MORPHOFUNCTIONAL CHANGES IN TEMPOROMANDIBULAR JOINT CORRELATING WITH ITS MORPHOLOGICAL VARIATIONS IN PATIENTS WITH DENTITION DEFECTS COMPLICATED BY DISTAL OCCLUSION

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ABSTRACT — Dentition issues combined with distal occlusion are accompanied by structural and functional changes in the temporomandibular joint (TMJ). This study involved 180 patients with dentition defects in combination with distal occlusion. Clinical and laboratory research methods allowed identifying three variants of the TMJ morphology; the clinical and radiological features of the pathology were detected, and an algorithm for orthodontic and orthopedic treatment of this pathology was proposed depending on a particular TMJ.

KEYWORDS — dentition issues, temporomandibular joint, distal occlusion.

INTRODUCTION

Defects of the dentition in combination with distal occlusion occur through all age periods of human life and in case no timely treatment is offered, they may get complicated with secondary deformations including impaired morphofunctional ratios in the maxillofacial area [1, 3, 4, 5, 8–10, 34, 42]. Besides, they are accompanied by structural and functional changes in the TMJ, which is due to its close link with the neuromuscular maxillofacial apparatus and the pattern of the occlusal contact [2, 6, 7, 35, 41, 43]. Disturbed occlusal relationship contributes to the development of non-functional stress in the TMJ and reduces the adaptive capacity of its structural elements, which leads to restricted mandible movements, tension and pain and, subsequently, degenerative changes in its structural elements [25, 26, 36]. Clinical dentists often see dentition defects combined with muscle and joint dysfunction symptoms; however, the correlation between the occlusion pathology and the TMJ issue is not always clear. Yet, normalization of the occlusal contact is known to improve or facilitate the physiological function of the TMJ elements [31–33].

Treating adult patients with impaired occlusion has its own specifics. For instance, the specific features of treatment of adult patients with dentofacial issues and deformities are due to the complete growth of the facial skeleton, which makes it difficult to restructure the bone tissue under the influence of the active elements of orthodontic equipment, and hence the medical approach tactics is of great importance [11–18, 22, 24, 44, 45]. The diagnostics and comprehensive treatment of patients with impaired occlusion combined with a TMJ pathology has been quite the focus of attention currently [19–21, 23, 27–30, 37–40]. At the same time, the issue of changes in the TMJ with dentition defects depending on its structure appears of interest.

Aim of study

to increase the efficiency of treatment offered to patients with dentition defects combined with distal occlusion, depending on the TMJ morphology type.

Materials and methods

The study included 180 patients who were undergoing orthopedic treatment for dentition defects combined with distal occlusion.

Diagnostics, planning and selecting the most appropriate treatment method was done based on the outcomes of clinical, laboratory, radiological and graphic research methods. Based on the clinical examination, the degree of muscle & articular dysfunction was identified. For this purpose, the clinical dysfunction M. Helkimo index was modified. Studying functional occlusion, installation and preparation of the functionograph for operation, manufacturing orthodontic appliances and orthopedic structures — all this was done using an articulator. The anatomical and topographic status of the

TMJ was assessed through zonograms obtained with a universal radiological installation *Orthophos 3*. Studying the function of the TMJs, masticatory muscles, as well as the detection of occlusal disorders was performed using a functional analyzer by M. Kleinrok and V.A. Khvatova, which is based on intraoral recording of mandibular movements with a functionograph. An electromyographic study allowed the assessment of the functional status of the masticatory muscles. To register the masticatory muscles electrical potentials, an interference (surface) electromyography method was employed. The masticatory muscles electromyographic activity was assessed with a *Neuromian* electromyograph.

RESULTS AND DISCUSSION

The zonogram analysis allowed identifying the parameters of the mandible head, mandibular fossa and the articular tubercle. Systematization of the obtained data helped identify three main types of TMJ:

First — a narrow mandibular fossa and a mandible head of medium width; the mandibular fossa of medium width and the mandible head of a large width (i.e., when the structure of the mandible head was larger than the mandibular fossa structure) (Fig. 1).

