

Condylar Asymmetry in Bilateral Posterior Crossbite Patients

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ABSTRACT

Objective: To investigate whether patients with bilateral posterior crossbite have asymmetrically developed condyles.

Materials and Methods: The study group consisted of 75 patients with bilateral posterior crossbite, and a control group of 75 subjects with normal occlusion. Condylar, ramal, and condylar plus ramal asymmetry values were computed for all of the subjects on orthopantomograms. Data were analyzed statistically by means of paired *t*-test and Student's *t*-test.

Results: The patients with bilateral posterior crossbite had more asymmetrical condyles relative to the controls. However, there were no statistically significant differences in condylar, ramal, or condylar plus ramal heights between left and right sides in both the control and crossbite groups.

Conclusion: Patients with bilateral posterior crossbite can have asymmetrical condyles and might be at risk for the development of future skeletal mandibular asymmetries.

KEY WORDS: Condylar asymmetry; Crossbite; Posterior crossbite; Orthopantomograph

INTRODUCTION

Posterior crossbite is one of the most common problems in orthodontics.¹⁻⁴ In patients with bilateral posterior crossbites, the buccal cusps of the maxillary teeth occlude to the lingual of the buccal cusps of the corresponding mandibular teeth on both sides. Both dental and skeletal factors contribute to development of posterior crossbite.⁵

It is commonly accepted that many narrow maxillary arches are the result of abnormal function.^{6,7} Abnormal finger-sucking habits, perverted perioral muscle functions, premature primary tooth loss, and similar factors may cause morphologic and functional changes detrimental to the dentition. A frequent result of a prolonged thumb-sucking habit with associated perioral muscle malfunction is a posterior crossbite.⁸

Prolongation of posterior crossbite can cause permanent changes in tooth position, in the bony support, and possibly in the growth center at the temporoman-

dibular joint.⁸ It has been shown that malocclusions, especially transverse anomalies, have a marked effect on mandibular condyle morphology.⁹⁻¹¹

Habets et al¹² introduced a method to determine the asymmetries between the mandibular condyles. This method was a comparison of vertical heights of the mandibular right and left condyles and rami and was used as an acceptable method for diagnosis in temporomandibular disorder (TMD) patients.¹²⁻¹⁴ In addition, it has been used to determine condylar asymmetries in Class II and III^{15,16} malocclusions and in different skeletal patterns.¹⁷

In unilateral crossbite patients, skeletal, dental, and muscular characteristics have been extensively investigated.¹⁸⁻²⁵ To our knowledge, no attempt has been made to examine these features in an isolated population having bilateral crossbites. Therefore, this study was aimed at investigating the effects of bilateral posterior crossbite on condylar and ramal heights and to determine whether the subjects with bilateral crossbite had asymmetrical condyles.

MATERIALS AND METHODS

For this study, 75 patients with bilateral crossbite and 75 individuals with normal occlusion were selected from the files of Department of Orthodontics, Faculty of Dentistry, Atatürk University, Erzurum, Turkey. This study was approved by the local ethics committee.

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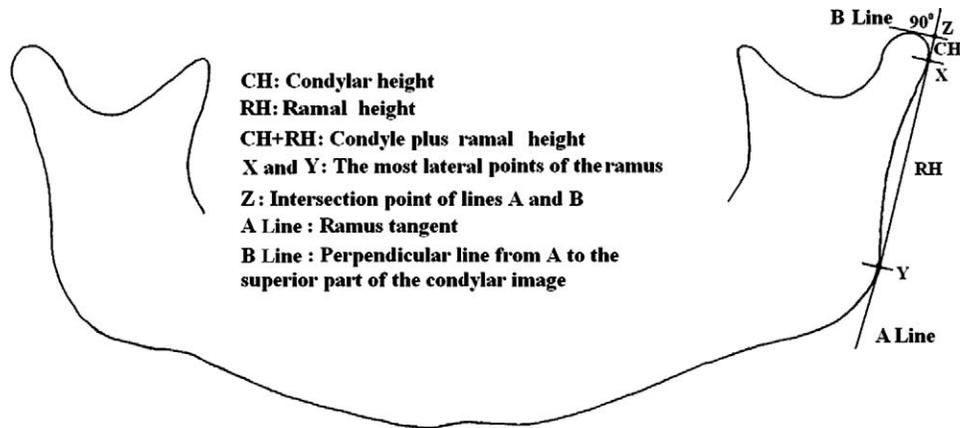


Figure 1. Measuring method according to Habe et al.¹²

In the subjects with normal occlusion, patient selection criteria were as follows:

1. Skeletal and dental class I relationship, which was determined by ANB angle, convexity angle, Wits appraisal, and molar occlusion;
2. Mesiofacial growth pattern;
3. Excellent posterior interdigitation with normal overjet and overbite and harmonious dental midline;
4. No remarkable facial or occlusal asymmetry;
5. No developmental or acquired craniofacial or neuromuscular deformities;
6. No systemic disease;
7. No history of orthodontic treatment;
8. No signs or symptoms of TMD;
9. No missing teeth, excluding third molars;
10. No carious lesions, extensive restorations, or pathologic periodontal status.

