ORIGINAL ARTICLE

CONTENTS

Analysis of the significance of risk factors in the development of temporomandibular joint dysfunction pain syndrome

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ABSTRACT

Aim: To perform a statistical evaluation of clinical and anamnestic indicators in patients presenting with functional disturbances of the masticatory system, accompanied by occlusal and articulatory abnormalities, both in the presence and absence of pain symptoms.

Materials and Methods: A total of 150 patients with occlusal disturbances underwent clinical and laboratory evaluation followed by orthopedic treatment. Among them, 90 individuals exhibited functional disorders of the masticatory system without associated pain symptoms (comparison group), while the remaining 60 patients (main group) presented with temporomandibular joint (TMJ) dysfunction accompanied by pain.

Results: The analysis revealed a significant etiological association between the development of TMJ dysfunction pain syndrome and several clinical factors: functionally stable and marked mandibular displacement ($p = 0.000$); increased masticatory muscle tone with hypertrophy ($p = 0.000$); non-stable occlusion ($p = 0.000$); a reduction of interalveolar height ($p = 0.017$); pronounced advanced attritional wear of the occlusal surfaces ($p = 0.039$); presence of audible TMJ sounds, including clicking and crepitus during mandibular movement ($p = 0.548$); reduced range of mouth opening ($p = 0.004$); and the use of direct or indirect restorations with inadequately reproduced occlusal morphology ($p = 0.031$).

Conclusions: The prognostic models developed in the course of this study may be utilized as indicators for identifying the risk of TMJ dysfunction-related pain during the planning phase of orthopedic treatment.

KEY WORDS: predictors, TMJ dysfunction pain syndrome, temporomandibular joint, functional occlusion disorders

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INTRODUCTION

Functional disorders of the masticatory apparatus arise from various components of the temporomandibular joint (TMJ), affecting the masticatory muscles, the joint itself and the structures associated with it. This is a widespread problem worldwide. According to epidemiological studies, up to 50% of the adult population has symptoms associated with TMJ dysfunction [1-3]. And the root cause of TMJ and masticatory muscle dysfunction is considered to be functional occlusion disorders [4-7]. In modern dentistry, it is relevant to study the relationship between various causes of articulation-occlusal relationships and the development of temporomandibular disorders [8-12]. Among them, the greatest attention is paid to pathological types of occlusion, dentition defects, and dentofacial anomalies [12-15].

Pain associated with TMJ dysfunction, as well as impairments in chewing, speech, and other vital functions, often results from internal TMJ disorders [16]. Functional occlusal disturbances and masticatory muscle parafunction are regarded as the primary etiological factors in the development of TMJ and masticatory muscle dysfunction [17]. In this context, identifying reliable predictors of such pathology and developing effective preventive strategies remains a pressing concern. A comprehensive understanding of the underlying risk factors is essential–not only for designing preventive measures but also for informing orthopedic treatment planning and forecasting treatment outcomes.

Functional disorders of the temporomandibular joint (TMJ) are closely associated with disturbances in the anatomical structure of the joint, particularly with the dystopic positioning of mandibular condyles–both at rest and during mandibular movements [18]. Alterations in joint structure can trigger functional impairments; however, disorders of the dentofacial system are inherently multifactorial. They arise under the influence of both intrinsic and extrinsic, modifiable and non-modifiable factors such as age, sex, occlusal abnormalities, the presence and duration of crown defects, asymmetry in dental arch length, dentofacial deformities, persistent

mandibular displacement, pronounced attritional wear of the occlusal surfaces, traumatic injuries, and systemic muscular pathologies [19].

Given the clear role that occlusal-articulatory disturbances play in the emergence of both painful and non-painful functional disorders of the masticatory system, it remains critical to identify and evaluate these contributing factors. This would enable the development of accurate prognostic models, targeted prevention strategies, and optimization of orthopedic treatment and rehabilitation outcomes [20].

The task of determining the most influential predictors and assessing their relative significance remains a subject of ongoing debate. However, comprehensive knowledge of the underlying risk factors is vital–not only for effective prevention but also for guiding the planning and improving the prognostic accuracy of orthopedic interventions.

AIM

To perform a statistical evaluation of clinical and anamnestic indicators in patients presenting with functional disturbances of the masticatory system, accompanied by occlusal and articulatory abnormalities, both in the presence and absence of pain symptoms.

MATERIALS AND METHODS

A total of 150 patients with different types of occlusal disturbances underwent comprehensive clinical and laboratory assessment, followed by orthopedic treatment. Among them, 90 individuals formed the comparison group, characterized by functional disorders of the masticatory system without any reported pain symptoms. The remaining 60 patients, who comprised the main study group, were diagnosed with temporomandibular joint (TMJ) dysfunction accompanied by pain.

