ORIGINAL ARTICLE

Evaluation of vertical mandibular asymmetry in unilateral and bilateral posterior crossbite adult patients

Amjad Al Taki, Omar Othman[1], Fatma Al Kaddah

Private Practice, Dubai, [1]Department of Orthodontics, College of Dentistry, Ajman University of Science and Technology, Ajman, United Arab Emirates

ABSTRACT

Objective: The aim of this study was to estimate possible differences in skeletal asymmetry between group of adult subjects with normal occlusion and unilateral and bilateral posterior crossbite malocclusions. **Materials and Methods:** A sample of 91 subjects (consisted of 37 unilateral posterior crossbite [14 male and 23 female; mean age 22.49 ± 4.19 years] and 31 bilateral posterior crossbite patients [18 male and 13 female; mean age 24.36 ± 3.76 years] and a control group (CG) of 23 subjects with normal occlusion [13 male and 10 female; mean age 22.74 ± 1.74 years]) was examined in the study. Condylar, ramal, and condylar-plus-ramal asymmetry values were measured for all subjects on panoramic radiographs. Data were analyzed statistically by means of paired *t*-test. **Results:** Unilateral crossbite group (UCG) and bilateral cossbite group (BCG) showed significant asymmetric indices (condylar, ramal, and condylar-plus-ramal) relative to the CG, except for condylar index when comparing BCG and CG ($P > 0.05$). Comparisons within the crossbite groups showed no statistically significant differences in condylar, ramal, or condylar-plus-ramal heights (RHs) between left and right sides of the UCG, while for the BCG, significant difference was found only for the condylar-plus-RH ($P < 0.05$). **Conclusions:** Both UCG and BCG have asymmetrical condyles compared to CG. Side comparisons within crossbite groups showed asymmetric mandible in BCG.

Key words: Condylar asymmetry, panoramic radiograph, posterior crossbite, ramal asymmetry

Introduction

Assessing symmetry is important in any esthetic evaluation of the craniofacial region. Posterior crossbite is a reverse occlusion of at least one buccal tooth including the canine. In most patients, insufficient maxillary arch width accounts for the transverse discrepancy.[1,2]

The causes of maxillary constriction can be abnormal finger-sucking habits, perverted perioral muscle functions, premature primary tooth loss, and obstruction of the upper airway.[3]

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Untreated unilateral posterior crossbite could cause an asymmetry in condylar position, with displacement of the ipsilateral condyle toward the crossbite side and increased growth of the contralateral condyle.[4] Accordingly, an asymmetrically positioned mandible in a unilateral crossbite patient might lead to asymmetrical condylar heights (CHs).

Habets *et al*.[5] introduced a method to determine asymmetries between the condyles of the mandible. This method compared the vertical heights of the mandibular right and left condyles and rami.

Habets *et al*. method has been used for diagnosis in temporomandibular-disorder patients.[6] In addition, it was used to determine condylar asymmetries in various malocclusions such as Class II and III[7,8] and in various skeletal patterns.[9,10]

In literature, there are fewer studies comparing mandibular vertical asymmetry using the method of Habets *et al*.[5] in

Address for correspondence: Dr. Amjad Al Taki, Private Practice, P.O. Box 10462, Dubai, United Arab Emirates.
E-mail: al_taki@hotmail.com

unilateral and bilateral crossbite patients with a normal occlusion sample. Uysal *et al*.[11] investigated condylar asymmetry with the method of Habets *et al*. in adolescent patients with unilateral and bilateral posterior crossbites and a normal occlusion sample and found no significant difference between the groups. Veli *et al*.[12] studied mandibular asymmetry in unilateral and bilateral posterior crossbite patients using cone-beam computed tomography and found that bilateral crossbite patients have side-specific asymmetry.

The aim of this study was to investigate vertical condylar and ramal asymmetry in a group of untreated adult patients with unilateral and bilateral posterior crossbite malocclusions and compare them with a control group (CG) with normal occlusion.

Materials and Methods

This study examined panoramic radiographs of 91 patients presenting for routine orthodontic treatment at Ajman University of Science and Technology obtained as part of diagnostic record gathering. The subjects were divided into three groups: 23 subjects with normal occlusion, 37 subjects with unilateral crossbite, and 31 subjects with bilateral posterior crossbite.

The inclusion criteria for CG were as the following:
1. Class I canine and molar relationships with minor or no crowding;
2. No missing teeth, excluding the third molars;
3. No history of orthodontic treatment or facial trauma;
4. No signs or symptoms of temporomandibular disorder (TMD).

The inclusion criteria for unilateral crossbite group (UCG) were as following:
1. Unilateral posterior crossbites involving at least 2 posterior teeth in crossbite;
2. Functional unilateral posterior crossbite, as reported in the clinical history;
3. Mandibular dental midline deviation of at least 1 mm to the crossbite side;
4. No remarkable facial asymmetry;
5. Absence of any severely malaligned or blocked out teeth;
6. No missing teeth, excluding the third molars.

