

UDC: 616.724-008.6-073.7-089.23-76  
[https://doi.org/10.32345/USMYJ.1\(149\).2024.12-18](https://doi.org/10.32345/USMYJ.1(149).2024.12-18)

Received: May 31, 2024  
Accepted: September 01, 2024

## Occlusal therapy in patients with temporomandibular joint dysfunction and occlusal and articulatory disorders

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*Abstract: the article presents a statistical analysis of the assessment of the impact of various factors that led to occlusal and articulatory disorders and functional disorders of the masticatory apparatus on the choice of occlusal constructions therapy for the treatment of temporomandibular joint dysfunction. For conducting the research, a clinical and laboratory examination was carried out and orthopedic treatment of 150 patients with various occlusal options violations Variants of occlusion therapy are described and given characteristic.*

**Keywords:** [Dental Arch/diagnostic imaging](#), [Models, Dental](#); [Occlusal Splints](#), [Temporomandibular Joint Dysfunction Syndrome](#); [Temporomandibular Joint Disorders / therapy](#); [Traumatic Dental Occlusion](#); [Vertical Dimension](#).

### Introduction

Temporomandibular disorders and temporomandibular joint (TMJ) dysfunction, in particular, is a common pathology among patients not only of dentists, but also of doctors of related specialties – neuropathologists, otorhinolaryngologists, therapists. This pathology doesn't threaten the patient's life, but it can significantly negatively affect the quality of his life, primarily due to the long-term existence of a debilitating pain syndrome. Thus, a recent large multicenter prospective cohort study in the United States (the OPPERA research) showed that each year 4% of adults aged 18–44 years without previously diagnosed TMJ dysfunction develop a clinically confirmed tempo-

mandibular pain syndrome for the first time, and the annual incidence of such cases increases with age: 18–25 years – 2.5%; 35–44 years old – 4.5%). Overall, 19% of adults demonstrated symptoms of temporomandibular disorders (orofacial pain at least 5 episodes per month for one or more months) (Slade GD et al., 2013; Kim JE et al., 2019).

Various modifications of occlusive devices are widely used to treat TMJ dysfunction. Several recent systematic reviews on the effects of occlusive therapy on pain in temporomandibular disorders confirm that a stabilizing splint leads to improvement compared with no treatment, physical therapy, behavioral therapy, and acupuncture, but at the same time, when compared with placebo (a non-oc-

clusive palatal splint), the evidence was inconclusive (List T. & Axelsson S., 2010). However, the treatment effect from the stabilization mechanism is not fully understood.

Most studies evaluating the effects of treatment do not take into account etiopathogenetic mechanisms and the predominance of muscle or joint components. Thus, some studies prove the effectiveness of night-time occlusive splints for myogenic pain, and round-the-clock splints for arthrogenic pain (Wassell RW et al., 2014). And splints that do not cover the entire chewing surface and splints that are not selected by the doctor, as well as nociceptive inhibition of the trigeminal nerve can be associated with undesirable occlusal changes (Brown JL et al., 2020; Cadar M, Almășan O., 2024). Controversial issues remain regarding the factors influencing the effectiveness of splints in TMJ dysfunction, for example, reduced masticatory muscle activity, change in proprioceptive influence due to occlusal obstacles, changes in intra-articular head-socket ratios, occlusion stabilization effect, increase in interalveolar height, as well as the placebo effect (Dimitroulis G., 2018; Duman F, et al., 2020; Proshchenko A.M. et al., 2024).

#### **Aim**

The aim of the research was to evaluate the predictors of choosing the stage of occlusion therapy with the help of removable or non-removable occlusion structures in the orthopedic treatment of functional disorders of the masticatory apparatus caused by occlusal and articulatory disorders.

#### **Materials and methods**

In order to solve the task of our research, a prospective examination and treatment of 150 patients with TMJ dysfunction and various variants of occlusal disorders was carried out. Exclusion criteria were injuries, TMJ arthritis of infectious or autoimmune origin, severe somatic diseases, refusal of patients to participate in the study.

Factors that can potentially be associated with the choice of occlusive therapy design were identified during a clinical dental examination, during additional research methods – electromyography using the TEETHAN device, cone-beam CT of the TMJ, T-Scan computer occlusion analysis system.

