

DOI: <https://doi.org/10.17816/uds632214>

# Contemporary concepts about the etiology and pathogenesis of musculoskeletal dysfunction in the temporomandibular joint

Roman A. Fadeev, Andrei V. Kuznetsov

North-Western State Medical University named after I.I. Mechnikov, Saint Petersburg, Russia

## ABSTRACT

The temporomandibular joint is one of the most complex joints in the human body anatomically and morphologically. It works nearly constantly, ensuring the physiological needs of the body and communication links with the external environment. Muscular and articular dysfunctions of the temporomandibular joint are among the most common diseases of the maxillofacial region. The article systematizes modern knowledge and ideas about the etiology and pathogenesis of temporomandibular joint dysfunction.

**Keywords:** TMJ dysfunction; deformity of the dentition; parafunctions of the masticatory muscles; stress.

## To cite this article

Fadeev RA, Kuznetsov AV. Contemporary concepts about the etiology and pathogenesis of musculoskeletal dysfunction in the temporomandibular joint. *Acta Universitatis Dentistriae et Chirurgiae Maxillofacialis*. 2024;2(2):67–72. DOI: <https://doi.org/10.17816/uds632214>

Received: 19.05.2024

Accepted: 29.05.2024

Published online: 24.06.2024

DOI: <https://doi.org/10.17816/uds632214>

# Современные представления об этиологии и патогенезе мышечно-суставной дисфункции височно-нижнечелюстного сустава

Р.А. Фадеев, А.В. Кузнецов

Северо-Западный государственный медицинский университет им. И.И. Мечникова, Санкт-Петербург, Россия

## АННОТАЦИЯ

Височно-нижнечелюстной сустав — один из самых сложных суставов в организме человека анатомически и морфологически. При этом он работает практически постоянно, участвуя в обеспечении физиологических потребностей организма и коммуникативных связей с внешней средой. Мышечно-суставная дисфункция височно-нижнечелюстного сустава — одно из наиболее часто встречающихся заболеваний челюстно-лицевой области. В статье систематизированы современные знания и представления об этиологии и патогенезе дисфункции ВНЧС.

**Ключевые слова:** дисфункция ВНЧС; деформация зубных рядов; парафункции жевательных мышц; стресс.

## Как цитировать

Фадеев Р.А., Кузнецов А.В. Современные представления об этиологии и патогенезе мышечно-суставной дисфункции височно-нижнечелюстного сустава // Университетская стоматология и челюстно-лицевая хирургия. 2024. Т. 2. № 2. С. 67–72. DOI: <https://doi.org/10.17816/uds632214>

## INTRODUCTION

In the human body, the temporomandibular joint (TMJ) is one of the most complex and active joints. The lower jaw exhibits a high degree of mobility, such as during eating, speaking, and yawning. This results in approximately 2,000 instances of jaw movements per day. The correct functioning of the dentoalveolar system is essential for communication, social adaptation, and comfort.

The TMJ is an important element of the dentoalveolar system and is a complex multicomponent muscle–joint complex. The joint is paired, and the articular heads located on either side of the mandible function simultaneously [2]. The TMJ functions as a third-class lever [3].

The elements of the musculotendinous complex form a single finely tuned mechanical system. With each mandibular movement, the right and left TMJs work simultaneously in strict coordination.

The TMJ is a combined joint, which means that the two joints working simultaneously creates a single kinematic system. This system is represented by two anatomically isolated joints acting simultaneously. Only the combined joint in the human body produces motion in three planes. The TMJ, a complex joint, has an articular disk. This disk compensates for the incongruence of the articular surfaces, increases stability, and separates the joint into upper and lower isolated sections. The TMJ is also a muscle-type joint. The movement and position of the dentoalveolar system is determined by the muscles when raising the lower jaw, lowering the lower jaw, and extending the lower jaw [2].

The configuration of the joint elements and system as a whole when the mouth is closed is primarily determined by the hard substance, namely, the dentition. The mandible makes contact with the skull at three points: two with the TMJ heads and the third with the dental rows. During the formation of occlusal contacts, if the centric ratio (CR) of the jaws, determined by the position of the joints' heads in relation to the articular fossae and joint structures, corresponds to the central occlusion (CO), which is determined by the relationship between the upper and lower tooth rows, the masticatory apparatus will function appropriately. If a discrepancy exists between the CO and CR, the lower jaw is forced into a particular position when the mouth is closed. A syndrome of forced mandibular position is formed [4].

R.A. Fadeev et al. [4] proposed a set of symptoms that determine the incorrect, forced position of the mandible as a distinct nosological unit among TMJ disorders, that is, mandibular forced position syndrome.

