Original Article

Stability in Dental Changes in RME and SARME: A 2-Year Follow-up

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ABSTRACT

Objective: To compare the effects of rapid maxillary expansion (RME) and surgically assisted rapid maxillary expansion (SARME) on dentoalveolar structures following orthodontic treatment, as well as stability at 2-year follow-up.

Materials and Methods: Two groups of subjects were used in the study. Group 1 consisted of 14 subjects (mean age, 12.7 ± 1.4 years) who were treated with RME, and Group 2 consisted of 13 subjects (mean age, 18.5 ± 2.3 years) who were treated with SARME. In both groups, all cases had a maxillary width deficiency with bilateral crossbites. Maxillary dental casts were available at three different intervals: pretreatment (T1), after orthodontic treatment (T2), and at follow-up recall (T3). Intermolar and interpremolar width, palatal height, and maxillary arch depth and length were assessed from maxillary dental casts.

Results: Treatment by RME and SARME produced significant increases in intermolar and interpremolar width and maxillary arch length after expansion (T2) ($P < .05$). The amount of relapse was not significantly different 2 years after treatment ($P > .05$).

Conclusions: Although age ranges of the patient groups are different, the dentoalveolar responses of RME and SARME were similar after orthodontic treatment. (*Angle Orthod.* 2009:79;)

KEY WORDS: Rapid maxillary expansion; Surgically assisted rapid maxillary expansion; Dentoalveolar changes; Dental cast

INTRODUCTION

Maxillary constriction with concomitant posterior crossbite is one of the most common dentoskeletal problems encountered clinically. The treatment procedure for this problem was first introduced by Angell in 1860.[1] The effects of rapid maxillary expansion (RME) are not limited to the upper jaw because the maxilla is connected with many other bones.[2] An RME procedure separates the external walls of the nasal cavity laterally and causes lowering of the palatal vault and straightening of the nasal septum.[3] This remodeling decreases nasal resistance, increases internasal capacity, and improves breathing.[4,5]

Maxillary width deficiencies are corrected routinely in growing patients with the use of appliances that help to separate the midpalatal and associated maxillary sutures. However, this technique is not useful in skeletally mature individuals.[6] Isaacson et al[7] showed that the facial skeleton increases its resistance to expansion as it ages and matures. After sutural closure or completion of skeletal maturation, expansion without surgery causes less bony displacement and more dentoalveolar movement. This can lead to many problems in adults, including pain upon activation of the appliance, extrusion of the teeth, and periodontal complications.[8] Therefore, large transverse discrepancies in adults are corrected preferably through combined surgical orthodontic treatment. Surgically assisted rapid maxillary expansion (SARME) or a segmental Le Fort I osteotomy is used in an attempt to overcome the resistance of maturing sutures.

Another alternative, SARME, was first described by Brown in 1938.[9] Recently, SARME has been accepted as a simple and effective surgical procedure for treatment of severe maxillary deficiencies in adult patients.

Long-term stability of RME is inquired by many investigators.[10–12] The various sample sizes, age ranges, and methods of retention have not provided a concrete idea about relapse after retention. However, the ortho-

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Accepted: April 2008. Submitted: March 2008.

Table 1. Distribution of Age, Average Years of Treatment, and Retention Periods of the Groups

		T1	T2	T3
Groups	n	Mean Age	Years in Treatment	Years in Retention
RME	13	12.71 ± 1.43	2.01 ± 1.05	2.02 ± 0.57
SARME	14	18.46 ± 2.33	1.83 ± 0.90	2.12 ± 0.37

dontic literature regarding stability following SARME is limited. Byloff and Mossaz[8] observed the stability of dental and skeletal effects of SARME for 1 year.

Atac et al[13] compared skeletal changes between RME and SARME after expansion and suggested that long-term studies of the outcomes of these treatments were needed. Northway and Meade[14] and Berger et al[15] compared the long-term outcomes of RME vs SARME. However, the RME group consisted of different age ranges in both studies.[14,15] Northway and Meade[14] studied patients older than 20 years of age, and Berger et al[15] studied prepubertal patients with a mean age of 8.5 years. The average age range for RME is between 11 and 13 years, just before maxillary sutural ossification occurs.[16]

The aim of this study was to compare the detailed dental changes seen with RME and SARME following orthodontic treatment, as well as stability after 2-year follow-up.

