Original Article

Anchorage control using miniscrews in comparison to Essix appliance in treatment of postpubertal patients with Class II malocclusion using Carrière Motion Appliance:

A randomized clinical trial

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ABSTRACT

Objectives: To evaluate anchorage control using miniscrews vs an Essix appliance in treatment of Class II malocclusion by distalization using the Carrière Motion Appliance (CMA).

Materials and Methods: Twenty-four postpubertal female patients with Class II, division 1 malocclusion were randomly distributed into two equal groups. CMA was bonded in both groups, and one group was treated with miniscrews as anchorage (12 patients, mean age = 18.0 years) while the other group was treated with an Essix appliance as anchorage (12 patients, mean age = 17.8 years). For each patient, two cone-beam computed tomographic scans were obtained: one preoperatively and another after completion of distalization.

Results: In the Essix appliance group, there was a statistically significant anterior movement (2.2 ± 1.43 mm) as well as proclination of the lower incisor (5.3° ± 4.0°), compared to a nonsignificant anterior movement (0.06 ± 1.45 mm) and proclination (0.86° ± 2.22°) in the miniscrew group. The amount of maxillary molar distalization was higher in the miniscrew group (2.57 ± 1.52 mm) than in the Essix appliance group (1.53 ± 1.11 mm); however, the difference was not statistically significant.

Conclusions: Miniscrews led to a decrease in the amount of anchorage loss in the mandibular incisors, both in terms of anterior movement and proclination. (*Angle Orthod.* 0000;00:000–000.)

KEY WORDS: Class II; Distalization; Carrière Motion Appliance; Miniscrews; Essix appliance; Anchorage

INTRODUCTION

Class II malocclusion is one of the most frequent treatment problems, representing nearly a third of all malocclusions.[1] In 2004, a new appliance was introduced, the Carrière Motion appliance (CMA) (Henry Schein Orthodontics, Melville, NY). This appliance was designed to change a Class II molar relationship into a Class I relationship by distalizing the whole posterior maxillary segment. To avoid protrusion of the mandibular incisors during activation of the appliance, several different means of anchorage have been suggested,[2] including the use of a lingual arch, Essix appliance, or miniscrews.

Several case reports[3–7] have evaluated the use of the CMA, and a retrospective study[8] compared the treatment effects when two different types of anchorage were used in the mandibular arch—full fixed orthodontic appliances or a lingual arch—and concluded that both methods led to proclination of the lower incisors. Other studies[9–11] evaluated the treatment changes produced by the CMA with the Essix appliance used for anchorage and found significant

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Table 1. Eligibility Criteria of Patients Included in the Study

Inclusion Criteria	Exclusion Criteria
Postpubertal female patients	Systemic conditions that may interfere with the treatment
Class II, division 1 malocclusion with at least an end-on Class II molar relationship bilaterally	Bad habits that might jeopardize the appliance
Well-aligned posterior maxillary segments from the canine to the maxillary second molar	Patients with dental anomalies (eg, enamel hypoplasia, root dilacerations in maxillary canines)
Full permanent dentition, including the second maxillary and mandibular permanent molars	Previous orthodontic treatment

mesial movement and mesial tipping of the first mandibular molar, along with lower incisor proclination.

No randomized clinical trial (RCT) has evaluated anchorage control using miniscrews with the CMA, and, therefore, uncertainty remains about the most effective method of anchorage. Therefore, the aim of this study was to evaluate anchorage control using miniscrews vs an Essix appliance in the treatment of patients with Class II malocclusion using the CMA. The null hypothesis was that there would be no difference in anchorage control between miniscrews and an Essix appliance in the treatment of postpubertal patients with the CMA.

MATERIALS AND METHODS

Trial Design

The study design was a randomized clinical trial, a parallel design in which participants were randomly assigned to either an intervention or comparison group with a 1:1 allocation ratio. The trial was registered with the Pan African Clinical Trial Registry (PACTR201607001702305). No changes to the methods occurred after trial commencement.

Participants

Patients were recruited from the Outpatient Clinic at the Department of Orthodontics, Faculty of Dentistry, Cairo University, from April 2014 through August 2015. The Research Ethics Committee of the Faculty of Dentistry, Cairo University, approved this study. All patients were informed about the study and were asked to sign informed consent forms. The patient eligibility criteria are shown in Table 1.

