Original Article

Skeletal and dentoalveolar effects of slow vs rapid activation protocols of miniscrew-supported maxillary expanders in adolescents: *A randomized clinical trial*

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ABSTRACT

Objectives: To compare between skeletal and dentoalveolar effects of slow and rapid activation of miniscrew-supported expanders.

Materials and Methods: A total of 30 patients were randomly allocated to two groups using block randomization and the allocation ratio 1:1. Both groups received maxillary expanders anchored using four miniscrews. Activation protocol was once every other day in the slow expansion (SME) group and twice daily in the rapid expansion (RME) group. Cone-beam computed tomography (CBCT) scans were obtained before expansion and after removal of the expanders. Transverse skeletal and dentoalveolar changes were measured using CBCT.

Results: A total of 12 patients in the SME group (mean age, 14.30 $\pm$ 1.37 years) and 12 patients in the RME group (mean age, 15.07 $\pm$ 1.59 years) were analyzed. RME showed significantly greater widening of the mid-palatal suture at the level of first molars (mean difference [SME $-$ RME] $= -0.61$ mm), and a greater increase in right and left molar buccal inclination (mean difference= $-3.83°$ and $-2.03°$, respectively). Percentage of skeletal expansion relative to the jackscrew opening was not significantly different between the groups. Palatal inflammation was evident following appliance removal. Miniscrew mobility and bending were observed with RME.

Conclusions: Both SME and RME were effective in correcting skeletal transverse maxillary deficiency. However, RME resulted in more buccal tipping of maxillary molars and in miniscrew failures and bending. (*Angle Orthod.* 2022;92:579–588.)

KEY WORDS: Rapid maxillary expansion; Slow maxillary expansion; Miniscrew-supported expansion; Activation protocol

INTRODUCTION

Transverse maxillary deficiency is commonly encountered by orthodontists, and its treatment usually involves rapid maxillary expansion (RME).[1] Many tooth-supported expanders were described in the literature, but their expansion forces are transmitted to the mid-palatal suture through anchor teeth, which often results in adverse effects, including buccal tipping and root resorption of anchor teeth, gingival recession, and fenestration of the buccal bone.[2–4]

Miniscrew-supported maxillary expanders were proposed to reduce the deleterious effects of conventional expanders.[5] The effectiveness of maxillary expanders supported solely by miniscrews without banding any teeth was previously demonstrated using cone-beam computed tomography (CBCT).[5–11]

Tooth-supported expanders are commonly activated rapidly to maximize skeletal effects and minimize dentoalveolar effects.[12] However, it is currently not clear whether this activation protocol may be appropriate to miniscrew-supported expanders. A recent finite element analysis study found that a single miniscrew-supported expander activation resulted in the same amount of mid-palatal suture opening as three activations of tooth-supported expanders.[13] Hence, it was suggested that the activation protocol should be slow to allow dissipation of stresses to avoid

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bone fractures around miniscrews that in turn might affect miniscrew stability.[13]

Activation protocols of miniscrew-supported expanders in previous studies ranged from slow expansion once every other day[5] to rapid expansion four times daily.[10] The most common expansion regimen, however, was found to be twice daily.[7,9,11,14] A recent systematic review found that a comparison between miniscrew-supported slow maxillary expansion (SME) and RME has not been described in the literature.[15]

Therefore, this randomized clinical trial (RCT) was conducted to evaluate and compare between skeletal and dentoalveolar effects of slow and rapid activation protocols of miniscrew-supported maxillary expanders. The null hypothesis was that there would be no difference between the activation protocols regarding their skeletal and dentoalveolar effects on the maxilla.

MATERIALS AND METHODS

Trial Design

This study was a single-center, two-arm parallel RCT with a 1:1 allocation ratio. The protocol was registered at Clinicaltrials.gov (NCT04225637).

Participants, Eligibility Criteria, and Setting

Patients were recruited from the outpatient clinic, Faculty of Dentistry, Alexandria University after obtaining approval from the faculty's research ethics committee (IRB: 00010556 - IORG: 0008839). Inclusion criteria were age 12–16 years, permanent dentition, good oral hygiene, and transverse maxillary deficiency warranting skeletal maxillary expansion. The need was quantified on digital dental casts by measuring the difference between maxillary width (distance between right and left most concave points of the maxillary vestibule at the mesio-buccal cusp of the first molars) and mandibular width (distance between right and left mandibular WALA ridge at the mesio-buccal groove of the first molars).[16] Patients with a history of maxillary trauma, previous orthodontic treatment, congenital craniofacial malformations, or systemic diseases or who were taking medications were excluded. Participants were excluded in cases of oral hygiene deterioration, lack of miniscrew primary stability, failure of all miniscrews during the experimental period, or discontinuation requests as a result of severe pain.

