Nonsurgical rapid maxillary alveolar expansion in adults: A clinical evaluation

Chester S. Handelman, DMD

Haas began popularizing the fixed, tooth-and-tissue-borne palatal expander in the United States in an article published in 1961.[1] Since then, malocclusions with transverse deficiencies in children and young adolescents have proven to be responsive to correction.[2,3] In contrast, the use of expanders to significantly widen the maxillary arch in mature patients has generally been considered unsuccessful. For example, the recent review by Bishara and Staley[4] and the orthodontic texts by Proffit[5] as well as by McNamara and Brudon[6] all state that the feasibility of palatal expansion beyond the late teens and early twenties is questionable.

This pessimistic view of rapid maxillary expansion (RME) in adults is based in part on anatomic studies of the maturing face, which show the midpalatal suture and adjacent circummaxillary articulations becoming more rigid and beginning to fuse by the midtwenties.[7,8] In order to overcome the resistance of the adult sutures to expansion, "surgically assisted" rapid maxillary expansion (SA-RME) has been advocated. Surgical approaches, from a subtotal LeFort I[9-10] to more limited osteotomies of the lateral maxilla and palate,[11-16] when combined with fixed palatal expanders, have been successful in allowing the palatine suture to split and the maxilla to widen.

The authors of the surgical papers felt that sur-

Abstract

Palatal expansion in adults has traditionally been performed on a very limited basis. The expansion has been thought to be limited in scope and stability and to be associated with unacceptable complications. Instead, surgically assisted rapid maxillary expansion (SA-RME) has been advocated. Five adults with transverse arch deficiency are presented to illustrate the feasibility of nonsurgical expansion using the Haas appliance. Transmolar expansions of 3.9 to 7.5 mm, sufficient to correct the malocclusions, were achieved. Limiting the rate of appliance activation is thought to be important to avoid pain, swelling, and ulceration. Measurements of molar axial angulation, facial divergence, and clinical crown heights demonstrated modest molar tipping, stable mandibular divergence, and only minimal gingival recession. Radiographs revealed minimal observable root resorption of the maxillary molars and premolars. Contour tracings of the palate indicated that most of the correction of the maxillary transarch deficiency occurred at the level of the lateral walls of the palate (the alveolar process) rather than in the skeletal base of the maxilla. For this reason the technique is defined as rapid maxillary alveolar expansion (RMAE). RMAE is an acceptable alternative to SA-RME in adults for most cases of maxillary transarch deficiency.

This article is followed by a commentary by Robert L. Vanarsdall Jr., and by an author's response.

Key words

Maxillary expansion • Surgically assisted maxillary expansion • Posterior crossbite • Adult treatment.

Submitted: May 1996 **Revised and accepted:** November 1996 Angle Orthod 1997; 67(4):291-308.

Table 1
Transarch width changes for adult RMAE subjects in mm

Case	Time	Age Years, months	Maxilla 6-6	Δ	4-4	Δ
1	T_1	30, 0	28.4	>7.5	17.5	>9.1
	T_2	31, 5	35.9	>-0.9	26.6	>-0.1
	T_3	41, 5	35.0		25.6	
2	T_1	44, 4	29.4	>6.1	25.3	>3.8
	T_2	46, 3	35.5	>-1.7	29.1	>-0.9
	T_3	55, 9	33.8		28.2	
3	T_1	23, 5	24.7	>6.5	22.6	>1.7
	T_E	24, 9	31.2	>-0.9	24.3	> 0.6
	T_2	25, 9	30.3	>-0.3	24.9	>-0.3
	T_3	34, 4	30.6		24.6	
4	T_1	41,10	29.3	>3.9	22.3	>2.9
	T_2	42, 9	33.2	>0.4	25.2	>0.3
	T_3	46,7	33.6		25.5	
5	T_1	32, 1	28.8	>7.5	20.2	>6.5
	T_E	32, 7	36.3	>-2.5	26.7	>0.1
	T_2	33, 7	33.8	>0.6	26.8	>-0.3
	T_3	39,10	34.4		26.5	

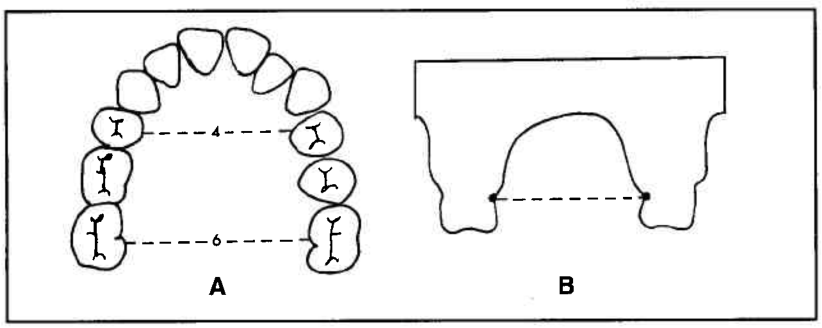


Figure 1A-B

Figure 1A-B
A: Maxillary transarch widths, occlusal view.
B: Maxillary transarch width, cross sectional view. (After Howe,[23] McNamara and Brudon.[6])

gery was necessary because maxillary expansion, beyond limited dental changes, was either not achievable or else it relapsed. Maxillary expansion was also associated with unwanted sequelae, such as pain, swelling, ulceration, flared posterior teeth, bite opening, gingival recession, and perforation of the buccal alveolus.[9-16] Vanarsdall[17] stated that even children with maxillary transverse deficiencies are subject to dehiscence of bone and gingival recession following nonsurgical RME. Additionally, Vardimon and coworkers have expressed concern about root resorption with tooth-borne expanders in nongrowing subjects.[18]

Is the pessimism for nonsurgical maxillary arch expansion in adults justified? The author has presented data on 27 adults treated with the Haas expander and without surgical assistance.[19] The maxilla was expanded sufficiently in every case to correct the crossbite and arch constriction. Final arch widths were in the normal range and were stable, long-term, in those cases in which records were available after discontinuance of retention.

Published cases of adults treated by nonsurgical RME are few—limited to two males in their twenties.[20-21] In a recent paper, Capelozza and coworkers attempted sutural expansion in 38 nongrowing subjects with mixed results.[22] Failure to expand, pain, swelling, or ulceration were frequent complications.

In view of the negative outlook for successful nonsurgical palatal expansion and concerns about gingival recession and other complications, it seemed appropriate to present a series of case studies of older, adult patients. For each subject, photos of the dentition, measures of transarch widths, buccolingual molar angulation, gingival recession, mandibular divergence, as well as periapical radiographs and contour tracings of the study models are presented so that the clinician can evaluate the outcome of treatment.

Expansion of the maxillary transverse width is defined in this paper as rapid maxillary alveolar expansion (RMAE), rather than rapid maxillary expansion (RME) because the expansion appears to be centered in the alveolar process of the maxilla rather than in the body of the maxilla.

The Haas expander is used to treat a diverse group of problems involving maxillary transverse deficiency. The cases presented illustrate the problems associated with bilateral crossbite, unilateral crossbite, arch constriction without crossbite, and preparation of arch form prior to orthognathic surgery.

Table 2
Maxillary first molar axial angulation in adult RMAE subjects in degrees

Case	T_1	T_2	T_3	$T_1 - T_2$*
1	170.5	152.5	155.0	18.0
2	179.0	161.5	178.0	17.5
3	167.5	157.0	156.0	10.5
4	147.0	129.0	**	18.0
5	172.5	162.5	161.5	10.0

* The difference represents the combined increased angulation to the buccal of the right and left first molars.
** Crowns altered occlusal anatomy at T_3.

Materials and methods

Five patients, all treated by the author, were selected from a group of 27 adults who were in a previous study.[19] The cases were selected because they illustrate treatment of a diverse group of problems that would benefit from maxillary arch expansion. All subjects had maxillary width deficiency and were treated with a tooth-and-tissue-borne fixed expander as advocated by Haas, except the buccal bars were left off to allow easier seating of the appliance (Figure 8B).

The expander was cemented at the start of comprehensive treatment and was turned two quarter-turns at that time. The patients were instructed to turn the expander one quarter-turn per day (Case 4 turned every other day) and were seen at 2-week intervals. Expansion was discontinued when the palatal cusp of either maxillary molar was about to go into buccal crossbite. The expander was generally removed following 12 weeks of stabilization. The maxillary central incisors showed no sign of separation or mobility in any of the five cases during the RMAE procedure.

Following removal of the expander, an acrylic palatal retainer was placed, usually on the same day. This plate was relieved on occasion to allow palatal adjustment of the overexpansion. Generally, the palatal plate was maintained until retention, when it was replaced with a wire-and-acrylic second-molar-to-second-molar retainer.

Measurements were made on the study models. All linear measurements were made with an electronic caliper (Mitutoyo No. 573) and recorded to the nearest 0.1 of a millimeter.

Transarch widths (Table 1)

The widths of the maxillary and mandibular arches were recorded between the right and left

Table 3
Gingival recession in adult RMAE subjects judged by change in crown heights: (-) = gingival recession, an increase in crown height in mm; (+) = decrease in crown height in mm

		Maxilla					
Case	Time	Right 6	5	4	Left 4	5	6
1	T_1-T_2	-0.2	-0.1	0.0	-1.4	-0.6	xx
	T_2-T_3	+0.5	+0.6	+0.7	+0.8	+0.1	xx
2	T_1-T_2	0.0	+0.7	xx	xx	+0.8	+1.0
	T_2-T_3	-2.3	-1.8	xx	xx	-1.1	-1.5
3	T_1-T_2	-0.1	-1.3	-0.8	0.0	-0.1	+0.3
	T_2-T_3	0.7	-0.5	-0.7	0.1	-0.1	-0.7
4	T_1-T_2	-0.7	-0.2	+0.1	0.9	-1.2	-0.7
	*T_1-T_2	+0.2	+0.2	-0.4	+0.5	-0.4	-0.0
5	T_1-T_2	-0.3	-0.5	+0.1	-0.1	+0.1	-0.3
	T_2-T_3	+0.4	+0.5	-0.2	+0.6	+0.1	+0.9

* Mandibular measurements.

