Ukrainian Scientific Medical Youth Journal
Issue 2 (146), 2024
Creative Commons «Attribution» 4.0

ISSN 2786-6661
eISSN 2786-667X

DENTISTRY / СТОМАТОЛОГІЯ

UDC: 617.51:616.716.4-008.9:616.314-089.23]-021.2
https://doi.org/10.32345/USMYJ.2(146).2024.7-14

Received: April 07, 2024
Accepted: June 02, 2024

Analysis of Etiological Factors of Temporomandibular Joint Dysfunction Associated with Reconstructive Changes in Dental Occlusion

Naumovich Ilya, Koval Yevhen

Department of Prosthetic Dentistry of Bogomolets National Medical University, Kyiv, Ukraine

Address for correspondence:

Naumovich Ilya

E-mail: dr.naumovich@gmail.com

Abstract: *in this study we focused on investigating the etiological factors that contribute to the development of temporomandibular joint dysfunction (TMD) following reconstructive changes in occlusion in patients. Our goal was to identify and assess pathological changes occurring in temporomandibular joint (TMJ) after reconstructive occlusal treatment, as well as to determine possible causes of these changes. In order to achieve this goal, we applied various diagnostic methods, such as collecting and analyzing patient complaints, clinical examination, palpation of muscles and temporomandibular joint, occlusal analysis using an intraoral scanner, radiographic examination and axiography. The study involved 28 patients who had previously undergone reconstructive occlusal treatment and reported complaints related to temporomandibular disorders. Most patients experienced pain in the joint and muscles, had jaw movement limitations and chewing function disturbances. Radiographic studies showed pathological changes in the structure of the temporomandibular joint. The study revealed that reconstructive occlusal changes in patients can lead to various pathological changes in temporomandibular joint. It was found that the majority of participants experienced painful sensations and jaw movement limitations, as well as changes in joint structure according to radiographic studies. Disorders in the anatomical structure and function of TMJ were also identified. Conducting comprehensive examination and timely correction considering the identified disorders are important in order to prevent mistakes in patient treatment and achieve positive treatment outcomes.*

Keywords: Temporomandibular Joint Dysfunction Syndrome, Dental Occlusion, Etiology, Treatment, Axiography.

Introduction

In the past decade, there has been a significant increase in the number of patients seeking orthopedic and orthodontic treatment involving various constructions altering occlusal relationships. These medical interventions aim to improve the functionality of the masticatory system and the aesthetics of maxillofacial system. However, despite the high effectiveness and widespread use of these methods, there is a risk of temporomandibular joint dysfunction (TMD) development which is one of serious problems arising from such interventions.

However, the issue of potential complications, such as TMD, is often not given enough attention. TMD dysfunction can manifest through pain, joint noises, limited movements and other symptoms significantly affecting patients' quality of life. Subsequently, these symptoms require additional diagnostics and treatment, leading to increased medical costs and social burden associated with these conditions.

ISSN 2786-6661
eISSN 2786-667X

The relevance of this topic is determined not only by the increase in the number of orthopedic and orthodontic interventions but also by the heightened demands for patients' quality of life. This makes it extremely important to have a deep understanding of all potential risks associated with these procedures and to develop strategies to minimize them. Understanding how reconstructive changes in occlusion can trigger TMD is necessary for creating safer and more effective treatment approaches.

This paper will analyze scientific literature and clinical cases related to the issue of TMD after orthopedic and orthodontic interventions, allowing the identification of key etiological factors and proposing possible ways to optimize treatment procedures.

With the increasing number of orthopedic and orthodontic treatments aimed at correcting dental occlusion by altering occlusal relationships, the incidence of temporomandibular joint dysfunction (TMD) is also rising. This condition can significantly worsen patients' quality of life, causing pain, joint noises, or clicking, and limiting jaw movements (Greene C. S. 2001).