Statistical analysis was performed in R statistical programming (r-project.org, ver. 4.0). The method of univariate binary logistic regression

analysis with odds ratio calculation was used to assess the impact of each of the predictors. The results were considered statistically significant at  $p < 0.05$ . The magnitude of the effect was determined by the magnitude of the odds ratio (OR, 95% confidence interval). This method uses the binomial theory of probability, in which there are only two values for the forecast: the probability is 1 or 0, that is, the event belongs to only one or the other group. At the same time, logistic regression uses the maximum likelihood method, which allows you to increase the probability of classifying the observed data into a certain category using regression coefficients.

The conduct of the study was coordinated with the commission on bioethical expertise and ethics of scientific research of Bogomolets National Medical University (protocol No. 185 dated 05/27/2024), the study was conducted with the informed consent of the patients and in compliance with the principles of bioethics and patient rights.

#### **Results and their discussion**

During the initial examination, we assessed signs of TMJ dysfunction with a predominance of muscular or articular components. First of all, the presence of pain syndrome was established in 60 patients (40.00%), and in 22 patients (14.67%) its duration was up to 2 months. 19 patients (12.67%) had pain syndrome for about 2-6 months and other 19 patients (12.67%) complained of pain for more than half a year. The intensity of pain sensations was assessed using the visual analog pain (VAP) scale. TMJ pain was found in 30 (20.00%) patients, in masticatory muscles in 43 patients (28.67%), headache in 47 patients (31.33%).

During bimanual palpation of the masticatory muscles at rest and during contraction, their tone, presence of hypertrophy and segmentation, the number of sensitive muscle points – trigger pain points, the intensity of sensitivity in the most sensitive point, and the range of pain-free opening of the mouth were determined. Hypertonus of the masticatory muscles was established – 94 patients -62.67% with their hypertrophy – 46 patients -30.67%, both unilateral and bilateral, which were observed simultaneously with the parafunction of the masticatory muscles (34- patients 22.67%). These data were confirmed by additional examination methods. When analyzing the neuromuscular and occlusal characteristics of the dental and jaw

apparatus of patients by the electromyography method using the TEETHAN device, an imbalance of the symmetry of muscle activity in correlation with the occlusal component was established in 122 patients -81.33% and moderate (76 patients -50.67%) and severe (74 patients -49.33%) imbalance of muscle activity of masticatory muscles according to the total index.

Therefore, the obtained data indicate the presence of a muscular component in the pathogenesis of TMJ dysfunction to a greater or lesser extent, and the absence of pain syndrome indicates only a temporary compensation of an already initiated pathological process and thereby justify the need for occlusion therapy for the relaxation of individual masticatory muscles and the formation of harmonious work of all their groups during chewing, speaking with the formation of a new myotatic reflex. When palpating the TMJ, the presence of a pathognomonic sign of functional disorders of the maxillofacial apparatus was evaluated – the presence of crunching and clicking in the joint (89 patients – 59.33%) – unilateral or bilateral, during opening or closing of the mouth and articulation of the lower jaw. An equally important sign was the limitation of opening the mouth, which was present in 57 patients – 38.00%, and in 22 patients – 14.67% it was less than 2.5 cm. These clinical signs indirectly indicated a functional stable displacement of the lower jaw – 135 patients -90.00%, which can be significant – 57 patients – 8.00%; or insignificant – 78 patients -52.00%.

This was also confirmed by the data of cone-beam tomography with an assessment of intra-articular ratios (the ratio of the anterior/posterior and lateral/medial articular spaces in each joint was calculated, as well as the ratio of the upper articular space to the average value of the anterior and posterior spaces was calculated, which indirectly indicated a deficiency of the interalveolar altitude). When assessing the clinical situation in the oral cavity at the stage of planning orthopedic treatment, a decrease in the interalveolar height was established in 85 patients (56.67%) from moderate (0.5-2.5 mm – 67 patients -44.67%) to significant (2.5 mm and more – 18 patients -12.00%), excessive abrasion of the chewing surface of teeth with exposed dentin (133 patients – 88.67%), especially generalized form (74 patients -49.33%),

