ORIGINAL ARTICLE

CONTENTS

Study of axiography changes in patients with temporo-mandibular joint dysfunction

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ABSTRACT

Aim: To determine the effectiveness of treatment of temporomandibular joints muscle and joint dysfunction with occlusive splints based on the analysis of axiography data.

Materials and Methods: 274 (two hundred and seventy-four) patients aged 18 to 44 years with a diagnosis of temporomandibular joints dysfunction before and after treatment.

Results: All patients with signs of temporomandibular joints dysfunction before treatment had a violation of the movement trajectory of the lower jaw: deviation – 68.7%, diflexion – 31.3%. When opening and closing the mouth, asymmetric shifts of the lower jaw of more than 2 mm were observed. After treatment with occlusive splints, the correct trajectory of opening and closing the mouth was noted: the number of patients with a trajectory violation decreased by 89.1%, and the amount of displacement of the lower jaw during opening and closing the mouth in 92.4% of patients decreased on average to 0.9 mm. When analyzing the movements of the lower jaw in the sagittal plane, deviations of the trajectory of the lower jaw were found in 79% of clinical cases. After the treatment using occlusive splints, 93.4% of cases of mandibular movement trajectory violations in the transversal plane were eliminated, and 78.1% of patients had a reduction in displacement volume to 0.9 mm. When analyzing the movements of the lower jaw in the sagittal plane, deviations of the trajectory of the lower jaw were found in 79% of clinical cases. After the treatment using occlusive splints, 93.4% of cases of mandibular movement trajectory violations in the transversal plane were eliminated, and 78.1% of patients had a reduction in displacement volume to 0.9 mm.

Conclusions: Movement trajectories of the lower jaw in the sagittal plane improved in 80.1% of patients, normalization of the position of the lower jaw in relation to the neuromuscular trajectory was achieved in 93.4% of clinical cases. According to the analysis of the parameters, this treatment should be considered effective.

KEY WORDS: dysfunction, prosthetic dentistry, clinical index of dysfunction, axiography, movement trajectories

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INTRODUCTION

The prevalence of temporomandibular joint (TMJ) dysfunction, especially in persons aged 18-45 years, reached 95-98% among all dental referrals. The course of the pathology is hidden, with periodic relapses and has a long-term nature, which is accompanied by a decrease in the overall quality of life. From the analysis of world scientific sources: the true prevalence of this pathology is uncertain due to the variety of diagnostic criteria [1-3].

According to modern scientific literature, the prevalence of this pathology is up to 95% [4, 5]. Patients with symptoms of TMJ dysfunction most often complain of impaired movement of the lower jaw, the appearance of sounds when opening and closing the mouth, discomfort and periodic pain in the joint area [3]. TMJ dysfunction is a polyetiological disease. According to domestic and foreign authors, the occurrence and development of disorders of the temporomandibular joint are influenced by genetically determined disorders of the development of bone, cartilage and connective tissues, as well as stress factors. At the same time, other authors [6-8] indicate that TMJ dysfunction is always accompanied by muscle pathology. Violation of the tone of the masticatory and temporal muscles is one of the main etiological factors of the TMJ function disorder in musculo-articular forms of manifestation, which are confirmed by the data of clinical and instrumental research methods [9,10].

Reatment of joint dysfunction is a multi-complex of complex therapeutic, orthopedic and psychological measures. In the literature, many methods of treating TMJ dysfunction are described, one of the modern ones is the use of occlusive splints, which allow you to change the position of the lower jaw, diagnose and eliminate TMJ muscle and joint dysfunction.

AIM

To determine the effectiveness of treatment of TMJ muscle and joint dysfunction with occlusive splints based on the analysis of axiography data.

MATERIALS AND METHODS

At the department of orthodontics and propaedeutics of orthopedic dentistry of the Bogomolets National Medical University, an examination of 274 patients aged 18 to 44 with a diagnosis of temporomandibular joint dysfunction was conducted. According to the research algorithm, all patients included in the examination groups were subject to diagnosis before and after treatment. At the time of the initial consultation, all patients had complaints of pain in the area of one or two temporomandibular joints, masticatory muscles, and clinical manifestations of TMJ dysfunction. We used axiography as a method that allows us to obtain accurate graphic data about the trajectory of the movement of the articular head during movements of the lower jaw.

This research method was used by us for the purpose of functional diagnosis of TMJ, as well as for adjusting articulators according to the individual parameters of the patient. This individual setting of the articulator eliminates the need to use additional methods of registering the position of the lower jaw and allows for maximum occlusal accuracy. We used the electronic device «Axioquick-recorder» of the company «SAM» - a device whose principle of operation consists in the interaction of ultrasonic sensors and receivers-registers, concentrated on the facial and dental arches.

