

Evaluation of mandibular condyles in children with unilateral posterior crossbite

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Abstract: The relationship of mandibular condyle dimensions and its association with unilateral posterior crossbite (UPXB) has been suggested in the literature. The purpose of this prospective study was to evaluate mandibular condyles on the left and right sides and between crossed and non-crossed sides in the sagittal and coronal planes, using cone-beam computed tomography (CBCT). Twenty CBCT images of 40 temporomandibular joints (TMJs) in individuals in mixed dentition phase, which included 9 males (mean 7.9 years) and 11 females (mean 8.2 years), with unilateral posterior crossbite without premature contacts and functional mandibular shifts and with transverse maxillary deficiency. The criteria for sample exclusion included the presence of painful symptoms, facial trauma history, systemic diseases such as juvenile rheumatoid arthritis, mouth opening limitation (< 40 mm), congenital or genetic anomalies, and skeletal asymmetries that may result in TMJ disorders. Dimensional measurements of the condyles between the right and left sides and crossed and non-crossed sides in sagittal and coronal view were made. There was no significant difference between the measurements of the crossed and non-crossed sides in both sagittal and coronal view. These findings suggest that the presence of unilateral posterior crossbite in children with UPXB did not result in changes between the mandibular condyles in the right and left sides or between the crossed and non-crossed sides in the coronal or sagittal plane.

Keywords: Malocclusion; Mandibular Condyle; Cone-Beam Computed Tomography.

Introduction

The temporomandibular joint (TMJ) region, more specifically the condyles, may undergo changes and remodeling according to the malocclusion present. This important joint involves not only mandibular movements during chewing, deglutition, and phonation but also the region where mandibular growth is expressed. The presence of any change, whether dimensional or positional, may affect not only its morphology but also compromise the facial cranial development taking place during that period.^{1,2}

Unilateral posterior crossbite (UPXB) are malocclusions frequently found during the mixed dentition phase (11%-20%).^{3,4} It is a transversal

problem that may involve one or more elements and is characterized by the inversion of the lingual vestibule relation of the upper and lower posterior teeth. UPXBs are classified into skeletal, dental, or functional, and may be uni- or bilateral. Perpetuation of that malocclusion in adult ages or even in young adults may cause changes both to the face, such as those seen in the TMJ. Considering that the possibility of spontaneous correction of that type of malocclusion is practically unfeasible, the diagnosis and treatment must occur as soon as possible.^{5,6,7}

Changes in morphology of mandibular condyles, articular fossa, and its associations with the existing malocclusion are broadly reported in the phase of permanent dentition; however, few studies in the literature report the relation of mandibular condyle dimensions and its association with UPXB, and a vast majority of studies assess the mandibular condyle position relative to the mandibular fossa.^{8,9,10} Imaging exams have been used in the identification of structural and positional changes, which is similar to the bone contour of mandibular condyle and articular fossa, in the articular inter-relations and in the assessment of articular spaces considering the verification of possible changes in the beginning and end of the orthodontic treatment.¹¹

Images obtained by cone-beam computed tomography (CBCT) were shown to be a great method in the assessment of bone structures comprising the TMJ, mainly of the mandibular condyle and articular fossa. This imaging technique allows both linear and a volumetric measurement of the structures described and has high accuracy.^{12,13}

The aim of this study was to evaluate if the presence of unilateral posterior crossbite in children during the mixed dentition period could lead to alterations in dimensional mandibular condyles. This was performed by CBCT.

Methodology

The sample consisted of 20 CBCT images of 40 TMJs of subjects in the mixed dentition phase, which included 9 males (mean age 7.9 years) and 11 females (mean age 8.2 years), with UPXB without premature contacts and functional mandibular shifts and with transverse maxillary deficiency.

Images were obtained for diagnosis, planning, and treatment of this malocclusion. Criteria adopted for sample exclusion included the presence of painful symptoms, facial trauma history, systemic diseases such as juvenile rheumatoid arthritis, mouth opening limitation (< 40 mm), congenital or genetic anomalies, and skeletal asymmetries that may result in TMJ disorders. The data was collected in each participant's initial clinical assessment file.

