Original Article

Assessment of condylar morphology in patients with unilateral posterior crossbite

ABSTRACT

Introduction: Symmetry and balance in the facial morphology is an important factor determining facial attractiveness. Unilateral posterior crossbite is a common form of posterior crossbite that is usually associated with a functional mandibular shift which might, in the long run, lead to mandibular asymmetry. Thus, there was a need to study this malocclusion and its influence on the facial symmetry in young adults as any factor contributing to alteration in facial symmetry requires evaluation. The purpose of the study was to assess the condylar symmetry in patients with unilateral posterior crossbite.

Materials and Methodology: The study was conducted on the pretreatment orthopantomograms (OPGs) of sixty cases, out of which thirty had unilateral posterior crossbite (crossbite group) and thirty had normal occlusion in the transverse plane (control group). The Condylar height(CH), Ramal height(RH), and Condylar + Ramal height(CH+RH) were compared within the groups, and their asymmetry indices were compared between the groups using ANOVA test.

Results: The CH and CH + RH were significantly reduced on the crossbite side as compared to the normal side in the unilateral posterior crossbite group. The asymmetry indices were increased in the unilateral posterior crossbite group as compared to the control group.

Discussion: OPGs can be used to evaluate vertical mandibular asymmetry. The condylar asymmetry index was increased in the group with unilateral posterior crossbite indicating a greater asymmetry between the two condyles in that group as compared to the control group. The finding was in concordance with a study done in the past.

Conclusion: The unilateral posterior crossbite group showed reduced CH and CH + RH values on the crossbite side in comparison to the noncrossbite side. The same group showed a greater CH index (more than 3%) as compared to the control group, indicating that the patients with unilateral crossbite develop asymmetry in the mandibular condyle region.

Keywords: Asymmetric index, asymmetry, mandibular condyle, unilateral posterior crossbite

INTRODUCTION

Facial symmetry and balance are both essential factors for attractiveness.[1] Establishing facial symmetry remains an important goal of orthodontic treatment. However, not all esthetically pleasing faces are totally symmetrical. Although, any factor that might play even a little role in facial asymmetry needs to be evaluated and carefully examined.

The term crossbite is defined as the abnormal transverse relationship between the upper and lower teeth[2] which might involve a single or a group of teeth. The prevalence of this malocclusion ranges from 8% to 22%.[3] The posterior crossbite can be either unilateral or bilateral. The most common type of posterior crossbite seen is the unilateral

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posterior crossbite which is usually associated with a functional mandibular shift.[4] This unilateral posterior crossbite could be the result of narrow maxilla which is usually associated with either genetic or environmental factors[5] (deleterious habits such as finger sucking or mouth breathing). Upper airway obstruction due to large adenoids is also known to be a cause of narrow maxilla.

In the patients with posterior unilateral crossbite, the mandible usually shifts to the crossbite side when the patient moves his mandible from the postural rest position to maximum intercuspation.[6] It is well established that if this functional shift of the mandible is continued for a long period of time, it can result in skeletal asymmetry due to the suppression and activation of mandibular growth at the condylar region on the crossbite and the noncrossbite side respectively.[7] As it is well known that structure and function reciprocate each other, so a change in the function of the mandible, in prolonged period of time, can alter its form or structure.[8]

The earliest intervention for transverse malocclusion is of utmost importance in the maxillomandibular complex to prevent the functional mandibular shift which might lead to abnormal growth.[9]

The orthopantomogram (OPG) has been proved to be reliable for vertical measurements of the condyle and ramus by Habets *et al*., and this conventional radiograph produces less ionizing radiation. This method can be used to compare the vertical measurements between the right and the left condyle and ramus in transverse malocclusions. The asymmetry index of more than 3% indicates asymmetry.

The present study aimed to assess the ramus and condylar asymmetries in patients with a unilateral crossbite.

MATERIALS AND METHODOLOGY

The present study was conducted in the Department of Orthodontics and Dentofacial Orthopedics on the pretreatment records of sixty patients who reported to the Baba Jaswant Singh Dental College and Hospital, Ludhiana, Punjab (India). The study was done on the secondary data, i.e., the pretreatment radiographs and the diagnostic casts (routine diagnostic procedures) of the cases who reported to the hospital for the orthodontic treatment. The diagnostic casts were used to divide the sample into two groups. Thirty patients (mean age: 20.7 years) having a good posterior occlusion in the transverse plane were included in the control group and thirty patients (mean age: 18 years) with unilateral posterior crossbite formed the crossbite group.

