Changes in condylar position and occlusion associated with maxillary expansion for correction of functional unilateral posterior crossbite

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The purpose of this study was to confirm that correction of functional posterior crossbite through maxillary expansion is associated with a change in condylar position and occlusal relationships, and to determine whether maxillary expansion is associated with autonomous increase in mandibular arch width. Pretreatment and posttreatment study models of 61 patients ages 4.1 to 12.0 years (mean 8.5 years, SD 1.5) were available after maxillary expansion with a Quad Helix or a Haas expander for correction of a functional posterior crossbite. Pretreatment and posttreatment tomograms were available for 22 of the patients. Tomographic evaluation revealed that the condyles moved posteriorly and superiorly on the noncrossbite side from before to after treatment ($p < 0.05$). No differences were observed on the crossbite side. Superior joint space was greatest on the noncrossbite side before treatment, whereas, conversely, it was greatest on the crossbite side after treatment ($p < 0.05$). Relative condylar position was more anterior on the noncrossbite side before treatment ($p < 0.05$), but similar on both sides after treatment. Molar and canine relationships were more Class II on the crossbite side before treatment ($p < 0.01$ and < 0.05, respectively) and similar on both sides after treatment. A significant reduction in midline deviation was seen from before to after treatment ($p < 0.001$). A small, but significant autonomous increase in mandibular intermolar width ($p < 0.001$) occurred concomitant with the maxillary expansion. (Am J Orthod Dentofac Orthop 1997;111:410-8.)

Unilateral posterior crossbite is one of the most frequently occurring malocclusions in the deciduous and mixed dentitions, with a reported incidence of 7% to 23%.[1-7] In the early stages, such crossbites are associated with a lateral functional shift of the mandible in approximately 80% of cases.[7,8] As a result, an asymmetric condylar position has been documented in maximum intercuspation, with the crossbite side condyle being forced upward and backward, while the noncrossbite side condyle is distracted relative to the glenoid fossa.[9-11] This type of malocclusion is frequently corrected early through bilateral maxillary expansion and possibly occlusal grinding, eliminating the occlusal interferences and deviation of the mandible on closure.[12-15] As a result, the condyles may be expected to change from an asymmetric to a more symmetric position after treatment.[9] Few studies, however, have documented such changes. In one such study, where transcranial radiographs[9] were used with a sample size of only 10, only superior and anterior joint space was measured. The use of transcranial radiographs also introduces greater potential methodologic error, as they do not allow detailed description of the condyle-fossa relationship because of compromised image quality and projection effects.[16] With elimination of the mandibular shift, molar relationship may be expected to change in the direction of becoming more symmetric, with a concomitant reduction in the midline deviation after treatment. Such changes are poorly documented. Authors have also suggested that maxillary expansion is associated with spontaneous width increase in the mandibular arch.[17-20]

Inferences from studies on frequency of unilateral crossbite in various age groups,[1-7] as well as follow-up studies of untreated subjects, suggest that unilateral crossbite develops early and has a low rate of spontaneous correction.[1,3,21,22] The fact that a functional shift is rarely detected in adults with unilateral crossbite[10,23] may be an indication of adaptive remodeling changes of the temporomandibular joint with age, with development of a skeletal asymmetry.[10,23-25] Accordingly, the verification of

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a change from asymmetric to more symmetric condylar position concomitant with treatment of functional posterior crossbite in children would support the need for early intervention to minimize the potential for development of a skeletal asymmetry.

The purpose of this study was to confirm that early correction of functional posterior crossbite through maxillary expansion is associated with a change in condylar position and occlusal relationships, and to determine whether maxillary expansion is associated with spontaneous increase in mandibular arch width.