The sample size was calculated to observe the difference between the measures in crossed and non-crossed sides. A power of 90% was assumed and 5% level of significance was set in both sagittal and coronal cuts. The difference in the measures was around 10%. In sagittal cut, the mean was 6.6 in the non-crossed side and standard deviation (SD) was 0.3. The SD was 0.6 in the crossed side. Thus, an n of 18 subjects was determined. In coronal cuts, the mean was 14 and SD was 1.3 in non-crossed sides SD was 1.4 and, the n of 20 subjects. For simplification, the sample size was standardized to 20 participants.

The study was approved by the Research Ethics Committee of the *Universidade de São Paulo – USP*, School of Dentistry (numbers 200/06 and 16/2008).

The measurements obtained in this study were conducted prior to the UPXB correction orthodontics treatment, repeated three times, and performed by one single examiner, with a 1-week interval between the times proposed. The variance analysis test was applied to assess the reliability of intra-examiner results.

All images were obtained with an i-CAT-KaVo – 3D Dental Imaging System (Imaging Sciences International, Kavo Group, Hatfield, USA), with a field of view (FOV) of 13 cm × 17 cm, with automatic collimation, acquisition time between 5 and 26 s, and pulse exposure in the 14-bit gray scale and 16,384 shades of gray. The focal point was 0.5 m with a 0.3 mm voxel. Effective dose of 36.74 uSv and cylindrical reconstruction, being primary with scan obtainment from 20 seconds to 1 minute, and secondary in real time. Prior to the CBCT acquisition, the patient was positioned seated in the device. For better control in capturing images, the head was stabilized to obtain the Frankfurt plane parallel to the ground and then the tomographic sensor was positioned to capture the image of the entire head. The patient was instructed to

remain still, with lips relaxed, and to avoid deglutition during image acquisition. After capturing attenuated X-rays, the data was digitalized by tomography sensors through reconstruction algorithms and converted to the Digital Imaging and Communication in Medicine (DICOM) format. After capturing the images, primary image reconstruction was performed at the workstation. After confirmation of the accurate obtainment of the reconstructed image, the patient was released. Software Dolphin 3D® (Dolphin Imaging/Patterson Dental, Chatsworth, USA) was used to perform proposed measurements. Prior to measuring the mandibular condyle dimensions, images were standardized according to the cranial positioning orientation.¹³ In Figure 1, the axial plan coincides with the orbital points; in the side images, the coronal plan coincides with the Porion (Po), in the left and right sides, and the axial plan is superimposed to the Frankfurt plan; the median sagittal plan unites the Nasion (N) and the anterior nasal spine (ANS).

In the Dolphin software, we accessed the Build X-ray, selected the TMJ imaging screen, performed orientation of the TMJ cut, and then captured images of the mandibular condyles in the respective articular fossa. To obtain measurements, we adopted the criteria developed by Schluter *et al.*,¹⁴ as follows:

- **M** (medial face of the condyle): Anatomic point representing the most medial position of the mandibular condyle in coronal cut;

- **L** (lateral face of the condyle): Anatomic point representing the most lateral position of the mandibular condyle in coronal cut;
- **A** (anterior face of the condyle): Anatomic point representing the most anterior position of the mandibular condyle in sagittal cut;
- **P** (posterior face of the condyle): Anatomic point representing the most posterior position of the mandibular condyle in sagittal cut;
- **M-L** (mandibular condyle width): Distance between anatomic points **M** and **L** in coronal cut;
- **A-P** (Mandibular condyle length): Distance between anatomic points **A** and **P** in sagittal cut. Figures 2 and 3.

All values obtained were tabulated for analysis with the appropriate statistical tests, and average values and standard deviations were obtained separately for crossed and non-crossed sides as well as for the right and left sides, both in coronal and sagittal cuts.