The last seven criteria (4–10) were also valid for the study group. Patients having at least two teeth in reverse occlusion on both left and right sides were taken as the study group. The subjects in the control and crossbite groups were all 11–17 years of age.

Plaster models were used to verify the posterior occlusion and panoramic radiographs were used to determine the condyle and ramus heights. Distorted films on which the contours of the condyles and rami were not easily detectable were excluded.

The panoramic radiographs were scanned (Epson Expression 1860 Pro, Seiko Epson Corp, Naoano-Ken, Japan) under a magnification of 100% and the images were saved on a computer. The outlines of the left and right condyle and ascending ramus on the panoramic radiographs were traced using Quick Ceph 2000 (Quick Ceph Systems, San Diego, Calif).

On both the left and right sides, the most lateral points of the condyle and ramus were marked as X

and Y, respectively. On each side a line (ramus tangent) was drawn passing through points X and Y and termed the A-line. Another line was drawn from the most superior points of the condylar images perpendicular to the A-line and termed the B-line. The intersection of the A and B lines was named point Z (Figure 1).

The distances between points X and Z were measured and recorded as condylar height (CH). Similarly, the distances between points X and Y and between points Z and Y were measured and recorded as ramus height (RH) and condylar plus ramus heights (CH + RH), respectively (Figure 1).

All of the films were digitized by one of the authors to avoid interobserver variability. The author was unaware of which radiographs belonged to which group at the time of digitizing. The asymmetry indexes of the condyle, ramus, and condyle plus ramus were computed by the following formula developed by Habets et al.¹²

$$\text{Asymmetry index: } \left| \frac{\text{Right} - \text{Left}}{\text{Right} + \text{Left}} \right| \times 100\%$$

Statistical Analysis

All measurements of the 30 subjects were taken again 2 weeks later to determine the measurement error. A paired *t*-test was applied to the first and second measurements and no error associated with the radiographic tracings and measurements was found.

A Student's *t*-test was applied to determine whether there was any difference between the asymmetry indices of the groups. This test was also used to determine the sex differences regarding the asymmetry indices. A paired *t*-test was used to determine the differences in condylar, ramal, and condylar plus ramal heights between the left and right sides of the subjects

Table 1. Means and Standard Deviations of Chronological Ages for Each Group and *P* Value Found by Student's *t*-Test

	Control Group (n = 75)	Crossbite Group (n = 75)	<i>P</i>
Age, y	14.68 ± 2.34	14.20 ± 1.94	.181

Table 2. Means and Standard Deviations of Indices for Both Sexes and *P* Values Found by Student's *t*-Test

Parameter	Female (n = 114)		Male (n = 36)		<i>P</i>
	Mean	SD	Mean	SD	
Condylar index	5.59	5.39	4.33	3.24	.186
Ramal index	1.55	1.20	1.59	1.36	.848
Condylar + ramal index	1.53	1.19	1.61	1.24	.724

in each group. All statistical analysis were performed using the SPSS software package (SPSS for Windows 98, version 10.0, SPSS Inc, Chicago, Ill).

RESULTS

The means and standard deviations of the chronological ages of all subjects in both groups and their comparisons are shown in Table 1. No statistically significant difference was found between the groups in terms of age.

The means and standard deviations of the condylar index, ramal index, and condylar plus ramal index computed for the male and female subjects and their comparisons are shown in Table 2. No gender-related difference was observed for any of the asymmetry indices, and therefore male and female groups were pooled for statistical analyses.

The statistical data and the results of paired *t*-tests

Table 5. Means and Standard Deviations of Asymmetry Indices in Each Group and *P* Values Found by Student's *t*-Test

Parameter	Control Group (n = 75)		Crossbite Group (n = 75)		<i>P</i>
	Mean	SD	Mean	SD	
Condylar index	3.81	2.90	6.77	6.08	0.000
Ramal index	1.80	1.35	1.53	1.22	0.201
Condylar + ramal index	1.69	1.13	1.60	1.37	0.701

comparing the measurements of the left and right sides in control and bilateral crossbite groups are presented in Tables 3 and 4, respectively. There was no statistically significant difference between the right and left sides in the CH, RH, or CH+RH measurements of the control group (Table 3). The same measurements were not statistically different in the crossbite group (Table 4). Comparisons of the asymmetry indices between the groups are shown in Table 5. A statistically significant difference was found only for the condylar index.

