ORIGINAL ARTICLE

Asymmetric maxillary expansion (AMEX) appliance for treatment of true unilateral posterior crossbite

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The aim of this study was to evaluate the effects of an asymmetrical maxillary expansion (AMEX) appliance. Patients with true unilateral posterior crossbites were included in the study. The treatment group consisted of 18 patients who had a mean age of 14 ± 2.3 years. Treatment effects were evaluated on posteroanterior radiographs, dental casts, and photographs of the dental casts. All unilateral posterior crossbites were corrected in a mean expansion treatment time of 3.3 ± 0.48 months. As a result of expansion, maxillary interfirst molar, interfirst and second premolar, and intercanine arch widths increased significantly. Comparison of the 2 sides showed that the teeth on the crossbite side moved and tipped more buccally than the teeth on the noncrossbite side. Of the total expansion gained, 75.8% to 91.7% was due to the buccal movements of the teeth on the noncrossbite side. The AMEX appliance was found to be effective in correcting true unilateral posterior crossbites, and therefore it can be recommended for clinical use. (Am J Orthod Dentofacial Orthop 2002;122:164-73)

Posterior crossbite is a commonly occurring type of malocclusion seen in orthodontic practice. Posterior crossbite can be bilateral or unilateral. Several studies have shown that the prevalence of posterior crossbite is between 2% and 16%, with a predominance of unilateral crossbite.[1-6] Sucking habits, obstruction of the upper airway, and certain swallowing patterns have been identified as etiologic factors of the posterior crossbite.[3,7,8]

In bilateral posterior crossbite, the buccal cusps of the maxillary teeth are occluded lingual to the buccal cusps of the corresponding mandibular teeth.[9] Unilateral posterior crossbite involves multiple teeth on 1 side of the occlusion and can be defined either as functional posterior crossbite or as true unilateral posterior crossbite.[10] In functional posterior crossbite, occlusal interferences lead to a lateral shift of the mandible during its closure, to a new position for maximum intercuspation.[5,10,11] True unilateral posterior crossbite can be distinguished from functional crossbite by observing the mandible along its path of closure and by determining a crossbite both in centric relation and centric occlusion without a functional shift of the mandible.[10,11]

Increasing the maxillary arch width, grinding the occlusal interferences, eliminating the mandibular shift, and maintaining the symmetric positions of the teeth relative to the dental arch midline accomplish the correction in bilateral or functional posterior crossbites.[11]

In most cases, the deficiency between maxillary and mandibular arch widths is due to insufficient maxillary arch width.[5,10-14] Therefore, expanding maxillary arch width is a major goal of posterior crossbite treatment. Numerous treatment modalities, including rapid palatal expansion with jackscrew, removable appliances, lingual W-arches, and quad-helix appliances have been recommended to correct maxillary arch constriction. The maxillary dental arch can be expanded transversely with the aid of the orthodontic and orthopedic effects of these appliances.[15-19] Orthodontic effects include tooth tipping or bodily movement of the maxillary posterior teeth and canines.[20] Midpalatal suture opening is the skeletal response to maxillary expansion, particularly in young patients.[15-19] Increased arch perimeter has also been reported because of the transverse expansion of the maxillary alveolar and dental arches.[21]

In true unilateral posterior crossbite, the aim should be to move selected teeth on the constricted side of the maxillary arch. If conventional expansion appliances

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are preferred to treat true unilateral posterior crossbite, then the maxillary dental arch will be expanded bilaterally, resulting in undesirable overexpansion of the unaffected side.[10,22] In this situation, additional appointments are required for compensatory orthodontic tooth movements on both noncrossbite and crossbite sides.[22]

A simple way to treat a true unilateral posterior crossbite is to use a removable appliance incorporated with finger springs.[10,11] This type of treatment approach might be preferred when the posterior crossbite is unilateral and involves 1 or 2 teeth. Alternatively, a removable appliance with a jackscrew, sectioned asymmetrically, can be used.[10,11] Sometimes, the low height of the clinical crowns of molars makes retention difficult and lessens the effective force necessary to produce maxillary expansion.[23] Unfortunately, any removable appliance leaves the clinician totally dependent on patient cooperation and presents hygiene problems.

Elastics can be attached from the buccal attachments of the maxillary teeth to the lingual attachments of the mandibular teeth. This is an appropriate treatment approach only when the mandibular teeth have erupted with buccal inclination.[10] Otherwise, a mandibular lingual arch must be inserted to avoid lingual tipping and constriction of the mandibular arch. Elastics, like removable appliances, require patient compliance and might extrude the involved teeth with the vertical component of force.[24] This extrusion effect is undesirable in vertical growers and in patients with limited overbite.