TMD can be caused by various factors, including changes in occlusion after orthopedic and orthodontic interventions. These changes may involve inadequate distribution of masticatory loads, discrepancies in dental arch sizes and alterations in the positioning of joint heads relative to other anatomical structures of the temporomandibular joints (Coronel-Zubiate, F. T., Marroquín-Soto, C., Geraldo-Campos, L. A., Aguirre-Ipenza, R., Urbano-Rosales, L. M., Luján-Valencia, S. A., Tozo-Burgos, J. G., & Arbildo-Vega, H. I. 2022). Scientific research analysis indicates that improper planning or carrying out of reconstructive procedures can lead to long-term complications, including temporomandibular dysfunction (Gauer, R. L., & Semidey, M. J. 2015).

It is important to note that the mechanisms underlying TMD after reconstructive occlusal changes can vary. For instance, excessive changes in occlusal height may result in improper joint loading, increasing the risk of dysfunction. Additionally, the use of inappropriate materials or techniques can cause jaw movement anomalies, leading to asymmetric loading on the joints (Klasser, G. D., & Greene, C. S. 2009; Okeson, J. P. 2013).

To minimize the risks of TMD development, special attention should be paid to joint diagnostics before initiating treatment and all stages of orthopedic and orthodontic procedures should be carefully planned and monitored. Interdisciplinary collaboration among orthopedists, orthodontists, and general dental practitioners is also essential (List, T., & Jensen, R. H. 2017).

Aim

The main objective of this study is to analyze the etiological factors of temporomandibular joint dysfunction (TMD) associated with reconstructive changes in occlusion, aiming to develop recommendations for minimizing the risks of dysfunction in orthopedic and orthodontic interventions.

Our research tasks were:

1. To assess the impact of reconstructive changes in occlusion on the condition of temporomandibular joints by analyzing clinical post-treatment outcomes and identifying the most vulnerable aspects of treatment approaches.

2. To identify the main cause-effect relationships between types of reconstructive interventions and the peculiarities of resulting TMD.

3. To develop methodological recommendations for the diagnostics, prevention and correction of TMD in the context of orthopedic and orthodontic treatment.

4. To propose directions for further research based on the identified data.

Materials and Methods

The study involved 28 patients with temporomandibular joint dysfunction (TMD) after orthopedic or orthodontic occlusal changes.

As part of the study, a collection of dental history was carried out for all participants. This stage included filling in the questionnaires regarding performed dental procedures, existing complaints, and self-assessment of the severity of the condition at the time of examination. Additionally, a detailed collection of medical history was conducted, covering information about past and current illnesses affecting various body systems.

To assess the condition of the temporomandibular joints (TMJ), a comparative palpation technique was used at rest and during rotational movements. The condition of the masticatory muscles was analyzed through palpation of the following muscle groups: temporal (including anterior, mid-

ISSN 2786-6661
eISSN 2786-667X

dle, and posterior bundles), masseter (superficial and deep portions), medial pterygoid, trapezius, sternocleidomastoid, and genioglossus muscles.

The analysis of occlusal contacts in static was conducted using the results obtained during intraoral scanning with "Medit i500" scanner.

Impressions from the upper and lower jaws were taken to fabricate diagnostic models from class IV gypsum, which were installed in a fully adjustable articulator. The installation of the models was carried out according to the occlusal record data and individual parameters obtained by axiography.

Axiography was performed using the CADIAX diagnostic (Gamma dental, Austria) electronic condylograph, which allows obtaining precise data on the dynamics of lower jaw movements.

Instrumental analysis of the models in the articulator was carried out using articulating paper of various thicknesses (80, 40, 16, and 8 microns), ensuring a detailed assessment of tooth contacts.

Cone-beam computed tomography of the upper and lower jaws, as well as TMJs, and cephalometric analysis of the skull were performed for comprehensive analysis of anatomical structures and identification of possible pathologies.