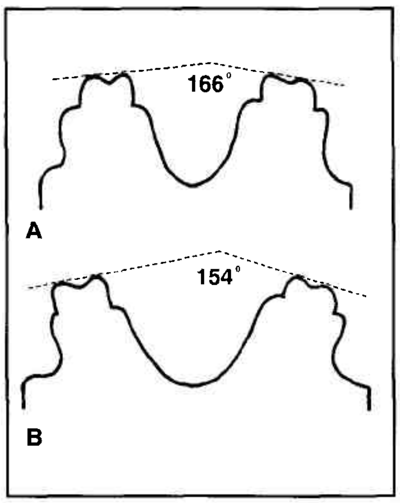


Figure 2A-B

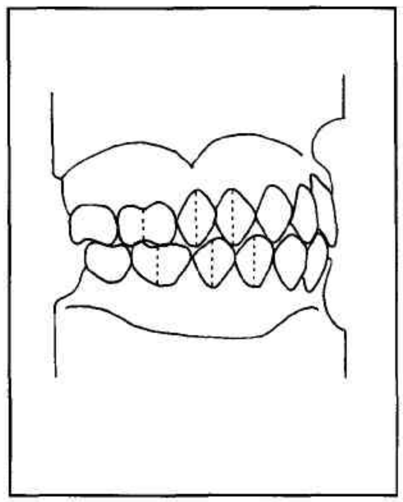


Figure 3

Figure 2A-B
Maxillary first molar axial angulation measured on study models. See text for explanation.
A. Pretreatment measure in this case was 166°.
B. Posttreatment measure was 154°. This indicates a decrease of 12 degrees or a 6° increase in buccal inclination per side. (After Brust[24] and McNamara and Brudon.[6])

Figure 3
Clinical crown heights as measured from study models. An increase in clinical crown height from T_1 - T_2 is considered a reflection of gingival recession.

Figure 4A

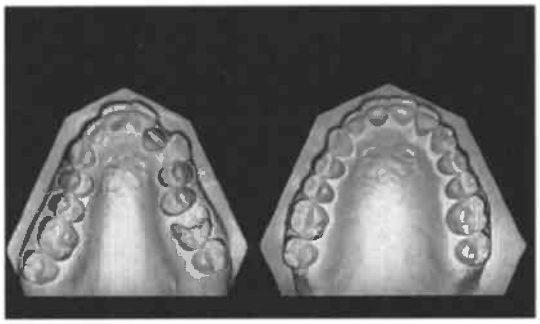


Figure 4B

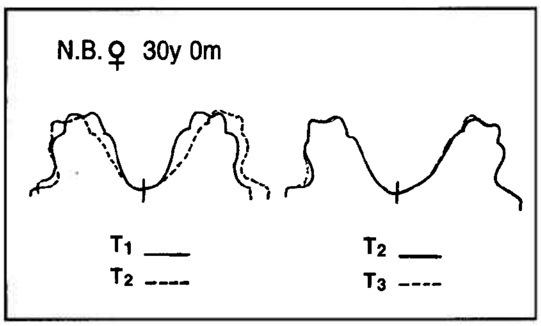


Figure 4C

Figures 4A-C
A: Pretreatment (above) models of a 30-year-old female with bilateral posterior crossbite and crossbite of maxillary right lateral incisor. Posttreatment models (below) show crossbite correction.
B: Pretreatment (left) and posttreatment (right) occlusal views showing increases in transarch width, arch perimeter, and palatal volume.
C: Palatal contour tracings: T_1 – pretreatment; T_2 – posttreatment following RMAE showing expansion which starts high in the vault; T_3 – 10 years following completion of treatment showing expansion is stable.

antimeres of the first premolars and the first molars. If a first premolar was absent, the second premolars were measured. The value for the premolars was recorded at the cervical margin of the crown at its point of greatest convexity; for the first molar at the point on the cervical margin adjacent to the lingual groove (Figure 1A-B), as suggested by Howe and coworkers.[23]

Maxillary first molar axial angulation (Table 2)

The angle formed by the intersecting lines drawn across the mesiobuccal and mesiolingual cusp tips of both the right and left first molars (Figure 2) was defined by Brust[24] as the maxillary first molar angulation. In this study the measure was recorded directly from the model using a Starett no. 1a protractor and was read to the nearest 0.5°.

Clinical crown height (Table 3)

This measurement, performed on study models, was used to determine gingival recession of the maxillary and mandibular premolars and

Table 4
Mandibular plane angle (SN-MP°) and lower facial height (ANS-Me mm) for adult RMAE subjects

	SN-MP		ANS-Me	
Case	T_1	T_2	T_1	T_2
1	38.2	38.0	76.3	76.6
2	30.5	31.0	87.0	87.5
3	38.5	38.5	72.0	71.0
4	48.0	50.0	69.0	71.0
5*	56.0	56.0	84.0	84.4

* T_2 measures substituted by T_E measures.

first molars. Premolar measurements were taken from the tip of the buccal cusp to the gingival margin. First molar measurements were taken from the most occlusal aspect of the buccal groove to the gingival margin directly below the buccal groove (Figure 3).

Palatal contour tracings

A duplicate of the maxillary study model was trimmed so that the base reflected the occlusal plane of the first molars and premolars. The distal face of the model was trimmed through the lingual groove of the right and left first molars. This face was then photocopied at 1-to-1 magnification. The resulting profile could be easily traced. Tracings from different time intervals were superimposed on the midpalatal raphe and assumed symmetrical expansion of the apical third of the palate.

Measures of mandibular divergence (Table 4)

The following measurements were made on the lateral cephalometric radiographs with the patient's teeth in occlusion:

Mandibular plane angle: Nasion-sella line/gonion-gnathion line to the nearest 0.5°.

Lower facial height: Anterior nasal spine to menton, to the nearest 0.5 mm.

Time periods

Data were recorded prior to the start of treatment (T_1), at the visit following completion of comprehensive treatment (T_2), and at variable lengths of time following the start of retention (T_3). At T_3 two subjects had discontinued retention of the maxillary arch. A few records were available following expansion, during the appliance phase of treatment (T_E).

Case presentations

(Refer to Tables 1, 2, 3, and 4 for data on transarch dimensions, first molar angulation, gingival recession, and mandibular divergence. Refer to Figure 9 for incidence of root resorption.)

Case 1 (NB)

A 30-year-old woman presented for treatment because of bilateral crossbite of the maxillary molars and premolars (Figure 4); the premolars were especially collapsed. The maxillary right canine and left lateral incisor were also in crossbite. The patient's chief concerns were the crossbite and the crowding of the maxillary left lateral incisor. She was a professional singer and was enthusiastic about the prospect of increasing the volume of the palatal vault, which she felt might improve her voice and articulation. Two expanders were required to achieve the necessary overexpansion (probably exceeding 11 mm). The final expansion at retention was 7.5 mm for the molars and 9.1 mm for the premolars. The increased arch perimeter plus moderate slenderizing of the maxillary incisors allowed correction of the crowded maxillary left lateral incisor.

The maxillary first molars diverged 18°, or about 9° per side. There was minimal gingival recession at T_2 and some improvement at T_3, indicating that palatal expansion did not cause the gingiva to undergo recession. There was insignificant root resorption of the maxillary molars and premolars. There was no change in mandibular divergence or facial height from T_1 to T_2.

Contour tracings (Figure 4C) indicate that palatal expansion started at the roof of the palatal vault with an increase in volume of the vault.

Ten years after completion of treatment there are no signs of relapse. The patient was advised to discontinue the palatal retainer after the fifth year of retention; however, she continues to wear a retainer at night.

Case 2 (DL)

A 44-year-old male presented with a left unilateral crossbite extending from the first molar through the lateral incisor (Figure 5). In addition, there was ankylosis and advanced internal root resorption of the maxillary left central incisor due to trauma at age 17. The maxillary incisors were moderately crowded. Previous orthodontic treatment between ages 12 and 14 included extraction of the four first premolars.

The patient's reason for seeking orthodontic treatment was the dentist's inability to replace the maxillary left central incisor (designated for extraction) with acceptable esthetics due to crowding and the crossbite of the left lateral incisor and canine. RMAE provided a 6 mm increase in transmolar width. Following RMAE, the mandible shifted significantly to the right (Figure 5A), helping to move the mandibular midline toward the facial midline and minimizing overexpansion on the right side. The expansion increased the arch perimeter, allowing for a properly sized pontic and well aligned abutments. Interproximal reduction of the mandibular anterior teeth also aided in correction of the anterior crossbite.

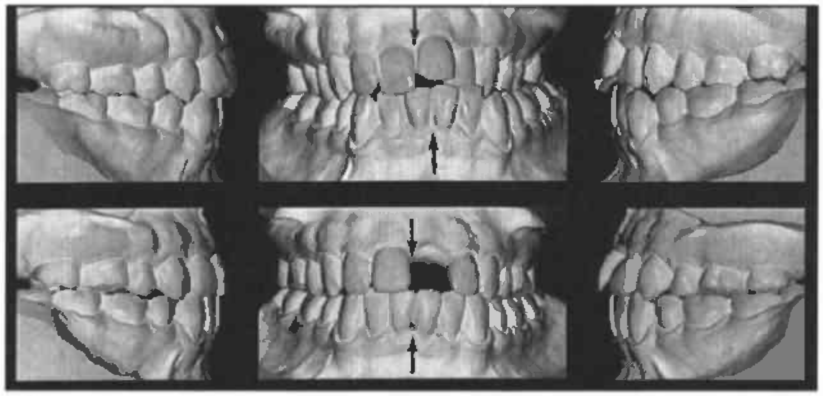


Figure 5A

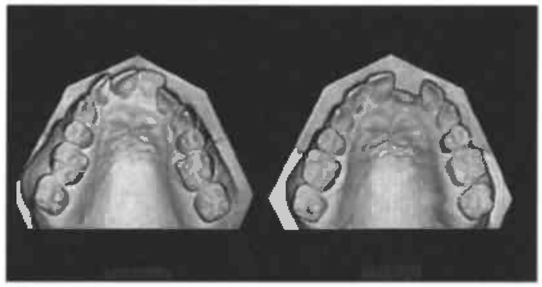


Figure 5B

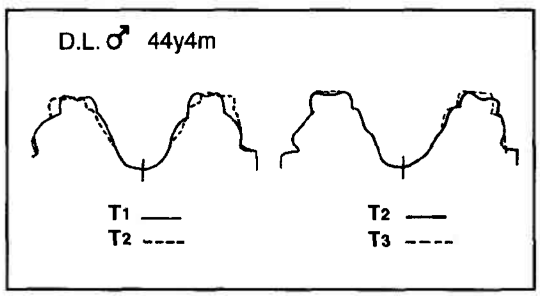


Figure 5C

Figure 5A-C
A: Pretreatment (above) models of a 44-year-old male with left unilateral crossbite extending to the lateral incisor. Left central incisor was ankylosed with advanced root resorption and was scheduled for extraction. Note difficulty in replacing tooth without prior orthodontic treatment. Also note mandibular midline displaced to the left. Posttreatment models (below) show correction of crossbite and alignment of abutments for bridge. Dental midlines improved following maxillary expansion.
B: Pretreatment (left) and posttreatment (right) occlusal views of maxillary arch. Note increases of transarch width and arch perimeter to allow properly sized pontic.
C: Palatal contour tracings: T_1– pretreatment; T_2–following RMAE and orthodontic treatment with expansion starting at midlevel of palate; T_3– 9 years following discontinuance of retention showing stability of the crossbite correction and palatal expansion, although transmolar width did decrease slightly due to failure to wear a retainer.