Intervention

The CMA was bonded on the permanent maxillary canine and first molar, and the correct size was chosen according to the manufacturer's instructions. Each participant was then assigned to one of the two groups according to the randomization procedure.

In the miniscrew group, lower second molar bands were fit, an alginate impression was taken for the lower arch with the bands in place, and a cast was poured. A fixed extension arm was fabricated from stainless-steel (SS) wire measuring 0.036 inches in diameter and was adapted to the lingual surfaces of the lower first molars and soldered to the lingual surfaces of the lower second molar bands. The bands were then cemented, and the extension arms were bonded to the lingual surfaces of the mandibular first molars.

Two miniscrews (Tomas, Dentaurum, Newtown, Pa), 8 mm in length and 1.6 mm in diameter, were inserted between the lower first molar and second premolar, one on each side. A small piece of 0.017×0.025-inch SS wire was bent, inserted into each screw head, and bonded to the buccal surface of the mandibular first molar and second premolar. This method has been described in detail previously.[7]

In the Essix appliance group, lower second molar bands were cemented, and a hard vacuum sheet (Leone S.p.a, Sesto Fiorentino, Firenze, Italy) of 1.5-mm thickness was used to fabricate the Essix appliance. The posterior end of the buccal surface was trimmed in each lower second molar region, creating a window to allow for attachment of the elastics.

Class II elastics (Ortho Organizers, Carlsbad, Calif) were attached from the maxillary canine to the mandibular second molar bilaterally. During the first month, 1/4-inch heavy elastics were used. In the following months, 3/16-inch heavy elastics were used. The patients were instructed to wear the elastics 24 hours per day, except during mealtimes, and to change them daily.

A follow-up session was scheduled every 4 weeks, and the appliance was removed in both groups after the patient had reached a Class I relationship. For each patient, two cone-beam computed tomographic (CBCT) scans were obtained using a Next Generation i-CAT scanner: one preoperatively and another after completion of distalization.

Outcomes

The primary outcome was the amount of anchorage loss in the lower arch, while the secondary outcomes were the amount and type of distalization as well as the treatment duration. There were no outcome changes after the commencement of the trial.

Table 2. Cone-Beam Computed Tomographic (CBCT) Variables

Measurement	Definition
Skeletal measurements	
SNA	The angle between 3 point landmarks: S, N, and A point
SNB	The angle between 3 point landmarks: S, N, and B point
ANB	The angle between 3 point landmarks: A, N, and B point
Anterior facial height (AFH)	The vertical distance between N and Me
Lower facial height (LFH)	The vertical distance between ANS and Me
Facial height ratio ANS-Me/N-Me	The ratio of lower to total facial height
Dental measurements	
Mandibular central incisor	
Torque (L1 TQ)	Measured as the angle between the long axis of mandibular central incisor and the mandibular plane from the sagittal view
Antero-posterior position (L1 AP)	Measured as the horizontal distance from the edge of the mandibular central incisor to frontal plane from the sagittal view
Mandibular second molar	
Antero-posterior position (L7 AP)	Measured as the perpendicular distance from mandibular second molar mesio-buccal cusp tip to frontal plane from the sagittal view
Mesio-distal angulation (L7 MD)	Measured as the angle between the mandibular second molar long axis and the mandibular plane from the sagittal view
Vertical position (L7 VER)	Measured as the perpendicular distance from mandibular second molar furcation point to mandibular plane from sagittal view
Maxillary canine	
Antero-posterior position (U3 AP)	Measured as the horizontal distance from cusp tip of maxillary canines to frontal plane from the sagittal view
Mesio-distal angulation (U3 MD)	Measured as the angle between the long axis of maxillary canine and the maxillary plane from the sagittal view
Vertical position (U3 VER)	Measured as the perpendicular distance from center of maxillary canine to the maxillary plane from sagittal view
Maxillary first molar	
Antero-posterior position (U6 AP)	Measured as the perpendicular distance from maxillary first molar mesio-buccal cusp tip to frontal plane from the sagittal view
Mesio-distal angulation (U6 MD)	Measured as the angle between the maxillary first molar long axis and the maxillary plane from the sagittal view
Vertical position (U6 VER)	Measured as the perpendicular distance from maxillary first molar furcation point to maxillary plane from sagittal view
Other dental measurements	
Overjet	The horizontal distance from incisor superius (Is) to incisor inferius (Ii) on to FH plane from the sagittal view
Overbite	The vertical distance from incisor superius (Is) to incisor inferius (Ii) on the MSP from the frontal view
Inter-U canine width tip (U3 width tip)	The linear distance between the cusp tips of the UR3 and the UL3
Inter-U molar width cusp (U6 width tip)	The linear distance between the mesio-buccal cusp tip of the UR6 and the UL6