MATERIALS AND METHODS

Sample

A total of 61 patients ages 4.1 to 12.0 years (mean 8.5 years, SD 1.5), after correction of functional unilateral crossbite by one of the authors (D.K.), were included in this study. At the time of pretreatment records (T1), the patients exhibited a minimum of two molars in crossbite on one side only, with the mandibular dental midline shifted toward the crossbite side. No patients demonstrated anterior crossbite, Class III tendency, or missing deciduous molars. Dental histories were negative for previous orthodontic treatment, trauma, or growth abnormalities. All patients had experienced slow maxillary expansion with a Quad helix or a Haas expander until crossbite and shift were eliminated. Active treatment time ranged from 6 to 14 weeks. Posttreatment records were taken after a retention period of approximately 3 months (T2). T1 and T2 study models were available for all patients. In addition, temporomandibular joint tomograms were taken in closed lateral view of 25 patients at T1. Of these, 22 complied with the T2 tomographic radiographs. Attempts were made to take all records in centric occlusion.

Tomographic Measurements

All tomograms were taken at Wilson Radiographic Center in Vancouver, Canada, using a standardized procedure. Most patients had a submental vertex (SMV) radiograph to determine which angulation and depth of the linear section would pass through the center of the condyle. When an SMV radiograph was not available, a standard 20° posterior correction angle was used. Most joints were imaged at two or three different depths of cut. At the posttreatment radiographic session, a few joints were exposed only once if the image was determined to be of sufficient quality. The number of tomographic cuts per joint at T1 and T2 ranged from one to four with an average of two. For each joint, one representative cut was selected for measurement on the basis of clarity and contrast of condyle and fossa, similarity of depth of cut, angulation, and joint anatomy at T1 and T2. The noncrossbite side images of one patient were eliminated because of unsatisfactory match. After random coding for identification, the tomograms were projected onto a screen at about X7 magnification, oriented to appear as a left-sided view. Linear measurements of the smallest anterior, superior, and posterior joint space (Fig. 1) were made directly on the screen with a Fowler Ultra-Cal III electronic caliper to the nearest 0.014 mm, the nearest whole millimeter on the magnified image. The measurements were made twice, at least 1 week apart.

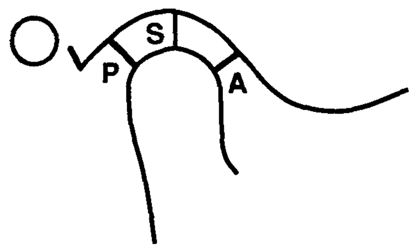

Fig. 1. Locations of measurements of narrowest anterior (A), posterior (P) and superior (S) interarticular spaces in temporomandibular joint tomograms. Relative condylar position is expressed as[27]:

$$\frac{P - A}{P + A} \times 100$$

After joint space measurements, each pair of T1 and T2 tomograms for each joint was coded randomly. Each pair was traced simultaneously to facilitate identification of identical anatomic structures. The center point of the T1 condylar tracing (A1) was marked and a second reference mark (B1) was placed 20 mm from A1 on a line parallel to the posterior border of the ramus. The points A1 and B1 were then transferred onto the T2 tracing (A2 and B2, respectively) superimposing the condylar tracings according to best fit. The tracings were then superimposed on the best fit of the fossa by using anterior and posterior structures of the cranial base for rotational correction. A horizontal reference line was constructed from the most inferior border of the articular eminence to the superior border of the petrotympanic fissure on the superimposed tracing. A vertical reference line was constructed perpendicular to this line through A1. Lines were also drawn from A1 to B1 and from A2 to B2. Horizontal (Dx) and vertical (Dy) movement of the condyle from T1 to T2 was measured as the distances between A1 and A2 along the horizontal and vertical reference lines, respectively (Fig. 2). Rotational change in condylar position from T1 to T2 was measured as the angle between the lines from A1 to B1 and from A2 to B2 (Fig. 2).

Study Model Measurements

For each patient, the T1 and T2 study models were evaluated simultaneously and similar points were marked on the tips of each deciduous canine, the mesiolingual and mesiobuccal of each maxillary first molar, and the mesiolingual of each mandibular first molar cusp. A few patients were missing canines. The second deciduous molar was