The inclusion criteria for bilateral crossbite group (BCG) were as following:
1. Bilateral posterior crossbites involving at least 2 posterior teeth in crossbite on both sides.

Selection criteria numbered 4-6 for UCG were also valid for the BCG.

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

Habets' technique[5] was used to assess the mandibular asymmetry. This technique consists of measuring the vertical height of the right and left condyles 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 the line A, tangential to the highest point of the condyle. The CH corresponds to the distance measured between the tangent (B) to the most lateral point of the condyle (O1), and the ramal height (RH) corresponds to the measurement that goes from the most lateral point of the ramus to the most lateral point of the condyle (distance between O1 and O2). Thus, a condylar asymmetry index (CAI) is proposed that is obtained by applying the following formula:

$$AI = \frac{CHright - CHleft}{CHright + CHleft} \times 100$$

Statistical analysis

To determine the errors associated with tracing and measuring, 20 radiographs were selected randomly. Tracing and measuring the radiographs were repeated 2 weeks later. A paired *t*-test was used for the first and second measurements, and no error was found.

A paired *t*-test was used to determine the differences in condylar, ramal, and condylar-plus-RHs between the left and right sides of the subjects in each group. *T*-test was also applied to determine whether there was any

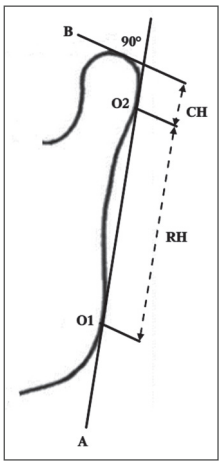

Figure 1: Measuring vertical mandibular asymmetry by Habets *et al*. method

difference between the asymmetry indices of the groups. 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

The statistical data and the results of paired *t*-tests comparing the measurements of the left and right sides in UCG and BCG are presented in Tables 1 and 2, respectively. Comparisons within the crossbite groups showed no statistically significant differences in CH, RH, or CH + RH between left and right sides of the UCG, while for the BCG, significant difference was found only for the CH + RH ($P < 0.05$).

Comparisons of the asymmetry indices between the CG and the crossbite groups are shown in Tables 3 and 4. Table 3 showed statistically significant differences between CG and UCG for the CAI, ramal AI (RAI), condylar and ramal AI (CRAI). On the other hand, Table 4 showed significant differences between CG and BCG for the RAI and CRAI only.

Comparisons of the asymmetry indices between the crossbite groups are shown in Table 5. No significant difference was observed for any of the asymmetry indices.

Discussion

Assessment of mandibular asymmetry has been performed using submentovertex,[13] postero-anterior cephalometric radiographs,[14] and computed tomography.[15] However, panoramic radiographs are the most frequently used viewing technique because it is possible to image joints, teeth, and other parts of the jaws in one exposure.

Panoramic radiographs are known to provide a reproducible vertical and angular measurements if they were recorded properly.[16] Thus in the present study, orthopantomogram were used for evaluation of mandibular asymmetry. Habets *et al*.[5] 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 subjects 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 of the vertical condylar and ramal asymmetries in which sex differences were investigated found no statistically significant differences.[5,11,16,17]

Table 1: Descriptive statistics of side comparison in UCG (paired *t*-test)

Parameter	Right side		Left side		Difference		*P Value*
	Mean	SD	Mean	SD	Mean	SD	
Condylar height	6.82	1.65	6.91	1.67	−0.081	0.30	0.791
Ramal height	51.43	6.20	50.10	5.63	1.32	0.95	0.172
Condylar+ramal height	58.26	6.28	57.01	5.89	1.24	0.94	0.196

SD: Standard deviation, UCG: Unilateral crossbite group

Table 2: Descriptive statistics of side comparison in BCG (paired *t*-test)

Parameter	Right side		Left side		Difference		*P*
	Mean	SD	Mean	SD	Mean	SD	
Condylar height	7.63	2.36	7.06	1.93	0.56	1.75	0.082
Ramal height	56.34	7.56	54.82	7.51	1.52	5.64	0.145
Condylar+ramal height	63.97	7.92	61.89	8.09	2.08	5.45	0.042

SD: Standard deviation, BCG: Bilateral crossbite group

Table 3: Descriptive statistics and comparison of mandibular asymmetry indices between CG and UCG (paired *t*-test)

Parameter	CG		UCG		Difference		*P*
	Mean	SD	Mean	SD	Mean	SD	
Condylar index	4.08	3.87	11.45	6.84	−7.37	1.77	0.000
Ramal index	1.76	0.88	4.53	3.17	−2.77	0.76	0.001
Condylar+ramal index	1.49	0.82	3.75	3.06	−2.26	0.77	0.011