DISCUSSION

The orthopantomograph used in this study gives sharply defined images of the structures within the pre-selected plane by the blurring out of other images.^{26,27} There is magnification of the radiographic images of the structures in both vertical and horizontal directions.^{27,28} According to Graber,²⁹ the magnification on the orthopantomograph is uniform and should not materially affect diagnostic decisions.

In the vertical plane, magnification is dependent on projection factors alone. The distance between the focal point of the x-ray tube and the film is always the

Table 3. Means and Standard Deviations of Condylar Height, Ramal Height, and Condylar Plus Ramal Height in the Right and Left Sides and the Results of Paired *t*-Tests in the Normal Occlusion Group

Parameter	Right		Left		Difference		<i>P</i>
	Mean	SD	Mean	SD	Mean	SD	
Condylar height	7.62	1.47	7.55	1.49	0.06	0.73	.459
Ramal height	50.23	4.04	50.02	4.43	0.21	2.23	.419
Condylar + ramal height	57.84	4.70	57.57	5.10	0.27	2.31	.312

Table 4. Means and Standard Deviations of Condylar Height, Ramal Height, and Condylar Plus Ramal Height in the Right and Left Sides and the Results of Paired *t*-Tests in the Crossbite Group

Parameter	Right		Left		Difference		<i>P</i>
	Mean	SD	Mean	SD	Mean	SD	
Condylar height	7.42	1.66	7.14	1.29	0.28	1.38	.084
Ramal height	51.84	5.38	51.43	5.19	0.41	2.21	.112
Condylar + ramal height	59.15	5.83	58.62	5.50	0.53	2.54	.072

same.³⁰ In a recent study, Kambylafkas et al³¹ stated that panoramic radiographs could be used to evaluate vertical posterior mandibular asymmetries. Many authors suggest that the reproducibility of vertical and angular measurements is acceptable provided that the patient's head is positioned properly in the equipment.³²⁻³⁴ In the present study, special attention was given to the positioning of the subjects during exposure, and the films with distorted and/or poor quality were excluded.

In this study, we aimed to determine whether there was a condylar asymmetry in bilateral crossbite patients. Because computerized digitizing has some advantages,³⁵⁻³⁷ such as accurate determination of the contours of bony structures by enlarging the image and changing the contrast when needed, the asymmetry evaluation method of Habets et al¹² was used with the aid of a computer software program.

According to Habets et al,¹² a 3% index ratio may result from a 1-cm change in head position while the orthopantomograph is being taken, and thus asymmetry index values greater than 3% should be considered as vertical asymmetry.

A slight asymmetry between the right and left condyles of the subjects was observed in the control group of this study (condylar asymmetry index: 3.81 ± 2.90). This finding is similar to that of the normal groups in the studies of Miller and Smith¹⁵ and Miller and Bodner.¹⁶ On the other hand, it is not coincident with the findings of other studies.^{12,17,38} This difference could be explained by patient selection criteria and age groups.

The results of this study revealed that bilateral crossbite patients had asymmetrical mandibular condyles (condylar asymmetry index: 6.77 ± 6.08). There are a lot of studies concerning mandibular morphological and functional asymmetries in unilateral crossbite patients^{18,19,22,39} but no study was encountered in the literature regarding the vertical morphology of the mandible and its components in bilateral crossbite patients. Thus, we could not compare our findings with those of any other study.

Condylar heights, ramus heights and condyle plus ramus heights in the control group were very similar on the right and left sides (Table 3). In the crossbite group, the differences between the right and left sides were greater than those of the subjects with normal occlusion. However, no statistically significant differences between the right and left sides were observed in either group.

Condylar asymmetry index values in bilateral crossbite patients were significantly higher than those in the normal occlusion individuals. One possible explanation of this finding may be the presence of interdental disharmony in bilateral crossbite patients.⁴⁰ Inui et al⁴¹

hypothesized that the continuous condylar displacement in the glenoid fossa during the growth period, derived from occlusal problems, induced differential growth of the left and right condyles.

The condyle is one of the most sensitive structures to occlusal changes⁴² and it is generally affected by transverse anomalies in growing individuals.⁹ Therefore, a posterior crossbite may be a potential factor in the development of condylar asymmetry. In addition, the asymmetrical constriction of the palatal vault may account for this situation.⁴³ Hayashi et al⁴³ demonstrated a significant correlation between asymmetry in the mandible and the right-left difference in the radius of the palatal curvature in the molar region. In a recent study, Kusayama et al¹¹ reported that there was a high correlation between transverse dental anomalies and skeletal asymmetry. In autopsy material from young adults, Solberg et al¹⁰ found that variation in the form of condyle was associated with malocclusions such as crossbite.

