Bogomolets National Medical University
Departament of Pediatric and Preventive Dentistry

Preclinical conservative pediatric dentistry

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The textbook is devoted to preclinical course of conservative pediatric dentistry, which is the basis of clinical practice. The goal of the conservative pediatric dentistry is to maintain the health and integrity of teeth and their supporting structures in children. Information about organization of the dental office, infection control, development and anatomical structure of primary and permanent teeth is presented. Much attention is paid to modern methods of preparation and filling of I-V class carious cavities in primary and permanent teeth in children. Composition, properties, indication and contraindication of different dental materials, selection suitable restorative materials for restoration of primary and permanent teeth in children are given. Large chapter of the book is devoted to the endodontic technique and the filling of root canals of primary and permanent teeth in children.

For English-speaking students of the Faculties of Dentistry of Higher educational institutions, interns and dentists.

CONTENT

Chapter 1

EQUIPMENT OF THE OPERATIVE DENTAL OFFICE. MAIN DENTAL INSTRUMENTS AND THEIR USE

Sanitary and hygienic requirements to the premises of dental clinics are regulated national legislation, and are different in different countries.

The area of operative and pediatric dental offices should be at least 14 m^2 for one dental unit and 7 m^2 for each additional unit. If additional unit is equipped with universal dental equipment, the area increases up to 10 m^2. A general view of the dental office is shown in Fig. 1.1.

The height of walls in the dental office should be not less than 3 m. The depth of room with one-way natural light should not exceed 6 m. The identified parameters determine appropriate amount of space required for a comfortable stay of patients and staff in the office.

The specifics of dental work, air-water aerosols, produced during work with a patient, contribute to spread of microbial flora in the office. Therefore, interior decoration of the dental office must also meet certain requirements. Walls should be with a smooth surface, without cracks. All corners and joints of walls, ceiling and floor should be rounded, without cornices and decorations. Frequency of wet cleaning of room determines the nature and quality of walls and floors.

The color of walls of the office has great importance not only as a factor affecting the central nervous system and the visual analyzer of a doctor but also as a factor that determines the degree of lightning of the room. When choosing a color palette, preference should be given to shades approaching the visible spectrum of sunlight. The highest percentage of reflection of rays falling

Fig. 1.1. *Dental office (general view)*

on surface belongs to the walls of white (80 %), light yellow (60 %), light shades of green (45 %) and blue (30 %).

The ceiling of the dental office is covered with water-emulsion, oil or silicate glutinous paints of white color, which greatly enhances the degree of reflection of natural and artificial light. The floor should be smooth, solid, convenient for washing. For this purpose, roll polyvinyl chloride materials (rigid-vinyl plastic, li- noleum) meet hygienic standards the most. The plinths have to be internal, mount- ed under linoleum. The edge of linoleum should lay on surface of the wall to the height of 5–10 cm and fit hermetically to it. The use of welding technology allows you to create a floor surface without cracks and gaps. Compliance with these con- ditions avoids the accumulation of chemicals in hard-to-reach places.

Color of the floor in dental office should be light, with a coefficient of light reflection not less than 40 % (salad, ochre, gray). The decor of the dental office in light neutral tones has a positive effect on psycho-emotional state of a patient, it does not tire eyes, and does not change the perception of color shades by the vi- sual analyzer of a doctor. It is of great importance during the examination of oral mucosa, skin and teeth of a patient, when choosing the color of filling material.

Natural lightning of the dental office

When designing a dental clinic, it is necessary to take into account that the windows in therapeutic and pediatric dental offices should face the north-east. The flow of natural light with this orientation of windows provides a sufficiently high level of illumination, without forming bright flecks on the working surfaces of the room.

All rooms of the dental clinic should be illuminated by direct and diffused sunlight. Lighting should be intense, even, but it should neither create sharp shadows, nor dazzle. In offices with one-way natural light dental chairs are installed in a row along the window wall. In dental therapeutic offices it is advisable to place no more than 3 chairs. In large clinical offices chairs are arranged in two rows. When one-way natural light is involved it is necessary to use artificial light in the second row of chairs even during a day, because day light factor (DF) is below the norm. Dental office belongs to the category of premises where accurate work is performed. According to sanitary and hygienic standards DF should not be less than 1.5–2 % here. Doctors working in offices with a double-row arrangement of dental chairs are recommended to periodically change their working places.

Artificial lighting of the dental office

For general artificial lighting of the dental office, it is recommended to use lamps with radiation spectrum that does not affect the color perception. Fluorescent lamps of daylight and fluorescent lamps of cold natural light meet these characteristics. Choosing the construction of lamp, it is necessary to take into account the principle of distribution of luminous flux (direct, diffused, reflected). It is very important for a doctor not to have a feeling of light readaptation when looking at surfaces with different degrees of illumination during the work. Therefore, general lighting lamps should be placed according to the following requirements:

– the level of illumination of workplaces shall not be less than 10 %;
– the lamps must not be visible to a doctor.

It is recommended to place lamps at height of 2.6−2.8 m from the floor. In all dental offices, general artificial lighting must provide sufficient illumination on the working surfaces. When using fluorescent lamps, it is 500 meter-candles, incandescent lamps − not less than 200 meter-candles.

The work of a dentist requires high-quality lighting of patient’s mouth. Therefore, each dental unit is equipped with a local lighting lamp in the form of a special reflector.

Ventilation

In the process of work, harmful gaseous substances, dust, microorganisms, excess of heat and moisture gradually accumulate in air of the dental office. The intensity of ventilation in the office depends on volume and nature of the performed procedures, number of medical staff and patients.

Dental offices are equipped with the general plenum-and-exhaust ventilation system. The concentration of carbon dioxide in air should not exceed 0.1 %. According to sanitary and hygienic standards, the air exchange rate in dental offices is: 2 times per inflow of air and 3 times per exhaust for 1 hour.

Except for the general plenum-and-exhaust ventilation, the local artificial ventilation must be in dental offices. Hoods should be installed in the places where instruments are sterilized and where amalgamators are located. Windows in dental offices should be easily opened, have transoms and vents.

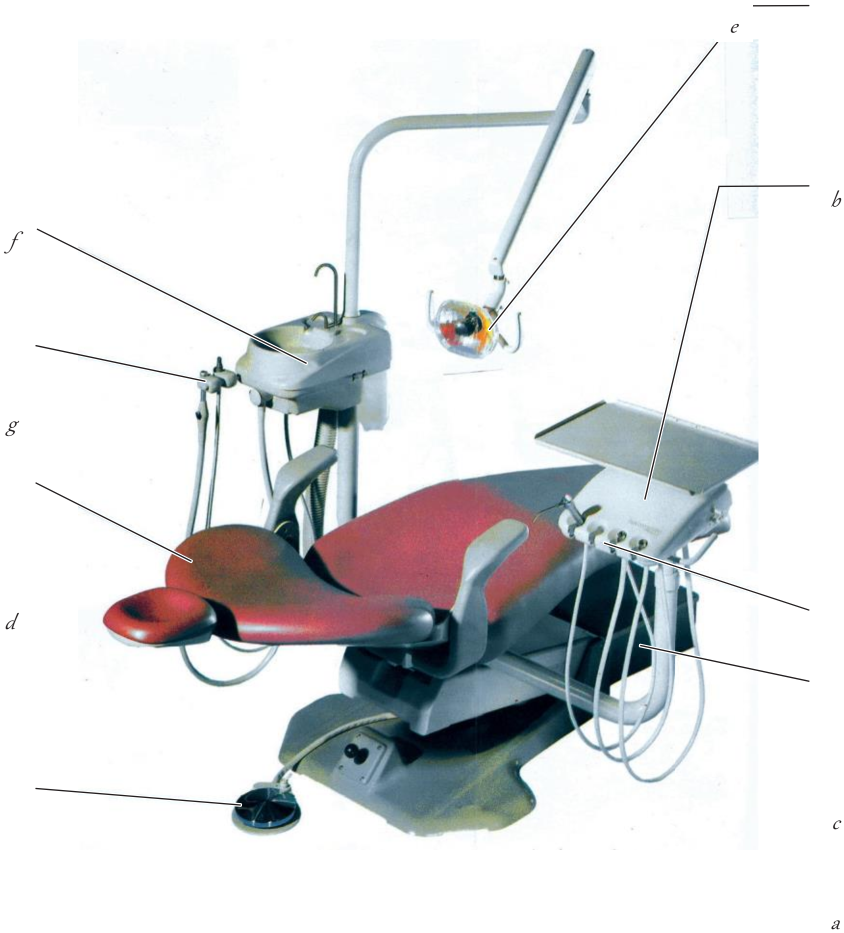
The noise level in dental offices, coming from external and internal sources, should not exceed the parameters regulated by «Sanitary rules of admissible noise in premises of inhabited and public buildings and on the territory of residential development».

For effective work of dental offices, they are connected to the centralized wa- ter supply systems (cold, hot), canalization, heating. Radiators of water heating should be placed under the windows of the office. To facilitate sanitation, they should have a smooth surface.

Equipment of the operative dental office

In the operative dental office (department) the equipped working places for a doctor and dental nurse must be created.

The workplace of dentist is the main functional element of the dental office. The nurse's workplace can be equipped as in the dental office or in a separate room. Table and containers for preliminary disinfection of tools, a sink for per- forming pre-sterilization cleaning of instruments, equipment for their steriliza- tion, a sterile table or chamber for storage of the sterile instruments are needed. The basin for hand wash is located separately.



h

Fig. 1.2. *Universal dental unit: a* – power supply; *b* – instrument block, tool panel; *c* – tool block, «sockets» *for fixing* handpieces; *d* – dental chair; *e* – dental lamp; *f* – hydroblock; *g* – aspiration system; *h* – control pedal

The complete equipment of the workplace of a dentist includes:

– an universal dental unit;
– devices for different procedures (light-curing lamp, ultrasonic scaler, endodontic motor, etc.);
– special mobile chairs for a doctor and an assistant, with adjustment of height of a seat and a backrest;
– doctor's worktable;
– medicine cabinet;
– the table for conducting medical documentation.

U**niversal dental unit** is the complex of electrical, mechanical and hydraulic elements that convert external energy into energy of dental instruments (Fig. 1.2). The unit provides a dentist with conditions necessary for the effective implemen- tation of main types of dental treatment.

The universal dental unit includes a handpiece control block (dental delivery system), dental chair, power supply, compressor, water unit with a spittoon, aspiration system (low (saliva ejector) and high-velocity vacuum systems), a source of local lighting, pedals to control the operation of the unit.

Now the universal dental units for equipment of a pediatric dental office are produced (Fig. 1.3).

The *power supply* is designed to supply water, air and electricity to the dental unit, it provides:

– filtration and air pressure regulation;
– filtration and water pressure regulation;
– heating water for the dental system.

Universal power supply makes it possible to use any electric tools: handpieces with lighting and electric motors, scalers, water heater and a light-curing lamp.

The *dental compressor* is a source of pure compressed (oil − free) air intended for operation of the dental unit. The compressor is located separately from the dental unit and operates in standalone mode (Fig. 1.4). Air under pressure from the compressor through

Fig. 1.3. *Universal dental unit for children's dental office*

hose system is supplied to the tool table, ensuring the operation of high-speed (turbine) handpiece, pneumatic machine and air-water syringe.

The *instrument block* (dentists block) includes the control panel (button or sensory) and tubing in which handpieces (two electric micromotors, one-two high speed, a scaler) are fixed. In addition, on the instrument table there is air-water syringe through which water and air streams are supplied. On the *control panel* you can adjust water flow, turn on lights, micromotor rotation speed, reversible movement of burs in the handpiece of a low-speed micromotor, dental chair position.

Fig. 1.4. *Dental compressor*

Dentist performs direct activation of the handpiece from the foot control block (pedal).

Taking into account ergonomics and in order to streamline the work of adentist, several variants of design of the instrumental block have been developed:

– mobile instrument table (mobile attachment-cart);

– table, fixed on the office built-in holder;

– tool table on the holder of dental unit.

The mobile instrument table is portable and universal to use. Effective access to handpieces during all manipulations enables a doctor to work in various positions (Fig. 1.5). The advantage is that dynamic instrumentation is usually located out of the patient's area of attention during entire time of dental intervention.

The most common is construction of the tool table, fixed to the unit. The presence of a movable arm creates maximum flexibility in choosing position of the handpieces in the working area. Movements of table in vertical and horizontal planes provide the possibility of placing dynamic instruments directly above patient.

The *dental chair* is designed for performing dental manipulations in patient's lying, reclining and sitting positions (Fig. 1.5, 1.6).

The dental chair consists of two parts: upper and lower (Fig. 1.2, *d*). The lower part consists of base, motor and drive, the upper part – seat with a leg rest and headrest. The base of a chair should be balanced to keep patient in horizontal and vertical positions. The dental chair is available with two types of motors – hydraulic and electric. With help of the appropriate drive (hydraulic or electromechanical), chair can be folded, unfolded, change the position in height. The chair position (depending on the dental unit model) is controlled by:

– keypad for manual operation (on the right side surface of the seat back);
– foot pedal;
– membrane-key board located on instrument block of the unit.

The *dental lamp* (source of local lighting) has well-regulated parameters: illumination of working object without shadow («cold light»), clear boundary of the light from reflector (a rectangular shape), adjustable illumination with an upper boundary up to 24,000 me- ter-candles. In such lamps reflectors with an interference coating, thermal and ultraviolet filters, halogen or led lamps are used (Fig. 1.2, *f*).

Reflector of the dental unit is represented by an ergonomic lamp with three degrees of brightness. Typically, the lamp is fixed to the unit on mobile (kinematic) arm, that allows it to be moved in three planes. The halogen lamp generates a flow power of 3800−4500 K, equipped with reflector that filters the ultravi- olet and infrared parts of the spectrum.

The *hydroblock* (block of spittoon) consists of the following elements: bowl of spittoon, rinse and cup filler (Fig. 1.2, *f*). The bowl of spittoon can be ceramic, metal or plastic. It can be both removable and stationary. The rinse is used to clean the bowl of spittoon with water. It can operate automatically and turn on after the patient spits liquid from oral cavity into a bowl. The filling of cup with water is regulated either by the length of time or by the mass of liquid. Additional equipment of the hydrob- lock with various systems (collection of solid

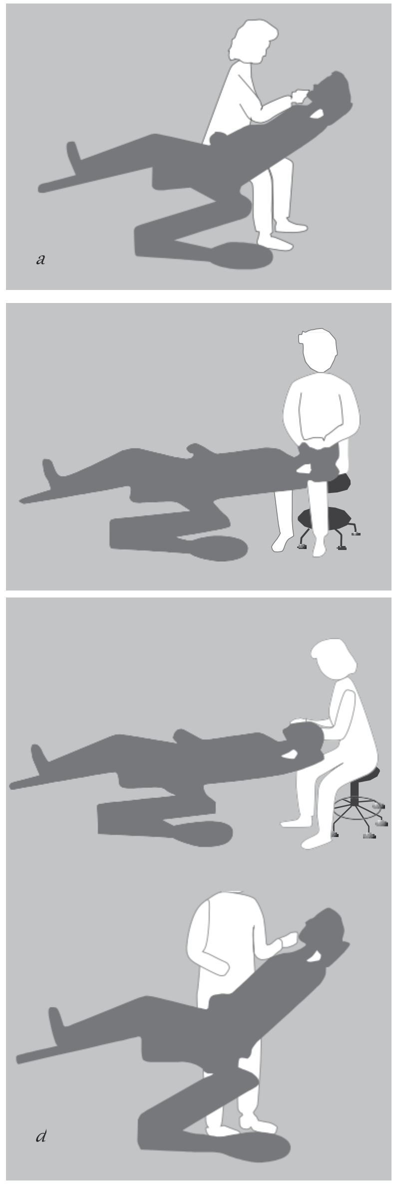


Fig. 1.5. Location options of dentist during operation: *a* – with a patient sit- ting (at 9 o'clock); *b* – with a patient lying (at 11 o'clock); *c* – with a patient lying (at 12 o'clock); *d* – staying near a patient who is sitting

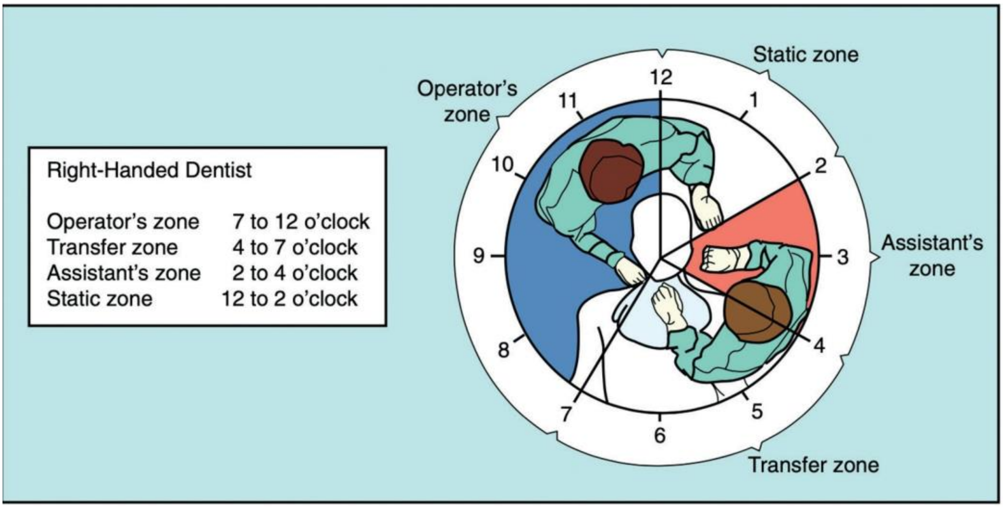


Fig. 1.6. *Optimal location option of right-handed dentist and assistant during operation*

particles, amalgam separator, water and air heating system, water disinfection) allows to expand functionality of the dental unit.

The hydroblock can be self-contained unit. In this case, it is fixed to unit stand. For the convenience of a dentist in many modern models of universal dental units, the dental chair is connected to hydroblock, a table for instruments and a lamp in single complex. As a result, the effect of synchronicity of patient's movement in chair and above mentioned units is achieved.

The *aspiration system* is designed to evacuate liquid (saliva, water) and solid particles (tooth dust, tooth fragments, fillings) from a patient's mouth. It includes saliva pump and «vacuum cleaner». The hoses of system are usually withdrawn to the left of patient's chair (Fig. 1.2, *g*). The operation of aspiration system is provided by a special suction unit. The electromotor with impeller generates a negative pressure in the system, necessary for functioning of saliva pump and «vacuum cleaner». The principle of operation of aspiration system can be injection or vacuum. The liquid from an oral cavity is removed through filter system into canalization.

If unit is equipped with doctor's assistant table, it can be additionally equipped with saliva pump and «vacuum cleaner»: gun (air-water) for an assistant, photopolymer lamp, the control panel of patient's chair.

Control pedals. Using the control pedals, doctor can control chair and instruments work (Fig. 1.2, *h*).

Dental handpieces are the parts of dental unit and belong to the category of rotary instruments. Handpiece directly converts the drive energy of dental unit into movement of the dental instrument fixed in it.

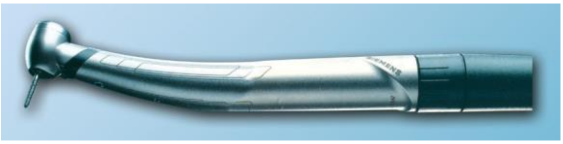


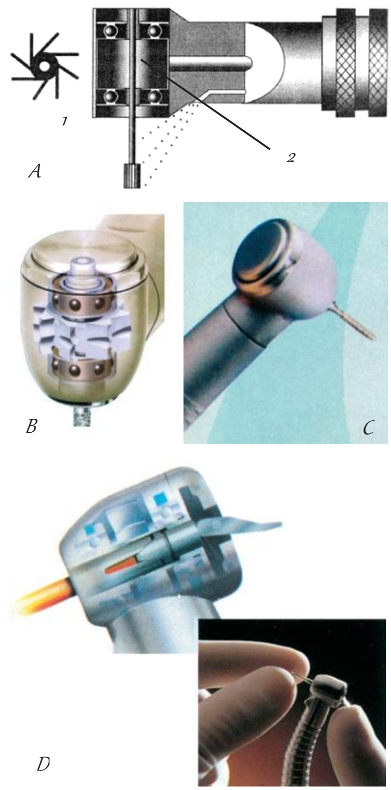
Fig. 1.7. The high-speed (turbine) handpiece connected to the dental unit

Dental unit can be equipped with different types of drives. In the modern units air-driven or electric micromotor driven are used.

The air-driven of dental unit ensures operation of pneumatic instruments: high-speed (turbine) handpiece, air-driven micromotor and air scaler (sonic).

The high-speed (turbine) handpiece is the instrument that converts energy of compressed air flow into rotation of burs (Fig. 1.7). The high operating potential of turbine handpiece is due to the high-tech features of the structure of its head.

Air under pressure is supplied to the turbine blades (impellers, Fig. 1.8, *A*, *1*) located di- rectly in the head of high-speed handpiece. The impeller, connected to two bearings (top and bottom), makes a strong element of rotation (Fig. 1.8, *A; 2, B*). Fixed in the high-speed (tur- bine) handpiece head a bur is tightly connected to impeller and bearings, forming a single axis of rotation. Thus, impeller and bur rotate syn- chronously at the same speed. The fixation of a bur in the head is carried out using a button (Fig. 1.8, C), screw (special key) or wrench bur remover (Fig. 1.8, *D*). Rotary groups of turbine handpieces can be on mechanical (metal, ceramic, Fig. 1.8, *B*) and on air bearings.



The main advantage of high-speed (turbine) handpieces in comparison with other types of handpieces is the high speed of bur rotation. The handpiece with a rotary group on bearings create a rotation speed of bur up to 310 000 rpm (Fig. 1.9, *c*), and on air bearings (Fig. 1.9, *a)* – 450 000 rpm and more. The high speed of rotation of bur in handpieces on air bearings is caused by the technical features of the rotor group (lack of mechanical contact between rotor and body).

With help of the turbine handpieces, it is possible to quickly and qualitatively prepare

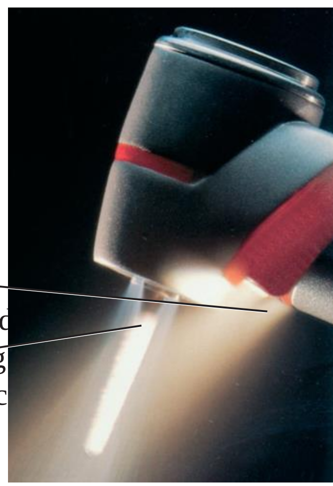
Fig. 1.8. *Scheme of the structure of turbine head and fixing of a bur in it: A – impeller (1 – cross section, 2 – longitudinal section). B – rotor group on mechanical ceramic bearings. C – fixation of a bur in the turbine head with push-button. D – fixation of a bur in the turbine head with a wrench bur remover*

a *b* *c* *d*

Fig. 1.9. *Types of fixing the high-speed (turbine) handpiece: a – turbine handpiece on air bearings, rotation speed up to 450 000 rpm. Fixing the handpiece with Unifix type of connector; b – quick-detachable connector of Unifix type; c – turbine handpiece on metal bearings, speed of rotation up to 310 000 rpm;*
d – fixing system of the handpiece – direct hose connection with screw

hard tissues of a tooth (primarily enamel), remove old fillings of large sizes. The optimum speed of bur rotation during preparation of a carious cavity is from 150 000 to 200 000 rpm.

There are some features of the high-speed (turbine) handpieces, slowing of bur rotation with increase in the pressure force on the bur. Therefore, during cavity preparation, it is necessary to use the minimum intermittent pressure on a bur, avoid lateral pressure on a bur during preparation, in order to reduce the risk of wearing the rotor group of turbine head. Preparation with turbine handpiece should be accompanied by air-water cooling (Fig. 1.10, *a*; 1.12, *a*), which will avoid hard tissues overheating, thermal irritation of pulp during preparation. Modern models of high-speed (turbine) handpieces are equipped with air-water cooling system and LED illumination (Fig. 1.10, *b*).



Connection of the turbine handpiece into dental unit can be carried out in two ways: with help of quick-detachable couplings or direct connecting of a handpiece on a rubber hose of dental unit. The final part of rubber hose of dental unit has the form of special connector with holes on its end part (Fig. 1.11). In the first case of connection, a spe- cial coupling of the Unifix type (KaVo MUL- TIflex) is screwed onto the hose connector by means of clamping nut (Fig.

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Fig. 1.10. Turbine head: *a* – a cooling system jet; *b* – light guide

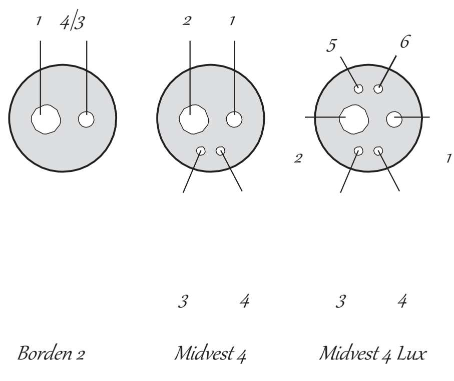
change the handpiece and to rotate it a full 360 around its axis. In the second case of connection the turbine handpiece, connector of the hose of unit is screwed directly onto the turbine handpiece body (Fig. 1.9, d).

Lubrication of turbine handpieces is recommended after 4–5 patients, as well as before and at the end of each working day. Pro- cedure can be carried out using special spray or special device for cleaning and lubricating the handpieces (Fig. 1.13).

Fig. 1.11. *Hoses for connection of high-speed (turbine) handpiece, air-driven or electric-driven micromotors*

Lubrication is carried out through the drive air hole (Fig. 1.12, c). The most effective is use of spray, which simultaneously performs two functions – it cleans and lubricates the handpiece. Procedure is continued until the clean lubricant flow out of the handpiece. After that it is necessary to remove oil residues by at- taching the handpiece to unit and turning on the blowing.

Working of the air-driven (pneumatic) micromotor (Fig. 1.13, 1.14), as well as turbine handpiece, is provided by an air pressure of dental unit. Compressor builds up the pressure to 2–3 atm in air system pressure, air under pressure is sup-



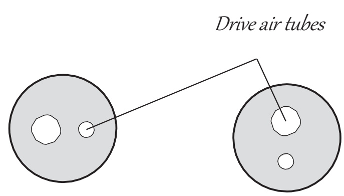


Fig. 1.12. Air-water cooling system (*a*). The connector options of turbine handpieces (*b*): *1* – drive air; *2* – exhaust (Return air); *3* – coolant water; *4* – coolant air; *5–6* – electric contact. Arrangement of the tubes of drive air for the lubrication of turbine handpieces (*c*)

plied through the tubes to the tool table of unit. When the air-driven (pneumatic) micromotor is switched on, compressed air enters its rotor part (Fig. 1.14, *a*) through the supply tube (of smaller diameter, Fig. 1.14, *b)* and drives blades of the rotor group. The exhaust air is removed through the appropriate tube (of larger diameter, Fig. 1.14, *c*).

Fig. 1.13. Device (*a*) and spray (*b*) for cleaning and lubricating handpieces

Rotational moment of blades is transmitted to the shaft of micromotor (Fig. 1.15, *b*, 1; Fig. 1.16, *b*), which in turn, drives the bur fixed in handpiece, through the system of handpiece gears (Fig. 1.16, *a*).

Air-driven micromotors have less power compared to electric-driven motors, but provide a softer work of the fixed instrument. The operating speed range is from 3,000 to 25,000 rpm.

The electric-driven micromotor (Fig. 1.17) is endowed with high power, precise control of the speed of rotation of bur in the range from 1 000 to 40 000 rpm, equipped with a cooling system, has a smooth control of rotations and a universal connector for attaching micromotor handpieces.

The handpiece for electric micromotor provides movement of bur fixed in it by transmitting rotational movements from the shaft of electric motor to bur.

According to the type of electric energy supply to rotating shaft, all models of micromotors are divided into brush (they have brushes) and brushless.

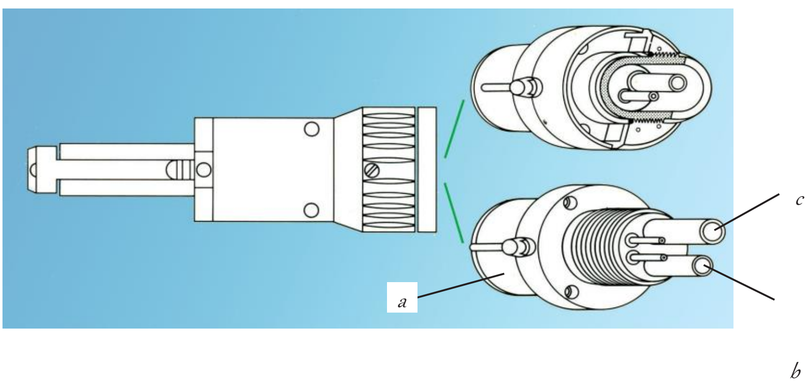


Fig. 1.14. Scheme of structure of the air-driven (pneumatic) micromotor: *a* – rotor part; *b* – tube supplying air to blades of the rotor group of pneumatic motor;

c – tube venting air from rotor blades of the micromotor (appearance – *a*)

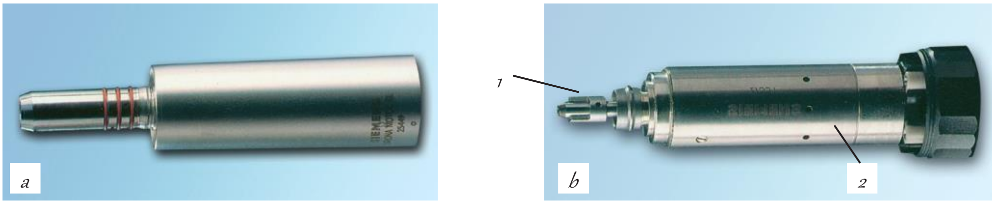


Fig. 1.15. *Air-driven (pneumatic) micromotor (appearance) (a).*
Working part of pneumatic motor (b): 1 – micromotor shaft, 2 – rotor

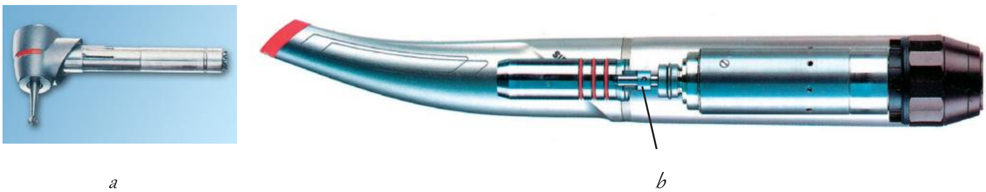


Fig. 1.16. *Contra-angle handpiece of air-driven (pneumatic) micromotor: a – head of handpiece; b – shaft of micromotor*

The electric micromotors can carry out not only rotational movements, but also reciprocating. To do this, press the button on control panel and the micromotor will switch to another operating mode. In this case, a tool, fixed in the handpiece, performs reciprocating movements, amplitude, and frequency of which can be adjusted if necessary. This function of the micromotor is used during endodontic manipulations.

Depending on the ratio of handpiece axis and the axis of tool fixed in it, there are straight and contra-angle handpieces. The handpieces can work with both electric and air-driven (pneumatic) micromotors.