The pre- and postdistalization CBCT images were compared by a single blinded assessor using InVivo-Dental software (version 5.3; Anatomage, San Jose, Calif). The analysis included skeletal and dental measurements (Table 2). Five pre- and post-CBCT images were analyzed again by the same assessor and another observer to assess the intra- and interobserver reliability statistically.

Sample Size Calculation

The sample size was calculated using G*Power (University of Düsseldorf, Düsseldorf, Germany) for the primary outcome. A similar study[12] that measured anchorage loss in the lower arch while using intermaxillary Class II elastics for distalization was used as a reference.

The calculation indicated that, for a trial with a power of 90% and an alpha of .05, 9 participants were required per group. Thus, a total number of 18 participants would be needed. To account for patient loss to follow-up, a dropout rate of 25% was used, and, therefore, a sample size of 24 participants was selected.

Randomization

Simple randomization was performed by writing the numbers from 1 to 24 in the first column and using Kutools for Excel (Microsoft, Redmond, Wash) to randomly sort the numbers. The first 12 numbers were assigned to the miniscrew group, while the next 12 numbers were assigned to the Essix appliance group. Allocation concealment was achieved by writing the randomized numbers on opaque white papers, which

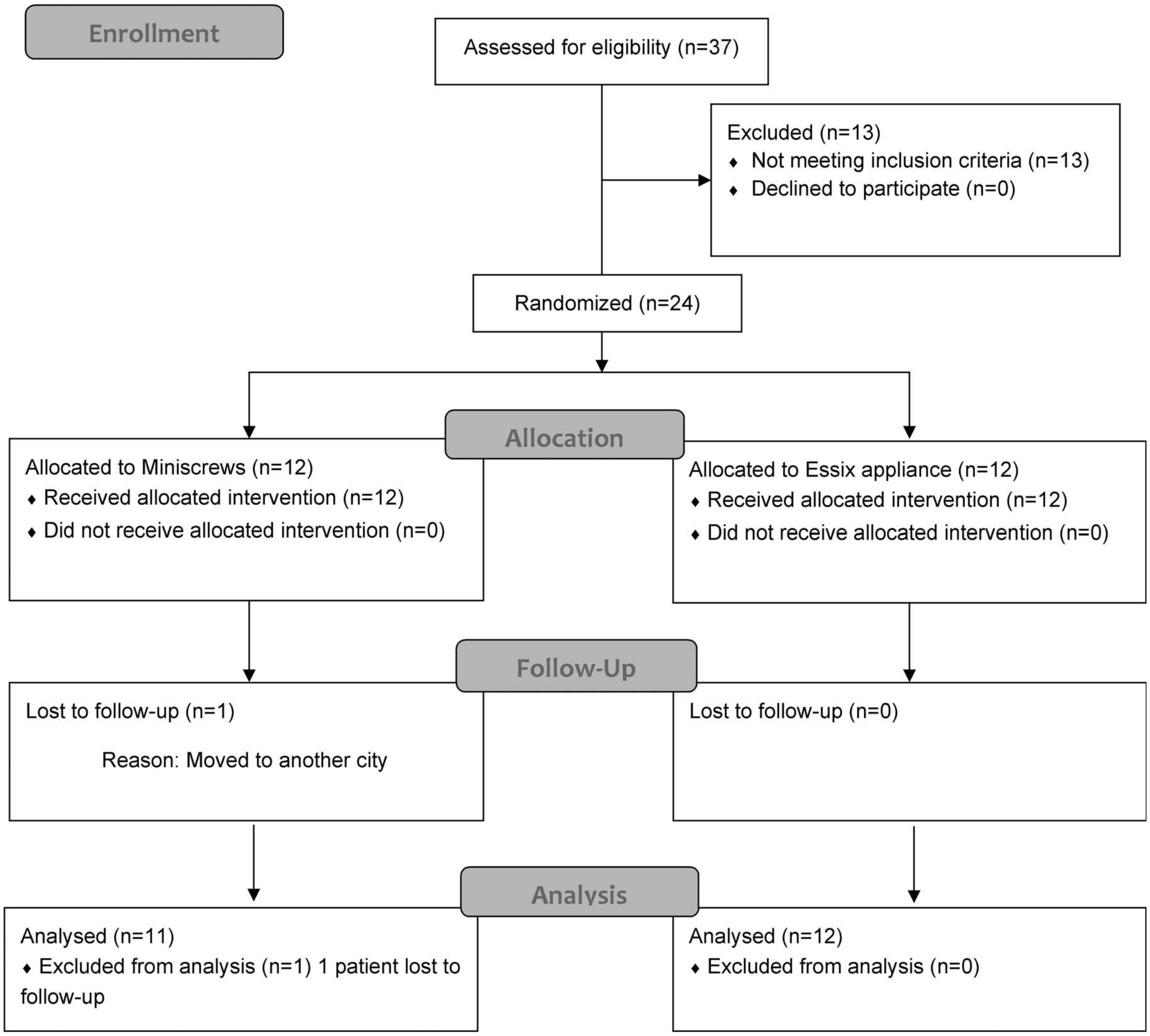

Figure 1. The Consolidated Standards of Reporting Trials (CONSORT) participant flow diagram.

were folded three times to form sealed envelopes and kept inside a box. After bonding of the CMA, one envelope was picked from the box and the participant was assigned to the corresponding group.

Blinding

The principal operator was only blinded during bonding of the CMA. An external assessor carried out the measurements of the CBCT images for all patients blindly and independently.

Statistical Analysis