Sample Size Calculation

Sample size calculation was made using NCSS 2004 and PASS 2000 programs (NCSS LLC, Kaysville, Utah). A mean difference of sutural separation at the maxillary first molars of 2 mm was used as the mean difference for comparison between the two groups using independent-samples *t*-tests, and the standard deviation (SD) of suture separation was set at 1.5.[9] At $\alpha = 0.05$ and a power of 0.90, a minimum sample size of 12 patients per group was required, which was increased to 15 patients to allow for possible attrition.

Randomization

Patients were randomly assigned to one of two groups (SME or RME) via computer-generated block randomization with a block size of six and a 1:1 allocation ratio.[17] Allocation was concealed from the orthodontist and the patients using sequentially numbered, opaque, sealed envelopes prepared by another researcher. When deemed eligible, each patient's name was written on the next envelope in the sequence, the envelope was then opened, and the group allocation was reported to the orthodontist.

Interventions

Oral assents and informed consents were obtained from patients and parents, respectively, before study commencement. Both groups received a miniscrew-supported maxillary expander (Figure 1). Four self-drilling miniscrews (1.6 $\times$ 10 mm, H-screw, Hubit Co Ltd, Ojeon-Dong, Korea) were placed in the palate, bilaterally, between the first and second premolars and between the second premolars and first molars. An alginate impression was made and poured in dental stone. A 9-mm expansion screw (Leone Orthodontic Products, Sesto Fiorentino, Firenze, Italy) was placed, and acrylic pads were fabricated. The finished appliance was cemented using light-cure flowable composite resin (Te-econom flow, Ivoclar Vivadent, Schaan, Liechtenstein). The appliance was activated once every other day in SME group and twice daily in RME group. Expansion was considered complete when transverse maxillary deficiency was corrected as measured on digital dental casts.[18] The appliance was left in place for retention. At the end of the retention period, 5 months after the initial activation, the appliance was removed.

CBCT scans were obtained before expansion (T1) and after removal of the appliance (T2) with the following parameters: 120 Kvp, 5 mA, 640 $\times$ 640 $\times$ 544 field of view, 25-second scanning time, and 0.25 voxel size (i-CAT Next Generation, Imaging Sciences International, Hatfield, Pa). Data were exported in Digital Imaging and Communications in Medicine (DICOM) format and processed using OnDemand3D software (Cybermed Inc., Seoul, Korea). To standard-