The contra-angle low-speed handpieces (RA – Right Angle) (Fig. 1.17, *a*). The position of bur at angle of 90 ^{0} to the handpiece axis is optimal for preparation

c *a* *b*

Fig. 1.17. Contra-angle handpiece with internal cooling supply system (a) and electric brushless micromo- tor (appearance – *b*); gear ratio (c)

of the buccal, lingual and contact surfaces of teeth.

The low speed of bur rotation, as well as the significant mechanical power (torque) of micro- motor, allow the use of contra-angle handpieces for removal of carious dentin, finishing and polishing of restorations.

For endodontic manipulations, even lower speed of tool rotation in the handpiece is necessary.

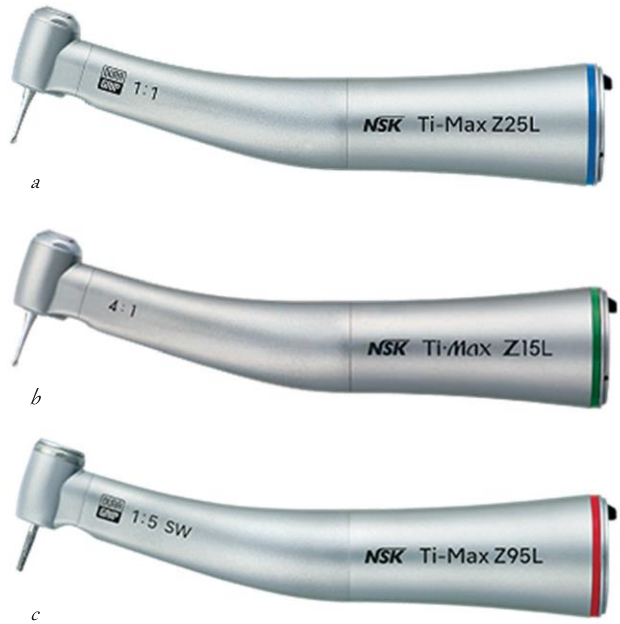
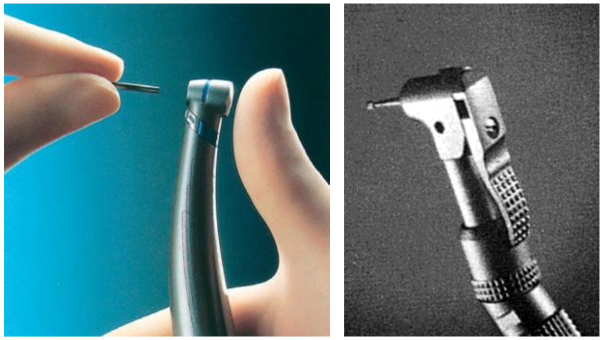


Fig. 1.18. *Codes of the gear ratios of handpieces: blue ring — 1:1 ratio (a); green ring — reduce the speed (b); red ring — increase the speed of bur rotation (c)*

The speed of tool rotation depends on the gear ratio of rotation. It indicates the ratio of bur rotation speed in handpiece and the speed of micro- motor shaft rotation. Gear ratios 10:1; 4:1; 2,5:1 mean a decrease of bur rotation speed in the handpiece, respectively, by 10, 4 and 2.5 times. Ratio 1:5, on the contrary, indicates an increase of bur rotation speed in the handpiece by 5 times. The gear ratio information is coded as a colorful mark – green, blue or red ring or spot on the handpiece body. The blue ring corresponds to 1:1 ratio. Handpieces with such marking can rotate bur at the speed from 200 to 40 000 rpm. The handpieces with green ring reduce the speed, and with red – increase the speed of bur rotation (Fig. 1.17, *c;* Fig. 1.18). Contra-angle low-speed handpieces, as well as high-speed (turbine) ones, are equipped with system of air-water cooling of prepared surface. In contra-an- gle low-speed handpieces a bur is fixed by flip latch (Fig. 1.19, *b*) or push-button (Fig. 1.19, *a*).

Straight low-speed handpieces for electric and air-driven (pneumatic) micro- motors have the same speed characteristics as contra-angle ones. In straight handpieces, the axis of rotation of tool coincides with the axis of handpiece. The straight handpiece is widely used in surgical and prosthetic dentistry.

Also, different types of handpieces are available, like Prophy angles (for prophylaxis), Endodontic handpieces (for endodontic treatment) (Fig. 1.20, *a*, *b*).



a *b*

Fig. 1.19. Fixation of burs in the angle handpiece:
a – by push-button; *b* – by flip latch

The low-speed handpieces should be lubricated at least twice during shift and always before sterilization. Special nozzles on the spray are used to lubricate the low-speed handpieces by spray under pressure. Lubrication is carried out under the control of purity of the oil coming out of handpiece.

Collet (latch) is lubricated every week. After lubrication, the handpiece must be thoroughly wiped with a dry cloth to prevent oil from entering the motor.

Lubrication of air micromotors should be carried out once a week. The oil is put into hole of the drive air tube. Electric micromotor, on contrary, should be protected from oil ingress, especially on brushes.

Dental instruments

The work of dentist specialized in operative or pediatric dentistry is to conduct a variety of diagnostic and operative procedures that require high accuracy of manual movements and the availability of appropriate instruments. Sufficient range and good quality of dental instruments are of great importance to ensure qualitative work of dentist.

The dental instruments for operative dentistry use are divided into following groups

ac rpo

b

a

Fig. 1.20. *Different types of handpieces:*
a – prophy angle; *b* – endodontic handpiece

1) for examination of oral cavity;
2) for preparation of carious cavities of teeth;
3) for endodontic treatment;
4) for filling carious cavities and restoration of anatomical shape of the tooth;
5) periodontal instruments.

Depending on the usagemethod, the tools can be manual or machine. During clinical practice a dentist most often uses standard kit of 6 basic dental instruments: mouth (dental) mirror, straight dental probe, dental excavator, plastic filling instrument-plugger (burnisher), double-ended cement spatula, dental dressing plier (tweezer). Length of the instruments ranges from 150 to 160 mm.

Dental mirror is small round-shaped glass in a metal frame fixed at the end of metal shank (Fig. 1.21).

Shank is screwed onto the handle. The surface of mirror is of two types: flat (creating a 1:1 sized image) and concave (to enlarge the image). Coating is present on back side of the mirror

This instrument is designed for:

– examination of teeth, periodontal tissues and areas of oral mucosa, which are not available for direct visual examination of a patient (indirect view);
– additional illumination of the oral cavity (reflects the light of dental lamp);
– mechanical protection of lips, cheeks and tongue during dental procedures;
– retraction of lips, cheeks and tongue during the examination of a patient.

Dental probe consists of: handle, shank and working tip (Fig. 1.22). The working part of the probe is located at obtuse angle to handle. It is made of modern alloys with high hardness and wear resistance.

This instrument is applied for:

– detection of carious cavity in tooth and determination of its depth;
– assessment of consistency of enamel and dentin;
– detection of connection of carious cavity with pulp chamber;
– detection of the orifices of root canals;
– assessment of the quality (irregularities) of marginal adaptation of restorations;
– percussion of tooth (it is made with the probe handle).

Dental pliers (tweezers) with narrow tips without notches, curved along the edge at angle of 115^0–120^0 (Fig. 1.23).

With help of pliers a doctor can carry out various dental manipulations:

– to hold or apply cotton balls and rolls into the mouth of patient;
– to insert liquid drugs into carious cavity;
– to determine the tooth mobility;

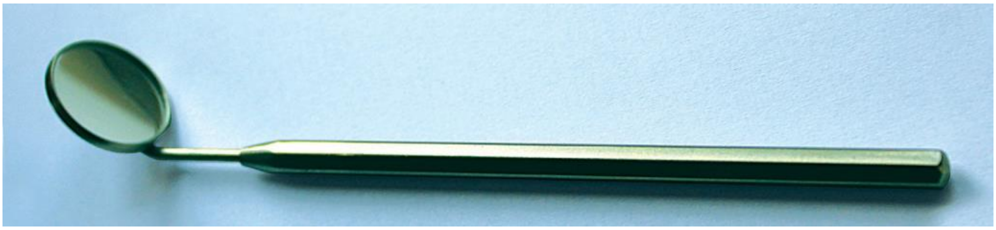


Fig. 1.21. Dental mirror

Fig. 1.22. Dental probe

– to remove small foreign objects from carious cavity and oral cavity;

– to carry out diagnostic and therapeutic procedures on the oral mucosa;

– to use blunt part of the pliers as a retractor (to fix tongue, lips).

Dental excavator – the double-ended tool with working parts in form of small spoons with sharp edges (Fig. 1.24).

It is manual cutting tool that is used to remove softened layers of dentin from carious cavity, remove temporary restorations, remove the crown part of pulp (pulpotomy). The working part can be round or oval in different sizes.

Placement instruments (carver, burnisher) is intended for carrying filling materials into prepared carious cavity, sculpting of fillings by smoothing their surface and removal of excess material (Fig. 1.25, *b*).

Carvers are produced in different sizes, one- and double-ended (Fig. 1.26), combined − with a plugger (Fig. 1.25, *a*).

Plugger (condenser) is the tool for condensing and adaptation of filling material in carious cavity. It is metal shank with pear-shaped, spherical or cylindrical head located at an obtuse angle to the shank. Also they can be smooth or serrated (Fig. 1.25 *c*, *d*).

Double-ended cement spatula consists of handle on both ends of which the extended straight shovels are located (Fig. 1.26). With help of spatula, medicinal substances are prepared on a glass plate (slab), filling materials are mixed, and crystalline and powdered medicinal products are ground.

The minimum set of hand tools required for examination of patient's mouth (examination set) includes: dental mirror, straight dental probe, dental plier.

The following is list of dental instruments included in ***the standart therapeutic (operative) dental kit:***

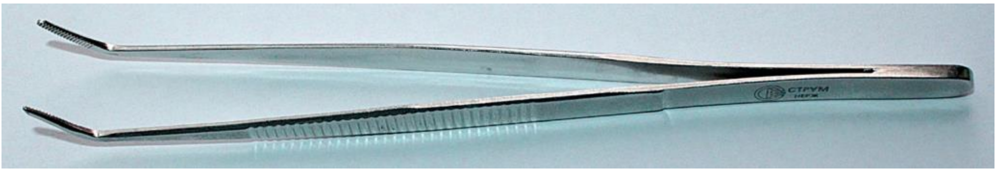


Fig. 1.23. *Dental dressing plier (tweezer)*

Fig. 1.24. *Dental excavator*

– straight dental probe;
– dental mirror with handle;
– plugger-carver;
– excavator;
– double-ended cement spatula;
– dental pliers.

Modifications of the main dental instruments are developed taking into account the specifics of individual diagnostic and therapeutic procedures. For example, there are some modifications of dental probes (Fig. 1.28).

Periodontal probe is a curved probe with a graduated shank and an atraumatic spherical tip (Fig. 1.29, *b*). The working part of probe is calibrated (in millime- ters) in the form of notches or colored rings (Fig. 1.29, *a*). The tool is included in periodontal set and is intended for the study of periodontal tissues.

A large group of dental instruments includes machine tools – rotation instruments: burs (cutting rotary instruments) and abrasive rotary instruments used for the preparation of cavities.

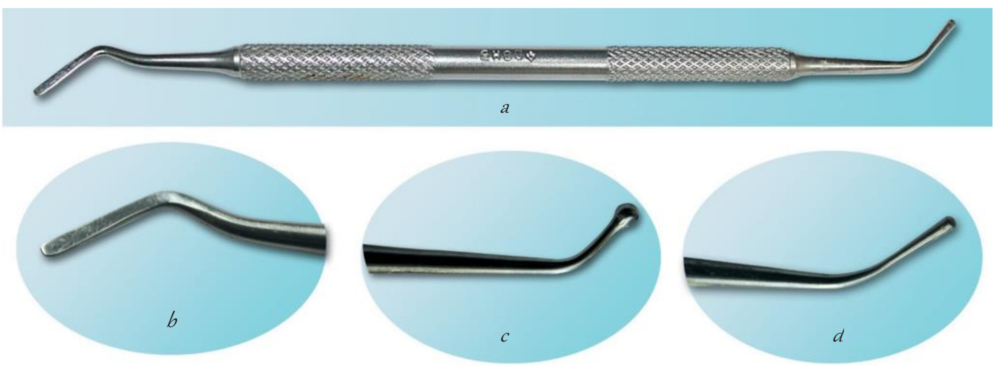


Fig. 1.25. Plugger-carver (*a*); *b*— carver; *c*— a ball-like plugger; *d*— a pear-shaped plugger

Fig. 1.26. Double-ended cement spatula

Fig. 1.27. Double-ended carver – sickle and distal

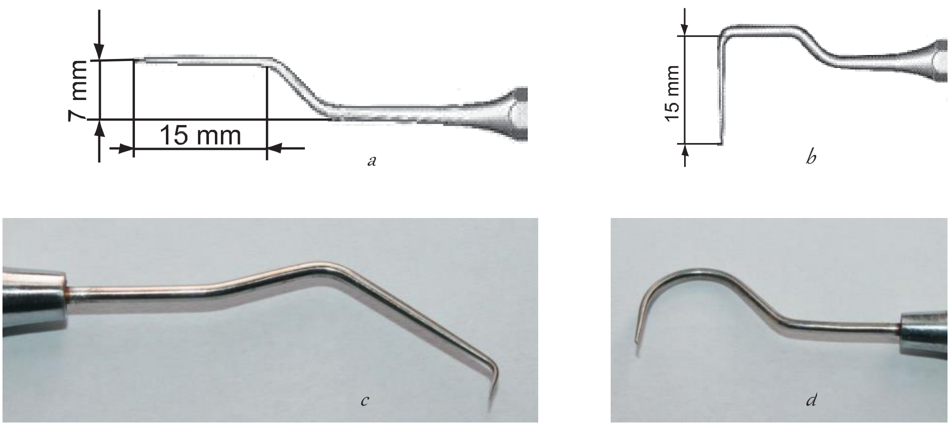


Fig. 1.28. Modifications of dental probe: *a, b* – straight; *c* – straight probe with bended end; *d* – curved probes (sickel)

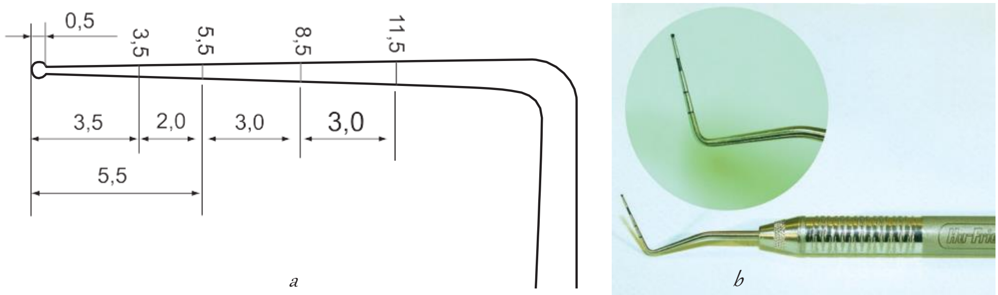


Fig. 1.29. Periodontal probe: *a* — scheme of the working part; *b* — photo of the probe

Dental burs are the cutting instruments and is driven into motion (rotation) with help of dental handpiece. In operative dental practice, burs are used for the preparation of hard tissues of tooth, the orifices of root canals opening, removal of old fillings, finishing and polishing the surfaces of fillings of different materials.

Burs consist of three parts: head, neck and shank. Shank is the longest part of instrument and serves to connect it to the rotary device (handpiece).

Shape and diameter of shank determine the purpose of burs: for a highspeed handpiece, contra-angle low-speed handpiece or straight handpiece (Fig. 1.30).

To connect to the straight handpiece shank is long and smooth (HP type). For the contra-angle low-speed handpiece, shank is short and has a latch, being called right angle/latch type or RA/CA. For the highspeed handpiece, shank is thinner, shorter, and does not have latches, because the connection happens by friction, being called friction grip or FG. The shank diameter is standardized. For contra-angle low-speed handpiece it is 2.35 mm, for highspeed handpiece – 1.6 mm (Fig. 1.31). The length of burs can be different, due to variety of dental manipulations. The length of standard burs, which are most often used by a doctor, is 44 mm for straight and and 22 mm for contra-angle low-speed handpieces. For highspeed handpiece burs, this value is 19 mm. Classification of burs according to the ISO standart is shown in Fig. 1.30.

The working part of burs is designed to remove hard tissues of tooth by layer-by-layer cutting (Fig. 1.32). On the cutting part of burs there are blades (knives edges), which provide this process. The working characteristics of burs are determined by the hardness of metal of working part, number and height of the edges. There are about 100 types of burs. The working part of burs may vary in:

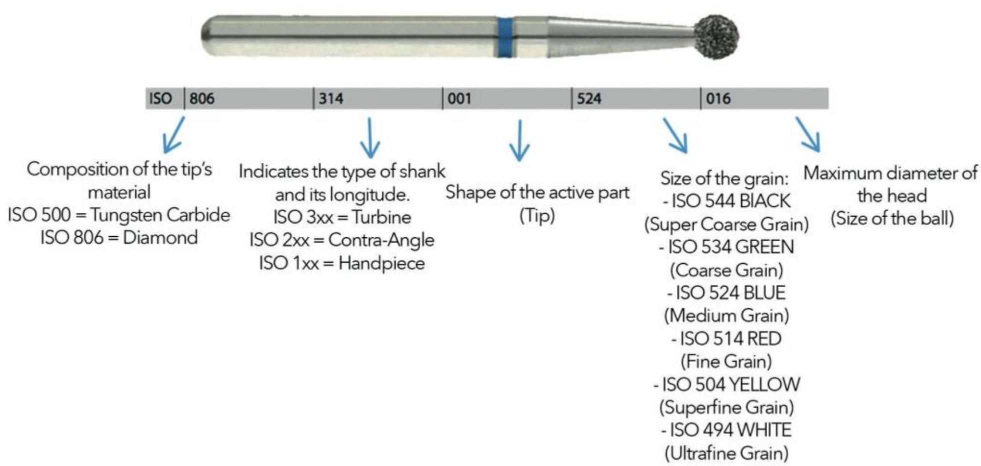


Fig. 1.30. *Classification of burs according to the ISO standart*

– form;
– size;
– number, size and direction of cutting edges;
– the material from which they are made;
– purpose and other characteristics.

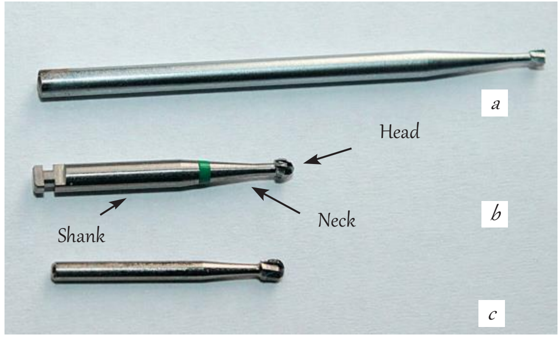


Fig. 1.31. Burs for different handpieces: *a* – straight; *b* – contra-angle; *c* – high-speed

Most often, round and cylindrical (straight fissure) burs are used, less often – burs of differ- ent shape: pear-shaped, cone-shaped, inverted-cone, spear-shaped, wheel-shaped, etc. (Fig. 1.32).

The size of working part of burs varies from 0.6 to 3 mm in diameter. Shape and size of working part of the burs determines its purpose.

Round burs of small size are ideal for preparation of a small carious cavities located on the contact surfaces of front teeth. They are also used to open a pulp horn. The round medium-sized burs are designed for preparation of carious den- tin in cavities located on occlusal and contact surfaces of molars and premolars (Fig. 1.32, *a*).

Pear-shaped burs are convenient for preparation of large cavities on the oc- clusal surface of molars and premolars. The shape of working part of pear-shped burs allows to form cavity with rounded angles (Fig. 1.32, *b*).

Cylindrical (straight fissure) burs are used to openung carious cavity (removal of overhanging edges of the enamel), formation of straight walls of carious cavity (at the angle of 90^0), creation of retention points on the cavity walls and the enam- el bevel; endodontic access formation (Fig. 1.32, *c*).

Fig. 1.32. Form of the working part of burs: *a* – spherical; *b* – pear-shaped; *c* – cylindrical; *d* – torpe- do-like; *e* – cone-shaped; *f* – inverted conical

Torpedo-like burs − cylindrical (fissure) burs with a rounded end. This type of burs is ideal for preparation of small cavities located on the occlusal surface of premolars and molars (Fig. 1.32, *d*).

Cone-shaped burs are used to form the walls of carious cavity at an angle that exceeds 90^0 (Fig. 1.32, *e*).

Inverted cone burs are used to prepare cavities located on the occlusal surface of molars and in the cervical part of teeth; to form cavities on the approximal surfaces of molars and premolars (Fig. 1.32, *f*).

The material from which working part of burs is made, significantly affects its technical characteristics and purpose. The burs are made from stainless steel, tungsten carbide, special plastic and ceramics.

On the surface of working part of burs there are 6–8 edges. These burs are designed for preparation of dentin at low speed. Recommended rotation speed of metal burs during the dentin preparation is not more than 10 000 rpm. Steel burs with small crosscuts (finishers) and without crosscuts on the working part (polishers) are used for finishing metal fillings.

Tungsten carbide burs are more durable, they have an increased cutting efficacy. Their working part (head) is made of hard alloy (tungsten carbide) and soldered to stainless steel shank. These burs are widely used in dental practice (Fig. 1.33). They provide good quality of preparation of enamel, dentin, they are effective for finishing of amalgam and composite fillings. Carbide burs with stand thermal loads, so they are used when working with a high-speed handpiece. The disadvantage of these burs is the possible breakage of working part (head) in the place of solder of various metals.

Information about cutting efficiency of carbide burs can be encoded in the form of colored ring on the shank (Fig. 1.33). Green ring indicates the highest cutting efficiency of burs (6 edges). Yellow and white rings indicate that the burs

Fig. 1.33. *Tungsten carbide round burs of various sizes*

belong to finishers or polishers with number of edges – 16 and 30. These tools provide high-quality grinding and polishing of fillings. Higher number of blades, lower cutting efficiency, but smoother is the resulting surface. Usual burs with normal cutting capacity, used for preparation of hard tissues of teeth, do not have color markings.

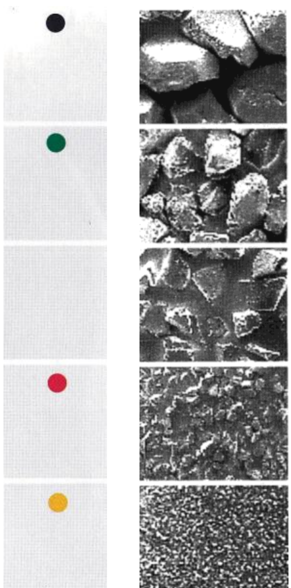
Abrasive rotary instruments are also widely used in routine dental practice. These include diamond points (they are mistakenly called diamond burs), mounted stones (Arkansas, silicon carbide stones), abrasive-impregnated rubber heads, discs. With help of these tools, the grinding of corresponding surface (tooth, filling, prosthesis) is carried out.

Diamond points are the abrasive dental instruments with diamond coating of working part (head), which are driven (rotated) by a dental handpiece.

The diamond points consists of shank, neck and working part (head). Diamond grains made of synthetic or natural diamond are fixed on the working head with help of binding material. Shank is made of stainless steel. The widest range of diamond points is produced for the high-speed handpiece (Fig. 1.35).

Standard length of diamond points for high-speed handpiece is 19 mm with shank diameter of 1.6 mm.

Diamond points are designed for enamel preparation, rapid removal of old fillings, tooth cavity preparation, finishing of composite fillings and fillings made



a *b*

Super large	*180 microns*	*Super course*
Large	*135 microns*	*Course*
Normal	*100-120 microns*	*Medium grain*
Thin	*50 microns*	*Fine grain*

Ulrathin 30 microns Super fine grain

c

Fig. 1.34. Color marking of the graininess of diamond heads: *a* — a color code; *b* — graininess; *c* — average grain size, micron

of glass-ionomer cement (Fig. 1.33). It should be noted that diamond points are less effective for preparation of den- tin, since the organic part of dentin fills empty spaces between diamond grains very quickly, thereby rapidly reducing the abrasive properties of diamond points.

Abrasive points differ in the size of working part, the properties of diamond, the density of diamond grain. The size of diamond particles determines the grain size of diamond points and the scope of their application (Fig. 1.35). This information is encoded as a colored ring on the shank of diamond points. Black and green colors of ring mean super-large and large graininess of working head, which allows you to quickly remove a large array of hard tissues. Universal instruments with normal grain size (100 microns) do not have color coding or are marked with blue ring. Red ring corresponds to the thin grain surface of head. These tools are recommended for finishing tooth tissues after preparation. Diamond heads with yellow or white ring are recommended for grinding and polishing the fillings made of composite filling materials. Color marking facilitates the process of selec- tion of tools for the appropriate stage of treatment, determines the order of their use in the work. The greater particle size, the more efficient the abrasion will be and the rougher will be surface. Conversely, the smaller particles, the smoother resulting surface will be.

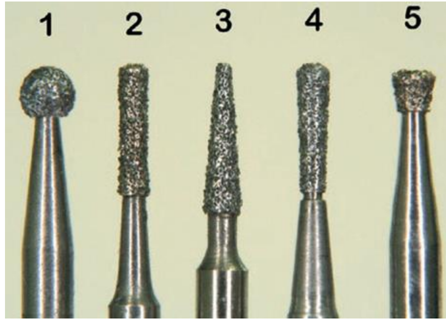


Fig. 1.35. *Diamond points of various shapes for a turbine handpiece*

Particular care should be taken when working with the diamond heads of thin graininess. Their contact with hard tissues of tooth should be intermittent. During preparation, it is recommended to use abundant water cooling, since these diamond points get heated during operation faster than others, which can cause complications after treatment.

Control questions

1. What are the sanitary and hygienic requirements for the dental office?
2. What blocks does the universal dental unit consist of? What drives are available in the dental unit?
3. The work of what tools is provided by air sleeve of the dental unit?
4. What is the principle of operation of turbine handpiece? What is rate of rotation of bursl in the turbine handpiece?
5. The work of what tools is provided by electric drive of the dental unit?

6. What handpieces for electric micromotor do you know?
7. What dental instruments are included in the standard dental kit? What is their purpose?
8. Name the tools that are used for preparation of dental hard tissues?
9. According to what characteristics are classified dental burs? What is name and what are ndications for use of the main types of burs, depending on the shape of working part?
10. What is a diamond point? What are indications for use of diamond points? What does the colour marking on the diamond point shank mean?

Test tasks to the section "The equipment of the operative dental office. The main dental instruments and their use"

1. **In pediatric clinic, the area of operative office, where dental unit is located, is 16m2. What should be the minimum area of dental office?**

A. 7 m²; B. 10 m²; C. 14 m²; D. 18 m².

2. **During clinlcal practice, dentist used various devices and units. Which of them does not have connection to the universal dental unit?**

A. Aspiration block D. Dental lamp B. Dental chair E. Amalgamator C.Hydroblock

3. **To prepare carious cavity within enamel on occlusal surface of the tooth 36, doctor used the turbine handpiece. From what drive of the dental unit does this handpiece work?**

A. Electric B. Air C. Hard

4. **During preparation of carious cavity within cover dentin in tthe ooth 85, doctor used the handpiece of electric micromotor. What speed of rotation of burs can be provided by this handpiece?**

A. 1000-5000 rpm C. 5000-100 000 rpm B. 1000-40 000 rpm D. 100 000-200 000 rpm

5. **During endodontic treatment of the tooth 46 of 12-year-old patient, a dentist needs to expand orifices of root canals. What dental instrument should be used to determine their topography?**

A. Plugger C. Probe E. Excavator B. Carver D.Mirror

6. **When carrying out preventive examination of a 7-year-old child, dentist used an examination kit. What instruments does it consist of?**

A. Curved dental probe, dental mirror, dental tweezers

B. Dental mirror, dental tweezers, excavator

C. Curved dental probe, dental mirror, excavator

D. Curved dental probe, dental mirror, periodontal probe

7. **Dentist restored anatomical shape of the first molar with silver amalgam. What tools should be used to finish the filling?**

A. Polishers B. Burnishers C. Diamond points

8. **During preparation of the walls of carious cavity located on occlusial surface of the tooth 46, dentist used a fissure burl. What form of the working part does this drill have?**

A. Spherical B. Cylindrical C. Cone-shaped D. Inverted conical

9. **During treatment of dental caries of the tooth 85 in a 5-year-old child, doctor conducted preparation of carious cavity within dentin. Which tool is the most appropriate to use for necrectomy of softened dentin?**

A. Diamond point B. Burnisher C. Carbide bur D. Carborundum point

10. **Dentist prepared carious cavity in the tooth 21 of a 10 years old chald and put permanent composite material filling. In the process of treatment, diamond points of different degrees of graininess were used. What color is marking ring of the diamond point intended for finishing the composite filling?**

A. Black B. Green C. Blue D. White E. Red

Correct answers to test tasks to the section “The equipment of the operative dental office. The main dental instruments and their use”

1. C	3. B	5. C	7. A	9. C
2.E	4. B	6. A	8. B	10. D

Chapter 2

DISINFECTION AND STERILIZATION OF DENTAL INSTRUMENTS AND EQUIPMENT

Among all medical specialties, the highest risk of transmission of infections exists in gynecology, urology and dentistry. Both the patient and the staff are at risk of infection by microorganisms in different ways during the dentistry appointment: through blood, contact with secretions or infected instruments, microorganisms that are transferred by droplet spread from the mouth and respiratory system.

Recently, the number of carriers of hepatitis B, C, D, HIV/AIDS viruses has increased. The risk of hepatitis B and AIDS for dentists is by 3.6 times higher than for doctors of other specialties (Table 2.1). Therefore, each patient must be treated as potentially infected. Patients, who are unaware of the presence of disease, often become the source of hospital-acquired infections among both patients and staff.

Hospital-acquired infection is defined by WHO as the disease of microbial origin of a patient during his stay in hospital or after discharge, or any infectious disease of a hospital employee that has developed as a result of his work in this institution regardless of the time of onset of symptoms.

Every day, performing his professional duties, a dentist contacts with the biological fluids of patient, uses tools and medical equipment. The use of turbine, ultrasonic handpieces promotes formation of aerosols containing microorganisms, drops of saliva, blood, pus. In this regard, not only patients, but also the medical staff themselves can be infected during the dental treatment.

The main ways of infection during dental treatment:

– potentially infected bodily fluids (blood, saliva, nasal discharge);
– infected instruments, dentures;
– aerosols (small, airborne particles);
– suction devices (aspiration systems, hoses);
– water supply system;
– transmission instruments (turbine and mechanical dental handpieces).