An alternative treatment for a true unilateral posterior crossbite is to use fixed lingual maxillary expansion appliances. W-arches and quad-helix appliances can be modified by changing the length of the arms to include more teeth in the anchorage unit.[10,11] Fixed lingual arches have been shown to require less overall treatment time and to be cost-effective when compared with removable appliances.[4]

A modified quad-helix appliance has been designed to produce asymmetrical expansion.[25,26] However, its effectiveness has been presented in case reports; it has not been evaluated by evidence-based research. The purpose of this study was to evaluate the dental effects of the asymmetric maxillary expansion (AMEX) appliance in treating true unilateral posterior crossbite.

MATERIAL AND METHODS

The sample consisted of 18 patients (12 girls and 6 boys); the mean age of the group was 14 ± 2.3 years. All patients were in the permanent dentition and had a unilateral posterior crossbite of the nonfunctional type. In 11 children, the crossbite was on the left side, and in 7 it was on the right side. The assessment of whether the unilateral posterior crossbites had an association with mandibular displacement was performed clinically.[27] Patients were asked to relax, and their mandibles were guided along the path of closure until the first contact was reached. Then they were instructed to continue closing until they reached maximum intercuspation (centric occlusion). At this stage, midline deviations of less than 1 mm were accepted as normal.[13,28] No sign or symptom of temporomandibular disorder was detected during clinical examination.

The appliance was constructed following the recommendations of Enacar and Özgen.[25] Orthodontic bands were adapted to the maxillary first molars. Maxillary and mandibular impressions were taken and poured in orthodontic plaster. The study casts were mounted in centric occlusion.

An AMEX appliance was made of 0.036-in diameter stainless steel wire (Fig 1). At first, a quad-helix appliance, consisting of 2 helixes on the crossbite side, was constructed. The force arm of the appliance was extended to the most anterior teeth in crossbite. In 6 patients, the maxillary canines were in proper buccal occlusion with the mandibular arch, so that the force arm of the appliance ended on the maxillary first premolars. On the noncrossbite side, a vertically extending "stopper" between the maxillary first molar and first premolar was bent and adapted to the lingual surfaces of the mandibular first molar and first and second premolars. In constructing the stopper, care was taken not to bend it beyond the freeway space. The quad-helix appliance with the stopper was soldered to the molar bands. The anterior extension of the stopper was also soldered to the quad-helix appliance.

The appliance was activated by expanding the force arm to a distance equivalent to 8 mm and keeping the arms parallel to each other.[29] Necessary reactivations were performed at 4-week intervals until the posterior crossbite was corrected.[30] For reactivations, the appliance was removed and recemented. Expansion was stopped when the buccal aspects of the lingual cusps of the maxillary teeth contacted the lingual aspects of the buccal cusps of the mandibular teeth (Fig 2, *A-C*).

Posteroanterior cephalometric radiographs and plaster casts were obtained before the expansion treatment and after adequate expansion was achieved.

An 0.18 × 0.25-mm stainless steel wire was bent and kept for each subject until the end of the expansion.[31,32] This wire was inserted into the maxillary right and left first molar tubes before preexpansion and postexpansion posteroanterior radiographs were taken (Fig 3). We used the appearance of this wire on posteroanterior cephalometric radiographs to measure

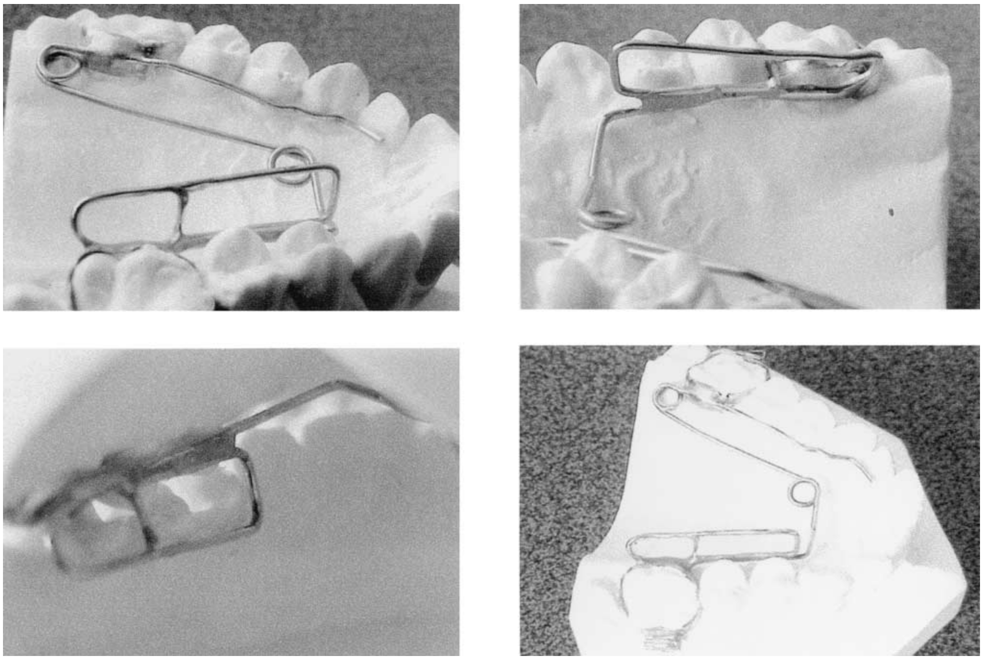

Fig 1. AMEX appliance.