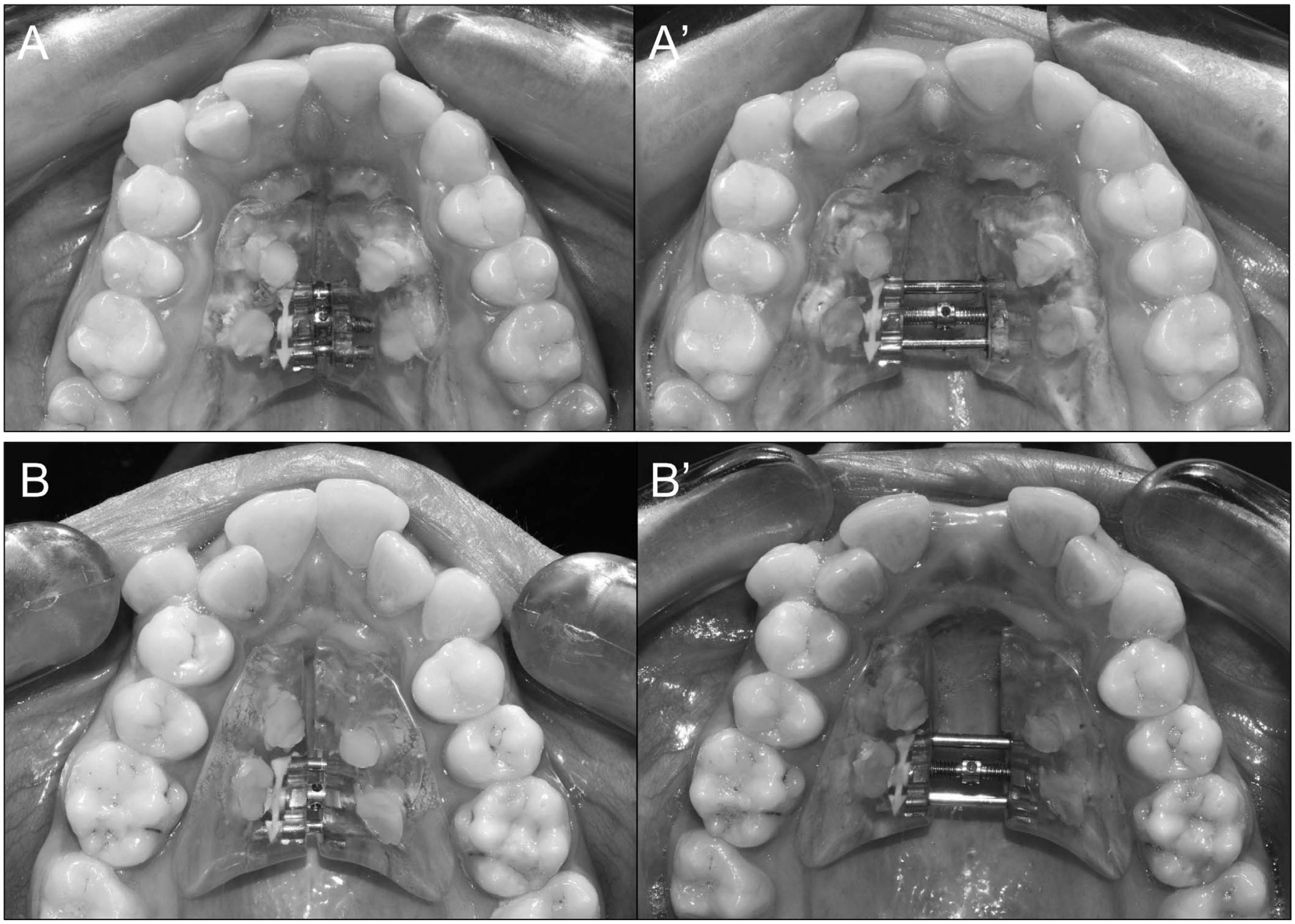

Figure 1. Pre- and postexpansion occlusal photographs of (A and A’) an SME patient and (B and B’) an RME patient.

ize the analysis procedures, the axial plane was reoriented to be parallel to the palatal plane in both the sagittal and coronal cuts. Then, the coronal axis was reoriented in the axial cut to bisect the palatal roots of maxillary first premolars or first molars when making measurements at the level of first premolars or at the level of first molars, respectively.

Outcomes

Primary outcomes of the study were the transverse skeletal and dentoalveolar changes at the end of the retention period measured using CBCT. The measured parameters are defined in Table 1 and shown in Figures 2 and 3. Secondary patient-related outcomes will be reported in a future publication.

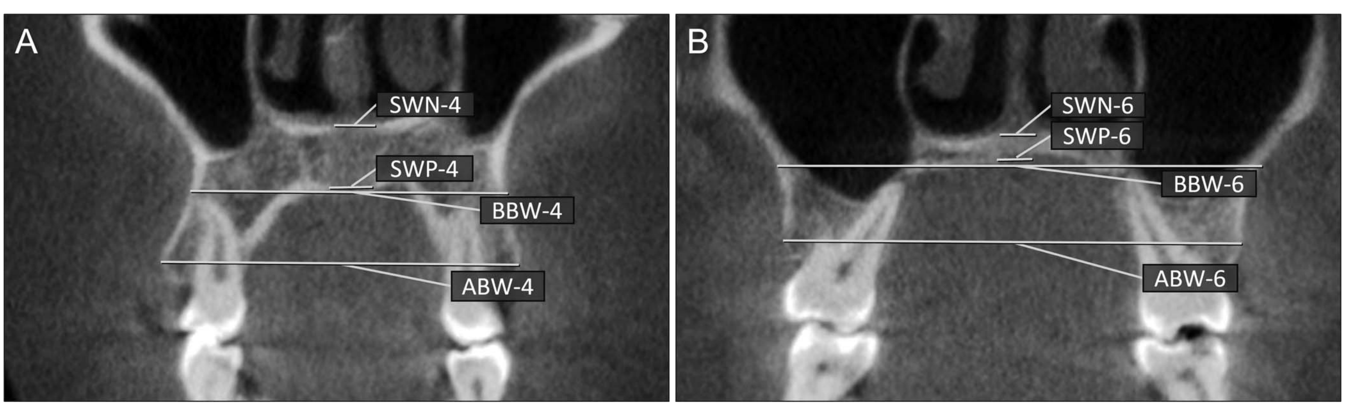

Figure 2. Skeletal transverse measurements. (A) At first premolars. (B) At first molars. (See Table 1 for abbreviations.)