Results

The study assessed the consequences of orthopedic or orthodontic reconstructive occlusal treatment. During the analysis of primary diagnostic data, the following clinical findings were identified:

1. Pain in the temporomandibular joint (TMJ) area (Greene, C. S., & Laskin, D. M. 2000): all study participants reported painful sensations in this area. Among them, 15 study participants also noted the presence of clicks in the TMJ when opening the mouth, 9 individuals experienced clicks on both sides, 7 on the right side, and 4 on the left TMJ area only.

2. Psychological aspects: 1 patient noted the development of depressive disorder associated with painful sensations in the muscles and TMJ. Other participants did not report any changes in their mental state.

3. Chewing problems:
– 18 patients experienced rapid fatigue of the chewing muscles.
– Among them, 7 noted more fatigue on the right side, 8 on the left.
– 6 patients reported muscle hyperreactivity at rest.

The previous study indicated that dysfunction of the TMJ may be associated with changes in the electrical activity of muscles involved in mastication, which may be reflected in increased levels of muscle biopotentials recorded during electromyographic studies (Klasser, G. D., & Okeson, J. P. 2006).

4. Sensitivity and discomfort:
– 8 patients reported increased sensitivity in the incisor area.
– 14 patients sought a more comfortable jaw position when closing the teeth.
– 7 participants experienced limitations when opening their mouths widely.

5. Additional symptoms:
– 10 patients reported headaches.
– 5 patients reported changes in posture.
– 13patients noted grinding and clenching of teeth during sleep or stressful situations.

During palpation of the temporomandibular joints it was recorded that 7 study participants experienced high-intensity pain. Additionally, a moderate degree of pain was registered in 11 patients.

Muscle palpation is a key method for the objective assessment of the condition of patients' masticatory muscles. Pain, tissue tightening, or swelling indicate muscle overload. Below there are the results of palpation of various muscle groups in patients evaluated as part of the study:

1. Temporal muscles:
– General tenderness was noted in 12 patients.
– Among them, 7 individuals experienced increased tenderness on the right side, 3 on the left side.
– For the remaining 2 patients, tenderness was symmetric on both sides.

2. Masseter muscles:
– Tenderness was detected in 23 individuals.
– 12 of them reported intensified tenderness on the right side, 5 on the left side.
– Tenderness was equal on both sides for 6 patients.

3. Medial pterygoid muscles:
– 9 patients indicated the presence of tenderness.
– Among them, 3 experienced more pronounced pain on the right side, 1 on the left.

ISSN 2786-6661
eISSN 2786-667X

– The remaining 5 felt pain equally on both sides.

4. Trapezius muscles:
– Tenderness was found in 13 patients.
– Among them, 3 had more pronounced pain on the right side, 2 on the left.
– For the remaining 8 patients, tenderness was symmetrical.

5. Sternocleidomastoid muscles:
– 9 patients reported tenderness.
– 4 of them experienced intensified pain on the right side, 2 on the left.
– Tenderness was evenly distributed for 3 patients.

6. Mylohyoid muscles:
– Tenderness was observed in 5 patients.

The occlusion analysis was conducted based on data obtained using the intraoral scanner "Medit i500" and software «Medit link» (Fig. 1). Scanning allowed to achieve the detailed evaluation of occlusal contacts and identification of deviations in the static position of dental arches. Based on the obtained data, the following deviations from the norm were identified:

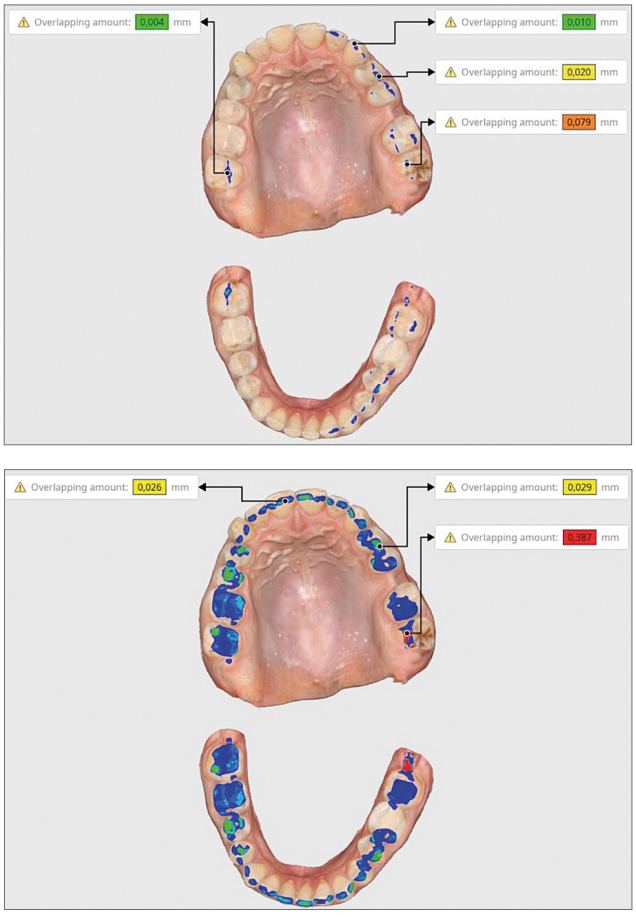

Fig. 1. Analysis of occlusion, which helps to quickly evaluate the occlusion, showing the result in color and digital codes

1.Asymmetric occlusal contacts:
– Asymmetric contacts were observed in 16 patients, characterized by predominance of load on one side. This may indicate a disturbance in the distribution of chewing load and lead to additional stress on the temporomandibular joint (TMJ).

2. Predominance of contacts on the frontal tooth group:
– More pronounced contacts on the frontal tooth group were identified in 9 patients. This condition may lead to overload of the anterior teeth and exert excessive pressure on the joint structures.

3. Presence of premature contacts among the lateral tooth group:
– Premature contacts among the lateral tooth group, especially in the area of second molars, were identified in 11 patients.

4. Changes in the area of occlusal contacts:
– The area of occlusal contacts was greater on one side in 10 patients, indicating imbalance in the occlusal scheme and possible displacement of the lower jaw.

After conducting axiography, the following data was obtained:

1. During protrusive movements (fig. 2a), pronounced asymmetry between the right and left temporomandibular joints was observed in 17 patients. In 7 patients, the range of motion was reduced in the left TMJ, while in 5 patients, it was reduced in the right TMJ. Conversely, in 5 patients, the range of motion was significantly increased in the left TMJ, while in 4 patients, it was increased in the right TMJ. Reciprocal clicks on the left during protrusive movement were recorded in 8 patients, and on the right in 9 patients.

2. During left lateral movements (Fig. 2b), reduced range of motion in the right TMJ was observed in 5 patients, while increased range of motion was observed in 4 patients. In 9 patients, there was a significant discrepancy and double crossing of the trajectories of forward and backward movements in the right TMJ.

ISSN 2786-6661
eISSN 2786-667X

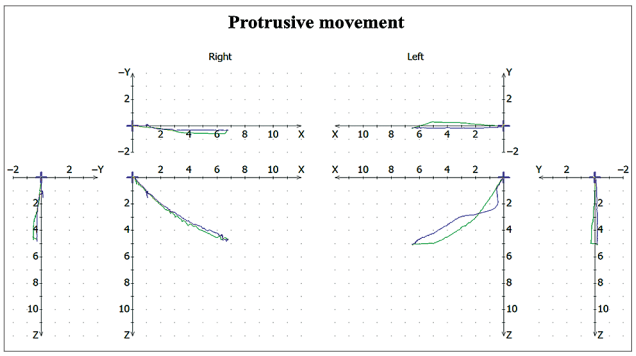

Fig. 2a. Double crossing of the movement trajectories of the right condyle and zigzag deviation of the mandible

