Original Article

Mandibular Asymmetry in Different Occlusion Patterns

A Radiological Evaluation

Omer Said Sezgin[a]; Peruze Celenk[b]; Selim Arici[c]

ABSTRACT

Objective: To investigate the effects of different occlusion types on the mandibular asymmetry in young individuals.

Materials and Methods: Mandibular asymmetry measurements were performed on the panoramic radiographs of 189 subjects (104 females and 85 males; age range, 11–15 years), with different occlusion patterns. The subjects were divided into five groups according to the occlusion types, namely, Angle Class I (Cl I), Class II division 1 (Cl II/1), Class II division 2 (Cl II/2), Class III (Cl III), and normal occlusions. The Kruskal-Wallis test was used to determine the possible statistically significant differences between the groups for condyle, ramus, and condyle-plus-ramus asymmetry index measurements. Identified differences between groups were further analyzed using the Mann-Whitney *U*-test at the 95% confidence interval ($P < .05$).

Results: There were no statistically significant differences between male and female subjects. The Kruskal-Wallis test showed that the occlusion type had a significant effect on the condylar asymmetry. In Cl II/1 cases, condylar asymmetry values were significantly different from the values of Cl II/2 and Cl III malocclusion and normal occlusion types. The normal occlusion control group was significantly different from those of Cl II/1 and the Cl I malocclusion groups.

Conclusion: Cl II/1 malocclusion has a significant effect on the condylar asymmetry index when compared to Cl II/2 and Cl III malocclusion and normal occlusion types. However, the mean condylar asymmetry index value in Cl II/1 malocclusion was not different from Cl I malocclusion.

KEY WORDS: Mandibular asymmetry; Condylar asymmetry; Asymmetry indexes; Panoramic radiography; Angle malocclusion

INTRODUCTION

Symmetry, when applied to facial morphology, refers to the correspondence in size, shape, and location of facial landmarks on the opposite sides of the median sagittal plane.[1]

The mandibular asymmetry, also known as the lower third of the face, is important because of its direct effect on facial appearance. Asymmetries of the mandible may cause not only esthetic but also functional problems because of its role in the stomatognathic system. The regions that have the highest growth potential on the mandible are the condylar cartilages. Injuries occurring in these areas during the growth period can disturb the mandibles' down-and-forward growth potential, resulting in the displacement of the mandible toward the affected side. Thus, condylar asymmetries are thought to be one of the most important causes of mandibulofacial asymmetries.[2–4]

The relationships between the condylar asymmetries and craniomandibular disorders were investigated by Habets and his coworkers.[5] Kjellberg et al[6] developed and used a new method of quantitatively measuring the effects of condylar heights on panoramic radiographs.

Condylar asymmetries have also been evaluated in patients with Class II division 2 (Cl II/2)[7] and Class III (Cl III)[8] malocclusion without any temporomandibular disorder (TMD). There is no published study, however, that has investigated mandibular asymmetry in all occlusion types (Angle Class [Cl I], Class II division 1 [Cl II/1], Cl II/2, Cl III, and normal occlusion). The aim of

[a] Private Practice, Samsun, Turkey.

[b] Professor, Department of Oral Diagnosis and Radiology, Ondokuz Mayis University, Samsun, Turkey.

[c] Associate Professor, Ondokuz Mayis University, Department of Orthodontics, Samsun, Black Sea, Turkey.

Corresponding author: Dr Selim Arici, Ondokuz Mayis University, Department of Orthodontics, Kurupelit, Samsun, Black Sea 55139, Turkey (e-mail: sarici@omu.edu.tr)

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this study was therefore to investigate the effect of different occlusion patterns on mandibular asymmetry in adolescents with no clinical signs or symptoms of TMD.

MATERIALS AND METHODS

A total of 189 patients (104 female, 85 male; age range, 11–15 years) who attended our clinic for various reasons participated in this study. The following inclusion criteria were used for subject participation in the study: (1) skeletally and dentally Cl I, II/1, II/2, and III relationship (and normal occlusion for the control group); (2) absence of posterior crossbites (unilateral or bilateral), mandibular deviation during closure, and any history of jaw trauma; (3) no symptoms of occlusal trauma, masticatory disharmony, pain during jaw movements, or clinically diagnosed temporomandibular joint disorders; and (4) no recent history of occlusal adjustment or orthodontic treatment. The subjects were skeletally classified by evaluating cephalometric norms, particularly ANB angle, on the lateral cephalograms in the sagittal plane. In Class II malocclusion cases, the patients with retroclined upper incisors and deep anterior overbites were classified as Cl II/2 malocclusion group.

The study group consisted of 163 subjects with various malocclusions and was divided into four subgroups according to the malocclusion type. The subgroups were as follows: Cl I, 39 subjects (18 female, 21 male); Cl II/1, 43 subjects (24 female, 19 male); Cl II/2, 39 subjects (23 female, 16 male); and Cl III, 42 subjects (25 female, 17 male). The control group consisted of 26 subjects (14 female, 12 male) with normal occlusion.

