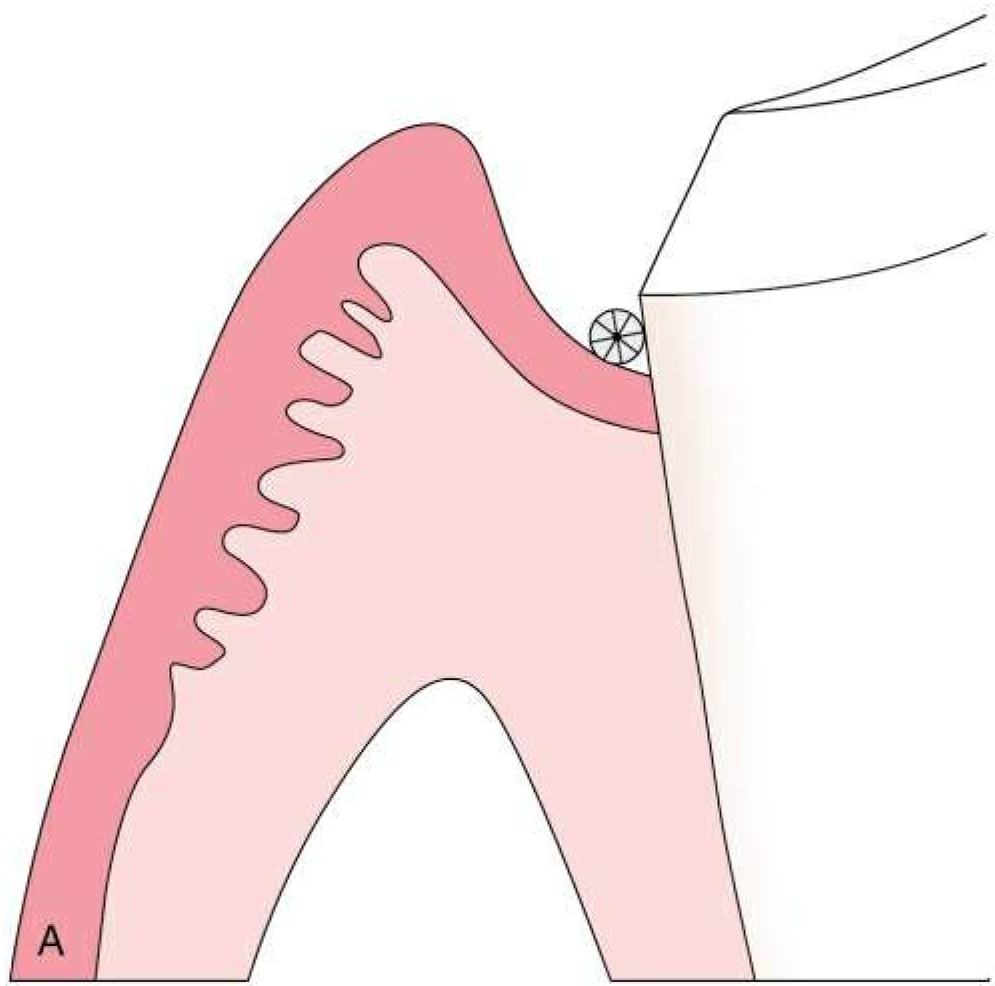
Double-cord technique

- The double-cord technique is indicated when making impressions of multiple prepared teeth and when tissue health is slightly compromised with more than normal bleeding anticipated.
- A small diameter cord is first placed into the sulcus. The ends of this cord should be cut so that they exactly abut against one another in the sulcus. This cord is left in the sulcus during impression making (Fig. 36.27A).

- A second cord, soaked in the haemostatic agent of choice, is placed in the sulcus above the small diameter cord. The diameter of the second cord should be the maximum diameter that can be placed easily in the sulcus (Fig. 36.27B).

- Eight to ten minutes after placement of the second cord, it is moistened, removed and impressions are made with the first cord in place.

- After making the impression, the small diameter cord is moistened and removed from the sulcus.



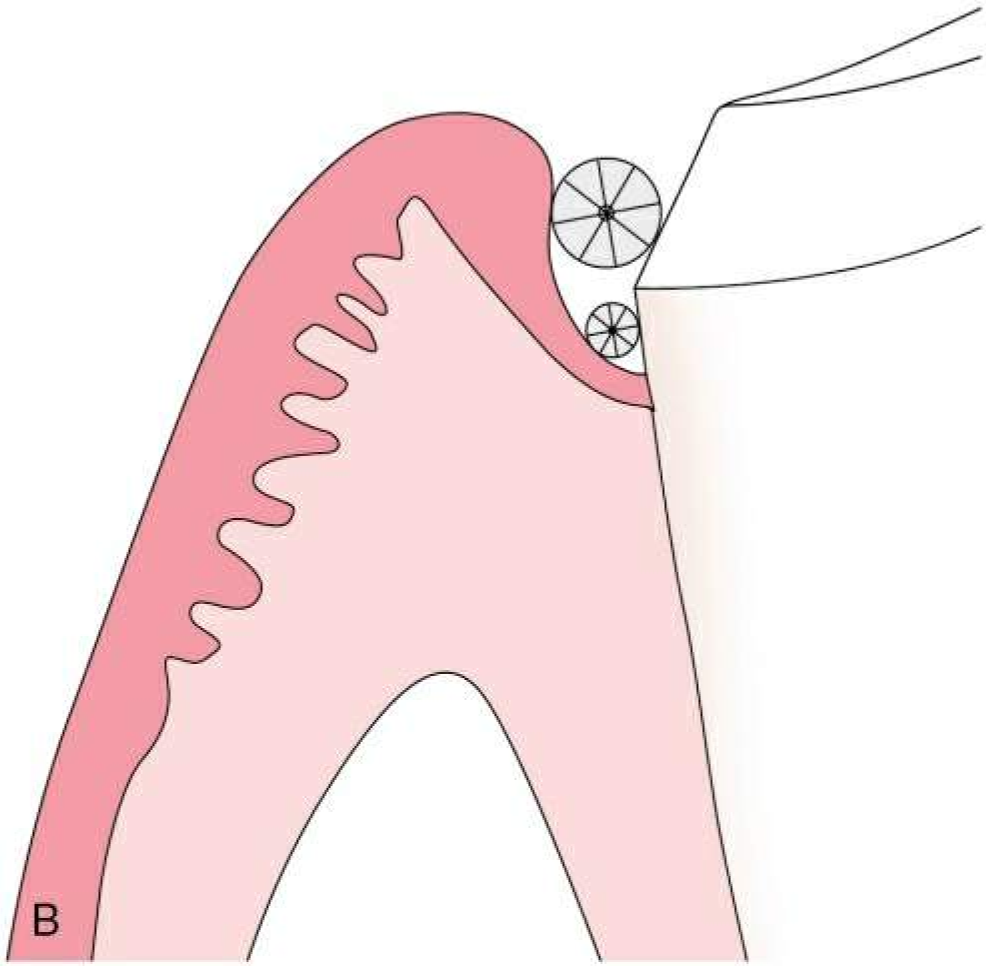


FIGURE 36.27 **(A)** Extra thin cord is placed first **(B)** followed by impregnated cord placed on the top which is removed prior to the impression.

Chemical

This is a recent development where retraction is achieved using only chemicals.

This consists of an aluminium chloride–containing paste (Expasyl) (Fig. 36.28) which is injected into the sulcus prior to impression making (Fig. 36.29). The paste is left in the sulcus for 3–4 min to achieve the desired retraction. It is washed off and impression is made (Fig. 36.30).

FIGURE 36.28 Expasyl.

FIGURE 36.29 Injection of the paste.

FIGURE 36.30 Paste is washed off to achieve retraction and haemostasis.

Advantage

- Achieves good haemostasis with less trauma.

Disadvantage

- Retraction is much less compared to cord.

Surgical

1. Rotary curettage (gingettage)

It is also called 'gingettage'. The concept of using rotary curettage was described by Amsterdam in 1954.

Rotary curettage is a troughing technique. Epithelial tissue in the sulcus is removed by a rotary instrument while finish line is being created.

This technique is well suited for use with reversible hydrocolloid impression materials. Rotary curettage must be done only on healthy gingiva to avoid tissue shrinkage. This technique can be used only when there is

- Absence of bleeding upon probing.
- Sulcus depth less than 3 mm.
- Presence of adequate keratinized gingiva.

Technique

A supragingival finish line is first created to complete the tooth preparation (Fig. 36.31).

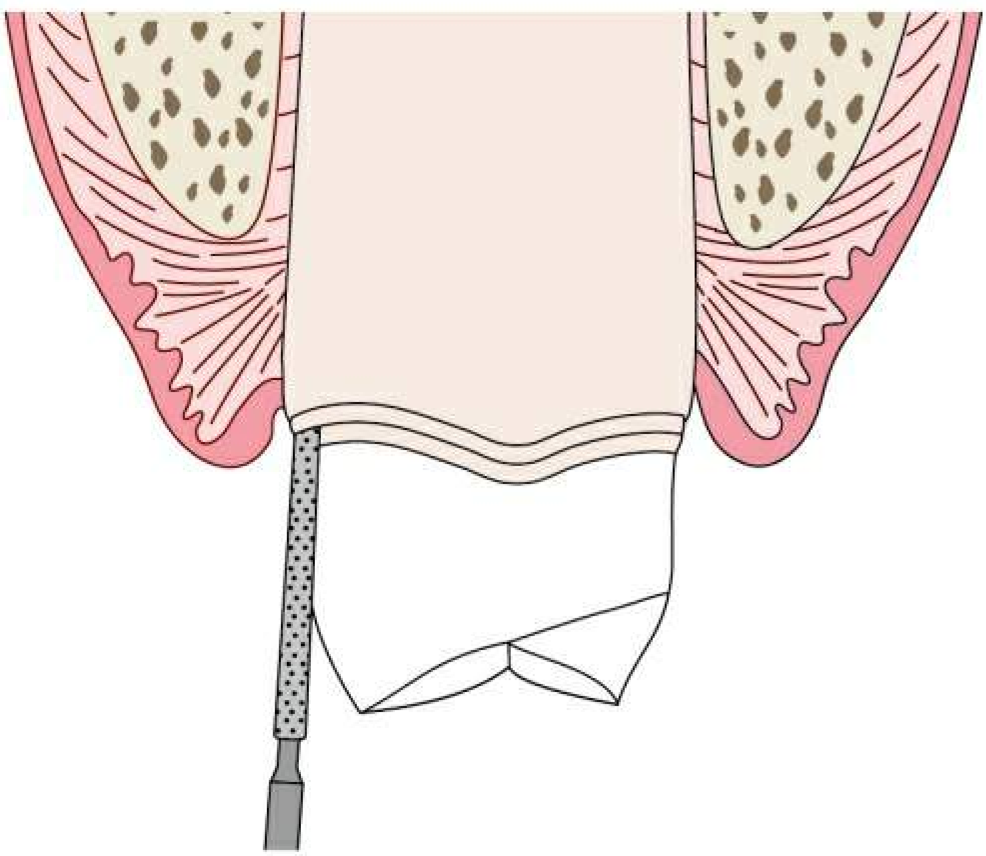


FIGURE 36.31 A shoulder is formed at the level of gingival crest prior to rotary curettage.

A torpedo diamond is used to extend the finish line apically, one-half to two-thirds the depth of sulcus to produce a chamfer finish line (Fig. 36.32).

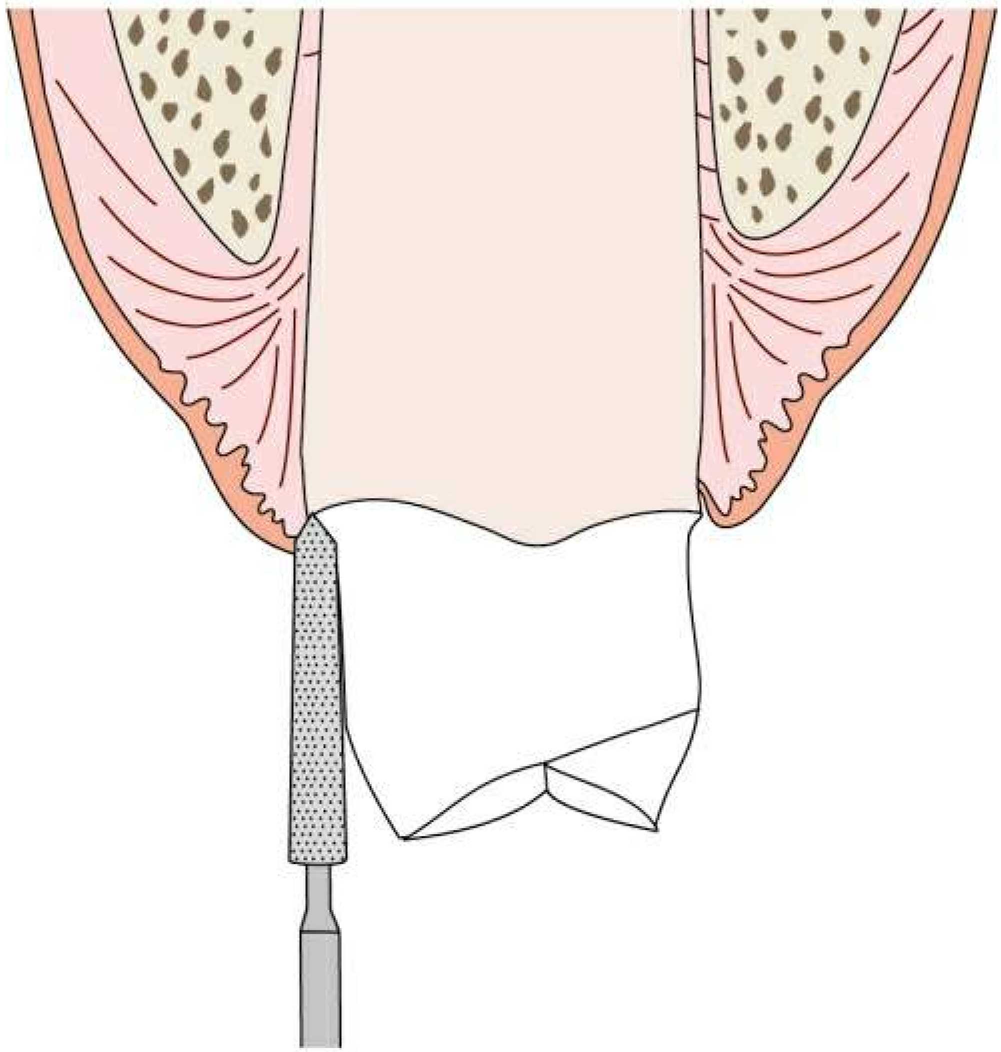


FIGURE 36.32 Epithelial tissue in the sulcus is removed by a torpedo diamond while finish line is being created.

As only half the diamond is used to produce the chamfer, the other half will create a trough around the tooth removing a layer of epithelial tissue achieving the desired retraction (Fig. 36.33).

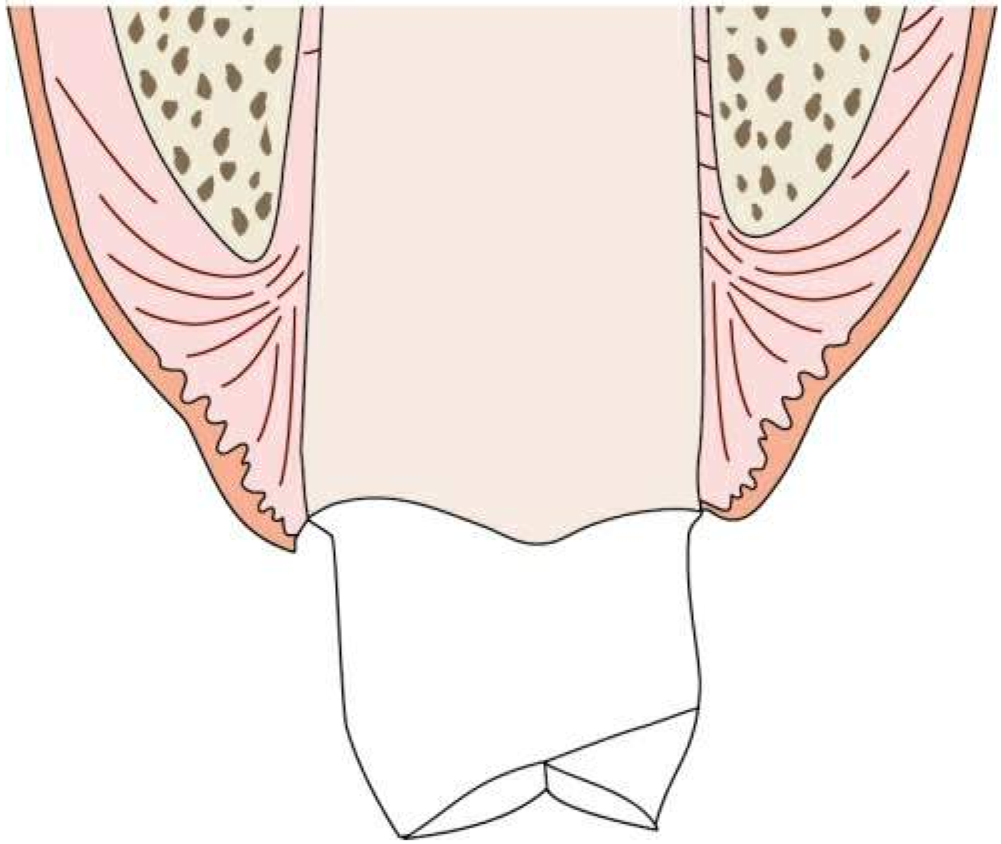


FIGURE 36.33 Gingival retraction produced by the creation of a trough around the finish line.

A retraction cord impregnated with aluminium chloride or alum is gently placed in the sulcus or a haemostatic agent is injected to control haemorrhage.

After 4–8 min the cord is removed and sulcus is thoroughly irrigated with water and impression is made.

Disadvantages

There is poor tactile sensation while using diamonds which can lead to deepening of the sulcus.

It has potential for destruction of periodontium with inexperienced hands.

2. Electrosurgery

It produces controlled tissue destruction to achieve a surgical result.

Mechanism

- High density current from a small cutting electrode produces a rapid rise of temperature at the point of contact with tissue. The cells in contact with the electrode are destroyed by this temperature rise.

- An unmodulated alternating current is recommended for gingival displacement.

Indications

1. Gingival sulcus enlargement and haemostasis

2. Gingivectomy

3. Crown lengthening

Contraindications

1. Patients with electronic medical devise – cardiac pacemaker, insulin pump.

2. Patients with delayed healing because of debilitating diseases or radiotherapy.

3. Not used if attached gingiva is thin.

4. Not to be used with metal instruments as contact with them can produce electric shock – better to use plastic mouth mirrors and saliva ejectors.

5. It should not be used in presence of flammable agents, like topical anaesthetics such as ethyl chloride or other aerosols, nitrous oxide analgesia as electrosurgery can produce sparks during use.

Electrosurgical equipment (fig. 36.34)

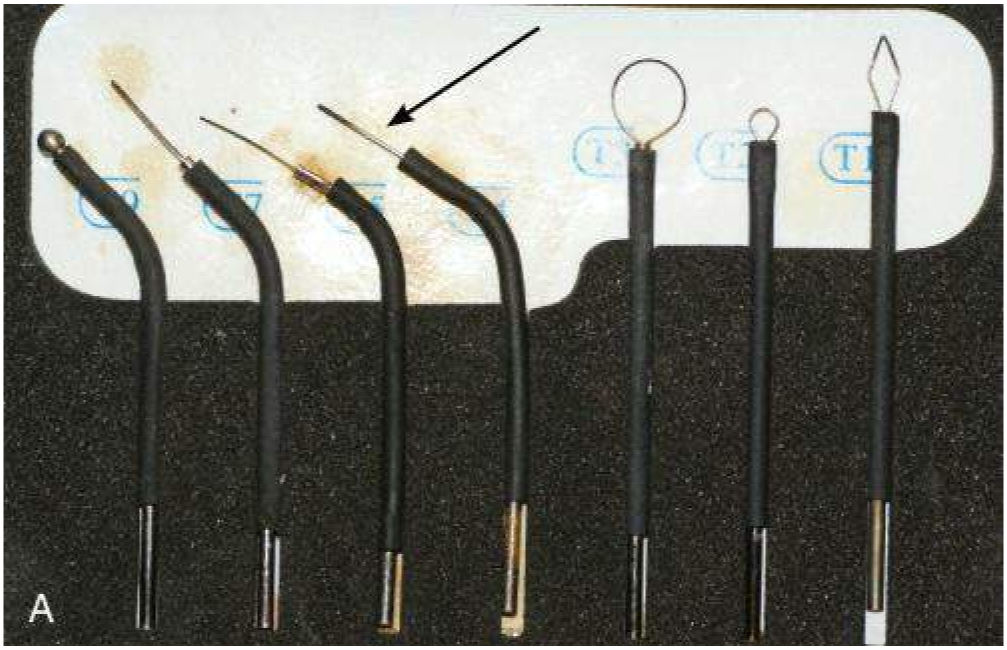
It consists of the following:

1. **Unit** – a high frequency oscillator or radio transmitter that generates heat.

2. **Handpiece** – holds the electrodes.

3. **Electrodes** – basically like probes of different shapes that fit into the handpiece and are used for cutting or coagulation, e.g. coagulating, diamond loop, round loop, small straight and small loop. The small straight electrode is used for gingival displacement (Fig. 36.35 A and B).

4. **Grounding plate** – Circuit is completed by placing a grounding plate in the back or under the thigh of the patient. It is important to prevent burns.



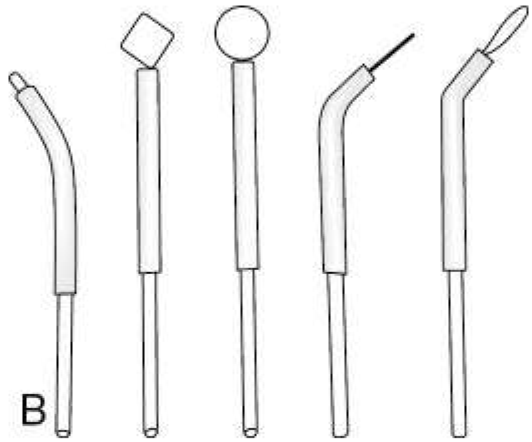


FIGURE 36.35 **(A)** Commonly available electrodes, small straight is used for gingival displacement. **(B)** Different shapes of electrodes used. L–R: Coagulating, diamond loop, round loop, small straight, small loop.

FIGURE 36.34 Electrosurgical equipment.

Technique for gingival displacement

Width of gingival sulcus is enlarged by creating a trough around the finish line (Fig. 36.36). This allows greater visibility and impressioning of the finish line. The height of the sulcus should never be decreased.

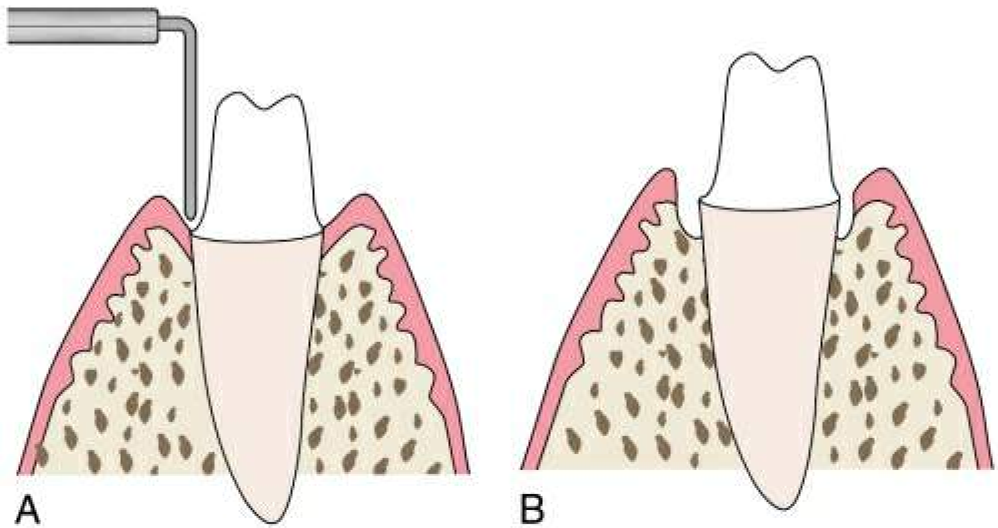


FIGURE 36.36 **(A)** Gingiva prior to electrosurgery. **(B)** Enlarged sulcus following the procedure.

There may be gingival recession if not properly performed. Profound local anaesthesia is necessary.

The working electrode must be clean and without carbonization. Electrode must be used with very light pressure and quick, deft strokes. It must be wiped with cotton soaked in alcohol to remove tissue debris after every stroke. Debris inside the sulcus is removed with cotton soaked in hydrogen peroxide.

By angling the working electrode at approximately 15–20° and carrying the tip through the tissue until it rests against the tooth, a small wedge of tissue can be removed. In cases of thin gingiva the angle of the working electrode is changed to be more parallel to the long axis of the tooth (Figs 36.37 and 36.38).

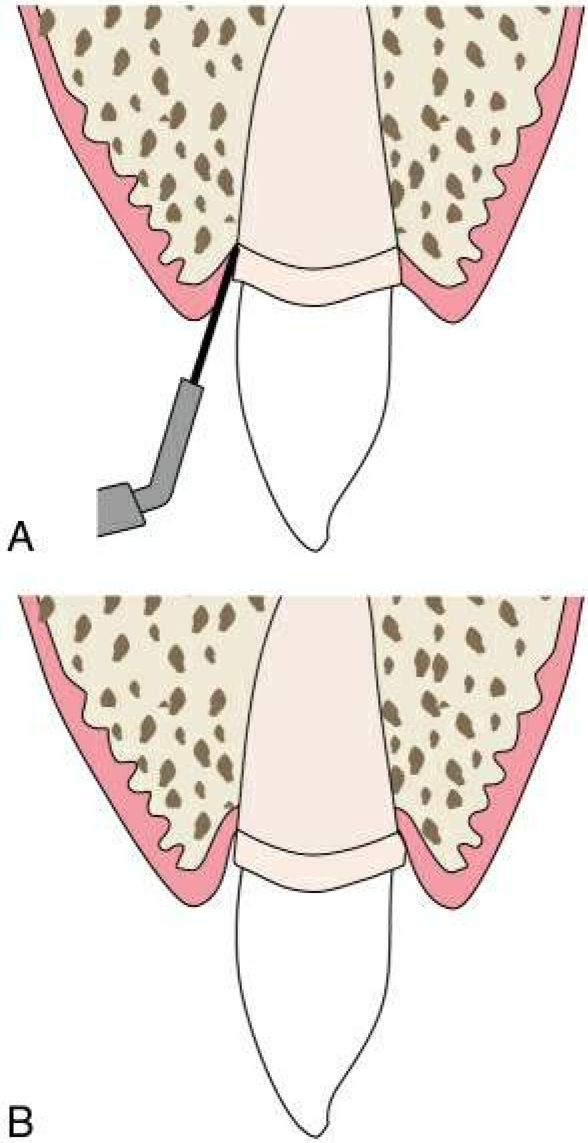


FIGURE 36.37 **(A)** Correct angulation and placement of electrode against the tooth and gingiva. **(B)** Following tissue removal.

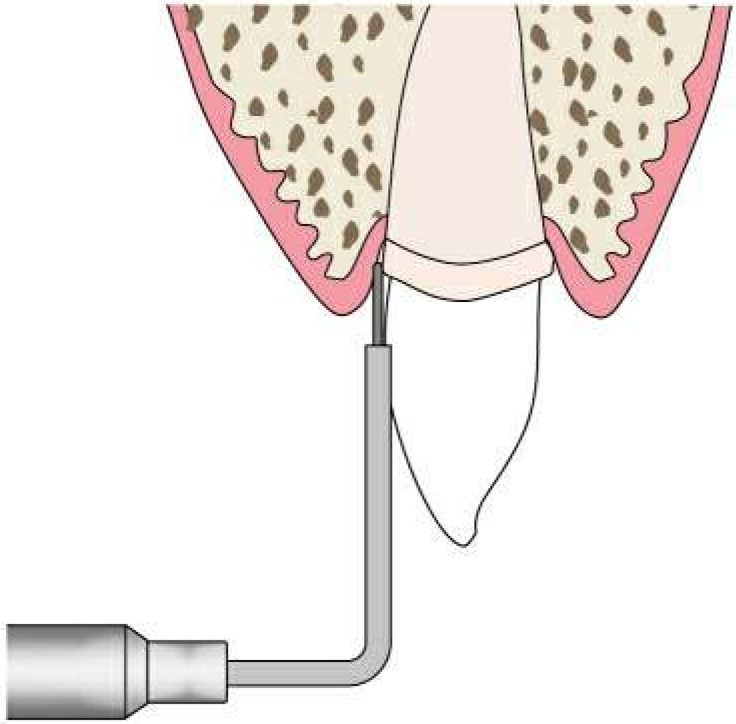


FIGURE 36.38 Parallel angulation for thin gingiva.

It must be moved at a speed of 7 mm/s to prevent lateral heat penetration. No stroke should be immediately repeated. If it is necessary to retrace the path of a previous cut, at least 5 s should be allowed to elapse before repeating the strokes.

The sequence of surgery should be, lingual surface first, followed by the facial surface, mesial surface and lastly the distal surface. This prevents the heat accumulation in the tissue (Fig. 36.39).

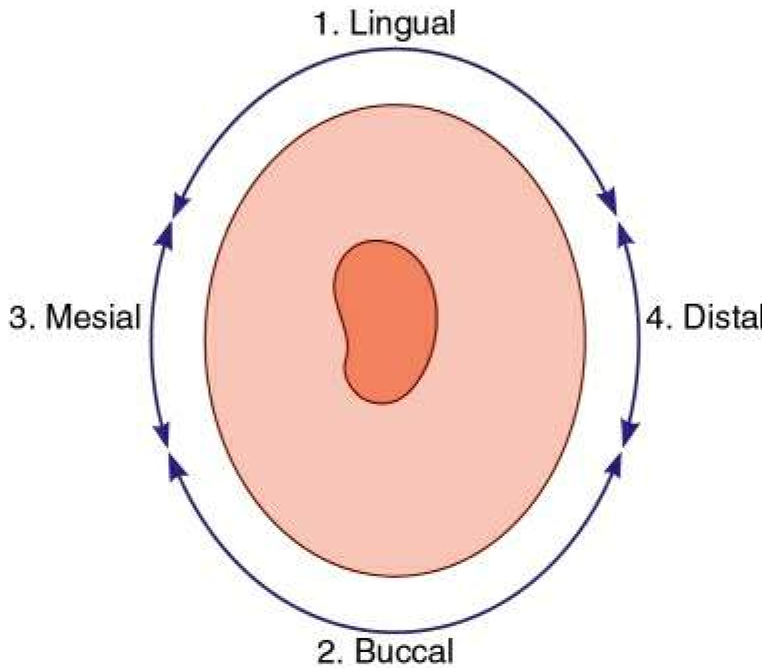


FIGURE 36.39 Recommended sequence for electrosurgical gingival displacement.

Moist tissue will cut best if it dries out; sterile water/saline is sprayed lightly. A high volume vacuum tip should be kept immediately adjacent to the cutting electrode at all times to remove the unpleasant odour that is generated.

Impression is made immediately following the procedure.

Proper technique can be summarized as follows:

1. Proper power setting.

2. Quick passes with the electrodes.

3. Adequate time intervals between strokes.

3. Soft tissue lasers

These can also be used for gingival displacement similar to electrosurgery.

SUMMARY

Gingival displacement is an important procedure for fabricating indirect restoration, especially when subgingival finish lines are used. Gingival displacement is relatively simple and effective when dealing with healthy gingival tissue and when margins are properly placed. The most common technique used for gingival displacement is the use of gingival retraction cord with a haemostatic medicament. Retraction cords of appropriate diameter should be used.

CHAPTER 37

Impression making

CHAPTER CONTENTS

Introduction

Impression: An imprint or negative likeness of the teeth and adjacent structures for use in dentistry (GPT8).

This is the first step necessary to fabricate an indirect restoration because it is not possible to make prosthesis directly in the mouth. An elastic impression material is loaded in a tray and inserted in the patient's mouth. Upon setting, a cast is poured and a positive likeness of the oral tissues is obtained.

An impression for a cast restoration should meet the following requirements:

1. Should be an exact duplication of the prepared tooth, inclusive of the preparation and adequate uncut tooth surface beyond the preparation to be certain of the configuration of the finish line.

2. Teeth and soft tissues adjacent to the prepared tooth must be accurately reproduced to permit articulation of the cast and contouring of the restoration.

3. Should be free of bubbles particularly at the finish lines and the occlusal surfaces of other teeth in the arch.

To make a successful impression knowledge of the following is essential:

1. Material

2. Mould or tray

3. Method or technique

Impression material

Ideal requirements

The fabrication of a cast requires an impression material that produces an accurate negative likeness of the oral tissues.

The ideal properties of an impression material are as follows:

1. Accurately reproduces the oral tissues for which they need to exhibit:

i. **Complete plasticity before cure** – facilitates seating the impression

ii. **Sufficient fluidity** – to record fine details like finish lines

iii. **Ability to wet the oral tissues** – to record gingival areas

iv. **Dimensional accuracy** – absence of dimensional change during setting

v. **Dimensional stability** – to enable transport to laboratory

vi. **Complete elasticity after cure** – to enable removal from undercuts in mouth

vii. **Optimal stiffness** – to prevent deformation from weight of poured die material

2. Have an infinite shelf life.

3. No armamentarium.

4. Nontoxic and nonirritating.

5. Acceptable odour, taste and colour.

6. Suitable working and setting times.

7. Strength to resist tear.

8. Compatible with model and die materials.

9. Inexpensive.

10. Easy to dispense, proportion and mix.

11. Easy to cleanup.

12. Facilitates visualization of the finish line.

13. Permits multiple die pours.

14. Facilitates the clinical identification of beginning and end of cure.

Elastic impression materials

Only elastic materials can be used to make impressions for fabricating fixed restorations because of their ability to record undercuts without permanent deformation. The following can be used in the order of their development:

1. Reversible hydrocolloids

2. Elastomeric impression materials

i. Polysulphides

ii. Condensation silicones

iii. Polyether

iv. Addition silicones

Irreversible hydrocolloids (alginates) do not possess sufficient accuracy for fabricating fixed prostheses and should not be used. The above-mentioned materials can produce casts of sufficient accuracy to fabricate clinically acceptable fixed restorations.

Reversible hydrocolloids

(Synonyms: Agar hydrocolloid, agar agar)

- It is a polysaccharide derived from seaweed.

- It is supplied by the manufacturer as a preformed gel that is liquefied before use. At high temperatures the agar changes from gel to a sol. This is reversible; as the material that cools it is converted from sol to a gel, hence the name reversible hydrocolloid. Agar changes from gel to a sol at 99°C and remains a sol till about 50°C, forming a gel slightly above room temperature.

- Practically, the required temperature changes are affected with a special conditioning unit which includes a boiling water bath to liquefy the hydrocolloid gel, a second bath for storing the material at 63–66°C and a bath for tempering the material at 44–46°C (Fig. 37.1).

- Water cooled trays (Fig. 37.2) are used for reversible hydrocolloid impressions. They have internal cooling water channels that accelerate gelation (set the material).

- Gelation occurs from the tray towards the tissue hence any shrinkage is compensated for. Thus they have an excellent dimensional accuracy. Dimensional stability is, however, compromised by the ease with which water can be released from (syneresis) or absorbed (imbibition) by the material. Hence, the impression must be poured immediately to avoid distortion. They also have poor tear strength.

- They are available in tubes as a heavy bodied tray material and a less viscous wash, regular and syringe material.

- The complexity of the equipment combined with inherent disadvantages of the material limits the widespread use of this material routinely in fixed prosthodontics.

FIGURE 37.1 Equipment for agar with liquefying, storage and tempering baths.

FIGURE 37.2 Water cooled trays with attachment for tubes connected to a water source.

Elastomeric impression materials

The elastomeric impression materials include polysulphide, condensation silicones, polyethers and addition silicones.

Polysulphide rubber

(Synonyms: Rubber base, mercaptan, thiokol rubber)

- They were introduced in the 1950s and were then accepted widely as they had better dimensional stability and tear strength than irreversible hydrocolloids.

- The polysulphide base reacts with an appropriate chemical usually lead dioxide (catalyst) in the presence of sulphur to form the soft rubber. Lead oxide is responsible for the typical brown colour which can stain clothing permanently if not handled properly. Alternatives like copper hydroxide make it more aesthetically pleasing (green colour) and cleaner in handling. Water and lead sulphides are by-products of this condensation reaction. The unpleasant sulphide odour is not well tolerated by patients.

- Loss of water limits the dimensional stability; hence, it also needs to be poured within an hour after allowing for elastic recovery. It also has an unfavourably long setting time, almost 10 min. High humidity (more than 60%) and temperature (more than 25°C) also dramatically reduce working time which can also affect dimensional stability.

- With no obvious advantages over other elastomerics and the above-mentioned disadvantages limit its routine use.

- Available as base and catalyst paste which are mixed to polymerize the material (Fig. 37.3).

FIGURE 37.3 A polysulphide impression material (*courtesy* GC).

Condensation silicone

(Synonyms: Silicone, polysiloxane) (Fig. 37.4)

- Polysulphide's disadvantages were overcome by this material. It is odourless and could be pigmented to any shade. It has a relatively short setting time (6–8 min) and is also less affected by temperature and humidity.

- Its dimensional stability is less than that of polysulphide because a volatile like ethyl alcohol was commonly a by-product of the condensation setting reaction. The main disadvantage is its poor wettability because of its hydrophobic nature. Hence, the teeth and gingival tissues must be completely free of moisture to enable a perfect impression without trapping air bubbles. A surfactant may also be required to pour a bubble-free cast.

FIGURE 37.4 A condensation silicone putty (jar) and light body base and catalyst (activator) paste (*courtesy* Coltene–Whaledent).

Polyether

(Synonym: Epimine)

- Polyethers were introduced in Germany in 1960s. With no formation of volatile by-products, dimensional stability is excellent and casts can be poured even after a day.

- A short setting time (5 min) combined with least polymerization shrinkage makes it a very useful material with high accuracy.

- Its high rigidity after setting is a disadvantage which causes problems when separating stone casts from impressions and making impressions of periodontally compromised teeth. Recently introduced polyethers have been modified to greatly reduce the stiffness. The catalyst can be a sensitizer; hence, patients who develop allergic reactions should avoid further contacts.

- They are available in a wide range of consistencies as base and catalyst pastes.

Additional silicones

(Synonym: Polyvinyl siloxanes)

- Introduced in 1970s, they are characterized by excellent dimensional accuracy and long-term dimensional stability. It is also less rigid than polyether making its properties more desirable.

- They are inherently difficult to wet, making it difficult to pour a bubble-free cast. Newer materials have also been modified for improved wettability. Release of hydrogen gas necessitated delayed pouring of casts, but newer materials contain finely divided palladium as hydrogen absorber and can be poured immediately. Setting inhibition can occur with selected latex gloves. This is due to dithiocarbamates used in gloves manufacturing.

- They are available in a wide range of consistencies as base and catalyst pastes.

A comparison of the various impression materials is given in Table 37.1.

Table 37.1

Comparison of elastomeric impression materials

Material	Advantages	Disadvantages
Reversible hydrocolloid	Dimensionally accurate Hydrophilic Long working time No custom tray required No mixing Material cost less	Low tear resistance Low dimensional stability Expensive equipment Difficult to disinfect
Polysulphide	High tear strength Easier to pour Lower cost High flexibility Accurate	Messy Unpleasant odour Long setting time Stability only fair
Addition silicone	Dimensionally stable Pleasant to use Short setting time Automixing Highly accurate	Hydrophobic Hydrophilic formulations Imbibes water Some release hydrogen
Condensation silicone	Short setting time Pleasant to use Good elastic properties Accurate	Hydrophobic Poor wetting Stability is low
Polyether	Dimensional stability High accuracy Short setting time Automixing	Short working time Very stiff Imbibition Most expensive

Consistency

The elastic impression materials are available in a range of consistencies depending on the viscosity and amount of filler used. They can be classified as:

1. Putty

2. Heavy body

3. Medium or regular body

4. Light body or wash or syringe material

- Selection of the material depends on the impression technique.

- Putty and heavy body materials cannot record fine detail.

- Light body material has very good flow and can be highly accurate. But light body cannot be used alone as it undergoes most polymerization shrinkage. So the thicker the light body layer more will be the shrinkage and less accurate will be the impression.

- Putty and heavy body are generally used as tray materials in combination with a light body as wash material.

- The medium or regular or monophase materials can be used as tray materials and because of their thixotropic properties; they can also be used as syringe materials. They require custom trays so that uniform material thickness can be maintained to reduce any polymerization shrinkage.

Manipulation

The elastomeric impression materials can manipulated as follows:

1. **Manual:** By mixing the base and catalyst by hand (Fig. 37.5).

2. **Automixing:** Most manufacturers now offer the materials as cartridges which include the base and catalyst, along with a mixing tip (spiral). The cartridge is inserted into a caulking gun-like device. Extrusion of material into the mixing spiral automatically mixes the base and catalyst and it can be directly placed into the tray or oral cavity depending on the need and consistency (Fig. 37.6).

FIGURE 37.5 A typical putty, regular and light body material for manual mixing (*courtesy* GC).

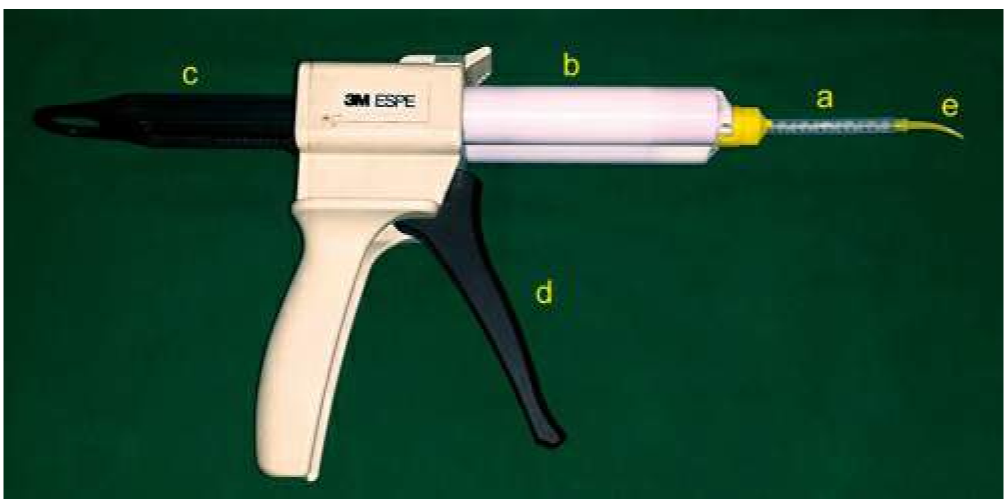


FIGURE 37.6 Anautomix gun with material: spiral mixing tip (a), cartridge containing base and catalyst (b), plunger (c), trigger (d), intraoral tip (e).

Advantages

- Mixing is certainly more homogenous with less voids; hence, mechanical properties are better.
- Less material wastage.

- No clean-up mess.
- Reduced chairside time.

This is not available for polysulphide materials as they are too sticky.

Impression trays

The choice of impression material and technique influence a tray selection. Time, expense and accuracy must all be considered for making a tray selection.

Trays can be classified as follows.

Stock trays

- These are prefabricated trays made in metal or plastic. Metal trays are preferred as they are rigid and not susceptible to distortion (Fig. 37.7).
- Retention for the material is provided by perforations, rim locks and/or tray adhesives.

FIGURE 37.7 Stock trays.

Advantages

- Stock trays eliminate the time and expense of making custom trays.
- Can be reused.

Disadvantages

- As their fit in the mouth is only an approximation, it is not possible to obtain a uniform thickness of impression material which could cause more distortion than when custom trays are used.
- More material is also required.

Custom trays

These are fabricated individually for each patient.

Advantages

- Less material is used.
- A uniform thickness of impression material minimizes distortion resulting from polymerization shrinkage.

Disadvantages

- It requires more time for construction.
- It is more expensive.

Triple trays

- They record the prepared and adjacent teeth, opposing teeth and the maximum intercuspal occlusion (bite), hence the name triple tray (Fig. 37.8).
- These are indicated for single unit, less extensive restorations in each arch.
- When a triple tray is used the technique is called **closed-mouth impression** as the patient is required to occlude while the material polymerizes.

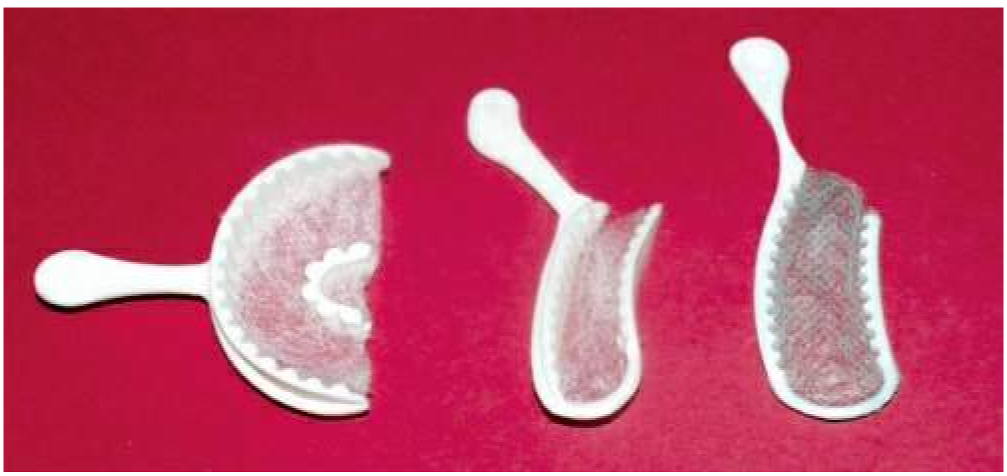


FIGURE 37.8 Triple trays – anterior (left) and posterior (right).

Advantages

- They eliminate the need for an articulator.
- Utilize less material.
- Minimize deformation of the mandible during opening.

Disadvantages

- Chances of distorted impression are high if the patient is not trained properly to occlude in maximum intercuspation prior to impression making.

- Distribution of impression material is not uniform.

- Eccentric occlusion needs to be evaluated and adjusted during restoration delivery.

Tray adhesives

These are applied to impression trays to enhance the adhesion of impression materials to intraoral impression trays. They ensure that the completed impression remains firmly attached to the tray upon removal from the mouth.

Generally, it is composed of silicone adhesive, alcohol and a colourant. It is supplied in dark bottles which should be immediately closed after use and kept out of sunlight. Every impression material manufacturer supplies the adhesive compatible with the material.

Impression techniques

There are two impression techniques that can be employed:

1. **Single impression:** While making an impression, tray is inserted into the patient's mouth only once. Depending on whether one/two viscosities of material are used it can be further classified as:

   i. Single mix

   ii. Double mix

2. **Double impression:** Impression is made once with high-viscosity material, a space is created and a second impression is made with low-viscosity material.

- Both of the above techniques can be performed using stock trays, custom trays and triple trays.
- While making single impression with single mix technique a custom tray is mandatory as uniform thickness of material is required.

Single-impression technique: Double mix (heavy + light body) – using custom tray and automixer

- A custom tray is fabricated in autopolymerizing resin using two sheets of baseplate wax (3 mm) as spacer and four widely placed tissue stops in nonfunctional surfaces of the teeth (Fig. 37.9). This helps in proper orientation of special tray. It should extend 3–5 mm from the gingival margin and extend 3 mm beyond the distal tooth.

There is no need to cover the palate for maxillary special trays (Fig. 37.10). The wax spacer is then removed after the final set of the resin. It is stored at room temperature for about 24 h to minimize distortion.

- Evaluate the custom tray in the mouth and correct the extension.
- Gingival retraction cords are placed in sulcus of abutment teeth.
- Apply tray adhesive to the tissue surface and also cover the border of the tray with the same (Fig. 37.11).
- Fix the light body cartridge in the gun with the spiral and the intraoral tip.
- Remove the cord from the sulcus and gently dry with compressed air.
- Place the intraoral tip of the spiral of the light body cartridge in the margin of abutment and inject material slowly. Start with distal embrasure and follow the material. After the abutment is covered, place additional light body material onto edentulous spaces and occlusal surfaces of posterior teeth (Fig. 37.12).
- Simultaneously have the assistant extrude the heavy body material onto the custom tray (Fig. 37.13).
- Seat the tray in the mouth from posterior to anterior allowing excess material to extrude anteriorly and hold it immobile while it polymerizes. The time varies with the material (Fig. 37.14).
- Remove the tray in a snap after checking if material has set (Fig. 37.15).
- Rinse with ambient water and dry with short bursts of compressed air.

FIGURE 37.9 Wax spacer with stops.

FIGURE 37.10 Custom tray fabricated without palatal portion.

FIGURE 37.11 Tray painted with tray adhesive.

FIGURE 37.12 Light body injected on preparation using automixer.

FIGURE 37.13 Heavy body dispensed onto custom tray using automixer.

FIGURE 37.14 Tray seated in patient's mouth.

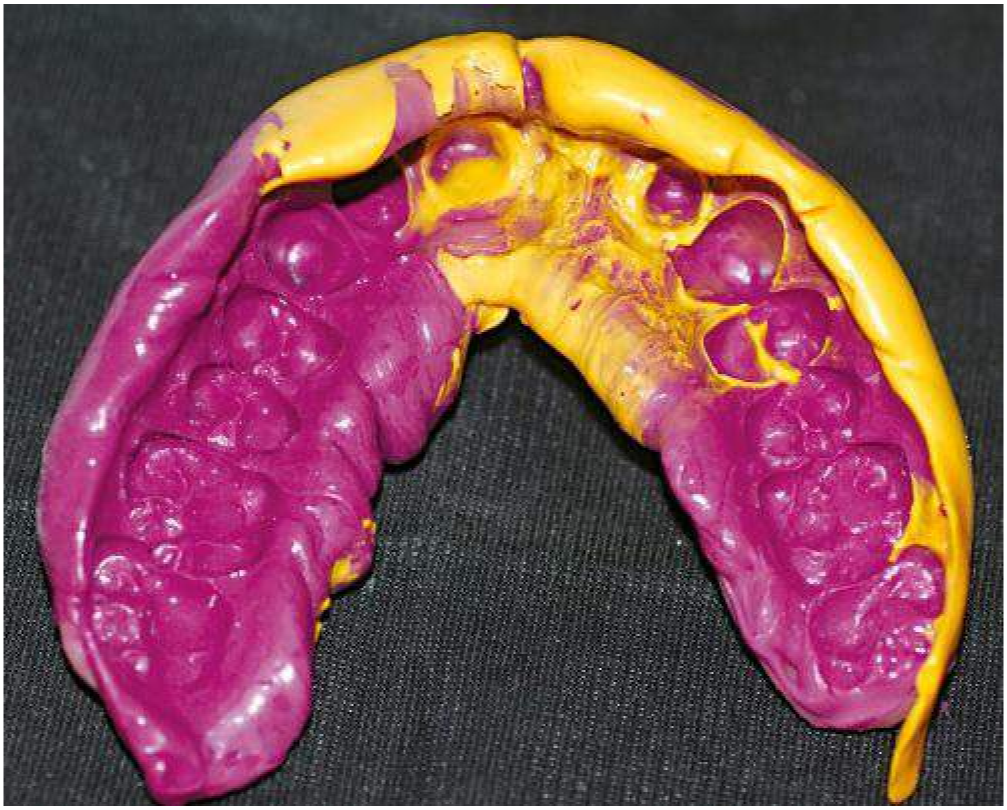


FIGURE 37.15 Completed impression.

The procedure for single-impression technique using a single mix is similar to the above method except that the same regular body or monophase material is used both as a tray and as a syringe material.

Double-impression technique

Method 1: Double-impression technique with stock trays using putty and light body (manual mix) with spacer

This is one of the most commonly used methods of making an impression for a fixed prosthesis.

- A stock tray is selected based on the shape and size of the patient's arch. It is then coated evenly with a tray adhesive.

- The high-viscosity putty material is mixed according to the manufacturer's instructions and rolled into an elongated cylinder. If addition silicones are used, mixing putty with latex gloves must be avoided as it retards the setting of the material. It is then loaded onto the stock impression tray (Fig. 37.16A–D).

- A sheet of polyethylene is used to cover the putty as a spacer. The spacer provides space for the final impression material and also allows tray to be repositioned a second time easily by blocking the undercuts (Fig. 37.17).

- The tray is then inserted and seated in a rocking type of motion. It is kept in place for approximately 2 min and removed (Fig. 37.18A and B).

- The spacer is then peeled off and excess impression material is removed with a sharp knife.

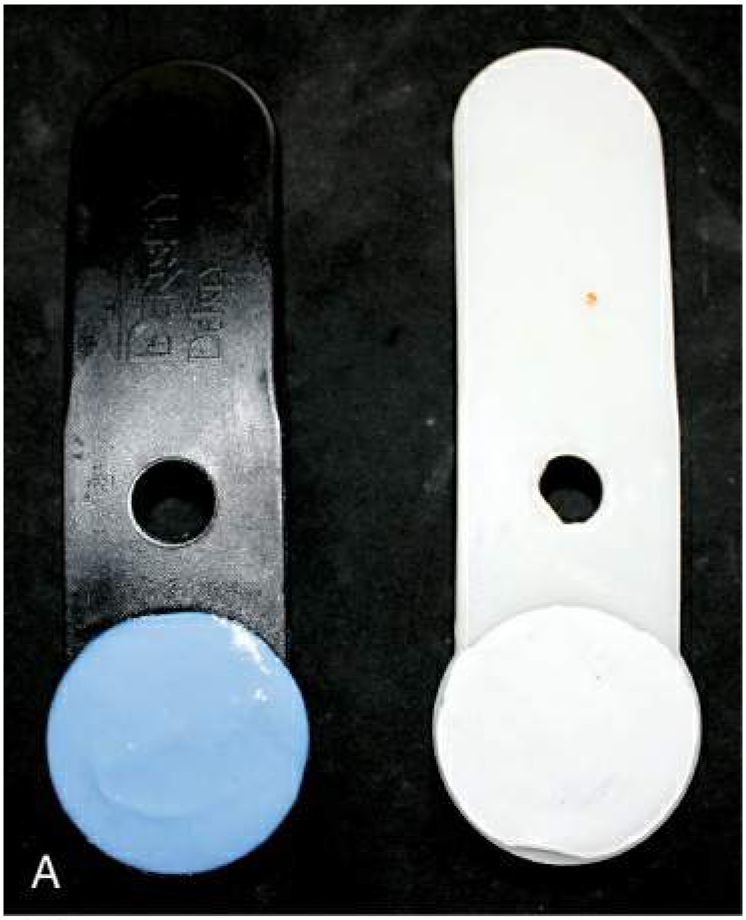
- The gingiva is then displaced with a gingival retraction cord after isolation with cotton rolls and drying the preparation with compressed air. The cords are left in place for 8–10 min.

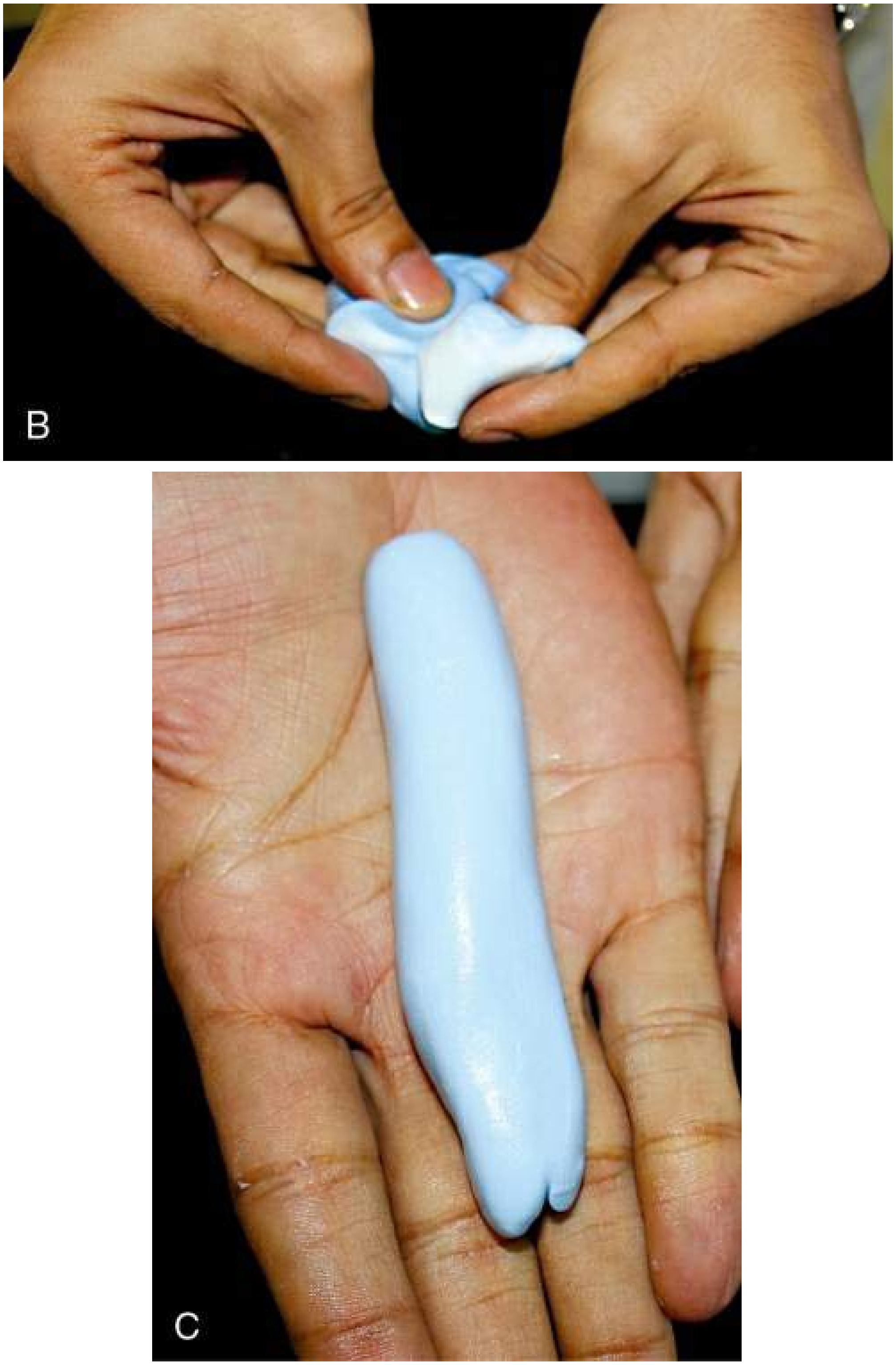
- A large mixing pad (6 × 8 inches) or a glass slab is selected. Equal lengths of base and catalyst pastes of light body manual mix impression material are dispensed (Fig. 37.19).

- The low-viscosity material is then mixed according to the manufacturer's instruction. First, using a circular motion and then a figure eight motion to blend and flatten the mixture onto the mixing pad in order to reduce the number of voids in the mixture. Half of the material is loaded into the light body syringe by holding the barrel at an angle pushing it through the mix and sliding it over the mixing pad (Fig. 37.20). The remaining material is loaded onto the tray on top of the putty without overfilling it (Fig. 37.21).

- The gingival cord is then removed and the light body is syringed onto the abutments and other areas (Fig. 37.22).

- The tray is then positioned over the arch and seated from posterior to anterior allowing the excess to extrude anteriorly. Force is applied in vertical direction until further seating is not possible (Fig. 37.23).
- The tray is removed after the material sets (Fig. 37.24).




B
C

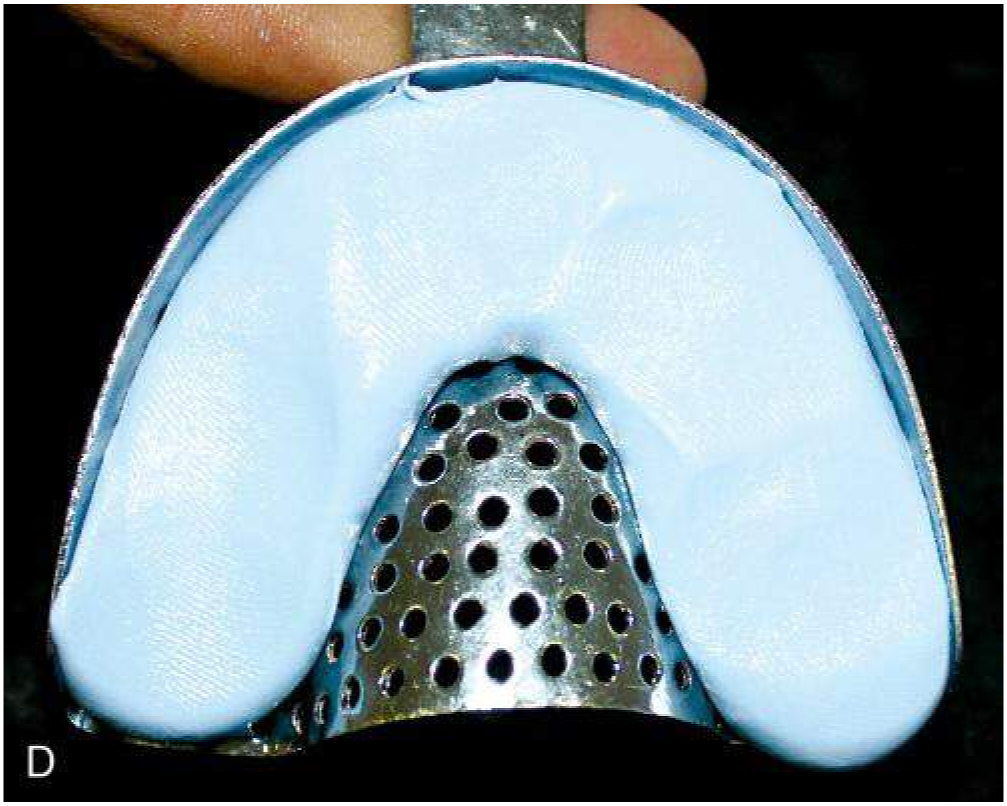


FIGURE 37.16 **(A)** Equal scoops of putty base and catalyst are taken. **(B)** Mixed homogenously. **(C)** Rolled into a cylinder. **(D)** Putty is loaded onto the stock tray.

FIGURE 37.17 Polyethylene spacer.

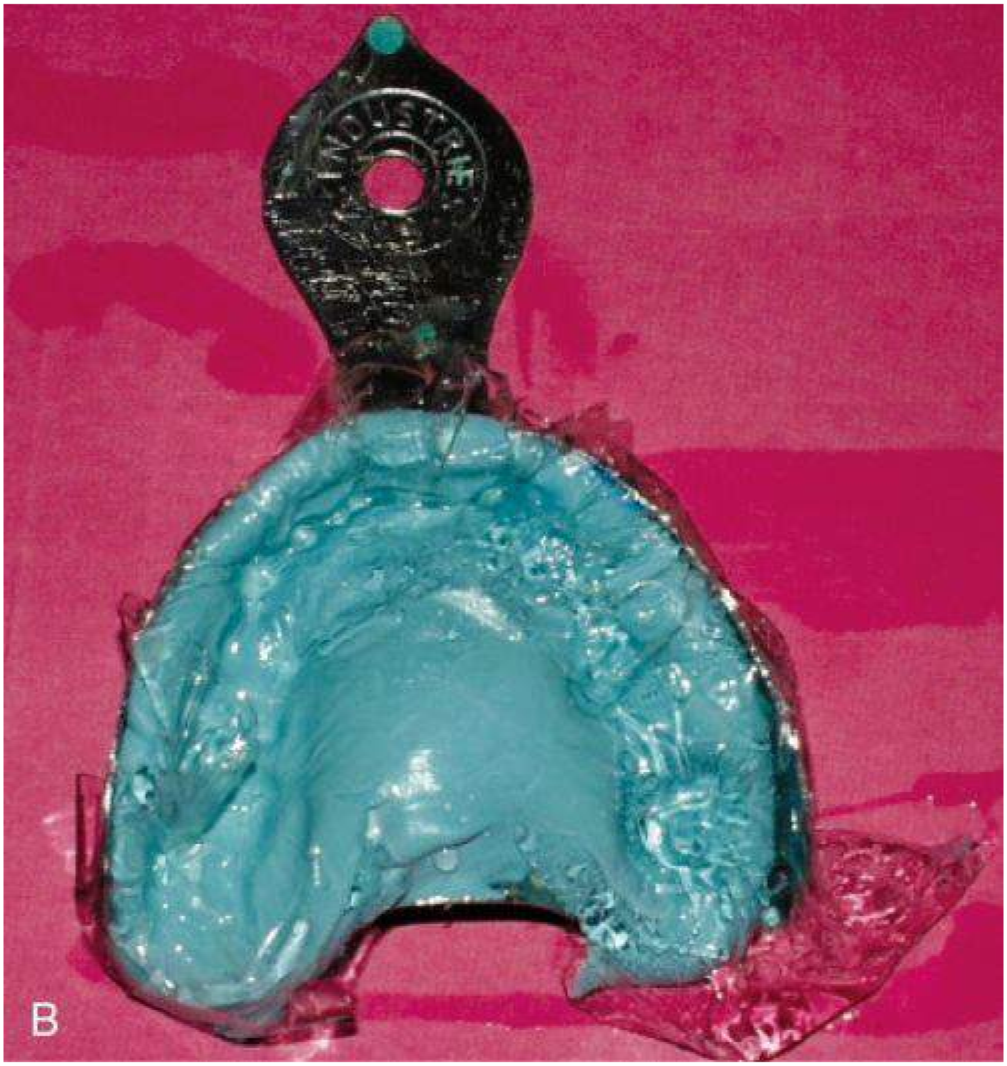


FIGURE 37.18 **(A)** Tray inserted and positioned in the patient's mouth. **(B)** Tray with spacer after removal from mouth.

FIGURE 37.19 Equal lengths of light body base and catalyst paste dispensed.

FIGURE 37.20 Part of material is loaded into light-body syringe.

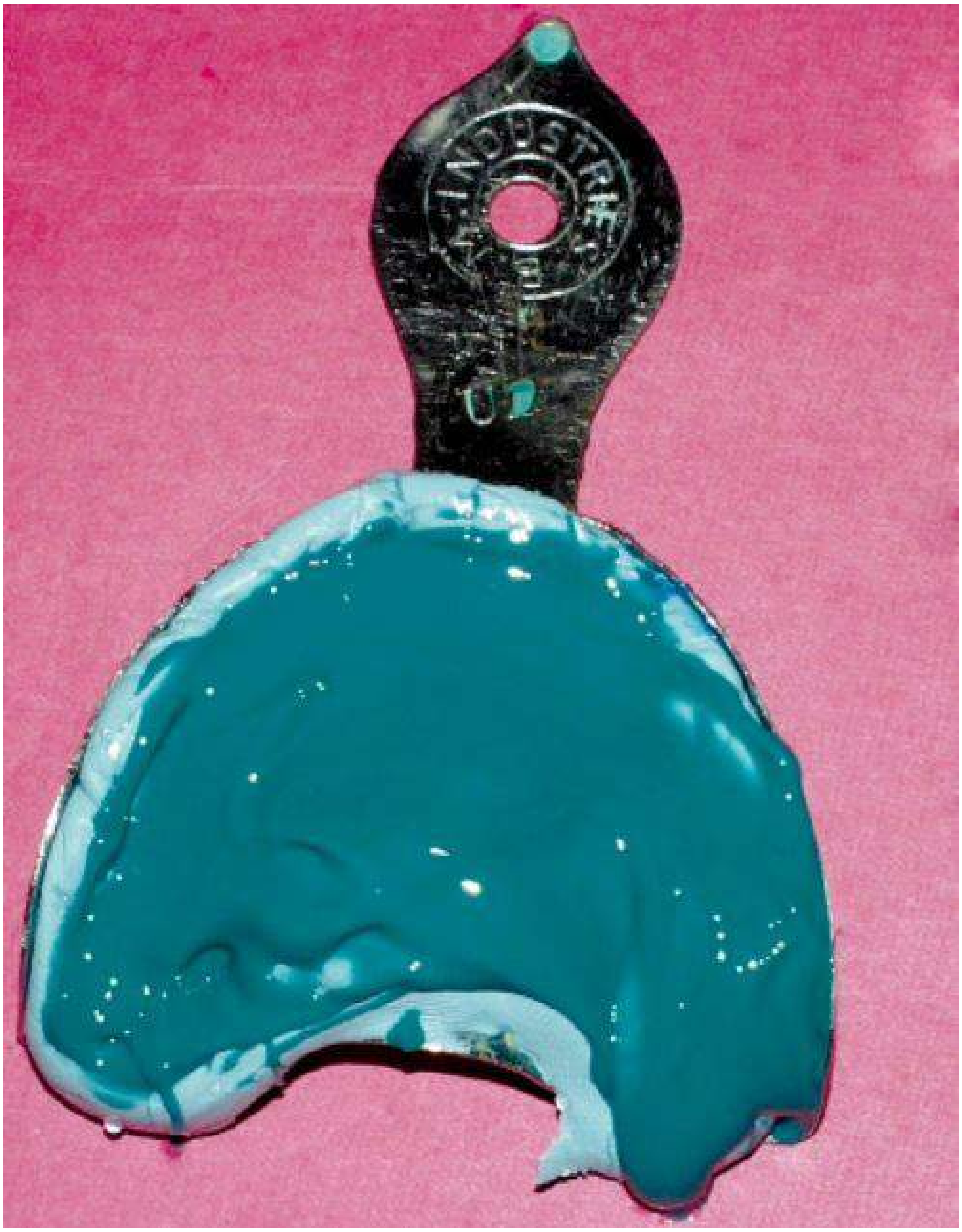


FIGURE 37.21 Remaining material is loaded onto tray.

FIGURE 37.22 Light body injected on the prepared teeth.

FIGURE 37.23 Tray placed in the mouth.

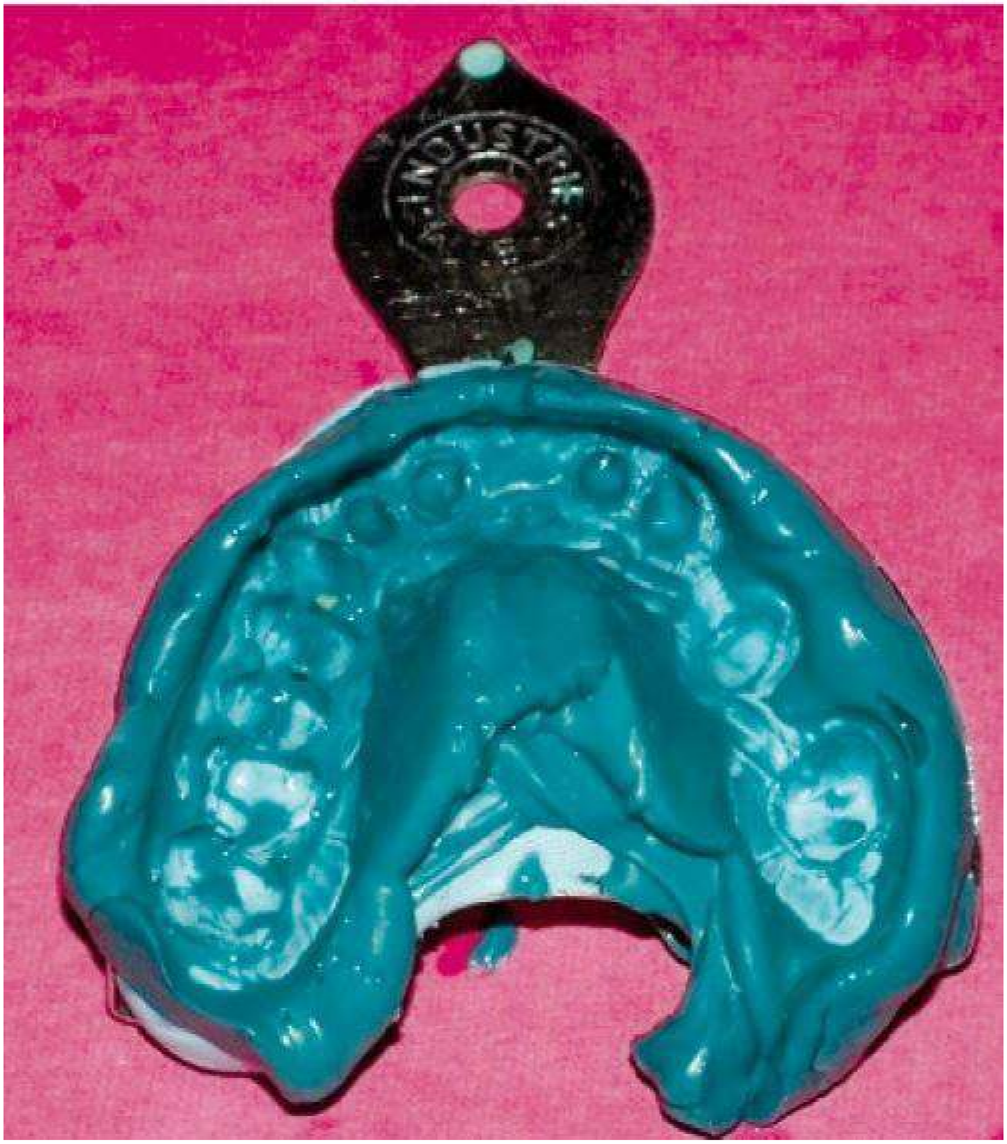
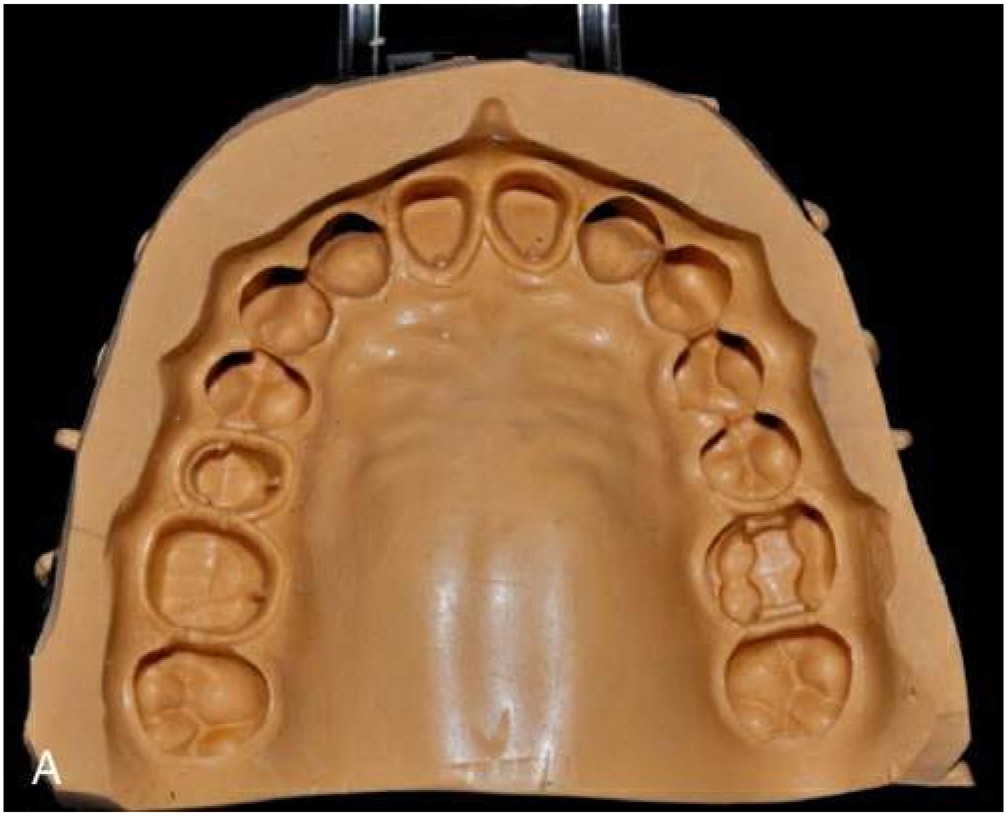


FIGURE 37.24 Final impression.

Method 2: Double-impression technique with stock tray using putty and light body (manual mix) by scraping

- Instead of cellophane sheet, the putty material around the prepared tooth in the interdental spaces and over the palatal surface to displace the excess light body material is scraped out using a ‘putty cutter’ instrument or surgical blade to provide space for the light body material (Fig. 37.25A–C).



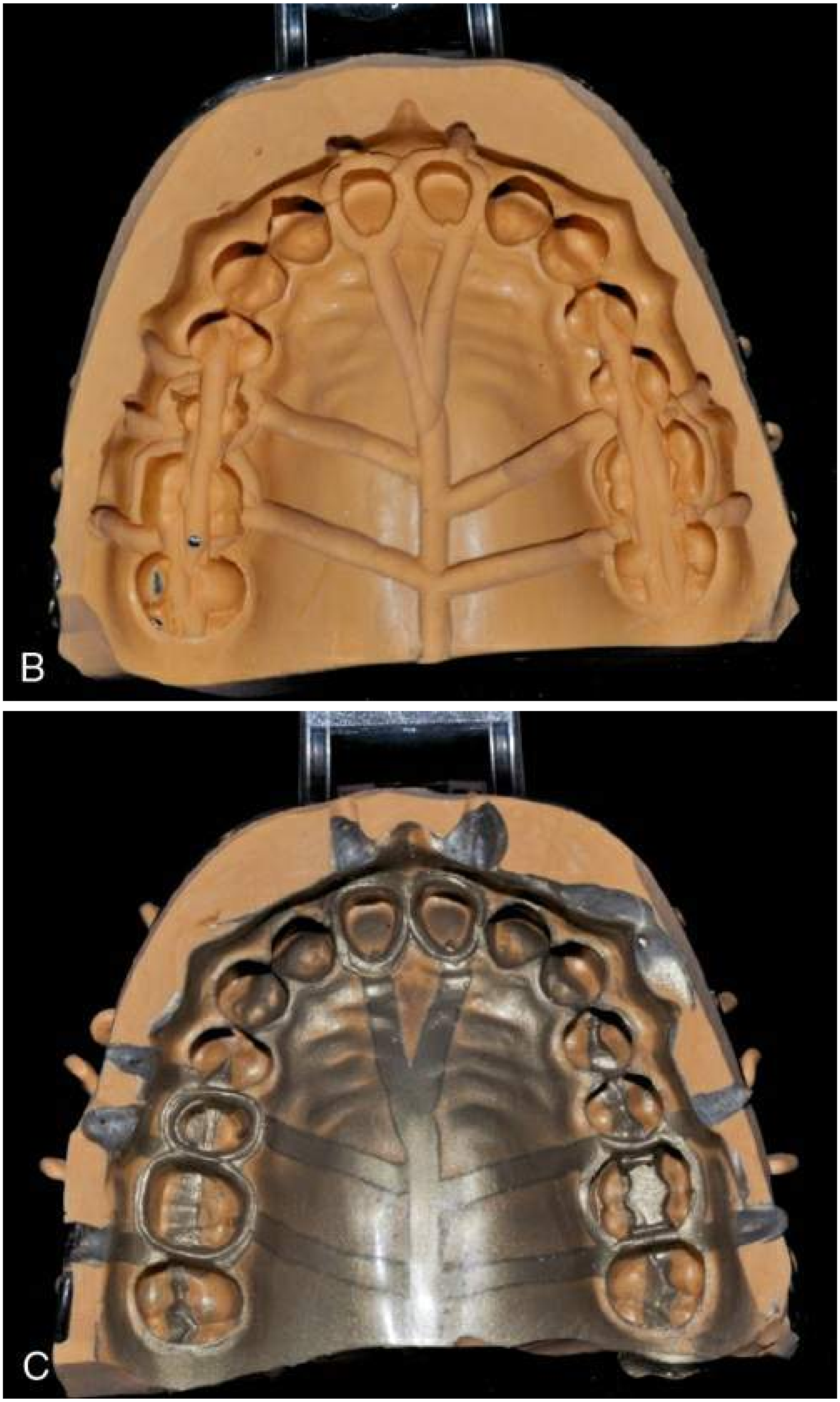


FIGURE 37.25 **(A)** Putty impression following removal from

patient's mouth. **(B)** Scraping of the putty material done. **(C)** Final impression made using the light body.

The impression techniques so far, were 'open-mouth' techniques where the patient's mouth remains open while the impressions are made. The following technique is a 'closed-mouth' technique where patient is made to close the mouth in Maximal intercuspal position while the impression is made.

Single-impression technique: Double mix (putty + light body) – using triple tray and automixer

- Select a triple tray and check its fit to ensure patient closes in maximum intercuspation without interference. Also get the patient to practice closing in that position.
- Remove the retraction cord and inject the automixing light body material with intraoral tip onto the abutment tooth and opposing teeth (Fig. 37.26).
- Concurrently make the assistant load the putty on both sides of the triple tray after mixing the same with a machine mixing system for putty (Fig. 37.27A–C). Example: Pentamix, Sympress.
- Place the loaded tray onto the arch and have the patient close in the desired position. Check contralateral side to verify occlusion (Fig. 37.28A and B).
- Remove the set impression by applying pressure on unprepared side and helping the patient to open the mouth (Fig. 37.29).

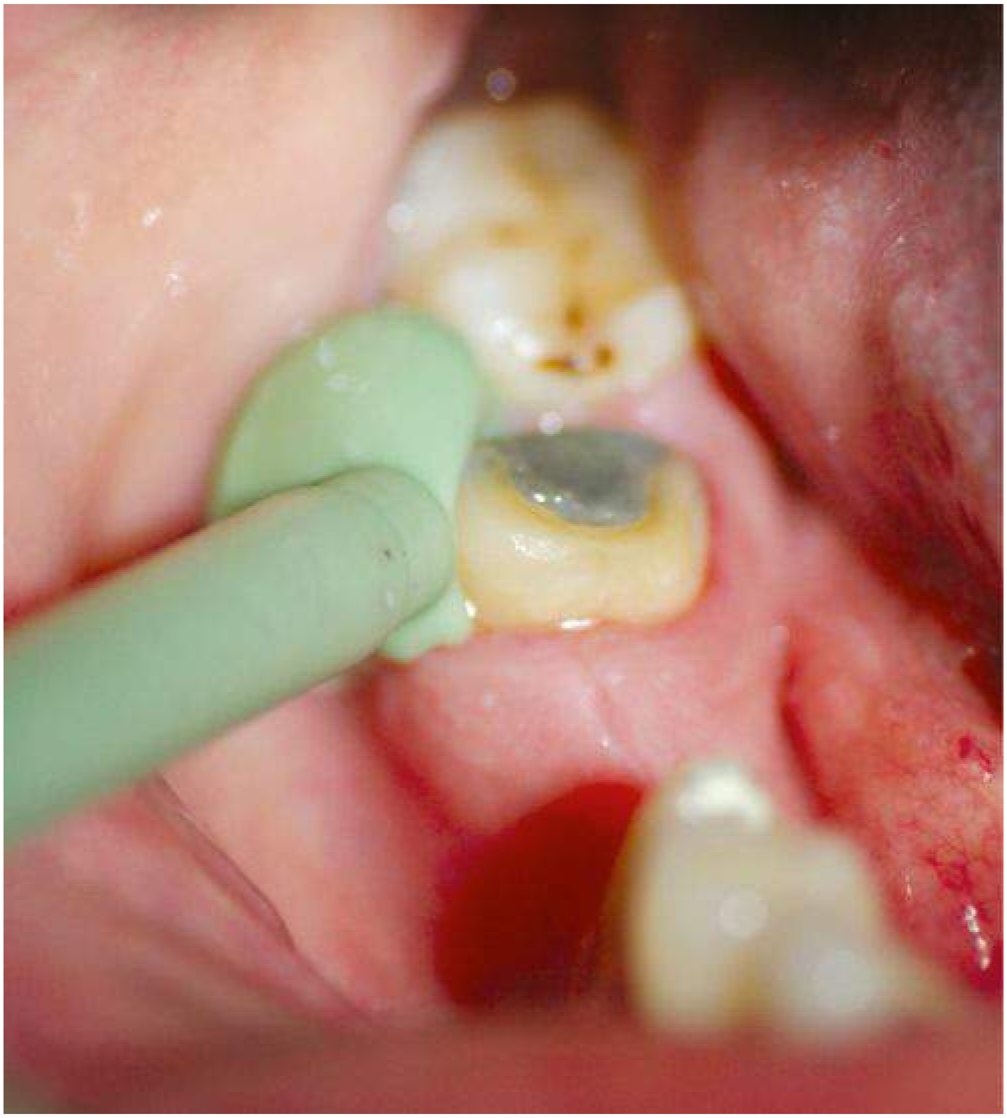


FIGURE 37.26 Light body from automix cartridge injected onto prepared tooth.


SYMPRESS
A

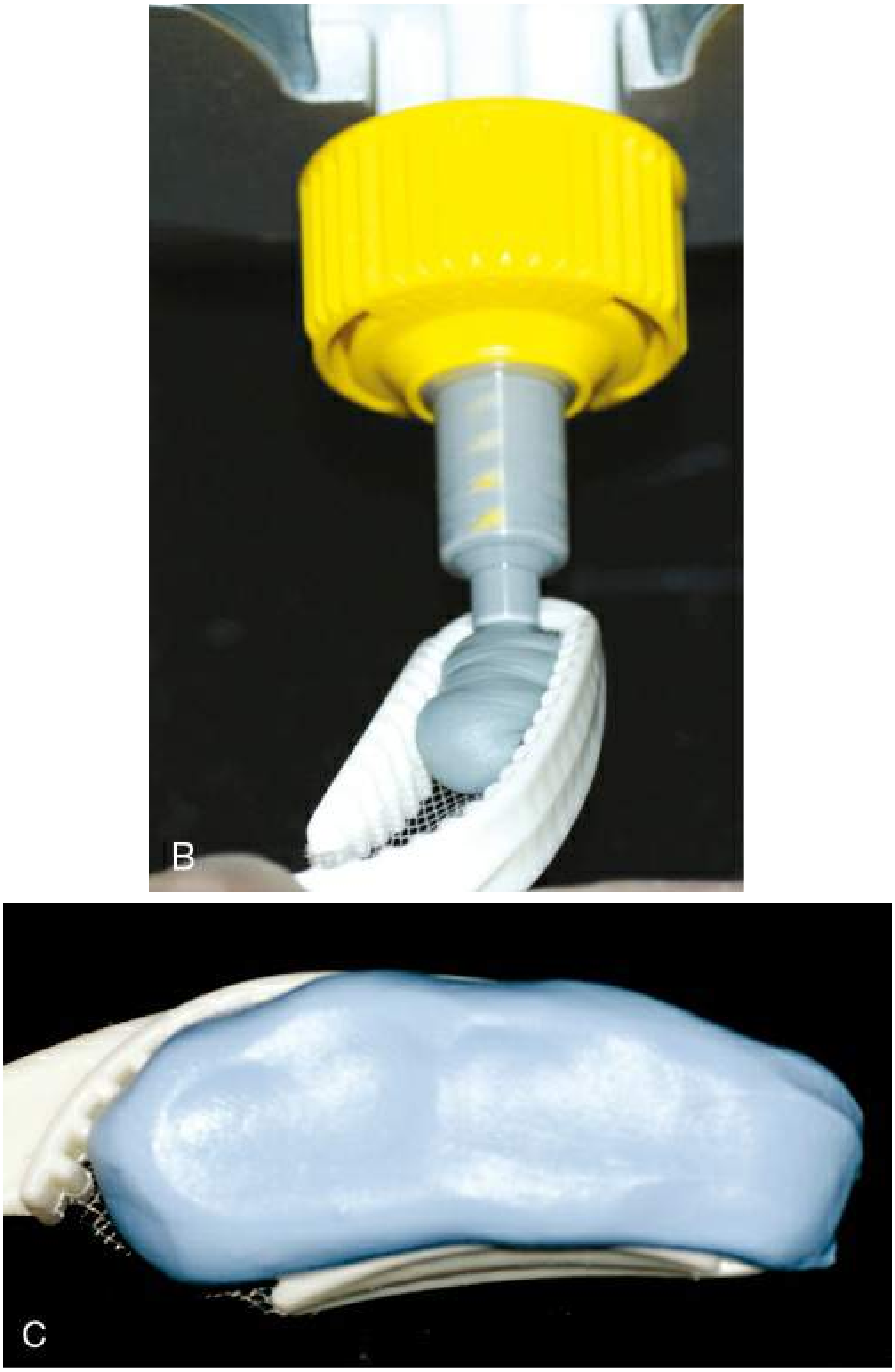


FIGURE 37.27 **(A)** and **(B)** Putty loaded using an automixing system. **(C)** Putty loaded onto both sides of triple tray.

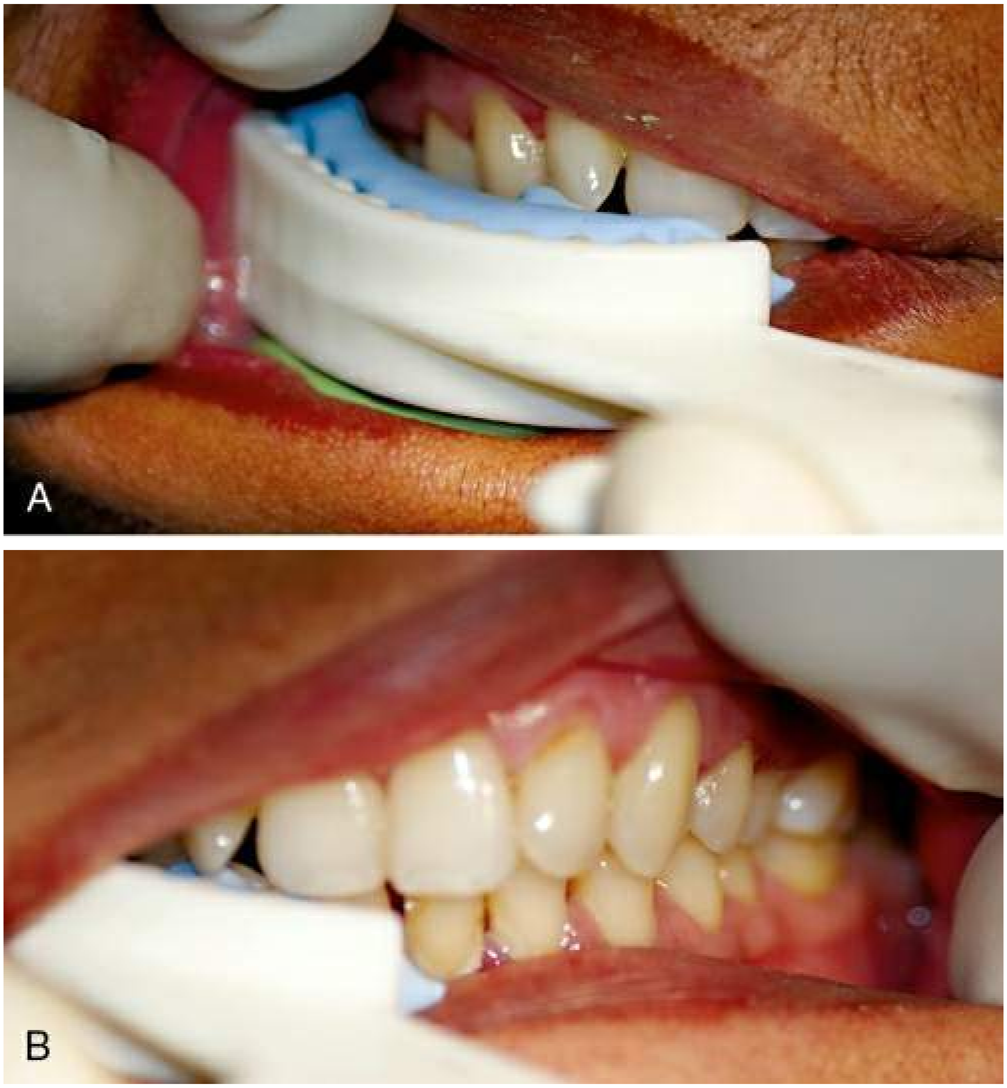


FIGURE 37.28 **(A)** Patient made to close in maximum intercuspation on tray. **(B)** Contralateral side check for correct occlusion.

FIGURE 37.29 Final impression.

Making a cast with triple tray impression

A cast can be made with a plaster index to perform the role of an articulator but eccentric occlusion cannot be checked.

The surface of impression with the tooth preparation is poured with die stone, while the counter surface is poured with dental stone. Retention tags are made for retention to base. This is allowed to set (Fig. 37.30).

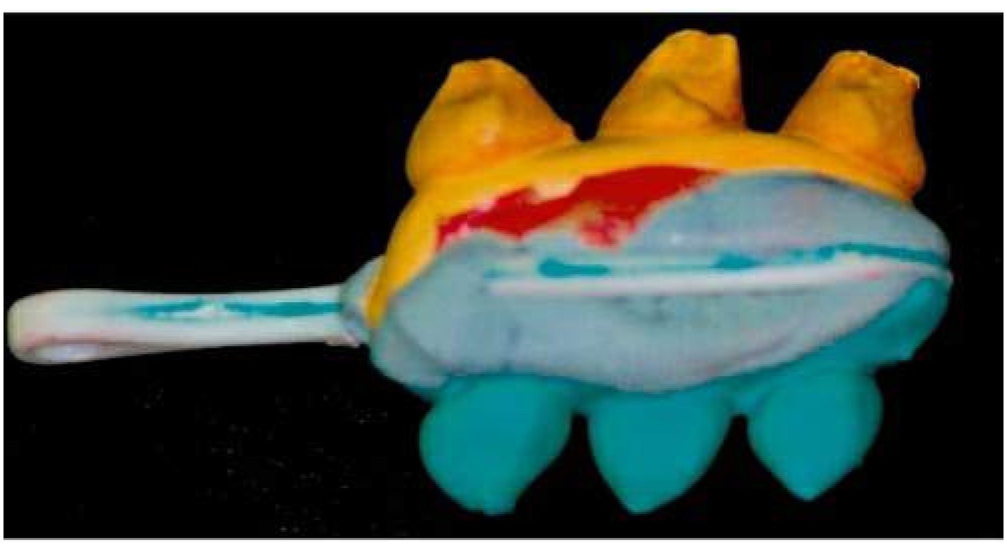


FIGURE 37.30 Upper and lower surfaces poured with tags for retention.

A base is made in plaster and the mandibular impression with the set stone is positioned on the base. The base is extended posteriorly and a 'T'-shaped index is created. This is then allowed to set (Fig. 37.31).

FIGURE 37.31 Extended base made in plaster with index.

Separating medium is applied on the set base and plaster is poured on the base and extended to cover the upper part of the impression. It is allowed to set.

The impression is separated from the upper and lower parts of the fabricated cast (Fig 37.32).

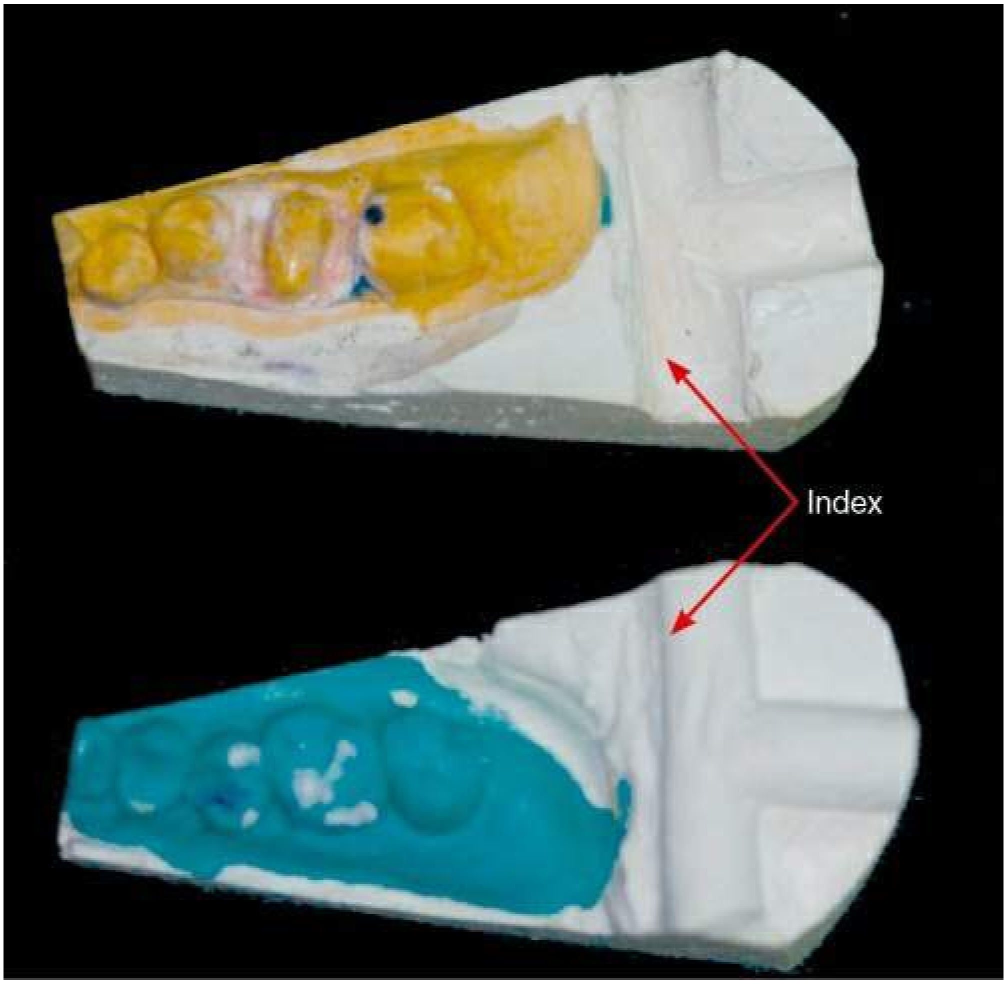


FIGURE 37.32 Showing the two parts with index.

The upper part fits into the index created which acts as a hinge articulator (Fig. 37.33).

FIGURE 37.33 Index used as a hinge articulator.

Copper band

It is used when the margins of some abutments in an impression of multiple abutments are not clearly replicated. Instead of repeating the whole impression, copper band can be used to make impression of only that particular abutment which needs correction. But proper orientation of die with the other dies may be difficult.

- The copper band is selected and annealed by heating in flame and quenching in alcohol.
- The fit is evaluated to extend 1 mm beyond the finish line with minimal tissue blanching (Fig. 37.34).
- Fingers are then covered with light coat of petroleum jelly and the green stick compound is gently heated and manipulated with the lubricated fingers.
- After evaluating the viscosity it is inserted to fill up to one-third of

the copper tube and placed on abutment to ensure space for impression material.

- Using the Backhaus towel clamp the copper tube is then removed from the mouth. After cutting holes in the band for the retention of the elastomeric material, the internal surface is coated with an adhesive.
- The preparation is cleaned and isolated. Medium-viscosity material is then mixed and injected into the copper band which is then seated over the tooth (Fig. 37.35).
- The impression is then removed and boxed and poured in die stone. The die stone is then trimmed to form an elongated tapered cylinder base for convenient manipulation during wax-up.

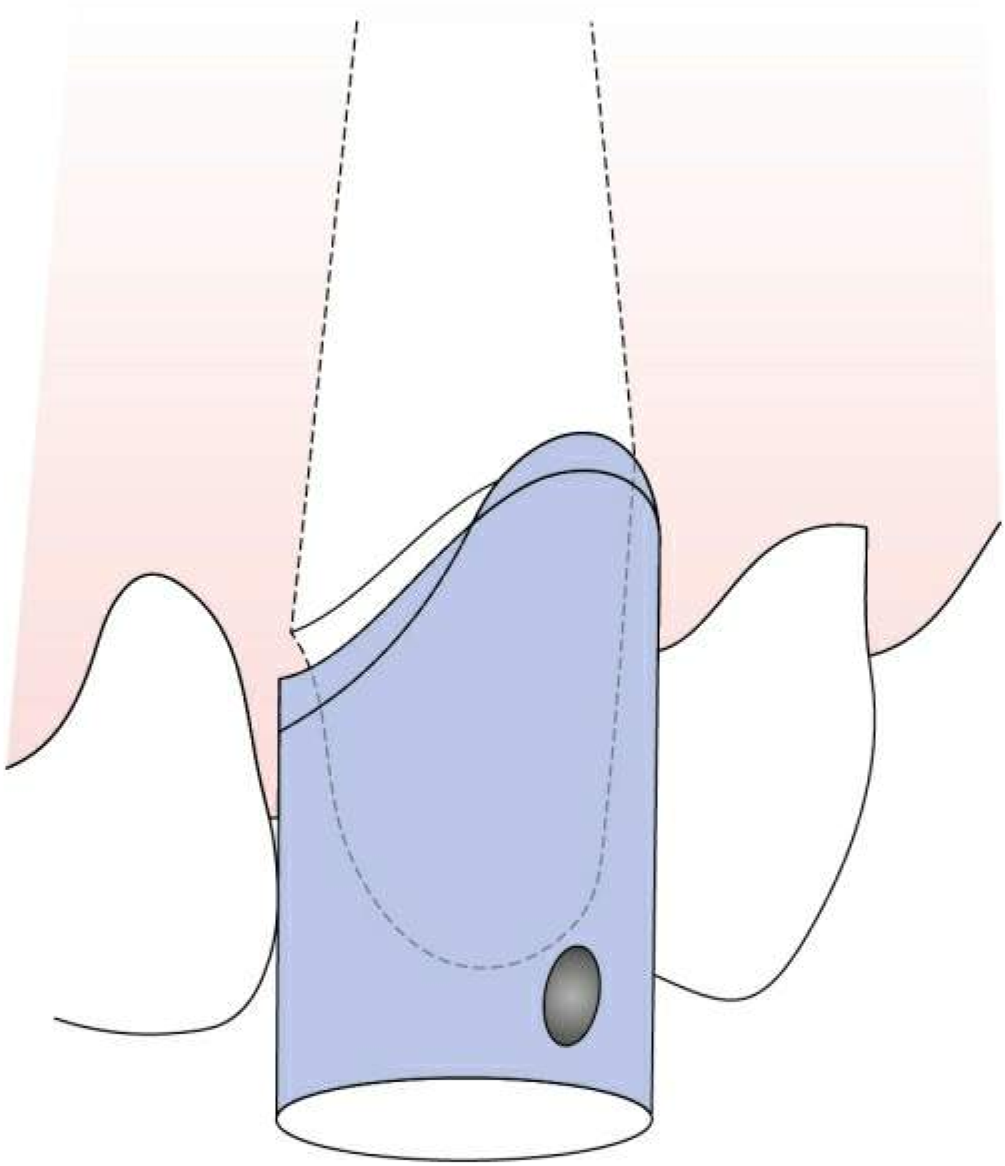


FIGURE 37.34 Fit of copper band evaluated on abutment.

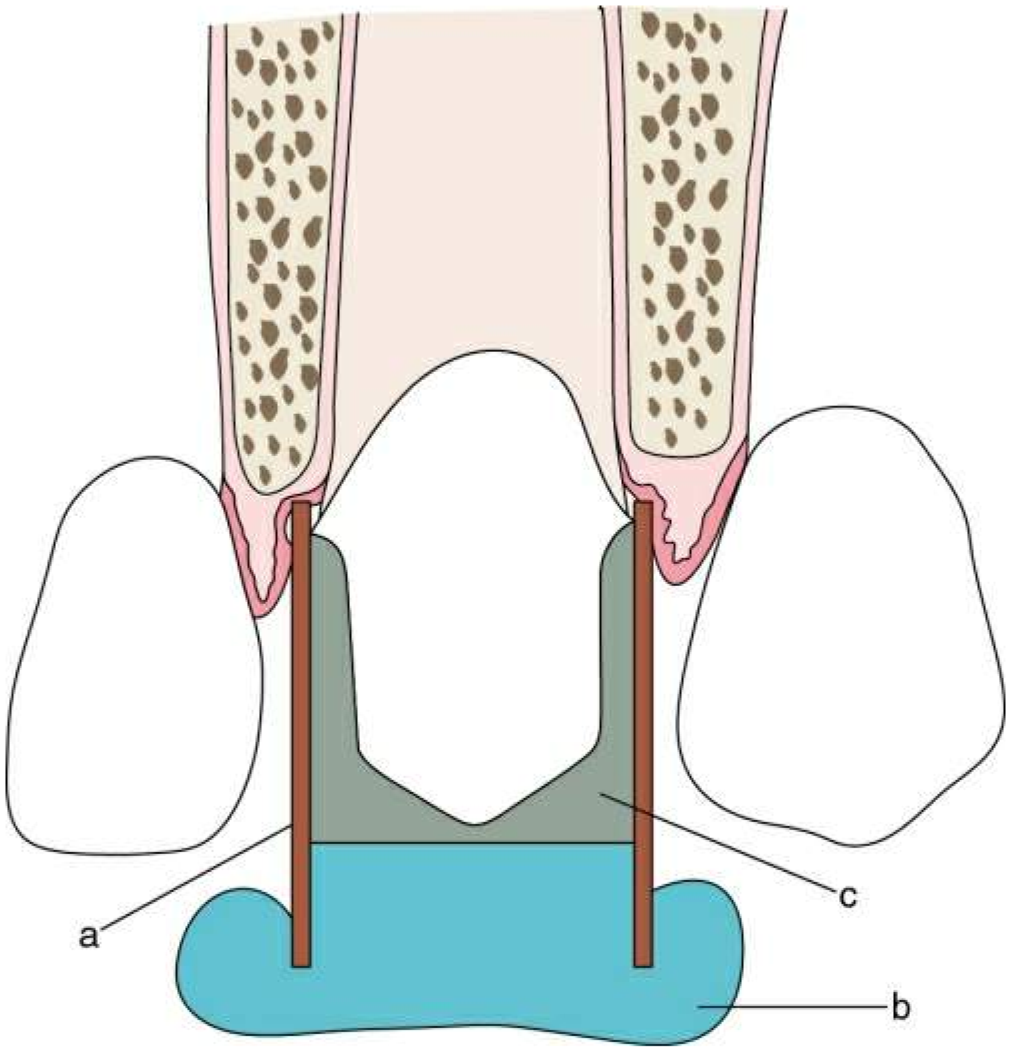


FIGURE 37.35 Copper band impression: copper band (a), green stick compound (b), medium body (c).

Hydraulic and hydrophobic technique (H & H technique)

This technique was developed by Dr Jeff Hoos.

The proponents of this technique state that the hydraulic and the hydrophobic technique of impression making is one of the easiest and predictable method of impression making in a crown preparation with subgingival finish lines eliminating the need for tissue retraction, haemostasis and isolation. It also eliminates the pain and discomfort experienced by the patient.

A double arch impression is made using a quadrant tray with a thixotropic addition silicone bite registration material which in turn captures the impression of the prepared tooth down to the gingival.

After the initial set, the impression is held onto the arch opposing the prepared tooth and the patient is asked to open the mouth. The prepared tooth surface is then washed and dried and then a small amount of low-viscosity vinyl addition silicone is delivered to the cervical area of the first impression.

The patient is then asked to close the mouth which in turn generates a hydraulic force by compressing the low-viscosity material into the sulcus, insinuating itself in between the gingival and root interface thereby displacing saliva and blood.

All the disadvantages of closed-mouth impressions and dual arch trays will also be seen with this technique.

Matrix impression system

The matrix impression system was described by Livaditis in 1998.

It uses a custom matrix to control the sulcular environment and to deliver the impression material to the subgingival parts which need to be impressed. Four types of forces, namely retraction, displacement, collapsing and relapsing forces are involved in gingival displacement during impressions. Effective delivery of impression material with simultaneous sulcular cleansing and simplification of complex impressions with or without segmentation is made possible with the matrix system (Fig. 37.36).

- A matrix (impression) with occlusal/bite registration elastomeric material is made over the tooth preparation and removed after it sets (Fig. 37.37A and B). The matrix maybe made in one piece or in two or more sections depending on the distribution and complexity of the preparations.

- The matrix is selectively trimmed interproximally and internally to prescribed dimensions and tray adhesive is applied to the fitting surface of the matrix.

- After the retraction cord is removed, the matrix is filled with medium body elastomeric impression material (Fig. 37.37C). Simultaneously the same material is syringed onto the preparations. Definitive impression is made by seating the matrix on the abutments (Fig. 37.37D).

- A stock tray filled with putty or heavy viscosity elastomeric impression material is seated over the matrix and the remaining teeth to make an impression of the entire arch (Fig. 37.37E and F). The matrix facilitates the formation of the optimum flange. Tearing is virtually eliminated because of the improved configuration of the sulcular flange and by elimination of the voids and contaminants in the sulcus.

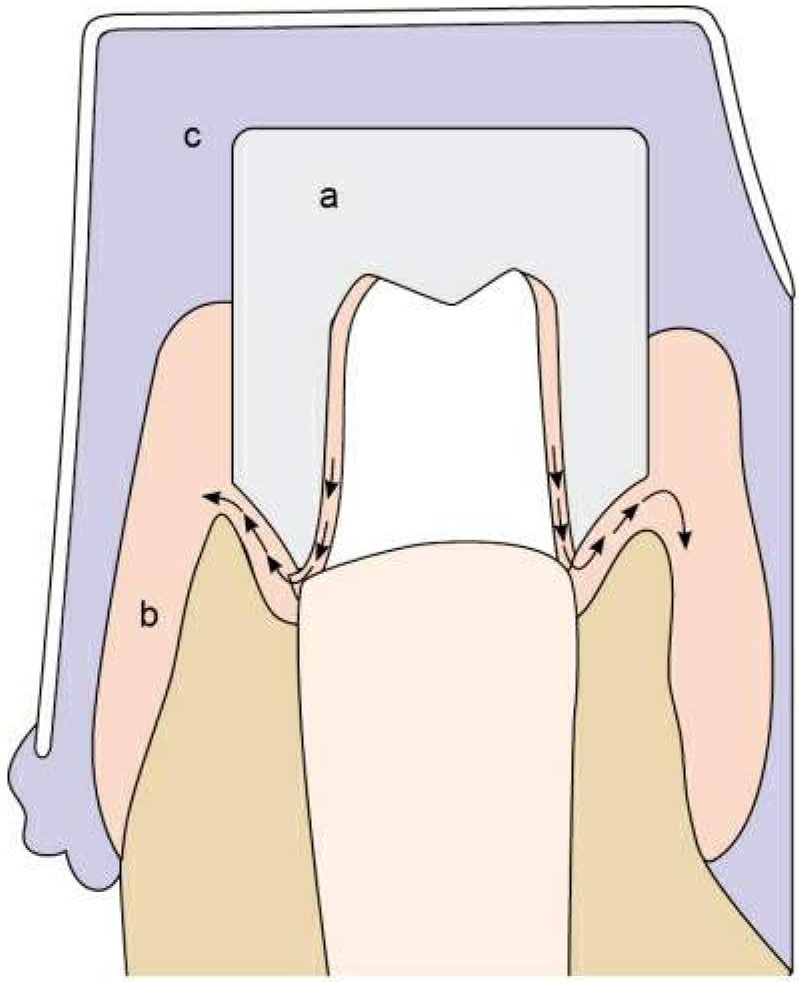
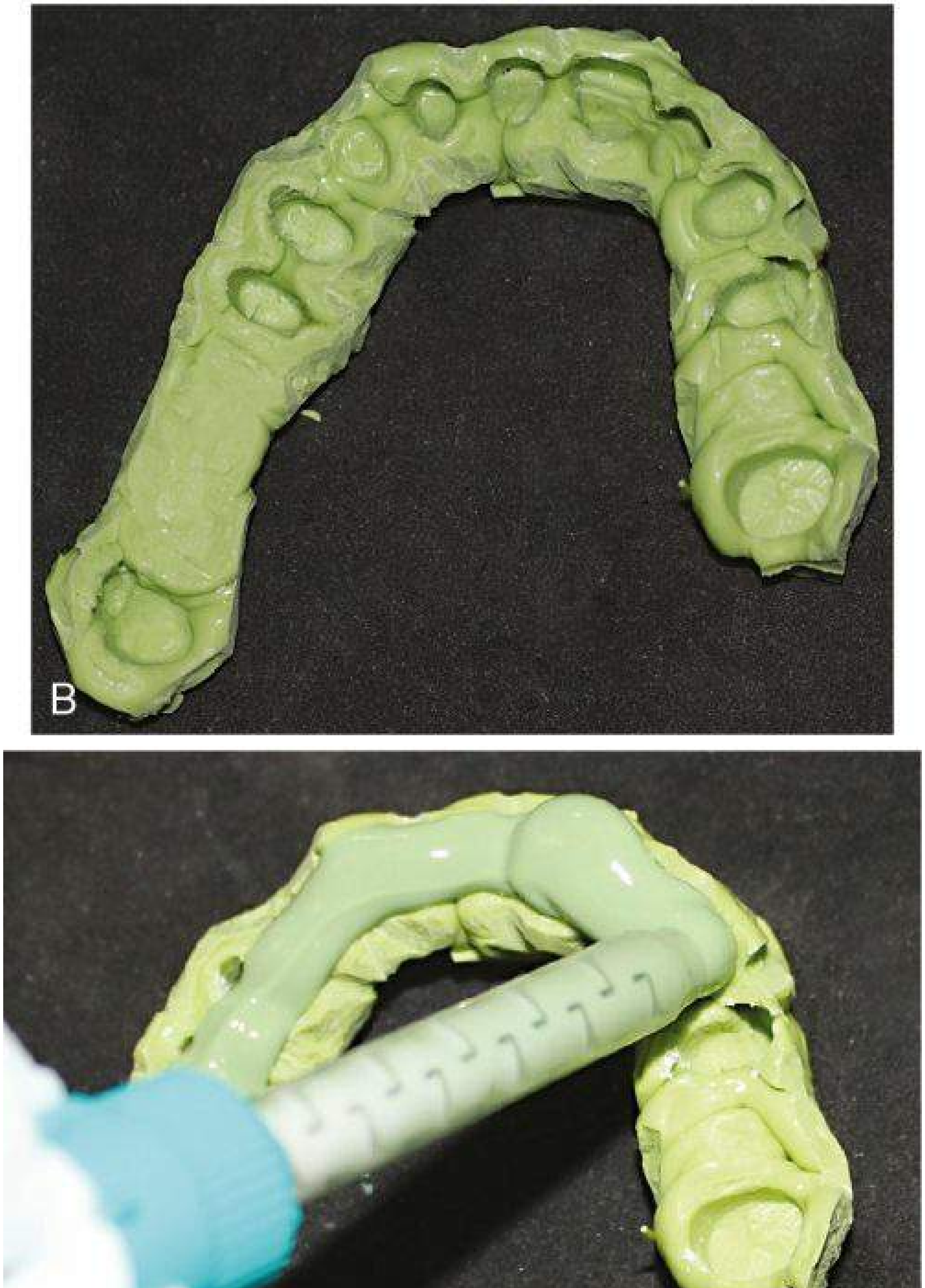


FIGURE 37.36 Matrix-bite registration material (a) is fully seated as seen by contact of untrimmed occlusal area. Matrix extrudes out medium body material (b) displacing air and fluid contaminants from sulcus. Tray impression material (c) picks up the matrix and also registers remaining natural teeth.


A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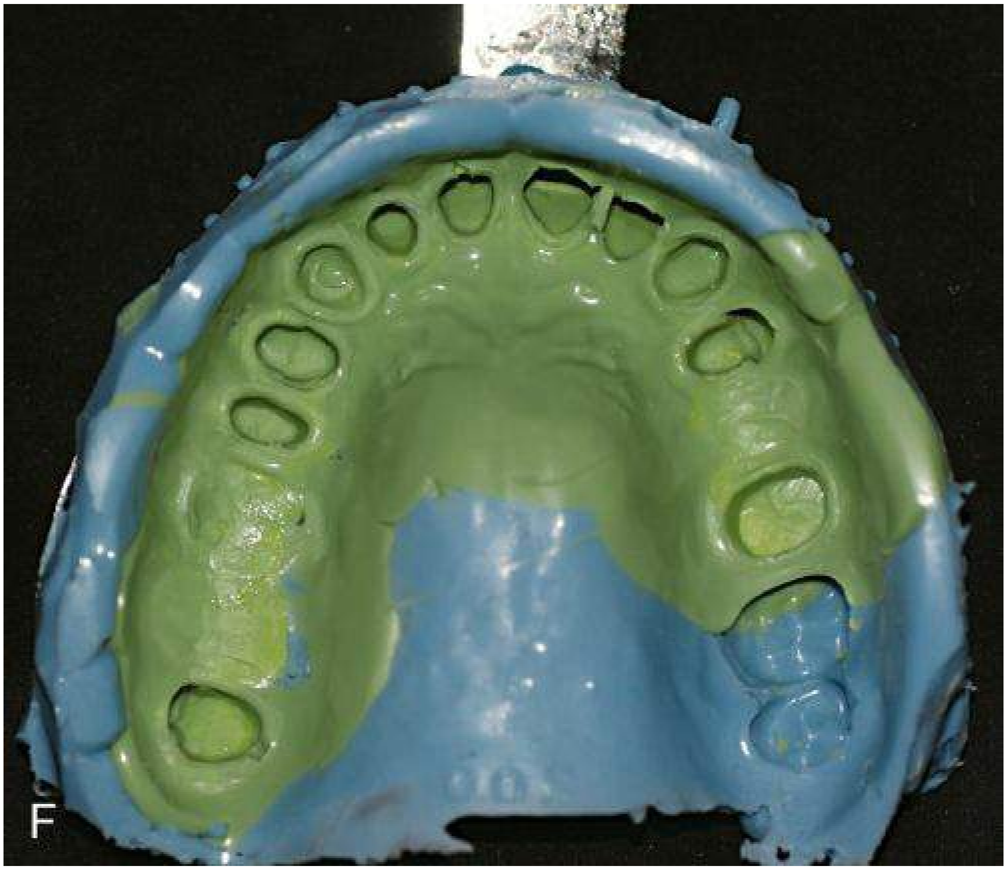


FIGURE 37.37 **(A)** Bite registration injected over the prepared teeth to make the matrix. **(B)** Matrix removed after it sets. **(C)** Matrix is filled with medium-viscosity material. **(D)** Definitive impression made by seating matrix and medium body. **(E)** Tray material seated over matrix to make impression of entire arch. **(F)** Completed matrix impression.

Impression for pin retained restorations

To make an impression of a preparation for a pin retained restoration two methods can be employed.

Lentulo spiral

Use a lentulo spiral with a slow speed handpiece. Pick up the light body impression material in the lentulo spiral and place it in the pinhole with clockwise rotation.

While removing the lentulo spiral from pinhole, increase the speed to prevent material from being pulled out. Using the lentulo spiral prevents formation of air bubbles in the pinhole.

An orthodontic wire cut to fit the pinhole and coated with tray adhesive, may be inserted into the hole to stabilize the light body impression material.

The rest of the prepared tooth is now covered with light body and the tray material is seated on the preparation using the double-impression technique.

Prefabricated plastic pin/bristle

Plastic bristles may be used to duplicate the pinholes (Fig. 37.38). The bristle is supplied corresponding to the size of the final drill preparing the pinhole along with the tooth preparation kit.

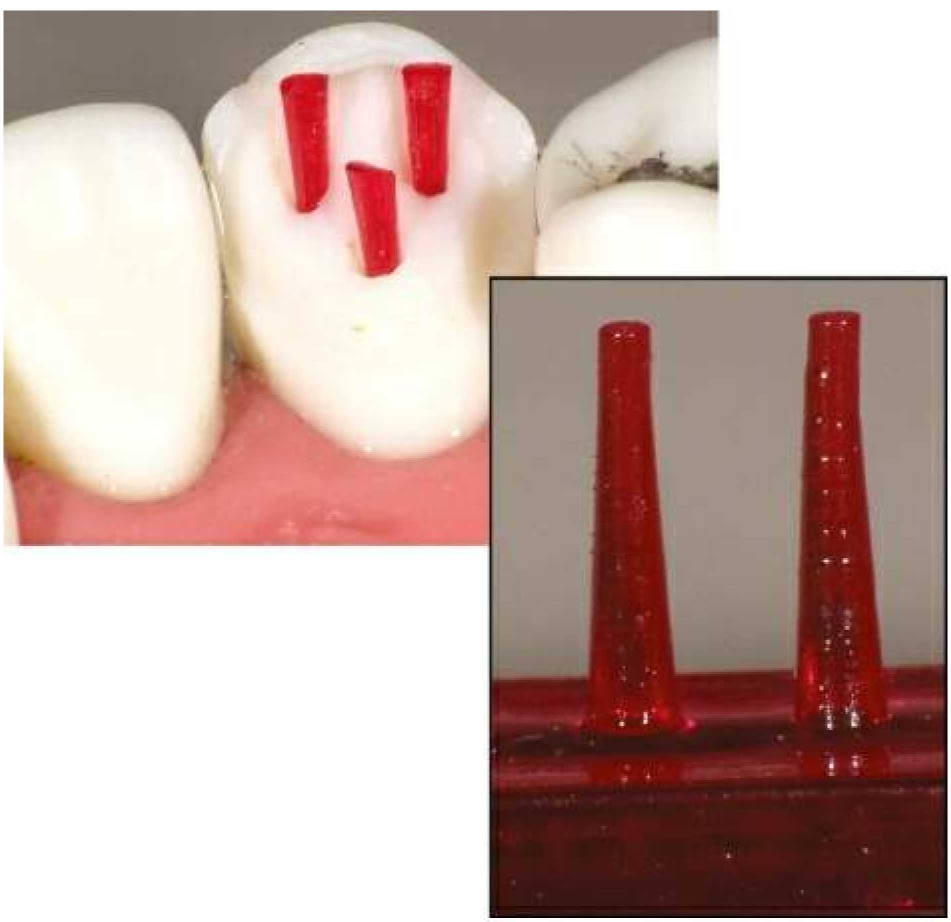


FIGURE 37.38 Prefabricated castable palstic pins.

The length of the bristle is cut to appropriate dimensions to fit the tray. The bristle is placed in each of the pinholes and impression material is injected all the way around the head of the bristle.

While removing the impression, the bristle will come secured to the impression and a cast is poured after applying separating medium on the exposed bristle. The bristle will now be incorporated in the cast and a wax pattern is made on the same and burnt out. The casting will now contain the pin retained restoration.

Disinfection of impressions

After the impression is removed from the patient’s mouth, it is rinsed with tap water and dried with air syringe.

Then appropriate chemicals are used to disinfect the impression. This is an essential procedure to prevent cross-infection and exposure of dental auxiliary and lab personnel. It does not affect the accuracy or surface reproduction of the impression if performed properly.

There are five types of chemical disinfectants that can be used for this purpose – glutaraldehydes, chlorine compounds, phenolic compounds, iodophors and phenolic glutaraldehydes.

A 2% glutaraldehyde solution is commonly used and is recommended for silicones and polysulphide impressions. The impressions are soaked in this solution for 10 min.

As hydrocolloids, ‘hydrophilic’ addition silicones and polyethers absorb moisture, they should not be immersed in disinfectant, instead they should be sprayed with sodium hypochlorite (1:10) and stored in a plastic bag.

Evaluation

After disinfection the impression is inspected for any discrepancy and then poured. The following may be checked:

- Retention of impression material to tray – any separation.
- Streaks of base/catalyst – impression not mixed properly.
- Tray exposure – whether exposure is in a critical area.
- Voids, folds and creases – criticality to be assessed.
- Extension of impression adequately beyond margins of preparation.

SUMMARY

Impression making is an important and mandatory procedure for fabrication of fixed cast prosthesis. There are three 'M's to remember during this process – mould or tray, material used and method of impression making. There are innumerable companies, manufacturing these materials, but they all manufacture only the five basic consistencies like putty, heavy, monophase, medium and light-bodied materials. The methods vary depending on the clinical situation and the operator's choice. The most commonly used technique is a double or single impression using putty and light body combinations.

CHAPTER 38

Provisional restorations

CHAPTER CONTENTS

Introduction

The term provisional, temporary, interim and transitional are routinely and interchangeably used in dentistry. It is a restoration which is fabricated for a particular period of time until definitive restoration is fabricated. It is fabricated immediately following tooth preparation preferably in the same appointment. Provisional restorations can also be readily modified and serve as a blueprint for fabrication of the definitive restoration.

Ideal requirements of provisional restoration

These can be classified as:

1. Biologic requirements

2. Mechanical requirements

3. Aesthetic requirements

Biologic requirements

Pulp protection

It should protect the prepared tooth from the oral environment, thereby preventing sensitivity and irritation to the pulp.

Periodontal health

It must have good marginal fit, proper contour and a smooth surface to prevent plaque accumulation, facilitate easy plaque removal and maintain periodontal health.

Positional stability

It should provide a comfortable, stable and functional occlusal relationship by maintaining interarch and intra-arch stability thereby preventing tooth migration, supraeruption and joint or neuromuscular imbalance.

Prevention of fracture

It should protect the prepared tooth surface from fracture which is commonly seen with partial coverage restorations in which margin of the preparation is close to the occlusal surface of the tooth and could be damaged during chewing.

Mechanical requirements

Functional

It should possess good compressive and flexural strength. The strength of materials used for fabricating provisional restorations is always much lower than that of the definitive restoration material. Thus, cross-sectional size of the connector needs to be larger than the final restoration to reduce potential failure produced by stresses.

Loss of retention

It should have close adaptation to the prepared tooth surface to prevent displacement and recementation, which will increase patient visits.

Removal for reuse

Temporary restorations may need to be removed and recemented often. If they are well fabricated with adequate thickness and cemented with weak cement, it can be removed without breakage and can be reused.

Aesthetic requirements

It should match the shape, size, colour and texture of the restored tooth especially in the anterior region. Colour stability is also important if the provisionals are to function for a prolonged period. It also serves as a guide to achieve aesthetics for the final restoration.

Classification

Provisional restorations are classified on the following basis.

According to the method of fabrication

Preformed

The anatomic form is prefabricated and readily available in different tooth types and sizes. The appropriate type is selected, modified and mostly relined to fit the prepared tooth.

Indication

- Single-tooth restorations.

Advantages

- Less technique sensitive to fabricate.
- Requires less chairside time.

Disadvantages

- Cannot be used for fixed partial dentures (FPDs).
- Most types need some modification to fit the preparation.

Custom-made

The anatomic form and shape of the tooth being restored (the entire provisional restoration) is fabricated by the dentist/dental technician. The technique provides intimate contact between a provisional restoration and prepared tooth. It is the most commonly used method for FPDs.

Advantages

- Most versatile, can be used for any clinical situation.
- Better fit.

Disadvantage

- Requires more time.

According to the material used

According to the material used provisional restorations are classified as:

1. Resins

    i. Preformed

    a. Polycarbonate

    b. Cellulose acetate

    ii. Custom-made

    a. Acrylics

    b. Bis-acryl composites

2. Metals

    i. Preformed

    a. Aluminium

b. Tin–silver

c. Nickel–chromium

ii. Custom-made

a. Cast metal alloys

According to the duration of use

Short-term temporary restoration

- Most common.
- These are used for up to 2 weeks.
- Cast metal is not used – all other preformed and custom-made materials can be used.
- They are used routinely as an interim restoration until a final restoration is fabricated, such as for crowns and FPDs.

Long-term temporary restoration

- May be used for few months.
- Usually cast metal is indicated.

Indications

- FPDs for patients with conditions which are difficult to diagnose like gross maxillomandibular discrepancies and TMD.
- Maintenance of vertical dimension while restoring anterior teeth.

- Evaluation of tolerance when extensive rehabilitation is planned.
- Healing after periodontal surgery.
- If orthodontic treatment is required prior to fabrication of final restoration.

According to the technique of fabrication

1. **Direct technique** – restorations are fabricated intraorally.

2. **Indirect technique** – restorations are fabricated extraorally on a cast.

3. **Direct/indirect** – restoration are fabricated using a combination of intraoral and extraoral procedures.

Provisional restorative materials

Ideal requirements of provisional restorative materials

Following are the ideal requirements of provisional restorative materials:

- Adequate strength and wear resistance.
- Biocompatibility.
- Dimensional stability.
- Easy to contour and polish.
- Odourless and nonirritating.
- Chemically compatible with the luting cements.
- Aesthetically acceptable.
- Adequate working and setting time.
- Easy to repair.

Custom-made materials

Custom-made materials are classified as:

1. Resins

   i. Acrylics

   a. Polymethylmethacrylates

b. Poly-R′ methacrylates (R′ – ethyl, vinyl, isobutyl)

ii. Bis-acryl composites

a. Chemically

b. Light activated

c. Dual activated

2. Metals

i. Cast metal alloys

Resins

1. Acrylics

- These have been used as provisional materials since 1930s.
- Most commonly used autopolymerizing materials, available as powder and liquid and in various shades (Fig. 38.1).
- Used for single- and multiple-unit restorations.
- **Advantages:** Low cost, aesthetic, easy to smooth and polish, versatile.
- **Disadvantages:** Polymerization shrinkage, objectionable odour, exothermic heat generation during setting.
- These are divided into two categories:

○ Polymethylmethacrylates (PMMA)

○ Poly-R′methacrylates (R′ – ethyl, vinyl or isobutyl).

• PMMA has greater colour stability and strength, but more polymerization shrinkage and exothermic heat than PRMA.

FIGURE 38.1 Autopolymerizing acrylic resin – Unifast (courtesy GC).

2. Bis-acryl composites

• They are basically bis-GMA resins, which are available in a variety of shades and can be automixed in cartridges (Fig. 38.2).

• They evolve less exothermic heat, odour and show less polymerization shrinkage but are more brittle and expensive than acrylics.

• They are generally not glossy like the acrylics and also have a pronounced oxygen-inhibited layer that should be removed (usually with alcohol-saturated gauze) prior to finishing and polishing.

- They are available as chemical, light and dual activated types. The light activated resins have greater working time, but poor colour stability.

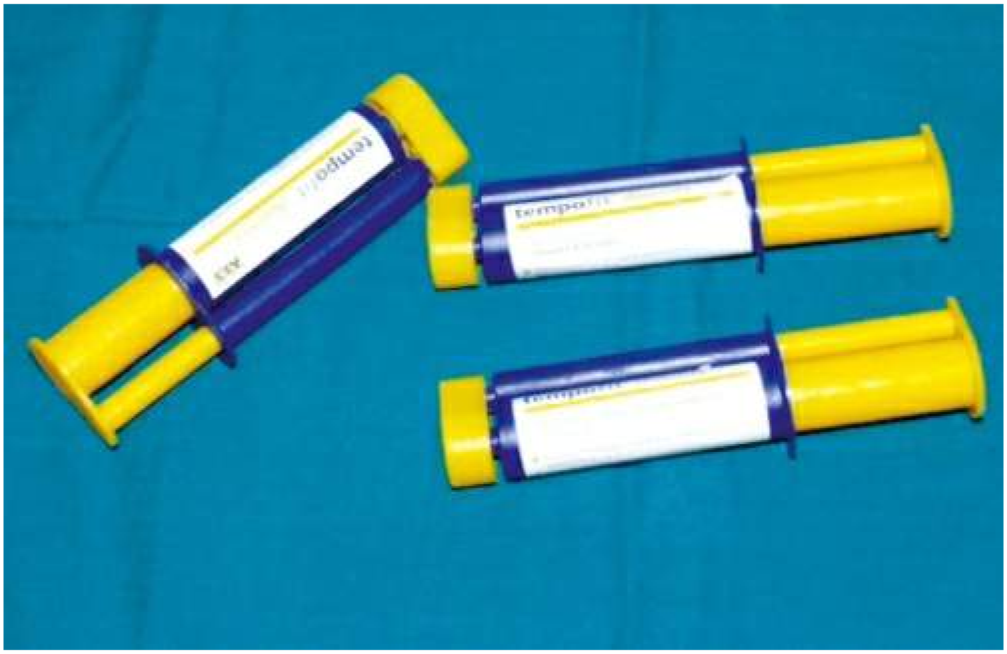


FIGURE 38.2 Bis-acryl composite materials.

Tables 38.1–38.3 compare the advantages and disadvantages of various resin provisional materials.

Table 38.1

Advantages and disadvantages of polymethylmethacrylates

Advantages	Disadvantages
• Low cost • Good wear resistance • Good aesthetics • High polishability • Good colour stability	• Significant amount of heat given off by exothermic reaction • High degree of shrinkage (about 8%) • Strong, objectionable odour • Short working time • Hard to repair • Must be mixed • Radiolucent

Table 38.2

Advantages and disadvantages of poly-R' methacrylates

Advantages	Disadvantages
• Low cost • Less exothermic heat and shrinkage than PMMA • Extended working time	• Less aesthetic • Poor wear resistance • Poor colour stability • Strong, objectionable odour • Hard to repair • Must be mixed • Radiolucent

Table 38.3

Advantages and disadvantages of bis-acryl composites

Advantages	Disadvantages
• Less shrinkage than acrylics • Minimal heat generation • Minimal odour • Excellent aesthetics • Most products use automix delivery • Can be repaired or characterized using resin composite • Easy to trim • Good colour stability • Radiopaque	• Greater cost than acrylics • Viscosity cannot be altered • Sticky surface layer present after polymerization • More brittle than acrylics

Cast metal alloys

These are used as 'long-term temporary restorations'. The indications are given under that category. These are rarely used.

Preformed crowns

According to the type of material used for the fabrication of the anatomic form crowns are classified into two types:

1. Resins

   i. Polycarbonate

ii. Cellulose acetate

2. Metals

i. Aluminium

ii. Tin–silver

iii. Nickel–chromium alloy

Resins

1. Polycarbonate crowns

- They combine microglass fibres with a polycarbonate plastic material.
- It is used as a matrix material around a prepared tooth that is relined with acrylic resin to customize fit.
- It possesses high impact strength, abrasion resistance and good bond with methyl acrylate resin.
- Best aesthetics among all preformed crowns.
- Available in a single shade which can be modified by the shade of lining resin.
- Available in the shape of incisors, canines and premolars in varying sizes (Fig. 38.3).

FIGURE 38.3 Prefabricated polycarbonate crowns.

2. Cellulose acetate

- It is a thin, soft and transparent scaffold material.
- It is available in all tooth shapes and different sizes.
- It does not bond to the relining resin.

- Shade is entirely dependent on the relined resin.
- An appropriate size of this transparent anatomic form is selected from a mould guide and filled with autopolymerizing resin of appropriate shade. This is inserted over the lubricated tooth preparation. The cellulose acetate is peeled off once the resin sets. Proximal contact needs to be re-established with the relining resin.

Metals

1. Aluminium and tin–silver

- These are generally limited to posteriors for aesthetic reasons.
- Available as simple shells (which resemble a tin can) and in anatomic forms.
- They provide good adaptation due to softness and ductility of the material, but can also promote rapid wear resulting in perforation.
- They may require cervical enlargement during insertion and this may be accomplished by pushing down on a swaging or stretching block.
- They may be relined with a resin to obtain better fit and rigidity and then luted to the prepared tooth.

2. Nickel–chromium

- Indicated for use in children with damaged primary teeth.
- They need not be relined with resin.
- They are trimmed, contoured and adapted to the tooth.
- Strong cements are used for luting.

- They are very hard and hence used as long-term temporary restorations (Fig. 38.4).

- Preformed crowns are summarized in Table 38.4.

FIGURE 38.4 Preformed nickel–chromium crowns.

Table 38.4

Summary of properties of various types of preformed crowns

Preformed crowns	Properties
1. Polycarbonate crowns	Aesthetically acceptable Supplied in incisor, canine and premolar tooth types
2. Cellulose acetate	Thin transparent material available in all tooth ranges Colour depends on the autopolymerizing resin
3. Aluminium–tin silver	Suitable for posteriors Different size and shapes are available Care should be taken while adapting to the tooth surface
4. Nickel–chromium	Extensively damaged primary tooth mostly used Relatively hard and used as long-term provisional restoration

Recent advances in provisional materials

Computer-aided design (CAD)/computer-aided engineering (CAE) aided fabrication using precision-milled acrylate polymer-filled contoured single- and multiple-unit provisional restorations are now available that offer increased strength and fit along with a customizable solution for even the most demanding of patients. The main disadvantage is increased cost.

Techniques of fabrication

The following techniques are used for fabrication:

1. Direct technique – restorations are fabricated intraorally

   i. Preformed with polycarbonate crowns

   ii. Custom-made with index

2. Indirect technique – restorations are fabricated extraorally on a cast

   i. Preformed with nickel–chromium crowns

   ii. Custom-made with template

3. Direct–indirect technique – restorations are fabricated using a combination of intraoral and extraoral procedures.

Direct technique

Restoration is fabricated intraorally directly in the patient's mouth.

Advantages

- Less time
- Less cost as there is no need to make a cast

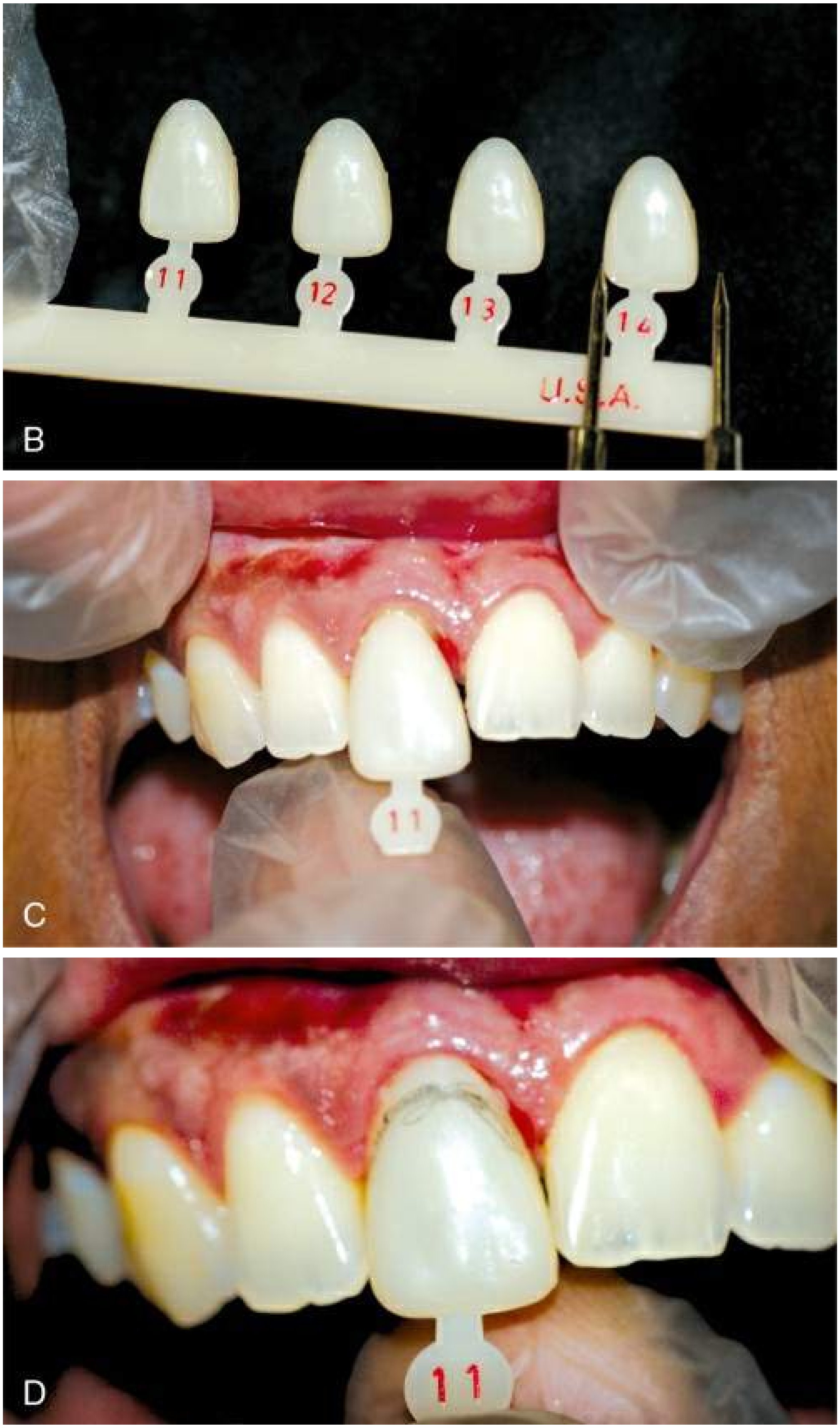
Disadvantages

- Only used for single-unit restorations and short-span bridges.
- Patient cooperation is required.

- Exothermic heat may cause pulpal irritation.
- Offensive odour.
- May be difficult to remove the provisional restoration if attention is not given to setting characteristics.

Direct technique: Preformed (polycarbonate) provisionals

Measure the mesiodistal width and the occlusocervical length and select a preformed polycarbonate crown of appropriate shade that is slightly larger from the assorted kit (Fig. 38.5A and B).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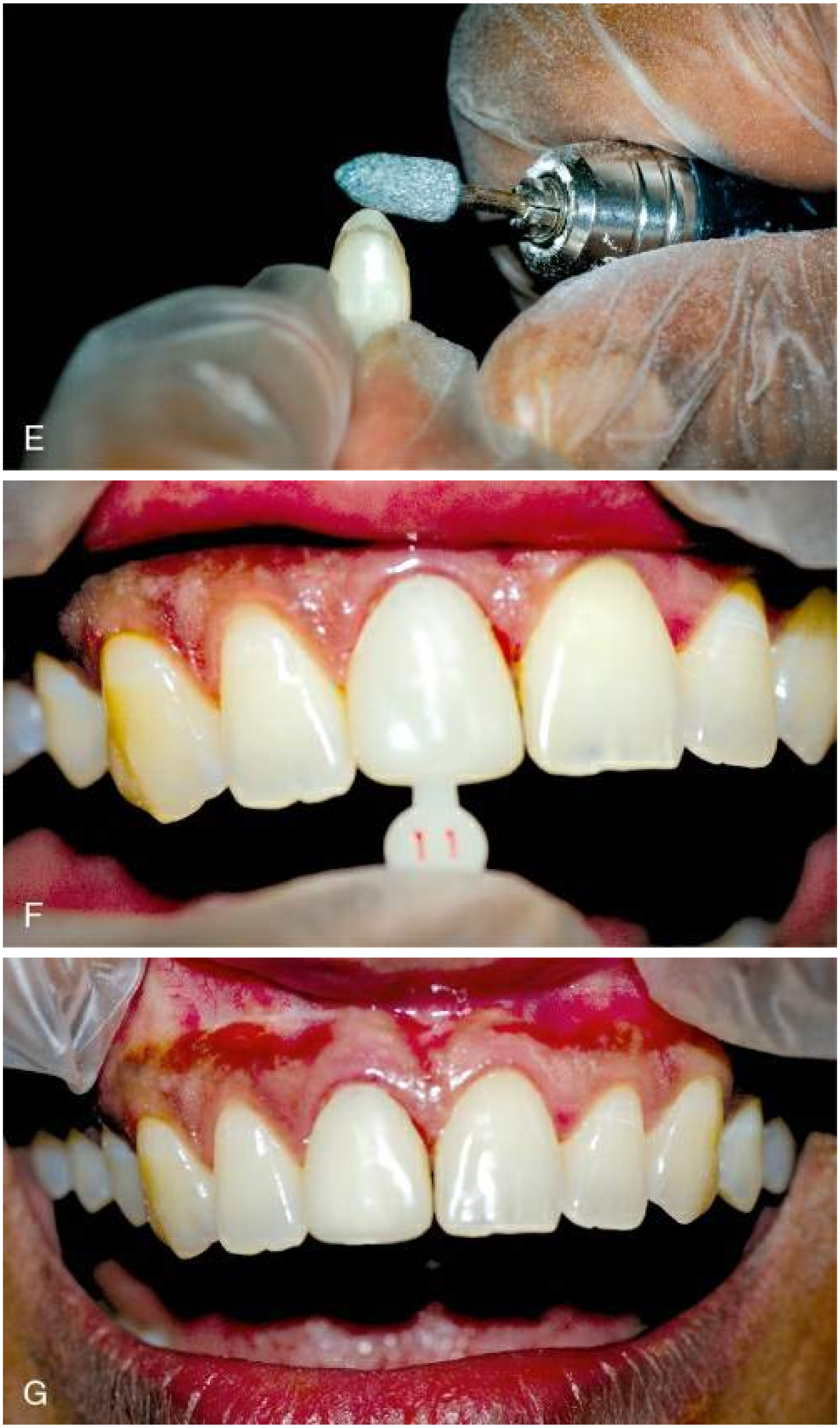
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G

FIGURE 38.5 **(A)** Mesiodistal and incisocervical measurements made with the help of a divider. **(B)** Appropriate size of crown is selected from the assorted kit. **(C)** Selected crown is tried in the patient's mouth. **(D)** Excess portion is marked on the cervical portion. **(E)** Excess is trimmed carefully at the cervical and never at the incisal portion. **(F)** The trimmed crown is filled with autopolymerizing acrylic and seated on the prepared tooth. **(G)** The polymerized crown is trimmed, finished, polished and cemented with provisional cement.

The selected crown is tried in the patient's mouth and trimmed to fit using mounted stones or vulcanite trimmers. Care should be taken to reduce the cervical portion and never the incisal aspect to adjust the height (Fig. 38.5C–E).

Apply petrolatum/Vaseline to the prepared teeth and adjacent gingiva to prevent irritation from monomer and easy removal of temporary. The crown is filled with autopolymerizing acrylic resin (poly-R′ methacrylate preferred) and seated on the prepared tooth while in a flowable consistency (Fig. 38.5F). The excess is removed with a probe.

Once the dough stage is reached (approximately 2 min after mixing) the crown is removed by rocking faciolingually and placed in warm water to set (5 min). The polymerized crown is trimmed, finished, polished and cemented with provisional cement (Fig. 38.5G).

Direct technique: Custom-made provisionals using index

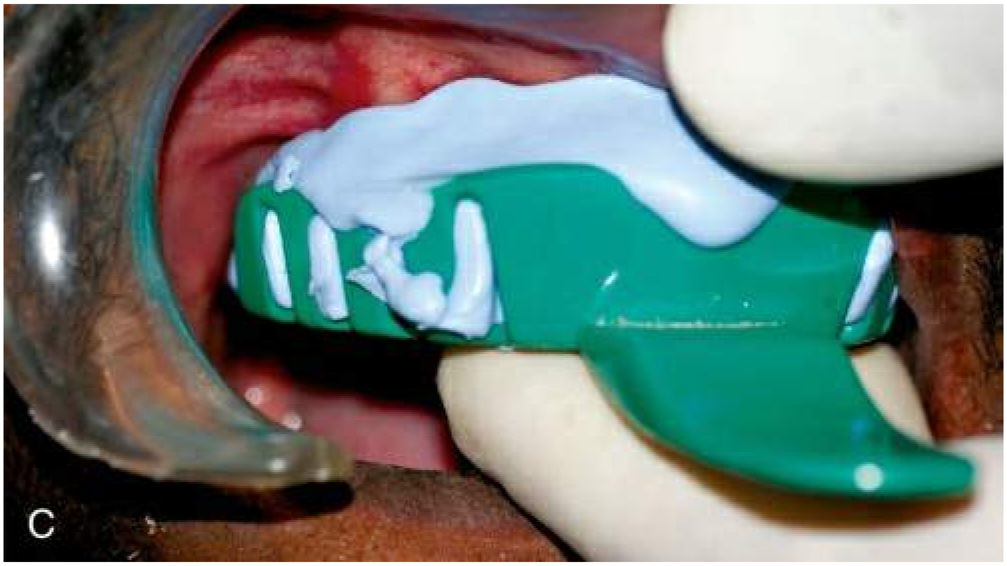
The anatomic form of the provisional restoration is obtained by making an impression prior to tooth preparation and restoring/replacing the teeth to be temporized.

Single-unit restorations

If the tooth is damaged, it is restored with wax and an index is made intraorally with putty/irreversible hydrocolloid impression material.

Fixed partial dentures

Existing RPD can be used to make the index intraorally (Fig. 38.6A–D).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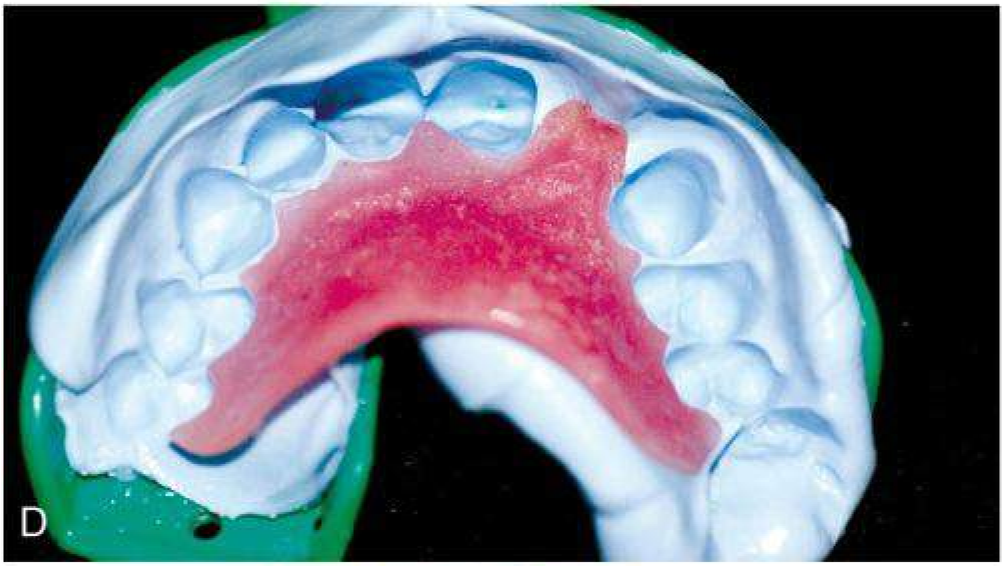
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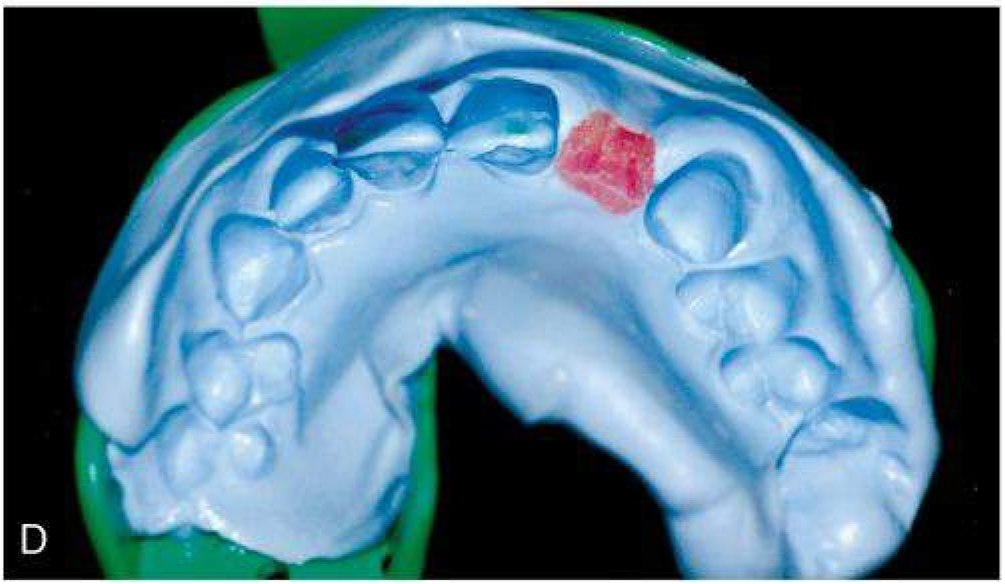
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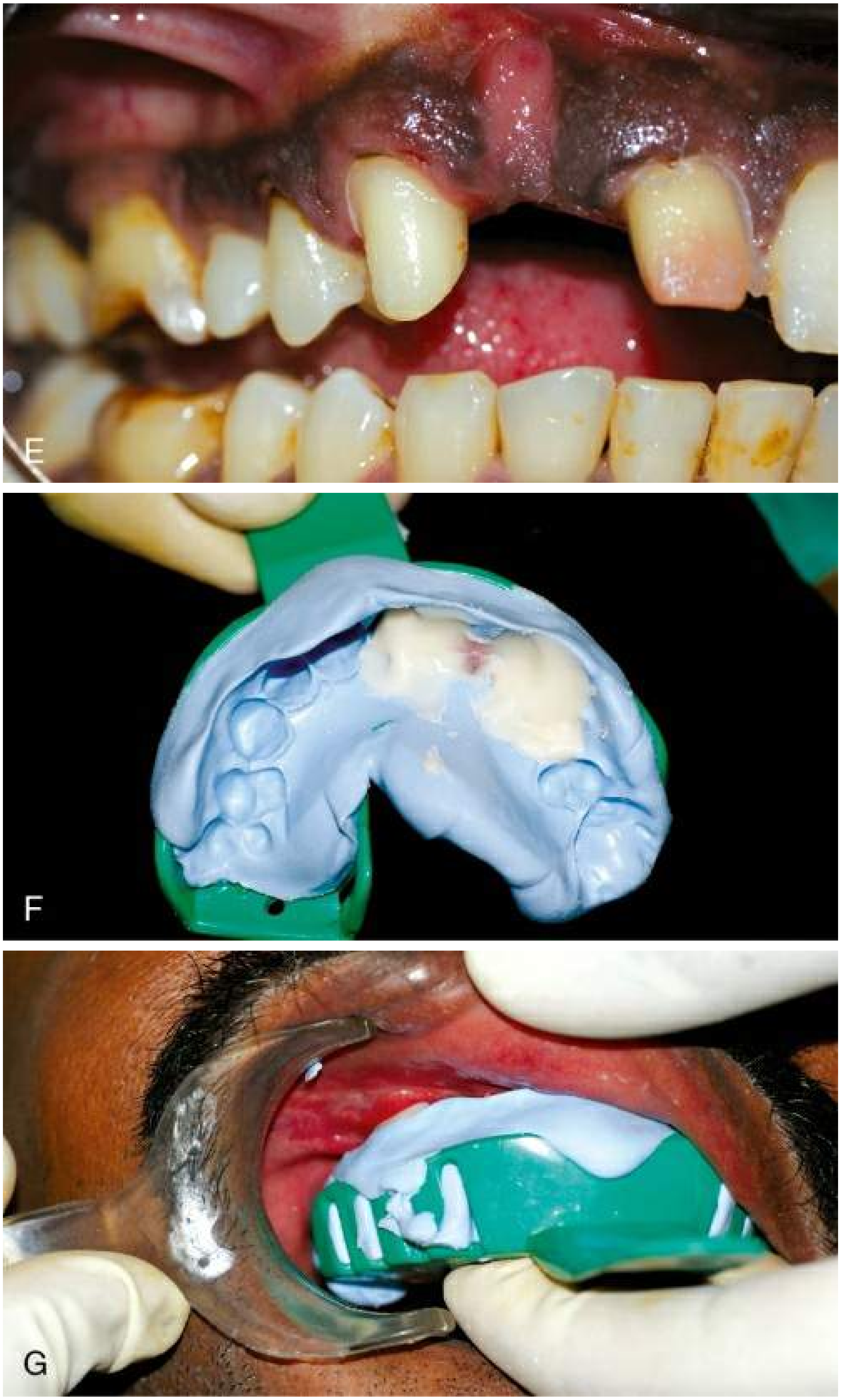
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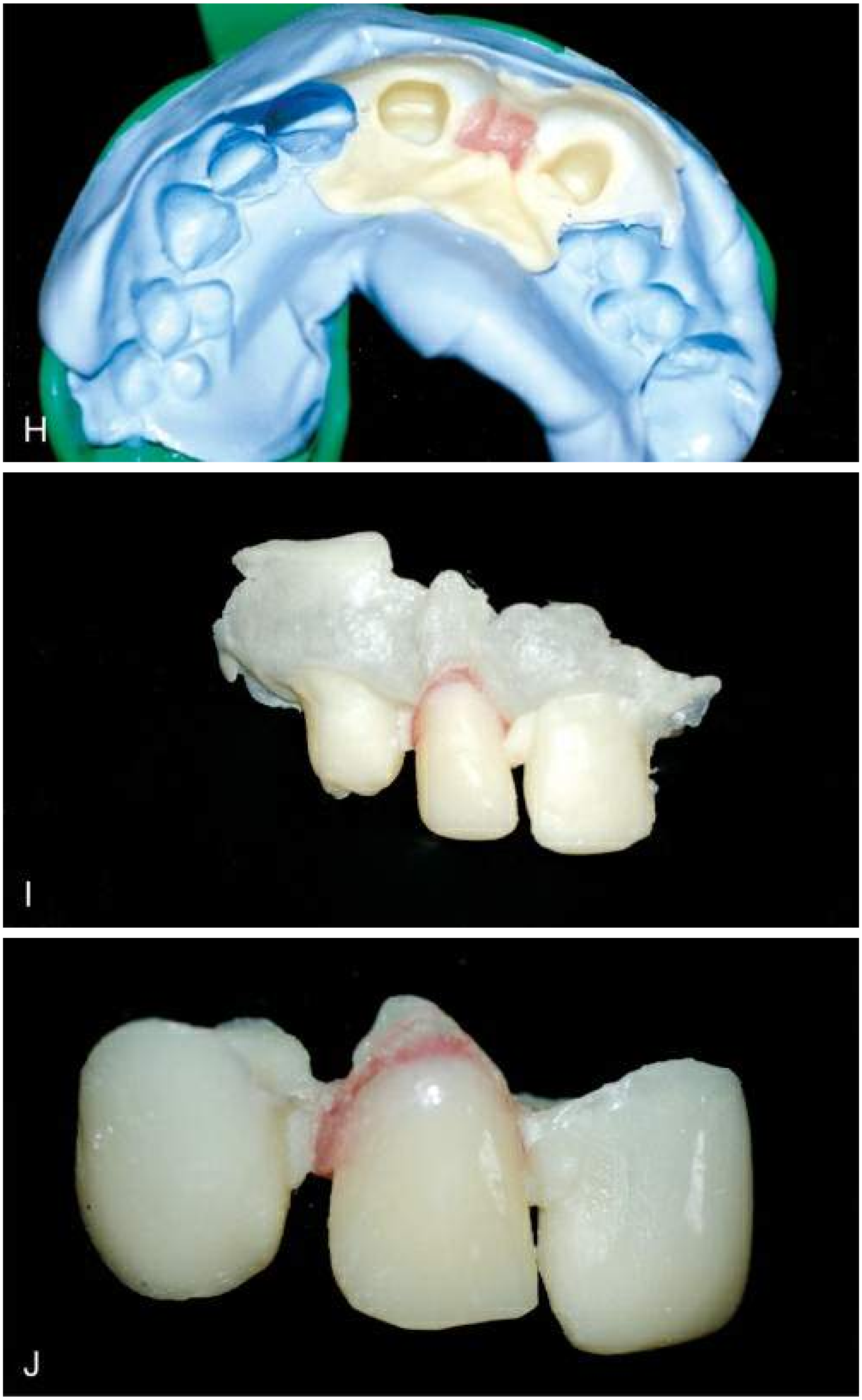
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FIGURE 38.6 **(A)** Preoperative picture – missing maxillary central incisor (tooth No. 11). **(B)** Removable partial denture in place. **(C)** Making putty index intraorally with existing RPD. **(D)** Putty index with existing RPD and flanges trimmed. **(E)** Application of separating medium on prepared teeth. **(F)** Resin mixed and poured in index. **(G)** Index reseated in mouth. **(H)** Allowed to set in index. **(I)** Provisional prosthesis needs to be trimmed after removal from index. **(J)** Trimmed provisional prosthesis. **(K)** Cemented provisional prosthesis.

If there is no existing denture/restoration, the teeth to be replaced are arranged/waxed-up on the diagnostic cast and an index is made with putty/irreversible hydrocolloid of the teeth to be restored, on the cast.

- Tooth preparation is performed.
- Separating medium like petroleum jelly is applied to the prepared tooth and adjacent tissues (Fig. 38.6E).
- Autopolymerizing resin (preferably bis-acryl composite) is mixed and poured in the putty index on the teeth to be restored and positioned in the patient's mouth (Fig. 38.6F and G).
- The index with the provisional material is removed from the oral cavity before the exothermic heat is evolved.

- The restoration is allowed to set completely in the putty index (Fig. 38.6H).
- The restoration is removed from the index and will need some adjustment to be refixed in the mouth due to polymerization shrinkage (Fig. 38.6I).
- It is then contoured, polished and cemented (Fig. 38.6J and K).

Indirect technique

- Restoration is fabricated extraorally on a cast.
- Preferred method for making provisionals for FPDs.

Advantage

- Patient is not affected by material properties like odour and exothermic heat.

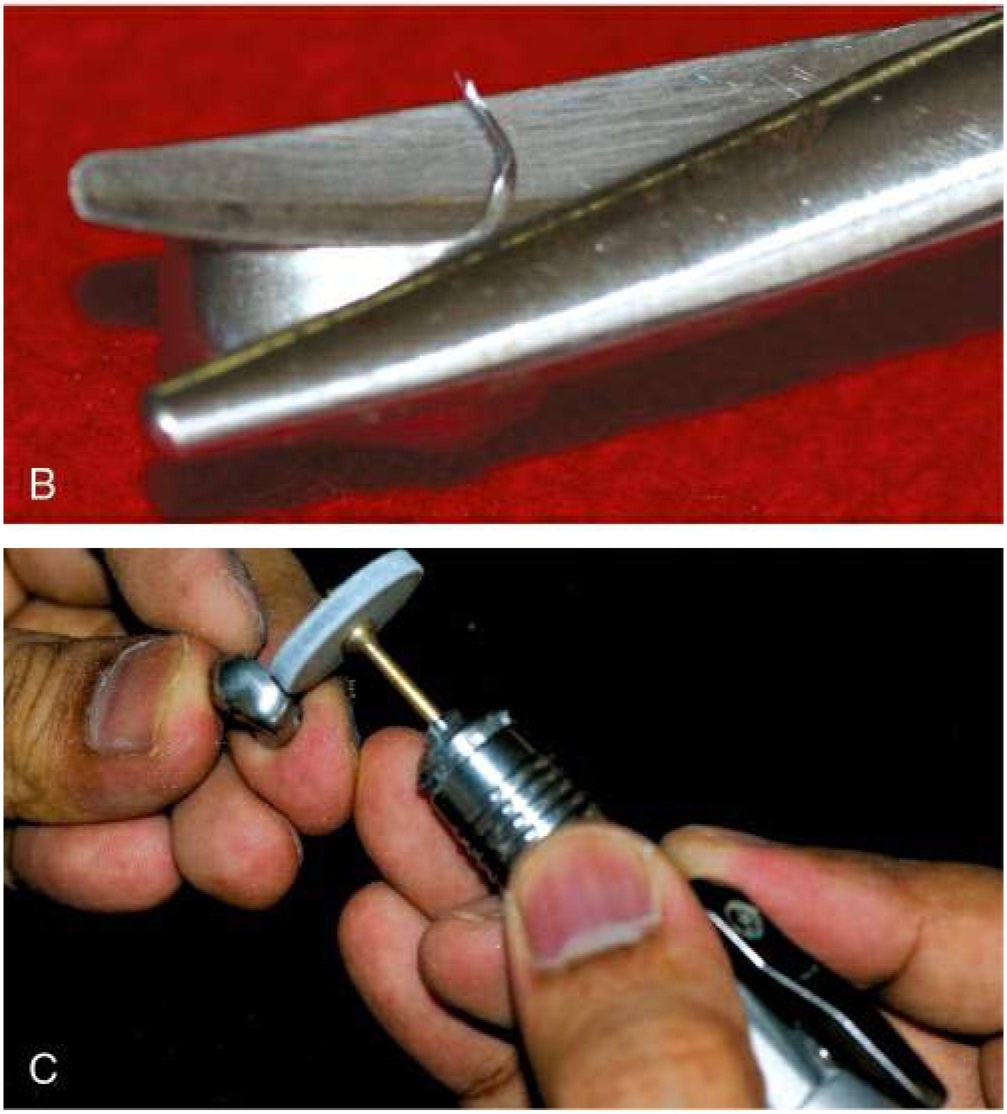
Disadvantages

- Takes more time as impressions are made after tooth preparation.
- More cost.

Indirect technique: Preformed nickel–chromium crowns

- An impression is made after tooth preparation with irreversible hydrocolloid (alginate), and cast is poured in quick setting plaster.
- The mesiodistal width of the restoration is measured with a divider or calipers and an appropriate size of the preformed nickel–chromium crown is selected (Fig. 38.7A).

- If the gingival margin is too tight, the crown is pushed down on an appropriate stretching block to flare the gingival margin.
- The gingival margin is then trimmed and festooned till the correct occlusogingival height and contour are obtained (Fig. 38.7B and C).
- The axial surface is contoured with pliers to obtain a convex surface (Fig. 38.7D).
- The crown is checked in the mouth, occlusal correction done and margins burnished (Fig. 38.7E).
- It is then cemented using provisional cement (Fig. 38.7F–H).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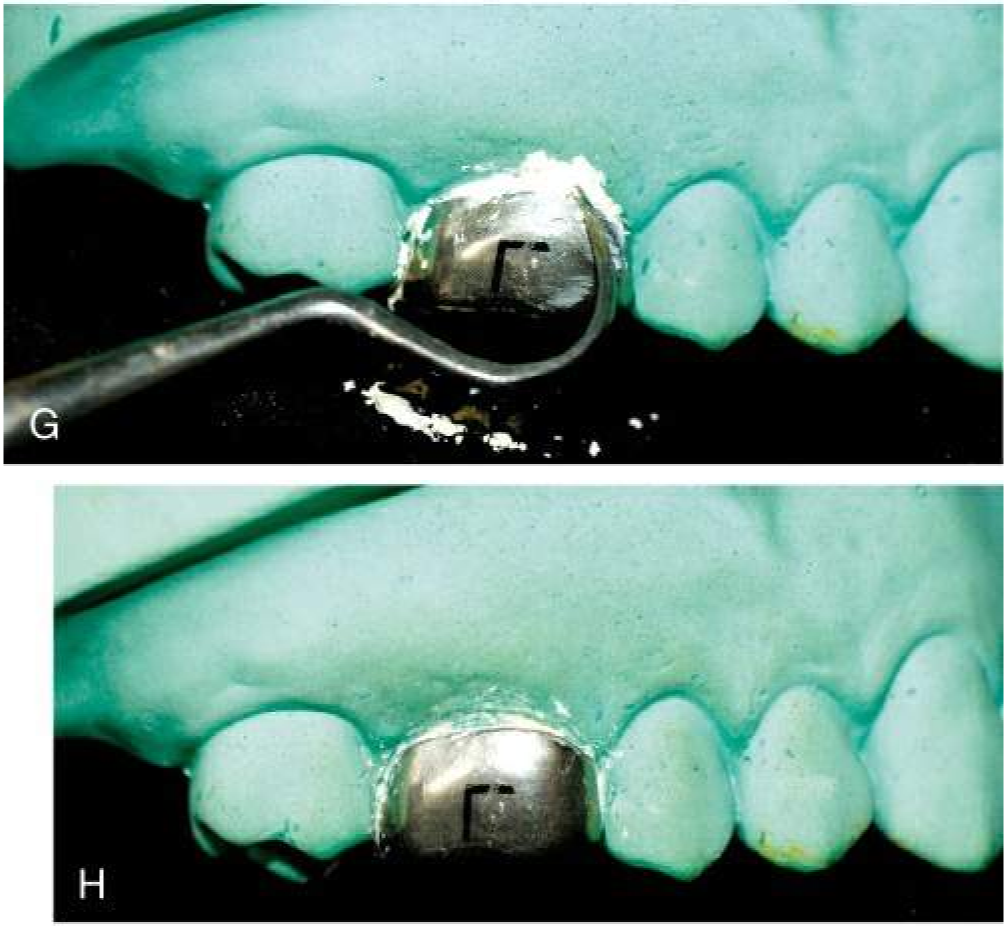


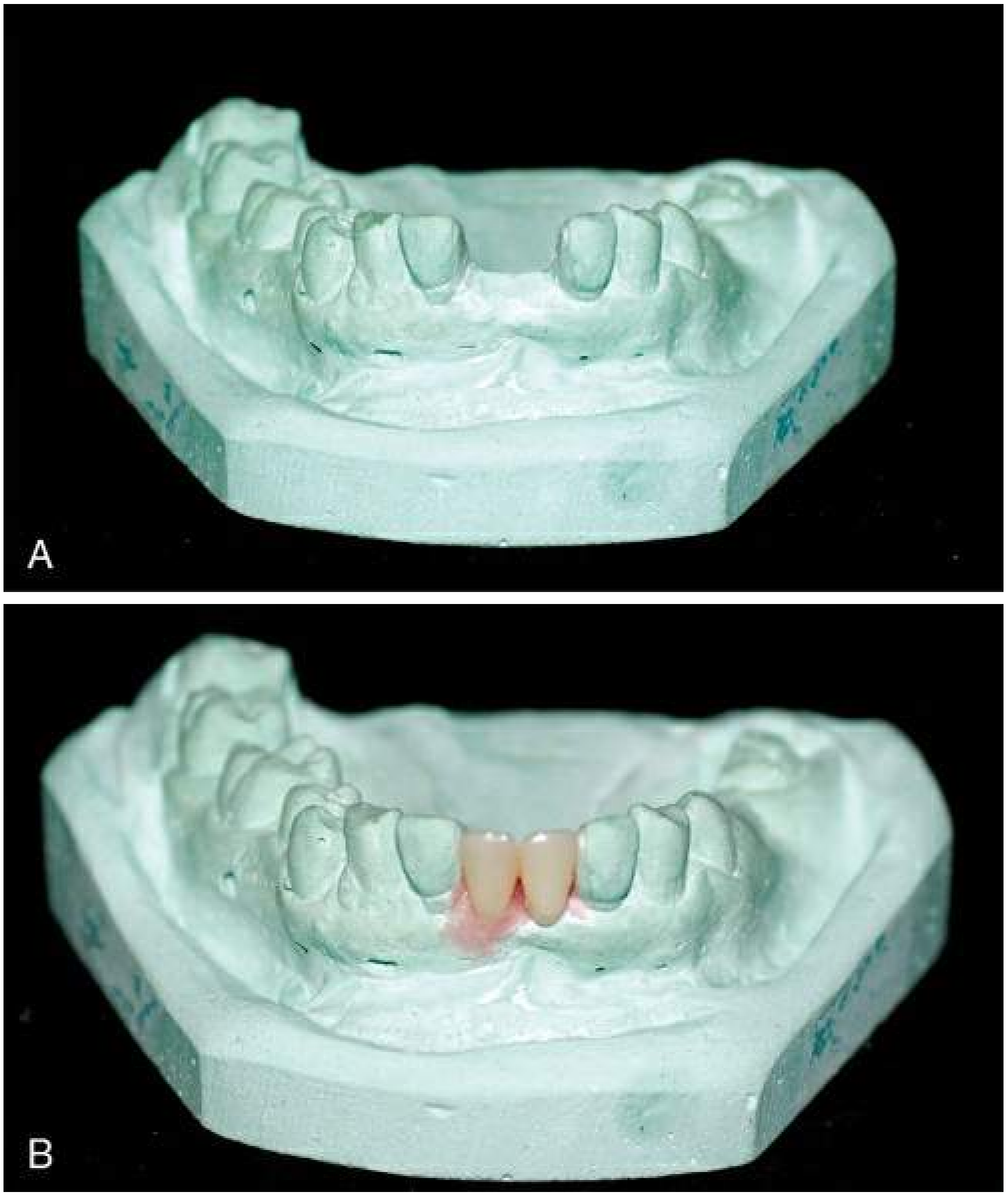
FIGURE 38.7 **(A)** Appropriate size of nickel–chromium crown is selected. **(B)** Excess height is removed from the gingival margin. **(C)** Gingival margin is smoothened. **(D)** Contouring axial surfaces with pliers. **(E)** Occlusion is checked with articulating paper. **(F)** Crown filled with provisional cement is seated. **(G)** Excess cement is removed from the crevice with an explorer. **(H)** Cemented crown.

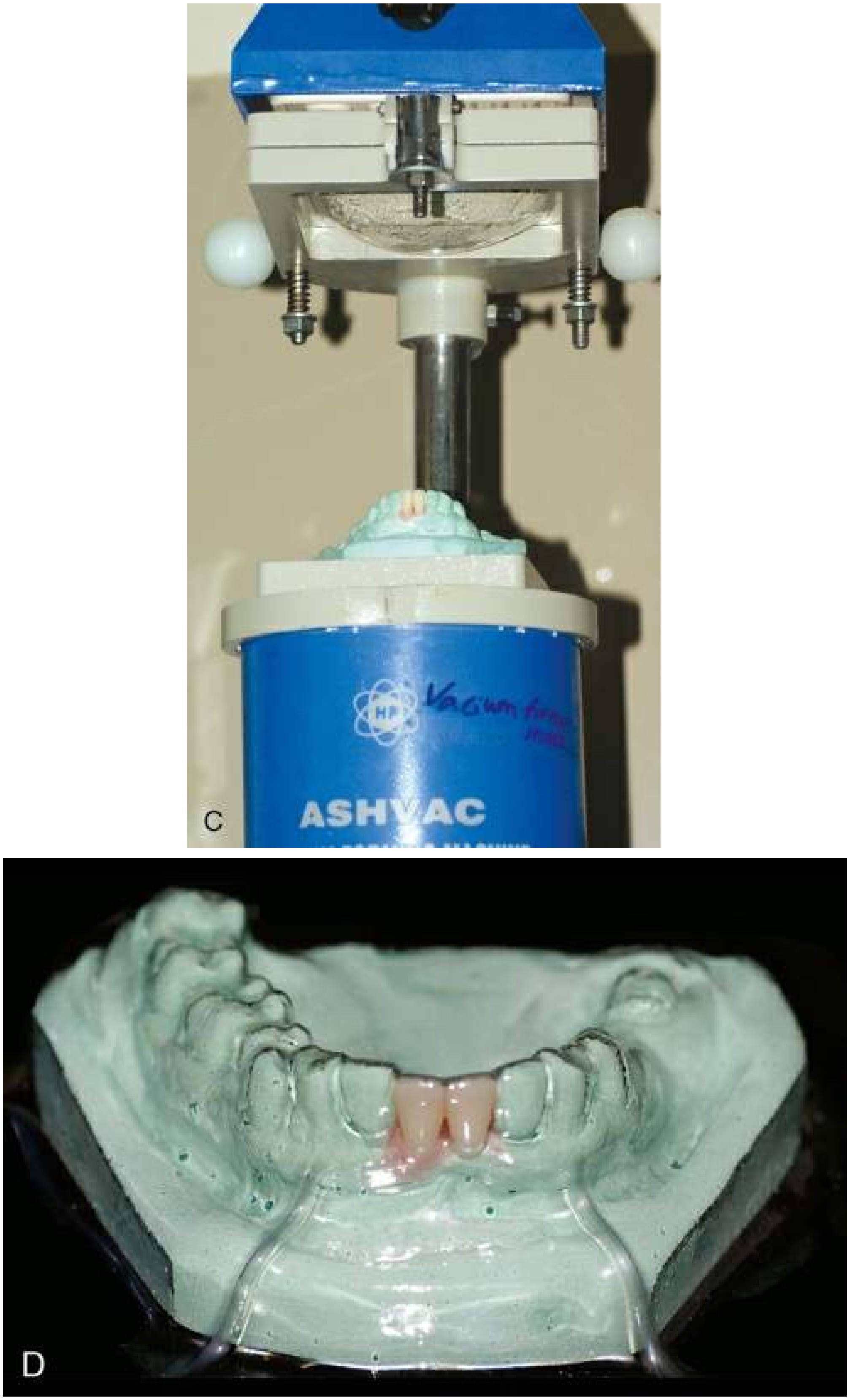
Indirect technique: Custom-made provisionals using vacuum-formed template

- A diagnostic cast is obtained and artificial teeth are arranged (Fig. 38.8A and B). Putty is used to stabilize the artificial teeth on the cast instead of wax. Wax will melt while using the thermoforming machine.

- Place a hole in the middle of the cast in midpalatal or midlingual region, and place the cast at the centre of the vacuum machine.
- Place the temporary splint material in the vacuum machine.
- Turn on the heating element and allow the sheet to sag (Fig. 38.8C).
- At the appropriate level of sagging, forcefully lower the frame over the cast and turn on the vacuum, and adapt the sheet over the cast and allow it to cool (Fig. 38.8D).
- The artificial teeth are removed from the cast and the thermoformed sheet is trimmed to fit the gingival contours and a template (anatomic contour/index) is obtained of the restoration.
- Index can also be obtained as described previously using putty.
- The abutment teeth are prepared in the mouth (Fig. 38.8E).
- A quick setting plaster cast is made from an alginate impression of the tooth preparation (Fig. 38.8F).
- The thermoformed template is tried on the model to check fit and is removed (Fig. 38.8G).
- Separating medium is applied on the cast and autopolymerizing acrylic resin of appropriate shade is mixed and poured into the template in the area of the restoration.
- The template is now positioned on the cast with the provisional material, ensuring correct seating (Fig. 38.8H).
- Hold the template to the cast using rubber bands.
- Finally after polymerization is complete the provisional is removed from the cast and index, the excess is trimmed and the pontic area is contoured (Fig. 38.8I and J).

- After finishing and polishing occlusion is checked and cemented using temporary cement (Fig. 38.8K).

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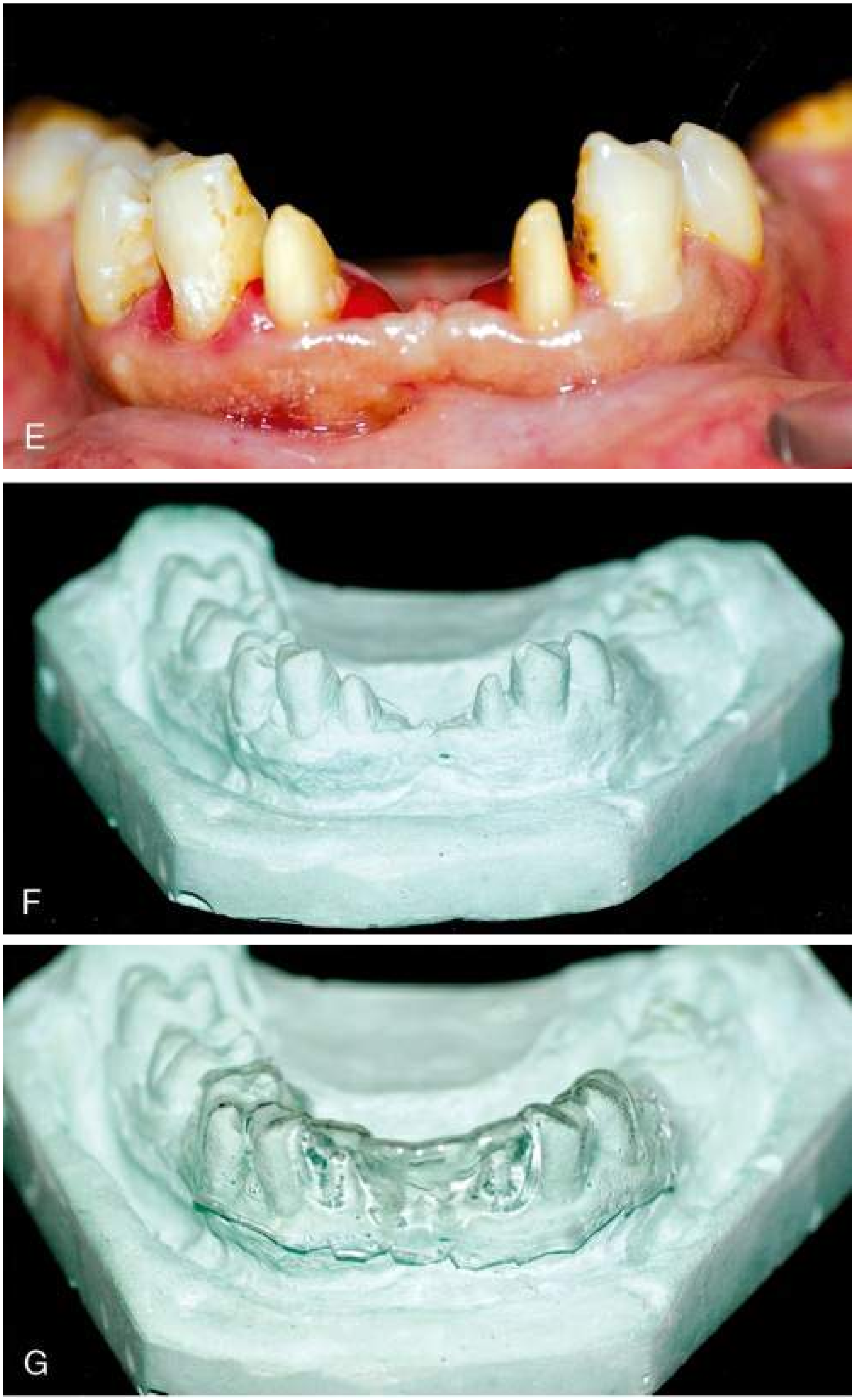
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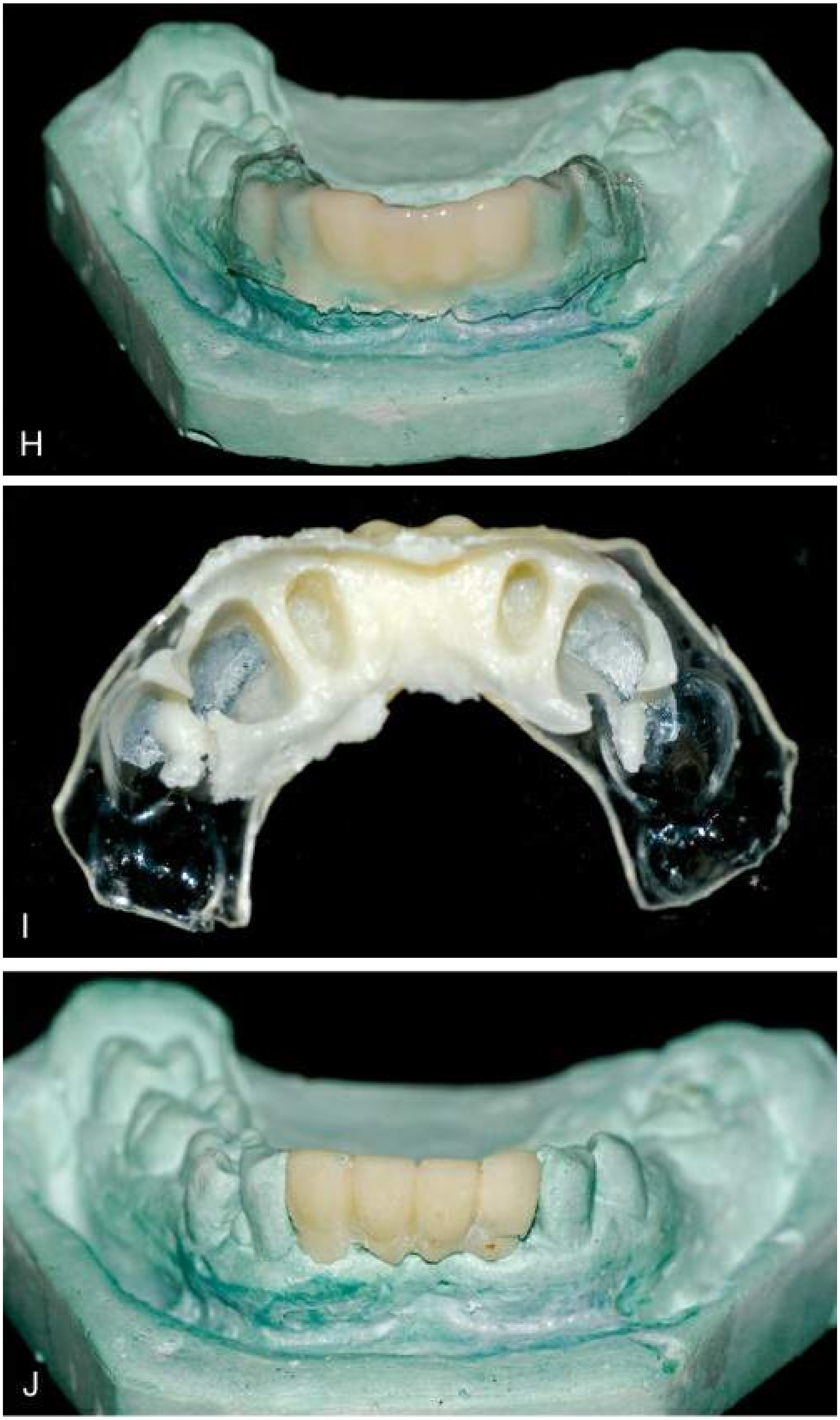
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FIGURE 38.8 **(A)** Diagnostic cast with missing mandibular anterior teeth. **(B)** Teeth arranged. **(C)** Cast placed in machine and thermoformed sheet heated and allowed to sag. **(D)** Cast with artificial teeth vacuum formed. **(E)** Tooth preparation done. **(F)** Plaster cast following tooth preparation. **(G)** Template placed on cast to check fit. **(H)** Template seated on cast filled with the provisional material in the area of the restoration. **(I)** Template removed from cast after polymerization. **(J)** Provisional restoration trimmed and fitted on cast – buccal view. **(K)** Final provisional cemented in mouth.

