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Relationship between unilateral posterior crossbite and mandibular asymmetry during late adolescence

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SUMMARY

The aim of the study. was to evaluate the relationship of mandibular condylar and ramal symmetry with unilateral posterior crossbite during late adolescence.

Material and method. 120 pre-orthodontic patients of the Lithuanian University of Health Sciences Department of Orthodontics were included in the study. The main inclusion criteria of the study group were the following: permanent dentition, age 15 to 18 years, unilateral crossbite. Panoramic radiographs database were analyzed, the following parameters were evaluated: mandibular condylar and ramal height, and asymmetry index according to Habets' technique. Statistical data analysis was performed using SPSS 22.0 statistical software.

Results. In the study group the mandibular condylar height, ramal height, and ramal plus condylar height on the crossbite side were statistically significantly lower than those on the non-crossbite side. Comparing the asymmetry indices between the study and the control groups, it was found all indices were statistically significantly higher in the group with unilateral posterior crossbite than those in the control group, p<0.001.

Conclusion. Relationship between unilateral posterior crossbite and mandibular asymmetry during late adolescent was found, in subjects with unilateral posterior crossbite statistically significantly reduced mandibular condylar height and mandibular ramal height on the crossbite side was detected, they demonstrated a higher mandibular condylar and mandibular ramal asymmetry index, compared to the control group subjects, p<0.001.

Key words: unilateral posterior crossbite, mandibular asymmetry.

INTRODUCTION

The goal of modern orthodontic treatment is not limited to the ideal functional occlusion and well aligned dental arches, but also is normal soft tissue relationship and adaptations, smile esthetics, facial symmetry, and solved patient's problems. Unilateral posterior crossbite is rather prevalent malocclusion and it can influence growth of the dentofacial complex, temporomandibular joint disorders, early dental attrition, and facial asymmetry. Over the recent years, during the optimization of treatment and the development of preventive programs, increasing attention is focused on the assessment and a precise definition of the risk factors of this malocclusion as well as on the evaluation of its impact on the growth and development of face and jaws.

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The prevalence of unilateral posterior crossbite varies from 8% to 22%, depending on the population and registration method. Both unilateral and bilateral posterior crossbite are equally prevalent (1-3), and some researchers state that this malocclusion is not related with patients' age. More often, development of posterior crossbite is resulted by a complex interaction among multiple factors that influence dentofacial growth (2). The most common causes are the following: congenital cleft lip and/or palate, congenital genetic syndromes and unfavorable factors during the growth of the child – such as early loss of deciduous teeth, dental crowding, frequent and prolonged inflammation of nasal mucosa, adenoid and/or tonsil hypertrophy, which causes upper airway obstruction (4-7). In addition, there are unfavorable environmental factors that may affect the development of malocclusion. These include non-nutritive sucking, prolonged sucking of pacifier or finger, short period of breastfeeding, nutrition habits, or frequent use of soft food, which results in the weakening of the masticatory muscles (5, 8-10).

During the past decades there has been an increase in the number of studies on the analyzing unilateral posterior crossbite and facial symmetry. The results of the studies showed that subjects with this type of malocclusion rather often had mandibular deviation towards the side of the crossbite during maximum intercuspidation, and, in some cases, even at rest (11). During the active growth period, if mandibular deviation is not corrected for a prolonged time, mandibular growth may be stimulated or inhibited – especially in the condylar region (11, 12), and this may result in the dysfunction of the stomatognathic system and facial asymmetry (4, 13). A change in the occlusion causes asymmetric activity of the masticatory muscles (14) and studies indicate that patients with unilateral posterior crossbite have altered mandibular kinematics – reverse-sequencing chewing patterns and changes in the bite force (14-16).

A review of the researches has revealed studies that analyzed the relationship of the symmetry of mandibular condyles with unilateral posterior crossbite in deciduous and mixed dentition, yet no studies have been performed in older children, after the growth peak. In this study, we raised a hypothesis that subjects with unilateral posterior crossbite will have condylar height asymmetry of the mandible.

The aim of the study was to evaluate the relationship of mandibular condylar and ramal symmetry with unilateral posterior crossbite during late adolescence.