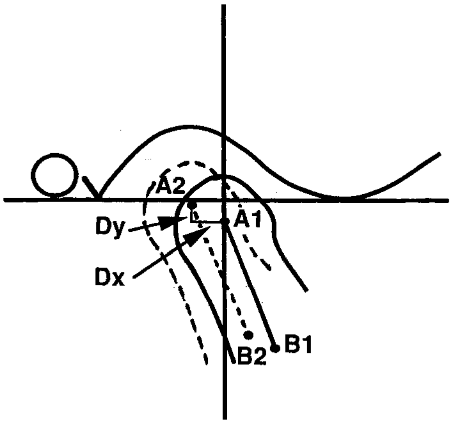

Fig. 2. Superimposition showing measurement of horizontal (*Dx*) and vertical (*Dy*) movement of condyle and rotational change in condylar position (angle between lines from *A1* to *B1* and from *A2* to *B2*) from before to after treatment of functional posterior crossbite (see text).

used if the permanent molar was not present at T1. The midline was interpreted as the contact point of the central incisors. In situations with a diastema or missing incisors, the midline was recorded as the midpoint of the space between mesial edges of adjacent contralateral teeth, using the incisive papilla as an additional guide in the maxilla, and marked on the model. In addition, lines were scribed on the facial surfaces of the teeth, through the cusp tip marks and perpendicular to the occlusal plane. Finally, a line was scribed in the buccal groove of the mandibular first molar.

After random coding for identification, arch width, molar and canine relationship, and any midline deviation was measured on each study model, with a Fowler Ultra-Cal III caliper to the nearest 0.1 mm, eliminating cases with missing deciduous canines. Each measurement was made twice at least 1 week apart. Arch width was measured as the distance between contralateral marks at the tip of the canine and mesiolingual molar cusps. Molar relationship was recorded as zero if the reference lines were flush. A negative measurement indicated a Class III relationship and a positive a Class II relationship. The terminal plane of the deciduous second molars was used at both T1 and T2 in situations where a first permanent molar was not erupted at T1, and a zero recording indicated a flush terminal plane. Canine relationship was recorded as zero if the cusp tip of the maxillary deciduous canine occluded into the distal contact point of the mandibular deciduous canine. Positive and negative recordings were given as for molar relationship. Midline deviation was recorded as the distance along the occlusal plane between the contact point of the maxillary and mandibular central incisors or the reference lines.

Error of the Method

Method error was calculated according to the formula:

$$\sqrt{\Sigma D^2/2N}$$

Where D is the difference between duplicated measurements and N is the number of double measurements.[26] The errors were 0.22 and 0.20 mm for canine and molar relationship, 0.17 mm for midline deviation, 0.13 and 0.12 mm for maxillary and mandibular intercanine width, and 0.14 and 0.10 mm for maxillary and mandibular intermolar width, respectively. The errors for joint space measurements were 0.22 mm for anterior, 0.20 mm for superior, and 0.29 mm for posterior joint space. The error for calculated relative condylar position was 6.49%. The method error for evaluation of condylar movement was determined by repeating the tracing, superimposition, and measurement of tomograms for 20 joints, and calculated as previously mentioned. The errors were 0.22 mm for Dx, 0.34 mm for Dy, and 1.60° for rotational change.

Statistical Analysis

The duplicated data were pooled, and the averaged value for each measurement was used for the statistical analysis. The relative position of each condyle at each time period was calculated according to the formula (Fig. 1):

$$\frac{\text{posterior} - \text{anterior interarticular joint space}}{\text{posterior} + \text{anterior interarticular joint space}} \times 100\%$$

A zero value indicated a concentric location of the condyle within the fossa. A positive value indicated an anterior and a negative a posterior condylar position (in %).[27] For each joint, change from T1 to T2 in relative condylar position, in anterior, superior and posterior joint spaces, in Dx and Dy, and in rotation was calculated. Also, contralateral differences in relative condylar position and superior joint space were calculated at T1 and T2. Student's t test for paired data was used to determine any statistically significant differences. Pearson's product-moment correlation coefficients were calculated between change in relative condylar position and superior joint space from T1 to T2, and between Dx and Dy.

For each patient, change from T1 to T2 in intermolar and intercanine width, in midline deviation, and in molar and canine relationship on each side was calculated, in addition to contralateral differences in molar and canine relationship at T1 and T2. Student's t test for paired data was used to determine any statistically significant differences. Pearson's product-moment correlation coefficients were calculated to test for any associations between changes in molar and canine relationship and midline relationship from T1 to T2.