Table 1. Definitions of Measured Parameters on the CBCT

Parameter		Definition
Skeletal parameters		
SWN-4	Suture width at nasal floor at first premolar	Widest intermaxillary suture width between the right and left cortical borders at the nasal floor measured on the coronal slice at the level of maxillary first premolars
SWP-4	Suture width at palatal floor at first premolar	Widest intermaxillary suture width between the right and left cortical borders at the palatal floor measured on the coronal slice at the level of maxillary first premolars
SW-4	Average suture width at first premolar	The average suture width on the coronal slice at the first premolar calculated as the average of SWN-4 and SWP-4
SWN-6	Suture width at nasal floor at first molar	Widest intermaxillary suture width between the right and left cortical borders at the nasal floor measured on the coronal slice at the level of maxillary first molars
SWP-6	Suture width at palatal floor at first molar	Widest intermaxillary suture width between the right and left cortical borders at the palatal floor measured on the coronal slice at the level of maxillary first molars
SW-6	Average suture width at first molar	The average suture width on the coronal slice at the first molar calculated as the average of SWN-6 and SWP-6
BBW-4	Basal bone width at first premolar	Maxillary basal bone width measured on the coronal slice at the level of the maxillary first premolars on a line parallel to the palatal plane and tangent to the lower border of the hard palate
BBW-6	Basal bone width at first molar	Maxillary basal bone width measured on the coronal slice at the level of the maxillary first molars on a line parallel to the palatal plane and tangent to the lower border of the hard palate
ABW-4	Alveolar bone width at first premolar	Widest maxillary alveolar bone width measured on the coronal slice at the level of the maxillary first premolars
ABW-6	Alveolar bone width at first molar	Widest maxillary alveolar bone width measured on the coronal slice at the level of the maxillary first molars
Dentoalveolar parameters		
Apex-4	First premolar interapex width	Distance between the (palatal) root apex of the maxillary right first premolar and maxillary left first premolar
Apex-6	First molar interapex width	Distance between the palatal root apex of the maxillary right first molar and maxillary left first molar
Cusp-4	First premolar intercusp width	Distance between the palatal cusp tip of the maxillary right first premolar and maxillary left first premolar
Cusp-6	First molar intercusp width	Distance between the palatal cusp tip of the maxillary right first molar and maxillary left first molar
RtDentInc-4	Right first premolar inclination	Buccolingual inclination of the maxillary right first premolar measured as the angle between its (palatal) root axis and a horizontal reference line parallel to the palatal plane
LtDentInc-4	Left first premolar inclination	Buccolingual inclination of the maxillary left first premolar measured as the angle between its (palatal) root axis and a horizontal reference line parallel to the palatal plane
RtDentInc-6	Right first molar inclination	Buccolingual inclination of the maxillary right first molar measured as the angle between its palatal root axis and a horizontal reference line parallel to the palatal plane
LtDentInc-6	Left first molar inclination	Buccolingual inclination of the maxillary left first molar measured as the angle between its palatal root axis and a horizontal reference line parallel to the palatal plane
RtAlvInc-4	Right first premolar alveolar inclination	Angle between the palatal alveolar bone of the right maxillary first premolar and a horizontal reference line parallel to the palatal plane
LtAlvInc-4	Left first premolar alveolar inclination	Angle between the palatal alveolar bone of the left maxillary first premolar and a horizontal reference line parallel to a horizontal reference line parallel to the palatal plane
RtAlvInc-6	Right first molar alveolar inclination	Angle between the palatal alveolar bone of the right maxillary first molar and a horizontal reference line parallel to the palatal plane
LtAlvInc-6	Left first molar alveolar inclination	Angle between the palatal alveolar bone of the left maxillary first molar and a horizontal reference line parallel to the palatal plane

Blinding

Because of the nature of the intervention, blinding of the patients or the orthodontist was not possible. However, the statistician was blinded during data assessment.

Statistical Analysis

Statistical analysis was performed using IBM SPSS software, version 25 (IBM Corp., Armonk, N.Y.). Significance level was set at $P \leq .05$. Data were tested for normal distribution using descriptive statis-