Intermolar angulation decreased 17.5°, which translated into approximately 9° of increased buccal crown angulation per side. Clinical crown heights at T_2 and T_3 (11 years after expansion) demonstrated no tendency for gingival recession. Root resorption of maxillary molars and premolars was not observed. There were no changes in mandibular divergence or facial height from T_1 to T_2.

The palatal contour tracings (Figure 5C) indicate that expansion started midway between the gingival margin and the height of the palate.

The patient, on his own, discontinued the max-

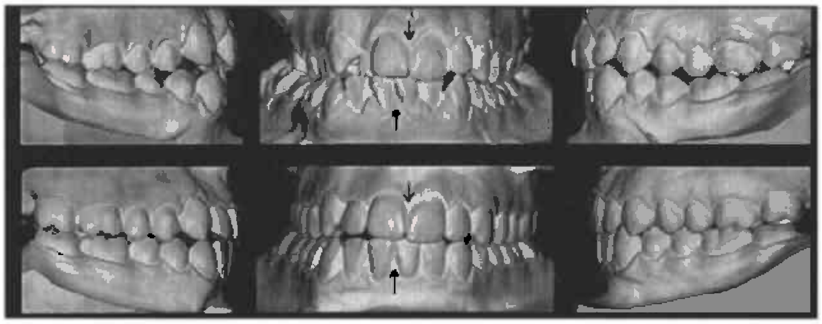


Figure 6A

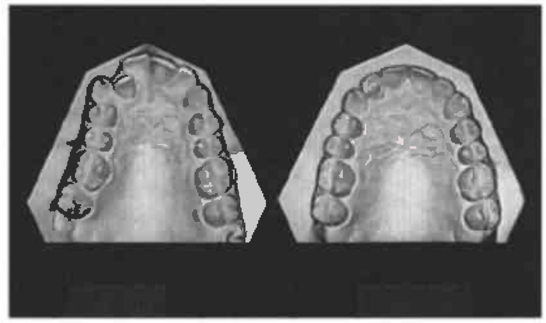


Figure 6B

Figure 6C

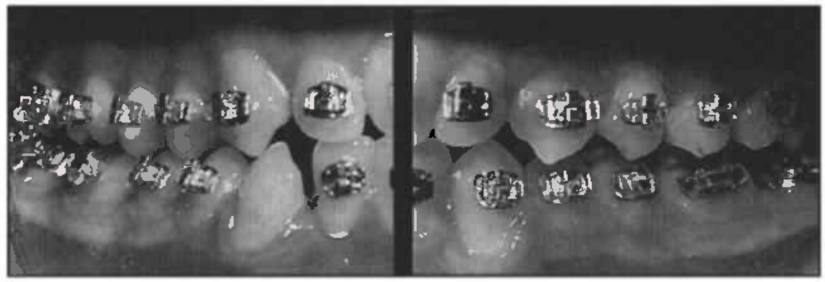
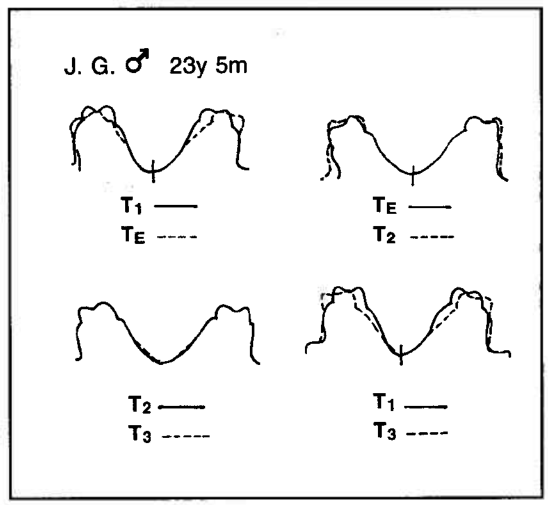


Figure 6D

Figure 6A-E
A: Pretreatment (above) models at 23 years 5 months, with right unilateral crossbite extending to lateral incisor. Mandibular midline was off to the right. Posttreatment models (below) show crossbite correction. The mandible did not spontaneously center following RMAE.
B: Pretreatment (left) and posttreatment (right) occlusal views of maxillary arch showing bilateral transarch deficiency, especially on right. Posttreatment view shows increase of transarch width. Note stabilization of maxillary right lateral with a lingual bonded wire.
C: Pretreatment portrait showing mandibular asymmetry with center of chin displaced to the right.
D: Right side (crossbite side, shown at left) following RMAE. Note correction, but overtreatment was not achieved. Left side (shown at right), which showed normal relations at outset, began developing a buccal crossbite. Expansion was stopped at this point.
E: Palatal contour tracings; T_1– pretreatment; T_E– following RMAE with expansion starting at midpoint of palatal vault. Note buccal tipping of molar crowns; T_2– at completion of orthodontic treatment the molars have partially uprighted; T_3– 9 years after completion of treatment and 5 years without maxillary retention. Note stability of palatal expansion from T_2 to T_3.



Figures 6E

illary retainer once the fixed anterior bridge was seated, which was less than a year after the completion of orthodontic treatment. This may have allowed a decrease in transarch width of 1.7 mm, or 28% of the achieved expansion. The crossbite, however, did not relapse, and the correction has been maintained for the last 9 years.

Case 3 (JG)

A 23-year-old male presented with a right unilateral posterior crossbite, with crowding and crossbite of the maxillary right lateral incisor (Figure 6). The mandibular incisors were also crowded. The dental midline of the mandible was shifted to the right 4.5 mm. The occlusion on the left side tended toward Class III. The face demonstrated mandibular skeletal asymmetry, with the center of the chin off to the right of the facial midline (Figure 6C).

Functional examination revealed an asymmetric path of closure with no indication that the mandible could center following expansion. The patient's chief concern was the crossbite and crowding of the maxillary right lateral incisor. He agreed to undergo a mandibular osteotomy following RMAE and arch alignment to center the mandible and correct the facial asymmetry.

The mandible, as expected, did not adjust toward the midline following the increase in maxillary transarch width. The left side, which had a normal buccal relationship pretreatment, was

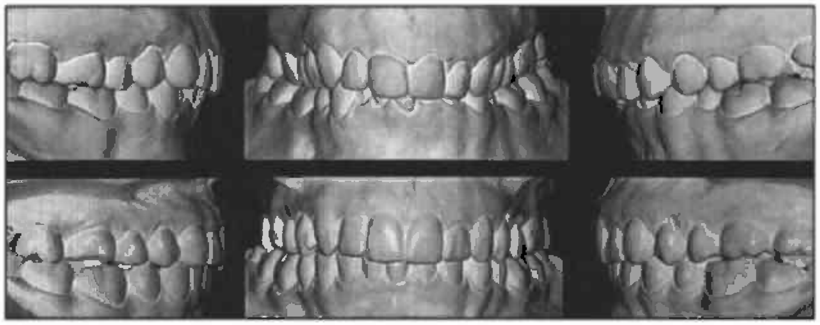


Figure 7A

Figure 7B

Figure 7C

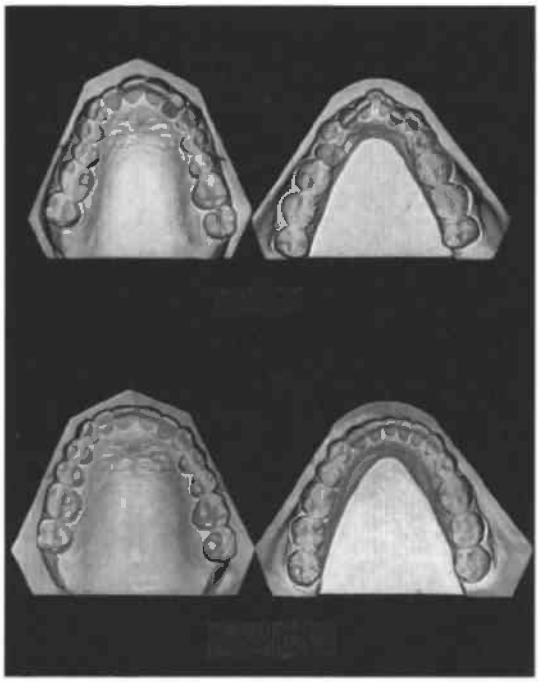


Figure 7D

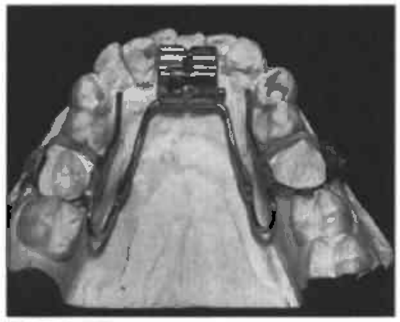


Figure 7E

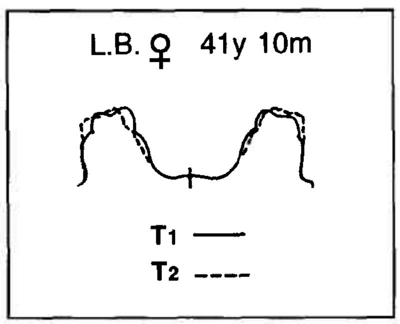


Figure 7F

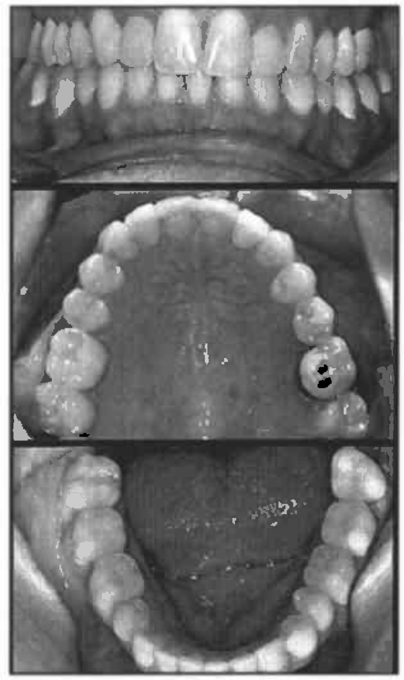


Figure 7G

becoming inlocked; that is, the upper palatal cusps were beyond the occlusion of the lower buccal cusps. The right side (the crossbite side) was corrected but the usual amount of overcorrection could not be achieved without driving the pretreatment normal side further into buccal crossbite (Figure 6D). Expansion of the appliance was discontinued at this point.