In order to prevent the spread of infection from patient to patient or from patient to doctor, medical staff should strictly adhere to the rules of aseptic and antiseptic in their work. According to the American Dental Association (ADA), in case of violation of the sanitary and anti-epidemic regime medical staff of den-

Table 2.1. *The main infectious diseases that are important during dental treatment (Kolmakov S., 1999)*

Disease, virus	**Source of infection**	**Incubation**	**Danger of infection**
Hepatitis B (HBV)	Blood, saliva, other secretions	2—6 months	The carrier of infection is always danger- ous in terms of the spread of infection (the source of infection is HBsAg-positive carrier)
Hepatitis C (HCV)	Blood, discharge	2—20 weeks	If positive indicators of antibodies are present
Hepatitis D (HDV)	Blood	2—20 weeks	All stages (HDV is transmitted only when the percipient is a carrier of HBV infec- tion, or
AIDS (HIV)	Blood, plasma, saliva, sperm, genital secretions, pleural and	3 months – 5 years	All stages
Herpes simplex virus I (HSVτι)	Saliva, contact way	2—12 days	1 day before the appearance of vesi- cles and until the healing stage. Acute stomatitis – for several weeks after
Epstein-Barr virus	Saliva, contact way	4–6 weeks	Laryngeal secretions are contagious for one year
Cytomegalovirus	Saliva, contact way,	2—20 weeks	For a few months or years
Tuberculosis	Saliva	4—12 weeks	It spreads from patients by airborne droplets (coughing, sneezing, talking) and dust (dried droplets of sputum turn into infected dust,
Flu	Saliva, discharge from the	1—3 days	10—21 days of the disease
Staphylococcal	Saliva, exudate	4—10 days	Possible transmission if there are clinical
Herpangina	Saliva	4–10 days	The highest level of infection is during the first 4–7

tal clinics are exposed to the risk of infections, which can lead to the following consequences:

– AIDS – lethal outcome;
– candidiasis – systemic organ damage;

- chickenpox – shingles (possibly);
- tuberculosis – disability, possible death;
- gonorrhea – infertility, arthritis;
- hepatitis A – virus carrying;
- hepatitis B – virus carrying, possible death;
- herpetic conjunctivitis – virus carrying, possible blindness;
- herpetic whitlow – virus carrying;
- infectious mononucleosis – virus carrying;
- flu – virus carrying;
- measles – disability, possible encephalitis;
- rubella – fetal congenital anomalies of pregnant women;
- diphtheria – virus carrying, in severe cases, a fatal outcome is possible;
- mumps – virus carrying;
- pneumonia – in severe cases, possible death;
- staphylococcal infection – skin lesions, in severe cases, can be fatal;
- streptococcal infection– rheumatoid lesions of the heart, joints, in severe cases, a fatal outcome is possible;
- syphilis – a defeat of the central nervous system, in case of untimely assis- tance, a fatal outcome is possible;
- tetanus – often disability, possible death;
- respiratory infections – temporary disability, virus carrying.

In daily work, a dentist and other medical staff should adhere to the following rules:

- use an individual sterile kit of dental instruments for the treatment of each patient;
- medical staff should avoid contact of skin and mucous membranes with saliva, blood and other biological fluids of patient, therefore it is necessary to work in medical overalls, to use individual means of skin protection (rubber gloves), eyes (glasses, shields) and respiratory organs (masks);
- during the treatment of patient, avoid contacts that contribute to microbial contamination and spread of infection (do not keep records, do not talk on the phone, etc.);
- all injuries on the hands should be covered with adhesive plaster.

Sanitary-hygienic and disinfection-sterilization regime of dental institutions is regulated in State sanitary norms and rules, special instructions and orders. The responsibility for compliance with the requirements of sanitary and hygienic regime is imposed on a heads of departments (offices) of medical institutions.

The control over the implementation of sanitary rules is carried out by relevant health authorities and the state sanitary service.

Disinfection and sterilization of dental instruments and equipment

Depending on the required level of sterilization, there are critical, semi-critical and non-critical medical items.

Critical medical items penetrate into sterile tissues, cavities, vascular system (injection needles), touch damaged skin and mucous membranes (surgical instru- ments, probes, burs, endodontic instruments, inhalation equipment, dental mir- rors, spatulas). They should be definitely sterilized.

Semi-critical medical items contact with mucous membranes of non-sterile cavities in the process of operation. They are subject to high-level disinfection and sterilization, if permitted by the instructions.

Non-critical medical items come into contact with intact skin and do not come into contact with mucous membranes of the patient (top of chairs, handles of operating lamps, control buttons, floor, walls). They are subject to medium / low level disinfection.

Most dental instruments are critical items and therefore require all stages of treatment – disinfection, pre-sterilization cleaning and sterilization (table 2.2).

Disinfection – measures aimed at the destruction of pathogenic and opportu- nistic microorganisms (viruses, bacteria and fungi) in the environment, includ- ing objects and instruments for medical purposes. After the end of patient's treat- ment, all used instruments (including disposable), dressings and other medical items are subject to disinfection. After disinfection, some of them can be used again, and the rest are subject to further processing – pre-sterilization cleaning and sterilization. The items or medical instruments are not intended for re-use (disposable), after disinfection they are subject to culling (disposal).

Table 2.2. *Sterilization and levels of disinfection along with their effect, methods and uses*

Method	Effect	Measures	Used for
Sterilization	Destroys all microorganisms including spores	Moist Heat, Dry heat, ETOX, glutaraldehyde, H_2O_2, glutar-	For critical and semicritical items
High-level	Destroys all microorganisms but	Glutaraldehyde, hydrogen	Semicritical items
Inter- mediate-	Destroys most of bacteria, in- activate Mycobacterium bovis but	Chlorine containing prod- ucts, iodoform, guarternary	Non-critical surfaces
Low-level disinfection	Destroys vegetative bac- terias. Does not inactivate	Iodoform, guarternary ammonium compounds,	Non-critical surfaces

There are three main methods of disinfection of medical (dental) instruments: chemical, thermal and ultraviolet irradiation (table 2.3).

Table 2.3. Methods and means of disinfection of medical items

Disinfection methods	*Disinfectants*
Chemical	Alcohols; halogen-containing compounds; quaternary ammonium compounds;
Thermal (physical)	Boiling; air (t 120 °C, 45 min.); steam under pressure P 0.05 MPa at t 110 °C 20 min
Ultraviolet irradiation	Ultraviolet rays

The disinfection by physical methods has a number of disadvantages: boiling leads to corrosion of the metal, sharp surfaces quickly get blunted, mirrors fade. In the air sterilizer, only clean instruments that are not contaminated with protein and fat inclusions can be disinfected. Using chemicals to disinfect can cause allergic reactions of medical staff and development of resistance of microorganisms. Ultraviolet irradiators (Fig. 2.1), as a rule, are used for storage of sterilized medical items. Among physical methods of disinfection, autoclaving is the best.

Large number of chemicals are used for disinfection. In the form of release they can be liquid, tableted, powdered, granular. They are produced in a ready-to-use form or as a concentrate. The chemical composition of disinfectants can be: chlorinated, based on active oxygen, based on alcohols, aldehydes, cationic surfactants, guanidine derivatives, etc.

Chlorine-containing agents have a wide range of antimicrobial action, relative- ly short exposure, compatible with soap, cheap. However, they due to the high corrosion activity are used for disinfection of only corrosion-resistant coatings and items. In addition, chlorine-containing agents discolor and spoil tissues, irritate the mucous membranes of respiratory and visual organs. Therefore, when working with

solutions of high concentration, it is necessary to use individual means of

Fig. 2.1. *Ultraviolet irradiator*

protection. Improper disposal of drugs of this group has an adverse impact on the environment, does not meet modern requirements of ecological safety.

Disinfectants based on hydrogen peroxide are the most environmentally friend- ly because they break down into oxygen and water. The broad spectrum of activity makes it possible to use some agents of this group not only for disinfection, but also for sterilization. They are low-toxic, without peculiar smell, can be used in the presence of people. New agents of this group are also used for pre-sterilization cleaning, since the corresponding components have been added to the formula, they have cleaning properties.

Quaternary ammonium compounds (QAC) are now widely used. They have cleaning properties, so they are used for pre-sterilization cleaning of medical products, as well as a combination of cleaning and disinfection. The agents of this group do not damage instruments and equipment, are low-toxic, do not have an irritating effect, without sharp odors, so they are used for disinfection in places of constant presence of staff and patients. The disadvantage of QAC may be the emergence of the strains of microorganisms resistant to their action.

Agents on the basis of tertiary amines, as well as QAC, have good cleaning properties, do not damage surfaces, are low-toxic. High anti-microbial activity allows them to be widely used. Currently, these agents are used in all countries of the world.

Alcohol-containing agents based on ethanol, propanol and isopropanol are used primarily as skin antiseptics. In addition, they are used in combination with QAC and aldehydes in the form of aerosols for treatment of small hard-to-reach surfaces. Products containing alcohols, fix organic contamination, so it is nec-essary to pre-cleaning of instruments from blood, mucus, pus or it is advisable to use a combination of alcohol-containing products with components that have cleaning properties. Ethyl alcohol is recommended to disinfect metal products. The disadvantage of these agents is fire and explosion hazard.

Aldehyde-containing agents based on glutaric dialdehyde, succinaldehyde, or- thophthalic aldehyde have a number of advantages: they act on all types of mi- croorganisms, including spores, do not damage the product. However, their high toxicity does not allow the use of these products in the presence of patients, and the ability to fix organic contamination requires careful pre-cleaning of contam- inated products.

Guanidines are a group of modern disinfectants with low toxicity, high stabil- ity and gentle action on objects. Agents containing guanidines have a so-called residual effect, that is, they form a bactericidal film on the surface. Due to low toxicity level, these agents are used for hand disinfection. Disadvantages of guan- idines: solutions fix organic contamination, an adhesive film is formed, it is diffi- cult to remove it from surfaces.

Modern disinfectants are multi-component agents. They include solvents, corrosion inhibitors, thickeners, antioxidants, dyes, aromatic and other substances.

Chemical disinfection method is the most common. In the process of disinfection using any disinfectant, it is necessary to take into account the following points:

– washing out dental instruments under running water prior to disinfection is not allowed, as the aerosol generated during washing process can infect the persons who perform the treatment;
– methods of preparation of solutions, modes and conditions of use, terms of exposure are set out in the guidelines and instructions for use of a particular disinfectant;
– be sure to wash out the instruments with running water after disinfection.

The algorithm of disinfection of dental instruments by chemical method provides a number of consecutive stages:

– decontamination, or pre-disinfection, by soaking in a disinfectant solution;
– cleaning (pre-sterilization cleaning);
– final disinfection.

Decontamination, or pre-disinfection, is used with a purpose to reduce the number of microorganisms on used instruments, to clean instruments from organic residues, prevent the risk of infection of staff during further cleaning of tools and prevent infection of the environment. The closed vessel (tank) for decontamination should be located in the dental office (Fig. 2.2). Immediately after use trays with medical instruments are completely immersed in the tank with disinfecting solution, following the soaking time according to the manufacturer's instructions. Disinfectant solutions are used only once. Cleaning (pre-sterilization cleaning) is carried out after preliminary disinfection in order to remove protein, fat and other contaminants, as well as residues of drugs. It is carried out manually or in a mechanized way (washing machines, ultrasonic baths), using such agents as "Biolot", " Biodez», "Bodefen", "Dezak- tin", "Septusin" with the addition of 33 % perhydrol.

A nurse should wear thick protective rubber gloves to clean medical (dental) instruments.

The manual cleaning process includes the following options:

1) washing each item in a washing solution with a brush or cot-

Fig. 2.2. *Tank for disinfection*

ton-gauze swab, cloth for 0.5–1 min (follow the temperature regime, if for a particular instrument it is provided in the guidelines);

2) washing out with running water is carried out in containers (baths, sinks) for the time provided by the instructions to disinfectant (from 0.5 to 10 minutes). The washbasin for washing out the instruments should not be used for washing hands of staff;
3) washing out with distilled water is carried out for 30 seconds;
4) hot air drying (85 °C): in the air sterilizer with an open vent until the complete disappearance of moisture; in the drying cabinet – with the doors loosely closed.

Improvement of the process of pre-sterilization cleaning is possible with help of units, the cleaning process in which is carried out by treating products with detergents or detergents-disinfectants in combination with ultrasound (Fig. 2.3). With the help of pre-sterilization treatment with ultrasound, complete cleaning of burs, endodontic and other instruments from remains of dentin, blood, oral fluid, filling masses is achieved, which is impossible to achieve with manual wash- ing with brushes even after prolonged soaking in the cleaning solution.

The principle of operation of ultrasonic washing is that the ultrasonic wave is generated through disinfecting solution located inside the container. The operation of ultrasonic wave contributes to the increase of dielectric pressure, resulting in the formation of numerous micro-vacuum bubbles, providing the effect of cavitation. The force of the explosion of these micro-bubbles completely removes dirt from instruments of any size and shape, even in narrow and hard-to-reach places.

Use of ultrasound washing for pre-sterilization cleaning makes it possible to avoid tactile contact of medical staff with treated instrument, which guarantees reduction of the risk of infection and spread of hospital-acquired infections; to prevent damage of expensive medical instruments and products, increasing their service life; to significantly improve the quality of cleaning of medical instruments and products of complex configuration; to significantly reduce the processing time in case of a large volume of instruments and products.

Fig. 2.3. Ultrasonic washing

Final chemical disinfection is used for semi-critical medical instruments. They are immersed in a bath with disinfectant solution of the required concentration and kept in it for the time provided by the instructions. After that, the instruments are washed until the smell of disinfectant solution disappears, dried and folded into containers or boxes. Such instruments are disinfected, but not sterile, because they are in contact with air.

Fig. 2.4. *Agents for disinfection and pre-sterilization cleaning of medical instruments*

The emergence of new disinfectants for the treatment of medical instruments allows you to combine pre-disinfection (decontamination) with pre-sterilization cleaning, conducting them simultaneously. For example, the use of such means as "Bodefen", "Korzolin", "Korzolex Bazik" ("BODE", Germany), "Lysoformin 3000" (Germany), "Trichlorol», "Desoform" ("Lysoform", Germany), "Surfanios" ("Laboratories ANIO", France), etc. (Fig. 2.4) involves pre-soaking (disinfection) and pre-sterilization cleaning of instruments in the same solution.

Quality control of pre-sterilization cleaning is carried out with help of the following tests:

– amidopyrin test (to control of blood residues from instruments);
– phenolphthalein test (control of washing of instruments from alkaline components of synthetic detergents);
– azopirame test (control of washing of instruments from blood residues and alkaline components of detergents).

Multiuse dental instruments in contact with hard tissues of teeth and oral mucosa, binding materials, as well as instruments for injecting drugs are subject to mandatory sterilization.

Sterilization is the set of measures aimed at the destruction of vegetative and spore forms of all pathogenic and non-pathogenic microorganisms.

There are the following methods of sterilization: steam, air, gas, chemical, glass bead. They are used in the appropriate modes, the choice of which depends on characteristics of medical items that have to be sterilized.

The steam method involves the use of saturated steam under high pressure (0.05–0.21 MPa, or 0.5–2.1 kgf/cm^2 (atm)) as a sterilizing agent. Sterilization by steam method is carried out in steam sterilizers (autoclaves) (Fig. 2.5), and the process of sterilization is called autoclaving. Today, this is the most reliable method of sterilization, since water steam under pressure penetrates well into all cavities available in medical instruments, and temperature and humidity denature proteins and hydrolyze bacteria. In dental practice, two modes of autoclaving are used:

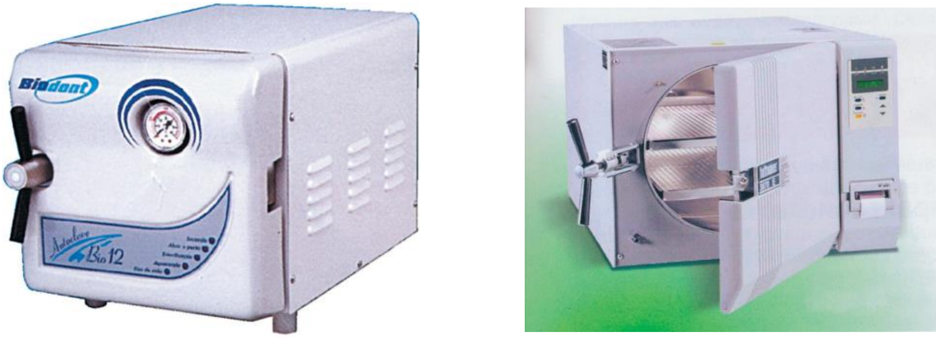


Fig. 2.5. *Steam sterilizers (autoclaves)*

I mode: temperature – 132 ± 20 ^{0}C, pressure – 2.0 kgf/cm^2 (atm), time – 20 min. It is recommended for sterilization of products made of corrosion-resistant metals, glass, textile materials.

II mode: temperature – 120 ± 20 ^{0}C, pressure – 1,1 kgf/cm^2 (atm), time – 45 min. It is used for sterilization of products made of rubber, latex and separate polymeric materials.

The air method involves use of dry hot air as a sterilizing agent. Sterilization by air (dry-heat) method is carried out in air sterilizers (dry-heat sterilizers) (Fig. 2.6). It is used for sterilization of metal, glass, silicone rubber products.

The modes of steam sterilization method:

I mode: 180 ^{0}C (+20^0–10^0) for 60 (+5) min

II mode: 160 ^{0}C (+20^0–10^0) for 150 min

The gas method is used for medical products that are not subject to sterilization under the influence of high temperature. For this purpose, gas mixtures are used in various sterilization modes.

I mode: ethylene oxide and a mixture of ethylene oxide and methyl bromide at a proportion of 1 : 25 at a temperature of 18 ^{0}C, 35 ^{0}C, 42 ^{0}C and 52 ^{0}C.

II mode: vapors of aqueous formaldehyde solution at a temperature of 70 ^{0}C, formaldehyde vapors in ethyl alcohol at a temperature of 42 ^{0}C, 45 ^{0}C, 60 ^{0}C and 80 ^{0}C.

Fig. 2.6. *Dry heat sterilizers*

Gas sterilization method requires a separate room and personnel, so it is rarely used.

Thus, the steam sterilization method has an advantage over other methods (table 2.4). The short

Table 2.4. *Comparative characteristics of the main sterilization methods*

Methods	Advantages	Disadvantages
Steam	A short full cycle, the possibility of ster- ilization of heat-sensitive products, the use of different	High cost of equipment
Air	Low cost of equipment	A long cycle, danger of damage by high tem- peratures, limited use, operation by one control parameter –
Gas	Possibility of use for medical products that are not subject to sterilization at high temperature	The need for separate accommodation and staff

cycle and low temperatures allow this method to be used for sterilization of almost all instruments and medical supplies.

Development of steam and air sterilizers of new generation presupposes the introduction of devices that differ from the models produced earlier, by an automatic control method, possibility of blocking the process, presence of means of light and digital indication, as well as sound signaling.

Sterilization of medical products in steam and air sterilizers is carried out, as a rule, when the instruments are packed in special packaging

Chemical sterilization method (or cold sterilization) is used for products that do not withstand high-temperature sterilization regimes. The sterilizing agent is solution of chemical agent with strong disinfectant effect: 6 % solution of hydrogen peroxide, 8 % solution of "Lysoformin 3000", "Saidex", etc. Cold sterilization technique presupposes complete immersion of the products in the disinfectant solution (in a closed vessel) in a certain mode (according to the instructions of the manufacturer of the disinfectant):

– hydrogen peroxide (6 %) – at temperature of 18 ^{0}C with an exposure of 360 min, at temperature of 50 ^{0}C with an exposure of 180 min;
– dezoxone–1 (1 % solution) – at temperature not less than 18 ^{0}C with an exposure of 45 min;
– glutaric dialdehyde – at temperature of not less than 20 ^{0}C with an exposure of 360 min.

After sterilization, the product is removed from the solution with sterile forceps and consistently washed in three sterile vessels with sterile distilled water (if hydrogen peroxide is used – in two sterile vessels). Products are stored in sterile closed containers for no more than 3 days, and laid out on a sterile table – for no more than 6 hours.

Glass bead method provides the sterilization of medical instruments by heat treatment in a special glass bead sterilizer (Fig. 2.7). It contains a metal cup with filler (2 mm diameter glass balls, which are heated by electric heating element). Heat transfer to sterilizing instruments occurs through the filler. In dental practice, this method can be used for flash sterilization of small products: burs, endodontic instruments, metal matrices, metal intracanal pins. The time of sterilization is 20 s, sterilization temperature is 190–250 ^{0}C. If the working parts of dental instrument (probes, carvers, excavators, forceps, etc.) are sterilized, the sterilization time is 3 minutes.

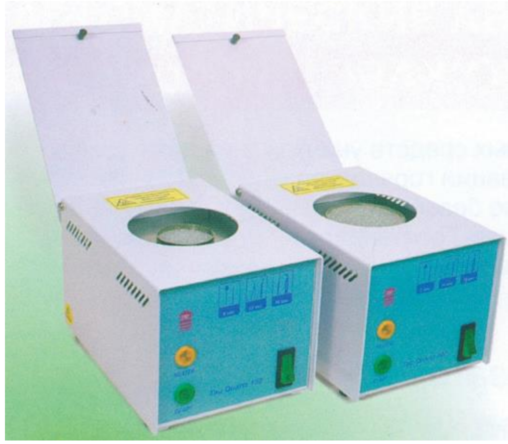


Fig. 2.7. *A glass bead sterilizers*

Disinfection and sterilization of certain types of dental instruments

New dental instruments are pre-sterilized and sterilized before use after oil removal. Small dental tools (root needles, pulp extractors, canal fillers) are used once after preliminary cleaning and sterilization. Paper-based separating discs are also used once.

Burs and small endodontic instruments are immersed for disinfection and degreasing in the solution consisting of equal parts of 3 % hydrogen peroxide solution and 10 % ammonia solution immediately after use. Then they are washed in running water, washed with a brush in the solution of detergent, again washed with running water, rinsed with distilled water, dried in the dry heat sterilizer and sterilized by one of the above-mentioned methods.

If there are modern disinfectants, allowing to unite the processes of disinfection and pre-sterilization cleaning ("Korsolex bask" (BODE, Germany), "Desonex dental BB" (Borrer Chemie, Switzerland), ID 212 forte, ID 220 (Durr dental, Germany), etc.), small instruments are immersed in such an agent for the time specified in the instructions (an average of 30 minutes), then pre-sterilization cleaning is carried out mechanically or with help of ultrasonic devices. Then instruments are washed in running and distilled water, dried in a dry heat sterilizer at a temperature of 85 ^{0}C, and then sterilized.

Sterilization of burs and endodontic instruments is usually carried out by the dry heating method in an open container (Petri dish). Dish is covered with a sterile cap immediately after sterilization. Instruments made of corrosion-resistant materials can be chemically sterilized.

Dental instruments (probes, forceps, carvers, pluggers, handles of dental mirrors, etc.) are disinfected after use by immersion in a disinfectant solution for the time recommended by the manufacturer. Then pre-sterilization treatment is carried out in the following sequence:

– pre-rinse with running water to remove disinfectant solution from the surface;
– hand washing with detergent solutions at 50 ^{0}C for 15 minutes.

For pre-disinfection and pre-sterilization cleaning, disinfectants combining these steps into one process can be used.

After that, the following manipulations are carried out:

– rinsing with warm running water for 10 minutes.;
– rinsing with distilled water;
– drying with hot air in a dry heat sterilizer at a temperature of 85 ^{0}C. Then instruments are sterilized in an autoclave or in a dry heat sterilizer.

Dental mirrors are disinfected after use and pre-sterilized by the same means as other stomatological instruments. Sterilization of dental mirrors by high-temperature methods causes damage of their mirror surface, therefore they are more often sterilized by chemical (cold) method. At the end of exposure, mirrors are rinsed with distilled water, wiped with a sterile cloth and stored in a dry sterile tray.

The sterile dental instruments are stored on a sterile table, or in hermetically sealed sterile bags, or in special ultraviolet chambers for sterile instruments (Fig. 2.8). It should be emphasized that these chambers are not intended for sterilization, but only for storage of sterilized instruments.

The sterile table is laid for one working shift (6 h) with a mark of the date and time of laying. All manipulations related to the preparation of a sterile table are

Fig. 2.8. Ultraviolet chambers for storage of sterile instruments

carried out in sterile gloves, a sterile robe and mask. The nurse must take items from a sterile table with forceps or dressing forceps. Forceps, dressing forceps for taking sterile material must be stored dry on a sterile tray between the layers of sterile diapers, their replacement is carried out every 1.5 hours. You must have sterile packing with 3–4 forceps (or dressing forceps) to replace.

Dental handpieces should be disinfected after each patient. The method of disinfection of dental handpieces is as follows:

- cleaning: carefully wipe the outer surface and drill hole with a swab moist- ened with water or detergent to remove dirt;
- disinfection: double wiping of external surfaces and drill holes with sterile gauze swab moistened with disinfectant solution (“Bacillol-AF” (BODE, Germany), “ Aerodezin 2000», “Surfanios” (“Laboratories ANIO”, France), etc.) with an interval of 15 minutes followed by exposure according to the instructions for disinfectant.

High speed handpieces are treated as follows:

- a water jet is connected to the handpiece, connected to the compressed air system, for 30 seconds, thus cleaning it from inside;
- twice (with an interval of 15 min) the handpiece is treated with a disinfectant or wiping with a sterile cloth, moistened in one of the above disinfectant solutions;
- it is wiped with sterile distilled water and stored on the table for no more than 6 hours.

Sterilization of handpieces, if the manufacturer’s instructions allow, is desirable to carry out in an autoclave. Currently, there are special autoclaves for sterilization of dental handpieces (Fig. 2.9).

Fig. 2.9. *Autoclave for sterilization of dental handpieces*

Cartridge syringes, handpieces to saliva ejectors are subject to disinfec- tion, pre-sterilization treatment and sterilization in case of repeated use: metal items – by air or steam method, plastic items – by a chemical method.

Disinfection of surfaces in the dental office is an extremely important link in prevention of hospital-acquired infection. When working with high speed handpiece (turbines), burs and ultrasonic devices, aerosols are formed in the dentist's office, consisting of tiny drops of oil, pus, blood, saliva, microorganisms. Aerosols are in the breathing zone of a doctor and patient for up to 30 minutes and can be spread over a distance of up to two meters. Thus, treatment of surfaces of the dental office should be aimed at reducing bacterial contamination of all surfaces, including equipment, door han- dles and taps. For disinfection of surfaces such disinfectants are used: "FD 312", "FD 322", "FD 333" (Durr Dental, Germany), "Deconex 50 FF", "Deconex 51 DR" (Borrer Chemie, Switzerland), "Delansin", "Amilain" (CJSC "Petrospirt", Russia), "Mikrobac forte" (BODE, Germany), etc.

In dental offices there are 3 zones with different requirements to the levels of hygiene:

1 – the first one – treatment area where high level of hygiene must be observed. The following principles must be adhered to in this zone: sterility (all dental instruments); expendability (one-time instruments), individuality (gloves);

2 – the second one – boundary of the treatment area, including surface of manipulation table, armrests, dental unit, chip blower, individual cups. Treatment and disinfection of surfaces of these objects are carried out after reception of each patient, at the end of shift and considering extent of contamination;

3 – the third one – furniture, equipment, door handles, taps and sinks, germicidal lamps, lamps, floors. In this area, the current cleaning is carried out every day – but not less than 2 times with use of disinfectants.

The main problem of disinfection of surfaces in dental cabinets is a complete treatment of surfaces of the boundary of the treatment zone (the surface of manipulation table, armrests, dental equipment, etc.). Disinfection should be carried out here after the reception of each patient. Treatment of these surfaces can be carried out in the presence of patient, so the disinfectant should not have a sharp smell.

Bactericidal irradiators are used to disinfect air and surfaces in the dental office (Fig. 2.10).

Bactericidal irradiator (BI) is an electrical device consisting of bactericidal lamp, reflector, starting, and control device and other auxiliary elements, as well as devices for its attachment.

Bactericidal irradiators are classified according to:

– location: ceiling, wall, mobile;
– construction: open type, closed type (recirculators), combined type (open and shielded);

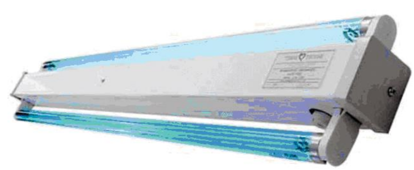


Fig. 2.10. Bactericidal irradiator

– purpose: for disinfection of air and premises in the absence of people (BI of open type and combined type), for disinfection both in the presence of people and in their absence (BI of closed type).

Open-type irradiators are designed for disinfection of premises with bactericidal flow of ultraviolet rays. In open irradiators mounted on a ceiling or wall, the direct bactericidal flow from lamps and reflector (or without it) covers a wide area in space, so they should only be switched on in the absence of people in room. During the irradiation session a sign should be posted on the front door of the office: “Do not enter! There is an ultraviolet irradiation!”.

The work of irradiators of closed type (recirculators) is based on pumping of air through the chamber in which there is irradiation by ultraviolet rays. The bactericidal flow from lamps is distributed in a limited small enclosed space and has no way out. Disinfection of air is carried out in the process of its pumping through the ventilation holes of recirculator. These irradiators are designed to disinfect air in the room during the stay of people there.

In open combined irradiators, the bactericidal flow from lamps can be directed to the upper or lower zone by a shield that rotates. During the operation of such an irradiator, it is possible to stay in the irradiated room for a short time.

Treatment of hands of medical staff. Means, technique

In dentistry significant role in the transmission of a variety of microorganisms belongs to the hands. There are three levels of treatment of the hands of medical staff: regular washing (sanitary treatment), hygienic and surgical treatment.

Regular hand washing ensures the removal of dirt and transient microflora that appeared on skin of the hands of medical stuff during contact with infected patients and (or) contaminated objects of the environment. It is carried out by thoroughly washing hands with detergent (liquid soap, granules, powder, soap pieces):

– before work;
– before and after physical contact with patient;
– in the case of change of clothes and workplace.

It is necessary to wash hands twice because in this case, the efficiency is 65–70 % (a one-time – only 40 %). It is the best to use liquid soap in disposable dispensers. When using soap in pieces, it is necessary that the soap dish ensures soap dries before subsequent use.

The normal sequence of a usual treatment of hands:

– check the skin integrity;
– remove rings and other jewelry (rings and nail polish, which is cracked,

that interfere with the removal of microorganisms; medical staff should refuse to wear rings. Nails should be cut short (no more than 1 mm can protrude beyond the pads of fingers) and they should not be painted with nail polish);
- hands should be well lathered, rubbed at each other for at least 10 seconds under moderate pressure of comfortably warm water (20 ^{0}C), then rinsed. Repeat twice;
- dry hands with individually clean (in surgical offices – sterile) napkin, after washing close the tap with it. Do not use a shared towel. Napkin (or towel) must be of clean or disposable (paper) fabric.

Fig. 2.11. *Means for antiseptic treatment of hands*

Hygienic (antiseptic) treatment of hands involves the removal or destruction of transient microflora, located on the skin of hands. Antiseptic treatment should be carried out before starting work with patient, at the end of work and in all cases associated with contamination.

Use skin antiseptics in the form of a special liquid bactericidal soap; alcoholic solutions of skin antiseptics; water bactericidal agents. To prevent the violation of integrity and maintain the elasticity of skin, softening agents (1% glycerin, lano- lin) are added to the composition of antiseptic agent.

A convenient form of these antiseptics is gel (“Delasept-gel” (CJSC “Petro- spirt», Russia), “Izisept-gel” (LLC “Pharmos”, Russia), “Sterillium gel” (BODE, Germany) (Fig. 2.11). Such products are quickly absorbed into skin and give it softness, elasticity, without causing dryness. Sequence of antiseptic (hygienic) treatment of hands (Fig. 2.12). Antiseptic (3−5 ml) is poured into recess of the palm of dry hands and vigorously rubbed for 30−60 sec. into skin of the hands to joints of the hands in such a sequence:

- palm to palm (Fig. 2.12, *a*);
- right palm is located on the back of left hand, and then the left palm is on the back of right hand; the bent fingers of one hand go between the opened fingers of other hand (Fig. 2.12, *b*, *c*);

– the inner surface of bent fingers of right palm is located on the inner sur-

face of bent fingers of left palm (Fig. 2.12, *d*);
- circular rubbing of the right thumb in closed palm of left hand, and then the left thumb of right hand (Fig. 2.12, *e*);
- circular rubbing with closed tips of the fingers of right hand on the in- ner surface of left hand, and then the inner sur- face of right palm (Fig. 2.12, *f*).

