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THE STATE OF THE TEMPOROMANDIBULAR JOINT IN PATIENTS WITH A CROSS BITE AND MANDIBLE DISPLACEMENT BASED ON X-RAY METHODS

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The article presents data on the improvement of diagnostic methods of temporomandibular joint during planning orthodontic treatment in patients with a cross bite in combination with mandible displacement. Based on X-ray analysis, especially orthopantomograms, the anatomical features of the position of the temporomandibular joint elements in cases with a cross bite and mandible displacement are studied. The shape and width of the condyle and articular fossa are found to be changed. The different level of condyle position in articular fossa is determined in side of mandible displacement and the opposite side. It was found that the more degree of the mandible displacement is the more inconsistency in the position of both joints is. Therefore, it is necessary to carefully analyze the structure of the joints, the parallelism of the condyles position, to differentiate the nature of the changes in order to decrease potential complications of orthodontic treatment.

Key words: cross bite, mandible displacement, temporomandibular joint.

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СТАН СКРОНЕВО-НИЖНЬОЩЕЛЕПНОГО СУГЛОБА У ПАЦІЄНТІВ З ПЕРЕХРЕСНИМ ПРИКУСОМ ЗІ ЗМІЩЕННЯМ НИЖНЬОЇ ЩЕЛЕПИ ЗА ДАНИМИ РЕНТГЕНОЛОГІЧНИХ МЕТОДІВ ДОСЛІДЖЕННЯ

У статті представлені дані щодо удосконалення методів діагностики стану скронево-нижньощелепного суглобу на етапах планування ортодонтичного лікування у пацієнтів із перехресним прикусом у поєднанні зі зміщенням нижньої щелепи. На основі аналізу даних рентгенологічного методу досліджень, а саме ортопантомограми визначені анатомічні особливості розташування елементів скронево-нижньощелепного суглобу при перехресному букальному прикусі зі зміщенням нижньої щелепи незалежно від сторони локалізації. Змінюється форма та ширина суглобових ямок і відповідно трансформується форма та ширина суглобових голівок. Визначається різний рівень розташування суглобових голівок в ямках, як з боку зміщення нижньої щелепи так і з протилежної сторони. Встановлено, що чим більший ступінь зсуву нижньої щелепи вбік тим більший градус невідповідності розташування суглобових голівок. Тому потрібно ретельно аналізувати будову суглобів, паралельність розташування голівок, диференціювати характер змін з метою сприяння звуження кола потенційних ускладнень в період ортодонтичного лікування.

Ключові слова: перехресний прикус, зміщення нижньої щелепи, скронево-нижньощелепний суглоб.

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In recent years, the study of the peculiarities of the formation of elements and functions of the temporomandibular joint (TMJ) under the influence of various factors, is becoming one of the actual issues in dentistry [1]. Studying of temporomandibular joint dysfunction (TMD) in patients with malocclusion is divided into two directions: features of the TMJ structure in subjects with malocclusion; the role of malocclusion in the TMJ pathology. Opinions of various researchers on these issues are contradictory, but a lot of statements have become classic [2, 9]. Therefore, discussions on these issues are very relevant and actual.

A significant number of clinical cases with malocclusion in the transverse plane forces dentists to seek new methods of diagnosis and treatment, especially in adult patients, the number of which has been increasing recently. Morphological and aesthetic disorders of facial development in cross bite cases in combination with the mandible displacement encourage orthodontists to carefully study the morphogenesis of this anomaly [7, 9]. The TMJ is one of the most complicated joint in humans. Patients with malocclusion often complain of difficulty opening the mouth, pain, crunch, clicking [6]. The prevalence of TMD among patients with the presence of malocclusion according to various authors is from 30 % to 85 % (Uzhumetskene II 1973; Khvatova VA 1982; Persin LS 1991; Kopeikin VM 1993; Kalamkarov HA 1996; J. Matthews 1986; and others). Clinical studies showed, that malocclusion with chronic lateral mandibular displacement are much more common than previously thought. That is why; it is very difficult to identify chronic lateral mandibular displacement, because there are a lot of cases without clinical signs of transverse malocclusion. As a result, this leads to unstable treatment results and complications [3].

One of the main predictors of TMD is a violation of the lower jaw movements – limitation or hypermobility, which are diagnosed during clinical functional tests. TMD is diagnosed by different

research methods [3, 7, 8]: clinical, graphic, X-ray. Each method adds information about the nature of morphological and functional disorders.