The arch perimeter was sufficiently increased to allow for alignment of the maxillary right lateral incisor out of palatal crossbite. Once this tooth was aligned, the patient decided that his goals had been met and he refused orthognathic surgery to correct the facial and dental asymmetry. Cross elastics were then used to re-establish normal occlusion on the left side (Figure 6A).

Despite the inability of the mandible to posture more concentrically, the crossbite was corrected and a significant transmolar expansion (6.5 mm) was achieved.

Maxillary first molar angulation decreased

Figures 7A-G
A: Pretreatment (above) study models of 42-year-old female with deepbite and crowded mandibular incisors. Both arches are constricted across the premolars and molars but patient does not have a crossbite. Posttreatment models (below) following maxillary and mandibular arch expansion and orthodontic treatment show bite was opened and the appearance of the maxillary incisors was improved by placing a crown and laminates.
B: Pretreatment portrait. Note broad smile showing insufficient fullness of buccal dentition.
C: Posttreatment portrait. Note increased fullness of buccal dentition.
D: Pretreatment (above) and posttreament (below) occlusal views of models. Pretreatment, note constriction of maxillary arch and mandibular arches (5 to 6 mm less than the norm), and crowding of the mandibular incisors. Posttreatment view following RMAE in maxilla and a fixed mandibular expander in the lower arch shows increased transalveolar widths and correction of crowding due to increase in arch perimeter.
E: Mandibular expander fabricated from distal arms of a hygienic expander, which are soldered onto a lingual arch.
F: Palatal contour tracings: T_1-pretreatment; T_2-posttreatment, demonstrating expansion by RMAE that starts high to midway on the lateral walls of palate.
G: Dentition after 3 years 10 months retention. The occlusion is stable. Most of the posterior teeth have been crowned, and there does not appear to be any tendency for gingival recession.

10.5° for an increase in buccal angulation of 5° per side. There was no change in mandibular divergence or facial height from T_1 to T_2 despite RMAE and the use of cross elastics. The expansion did not significantly increase gingival recession at retention or 9 years posttreatment. There was no evidence of root resorption of the maxillary molars and premolars.

Tracings of the palatal contours (Figure 6E) showed midlevel palatal expansion with some molar tipping from T_1 to T_E. From T_E to T_2 the molars uprighted while maintaining transmolar width.

The patient discontinued maxillary retainers after 4 years, and the result has remained stable for 5 years. However, a lingual bonded wire to stabilize the maxillary right lateral remained in place.

Case 4 (LB)

A 42-year-old female presented for treatment because of severe crowding of her mandibular incisors (Figure 7). The mandibular right second premolar had been extracted. Both arches appeared constricted in the premolar and first molar regions. A diagnostic set-up indicated that there were two options for treatment: one mandibular incisor could be extracted and the mandibular teeth aligned, or the upper and lower transarch widths could be expanded to avoid extraction. The patient had a high appreciation of dental esthetics, and the increase in width appealed to her because she favored the elimination of dark vestibular voids caused by collapse of the posterior dentition (Figure 7B).

The maxillary arch was expanded with a Haas expander. The mandibular arch was expanded with a fixed lower expander. This incorporated the distal arms of a hygienic expansion screw soldered to a modified lingual arch (Figure 7E). Both appliances were turned every other day. Maxillary transmolar width increased 3.9 mm. Mandibular transalveolar width increased 5 mm at the first molars and 4.5 mm at the first premolars.

The increase in transarch width, combined with moderate enamel reduction of the mandibular incisors, allowed for the correction of anterior crowding (Figure 7D).

Maxillary first molar angulation decreased 18°, which translates into an increased buccal angulation of 9° per side. There was minimal change in mandibular divergence or facial height, despite a pretreatment SN-MP angle of 50°. Gingival recession in both arches was minimal. There was no sign of root resorption on the expanded maxillary molars or premolars.

The contour tracings showed that both palatal and dental expansion occurred (Figure 7F). There was no change in the palatal contour at T_3, almost 4 years into retention.

The patient is happy with her broad smile and the presence of buccal teeth where there had been dark vestibular voids (Figure 7C). Following the completion of orthodontic treatment she had crowns and laminates placed on the maxillary incisors for improved esthetics. Most of the posterior teeth were also restored with crowns. She continued to wear removable retainers at night, and the occlusion was stable 3 years 10 months postretention (Figure 7G).

Case 5 (HD)

A 32-year-old female presented for treatment because of an overjet of 6 mm and an anterior openbite (Figure 8). She had a bilateral posterior crossbite and a V-shaped arch in the maxilla. The mandibular anterior teeth were crowded. The face was elongated with lip incompetence, narrowed nares, and inadequate projection of the chin. Cephalometric radiographs showed vertical maxillary excess, mandibular divergence, long lower face height, and mandibular retrognathia.

Following a series of conferences, the patient accepted the need for comprehensive treatment involving orthognathic surgery as well as orthodontic treatment. When the handheld models were placed in a Class I position, the crossbite increased and the narrow transcanine width interfered with proper interdigitation. Maxillary arch width would need to be expanded prior to surgery to avoid a multiple segment LeFort I osteotomy.

Nonsurgical RMAE prior to orthognathic surgery, using a Haas expander (Figure 8B), increased transmolar width by 7.5 mm and transpremolar width by 6.5 mm. This allowed for overcorrection of the bilateral crossbite as well as sufficient increase in the arch perimeter to normalize the V-shaped pretreatment arch form (Figure 8C). Crowding of the mandibular incisors was corrected by moderate arch expansion and interproximal reduction. Maxillary first molar axial angulation decreased 10°, which means each side was tipped to the buccal by 5°.

One might speculate that the pretreatment height mandibular plane angle (56°), long lower facial height (84 mm), anterior openbite, and mouthbreathing would have predisposed for an increase in mandibular divergence following RMAE. However, the postexpansion (but presurgical) cephalometric X-rays showed no change in mandibular orientation.

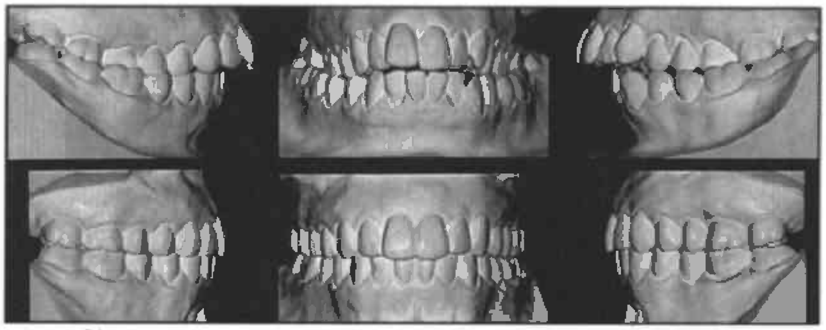


Figure 8A

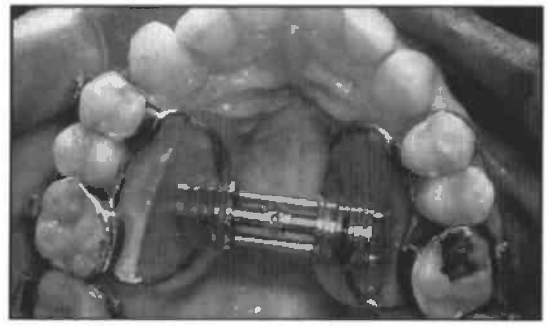


Figure 8B

A one-piece maxillary osteotomy to impact the posterior maxilla, combined with a sagittal split osteotomy to advance the mandible, corrected the skeletal dysplasia.

Crown heights have been essentially unchanged, indicating absence of gingival recession from the start of treatment to 6 years postretention. There was moderate blunting of the roots of the first premolars, but there was also blunting of the maxillary incisors.

The palatal contour tracings (Figure 8D) showed expansion across the roof of the palate on the model taken just prior to orthognathic surgery (T_E). The increase in palatal dimensions was stable at retention, although the molars had uprighted, yielding a decrease in transmolar width of 2.5 mm. The increase in transarch width from T_1 to T_2 was, nevertheless, considerable at 5.0 mm.

The patient chose to continue wearing her palatal retainer at night, and the maxillary widths remained stable 6 years after appliance removal.