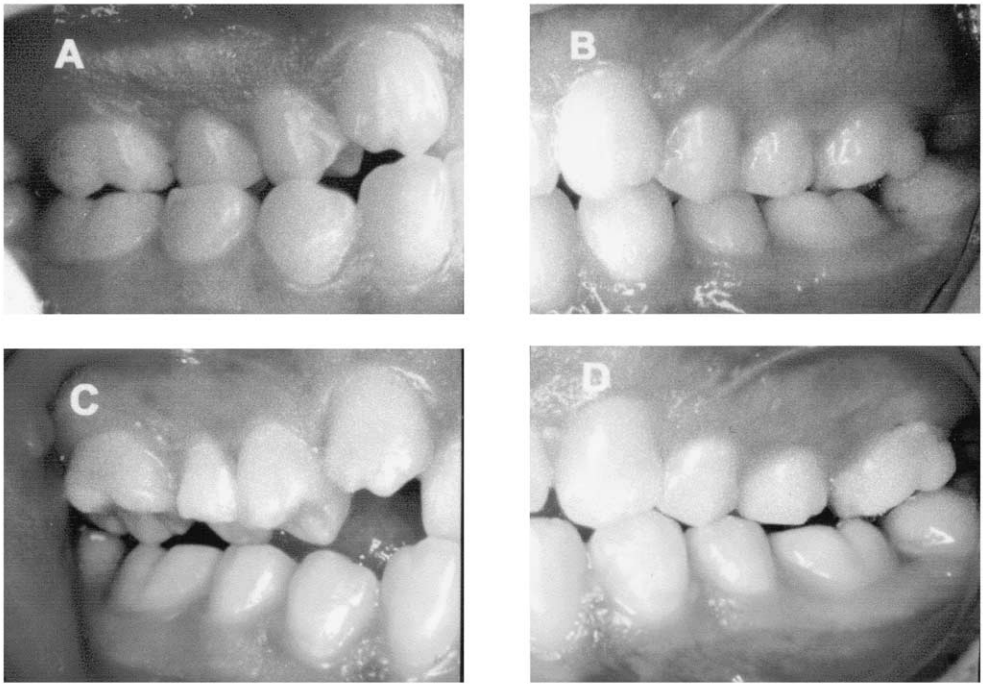

Fig 2. Intraoral views of patient treated with AMEX appliance. **A**, Initial views of crossbite side; **B**, initial views of noncrossbite side; **C**, occlusion of crossbite side at end of expansion; **D**, occlusion of noncrossbite side at end of expansion.

the changes in the axial inclinations of the maxillary first molars. On the posteroanterior cephalometric radiographs, a line was extended from the image of the wire to the Z-Z plane, a line between the zygomatic

Fig 3. Stainless steel wire (0.18 × 0.25 mm) was inserted into right and left first molar tubes before preexpansion and postexpansion posteroanterior radiographs were taken.

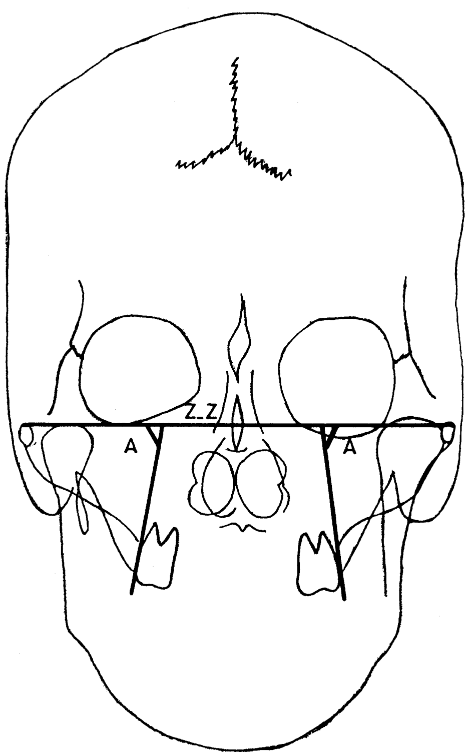

Fig 4. Reference plane (*Z-Z*) was constructed by drawing line between zygomatic arches. Inclination of maxillary first molars (*A*) was measured from outer angle between image of wire and *Z-Z* plane.

arches (Fig 4). The outer angle was used for measuring the axial inclination of the maxillary first molar (U6-ZZ).