The inclusion criteria for the control group were as follows:

i. Good posterior occlusion with excellent interdigitation
ii. No scissor bite or crossbite
iii. Good quality radiographs.

The inclusion criteria for the unilateral posterior crossbite group were as follows:

i. Reverse occlusion involving at least one buccal tooth unilaterally
ii. Good quality radiographs.

The exclusion criteria for the cases were as follows:

i. Any craniofacial or neuromuscular deformities
ii. History of orthodontic treatment
iii. Signs and symptoms of temporomandibular disorders
iv. Any systemic disease
v. Poor quality radiographs.

The sample size for the study was collected using the formula:

$N = (Z_{\alpha/2})^2\, 2s^2/d^2$

$N = (1.96)^2\, 2 \times 1.90^2/1^2 = 27.73$

Considering the error and dropout, the sample size was increased to 30 per group.

All the panoramic radiographs of the participants were taken using the Orthophos XG 3D (Dentsply Sirona, Germany) cephalostat for standardization. The OPGs were taken with the patient's incisors in edge-to-edge relationship. The radiographs were traced manually on the matte acetate tracing paper using the 3H pencil on an X-ray view box.

To evaluate the asymmetry, Habets method was used for which the outline of the ascending ramus and condyle was drawn for each participant on the acetate tracing paper. The most lateral points were marked on the condyle and the ramus which were named point A and point B, respectively. A line was then drawn joining the two points. From this line, a perpendicular was drawn passing through the most superior point on the condyle. The intersection of both the lines was marked as point C.

- The distance from point C to A was taken as the condylar height (CH)
- The distance from point A to B was taken as the ramal height (RH)
- The distance from C to B is the total condylar and ramal height (CH + RH) [Figure 1].

For determining the asymmetry between the vertical measurements on the left and the right sides, the following formula was used:

Asymmetry index = ([right – left]/[right + left]) × 100

Statistical analysis

The statistical analyses used in this study were performed using the SPSS software (SPSS for Windows 98, version 13.0, SPSS, Chicago, Illinois, USA).

The ANOVA test was used to discover the differences in the CH, RH, and CH+RH between both sides of all the participants in the crossbite group and the control group.

The effects of the sexes of the participants and the crossbite and control groups on condylar, ramal, and condylar + ramal asymmetry indices were investigated using univariate ANOVA.

RESULTS

The ANOVA test was applied to the two groups, and it was seen that CH and CH + RH on the crossbite side were reduced as compared to the noncrossbite side [Graph 1] and the difference was highly significant [Table 1].

On the comparison of the heights on the left and right sides of the control group, it was found that there is no statistically significant difference between the heights on both sides [Table 2].

On the comparison of the mean of CH and RH indices in both the groups, the results showed a much higher asymmetric index in the crossbite group revealing asymmetry between both sides in that group [Table 3].

The condylar index, ramal index, and condylar + ramal index were higher in the group with unilateral posterior crossbite [Graph 2] as these differences were highly significant [Table 4]. The effect of gender on the condylar index and the ramal index was not statistically significant, but the effect of gender of the participant on the condylar + ramal index was statistically significant.

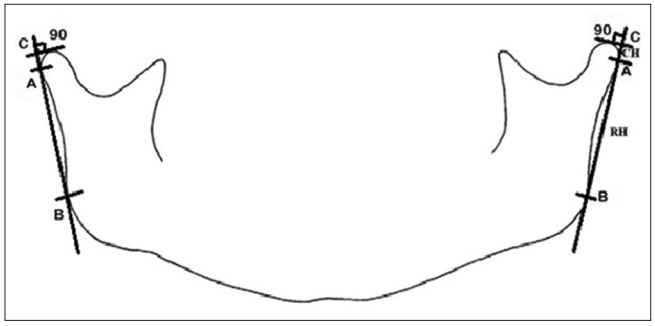


Figure 1: Habets method for vertical symmetry. The figure showing points A and B which are the lateral points on the condyle and ramus and CH represents condylar height, RH represents ramal height and CH+RH is the total height of condyle plus the ramus

DISCUSSION

A unilateral posterior crossbite is usually associated with a functional shift of the mandible during full closure. It was well established in the past that the patients with this crossbite develop unusual chewing patterns[10] as the mandible in these patients shifts to the crossbite side when moving from rest to the maximum intercuspation. This asymmetric masticatory function can lead to altered growth at the condylar and