Results

We used variance analysis (ANOVA) for repeated measurements for error assessment of the intra-examiner method. The descriptive analysis of data and result of the model applied are presented in Table 1, showing that at the 5% significance level, there is no method error for the single examiner in the three measurements in any of the positional

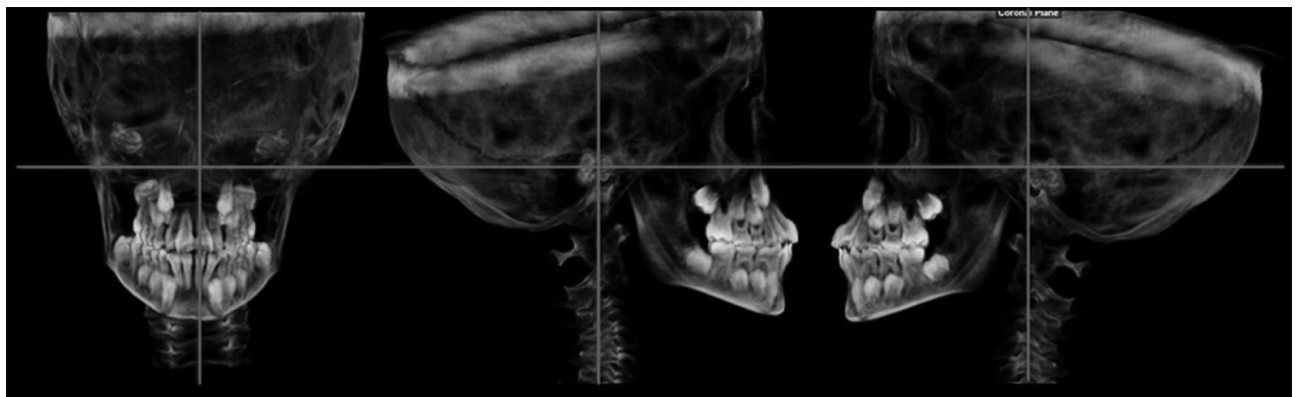


Figure 1. Cranial positioning orientation using Software Dolphin 3D® (Dolphin Imaging/Patterson Dental, Chatsworth, USA).

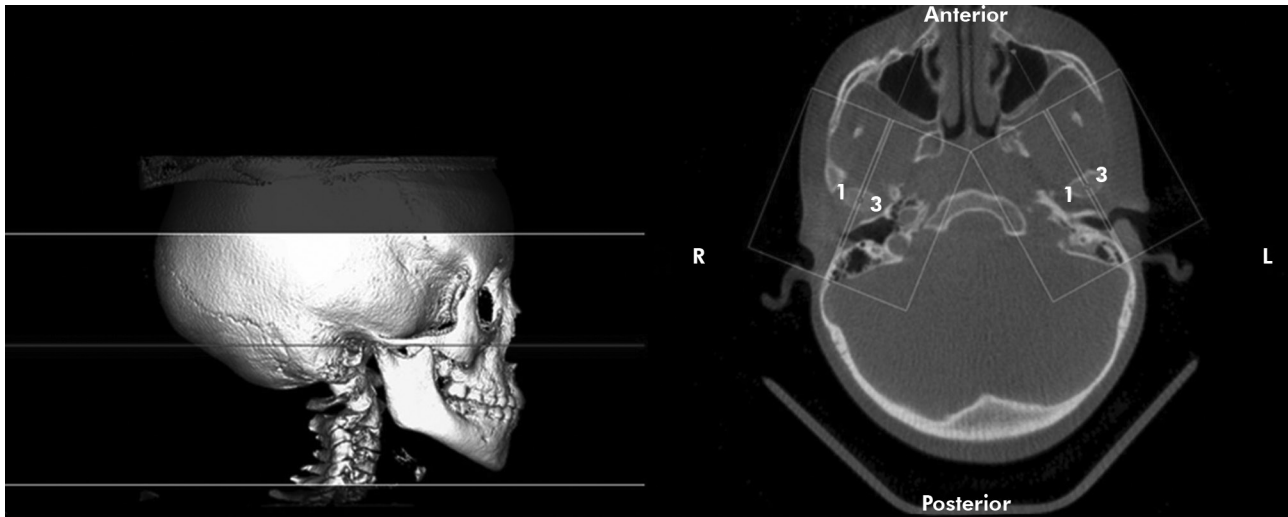


Figure 2. Cuts Orientation – Software Dolphin 3D® (Dolphin Imaging/Patterson Dental, Chatsworth, USA).