Statistical analysis was performed with SPSS software (version 20; IBM, Armonk, NY). Data were explored for normality by checking the data distribution using Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed a parametric distribution, except for duration of distalization, overbite, and changes in all measurements. For parametric data, a paired *t*-test was used to study the changes after treatment within each group. For nonparametric data, the Wilcoxon signed-rank test was used to study the changes after treatment within each group. The Mann-Whitney *U*-test was used to compare changes between the two groups.

Comparisons between the right and left sides yielded a non–statistically significant difference between the sides, so the mean of the two sides was used for further comparisons. The significance level was set at $P \leq .05$.

RESULTS

Participant Timeline

Recruitment to this study began in April 2014 and continued until August 2015. A total of 24 patients were recruited and randomized in a 1:1 ratio to either the miniscrew group ($n = 12$) or the Essix appliance group ($n = 12$). All treatments were completed by May 2016 (Figure 1).

Table 3. Baseline and Clinical Characteristics of Patients in Each Group[a]

Baseline Characteristics	Miniscrew Group (A)	Essix Appliance Group (B)	*P*-Value
Age in years, (SD)	18.0 (3.7)	17.8 (3.3)	.915
Molar relationship, n (%)			.684
Half cusp	4 (33.3)	7 (58.3)	
3/4 cusp	1 (8.3)	1 (8.3)	
Full cusp	7 (58.3)	4 (33.3)	
Overjet in mm, mean (SD)	8.58 (1.44)	8.96 (1.93)	.596

[a] SD indicates standard deviation.

Table 4. Duration of Distalization and Number of Debonded Carrière Motion Appliances (CMAs) in Each Group[a]

Characteristics	Miniscrew Group (A)	Essix Appliance Group (B)	*P*-Value
Duration of distalization in months, mean (SD)	6.1 (3.0)	7.5 (3.7)	.355
Number of debonded CMAs, n (%)			.810
1 CMA	3 (13.6)	2 (8.3)	
2 CMAs	1 (9.1)	1 (8.3)	

[a] SD indicates standard deviation.

One participant from the miniscrew group dropped out, as she moved to a different city and could not attend the recall visits. Therefore, the data from 11 out of the 12 participants in the miniscrew group and 12 out of the 12 participants in the Essix appliance group were included in the analysis.

Baseline Data

The baseline characteristics were similar in the two groups at the start of treatment, as there were no statistically significant differences between them (Table 3).