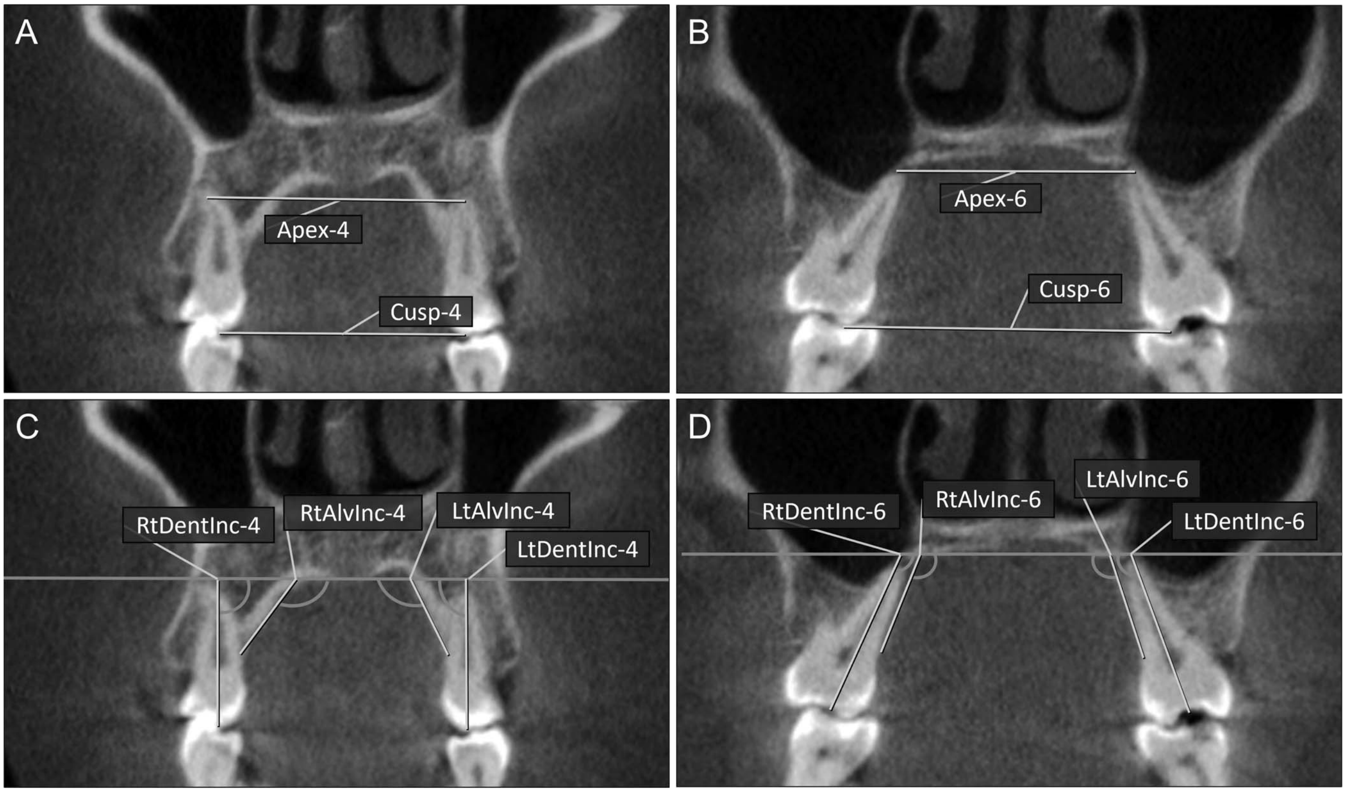

Figure 3. Dentoalveolar measurements. (A and B) Linear measurements at first premolars and first molars. (C and D) Angular measurements at first premolars and first molars. (See Table 1 for abbreviations.)

tics, plots (histogram and box plot), and Shapiro-Wilk test. When found to be normally distributed, parametric tests were applied, and when not normally distributed, nonparametric tests were applied. To calculate the error of measurement, CBCT measurements were repeated after 2 weeks by the same researcher and another investigator on 20% of the sample. Intra-examiner and interexaminer reliability were assessed using intraclass correlation coefficient (ICC).

RESULTS

Patient recruitment started in February 2019 and ended when the required sample size was attained in December 2020. Flow of participants during the trial and reasons for losses and exclusions from the study are shown in Figure 4. The demographic and clinical characteristics of both groups are shown in Table 2.

The intervention was discontinued for one RME patient because of loosening of all miniscrews during appliance activation as evidenced by appliance mobility, enlargement of palatal soft tissues around the appliance, and failure to develop a midline diastema.

The posterior crossbite was successfully corrected in all patients analyzed in the RME group. Conversely, two patients in the SME group had a dental crossbite remaining at the end of the expansion period despite correcting the skeletal transverse discrepancy.

Intraexaminer and interexaminer reliability for the measured CBCT variables were considered excellent (ICC greater than 0.90).[19]

Changes in the measured parameters from T1 to T2 in both groups are shown in Table 3. RME resulted in significantly greater sutural expansion at the level of first molars compared with SME. The increase in first molar intercusp width was significantly higher with RME compared with SME, whereas the increase in interapex width was significantly higher with SME compared with RME. The increase in first molar dental inclination was significantly higher in RME than in SME.

The mean mid-palatal suture expansion at the level of first molars (SW-6) was 38.99% $\pm$ 12.26% and 48.58% $\pm$ 13.67% of the jackscrew opening in the SME and RME groups, respectively. An independent-samples *t*-test did not show any significant difference between the two groups ($P = .084$).

The percentage of skeletal expansion (SW-4) out of total expansion (Cusp-4) at the level of first premolars was 62.12% $\pm$ 16.62% in the SME group and 50.24% $\pm$ 16.86% in the RME group, and an independent-samples *t*-test did not show any significant difference