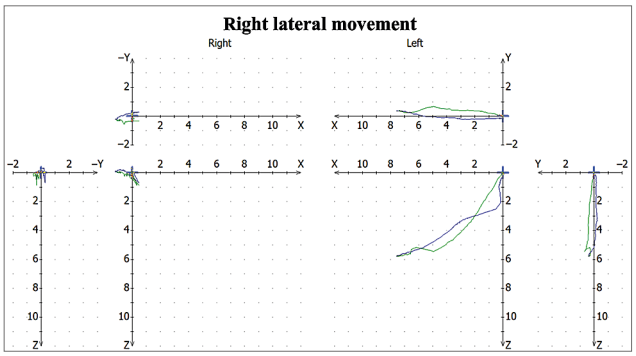

Fig. 2c. Pronounced divergence and double crossing of the forward and backward movement trajectories in the left TMJ

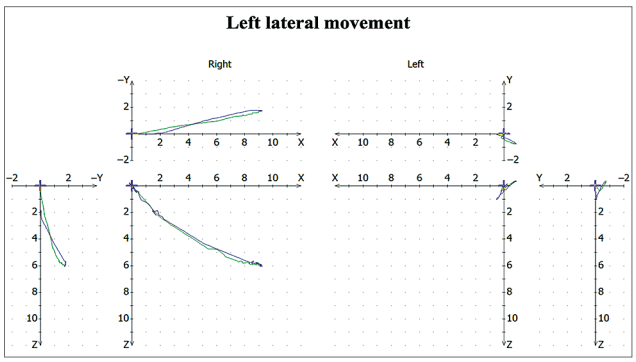

Fig. 2b. Slight divergence and crossing of the forward and backward movement trajectories in the right TMJ

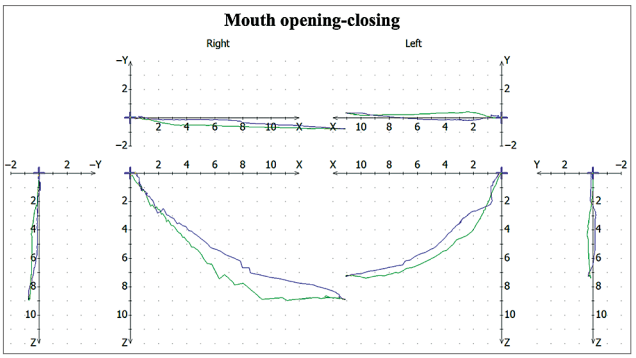

Fig. 2d. Asymmetry of movements in both TMJs, moderate mismatch and crossing of the forward and backward movement trajectories in both TMJs, zigzag deviation of the mandible

3. During right lateral movements (Fig. 2c), reduced range of motion was observed in 7 patients, while increased range of motion was observed in 5 patients. In 8 patients, there was a significant discrepancy and double crossing of the trajectories of forward and backward movements in the left TMJ.

4. During mouth opening-closing (Fig. 2c), increased range of motion in the right TMJ was observed in 7 patients, and in 5 patients, it was observed in the left TMJ. Asymmetry of movements in both TMJs was detected in 18 patients.

Results of cephalometric analysis:

Skeletal classes:

– 13 participants were diagnosed with skeletal Class I, indicating a harmonious skeletal relationship between the upper and lower jaws.
– 8 patients demonstrated skeletal Class II, indicating mandibular retrusion relative to the upper jaw.
– 7 participants were classified as skeletal Class III, characterized by mandibular prognathism, i.e., protrusion relative to the upper jaw.

Height of the lower third of the face (Fig. 3):

– Analysis of the height of the lower third of the face showed that for 9 participants, it fell within normal ranges, indicating an adequate vertical relationship between the jaws.
– 12 patients had an elevated height of the lower third of the face compared to the norms, which may indicate an error in determining the height of the lower third of the face.
– 7 participants exhibited significantly reduced measurements of the height of the lower third of the face."