Table 1: Results of ANOVA in the crossbite group

Parameter	Mean±SD		Comparison, *P*
	Crossbite side	Noncrossbite side	
CH	5.6500±1.78185	5.8333±1.97978	0.000*
Male	5.3125±1.46232	5.6875±2.10336	
Female	5.7727±1.90067	5.8864±1.98165	
RH	41.9200±3.23914	41.6333±3.82355	0.000*
Male	43.2500±3.80789	42.5625±5.24702	
Female	41.4364±2.95579	41.2955±3.25012	
CH + RH	47.5000±4.00861	47.5333±4.86177	0.000*
Male	48.5625±4.06586	48.5000±6.01783	
Female	47.1136±4.01168	47.1818±4.48156	

*$P<0.05$. CH: Condylar height, RH: Ramal height, SD: Standard deviation

Table 2: Results of ANOVA in the control group

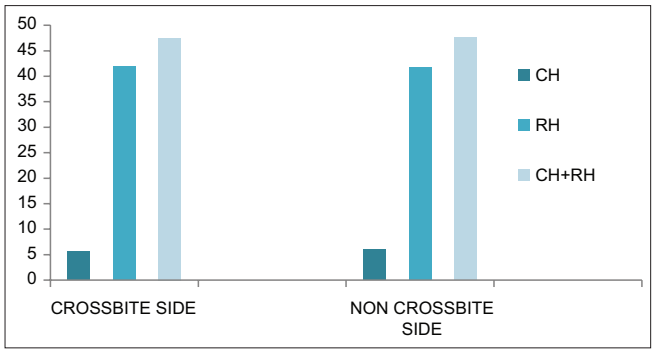
Parameter	Mean±SD		Comparison, *P*
	Right side	Left side	
CH	6.1833±1.48256	6.2167±1.44844	0.884 (NS)
Male	6.6667±1.12546	6.5833±0.97040	
Female	6.0625±1.55558	6.1250±1.54814	
RH	42.6833±8.23940	42.6333±8.24091	0.963 (NS)
Male	48.4167±3.05641	48.5833±3.48449	
Female	41.2500±8.53509	41.1458±8.45253	
CH + RH	50.5333±4.77409	50.5167±4.81285	0.969 (NS)
Male	56.7500±2.82400	56.8333±2.63944	
Female	48.9792±3.79496	48.9375±3.83154	

NS: Not significant, CH: Condylar height, RH: Ramal height, SD: Standard deviation

Table 3: Means and standard deviations of asymmetry indices

Parameter	Mean±SD	
	Crossbite group	Control group
CH	5.5660±5.33207	1.1183±2.18241
Male	5.5229±5.02722	0.5050±1.23699
Female	5.5791±5.51881	1.2717±2.35586
RH	1.6063±1.504	0.6703±0.67833
Male	2.4243±1.66009	0.8583±0.77306
Female	1.3574±1.39731	0.6233±0.66237
CH + RH	1.5830±1.40353	0.4910±0.51786
Male	2.4700±1.50377	0.6500±0.67284
Female	1.3117±1.28557	0.4513±0.48112

CH: Condylar height, RH: Ramal height, SD: Standard deviation



Graph 1: The difference in condylar, ramal, and condylar + ramal heights in crossbite and noncrossbite sides of participants with unilateral posterior crossbite

Table 4: Univariate ANOVA test to check the significance of gender and groups on the asymmetric indices

Parameter	Group		Sex	
	F	*P*	*F*	*P*
Condylar index	17.930	0.000*	0.041	0.906 (NS)
Ramal index	9.655	0.003*	3.517	0.066 (NS)
Condylar + ramal index	15.955	0.000*	4.408	0.040*

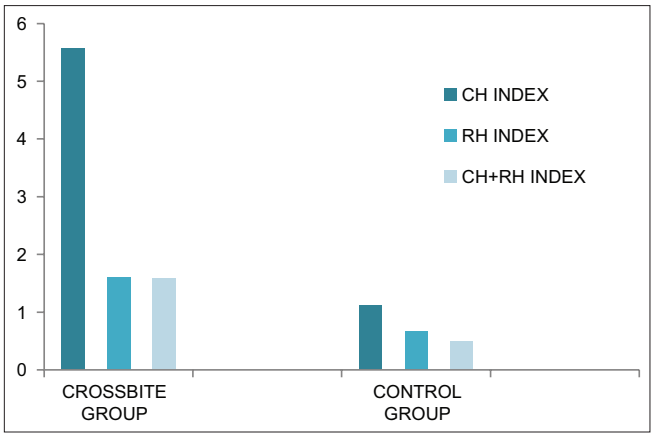
*$P<0.05$. NS: Not significant

ramal region as the mandibular condyle gets displaced in the posterior and superior direction on the crossbite side and in the anterior and inferior direction on the noncrossbite side.[11]

The OPGs have proven to be an admirable conventional method of radiography as it radiographs both the temporomandibular joint and the mandibular jaw with just one exposure.[12] Panoramic radiograph is an effective diagnostic tool with reduced radiation hazard[13] which is around 0.010 mSv. Being a noninvasive technique, these radiographs have a good cost–benefit relationship.