Maurice and Kula's[33] method was used to analyze dental casts. Plaster casts were trimmed in centric occlusion with the backs 90° to the median palatal raphe. The maxillary and mandibular casts were photographed with their backs aligned as described by Maurice and Kula.[33] A millimeter ruler was placed near the models to provide scale of the distance. Before taking the photograph, the following landmarks were marked on the maxillary dental casts with a 0.5-mm lead pencil (Fig 5):

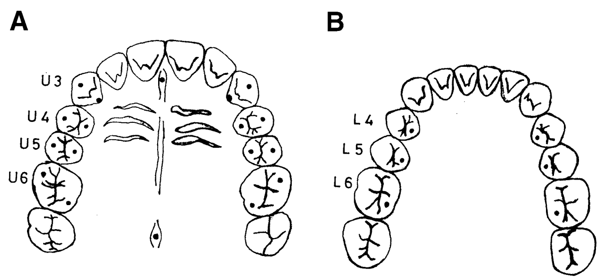

Fig 5. A, Maxillary cast landmarks; **B**, mandibular cast landmarks.

- Anterior raphe point
- Posterior raphe point
- Cusp tips and lingual cingulum points of the right and left canines
- Buccal and palatal cusp tips of the right and left first premolars
- Buccal and palatal cusp tips of the right and left second premolars
- Distolingual and mesiobuccal cusp tips of the right and left first molars

The following landmarks were marked on the mandibular dental casts:

- Palatal cusp tips of the right and left first premolars
- Palatal cusp tips of the right and left second premolars
- Distolingual cusp tips of the right and left first molars

On the photographs, a line was drawn connecting the anterior raphe and posterior raphe points. This line was considered the median of the maxillary arch, or the median palatal plane (MPP). The mirror image of the angle between the MPP and the back of the maxillary cast was transferred to the mandibular cast to establish the mandibular median plane.[33]

Movements of the maxillary canines, the maxillary first and second premolars, the maxillary first molars, the mandibular first and second premolars, and the mandibular first molars were assessed relative to the MPP.

The photographs of the maxillary dental casts were evaluated by means of the following measurements (Fig 6):

- U6-MPP (mm): Perpendicular distances of the maxillary right and left first molars to the MPP were measured from the distolingual cusp tip of the molar.
- U6-MPP (°): The degree of rotation of the maxillary left and right first molars was measured from the angle between MPP and the line through the tips of the mesiobuccal and distolingual cusps of the first molar.
- U5-MPP (mm): Perpendicular distances of the maxillary right and left second premolars to the MPP were measured from the buccal cusp tip of the second premolar.
- U5-MPP (°): The degree of rotation of the maxillary right and left second premolars was measured from the angle between MPP and the line through the buccal cusp tip and palatal cusp tip of the second premolar.
- U4-MPP (mm): Perpendicular distances of the maxillary right and left first premolars to the MPP were measured from the buccal cusp tip of the first premolar.
- U4-MPP (°): The degree of rotation of the maxillary right and left first premolars was measured from the angle between MPP and the line through the buccal cusp tip and palatal cusp tip of the first premolar.
- U3-MPP (mm): Perpendicular distances of the maxillary right and left canines to the MPP were measured from the cusp tip of the canine.
- U3-MPP (°): The degree of rotation of the maxillary right and left canines was measured from the angle between MPP and the line through the cusp tip and the lingual cingulum of the canine.

The photographs of the mandibular dental casts were evaluated by means of the following measurements:

- L6-MPP (mm): Perpendicular distances of the mandibular right and left first molars to the MPP were measured from the distolingual cusp tip of the first molar.
- L5-MPP (mm): Perpendicular distances of the mandibular right and left second premolars to the MPP were measured from the palatal cusp tip of the second premolar.

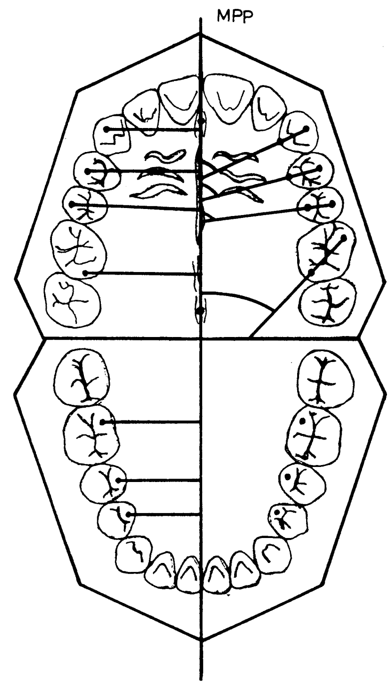

Fig 6. Linear and angular measurements. Perpendicular distances of each included tooth to MPP and angles between MPP and reference lines of each included tooth were measured.