Discussion

RME versus RMAE

Rapid maxillary expansion (RME) was initially advocated for use in children.[1-3,20,21] Separation of the midpalatal suture as demonstrated on occlusal X-rays and development of an interincisal diastema indicates skeletal expansion of the maxilla.[1-4] However, the separation between the palatal shelves was never as great as the increase in transmolar width. Krebs, using metallic implants, demonstrated that approximately 50% of the expansion achieved by RME in children was skeletal and the remainder was dentoalveolar.[25]

Capelozza and coworkers performed RME on a group of nongrowing patients and attempted to initiate sutural opening as demonstrated by the development of a midline diastema.[22] They used a Haas appliance and activated the screw four quarter-turns in the first 24 hours. On the following days, they activated two turns morning and evening for a total of four turns per day until a midline diastema was noted. Eighteen

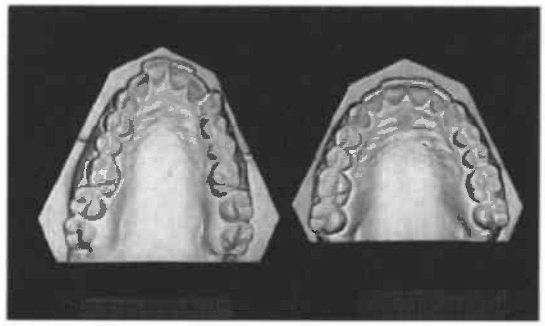


Figure 8C

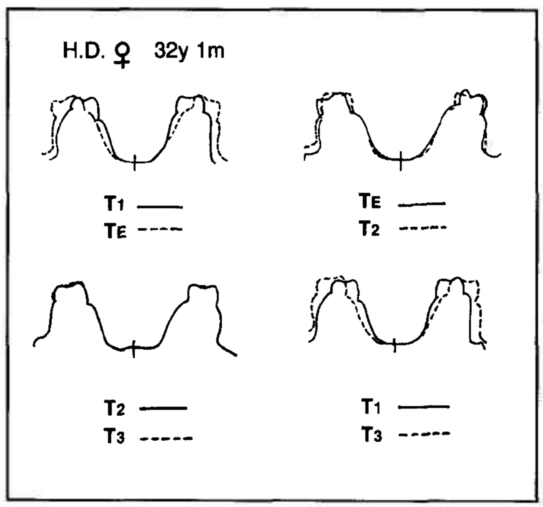


Figure 8D

percent of the sample failed to demonstrate a separation, and they were referred for surgical procedures. Undesired side effects (pain, edema, and/or ulceration) were frequent. Only 32% of the sample were free of complications.

In order to avoid complications, only two turns at the start and one turn on succeeding days is advocated for rapid maxillary alveolar expansion (RMAE) in adults. Separation of the suture is rarely observed, but this is not considered essential.

Contour tracings of the palates demonstrate dentoalveolar expansion as well as some dental tipping. The expansion starts at the apical third to midlevel of the palatal vault. Occasionally, a

Figure 8A-F
A: Pretreatment (above) models of a 32-year-old female with bilateral crossbite, Class II occlusion, openbite, and long face skeletal pattern. Posttreatment models (below) show crossbite correction (by RMAE prior to orthognathic surgery). Class II occlusion and openbite were corrected by orthognathic surgery. Four third molars were extracted early in treatment.
B: Haas palatal expander fully expanded during presurgical stage of treatment.
C: Pretreatment (left) occlusal view of maxilla showing narrow V-shaped arch. Posttreatment view (right) shows transarch widths increased following RMAE, with an increase in arch perimeter that allowed for broadening of the anterior arch form.
D: Palatal contour tracings: T_1–pretreatment; T_E–following RMAE, but prior to orthognathic surgery, demonstrating expansion starting at height of palatal vault with expansion possibly across suture; T_2–at completion of orthodontic treatment and after orthognathic surgery, showing molar uprighting and stability of expansion; T_3–six years posttreatment, showing stability of palatal expansion. Patient chose to continue wearing retainer at night.

patient may show expansion across the top of the palatal vault, indicating that some of the width increase might have occurred across the suture (Figure 8D). RME and RMAE probably represent a continuum: from young children who experience about half of their expansion in the base of the maxilla and half in the dentoalveolar complex, to older adolescents who experience a greater percentage in the alveolus, to adults, whose expansions occur largely in the alveolus.

The Haas tooth-and-tissue-borne expander apparently has the ability, in adults, to expand the posterior dentition with its alveolar housing, perhaps by bending the alveolus with subsequent bone remodeling. In his 1970 paper, Haas suggested such a possibility.[20] He stated that after the age of 18 it is often impossible to open the midpalatal suture. He emphasized the importance of using a tissue-borne as opposed to a tooth-borne expander and the need to reduce the expansion schedule in such cases. He suggested that a "height alveolar expansion" might be possible.

The Haas expander is unique in its use of palatal acrylic pads. Are these pads essential? We cannot be certain until a large number of adult cases expanded with hygienic tooth-borne appliances, as well as other expansion appliances, are studied.

Magnitude of expansion

The magnitude of expansion was determined by measuring transarch widths (Figure 1A-B, Table 1). Howe et al. determined that transmolar width in adults selected for their lack of crowding averaged 36.2 mm in females and 37.4 mm in males.[23] In a previous report by the author, using the same method of measurement, transmolar width was found to average 34.4 mm for adult orthodontic patients (mostly females) who were selected for the absence of obvious maxillary width discrepancy.[19] The five subjects in this study certainly had maxillary width deficiencies, as their transmolar widths ranged from 24.7 and 29.3 mm.

Despite statements in the literature on the improbability of adult nonsurgical maxillary arch expansion,[4-6,9-12,14-16] the transverse dimension did expand. This was evidenced by increases in transarch widths of 3.4 mm to 7.5 mm, which normalized the maxillary widths at retention (Table 1). It should be noted that the youngest patient was 23 years and the others were between 30 and 44 years of age.

The contour tracings indicate that the first molars were expanded with their alveoli. This increased the volume of the palatal vault. It must be noted that superimposition of the tracings from T1, T2, and T3 can be influenced by changes in A-P position and rotation of the first molars, as well as changes in the occlusal plane. However, the changes in palatal contours following RMAE were large (Figures 4C, 5C, 6E, 7F, 8D) so that any inaccuracy due to the method of superimposition is unlikely to change the observed pattern of expansion.

No measurements were made of changes in arch perimeter. Adkins and coworkers estimated that for every millimeter of increase in arch width due to palatal expansion, there is an increase of 0.7 mm in arch perimeter.[26] If we use Adkins' coefficient, the patients in this study were "uncrowded" 2.4 to 5.3 mm, and this was a significant factor in the nonextraction approach taken in the cases presented.

Four of the five cases had expansion in the 6 to 7.5 mm range. This rather large expansion was necessary because the cases were selected for their severity. The final expansion achieved was determined by the lower arch width rather than some as-yet-to-be-determined limit of RMAE. The arches, with the exception of Case 3, were overexpanded. This allowed for partial adjustment of the tipping of the buccal segments and it increased the stability of the expanded teeth. There is certainly a limit to RMAE in adults, and some patients may require surgical assistance. However, cases with up to 7.5 mm of increased transarch width at retention may not require surgical assistance. Fortunately, very few cases require expansion greater than this.

Morbidity

RMAE was well tolerated by the patients in the present study. In a larger series of patients, a few instances of swelling of the palatal gingiva were encountered.[19] These were due to oversized acrylic pads that impinged on the palatal gingiva. The acrylic from the area was cut away and the expansion screw was turned back three to four times. After a period of rest, expansion was resumed without further problems. Poorly fitted expanders can also lead to pressure points on the lateral walls, and if this cannot be adjusted, a new expander should be made.

It is important to remember that since the midpalatal suture is unlikely to split, the appliance should be turned, at most, once per day. Patients who turn more frequently can experience pain, edema, and eventual ulceration of the tissue under the palatal acrylic pads, as was evident in the study of Capelozza et al.[22] Turning every other day will also produce successful expansion. The morbidity problem with RMAE is not significant and is manageable, and is certainly less than the morbidity associated with SA-RME.

Maxillary first molar axial angulation

Maxillary first molar axial angulation decreased between 10° and 18° when measured at the end of treatment (Table 2). If we assume symmetrical movement, each molar tipped between 5° and 9° to the buccal (Figure 2). Overtreatment of the transarch width with RMAE is crucial, as it allows molar uprighting toward the midline during the fixed appliance phase that follows.

The contour tracings show that the palatal shelves were tipped to a similar degree as the molars. These tracings, however, cannot be used to measure molar axial angulation, as they transect variable contours of the crown's occlusal anatomy.

Surgically assisted RME may result in greater bodily translation of the maxillary segments, and therefore, less tipping of the molars. However, data on this issue is not available.

Gingival recession

Patients in this series did not show meaningful increases in clinical crown heights, reflecting a lack of gingival recession (Table 3). The T_2 period was usually about 2 years after the start of RMAE, which was initiated at the start of treatment. The follow-up records (T_3) did not demonstrate late gingival recession. In a previous study of 27 adults treated with RMAE, the mean increase in crown height was 0.5 mm, while the control group of orthodontic patients showed an increase of 0.2 mm.[19] The clinical significance of this increase of 0.5 mm of gingival recession, in terms of periodontal health, is probably minimal.

Gingival recession at T_2 and T_3 may be due, in part, to individual susceptibility to recession, independent of expansion treatment. Serino et al., in a longitudinal study of gingival recession in subjects with excellent oral hygiene, reported that 52% of the buccal sites in the 30- to 41-year-old subjects had ⊕2 mm of attachment loss.[27]

Several authors have stated that RME in adults may cause gingival recession and perforation of the thin buccal plate of bone.[9-12,14-17] Vanarsdall stated that an increase in gingival recession may be seen in children 8 to 10 years following palatal expansion.[17] In cases of maxillary deficiency beyond the age of 15, he recommends surgically assisted RME to avoid expansion beyond the transverse envelope of discrepancy.

Greenbaum and Zachrisson studied patients younger than 21 years of age who underwent RME.[28] They examined the levels of buccal alveolar bone and gingival attachment directly in patients and found that periodontal tissues were clinically acceptable following expansion for the group, although a few individuals exhibited excessive changes in bone levels. In this study the measure of clinical crown height is an indirect measure of gingival recession. This rationale is less than ideal, since it is influenced by attrition of the crown and gingival hyperplasia, and it does not consider pocket depth. Nevertheless, recession of a significant nature does not appear to be obligatory following RMAE and was not observed in this series.

The contour tracings suggest that the posterior dentition appears to expand with, rather than through, the alveolus. This is fortunate, considering the thin nature of the buccal alveolus. In contrast, labial expansion of incisors with orthodontic appliances is associated with gingival recession and dehiscence of the labial bone.[29, 30]

Are patients with advanced, pre-existing gingival recession candidates for nonsurgical RMAE? There is insufficient evidence to know if RMAE would accelerate recession of the already compromised buccal periodontium, but caution is advised. SA-RME may be indicated in cases with maxillary deficiency and a significant tendency for gingival recession.

