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Impact of different malocclusion types on the vertical mandibular asymmetry in young adult sample

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ABSTRACT

Objective: The aim of this study was to investigate the vertical mandibular asymmetry in a group of adult patients with different types of malocclusions, based on Angle's dental classification. **Materials and Methods:** A sample of 102 patients (age range 19–28) who went for routine orthodontic treatment in the institution were divided into four groups: Class I, 26 patients; Class II/1, 30 patients; Class III, 23 patients; and control group (CG) with normal occlusion, 23 patients. Condylar asymmetry index (CAI), ramal asymmetry index (RAI), condylar-plus-ramal asymmetry index values were measured for all patients on panoramic radiographs. Data were analyzed using Kruskal–Wallis and Mann–Whitney U-test at the 95% confidence level ($P < 0.05$). **Results:** The results of the analysis showed that different occlusal types significantly affected the vertical symmetry of the mandible at the condylar level. Class I and Class II/1 malocclusion groups showed a significant difference in CAI values relative to the CG ($P < 0.05$, $P < 0.001$). No statistically significant difference was found between the CG and Class III malocclusion group ($P > 0.05$). Comparisons between Class II/1 and Class I malocclusions revealed a significant difference in CAI values ($P < 0.01$). **Conclusions:** Both Class II/1 and Class I malocclusions patients had significantly higher CAI values compared to CG and Class III group. CAI value was significantly higher in Class II/1 malocclusion compared to Class I malocclusion. Both these malocclusions could act as a predisposing factor for having asymmetric condyles if left untreated.

Key words: Asymmetry index, malocclusion, mandibular asymmetry, panoramic radiograph

INTRODUCTION

Asymmetry in the face and dentition is a naturally occurring phenomenon. Symmetry can be defined as equality or correspondence in the form of parts distributed around a center or an axis, at the two extremes or poles, or on the two opposite sides of the body.[1] Previous studies have shown that malocclusions have a remarkable effect on mandibular condyle morphology. The asymmetrical function and activity of the jaws show the right and left sides of the mandible that has developed differently.[2,3] Thus, symmetry assessment is important in any esthetic evaluation of the craniofacial region as well as in malocclusions evaluation.

Asymmetry of the craniofacial skeleton is most readily diagnosed from the frontal rather than from any other view. Habets *et al*.[4] described a method utilizing panoramic radiographs for evaluating condylar and ramal asymmetry. This method compared the vertical heights of the mandibular right and left condyles and rami. The method has been used for the diagnosis of temporomandibular-disorder (TMD) in patients,[5] and for determining condylar asymmetries in

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various malocclusions, such as Class II and III,[6,7] and in various skeletal patterns.[8-10]

Few studies have investigated mandibular vertical asymmetry in different occlusion types. Sezgin *et al*.[9] evaluated mandibular asymmetry in different occlusion patterns in young individuals and concluded that both Class II/1 and Class 1 malocclusions have a significant effect on the condylar asymmetry index (CAI) when compared to other occlusion types. Kasimoglu *et al*.[10] investigated the relationship between vertical asymmetries of the mandibular condyle with different occlusion types in adolescent patients and found no significant difference between the condylar asymmetry values of Classes I, II, and III malocclusions. As there are contradictory reports about the effect of occlusal type on mandibular vertical asymmetry, the aim of this study was to provide further evidence by evaluating the degree of vertical mandibular asymmetry in different occlusion types in young adult patients.

MATERIALS AND METHODS

This retrospective study was conducted in the Ajman University of Science and Technology. The study examined the panoramic radiographs of 102 patients (54 males and 48 females) who visited the institution for routine orthodontic treatment. The radiographs were obtained as part of diagnostic record gathering. The patients, aged between 19 and 28 years with a mean age of 23.60 years, were divided into four groups: Class I malocclusion (26 patients), Class II/1 malocclusion (30 patients), Class III malocclusion (23 patients), and the control group (CG) that consisted of 23 patients with normal occlusion.

The inclusion criteria to select the patients for the study were as follows: (1) Dental Class I, II/1, and III relationship (and normal occlusion for the CG); (2) no remarkable facial asymmetry; (3) no developmental or acquired craniofacial or neuromuscular deformities; (3) no sign or symptoms of temporomandibular joint dysfunction; (4) no history of orthodontic or prosthodontic treatment; and (6) no missing teeth (excluding third molars).