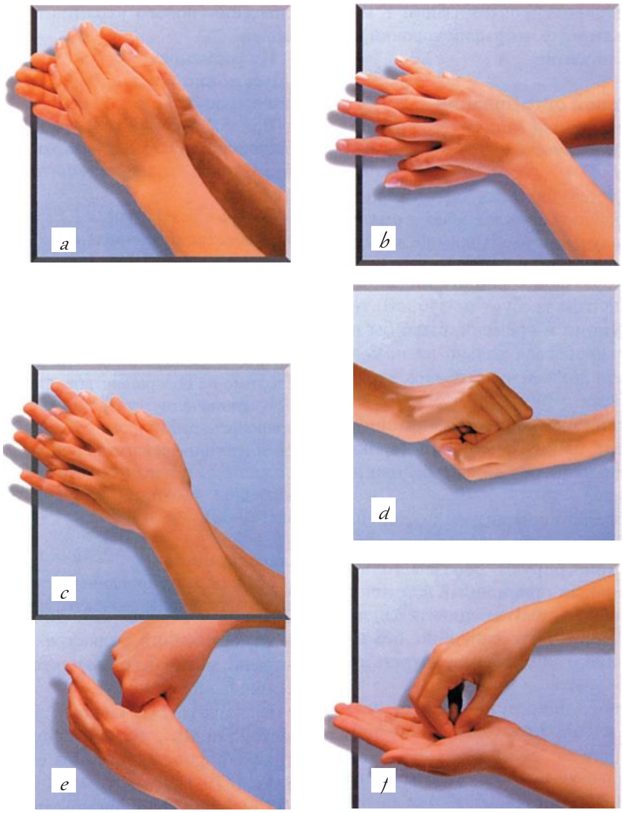


Fig. 2.12. *Technique of antiseptic treatment of hands*

Surgical treatment of hands is aimed to remove or destroy the transient micro- flora and reduce amount of resistant microflora on the skin of the hands, it provides a high level of purity. It is car- ried out before surgery, using only alcohol-containing anti- septics ("Sterillium"(BODE, Germany), "Yodobak"(BODE, Germany), etc.).

The technique of surgical treatment of hands:
- put on a surgical suit.
- wash hands with soap, preferably liquid. Use antiseptic soap at this stage is not necessary. It is recommended to use sanitary-technical devices and dispensers of soap and antiseptics with elbow control. Brushes are not rec- ommended. If necessary, sterile soft disposable brushes or those that can withstand autoclaving should be used. Use of brushes is necessary only for the treatment of nails and adjacent skin areas. Brushes are used during the shift only for the first treatment of hands.
- after washing, hands should be thoroughly dried with sterile wipes (before the treatment with antiseptic, the skin should be completely dry, because rubbing antiseptic into the moistened skin reduces its concentration, and such treatment will not give the desired effect).
- carefully treat hands with an antiseptic for the skin. During the time of

treatment, the areas of skin that are treated must remain moistened with antiseptic to ensure the process of destruction of microorganisms is continuous. To do this, antiseptic must be put on your hands in portions. The treatment is completed after use of the required amount (6 ml) of product and complete drying of skin.
– put sterile gloves on dry hands (if gloves are put on moistened hands, the layer of moisture that remains under the gloves contributes to growth of microorganisms).

Rules of emergency assistance in case of threat of infection of medical staff

Each dental office should have a first aid kit designed for use in case of a threat of infection of the doctor or other medical staff as a result of contact with the skin or eyes of saliva or blood of the patient, as well as in case of skin damage. In the first-aid kit there should be 20 % aqveous solution of chlorhexidine bigluconate, 3 % hydrogen peroxyde, sterile dressing material, fingertips, adhesive plaster, scissors.

1. In case of contamination of the skin of hands with saliva or blood, they are thoroughly washed under running water with soap.
2. If there is the violation of integrity of skin o of the doctor hands (an accidental prick, sharp instrument contaminated with blood or biological materials):

– take off the gloves with working surface inside;
– wash damaged area with soap and water (the injured surface is kept under running water for a few minutes or until bleeding stops, do not squeeze or rub the injury site);
– In the absence of running water, damaged area is treated with a disinfectant gel or hand wash solution.
– put a plaster on the wound, put on a fingertip;
– if necessary, continue to work with new gloves.

3. If there is bitten with the violation of integrity of skin of doctor hands:

– take off the gloves with working surface inside;
– wash the wound with water;
– remove necrotic tissue;
– to treat the wound with a disinfectant (20 % aqueous solution of chlorhexidine bigluconate, 3 % hydrogen peroxide);
– prescribe antibacterial therapy;
– put a plaster on the wound, put on a fingertip;
– if necessary, continue to work with new gloves.

4. In case of contact with the patient's biological material on mucous membranes:
– of mouth – spit them out, rinse oral cavity several times with water or normal saline (the use of soap or disinfectant solutions is not allowed for rinsing oral cavity);
– of nasal cavity – rinse the nose with water or normal saline;
– of eyes – rinse the eye with water or normal saline (not allowed: rinsing eyes with soap or disinfectant solution; removing contact lenses while rinsing eyes), remove and process contact lenses (after which they are considered safe for further use);
5. Hygienic hand treatment is mandatory after treatment of inflammatory processes in the periodontal tissues, after lancing of abscess and treatment of its cavity, after treatment of infected root canals, after treatment of a patient with the history of hepatitis B, C, or HBsAg carrier.
6. At the end of the reception, hands are treated immediately after removing the gloves.
7. In case if clothing is contaminated, remove clothing.

Algorithm to perform dental procedures. Antiseptic hand treatment

Sequence of actions	Criteria of control of
1. Wash hands with soap and water, preferably liquid. You can use brush for treatment of nails and adjacent skin areas	Sanitary devices and soap dispensers with elbow control were used
2. Dry your hands thoroughly with sterile wipes	Hands are dry
3. Pour an alcohol-containing antiseptic solution (3–5 ml) into the recession of palms	Antiseptic dispensers with
4. Rub the antiseptic for 30–60 seconds into skin of hands from the fingertips to joints of hands in such a sequence: – palm to palm; – right palm is located on the back of left hand, then left palm – on the back of right hand; thus the bent fingers of one palm come between opened fingers of the other palm; – inner surface of the bent fingers of right palm is located on inner surface of the bent fingers of the left palm; – circular rubbing of the right thumb in closed palm of the left hand and then the left thumb with the right hand;	The sequence and duration of the treatment of hands with antiseptic is observed until it dries completely
5. Put sterile gloves on dry hands	Sterile gloves fit your hands

THE HYGIENE SCHEME OF DENTAL OFFICE

Hygienic hand washing and drying

is carried out to clean the hands of staff before antiseptic

1. On wetted hands, apply a portion of the detergent Blanidas Soft with the help of the Lidos wall dispenser.
2. Rub the detergent and rinse hands under running water.

Antiseptic treatment of personnel's hands

is carried out before and after the completion of procedures

1. Put 3 ml of antiseptic on the palm of hands AHD 2000 gel, AHD 2000 Express, Hospisept or wipe with a Hospisept-napkin.
2. Hygienic treatment - 15-30 sec.
3. Surgical treatment - 1-4 min.
4. Do not wipe or dry your hands.
5. Repeat the treatment after working with patient.

Hands skin care

is carried out after completion of work with the patient

1. To eliminate irritations andprevent eczema of the skin, put a restorative emulsion of Mayol-H5-Cream with help of an elbow dispenser Lidos on dry and clean hands.
2. Rub into the skin with light massage movements.

Sterilization of thermolabile stomatological instruments

1. Make a work solution of Lysoformin 3000 of 8% concentration.
2. Immerse the tool into a special container with a work solution of the agent.
3. The exposure time is 60 min.
4. Double wash the instruments with sterile water.

Quick disinfection

is carried out before and after working with the patient (headrests, seats, armrests, push-buttons, thermolabile handpieces, etc.)

1. Evenly put the product Aerodezin, Aerodezin 2000, AHD 2000 Express on the object using a disposable cloth.
2. The exposure time should be maintained in accordance with the methodical instructions.

Hand drying paper

Double-layer paper towel of Z-type Lysoform in the wall dispensary.
100 % cellulose.
Packaging: 200 paper towels.

Disinfection of surfaces

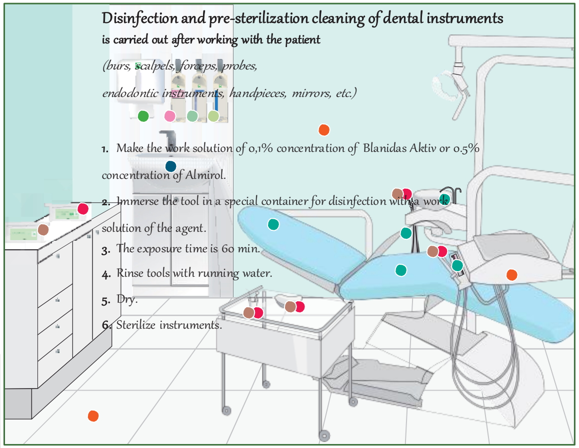
regular cleaning is carried out at least 2 times a day,
general cleaning - 1 time a week (floors, walls, doors, window sills, furniture, appliances, cleaning equipment, sanitary equipment, etc.)

1. Make a work solution of 0.05% concentration of Blanidas Active.
2. Perform disinfection of objects by wiping with help of professional equipment Vermop.

Technology for the disinfection of VMP

Capacity for disinfection, pre-sterilization cleaning and chemical sterilization of VMP.

EDPO capacity, of volume: 1 l, 3 l, 5 l, 10 l.



Disinfection and pre-sterilization cleaning of dental instruments

is carried out after working with the patient

(burs, scalpels, forceps, probes, endodontic instruments, handpieces, mirrors, etc.)

1. Make the work solution of 0,1% concentration of Blanidas Aktiv or 0.5% concentration of Almirol.
2. Immerse the tool in a special container for disinfection with a work solution of the agent.
3. The exposure time is 60 min.
4. Rinse tools with running water.
5. Dry.
6. Sterilize instruments.

Disinfection of medical waste, disposable products, biological waste before disposal

1. Make the work solution of: 0,03 % concentration of Blanidas 300.
2. Immerse the waste materials or products in a special container for disinfection with a work solution of the agent.
3. The exposure time is 120 min.
4. After the end of disinfection materials, disposable products are disposed.

Control questions

1. List medical items according to their criticality.
2. What are the stages of sterilization of dental instruments? Define them.
3. What are the methods of disinfection, their advantages, and disadvantages?
4. List the main chemical compounds included in the composition of disinfectants, characterize them.
5. Describe the sequence of chemical disinfection.
6. Name the methods of pre-sterilization cleaning, characterize them. Describe the technique of pre-sterilization cleaning by hands.
7. What are the methods of sterilization, their advantages and disadvantages?
8. What are the main ways of transmission of infection during dental treatment?
9. Describe the sequence of antiseptic (hygienic) and surgical treatment of doctor's hands.
10. What safety rules should a dentist follow to prevent infection?

Test tasks to the section "Disinfection and sterilization of dental instruments and equipment"

1. **After use of dental instruments, which came into contact with the damaged mucous membrane during treatment, a nurse took appropriate sanitary and epidemiological measures. To which group does the used tools belong according to criticality?**

   A. Critical B. Semi-critical C. Uncritical.

2. **During treatment of patient, a dentist damaged medical gloves and injured the skin of his palm. He removed gloves with the working surface inside, squeezed blood out of the wound, washed his hands with soap under running water and put a plaster on the wound, put a fingertip on, put on new gloves and continued treatment. What mistake did doctor make?**

   A. Washed his hands under running water B. Put plaster on the wound
   C. Squeezed blood out of the wound D. Put fingertip on.

3. **After use of dental instruments, which came into contact with the damaged mucous membrane during treatment, a nurse carried out the appropriate treatment. What measures of sanitary and epidemiological treatment should be taken in this case?**

   A. Mandatory sterilization B. Cleaning only
   C. High level disinfection D. Low level disinfection.

4. **Before treatment of patients, dentist carried out the appropriate treatment of hands in order to remove or destroy transient pathogenic and opportunistic microflora. What is the treatment used to prevent the spread of infection through the hands?**

   A. Regular washing B. Sterilization
   C. Hygienic washing D. Surgical treatment.

5. **After a dentist used the endodontic instruments, a nurse disinfected and made pre-sterilization cleaning of them. What is the purpose of disinfection?**

A. Destruction of opportunistic microorganisms

B. Ddestruction of pathogenic microorganisms

C. Destruction of all types of microorganisms

D. Removal of protein, fat and mechanical contaminations

E. Removal of drug residues.

6. **After use of dental instruments, its disinfection and pre-sterilization cleaning was carried out. Determine the purpose of pre-sterilization cleaning.**

A. Destruction of pathogenic microorganisms

B. Destruction of all types of microorganisms

C. Destruction of opportunistic microorganisms

D. Removal of protein, fat and mechanical contaminations.

7. **At the end of work shift,a nurse disinfected and pre-sterilized the dental instruments and placed them in dry heat sterilizers for sterilization. What is the purpose of sterilization?**

A. Destruction of pathogenic microorganisms

B. Destruction of all types of microorganisms

C. Destruction of opportunistic microorganisms

D. Removal of protein, fat and mechanical contaminations

E. Removal of drug residues.

8. **Before carrying out the surgical manipulation, a dentist performed surgical treatment of hands. What agents are more efficient to use?**

A. Bactericidal soap

B. Aqueous antiseptic solution

C. Alcohol antiseptic solution.

9. **Before sterilization of dental instruments, a nurse carried out quality control of its pre-sterilization cleaning, checking the presence of blood residues and alkaline components of synthetic detergents. What tests should be used for this?**

A. Azopirame test

B. Fuchsin test

C. Lilac test

D. Methylene test

E. Erythrosine test.

10. **In the dental office during treatment of patients with use of turbine handpieces and water-air guns, the infected aerosol suspension was formed. After the end of working shift, a nurse disinfected all surfaces. What agent should be used for this?**

A. Chlorhexidine

B. Eritrozin

C. Korzolex

D. Sterillium

E. Ethyl alcohol

Correct answers to test tasks to the section "Disinfection and sterilization of dental instruments and equipment"

1.	A	2.	C	3.	A	4.	C
5.	B	6.	D	7.	B	8.	C
9.	A	10.	C				

Chapter 3

DEVELOPMENT OF PRIMARY AND PERMANENT TEETH

The development of teeth is closely related to the growth and development of the child. During the period of formation, teeth are influenced by various factors of the external and internal environment, which is reflected both in the rate of their growth, degree of mineralization and timing of eruption.

DEVELOPMENT OF PRIMARY TEETH

The development of primary teeth is subdivided into five periods: 1st – laying and intramandibular development; 2nd – eruption; 3rd – formation of root and periodontium; 4th – stabilization; 5th – root resorption.

During the period of intramandibular development of tooth, there are three successive stages:

1. Formation of the dental plate and dental buds (6–10th week of embryonic development).
2. Formation of dental epithelial organs (10–16th week of embryonic development).
3. Histogenesis of tooth tissues (from the 16th week of embryonic development to the middle of 1st year of life).

The laying of embryonic material from which the teeth develop occurs at 6–8 weeks of fetal development. The stratified squamous epithelium of the oral fossa of embryo thickens, forming the so-called “dental plate”. The epithelium of dental plate gradually grows into the mesenchyme located deeper, forming a dental ridge (Fig. 3.1). Soon, separate areas grow on it in the form of bulbous buds – the buds of primary (deciduous) teeth. Above and below, 10 such buds are formed, which corresponds to the number of future primary teeth. At the 10th week of embryonic development, mesenchyme begins to grow into each epithelial bud, resulting in the formation of a dental epithelial (enamel) organ (Fig. 3.2).

In the dental epithelial organ, internal, external, and intermediate cells are distinguished. The latter forms the pulp of enamel organ. The mesenchyme, growing into dental epithelial organ, forms the dental papilla. Its surface cells adjoin directly to the inner cells of enamel organ. The dense mesenchyme that surrounds enamel organ is called the dental sac. Internal cells adjacent to the dental papilla, and external cells located closer to the bone buds of alveolar processes are distinguished in the dental sac. All these structures are the sources of development of independent cell populations and, accordingly, various dental tissues at the next, third, stage of odontogenesis (Fig. 3.3).

Internal enamel cells are the beginning of formation of ameloblasts *(enameloblasts)* – cells in- volved in the formation of enamel. Flattened outer enamel cells form the peripheral part of the enamel organ. Site of their tran- sition to the internal enamel cells forms epithelial root sheath (Her- twig's epithelial sheath), which is directly involved in the subse- quent formation of teeth roots. The functions of pulp of the enamel organ (stellate reticulum) are diverse. It maintains the shape of tooth germ, providing the nec- essary space for development of a crown. Perhaps it is a transport

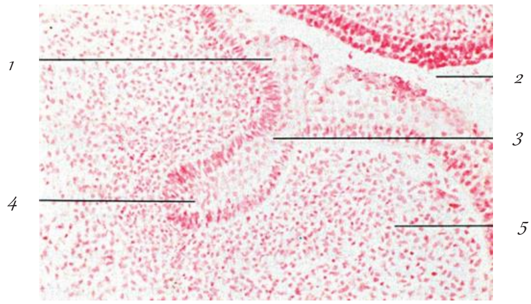


Fig. 3.1. *The bud of a primary tooth (5 week old human embryo): 1 – proliferating epithelium of oral fossa; 2 – oral fossa; 3 – dental plate; 4 – enamel organ; 5 – jaw mesenchyme (Falin L.I., 1957)*

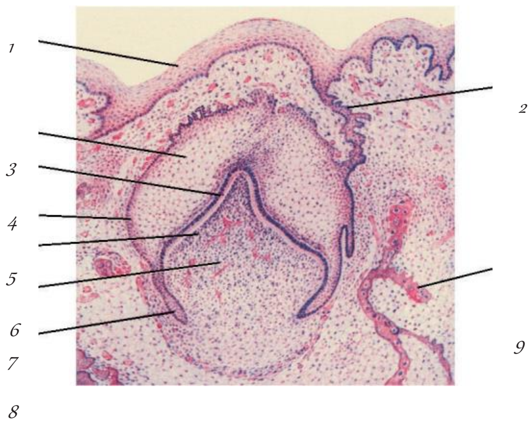


Fig. 3.2. *The rudiment of a primary tooth during the period of differentiation (3.5 month old human embryo): 1 – epithelium of oral cavity; 2 – dental plate;*
3 – pulp of the enamel organ; 4 – internal enamel cells; 5 – outer cells of the enamel organ; 6 – layer of odonto- blasts; 7 – dental papilla; 8 – edge of the enamel organ; 9 – wall of the bone alveoli (Falin L.I., 1957)

route through which substances from the capillaries of dental sac move into the cells of internal enamel epithelium.

In process of growth, the enamel organ is gradually separated from dental plate and at the end of the 3rd month of embryonic development is connected to it using a thin epithelial cord called the neck of enamel organ.

By the 11–12th week of embryonic development, the necks of enamel organs are permeated by mesenchyme and gradually dissolve, as a result of this process the dental germs lose their connection with the dental plate and are separated from it. The dental plate also loses its connection with oral epithelium and gradu-

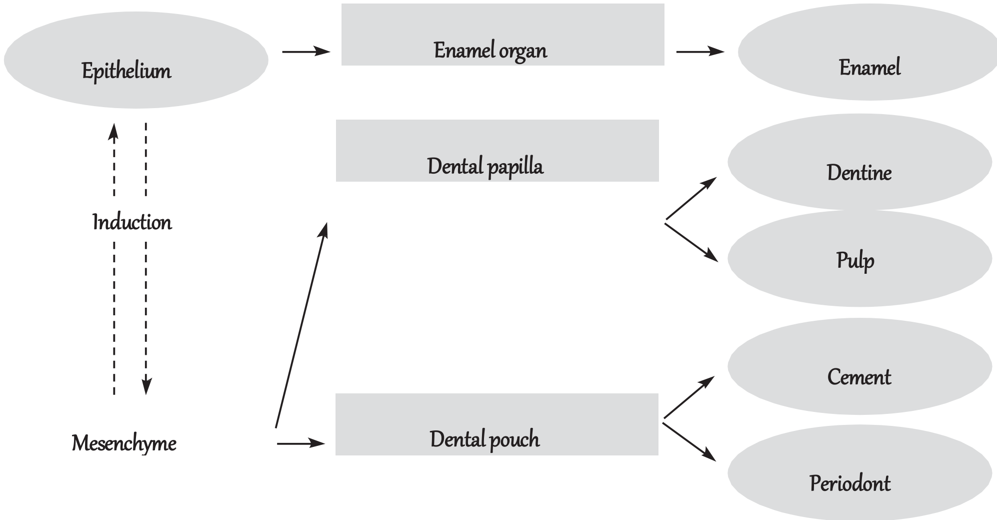


Fig. 3.3. *Development of tooth tissues in embryogenesis (Bykov V.L., 1996)*

ally dissolves. Only its posterior parts and the lower free edge are preserved and grow, which subsequently are the beginning of development of the enamel organs of permanent teeth.

An important point at the stage of differentiation of tooth germs is the bending of inner epithelium of the enamel, which further determines the shape of tooth crown. Therefore, at this stage, the influence of various unfavorable factors contributes to development of defects in the coronal part of a tooth.

The period of histogenesis of dental tissues of primary (deciduous) teeth begins at the end of the 4th month of embryonic development. During this

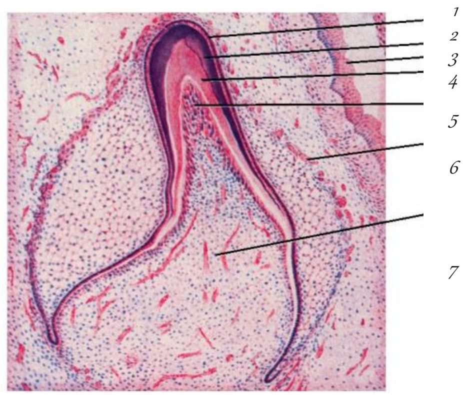


Fig. 3.4. The bud of a primary incisor during histogenesis (5 month old human fetus): 1 – ameloblasts; 2 – enamel; 3 – the epithelium of oral cavity; 4 – dentin; 5 – a layer of odontoblasts; 6 – blood vessels of the dental sac; 7 – dental papilla (Falin L.I., 1957)

period, the most important dental tissues are formed: dentin, enamel, and pulp (Fig. 3.4, 3.5).

The first dental tissue that differentiates during development of a temporary tooth is dentin. **The formation and calcification of dentin (dentinogenesis)** are carried out by specialized cells of the dental papilla – *odontoblasts* (dentinoblasts). These cells are in close morpho-functional connection with the inner enamel cells, which, as evidenced by the results of modern studies, trigger the differen- tiation mechanism of odontoblasts and formation of dentin by them.

Resulting dentin stimulates the differentiation and beginning of the activity of ameloblasts, producing enamel on top of the formed dentin layer.

The process of dentinogenesis oc- curs in two successive stages.

The first stage includes synthe- sis and secretion of collagen and non-collagen components of the in- tercellular substance – components of organic matrix of dentin are formed. In the cytoplasm of odonto- blasts, numerous secretory granules are formed, secreting their contents into extracellular space by exocy- tosis. Odontoblasts synthesize and secrete type I collagen (the main organic component of dentin), glycoproteins, phosphoproteins, proteoglycans, glycosaminoglycans.

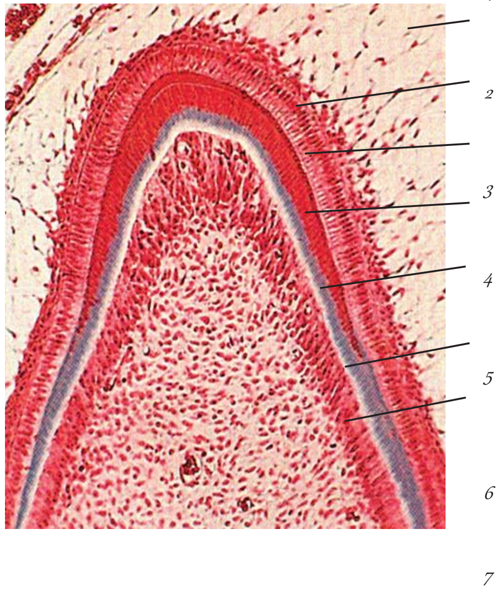


Fig. 3.5. *A fragment of the primordium of a primary incisor during the period of histogenesis of dental tissues (5 month old human fetus):*
1 – connective tissue surrounding the tooth bud;
2 – pulp of the enamel organ; *3* – ameloblasts;
4 – enamel; *5* – dentin; *6* – predentin;
7 – odontoblasts (Falin L.I., 1957)

The products of odontoblasts are the so-called phosphorins – phosphorylated proteins. They control areas and speed of dentin mineralization. Odontoblasts also form calcium-binding proteins, osteocalcin, and osteonectin, which are ob- served not only in dentin but also in bone tissue.

The first collagen fibers are deposited directly into amorphous intercellular substance of dental papilla. These fibers are called predental (Korff fibers) and have a radial direction. As soon as the layer of dentin with predental fibers reaches a thickness of 60–140 µm, it is pushed back to periphery of the crown of a tooth by new layers of dentin, in which fibers are located in the tangential direction – parallel to the surface of dental papilla. These fibers are called Ebner fibers. Subsequently, the predental fibers form mantle dentin, and the Ebner fibers form peri-pulp, which is the main mass of this tooth tissue.

With thickening of the dentin layer, odontoblasts gradually move deeper into the papilla, leaving thin cytoplasmic processes in dentin – the dental processes of odontoblasts (Tomes fibers), located in dental tubules. Dentinoblasts themselves are not included in the dentin formed by them but remain in the outer layers of dental papilla, and formed tooth – in the outer layer of pulp.

In the second stage of dentinogenesis, organic matrix is impregnated with salts of calcium phosphate, tricalcium phosphate, and hydroxyapatite. Dentin calcification of primary (deciduous) teeth begins at 19–20 weeks of intrauterine development. In mantle dentin, vesicles surrounded by a membrane appear, containing calcium-binding lipids and alkaline phosphatase. The first crystals of hydroxyapatite formed in the vesicles rupture their membrane, grow, and are deposited between collagen fibers in the area of the enamel-dentin junction. Calcification of collagen fibers does not normally occur.

Dentin mineralization occurs in such a way that discrete spherical areas (dentin globules) are formed in it, and they are not completely merged. Between them, there may be areas of not mineralized dentin, called interglobular dentin, especially well expressed near the enamel-dentin junction. A layer of highly mineralized dentin, called peritubular, is formed around the processes of odontoblasts.

Calcium salts are deposited in dentin primarily in the area of future incisal edge of a tooth or in the area of masticatory tubercles (cusps). Subsequently, calcification islets increase, merge, and the mineralization process spreads to the lateral surfaces of the crown, neck, and root of a tooth. In the dentin of mature tooth, there is a zone that normally does not undergo calcification. This is the inner part of peri-pulp dentin, directly adjacent to the layer of odontoblasts. Dentinal tubules and Tomes fibers pass through it before they penetrate the calcified dentin. This area is usually seen as a thin pink stripe. The area of non-mineralized dentin is called dentinogenic or predentin and is a place of constant dentin growth that does not stop in the teeth of an adult throughout his life.

The period of activity of dentinoblasts, carrying out dentin mineralization, lasts approximately 300–350 days in temporary teeth and approximately 650–700 days in permanent ones until the tooth acquires its final anatomical shape.

Violation of dentinogenesis is possible both at the first and at the second stage of its development. Such inherited diseases are called imperfect dentinogenesis.

Enamel formation (amelogenesis). Immediately after the onset of dentinogenesis, the process of amelogenesis begins. At the apex of dental papilla, amelo- blasts are differentiated from the inner cells of epithelial dental organ.

Dentin formation precedes the onset of amelogenesis; these processes are closely related and do not occur without each other. The proliferation and release of internal enamel cells stimulate the differentiation of odontoblasts at the apex of papilla; depositing a thin layer of dentin is a prerequisite for the onset of enamel formation.

In the first phase of enamel development, ameloblasts, due to complex transformations, form an enamel prism, which is the main structural element of enamel. This process begins with the formation of a short cytoplasmic process (Tomes process) in the apical section of ameloblast facing dentin.

The synthesis of enamel proteins – amelogenins and enamelins – occurs on the elements of granular endoplasmic reticulum. In the Golgi complex, enamel proteins ripen and form secretory granules that enter the cytoplasmic process. When the length of these processes reaches 20 microns, they begin to calcify and form enamel prisms.

The surface of adjacent dentin becomes uneven, which ensures a tight enamel-dentin connection.

A distinctive feature of enamel in comparison with dentin, cement, and bone tissue is extremely rapid mineralization – during its deposition, there is practically no stage of non-mineralized precursor (pre-enamel).

As the enamel prisms lengthen, the size of ameloblasts decreases, and before the eruption of tooth begins, they are reduced, almost completely turning into prisms.

The growth and development of enamel are carried out from the enamel-dentin junction to periphery of a tooth crown. The enamel surface of erupted tooth is covered with a thin structureless shell (enamel cuticle), is closely connected with the enamel prism membrane, and is a remnant of the outer enamel epithelium. After the eruption of a tooth, it is erased, remaining only on the contact surfaces.

The second phase of enamel development – *maturation* – lasts about 3 months. In enamel, the content of water and organic matter decreases, accumulation and crystallization of mineral salts occur.

Immature enamel formed by secretory ameloblasts, in which the initial mineralization occurs, consists of water (65 %), organic (20 %), and mineral (15 %) substances. Crystals of hydroxyapatite have dimensions of 29 x 3 nm, their density is 1240 per 1 μm^2. This enamel has the consistency of cartilage and is unable to fulfill its function. Enamel maturation is accompanied by the accumulation of mineral substances (up to 96–98 %), the size of hydroxyapatite crystals increases to 140 x 80 nm, and the density of their location decreases to 560 per 1 μm^2. The process of enamel maturation continues for a certain time after eruption of a tooth.

In mature enamel, the percentage of mineral salts is 97–98 %, the percentage of organic substances and water is only 1–2 %. Mature enamel consists of densely packed hydroxyapatite crystals. A high level of mineralization of enamel is observed in its surface layer, and towards the enamel-dentin junction, it decreases.

Proteins produced by ameloblasts play an important role in enamel mineralization. Enamel proteins perform many functions:

1) create primary sites of nucleation (initiation) during the formation of hydroxyapatite crystals;
2) participate in the binding of calcium ions and regulate their transport by

secretory ameloblasts;

3) form an environment that ensures the formation of hydroxyapatite crystals and their dense arrangement in enamel;
4) promote the orientation of growing crystals of hydroxyapatite.

Enamel proteins are not collagenous, which also distinguishes enamel from other calcified tissues of the human body (Bykov V.L., 1996).

The main enamel proteins during the period of its secretion are amelogenins, which make up 90 % of all proteins secreted by ameloblasts. Amelogenins are hy- drophobic proteins high in histidine, glutamine, and proline. They are mobile and are not associated with hydroxyapatite crystals. The second group of enamel pro- teins is enamelins, containing aspartic acid, serine, and glutamine, which bind to hydroxyapatite crystals, participating in the processes of their placement in enam- el prisms. As the enamel matures, a high concentration of proteins in it is retained in the peripheral layer of enamel prisms, which are traditionally called a shell.