Pearson's product-moment correlation coefficients were calculated between changes in relative condylar position, in superior joint space, in Dx and in Dy of each

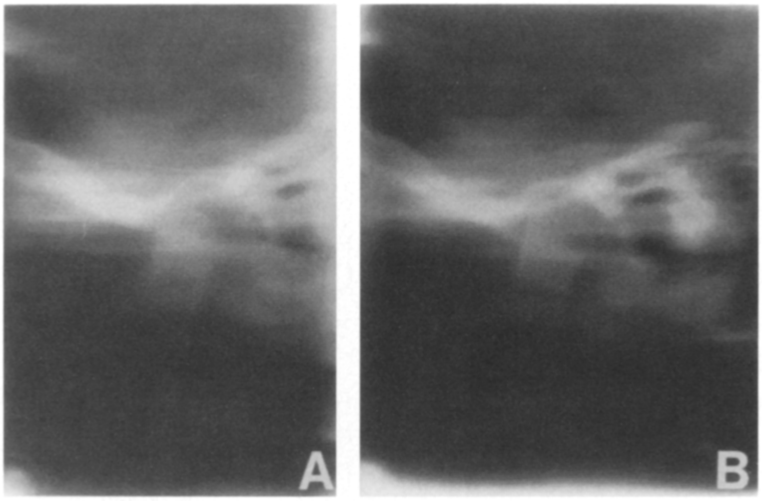

Fig. 3. Tomograms of noncrossbite side condyle made before (**A**, T1) and after (**B**, T2) treatment of patient presenting with functional posterior crossbite. Note more posterior and superior position of condyle at T2.

Table I. Anterior, superior and posterior joint space and relative condylar position before (T1) and after (T2) as well as change from before to after (T2-T1) treatment of functional posterior crossbite in the deciduous and mixed dentitions

	Crossbite side (n = 22)						*Noncrossbite side (n = 22)*					
	T1		*T2*		*T2-T1*		*T1*		*T2*		*T2-T1*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Anterior (mm)	1.69	0.45	1.76	0.58	0.06	0.45	1.51	0.42	1.74	0.34	0.23	0.30**
Superior (mm)	3.07	0.65	3.30	0.66	0.23	0.64	3.52	0.84	2.98	0.51	−0.54	0.76**
Posterior (mm)	3.13	0.89	3.29	0.95	0.16	0.66	3.78	1.32	2.80	0.73	−0.98	1.20**
Relative position (%)	28.55	19.77	29.18	19.49	0.62	16.08	40.44	19.66	22.05	16.19	−18.38	17.79***

**$p < 0.01$; ***$p < 0.001$.

joint from T1 to T2, and changes in corresponding molar, canine, and midline relationship from T1 to T2.

RESULTS

Changes in Joint Space and Relative Condylar Position

Anterior joint space increased, superior and posterior joint space decreased, and relative position of the condyle changed to a more posterior position within the fossa from T1 to T2 on the noncrossbite side (Fig. 3, Table I). No significant differences were observed on the crossbite side from T1 to T2 (Fig. 4). Of the two sides, superior joint space was greatest on the noncrossbite side at T1 (mean 0.45 mm, SD 0.85, $p < 0.05$, Fig. 5) and on the crossbite side at T2 (mean 0.33 mm, SD 0.69, $p < 0.05$, Fig. 6). Also, relative condylar position was more anterior on the noncrossbite than on the crossbite side at T1 (mean 11.89%, SD 20.70, $p < 0.05$, Fig. 5). The relationship was reversed at T2 but was not statistically significant (mean 7.13%, SD 14.72, $p > 0.05$, Fig. 6). An association was found between amount of change to a more posterior relative condylar position and a decrease in superior joint space on the noncrossbite side($r = 0.77$, $p < 0.001$), whereas the amount of change to a more anterior relative condylar position was associated with an increase in superior joint space on the crossbite side ($r = 0.45$, $p < 0.05$).

Condylar Movement

The condyles moved posteriorly and superiorly ($p < 0.05$) on the noncrossbite side from T1 to T2.