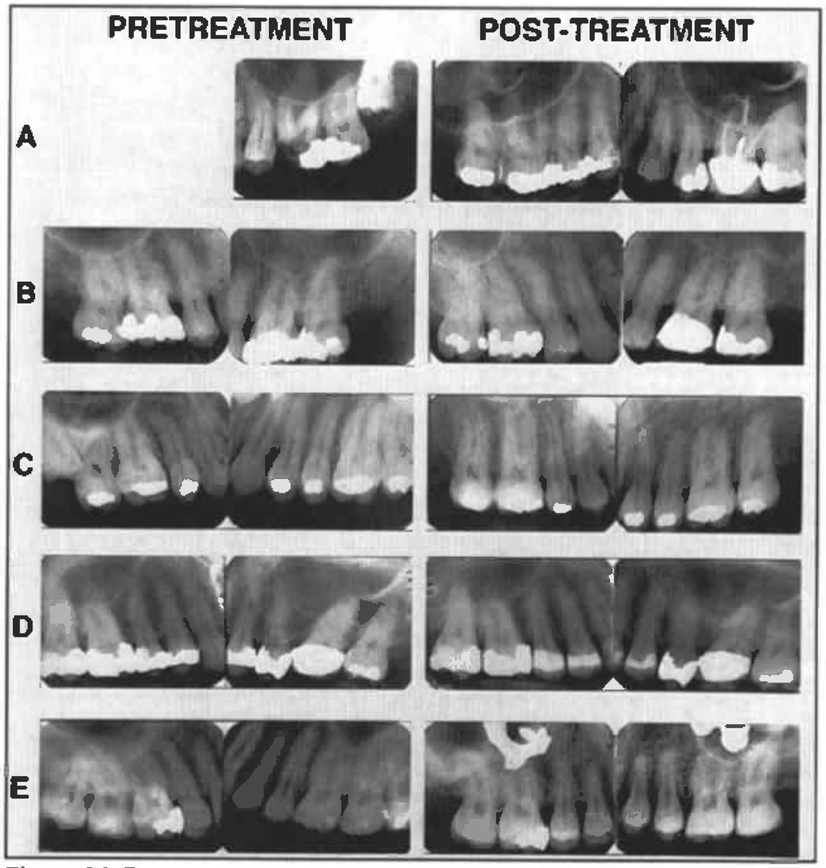


Figure 9A-E

Figure 9 A-E
Periapical radiographs of the maxillary molars and premolars: A - case 1; B - case 2; C - case 3; D - case 4; E - case 5. Pretreatment X-ray of right molar for case 1 was not available. Comparison of pretreatment (left) and posttreatment (right) radiographs does not reveal significant root resorption. In E (case 5), the moderate resorption seen on the first premolars was also seen on the incisors.

Root resorption

Examination of the posttreatment periapical radiographs of the maxillary molars and premolars revealed minimal root resorption (Figure 9). When root blunting of the first premolars was observed, similar resorption was also observed on the maxillary incisors (Figure 9E).

Studies of root resorption associated with RME have examined the roots of extracted anchor teeth in animals[18] and in children or adolescents.[31-34] These reports show broad but shallow resorption areas on the buccal surfaces of the roots, most prevalent toward the cervical one-third of the root. Barker and Sims[32] pointed out that these resorption sites cannot be seen in radiographs of the patient. Resorption sites on the buccal surfaces might be more significant in adult expansion patients. However, there does not appear to be clinical evidence of a root resorption problem in this series.

Development of openbite

Opening rotation of the mandible is observed during the course of expanding the palate due to the rapid change in intercuspation caused by the expander. However, the dentition tends to settle in during the postexpansion phase of treatment. Selective equilibration can be helpful in restoring the pretreatment overbite.

Significantly, the palatal contour tracings do not reveal any increase in the distance between the palatal vault and the occlusal plane of the first molars. There is no evidence in these cases that RMAE causes extrusion of the posterior teeth.

Patients with severely divergent mandibles, however, are at risk for an increase in mandibular rotation. In these cases, the possible need for LeFort I surgery should be incorporated in the treatment plan and entered in the patient's record. Patients with anterior openbite and a hyperdivergent mandible might best be treated with LeFort I maxillary impaction surgery (Case 5). Any opening of the mandibular plane due to RMAE could be corrected during surgery.

In this series, none of the five patients showed an increase in mandibular plane angle or facial height (Table 4). This was true even for Case 5, despite the long facial height combined with anterior openbite and mouthbreathing.

Surgically assisted RME is not immune to opening of the mandibular plane. Betts et al. (their Figure 20a) describe a step cut as opposed to a ramped cut in the lateral maxilla to control this problem.[10] Alpern and Yurosko use a bonded expander in the maxilla that covers the occlusion to prevent increasing mandibular divergence in surgically assisted RME patients.[35]

Retention and relapse

Placement of an acrylic palatal retainer, on the same day as or soon after removal of the Haas expander, allows the retainer to act as a fulcrum for uprighting the posterior teeth and limits unwanted palatal width relapse. Since the posterior teeth are overexpanded, some decrease in transarch width is expected. This settling in of the occlusion should not be considered relapse, a term that should be reserved for a return of the original malocclusion.

Subjects are advised to use a maxillary retainer at night for a period of 5 years. None of the patients in this series demonstrated return of the crossbite, but only two had discontinued retention at night. Wearing a maxillary retainer at night is not considered a burden by most patients.

Bilateral crossbite

When bilateral crossbites are severe, treatment is challenging because of the magnitude of expansion required for correction. For example, Case 1 required a final expansion of 7.5 mm at the molars and 9.1 mm at the premolars. The appliance in this case was expanded in the range of 12 mm. Despite expansion of this magnitude, gingival recession and root resorption were inconsequential. Ten years following retention, there have been no signs of gingival recession.

Unilateral crossbite

Children with unilateral crossbite usually have the ability to center the mandible following expansion of the maxilla. This clinical observation is less predictable in adults because the temporomandibular joints and condyles, in most cases, have accommodated to the shift of the mandible, which can no longer shift back when free of occlusal interference. The ability of the adult to center the mandible is variable; a few patients will center completely, most partially, and some not at all. Patients who lose the ability to center the mandible or have asymmetric mandibular form are the most difficult to treat.

In Case 2, concentricity of the maxillary and mandibular dental midlines was improved following maxillary expansion, despite the patient's age (44 years). Some patients retain the ability to be restored to their original centric occlusion despite years of functioning in an accommodated occlusion. This ability can be tested using an occlusal deprogramming splint that frees the mandible from feedback due to intercuspation.

Case 3 could not center because of mandibular asymmetry. This patient was difficult to treat because, when the crossbite side was corrected, the normal side was overexpanded. This created two problems: the crossbite side was difficult to overcorrect, and the pretreatment normal side needed treatment with elastics to reestablish normal occlusion. Surgical osteotomy of the mandible had been recommended to correct this problem, but the patient ultimately declined surgery.

Unilateral surgical osteotomy of the maxilla on the crossbite side prior to RME has been advocated to allow unilateral expansion.[9,16] This may have been another option for Case 3. Nevertheless, Case 3 does demonstrate that patients with unilateral crossbite and limited ability to center their mandible can be treated successfully, although perhaps not ideally, without surgery.

Maxillary arch constriction without crossbite

The transarch width of the maxillary and mandibular posterior teeth can be significantly diminished without the presence of crossbite. Usually the maxillary and mandibular first molars show mesial rotation and the premolars bow lingually, giving the arch an hourglass appearance. The loss in transarch width is usually reflected in incisor and premolar crowding. Correction must involve expansion of both arches.

The concept of correcting crowding in the mixed dentition, in the presence of arch constriction, has been advanced by McNamara.[6,36] Extending this concept to adults, one must select only those who have obvious lingual collapse of the buccal dentition.

Case 4 had constricted maxillary and mandibular transarch widths, about 5 to 6 mm less than the norm.[19,23] Both arches were expanded; the lower expansion measured 5.1 mm at the molars and 4.5 mm at the premolars. The increase in arch perimeter, combined with moderate enamel reduction of the incisors, was sufficient to correct the lower crowding. The patient also preferred reduction of the dark vestibular voids through buccal expansion of the posterior teeth. Stability is a question mark, and long-term retention will be required. However, the pretreatment arch constriction may indicate that the mandibular arch had been expanded and uprighted over basal bone.

Preparation of arch form prior to surgery

Orthognathic surgery requires that arch form reflect the final occlusion after the jaws are repositioned. This can be accomplished prior to or at surgery. Expansion of the maxilla at the time of surgery requires segmenting the maxilla into either two or three pieces, with the two posterior segments repositioned to the buccal. This potentially compromises the blood supply, and as a consequence, aseptic necrosis is a possibility.[37]

Expansion of the maxilla prior to surgery allows correction of crowding and arch form, allowing coordination of the two arches at the time of surgery. Case 5 illustrates a case that achieved these goals using nonsurgical RMAE.

The Class II orthognathic case usually requires expansion of the maxillary arch. This is because when the maxilla is retropositioned and/or the mandible is advanced, a crossbite is created or made more severe. In Case 5, the pretreatment crossbite had to be overcorrected and the arch form expanded in the canine and premolar regions so that the maxillary arch could be coordinated with the mandibular arch.

In the Class III orthognathic patient, moderate maxillary transarch deficiency may not need correction because, following surgery, the wider part of the maxillary arch will be in occlusion with a narrower part of the mandibular arch. The Class III patient, however, often demonstrates maxillary deficiency in both the transverse as well as the sagittal dimensions. The prognathic mandible is often overdeveloped in the transverse plane. In either case, the maxillary arch may need to be expanded to allow final coordination at the time of surgery.

Surgically assisted RME versus nonsurgical RMAE

Maxillary osteotomy allows expansion of the skeletal base of the maxilla. SA-RME is a true orthopedic expansion, starting at the apex of the palatal vault with bone apposition at the suture. In adult patients, the Haas palatal expander also produces an orthopedic expansion, generally starting at the apical third of the lateral walls of the palate (Cases 1 and 5) or midway on the lateral walls (Cases 2, 3, and 4). This correction produces an increase in the volume of the palatal vault. The transverse width of the skeletal base of the maxilla may not be expanded, but transalveolar expansion can be an acceptable alternative.