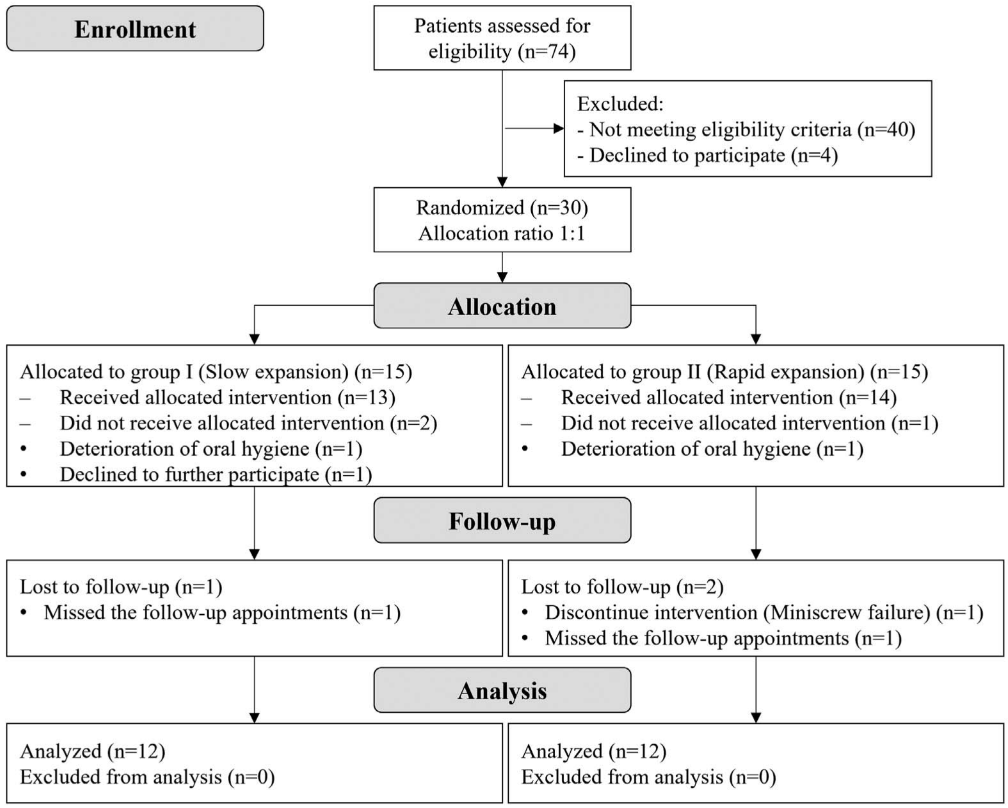

Figure 4. Consolidated Standards of Reporting Trials flowchart.

between the two groups ($P = .096$). Similarly, at the level of first molars, the percentage of skeletal expansion (SW-6) out of total expansion (Cusp-6) was not significantly different ($P = .273$) between the two groups (47.35% $\pm$ 17.9% in the SME group and 40.88% $\pm$ 9.33% in the RME group).

Harms

All patients showed inflammation of the palatal mucosa following appliance removal. Miniscrew mobility was observed at the time of appliance removal in three of the analyzed RME patients, in which one miniscrew in each patient was found to be mobile.

Table 2. Demographic and Clinical Characteristics of Patients in the SME and RME Groups

	SME, n = 12	RME, n = 12	*P* Value
Demographic characteristics			
Mean age at start of treatment (SD), years	14.30 (1.37)	15.07 (1.59)	.218[a]
Sex, n			
Male	4	3	1.00[b]
Female	8	9	
Clinical characteristics			
Posterior occlusion, n			
Bilateral crossbite	9	11	.590[c]
Unilateral crossbite	2	1	
Constriction without crossbite	1	0	
Mean transverse discrepancy (SD), mm	4.44 (0.84)	4.66 (0.85)	.799[a]
Mean jackscrew opening (SD), mm	5.75 (0.76)	5.90 (0.68)	.617[a]
Mean duration of expansion (SD), days	58.50 (7.36)	16.58 (2.06)	$<$.0001[a,d]
Mean duration of retention (SD), days	90.66 (9.49)	129.66 (5.63)	$<$.0001[a,d]

[a] Independent-samples *t*-test.
[b] Fisher's exact test.
[c] Monte Carlo simulation of the Pearson χ^2 test.
[d] Statistically significant at $P \leq .05$.