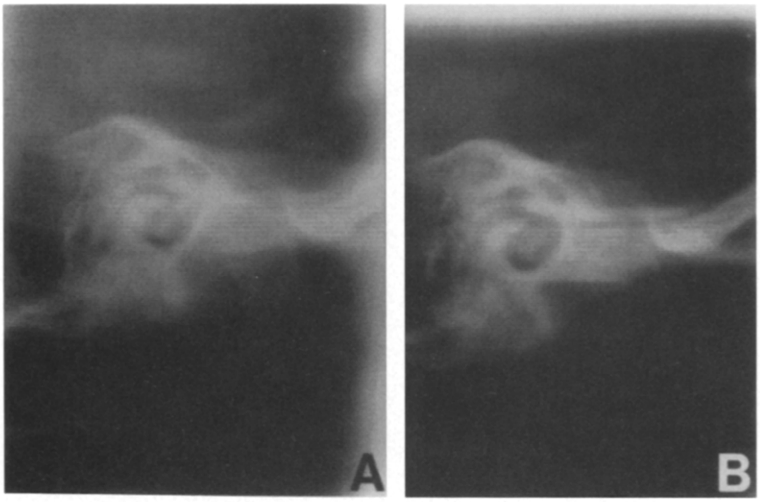

Fig. 4. Tomograms of crossbite side condyle made before (**A**, T1) and after (**B**, T2) treatment of patient presenting with functional posterior crossbite. Note minor differences in condylar position.

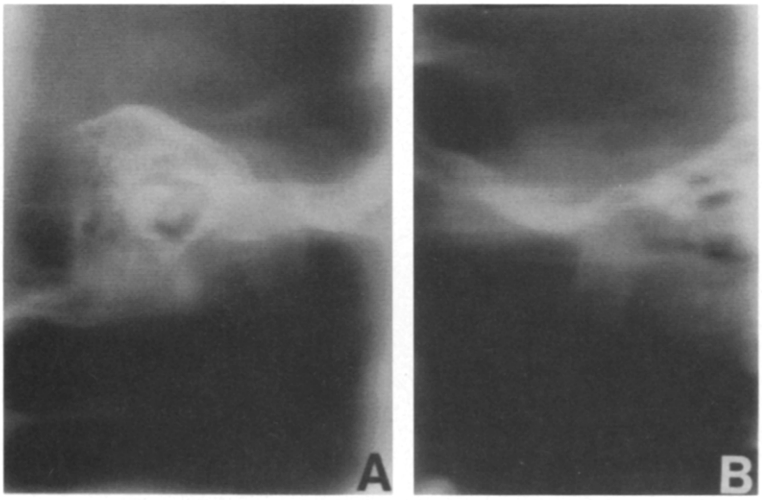

Fig. 5. Tomograms of crossbite (**A**) and noncrossbite (**B**) side condyle made before treatment of patient presenting with functional posterior crossbite. Note larger superior joint space and more anterior condylar position on noncrossbite side.

No significant movement was observed on the crossbite side, and rotational change of the condylar neck was not significant on either side (Table II). An association was found between the amount of posterior and the amount of superior movement of the noncrossbite side condyle ($r = 0.60, p < 0.01$). No such association was found for the crossbite side condyle ($r = 0.36, p > 0.05$).

Changes in Occlusion

Molar and canine relationship were less Class II at T2 than at T1 on the crossbite side ($p < 0.01$ and < 0.05, respectively). On the noncrossbite side, the differences were not statistically significant (Table III). At T1, molar and canine relationship were more Class II on the crossbite than on the noncrossbite side (mean 0.96 mm, SD 1.43 and mean 0.75 mm, SD 1.28, respectively, $p < 0.001$). The differences at T2 were not significant (mean 0.28 mm, SD 1.16 and mean 0.28 mm, SD 1.14, respectively, $p > 0.05$). The mandibular midline was 2.47 mm (SD 1.04) to the crossbite side of the maxillary midline at T1 and only 0.63 mm (SD 1.03) at T2. This change was statistically significant ($p < 0.001$) and also