Analysis of Treatment

The CMA was able to correct the molar Class II relationship into a Class I relationship for all of the cases within a mean time of 6.1 ± 3 and 7.5 ± 3.7 months in the miniscrew and Essix appliance groups, respectively. There was no statistically significant difference in the duration between the two groups. Out of a total of 22 miniscrews inserted, only three failed. In addition, debonding of the fixation wire to the miniscrew occurred in five out of 22 miniscrews. Figures 2 and 3 show the corrected molar relationship and the space gained mesial to the canines in examples from each group. Table 4 shows the difference between the two groups in the duration of distalization and the number of debonded CMAs.

Regarding anchorage loss, in the miniscrew group there was no statistically significant change in incisor forward movement (0.06 ± 1.45 mm) or proclination (0.86° ± 2.22°). However, there was statistically significant mesial movement of the second molar (1.1 ± 0.89 mm), with tipping that was not statistically significant (–0.65° ± 3.06°). In the upper arch, the canine and first molar were distalized significantly by –2.68 ± 1.9 mm and –2.57 ± 1.52 mm, respectively, with distal tipping of 5.43° ± 3.12° and –3.75° ± 4.71°, respectively.

In the Essix appliance group, there was statistically significant anterior movement (2.2 ± 1.43 mm) and proclination (5.3° ± 4.0°) of the mandibular incisor as well as second molar mesial movement (2.13 ± 1.43 mm) and tipping (–2.52° ± 2.67°). In the upper arch, the canine and first molar were distalized significantly by –1.49 ± 0.92 mm and –1.53 ± 1.11 mm, respectively, with distal tipping of 5.03° ± 3.01° and –3.71° ± 3.59°, respectively, for the canine and first molar.

There was a statistically significant difference between the two groups regarding lower incisor forward movement and proclination. However, there was no significant difference between the groups in lower second molar mesial movement and tipping and upper canine and molar distalization and distal tipping. Figure 4 and Tables 5 through 7 show the changes after treatment within each group and the comparison between the two groups.

Harms

No significant harms were observed during the trial, other than the discomfort experienced by some patients receiving the miniscrews.

Error of the Method

Inter- and intraobserver reliability were assessed using the Cronbach's alpha reliability coefficient and the intraclass correlation coefficient (ICC). There was very good inter- and intraobserver agreement, with the range of values greater than 0.7 with regard to all measurements.

DISCUSSION

The CMA works by distalizing the whole maxillary posterior segment from the canine to the first molar with the aid of Class II intermaxillary elastics. However, no RCT in the orthodontic literature has previously evaluated the use of this appliance. Hence, the aim of this RCT was to assess the amount and nature of distalization achieved by this appliance three-dimensionally and to evaluate the side effects of the Class II intermaxillary elastics between two methods of anchorage control in the mandibular arch.