Second — a narrow mandibular fossa and a small width of the mandible head, the mandibular fossa and the mandible head of medium width, a wide mandibular fossa and a wide mandible head (i.e., when the mandible head structure corresponded to the mandibular fossa structure) (Fig. 2).

Third — the mandibular fossa of medium width and a small mandible head, a wide mandibular fossa and a medium-wide mandible head, a wide mandibular fossa and a small width of the mandible head (i.e., when the mandible head structure is smaller than the mandibular fossa structure) (Fig. 3).

Following the selected TMJ types, all the patients were divided into three groups.

The clinical examination allowed identifying that the symptoms of muscle & articular dysfunction were observed in 97.3% of Group 1 patients. As for the patients in Groups 2 and 3, they revealed the muscle & articular dysfunction symptoms 10.1% and 17% less frequently, respectively.

Analyzing the teeth occlusal contacts in the studied groups revealed that 83.4% of the cases in Group 1 accounted for premature occlusal contacts, in Group 2 this index was 82.9%, and in Group 3 — 80.3%. During laterotrusive mandible movement, 80.6% of Group 1 patients had disturbed *canine guidance*. In Groups 2 and 3 laterotrusive mandible movement revealed impaired *canine guidance* in a fewer number of cases (by 6.1% and by 15.2%, respectively).

When doing occlusography, the occlusogram index was identified, which was 34.91 ± 3.49 in Group 1; 41.31 ± 1.69 – in Group 2, and 38.50 ± 3.50 — in Group 3.

Depending on the TMJ type, the zonograms showed two degrees of the mandible head posterior displacement within the mandibular fossa. In Group 1, the central position of the mandible head in the mandibular fossa was observed. Patients of Group 2 revealed potential posterior mandible head displacement up to 2 mm (first degree). In Group 3, the posterior mandible head displacement could be up to 4 mm (second degree).

Functiograms in the studied groups showed that the patients had disturbed Gothic angle and Gothic arc. The Gothic angle revealed asymmetry, disturbed straightness and length of the sides, and in Group 1 was smaller — by 20.20° ($p < 0.001$), in Group 2 — by 15.40° ($p < 0.01$), and in Group 3 – by 15.80° ($p < 0.01$).

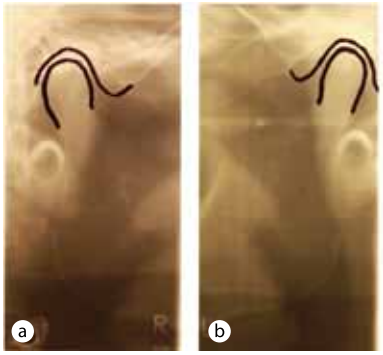

Fig. 1. *TMJ zonogram, patient K. Large size and central position of the mandible head with a medium width of the mandibular fossa on the right (a) and left (b)*

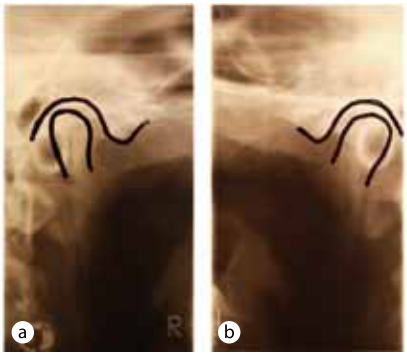

Fig. 2. *TMJ zonogram, patient D. The average size and distal position of the head of the mandible with an average width of the mandibular fossa, right (a) and left (b)*

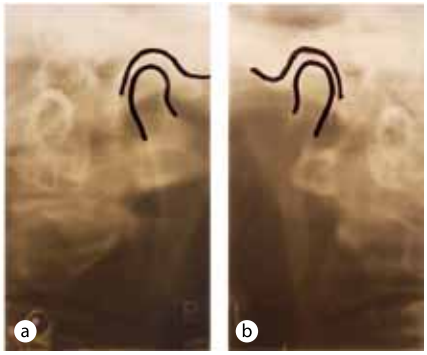

Fig. 3. *TMJ zonogram, patient C. Small size and distal position of the mandible head with a medium-width mandibular fossa, right (a) and left (b)*

As for the Gothic arc, the functiograms showed their shortening of one or two sides, the asymmetry and curved lateral movements, as well as asymmetry of the occlusal field location.