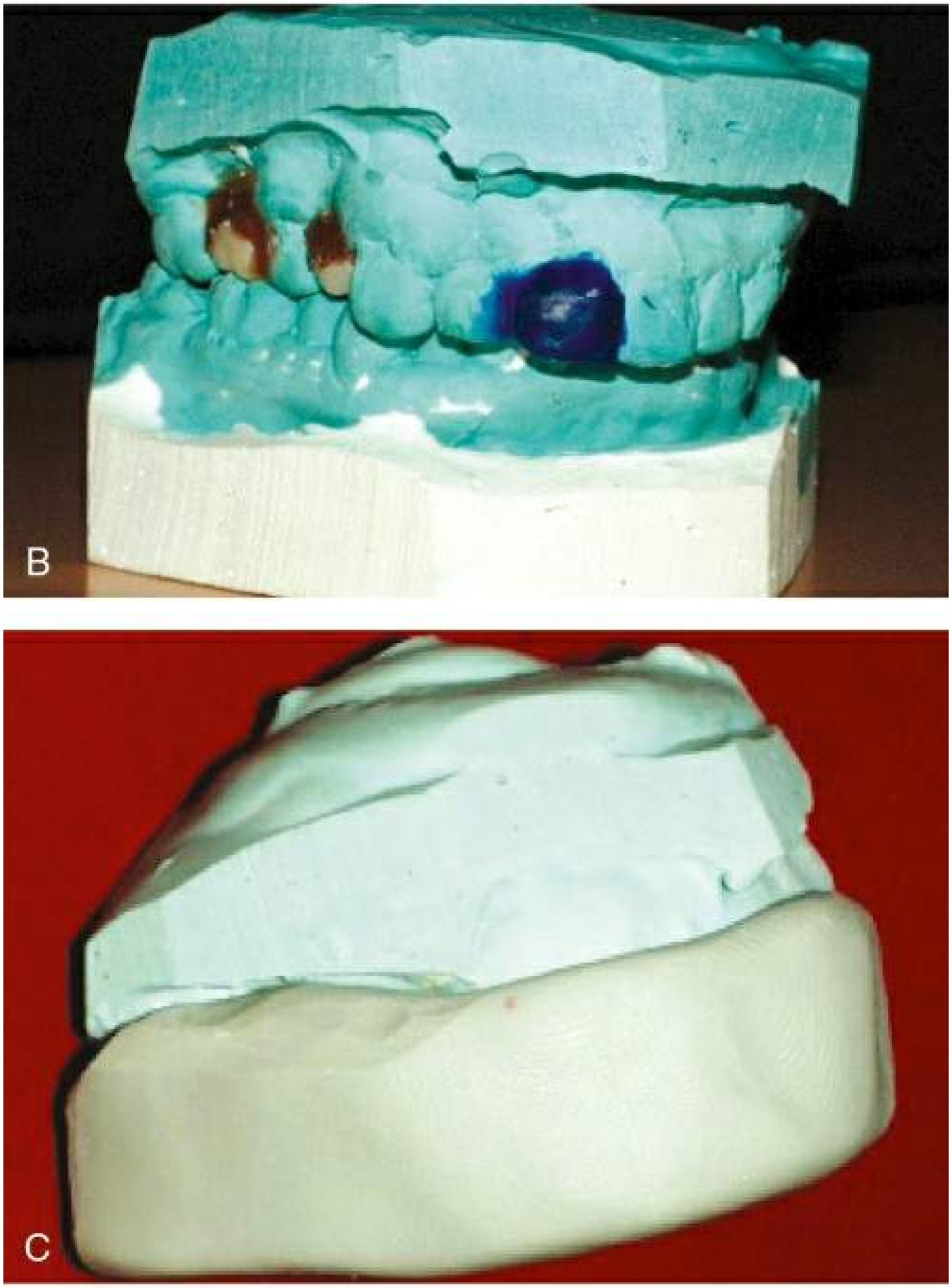
Direct–indirect technique

This technique combines the merits of the indirect and direct techniques. A shell (anatomic form) of the provisional restoration is fabricated indirectly on a cast with the material used for the restoration, before tooth preparation. The shell is relined with the same material intraorally after tooth preparation to ensure accurate fit.

- The diagnostic impression is made before preparation and cast is obtained (Fig. 38.9A).

- The edentulous areas are restored with acrylic denture teeth and necessary corrections are made on the abutment teeth with wax (Fig. 38.9B).

- A putty index is made up of the restored cast (Fig. 38.9C).
- The arranged artificial teeth are removed and the abutment teeth are prepared on the cast. Care is taken to ensure that preparation is minimal and less than that intended for the final restoration in the mouth (Fig. 38.9D and E).
- Autopolymerizing acrylic resin of appropriate shade is mixed and poured in the putty index (Fig. 38.9F).
- The putty index filled with resin is then correctly repositioned on the cast after applying separating medium on cast. The index is secured with rubber bands for maximum adaptation (Fig. 38.9G).
- After setting, the provisional restoration is trimmed and replaced on the cast (Fig. 38.9H).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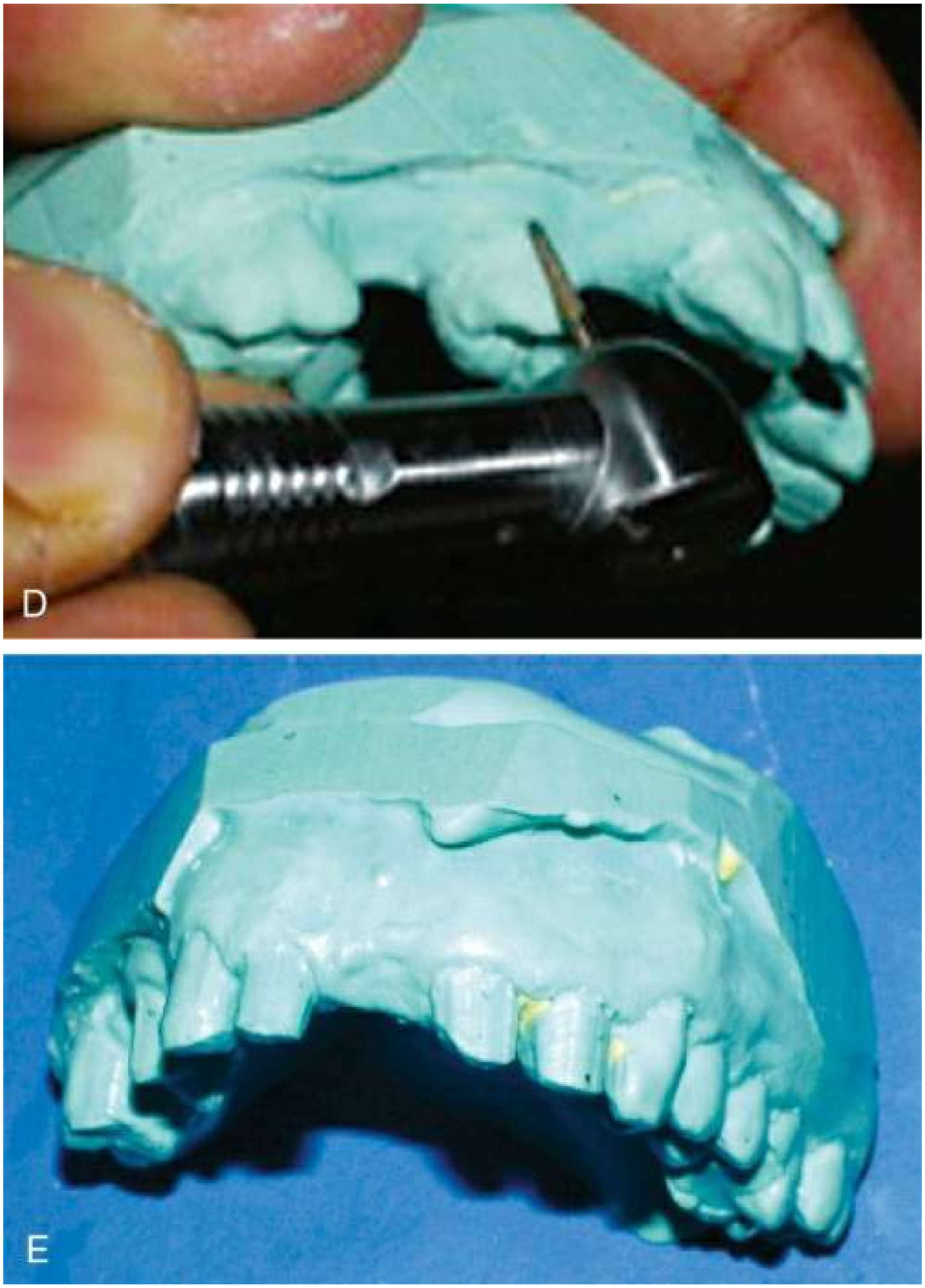
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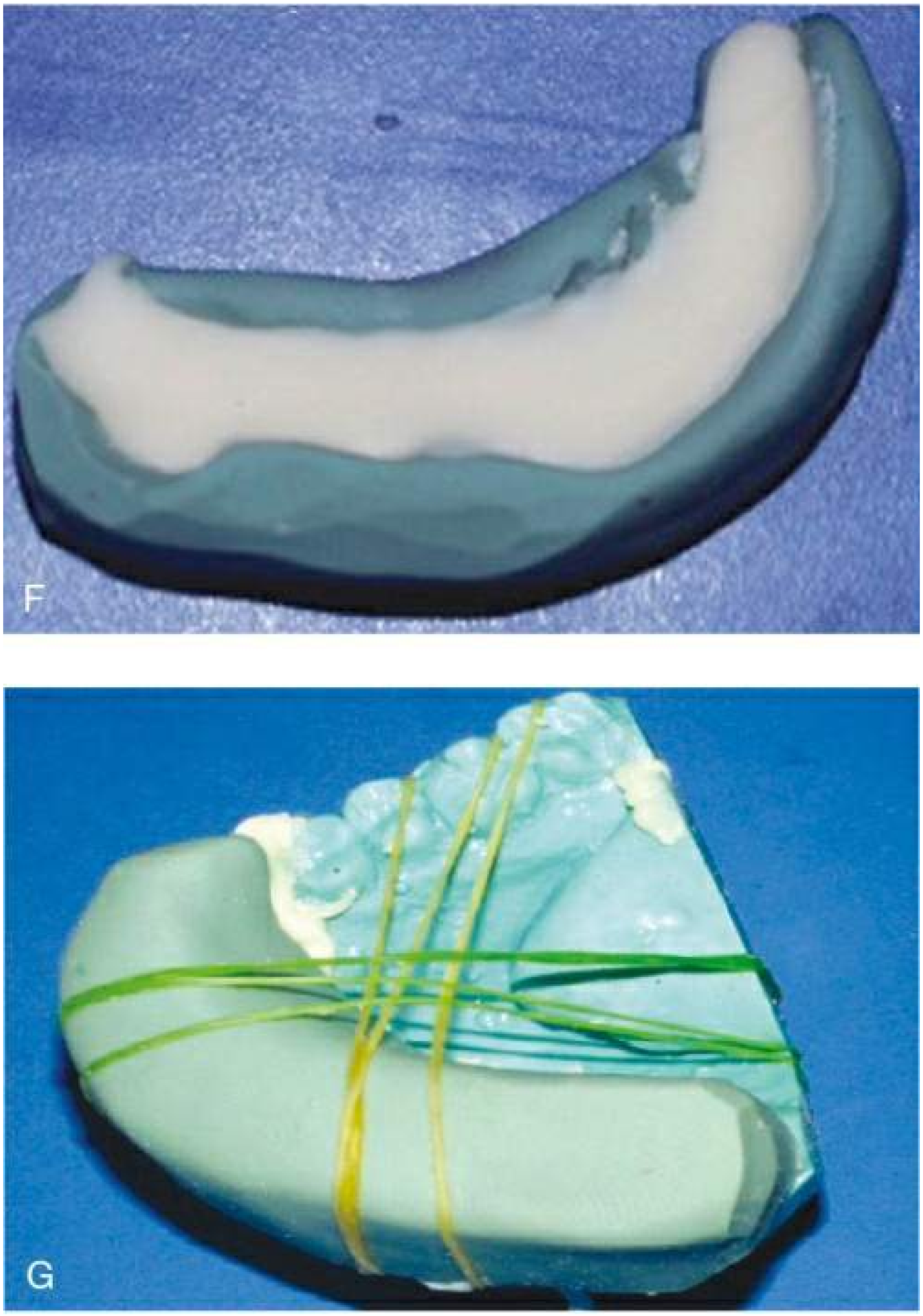
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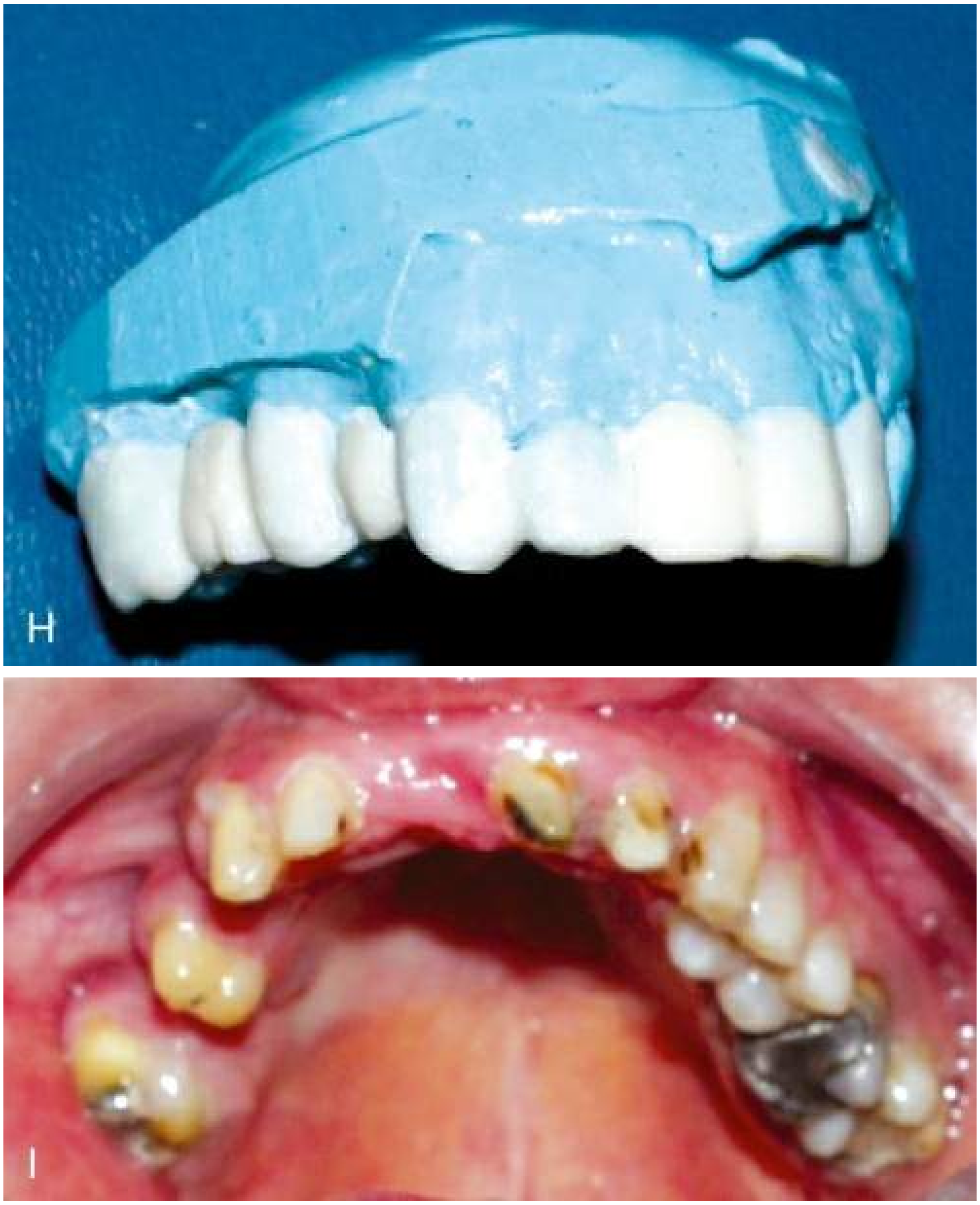
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FIGURE 38.9 **(A)** Intraoral picture showing missing first premolar, first molar and fractured anterior FPD requiring replacement. **(B)** On the diagnostic cast, edentulous areas are restored and wax corrections are done. **(C)** Putty index fabricated. **(D)** Tooth prepared minimally in the stone model. **(E)** Preparation completed on stone model. **(F)** Autopolymerizing acrylic resin is poured into the putty index. **(G)** Putty index secured onto cast using rubber bands. **(H)** Indirect provisional restoration trimmed and fitted on the cast. **(I)** Abutment teeth prepared in the patient's mouth. **(J)** After

tooth preparation in the patient's mouth acrylic resin is added to retainers in the indirect provisional. **(K)** Stabilized using finger pressure in the patient's mouth and allowed to partially set. **(L)** Relined provisional after removal from mouth. **(M)** Final indirect–direct provisional cemented after trimming and polishing.

This provisional is fabricated indirectly on the cast with a tentative tooth preparation and so will not fit accurately after final tooth preparation. This restoration is fabricated and kept ready before the abutment teeth are prepared in the patient's mouth.

- The abutment teeth are prepared in the patient's mouth to its final shape (Fig. 38.9I).
- The retainers of the indirectly made provisional are relined with the same acrylic resin used for its fabrication (Fig.38.9J).
- This is placed in the mouth after application of separating medium on the teeth and adjacent areas and held with finger pressure till the initial set (Fig. 38.9K).
- It is removed before the final set or exothermic reaction begins, and allowed to polymerize in warm water (Fig. 38.9L).

This is the direct method performed intraorally to obtain accurate fit.

- The restoration is trimmed, checked for fit, occlusal correction done, polished and cemented (Fig. 38.9M).

Limitations of provisional restoration

- Lack of adequate strength – fracture of provisional is possible in long span FPDs, patients with bruxism and reduced interocclusal clearance.
- Inadequate marginal adaptation.
- Poor aesthetics in long term provisional restoration.
- Plaque accumulation due to poor surface characteristics.
- Compromised bonding characteristics.
- Mild to moderate tissue irritation.

Cementation

Ideal properties

• Ability to seal against leakage of oral fluid.

• Strength consistent with intentional removal.

• Low solubility.

• Blandness or obtundency.

• Chemical compatibility with the provisional polymer.

• Convenience of dispensing and mixing.

• Ease of eliminating excess.

• Adequate working time and short setting time.

• Compatibility with the definitive luting agent.

Cements

1. Zinc oxide eugenol

2. Reinforced zinc oxide eugenol

3. Noneugenol cements.

Noneugenol cements are used as free eugenol interferes with the setting of acrylic resins and bonding of composite to tooth if final cement is a resin cement.

Eugenol has good antimicrobial properties and reduces postpreparation sensitivity. If this is desired, then reinforced zinc oxide eugenol is used.

Zinc phosphate, zinc polycarboxylate and glass ionomer cement are not recommended because their comparatively high strength makes intentional removal difficult. The cements are available as powder–liquid, paste–paste and automixing varieties.

Procedure

- The external surfaces of the restoration are lubricated with petrolatum to facilitate removal of excess cement.

- Mix the base and catalyst together rapidly and apply small quantity just occlusal to the margins. This forms the required seal against oral fluids. Completely filling the crown or abutment retainers should be avoided, because it prolongs cleanup and increases the risk of leaving the debris in the sulcus.

- Seat the restoration and allow the cement to set.

- Carefully remove excess with an explorer and dental floss.

Removal of provisional restoration

Provisional restoration can be removed using forces given parallel to long axis of tooth preparation. Haemostatic artery forceps are used for single-unit restorations giving slight buccolingual movement to break the cement seal. Looping dental floss under the connector at each end of the connector is useful in case of FPD. Crown removers and cutting of crowns are more often used only with definitive restorations (see Chapter 42).

SUMMARY

Provisional restoration is essential immediately after tooth preparation to prevent the tooth from injury, abnormal tooth movement. It should fulfil the ideal requirements and should be well tolerated and easily accepted by patients. Each provisional restorative material has certain advantages and disadvantages and is selected based on the clinical situation. Various techniques for fabrication have been discussed in detail and the techniques can be selected depending on the patient comfort, feasibility, and cost factor. Temporary cementation provides easy removal of the restoration.

CHAPTER 39

Shade selection and lab communication

CHAPTER CONTENTS

Introduction

To provide aesthetic restorations to the patients, the dentist must understand the scientific as well as artistic basis of shade selection. To accomplish this, a thorough knowledge of the concepts of colour and light is necessary with clear communication to the laboratory. All these aspects will be discussed in this chapter.

Colour and light

Colour of an object is determined by the light that enters the human eye from that object.

Light is a form of visible energy that is part of the radiant energy spectrum. Radiant energy possesses specific wavelengths measured in nanometres (nm).

Visible light spectrum ranges from 400–700 nm. Wavelengths lesser than visible light include ultraviolet, X-rays, gamma and cosmic rays. Above visible spectrum there are infrared, microwaves, television, radio and electrical waves.

Colour mixing

In the additive or light-mixture colour mixing system; red, green, blue are the primary colours. Mixing two primary colours produces a secondary colour.

Red + green = yellow

Green + blue = cyan

Red + blue = magenta

This system applies only to combining lights and illuminants (Fig. 39.1).

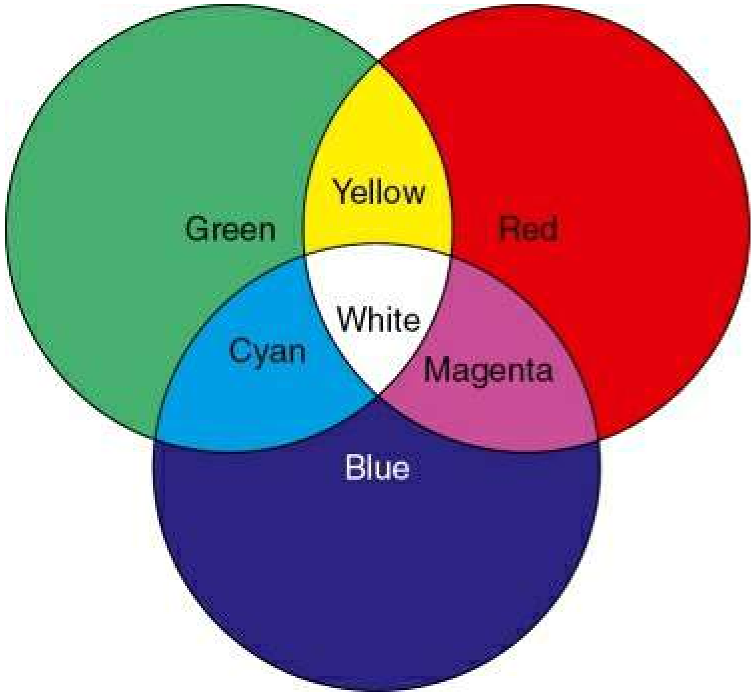


FIGURE 39.1 Additive colour mixing system.

In the subtractive or pigment-mixture colour mixing system, the secondary colours in the additive system yellow-cyan-magenta are the primary colours. Mixing any two of them produces a secondary colour – red, green, blue.

Yellow + cyan = green

Cyan + magenta = blue

Magenta + yellow = red

This system is used in fields such as painting and printing (Fig. 39.2). In dental ceramics both additive and subtractive colour concepts are used.

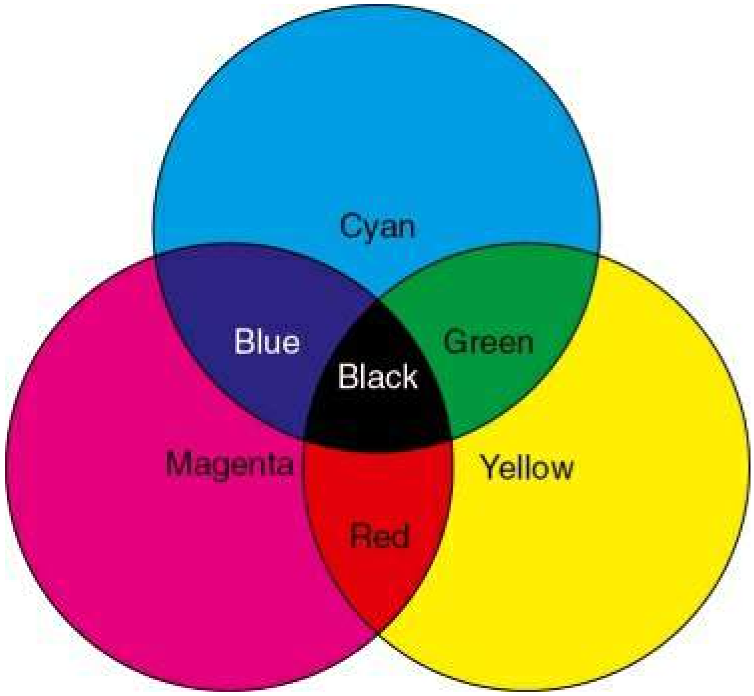


FIGURE 39.2 Subtractive colour mixing system.

Colour wheel

Primary and secondary colours are arranged in the form of a wheel (Fig. 39.3). It is produced by bending the spectrum of light into a circle.

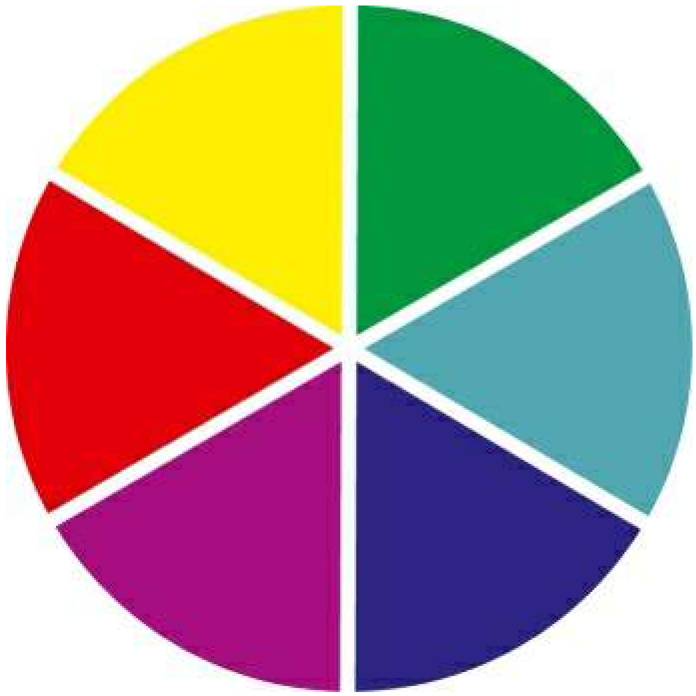


FIGURE 39.3 Colour wheel showing complementary colours.

Colours directly opposite each other are called complementary colours. For example, the complementary colour of yellow is blue. Mixing of a colour with its complementary gives an achromatic result. Mixing of three primary colours also produces an achromatic result.

Colour description

Two systems may be used to describe colour:

1. Munsell colour order system – more visually descriptive.

2. Cielab colour system – more quantitative.

Munsell colour order system

Developed by Albert Henry Munsell in 1915, the system describes colour possessing three dimensions – hue, chroma and value (Figs 39.4A and 39.5).

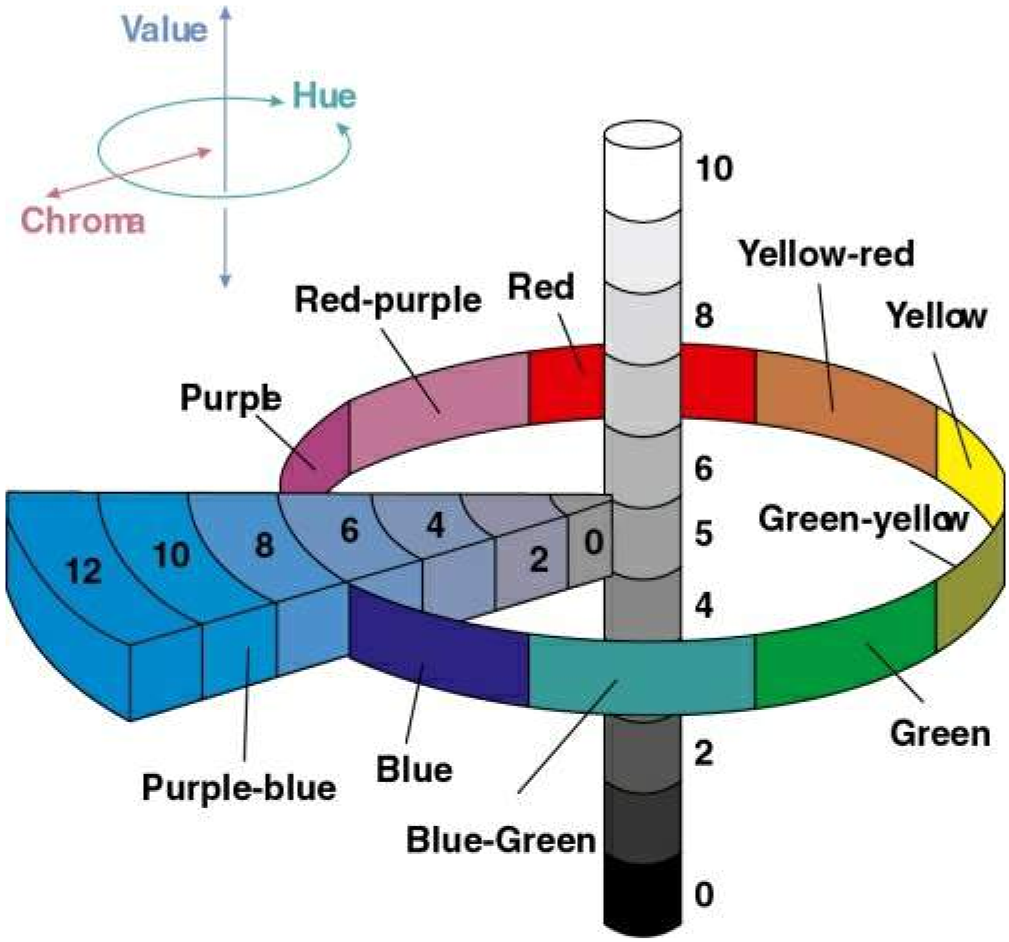
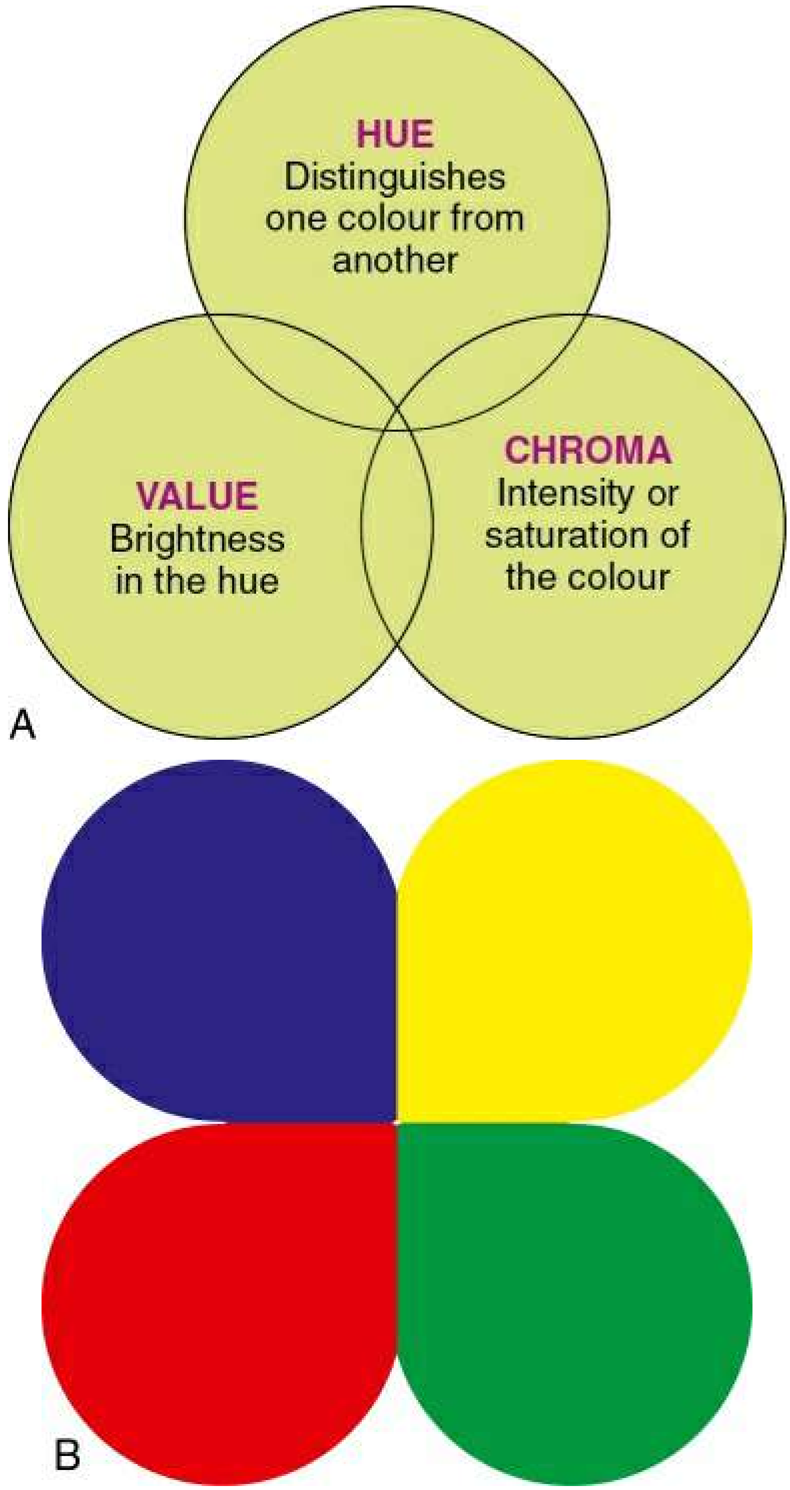


FIGURE 39.5 Munsell colour order system – showing effects of variations in hue, value and chroma.

Hue

It is the particular variety of a colour (Figs 39.4B and 39.5). Often referred to as the basic colour, hue is used to distinguish one family of colour from another – red, green, blue, as determined by the wavelength.


HUE
Distinguishes one colour from another
VALUE
Brightness in the hue
CHROMA
Intensity or saturation of the colour
A
B

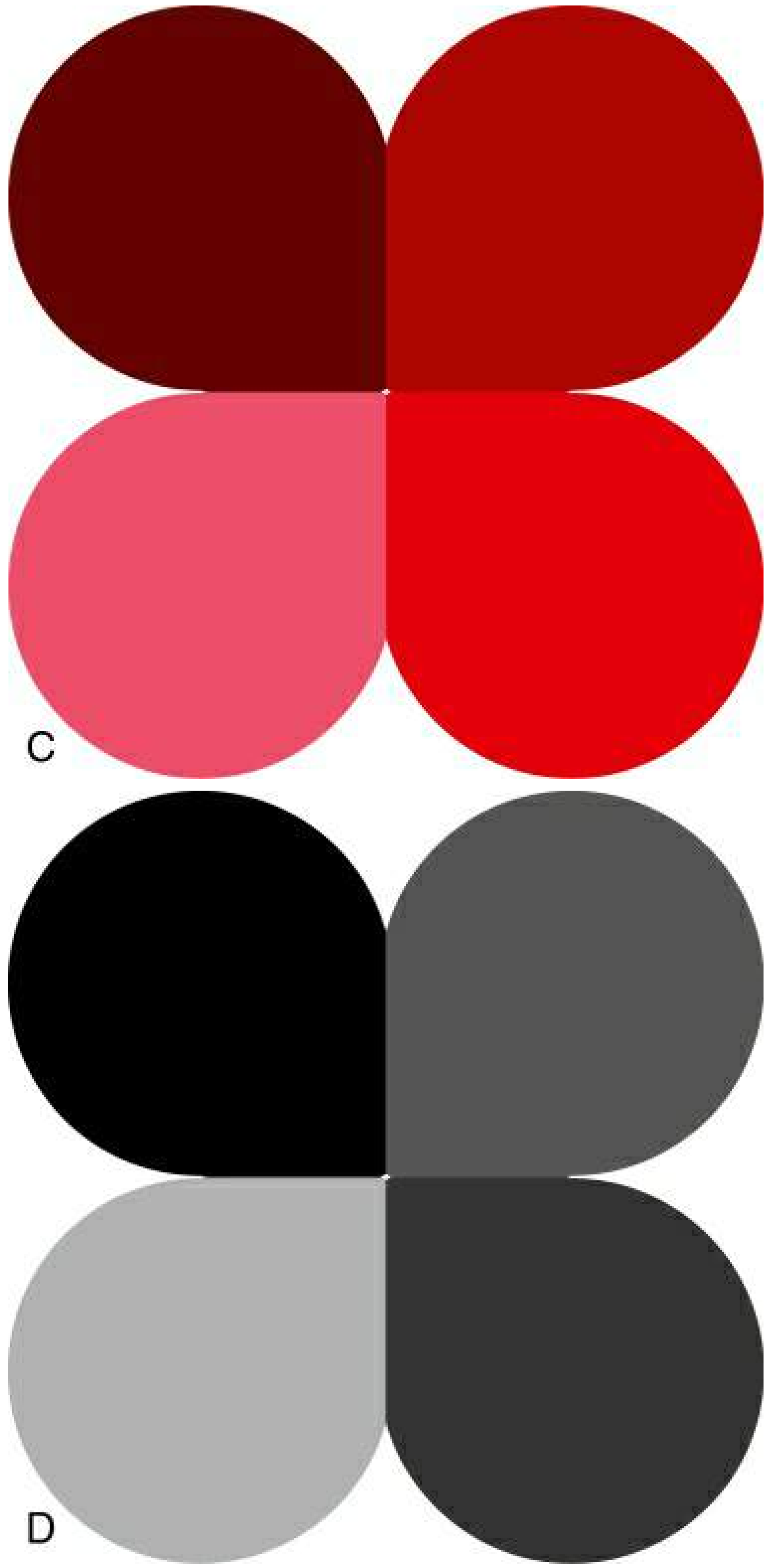


FIGURE 39.4 **(A)** Three dimensions of colour. **(B)** Hues – blue, yellow, red and green. **(C)** Saturation of the hue red. **(D)** Values of light intensities or saturations.

There are 10 hue families:

1. R – red
2. YR – yellow-red
3. Y – yellow
4. GY – green-yellow
5. G – green
6. BG – blue-green
7. B – blue
8. PB – purple-blue
9. P – purple
10. RP – red-purple

Each of these is further divided into 10 numbered segments, e.g. middle of red would be 5R.

Chroma

It is the intensity or saturation of the colour (Figs 39.4C and 39.5). The chroma scale starts from achromatic, or zero, with increasing values indicating stronger colour.

A particular colour is classified as weak, moderate or strong according to chroma.

Value

It is the brightness or the relative amount of darkness or lightness in the hue (Figs 39.4D and 39.5).

It is an achromatic or colourless distinction. Black is zero and white is 10. Colours with low values are dark, while colours with high values are light.

For shade matching, value is the most important characteristic.

This is because value differences are easily detected by even the individuals untrained in colour perception. They are also easily detected even from a distance. Whenever it is not possible to match perfectly using the shade guide, it is better to select the lighter shade which will allow modifications via staining later.

These are designated as HV/C, e.g. 5R 4/6, would mean hue is medium red, value is 4 and chroma is 6.

Cielab colour system

In 1976, the International Commission of I'Eclairage (CIE) introduced this system to describe colour. For the first time it was possible to express colour in numbers and to calculate the difference in two colours quantitatively using a formula.

The method used in dentistry is the uniform colour space, known as CIEL*a*b* (Fig. 39.6). Colour space is a numerical value that expresses the object's colour.

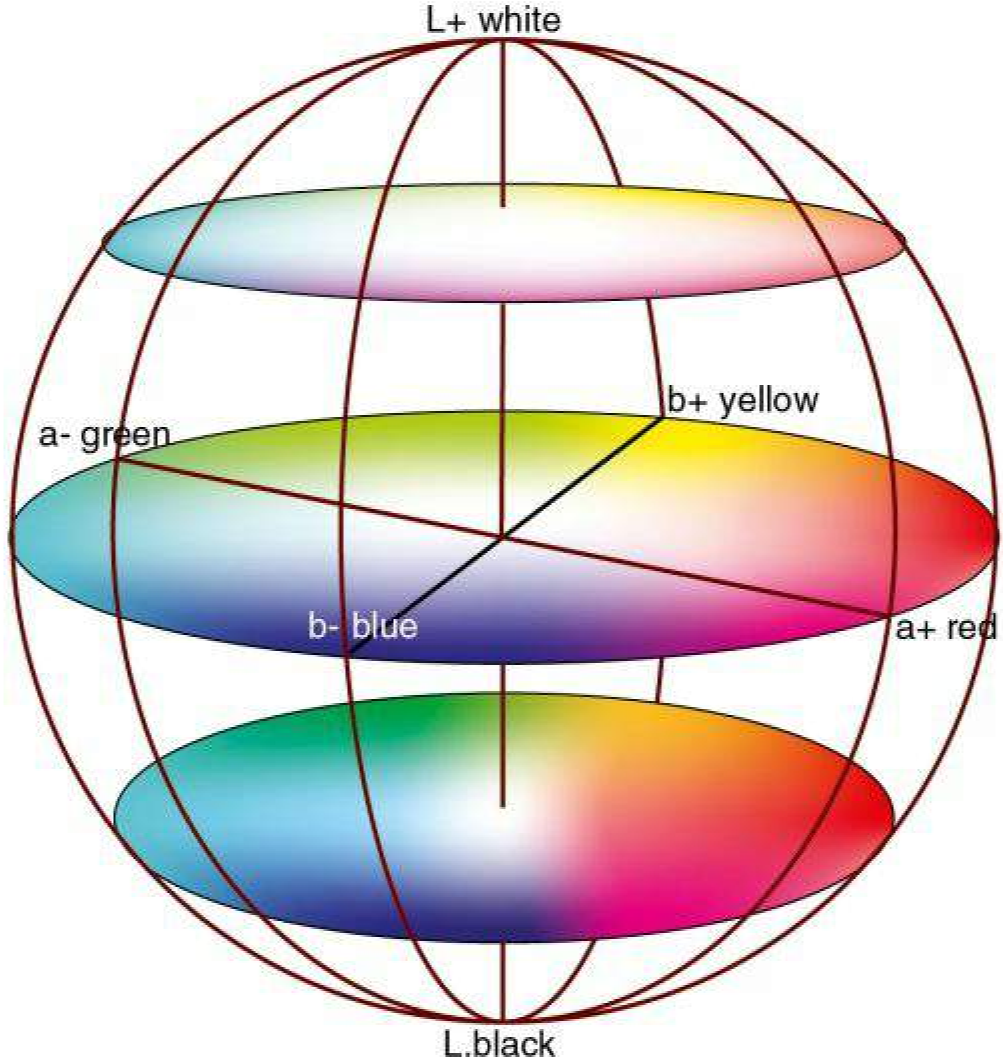


FIGURE 39.6 Cielab colour system.

L* indicates the lightness coordinate of the object, with values from 0 (absolute black) to 100 (absolute white).

The values a* and b* indicate the chromaticity coordinates, showing the three-dimensional position of the object in the colour space and its direction. When the coordinate a^* is positive ($+a^*$), the object colour tends to be red. When this coordinate is negative ($-a^*$), the trend is green. This coordination can range from −90 to 70 Δa^*. The coordinate b^* indicates the direction to yellow ($+b^*$) or blue ($-b^*$), and can vary from −80 to 100 Δb^*.

Colour differences or ΔE represent equally perceived shade gradations.

Colour of human teeth

Spectrophotometer studies show a hue range of 6 YR to 9.3 Y, a value range of 4–8 and a chroma range from 0 to 6. Hence, the human teeth lie in the yellow-red to yellow portion of colour wheel, with value range in the lighter portion, which indicates that very dark teeth are uncommon. The chroma range is towards the lower scale, which indicates that strong colours are not found.

Colour perception

This involves the participation of three factors:

1. The observer

2. The object being observed

3. The light source

Observer

Perception of colour is a subjective process and depends on the observer's visual individuality. It depends on the age, duration of exposure of the eye, fatigue or illness related to the colour like colour blindness. It is important that a dentist should be aware if a visual deficiency exists in him. If so, he could rely on a well-trained assistant or lab technician to match shades.

Object

When light falls on an object, it is absorbed, reflected, transmitted or refracted depending on the light transmitting ability of the object. This produces a characteristic quality of that colour.

Different parts of the same object can also exhibit varying light transmission thereby changing the perceived colour.

Light scattering or reflecting off the operatory walls, and furniture also influences the colour of an object. Hence the operatory should have neutral colours.

Light source

The light source utilized has a definite effect on the perception of colour. There are commonly three available sources – natural daylight, incandescent light and fluorescent light (Fig. 39.7). Light-emitting diode (LED) lights are also being used currently. Colour corrected lights are also available which emit light with a more uniform distribution of colour. Each light source produces a characteristic distribution of colour in the light it emits. Natural daylight is also extremely variable, with a different hue of light during morning, noon, afternoon and when it is cloudy. Hence, it is necessary to select shade first with colour corrected lights and then check the same with other sources so that metamerism is minimized. Examples of commercially available colour corrected lights are – Demetron shade light and Vita-Lite.

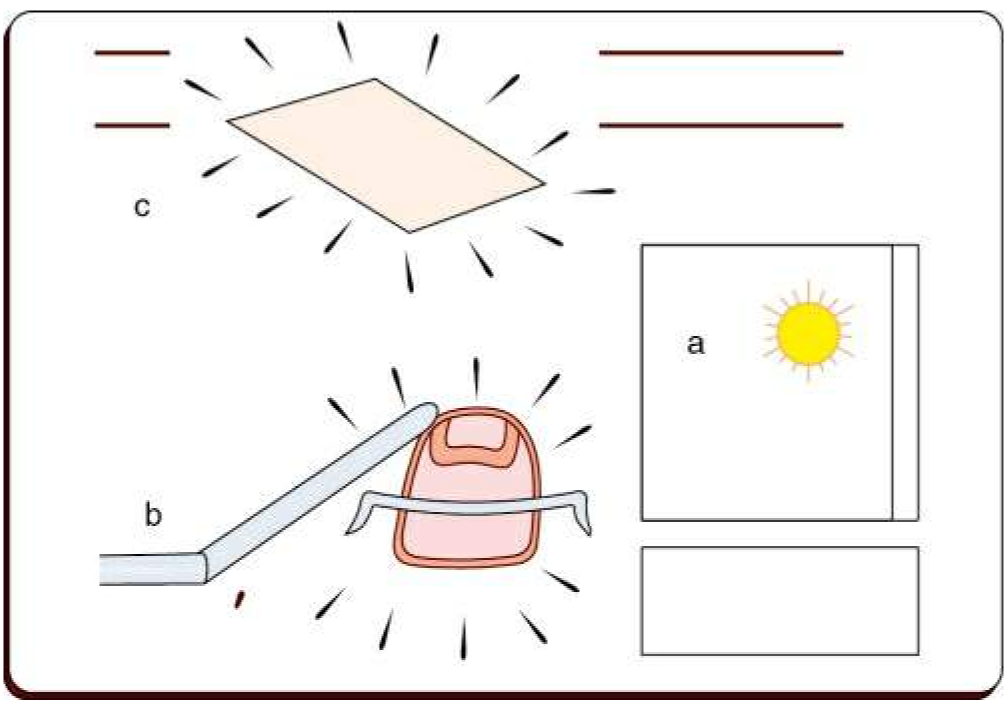


FIGURE 39.7 Three common sources of light (a) natural daylight, (b) incandescent light (dental chair) and (c)

fluorescent light (operatory).

Metamerism: An object appears to be having different colours when viewed under different light sources.

A spectrally balanced light source with a colour temperature close to 5500 K is ideal for shade selection. Table 39.1 gives the colour temperature of common light sources.

Table 39.1

Colour temperature of common light sources

Source	Colour temperature (K)
Incandescent bulb	2900
Warm fluorescent bulb	3000
Cool white fluorescent bulb	4200
White LED light	2700
Overcast sky	6500

Shade guides

Visual

Shade matching is performed visually using shade guides. It is preferable that the porcelain powder manufacturer has the powders in that shade.

Each shade tab has an opaque backing colour, neck, body and incisal colours (Fig. 39.8 A and B). They are made of high fusing porcelains without a metal backing, where the thickness of the porcelain is much more than that on the restoration. Selecting shade with a lower value may be beneficial with metal-ceramic restorations.

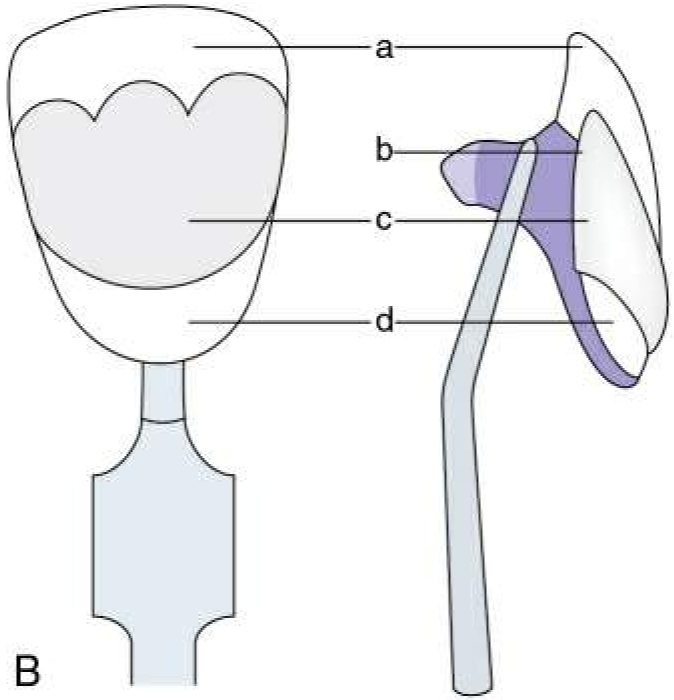


FIGURE 39.8 (A) Tabs of different shades, (B) Shade tab. (a) Incisal, (b) opaque backing, (c) body, (d) neck.

Three shade guides are used commonly and universally.

Vita lumin vacuum shade guide

The first shade guide was introduced in the market by Vita Zahnfabrik in 1956. It consists of 16 tabs arranged in four groups depending on hue (A–D). Each is further divided in an increasing order of chroma (1–4) (Fig. 39.9).

FIGURE 39.9 Vita Lumin vacuum shade guide (courtesy VITA Zahnfabrik).

Ivoclar vivadent chromascop

It consists of 20 tabs arranged in five groups based on hue (1 – white, 2 – light yellow, 3 – dark yellow, 4 – grey, 5 – brown) and within the groups according to increasing chroma (10–40) (Fig. 39.10).

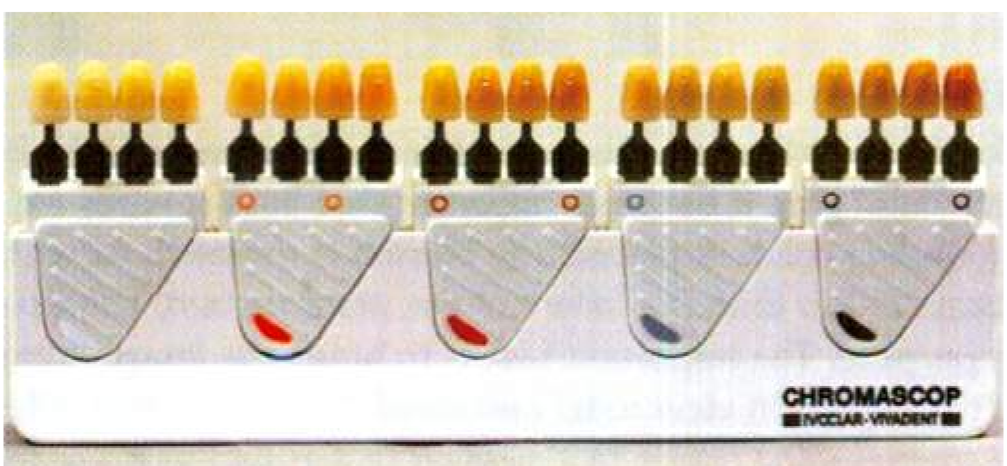


FIGURE 39.10 Ivoclar Vivadent chromascop shade guide (courtesy Ivoclar Vivadent).

In both the above guides, hue is selected first followed by chroma and value.

Vita 3D-master

This is claimed to be the most scientifically based guide and is based on the value rather than the hue. It consists of 26 tabs. They are divided into 5 groups (1–5) based on lightness (value). Each group has evenly spaced hue and chroma variations. Hues are separated into L – yellow, M – middle, R – red. Each hue is then segregated based on the chroma. The value is selected first, followed by hue and finally by chroma (Fig. 39.11).

FIGURE 39.11 Vita 3D-Master shade guide (courtesy VITA Zahnfabrik).

Arrangement of the shade tabs of the three systems in the colour space shows more uniform distribution for Vita 3D-Master (Fig. 39.12).

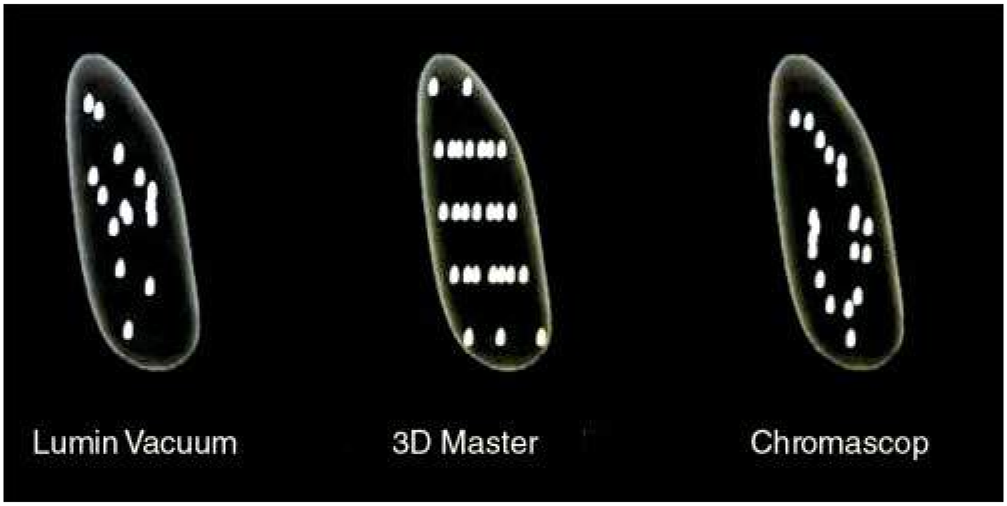


FIGURE 39.12 Arrangement of shade tabs in colour space of the three shade guides – 3D Master shows even distribution.

Electronic shade taking devices

These are electronic instruments which record the colour of the tooth. They allow an improved understanding of colour perception and its correlation with clinical aspects. They are more expensive.

They can be divided into two categories.

Colourimeters

It measures the absorbance of different wavelengths of light in a solution. Different filters are used to select the wavelength of light that the solution absorbs the most, e.g. shade eye – shofu (Fig. 39.13).

FIGURE 39.13 Shade eye (courtesy Shofu).

Spectrophotometers

It quantitatively measures the reflection or transmission properties of a material as a function of wavelength, e.g. easy shade – vita (Fig. 39.14).

FIGURE 39.14 Easy shade – vita (courtesy VITA Zahnfabrik).

Shade distribution chart

The tooth is divided into incisal, middle and cervical portions and the colour of each region is matched independently.

Various patterns of translucency must be recognized to attain good results. In younger patients the incisal enamel is thick and very translucent. As translucency increases the value decreases. Over years of function, this enamel is lost. Similarly the thickness of the enamel on the buccal aspect of the teeth also decreases and allows the dentine to dominate the shade.

Individual characteristics are then marked (Fig. 39.15). The surface of the tooth or the restoration determines how much of the light is reflected away. This produces changes in the perceived colour of the restoration. Younger teeth show a great deal of surface characterization like stippling, developmental lobes, ridges and striations. Older teeth, due to wear show a smoother, highly polished surface. Communicating this characteristic is extremely difficult and the use of custom shade guides or extracted teeth has been advocated by some authors.

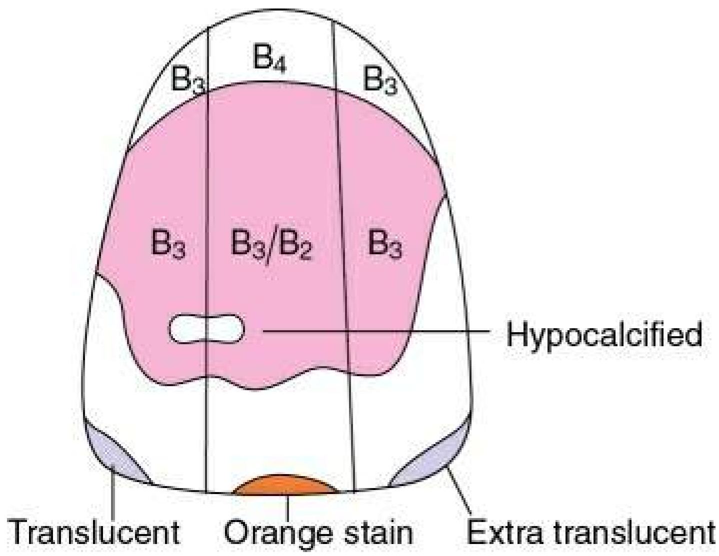


FIGURE 39.15 Shade distribution chart.

Shade selection guidelines

1. The external environment like walls and cabinets should be in grey/pastel colours. Colour corrected light is used.

2. The shade should be matched at the beginning of an appointment/procedure. Teeth become dehydrated following a procedure and the operator's eye is also fatigued after focussing on the same. It may be a good option to select shade during the diagnostic appointment itself.

3. All distractions like makeup, heavy jewellery should be removed prior to shade selection. Bright clothing is covered.

4. The teeth should be free of plaque and stains and should be kept moist.

5. The patient is seated upright with the teeth at eye level of operator who is positioned between the patient and the light source. A viewing distance of 10 inch is maintained (Fig. 39.16).

6. A shade guide that corresponds to the porcelain that the technician uses should be selected.

7. The entire shade guide is first scanned quickly placing it adjacent to the teeth, and the worst matches are eliminated.

8. Quick 5 s observations are made with matching shade tabs placed next to the tooth being matched, to avoid fatigue. In between the dentist should rest his eyes by glancing at a neutral grey surface. The shade is matched in the order of hue, chroma and value depending on the guide. Value is selected better by squinting the eyes.

9. In case a decision has to be made between two shades, the tabs are held on either side of the tooth. If none of the tabs allow a good match,

the gingival portion is matched separately followed by the incisal portion (Figs 39.17–39.19).

10. Selection is first made in a corrected light source; the process is then repeated in another light source.

11. Finally, the teeth are examined for any characterizations like hypocalcifications, craze lines and internal stains. The location of these can be measured using a periodontal probe and is noted on the shade distribution chart.

12. Finally the shade guide is disinfected.

FIGURE 39.16 Position of patient and operator.

FIGURE 39.17 Tabs are held on either side of the tooth, if choice has to be made between two shades.

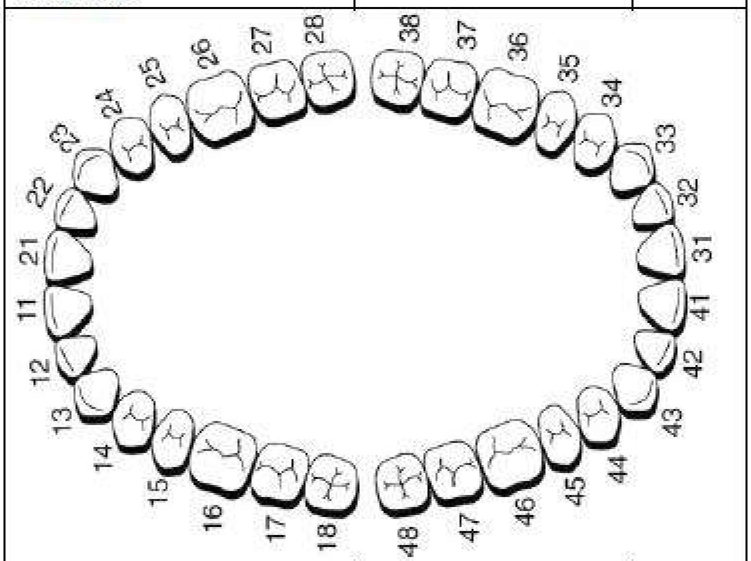
FIGURE 39.18 Gingival portion shade matching.

FIGURE 39.19 Incisal portion shade matching.

Lab communication

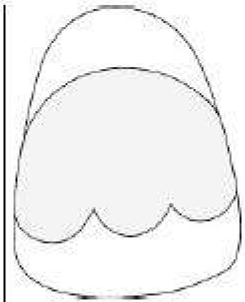
There is nothing more frustrating for the clinician than to modify restorations at the try-in appointment. Usually these problems occur due to improper communication between the clinician and technician. This problem can be prevented to a great extent through improved communication with written work authorization. A sample laboratory prescription form is given below.

Sample laboratory prescription form		
Name of the patient:		
Doctor's name:		Date:
Patient details		
Name:		
Age:		
Sex		
Prosthesis details:		
Type of prosthesis:	All ceramic	
	PFM – full coverage	
	PFM – facing	
	All metal	
	Metal with acrylic	
Number of units:		
Teeth involved:		



Type of occlusion:	Canine guided	
	Group function	
	Other	
Connector design:	Nonrigid	
	Rigid	
Type of pontic:		
	Sanitary	
	Conical	
	Modified ridge-lap	
	Ovate	

Details on shade:		
Shade guide company:		
Shade selected:		
Shade distribution:		



Additional details:		
Date of try-in appointment:		
Date of final cementation:		
Material being submitted:		
Master impressions casts:		
Jaw relation record:		
Any other:		
Signature of doctor:		
Signature of technician:		

SUMMARY

Colour is the visual perception of light that permits the differentiation of otherwise similar objects. There are three factors upon which this colour perception is dependent – the observer, the object and the light source.

Selecting the basic shade of the restoration is the first step to aesthetic restorations. Other factors such as translucency, surface texture and lustre play an important role in bringing natural looking results to ceramic restorations. Effectively communicating the information to the laboratory technician is equally important. There are various methods available such as shade guides and shade distribution charts where the relevant information is marked out graphically.

CHAPTER 40

Lab procedures

CHAPTER CONTENTS

Introduction

The fabrication of a fixed partial denture is an indirect laboratory procedure as direct fabrication in mouth is not possible. This commences with the receipt of impression from the clinician along with the necessary instructions for the fabrication (lab communication). The procedures discussed here are aimed at fabricating a cast metal prosthesis veneered with resin or ceramic. It involves making a working (master) cast with removable dies on which the wax pattern is fabricated. The pattern is invested and cast using the lost wax process. The metal restoration is then veneered with resin or most commonly ceramic as required.

The lab procedures involved in fabricating a fixed partial denture involve:

- Pouring working casts and dies
- Fabricating wax patterns
- Spruing
- Investing
- Casting
- Veneering
- Soldering

Working cast and dies

- Working cast is a master cast that reproduces the entire arch including the prepared and unprepared teeth, relevant soft tissues and edentulous areas.

- The die is a positive reproduction of only the prepared teeth (abutments).

- Wax patterns are fabricated and the critical margins are finished on a die. This is then placed on the articulated working cast to check the occlusion, axial contours and interproximal contacts.

- Dies may be removable but are an integral part of the same working cast or they can be also separate from the cast.

Requirements

Working casts

- The prepared and unprepared tooth surfaces must be accurately reproduced.

- The cast must be free of voids in critical areas like prepared teeth and adjacent teeth.

- Should allow proper articulation with the opposing casts.

- The soft tissues including the residual ridges should be recorded properly.

Dies

- They must be an accurate reproduction of the prepared tooth, both in dimension and surface details, without voids.

- Unprepared tooth structure cervical to finish line should also be accurately reproduced to aid in development of proper cervical contour.
- The margins must be clearly visible and easily accessible.
- Its form should aid easy handling during waxing and other procedures.

Materials for working casts and dies

Requirements

- Should be accurate.
- Should be strong and resistant to abrasion.
- Should be easy to section and trim.
- Must be in a contrasting colour to that of the wax so that the margins can be easily visualized.
- Must be compatible with the impression material.
- Must be wettable by wax and should also be compatible with separating agents so that the prepared wax pattern does not stick to it.

Gypsum products

The most commonly used die material is type IV gypsum also called die stone. Type V gypsum can also be used if higher expansion is required.

Advantages

- Easy to use and are cost effective.
- Good compatibility with all impression materials.
- Adequate surface detail reproduction and dimensional accuracy.

Disadvantage

- Poor abrasion resistance.

  Several methods have been used to increase abrasion resistance:

- Gypsum hardeners such as aqueous colloidal silica or soluble resin solutions can be used instead of water.
- The surface of the die stone can be treated with a resin such as epoxy, acrylic or cyanoacrylate (such a treatment can form an excessively thick surface layer).

Resins

Epoxy resin and polyurethanes are used.

Advantages

- High strength and abrasion resistance.
- Good detail reproduction.

Disadvantages

- Expensive.
- Polymerization shrinkage (less of a problem with newer materials and polyurethanes).
- Not compatible with polysulphides and hydrocolloids.

Electroformed dies

This is the process of coating the impression by placing the impression in an electroplating bath. Pure silver or copper is deposited on the impression and a cast is then poured with type IV gypsum or resin.

Advantage

- Good abrasion resistance and detail reproduction.

Disadvantages

- Distortion may occur if not handled properly.
- Time-consuming procedure and special equipment is required.
- Incompatible with polyethers and sometimes even with some brands of silicones.
- Silver electroplating uses cyanide solution which is extremely toxic.

Divestment

- This is a gypsum-bonded material which is used both as a die and investment material. To make the working cast and die, it is mixed with colloidal silica. The wax pattern is fabricated on this. The wax pattern along with the cast is invested in the same material. This eliminates the need to remove the wax pattern for investing and prevents distortion.
- It cannot be used with high-fusing alloys (base metal and metal ceramic) and can be used only for conventional gold alloys.

Type IV gypsum is the most popular and commonly used die material for fixed prosthodontics.

Fabrication

There are two methods of fabrication:

1. Working cast with separate dies

2. Working cast with removable dies

Working cast with separate dies

The impression is poured twice. First, only the prepared teeth are poured with type IV gypsum for making a die and the partial cast is removed from the impression. Then a full arch cast is poured for the working cast, which is then articulated. The wax pattern is first fabricated on the die and then transferred to the working cast for checking contour, contact and occlusion. It is finally returned to the die to refine the margins.

Advantages

- Simple method.

- Working cast requires only minimal trimming.

- Intact gingival tissues around the prepared teeth in the working cast guide proper contouring of cervical aspect.

Disadvantages

- May be difficult to transfer and seat delicate patterns from dies and working casts.

- Distortion is a concern.

Technique

- Moisture is removed from the elastomeric impressions by using a surfactant and from hydrocolloid impressions by blowing with air.

- The required amount of die stone is mixed as per the manufacturer's instructions and the prepared and adjacent sections of the cast are poured.

- The stone is built up to a height of approximately 1.0 inch (2.5 cm) over the preparation. This allows bulk for an adequate handle on the die.

- It is allowed to set for 1 h and the sectional cast is removed from the impression.

- The handle of the die should be octagonal in cross-section, slightly larger in diameter than the preparation and parallel to the long axis of the tooth. The ideal length of the handle should be about 1 inch (Fig. 40.1).

- An acrylic bur is used to trim the die below the margin and the contour near the margin can be finished using a scalpel blade. The contour of the die apical to the finish line should be similar to natural tooth root to allow good axial contours of the finished restoration (Fig. 40.2A and B).

- A separate working cast is then poured of the entire arch with base and articulated.

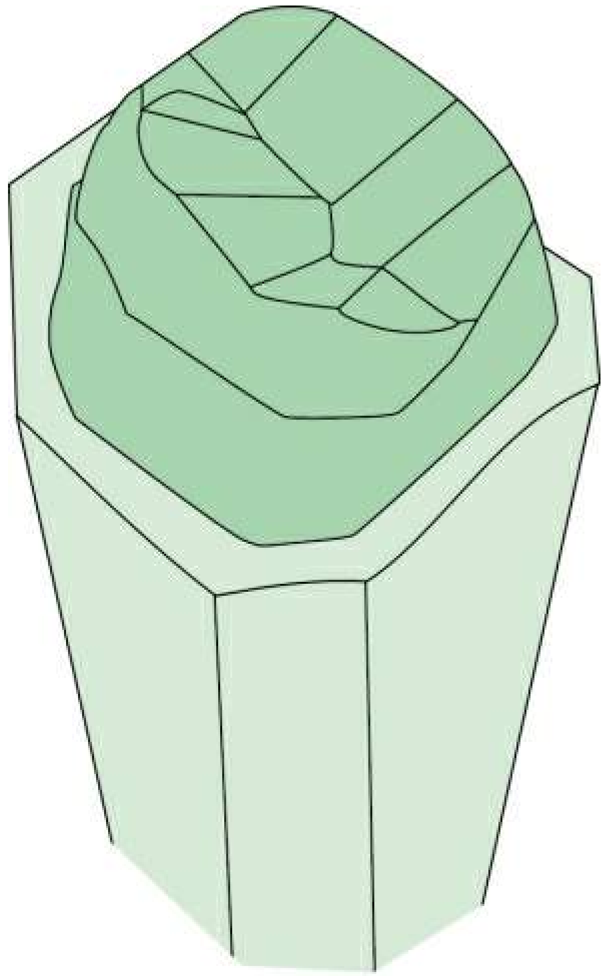


FIGURE 40.1 Handle should be octagonal and one inch in length.

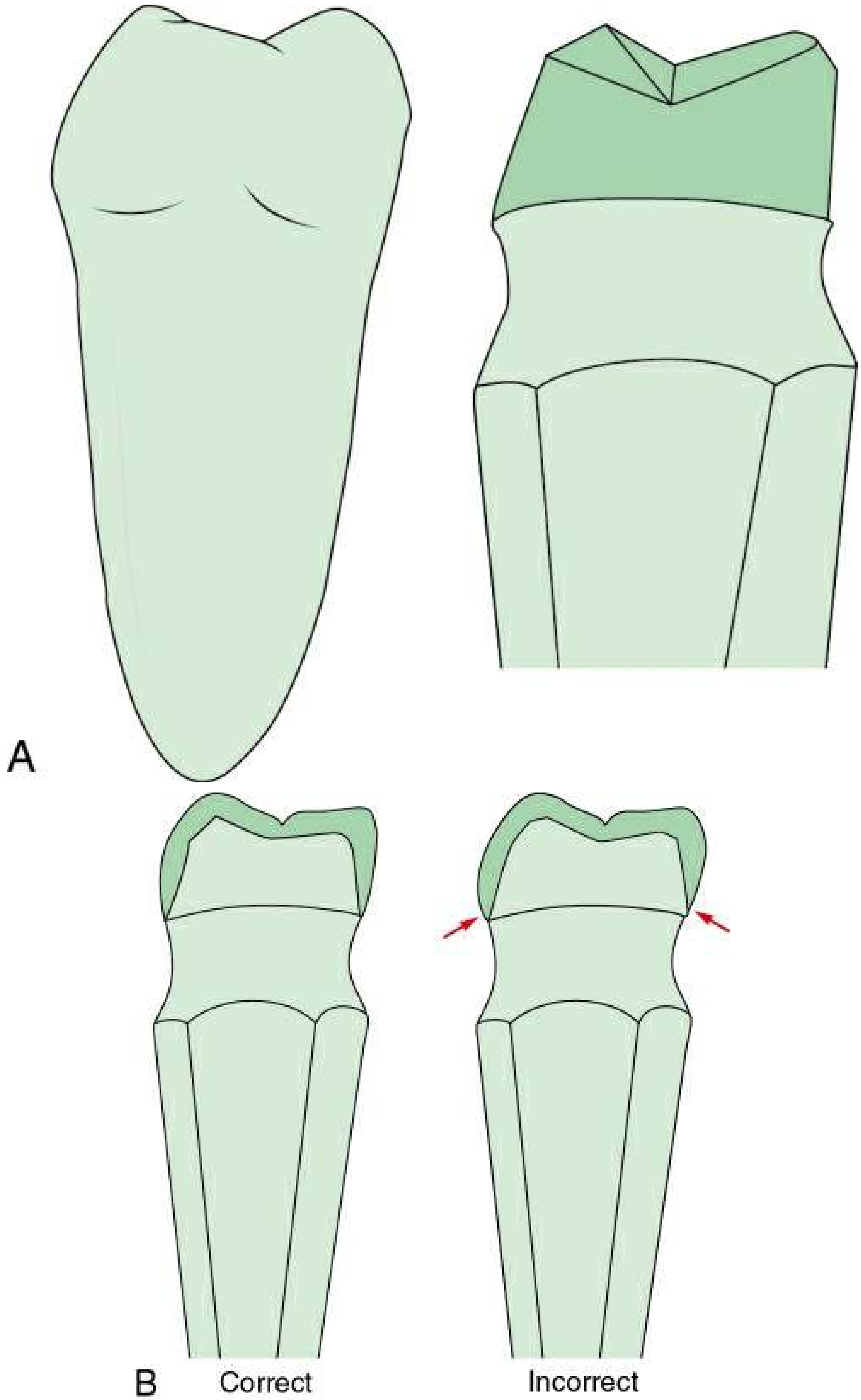


FIGURE 40.2 **(A)** Contour below margin similar to natural

tooth. **(B)** Die trimming influences axial contours.

Working cast with removable dies

In these, the die is an integral part of the working cast and can be removed to facilitate fabrication and finishing of the restoration.

Advantage

The wax pattern need not be removed from the die while transferring it to the working cast. This reduces the chances of distortion of the wax pattern.

Disadvantage

Gingival portion of the abutment is destroyed while making the die and hence it becomes difficult to verify the emergence profile of the restoration.

Removable dies can be made using the following:

1. Dowel pins

2. Di-Lok trays

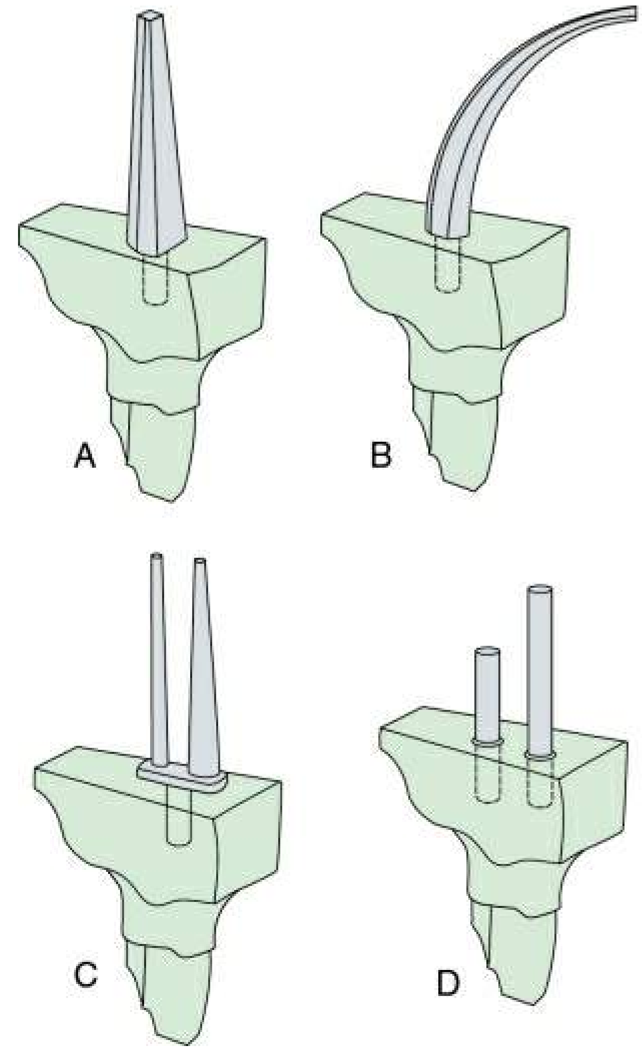
1. Dowel pins

Dowel pins are most commonly used to make removable dies. These are also called 'die pins'.

Definition: A metal pin used in stone casts to remove die sections and replace them accurately in the original position (GPT8).

Types

There are various types of commercially available dowel pins all only differing in their mechanism to prevent rotation of the removable die. They are also available with a metal or plastic sleeve to facilitate accurate repositioning on cast (Fig. 40.3A–E).


A
B
C
D

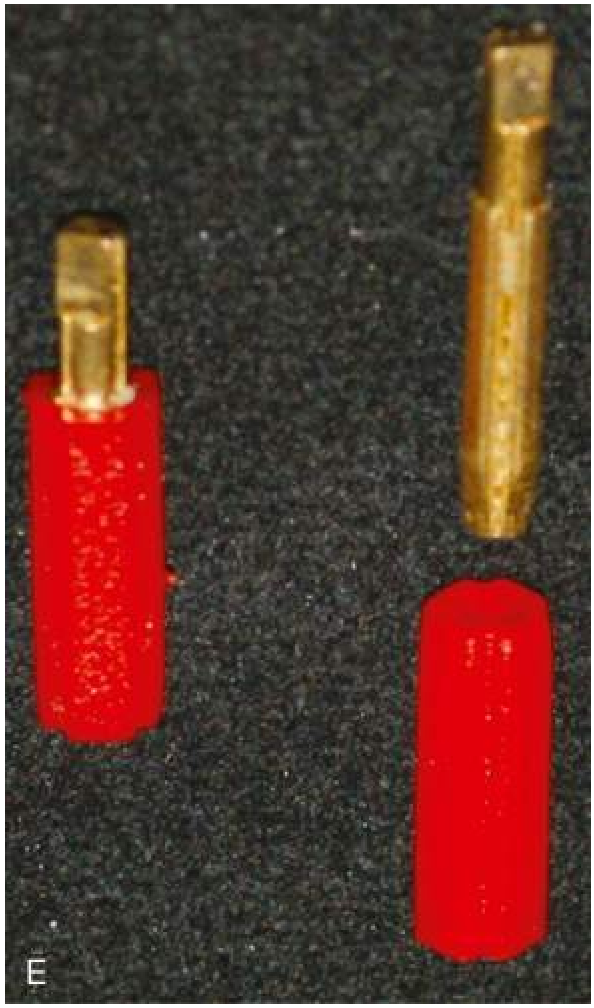


FIGURE 40.3 **(A)** Flat-sided single dowel, **(B)** curved dowel, **(C)** straight double dowel with common head, **(D)** two separate parallel dowels, **(E)** dowel with plastic sleeve.

The following methods are employed to position the dowel pin in the working cast:

1. **Prepour technique:** The pins are oriented before the impression is poured.

2. **Postpour technique:** The pins are placed after the cast has been poured.

i. Prepour technique

- Any type of dowel pin can be used.

- A bobby pin is most commonly used to hold and position the dowel pin. Other materials that can be used for this purpose are anaesthetic needles, paper clips and paper matches.

- A dowel pin is placed between the arms of a bobby pin. The bobby pin is then positioned buccolingually across the impression such that the dowel pin will be centred directly over the preparation, without touching the impression, and along its long axis. The bobby pin is attached to the impression with sticky wax (Fig. 40.4).

- Die stone is mixed and poured into the impression covering the knurled end of the dowel pin and at least 3–4 mm beyond the gingival margins of the teeth. Paper clips are placed in the stone before it sets in other areas of the cast to aid retention to the base (Fig. 40.5).

- After the stone sets, the bobby pins are removed from the impression and a small ball of soft utility wax 5 mm in diameter is placed on the tip of each dowel to aid in removing the dowel pin after setting (Fig. 40.5). A ‘V’-shaped groove is carved on the cast with a Bard–Parker (BP) blade running buccolingually from each dowel pin to aid in reseating the die completely and accurately during use (Fig. 40.5).

- The open lingual/palatal space of the impression is covered with baseplate wax or a paper towel to enable pouring of a complete base (Fig. 40.5).

- The cast is lubricated around each dowel with Vaseline or separating medium to permit easy separation of the dies from the working cast.

- The base of the cast is poured with dental stone. After the stone has set, the cast is removed from the impression and the excess is trimmed till the wax balls are exposed. The wax is removed to expose the tips of the dowel pins (Fig. 40.6).

- A die cutting saw with thin blades is used to section the dies. Cuts are made vertically and interproximally on either side of the prepared teeth, such that it converges towards the base (Fig. 40.7).
- The exposed end of the dowel is gently tapped with an instrument handle to loosen and remove the die (Fig. 40.8).
- **Advantage**: Simple method without any elaborate equipment.
- **Disadvantage**: Pins can be displaced while the cast is poured.

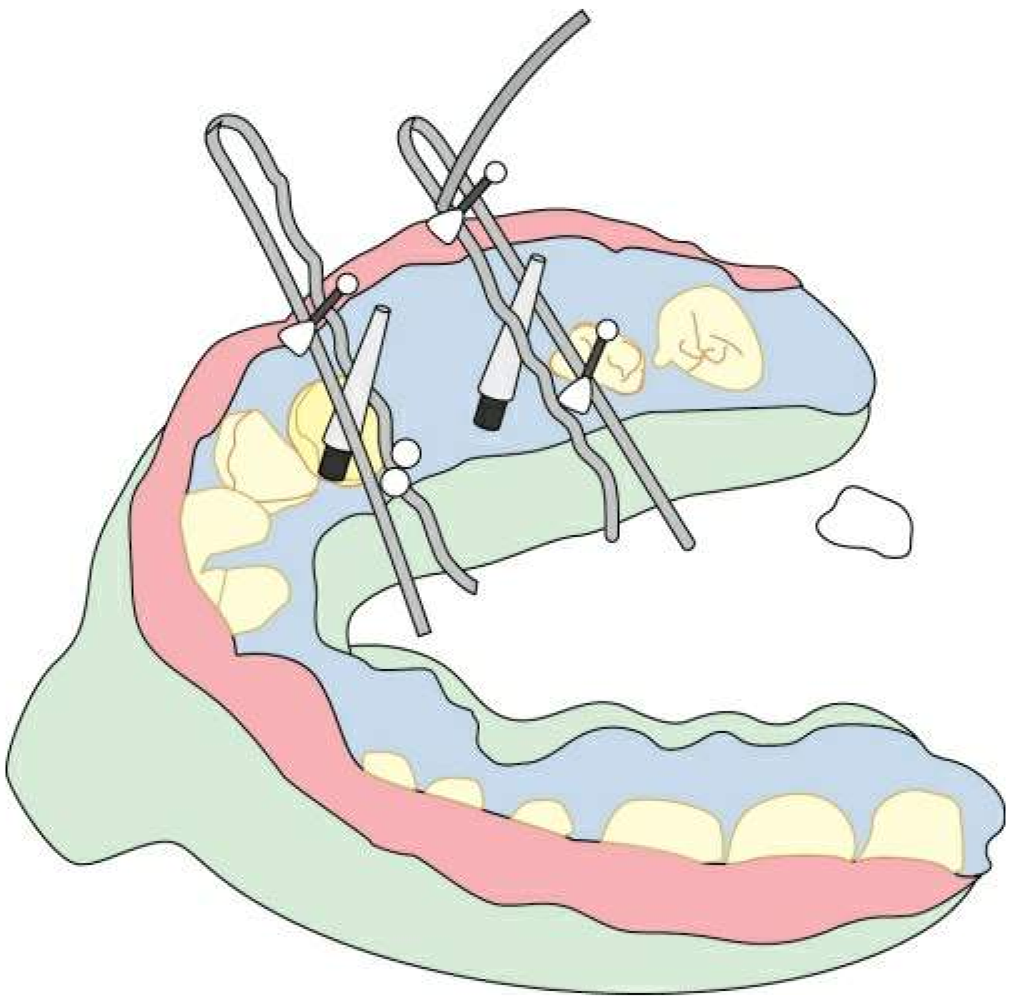


FIGURE 40.4 Dowel pins positioned with bobby pins attached to impression with pins or sticky wax.

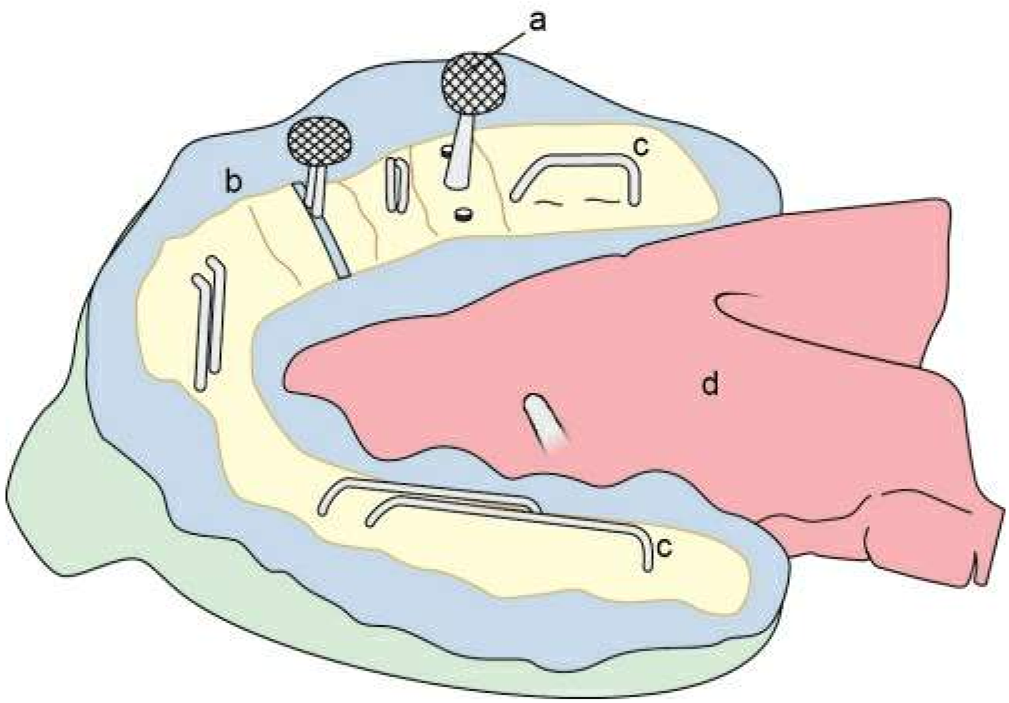


FIGURE 40.5 Wax ball (a), groove (b), paper clips (c) and lingual/palatal space coverage (d).

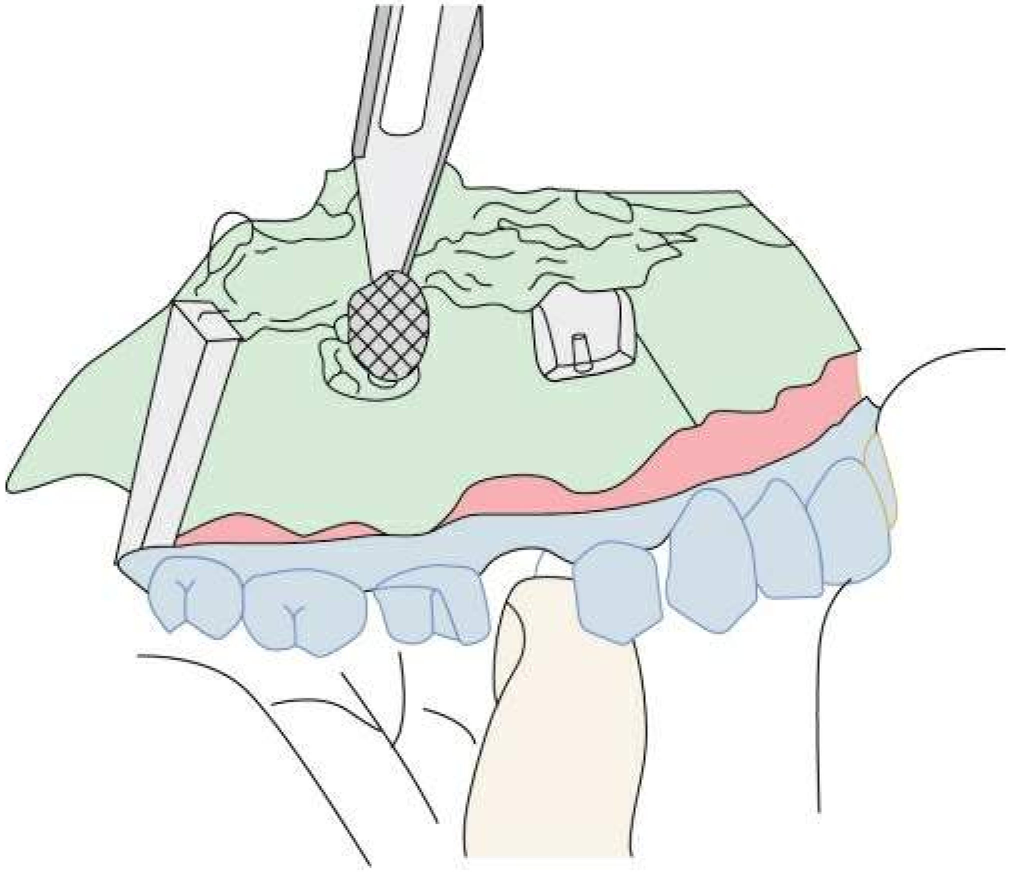


FIGURE 40.6 Wax removed to expose tip of dowel pin.

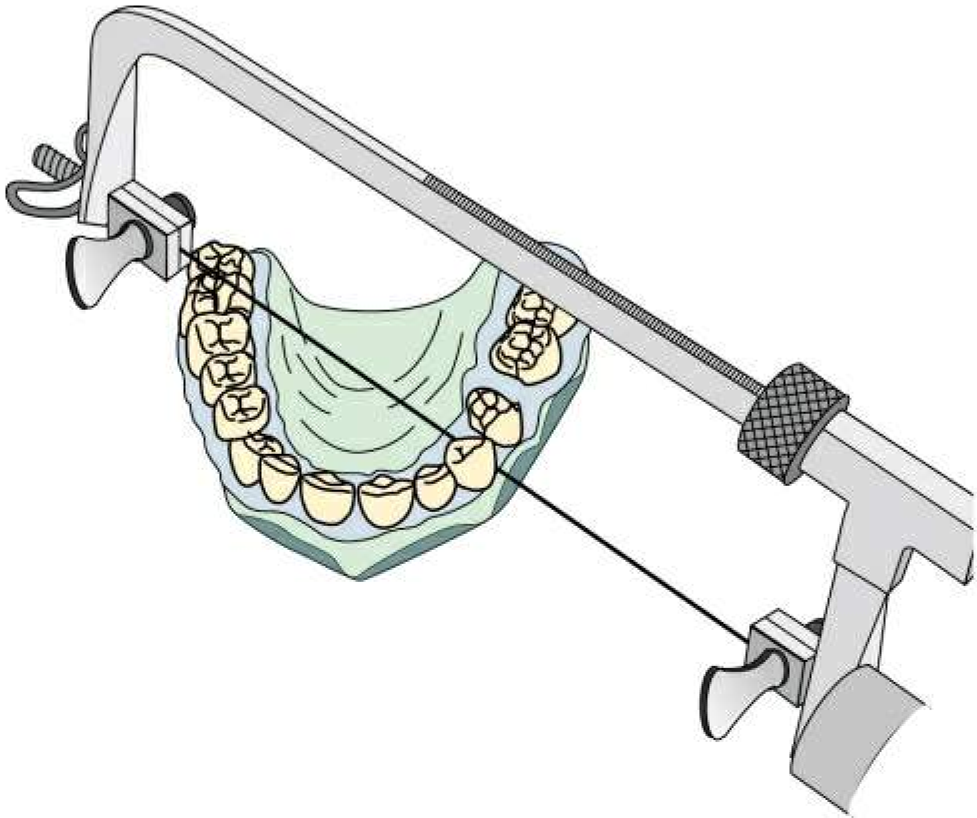


FIGURE 40.7 Die sectioned with saw.

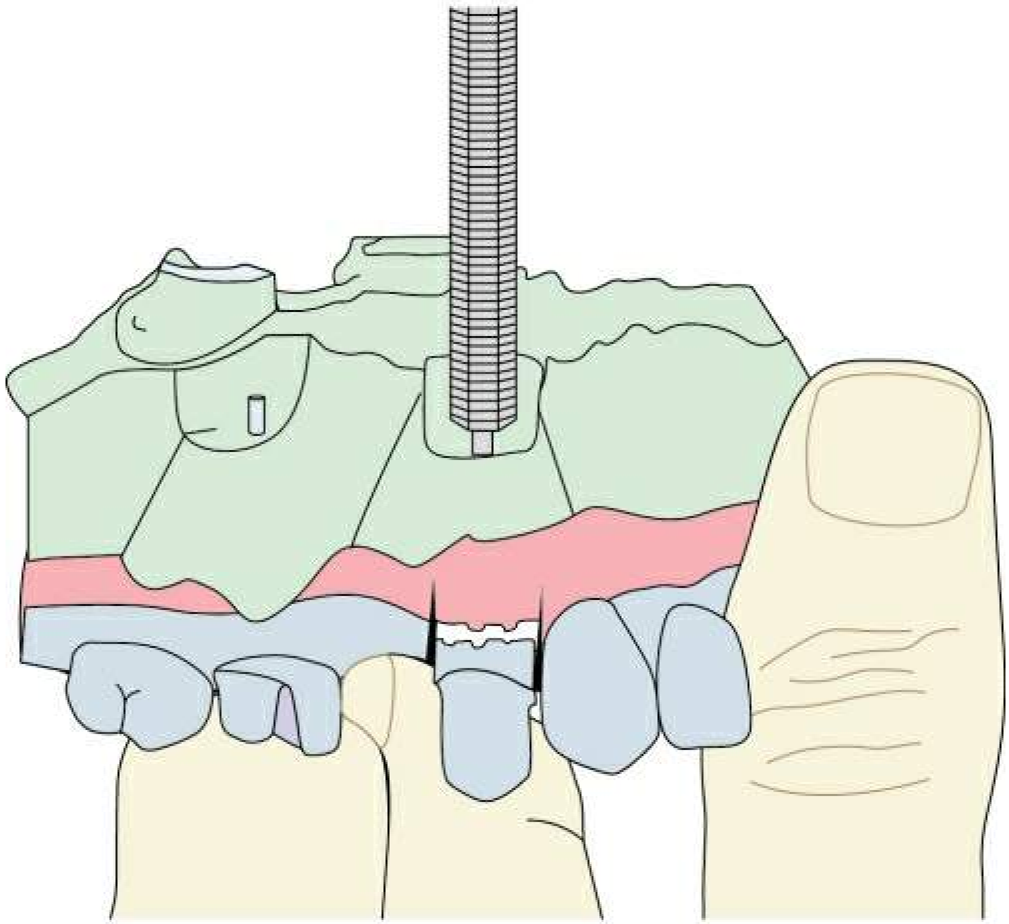


FIGURE 40.8 End of pin tapped with an instrument handle to remove die pin.

ii. Postpour technique

- In the postpour technique, a full arch cast is first poured to cover the entire impression (Fig. 40.9).
- After setting, the cast is removed from the impression and base is trimmed such that at least 5 mm of base is available beyond the gingival margins of the teeth (Fig. 40.10).
- Holes are drilled with fissure bur on the base of the cast corresponding to the centre of the prepared teeth and other areas of cast so that all the holes are parallel (Fig. 40.11).

- Dowel pins are cemented with cyanoacrylate or luting cement such as zinc phosphate on the prepared holes (Fig. 40.12A and B).
- Wax ball and grooves are placed as described previously (Fig. 40.13A). Separating media is applied around the dowels on the prepared teeth (Fig. 40.13B). The cast is boxed and the base is poured with dental stone (Fig. 40.13C).
- Die is sectioned and removed as described with the previous technique (Fig. 40.14A–C).
- **Advantages**:

○ Final impression can be poured immediately without any obstructing pins.

○ Removable section is planned with master cast rather than impressions.

- **Disadvantage**: Fracture of first pour of cast if made too thin.

FIGURE 40.9 Full arch cast poured to cover the entire impression.

FIGURE 40.10 Cast is removed and trimmed.

FIGURE 40.11 Holes drilled corresponding to the teeth.

FIGURE 40.12 **(A)** Cyanoacrylate applied on base of dowel pin. **(B)** Pin is then fixed in the holes made.


A
B

FIGURE 40.13 **(A)** Wax ball and grooves placed. **(B)** Separating media applied. **(C)** Base poured.


B

FIGURE 40.14 **(A)** The die is sectioned interproximally to the abutments, tapering to the base. **(B)** They are removed by tapping the exposed end. **(C)** Removed individual die.

Pindex system

- This is basically a postpour technique and the Pindex machine is used to place the dowel pins accurately parallel over the centre of the prepared teeth (Fig. 40.15).
- After the cast is retrieved and trimmed to appropriate dimension as described previously, the pins are placed with the help of the Pindex system.
- The desired location of the pins is marked on the occlusal surfaces of

the teeth and preparations. There should be two pins for each die, each for an edentulous area and the segment containing unprepared teeth.

- The machine is turned on and the cast is placed on the worktable. The red illuminated dot from the light beam director is aligned with the pencil dot marked on the cast (Fig. 40.16). A hole is drilled by the machine directly below the red light on the base of the cast as the cast is pressed down. All the marked areas are drilled and dowel pins are cemented with cyanoacrylate.

- When the cement has dried, the sleeves are placed over the pins such that the flat sides of their bases face each other.

- The base of the cast can be added by either boxing the cast conventionally or by using specially fabricated base formers. After sectioning the dies, die hardener and die spacer are added and the casts are mounted.

- **Advantage:** Pins are placed accurately and parallel to each other.

- **Disadvantage:** Special equipment is required.

FIGURE 40.15 Pindex machine: laser pointer (a), platform (b).

FIGURE 40.16 Pindex machine platform. Drill in the platform makes a hole on the base of cast whereas indicated by the laser pointer.

2. Di-lok trays

It involves the use of a specially fabricated tray that allows precise reassembling of a sectioned working cast.

- Impression is poured with die stone to a height of 1 inch or 2.5 cm.
- The ‘U’-shaped cast, must have an open lingual area, and must be trimmed so that it fits into a Di-Lok tray (Fig. 40.17).
- Stone is mixed and vibrated into the tray until it is three-quarters full.
- The cast is seated such that the cervical lines of the teeth are about 4 mm above the edge of the tray.
- The stone is allowed to set.
- The cast can be removed by tapping on the front of the base of the tray with the handle of a laboratory knife.

- A saw blade is used to cut between the prepared and adjacent teeth.
- The die and the other parts of the cast can be removed and reassembled as required (Figs 40.18 and 40.19).
- The Di-Lok trays can be attached to an articulator by means of undercut rails on it.
- **Advantage**: It is a simple procedure.
- **Disadvantage:** The large size of the tray makes articulation and manipulation cumbersome.

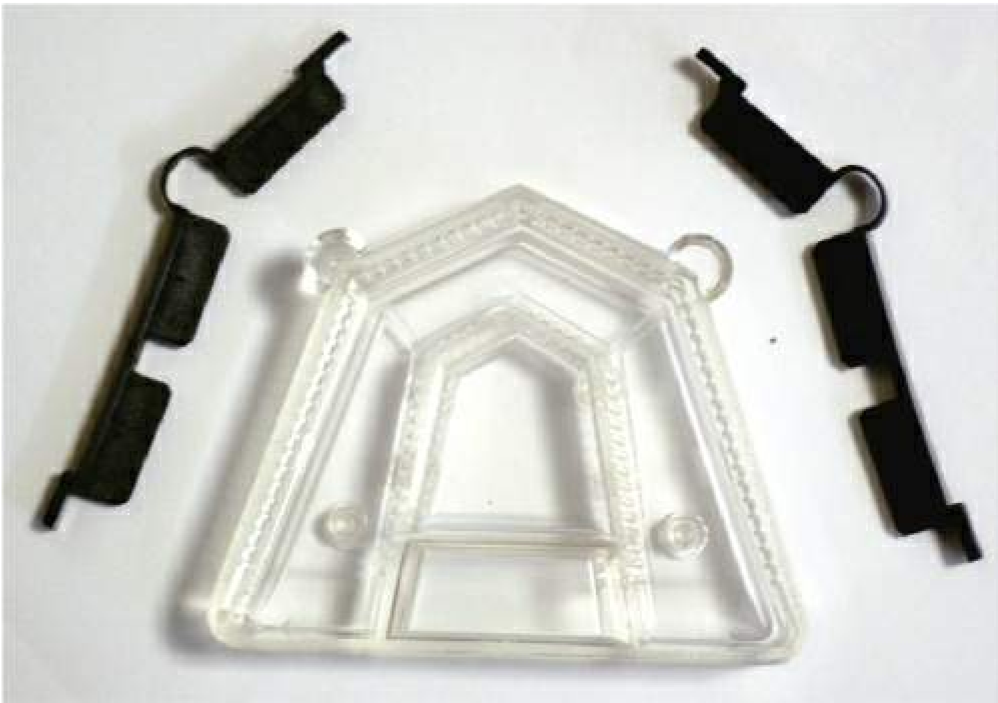


FIGURE 40.17 A Di-Lok tray.

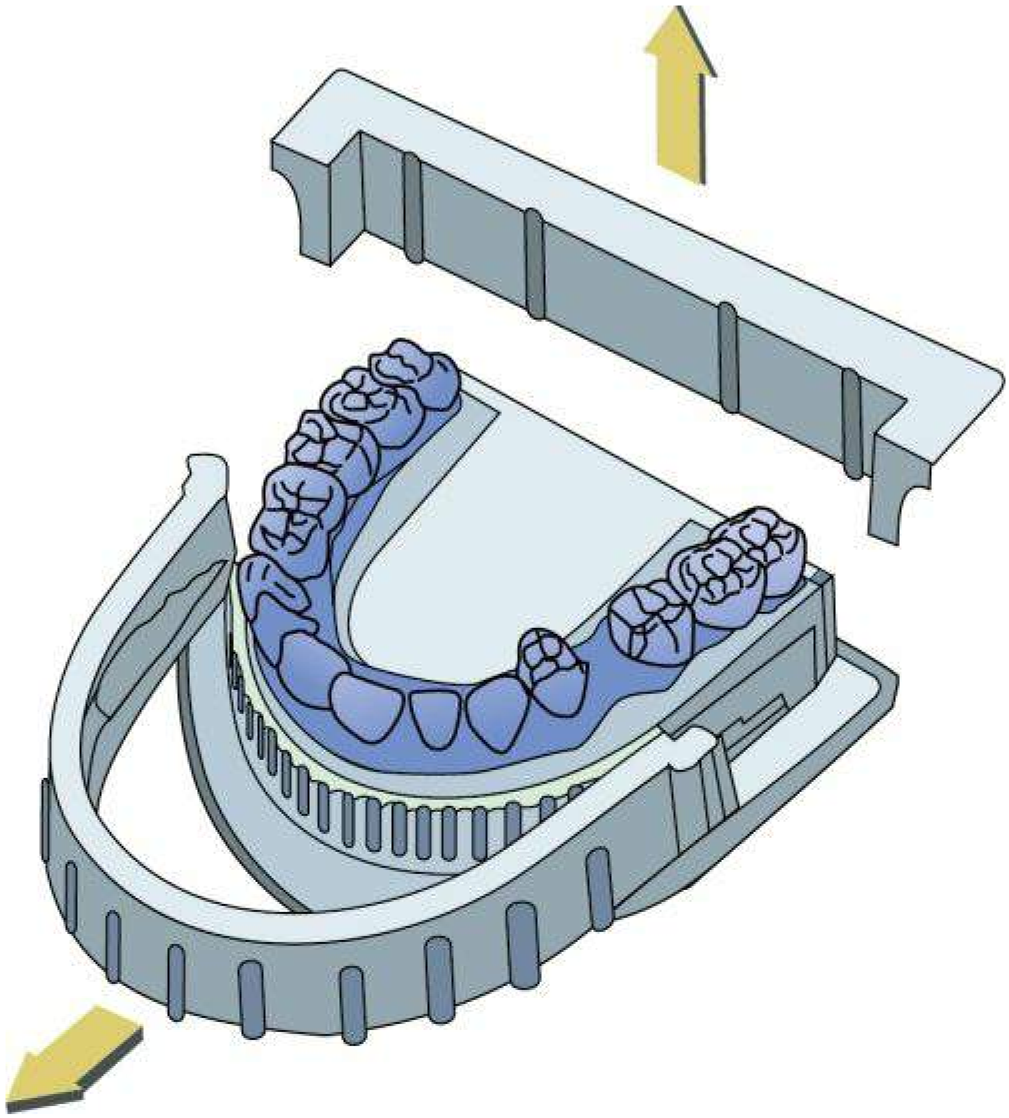


FIGURE 40.18 Parts of tray can be removed.

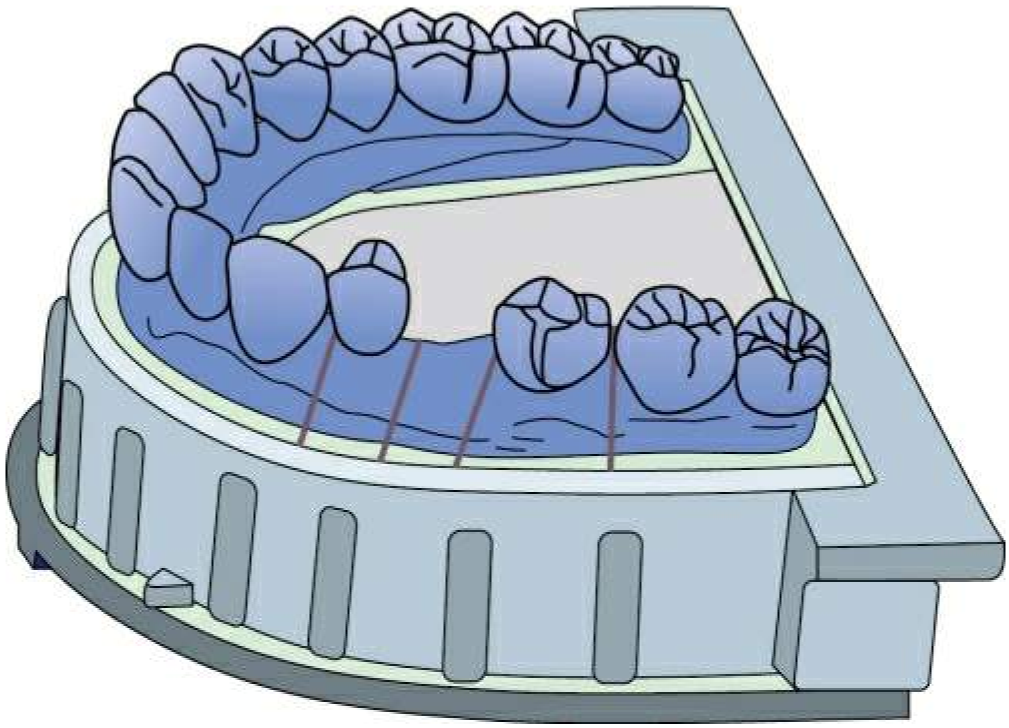


FIGURE 40.19 Cast reassembled after sectioning the die.

Die trimming

Whichever procedure is used to fabricate removable dies, the apical portion below the margins should be trimmed similar to that described for working cast with separate dies.

Die spacer

Definition: An agent applied to a die to provide space for the luting agent in the finished casting (GPT8).

- It is applied prior to commencing the fabrication of wax patterns.
- The die spacer is a material that is applied to the surface of a die to create space between the tooth and the restoration. This space is required for the cementing material.
- The margins should not be coated with the spacer (Fig. 40.20A and B). A band of about 1 mm adjacent to the finish line is not coated.

This allows for adequate marginal adaptation.

- The thickness of the die spacer depends on the number of coats applied. A thickness of about 20–40 μm is adequate.
- The solvent of the die spacer has a tendency to evaporate, hence a thinner is supplied along with the spacer.

FIGURE 40.20 **(A)** Die coated with commercially available die spacer. **(B)** Spacer should not cover the margins.

Wax patterns

A wax pattern of the restoration is the next step in the fabrication of a fixed partial denture. For any restoration involving castings (lost wax process), a wax pattern is essential. It is used for making the metal portion of all metal and metal veneered with ceramic or resins.

A wax pattern can be fabricated *directly* or *indirectly.*

- In the direct technique the pattern is waxed on the prepared tooth in the patient's mouth. It is made with type I inlay wax and can be adopted for small restorations like inlays and posts. It is practically impossible to make extracoronal restorations directly as it is cumbersome, technique sensitive and will take away a lot of chairside time.

- The indirect technique is the most commonly used method for fabricating fixed partial dentures. The pattern is fabricated on a die made from an impression of the prepared tooth. It offers the following advantages:

  - Allows better visualization of the restoration.
  - Margins can be accessed and finished better.
  - Chairside time of clinician is reduced.
  - Better standardization in technique as it is fabricated in a laboratory.

Wax

Type II inlay wax is used to fabricate indirect restorations.

Ideal requirements

- It should soften uniformly.
- The wax colour should be in contrast to that of the die to facilitate proper finishing of margins.
- It should not flake or chip when carved.
- It should burn out without any residue.
- It should be rigid and dimensionally stable.
- Must not flow at room temperatures.

Composition

1. Paraffin wax (40%–60%) – main ingredient.

2. Carnauba wax, ceresin, candelilla wax – decreases the flow at mouth temperature.

3. Gum dammar – reduces flaking.

4. Synthetic waxes – replace carnauba wax to improve the working characteristics.

5. Dyes – give colour.

Properties

1. Flow

- At 45°C – type I and II should flow between 70% and 90%.
- At 37°C – type I should not flow more than 1%.

- At 30°C – type II should not flow more than 1%.
- Flow should be as low as possible during removal from die and subsequent handling.

2. Thermal properties

- Low thermal conductivity – takes time for them to heat and cool uniformly.
- High coefficient of thermal expansion – expand and contract when heated and cooled.

3. Wax distortion

When distortion occurs, the wax is bent and the inner molecules are under compression and the outer ones are in tension. Once the stresses are gradually relieved, the wax tends to straighten and distort.

To minimize distortion:

- Wax should be added in melted increments or drops, or by dipping in melted wax.
- Margins must be remade just before investing.
- Wax pattern should be invested as soon as it is completed.

Waxing instruments

1. **PKT set**: The waxing instruments designed by Dr Peter K. Thomas (PKT) are the most commonly used (Fig. 40.21). It consists of five instruments each with a specific use:

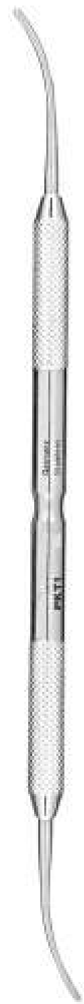
○ No. 1 and No. 2 – wax adding

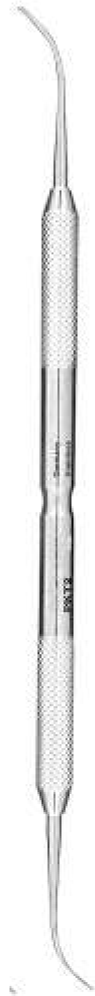
- No. 3 – burnishing
- No. 4 and No. 5 – carving

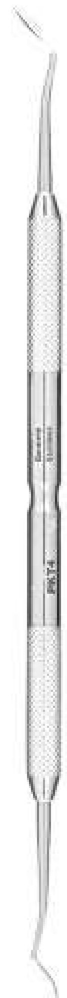
2. **No. 7:** Wax spatula is used for adding large amount of wax.

3. **Electric waxing instruments:** These are also available for adding wax (Fig. 40.22).

- Advantages:
  - Allows precise temperature control.
  - Carbon buildup in instrument due to overheating will be minimal.






PKT4

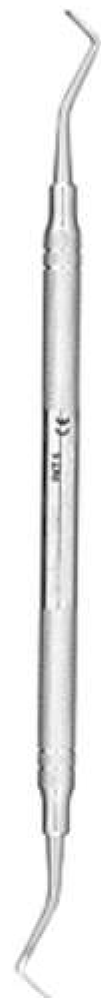


FIGURE 40.21 PKT instruments No: 1–5.

FIGURE 40.22 Electric waxing unit.

Fabricating wax pattern

Posterior crown/retainer

1. Coping fabrication

- The coping can be made up of wax or resin. Wax is commonly used. It must reproduce the retentive features of the restoration.
- The die is first coated with a die lubricant (separating medium) to

facilitate easy removal of pattern (Fig. 40.23).

- The coping is formed by adding wax with a No. 7 wax spatula (Fig. 40.24) or dipping the die into molten wax (Fig. 40.25).
- Ensure that the previous layer of wax is melted before the addition of new layers of wax. This prevents the formation of voids and flow lines.
- The proximal areas should be given extra bulk to help removal from die.
- Excess wax is trimmed from the margins so that the coping can be removed and evaluated (Fig. 40.26).

FIGURE 40.23 Applying die lubricant.

FIGURE 40.24 Adding with wax spatula.

FIGURE 40.25 Die dipped in molten wax.

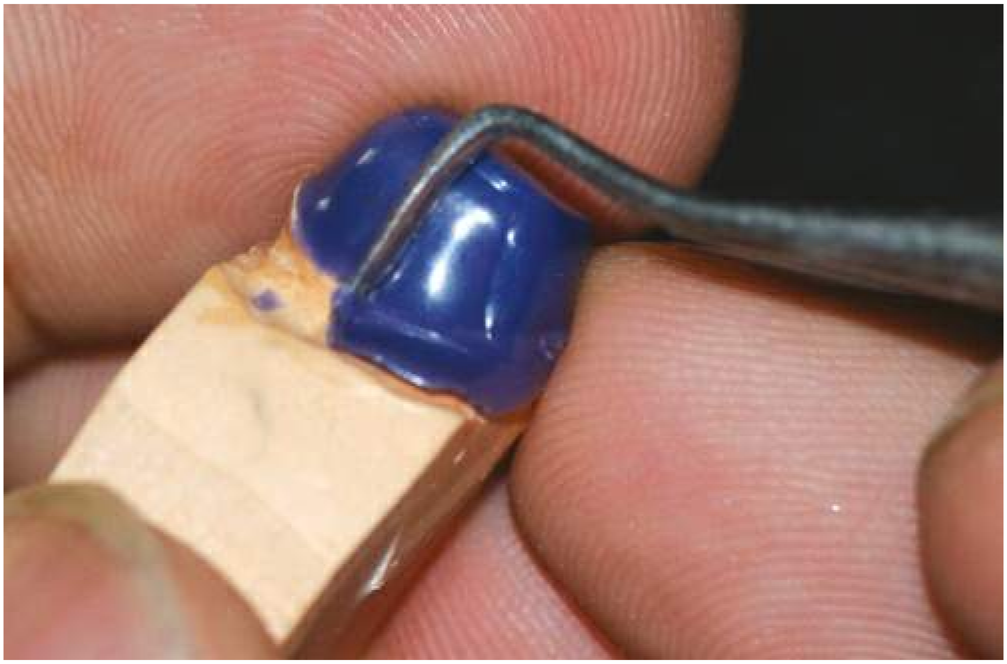


FIGURE 40.26 Excess wax in margin trimmed.

2. Axial contours

This involves fabrication of the proximal, buccal and lingual surfaces.

Proximal

- Size and location of contact is first established. If the contact area is too narrow, there may be wedging of food and on the other hand, if the contact area is wide, it may injure the gingival tissues.

- When viewed from the occlusal aspect, the contact of maxillary posteriors is located facially, except for the maxillary molars where it is located centrally (Fig. 40.27A and B). The contact of mandibular posteriors is located centrally (Fig. 40.28).

- When viewed buccally, the contact of maxillary and mandibular posterior teeth is located in the occlusal third with the exception of the maxillary first and second molars, which are located in the middle third (Fig. 40.29A and B).

- Contour of the proximal axial surface below the contact point should be flat or slightly concave (Fig. 40.30). Overcontouring makes flossing and maintenance of periodontal health difficult.

- **Fabrication:** The wax coping is replaced on the die. Wax is added in the contact areas ensuring that its size and location are in harmony with the anatomic form. The proximal surface gingival to the contact area is then correctly contoured (Fig. 40.31).

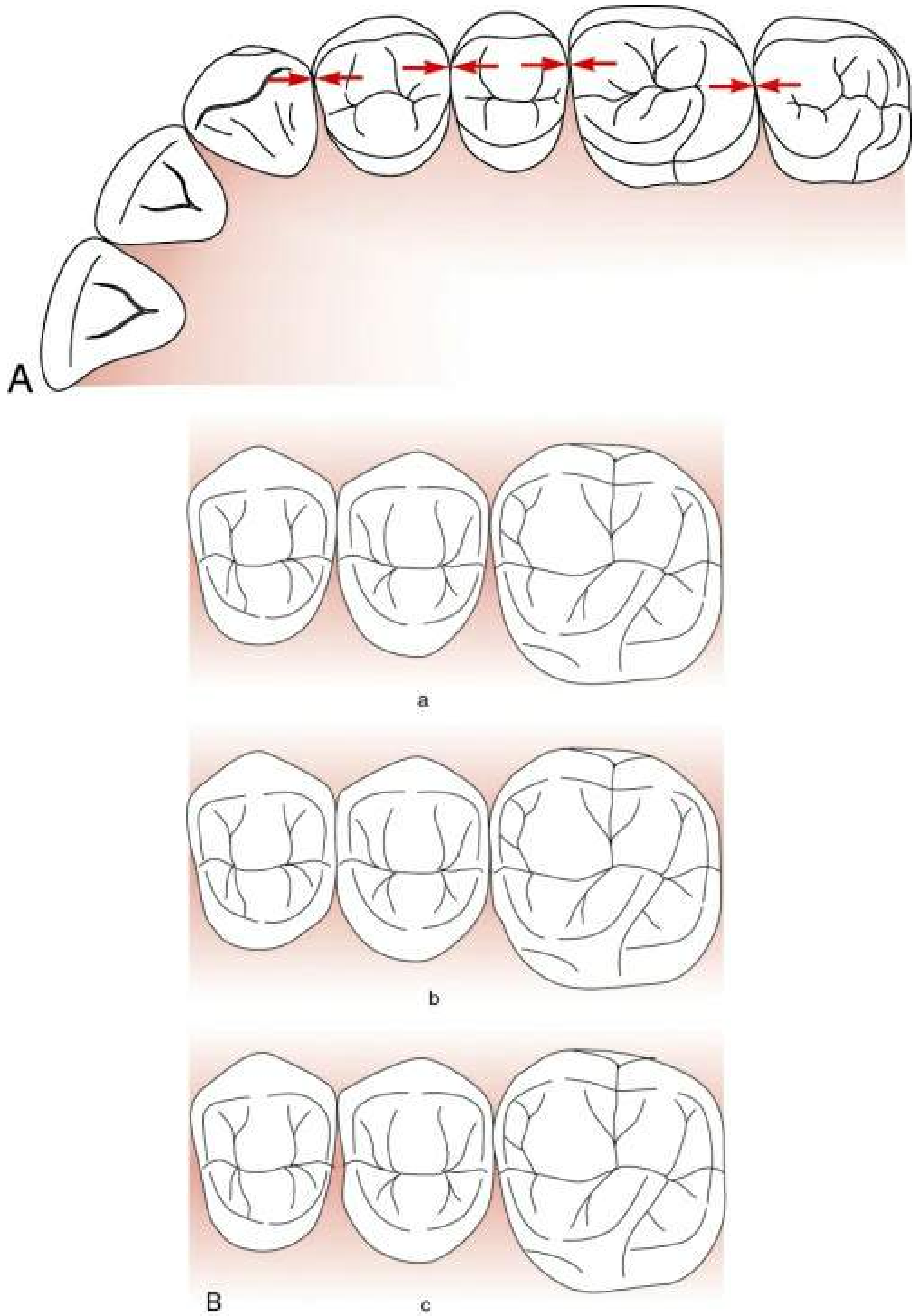


FIGURE 40.27 **(A)** Occlusal view of contact of maxillary posterior teeth. **(B)** Correct (a), large (b), narrow (c).

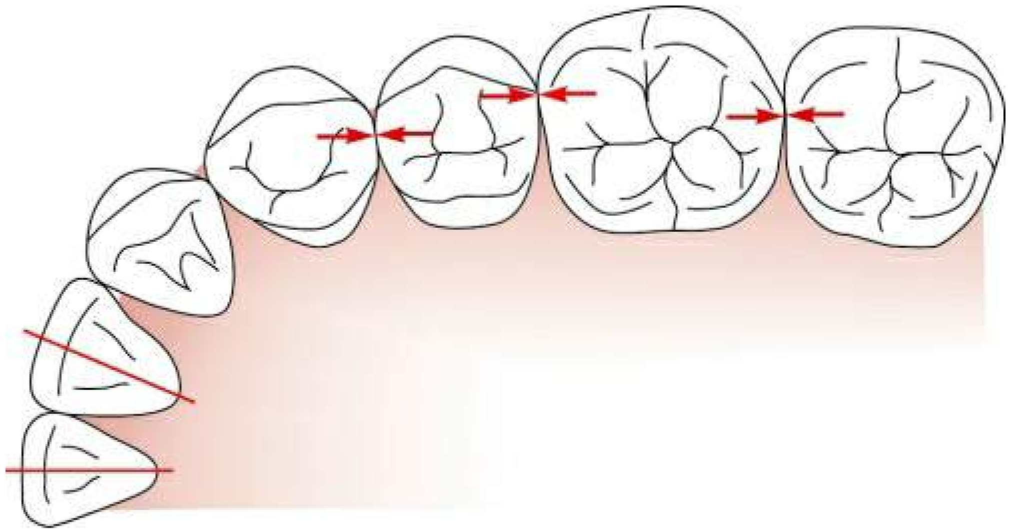
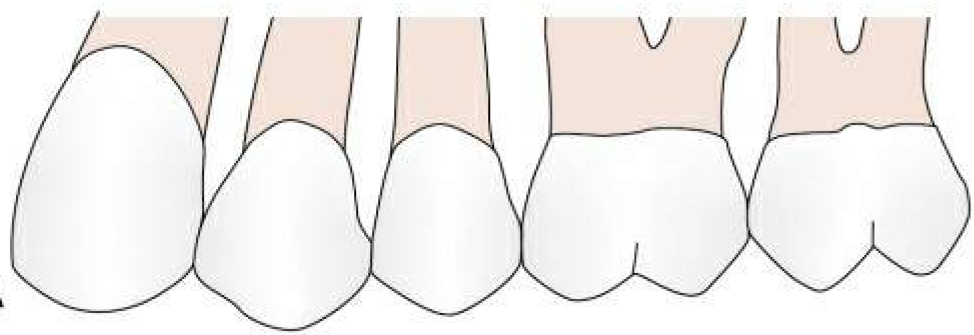


FIGURE 40.28 Occlusal view of contact of mandibular posterior teeth.



A

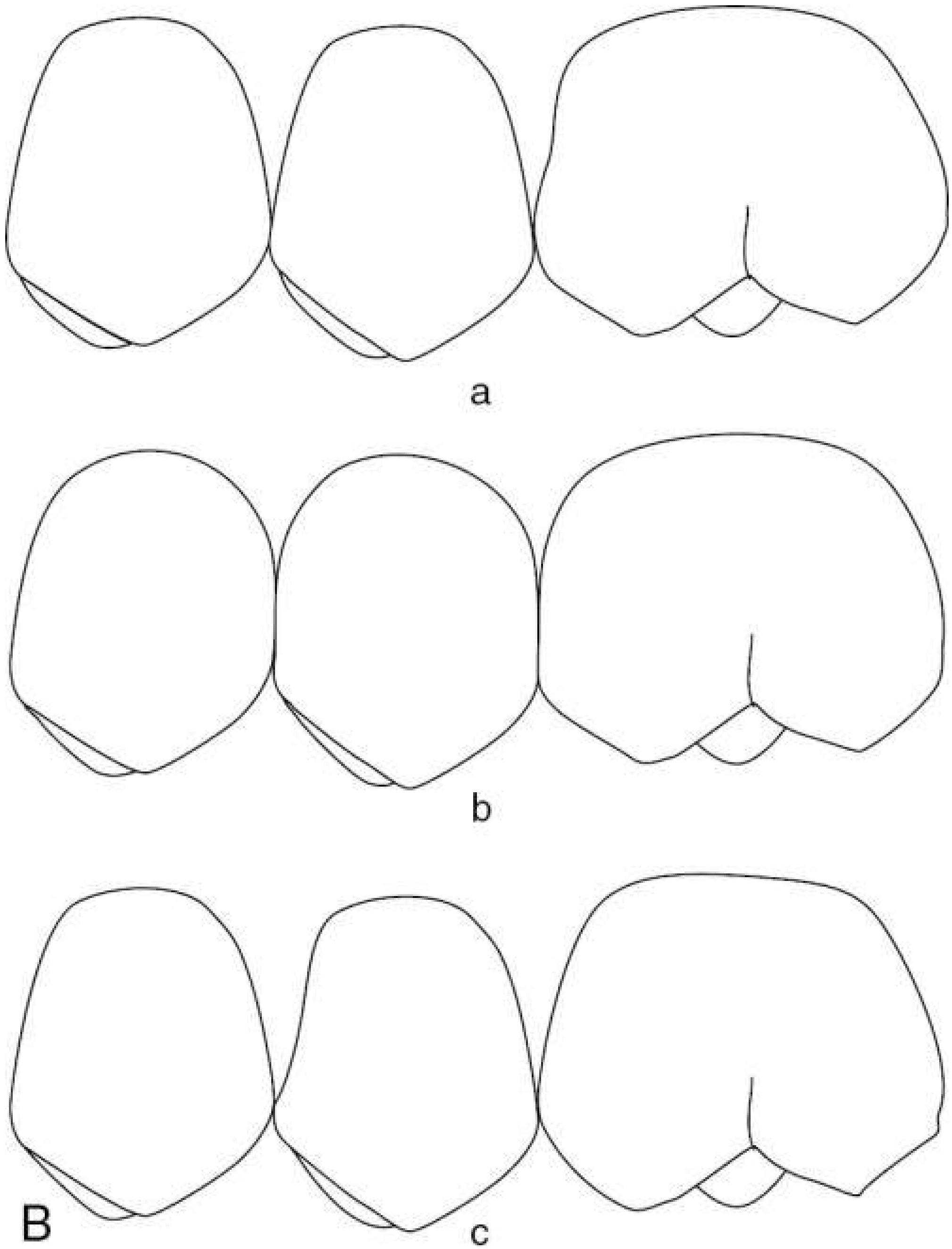


FIGURE 40.29 **(A)** Buccal view of maxillary posterior contact – contact present in occlusal third except for I and II molar where it is present in middle third. It is similar for mandibular posteriors. **(B)** Proximal contact: correct (a), too large (b), narrow (c).

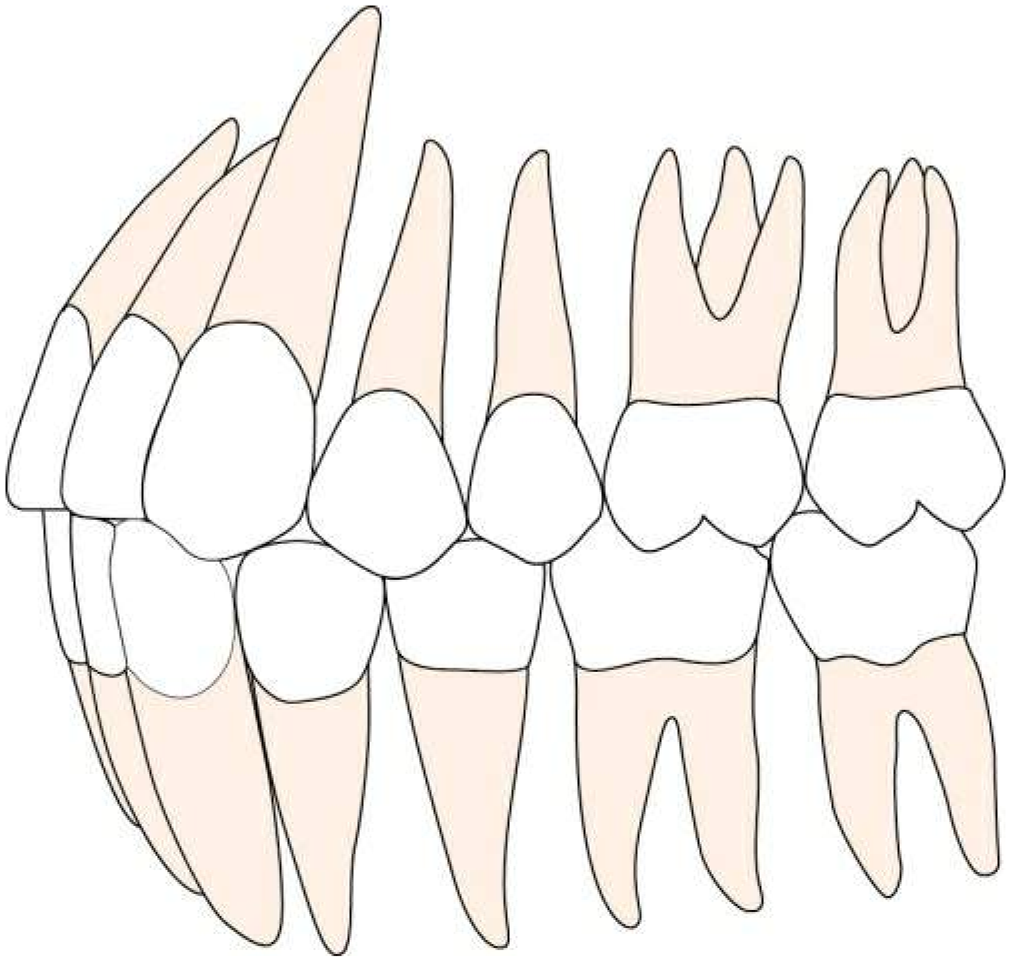


FIGURE 40.30 Contour of proximal surface below contact point, should be flat or slightly concave.

FIGURE 40.31 Proximal contact is established and the surface is contoured.

Buccal and lingual surfaces

- They should follow the contour of the adjacent teeth (Fig. 40.32).
- Height of contour of the buccal surface of posterior teeth occurs in the cervical third of the teeth (Fig. 40.33).
- Height of contour of the lingual surface of maxillary posteriors also occurs in the cervical third, but on the lingual surface of mandibular posteriors it occurs in the middle third (Fig. 40.34).

- Emergence profile is the contour of a tooth in relation to the gingival tissues or below the height of contour. It should be straight or concave. Overcontouring this part results in gingival inflammation and hyperplasia (Fig. 40.35).
- **Fabrication:** The buccal and lingual surfaces are contoured to their

anatomic form using the adjacent and contralateral teeth as guides. A smooth flat emergence profile is shaped (Fig. 40.36).

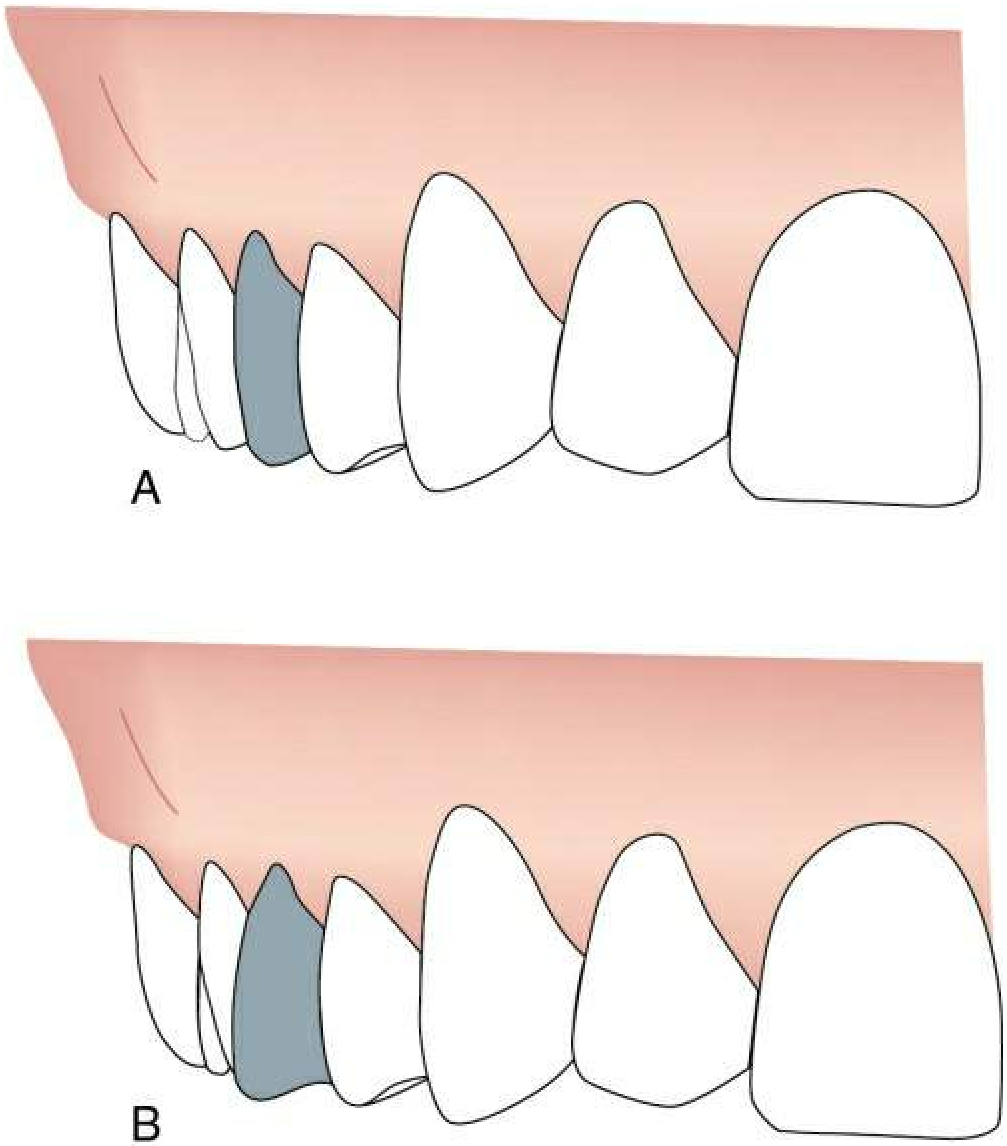


FIGURE 40.32 Buccal and lingual contour should follow the adjacent teeth: **(A)** correct, **(B)** incorrect.

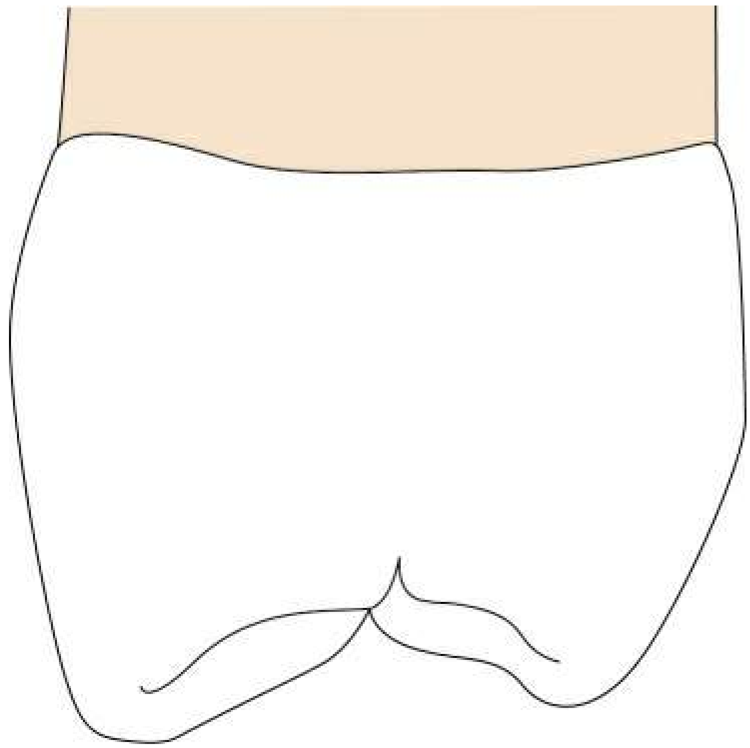


FIGURE 40.33 Height of contour of maxillary posterior tooth located in the cervical third both buccally and lingually.

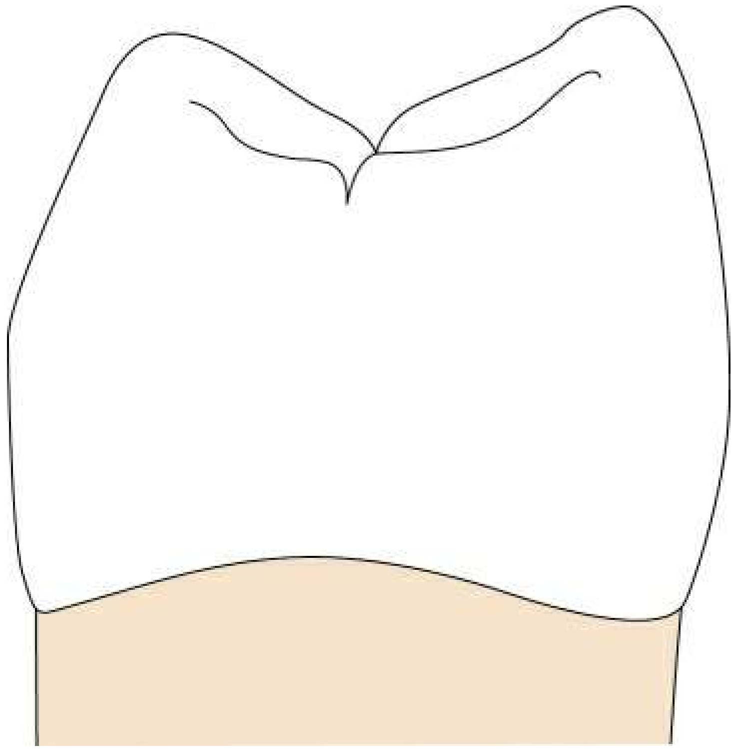


FIGURE 40.34 Height of contour of mandibular posterior tooth occurs in the cervical third buccally and in the middle third lingually.

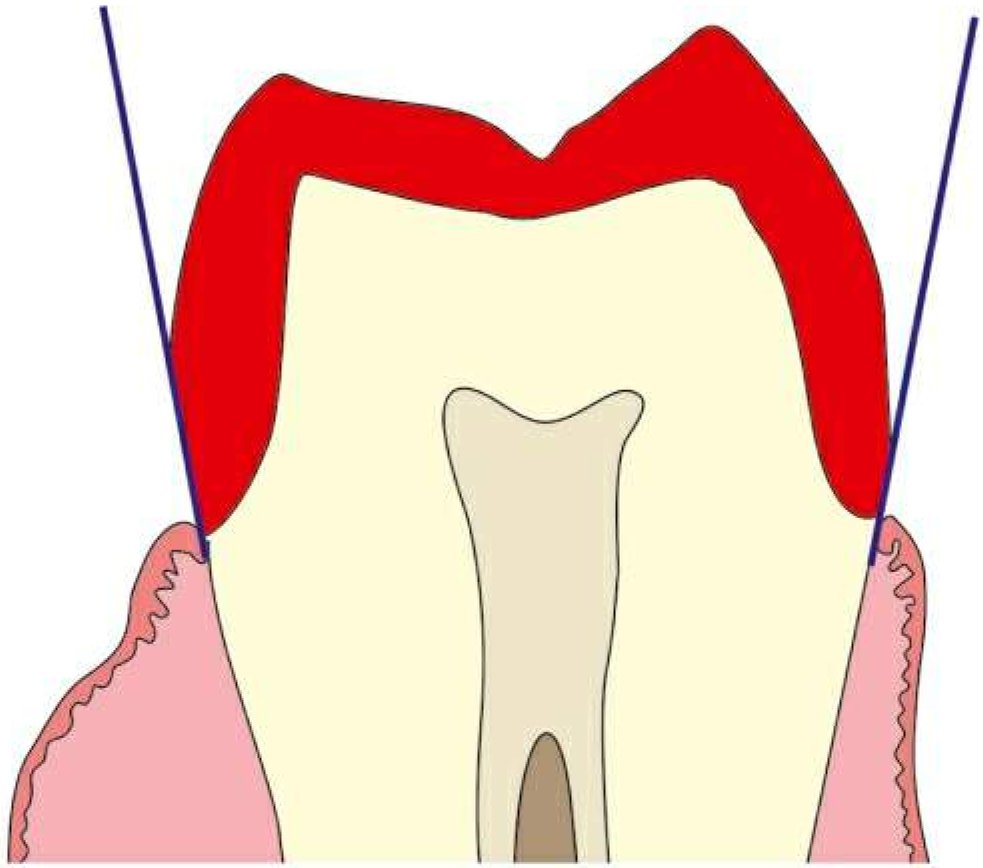


FIGURE 40.35 Straight emergence profile.

FIGURE 40.36 Axial surfaces contoured.

3. Occlusal surface

Functional cusps: The posterior maxillary palatal cusps and the mandibular buccal cusps are termed as functional cusps. They contact the opposing occlusal fossa or marginal ridge and are used to grind food during mastication.

Nonfunctional cusps: The posterior maxillary buccal cusps and the mandibular lingual cusps are termed as nonfunctional cusps. They do not contact the opposing teeth, prevent food from overflowing and protect the cheek and tongue during mastication.

Two types of occlusal schemes can be developed based on the location of contact of the functional cusps:

i. Cusp-marginal ridge

• Natural occlusion found in 95% adults.

• The functional cusps contact the embrasure (two teeth) of the opposing teeth. It is a one tooth-to-two teeth occlusal arrangement (Tables 40.1and 40.2).

• Most commonly used and indicated for most short span replacements.

• Food impaction into lingual embrasures causing displacement of teeth is sometimes a disadvantage.

• The waxing technique for this scheme was devised by E.V. Payne.

Table 40.1

Location of mandibular functional contact in cusp-fossa and cusp-marginal ridge occlusion

Mandibular buccal cusps	Maxillary occlusal surfaces	
	Cusp-marginal ridge	Cusp fossa
First premolar	Mesial marginal ridge of the first premolar	Mesial fossa of the first premolar
Second premolar	Distal marginal ridge of the first premolar and mesial marginal ridge of the second premolar	Mesial fossa of the second premolar
Distobuccal cusp of the first molar	Central fossa of the first molar	Central fossa of the first molar
Distal cusp of the first molar	Usually nonfunctional	Distal fossa of the first molar
Mesiobuccal cusp of the second molar	Distal marginal ridge of the first molar and the mesial marginal ridge of the second molar	Mesial fossa of the second molar
Distobuccal cusp of the second molar	Central fossa of the second molar	Central fossa of the second molar
Distal cusp of the second molar	Usually not present	Usually nonfunctional

Table 40.2

Location of maxillary functional contact in cusp-fossa and cusp-marginal ridge occlusion

Maxillary lingual cusps	Mandibular occlusal surfaces	
	Cusp-marginal ridge	Cusp fossa
First premolar	Distal fossa of the first premolar	Distal fossa of the first premolar
Second premolar	Distal fossa of the second premolar	Distal fossa of the second premolar
Mesiolingual cusp of first molar	Central fossa of the first molar	Central fossa of the first molar
Distolingual cusp of first molar	Distal marginal ridge of the first molar and mesial marginal ridge of the second molar	Distal fossa of the first molar
Mesiolingual cusp of the second molar	Central fossa of the second molar	Central fossa of the second molar

ii. Cusp-fossa

- Rarely found in natural dentition.
- The functional cusps contact the fossa of the opposing teeth. It is a one tooth-to-tooth occlusal arrangement (Tables 40.1 and 40.2).
- Indicated in full mouth occlusal reconstructions.
- Occlusal forces are directed centrally and along the long axis of the teeth, with less food impaction. Tripod contact produces greater stability.
- Can be used only when several teeth are being replaced.
- The waxing technique for this scheme was devised by P.K. Thomas.

Fabrication: Whichever occlusal scheme is used, the following procedure is adopted to fabricate the occlusal surface:

i. Placement of cusp cones

Cones are placed at the desired location and height of the cusps with a PKT No. 1 instrument. Location and height of functional cusp is determined by the area of location of its contact with its antagonist (depending on whether it is a cusp-fossa or cusp-marginal occlusal scheme). The location and height of nonfunctional cusp is determined by the curve of Spee and curve of Wilson, the adjacent teeth and the clearance required in excursive movements (Fig. 40.37A and B).

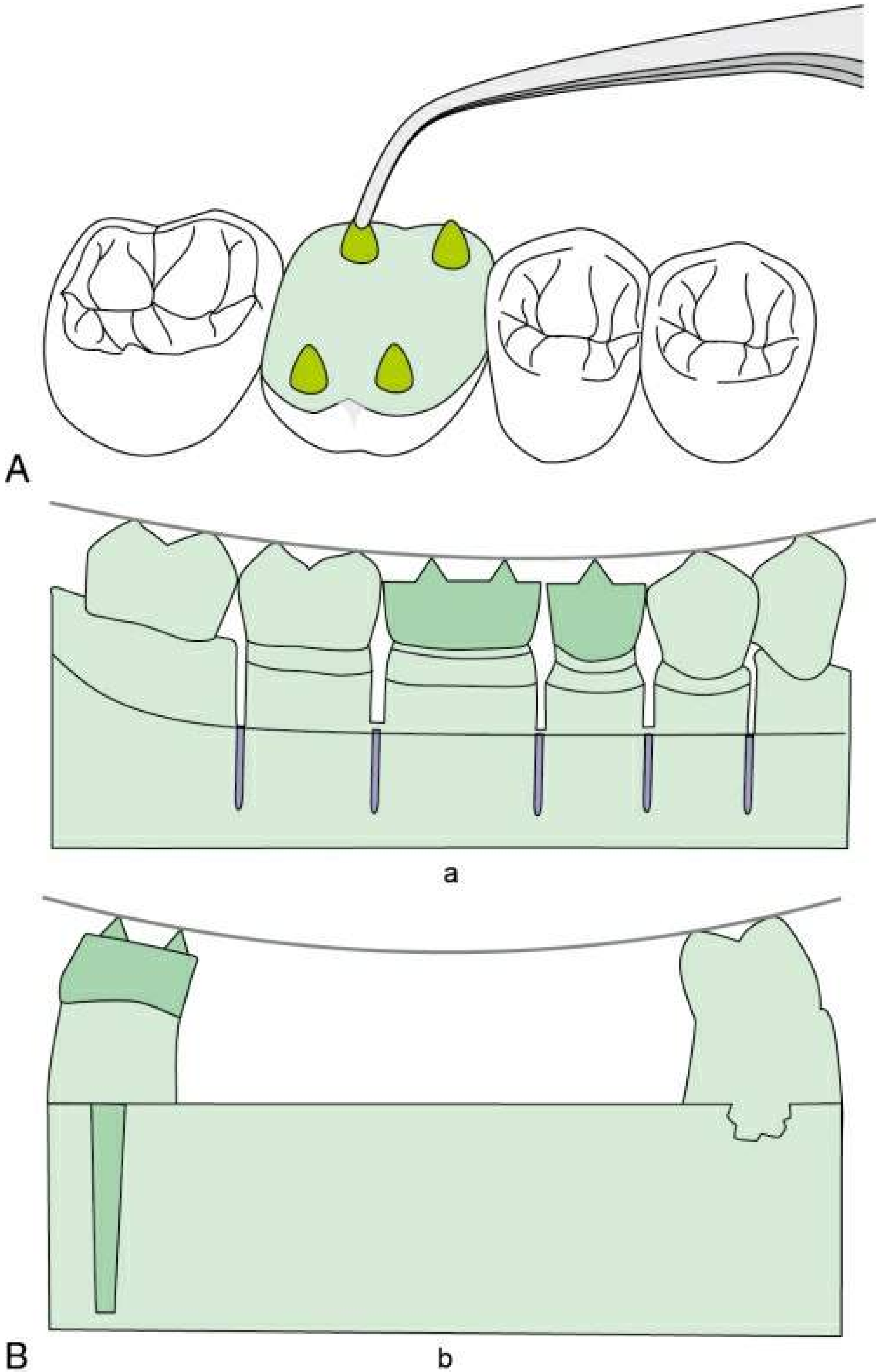


FIGURE 40.37 (A) Placement of cusp cones. **(B)** Curve of Spee (a) and curve of Wilson determining cusp height (b).

ii. Placement of marginal and cusp ridges

The cusps are connected by placing the marginal and cusp ridges with the same instrument. Occlusion is checked by closing the articulator so that vertical dimension is not raised. The axial surface is carved with a PKT No. 4 instrument (Fig. 40.38).

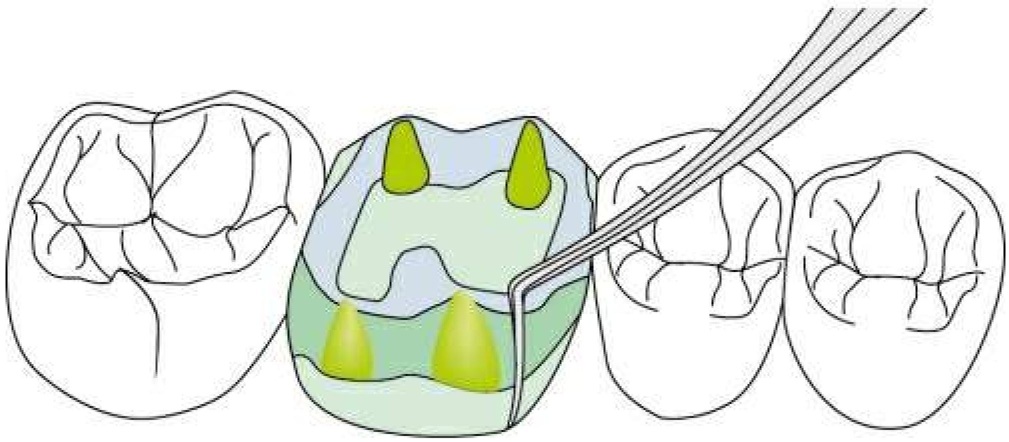


FIGURE 40.38 Placement of buccal and lingual cusp ridges and marginal ridges.

iii. Placement of triangular ridges

A triangular ridge is placed for each cusp which runs towards the centre of the tooth. The apex of the triangle is at the cusp tip and the base is at the tooth centre. The bases should be convex buccolingually and mesiodistally (Fig. 40.39). Occlusion is checked.

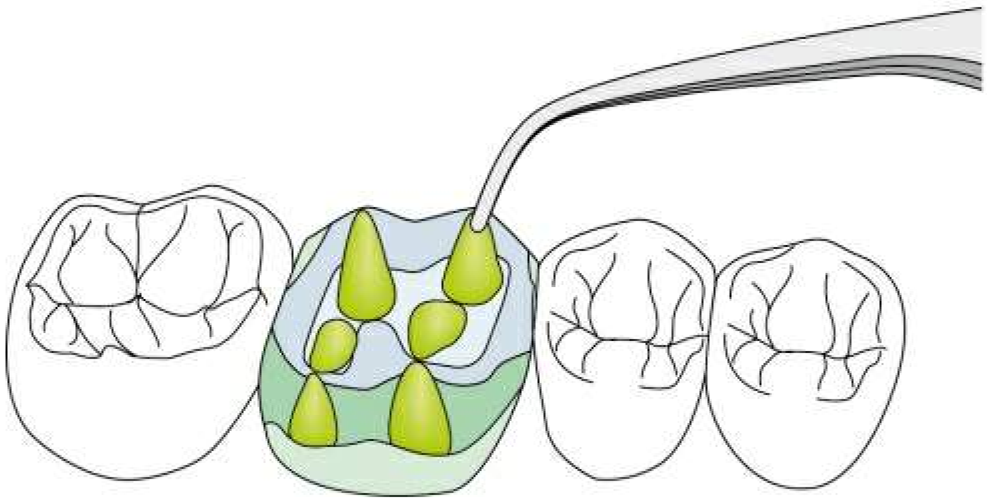


FIGURE 40.39 Placement of triangular ridge.

iv. Completing the occlusal surface

Remaining areas (pits) between the ridges are filled with wax by using PKT No. 2 instrument. Secondary and supplemental grooves are carved with a PKT No. 3 instrument (Fig. 40.40). Occlusal surface is dusted with a powder such as zinc stearate and contacts are verified by closing the articulator.

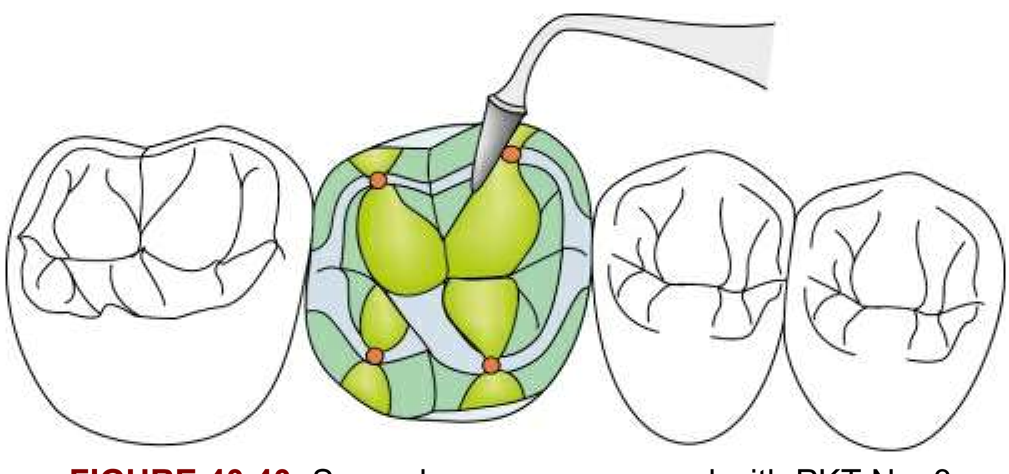


FIGURE 40.40 Secondary grooves carved with PKT No. 3 instrument.

4. *Remargination*

To obtain optimum fit, the margins must be refabricated and finished just before investing the wax pattern. This is termed as remargination.

Procedure

- The die is lubricated and pattern is reseated.
- The entire margin is remelted using a PKT No. 1 instrument ensuring that the wax is melted through to the die (Fig. 40.41). This results in a depression around the entire margin (Fig. 40.42).
- The depression is filled with additional wax (Fig. 40.43).
- The margin is finished by carving the excess wax with a PKT No. 4 instrument (Fig. 40.44). A sharp instrument should not be used as it may destroy the delicate margin in the die.
- Marginal discrepancies and their consequences are given in Table 40.3.

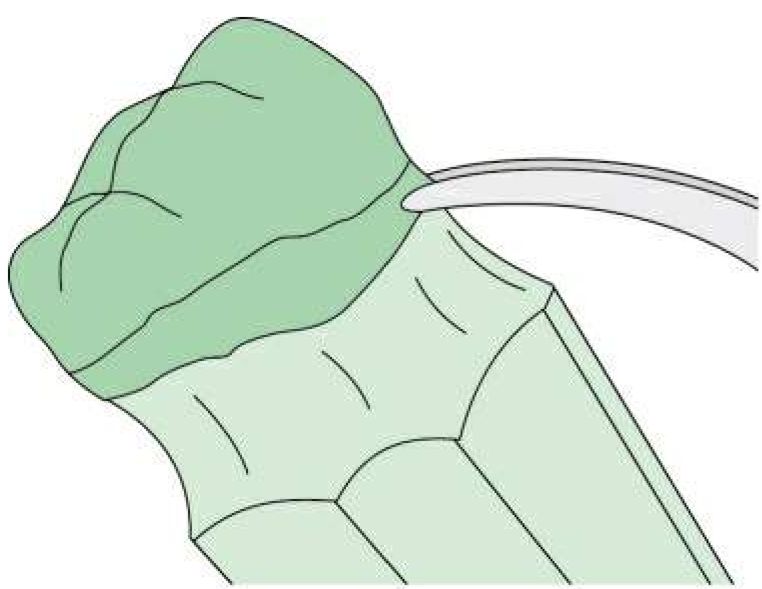


FIGURE 40.41 Wax melted with PKT No. 1.

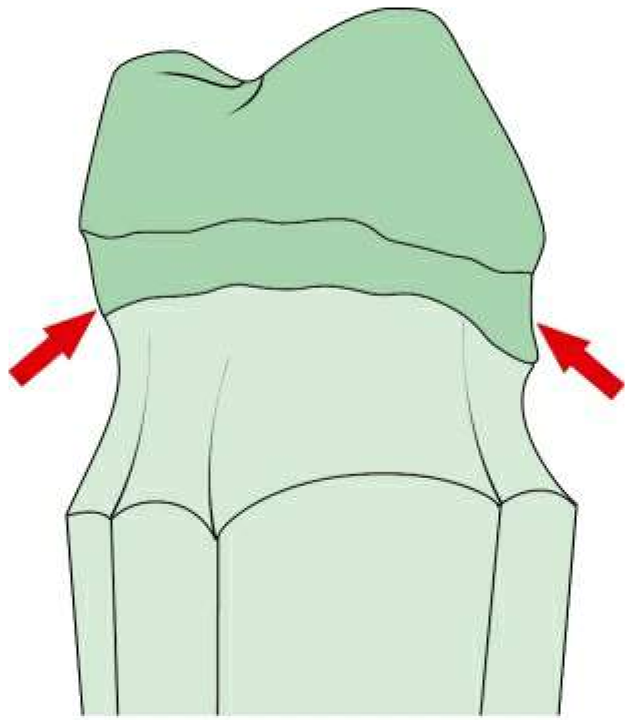


FIGURE 40.42 Depression formed.

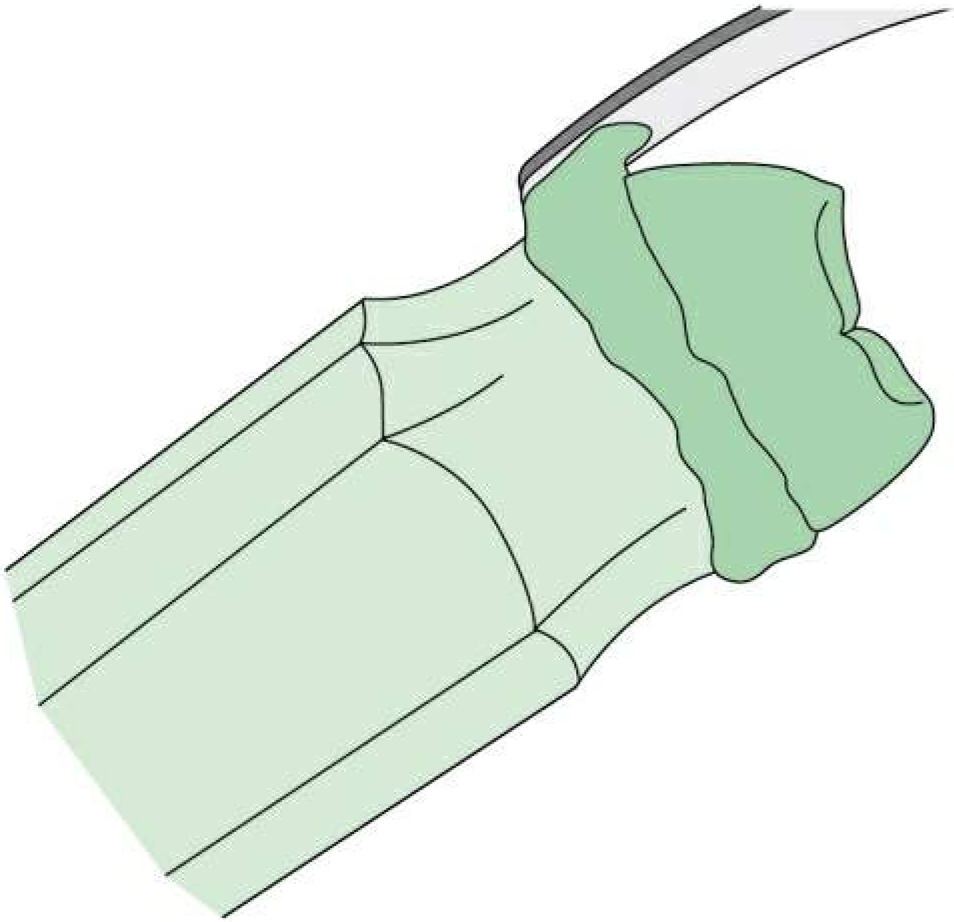


FIGURE 40.43 Wax added with No. 7 wax spatula.

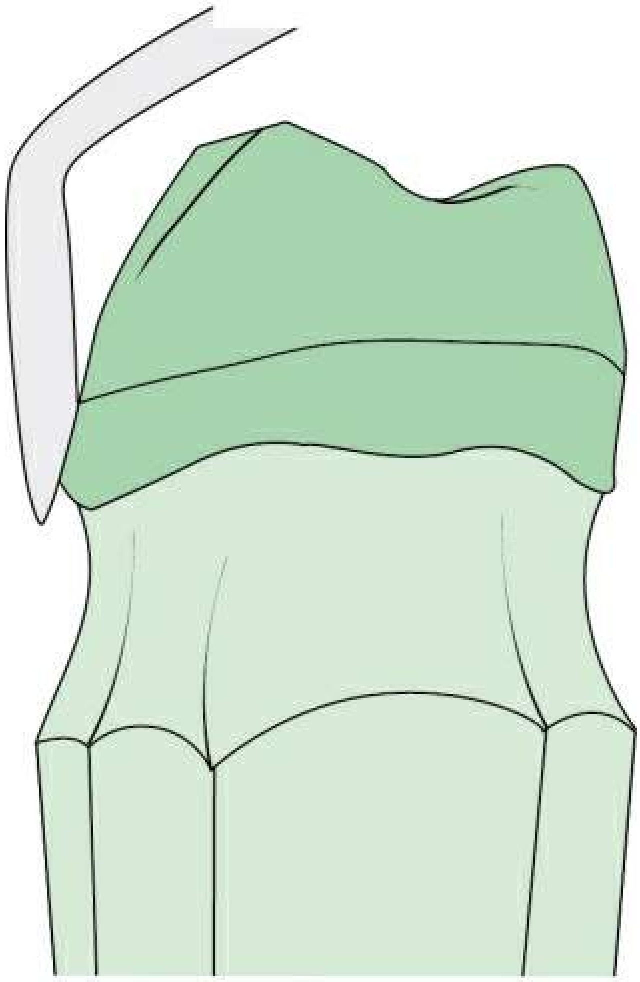


FIGURE 40.44 Finished with a PKT No. 4.

Table 40.3

Marginal discrepancies and their consequences

Problem	Consequence
1. Overextended margin	Prevents seating of casting
2. Short margin	Inadequate marginal seal
3. Thick margin	Overcontour
4. Rough margins (ripples)	Plaque accumulation

5. Finishing and polishing

- Cotton pellet held by tweezers and dipped in die lubricant is used to finish the occlusal surface (Fig. 40.45).

- The axial surfaces are smoothed and finished using wet silk cloth and liquid detergent. It can also be finished by applying die lubricant dipped in cotton roll and then buffing with dry cotton.

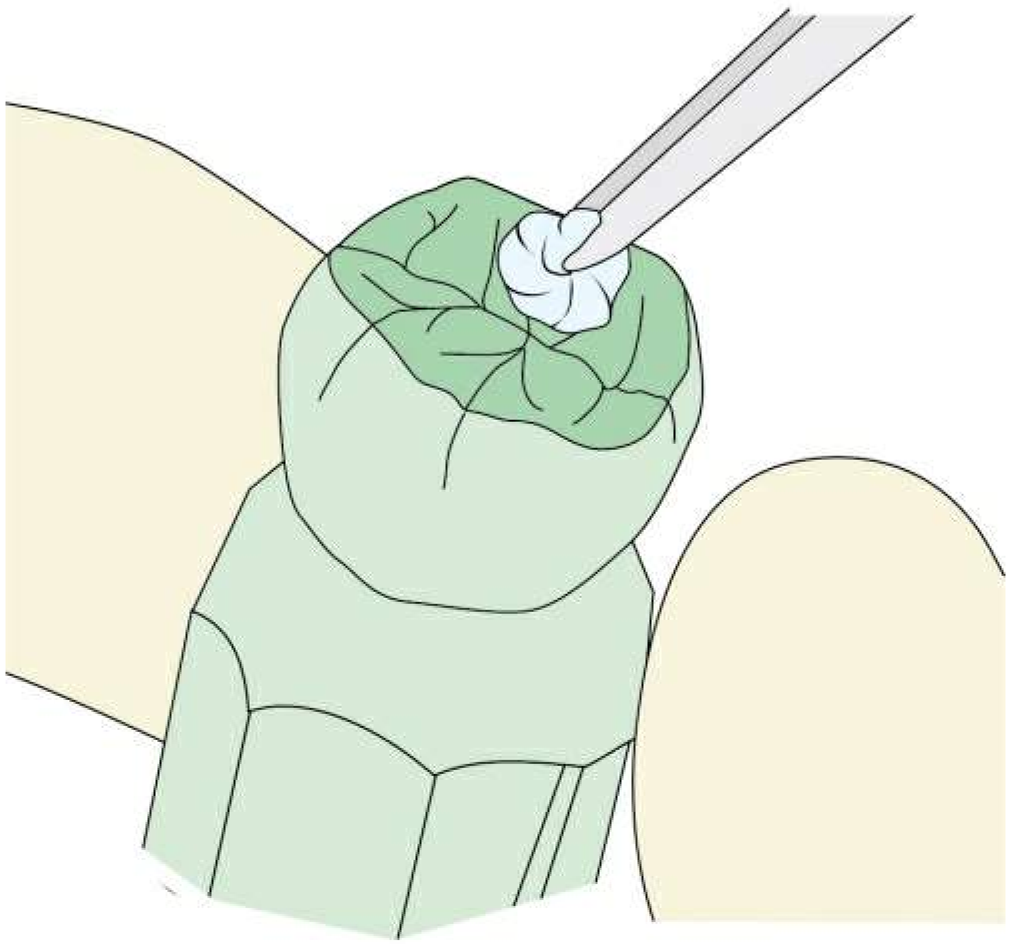


FIGURE 40.45 Cotton pellet used to finish occlusal surface.

6. Removing the wax pattern

Whenever the pattern is removed, the following technique is adopted.

The pattern is held by the thumb and forefinger of one hand while force in the opposite direction is applied by holding the die with the thumb and forefinger of the other hand (Fig. 40.46). A small piece of rubber dam can also be used to hold the pattern, thereby increasing the frictional grip.

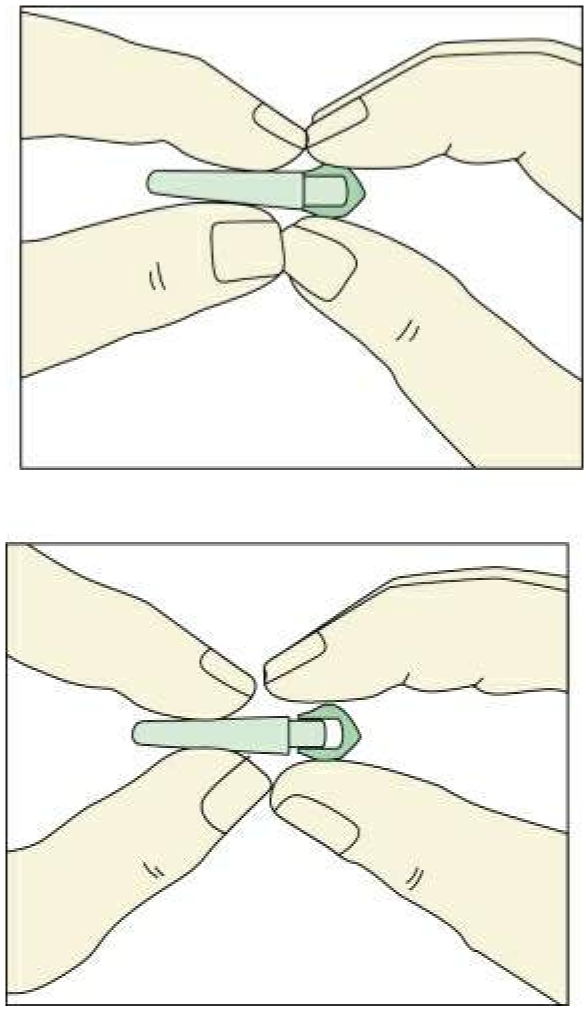


FIGURE 40.46 Technique to remove wax pattern.

Anterior crown/retainer

A *coping* is first fabricated as described for the posterior teeth.

Cusp cones are placed on the coping to determine the position of the incisal edge. For incisors, two proximoincisal cones are used, on mesioincisal and distoincisal angles of the crown. For canines, a third cone extending to the cusp tip is used.

Proximal contour

Wax is placed between the margin and each proximoincisal cone. The pattern with die is reseated on working cast with the wax still soft so that the adjacent teeth displace the excess wax. The location of contact, contour of proximal surface and embrasure form are then established.

Incisal edge form

Another rim of wax is placed between the proximoincisal cones to establish the curvature and thickness of the incisal edge. The position of the incisal edge is determined by adjacent teeth, arch form and eccentric occlusal relationships.

Labial surface

The labial surface is then contoured in harmony with the adjacent teeth, arch form and aesthetics.

Lingual surface

For maxillary incisors, there should be even contact with opposing incisors during protrusive movements, no contact during lateral movements and slightly out of contact in maximum intercuspation. A concavity in the lingual surface is necessary to achieve this. Lingual surface of mandibular anteriors should be contoured for plaque control.

Wax cutback

- All anterior teeth will need to be veneered with resin or ceramic for aesthetics. Posterior teeth may also need to be veneered.
- A full contour wax pattern of the entire crown is first made in wax and then the required space for the resin or ceramic is cutback (Figs 40.47 and 40.48).
- Advantages of full contour wax pattern:
    - It is a valuable aid in determining the form of the final restoration.

○ Cervical areas are reproduced better.

○ The veneering material is supported better.

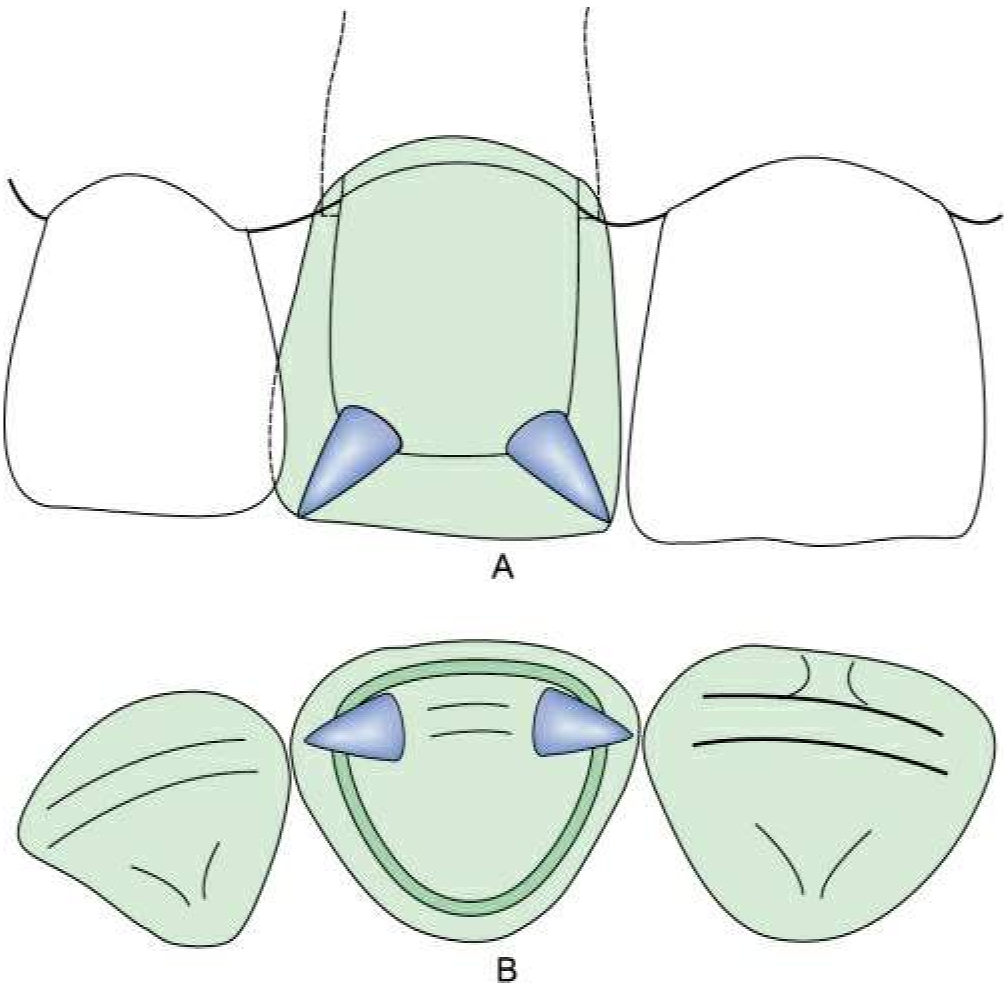
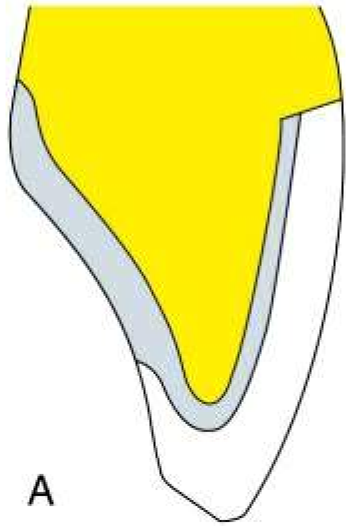


FIGURE 40.47 Anterior wax adding technique using wax cones: **(A)** labial view, **(B)** occlusal view.



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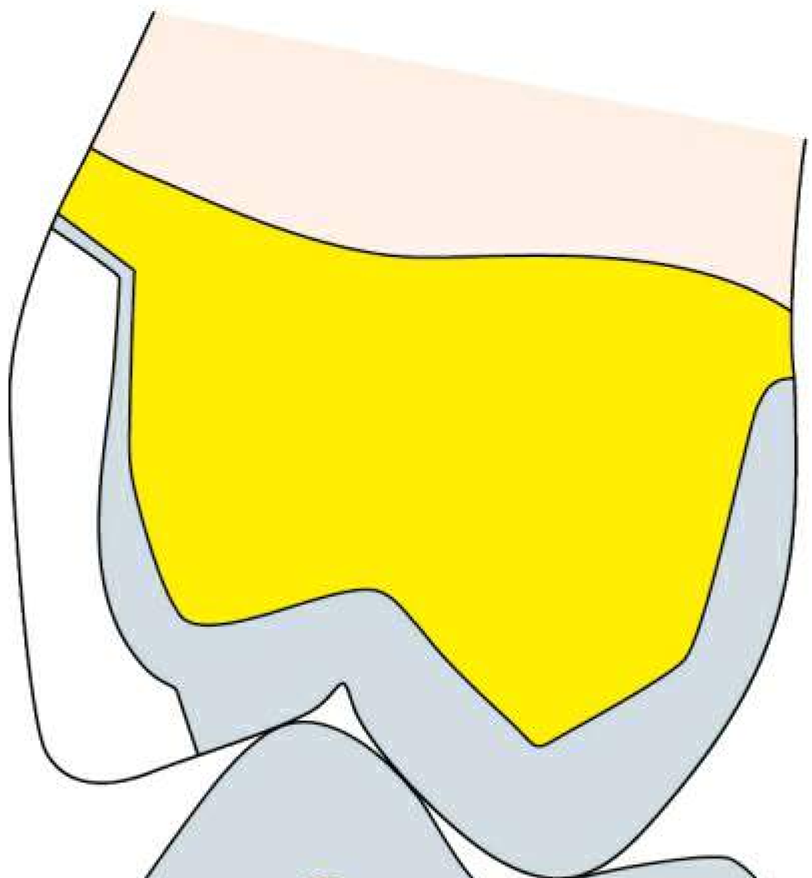

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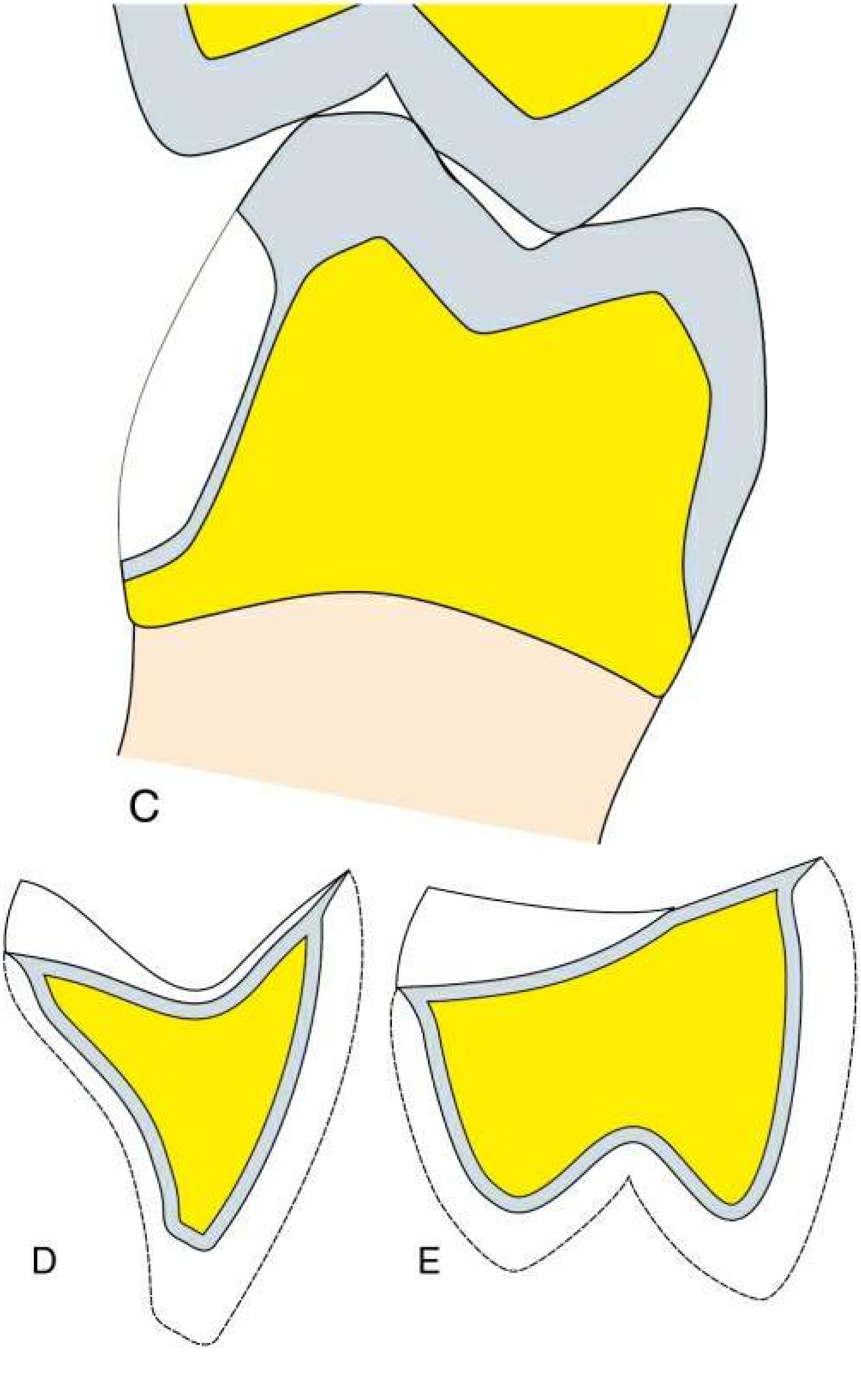
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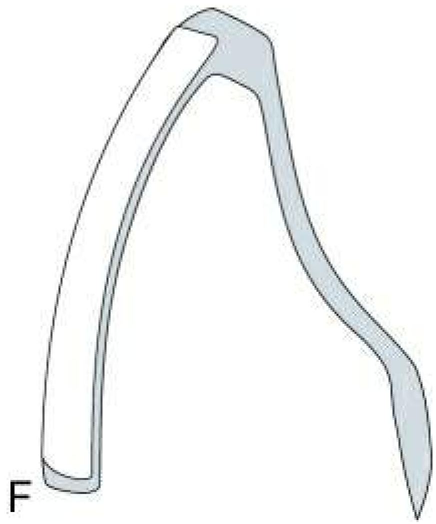


FIGURE 40.48 **(A)** Cutback for anterior metal with ceramic facing. **(B)** Cutback for maxillary posterior metal with ceramic facing. **(C)** Cutback for mandibular metal with ceramic facing. (D and E) Cutback for metal with complete ceramic coverage – **(D)** anterior, **(E)** posterior. **(F)** Cutback for resin facing. Note provision of undercut and noncoverage of incisal edge.

Procedure

- The outline of the cutback is marked with a BP blade.
- Depth-orientation grooves are made with a discoid carver.
- Remaining wax is removed such that a uniform thickness is provided for veneering material.
- Design of cutback depends on the type of restoration – metal with ceramic facing, metal with complete ceramic coverage, metal with resin facings.

Pontic

- For waxing fixed partial dentures, the retainers are fabricated as described previously.
- They are placed on the working cast after a full contour wax-up.

- The retainers are connected with a piece of inlay wax (Fig. 40.49).
- The occlusal surface is made flat and the occlusal scheme is developed with the wax-adding technique as described for retainers (Fig. 40.50).
- The axial, proximal and gingival contours are developed as determined by the design of the pontic (Fig. 40.51).
- The wax is cutback if a veneered restoration is planned.
- The entire assembly is cast as such. Alternately, the retainers are sectioned from the pontics at the connector area by a ribbon saw or 3–0 silk suture; the components are cast separately and later are attached by soldering.

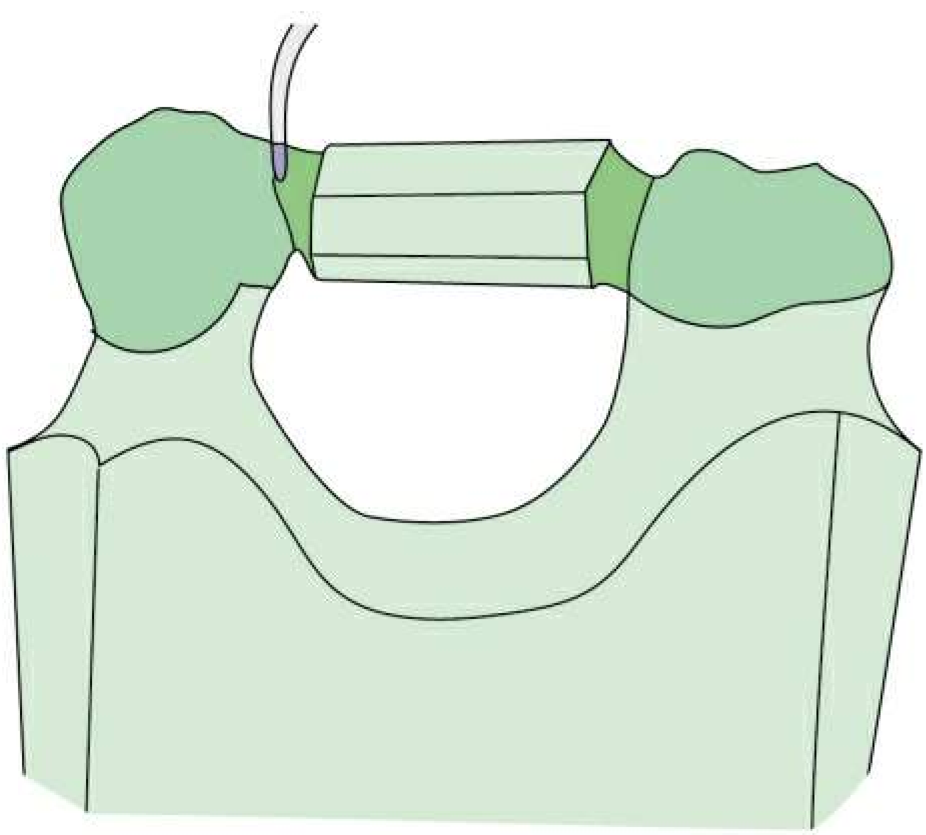


FIGURE 40.49 Retainers attached with inlay wax.

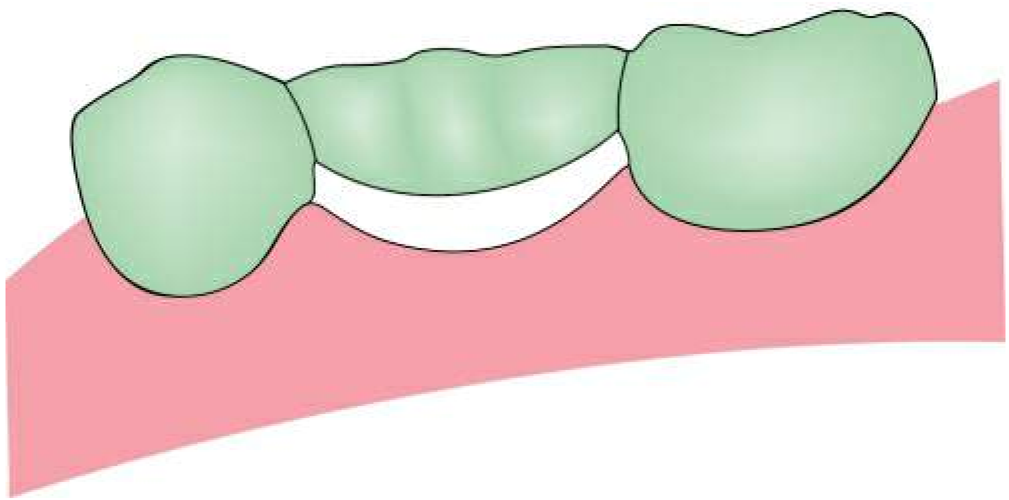


FIGURE 40.50 Occlusal surface is made flat and gingival surface is contoured according to pontic design.

FIGURE 40.51 Completed wax pattern.

Spruing

Sprue

Sprue: The channel or hole through which plastic or metal is poured or cast into a gate or reservoir and then into a mould (GPT8).

Sprue former: A wax, plastic or metal pattern used to form the channel or channels allowing molten metal to flow into a mould to make a casting (GPT8).

After the wax pattern is completed, it is attached with a sprue former to a crucible former into which a casting ring is inserted to contain the investment (Fig. 40.52).

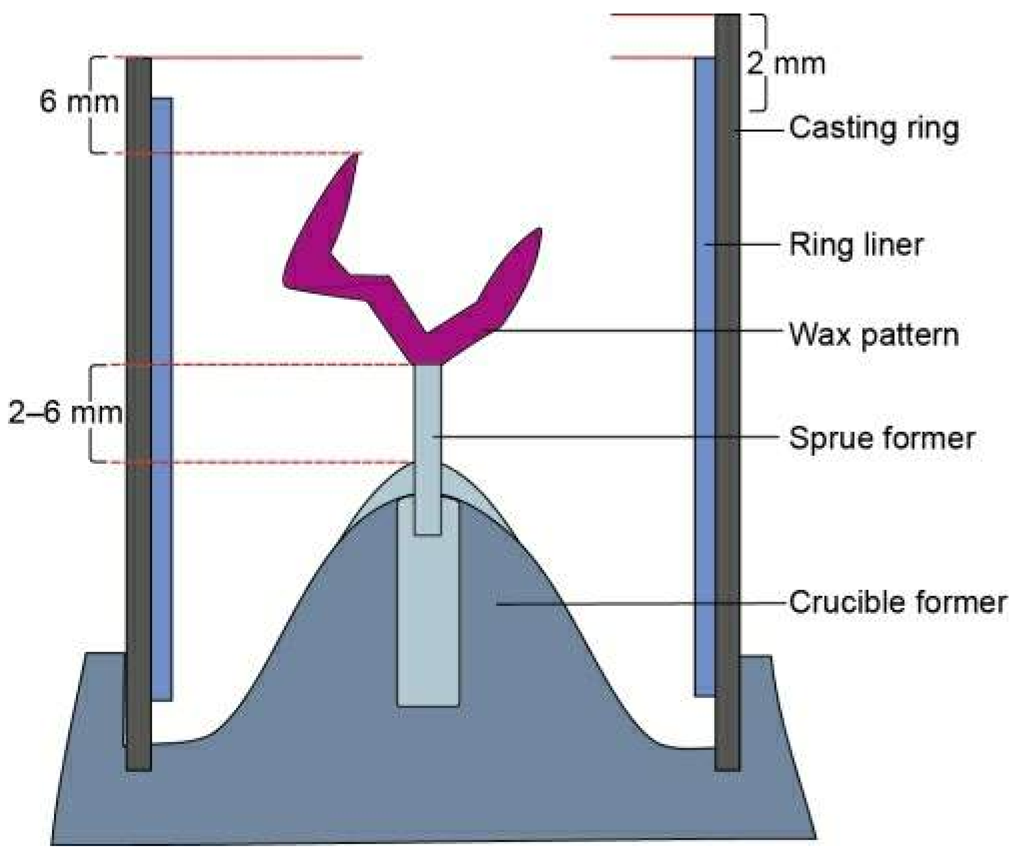


FIGURE 40.52 Sprue former with other components of the casting assembly.