After classification of the occlusion by the use of Angle standards in clinical examination, the panoramic radiographs of all the patients were taken under standardized conditions (Planmeca proline cc, Helsinki, Finland) and processed (Dent-X 810, Elmsford, NY).

The condylar asymmetry, ramus asymmetry, and condyle-plus-ramus asymmetry in vertical heights were determined according to the method suggested by Habets et al[5] (Figure 1). The outlines of the condyle and ascending ramus of both sides on the panoramic radiographies were traced on acetate paper. A line (A) was drawn connecting the most lateral points of the condylar image (O1) and the ascending ramus image (O2). The distance between O1 and O2 was called the ramus height (RH). To the A line (ramus tangent) from the most superior point of the condylar image, a perpendicular line (B) was drawn. For condylar height (CH), the vertical distance from this line on the A line to the O1 point was measured (Figure 1). Asymmetry indexes were estimated using the following formula:

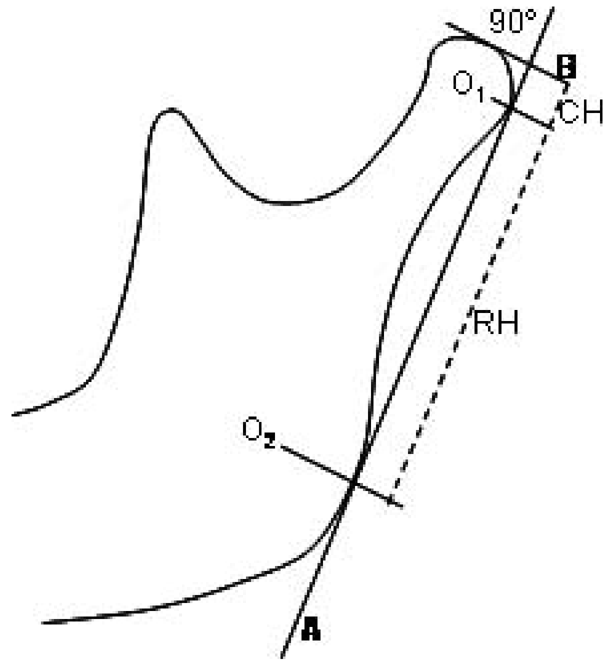

Figure 1. Measuring method according to Habets et al.[5] O1 and O2 indicate the most lateral points of the image; A, ramus tangent; B, perpendicular line from A to the superior part of the condylar image; CH, condylar height; and RH, ramus height.

$$\text{Condylar Asymmetry Index (AI)} = \left|(CH_{right} - CH_{left})/(CH_{right} + CH_{left})\right| \times 100.$$

Ramus and condyle-plus-ramus asymmetries were also evaluated using the same formula.

All measurements were performed by one investigator on the panoramic radiographs of the subjects using a digital caliper with a 0.01-mm sensitivity.

Statistical Analysis

The error of the method was assessed by statistically analyzing the difference between double determinations made 2 weeks apart on the panoramic radiographs of 20 subjects selected at random. A paired-sample *t*-test at the 95% confidence level showed that the difference between the first and second measurements of the 20 patients was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value (.98) for condylar asymmetry index measurements and the lowest *r* value (.96) for condyle-plus-ramus index measurements.

Considering the number of groups and the independence of subjects, the Kruskal-Wallis test was used to determine the possible statistically significant differences between the groups. Differences between groups were further analyzed by the Mann-Whitney *U* test. All statistical tests were set at the 95% confidence level ($P < .05$).

Table 1. Descriptive Statistics and Comparison of Asymmetry Index Values for Groups

	Group	N	x̄	SD	Min	Max	Between-Groups *P*
Condyle	Cl I	39	6.99	5.46	1.17	27.37	
	Cl II/1	43	8.51	4.87	0.00	18.66	
	Cl II/2	39	6.49	6.44	0.00	20.41	.004*
	Cl III	42	6.41	7.08	0.00	29.63	
	Normal (control)	26	3.88	3.81	0.00	19.48	
Ramus	Cl I	39	2.12	1.54	0.00	5.08	
	Cl II/1	43	2.74	2.01	0.01	7.78	
	Cl II/2	39	1.68	1.46	0.00	6.40	.181
	Cl III	42	2.44	2.13	0.00	7.12	
	Normal (control)	26	2.12	1.79	0.27	7.11	
Condyle + ramus	Cl I	39	1.94	1.31	0.11	5.58	
	Cl II/1	43	2.69	2.16	0.02	7.86	
	Cl II/2	39	1.51	1.30	0.00	4.79	.060
	Cl III	42	1.76	1.66	0.08	6.17	
	Normal (control)	26	1.98	1.50	0.34	6.82	

* Significant difference between the groups ($P < .01$).

RESULTS

The mean asymmetry values for both male and female subjects were calculated separately to investigate the relationship between genders. However, the results of the Student's *t*-test for independent samples revealed no statistically significant differences between the mean values of the male and female subjects ($P = .56$). Therefore, data for both genders were pooled. The mean and standard deviation values for the mandibular asymmetry indexes in the control and experimental groups are presented in Table 1.