Analyzing the amplitude of the masticatory muscles biopotentials during the jaws compression in conventional occlusion showed its link with the degree of muscle & articular dysfunction. The patients of the studied groups manifested a decrease in the biopotentials amplitude of the masticatory and temporal muscles, and an increase in the biopotentials amplitude of the suprahyoid muscles.

This means that the analysis of the maxillofacial area in the studied groups allowed identifying morphological and functional disorders of the TMJ, masticatory muscles and occlusion as well.

Treating adult patients in the groups was planned in view of the muscle & articular dysfunction degree. In case of patients with mild muscle & articular dysfunction, for instance, orthodontic or orthopedic treatment was immediately started, while cases of moderate or severe muscle & articular dysfunction required killing the pain syndrome and coordinating the masticatory muscles function first.

In case of pain syndrome, symptomatic treatment was performed first, which was aimed at eliminating the pain symptoms. Medication and physiotherapy were used to relieve pain. Drugs and physiotherapeutic treatment were selected individually, taking into account the clinical image of the disease and the patient's individual tolerance of drugs and physiotherapeutic treatment.

To identify the mandible optimal position, as well as to improve the topographic relationships of the TMJ elements and to restore the *canine guidance*, occlusal splints were made.

Once the pain in the TMJ and masticatory muscles was eliminated, orthodontic and orthopedic treatment was started. When planning treatment, the TMJ morphology and the mandible head position in the mandibular fossa were taken into account as decisive.

In Group 1, orthodontic and orthopedic treatment implied dental alveolar compensation of the main pathology and prosthetic measures without displacing the mandible and changing the topography of the TMJ elements (Fig. 4).

In Groups 2 and 3, the comprehensive treatment involved the stage of displacing the mandible forward along with the mandible head displacement to the posterior slope of the articular tubercle, keeping the joint gap in the anterior part at not less than 2 mm (Fig. 5).

The magnitude of displacing the mandible head forward to the posterior slope of the articular tubercle keeping the joint space in the anterior part of not less than 2 mm was determined at the stage of developing a constructive bite, and was controlled by zonograms. Then, the mandible position was corrected with respect to the maxilla, taking into account the normalization of the dentition occlusal & articulation relations, the functional status of the masticatory muscles, and the topography of the TMJ elements. The outcome of restored occlusal disorders was improved relation of the dentition in static and dynamic occlusion, with developing *canine guidance*, as well as *canine protection* or *group guiding function* on the working side. A sign of restored functional status of the masticatory muscles was their coordinated work, which was to be seen from an electromyographic study. Besides, these changes were controlled through analyzing the Gothic angle based on the results of functiograms.

Orthopedic treatment was performed in two stages. The first stage included making temporary prosthetic constructions with restoring the *canine guidance*, which facilitated the patient's adjustment to the new conditions of the maxillofacial functioning. The main criterion of adjustment was improved functional status of the masticatory muscles based on the data from functiography and electromyography. At the second stage, permanent dental prostheses were made.

A clinical examination done after treatment allowed diagnosing the signs of muscle and articular dysfunction in 59.7% of Group 1 patients. In Groups 2 and 3, symptoms of dysfunction were less common (by 18.2% and 20.4%, respectively). In 40.3% of patients of Group 1, 58.5% of patients of Group 2, and 60.7% patients of Group 3, there were no signs of muscle & articular dysfunction detected. In addition, the treatment helped decrease the number of patients showing symptoms of moderate and severe degrees of muscular and articular dysfunction in the studied groups.