As panoramic radiographs are routinely used as a diagnostic tool in the orthodontic clinics, all patients had films available for evaluation. The same image size was taken in the standard manner and for standard size. All films were traced and measured manually by the first author.

Informed consent was not obtained due to the design of the research as being a retrospective archived study.

The outline of the condyle, the ascending ramus, and the corpus of both sides were traced on acetate paper. Habets' technique[4] was used to assess mandibular asymmetry. In this technique, the vertical height of the right and left condyles is measured on the panoramic X-ray [Figure 1]. A tangent (A) is traced to the most lateral points of the ramus (O1) and the condyle (O2). Then a perpendicular (B) is traced to line A, such that it is tangential to the highest point of the condyle. The condylar height corresponds to the distance measured between the tangent (B) and the most lateral point of the condyle (O1), and the ramal height corresponds to the measurement from the most lateral point of the ramus to the most lateral point of the condyle (distance between O1 and O2). The CAI was obtained from the following formula:

$$\text{Asymmetry index} = \left| \frac{CH_{right} - CH_{left}}{CH_{right} + CH_{left}} \right| \times 100$$

Statistical analysis

In order to determine the errors associated with tracing and measurements, 20 radiographs were selected randomly. The radiographs were traced and measured again after 2 weeks. A paired *t*-test was used for the first and second measurements, and no error was found.

The Kruskal–Wallis test was used to determine the possible statistically significant differences between the groups. The identified differences between the groups

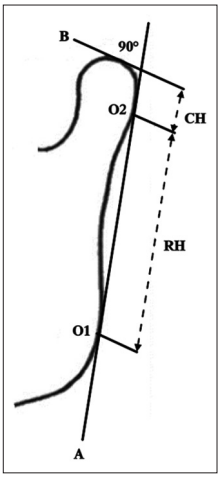

Figure 1: Measuring vertical mandibular asymmetry by Habets *et al*. method

were further analyzed using the Mann–Whitney U-test. Statistical analysis was performed using the SPSS software package (version 19.0, SPSS Inc., Chicago, IL, USA).The results were regarded as statistically significant at $P < 0.05$.

RESULTS

Comparisons of the asymmetry indices between the groups are shown in Table 1. Results have shown that CAI values ranged between 4.08% and 14.90% in all occlusal types, whereas both ramal asymmetry index (RAI) and condylar-plus-ramal asymmetry index (CRAI) values were below the 3% threshold. Statistical comparisons showed that CAI values were significantly affected by the occlusal type ($P = 0.000$). However, there were no statistically significant differences between the groups for the RAI values ($P = 0.745$) and CRAI values ($P = 0.155$). As there were statistically significant differences for CAI values, Mann–Whitney U-test was performed to these values only [Table 2]. Results showed that there was no statistically significant difference between CG/Class III subjects ($P = 0.928$). On the other hand, significant differences were found between CG/Class I subjects ($P = 0.01$), and CG/Class II division I subjects ($P = 0.000$). Further comparison between Class II division I/Class I subjects revealed that there was still significantly higher CAI values for Class II subjects ($P = 0.009$).

Table 1: Descriptive statistics and comparison of mandibular asymmetry indices between the groups (Kruskal–Wallis test)

Group	Mean	SD	*P*
CAI			
Class I	9.13	7.06	0.000
Class II/I	14.90	6.93	
Class III	4.55	4.37	
CG	4.08	3.87	
RAI			
Class I	2.05	1.50	0.745
Class II/I	2.09	1.58	
Class III	1.90	1.66	
CG	1.76	0.88	
CRAI			
Class I	2.21	1.57	0.155
Class II/I	1.64	1.35	
Class III	1.48	1.26	
CG	1.49	0.83	

CAI: Condylar asymmetry index, RAI: Ramal asymmetry index, CRAI: Condylar-plus-ramal asymmetry index, CG: Control group, SD: Standard deviation

Table 2: Comparison of the condylar asymmetry indices between the groups (Mann–Whitney U-test)

Condylar index	*P*
CG/Class I	0.010
CG/Class II division I	0.000
CG/Class III	0.928
Class II division I/Class I	0.009

CG: Control group

DISCUSSION

The mandibular asymmetry was assessed using submentovertex,[11] postero-anterior cephalometric radiographs,[12] and computed tomography.[13] However, panoramic radiographs are the most frequently used viewing technique because it allows for imaging of joints, teeth, and other parts of the jaws in one exposure.