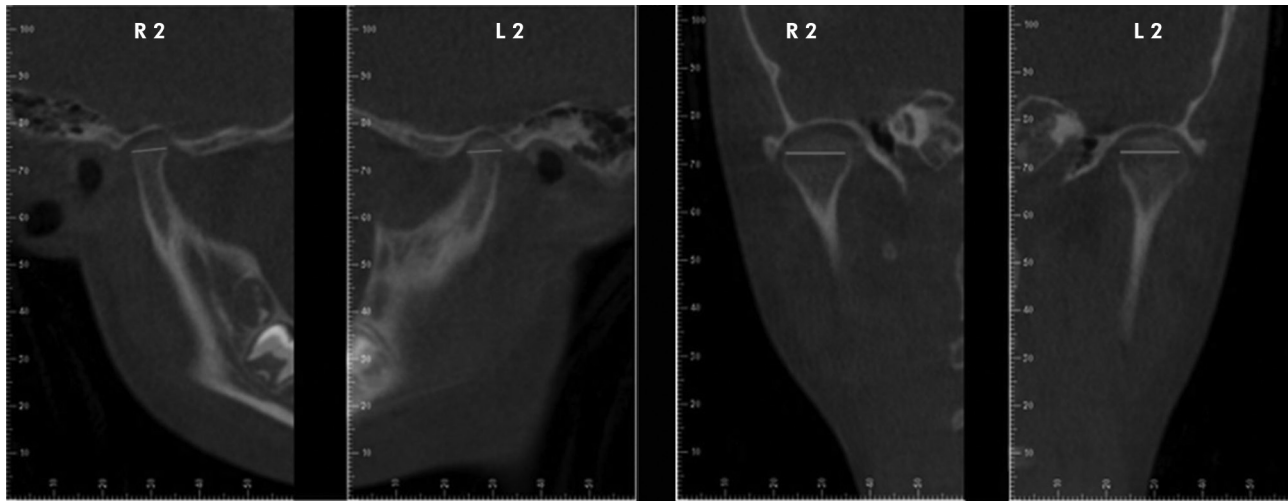


Figure 3. Measures in Sagittal and Coronal Planes – Software Dolphin 3D® (Dolphin Imaging/Patterson Dental, Chatsworth, USA).

images that were captured: crossed sagittal side, non-crossed sagittal side, crossed coronal side, non-crossed coronal side.

The descriptive analysis of the dimensional measurements of the mandibular condyle between the crossed and non-crossed sides in sagittal and coronal cuts, and the results obtained by the Paired t-Student parametric test are shown in Table 2. It was noted that at the 5% significance level, there is no significant difference in the dimensional measurements between the crossed and non-crossed sides in sagittal and coronal cuts.

Discussion

UPXB are described as predisposing factors for changes in the mandibular condyle morphology and may affect cranial facial development. During the mixed dentition period, cranial facial development is expressed singularly and 30%-40% of all development occurs during this phase. Thus, in addition to establish favorable occlusal relations, the primary condition to obtain images involves the balance of stomatognathic functions such as chewing, phonation, deglutition, and breathing.^{4,7,9}

Table 1. Descriptive analysis of data and results of three measurements to assess intraexaminer errors using model analysis of variance (ANOVA) for repeated measures.

Variable	Measure 1	Measure 2	Measure 3	p-value
Crossed side – Sagittal				
Mean ± Standard deviation	6.63 ± 0.89	6.59 ± 0.89	6.53 ± 0.81	0.254
Median (Minimum - Máximum)	6.55 (4.5 - 8.6)	6.55 (4.4 - 8.4)	6.55 (4.5 - 8.3)	
Total	20	20	20	
Non-crossed side – Sagittal				
Mean ± Standard deviation	6.71 ± 0.64	6.61 ± 0.72	6.58 ± 0.71	0.230
Median (Minimum - Maximum)	6.8 (5.4 - 8.1)	6.7 (5.4 - 7.9)	6.65 (5.3 - 8)	
Total	20	20	20	
Crossed side – Coronal				
Mean ± Standard deviation	14.22 ± 1.97	14.09 ± 1.64	14 ± 1.8	0.261
Median (Minimum - Maximum)	14.35 (11.1 - 18.8)	14 (11.9 - 18.4)	13.9 (10.9 - 18.6)	
Total	20	20	20	
Non-crossed Side – Coronal				
Mean ± Standard deviation	14.8 ± 1.9	14.46 ± 1.75	14.42 ± 1.81	0.051
Median (Minimum - Maximum)	14.65 (12 - 18.8)	14.35 (12.1 - 18.4)	14.1 (11.8 - 18.3)	
Total	20	20	20	
Total	20	20	20	-