Betts and coworkers have presented a radiographic analysis of the posteroanterior cephalogram to define a maxillomandibular width differential.[11] They state that a differential greater than 5 mm from the norm may indicate a need for surgically assisted expansion. In the present paper, the maxillary transarch widths, measured from study models, were used for comparison with the control samples[19,23] and also to measure the expansion achieved. Unfortunately PA cephalograms were not taken at the time of treatment. Further clinical studies are required to define the relative importance of the maxillomandibular skeletal differential and maxillary transarch measures in setting limits to nonsurgical expansion in adults.

Are there negative factors which should be considered before the orthodontist decides whether to proceed with nonsurgical RMAE or refer for surgical assistance? Surgical procedures are expensive; the charges by the surgeons, the hospital, or the outpatient surgery center, combined with orthodontic fees, may be beyond the patient's means. This issue has become more critical as insurance coverage has become less available for surgical procedures.

Surgical procedures are associated with morbidity such as pain, facial swelling and sinus infection. Work loss of a few days to a week is to be expected. The subtotal LeFort I procedures, in particular, expose the patient to grave though rare complications of surgery. Lanigan states that separation of the pterygoid plates may infrequently cause excessive hemorrhage, thrombosis (which can lead to stroke), and arteriovenous fistulae between the carotid sinus and carotid artery.[38]

Most patients with maxillary transverse deficiencies have malocclusions without associated facial dysplasia (for example, cases 1, 2, and 4). These patients are usually reluctant to undergo surgery to correct dental alignment problems.

In view of the costs, morbidity, risks, and patient reluctance to undergo surgery, each case should be evaluated to determine if a nonsurgical approach will provide an acceptable correction of maxillary transarch deficiency.

Cases requiring more than 8 to 10 mm of expansion, severe unilateral posterior crossbites with diminished prospect of the mandible centering, and patients with significant gingival recession are likely candidates for SA-RME. Glassman et al. and Kuo and Will have proposed a simplified in-office procedure limited to lateral maxillary corticotomies.[39-40] This approach would involve less risk and cost than the more extensive surgical alternatives. However, for most patients with maxillary width deficiency, as demonstrated by the five cases illustrated in this paper, nonsurgical RMAE using the Haas expander, offers a safe and dependable method of correction.

Acknowledgment

The author wishes to acknowledge the dialogue over many years about the possibility of adult palatal expansion with Dr. Andrew J. Haas of Cuyahoga Falls, Ohio.

The author wishes to acknowledge the critical reading of the manuscript and valuable suggestions by Dr. Carla Evans, Department of Orthodontics, The University of Illinois at Chicago. Thanks are also extended to Adrian Charniak for her careful preparation of this manuscript.

Author Address

Chester S. Handelman
25 East Washington Street
Chicago, IL 60602

C. Handelman, clinical associate professor, Department of Orthodontics, College of Dentistry, University of Illinois, Chicago, Ill.

References

1. Haas AJ. Rapid expansion of the maxillary dental arch and nasal cavity by opening the mid-palatal suture. Angle Orthod 1961; 31:73-90.
2. Wertz RA. Skeletal and dental changes accompanying rapid mid-palatal suture opening. Am J Orthod 1970; 58:41-66.
3. Haas AJ. Long-term posttreatment evaluation of rapid palatal expansion. Angle Orthod 1980; 50:189-217.
4. Bishara SE, Staley RN. Maxillary expansion: clinical implications. Am J Orthod Dentofac Orthop 1987;91:3-14.
5. Proffit WR. Contemporary orthodontics. St. Louis: Mosby, 1986; pp. 239 and 619.
6. McNamara JA Jr., Brudon WL. Orthodontic and orthopedic treatment in the mixed dentition. Ann Arbor: Needham Press; 1993.
7. Melson B. Palatal growth studied on human autopsy material: a histologic microradiographic study. Am J Orthod 1975; 68:42-54.
8. Persson M, Thilander B. Palatal suture closure in man from 15-35 years of age. Am J Orthod 1977; 72:42-52.
9. Bell WH, Epker BN. Surgical orthodontic expansion of the maxilla. Am J Orthod 1976; 79:517-528.
10. Betts NJ, Vanarsdall RL, Barber HD, Higgins-Barber K, Fonseca RJ. Diagnosis and treatment of transverse maxillary deficiency. Int J Adult Orthod Orthognath Surg 1995; 10:75-96.

11. Lines PA. Adult rapid maxillary expansion with corticotomy. Am J Orthod 1975; 67:44-56.
12. Kennedy JW, Bell WH, Kimbrough OL, et al. Osteotomy as an adjunct to rapid maxillary expansion. Am J Orthod 1976; 70:123-37.
13. Lehman JA, Haas AJ, Haas DG. Surgical orthodontic correction of transverse maxillary deficiency: a simplified approach. Plast Recontr Surg 1984; 73:62-66.
14. Bays RA, Greco JM. Surgically assisted rapid palatal expansion: an out-patient technique with long-term stability. J Oral Maxillofac Surg 1992; 50:110-113.
15. Pogrel MA, Kaban LB, Vargerik K, Baumrind S. Surgically assisted rapid maxillary expansion in adults. Int J Adult Orthod Orthognath Surg 1992; 7:37-41.
16. Mossaz CF, Byloff FK, Richter M. Unilateral and bilateral corticotomies for correction of maxillary transverse discrepancies. Eur J Orthod 1992; 14:110-116.
17. Vanarsdall RL. Periodontal/orthodontic interrelationships. In: Graber TM, Swain BF,eds. Orthodontics, current principles and techniques. St. Louis: Mosby, 1994; pp.715-721.
18. Vardimon AD, Graber TM, Voss LR, Lenke J. Determinants controlling iatrogenic external root resorption and repair during and after palatal expansion. Angle Orthod 1991; 61:113-122. (Also see commentary on page 123-124).
19. Handelman CS. Limitations of orthodontic treatment in adults: Part 2, The significance of alveolar width in orthodontic diagnosis and treatment planning. In: McNamara JA, Jr., Trotman CA, eds. Orthodontic treatment: The management of unfavorable sequela. Monograph 31, Craniofacial Growth Series, Center for Human Growth and Development. Ann Arbor: The University of Michigan, 1996; pp.232-240.
20. Haas AJ. Palate expansion: Just the beginning of dentofacial orthopedics. Am J Orthod 1970; 57:219-255.
21. Wertz R , Dreskin M. Midpalatal suture opening: a normative study. Am J Orthod 1977; 71:369-381.
22. Capelozza L, Neto JC, da Silva OG, Ursi WJS. Nonsurgically assisted rapid maxillary expansion in adults. Int J Adult Orthod Orthognath Surg 1996; 11:57-66.
23. Howe RP, McNamara JA, O'Connor KA. An examination of dental crowding and its relationship to tooth size and arch dimension. Am J Orthod 1983; 83:363-373.
24. Burst EW. Arch dimensional changes concurrent with expansion in the mixed dentition. Unpublished Master's thesis. Ann Arbor: Department of Orthodontics and Pediatric Dentistry. University of Michigan: 1992; pp.78 and 82.
25. Krebs A. Midpalatal suture expansion studied by the implant method over a seven year period. Trans Eur Ortho Soc 1964; 40:131-142.
26. Atkins MD, Nanda RS, Currier GF. Arch perimeter changes on rapid palatal expansion. Am J Orthod Dentofac Orthop 1990; 97:194-199.
27. Serino G, Wennström J, Lindhe J, Eneroth L. The prevalence and distribution of gingival recession in subjects with a high standard of oral hygiene. J Clin Periodontal 1994; 2:57-63.
28. Greenbaum KR, Zachrisson BU. The effect of palatal expansion therapy on the periodontal supportive tissues. Am J Orthod 1982; 81:12-21.
29. Årtun J, Krogstad O. Periodontal status of mandibular incisors following excessive proclinations: a study in adults with surgically treated mandibular prognathism. Angle Orthod 1993; 63: 293-299.
30. Steiner CG, Pearson JK, Ainamo J. Changes of the marginal periodontium as a result of labial tooth movement in monkeys. J Periodont 1981; 52:314-320.
31. Timms DJ, Moss JP. An histological investigation into the effects of rapid maxillary expansion on the teeth and their supporting tissues. Trans Eur Orthod Soc 1971; 263-271.
32. Barber AF, Sims MR. Rapid maxillary expansion and external root resorption in man: a scanning electron microscope study. Am J Orthod 1981; 79:630-652.
33. Odenrick L, Karlander EL, Pierce A, Kvetschmar U. Surface resorption following two forms of rapid maxillary expansion. Eur J Orthod 1991; 13:264-270.
34. Erverdi N, Okar I, Kücükkeles N, Arbak S. A comparison of two different rapid palatal expansion techniques from the point of root resorption. Am J Orthod Dentafac Orthop 1994; 106:47-51.
35. Alpern MD, Yurosko JJ. Rapid palatal expansion in adults with and without surgery. Angle Orthod 1987;57:245-263.
36. Spillane LM, McNamara JA, Jr. Maxillary adaptation to expansion in the mixed dentition. Semin Orthod, 1995; 1:176-187.
37. Lanigan DT, Hey JH, West RA. Aseptic necrosis following maxillary osteotomies: report of 36 cases. J Oral Maxillofac Surg 1990; 48:142-156.
38. Lanigan DT. Injuries to the internal carotid artery following orthognathic surgery. Int J Adult Orthod Orthognath Surg 1988; 4:215-220.
39. Glassman AS, Nahigsan SJ, Medway JM, et al. Conservative surgical orthodontic adult rapid palatal expansion: sixteen cases. Am J Orthod 1984; 86:207-213.
40. Kuo PC, Will LA. Surgical-orthodontic treatment of maxillary constriction: state of the art. Oral Maxillofac Surg Clin North Am 1990; 2:751-759.

Commentary: Nonsurgical rapid maxillary alveolar expansion in adults: A clinical evaluation

Robert L. Vanarsdall Jr., DDS

The author should be congratulated for his presentation of five adult cases, "selected for their severity," that received maxillary alveolar expansion in which palatal suture separation was not considered to be essential. The framework of the study mirrors traditional and current orthodontic viewpoints. However, there may be more to be learned by examining critical deficiencies in this report.