Calcification of the enamel of primary (deciduous) teeth begins at 4–5 months of embryonic development of the fetus (Fig. 3.6). At 18–19 weeks (4.5 months) of pregnancy, incisal edge and 1/3 of the incisor crown, incisal edge of the canines, and medial-buccal tubercle of the first primary molars calcify (Vinogradova T.F., 1988).

At the 20th to 25th week of pregnancy (6th month), mineralization of the in- cisors continues, calcification of incisal edge of the canines is almost completed, mineralization of buccal tubercles of the first primary molars is accelerated, areas of calcification of the lingual-medial tubercles arise, mineralization of buccal-me- dial tubercles of the second primary molars begins.

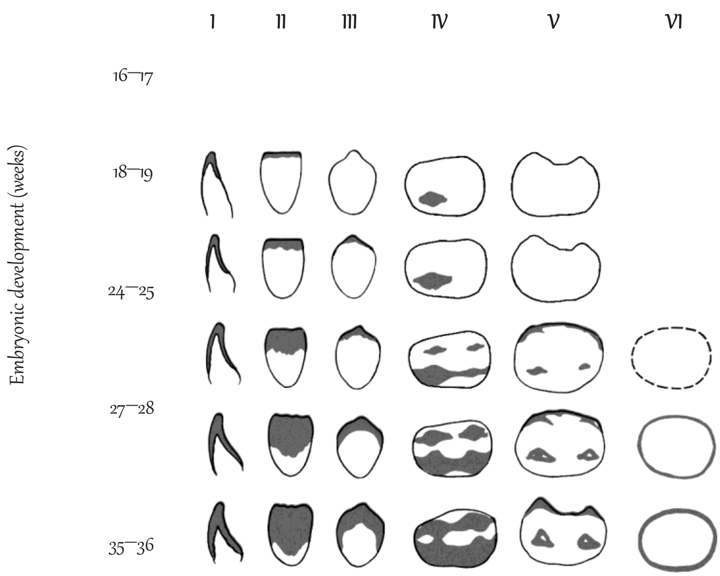


Fig. 3.6. *Schematic representation of the process of intramandibular mineralization of primary (deciduous) teeth (Vinogradova*

T.F., 1988)

At the 26th week (7th month) of pregnancy, mineralization of the primary incisors and canines continues, buccal cusps of the first primary molars almost merge, the first signs of mineralization of distal-buccal cusps of the second primary molars appear.

At the 32nd week (8th month) of pregnancy, mineralization of the primary incisors and canines continues. Buccal tubercles of the first primary molars merge. The tip of medial-lingual tubercles of the second primary molars is being formed.

At the 36th week (9th month) of pregnancy, calcification covers all surfaces of the primary incisors (except for the cervical area), buccal tubercles of the first primary molars completely merge, their lingual tubercles are traced, the process of mineralization extends to proximal surfaces of the first primary molars. The mineralization of distal-lingual tubercles of the second primary molars occurs intensively. At the time of birth, crowns of the central primary incisors are almost completely formed. To a lesser extent – the lateral incisors, half of crown of the primary canines, chewing surfaces of primary molars, and medial-buccal tuber- cles of the first permanent molars. Cervical area of the incisors, vestibular, cervi- cal, and approximal surfaces of the canines, lingual surface of the first primary molars, as well as the fissures of all primary teeth are not completely mineralized (Table 3.1).

The final development of enamel occurs after eruption of tooth, especially intensively during the 1st year of life.

Table 3.1. *The timing of intramandibular formation of primary teeth (according to Schroeder, 1991)*

Tooth		The beginning of mineralization (week of embryonic development)	Completion crown formation
Central incisor	upper	13–16	13–16
	lower	13–16	2,5
Lateral incisor	upper	14,5–16,5	2,5
	lower	14,5–16,5	3
Canine	upper	15–18	9
	lower	16–18	8–9
First molar	upper	14,5–17	6
	lower	14,5–17	5–6
Second molar	upper	16–23,5	11
	lower	17–19,5	8–11

The main source of entry of inorganic substances into enamel after the eruption of a tooth is saliva, but some of them can also come from dentin. During this period, the mineral composition of saliva and presence of required amount of calcium, phosphorus, and fluoride ions in it is quite important for full mineralization. Enamel participates in the exchange of ions, undergoing the processes of demineralization (release of mineral substances) and remineralization (re-entry of mineral substances), balanced under physiological conditions.

During their development, teeth respond to all changes in the child's body. Anything that disrupts and affects a child's growth also affects the growth, devel- opment, and eruption process.

Enamel saturation with mineral components is disturbed in premature babies, in the case of pathological childbirth, and in children who have undergone various diseases during the neonatal period and in infancy (rickets, hypovitaminosis, diseases of the digestive tract, tuberculosis intoxication, chronic starvation).

Tooth pulp development. The pulp is formed from the mesenchyme of dental papilla. This process begins at the papilla's top, where dentin has already formed. At the same time, differentiation of mesenchymal cells occurs in the central part of dental papilla. Most of cells of the mesenchyme turn into fibroblasts, which begin to secrete components of the extracellular matrix.

Gradually, the papilla mesenchyme turns into a loose connective tissue rich in fibroblasts, fibrocytes, and macrophages, as well as blood vessels and nerve fibers. By the time the tooth erupts, the papilla mesenchyme is almost completely differentiated into pulp, although the final restructuring of its tissue elements is completed in the first years of life.

Teeth eruption. The eruption is the process of vertical movement of a tooth from the place of its initiation and development inside jaw to the appearance of a crown in the oral cavity. Teething of primary teeth begins at 5-6 months life and ends at 2–2.5 years (Fig. 3.7).

The signs of physiological teething are: timeliness, the sequence of eruption of certain groups of teeth, and pairing.

The lower central incisors erupt first, then - their antagonists on the upper jaw, the next are lower lateral incisors, then - the upper lateral incisors. Until the 10–12th month (1 year) of life, all 8 temporary incisors erupt. After a short break (2–3 months), the first temporary molars appear, followed by the canines (lower and upper), the last is the second upper molars (Tables 3.2, 3.3). The given terms of teething can vary from 4 months to 2 years (early teething) or from 8–10 months to 3–3.5 years (late teething).

In the process of eruption, tooth passes a long way in the jaw, during which the following processes occur:

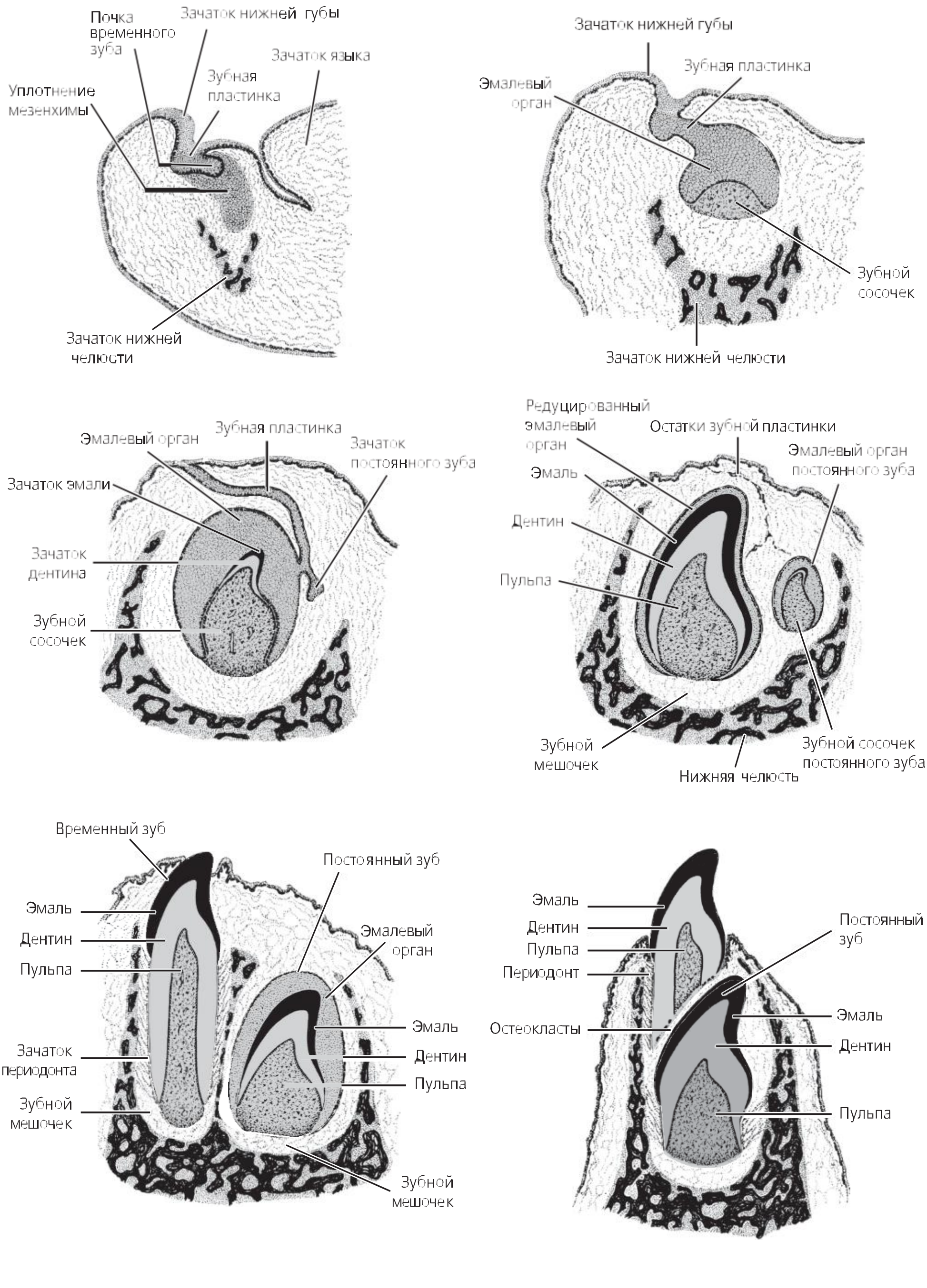


Fig. 3.7. *Scheme of the successive stages of odontogenesis: development of the lower temporary incisor (A – D), and its replacement with a permanent tooth (E) (Koch G. et al., 1994)*

Table 3.2. *The timing of primary (deciduous) teeth development (according to Kunzel W., 1988)*

Tooth	The first radiological signs of mineralization of the tooth crown, month	Timing eruptions,	Completion formation	Onset of resorption root, years
I	5th	6–8 th	1.5–2 th	4 th
II	5th	8–12 th	2-2.5 th	5 th
III	6th	16–20 th	4.5–5.0 th	8 th
IV	5th	12–16 th	3.5–4.0 th	6.5–7.0 th
V	8th	20–30 th	4.5–5.0 th	7.5–8.0 th

Table 3.3. *The average timing of primary (deciduous) teeth eruption (according to Illingworth R., 1997)*

Tooth	Terms of eruption, month of life	
	lower jaw	upper jaw
I	6 th	7.5 th
II	7 th	9 th
III	12 th	14 th
IV	16 th	18 th
V	20 th	24 th

– changes in tissues surrounding the tooth;
– development of the tooth root;
– reconstruction of the alveolar bone;
– development and reconstruction of the periodontium.

The reduced enamel epithelium covering the crown of tooth secretes enzymes that destroy the connective tissue that separates it from epithelium of oral cavity.

Approaching the oral epithelium, the enamel epithelium proliferates and further merges with it, forming so-called germination channel. Epithelium of the oral cavity above the crown of tooth degenerates and through the resulting hole, crown erupts into oral cavity without causing bleeding, as the crown moves through the canal lined with epithelium.

In the process of an eruption, a cuticle that covers enamel is formed from the remnants of epithelium of the enamel organ and the epithelium of oral cavity. Reduced epithelium of the enamel remains attached to the enamel, not erupted part of crown. This is the primary attachment epithelium.

The eruption of primary teeth is one of the physiological indicators of a child's general health, development, and growth. Quality of food, sanitary and hygienic conditions, pathological conditions (rickets, hypovitaminosis, dyspepsia, intoxication, etc.) significantly affect the process of eruption. Erratic teething with violation of the time intervals between the appearance of certain groups of teeth can be a sign of rickets.

Root and periodontal formation. The formation of root of the tooth begins shortly before its eruption. By this time, the crowns of primary teeth are mostly formed. Along the edge of enamel organ, the cells of inner and outer epithelium of the enamel are preserved, multiply intensively and turn into so-called epithelial root sheath (Hertwig's vagina), which plays an important role in formation of tooth root. It consists of internal and external cells of the enamel organ, closely adjacent to each other.

The mesenchymal cells of dental papilla, adjacent to the Hertwig's epithelial root sheath from the inside, turn into odontoblasts, which take part in the for- mation of root dentin. After formation of dentin, the layer of epithelial cells of Hertwig's epithelial root sheath loses its continuity, disintegrating into separate epithelial islets, connected by bridges. Most of the islets dissolve and disappear, some of the remaining islands are formed by so-called epithelial rests of Malassez
– epithelial remnants on root surface in the periodontium. They can be a source of cysts development.

The root is more difficult to develop in multi-rooted teeth. First, a single wide root canal is formed, which in the process of development is divided into two or three sleeves, depending on the tooth belonging.

Root dentin differs in chemical composition from crown dentin, it is less mineralized, collagen fibers do not have a clear orientation, the rate of its development is slightly less. If in the process of root formation, the edge of growing epithelial root sheath encounters blood vessels or nerve fibers on its way, it overgrows these structures, an additional (lateral) root canal is formed in this area, connecting pulp with periodontium. Such channels can become a source of infection spread- ing into periodontium.

Development of cement. After disintegration of the epithelial root sheath, the mesenchymal cells of dental sac connect to the root dentin and become cementoblasts (cells similar to osteoblasts), which begin to deposit cement on the surface of dentin of tooth root. Cement formation begins at the 4th to 5th month of postnatal development, immediately before eruption of a tooth by the type of periosteal osteogenesis. In its structure, cement is similar to coarse-fibrous bone. Cementoblasts in their structure do not differ from osteoblasts. They form collagen fibers and a matrix that is mineralized to form hydroxyapatite crystals.

With development of the matrix, cementoblasts turn into cementocytes.

First, cement is formed that does not contain cells (acellular or primary), it is slowly deposited in parallel with the eruption of the tooth, covering 2/3 of root surface located closer to the crown.

After eruption of the tooth, a cement containing cells (cellular or secondary) is formed. The cellular cement is located in apical third of the root. It forms faster than acellular but is inferior to it in terms of the degree of mineralization. The formation of secondary cement is a continuous process, as a result of which its layer thickens.

Development of the periodontium and bone alveoli. The periodontium is formed from the mesenchyme of dental sac simultaneously with the formation of root. After formation of cement, the remainder of cells of the outer layer of dental sac differentiates into fibroblasts and gives rise to the formation of dense connective tissue of periodontium. The bundles of collagen fibers of periodontium at one end penetrate into the cement matrix, at the other end - into alveolar bone matrix. Due to this, the root is tightly attached to the wall of bone alveoli.

The thickness of periodontal fiber bundles increases only after eruption of the tooth and after the beginning of its functioning. Throughout life, there is a constant restructuring of periodontium following the change in the load on the tooth. Formation of root and periodontium in primary teeth lasts from 1.5–2 years (incisors) to 2–2.5 years (canines, molars) after the eruption.

The stabilization period is the period of a functionally complete primary occlusion. It is characterized by the fact that all tissues of tooth and its root are fully formed and are in a stable state. This period lasts an average of 2.5–3 years. At the same time, functional stimuli significantly affect the growth and formation of the child's chewing apparatus, therefore, during this period, it is advisable to create a chewing load to ensure the full development of the chewing and facial muscles, jaws, and periodontal tissues.

Resorption period. Beginning at the age of 5–6, the temporary occlusion is replaced with a permanent one. This is preceded by the growth of primordia of permanent teeth and physiological resorption of the roots of primary teeth. As a result of the vertical advancement of a permanent tooth in the jaw, it begins to press on the bone plate, separating it from the alveoli of primary tooth. In the connective tissue located in this place, osteoclasts, actively resorbing bone tissue, differentiate. In the process of further growth, permanent tooth presses on the root of primary tooth. In connective tissue around the root, osteoclasts (more precisely, odontoclasts) also differentiate, which begin resorption of the root of primary tooth. The initial stage of destruction of tooth root tissue (cement and dentin) by odontoclasts is their demineralization; further - extracellular de- struction and intracellular digestion of the decay products of their organic matrix occurs.

Resorption of roots of primary teeth begins from the area to which the bud of a permanent tooth is located closer. Therefore, it is necessary to know the location of the primordia of permanent teeth con- cerning the roots of corre- sponding deciduous teeth. The buds of permanent anterior teeth are located in the region of lingual surface of root of the pri- mary, and the canine bud is located much further from the alveolar ridge of the jaw than incisor buds. The premolar buds are located between roots of primary molars on lower jaw – closer to the distal root, on upper – to the distal-buccal, and farther from the palate. Therefore, in single-rooted primary teeth, root resorption begins from the lingual surface, then covers the root from all sides and spreads in the direction from the apex of root to the crown of tooth. Lingual surface is absorbed faster than labial surface, so an oblique line is projected on the radiograph in this place (Fig. 3.8).

Fig. 3.8. *Root resorption in primary molars begins at inter-radicular area* (Rashmi G.S. et al.,2014)

In primary molars, the process of root resorption begins from their inner surface, that is, from the surface facing inter-root septum, in the area where the primordium of a permanent tooth is located. If the bud of a permanent tooth is absent, the resorption of roots of the corresponding primary tooth does not always or not along the entire length and with less intensity. Such primary teeth can remain in the jaw for a long time.

Loss of deciduous teeth occurs symmetrically on right and left halves of the jaws. In lower jaw, all teeth, except for the second primary molars, fall out faster.

DEVELOPMENT OF PERMANENT TEETH

In process of development and formation of permanent teeth, four periods are distinguished: 1st – intramandibular development; 2nd – teething; 3rd – formation and growth of roots and periodontium; 4th – formed root (Tables 3.4, 3.5).

Period of intramandibular development. The source of formation of permanent teeth is that dental plate from which the buds of primary teeth develop. Starting from the 5th month of embryogenesis, along the lower edge of dental

Table 3.4. *The timing of intramandibular formation of permanent teeth (according to Schroeder, 1991)*

Tooth		Beginning of mineralization	Completion of crown formation, years
Central incisor	upper	3–4	3,3–4,1
	lower	3–4	3,4–5,4
Lateral incisor	upper	9–12	4,4–4,9
	lower	3–4	3,3–5,9
Canine	upper	6	4,5–5,8
	lower	6	4,0–4,7
First premolar	upper	19	6,3–7,0
	lower	19	5–6
Second premolar	upper	36	6,6–7,2
	lower	36	6,1–7,1
First molar	upper	2	2,1–3,5
	lower	2	2,1–3,6
Second molar	upper	36–48	6,9–7,4
	lower	36–48	6,2–7,4
Third molar	upper	9–104 years	12,8–13,2
	lower	9–10 years	12,0–13,7

plate behind each primordium of a primary tooth, the enamel organs of permanent teeth are formed. These teeth are also called replacement teeth since they replace the primary teeth in the jaw.

There are no premolars in the primary occlusion, so the primary molars are subsequently replaced with permanent premolars.

As with development of primary teeth, mesenchyme grows into the enamel organs of permanent teeth and dental papilla is formed. A dental pouch is formed around it. Earlier than others, the first permanent molars, incisors, and canines are laid. In total, there are 20 primordia of replacement permanent teeth. First, the buds of these teeth are located in the bone alveoli, which are common to the buds of deciduous teeth. But over time, a bone septum forms between them. Thus, separate alveoli are formed for primary and permanent tooth. At the same time, the dental plate continues to grow in both jaws posteriorly. Enamel organs of permanent molars are formed along its edge. They have no predecessors among deciduous teeth, therefore they are called complementary.

Table 3.5. The timing of the development of permanent teeth (according to Kunzel W., 1988)

Jaw	Tooth	The first radiological signs of		End of intramaxillary	Deadlines eruption	The end root growth,
		Months	Years			
The bottom	1	3–4		4–5	6–7	9
	2	3–4		4–5	7–8	10
	3	4–5		6–7	10–12	12–14
	4		1 3/4–2	5–6	10–11	12–13
	5		2 1/4–2 1/2	6–7	11–12	13–14
	6	At birth		2 1/2–3	5–6	9–10
	7		2 1/2–3	7–8	12–13	14–15
Upper	1	3–4	1	4–5	7–8	10
	2			4–5	8–9	11
	3	4–5		6–7	11–13	13–15
	4		1 1/2–1 3/4	5–6	9–10	12–13
	5		2–2 1/2	6–7	10–11	12–14
	6	At birth		2 1/2–3	6–7	9–10
	7		2 1/2–3	7–8	12–14	14–16

At the 24–25th week (5th month) of pregnancy, the bud of first permanent molar begins to form. Somewhat later, at the 8th month of intrauterine development, the buds of permanent incisors and canines are laid. Thus, 16 permanent teeth are laid during the embryonic period. The bud of second permanent molar is laid in the middle of the 1st year of life, the third – at the 4th or 5th year of life.

The processes of calcification of hard tissues of permanent teeth begin mainly after the birth of a child. The first to mineralize is the 6th tooth or first permanent molar. At the 9th month of intrauterine development, the medial-buccal tubercle of this tooth is calcified. At the 2nd month of a child's life, all the tubercles of occlusal surface are mineralized, at the 9th month – the entire occlusal surface, at the age of 3 years – the entire crown of the tooth. At the age of 4 years, the calcification of bifurcation of roots occurs and their formation begins, ending at the age of 10 years.

Mineralization of the permanent central incisors of upper and lower jaws begins at 3–4 months of life. Up to 9 months, 1/3 calcify, up to 2 years – half of the crowns. Up to 3 years of age, the crowns of incisors are 3/4 formed, and at 4 years

of age, signs of formation of the necks of teeth appear, then roots. Root formation ends at the age of 9–10 years.

Calcification of the permanent lateral incisors of lower jaw begins at 3–4 months of life, upper jaw – at the 9–12th. At 2 years of age, the size of lateral in- cisors of upper and lower jaws becomes the same and is 7 mm. At 4 years of age, the mineralization of crowns of teeth ends and signs of neck formation appear, at the end of the 5th year of life, formation of roots of teeth begins, which ends at the age of 10–11 years.

Calcification of permanent canines begins at 5–6 months of life. At 9 months, the canine tubercle at the top of its crown mineralizes. Canine development slows down with age. At the age of 1.5 years, the height of crown is 4.5 mm, 2 years – 7 mm, 3 years – 2/3 of the crown is formed, at 6 years of age a neck of teeth is formed, in the 8th year the formation of roots begins, which ends at the age of 13–15 years.

Mineralization of the first premolars occurs at the age of 1.5–2 years, at 4 years of age 1/2 of the crown undergoes mineralization, at 6 years of age – 3/4 of the crown, at the age of 7, root growth begins, and at 12–13 years of age this process ends.

Bud of the second premolar is formed at the age of 2 years. At the age of 2.5 years, two foci of mineralization are determined according to the tubercles of oc- clusal surface. At the age of 5 years, 1/4 of crown of the tooth is formed, at 6 years
– 1/2, at 7 years – the entire crown. At the age of 9 years, formation of the tooth root begins, at the age of 12–14 this process ends.

Bud of the second permanent molar is formed at 2.5 years, the tubercles calcify at 3 years, the entire occlusal surface at 4 years, 1/2 of the crown at 6 years, and the entire crown at 8 years. At the age of 9 years, root bifurcation is formed and its growth begins, the formation of root is completed at 15–16 years.

Bud of the third molar is formed at the age of 5 years, at the age of 8, calci- fication of its occlusal surface begins, at the age of 12, intramandibular crown formation is completed.

The timing of mineralization of all permanent teeth may vary.

Thus, the development of permanent and primary teeth occurs in the same type, but at different times. At the end of development of primary teeth, buds of permanent teeth of earlier stages of formation appear in the jaws. Permanent teeth develop more slowly than primary teeth. For example, the period of formation of primary incisors lasts 2 years, permanent ones – about 10 years. The replacement of primary teeth with permanent ones begins at the age of 5–6 years after erup- tion of the first permanent molars, which have no primary predecessors. This pe- riod lasts up to 12 years and is called the mixed occlusion period. The replacement of primary teeth occurs in the same sequence as their eruption (Fig. 3.9).

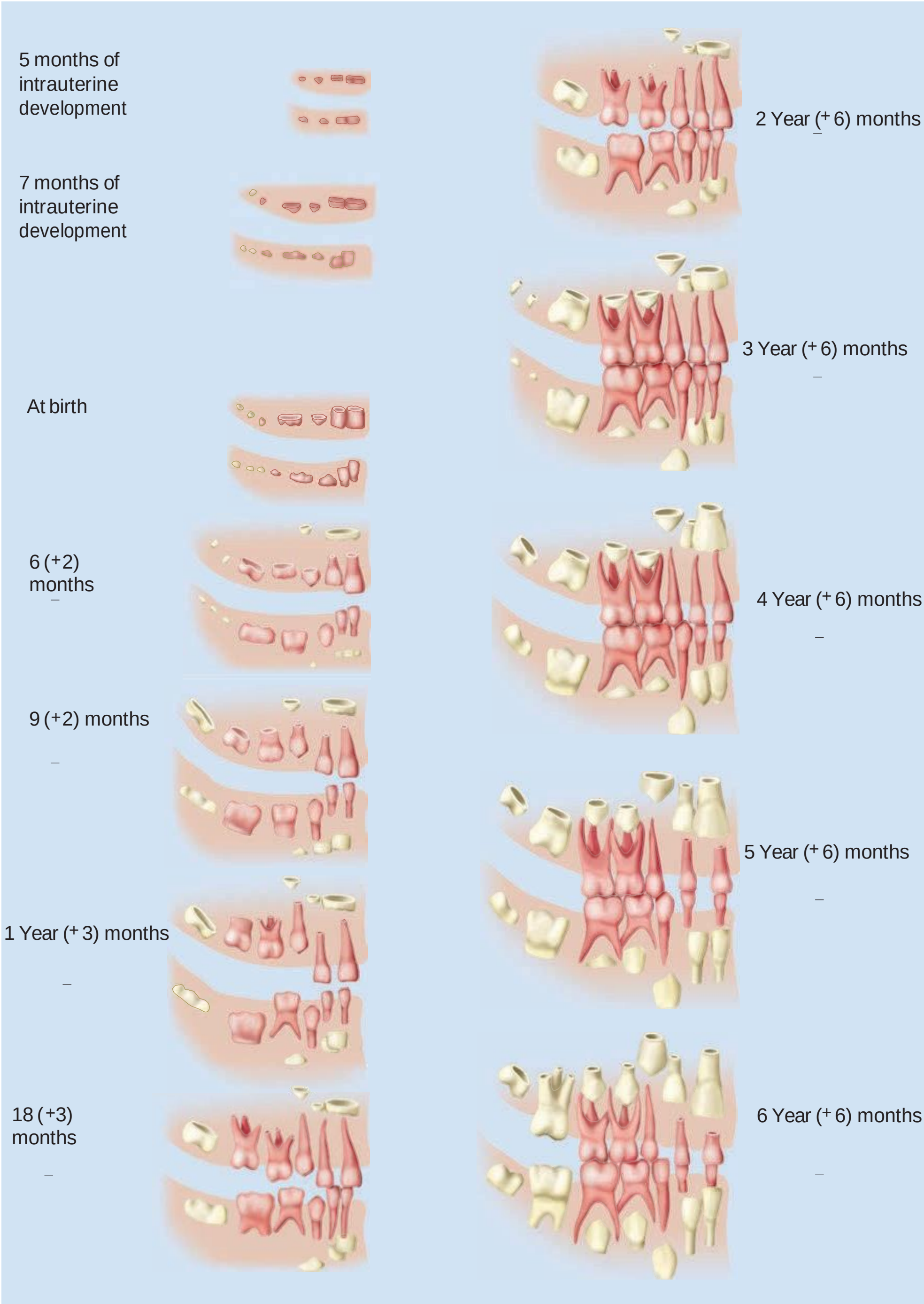


Fig. 3.9. *Development of primary and permanent teeth (Meyer-Lueckel H. et al., 2013)*

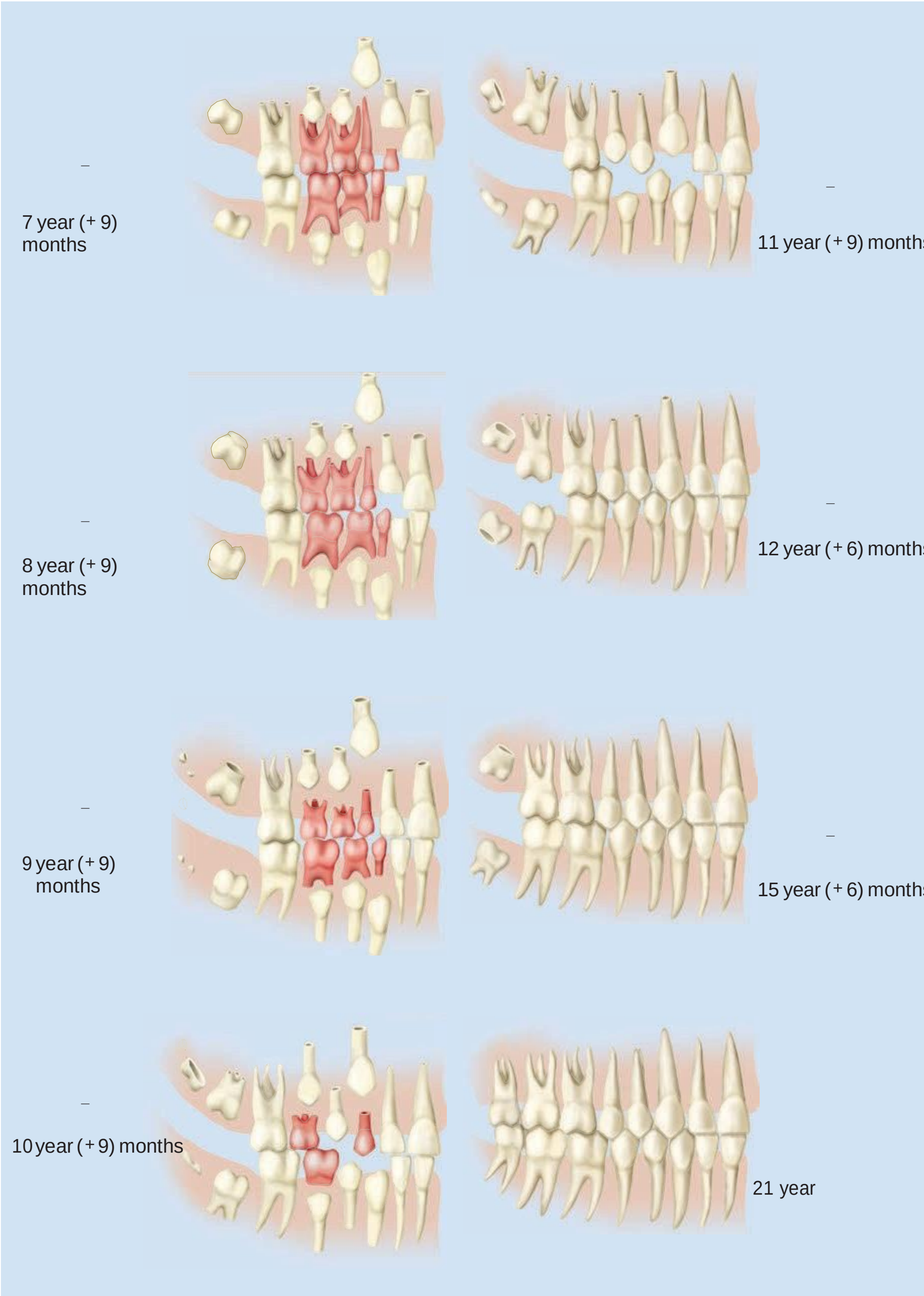

7 year (+ 9) months
11 year (+ 9) months
8 year (+ 9) months
12 year (+ 6) months
9 year (+ 9) months
15 year (+ 6) months
10 year (+ 9) months
21 year

Fig. 3.9. *Continuation*

Test questions

1. How many stages in the development of primary (deciduous) teeth are there? Name them.
2. How many stages in the development of permanent teeth are there? Name them.
3. What processes occur during the intramandibular stage of tooth development?
4. How does the histogenesis of hard dental tissues (enamel, dentin) occur during the intramandibular stage of tooth formation?
5. Name the sources of development of dental tissues in embryogenesis.
6. What are the signs of physiological teething?
7. What are the terms of eruption of permanent and primary teeth?
8. How does the formation of tooth root and periodontium occur?
9. Describe the mechanism of resorption of the roots in primary (deciduous) teeth.
10. What factors affect the processes of formation and eruption of primary and permanent teeth?