From a practical point of view, in the process of diagnosis there is a contradiction: if you examine the entire dento-facial system, there is a complex of symptoms and, accordingly, a cumbersome and vague diagnosis; if you carry out express diagnostics, there is an incomplete detection of etiological and pathogenetic factors which can lead to treatment complications. This forces orthodontists to look for new approaches in diagnostic algorithms in which identifying of symptoms is carried out consistently, structured, with comparison. Finding the main links of the pathogenesis allows moving reasonably from the previous diagnosis to the differential and completing one.

Therefore, the improvement of methods of TMJ diagnosing in the stages of orthodontic treatment planning can decrease the range of potential complications of orthodontic correction and determine the feasibility of any intervention in relation to changes in the mandible position in cases with cross bite.

The purpose of the study was to determine the parameters that characterize the state of the temporomandibular joint elements in patients with cross bite and mandible displacement on the basis of orthopantomograms analysis (OPTG) and to find out the features of the relationship of the joint elements in subjects with different degrees of mandible displacement.

Materials and methods. The study group consisted of 20 people aged 21-24 years with permanent teeth, cross buccal bite and mandible displacement according to the classification of Uzhumetskene (1967). They complained of facial asymmetry, TMJ clicking during mouth opening, the midline dental shift. All patients are divided into two groups according side of cross bite: 1 group – patients with right-sided and the second group – with left-sided buccal cross bite.

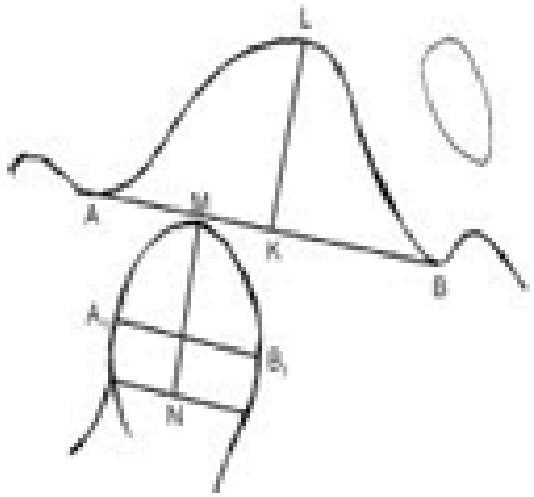

Fig. 1. Measured segments of the tempo-romandibular joint elements on orthopantomogram, the mouth is open. AB – joint space distance (between the bone peaks that limit the articular fossa), A_1B_1 – width of the condyle (between the anterior and posterior poles), LK – the depth of the articular fossa (the length of the perpendicular dropped from the deepest point of the fossa to the line AB), MN - height of the condyle (the length of the perpendicular dropped from the upper point of the condyle to the line of the condylar neck).

To determine the character of the mandible displacements the method by Ilyina-Markosyan (1959) was used. When a patient slowly closed his mouth, the direction of the lower jaw movements and midlines shifting were studied. If the lower jaw is centered when the mouth is opened, and at the time of closing it sharply shifted to the side, then there was an occlusive type of functional mandible displacement. If it is smoothly shifted to the side before contact with the upper teeth, it is a muscle imbalance and muscular functional mandible displacement. If the shift occurs stepwise, then it is diagnosed a joint type of functional displacement of the lower jaw. The greatest degree of TMDjoint dysfunction is observed when the mouth is open, so in our opinion it was advisable to analyze orthopantomograms in its traditional method with a biting roller between the central incisors. The location of the joint elements was evaluated according to Rabukhina method (1966).

The anterior and posterior joint space distances were measured. The shapes of the tubercle slope, condylar head of both sides and their relationship were studied. These indicators are easily identified during traditional head positioning during orthopantomography.

The procedures received approval from the Bioethics Committee of the Ukrainian Medical Stomatological Academy (Poltava, Ukraine). All patients signed a statement of informed consent.

The obtained data was statistically analyzed using the Student's t-test and the Fisher's F-test $\chi 2$. The hypotheses were verified at the level of significance $p<0.05$.

Results of the study and their discussion. The obtained data are shown in tableis 1 and 2.

Analysis of obtained results of group 1 with right buccal cross bite and mandible displacement showed that the width of the condyle on the right side is 0.73 mm more than on the left.

The height of the joint head on the right side is 0.6 mm more. The anterior and posterior space distances on the right side is 0.46 mm more and 1.6 mm more respectively than on the left. The height of

the articular fossa on the right side is also 1.7 mm more. The height of the condyle on the right side is 1.64 mm more ($p \leq 0.05$).