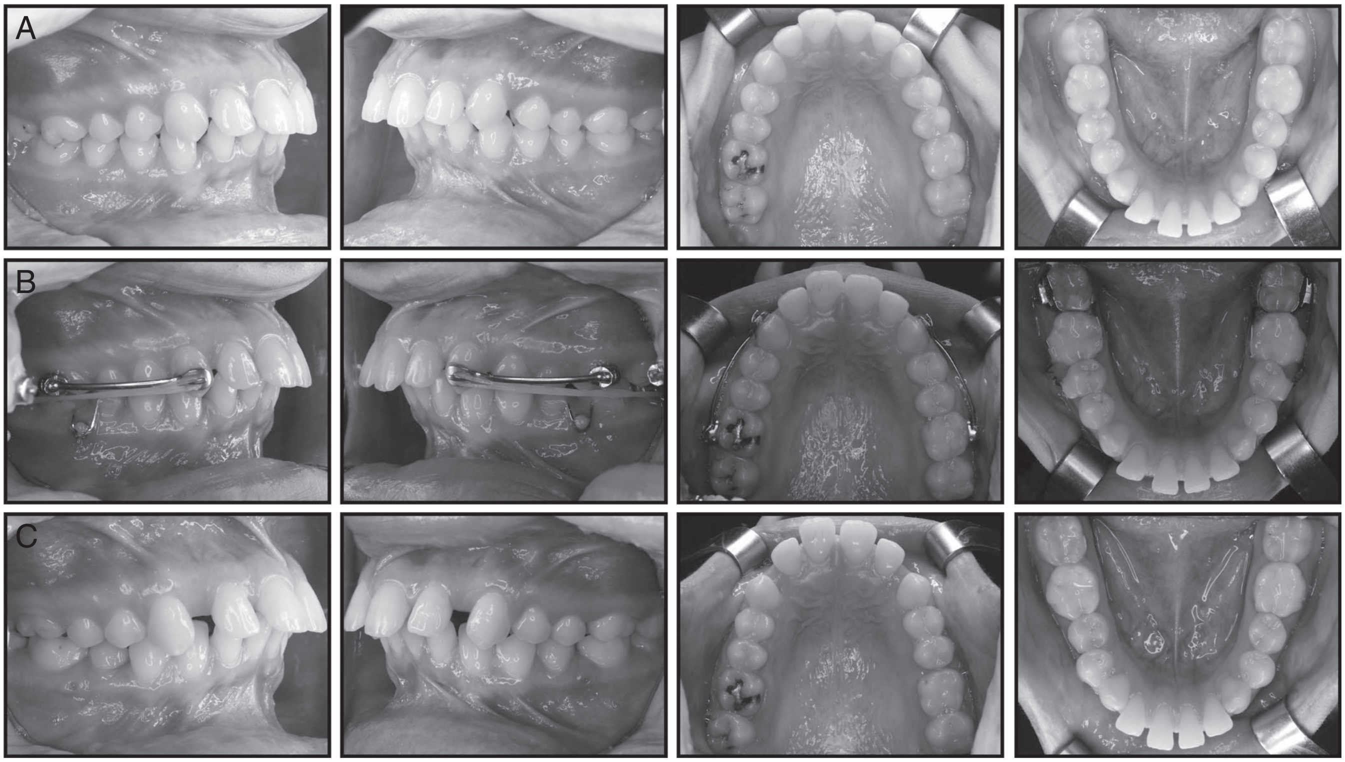

Figure 2. (A) Predistalization intraoral photos of a patient in the miniscrew group. (B) Class II elastics attached to the CMA with miniscrews used as anchorage. (C) Postdistalization with Class I molar and canine achieved.