Self-control tests

1. **At the stage of formation and differentiation of the tooth germ and epithelial dental organ is formed. What shape does it have?**

A. Kidney-shaped
B. Double-walled glass
C. Round
D. Oval
E. Flat

2. **At the stage of formation and differentiation of tooth germ and epithelial dental organ is formed. What is the shape of its inner cells?**

A. Flat
B. Cuboid
C. Prismatic
D. Round
E. Star-shaped

3. **At the stage of formation and differentiation of the tooth germ and epithelial dental organ is formed. What is the shape of its intermediate cells?**

A. Flat
B. Cuboid
C. Prismatic
D. Round
E. Star-shaped

4. **The tooth bud consists of an epithelial dental organ, a dental papilla, and a dental sac. What is the source of dentin development?**

A. Internal cells of the epithelial organ
B. External cells of the epithelial organ
C. Internal cells of the dental sac
D. Outer cells of the dental sac
E. Outer cells of the dental papilla

5. **The tooth bud consists of an epithelial dental organ, a dental papilla, and a dental sac. What is the source of enamel**

development?

A. Internal cells of the epithelial organ

B. External cells of the epithelial organ

C. Internal cells of the dental sac

D. Outer cells of the dental sac

E. Outer cells of the dental papilla

6. **The tooth bud consists of an epithelial dental organ, a dental papilla, and a dental sac. What is the source of the development of cement?**

A. Internal cells of the epithelial organ
B. External cells of the epithelial organ
C. Internal cells of the dental sac
D. Outer cells of the dental sac
E. Outer cells of the dental papilla

7. **The tooth bud consists of an epithelial dental organ, a dental papilla, and a dental sac. What is the source of periodontal development?**

A. Internal cells of the epithelial organ
B. External cells of the epithelial organ
C. Internal cells of the dental sac
D. Outer cells of the dental sac
E. Outer cells of the dental papilla

8. **With the development of the tooth root, Hertwig's epithelial root sheath is formed. What is the significance of its cells?**

A. Induce differentiation of dentinoblasts
B. Induce cementoblast differentiation
C. Produce dentin intercellular substance
D. Produce intercellular substance of the cement
E. Produce periodontal intercellular substance

9. **Dental development begins at the 6th week of embryogenesis. At this time, ingrowth into the mesen- chyme occurs in the area of the future jaws:**

A. Endodermal epithelium
B. Ectodermal epithelium
C. Angiodermal epithelium
D. Neural crest cells

10. **The number of histological structures that appear during the development of teeth is further reduced. The remains of some of them can be the cause of the development of cysts and tumors of the jaw. Name these temporary structures.**

A. Pulp of the enamel organ
B. Hertwig's epithelial root sheath
C. The inner layer of the dental sac
D. Outer layer of the dental sac
E. Dental papilla

Correct answers to the test tasks to the section The anatomical structure of temporary and permanent teeth

1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Chapter 4

ANATOMICAL STRUCTURE OF PRIMARY AND PERMANENT TEETH

Teeth are organs of the dentition system. They are located in the alveolar processes of upper and lower jaws, aimed for biting and chewing food. Human teeth take part in sound and speech formation, perform aesthetic and communicative functions (Nikolaev A. I., Tsepov L. M., 2009).

There are crown, neck, and root in a tooth. The crown is a visible part of tooth, covered with enamel. The root is part of tooth, covered with cement, it is located in alveolar process. Root of tooth ends with the apex. The major mass of hard tissues of tooth is formed by dentin. The border between crown of tooth and its root is the neck of tooth (Fig. 4.1).

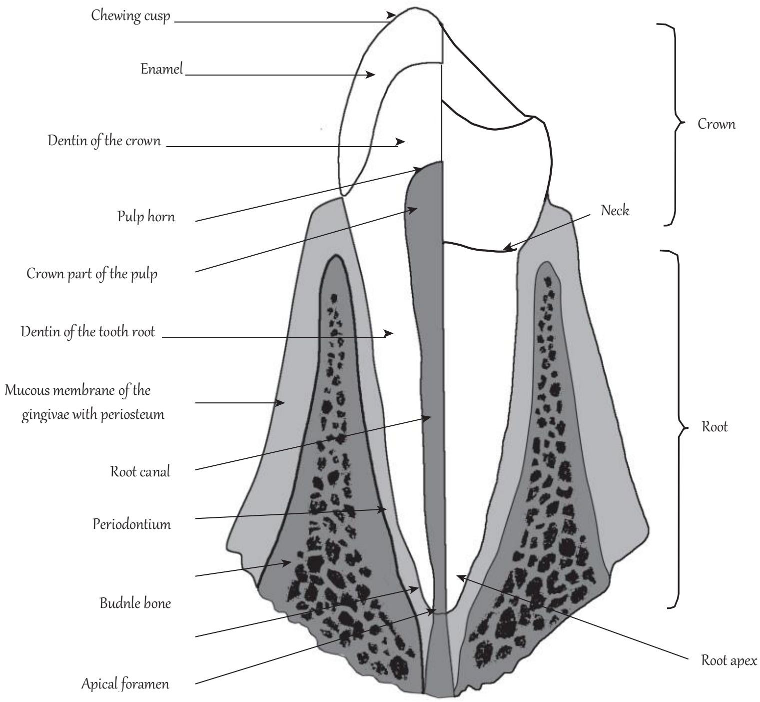


Fig. 4.1. Schematic image of tooth and surrounding tissues

The central part of tooth is occupied by the tooth cavity, repeating tooth shape in its outlines. The tooth cavity is divided into crown part and root canals. The cavity of tooth is filled with pulp, and according to its location is divided into crown and root cavities. Between root and crown pulp of multi-rooted teeth, there is a clearly defined anatomical border in form of the orifices of root canals. In single-rooted teeth, the crown pulp turns into the root one without a clear border. The root canal ends with a hole at the top of tooth root – the apical foramen. Nerves, blood, and lymphatic vessels pass through the apical foramen into the tooth cavity, forming a neurovascular bundle in the root canal. In the crown part of tooth cavity, there are such formations: orifices of root canals – inlet openings to the root canals are located at the bottom of tooth cavity; the lateral walls and roof of tooth cavity – its wall faces the occlusal surfaces. In the roof of tooth cav- ity, there are recessions where the horns of pulp are located. Their number corre- sponds to the number and localization of cusps on occlusal surface of the tooth.

The crown part of tooth has several surfaces. In incisors and canines there are 4 surfaces:

– vestibular (labial, buccal);
– mouth or oral (palatal, lingual);
– contact (approximal) medial, facing the median line;
– contact (approximal) distal, turned from the median line (laterally).

In the chewing teeth (premolars and molars), the crown part has 5 surfaces:

– occlusal, on which the cusps, fissures, and marginal ridges are located;
– buccal (vestibular);
– mouth or oral (lingual and palatal)
– contact (approximal) medial;
– contact (approximal) distal.

The location of teeth in the jaw in relation to each other forms upper and lower dental arches (Fig. 4.2). Closing of teeth of the upper and lower dental arches is called occlusion. On the crown part of tooth, there are anatomical elements that are important from a clinical point of view.

Equator is the most convex part of the crown of tooth, protecting gingival margin from injury during chewing. Chewing cusps – formations of a pyramidal form, located on the occlusal surface of molars and premolars, involved in grinding and rubbing of food. The chewing cusp consists of the apex and slopes.

Fissures – are the grooves in enamel, located between chewing cusps. They are aimed to direct the movement of opposing teeth during chewing (Fig. 4.3). In the area of fissures, the thickness of enamel is much less than in other areas of oc- clusal surface. Fissures can be of different shapes and depths, it creates favorable conditions for retention of microorganisms and food residues in them. Therefore, in children, caries develops very quickly in the area of fissures of chewing teeth.

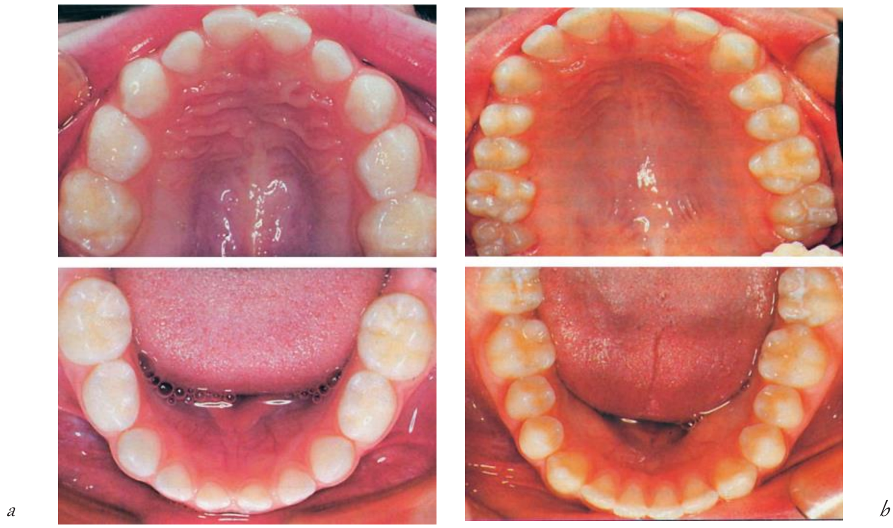


Fig. 4.2. Upper and lower dental arches: *a* – primary bite, *b* – permanent bite

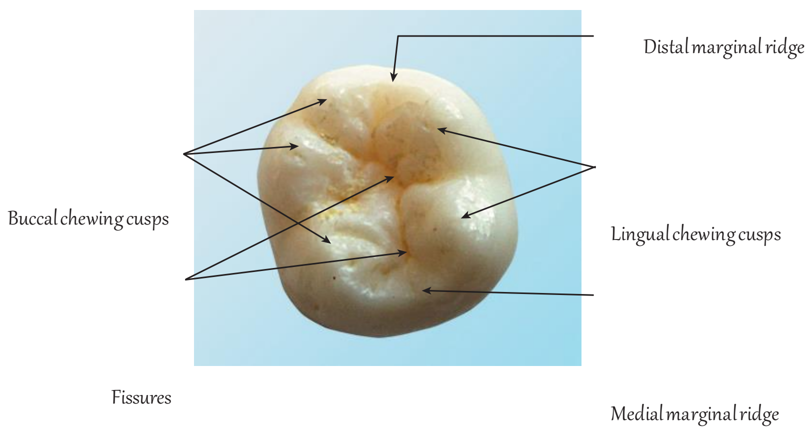
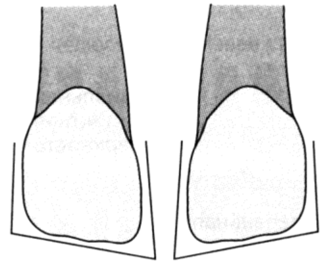


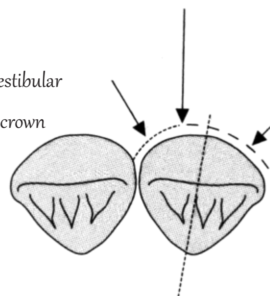
Fig. 4.3. Elements of occlusal surface of the first lower left molar (Rashmi G.S. et al., 2014)

Contact point – the area of contact beetwen two teeth in a tooth row. Contact points are located at the equator level, about 1.5–2.0 mm from the occlusal surface or incisal edge of tooth. There are a point contact – between teeth of the chewing group and plane contact – between the frontal teeth. The contact point together with marginal ridge of occlusal surface protect a gingival papilla from injury by food. Besides, presence of tight contact between teeth ensures the unity of tooth row and its functional stability during chewing.

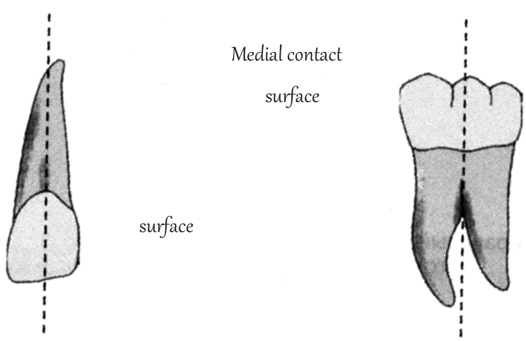
Teeth have anatomical features, which determine which half of the jaw (right or left) a particular tooth belongs to. There are three main signs of tooth belonging: the sign of crown angle, the sign of curvature of crown, and the sign of root inclination (Fig. 4.4).


Lateral angle
Lateral angle
Medial angles

a


The area of largest convexity of the vestibular surface of crown
Medial part of vestibular surface of the crown
Lateral part of vestibular surface of the crown
Palatal surfaces
Tooth middle line

b


Longitudinal axis of tooth
Medial contact surface
Distal contact surface
surface
Medial contact

lateral contact
surface

T
h
e

c

Longitudinal axis of tooth

Fig. 4.4. The main signs of tooth belonging: *a* – the sign of crown angle; *b* – the sign of curvature of crown; *c* – the sign of curvature of root

1. The sign of the angle of crown means that the angle of crown formed by medial-approximal surface and incisal edge of tooth is sharper than the angle formed by distal-approximal surface and incisal edge. The medial angle of crown is usually sharp, less often right, and the distal angle is obtuse and rounded. Sign of the angle of crown is especially clearly distinguished in the central and lateral incisors, as well as the premolars of upper jaw.

2. The sign of crown curvature is that the medial part of vestibular surface of crown is more convex, and the lateral part is more sloping. This sign is visible if you observe crown from incisal edge or occlusal surface of the tooth.

3. The *sign of curvature* of root is the lateral (distal) curvature of root or its apex relative to longitudinal axis of tooth.

The ratio of crown length and root length in most teeth is 1 : 2, in canines – 1 : 2.5.

Humans have two sets of teeth during their life. The first set is called primary teeth (also called deciduous dentition), and are the first teeth to appear in the mouth. Deciduous dentition period lasts from 6 months to 6 years. The primary teeth are replaced later on in childhood with permanent teeth (also referred to as succedaneous teeth). This phenomenon is obviously due to the adaptation of size and number of teeth to size of the jaws. In jaws of small children, small teeth develop first and in smaller numbers, and only with the growth of jaws the larger teeth develop in greater numbers. The size and function of teeth correspond to the size of jaws.

There are a total of 20 teeth in the primary dentition, 10 in each jaw. Each jaw has two central incisors, two lateral incisors, two canines, and four molars. The primary first and second molars will eventually be exfoliated and replaced by the first and second permanent premolars. **There are no premolars in the primary dentition.** The premolars and the 3rd molar are the teeth that are present only in permanent dentition.

It is important to note, that the permanent molars do not replace any teeth but erupt distally to the primary molars. The permanent molars are not succedaneous teeth as they do not have predecessors in the primary dentition.

There are some important differences between primary and permanent teeth in their external morphology, structure, mineral density, etc.

Primary teeth differ from permanent teeth in such features:

- primary teeth are smaller in overall size and crown dimensions when compared to their permanent counterparts;
- primary teeth are lighter in color. They appear bluish-white (milky-white) and are also called milk teeth;
- crowns of primary teeth are wider mesiodistally in comparison to their crown height;

– deciduous teeth are more constricted at the cervical portion of crown, they are narrower at their necks;
– cervical ridges on the buccal aspect of deciduous crown are more prominent (especially on the 1st molar);
– primary teeth have the prominent thickening of enamel – enamel bulge (cingulum) near the neck, so diameter of the crown of primary tooth is largest in the neck area, and diameter of a permanent one – in the equator area;

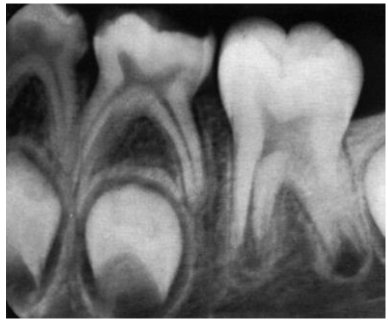


Fig. 4.5. *Permanent tooth germ, located between roots of temporary tooth*

– in primary teeth the transition of crown to the root is clearly seen;
– roots of primary teeth are comparatively more flattened and thinner than roots of permanent teeth;
– root canals and apical foramens of primary teeth are wider, especially during formation and resorption of roots;
– roots of primary molars diverge more with the distance from neck, have a curved shape and uneven contours since a germ of permanent tooth is placed between the roots of primary tooth (Fig. 4.5);
– relative volume of the tooth cavity of primary teeth is larger;
– enamel of primary teeth unlike regular enamel has a white color with a blue tint;
– thickness of hard tissues of primary tooth is less than permanent one's, hard tissues of temporary teeth are less mineralized, so they are not as solid;
– shape of pulp chamber repeats the shape of primary tooth (Fig. 4.6). The horns of pulp of primary teeth are clearly seen, they are much closer to incisal edge or occlusal surface than in permanent teeth. With age, the volume of pulp in primary teeth is somewhat reduced. Roots of primary teeth, as well as permanent ones, have additional canals in apical part, where branching of pulp is placed. However, they are less numerous than in permanent teeth. The number of apical foramens in primary teeth reaches 3–5;
– frontal primary teeth are closely adjacent to each other. Starting from the age of 4, between them there form gaps – diastemata (Fig. 4.7). By the end of 5 th and especially during 6 th year of life diastemata significantly increase. Formation of diastemata is caused by the growth of jaws and growth of germs of permanent teeth, which should grow and take the place of prima- ry ones. This process is physiological, so the diastemata have been called

Fig. 4.6. *X-ray of the pulp chamber in temporary tooth*

Fig. 4.7. Diastemata in the area of frontal temporary teeth of lower jaw

physiological. On upper jaw, the diastemata between primary teeth are much more distinct than on lower one. Absence of physiological diastemata at the age of 6 indicates insufficient growth of jaws, and therefore there may not be enough space in the dental arch for growth of permanent teeth.

Starting from the age of 3, there is a physiological abrasion of primary teeth, contributing to normal development of chewing apparatus of a child. The process of abrasion is manifested by formation of abrasion facets on the occlusal surface or the incisal edge of teeth. The absence of abrasion of temporary teeth can disrupt the proper development of jaws.

ANATOMICAL STRUCTURE OF PRIMARY TEETH

Primary incisor

A child has 8 primary incisors in the oral cavity - 4 incisors on each jaw (two central and two lateral). All incisors have shovel-shaped crown, flattened in vestibular-oral direction and one root. The dimensions of primary incisors of upper jaw are larger than the similar parameters of lower incisors. The largest in group of primary incisors is the upper central incisor, the smallest is the central incisor of lower jaw (Fig. 4.7).

Crowns of primary incisors resemble permanent ones in shape but differ from them in much smaller sizes and the absence of incisal ridges on incisal edge.

Crowns of ***maxillary primary central incisors*** have convex lateral surfaces, the crown in the middle part is wider than the incisal edge and neck of tooth. The transverse size of crown of maxillary central incisor is slightly larger than the ver- tical one. The distal angle of incisal edge is obtuse, the medial angle is somewhat longer and sharper (Fig. 4.8).

Crown of maxillary central primary incisor has a convex labial (vestibular) surface and a concave palatal surface. On the proximal (lateral) side, crown of the central incisor resembles a “chisel” in shape.

On the vestibular surface of crown of maxillary primary central incisors, a distinct thickening of enamel in the precervical area, so-called “enamel bulge”, is determined. It is the most seen at the medial edge of crown, which determines the sign of curvature of crown in central incisors.

On the palatine side in precervical area of maxillary primary central incisors, there is the distinct cusp. Furrows directed towards the incisal edge are weakly distinct, and sometimes can be completely absent.

Width of crown of the ***maxillary primary lateral incisor of upper jaw*** is much smaller compared to central incisor. Enamel bulge on vestibular surface of the maxillary lateral upper incisor is weakly distinct, on palatal surface the cusp is not defined (Fig. 4.9).

The sign of the angle of crown, which is characteristic for all maxillary prima- ry incisors, is the most distinct in the lateral incisors. Medial angle of crown is sharper, the distal angle, formed by incisal edge and distal-aproximal surface of the crown, is much more rounded compared to medial angle.

Roots of maxillary primary incisors are flattened laterally and have an oval shape on horizontal section. In the central incisors, roots are flattened in vestibular-oral direction, in the lateral incisors – in medial-distal direction.

Roots of maxillary incisors may have an inclination in the distal direction (a sign of curvature of root).

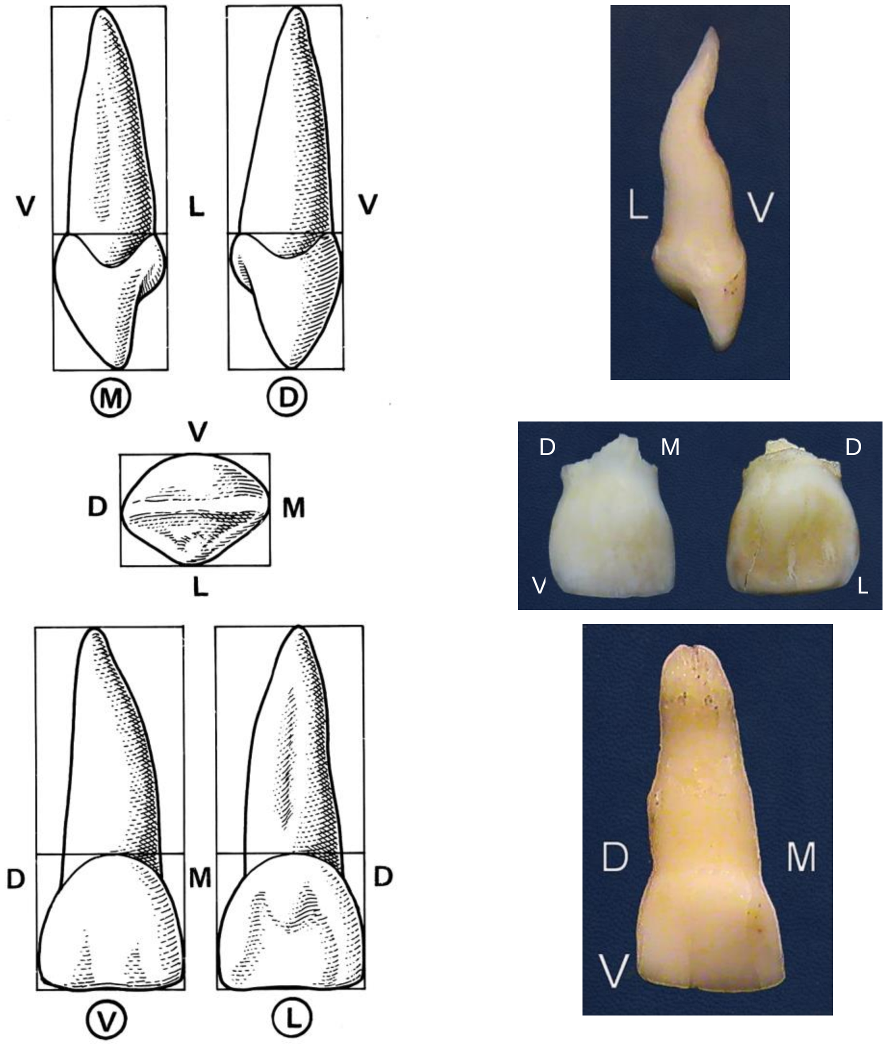


Fig. 4.8. *Anatomical structure of the maxillary primary central incisor:*

V – vestibular surface; L – oral surface; D – distal surface; M – medial surface

Length of maxillary central primary incisors is 16–17,2 mm, height of the crown is 6,0–6,5 mm. The same indicators for maxillary lateral primary incisors are, respectively,: tooth length 14.4-16.8 mm: crown height – 5,4–7,4 mm, root length – 8,8–11,4 mm.

The maxillary primary incisors have one main root canal in 100 % cases, Additional canals are distinct much less frequently: in maxillary primary central incisors in 14 % of cases – one, in 4 % – two; in maxillary primary lateral incisors in 16 % – one, in 12 % – two.

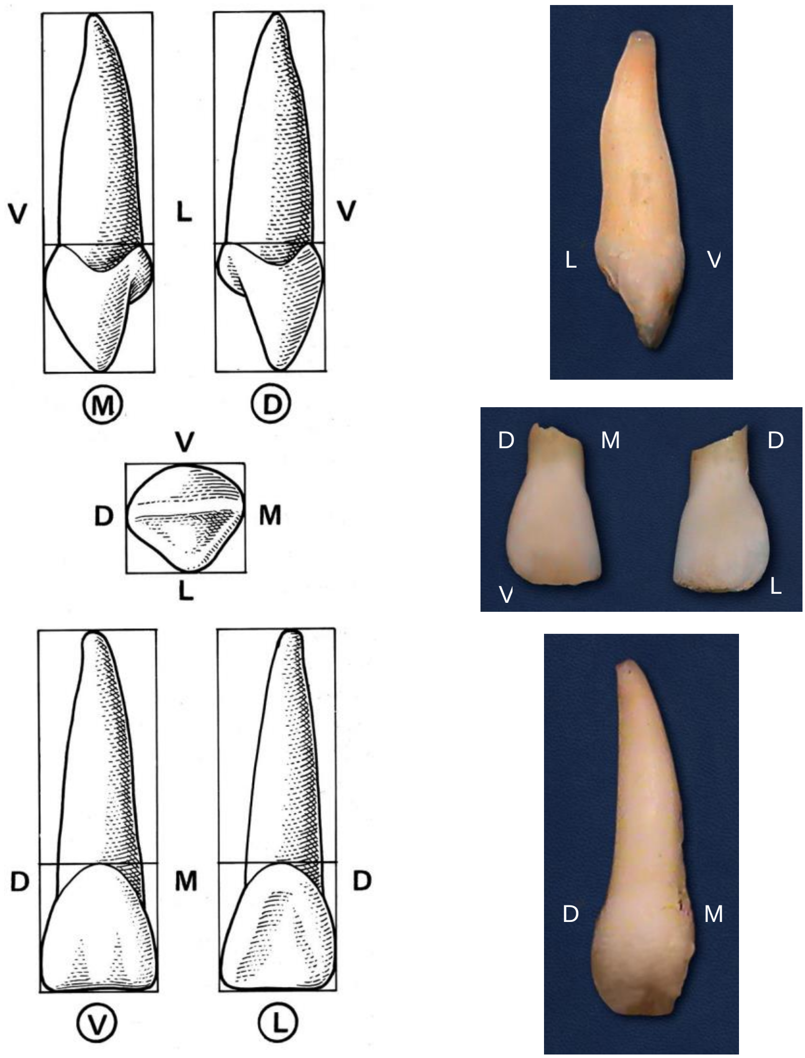


Fig. 4.9. *Anatomical structure of the maxillary primary lateral incisor: V – vestibular surface; L – oral surface; D – distal surface; M – medial surface*

The crowns of mandibular primary incisors are much smaller in size than the upper ones.

The signs of angle and curvature of the crown are not distinct in the mandibular primary central incisor, the medial and distal angles of the crown are equal to each other (Fig. 4.10). The mandibular primary lateral incisor is slightly larger than the mandibular primary central incisor and has weak signs of angle and curvature of crown (Fig. 4.11). Roots of mandibular primary incisors are flattened in the medial-distal direction and have weakly distinct furrows on the lateral surfaces, resembling similar furrows on the roots of permanent incisors.

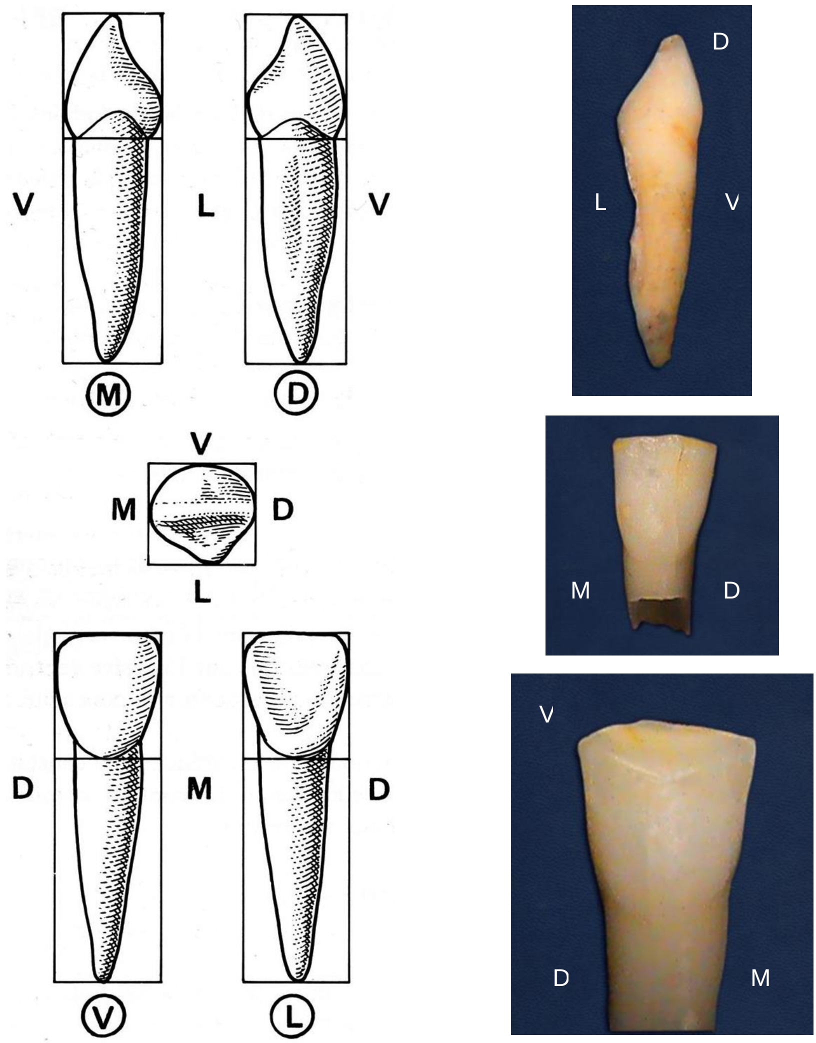


Fig. 4.10. *Anatomical structure of the mandibular primary central incisor: V – vestibular surface; L – oral surface; D – distal surface; M – medial surface*

Length of mandibular primary central incisors is 13.6–16.0 mm, crown height – 4.8–6.1 mm, root length – 8.8–10.5 mm.