Table 1

Temporomandibular joint state in patients with cross bite with mandible displacement based on OPTG analysis (measurements in mm)

Study group	Width of joint head		Height of joint head		Height of joint fossa		Height of joint tubercule	
	left	right	left	right	left	right	left	right
1	11.12 ±0.33	11.85 ±0.23 $p_1 \leq 0.05$	9.43 ±0.31	10.04 ±0.11	11.88 ±0.53	13.58 ±0.42	11.50 ±0.74	12.19 ±0.62 $p_2 \leq 0.05$
2	12.64 ±0.28 $p_1 \leq 0,05$	10.21 ±0.10 $p_1 \leq 0.05$ $p_2 \leq 0.05$	12.93 ±0.12 $p_1 \leq 0.05$	10.71 ±0.63 $p_2 \leq 0,05$	14.14 ±0.99 $p_1 \leq 0,05$	13.07 ±0.01 $p_2 \leq 0,05$	14.21 ±1.14 $p_1 \leq 0,05$	13.64 ±0.95

Note: p_1 - significance of differences in the group with right-sided and left-sided cross bite; p_2 - the significance of differences between the indicators of left and right side.

Table 2

Temporomandibular joint state in patients with cross bite with mandible displacement based on OPTG analysis (measurements in mm)

Study group	Anterior space distance		Posterior space distance	
	left	right	left	right
1	2.23±0.18	1.77±0.18	5.15±0.92	4.50±0.42
2	2.60±0.21	1.64±0.14; $p_2 \leq 0,05$	3.71±0.24	3.36±0.83

Note: p_2 - the significance of differences between the indicators of left and right side.

Analysis of obtained results of group 2 with left buccal cross bite and mandible displacement indicates the opposite changes. The width of the condyle of the left side is 2.43 mm more than on the right.

The height of the joint head on the left is 2.22 mm more. The anterior space distance on the left sideis greater by 0.96 mm. The posterior width of the joint space on the left is greater by 0.35 mm. The height of the articular fossa on the left is greater by 1.07 mm. The height of the articular head on the left is greater by 0.57 mm ($p \leq 0.05$).

Thus, the nature of the changes that occur in cross bite cases is the same and does not depend on the location of the anomaly. Mathematical characteristics of TMJ elements increase on the side where the lower jaw is displaced.

Analyzing clinical cases, it can be noted that there is an appropriate ralationship of TMJ elements in each case, which may appear due to duration of the causes, the adaptive capacity of the organism. There are differences in the location of the elements of the joint in patients who have the third permanent molars be erupted and in which they are retained or semi-retained. Thus, we can assume that the eruption of the third permanent molars contributes to the unilateral mandible displacement, which may be associated with late growth of the mandible (fig. 2).

Fig. 2. Orthopantomogram of patient B., 21 years. Diagnosis: right-side buccal cross bite.

Regardless of the mandible displacement, the typical nature of morphological disorders is determined: on the displacement side the joint fossa is flatter, the shape of the joint head is flatte ned

and elongated, the neck of the articular head is elongated. At the same time, the proportionality between the height of the joint fossa and the height of the joint head is practically preserved. There is flat joint tubercle (fig. 3).

Fig. 3. Orthopantomogram of patient M., 22 years. Diagnosis: left-side buccal cross bite.

Another picture is observed from the direction where the lower jaw has shifted: a joint head has a spherical shape, the neck of a joint head is a wider; a joint fossa is deeper and wider. The articular tubercle has a conical shape.

Regardless of the degree of the mandible displacement from 1/3 to 2/3 of the crown width of the lower incisor, the location of the joint elements is similar. Thus, we can assume that in the process of formation of the cranio-mandibular system and occlusal contacts there are certain natural compensatory mechanisms. It is also possible that other factors contribute to the state of the TMJ.

Analyzing OPTG, we paid attention to the different level of location of the joint heads in relation to each other. This prompted us to investigate their parallelism. To aim this, on a standard OPTG we conducted a mid - sagittal plane, through the condylon points of both joint heads and then drawn perpendicular to the plane and determined the angle of inclination of each head in degrees.