Table 3. Skeletal and Dentoalveolar Changes From T1 to T2 in Both Groups

	SME, n = 12				RME, n = 12				SME vs RME		
	T1	T2	T1–T2		T1	T2	T1–T2				
	Mean (SD)	Mean (SD)	Mean Change (SD)	*P* Value	Mean (SD)	Mean (SD)	Mean Change (SD)	*P* Value	Mean Difference	95% CI Lower, Upper[a]	*P* Value
Skeletal, mm											
SWN-4	0.06 (0.09)	3.71 (0.82)	3.64 (0.87)	.002[b,c]	0.09 (0.15)	3.17 (1.06)	3.08 (1.04)	.002[b,c]	0.57	−0.24, 1.38	.161[d]
SWP-4	0.13 (0.15)	4.08 (0.72)	3.94 (0.80)	.002[b,c]	0.16 (0.25)	3.43 (1.11)	3.27 (1.11)	.002[b,c]	0.67	−0.15, 1.49	.103[d]
SW-4	0.10 (0.11)	3.89 (0.75)	3.79 (0.81)	.002[b,c]	0.12 (0.18)	3.30 (1.08)	3.17 (1.06)	.002[b,c]	0.62	−0.18, 1.42	.124[d]
SWN-6	0.03 (0.07)	2.12 (0.64)	2.08 (0.68)	.002[b,c]	0.04 (0.15)	2.75 (0.71)	2.71 (0.65)	.002[b,c]	−0.62	−1.19, −0.06	.033[b,d]
SWP-6	0.06 (0.09)	2.39 (0.56)	2.33 (0.62)	.002[b,c]	0.07 (0.13)	3.01 (0.73)	2.93 (0.71)	.002[b,c]	−0.60	−1.17, −0.03	.042[b,d]
SW-6	0.04 (0.07)	2.25 (0.58)	2.21 (0.63)	.002[b,c]	0.06 (0.11)	2.88 (0.71)	2.81 (0.66)	.002[b,c]	−0.61	−1.16, −0.06	.032[b,d]
BBW-4	38.70 (2.91)	42.78 (3.15)	4.08 (0.93)	<.001[b,e]	37.77 (2.83)	41.21 (2.37)	3.43 (1.16)	<.001[b,e]	0.64	−0.25, 1.54	.150[d]
BBW-6	59.00 (3.68)	61.32 (3.63)	2.32 (0.66)	<.001[b,e]	62.53 (3.43)	64.83 (3.20)	2.29 (0.99)	<.001[b,e]	0.02	−0.69, 0.74	.945[d]
ABW-4	43.72 (3.10)	49.05 (2.96)	5.32 (0.87)	<.001[b,e]	41.84 (2.51)	46.61 (2.34)	4.76 (1.42)	<.001[b,e]	0.56	−0.45, 1.65	.263[d]
ABW-6	54.32 (4.18)	58.66 (3.97)	4.33 (1.05)	<.001[b,e]	55.17 (3.46)	59.76 (3.18)	4.59 (1.60)	<.001[b,e]	−0.26	−1.41, 0.89	.642[d]
Dentoalveolar linear, mm											
Apex-4	27.41 (2.05)	33.04 (1.85)	5.63 (0.94)	<.001[b,e]	26.18 (2.33)	30.50 (2.21)	4.32 (2.01)	<.001[b,e]	1.31	−0.03, 2.64	.055[d]
Apex-6	29.14 (2.20)	34.32 (2.45)	5.18 (0.85)	<.001[b,e]	28.28 (2.92)	32.39 (2.71)	4.11 (1.29)	<.001[b,e]	1.08	0.15, 2.01	.025[b,d]
Cusp-4	28.23 (3.18)	34.48 (3.13)	6.24 (0.79)	<.001[b,e]	25.53 (3.17)	31.94 (2.98)	6.41 (0.98)	<.001[b,e]	−0.16	−0.92, 0.59	.658[d]
Cusp-6	36.44 (3.07)	41.46 (2.60)	5.02 (1.74)	<.001[b,e]	33.97 (3.75)	40.89 (3.24)	6.91 (0.93)	<.001[b,e]	−1.89	−3.07, −0.72	.003[b,d]
Dentoalveolar angular, °											
RtDentInc-4	92.43 (6.99)	95.02 (6.88)	2.59 (2.47)	.004[b,e]	90.54 (7.23)	93.48 (7.01)	2.93 (2.68)	.003[b,e]	−0.34	−2.53, 1.84	.671[f]
LtDentInc-4	93.67 (8.81)	94.75 (9.62)	1.07 (2.04)	.096[e]	91.79 (5.74)	96.25 (7.78)	4.45 (4.32)	.004[e]	−3.38	−6.25, −0.52	.033[b,f]
RtDentInc-6	103.36 (4.03)	103.47 (3.44)	0.11 (2.43)	.881[e]	103.90 (4.98)	107.83 (6.18)	3.93 (3.29)	.002[b,e]	−3.83	−6.28, −1.37	.001[b,f]
LtDentInc-6	105.30 (7.51)	105.60 (6.55)	0.29 (2.40)	.683[e]	107.35 (7.11)	109.68 (7.54)	2.32 (1.59)	<.001[b,e]	−2.03	−3.76, −0.30	.014[b,f]
RtAlvInc-4	111.19 (12.22)	113.60 (11.19)	2.41 (2.51)	.007[b,e]	107.68 (8.41)	110.63 (8.13)	2.95 (2.34)	.001[b,e]	−0.53	−2.59, 1.53	.799[f]
LtAlvInc-4	113.68 (16.50)	115.68 (15.92)	1.99 (2.54)	.020[b,e]	108.16 (9.97)	112.35 (10.82)	4.18 (2.65)	<.001[b,e]	−2.19	−4.39, 0.02	.039[b,f]
RtAlvInc-6	104.46 (3.85)	107.22 (3.05)	2.75 (1.94)	<.001[b,e]	104.02 (4.17)	107.69 (3.74)	3.66 (2.30)	<.001[b,e]	−0.91	−2.71, 0.89	.114[f]
LtAlvInc-6	104.70 (7.40)	106.45 (6.11)	1.75 (1.94)	.010[b,e]	106.11 (5.23)	108.84 (5.64)	2.72 (2.55)	.003[b,e]	−0.98	−2.90, 0.95	.291[f]

[a] CI indicates confidence interval.
[b] Statistically significant at $P \leq .05$.
[c] Values are compared using a Wilcoxon signed-rank test.
[d] Groups are compared using an independent-samples *t*-test.
[e] Values are compared using a paired *t*-test.
[f] Groups are compared using a Mann-Whitney *U*-test.