The channel formed is *the sprue* and the material used to form the channel is the *sprue former.*

Requirements of sprue

1. It must allow molten metal to flow into the mould without turbulence.

2. It must allow molten wax to escape from mould.

3. It must provide a reservoir of metal to compensate for casting shrinkage.

Materials (sprue formers)

The sprues may be formed in wax, metal or plastic. Wax is the most commonly used and preferred material.

Wax

- Versatile, as it can be made in different shapes, sizes and lengths.
- Melt at the same rate as the pattern.
- Allow easy escape of molten wax.

Plastic

- More rigid, hence less distortion than wax.
- Indicated for one-piece castings.
- Solid plastic sprues soften at higher temperatures than wax pattern, thus preventing escape of wax producing rough castings. Hollow plastic sprues are available which overcome this problem.

Metal

- A noncorroding metal is used to prevent contamination of casting.
- The metal sprues are made hollow to increase the area of contact and strengthen attachment with pattern.
- They must be removed along with crucible former before casting. Care must be taken during removal to ensure that bits of investment are not broken as these may block the channel leading to incomplete castings.

Placement

1. Location of sprue

- Must be attached to the thickest portion of the wax pattern to prevent 'shrinkage porosity'.
- It should not be located in critical areas like margins or centric contacts. Nonfunctional cusps are generally preferred locations for sprue former attachment.

2. Angulation

- The angulation should allow the molten metal to flow to all parts of the mould without having to flow in an opposite direction (Figs 40.53 and 40.54A).
- Should not be placed perpendicular to a flat portion as this will cause turbulence (Fig. 40.54B). Hence, it should not be attached to a proximal surface.

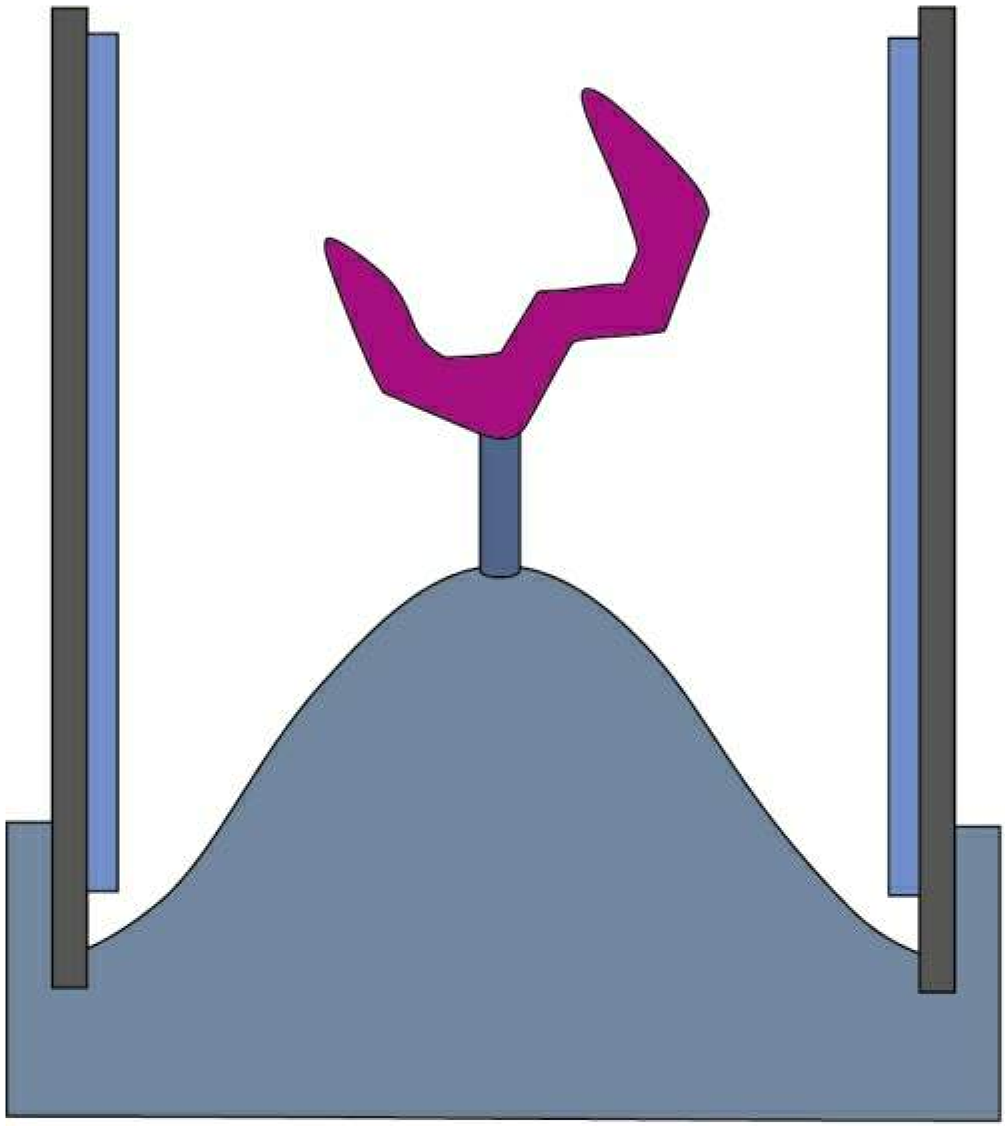
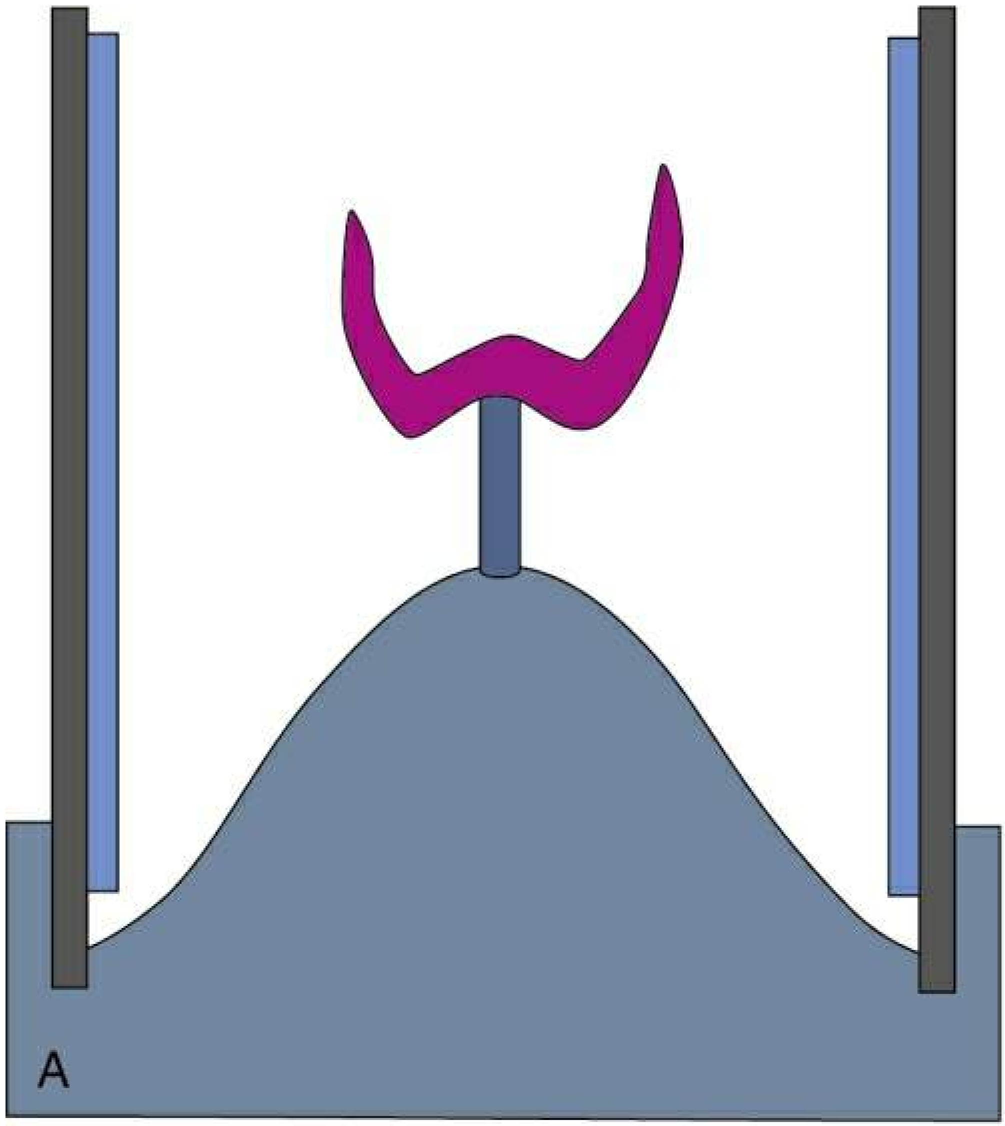


FIGURE 40.53 Correct angle of placement of sprue former.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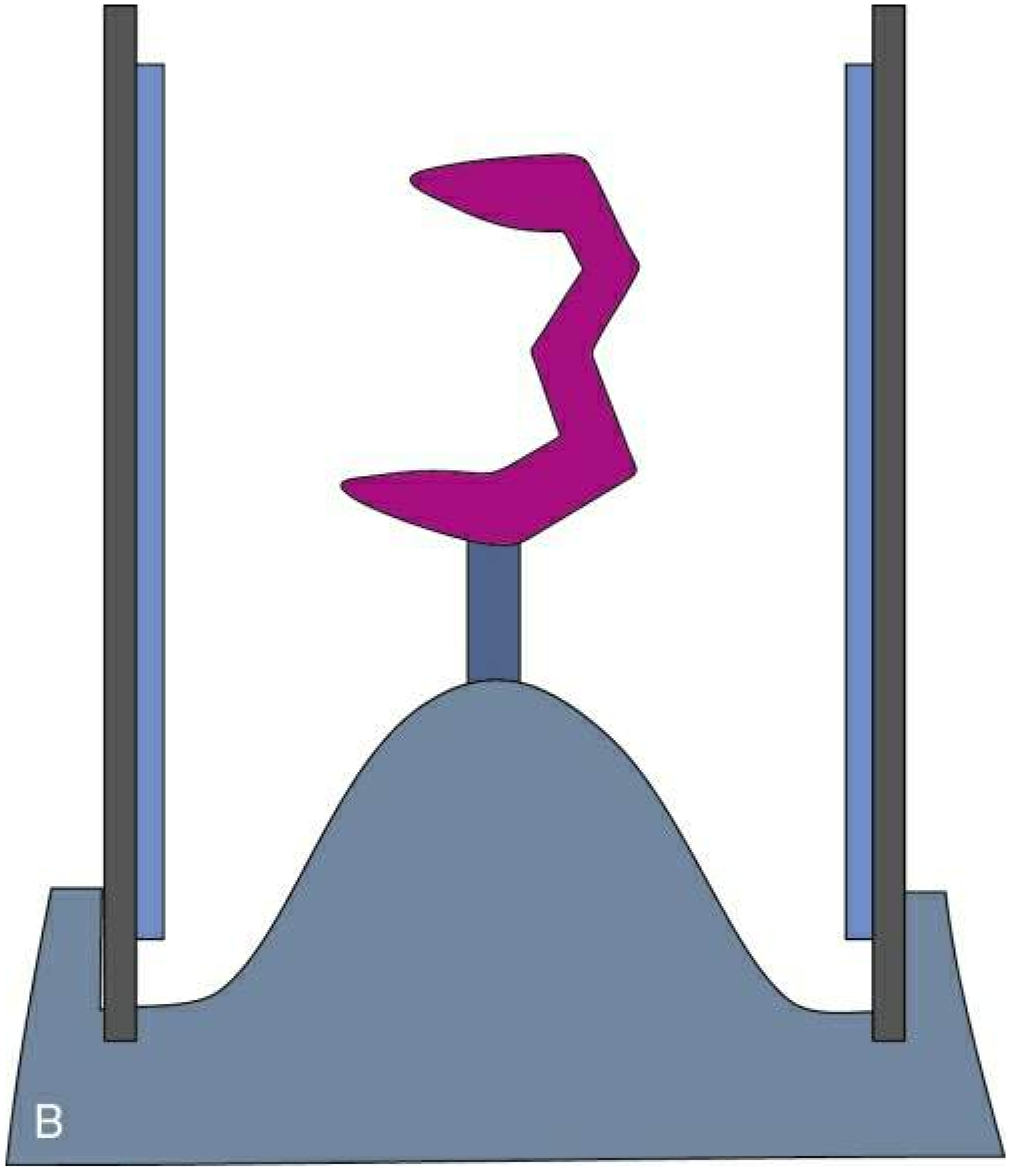


FIGURE 40.54 **(A)** Incorrect placement – metal has to flow in a direction opposite to the casting force, to fill the cusp tips. **(B)** Incorrect placement of sprue perpendicular to a proximal surface.

3. Diameter

- The diameter should be thicker than the thickest portion of wax pattern to prevent shrinkage porosity (Fig. 40.55).
- A 2.5 mm diameter (10 gauge) sprue is recommended for molars

and 2 mm (12 gauge) for premolars and partial veneer crowns.

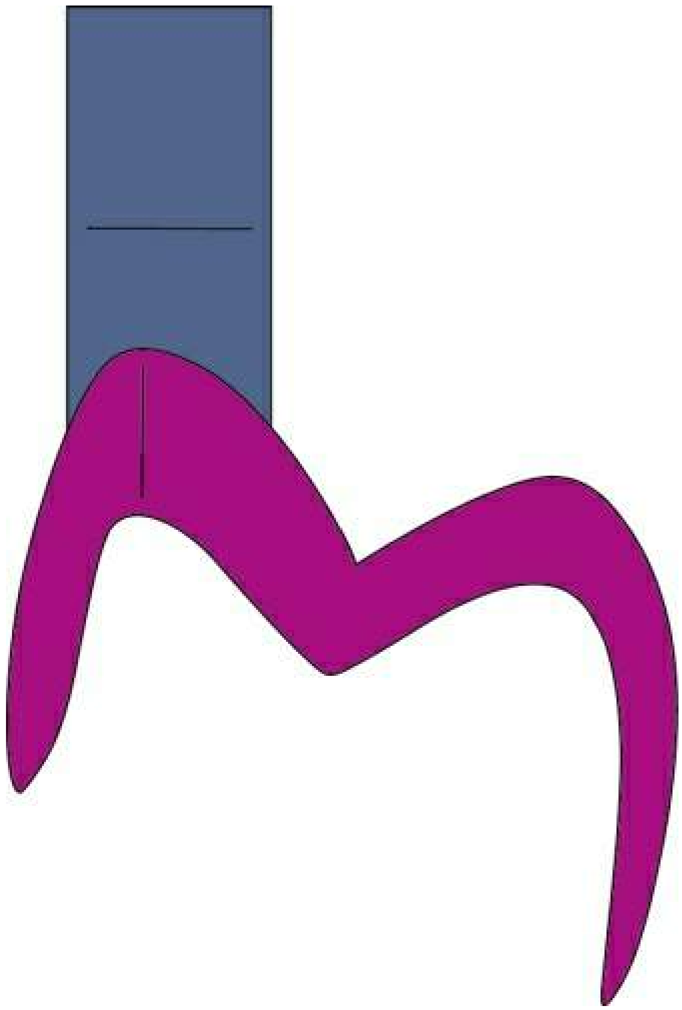


FIGURE 40.55 Sprue – should be thicker than thickest portion of wax pattern.

4. *Length*

- It should not exceed 6 mm or should be less than 2 mm.
- Short sprue former does not allow escape of gases leading to back pressure porosity. Portion of pattern farthest from the sprue former should be 6 mm from the base of the mould (Fig. 40.52).

- Long sprue former will cause shrinkage porosity. This can be prevented by attaching a reservoir in case the length is too long (Fig. 40.56).

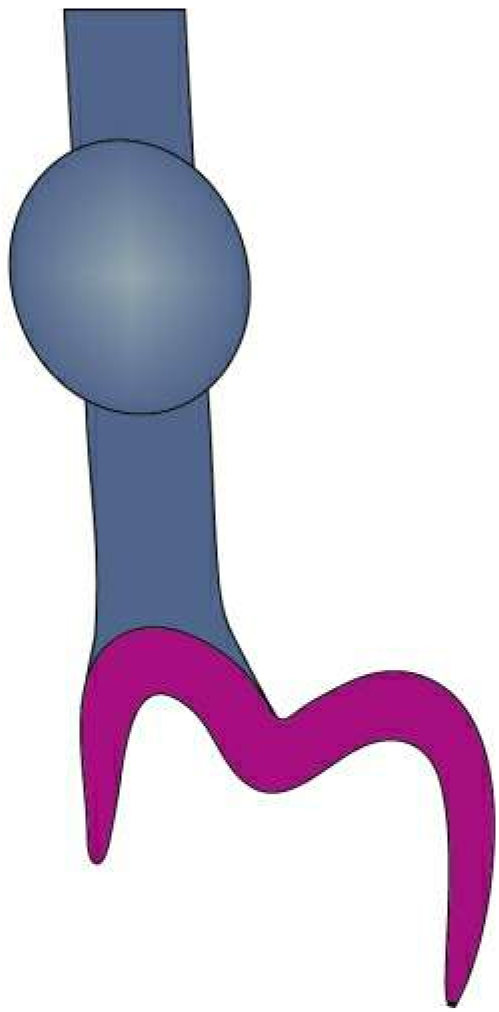


FIGURE 40.56 Reservoir to avoid shrinkage porosity.

5. Attachment

- The point of attachment of the sprue former to the pattern should be smooth without any pits and irregularities. It may be flared.

- Auxiliary sprues or vents can be used in thin patterns to ensure casting of critical areas (Fig. 40.57).

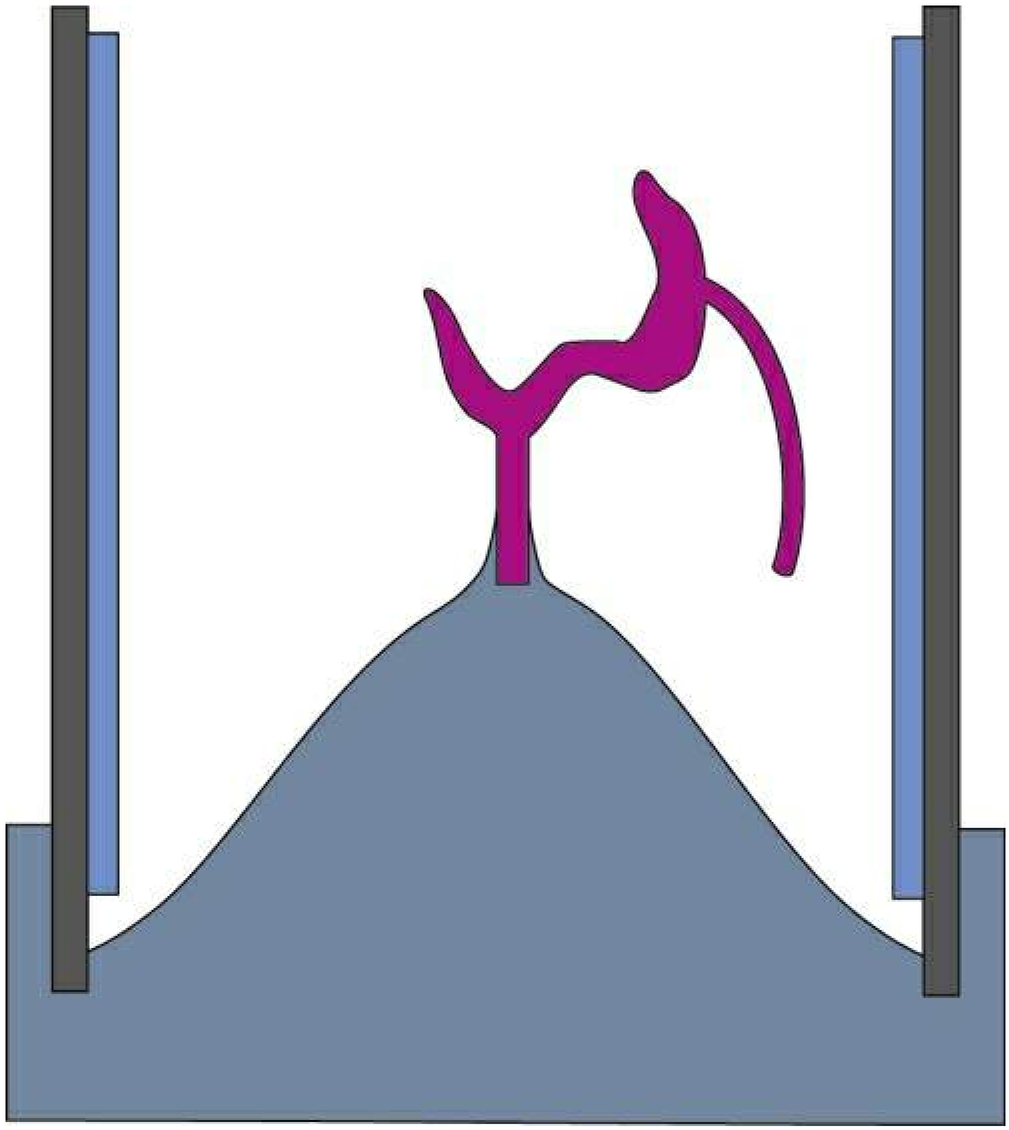


FIGURE 40.57 Auxiliary sprue or vent.

6. *Multiple unit spruing*

- To cast multiple units, a transverse bar or runner bar is used. The individual sprue formers are connected to a transverse or runner bar with a slightly larger diameter. The runner bar can be attached to the crucible former by one or two feeder sprues of larger diameter than the runner bar (Fig. 40.58).
- For casting two units, sprue formers attached to the individual units

can be angled towards each other and joined with the crucible former (Fig. 40.59). A runner bar can also be used.

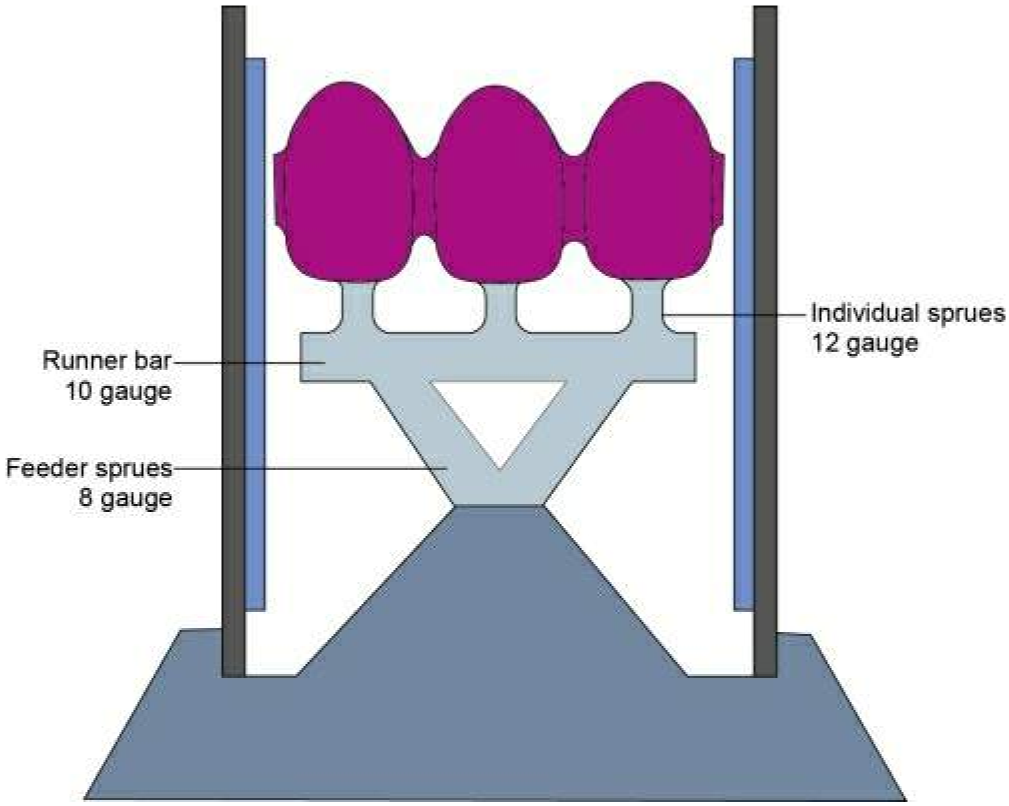


FIGURE 40.58 Multiple unit spruing using runner bar.

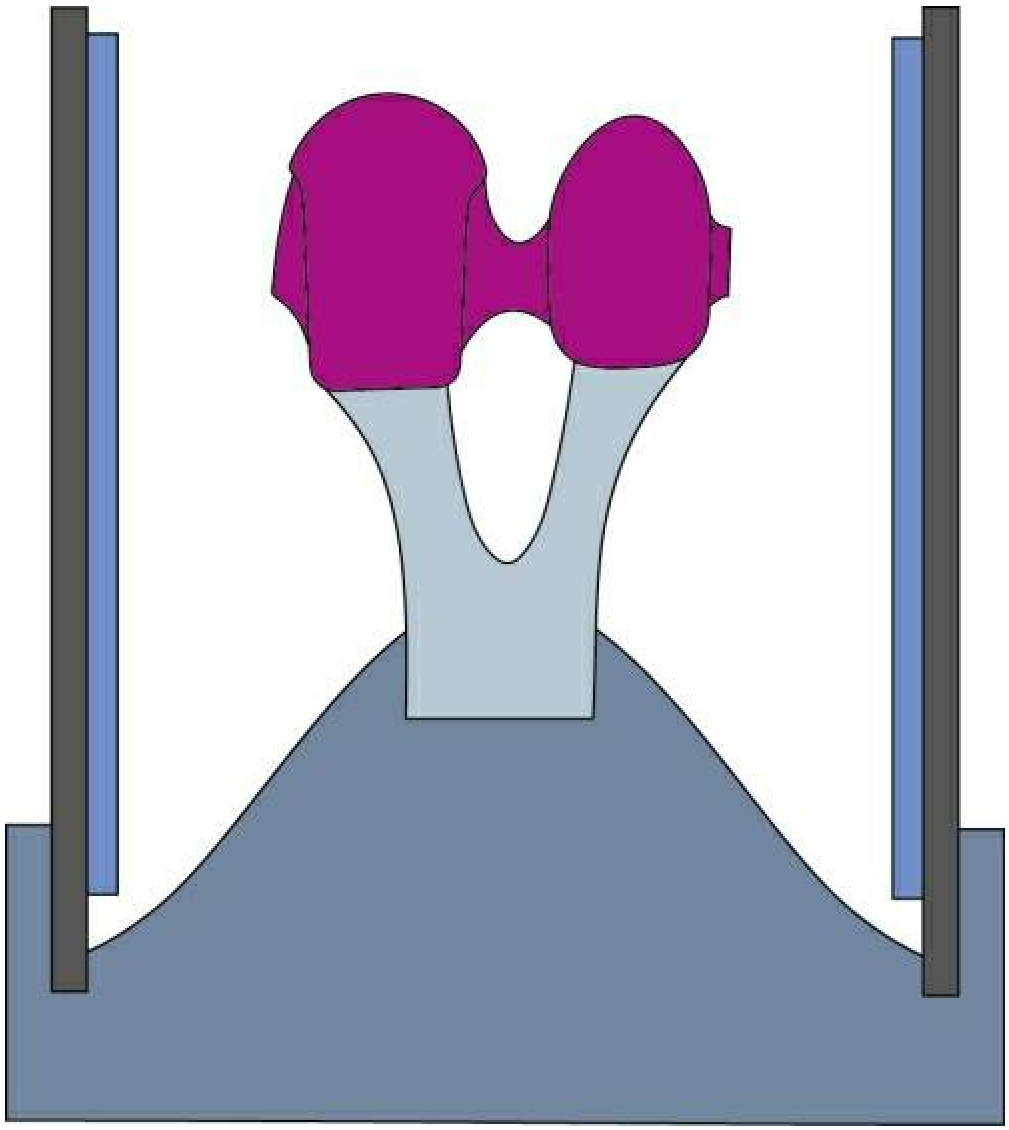


FIGURE 40.59 Two unit spruing.

Crucible former

Definition: The base to which a sprue former is attached while the wax pattern is being invested in refractory investment; a convex rubber, plastic or metal base that forms a concave depression or crucible in the refractory investment (GPT8).

The crucible former is attached to the sprue former till the investment procedure is completed and removed once the investment sets, prior to burnout (Fig. 40.60). The crucible present in the casting machine where the alloy is melted will direct the molten metal into the sprue through the conical depression formed in the mould by the crucible former (Fig. 40.61).

FIGURE 40.60 Sprue former attached to the conical part of sprue former, which after investing and burnout forms the entry to the mould space.

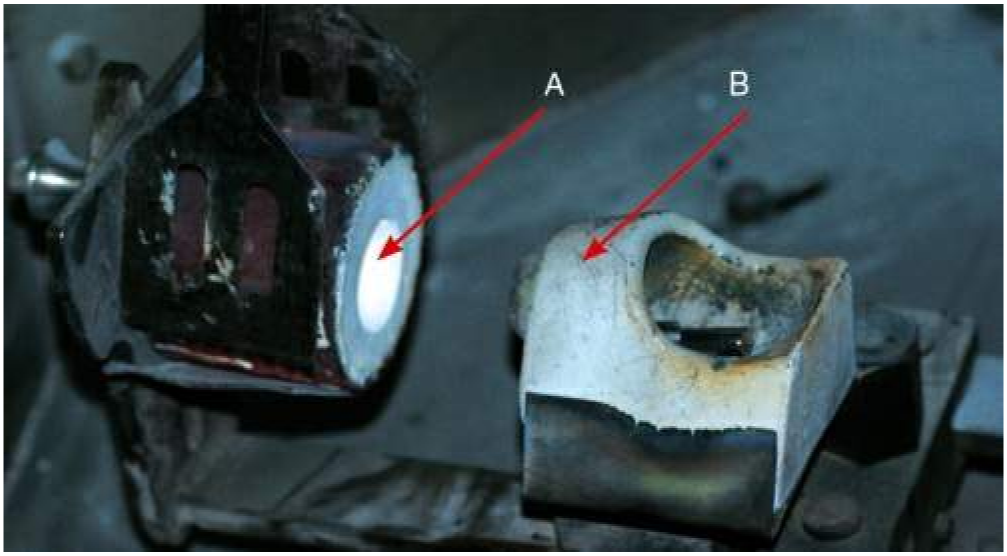


FIGURE 40.61 Ring placed in casting machine with crucible

(B) containing metal pellets directed towards the space created by the conical crucible former (A).

Casting rings and liners

Definition: Casting ring is a metal tube in which a refractory mould is made for casting dental restorations (GPT8).

- Casting ring is placed on the crucible former, surrounding the wax pattern and confines the fluid investment around the wax until it hardens.

- It also allows the hardened investment to be handled safely during burnout and casting.

- It is made of a metal that can withstand high heat.

- A wet liner is placed on the inside of the ring to allow setting expansion of the investment. Liners were previously made with asbestos, but to avoid the carcinogenic potential of asbestos a cellulose material or a silica–alumina compound is now used (Fig. 40.62A and B). The liner should end 2 mm below the open end of the casting ring (Fig. 40.52).


A

FIGURE 40.62 **(A)** Ring liner **(B)** Liner adapted inside ring 2 mm short of open end.

Ringless castings

These are used with high strength phosphate-bonded investments and high-melting alloys (base metal) which shrink more. A paper, rubber or plastic ring is used to initially confine the investment, which is then removed once the investment hardens. This allows for more expansion to compensate for the metal shrinkage (Fig. 40.63).

FIGURE 40.63 Rubber casting ring for ringless casting.

Procedure

- The wax pattern with the attached sprue former is removed from the die.
- The crucible former is cleaned and coated with petroleum jelly to prevent adherence of investment.

- Sticky wax is applied to the apex of the cone-shaped portion of the crucible former.
- End of sprue former is placed into the molten sticky wax and is held there until the wax hardens. The area of attachment should be smooth (Fig. 40.64).
- The pattern is sprayed with a surfactant (surface tension–reducing agent) to enhance the wetting of the pattern during investing.
- The pattern should be centred in the ring (Fig. 40.65). The end of the pattern must be at least 6 mm from the open end of the ring (Fig. 40.52). If necessary, sprue length may be shortened or a longer ring may be chosen.
- The pattern is now ready for investing.

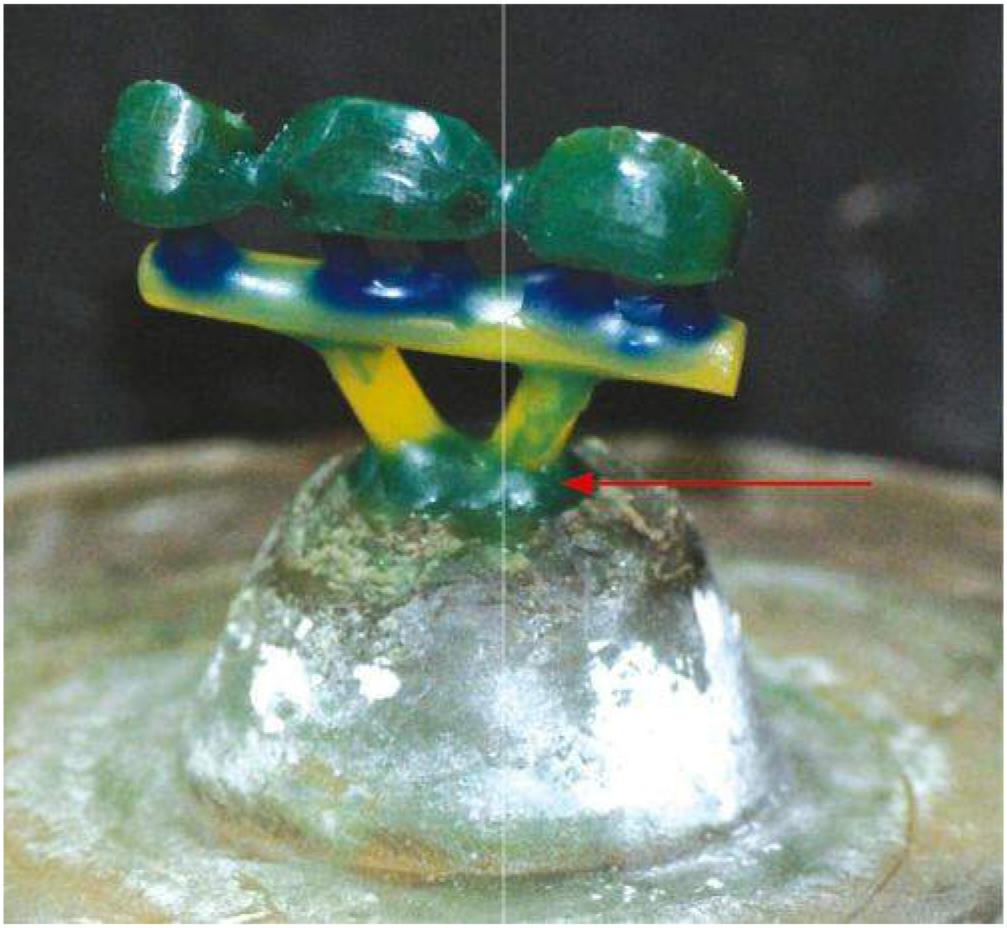


FIGURE 40.64 End of sprue former is attached with molten sticky wax to the cone-shaped portion of crucible former.

FIGURE 40.65 Wax pattern is centred in the ring.

Investing

Definition: The process of covering or enveloping, wholly or in part, an object such as a denture, tooth, wax form, crown, etc. with a suitable investment material before processing, soldering or casting (GPT8).

Investment material

Investment materials are composed of a refractory material, binder and modifiers.

They are classified according to the type of binder such as – gypsum-bonded, phosphate-bonded and silica-bonded investments. Gypsum-bonded investments are used for noble metal alloys, phosphate-bonded investments are used for base-metal and metal-ceramic alloys, and silica-bonded investments are used for high heat alloys used in removable cast partial dentures.

Three types of expansions can be manipulated from the investment material to compensate for casting shrinkage – setting, hygroscopic and thermal. They can be manipulated by changing the powder–liquid ratio, thickness of liner and allowing the investment to set in water (hygroscopic).

Ideal requirements

Ideal requirements for investment materials are

- Ability to produce smooth castings.
- Controllable expansion to compensate for casting shrinkage.
- Stability at high temperatures.
- Good strength to resist forces of casting.

- Enough porosity to allow escape of gases.
- Easy recovery of castings.

Procedure

- The powder and liquid of the investment material are hand spatulated or mixed under vacuum.
- The material is first applied on the wax pattern with a brush (Fig. 40.66).
- The casting ring is then placed over the pattern and then the entire ring is filled with investment material under vibration (Fig. 40.67).
- The investment is allowed to set for 1 h.
- For the hygroscopic technique, the casting ring is immediately immersed in a water bath at 38°C for 1 h.

FIGURE 40.66 Applying with brush.

FIGURE 40.67 Filling ring with investment.

Burnout or wax elimination

Definition: The removal of wax from a mould, usually by heat (GPT8).

Procedure

- The crucible former is removed from the casting after the setting of the investment.
- The ring is placed in the burnout or muffle furnace with the sprue hole down to facilitate flushing out of wax (Fig. 40.68).

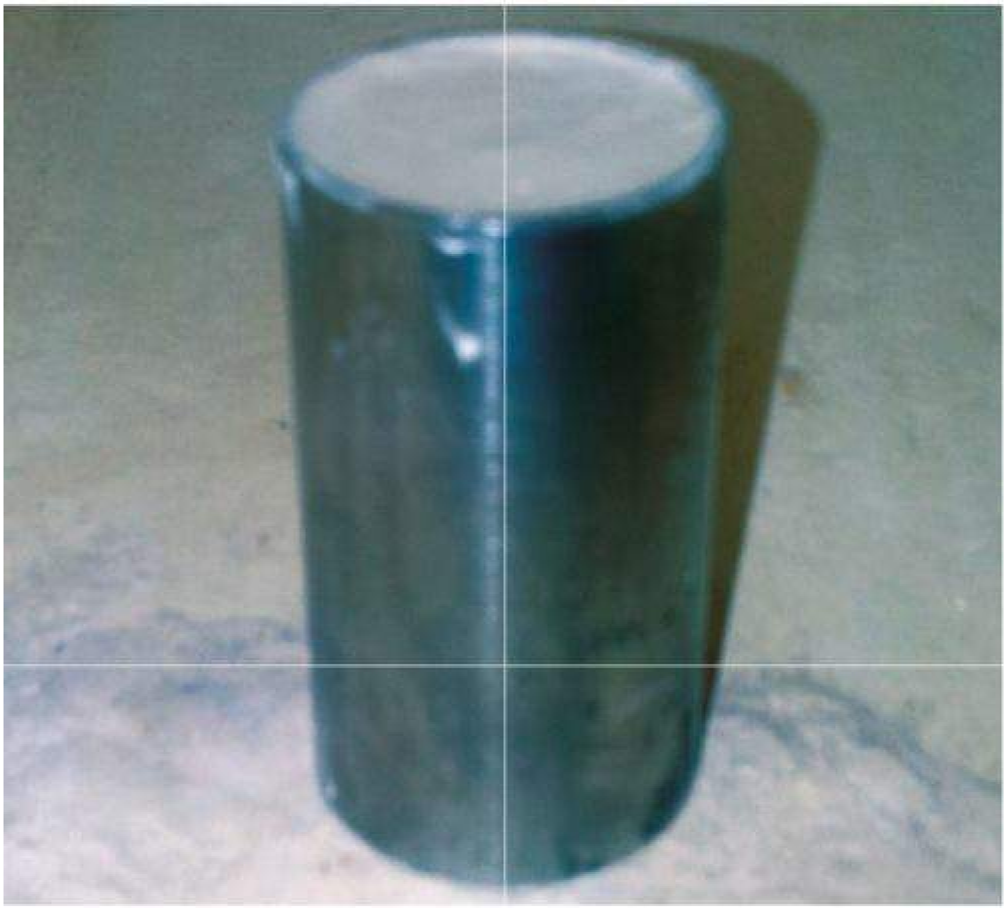


FIGURE 40.68 The ring should be placed with the sprue hole facing down.

Casting temperature

- For gypsum-bonded investments, when using noble metal alloys, the ring can be placed in the furnace at 200°C temperature for 30 min to eliminate the wax. The temperature is then raised to 480°C (hygroscopic expansion technique) or 650°C (thermal expansion technique) and maintained for 1 h. It should not be heated beyond 700°C as investment may disintegrate to release sulphur dioxide and contaminate the alloy.

- For phosphate-bonded investments, when using base metal alloys, the ring is placed in a cold furnace and the temperature is raised to 815°C in 1 h and maintained for 2 h.

Casting

Definition: An object formed by the solidification of a fluid that has been poured or injected into a mould (GPT8).

Casting equipment

1. Heat source – melts the alloy.

2. Casting machine – drives the molten alloy into the mould.

3. Crucible – holds the alloy during melting.

Heat source

Two types of heat sources are available:

1. Torch

Torch is used to direct the flame. There are two types of torches – single orifice, used for noble metal alloys, and multiorifice, used for metal-ceramic and base metal alloys. The fuel is obtained from a combination of gas–air (for low-melting noble metal alloys), gas–oxygen (for higher melting metal-ceramic alloys) and oxyacetylene (for base metal alloys).

2. Electricity

- Electrical resistance or an induction field is used to melt the alloy.

- **Advantage:** Heating is evenly controlled with minimal changes in alloy composition.

- **Disadvantage**: Expensive.

Casting machines

1. Air-pressure casting machine

This machine uses air pressure to push the alloy into the mould. Mostly it is used for noble metal alloys. Alloy is premelted on a charcoal block and is placed in the air pressure casting machine directly on the crucible formed in the investment. It is melted again and a piston above the ring applies air pressure to push the metal into the mould. Vacuum is also activated as the pressure is applied. This technique is rarely used now. The alloy is melted using a torch.

2. Centrifugal casting machine

The alloy is melted in a crucible separate from the ring. The arm of the machine is spring loaded. As the metal melts, the spring is released, which pushes the alloy into the mould by centrifugal force. To provide adequate force 3–4 counter turns are sufficient to load the spring. The alloy is melted using a torch.

3. Induction casting machine

The alloy is melted in the machine itself using an induction field to generate electricity and molten metal is pushed into the mould using a centrifugal force. Advantages of electrical melting are discussed above (heat source – electricity) and the procedure for using the machine is discussed in Chapter 27.

4. Electrical resistance-heated machine

Similar to induction casting, current is passed through a resistance heating conductor to melt the alloy and the metal is pushed into the mould with a spring wound casting machine.

Crucible

Definition: A vessel or container made of any refractory material (frequently porcelain) used for melting or calcining any substance that requires a high degree of heat (GPT8).

Crucibles are made of clay, quartz or zirconium. Quartz and zirconium are used for casting high-melting alloys (Fig. 40.69).


A

FIGURE 40.69 Quartz crucible used for **(A)** induction casting and **(B)** centrifugal casting.

The crucible contains an opening which is aligned with the sprue opening in the mould and is used to push the molten metal into the mould.

Casting using a torch flame and centrifugal casting machine

Procedure

- The parts of a broken arm centrifugal casting machine are shown in (Fig. 40.70).
- The arm of the machine is given three turns and is locked with the pin. Four turns are given for metal-ceramic and base metal alloys as they have less density than gold alloys (Fig. 40.71).

- The cradle is checked for appropriate size of casting ring. The counter weights are adjusted for balance.
- The blow torch is lit and adjusted to produce a conical flame. The reducing zone should be used for heating as this is the hottest part (Fig. 40.72).
- The crucible is preheated with the flame to avoid freezing of alloy and incomplete casting (Fig. 40.73).
- Sufficient amount of alloy is placed in the crucible. 6 g – for premolar and anterior castings, 9 g – for molar castings and 12 g – for pontics.
- The alloy is heated in the reducing zone of the flame. Some flux can be added for noble metal alloys.
- Gold alloys present a mirror like shiny surface when ready to be cast. Rounding of ingot edges of base metal alloys indicate that they have melted.
- The casting ring is removed from the furnace and placed in the cradle of the casting machine (Fig. 40.74A–C). The flame is kept directed at the molten metal (Fig. 40.75).
- The casting arm is released to make the casting (Fig. 40.76).

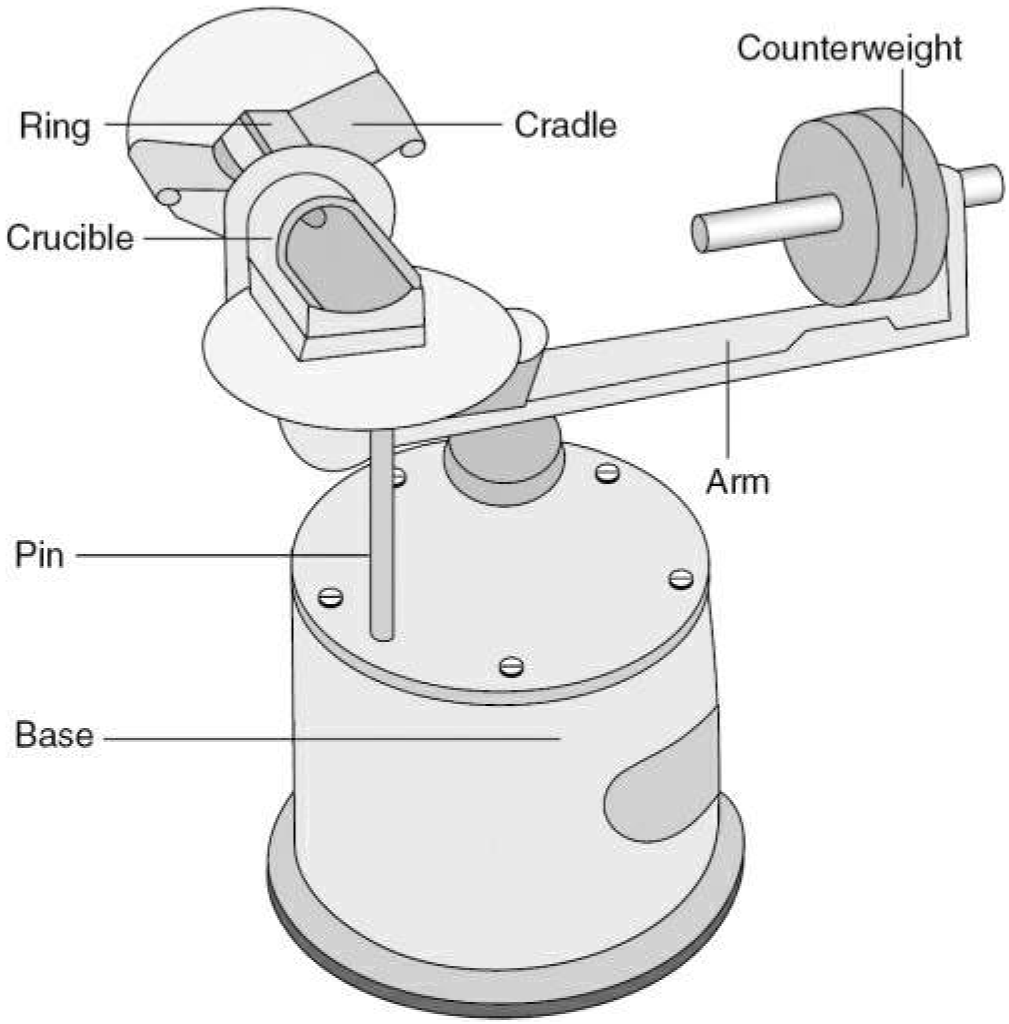


FIGURE 40.70 Parts of a centrifugal casting machine.

FIGURE 40.71 The arm of the machine is given three turns and locked with the pin.

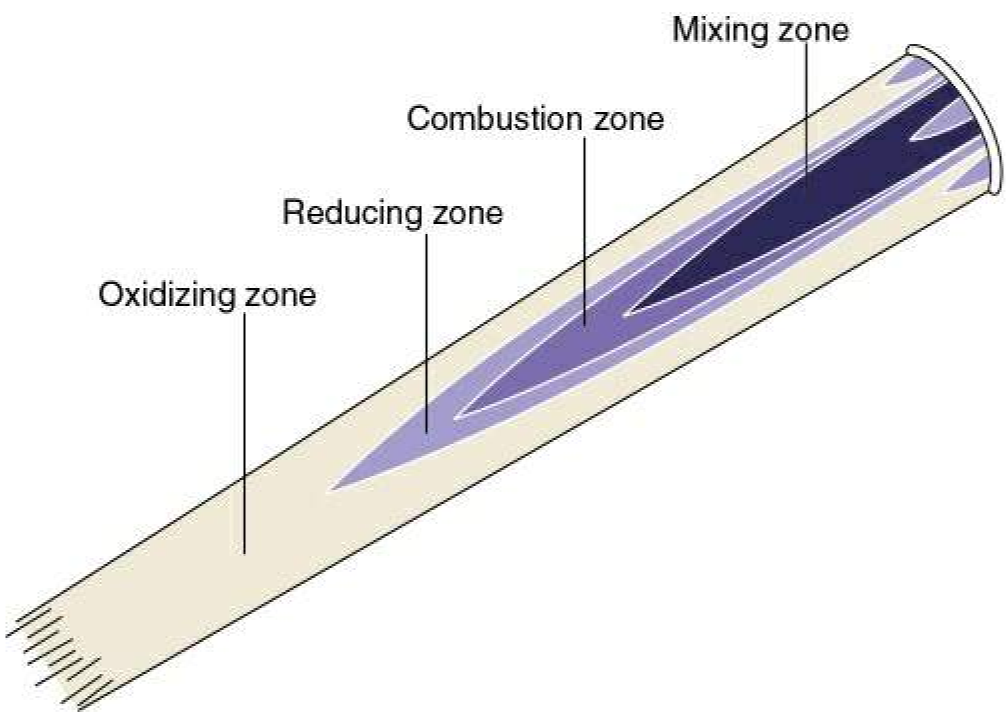


FIGURE 40.72 Parts of the flame.

FIGURE 40.73 The crucible is preheated with the flame.

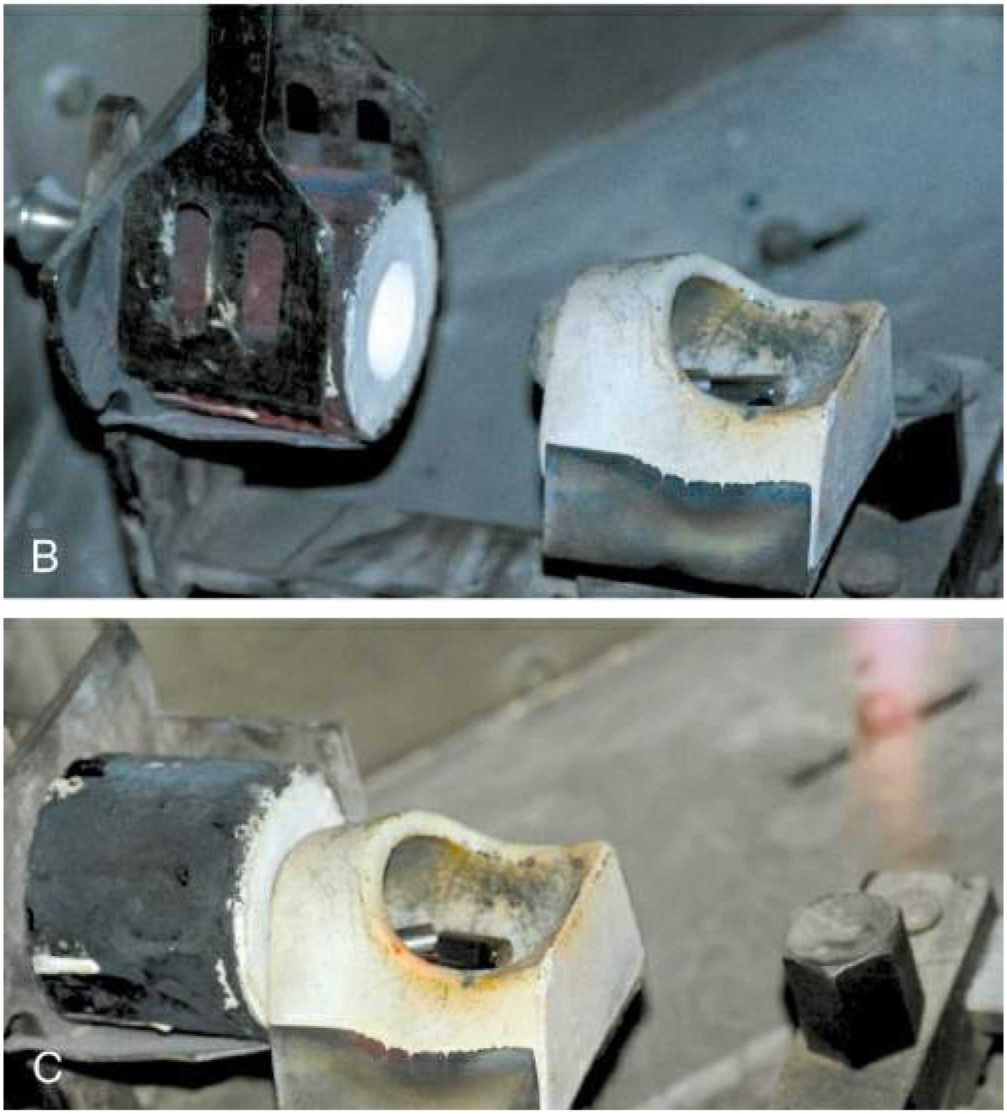


FIGURE 40.74 **(A)** The casting ring is removed from the furnace. **(B)** The casting ring is placed in the cradle of the casting machine. **(C)** The crucible containing metal pellets directed towards the mould space created by the conical crucible former.

FIGURE 40.75 The flame is kept directed at the molten metal.

FIGURE 40.76 The completed casting.

Casting recovery

- After the machine has stopped spinning, the ring is removed with tongs.
- Once the glow disappears from the casting, it is placed under cold running water.
- Gypsum-bonded investments disintegrate quickly and the residual material is removed with a brush, followed by ultrasonic cleaning and pickling with 50% hydrochloric acid.
- Phosphate-bonded investments are tougher to remove. A knife is used to trim the material around the edge of the ring to expose the liner. The mould is then pushed out of the ring and the investment is broken from the casting with a blunt instrument (Fig. 40.77). Base metal alloys cannot be pickled. Gross removal of investment is achieved with fissure bur on a slow-speed lathe and then it is sandblasted using 200–250 micron alumina (Fig. 40.78).

FIGURE 40.77 Casting recovery.

FIGURE 40.78 The investment material is removed by sandblasting.

Finishing and polishing of all metal restorations

Finishing and polishing is accomplished starting with coarse abrasives followed by abrasives of smaller particle size.

The casting is evaluated for acceptability. If there are any gross defects, it should be discarded.

The *fitting surface* of the casting is inspected for irregularities (Figs 40.79 and 40.80). These are removed with a small round bur. Coloured liquids that rub off and transfer a mark can be painted on a die to determine any obstruction in fitting surface.

FIGURE 40.79 The fitting surface is checked for irregularities.

FIGURE 40.80 Obstructions in the fitting surfaces are removed.

The *margins* are then evaluated and if they are short, casting should be discarded. Some burnishing can be attempted with noble metal alloys.

The sprue is now separated from the casting using a carborundum disc without altering the normal contour of the surface (Fig. 40.81). The normal contour is established with the same disc or with abrasive stones (Fig. 40.82).

FIGURE 40.81 The sprue is separated from the casting using a carborundum disc.

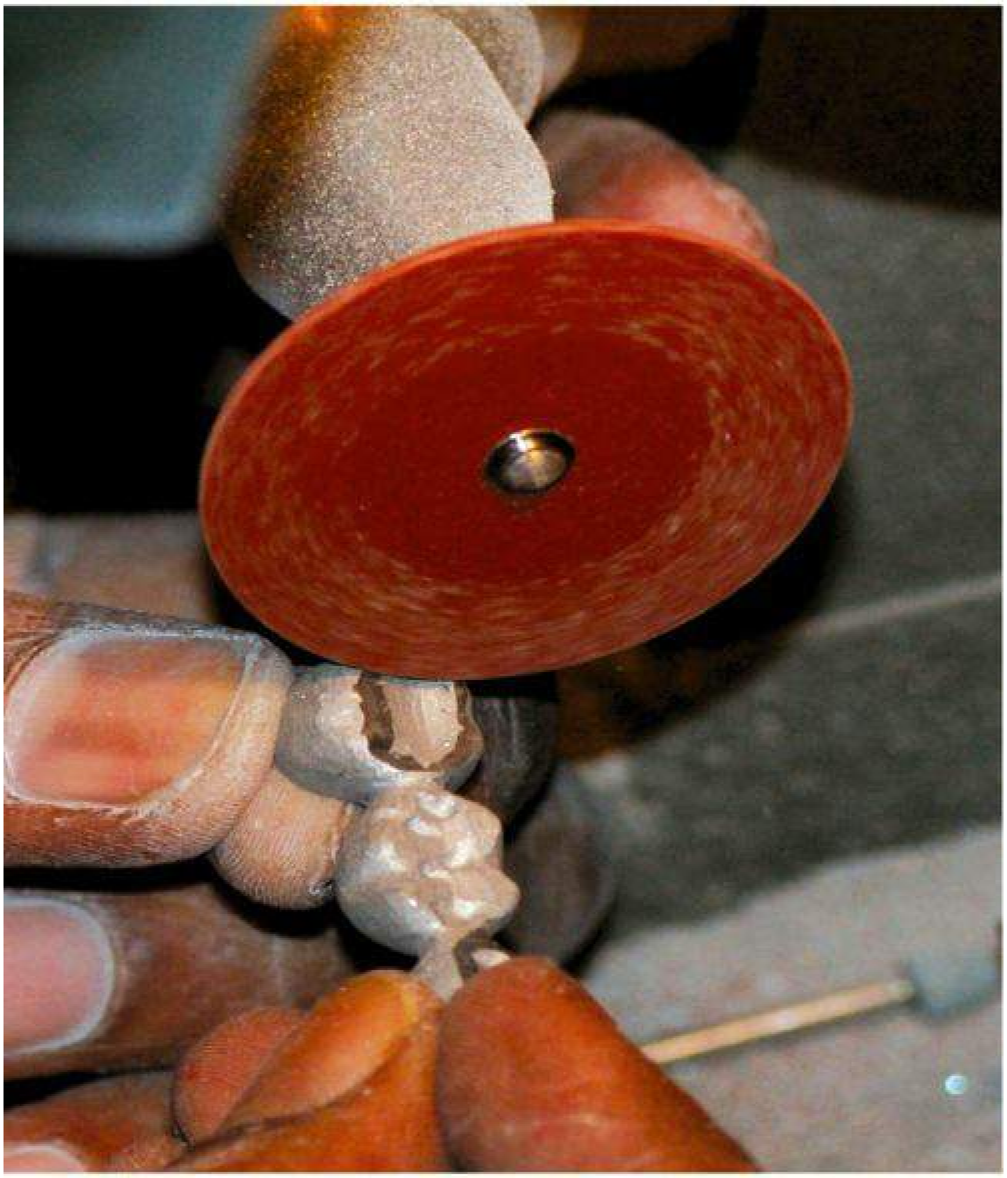


FIGURE 40.82 The normal contour is established.

The *proximal contact* is adjusted with cuttle disc or fine rubber wheel.

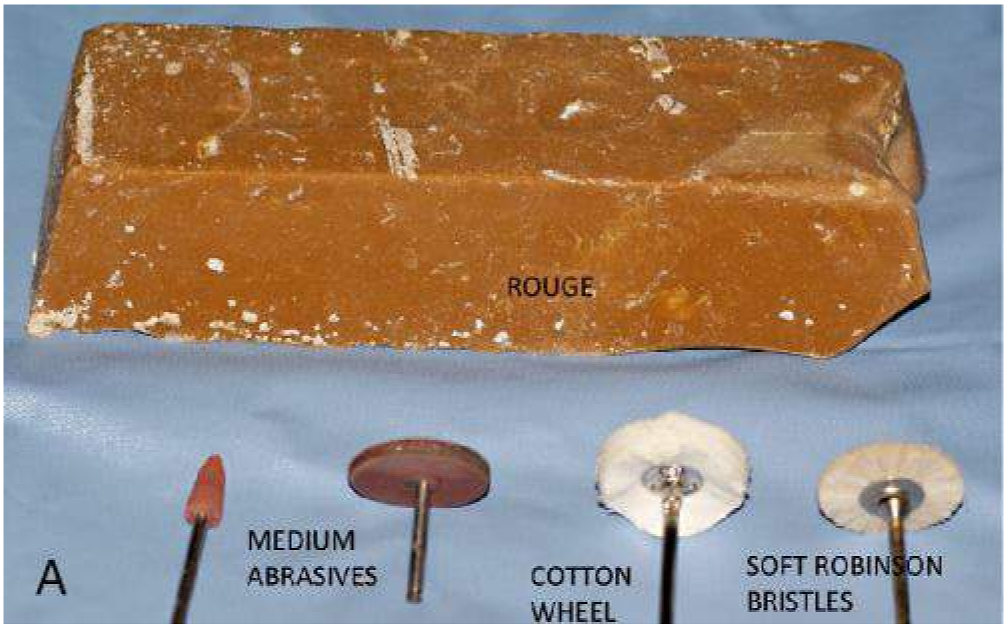
The *occlusion* is checked with two colours of articulating paper – one for centric contact and other for eccentric contact. Care should be taken to avoid eliminating the centric contact. The correction is done using medium-grit stones (Figs 40.83 and 40.84).

FIGURE 40.83 Occlusion is checked.

FIGURE 40.84 Occlusion is corrected.

Final polishing is achieved using abrasive discs, rubber points and wheels, tripoli on wheel brush and rouge on a leather chamois wheel.

For base metal alloys, the abrasives used should be coarser and harder. Rough finishing is accomplished using aluminium oxide coral wheel. Final finishing is done with rubber wheels and mounted points (Fig. 40.85A–D).




C
D

FIGURE 40.85 **(A)** Finishing and polishing kit. **(B)** Finishing of the proximal surface. **(C)** Finishing of the occlusal surface. **(D)** Final finishing. **(E)** Final polishing.

Finishing of metal for ceramic application

- The same procedure as described for metal crowns is followed till the sprue is separated.
- The metal thickness of the veneering surface is reduced using discs on a high-speed lathe to 0.2 mm for base metal alloys and 0.3 mm for gold alloys. A metal caliper is used to check the thickness as the surface is reduced using abrasive stones and carbide burs (Fig. 40.86).
- Instruments used for grinding conventional alloys should not be used with metal-ceramic alloys to prevent contamination.
- Veneering surface should have a rounded form and surface should be smooth and should have a distinct margin for the ceramic joint (Fig. 40.87). The nonveneered surface should be finished as described for metal crowns.

• Gold alloys are then cleaned with 52% hydrofluoric acid and ultrasonics for 20 min. The veneering surface of base metal alloys is sandblasted with 50 μm alumina followed by ultrasonic cleaning for 20 min (Figs 40.88 and 40.89).

FIGURE 40.86 The metal caliper is used to check the thickness.

FIGURE 40.87 Veneering surface should have a rounded form and surface should be smooth.

FIGURE 40.88 The veneering surface is sandblasted.

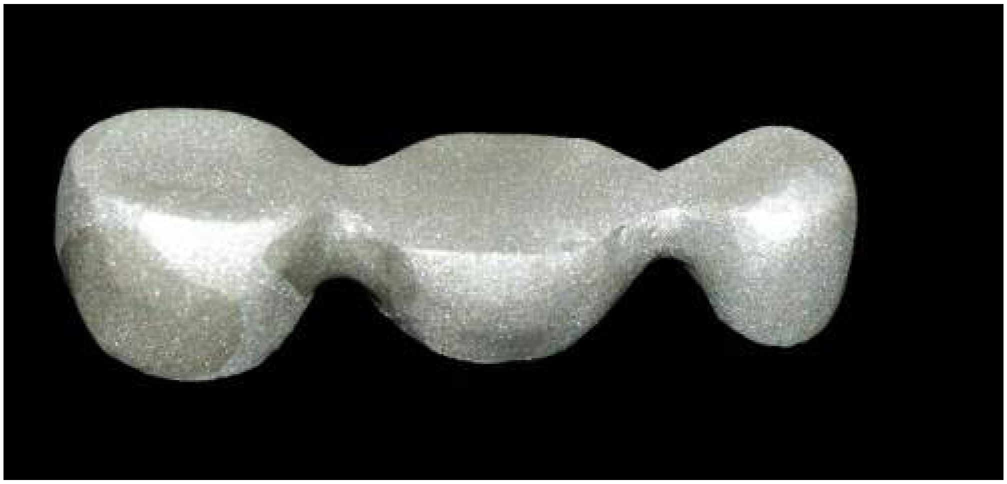


FIGURE 40.89 The sandblasted metal surface.

Veneering

The metal surface can be veneered with ceramic or resin for aesthetics.

Ceramic veneering

This is the most popular and commonly used veneering material.

Advantages

- Excellent aesthetics.
- Good wear resistance and colour stability.
- Chemical bonding to metal through oxide formation.

Disadvantages

- Wear of opposing tooth.
- Difficult to repair.
- Expensive.

Procedure

After the metal is finished for the ceramic application, gold alloys are oxidized to produce a controlled oxide layer for bonding with ceramics. The metal substructure is placed in a porcelain furnace and heated according to the manufacturer's instruction for the specific alloy. Porcelain application begins after the coping is removed from the furnace and cooled. Base metal alloys do not require any oxidation procedure and porcelain application begins immediately following the metal finishing.

The appropriate shade of the porcelain powders is selected.

Opaque porcelain powder is mixed with the modelling liquid and the paste is applied on the metal substructure in a thin layer first (Fig. 40.90). After firing in the ceramic furnace, a second thicker layer is added with a brush with light vibration, which will completely mask the metal (Fig. 40.91). This is again fired according to the manufacturers' instruction applicable for that particular ceramic powder. Some manufacturers also supply the opaque porcelain as a paste.

FIGURE 40.90 Thin layer of opaque porcelain is first applied.

FIGURE 40.91 A thicker layer of opaque is applied second to cover all the metal completely.

The dentine and enamel powders are then mixed with modelling liquid and the tooth contour is built up with specific brushes (Fig. 40.92A and B).

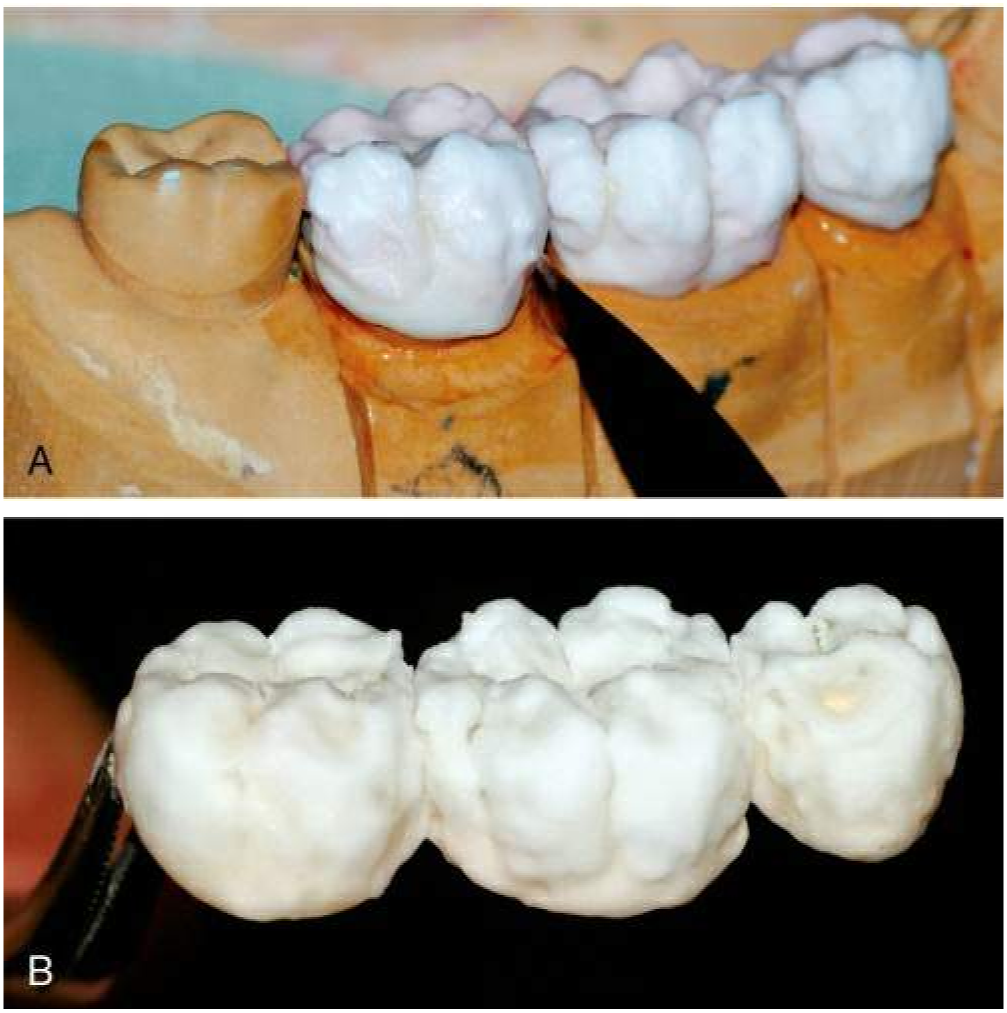


FIGURE 40.92 A, B Dentine and enamel powders are mixed and built to the required tooth contour.

A second application and firing of the dentine and enamel portions may be necessary to complete the contour of the restoration (Figs 40.93–40.95).

FIGURE 40.93 After first firing of dentine and enamel.

FIGURE 40.94 A second build-up is done in the required areas, occlusion is checked and fired.

FIGURE 40.95 Complete contour achieved after the second firing.

A porcelain release agent is applied to the die while adding porcelain under pontics and cervical areas.

Finally the restoration is glazed to produce a glass-like surface and characterizations like stains are added as required (Figs 40.96 and 40.97).

FIGURE 40.96 **(A)** The surface is stained to produce necessary characterizations **(B)** after glazing.

FIGURE 40.97 Completed ceramic veneering.

Resin veneering

Acrylic and composite resins are used.

Advantages

- Low cost.

- Ease of manipulation.

Disadvantages

- Poor wear resistance.
- Colour instability.
- Mechanical retention to metal.

Procedure

Only the labial surface will be covered by resin. Proximal contact and occlusal/lingual surfaces are in metal. Incisal edge should not be covered by resin as shown in the cutback.

Mechanical undercuts must be provided on the metal surface for retention of resin. This is achieved by incorporating 27 or 28 gauge wire loops or retention beads in the wax pattern. The junction or margin of metal with resin should also be undercut.

After casting and finishing of metal as described previously, the labial surface of metal that is to be veneered, is built up to the appropriate contour with wax. This is flasked and dewaxed as for any acrylic resin. After dewaxing, an opaque resin is painted on the labial metal surface to mask the metal and heat-cure tooth colour acrylic resin of appropriate shade is mixed and packed on the surface. The flask is then closed and the resin is cured under heat and pressure as recommended. The resin is finished and polished with acrylic trimmers and polishing agents.

Heat and/or light activated lab composites can also be used.

Soldering

Fixed partial dentures can be fabricated as single piece casting or pontics and retainers can be joined after casting them individually through the process of soldering. Thus, the connector of the fixed partial denture can be fabricated using either method.

Although the single piece casting is the more popular and commonly used method for fabricating fixed partial dentures, it may be preferable to make large castings in two to three pieces and join them by soldering. The marginal adaptation is better with this technique.

Definition: Soldering is the act of uniting two pieces of metal/alloy by a filler metal whose fusion temperature is lower than the metals/alloys being soldered.

The filler metal is called *solder*.

Apart from fabricating connectors in fixed partial dentures, soldering can also be used to:

1. Add proximal contact.

2. Repair casting voids.

3. Repair single piece fixed partial dentures with poor seating.

Requirements of a solder

1. Lower fusion temperature than the alloys being soldered at least 55°C lower

2. Corrosion resistant

3. Strong

4. Nonpitting

5. Free flowing

6. Similar colour as metals being soldered

Soldering materials

The following materials are necessary for soldering.

Solder

A solder constitutes the following:

1. Gold-based solders

Mainly composed of Au–Ag–Cu to which zinc, tin and indium have been added to control melting temperature and flow. They are designated by their fineness – pure gold is 1000 fine. Conventional crown and bridge gold alloys are soldered by 600 fine solders. Metal-ceramic gold alloys will use much lower fineness.

2. *Silver-based solders*

Composed mainly of Ag–Cu–Zn to which small amounts of tin have been added. They can be used for base metal alloys.

Higher fusing solders for high-fusing alloys are specially formulated for a particular alloy composition by the manufacturer.

Flux

Definition: Any substance applied to surfaces to be joined by brazing, soldering or welding to clean and free them from oxides and promote union (GPT8).

Flux means flow. It acts as a surface protector, reduces or dissolves oxides.

For noble metals, the flux used is composed of borax glass (55%), boric acid (35%) and silica (10%). The composition of flux for base metal alloys is fluoride based but the ingredients are not published.

In general, soldering of base metal alloys is unpredictable.

Fluxes are available in powder, liquid or paste form. They can also be made into a paste by mixing with petrolatum. The petrolatum prevents oxidation and then carbonizes and vapourizes.

Antiflux

Definition: Antifluxes are materials that prevent or confine solder attachment or flow (GPT8).

They prevent flow of excess solder into undesirable areas. Graphite (pencil) is used as antiflux, but it evaporates at high temperatures. Iron oxide (rouge) in chloroform or turpentine can also be used.

Soldering investment

It is similar to casting investments but contain fused quartz to reduce the thermal expansion.

Heat source

The following heat sources can be used:

1. Torch

A gas–air or gas–oxygen flame torch as described for casting is most commonly used for soldering. As for casting, the reducing part of the flame should be used to prevent oxidation.

2. *Oven soldering*

This is performed in a furnace under vacuum or air. The soldering index along with the castings and the solder is heated in a furnace up to the melting temperature of the solder. Although a strong joint is obtained, the melting of solder cannot be observed and the longer the solder is molten, it can dissolve the parent metal producing a weak joint.

3. Laser welding

This has demonstrated joints with high strength and reduced corrosion compared to conventional torch soldering. Fatigue failure has been a problem. It may be more suitable to solder titanium.

Soldering procedure

The soldering procedure involves the following:

1. Soldering index

2. Investing

3. Soldering

Soldering index

Definition: A mould used to record the relative position of multiple cast restorations prior to investing for a soldering procedure (GPT8).

The position of the retainers and pontic is recorded so that the connector can be made accurately.

The index can be made intraorally or it can be made on the working cast. Accurate assembling of components and soldering can be done with both methods. But if there is any change in position of abutments following impression making, then the prosthesis made by the working cast method will not fit.

Intraoral index

- The component parts – retainers and pontics are verified for fit and occlusion and necessary corrections are made.

- The retainers can be fixed to the abutments with light body impression material or zinc oxide eugenol cement so that their position is not disturbed while making the index. The pontic can be attached to the retainer with sticky wax. The connector space where the soldering is to be performed should be 0.2 mm.

- A tray is fabricated with baseplate wax to carry the indexing material. Sectional stock trays can also be used. It should extend one tooth beyond each retainer. It should also extend 6 mm facially and lingually beyond the perimeter of the prosthesis components.

- Impression plaster or zinc oxide eugenol impression paste is loaded onto the tray and seated over the castings such that the occlusal surfaces are covered with minimal extension facially and lingually. Care should also be taken to ensure that the material does not flow into the tooth undercuts.
- The index is removed after the material sets and the components will come attached to the index.
- Intraoral index can also be made with green stick impression compound and pattern resin.

Working cast index

- The components are seated on the cast and attached with sticky wax. Wax is also flowed in the connector space after a gap of 0.2 mm is made between the pontic and retainers (Fig. 40.98).
- The components are blocked out with modelling clay leaving only the occlusal surface with some extension to the facial and lingual surface (Fig. 40.99).
- The components are boxed and model plaster is poured on the occlusal surface and built up to a height of 5 mm (Fig. 40.100).
- The plaster index is removed after the material sets. The components will come attached to the index.

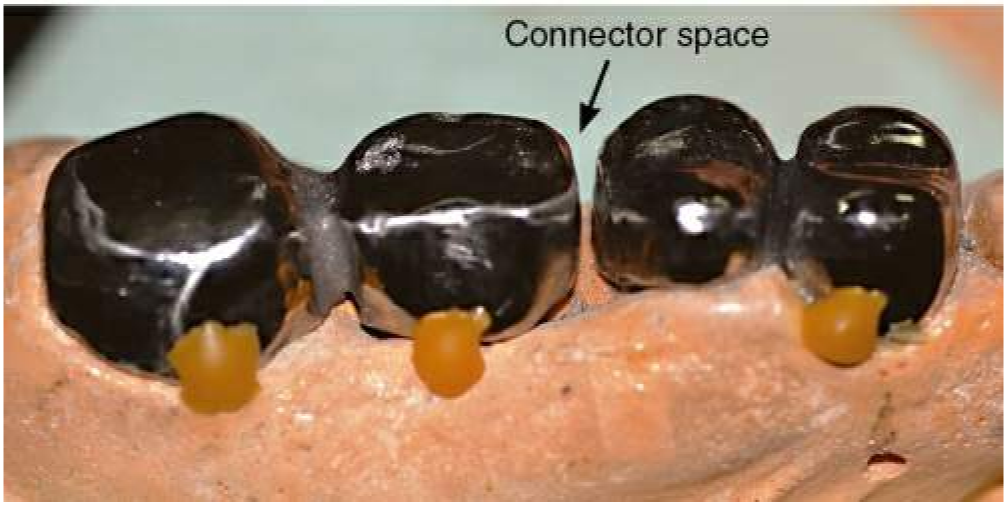


FIGURE 40.98 Components attached with sticky wax.

FIGURE 40.99 Connector space filled with wax and restoration is blocked out with modelling clay.

FIGURE 40.100 Boxed and plaster index poured.

Investing

The components are attached to the index with sticky wax. Index is trimmed such that 6 mm of plaster surrounds the castings (Fig. 40.101).

FIGURE 40.101 Components fixed with sticky wax.

Wax is flowed into the connector area to prevent investment from flowing into the gap. Wax is also added facially and lingually, in a triangular shape, to the connector joint, to produce sluiceways. This helps in directing the flame through the joint area (Fig. 40.102).

FIGURE 40.102 Sluiceway created in wax.

Separating medium is applied to the exposed plaster and the index is boxed and poured with appropriate investment. The height of the soldering index should be 12 mm above the margin of the castings (Fig. 40.103).

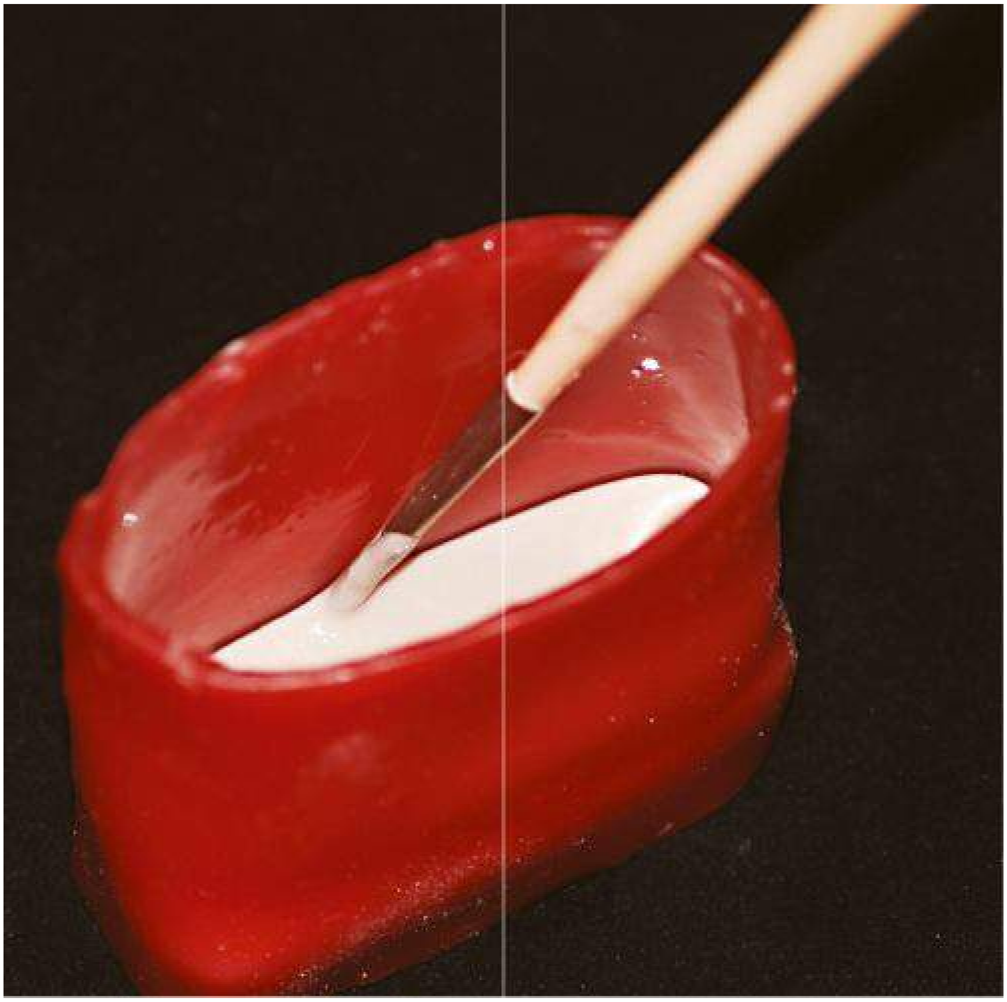


FIGURE 40.103 Index boxed and investment poured to make the soldering index of appropriate height.

After setting, the boxing wax is removed and sticky wax is flushed out with boiling water.

Soldering

All metal restoration

The following procedure is followed when soldering restorations are made up of metal only.

A graphite pencil is used to outline the soldering area to act as antiflux. Soldering flux is placed in the soldering area (Fig. 40.104).

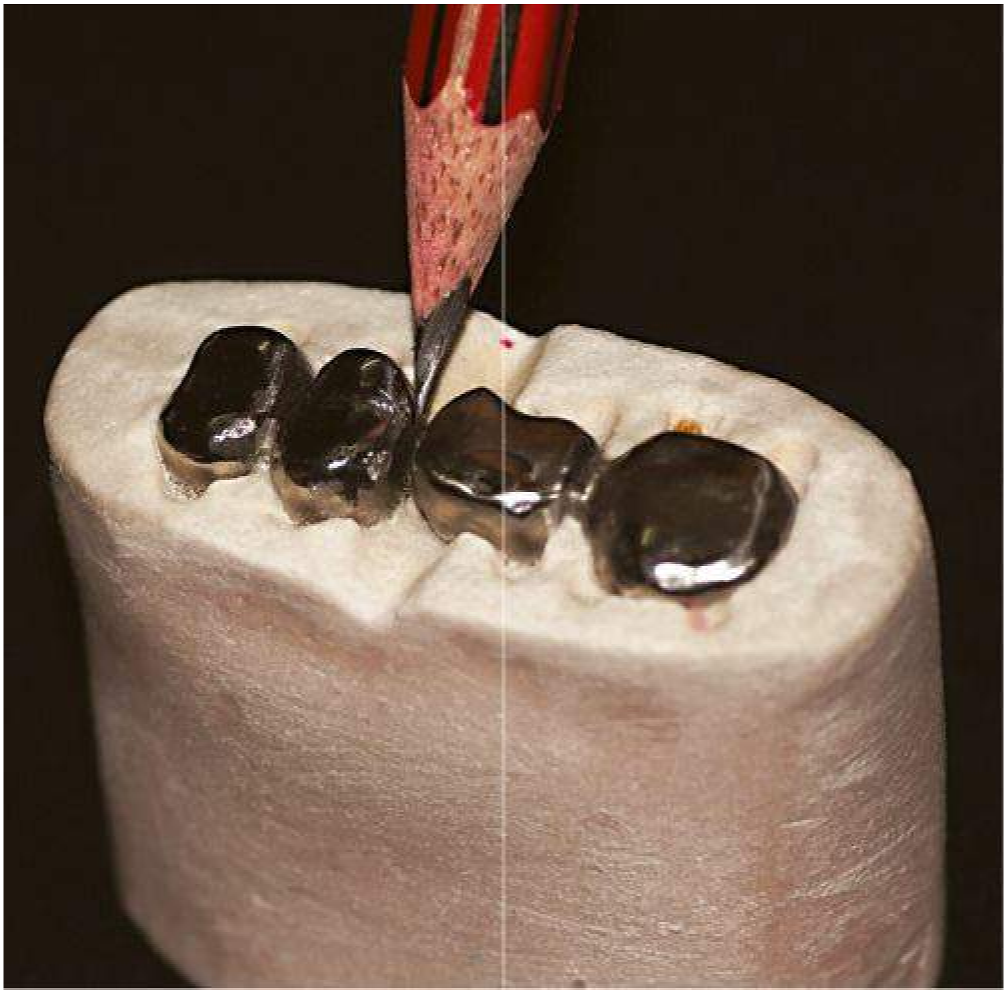


FIGURE 40.104 Area marked with graphite pencil.

The assembly is preheated in a burnout furnace to 650°C or 850°C depending on the fusion temperature of the alloy. It is removed and placed in a wire mesh stood over a Bunsen burner flame. The assembly is heated with a torch flame, first with a brush flame and then a hotter reducing flame, continuously moving the flame around the assembly.

As soon as the castings exhibit a reddish glow, the solder is dipped in flux and is placed in the lingual side of the joint area (Fig. 40.105).

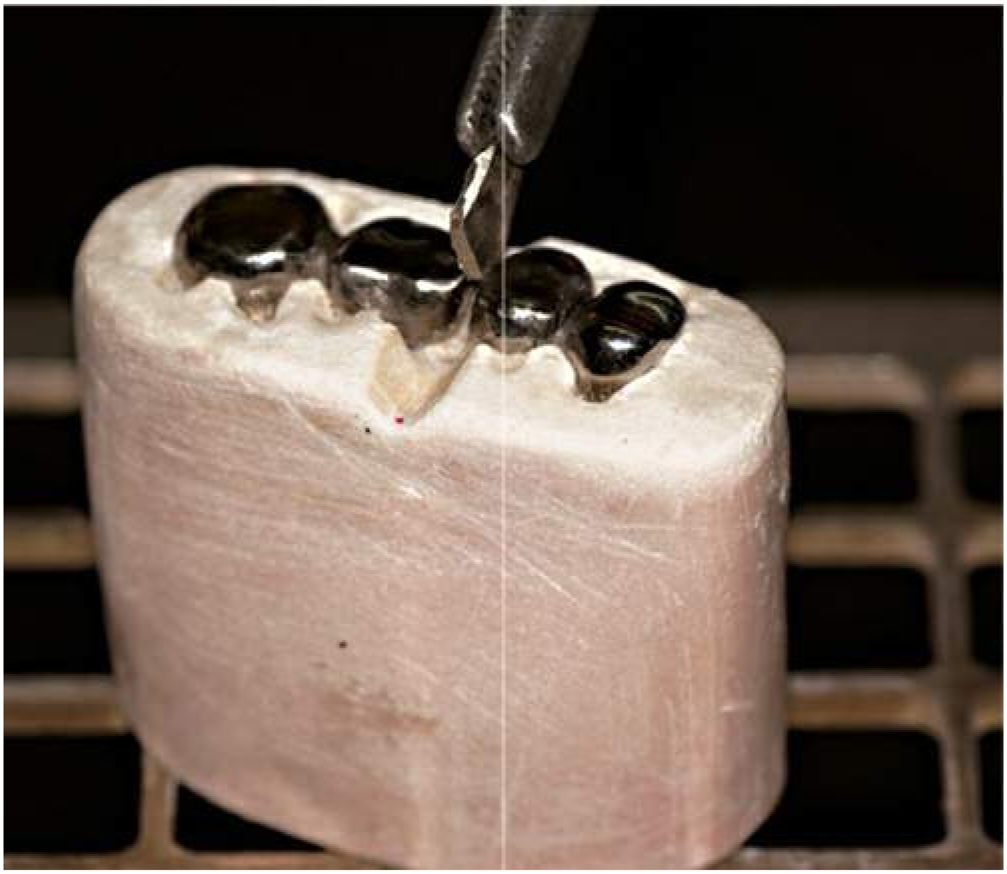


FIGURE 40.105 Solder placed on lingual side.

The flame is directed towards the buccal notch ensuring the solder will flow towards that side (Fig. 40.106). The flame should never be directed directly on solder.

FIGURE 40.106 Flame is directed towards buccal notch.

The assembly is allowed to cool for 5 min and then quenched in water, which will disintegrate the investment.

Soldering metal-ceramic fixed partial dentures

Soldering can be performed either before or after ceramic application – preceramic and postceramic soldering. The solders vary depending on the procedure and alloy used.

Preceramic soldering

Advantages

- Trial of the soldered prosthesis can be done in an unglazed state.
- Any adjustments required on porcelain can be made.

Disadvantages

- Contouring proximal embrasures is difficult.
- As porcelain has to be applied to a longer structure, sag may be a problem with some alloys.

Postceramic soldering

Advantages

- Proximal surface can be shaped properly.
- No problem of sag.

Disadvantage

- Adjustments on porcelain not possible after soldering, as it has to be finished completely before the soldering procedure.

SUMMARY

The lab procedures and the technicians play a major role in the success of a prosthodontic procedure. The lab procedure starts from pouring the models till finishing the restoration. All precautions should be taken to make sure that the procedures are done according to the prescribed methods, because any mistake in the first step will only have a snowball effect with a poor restoration at the end. This chapter has dealt with casting, ceramic veneering, soldering, etc. However, all clinicians are not good technicians and it is good to know all the procedures involved in fabrication of a ceramic restoration.

CHAPTER 41

Try-in and cementation

CHAPTER CONTENTS

Summary 636

Introduction

This is the first clinical procedure after the completion of the laboratory procedures involved in fabrication of the fixed partial denture. This comprises of the following procedures:

1. Evaluation of prosthesis on cast

2. Try-in in the mouth

3. Cementation

The restoration is first checked intraorally for its clinical acceptability and correctness. Cementation is then performed by a dental luting agent which provides the link between a fixed prosthesis and the prepared tooth structure. There are several types of available luting agents, each possessing unique properties and handling characteristics. A single product is not ideal for every type of restoration and hence the choice of cement is mandated to a large degree by the functional and biological demands of the particular clinical situation.

Evaluation of prosthesis on cast

Upon receiving the prosthesis from the laboratory, it is placed on the master cast and the following are evaluated:

Tissue surface of retainers

The fitting surface or tissue surface of the retainer is checked for any irregularity like blebs and nodules. These are removed if present.

The surface is also checked for any white spots (Fig. 41.1). This is usually a perforation in the metal coping of a metal-ceramic restoration. The perforation is seen clearly when viewed under a light source (Fig. 41.2). If this is present, the prosthesis is sent back to the lab to be remade as the ceramic over the perforation is unsupported and will fracture over a period of time if cemented in the mouth.

FIGURE 41.1 White spot on tissue surface.

FIGURE 41.2 Perforation seen when viewed under a light source.

Proximal contact

The proximal contact of the retainer with the adjacent natural teeth is checked with dental floss (Fig. 41.3).

FIGURE 41.3 The proximal contact of the retainer with the adjacent natural teeth is checked with dental floss.

If the floss moves freely or if there is a space between the retainer and natural teeth, the contact needs to be added. In case of metal restorations, the contact can be added only by soldering or the restoration may need to be refabricated. It is easier to add contact in metal-ceramic restorations as ceramic can be fired to develop the same.

If the contact is too tight on cast, the same is again evaluated in the mouth before any correction.

Margins

The retainers are placed on the sectioned dies and margins are evaluated for over and underextension (Fig. 41.4).

FIGURE 41.4 Marginal fit checked on cast.

Stability

The prosthesis should not rock or rotate when force is applied. This will cause the restoration to fail. If the cause is a nodule on the fitting surface, then it is removed. Otherwise the stability is reviewed during try-in in the patient's mouth and if the same persists, the prosthesis is refabricated.

Occlusion

Occlusion on cast is verified with articulating paper. Contact in maximum intercuspation (MIP) or centric contacts is verified (Fig. 41.5A and B) and corrected, eccentric contacts are corrected during try-in.

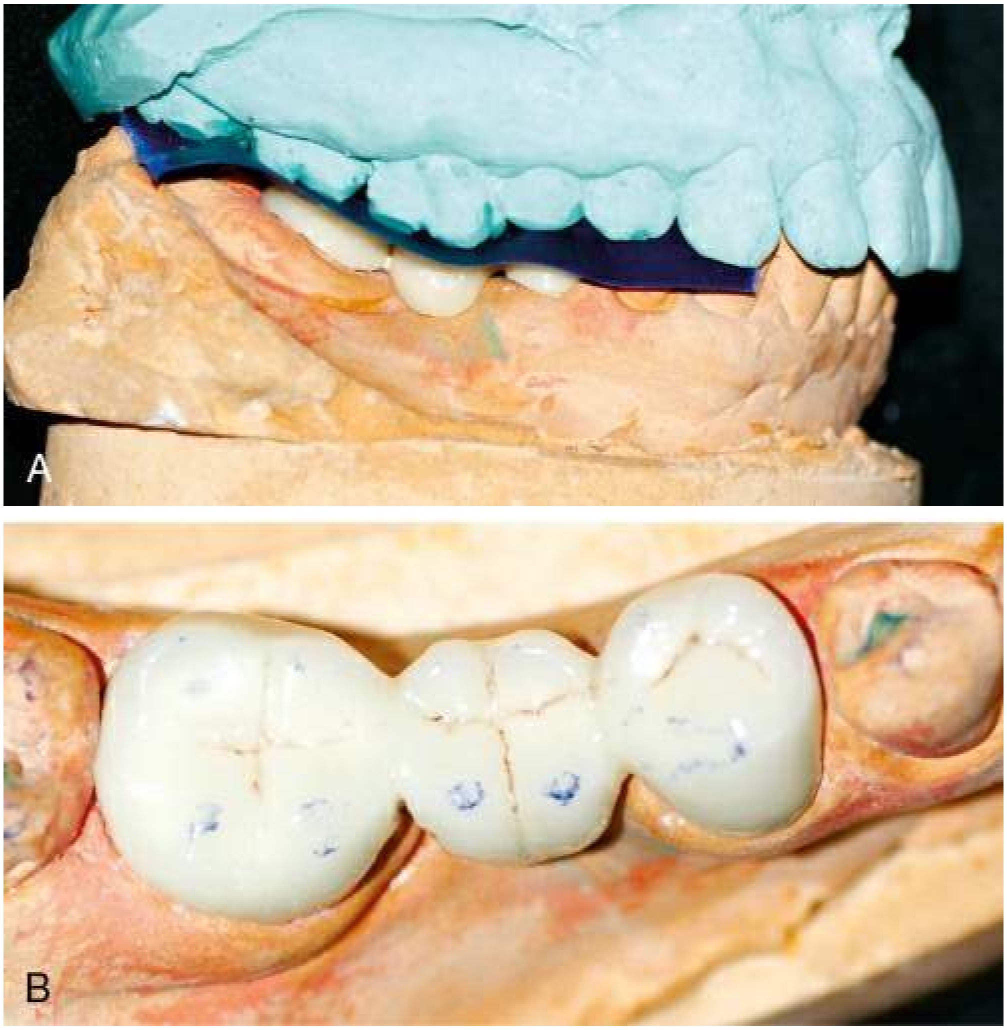


FIGURE 41.5 Contacts are verified on casts in MIP.

Try-in

- During try-in the restoration is checked intraorally.
- The provisional restoration is removed and preparation is cleaned of all temporary cement.
- Try-in can be performed without local anaesthesia as the patient's unimpaired tactile sense provides valuable information while checking contacts and occlusion. Local anaesthetic is administered only if the teeth are sensitive and patient is uncomfortable during the adjustment procedure.
- During try-in, the following are evaluated in a sequence:

1. Seating the crown and checking fit
2. Proximal contact
3. Marginal integrity
4. Occlusion
5. Contours and aesthetics
6. Finishing and polishing

Seating the crown and checking fit

First the crown is placed on the abutment and seating is attempted. If complete seating is prevented, it is due to the following reasons:

1. Tight proximal contact

2. Binding on abutment surface

3. Blebs on fitting surface

4. Distorted impression or die

The first two can be checked and corrected. The same is discussed below.

Blebs are corrected while evaluating the restoration on the cast as discussed previously.

If the prosthesis does not seat properly following these corrections, then the problem could be a distorted impression or a damaged die. In either case a new impression is made and prosthesis is refabricated.

Correction of tight contact

A thin articulating paper/shim stock should be placed between the casting and the adjacent natural tooth and the restoration is seated (Fig. 41.6). This helps in identifying the exact area where the contact on the restoration needs to be corrected. Arbitrarily trimming a tight contact to seat a restoration may open up the contact. Alternately the proximal surface of the retainer can be painted with colour aerosol spray or marker pen, and the area where the marking is removed is corrected. After the correction to seat the restoration, the proximal surface is polished.

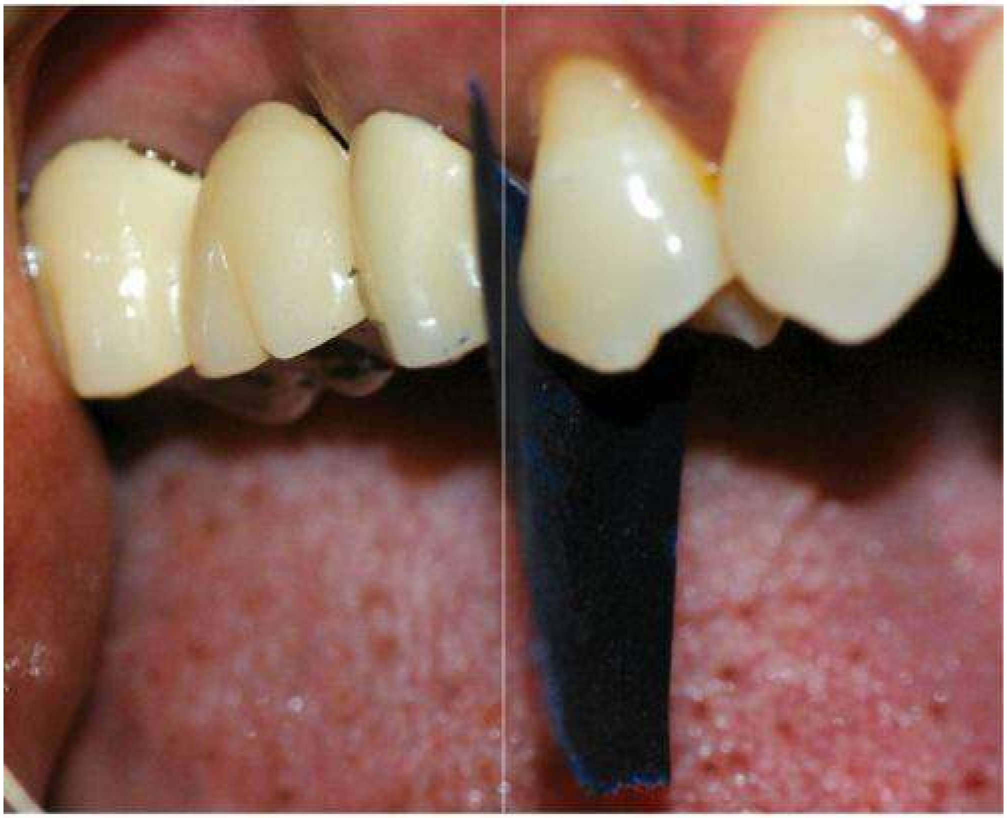


FIGURE 41.6 Correction of tight contact using articulating paper.

Correction of binding

Any binding area preventing seating of restoration is relieved by grinding after identification. This is accomplished using disclosing waxes, colour aerosol sprays or elastomeric pastes. Elastomeric pastes such as Fit Checker™ are similar to light body silicone impression materials with viscosity comparable to luting cements. The paste is loaded in the fitting surface of the retainer and seated on the abutment. The crown is removed after the material sets and inspected. Areas where the paste is eliminated reveal binding and are trimmed. The paste can be easily peeled off (Figs 41.7–41.9).

FIGURE 41.7 **(A)** Fit Checker™ commercially available pressure indicating paste (courtesy GC). **(B)** The paste is loaded in the fitting surface of the retainer.

FIGURE 41.8 The retainer is seated onto the abutment.

FIGURE 41.9 The crown is removed after the material sets and is inspected.

Proximal contacts

- The proximal contacts are checked with a floss or Mylar strip. The contact is compared to that of the other teeth. A proper contact allows the floss to snap through with resistance, without tearing.

- Tight contacts may interfere with correct seating as previously described, produce discomfort, cause pressure on adjacent teeth and make it difficult for the patient to floss. They are checked as described previously for correcting a tight contact.

If the contact is open allowing easy movement of floss without resistance, then it causes food impaction which can lead to secondary caries, caries on adjacent teeth and interproximal gingivitis with bone loss. The contact can be added as follows:

- In case of metal restorations, contact is added by soldering or the prosthesis is refabricated.

- In metal-ceramic restorations, the contact can be easily added by refiring porcelain.

- Rarely, if time is a constraint, then contact may be built up on adjacent natural teeth with composite resin.

Marginal integrity

The margin of the restoration is evaluated using a sharp explorer probe. The tip of the probe is held perpendicular to the marginal area and is moved occlusocervically across the margin. This is performed around the entire tooth circumference giving finger pressure to seat the crown. A marginal discrepancy of about 50 microns only is acceptable.

Overextended margins in depth (overhangs) and width (positive ledges) (Fig. 41.10) can be corrected by trimming and finishing. If not corrected, they cause gingival and periodontal problems.

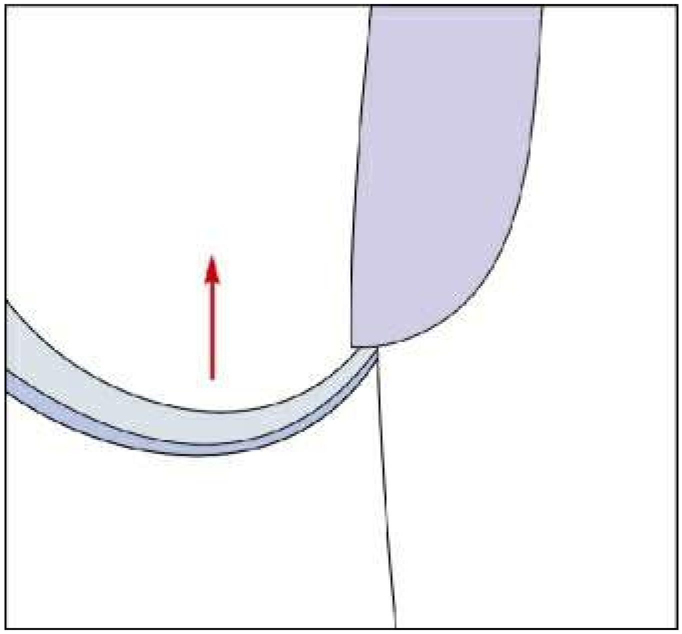


FIGURE 41.10 Overextended margin.

Underextended margin in width (negative ledges) and underextended margins in depth (open margins) run the risk of recurrent secondary caries and the restoration must be refabricated (Figs 41.11 and 41.12).

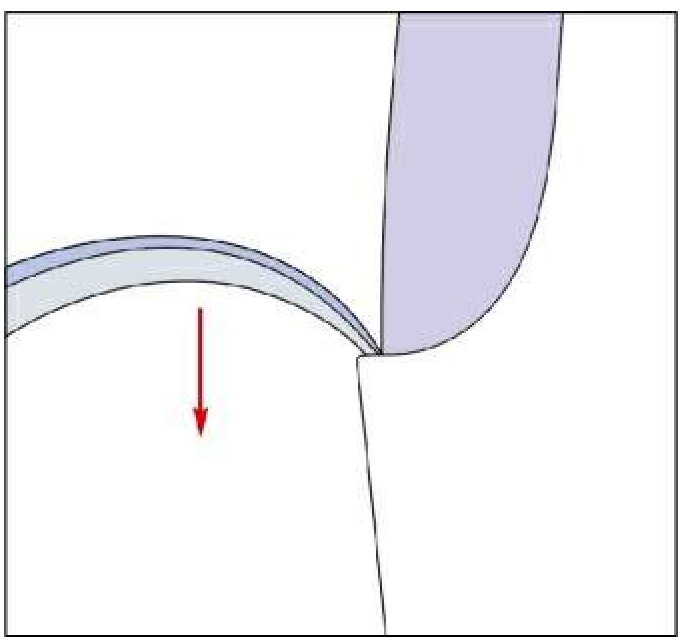


FIGURE 41.11 Underextension in width.

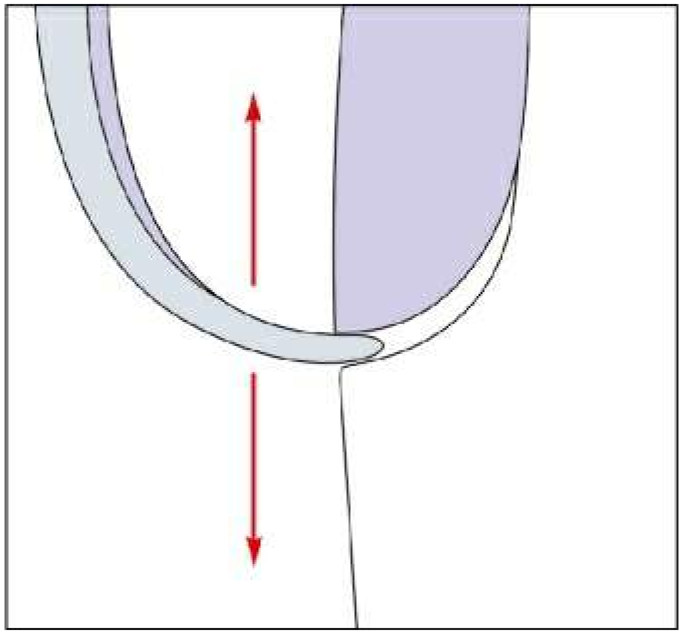


FIGURE 41.12 Open margins – underextension in height.

Marginal fit can also be evaluated with an elastomeric paste as described previously for binding. Supragingival margins can be evaluated easily and finished intraorally with fine grit stones and rubbers. It may be difficult to detect discrepancies with subgingival margins.

Occlusion

Occlusal adjustments are performed after the fit and seating of the restoration are satisfactory. Occlusal contacts are established in static and dynamic relationships to the opposing arch.

A pair of teeth near the prepared tooth is located and the patient is asked to close onto a strip of 12 microns shim stock in maximum intercuspation without the restoration. The restoration is then inserted and the process is repeated. If the patient is not able to hold the strip then the restoration is high in intercuspal position.

A 12 microns articulating paper is now held with artery forceps or Miller's forceps; and the patient is asked to close in MIP (Fig. 41.13).

Contact areas with heavy contact are identified and the marks are removed with carbides in case of metal restorations and diamonds for ceramic restorations (Fig. 41.14).

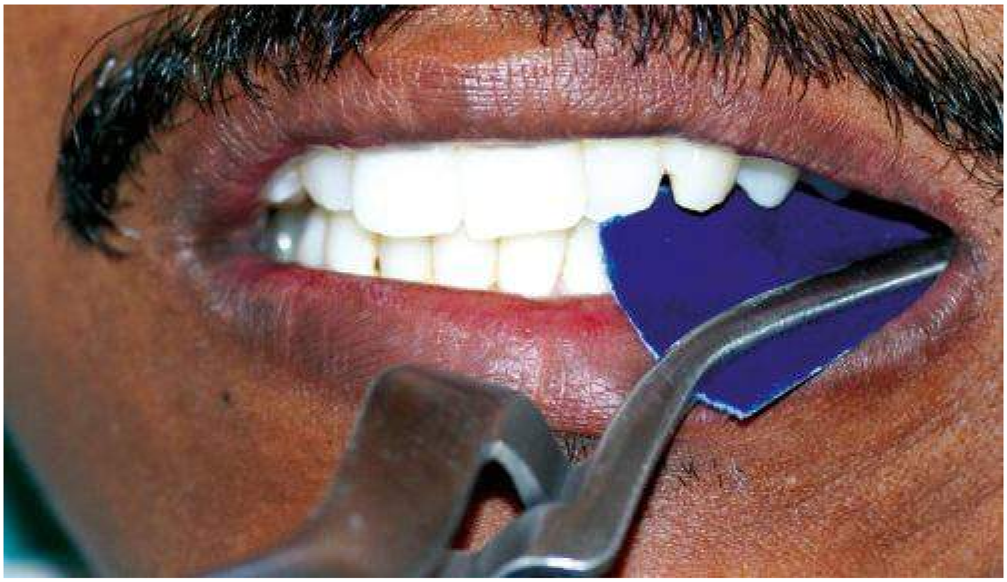


FIGURE 41.13 Articulating paper placed in maximum intercuspation with the restoration in position.

FIGURE 41.14 The marks on restoration showing high contacts.

The procedure is repeated until shim stock or Mylar strip can be held between adjacent pair of unprepared teeth. The thickness of the occlusal surface restoration should be constantly checked with a metal caliper to ensure that the surface is not perforated by grinding.

Following the correction in MIP, eccentric interferences are also removed. A different colour paper is used for this purpose (Fig. 41.15) so that the MIP contacts are not eliminated (Figs 41.16A and B).

FIGURE 41.15 Different colour papers used to check eccentric interferences.

FIGURE 41.16 A, B Marks showing the MIP contacts (blue) and eccentric interferences (red).

Contours and aesthetics

Health of the gingival tissues adjacent to the restoration depends on the contours of the restoration (Fig. 41.17) and the same is true with posterior and anterior restorations.

FIGURE 41.17 Gingival embrasures showing proper

contours.

Overcontouring also affects aesthetics of anterior teeth with ceramic restorations. Only minor correction is possible clinically if inadequate tooth preparation is the cause. Undercontouring affects the colour of metal-ceramic restoration as it will look opaque.

The gingival embrasures of anterior restorations are also checked for contour and dark spaces (Figs 41.18 and 41.19).

FIGURE 41.18 Gingival embrasures showing improper contouring.

FIGURE 41.19 Embrasures showing dark spaces.

The shade is checked and minor corrections are possible by staining if restoration is lighter in shade.

The incisal edge is verified for translucency (Fig. 41.20A). Characterizations like enamel cracks, stain lines and incisal halo may be incorporated (Fig. 41.20B).

FIGURE 41.20 A,B Showing incisal edge translucency and gingival stain lines.

Finishing and polishing

The final step before cementation is finishing and polishing. Rough surfaces tend to accumulate plaque more and with porcelains they will rapidly wear the opposing natural tooth.

It is very important to use a sequence of abrasives designed for each material to achieve a smooth surface.

Metal surfaces can be finished with finishing burs (Fig. 41.21A and B) followed by rubber abrasive points.

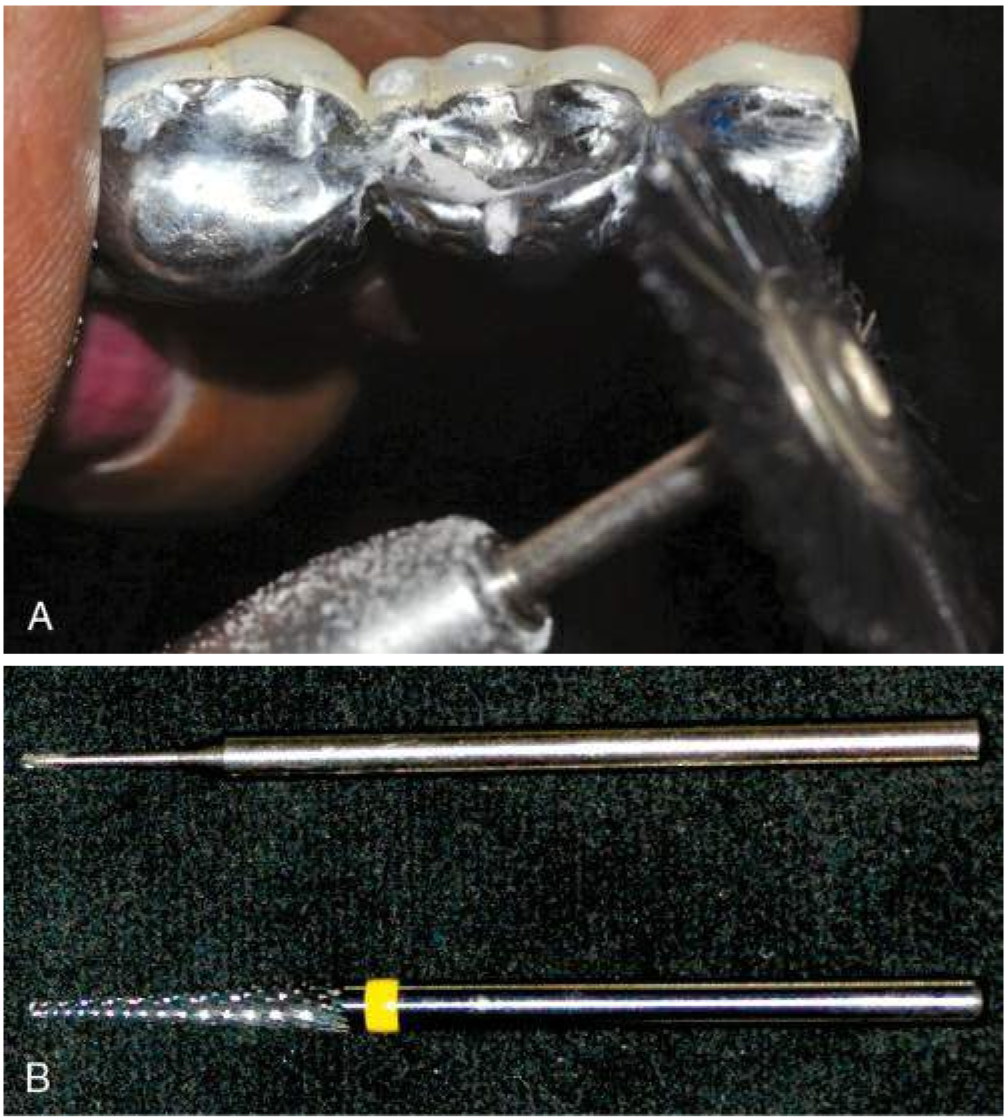


FIGURE 41.21 A,B Metal finishing burs.

Porcelain finishing is achieved with diamond abrasive points and ceramic finishing stones (Figs 41.22 and 41.23) followed by a felt wheel or rubber cup coated with diamond polishing paste. The best method to finish porcelain is to reglaze it in the furnace.

FIGURE 41.22 Ceramic trimmers.

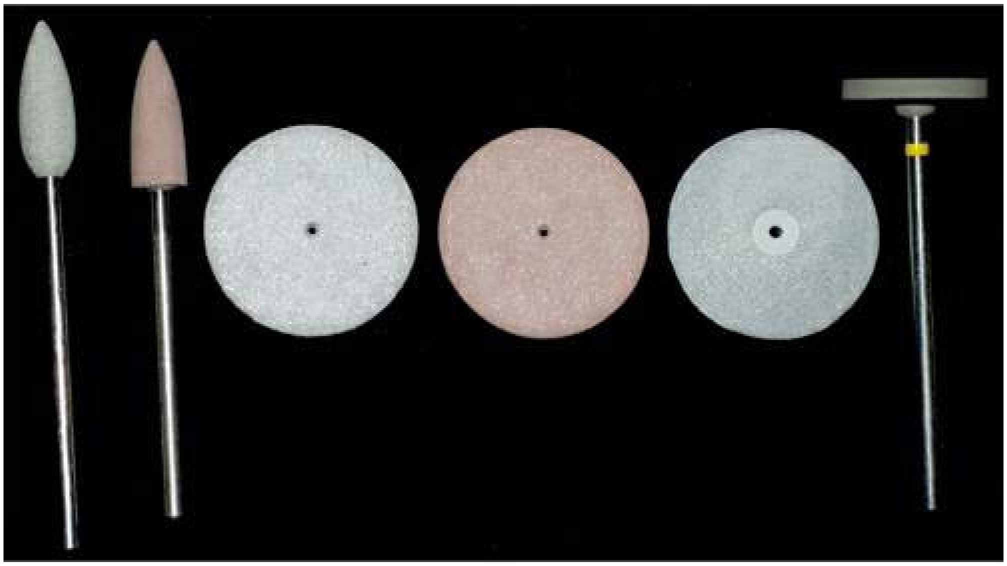


FIGURE 41.23 Ceramic finishing silicone points.

Cementation

Definition: The process of attaching parts by means of cement (GPT8).

The clinical success of these luting agents depends on the cementation procedure and clinical handling of these materials. The word 'luting' is often used to describe the use of a mouldable substance to seal a space or to cement two components together.

Mechanisms of cementation

1. **Nonadhesive luting:** It holds the restoration in place by engaging small irregularities in the intaglio surface of tooth and restoration measuring 20–100 microns. This is applicable to all cements – zinc phosphate possesses only this mechanism.

2. **Micromechanical bonding:** It holds the restoration in place by engaging finer surface irregularities less than 2 microns created on the intaglio surface of the tooth and restoration. These are produced on enamel by etching with phosphoric acid, on ceramics by etching with hydrofluoric acid and on metal surfaces by electrolytic etching, chemical etching or sandblasting. It is usually in combination with a dentine bonding agent with formation of hybrid layer – resin cements.

3. **Chemical (molecular) bonding:** Adhesion produced by bipolar, van der Waals forces and chemical bonds – glass ionomers, zinc polycarboxylates and resin modified glass ionomers.

Cements used for luting

Ideal requirements

- Provide a durable bond between dissimilar materials.

- Possess favourable compressive and tensile strengths.
- Have sufficient fracture toughness to prevent dislodgement.
- Be able to wet the tooth and the restoration.
- Exhibit adequate film thickness and viscosity to ensure complete sealing.
- Should be resistant to disintegration in the oral cavity.
- Be tissue compatible.
- Demonstrate adequate working and setting times.

Classification

1. **Provisional (soft) cements:** Used for cementing provisional restorations.

2. **Definitive (hard) cements:** Used for cementing definitive permanent restorations.

The currently available cements for definitive cementation of fixed prosthesis are the following:

1. Zinc phosphate cement

Indications

Permanent luting of posts, metal inlays, onlays, crowns and short-span fixed partial dentures.

Advantages

- Long track record (used since 1878).
- Good compressive strength.

- Good film thickness (25 microns).
- Reasonable working time.
- Resistant to water dissolution.

Disadvantages

- Low tensile strength.
- No chemical bonding.
- Not resistant to acid dissolution.
- Adverse effect on pulp as it is initially acidic, only if preparation is close to pulp.

Composition and chemistry

It is supplied as powder and liquid. Powder is principally zinc oxide and liquid is phosphoric acid and water. Metallic salts are added to increase the working time. When the powder is mixed with liquid, solid zinc phosphate is formed with considerable evolution of heat.

Manipulation

A cool mixing slab should be employed. The cool slab prolongs the working and setting times. This can be achieved by keeping slab in refrigerator. The liquid should not be dispensed until the mixing is to be initiated to prevent loss of water. Mixing is initiated by incorporation of small portions of powder into the liquid over a wide area to minimize the heat and effectively dissipate it. Setting time is 5–9 min.

2. Zinc polycarboxylate cement

Indications

Used for the cementation of single-unit crowns and short-span bridges in low-stress areas on vital and sensitive teeth.

Advantages

- Reasonable track record.
- Good compressive strength.
- Bonds to enamel and dentine.
- Adequate resistance to water dissolution (but less than zinc phosphate).
- No adverse effect on pulp.
- Anticariogenic property but less than glass ionomer.

Disadvantages

- Short working time – difficult to use with multiple units.
- Low tensile strength.
- Offers less retention than zinc phosphate.
- Can deform under loading.
- It is very viscous, can be difficult to obtain low film thickness.
- Not resistant to acid dissolution.

Composition and chemistry

Supplied as powder and liquid. Powder is similar to zinc phosphates and consists of zinc oxide, magnesium oxide/stannic oxide and stannous fluoride. Liquid consists of polyacrylic acid, itaconic and tartaric acid. When the powder is mixed with liquid, the acid reacts with zinc ions via the carboxyl groups and a crosslinked structure is formed. The polyacrylic acid also reacts with the calcium of the tooth in the same manner to chemical adhered to it. Adhesion to enamel is stronger than that to the dentine.

Manipulation

The cement should be mixed on a surface that does not absorb liquid. Hence, a glass slab is preferred to treated paper pads. The liquid should not be dispensed prior to mixing since it tends to lose water.

The powder is rapidly incorporated into the liquid in large quantities for a period of 30–60 s. Mixing on a cooled glass slab prolongs the working time.

The cement must be placed on the inner surface of casting and on the tooth surface before it loses its glossy appearance. Loss of gloss indicates decreased availability of carboxyl groups, poor bonding, poor wettability due to stringiness and increased film thickness causing incomplete seating of the casting.

3. Glass ionomer cement (GIC)

Indications

- Used commonly to cement cast posts, metal inlays, onlays, crowns, short- and long-span fixed partial dentures.
- Patients with high caries activity.

Advantages

- Better mechanical properties and retention than zinc phosphate and polycarboxylates.
- Chemical bond to enamel and dentine.
- Good bacteriostatic and anticariogenic properties.
- Resistant to water dissolution.

Disadvantages

- Sensitive to early moisture contamination which causes rapid cement dissolution.

- Low tensile strength.
- Not resistant to acid dissolution.
- Causes sensitivity during initial set and may also produce post cementation sensitivity. This may be compounded by desiccation of dentine by the operator.

Composition and chemistry

Type I glass ionomers are used for luting. They are supplied as powder and liquid and capsules.

Powder consists of soluble fluoroaluminosilicate glass, with calcium fluoride, sodium fluoride and lanthanum, strontium, barium or zinc oxide for radiopacity. Liquid mainly contains water along with polyacrylic acid in the form of a copolymer with itaconic, maleic or tricarboxylic acids. When the powder is mixed with liquid, the acid etches the glass particles and the polyacrylic acid chains are crosslinked by calcium ions which is replaced by aluminium in 24 h. This becomes hydrated with time. The adhesion mechanism to tooth is similar to polycarboxylate cement.

Manipulation

A glass slab or a paper pad is used for mixing. A plastic spatula should be used. Use of a metal spatula, causes abrasion by the glass particles of the metal surfaces resulting in discolouration of the set cement.

P/L ratio for GIC type I is 1.3:1. The powder is introduced into the liquid in large increments and spatulated rapidly for 30–45 s (Figs 41.24–41.26). The cement must be used before it loses its glossy appearance. Once the cement has achieved its initial set (7 min), the cement margins should be coated with a varnish. The field must be isolated completely.

FIGURE 41.24 Cement mixed in small increments.

FIGURE 41.25 Mixing with sweeping strokes.

FIGURE 41.26 Cement that is ready to use will string out from the lifted spatula.

Encapsulated products typically are mixed for 10 s in a mechanical mixer and dispensed directly. Advantages of capsules are convenient and control of P/L ratio consistently (Fig. 41.27A and B).

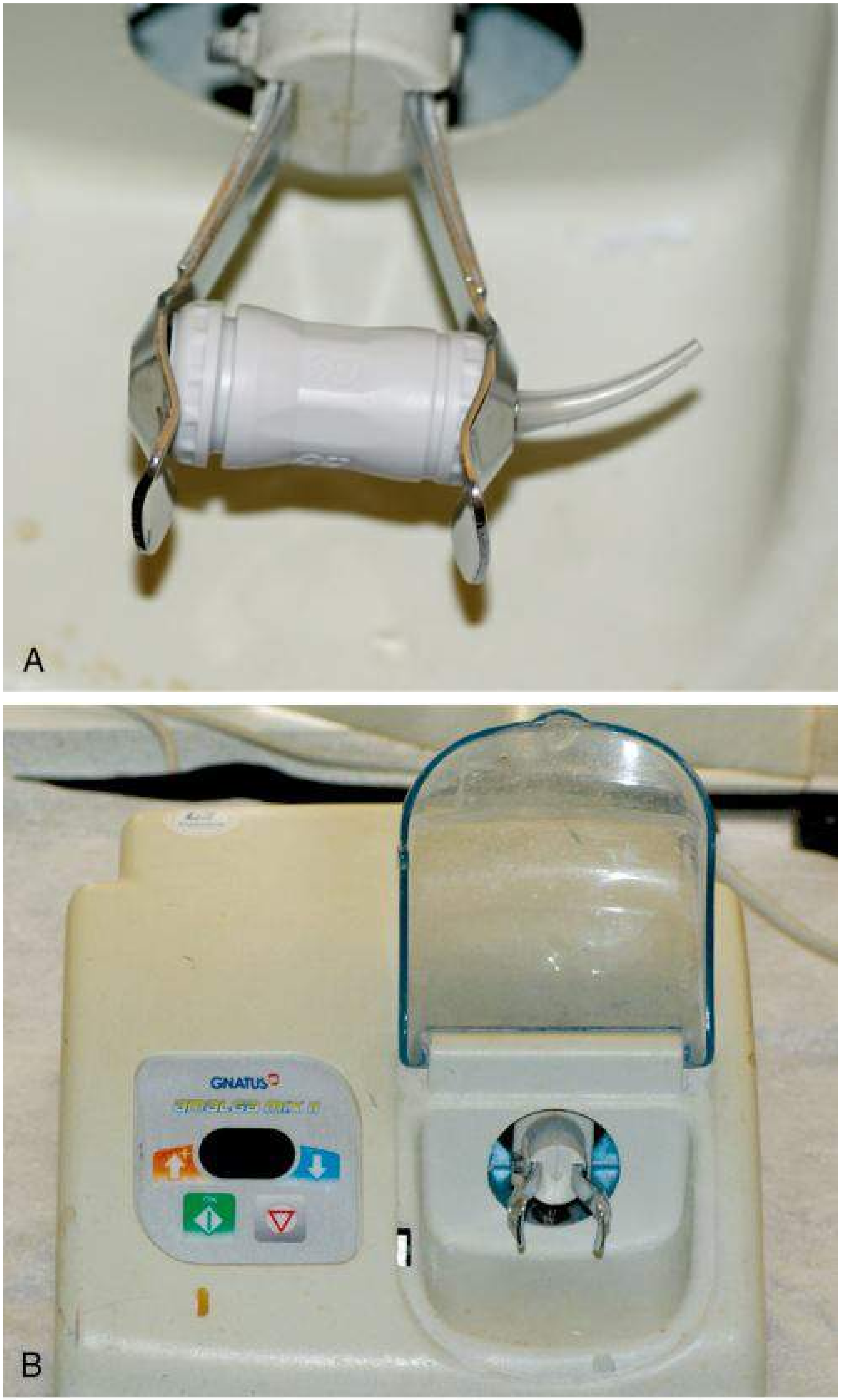

A
GNATUS
B

FIGURE 41.27 **(A)** Capsule. **(B)** Mechanical mixer used for manipulation of the capsule.

4. Resin modified glass ionomer cements

Indications

- Similar to type I glass ionomers.
- Metal or metal ceramic crowns, especially where preparation retention is borderline.

Advantages

- Similar to type I glass ionomers.
- Good compressive and tensile strengths, better than type I glass ionomers.
- Reasonable working time.
- Less sensitive to moisture than conventional glass ionomers.
- Resistance to water dissolution.

Disadvantages

- Initial setting and postcementation sensitivity similar to GIC.
- They may expand and crack overlying porcelain because of water absorption, therefore, not indicated for all ceramic restorations.

Composition and chemistry

They are dispensed as powder and liquid, two pastes and capsules.

The composition is similar to GIC except that the liquid component is modified with methacrylate and hydroxyethyl methacrylate monomers. The initial setting reaction is by polymerization of methacrylate groups, the acid–base reaction is responsible for maturing and final strength. The bonding to tooth is similar to conventional GIC but stronger.

Manipulation

Manipulation is similar to type I GIC. Setting time is less than 6 min. Hence, the restorations should be promptly seated and excess cement should be removed immediately as it sets to a harder consistency.

5. Resin cements

Indications

- Material of choice for porcelain laminate veneers, ceramic inlays and onlays, resin-bonded bridges, fibre-reinforced composite restorations and all ceramic crowns and fixed partial dentures.
- May be used to improve retention where preparation geometry is suboptimal.

Advantages

- Good compressive and excellent tensile strengths.
- Insoluble in oral fluids.
- Enhances the strength of all ceramic restorations.
- Chemical and mechanical bond to tooth structure.

Disadvantages

- Excess material extruded at margin may be difficult to remove especially proximally.
- Film thickness varies substantially between materials.
- No anticariogenic property.

- High cost.
- Pulpal irritation.

Composition and chemistry

They are basically microfilled bis–GMA resins with low viscosity; mechanical adhesion occurs due to the flow of resin tags in between the etched enamel crystals; chemical adhesion can be obtained by using bonding agents like HEMA (hydroxyethyl methacrylate) or 4-META (4-methacryl ethyl trimellitic anhydride).

Manipulation

The chemically activated systems are available in powder–liquid system or as two paste systems. The peroxide initiator is in one component and the amine activator is contained in the other. The components are mixed on a paper pad for 20–30 s. The restorations should be promptly seated and excess cement should be removed immediately.

Light-activated systems are single-component systems. The time of exposure to light needed for polymerization of the resin cement is dependent on the light transmitted through the ceramic restoration. It should never be less than 40 s.

The dual cure systems are two-component systems. Chemical activation is slow and provides extended working time till the cement is exposed to curing light after which it solidifies rapidly.

Cementation procedure with resin cements is discussed in detail in the chapter on all-ceramic restorations.

Cementation procedure for conventional restorations

The prepared tooth should be cleaned prior to cementation. Any contamination will hinder the performance of the luting agent. It should be gently dried without desiccating the odontoblasts and isolated with cotton rolls to prevent saliva contamination. A saliva ejector is also placed.

If zinc phosphate cement is used then a cavity varnish should be applied. The fitting surface of casting is prepared by sandblasting with 50 microns alumina. Alternately, steam cleaning, ultrasonic cleaning or organic solvents may be used.

The cement is mixed to a luting consistency and applied to the internal surface of the casting according to the manufacturer's instructions. The prosthesis is inserted with a rocking, dynamic-seating force. A static force will lead to incomplete seating. Margins are examined to ensure correct seating of the prosthesis.

Seating force on the crown is maintained for 1 min either by the dentist or by the patient biting onto a cotton roll. Some operators prefer patients to bite on an orangewood stick. If not done carefully, it can tip the crown. Patient is asked to close in maximal intercuspal position and occlusion is verified on unprepared teeth.

An explorer is used to remove the excess cement after it has set (Fig. 41.28). Dental floss may be used to remove the cement from the interproximal areas (Fig. 41.29).

FIGURE 41.28 A,B Explorer used to remove excess cement after setting.

FIGURE 41.29 Dental floss is used to remove cement in interproximal areas.

Post cementation instructions

1. Patient is advised against chewing for at least 1 h after cementation.

2. Patient is warned to expect sensitivity for a few days in vital cementations with zinc phosphate and glass ionomers. This should subside, if not, the patient should report back to the dentist.

3. Patient is advised against flossing for a couple of days but regular brushing with a soft toothbrush should be commenced immediately. Regular methods to maintain oral hygiene should then be routinely followed.

4. Biting on hard food like nuts is avoided for 24 h and patient should report back if he/she feels any obstruction while chewing (occlusal discrepancy).

5. Patient is instructed on recall appointments.

SUMMARY

Proper moisture control is important for successful cementation. Careful tooth preparation including air abrasion of the fitting surface and cement selection are critical for the longevity of the restoration. The cement must be protected from moisture during its initial set. Removal of excess cement from the gingival sulcus is critical for continued periodontal health.

CHAPTER
42

Failures in fixed partial dentures

CHAPTER CONTENTS

Introduction

It is important to analyse failure so that the reasons can be evaluated and prevention is imparted. A fixed partial denture (FPD) can fail as a result of poor patient care or defective design and inadequate execution of clinical and lab procedures. The various causes of such failure have been classified as biologic, mechanical, aesthetic and psychogenic and the reasons and treatment for the same have been discussed.

Classification

Failures in FPDs can be classified as (Table 42.1):

- Biologic
- Mechanical
- Aesthetic
- Psychogenic

Table 42.1

Failures in fixed partial dentures

Biologic	Mechanical	Aesthetic	Psychogenic
Caries	Loss of retention	Immediate	Lack of counselling
Pulpal degeneration	Connector failure	Delayed	
Endodontic	Occlusal wear		
Periodontal	Tooth fracture		
Tooth perforation	Porcelain fracture		
Subpontic inflammation			
Occlusal problems			
General pathosis			
Maintenance failure			

Biologic failure

Caries

Caries is the most common cause of biologic failure. This can be of the following types:

1. Secondary caries

This can happen under the margins of the retainers (Fig. 42.1A and B).

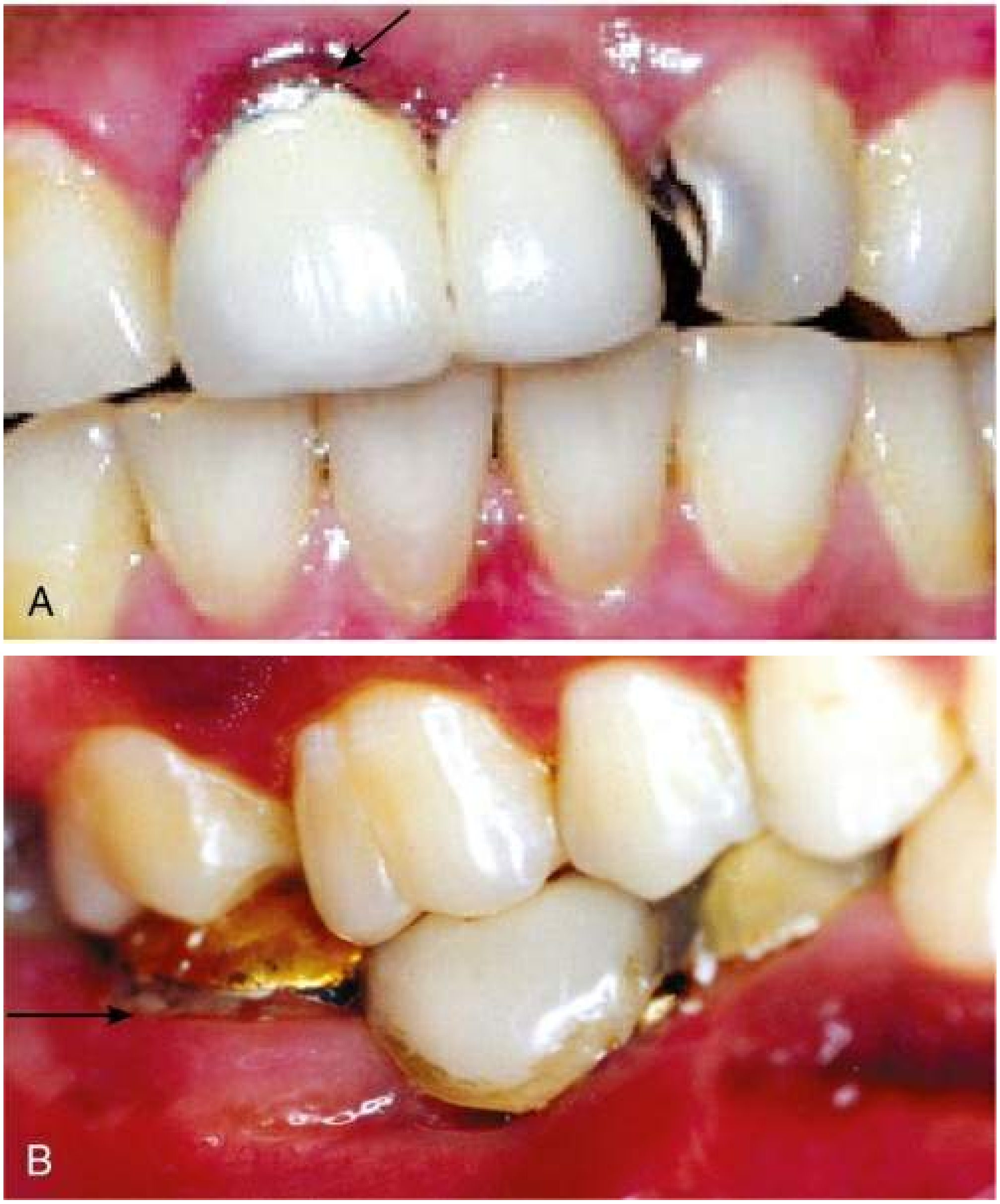


FIGURE 42.1 Caries under the retainer.

Causes

Marginal leakage due to poor margins (open margins) or poor maintenance by patient.

Symptoms

Secondary caries may be perceived by the patient as pain or sensitivity to hot, cold and sweet food/liquids, bad taste, bad breath, loose restorations, fractured teeth and discoloured teeth.

Detection

The caries can be detected visually (if present on labial surface), by probing and with radiographs (if present interproximally) (Fig. 42.2A and B).

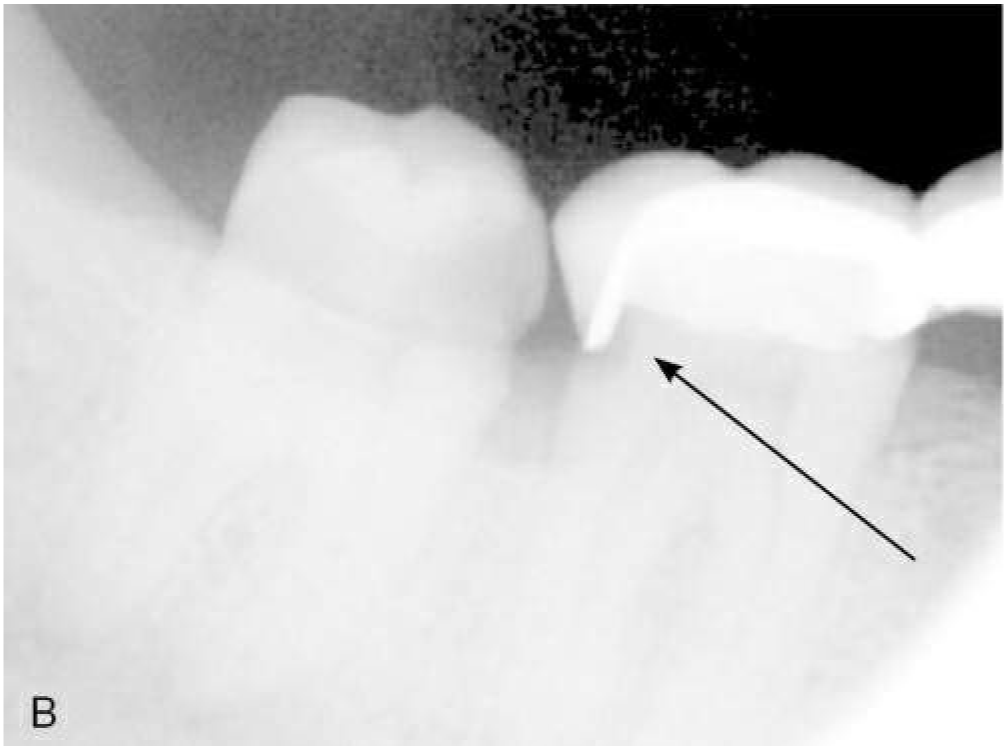


FIGURE 42.2 **(A)** Secondary caries seen visually. **(B)** Interproximal secondary caries under molar retainer.

Treatment

If the caries is minor and restricted to the facial surface, it can be restored without removing the prosthesis. Material used for such restoration in order of preference is gold foil, silver amalgam, composite resins and glass ionomers, depending on location on anterior or posterior teeth.

Extensive lesions may require removal of prosthesis and restoration, endodontic treatment or extraction followed by fabrication of a new prosthesis.

Prevention

Ensuring adequate marginal adaptation during try-in of restoration (discussed in Chapter 41) and educating the patient in maintaining oral hygiene and reviewing the same during recall appointments can prevent this failure.

2. Caries of tooth adjacent to retainer

The main cause for this is lack of proximal contact at the time of cementation (Fig. 42.3A and B).

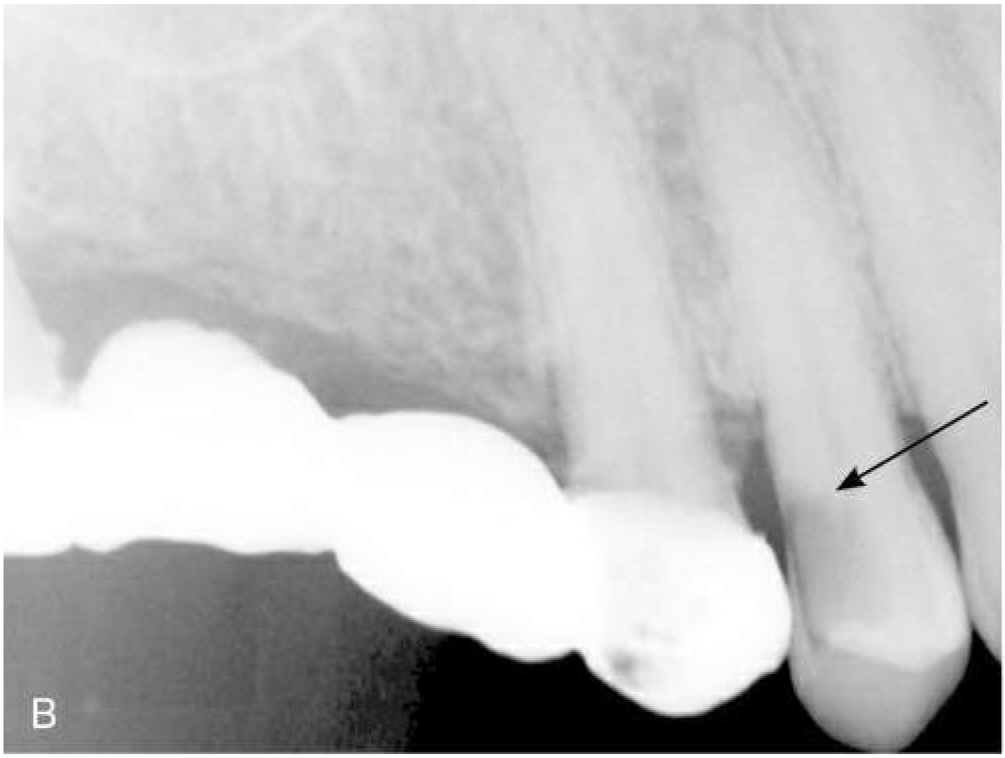


FIGURE 42.3 **(A)** Lack of proximal contact. **(B)** Lack of proximal contact causing carious of proximal tooth.

This could have been easily prevented if the contact was checked as described in Chapter 41.

3. Root caries

This is a problem associated in the elderly patients with FPDs (Fig. 42.4). It can occur even in the absence of gingival recession and pockets. As the elderly patients may also have reduced salivary flow due to medications and sometimes radiation, the problem is accentuated.

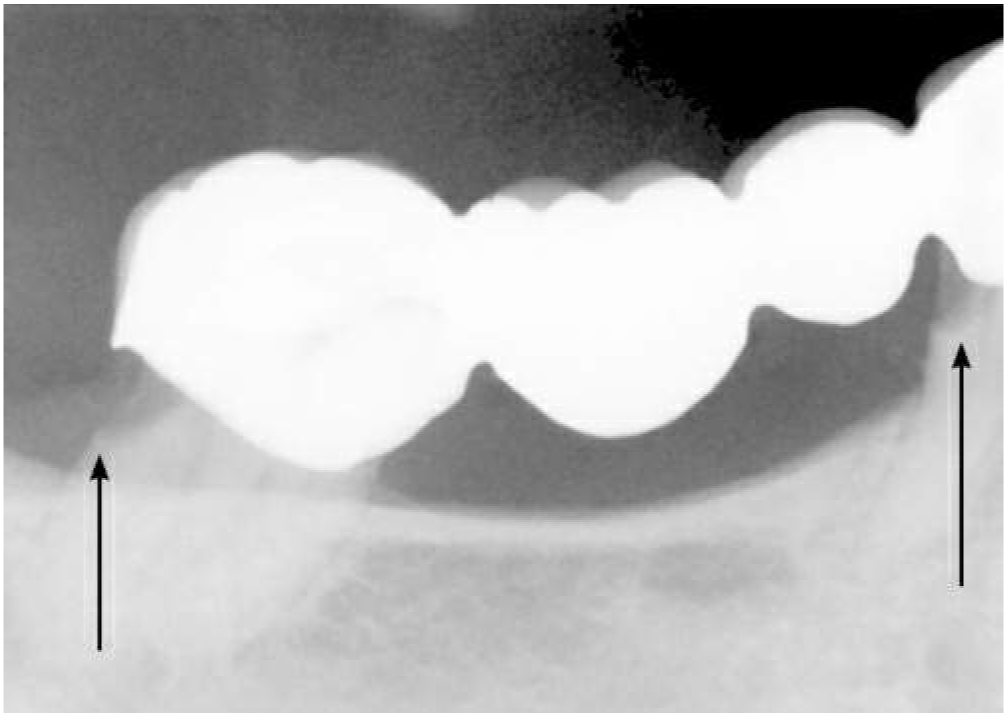


FIGURE 42.4 Root caries in abutments.

The cause has been identified as *Actinomyces viscosus* commonly present in the filiform papillae of the tongue.

Advising meticulous oral hygiene measure along with cleaning of tongue for such patients may reduce the risk of developing this problem.

Pulpal degeneration of abutment

Causes

- Tooth preparation without sufficient cooling or an improperly directed water spray (Fig. 42.5A and B).
- An abutment with an old restoration with secondary caries or unrestored carious lesion (Fig. 42.6).
- Cements like zinc phosphate, glass ionomers and resin cements can cause pulpal irritation, especially if the preparation is close to the pulp. This can also lead to degeneration.

- Presence of interfering occlusal contacts.

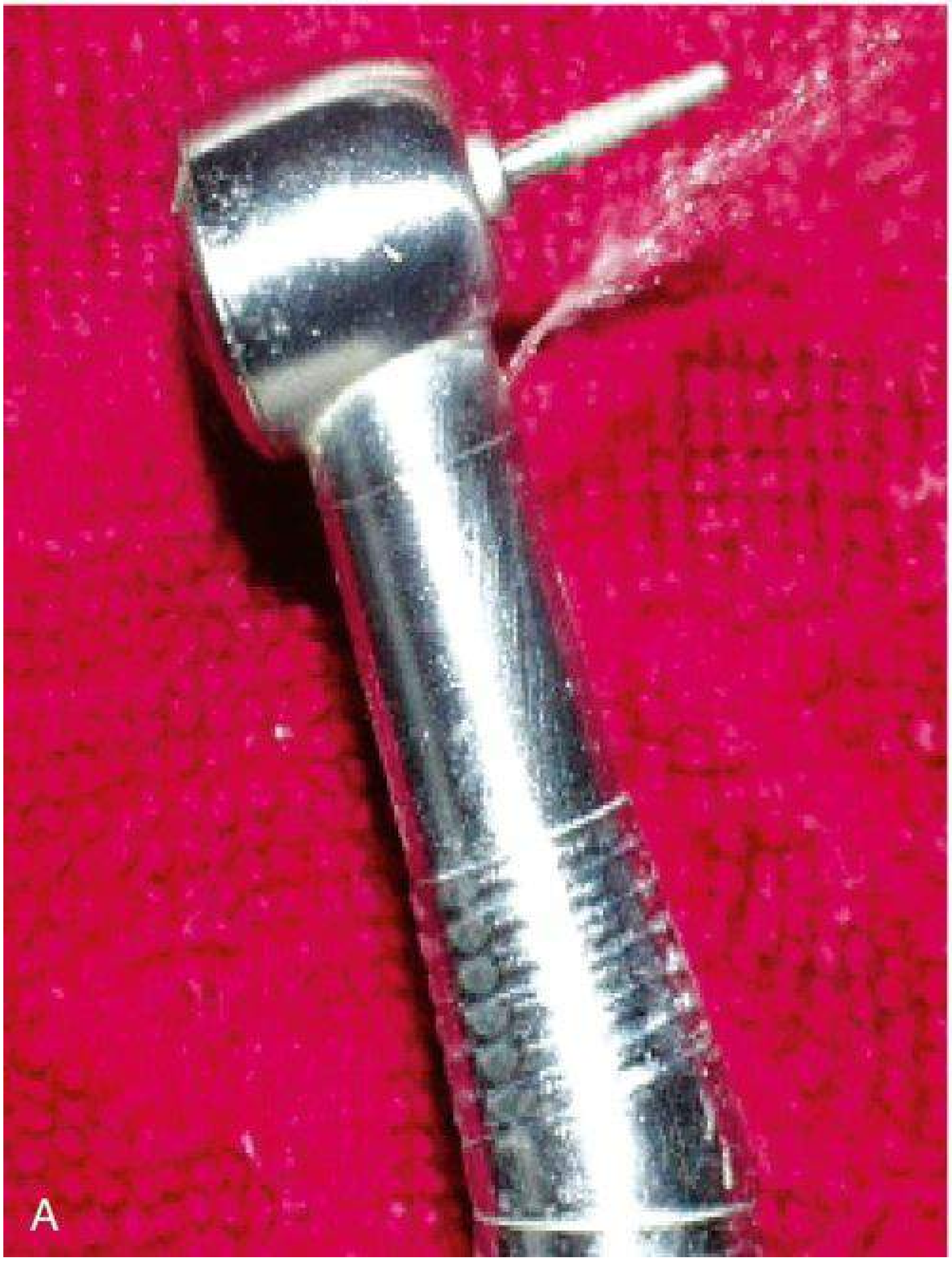


FIGURE 42.5 **(A)** Spray not directed on handpiece. **(B)** Spray not directed on tip.

FIGURE 42.6 Unrestored abutment.

Symptoms

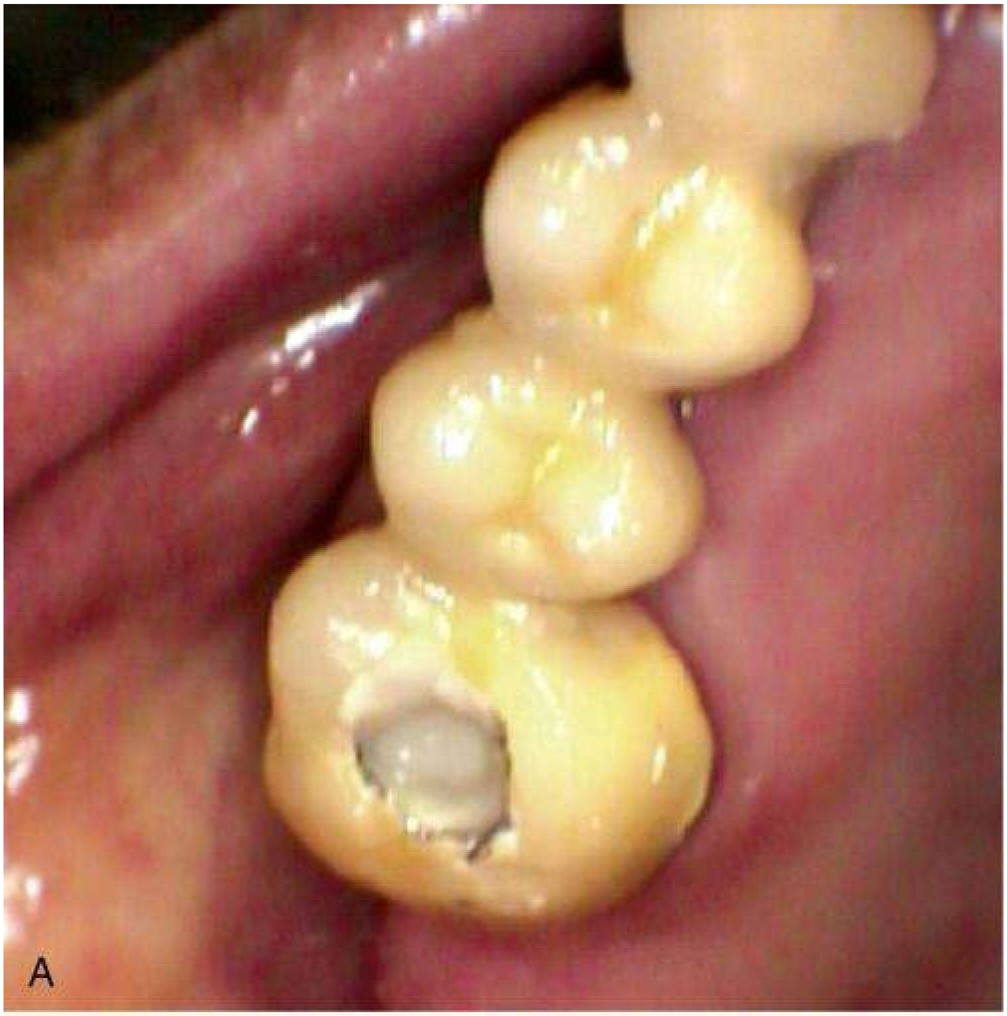
Perceived by patient as pain which could be spontaneous or related to hot/cold/sweet food or accentuated by lying down/exercising.

Detection

Usually based on symptoms as vitality testing is difficult because of the presence of retainer. Radiograph may be useful only if periapical lesions are present.

Treatment

Access is made through the retainer and endodontic treatment is performed (Fig. 42.7A and B). The access opening can then be restored with a post and/or a core. If occlusion is the problem, it should be corrected.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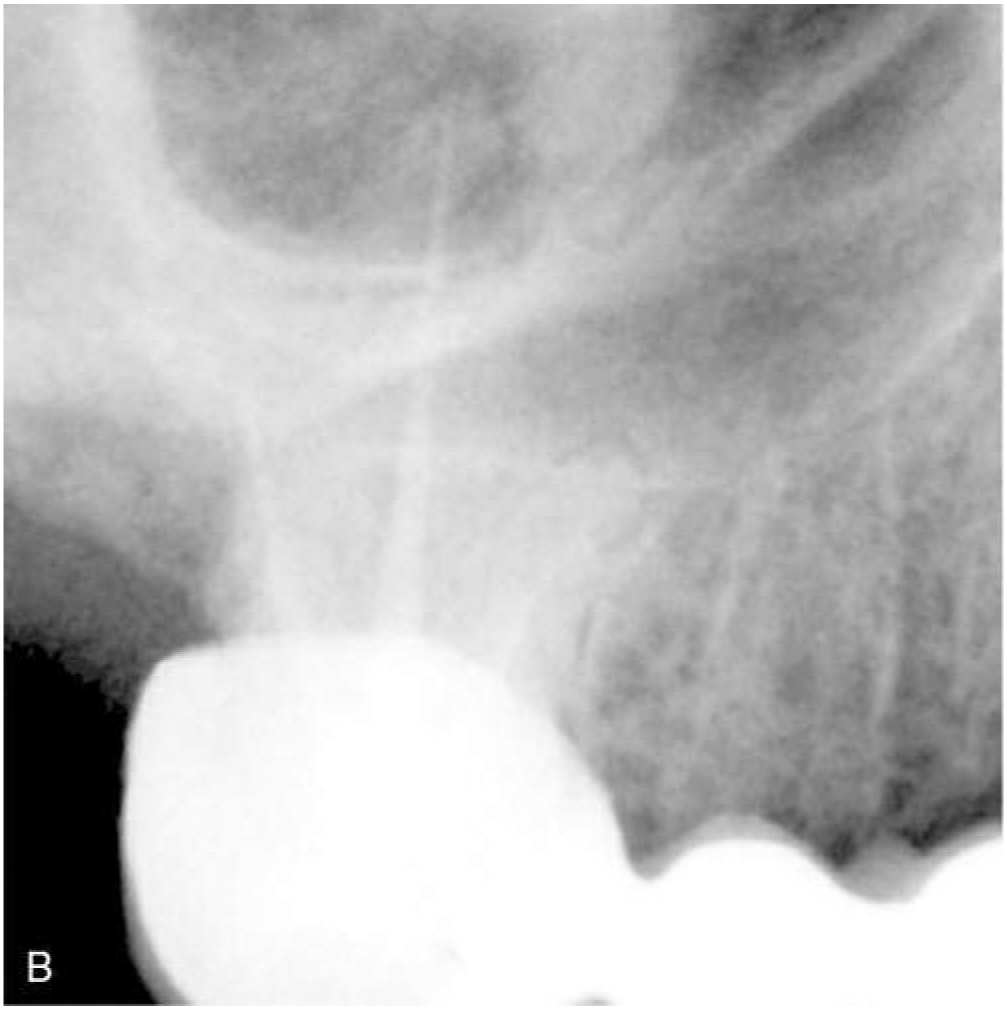


FIGURE 42.7 **(A)** Access made through retainer. **(B)** Endodontic treatment completed.

Prevention

- The water spray of the high speed handpiece should be cleaned regularly and checked before tooth preparation.
- All caries lesions on abutment teeth should be restored prior to preparation. Even old restorations may be removed and new restorations made.
- Correct cement should be selected for sensitive teeth.
- Occlusion should be corrected before cementing the prosthesis and

the same should be verified in recall appointments.

Endodontic failure of abutment

Causes

- The endodontic treatment of the abutment was improper or inadequate (Fig 42.8).
- A root perforation or crack of the tooth during the old endodontic treatment may manifest much later.

FIGURE 42.8 Inadequate endodontic treatment of first premolar abutment causes periapical infection and failure of FPD.

Symptom

Perceived by patient as pain on biting or swelling.

Detection

With the help of symptoms and radiographs.

Treatment

Extraction must be postponed if possible. Endodontic retreatment and apicoectomy may be attempted through the retainer or after removing the prosthesis.

Karlsson (1986) demonstrated that 10% of 641 bridge abutments exhibited periapical lesions after 10 years, 19.8% of 303 root filled abutments exhibited nonhealed periapical lesions. This conveys that just the presence of lesions on radiographs may not necessitate any treatment. Patient symptoms need to be assessed.

Prevention

Endodontically treated teeth must be used as abutments only after thorough evaluation. If endodontic treatment is found inadequate, retreatment may be performed. When in doubt, the design of the prosthesis should be altered to exclude the tooth as abutment.

Periodontal failure

Causes

1. Faulty prosthesis which hinders maintenance of oral hygiene is due to:

- Poor marginal adaptation (Fig. 42.9A).
- Overcontouring of retainer axial surfaces.
- Large connectors.
- Pontic contact a large tissue area.

○ Prostheses with rough surfaces.

2. Poor maintenance by patient (Fig. 42.9B).

3. Patient with existing periodontal disease.

4. Lack of abutment support due to improper treatment planning.

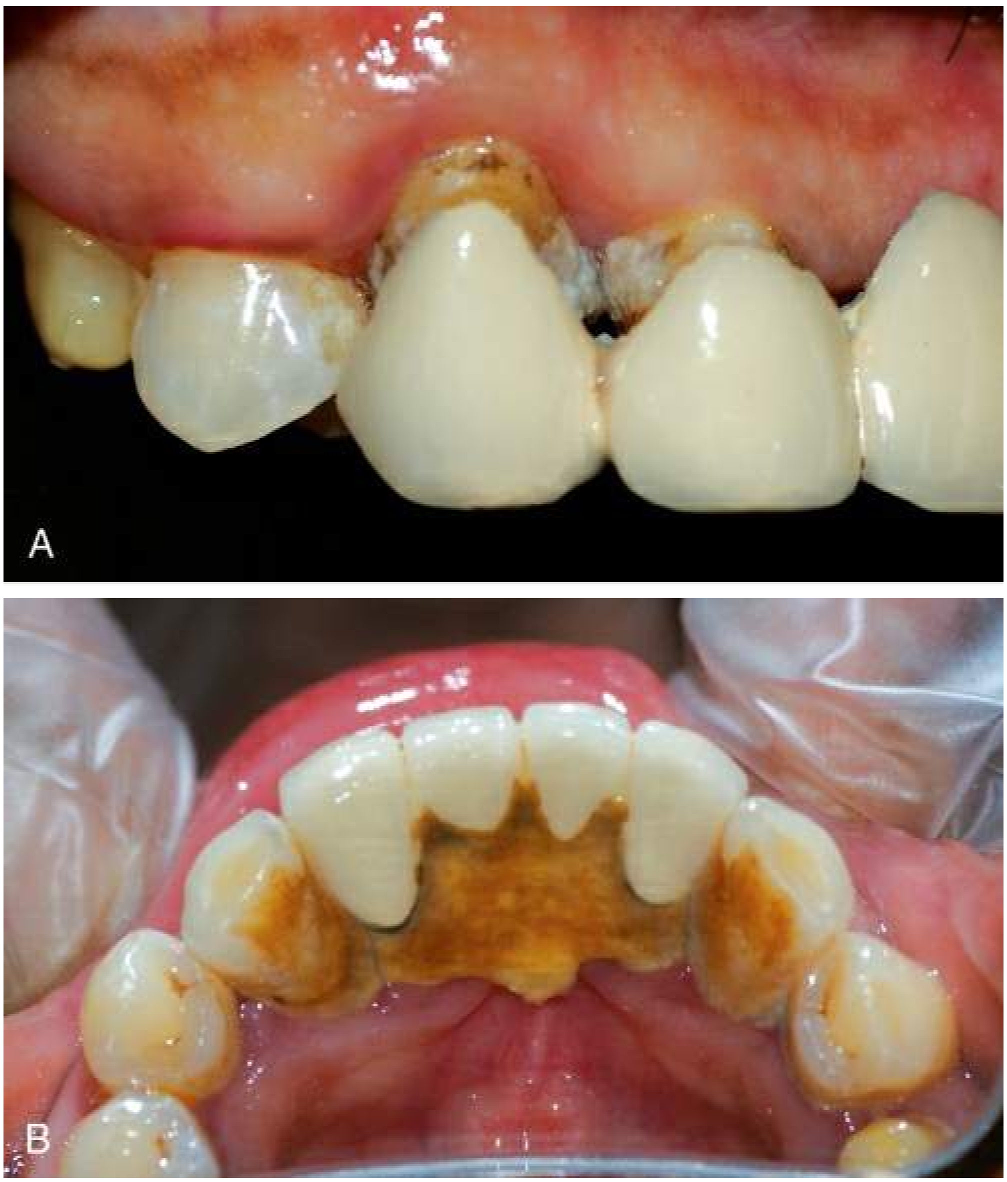


FIGURE 42.9 **(A)** Poor margin adaptation. **(B)** Poor maintenance by patient.

Treatment

Severe bone loss results in loss of abutment teeth and attached prosthesis.

In less severe breakdown, it may be corrected by periodontal surgery but may produce an unacceptable relationship between the prosthesis and soft tissue.

If the problem is localized and related to a prosthesis that hinders effective oral hygiene, prosthesis may be recontoured or remade to correct the defect.

Prevention

- Any existing periodontal disease must be eliminated and tissues should return to optimal health before commencing fixed prosthodontics treatment.
- The prosthesis should be supported adequately by sufficient number of abutments to function on a long term basis as described in Chapter 35.
- Patient should be instructed on proper oral hygiene measures and implementation must be verified through recall appointments.

Tooth perforation

Causes

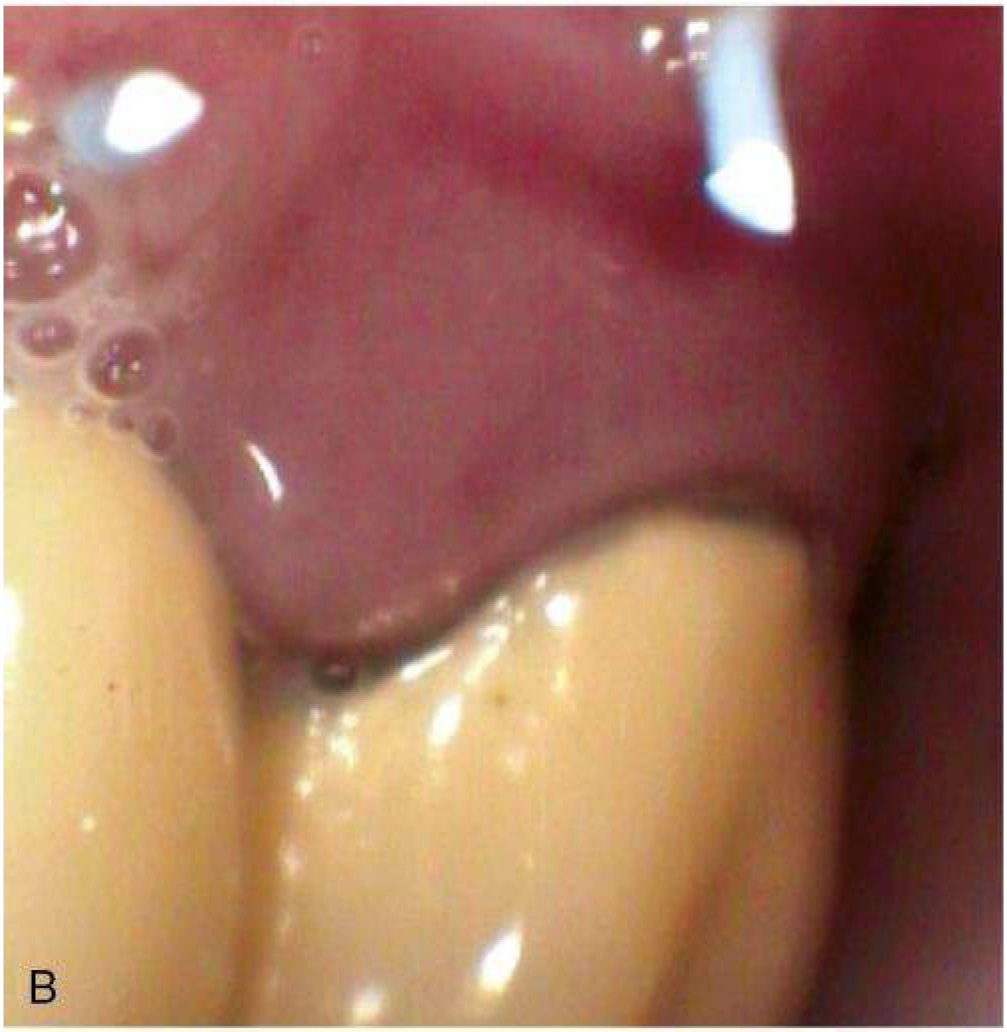
Tooth perforation may have occurred during:

- Placement of pinholes/pins
- Endodontic treatment
- Preparation for post and core

Treatment

- Endodontic treatment is performed when pinholes or pins perforate into pulp chamber.
- If perforation is located occlusal to alveolar crest, preparation can be extended to cover defect.
- If located below crest and is accessible, perforation can be sealed through periodontal surgery.
- If perforation is inaccessible then the abutment requires extraction.
- The location of the perforation can be verified by passing a gutta-percha point through the sinus tract and making a radiograph (Fig. 42.10A–C).


A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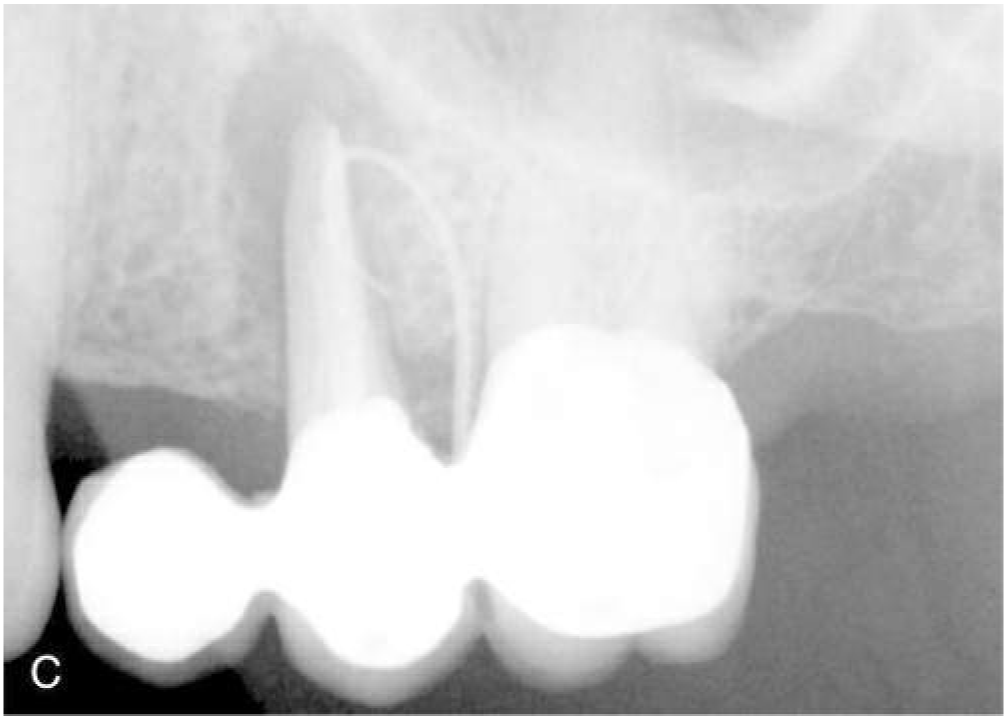
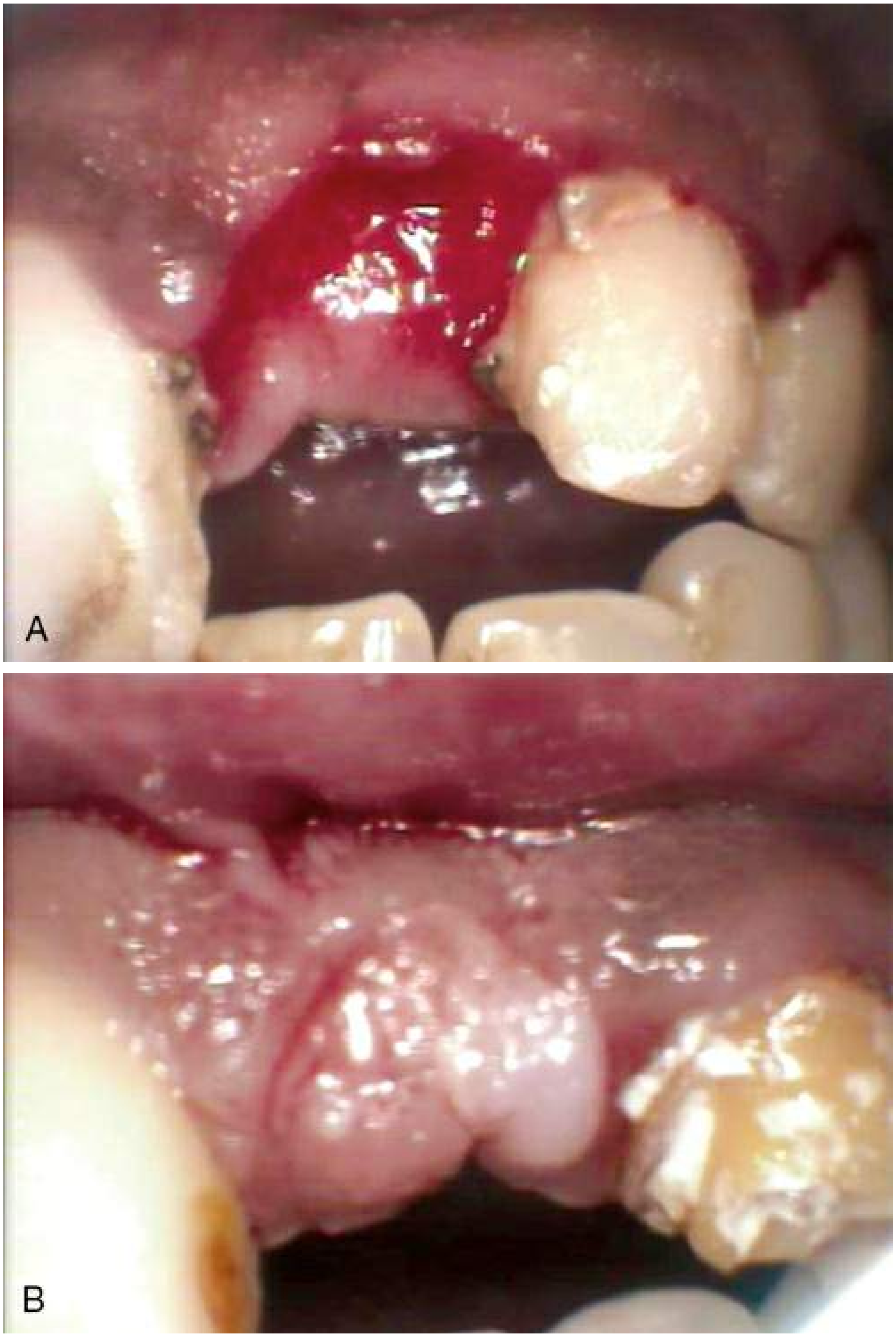


FIGURE 42.10 **(A)** Periapical infection in second premolar abutment due to perforated root canal. **(B)** Gutta-percha point passed through sinus tract. **(C)** Perforation located.

Subpontic inflammation

Causes

- Excessive pressure by pontic due to improper pontic design and pontic contacting too large an area (Fig 42.11A).
- Improper prosthesis design (Fig. 42.11B).
- Poor maintenance by the patient.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B

FIGURE 42.11 **(A)** Subpontic inflammation due to pontic contacting a large area. **(B)** Improper prosthesis design with a lateral incisor used as a cantilever abutment to replace a central incisor, resulting in intermittent pressure under pontic surface resulting in hyperplastic tissue. **(C)** Superfloss in use to clean beneath the pontics.

Symptoms

Perceived by the patient as pain, swelling, bad breath, bad taste, bleeding gums and poor aesthetics.

Treatment

If improper design is the problem, the prosthesis should be refabricated with proper design after allowing the inflammation to subside.

Patient should be educated to maintain the pontic space using aids like superfloss (Fig. 42.11C).

Occlusal problems

Causes and treatments

1. Interfering centric or eccentric contacts can cause tooth mobility and irreversible pulpal damage. Tooth mobility is reversible if problem is

detected early and adjusted but correction may cause prostheses failure due to perforation and loss of aesthetics. Pulpal damage should receive endodontic treatment following occlusal correction.

Mobility due to long term occlusal interferences on normal teeth and due to traumatic occlusion on teeth weakened by periodontal disease, are treated by removing FPD and splinting teeth with removable prosthesis. If mobility is severe extraction is necessary.

2. An altered vertical dimension also leads to occlusal problems. This is the result of poor treatment planning and needs to be identified and corrected. It may also lead to temporomandibular disorders.

Symptoms

Problems in occlusion is perceived by the patient as discomfort on biting, sore teeth, loose teeth or bridges, sensitive teeth and tired or sore muscles.

General pathosis

Failure to diagnose a pathological change, having a vital bearing on the patient's life expectancy is a failure. For example a patient with a squamous cell carcinoma being treated for missing teeth with a FPD instead of the more important condition is a failure.

Patients may come back to the dentist after many years for restorative treatment. Patient's current medical condition should be evaluated. A change in a patient's medical condition like cerebral haemorrhage alters patient's motivation, physical ability to maintain teeth, diet and general resistance, leading to a deterioration of restorations and abutments.

Maintenance failure

Maintenance of the prosthesis is very important for the biologic survival of the restoration.

Failure may be due to:

- Failure of the dentist to prescribe a maintenance programme.
- Failure to implement or prescribe a recall system.
- Inadequate motivation of patient.
- Inadequate motivation by dentist.

Mechanical failure

Loss of retention

Causes

- Improper cementation procedure.
- Poor retention and resistance form.
- Poor fit of casting.
- Excessive span length.
- Heavy occlusal forces like cantilevers if designed improperly.

If not detected early, a loose retainer can lead to extensive caries of the abutment.

Symptoms

Patient may perceive a loose retainer as sensitivity to temperature or sweets and bad taste or odour.

Detection

A curved explorer is placed under the connector and an occlusal force is applied. The retainer is then pressed cervically with a finger. If retainer is loose, the occlusal force causes fluids to be drawn under the casting is reseated with a cervical force, the fluid is expressed in the form of bubbles as air and liquid are simultaneously displaced (Fig. 42.12).

FIGURE 42.12 Loose retainer causing bubbles.

Treatment

- Prosthesis must be removed intact or otherwise. It can be recemented if the reason was a cementation problem and it is intact.
- If loss of retention is due to preparation design, the teeth should be modified to improve retention and resistance form and new prosthesis fabricated.
- If excessive span length is the problem, a removable partial denture

may be the only option.

Connector failure

Causes

Inadequate connector width if posterior (occlusocervical), if anterior (buccolingual). This is usually due to supraeruption leaving no space for pontic in height (Fig. 42.13A and B).

FIGURE 42.13 **(A)** Supraeruption of upper first molar. **(B)** Causing connector failure.

Internal porosity, incomplete casting or soldering which has weakened the metal can also cause connector failure.

Treatment

If the cause is supraeruption, then the offending tooth may be contoured to provide adequate clearance. If severe, intentional endodontics may be required. Following this a new prosthesis is made.

If casting defect was the problem, an inlay like dovetailed preparation can be prepared in the metal to span the fracture site and a casting can be cemented to stabilize the prosthesis. Most often a new prosthesis is made.

Occlusal wear

Causes

- Insufficient thickness of restoration due to inadequate preparation of occlusal surface, lack of functional cusp bevel (Fig. 42.14).
- Heavy chewing forces/bruxism.
- Rough porcelain occlusal surfaces cause wear of opposing natural teeth.

FIGURE 42.14 Inadequate occlusal preparation.

Treatment

- If wear is due to inadequate preparation, a new prosthesis is made after providing adequate clearance.
- Any rough porcelain surface should be polished or glazed.
- For bruxers, a night guard may be a solution.

- When occlusal wear is anticipated, it is better to plan metal occlusal surfaces opposing natural teeth or metallic restorations.

Tooth fracture

1. Crown fracture

Causes

- Excessive tooth preparation leaving insufficient tooth structure to resist occlusal forces.
- Endodontically treated abutment without post.
- Abutment mostly comprises of restorative material.
- Interfering centric/eccentric contacts.
- Attempting to forcibly seat an improperly fitting prosthesis.
- Unseating a cemented bridge incorrectly.

Treatment

- Small coronal fractures common around inlays and partial veneer crowns. These can be restored.
- Large fractures around partial veneer crowns require a build-up and full veneer crown.
- Fracture around partial veneer crowns with pulp exposure will require endodontic treatment, post and core followed by full veneer crown.
- Fracture around full crowns if occurs horizontally at level of finish line, is treated by endodontics, followed by post and core and a new prosthesis.

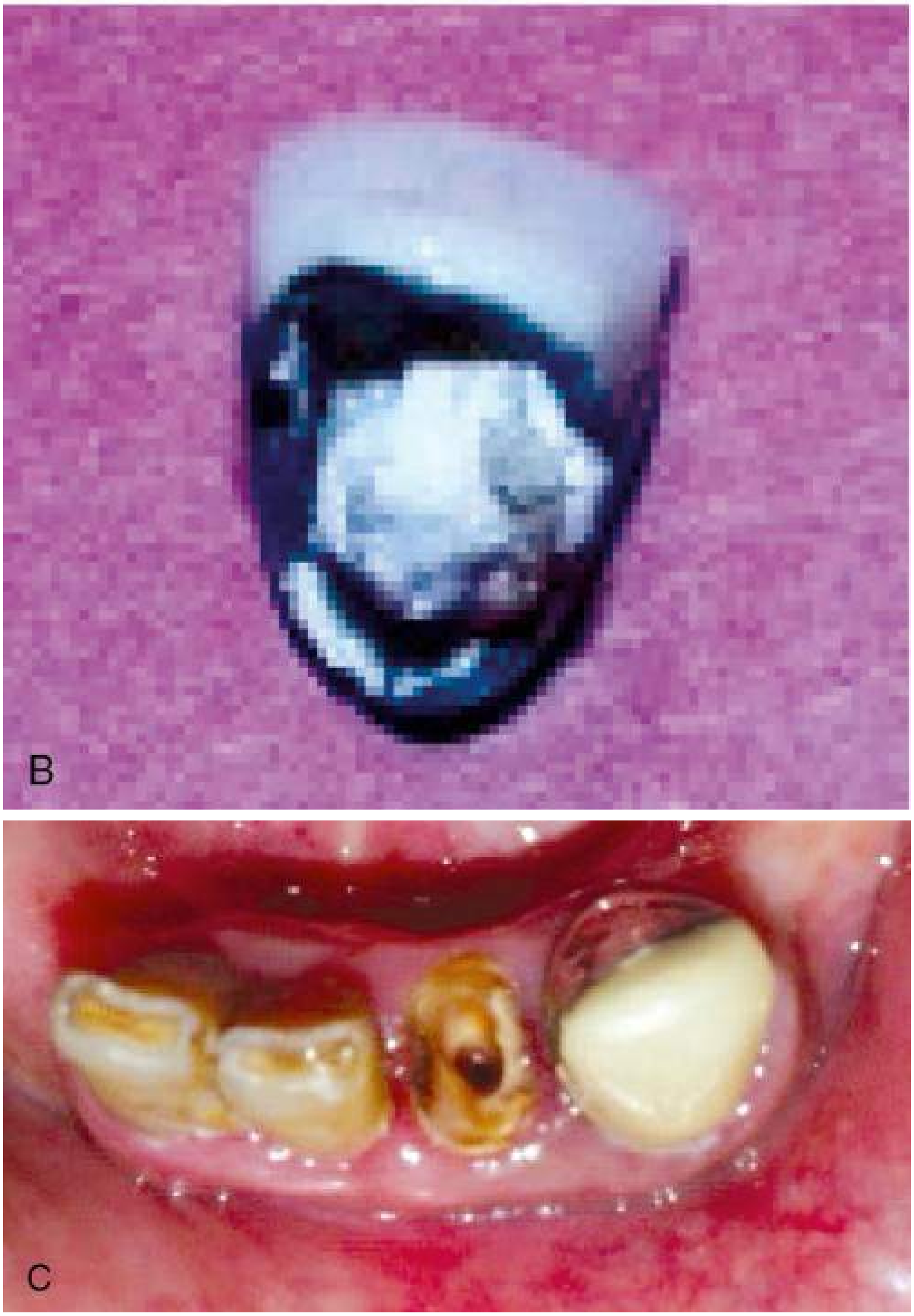
• If finish line is intact then 'retrofit technique' can be attempted to salvage the retainer or crown.

Retrofit technique

In this technique, a post and core is fabricated to fit an existing fractured abutment tooth with an intact crown or retainer. Hence, it is termed 'retrofit'.

The procedure for fabricating a retrofit cast post and core is as follows:

A post space is prepared in the abutment tooth (Fig. 42.15A–C). A resin pattern of the post and core is fabricated to fit the crown (Fig. 42.15D–I). The pattern is cast and cemented along with the crown (Fig. 42.15J–M).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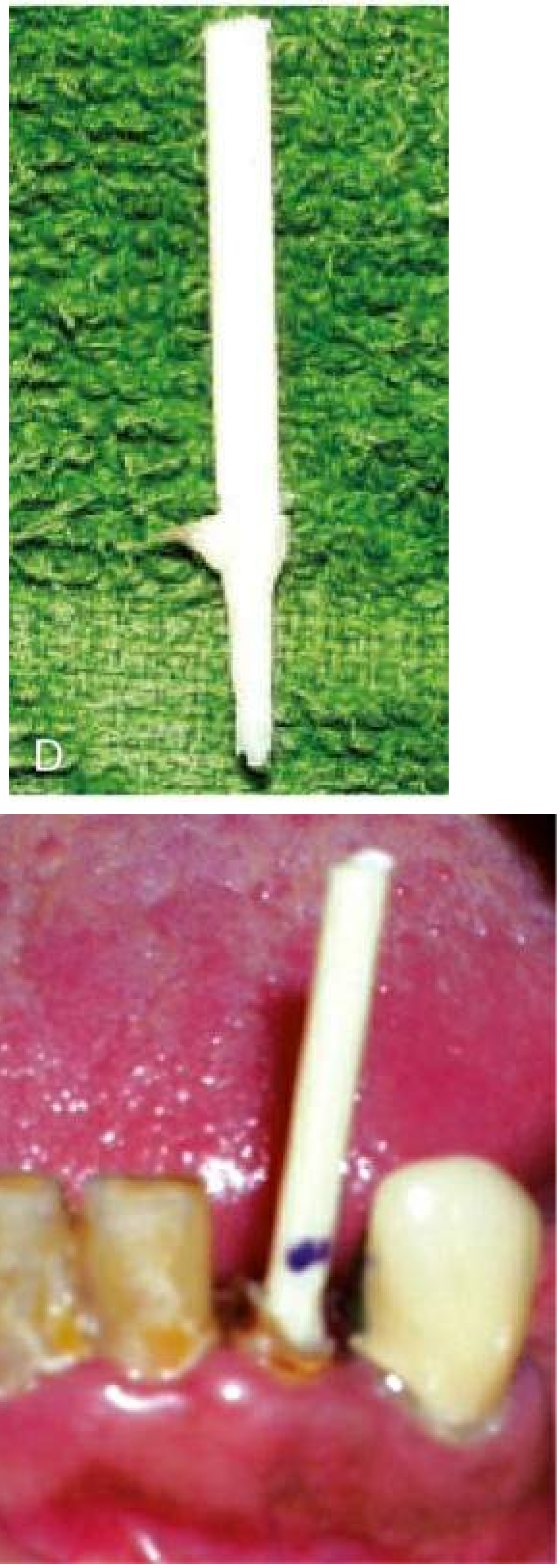
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J
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L
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FIGURE 42.15 **(A)** Fractured coronal portion on endodontically treated mandibular lateral incisor (32). **(B)** Intact crown with damaged coronal portion. **(C)** Post space is prepared. **(D)** Plastic pattern used to record the radicular anatomy. **(E)** Height of core is marked on the post and trimmed. **(F)** The fitting surface of the crown is cleaned and sandblasted. **(G)** Separating medium is applied on the fitting surface of crown, it is filled with pattern resin and placed on the cut portion of core to build the same, ensuring the core fits existing crown. **(H)** The core fabricated to fit the crown. **(I)** Resin pattern ready for casting. **(J)** Casting ready for cementation. **(K)** Cast post and core cemented. **(L)** Old crown cemented on the core. Lingual view showing good margin adaptation of crown. **(M)** Labial view of cemented crown.