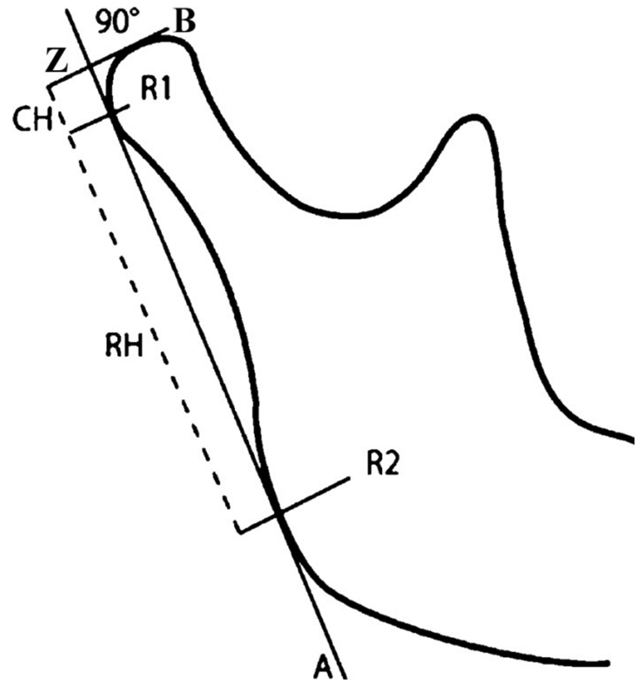

Fig. Measurements of mandibular condylar and ramal height: R1 – the most lateral point of the mandibular condyle; R2 – the most lateral point of the mandibular ramus; A line – the line drawn through points R1 and R2; B line – the line perpendicular to line A, drawn though the highest point of the mandibular condyle; and Z – the intersection point between lines A and B. Mandibular condylar height (CH) – the distance between points Z and R1; mandibular ramal height (RH) – the distance between points R1 and R2; mandibular condylar plus ramal height (CH-RH) – the distance between points Z and R2 [17].

Table 1. Mandibular condylar height, mandibular ramal height, and mandibular ramal plus condylar height in the study group

Measurement (mm)	Posterior crossbite side		Non-crossbite side		p
	Mean	SD	Mean	SD	
Mandibular condylar height (CH)	7.19	0.64	7.45	0.74	0.005*
Mandibular ramal height (RH)	43.51	2.22	43.84	2.06	0.006*
Mandibular ramal plus condylar height (CH-RH)	50.70	2.40	51.29	2.47	<0.001*

*statistically significant, $p<0.05$.

Table 2. Mandibular condylar height, mandibular ramal height, and mandibular ramal plus condylar height in the control group

Measurement (mm)	Left side		Right side		p
	Mean	SD	Mean	SD	
Mandibular condylar height (CH)	7.61	1.03	7.64	1.05	0.597
Mandibular ramal height (RH)	42.83	1.93	42.91	1.91	0.152
Mandibular ramal plus condylar height (CH-RH)	50.45	2.30	50.54	2.30	0.070

Table 3. Comparison of mandibular condylar height, mandibular ramal height, and mandibular ramal plus condylar height asymmetry indices between the study and the control groups

Asymmetry index	Study group		Control group		p
	Mean	SD	Mean	SD	
Mandibular condylar height asymmetry index	4.18	2.06	1.59	0.73	<0.001*
Mandibular ramal height asymmetry index	0.87	0.53	0.37	0.26	<0.001*
Mandibular ramal plus condylar height asymmetry index	1.16	0.66	0.32	0.24	<0.001*

*statistically significant, $p<0.05$.

MATERIALS AND METHODS

After the evaluation of clinical and radiological data, 120 pre-orthodontic patients of the Lithuanian University of Health Sciences Department of Orthodontics were selected for this retrospective study: 60 subjects with unilateral posterior cross-bite to the study group and 60 without crossbite to the control. The study was conducted with the permission of the Kaunas Regional Biomedical Research Ethics Committee (February 9, 2015, No.BE-2-12). The main inclusion criteria of the study group were the following: permanent dentition, age 15 to 18 years, unilateral cross-bite (if at least two teeth of the lateral tooth group were in crossbite in the diagnostic models), and no previous orthodontic treatment or congenital syndromes, maxillofacial and/or mandibular traumas, congenital hypodontia, or extracted teeth. To the control group were included patients with molar relationship Angle Class I, overjet and/or overbite less than 6 mm.

Panoramic radiographs from the "Kodak Dental Imaging" database were analysed, the following parameters were evaluated: mandibular condylar and ramal height according to Habets' technique (Figure). After calibration of radiographs, measurements were performed by using the "Kodak Dental Imaging" software. We evaluated mandibular condylar height (CH), mandibular ramal height (RH), and mandibular condylar plus ramal height (CH-RH) on the left and the right sides (17).