This division, in our view, is appropriate for identifying key predictors associated with the development of pain syndrome. The diagnostic protocol included a thorough review of general and dental anamnesis, clinical examination of the oral cavity, and evaluation for TMJ dysfunction indicators based on the Hamburg protocol during the initial dental consultation.

Inclusion criteria: patient age between 18 and 60 years, the presence of articulatory and occlusal abnormalities accompanied by functional disorders of the masticatory system, and the provision of signed informed consent for participation in the study.

Exclusion criteria: included individuals younger than 18 or older than 60 years, a medical history of maxillofacial trauma or contusions, the presence of serious systemic illnesses contributing to a premorbid state, and cases where patients declined to participate in the study.

Statistical analysis was conducted using the R programming environment (r-project.org, version 4.0). To evaluate the potential influence of individual factors, univariate binary logistic regression was applied, with odds ratios (ORs) calculated for each predictor. This method allows for the prediction of binary outcomes–such as the presence or absence of a condition–based on a set of independent variables. The outcome variable, representing the predicted event, is binary (typically coded as 0 or 1), while the predictors are referred to as independent variables. Logistic regression relies on binomial probability theory, where the event's likelihood is estimated to fall into one of two categories. The analysis utilizes the maximum likelihood estimation method, which determines the most probable classification of the observed data using regression coefficients. A p-value less than 0.05 was considered indicative of statistical significance. Effect size was expressed as an odds ratio (OR), accompanied by a 95% confidence interval (CI). The OR reflects the relative likelihood of an outcome occurring in one group compared to another. Confidence intervals were calculated using the Katz method. If the CI spans the value of 1, it suggests no statistically significant difference between groups. Conversely, if the entire CI lies above 1, the OR is significantly increased in the group, and if entirely below 1, the OR is significantly decreased.

The study protocol received ethical approval from the Commission on Bioethical Expertise and Research Ethics of Bogomolets National Medical University (Protocol No. 185, dated May 27, 2024). All procedures adhered to ethical principles outlined in the Declaration of Helsinki by the World Medical Association.

RESULTS

An evaluation of clinical and anamnestic data, with consideration of the potential association between functional disturbances of the masticatory system and the presence of pain during the initial patient assessment, revealed the following: in the main group, 42 participants (70.00%) were female, whereas in the comparison group, women accounted for 49 individuals (54.44%). According to univariate analysis, this indicator was on the verge of statistical significance (OR=1.952, 95% CI: 0.988-3.953, p = 0.058). The association of age with the development of pain syndrome of TMJ dysfunction was not established. The distribution of examined patients by age was as follows: age 18-39 years – 27 (45.00%) patients in the main group, versus 45 (50.00%) in the

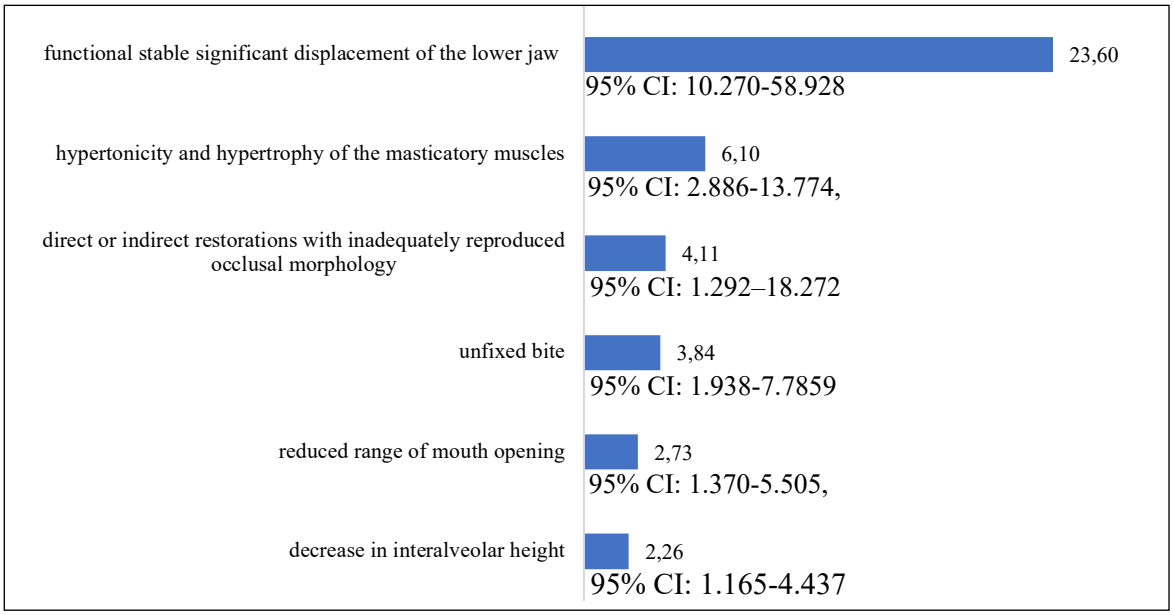

Fig. 1. Odds ratios of risk factors associated with TMJ dysfunction pain syndrome