Table 2. Descriptive analysis, mandibular condyle between the crossed and non-crossed side, in the sagittal and coronal planes, and the result of parametric test t-Student test.

Variable – Side	Crossed	Non-crossed	p-value
Sagittal			
Mean ± Standard deviation	6.58 ± 0.85	6.63 ± 0.66	0.645
Median (Minimum - Maximum)	6.57 (4.47 - 8.43)	6.75 (5.4 - 8)	
Total	20	20	
Coronal			
Mean ± Standard deviation	14.1 ± 1.78	14.56 ± 1.79	0.051
Median (Mimumum - Maximum)	14.18 (11.3 - 18.6)	14.35 (12.1 - 18.5)	
Total	20	20	-

In contrast to our findings, a study on the morphological features of dentition and palate in subjects with skeletal asymmetries reported that there is a significant correlation between the lateral mandibular deviation, present to some degree in the UPXB, and the morphology, both in the palate and other structures such as the mandibular condyle.¹⁵ However, it should be noted that only patients with non-functional UPXB were studied. Kiliç *et al.*¹⁶ showed that patients with UPXB have asymmetric mandibular condyles on panoramic radiographs, which may contribute to a skeletal mandibular asymmetry. During the growth period, mandibular

condyle displacement in the articular fossa induces differential growth. Hence, it is likely that UPXBs may induce asymmetries both in the mandibular condyle and on the face. Our results show that UPXB results in numerically different values between the crossed and non-crossed sides; however, it was not possible to confirm that such difference in values could lead to an actual asymmetry of mandibular condyle.

In a study conducted using CBCT in the assessment of volume and stresses on the mandibular condyle in children with juvenile idiopathic arthritis, Huntjens *et al.*¹⁷ concluded that CBCT is an accurate method to make such measurements (volumetric

and linear) on the mandibular condyles and that the asymmetry degree was variable and frequent in the majority of the sample. Similarly, our results show that the CBCTs presented good accuracy and excellent quality.

Studies by Pinto *et al.*¹⁸ and Kiki *et al.*¹⁹ demonstrated a relationship between the crossed and non-crossed sides as well as the presence of condylar asymmetry, both in numeric values when comparing crossed and non-crossed sides; however, no statistical significance was noted. These results agree with our findings despite different methodologies used, *i.e.*, submento vertex projection radiography and panoramic radiography.

It is suggested in the literature that the posterior crossbite, whether functional or skeletal should be corrected even in the primary dentition. However, when corrected during the mixed dentition period (age 7-9 years), the results on follow-up proved to be more stable, whereas phase recurrences are more frequent in advancing years during primary dentition.^{20,21} The cost-benefit relationship should be taken into consideration because corrective treatment can help in eliminating the functional deviations and possible asymmetries in both the condyle, the mandibular ramus, and of the face.²²

Despite the assessment of volume and stresses on the mandibular condyle in young adults, who did not show pain or dysfunction of TMJ, Tecco *et al.*²³ reported no statistically significant differences between the crossed and non-crossed sides. They also indicate that there is a statistical difference between genders, males presenting a slightly higher volume compared to females.

Even the results of our study, using a sample with young children (mean age 8.6 years), show that there was no statistically significant difference between crossed and non-crossed sides. Based on the literature describing asymmetries between the left and right sides and crossed and non-crossed sides in patients with UPXB, we understand that if the malocclusion is not corrected accordingly, these asymmetries may become evident with natural development.

Conclusion

The results of the present study show that the presence of unilateral posterior crossbite in children did not result in changes between the right and left mandibular condyles, between right and left sides, or between crossed and non-crossed sides in sagittal or coronal plans.

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