Based on the results of cone-beam computed tomography (CBCT) of the temporomandibular joint (TMJ), the following changes were identified:

1. Posterior positioning of the condylar heads:

– Posterior positioning of the condylar heads was observed in 11 participants, chara-

ISSN 2786-6661
eISSN 2786-667X

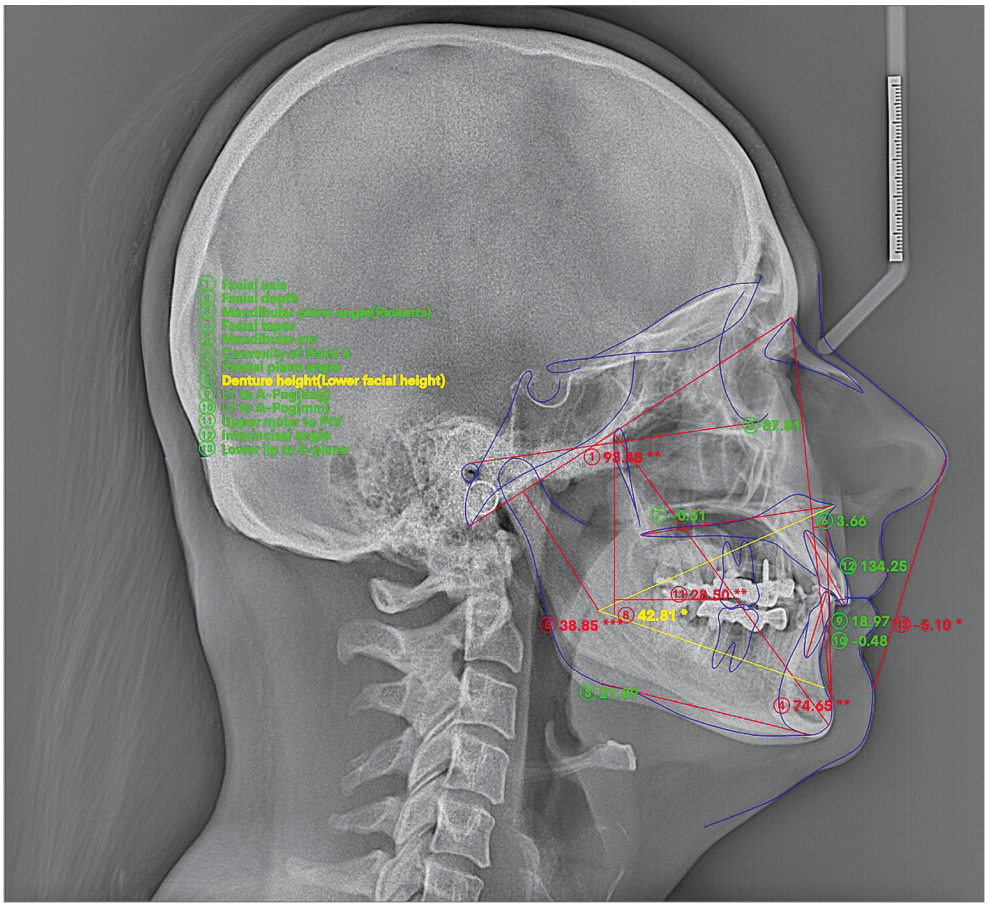

Fig. 3. Reduced lower facial height determined by cephalometric analysis according to Ricketts

cterized by a reduction in the joint space distance in the posterior third below normal values: 2.1 ± 0.3 mm. Among them, 7 individuals also showed a decrease in the joint space in the middle third relative to normal values: 2.5 ± 0.5 mm.

2. Decrease in joint space distance in the middle third:

– A decrease in joint space distance exclusively in the middle third relative to normal values: 2.5 ± 0.5 mm was observed in 5 participants.

3. Decrease in joint space distance in the anterior third:

– A decrease in joint space distance in the anterior third relative to normal values: 1.3 ± 0.2 mm was observed in 5 participants.

4. Increase in joint space distance in the middle third:

– An increase in joint space distance in the middle third relative to normal values (2.5 ± 0.5 mm) was observed in 4 participants.

5. Normal joint space measurements:

– The remaining 3 participants had joint space distance within the normal range.