Authors like Kambylafkas *et al.*[14] in the past have shown that OPGs can be used to evaluate vertical mandibular vertical asymmetry. Habets *et al*.,[15] proved that vertical asymmetry within a 3% difference is acceptable and a difference of more than that indicates condylar asymmetry, although the reproducibility of the vertical measurements was also dependent on accurate patient positioning during exposure.[16]

Habets method[17] was used in the study to evaluate the condylar asymmetry on the crossbite side and noncrossbite side on the OPGs of the unilateral posterior crossbite group and on the left and right sides of the control group. The results showed a significant difference in the vertical measurements of the ramus and the ramus + condyle on the crossbite and noncrossbite sides with the vertical dimensions of condyle and condyle + ramus being relatively shorter on



Graph 2: The difference in asymmetric indices between crossbite and control group

the crossbite side. The CH on the crossbite side came to be 5.65 ± 1.78 mm which was less than the normal side. In the control group that had a good posterior occlusion in the transverse plane, no significant difference of vertical measurements was seen on the left and right sides.

The mean of the asymmetric index of the condyle in the control group came out to be 1.11 ± 2.18%, which suggests that the condyles on both sides are almost symmetrical. Habets *et al*. mentioned in their study that up to 3% of difference between the two sides could be due to the technical errors.[17] The asymmetric index in the crossbite group came to be 5.56 ± 5.33% which indicated condylar asymmetry on the crossbite side and the noncrossbite side. The asymmetric index of RH and CH + RH was significantly more in the crossbite group as compared to the control group, however, the index value was <3%.

Our results were similar to the finding by Lopatienė and Trumpytė[18] who too found reduced CHs on the crossbite side. Another study by Kilic *et al*. found reduced CH and RH on the crossbite side in patients with posterior unilateral crossbite,[19] although the ramal and condylar + ramal indices were not statistically different in their study which could be due to the difference in the inclusion criteria of their study and our study. Another difference seen was that Kilic *et al*. found reduced RHs on the crossbite side as compared to the noncrossbite side, but in our study, reduced RHs were seen on the noncrossbite side. This observation in our study was different from past studies, thus leaving scope for future studies.

The findings of our study were inconsistent with the observations made by Uysal *et al*., who found no significant difference in the asymmetry index of CH and RH between patients with unilateral crossbite and patients with normal posterior occlusion[20] which might be due to the reason

that the mean age of the participants in their study was 13.06 ± 3.05 years, and in our study, the mean age of participants in the crossbite group is 18 years. Illipronti-Filho *et al*. who used cone-beam computed tomography (CBCT) to assess asymmetry also found no significant difference in the mandibular condyle on the crossbite side and the noncrossbite side.[21]

Our results show that there is some difference in the growth activity of the condyle between the crossbite and noncrossbite sides. This difference could be due to some altered muscle activity on both sides as the masticatory muscle activity was reported to be different on the crossbite side and the noncrossbite side.[22]

Orthodontics deals with the art of the face, and facial symmetry and balance is the key to maintain this. However, it is well established that some amount of asymmetry is physiological. But still, the orthodontist needs to lay stress on any factor that might contribute to even a little amount of facial asymmetry.

CONCLUSION

- The CH and CH + RH were significantly reduced on the crossbite side of participants with a unilateral posterior crossbite
- The CH index, RH index, and CH + RH index were highly increased in the unilateral posterior crossbite group, but only the CH index was more than 3% indicating asymmetry only in the condylar region
- The gender of the patient was not a significant factor in influencing the asymmetry between the condyles.

Recommendations of the study

It is well known that a three-dimensional assessment of facial symmetry is more reliable. Therefore, a CBCT-based three-dimensional study could help to enlighten more about the effect of unilateral posterior crossbite on mandibular symmetry. However, OPG which is a routinely done diagnostic procedure should be exploited well before going for any further investigation.