comparison group (OR=0.818, 95% CI: 0.423-1.574, p = 0.548), age 40-49 years – 19 (31.67%) patients in the main group, versus 18 (20.00%) in the comparison group (OR=1.853, 95% CI: 0.874-3.951, p = 0.106), age over 50 years – 14 (23.33%) patients in the main group, versus 27 (30.00%) in the comparison group (OR=0.778, 95% CI: 0.365-1.612, p = 0.504).

Analysis of dental history revealed the following findings: prior orthodontic treatment was reported in 21 individuals (35.00%) from the main group and in 33 individuals (36.67%) from the comparison group. However, this factor did not show a statistically significant association with the onset of TMJ dysfunction accompanied by pain (OR = 0.930, 95% CI: 0.466–1.833, p = 0.834).

On the other hand, orthopedic history revealed that 57 participants (95.00%) in the main group had direct or indirect restorations with inadequately reproduced occlusal morphology, compared to 74 patients (82.22%) in the comparison group. This characteristic was found to increase the likelihood of developing pain-related TMJ dysfunction by approximately four times (p = 0.031) (Fig. 1). Based on the results of the dental examination, the statistically significant predictors of TMJ dysfunction with pain syndrome were identified and ranked in order of their predictive strength, from highest to lowest: functional stable significant displacement of the lower jaw (p = 0.000); hypertonicity and hypertrophy of the masticatory muscles – 49 (81.67%) participants in the main group, versus 38 (42.22%) in the comparison group (p = 0.000); unfixed bite – 38 (63.33%) participants in the main group, versus 34 (37.78%) in the comparison group (p = 0.000); decrease in interalveolar height– 13 (21.67%) patients in the main group, versus 9 (10.00%) in the comparison group (p = 0.017); advanced attritional wear of the occlusal surfaces – 37 (61.67%) patients in the main group, versus 40 (44.44%) in the comparison group (OR=2.011, 95% CI: 1.039-3.952, p = 0.039); audible TMJ sounds, including clicking and crepitus during mandibular movement – 43 (71.67%) patients in the main group versus 50 (55.56%) in the comparison group (OR=2.023, 95% CI: 1.017-4.137, p = 0.548); reduced range of mouth opening – 29 (48.33%) participants in the main group versus 23 (25.55%) in the comparison group (p = 0.004).

Thus, the most significant factor in the development of TMJ dysfunction pain syndrome is the displacement of the lower jaw, which is obviously a manifestation of the narrowing of the distal joint space and is confirmed by computed tomography in the sagittal projection.

At the same time, statistical analysis of clinical signs showed that the identified potential factors were not statistically significant: dentofacial deformations – 25 (41.67%) patients in the main group, versus 44 (48.89%) in the comparison group (p = 0.385); excessive localized abrasion of the chewing surface of the teeth – 18 (30.00%) patients in the main group, versus 38 (42.22%) in the comparison group (p = 0.385); presence of supracontacts – 60 (100.00%) patients in the main group, versus 85 (94.44%) in the comparison group (p = 0.987); single defects of the dentition and the crown of the teeth – 23 (38.33%) patients in the main group, versus 34 (37.78%) in the comparison group (p = 0.945); occlusion pathology – 26 (43.33%) patients in the main group, versus 29 (32.22%) in the comparison group (p = 0.168); parafunction of the masticatory muscles – 15

(25.00%) patients in the main group, versus 18 (20.00%) in the comparison group (p = 0.469); deviation or deflection – 26 (43.33%) patients in the main group versus 48 (53.33%) in the comparison group (p = 0.231).

DISCUSSION

Thus, the most important factor in the development of pain syndrome of TMJ dysfunction is the displacement of the lower jaw, which is obviously a manifestation of the narrowing of the distal joint space, confirmed by computed tomography in the sagittal projection. At the same time, when conducting a statistical analysis of clinical signs, the identified potential factors did not show their statistical significance: dentofacial deformations – 25 – 41.67% in the main group, versus 44 – 48.89% in the comparison group (p = 0.385); excessive localized abrasion of the chewing surface of the teeth – 18 – 30.00% in the main group, versus 38 – 42.22% in the comparison group (p = 0.385); presence of supracontacts presence of supracontacts – 60 – 100.00% in the main group, versus 85 – 94.44% in the comparison group (p = 0.987); single defects of the dentition and the crown part of the teeth – 23 – 38.33% in the main group, versus 34 – 37.78% in the comparison group (p = 0.945); occlusion pathology – 26 – 43.33% in the main group, versus 29 – 32.22% in the comparison group (p = 0.168); parafunction of the masticatory muscles – 15 – 25.00% in the main group, versus 18 – 20.00% in the comparison group (p = 0.469); deviation or deflection – 26 – 43.33% in the comparison group; vs. 48 – 53.33% in the comparison group (p = 0.231).