To evaluate the symmetry of the mandible, we calculated the mandibular condylar, mandibular ramal, and mandibular condylar plus ramal asymmetry indices on the basis of the Habets' asymmetry index (17).

$$\text{Asymmetry index (AI)} = \frac{right - left}{right + left} \times 100\%$$

Statistical data analysis was performed using SPSS 22.0 statistical software. The following statistical methods were applied in the analysis: descriptive statistics, the Shapiro-Wilk test, parametric tests – Student's t test for paired samples and Student's t test for independent samples, and non-parametric tests – the Mann-Whitney U and Wilcoxon tests. The differences and interdependence between the attributes were considered to be statistically significant when $p<0.05$.

For the panoramic radiograph, the error margin was determined by repeating the measurements of the variables on randomly selected 20 radiography images at 2 week intervals with the same operator; the paired sample test showed no significant mean differences in the two data sets.

RESULTS

The study included 120 patients (96 girls and 24 boys) with the mean age of 15.8±1.2 years. The study sample consisted of two groups: the study group - subjects with a unilateral posterior crossbite (60 patients), and the control group (60 patients).

In the study group, the comparison of the heights between the crossbite and non-crossbite sides was performed using Student's t test for dependent samples and Wilcoxon's signed-rank test. In this group, the detected mandibular asymmetry in the vertical plane, the mandibular condylar height, ramal height, and ramal plus condylar height on the crossbite side were statistically significantly lower than those on the non-crossbite side (Table 1).

In the control group, the comparison of measurements on the right and the left sides was performed by applying Student's t test for dependent samples and Wilcoxon's signed-rank test. In this group, no statistically significant differences were detected in mandibular condylar height, ramal height, or ramal plus condylar height between the right and the left sides (Table 2).

We calculated the mandibular condylar height, mandibular ramal height, and mandibular ramal plus condylar height asymmetry indices in the study and the control groups. When comparing the asymmetry indices between the study and the control groups, we used the Mann-Whitney U test for independent samples. In the study group, all asymmetry indices were statistically significantly higher than those in the control group, $p<0.001$ (Table 3).

The evaluation of the influence of the subjects' age and sex on the vertical parameters and symmetry of the mandibular condyle and mandibular ramus and on the presence of posterior crossbite revealed no statistically significant correlations.

DISCUSSION

Unilateral posterior crossbite is one of the most common malocclusions during deciduous, mixed, and permanent dentition. An epidemiological study on adult subjects who had no history of orthodontic treatment found it in 17.95% of the studied population (1, 18). Long-term monitoring of children from 3.5 to 11.5 years of age has indicated a spontaneous reduction in the prevalence of posterior crossbite from 15.9% during deciduous dentition to 5.1% in permanent dentition without any orthodontic treatment. Based on these results, some researchers have stated that the treatment of unilateral posterior crossbite with orthodontic appliances is not indicated during deciduous dentition because of the possibility of spontaneous correction (2). Conversely, other researches indicate that spontaneous correction of unilateral posterior crossbite in children over 4 years of age is unlikely (19, 20).

The aim of our study was to evaluate the relationship of unilateral posterior crossbite with mandibular symmetry in subjects after the active growth period. During this study, we evaluated vertical ramal and condylar measurements of the mandible on both sides. Mandibular asymmetry was evaluated on panoramic radiographs by applying the technique proposed by Habets *et al.* (17). In our studied population of 15-18 year-old children, the mandibular condylar height, ramal height, and condylar plus ramal height were statistically significantly greater on the non-crossbite side than on the crossbite side. In the control group, no statistically significant differences in the parameters between the left and the right sides were detected.

Studies indicate that the asymmetry index exceeding 3% should be classified as vertical asymmetry, in our study, the asymmetry index of the mandibular condylar height in the posterior crossbite group was 4.18±2.06, which shows vertical asymmetry. The data of our study are in line with those obtained by Al Taki and Kasimoglu, where significantly lower vertical parameters of the mandible were detected on the crossbite side (11, 12, 21). Conversely, Uysal in his study failed to detect a reliable difference between condylar heights on the crossbite and non-crossbite sides (22).