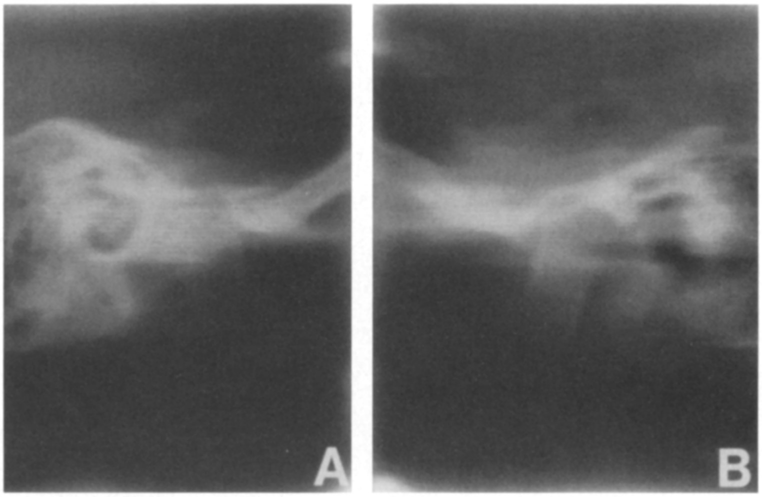

Fig. 6. Tomograms of crossbite (**A**) and noncrossbite (**B**) side condyle made after maxillary expansion and elimination of functional shift. Note minor differences in condylar position.

Table II. Horizontal (Dx) and vertical (Dy) movement of the condyle and rotation of the condylar neck from before to after treatment of functional posterior crossbite in the deciduous and mixed dentition. (Negative values indicate posterior and inferior movement and upward and forward rotation)

	Crossbite side $n = 22$		*Noncrossbite side* $n = 22$	
	Mean	*SD*	*Mean*	*SD*
Dx (mm)	0.06	0.65	−1.00	1.06***
Dy (mm)	−0.18	0.71	0.54	0.75**
Rotation (deg)	−0.05	2.42	0.88	2.40

$^{**}p < 0.01$; $^{***}p < 0.001$.

Table III. Canine and molar relationship before (T1) and after (T2) as well as change from before to after (T2-T1) treatment of functional posterior crossbite in deciduous and mixed dentitions. (Positive values indicate Class II relationship)

	Crossbite side (n = 58 canine, 61 molar)						*Noncrossbite side (n = 56 canine, 61 molar)*					
	T1		*T2*		*T2-T1*		*T1*		*T2*		*T2-T1*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Canine (mm)	2.10	1.45	1.82	1.33	−0.28	0.97*	1.43	1.22	1.55	1.37	0.12	1.12
Molar (mm)	1.85	2.08	0.95	1.80	−0.90	1.11**	0.88	1.59	0.67	1.65	−0.21	1.09

$^{*}p = 0.05$; $^{**}p = 0.01$.

associated with the change toward a Class II canine relationship ($r = 0.42, p < 0.01$) and molar relationship ($r = 0.41, p < 0.001$) on the noncrossbite side. No such association was found on the crossbite side ($r = 0.11$ and 0.02, respectively, $p > 0.05$).

The maxillary arch was expanded significantly from T1 to T2. In addition, a spontaneous increase in mandibular intermolar width occurred ($p < 0.001$). No difference was found in mandibular intercanine width (Table IV).

Changes in Relative Condylar Position and Condylar Movement Versus Changes in Occlusion

Change in relative condylar position was associated with change in canine ($r = 0.52$) and molar ($r = 0.50$) relationship on the noncrossbite side ($p < 0.05$). No such association was found on the crossbite side ($r = 0.19$ and 0.36, respectively, $p > 0.05$). Horizontal movement of the condyle was not associated with change in canine or molar relationship on either side ($r = 0.39$ and 0.35 on

Table IV. Maxillary and mandibular intercanine (C-C) and intermolar (6-6) width before (T1) and after (T2) as well as change from before to after (T2-T1) treatment of functional posterior crossbite in the deciduous and mixed dentitions

	Arch width					
	T1		*T2*		*T2-T1*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Max. C-C (n = 58) (mm)	28.21	2.37	32.99	2.36	4.78	1.90***
Max. 6-6 (n = 60) (mm)	35.98	3.23	40.84	3.42	4.86	1.63***
Man. C-C (n = 58) (mm)	25.86	1.85	25.71	1.90	−0.15	0.75
Man. 6-6 (n = 60) (mm)	34.50	3.22	35.14	3.25	0.64	0.90***

***$p < 0.001$.

the noncrossbite and 0.18 and 0.00 on the crossbite side, respectively, $p > 0.05$). Midline deviation was not associated with any parameter for change in condylar position from T1 to T2 ($p > 0.05$).