- L4-MPP (mm): Perpendicular distances of the mandibular right and left first premolars to the MPP were measured from the palatal cusp tip of the first premolar.

Arch widths were calculated by finding the sum of the perpendicular distances of each right and left tooth to the MPP.[34]

Overjet and overbite were measured on the patients' dental casts.[35] A line was scribed on the labial surface of the mandibular central incisor that the most labial maxillary central incisor overlapped. The distance between the incisal edge of the mandibular incisor and the scribed line was accepted as overbite. The distance between the most labial maxillary central incisal edge and the scribed line was accepted as overjet.

The ratios of maxillary first molar and maxillary first and second premolar expansion gained on the crossbite side to the overall expansion gained were calculated with the following formula:

$$(CE2-CE1)/(CE2-CE1) + (NCE2-NCE1)$$

where C = perpendicular distance of the crossbite teeth to MPP; NC = perpendicular distance of the noncrossbite teeth to MPP; E1 = before expansion; E2 = after

Table I. Repeatability of measurements

	Spearman's ρ coefficients	
Measurements	*Crossbite side*	*Noncrossbite side*
U6-UMP (mm)	0.996	0.988
U6-UMP (°)	0.963	0.974
U6-ZZ (°)	0.983	0.970
U5-UMP (mm)	0.964	0.977
U5-UMP (°)	0.988	0.995
U4-UMP (mm)	0.982	0.960
U4-UMP (°)	0.991	0.995
U3-UMP (mm)	0.942	0.960
U3-UMP (°)	0.990	0.980
L6-LMP (mm)	0.995	0.984
L5-LMP (mm)	0.966	0.976
L4-LMP (mm)	0.994	0.996

U, Maxillary; *L*, mandibular.

expansion; (CE2−CE1) = amount of expansion gained on the crossbite side; (NCE2−NCE1) = amount of expansion gained on the noncrossbite side; and [(CE2−CE1)+(NCE2−NCE1)] = amount of overall expansion gained.

Initial measurements of each side were repeated a week later. Spearman's ρ coefficients were calculated to analyze the repeatability of the measurements. The coefficients were found to be close to 1.00 (Table I). Wilcoxon signed rank test was used to analyze the differences of means and the total change in measurements between the 2 sides. All statistical analyses were made with SPSS for Windows 10.1 (Chicago, Ill); $P = .05$ was accepted as the critical significance level.

RESULTS

The AMEX appliance was generally well tolerated by the patients. Two patients complained of difficulty eating and speaking. Some breakage occurred. In these situations, the AMEX appliance was removed, repaired in the laboratory, and recemented in the same day. All patients experienced slight inflammation of the palatal mucosa at appliance removal, but these symptoms disappeared within a few days.

The desired amount of expansion was achieved in 2.5 to 4 months (mean, 3.3 ± 0.48 months) (Fig 2). As measured on the dental casts and posteroanterior radiographs, the changes in the positions of the maxillary first molars, the maxillary first and second premolars, and the maxillary canines were found to be statistically significant (Table II). Insignificant changes were obtained for the mandibular arch measurements (Table II). The detailed significant findings for the crossbite side (Table II) were as follows:

- The buccal movement of the maxillary first molar (U6-MPP) was 5.9 mm ($P < .001$), and it rotated 5.7° ($P < .001$) distopalatally. The axial inclination of the maxillary first molar (U6-ZZ) decreased 7.3° ($P < .001$).
- The maxillary second premolars moved buccally (U5-MPP) for a mean value of 3.9 mm ($P < .01$) with a distopalatal rotation of 6.4° ($P < .01$).
- The maxillary first premolars moved buccally (U4-MPP) for a mean value of 4.8 mm ($P < .001$) with a distopalatal rotation of 6.2° ($P < .001$).
- The maxillary canines moved buccally (U3-MPP) for a mean value of 4.6 mm ($P < .01$) with a distopalatal rotation of 4.7° ($P < .01$).

The detailed significant findings for the noncrossbite side (Table II) were as follows:

- The maxillary first molars moved buccally (U6-MPP) for a mean value of 0.8 mm ($P < .05$) with a distopalatal rotation of 0.8° ($P < .05$). The axial inclination of the maxillary first molar (U6-ZZ) decreased 2.5° ($P < .05$).
- The maxillary second premolars moved buccally (U5-MPP) for a mean value of 0.8 mm ($P < .05$) with a distopalatal rotation of 0.6° ($P > .05$).
- The maxillary first premolars moved buccally (U4-MPP) for a mean value of 0.6 mm ($P < .05$) with a distopalatal rotation of 1.0° ($P < .05$).
- The maxillary canines moved buccally (U3-MPP) for a mean value of 0.1 mm ($P > .05$) with a distopalatal rotation of 0.3° ($P > .05$).