According to Graber,⁸ ". . . prolonged crossbite conditions also accentuate individual tooth malpositions so that asymmetry of the arch results. In the initial stages, however, the upper arch can be quite symmetrical despite the crossbite. The belief is widespread that unless these crossbites are eliminated, they lead to asymmetry of the dental arches as well as an actual facial asymmetry in the adult. Obviously, crossbites should be eliminated whenever possible." As emphasized by Graber,⁸ to avoid future skeletal asymmetries, it should be remembered that the early correction of posterior crossbite is of major importance.

CONCLUSIONS

- A higher degree of condylar asymmetry was found in crossbite patients as compared to normal-occlusion controls.
- The condylar, ramal, and condylar plus ramal heights were not statistically different between the right and left sides of the subjects in either group.
- Asymmetry indices were similar in both sexes.

REFERENCES

1. Thilander B, Pena L, Infante C, Parada SS, de Mayorga C. Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. *Eur J Orthod.* 2001;23:153-1S67.
2. Thilander B, Lennartsson B. 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;63:371-383.
3. Kurol J, Berglund L. Longitudinal study and cost-benefit analysis of the effect of early treatment of posterior cross-

- bites in the primary dentition. *Eur J Orthod.* 1992;14:173–179.
4. Sandkicoglu M, Hazar S. Skeletal and dental changes after maxillary expansion in the mixed dentition. *Am J Orthod Dentofacial Orthop.* 1997;111:321–327.
 5. Allen D, Rebellato J, Sheats R, Ceron AM. Skeletal and dental contributions to posterior crossbites. *Angle Orthod.* 2003;73:515–524.
 6. Graber TM. Dentofacial orthopedics. In: Graber TM, ed. *Current Orthodontics Concepts and Techniques*. Vol. 2. 2nd ed. Philadelphia, Pa: WB Saunders Co; 1969:918–988.
 7. McNamara JA. Influence of respiratory pattern on craniofacial growth. *Angle Orthod.* 1981;51:269–300.
 8. Graber TM. *Orthodontics—Principles and Practice*. Philadelphia, Pa: WB Saunders Co; 1967:470, 674–675.
 9. Tadej G, Engstrom C, Borrman H, Christiansen EL. Mandibular condyle morphology in relation to malocclusions in children. *Angle Orthod.* 1989;59:187–194.
 10. Solberg WK, Bibb CA, Nordstrom BB, Hansson TL. Malocclusion associated with temporomandibular joint changes in young adults at autopsy. *Am J Orthod.* 1986;89:326–330.
 11. Kusayama M, Motohashi N, Kuroda T. Relationship between transverse dental anomalies and skeletal asymmetry. *Am J Orthod Dentofacial Orthop.* 2003;123:329–337.
 12. 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;15:465–471.
 13. Miller VJ. Condylar asymmetry and handedness in patients with temporomandibular disorders. *J Oral Rehabil.* 1997;24:549–551.
 14. Miller VJ, Zeltser R, Zeltser CH, Yoeli Z. The condylar asymmetry-age relationship in determining myogenous or arthrogenous origin of pain in patients with temporomandibular disorders. *J Oral Rehabil.* 1996;23:392–394.
 15. Miller VJ, Smidt A. Condylar asymmetry and age in patients with an Angle's Class II division 2 malocclusion. *J Oral Rehabil.* 1996;23:712–715.
 16. Miller VJ, Bodner L. Condylar asymmetry measurements in patients with an Angle's Class III malocclusion. *J Oral Rehabil.* 1997;24:247–249.
 17. Saglam AM. The condylar asymmetry measurements in different skeletal patterns. *J Oral Rehabil.* 2003;30:738–742.
 18. Pirttiniemi P, Kantomaa T, Lahtela P. Relationship between craniofacial and condyle path asymmetry in unilateral crossbite patients. *Eur J Orthod.* 1990;12:408–413.
 19. Lam PH, Sadowsky C, Omerza F. Mandibular asymmetry and condylar position in children with unilateral posterior crossbite. *Am J Orthod Dentofacial Orthop.* 1999;115:569–575.
 20. Hesse KL, Artun J, Joondeph DR, Kennedy DB. Changes in condylar position and occlusion associated with maxillary expansion for correction of functional unilateral posterior crossbite. *Am J Orthod Dentofacial Orthop.* 1997;111:410–418.