DISCUSSION

In keeping with previous studies, we showed that children with unilateral posterior crossbite resulting from lateral functional shift into maximum intercuspation have asymmetric condylar position in centric occlusion.[9-11] We could confirm that the asymmetry was due to an anterior and inferior position within the glenoid fossa of the noncrossbite side condyle compared with that of the crossbite side.[9,11] The crossbite side condyle was found to be in a relatively normal position.[11] We could also confirm the obvious assumption that patients with functional posterior crossbite shift into asymmetric occlusal relationships.

Our data confirm that elimination of a lateral functional mandibular shift through maxillary expansion results in a more symmetric condylar position.[9] Previously, this change was documented with transcranial radiographs,[9] which may not allow accurate description of individual changes in condylar position.[16,28] We found that the mechanism for achieving posttreatment symmetry was primarily due to posterior and superior movement of the condyle on the noncrossbite side condyle. This conclusion was based on evaluation of changes in joint space measurements, as well as measurements of condylar movement on tomograms superimposed on the outline of the glenoid fossa. Concomitant with this change toward a more symmetric condylar position, the posterior joint space was reduced approximately four times more than the anterior joint space increased. This may be explained by the conic shape of the glenoid fossa, as well as the difference in slope of the anterior and posterior borders. As the condyle slides on the articular eminence, anterior joint space remains constant, probably determined by the thickness of the articular disk, while posterior and superior joint space change. Neither measurement technique disclosed any change in condylar position on the crossbite side, most likely due to the greater proximity of this condyle to the center of rotation of the mandibular movement.

The occlusion changed toward greater symmetry. The midline deviation reduced approximately 75% with elimination of the functional shift, and a bilateral symmetry in canine and molar relationship was established. However, contrary to expectations, the actual change in molar and canine relationship was significant only on the crossbite side (Table III). Regarding molar relationship, one likely explanation may be the observed mesiobuccal rotation of the maxillary first molars, which took place with the Quad Helix appliance, exaggerating the change in molar relationship on the crossbite side and reducing the change on the noncrossbite side. Any mesial eruption of the lower first molars and closure of residual primate spacing would also have a similar effect. Distal movement of the maxillary canines concomitant with maxillary expansion would similarly affect the measured canine relationship.

Although our statistical analysis failed to disclose any anteroposterior asymmetry in condylar position at T2, evaluation of actual mean values indicates that perfect symmetry was not achieved (Table I) with the noncrossbite side condyle being slightly more posterior than that on the crossbite side. This could be explained by compensatory resorption of the articular eminence on the noncrossbite side before correction of the functional crossbite. Such resorption would tend to increase the anterior joint space and thereby contribute to a more posterior relative condylar position after treatment. This theory may be supported by the observation that patients with unilateral posterior crossbite have a less steep condylar path on the noncrossbite than on the crossbite side.[25] Another possible reason for this slight asymmetry is a relative anterior translation of the temporal bone by anteriorly directed forces from the distracted noncrossbite side condyle. These changes are probably progressive and would increase with the length of time the functional shift is present. Our sample was not large enough to analyze such associations. Explanation of the significant difference in superior joint space after treatment is more difficult. Compensatory eruption of the posterior teeth on the crossbite side before treatment may result in initial tooth contact on this side, necessitating additional mandibular closure on the noncrossbite side to achieve maximum intercuspation. Differences in contact relationship on the noncrossbite side could have a similar effect. Such subtle changes may not be associated with a clinically detectable shift. It should be stressed that some degree of condylar or occlusal asymmetry may be considered normal. Several authors have documented asymmetry in condyle and fossa structure,[29] as well as right and left differences in condylar position,[27,30-32] in asymptomatic adult samples. The initial midline deviation was also not fully corrected in our sample. Any residual component of mandibular shift due to occlusal interferences, asymmetric activity in the muscles of mastication,[33-35] or anterior dental asymmetries due to crowding could account for this.