Panoramic radiographs are known to provide reproducible vertical and angular measurements if they were recorded properly.[14] Thus, in the present study, orthopantomogram (OPG) was used for evaluating mandibular asymmetry. Habets *et al*.[4] concluded that the head holder must be fixed well to the OPG, and the head has to be well-centered in the head holder of the OPG when a clinical OPG is to be evaluated. In this study, the age of all patients was >18 years to ensure that mandibular growth had reached adult levels.

The sex differences of the groups did not seem to be a problem because studies on the vertical condylar and ramal asymmetries in which sex differences were investigated found no statistically significant differences.[4,9,10,14]

To the best of our knowledge, the current study is the first to investigate vertical mandibular asymmetry using the method of Habets *et al*.[4] in adult patients with different occlusal types. All other previous studies have focused on adolescent patients.

The Habets-method[4] has been used for evaluating condylar and ramal asymmetries in patients with TMD, having different malocclusions. They found that asymmetry index values >3% must be taken into consideration as vertical asymmetries. In this study, CAI in CG, Class I, Class II, and Class III patients were found above 3% (4.08, 9.13, 14.90, and 4.55, respectively), indicating the presence of asymmetry. On the other hand, RAI and CRAI measurements were below the 3% threshold value in all groups.

The results in Table 1 reveal significant differences ($P < 0.001$) between the groups in CAI values only. No significant differences ($P > 0.05$)

were found for RAI and CRAI, which means that different occlusal patterns could have affected the vertical symmetry of the mandible at the condylar level.

Other studies that evaluated condylar asymmetry using this method in different malocclusions and in TMD patients also found asymmetry values >3% both in study and CGs.[8-10,15] These high percentage values can be attributed to shape, angular and positional differences between right and left condyles or systematic measurement errors because of the small dimension of the condyle.

The results of the comparison of the CAI values between the groups [Table 2] show that CAI were significantly increased for both Class II/I patients (P = 0.000) and Class I patients (P = 0.01), which indicates that both types of malocclusions can act as a predisposing factor for having asymmetric condyles.

These results are partly in accordance with Sezgin *et al*.[9] who found that Class I and Class II/1 malocclusions have a significant effect on the CAI when compared to Class III malocclusion and CG types. However, our results differed from their results when they compared Class I to Class II/1 and found no significant differences. In their study, they found a higher CAI value for Class II/1 group of 8.51% compared to Class I group with CAI value of 6.99%, but with no significant difference between both groups. In our study, we compared the two groups at the adulthood stage, where the Class II/1 malocclusion group continued to show further asymmetry compared to the Class I malocclusion.

Moreover, similar results were obtained with Miller and Bodner[6], who investigated the differences in CAI between CG and Class III malocclusion group, and concluded that there was no statistically significant difference between the groups.

However, Sievers *et al*.[16] assessed possible differences in skeletal asymmetry between patients with skeletal Classes I and II relationships and concluded that the discrepant jaw growth resulting in a Class II skeletal pattern results in no more skeletal asymmetry than Class I skeletal patterns; this disagrees with the present study findings. A possible explanation for the difference in findings could be attributed to the difference in the patients' inclusion criteria for each research. In Sievers *et al*.[16] research, the inclusion criteria was based on skeletal malocclusion, and it was not mentioned whether the Class II sample were dentally Class II/1 or Class II/2.

On the other hand, Saglam[8] investigated the effect of A point, nasion, and B point, (ANB) angle on condylar asymmetry and concluded that the CRAI measurements were affected by the change of ANB angle, while the CAI and RAI had no influence on the change of ANB angle. In the present study, there were no statistically significant differences between the groups for the RAI and CRAI values.

As the panoramic radiograph that provides only two-dimensional view was used in the study as a tool for evaluating the vertical mandibular asymmetry, future analysis of mandibular asymmetry should be obtained with the use of three-dimensional cone-beam computed tomography (CBCT). The results of this study can be compared with the results that will be obtained with the use of CBCT. Another limitation of the study is a lack of justification of the sample size, where the study sample was not determined using a power analysis.

CONCLUSIONS

From the above findings, it can be concluded that the CAI values were higher than the 3% threshold value of Habets *et al*. in all groups. In addition, both Class II/1 and Class I malocclusions patients had significantly higher CAI values compared to CG and Class III group. The CAI value was significantly higher in Class II division I malocclusion compared to Class I malocclusion. Thus, these two types of malocclusions may act as a predisposing factor for having asymmetric condyles if left untreated.

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