Miniscrew bending was observed in five miniscrews after retrieval from five different RME patients.

DISCUSSION

Although miniscrew-supported maxillary expanders were initially described more than a decade ago,[5] there is a lack of consensus regarding their optimal activation rate.[15] Therefore, this RCT was conducted to compare slow and rapid activation protocols of miniscrew-supported maxillary expanders.

Separation of the mid-palatal suture, as evidenced by the appearance of a midline diastema, and correction of the skeletal discrepancy were accomplished in all analyzed patients. The residual dental crossbite reported at the end of expansion in two SME patients may be a manifestation of mandibular intermolar width increase. Previous research showed that mandibular intermolar width significantly increased following expansion using bone-borne expanders[14] and tissue-bone-borne expanders.[20]

Miniscrew failure encountered with RME may be attributed to bone micro-fractures that might have resulted from an accumulation of stresses in the bone around miniscrews with rapid activation, whereas the slow rate of activation in the SME patients might have allowed the dissipation of such stresses.[13,21] A recent study showed that the 12-month survival rate for palatal miniscrews used for maxillary expansion was lower than survival rates for palatal miniscrews used for other orthodontic purposes.[22] The authors attributed this to the high forces generated by RME. Similarly, miniscrew bending may be related to rapid activation possibly causing the build-up of forces at the miniscrews,[13,21] resulting in increased flexural load.

In the current study, SME resulted in significant skeletal and dental expansion. Similar results were previously reported by Lagravère et al.[5] using the same activation protocol; however, they reported a smaller increase in interpremolar width (1.92 mm) than reported in the current study (6.24 mm). This may be attributed to different expander designs. The appliance was anchored using only two posterior miniscrews,[5] whereas in the current study, two additional miniscrews were placed anteriorly in addition to acrylic pads, which may have resulted in more expansion anteriorly.

RME resulted in significant skeletal expansion as evidenced by the increase in basal bone width of the maxilla at the first premolars and first molars. Analogous results were obtained in previous studies investigating RME using the same appliance design.[6,23] Significant buccal tipping of the first premolars and first molars took place with RME in the current study. The amount of dental and alveolar tipping reported with miniscrew-supported RME is controversial, where some studies[6,8,24] reported significant buccal tipping, whereas others[7,10,11] did not find a significant change. The different miniscrew positions[25] and the manner of connection between the expansion screw and the miniscrews[26] may affect stress distribution and hence skeletal and dentoalveolar expansion effects of the appliance.

Intergroup comparison showed that RME resulted in significantly greater sutural expansion at the level of first molars compared with SME. However, the difference between the groups was small and not clinically significant. Other skeletal readings were not significantly different between the two groups, nor was the percentage of skeletal expansion at the level of first molars. Previous RCTs[27–29] reported more skeletal expansion with RME than SME; however, those studies evaluated conventional tooth-supported expanders.

The amount of jackscrew opening in the current study was based on the individual treatment needs of each patient. Therefore, the percentage of sutural expansion relative to jackscrew opening was calculated for SME (38.99%) and RME (48.58%). No significant difference was found between the two groups. Previous research on miniscrew-supported expanders has shown that skeletal expansion and jackscrew opening do not take place in a 1:1 ratio.[7,8,11] The disparity between the amount of sutural expansion and jackscrew opening can be explained by the build-up of force that takes place until it is enough to overcome the resistance of the skeletal structures, which is evident clinically when multiple activations are made before separation of the mid-palatal suture takes place.[30]

Dental inclination of the first premolars and first molars changed in both groups despite not being directly attached to the expansion appliances. A part of this change may be attributed to the rotation of the maxillary halves laterally.[31] RME resulted in a greater dental inclination change compared with SME. In RME, the increase in Cusp-6 (6.91 mm) was higher than Apex-6 (4.11 mm), suggesting dental tipping. However, in SME, the increase in Apex-6 (5.18 mm) was comparable to Cusp-6 (5.02 mm), suggesting a more bodily pattern of expansion.

Regarding the increase in alveolar inclination, no significant difference was found between the two groups except for the left first premolar measurement, suggesting that treatment with either SME or RME results in significant alveolar bone bending. Published research has previously demonstrated that such an increase in alveolar inclination is a common finding with the expansion appliance used in the current study.[6,23]

Limitations

Double blinding was not possible because of the nature of the clinical procedures. The statistician, however, was blinded during data assessment.

Comparison of the study results with previously published research was challenging because of the variability in appliance designs and lack of uniformity in the landmarks used.

Generalizability

Results can be generalized to adolescents having no congenital craniofacial malformations and no systemic diseases affecting bone metabolism.

CONCLUSIONS

- Both slow and rapid rates of miniscrew-supported maxillary expander activation were successful in correcting the transverse maxillary deficiency, with SME resulting in less complications than RME.

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