 21. O'Byrn BL, Sadowsky C, Schneider B, BeGole EA. An evaluation of mandibular asymmetry in adults with unilateral posterior crossbite. *Am J Orthod Dentofacial Orthop.* 1995;107:394–400.
 22. Pinto AS, Buschang PH, Throckmorton GS, Chen P. Morphological and positional asymmetries of young children with functional unilateral posterior crossbite. *Am J Orthod Dentofacial Orthop.* 2001;120:513–520.
 23. Langberg BJ, Arai K, Miner RM. Transverse skeletal and dental asymmetry in adults with unilateral lingual posterior crossbite. *Am J Orthod Dentofacial Orthop.* 2005;127:6–15.
 24. Alarcon JA, Martin C, Palma JC. Effect of unilateral posterior crossbite on the electromyographic activity of human masticatory muscles. *Am J Orthod Dentofacial Orthop.* 2000;118:328–334.
 25. Ingervall B, Thilander B. Activity of temporal and masseter muscles in children with a lateral forced bite. *Angle Orthod.* 1975;45:249–258.
 26. Haidar Z. Diagnostic limitations of orthopantomography with lesions of the antrum. *Oral Surg Oral Med Oral Pathol.* 1978;46:449–453.
 27. Langland OE, Sippy FH. Anatomic structures as visualized on the orthopantomogram. *Oral Surg Oral Med Oral Pathol.* 1968;26:475–484.
 28. Manson-Hing LR, Lund TM. A study of the focal troughs of three panoramic dental x-ray machines. Part II. Image dimensions. *Oral Surg Oral Med Oral Pathol.* 1975;39:647–653.
 29. Graber TM. Panoramic radiography in orthodontic diagnosis. *Am J Orthod.* 1967;53:799–821.
 30. Lund TM, Manson-Hing LR. A study of the focal troughs of three panoramic dental x-ray machines. Part I. The area of sharpness. *Oral Surg Oral Med Oral Pathol.* 1975;39:318–328.
 31. Kambylafkas P, Murdock E, Gilda E, Tallents RH, Kyrkaniades S. Validity of panoramic radiographs for measuring mandibular asymmetry. *Angle Orthod.* 2006;76:388–393.
 32. Larheim TA, Svanaes DB. Reproducibility of rotational panoramic radiography: mandibular linear dimensions and angles. *Am J Orthod Dentofacial Orthop.* 1986;90:45–51.
 33. Larheim TA, Svanaes DB, Johannessen S. Reproducibility of radiographs with the Orthopantomograph 5: Tooth length assessment. *Oral Surg Oral Med Oral Pathol.* 1984;58:736–741.
 34. Oktay H. The study of the maxillary sinus areas in different orthodontic malocclusions. *Am J Orthod Dentofacial Orthop.* 1992;102:143–145.
 35. Liu YT, Gravely JF. The reliability of the 'Ortho Grid' in cephalometric assessment. *Br J Orthod.* 1991;18:21–27.
 36. Verdonck A, Jorissen E, Carels C, Van Thillo J. The interaction between soft tissues and the sagittal development of the dentition and the face. *Am J Orthod Dentofacial Orthop.* 1993;104:342–349.
 37. Cangialosi TJ, Chung JM, Elliott DF, Meistrell ME Jr. Reliability of computer-generated prediction tracing. *Angle Orthod.* 1995;65:277–284.
 38. Bezuur JN, Habets LL, Hansson TL. The recognition of craniomandibular disorders; condylar symmetry in relation to myogenous and arthrogenous origin of pain. *J Oral Rehabil.* 1989;16:257–260.
 39. Martin C, Alarcon JA, Palma JC. Kinesiographic study of the mandible in young patients with unilateral posterior crossbite. *Am J Orthod Dentofacial Orthop.* 2000;118:541–548.
 40. van der Linden PGM, Boersma H. *Diagnosis and treatment planning in dentofacial orthopedics*. London, England: Quintessence Publishing Co Ltd; 1987:62–63.
 41. Inui M, Fushima K, Sato S. Facial asymmetry in temporomandibular joint disorders. *J Oral Rehabil.* 1999;26:402–406.
 42. Pirttiniemi P, Kantomaa T, Salo L, Tuominen M. Effect of reduced articular function on deposition of type I and type II collagens in the mandibular condylar cartilage of the rat. *Arch Oral Biol.* 1996;41:127–131.
 43. Hayashi K, Muguruma T, Hamaya M, Mizoguchi I. Morphologic characteristics of the dentition and palate in cases of skeletal asymmetry. *Angle Orthod.* 2004;74:26–30.