For ease of work and to study changes in the neuromuscular component, which is pathogenetically and symptomatically key in the development of TMJ muscle-articular dysfunctions, patients were divided into clinical groups according to the severity of clinical dysfunctional manifestations of neuromuscular disorders:

1. TMJ dysfunction (h=5-10) with clinical manifestations only in the main masticatory muscles (79 people);
2. TMJ dysfunction (h=11-15) with clinical manifestations in the main and auxiliary masticatory muscles (106 people);
3. TMJ dysfunction (h=16-25) with clinical manifestations in the main, auxiliary masticatory and mimic muscles (89 people).

Treatment of all patients was carried out using an occlusive myorelaxant splint. The splint was made individually, thanks to the «EXOCAD» system, or manually in an analog articulator using an interocclusal register in a neutral neuromuscular position of the lower jaw. Setting the manufacturing parameters was necessarily based on axiography data. The average duration of treatment was six months with monthly adjustments of the occlusive splint. After treatment, all patients were re-examined.

The research results obtained by us belonged to statistical processing. The analysis was carried out using the author's MedStat package [2]. To compare pretreatment and posttreatment data, we used the appropriate comparison criteria for related samples. Comparison of qualitative features was carried out using the Chi-square test. In the case of comparison of data from more than two clinical groups, for quantitative indicators we used univariate analysis of variance (if the distribution law was normal) or the Kruskal–Wallis test (if the distribution law was different from normal).

RESULTS

All patients with signs of TMJ dysfunction before treatment had a violation of the movement trajectory of the lower jaw (deviation - 68.7%, diflexion - 31.3%). When opening and closing the mouth, asymmetric shifts of the lower jaw of more than 2 mm were observed (deviation from the middle line - more than 2 mm). After the treatment with occlusive splints, an improvement in the trajectory of opening and closing the mouth was noted: the number of patients with a trajectory violation decreased by 89.1%, and the volume of displacement of the lower jaw during opening and closing the mouth in 92.4% of patients decreased on average to 0.9 mm. When analyzing the movements of the lower jaw in the sagittal plane, in 79% of cases deviations of the trajectory of the lower jaw (change in the symmetry of the release and raising of the lower jaw) were detected. After treatment with occlusion splints, the trajectory of movement of the lower jaw in the sagittal plane improved in 89.1% of patients.

An example of a clinical case. Patient M., 38 years old, complained of pain, discomfort and clicking in the TMJ region. Medical history: no previous orthodontic treatment. At the time of consultation, the patient had been experiencing pain in the left TMJ area for about eight months, clicking in both joints for about three years. Tooth 26 was removed six years ago. Analysis of occlusion: closure of molars and canines according to Engle class II, incisal overlap in the sagittal direction - 2.7 mm, in the vertical direction - 2.4 mm. Analysis of cone-beam computed tomography (CPCT) of the TMJ: the distal displacement of the articular heads is determined, morphological changes in the TMJ area are not detected. Axiography of the movements of the lower jaw: a deviation of the lower jaw in the transverse plane was noted (displacement of the lower jaw during open-

Table 1. Analysis of axiography data in patients of the studied clinical groups before treatment

Indicators	I clinical group, degree	II clinical group, degree	III clinical group, degree	0 clinical group, degree
ASCI	47,1±0,9	45,9±1,3	45,1±1,4	48,1±1,1
BA	10,7±1,2	12,2±1,4	13,6±1,2	8,9±1,1
ASII	46,8±1,1	44,3±1,7	43,8±1,4	53,5±1,1

* Note: the Mann-Whitney test was used when comparing indicators.

Table 2. Analysis of axiography data in patients of the studied clinical groups after treatment

Indicators	I clinical group, degree	II clinical group, degree	III clinical group, degree	0 clinical group, degree
ASCI	48,1±1,3	47,9±1,3	46,7±1,4	48,1±1,5
BA	10,9±1,4	11,1±1,4	12,8±1,2	8,9±1,4
ASII	48,8±1,4	46,9±1,5	46,9±1,3	53,5±1,5

* Note: the Mann-Whitney test was used when comparing indicators.