Several authors have documented autonomous increases in mandibular arch width and buccal tipping of the mandibular posterior teeth concomitant with maxillary expansion.[17-20] This association has been attributed to alterations in occlusion, providing lateral forces as cuspal contacts move from the fossa of opposing teeth to cuspal inclines[17,19,20] and to widening of the area of attachment of the buccal musculature, altering the balance with tongue pressure.[17] Our study confirms that maxillary expansion is associated with autonomous increase in mandibular molar width ($p < 0.001$). However, part of the expansion may be explained by normal developmental changes.[36] The lack of increase in mandibular intercanine width may be explained by elimination of labial pressure from the maxillary canines after elimination of interferences concomitant with correction of the posterior crossbite. Overall, the changes in arch width that accompanied maxillary expansion were small and may be considered clinically insignificant.

Our results and inferences from previous studies support two primary reasons for early treatment of functional posterior crossbite. First, self-correction does not occur frequently enough to justify a delay in treatment,[1,8] and correction in the deciduous or early mixed dentition greatly increases the probability of the permanent molars and premolars erupting into normal transverse relationship.[1,14,22] Second, the asymmetric condylar position may predispose to progressive asymmetric compensation of the condyle-fossa relationship, resulting in craniofacial asymmetry[23-25,35] and increased risk of temporomandibular disorders.[24,25,37,38] Several authors have shown an increase in electromyographic activity of the muscles of mastication on the crossbite side in children with functional mandibular shifts.[33-35] According to the functional matrix theory, alterations of the muscular pattern may affect the structure of the developing mandible.

Tomographic evaluation of change in condylar position has limitations because variations in depth of the cut and angulation of the radiation beam may cause dramatic changes in the apparent structure of the condyle and fossa as well as the relative position of the condyle within the fossa. This is primarily due to the bipolar structure and medial angulation of the condyle. In part of our sample, SMV radiographs were used to orient the beam according to the angulation of the condylar head in relation to the cranial base. In a few cases, however, a standard correction angle was used to reduce the overall radiation exposure, probably with minor risk of bias.[27] We made all attempts to select pretreatment and posttreatment tomograms of similar depth of cut, to minimize bias due to the documented variation in condylar position between adjacent tomographic sections.[27,39] Also, the fact that all tomograms were made in the same radiographic facility maximized consistency in positioning of the patient and in orientation of the radiation beam at both time periods in our study. Superimposing the pretreatment and posttreatment tomographic images on the best fit of the fossa allowed direct interpretation of positional and rotational changes of the condyles. This was to verify the interpretation of condylar position through joint space analysis. Any variation in condylar structure could affect the joint space measurements, because slightly different parts of the condyle were in closest proximity to the fossa at the two time periods. However, both techniques gave similar results, both having clinically acceptable accuracy in describing condylar movement.

CONCLUSIONS

Children with functional unilateral posterior crossbite are characterized by:

1. An asymmetric pretreatment condylar position with the noncrossbite side condyle in an anterior and inferior position in the glenoid fossa.
2. An asymmetric pretreatment molar and canine relationship with a more Class II relationship on the crossbite side and a less Class II relationship on the noncrossbite side, concomitant with a midline deviation toward the crossbite side.
3. Establishment of more symmetric occlusal and condylar relationship after maxillary expansion through elimination of the crossbite and shift.
4. Establishment of more symmetry through posterior and superior movement of the noncrossbite side condyle and only minimal anterior and inferior movement of the crossbite side condyle.
5. A small amount of autonomous mandibular intermolar expansion concomitant with the maxillary expansion.

On the basis of these and other findings, it may be hypothesized that early treatment of unilateral functional posterior crossbite reduces the possibility of development of permanent skeletal asymmetry and dentoalveolar compensations.

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