Temporomandibular disorders are an umbrella term encompassing a group of musculoskeletal conditions characterized by pain and/or functional impairment of the masticatory muscles, the TMJ, and associated anatomical structures [20, 21]. The most common clinical manifestations include orofacial pain, limited mandibular range of motion, and joint sounds such as clicking or crepitus during jaw movements [22]. The first descriptions of TMJ dysfunction date back to the late 19th century by a British surgeon who explored surgical methods for disc displacement. In 1934, James Costen proposed that occlusal disturbances could cause pain in the TMJ and the preauricular region [23]. Currently, various etiopathogenetic mechanisms are considered in the development of TMDs, including the isolated or combined impact of TMJ dysfunction, hyperactivity of the masticatory muscles, occlusal factors, and genetic polymorphisms [24]. In particular, studies have established associations between malocclusions, dental arch defects, and TMJ dysfunction [1]. Another case-control clinical study found that excessive generalized abrasion of chewing surfaces of teeth was associated with chronic TMJ dysfunction (OR = 2.3), while pathological TMJ sounds during mandibular movements were associated with an OR of 3.4 [25]. These findings align with our results, which demonstrate that decreased interalveolar height, advanced attritional wear of the occlusal surfaces and presence of audible TMJ sounds, including clicking and crepitus during mandibular movement are significantly associated with temporomandibular disorders related pain (OR = 2.258; 2.011; 2.023, respectively). Our statistically significant findings suggest that both the muscular-articular component and occlusal-articulatory disturbances, as well as the disrupted interrelationship between them, play an etiopathogenetic role in the development of pain associated with TMJ dysfunction. The most significant occlusal predictors identified were persistent functional mandibular displacement and masticatory muscle hypertonicity with hypertrophy.

Thus, while the theory of the primacy of occlusal-articulatory factors in the onset of TMJ dysfunction is relevant, it remains incomplete. It highlights the necessity for a comprehensive treatment approach that not only addresses pain via occlusal therapy and subsequent prosthetic rehabilitation but also takes into account subclinical intra-articular changes during prosthetic planning. This justifies the importance of thorough diagnosis of functional disorders of the masticatory system prior to treatment. Prosthodontic planning should include measures for diagnosing and correcting functional disturbances and support the individualized application of prosthetic treatment algorithms involving mandibular repositioning, normalization of TMJ and masticatory muscle function, and the establishment of adapted, rational occlusal-articulatory relationships. Given that chronic pain in TMJ dysfunction may be associated with impaired general health, altered emotional status, behavior, and social interactions – as manifestations of central nervous system dysregulation – it can significantly reduce the patient's quality of life [26, 27].

A limitation of the present study is the sample selection, which included only patients seeking dental care, and the use of a univariate statistical approach, which assessed the isolated effect of each potential predictor without accounting for the cumulative influence of factors on the onset of TMJ dysfunction pain. Nevertheless, future research should aim to develop prognostic models using multivariate statistical analyses based on the established ranking of TMJ dysfunction pain predictors. Future research will focus on evaluating and interpreting the prognostic value of identified factors contributing to the development of pain-related dysfunction syndrome. An additional aim will be the development

of a user-friendly online tool for use in clinical practice to support accurate prediction and prevention of this syndrome during the planning of orthopedic treatment.

CONCLUSIONS

The analysis revealed several factors that show a strong etiological association with the development of pain-related TMJ dysfunction. These include: persistent and functionally stable mandibular displacement (OR = 23.597, p = 0.000); hyperactivity and hypertrophy of the masticatory muscles (OR = 6.096, p = 0.000); unstable occlusion (OR = 3.843, p = 0.000); a reduction in interalveolar height (OR = 2.258, p = 0.017); advanced attritional wear of the occlusal surfaces (OR = 2.011, p = 0.039); presence of audible TMJ sounds, including clicking and crepitus during mandibular movement (OR = 2.023, p = 0.548); reduced range of mouth opening (OR = 2.725, p = 0.004); and the presence of direct or indirect restorations with inadequately formed occlusal morphology (OR = 4.108, p = 0.031).

These findings may serve as predictive indicators for the onset of TMJ pain dysfunction and could be effectively utilized during the planning phase of orthopedic treatment.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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