2. Root fracture

Causes

- Improperly designed or a poorly fitting post.
- Root fracture occurring during endodontic or post treatment, but manifests later.
- Trauma.
- Reduced neural feedback leading to increased loading in endodontically treated teeth.

Treatment

- Extraction followed by a new prosthesis.

Porcelain fracture

1. Metal-ceramic fracture

Causes

i. Improper framework design:

○ Sharp angles or extremely rough and irregular areas over coping surface cause stress concentrations which leads to cracks.

○ Perforations in metal (Fig. 42.16A and B).

○ Overly thin metal casting does not adequately support the porcelain.

○ With facings, occlusal contact on or adjacent to metal-to-ceramic junction causes porcelain fracture (Fig. 42.17).

○ In facings, when angle between veneering surface and nonveneered aspect of casting is less than 90° (Fig. 42.18).

○ Any unsupported porcelain can fracture.

ii. Occlusion:

○ Heavy occlusal forces like clenching, bruxism.

○ Centric or eccentric occlusal interferences.

iii. Metal handling procedures:

○ Improper handling of alloy during casting, finishing or porcelain application can cause contamination which leads to ceramic fracture.

- Excessive oxide formation in metal can also cause porcelain fracture. This is caused by improper conditioning of base metal alloys.

Clinician has no role in the above-mentioned causes.

iv. During clinical procedures:

- Teeth prepared with slight undercut can cause binding of prostheses during insertion, which initiates crack propagation.

- Distorted impressions can also cause similar failure.

- When teeth are prepared with feather-edge finish lines or if finish lines are not recorded properly in impression, the technician may extend the metal beyond finish line as finish line is vague. The thin metal may bind against tooth and initiate crack of overlying porcelain.

- Attempts to seat a prosthesis using mallet and wooden stick during try-in or cementation can crack the porcelain.

- Cleaning fitting surface of prosthesis using ultrasonic scalers can initiate cracks in the porcelain. This typically happens when the prosthesis has been fixed provisionally or when a dislodged prosthesis is recemented (Fig. 42.19A and B).

v. Metal and porcelain incompatibility: This happens rarely. This can be easily prevented if manufacturer's instructions are followed when choosing the porcelains for a particular metal.

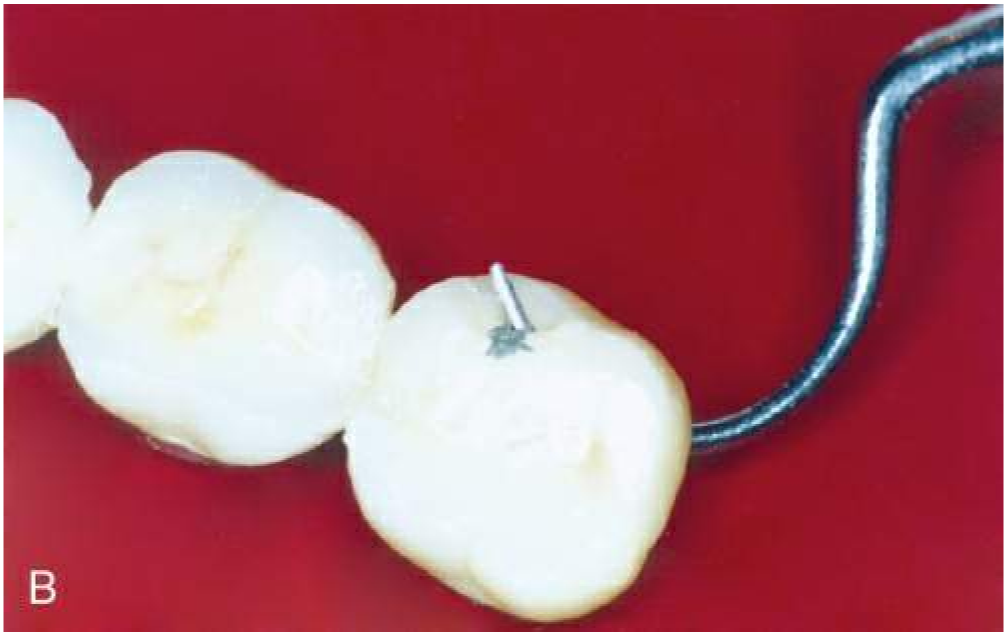

FIGURE 42.16 **(A)** Fractured ceramic portion on second molar retainer. **(B)** Examination reveals metal perforation.

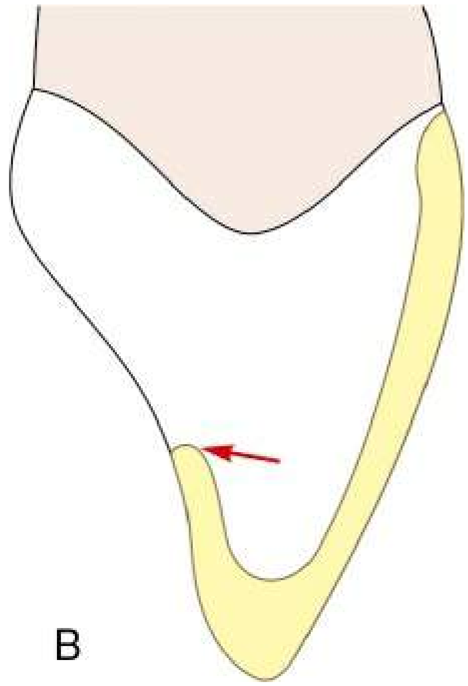

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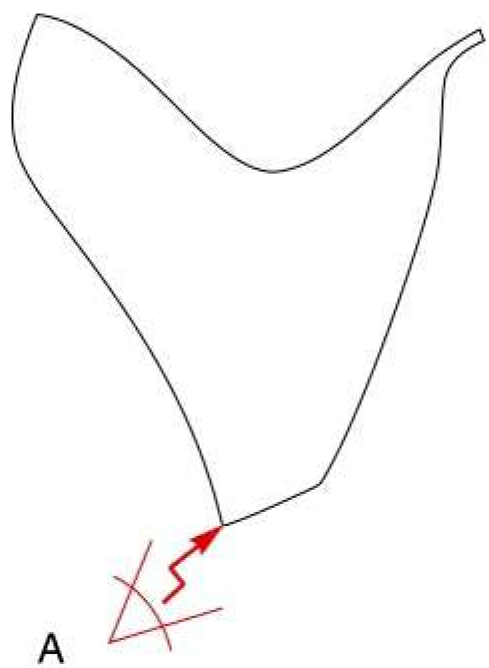
FIGURE 42.17 **(A)** Fracture of ceramic due to placement of metal ceramic junction at the contact of mandibular incisal edge. **(B)** Ceramic should end at a stress-free rounded but joint prepared on the metal.



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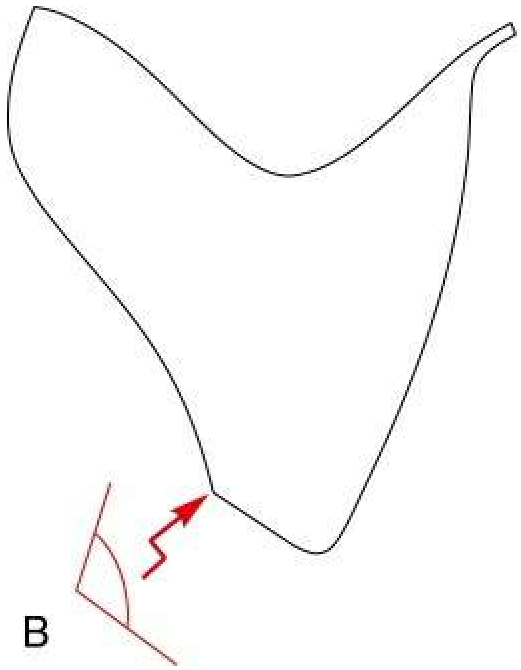


FIGURE 42.18 **(A)** Incorrect acute angle formed between veneering surface and nonveneered aspect of casting, will lead to porcelain fracture. **(B)** Correct incisolingual angle.

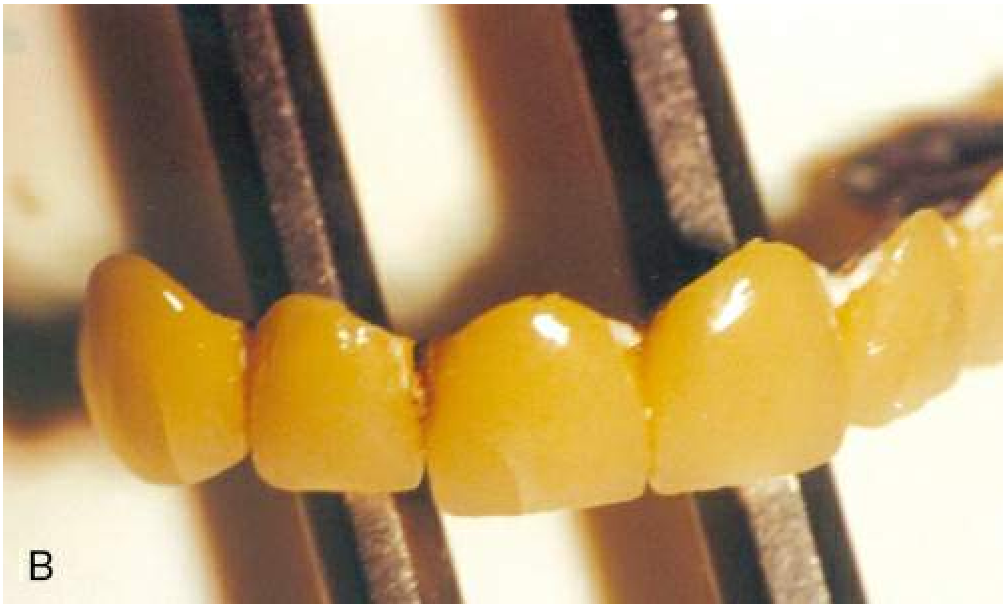


FIGURE 42.19 **(A)** Ultrasonic cleaning to remove cement. **(B)** Cracks in porcelain following such cleaning.

Treatment

The best method is to fabricate a new prosthesis. Repairs can be attempted until a new prosthesis is fabricated.

i. Resin repair

- Composite resins of appropriate shade are used and repair is made directly in the mouth.
- The exposed ceramic surface is etched with hydrofluoric acid for 30 s. The exposed metal surface can either be sandblasted intraorally or roughened for mechanical retention (Fig. 42.20A).
- A silane coupling agent is applied and allowed to remain on the surface for 1 min. It is not light cured.

- A composite bonding agent is applied and light cured for 10 s.
- An opaque composite paste is applied on the exposed metal surface to mask the colour of metal and light cured for 20 s (Fig. 42.20B).
- Composite resin of appropriate shade is selected and contoured on the surface, light cured for 20 s, finished and polished (Fig. 42.20C).

ii. Facing repair

- This is a repair made with porcelain indirectly in the laboratory. It is a more definitive repair but requires adequate framework thickness. It works well with facings (Fig. 42.21).
- The fractured porcelain is completely removed from the metal by grinding.
- Four to five pinholes are made on the metal surface.
- Impression is made and a thin metal with porcelain superstructure is fabricated.
- This is cemented over the labial metal surface.


A
B

FIGURE 42.20 **(A)** Resin repair of porcelain fracture – porcelain surface etched with hydrofluoric acid and exposed metal is sandblasted intraorally or roughened. **(B)** Silane coupling agent applied, followed by bonding agent and application of opaque composite paste. **(C)** Composite resin of appropriate shade contoured and finished.

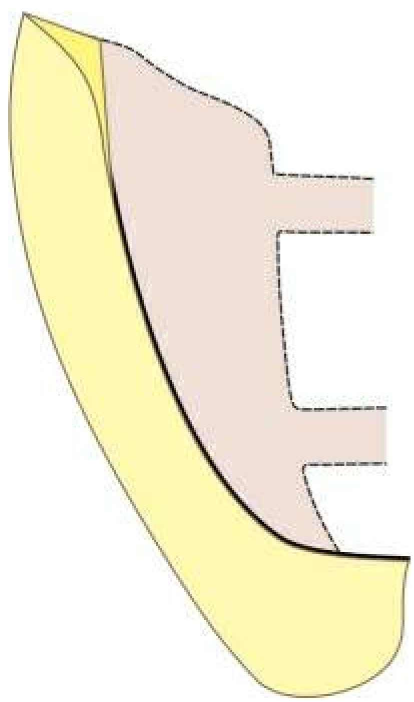


FIGURE 42.21 Facing repair. A thin metal with porcelain

superstructure is fabricated indirectly and cemented over the labial metal surface.

2. All ceramic fracture

Causes

i. Vertical fracture:

- Inadequate finish lines like feather edge.
- Sharp areas on prepared tooth.
- Large portion of proximal preparation form is missing and not restored prior to impression procedure (Fig. 42.22).
- Round preparation form without resistance to rotational forces.

ii. Facial-cervical fracture:

- If tooth is overprepared and it is less than two-third or three-fourth of final restoration in height, this fracture occurs due to poor resistance.
- Opposing tooth contact located incisally to prepared tooth.

iii. Lingual fracture:

○ Inadequate lingual tooth preparation.

FIGURE 42.22 Proximal surface not restored prior to preparation can cause vertical fracture of all ceramic restoration.

Aesthetic failure

Immediate aesthetic failure

Aesthetic problems at the time of cementation can be due to:

• Poor shade match – reasons for this may be:

○ Inadequate selection and communication

○ Metamerism

○ Insufficient tooth preparation

○ Failure to properly apply and fire porcelain

- Poor tooth contour, gingival contour, pontic ridge contour and embrasure.
- Poor margin placement.
- Framework design that displays metal.
- Unrealistic expectations of patient due to poor communication.

Delayed aesthetic failure

These occur over a period of time following cementation due to:

- Gingival recession (Fig. 42.23) due to:

○ Poor fit

○ Overcontour

○ Excessive trauma during tooth preparation and impression making.

- Subpontic tissue shrinkage following extraction – if sufficient time is not allowed for healing following extraction, then the tissue shrinks after cementation and a gap is formed between the pontic and ridge which can be unaesthetic especially in anteriors.
- After periodontal surgery – margins will be exposed due to gingival recession if sufficient healing time is not given following any surgery.
- Unglazed porcelain can cause unsightly wear of opposing natural teeth.

• Poorly glazed porcelain restorations also develop black specks over time.

FIGURE 42.23 Aesthetic failure due to gingival recession.

Psychogenic failure

When all the parameters for a successful FPD have been met with, rarely a patient may still feel uncomfortable with the restoration. This has been attributed to the stress and behavioural changes in the individual. The patient may require counselling to get over this problem. A failure to recognize this problem during the diagnostic phase itself, can lead to a failure of the prosthesis.

Methods of removing a failed FPD

If a FPD fails; usually it needs to be removed for any treatment. Most often it cannot be removed intact and must be cut off from the abutment. It is necessary at least to attempt intact removal.

The following methods can be employed with abundant caution not to damage the abutment:

1. **Using a straight chisel**: By applying a sharp force in an occlusal direction using a mallet, with a sharp chisel placed under the retainer margin. The tapping should be done parallel to the path of withdrawal of prosthesis.

2. **Using a crown remover**: These are commercially available and may be of the following common types:

i. Back action: Uses a weight to deliver a force directed backward with the tip placed such that it transfers the force occlusally (Fig. 42.24).

ii. Spring loaded: Uses a spring mechanism to deliver a sudden force (Fig. 42.25).

iii. Pneumatic: Uses compressed air to deliver a controlled force to remove crowns and bridges (Fig. 42.26).

They are all manufactured with different tips to engage retainers and pontics. Other commercial examples include – Richwill, Metalift and Coronaflex, each with its own unique method of usage.

3. **By cutting retainer:** This is the best method to prevent any damage to the abutment. But it will destroy the prosthesis.

FIGURE 42.24 Back action crown remover.

FIGURE 42.25 Spring loaded crown remover.

FIGURE 42.26 Pneumatic crown remover.

A thin groove is placed in the middle of the restoration with a high speed airotor handpiece using diamonds (ceramic) and carbides (metal) (Fig. 42.27A and B). This should cut through the restoration and expose the abutment. The grove can be placed in the facial aspect but placing it lingually especially for anteriors, may allow the restoration to be used provisionally after removal. A facial slot works best for maxillary and mandibular molars because lingual access is difficult.

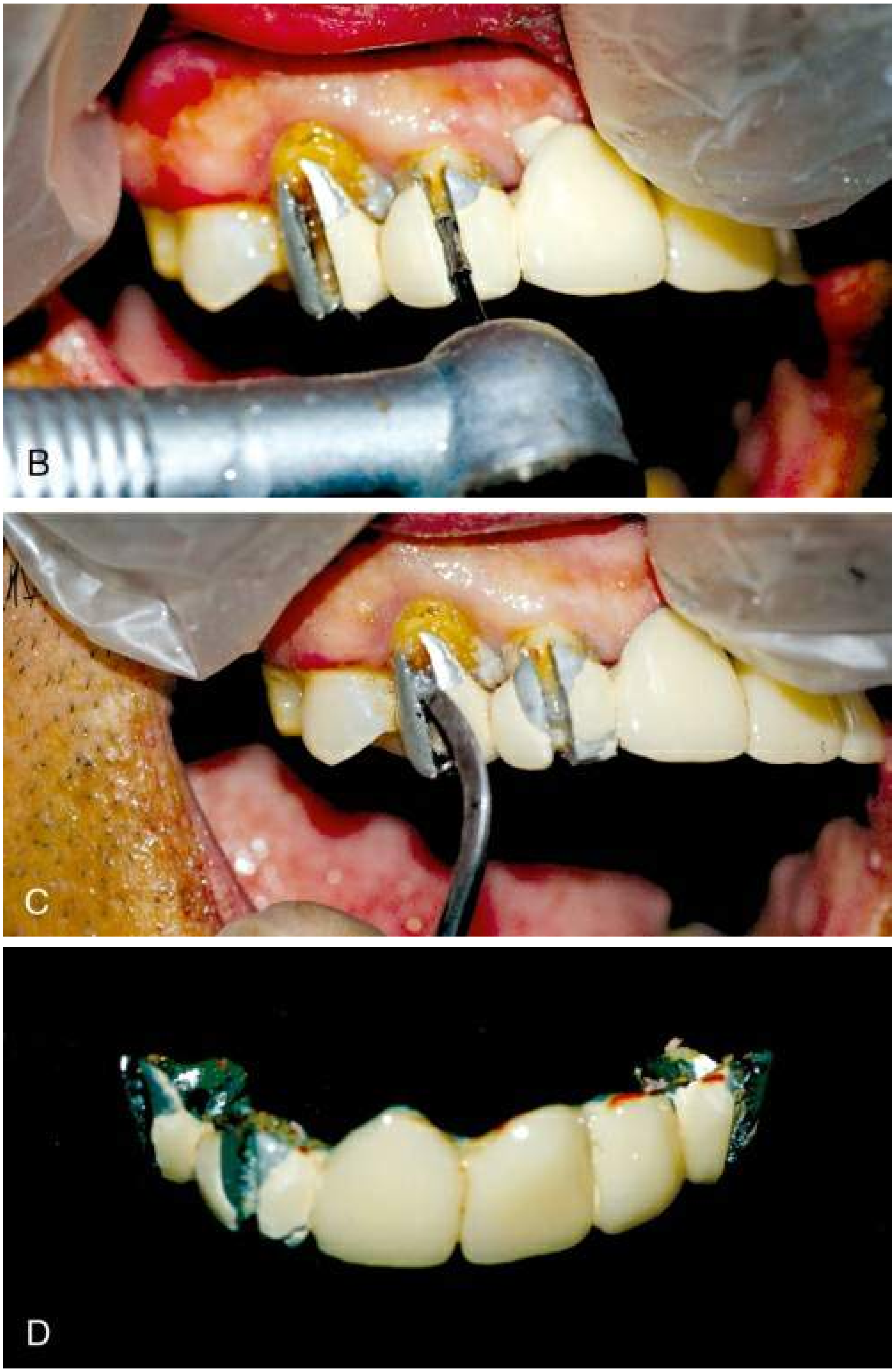


FIGURE 42.27 **(A)** Diamond used to cut the ceramic. **(B)** Carbide bur used to cut the metal. **(C)** Using a sharp instrument the cut metal is pried open. **(D)** Prosthesis removed.

Removal is attempted with a crown remover following cutting through one surface, if not, both facial and lingual surfaces are cut dividing the retainer into two halves. It is now easy to remove with a crown remover or a sharp instrument is used to wedge the two halves (Fig. 42.27C and D).

SUMMARY

The first consideration when confronted with any failure is to ascertain the cause. The causes have been classified and discussed. Most failures are unique and present varying challenges to the dentist. Treatment plan for each situation differs and is individualized. Great satisfaction can be achieved in meeting a situation and solving it in an effective and economical manner.

CHAPTER

43

Metal-free ceramic restorations

CHAPTER CONTENTS

Introduction

The brittle nature and poor flexural strength of ceramics lead to the development of metal-ceramic restorations, which have been used extensively in fixed prosthodontic restorations for decades. As discussed in Chapter 40, it involves making a coping or core in metal that gives the strength, and then firing ceramic on the metal, which provides the aesthetics. The opaque nature of these restorations due to poor light transmission and the need to place margins subgingivally to hide the metal, lead to the development of high strength ceramics or metal-free ceramic restorations. Metal-free ceramics or all ceramic systems have currently gained huge popularity due to their excellent aesthetics and ability to be designed and fabricated by CAD–CAM. Though metal-free ceramics have superior aesthetics, their constant development can be traced to find a system that can match the strength of metal ceramics.

In this chapter we will discuss the development, clinical procedures and methods of fabrication of various metal-free ceramics.

The metal-ceramic restorations, which these metal-free ceramics are trying to replace, have the following advantages and disadvantages.

Advantages of metal-ceramic restorations

- Predictable – used for a number of years with good success.
- Excellent strength – compressive and tensile.
- Good fit.
- Versatile.
- Less knowledge required in choosing a particular system.

Disadvantages of metal-ceramic restorations

- Lack of translucency, as metal is opaque.
- Metal margin may be seen as a black reflection.
- Subgingival placement is necessary to hide the margin.

History and development

1887 – C.H. Land made the first all ceramic crowns using the platinum foil technique.
1965 – Maclean and Hughes developed aluminous porcelain with 40%–50% alumina.
1984 – Peter Adair and David Grossman introduced castable ceramic – DICOR. A glass structure was obtained by casting, and tetrasilicicfluoromica crystals were introduced into the glass by a 'ceramming' process to increase the strength.
Early 1980s – Direct intraoral scanning of prepared tooth introduced by Cerec. Transfer moulded shrink-free all ceramic system 'Cerestore' reinforced with Spinel, was introduced and developed by the Coors Biomedical Co.
1987 – Mcrmann et al. introduced the first CAD–CAM milling unit CEREC (Siemens, A.G. Munchen).
1988 – Sadoun introduced In-Ceram – spinel, alumina and zirconia. These were 'infiltrated' ceramics fabricated by a method called 'slip-casting'.
1990 – 'IPS Empress' leucite-reinforced 'heat pressed' ceramic was presented to the profession by Ivoclar Vivadent. They introduced 'lithium-di-silicate' reinforced 'heat pressed' ceramics in the late 1990s.
1990 – Anderson and Oden developed Procera alumina – dry pressed and sintered using CAD–CAM technology.

Development of all-ceramic restorations was aided by the following discoveries:

- Etching of enamel by Buonocore (1955).
- Bowen's Bis-GMA resins (1960s).
- Ceramic surface treatment and bonding by Rochette (1973).
- Introduction of CAD–CAM to dentistry by Duret (1972).

Strengthening ceramics

Metal-free ceramic restorations commonly utilize two ceramic materials – a high strength ceramic, which is used as a core (similar to a metal coping in metal ceramics). This core is veneered by feldspathic porcelain (similar to porcelains used for veneering metal ceramics). Alternately, the entire restoration can be fabricated with a single moderately high strength ceramic.

The higher the strength of the ceramic, the more opaque is the ceramic with poor light transmission and aesthetics. Hence, these materials are used as core materials and are veneered with low strength ceramics with good translucency and aesthetics.

Mechanisms

Ceramics contain fabrication defects and surface flaws which initiate cracks, making them susceptible to fracture. Mechanisms to strengthen ceramics include the following.

Crack tip interactions

Obstacles in the microstructure prevent crack propagation by reorienting and deflecting the plane of fracture. Alumina, leucite, zirconia and magnesium-aluminium oxide spinel crystals are used to strengthen ceramics by this method (Fig. 43.1).

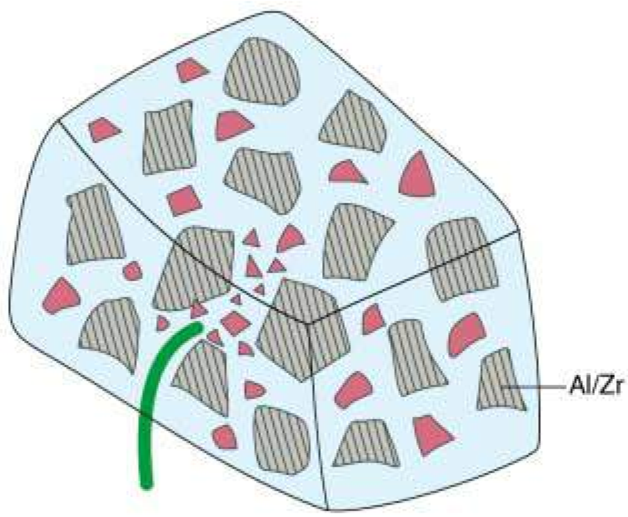


FIGURE 43.1 Aluminium oxide and zirconium oxide crystals strengthen ceramics by crack tip interactions.

Crack tip shielding

Increase in grain volume near the crack tip can prevent crack propagation. This is called 'transformation toughening' and is applicable to zirconia. The crystal structure of zirconia is monoclinic at room temperature and tetragonal at high temperature. The tetragonal form can be retained at room temperature by addition of oxides such as yttrium. Stress transforms the zirconia to monoclinic form leading to an increase in volume and subsequent strengthening (Fig. 43.2).

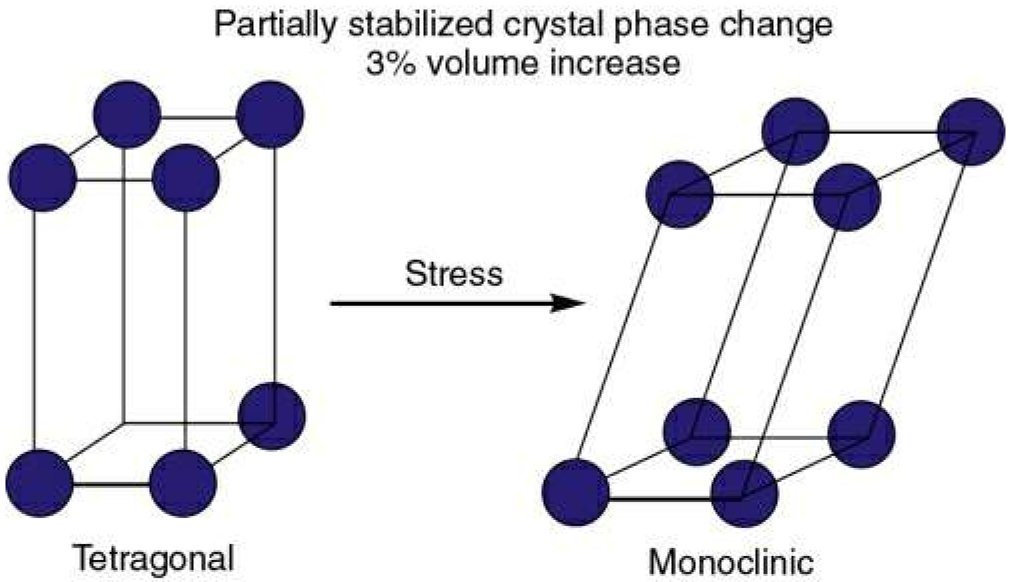


FIGURE 43.2 Transformation toughening – change from tetragonal structure to monoclinic.

Crack bridging

This presents a second crystalline phase to prevent crack propagation. Crystallization of glasses by 'ceramming' as with castable glass ceramics is an example of this type of strengthening.

Materials used to strengthen ceramics

Leucite

- This is a glass ceramic reinforced with leucite crystals (potassium and aluminium tectosilicate).
- Highly translucent hence excellent aesthetics.
- Flexural strength – 150 MPa.
- Fabricated by heat-pressed technique and CAD–CAM.
- May be used as a core material and as a single material.

- Indicated for inlays, onlays, veneers and anterior crowns.
- Have to be adhesively cemented using resin.
- Commercial example – IPS Empress.

Lithium disilicate

- This is a glass-ceramic reinforced with lithium disilicate.
- Good translucency with excellent aesthetics.
- Flexural strength – 400 MPa.
- Fabricated by heat-pressed technique and CAD–CAM.
- May be used as a core material and as a single material.
- Indicated for inlays, onlays, veneers, anterior and posterior crowns, and anterior three-unit fixed partial dentures.
- Have to be adhesively cemented using resin.
- Commercial example – IPS e.max.

Spinel

- Ceramic is reinforced with $MgAl_2O_4$.
- Good translucency, but flexural strength of only 350 MPa.
- Fabricated using slip-casting and CAD–CAM.
- Used only as a core material.
- Indicated for anterior crowns.

- Adhesive cementation not critical.
- Commercial example – In-Ceram spinel.

Alumina

- Ceramic is reinforced with aluminium oxide.
- More opaque, so can be used only as a core material.
- Strength depends on amount of alumina:
  - 50% Alumina – flexural strength is 120–180 MPa (Hi-ceram).
  - 70% Alumina – flexural strength is 500 MPa (In-Ceram).
  - 99% Alumina – flexural strength is 600 MPa (Procera).
- Fabricated with powder-slurry method, slip-casting and CAD–CAM.
- Indicated for anterior and posterior crowns, and anterior three-unit fixed partial dentures.
- Adhesive cementation not critical.
- Commercial examples – In-Ceram alumina, Procera alumina.

Zirconia

- Most commonly used now for all ceramic fixed partial dentures.

- Ceramic is reinforced with yttrium oxide partially stabilized zirconia (Y-TZP.)
- Very opaque, so can be used only as a core material.
- High strength – 900–1200 MPa.
- Fabricated using slip-casting and CAD–CAM.
- Indicated for anterior and posterior crowns and bridges.
- Adhesive cementation not critical.
- Commercial examples – Lava, Cercon, Procera Zirconia.

Advantages

- Translucency and light transmission.
- Excellent tissue response – researchers report recovering smaller amounts of plaque and adherence molecules.
- Eliminate need for ceramic opaque.
- Subgingival placement avoided.
- Reduced risk of overcontouring.
- Reduced thermal conductivity.
- No allergic potential.
- Superior to metals with respect to corrosion, galvanism and biocompatibility.

Disadvantages

- Strength still not comparable to metal-ceramic restorations.
- Long-term performance using fixed partial dentures – no data available yet.
- Proper tooth preparation design is critical to ensure mechanical success.
- More knowledge required in choosing appropriate material.

Indications

This has been discussed under each material used for strengthening ceramic, as translucent materials will have different indications than opaque ceramics.

Contraindications

- Occlusal clearance after tooth preparation is less than 0.8 mm.
- Thin teeth labiolingually.
- Deep bite with lingual wear facets.
- Bruxism and parafunctional activity.

Classification

Ceramics are commonly classified according to:

Firing temperature

- High fusing: >1300°C
- Medium fusing: 1101–1300°C
- Low fusing: 850–1101°C
- Ultra low fusing: <850°C.

Processing technique

- Powder slurry
- Castable
- Slip-casting
- Heat pressed
- CAD–CAM

Glass content

- Predominantly glass-veneering porcelains like feldspathic porcelains.
- Particle filled glass (also called glass ceramics).

○ High glass content – leucite reinforced.

- Low glass content:
  - Lithium-disilicate reinforced
  - Infiltrated – In-Ceram
- Polycrystalline – alumina and zirconia.

Methods of fabrication

All-ceramic restorations can be fabricated by the following methods.

Powder slurry

- The core porcelain is fabricated by mixing the powder with modelling liquid and firing in a ceramic furnace similar to fabricating conventional feldspathic porcelains. The veneering porcelain is then built up over the core (Figs 43.3 and 43.4).
- This method was used for the early aluminous porcelains and is no longer used. Commercial examples are Hi-Ceram and Duceram.

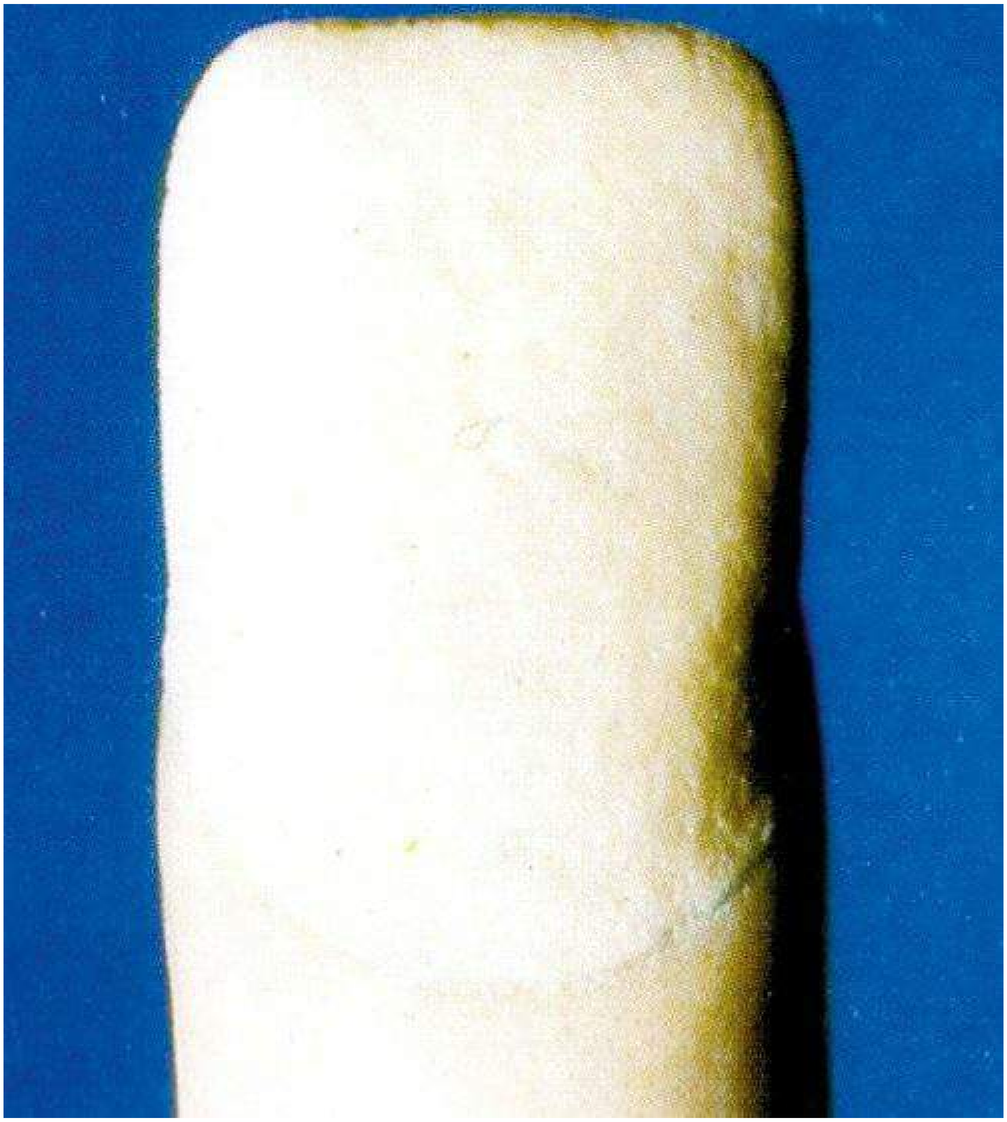


FIGURE 43.3 Alumina core fired.

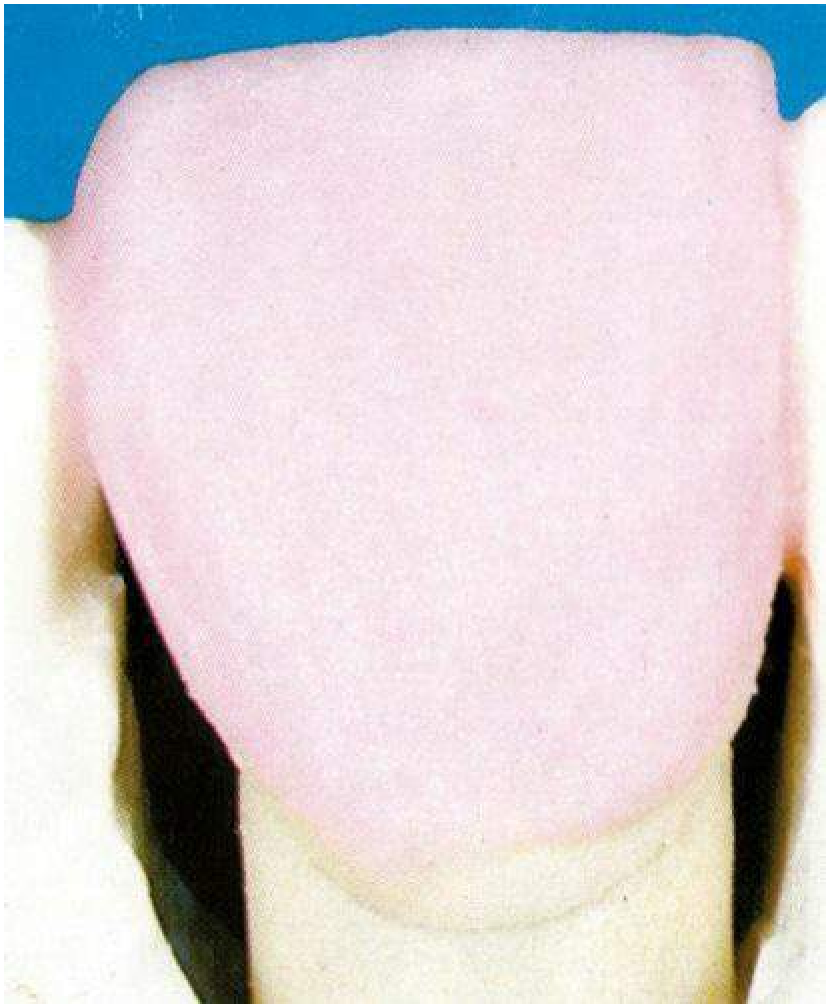


FIGURE 43.4 Veneering ceramic built up on core and fired (courtesy VITA Zahnfabrik manual).

Castable

- The restoration is fabricated by the lost wax process, similar to making metal copings in metal-ceramic restorations.
- A wax pattern is made, invested, burnt-out and molten glass is cast into the mould. The glass is then heat-treated in the ceramic furnace to form the glass-ceramic and then stained to form the final restoration (Figs 43.5 and 43.6).
- This method and the ceramics used are now obsolete. Commercial

examples are Dicor, Cerapearl.

FIGURE 43.5 Wax pattern sprued.

FIGURE 43.6 Glass after casting.

Slip-casting

- The 'slip' which is a mixture of the reinforced ceramic with an aqueous medium, is first applied on a gypsum die (Fig. 43.7). This is sintered (fired) in a ceramic furnace (Fig. 43.8). Special glass particles are then applied on this sintered ceramic and again sintered (fired). This allows the glass to get 'infiltrated' into the ceramic. This forms the core (Figs 43.9 and 43.10). Veneering porcelains are then built up to complete the restoration (Fig. 43.11).

- This procedure was developed by the VITA Zahnfabrikcompany to fabricate all-ceramic restorations called ‘In-Ceram’. Three materials were used with this method – spinel, alumina and zirconia.

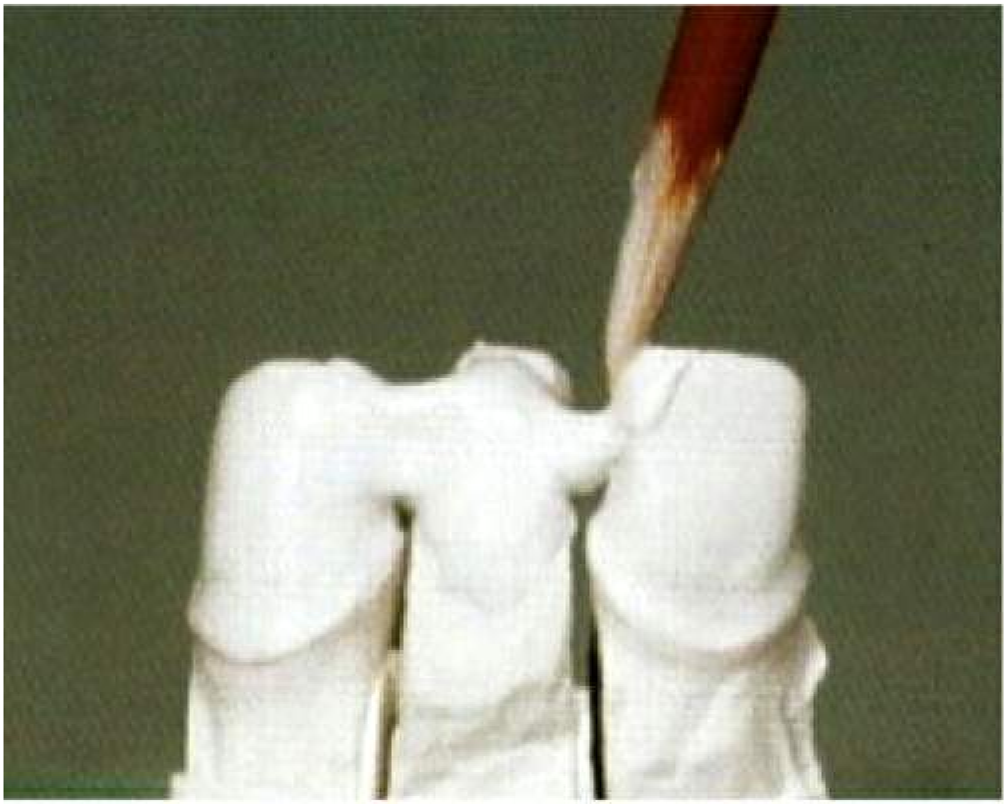


FIGURE 43.7 Slip fabricated (courtesy VITA Zahnfabrik manual).

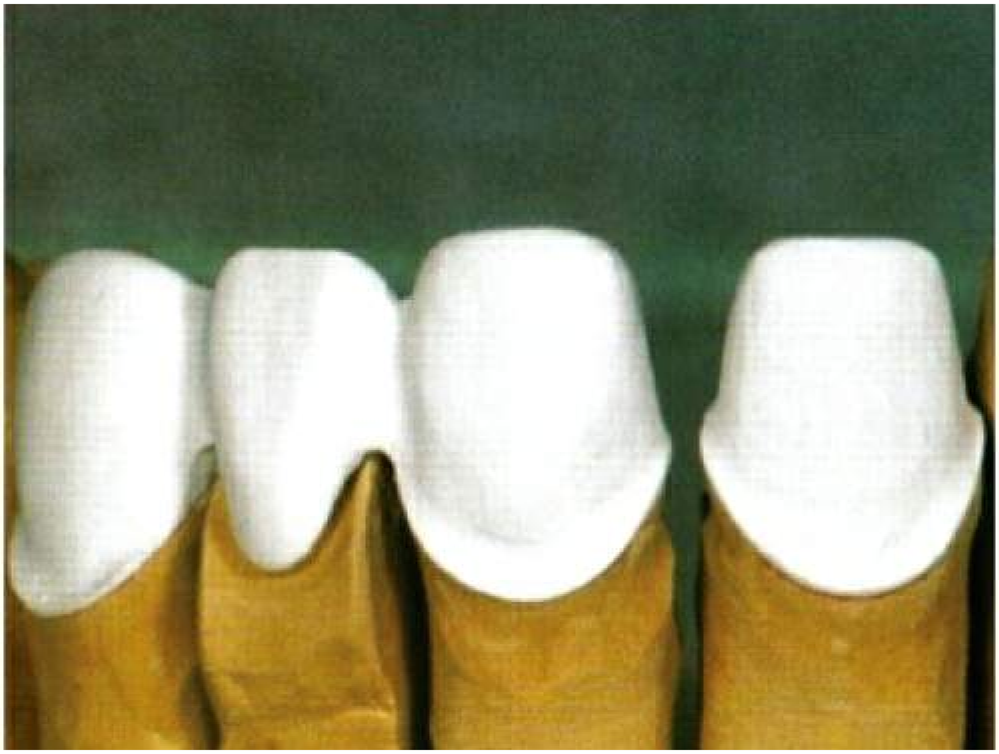


FIGURE 43.8 Following sintering of slip (courtesy VITA Zahnfabrik manual).

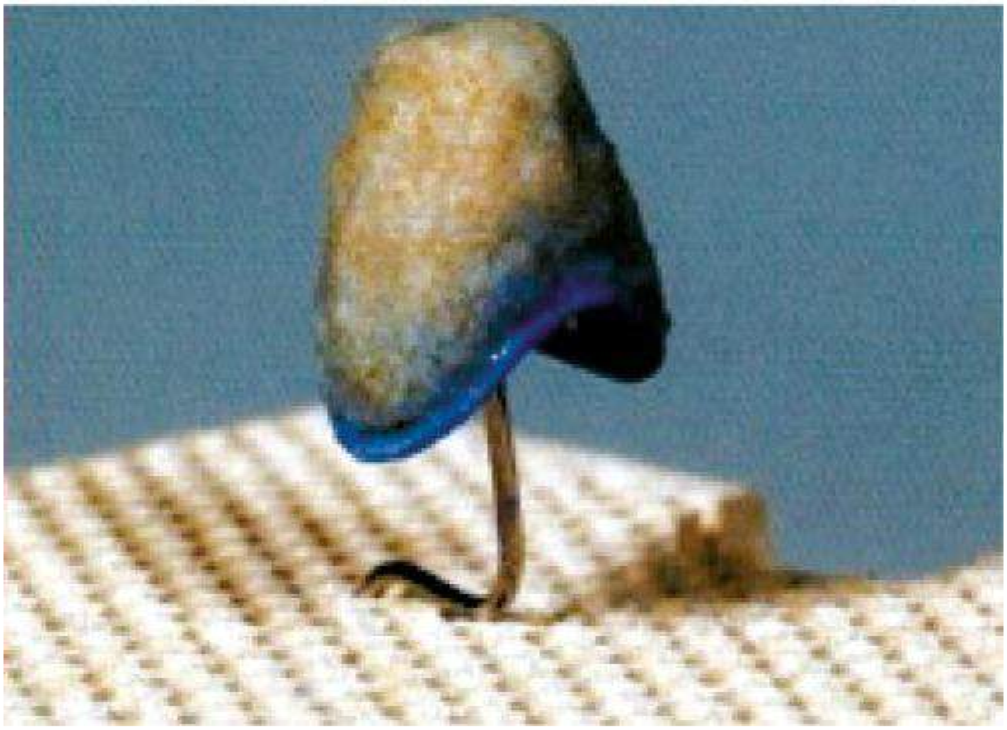


FIGURE 43.9 Glass infiltration (courtesy VITA Zahnfabrik manual).

FIGURE 43.10 Following sintering of glass infiltrate (courtesy VITA Zahnfabrik manual).

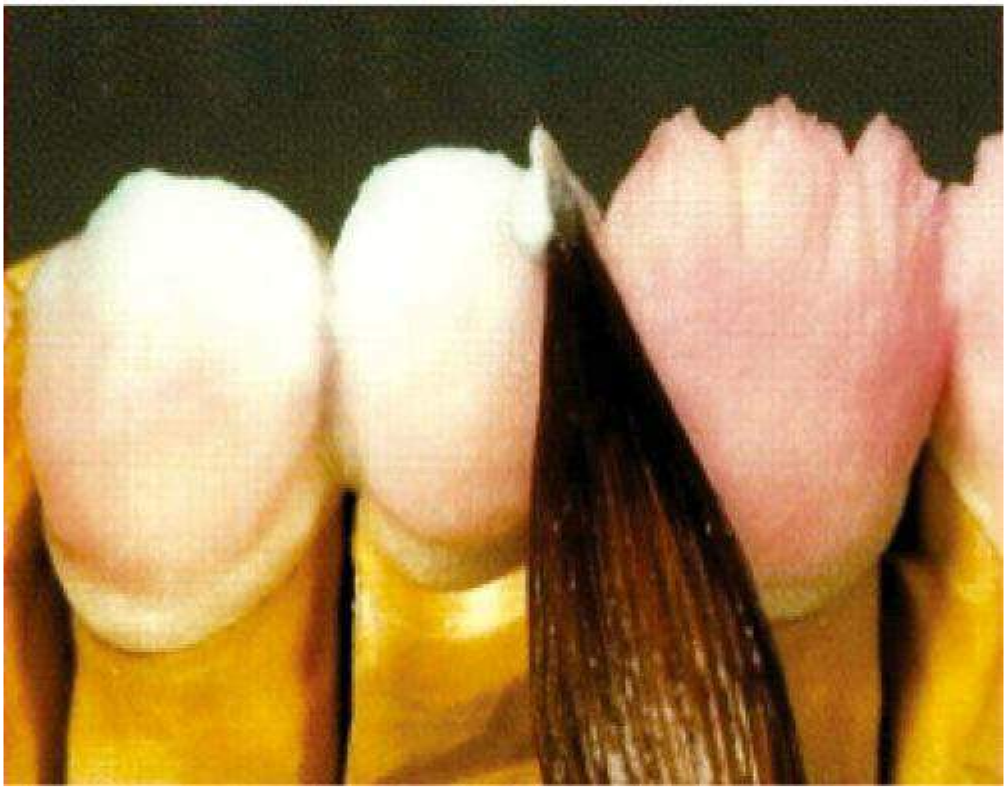


FIGURE 43.11 Build-up of veneering porcelains (courtesy VITA Zahnfabrik manual).

Heat-pressed

- The procedure is similar to the lost wax casting procedure. The ceramic block is heated and allowed to flow into the mould using hydrostatic pressure (Figs 43.12–43.17).

- This procedure was developed to fabricate all-ceramic restorations reinforced with leucite and lithium disilicate. They are hence called ‘pressable ceramics’.

- As the materials have good translucency they can be fabricated as a core ceramic (layering technique) or as a single fully contoured restoration (staining technique).

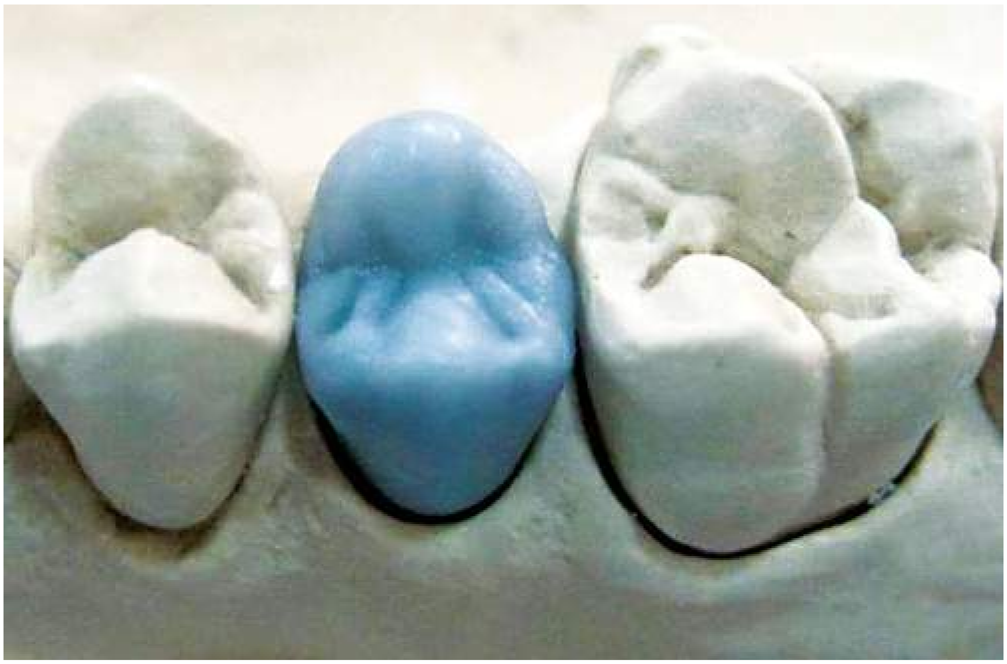


FIGURE 43.12 Full contour wax up done.

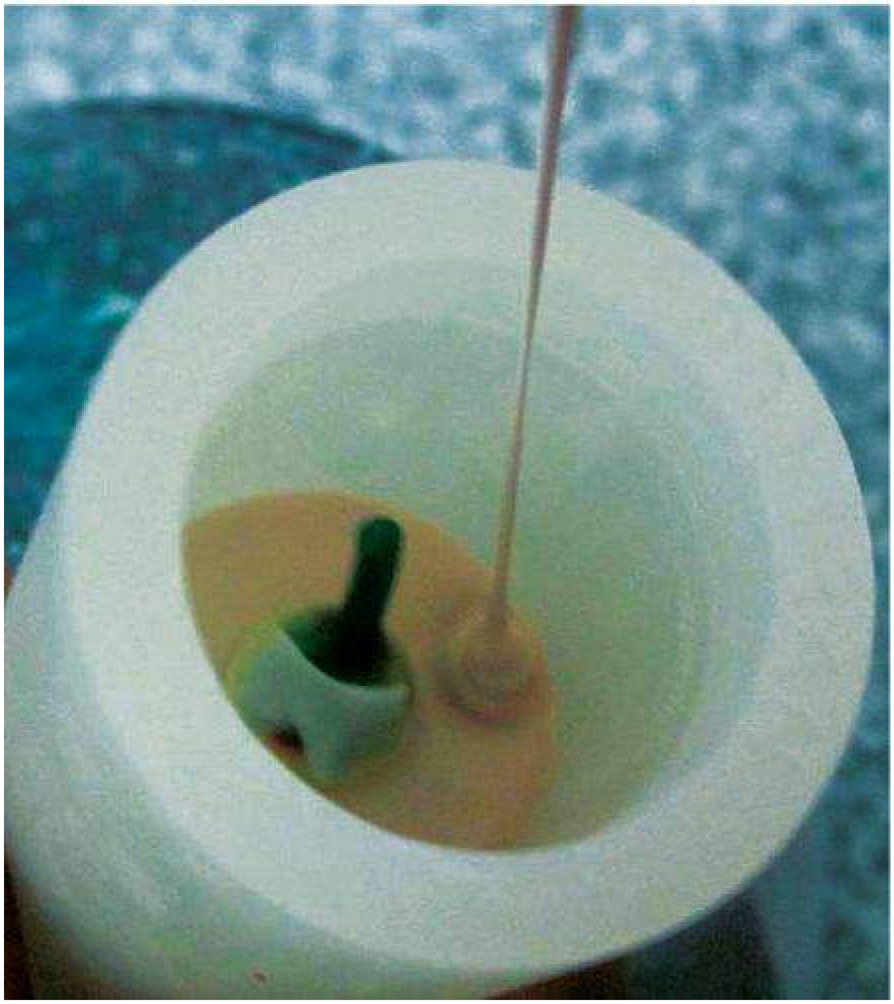


FIGURE 43.13 Wax pattern invested.

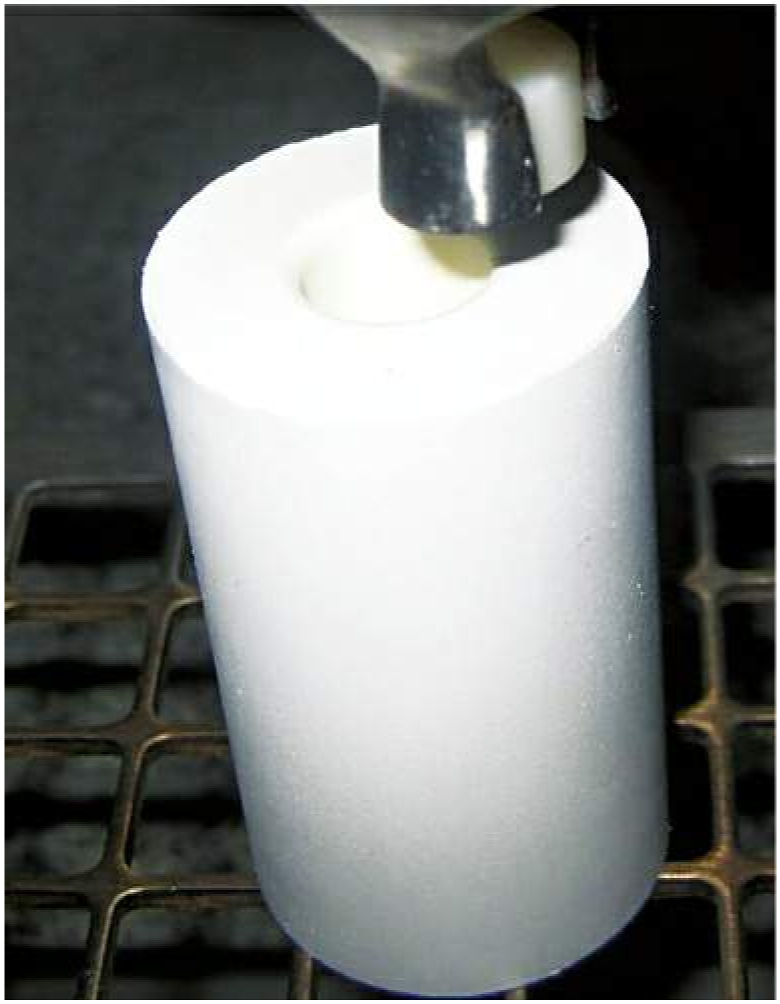


FIGURE 43.14 Ingot placed.

FIGURE 43.15 Plunger positioned.

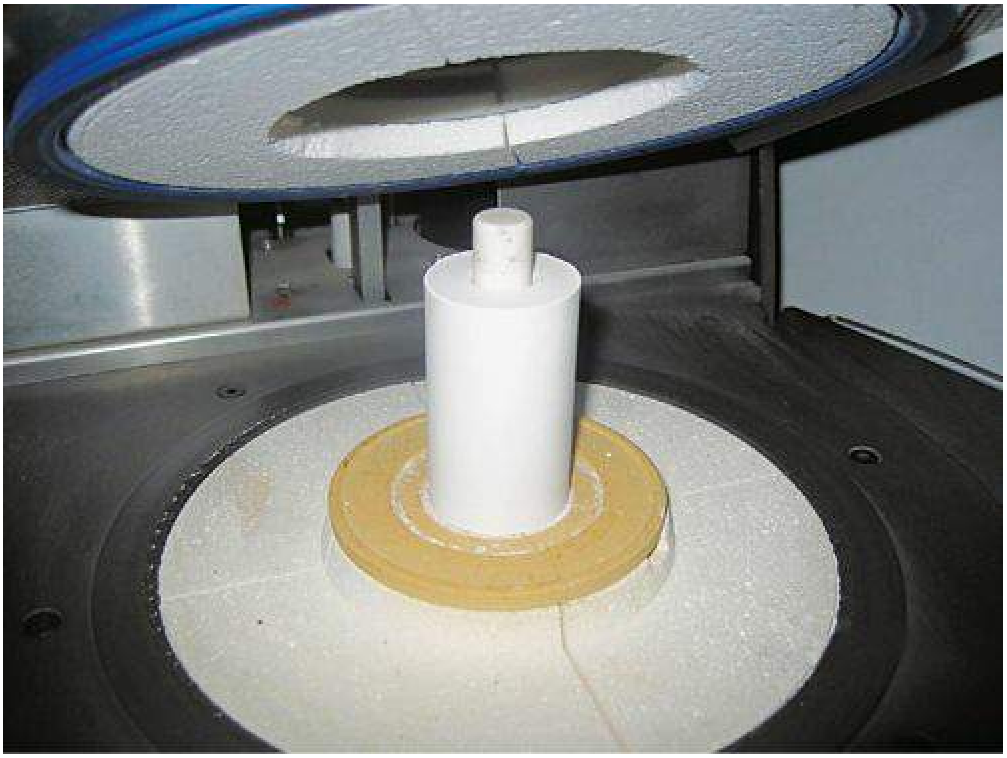


FIGURE 43.16 Heat pressing in ceramic furnace.

FIGURE 43.17 Staining and finishing the final restoration.

CAD–CAM

The restorations are fabricated using computer-aided designing (CAD) and computer-aided machining (CAM).

Restorations can be fabricated using two types of processing methods.

Dry pressed and sintered

- One of the first systems to use computer technology in its fabrication was 'Procera', involving an industrial CAD–CAM process.

- Dies are scanned and coping is designed using CAD (Figs 43.18 and 43.19). The data are sent to a centralized workstation where an enlarged computer-aided model is produced to exactly compensate for sintering shrinkage of the ceramic. High alumina-based core ceramic (99% alumina) is then dry-pressed and sintered on the dies using an industrial process (Fig. 43.20). The core or coping is sent back to the respective laboratories where veneering porcelain is built up and restoration is completed. The same technology is also available for zirconia-based core ceramics.

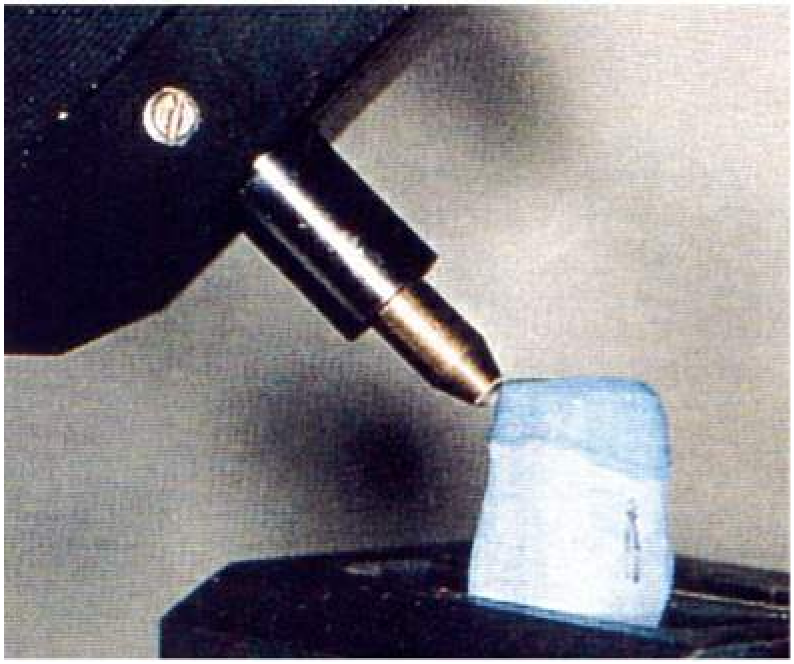


FIGURE 43.18 Scanning of die (courtesy Nobel-Biocare).

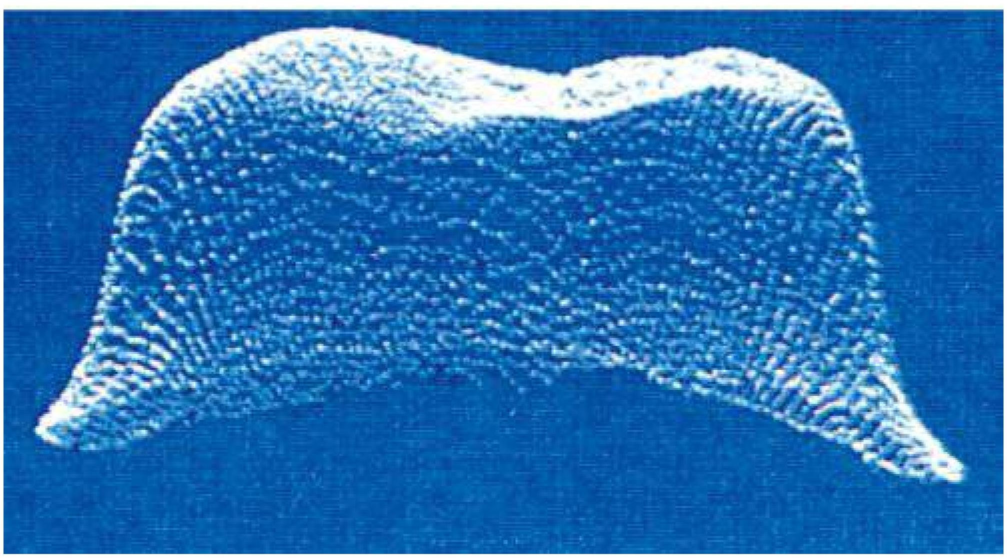


FIGURE 43.19 Computer generated die after scanning where coping is designed (courtesy Nobel-Biocare).

FIGURE 43.20 Finished coping after fabrication (courtesy Nobel-Biocare).

Machined

Restorations are milled from blocks of reinforced ceramic materials (Fig. 43.21). All the materials – leucite, lithium-disilicate, spinel, alumina and zirconia can be used with this method.

FIGURE 43.21 A ceramic blank for milling (courtesy VITA Zahnfabrik).

In general, blocks are made from the respective ceramic powders by mixing them with a binder and pressing them into a mould. The blocks are then sintered and ready for milling. This type of fabrication results in an increase in density and mechanical properties of the ceramic.

Two methods can be used to make machined restorations:

1. Direct technique

An intraoral scanner is used to scan the preparation directly in the mouth. The restoration is designed on the computer (CAD) and the data are transferred to a milling machine, which mills the restoration to the designed shape (CAM).

Commercial examples of intraoral scanners are CerecBluecam, Lava (Fig. 43.22) and CadentItero.

FIGURE 43.22 Intraoral scanner.

2. Indirect technique

A model is fabricated using conventional impression materials and dies. The model is scanned and the restoration is designed using CAD and data are transferred to a milling machine for fabrication (Fig. 43.23).

FIGURE 43.23 Milling a restoration using CAD–CAM.

Alternately, the wax pattern can also be scanned and a coping or core milled accordingly. This is known as '*copy milling*'.

Both cores and fully contoured restorations can be made with the above methods depending on the ceramic used. Alumina and zirconia can only be used as core materials, which are then veneered with conventional porcelains.

Commercial systems that design and fabricate all-ceramic restorations by milling using indirect technique are Lava, Cercon, Cerec-in-lab.

Fixed partial dentures

- Fracture of all-ceramic fixed partial dentures is related to size, shape and position of connectors (Fig. 43.24). Hence, the dimension of the connector is critical for success. For zirconia-based ceramics the minimal thickness of connector should be 3 mm buccolingually and occulusogingivally. In comparison, metal-ceramic fixed partial dentures can function with a connector size of 2.5 mm.

- Gingival and lingual surfaces of connectors and intaglio surface of pontic made with core material.

- Span of pontic should not be greater than length of one molar.

- Currently only the following reinforcing materials are indicated:

  ○ Anterior FPDs – lithium disilicate, alumina and zirconia

  ○ Posterior FPDs – zirconia

- Contraindications:

  ○ Periodontally involved teeth

  ○ Cantilevers

  ○ Deep bite

  ○ Parafunctional activity

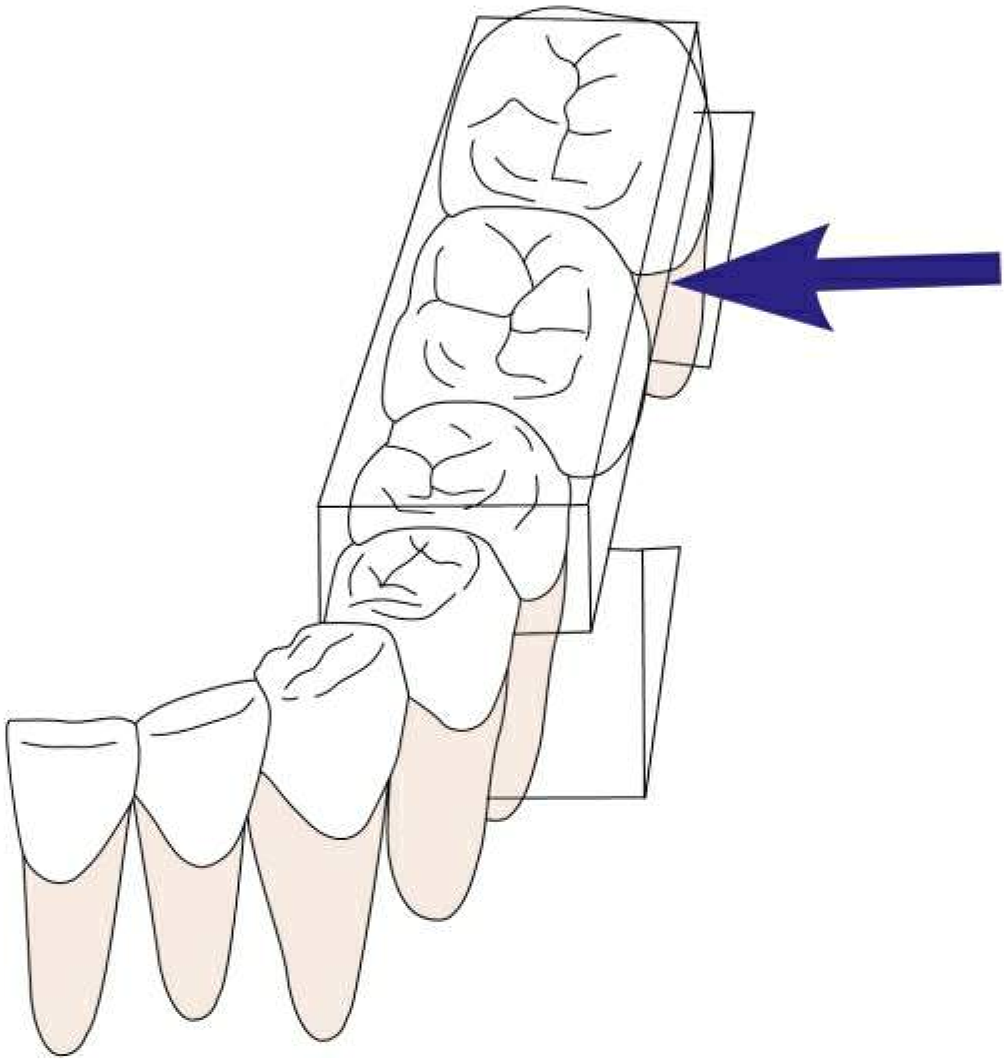


FIGURE 43.24 Connector size is important for success of all-ceramic fixed partial dentures.

Clinical procedures

Tooth preparation for all ceramic restorations is discussed in Chapter 35.

Impression making, fabricating provisional restorations and shade selection is similar to that described for any fixed prosthodontic restoration.

Cementation

The procedures differ only for cementation. Adhesive cementation (bonding) using resin cements is critical for ceramic systems using leucite and lithium-disilicate. Although this is not critical for alumina- and zirconia-based systems, adhesive cementation has demonstrated reduced microleakage. Resin-modified glass ionomer cements are contraindicated for use with all-ceramic systems as they may undergo expansion due to water absorption following cementation.

Adhesive cementation using resin cements

- Fit of all-ceramic crown is checked on cast (Fig. 43.25).
- The fitting surface of crown is etched with 15%–30% hydrofluoric acid, rinsed and dried (Fig. 43.26). Alumina and zirconia cannot be etched, so they are sandblasted. Zirconia can also be silicoated.
- Ceramic primer or silane coupling agent is then applied and allowed to dry for one minute (Fig. 43.27).
- Regular bonding agent is then applied. Light curing may form a layer that can prevent seating, so it can be avoided.
- The prepared tooth is then etched with 37% phosphoric acid and bonding agent applied. Again light curing may be avoided (Figs 43.28 and 43.29).

- The resin cement is mixed, applied to the fitting surface of crown and seated on the prepared tooth (Figs 43.30 and 43.31). For dual cure cements, light curing is done for 5 s after which the excess cement is removed (Fig. 43.32). It may be difficult to remove the excess if resin hardens completely (Fig. 43.33). The margins are then light cured for 1 min.

- The margins are finished with fine grit diamonds (Fig. 43.34). Occlusion is also checked and corrected only after cementation.

- A self-etch, self-bond single component resin cement is now available for adhesive cementation (Fig. 43.35). The manufacturers claim enhanced bond strength to both ceramic and tooth and it is also not necessary to etch and bond the tooth and restoration. This is available in capsule form and is mixed using an automixer. Commercial examples: G-CEM (GC) and RelyX (3M).

FIGURE 43.25 Check fit on cast.

FIGURE 43.26 Etch with hydrofluoric acid.

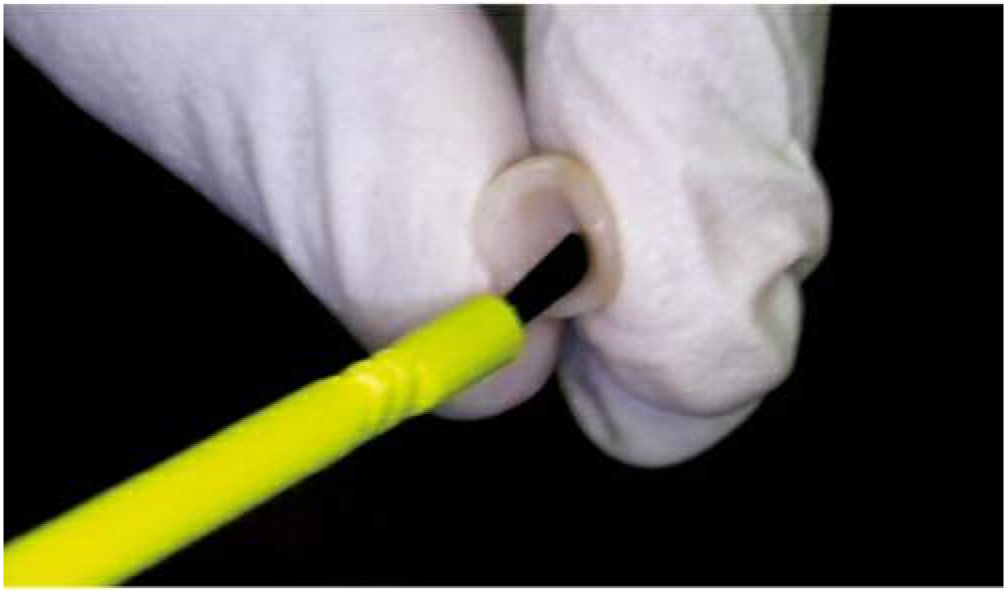


FIGURE 43.27 Application of silane.

FIGURE 43.28 Etching tooth.

FIGURE 43.29 Application of bonding agent.

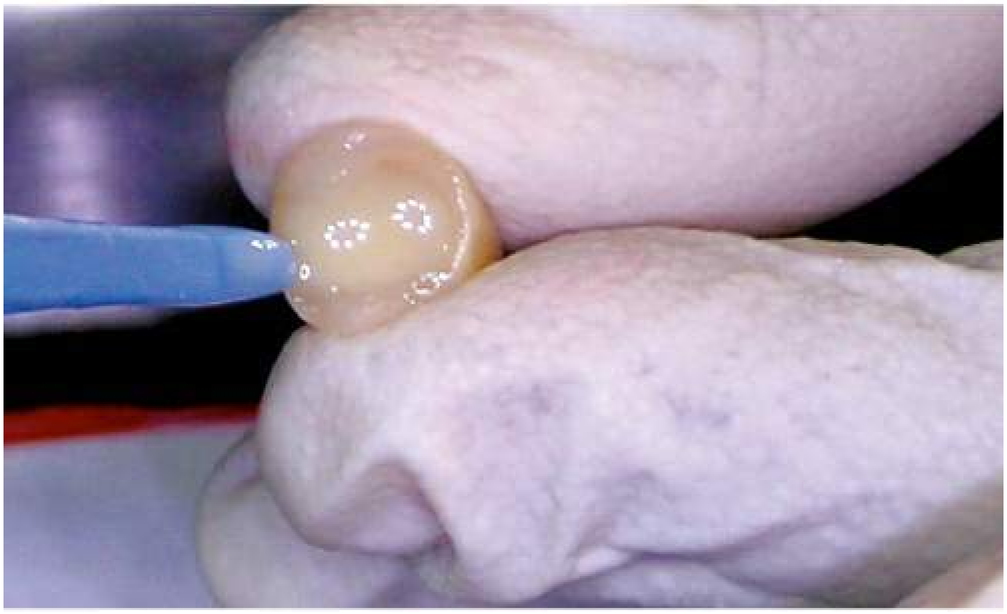


FIGURE 43.30 Resin cement mixed and loaded on crown.

FIGURE 43.31 Crown placed on tooth.

FIGURE 43.32 Initial light curing for 5 s.

FIGURE 43.33 Excess cement is removed from margins.

FIGURE 43.34 Finishing with fine grit diamonds.

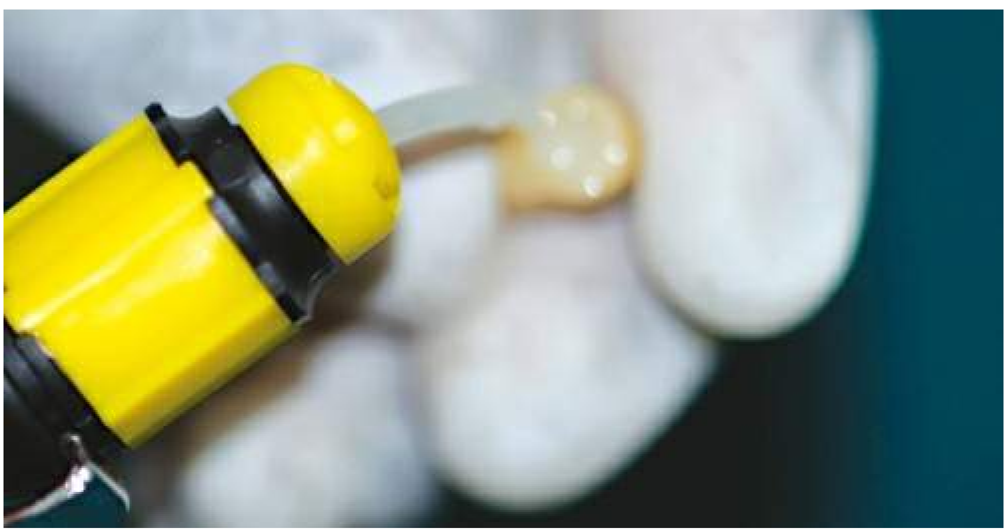


FIGURE 43.35 A self-etch, single bond, single component resin cement in capsule.

SUMMARY

Metal-free ceramic restorations will probably replace metal-ceramic restorations, especially for anterior regions due to their superior aesthetics. All the development in these ceramics has been aimed at matching the strength of metal-ceramic restorations. A plethora of

systems and manufacturers make selection of a particular system difficult. In general, only the reinforcing material and method of fabrication dictate the strength and aesthetics and not the system used. Leucite and lithium disilicate reinforced ceramics are more translucent and used for anterior inlays, veneers and crowns with adhesive cementation. Alumina-based restorations fabricated by the CAD–CAM technology can also be used for anterior fixed partial dentures, while zirconia-based materials are indicated for posterior fixed partial dentures. Data on long-term success of these materials for posterior fixed partial dentures are still not available. Alumina and zirconia are both opaque materials and are used only as core materials. They do not require adhesive cementation.

CHAPTER 44

Resin-bonded fixed partial dentures

CHAPTER CONTENTS

Introduction

Definition: A fixed dental prosthesis that is luted to tooth structures, primarily enamel, which has been etched to provide mechanical retention for the resin cement (GPT8).

- It is also termed as 'adhesive bridge'.
- First described by Rochette in 1973 (mandibular anterior teeth).
- It involves replacing teeth by attaching pontics to thin metal retainers, which are bonded to the palatal/lingual surface of the abutments using resin cements. The retention to metal formed the basis of development of this prosthesis.
- Buonocore acid-etch technique and Bowen's resins assisted the development of this concept.

Indications and contraindications

Indications and contraindications of resin-bonded fixed partial dentures (RBFPDs) are presented in Table 44.1.

Table 44.1

Indications and contraindications of resin-bonded fixed partial dentures

Indications	Contraindications
1. Replacement of missing anteriors in children and adolescents 2. Abutments with sufficient enamel to etch for retention 3. Short-span bridges 4. Splinting periodontally weak teeth 5. Medically compromised patients 6. As a long-term temporary restoration in patients with craniofacial anomalies 7. Postorthodontic retention	1. Insufficient occlusal clearance 2. Thin anterior teeth faciolingually 3. Short clinical crowns 4. When facial aesthetics of teeth require a change 5. Deep vertical overlap 6. Insufficient enamel available for bonding – caries, restorations, hypoplasias 7. Parafunctional habits 8. Long-span bridges 9. Sensitivity to base metal alloys

Advantages and disadvantages

Advantages and disadvantages of RBFPDs are presented in Table 44.2.

Table 44.2

Advantages and disadvantages of resin-bonded fixed partial dentures

Advantages	Disadvantages
1. Conservation of tooth structure, preparation is confined to enamel	1. Longevity is in question
2. Tolerant to tissues with no pulpal trauma and supragingival margins	2. Technique sensitive
3. Anaesthesia not required	3. Space, contour and alignment correction of abutment not possible
4. Impression making is easy	4. Possibility of overcontouring is high which can lead to increased plaque accumulation
5. Provisional restorations are not required	5. Can be used to replace only one tooth
6. Less chairside time	6. Can cause 'greying' in thin teeth
7. Does not require cast alterations or removable dies	7. Aesthetics is moderate
8. Reduced cost	
9. Rebonding possible	

Classification

RBFPDs are classified based on the type of retention utilized by the retainers which also incidentally forms the basis of their development, as follows:

1. Mechanical
2. Micromechanical
3. Macromechanical
4. Chemical

Mechanical (Rochette bridge)

- It was developed in 1973 by Rochette.
- This was the first resin-bonded prosthesis to be developed.
- Rochette utilized a wing-like retainer with multiple flared perforations to provide mechanical retention for resin cement (Fig. 44.1).
- This was used at that time for both anterior and posterior fixed partial dentures.
- A clinical study by Boyer et al. (1993) reported that anterior FPDs with perforated retainers had a 50% failure in 110 months and 63% in 130 months.

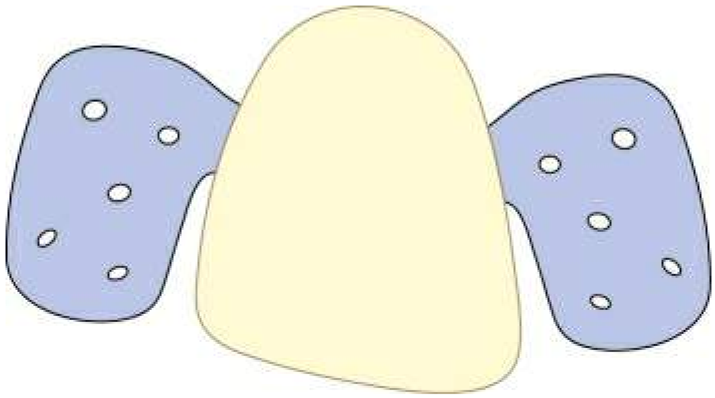


FIGURE 44.1 Rochette bridge with perforation in metal retainers.

Limitations

- Perforations weakened the metal retainers.
- The resin in the perforations was exposed to oral fluids, which caused wear and microleakage.
- Retention provided by the perforations was limited.

Micromechanical (Maryland bridge)

- It was developed by Livaditis and Thompson at the University of Maryland in 1981.
- Electrolytic etching was used to provide micromechanical retention to nonperforated base metal retainers, bonded by resin cement (Fig. 44.2).
- For etching they used a 3.5% solution of nitric acid with a current of 250 mA/cm^2 for 5 min followed by immersion in 18% hydrochloric acid solution in an ultrasonic cleaner for 10 min.
- Ten per cent sulphuric acid in 300 mA/cm^2 current has been used for etching beryllium containing alloys and a one step technique has

also been advocated using a combination of sulphuric and hydrochloric acids placed in an ultrasonic cleaner for 99 s while current is passed. Chemical etching and gel etching have also yielded similar results. Retention of similar values was provided by all these techniques.

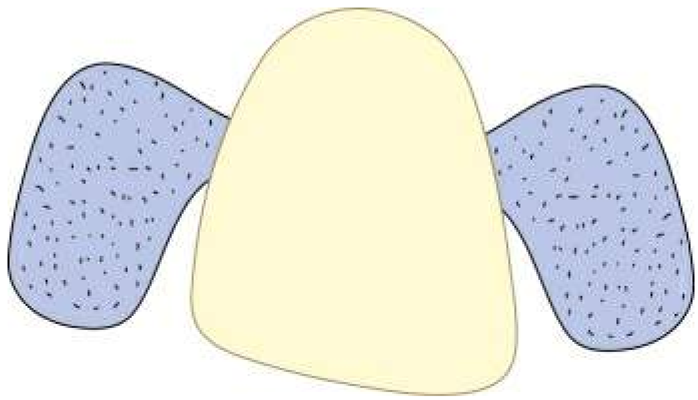


FIGURE 44.2 Maryland bridge.

Advantages

- Better retention than perforated retainers.
- Highly polished retainers prevented plaque accumulation.

Limitations

- Highly technique sensitive depending on procedure adopted at laboratory.
- Variable results were reported for etching the same alloy.
- Retention decreased with time.

Macromechanical

Virginia bridge

- It was developed by Moon and Hudgins at the University of Virginia in 1983.
- Utilized macroscopic mechanical retention using 'lost salt crystal technique' (Fig. 44.3).

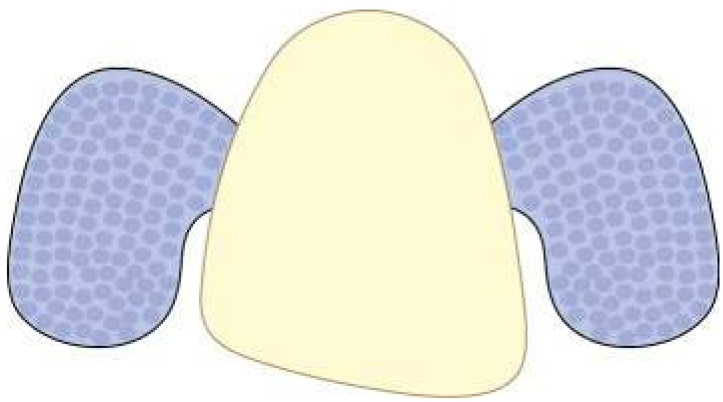


FIGURE 44.3 Virginia bridge.

Procedure

- The die is lubricated and sieved cubic salt (NaCl) 150–250 microns is sprinkled on the surface leaving out the margins.
- A resin pattern is now constructed over the salt allowing it to get incorporated in the resin.
- The salt is then dissolved by placing the set pattern in an ultrasonic cleaner. This leaves behind voids in the pattern, which are reproduced in the casting. This provides the retention.

Advantages

- Procedure can be used with any metal.

• Bonding to metal superior to electrolytic method.

Disadvantage

• Thickness of retainer is increased to allow for retentive layer.

Cast mesh fixed partial denture

A nylon mesh is placed on the palatal/lingual surface of the abutment die and the pattern is fabricated over this mesh (Fig. 44.4). The mesh gets incorporated and following casting provides retention for resin to metal.

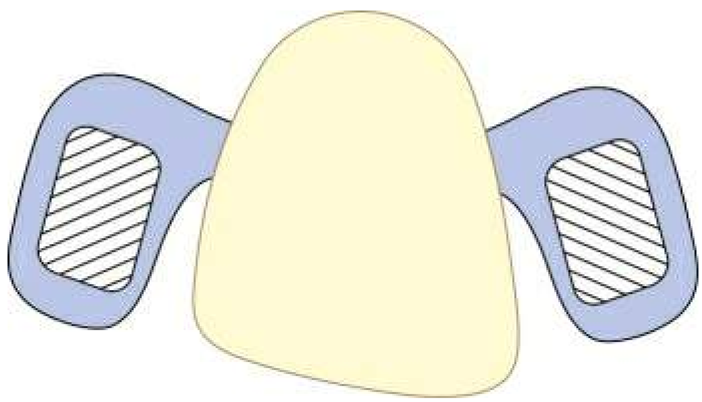


FIGURE 44.4 Cast mesh fixed partial denture.

Disadvantages

• Adaptation of the nylon mesh to the cast is not good.

• The wax may flow in between the mesh locking all the undercuts.

The retention of the metal to the resin in all the above types of RBFPDs can be improved with silanation and/or air abrasion with aluminium oxide.

Chemical (adhesive bridges)

These are now the most commonly used methods for bonding the resin cements to metal. Their high bond strength, fracture toughness and long-term clinical success have rendered alloy etching and macroscopic retention mechanisms obsolete. The following materials are employed:

Modified bis-GMA cement

This was developed in the mid-1980s. A metal primer (similar to a silane coupling agent) is used to bond the resin cement to metal alloys. This is effective for both noble and base metal alloys. Different resin cement manufacturers use different primers. A popular resin, cement Panavia uses 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) as the adhesion promoter or primer. This primer is applied to the fitting surface of the metal retainer following sandblasting with 50 microns alumina, before cementing the prosthesis.

Superbond

This resin cement was developed in Japan in the 1983. In this resin system, the powder is a polymer of methyl methacrylate and liquid is composed of methyl methacrylate modified with adhesion primer 4-META (4-methacryloxyethyl trimellitic anhydride). A unique catalyst tri-*n*-butylborane is added to the liquid before mixing with powder. The set resin cement has a chemical bond to base metal alloys. For bonding to noble metal alloys, a special primer has been developed.

Rocatec system

This is a laboratory method of bonding to both noble and base metal alloys. Fitting surface of metal is sandblasted (abraded) with 120 microns alumina. This is followed by abrasion with a special silicate-particle containing alumina, which deposits a coating of silica and alumina on alloy surface. A silane coupling agent is then applied to bond the metal to the resin cement. There is a risk of contamination of the silica treated surface before or during clinical procedures.

Whichever technique is employed to achieve bonding, to limit the stress on the bonding interfaces and prevent cement dissolution, it is important for the framework to achieve mechanical retention through the tooth preparation design.

Fabrication

Tooth preparation

Principles

- Lingual-axial reduction following the anatomic planes.
- Proximal preparation must extend labially just beyond contact dictated by aesthetics.
- Should encompass at least 180° of tooth.
- Supragingival chamfer finish line.
- Occlusal clearance of 0.5 mm where required.
- Resistance can be enhanced with proximal grooves, boxes (Fig. 44.5).
- Vertical stops or support can be provided by countersinks or cingulum rest in anterior abutments and occlusal rests in posteriors (Fig. 44.6).

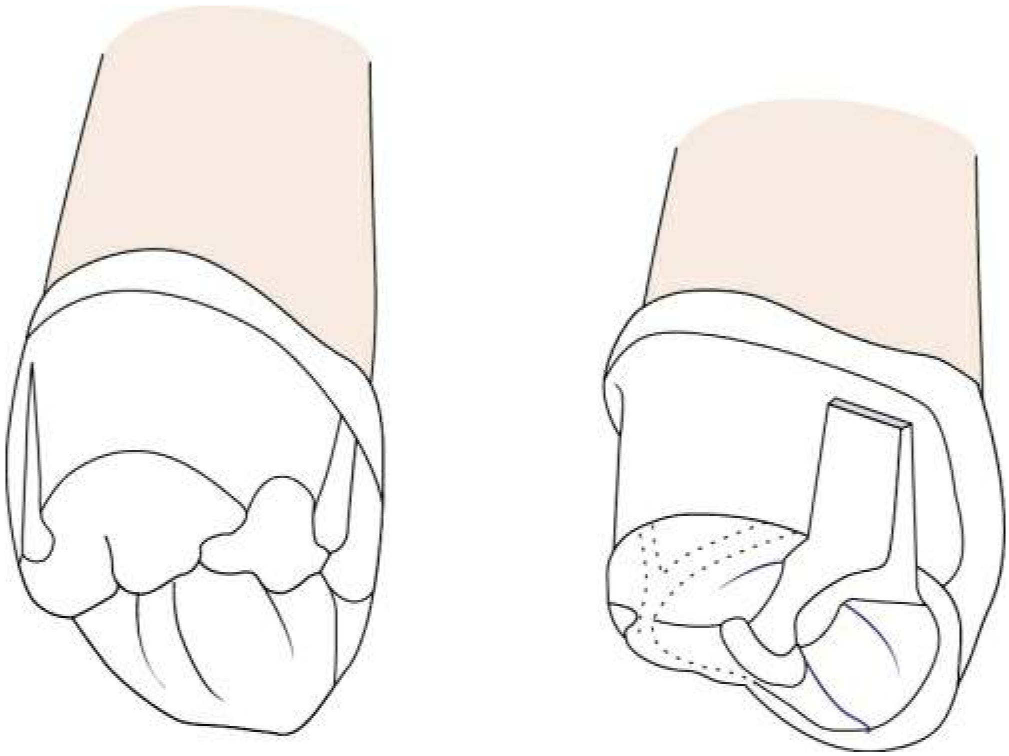


FIGURE 44.5 Grooves and boxes to increase resistance.

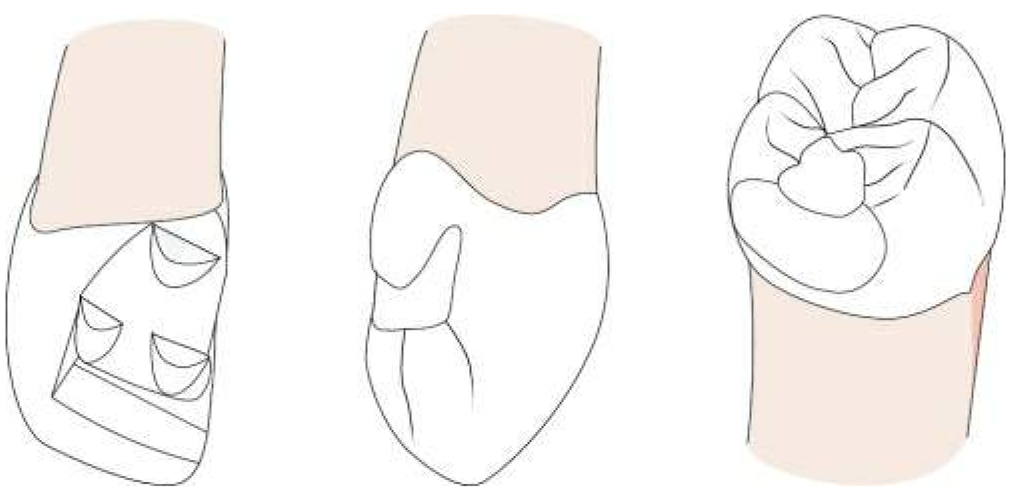


FIGURE 44.6 Countersinks, cingulum rests and occlusal rests provide support.

Anterior preparation design and sequence

Lingual cingulum

Depth orientation grooves are placed with a No. 1 round bur (1 mm diameter) on the lingual cingulum surface and reduced with a wheel diamond to provide 0.5 mm clearance (Fig. 44.7 A and B). Preparation is terminated 1.5–2 mm from the incisal edge.

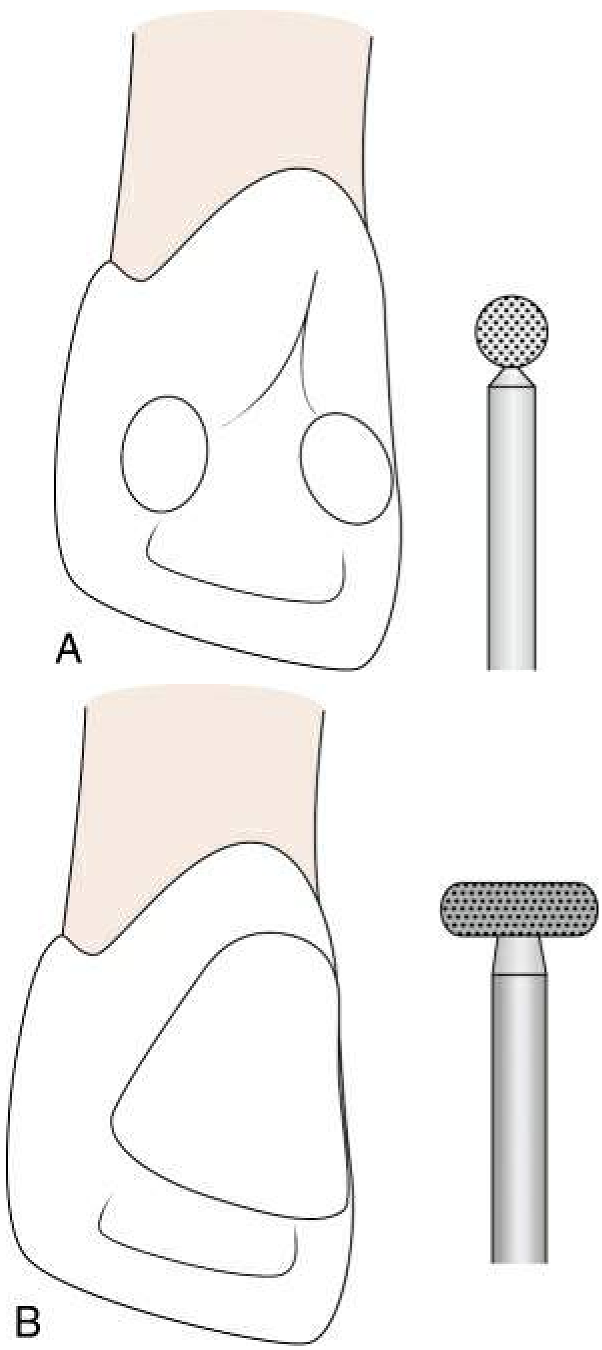
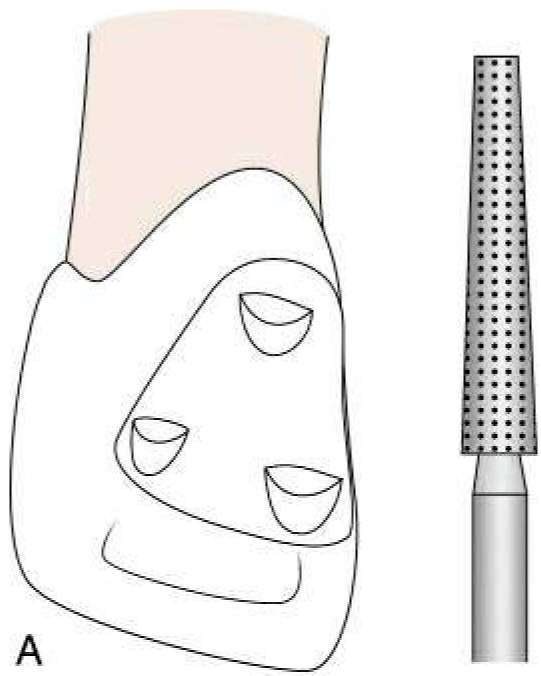


FIGURE 44.7 **(A)** Lingual cingulum reduction: depth orientation grooves with round bur. **(B)** Lingual cingulum – remaining tooth structure is removed with wheel diamond.

Countersink or cingulum rest

Flat notches or countersinks are prepared on lingual surface using a flat-end tapering diamond (Fig. 44.8A). Alternately, a cingulum rest can also be prepared (Fig. 44.8B).



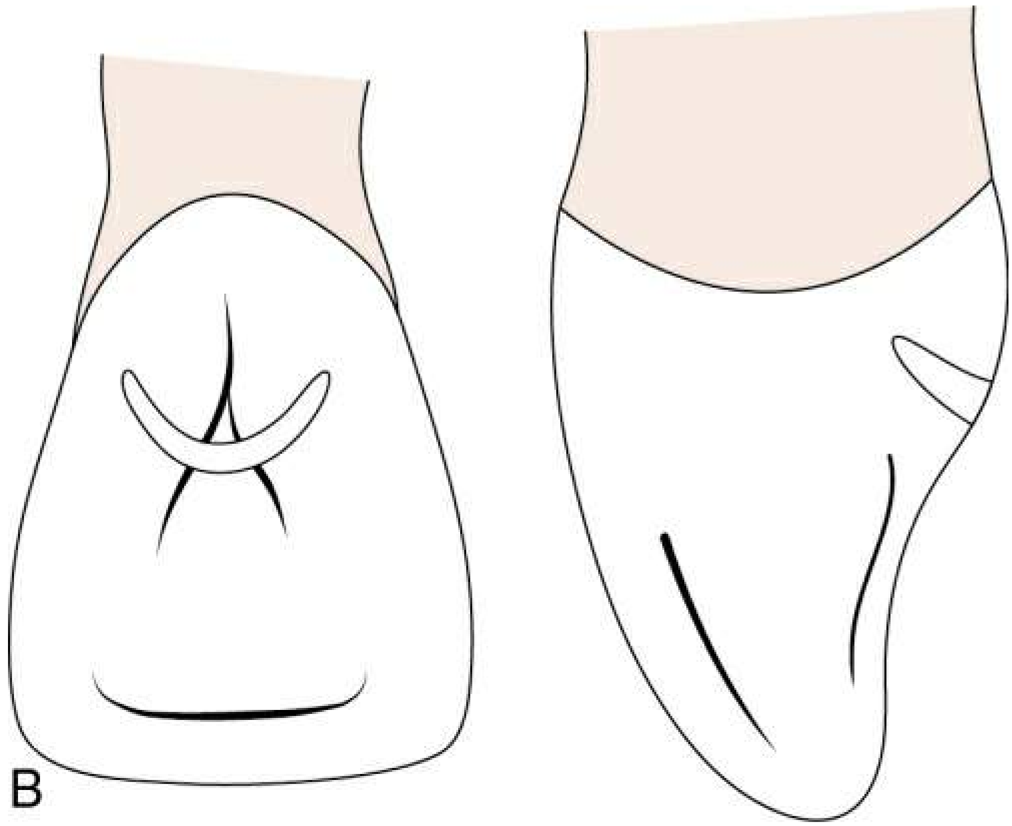


FIGURE 44.8 **(A)** Countersink prepared with flat-end tapering diamond. **(B)** Cingulum rest prepared with a flat-end tapering diamond.

Proximal

Proximal reduction adjacent to edentulous space should ensure resistance form and prevent any unsightly metal display. It is prepared in two planes – labial and lingual (Fig. 44.9A and B) using round-end tapering diamond. If creation of labial plane will display metal, then a proximal groove is placed far enough labially as dictated by aesthetics. The groove is prepared with a flat-end tapering fissure bur parallel to the incisal two-thirds of the labial surface (Fig. 44.10).

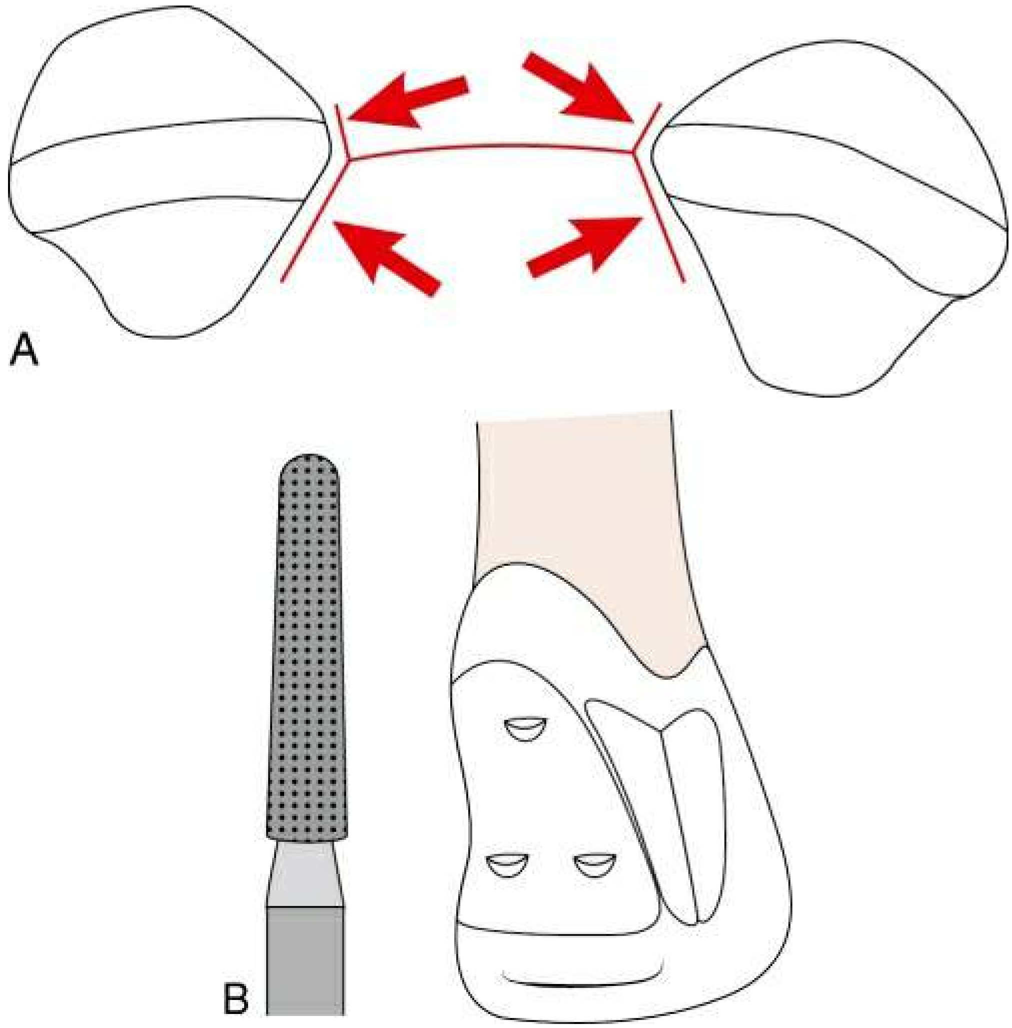


FIGURE 44.9 **(A)** Proximal reduction in two planes. **(B)** Two planes proximal reduction with round-end tapering diamond.

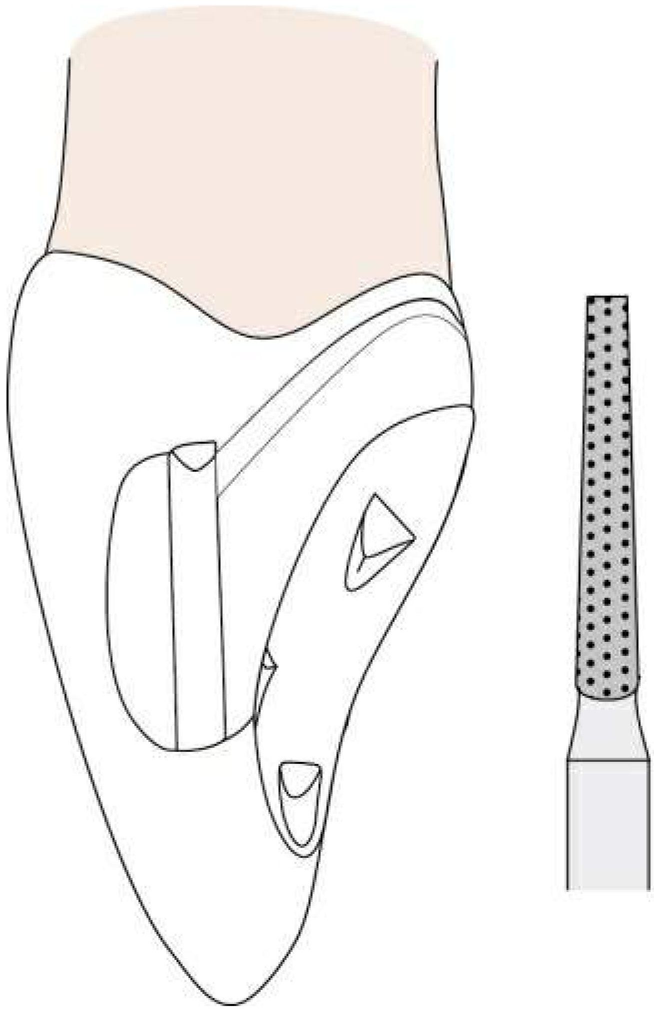


FIGURE 44.10 Proximal groove prepared with flat-end tapering fissure bur.

Lingual axial

The lingual-axial preparation is continued from the proximal preparation adjacent to the edentulous space, continued around the cingulum and stopped just short of the contact on the other proximal surface. The surface is prepared with round-end tapering diamond parallel to the path of placement (Fig. 44.11).

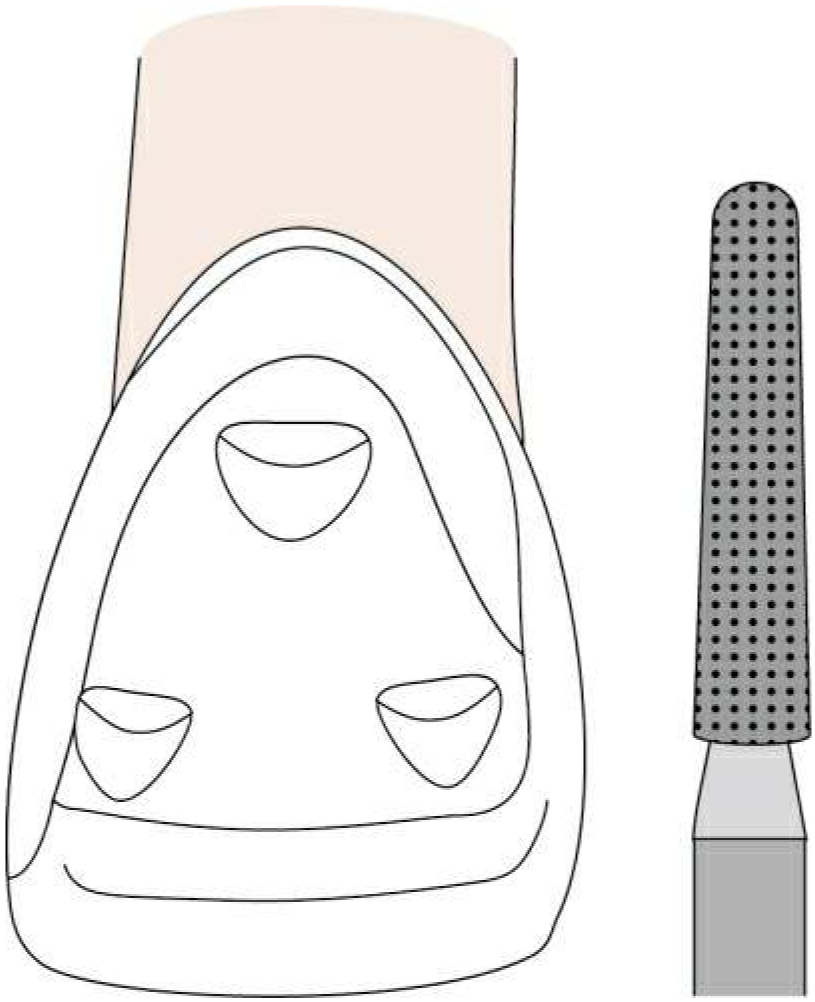


FIGURE 44.11 Lingual-axial reduction with round-end tapering diamond.

Posterior preparation design and sequence

- Proximal and lingual-axial preparations are only aimed at lowering the height of contour and creating parallel surfaces (Fig. 44.12). Height of the contour is lowered to within 2 mm of the gingival margin.

- The proximal preparation adjacent to the edentulous space should extend beyond the facial line angle. It is extended as far as possible to the embrasure of the opposite side such that 180° encirclement is achieved (Fig. 44.13). A short thin tapering diamond/needle diamond is used for the preparation which results in a knife-edge finish line.

- An occlusal rest is prepared adjacent to the edentulous space similar to the removable partial dentures (Fig. 44.14). Its dimensions should be 1.5–2 mm faciolingually and mesiodistally, and 1–1.5 mm in depth. The vertical walls should be very distinct unlike rests for RPD to prevent lateral movement and preparation should be progressively deeper as it moves from the marginal ridge to fossa.

- In most cases occlusal clearance may not be needed because of placement of centric stops away from the framework. If required, a clearance of 0.5 mm is given.

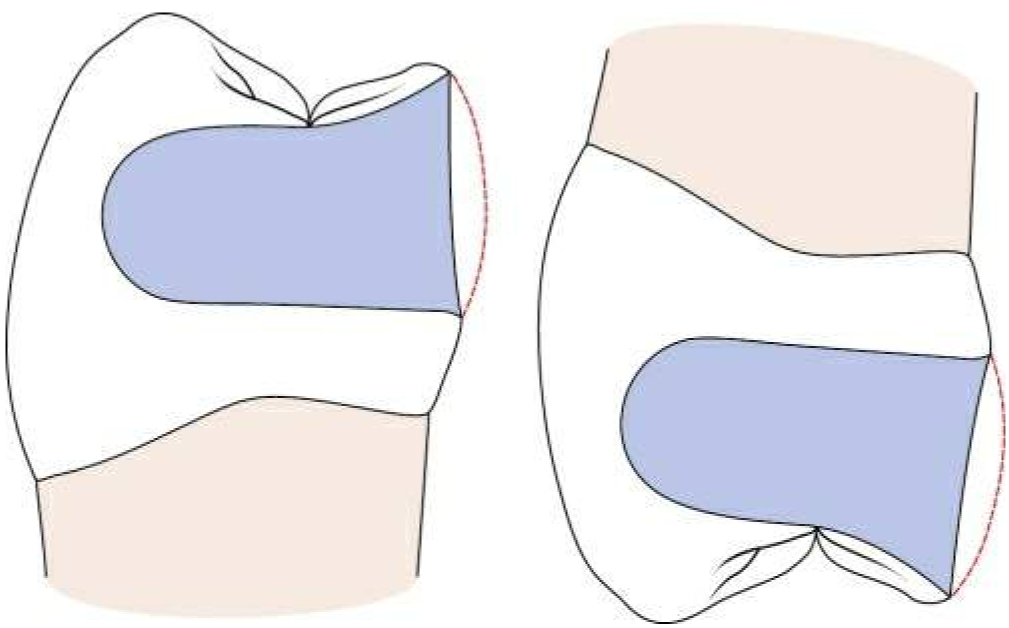


FIGURE 44.12 Lowering the height of the contour.

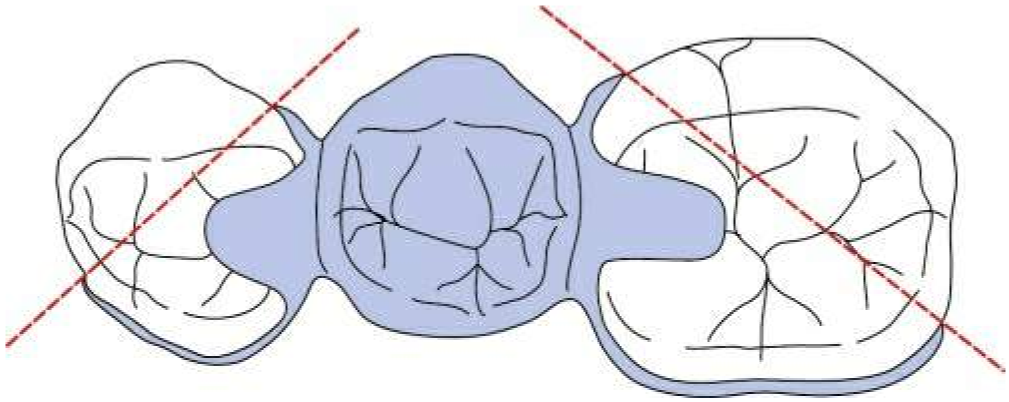


FIGURE 44.13 180° Encirclement.

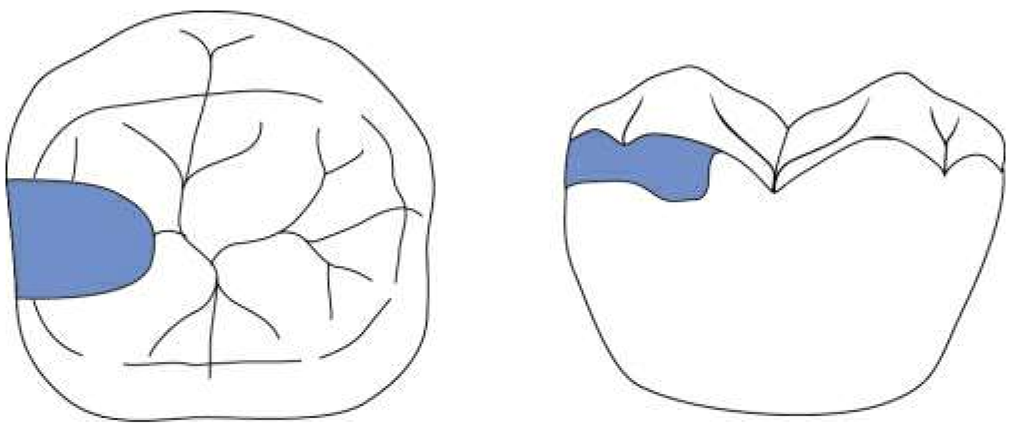


FIGURE 44.14 Occlusal rest.

Impressions and provisionals

Impression making is similar to any other fixed partial denture. Elastomeric impression materials are indicated. A single-impression technique, double mix using putty and light body is preferred as amount of tooth preparation is minimal.

Bonding

- The prepared tooth surface is cleaned using pumice and water.

- Thirty- seven per cent phosphoric acid is used to etch the prepared enamel for 15 s. It is then rinsed and dried.
- Specially formulated composite resin cements are available for bonding RBFPDs as discussed previously.
- A metal primer or silane is applied on the fitting surface of the casting as recommended by the manufacturer of the resin cement.
- A bonding agent or primer is also applied on the prepared enamel surface as recommended by the manufacturer.
- Resin cement is mixed and placed on the internal surface of the retainer.
- The prosthesis is inserted and finger pressure is maintained for 60 s till the initial set. The excess cement is removed and material is allowed to completely set. The manufacturer's instructions are followed regarding protecting the margins from oxygen depending on whether the cement is autopolymerizing or dual cured.
- The occlusion is adjusted and the margins are finished and polished.

Maintenance and recall

Resin-bonded restorations should be reviewed and maintained through periodic recall appointments. Any signs of debonding if detected early can prevent unnecessary damage to the abutments. Periodontal health should also be reviewed and maintained due to the propensity of the retainer to accumulate plaque and overcontouring of lingual surface.

Failures

The causes for failure of RBFPDs are summarized in Table 44.3.

Table 44.3

Causes of failure of resin-bonded FPDs

Inappropriate patient selection	Incomplete tooth preparation	Bonding failure
1. Malalignment of teeth resulting in poor path of insertion 2. Short abutments 3. Thin abutments 4. Inadequate enamel for bonding 5. History of metal sensitivity 6. Heavy occlusal forces	1. Inadequate proximal and lingual reduction 2. Less than 180° extension of the retainer 3. Lack of clearance in protrusion	1. Contamination 2. Prolonged mixing 3. Inappropriate luting agent

SUMMARY

Resin-bonded prostheses are viable prostheses in select situations. They should receive the same attention to detail as conventional fixed partial dentures for long-term success. Patient selection is vitally important and the tooth preparation or enamel activation is mandatory. Although newer metal-free ceramic resin-bonded bridges show promising results, we have to wait for long-term results to replace the conventional metal resin-bonded restorations.

CHAPTER 45

Restoration of Endodontically Treated Teeth

CHAPTER CONTENTS

Introduction

The loss of vitality in teeth decreases the physical properties (due to loss of collagen-bound water) and fracture resistance of the remaining tooth structure. The poor resistance to fracture can be attributed to loss of tooth structure due to access preparation, caries, absence of pulp and moisture, effect of root canal preparation and loss of mechanoreception.

The complete coverage crown is the most ideal restoration to protect the remaining natural teeth in endodontically treated teeth. As coronal tooth structure is mostly damaged, the crown requires a core or a post and core for retention, depending on the extent of damage and location of the tooth.

Tooth preparation and fabrication of crowns have been discussed in various chapters in the FPD section. In this chapter, we will discuss 'posts and cores'.

Principles of restoration of endodontically treated teeth

- Provide good coronal seal.
- Protect/conserve remaining tooth structure.
- Satisfy functional and aesthetic needs.
- Reduction of stresses with favourable distribution within remaining tooth structure.

Treatment options

Anterior teeth

1. Intact coronal tooth structure except for prepared access opening –

access opening is restored with composite resin if no discolouration is present.

2. Less than 25% coronal tooth structure is damaged – a complete coverage crown is required.

3. More than 25% coronal tooth structure is damaged – a post and core with crown is required.

Posterior teeth

1. Less than 50% coronal tooth structure is damaged – core and crown are required.

2. More than 50% coronal tooth structure is damaged – post, core and crown are required.

Post

It is that part of the prosthesis usually made of metal that is fitted into a prepared canal of a natural tooth (Fig. 45.1). The basic purpose of a post is to retain a core.

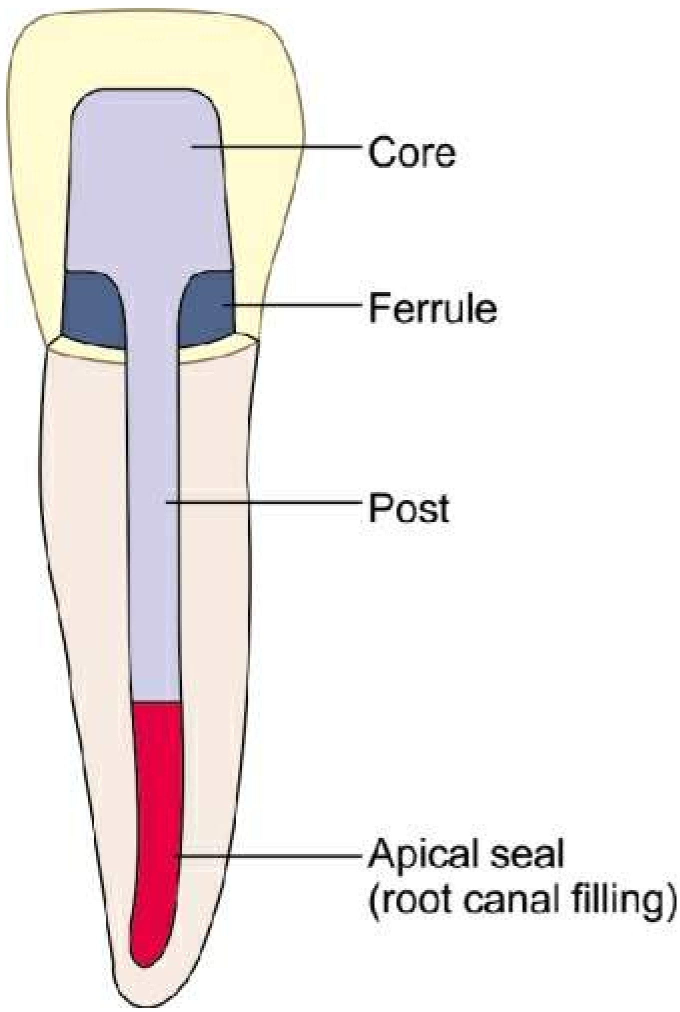


FIGURE 45.1 Parts of a post.

Rationale for the use of post

An endodontically treated tooth may require a post due to the following reasons:

- Decreased moisture content.
- Subsequent brittleness of pulpless teeth.
- Loss of both internal and external tooth structure (Fig. 45.2).
- Unrestored teeth less resistant to stress and an undesirable abutment.
- Increase the resistance to horizontal and vertical forces (Fig. 45.3).
- Coverage of the entire occlusal surface of the tooth with a restoration reduces the incidence of vertical fracture.
- Internal reinforcement using the residual root for anchorage will resist horizontal fractures.

FIGURE 45.2 Loss of both internal and external tooth structure.

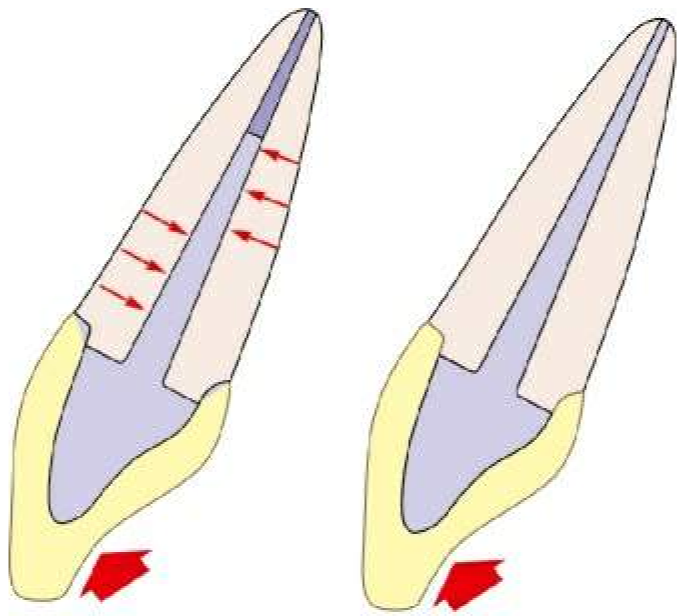


FIGURE 45.3 Post provides better resistance to horizontal and vertical forces.

Ideal requirements

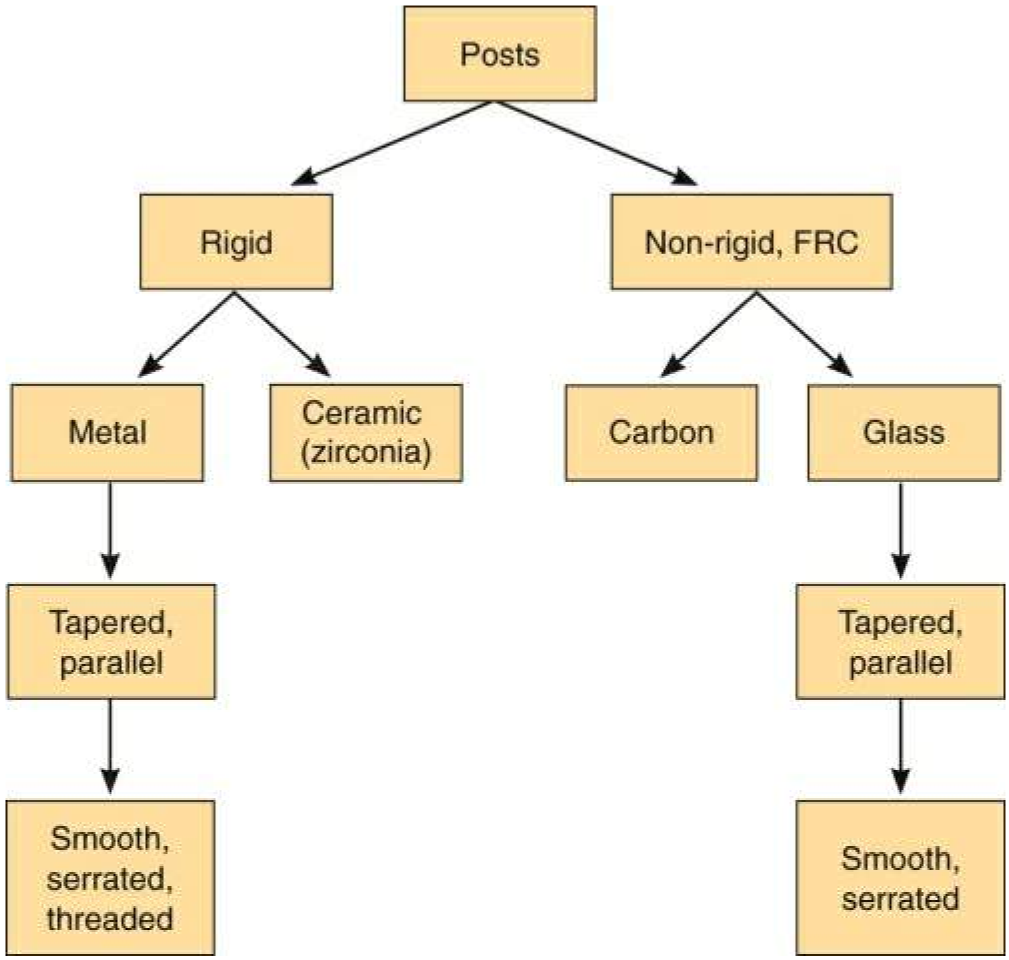
- Maximal retentiveness of the core, with minimal removal of dentine.
- Physical properties compatible to dentine, and with core material.
- Even distribution of functional forces along the root surface.
- Aesthetic compatibility with the definitive restoration and surrounding tissue.
- Minimal stress during placement and cementation.
- Resistance to displacement yet easy retrievability.
- Ease of use, safety and reliability.

- Reasonable cost.

Classification of posts

All posts can be classified as rigid and nonrigid, which can be subclassified according to the post material, shape and surface configuration (Flowchart 45.1). Posts can be classified according to the following features:

- **Shape** – parallel, tapered
- **Stiffness** – rigid, nonrigid
- **Surface** – smooth, serrated, threaded
- **Colour** – aesthetic, nonaesthetic
- **Pressure on root** – active, passive
- **Fabrication** – prefabricated, custom-made (cast posts).



FLOWCHART 45.1 Classification of posts.

Parallel and tapered posts

Parallel-sided posts direct the occlusal forces apically while tapered posts direct the forces laterally by producing a wedging effect (Fig. 45.4). Hence, occlusal forces are better directed by parallel posts. They are also more retentive than tapered posts. Tapered posts are more conservative of tooth structure.

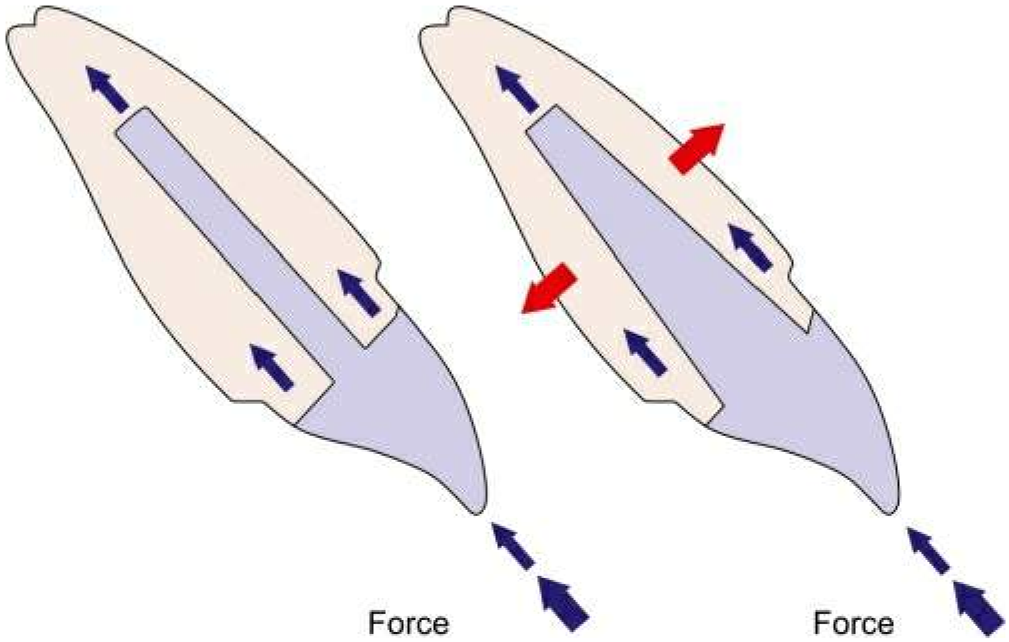


FIGURE 45.4 Tapered post directs force laterally.

Rigid and nonrigid

If a post has higher rigidity than anchoring material (dentine), stress is transmitted adjacent to the bottom of post, which can cause root fracture. On the other hand, a flexible post can distort and open crown margins. *Hence, the post should be resilient enough to cushion an impact and strong enough to resist permanent deformation.*

Rigid posts

- Can be made of crown and bridge alloys (cast posts), stainless steel, titanium, zirconia (prefabricated posts).
- Zirconia has greatest stiffness followed by steel and titanium alloy.
- More chance of root fracture than nonrigid.
- Indicated for teeth with less than 3–4 mm vertical height or less than 25% tooth remains.

Nonrigid posts

- Made of glass, quartz or carbon fibres embedded in a resin matrix, also called 'fibre-reinforced composite' posts (FRC).
- They have to be adhesively bonded to the root canal space.
- Can reinforce weak teeth with flared canals.
- Require less preparation – preserve integrity and strength of dentine.
- Less root fracture.
- Indicated in teeth with more than 25% remaining tooth structure.

Smooth, serrated, threaded posts

- Smooth posts provide least retention, but are passive (no force transmitted to tooth).
- Serrated posts provide better retention and are also passive.
- Threaded posts provide best retention, but are active; hence, root fractures may occur.

Aesthetic and nonaesthetic posts

- Metal posts are nonaesthetic, as they may reflect through an all-ceramic crown (Figs 45.5 and 45.6).
- Zirconia posts and fibre-reinforced composite posts are called aesthetic posts. They are indicated for use with all-ceramic restorations. The glass fibre posts can also be used to reinforce the root surface in case of excessively large canal space.

FIGURE 45.5 Prefabricated metal (unaesthetic) post on 11 and fibre post (aesthetic) on 12 (courtesy Coltene–Whaledent).

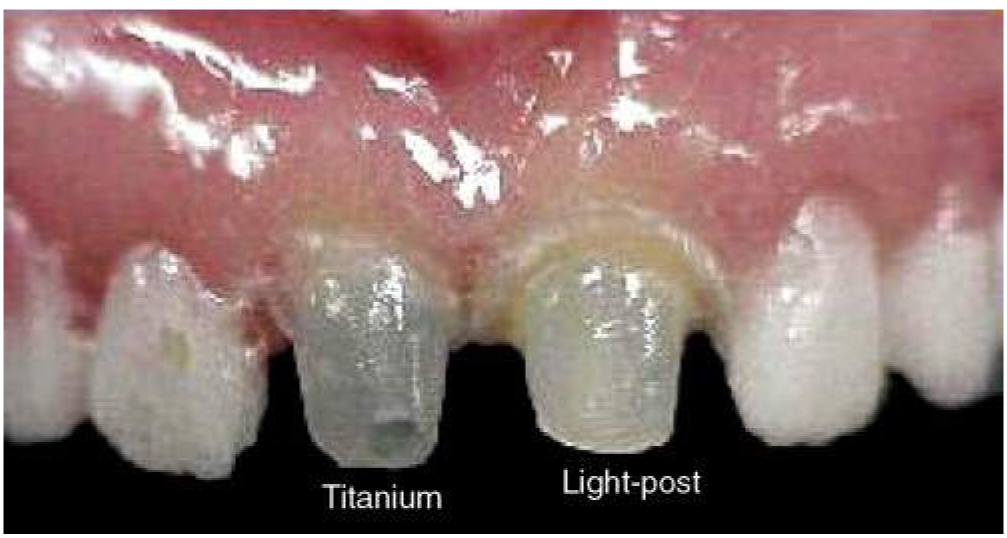


FIGURE 45.6 Metal seen through following core build-up (courtesy Coltene–Whaledent).

Active and passive

- All threaded posts are active as they exert pressure on the root.

- Smooth and serrated posts are passive.

Custom-made and prefabricated posts

The only custom-made post is the 'cast post'. It is also called 'one-piece' post, as the post and core are not separable. The use of this post is declining.

Cast post and core

A one-piece foundation restoration for an endodontically treated tooth that comprises a post within the root canal and a core replacing missing coronal structure to form the tooth preparation (GPT8).

Advantages of cast post

○ Conservative of tooth structure.

○ High strength.

Disadvantages of cast post

- *Time* – requires two appointments.
- *Wedging effect* – because they can only be made tapering and high rigidity.
- *Porosity* – problem and casting procedure.
- *Fit* – may not be very accurate because of indirect method.
- *Unaesthetic* – as it can be made only of crown and bridge alloys. Hence, it cannot be used with all-ceramic restorations.
- *Cost* – lab costs will be incurred.

Prefabricated posts

- They are versatile. They are available in different configurations and can be selected as per the given clinical situation.

- They are also available in different diameters corresponding to the size of the drill. Hence, the fit is accurate.
- Though post and core is inserted in two separate procedures, it requires only one appointment with no laboratory costs.

A classification of posts can be made combining the above categories as depicted in Flowchart 45.1.

Selection of post

The following parameters govern post selection:

- Length
- Diameter
- Shape
- Surface configuration
- Location

Length

Adequate length of post is very important for retention. The post should be as long as possible without compromising the apical seal and strength or integrity of remaining root structure.

Guidelines for determining post length are

- Equal to half the remaining length of the tooth.
- Equal to two-thirds the root length of the root.
- Equal to the length of the remaining crown.

- Half the length of root contained in bone.
- Have minimum of 4 mm of gutta-percha apically to provide adequate seal.

Diameter

Resistance to fracture is directly related to the remaining root structure. Hence, the diameter of post:

1. Should not exceed one-third the mesiodistal root diameter (Fig. 45.7).
2. At least 1 mm of dentine should surround the preparation (Fig. 45.8).

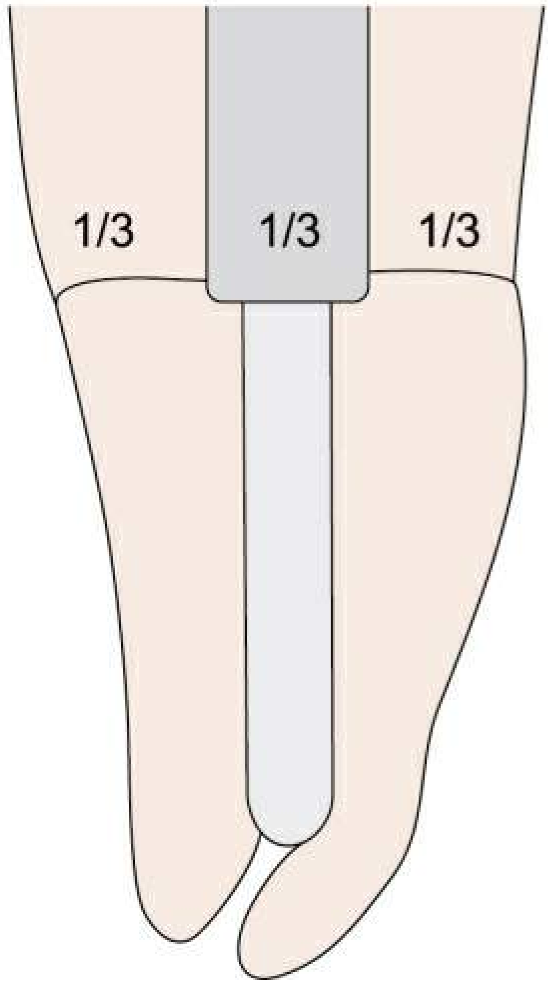


FIGURE 45.7 Post diameter should not exceed one-third mesiodistal root diameter.

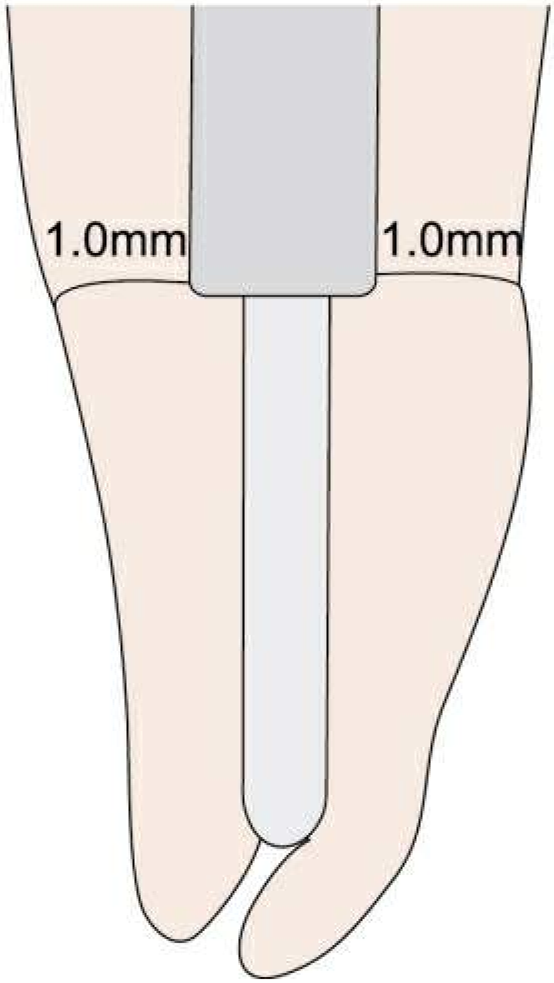


FIGURE 45.8 1 mm dentine should surround the post preparation.

Minimal preparation of root canal limited to removal of undercuts has also been advocated.

Shape

- Parallel-sided posts are preferred as they have better retention and more favourable stress distribution.

- Tapered posts are indicated for the significantly tapered canal system, where use of a parallel-sided dowel would involve vigorous preparation of the radicular dentine walls. To minimize the splitting potential of a tapered dowel, there should be flat seat at the occlusal end of the preparation to resist apically directed forces and prevent wedging.

Surface configuration

- Parallel-sided serrated posts are generally indicated.
- If root length is less, threaded posts offer better retention.

Location

- Posts should be placed in roots that are round straight and long.
- In the anterior teeth, roots are seen mostly with circular cross-section.
- Root anatomy of multirooted teeth is most suitable in the palatal roots of maxillary molars, palatal roots of maxillary premolars and distal roots of mandibular molars.

Tooth preparation for post

Preparation of coronal tooth structure

Coronal tooth structure is prepared according to the type of extracoronal restoration planned (Fig. 45.9). All existing caries, restorations, cements, bases and unsupported tooth structures are removed (Fig. 45.10A). Preserve as much of intact coronal tooth structure as possible to externally brace the tooth.

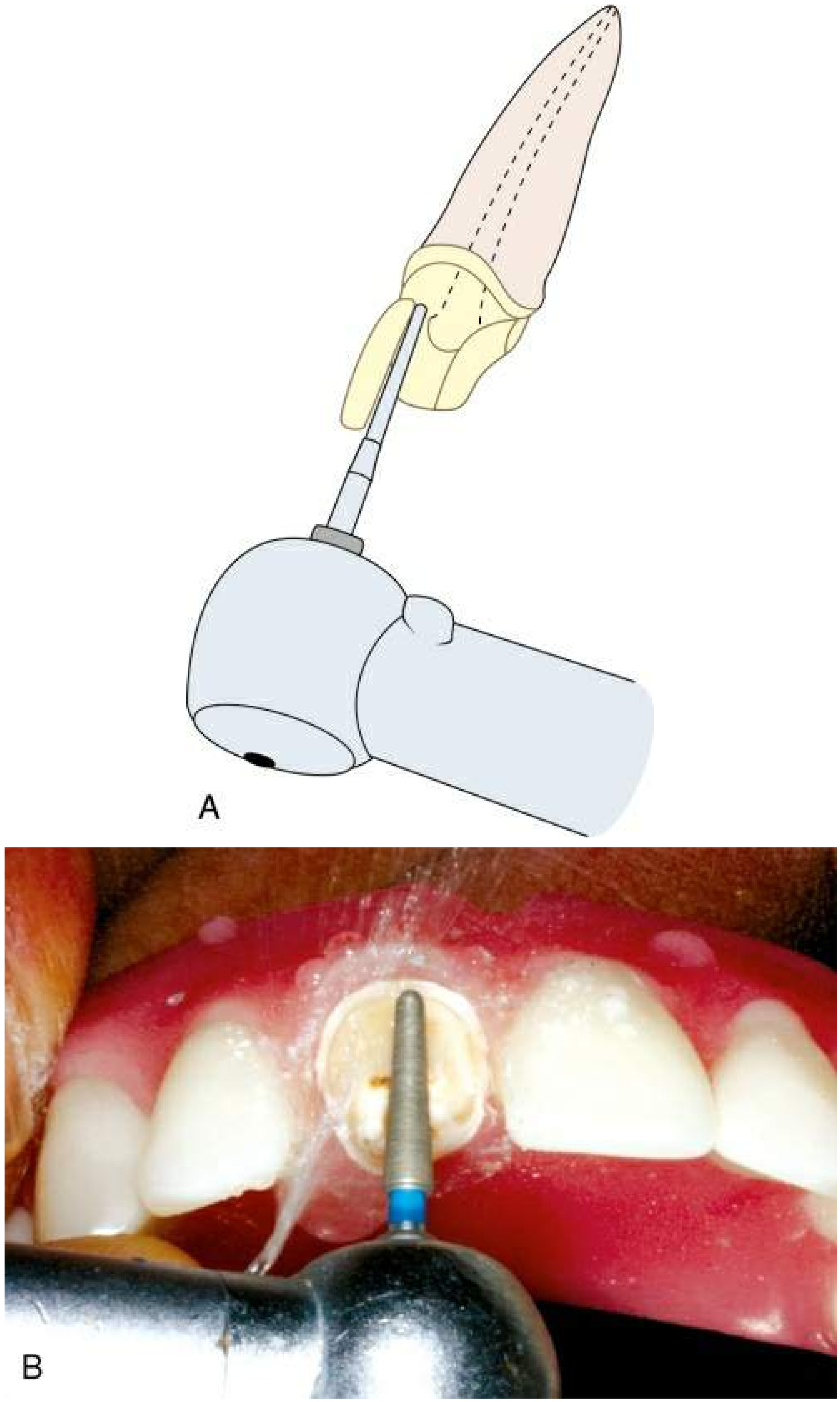
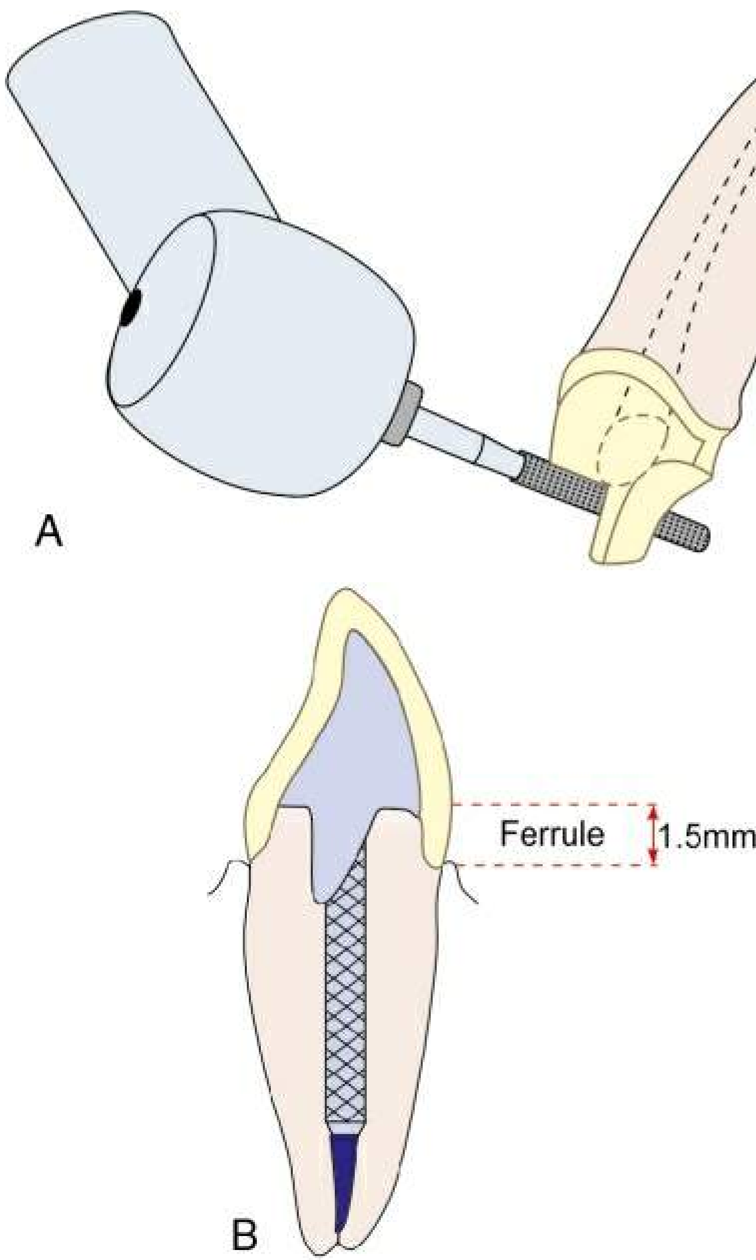

A
B

FIGURE 45.9 **(A)** Coronal preparation according to the type of extracoronal restoration. **(B)** Coronal preparation.



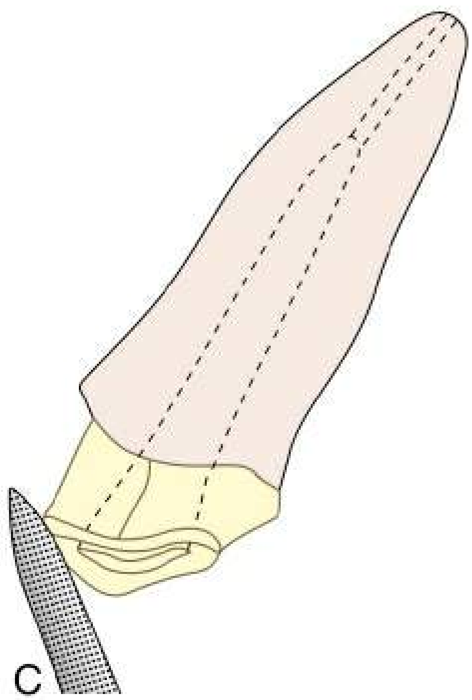


FIGURE 45.10 **(A)** All unsupported tooth structure is removed. **(B)** Ferrule effect. **(C)** Placement of contrabevel.

Ferrule

Minimum of 1.5 mm of sound tooth structure 360° around the tooth should be present, apical to the core. It improves structural integrity of the tooth and prevents fracture (Fig. 45.10B).

Contrabevel

This is provided for cast post preparations. A flame-shaped diamond is used to make a 360° wide bevel on the incisal part of the coronal portion. This aids in bracing the tooth against fracture (Fig. 45.10C).

Preparation of post space

Peeso reamers and Gates Glidden drills are used to remove the gutta-percha as they are safe-sided instruments as they are not end-cutting. They come is different sizes according to diameter (Figs 45.11 and 45.12, Table 45.1).

FIGURE 45.11 Peeso reamers.

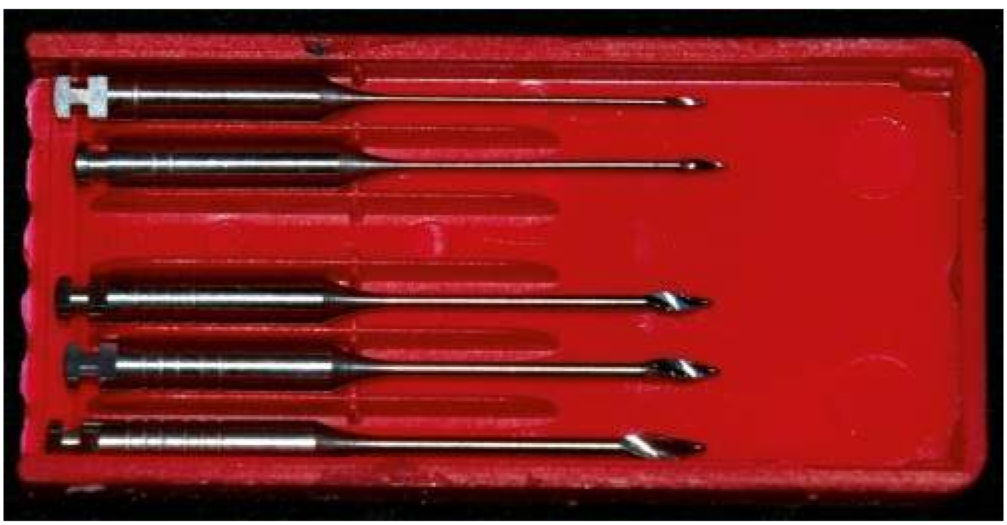


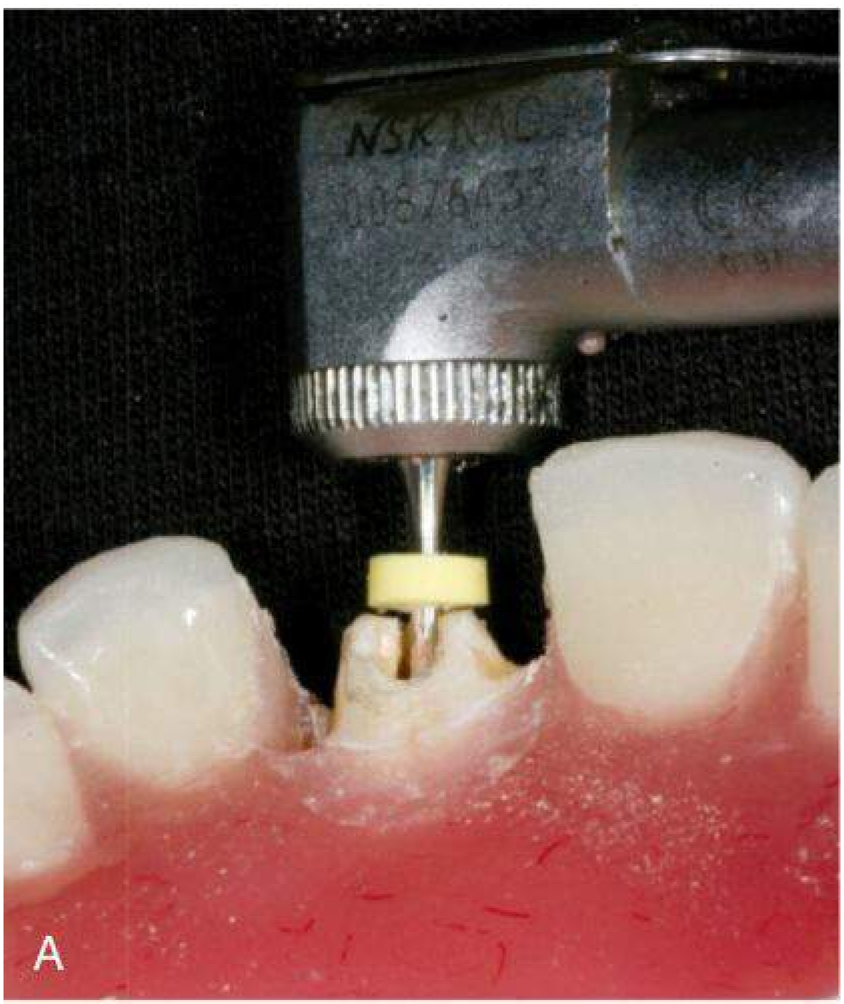
FIGURE 45.12 Gates Glidden drills.

Table 45.1

Diameter of Peeso and Gates and their sizes

	Diameter (mm)						
	0.6	0.7	0.9	1.1	1.3	1.5	1.7
Peeso reamer	–	1	2	3	4	5	6
Gates Glidden	1	2	3	4	5	6	–

Appropriate length and diameter of the post are determined using a radiograph as a guide and following the guidelines (Fig. 45.13A and B). The dimensions of the previous endodontic filling, if available, can also be a good guide to determine length and diameter. An endodontic stopper is placed in the shank of reamer or drill to ensure appropriate length.



B

FIGURE 45.13 **(A)** Peeso reamer in use is placed and radiograph taken. **(B)** Radiograph with reamer in position is used as a guide to determine length and diameter.

The procedure is begun with the largest Peeso or Gates that will fit into the canal. Once the root filling is removed, successively larger Peeso or Gates is used to enlarge the canal to desired dimensions. Some prefabricated post systems are provided with specific drills corresponding to the diameter of the posts (Fig. 45.14). These drills are used to enlarge the canals to the required diameter, when available.

FIGURE 45.14 Prefabricated posts (ParaPost) of varying widths with their corresponding drills.

Antirotational feature

Two antirotational features can be incorporated.

1. **Pins**: Used with prefabricated posts. Placed in the area of greatest bulk between the canal and periphery of the tooth. One or two holes 0.6 mm diameter may be drilled to a depth of 2 mm (Fig. 45.15).

2. **Key-way**: Used with cast posts. Placed in the orifice of canal in an area of greatest bulk. Flat-end tapering fissure bur is used to place the groove to a depth of 0.6 mm and length of 4 mm (Fig. 45.16).

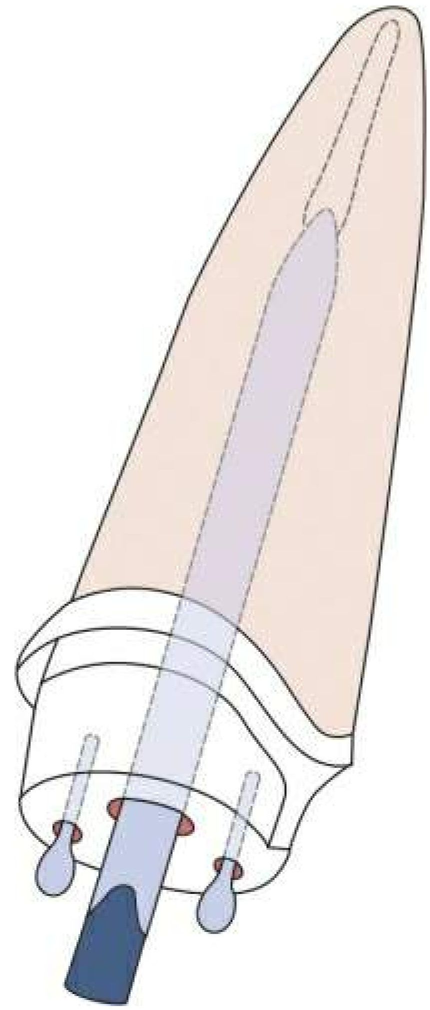


FIGURE 45.15 Pins placed for antirotation.

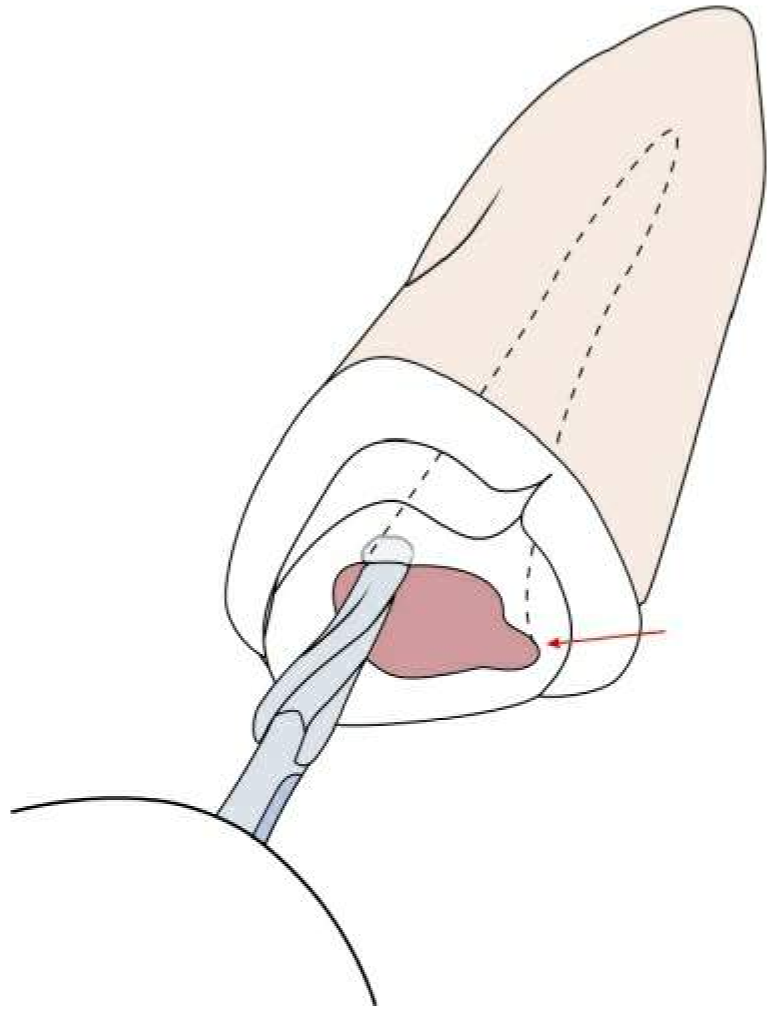


FIGURE 45.16 Key-way placed for antirotation.

Custom-made posts (cast posts)

Custom-made posts are categorized as rigid, metal, tapered, smooth, in the classification for posts (Flowchart 45.1). They can be fabricated:

1. Directly

2. Indirectly

Direct method

A pattern of the post and core is fabricated directly in the patient's mouth and then cast in the laboratory.

Disadvantages

- Consumes a lot of clinical time.
- Any problem in casting, procedure has to be repeated intraorally.

Procedure

A 14-gauge plastic sprue (a plastic toothpick or stainless steel wire can also be used) is trimmed to check the fit in canal. Grooves are cut on the surface for retention of the pattern material. A mark or notch is made facially to allow re-orientation subsequently (Fig. 45.17).

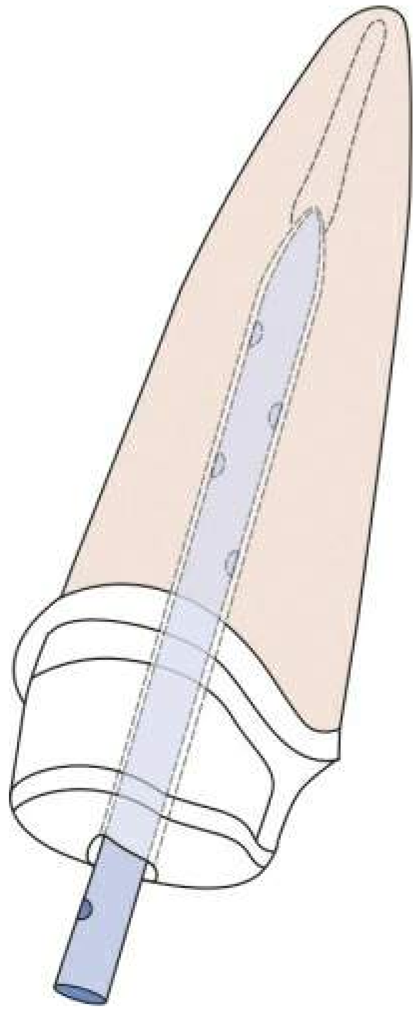


FIGURE 45.17 A plastic sprue is grooved and trimmed to fit canal with a coronal extension.

Canal and surrounding areas are lubricated with petroleum jelly. Autopolymerizing acrylic resin is mixed to a running consistency, coated on sprue and inserted in the canal (Fig. 45.18). As the resin becomes doughy, move the pattern up and down to ensure it is relieved from any undercuts. Any voids can also be filled with new resin, pattern reseated and finally allowed to set outside the mouth.

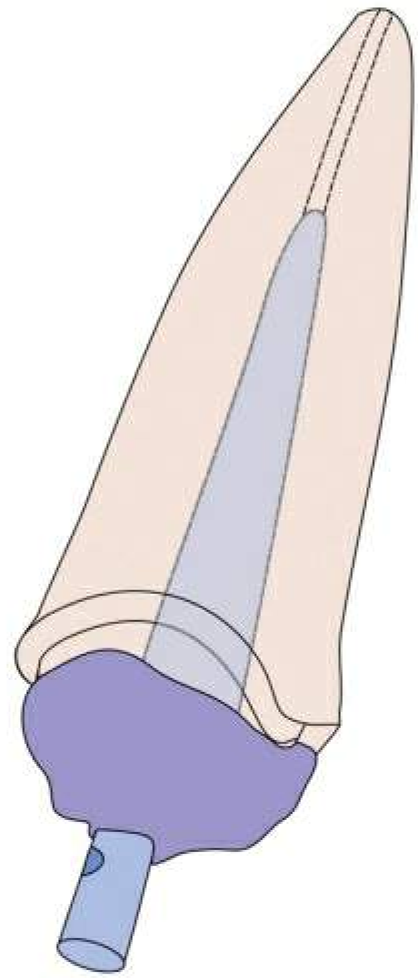


FIGURE 45.18 Plastic sprue coated with autopolymerizing resin and inserted in canal.

After the resin in the post portion sets, the core is built up with the same material and moulded with fingers (Fig. 45.19). After setting, it is prepared to the appropriate shape of core (Fig. 45.20). The pattern is then sprued, invested and cast in designated crown and bridge alloy. The cast post and core is then cemented using conventional definitive cements (Figs 45.21 and 45.22).

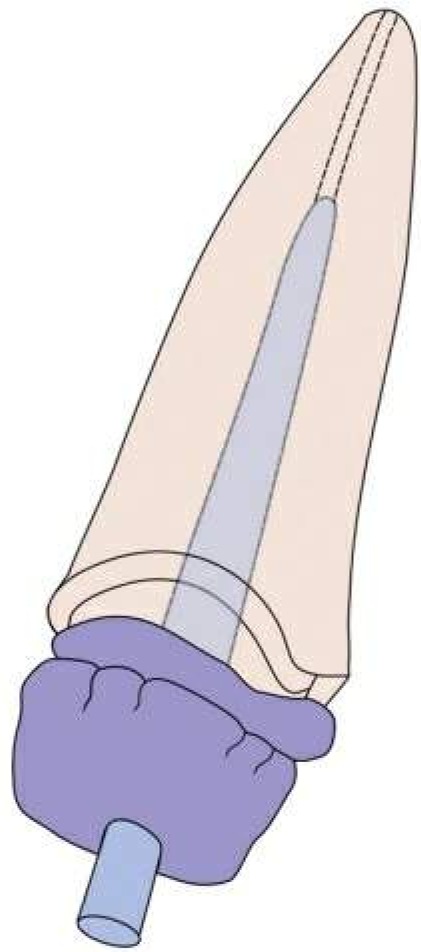


FIGURE 45.19 Core material is built up.

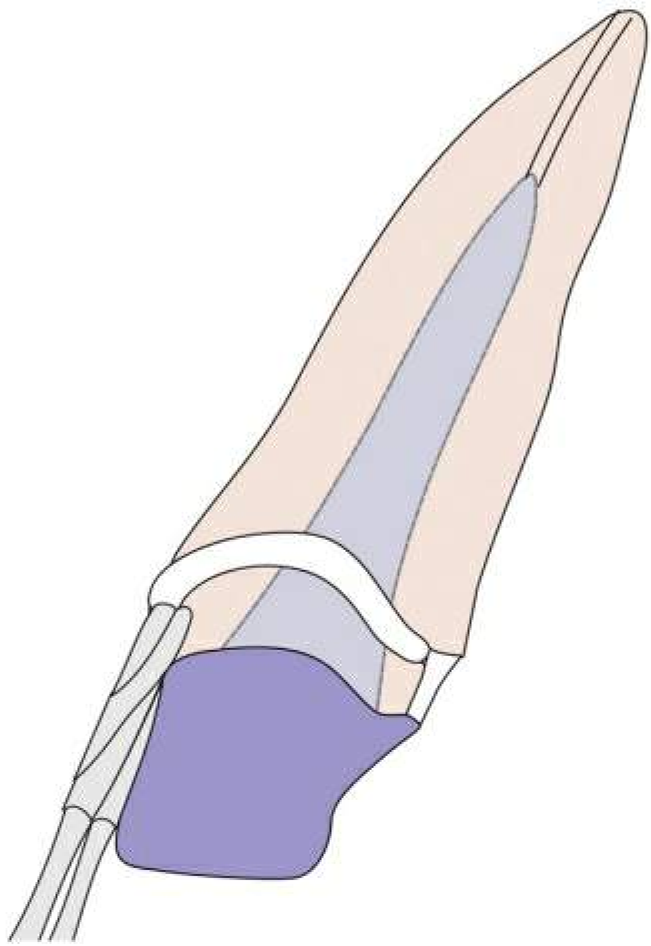


FIGURE 45.20 Core trimmed appropriately exposing finish lines.

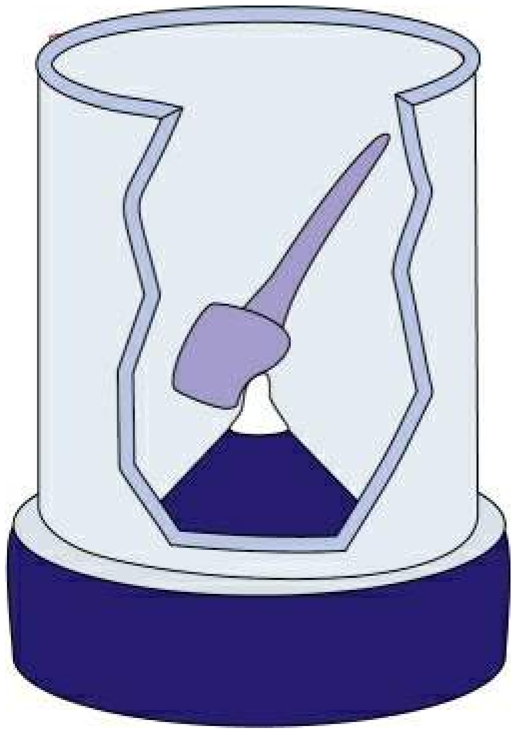
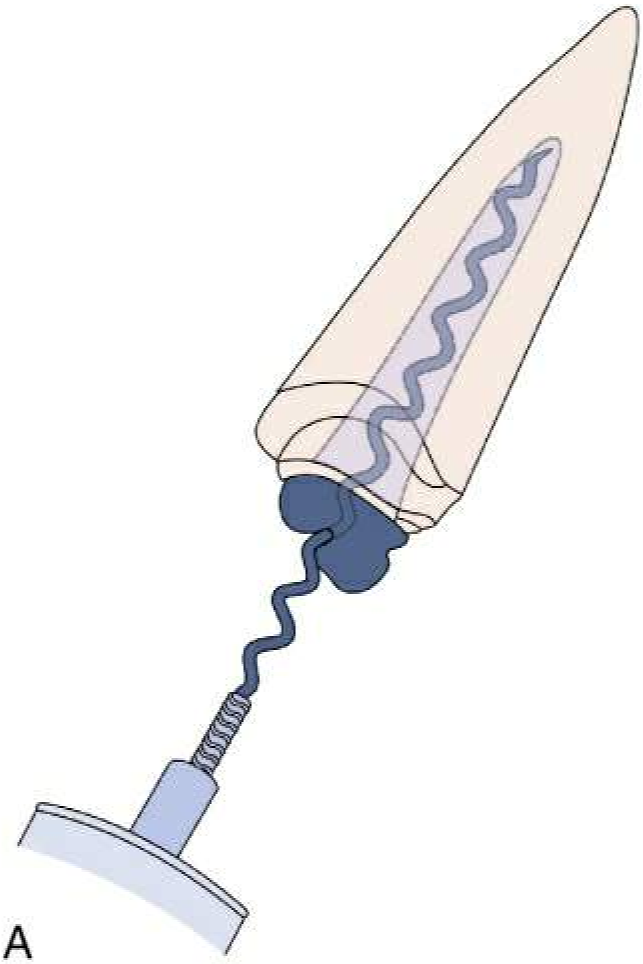


FIGURE 45.21 Spruing of post in the cingulum area, investing and casting.



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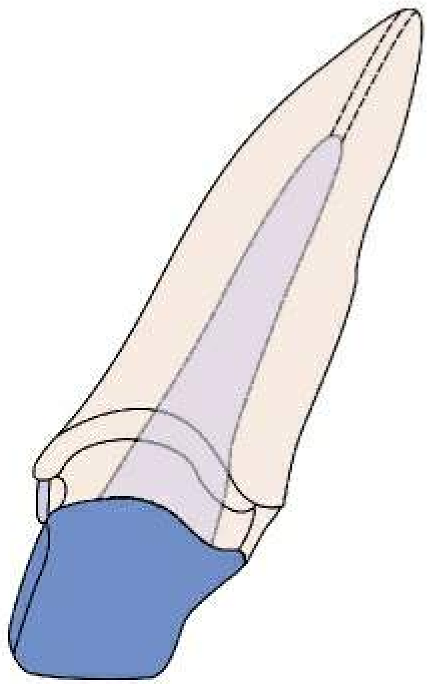


FIGURE 45.22 (A) The luting cement is coated in the canal space using lentulo spiral. (B) Cemented core.

Indirect method

In this technique, an impression is made of the canal space using a putty and light body wash, and the pattern is fabricated indirectly on a model and cast (Fig. 45.23). This is indicated for multiple posts and posts in multirooted teeth.

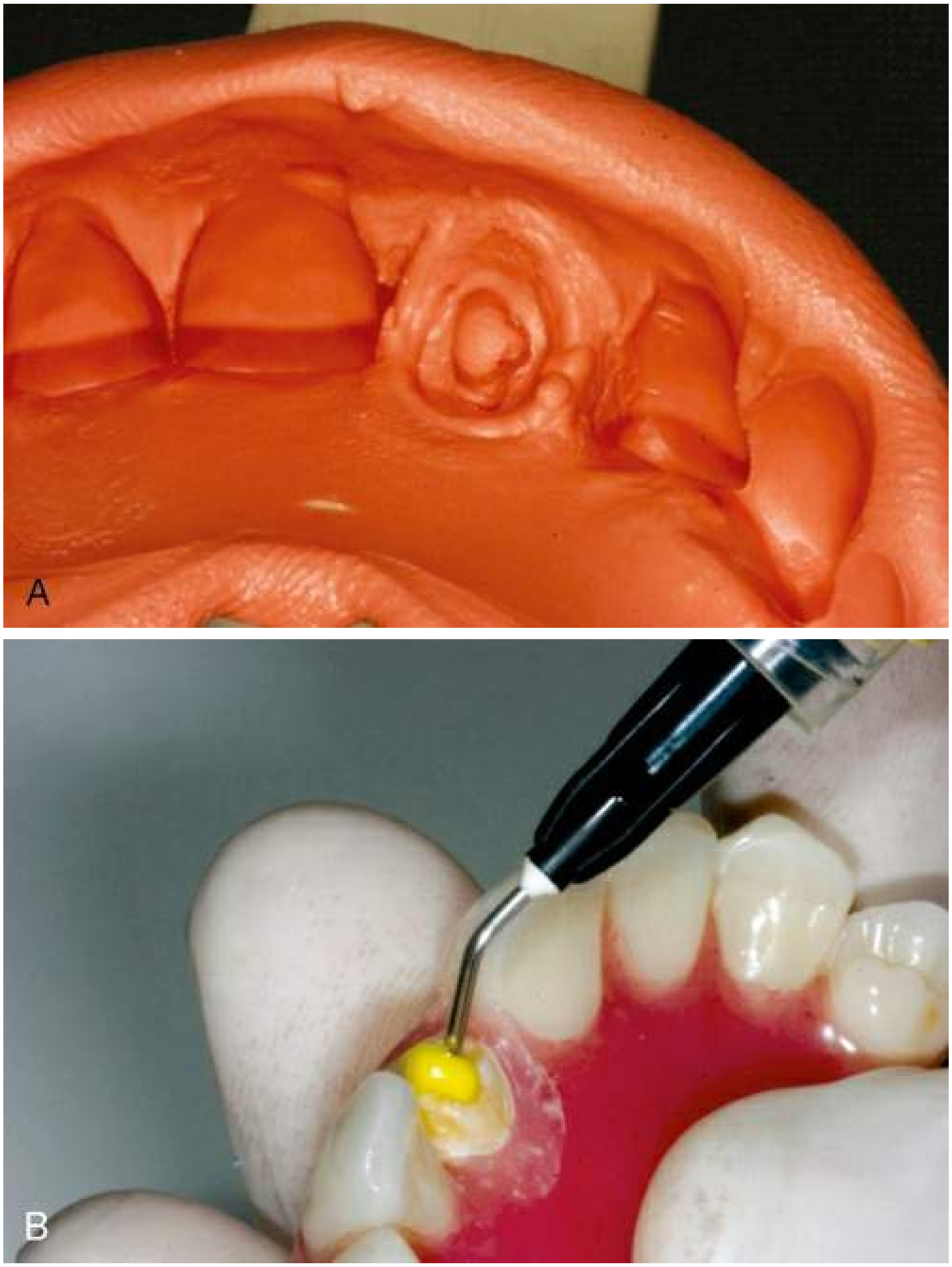

A
B

FIGURE 45.23 **(A)** Putty impression is made of prepared tooth along with the entire arch. **(B)** Light body material injected into post space and placed on the putty impression after creating adequate space – a second impression is made. **(C)** Following removal of final impression – cast can be poured where the post can be fabricated.

Advantages

There is less usage of chairside time and as a cast is available, any problems in casting can be easily repeated.

Fabrication of cast post in molar

1. Post can be made in one-piece if the canals are convergent or parallel (Fig. 45.24).

2. Post for posterior teeth may need to be made in two parts if canals are divergent (Fig. 45.25A–K).

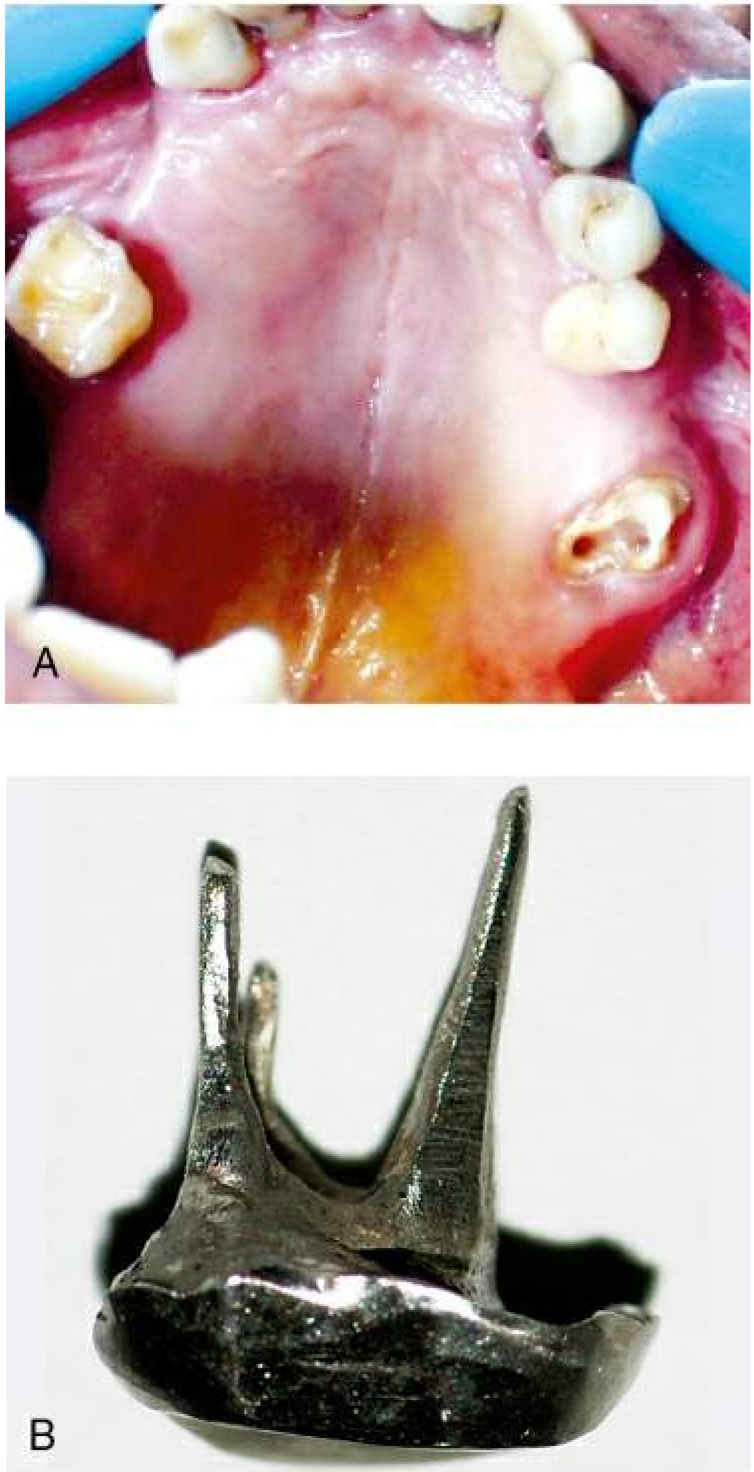
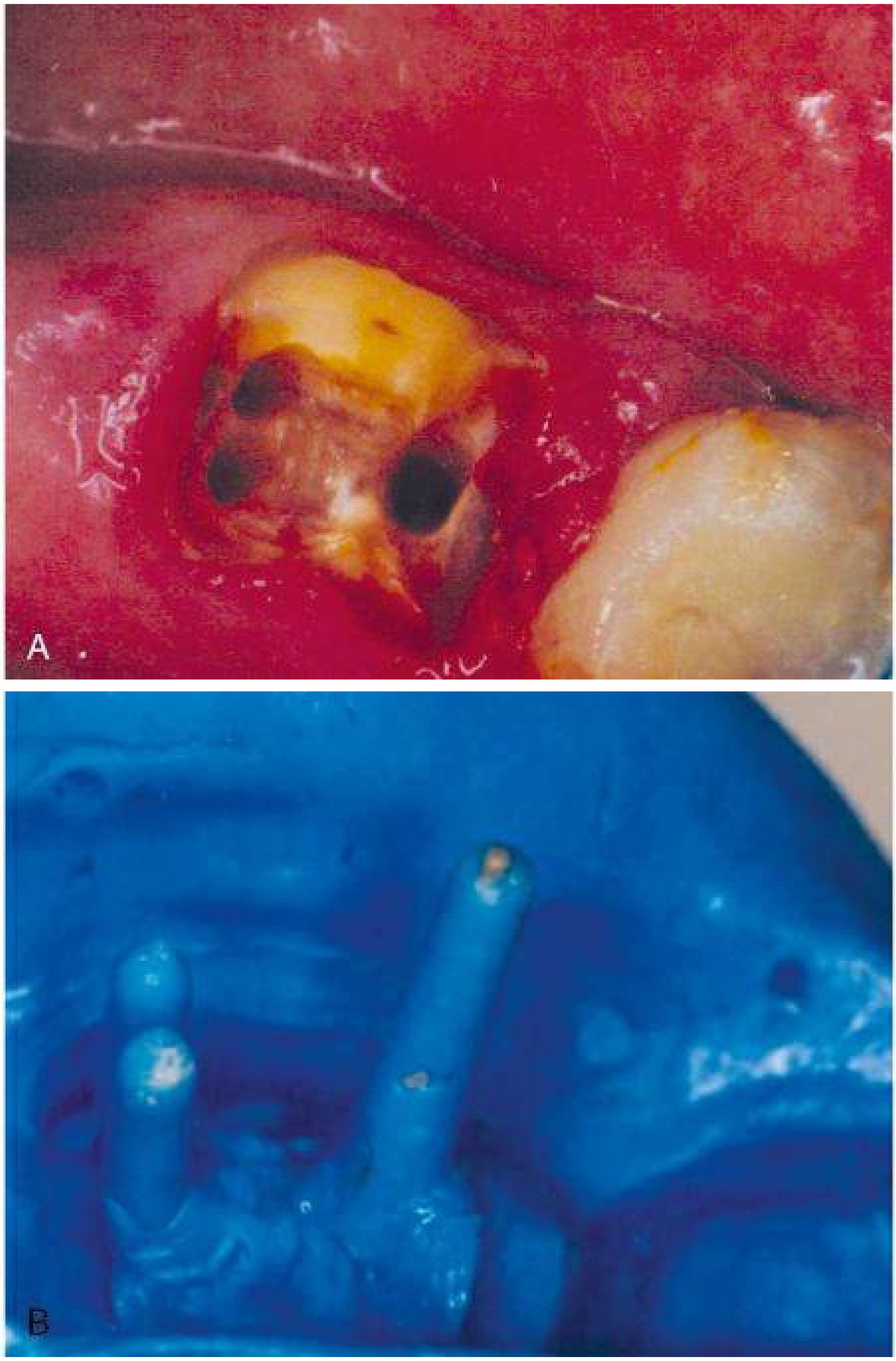

A
B

FIGURE 45.24 **(A)** Upper molar palatal and distobuccal canal prepared for cast post. **(B)** One piece cast post fabricated. **(C)** Cemented cast post and core.