MATERIALS AND METHODS

Subjects in this study were informed, and the study was approved by the local ethics committee. The sample included 27 subjects with maxillary bilateral crossbite. The study sample was divided into two groups. The first group (RME group) included 14 subjects—8 girls and 6 boys—whose mean age was 12.7 ± 1.4 years. The second group (SARME group) included 13 subjects—9 girls and 4 boys—whose mean age was 18.5 ± 2.3 years. Table 1 shows the distribution and average expansion periods, as well as average retention periods of subjects.

A modified bonded acrylic RME appliance was used for the expansion process in both groups. This type of RME appliance provides control of vertical dimension changes that occur in growing patients during maxillary expansion.[17] The RME appliance was cemented in all subjects with the use of glass ionomer cement (Ketac-Cem, Espe Dental AG, Seefeld, Germany).

In the SARME group, the surgical procedure was done as described in the literature.[18] The standard horizontal osteotomy, from the piriform aperture to the pterygomaxillary dysjunction bilaterally, was performed with the subject under sedation and local anesthesia.

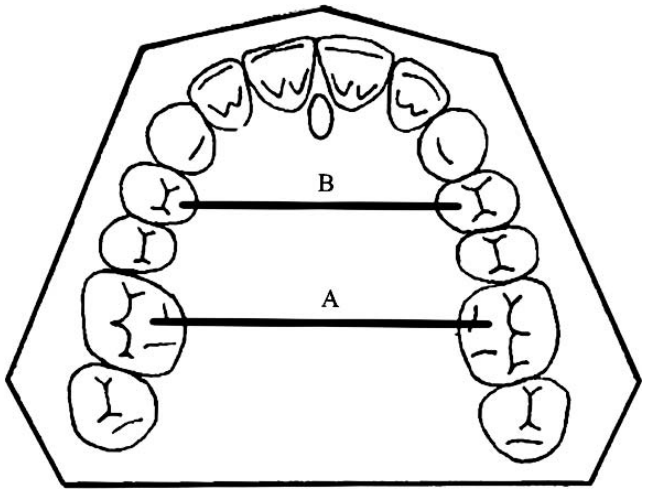

Figure 1. (A) Intermolar width, the distance between mesiolingual cusp tips of the upper molars. (B) Interpremolar width, the distance between the palatal cusp tips of the upper first premolars.

In both groups, the appliance was activated one-quarter turn once a day during the expansion period until the desired suture opening was achieved. At that time, the screw was fixed with 0.014-inch ligature wire, and the appliance was left for 1 week to minimize discomfort during removal. All subjects demonstrated sutural opening, which was confirmed by an occlusal radiograph. After removal, the appliance used in active treatment was cleaned and reused as a removable retention appliance for 6 months. A transpalatal arch was used during fixed appliance therapy, and nonextraction treatment was performed in all cases. After debonding, a Hawley plate was used for 1 year during the retention period. Two years after debonding, subjects were recalled for a follow-up appointment.

Cast Analysis

Dental casts were taken before treatment (T1), after orthodontic treatment (T2), and at follow-up recall (T3) (Table 1). Direct measurements of the maxillary casts were taken to the nearest 0.1 mm with Vernier calipers. The measurements were performed by one clinician. The following dimensions were measured.

Intermolar and Interpremolar Width

Intermolar width is the distance between the mesiolingual cusp tips of the upper molars (Figure 1). In some cases, the canines had not fully erupted and, therefore, the premolar was selected as an anterior width landmark. Interpremolar width is the distance between the palatal cusp tips of the upper first premolars (Figure 1).

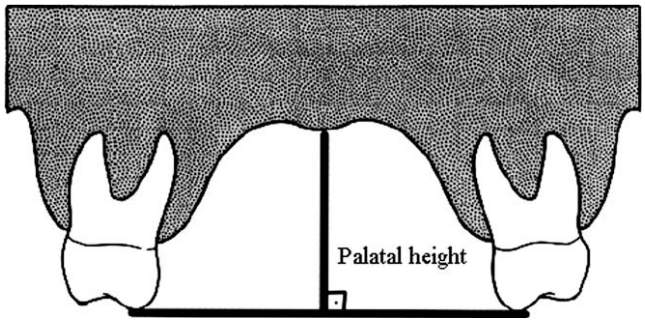

Figure 2. To standardize measurement of palatal depth, models were trimmed until the distal contact point of upper first molars showed up on edge. The distance from the mid-deepest part of the palate to the line connecting left and right distolingual cusp tips of the upper first molars was taken as the palatal depth.