Similar indicators for mandibular primary lateral incisors are slightly higher than those for the central ones. The total length of tooth is 14.4–16.5 mm; respectively, the height of crown – 5.2–7.3 mm, the length of root – 9.2–10.6 mm.

The roots of mandibular primary incisors have one main root canal in most cases (92 %) . In 8 % of cases, the root canal of a mandibular primary central in- cisors may have two branches, and the mandibular primary lateral incisors have two root canals in 6 % of cases.

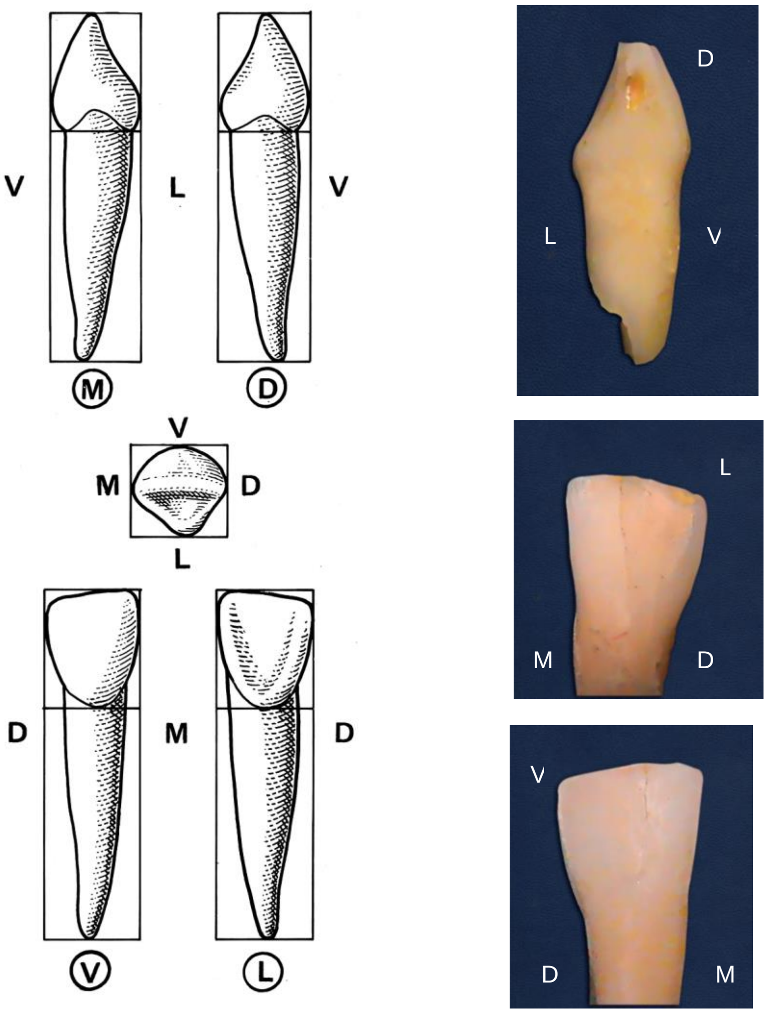


Fig. 4.11. Anatomical structure of the mandibular primary lateral incisor: V – vestibular surface; L – oral surface; D – distal surface; M – medial surface

Primary canines

Children have 4 primary canines in the oral cavity. Common signs of primary canines of upper and lower jaws are the presence of distinct incisal ridge on the incisal edge and long root. The incisal ridge on incisal edge gives the crown a pointed shape.

Primary canines resemble permanent ones in shape but differ in significantly smaller sizes and more symmetrical and short crown.

Crown of the maxillary prim***ary canine*** resembles in shape the "peak" (Fig. 4.12). The sharp incisal ridge of incisal edge of maxillary primary canine divides it into two parts – the relatively short medial and longer distal. The incisal faces form smoothed angles with lateral surfaces of crown. The "V" sharped incisal ridge of maxillary primary canine due to physiological abrasion of temporary teeth is gradually abrased, so the crown becomes shorter, that's why the width of crown can significantly exceed its height.

The crown of the maxillary primary canine is more convex and wide in comparison with the crown of mandibular primary canine. Enamel bulge in the neck of tooth is very distinct. The cusp on palatine surface of tooth in precervical area

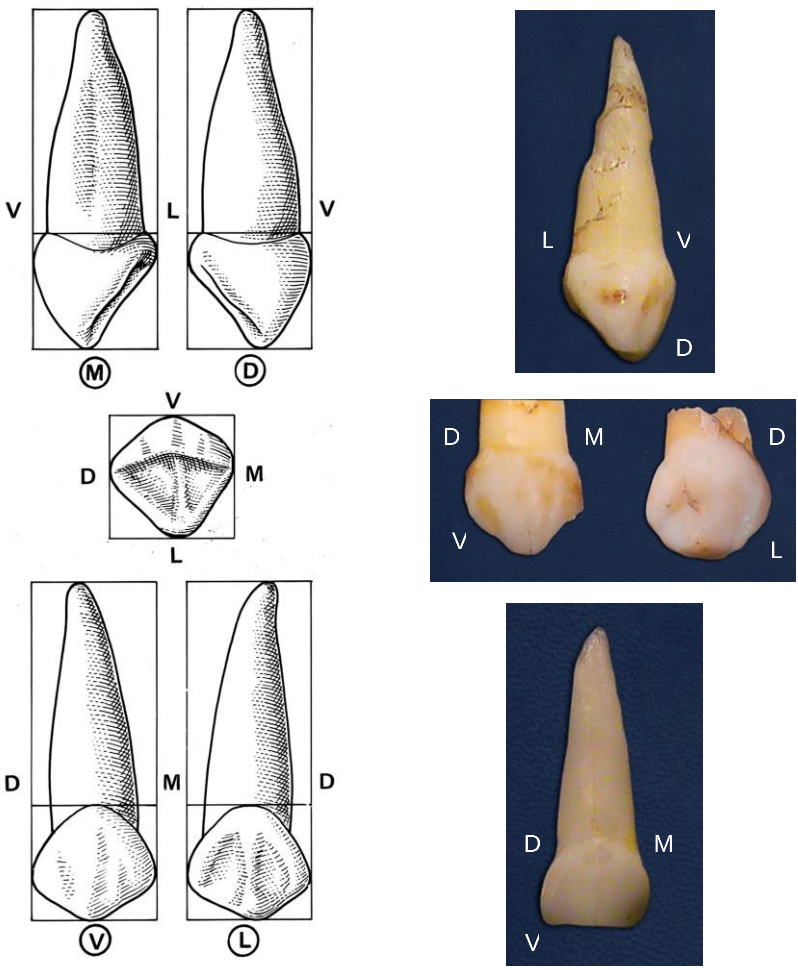


Fig. 4.12. Anatomical structure of the maxillary primary canine:

V – vestibular surface; L – oral surface; D – distal surface; M – medial surface is also significantly distinct. A weakly distinct enamel bulge and lateral ridges pass from the cusp in direction of incisal edge. The bulge divides palatal surface of crown into two almost symmetrical facets. The maxillary primary canine has one developed root, shape of which is close to triangular on the cross-section.

The crown of the ***mandibular primary canine*** is higher and somewhat narrower than the maxillary primary canine and is shaped like a rounded rhombus (Fig. 4.13).

The incisal ridge on incisal edge of crown of the mandibular primary canine remains long enough. Lingual surface of the mandibular primary canine is flat-

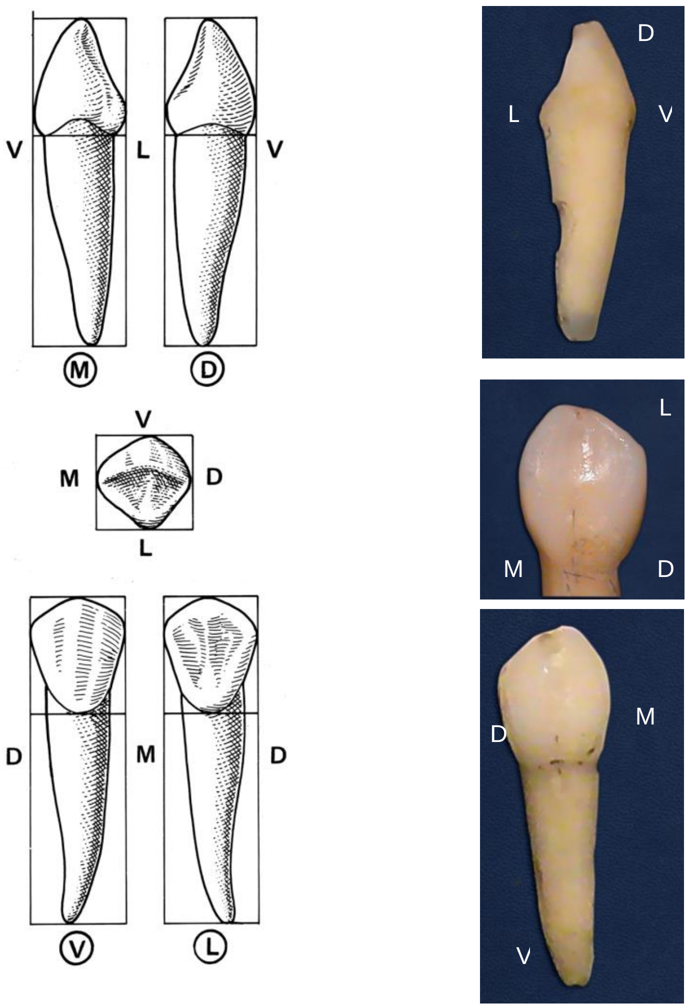


Fig. 4.13. Anatomical structure of the mandibular primary canine:

V – vestibular surface; L –oral surface; D – distal surface; M – medial surface ter compared to the maxillary primary canine. Lateral ridges, enamel bulge are weakly distinct on the lingual surface.

The length of maxillary primary canines is 18.2–20.2 mm (crown height – 6.4–7.6 mm), mandibular primary canines – 16.2–18.7 mm (crown height – 6–8.2 mm). In roots of primary canines there is one root canal.

Primary molars

Primary molars are teeth that have a multi-cusped occlusal surface and several roots. Children have 8 primary molars. They are the largest teeth in primary bite. The second primary molars are much larger than the first one. The maxillary primary molars have three roots – two buccal (medial, distal) and one palatal, the mandibular primary molars have two roots – medial and distal.

The characteristic morphological feature of primary molars is predominance of mesiodistal diameter of the crown over its height, i.e. the crowns of primary molars are much wider than higher.

In the maxillary primary molars the vestibulolingual size of crown prevails over mesiodistal size. In mandibular primary molars, the mesiodistal size of crown exceeds its vestibulolingual size, i.e. the crown of mandibular primary molars has an elongated shape along the alveolar process. This feature is more distinct in the first mandibular primary molars.

First primary molars. The first maxillary primary molars do not resemble any of permanent teeth. In size the ***first*** maxillary ***primary molars*** are much smaller than the second maxillary primary molars (Fig. 4.14). Their crowns are somewhat similar in shape to those of maxillary permanent premolars. The crown of first molar is elongated in buccal-palatine direction and has almost the same size in the neck of tooth and on the occlusal surface.

A well-distinguished enamel bulge is defined on the buccal surface of crown of the first maxillary primary molar in cervical region. It is the most distinct in its medial part. This protrusion often has appearance of an enamel drop, so in the first maxillary primary molar, the sign of curvature of crown is well seen.

The occlusal surface has trapezoidal shape. The buccal surface of crown is larg- er than the palatal one. The relief of furrows of occlusal surface is complex and depends on number of cusps and the degree of their intensity. The most clearly distinct medial-distal furrow separates buccal (vestibular) and palatal cusps. On the occlusal surface, 2–3 buccal and one palatal cusps are most often defined.

The first maxillary primary molar has three roots – two buccal (medial and distal) and one palatal, which quite often merges with the distobuccal root. The merging of roots may spread up to the top. The mesiobuccal root of first maxillary

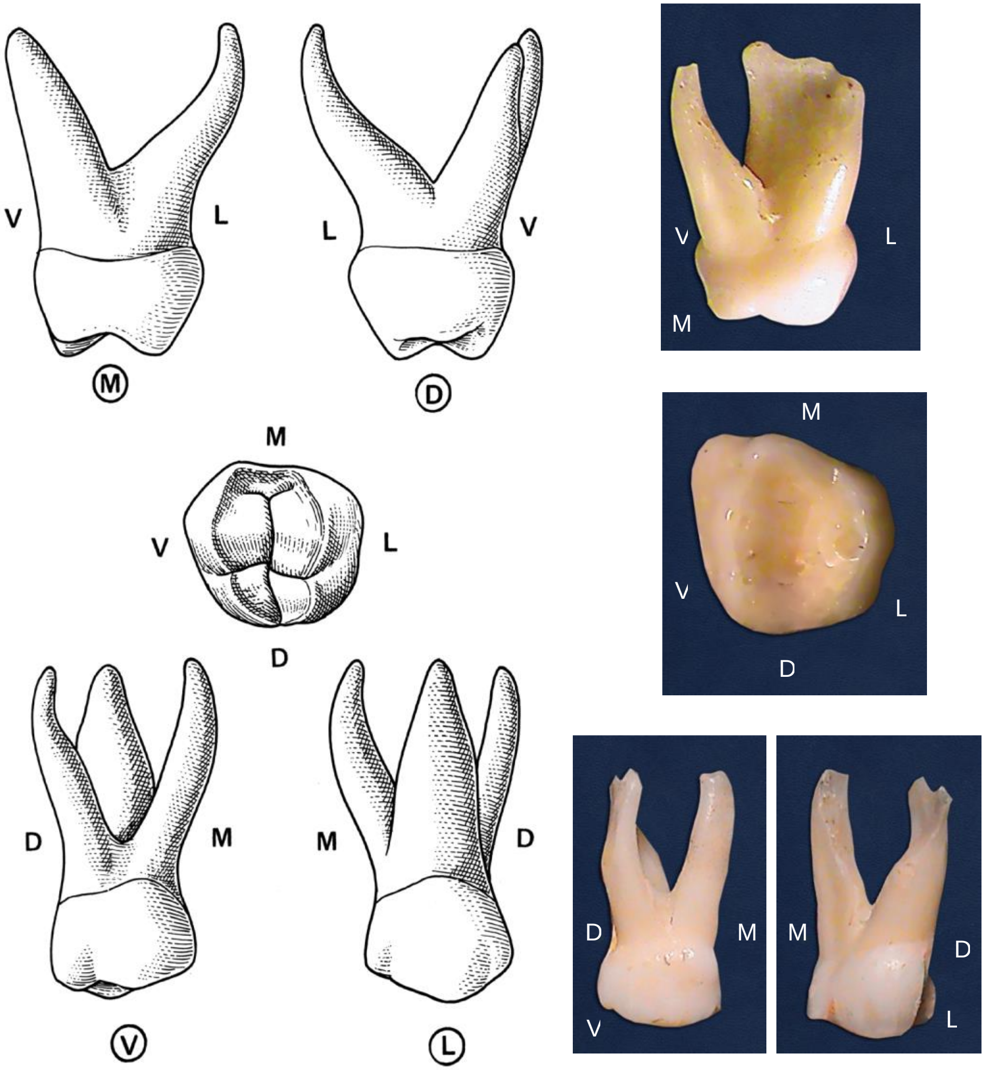


Fig. 4.14. *Anatomical structure of the first maxillary primary molar:*

V – vestibular surface; L – oral surface; D – distal surface; M – medial surface

primary molar is the most developed. It is thicker and longer than the distobuccal one and somewhat flattened in mesiodistal direction. Roots of the first maxillary primary molar can diverge widely, because there is the germ of first permanent premolar between roots of the first maxillary primary molar.

The length of the first maxillary primary molars is 14.2–17.1 mm: crown height – 5.0–6.0 mm, root length – from 9.2 to 12.5 mm. In the first maxillary primary molars three or four (76 %) root canals are identified.

The first mandibular primary molars are slightly smaller than the second mandibular primary molars. Crown has a prismatic shape, significantly elongated in medial-distal direction (Fig. 4.15). There are 4 cusps on occlusal surface. Several fissures, among them longitudinal fissure is the most distinct, delimit two buccal and two lingual cusps. Medial cusps (medial-buccal, medial-lingual) are wider and higher than the distal ones.

Shallow furrow divides the buccal surface into wider medial part and narrow distal part. The lingual surface has a similar appearance.

In precervical area on the buccal surface, there is well-marked enamel bulge, which is the most developed in medial part. As a result of which the first mandibular primary molar has well-expressed sign of the curvature of crown. The buccal surface of crown has a distinct slope towards the occlusal surface.

The first mandibular primary molar has two roots – medial and distal. Medial root is longer and often has a curved distal apex. Longitudinal furrow is determined on its outer surface. The distal root is weaker developed, it is somewhat shorter than medial.

Root divergence in the first mandibular primary is less distinct than in the second mandibular primary molar. The first mandibular primary molar is characterized by larger angle of inclination at the distal root compared to the medial one.

Length of the first mandibular primary molars is 15.6–15.9 mm: height of crown is 6.0–7.1 mm; length of the root is from 8.2 to 9.8 mm. In most cases, three root canals (mesiobuccal, mesiolingual and distal) are defined in the first mandibular primary molar. According to our observations, the first mandibular primary molar quite often (25 %) has four root canals – two in medial and two in distal root. Sometimes (15 %) there is also an additional canal in the area of root bifurcation.

Second primary molars. The crown of ***the second maxillary primary mo- lar*** resembles the crown of first maxillary permanent molar (Fig. 4.16). Occlusal surface of the second maxillary primary molar is shaped like a rhombus. The surface is clearly divided by fissures into four cusps: two buccal (medial, distal) and two palatal (medial, distal). Characteristic feature of the second maxillary primary molar is presence of well-defined ridge connecting medial-palatal and distal-buccal cusps on occlusal surface. Additional fifth cusp (tuberculum Cora- belli) is quite often identified on the palatal surface of medial-palatal cusp, as well as in the first maxillary permanent molar.

Buccal and palatal surfaces of tooth crown are almost square and strongly inclined to the occlusal surface. In the precervical area on buccal surface there is determined enamel bulge. Proximal surfaces of crown of the second maxillary primary molar are convex.

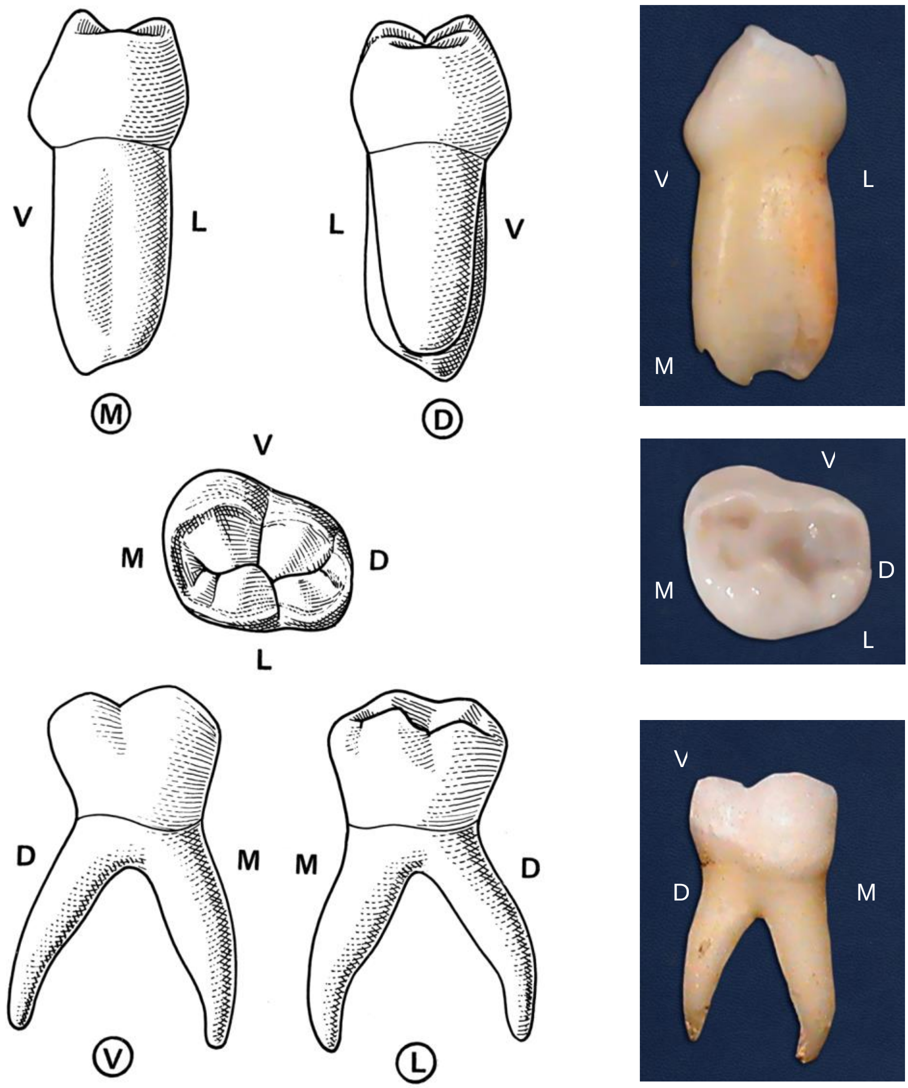


Fig. 4.15. *Anatomical structure of the first mandibular primary molar:*

V – vestibular surface; L –oral surface; D – distal surface; M – medial surface

The second maxillary primary molar has three roots that resemble roots of the first maxillary permanent molar. Root divergence in the second maxillary primary molar is more distinct than in the first maxillary primary molar.

The most developed among roots of second maxillary primary molar is the palatal root. It has rounded shape and distinct angle of inclination to palatal side. In some cases, the palatal root can merge with distobuccal root.

Mesiobuccal root of the second primaryl molar of upper jaw is well developed, more straight and long. The distobuccal root is shorter and can be strongly curved.

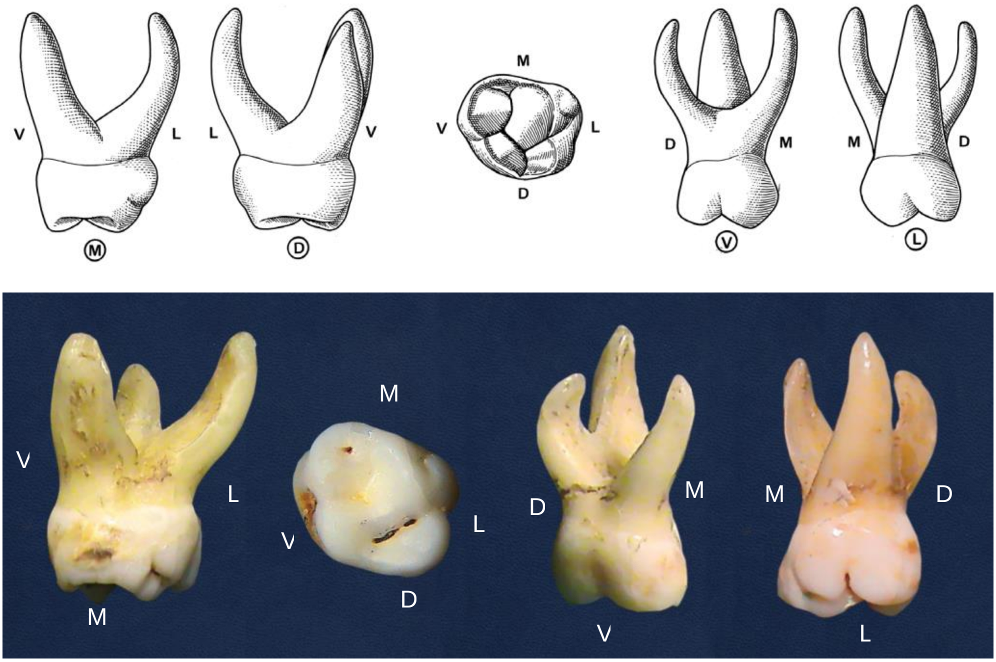


Fig. 4.16. *Anatomical structure of the first maxillary primary molar:*

V – vestibular surface; L – oral surface; D – distal surface; M – medial surface

Length of the second maxillary primary molars is 15.6–17 mm: height of crown is 5.7–6.4 mm, length of root is from 9.6 to 11.7 mm. Four (83 %) or three root canals are most often identified in the second maxillary primary molars.

The second mandibular primary molars are slightly larger than the first mandibular primary molars. Crown of the second mandsbular primary molar resembles crown of the first mandibular permanent molar (Fig. 4.17). On occlusal surface as well as on the first mandibular permanent molar, there are five cusps: three buccal and two lingual. Furrows on occlusal surface are less deep than in the permanent molar.

On the buccal surface, at the point of transition to occlusal surface, there are two well-defined furrows, which distinguish three buccal cusps on occlusal surface. Mesiobuccal cusp is the most developed. A distinct enamel bulge is observed in the area of neck of tooth on the buccal surface of crown. The buccal surface of crown has distinct slope towards occlusal surface.

Lingual cusps are better developed than the buccal ones and protrude more above a level of occlusal surface.

The second mandibuar primary molar has two roots: medial and distal. Roots are flattened in medial-distal direction and somewhat curved in the apical part.

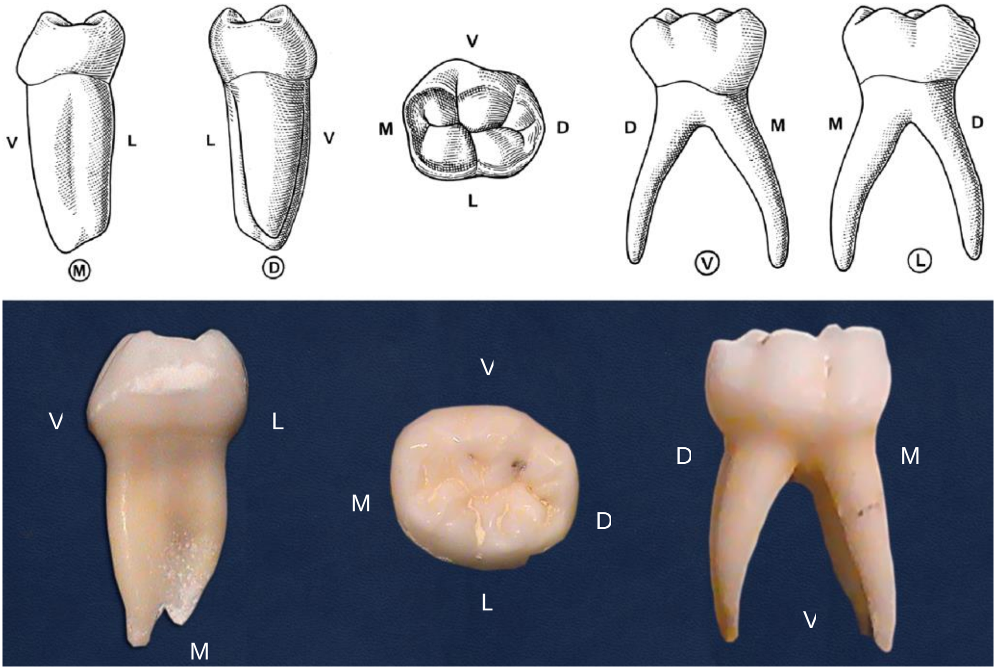


Fig. 4.17. Anatomical structure of the second temporary molar of lower jaw: V – vestibular surface; L – oral surface; D – distal surface; M – medial surface

Root divergence in the second mandibuar primary molar is more distinct than in the first mandibuar primary molar.

Medial root is more straight and somewhat longer than the distal one. Distal root is slightly curved and has more distinct angle of inclination. There is a longitudinal long furrow on outer surface of the medial root. On outer surface of distal root, the furrow is much weaker marked or completely absent.

Length of the second mandibuar primary molar is 17.5–19.5 mm: crown height – 5.5–6.6 mm; root length – from 10 to 11.1 mm. In most cases, the second molar has 3 root canals (82 %) – one distal and two medial (mesiobuccal and mesiolingual). In some cases (26 %) there are 4 root canals in the second primary molars of lower jaw, two of which are located in the distal root.

The bite is considered to be mixed in case when permanent teeth begin to appear next to primary teeth in the oral cavity. This period lasts from 5–6 up to 12–13 years. The change of primary teeth to permanent teeth begins after eruption of the first permanent molars, which do not have precursors - primary teeth. Frontal teeth erupt somewhat behind the corresponding primary teeth. They gradually move along the alveolar ridge and replace primary teeth after their loss. The canines often erupt in front and slightly distal to the primary teeth. Premolars usually erupt in dental arch according to the places of lost primary molars.

Eruption of the first permanent molar before other permanent teeth is physiologically important. During this period of the development of dentition system, the first permanent molars hold the height of bite and ensure correct location of other permanent teeth in a dental arch.

The first permanent molars of upper and lower jaws are in definite articulation relations: medial cusps of maxillary molars are in contact with furrows of mandibular molars. Timely eruption of the first permanent molars ensures normal formation of a dental arch, as well as the establishment of permanent teeth in certain articulatory relations.

Up to age of 6, the height of bite is supported by primary molars, and after 6 years – by first permanent molars. That is why the early loss of first primary molars (before the eruption of second molars) not only significantly reduces chewing efficiency of mixed bite, but also leads to decrease of the height of permanent bite and violation of occlusive relationships.

ANATOMICAL STRUCTURE OF PERMANENT TEETH

Permanent teeth are divided into 4 groups according to their shape, size and functional features: incisors, canines, premolars and molars) Permanent incisors, canines and premolars are formed in place of primary incisors, canines, molars and are referred to as replacing teeth. Permanent molars erupt behind a primary teeth and therefore belong to the additional teeth.

A man has 32 permanent teeth: 4 incisors, 2 canines, 4 premolars, 6 molars (total 16 teeth) on each jaw. In many people, the third molars (called wisdom teeth) do not erupt due to lack of their germs. Such people have 28 teeth. The absence of wisdom teeth, and sometimes lateral permanent incisors and second premolars is the sign of the reduction of dentition, which happens due to changes in nature of nutrition of modern man. In evolution of human dentition, the reduction is also evidenced by decrease in the size and intensity of morphological features of teeth.

Permanent maxillary teeth

A person has 8 permanent incisors. The common thing in anatomy of incisors is shape of the crown, flattened in vestibular-lingual direction at incisal edge, and the presence of single root. The maxillary incisors are larger than mandibular incisors. The largest is the maxillary medial incisor, the smallest is the mandibular medial incisor.

Permanent maxillary central incisor

The permanent maxillary central incisor has trapezoid-shaped crown and one well-developed cone-shaped root (Fig. 4.18). The vestibular surface of crown is somewhat convex, the lingual one – concave.