Limitations of the study

The present study was a cross-sectional study which proved a positive relationship between unilateral posterior crossbite and mandibular asymmetry, but a more extensive longitudinal study might be more reliable in evaluating the role of unilateral posterior crossbite on the mandibular asymmetry.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Peck S, Peck L, Kataja M. Skeletal asymmetry in esthetically pleasing faces. Angle Orthod 1991;61:43-8.
2. Almeida RR, Almeida MR, Oltramari-Navarro PV, Conti AC, Navarro Rde L, Marques HV. Posterior crossbite--Treatment and stability. J Appl Oral Sci 2012;20:286-94.
3. Petrén S, Bondemark L, Söderfeldt B. A systematic review concerning early orthodontic treatment of unilateral posterior crossbite. Angle Orthod 2003;73:588-96.
4. Kennedy DB, Osepchook M. Unilateral posterior crossbite with mandibular shift: A review. J Can Dent Assoc 2005;71:569-73.
5. Marshall S, Southard K, Southard T. Early transverse treatment. SemOrthod 2005;11:130-9.
6. Ferro F, Spinella P, Lama N. Transverse maxillary arch form and mandibular asymmetry in patients with posterior unilateral crossbite. Am J Orthod Dentofacial Orthop 2011;140:828-38.
7. Martín C, Alarcón JA, Palma JC. Kinesiographic study of the mandible in young patients with unilateral posterior crossbite. Am J Orthod Dentofacial Orthop 2000;118:541-8.
8. Hanson ML, Cohen MS. Effects of form and function on swallowing and the developing dentition. Am J Orthod 1973;64:63-82.
9. Gungor K, Taner L, Kaygisiz E. Prevalence of posterior crossbite for orthodontic treatment timing. J Clin Pediatr Dent 2016;40:422-4.
10. Piancino MG, Talpone F, Dalmasso P, Debernardi C, Lewin A, Bracco P. Reverse-sequencing chewing patterns before and after treatment of children with a unilateral posterior crossbite. Eur J Orthod 2006;28:480-4.
11. Thilander B, Lennartsson B. A study of children with unilateral posterior crossbite, treated and untreated, in the deciduous dentition--Occlusal and skeletal characteristics of significance in predicting the long-term outcome. J Orofac Orthop 2002;63:371-83.
12. Langland OE, Sippy FH. Anatomic structures as visualized on the orthopantomogram. Oral Surg Oral Med Oral Pathol 1968;26:475-84.
13. Graber TM. Panoramic radiography in orthodontic diagnosis. Am J Orthod 1967;53:799-821.
14. Kambylafkas P, Murdock E, Gilda E, Tallents RH, Kyrkanides S. Validity of panoramic radiographs for measuring mandibular asymmetry. Angle Orthod 2006;76:388-93.
15. Habets LL, Bezuur JN, van Ooij CP, Hansson TL. The orthopantomogram, an aid in diagnosis of temporomandibular joint problems. I. The factor of vertical magnification. J Oral Rehabil 1987;14:475-80.
16. Larheim TA, Svanaes DB. Reproducibility of rotational panoramic radiography: Mandibular linear dimensions and angles. Am J Orthod Dentofacial Orthop 1986;90:45-51.
17. Habets LL, Bezuur JN, Naeiji M, Hansson TL. The Orthopantomogram, an aid in diagnosis of temporomandibular joint problems. II. The vertical symmetry. J Oral Rehabil 1988;15:465-71.
18. Lopatienė K, Trumpytė K. Relationship between unilateral posterior crossbite and mandibular asymmetry during late adolescence. Stomatologija 2018;20:90-5.
19. Kilic N, Kiki A, Oktay H. Condylar asymmetry in unilateral posterior crossbite patients. Am J Orthod Dentofacial Orthop 2008;133:382-7.
20. Uysal T, Sisman Y, Kurt G, Ramoglu SI. Condylar and ramal vertical asymmetry in unilateral and bilateral posterior crossbite patients and a normal occlusion sample. Am J Orthod Dentofacial Orthop 2009;136:37-43.
21. Illipronti-Filho E, Fantini SM, Chilvarquer I. Evaluation of mandibular condyles in children with unilateral posterior crossbite. Braz Oral Res 2015;29:49.
22. Iodice G, Danzi G, Cimino R, Paduano S, Michelotti A. Association between posterior crossbite, skeletal, and muscle asymmetry: A systematic review. Eur J Orthod 2016;38:638-51.