The diagnostic signs and symptoms of forced mandibular position syndrome can be identified through specialized examination. Thus, diagnostic signs can be classified as obligatory or facultative signs [4].

Clinical obligatory diagnostic signs include the displacement of the lower jaw from the central position to the forced position when closing the dental rows, misalignment of the center line between the incisors of the upper and lower jaws when closing the tooth rows, alignment of the center line when opening the mouth, change in the trajectory of the mandible movement with the presence of deviation or deflexion, presence of unilateral or bilateral clicking in the T area MJ when opening and closing the mouth, presence of increased or decreased tone of masticatory muscles at static palpation, and impaired synchrony and symmetry of masticatory muscle activation during dynamic palpation.

Radiologically, computed tomography of the TMJ reveals the displacement of the mandibular head within the articular socket, occurring on one or both sides. This manifests as a change in the normal parameters of the articular gap in its anterior, superior, and posterior regions.

In addition, the indications of forced mandibular position syndrome may be facultative [4]. Optional clinical signs include narrowing of the maxillary dentition in the premolar and molar areas, shortening of the maxillary dentition in the anterior region, narrowing of the mandibular dentition in the premolar and molar areas, increase or decrease in the amplitude of mouth opening, and hypermobility of the TMJ on one or both sides.

## ETIOLOGIC FACTORS OF TMJ MUSCLE AND JOINT DYSFUNCTION

The dentoalveolar system is normally physiologically functioning based on the balanced work of all its components, which can be classified as mechanical, regulatory, or trophic. In the case of an imbalance, a polyetiologic disease – musculoarticular dysfunction – may occur. Several main theories have been proposed to explain its development.

1. The occlusal–articulation theory is espoused by those who consider several factors as the underlying disease causes: reduced interalveolar distance, partial tooth loss, deformation of the occlusal surface of the tooth rows, increased erasability, traumatic occlusion, complete loss of teeth, distal displacement of the mandibular heads due to the loss of lateral teeth, and other occlusal disorders [5].

V.A. Khvatova [6] observed that disturbances in the occlusion result in the reorganization of the masticatory muscle function to overcome these obstacles. This phenomenon leads to asymmetries in muscle activity, formation of a unilateral masticatory pattern, and displacement of the mandible to the side of forced occlusion. On the working side, the articular head of the mandibular condyle undergoes flattening, shifting in an upward, backward, and outward direction, accompanied by the

compression of the soft tissue structures within the joint. This leads to the disruption of the trophic processes and, consequently, the onset of aseptic inflammation. In the non-working position, the articular head exhibits downward, forward, and inward displacements, and the disk and posterior ramp of the articular tubercle display flattening. The soft tissues are subjected to excessive tensile forces, resulting in destructive alterations. Impaired blood circulation, innervation, and subsequent destructive changes in bony structures are also observed. The topography of the articular heads results in trauma to the nerve endings of the joint capsule, bilaminar zone, and disrupted blood circulation in the joint. The persistent malfunction of the lateral wing muscles results in a reflexive response, leading to their hypertonicity, functional overload, subsequent painful spasms, and dislocation of the intra-articular disk.

The curvature of mandibular movement trajectories is observed in intra-articular disorders, such as disk dislocation, and presence of supercontacts that prevent occlusal movements [7].

According to L.P. Gerasimova et al. [8], bilateral posterior displacement of the head of the condyle is accompanied by a narrowing of the posterior part of the articular gap and a widening in the anterior part. This phenomenon is observed in TMJ disorders associated with a decrease in the lower facial height.

A.V. Silin posited that musculoarticular dysfunction in patients with dentoalveolar anomalies is a complication associated with existing occlusal disharmony.

2. The myogenic theory posits that myofascial pain is caused by muscle contraction. The prevailing view is that masticatory muscles take on a primary role in the pathogenesis of TMJ disorders.

V.N. Trezubov and E.A. Bulycheva et al. [11] emphasized the crucial role of muscle disorders in the pathogenesis of TMJ dysfunction. Changes in the function of the masticatory muscles result in mandibular movements that are performed in a manner that circumvents occlusal impediments. This disrupts the synchronous contraction of the muscles and changes in the topography of the mandibular heads, resulting in trauma to the nerve endings of the joint capsule and articular disk, as well as impaired hemodynamics of the TMJ tissues.

Pathologies occur if the masticatory muscles are functionally overloaded when overcoming occlusal obstacles and parafunction of the masticatory muscles. The asynchronous contraction of the masticatory muscles results in hypertonia in specific regions, trigger point formation, impaired trophism of masticatory muscles, and painful sensations. Consequently, the patient is compelled to perform forced, unphysiological movements during articulation to circumvent the painful points, which ultimately increases the severity of the joint pathology.