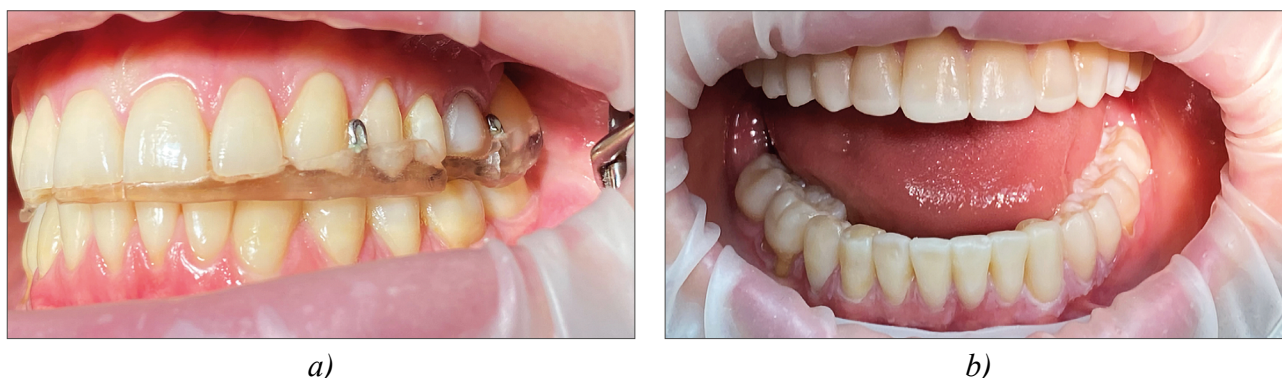
pathological types of bite – 55 patients -36.67%, presence supracontacts – 145 patients -96.67%, which apparently arose due to dento-jaw deformations – 67 patients -44.67%, multiple defects of tooth rows – 41 patients -27.33%, irrationally modeled chewing surfaces on direct and indirect restorations 121 patients – 0, 67%.

Thus, violations of the occlusal-articulation relations lead to a violation of the functioning of the entire dental and jaw apparatus, affecting the change of intra-articular relations and the work of the masticatory muscles, with the predominance of this effect on the muscular or articular component (Cadaru, M., & Almășan, O. 2024). At the same time, temporomandibular disorders are a multifactorial pathological process and depend on internal and external modified and unmodified factors: traumatic injuries of the maxillofacial area, orthopedic dental treatment, migraine, insomnia, depression, irritable bowel syndrome, fibromyalgia, systemic autoimmune pathology, genetic determinants, age.

At the same time, the planning of orthopedic treatment must necessarily take into account the undeniable influence of occlusal disorders caused by defects of the teeth and dental rows, dental and jaw deformities, iatrogenic causes due to orthodontic and orthopedic treatment on the formation of intra-articular disorders with and without pain syndrome. And it is advisable to start precisely with the normalization of TMJ and masticatory muscles, which is achieved in these cases by occlusion therapy.

In our research, we used permanent mouthguards in 53.33% (80 patients): in 41 (68.33%) – patients with pain syndrome and in 39 (43.00%) patients without it (Fig. 1a). For the rest of the patients (70–46.67%), the manufacture of non-removable temporary structures was used – occlusion therapy from protemp 4 material (full or partial Mock-up) (Fig. 1b).

Mock-up structures were digitally modeled in the Exo-Cad software: first, the new articulation-occlusion relationships of the upper and lower jaws were modeled in a constructive bite with the necessary increase in the interalveolar height, after which the models were printed on a 3D printer. In the clinic, a silicone two-layer impression was obtained from the models, filled with protemp 4 material and positioned on the jaw. Made in a direct



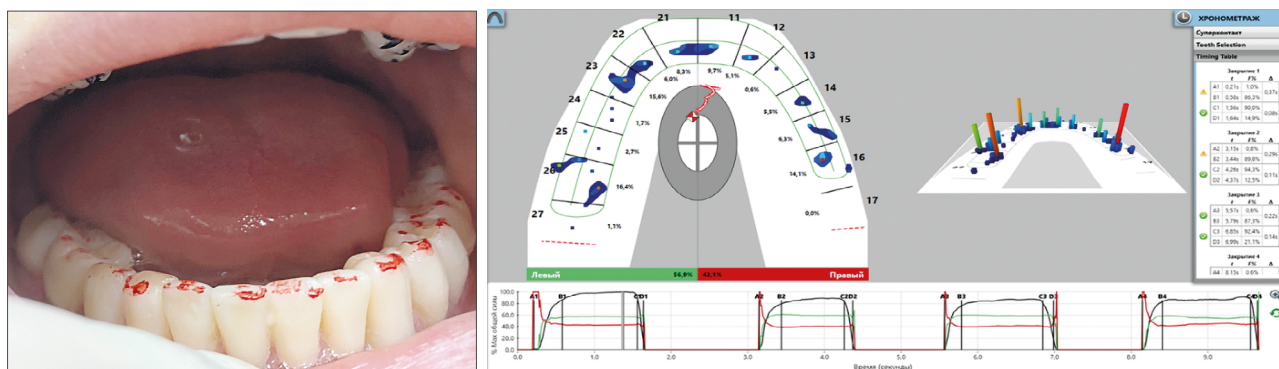
**Figure 1.** Image of occlusive devices for orthopedic treatment of patients with TMJ dysfunction and occlusal-articulation disorders (*a* – permanent splint on the upper jaw, *b* – complete Mock-up)