A
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C
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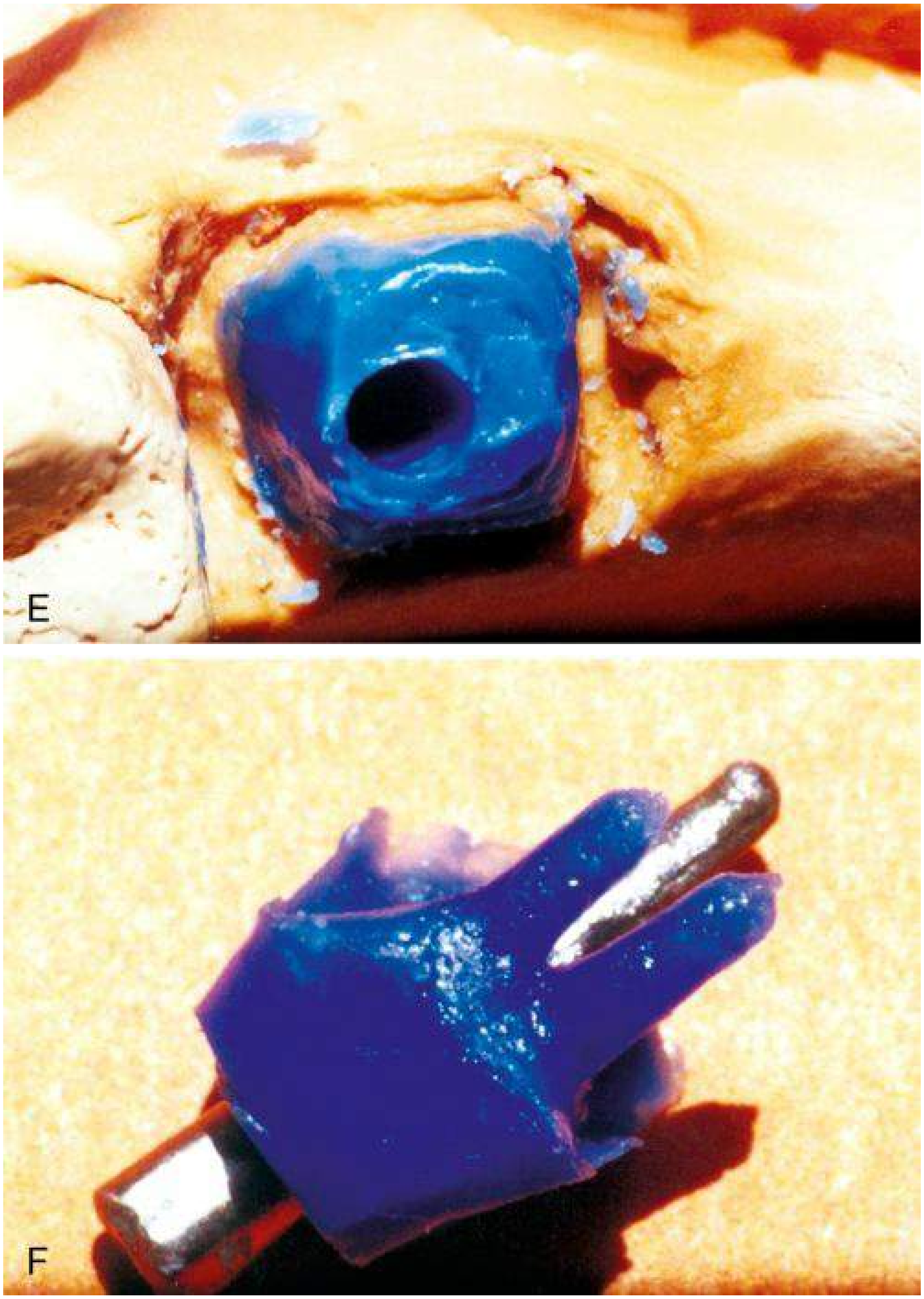
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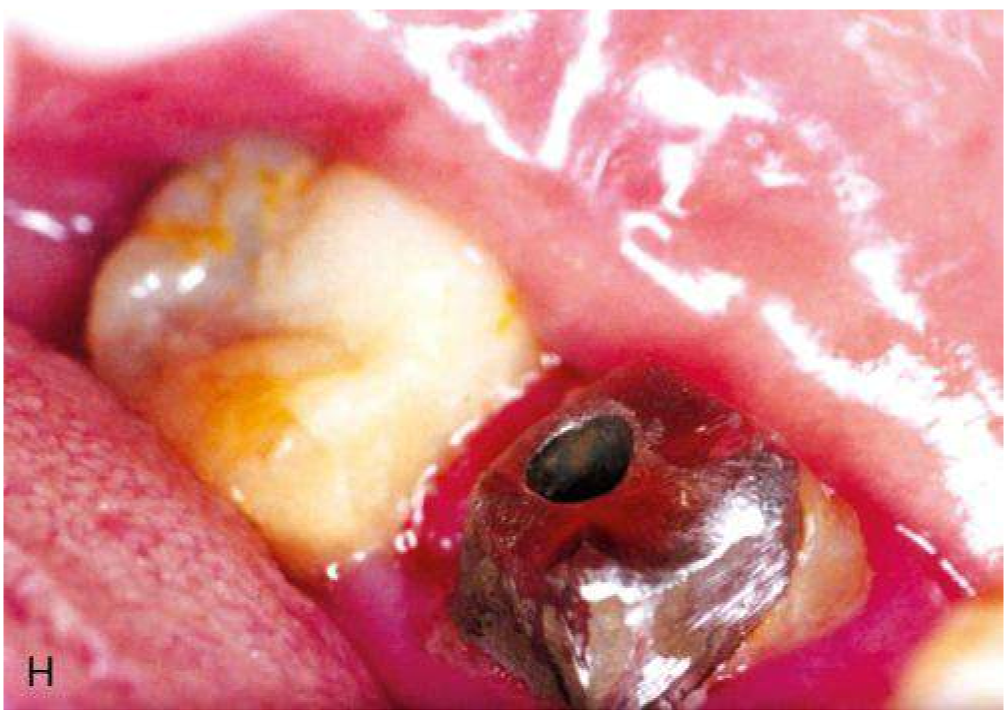
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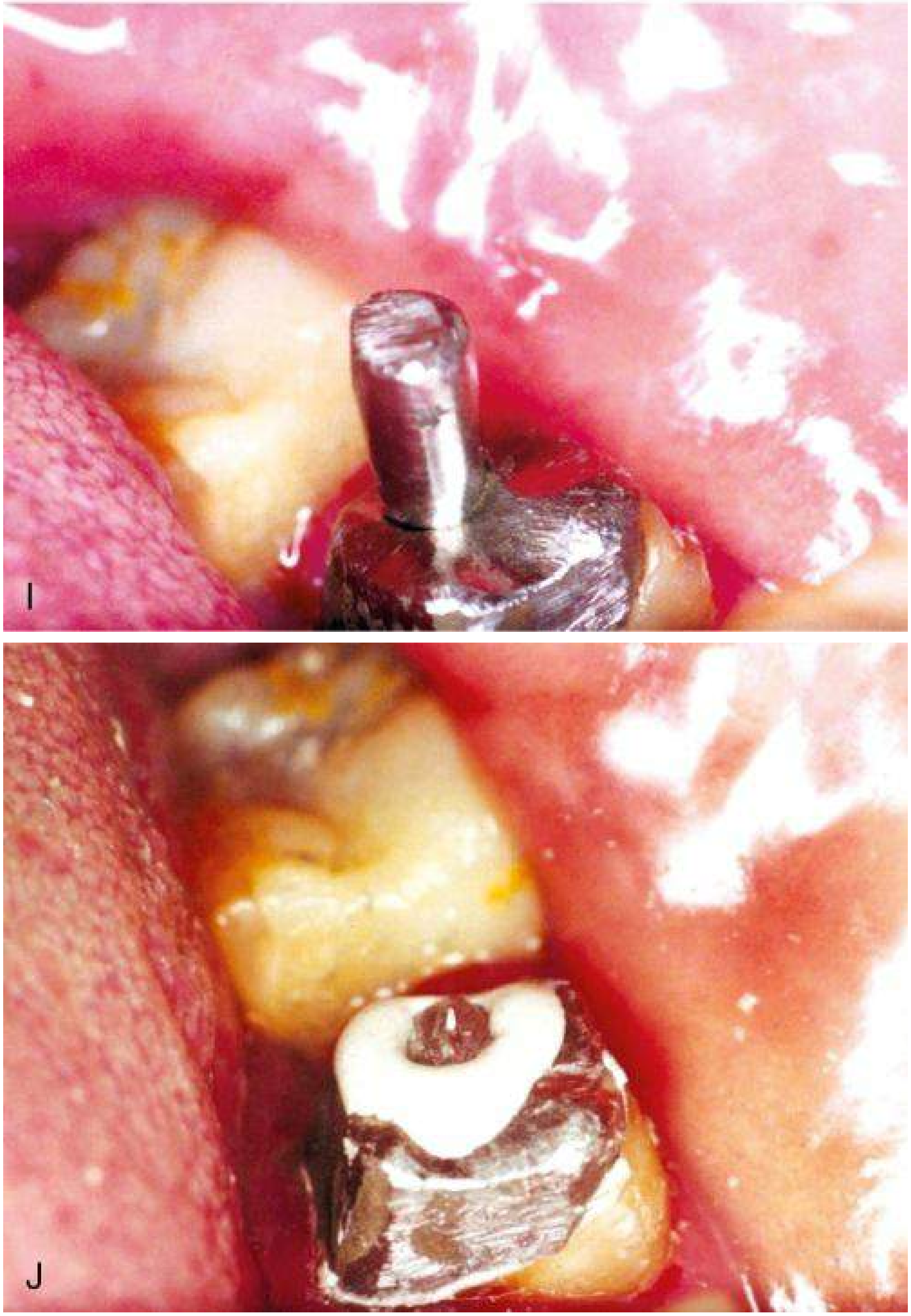

I
J

FIGURE 45.25 **(A)** Post space in mesiobuccal, distobuccal and distal canals in mandibular molar with divergent canals. **(B)** Post space impression made with putty and light body wash. **(C)** Cast is poured and cast post to fit distal canal (overextended occlusally) is fabricated first. **(D)** Wax pattern fabricated for the remaining posts along with the core is fabricated around the distal post. **(E)** Wax pattern minus the distal post. **(F)** Wax pattern with distal post. **(G)** The pattern is cast and distal post is fitted. **(H)** Larger casting (buccal posts with core). **(I)** Distal post is cemented next. **(J)** After the cement sets overextension in distal post is trimmed. **(K)** Cemented two piece cast post.

Prefabricated posts

Prefabricated posts are available in all the categories given in the classification (Flowchart 45.1).

Some common examples of each category are shown in Figs 45.26–45.31.

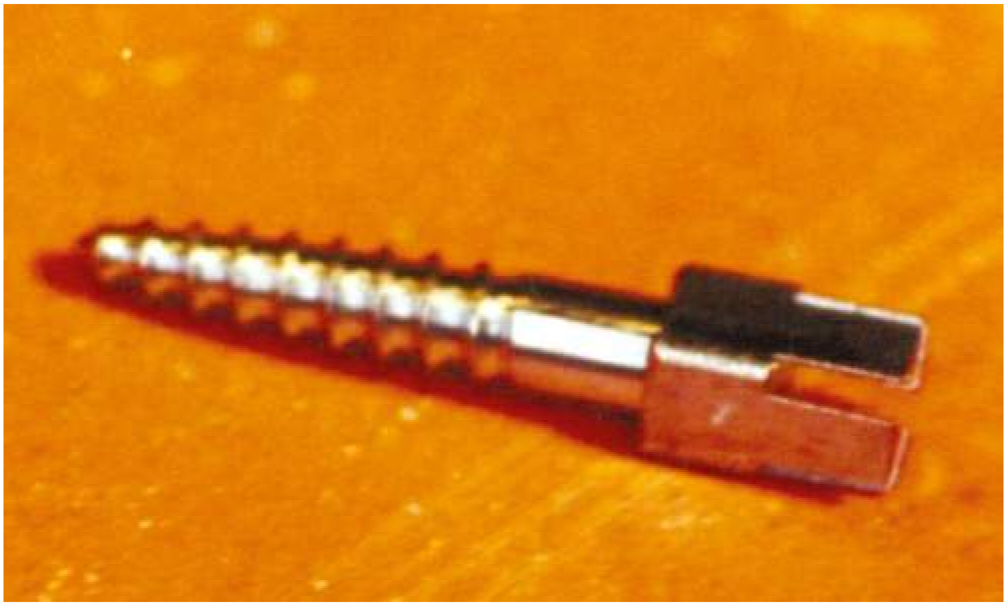


FIGURE 45.26 Rigid, metal, tapered, threaded (Dentatus) post.

FIGURE 45.27 Rigid, metal, parallel, threaded (Flexi-Post).

FIGURE 45.28 Rigid, metal, parallel, serrated (ParaPost).

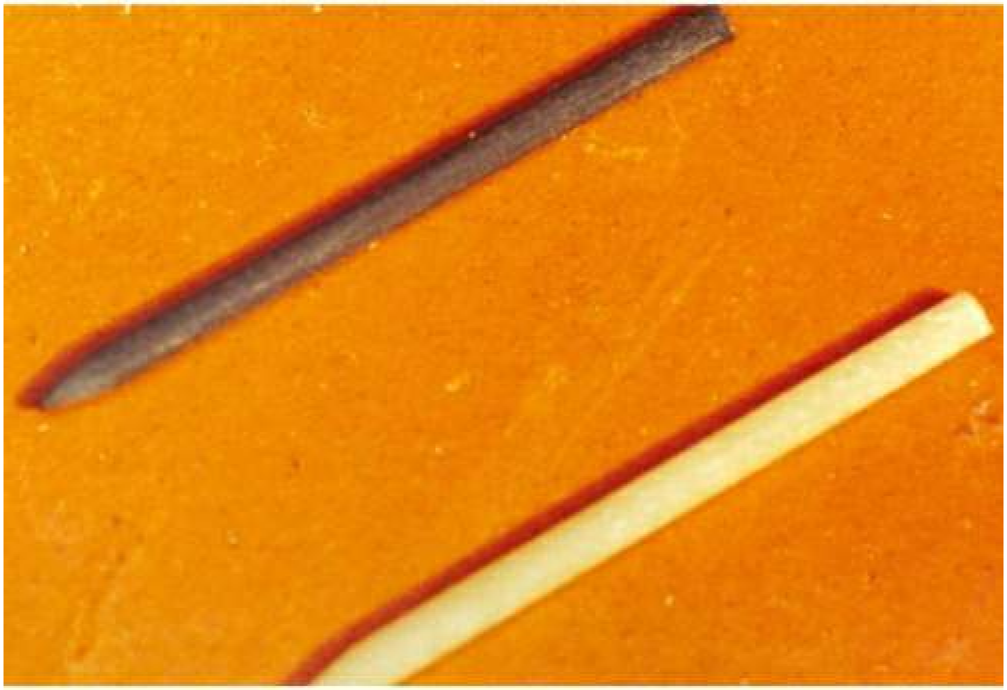


FIGURE 45.29 Nonrigid carbon (Mirafit posteriors) – quartz coated (right) for anteriors.

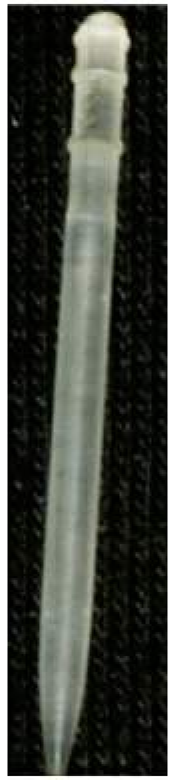


FIGURE 45.30 Nonrigid glass fibre-reinforced, tapered, smooth post.

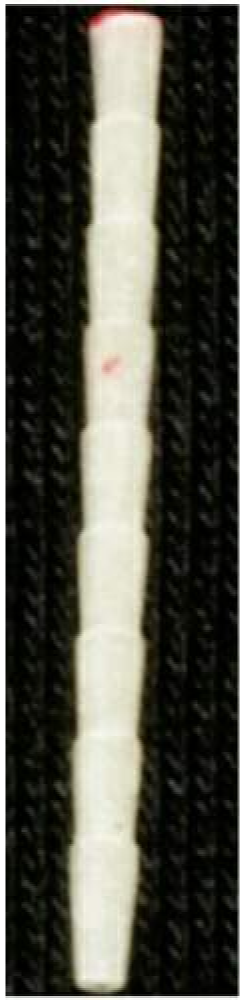


FIGURE 45.31 Nonrigid glass fibre-reinforced, parallel, serrated post (ParaPost Fibre Lux).

Procedure

Threaded post (metal, tapered, threaded post – dentatus)

- Available in sizes 1–6 (according to diameter) and length – short, medium, long (Fig. 45.32).
- A radiograph is used to determine the length and diameter as per the guidelines (Fig. 45.33A).
- According to the size, the canal is prepared with Peeso reamers or

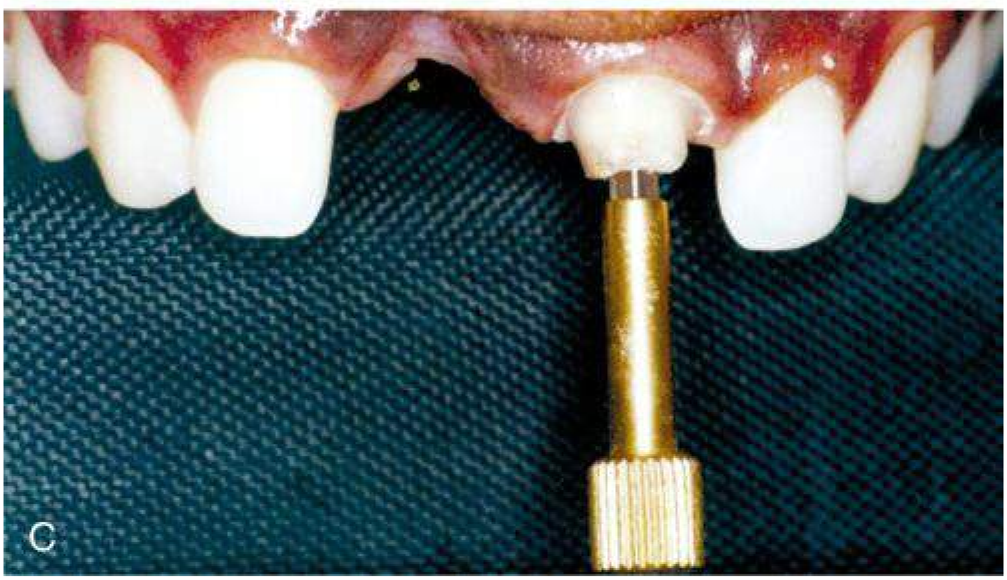
Gates drills, with a rubber stopper to achieve appropriate length. The final size of drilling is one more than post size while using Peeso reamer, and two more than the post size while using Gates (Fig. 45.33B).

- Drills may also be provided by the manufacturer to match the post size. The gutta-percha is always removed only with safe-sided Peeso or Gates.
- The threaded post is held with a driver and screwed in the canal till the ledged top part is flush with the incisal edge (Fig. 45.33C and D). *They do not require to be cemented.*
- The slit top part of the threaded post can be opened with an instrument to provide retention to core (Fig. 45.33E and F).
- A core is then built up with appropriate material (Fig. 45.33G).

FIGURE 45.32 Assorted kit of threaded posts in varying sizes and lengths with drivers.

GATES	PEESO	POST
6	5	4

B



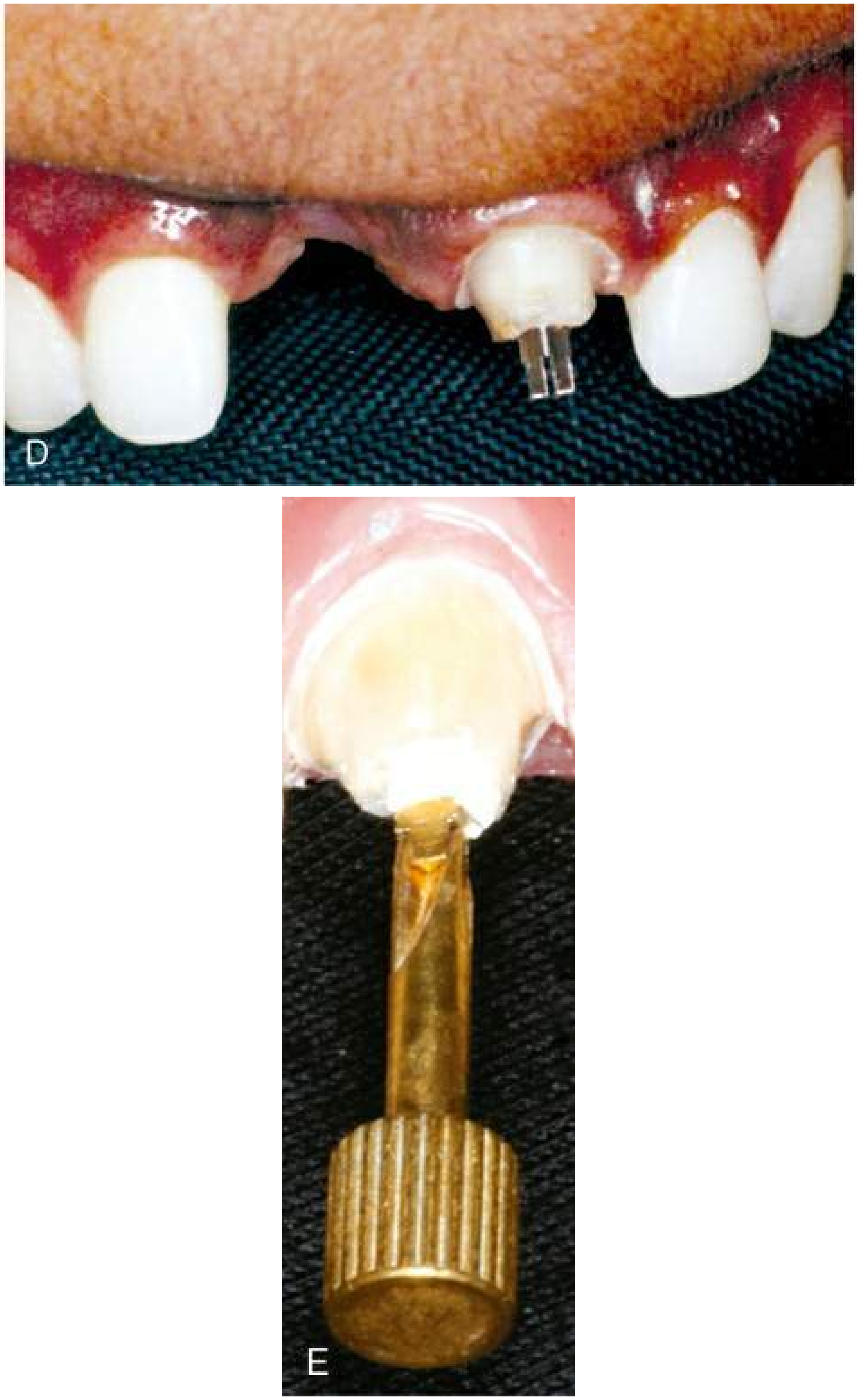

D
E

FIGURE 45.33 **(A)** Radiograph to determine length and diameter. **(B)** If post size selected is 4, the final Peeso used

should be size 5, and Gates should be size 6. **(C)** The post held with a driver is screwed into the canal. **(D)** Final placement. **(E)** The slit in the top is engaged by an appropriate instrument provided in the kit and opened. **(F)** Slit after opening, affords more retention to core. **(G)** Following core build up with reinforced glass ionomer.

Parallel post (metal, parallel, serrated post – parapost)

- These are commonly used posts as the parallel walls have no wedging effect and the serrated sides are passive, and offer good retention.

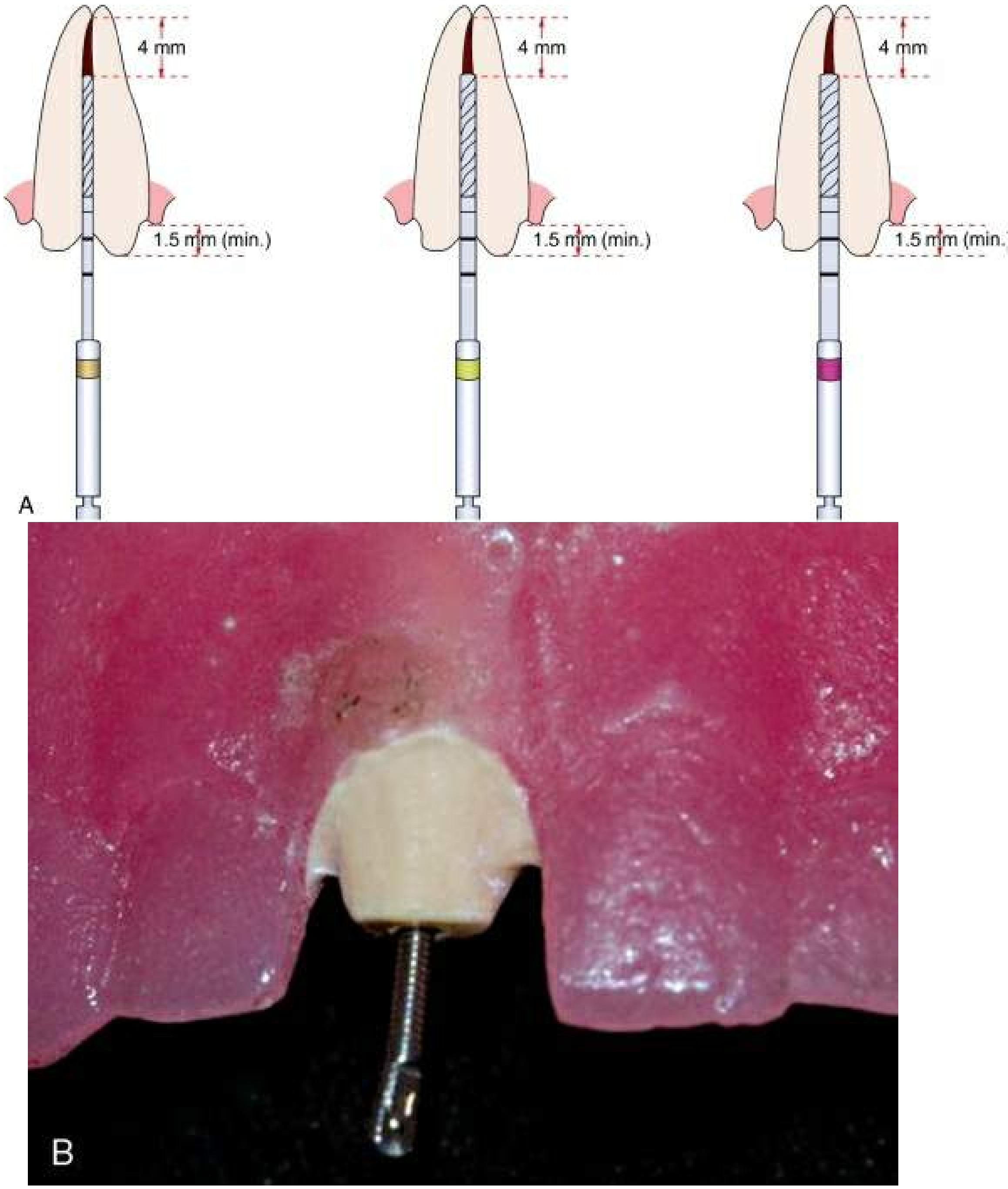
- They are available in various sizes and drills to match the post diameters (Fig. 45.14). The desired length can be cut from the apical end.

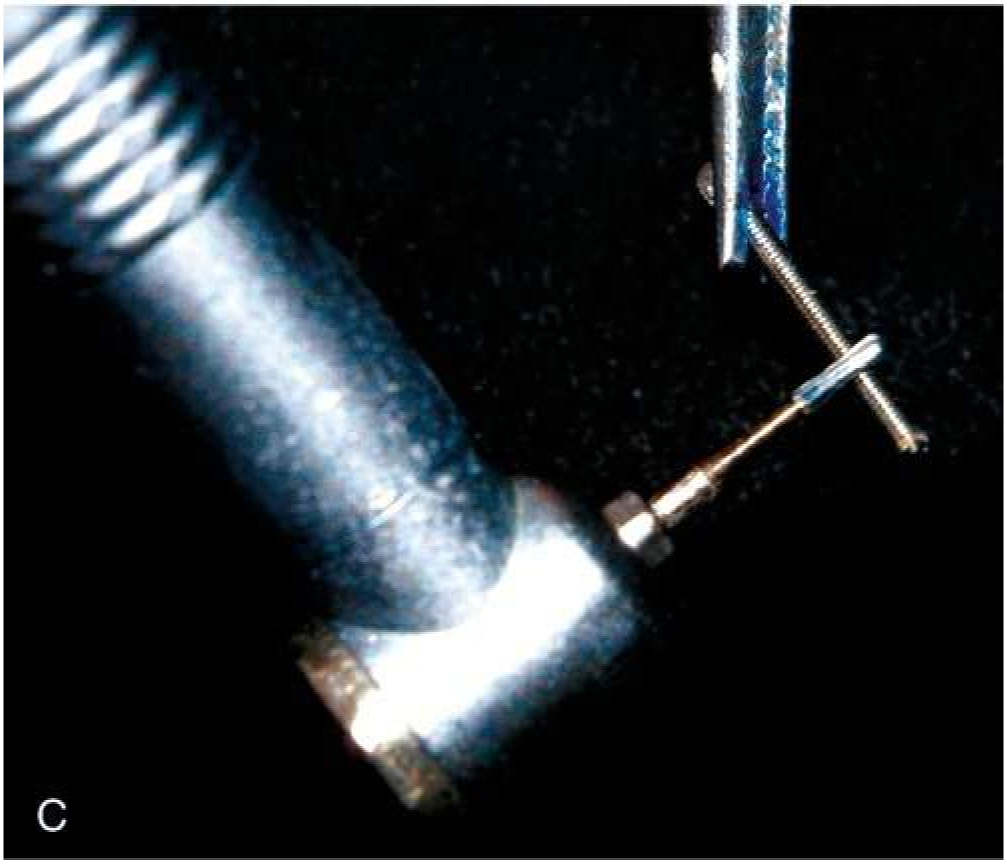
- As before, the Peeso reamers or Gates drills are used to remove the gutta-percha with a rubber stopper for length.

- The drills provided in the kit are used to enlarge the canal to the selected diameter of post (Fig. 45.34A).

- The post corresponding to the final drill is selected and tried in the canal space (Fig. 45.34B). If length is too long, it is cut from the apical end (Fig. 45.34C).

- The post is then cemented and the core is built up (Fig. 45.34D–G).


4 mm
1.5 mm (min.)
4 mm
1.5 mm (min.)
4 mm
1.5 mm (min.)
A
B


C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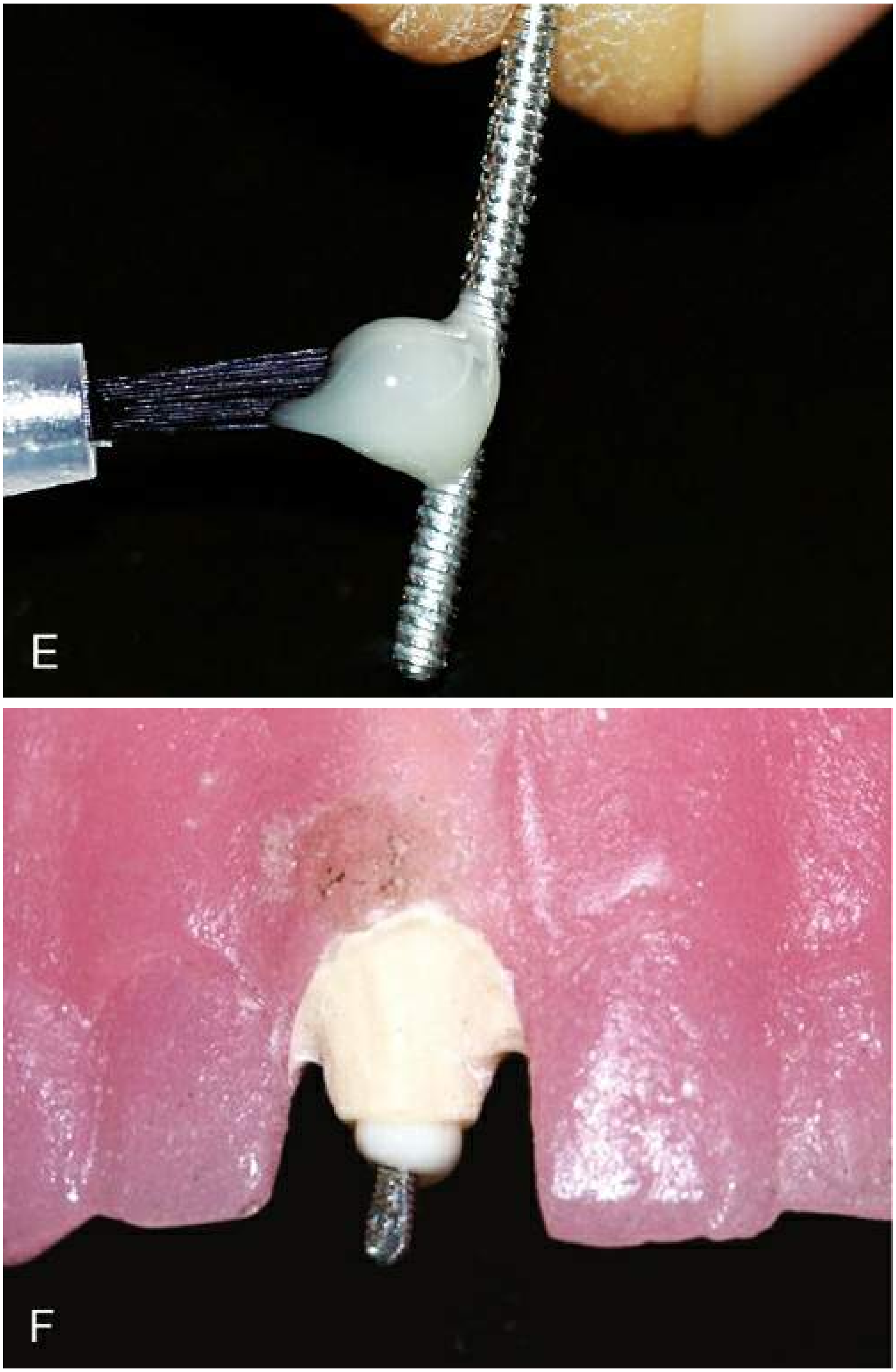
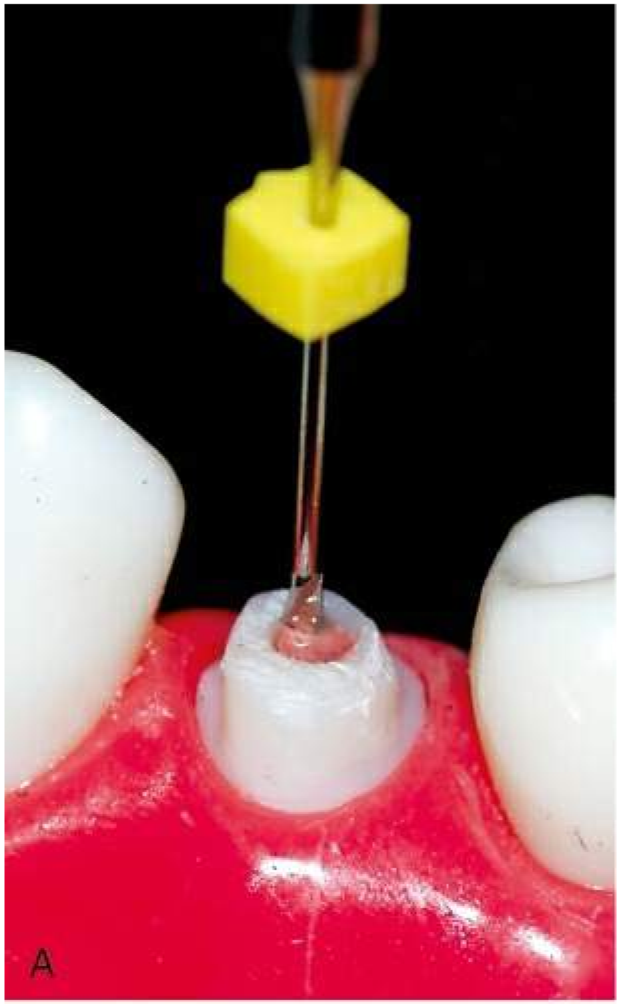

E
F

FIGURE 45.34 **(A)** Sequential drilling to enlarge canal space to appropriate diameter. **(B)** Try-in of post. **(C)** Cutting of post apically to get desired length. **(D)** Cement mixed and placed in canal with a lentulo spiral. **(E)** Post coated with cement. **(F)** Post inserted in canal. **(G)** Core builtup with composite resin.

Aesthetic post (nonrigid, glass, tapered, serrated – parapost taper lux)

These are used with all-ceramic crowns. They are bonded to the tooth using adhesive cementation (Fig. 45.35A–I).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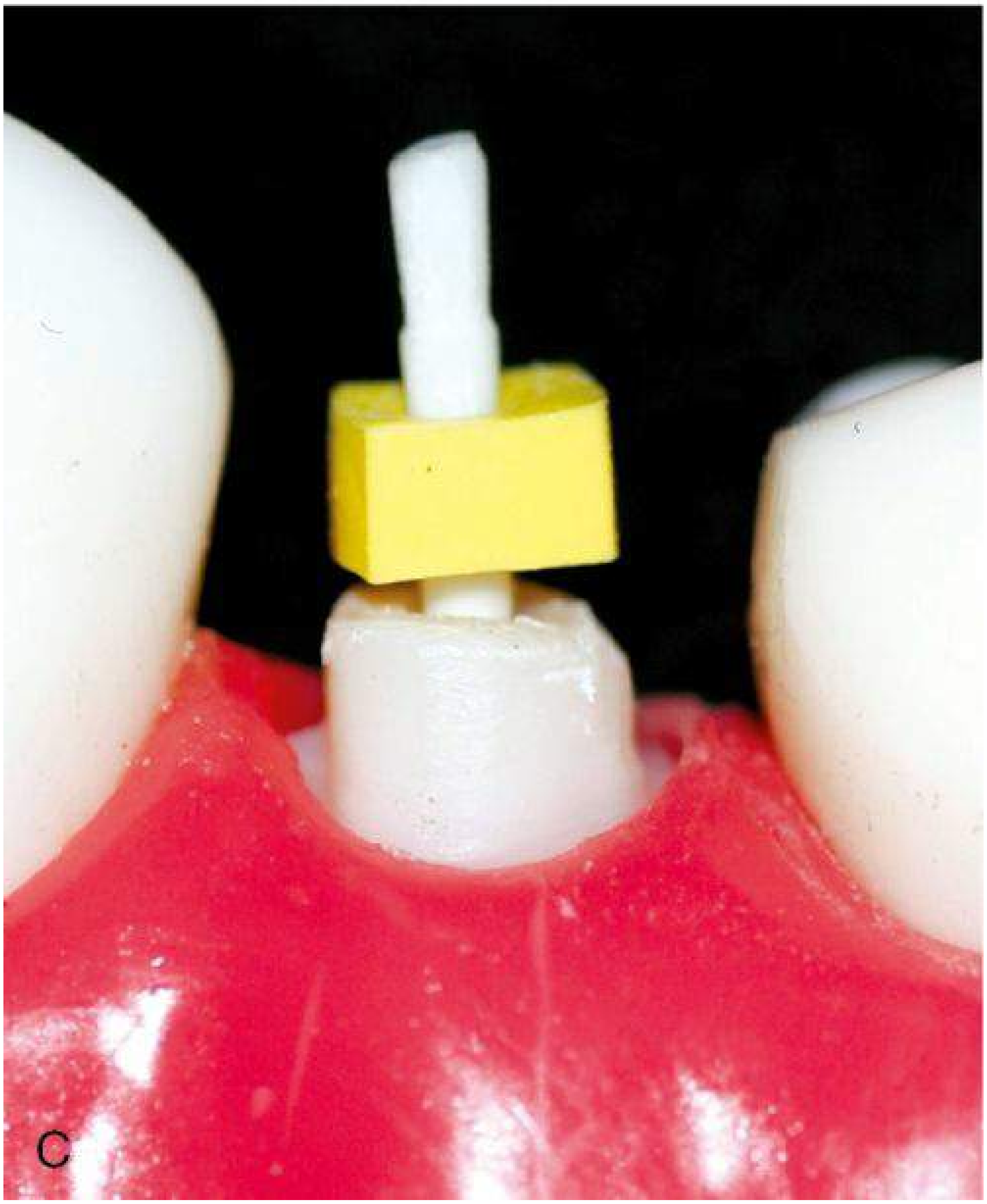
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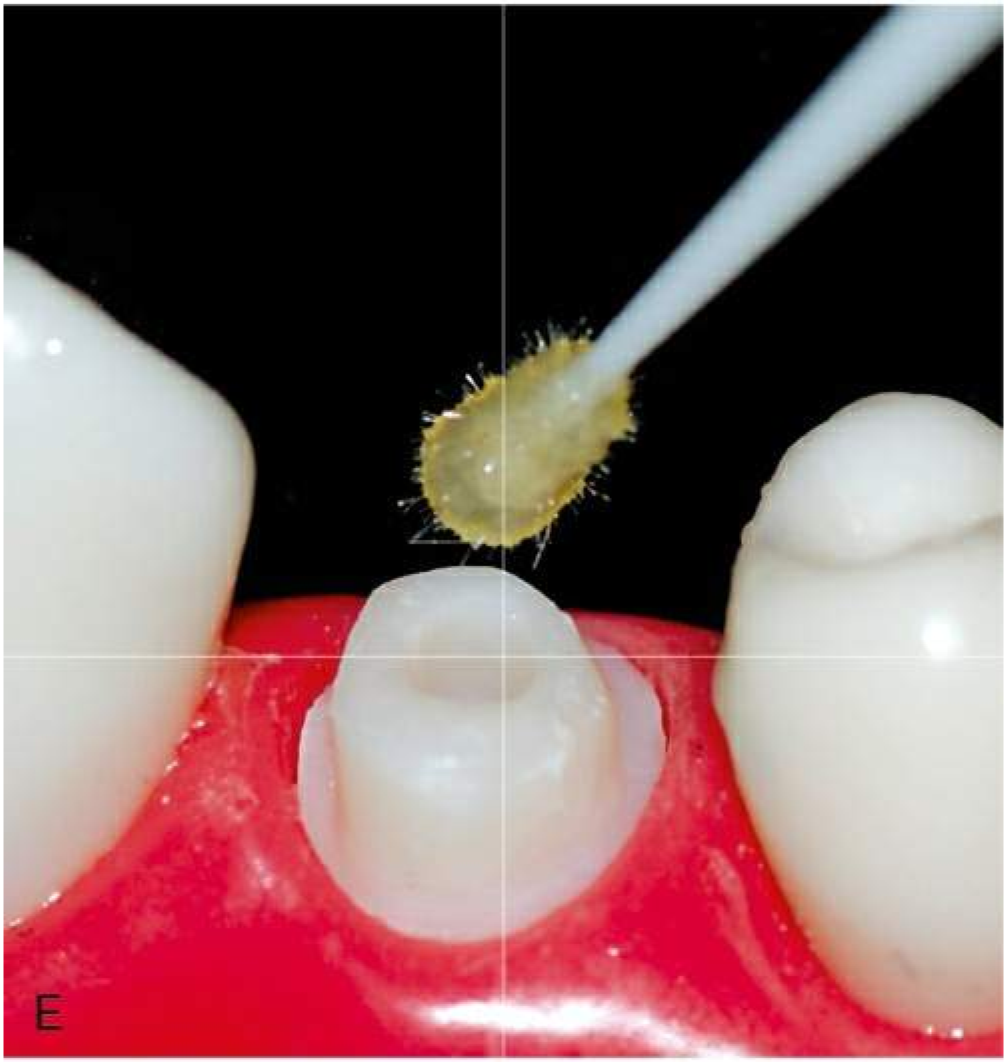
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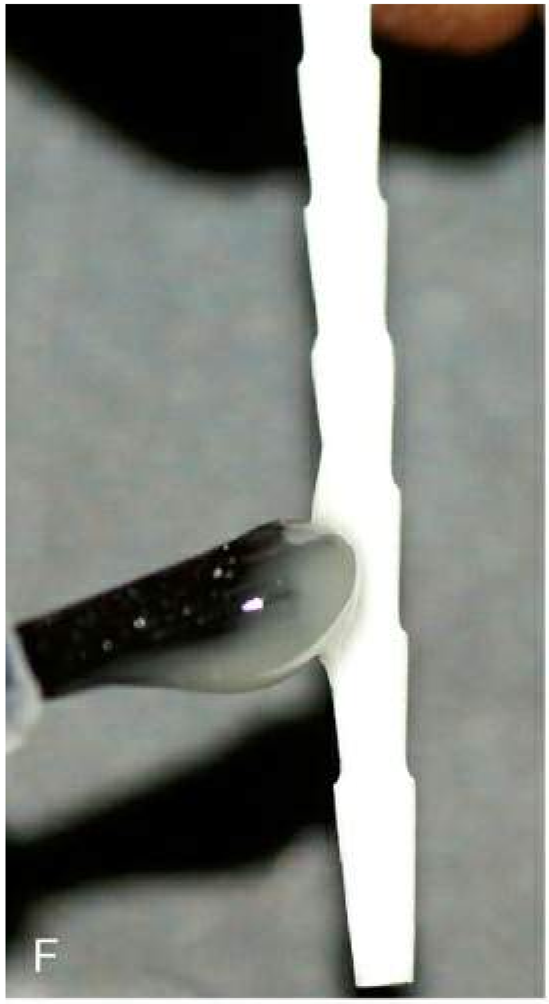

F

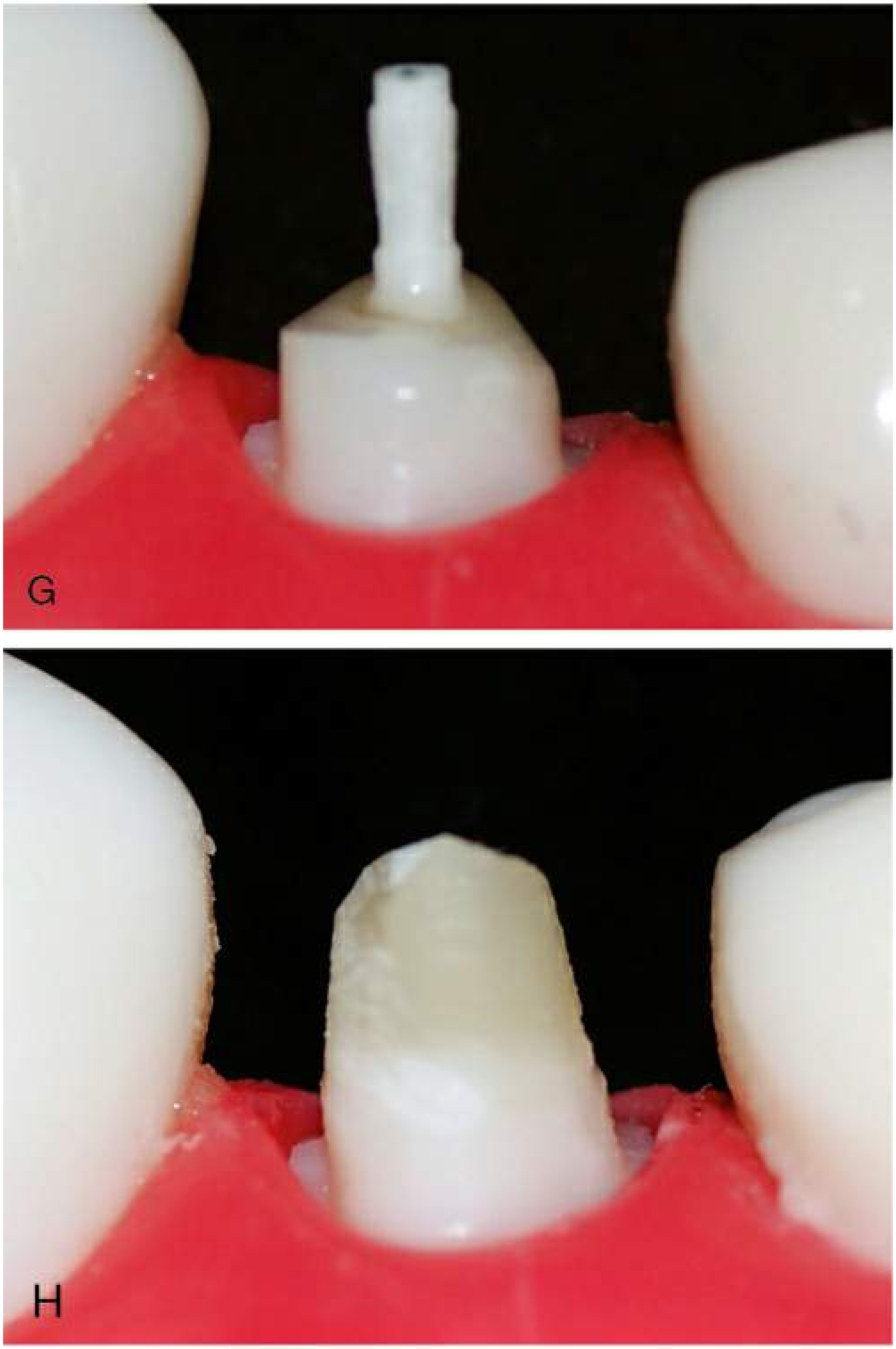

G
H

FIGURE 45.35 **(A)** Gutta-percha removed with Gates drill. **(B)** Canal enlarged to appropriate size with corresponding drills. **(C)** Post tried-in. **(D)** Canal space etched with phosphoric acid. **(E)** Bonding agent is applied, but not cured. **(F)** Dual-cure resin cement is mixed and placed in canal. The post is also coated with cement. **(G)** The post is inserted in canal and light-cured. **(H)** A core is built-up with composite resin. **(I)** Provisional restoration fabricated.

Post cementation

Retention of post to the root canal depends on:

- Post – material, length and surface texture
- Amount of remaining tooth structure
- Cement

Cements used

- Zinc phosphate cement (Table 45.2)

- Glass ionomer cement (Table 45.3)
- Resin cement (Table 45.4)

Table 45.2

Advantages and disadvantages of zinc phosphate

Advantages	Disadvantages
• Economical • Wide application • Easy to use • Easy to remove	• Mechanical retention only • Brittle

Table 45.3

Advantages and disadvantages of glass ionomers

Advantages	Disadvantages
• Adhesion to dentine • Fluoride release	• Requires several days until maximum strength is achieved • Resin-modified GIC is not used as expansion may cause root fracture • Water soluble • Brittle

Table 45.4

Advantages and disadvantages of resin cements

Advantages	Disadvantages
• Adhesion to dentine • No expansion • Low solubility • Elasticity – fewer root fractures • Reaches strength immediately after setting • Better bonding to most posts • Self-cure, light-cure, dual-cure	• Additional step of conditioning is necessary • Root canal sealers may affect bonding • More expensive

Selection of cement

- The type of cement used has little effect on retention or fracture resistance in teeth with adequate tooth structure.

- Resin cements improve the performance of posts with improved retention.
- Resin cements indicated for FRC posts.

Cores

Ideal requirements

- Easy to use
- High compressive strength
- Easy to manipulate
- Short setting time
- Good dimensional stability
- Less microleakage
- Ability to bond to tooth and post

Materials

- Cast core
- Amalgam
- Glass ionomers
- Composite resin

1. Cast cores

Used with cast post and as it is cast along with post there is no chance of core separating from post. It cannot be used with all-ceramic restorations and possesses all the other disadvantages of cast posts.

2. Amalgam (table 45.5)

3. Glass-ionomers

- Low strength, brittle but anticariogenic.
- Used for small build-ups especially in posterior teeth where significant sound dentine remains.
- Resin-modified GIC better, used for moderate build ups, but not with all-ceramic crowns.

Table 45.5

Advantages and disadvantages of amalgam

Advantages	Disadvantages
• High strength and modulus of elasticity • Easy to manipulate • Good setting time • Good retention	• Corrosion • Discolouration of gingiva and dentine • Use declining worldwide due to legislative, safety and environmental reasons

4. Composite resins

- Adhesive bonding, ease of manipulation, rapid set, translucent or opaque, good compressive strength.
- Better protection for teeth with metal posts from fracture compared to amalgam and GIC.

Retention of post to core

- Extremely critical for restoration survival.
- Important criteria with prefabricated posts, not a problem with cast post and core.
- May be adhesive and/or mechanical.
- Posts with mechanical interlocking feature in the heads and

roughened texture provide better retention.

- Fibre and zirconia posts chemically bond to composite core materials.

Post crown

This is a one-piece post crown. It is also called 'Richmond crown' (Fig. 45.36A–E). Indicated in patients with deep incisal overbite where it is difficult to provide space for a core and crown separately.

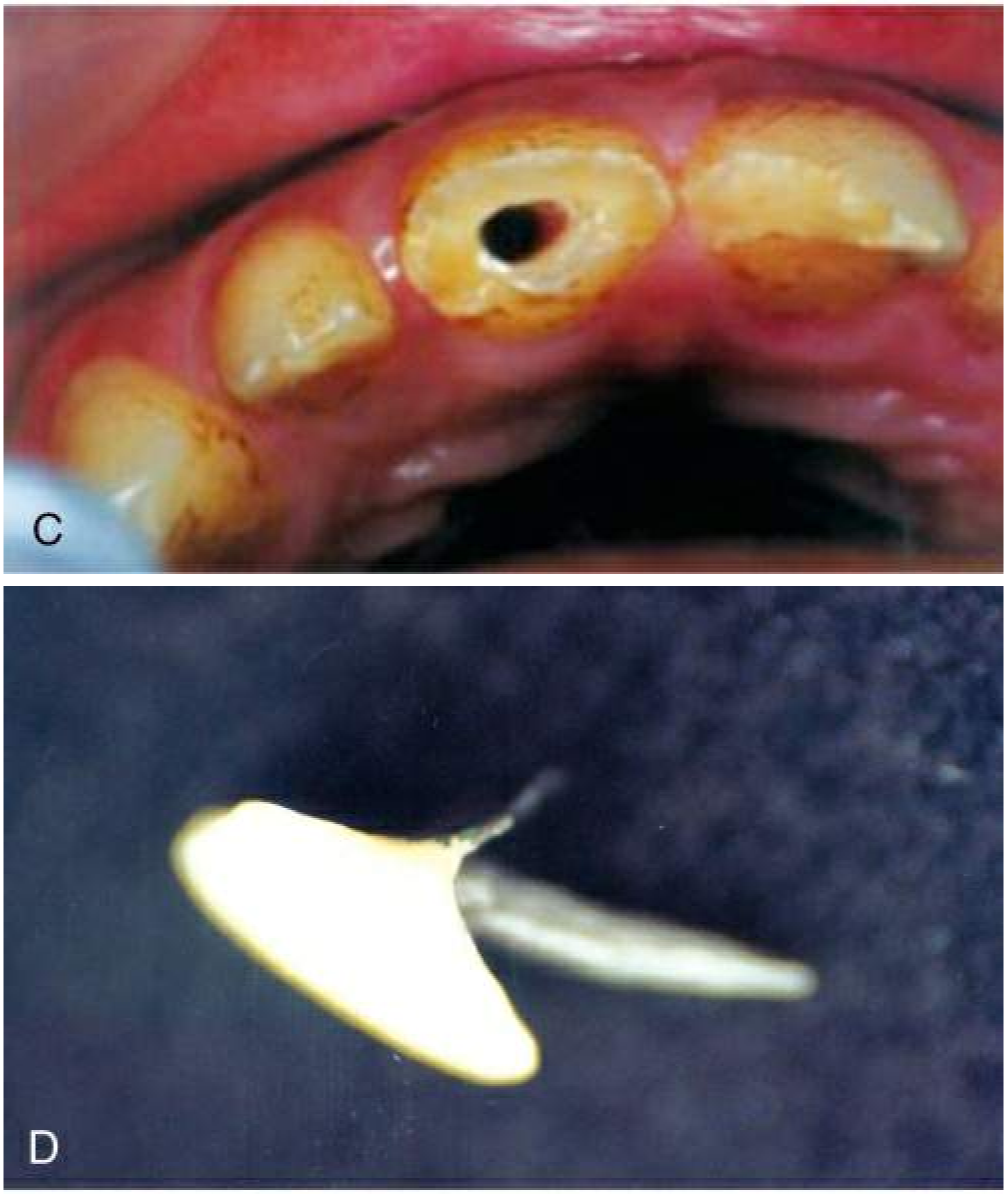

C
D

FIGURE 45.36 **(A)** Fracture maxillary central incisor (tooth no: 11) with lack of occlusal clearance. **(B)** Coronal tooth preparation. **(C)** Preparation of canal space. **(D)** Post crown fabricated by indirect method. **(E)** Cemented post crown.

SUMMARY

It is important to understand that posts only retain a core and do not reinforce the tooth. In general, parallel-serrated cementable post may be used with most clinical situations. With short roots, threaded posts may be used to increase the retention. Where aesthetics is a concern especially with all-ceramic restorations, fibre-reinforced posts are indicated with adhesive cementation. The use of custom-made cast post is declining, due to its rigidity, wedging potential, poor aesthetics and time consuming clinical and lab procedures.

SECTION 4
Miscellaneous

OUTLINE

CHAPTER 46

Ceramic laminate veneers

CHAPTER CONTENTS

Introduction

Laminate veneers have evolved over the last several decades to become one of aesthetic dentistry's most popular restorations. The laminate veneer is a conservative alternative to full coverage for improving the appearance of an anterior tooth.

Definitions

Porcelain laminate veneer: A thin bonded ceramic restoration that restores the facial surface and part of the proximal surfaces of teeth requiring aesthetic restoration (GPT).

Veneer: A thin sheet of material usually used as a finish (GPT8).

Laminating: Constructing a veneer and bonding it to etched tooth structure.

It is the prosthetic treatment that consists of replacing the visible portion of the dental enamel with a ceramic substitute, intimately bonded to the tooth surface, yielding optical, mechanical and biological properties closely resembling those of the natural enamel.

History

In 1930s, Dr Charles Pincus first used thin resin facings and then air fired porcelain facings to create the 'Hollywood smile' for American actors. He used denture adhesive to hold the veneer in place. In the 1970s, preformed plastic laminates were bonded to the teeth using composite resin, but bonding to the plastic was poor along with colour instability. The evolution of the modern ceramic laminate was assisted by the following discoveries:

1. Etching of enamel by Buonocore (1955)

2. Bowen's BIS-GMA resins (1960s)

3. Ceramic etching and bonding by Rochette (1973).

Indications

- **Extreme discolourations:** Such as tetracycline staining, fluorosis, devitalized teeth and teeth darkened by age which are not conducive for bleaching.
- **Enamel defects:** Small cracks in the enamel due to ageing, trauma or hypoplasias.
- **Diastemas:** Single or multiple spaces between the teeth.
- **Attritions and root exposure:** Can be used to restore localized attrition and root sensitivity due to cemental exposure.
- **Malpositioned teeth and abnormalities of shape:** Peg laterals and rotated teeth.
- **Repair of functionally sound metal-ceramic or all-ceramic restoration with unsatisfactory colour:** The labial surface of old porcelain restoration is prepared and a ceramic laminate is bonded correcting the anomaly.
- **Tooth fracture:** Restricted to incisal thirds.
- Restoring anterior guidance in worn mandibular incisors.

Contraindications

- **Insufficient coronal tooth structure:** Fractured teeth with more than one-third loss of tooth structure, grossly carious or extensively restored teeth. Full coverage restorations are preferred.
- Actively erupting teeth.
- Parafunctional habits like bruxism.
- Severe periodontal involvement and crowding.
- **Endodontically treated teeth:** Present a poorly receptive surface for bonding and full coverage restorations are indicated.

Advantages and disadvantages

The advantages and disadvantages of ceramic veneer laminates are enumerated in Table 46.1.

Table 46.1

Advantages and disadvantages of ceramic laminate veneers

Advantages	Disadvantages
• Minimally invasive – conservative • Excellent colour and light transmission – good aesthetics • High colour stability • Good tissue response • Excellent durability – good strength, wear resistance and no fluid absorption • Speed and simplicity	• Tooth preparation, however minimal, is required • Cementation is time-consuming and technique sensitive • Fragile – may fracture if improperly handled during try-in or cementation • Proper selection of underlying cement is critical for success • Difficult to repair • Cost

Shade selection

This should be done at the beginning, during the consultation or treatment planning appointment. It has to be done when the teeth have not been dried out for any period of time. It is done under a colour corrected light or outside in daylight. The conventional shade guides such as vita porcelain shade guide are not ideal for veneers because their porcelain thickness is high. It is best for a ceramist to make an individualized shade guide (also refer Chapter 39).

Tooth preparation

Principles of tooth preparation

Conservation of tooth structure: The preparation should be conservative, which is the main principle governing the fabrication of the ceramic laminate.

Retention is solely by adhesion: Adhesive luting or bonding using resin cements is the main contributor to retention rather than tooth preparation.

Rationale

Enamel preparation is done:

1. To provide adequate space for porcelain opaquing and composite resin luting materials.

2. To remove convexities in the surface and provide a definite path for insertion.

3. To assist veneer seating during placement and bonding.

4. To provide a receptive enamel surface for etching and bonding the laminate.

5. To facilitate margin placement.

6. To provide adequate contour and colour without overcontouring.

Types of preparation

Tooth preparation can be classified into three types (Fig. 46.1A–C):

1. **Type I – contact lens type:** Does not cover the incisal edge.

2. **Type II – classic or conventional type:** Most commonly used; covers the incisal edge and terminates lingually; thickness of tooth, need for increasing tooth length and occlusion determine whether type I or II is used.

3. Type III – wrap-around or three-fourth type: Almost similar to full coverage preparations; indicated for extensive changes and colour and contour.

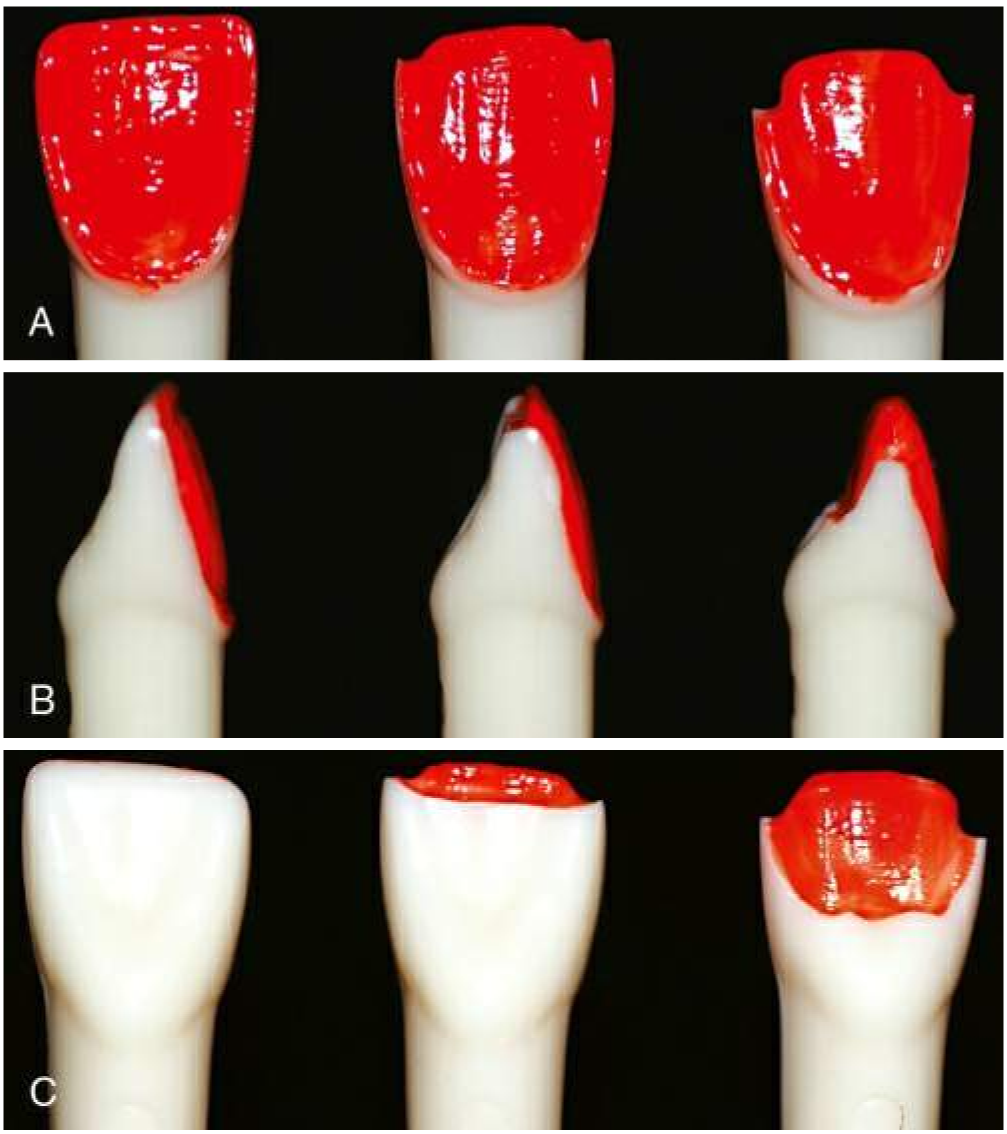


FIGURE 46.1 Different preparation types. **(A)** Labial view L–R – type I, II, III. **(B)** Proximal view. **(C)** Palatal view.

Armamentarium

1. A diamond depth cutter with three 2 mm diameter wheels mounted on a 1.0 mm diameter noncutting shaft. The radius of wheels from the noncutting shaft is 0.5 mm. Produces a depth cut of 0.5 mm (Fig. 46.2).

2. A diamond depth cutter with a wheel diameter of 1.6 mm produces a depth cut of 0.3 mm (Fig. 46.2).

3. Round bur (No. 1).

4. Round-end tapering diamond (medium and fine grit).

5. Finishing diamond and burs.

6. Airotor handpiece

FIGURE 46.2 Depth cutters.

Procedure

The preparation for the conventional type is described below. It involves the following steps:

1. Labial reduction

2. Proximal reduction

3. Sulcular extension

4. Incisal reduction

5. Lingual reduction

Labial reduction

The thickness of the ceramic laminate should be 0.5 mm. To achieve this, the labial preparation should achieve a uniform reduction of 0.3–0.5 mm, less gingivally and more incisally. This involves:

1. Depth cuts

2. Reducing remaining enamel

1. Depth cuts

These can be prepared using round bur only or a combination of round bur and the depth cutter.

Depth cuts using only round bur

Depth cuts are placed on the labial surface with a No. 1 round bur along the gingival margins, and extended proximally and incisally. The 0.8 mm diameter will produce a 0.4 mm depth of preparation (Fig. 46.3A and B).

FIGURE 46.3 **(A)** Depth cuts along gingival margins with a No. 1 round bur. **(B)** Depth cuts extended proximally and incisally.

The labial surface is then divided into a mesial and distal half by placing a depth cut cervicoincisally in the centre of labial surface with the round bur (Fig. 46.4).

FIGURE 46.4 Depth cut along centre of tooth.

The labial surface is then divided into cervical, middle and incisal third by placing two depth cuts mesiodistally with the round bur (Fig. 46.5).

FIGURE 46.5 Two depth cuts placed mesiodistally.

Depth cuts diamond depth cutter

After the first depth cut around the gingival margin with a round bur, depth cuts are placed on the entire labial surface by running the diamond depth cutter mesiodistally (Fig. 46.6). The depth of preparation dictates the choice of depth cutter. The cuts are placed in two planes following the contour of the labial surface. Also the wider depth cutter can be used on the incisal part and the other on the gingival part if the amount of preparation on the gingival half is to be lesser (because of reduced enamel).

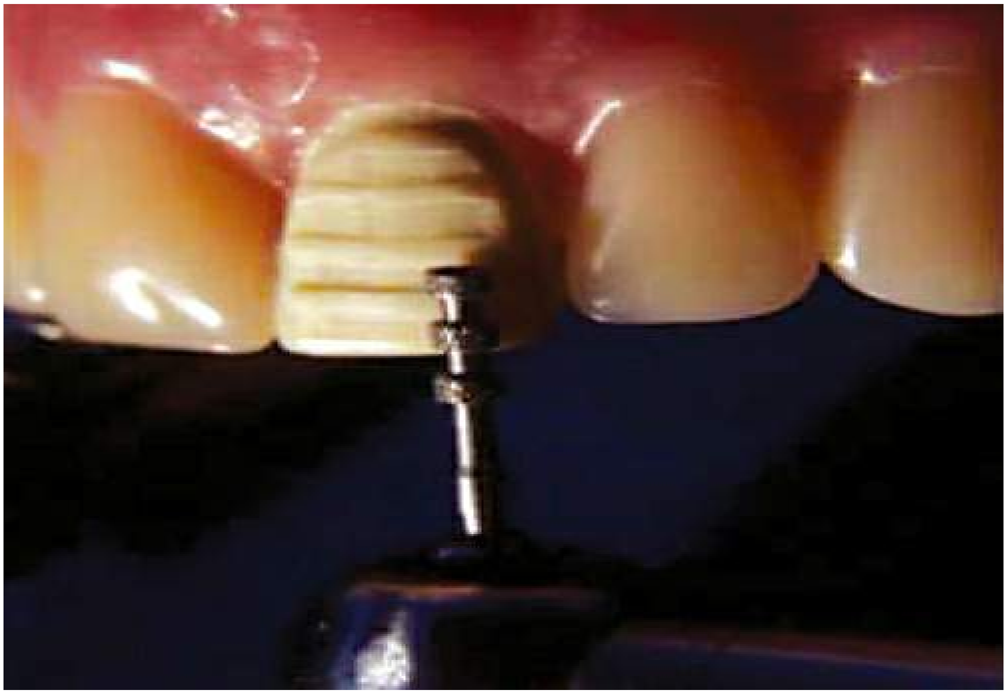


FIGURE 46.6 Depth cuts with depth cutter diamond.

2. Reducing remaining enamel

Whichever method is used to produce the depth cut, the remaining enamel on the labial surface is reduced using a round-end tapering diamond, which will produce a chamfer finish line. Only the direction of reduction varies depending on direction of the cut (Figs 46.7 and 46.8).

FIGURE 46.7 Direction of instrument to reduce remaining enamel if depth cuts are prepared using round bur only. If a direction parallel to the tooth is used here, it will only deepen the groove.

FIGURE 46.8 Direction of instrument if a depth cutter has

been used.

Proximal reduction

Depth can often be as great as 0.8–1 mm, since the enamel layer is thick towards proximal surface. The facial reduction using the round-end tapered diamond is just continued into the proximal area. It is ensured that the diamond is parallel with the long axis of the tooth. The proximal reduction should stop just short of breaking the contact (Fig. 46.9).

FIGURE 46.9 Proximal reduction just short of contact.

Reasons to preserve contact area

- It is an anatomical feature that is extremely difficult to reproduce.
- It prevents displacement of the tooth between the preparation and

placement appointment if no provisional restorations are planned.

- Postinsertion oral care is easier.
- Simplifies try-in – no need to adjust the contact.
- Simplifies bonding and finishing.

Sulcular extension

Routinely the margins are placed supragingivally. When discolouration is excessive, the margins are extended subgingivally. A rounded 0.3 mm chamfer serves as an ideal margin for ceramic laminate veneer (Fig. 46.10).

FIGURE 46.10 Supragingival margin placement.

Advantages of supragingival margin

- Increased areas of enamel in the preparation.
- Simplified moisture control.

- Visual confirmation of marginal fit.
- Margins are accessible for finishing and polishing.
- Access to margins for routine maintenance and dental hygiene procedure.

Advantages of chamfer finish line

- Conservative, distinct.
- Provides increased bulk of porcelain giving adequate strength, avoids over contouring.
- Good marginal seal.
- Accuracy of fit – veneer is easily inserted at try-in and final placement.

For type I preparations, the tooth reduction ends here. For type II preparations, incisal and lingual reductions are necessary.

Incisal reduction

As porcelain is stronger in compression than in tension, wrapping the porcelain over the incisal edge and terminating it on the lingual surface places the veneer in compression during function. It also provides a vertical stop that aids in proper seating of the veneer and improves translucency. Incisal reduction should provide a ceramic layer of at least 1 mm in thickness. Depth orientation grooves of 0.5 mm are placed in the incisal edge using a depth cutter or round-end tapering diamond (Fig. 46.11). A round-end tapered diamond is used to remove the tooth structure in between the grooves (Fig. 46.12).

FIGURE 46.11 Incisal depth cuts.

FIGURE 46.12 Incisal reduction.

Never end incisal edge where excursive movements of the mandible will cause shearing stresses across the junction of porcelain laminates and tooth.

Indications for incisal coverage

- The incisal thickness is too thin to support the veneer.
- A lengthening of the incisal edge of 1.0–2 mm is desired.
- Facioincisal margin is visible and unaesthetic.
- Incisal enamel is structurally compromised.
- The incisal edge is subject to functional stress.

Lingual reduction

The round-end tapered diamond is held parallel to the lingual surface with its end forming a slight chamfer 0.5 mm deep (Fig. 46.13).

FIGURE 46.13 Lingual reduction.

Besides placing the porcelain under compression lingual extension will also enhance the retention and increase the surface areas for bonding.

Soft tissue management

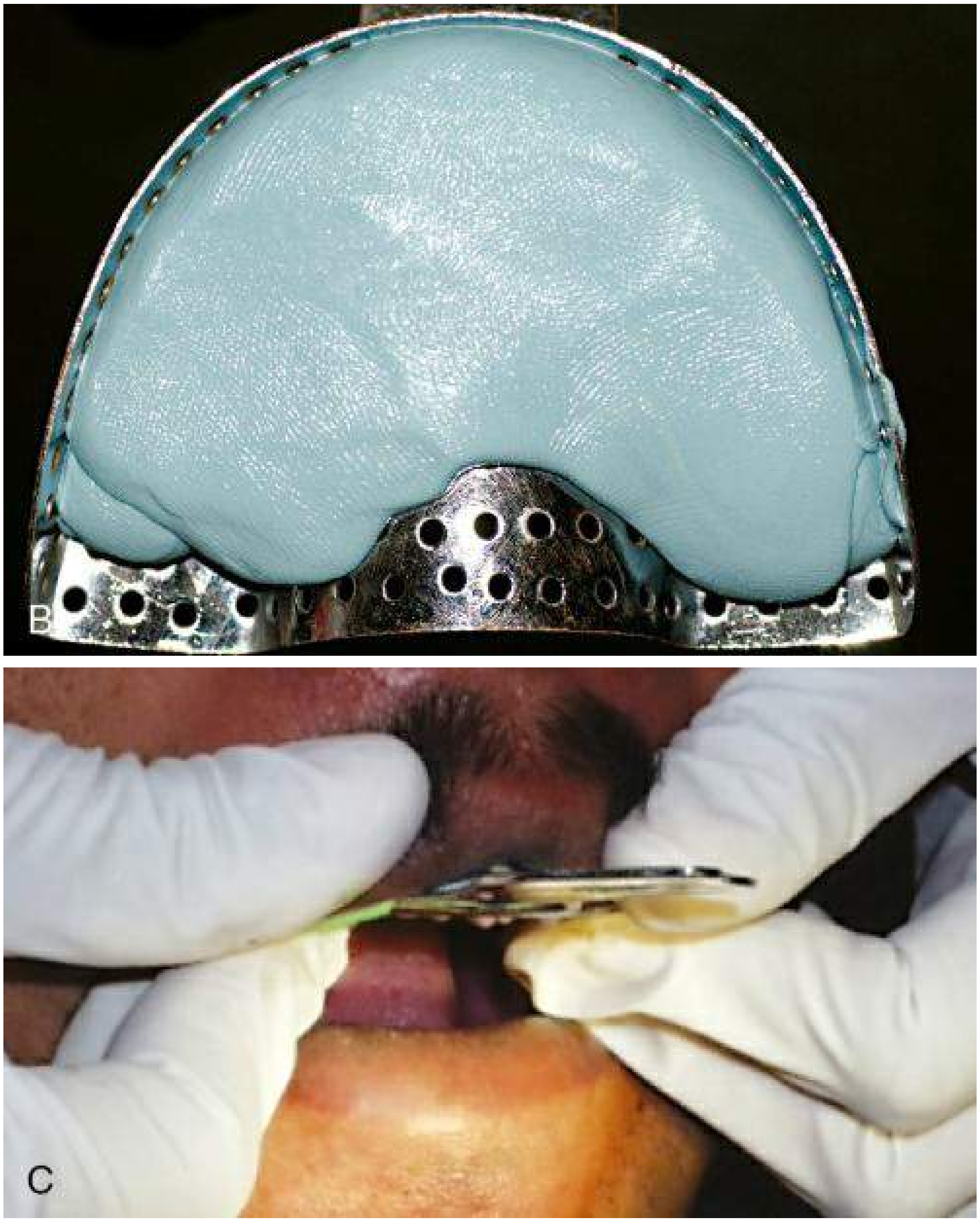
Gingival retraction can be done just prior to tooth preparation when the finish line is placed 0.5 mm subgingivally. It can also be done prior to impression making (Fig. 46.14). During cementation, placement of retraction cord prevents the contamination of the cervical margins with sulcular fluid and facilitates the finishing of the cervical margin.

FIGURE 46.14 Gingival retraction following tooth preparation.

Impression procedure

A single impression technique, double mix, using a combination of putty and light body is recommended for laminates. A double impression technique using a spacer is not recommended due to the reduced thickness of a laminate compared to a crown, which leads to greater shrinkage of light body. The impression is normally made with a standard fixed prosthodontic impression material such as addition silicones as they have excellent accuracy, remarkable mechanical properties and good dimensional stability.

The light body is syringed on the prepared teeth and gently spread so that the entire preparation is covered and no air bubbles exist. A simultaneously mixed putty material is loaded on a stock tray and inserted over the light body material. Tray is filled with putty and is kept in place (Fig. 46.15A–D).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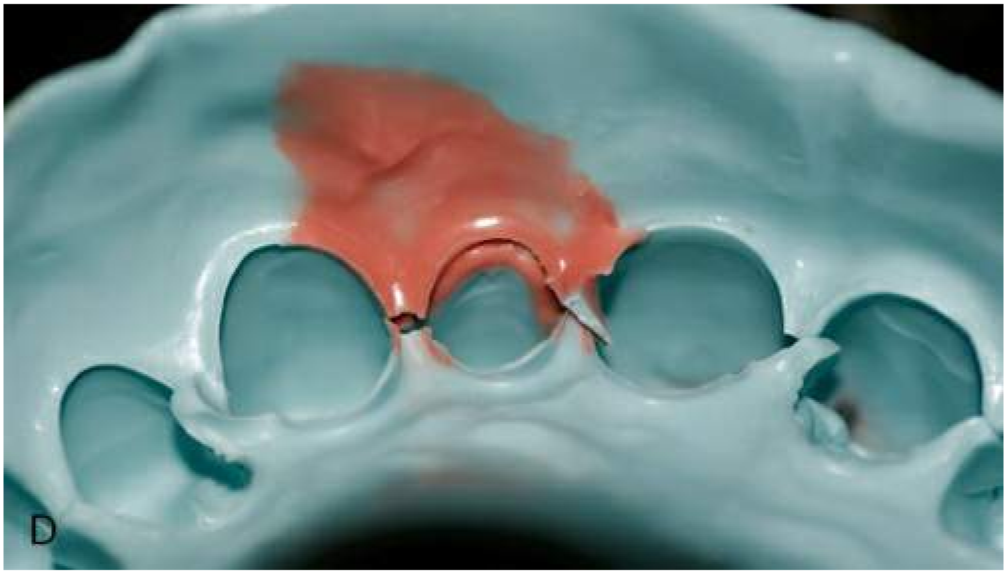

FIGURE 46.15 **(A)** Light body syringed around the preparation. **(B)** Putty mixed and loaded onto stock tray. **(C)** Tray placed over the syringed light body. **(D)** Single impression made using double mix.

Provisional restorations

Provisional restorations for laminates may not be essential as there is no exposure of dentine (no sensitivity) and the proximal contacts are maintained (no drifting of the adjacent teeth). But most often it may be necessary for a patient to maintain their social engagements and if proximal contact is broken (wrap-around technique).

Two methods may be used:

1. Direct method

2. Indirect method

Direct method

The provisional restoration is fabricated intraorally. It can be done by using the following.

Composite resin

A few spots on the prepared tooth or a central spot is etched (spot etching) with phosphoric acid and bonded. Restorative composite is built up on prepared tooth and light cured. This acts as a provisional restoration as it can be easily removed prior to try-in, as the entire surface was not etched (Fig. 46.16A and B).

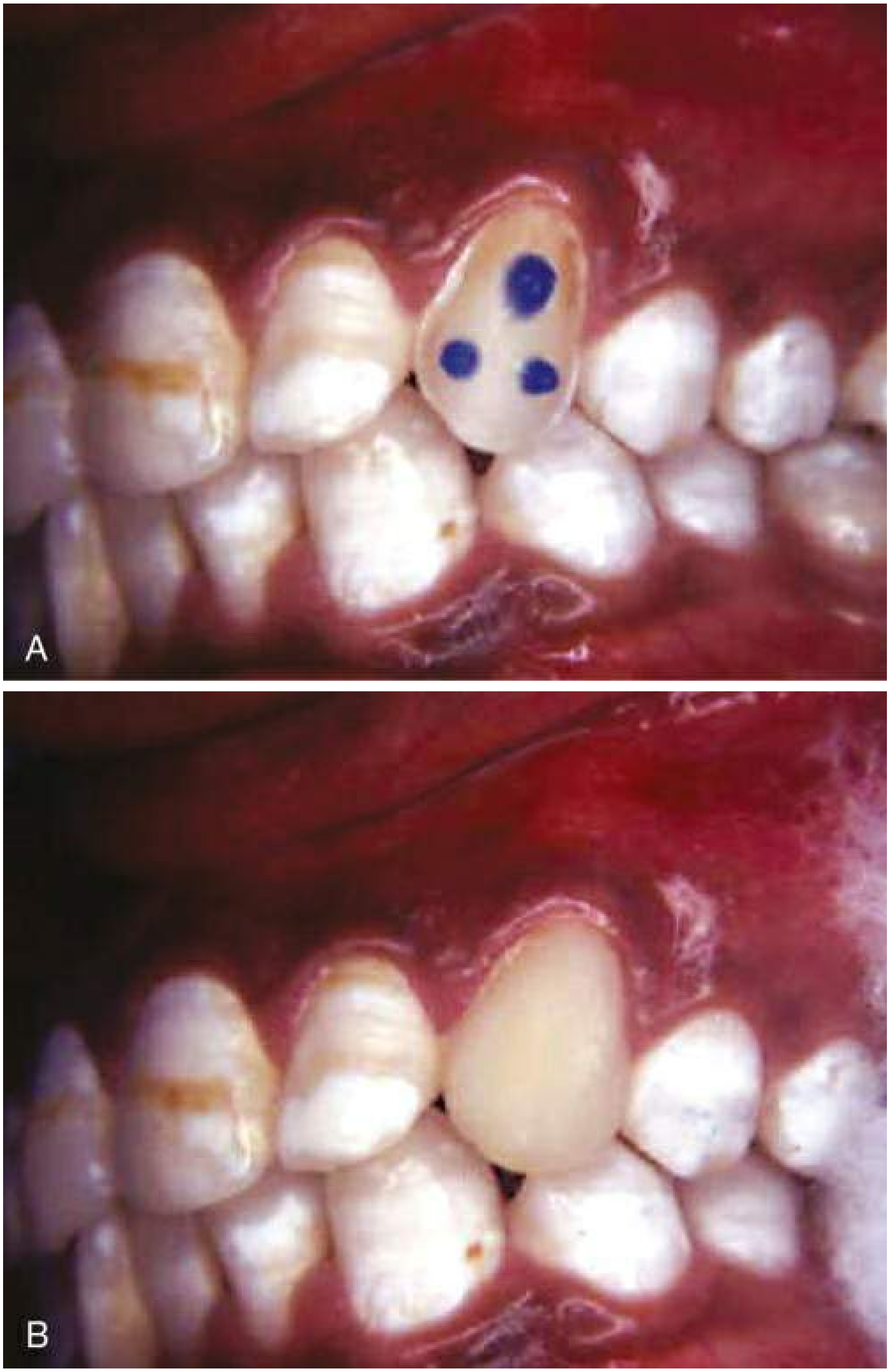

FIGURE 46.16 **(A)** Spot etching of prepared laminate surface. **(B)** Composite resin built-up provisionally.

Autopolymerizing acrylic resin

Tooth coloured acrylics can also be used similar to routine fixed prosthodontics. A putty index of the tooth made prior to tooth preparation, is filled with resin following the preparation and inserted in the mouth. It is removed following initial set, allowed to polymerize, trimmed and can be luted using provisional cements or spot etched and bonded with resin cements (Fig. 46.17A–E).


C
D

FIGURE 46.17 **(A)** Laminates to be made on maxillary laterals to close diastema. **(B)** Contour built-up with composite resin prior to tooth preparation and a putty index is fabricated. **(C)** Putty index filled with resin where laminate has been prepared. **(D)** Inserted in the mouth following application of separating medium. **(E)** Acrylic provisionals, to be trimmed and luted.

Indirect method

A model fabricated following tooth preparation will allow the acrylic provisional to be made indirectly on a cast (Fig. 46.18A–C). For a detailed discussion refer Chapter 38.

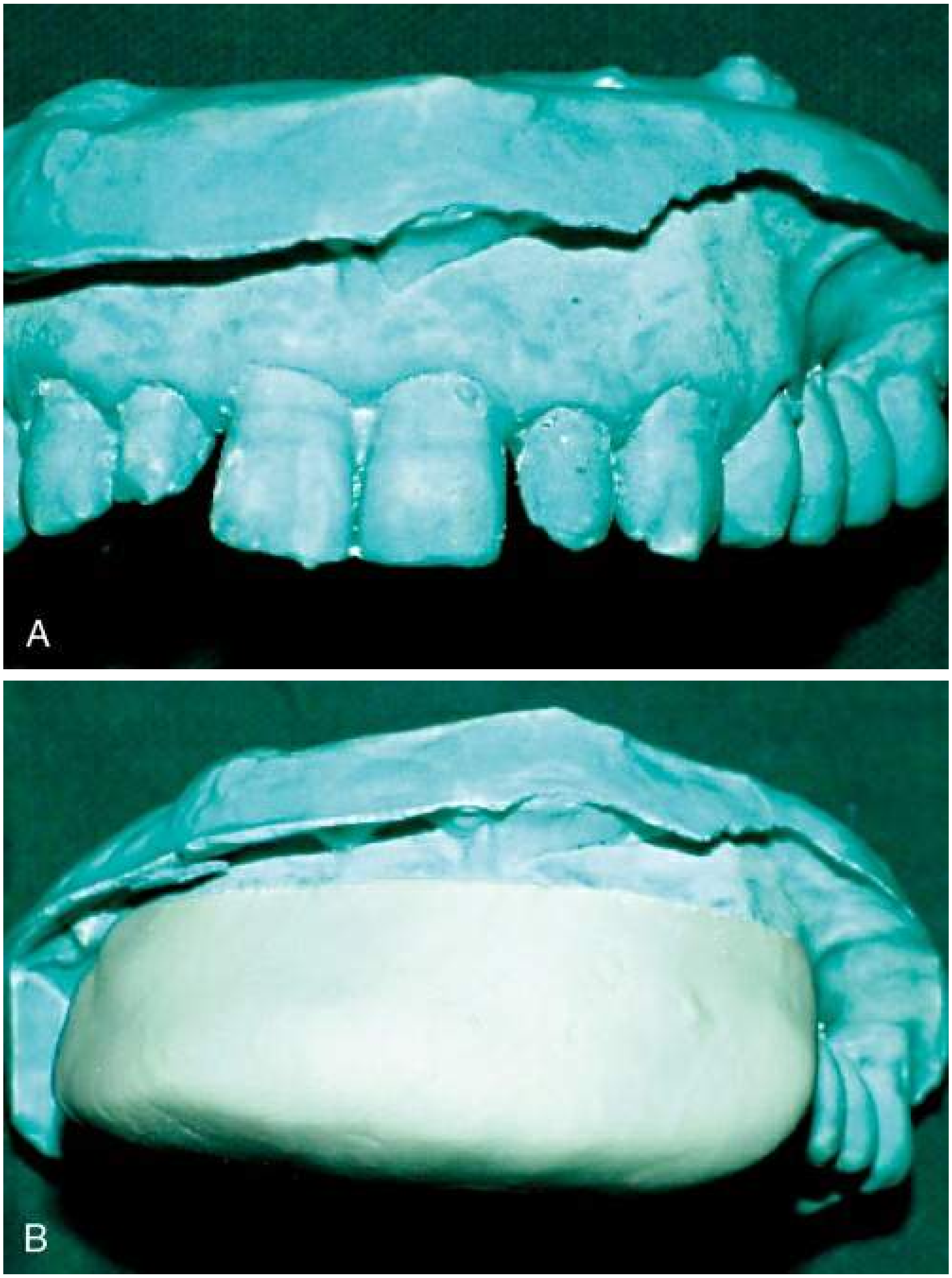
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FIGURE 46.18 **(A)** Cast made following tooth preparation. **(B)** Putty index (made prior to tooth preparation) is filled with resin and reinserted over the cast. **(C)** Provisional trimmed and fitted on cast following polymerization.

Laboratory procedures

Any of the all-ceramic materials described in Chapter 43 can be used to fabricate the ceramic laminate veneer. Leucite and lithium disilicate–reinforced ceramics are preferred due to their excellent translucency and aesthetics. The methods of fabrication are discussed in Chapter 43.

Cementation

Following the fabrication of the laminate in the laboratory, the same is cemented. This involves the following steps:

1. Initial veneer inspection

2. Preparation of site

3. Try-in

4. Bonding

5. Finishing

Initial veneer inspection

The veneer is placed on the cast (Fig. 46.19A and B) and assessed for the following:

- Imperfections

- Individual fit

- Collective fit (for multiple veneers)

- Veneer colour

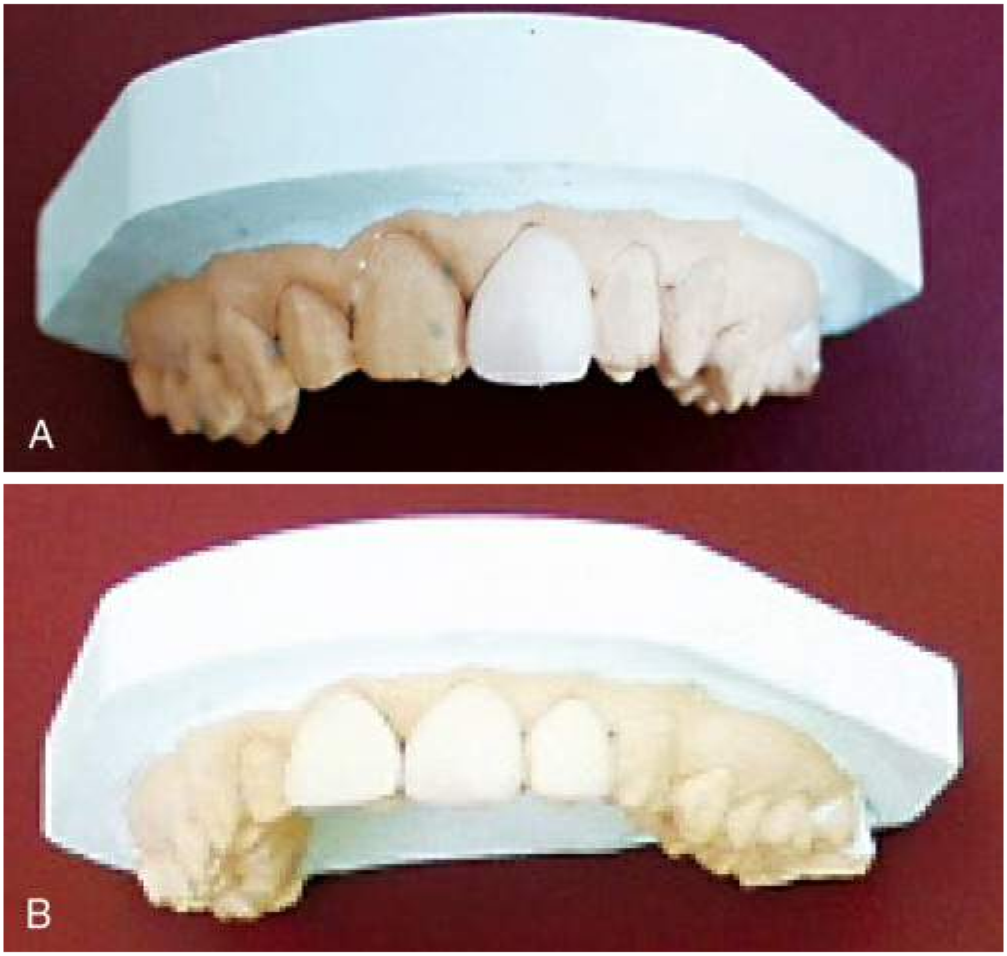


FIGURE 46.19 **(A)** Individual fit is verified on cast. **(B)** Collective fit verified.

Preparation of site

The prepared teeth are isolated, provisional removed and cleaned with pumice (Fig. 46.20).

FIGURE 46.20 Prepared teeth cleaned with pumice.

Try-in

The veneers are then tried-in the patient's mouth (Fig. 46.21). They are checked for:

- Individual fit
- Collective fit
- Colour

FIGURE 46.21 Try-in.

Water-soluble glycerin, transparent silicones and colour keyed try-in pastes can be used to attach the laminate to the tooth during try-in.

Factors influencing colour

Since most often laminates are indicated to correct discolourations, it is important to understand the factors influencing the same.

- Original tooth colour
- Porcelain shade and opacifier
- Luting resin colour and opacity

Tooth not requiring major colour change is influenced by the factors as follows:

- 80% Ceramic

- 10% Cement
- 10% Tooth

Tooth requiring major colour change:

- 70% Ceramic
- 10% Cement
- 20% Tooth

Hence, the most influential factor in changing colour is the ceramic itself, which can be achieved by using opaque dentines. Composite opaquers can be also applied on the tooth to mask colour. The colour or shade of resin cement can only make a minor correction in colour. For minor colour corrections, if laminate appears darker, a light colour resin is used and vice versa.

Bonding

Bonding involves the following procedures:

- Preparation of veneer
- Preparation of tooth
- Luting

The steps involved in preparation of veneer and tooth is enumerated in Table 46.2.

Table 46.2

Steps involved in preparing veneer and tooth for cementation of veneer

Preparation of veneer	Preparation of tooth
Clean	Clean

Etch	Isolate
Silane	Etch
Bond	Bond

Preparation of veneer

Following cleaning of the veneer with a solvent such as acetone, it is etched with 10%–15% hydrofluoric acid for 30 s to 1 min according to the manufacturer's instructions and the ceramic used (Fig. 46.22). Some clinicians tend to get the veneer etched by the laboratory; this is not recommended as the etched surface may get contaminated during handling and try-in procedures.

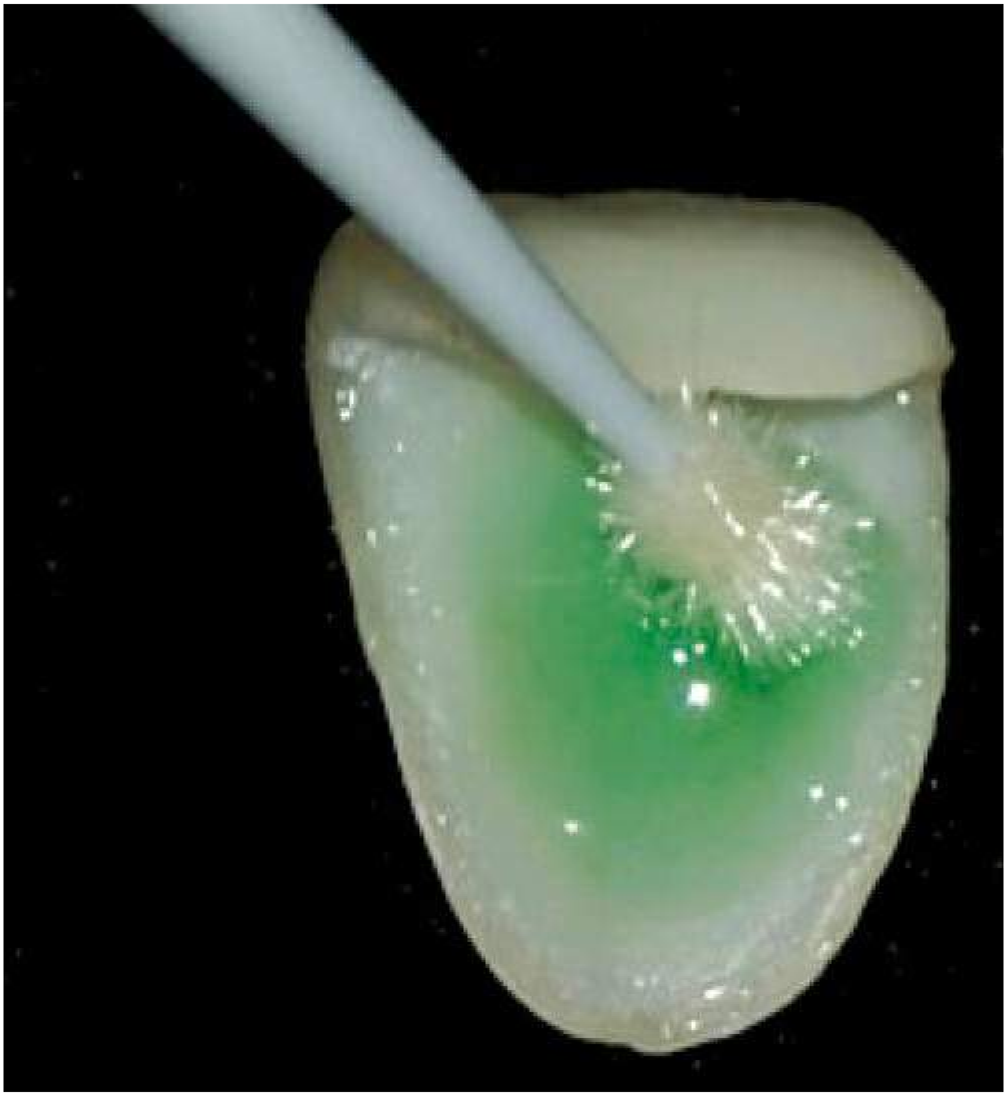


FIGURE 46.22 Fitting surface filled with ceramic etchant.

A silane coupling agent is now applied to the fitting surface of the veneer and is allowed to remain for 1 min. It is then air dried (Fig. 46.23). The silane creates a chemical bond between composite cement and ceramic.

FIGURE 46.23 Application of silane coupling agent.

A normal composite bonding agent is finally applied to the fitting surface at the same time when the tooth surface is also bonded. It is *not* light cured.

Preparation of tooth

The prepared teeth are pumiced again to remove any try-in paste or cement. They are isolated using soft metal bands or Mylar strips (Fig. 46.24). The tooth is etched with 35% phosphoric acid for 15 s (Fig. 46.25). It is thoroughly rinsed and gently air-dried. Surface should appear typically frosty following the etching procedure.

FIGURE 46.24 Isolation with soft metal bands.

FIGURE 46.25 Etching with phosphoric acid.

Composite bonding agent is applied on the tooth surface and is not light-cured now (Fig. 46.26).

FIGURE 46.26 Application of bonding agent on tooth.

Luting

The cement of choice for luting ceramic laminate veneers is resin cement. The resin is adhesively cemented or bonded to the tooth and the laminate. Although the resin cements are available as chemical-, light- and dual-cured varieties, the light-cured cement is preferred as it gives adequate working time and the open margins allow good light polymerization.

Ideal requirements of the luting cement:

1. Thin film thickness, 10–20 microns

2. High compressive and tensile strength

3. Ability to tint, opaque and characterize

4. Low viscosity

5. Low polymerization shrinkage

6. Good colour stability

Several manufacturers produce resin cements in variable shades with flowable viscosity and with opaquers. The cement is mixed and applied on the fitting surface of veneer and spread uniformly (Fig. 46.27A and B). Veneer is then placed on the prepared tooth giving finger pressure labially. When position is verified to be correct, veneer is initially light-cured for 5 s. The excess material is removed with a probe and then the light curing is continued for 45–60 s (Fig. 46.28A–C).

FIGURE 46.27 **(A)** Cement mixed. **(B)** Cement applied on fitting surface and spread evenly.

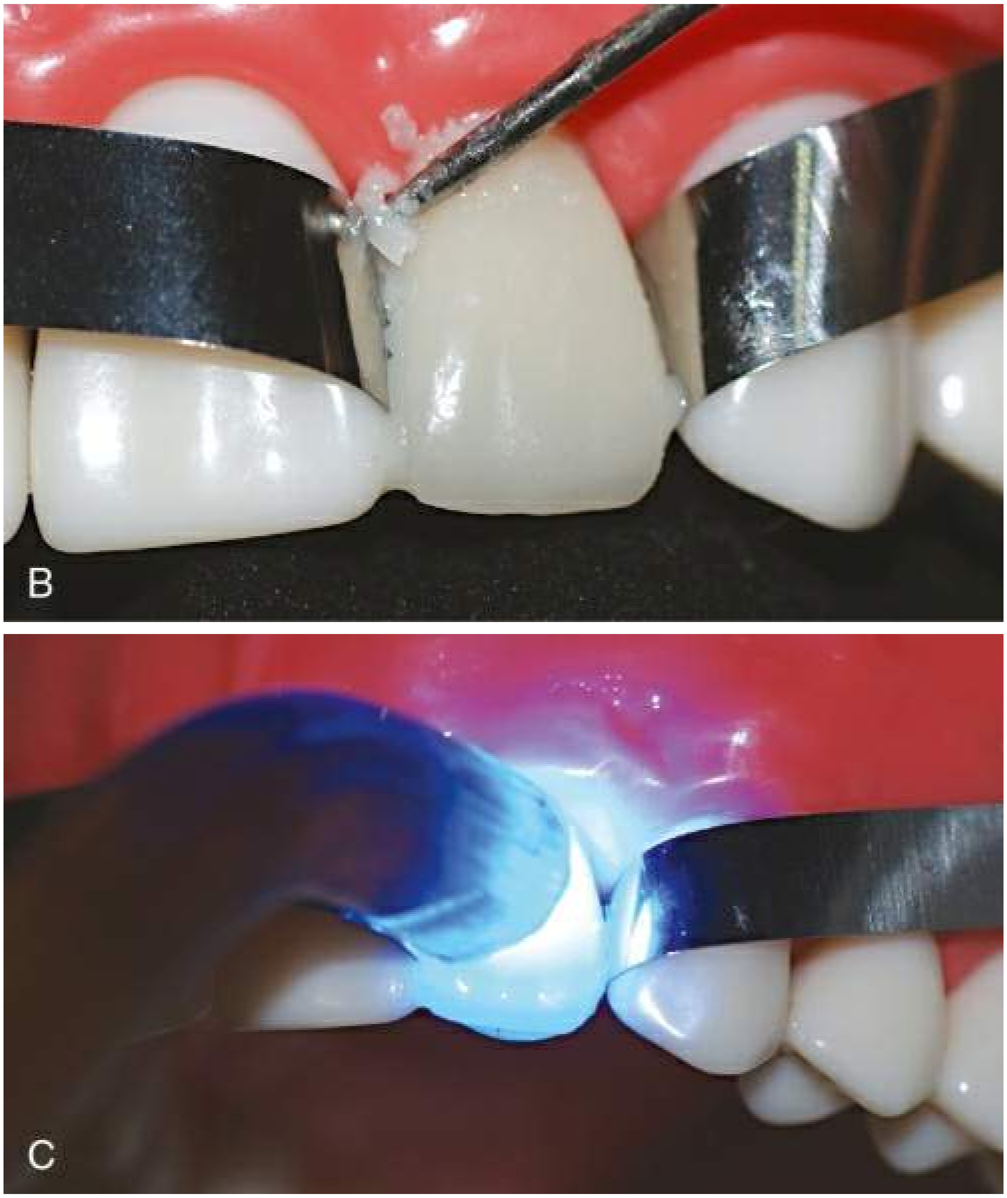


FIGURE 46.28 **(A)** Initially light cured for 5 s. **(B)** Excess removed. **(C)** Final curing for 45–60 s.

Finishing

- Fine grit diamonds are used to remove any excess cement from margins (Fig. 46.29A). Final finishing is accomplished with discs and diamond polishing pastes (Fig. 46.29B).
- Occlusion is checked only after veneer is bonded to tooth.

• Proximal areas are finished with finishing strips (Fig. 46.29C).

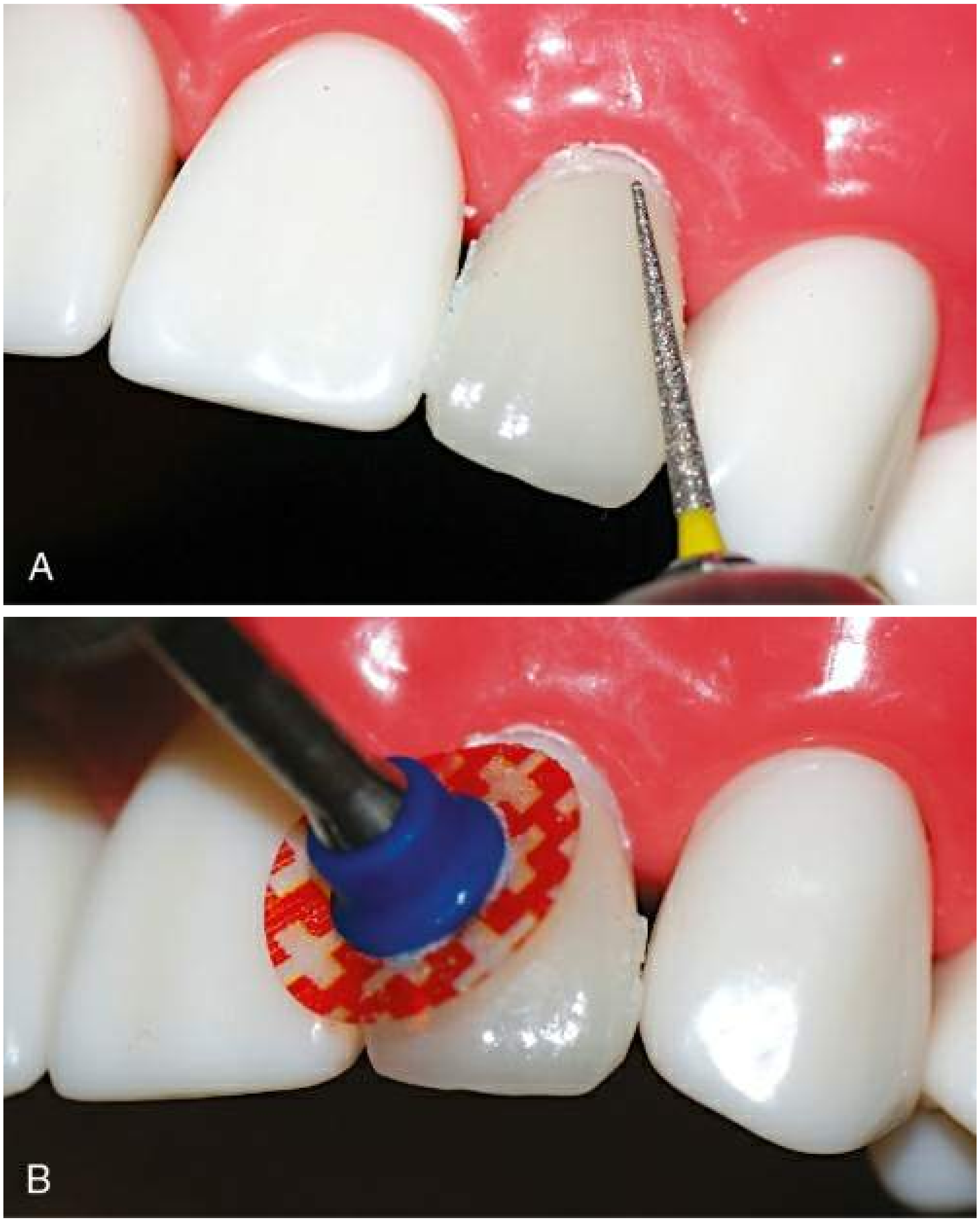


FIGURE 46.29 **(A)** Margins finished with fine grit diamonds. **(B)** Discs are used for final finishing. **(C)** Finishing strips are used for proximal surfaces.

Maintenance

- For 72–96 h following insertion, patients should avoid highly coloured foods, tea or coffee, hard food and extreme temperatures.
- Routine scaling should be done at least every 4 months, ultrasonic scalers may be avoided.
- Abrasive and highly fluoridated tooth paste should be avoided.
- Excessive biting forces and nail biting and pencil chewing habits should be avoided.
- Soft acrylic mouth guard can be used during contact sports.

Failures of laminate veneers

The causes of failure of laminate veneers can be classified as (Table 46.3):

- Mechanical
- Biological
- Aesthetic

Table 46.3

Causes of failure of ceramic laminate veneers

Mechanical	Biological	Aesthetic
• Fracture – poor positioning of incisal margin, less incisal thickness, margin too subgingival • Debonding – use of expired cement, faulty veneer/tooth preparation during luting	• Postoperative sensitivity – improper curing of cement, poor marginal adaptation • Marginal microleakage – poor fit and extension	• Improper shade selection • Visible margins in case of discoloured teeth • Gingival recession – overcontour and improper subgingival placement

SUMMARY

Ceramic laminate veneers remain as prosthetic restorations that best comply with the principles of present-day aesthetic dentistry. These are pleasing to the soft tissue and possess excellent aesthetic quality yet a conservative restoration can be called ‘bonded artificial enamel’.

CHAPTER 47

Attachment-retained dentures

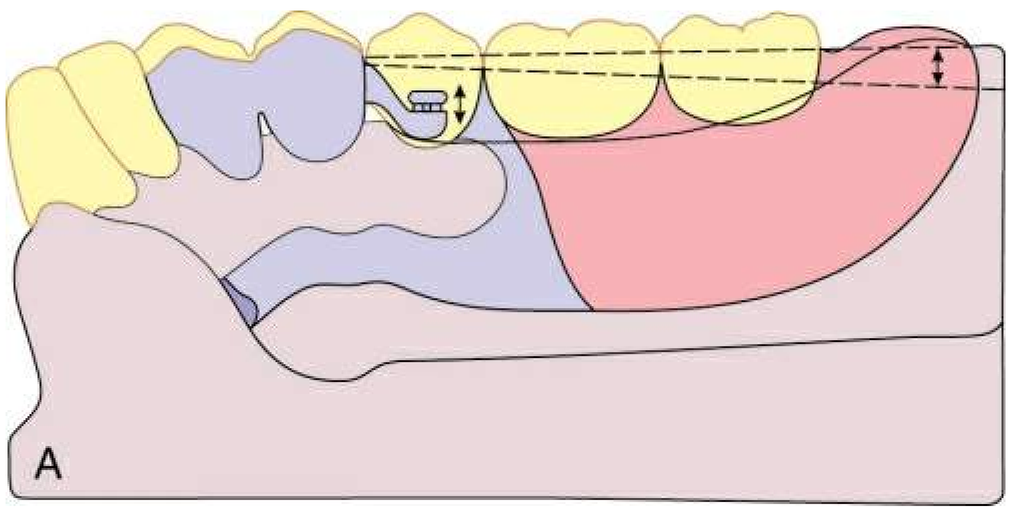
CHAPTER CONTENTS

Introduction

Definition: Attachment is a mechanical device for the fixation, retention, and stabilization of a prosthesis (GPT8).

In general, all attachments are called 'precision attachments'. They are also called parallel attachments, frictional attachments, internal attachments, key and keyway attachments and slotted attachments.

Attachments can be used to retain removable partial dentures (eliminating clasps) (Fig. 47.1), some fixed partial dentures and complete dentures as overdentures (Fig. 47.2).



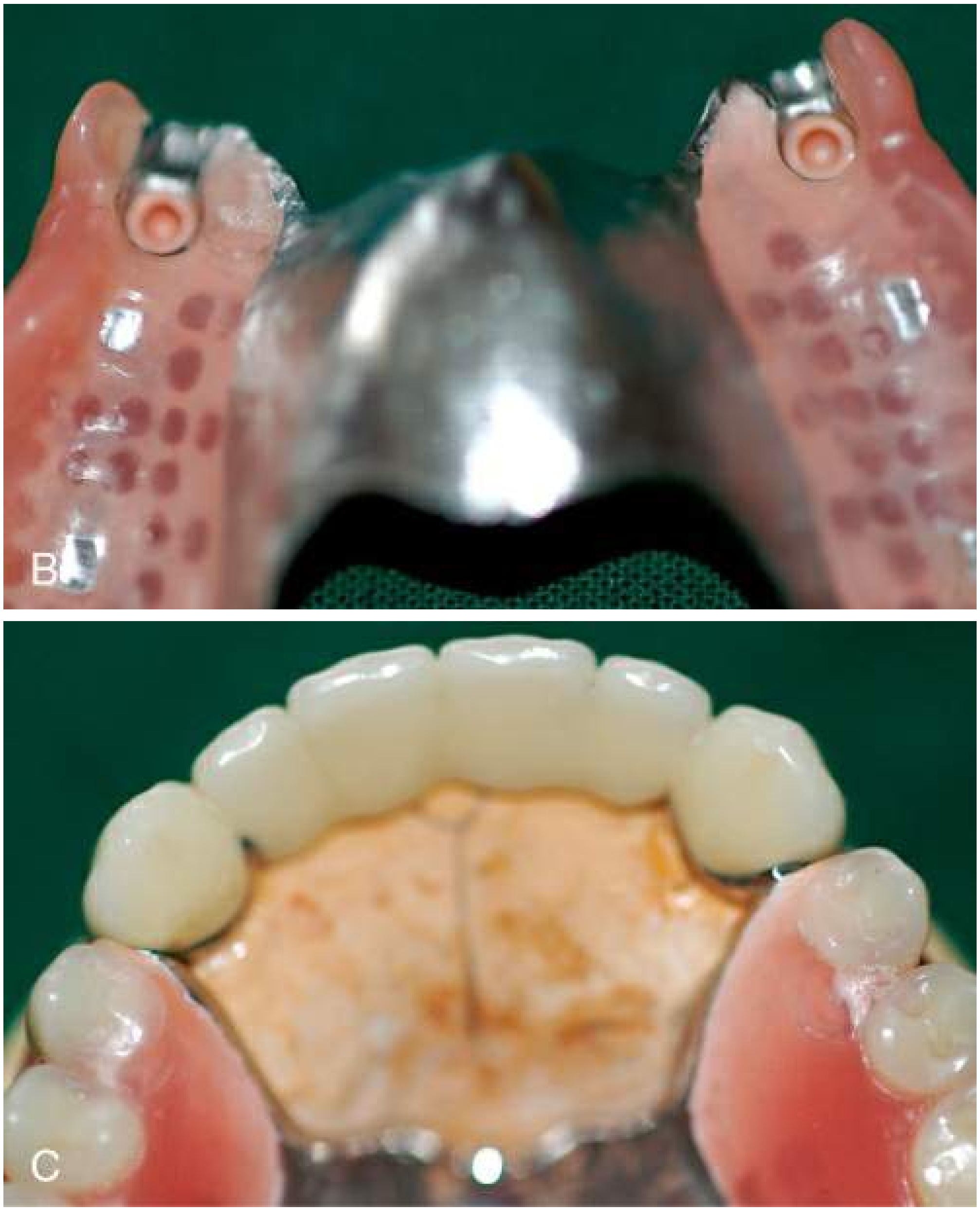


FIGURE 47.1 **(A)** Attachments (male components) fixed to crowns in tooth numbers 13 and 23. **(B)** Corresponding female components attached to removable partial denture. **(C)** Attachment-retained removable partial denture (ARRPD).

FIGURE 47.2 Overdentures.

It generally consists of two parts: male (matrix) and female (patrix). One part is fixed to the tooth and the other is fixed to the denture (Fig. 47.3).

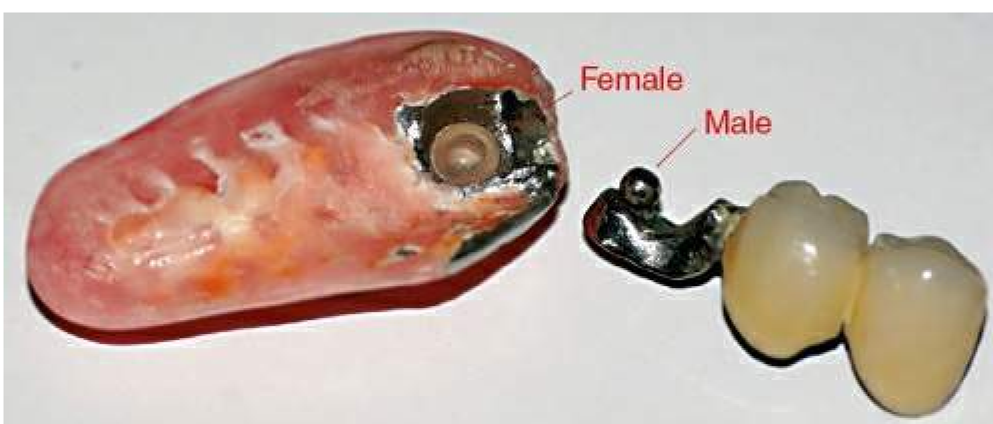


FIGURE 47.3 Female part (matrix) in denture, male part (patrix) attached to crown luted to the teeth.

In this chapter, the various types of attachments will be classified and attachments for partial dentures will be considered. The attachments for overdentures will be discussed in the Chapters 48 and 49.

Applications

- Partial dentures
- Overdentures – tooth and implant supported
- Maxillofacial prosthesis

Classification

Attachment-retained dentures can be classified based on:

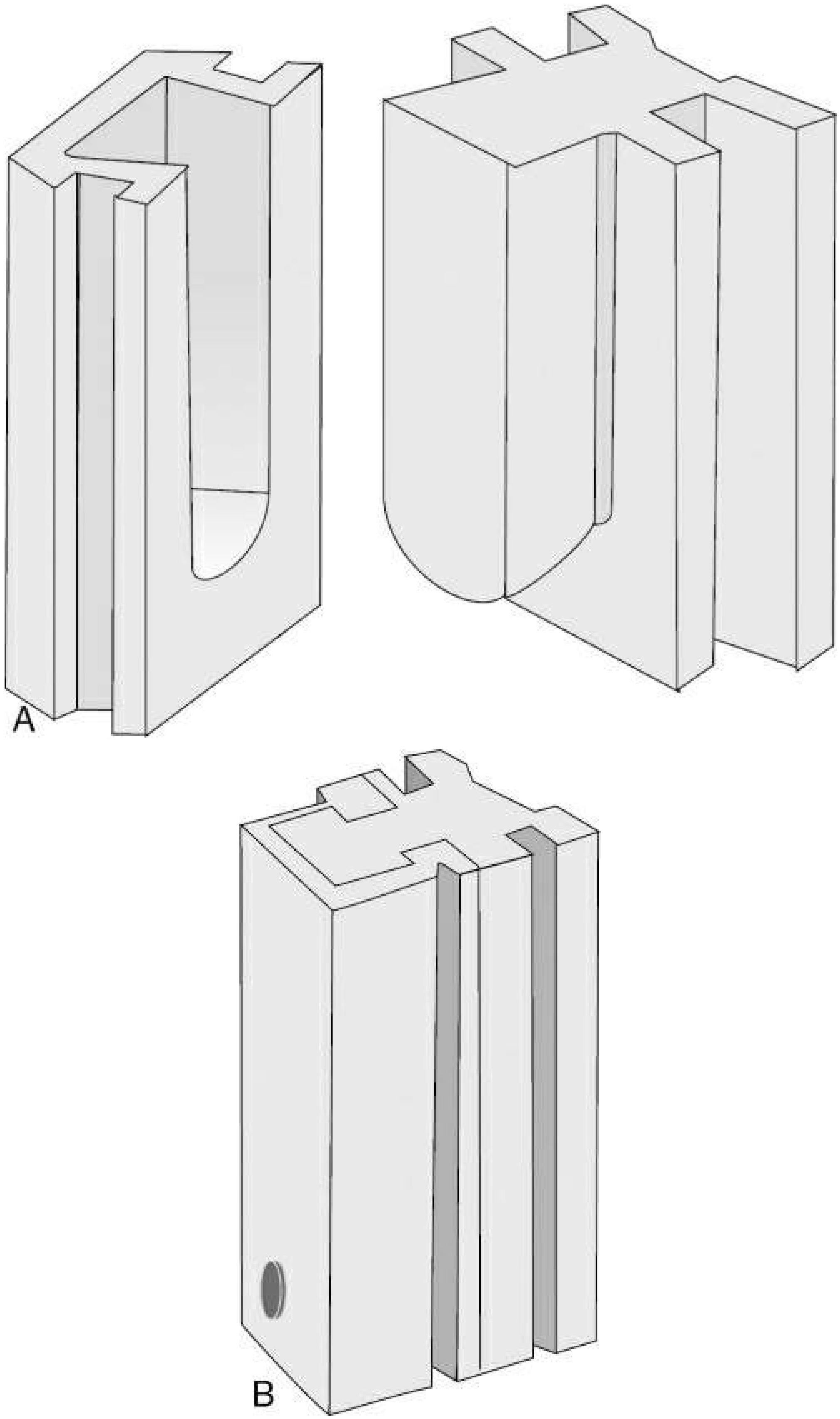
- Method of fabrication
- Function
- Retention
- Location

Methods of fabrication

Precision attachments

Definition: A retainer consisting of a metal receptacle (matrix) and a closely fitting part (patrix); matrix is usually contained within the normal or expanded contours of the crown on the abutment/dental implant and the patrix is attached to a pontic or the removable dental prostheses framework (GPT8).

- Components are machined and precise (Fig. 47.4A and B).
- They are manufactured with tolerance under 0.01 mm.
- They are interchangeable.
- Intracoronal attachments come under this category.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B

FIGURE 47.4 **(A)** Male and female machined precision attachments. **(B)** Precise fitting without any tolerance.

Semiprecision attachments

Definition: A laboratory fabricated rigid metallic extension (patrix) of a fixed or removable dental prosthesis that fits into a slot-type keyway (matrix) in a cast restoration, allowing some movement between the components.

- Fabricated by direct casting of plastic or wax pattern of the attachment in the dental laboratory. Hence, it is subject to dimensional changes (Fig. 47.5A and B).
- Has more tolerance compared to precision attachment.
- Economical.
- Easy to fabricate in a wide range of alloys.

FIGURE 47.5 **(A)** Wax pattern of semiprecision attachment. **(B)** After casting.

Function

Rigid attachments can be classified according to the following types:

1. Rigid

    i. Class Ia – rigid

    ii. Class Ib – rigid lockable

2. Resilient

    i. Vertical

    ii. Hinge

    iii. Vertical and hinge

    iv. Rotational and vertical

v. Universal, omniplanar

Rigid attachments do not permit any movement of the denture. Resilient attachments permit some movement of the denture and are further subdivided depending on the direction of movement permitted.

These are also classified as class I to VI. Class I attachments are rigid attachments while class II to class VI are resilient attachments.

Rigid

Class Ia

It includes rigid attachment, permitting no movement, e.g. Beyeler attachment (Fig. 47.6).

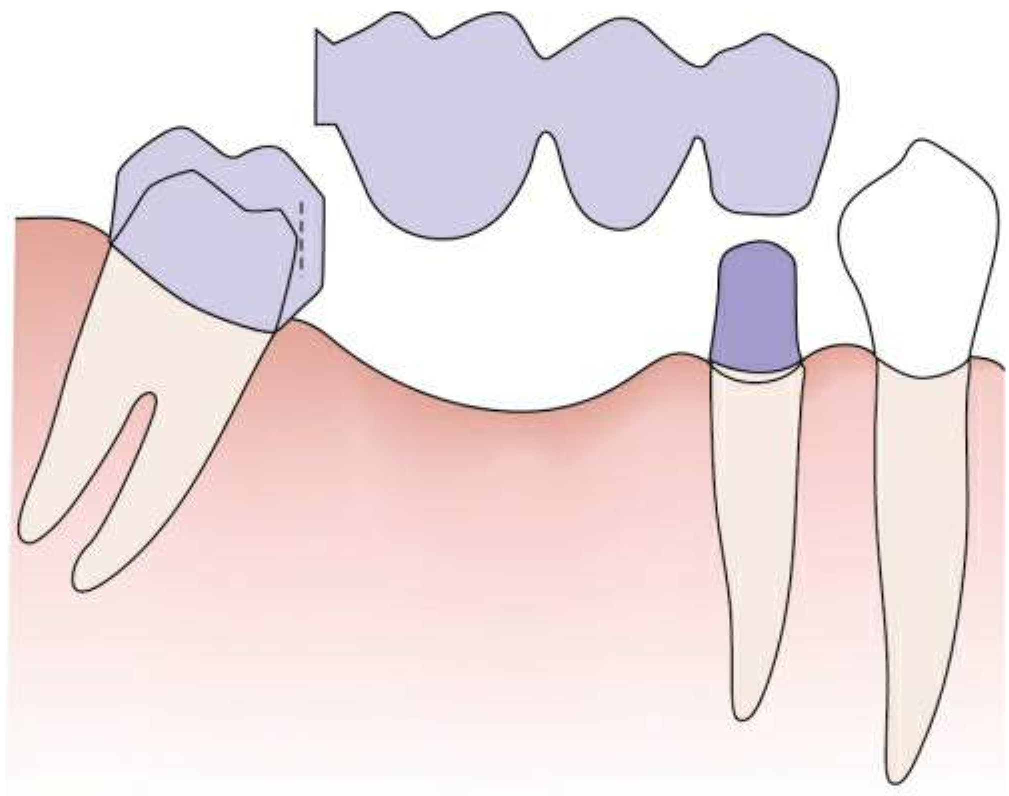
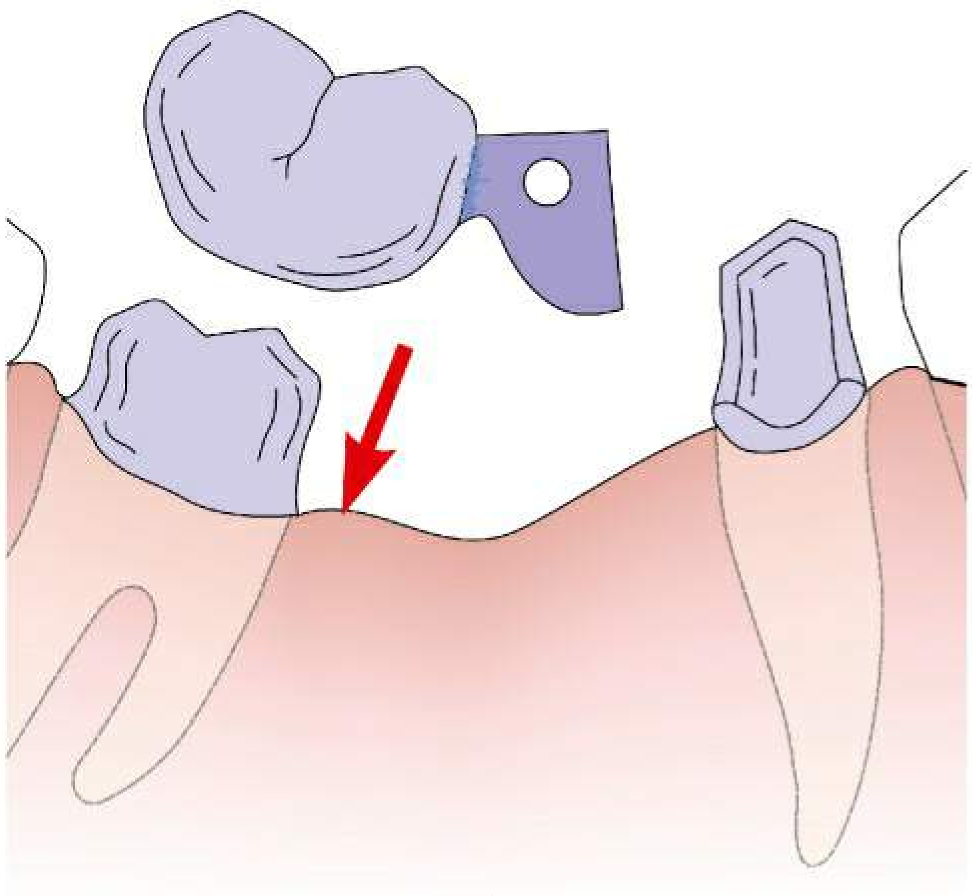


FIGURE 47.6 Class Ia: rigid attachment.

Class Ib

Rigid, lockable with a 'U'-pin or screw – same as class Ia but the male and female components are locked together with screw, e.g. Score-PD (Fig. 47.7).



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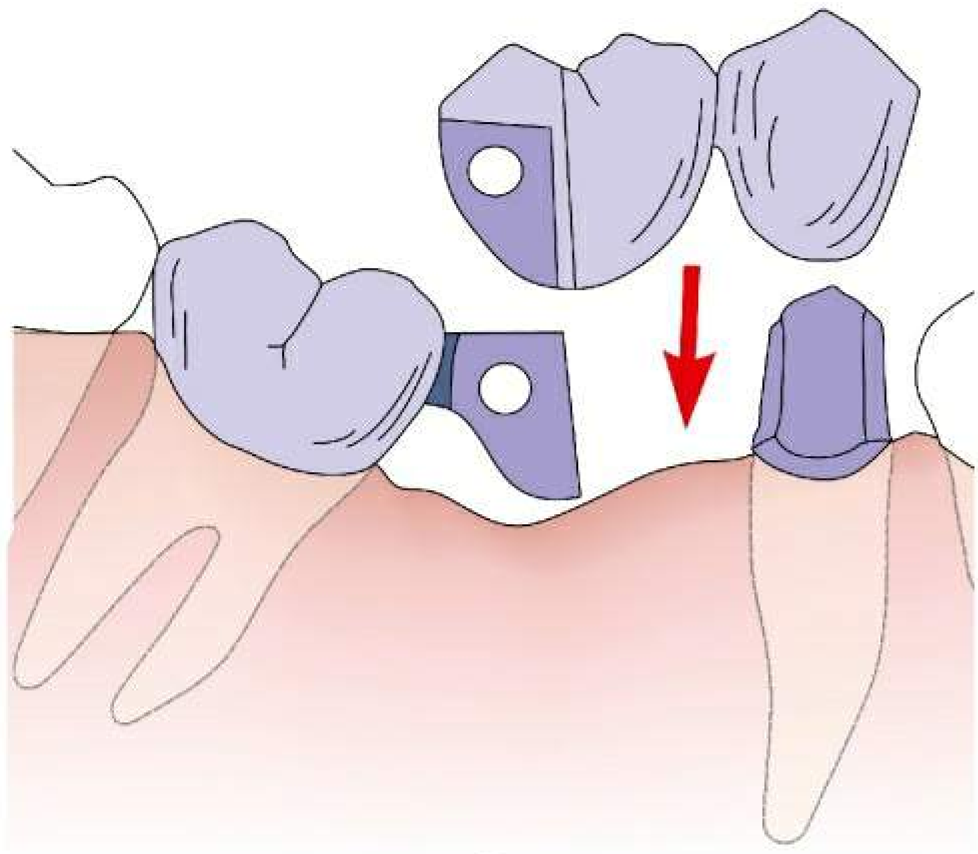


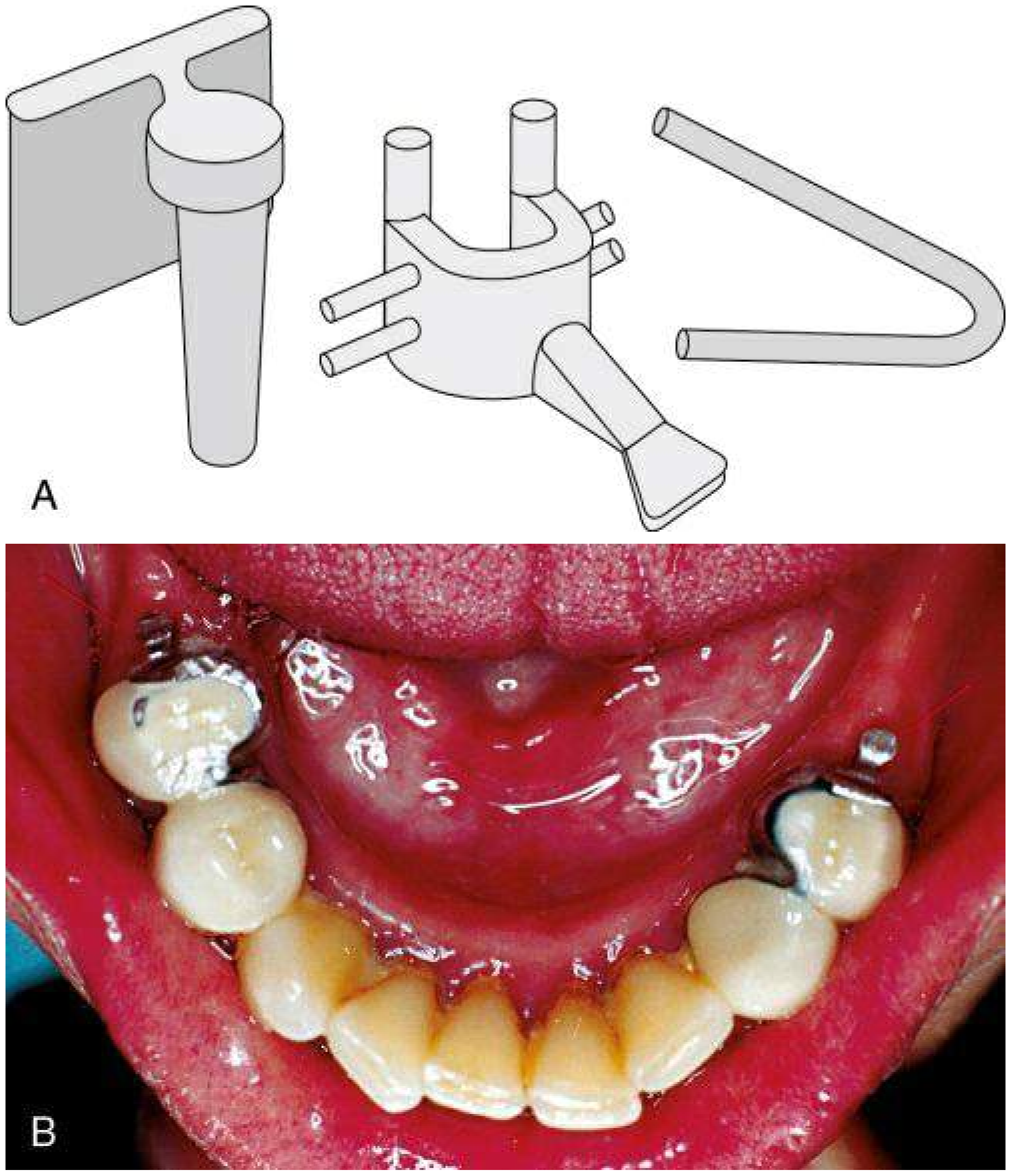
B

FIGURE 47.7 Class Ib. Rigid with a lockable mechanism – with screws for locking. **(A)** Male component cemented. **(B)** Female component is then cemented. Both are locked with a screw.

Resilient

Class II

Vertical, resilient – allows only vertical movement, e.g. TSE (Fig. 47.8A), Allegra attachment (Fig 47.8B and C).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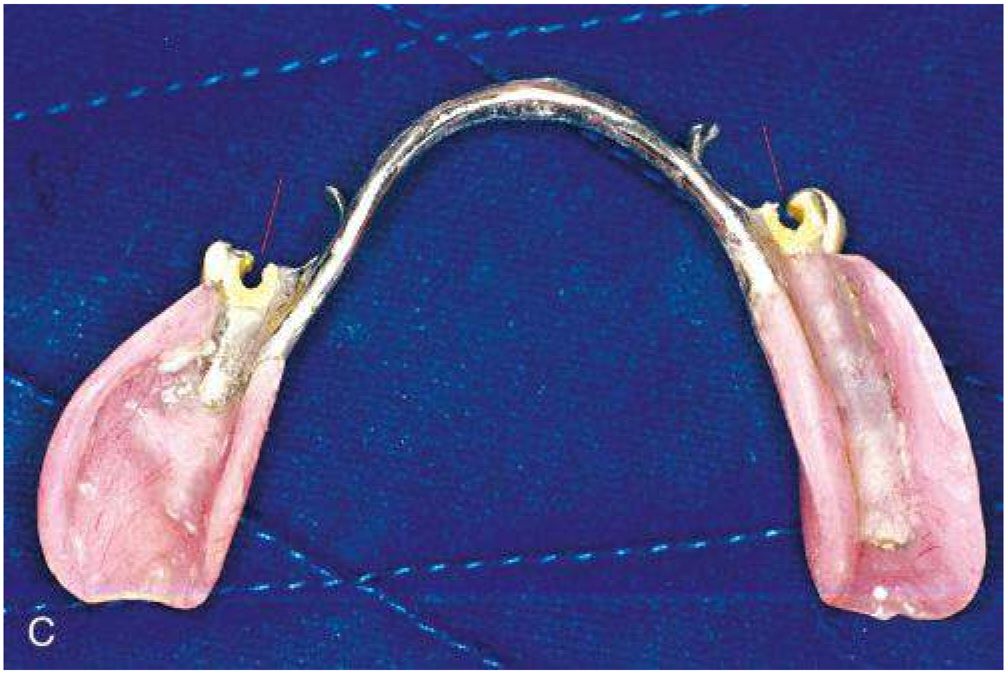


FIGURE 47.8 **(A)** TSE – allows vertical movement. **(B)** Class II allegra attachment, male component. **(C)** Class II allegra attachment – female component with vertical resiliency.

Class III

Hinge, resilient – allows hinge movement, e.g. AI Hinge (Fig. 47.9).

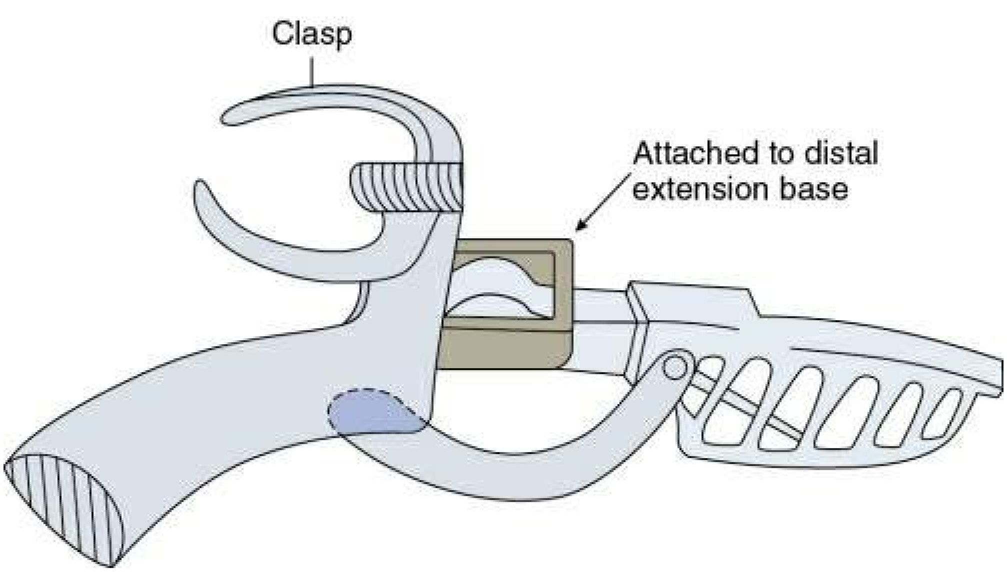
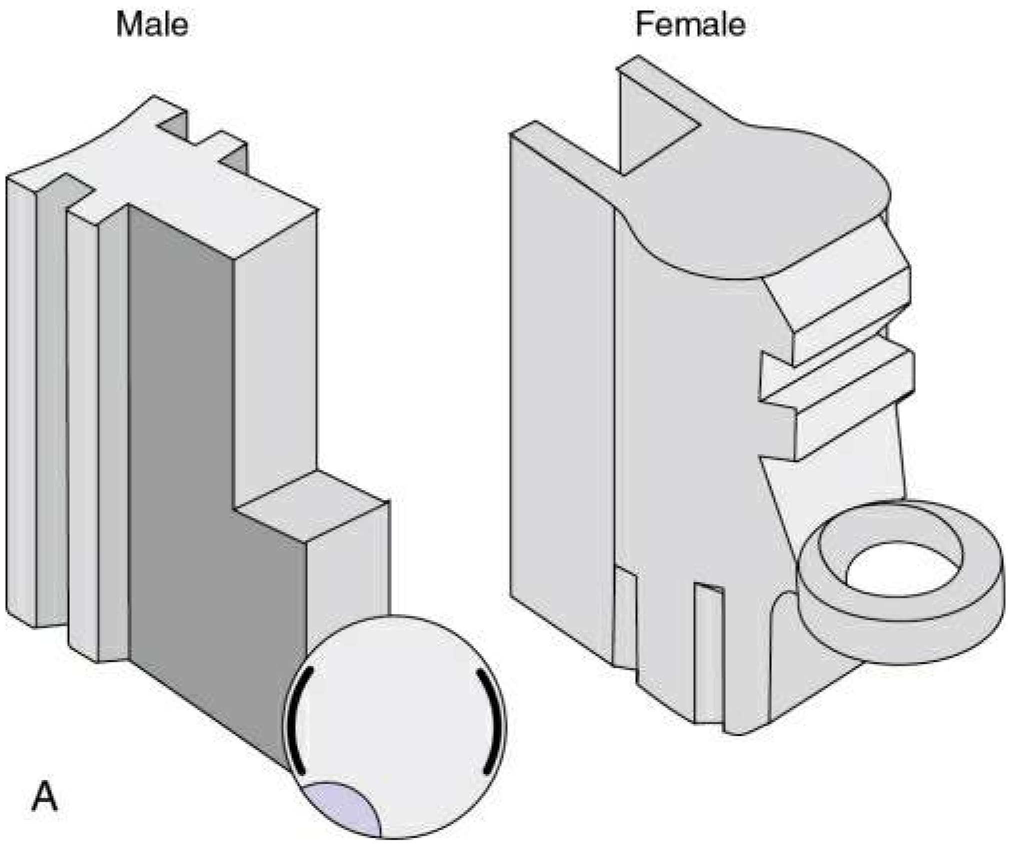


FIGURE 47.9 Class III AI hinge – hinge and resilient.

Class IV

Vertical and hinge resilient – allows vertical and hinge movement, e.g. Dalbo attachment (Fig. 47.10).



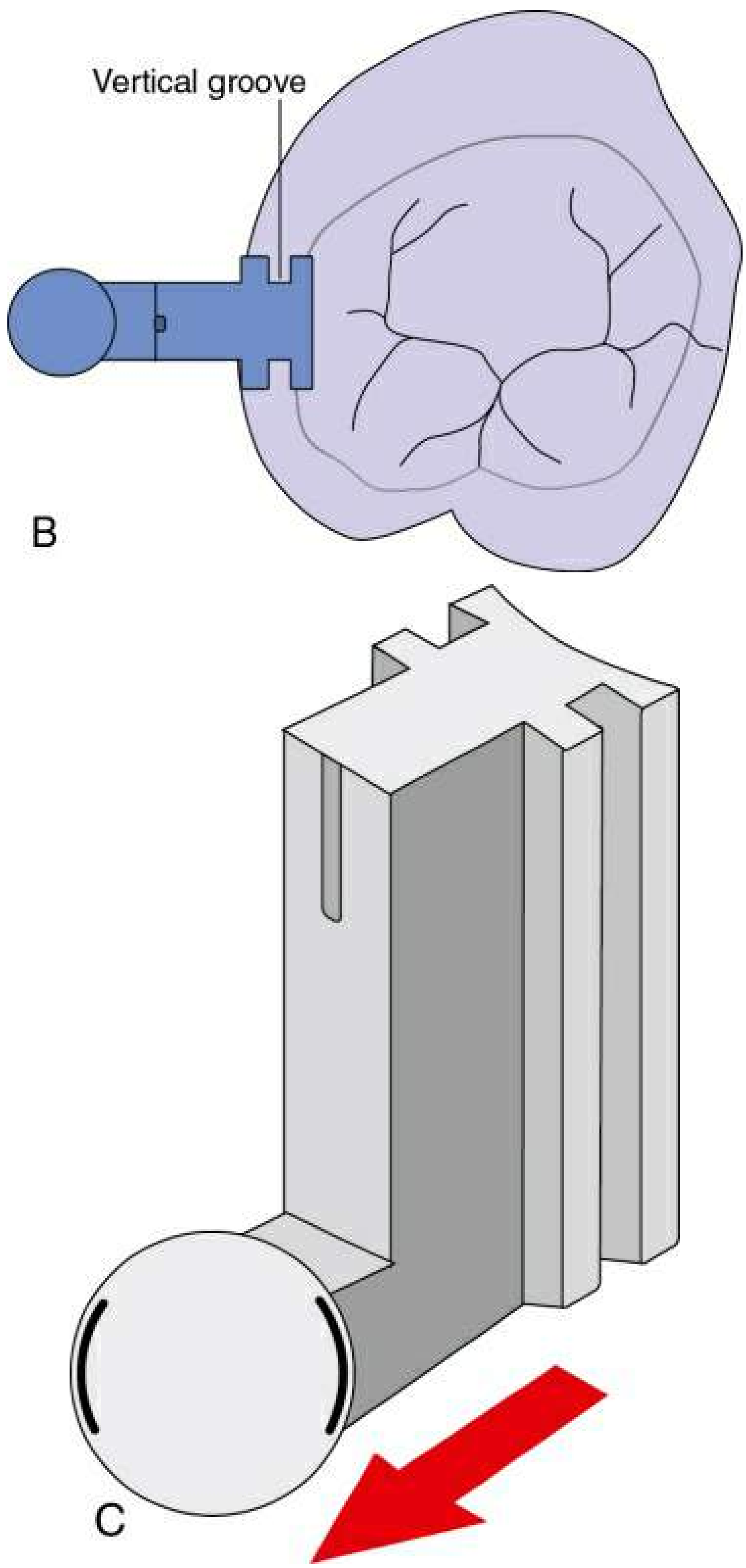


FIGURE 47.10 **(A)** Class IV Dalbo attachment – vertical and hinge movement. **(B)** Dalbo male component attached to tooth – vertical movement due to engagement of female at

the vertical groove. **(C)** Dalbo – hinge movement.

Class V

Rotational and vertical resilient – allows rotational and vertical movement, e.g. Ceka attachment (Fig. 47.11A), ASC 52 (Fig. 47.11B).

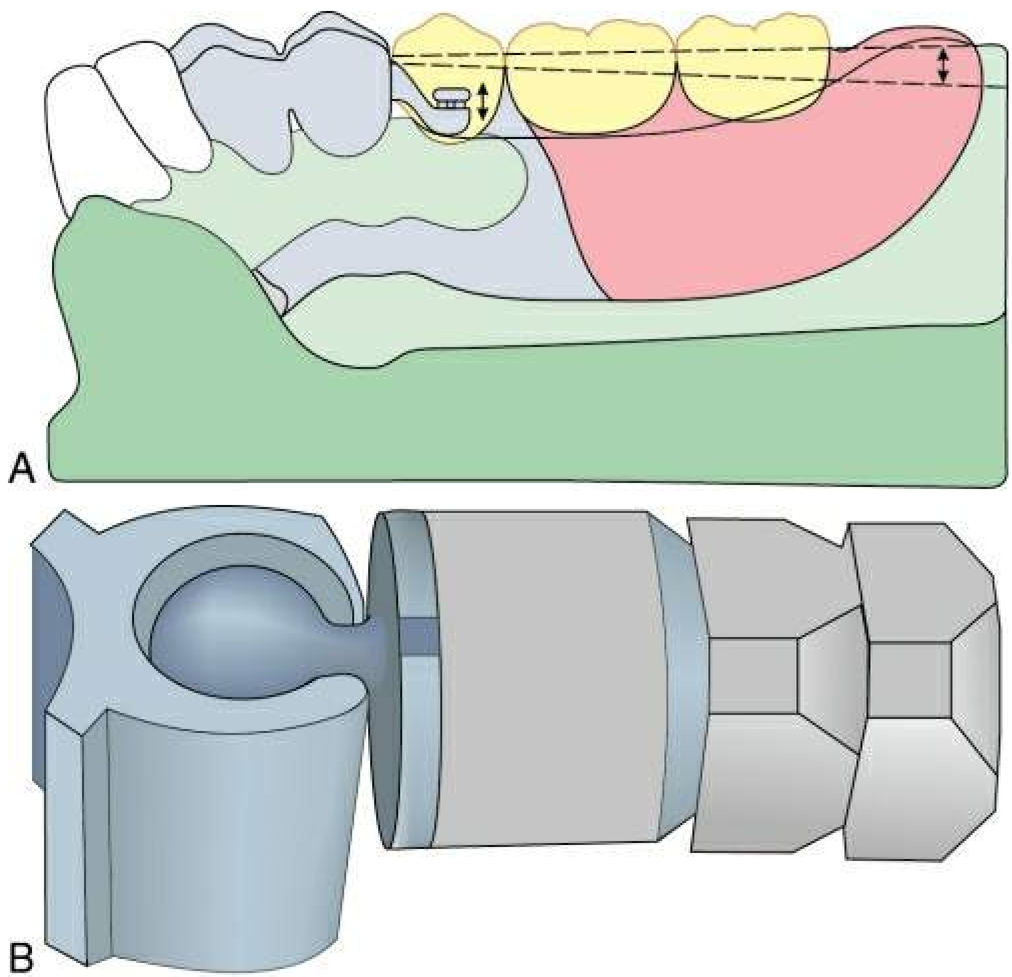


FIGURE 47.11 **(A)** Class V Ceka attachment – rotational and vertical. **(B)** Class V – ASC 52.

Class VI

Universal rotation – allows movement is all planes, e.g. Stud attachments (Fig. 47.12).

FIGURE 47.12 Class VI stud attachment.

Retention

According to the mechanism of retention provided, attachments can be classified as follows.

Frictional

Retention is provided by resistance to relative motion of two or more surfaces due to *intimate contact with each other*, e.g. Beyeler attachment (Fig. 47.13).

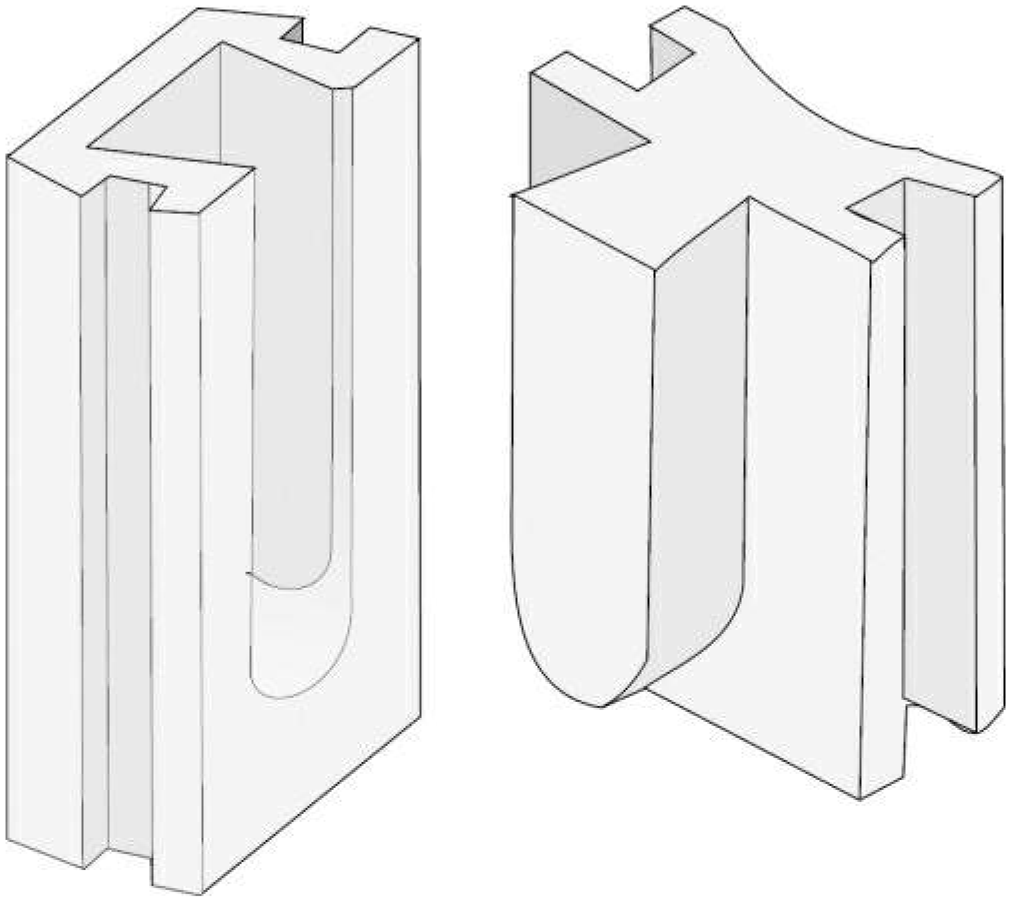


FIGURE 47.13 Frictional retention – Beyeler attachment.

Mechanical

Retention provided by resistance to relative motion of two or more surfaces *due to physical undercut*, e.g. Hannes anchor plunger (Fig. 47.14).

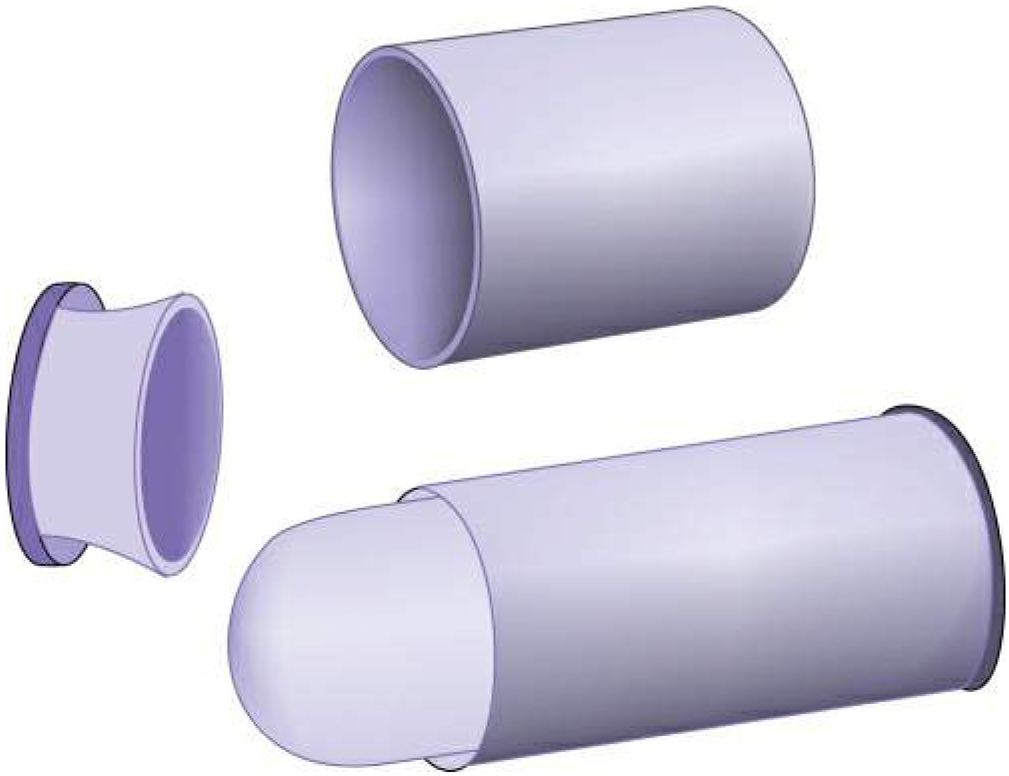


FIGURE 47.14 Mechanical retention – Hannes anchor.

Frictional and mechanical

Retention is provided by a combination of the above two methods, e.g. PT-Snap (Fig. 47.15).

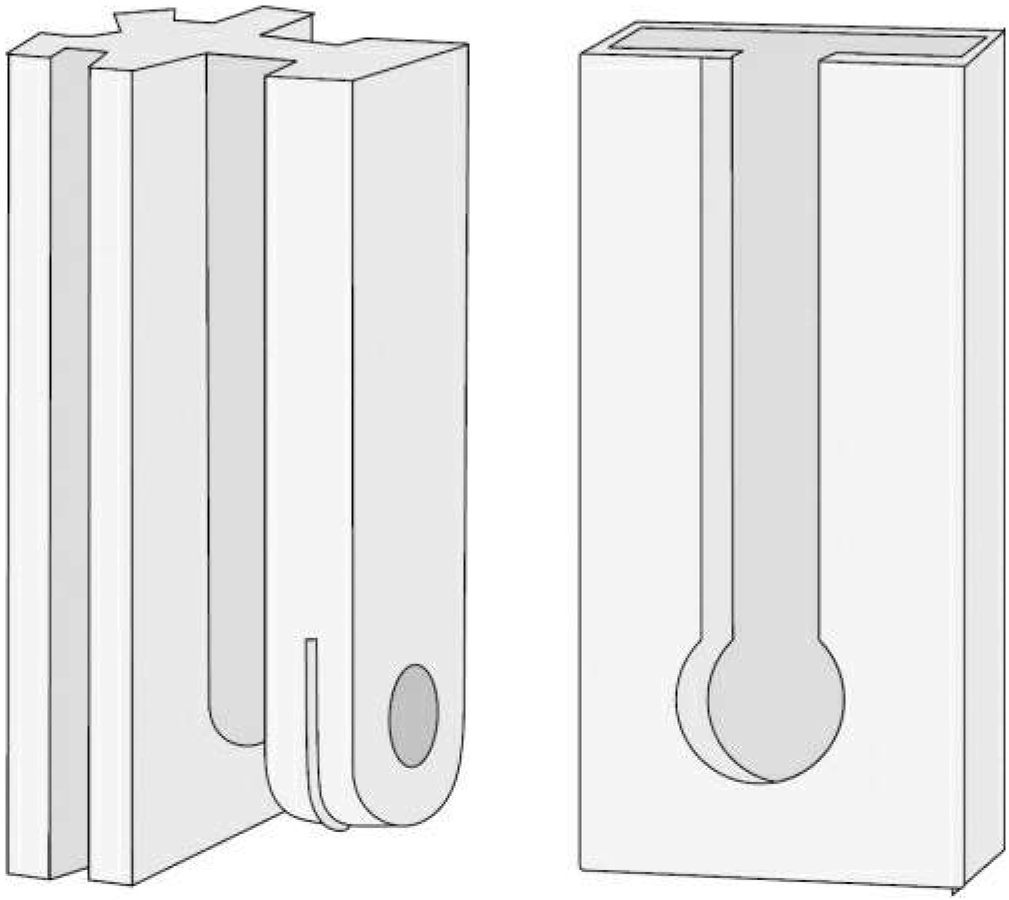


FIGURE 47.15 Frictional and mechanical retention – PT-Snap.

Magnetic

Retention is provided by resistance to movement caused by a magnetic body that attracts certain materials by virtue of a surrounding field of force produced by motion of its atomic electrons and alignment of its atoms, e.g. magnetic attachments (Fig. 47.16).

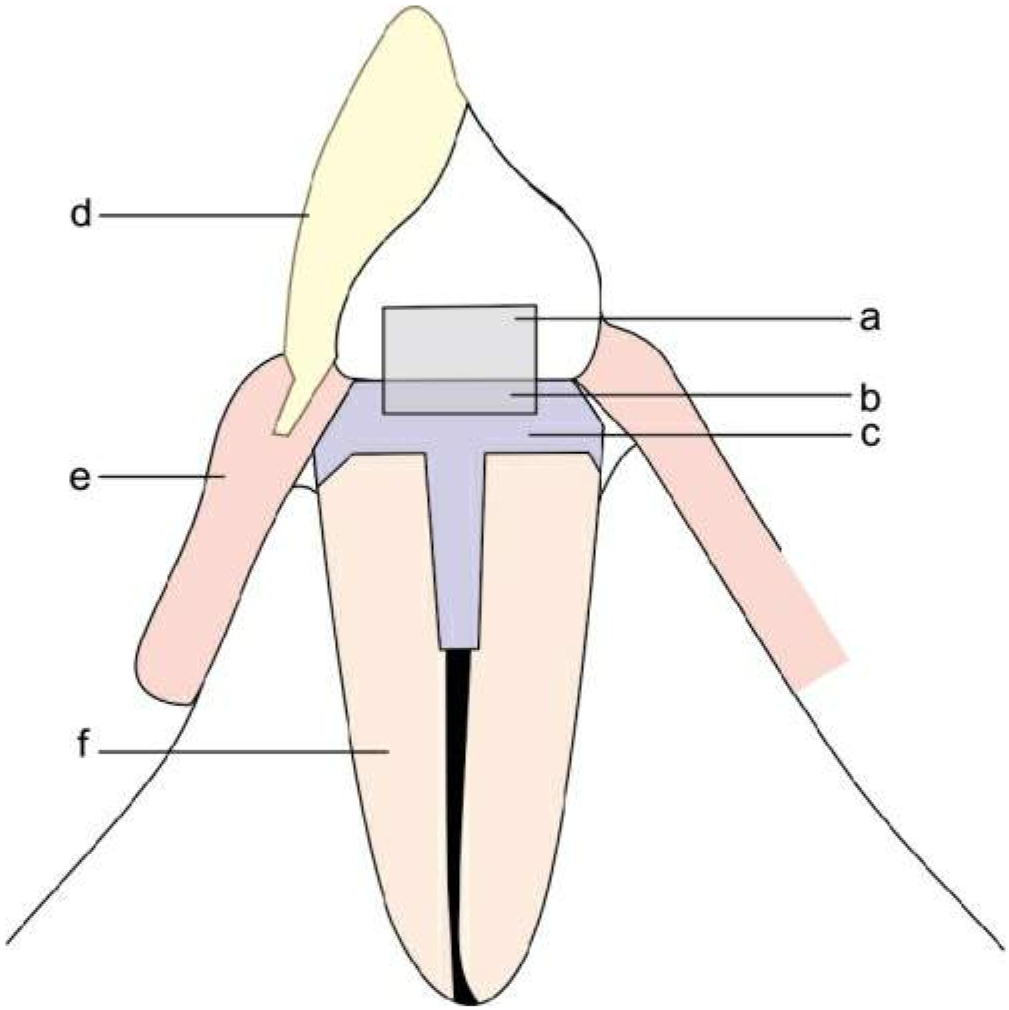


FIGURE 47.16 Retention using magnets. a. Magnet b. Keeper c. Coping with radicular extension d. Acrylic tooth of denture e. Denture base f. Root treated tooth.

Used with overdentures (also see Chapter 48).

Location

According to location the attachments are classified as:

1. Coronal

   i. Intracoronal

ii. Extracoronal

2. Radicular

i. Studs

ii. Bars

iii. Magnets

3. Auxiliary

Coronal

- This is the most commonly used classification based on the location of the attachment.
- The coronal attachments are used for partial dentures while the radicular attachments are used for tooth and implant supported overdentures.
- The auxiliary attachments are accessory attachments used to enhance retention.

Intracoronal

- In 1906, Dr Herman E.S. Chayes was the first person to formulate the principle of internal attachment and with only slight modifications is still in use.
- It is a prefabricated attachment in which male and female components are positioned within the normal contour of the abutment tooth (Fig. 47.17).
- Applied occlusal forces are close to long axis of abutments.

- Requires box preparation.
- Requires adequate space (at least 5 mm) vertically, buccolingually and mesiodistally (Fig. 47.18A–C).
- As they are nonresilient (rigid), double abutting is preferred – tooth adjacent to abutment is also crowned.

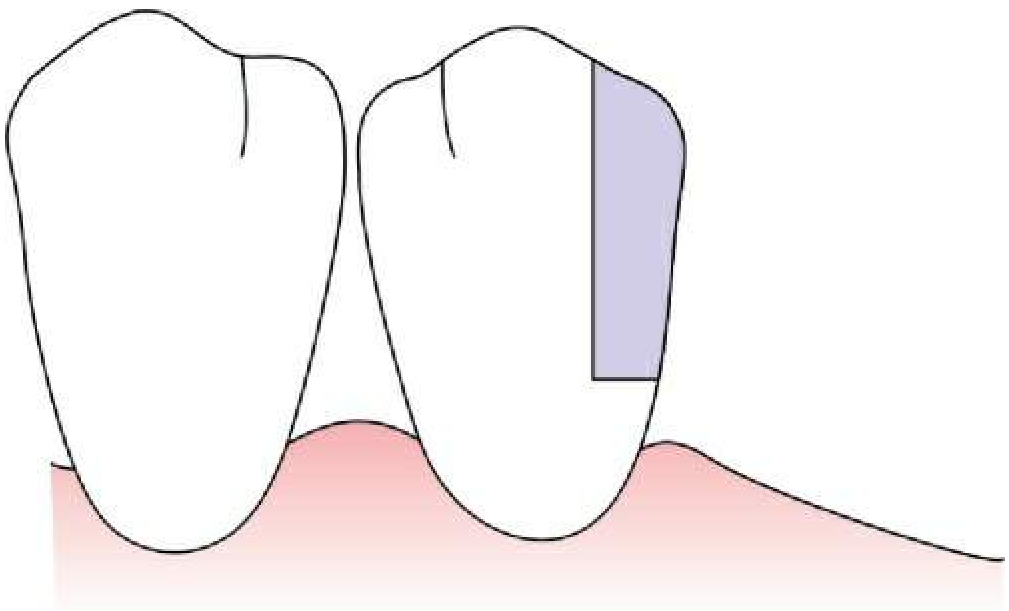
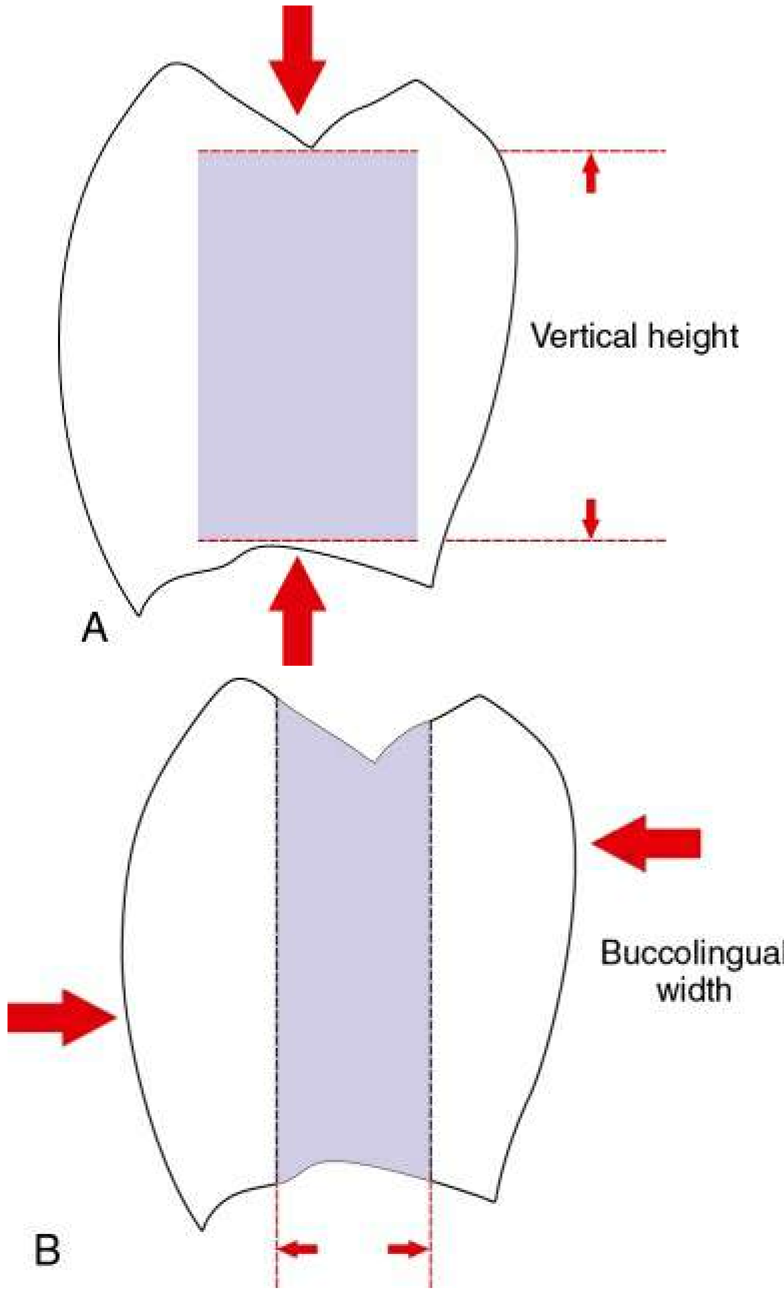


FIGURE 47.17 Intracoronal attachment placed within the crown contours.



Vertical height
A
Buccolingual
width
B

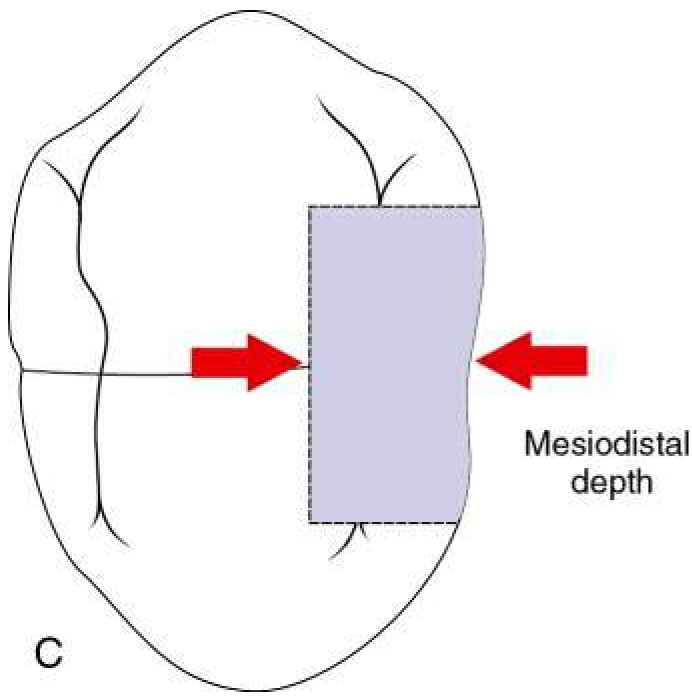


FIGURE 47.18 **(A)** Vertical height. **(B)** Buccolingual width. **(C)** Mesiodistal depth.

Parts

- Slot (female): it is usually incorporated into the contour of the crown of an abutment tooth.
- Flange (male): it is incorporated into the prosthesis (Fig. 47.19).

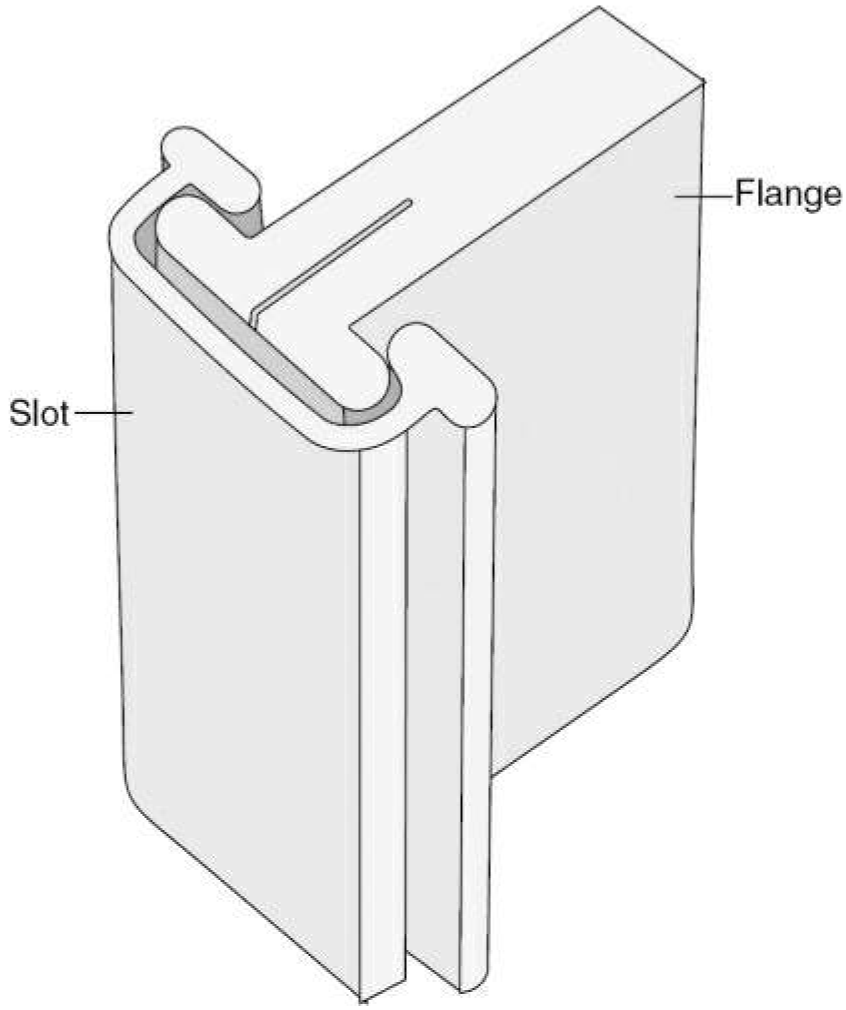


FIGURE 47.19 McCollum attachment with an adjustment slit that runs part way through the attachment on one side. By wedging the slit outward retention can be increased.

Retention principle

- Frictional
- Mechanical
- Frictional and mechanical

Classification

- With adjustment potential, e.g. Biloc.

- ○ Constant insertion and removal of prosthesis will cause wear of attachments. So these attachments have the potential to increase retention if wear occurs (Fig. 47.19).

- Without adjustment potential, e.g. Interlock, Beyeler (Fig. 47.13).

- ○ These are useful for joining crowns without a common path of insertion.

Applications

- Retainers for removable partial dentures.

- Connectors for joining sections of fixed prostheses.

- ○ Prostheses do not share common path of insertion yet can be rigidly connected.

- ○ Limit length of individual castings in long span fixed partial dentures.

- ○ Poor prognosis of distal abutment.

Advantages (over extracoronal attachments)

- Reduced bulk – components serve as rest and clasp.

- Applied occlusal forces are close to the long axis of the tooth – better bracing.

- Elimination of food stagnation.

Disadvantages

- Extensive preparation of abutment – chances of pulp devitalization is high.
- Adequate crown length and decreased pulp size is essential.
- Handling by patient more difficult – arthritic patients.
- More difficult to fabricate – alignment of attachment is critical.

Extracoronal attachments

- Have part or all of their mechanism outside the tooth contour (Fig. 47.20).
- It requires a minimum of 5 mm interocclusal space in height and width.
- Mainly used for distal extension removable partial dentures.
- Double abutments are preferred.

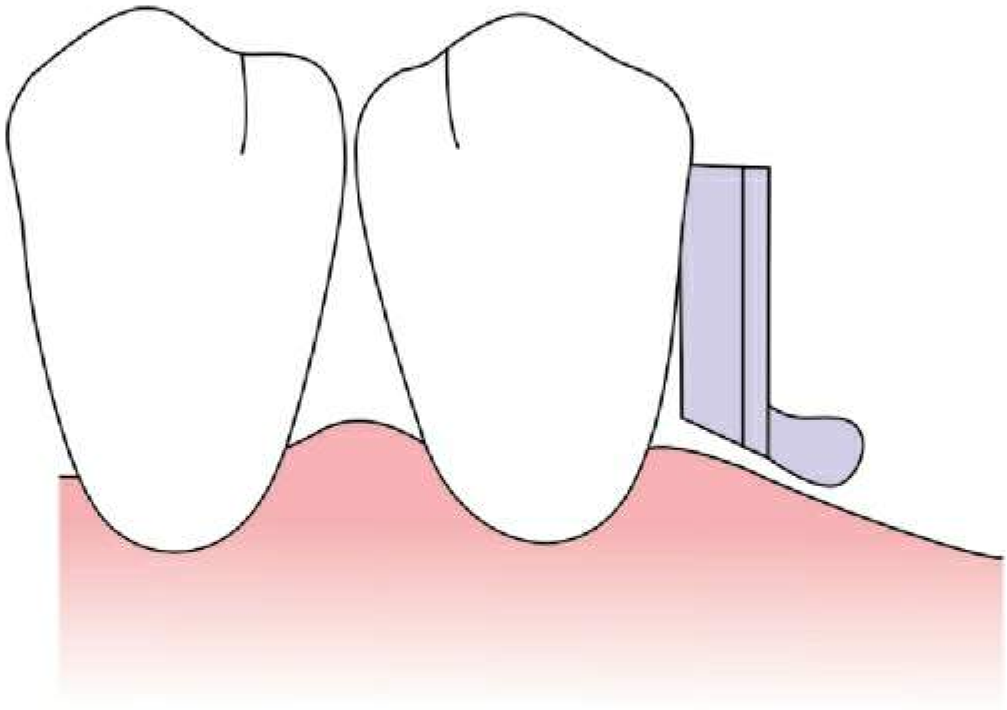


FIGURE 47.20 Part or all of attachment is present outside the crown contour.

Retention principle

- Frictional
- Mechanical
- Frictional and mechanical

Advantages (over intracoronal attachments)

- Normal contour of the tooth can be maintained.
- Amount of tooth preparation necessary is less.
- Possibility of devitalizing the abutment tooth is reduced.
- Attachment alignment not as critical.

- Insertion is easier for patients with dexterity problems.

Disadvantages

- Maintenance of hygiene is more difficult.
- Positioning artificial tooth in the attachment region is more difficult.

Classification

- Projection units
- Connecting units
- Combined units

Projection units

These are the prototype extracoronal attachments. These can be further subdivided into:

- Rigid units, e.g. Conex attachment (Fig. 47.21).
- Units allowing some play, e.g. Ceka and Dalbo attachments (Fig. 47.22).

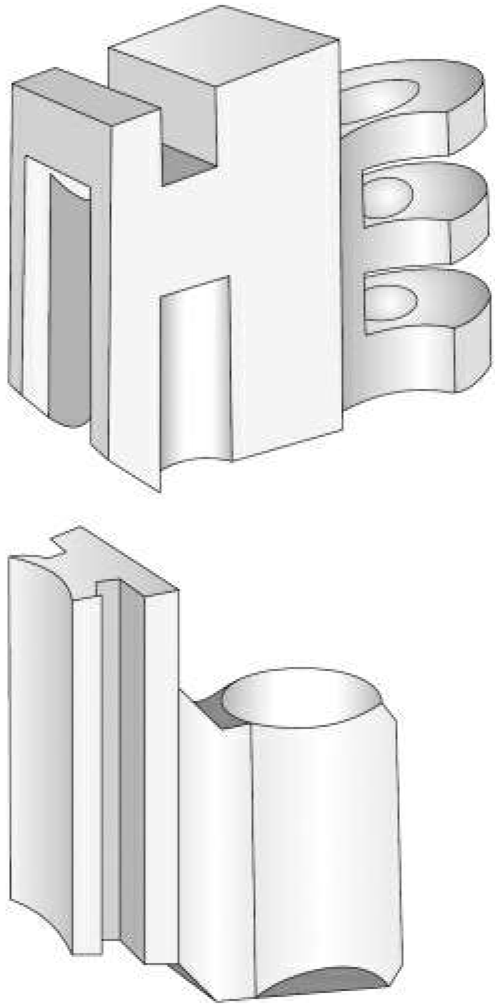


FIGURE 47.21 Conex attachment.

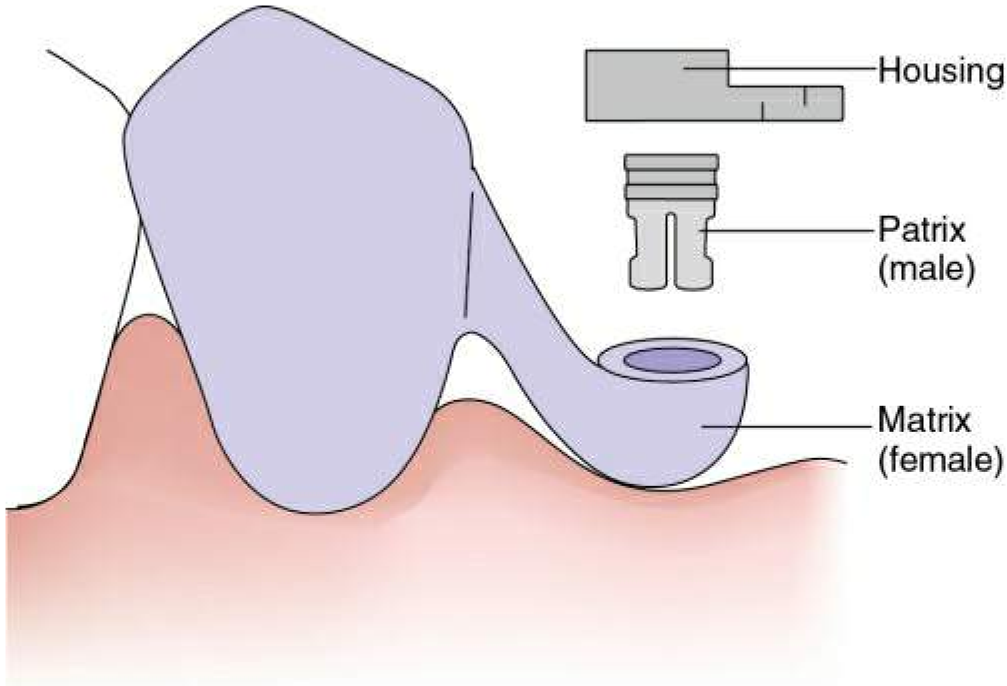


FIGURE 47.22 Ceka attachment.

Connecting units

- Connect two parts of a removable prosthesis, allowing limited movement.
- They are of two types: axial rotation joint (allows vertical movement) and rotation joint (no vertical movement).
- Female part consists of a vertical sleeve soldered to removable crowns or clasp-retained section of denture.
- Male unit is a flattened rod attached to denture saddle and fits into sleeve.
- The two parts of the attachment are held together by a small screw passing through the female and male sections (Fig. 47.23).

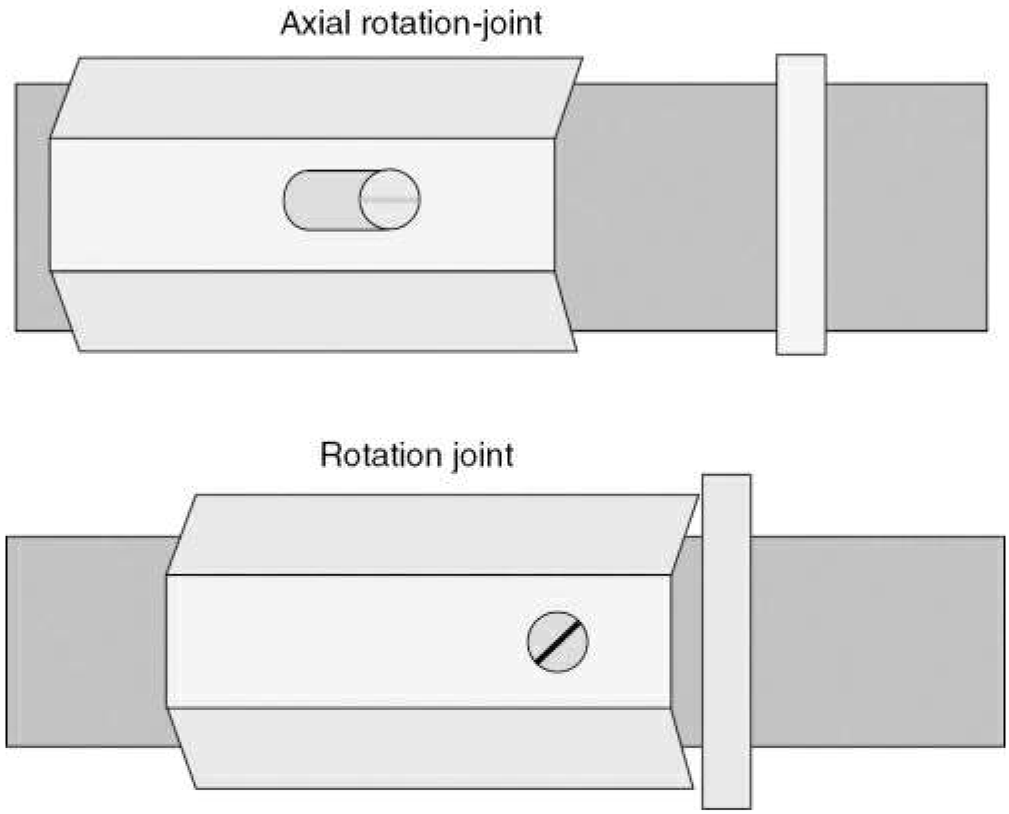


FIGURE 47.23 Connecting units – axial rotation and rotation joints.

Combined units

- Consist of a hinge connector joined to an intracoronal attachment.
- Hinge is buried in the denture so that when it is in position, the attachment closely resembles a rigid intracoronal attachment.
- These are used for distal extension bases with questionable abutments.
- Example: Crismani combined units.

Radicular

Studs, bars and magnets

These are used for tooth or implant supported overdentures and are discussed in Chapter 48.

Auxiliary

- These are used to enhance the stability and retention of the prosthesis.
- It includes the following:

○ Plungers (Fig. 47.24)

○ Hinges (Fig. 47.9)

○ Screws (Fig. 47.25)

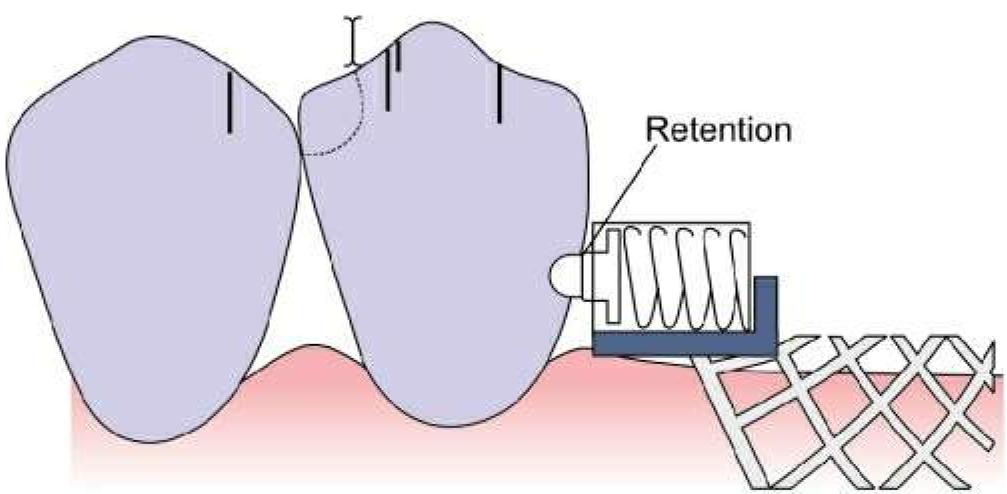


FIGURE 47.24 Use of plunger for retention.

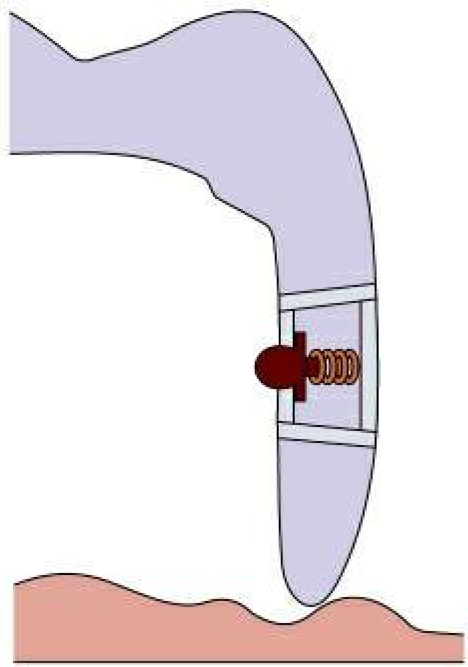


FIGURE 47.25 Use of screws for retention.

Rationale of using attachments with removable partial dentures

A clasp assembly should provide for the following (Fig. 47.26):

1. Support (occlusal rest)

2. Stability (reciprocal arm)

3. Retention (retentive arm)

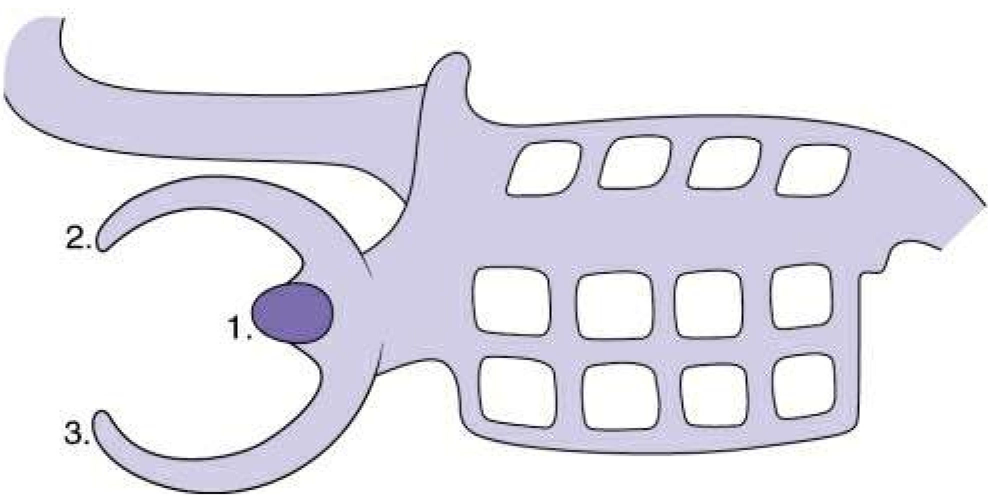


FIGURE 47.26 Components which provide the three properties in a clasp-retained removable partial denture (1) support (2) stability (3) retention.