The previous study indicates that incorrect occlusion can lead to changes in the position of the temporomandibular joint, which may result in a decrease in joint space and subsequent temporomandibular joint dysfunction (Slavicek R. 2011).

Conclusions

Based on the data obtained through diagnostic methods in the study of patients who previously underwent reconstructive changes in occlusion at the orthopedic dentistry clinic, the following conclusions can be drawn:

1. Complaints regarding occlusion were observed in 19 participants of this group, with joint clicks reported by only 9 participants, along with muscle pain, fatigue, and reduced chewing efficiency. However, only 4 participants had complaints related to the postural system.

2. All study participants showed muscle changes:

ISSN 2786-6661
eISSN 2786-667X

– Painful palpation of elevator muscles was found in 4 participants.
– Pain during palpation of protractor muscles was revealed in 5 participants.
– Pain in retrusion muscles was noted in 9 participants.
– Painful sensations from muscles involved in mouth opening were identified in 11 participants.
– Postural muscle pain was reported by 5 participants.

These data, in conjunction with other diagnostic findings, indicates an imbalance in the stomatognathic system, specifically that the dysfunction has progressed beyond temporomandibular joint dysfunction, as symptoms are present during function and at rest.

3. Posterior displacement of the joint heads was detected in 13 participants, indicating incorrect therapeutic positioning of the mandible, which is shifted backward. Lack of retrusive control on teeth also contributes to mandibular displacement into the bilaminar zone, subsequently causing painful sensations.

4. Heightened lower facial third was observed in 9 participants, lowered in 7, and within normal limits in only 3 individuals. Deviations from the physiological muscle-skeletal position of the lower facial third may lead to increased muscle tone and stretching of intra-articular and extra-articular ligaments, eventually resulting in temporomandibular joint dysfunction.

Among the 9 participants who underwent reconstructive changes in occlusion at the orthodontic dentistry clinic, the following features were identified:

1. Muscle imbalance was observed in all 9 participants, but unstable occlusion was present only in 4 of them.

2. Changes in the postural system were observed in 2 participants.

3. Mouth opening was limited in 4 participants, measuring less than 4 cm.

4. Anterior displacement of the joint heads was observed in 7 participants, which is not a physiological position and is maintained by muscles. This leads to overloading of protractor muscles and subsequent shortening of elevator muscles, negatively affecting the condition of the temporomandibular joints.

To prevent temporomandibular joint dysfunctional conditions in the context of orthopedic and orthodontic reconstructive occlusal changes, the following recommendations should be followed:

1. Thoroughly collecting of the patient's history and main complaints.

2. Performing muscle palpation on the right and left sides to assess their condition.

3. Evaluation of the temporomandibular joint condition using a comparative palpation method at rest and during rotational movements.

4. Using diagnostic equipment before, during, and after treatment.

5. Conducting CBCT and MRI diagnostics to assess the anatomical structures of the temporomandibular joints and their positioning relative to each other.

6. Prior to treatment initiation, the dentist should have a clear treatment plan and understanding of the desired treatment outcome.

Financing

This research did not receive external funding.

Conflict of interests

There are no conflicts of interests.

Consent to publication

All authors have read the text of the article and article and gave consent to its publication.

ORCID ID and authors' contributions

0000-0003-0531-9881 (A,B,C,D,E,F) Naumovich Ilya

0000-0002-9005-6686 (A,B,C,D,E,F) Koval Yevhen

A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article.

REFERENCES

Coronel-Zubiate, F. T., Marroquín-Soto, C., Geraldo-Campos, L. A., Aguirre-Ipenza, R., Urbano-Rosales, L. M., Luján-Valencia, S. A., Tozo-Burgos, J. G., & Arbildo-Vega, H. I. (2022). Association between orthodontic treatment and the occurrence of temporomandibular disorders: A systematic review and meta-analysis. Journal of clinical and experimental dentistry, 14(12), e1032–e1043. https://doi.org/10.4317/jced.59970

ISSN 2786-6661
eISSN 2786-667X

Gauer, R. L., & Semidey, M. J. (2015). Diagnosis and treatment of temporomandibular disorders. American family physician, 91(6), 378–386.