A vicious circle emerges, which can be disrupted by addressing occlusal disorders and engaging the masticatory muscles [5].

3. The psychosomatic theory posited that TMJ dysfunction was not solely attributable to occlusal or muscular disorders but to underlying mental trauma and chronic stress. Several authors point to the possible presence of the following chain of factors in TMJ dysfunction development: chronic stress → masticatory muscle parafunction → masticatory muscle dysfunction → TMJ dysfunction [12, 13].

Slavichek [14] reported that a particular stressor factor plays a distinctive role in the genesis of TMJ dysfunction and highlighted that the masticatory organ plays an integral role in the feedback mechanism of the organism with the environment. With the perpetually evolving external environment and an escalating influx of heterogeneous information, psychological resistance to emerging challenges persists. If a patient is unable to promptly identify a solution to the issues at hand, the problems will gradually accumulate in the subconscious. This will result in the activation of subconscious processes aimed at reducing the psychological load, particularly through the masticatory organ, which serves as a release valve. Therefore, psychological stimuli can elicit both conscious and unconscious reactions, the latter of which are of greater significance. On the oral side, these reactions manifest as parafunctions, teeth clenching, and bruxism.

P.I. Ivasenko identified the onset of muscle imbalance following chronic psychotrauma and chronic stress. This imbalance results from a disruption in neuromuscular regulation [15].

D. Brokar et al. [16] reported the necessity of normalizing the psychological background and reducing the influence of stress in parafunctional activity and treatment of patients with bruxism.

4. Postural theory posits that the dentomaxillofacial system is an integral component of a unified system that regulates body position in space and maintains vertical alignment. The musculoskeletal system is characterized by inextricable interconnectivity, whereby one element exerts influence on another and is simultaneously reliant on the other element. The proprioceptive system of the TMJ is one of the primary sources of sensory information for the postural system.

A. Baldini identified two distinct pathways [17]: an outgoing pathway, which occurs when TMJ dysfunction is one of the proprioceptive links of the postural system resulting in changes to postural balance and an imbalance of the musculoskeletal system as a whole and an ascending pathway, which occurs when disorders initially manifest in other areas of postural control, including the joints of the spine, hip joints, and joints of the feet, and exert a detrimental effect on the functional state of the TMJ.

Consequently, when musculoskeletal dysfunction manifests in the lower regions, compensation occurs through loading of the higher regions. The craniomandibular system represents the highest and ultimate point of compensation. Consequently, system deformation is determined by the forces in question.

Conversely, when the occlusal planes and curves are disrupted, the point of convergence for occlusal forces is shifted, resulting in the generation of stresses that affect the remainder of the human postural system in a downward direction.

5. The dysplastic theory stated that connective tissue dysplasia represents a genetically determined abnormality in connective tissue development. This condition is characterized by defects in fibrous structures and basic substance, which ultimately result in the loss of the strength properties of connective tissue. In particular, the TMJ capsule and ligaments are affected. A reduction in the mechanical properties of connective tissue elements within the joint, as well as a diminished capacity to resist mechanical loads in a balanced manner give rise to TMJ dysfunction. In this instance, the determining factors of the functional state of the lateral wing muscles are not conclusive [15].

6. The mixed theory employs multiple theories to create a more comprehensive understanding of a phenomenon. The polyetiology of TMJ dysfunction, complexity of the anatomy, joint morphology, types of movements, multidirectional nature of the functional load, and need to consider the dysfunctions of various organs and systems from a single-organism perspective present a challenge to the identification of a single cause of TMJ dysfunction among others. Thus, primary and secondary factors must be differentiated to ascertain the underlying causes of dysfunction.

## CONCLUSIONS

As mentioned above, the etiology and pathogenesis of TMJ dysfunction remains unresolved. The etiology of musculoskeletal dysfunction in the TMJ is multifaceted. In dysfunction, external and internal factors mutually reinforce one another. The rapid detection of the underlying

cause will enable the clinicians to halt the progression of the pathological process at the earliest possible stage.

## ADDITIONAL INFORMATION

**Authors' contribution.** All the authors made a significant contribution to the preparation of the article, read and approved the final version before publication. Personal contribution of each author: R.A. Fadeev — the concept and design of the study, making final edits; A.V. Kuznetsov — literature review, processing of materials, writing the text.

**Funding source.** The authors claim that there is no external funding when writing the article.

**Competing interests.** The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.

**Ethics approval.** The material of the article demonstrates the results of clinical observation, does not contain research materials.