Palatal Height

To standardize measurement of palatal depth, models were trimmed until the distal contact point of the upper first molars showed up on the edge. Distance from the mid-deepest part of the palate to the line connecting the left and right distolingual cusp tips of the upper first molars was taken as palatal depth (Figure 2).

Maxillary Arch Depth

Arch depth was determined by measuring the length of a perpendicular line constructed from the contact point between the mesial contact points of the central incisors to a line connecting the contact points between the second premolars and the first molars (Figure 3).

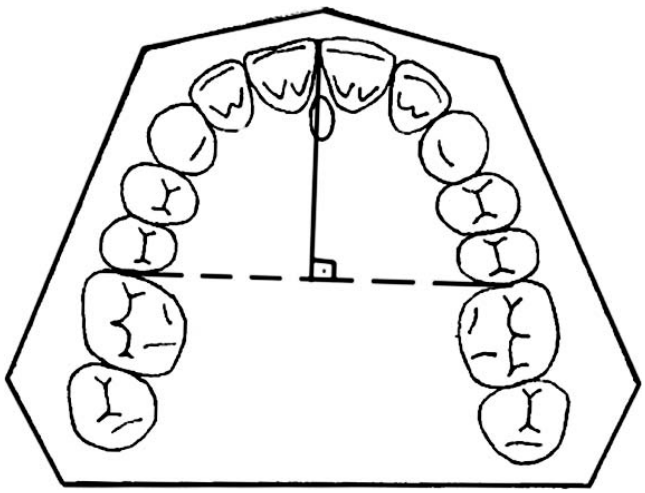

Figure 3. Arch depth was determined by measuring the length of a perpendicular line constructed from the contact point between the mesial contact points of the central incisors to a line connecting the contact points between the second premolars and first molars.

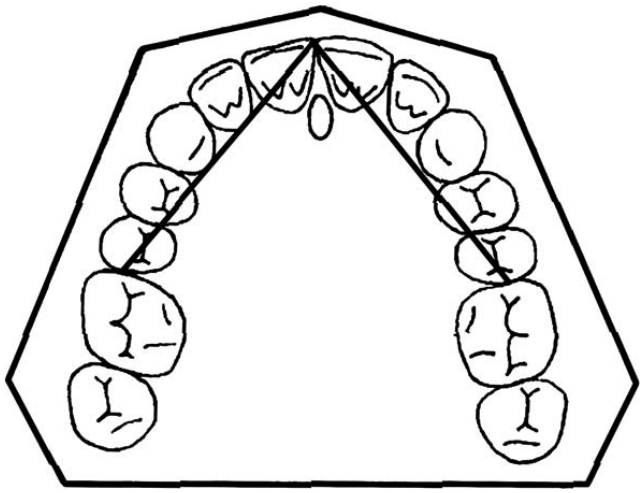

Figure 4. Arch length was determined by measuring the length of two lines connecting the contact points between the mesial contact points of the central incisors with the contact points between the second premolars and the first molars.

Maxillary Arch Length

Arch length was determined by measuring the length of two lines connecting the contact points between the mesial contact points of the central incisors with the contact points between the second premolars and the first molars (Figure 4).

Measurement Error and Statistical Analyses

To evaluate the measurement error in landmark identification, 15 randomly selected model casts were remeasured after a 1-month interval by the same clinician. Method errors were calculated with the use of Dahlberg's formula ($\sqrt{\Sigma\, d^2/2n}$). Results were calculated with the Statistical Package for the Social Sciences software (SPSS) for Windows (Release 10.0, SPSS Inc, Chicago, Ill). The arithmetic mean and the standard deviation among groups were studied through analysis of variance (ANOVA). To determine the differences among groups, Bonferroni tests were used. The Mann-Whitney *U*-test was performed to compare differences between groups.

RESULTS

The measurement error was calculated to vary from .268 to .755 and was found to be insignificant.

Intermolar and Interpremolar Widths Among Groups (Tables 2 and 3)

Both RME and SARME groups showed differences in intermolar and interpremolar widths among the groups ($P < .05$). These differences were seen between pretreatment and posttreatment (T1-T2) and

Table 2. Comparison of Intermolar Width Changes

Intermolar Width	T1	T2	T3	T1-T2	T1-T3	T2-T3
RME Mean ± SD	39.07 ± 3.05	41.9 ± 1.85	41.72 ± 2	*	*	NS[a]
SARME Mean ± SD	38.03 ± 2.47	41.13 ± 2.10	40.9 ± 1.37	*	*	NS
P value	.452 NS	.481 NS	.264 NS			

[a] NS indicates nonsignificant; * Significant at the .05% level of confidence.