Component parts of precision attachments also fulfil these properties (Fig. 47.27).

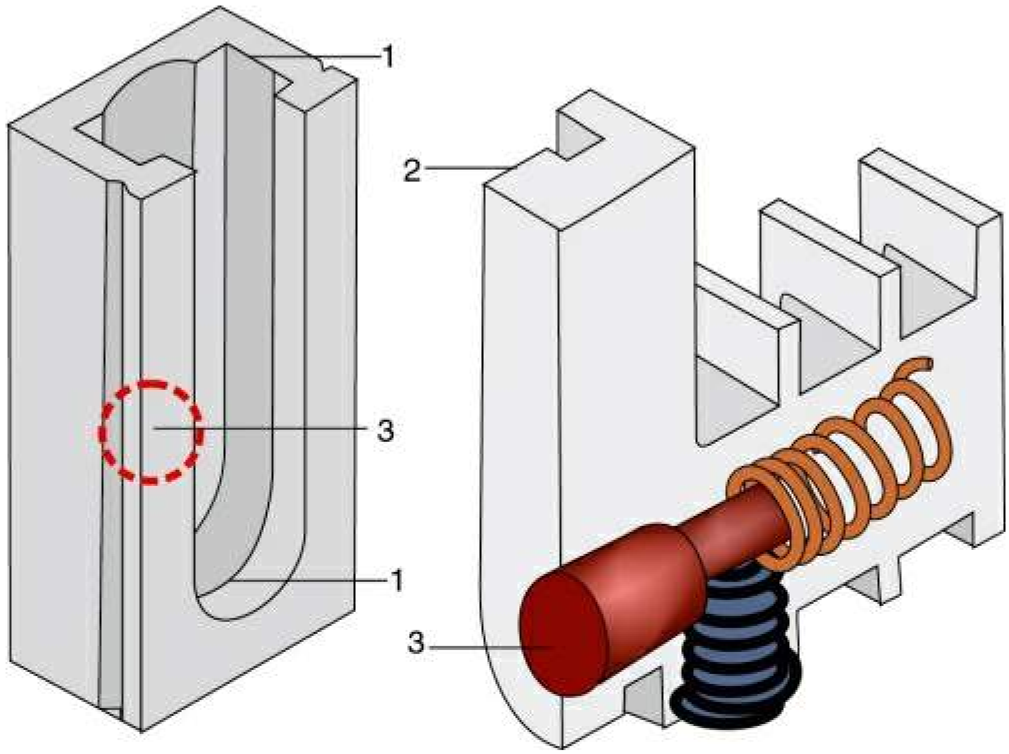


FIGURE 47.27 Components which provide the three properties in an attachment-retained removable partial denture.

Advantages

Advantages of attachments over clasp-retained removable partial dentures are

- Overloading of terminal abutment prevented by splinting (using double abutments with crowning).
- The functional load is transferred along the long axis of the abutments.
- Efficiency of the retention is not affected by the contour of the abutment teeth.
- Food impaction is prevented by intimate contact of components.

- Rotation of saddle is controlled.
- Retention, reciprocation and support are incorporated within the components.

Disadvantages

- Extensive preparation of the abutment teeth is required – minimum two teeth need to be crowned.
- More clinical time.
- The components can wear and lose their retentive properties.
- The initial and maintenance cost are much higher compared to cast partial denture.

SUMMARY

Attachments are very effective with distal extension removable prostheses and with tooth- and implant-supported overdentures. Attachment-retained removable partial dentures (ARRPD) show long-term clinical success but crowning and splinting of abutments is essential. Aesthetics is superior to clasp-retained partial dentures but fabrication is more complex and expensive. Resilient extracoronal attachments transfer less stress and are preferred for distal extension bases.

CHAPTER 48

Overdentures

CHAPTER CONTENTS

Introduction

Definition: Any removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants; a dental prosthesis that covers and is partially supported by natural teeth, natural tooth roots, and/or dental implants also called overlay denture, overlay prosthesis, superimposed prosthesis (GPT8).

As stated in the definition, overdentures are of two types:

- Tooth-supported (Fig. 48.1)
- Implant-supported (Fig. 48.2)

FIGURE 48.1 Tooth-supported overdenture.

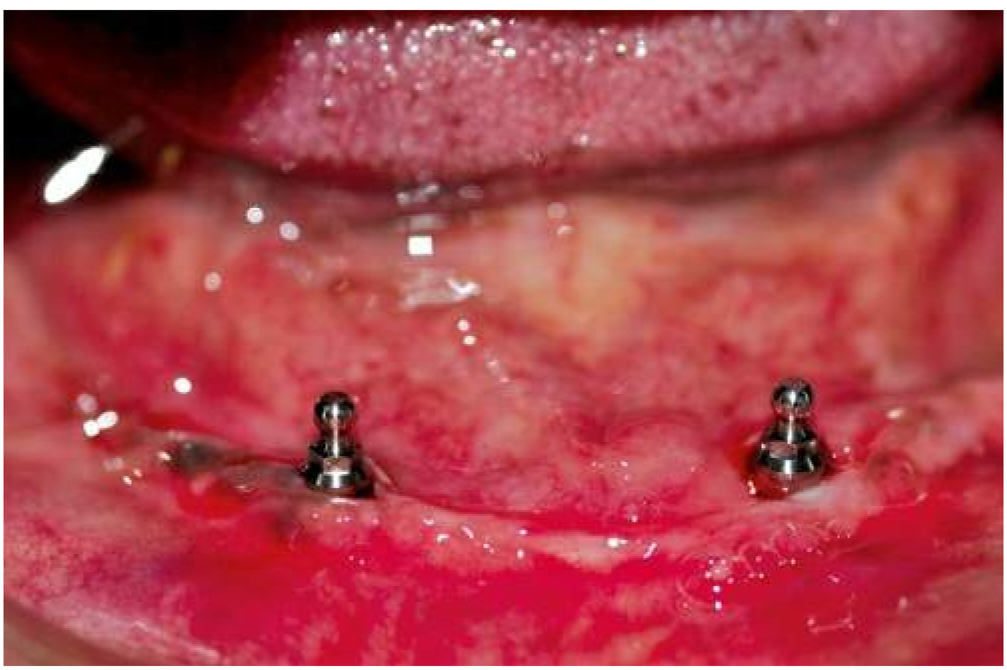


FIGURE 48.2 Implant-supported overdenture.

In this chapter, tooth-supported overdentures will be discussed, while implant-supported overdentures are discussed in the Chapter 49.

Tooth-supported overdentures alleviate some of the consequences of conventional complete dentures like:

- Residual ridge resorption.
- Loss of occlusal stability.
- Undermined aesthetic appearance.
- Compromised masticatory appearance.

Hence, it is regarded as a 'preventive' therapy. The treatment involves preservation of teeth (usually canines) on either side of the arch and extraction of all other teeth. These abutments are restored to good periodontal health, treated endodontically and coronal portion is reduced to the desired level depending on the type of overdenture (usually 2–3 mm above gingival margin). A conventional complete denture is then fabricated over these abutments. Attachments can be used on the abutments to retain the denture.

The various considerations to enable this treatment are discussed in the chapter.

Requirements

- Maintenance of health of the abutment teeth.
- Reduction of crown–root ratio to decrease mobility.
- Denture base extended to cover as wide an area as possible to distribute the load.
- Close fit of denture base to the tissues to prevent food accumulation.
- Easy to manipulate by patient.
- Simple to fabricate and maintain.

Advantages

- Preservation of residual ridge.
- Maintenance of proprioception – preservation of perceptive ability.
- Improved retention with attachment-retained overdentures.
- Improved stability as horizontal and torquing forces are minimized.
- Excellent support provided by the abutments.
- Reversibility – if abutment fails, it can be easily converted to a conventional complete denture by relining.
- Psychological gain of not having lost all the natural teeth.

Disadvantages

- Caries susceptibility of abutments.
- Periodontal breakdown of abutments if plaque control is ineffective.
- More interarch space is required than for conventional complete dentures.
- Bony undercuts labial to abutments pose problems to close adaptation of denture base because of limited path of insertion – this can lead to overcontour or undercontour of denture base.
- Bulkier.

Indications

- Few remaining teeth with unfavourable distribution.
- Severe loss of periodontal attachment of remaining teeth.
- Significant posterior tooth loss associated with attrition of anterior teeth.
- Complete denture opposing retained mandibular anterior teeth.
- Conditions where retention is difficult to obtain with complete dentures:
    - Xerostomia or sialorrhoea.
    - Poor residual ridge.
    - Congenital deformities like cleft palate.
    - Partial loss of maxilla or mandible.

Contraindications

- Patients who cannot maintain abutment teeth.
- Reduced interocclusal space – overdentures tend to occupy more vertical space than the tooth substance that they replace. The reason is more bulk material which is required for the strength of the denture base material.
- Bony undercuts adjacent to abutments.
- Abutments unsuitable for endodontic and periodontal treatment.

Abutment selection

Ideal requirements

- The gingival tissue should be firm, pink and tightly attached to the neck of the tooth and underlying bone.
- A sufficient level of alveolar and supporting bone should remain free from angular bony defects.
- The abutments should be definitely root filled and free from caries.
- The abutments should exhibit a minimal degree of mobility once they have been sectioned 2–3 mm above gingival margin.

Location

- Bilateral distribution – at least one tooth on either side of the arch is selected and retained.
- It is prudent to select the teeth that can be joined by an imaginary line at right angles to the sagittal plane rather than provide a diagonal fulcrum line (Fig. 48.3).
- The canines are ideal as overdenture abutments followed by bicuspids.
- Maxillary incisors may be used as abutments if the lower teeth are intact.

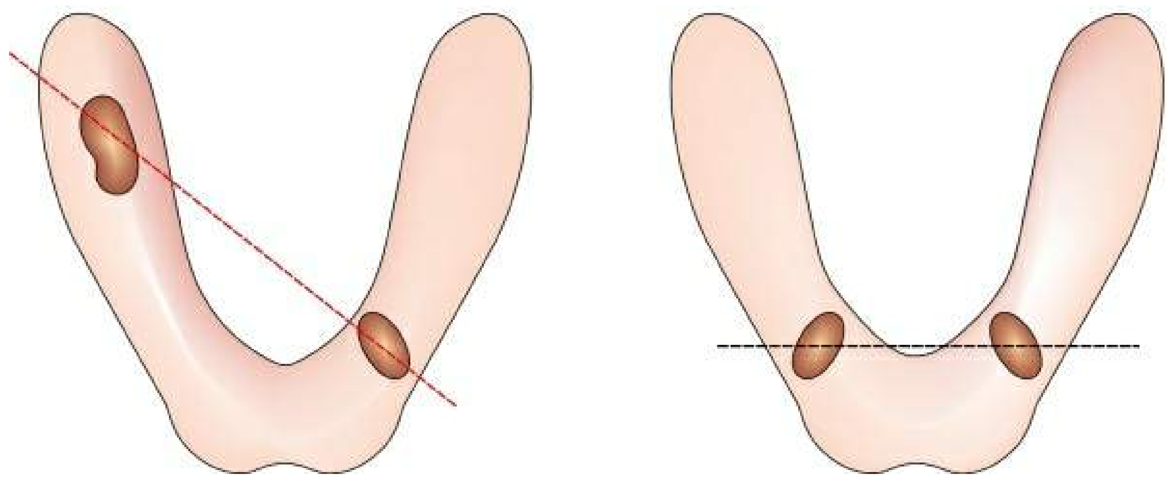


FIGURE 48.3 Straight fulcrum better than diagonal.

Number

- One abutment each on opposing side of the arch, in canine regions will give excellent results.
- If more abutments are retained, it will complicate construction of the overdenture.

Space

- Vertical space is essential as discussed previously in section Contraindications. When attachments and copings are used, the interocclusal space required is further increased.
- Amount of space in between the abutments is also an important consideration:

○ Adjacent roots can complicate plaque control and denture construction.

○ If adjacent roots are to be preserved, it is better to restore them individually rather than splint them. But another abutment should be located on the opposing arch (Fig. 48.4).

FIGURE 48.4 It is better to restore adjacent roots individually rather than splinting.

Endodontic considerations

- Sound teeth with satisfactory root fillings must be utilized.
- Single-rooted canals are easier to root fill than multirooted teeth. Multirooted teeth with hemisection procedure are normally valuable in these areas.

Periodontal considerations

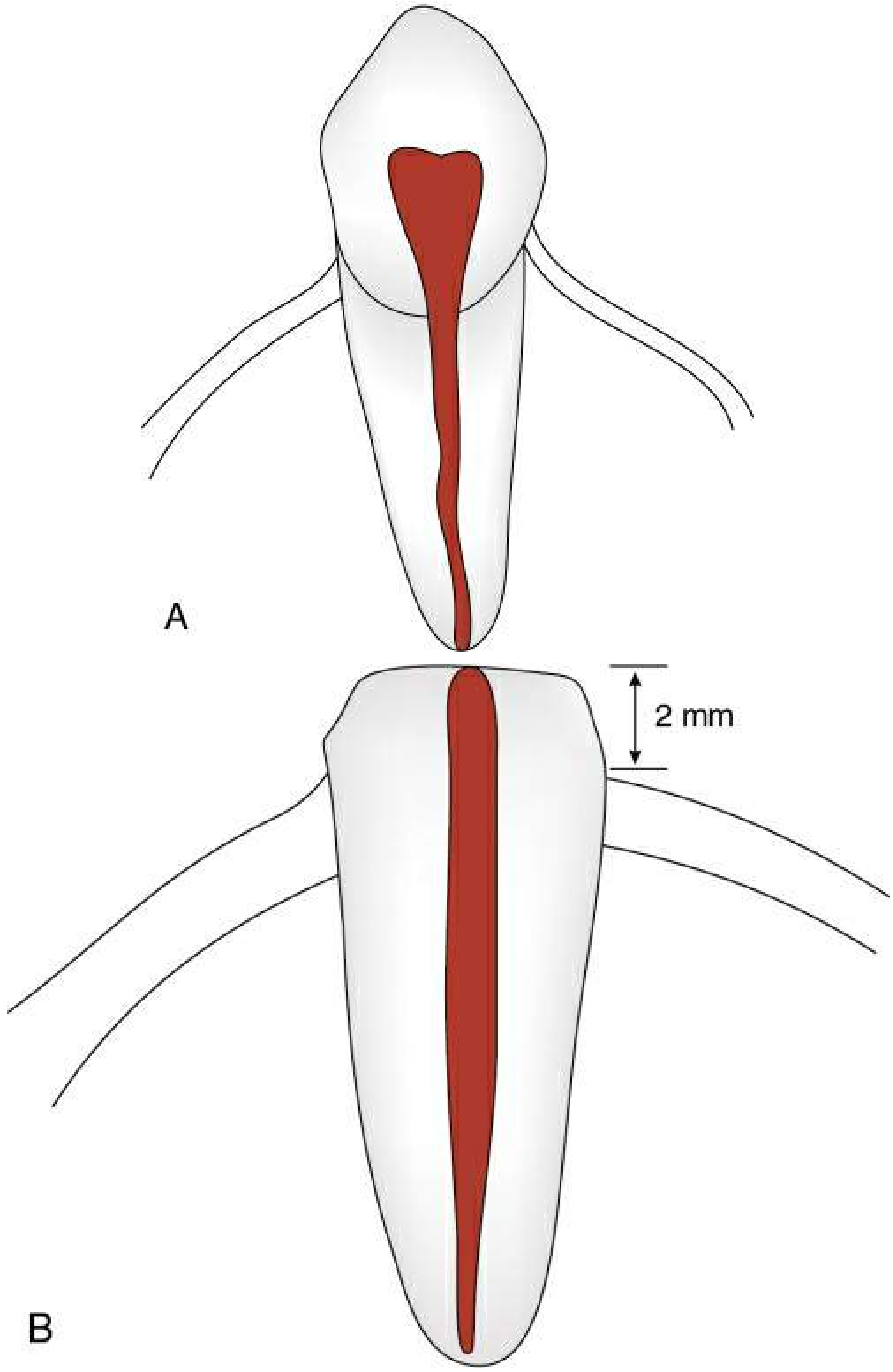
- Periodontal attachment of abutment should be greater than 5 mm attachment – at least one-third of the root should remain in the bone.

- At least 3 mm of attached gingiva should be present.
- Reducing the tooth to the gingival level drastically reduces the leverage forces.

Types of tooth-supported overdentures

Bare root surface

- The crown of the abutment is reduced to a height of 2–3 mm, is treated endodontically and the entrance (occlusal section) is filled with silver amalgam, glass ionomers or composite restorations. The occlusal surface should be contoured to a convex or dome-shape and is highly polished. This type of surface will minimize lateral occlusal stresses (Fig. 48.5A–C).
- It is the simplest, cheapest and least space-consuming option.
- It is ideal during maturation of the edentulous ridges.
- It can also be used to evaluate the questionable abutments.
- It should not be used on a long-term basis where natural teeth are in direct opposition – possibility of longitudinal root fracture.



A
2 mm
B

FIGURE 48.5 **(A)** Tooth should be endodontically treated. **(B)** The crown should be reduced to about 2–3 mm. **(C)** The entrance filled with amalgam.

Metal copings

Dome-shaped copings (Short)

- The abutment teeth are endodontically treated and reduced in height and a post space is created. Dome-shaped cast metal copings 2–3 mm in height with a chamfer finish line and a post are fabricated and cemented (Fig. 48.6).
- Coping should be at least 1 mm thick to withstand the forces.
- Because of the small size, lateral loads are reduced and space occupied is minimum.

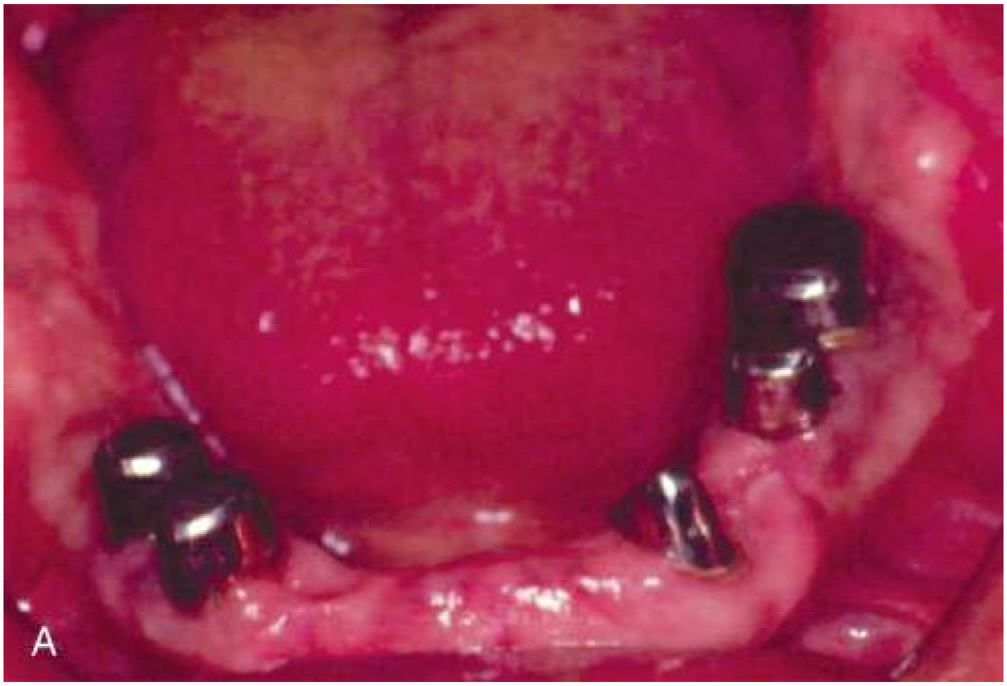
- Their contribution to the retention of the prosthesis is negligible.
- Coping must be contoured to facilitate the plaque control.
- As the coping is rounded, the denture itself can be used as the outer coping because it is easier to adjust the denture and control stability and to a lesser extent retention.

FIGURE 48.6 **(A)** The abutment teeth are endodontically treated and reduced in height and a post space is created. **(B)** Dome-shaped cast metal copings 2–3 mm in height with a

chamfer finish line and a post are fabricated and cemented.

Thimble-shaped copings (Long)

- They are 5–8 mm in height and need considerable space (Fig. 48.7A).
- The retention obtained will vary inversely with taper of the coping.
- The abutment teeth require greater osseous support.
- May not need to be endodontically treated.
- These copings can be used to support telescopic crowns to enhance retention.
- Telescopic crowns – an artificial crown constructed to fit over a coping (framework). The coping can be another crown, a bar or any other suitable rigid support for the dental prosthesis (GPT8).



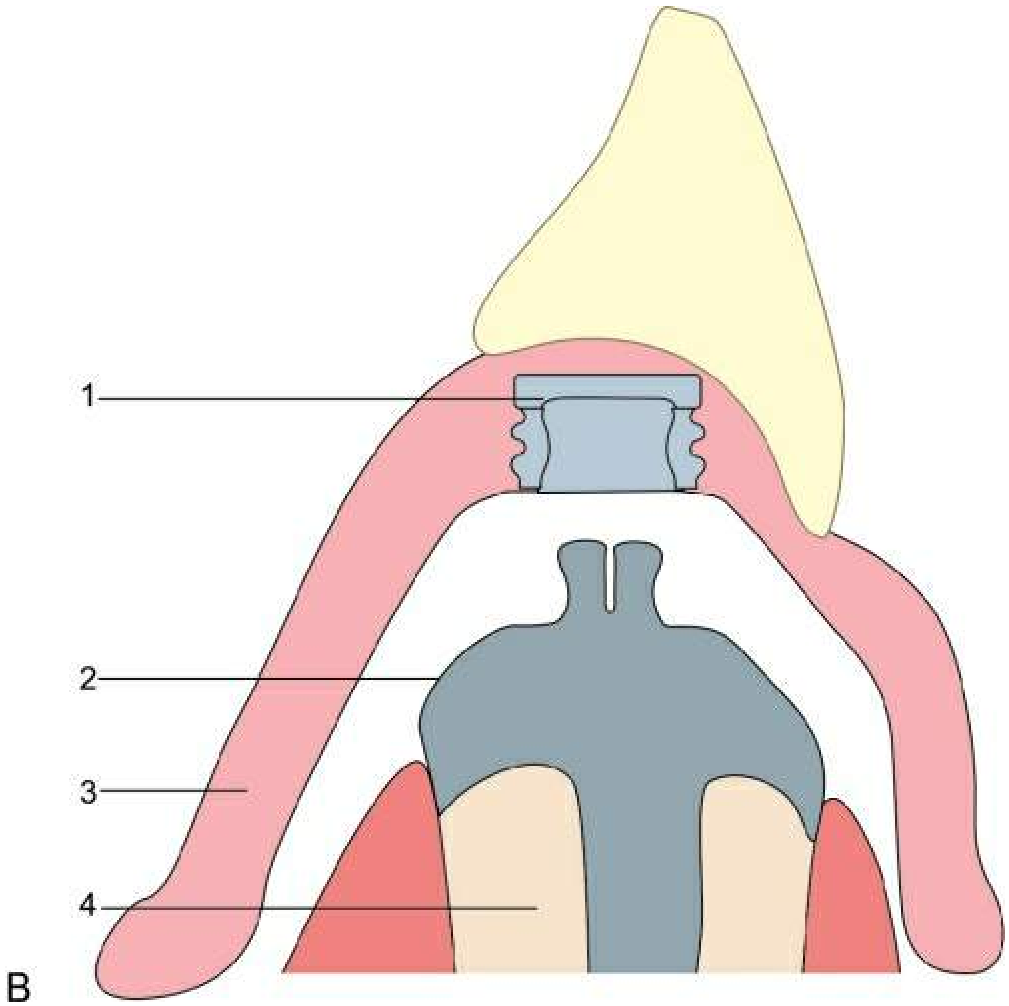


FIGURE 48.7 **(A)** Thimble-shaped coping. **(B)** Extraradicular attachment. (1) Female component attached to denture, (2) male component, (3) denture, (4) abutment tooth.

Attachments

- As the attachments used with overdentures take support from the root portion of the tooth, they are termed as 'radicular' attachments.
- Not only require precise location between the various components, but may place additional forces on their dowels.
- Best retention.

- Require adequate interocclusal space to place the components.
- Indicated only in patients with low caries activity.
- Meticulous oral hygiene maintenance is essential.
- Expensive.
- The attachments used for overdentures can be classified as:

  ○ Stud attachments

  ○ Bar attachments

  ○ Magnetic attachments

1. Stud attachments

Stud attachments are further classified into:

- Extraradicular attachments (Fig. 48.7B)
- Intraradicular attachments

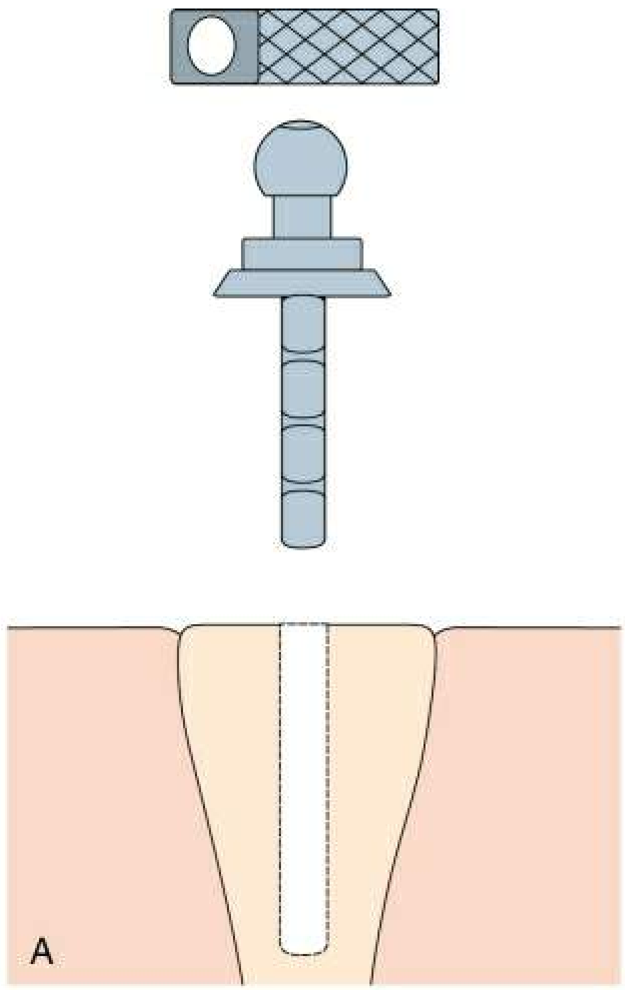
Extraradicular attachments

- Male element is fixed to the abutment and projects from the root surface of the preparation; the female component is attached to the denture (Fig. 48.8). Attachment of male component to the female component provides the retention.
- The male parts are available as:

  ○ Prefabricated metal post – cemented directly to the root (Fig. 48.9).

○ Prefabricated resin patterns – which is cast and cemented to the root (Fig. 48.10).

- The female component is also termed as 'retentive anchor' and may be made in metal or plastic and is in the form of an 'O'-ring or matrix (Fig. 48.8A and B).
- Example: ORS-OD, Ceka.



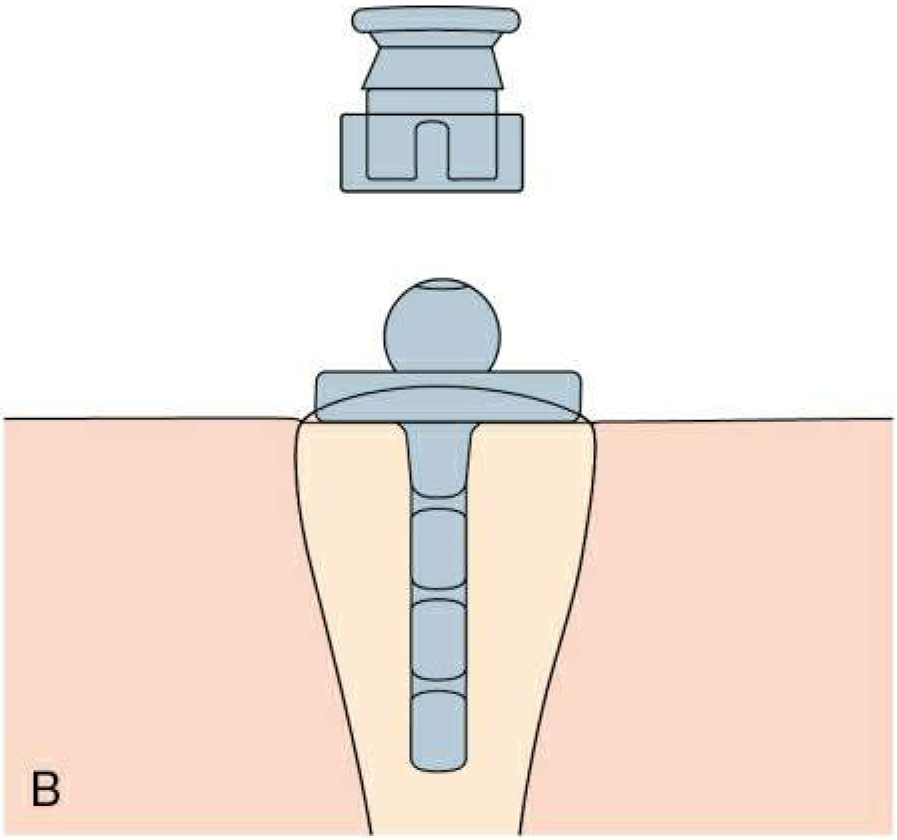
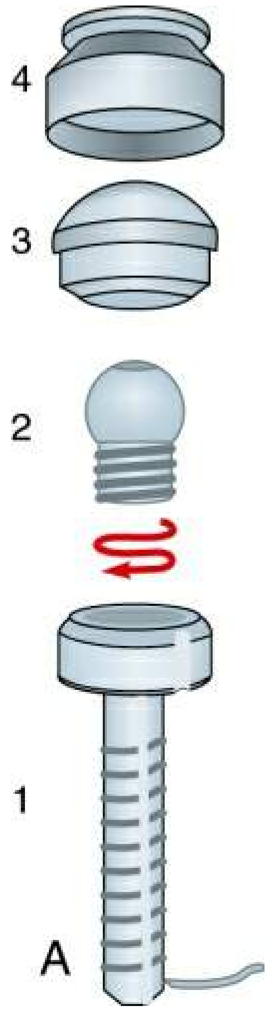
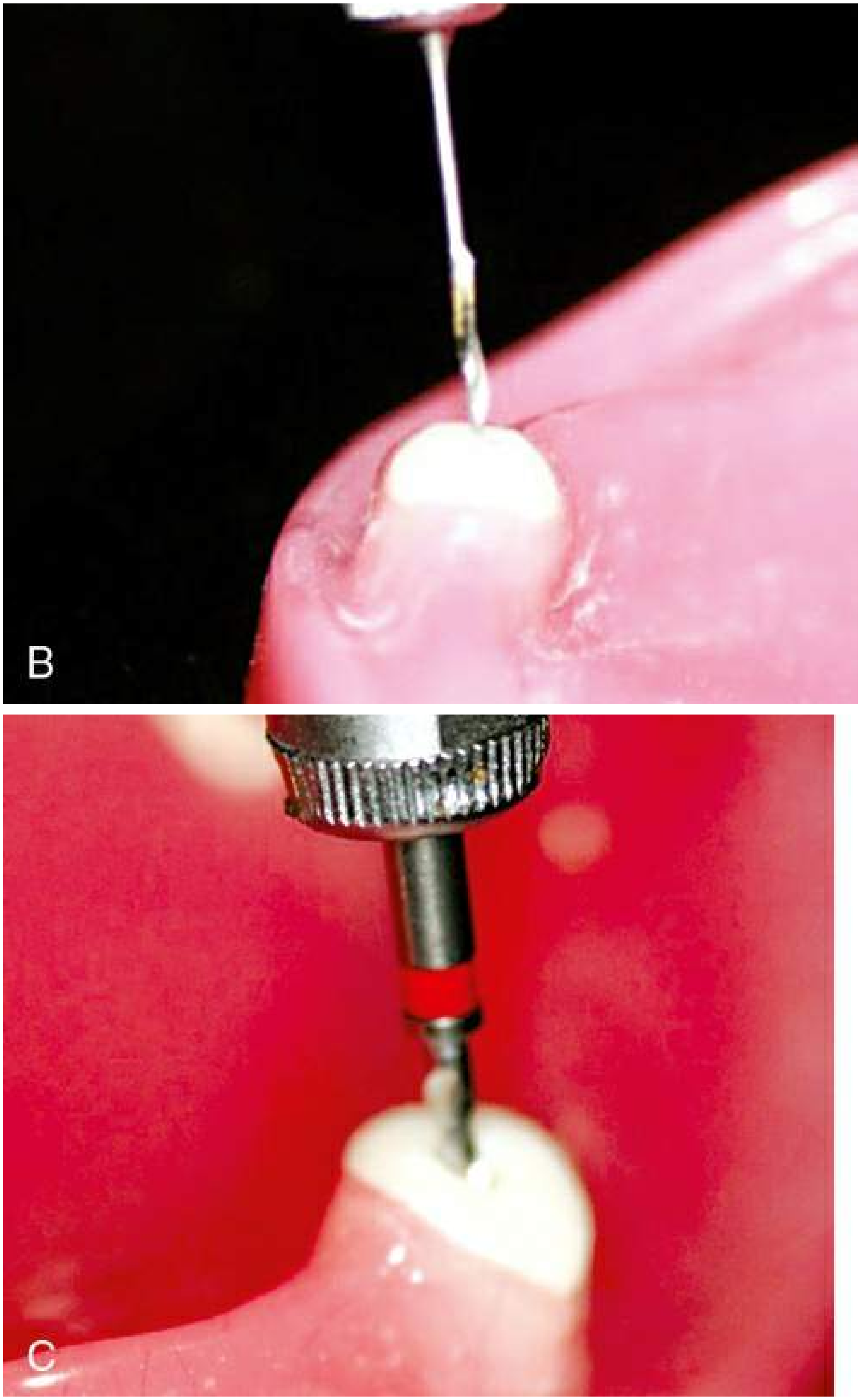
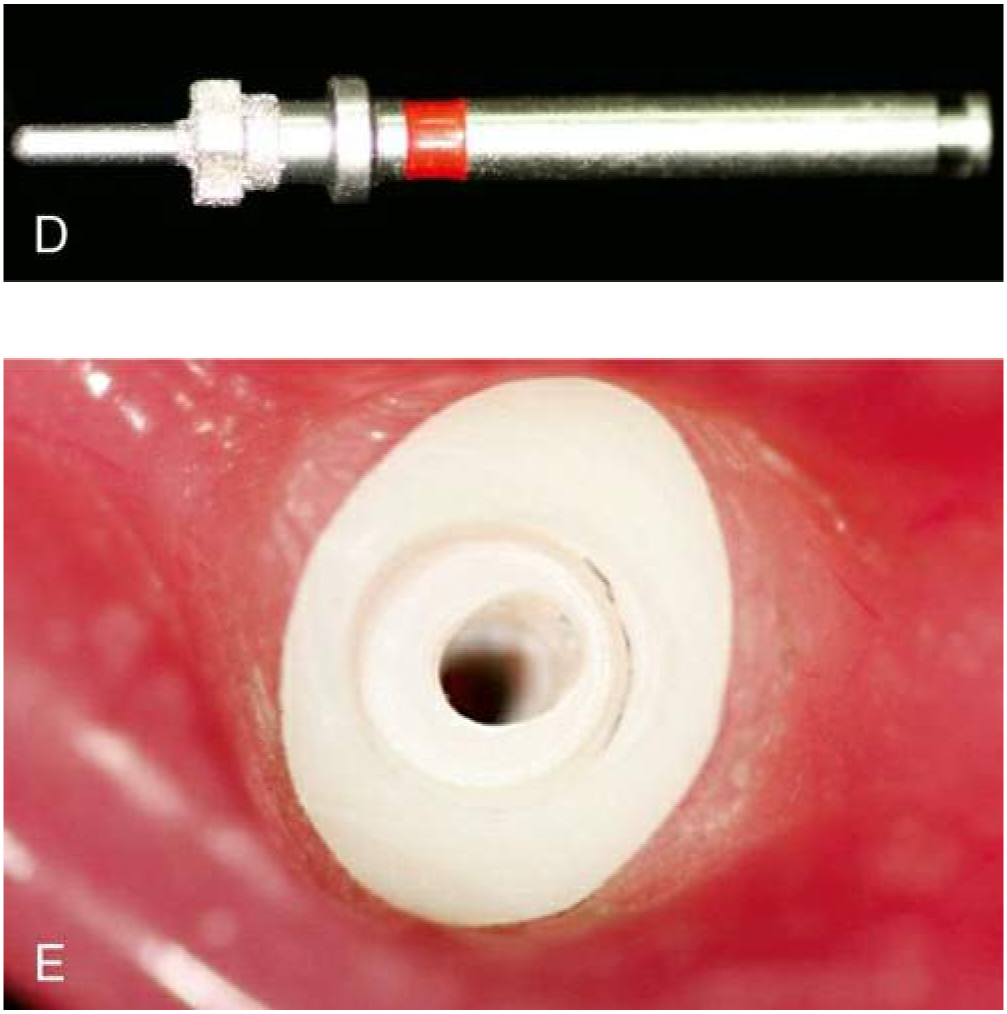
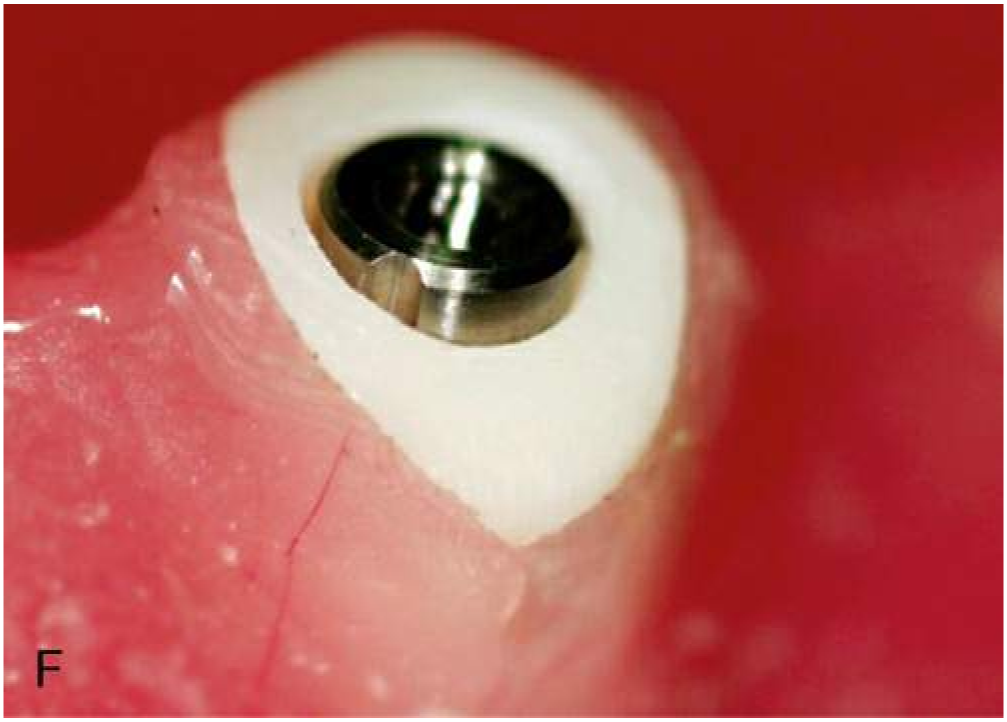


FIGURE 48.8 **(A)** Extraradicular attachment – male part with female (O-ring) attachment. **(B)** Extraradicular attachment – male part with female matrix (Dalla bona) attachment.


4
3
2
1
A


B
C


D
E


F


G

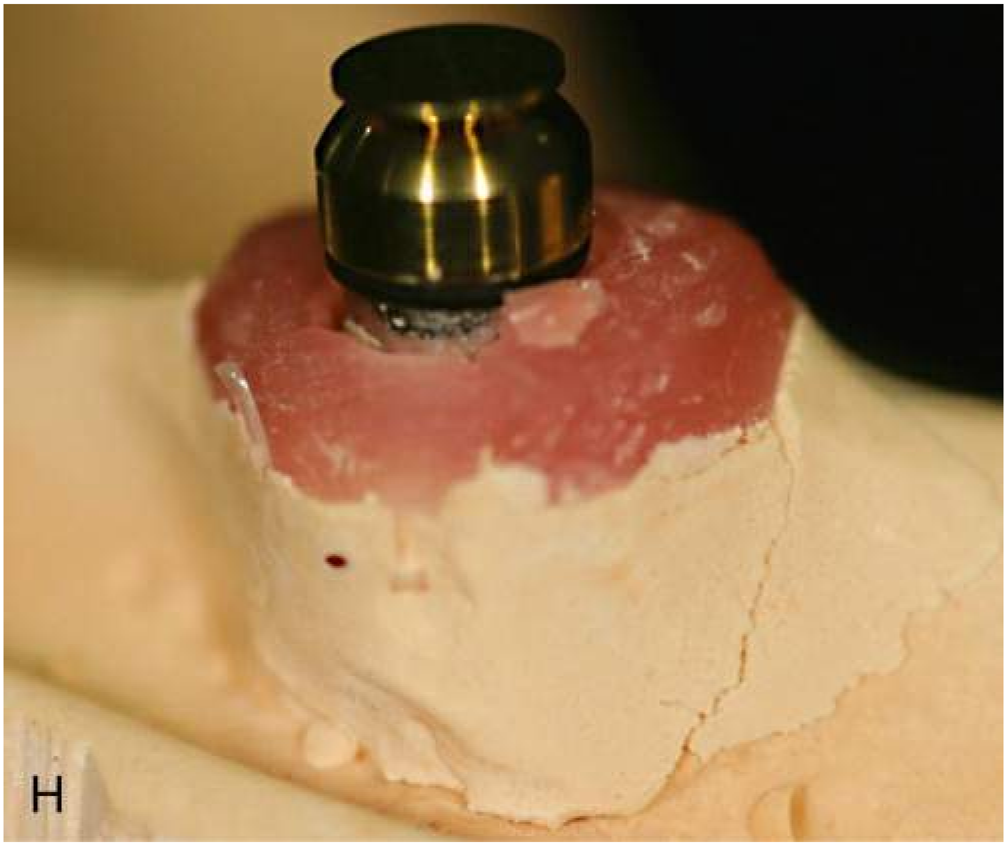
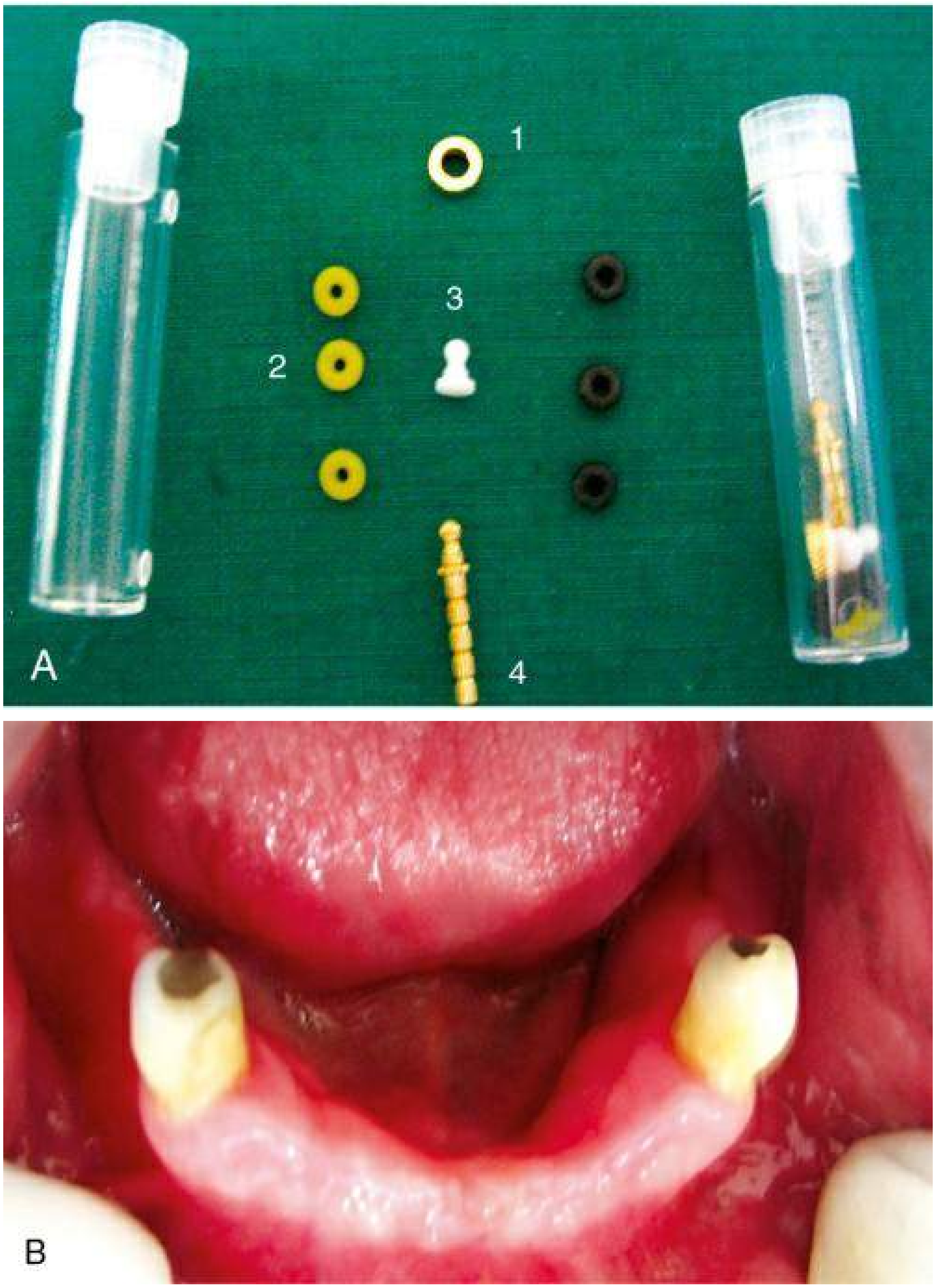
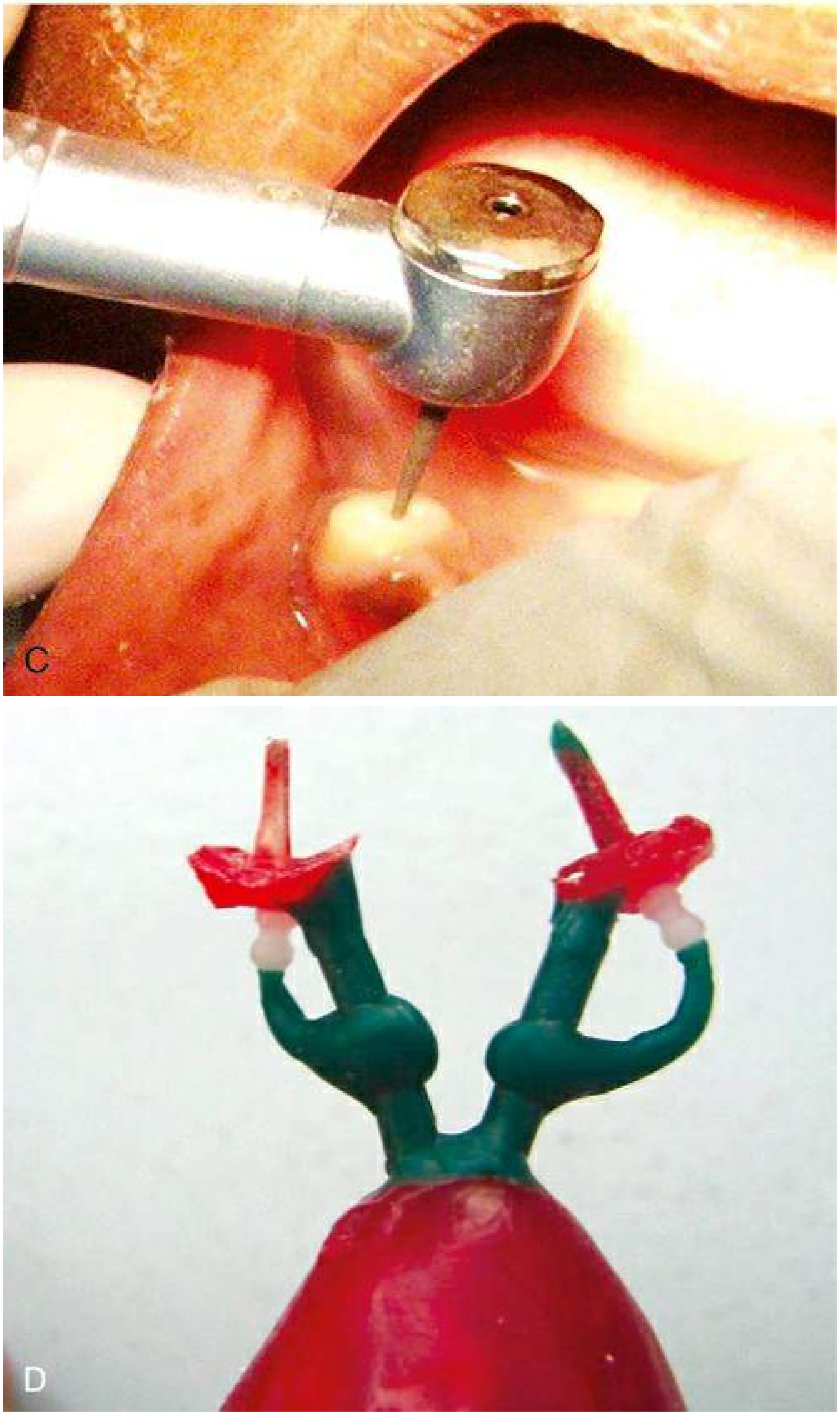


FIGURE 48.9 **(A)** Extraradicular – Ceka attachment. (1) Post (2) male stud (ball) attachment (3) female component (4) housing for female component. **(B)** Guttapercha is removed with Peeso reamer. **(C)** Sequential drilling is performed with appropriate drills to enlarge the post space. **(D)** The final drill should correspond to the shape and size of attachment. **(E)** Prepared post space. **(F)** Male component housing is

cemented on abutment. **(G)** Male component is attached to housing. **(H)** Female component with housing is positioned on male component prior to attaching it to denture. **(I)** Female component attached to denture with autopolymerizing acrylic.




C
D


E


G


G

FIGURE 48.10 **(A)** ORS-OD system (1) Housing for O-ring, (2) O-rings, (3) plastic castable stud attachment and (4) lab analogue for stud. **(B)** Abutments prior to preparation. **(C)** Abutment tooth was endodontically treated, reduced and post space is created. **(D)** A wax pattern of the post space with the resin stud attachment in place is fabricated and invested. **(E)** Following casting. **(F)** The cast attachment is finished and luted to the abutments and an impression is made. **(G)** The lab analogue is positioned in impression and model is poured. The female component is then attached to the denture in the laboratory using autopolymerizing acrylic resin. **(H)** Female (Housing and O-ring) attached to denture.

Intraradicular attachments

- Male element forms part of the denture base and engages a specially produced depression within the root contour (Fig. 48.11).
- Indicated in situations of reduced interocclusal space.
- Examples: Logic and Zest attachments.

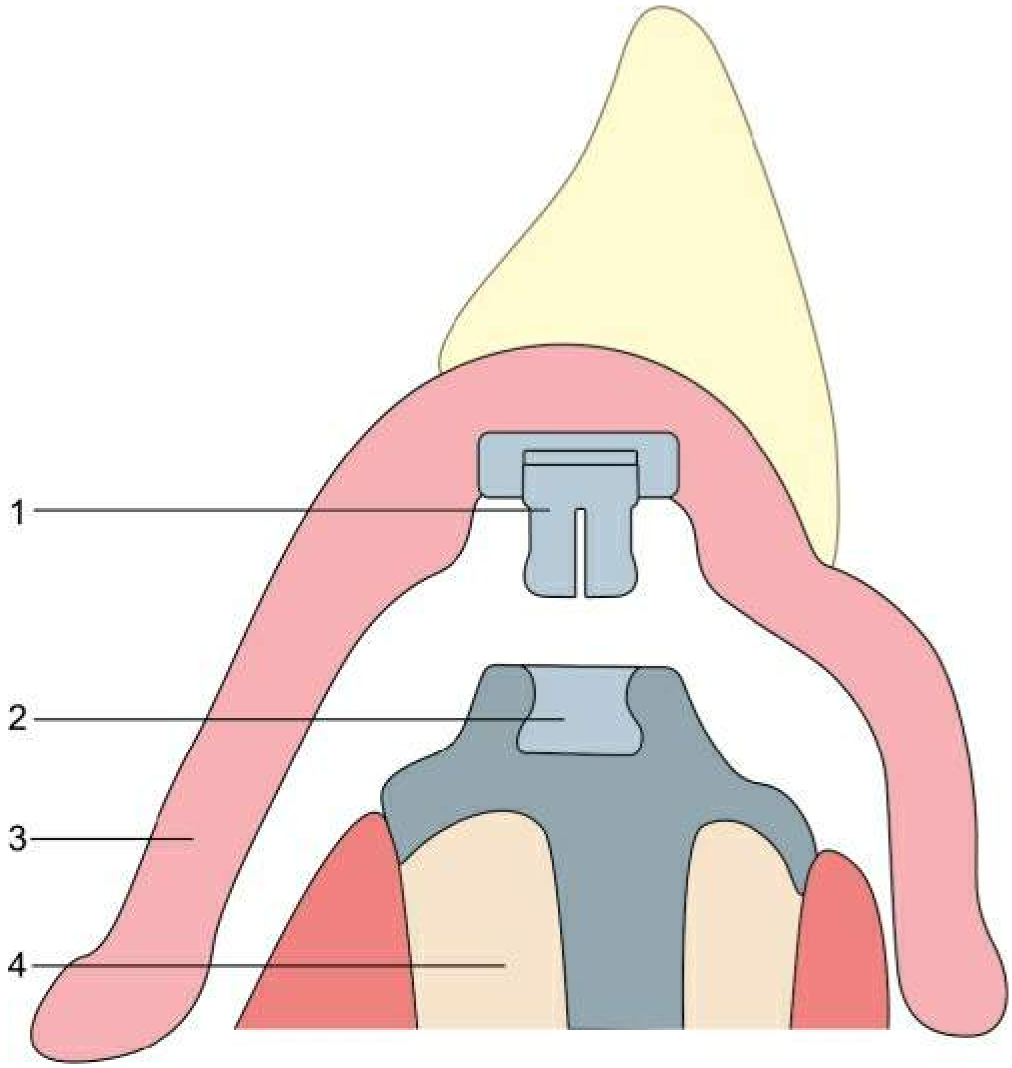


FIGURE 48.11 Intraradicular attachment. (1) Male component attached to denture, (2) female component, (3) denture, (4) abutment tooth.

Fabrication

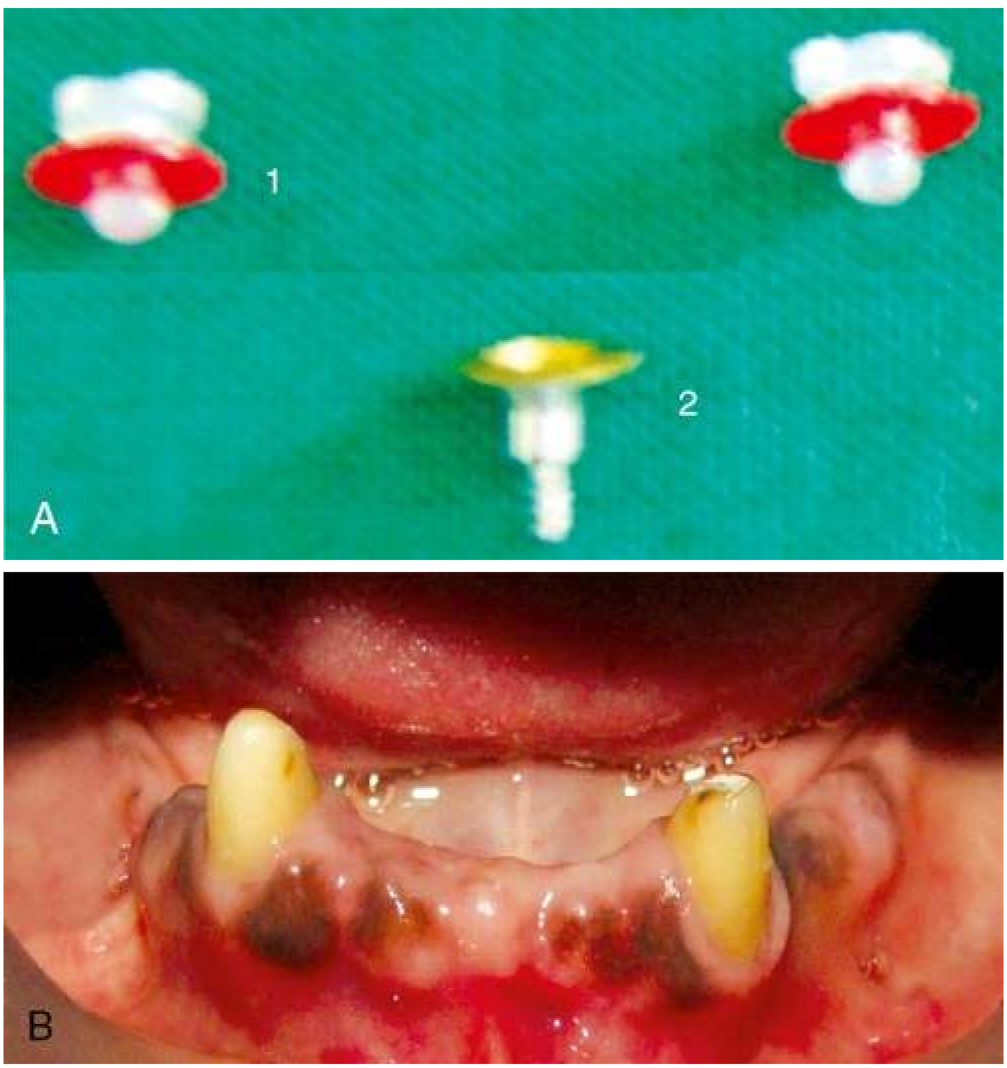
The root canal space is prepared similar to the preparation for a post depending on the type of attachment. Each attachment is provided with specific drills and the component that fits into the canal space is first cemented. The corresponding component can be fitted in the denture chairside or in the laboratory while processing the denture.

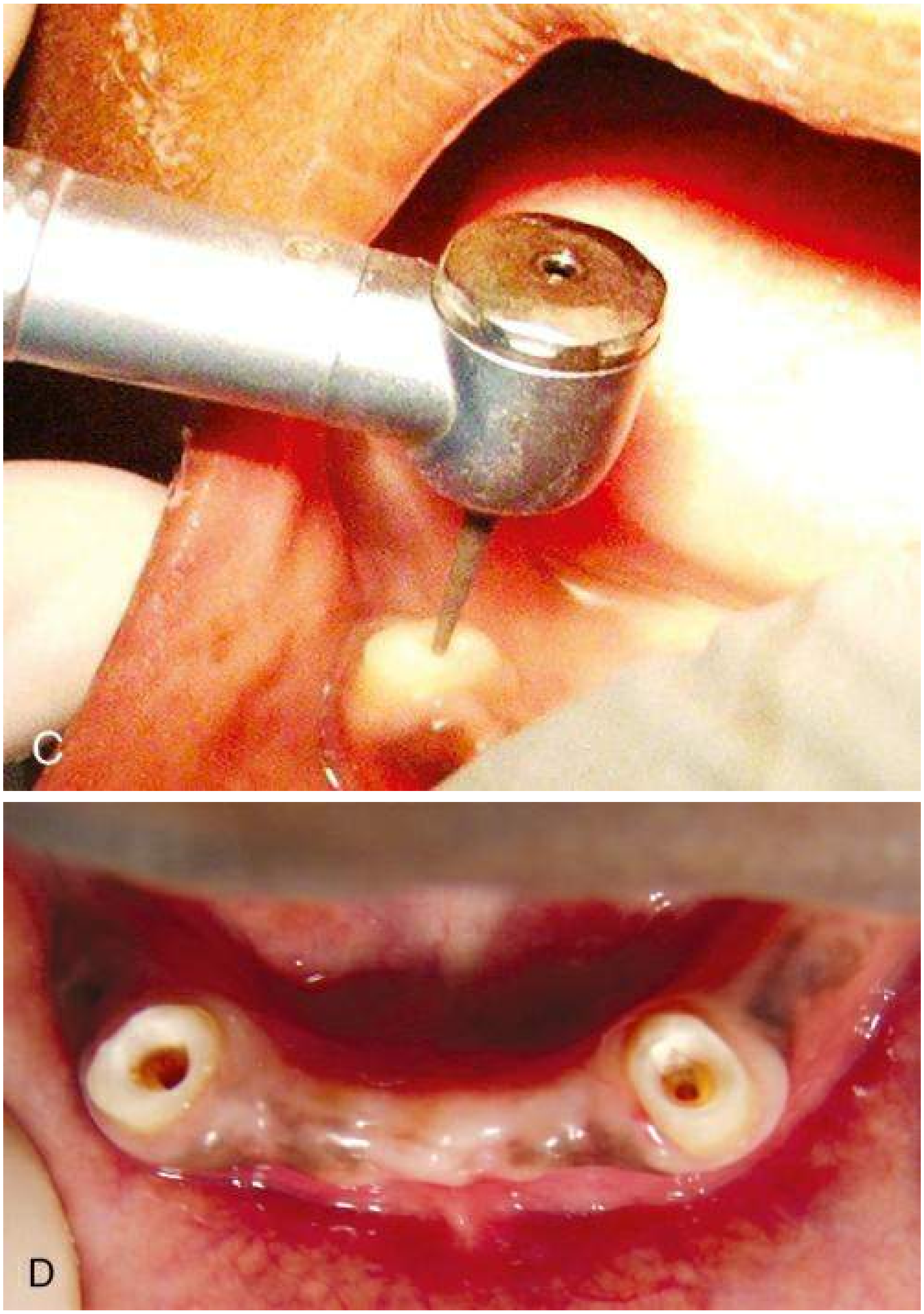
Extraradicular attachment

The fabrication of an overdenture using an extraradicular attachment (Ceka) which utilizes a prefabricated metal post is shown in Fig. 48.9. Fabrication using prefabricated resin patterns (ORS-OD) is shown in Fig. 48.10.

Intraradicular attachment

The fabrication of an overdenture using an intraradicular attachment (Zest) is shown in Fig. 48.12.

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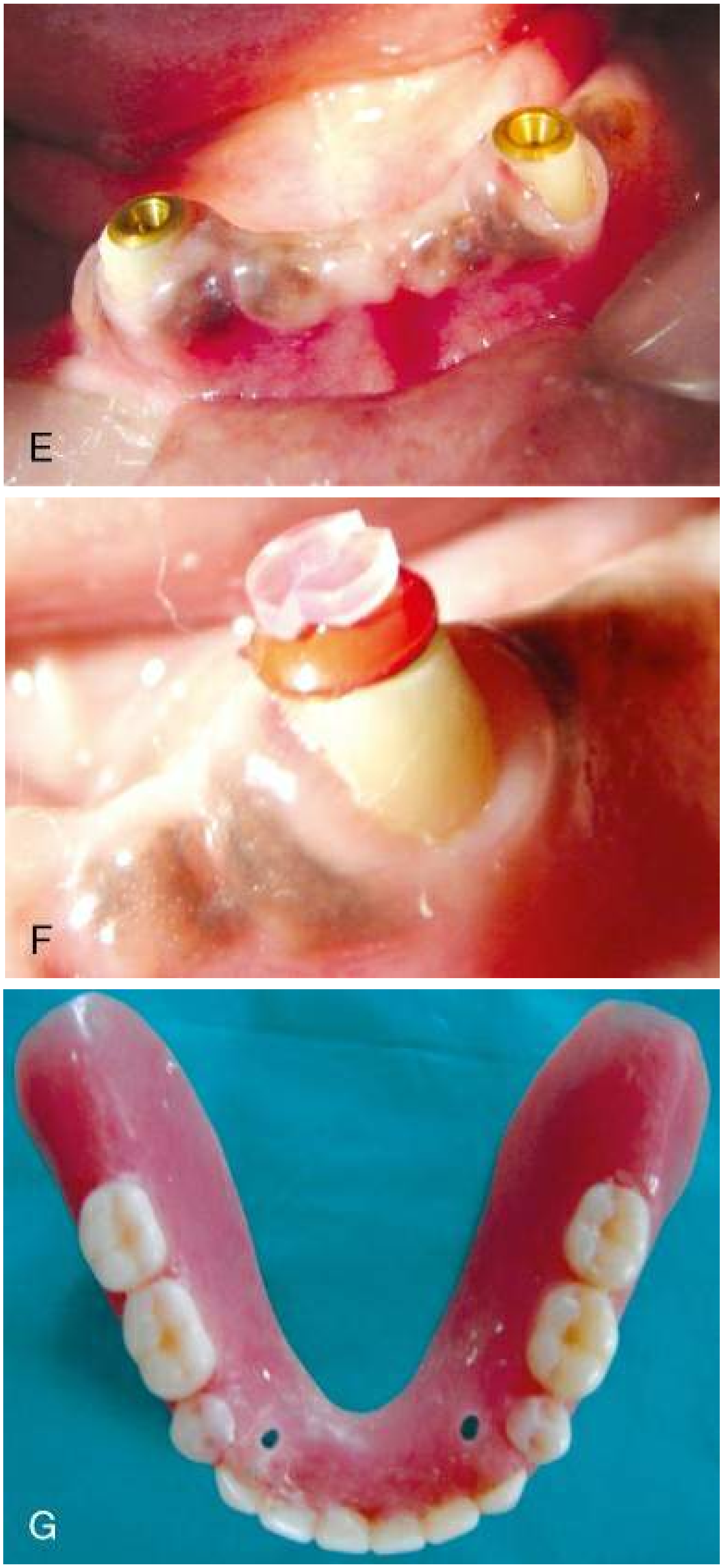
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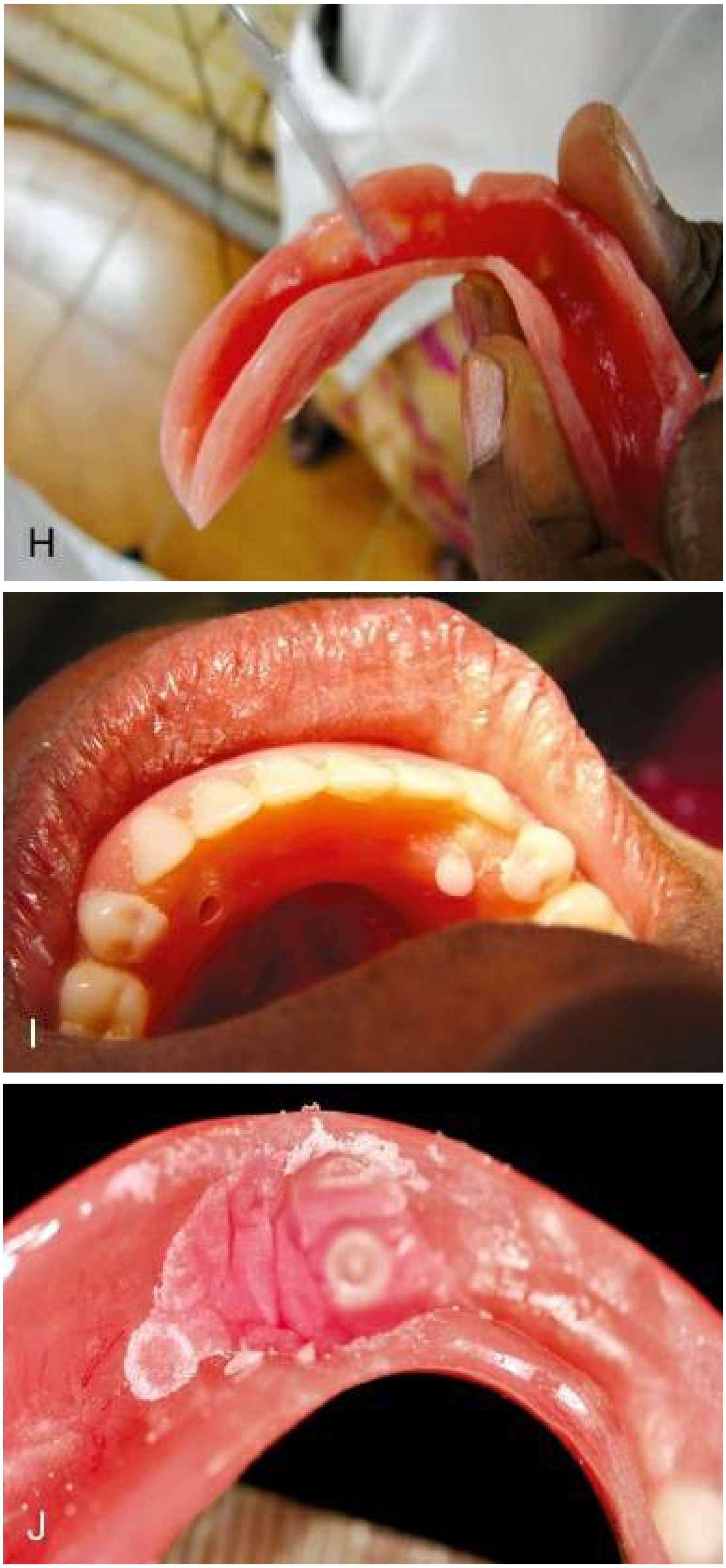
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FIGURE 48.12 **(A)** Zest attachment. (1) Male component attached to denture (2) female component fixed on abutment. **(B)** Abutments prior to preparation. (C) Preparation of the abutments with specific drills depending on the system following endodontic treatment. (D) Post space created in abutments. (E) Female component is luted in post space. (F) Male component is positioned on female component prior to attaching it to denture. **(G)** Space created in denture for attachment of male component. (H) Autopolymerizing denture base acrylic is mixed and the created space is filled with resin. **(I)** Denture with filled resin is placed over the positioned male component. **(J)** When resin sets, the male component will get attached to denture. Denture with attached male component is then removed from the mouth. **(K)** Overdenture with intraradicular attachments in occlusion. **(L)** Overdenture in function showing excellent retention and stability.

2. Bar attachment

- It consists of a bar spanning an edentulous area joining copings on the roots of the abutment teeth on either side of the arch (Fig. 48.13).
- Sleeves/clips placed in the denture attach to the bar when denture is inserted, providing retention (Fig. 48.14).
- The bar splints the abutment teeth, distributes forces apically.
- Requires vertical and buccolingual space.
- Meticulous oral hygiene maintenance is essential.
- It can be bar joint or bar unit.

FIGURE 48.13 Copings on roots of abutments connected with a bar.

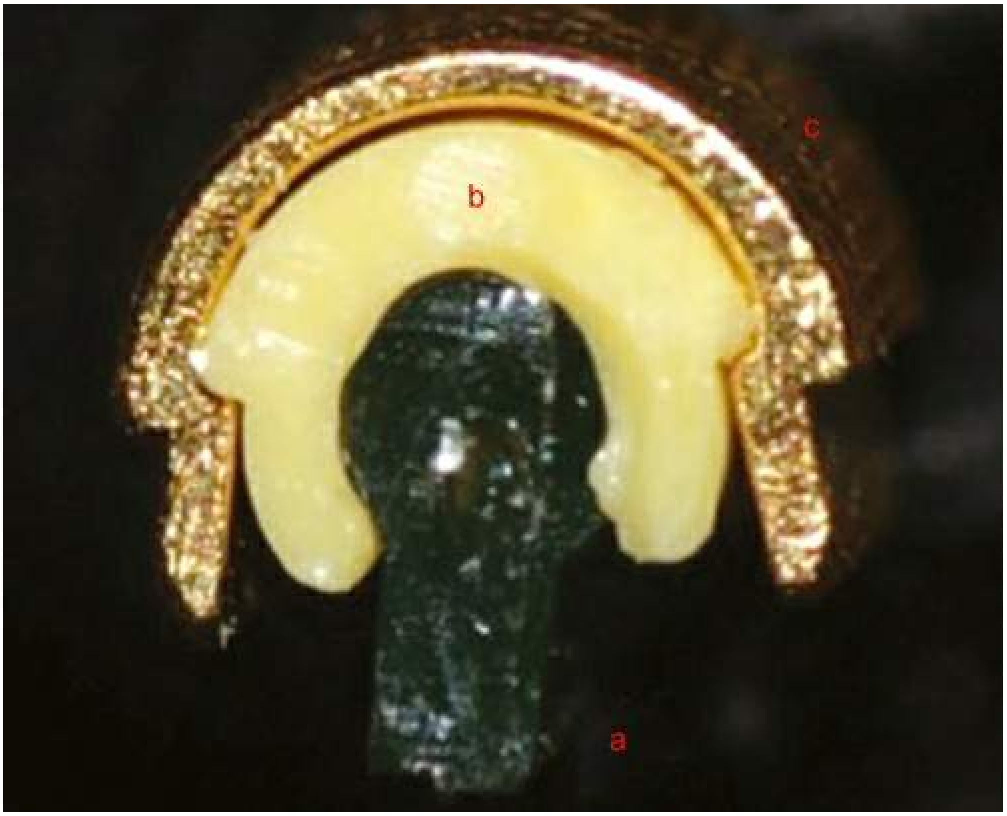


FIGURE 48.14 Cross-section showing. **(a)** Bar, **(b)** clip and **(c)** housing for clip. The clip and housing are attached to the denture.

Classification

Depending on number

- Single bar (Fig. 48.15)
- Multiple bars (Fig. 48.16).

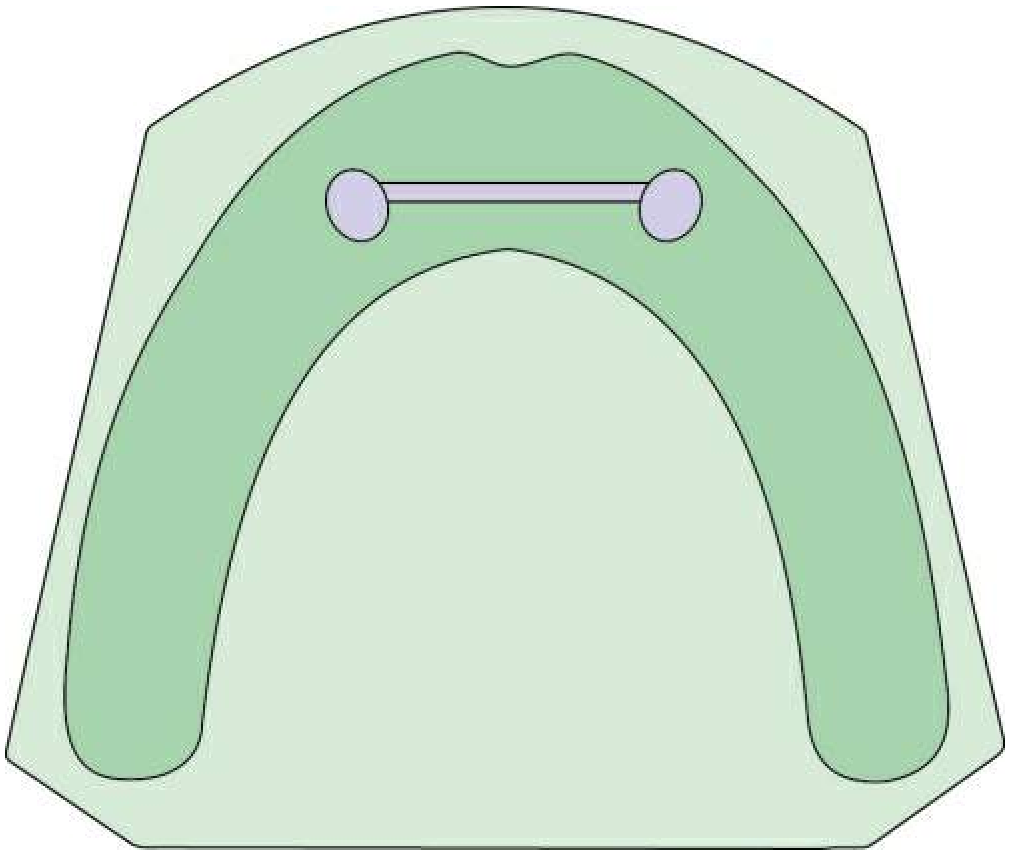


FIGURE 48.15 Single sleeve bar.

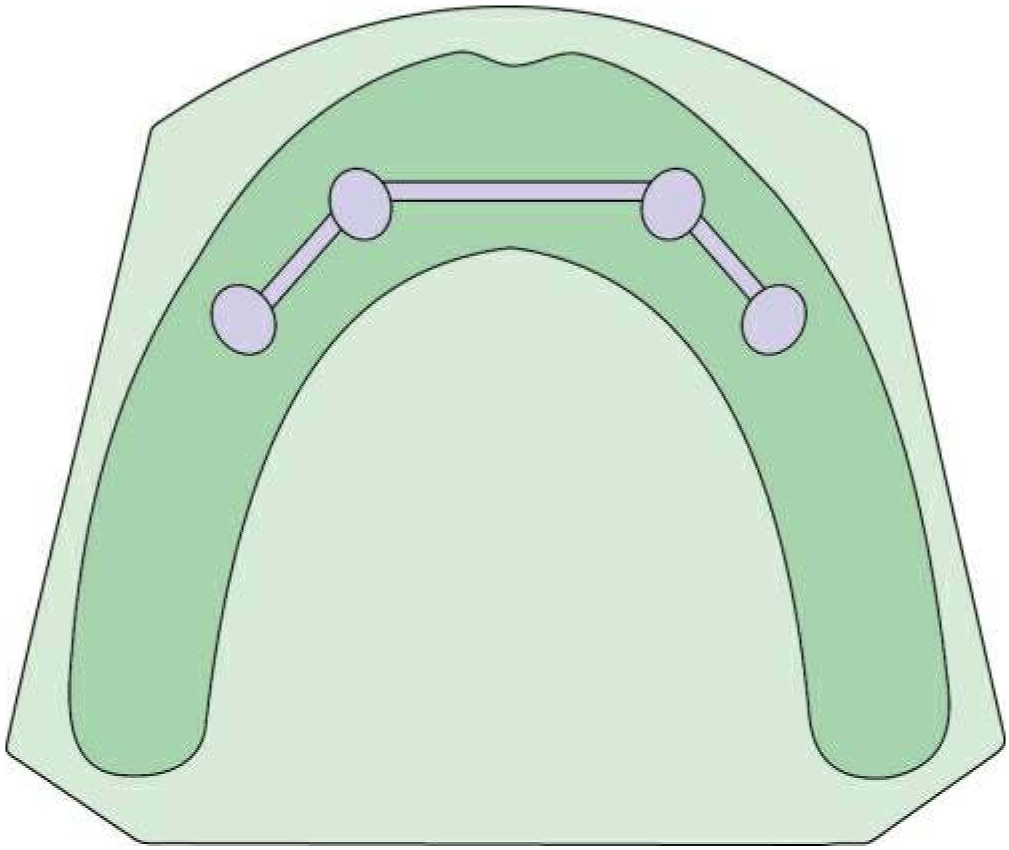


FIGURE 48.16 Multiple bars.

The single sleeve bars will show greater resiliency and tendency for rotation. The multiple sleeve bars are more versatile and will be more rigid.

Depending on movement (fig. 48.17)

- *Bar units*: permit no movement between bar and sleeve (solid/rigid).
- *Bar joints*: permit rotational movement between bar and sleeve (resilient).

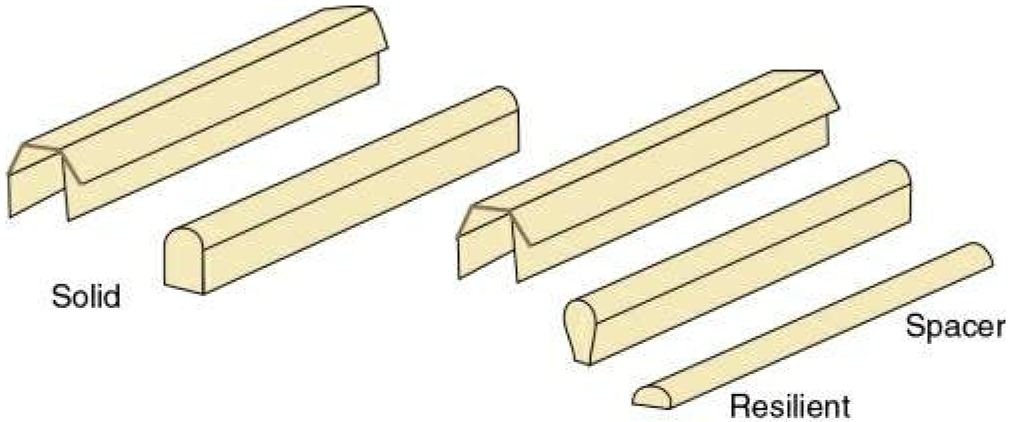


FIGURE 48.17 Rigid bars allow restricted movement while resilient bars with spacer between bar and sleeve provide more movement.

Greater movement is desired when some of the forces accruing on the attachments can be transferred to the residual ridges provided they are capable of withstanding the load. But this can cause ridge resorption.

The resiliency (movement) of a bar-retained denture is affected by:

- Shape of bar
- Spacer

Some of the commonly used bars are described here.

Hader bar

- A rigid bar connecting two or more abutments, which when viewed in cross-section, resembles a keyhole, consisting of a rectangular bar with a rounded superior (occlusal) ridge that creates a retentive undercut for the female clip within the removable prosthesis (GPT8) (Fig. 48.18).
- Named after the Swiss tool and die technician, Helmut Hader.
- Provides mechanical retention.

- The round shape of the superior part makes this bar a resilient type, which allows some movement.
- Available in diameter of 1.8 mm in plastic (cast with coping), gold (soldered to coping) and titanium (laser welded to coping).
- The sleeves are in plastic though they can be converted to metal if increased retention is desired.
- The preformed plastic bar can be cut to a small length and also used as a stud attachment.

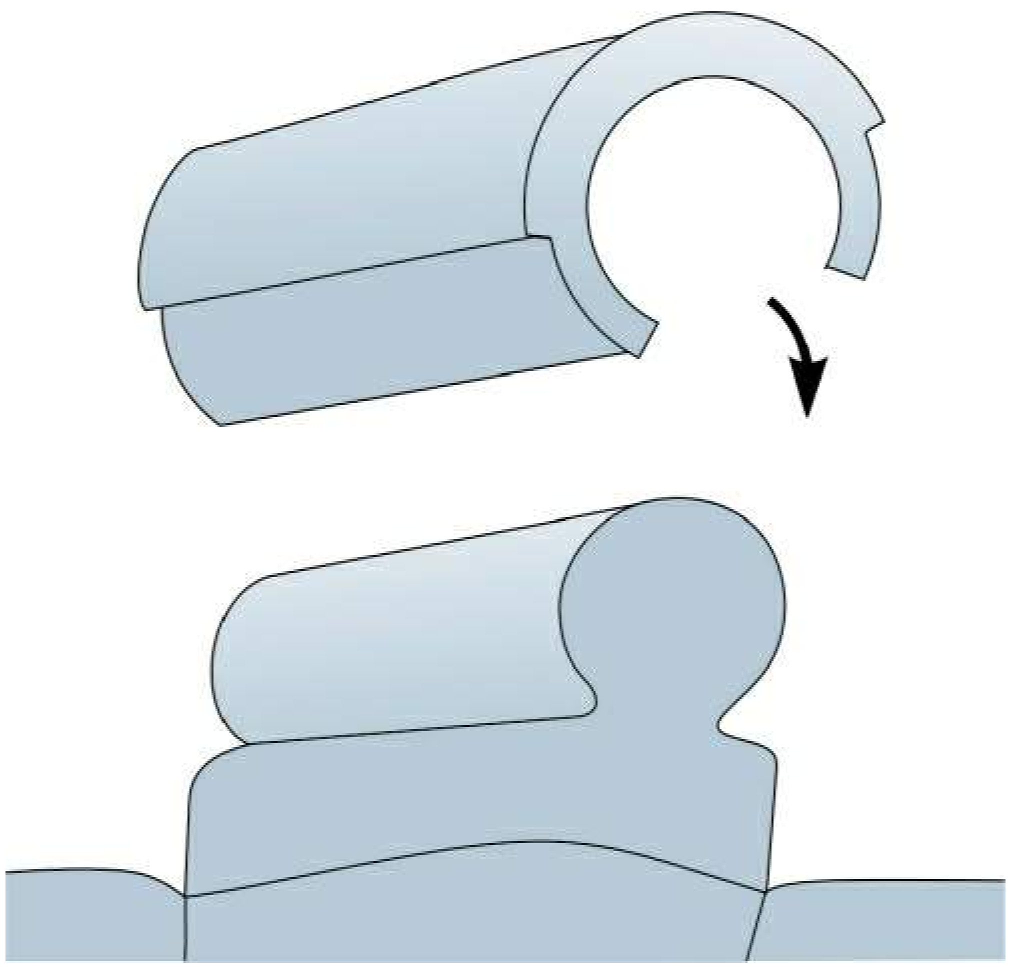


FIGURE 48.18 Hader bar.

Dolder bar

- The bar is straight with parallel sides and a round top. The sleeve or clip that fits over the bar gains retention by friction only. The bar may be of variable size and is pear-shaped at cross-section, similar to its accompanying sleeve. This clip allows for some measure of rotational movement about the bar (GPT8) (Fig. 48.19).
- Named after Eugene J. Dolder, a prosthodontist from Switzerland.
- It is available in diameters of 1.6 mm and 2.2 mm.
- Available as gold or titanium bars and sleeves.
- If more resiliency or movement is desired, a spacer is used between the bar and sleeve while attaching the sleeve to the denture. This is removed and the space provided allows more movement of the sleeve and denture.

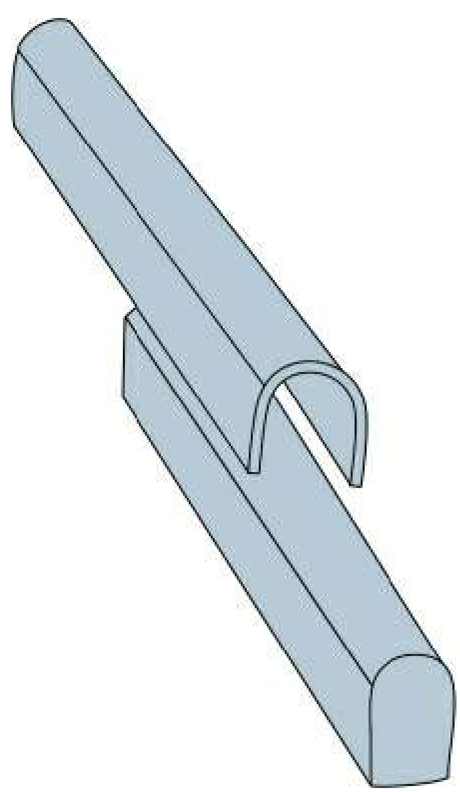


FIGURE 48.19 Dolder bar.

Ackermann and CM bar

- These bars are round at cross-section and hence are resilient (Fig. 48.20).
- Sleeves or clips are made up of gold.
- Available in 1.8 mm diameter, in plastic and gold.
- Spacer can be used if more movement is required.

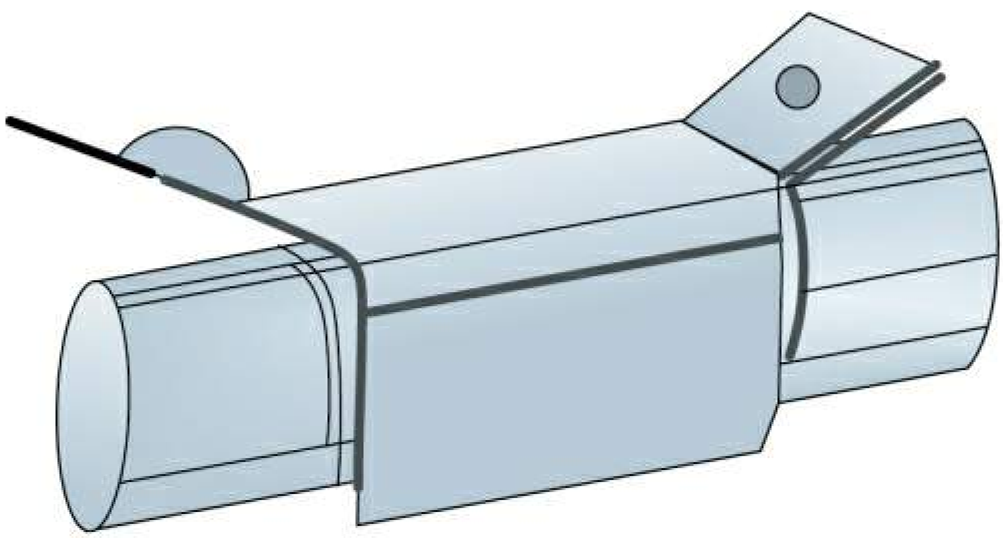


FIGURE 48.20 Round Ackermann bar.

Fabrication

If plastic patterns are used, they are attached to wax coping on the abutments and the entire assembly is cast as one unit and cemented. If metal bars are used, they are either soldered or welded depending on the metal, to the copings, and cemented. Following this the denture fabrication is commenced and the sleeves/clips are incorporated in the denture during processing or directly during insertion.

3. Magnetic attachment

- Magnetic attachments consist of (Fig. 48.21):

  ○ Keeper

  ○ Denture retention element

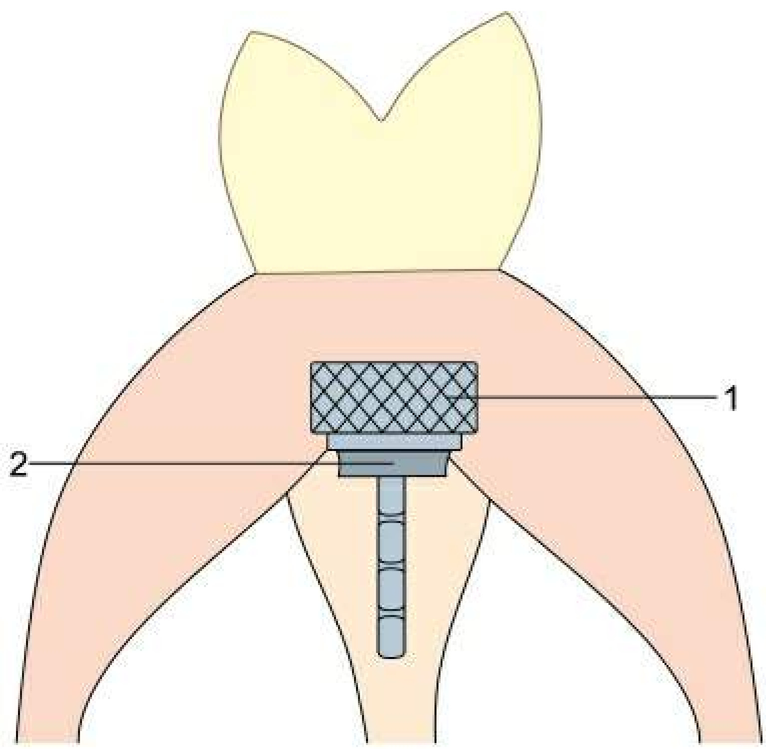


FIGURE 48.21 Parts of magnetic attachment. (1) Denture retention element – magnet and (2) keeper.

The keeper is made of stainless steel and is cemented to the abutment tooth (Fig. 48.22).

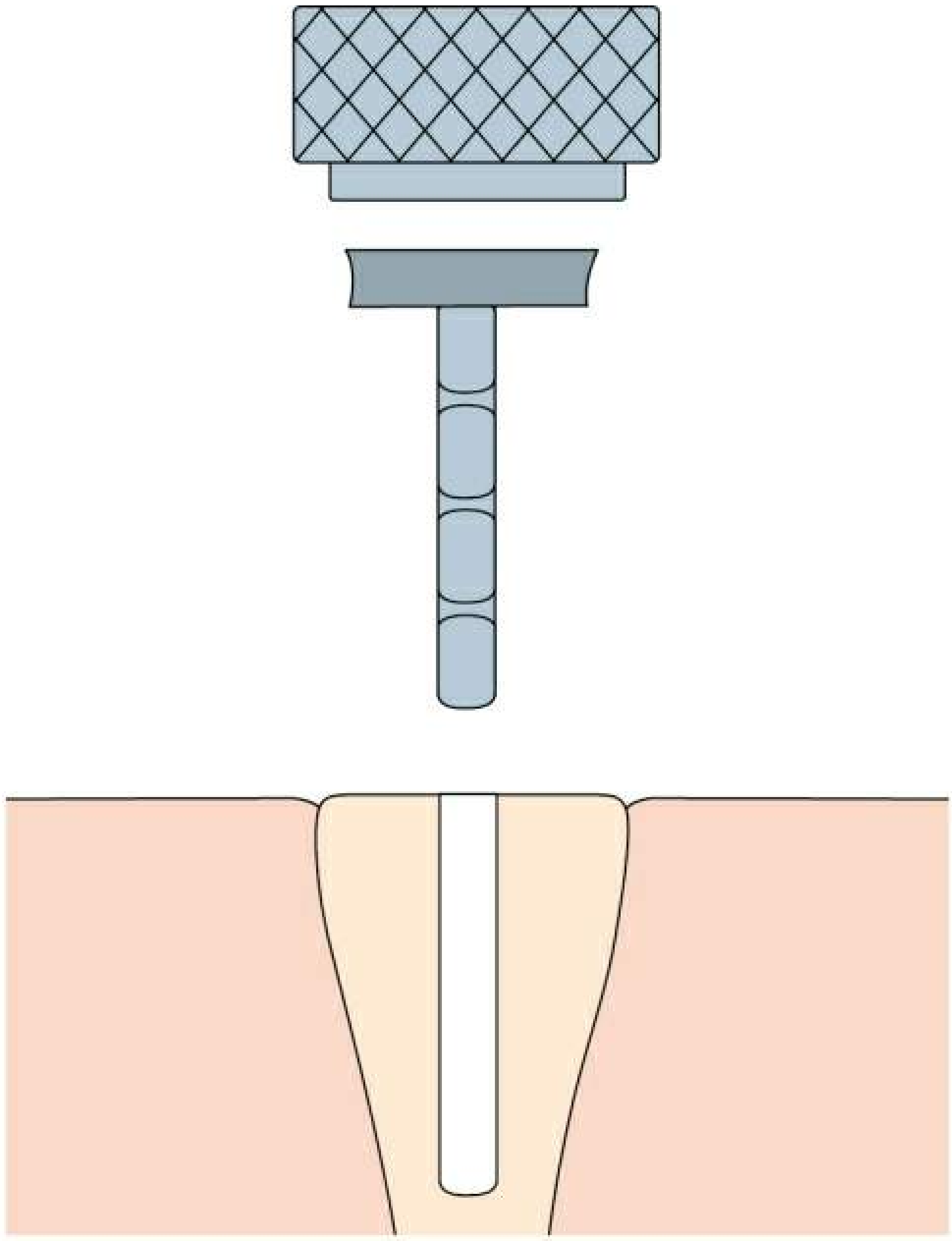


FIGURE 48.22 Keeper is cemented into root following endodontic treatment and creation of post space.

The denture retention element contains paired, cylindrical magnets made of cobalt–samarium with opposite poles placed adjacent. One end is covered with a knurled housing which fits into the denture and either end is smooth and fits on the keeper (Fig. 48. 23).

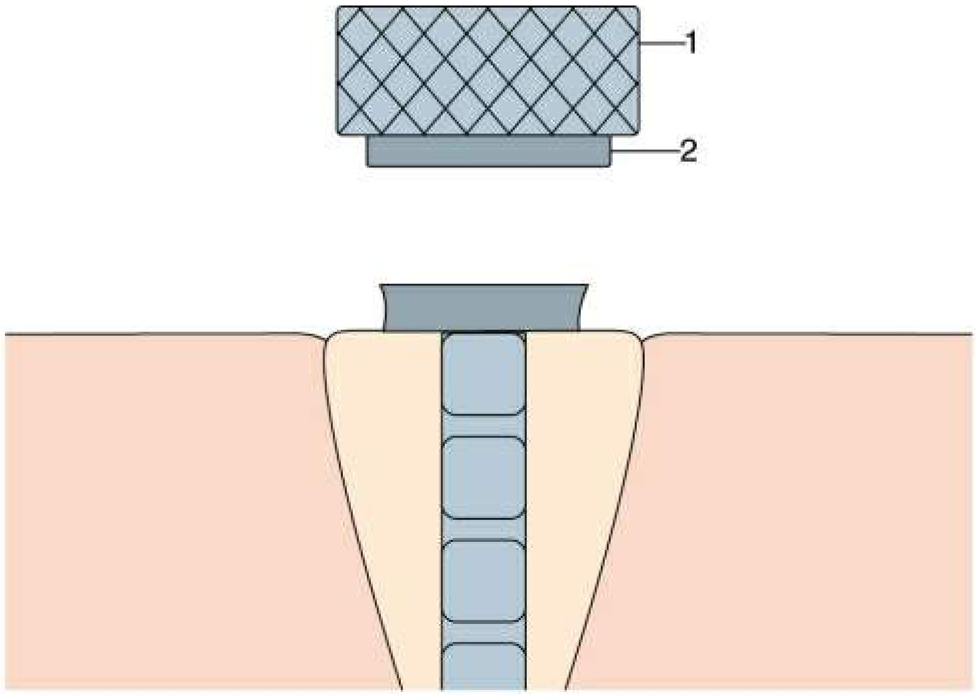


FIGURE 48.23 (1) Knurled housing of denture retention element is incorporated into denture while the (2) smooth extension provides magnetic retention by attaching to keeper.

Retention principle

- It is due to mutual attraction of unlike poles. During dislodging forces, the magnetic forces reseat the denture if the separation is within 3 mm. Therefore, minimal forces are transmitted to the root (Fig. 48.24).

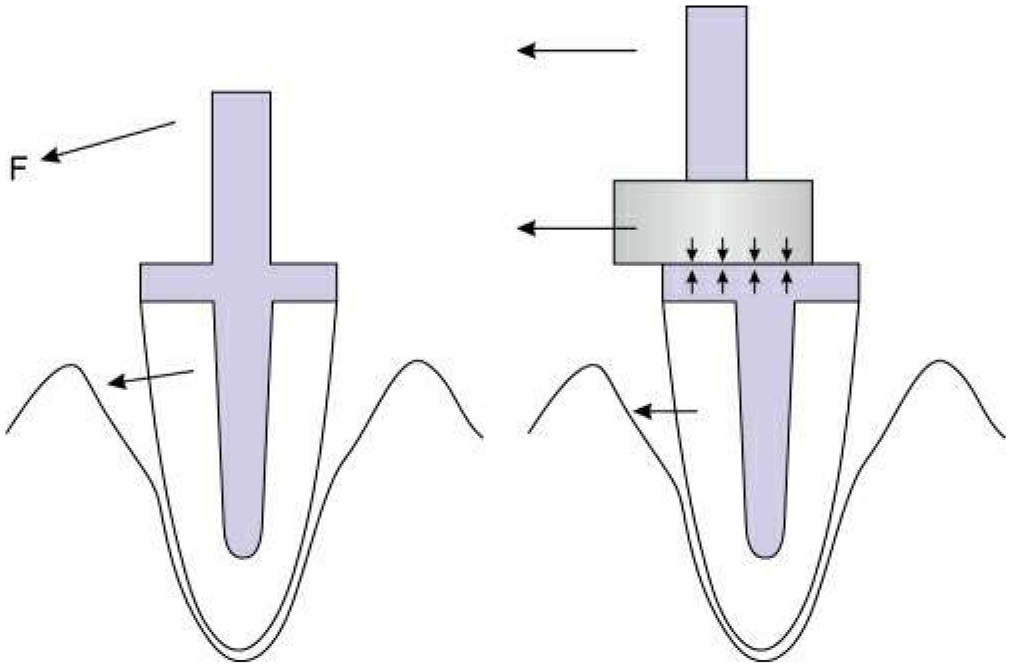


FIGURE 48.24 A lateral dislodging force on a rigid stud attachment (left) will transfer all load to the tooth. In a magnetic attachment (right) the sliding mechanism prevents transfer of stresses to abutment.

Advantages

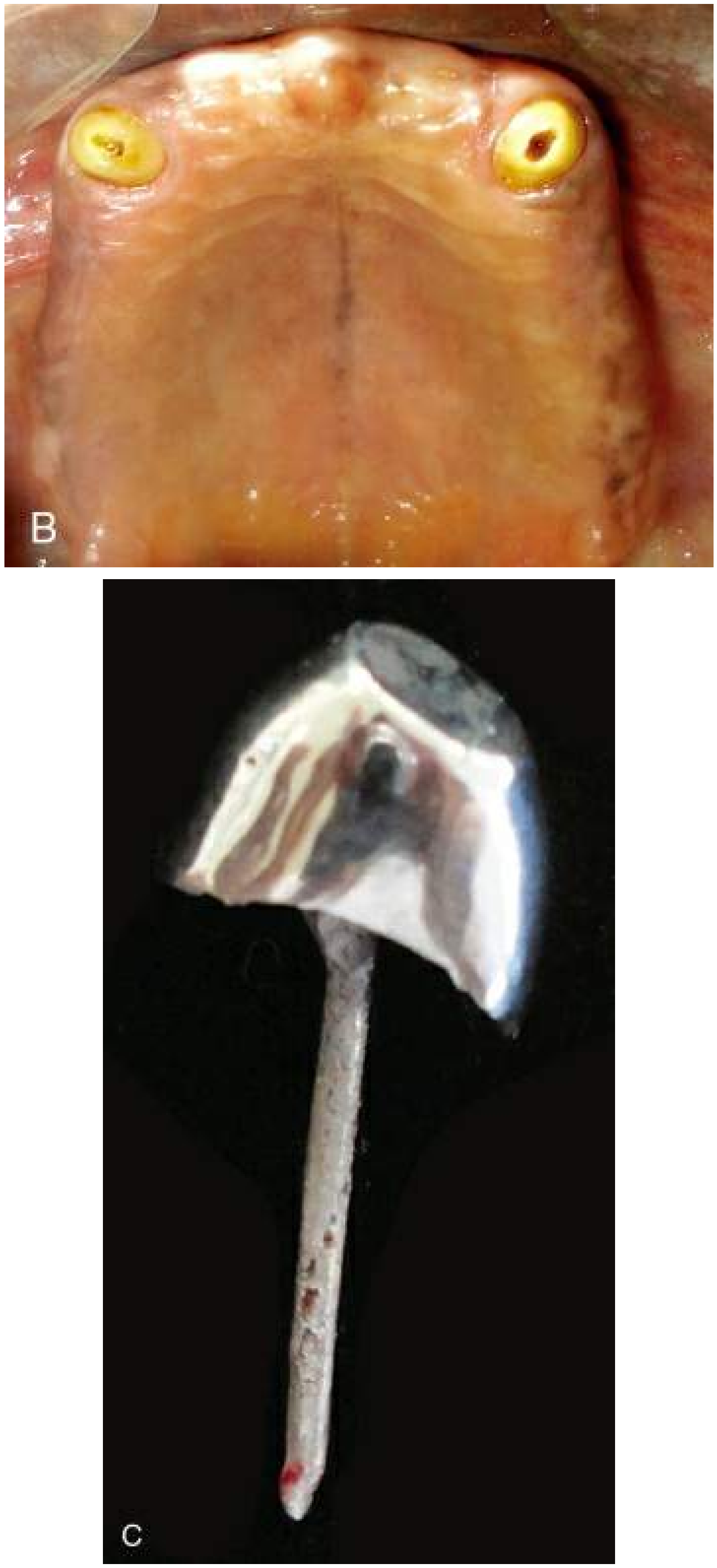
- No path of insertion.
- No specialized instrumentation.
- No paralleling of abutment.
- Automatic reseating.
- Ease of repair and reline.
- Freedom in lateral and rotational movements.
- Minimum forces transmitted to roots.

Disadvantages

- Smaller the root surface – decrease in retention.
- Alloy can corrode and fracture.
- Loss of magnetism is common with ensuing loss of retention – the elements need constant replacement.

Clinical procedure

The procedure involved in fabricating a magnetic overdenture is described in Fig. 48.25A–F.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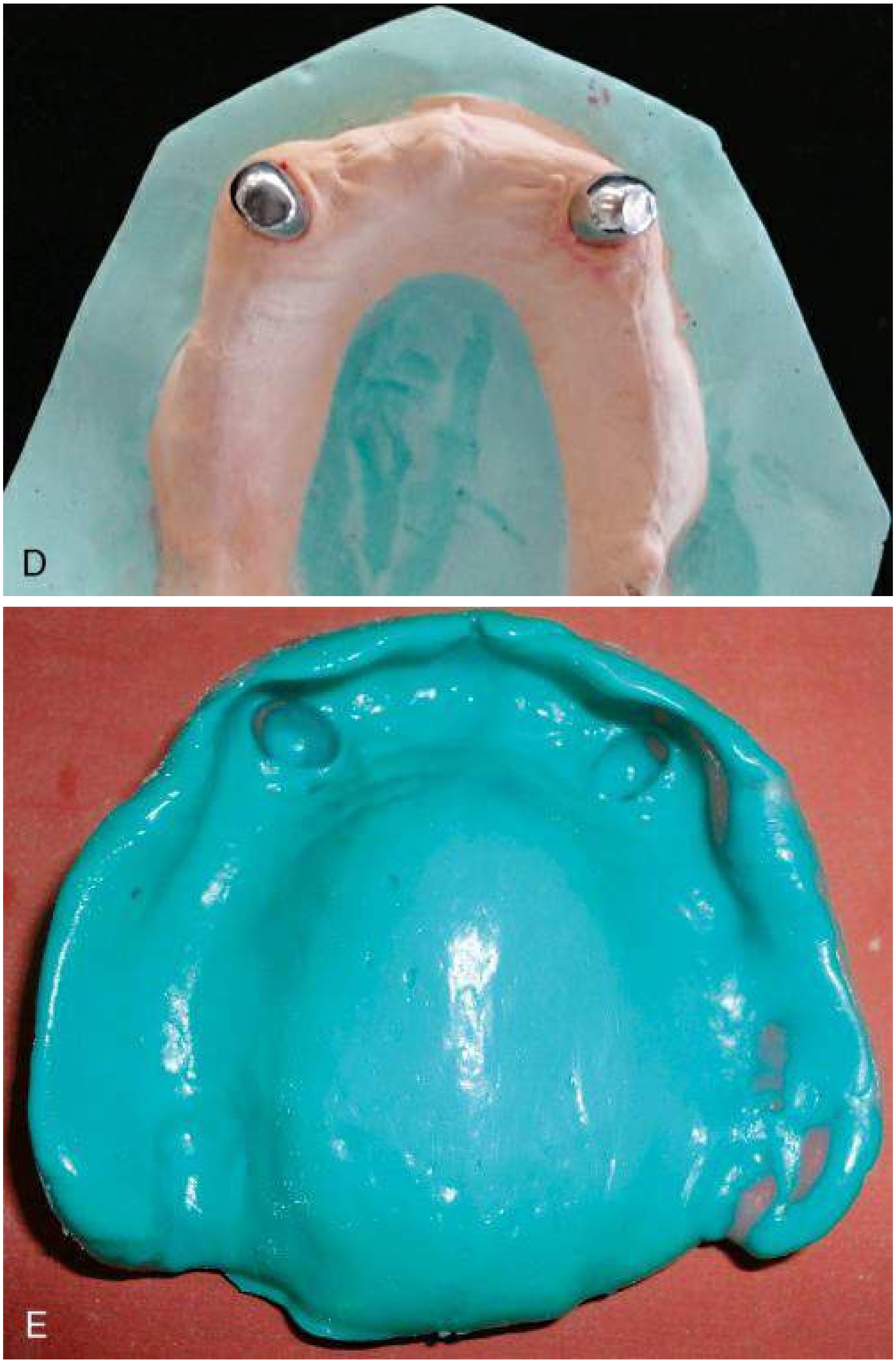
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FIGURE 48.25 **(A)** Abutments following endodontic treatment. **(B)** Post space created. **(C)** Coping is fabricated with the keeper. **(D)** Copings are fixed onto the abutment teeth. **(E)** Impression is made. **(F)** Denture retentive element – magnet is incorporated in denture.

Immediate overdentures

- Overdentures can also be provided immediately following the extraction of the remaining natural teeth (except those planned as abutments).
- The procedure is similar to conventional complete dentures, except that the abutment teeth need to be endodontically treated prior to the denture insertion appointment.
- The abutment teeth are reduced to the desired dimensions in the cast and immediate denture is fabricated.
- During insertion, the abutments are reduced and the denture is placed.
- Copings or attachments can be fixed following the healing during relining or remaking the denture depending on the method used for making the immediate denture (also see Chapter 17).

SUMMARY

Overdentures provide substantial benefit to the patient in terms of ridge preservation and retention. Patient should be educated regarding the provisional nature of the treatment and the inevitable need to progress to conventional complete dentures. Abutment selection is vitally important in success of this treatment modality, though cost is a deterrent, especially while using attachments.

CHAPTER 49

Oral Implantology

CHAPTER CONTENTS

Introduction

Modern oral implantology can be traced from the 1960s and it is now a predictable and successful treatment modality for edentulous situations. The implant is basically analogous to the root of a natural tooth which is surgically inserted into the alveolar bone followed by the fabrication of the prosthesis. This chapter will briefly discuss the current concepts, designs, components and treatment modalities with dental implants, along with its history and development.

Definition: Dental implant is a prosthetic device made up of alloplastic material(s) implanted into the oral tissues beneath the mucosal or/and periosteal layer, and on/or within the bone to provide retention and support for a fixed or removable dental prosthesis; a substance that is placed into or/and upon the jaw bone to support a fixed or removable dental prosthesis.

History and evolution

Ancient era (up to AD 1000)

Implantation of animal teeth and teeth carved out of ivory was performed on women in ancient Egyptian dynasties.

AD 600 – Mayans placed shells carved in tooth shape and precious stones in molar region.

Medieval period (1000–1799)

Transplantation of teeth was popular during this period. It lost its popularity during the beginning of nineteenth century due to transfer of diseases.

Foundation period (1800–1910)

1809 – Maggilio placed gold implant into freshly extracted socket. Others used porcelain, gutta-percha, platinum and lead as implants during this period.

1898 – Payne described implantation of a silver capsule.

Premodern era (1910–1930)

In 1913, Greenfield used a two-piece hollow basket fabrication (lattice cage) from 24 gauge iridium soldered with 24 karat gold.

Modern era (1935–1970)

- **1939** – Strock described a method of placing a screw type implant made of 'vitallium' (cobalt–chromium–molybdenum alloy) to provide anchorage for placement of missing tooth.

- **1940** – Formiggini designed a single helix wire spiral implant made of stainless steel or tantalum.

- **1943** – Gustav Dahl first suggested the construction of the **subperiosteal** type of implant.

- **1967** – Linkow introduced the **blade vent** implant.
- **1970** – Goteborg group in Sweden led by Branemark and Albrektsson presented the **Nobelpharma** implant – cylindrical root form implants made of titanium. The term and concept of 'osseointegration' was coined and described by Branemark. Research on it was into progress since 1950s.
- **1974** – Kawahara developed a cylindrical ceramic implant.
- **1978** – Kirsch developed the **'IMZ' implant** cylindrical implants. The surface was coated with titanium plasma spray which increased the surface area. An intramobile element was included in the abutment assembly to replicate the movement of the natural teeth.
- **1978** – ITI (International Team of Implantologists) developed the (titanium plasma sprayed screw) and titanium plasma sprayed hollow cylinder implants.
- **1982** – Niznick developed the **'core-vent'** cylindrical implants made of titanium.

Indications

1. Used for any tooth replacement – particularly useful for the following situations:

○ Single-tooth replacement – to avoid preparation of sound teeth.

○ Distal extension bases.

○ Completely edentulous state.

○ Long edentulous spans.

2. When a fixed partial denture is compromised due to:

○ Weak abutments.

○ Long edentulous span.

○ Cantilevers.

○ Unfavourable number and location of abutments.

3. When a conventional complete denture may be compromised due to:

○ Poor muscular coordination.

○ Low tolerance of mucosal tissues.

○ Compromised denture supporting areas.

○ Parafunctional habits that compromise prostheses stability.

○ Unrealistic prosthodontics expectations.

○ Hyperactive gag reflex.

○ Patient's requirement for fixed prostheses or psychological inability of patient to wear a removable prosthesis.

Contraindications

Absolute contraindications

- High dose irradiated patients.
- Haematologic systemic disorders.
- Patients with psychiatric problems such as psychosis and dysmorphophobia.
- Medically compromised individuals where surgery is contraindicated.

Relative contraindications

- Low dose irradiated patients.
- Diabetes.
- Smoking, alcohol and drug abuse.
- Children up to 18 years (until the jaw bones have stopped growing).
- Pregnancy.

Advantages of implant-supported prosthesis

Advantages of implant-supported prosthesis over conventional removable complete dentures are

1. **Preservation of bone:** The placement of an implant will ensure that the bone level is maintained in that region.

2. **Teeth can be positioned for aesthetics:** With an implant, the teeth

may be positioned where the natural existed rather than in the neutral zones for stability as dictated by traditional dentures.

3. **Maintenance of vertical dimension:** In patients with conventional complete dentures, the loss of vertical dimension decreases due to wear and bone resorption. Implant dentures can maintain the vertical dimension, as bone resorption is minimal.

4. **Occlusion:** Easier to establish proper occlusion and occlusal loads can be directed better.

5. **Improved mastication:** Enhanced bite force and masticatory efficiency.

6. Increased stability and retention.

7. Reduced size of the prostheses.

8. Enhanced success rate of prostheses.

Disadvantages

1. Expensive.

2. Prolonged treatment duration.

3. Involves surgical procedure.

Classification

Dental implants are classified into the following categories:

I. Based on their location as:

1. Endosteal

i. Spiral

ii. Tripod

iii. Plates

iv. Blades

v. Endodontic

vi. Root forms

a. Depending on shape:

□ Cylinders – threaded, nonthreaded

□ Tapered cylinders – threaded, nonthreaded

b. Depending on connection to abutment:

□ One (single)-piece implants

□ Two-piece implants

2. Transosteal

▪ Staple bone plates

3. Eposteal

▪ Subperiosteal – complete/unilateral

4. Mucosal

▪ Intramucosal inserts

II. Depending on exposure during surgery:

1. Submerged (two-stage surgery)

2. Nonsubmerged (one-stage surgery).

Based on location

Based on their location dental implants can be classified into the following categories.

Endosteal dental implants

Definition: A device placed into the alveolar and/or basal bone of the mandible or maxilla and transecting only one cortical plate (GPT8).

Spiral and tripod implants

These are part of history and are no longer used. They are named after their shape which is self-explanatory.

Blade dental implants

A faciolingual narrowed, wedge-shaped dental implant body with openings or vents through which tissue may grow (GPT8).

The blades and plates are similar and used with narrow ridges (Figs 49.1 and 49.2). They are made of titanium and are available in buccolingual widths of 1.2 mm.

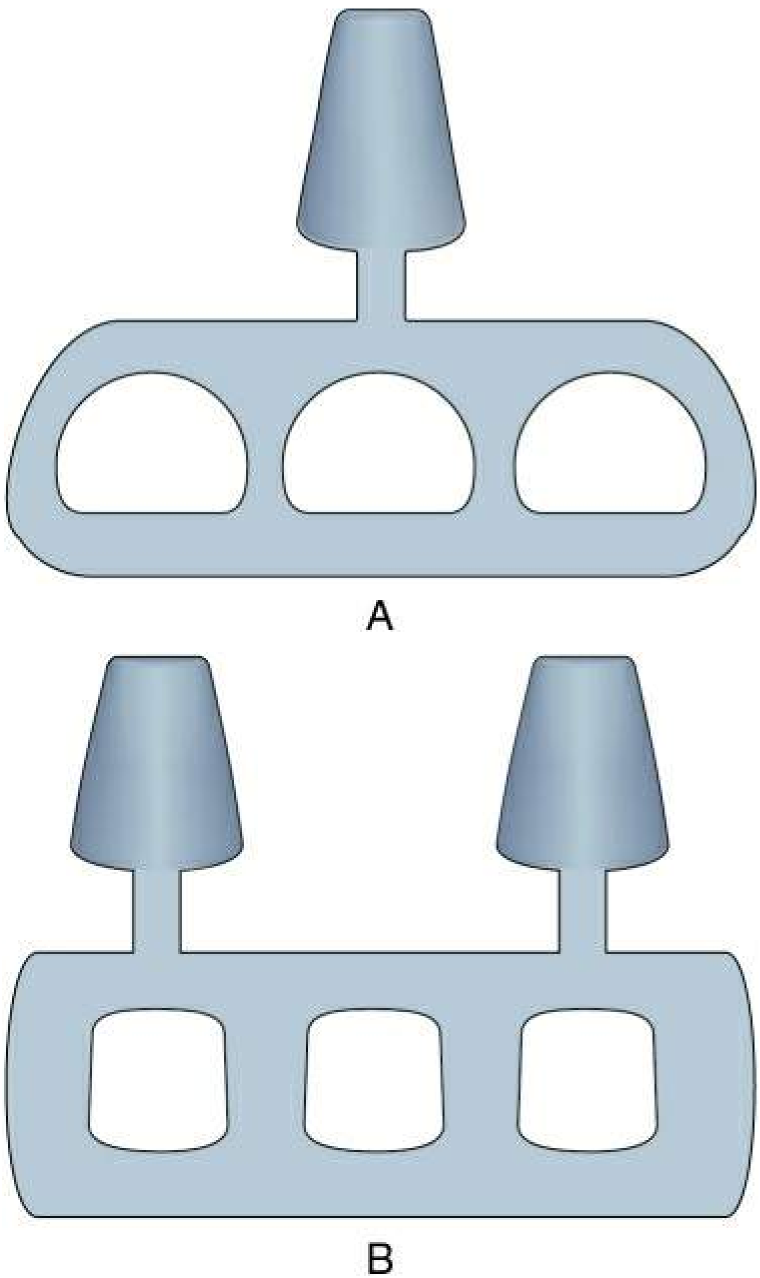


FIGURE 49.1 Blade implants **(A)** With single abutment **(B)** With 2 abutments.

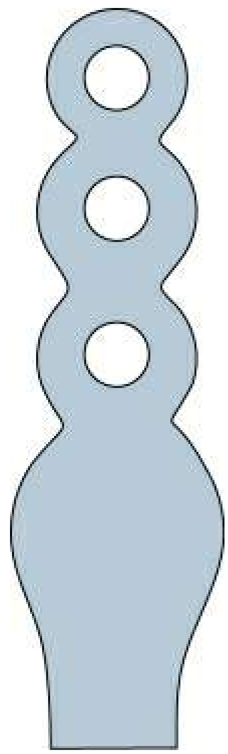


FIGURE 49.2 Plate implants.

Endodontic dental implant

A smooth and/or threaded pin implant that extends through the root canal of a tooth into periapical bone and is used to stabilize a mobile tooth, sometimes called an endodontic stabilizer (Fig. 49.3) (GPT8).

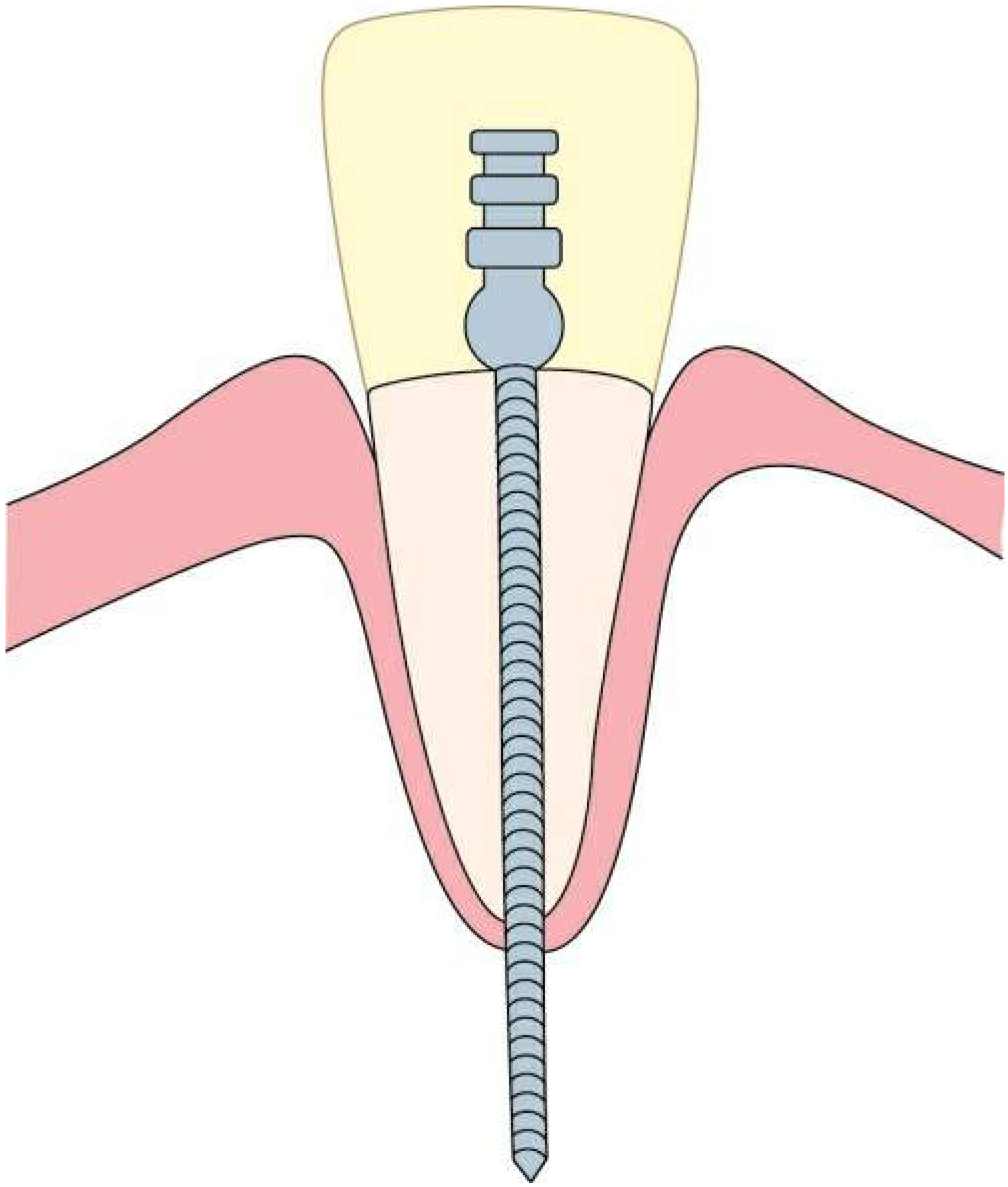


FIGURE 49.3 Endodontic stabilizer.

Root forms

Currently, these are the most popular and commonly used implants. They are made of titanium, though other materials have also been used.

They can be classified according to:

1. According to shape:

○ Cylinders

○ Tapered cylinders

2. According to presence of threads:

○ Threaded

○ Nonthreaded

3. According to abutment connection:

○ One piece

○ Two piece

▪ External connections

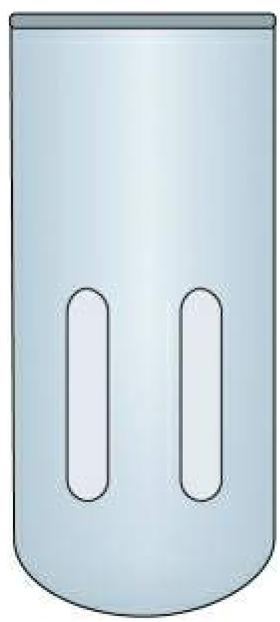
▪ Internal connections

○ They can be shaped like cylinders or tapered cylinders (Fig. 49.4A and B).

○ When the surface is threaded, they are then termed as 'screws' (Fig. 49.5A and B).

○ The surface can also contain vents, slots, dimples and coatings to enhance surface area and bonding to bone (Figs 49.6–49.8).

- ○ When the fixture and abutment are joined together they are termed as one-piece implants (Fig. 49.9).
- ○ When the fixture and abutment are separable, they are termed as two-piece implants (Fig. 49.10).
- ○ Two-piece implants are further classified depending on whether the connection to the abutment is within the implant or outside as – external connections (Fig. 49.11A) or internal connections (Fig. 49.11B).



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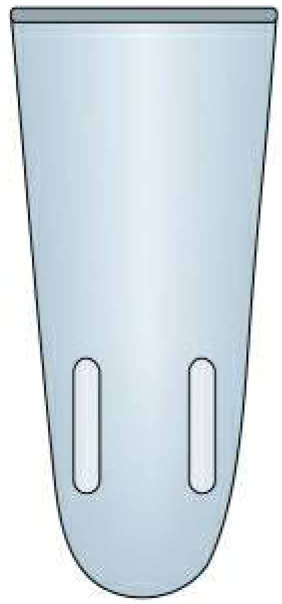

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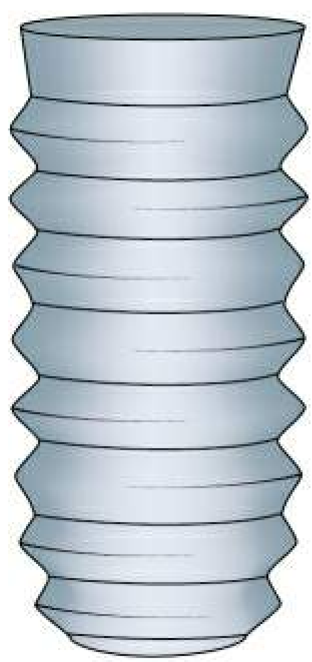
FIGURE 49.4 **(A)** Cylinder implant. **(B)** Tapered implant.



A

B

FIGURE 49.5 **(A)** Threaded implant. **(B)** Nonthreaded implant.

FIGURE 49.6 Vents.

FIGURE 49.7 Slots.

FIGURE 49.8 Surface coated implant (right).

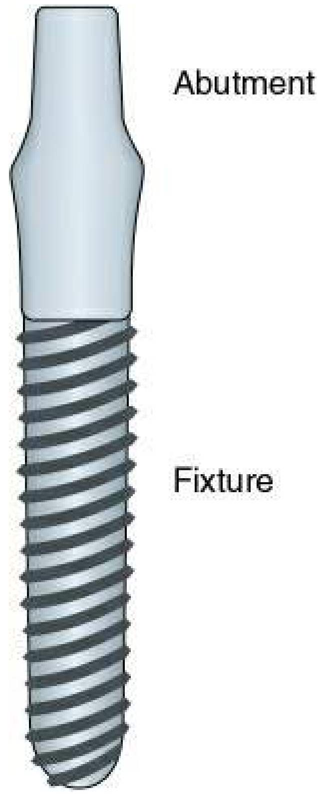


FIGURE 49.9 One-piece implant where the fixture and abutment are not separable.

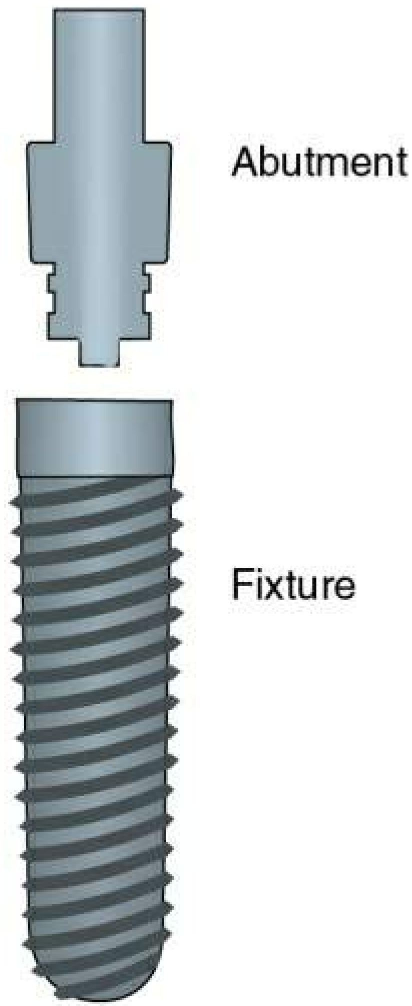


FIGURE 49.10 Two-piece implant where the abutment and fixture are separable.

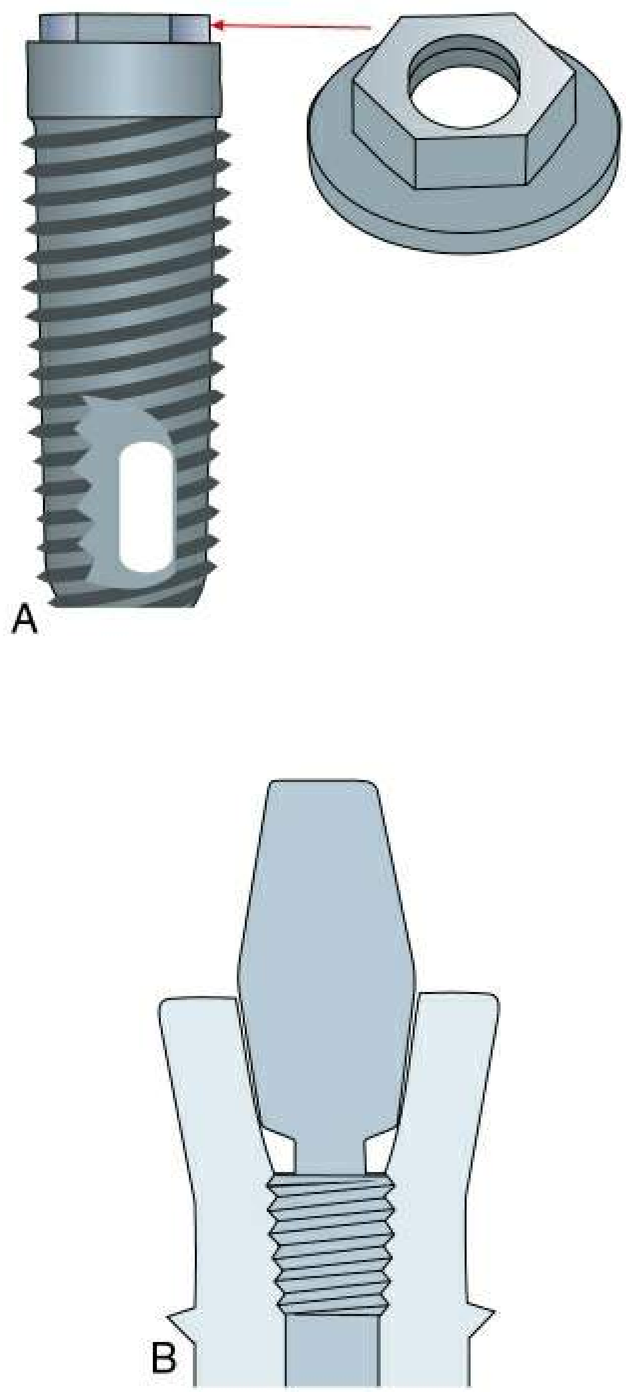


FIGURE 49.11 **(A)** External connection – the connection of fixture to the abutment is located outside the implant body. **(B)** Internal connection – connection of fixture to the abutment is located within the implant body.

Transosteal dental implants

Definition: A dental implant that penetrates both cortical plates and passes through the full thickness of the alveolar bone (GPT8).

It is also called staple bone implant, mandibular staple implant, transmandibular implant. It is normally used to support an overdenture. It is not widely used because of the possible damage to the infrabony soft tissue structures like the nerves and the vessels (Fig. 49.12).

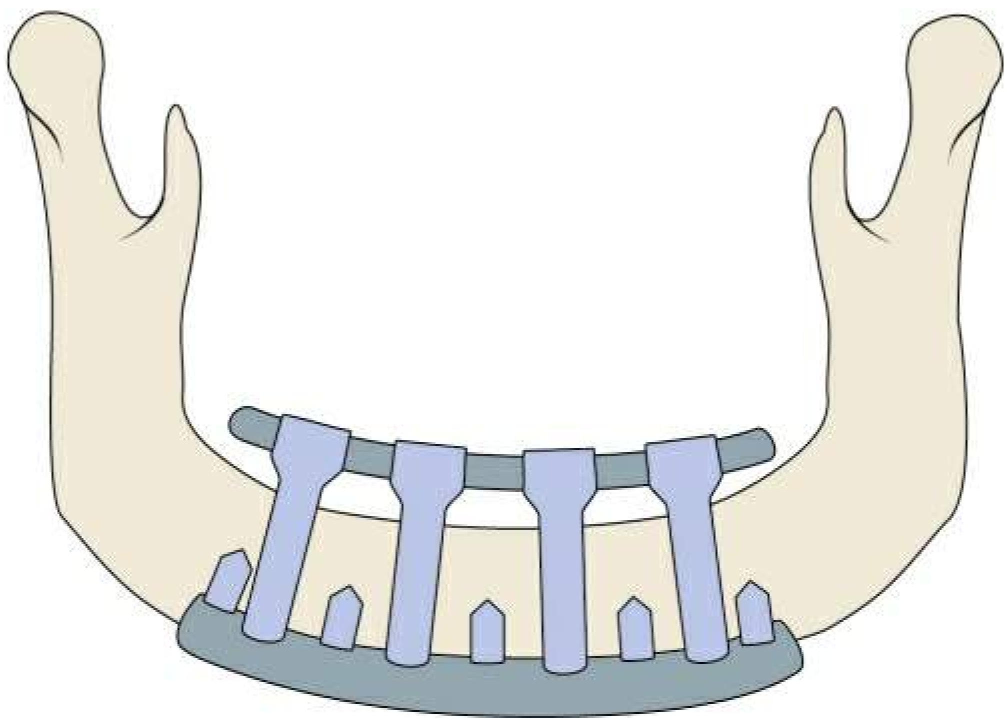


FIGURE 49.12 Transosteal implant.

Eposteal dental implant (subperiosteal)

Definition: A dental implant that receives its primary support by means of resting upon the bone (GPT8).

The subperiosteal implant (Fig. 49.13) is an example of an eposteal implant.

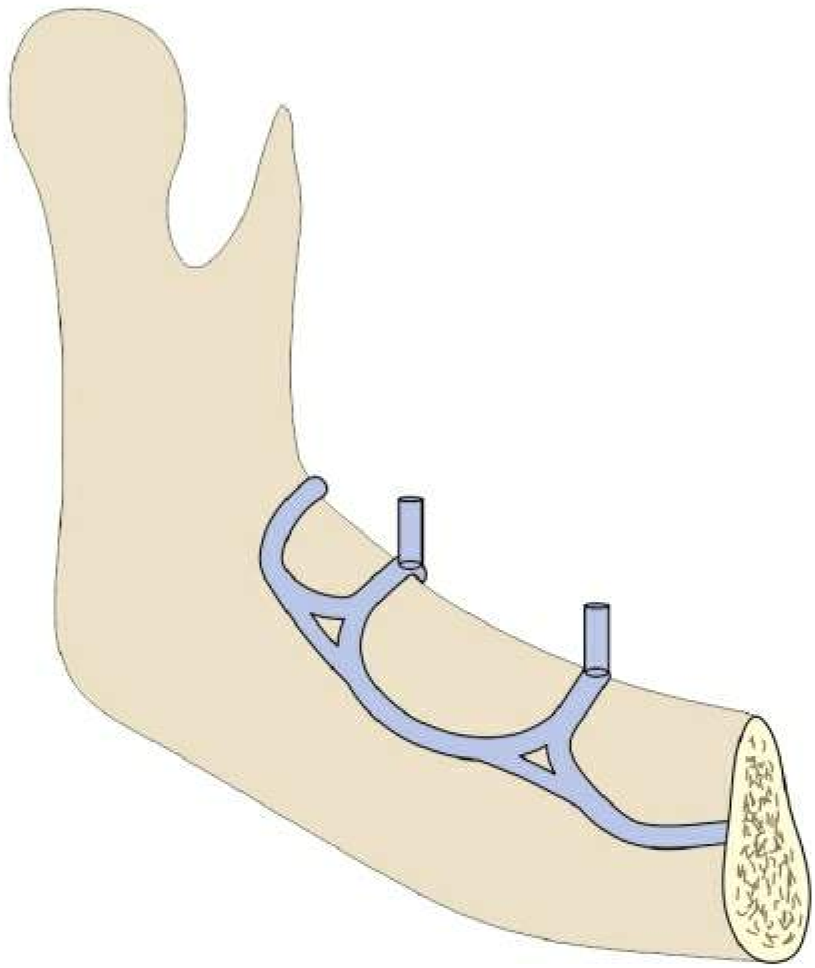


FIGURE 49.13 Subperiosteal implant.

Subperiosteal implant: An eposteal dental implant that is placed beneath the periosteum while overlying the bony cortex – first attributed to Swedish dentist, G.S. Dahl (GPT8).

The implant body lies over the bony ridge. It is made similar to a cast-partial denture frame. An impression is made of the bone after elevating a flap and the frame is fabricated. The frame is made with abutments projecting and this is then fitted on the bone following a second surgery.

When the subperiosteal implant supports a partial denture it is termed as unilateral subperiosteal implant, and when it supports a complete denture, it is termed as complete subperiosteal implant.

Mucosal

Any metal form attached to the tissue surface of a removable dental prosthesis that mechanically engages undercuts in a surgically prepared mucosal site – called also button implant, intramucosal insert, mucosal implant (GPT8).

Also termed as subdermal implants (Fig. 49.14).

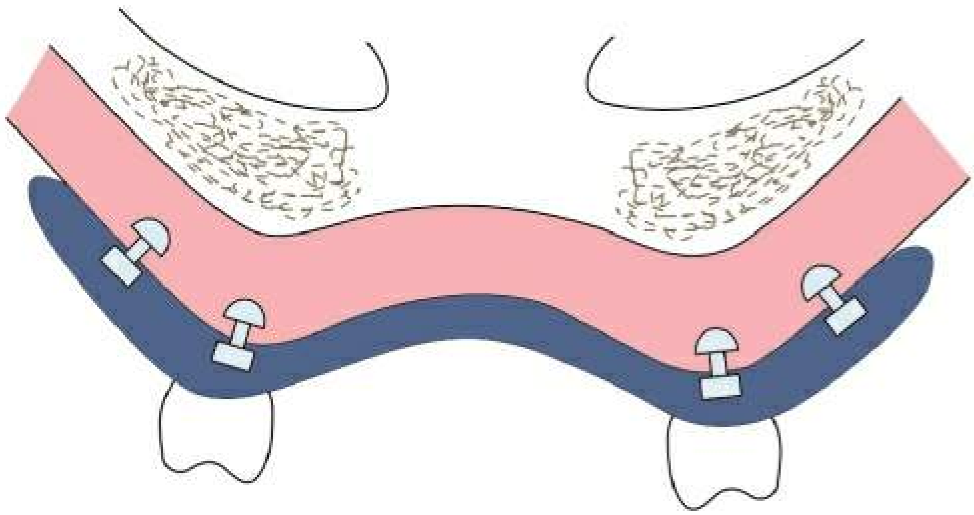


FIGURE 49.14 Mucosal insert – attached to denture base and mucosa (multiple inserts are utilized).

Based on exposure during surgery

Depending on the exposure during surgery, dental implants are of two types:

- Submerged (two-stage surgery)
- Nonsubmerged (one-stage surgery)

Submerged implants are not exposed to the oral cavity following the first surgery to place the implant. A second surgery is performed to expose them and proceed with impression making. Hence, they are termed as two-stage implants (Fig. 49.15A and B).

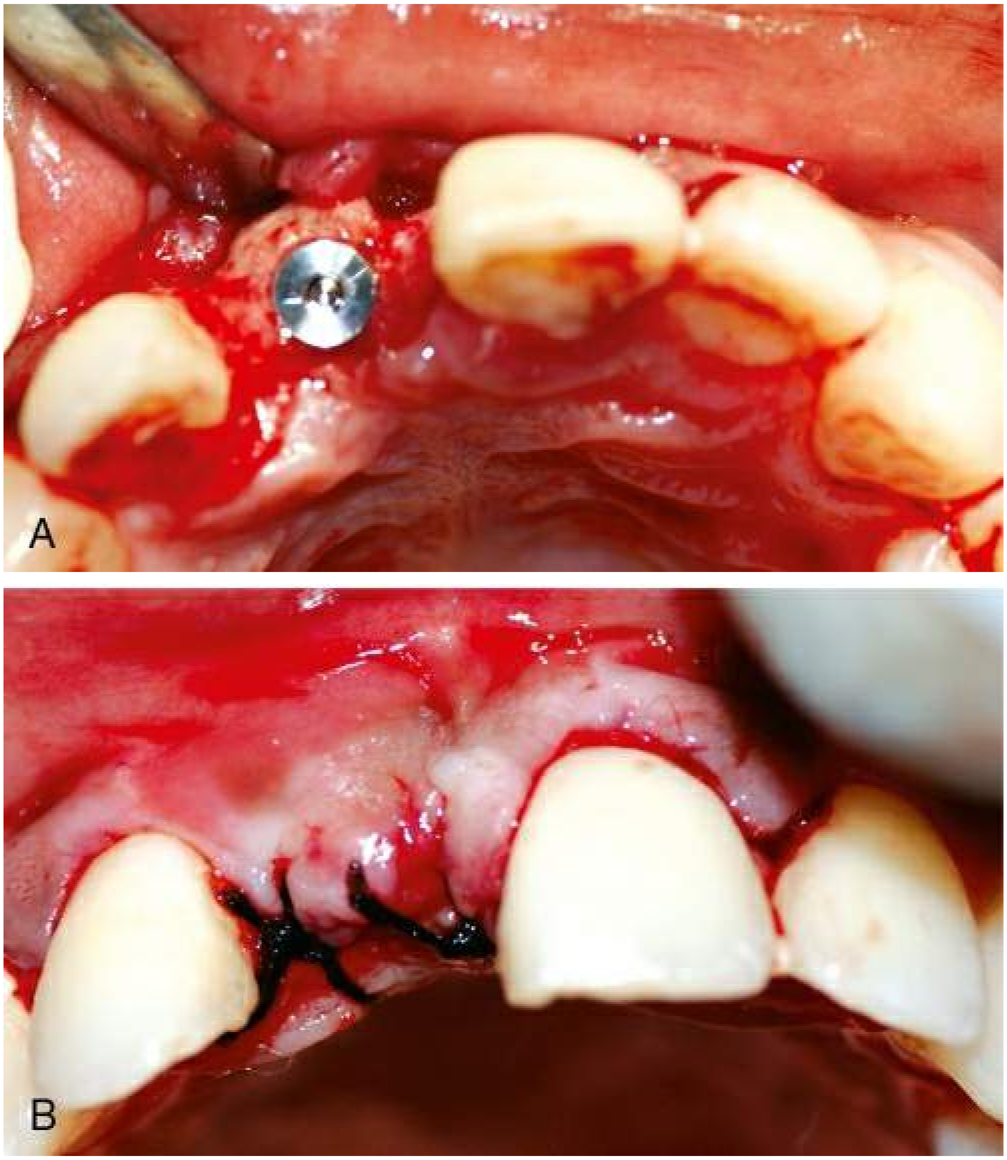


FIGURE 49.15 **(A)** Submerged implants – implant placed along with cover screw. **(B)** Flap sutured over the implant so that they are not exposed after the surgery.

Nonsubmerged implants are left exposed after the first surgery, so a second surgery is avoided. Hence, they are called one-stage/single-stage implants (Fig. 49.16).

FIGURE 49.16 Nonsubmerged implants. Top of implant (cover screw) left exposed after the implant placement surgery.

Implant-bone integration

Two mechanisms have been put forth for the attachment of implant to bone.

Fibro-osseous integration

Definition: Tissue to implant contact with interposition of healthy, dense collagenous tissue between implant and bone (American Academy of Implant Dentistry [AAID], Glossary of Terms [1986]).

This theory was put forth by Weiss, who proposed the presence of collagen fibres at the bone-implant interface. He interpreted it as peri-implant membrane with osteogenic effect.

This fibrous integration was stated to be similar to periodontal ligament around natural teeth. The theory was more suited for blades, plates and subperiosteal implants, but for root form of implants, any evidence of fibrous tissue around the implant, is now deemed as implant failure. Hence, this mechanism is not anymore associated with contemporary root form of implants.

Osseointegration (osseous integration)

Definition: The apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening connective tissue (GPT8).

- The word osseointegration consists of 'os', which is the Latin word for bone and 'integration' derived from Latin meaning the state of being combined into a whole.

- The concept was developed and the term was coined by Dr Per-Ingvar Branemark (1972). He discovered a direct strong bone anchorage of titanium chamber he was using while studying microcirculation in bone repair mechanisms. The titanium chamber was surgically inserted into the tibia of a rabbit.

• This is now proven to be the mechanism of attachment of implants to bone (Fig. 49.17). It is similar to ankylosis; there is no intervening connective tissue (periodontal ligament) unlike natural teeth.

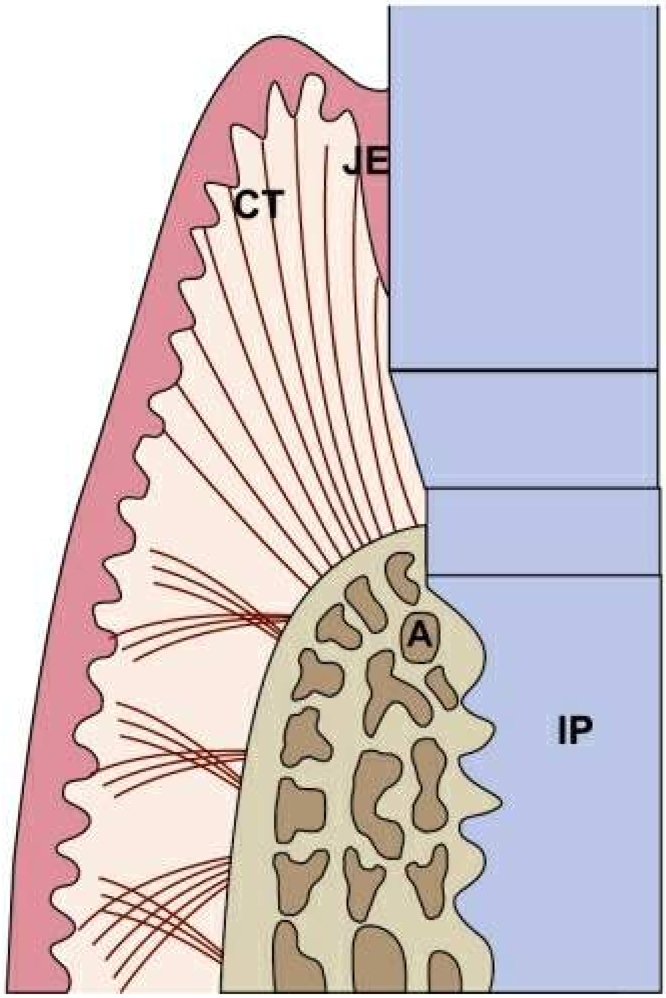


FIGURE 49.17 Histology of implant-supported region. IP, implant; CT, connective tissues; JE, junctional epithelium; A, alveolar bone.

Key factors in osseointegration

Branemark suggested that the following were essential for an implant to osseointegrate:

1. Implant material

Titanium is the material of choice. Branemark fixtures were made of commercially pure titanium. When the fixture comes into contact with atmosphere, an oxide layer, 50–100 Å thick, immediately forms. When fixture has properly healed in bone, a glycoprotein layer, then a calcified layer approximately 100 Ǻ thick, surrounds the oxide layer. Prior to insertion of fixture into bone the surface of titanium fixture must be kept sterile and contact with any other material should be strictly avoided.

2. Implant design

Root form implants are advocated.

3. Surface area

Osseointegration depends on surface area of implant. The surface area can be increased by using wider diameters, threading the surface and/or roughening the surface.

4. Implant site

Precision fit in vital bone is essential – this prevents soft tissue proliferation which would occur if a gap was present and helps stabilizing the implant in poor bone density situations. This precise fit of implant in bone without any observed movement is termed as *primary stability.*

5. Implant surgery

Prevention of excessive heat during bone drilling procedures is essential for osseointegration. Bone should not be heated beyond 43°C to maintain vitality and ideally it should not exceed 39°C. This is achieved by the following:

- Low drilling speeds below 2000 rpm, with minimal trauma.
- Use of coolant while drilling.
- Using sharp drills and widening the site gradually.

- Inserting the implant into bone at very low speeds (15–20 rpm).

6. Asepsis

Strict infection control measures should be adopted during surgery. The site should also be free of infection.

7. Loading

Maintaining fixtures in the bone without occlusal forces or load for 3–4 months with mandibular implants (better bone quality or density) and 6 months for maxilla. The restoration is commenced only after this period. Bone healing begins within the first week after insertion of fixtures and reaches a peak at the 3rd and 4th weeks. It gradually becomes bony tissue after 6–8 weeks.

Soft tissue interface

This is similar to gingiva around natural dentition:

- Junctional epithelium surrounds the abutment surface at the crevice and connective tissue adapts to abutment surface beneath.

- Sulcular epithelium consists of keratinized epithelial cells (Fig. 49.17).

Criteria for successful osseointegration

Albrektsson, Zarb, Worthington and Eriksson (1986) proposed following standards:

- That an individual, unattached implant is immobile when tested clinically.

- That a radiograph does not demonstrate an evidence of peri-implant radiolucency.

- That vertical bone loss should be less than 0.2 mm annually following the first year of service of implant.

- That individual implant performance should be characterized by an absence of persistent and/or irreversible signs and symptoms such as pain, infections, neuropathies, paraesthesia or violation of mandibular canal.

- A success rate of 85% at the end of a 5-year observation period and 80% at the end of a 10-year period.

Biointegration

Putter (1985) differentiated biointegration from osseointegration. He stated that biointegration was achieved by coating the implant surface with bioactive materials such as hydroxyapatite, which bond to bone, using plasma spraying and ion-sputtering techniques. Osseointegration involved contact of metallic surfaces (titanium) with bone. He described osseointegration as a mechanical retention of implant to bone as opposed to bioactive retention obtained with hydroxyapatite coating.

As root form implants are most popular and commonly used contemporarily, they will be discussed in detail.

Component parts of implant restoration

Implant components can be categorized as:

1. Main component

   i. Fixture

   ii. Abutment

   iii. Superstructure

2. Accessories

   i. Surgical

   ▪ Cover screw

   ▪ Gingival former

   ii. Prosthetic

   ▪ Implant analogue

   ▪ Impression post

Main components (fig. 49.18)

Implant fixture

The implant fixture is the component that is surgically placed into the bone. It is also termed as 'implant body'. The fixture can be divided into the following parts (Fig. 49.19):

1. Body

2. Crest module

3. Collar

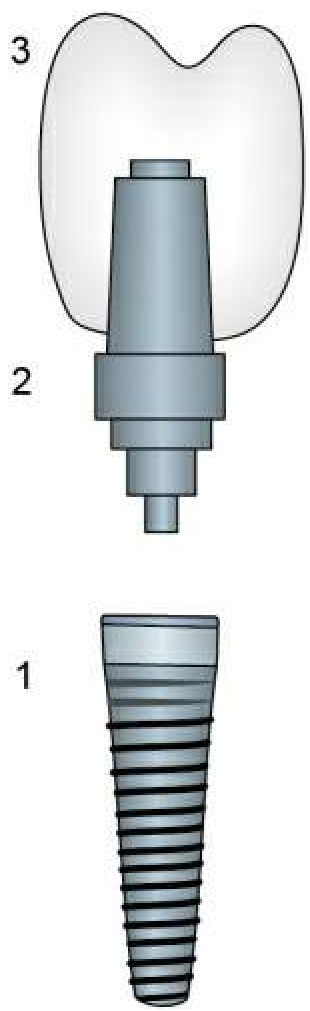


FIGURE 49.18 Main components. (1) Implant fixture, (2) abutment, (3) superstructure.

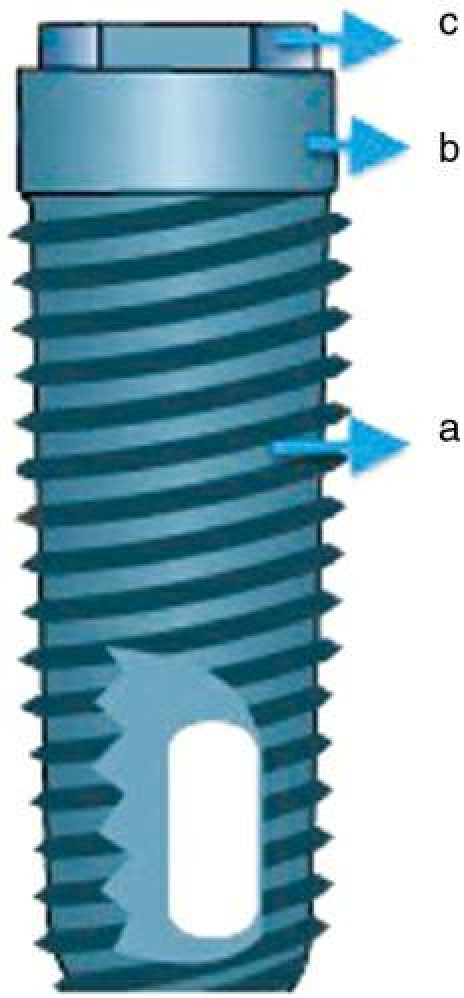


FIGURE 49.19 Parts of implant fixture. (a) Body, (b) collar, (c) crest module.

Body

The body of the root form implant can be cylindrical or tapered cylindrical, with a smooth or threaded surface (implant screws). The implant body can also be solid or contain holes or vents to allow bone to grow through. The threaded implant is suitable for placement in dense cortical and fine trabecular bone. It can be easily removed during surgery, if needed. Threads maximize initial contact with bone, enhance surface area and facilitate dissipation of stresses. They are tapped (screwed into bone) using ratchet or handpiece.

The functional surface area of a thread is dependent on:

- **Thread pitch** – distance between the threads (Fig. 49.20).
- **Thread shape** – 'V'-shaped, square and buttress (Fig. 49.21A–C).
- **Thread depth** – distance between the most outside thread and most inside thread (Fig. 49.20).

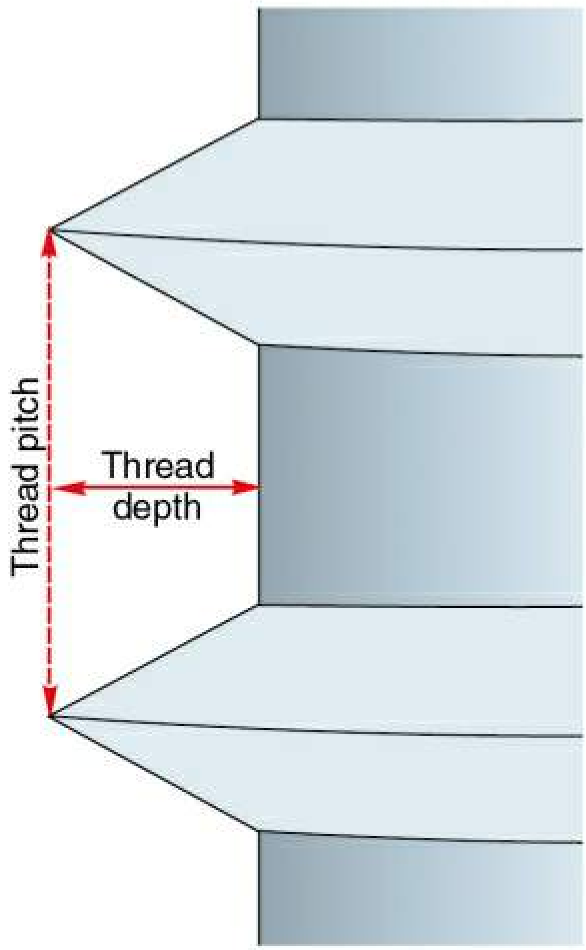
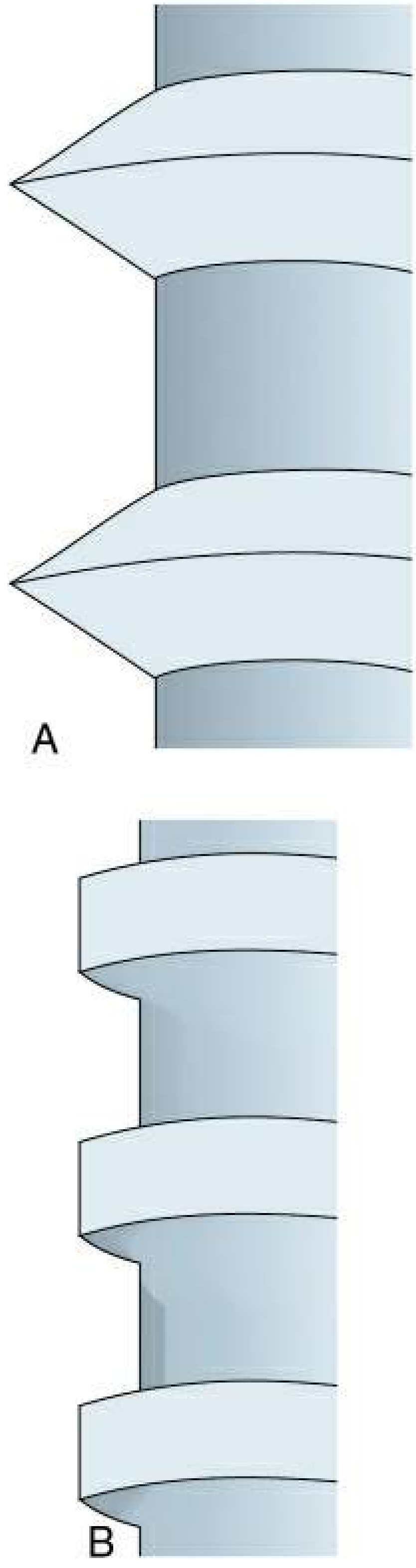


FIGURE 49.20 Thread depth and thread pitch.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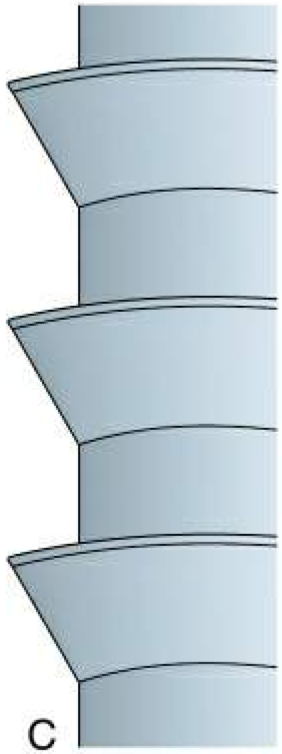


C

FIGURE 49.21 **(A)** 'V'-shaped thread. **(B)** Square shaped thread. **(C)** Buttress shaped thread.

Smaller the pitch, there will be more threads/unit length and greater is surface area. The square thread produces the least stress (shear) on the implant. Greater the thread depth, greater is the surface area.

Smooth-sided implants are easier to place even in areas difficult to access, like posterior maxilla, as they can just be pressed into bone – a threaded implant would require a ratchet or handpiece for placement. For the same reason, smooth implants are easier to place in single-tooth implant cases when crown height of the adjacent teeth is large.

Surface treatment: The surface of any implant type can be roughened using porous coatings or blasting with various materials and acid etching. Commonly used surface treatments are titanium plasma spray (TPS) and hydroxyapatite (HA) coatings and SLA surface. Cost, increased chances of flaking and bacterial accumulation are some disadvantages of coatings.

SLA (Sandblasting-large grit-acid etching) surface is produced by sandblasting with large-grit corundum particles followed by acid etching with a mixture of HCl/H_2SO4 at elevated temperature for several minutes.

Advantages of surface treatments are

- Increased surface area.
- Increased roughness for primary stability.
- Stronger bone-implant interface.

Crest module

This is the portion of the fixture that provides a connection to the abutment or attachment. It offers resistance to axial occlusal loads and aims to provide a precise fitting of abutment on the fixture with minimal tolerance. It consists of a platform and antirotation features.

The platform contains a connection to the abutment that is either present above or below the crestal bone level. If present above, it is termed as external connection and if present below, it is termed as internal connection. The antirotation feature in an external connection implant is usually a hexagon (Fig. 49.11A). A variety of antirotation features have been incorporated in the internal connection implant systems like hexagon, octagon, morse taper, grooves, etc. (Fig. 49.22).

FIGURE 49.22 Internal connections – hex is shown.

External connections

This type of connection is advantageous in restoring multiple implants where a passive fit is essential. Screw loosening is a common problem along with difficulty in assessing abutment seating radiographically. There is a documented 4–6° rotational wobble and 3–5° tipping of abutment depending on hex height, due to nonaxial transfer of occlusal forces.

Internal connections

This overcame the problems of external connections and contributed to axial loading. Most implant companies now manufacture only internal connection implants.

Implant collar

A smooth machined collar is usually designed on the superior surface of the crest module. For submerged implants, it is usually 0.5–1 mm in height, while it is 3–5 mm for nonsubmerged implant (Fig. 49.23). It serves the following purposes:

- Allows functional remodelling of bone to occur to a more consistent region on implant with migration of sulcular epithelium to the base of the collar.
- Improves the abutment-fixture interface.
- Prevents exposure of surface coatings.

FIGURE 49.23 Implant collar height for submerged (left) and nonsubmerged implant (right).

Implant abutment

Definition: The portion of a dental implant that serves to support and/or retain any fixed or removable dental prosthesis (GPT8). It is screwed to the implant fixture.

Abutments can be classified as:

1. Abutments for fixed prosthesis

i. Definitive

a. Prefabricated

□ Solid abutment

□ Hollow (two-piece abutments)

– Straight

– Angled

b. Custom-made

□ Castable abutments

□ CAD–CAM abutments

ii. Provisional or temporary

2. Abutments for removable prostheses (overdenture attachments)

i. Stud attachments

ii. Bar attachments

iii. Magnetic attachments

iv. Telescopic attachments

1. Abutments for fixed prosthesis

i. Definitive abutments

a. Prefabricated abutments

- They are available in specific heights or dimensions.
- They are made of titanium or zirconium.
- *Solid abutments:* These are one-piece abutments where the abutment and the abutment screw (used to attach the abutment to fixture) are not separable (Fig. 49.24). Hence, there is no channel provided inside the abutment for a screw, making it a solid piece. They are not versatile and have to be prepared in the mouth.
- *Hollow (two-piece) abutments*: These are the commonly used abutments. The hollow inside provides a path for the abutment to be screwed onto the fixture with a separate abutment screw (Fig. 49.25A and B). These abutments can be either straight or angled. Straight abutments are positioned straight and parallel to the implant fixture. The angled abutment is used to correct divergence between implant axis and neighbouring teeth (Fig. 49.26A and B). They are manufactured in angulations of 15–30°.

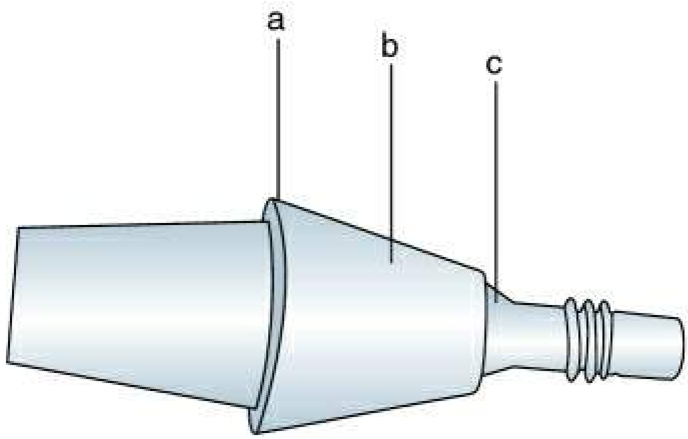
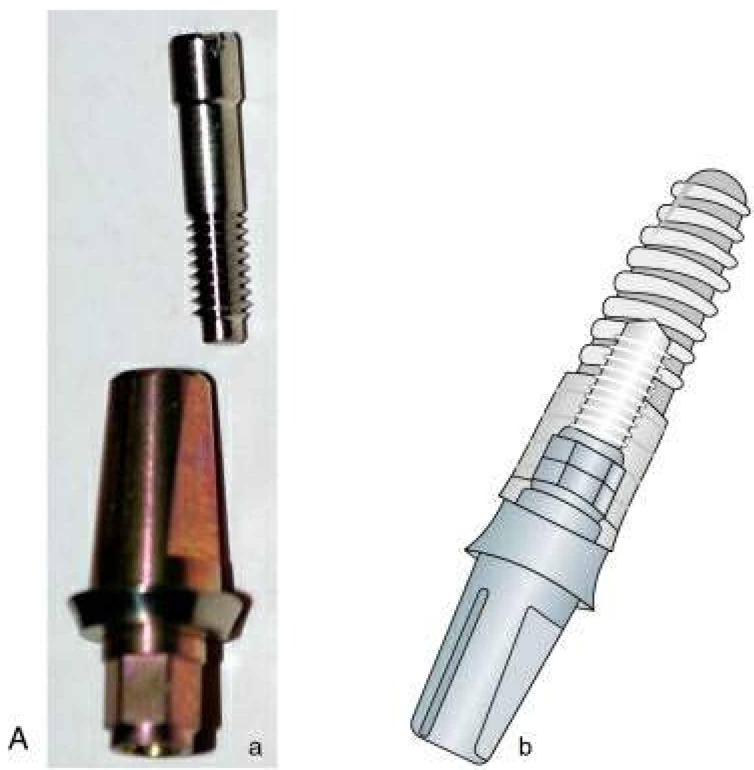


FIGURE 49.24 Solid abutment. Prosthetic platform (a), transmucosal area (b) and nonengaging internal connection (c).



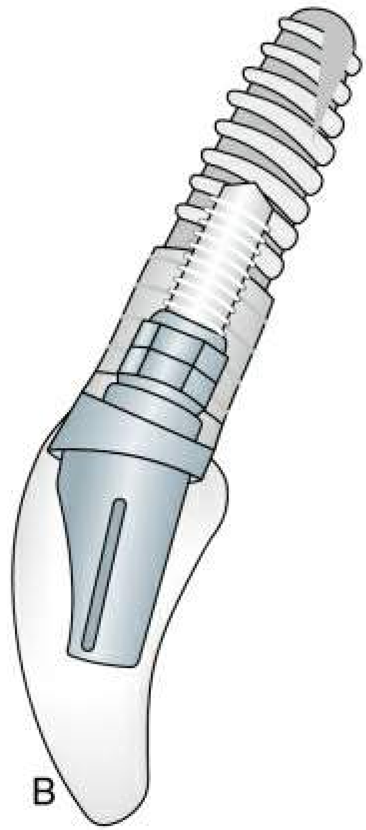


FIGURE 49.25 **(A)** Hollow abutment (two piece) (a). Abutment and screw are separate components. This is a straight abutment (b). **(B)** Angled abutment.

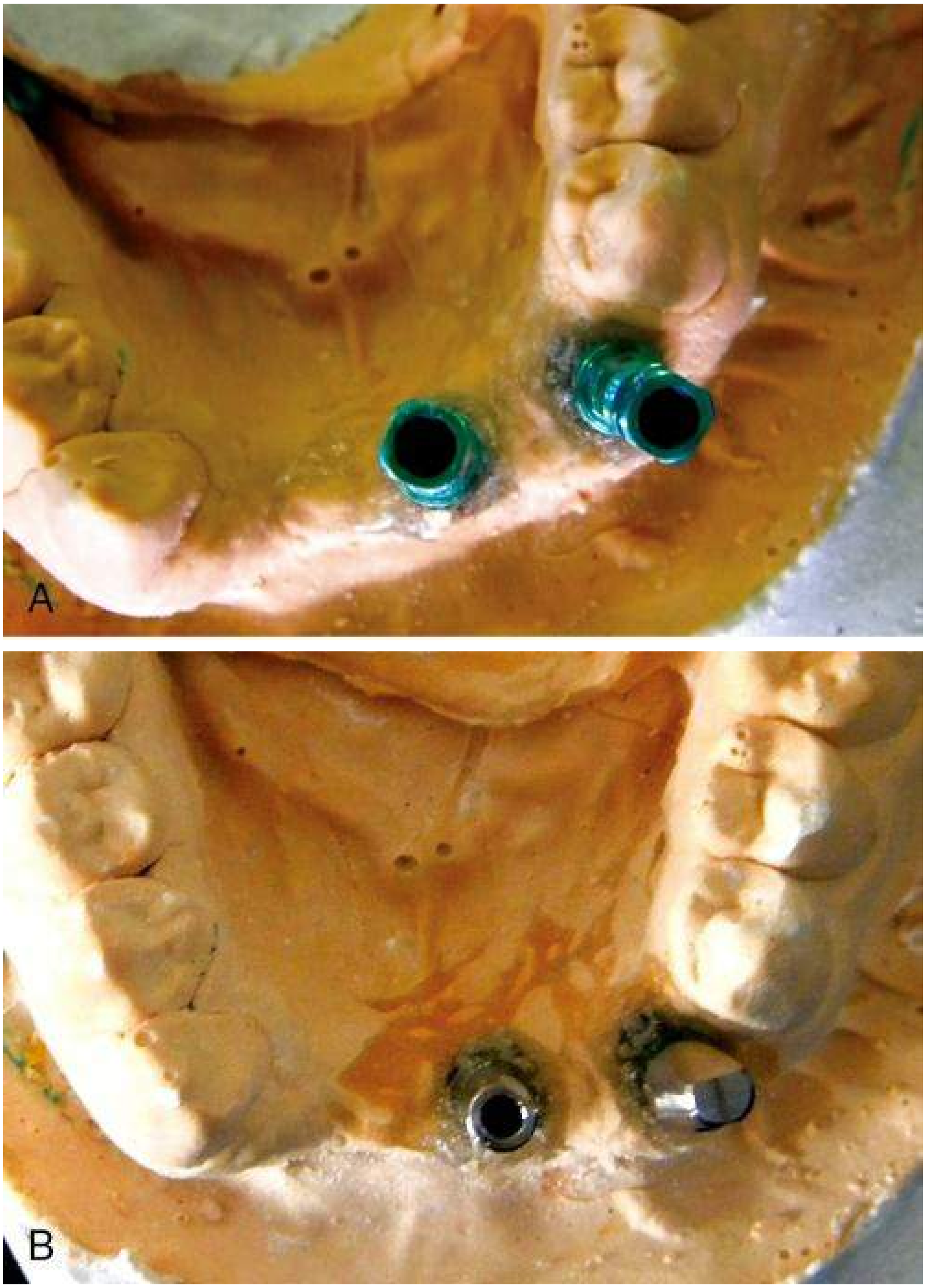


FIGURE 49.26 **(A)** Implant axis out of arch in site 33 if a straight abutment is used. **(B)** Implant axis corrected using angled abutment in 33.

b. Custom-made abutments

- These abutments can be fabricated to fit the individual space.
- They can be made of any castable or machinable alloy or material.
- *Castable abutments:* They are available in materials like plastic sleeves which can be easily modified and cast in metal to the desired shape and dimensions (Fig. 49.27). They are also termed as waxing sleeves or UCLA-type abutments.
- *CAD–CAM abutments*: These are custom abutments fabricated using computer-aided design and milling. Very precise abutments can be made using titanium and zirconium and other machinable materials. The model is scanned, abutment is designed and milled similar to fabricating all-ceramic restorations.

FIGURE 49.27 Castable abutment with sleeve.

ii. Provisional abutments

These are also called temporary abutments and are used to shape the gingival contour in the aesthetic zone and place a provisional restoration prior to the definitive restoration. They are usually made of resin (Fig. 49.28).

FIGURE 49.28 Provisional abutment (*Courtesy:* Myriad Implant System).

2. Overdenture attachments

These are similar to attachments used for tooth-supported overdentures described in Chapter 48. The following types of overdenture attachments are used:

1. Studs

2. Bars

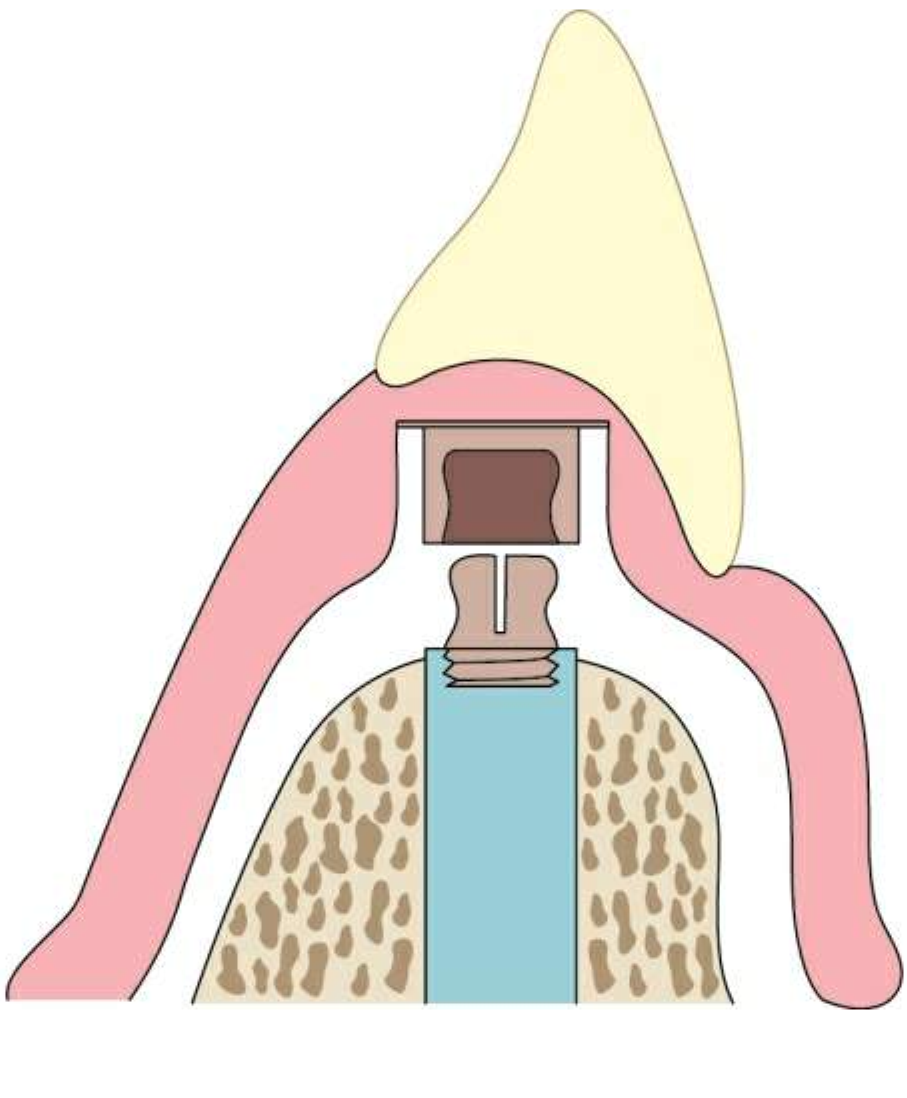
3. Magnets

4. Telescopic

They are also discussed later in this chapter under section 'Treatment Planning'.

i. Studs

- They may also be referred to as 'ball attachments'.
- Consist of two components – stud (male) and retentive anchor (female) (Fig. 49.29A).
- One of them is attached to the implant and the other to the denture.



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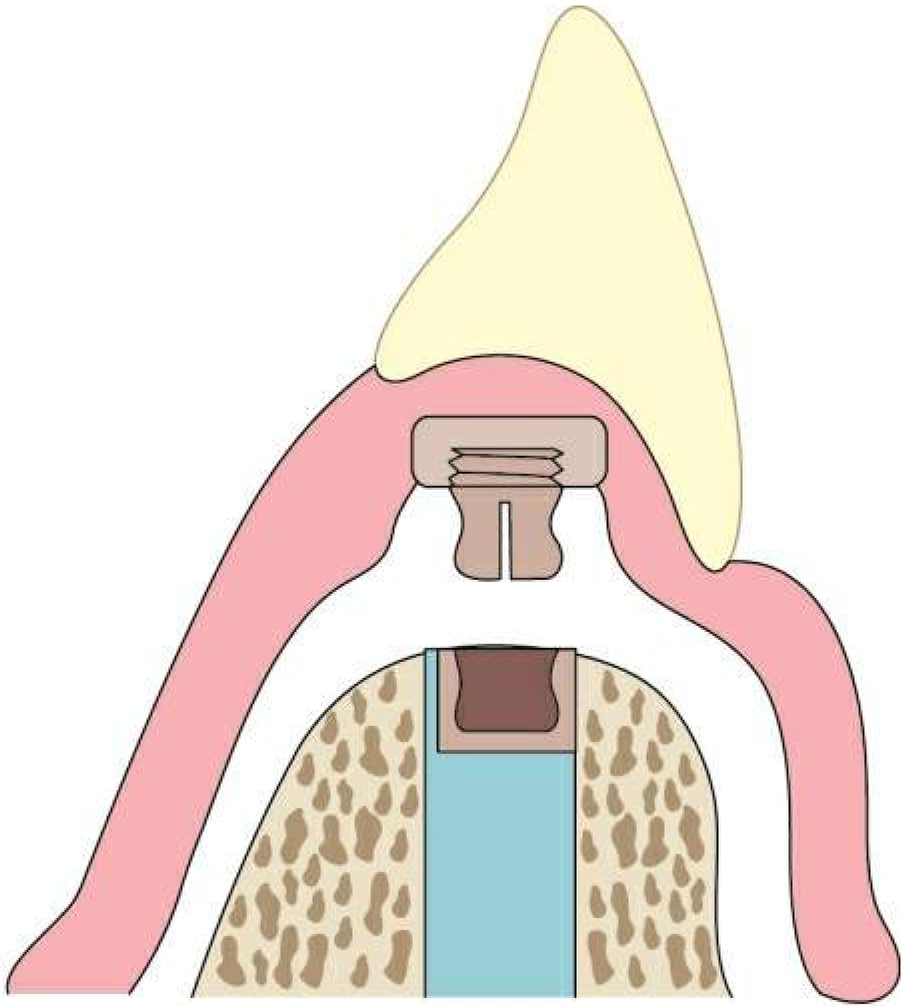
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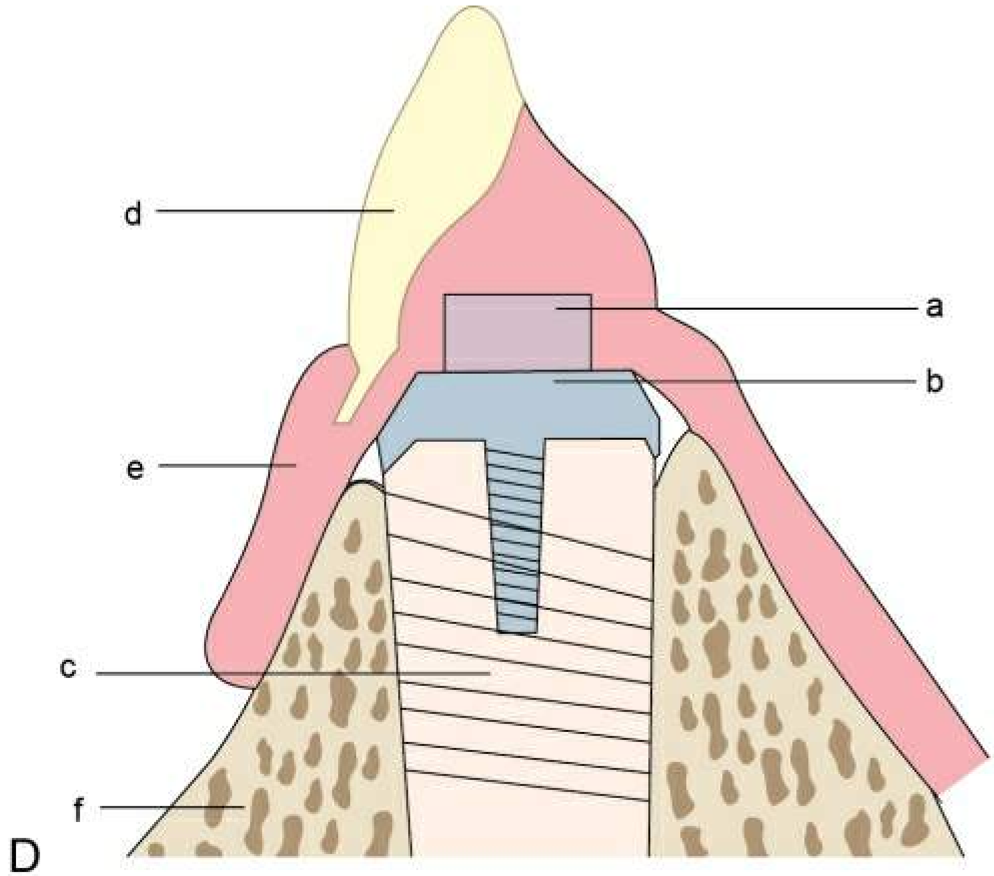


FIGURE 49.29 **(A)** Stud attachment (ball) – external connection. **(B)** Stud attachment – internal connection. **(C)** Bar attached to bar abutments on implants (a), Clip in denture for retention (*Courtesy:* Dr Shahvir) (b). **(D)** Magnet attachment. The keeper is normally fastened to the implant and the magnet will be incorporated in the denture. (a) Magnet, (b) keeper, (c) implant, (d) teeth, (e) acrylic flange, (f) alveolar bone.

Advantages

- Easy to change.
- Wide range of movement.
- Low cost.
- Different degrees of retention.

- Elimination of time and cost of superstructure.

Types

Basically stud attachments are of two types (similar to tooth-supported overdenture attachments).

- External connection (Fig. 49.29A) – stud (male) is attached to implant and retentive component (female) is attached to denture. Examples: Dalla Bona, O-ring, Cap attachments.
- Internal connection (Fig. 49.29B) – stud (male) is attached to denture and retentive component (female) is attached to implant. Examples: Locator, ERA.

ii. Bars

Bars consist of three components (Fig. 49.29C) bar retainer (abutment with coping), sleeve (bar) and clip.

- Splints the implants, distribute forces apical.
- Require more vertical and buccolingual space than studs.
- Require meticulous oral hygiene.
- Equal retention for bar retainers.

iii. Magnets (fig. 49.29D)

- They offer low profile retention.
- Less retention and stability compared to studs and bars.
- Frequent loss of magnetism has been a problem due to saliva contact.

iv. Telescopic

- Similar to those used on natural teeth.
- Good retention and stability.

Implant superstructure

This is the prosthesis that is fabricated with the support of dental implants. Implant superstructures can be of the following types:

1. Fixed prostheses
    i. Crowns
    ii. Bridges
2. Removable prostheses
    i. Overdentures
3. Fixed-detachable prostheses
    i. Hybrid dentures

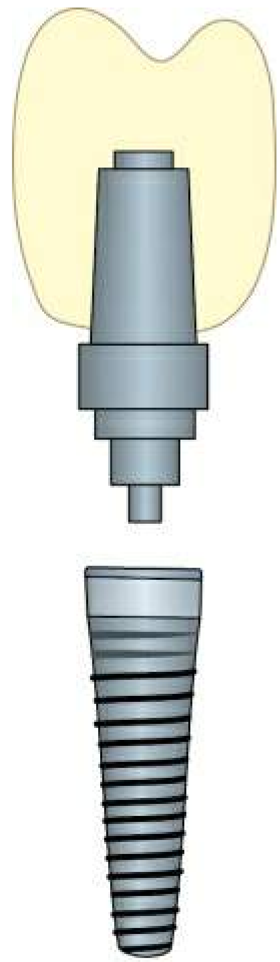
1. Fixed prostheses

Implant crowns and bridges can be used to replace single or multiple teeth in a fixed manner (Figs 49.30 and 49.31).

FIGURE 49.30 **(A)** Superstructure can be in the form of single crowns. **(B)** Superstructure in the form of multiple crowns.

FIGURE 49.31 Superstructure can be in the form of bridges.

These crowns and bridges are attached to the abutments using cement (similar to tooth-supported crowns) or screws. They are then termed as *cement-retained* or *screw-retained prosthesis,* respectively (Fig. 49.32).



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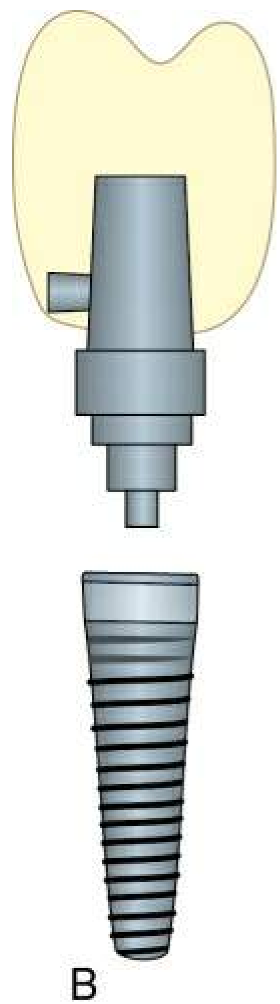


FIGURE 49.32 **(A)** Cement-retained prosthesis. **(B)** Screw-retained prosthesis.

2. Removable prostheses

Implant overdentures

These are removable prostheses supported by implants. Similar to tooth-supported overdentures, they also require attachments as abutments (Fig. 49.29A–D).

3. Fixed-detachable dentures

These are screw-retained complete dentures which cannot be removed by the patient, but can be removed by the dentist. Their fabrication is complex (Fig. 49.33).