SD: Standard deviation, UCG: Unilateral crossbite group, CG: Control group

Table 4: Descriptive statistics and comparison of mandibular asymmetry indices between CG and BCG (paired *t*-test)

Parameter	CG		BCG		Difference		*P*
	Mean	SD	Mean	SD	Mean	SD	
Condylar index	4.08	3.87	8.22	7.96	−4.14	1.83	0.067
Ramal index	1.76	0.88	3.84	3.36	−2.78	0.76	0.001
Condylar+ramal index	1.49	0.82	3.58	3.58	−2.09	0.80	0.027

SD: Standard deviation, CG: Control group, BCG: Bilateral crossbite group

Table 5: Descriptive statistics and comparison of mandibular asymmetry indices between UCG and BCG (paired *t*-test)

Parameter	UCG		BCG		Difference		*P*
	Mean	SD	Mean	SD	Mean	SD	
Condylar index	11.45	6.84	8.22	7.96	3.23	1.62	0.121
Ramal index	4.53	3.17	3.84	3.36	0.69	0.70	0.581
Condylar+ramal Index	3.75	3.06	3.58	3.58	0.17	0.70	0.968

SD: Standard deviation, UCG: Unilateral crossbite group, BCG: Bilateral crossbite group

Results of the side comparison of UCG showed that CH, RH, CH + RH were similar on the right and left sides, and no statistically significant side differences were found. Our result was in agreement with Uysal *et al*.[11] who found no

significant side-specific asymmetry for unilateral crossbite patients. On the other hand, some authors reported vertical mandibular asymmetry in unilateral posterior crossbite patients. Kilic *et al*.[18] found that CH, RH, CH + RH were significantly smaller on the crossbite side than on the corresponding side in unilateral posterior crossbite patients.

Side comparisons results of BCG revealed a significant difference in the CH + RH, which indicates that bilateral crossbite patients have asymmetric mandibles. Similar results were observed by Halicioglu *et al*.,[19] who found that bilateral crossbite patients have asymmetric RHs. Another study by Veli *et al*.[12] concluded that contrary to UCG, BCG was found to have side-specific asymmetry.

The method described by Habets *et al*.[5] has been used for evaluating condylar and ramal asymmetries in TMD patients and in various malocclusions. According to Habets *et al*., a 3% index ratio can result from a 1-cm change in head position while the panoramic radiograph is being taken, and thus AI values (CAI, RAI, and CRAI) >3% should be considered as mandibular posterior vertical asymmetry.

In this study, in UCG, BCG, and CG, CAIs were found above 3% (11.45 ± 6.84%, 8.22 ± 7.96%, 4.08 ± 3.87%, respectively) indicating the presence of asymmetry.

Other studies evaluating condylar asymmetry with this method in different malocclusions and in TMD patients also found asymmetry values >3% both in study and CGs.[9,11,12,19] These high values indicating asymmetry both in experimental and CGs can be attributed to shape, angular and positional differences between right and left condyles without any pathology or without any related malocclusion.

Cohlmia *et al*.[20] found that left condyle was positioned more anteriorly than the right condyle. Kambylafkas *et al*.[14] stated that CH was unreliable when determining asymmetry from the panoramic radiograph because of the small dimension of the measurement and operator error in tracing and identifying landmarks.

Inui *et al*.[21] suggested that continuous condylar displacement in the glenoid fossa during the growth period, derived from occlusal problems, induced differential growth of the left and right condyles. From this perspective, these asymmetries could be the result of a functional deviation of the mandible in all subjects in the crossbite group, or it is explained by either adaptation of the condyle or systematic measurement errors because of the small dimension of condyle.

Comparisons of asymmetry indices between UCG and CG showed statistically significant differences in CAI, RAI, CRAI, while comparisons between BCG and CG showed that the asymmetry was observed for RAI and CRAI values, rather than CAI value.

No, statistically significant differences were found in between crossbite groups for mandibular asymmetry determined separately by CAI, RAI, and CRAI.

In literature, studies that compared asymmetry indices in crossbite groups and CG showed different results. Halicioglu *et al*.[19] found an asymmetry between the UCB and BCB groups in RAI and CRAI values, rather than CAI values. On the other hand, Uysal *et al*.[11] results showed that CAI in crossbite groups and CG were high, but no statistically significant differences were found among the groups. Kiki *et al*.[16] compared CAI in BCG and CG and concluded that patients with bilateral posterior crossbite had more asymmetrical condyles relative to the controls.

To conclude, posterior crossbite patients have asymmetric mandibles as revealed by the high CAI values, but normal occlusion subjects also have some asymmetry. Results of this study have shown that posterior crossbite patients may act as a predisposing factor for having asymmetric mandibles, so it should be remembered that the early correction of posterior crossbite is of major importance.

Conclusions

1. Mandibular side asymmetry was observed in BCG.
2. Asymmetry indices were found to be significantly high in crossbite groups compared to CG.
3. Comparisons between the crossbite groups were not statistically significant.

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