Table 3. Comparison of Interpremolar Width Changes

Interpremolar Width	T1	T2	T3	T1-T2	T1-T3	T2-T3
RME Mean ± SD	27.37 ± 2.68	32.62 ± 1.62	32.02 ± 1.66	*	*	NS[a]
SARME Mean ± SD	28 ± 2.27	32.81 ± 2.19	31.94 ± 2.63	*	*	NS
P value	.496 NS	.734 NS	.593 NS			

[a] NS indicates nonsignificant; * Significant at the .05% level of confidence.

Table 4. Comparison of Palatal Height Changes

Palatal Height	T1	T2	T3	T1-T2	T1-T3	T2-T3
RME Mean ± SD	17.59 ± 2.42	18.23 ± 3.29	20.22 ± 2.53	NS[a]	*	*
SARME Mean ± SD	20.33 ± 1.91	19.94 ± 2.34	20.54 ± 2.22	NS	NS	NS
P value	.002*	.076 NS	.698 NS			

[a] NS indicates nonsignificant; * Significant at the .05% level of confidence.

Table 5. Comparison of Arch Depth Changes

Arch Depth	T1	T2	T3	T1-T2	T1-T3	T2-T3
RME Mean ± SD	38.53 ± 1.88	37.83 ± 2.03	38.19 ± 1.95	NS[a]	NS	NS
SARME Mean ± SD	36.34 ± 4.02	36.77 ± 3.77	36.44 ± 3.89	NS	NS	NS
P value	.089 NS	.343 NS	.120 NS			

[a] NS indicates nonsignificant; * Significant at the .05% level of confidence.

between pretreatment and follow-up (T1-T3) measurements ($P < .05$). Posttreatment and follow-up (T2-T3) measurements showed no significant differences ($P > .05$).

Intermolar and Interpremolar Widths Between Groups (Tables 2 and 3)

The RME group showed no differences from the SARME group throughout the whole measurement time ($P > .05$).

Palatal Height Among Groups (Table 4)

The RME group showed differences in palatal height among groups. Differences were seen between pretreatment and follow-up (T1-T3) ($P < .05$). Pretreatment and posttreatment measurements (T1-T2) and posttreatment and follow-up (T2-T3) measurements showed no significant differences ($P > .05$). The SARME group showed no differences in palatal height during the entire measurement time ($P > .05$).

Palatal Height Between Groups (Table 4)

The RME group showed statistically differences from the SARME group only in terms of pretreatment time (T1) ($P < .05$).

Maxillary Arch Depth Among Groups (Table 5)

Both RME and SARME groups showed no statistical differences in maxillary arch depth at all measurement times ($P > .05$).

Table 6. Comparison of Arch Length Changes

Arch Length	T1	T2	T3	T1-T2	T1-T3	T2-T3
RME Mean ± SD	68.98 ± 3.47	72.91 ± 2.26	72.17 ± 1.98	*	*	NS[a]
SARME Mean ± SD	67.62 ± 4.15	70.92 ± 3.83	70.77 ± 4.02	*	*	NS
P value	.98 NS	.109 NS	.149 NS			

[a] NS indicates nonsignificant; * Significant at the .05% level of confidence.

Maxillary Arch Depth Between Groups (Table 5)

The RME group showed no differences from the SARME group throughout the whole measurement time ($P > .05$).

Maxillary Arch Length Among Groups (Table 6)

Both RME and SARME groups showed differences in arch length between groups ($P < .05$). These differences were seen between pretreatment and posttreatment (T1-T2) and between pretreatment and follow-up (T1-T3) measurements ($P < .05$). Posttreatment and follow-up (T2-T3) measurements showed no significant differences ($P > .05$).

Maxillary Arch Length Between Groups (Table 6)

The RME group showed statistically differences from the SARME group only in the pretreatment time (T1) ($P < .05$).

DISCUSSION

The objective of this study was to compare the dental changes in RME and SARME groups after orthodontic treatment and during the retention period. Our results showed that the intermolar and interpremolar increase after expansion was significant in both groups. When RME and SARME groups were compared, a similar significant gain was seen in the intermolar width of the maxilla (2.83 mm and 3.10 mm, respectively) in both groups. Handelman et al[19] and McNamara et al[20] found an intermolar width increase of between 4.8 mm and 3.7 mm in their RME cases.