**Informed consent to publication.** All participants voluntarily signed an informed consent form prior to the publication of the article.

## ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

**Вклад авторов.** Все авторы внесли существенный вклад в проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией. Вклад каждого автора: Р.А. Фадеев — концепция и дизайн исследования, внесение окончательной правки; А.В. Кузнецов — обзор литературы, обработка материалов, написание текста.

**Источник финансирования.** Авторы заявляют об отсутствии внешнего финансирования при написании статьи.

**Конфликт интересов.** Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

**Этический комитет.** Материал статьи демонстрирует результаты клинического наблюдения, не содержит материалов исследований.

**Информированное согласие на публикацию.** Все участники добровольно подписали форму информированного согласия до публикации статьи.

## REFERENCES

1. Potapov VP. *Etiology, pathogenesis, diagnostics and complex treatment of patients with temporomandibular joint diseases caused by the violation of functional occlusion*. Samara: Pravo; 2018. 351 p. (In Russ.)
2. Fadeev RA, Chibisova MA, Ovsyannikov KA, et al. *Analysis of the temporomandibular joint according to dental computed tomography*. Saint Petersburg: Human; 2021. 48 p. (In Russ.)
3. Manfredini D. *Temporomandibular disorders. Modern concepts of diagnostics and treatment*. Moscow: Azbuka; 2013. 500 p. (In Russ.)
4. Fadeev RA, Parshin VV, Prozorova NV. Syndrome forced position of the lower jaw — nosological unit of temporomandibular joint diseases. *The dental institute*. 2020;(3):74–75. EDN: STPKEA
5. Trezubov VN, Bulycheva EA, Trezubov VV, Bulycheva DS. *Treatment of patients with diseases of temporomandibular joint and masticatory muscles. Clinical recommendations*. Moscow: GEOTAR-Media; 2024. 112 p. (In Russ.)
6. Khvatova VA. *Diagnostics and treatment of functional occlusion disorders: a manual*. Nizhny-Novgorod: Izd-vo NGMA; 1996. 276 p. (In Russ.)



7. Khvatova VA. *Clinical gnathology*. Moscow: Medicine; 2011. 296 p. (In Russ.)
8. Gerasimova LP, Matvienko AN, Novikov YuO, et al. X-ray diagnosis of temporomandibular disorders combined with the pathology of the cervical spine. *Parodontologiya*. 2023;28(3):227–233. EDN: ICWGKH doi: 10.33925/1683-3759-2023-800
9. Silin AV. *Problems of diagnostics, prevention and treatment of morphofunctional disorders in temporomandibular joints in dentoalveolar anomalies* [dissertation]. Saint Petersburg; 2007. 215 p. (In Russ.)
10. Kalamkarov HA. *Orthopaedic treatment of pathological erasability of hard tissues of teeth*. Moscow: Medical information agency; 2004. 176 p. (In Russ.)
11. Trezubov VN, Bulychева EA, Posokhina OV. Study of neuromuscular disorders in patients with temporomandibular joint disorders complicated by parafunctions of masticatory muscles. *The dental institute*. 2005;(4):85–89. EDN: MWCOIV (In Russ.)
12. Arutyunov SD, Lebedenko IYu, Antonik MM, Stupnikov AA. *Clinical methods of diagnostics of functional disorders of the dentoalveolar system*. Moscow: Medpress-Inform; 2006. 112 p. (In Russ.)
13. Puzin MN, Vyazmin AY. *Pain dysfunction of temporomandibular joint*. Moscow: Medicine; 2002. 160 p. (In Russ.)
14. Slaviczek R. *Chewing organ*. Moscow: Azbuka Stomatologa; 2008. 550 p. (In Russ.)
15. Ivasenko PI, Miskevich MI, Savchenko RK, Simakhov RV. *Pathology of temporomandibular joint: Clinic, diagnostics and principles of treatment*. Saint Petersburg: Medi publishing house; 2007. 80 p. (In Russ.)
16. Brocard D, Laluc J-F, Knellesen K. *Bruxism*. Moscow: Azbuka Stomatologa; 2009. 96 p. (In Russ.)
17. Baldini A, Nota A, Tripodi D, et al. Evaluation of the correlation between dental occlusion and posture using a force platform. *Clinics*. 2013;68(1):45–49. doi: 10.6061/clinics/2013(01)OA07