Table 3. Assessment of axiography indicators

Clinical group	Me (Q_I – Q_{III})		Level importance differences p	Growth ACSI indicator, (95% CI)
	ACSI to treatment	ACSI after treatment		
I, (n=79)	47,3 (46,9 – 47,9)	49,1(48,5 – 49,5)	<0,001	1,7 (1,5 – 1,8)
II, (n=106)	47,3 (46,9 – 47,6)	48,1 (47,4 – 49,3)	<0,001	1,2 (0,9 – 1,4)
III, (n=89)	45,2 (44,9 – 46,4)	47,6 (47,3 – 47,9)	<0,001	2,2 (2,0 – 2,5)

Note: comparisons are made using the Wilcoxon T-test for paired samples.

ing of the mouth by 2.1 mm to the right and 3.1 mm to the left), the trajectories of movements of the lower jaw in the sagittal plane when opening and closing the mouth do not coincide.

We carried out the treatment: setting the lower jaw in a therapeutic position with the help of an individual myorelaxation splint. Wearing mode - 16-18 hours a day. After three months of using the splint with monthly corrections of the device, the patient indicated the absence of pain, clicking in the TMJ area, comfortable and even teeth closing. After treatment, a re-examination was carried out.

Axiography: the improvement of the trajectory of the movement of the lower jaw in the transverse (presence of deviation of the position of the lower jaw by 2.3 mm when opening the mouth) and sagittal planes was determined. As a result of the treatment, the trajectories of the movements of the lower jaw in the sagittal and transversal planes improved, the spatial position of the lower jaw was normalized and the neuromuscular position was achieved. We carried out quantitative calculations for the indicators of the angles of the sagittal condylar snclsnation wave (ASCI), transverse articular path, sagittal incisal path, determined changes in qualitative indicators, namely: symmetry of movements according to both sides, trajectory of movements. All results were compared with the control group. Comparative research results are shown in Tables 1-2.

The obtained results made it possible to establish that in individuals of clinical group 0 (control group) the average values of ASCI were 48.1±1.1 degrees, in patients of the I clinical group - 47.1±0.9 degrees, in the II clinical group - 45.9±1.3 degrees, III clinical group - 45.1±1.4 degrees. Comparisons of the studied clinical groups according to the KSSS indicators revealed statistically significant differences between them ($p<0.005$). A comparison of the average indicators of ASII of individuals of clinical group 0, I, II and III clinical groups determined significant statistically significant differences between them ($p<0.05$). The determined average values of Bennett's angle (BA) were equal to: in clinical group 0 - 8.9±1.1 degrees, in Ia clinical group - 10.7±1.2 degrees, in Ib clinical subgroup - 11.2 ±1 ,1 degree

The determined average indicators of BA in patients had the following indicators: in clinical group 0 - 8.9±1.1 degrees, in clinical subgroup I - 10.7±1.2 degrees.

When analyzing the trajectories of the angles of the sagittal incisal path in the clinical groups we studied, the following indicators were obtained: In the clinical group 0 - 53.5±1.1 degrees, in the I clinical group -46.8±1.1 degrees. It is a well-known fact that there is a dependence of the ASCI indicators and the angle of the sagittal incisal path (ASII) on each other. The difference in parametric data between ASCI and ASII should be equal to 5-10 degrees. The decrease in this difference is a reflection of overloading of the frontal teeth in static

and dynamic occlusion, which indicates an adaptive pathological ratio of the structural elements of the TMJ.

The determined average indicators of BA in patients had the following indicators: in clinical group 0 - 8.9±1.1 degrees, in clinical subgroup I - 10.7±1.2 degrees.

Based on the analysis of the difference in the above indicators, we obtained the following results: in clinical group 0 - 4.4 ± 1.1 degrees, in clinical group Ia - (-)0.3 ± 1.1 degrees, in clinical group II - (-)3.1±1.1 degrees, in clinical group III –(-) 1.7±1.2 degrees. Considering the obtained results, it should be noted the existing mechanism of overload and pathological redistribution of pressure in all, without exception, patients of the studied groups.

In clinical group 0, the general average parameters of the movements of the articular heads of the TMJ corresponded to the established standards for the length of the path during protrusion and latetrusion movements, when opening the mouth, the trajectories were formed clearly, synchronously. The beginning of mouth opening and the end of closing corresponded to each other, which is a sign of normal functioning of intra-articular elements. In the horizontal plane, the symmetry of the lateral trajectories and also the shape of the mouth opening trajectory were determined.

Therefore, in all patients with muscle-joint dysfunctions in the studied clinical groups, the trajectories of TMJ articular heads were asymmetric in shape and path length during protrusion, laterotrusions, and when opening the mouth. Signs of curved trajectories, inconsistencies between the starting point of opening the mouth and the end of closing it were revealed. This is an existing sign of disc pathology and degenerative changes that have already occurred with the surfaces of the joints.