Comparison of changes between the 2 sides showed the following (Table II): The increases in the perpendicular distance of the maxillary first molar to the MPP and the angle between the maxillary first molar and the MPP and the decrease in the axial inclination of the maxillary first molar were greater on the crossbite side than on the noncrossbite side ($P < .001$; $P < .001$; and $P < .01$, respectively). The distance between the maxillary second premolar and the MPP increased more on the crossbite side ($P < .01$), and the maxillary second premolars also showed a greater rotation ($P < .01$). The distance between the maxillary first premolar and the MPP increased more on the crossbite side ($P < .001$), and the maxillary first premolars also showed a greater rotation ($P < .001$). The distance between the maxillary canine and the MPP increased more on the crossbite side ($P < .01$), and the maxillary canines also showed a greater rotation ($P < .01$).

Maxillary interfirst molar width increased 6.7 mm ($P < .001$), maxillary intersecond premolar width increased 4.7 mm ($P < .01$), maxillary interfirst premolar

Table II. Before and after expansion measurements of patients treated with AMEX appliance and comparison of treatment effects between crossbite side and noncrossbite side

		Crossbite side			*Noncrossbite side*			*Significance*		
		E1	*E2*	*E2-E1*	*E1*	*E2*	*E2-E1*	*C*	*NC*	*C-NC*
Measurements	*n*	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*E1-E2*	*E1-E2*	*E1-E2*
U6-UMP (mm)	18	22.5 ± 7.1	28.4 ± 7.6	5.9 ± 0.8	28.3 ± 3.2	29.1 ± 3.2	0.8 ± 0.9	***	*	***
U6-UMP (°)	18	23.1 ± 9.1	28.9 ± 8.2	5.7 ± 3.8	25.7 ± 2.5	26.6 ± 2.3	0.8 ± 1.5	***	*	***
U6-ZZ (°)	18	70.1 ± 5.8	62.7 ± 4.4	−7.3 ± 5.2	68.5 ± 5.9	65.9 ± 5.6	−2.5 ± 3.7	***	*	**
U5-UMP (mm)	18	28.8 ± 4.2	32.8 ± 2.9	3.9 ± 4.3	31.4 ± 3.6	32.2 ± 3.9	0.8 ± 1.7	**	*	**
U5-UMP (°)	18	57.8 ± 13.0	64.2 ± 14.3	6.4 ± 5.1	50.3 ± 21.7	50.9 ± 22.6	0.6 ± 3.4	**	NS	**
U4-UMP (mm)	18	26.2 ± 3.8	31.0 ± 3.7	4.8 ± 1.1	31.2 ± 3.6	31.8 ± 3.6	0.6 ± 1.1	***	*	***
U4-UMP (°)	18	54.4 ± 22.0	60.6 ± 20.9	6.2 ± 4.1	51.4 ± 15.4	52.4 ± 15.2	1.0 ± 1.7	***	*	***
U3-UMP (mm)	12	29.2 ± 3.5	33.8 ± 3.5	4.6 ± 1.1	31.1 ± 3.3	31.3 ± 3.6	0.1 ± 0.7	**	NS	**
U3-UMP (°)	12	64.9 ± 4.8	69.7 ± 4.2	4.7 ± 3.3	72.1 ± 16.7	72.5 ± 16.9	0.3 ± 1.7	**	NS	**
L6-LMP (mm)	18	33.1 ± 3.2	33.4 ± 3.1	0.6 ± 1.2	32.7 ± 2.9	33.4 ± 2.8	0.2 ± 1.2	NS	NS	NS
L5-LMP (mm)	18	30.8 ± 1.8	31.0 ± 1.9	0.2 ± 0.5	30.4 ± 2.4	30.6 ± 2.3	0.2 ± 0.4	NS	NS	NS
L4-LMP (mm)	18	29.5 ± 2.9	29.1 ± 2.9	0.4 ± 0.8	29.5 ± 2.3	29.7 ± 2.8	0.2 ± 1.6	NS	NS	NS

*$P < .05$; **$P < .01$; ***$P < .001$.
E1, Before expansion; *E2*, after expansion; *C*, crossbite side; *NC*, noncrossbite side; *NS*, not significant; *U*, maxillary *L*, mandibular.