On the concave lingual surface of crown, there is a small cusp, from which lateral faces branch out, reach- ing incisal edge. The incisal edge is slightly oblique in distal direction, its medial angle is sharp. The root of tooth is straight, slightly flattened in

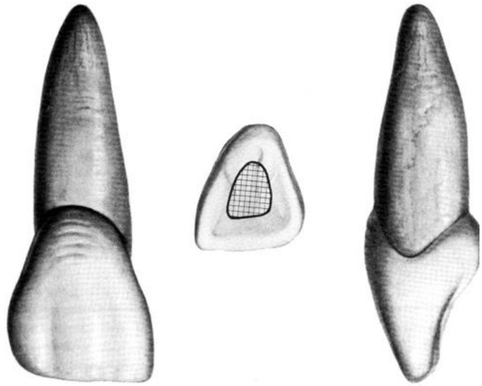


Fig. 4.18. Anatomical structure of the permanent maxillary central incisor

mesiodistal direction and inclined distally from the vertical axis of tooth. The root has an oval shape on cross section. The shape of tooth cavity repeats appearance of its crown and root.

Length of the permanent maxillary central incisors is 22.5–23.7 mm: height of crowns – 8.6–14.7 mm, root length – 6.3–20.3 mm. Root canal in the permanent maxillary central incisor is one, in 75 % of cases it is straight. Apical foramen is located at a distance of 0–1 mm from the top of tooth (apex) in 80 % of cases, in 20 % – 1–2 mm from apex.

Permanent maxillary lateral incisor

The shape of crown of the permanent maxillary lateral incisor is also trapezoid-shaped. Mesial angle is sharpened, distal angle is rounded (Fig. 4.19). Vestibular surface of the crown is convex, lingual surface is concave and bordered by the faces of crown. The lateral bulges of lin- gual surface often converge in the precervical area, forming a triangle, at the top of which there is a recess in enamel – a dental pit. The root is

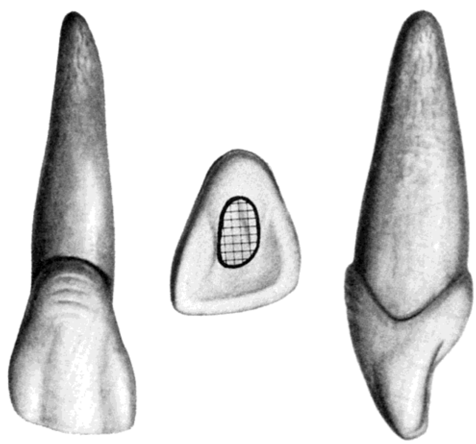


Fig. 4.19. *Anatomical structure of the permanent maxillary lateral incisor*

direction. Longitudinal furrows are defined on lateral surfaces of root. The upper third of root is often inclined in distal-palatine direction. The shape of tooth cavity corresponds to the shape of crown and root.

Length of permanent maxillary lateral incisors is in average 22.0 mm: height of crown – 7.4–11.9 mm, root length is 9.6–19,4 mm. The root canal in permanent maxillary lateral incisor is single, in 30 % – straight, in 50 % – inclined distally.

Permanent maxillary canines

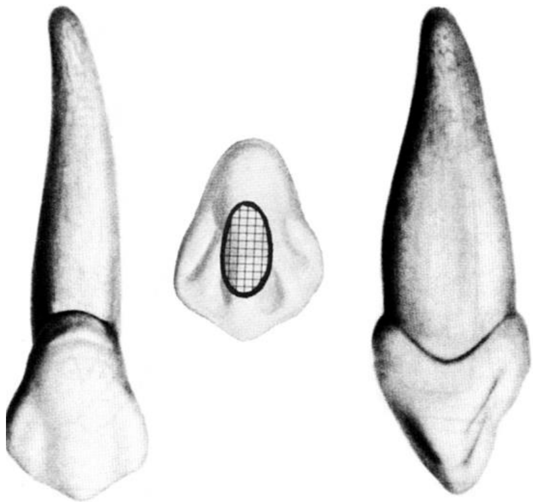


Fig. 4.20. *Anatomical structure of the permanent maxil- lary canines*

A man has 4 permanent canines. The permanent maxillary canine is larger than the permanent mandibular canine. Approximal surfaces of permanent maxillary canine converge more to the neck of tooth, the lingual cusp is better expressed than that of analogous antagonist, which makes it easy to determine whether it is a tooth of upper or lower jaw. The permanent maxillary canine has more sharper crown from all surfaces and a long root. Canine root is massive, cone-shaped, straight, with slight inclination of apex in distal direction (Fig. 4.20). On cross section the shape of root is rounded or oval. Vestibular surface of crown is convex. On the lingual surface of crown, there is longitudinal bulge that divides it into two facets, the lateral one has a large area. The longitudinal enamel bulges of both surfaces pass into cutting cusp. The lateral faces of crown form two angles with incisal edge – mesial and lateral, the mesial one is more obtuse. All three signs are well expressed in the tooth: the angle, the curvature of crown, the incli- nation of root. Tooth cavity follows contours of the crown and root.

Length of permanent maxillary canines is in average 26.5 mm: height of crown – is 8.2–13.6 mm, root length – 10.8–28.5 mm. A canine has only one root canal, in 40 % cases it is straight, in 32 % – inclined distally, in 13 % – vestibularly.

Permanent maxillary first premolar

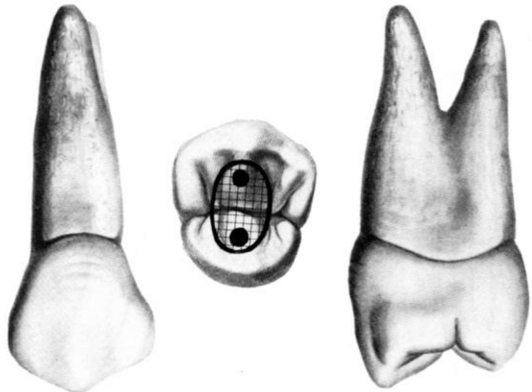


Fig. 4.21. Anatomical structure of the first premolar of the upper jaw

The crown of permanent maxillary first premolar has prismatic shape, buccal and lingual surfaces are convex (Fig. 4.21). On occlu- sal surface, there are two cusps – buccal and palatal, buccal is more distinct. Furrow (fissure) is locat- ed between cusps in mesio-distal direction. The permanent maxil- lary first premolars are larger than the mandibular. The largest is the permanent maxillary first premolar, the smallest is the permanent mandibular first premolar.

Root of permanent maxillary first premolar is flattened, on its wide lateral surfaces there are deep longitudinal furrows, that begin to divide root into two roots in the neck area: buccal and palatal. The palatal root is more developed. The shape of tooth cavity resembles the shape of it crown. The buccal horn of pulp is placed closer to occlusal surface. There are two root canals: palatal and buccal.

Length of permanent maxillary first premolar is 20.6–22.3 mm: crown height – 7,1–11,1 mm, root length – 8,3–19,0 mm. There is more often (up to 60 %) a variant of a tooth with two divergent roots. A single-root variant with one or two root canals occurs in 18 % of cases.

Permanent maxillary second premolar

Crown of the permanent maxillary second premolar has prismatic shape. On occlusal surface there are two cusps, the buccal is more developed (Fig. 4.22). The cusps are separated by a transverse furrow (fissure), passing along central occlusal surface. Buccal surface of the crown is larger than the lingual one. The medial part of vestibular surface of crown is less convex compared to the distal one (the reverse sign of crown curvature). Root is often single, cone-shaped, straight, flat- tened in the mesiodistal direction, with wide lateral surfaces on which shallow longitudinal furrows are placed. Sometimes closer to the top there is a bifurcation of root, forming two tops.

The shape of tooth cavity resembles the shape it crown. The buccal horn of pulp protrudes more than the palatial one. There can be one or two root canals:

buccal and palatal (approximately in 50 % of cases).

Length of permanent maxillary second premolar is 21.5–22.3 mm: crown height – 5.2–10.5 mm, root length – 8.0–20.6 mm. The permanent maxillary second premolar can have one or two roots. The variant with one or two canals, which ends with a single apical foramen, occurs in 75 % of cases. In other cases, separate canals are determined in this tooth.

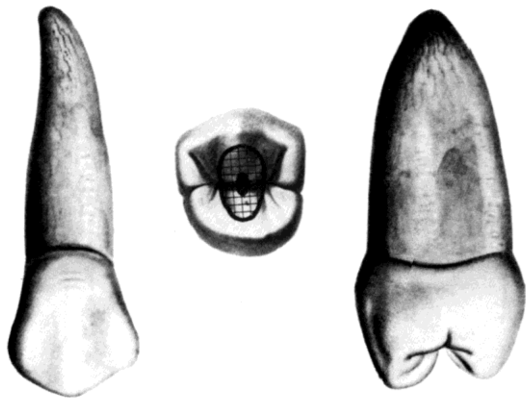


Fig. 4.22. *Anatomical structure of the second premolar of upper jaw*

Permanent maxillary first molar

The first permanent molar is the largest among molars of upper jaw. Crown has shape of a rectangle (Fig. 4.23). There are four cusps on rhomboid occlusal surface: two palatal and two, more developed, buccal. Among buccal cusps, the mesiobuccal is more developed than the distobuccal. Cusps are separated by H-shaped fissure. In the mesiopalatal cusp there is a shallow arcuate furrow sep- arating the small additional cusp (tuberculum anomale Corabelli), not reaching occlusal surface.

The shape of tooth cavity resembles the shape of crown. The buccal horns of pulp, especially mesiobuccal, protrude more. The permanent maxillary first molar has three roots. The palatal root is more massive, rounded and straight. Other two, buccomedial and buccodistal, are short, flattened laterally and inclined distally. Mesiobuccal root is more developed than the distobuccal. Sometimes (approximately in 25 %) it has two root canals.

Length of permanent maxillary first molars is 20.8–22.0 mm (crown height – 6.3–9.6 mm). The permanent maxillary first molar has 3 canals – in 70 % of cases, 4 canals – in 29 %, 5 canals – in 1% of cases. The long palatal canal is straight, the buccal-distal canal is short, with distal inclination.

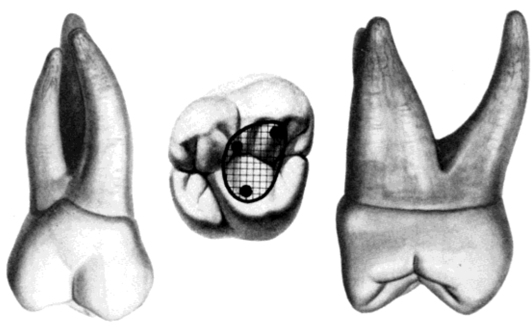


Fig. 4.23. *Anatomical structure of the first molar of upper jaw*

Permanent maxillary second molar

The crown of permanent maxillary second molar is cube-shaped. On occlusal surface there are four cusps, separated by X-shaped fis- sure (Fig. 4.24). Buccal cusps are more developed than the palatal ones. The buccomedial cusp is the largest. Number of cusps and loca- tion of fissures may vary.

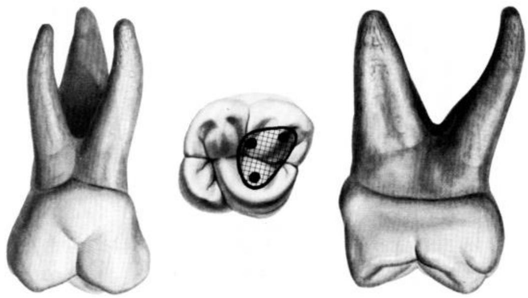


Fig. 4.24. *Anatomical structure of the second molar of upper jaw*

The permanent maxillary second molar has three roots. The palatal root is massive, straight, good to pass. Two buccal roots (medial and distal) are flattened, inclined distally. Mesial roots may have several root canals and apical foramens.

Length of permanent maxillary second molar is 22.0–22.3 mm (crown height – 6,1–9,4 mm). The permanent maxillary second molar has 3 canals (in 87 % of cases) and 4 canals (in 13% of cases). The long palatal canal is straight, the buc- cal-distal canal is short, with a distal inclination.

Permanent mandibular teeth

Permanent mandibular incisors

Permanent mandibular central incisor is the smallest tooth of permanent bite and the smallest incisor (Fig. 4.25). Trapezoid-shaped narrow crown of the tooth is relatively high, its vestibular sur- face is somewhat convex, the lingual, on contrary, is concave. Three small incisal ridges are clearly visible on incisal edge of the crown. Medial and distal angles of the crown almost do not differ from each other. On the vestibular surface, incisal ridges of the incisal edge pass into

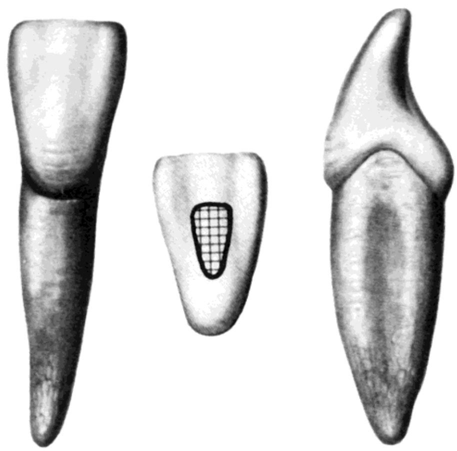


Fig. 4.25. *Anatomical structure of the permanent mandibular central incisor*

Root is relatively short, flattened in the medial-distal direction, on the cross section it has an oval shape. There are almost unseen signs of crown curvature and root inclination. In general, the shape of tooth cavity corresponds to its external shape. The root apex can be inclined to median (medial) plane.

The length of premanent mandibular central incisors is 20.7–21.8 mm: height of the crown – 6.3–11.6 mm, length of the root – 7,7–17,9 mm. There is one root canal in the premanent mandibular central incisor in 65 % of cases, in 35 % – there are two (labial and lingual).

Permanent mandibular lateral incisor

Permanent mandibular lateral incisor is slightly larger than the central one. The crown is also trapezoid-shaped, flattened at incisal edge (Fig. 4.26). On the vestibular surface of the crown of newly erupted tooth, small longitudinal bulg- es are located, ending at the incisal edge with well-marked three incisal ridges. Incisal edge differs in the angles: the dis- tal angle is obtuse, somewhat rounded, protrudes into canine side, the mesial angle is sharper.

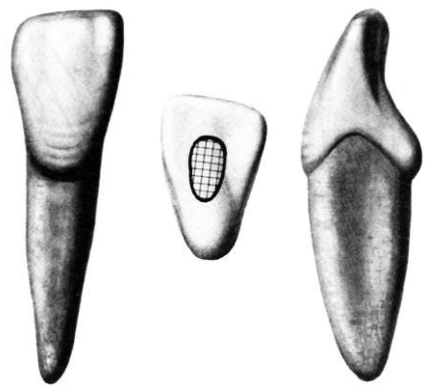


Fig. 4.26. *Anatomical structure of the permnent mandibular lateral incisor*

The tooth has one straight root, flattened from sides, with longitudinal furrows on the lateral surfaces, it has an oval shape on cross section. Apex of the root is inclined distally. The cavity of tooth crown has slit-like shape, the root canal is narrow.

The length of premanent mandibular lateral incisors is 21.1–23.3 mm: height of crown – 7.3–12.6 mm, length of root – 9,4–18,1 mm. There is one root canal in the premanent mandibular lateral incisor in 57 % of cases, in 43 % – there are two - labial and lingual.

Permanent mandibular canine

The structure of permanent mandibular canine resembles the corresponding tooth of upper jaw, but has slightly smaller size (Fig. 4.27). The crown is partially rhomboid, it is narrower, and its vestibular surface is convex. On the incisal edge there is central cusp. The medial part of incisal edge is shorter than distal, and therefore the medial angle is sharper and farther from the neck of the tooth.

The root is somewhat flattened laterally, it has an oval shape on cross section. The apex of root is inclined distally. The tooth cavity has fusiform shape with the greatest thickening in the neck area.

The length of the premanent mandibular canine is 25.5–26.0 mm: height of crown – 6,8–16,4 mm, root length – 9.5–22.2 mm. There is one root canal in the premanent mandibular canine in 97 % of cases, in 3 %
– there are two canals.

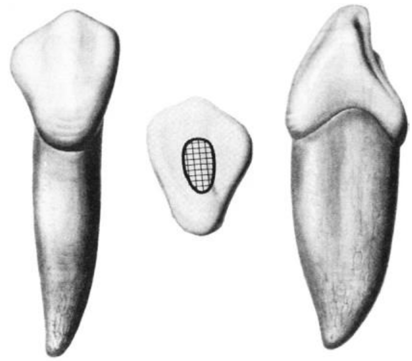


Fig. 4.27. *Anatomical structure of the permanent mandibular canine*

Permanent mandibular first premolar

On cross section, crown of the premanent mandibular first premolar has rounded shape (Fig. 4.28). The vestibular surface of the crown is longer than lingual. There are two cusps on occlusal surface of tooth: buccal (larger), signifi- cantly inclined to middle, and lingual, whose slope is less distinct. The cusps of occlusal surface are connected with each other by a shaft, along the side of which there are small pits. Due to different size of cusps, occlusal surface is somewhat oblique to the lingual side. There is one, straight, slightly flattened root, the apex
is inclined in distal direction. The cavity of tooth corresponds to its external outlines. The crown part of the tooth cavity passes into root canal without clear border.

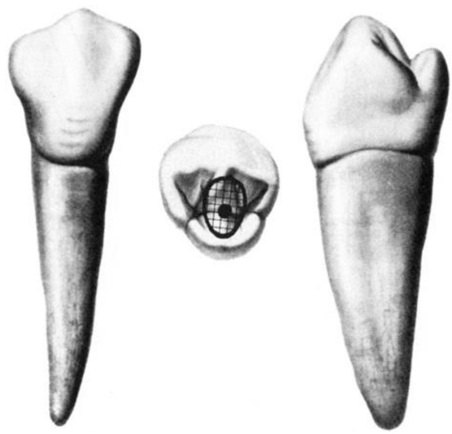


Fig. 4.28. *Anatomical structure of the permanent mandibular first premolar*

The length of premanent mandibular first premolar is 21.6–22.9 mm: crown height – 5,9–10,9 mm, root length – 9,7–20,2 mm. There is more often (80 % of cases) variant of the tooth with one root canal, with two root canals – 19 %, with three root canals – 1 %.

Permanent mandibular second premolar

Shape of the crown of permanent mandibular second premolar is somewhat similar to the shape of canine, but not so rounded on cross section (Fig. 4.29). The permanent mandibular second premolar is slightly larger than the first. Cusps, located on the occlusal surface, are developed in the same way, sep- arated by an enamel bulge, on sides of which there are small pits.

The root is usually single, somewhat flattened, with smooth lateral surfaces. The apex of root is inclined distally.

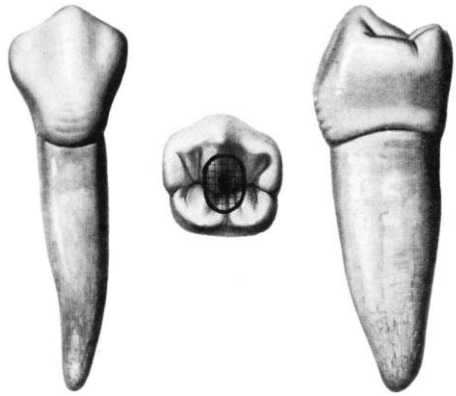


Fig. 4.29. *Anatomical structure of the permanent mandibular second premolar*

The length of the premanent mandibular second premolar is 22.3 mm: crown height – 6,7–10,2 mm, root length – 9,2–21,2 mm. The most common variant of tooth with one root canal happens in 97 % of cases, with two (buccal and lingual) – in 3 % cases.

Permanent mandibular first molar

Shape of the crown of premanent mandibular first molar is cubic (Fig. 4.30). On occlusal surface of the tooth there are five cusps: three buccal and two (more developed) lingual.

Among buccal cusps, the distal one is the most distinct. Cusps are separated by Ж-shaped fissure, the longitudinal part of which reaches enamel bulges located on the crown edge. Transverse fissures of occlusal surface can pass to vestibular surface and end with small dental pits.

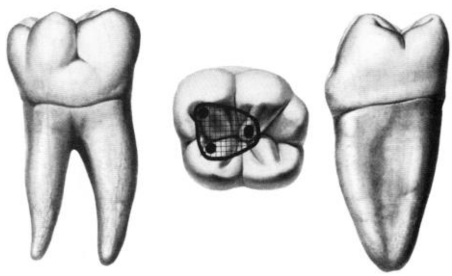


Fig. 4.30. *Anatomical structure of the permanent mandibular first molar*

The distal root is somewhat shorter than the medial one, smooth, with one root canal. The medial root is flattened, with deep longitudinal furrows on broad lateral surfaces, arched, has two root canals (medial-buccal and medial-lingual).

The length of premanent mandibular first molar is 21.0–22.0 mm (crown height – 6.1–9.6 mm). The premanent mandibular first molar has three canals – in 87 % of cases, 4 canals – in 13 % of cases.

Permanent mandibular second molar

The permanent mandibular second molar is smaller then the first in size, it has the similar crown shape and number of roots (Fig. 4.31). Four cusps – two buccal and two lingual – are located on the occlusal surface of cubical, some- what elongated in mediodistal direction crown, and lingual cusps are better de- veloped. The longitudinal fissure on oc- clusal surface is placed closer to lingual edge. The transverse fissure may extend

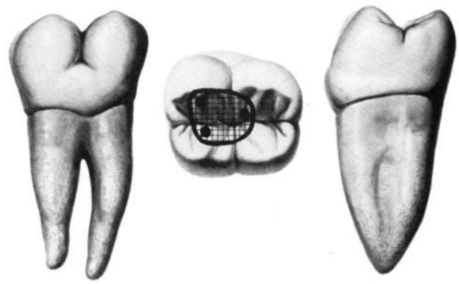


Fig. 4.31. *Anatomical structure of the permanent mandibular second molar*

to vestibular surface of the crown and end with dental pit.

The tooth has two roots – medial and distal. The distal root is large, straight, it has rounded or oval shape on a cross section. The medial root is flattened in mesiodistal direction, there are small furrows on its lateral surfaces. The root apex is inclined distally.

Root canals (mesiobuccal and mesiolingual) are curved, poorly passable.

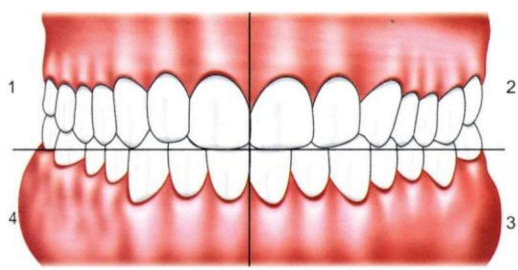
The length of premanent mandibular second molar is 19.8–21.7 mm (crown height – 6.1–9.2 mm). The premanent mandibular second molar has 3 root canals in 85 % of cases, 4 canals – in 10 %, 1 canal – in 5 % of cases.

Tooth Notaton Systems

Tooth notation system is method for the graphical designation of certain teeth in medical records, scientific publications and educational literature. The Tooth notation system is used to designate both permanent and temporary teeth.

The human jaw consists of two parts: maxillary, referring to upper jaw, and mandibular, referring to lower jaw.

The maxillary is divided into two quadrants called upper left quadrant and upper right quadrant. The mandibular is divided into lower left and lower right quadrants.



There are several ways (systems) of designation teeth and records of the dental formula.

1. **Zsigmondy-Palmer nota- tion system.** In this system, which

Fig. 4.32. *The division of the dentition into four quadrants:* 1 *– upper right;* 2 *– upper left;* 3 *– lower left;* 4 *– lower right*

was proposed in 1800s, the mouth is divided into 4 sections called the quadrants (Fig. 4.32).

The system uses a unique ‘L’ shaped symbol/grid. (┌, ┐└, ┘) to depict in which quadrant the specific tooth is found. The vertical line segment of the ‘symbol’ indicates the patient’s midline and the horizontal line indicates the occlusal plane that separates upper and lower arches. The counting always begins at the midline and progresses backwards. Numbers 1 through 8 are used to denote the perma- nent teeth in each quadrant. The numbers indicate position of the tooth from the midline.

The symbols used to denote quadrants in Zsigmondy-Palmer system:

Maxillary right quadrant.................. ┘

Maxillary left quadrant.....................└

Mandibular right quadrant................ ┐

Mandibular left quadrant.................. ┌

Symbol indicates the quadrant in which specific tooth is found and the number indicates position of the tooth from midline.

Zsigmondy-Palmer notation for permanent dentition is as follows:

Upper right	Upper left
7654321	1234567

Individual teeth are represented by writing the specific tooth number inside symbol of the quadrant.

For example, Maxillary right central incisor – 1┘

Mandibular left 1st molar – ┌6

When recording teeth of mixed bite, Arabic and Roman numerals are put into the formula according to the location of temporary and permanent teeth.

Zsigmondy-Palmer notation for primary dentition is follow:

E B C B A A B C D
E E D C B A A B C
D E

Individual teeth are denoted by placing the letter of specific tooth inside the quadrant symbol (Fig 4.33).

Permanent teeth

Right	Left
18 17 16 15 14 13 12 11	21 22 23 24 25 26 27 28
48 47 46 45 44 43 42 41	31 32 33 34 35 36 37 38

Primary teeth

Right	Left
55 54 53 52 51	61 62 63 64 65
85 84 83 82 81	71 72 73 74 75

Examples:
Permanent upper right central incisor = 11, pronounced “one-one”
Primary lower left second molar = 75, pronounced as “seven-five”

Fig. 4.33. Zsigmondy-Palmer tooth notation system

FDI Notation System (International Federation of Dentists) and WHO

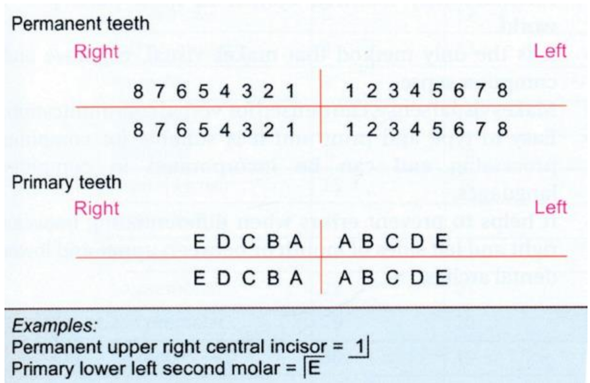


Fig. 4.34. FDI tooth notation system

The FDI system uses two-digit for each tooth – permanent and primary. The first-digit always denotes the quadrant: each quadrant is assigned a number 1 to 4 for the permanent dentition and 5 to 8 for the primary dentition. The quadrant code denotes the dentition, arch and side in which the tooth is present.

The second digit denotes the tooth (1 to 8 for permanent teeth and 1 to 5 for deciduous teeth). Teeth are numbered from midline to posterior. The two-digit combination of quadrant code and tooth code gives the notation of specific tooth (Fig. 4.34).

FDI notation for the whole permanent dentition is as follows:

Right	Left
18 17 16 15 14 13 12 11	21 22 23 24 25 26 27 28
48 47 46 45 44 43 42 41	31 32 33 34 35 36 37 38

For temporary teeth, number 5 representing the maxillary right quadrant, 6 representing the maxillary left quadrant, and 7 and 8 representing the mandibular right and left quadrants, respectively. The second digit in the number represents the tooth number. *As an example*, tooth 62 represents the maxillary left lateral incisor, and tooth 85 represents the mandibular right second molar. Pronunciation of the numbers is by digits; so tooth 62 is pronounced as "six, two," not "sixty-two," and tooth 85 is pronounced as "eight, five," not "eighty-five."

Upper right 55	Upper left
85 84 83 82 81	71 72 73 74 75

Control questions

1. Describe the main components of a tooth.
2. Name crown"s surfaces of teeth – incisors, canines, and molars.
3. Describe the main anatomical elements of tooth crown.
4. What is a "contact point"?
5. Describe the signs of crown angle, crown curvature and root inclination.
6. List the differences between temporary and permanent teeth.
7. Describe the anatomical structure of temporary incisors and canines.
8. Describe the anatomical structure of temporary molars.
9. Describe the anatomical structure of permanent incisors and canines.
10. Describe the anatomical structure of permanent molars and premolars.

Self-control tests

1. **Permanent tooth has a trapezoidl-shaped crown and one well-developed cone-like root. The vestibular surface is convex. There is cusp on the palatal surface. The incisal edge is distally oblique. The medial angle of crown is slightly sharper than the distal. Anatomical structure of what tooth is described?**

A. Maxillary permanent central incisor
B. Mandibular permanent central incisor
C. Maxillari permanent lateral incisor
D. Mandibular permanent lateral incisor
E. Maxillary permanent canine

2. **The crown part of temporary tooth has prismatic, elongated shape. There are 4 cusps on the occlusal surface: two buccal and two lingual. The mesial cusps are more developed than the distal ones. On the buccal surface of crown part in the cervical area, there is enamel bulge. How many roots does this tooth have?**

A. One
B. Two
C. Three
D. Four.

3. **The crown part of permanent tooth has rectangular shape. On the rhomboid occlusal surface there are 4 cusps, separated by H-shaped fissure. The mesio-palatal cusp has a small additional cusp, separated by small arcuate furrow. Anatomical structure of what tooth is described?**

A. Mandibular permanent second molar
B. Maxillary permanent second molar
C. Maxillary permanent first molar
D. Mandibular permanent first molar

4. **Dentist performs instrumental and medical treatment of root canals of the maxillary primary first molar for a 6-year old child. How many roots and canals does this tooth have?**

A. 3 roots and 3 canals
B. 3 roots and 2 canals
C. 2 roots and 3 canals
D. 2 roots and 2 canals.

5. **The incisal edge of primary tooth has sharp incisal ridge that divides the vestibular surface into two parts: short medial and wider distal. In the cervical area of tooth there is an enamel convex bulge. The root of tooth is rounded with one canal. Anatomical structure of what tooth is described?**

A. Maxillary primary central incisor

B. Mandibular primary central incisor

C. Maxillary primary lateral incisor

D. Mandibular primary lateral incisor

E. Maxillary primary canine

7. **The crown part of a permanent tooth has cubic shape. On the occlusal surface, 4 cusps are placed, sepa- rated by X-shaped fissure. The buccal cusps are more developed than the palatal ones. The buccomedial cusp is more distinct than the others. How many root canals does this tooth have?**

A. One B. Two C. Three D. Four.

8. **Dentist performs endodontic treatment of the permanent maxillary first premolar. How many roots and canals does this tooth have?**

A. 1 root and 1 canal B. 1 root and 2 canals C. 2 roots and 2 canals
D. 2 roots and 3 canals E. 3 roots and 3 canals.

9. **The distal root of permanent tooth is straighter and somewhat shorter than the medial one. It often has one root canal. The medial root is flattened, with deep longitudinal furrows on lateral surface. It has 2 root canals opening at the apex with two isolated foramens. Anatomical structure of what tooth is described?**

A. Mandibular permanent first molar B. Maxillary permanent first molar
C. Mandibular permanent second premolar D. Maxillary permanent second premolar
E. Maxillary permanent first premolar

10. **The crown part of permanent tooth has trapezoid-like shape. The medial angle of crown is pointed, the distal one is rounded. Vestibular surface of crown is convex. Palatal surface is concave, it has lateral bulges that converge in precervical region, forming triangle. with pit at its apex. The root of tooth is significantly flattened. On its lateral surfaces there are longitudinal furrows. The upper third of root is inclined in distal-palatine direction. Anatomical structure of what tooth is described?**

A. Maxillary permanent canine B. Maxillary permanent lateral incisor
C. Mandibular permanent lateral incisor D. Maxillary permanent central incisor
E. Mandibular permanent central incisor

Correct answers to test tasks to the section "The anatomical structure of primary and permanent teeth"

1-A, 2-B, 3-C, 4-A, 5-E, 6-C, 7-C, 8-C, 9-A, 10-B