## СПИСОК ЛИТЕРАТУРЫ

1. Потапов В.П. Этиология, патогенез, диагностика и комплексное лечение больных с заболеваниями височно-нижнечелюстного сустава, обусловленных нарушением функциональной окклюзии. Самара: Право, 2018. 351 с.
2. Фадеев Р.А., Чибисова М.А., Овсянников К.А., и др. Анализ височно-нижнечелюстного сустава по данным денальной компьютерной томографии. Санкт-Петербург: Человек, 2021. 48 с.
3. Манфредини Д. Височно-нижнечелюстные расстройства. Современные концепции диагностики и лечения. Москва: Азбука, 2013. 500 с.
4. Фадеев Р.А., Паршин В.В., Прозорова Н.В. Синдром вынужденного положения нижней челюсти — нозологическая единица заболеваний височно-нижнечелюстного сустава // Институт стоматологии. 2020. № 3. С. 74–75. EDN: STPKEA
5. Трезубов В.Н., Булычева Е.А., Трезубов В.В., Булычева Д.С. Лечение пациентов с заболеваниями височно-нижнечелюстного сустава и жевательных мышц. Клинические рекомендации. Москва: ГЭОТАР-Медиа, 2024. 112 с.
6. Хватова В.А. Диагностика и лечение нарушений функциональной окклюзии: руководство. Нижний-Новгород: Изд-во НГМА, 1996. 276 с.
7. Хватова В.А. Клиническая гнатология. Москва: Медицина, 2011. 296 с.
8. Герасимова Л.П., Матвиенко А.Н., Новиков Ю.О., и др. Рентгенологическая диагностика мышечно-суставной дисфункции височно-нижнечелюстного сустава сочетанной с патологией шейного отдела позвоночника // Пародонтология. 2023. Т. 28, № 3. С. 227–233. EDN: ICWGKH doi: 10.33925/1683-3759-2023-800
9. Силин А.В. Проблемы диагностики, профилактики и лечения морфофункциональных нарушений в височно-нижнечелюстных суставах при зубочелюстных аномалиях: дис. ... докт. мед. наук. Санкт-Петербург, 2007. 215 с.
10. Каламкар Х.А. Ортопедическое лечение патологической стираемости твердых тканей зубов. Москва: Медицинское информационное агентство, 2004. 176 с.
11. Трезубов В.Н., Булычева Е.А., Посохина О.В. Изучение нейромышечных нарушений у больных с расстройствами височно-нижнечелюстного сустава, осложненных парафункциями жевательных мышц // Институт стоматологии. 2005. № 4. С. 85–89. EDN: MWCOIV
12. Арутюнов С.Д., Лебеденко И.Ю., Антоник М.М., Ступников А.А. Клинические методы диагностики функциональных нарушений зубочелюстной системы. Москва: Медпресс-информ, 2006. 112 с.
13. Пузин М.Н., Вязьмин А.Я. Болевая дисфункция височно-нижнечелюстного сустава. Москва: Медицина, 2002. 160 с.
14. Славичек Р. Жевательный орган. Москва: Азбука стоматолога, 2008. 550 с.
15. Ивасенко П.И., Мискевич М.И., Савченко Р.К., Симахов Р.В. Патология височно-нижнечелюстного сустава: Клиника, диагностика и принципы лечения. Санкт-Петербург: Меди издательство, 2007. 80 с.
16. Брокер Д., Лалюк Ж.-Ф., Кнеллесен К. Бруксизм. Москва: Азбука стоматолога, 2009. 96 с.
17. Baldini A, Nota A, Tripodi D, et al. Evaluation of the correlation between dental occlusion and posture using a force platform // Clinics. 2013. Vol. 68, N1. P. 45–49. doi: 10.6061/clinics/2013(01)OA07

## AUTHORS' INFO

**Roman A. Fadeev**, MD, Dr. Sci. (Med.), Professor;  
ORCID: 0000-0003-3467-4479; eLibrary SPIN: 4556-5177;  
e-mail: sobol.rf@yandex.ru

\***Andrei V. Kuznetsov**, senior laboratory assistant; North-Western State Medical University named after I.I. Mechnikov;  
address: Kirochnaya st., 41, St. Petersburg, 191015, Russia;  
e-mail: 89119116143@mail.ru

## ОБ АВТОРАХ

**Роман Александрович Фадеев**, д-р мед. наук;  
ORCID: 0000-0003-3467-4479; eLibrary SPIN: 4556-5177;  
e-mail: sobol.rf@yandex.ru

\***Андрей Владимирович Кузнецов**, старший лаборант, Северо-Западный государственный медицинский университет им. И.И. Мечникова, адрес: ул. Кирочная, д. 41 Санкт-Петербург, 191015, Россия; e-mail: 89119116143@mail.ru

\* Corresponding author / Автор, ответственный за переписку