Greene C. S. (2001). The etiology of temporomandibular disorders: implications for treatment. Journal of orofacial pain, 15(2), 93–116.

Greene, C. S., & Laskin, D. M. (2000). Temporomandibular disorders: moving from a dentally based to a medically based model. Journal of dental research, 79(10), 1736–1739. https://doi.org/10.1177/00220345000790100101

Klasser, G. D., & Greene, C. S. (2009). The changing field of temporomandibular disorders: what dentists need to know. Journal (Canadian Dental Association), 75(1), 49–53.

Klasser, G. D., & Okeson, J. P. (2006). The clinical usefulness of surface electromyography in the diagnosis and treatment of temporomandibular disorders. Journal of the American Dental Association (1939), 137(6), 763–771. https://doi.org/10.14219/jada.archive.2006.0288

List, T., & Jensen, R. H. (2017). Temporomandibular disorders: Old ideas and new concepts. Cephalalgia : an international journal of headache, 37(7), 692–704. https://doi.org/10.1177/0333102416686302

Okeson, J. P. (2013). "Management of Temporomandibular Disorders and Occlusion." 7th ed. St. Louis: Mosby, pp. 112-130.

Slavicek R. (2011). Relationship between occlusion and temporomandibular disorders: implications for the gnathologist. American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics, 139(1), https://doi.org/10.1016/j.ajodo.2010.11.011

Аналіз етіологічних факторів дисфункції скронево-нижньощелепних суглобів, пов'язаних з реконструктивними змінами прикусу.

Наумович Ілля, Коваль Євген

Кафедра ортопедичної стоматології НМУ імені О.О. Богомольця, м. Київ, Україна

Address for correspondence:

Naumovich Ilya

E-mail: dr.naumovich@gmail.com

Анотація: *У цьому дослідженні ми зосередилися на вивченні етіологічних факторів, які сприяють розвитку дисфункції скронево-нижньощелепних суглобів (СНЩС) після проведення реконструктивних змін прикусу у пацієнтів. Нашою метою було виявлення та оцінка патологічних змін, які відбуваються в скронево-нижньощелепному суглобі після проведення реконструктивного лікування прикусу, а також визначення можливих причин цих змін. Для досягнення цієї мети ми використовували різні методи діагностики, такі як збір і аналіз скарг пацієнтів, клінічне обстеження, пальпація м'язів і скронево-нижньощелепного суглоба, аналіз прикусу за допомогою інтраорального сканера, рентгенологічне обстеження та аксіографію. У дослідженні брали участь 28 пацієнтів, яким було проведено реконструктивне лікування прикусу та мали скарги, пов'язані зі скронево-нижньощелепними розладами. Більшість пацієнтів відчували біль у суглобі та м'язах, мали обмеження рухів щелепи та порушення функції жування. Рентгенографічні дослідження показали патологічні зміни в структурі скронево-нижньощелепного суглобу. У дослідженні було виявлено, що реконструктивні зміни прикусу у пацієнтів можуть призводити до різних патологічних змін у скронево-нижньощелепному суглобі. Встановлено, що більшість учасників відчували болісні відчуття та обмеження рухів щелепи, а також спостерігалися зміни в структурі суглобу за результатами рентгенологічних досліджень. Порушення в анатомічній структурі та функції скронево-нижньощелепного суглобу. Проведення комплексного обстеження та своєчасна корекція з урахуванням виявлених порушень є важливими для запобігання помилок у лікуванні пацієнтів та досягнення позитивних результатів та відновлення функції.*

Ключові слова: синдром дисфункції скронево-нижньощелепного суглоба, прикус, етіологія.

Copyright: © 2024 by the authors; licensee USMYJ, Kyiv, Ukraine. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/).