As a result of the treatment, the occlusogram index increased in Group 1 going from 34.91±3.49 up to 63.84±1.10 ($p < 0.01$); in Group 2 — from 41.31±1.69 to 69.55±1.05 ($p < 0.001$), and in Group 3 — from 38.50±3.50 to 71.29±1.90 ($p < 0.05$). The *canine guidance* was observed in 58.3% of the patients in Group 1; 79.8% of the cases in Group 2, and in 85.2% of the patients of Group 3, which is 38.9%, 54.3% and 50.8% above for the same indicator prior to the treatment, respectively.

Due to the treatment, the functiographs showed an increase in the Gothic angle in Group 1 – from 85.04°±2.730° to 98.37°±1.820° ($p < 0.001$); in Group 2 – from 89.84°±4.420° to 103.47°±3.280° ($p < 0.05$), and in Group 3 — from 89.37°±3.390° to 104.86°±2.480° ($p < 0.001$), which indicated restored coordinated activity in the masticatory muscles.

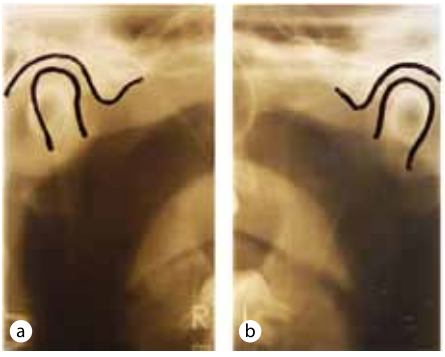

Fig. 4. TMJ zonogram, patient D. The anterior position of the mandible head after the treatment, right (a) and left (b)

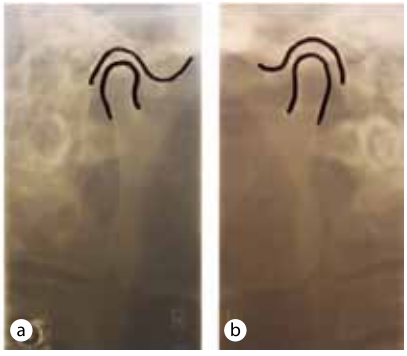

Fig. 5. TMJ zonogram, patient C. The central position of the mandible head after the treatment, right (a) and left (b)

The electromyographic study allowed us to record changes in the masticatory muscles through the course of treatment as well as to identify the moment of the masticatory muscles adjustment to new functioning conditions. The treatment resulted in changed biopotentials amplitude of the masticatory, temporal, and suprahyoid muscles. Electromyography done in the studied groups revealed recovered biopotentials amplitude of the masticatory muscles with a mild degree of muscle & articular dysfunction and its approximation to the normal parameters in cases of moderate and severe degrees of dysfunction.

Comparison of data from the respective literature with the results of our own research on the issue in question suggests that diagnostics and treatment methods for adult patients suffering from dentition issues combined with distal occlusion reveal features depending on the morphological variation of the TMJ and the degree of the muscle & articular dysfunction.

CONCLUSION

Given the zonogram data, depending on the ratios of the mandibular fossa width and the mandible head in the antero-posterior direction, three types of TMJ were identified in patients with dentition defects combined with distal occlusion. The major criterion for selecting comprehensive treatment methods of adult patients with dentofacial issues and deformities was the displacement degree of the mandible head forward to the posterior slope of the articular tubercle while keeping the articular gap in the anterior part of not less than 2 mm at the stage of formation of the constructive bite, which was controlled by zonogram. In Group 1, orthodontic and orthopedic treatment included dental alveolar compensation of the main pathology and prosthetic measures without displacing the mandible and changing the topography of the TMJ elements. In Groups 2 and 3, comprehensive treatment implied mandible anterior displacement with shifting the mandible head to the posterior slope of the articular tubercle keeping the joint gap in the anterior part of not less than 2 mm. Adjustment of the masticatory muscles to new functioning conditions in adult patients has been confirmed with a change in the biopotentials amplitude of the masticatory, temporal, and suprahyoid muscles on electromyograms. Adult patients feature recovered biopotentials amplitude of the masticatory muscles in case of a mild degree of muscle & articular dysfunction and its approximation to the normal parameters in case of moderate and severe dysfunction.

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