Table III. Mean and SD values for overjet, overbite, and arch widths before and after expansion and statistical significance of change

	n	*E1*	*E2*	*E2-E1*	*Significance*
Measurements					
Overjet (mm)	18	2.5 ± 1.1	2.4 ± 1.1	−0.06 ± 0.4	NS
Overbite (mm)	18	1.9 ± 0.9	1.2 ± 1.6	−0.8 ± 1.1	***
Arch width (mm)					
U6-6	18	50.8 ± 7.4	57.4 ± 8.0	6.7 ± 1.3	***
U5-5	18	60.2 ± 6.2	64.9 ± 5.8	4.7 ± 5.1	**
U4-4	18	60.2 ± 6.9	66.6 ± 6.7	6.4 ± 1.3	***
U3-3	12	60.3 ± 5.9	65.1 ± 6.1	4.7 ± 1.4	***
L6-6	18	66.1 ± 4.7	66.5 ± 5.1	0.4 ± 1.3	NS
L5-5	18	61.2 ± 2.9	61.6 ± 3.0	0.4 ± 0.6	NS
L4-4	18	58.8 ± 4.6	59.0 ± 4.8	0.2 ± 1.6	NS

NS, not significant; **$P < .01$; ***$P < .001$.
U, Maxillary; *L*, mandibular.

width increased 6.4 mm ($P < .001$), and maxillary intercanine width increased 4.7 mm ($P < .001$). Overbite decreased significantly (0.8 mm, $P < .001$) (Table III).

DISCUSSION

The characteristics of the unilateral posterior crossbites can be determined by careful diagnosis. In addition, knowledge of the treatment variables and their results is essential in successful orthodontic treatment. The selection of the appliance and its method of use are also important. In this study, we evaluated the effects of a modified quad-helix appliance (AMEX appliance) in treating true unilateral posterior crossbite.

The purpose of the AMEX appliance is to achieve differential expansion between the 2 sides of the maxillary dental arch by exerting light and continuous force. The AMEX appliance was designed to reinforce the anchorage of the noncrossbite side teeth by including the mandibular posterior teeth with the aid of the stopper part of the appliance.[25] It is known that light and continuous force produces better physiologic adaptation, greater stability, and less relapse potential than do other forces.[36,37] To deliver light physiologic force, 2 helixes were constructed on the crossbite side, and the appliance initially was expanded 8 mm.[1,10,29,30,38,39] Although no occlusal radiographs were taken during the expansion treatment to check for midpalatal suture opening, this amount of activation was considered to produce forces less than those in the orthopedic range.[29,39] Because the treatment group had a mean age of 14 years, expansion of the posterior teeth rather than the orthopedic response was expected. An orthopedic response would be expected in children age 7 to 9 years.[39,40]

Extraoral activation was the method of choice for reactivations. Although removing and recementing the appliances increase chair-side time, additional expansion requires the fixed lingual arches (ie, W-arches, quad-helix) to be activated extraorally[39] because intraoral adjustments produce rotation of the anchor teeth rather than any increase in actual width of the appliance. Also, extraoral activations allow the amount of activation to be clearly observed.

Linear and angular measurements of the tooth movements were assessed on occlusal views of dental casts because they permit greater accuracy when comparing bilateral measurements. The results of this study demonstrated significant increases in mean intercanine, interfirst and second premolar, and interfirst molar arch widths (4.7, 6.4, 4.7, and 6.7 mm, respectively). It might be concluded that the purpose of using an AMEX appliance is to expand the dental arches. However, the goal in treating true unilateral posterior crossbite with the AMEX appliance is for the noncrossbite side to resist buccal movement while the other side is expanded, not simply to achieve bilateral expansion. This is why we decided to use median palatal raphe as a reference plane for comparing the treatment changes of the bilateral dental landmarks. Additionally, median palatal raphe is accepted as a standard reference plane in dental cast analysis and is frequently used to evaluate dental arch asymmetry.[33,34,41-44]

Comparison of changes between 2 sides showed that the maxillary canines, the maxillary first and second premolars, and maxillary first molars on the crossbite side moved more buccally than did the opposing teeth. Loss of anchorage was measured at the maxillary and the mandibular first and second premolars and first molars, because the anchor unit consisted of the maxillary and the mandibular first and second premolars and first molars connected through a wire frame stopper. The maxillary first molar, and the maxillary second and first premolars on the crossbite side moved buccally, with mean values of 5.9, 3.9, and 4.8 mm, respectively. The anchorage loss for the maxillary first molar, and the maxillary second and first premolars (on the noncrossbite side) were 0.8, 0.8, and 0.6 mm, respectively. Although the buccal movements of the maxillary first molars and first premolars on the noncrossbite side were statistically significant ($P < .05$) for both measurements, the amounts were clinically minimal and would not affect the treatment objectives. Buccal molar movement on the crossbite side represented 90.4% of the overall expansion gained. The overall expansions gained that were attributable to buccal premolar movement on the crossbite side were 91.7% at the second premolar region and 75.8% at the first premolar region. Negligible amounts of increase were measured for the buccal movements of the mandibular teeth and for the mandibular interfirst molar and interfirst and second premolar arch widths. These results indicate the effectiveness of the AMEX appliance as a means of obtaining anchorage control on the noncrossbite side while offering expansion of the teeth on the crossbite side.