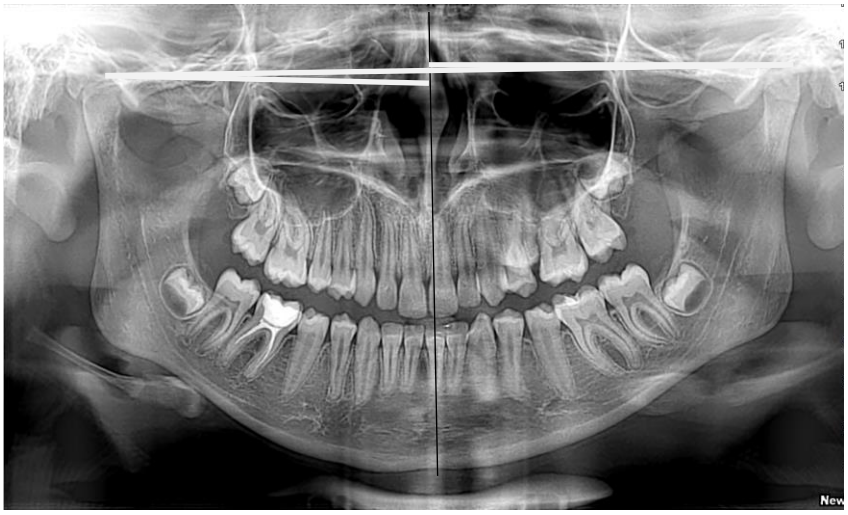

Fig. 4. Orthopantomogram of patient K., 23 years. Diagnosis: left-side buccal cross bite.

We found that in cases with the mandible displacement from 1/3 of the crown width of the lower incisor, the joint head on the side of mandible shift were 2° higher than the opposite one. The more degree of the mandible displacement, the more inconsistency in the position of both joint is. So we can predict that it is connected with anatomical structure of the skull bones, which form the joint fossa. It means that the skeletal component of the mandible displacement exists.

The prevalence of unilateral posterior cross bite is insignificant and averages up to 5 % [7]. According to the literature, cross-bite that accompanies TMD occurs in about 7-8 % cases. Cross bite can be caused not only by changes in the transverse dimensions of the upper and lower dental arches and their ratio, but also by the mandible displacement to the right or left side. In this case, an unilateral posterior cross-buccal bite is formed on the displacement side [4, 9]. In patients with such malocclusion and clinical signs of TMD symptoms, it is important to evalute the intra-joint structures. Thus, there are data on the measurements of the joint spaces and the joint head in subjects who had clinical manifestations of TMD. The condylar position can be assessed by the size of the joint spaces in three directions: anterior, posterior and upper when analyzing OPTG or come-beam computer tomography [9]. In our opinion, it is also important to determine the shape and size of the joint head, joint fossa and joint tubercle, especially with asymmetric malocclusion and mandible displacement. We found no data on the characteristics of the joint elements in patients with cross-bite, mandibular displacement and TMD.

According to the literature, the condyle of the patients with TMD and malocclusion were seated more posteriorly, while slight anterior condylar position were found in asymptomatic patients. In the

experimental group, the horizontal angle of the condyle in the symptomatic side was larger than that in the asymptomatic side, while the vertical angle was just opposite. No statistically significant asymmetries were found in the mediolateral diameter, the anteroposterior diameter, the angle of condylar axis, the distance between condylar center to midsagittal plane and anteroposterior difference of condyle center [8].

A large amount of data is devoted to a change in the size of joint structures in subjects malocclusion in the sagittal plane, namely in Class II and III of Angle. Significant differences were found in the long axis and radius of the condyles between Class I and III, Class I and II respectively. The widest joint fossa was observed in Class III, followed by Class I and II. Moreover, the deepest joint fossa was found in Class II, I and III. No significant differences were detected in the left and right condyle-related structures among different temporomandibular articulation. In addition, the anterior articular space was significantly larger in Class I patients, compared with Class II patients [10]. Regarding the change in size of joint elements in patients with mandible displacement in the transverse plane, such data are few.

We found, that the shape and width of the condyle and joint fossa are changed in patients with unilateral posterior cross bite and clinical signs of TMD. There is a different level of the location of the condyle in the joint fossa on the both sides. The more degree of the mandible displacement is, the more inconsistency in the position of both joints is.

In an experiment in which mandible displacement was reproduced and TMD was modeled, it was proved that the change in size of joint structural elements in patients with cross bite was caused by changes in osteoblast and osteoclast activities in TMJ subchondral bone, involvement of reduced osteoblast activity [11].

Conclusion

This study provides that in patients with cross buccal bite and the mandible displacement there are some anatomical features are observed regardless of the side. Thys: the shape and width of the condyle and articular fossa are changed. There is a different level of the location of the condyle in the articylar fossa on the both sides. The more degree of the mandible displacement is, the more inconsistency in the position of both joints is.

Therefore, during planning of orthodontic treatment you need to carefully analyze the structure of the joints, the parallelism of the location of the condyles. It assists to differentiate the nature of morphological and functional changes in order to decrease potential complications of orthodontic treatment, to determine the feasibility of any interventions in relation to change the position of the mandible in patients with cross bite.

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