The results of the Kruskal-Wallis test showed that although condylar asymmetry index measurements were affected by the occlusion type ($P = .004$), there were no statistically significant differences between the groups for the ramus ($P = .18$) and condyle-plus-ramus asymmetry indexes ($P = .060$). Thus, the Mann-Whitney *U* test was applied only to the values of the condylar asymmetry index. The results revealed a significant difference between the control and the Cl I and Cl II/1 experimental groups. There were no statistically significant differences between the control group and the Cl II/2 and Cl III experimental groups. The Cl II/1 experimental group also showed a higher asymmetry index value than did the Cl II/2 and ClII groups (Table 2).

DISCUSSION

In the literature, the assessment of dentofacial asymmetries has been performed by using submentovertex[9] or postero-anterior cephalometric radiographs,[10] computed tomography,[11,12] and magnetic resonance imaging.[13] Panoramic radiographs, however, are the most frequently used viewing technique because it is possible to image joints, teeth, and other parts of the jaws in one exposure. Beside mandibular measurements such as tooth length or bone height, panoramic radiographs are now being used as a diagnostic tool in more complicated situations, such as the evaluation of vertical mandibular asymmetry, condylar and ramal height, TMDs, and gonial angle measurements.[5–8,14–17]

The main question regarding the use of panoramic radiographs in evaluating mandibular asymmetries concerns the effect of magnification occurring at the vertical dimensions of the mandible on vertical measurements. Most authors have suggested that small changes in head position do affect horizontal dimensions, while big changes do not occur in vertical dimensions, allowing vertical asymmetry measurements to be performed on panoramic radiographs.[5,18,19] Accordingly, panoramic radiographs have been used to compare condylar and ramal heights in different experimental groups, such as denture wearers and patients with TMD or orthodontic anomalies.[20–22] Habets et al[19] evaluated the panoramic radiographs as an aid in the diagnosis of TMDs and concluded that a difference between the right and left condyle of more than 6% measured on the panoramic radiograph indicates condylar asymmetry. In most of the above studies, vertical asymmetry has been measured according to the method suggested by Habets and his coworkers.[5]

In the present study, significant differences between the groups in condylar asymmetry index values were found but not for the ramus and condyle-plus-ramus symmetry indexes. In other words, condylar height was significantly affected by the occlusion type, whereas significant differences were not observed for the ramus height between the occlusion types. A muscular compensatory mechanism could be responsible for the more symmetrical ramus height found on both sides of the subjects with malocclusions.[10] Miller et al[23] stated that condylar asymmetry was related to the strong forces affecting the articular surfaces of the temporomandibular joint (TMJ). These forces affect the skeletal and soft tissue components of the TMJ

Table 2. Comparison of the Groups With Mann-Whitney *U* Test[a]

Group	Cl II/1	Cl II/2	Cl III	Control
Cl I	NS	NS	NS	.005**
Cl II/1		0.043*	.016*	.000***
Cl II/2			NS	NS
Cl III				NS

[a] NS indicates not significant; * $P < .05$; ** $P < .01$; *** $P < .001$.

and increase the tissue thickness at the articular surfaces. Thus, the condylar asymmetry index value could increase, and this process might continue as the adaptive capacity of the joint surfaces would permit. In various studies investigating the relationship between TMD and condylar asymmetry, increased condylar asymmetry indexes have been reported in TMD groups.[5,6,22] In this study, TMD was considered to be a factor causing condylar asymmetry, and thus the panoramic radiographs of subjects with no clinical signs or symptoms of TMD were used.

Miller and Smith[7] have reported on the relationship between condylar asymmetry and malocclusions of subjects with Cl I occlusion (11–18 years) and Cl II/2 malocclusion with deep overbite and no signs of TMD. Miller and Bodner[8] investigated the differences in condylar asymmetry indexes between Cl I occlusion and Cl III malocclusion groups. In both studies, no statistically significant differences could be shown between groups. Our study revealed similar values in the comparisons of the control group with the Cl II/2 and Cl III experimental groups.

Sağlam[15] investigated the effect of ANB angle on condylar asymmetry in 72 subjects (36 male, 36 female) aged 12 to 16 years. It was concluded that the condyle-plus-ramus index measurements were affected by the change of ANB angle, while the condylar index and ramus index had no influence on the change of ANB angle. In our study, there were no statistically significant differences between the ramus and ramus-plus-condyle asymmetry indexes of the groups.

Studies of the etiology of condylar asymmetries in which sexual differences have been investigated also revealed no statistically significant differences.[5,15] In this study, the results of the Student's *t*-test that was used to compare male and female groups matched those of previous studies.

CONCLUSIONS

- Malocclusions have a marked effect on condylar height in comparison with ramal height.
- Angle Cl II/1 malocclusion cases seem to be more related to condylar asymmetries.
- The Cl II/1 malocclusion group had significantly higher condylar asymmetry values than the Cl II/2, Cl III, and normal occlusion control groups.
- The condylar asymmetry value was also significantly different between Cl I malocclusions and normal occlusions.
- No significant difference was detected between the condylar asymmetry values of Cl I and Cl II/1 malocclusions.

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