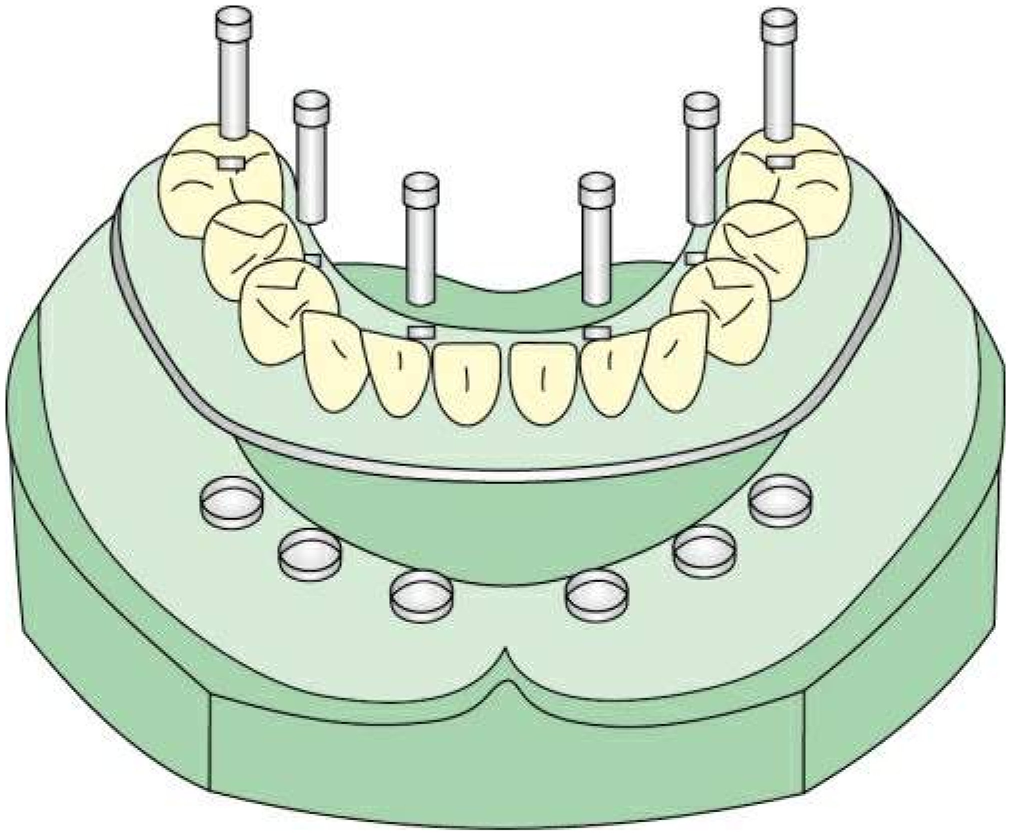


FIGURE 49.33 Fixed detachable prosthesis – hybrid denture.

The prosthetic options in implant dentistry were classified by Misch (1989) as follows:

1. FP-1

2. FP-2

3. FP-3

4. RP-4

5. RP-5

○ FP – Fixed prosthodontics options

○ RP – Removable prosthodontics options

1. FP-1 (Fig. 49.34A)

- ○ Fixed prosthesis.
- ○ Replaces only crown.
- ○ Minimal loss of soft and hard tissue.
- ○ Looks like a natural tooth.

2. FP-2 (Fig. 49.34B)

- ○ Fixed prosthesis.
- ○ Replaces crown and a portion of the root.
- ○ Crown contour appears normal in incisal or occlusal half, but is elongated in gingival half.

3. FP-3 (Fig. 49.33)

- ○ Fixed-detachable hybrid prosthesis.
- ○ Replacement of teeth and a portion of soft tissue.
- ○ Prostheses most often use denture acrylic teeth and gingiva on a metal frame.

4. RP-4 (Fig. 49.35)

- Removable overdenture prosthesis is completely supported by implants.
- Usually five implants in mandible and six to eight implants in maxilla are required for this type of prosthesis.
- The prosthesis is rigid when seated.

5. RP-5 (Fig. 49.36)

- Removable overdenture prosthesis is supported by implants anteriorly and soft tissue posteriorly.
- Usually one to three implants in mandible and two to four implants in maxilla are required for this type of prosthesis.
- The prosthesis is not completely rigid and shows movement depending on the number and type of attachment.

FIGURE 49.34 **(A)** FP1: Implant crown looks similar to natural tooth with minimal loss of soft and hard tissue. **(B)** FP2: Implant crown is elongated – gingival porcelain is added to mask the same.

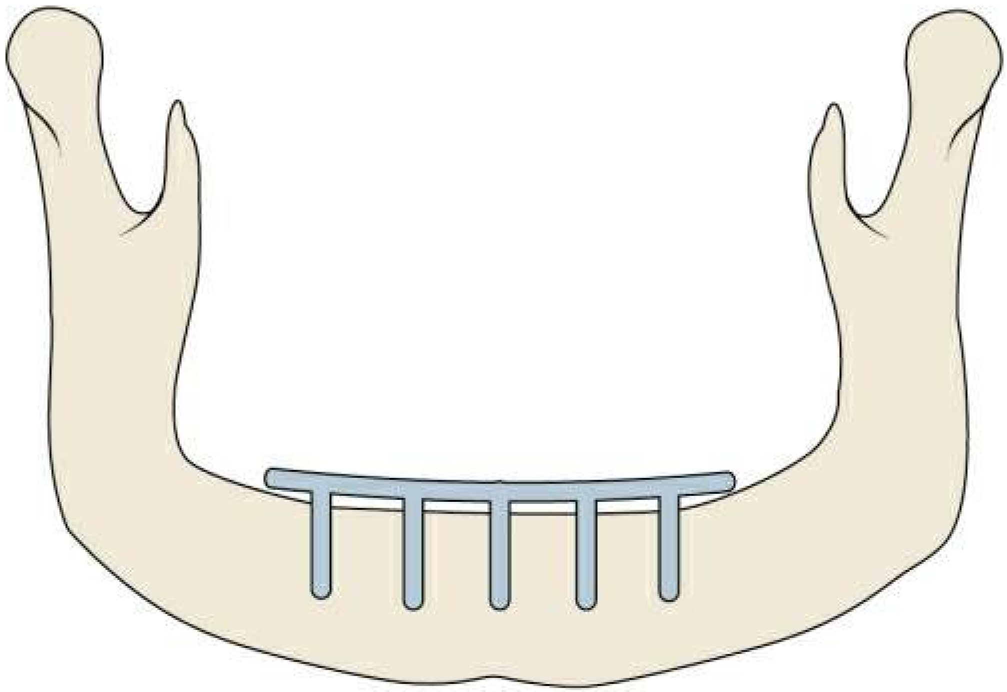


FIGURE 49.35 RP-4 – Removable overdenture prosthesis is supported by implants anteriorly and posteriorly.

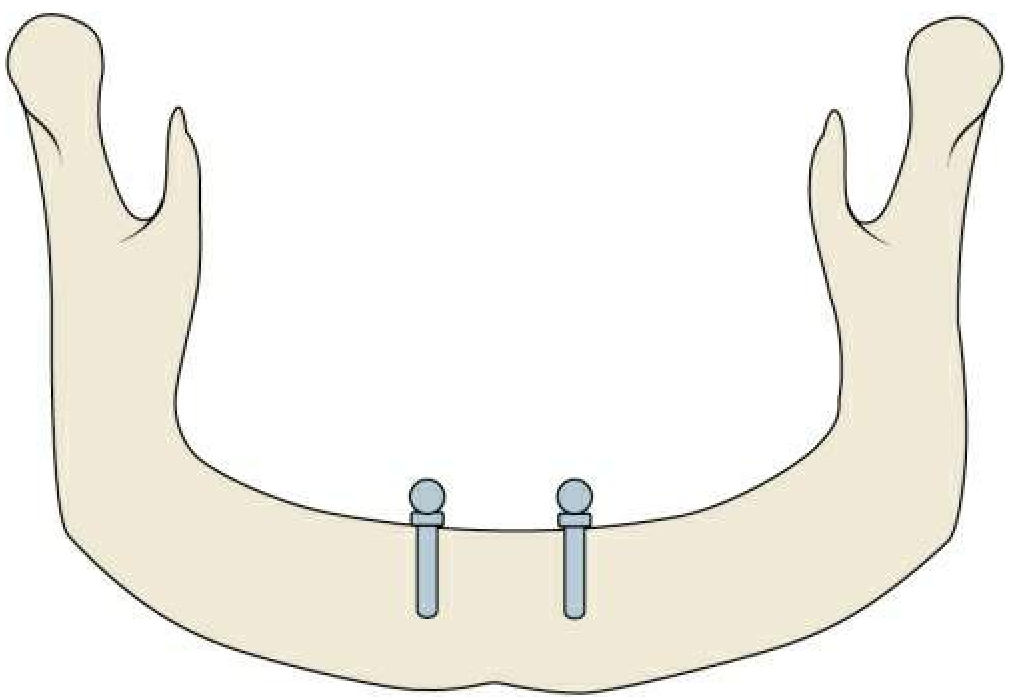


FIGURE 49.36 RP-5 – Removable overdenture prosthesis supported by implants anteriorly.

Accessories

Surgical

1. Cover screw

After surgical placement of implant, a screw is placed in the superior aspect of two-piece implants to cover the connection for abutment during the healing period (Figs 49.37, 49.15 and 49.16). It is usually low in profile to facilitate the suturing of soft tissue in two-stage implants and to minimize loading in the one-stage implants. It is also termed as *healing screw.*

FIGURE 49.37 Cover screws of different implant systems.

2. Gingival former

This component is required only for two-stage implants (Fig. 49.38A). Following the second surgery to expose the implant, the cover screws are removed and gingival formers, which are available in varying heights, are placed on the implant fixture (Fig. 49.39). They extend above the soft tissue into the oral cavity and form a gingival cuff around the implant (Fig. 49.38B). They are usually in place for 2–5 weeks depending on the healing, following which they are removed and impression procedures are commenced. They will be replaced by the abutment in the final restoration. They are also termed as *healing abutments or permucosal extensions.*


A

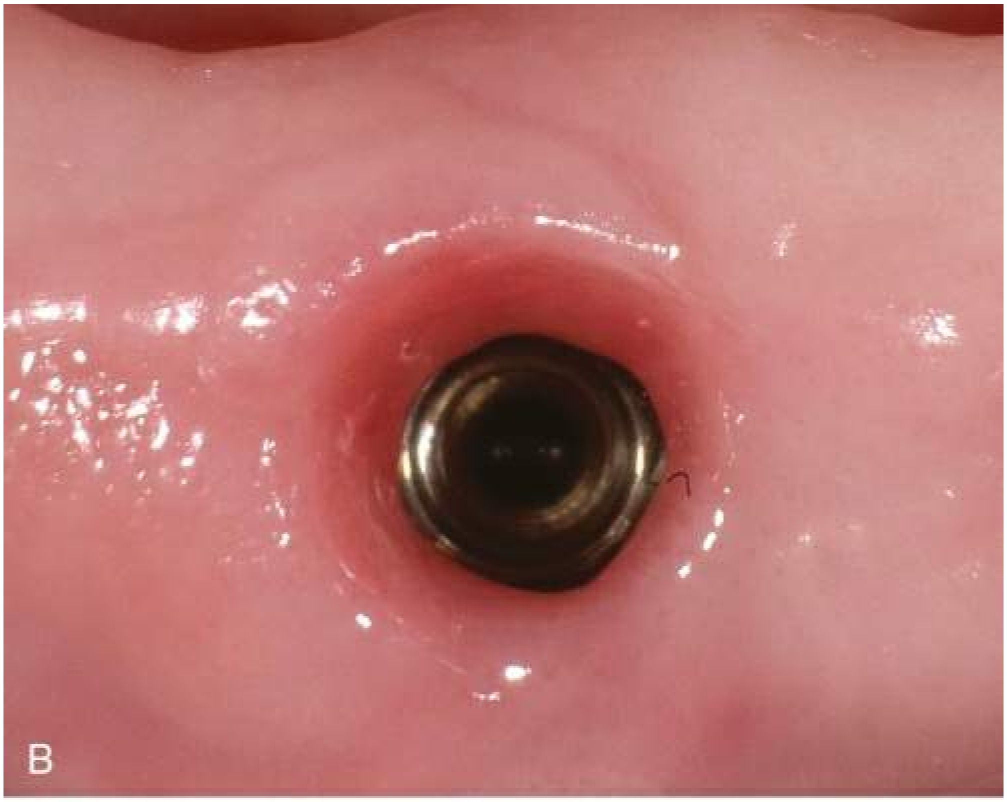


FIGURE 49.38 **(A)** Gingival former (*Courtesy:* Uniti Implant System). **(B)** Formation of gingival cuff following placement of gingival former.

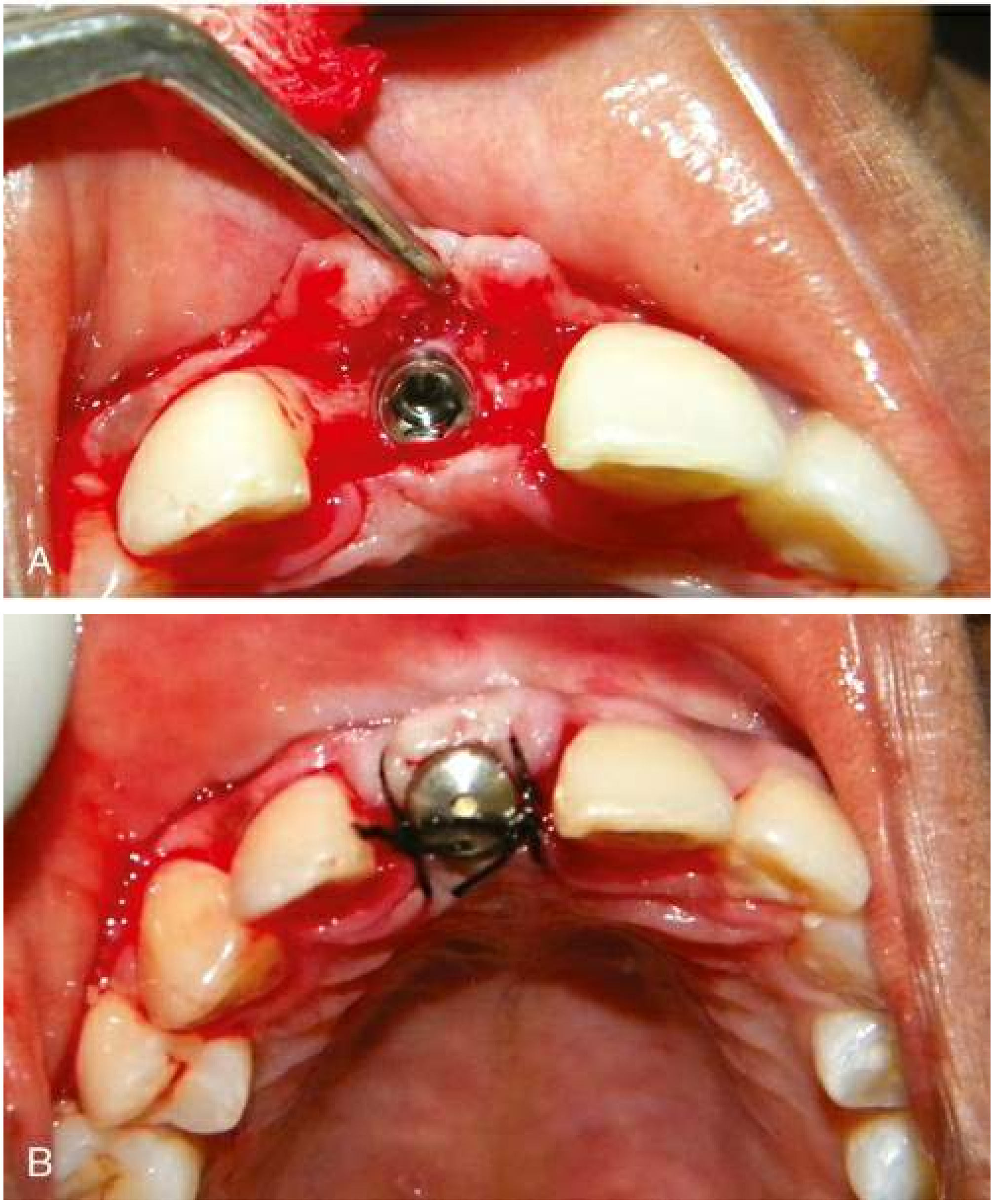


FIGURE 49.39 **(A)** Opening the implant site and removing cover screw. **(B)** Gingival former placed and suturing done exposing the site.

Prosthetic

1. Implant analogue

Definition: A replica of the entire dental implant, not intended for human implantation (GPT8).

This component is similar to the implant fixture, but used in the model to fabricate the prosthesis in the laboratory. It need not be of the same shape as the fixture but has to replicate the coronal portion of the fixture, which provides attachment to the abutment. A 'transfer impression' is made (described later in the chapter) of the implant in the mouth and the analogue replicates the implant position in the poured model. The abutment is fitted to the analogue and the prosthesis is fabricated in the laboratory (Fig. 49.40). It is also termed as *implant replica* or *lab analogue.*

FIGURE 49.40 Implant analogue.

2. Impression coping

Definition: That component of a dental implant system used to provide a spatial relationship of an endosteal dental implant to the alveolar ridge and adjacent dentition or other structures (GPT8). It is used with 'transfer impressions' to transfer the location of the implant body or abutment to a dental cast.

The coping is attached to the implant fixture during impression procedures using an impression screw. Following impression making, the coping is removed from the implant fixture and attached to the implant analogue, to pour a cast. It is also called *impression post, impression pin* or *transfer coping* (Fig. 49.41).

FIGURE 49.41 Impression coping with screw.

Implant treatment

Implant treatment includes diagnosis and treatment planning, surgical phase and prosthetic phase.

Implant treatment is prosthetically driven. It follows the following sequence:

- Designing the prosthesis.
- Determining the number of implants needed to support the prostheses.
- Determining the location of the implants.

Diagnosis

Medical evaluation

- A thorough medical evaluation should be performed for the implant patient. Systemic diseases have a range of effects on the patient, depending on their severity. Any condition that contraindicates surgery should be noted.
- The recording of vital signs like blood pressure, pulse, temperature, respiration, weight and height are part of the physical examination.
- The most common laboratory evaluation for implant dentistry may include a complete blood cell count (CBC), sequential multiple analysis (SMA) and bleeding disorder tests. The dentist should also select the tests needed to assist in the diagnosis of systemic diseases affecting implant treatment.
- Contraindications have been listed previously.

Dental evaluation

Diagnostic casts

Articulated diagnostic casts are essential for diagnosis and treatment planning. This includes edentulous patients also (Figs 49.42 and 49.43).

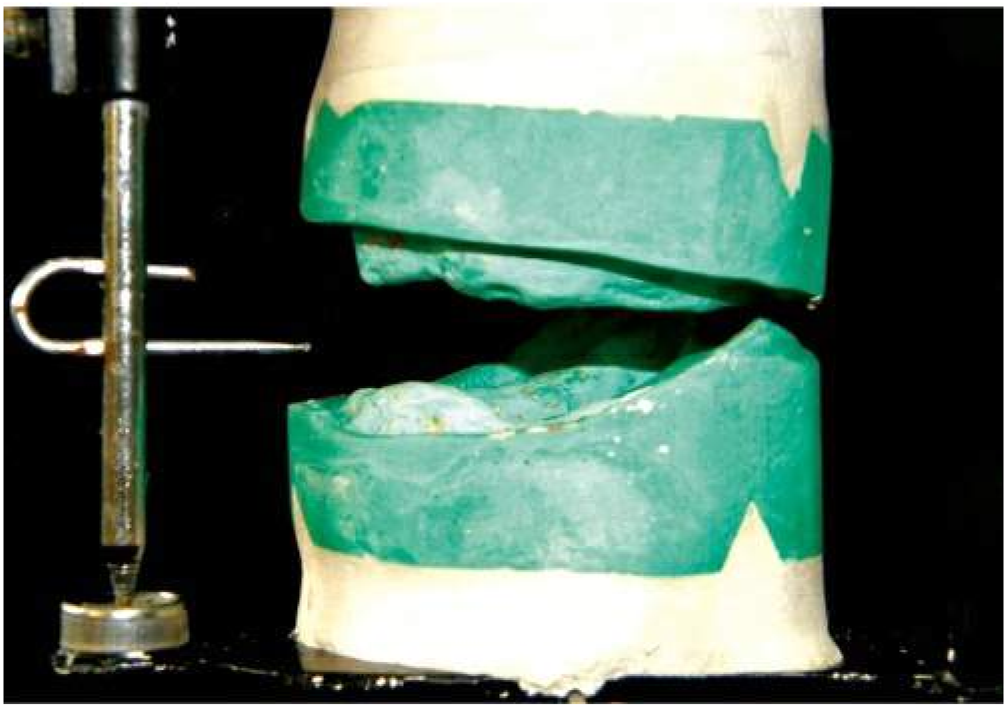


FIGURE 49.42 Articulated completely edentulous cast.

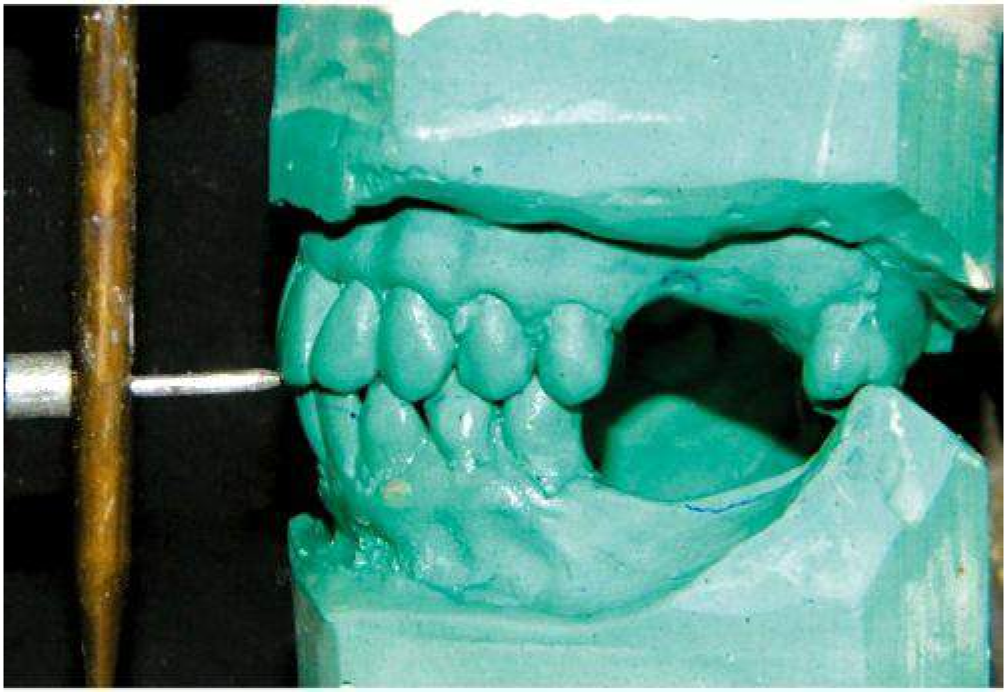


FIGURE 49.43 Articulated partially edentulous cast.

They provide information regarding:

1. Existing occlusion.
2. Relation of edentulous ridge to adjacent teeth and opposing arches.
3. Arch location of future abutments.
4. Direction of forces in potential implant sites.
5. Position and morphology of potential natural abutments.
6. Interarch space.
7. Arch form.
8. Opposing dentition.
9. Occlusal plane.

10. Missing teeth.

Diagnostic casts are used to fabricate the following:

- Diagnostic wax up
- Bone mapping
- Implant stents and guides

Radiographs

They provide the following information:

1. Quality, quantity and angulation of bone.
2. Relationship of critical structures to prospective implant sites.
3. Presence or absence of disease at the proposed surgery sites.

The following procedures may be used:

1. Periapical

Provides information regarding the quality of bone in implant site. It is also a valuable tool for monitoring crestal bone maintenance after implant placement.

2. Digital radiographs/radiovisiography (RVG)

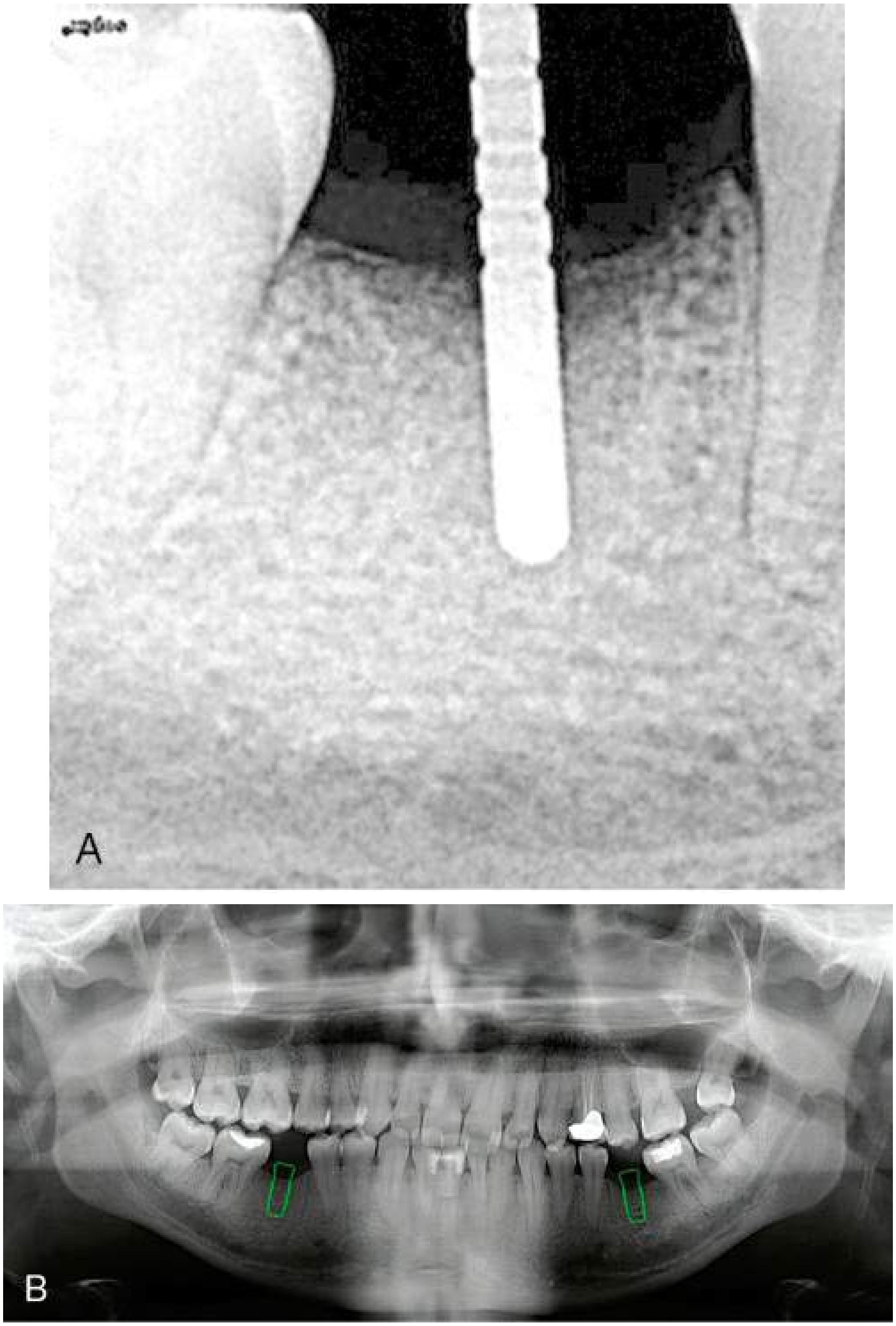
Very useful during surgical placement to verify sequentially the location of implant in relation to critical anatomical structures.

3. Occlusal radiograph

Provides information regarding the width of bone and bone density.

4. Lateral cephalogram

Provides information regarding amount and angulation of bone in anterior regions and skeletal arch relationship (Fig. 49.44A).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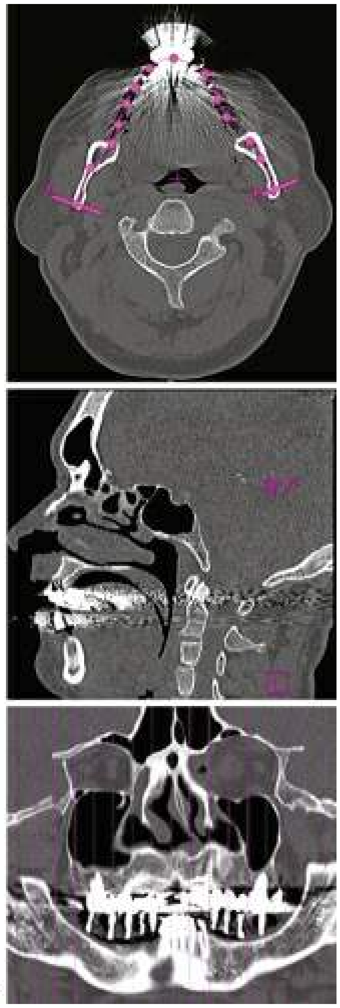


C

FIGURE 49.44 **(A)** RVG verifying the relation of implant to inferior alveolar nerve during surgery. **(B)** OPG for implant treatment planning. Current software allows placement of specific implant in the edentulous space to review its position. **(C)** CT images used for implant treatment planning. They will provide three-dimensional information.

5. Orthopantomogram (OPG)

This is the most commonly used radiograph. It provides information about the height of available bone, its relation to critical structures and bone quality. It is commonly used with radiographic stents (Fig. 49.44B).

6. Computed tomography (CT)

Both sectional and cone bean CT can be used. They are very accurate in providing information regarding bone width, height, quality and relation to critical anatomical structures (Fig. 49.44C). 3D models of the implant site can be fabricated using CT which help in making implant stents to guide accurate implant placement during surgery (surgical guides) (Fig. 49.45).


C
B

FIGURE 49.45 (A–D) Precision surgical guide fabricated using rapid prototyped model. **(A)** Stone model. **(B)** Surgical stent (note the metal sleeves for the drill to access the bone). **(C)** Rapid prototype model. **(D)** Stent on the model with marking 2,0 indicating the diameter of the drill.

Preimplant assessment

The following factors need to be assessed prior to implant placement:

1. Available bone

The most important consideration for placing implants is the quantity and quality of bone available in the implant site. The important anatomical landmarks which limit the available bone are (Fig. 49.46)

- Floor of the nares
- Maxillary sinus
- Inferior mandibular canal

• Mental foramen

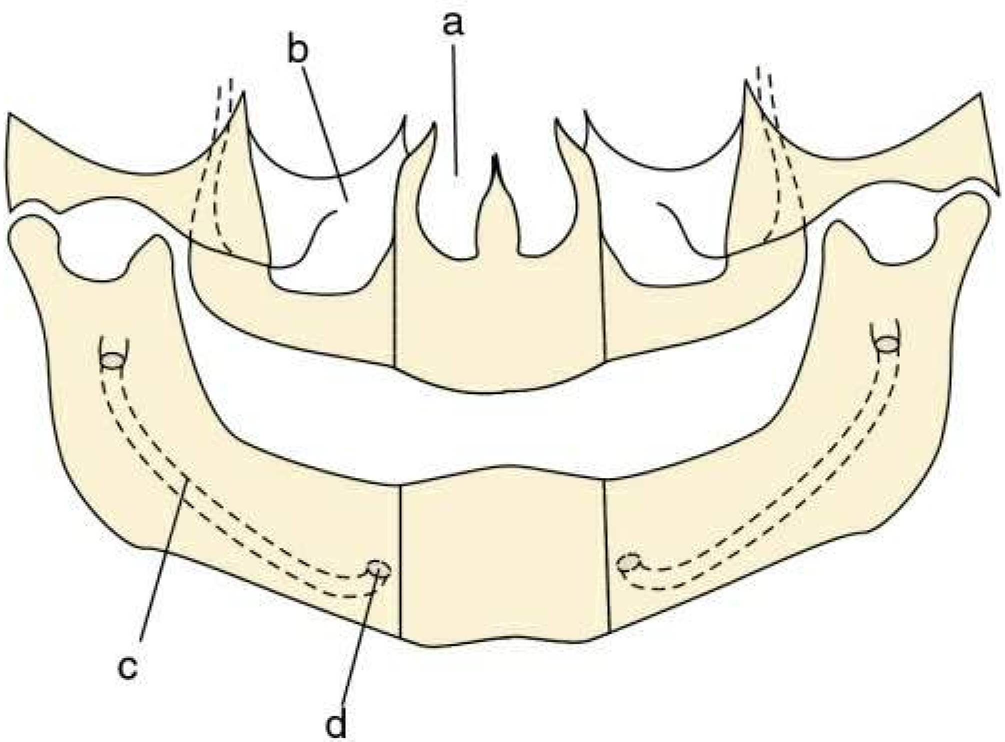


FIGURE 49.46 Anatomical landmarks. Floor of nares (a), maxillary sinus (b), inferior alveolar nerve (c), mental foramen (d).

As a general guideline, 2 mm is maintained between the implant and any anatomical landmark.

Classification

Misch and Judy (1985) classified available bone in the proposed implant site into four types:

• Division A (abundant bone)

• Division B (barely sufficient bone)

• Division C (compromised bone)

• Division D (deficient bone)

It describes the amount of bone in the edentulous area considered for implantation. It is measured in height, width, length, angulation (between prostheses and bone) and crown:implant body ratio (Fig. 49.47). The classification assists in treatment planning and implant selection. It is determined using radiographs and CT scans.

1. **Division A**

○ More than 5 mm width

○ More than 12 mm height

○ More than 7 mm length

○ Less than 1 crown:implant ratio

○ 25° angulation

2. **Division B**

○ 2.5–5 mm width

○ More than 12 mm height

○ More than 6 mm length

○ Less than 1 crown:implant ratio

○ 20° angulation

3. **Division C**

○ 0–2.5 mm width (C-w) – deficient width

○ Less than 12 mm height (C-h) – deficient height

○ More than 30° of angulation

○ More than 1 – crown-implant ratio

4. **Division D**

○ Sever atrophy

○ Basal bone loss – flat maxilla, pencil-thin mandible

○ More than 1 – crown-implant ratio

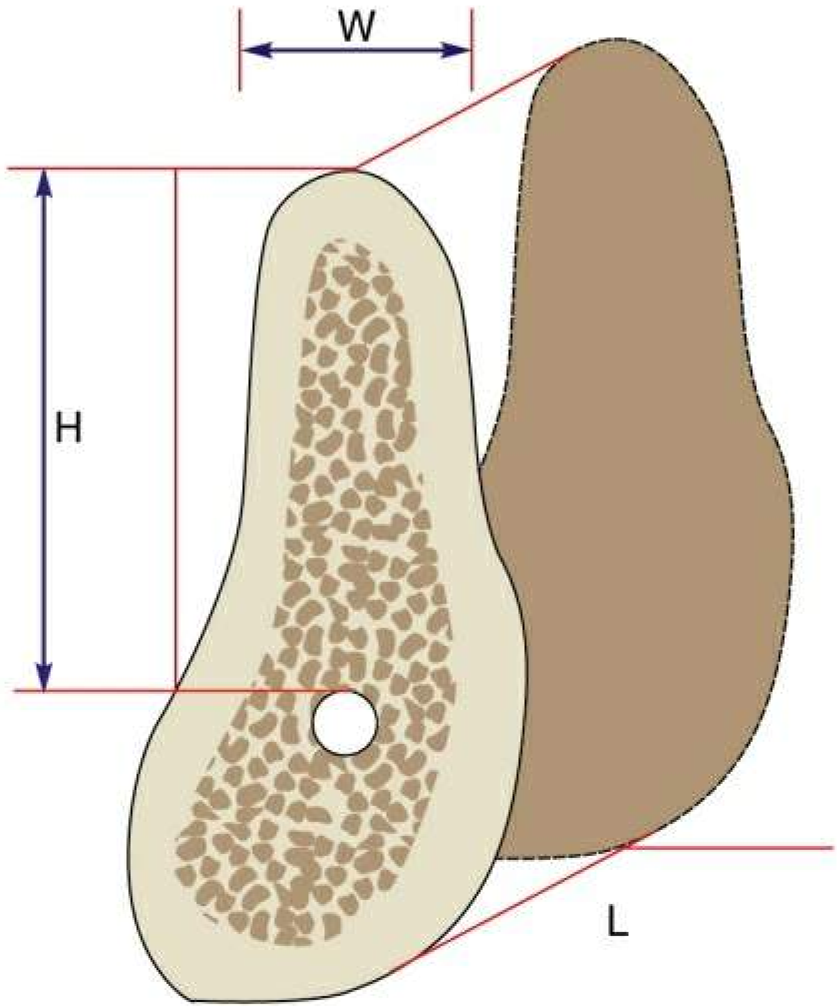


FIGURE 49.47 Calculation of available bone height, width and length.

2. Bone density

The bone density determines the quality of the available bone.

Misch classified bone into four types depending on the quality (Fig. 49.48).

- D1 – dense cortical bone
- D2 – thick dense to porous cortical bone on crest and coarse trabecular bone within
- D3 – thin porous cortical bone on crest and fine trabecular bone

within

- D4 – fine trabecular bone

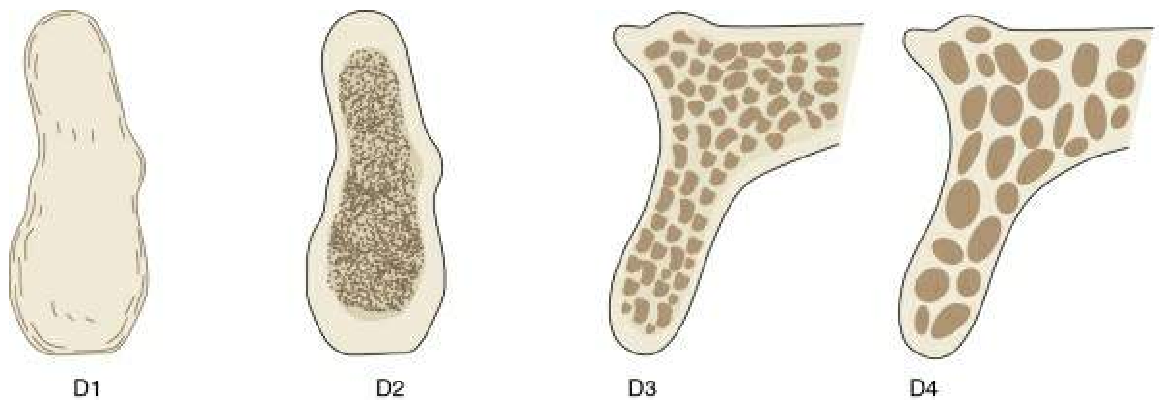


FIGURE 49.48 Misch classification of bone density.

The density is determined with radiographs and CT provides the data in Hounsfield units:

- D1: more than 1250
- D2: 850–1250
- D3: 350–850
- D4: 130–350

Anatomical location of bone types:

- Anterior maxilla – D2 and D3 bone
- Posterior maxilla – D3 and D4 bone
- Anterior mandible – D1 and D2 bone
- Posterior mandible – D2 and D3 bone

Bone density and treatment planning

Qu M and co-workers observed a ten-fold decrease in bone strength from D1–D4 bone density. The following will help reduce the load in poor quality bone:

- Having narrower occlusal tables.
- Minimizing off-vertical loads.
- Shortening or eliminating cantilevers.
- Directing the loads axially.
- Increasing the functional area over which the force is applied by:

○ Increasing the number of implants to support a given prostheses, e.g. using three implants to support three missing teeth rather than two.

○ Increasing the implant macrogeometry.

○ Using longer implants for initial fixation.

○ Increased width (diameter of implants) – every 0.5 mm increase in width increases surface area by 10%–15%.

○ Using threaded implants with deep threads for D3 and D4 bone to increase surface area.

○ Using implants with surface coatings to increase available area.

- Using ‘progressive loading protocol’ in softer bone.
- In complete edentulous situations using RP5 restorations rather than fixed prostheses to distribute stress to soft tissues.
- Using night guards and acrylic occlusal surfaces to distribute and dissipate parafunctional forces on an implant system.

3. Existing occlusion

Centric occlusion and its relationship to centric relation should be assessed and deflective occlusal contacts should be corrected by enameloplasty or crowns.

4. Implant permucosal position or arch location of future abutments

An implant placed too facial or lingual position can compromise the final results in aesthetics, biomechanics and maintenance. Ideally, the implant should be positioned under the incisal edge of anteriors and central fossa of posteriors. This is critical when FP1 type of prostheses is planned. The surgical guide or stent is important to ensure proper placement of implant in relation to the prostheses. The prostheses of a lingually placed implant are easier to correct and adjust aesthetically (Fig. 49.49A and B).

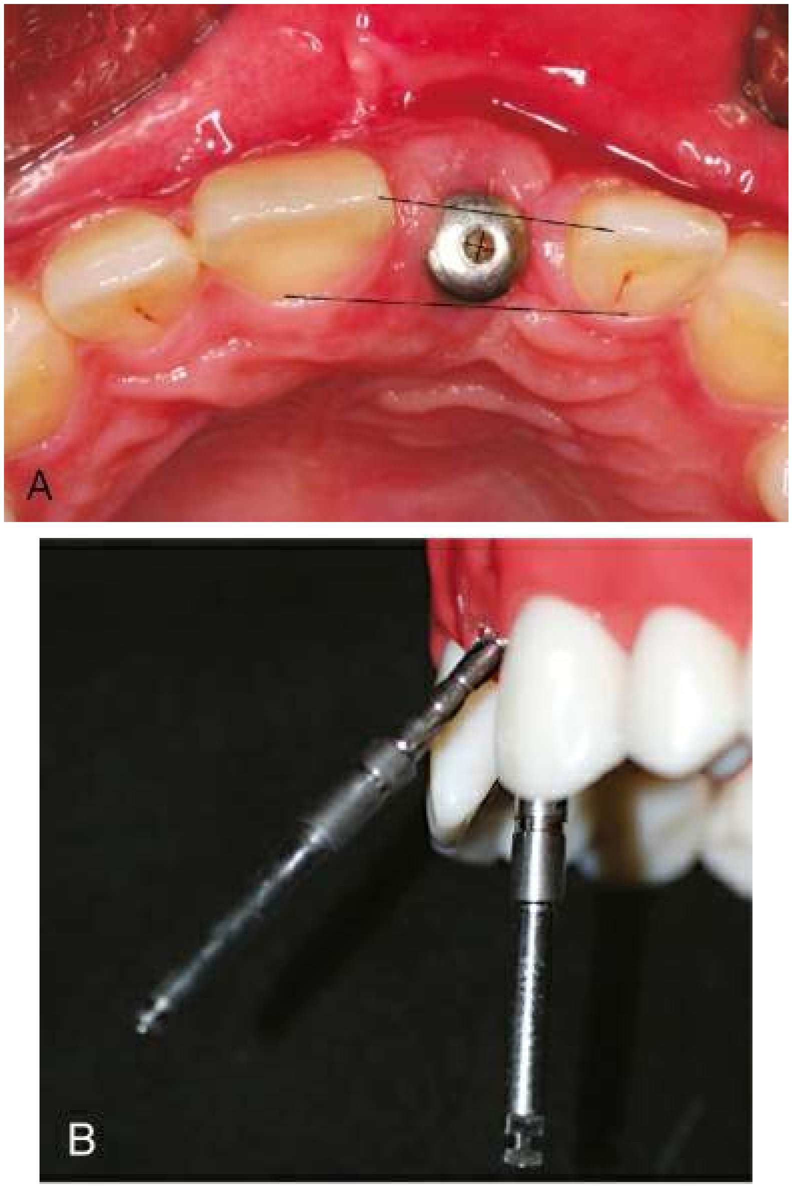


FIGURE 49.49 **(A)** Ideal implant position labiolingually. **(B)** Labially and lingually placed implants will compromise aesthetics because of their less than ideal angulations.

Interarch space

The required space is given in Table 49.1 for fixed and removable implant-supported prosthesis, when implants are placed anteriorly and posteriorly. A reduced interarch space can be treated by:

- Osteoplasty and/or soft tissue reduction of implant region.

• Selective grinding.

• Root canal and/or crowns of opposing teeth.

• Surgical reduction of tuberosities.

Table 49.1

Interarch space required for implant restorations

Type of restoration	Anterior	Posterior
Fixed	8–10 mm	7 mm
Removable	12 mm	12 mm

An increased interarch space is beneficial for a removable prosthesis to provide space for the attachment components, but in a fixed restoration there will be an increased crown–implant ratio, which is detrimental to the implant. The space can be decreased by addition of onlay grafts before implant placement. This has the following benefits:

• Improves crown–implant ratio.

• Better aesthetics.

• Increased surface area permits wider implant selection.

6. Arch form (anteroposterior distance or A-P spread)

This is critical when anterior implants are splinted to cantilever the posterior teeth.

The distance from the centre of the most anterior implant to a line joining the distal aspect of the two most distal implants – provides an indication of the amount of cantilever that can be planned (Fig. 49.50).

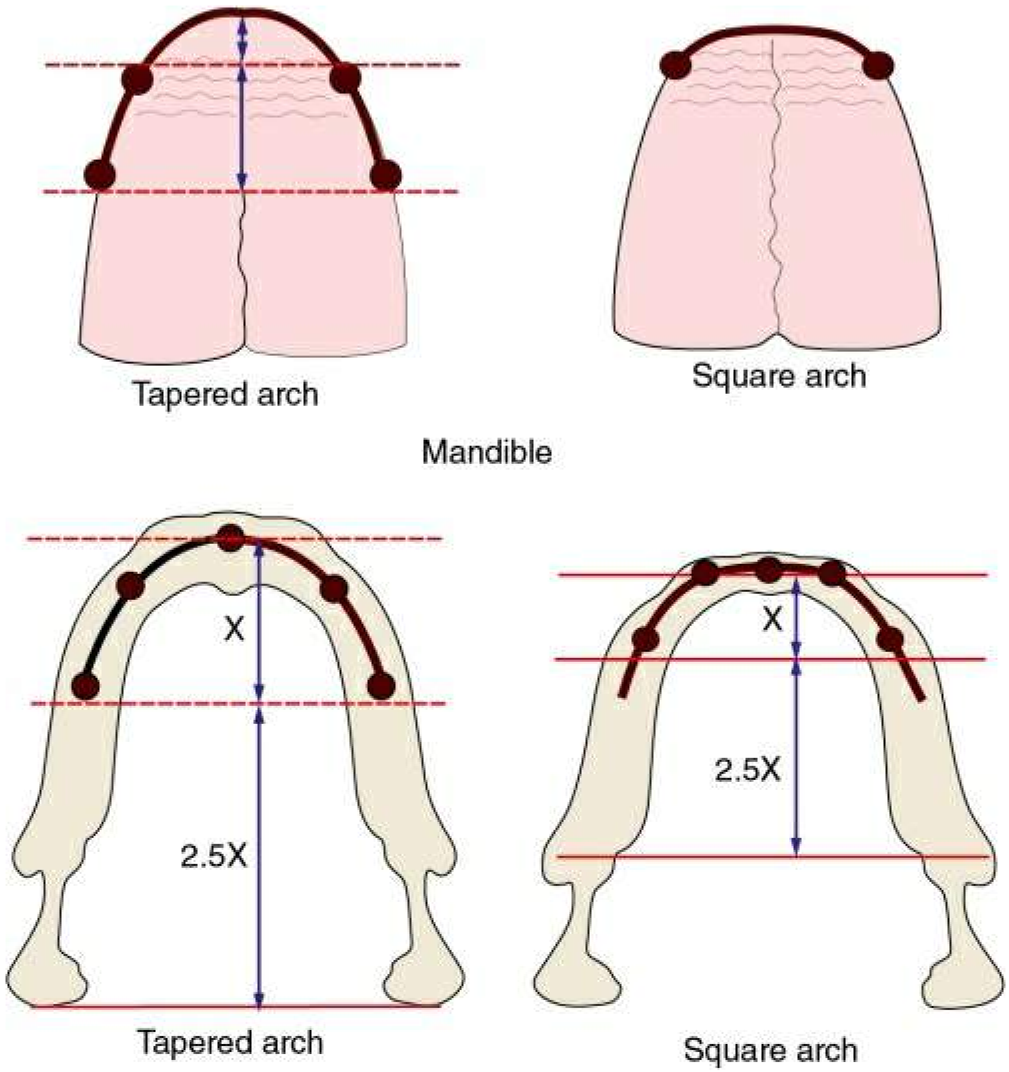


FIGURE 49.50 Arch form – tapered arch can take greater cantilever.

If this is 'x', then the prostheses can be cantilevered up to '2.5x'. Hence, a tapered arch is beneficial in this situation compared to a square arch.

The cantilever distance also depends on the following:

- Presence of parafunction
- Implant size and number
- Bone density

- Crown height
- Opposing arch restoration

7. Maxillomandibular relation

The pattern of resorption in anterior and posterior regions of the maxilla and mandible, changes the position of the arches depending on the presence or absence of teeth in the opposing arches. A jaw discrepancy is easier to correct with implant-supported prostheses than conventional dentures as neutral zone can be violated to some extent by implant prostheses.

8. Occlusal plane

- A proper plane is essential for proper aesthetics and to prevent posterior lateral interferences during excursion.
- Occlusal plane can be corrected by strategic extractions, intentional root canals and/or crowns.
- A diagnostic wax-up provides information on the required corrections.

9. Missing teeth

i. Location

- The second mandibular molar is generally not replaced.
- The mandibular first molar is designed to occlude with the mesial marginal ridge of a natural second molar to prevent extrusion.
- Maxillary second molar implants are often indicated.
- Single canine replacement is risky, requires occlusal planning.
- Implant should be placed with caution in 1st premolar area due to

distal angulation of canine root.

ii. Number

- The deflection or bending of a fixed prosthesis varies directly with the cube of the length of edentulous span. To limit the bending, independent implant-supported crowns or use of nonprecious alloys is recommended. The number of posterior pontics in fixed restoration should not extend beyond two.

10. Lip line and smile line

The lip line and smile line are important when replacing anterior teeth with implants. The FP2 type of prosthesis is indicated for patients with a low lip line.

11. Mandibular flexure

- The amplitude of mandibular movement on mouth opening is 0.8 mm in molar area and 1.5 mm in ramus area.

- Complete cross-arch splinting of posterior molar rigid, fixated implants is usually contraindicated in the mandible.

- Options:

  - Segmenting the restoration into two or more independent prostheses.

  - Using nonrigid connectors in midline.

  - Inserting posterior implants only in one section.

12. Soft tissue support

Soft tissue support is required in RP5 type of prostheses. If the soft tissues are capable of providing adequate support, the number of implants can be decreased. This depends on:

- Arch form – square arches provide better support than tapering.
- Ridge parallelism – parallel ridges are better than divergent.
- Height of muscle attachments and lateral throat form (similar to conventional complete dentures).

13. Existing prostheses

When present, existing prostheses are evaluated for proper design and function and the reasons for patient's dissatisfaction, if any, are noted. An acceptable pre-existing removable prosthesis, which will be replaced with fixed implant prosthesis, is used as a template or guide to evaluate the soft tissue support, position of teeth and the need for grafting.

14. Temporomandibular joint (TMJ)

The TMJ should ideally be free of symptoms before implant treatment is commenced.

Some patients suffering from TMJ problems may benefit from the stability and support provided by implant prostheses which can have favourable effect on the joint. So the cause of the problem needs to be assessed and addressed.

Implant stents

Stents or templates can be used for the following:

- Case diagnosis
- Radiographic evaluation
- Surgical guide
- Abutment selection
- Impression transfer

- To establish occlusal vertical dimension and centric relation in edentulous patients

Stents can be of two types:

1. **Radiographic stent/template**

- A radiographic stent is fabricated to evaluate the amount of bone available and its relation to important anatomic structures.
- A simple radiographic stent is fabricated as follows:

  ○ A clear acrylic plate is fabricated to cover the edentulous area.

  ○ A stainless steel ball bearing (BB) of known diameter is placed in the plate on the proposed implant site (Fig. 49.51).

  ○ An OPG is now made with the patient wearing the plate (Fig. 49.52).

  ○ The actual height of bone and percentage of elongation in the radiograph can now be easily calculated as follows:

$$\text{Actual bone height} = \frac{\text{Actual height of BB (5 mm)} \times \text{radiographic height of bone (26 mm)}}{\text{Radiographic length of BB (6 mm)}}$$

○ Making an occlusal radiograph with the stent will provide similar information regarding the maximum width of available bone.

• If a CT scan is used to make the image, gutta-percha can be used instead of the metal ball bearing. Radiopaque artificial denture teeth are also available, which can be used for diagnostic wax-up and the stent (Fig. 49.53).

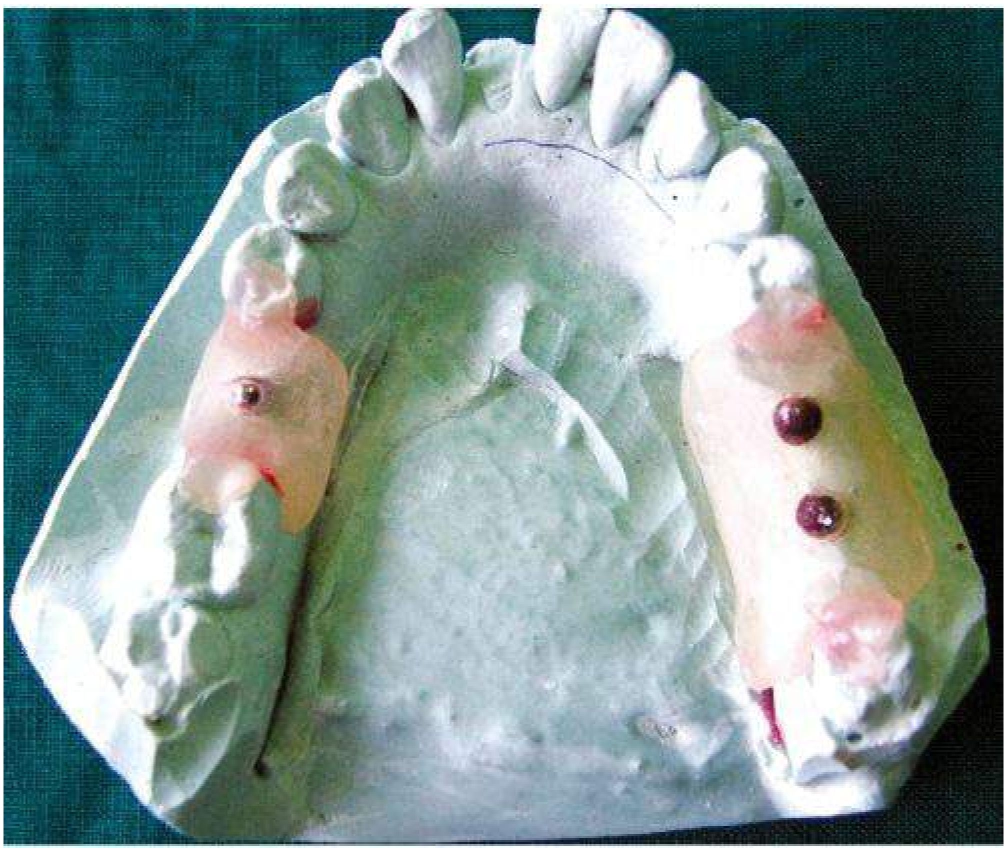


FIGURE 49.51 Stainless steel ball bearings placed on clear acrylic plate on proposed implant site.

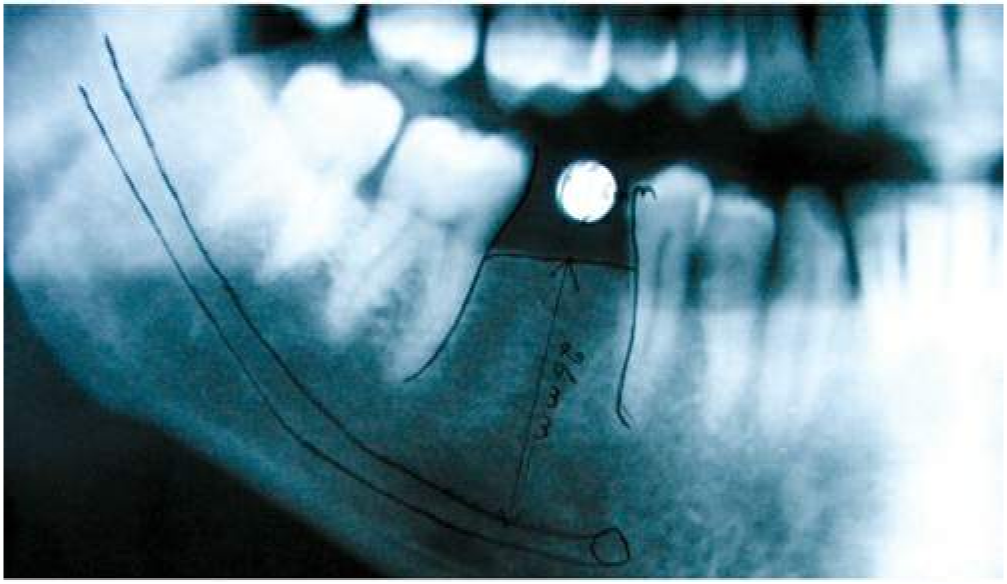


FIGURE 49.52 OPG shows the ball bearing above the proposed implant area.

FIGURE 49.53 Diagnostic template used in CT scan with radiopaque denture teeth (*Courtesy:* Dr Shahvir).

2. Surgical guide

As stated previously, the prosthesis dictates the position of the implant and this is determined with a diagnostic wax-up. A transfer device is essential to convey the position of the proposed prosthesis so that the surgeon could place the implant in the correct location to support the prosthesis accurately.

Definition: A guide used to assist in proper surgical placement and angulation of dental implants.

Ideal requirements:

- Stable and rigid.
- Should take support from natural teeth whenever possible to stabilize it. If teeth are not present, it should extend over unreflected soft tissues.
- Should provide for accurate location and angulation of implant.
- Should be transparent so the surgical drill can be visualized.
- Should be easy to insert, not bulky.
- It should be sterile.

Procedure

These are generally fabricated using clear acrylic. Most of the guides, which do not use a CT scan for its fabrication, can only provide information regarding the location of the implant. The angulation is adjusted during surgery (Fig. 49.54A and B). A radiographic stent can also be converted into a surgical guide.

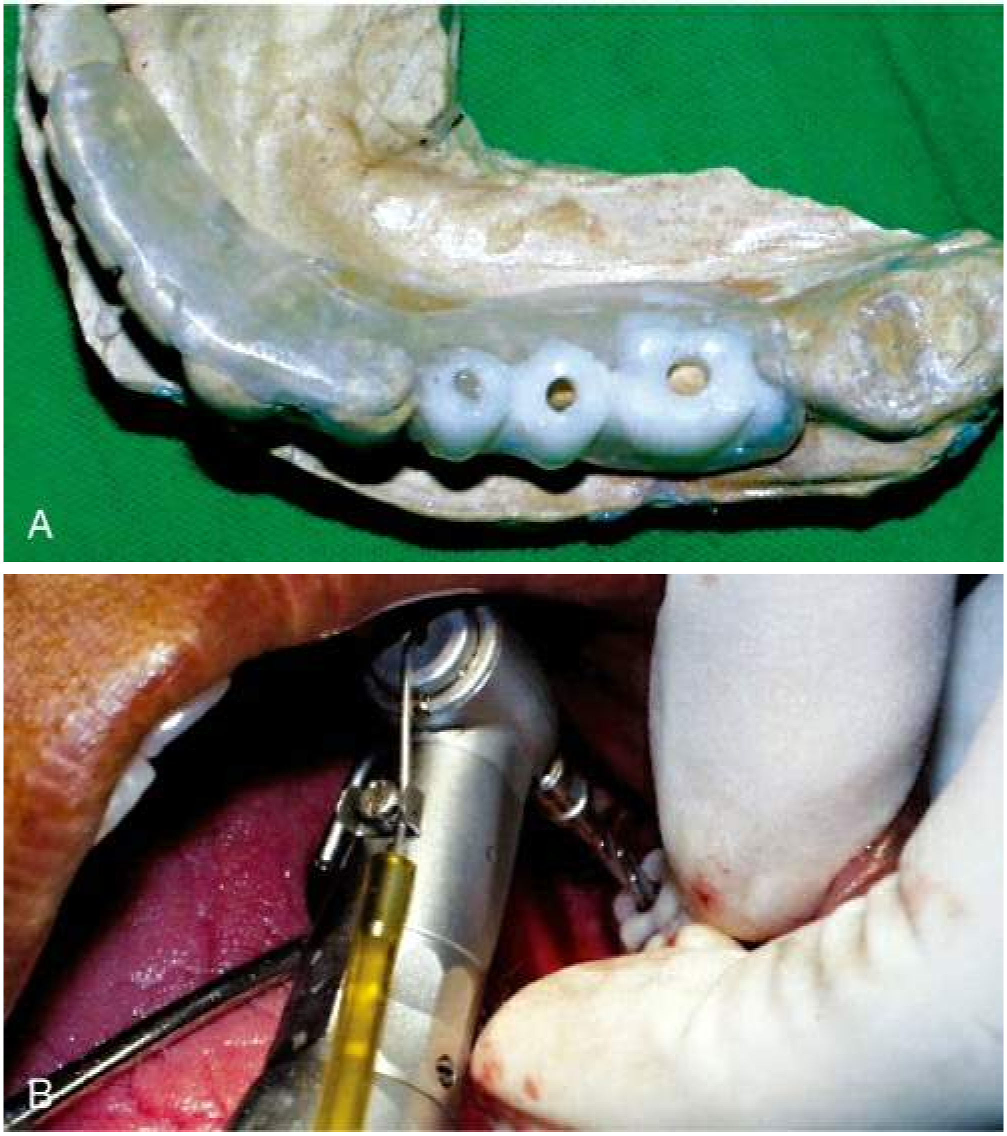


FIGURE 49.54 **(A)** A diagnostic wax-up with artificial teeth is made and a hole is drilled through the centre of the teeth to provide the correct location of implant. **(B)** During surgery, by drilling through the hole, the location is transferred to the patient.

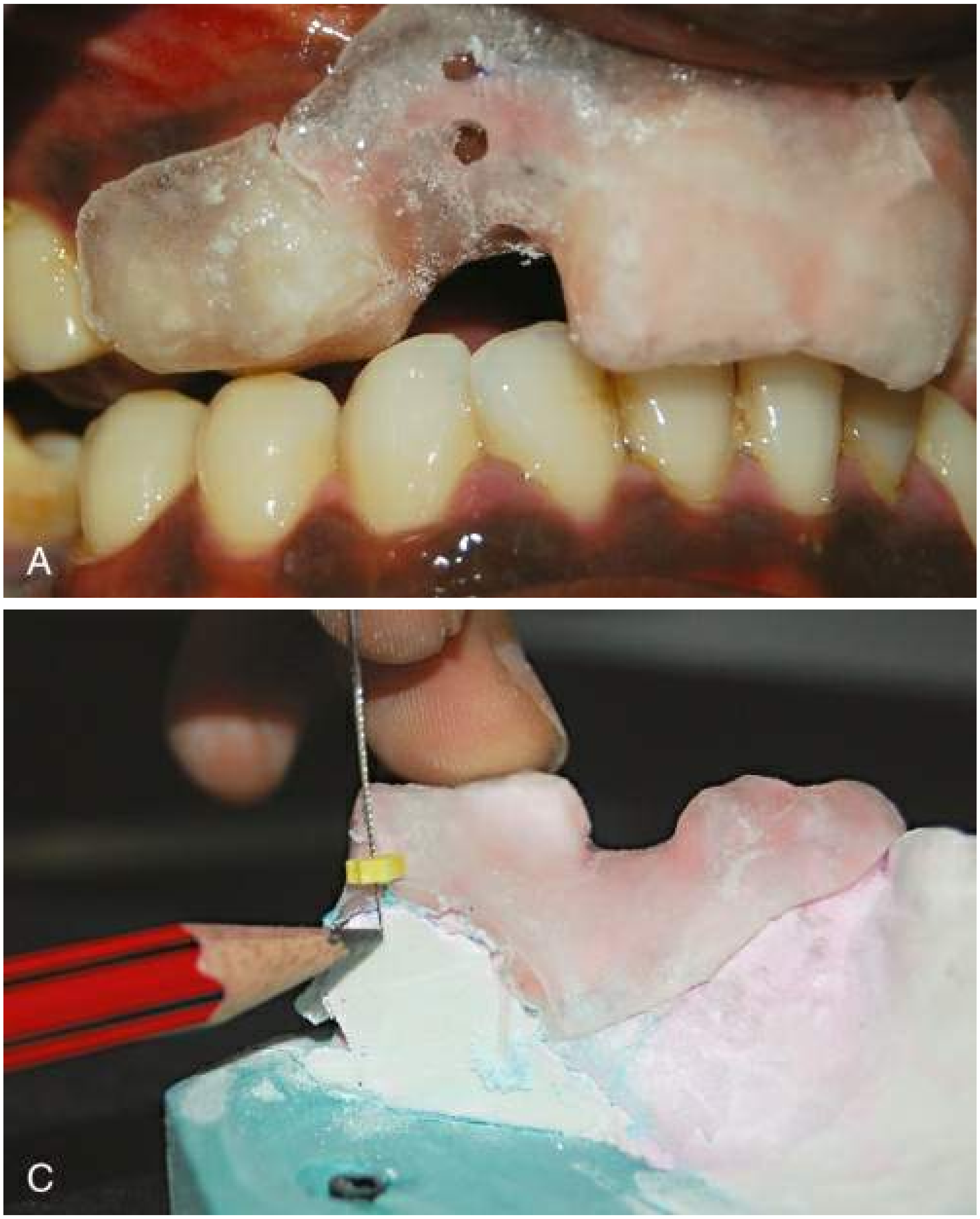
Advanced surgical guides

Currently, surgical guides are made using 3D models fabricated with CAM (computer-aided manufacturing) and CT scan images. Using rapid prototyped models precision surgical guides can be fabricated which even enable flapless surgery. Prostheses can also be prefabricated on these models and fitted in the patient's mouth immediately after implant placement.

Bone mapping

This is a technique to determine the soft tissue thickness and indirectly the bone width and angulation, in the implant region. This is a useful diagnostic tool that can be used to determine the width of available bone. Dies are made on the diagnostic cast for the implant and neighbouring areas, such that the area through the centre of the proposed implant site can be sectioned and removed.

An acrylic template is fabricated to cover the edentulous area and adjacent teeth with equally spaced holes placed along the centre of the edentulous space extending buccally and lingually (Fig. 49.55A). An endodontic file with a stopper is used to pierce the gingiva till it touches the bone (Fig. 49.55B). This will provide the width of the gingivae in that point. The procedure is performed on the crest of the ridge and a few points buccally and lingually. The width is simultaneously marked in the sectioned die corresponding to the point in the mouth (Fig. 49.55C). Joining the points will demarcate the thickness of gingiva in the implant site and the width of available bone (Fig. 49.55D).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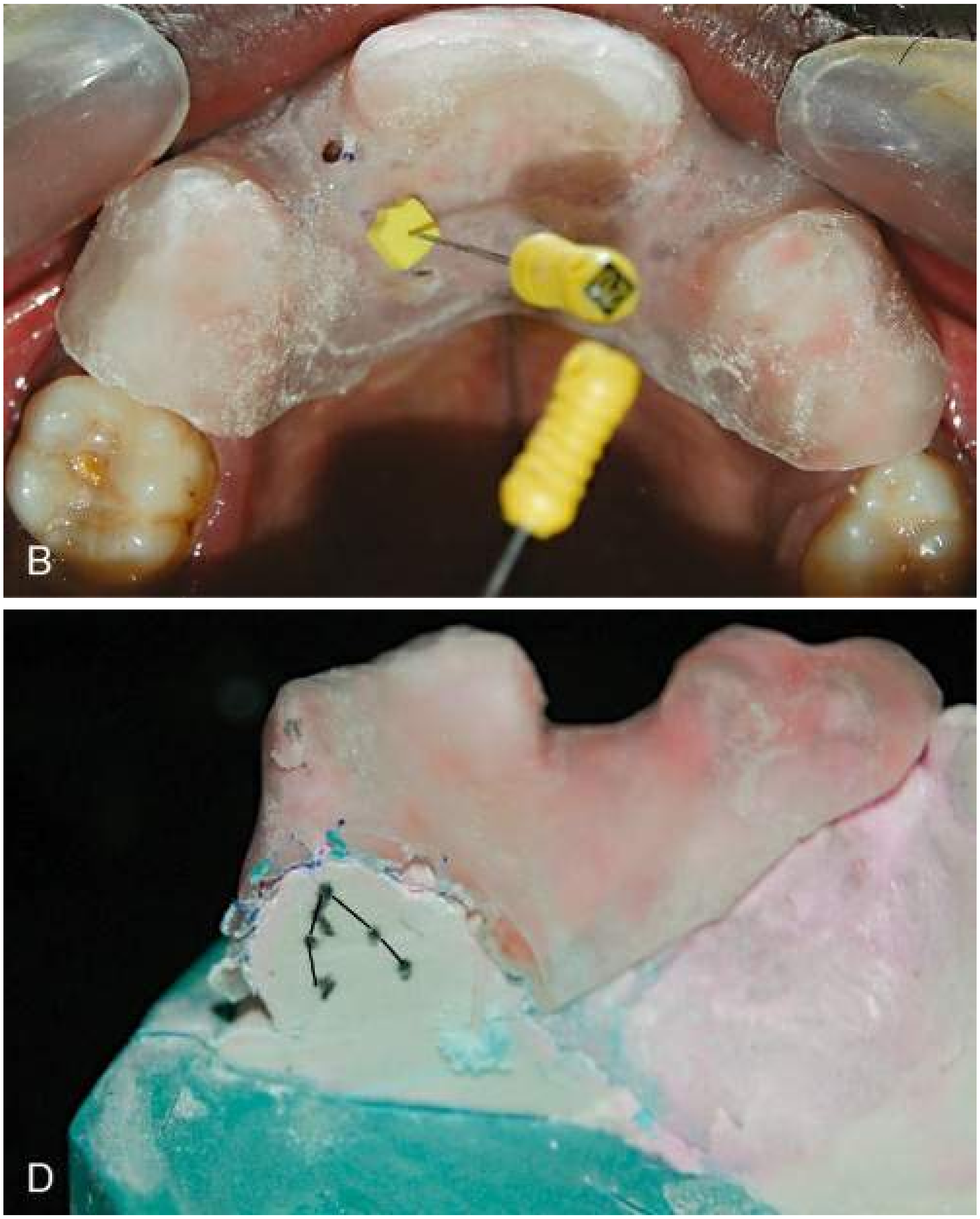


FIGURE 49.55 **(A)** Acrylic template with holes. **(B)** Endodontic file with stopper is used to pierce the mucosa through each hole and the thickness is marked. **(C)** The endodontic file measurement is marked on the same spot in the sectioned cast gingival depth. **(D)** Each measured point in the mouth is transferred to the corresponding area in the cast and joining the points gives an indication of available bone width and gingival thickness.

Treatment planning

• Single-tooth replacement

• Partially edentulous

• Completely edentulous

Single-tooth replacement

The single-tooth replacement by an implant-supported prosthesis requires a planned execution of treatment to achieve aesthetics, mastication and phonation.

Depending on the location of the tooth to be replaced in the anterior (aesthetic) region or posterior (nonaesthetic) area, the treatment plans vary.

Treatment plan for single-tooth replacement in aesthetic zone

Treatment planning for replacement of anterior tooth is governed by presence or loss of bone as in FP1 and FP2 cases, and the thickness of the mucosa. The requirements are

1. Emergence profile

2. Diameter of the implant

3. Gingival papilla – contour

4. Gingival zenith

5. Need for augmentation

6. Selection of abutments

1. Emergence profile

The emergence profile can be defined as the position and relationship of the crowns to the underlying mucoperiosteal layer and bone, which give the illusion, of the crown emerging from the gingival as seen in the natural tooth (Fig. 49.56). This is primarily dependent on the location of the head of the implant and the permucosal extension of the abutment. The permucosal extension is dependent on the height of placement of implant, diameter of the implant, and quality and quantity of the mucoperiosteal layer or the gingiva.

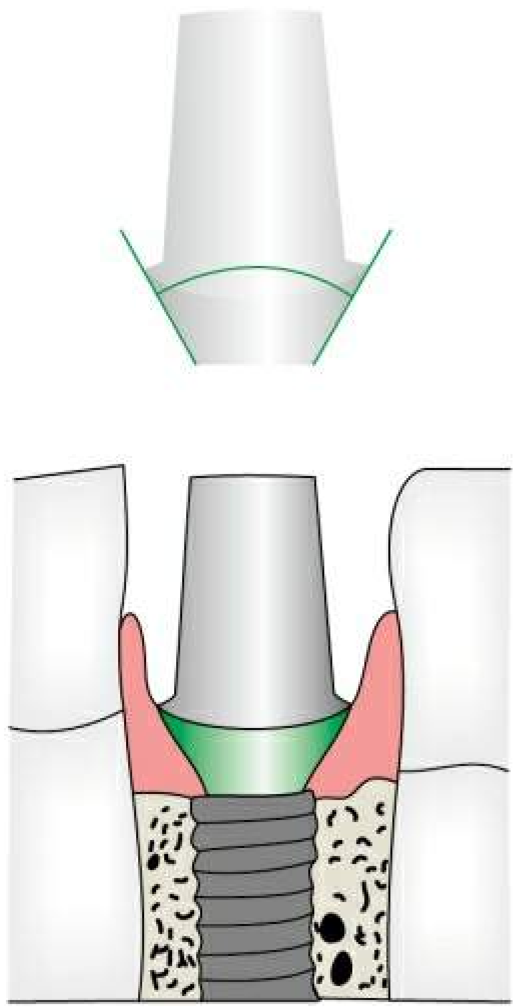


FIGURE 49.56 Emergence profile of implant prosthesis.

2. Diameter of the implant

The diameter of the implant plays a major role in aesthetics and the selection is depended on the available mesiodistal width of the edentulous area. The most important criterion in selection is that there should be a clear gap of 2 mm between the implant and the adjacent natural tooth abutment roots. The implant diameter will also have adverse effect on the emergence profile; therefore, optimum diameter should be selected.

3. Gingival papilla and contour

If the gingival papilla is present, it should be preserved (Fig. 49.57). The papilla can be preserved by altering the surgical incision to avoid the architecture of the papilla (Fig. 49.58). In cases where the papilla is absent (Fig. 49.59), it can be developed using multiple and sequential use of acrylic prosthesis (Fig. 49.60). Normally, the gingiva forms in 3–4 weeks. This is also an important aspect in immediate implantation cases.

FIGURE 49.57 Presence of papilla.

FIGURE 49.58 Incision lines preserving papilla.

FIGURE 49.59 Absence of papilla.

FIGURE 49.60 Custom acrylic provisional can be used sequentially to push the gingiva and develop the papilla.

4. Gingival zenith

The gingival zenith is formed by the cervical one-third contour of the crown. It is also dependent on the gingival biotype. The typical zenith for anterior teeth is shown in Fig. 49.61. Bone loss and bulky ceramic labial buildup will result in unacceptable zenith.

FIGURE 49.61 Gingival zenith for maxillary anteriors.

5. Need for augmentation

There are clinical situations where there will be deficient bone to place implants in the desired position. The deficiency may be either horizontal (Fig. 49.62) or vertical (Fig. 49.63). The horizontal defects can be augmented with bone grafts (allografts and autogenous) and expansion procedures like ridge split (Fig. 49.64), whereas the vertical augmentation can be done using autogenous block grafts (Fig. 49.65) and by distraction osteogenesis.

FIGURE 49.62 Horizontal defects where the width of bone is insufficient.

FIGURE 49.63 Vertical defects where the height is inadequate.

FIGURE 49.64 Ridge splitting and expansion to place implants in a horizontal defect.

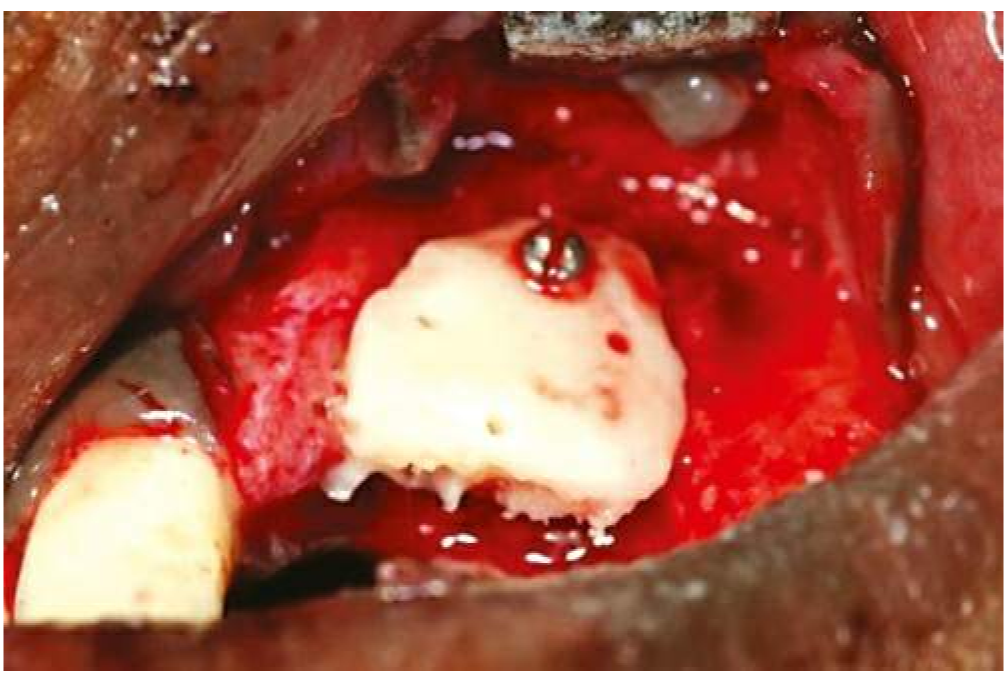


FIGURE 49.65 Autogenous block graft to augment a vertical defect.

6. Selection of abutments

Abutments can be made of metal or zirconium. The specific use of these combinations will depend on the aesthetic requirements of the patients and the gingival biotype. In general, metal abutments are used in thick biotype cases whereas the zirconium abutments are used in thin biotype.

Treatment plan for single-tooth replacement in nonaesthetic zone

Replacement of posterior teeth is primarily executed to restore the masticatory function of the patient. Since mastication is directly governed by the occlusal contacts and thereby the teeth, the position of the replaced teeth will guide the location of the implant. Hence, occlusion is an important consideration. The other factors that are involved in the treatment planning for posterior zone are

1. Number and diameter of implants

2. Interocclusal distance

3. Sinus elevation and augmentation

4. Immediate implantation

1. Number and diameter of implants

If the mesiodistal length of the edentulous area is very large, the large diameter implant cannot be accommodated due to the buccolingual anatomical deficiency. It will be a prudent plan to incorporate two smaller diameter implants and give two prosthetic bicuspids rather than a molar (Fig. 49.66).

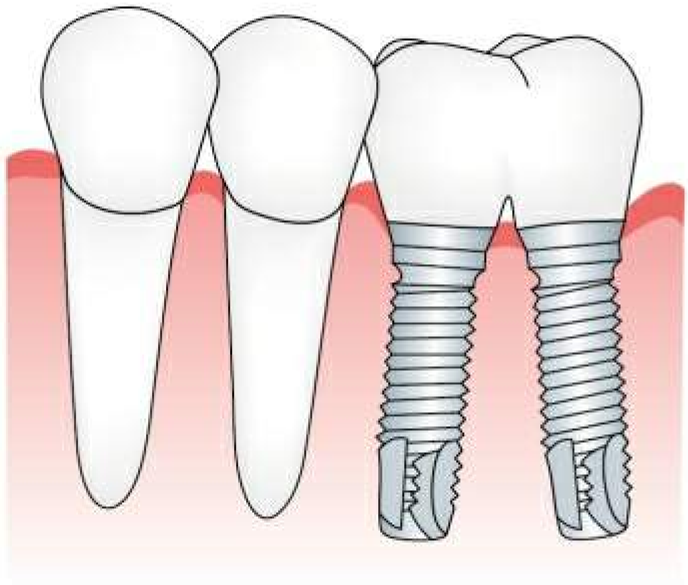


FIGURE 49.66 Two implants placed to replace one molar.

2. Interocclusal distance

Ideally the distance between the ridge and the occlusal plane of the antagonistic teeth should be 8 mm. If this distance is less, screw-retained prosthesis can be used to offer low-profile retention and if the distance is more it could be managed with onlay grafts (Fig. 49.67).

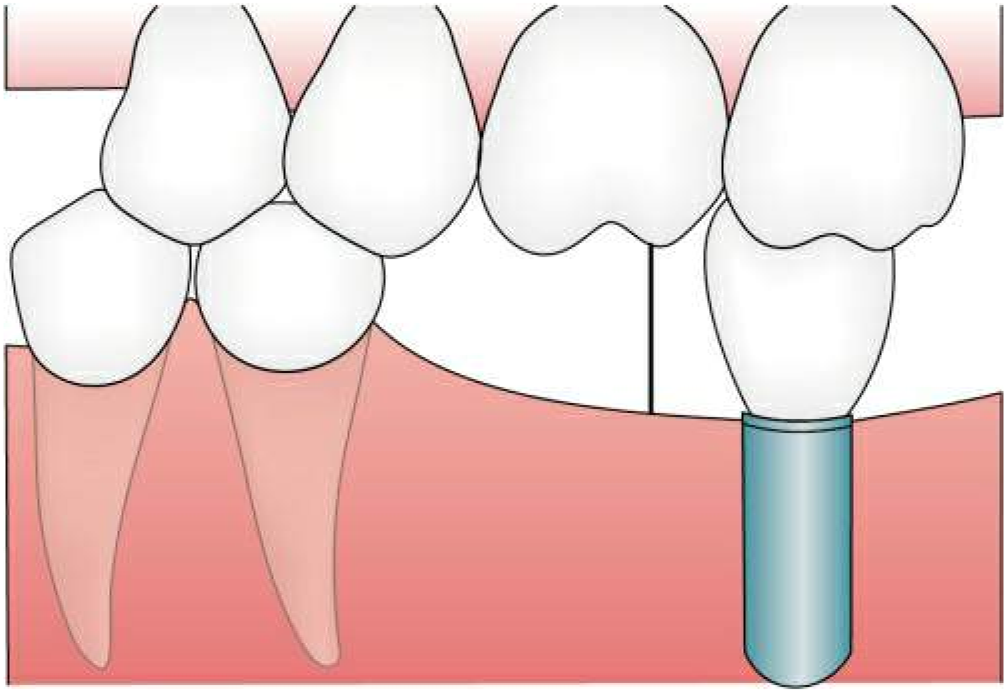


FIGURE 49.67 Interocclusal distance.

3. Sinus lift and grafting

Augmentation in posterior region is more relevant to maxillary situa tions, due to the presence and pneumatization of the maxillary sinuses. Maxillary sinus lift with grafting can be performed to increase the available bone height, either by direct technique or by indirect technique. Direct technique would involve a Caldwel-Luc surgical exposure of the sinus, followed by gentle elevation of the lining membrane and placement of the graft material. The graft material should be allowed to consolidate and mineralize for a period of at least 6–8 months, before placing the implants. Alternatively, the implants can be placed along with the graft in select situations (Figs 49.68–49.70). In the indirect method, the sinus floor is elevated through the osteotomy site and grafting done along with placement of implants. Refer to Table 49.2 for the treatment planning.

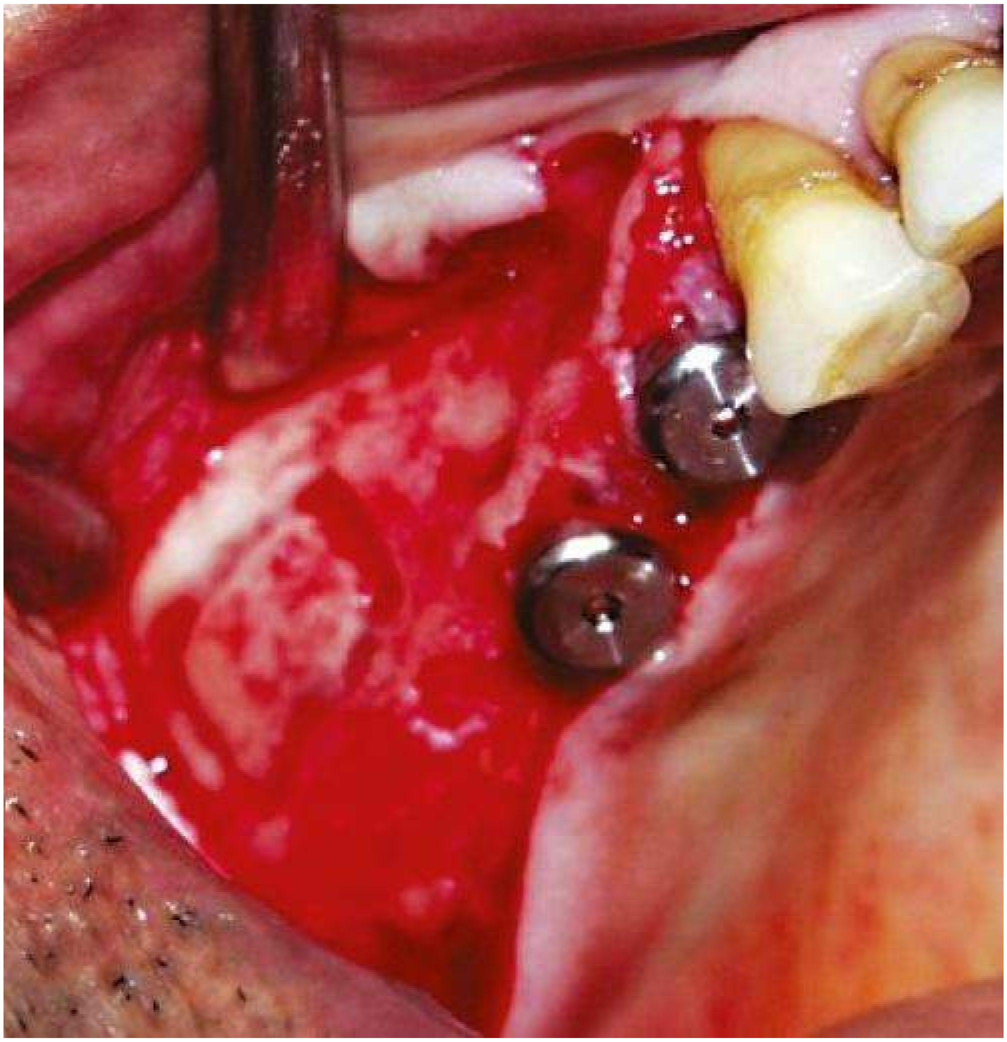


FIGURE 49.68 Lateral window created to expose the sinus membrane.

FIGURE 49.69 Sinus floor is elevated (sinus lift).

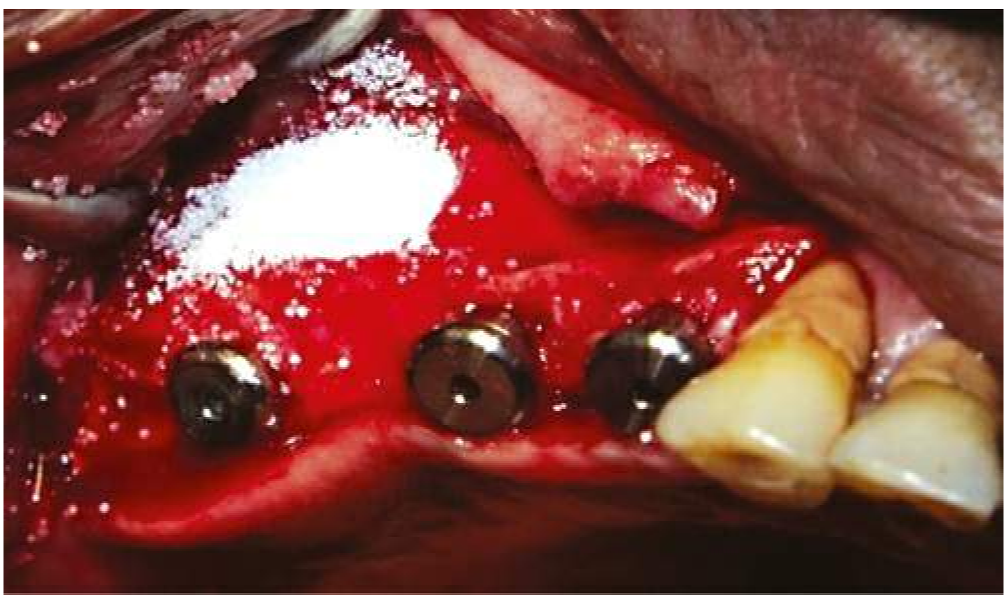


FIGURE 49.70 Sinus grafting with placement of implant.

Table 49.2

Treatment plans for posterior edentulous maxilla

Type	Height of bone	Treatment	Total healing period
SA-1	>12 mm	Placement of root form implants directly	4–6 months
SA-2	10–12 mm	sinus lift + simultaneous placement of root form implants	6–8 months
SA-3	5–10 mm	sinus graft + simultaneous placement of root form implants	6–8 months
SA-4	<5 mm	Sinus grafting + delayed placement of root form implants after a graft healing period of 6–10 months	10–20 months

Courtesy: Misch CE. Contemporary Implant Dentistry, 3rd ed. St. Louis: Mosby, 2008, p. 396.

4. Immediate implantation

The implant is placed immediately following the extraction of the teeth (Figs 49.71–49.73).

FIGURE 49.71 Fractured maxillary lateral incisor.

FIGURE 49.72 Atraumatic extraction with bone preservation.

FIGURE 49.73 Implant placed immediately following extraction of teeth.

Advantages

- Reduced surgical visits and treatment time
- Ideal orientation of implant
- Preservation of bone at extraction site
- Optimal soft tissue aesthetics

The teeth should be removed with least trauma. It is not recommended in the presence of infection and if the buccal cortical plate is thin or fractured. Primary stability of implant should be at least 35 N.

Partially edentulous

In the partially edentulous situation, fixed prostheses are indicated with implants. The prostheses may be of the following types:

- Independent crowns supported by implants with/without splinting (Fig. 49.74A).
- Fixed partial dentures supported by implants.
- Fixed partial dentures supported by natural teeth and implants (Fig. 49.74B).

A

FIGURE 49.74 **(A)** Class III partially edentulous space restored with implant-supported crowns (*Courtesy:* Dr D Arunachalam). **(B)** Class II partially edentulous space restored with fixed partial denture using implant and natural tooth for support.

The treatment plan depends on the location of the edentulous space, available bone, bone density and patient affordability.

The 'available bone volume' classification developed by Misch and Judy (described previously) is integrated on the four classes of partial edentulism described in the Kennedy–Applegate system.

Hence, all four Kennedy's classifications (class I–IV) in mandible and maxilla can have divisions (A–D); type of bones and treatment plan are as follows.

Mandible – classes I, II, III (posterior)

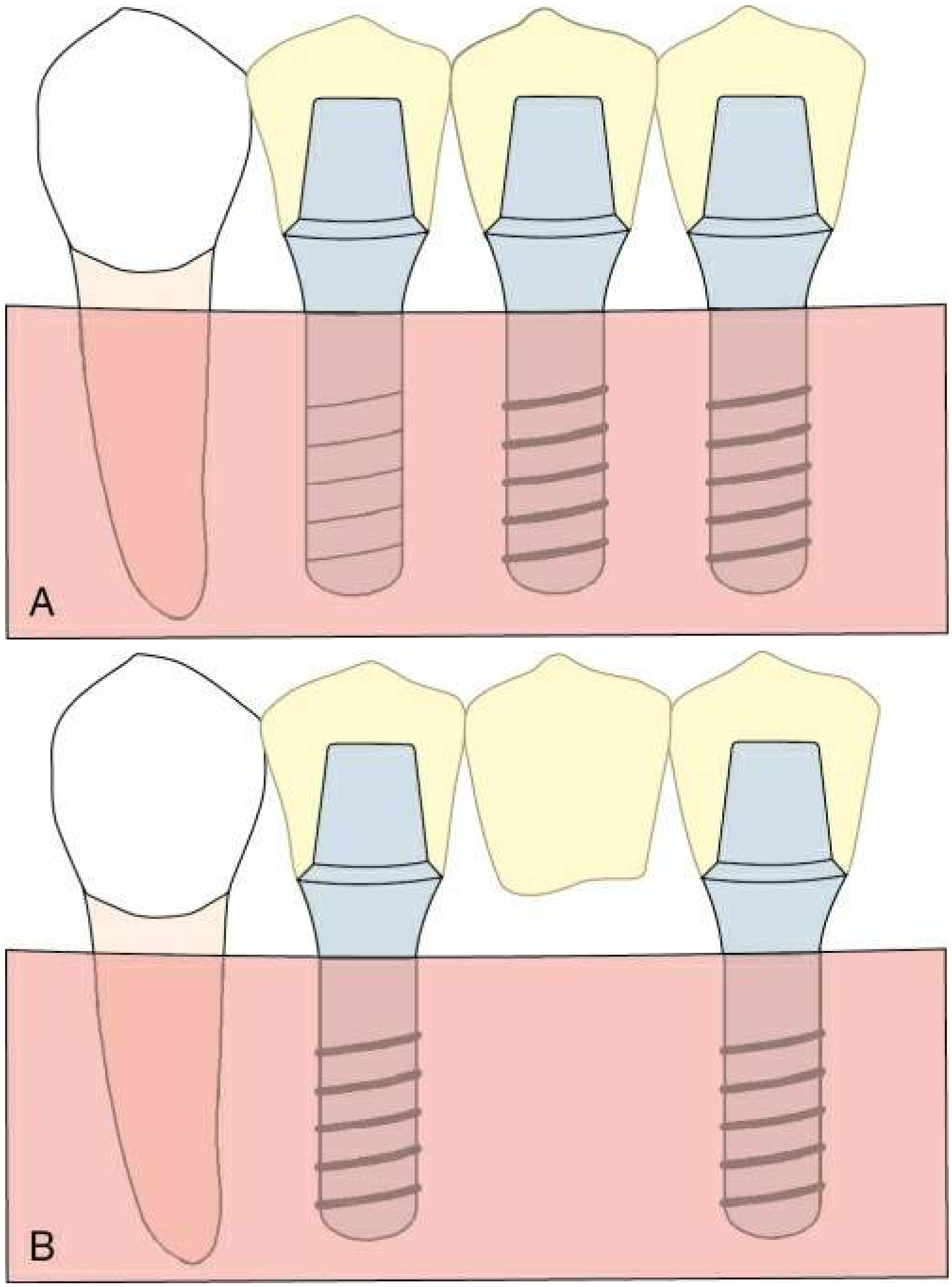
The main anatomical concern in the posterior mandible is the inferior alveolar canal and mental foramen. Available bone volume should be 2 mm above the canal.

Division A

The following types of restorations are indicated:

- Implants with diameter greater than 4 mm are indicated.
- Independent implant-supported fixed prosthesis (separate crowns) – (Fig. 49.75A).
- Two implants to support a three-unit FPD with a central pontic (Fig. 49.75B).

- A mesial cantilever is also indicated (Fig. 49.75C).
- The greater the number of missing teeth, the larger the size and/or number of implants required.



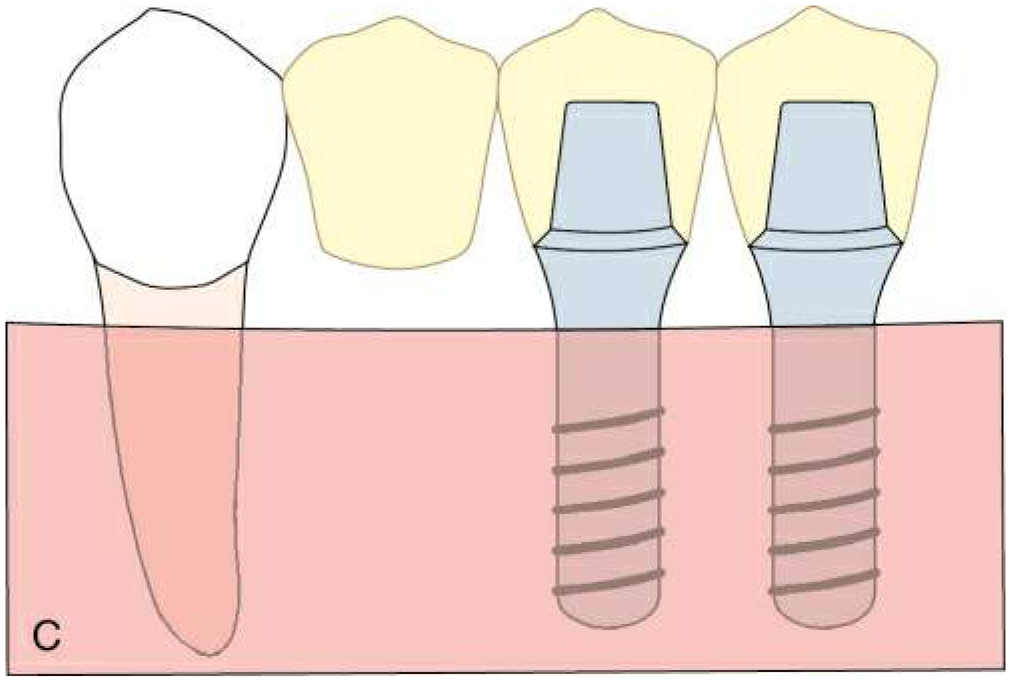


FIGURE 49.75 **(A)** Division A treatment plan – three implants with separate independent crowns. **(B)** Second option – two implants with a central pontic. **(C)** Third option – two implants with a mesial cantilever.

Division B

- Endosteal small diameter implants (less than 4 mm diameter) may be placed.
- The smaller diameter suggests the use of one implant for every missing tooth root with splinting (Fig. 49.76).
- No cantilever.

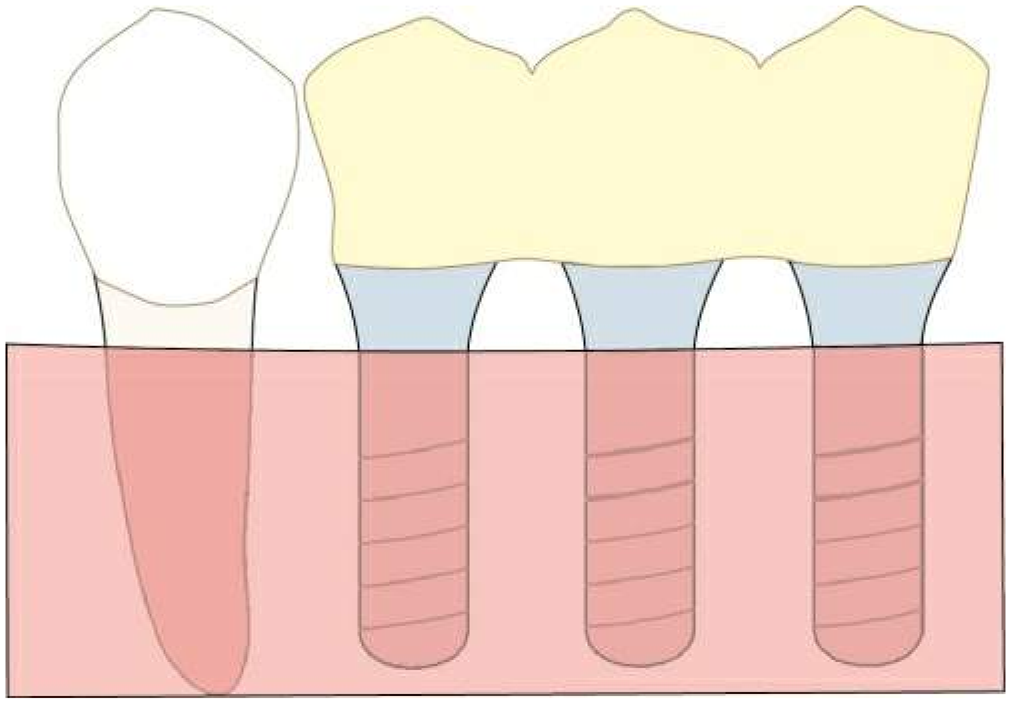


FIGURE 49.76 Division B.

Division C

Subperiosteal implants – unilateral or bilateral are indicated (Fig. 49.13). If endosteal implants are to be used, then nerve repositioning and/or bone augmentation may be necessary.

Division D

Require bone augmentation and bone grafting before implants can be placed. After grafting, they will be considered as divisions A or B depending on the available bone.

Mandibular class III (anterior) and class IV

It is similar to classes I and II. Since it involves the anterior regions, division B bone may also require augmentation if patient desires a FP1 type of prostheses to enhance aesthetics, crown contour and maintenance. Endosteal implants can be placed in division C type of bone by osteoplasty (reducing the crest, thereby increasing the width), if aesthetics is not a major concern, as bone density will be good and masticatory dynamics is not a problem – FP2 type of prostheses can be placed.

Maxilla

Classes I, II and III (posterior)

The main anatomical concern in the posterior maxilla is the maxillary sinus. Misch (1987) classified bone volume in the sinus area into four types depending on the height of available bone – SA 1–4 (subantral augmentation).

The classification and treatment plan for each type are given in Table 49.2.

Depending on the amount of bone available, division A or B treatment plan is implemented.

Class III (anterior) and class IV

Bone density (quality) is poorer compared to mandible. Hence, division B type of bone may also need to be augmented to be converted to division A following which endosteal implants are placed. Division A treatment is as described previously.

Connecting implants to natural teeth

The difference in movement of a natural tooth (surrounded by periodontal ligament) and implant (ankylosed to bone) was sited as a reason for not connecting implants to natural teeth – using natural tooth as abutment on one side and implant abutment on the other side to support a fixed partial denture. Intrusion of natural tooth and screw loosening in implant abutment were common problems. The reason for this was use of temporary cement to lute the implant and natural tooth retainer and use of nonrigid connectors.

Currently, connecting implants to natural tooth is no longer considered taboo and the same is indicated provided the natural tooth exhibits:

- No mobility
- Good retentive form

- Adequate crown height
- Minimum 1:1 crown root ratio
- Free of caries
- Good endodontic status

The implant retainer may be cemented by using a temporary/provisional cement but the natural tooth retainer should be luted with a definitive cement.

Indication

- Classes I, II and posterior class III (Fig. 49.74B).

Contraindication

- Anterior teeth replacement, as heavy lateral forces are involved.

Cement-retained and screw-retained restorations

Fixed prosthesis is indicated in partially edentulous arches and single-tooth replacements with implants. As previously discussed, these fixed restorations can be attached to the implant abutment using cement or screws. Each of these is assessed below, which will aid in their selection:

Cement-retained restorations (**fig. 49.32**a)

- This is most commonly and routinely used.
- Loss of cementation is rare compared to screw loosening from the prostheses.
- Fit is passive, no tightening with screws.
- No need to provide space for a screw on the occlusal surface, which has the following advantages:

- ○ More axial loading as occlusal table can be made narrow.
- ○ Aesthetics and hygiene better.
- ○ Less occlusal material fracture.
- ○ No fatigue failure.

- Progressive loading can be commenced with provisional restorations.
- Sealed abutment-crown crevice.
- Less cost and time.

Screw-retained restorations (fig. 49.32b)

- Retrievability – if there is any problem, the restoration can be easily removed by just unscrewing.
- Low profile retention.
- Indicated in limited interarch space.
- No cement in sulcus problem.

Completely edentulous

Both fixed and removable dentures can be planned for the completely edentulous patient.

1. Removable prostheses (overdenture)
2. Fixed prostheses

i. Full arch crowns/bridges (Fig. 49.77)

ii. Fixed-detachable bridge (hybrid denture) (Fig. 49.33)

FIGURE 49.77 Full arch bridge.

The treatment plan will depend on the available bone, bone density and patient affordability. Misch classified edentulous arches and integrated the bone volume classification (divisions A–D) into it, along with treatment plans.

The edentulous arches were divided into three segments (Fig. 49.78):

- Anterior
  - Maxilla – between the I premolar area on either side
  - Mandible – between the mental foramen on either side
- Right posterior (patient's right side)
- Left posterior (patient's left side).

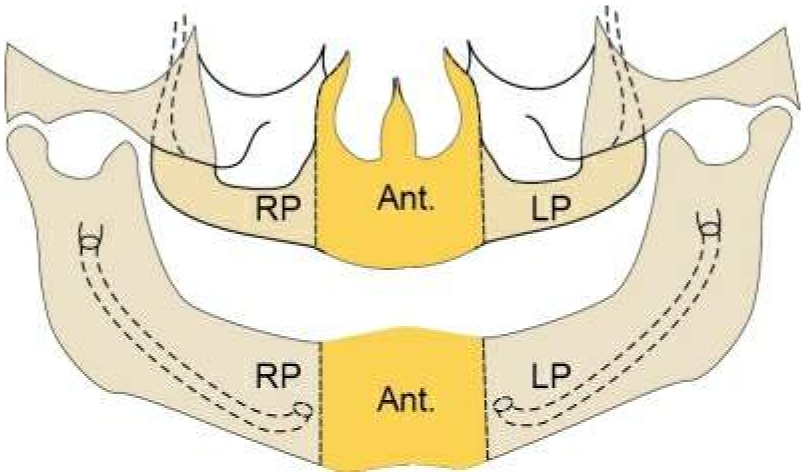


FIGURE 49.78 Misch classification of completely edentulous arches.

Type I: Volume of available bone is similar in all three segments.

Type II: Volume of available bone is similar posteriorly but differs anteriorly.

Type III: Volume of available bone is dissimilar in all three segments.

- A fully fixed prostheses with implant supported anteriorly and posteriorly are possible only when division A and/or division B bone is available in all three segments. A hybrid/overdenture prosthesis provided better lip support and aesthetics if there is bone resorption anteriorly.

- A hybrid prosthesis is possible when there is deficient bone posteriorly, but anteriorly there should be division A/division B bone.

- An overdenture is possible when there is division A/division B/division C and sometimes even division D bone anteriorly, but deficient bone posteriorly. Maxillary overdentures will require more implants (minimum of four) while mandibular overdenture can be planned with two implants.

- A deficient posterior region can be augmented by bone grafting.

Then fixed prosthesis is possible.

Overdentures

These are a cost-effective removable treatment option for the completely edentulous individual.

Advantages over conventional complete dentures

- Better retention, stability and support.
- Improved chewing speech.
- Reduced prosthesis size.
- Reduced anterior bone loss.

Advantages of overdentures compared to fixed implant prostheses

- Fewer implants
- Improved aesthetics
- Better hygiene and maintenance
- Less cost
- Less specific placement

Disadvantages

- Psychological (need for fixed teeth)
- Space (interarch) required for attachments (Table 49.1)
- Long-term maintenance due to continued posterior bone loss

- Food impaction
- Movement of denture

Overdenture movement

Carl Misch classified the degree or range of movement of an overdenture into five types. It was termed as ‘prosthesis movement (PM)’.

1. **PM0:** No movement, denture is rigid.
2. **PM2:** Movement in two planes, having hinge movement.
3. **PM3:** Apical and hinge movement.
4. **PM4:** Movement in four planes – mesial, distal, facial and lingual. This is generally featured in an overdenture using magnetic attachments.
5. **PM6:** Movement in all planes. The movement is dependent on:

    i. Number of implants and position

    ii. Type of attachment

Overdenture treatment options

Mandibular implant overdentures are more common because of the better quality of bone in the mandibular anterior region and patients generally have more problems with the mandibular conventional complete dentures. The location of the implant for mandibular overdentures should be anterior and symmetric to midline.

Anterior placement is considered due to:

- Minimal anatomical concerns.

- Optimal dentistry.
- Advantages in retention and stability.

The number of implants depends on the following:

- Desired degree of retention and comfort.
- Curve of ridge.
- Patients' age.
- Cost.

The location is determined by mapping the mandibular anterior edentulous region into five regions – A, B, C, D and E (Fig. 49.79). A and E are positioned 5 mm anterior to the mental foramen, while C is in the centre. B and D are located midway between AC and CE, respectively.

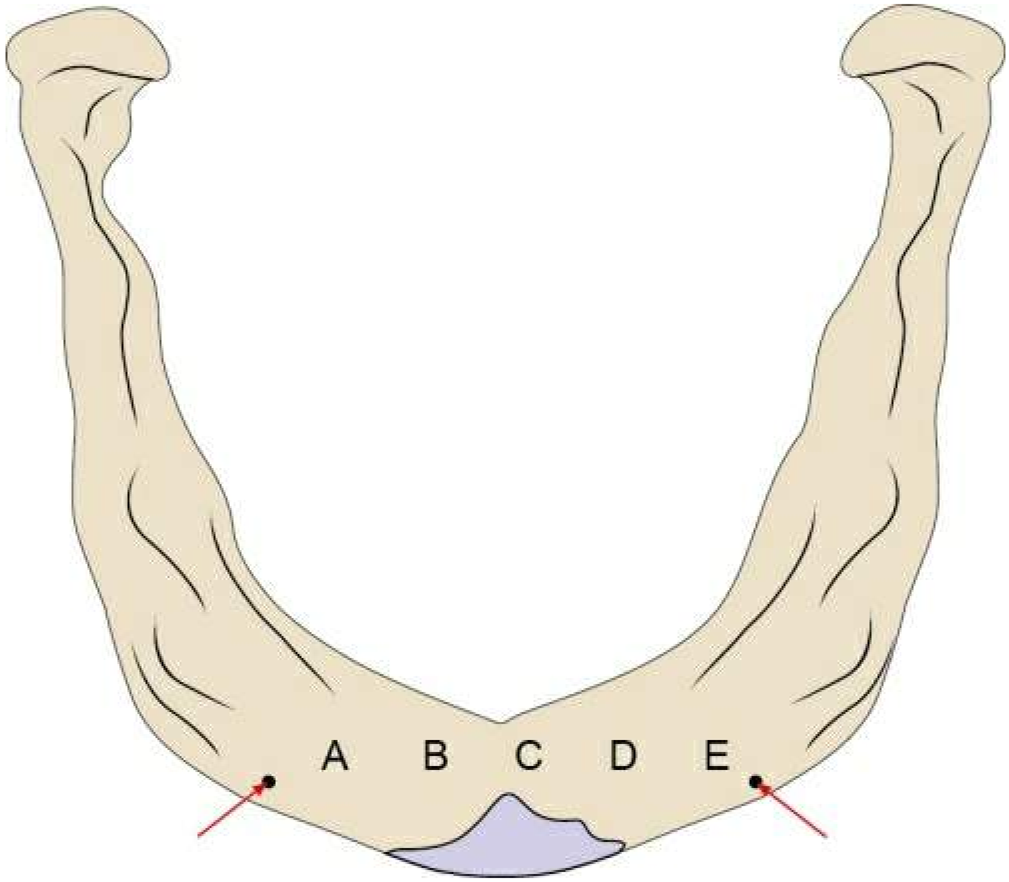
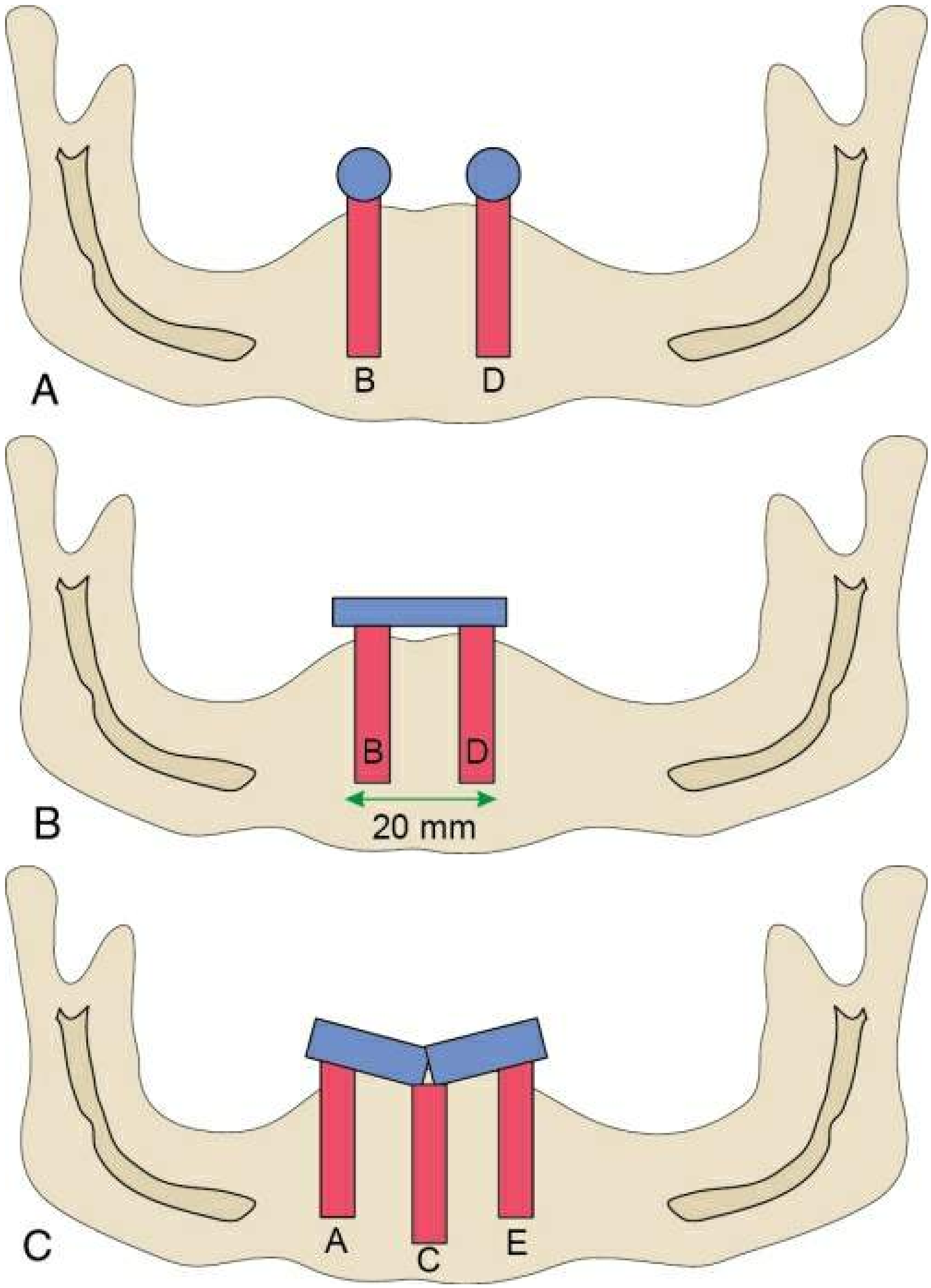


FIGURE 49.79 The anterior mandible is divided into five equal columns of bone between the mental foramen A, B, C, D, and E.

The treatment options are shown in Fig. 49.80A–F and summarized in Table 49.3.



A
B
D
B
B
D
20 mm
C
A
C
E

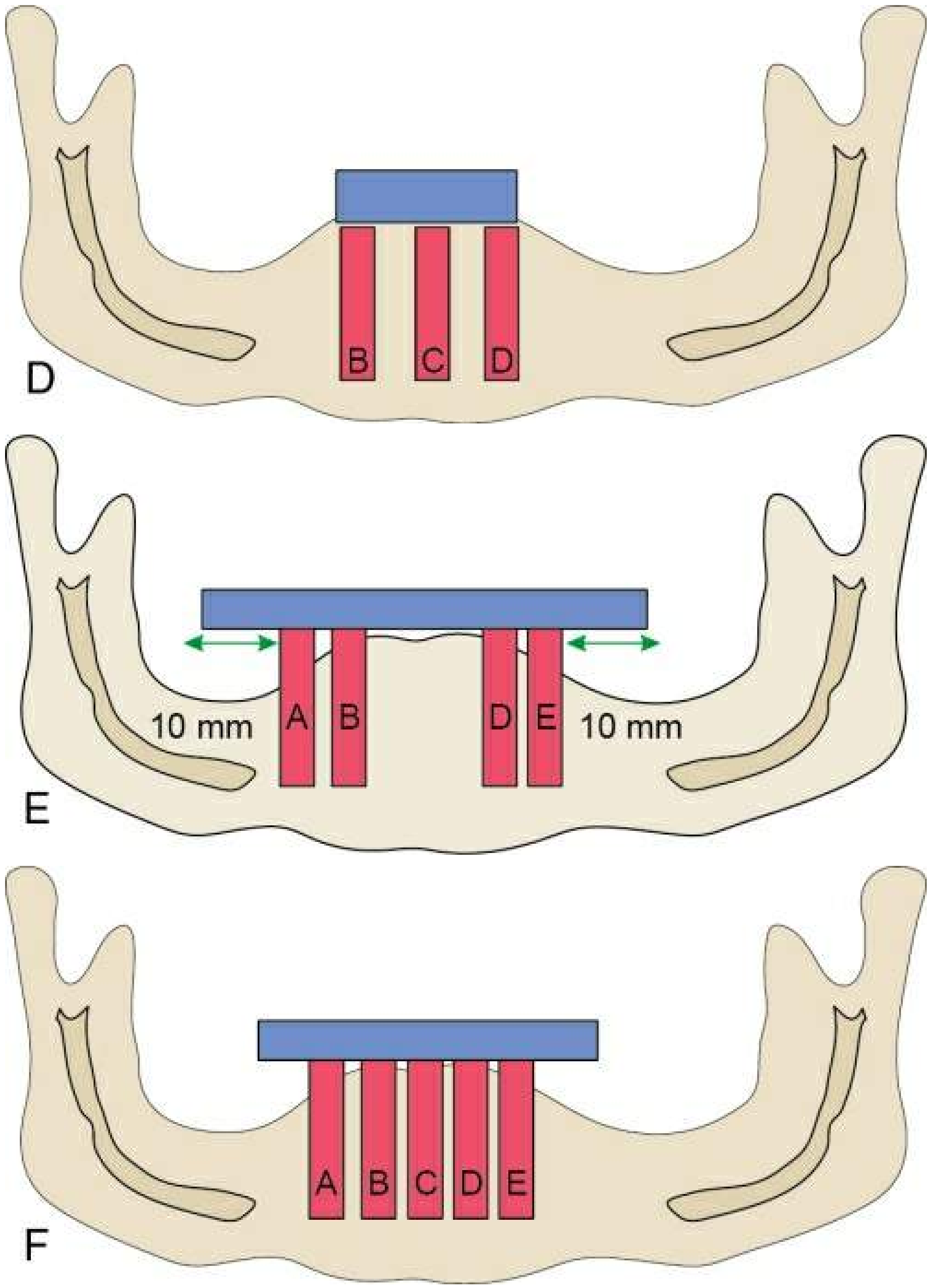


FIGURE 49.80 **(A)** OD1 – implants in band D position, overdenture using stud attachments. **(B)** Implants in B and D position connected by a bar attachment. **(C)** OD3A – implants placed in A, C, E positions connected by a bar. **(D)** OD3B – implants placed in B, C and D positions connected by bar. **(E)** OD4 – implants in A, B, D, E positions connected by bar, distal cantilever 10 mm. **(F)** OD5 – implants in A, B, C, D, E positions distal cantilever 15 mm.

Table 49.3

Mandibular overdenture treatment options (RP5)

Option	Implant position	Indication and description
OD-1	Implants in the B and D positions are independent of each other (Fig. 49.80A)	Ideal anterior and posterior ridge formWhen cost is major factor Retention only, PM6
OD-2	Implants in the B and D position rigidly joined by a bar (Fig. 49.80B)	Ideal posterior ridge formIdeal denture When cost is a major factor Retention and minor stability, PM3 to PM6
OD-3A	Implants in the A, C, and E position, rigidly joined by a bar if posterior ridge form is good (Fig. 49.80C)	Ideal posterior ridge formIdeal denture Retention and moderate stability, PM2 to PM6 (two-legged chair)
OD-3B	Implants in the B, C, and D positions, joined by a bar when posterior ridge form is poor (Fig. 49.80D)	Division C-h has anterior bone volumePoor posterior ridge form Retention and minor stability, PM3 to PM6
OD-4	Implants in A, B, D, and E positions, rigidly joined by a bar cantilevered distally about 10 mm (Fig. 49.80E)	Patient desires greater retention, major stability and support, PM2 to PM6 (three-legged chair)
OD-5	Implants in the A, B, C, D, and E positions, rigidly joined by a bar cantilevered distally about 15 mm (Fig. 49.80F)	Patient has high demands or desiresRetention, stability, support, PM0 (four-legged chair)

Courtesy: Misch CE. Contemporary Implant Dentistry, 3rd ed. St. Louis: Mosby, 2008, p. 301.

Maxillary implant overdentures require a minimum of four implants splinted with a bar attachment. This is due to the poor bone quality and the lateral forces involved in that region. Cantilevered bars are also not advocated. Implants can be placed in the canine and central incisor regions.

Surgical phase

Armamentarium

1. Physiodispenser (fig. 49.81)

Physiodispenser is a device designed for implant surgical operations with speed and torque controls. The microprocessor constantly controls the flow of physiological solution in millilitres per minute. To achieve primary stability the minimum torque required is 25 N·cm, it may be increased to 35 N·cm for dense bone. The speed controls range from 800–1200 rpm for implant placement.

FIGURE 49.81 Parts of a typical physiodispenser 1. Display & controls 2. Foot pedal 3. Micromotor 4. Handpiece stand 5. Stand for normal saline 6. Irrigation set 7. Reduction gear handpiece.

The physiodispensor is the specified equipment for osteotomy, which drives the implant into the osteotomized site. These motors are capable of running at different speeds and with different torques. As in case of osteotomy of anterior mandible, the bone in this site will be very dense, so the speed should be adjusted. If by slowing the motor stops to prevent this, the torque has to be increased. If torque is increased the resistance will also increase resulting in heat generation. So this equipment has adjustable coolant control also.

2. Handpiece

A reduction gear handpiece which is normally indicated for surgical use, reduces the speed of rotation at the delivery point, with high torque. Handpiece should provide precision, safety and flexibility for surgical procedure. High efficiency reduction gears provide safety by reducing the clearance of bur chuck and minimizes bur run out. Double water injection maximizes the cooling effect. Central and external water injections ensure reliable delivery to treatment area.

3. Implant kit

Implant kit consists of the following (Fig. 49.82):

- Surgical drills of various sizes specific to the implant system to perform osteotomy.
- Hex driver to drive the implant and implant components.
- Drill extender – used in situations, where the implant site is located deep in relation to the adjacent natural teeth and head of the handpiece encounters a mechanical interference due to this.
- Torque wrench to hold driver and torque the implant and implant component manually. It is also termed as ratchet.
- Paralleling pins to check the implant angle when multiple implants are placed.


A


B


C

FIGURE 49.82 **(A)** Surgical drills in increasing diameters and the black markings show the different lengths. **(B)** Hex driver. **(C)** Drill extender. **(D)** Paralleling pins with depth markings.

Implant placement

- Preoperative care
- Sterilization
- Prevention of excess of heat generation
- Anaesthesia and flap design
- Preparing the osteotomy site – flattening the site, first starting with round bur and sequentially enlarging

- Placing the implant (one and two stage)
- Suturing
- Postoperative care

Sterilization

Sterile environment is important for the success of any surgical procedure. Patients should rinse mouth with chlorhexidine gluconate for 30 s before the procedure.

Surgical suit should be similar to an operating room setting with cap, mask, sterile instruments, gloves, gown and drape.

Prevention of excess of heat generation

Excessive heat generation on implant site is avoided by using:

1. High speed motor not exceeding 2000 rpm and low speed not exceeding 40–50 rpm.

2. Sterile water irrigation either internally cools the bur or externally where the assistant irrigates the bur and bone when the surgeon is drilling the bone.

Anaesthesia and flap design

Adequate exposure of the surgical site but not at the expense of excessive stripping of the periosteum and compromise of the blood supply necessary for the implant and surgical wound healing. The flap design should allow for primary closure without tension of the flap.

Flap design and incision

- A crestal incision made bisecting the existing keratinized tissues (Fig. 49.83A).

- Vertical incision may be needed one or both the ends.
- Facial and lingual flaps in posterior areas should be carefully thinned before reflection to minimize the soft tissue thickness.
- The soft tissue is not thinned in anterior or other aesthetic areas of the mouth to prevent the metal collar exposure.
- Full thickness flaps are elevated facially and lingually (Fig. 49.83B).

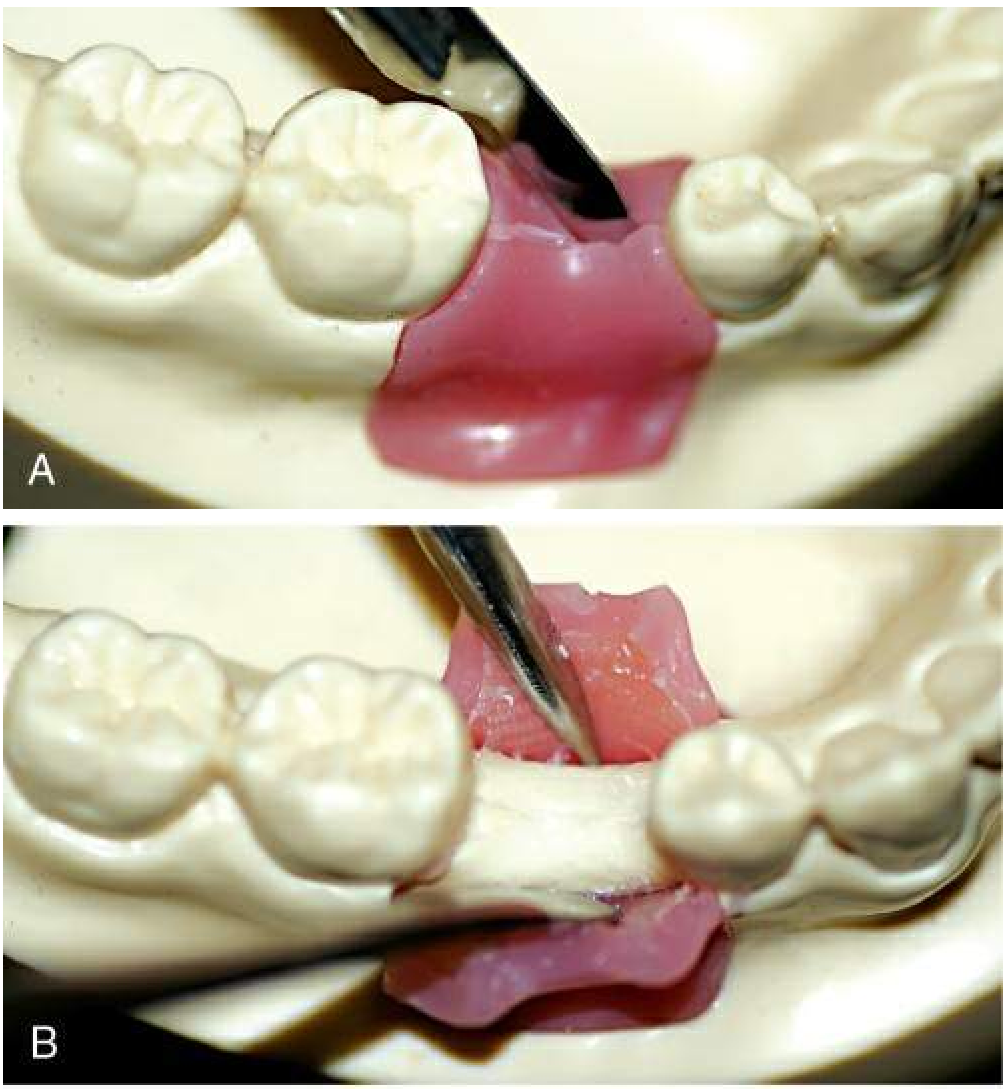
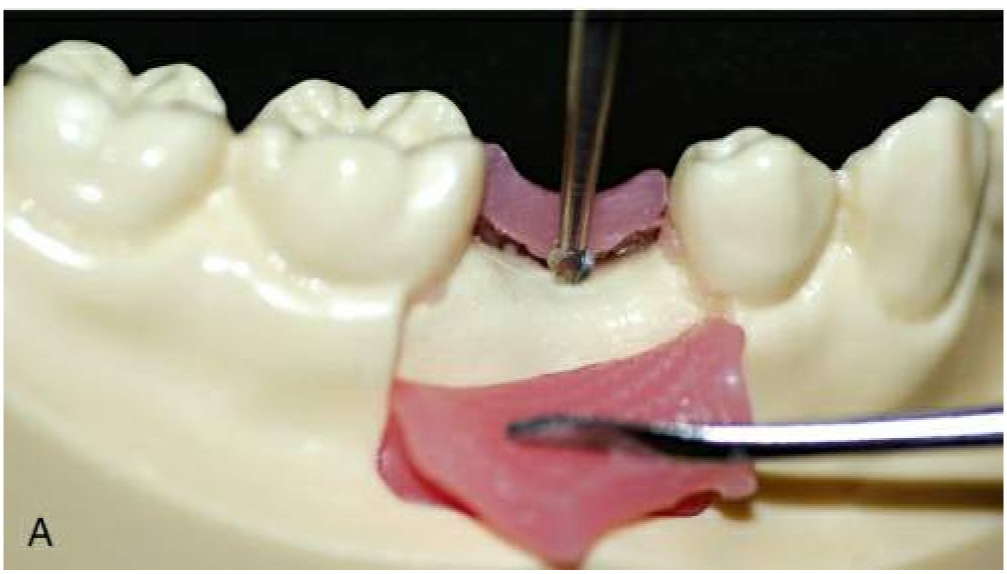
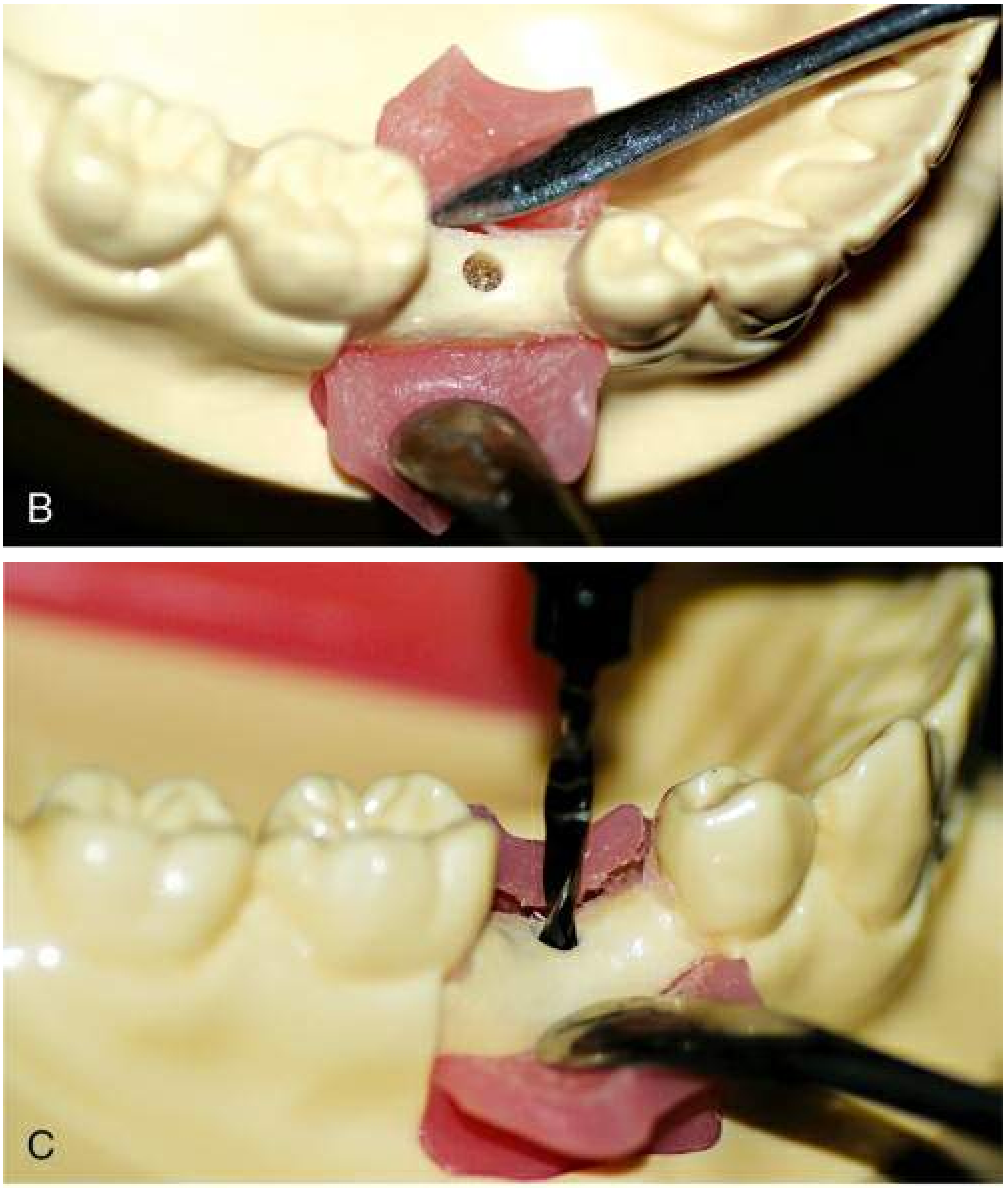


FIGURE 49.83 **(A)** Crestal incision. **(B)** Full thickness flap raised.

Preparing the osteotomy site

The crestal bone is flattened with straight fissure bur if needed. The surgical guide/template is placed to guide the implant placement in the planned position. A round bur may be used to mark the location on the bone and to penetrate the cortical plate (Fig. 49.84A and B). A 2 mm pilot drill is the first drill to be used in most implant systems (Fig. 49.84C and D). The osteotomy is prepared to the planned length and an RVG taken at this point with the drill or paralleling pin in place will give an indication regarding the implant angulation and its proximity to vital structures (Fig. 49.44A). Any changes can then be incorporated with the subsequent drilling. Subsequently, larger drills are used to enlarge the osteotomy site. The final drill should not exceed the implant width and its dimensions depend on the quality of bone (Fig. 49.84E and F).

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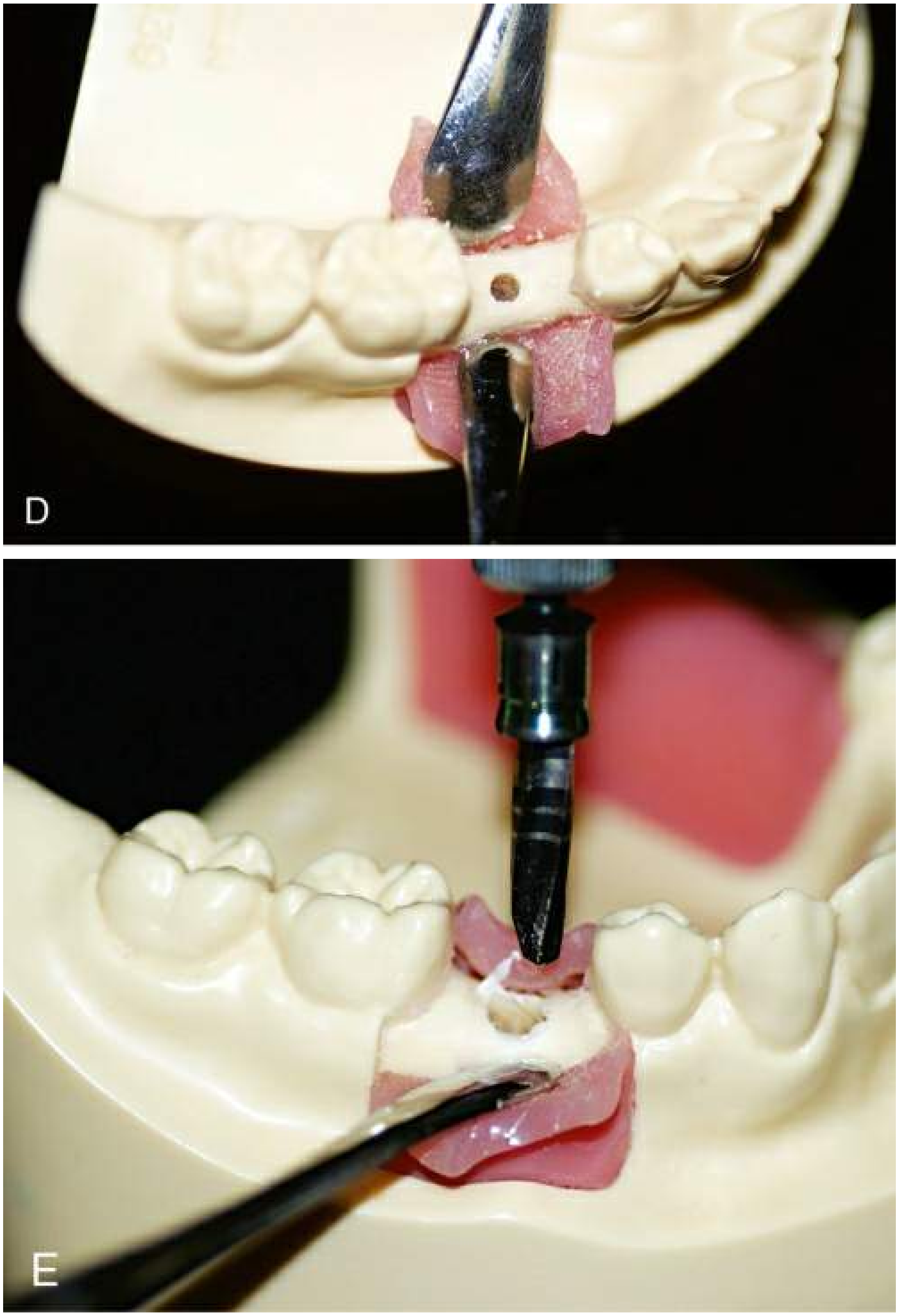
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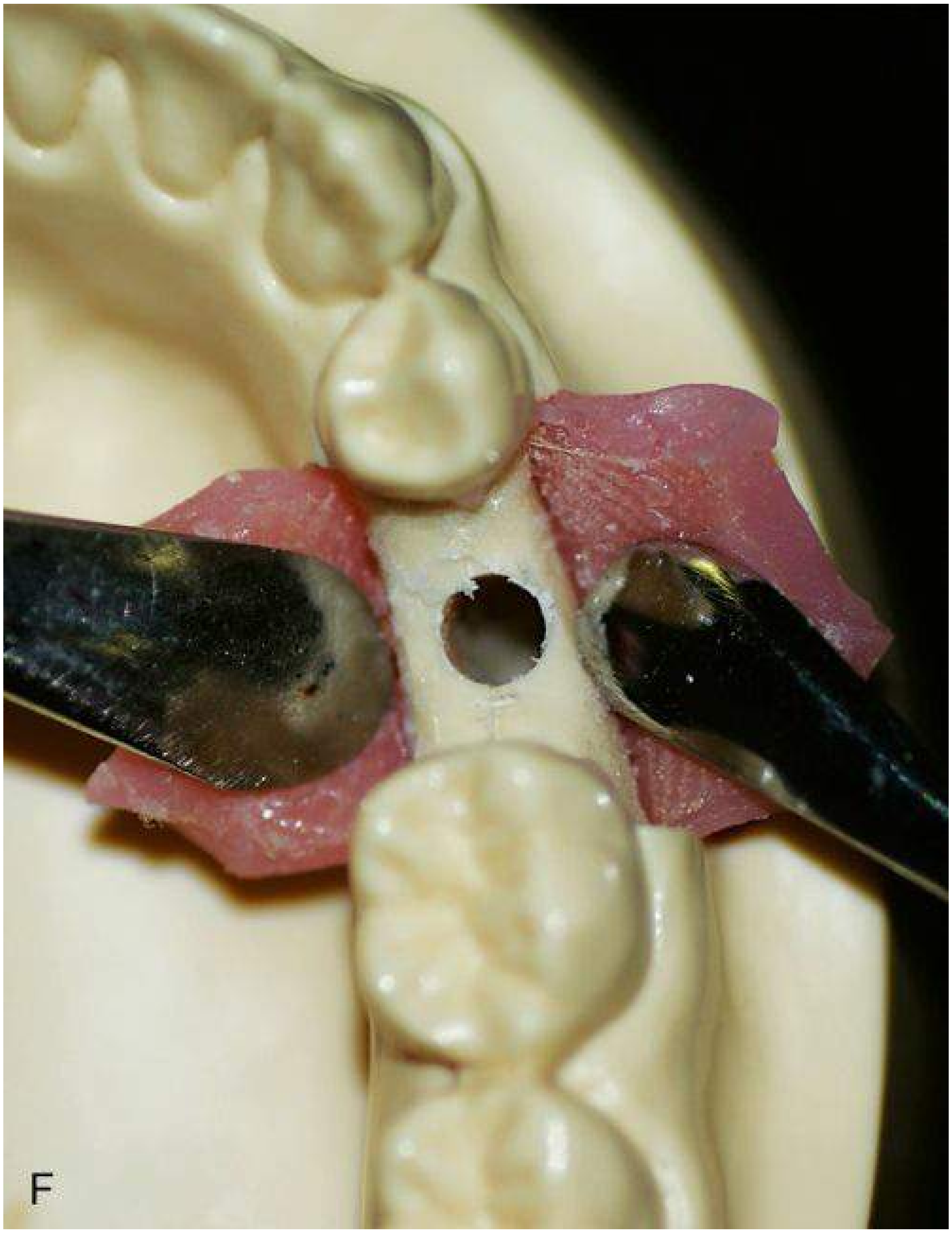

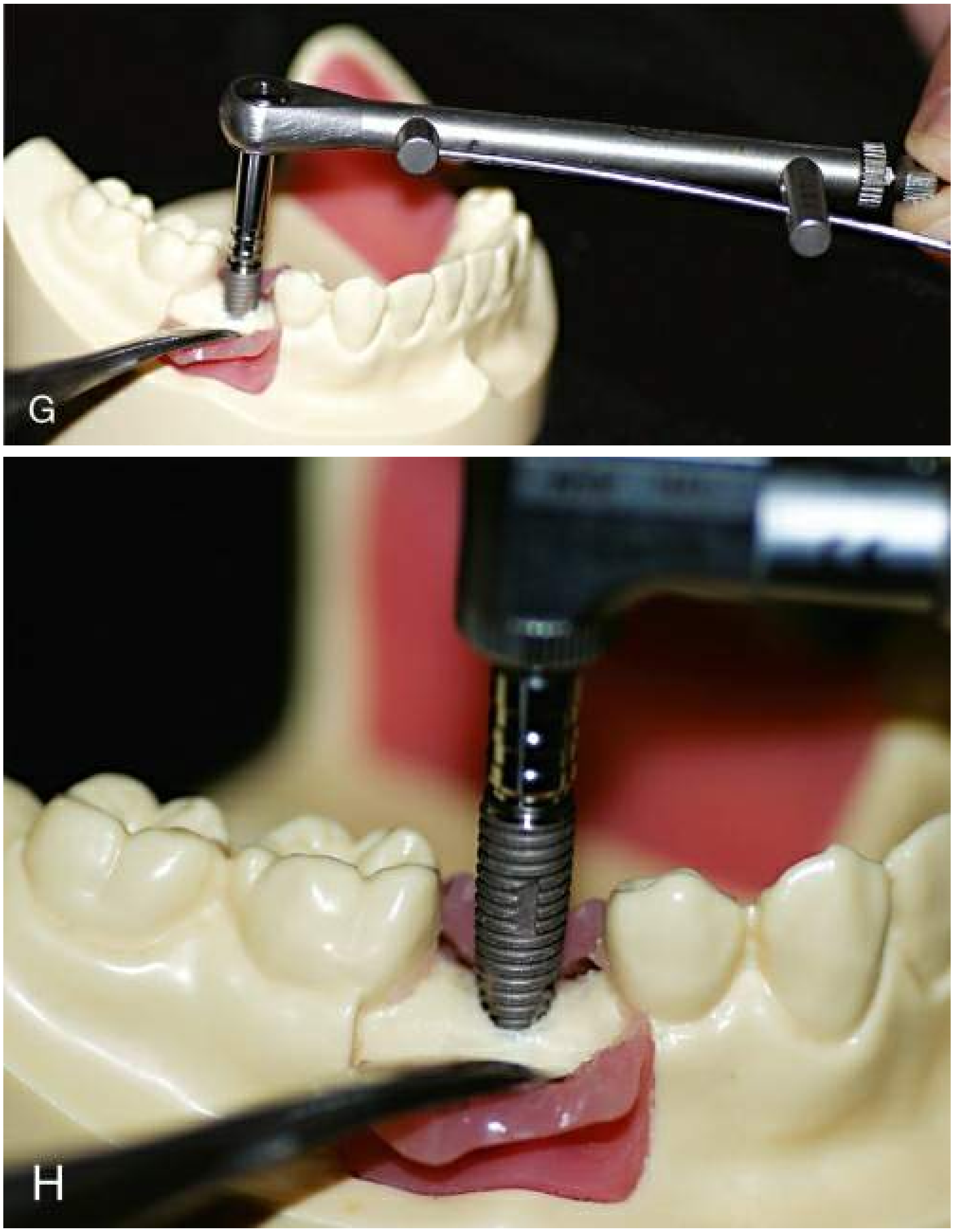
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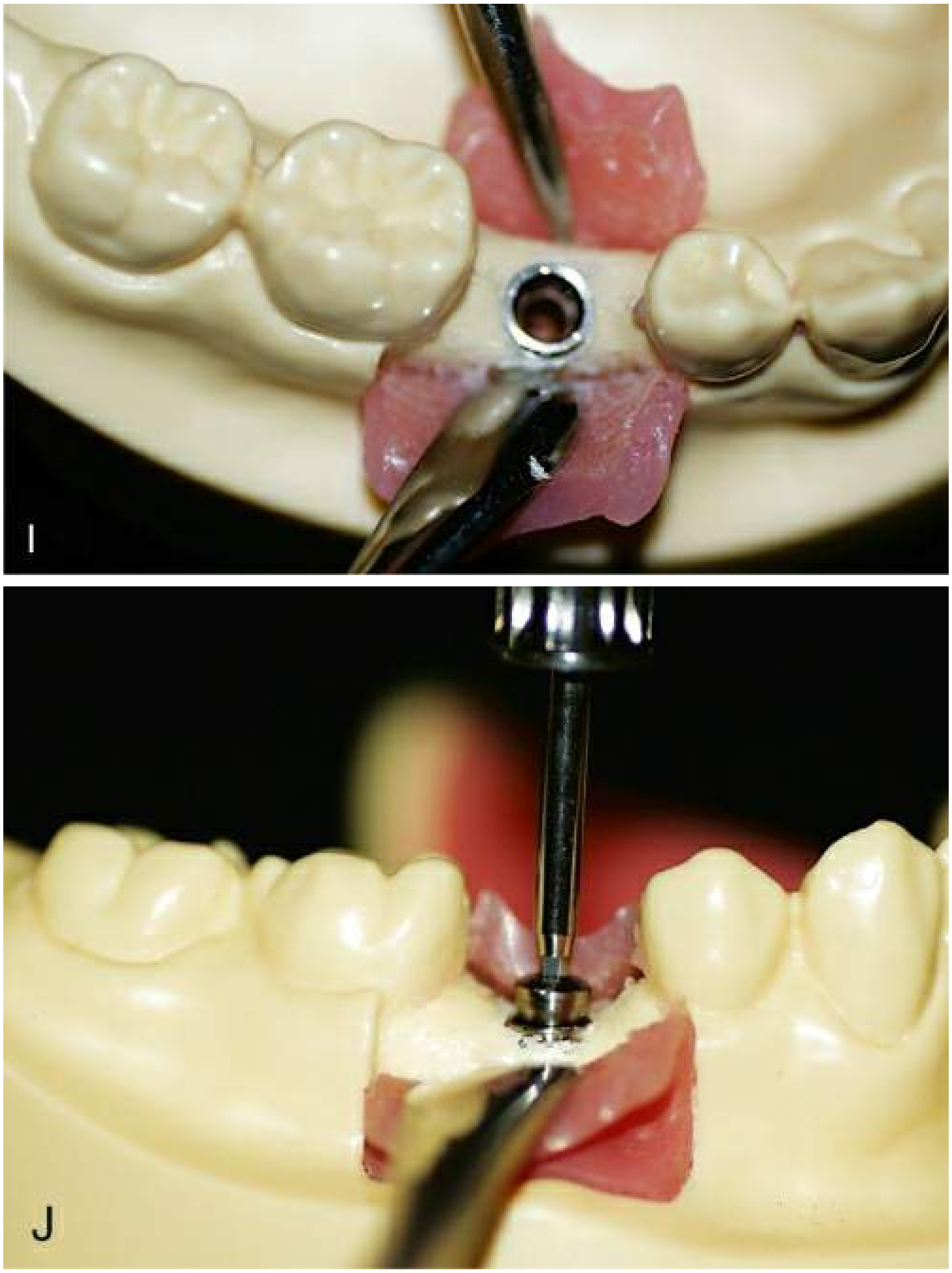
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FIGURE 49.84 **(A)** Round bur used to mark the osteotomy site. **(B)** Osteotomy site following drilling with round bur. **(C)** 2 mm Pilot drill used to prepare the site. **(D)** Site following pilot drilling. **(E)** Final drill in use. **(F)** Enlarged osteotomy site following final drilling. **(G)** Implant placed using a torque wrench or ratchet. **(H)** Implant can also be placed using handpiece under slow speed. **(I)** Implant completely driven into the prepared osteotomy site. **(J)** Cover screw placed with driver. **(K)** Submerged implant – flap is completely closed over the implant and sutured.

Placing the implant (one and two stage)

- Submerged implants are not exposed to the oral cavity following the first surgery to place the implant. A second surgery is performed to expose them and proceed with the impression making. Hence, they are termed as two-stage implants.

- Nonsubmerged implants are left exposed after the first surgery, so a second surgery is avoided. Hence, they are called one-stage implants.

- Threaded implants are driven into the prepared osteotomy site with a ratchet or with a handpiece using slow speed (Fig. 49.84G–I).

Nonthreaded implants are tapped into the site. The minimum required torque to ensure primary stability is 35 N. Following implant placement, a cover screw is fixed onto the implant (Fig. 49.84J). For submerged implants, the flap is completely closed over the implant and sutured (Fig. 49.84K). For nonsubmerged implants, the flap is sutured around the implant leaving the cover screw exposed.

Suturing

Closure of flap

A combination of inverted mattress and interrupted sutures produce the desired result. Closure of flap without tension is the most important aspect of flap management.

Postoperative care

- Antibiotics (amoxicillin 500 mg and metronidazole 400 mg BD TID) can be started the previous night of surgery and continued for 5 days.
- Analgesics: Paracetamol (650–100 mg) BD is sufficient usually for 2–3 days. In case of extensive surgery ibuprofen may be added.
- Ice packs are applied to avoid swelling.
- Chlorhexidine mouth rinses should be used twice daily.
- Liquid or semiliquid diet is maintained for at least first few days and tobacco and alcohol should be restrained for at least 1–2 weeks.

Second-stage surgery

This is applicable only to submerged implants. After the healing period of 3–4 months depending on bone quality, the implant is exposed by raising a flap. The aim is to basically expose the coronal portion of the implant. The coronal portion can also be exposed without raising a flap by using punch blades, electrocautery or laser. The cover screw is removed from the top of the implant and a gingiva former is screwed onto the implant. If a flap has been raised, it is sutured around the gingiva former, leaving it exposed to the oral cavity. The impression procedures are commenced after a healing period of 1–2 weeks.

The objectives of second-stage surgery are

- To expose the submerged implant without damaging the surrounding bone.
- To control the thickness of the soft tissue surrounding the bone.
- To preserve or create attached keratinized tissue around the implant.
- To facilitate oral hygiene.
- To insure proper abutment seating.

Prosthetic phase

Impressions

Two methods can be used for making impressions:

1. Similar to tooth-supported fixed partial dentures

In this method, following implant healing, the abutment is fixed to the fixture in the mouth. Any modification of the abutment is made intraorally and impression is made similar to tooth-supported fixed partial dentures and a cast is poured. The prosthesis is fabricated on the cast and then fixed intraorally (Fig. 49.85). As the prosthesis is being constructed, a provisional restoration is placed on the abutments intraorally and progressive loading can be initiated. This method is not recommended.

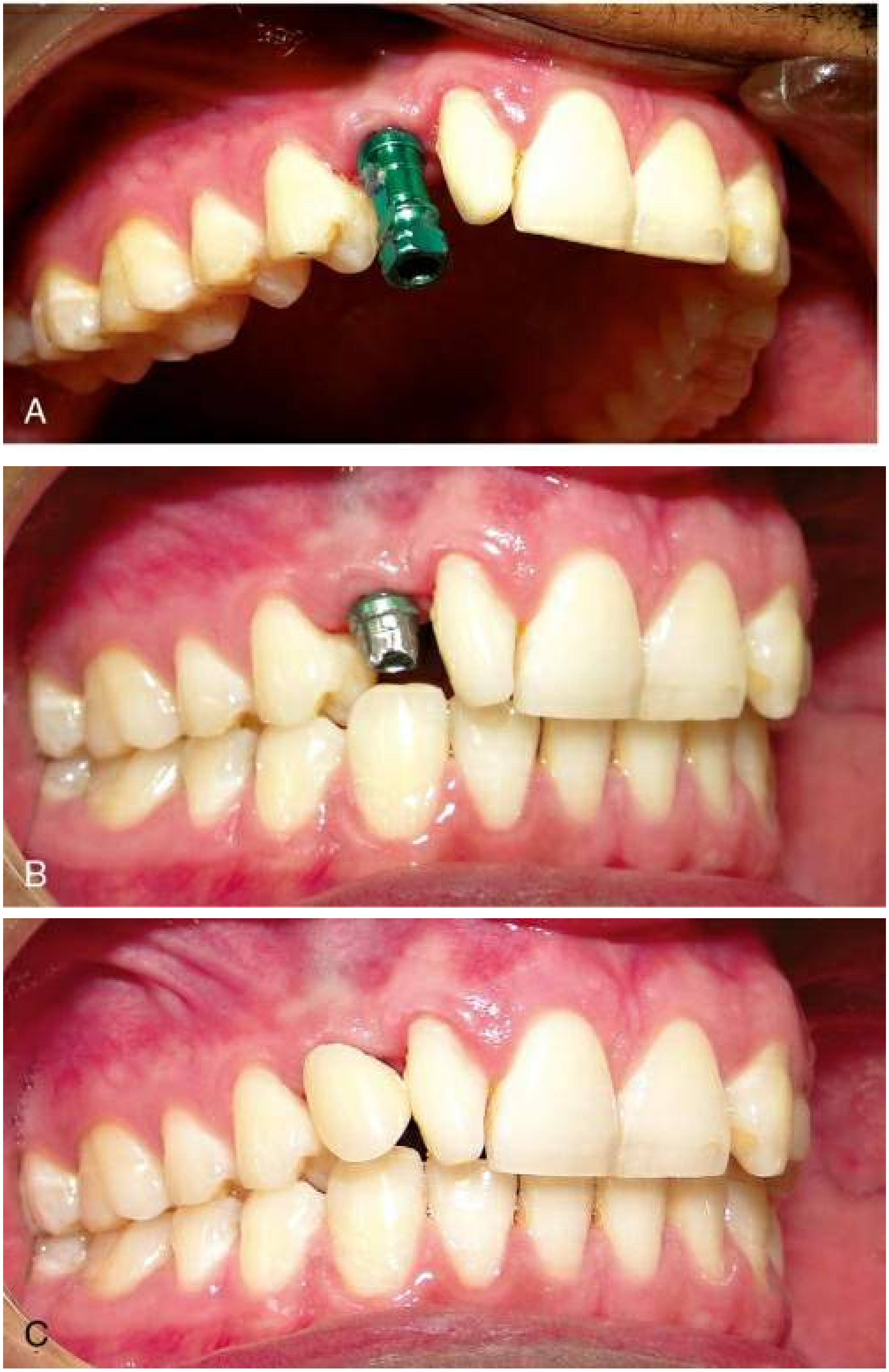


FIGURE 49.85 **(A)** Abutment fixed to the implant. **(B)** Abutment prepared in patient's mouth and impression made. **(C)** Crown luted to the abutment.

Indications

- Solid abutments and one piece implants.
- Implant is placed in ideal position and only minimal abutment (two piece) modification is necessary.
- Cement-retained prosthesis.

Disadvantages

- All abutment modifications have to be done intraorally, where heat transfer to implant is a concern while grinding the abutment.
- Obtaining parallelism with multiple implants is difficult.
- Cannot be used with screw-retained restorations and overdentures.

2. Transfer impressions

In this method, the position of the implant is transferred to the cast. Abutment is fitted and modified in the cast and prosthesis is also fabricated. The abutment and prosthesis is sent to the dentist and the same is then fixed intraorally. The purpose is to capture the coronal architecture of the implant fixture, as it exists in the oral cavity to be transferred to the cast using impression coping and the implant analogue.

This is the most common method of impression making for fixed (cementable and screw retained) and removable implant restorations.

Disadvantage

- Impression technique is complex and requires additional components

Transfer impression involves two accessory prosthetic components:

- Impression coping
- Implant analogue

Two methods are used:

- Open tray transfer
- Closed tray transfer

i. Open tray

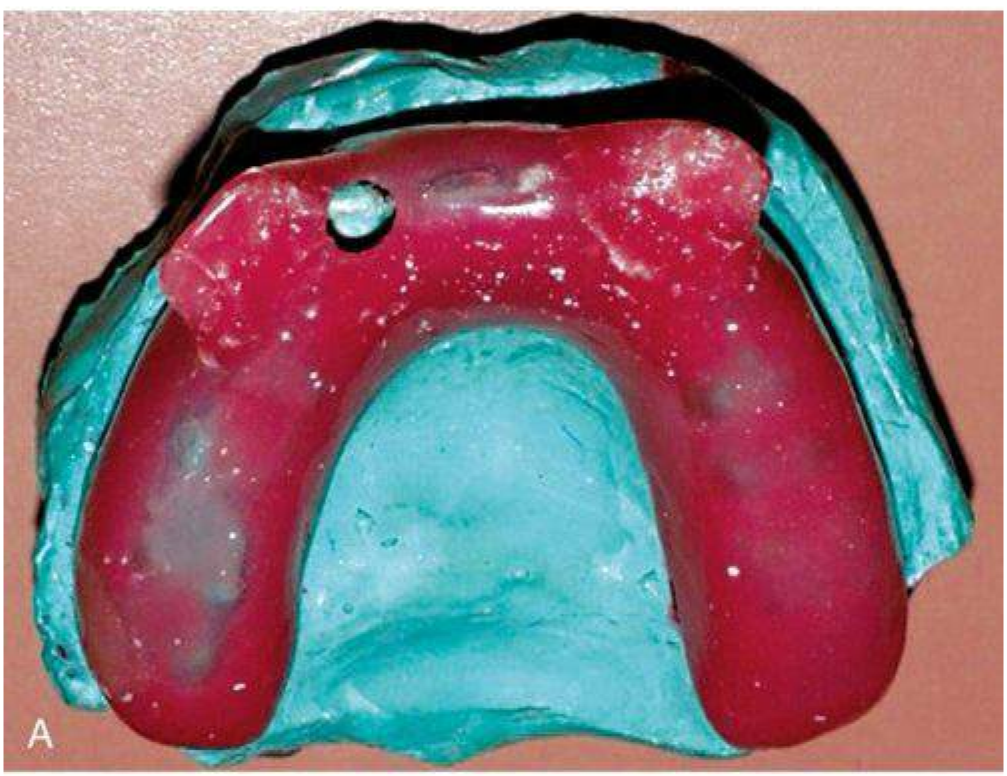
- Following healing, a full arch impression is made where implant is placed and a custom tray is fabricated.
- A hole is made in the custom tray corresponding to the implant (Fig. 49.86A). Alternately, a plastic stock tray can also be used so that a hole can be created (Fig. 49.86B).
- During final impression making, the cover screw or gingiva former is removed and the impression coping is attached to the implant fixture with impression screw (Fig. 49.86C).
- The tray is checked to ensure that the screw is accessible from the opening made in the custom tray (Fig. 49.86D). Normally the impression coping used for this kind of impression is different, with multiple deep undercuts and the screw used is longer and protrudes beyond the superior limit of the impression coping/transfer.
- A rigid impression material like polyether is preferable for making the impression. It is syringed around the impression coping and simultaneously loaded in the tray and inserted in the mouth. The opening in the tray allows the material to be wiped off to expose the impression screw (Fig. 49.86E).
- After the material sets, the exposed impression screw is loosened

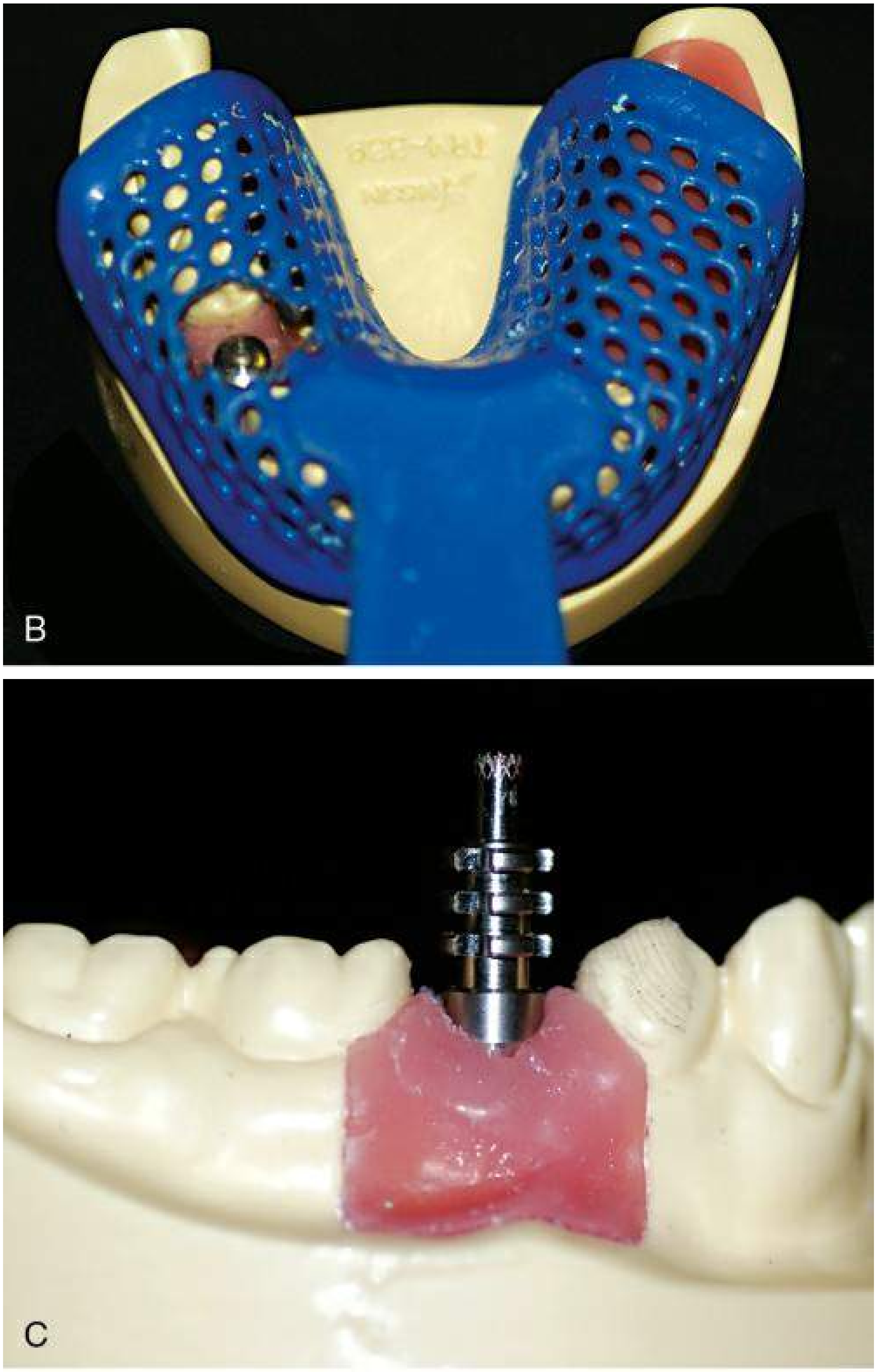
with a driver and removed (Fig. 49.86F). The impression is removed from the mouth, and as the impression coping has been detached from the implant, it will be retained in the impression (Fig. 49.86G).

- The implant analogue is now attached to the impression coping with the impression screw and a cast is poured (Fig. 49.86H–J).

- Once the stone sets, the impression screw is loosened to detach the coping from the analogue and the cast is separated from the impression (Fig. 49.86K and L). Thus, the position of implant is transferred to the cast. The abutments or attachments are fixed to the analogue and prosthesis is fabricated.

- The abutment and prosthesis is sent to the dentist and the same is then fixed intraorally (Fig. 49.86M).

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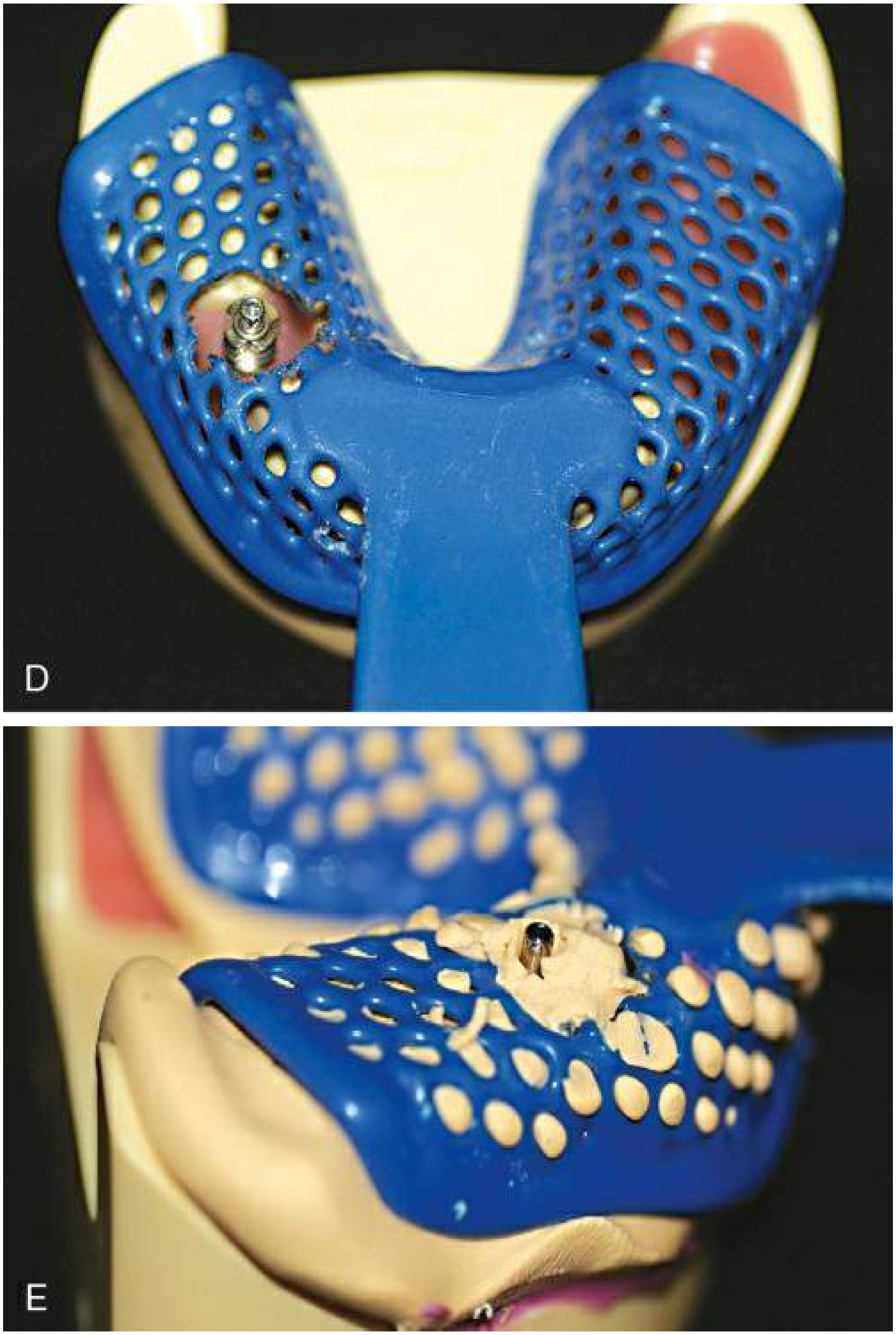
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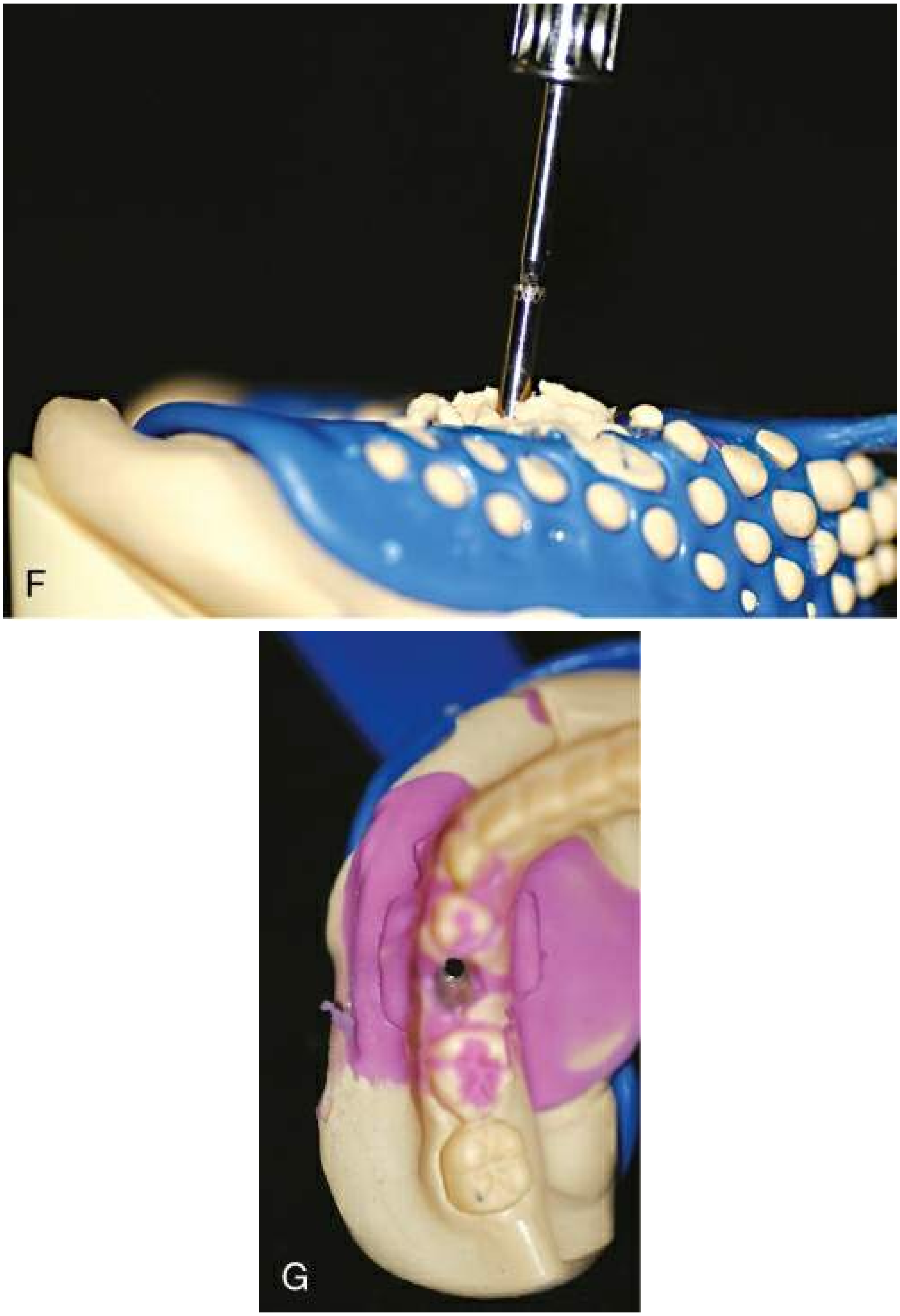
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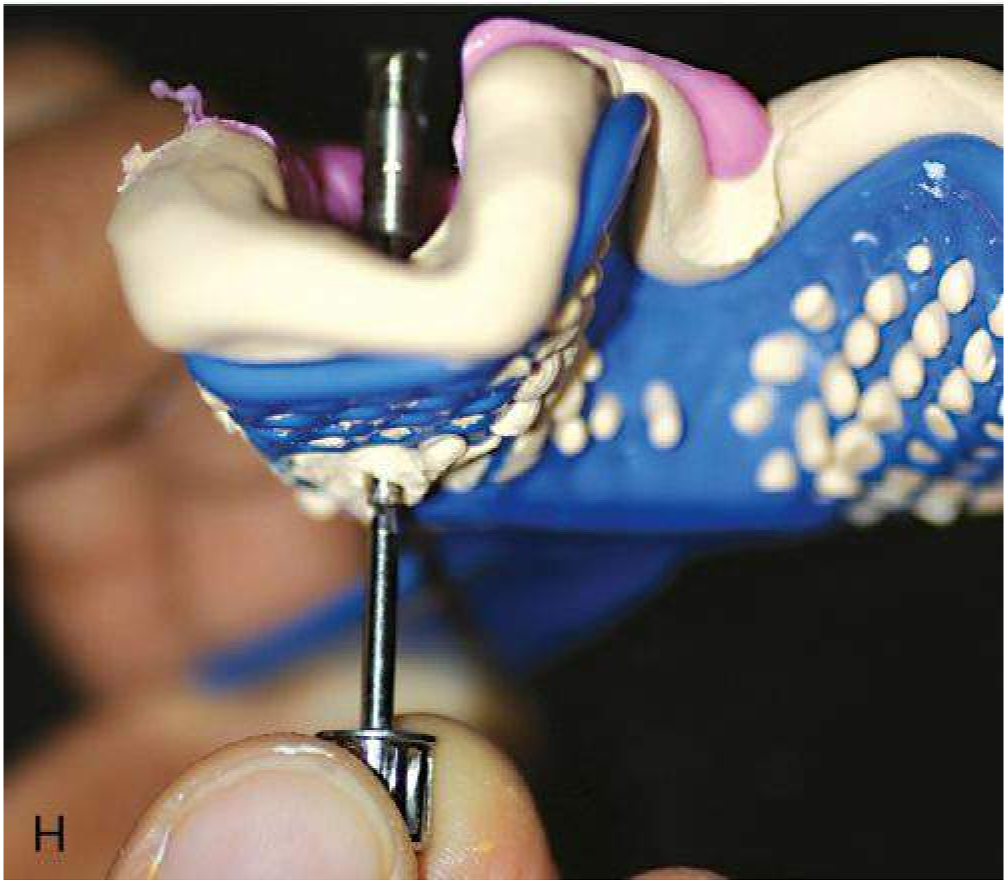
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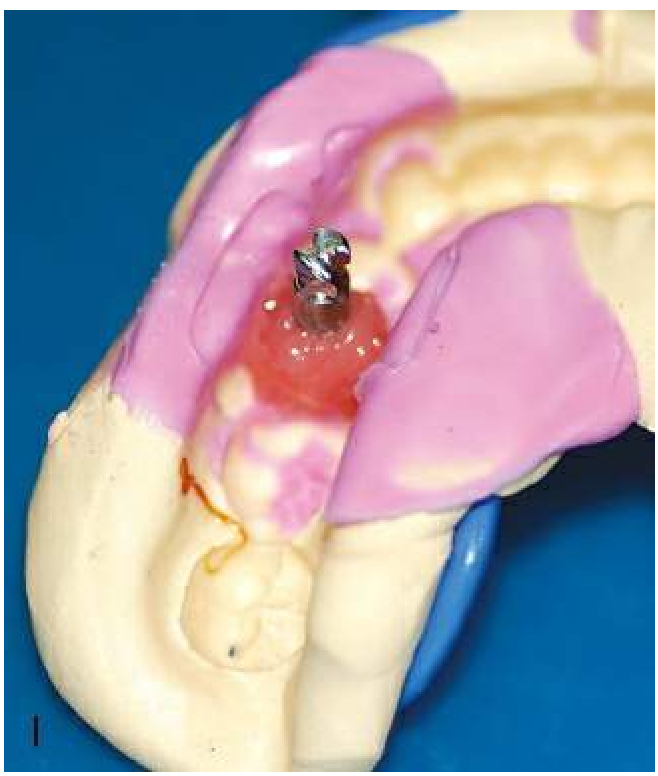
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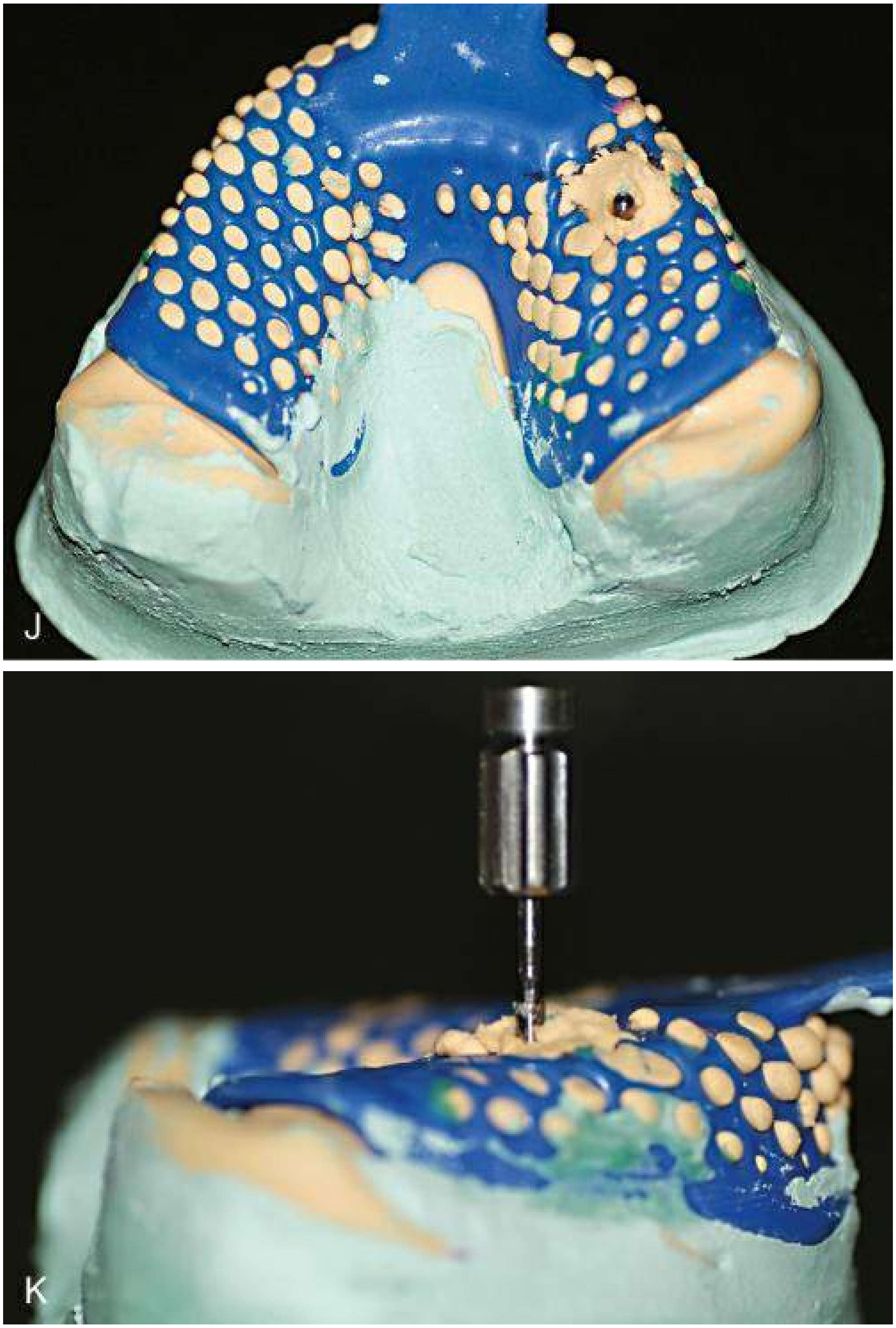
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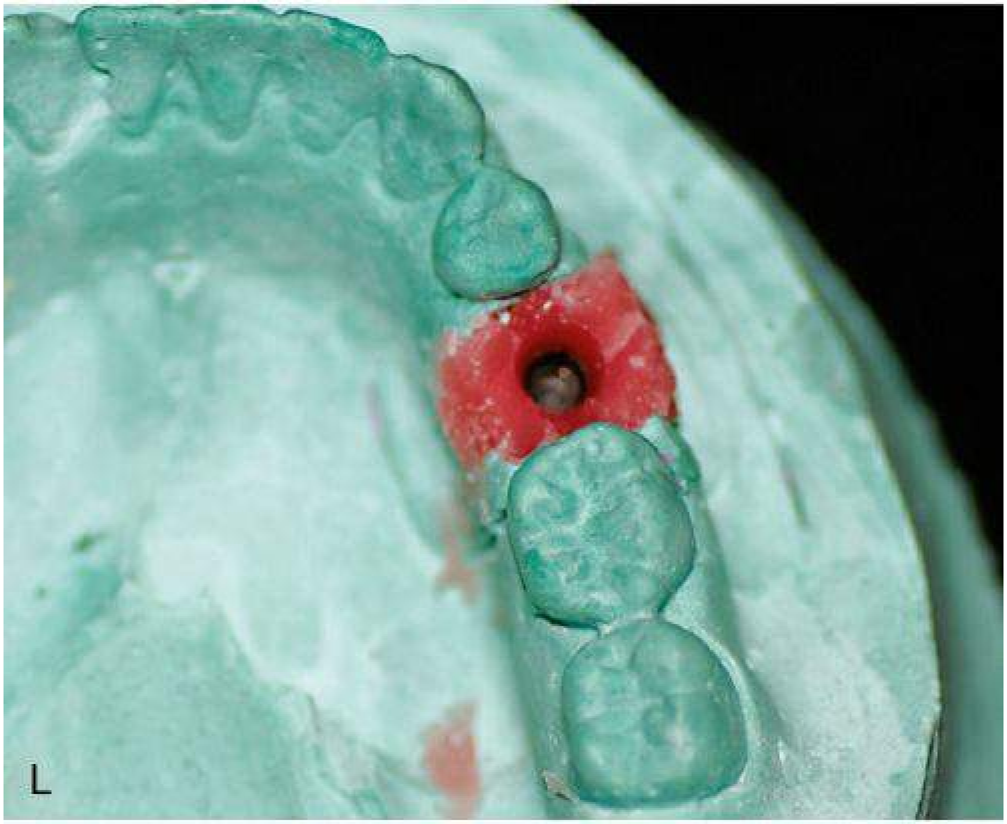
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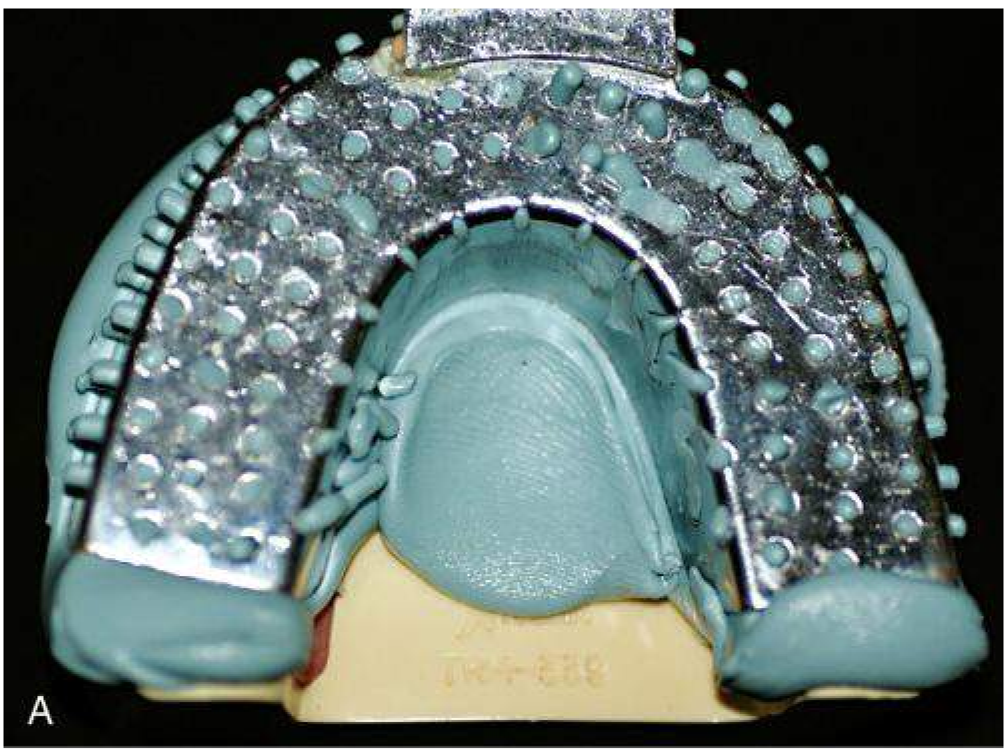
FIGURE 49.86 **(A)** Custom tray fabricated with area over the implant exposed. **(B)** Stock tray with a hole on top of implant. **(C)** Impression coping attached to implant fixture with impression screw. **(D)** Tray verified to ensure screw is accessible through the hole. **(E)** Impression made exposing the tip of the impression screw. **(F)** The screw is removed with a driver. **(G)** Impression coping retained in impression following removal of impression. **(H)** Implant analogue is attached to the impression coping (without removing the coping from impression) using a driver. **(I)** A gingival mask is poured around the junction of the impression coping and analogue to create a soft tissue emergence. **(J)** A cast is poured in stone. **(K)** Impression screw loosened. **(L)** Cast showing implant position replicated by implant analogue and the gingival mask providing the emergence profile. **(M)** Abutment is now fixed on the analogue and the crown is

fabricated on this.

In this technique, impression coping is retained in impression, so less chance of inaccuracy. It is indicated with multiple implants and when there is lack of implant parallelism.

ii. Closed tray

This can be done using stock trays and custom trays. There is no opening in tray to detach the impression coping, hence when the impression is removed, the coping is still attached to implant fixture (Fig. 49.87A and B). The coping is then removed from the implant, fixed to analogue and then relocated in the impression and a cast is poured (Fig. 49.87C–E). This method has more chances for inaccuracy and is indicated for single-implant restorations.