We looked at interpremolar changes in the anterior region, as Northway and Meade[14] had reported. Cases requiring palatal expansion often have labially occluding canines. These blocked-out canines can be moved into narrower positions through the alignment that takes place when the transverse discrepancy has been resolved; consequently, the canines will not show as much width increase as is shown by the molars. In this light, the interpremolar measurement looked to be a reliable method for use as a criterion of anterior expansion. The amount of expansion in the interpremolar width was significant in both groups (5.25 mm at RME; 4.81 mm at SARME).

Moussa et al[21] reported the results of RME cases 8 years after retention. The intermolar width had increased by 5.5 mm, and the intercanine width had increased by 2.7 mm. Similar buccal corticotomy results were reported by Northway and Meade[14] 3 years after retention (intermolar, 5.8 mm; intercanine, 4.5 mm). However, Byloff and Mossaz[8] observed a 36% relapse in their SARME group. They indicated that approximately 2 mm on each side had relapsed during fixed appliance therapy. These previous studies, which reported a high percentage of relapse after treatment, did not mention the overcorrection.[8,14,21]

It would appear that both expansion techniques provide adequate correction of transverse discrepancies. Our results showed that not only were intermolar and interpremolar width changes similar after expansion, but intermolar and interpremolar width increases were stable in retention, in both RME and SARME groups.

The conclusion of this study is that RME and SARME responses are the same after expansion and during the retention period. In support of this study, Northway and Meade[14] compared RME with SARME and reported no changes in intercanine and intermolar widths. Byloff and Mossaz[8] observed that interpremolar and intermolar widths had changed 1 year after fixed appliance therapy, and that SARME was clinically effective and stable. Babacan et al[5] did not find different amounts of expansion in either the RME or SARME group, and they believed that the surgical procedure is useful only for overcoming resistance in the SARME group.

Initially, the palatal height of the RME group was significantly lower than that of the SARME group (RME, 17.6 ± 2.4 mm; SARME, 20.3 ± 1.9 mm). Palatal height was increased in the RME group after expansion. Despite this, the palatal height in the SARME group after expansion was decreased, but this change was not statistically significant.

The RME group caught up to the SARME group after expansion in palatal height. The RME group consisted of juvenile patients who still had the potential for palatal growth.[22,23] Subjects in the SARME group who were older than 20 years of age had completed their growth in the palate.

Change in palatal height is an outcome of growth in

the RME. The growth of palatal height during the retention period continued in the RME group. The SARME did not give any response to the expansion in terms of any measurements. Finally, RME values were similar to SARME values during the retention period.

Another approach to palatal height is that expansion may stimulate palatal height by giving the tongue more space. The new position of the tongue provides an increase in palatal height only in cases with the potential for palatal growth. However, this new adaptation theory did not apply in the SARME group because of their older age.[24]

SARME groups showed a slight decrease in palatal height after the expansion. However, in the following period, palatal height was slightly increased. Northway and Meade[14] found similar results and related this change to the reorganization of scarring structures.

Arch depth followed similar trends after the expansion and in the retention period in both groups. Our study showed that the arch depth of the maxilla in both groups was not affected after the expansion and during the following period. McNamara et al[20] compared arch depth parameters of RME with those of the control group. The arch depth of the RME was initially smaller than that of the control group and remained so until completion of the observation period, which lasted longer than 3 years. Arch depth may be an important indicator for predicting stability after expansion. A change in this parameter may make it necessary to face relapse after expansion.

Arch lengths increased significantly in both groups (3.9 mm at RME; 3.3 mm at SARME). Although the arch length before the expansion was statistically different between groups, after the expansion no statistical difference was observed.

McNamara et al[20] and Moussa et al[21] observed a greater decrease in arch length during the retention period (−3.5 mm and −2.5 mm). However, in the overall observation period, the newly gained space was 2.8 mm and 1.6 mm, respectively. In our study, the space gained was stable in the RME group, and the SARME group (3.2 mm and 3.2 mm, respectively) was more stable during the overall observation period. Memikoglu and Iseri[25] looked at the expansion of RME 1 year after active treatment with a bonded expander and found the intercanine width to be stable. They related the stable results to the rigid acrylic bonded RME appliance. We used a similar appliance with Hyrax screws in our study. Therefore, long-term retention may be more stable in both groups.

CONCLUSIONS

- Although the age ranges of the patient groups are different, the dentoalveolar responses with RME and SARME are similar after orthodontic treatment.
- Dentoalveolar changes after both RME and SARME are stable 2 years after treatment.

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