Habets was the first to start using panoramic radiographs for the measurements of mandibular condylar height in clinical practice (17). Some authors have pointed out methodological shortcomings of this technique, such as errors in vertical measurements in panoramic radiographs due to possible magnification or distortion of anatomical structures (23). In experimental study comparing mandibular condylar measurements performed on human dry skulls with those performed on panoramic radiographs, some discrepancies were detected (24). Kambylafkas *et al.* conducted a study where they evaluated vertical measurements on panoramic radiographs with those on mandibular phantoms, and concluded that these X-ray images offered a sufficiently objective measurement technique in the evaluation of mandibular condylar height because the results of both measurement techniques were nearly identical (23). In modern diagnostics, computed tomography, magnetic resonance imaging, and 3D computed tomography are considered to be the most objective measurement techniques for mandibular condyles and mandibular size (25, 26). However, computed tomography has a serious drawback in the form of ionizing radiation, which may negatively affect condylar growth (25), and thus this method is not recommended as a first-line option in daily clinical practice. In addition, studies have shown that appropriate positioning of the head in the X-ray machine and the bite block minimizes the probability of image distortions to the levels that do not affect measurement accuracy. In our study, we selected panoramic radiographs for mandibular condylar and mandibular ramal measurements as a minimally invasive, simple, safe, and readily available technique. Several measurement techniques are applied for the evaluation of mandibular condylar symmetry. In literature, Habets' and Kjellberg's measurement techniques are the most common. Fuentes in his study compared these techniques and concluded that both are objective, easily reproducible, and reliable in the evaluation of mandibular condylar and ramal asymmetry (27). So in our study, we selected Habets' technique.

Unilateral posterior crossbite is characterized not only by malocclusion of posterior teeths, but also by asymmetrical functioning of other parts of the stomatognathic system – muscles and the temporomandibular joint (TMJ) (15, 28). Altered mandibular kinematics, reverse-sequencing chewing patterns, and reduced masticatory muscle activity on the crossbite side (29) result in the atrophy of masticatory muscle fibers and the reduction in their number on the crossbite side. Researchers in their studies have found that on the crossbite side, muscle tension is reduced due to lower mechanical load, whereas on the non-crossbite side, a slight hypertrophy of masticatory muscles can be observed, which has developed to compensate for the increased mechanical load (15).

Literature indicates that TMJ disorders are influenced by unilateral posterior crossbite (31), although contradicting opinions exist as well (30). Mostly, these disorders are associated with functional unilateral posterior crossbite. Thilander *et al.* in their study found that patients with unilateral crossbite more frequently had such complaints as clicking in the TMJ, pain, tension of the masticatory muscles, and headaches (31). During maximal intercuspidation, the condyle on the non-crossbite side moves down and medially, whereas on the crossbite side, it moves up and laterally. The altered position of the condyle in the articular fossa causes structural changes in the TMJ. Prolonged impairment of this function – especially during the intensive growth period – results in formation of occlusion, which, in turn, may cause asymmetrical growth of the condyles (31-33). In addition, Castelo *et al.* in their study found that children with unilateral posterior crossbite had weaker bite force on the side of the anomaly, compared to children without it (20).

In our study, we detected a significantly lower mandibular ramal height on the crossbite side, which may have been affected by the asymmetrical activity of the masticatory muscles. Kiliaridis *et al.* found that patients with unilateral crossbite had underdeveloped masseter muscle on the side of the pathology. Insufficient development of this muscle on the crossbite side may be associated with the shorter mandibular ramus on the crossbite side (34). Thus, the results of our study and the findings obtained by other researchers suggest that patients with unilateral crossbite have asymmetrical condyles. The relationship between unilateral posterior crossbite and facial asymmetry is still actual and further investigations higher sample size and long-term control is needed.

Facial symmetry is one of the criteria of attractiveness, which has an important effect on a person's psychological and social wellbeing. Timely treatment of unilateral posterior crossbite is important not only because of the correction of functional alterations, but also from the esthetic viewpoint. Petren *et al.* stated that early treatment is important for normal growth and development of dentofacial complex as well as for prevention of facial asymmetry (35). The evaluation and early diagnostics of the risk factors for unilateral posterior crossbite are an important part of patient examination and it cannot be overlooked.

CONCLUSIONS

Relationship between unilateral posterior crossbite and mandibular asymmetry during late adolescent was found, in subjects with unilateral posterior crossbite statistically significantly reduced mandibular condylar height and mandibular ramal height on the crossbite side was detected, they demonstrated a higher mandibular condylar and mandibular ramal asymmetry index, compared to the control group subjects, $p<0.001$.

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