Distopalatal rotation of the anchor teeth was evidenced by an increase in angular measurements, and it was consistent with the literature.[30,45] This effect can be used in the initial phase of treating Class II malocclusions[30]; Brin et al,[14] Ben-Bassat et al,[46] and O'Byrn et al[47] observed a high prevalence of Class II subdivision malocclusion in patients with unilateral posterior crossbite. Therefore, rotating posterior teeth in the distopalatal direction can be beneficial in appropriate cases.

Problematic buccal crown tipping of anchor teeth occurred during the expansion treatment with AMEX appliances, because the point of force application of the appliance was below the center of the resistance of the posterior teeth.[10] The maxillary first molars showed more buccal crown tipping on the crossbite side than on the noncrossbite side (7.3° and 2.5°, respectively). The present results are consistent with those of Hicks,[19] who found that molars on the crossbite side had greater palatal inclination than did those on the noncrossbite side. Adkins et al[21] found that, at the end of the expansion treatment, teeth exhibited greater buccal crown tipping in patients with unilateral posterior crossbites than in those with no crossbites. They concluded that, during expansion, a stage occurs in which the palatal cusps of the posterior teeth on the crossbite side come in contact with the buccal surfaces of the lingual cusps of the mandibular teeth, creating occlusal forces that might be responsible for greater buccal crown tipping. On the other hand, the lingual surfaces of the buccal cusps of mandibular teeth on the noncrossbite side acted as stoppers for maxillary posterior teeth on the noncrossbite side.

Various amounts of buccal tipping were observed clinically. Numerous possibilities, such as differences in arch shapes, crown heights, occlusal forces, and size of appliance, might cause variations in clinical response.[48] In a clinical study of this type, some parameters could not be controlled.

As a result of buccal tipping, palatal cusps of the posterior teeth extruded and contacted the buccal cusps of the mandibular posterior teeth, causing a decrease in the anterior overbite (0.8 mm).[6,15,16,49,50] This bite-opening tendency of the AMEX appliance can be a problem in patients with limited anterior overbite.

One way of evaluating the transverse asymmetry of the dental arches is to find the mean difference in measurements between opposing dental landmarks.[14,33,34,44] In most studies, the median palatal raphe was used as a reference plane, and differences of 1 to 2 mm between opposing dental landmarks were accepted as critical levels of asymmetry. In this study, the transverse asymmetry was evaluated by subtracting the perpendicular distances of the teeth on the non-crossbite side to MPP from the perpendicular distances of the teeth on the crossbite side to MPP and then averaging. A mean difference of 5.8 mm was measured for molar position before expansion; this difference was reduced to 0.64 mm after expansion. For the second premolars, the difference was 2.5 mm initially and −0.5 mm after expansion. For the first premolars, the difference was reduced from 4 to 0.78 mm. These findings indicate that maxillary posterior teeth show a greater degree of transverse symmetry at the termination of expansion treatment with AMEX appliances. In other words, the subjects of this study initially had asymmetric maxillary dental arches, which can cause unilateral posterior crossbites.

No attempt was made to distinguish whether the unilateral posterior crossbites of the included patients had any association with an asymmetry of the maxillary alveolus. Unilateral posterior crossbite can be the result of true unilateral posterior maxillary transverse deficiency, and maxillary expansion combined with unilateral surgical osteotomy commonly has been recommended as a treatment.[22,51,52] Initial records showed a collapse of the maxillary dental arch on the crossbite side, and the teeth on the crossbite side had greater palatal inclinations. Therefore, asymmetric expansion of the maxillary dental arches was indicated rather than orthopedic expansion of the maxillary base. In addition, the complications and risks of surgical procedures, as well as patient reluctance to undergo surgery, might lead the orthodontist to choose an AMEX appliance.

Although all patients in this study had their unilateral posterior crossbites corrected and their teeth on the crossbite side moved to more symmetric transverse positions, orthodontists must use care during the retention phase because there is a risk that expanded teeth will return to their preexpansion axial inclinations.[6,38,53]

CONCLUSIONS

The AMEX appliance proved to be effective for treating true unilateral posterior crossbites. All unilateral crossbites were successfully treated, and no crossbites were recorded at the end of the expansion treatment. The AMEX appliance was well tolerated by the patients and also reduced the need for patient compliance. Although cautious laboratory work is required, favorable results can rapidly be achieved.

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