It is important to note that none of the five patients had signs of gingival recession prior to treatment. Gingival recession is a documented characteristic of adult patients exhibiting significant skeletal maxillomandibular transverse discrepancy.[1-3] Measurement of transverse tooth widths alone is not diagnostic of transverse maxillomandibular skeletal problems.[4] Only the maxillary molar has been shown to relate to maxillary skeletal width. No other maxillary teeth, and no mandibular teeth have been shown to relate to mandibular arch transverse skeletal dimension.[5] The author's statement that "subjects certainly had maxillary width deficiency" can be questioned because patients were not evaluated from PA radiographs.

In addition, palatal contour tracings clearly reveal significant dental tipping (molars 5° to 9°) along with pure alveolar change. This has been shown to be detrimental periodontally, even in transverse-deficient adolescent patients.[6] Many patients have no buccal plate of bone or dehiscences on the maxillary roots. This precarious anatomy is more prevalent in the maxillary-deficient patient. A recommendation to expand teeth in the worse case scenario (no facial bone, thin soft tissue, dentally compensated teeth) would be considered questionable clinical judgment, a mere camouflaging of orthodontically significant skeletal discrepancy. It would be more stable and sounder periodontally to move posterior teeth into crossbite or leave posterior segments in crossbite and establish anterior functional occlusal goals in the presence of significant transverse discrepancy. Discussion of "envelopes of discrepancy" involves not only transverse tooth widths or dental dimensions in one arch, but should relate to skeletal limits between arches. It is well understood that orthodontic correction can be accomplished for a greater discrepancy in the sagittal plane of space than in the vertical or transverse. Proffit has further stated that, "surgical (only) widening of the maxilla is the least stable of the orthognathic surgical procedures."[7] These five cases (unless they are only transverse dental discrepancies) seem to contradict known expansion data.

The assumption that 0.5 mm of gingival recession is "minimal" would be incorrect since the root surface becomes exposed. Case four received the least amount of maxillary molar expansion (3.9 mm), but is the only case that appears to exhibit posttreatment cervical root exposure in the premolar area (Figure 7B). It is obvious that the transverse skeletal diagnosis has not been established for these patients. Recommendations of 8 to 10 mm of dental expansion ignores diagnostic information that has been gained over the past 20 years.

It is encouraging that surgically assisted expansion is recommended in cases of "maxillary deficiency and tendency for gingival recession." Again, this report is important because it illustrates the fact that any recommended treatment option must be based on a correct diagnosis. There is no evidence that the existence and severity of transverse maxillomandibular discrepancy has been established for patients presented in this report. Patients should do well because of our treatment strategies, *not* in spite of the lack of a definitive diagnosis.

Author Address

Robert L. Vanarsdall, Jr., DDS
Professor and Chair
Department of Orthodontics
University of Pennsylvania
School of Dental Medicine

References

1. Vanardsdall RL. Periodontal/orthodontic interrelationships. In: Graber TM, Vanardsdall RL, eds. Orthodontics: current principles and techniques, ed. 2. St. Louis: Mosby, 1994:712-749.
2. Saacks E, Vanarsdall RL. Evaluation of the skeletal transverse dimension as a risk indicator for maxillary buccal gingival recession in adults (thesis). Philadelphia: University of Pennsylvania, 1996.
3. Vanarsdall RL. Orthodontics and periodontal therapy. Periodontology 2000 1995;9:132-149.
4. Betts NJ, Lisenby CW. Normal adult transverse jaw values obtained using standardized posteroanterior cephalometrics. J Dent Res 1994;73:298.
5. Pedetta F. A comparison study between Dolphin imaging system and the cephalostat on the analysis of the transverse dimension (thesis). Philadelphia: University of Pennsylvania, 1993.
6. Vanarsdall RL, Herberger TA. Rapid palatal expansion: long-term stability and periodontal implications (thesis). Philadelphia: University of Pennsylvania, 1987.
7. Proffit WR, Turvey TA, Phillips C. Orthognathic surgery: a hierarchy of stability. Int J Adult Orthod Orthognath Surg 1996;11:3:200.
8. Betts NJ, Vanarsdall RL, Barber HD, Higgins-Barber K, Fonseca RJ. Diagnosis and treatment of transverse maxillary deficiency. Int J Adult Orthod Orthognath Surg 1995;10:75-96.

Author's response

The reason for labeling the expansion demonstrated in this paper rapid maxillary alveolar expansion (RMAE) was to emphasize that the site of the expansion was the alveolus. The Haas expander, as illustrated in the contour tracings, displaces the alveolus with the teeth rather than expanding the teeth through the alveolus.

The concerns voiced by Dr. Vanarsdall are applicable to "dental only" expansion. For example, a tooth moved buccally by a spring would, in a short time, show buccogingival recession and bone dehiscence.[1,2] Recession induced by tooth movement is usually concurrent with the expansion procedures, but significant recession was not observed with RMAE at retention nor during lengthy follow-up periods. Dr. Vanarsdall implies that the five cases, selected from a previous study,[3] were chosen especially because they did not have recession; in fact, they were selected because they demonstrated how RMAE could be used for correction of various malocclusions associated with maxillary deficiency. These cases had neither more nor less posttreatment gingival recession than did the larger group of 27 subjects. As stated in the paper, RMAE was not recommended for patients with significant pretreatment gingival recession; those patients were referred for surgically assisted expansion.

In a previous report, the control group of adult patients averaged 0.2 mm of gingival recession while the RMAE group had 0.5 mm.[3] I do not concur with Dr. Vanarsdall's concern about this moderate level of recession since gingival recession is frequently seen in adults with otherwise healthy periodontium.[4] This level of iatrogenic insult to the periodontium is probably of less consequence than the bone loss and root resorption seen in adult orthodontic patients.[5]

Acceptance of the crossbite, suggested by Dr. Vanarsdall, was not a realistic alternative for the adult patients in this series. Transverse arch correction was necessary because of the severity of the malocclusions and the need to increase arch length. Surgically assisted expansion was always available as an alternative; however, RMAE was sufficient for correction in each case. Orthodontists need to know that there is a reliable alternative to SA-RME because of its associated morbidity, risks, patient reluctance to undergo the procedure, and the cost, which currently are often borne by the patients.

Reference to the relapse associated with immediate surgical expansion by maxillary osteotomies seems irrelevant since that kind of relapse is caused by contraction of the stretched palatal tissue, and scar tissue formation and has little similarity to the slow expansion of RMAE.

Dr. Vanarsdall has stated previously there is a causal relationship between children who underwent RME and the presence of gingival recession several years later.[6] Before this conclusion can be accepted, we must have an untreated control group with similar malocclusions and maxillary deficiencies for comparison. Gingival recession is multifactorial, and this type of patient may develop gingival recession independent of orthodontic treatment.

Dr. Vanarsdall questions whether these five patients had maxillary width deficiency without confirmation of PA radiographs. Data on maxillary deficiency derived from PA radiography have been presented only in a brief abstract,[7] though its application to the clinical situation has also been described.[8] I would point out some potential problems. First, the data and suggested formulas have not been substantiated in a published controlled clinical study. Second, the use of antegonion may reflect mandibular width but not the width of the basal bone in the mandible. The use of pogonion in the lateral X- ray would present similar problems in determining the position of the lower incisors. Third, Pirttiniemi and coworkers have demonstrated that errors in landmark location and variance in head positioning (especially in the vertical axis) result in large errors in width measurements.[9] In the present paper I compared pretreatment transarch widths to normal standards[10] as well as to an adult orthodontic sample.[3] This approach results in a statistically significant separation of the transverse deficient malocclusion patients from the two control groups.[3]

Since the maxillary molars on pretreatment dental casts have either normal angulation or are angulated buccally (unpublished data), it is unlikely that these severe transverse malocclusions are of dental origin. If patients who required expansion of 7.5, 6.1, 6.5, and 7.5 mm for correction of transverse malocclusions did not have maxillary deficiency, then who does?

In the final analysis, it is the alveolar expansion produced by the Haas appliance that makes the difference, and this challenges us to change our thinking about the possibility of safe and reliable maxillary transarch expansion in the adult.

Chester S. Handelman, DMD
Chicago, Ill.

References

1. Årtun J, Krogstad O. Periodontal status of mandibular incisors following excessive proclinations: a study in adults with surgically treated mandibular prognathism. Angle Orthod 1993; 63: 293-299.
2. Steiner CG, Pearson JK, Ainamo J. Changes of the marginal periodontium as a result of labial tooth movement in monkeys. J Periodont 1981; 52:314-320.
3. Handelman CS. Limitations of orthodontic treatment in adults: Part 2, The significance of alveolar width in orthodontic diagnosis and treatment planning. In: McNamara JA, Jr., Trotman CA, eds. Orthodontic treatment: The management of unfavorable sequelae. Monograph 31, Craniofacial Growth Series, Center for Human Growth and Development. Ann Arbor: The University of Michigan, 1996; pp.232-240.
4. Serino G, Wennström J, Lindhe J, Eneroth L. The prevalence and distribution of gingival recession in subjects with a high standard of oral hygiene. J Clin Periodontal 1994; 2:57-63.
5. Lupi JE, Handelman CS, Sadowsky C. Prevalence and severity of apical root resorption and alveolar bone loss in orthodontically treated adults. Am J Orthod Dentofac Orthop 1996;107:28-37.
6. Vanarsdall RL. Periodontal/orthodontic interrelationships. In: Graber TM, Swain BF, eds. Orthodontics, current principles and techniques. St. Louis: Mosby, 1994; pp.715-721.
7. Betts NJ, Lisenby CW. Normal adult transverse jaw values obtained using standardized posteroanterior cephalometrics (abstract 1567). J Dent Res 1994;73(Special issue):298.
8. Betts NJ, Vanarsdall RL, Barber HD, Higgins-Barber K, Fonseca RJ. Diagnosis and treatment of transverse maxillary deficiency. Int J Adult Orthod Orthognath Surg 1995; 10:75-96.
9. Pirttiniemi P, Miettinen J, Kantomaa T. Combined effects of errors in frontal-view asymmetry diagnosis. Eur J Orthod 1996;18:629-636.
10. Howe RP, McNamara JA, O'Connor KA. An examination of dental crowding and its relationship to tooth size and arch dimension. Am J Orthod 1983; 83:363-373.