way – in the oral cavity, temporary occlusion therapy structures were fixed in the oral cavity with the help of an adhesive system or temporary cement. The criterion for effective transfer of occlusion-articulation ratios from 3D models to temporary structures was the same location of contact points both on the models and in the oral cavity.

The aim of occlusion therapy as a stage of orthopedic treatment is to restore the physiological position of the head of the lower jaw in the TMJ, stabilize the lower jaw and relax the tension of the masticatory muscles and gradually form a physiological myotatic reflex and balanced harmonious work of the TMJ and masticatory muscles. This stage involves a consistent change and restoration of the physiological movements of the lower jaw under the influence of the formation of new occlusal-articulation relationships. This is achieved by directing the movements of the lower jaw along the created inclined planes on the occlusal apparatus, their dynamic correction – polishing and modeling of the chewing surface of the splint or Mock-up (change of centric and eccentric contacts between the teeth of the lower jaw and the splint or Mock-up). The quality indicators at this stage were considered to be the normalization of the interalveolar height, the creation of optimal centric contacts, the elimination of occlusal blocks of the lower jaw, dento-maxillary deformations, supra-contacts, the creation of occlusive protection of the TMJ, the restoration of the synchronous excursion of the heads of the lower jaw during its vertical movements, the physiological volume of movements of the lower jaw (opening the mouth in full) simultaneously with a decrease in intensity and the absence of pain syndrome when the patient

subjectively assesses pain according to the VAP scale, a decrease in the number of sensitive muscle points and the intensity of sensitivity in them, a decrease in tone and asymmetric tension of the masticatory muscles, disappearance intra-articular noises (crunching and clicking), disappearance of complaints related to the hearing aid; if necessary, cone-beam CT of the TMJ was performed to assess intra-articular relationships in dynamics.

In our study, we carried out selective grinding and modeling of the chewing surface of occlusal structures using the computer occlusion analysis system – T-Scan NOVUS. In recent years, the concept of digital modeling has taken a dominant place in orthopedic treatment. This approach allows for the personalization of the creation of primary structures in a shorter time, taking into account individual parameters, improving the adaptation of the chewing muscles, reducing the stress reaction, reducing the load on the supporting structures, increasing the efficiency at the stage of their correction, reducing the duration and number of visits, which is an indisputable advantage for the patient. Digital analysis of occlusal ratios allows analysis and reporting of occlusion in terms of sequence of contact of each tooth, location of force on tooth contact surfaces, relative occlusal force in percent, and center of force trajectory (Figure 2). And 3D digital models obtained by intraoral dental scanning are just as accurate and reliable as extraoral scanned models. The use of digital precise methods of correcting centric and eccentric contacts on temporary structures or mouthguards, which provides a number of physiological advantages, such as improving the adaptation of the masticatory muscles, reducing the stress reaction, optimal positioning



**Figure 2.** Image of centric contacts determined by digital analysis (full Mock-up)

of the head of the lower jaw, reducing the load on supporting structures, improving tissue perfusion gums and periodontium, masticatory muscles, improving patient compliance.

The possibility of easy correction by selective grinding and rebasing of the splint (layering of acrylic material on the chewing surface with subsequent polymerization directly in the oral cavity) is an indisputable advantage of using a splint. Which makes it possible to change the parameters of the interalveolar height directly in the clinic, to create occlusive protection of the TMJ by selective grinding or layering of plastic on the inclined plane of the splint, which are guides during the articulation of the lower jaw – correction of eccentric contacts and opening of the lower jaw during protrusive and laterotrusive movements.