The obtained results made it possible to establish that the treatment of the studied patients of the main clinical groups had the following results: in patients of the 1st clinical group - 48.1±1.3 degrees. The analysis of the obtained indicators of the characteristics of the transverse movements of the lower jaw - Bennett's angle - was as follows: in clinical group 0 - 8.9±1.4 degrees, in clinical group 1 - 10.9±1.3 degrees, in clinical group II 11 ,1±1.3 degrees. Significant statistical differences ($p<0.005$) were determined by comparison of ASII indicators in the groups.

A correlative relationship between the ASCI and ASII indicators has been determined: yes, under the conditions of a change in the ASCI parameters by 0.5-1 degrees, the ASII value also naturally changes by 0.5-0.8 degrees. The presence of registered relevant changes indicates a natural change and positive dynamics of patient treatment results. Thus, according to the results obtained during treatment: in patients of clinical group 1, this difference was 0.5-0.7±0.05 degrees, in patients of clinical group II – 0.3-0.5±0.05 degrees, in patients of the III clinical group - 0.2-0.4±0.03 degrees. Under the conditions of a decrease in the ASII index in relation to the ASII or the absence of changes in the patients, the treatment was subject to correction precisely at the expense of the articulation-occlusion component of the TMJ biosystem, since this was evidence of overloading of the corresponding groups of teeth in static and dynamic occlusion and had a pathological effect on the ratio of intra-articular structural elements.

In order to analyze the effectiveness of treatment of patients with TMJ muscle and joint dysfunction, an assessment of axiography indicators was also carried out. The indicator that characterizes the sagittal movements of the lower jaw is the most significant in terms of diagnostic value. For a reliable assessment, we selected the index of ASCI and performed its analysis before and after treatment in three groups. Table 3 shows the results of the analysis.

DISCUSSION

Thus, for all three clinical groups, after treatment, an increase ($p<0.001$) of the ASCI index was found on average, by more than 1 degree, which indicates a change in the trajectory of the movement of the articular head and the cancellation (absence) of spastic blocks due to the restructuring of the usual neuromuscular reflex with clinical dysfunctional manifestations of neuromuscular disorders. According to the analysis of the results of the treatment: for patients of the 1st clinical group, the ASCI h indicator was changed by 1.5-1.6 degrees. which is evidence of the alignment of the trajectory and the change in the vector of the direction of the movement of the jaw, for patients of the II clinical group, the index of ASCI increased by 0.9-1.4 degrees, which indicates the positive dynamics of treatment, however, such a change in parameters is due to the time of development of the pathology. For patients of the III clinical group, the ASCI index was increased by 2.0-2.5 degrees, which indicates significant changes in the ratio of structural elements of the TMJ biosystem, a corresponding increase in the articulatory movements of the jaw, and the qualitative dynamics of treatment and restoration of the TMJ biosystem.

Our study is important because it provides an opportunity to compare and analyze axiography data before and after treatment. The experience of world scientists, in whose works the analysis of occlusion-articulation parameters is given [8-10], shows us how thorough our approach to this research is. The new data obtained by

us as a result of the research make it possible not only for the convenience of the doctor's work, but also to increase the level of providing dental care as a whole.

In the future, it is planned to delve more and more into the study of the articulating component of the dental and jaw apparatus, including the functional biomechanical component of the TMJ. Practical recommendations: it is advisable to carry out research not only as an initial diagnosis, but also every three months during treatment: in order to detect changes and adjust treatment measures. Improvement of the diagnostic algorithm of patients with TMJ dysfunction will allow detection of pathology in the early stages, which will certainly improve the quality of dental care provided to patients.

CONCLUSIONS

After the treatment with the use of occlusive myorelaxation splints, the elimination of violations of the movement pattern of the lower jaw in the transverse plane was noted in 93.4% of cases, the volume of shifts was reduced to 0.9 mm in 78.1% of patients. The trajectory of movement of the lower jaw in the sagittal plane improved in 80.1% of patients, normalization of the position of the lower jaw in relation to the neuromuscular trajectory was achieved in 93.4% of clinical cases. According to the analysis of the parameters, this treatment should be considered effective.

According to our observations: the use of myorelaxing occlusive splints made according to a digital protocol for the treatment of temporomandibular joint dysfunction is more appropriate, compared to the use of splints made in an analog mechanical articulator (the effectiveness of therapy is, respectively, 92.8 and 85.7% of clinical cases).

The use of electronic axiography and a virtual articulator for the manufacture of myorelaxing splints allows you to shape them in strict accordance with the patient's individual parameters. Thanks to its application, a new opportunity appears to model myorelaxant splints taking into account individual trajectories of mandibular movements, which increases the effectiveness of treatment of patients with intra-articular disorders of the temporomandibular joints.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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