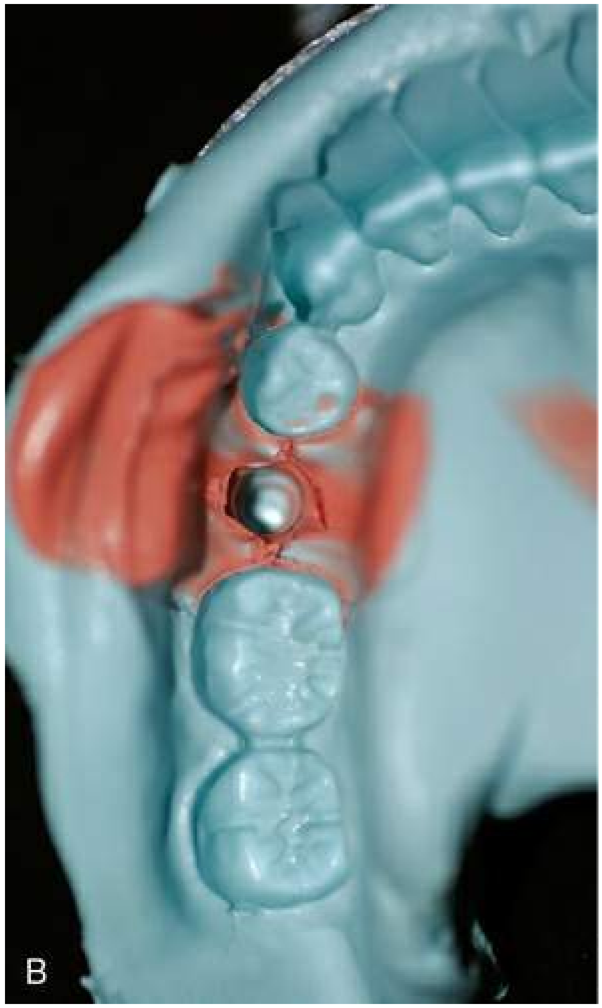

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FIGURE 49.87 **(A)** Impression made with a stock tray without any hole on top of implant. **(B)** Impression coping remains attached to implant after removal of impression. **(C)** The impression coping is screwed to the implant analogue. **(D)** The coping with attached analogue is relocated in the impression. **(E)** On separating the impression from cast, coping will remain in cast. It is unscrewed from the analogue, abutment is fixed and prosthesis is fabricated (as for open tray technique).

Loading

Definition: The process of placing axial or tangential force on a dental implant usually associated with the intentional exposure of the dental implant either at the time of initial surgical placement of the dental implant or subsequent surgical exposure. Such forces may come from a variety of sources including intentional or/and unintentional occlusal loading, unintentional forces from the tongue or other oral tissues, food bolus, as well as alveolar/osseous deformation. Generally application of intentional occlusal forces may be termed immediate loading, progressive loading or delayed loading (GPT8).

Generally loading is associated with fixing prosthesis to the implant and functional use of the implant for chewing, etc. The various types can be classified as:

1. Delayed loading

Procedures for fabrication of prosthesis commence only after 3–6 months of implant placement. Three months for mandible and 4–6 months for maxilla. The definitive prosthesis is inserted following this healing period.

2. Progressive loading

It was proposed by Carl Misch. A gradual or progressive bone loading was proposed during prosthetic phase. Following healing of implants (3–6 months), a transitional (provisional) restoration is attached to the implant, which is gradually put into occlusion. Only soft diet is advised during this period. After a few weeks (the time is dependent on bone quality) the definitive prosthesis is inserted and normal diet is advised.

3. Immediate loading

The prosthesis is inserted immediately following placement of the implant. The prosthesis is inserted immediately following placement of the implant. It is indicated when the bone quality and quantity is good and a good primary stability of at least 35 N is achieved during implant placement. Splinting of prostheses with use of longer and wider threaded implants is recommended.

Occlusion

Two important considerations differentiate an implant from a natural tooth with regard to occlusion.

1. The implant is effectively ankylosed and hence will not move under occlusal contact when compared to a natural tooth.

2. Lack of proprioception can produce higher bite force in an implant.

This should be taken into consideration while designing the occlusal scheme for implant restorations.

Single-tooth restorations

- In initial occlusal contact, the implant restoration should be in enough contact to lightly mark occlusal indicator paper but should not hold shim stock. As the patient exerts pressure, the implant restoration can come to hold shim stock.

- The dimension of the occlusal table should be reduced.

- The forces should be centralized along the long axis of the implant and there should be no excursive contacts.

Partially edentulous – fixed prostheses

- All of the above.

- Group function or mutually protective occlusion.

Completely edentulous

Removable prostheses (overdentures) – bilateral balanced or lingualized occlusion.

Fixed full arch bridges – some authors advocate group function and one school of thought also suggests canine protected occlusion. Selection of occlusal scheme depends on the bone density and the number of implants used to support the prosthesis.

Hygiene and maintenance of implants

Following implant placement if oral hygiene measures are inadequate, there is a high chance of plaque accumulation, which facilitates the bacterial growth. This may in long term lead to inflammation of periodontium and peri-implantitis. So it is very important to maintain the gingival health for the success of the implants.

1. **Patient role:** Patients should follow their routine oral hygiene measures meticulously. They are advised to use interdental brushes (hand and motorized). Dipping brushes in 0.12% chlorhexidine, flosses, yarns and tapes dipped in chlorhexidine at night help in maintenance.

2. **Dentist's role:** Patient is recalled every 3–4 months, and radiographs are made every 12–18 months. Dentist should check for plaque and inflammatory changes. If these are present supragingival scaling should be done. Also loose suprastructure, broken screws and sore spots should to be noted and rectified. If implants need repair, degranulate, detoxify and graft with bone regeneration. All the details of the procedures should be documented.

Failures in implants

Following are the causes of implant failures:

1. Surgical failure

Surgically related problems can be subdivided into failure related to stage I surgery and period between the osseointegration and stage II surgery.

Stage I

Failures that can occur at this period are due to the surgical procedure carried with the risk of bleeding, infection, swelling and ecchymosis.

Period between osseointegration and stage

Ulcerations can be produced by the rough and sharp flanges of the denture. This can be avoided by applying soft liner or tissue conditioners. Soft liners should replace in every 4–5 weeks. **Dehiscence** of cover screw of the implant through mucosal covering may occur. Meticulous care to keep the site clean and antibacterial rinse are advised to the patient.

2. Osseous healing failures

Failure occurs from the time of implant placement and osseointegration. It happens during the healing phase to stage II surgery. Causes of the failure are trauma, heat produced during the surgery, micromotion and infection.

3. Early loading failure

An early loading of an implant failure occurs during the first year of prosthetic loading. It may be due to the overload of the transitional prosthesis or the bacterial infection.

4. Intermediate implant failure

Implant failure occurs after first year of loading to 5 years of function is classified as intermediate implant failure.

5. Late implant failure

Failures occur after 5 years to 10 years of function.

6. Long-term failure

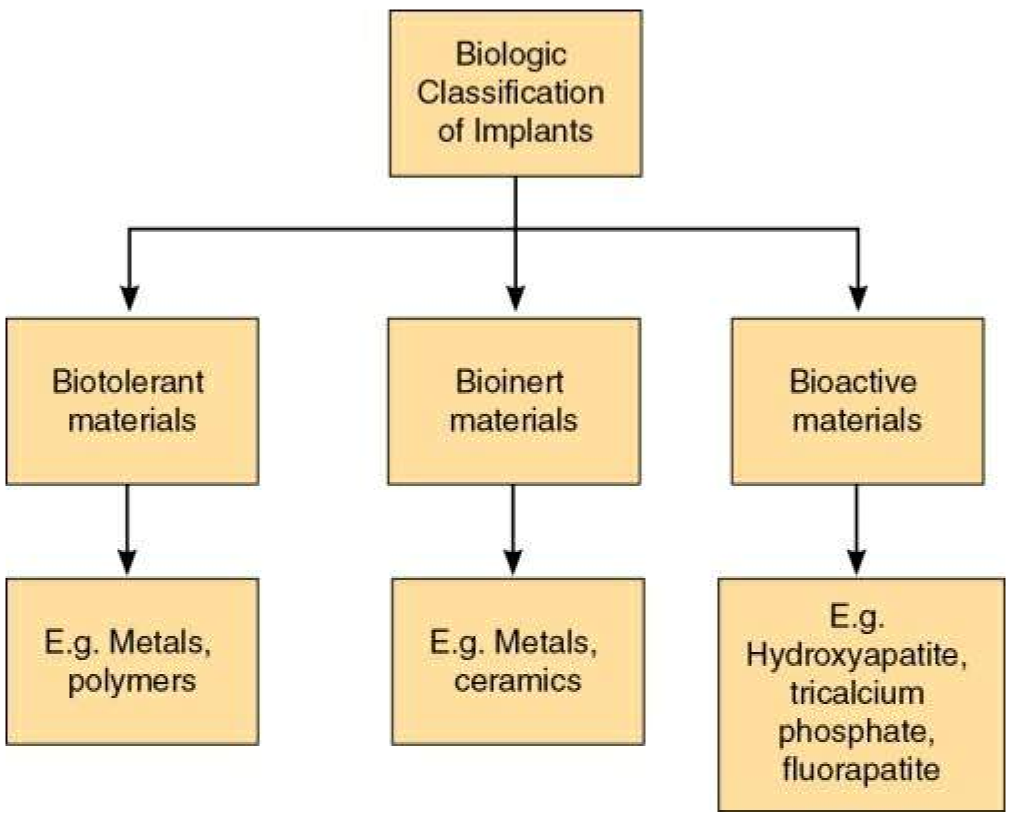
Failure occurs after 10 years in function.

Implant materials

Biologic classification (flowchart 49.1)

Biotolerant materials

These materials are not necessarily rejected when implanted into the living tissues. These may or may not induce bone formation.



FLOWCHART 49.1 Classification of implant materials.

Examples:

1. **Metals:** Gold, stainless steel, zirconium

2. **Polymers:** Polyethylene, ceramics, polyamide

Bioinert materials

These materials allow the bone formation on their surfaces resulting in a chemical bond along the interface without undergoing any degradation in the tissues.

Examples:

1. **Metals**: CP titanium, titanium alloys

2. **Ceramics:** Aluminium and zirconium oxides

Bioactive materials

These materials allow the bone formation onto their surfaces and later may or may not undergo degradation in the tissues.

Examples: Hydroxyapatite, tricalcium phosphate, florapatite, etc.

Bioactive and bioinert materials are also known as osteoconductive material. Most of the implants are constructed from metals or alloys. The major groups of materials available are titanium and alloys, cobalt–chromium alloys, austenitic Fe–Cr–Ni–Mo alloys, tantalum, niobium and zirconium alloys, precious metals, ceramics and polymeric materials.

The most widely used nonmetallic implants are oxidic, carbonitic or graphitic oxide–like materials.

1. Commercially pure (cp) *titanium and titanium-6 aluminium-4 vanadium alloy*

- This group forms tenacious oxides in air or oxygenated solutions.

- Titanium oxidizes upon contact with room temperature air and normal tissue fluids. It has also got the capability of deoxidation when scratched or abraded during placement.

- Corrosion of titanium and alloys in the tissue fluids results in accumulation of particles in the peri-implant zone which are known as black particles.

- The modulus of elasticity of titanium is five times greater than that of compact bone and this property emphasizes the importance of design in the proper distribution of mechanical stress transfer.

- The ductility of titanium is more than its alloys; hence, it is more favourable to use titanium as an endosteal implant.

- If the implant abutment is bent at the time of implantation, the metal is strained locally at the neck region. This is one reason, why reuse of titanium implants is not recommended.

2. Cobalt–chromium–molybdenum-based alloys

- They are often used as cast or cast and annealed metallurgic condition that permits the fabrication of custom design implants such as subperiosteal frames.

- Cobalt has continuous phase for basic properties.

- Chromium has corrosion resistance through the oxide surface.

- Molybdenum has strength and bulk corrosion resistance.

- Also includes minor concentrations of nickel, manganese and carbon. Nickel has been identified in biocorrosion products. Carbon must be precisely controlled to maintain mechanical properties such as ductility.

- In general, the cast cobalt alloys are least ductile of the alloy systems and bending of the finished implants should be avoided.

3. Iron–chromium–nickel-based alloys

- They are used in wrought and heat treated metallurgic conditions which result in a high strength and high ductile alloy.

- Example: Ramus blade, ramus frame, stabilizer pins and mucosal inserts.

- This alloy is most subject to crevice and pitting biocorrosion and care must be taken to use and retain the oxidized surface condition.

- This alloy contains nickel as a major element, so use in patients allergic or hypersensitive to nickel should be avoided.

- However, these alloys when used properly can function without significant in vivo breakdown.

4. Ceramics and carbon

These are inorganic, nonmetallic, nonpolymeric materials manufactured by compacting and sintering at elevated temperatures. These can be divided into metallic oxides or other compounds. These have been used in bulk form and more recently as coatings on metals and alloys.

SUMMARY

Implants have established themselves as the treatment of choice for majority of the partially and totally edentulous situations. If all the governing factors of implant treatment such as the underlying bone quality and quantity, occlusion and arch space are favourable then this treatment modality is most often predictable. The selection of implant fixture, where one has to consider both macro and micro anatomy, plays a major role in osseointegration. The materials and metals used should also be taken into consideration. The selection of patients, with uncontrolled systemic diseases is contraindicated even if other anatomical factors are favourable. Surgical placement of the fixture should be performed with minimal trauma to the tissues. Occlusion also plays a pivotal role in the prognosis.

CHAPTER 50

Maxillofacial Prosthetics

CHAPTER CONTENTS

Introduction

Maxillofacial prosthesis is the art and science of anatomic, functional or cosmetic reconstruction by means of nonliving substitutes in the regions of maxilla, mandible and face that are missing or defective because of surgical intervention, trauma, pathology or congenital malformation. Despite remarkable advances in surgical management of oral and facial defects, these reconstructive surgical procedures cannot satisfactorily rehabilitate the defect. Extensive research and developments in the field of materials have made it possible for restoration of aesthetics in the patient with gross defects of the face and the head. The increasing life span of the affected individuals, and also the increased awareness of health care services have made maxillofacial prosthetics a challenge in the field of dentistry.

The most important objectives of the maxillofacial prosthesis and rehabilitation include:

1. Restoration of aesthetic and cosmetic appearance of the patient.

2. Restoration of function.

3. Protection of tissues.

4. Therapeutic or healing effect.

5. Psychologic therapy.

6. Improving the quality of life.

Classification of maxillofacial defects

Maxillofacial defects can be classified according to aetiology, residual defect, incidence and location into the following types:

1. Intraoral defects

i. Congenital

▪ Cleft lip and palate

□ Adult

□ Infant/toddler

ii. Acquired

▪ Trauma – maxilla and mandible

▪ Tumour – maxilla, mandible, tongue

2. Extraoral defects

i. Congenital

▪ Auricular defects

▪ Ocular defects

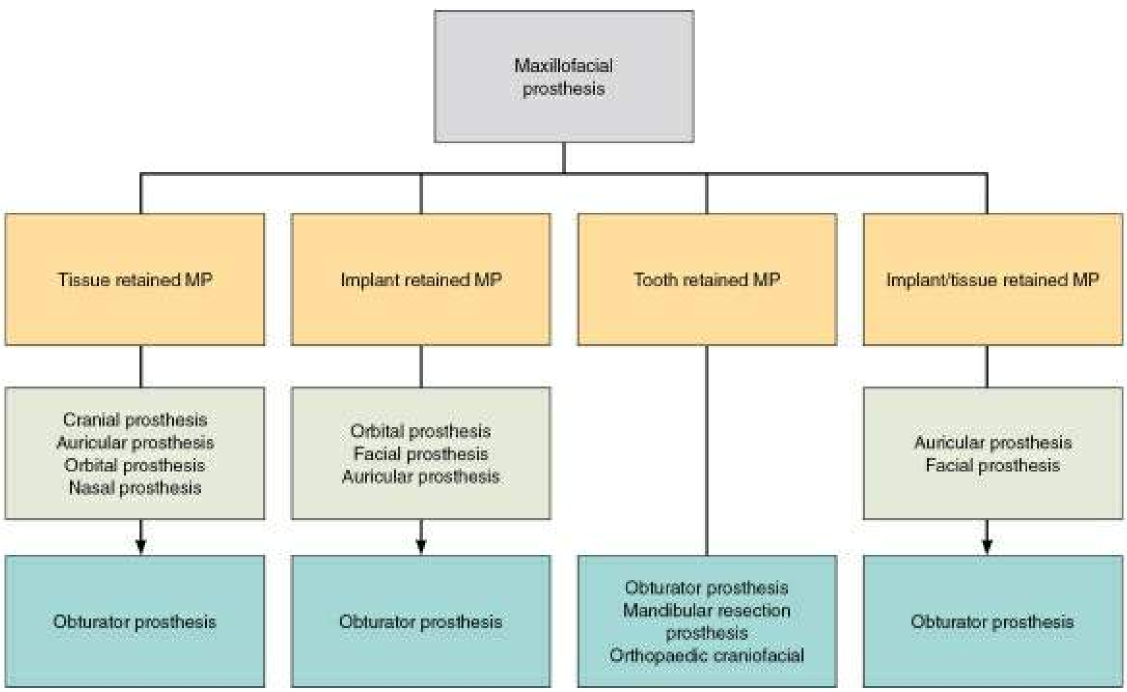
▪ Syndromatic defects

ii. Acquired

- Trauma – ocular, orbital, nasal, auricular defects

- Tumour – ocular, orbital, nasal, auricular defects

The classification of maxillofacial prosthesis is shown in Flowchart 50.1.



FLOWCHART 50.1 Classification of maxillofacial prosthesis

Embryology

Development of upper lip

Each maxillary process grows medially and fuses, first with the lateral nasal process and then with medial nasal process (Fig. 50.1).

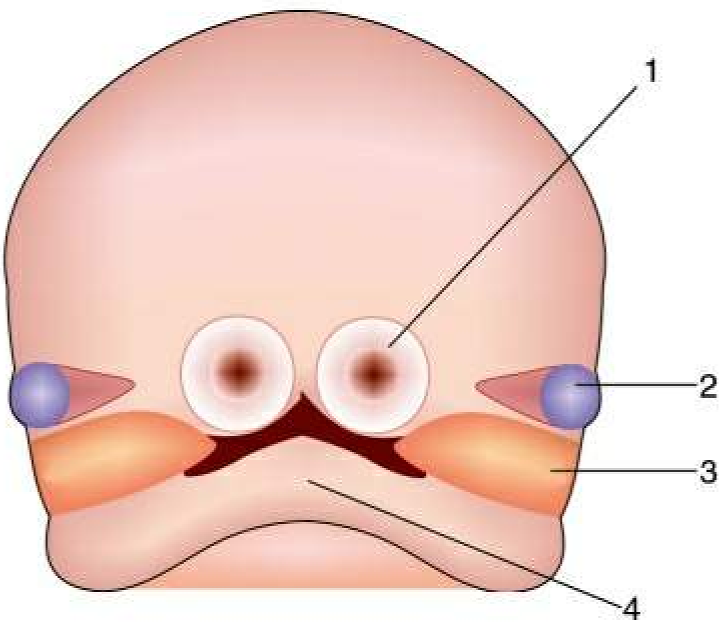


FIGURE 50.1 Development of upper lip. (1) Nasal process, (2) eye (3) two maxillary process (4) mandible.

Development of palate

The palate is formed from three components:

- The two palatal processes (Fig. 50.2A).
- The primitive palate formed from the frontonasal process.

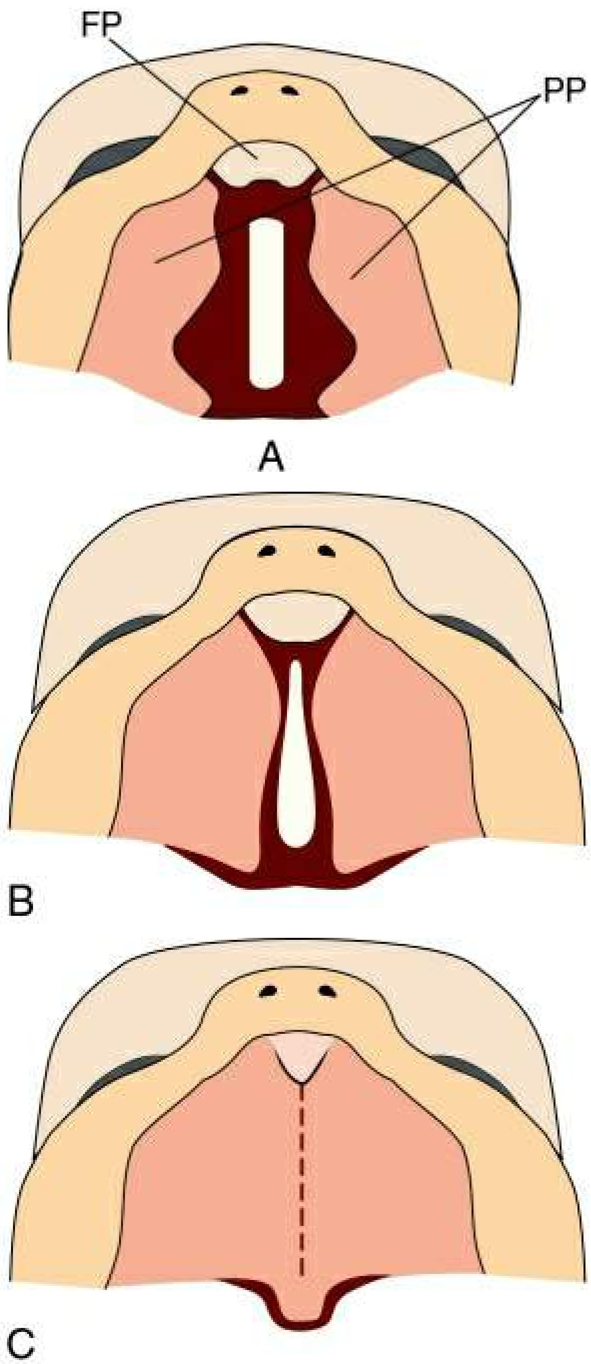


FIGURE 50.2 Development of palate. **(A)** Two lateral palatal process (PP) and frontal process (FP). **(B)** Fusion of anterior part of the PP with FP. **(C)** Fusion of posterior part of PP.

The definitive palate is formed by the fusion of these three parts as follows:

- Each palatal process fuses with the posterior margin of the primitive palate (Fig. 50.2B).

- The two palatal processes fuse with each other in the midline anteriorly backwards (Fig. 50.2C).

Maxillary defects

Defects that are either acquired or congenital in nature in the midfacial (maxillary) region are referred to as maxillary defects. They are classified as follows:

1. Congenital maxillary defects

2. Acquired maxillary defects

Congenital maxillary defects

Congenital maxillary defects include the cleft lip and cleft palate. Other defects are submucous cleft palate, Pierre Robin syndrome and hemifacial microsomia

Developmental anomalies

Cleft lip

This defect is formed when one or both maxillary processes do not fuse with the medial nasal process. If there is a failure on one side, the patient suffers a unilateral defect and if on both the sides, the individual suffers a bilateral defect (Fig. 50.3).

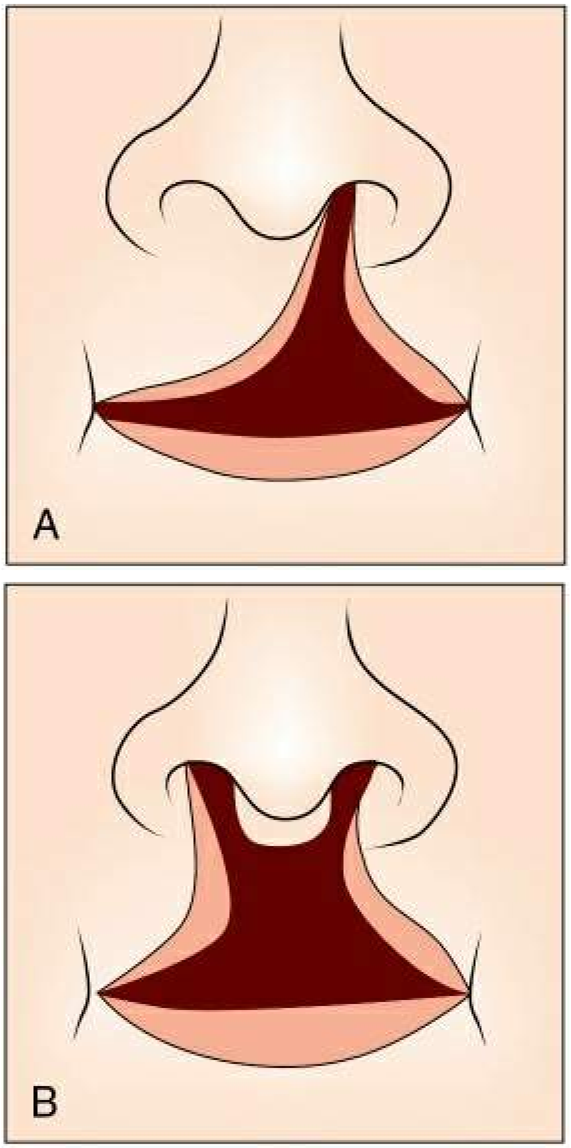


FIGURE 50.3 Cleft lip. **(A)** Unilateral. **(B)** Bilateral.

The defective development of lower part of the frontal process may give rise to a midline defect of the upper lip. This condition is encountered less often.

The common aetiology for these could be infections, drug induced or due to hormonal imbalance and may also be genetically inherited.

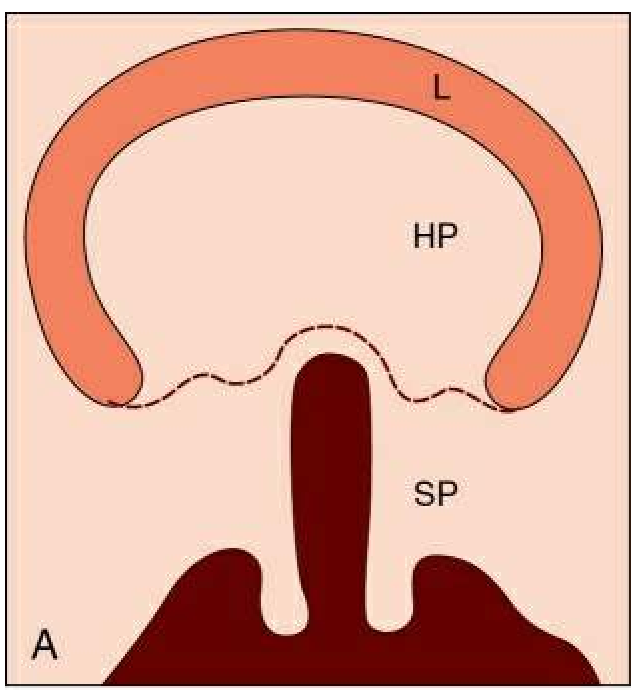
Cleft palate

- Defective fusion of various components of palate gives rise to clefts in the palate. The defect may be from a simple cleft of the alveolus, to an extensive defect involving the soft and hard palate. The alveolar cleft may occur unilaterally or bilaterally also. Many a times the palatal clefts are also associated with the cleft lip. However, the cleft lip can also occur as an individual defect.

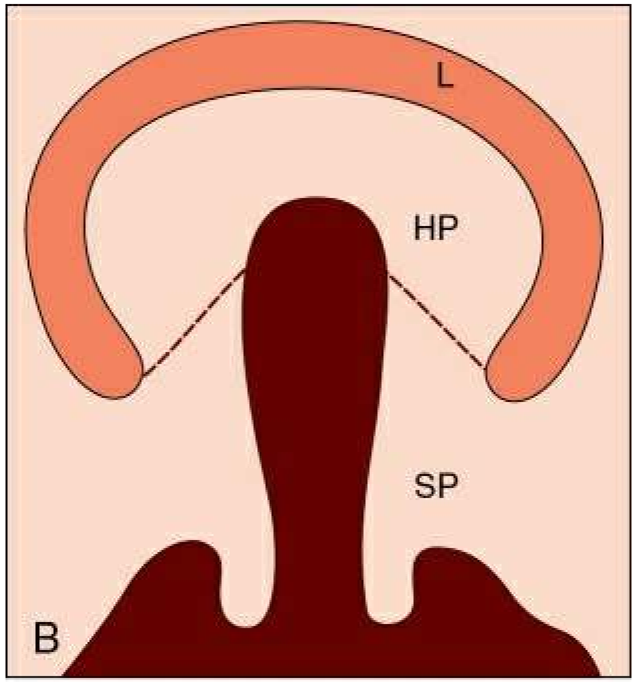
There are many classifications of the defects and a comprehensive and simple classification of both the defects is the Veau's classification, which is as follows:

Veau's classification of cleft palate

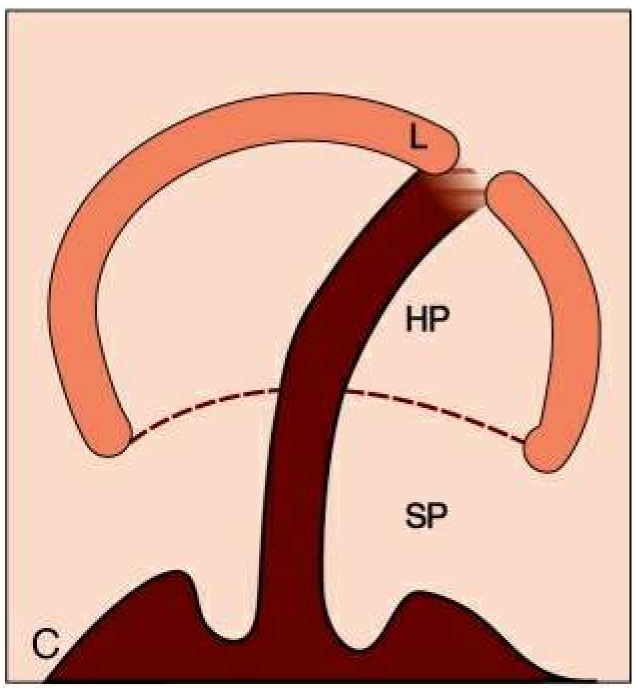
- Class I: Isolated soft palate cleft (Fig. 50.4A).
- Class II: Isolated hard and soft palate (Fig. 50.4B).
- Class III: Unilateral cleft lip and palate (Fig. 50.4C).
- Class IV: Bilateral cleft lip and palate (Fig. 50.4D).



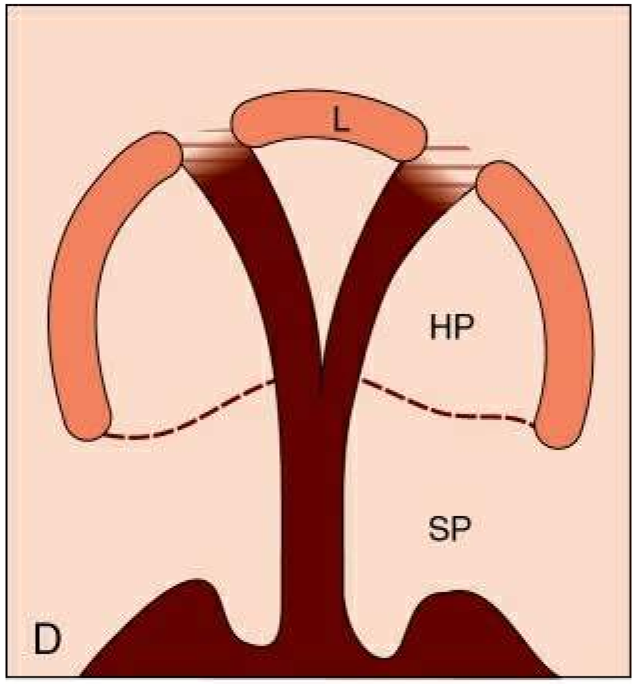
Class I



Class II



Class III



Class IV

FIGURE 50.4 **A–D** Veau's classification of clef palate class I to class IV. L, lip; HP, hard palate; SP, soft palate.

Prosthetic rehabilitation of congenital cleft lip and palate

The rehabilitation of congenital cleft lip and palate starts soon after the child is born. It is so challenging, that it involves a team of dedicated specialists, and the timing of the treatment is of paramount importance.

Role of team members for management of cleft lip and palate are

1. **Paedodontist**: Involved in fabrication of feeding plate and obturator and assists in planning the feeding techniques that are best suited for children.

2. **Paediatrician**: Responsible for overall maintenance of health.

3. **Orthodontist**: Identifies the problem, predicts growth and provides comprehensive orthodontic care.

4. **Plastic or oral surgeon**: Responsible for surgery when needed.

5. **Speech pathologist**: Monitors speech and offers therapy.

6. **ENT surgeon**: Performs test to identify any hearing difficulties, as parents would not be able to recognize the problem.

7. **Psychiatrist**: Evaluates emotional, social and behavioural and social development. Emphasis is placed on the patient's ability to cope with emotional and physical stresses created by cleft defect.

8. **Social worker**: Acts as the patient's advocate and aids in psychological assessment. Helps the parents in guiding the doctor and provides medical care. Table 50.1 explains the protocol for management of cleft lip and palate.

9. **Maxillofacial prosthodontist:** Plays an important role in fabrication of surgical, interim and definitive prostheses, which have to be monitored at regular intervals and changed if needed. He is also responsible for designing and fabrication of definitive prosthesis as explained in Table 50.2.

Table 50.1

Protocol for management of cleft lip and palate

Duration	**Management**
Prenatal	Diagnosis and parental counselling
0–6 months	General assessment of associated anomaliesENT evaluation – feeding, swallowing, hearing Presurgical orthopaedics (0–3 months) Primary lip repair (3–4 months)
6 months to 2 years	Speech and oral motor sensory assessment Primary palate repair (9–12 months)
Preschool: 3–5 years	Dental careSpeech assessment and therapy Assess need for lip revision
Childhood: 6–12 years	Correction of velopharyngeal dysfunction Orthodontic treatment Alveolar cleft repair (8–11 years)
Adolescence: 13–18 years	Orthodontic correction – phase-II Orthognathic surgery (14–16 years – female and 8–11 years – male) Revision cheilorhinoplasty Replacement of missing teeth

Table 50.2

Role of prosthodontist in cleft lip and palate rehabilitation

Phase	Prosthodontic intervention
1. Neonates born with cleft lip and palate	A feeding plate (Fig. 50.5)
2. Presurgical phase	Palatal surgical obturator
3. Postsurgical phase	Immediate postsurgical obturator
4. Postsurgical fistula	Palatal obturator
5. Speech problem	Palatal obturator is fabricated with a speech bulb in soft palatal region
6. Rehabilitation	Palatal obturator with replacement of teeth

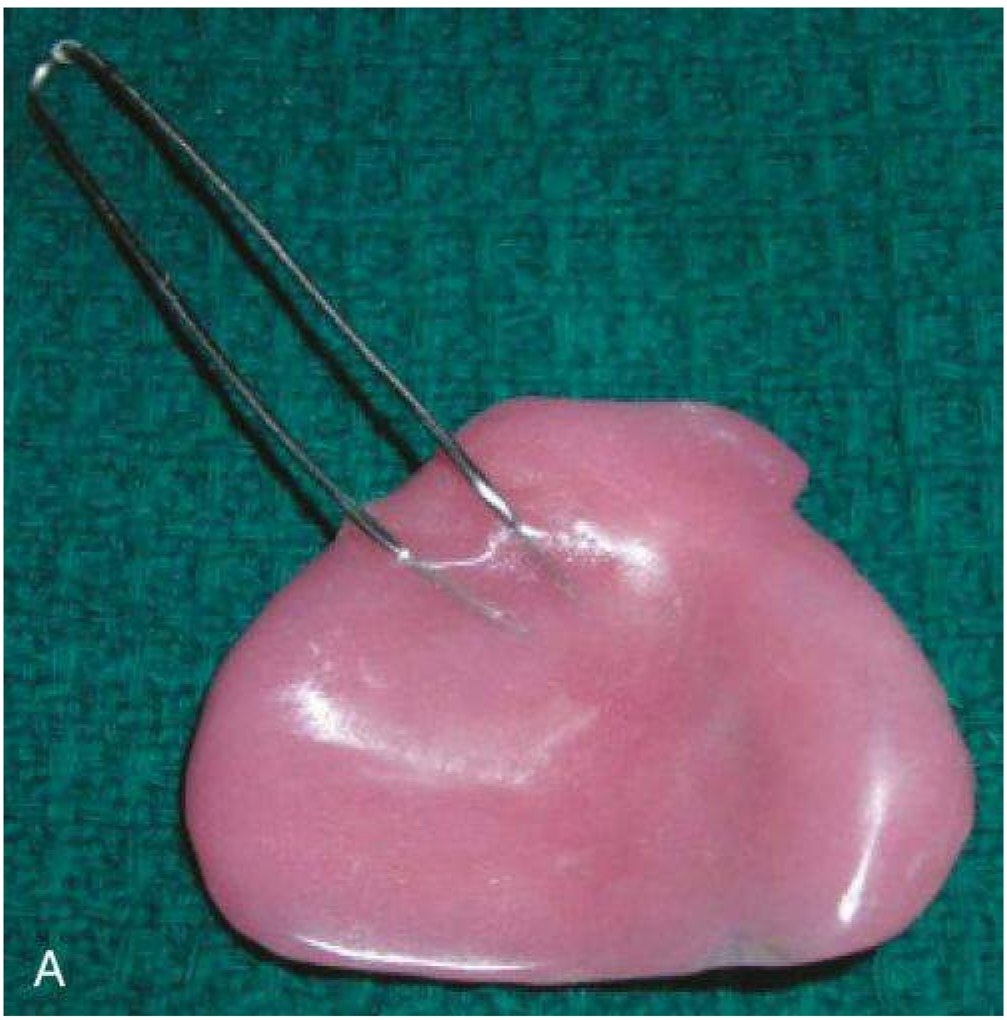


FIGURE 50.5 Feeding plate.

Acquired maxillary defects

Most acquired defects occur due to surgical resection of tumours. Common tumours of this region include epidermoid carcinoma, salivary gland tumours, malignant mesenchymal tumours, benign mesenchymal tumours, etc.

The resection of a maxillary tumour requires a medical and rehabilitation team composed of a surgeon, maxillofacial prosthodontist, radiologist, radiation oncologist, medical oncologist, nutritionist, psychologist, nursing staff, laboratory technician and social worker, to obtain an optimal treatment outcome. A maxillofacial prosthodontist should be consulted prior to performing the surgery, if the patient needs to be rehabilitated with obturator prosthesis. It is the responsibility of the prosthodontist to suggest various treatment plans to the surgeons regarding prosthodontic requirements for restoring maxillectomy defects. Thus, a proper diagnosis, consultation and good planning are of prime importance prior to treatment.

Surgical considerations for optimal prosthetic outcome

An overall successful treatment depends on complete elimination of the tumour and functional rehabilitation. This can be achieved by good presurgical and postsurgical planning. The role of the maxillofacial surgeon is not only in complete elimination of the tumour but also in providing a favourable postsurgical foundation which would enhance the prosthetic prognosis and improve patient's quality of life. The surgical factors to be considered are as follows.

Remaining hard palate and teeth

Good bone support of the palatal area as well as the proximal alveolar bone of the tooth adjacent to defect is crucial for the obturator prosthesis. Palatal bone functions as a supportive structure to transfer the forces of occlusion through the denture base and the remaining teeth of the arch will aid in retention of the obturator. Therefore, preservation of as much of dentition and palatal bone possible without compromising a tumour free margin should be considered.

Soft tissue around the defect

1. **Skin graft on the defect wall:** On the lateral wall of the defect, a split thickness skin graft can be placed to prevent the vertical displacement. Another advantage is the ability to withstand the masticatory loads and prevent tissue irritation during insertion and removal of the obturator. This skin graft can be obtained from forearm or the thigh area.

2. **Keratinized tissue over the bony area:** The medial wall of the hard palate area should be covered with adjacent keratinized palatal mucosa and sutured onto the periosteum. This keratinized tissue will help in absorbing the masticatory load and prevent trauma during insertion and removal of the maxillary obturator.

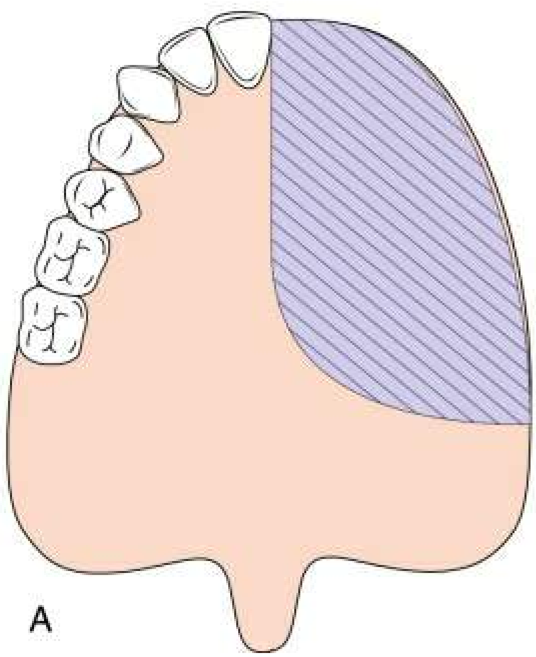
3. **Structures related to the nasal cavity:** The presence of nasal turbinates will prevent the desired extension of the obturator bulb into the defect, thereby, affecting its stability and may traumatize the patient during insertion and removal of the prosthesis.

4. **Soft palate consideration:** The maxillary obturator can extend above the remaining soft palate to gain retention and resistance to displacement. The soft palate should be spared as it provides the posterior palatal seal and defines the limit for the posterior extension of the obturator. In cases of defects extending up to or beyond the middle third of the soft palate the entire soft palate should be removed. Failure to do so may result in a thick fibrous inactive band of tissue that limits the extension of the obturator.

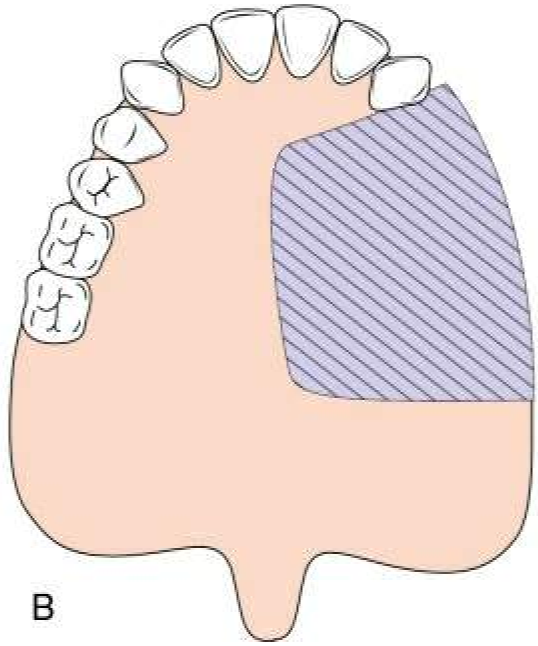
Surgical procedures

The understanding of the resection terminology is essential for communication with the surgical team as well as for preparing the patient undergoing surgical resection. The maxilla is composed of two halves fused along the midline forming the midpalatine suture. Previously terminologies such as hemimaxillectomy, semimaxillectomy and/or partial maxillectomy were used to describe the resection of the maxilla without specifically identifying the precise location. To make it more logical, terms such as left/right, partial/total, anterior/posterior in combination with the word 'maxillectomy' can be used for better communication between health care practitioners. For example, since the maxillary bone is divided into separate halves, it should be called the left or right maxilla. Thus, if the left maxilla is being resected, it should be termed as left maxillectomy that identifies the left side of the maxillary bone. Furthermore, if the entire left maxillary bone is being resected, it should be known as left total maxillectomy. On the other hand, if a portion of left maxillary bone is being resected, it should be called partial left maxillectomy. However, it must further indicate the specific location as the anterior or posterior portion that is being resected. Therefore, if an anterior portion is being resected, then a specific additional location must be included, such as an anterior partial left maxillectomy. The resultant acquired palatal defects are classified on the basis of surgical extension of the defect (Spiro and Shah), incidence and prosthetic planning (Aramany classification).

The Aramany's classification is divided into six different groups based on the relationship of the defect area to the remaining abutment teeth (Fig. 50.6A–F).



A



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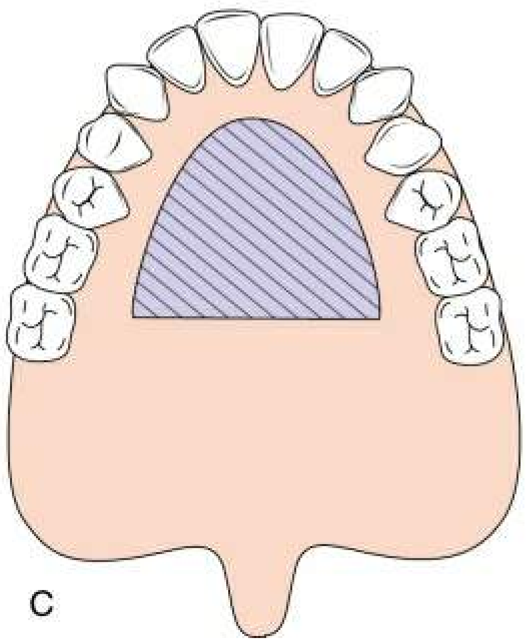

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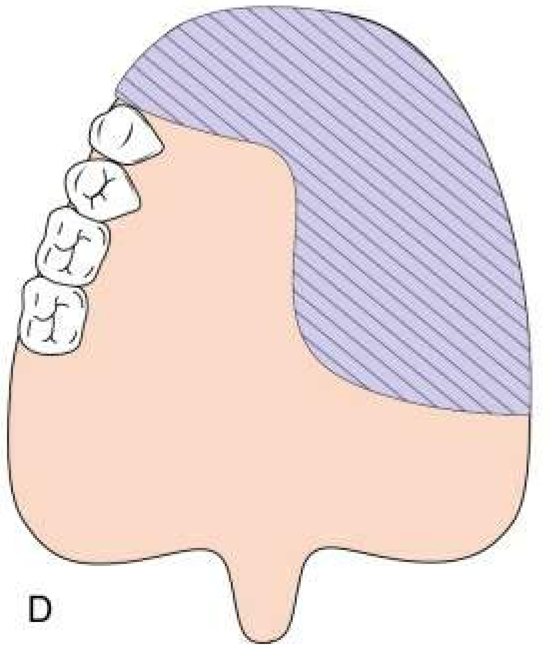

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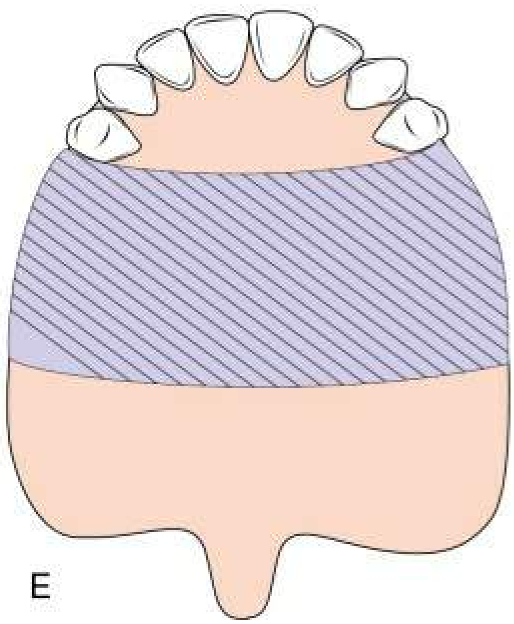

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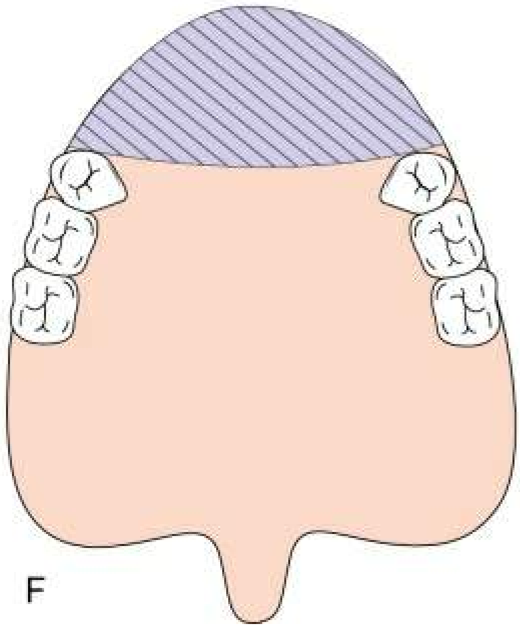


FIGURE 50.6 **(A)** Class I: Midline resection. **(B)** Class II: Unilateral resection. **(C)** Class III: Central resection. **(D)** Class IV: Bilateral anteroposterior resection. **(E)** Class V: Posterior resection. **(F)** Class VI: Anterior resection.

Class I

The resection in this group is performed along the midline of the maxilla; the teeth are maintained on one side of the arch. This is the most frequent maxillary defect, and most patients fall into this category (Fig. 50.6A).

Class II

The defect in this group is unilateral, retaining the anterior teeth on the contralateral side. The recommended design is similar to the design of a class II Kennedy removable partial denture (RPD) (Fig. 50.6B).

Class III

The palatal defect occurs in the central portion of the hard palate and may involve part of the soft palate. The design for these patients is simple and retention, stabilization and reciprocation can be effectively planned (Fig. 50.6C).

Class IV

The defect crosses the midline and involves both sides of the maxillae. There are few teeth remaining which lie in a straight line (Fig. 50.6D).

Class V

The surgical defect in this situation is bilateral and lies posterior to the remaining abutment teeth (Fig. 50.6E).

Class VI

It is rare to have an acquired maxillary defect anterior to the remaining abutment teeth. This occurs mostly in trauma or it is congenital (Fig. 50.6F).

Although this classification is comprehensive and well accepted, it still suffers a drawback of not defining and explaining the vertical extension of the defect.

Acquired soft palate defects

Acquired soft palate defects are among the most difficult deformities to rehabilitate. When there is tumour resection of a soft palate, the problem faced mostly is speech intelligibility. The soft palate is divided into three parts – anterior, middle and posterior, the muscles of the soft palate is involved in swallowing and speech. The soft palate is a crucial part of the velopharyngeal mechanism; to function properly, in all its complexity, is primarily constriction of the lateral and posterior pharyngeal walls to form a ‘velum’. The degree of speech intelligibility depends on the remaining portion of the soft palate after resection. However, all five muscles comprising the soft palate work integrally to allow movements, depending on whether speech or swallowing actions are being performed. **Velopharyngeal inadequacy** (VPI) is a malfunction of a velopharyngeal mechanism.

Velopharyngeal insufficiency: The inability of the velopharyngeal sphincter to sufficiently separate the nasal cavity from the oral cavity during speech.

Velopharyngeal incompetency: When the soft palate and the lateral/posterior pharyngeal walls fail to separate the oral cavity from the nasal cavity during speech.

Prosthetic rehabilitation of acquired maxillary defects

The treatment can be dealt under two categories namely treatment for soft palate defects and treatment for hard palate defects.

Treatment of soft palate defects

Palatal lift prosthesis

A palatal lift prosthesis addresses velopharyngeal incompetence by physically displacing the dysfunctional soft palate in the hope of closing the velopharyngeal port, enough to mitigate hypernasal speech and/or prevent nasopharyngeal regurgitation of liquids or solids during the pharyngeal phase of swallowing. A palatal lift prosthesis consists of an oral component that stabilizes and secures the prosthesis and an oropharyngeal extension that superiorly and posteriorly displaces the impaired soft palate. Palatal lift prostheses are classified as interim or definitive prostheses (Fig. 50.7A).

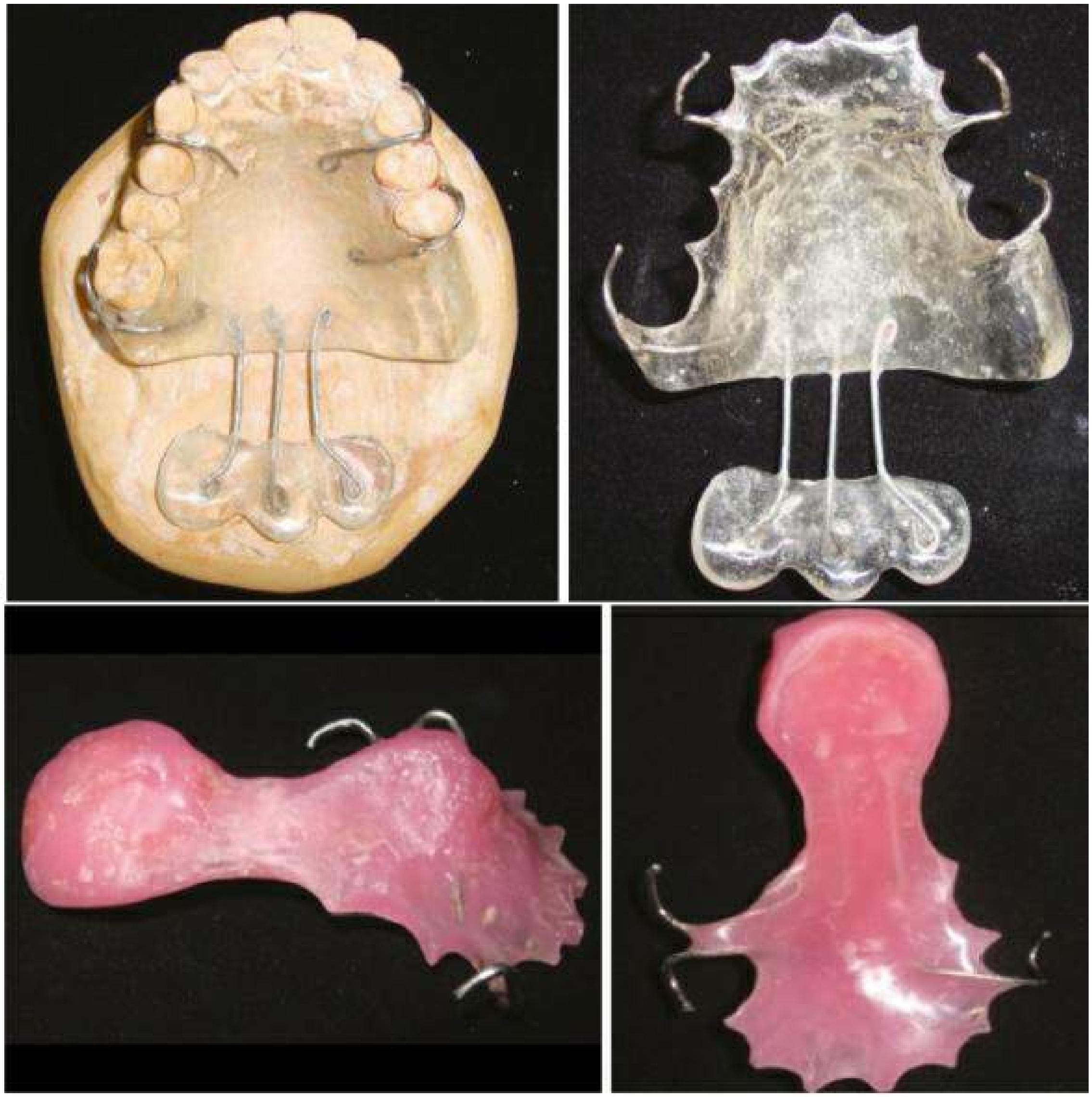


FIGURE 50.7 **(A)** Palatal lift prosthesis. **(B)** Speech bulb prosthesis.

Speech aid prosthesis

In a total soft palate resection (velopharyngeal insufficiency), speech aid prosthesis can be used for rehabilitation of the defect. Proper speech aid prosthesis must have extension into the velopharyngeal space which occupies the nasopharyngeal space at the level of the atlas and axis. The anatomical band at the posterior portion of the posterior pharyngeal wall is known as 'torus tuberius' or in some patients such as in congenital cleft patients the muscle of the posterior pharyngeal wall forms an exaggerated roll of muscle called 'Passavant's ridge or Passavant's pad' (Fig. 50.7B).

To rehabilitate the acquired soft palate defect, proper extension must allow the remaining structures, lateral and posterior pharyngeal muscles to constrict and contact the bulb portion of the speech aid prosthesis. Therefore, functional moulding is required. The long cantilever of the bulb into the velum space in edentulous patients makes it quite difficult to achieve adequate retention when compared to conventional complete dentures due to the lack of the posterior palatal seal and the cantilever of the bulb. Osseointegrated implants can be used to obtain more retention and also improve mastication. However, the anteroposterior (AP) spread of the implant positions must be considered for treatment planning to assure a favourable prognosis for the speech aid prosthesis.

Treatment of hard palate defects

The surgical procedures as explained are normally well planned and the role of prosthodontist starts in planning the surgery. Most often the surgical defects are covered by a prosthesis called obturators.

Obturators

An obturator is defined as 'prosthesis used to close a congenital or acquired tissue opening primarily of the hard palate and/or contiguous alveolar structures'.

Prosthetic restoration of the defect often includes use of surgical obturator, interim obturator and definitive obturator (Fig. 50.8).

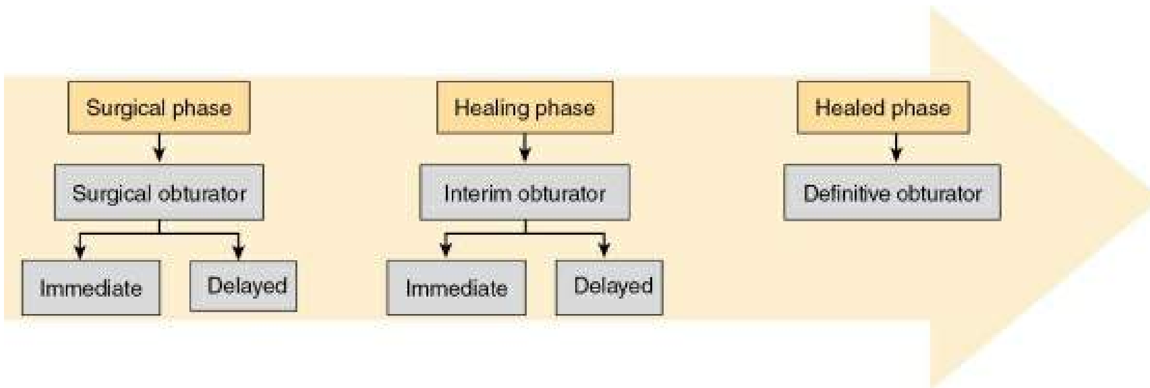


FIGURE 50.8 Types of obturators.

Surgical obturator

It is inserted at the time of surgery (immediate surgical obturator) or sometimes due to the unavailability of services or due to the type of tumour the surgery would be carried on and after 1–2 weeks postmaxillectomy this obturator can be inserted (delayed surgical obturator). It can be either for partially edentulous or for completely edentulous, but no teeth will be present on the obturator. Reduces oral and nasal contamination and permits deglutition and reduces hospitalization.

This prosthesis will eliminate the need of nasogastric tube, which collectively reduces psychological trauma. The presurgical models are fabricated from the impression before the surgery (Fig. 50.9).The models are discussed with the surgeon for the extent of the surgery and marked. The prosthodontist will perform the simulated surgery in the model. This model is used for fabrication of surgical obturator (Fig. 50.10A). The prosthesis is made up of 2 mm thick acrylic plate with heat-cured clear polymethyl methacrylate (PMMA). Should have retentive tags on the tissue side of the defect to retain the surgical pack that supports the split thickness skin graft on the lateral wall of the defect. This prosthesis will invariably have to be altered with tissue conditioning material in the operating table. Teeth and bulb are not present (Fig. 50.10B).

FIGURE 50.9 Maxillary cast showing the defect.

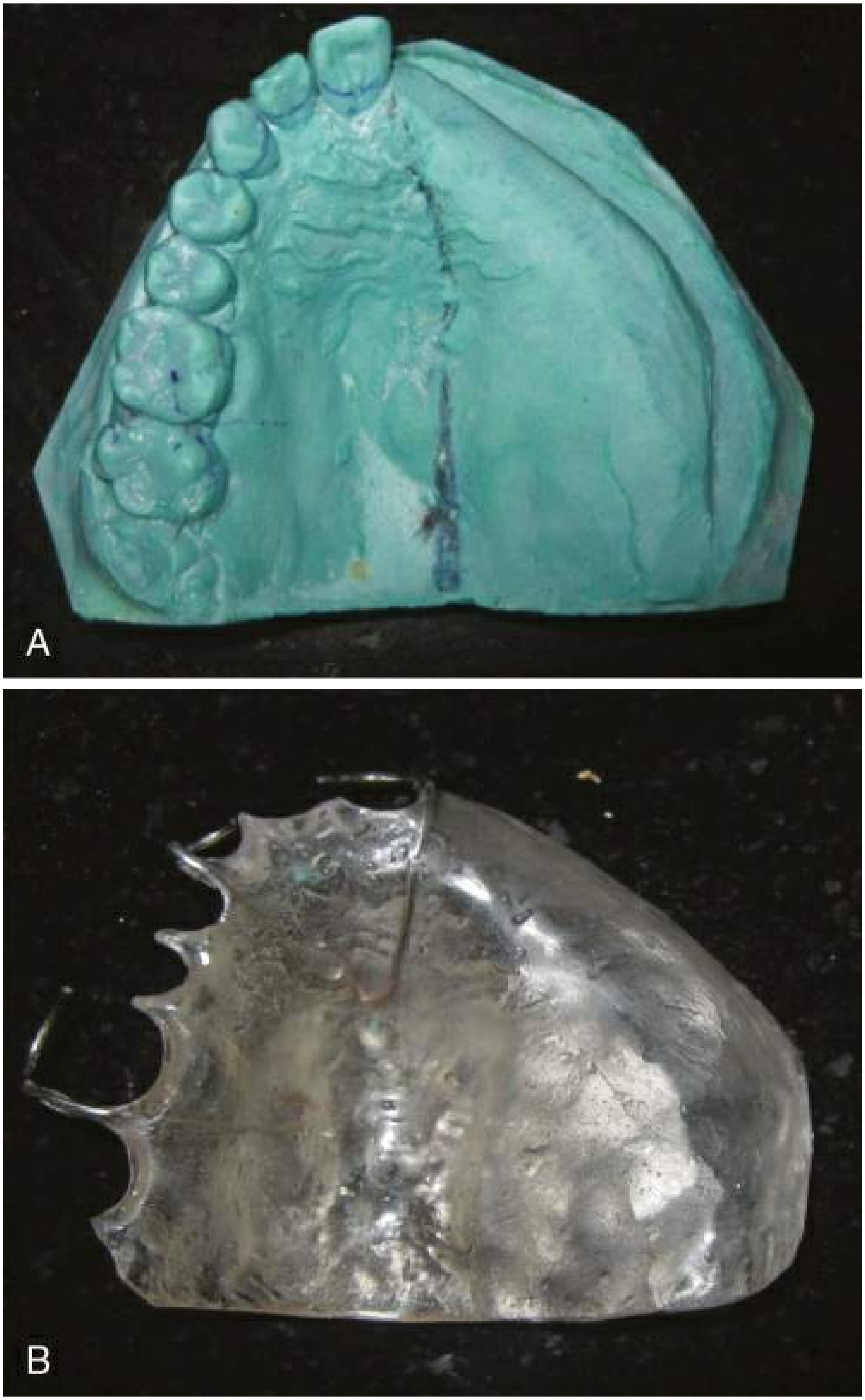


FIGURE 50.10 **(A)** Cast showing surgical extension and proposed resection of the defect and the remaining abutment

teeth for support. **(B)** Surgical obturator polished—palatal surface

The success of a surgical obturator may depend on the number and health of the remaining teeth. These teeth govern the retention of the prosthesis. In the absence of the teeth, the obturator is wired with the bone.

Advantages

1. Provides a matrix on which the surgical packing can be placed.

2. It ensures close adaptation of the skin graft to the raw surface of the cheek flap.

3. Reduces oral contamination of the wound and thus may reduce the incidence of local infection.

4. Enables the patient to speak more effectively postoperatively by reproducing normal palatal contours and by covering the defect.

5. Permits deglutition, thus eliminating the need for a nasogastric tube.

6. Lessens the psychological impact of surgery by making the postoperative closure easier to bear with.

7. May reduce the period of hospitalization.

Interim obturator

It is inserted after 3–4 weeks postsurgery to ensure the wound contraction is minimized. It can be modified from ISO (immediate surgical obturator), teeth and a bulb can be added, but this bulb should be relined with tissue conditioner. This lining material should be changed once a week for 4–5 weeks. This is commonly termed as immediate interim obturator.

This improves speech, deglutition, function and sometimes if the patient undergoes radiation therapy, this can be used to maintain the defect and provide adequate function. Therefore, quality of life of the patient is elevated. This may serve for several months or even indefinite periods as well. When such procedures have to be carried out the interim prosthesis is fabricated again at a later date and often is termed as delayed interim obturator.

The interim obturator is fabricated with clear or pink-coloured PMMA and light wire clasping may be incorporated to enhance retention (Fig. 50.11). Teeth have to be given in anterior segments to give aesthetic acceptability. Posterior teeth and posterior occlusion should be avoided to reduce the abutment stress.

FIGURE 50.11 Interim prosthesis with light wire clasping – tissue surface.

Definitive obturator

This type of prosthesis is given when the surgical wound is fully healed. The response of individual patients to surgery, radiation therapy, nutritional status and a host of reasons will determine when the definitive obturator (Fig. 50.12) should be considered. At this stage, all carious teeth should be restored and prognostically poor teeth should be indicated for extraction. Care should be executed during surgical extraction in patients who have undergone pre- or postsurgical radiation therapy. Normally, it is fabricated using cast metals; however, acrylic definitive obturators can also be used. The patients may be partially edentulous, or fully edentulous along with the maxillectomy defect. The treatment options and plan will vary accordingly.

FIGURE 50.12 Definitive obturator.

Prosthetic rehabilitation of partially edentulous maxillectomy defects

Principles of designing obturator prosthesis for partially edentulous situations:

The general principles of RPD design apply to obturator prosthesis design as well. Relevant among these are

1. Rigid major connector.

2. Guide planes and other components that facilitate stability and bracing.

3. Rests that place supporting forces along the long axis of the abutment tooth.

4. Direct retainers that are passive at rest and provide adequate resistance to dislodgment without overloading the abutment teeth.

5. Control of the occlusal plane that opposes the defect.

In addition, other considerations involved in the design are

1. Location and size of the defect, especially as it relates to the remaining teeth.

2. Importance of the abutment tooth adjacent to the defect, which is critical to the support and retention of the obturator prosthesis.

3. Usefulness of the lateral scar band, which flexes to allow insertion of the prosthesis but tends to resist its displacement.

4. Use of the surveyor to examine the defect for the purpose of locating and preserving useful undercuts or eliminating undesirable undercuts.

The prognosis of the obturator will improve with:

1. The size (amount remaining after surgery) and curvature of the arch.

2. Quality of the tissue covering the ridge and lining the defect.

3. Abutment alignment that is curved instead of linear.

4. Availability of teeth on the defect side for support and retention.

5. Periodontal health of the abutment teeth.

Types and design of obturator prosthesis for partially edentulous

Maxillectomy defects

The definitive obturator for a partially edentulous patient can be of the following type:

1. Wrought wire-retained full acrylic prosthesis, with or without bulb depending upon the vertical extent of the defect.

2. Cast metal clasp-retained prosthesis, with or without bulb depending upon the vertical extent of the defect.

3. Attachment-retained prosthesis, with or without bulb depending upon the vertical extent of the defect.

The various designs of cast metal-retained obturator for different classes of acquired maxillary defect are as follows.

Class I (fig. 50.13A)

Support

- Rigid major connector – distributes functional load as equally as possible.
- Support is gained by

  ○ Rests

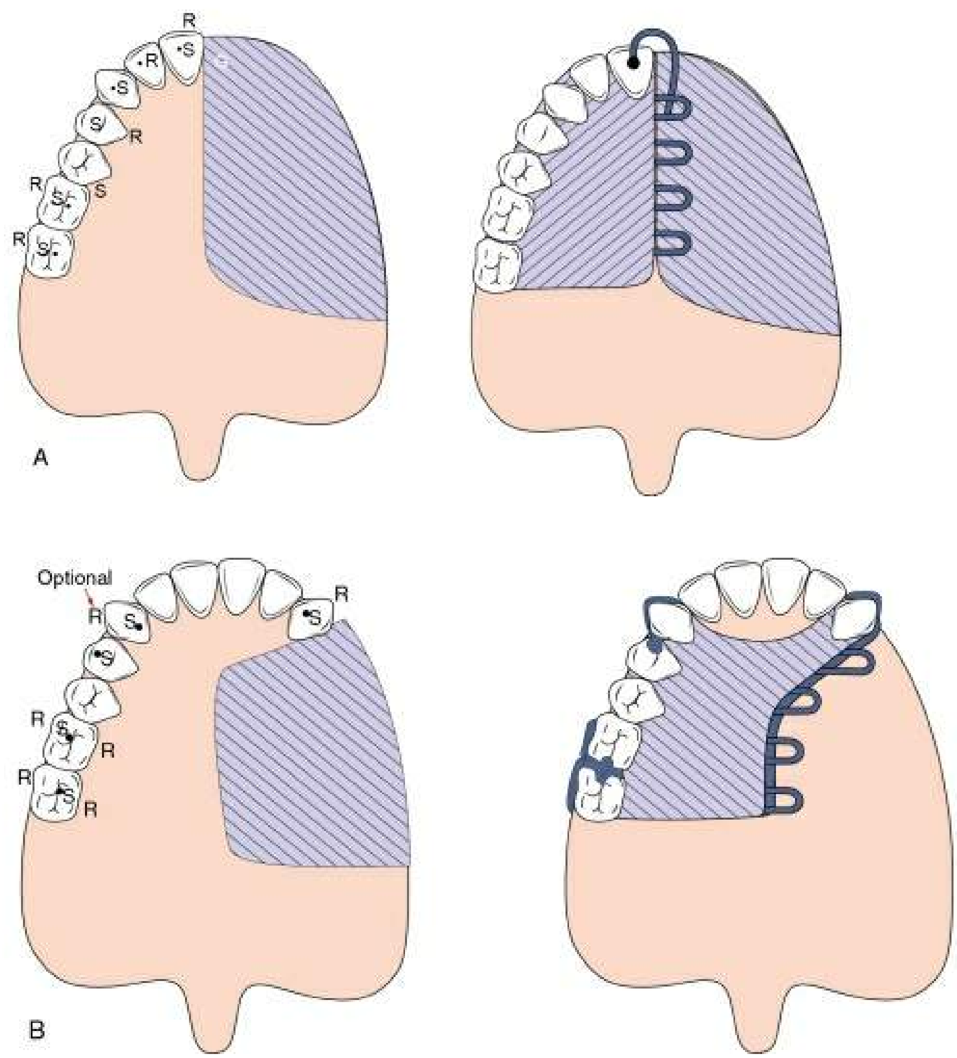
  ○ Guide planes

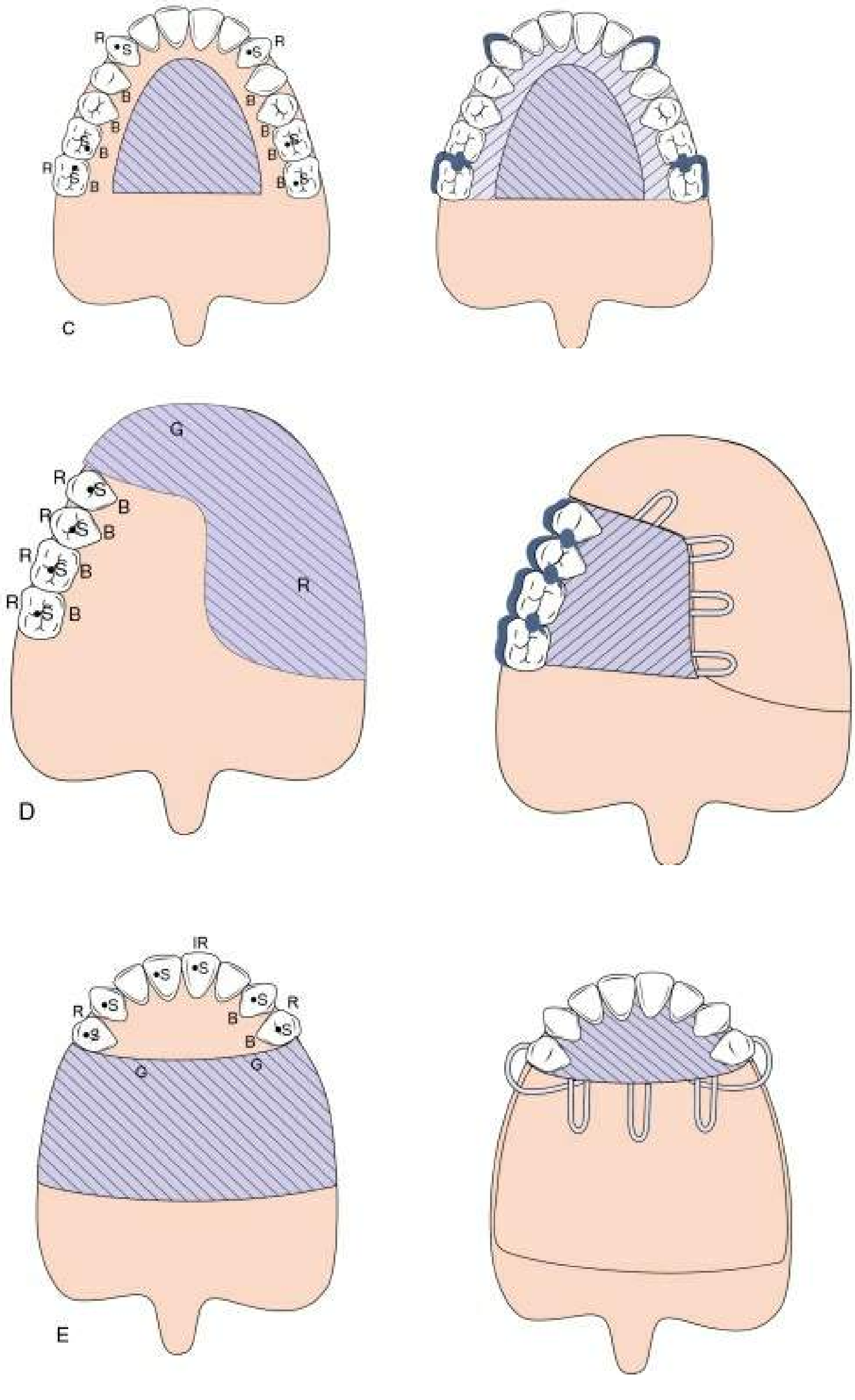
  ○ Indirect retainers

- Rests are placed on the most anterior abutment (closest to the defect) with mesio-occlusal posterior rest and disto-occlusal rest.

• Guide planes have predictable retention and greater degree of stability.

• Indirect retainer is located perpendicular to the fulcrum line (which connects the most anterior and most posterior rests) which is usually a canine or first premolar.





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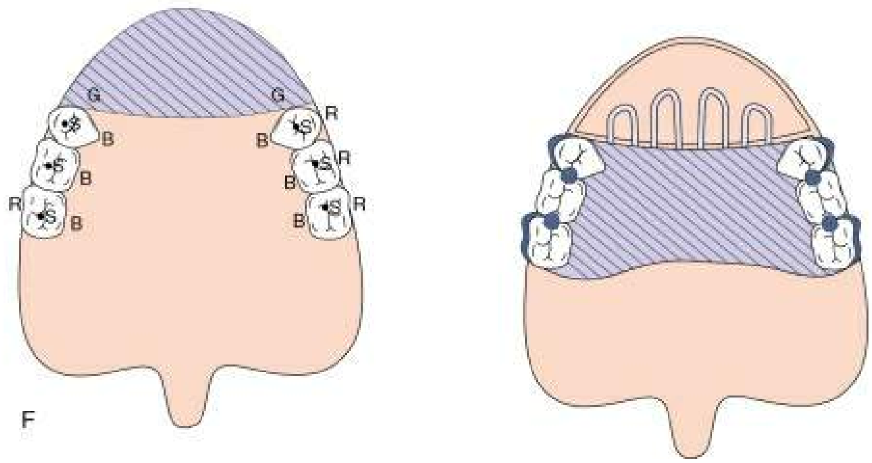


FIGURE 50.13 **(A)** Class I defect and its prosthesis design. S, support; R, retention; B:, bracing; G, guiding plane; IR, indirect retention. **(B)** Class II defect and its prosthesis design. Defect: curvilinear. Prosthetic design: tripodal. S, support; R, retention; B, bracing; G, guiding plane. **(C)** Class III defect and its prosthesis design. Class III design: quadrilateral. S, support; R, retention; B, bracing. **(D)** Class IV defect and its prosthesis design. Class IV design: linear. S: support, R: retention, B: bracing, G: guiding plane. **(E)** Class V defect and its prosthesis design. Class V design: tripodal. S, support; R, retention; B, bracing; G, guiding plane; IR, indirect retention. **(F)** Class VI defect and its prosthesis design. Class VI design: quadrilateral. S, support; R, retention; B, bracing; G, guiding plane.

Retention

- It is gained by using direct retainers.
- Anterior retainer – wrought wire clasp with 'I-bar' design is used to engage on the midlabial undercut of abutment.
- Posterior retainer – cast circumferential clasp using the buccal surface undercut.

Class II (fig. 50.13B)

Support

- Similar to class I with rest involving the palate.
- Double rests are used between adjacent posterior teeth.
- Guide-plane similar to the class I situation with full use of the palatal surfaces of the posterior teeth.
- Indirect retainer located on the canine or first premolar.

Retention

- Similar to that in the class I design. The abutment tooth closest to the defect is engaged with a direct retainer that resists downward displacement.
- A cast circumferential clasp or an I-bar clasp is used.
- Occlusion on the defect side can be destructive; so occlusal scheme with fewer, smaller teeth is desirable.

Class III (fig. 50.13C)

Support

- Rests widely separated and bilaterally located.
- The canines and molars used for quadrilateral configuration.
- Little or no support is expected from the palate or the defect.
- Short guide planes from the palatal surfaces of the posterior teeth.
- Indirect retention is not required because each terminus is supported by a direct retainer.

Retention

- Cast retainers using undercuts on the facial surfaces of the teeth.
- They may be circumferential retainers, I-bars or modified T-bars.
- Combination-type retainers can be used in the aesthetic zones.

Class IV (fig. 50.13D)

Support

- Rests located centrally on all of the remaining teeth.
- Multiple mesio-occlusal and disto-occlusal rests designed.

Retention

- Retention is problematic.
- Mixture of buccal retention on the premolars and palatal retention on the molars is used similar to the class I linear design.

Class V (fig. 50.13E)

Support

- Rest is located on the mesio-occlusal surface of the most posterior abutment.
- If adjacent posterior teeth are involved, double rests are used.
- Stabilization and bracing is by broad palatal coverage.
- Indirect retention is by rests located on the central incisors.

Retention

- The I-bar retainer is located in midbuccal surface undercut.
- A swing-lock type of prosthesis is advised.

Class VI (fig. 50.13F)

Support

- Rests located on disto-occlusal surfaces of the most anterior abutment teeth.
- Double rests are used when adjacent posterior teeth are involved.
- The remaining natural teeth provide all of the support.
- Guide planes are located on the proximal surfaces adjacent to the defect.

Retention

- Cast retainers using facial undercut.
- I-bar located on the anterior abutment in a midfacial undercut.
- Other modification – meatus obturator, it is a special kind of obturator that extends up to the nasal aperture. It establishes closure with the nasal structures and separates the oral and the nasal cavity.

Attachment-retained cast obturator

The unsightly exposure of metal clasp in class I, II and IV and also the deleterious forces exerted on the week anterior abutment have necessitated an opportunity to use the attachment for use in obturator prosthesis. Depending on the horizontal and vertical extension of the surgical excision, two or three teeth adjacent to the defect may be prepared to receive full veneer crowns. The cast crowns are normally splinted together to gain additional stability. The male component of the attachment will be cast to the crown and the female is incorporated in the removable obturator prosthesis (Fig. 50.14–50.17).

FIGURE 50.14 Intraoral picture of the extensive defect.

FIGURE 50.15 Splinted crown with extracoronal attachment cemented.

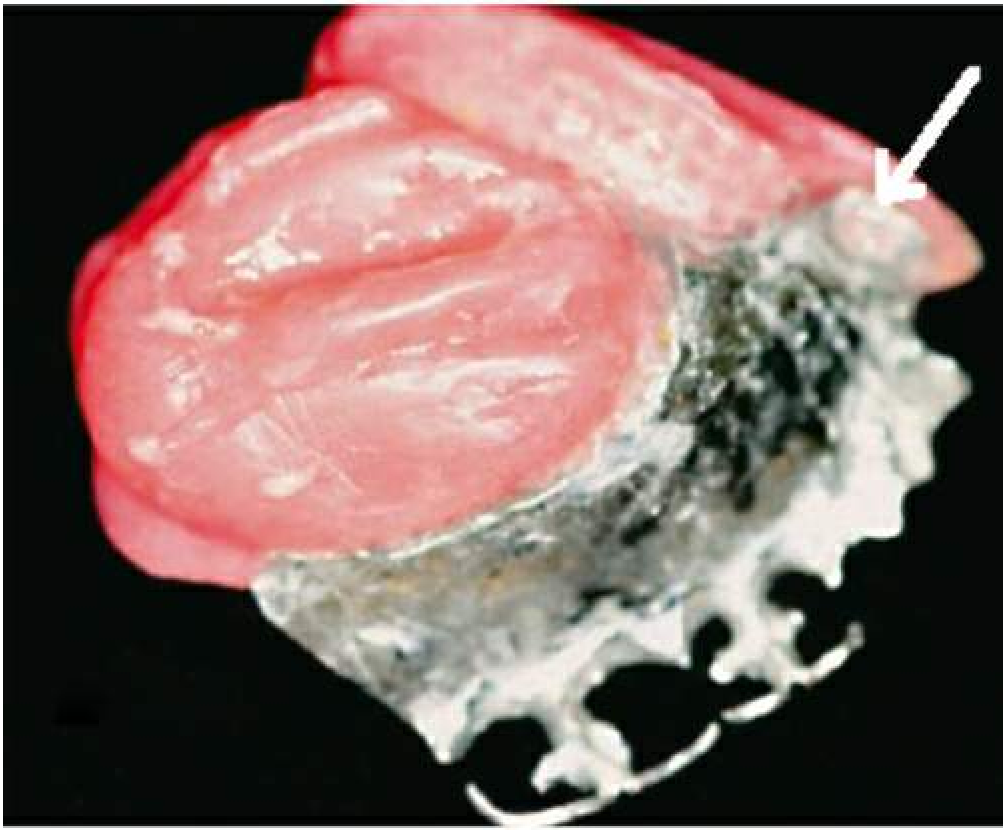


FIGURE 50.16 Obturator prosthesis with female incorporated.

FIGURE 50.17 Prosthesis in the oral cavity.

Hollow bulb obturator

Palatal defect causes various problems in speech, mastication, deglutition and aesthetics. Palatal obturator is the only substitute that covers this defect and aids in normal speech production with elimination of hypernasality (Figs 50.18–50.22). The vertical extent of the defect will govern the choice of use of hollow bulb obturators.

FIGURE 50.18 Defect with only one molar present.

FIGURE 50.19 Hollow bulb made of acrylic.

FIGURE 50.20 Acrylic denture without palate.

FIGURE 50.21 Acrylic denture and hollow bulb assembly retained with magnets.

FIGURE 50.22 Denture assembly in the oral cavity.

Advantages of Hollow Bulb Design

- Easy to fabricate.
- Increased speech intelligibility
- Lighter in weight.
- More hygienic.
- Aid speech resonance.

Types of hollow bulb obturator

1. Type 1

    i. Open – unhygienic, foul smelling and unpleasant for the patient.

    ii. Closed – prevents fluid and food collection, reduces air space.

2. Type 2

    i. Single piece – less comfortable and has reduced extensions.

    ii. Two piece – more hygienic and easy to handle.

Most often the obturator prosthesis should be changed periodically.

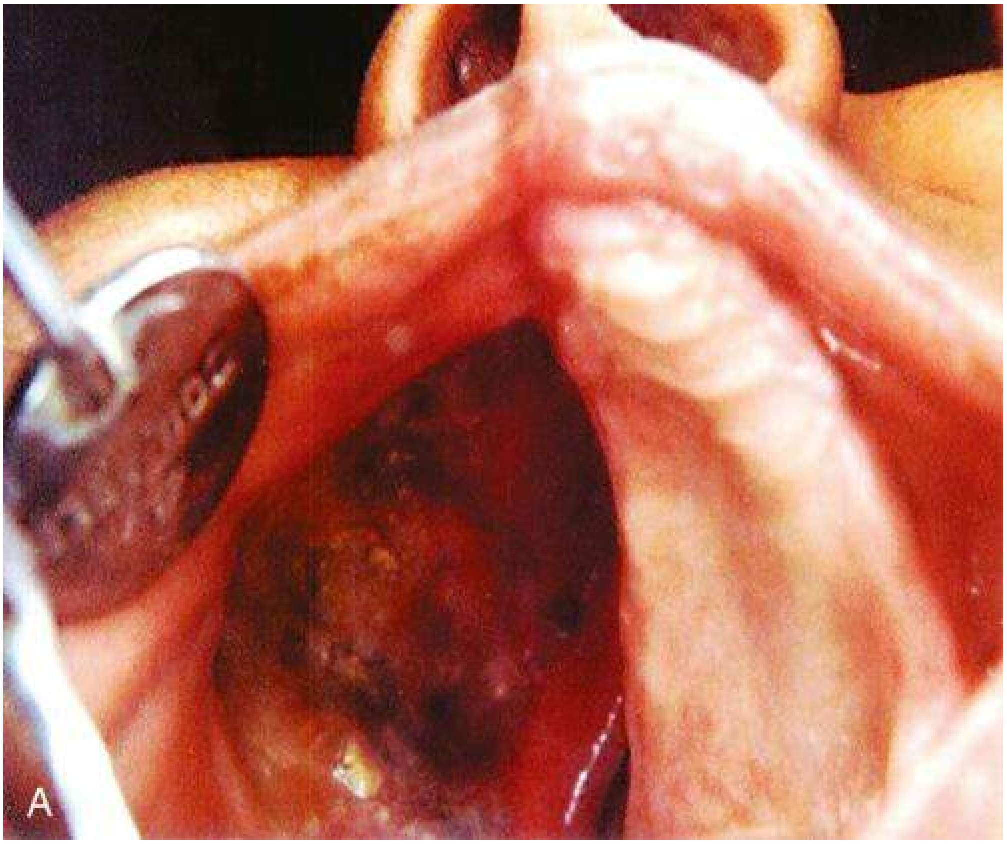
Prosthetic rehabilitation of edentulous maxillectomy defects

Prosthetic restorations are the preferred method for the rehabilitation of complex midfacial defects like the bilateral maxillectomy. Prosthetic prognosis is poor due to lack of a stable supportive hard tissue for stability and retention of the prosthesis. Prosthetic reconstruction in these patients depends on the size of the defect, availability of hard and soft tissues in the defect area to provide support, proximity of vital structures, patient attitude and systemic conditions.

Various treatment options include:

- Closed or open hollow bulb obturator.
- Hollow bulb obturator connected to complete denture with magnet.

• Implant-retained maxillary obturator (Fig. 50.23).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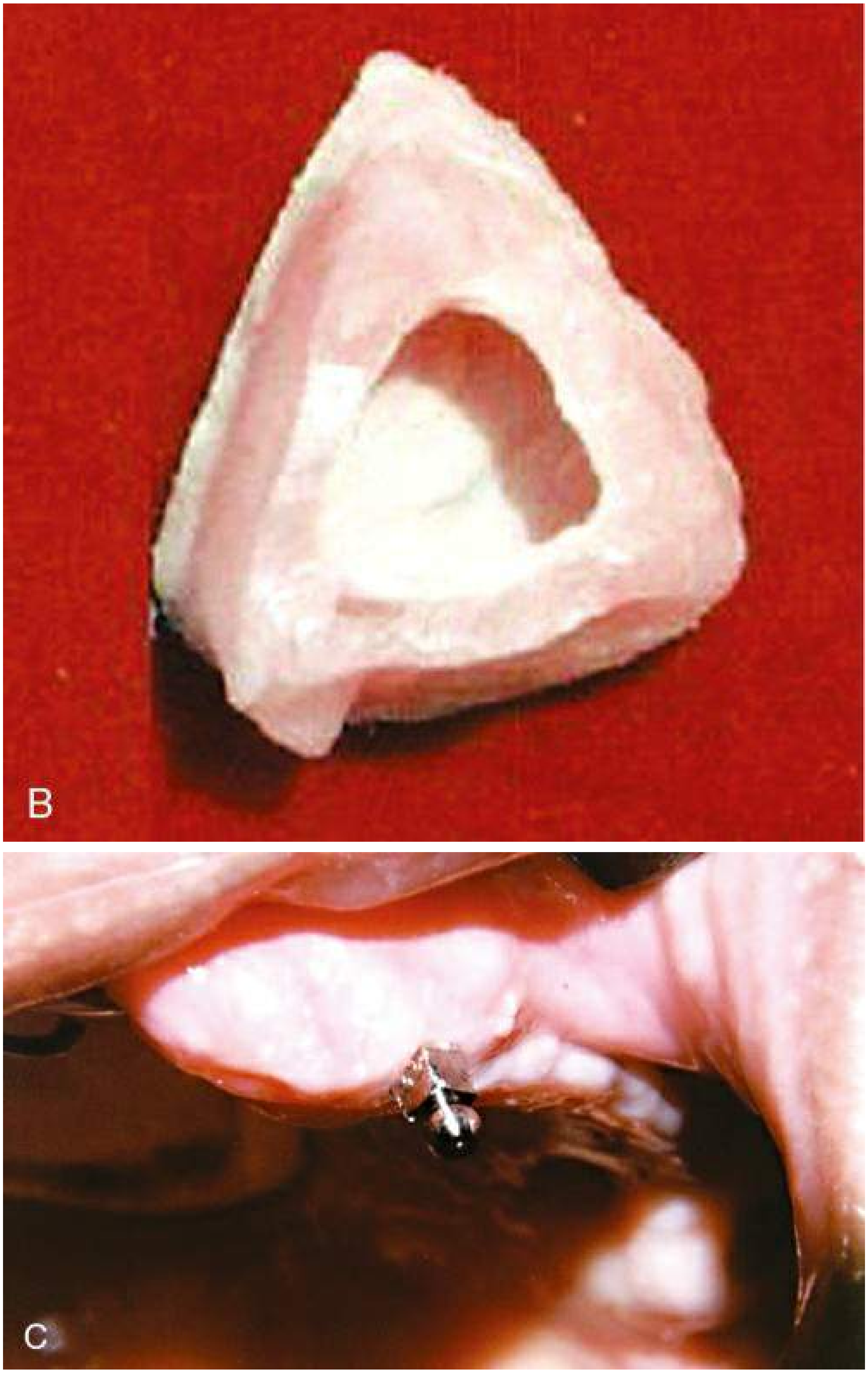
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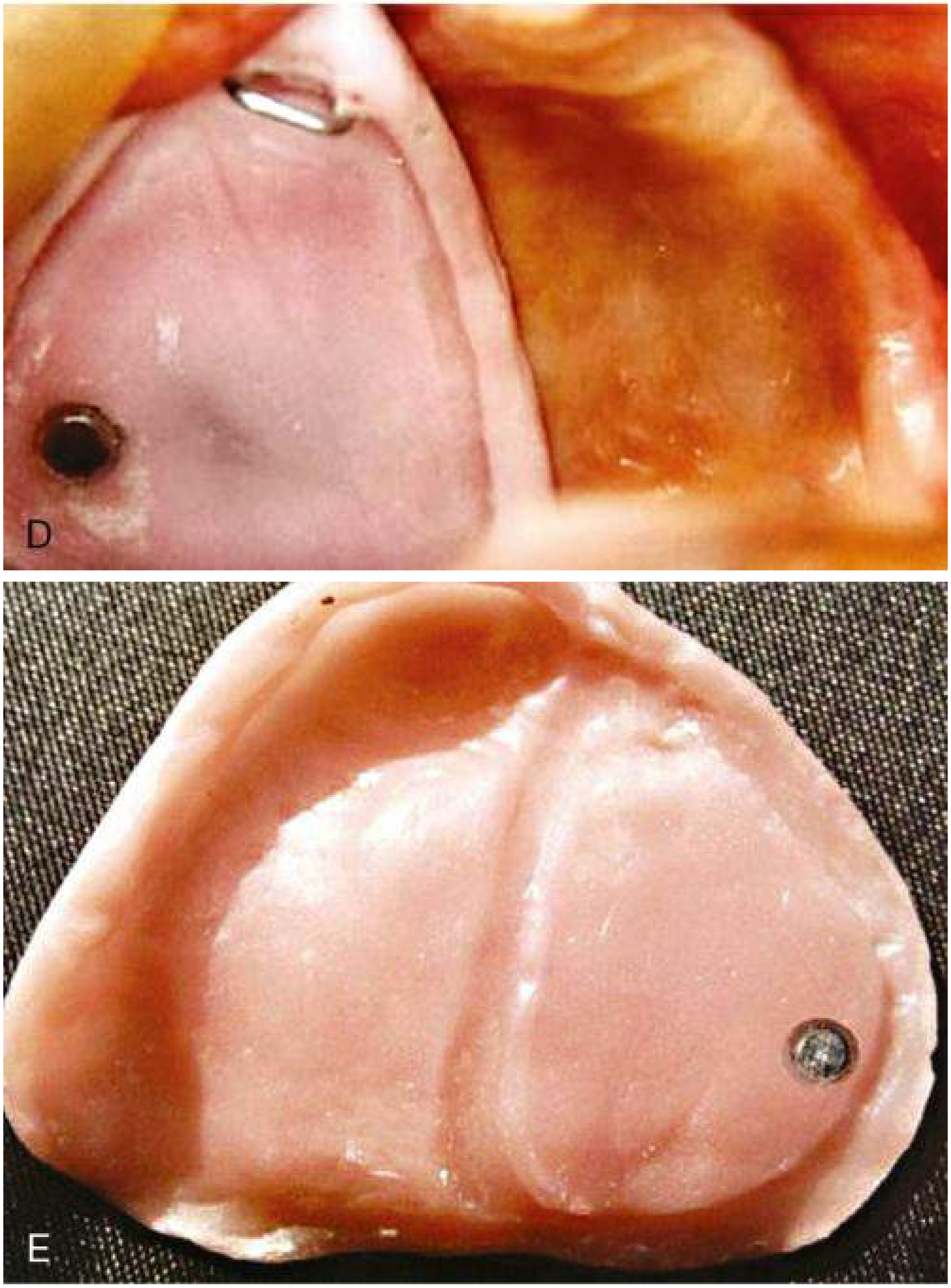


FIGURE 50.23 **(A)** Maxillary defect in totally edentulous situation. **(B)** Open type hollow bulb fabricated with soft liner. **(C)** Implant in the anterior maxilla to help retention. **(D)** Hollow bulb in the oral cavity. Note the magnet at the distobuccal end. **(E)** Finished prosthesis with the magnet attached to the hollow bulb.

Despite all the efforts, the success of the obturator prosthesis is always guarded. It may be attributed to the psychological influence of the patients to a large extent.

Mandibular defects

Congenital mandibular defects

Common congenital mandibular defects include micrognathia, mandibulofacial dysostosis, ankylosis of the TMJ, etc. Most often the role of the maxillofacial prosthodontist is limited.

Acquired mandibular defects

Neoplastic resections are the most common cause for an acquired mandibular defect. Resection of the mandible may often lead to speech and swallowing dysfunction due to deviation of the mandible, and also the poor equilibrium of muscles on either side of the mandible.

Classification of mandibular defects

Based on the amount of resection or bone loss

Continuity defect

The superior portion of the mandible is resected and lower border is left intact. These defects do not show any deviation and are easy to restore.

Discontinuity defect

Entire segment of the mandible is resected. There are no connections between the remaining parts of the mandible resulting in the midline deviation of the mandible due to movement of the bone.

Chalian classification (1985)

Class I: Resection of the ipsilateral condyle.

Class II: Resection of the ipsilateral condyle and ascending ramus.

Class III: Resection of the ipsilateral condyle and body to midsymphysis.

Class IV: Resection of the ipsilateral condyle to the contralateral body.

Class V: Total mandibulectomy.

Class VI: Resection of the midsypmphysis.

Class VII: Segmental resection of the body.

Class VIII: Marginal or coronal resection of the body.

Cantor and curtis classification of mandibular defects

1. **Class I**: Mandibular resection involving alveolar resection and preservation of mandibular continuity (Fig. 50.24A).

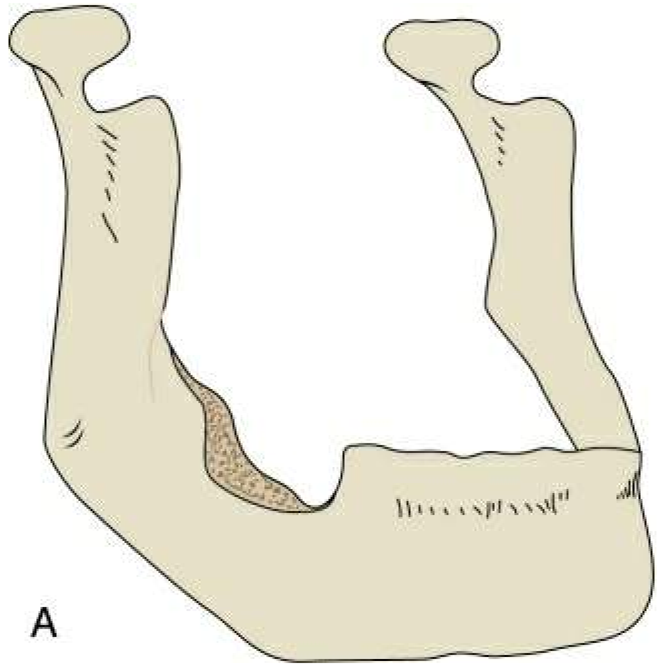
2. **Class II**: Loss of continuity distal to the canine area (Fig. 50.24B).

3. **Class III**: Mandibular resection involving a minimum of midline loss of continuity (Fig. 50.24C).

4. **Class IV**: Resection of lateral portion of the mandible with subsequent augmentation (Fig. 50.24D) to restore form and function.

5. **Class V:** Midline resection with subsequent augmentation (Fig. 50.24E) to restore form and function.

6. **Class VI:** Similar to class V but there is no augmentation following resection (Fig. 50.24F).



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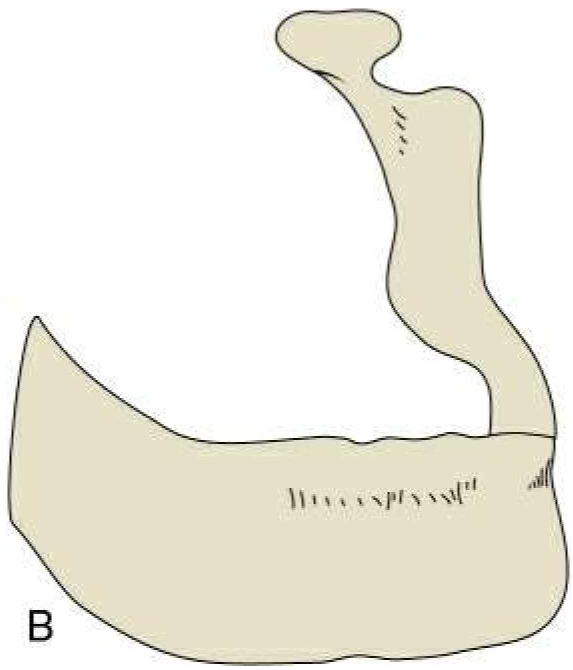

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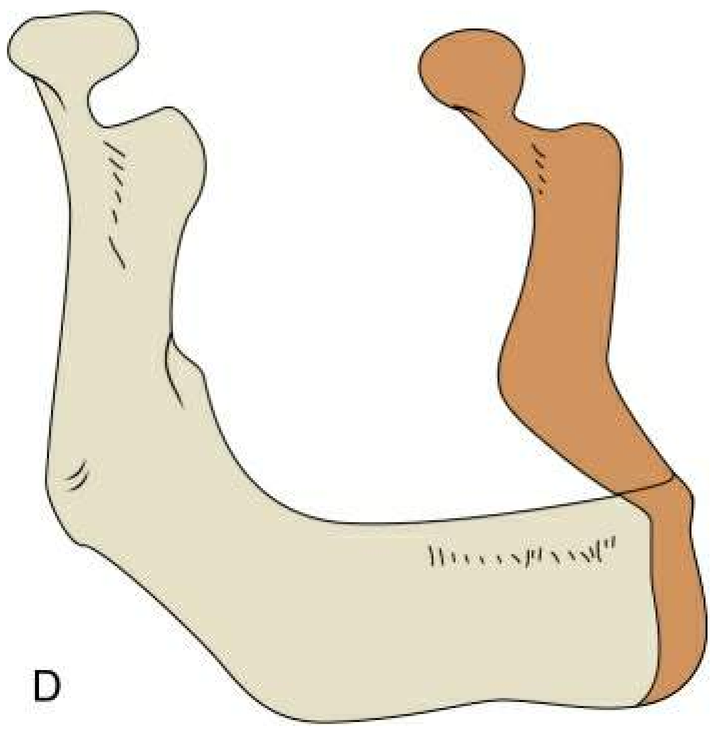

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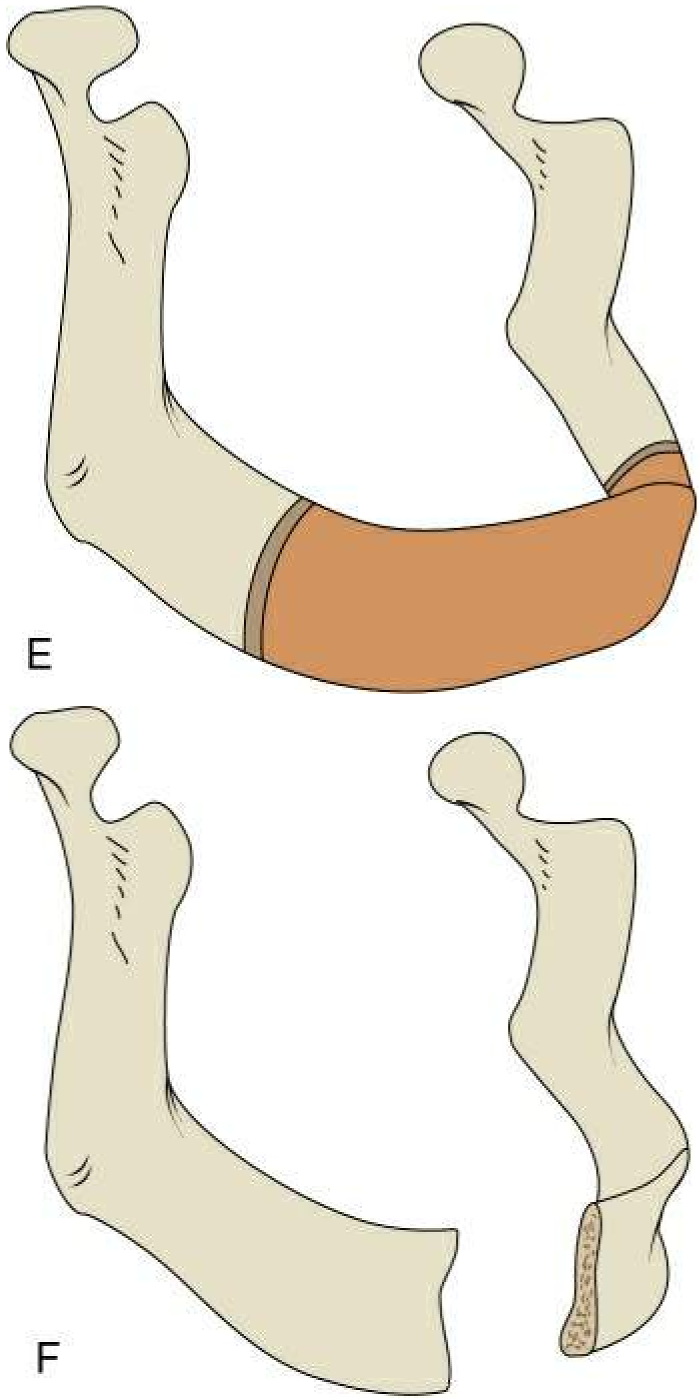

FIGURE 50.24 **(A)** Class I. **(B)** Class II. **(C)** Class III. **(D)** Class IV. **(E)** Class V. **(F)** Class VI.

Prosthetic rehabilitation of completely edentulous mandibular defects

To improve the prognosis the following procedures can be followed:

- Vestibuloplasty to create vestibule.
- Mandibular guidance flange to guide the mandibular movements.
- Lip bumpers are given to support the lower lip.
- Neutrocentric occlusion with nonanatomic teeth to distribute the occlusal forces. Implants are a boon to these patients, as it will help in the retention of the prosthesis. However, care and caution should be taken to make sure that the patient has undergone any radiation therapy.

Mandibular guidance flange

- It is indicated for mandibulectomy patients.
- The appliance consists of an RPD with a metal flange/acrylic ramps.
- For patients with severe deviation and poor occlusion, wax ramps can be used.

Prosthetic rehabilitation of partially edentulous mandibular defects

- For marginal mandibular resection – mandibular guidance flange prosthesis (Fig. 50.25A) or palatal ramp prosthesis (Fig 50.25B) can be fabricated. This prosthesis is instituted immediately or as soon as possible after the surgery to prevent deviation of the mandible. The ramp or the flange will prevent the mandible from deviation towards the resected side.
- For segmental midline defect – magnet-retained snap-on prosthesis or a bar-supported overdenture or an implant-supported prosthesis can be given.
- Maxillary guidance ramp or palatal ramp is an interim appliance used in the correction of mandibular deviation.

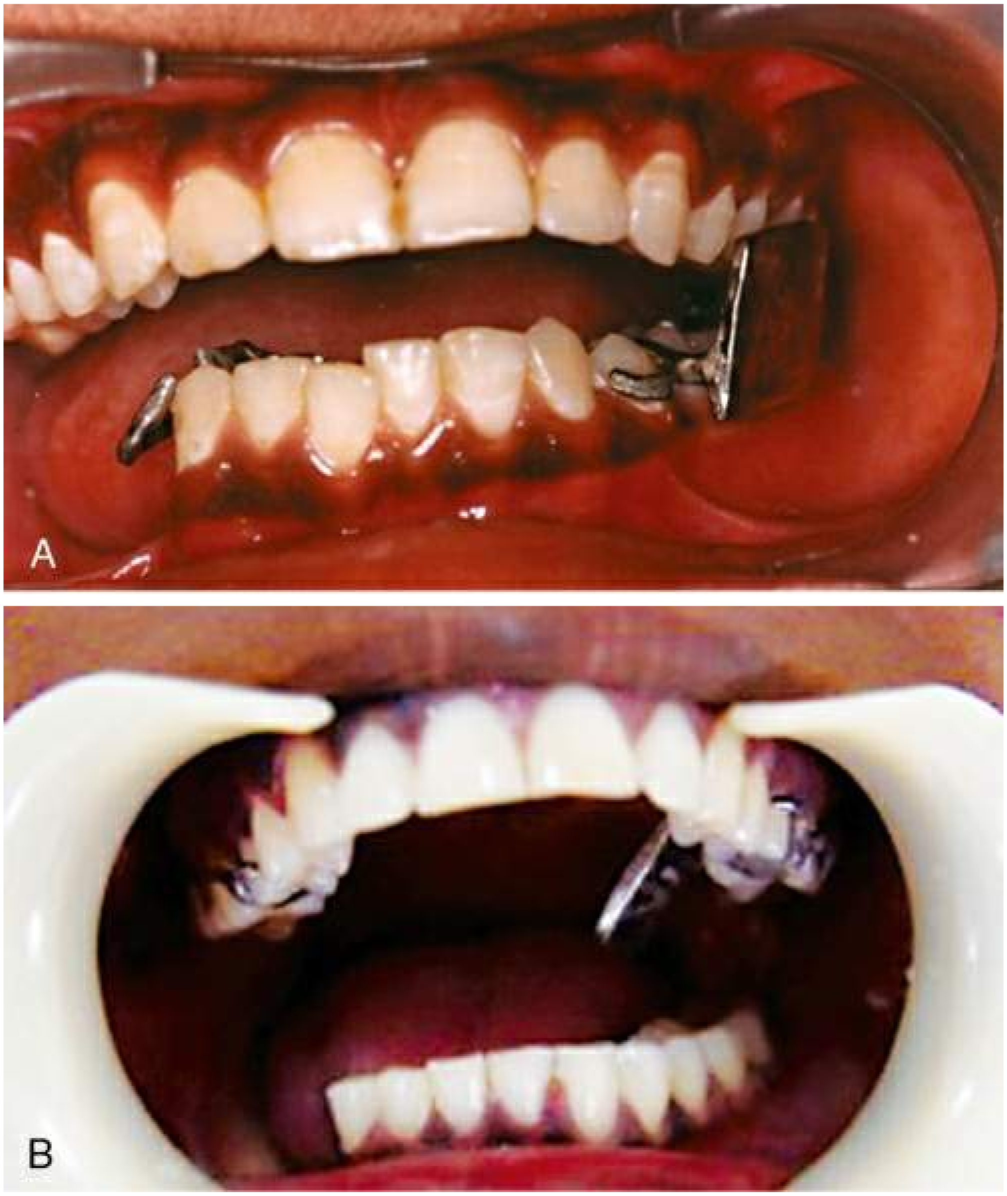

FIGURE 50.25 **(A)** Mandibular guide flange. **(B)** Palatal ramp to guide deviated mandible.

Retention in maxillofacial prostheses

The retention of the prosthesis is a prime factor in gauging the outcome of the treatment. The prosthesis whether intraoral or extraoral should be very retentive. Obtaining a good retention is always difficult in most situations due to the extent of the defect and the positioning and health of the remaining teeth.

Retention of maxillofacial prosthesis is classified into the following:

1. Intraoral retention

○ Anatomic and tissue retained

○ Tooth retained

○ Implant retained

○ Combination

2. Extraoral retention

○ Anatomic retention

○ Mechanical retention

○ Adhesive retention

○ Craniofacial implants

○ Combination

Intraoral retention

1. **Anatomic retention**: Retention depends on the size and location of the anatomical undercut areas in the surgical site.

2. **Retention from the dentition**: It is gained by providing effective clasping to the remaining dentition.

Conventional cast clasp

The properly designed and fabricated clasp (Fig. 50.26) will provide stability, splinting, bilateral bracing and reciprocation as well as retention.

FIGURE 50.26 Conventional cast clasp.

Types of extracoronal retainers

Most frequently used are the clasps because of their reliability, ease of fabrication and adaptability. They are mainly indicated in tooth-supported prostheses.

1. Cast wrought combination circumferential clasp

• It substitutes a contoured wrought wire (Fig. 50.27A) for the cast clasp that has great ability to flex in any direction but more likely to fracture after repeated usage.

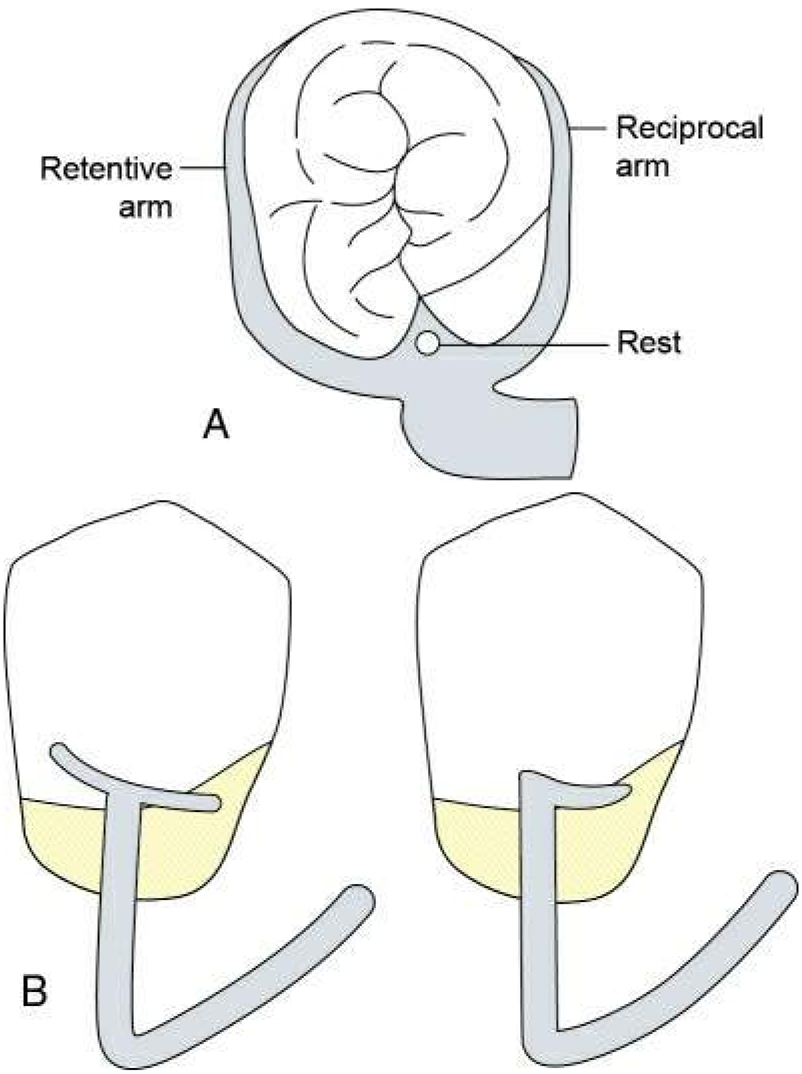


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FIGURE 50.27 **(A)** Contoured wrought wire in the place of cast clasp. **(B)** T-bar cast circumferential clasp (netcervical approach). **(C)** Telescopic crown in overlay denture prosthesis. **(D)** Intraoral implants to aid retention. **(E)** Extraoral implants to enhance retention.

2. T-bar cast circumferential combination

- It provides a cervical approach (Fig. 50.27B) to the tooth surface and utilizes the existing distobuccal undercut.

3. Ring clasp

- This also uses an undercut adjacent to the edentulous area but reaches it by circumnavigating (Fig. 50.27C) the tooth.
- It is used on long standing molar abutments distal to the edentulous space.

4. Prefabricated precision attachments

- They are placed into cast crowns for the aesthetic and mechanical retention.

- They are useful in rehabilitating cleft lip and cleft palate cases.

5. Telescopic crown

- They are used in overlay denture prostheses (Fig 50.27C).

- It is indicated when major change in the vertical or centric dimension is indicated as in cleft lip and cleft palate cases and resected mandible.

6. Intermaxillary springs

- They are preformed and can be inserted into upper and lower dentures to help stabilize them on the ridges during function. It is not being used often.

7. Auxiliary retention devices

- These include buccal and lingual continuous clasp, valve seal, Fauchard wing device for clefts, guide planes, surface adhesion devices.

8. Intraoral implants

- These help in retention and to some extent in the support of the prosthesis (Fig. 50.27D).

Extraoral retention

Anatomic retention

Both hard and soft tissues of the head and neck area can be used for retention of the prostheses.

Mechanical retention

It is mostly needed in cases such as large defects involving half of the face or heavily radiated tissues.

Adhesives

Adhesives used are different kinds of medical adhesives and double-coated polyethylene tapes that enhance retention by increasing adhesive and cohesive properties.

Magnets

Magnets have generated great interest within the field of dentistry and they have numerous applications. Due to their small size and strong attractive forces, they can be placed within prosthesis without being obtrusive.

Advantages

- Ease of cleaning
- Ease of placement
- Automatic reseating
- Constant retention

Despite the numerous advantages, reluctance to use magnets has arisen in the past because of the corrosive potential of the magnet component and lack of the breakaway strength that results in reduced patient comfort.

Newer generation magnets and associated abutments (magna cap component) have been successfully used in a variety of patients. The newer design of magnets provides a larger surface area that can provide pull force per magnet in excess of 900 g which nearly doubles retention and decreases the potential lateral displacement.

Magnetic attachments are applied in various types of prostheses more recently. The increase in denture stability with magnets has varied with the method of use and with the energy products of the magnets. The newer iron–neodymium–boron magnets are used as a substitute for conventional prostheses and have a good prognosis, provided they are encapsulated to prevent corrosion from oral environment.

These magnets transmit minimal lateral forces to the implants, require no exact paralleling technique and have nondiminishing retentive properties when compared to other mechanical attachments.

Facial implants

Often incorporated in treatment plan to enhance retention of prosthesis (Fig. 50.27E).

The standard technique for the retention of facial prostheses has been through the use of adhesives. The concepts of surface area, force and stress distribution are of significant concern with the implant retained and supported facial prostheses. Bone stock in the temporal, orbital and midface regions is seldom adequate for implants designed for intraoral use. To compensate for this, extraoral implants are 3–5 mm short in length and possess a peripheral flange. This flange increases the implant surface area in contact with bone.

Benefits of the implant-retained prostheses

- Improved retention and stability of the prostheses.
- Elimination of occasional skin reactions to adhesives.
- Ease and enhanced accuracy of prosthesis placement.
- Improved skin hygiene and patient comfort.
- Decreased daily maintenance associated with removal and reapplication of skin adhesives.
- Increased life span of facial restoration.
- When skin adhesives are used for retention, they must be removed and reapplied each day, leading to loss of colourants at the margin of the prostheses and eventually rendering the prosthesis unacceptable.
- Enhanced aesthetics at the lines of junction between the prosthesis and skin. When an implant-borne prosthesis is fabricated, its margins can be made thinner.

Treatment prosthesis

Treatment prosthesis can be defined as ‘a prosthetic appliance used for the purpose of treating or conditioning the tissues that are called upon to support and retain it’.

Radiation appliances

- These include stents, splints, shields, carriers or positioners. They are used to optimize the delivery of radiation while reducing associated morbidity.

- Positioning stents can be oral or peroral cone that is used to rearrange tissues within the radiation field and to displace normal tissues outside the radiation field.

- Radiation shields are metallic screens made up of Cerrobend alloy that prevents unwanted exposure of normal tissues.

- Radiation carriers administer radiation to confined areas, by holding the radiation source securely in position during the entire period of treatment.

Extraoral prosthesis

Extraoral prosthesis is also called the facial prosthesis. Ideal properties of facial prostheses must include:

- Tissue compatibility
- Durability
- Lightness in weight
- Flexibility
- Translucency
- Easily processed
- Easily duplicated
- Easily cleaned
- Nonconducive and readily available

Currently facial prostheses are fabricated of silicones, acrylic resins and polyurethanes. The bulk of the prostheses may be fabricated with silicone, whereas, acrylic resins are incorporated to provide strength and rigidity. Polyurethane may be applied as a backing to provide a thin transparent junction with the skin.

Some of the extraoral prostheses are as follows.

Eye prosthesis

The surgical or trauma residual defect of the eye can be of one of the following types. It may be **enucleation** which involves only the removal of the eye ball. It may be **evisceration** where the eyeball and the extraocular muscles are removed. **Exenteration** will involve the removal of the entire content of the orbit. Depending upon the defect an eye prosthesis can either be (i) ocular (Fig. 50 28A) (ii) orbital (Fig. 50.28B).

B

FIGURE 50.28 **(A)** Ocular prosthesis. **(B)** Orbital prosthesis.

Ocular: it replaces only the eyeball following an enucleation or evisceration.

Orbital: it replaces not only eyeball but also eyelids and surrounding structures.

Impressions are made with irreversible hydrocolloid/elastomers and prosthesis is fabricated in acrylic or silicone. Retention of this prosthesis is through glass frames, adhesives or implants.

Ear prosthesis

This is also known as auricular prosthesis. Impressions are made with irreversible hydrocolloid/elastomers and prosthesis is fabricated in acrylic or silicone. Retention of this prosthesis is through glass frames, adhesives, hair bands (Fig. 50.29A) or implants (Fig. 50.29B).

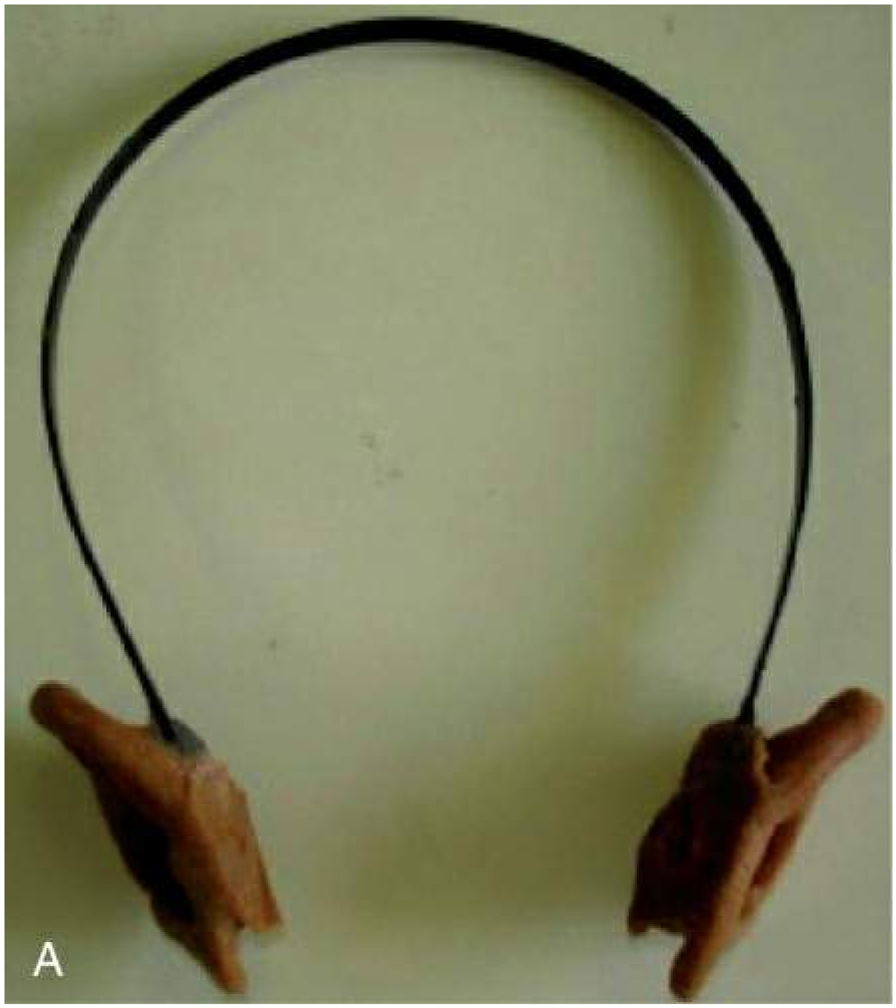

FIGURE 50.29 **(A)** Ear prosthesis with hair band. **(B)** Implants to retain the ear prosthesis. **(C)** Implants to retain the ear prosthesis.

Nasal prosthesis

Nasal defects resulting from neoplasm, congenital malformations or trauma can be restored with nasal prosthesis. Impression procedures and prosthesis fabrication are similar to ear prosthesis.

Retention is achieved with anatomic undercuts, adhesives, eyeglasses and attachment to maxillary obturator and implants.

Nasal stents

It improves nasal symmetry in unilateral cleft patients by neonatal nasoalveolar moulding. The congenital or acquired strictures of the nasal openings are corrected by nasal stents (Fig. 50.30).

FIGURE 50.30 **(A)** Nasal stent. **(B)** Stent in place.

Materials used in maxillofacial prosthesis

Advances in polymer chemistry renewed the interest of developing new materials for facial prosthesis.

Prostheses are composed of the following:

1. Silicones – used to fabricate bulk of the prosthesis.

2. Acrylic resins – incorporated to provide strength and rigidity.

3. Polyurethanes – provide a thin transparent junction with the skin.

An ideal material for the fabrication of facial prosthesis should have the following features:

- Excellent tissue receptivity.

- Nontoxic and nonallergic.

- Accurate forming, retention of fine details and without introduction of obvious parting lines.

- A degree of translucency is required.

- The material must be essentially colourless so that it can be tinted to simulate pastel skin tones.

- It must be durable and should have resistance to outdoor weathering.

- Should remain flexible over a range of ambient temperatures.

- Must adhere securely and comfortable and exhibit a fine line marginal contact.

Materials available

Materials are broadly classified into metals and nonmetals.

1. **Metals**

Usually Co–Cr is used in the fabrication of framework of the definitive prosthesis.

2. **Nonmetals**

○ Acrylic resin and copolymers.

○ Polyvinyl chloride and copolymer derivatives – realistic, mediplast, prototype II.

○ Silicone elastomers:

i. ***HTV silicones***

a. Silastics 370, 372, 373, 4-4514, 4-4515

b. PDM siloxane

c. Q4635, Q7-4650, Q7-4735, SE-4524

ii. ***RTV silicones***

a. Silastic 382, 389

b. MDX 4-4210

c. SILASTIC 891

d. Cosmesil

e. A-2186

Acrylic resins

- These are used in the fabrication of both intraoral and extraoral prostheses.
- Facial prosthesis made of this material remains serviceable for up to 2 years.
- Successfully employed for specific types of facial defects (e.g. fabrication of orbital prosthesis).
- Intrinsic and extrinsic colouration can be utilized.
- Compatible with most adhesive systems.
- *Heat polymerizing methyl methacrylate* (Fig. 50.31) is preferred to the autopolymerizing resin.
- Colour stability is better.

FIGURE 50.31 Heat-cure acrylic resin – Triplex SR (courtesy Ivoclar-Vivadent).

Disadvantages of hard acrylic prosthesis

- Rigid.
- Trauma to the defect area.
- Inferior aesthetic result due to lack of reproduction of skin.

Vinyl polymers and copolymers

They are copolymers of vinyl chloride and vinyl acetate.

Polyvinyl chloride

- Clear hard resin, tasteless and odourless.
- Hardens when exposed to ultraviolet light and heat.
- Requires heat and light stabilization to prevent discolouration

during fabrication and use.

Polyvinyl acetate

- Stable to light and heat.
- Abnormally low softening point (35–40°C)
- Flexible
- Adapt to intrinsic and extrinsic colouration
- Present an acceptable clinical appearance

Disadvantages

- Discolouration and hardening of prosthesis particularly at the margins.
- Edges tear easily if thin and require reinforcement with nylon fibres.
- Easily stained and degrade when exposed to ultraviolet light, peroxides and ozone.
- Lack life like appearance.
- Metal moulds are required for curing.
- Can be used from 1 to 6 months.

Chlorinated polyethylene

The processing involves high heat curing of pigmented sheets of the thermoplastic polymer in metal moulds.

- Colouration using oil soluble dyes and repeated moulding is possible.
- CPE 726/19-15, as a potential maxillofacial material.

Polyurethane elastomers

They serve a variety of commercial and medical uses but only one of them (epithane 3) is available for use in facial restorations. It has urethane linkages.

They possess a number of excellent properties:

- Elastic, not compromising edge strength.
- Flexibility which can be used in defects with movable tissue beds.

Coloured both intrinsically and extrinsically.

Silicones

They were introduced in 1946 and they exhibit good weathering properties. They also maintain good physical properties over wide range of temperatures.

Advantages

- Soft and comfortable to the patients.
- Allow good colour matches to be achieved.

Silicones are a combination of organic and inorganic compounds. Most rubbery forms of silicones are compounded with fillers that provide additional strength. Additives are used to provide colour. Antioxidants and vulcanizing agents are used to transform the raw mass form plastic to rubbery resin during processing.

The process of cross-linking the polymer is referred to as *vulcanization.* Vulcanization occurs both with and without heat and depends on the *catalytic or cross-linking agents utilized.*

Types

1. Heat temperature vulcanization silicones (HTV)

2. Room temperature vulcanization silicones (RTV)

HTV silicones

A white opaque material with highly viscous, putty-like consistency; it is available as 1 component or 2 component putty.

Properties

- Exhibit excellent thermal stability.
- Colour stable when exposed to ultraviolet light.
- Biologically inert.
- Do not posses sufficient elasticity to function in movable tissue beds.

Disadvantages of HTV

- Opaque and lifeless appearance.
- Do not readily accept extrinsic colouration, the internal colourants must be incorporated into the gum stock with a *milling device.*
- Because high temperatures are required for vulcanization, *metal moulds are necessary*.
- Examples: Silastic 370, 372, 373, 4-4514, 4515.

RTV silicones (fig. 50.32)

The properties RTV silicones are similar to the HTV types:

- Colour stable.
- Biologically inert.
- Retain their physical and chemical properties at wide temperature ranges.

• Clear solutions are available that enable the fabrication of translucent prostheses.

FIGURE 50.32 RTV silicone base is dispensed in a white paper pad and liquid catalyst added according to manufacturer's specification.

The RTVs are much easier to process than heat-cured forms. Moulds of dental stone can be used.

Disadvantages

• Poor edge strength.l

Difficult to colour.

• The cosmetic appearances of these materials are much lesser than acrylics, polyurethanes and polyvinyl chlorides.

• Examples:

○ Silastic 382, 399

- MDX 4-4210
- Silastic 891
- Cosmesil
- Siphenylenes

Newer materials

Silicone block copolymers

These are new materials under development to improve some of the weakness of silicone elastomers, such as low tear strength, low per cent elongation, more tear resistance.

Primers

Primers used for promotion of bonding between silicone and other maxillofacial prosthetic materials.

Adhesives

They are commonly classified by the method in which they are dispensed – pastes, liquid emulsions, spray on and double sided tapes (Fig. 50.33).

FIGURE 50.33 The liquid emulsion adhesive is applied on the tissue surface of the ear prosthesis.

Removers

These are used to clean the adhesive form the skin. The various adhesive removers available are

- 1:1 Trichloroethane
- Acetone
- Kryolan medical sprit gum remover

Disadvantages

- Sebum acts as a barrier between skin and adhesive.
- Moisture reduces adhesive nature of the adhesive.

- Solvents used to remove adhesive from the skin act as irritants.
- Allergy.
- Trauma to the skin at the time of removal.

Tissue conditioners

It consists of *ethoxyethyl acid copolymer ethyl acetate***.** It provides an elastic protective barrier that prevents skin damage.

SUMMARY

Prosthetic rehabilitation of maxillofacial defects is most challenging. Very often the surgical team and the prosthetic team do not work hand in hand. This results in a very poor outcome of the prosthesis which will eventually affect the self-esteem of the patient and the quality of life of such patients drastically reduce. It is prudent to be proactive for a prosthodontist to get involved in the surgery for a favourable prognosis. The advent of material science has paved way for improved quality of prosthetic service. Till date none of the materials satisfy all the requirements of the ideal material. Each material has its own advantages and disadvantages.

CHAPTER
51

Smile Design

CHAPTER CONTENTS

Introduction

The art and science of beauty is known as aesthetics. A successful prosthodontic treatment is one that provides the patient with long-term function and also an attractive smile. The factors that make a smile appear beautiful differ from culture to culture. A smile is considered attractive and youthful when it shows the complete outline of the maxillary anterior teeth and teeth posterior to the first molar also. In the elderly, the smile shows less of maxillary incisors and more mandibular incisors. The smile considered most attractive is the one in which the incisal edges of maxillary teeth are parallel to the lower lip.

While smiling, a person typically displays the maxillary anterior and premolar teeth, and frequently maxillary first molars also. This zone of exposure during smile is called the 'appearance zone' (Fig. 51.1). The zone varies from person to person depending on mouth size, smile width, tooth length, lip size and tightness, and also the person's self-image.

FIGURE 51.1 Ideal exposure of teeth while smiling – appearance zone.

In order to achieve a good appearance and smile with prosthesis, it is essential that we learn about the anatomy of smile, components of smile aesthetics and its principles, so as to incorporate the same during treatment.

The anatomy of smile includes upper and lower lip frame which displays zone of the smile. Within this framework or composition, the components of smile are teeth and gingival scaffold. The soft-tissue determinants of the display zone are lip thickness, intercommissure width, interlabial gap, smile index (width/height) and gingival architecture.

Components of smile aesthetics

The overall impact of a smile can be divided into four specific components namely:

- Facial aesthetics
- Gingival aesthetics
- Macroaesthetics
- Microaesthetics

The treatment planning during designing of a smile will also follow the same order. Planning of typical smile design begins with the following:

- Initial patient visit knowing the expectation of the patient.
- Medical and dental history.
- This is followed by static (photographic) and dynamic (video) record.
- Clinical examination of existing components of smile.
- Treatment planning.

Facial aesthetics

Facial features in smile design include facial height, facial shape, facial profile, gender and age. In addition personality, hair colour, skin tone also affect in designing the smile. Facial and muscular considerations vary from person to person and are studied through visual and photographic analysis.

Gingival aesthetics

The health, symmetry and architecture of gingiva are the next essential elements in smile design. The gingival components include the colour, contour, texture and height of the gingivae.

Health

Healthy gingival tissues are pale pink and can vary in degree of vascularity, epithelial keratinization, pigmentation and in the thickness of the epithelium. The texture of the tissues should be stippled (orange peel–like appearance) in most cases (Fig. 51.2). In younger females, the tissue is more finely textured and has a finer stippling when compared with that of males.

FIGURE 51.2 Orange-peel appearance showing healthy gingivae with stippling.

Architecture

The architecture has a positive radicular shape, forming a scalloped appearance that is symmetric on both sides of the midline. The marginal contour of the gingiva should be sloped coronally to the end in a thin edge.

Symmetry

The gingival contours should be symmetric, even in the cases of teeth not being aligned properly (Fig. 51.3). The marginal gingival tissues of the maxillary anterior teeth should be located along a horizontal line extending from cuspid to cuspid. Ideally, the laterals reach slightly short of that line (Fig. 51.4).

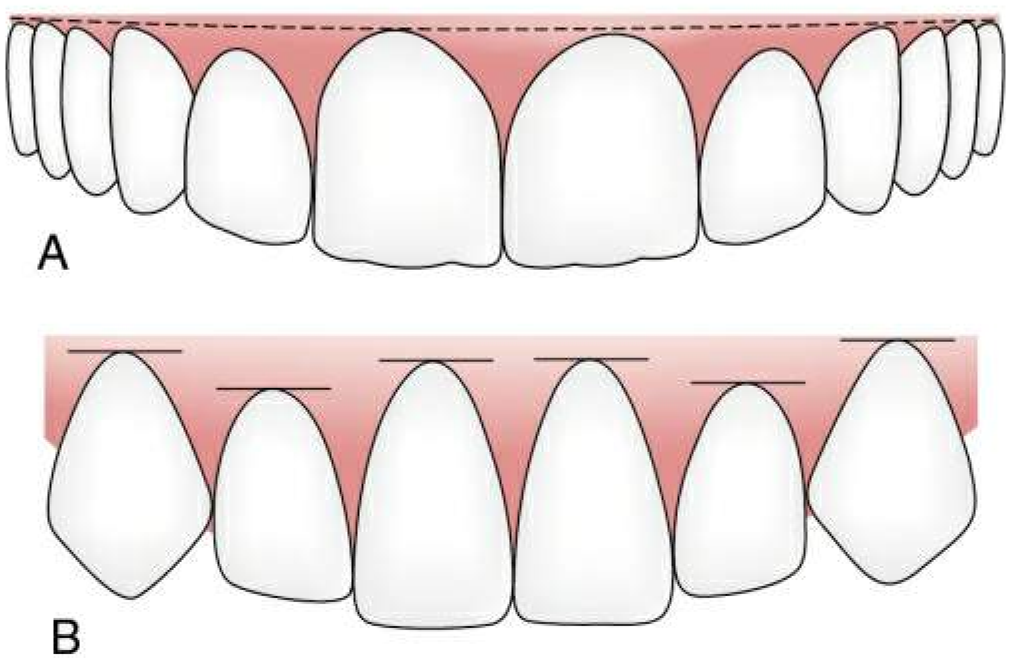

FIGURE 51.3 (A) Gingival symmetry in normally aligned teeth. (B) Gingival symmetry in malaligned teeth.

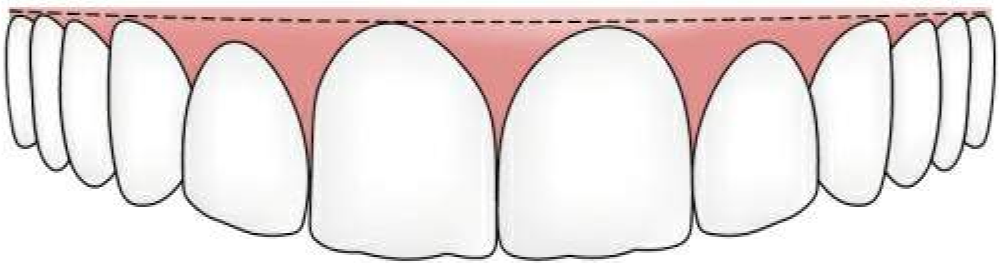

FIGURE 51.4 Location of gingiva. Note lateral incisor slightly short of the rest.

The gingival zenith point is the most apical point of the gingival tissues along the long axis of the tooth. This most apical point is located distal to the long axis on the maxillary centrals and cuspids. The zenith point of the maxillary laterals and the mandibular incisors is coincident with the long axis of these teeth (Fig. 51.5).

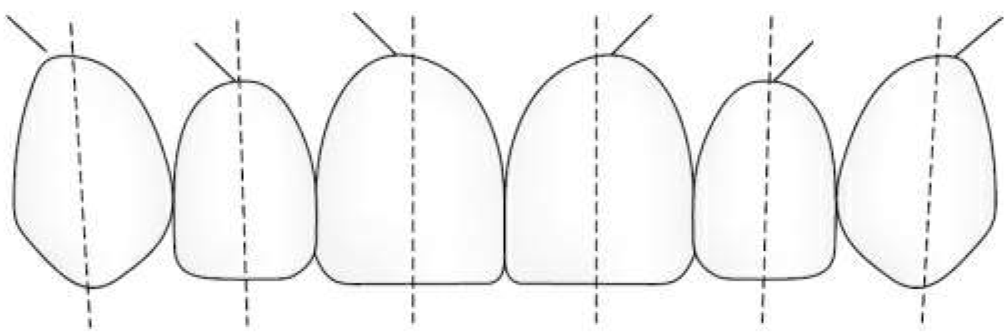

FIGURE 51.5 Gingival zenith and its relationship to the long axis of the teeth.

Macroaesthetics

This refers to the composition consisting of the lips, its relationship with each other, anterior set of teeth and its dynamic quotient with the lip activity.

Lip analysis

Lips form an important role such that, they create the boundaries of the smile design's influence. Understanding lip morphology and lip mobility can often be helpful in meeting patients' expectations and determining the criteria for success. The upper and lower lips should be analysed separately and independent of one another.

Lip morphology

Three aspects of the lip morphology that should be considered are width, fullness and symmetry.

- A smile that is at least half the width of the face is considered aesthetic.
- The fullness of the lip or lip volume can be categorized as full, average or thin and this is arbitrary.
- Lip symmetry involves the mirror image appearance of each lip when smiling (Fig. 51.6).

FIGURE 51.6 Lip symmetry during smile. Figure shows distance from midline equal on both sides.

Lip mobility

The position of the lips in the rest position should be evaluated for lip contact as well as for the range of lip mobility when smiling. These two determinants establish how much tooth structure and gingival tissue are revealed when comparing the repose and full smile positions.

Smile line

The smile line or incisal curve is made up of the incisal edges of the maxillary anterior teeth and parallels the inner curve of the lower lip (Fig. 51.7). It is parallel with the interpupillary axis and perpendicular to the midline of the face (Fig. 51.8). Nearly 80% of young subjects display the entire length of the maxillary anterior teeth. With the upper lip at rest, women show approximately twice as much maxillary central incisor as men (3.4:1.9 mm). Men are 2.4 times more likely to have a low smile line than women.

FIGURE 51.7 Smile line – maxillary incisal edge parallel to inner curve of lower lip.

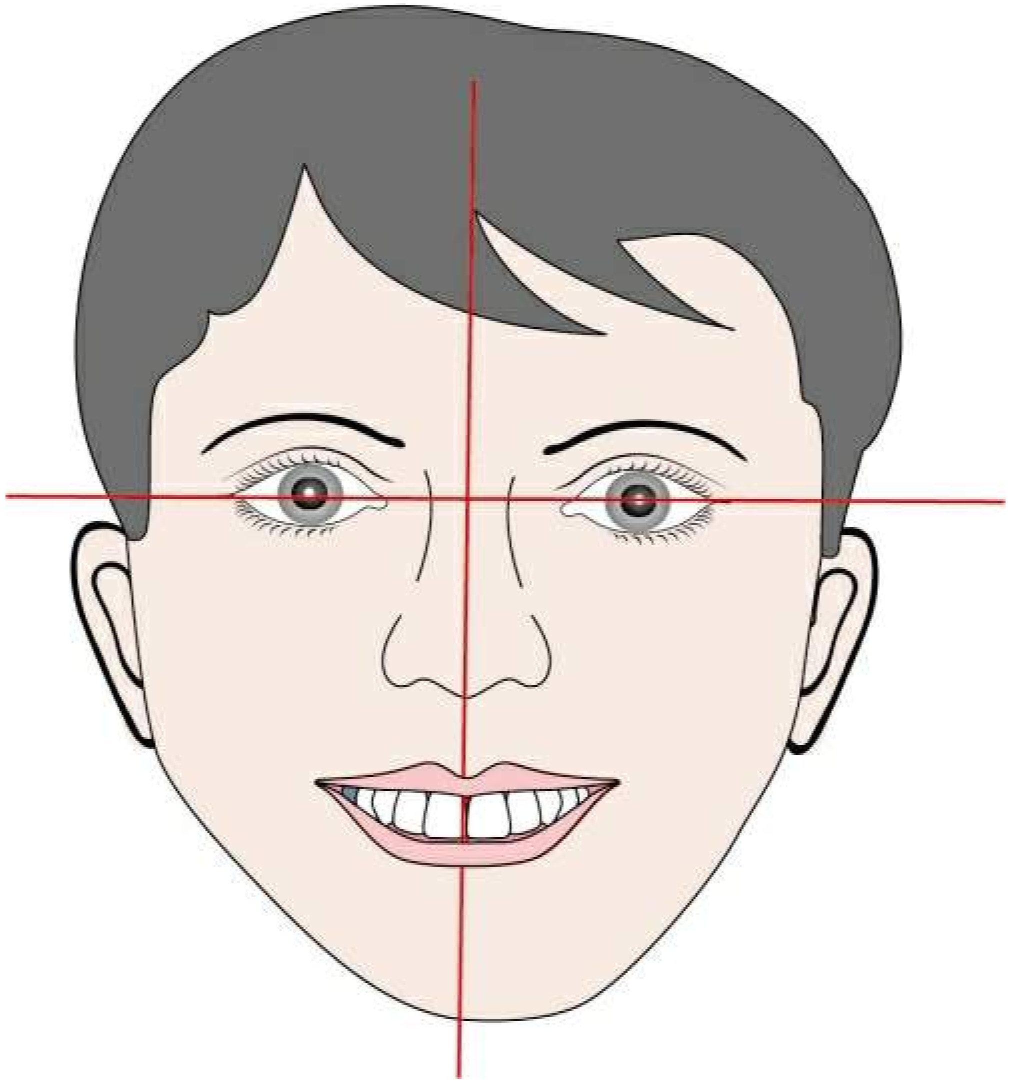

FIGURE 51.8 Midline of the face coincides with dental midline.

Midline

The midline is the focal point of the smile. It is centred on the face perpendicular to the interpupillary axis. Facial and incisal midlines need to coincide as in Fig. 51.8. This coincidence is important when planning orthodontic treatment and when planning treatment for prosthodontics.

Perfect symmetry is rare, and in case compromises have to be made, the midline of the smile should correspond to the features nearest to it, like the columella of the nose or the philtrum (Fig. 51.9).

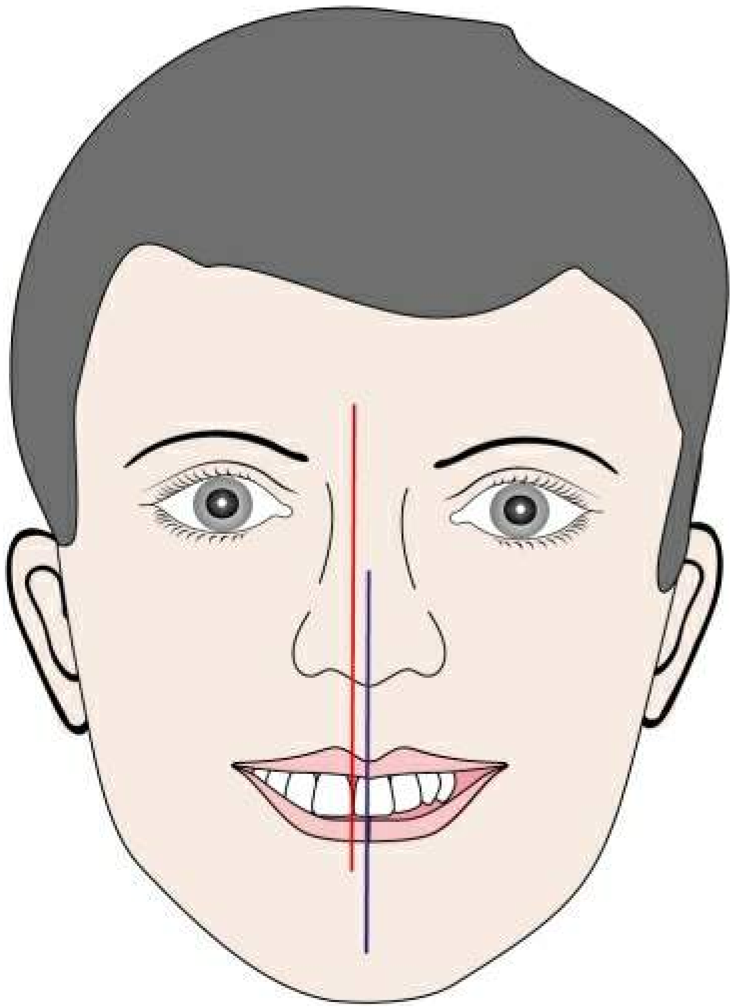

FIGURE 51.9 When facial midline does not coincide with dental midline philtrum can be used as reference line.

Balance

Balance, including the location of the midline is aesthetically important. The left and the right sides of the mouth should balance out, if not to match precisely. Even if the teeth are malformed or malaligned there should be a symmetry between the right and the left side. A balanced arrangement implies stability and permanence besides being aesthetically satisfying.

Length of incisors

The length of maxillary incisors is important since they play an important role in phonetics and anterior guidance. So aesthetics alone cannot establish the length.

- When the patient utters the letter ‘f’ the incisal edges of maxillary incisors with the correct length will be placed against the inner edge of the vermilion border (the wet dry line) of the lower lip (Fig. 51.10).
- The sounds ‘m’ and ‘e’ also determine the incisal length.
- The ‘f’/’v’ sound determines both incisal length and incisal profile.

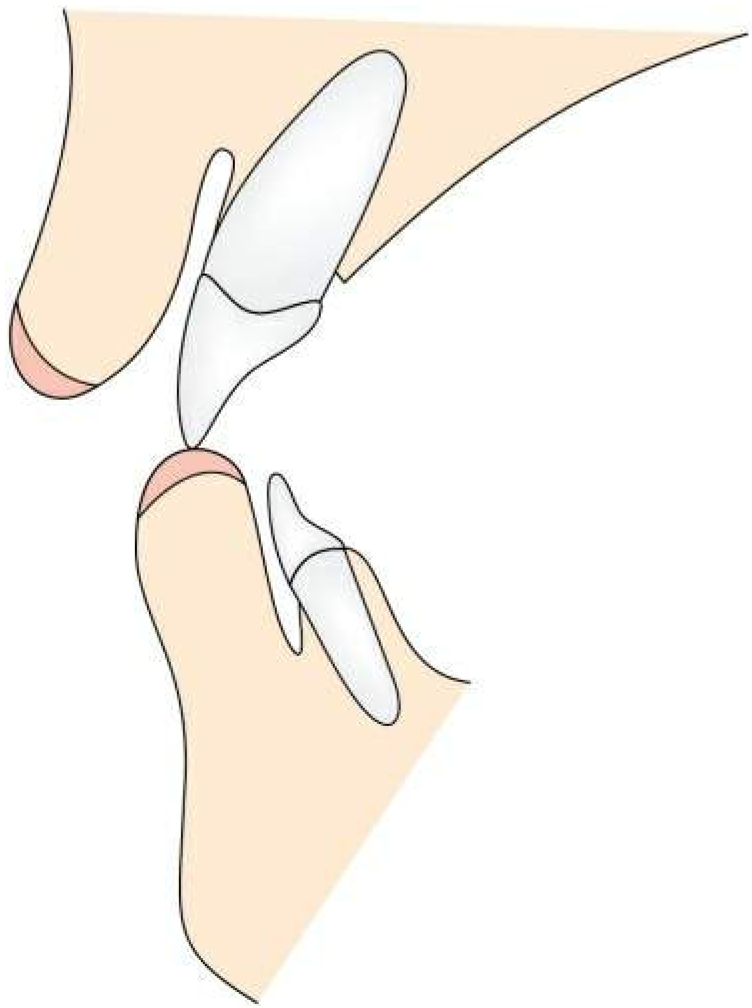

FIGURE 51.10 The position of maxillary central incisors for ‘f’ sound in vermilion border.

The incisal edges of mandibular incisors are established both by occlusal contact with the maxillary incisors and by their position 1.0 mm behind and 1.0 mm below the edges of the maxillary teeth when pronouncing the letter ‘s’. In young people below the age of 30 years, very little is seen of the mandibular central incisors. As the age progresses and tissues around the mouth sag, the length of maxillary incisors which are exposed diminishes and the amount of mandibular incisors which are seen increases. At the age of 60 while nearly 3.0 mm of the mandibular incisors are exposed, the length of maxillary central incisors showing below the upper lip is 0.0 mm.

Incisor angulation

Studies of subjects with normal occlusion that have not received any orthodontic treatment reveal the following:

- The crowns of teeth are angled so that the incisal portions of the long axes of the crowns were more mesial than the gingival segments (Fig. 51.11).
- Also, there is a lingual inclination of the incisal or occlusal segment of the facial surfaces of canines, premolars and especially molars (Fig. 51.12).

FIGURE 51.11 The gingival one-third more mesial than incisal third.

FIGURE 51.12 Lingual inclination of canine.

So to achieve an aesthetic effect, biplanar facial reduction is required in tooth preparations for all-ceramic or metal-ceramic crowns on anterior or posterior teeth.

Radiating symmetry

If teeth have different shapes but left and right sides are mirror images of each other, it is called radiating symmetry. Introducing slight variations on each side produces a more natural appearance.

Incisal embrasure form

Incisal embrasure is an open space that is formed between the proximal surfaces of incisal edges from the contact points.

- The incisal edges of the maxillary central incisors and the cusp tips of the canines should be on the same gently curved horizontal line, with the lateral incisors nearly 1.0 mm above the line.

- Beginning with the mesial of the central incisors, the interproximal contacts of the maxillary anterior teeth are situated successively more gingivally, all the way to the distal of the canines.

- As the contacts become located farther gingivally, the incisal embrasures become progressively larger, creating a more dynamic and youthful smile (Fig. 51.13).
- With age and increased wear, the incisal embrasures become minimal.

FIGURE 51.13 Incisal embrasure becoming progressively larger in posterior teeth.

Buccal corridor

The area between the corners of the mouth during smile formation and the buccal surfaces of the maxillary teeth (particularly the bicuspids and molars) form a space known as the buccal corridor (Fig. 51.14).

FIGURE 51.14 Buccal corridor space.

A full and symmetric buccal corridor is an important element of an aesthetic smile. The buccal corridor should not be completely eliminated because a hint of negative space imparts a suggestion of depth to the smile. Several factors influence the appearance of the buccal corridor.

- Width of the smile and the maxillary arch.
- Tonicity of facial muscles.
- Individual smiling characteristics.
- Position of the labial surfaces of the maxillary bicuspids.
- Predominance of the cuspids, particularly at the distal facial line angle.
- Any discrepancy between the value of the bicuspids and the six anterior teeth.

Microaesthetics

The ideal restoration is one with qualities closely resembling those of natural teeth. Specific incisal translucency patterns, characterization, lobe development and incisal haloing all are components of the microaesthetics of each tooth.

Specific tooth form

The different tooth forms can be correlated invariably to sex or personality and specific age which have been explained in dentogenic concept.

Shade matching

When observing the natural dentition, a significant difference in colour can be seen between the teeth in both the arches. Also, the colour of the tooth depends on the thickness of the enamel and the level of saturation of the dentine.

- The maxillary central incisors are the lightest teeth in the mouth.
- In most individuals, the lateral incisors appear to be of the same hue as the central incisors but slightly less intense, therefore, they look less bright.
- The canines both maxillary and mandibular often show a much more intense chroma, sometimes appearing much darker than the teeth adjacent to them (Fig. 51.15).
- The premolars are of a similar colour to the lateral incisors, therefore, distinguishing themselves from the canines.
- In the cervical area, the reduced thickness of the enamel makes the colour of the dentine more evident, producing greater chromatic saturation. Thicker enamel on the other hand produces a marked translucency in the incisal third.

FIGURE 51.15 Canines exhibit an increased chroma when compared to central incisors.

When restoring anterior teeth, due consideration must be given to recreating a natural colour progression and the colour obtained in this way will represent the new point of reference for the restorative therapy.

Proportion in smile design

Golden proportion

Beauty is a matter of having the right proportions. The ‘golden proportion’ found in many aspects of the natural world is presented in a mathematical progression called the *Fibonacci series,* in which each number is the sum of the two immediately preceding it (i.e. 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, and so on). The ratio between succeeding terms is approximately 1:1.618 and is known as *the golden proportion or divine proportion.* Concept of golden proportion to dentistry was first mentioned by Lombardi and later developed by Levin. When a line is bisected in the golden proportion, the ratio of the smaller section to the larger section is the same as the ratio of the larger section to the whole line (Fig. 51.16). The golden proportion exists in natural dentitions in the ratio of the widths of incisors and canines as seen from the front.

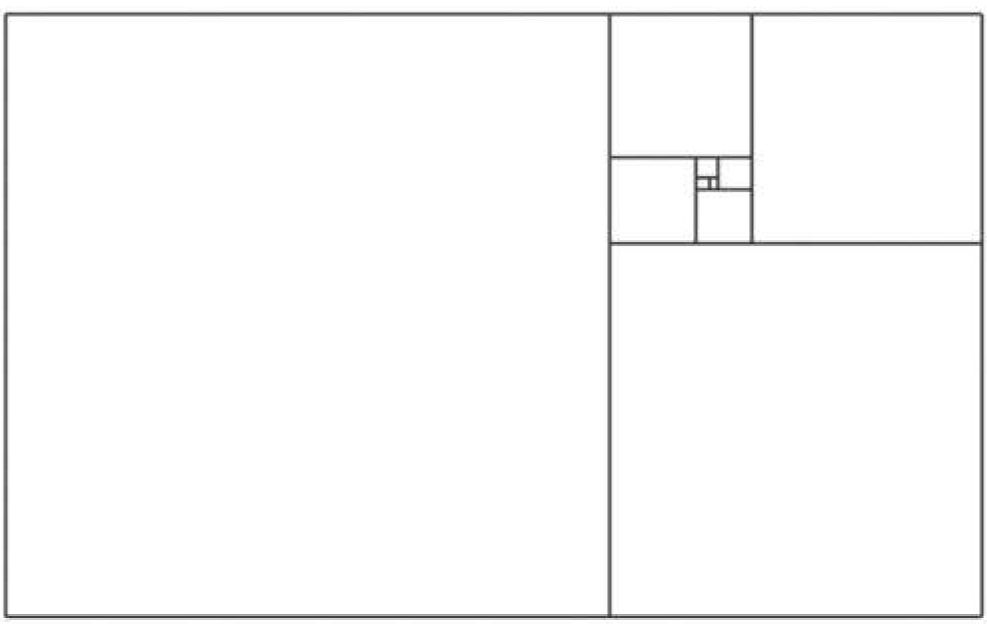

FIGURE 51.16 A typical example of a golden proportion.

In nature, golden proportion exists in almost every entity that is appealing, i.e. for example wings of a butterfly, flowers, peacock feather, molluscan shells, Greek architecture, Egyptian pyramids and DNA molecule (Fig. 51.17).

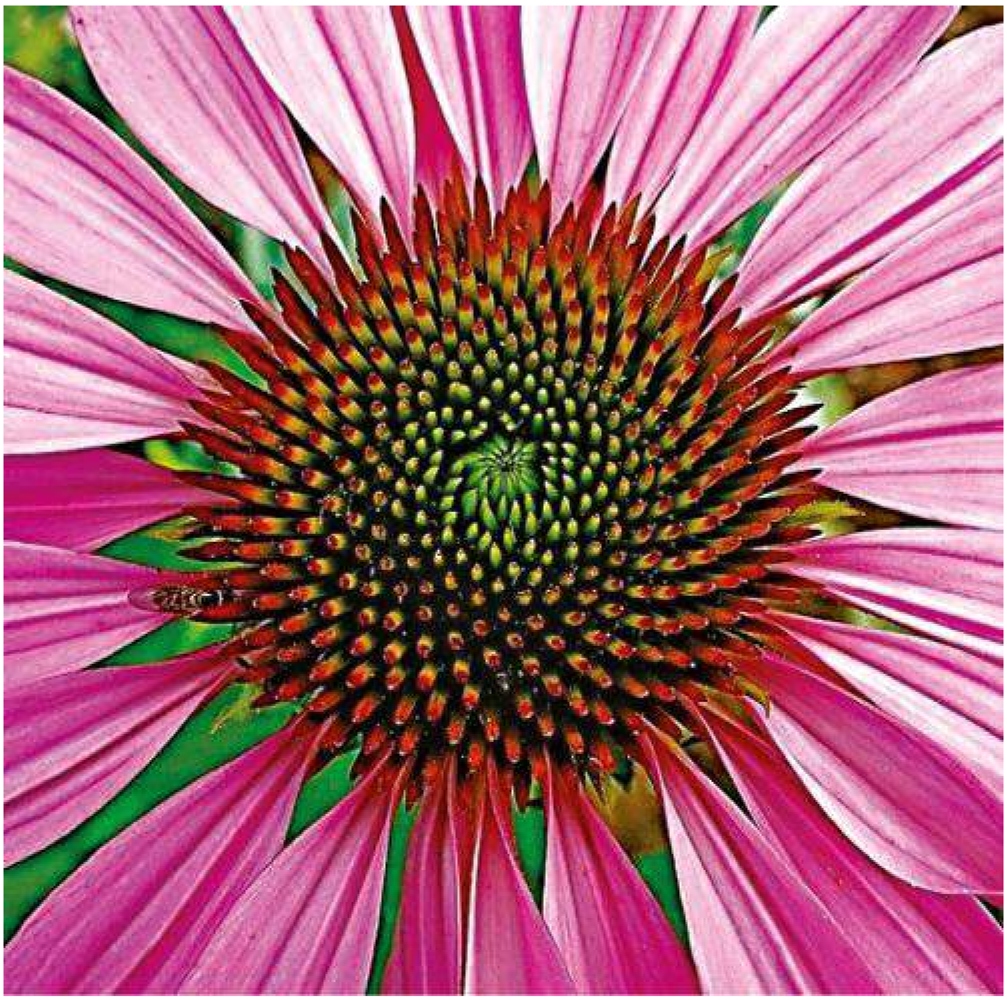

FIGURE 51.17 A flower exhibiting golden proportion ratio.

Levin (1978) demonstrates that the three anterior teeth (central, lateral, canine) and sometimes the premolars are in golden proportion to the width of the smile.

- Levin observed that widths of maxillary anterior teeth when viewed from front, lie in golden proportion, i.e.

- Central incisor × 0.618 = width of lateral incisor.
- Or 62% of central incisor width = width of lateral incisor.
- 62% of lateral incisor width = canine, and so on.

- Special calipers that extend to the golden proportion are helpful in designing a well-proportioned prosthesis.
- Maxillary central incisors are the most prominent and are positioned at the middle of the smile. They have the widest crowns of the anterior teeth. Canines are the next widest, lateral incisors are the narrowest.

From a frontal view even though the width of teeth varies, the apparent sizes of teeth should get progressively smaller from the midline distally. This reduction in size should be in proportion to the golden ratio (1:1.618). This means that starting from the midline, each of the anterior teeth should be slightly less than 40% narrower than the tooth immediately mesial to it (Fig. 51.18).

FIGURE 51.18 Golden proportions in smile from frontal view.

Facial proportion

The rule of thirds divides the face vertically into approximately three equal segments – the superior border of the face is the trichion (ideal hairline), the junction between the upper and middle thirds is the nasion, the junction of the middle and lower third is subnasale, and the inferior border is the menton. If the lower third of the face subsequently is subdivided into thirds, the ideal position of the incisal plane is at the junction of the upper and middle thirds.

Dental proportion

It has been stated throughout dental literature that the height of the central incisor should be one-sixteenth of the height of the face from ideal hairline to the chin and that the width of the ideal central incisor should be one-sixteenth of the interzygomatic width. Another common rule of smile design is that the widths of the anterior six teeth as viewed from the frontal should be in golden proportion to the intercommissural width.

Golden percentage

Snow considered a bilateral analysis of apparent individual tooth width as a percentage of the total apparent width of the six anterior teeth. He proposed the golden percentage wherein the proportional width of each tooth should be central 25%, lateral 15% and canine 10% of the total distance across the anterior segment in order to achieve an aesthetically pleasing smile.

Absolute and conversational aesthetics

- 'Absolute aesthetics' require that no metal be visible even if one was to look carefully. If metal is visible when the lip is retracted and a strong light shone is in the mouth, the restoration or replacement does not meet the requirement of 'absolute aesthetics'.

- 'Conversational aesthetics' require that surface metal be not visible in normal conversation.

- The patient is the ultimate judge and satisfaction of the patient is most important. It is best to discuss the aesthetic requirements with the patient in front of a wall mirror and not with a hand mirror under a dental unit.

SUMMARY

To contribute to a pleasing facial appearance, designing of smile is one of the key factors which should be applied in restoration of both partially and completely edentulous patients. This requires an analysis of the face, lips, gingiva, tooth contour, size, incisal plane, incisal edges and midline all of which must be in harmony. For optimum stability, comfort and function; the anterior teeth must be in harmony with the neutral zone, lips, phonetics, centric relation and envelope of function. This results in reproduction of face with the most natural aesthetics.

Appendices

Questions

Chapter 1 Introduction

Essay

1. Discuss in detail the effects of ageing in a completely edentulous patient.

2. Describe aetiology, pathology and clinical manifestations of RRR and prosthetic management of same.

Short notes

1. Residual ridge resorption

2. Nutrition guidelines for prosthetic patients

3. Surfaces of a complete denture

4. Component parts of a complete denture.

Chapter 2 diagnosis and treatment planning

Essay

1. What do you understand by the term 'examination of the patient'? Name the objectives of examination of patient. Discuss in detail the clinical significance of anatomical landmarks of edentulous maxilla and mandible.

2. A patient forty-years-old suffering from diabetes comes to you for complete denture. Give your outline of the treatment with special

reference to impression procedure.

3. Role of saliva in success of complete denture prosthodontics.

Short notes

1. Gagging

2. Mental attitudes of patients

3. House's classification

4. Importance of counselling for complete denture wearer

5. Maxillary torus

6. Psychological evaluation of edentulous patients

7. Pre-extraction records

8. Diagnostic casts

9. Prosthodontic Diagnostic Index

10. Classification of soft palate

11. Residual alveolar ridge

12. Saliva.

Chapter 3 mouth preparation

Essay

1. Discuss the sequelae of wearing complete dentures.

2. Discuss in detail mouth preparation for complete denture patient.

Short notes

1. Preprosthetic surgery

2. Denture stomatitis

3. Denture sore mouth

4. Denture hyperplasia

5. Epulis fissuratum

6. Flabby ridge

7. Combination syndrome

8. Burning mouth syndrome

9. Gagging

10. Angular cheilitis

11. Tori

12. Vestibuloplasty

13. Ridge augmentation.

Chapter 4 impressions and casts

Essay

1. Write in detail about the anatomical landmarks of maxillary and mandibular edentulous arches in relation to complete denture construction.

2. Give a short summary of the applied anatomy regarding denture

foundation area for complete denture.

3. Define impressions in complete dentures. Write in detail the principles, objectives and theories of impressions.

4. Define retention, stability and support. Write in detail about the factors influencing the retention, stability and support in complete denture.

5. Mention the objectives of impression making and discuss the procedures of merits and demerits of different impression techniques for complete denture patients.

6. Define and discuss various impression theories and techniques in complete denture fabrication.

7. Define posterior palatal seal and mention its importance. Discuss in detail, its boundaries and methods of recording it for complete denture patient.

8. Explain how impression surface and periphery of the maxillary complete denture contribute to retention of denture.

9. Define and explain the need for border moulding procedure. Describe the various impression techniques in complete denture.

10. Define retention. Enumerate and discuss various factors responsible for retention in complete denture.

Short notes

1. Primary stress-bearing area in maxilla and mandible

2. Buccal shelf area

3. Relief areas in complete denture

4. Stress-bearing areas

5. Retromolar pad

6. Significance of hamular notch

7. Clinical consideration of microscopic anatomy of complete denture foundation

8. Maxillary tuberosity

9. Alveolingual sulcus

10. Macroscopic anatomy of supporting and limiting structures of maxilla

11. Muscles of soft palate

12. Mucostatic vs mucocompressive impression techniques

13. Interfacial surface tension

14. Retention and stability

15. Vibrating line of palate and its importance in

16. Fabrication of custom tray for completely edentulous arches

17. Selective pressure impression technique in complete denture patients

18. Retention in complete dentures

19. Significance of peripheral seal in complete denture

20. Fluid wax impression

21. Posterior palatal seal

22. Mucostatic impression

23. Advantages of special trays for complete denture

24. Mechanism of complete denture support

25. Impression technique for flabby ridge

26. Pascal's law

27. Functions of posterior palatal seal

28. Important anatomical landmarks in complete denture construction

29. Mouth temperature fluid wax

30. Vibrating line

31. Cast indexing.

Chapter 5 record bases and occlusal rims

Short notes

1. Occlusal rims for construction of complete denture

2. Advantages of metallic denture bases

3. Chrome cobalt complete denture base

4. Guidelines for occlusal rims

Chapter 6 maxillomandibular relations

Essay

1. Discuss in detail mandibular movements.

2. What are jaw relations? Discuss its biological significance during complete denture preparation.

3. Write the importance of centric relation in complete denture treatment. Write in brief the methods to record centric relation in complete dentures.

4. Define centric relation. Enumerate the various methods of recording centric jaw relation for a complete denture. Describe any one method in detail. Add a note on difficulties encountered while recording centric relation.

5. Write about the maxillomandibular relations and concepts of occlusion for complete denture.

6. What is jaw relation? Classify jaw relations. Enumerate various methods of recording different jaw relations. Discuss in detail any one method of recording vertical jaw relation.

7. Define jaw relation. Mention the significance of physiological rest position. Discuss the effects of increased and decreased vertical jaw relation.

8. Mention the jaw relations to be transferred from patient to the articulator. Describe the methods to record vertical dimension of occlusion.

9. Define rest position of the mandible. Classify the methods of recording vertical relations for complete denture.

10. Define and classify facebows. Describe briefly a facebow used for complete denture.

11. Define centric relation. Mention the various methods of recording centric relation. Describe in detail the extraoral method of gothic arch

tracing.

Short notes

1. Posselt's envelope of motion

2. Hinge axis

3. Physiological rest position

4. Arbitrary facebow

5. Parts of a facebow

6. Christenseon's phenomenon

7. Significance of centric relation

8. Gothic arch tracing

9. Vertical jaw relations

10. Niswonger's method

11. Needles–House chew-in technique

12. Nick and notch method

13. Significance of centric relation

14. Physiological methods of determining vertical dimension

15. Vertical jaw relation

16. Centric relation and centric occlusion

17. Ill effects of altered vertical dimensions

18. Significance of centric relation

19. Silverman's speaking space

20. Methods of retruding the mandible

21. Functional method of registering centric relation

22. Bennett movement

23. Freeway space

24. Significance of rest position of the mandible

25. Interocclusal check records

26. Boos bimeter.

Chapter 7 articulation

Essay

1. Define and classify articulators. Add a note on the uses of an articulator.

2. List the steps in the procedure for mounting upper and lower casts on mean value articulator.

Short notes

1. Semi-adjustable articulators

2. Average movement articluators

3. Articulators and its uses

4. Three point articulator

5. Arcon articulators

6. Requirements of articulators

7. Spherical theory

8. Bonwill theory

9. Conical theory.

Chapter 8 occlusion

Essay

1. Classify various complete denture occlusions. Discuss in detail balanced occlusion.

2. What is balanced occlusion. How do you establish it while fabricating a complete denture.

3. Define balanced occlusion. Explain in detail, the various factors of balanced occlusion.

4. Mention the importance of occlusion in complete dentures. Write in brief the factors governing balanced articulation.

5. Define balanced occlusion. Explain in detail, the importance of five cardinal factors while fabricating complete denture for an edentulous patient.

Short notes

1. Law of balanced occlusion

2. Non balanced concept of occlusion

3. Advantages of balanced occlusion

4. Monoplane occlusal scheme

5. Lingualized occlusion

6. Rationale of balanced occlusion

7. Balanced occlusion

8. Hanau's quint

9. Compensating curves.

Chapter 9 selection of artificial teeth

Essay

1. Discuss selection of teeth for a completely edentulous patient.

2. Describe in brief the various posterior tooth forms for denture.

Short notes

1. Hardy's tooth form

2. Non-anatomic teeth

3. Leon William's contribution to selection of teeth

4. Selection of anterior teeth for complete denture patient

5. Non-anatomic posterior tooth form

6. Selection and arrangement of anterior teeth

7. Colour of teeth in complete denture fabrication

8. Selection of teeth for geriatric patient

9. SPA factor in complete denture

10. Incorporation of SPA factor in selection and positioning of artificial teeth

11. Dentogenic concept

12. Realeff.

Chapter 10 teeth arrangement

Short notes

1. Anatomical landmarks influencing teeth arrangement

2. Vertical and horizontal overlaps

3. Key of occlusion

4. Setting principles of upper anterior teeth

5. Setting principles of lower anterior teeth

6. Neutral zone.

Chapter 11 try-in

Essay

1. Define denture aesthetics. Give in detail the aesthetic requirements of complete denture.

2. Describe step-by-step procedures for try-in.

Short notes

1. Phonetics in complete denture

2. Try-in.

Chapter 12 processing and remounting

Short notes

1. Waxing and carving

2. Remounting

3. Selective grinding

4. Abrasives and polishing agents for dental prosthesis

5. Finishing and polishing of resin prosthesis.

Chapter 13 denture insertion

Short notes

1. Postinsertion instruction to the patients wearing dentures

2. Hygiene of complete denture

3. Denture cleansers

4. Denture adhesive

5. Pressure indicating paste

6. Remount cast.

Chapter 14 post-insertion problems

Essay

1. Enumerate various postinsertion problems in complete denture wearers. Write in detail about their causes and management. Add a note on laboratory remounting.

Short notes

1. Problems associated with complete denture use

2. Causes of midline fracture of maxillary denture

3. Speech problems

4. Porosities in complete denture.

Chapter 15 refitting and repair

Short notes

1. Indications for relining and rebasing

2. Relining and rebasing

3. Tissue conditioners

4. Treatment of abused tissues

5. Resilient liners

6. Soft liners

7. Reline jig.

Chapter 16 single complete denture

Short notes

1. Single complete dentures

2. Mouth preparation for single complete dentures

3. Combination syndrome.

Chapter 17 immediate dentures

Essay

1. Describe in detail the indications, contraindications and steps involved in fabrication of immediate dentures.

Short notes

1. Immediate denture

2. Surgical template for immediate dentures

3. Follow up care for immediate dentures

4. Instructions following insertion of immediate denture

5. Advantages and disadvantages of immediate denture

6. Interim immediate dentures.

Chapter 18 introduction

Short notes

1. Indications of removable partial dentures.

2. Steps in the fabrication of a cast removable partial denture.

Chapter 19 sequelae of partial edentulism

Essay

1. Discuss in detail the sequelae of tooth loss or partial edentulism.

Short notes

1. Classify supraerupted teeth.

Chapter 20 classification of partially edentulous arches

Essay

1. Explain the modes of classification of removable partial denture with diagram. Discuss the importance of such classification.

Short notes

1. Kennedy's classification

2. Need for classification of partial edentulous system

3. Applegate's rules for Kennedy's classification

4. Applegate–Kennedy classification

5. ACP classification

6. Demerits of Kennedy's classification.

Chapter 21 component parts

Essay

1. Define major connectors in removable partial denture. Discuss with diagrams different mandibular major connectors.

2. What is a major connector? Describe the different types of maxillary and mandibular major connectors.

3. Write the components of removable partial dentures and discuss major connectors.

4. Classify 'rests' in removable partial denture. Describe the function and topography of occlusal rest, illustrating with diagram the occlusal rest seat.

5. Enumerate the various component of a removable partial denture and discuss in detail about maxillary major connectors.

6. Discuss the requirement of major connectors, explain the indication, contraindication, advantages, disadvantages and design features of mandibular major connectors.

7. Write the components of cast partial denture and write in detail about direct retainers.

8. Write in detail about various modifications of circumferential clasps and add a note on intracoronal direct retainers.

9. Write an essay on minor connector.

10. Define, classify and describe the commonly used clasps in RPD.

11. Define and classify direct retainers. List the differences between occlusal approaching and gingival approaching clasps. Explain in detail combination clasps.

12. Define a clasp. Describe the parts of clasps. Illustrate with diagram about the various configurations of clasps and their relevance to survey lines.

Short notes

1. Kennedy's bar

2. Role of indirect retainers and types used

3. Reciprocal arm

4. Linguoplate

5. Lingual bar

6. Bar clasp/gingivally approaching clasp

7. Embrasure clasps

8. Combination clasps

9. I-bar clasps

10. Indirect retainer

11. Compare retentive and reciprocal arm in removable partial dentures

12. Selection of mandibular major connector

13. Functions of occlusal rest

14. Requirements of major connector

15. Rest and rest seat

16. Disadvantages of clasp retained partial denture

17. Form and location of minor connector

18. Minor connector

19. Cast clasp vs wrought clasp

20. Rules for using ring clasp

21. Clasp assembly

22. Akers' clasp with diagram

23. Minor connector

24. Occlusally approaching clasp

25. Direct retainers

26. Types of bar clasps

27. Canine rests

28. Occlusal rest

29. Types of dentures bases for removable partial dentures

30. Artificial teeth for removable partial dentures

31. Tube teeth.

Chapter 22 diagnosis and treatment planning

Essay

1. Discuss diagnosis and treatment planning for cast removable partial dentures.

Short notes

1. Treatment planning of removable partial denture.

Chapter 23 surveying

Essay

1. Define surveyor. What are the principles of surveying. Draw the diagram of surveyor and list out its uses.

2. Discuss in detail how surveyor is utilized in selecting the path of insertion and removable of RPD. Add a note on tripoding.

3. Write in brief the importance of dental cast surveyor in designing biologically acceptable removable partial denture.

4. Define surveyor. Write parts and explain the uses of surveyor.

5. What is a surveyor? Mention its uses and describe step-by-step procedure of surveying a diagnostic cast.

Short notes

1. Path of insertion in RPD

2. Guide planes

3. Factors influencing the path of insertion on removable prosthesis

4. Survey lines

5. Undercut gauge and their application in surveying

6. Surveyor

7. Surveyor draw figure and mark parts

8. Tripodisation

9. Block out

10. Near zone and far zone.

Chapter 24 principles and design

Essay

1. Discuss the indications for RPD. Discuss the advantages, disadvantages and principles in designing an RPD.

2. Discuss in detail the principles and philosophies of designing a cast partial denture.

3. Discuss direct and indirect retention in RPD.

4. Define direct retainer. Write the various principles of designing a clasp. Add a note on various types of clasps.

5. Discuss the various biomechanical considerations in designing a RPD.

Short notes

1. Problems of Kennedy class I and class II partial dentures.

2. Principles of indirect retention.

3. Compare between direct versus indirect retention in RPD.

4. Factors affecting support in distal extension situation.

5. Fulcrum axis and its importance in RPD design.

6. Requirements of clasp design.

7. Stress breakers.

8. Design philosophies.

Chapter 25 mouth preparation

Essay

1. Discuss mouth preparation in removable partial denture.

2. Describe the importance of mouth preparation in designing of partial dentures.

Short notes

1. Mouth preparation prior to RPD surveying.

2. Importance of mouth preparation in partial denture treatment.

3. Rest seat preparation.

Chapter 26 secondary impressions and master cast

Essay

1. Describe the impression methods of registering support in distal extension base prosthesis.

2. Classify impression techniques. Describe the impression technique for distal extended RPD.

Short notes

1. Impression procedure in cast RPD

2. Pick-up impressions

3. Impression in distal extension partial denture

4. Mclean's physiological impression

5. Functional relining technique

6. Altered cast technique

7. Comparison of McLean and Hindels' impression technique

8. Classification of RPD impression techniques

9. Ridge correction technique

10. Fluid wax impression technique.

Chapter 27 fabrication of removable partial denture

Short notes

1. Distal extension denture base in removable partial denture construction

2. Denture base materials for RPD

3. Selection of prosthetic replacement teeth for RPD

4. Denture base for cast RPD

5. Occlusal registration in removable partial denture

6. Phosphate bonded investments

7. Block out

8. Refractory cast

9. Duplication

10. Beading.

Chapter 28 denture insertion

Short notes

1. Postinsertion problems in cast RPDs

2. Adjusting clasps in RPD.

Chapter 29 refitting and repair

Short notes

1. Rebasing of removal partial denture

2. Repair of RPD.

Chapter 30 forms of removable partial dentures

Short notes

1. Indication, advantages, disadvantages of Swing–Lock denture

2. Every denture

3. Spoon denture

4. Disjunct denture

5. Sectional dentures

6. I-bar RPDs

7. RPI denture

8. RPA denture

9. Guide plane dentures

10. Unilateral dentures

11. Interim RPD

12. Transitional RPD.

Chapter 31 introduction

Short notes

1. Contraindication for FPDs

2. Indications for FPDs

3. Classifications of FPDs

4. Spring cantilever bridges

5. Fixed removable bridges

6. Tensofrictional resistance.

Chapter 32 component parts

Essay

1. Define pontic. Explain various types of pontic used in FPD.

2. Name various types of bridges. Diagrammatically name the parts of bridge. Classify retainers. Discuss in detail about radicular retainers.

3. Describe the component parts of FPD.

4. Describe the method of classifying fixed bridge. Explain the various design of pontics and their indications in bridges.

5. Classify bridge pontics. Give the biomechanical requirements in design and fabrication of pontic.

6. Discuss the component parts of FPD. Describe in detail retainers and their selection.

Short notes

1. Selection of retainers in FPD

2. Non-rigid connectors

3. Semi-rigid connector

4. Hygienic pontic

5. Connectors in FPD

6. Ovate pontic

7. Residual ridge in partially edentulous patient

8. Extracoronal retainers in FPD

9. Types of connectors used in FPD

10. Pontic in fixed partial denture

11. Ridge lap pontics

12. Pontic design

13. Sanitary pontic.

Chapter 33 diagnosis and treatment planning

Essay

1. Define abutment. Discuss selection of an abutment teeth for fixed partial denture.

2. What are the requirements of ideal abutment for fixed partial denture.

3. Define fixed partial denture. Enumerate the indications and contraindications for its use and give an account of the factors affecting the selection of abutment teeth.

Short notes

1. Criteria for good abutment selection

2. Importance of radiographs in FPD

3. Ideal abutment

4. Evaluation of abutment teeth

5. Diagnostic cast and its importance in FPDs

6. Pier abutment and its significance

7. Cantilever bridge

8. Tilted molar abutment

9. Telescopic crown

10. Double abutments

11. Ante’s law and its significance.

Chapter 34 occlusion

Essay

1. Discuss in detail mandibular movements and occlusal contact in natural dentition.

Short notes

1. Concepts of occlusion in FPDs

2. Interocclusal check records

3. Mutually protected occlusion

4. Unilateral balanced occlusion

5. Canine guided occlusion

6. Pathogenic occlusion

7. Interferences and correction

8. Ideal occlusion.

Chapter 35 tooth preparation

Essay

1. Classify retainers used in fixed partial denture. Enumerate the steps in preparation of full ceramic crown for 21. Add a note on advantages and disadvantages of the same.

2. Describe the biomechanical consideration of tooth preparation for fixed partial denture.

3. Mention the principles of tooth preparation and discuss how you obtain retention and resistance form.

4. Discuss biomechanical principles of tooth preparation for fixed partial denture.

5. Explain the indication, contraindication steps to be followed in tooth preparation of partial veneer crown.

6. Mention indication and contraindication for metal ceramic crown. Describe the step-by-step procedure in preparation of molar tooth for metal ceramic crown.

7. Discuss tooth preparation for metal ceramic restoration in maxillary central incisors.

8. Discuss various marginal preparations on abutments in crown and bridge restoration. Give the indication, significance, merits and demerits of each.

9. Discuss in detail about partial veneer crown. Mention their advantages, disadvantages over other types of retainers.

10. Define partial veneer crown. Write in detail step-by-step preparation of maxillary canine to receive ¾ crown.

11. Describe in detail the procedure of preparing vital teeth to receive a metal ceramic retainer.

12. Enumerate the principles of tooth preparation. Explain in detail the evaluation of abutment teeth for fixed partial denture.

Short notes

1. Finishing lines of prepared teeth

2. Marginal integrity

3. Taper

4. Conservation of tooth structure

5. Structural durability

6. Path of insertion in FPDs

7. Gingival finish lines

8. Partial veneer restorations

9. Resistance and retention form in tooth preparation

10. Cervical finish lines in tooth preparation

11. Porcelain jacket crown (all ceramic crown)

12. Partial veneer crown

13. Axioproximal groove

14. Principles of tooth preparation

15. Proximal grooves in partial veneer crown

16. Biological considerations on tooth preparation for crown and bridge

17. Depth orienting groove

18. Facial veneers in full crown

19. Preparation of jacket crown on central incisor

20. Biomechanical principles of tooth reduction

21. Resistance form

22. Comparison between full veneer and partial veneer crown

23. Types of partial crowns

24. Advantages of porcelain fused to metal crown

25. Functional cusp bevel

26. Occlusal offset.

Chapter 36 fluid control and gingival displacement

Essay

1. Describe the methods to control saliva and soft tissue management for fixed partial denture procedure.

2. Define gingival retraction. What are the various methods of gingival retraction followed in fixed partial denture work.

3. Describe in detail the various isolation and gingival retraction techniques in FPD impression making.

Short notes

1. Chemical methods of gingival retraction

2. Retraction cords

3. Gingival sulcus dilatation

4. Fluid control

5. Gingival retraction techniques

6. Tissue management in FPD

7. Gingettage

8. Electrosurgery and gingival retraction.

Chapter 37 impression making

Essay

1. What are the objectives of impression and classify and discuss the technique of recording impression of fixed partial denture.

Short notes

1. Impression techniques for FPD

2. Double mix double impression technique in crown and bridge

3. Rubber base impression materials

4. Triple trays

5. Disinfection of impressions

6. Agar agar.

Chapter 38 provisional restoration

Essay

1. What is a provisional restoration? What are the requirements of provisional restoration? Write an account on various types of provisional restoration.

Short notes

1. Material for provisional restoration

2. Classification of provisional restorations

3. Temporary protection of prepared abutment

4. Need for provisional restoration

5. Temporary crowns/provisional crown

6. Preformed crowns

7. Direct-indirect technique.

Chapter 39 shade selection and lab communication

Short notes

1. Shade guides

2. Shade selection guidelines for FPDs

3. Metamerism.

Chapter 40 lab procedures

Essay

1. Define ‘die’. Describe any one technique of making separable dies for fixed partial prosthesis.

Short notes

1. Foundation restoration
2. Bonding between metal and porcelain
3. Die lock trays
4. Dowel pin
5. Pindex
6. Die spacer
7. Die materials
8. Separable die
9. Gold alloys in FPDs
10. Sprue
11. Crucible former
12. Ring liners
13. Casting rings
14. Casting machines
15. Soldering techniques
16. Soldering index

17. Investment material

18. Casting defects

19. Casting failures

20. Divestment

21. Electroformed dies.

Chapter 41 try-in and cementation

Essay

1. Discuss various luting agents used in crown and bridge cementing. Describe the procedure and care to be taken to cement metal-ceramic crown.

2. Discuss in detail the steps involved in try-in of a fixed partial denture.

Short notes

1. Cements used in crown and bridge

2. Resin cements.

Chapter 42 failures in fixed partial dentures

Essay

1. Classify and discuss in detail the fixed partial denture failures.

Short notes

1. Abutment failures

2. Crown removers

3. Biologic failures in FPDs

4. Mechanical failures in FPDs

5. Aesthetic failures if FPDs

6. All ceramic failure.

Chapter 43 metal free ceramic restorations

Essay

1. Discuss various luting agents used in crown and bridge cementing. Describe the procedure and care to be taken to cement all-ceramic crown.

Short notes

1. Metal free ceramic

2. Indications for all ceramic crown

3. Preparation for anterior all – ceramic crown

4. Adhesive cementation

5. Mechanisms of strengthening ceramics

6. Zirconia

7. All ceramic bridges.

Chapter 44 resin bonded fixed partial dentures

Essay

1. Classify resin-bonded bridges. Discuss in detail the tooth preparation for an anterior bridge.

Short notes

1. Resin bonded fixed partial dentures

2. Advantages and disadvantages of resin-bonded bridges

3. Indications and contraindications of resin-bonded bridges

4. Adhesive bridge

5. Maryland bridge

6. Acid-etch bridge

7. Rochette bridge

8. Virginia bridge.

Chapter 45 restoration of endodontically treated teeth

Essay

1. Classify retainers. Discuss in detail about radicular retainers.

Short notes

1. Ferrule

2. Retention form for postretained crown

3. Post and core crown

4. Management of mutilated teeth

5. Radicular retainers

6. Richmond crown

7. Classification of posts

8. Cores

9. Rationale for use of posts

10. Cementation of posts.

Chapter 46 ceramic laminate veneers

Short notes

1. Indications, contraindications of ceramic laminate veneers.

2. Cementation of ceramic laminate veneer.

Chapter 47 attachment retained dentures

Short notes

1. Classification of attachments in prosthodontics

2. Intracoronal attachment

3. Extracoronal attachment

4. Precision attachments

5. Semi-precision attachments

6. Advantages of attachment retained partial dentures.

Chapter 48 overdentures

Essay

1. Define overdentures. Describe advantages, disadvantages and treatment planning of tooth supported overdenture.

Short notes

1. Tooth supported over dentures

2. Classification of tooth supported overdentures

3. Overdentures

4. Rationale for overdenture

5. Abutment selection for tooth-supported overdentures

6. Stud attachments

7. Hader bar

8. Dolder bar

9. Proprioception.

Chapter 49 oral implantology

Short notes

1. Indication, contraindication and advantages of dental implants

2. Classification of dental implants

3. Component parts of implant restoration

4. Implant denture

5. Osseointegration

6. Implant fixture

7. Implant biomaterials

8. Endosseous implant system

9. Indications for subperiosteal implants

10. Fixture design

11. Implant failures.

Chapter 50 maxillofacial prosthetics

Short notes

1. Classification and advantages of obturators

2. Cleft palate prosthesis

3. Palatal speech prosthesis

4. Obturators

5. Write in brief the treatment planning for maxillary obturator prosthesis

6. Hollow bulb obturator

7. Surgical obturator

8. Retention in maxillofacial prosthodontics

9. Mandibular resection devices.

Chapter 51 smile design

Short notes

1. Golden proportion.

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Section IV Miscellaneous

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