The ability to quickly create optimal occlusal contacts between the supporting tubercles of the lower jaw and the chewing surface of the tire, control of the area of occlusal contacts is also available. Thereby ensuring adequate relaxation of the masticatory muscles, elimination of centric and eccentric supracontacts, alignment of the occlusal plane and creation of the necessary sagittal and transverse occlusal curves, elimination of the forced position of the lower jaw. At the same time, the main disadvantage of the tire is that it is a removable structure that requires adaptation. During this period, the patient may feel discomfort associated with the feeling of a foreign body in the oral cavity, speech disorder, discomfort during chewing. At the same time, non-removable Mock-up structures, in addition to the absence of the above-described adaptation, do not require prior tooth preparation, have an aesthetic effect and provide guidelines for tooth preparation and are a prototype of permanent structures.

When conducting a statistical evaluation of the obtained data, a number of predictors were established that were associated with the need to use splints as an occlusive device:

- parafunction of masticatory muscles (OR 16.507, regression coefficient 2.803,  $p=0.000$ )
- pathological types of bite (OR 9.000, regression coefficient 2.197,  $p=0.000$ )
- multiple defects of the crown part of the tooth (OR 6.960, regression coefficient 1.940,  $p=0.004$ )
- hypertrophy of masticatory muscles (OR 6.447, regression coefficient 1.863,  $p=0.000$ )
- functional persistent significant displacement of the lower jaw (OR 6.142, regression coefficient 1.815,  $p=0.004$ )
- headache (OR 6.132, regression coefficient 1.813,  $p=0.000$ )
- restriction of opening the mouth (OR 4.387, regression coefficient 1.478,  $p=0.000$ )
- masticatory muscle hypertonus (OR 3.399, regression coefficient 1.224,  $p=0.001$ ).

At the same time, individual tooth defects were associated with the possibility of using Mock-up as a design for occlusion therapy (OR 2.488, regression coefficient 1.098,  $p=0.023$ ). It should be noted that 11 (7.33%) patients failed to achieve the expected effect of TMJ dysfunction treatment using Mock-up as designs for occlusal therapy and they required further placement of the splint. 9 of them had a long-term pain syndrome with a predominance of the muscular component and violations of occlusal-articulation relations with lateral multiple defects of the tooth rows and a significant loss of the interalveolar height.

## Conclusions

A detailed analysis of clinical and laboratory examination data of patients allows to objectively assess the state of the maxillofacial system and carry out rational planning of orthopedic treatment. The use of occlusive therapy for TMJ dysfunction should be individualized taking into account the clinical situation in the oral cavity. Parafunction of the masticatory muscles (OR 16.507,  $p=0.000$ ), hypertonus of the masticatory muscles (OR 3.399,  $p=0.001$ ), hypertrophy of the masticatory muscles (OR 6.447,  $p=0.000$ ), functional stable displacement of the lower jaw (OR 6.142,  $p=0.000$ ) demonstrate an association with the need to use non-removable, 24-hour constructions made of hard materials for occlusive therapy of TMJ dysfunction. The construction of occlusal appliances and the correction of occlusal surfaces on them should be carried out by digital analysis of occlusal ratios.

## Financing

This work is a fragment of the research work of the Department of Dentistry of Institute of

Postgraduate Education of Bogomolets NMU «Interdisciplinary approach in the prevention, treatment and rehabilitation of patients with periodontal diseases and functional occlusion disorders» (state register No. 0123U105134), (initiative and search).

## Conflict of interest

The authors certify the absence of conflicts of interest.

## Consent to publish

All authors have read the text of the manuscript and have given their consent for its publication.

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## Оклюдійна терапія у пацієнтів із дисфункцією скронево-нижньощелепного суглобу і оклюдійно-артикуляційними порушеннями

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*Анотація:* у статті представлено статистичний аналіз оцінки впливу різних факторів, що призвели до оклюдійно-артикуляційними порушень й функціональних розладів жувального апарату на вибір конструкцій оклюдійної терапії лікування дисфункції скронево-нижньощелепного суглобу. Для проведення дослідження було проведено клініко-лабораторне обстеження і ортопедичне лікування 150 пацієнтів із різними варіантами оклюдійних порушень. Описано варіанти проведення оклюдійної терапії та дана їх характеристика.

**Ключові слова:** Дисфункція СНЩС; зубна дуга/діагностичне зображення; комп'ютерна обробка зображень, лікування скронево-нижньощелепних розладів; моделі, стоматологія; оклюдійна капа; травматична оклюдія зубів.



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