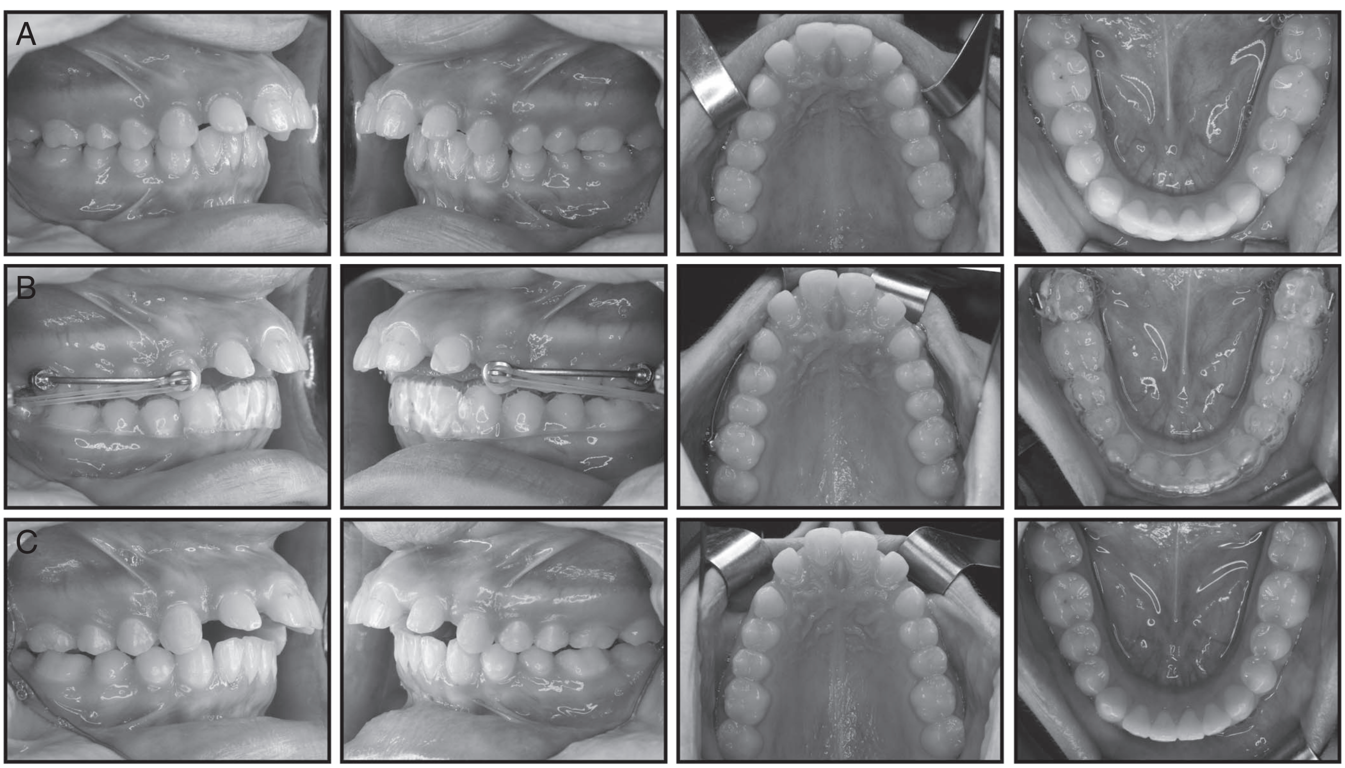

Figure 3. (A) Predistalization intraoral photos of a patient in the Essix appliance group. (B) Class II elastics attached to the CMA with the Essix appliance used as anchorage. (C) Postdistalization with Class I molar and canine achieved.

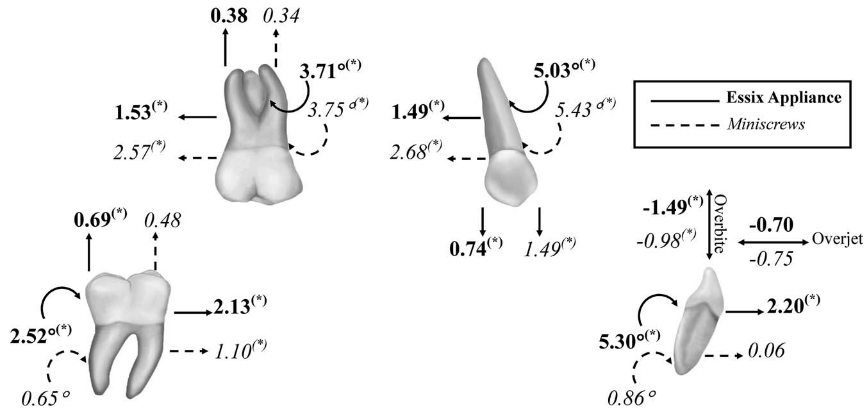

Figure 4. A summary of the main dentoalveolar changes. * Significant at $P \leq .05$.

The null hypothesis of this trial was rejected: the amount of incisor anterior movement and proclination was significantly greater in the Essix appliance group compared to the group with miniscrew anchorage. There was also a tendency for greater mesial movement and tipping of the mandibular second molar in the Essix group, although the difference was not statistically significant. This can be explained by the Essix appliance holding all of the mandibular teeth together such that they acted as one single unit. Therefore, the anchorage loss was expressed as mesial movement and proclination of all of the lower arch.

Despite the use of a miniscrew to anchor the mandibular second molar, there was some mesial movement and tipping. This could have occurred as a result of slight deformation of the 0.017 × 0.025-inch SS wire connecting the miniscrew to the tooth or of

Table 5. Mean, Standard Deviation (SD) Values, and Results of Paired *t*-Test and Wilcoxon Signed-Rank Test for the Changes After Treatment in the Miniscrew Group

	Pretreatment		Posttreatment		Change		95% CI for the Change		
Variable	Mean	SD	Mean	SD	Mean	SD	Lower Bound	Upper Bound	*P*-Value
Skeletal measurements									
SNA, °	83.56	3.40	83.48	3.66	−0.08	1.06	−0.79	0.63	.812
SNB, °	76.79	3.38	76.72	3.57	−0.08	1.01	−0.75	0.60	.810
ANB, °	6.84	2.34	6.88	2.76	0.04	0.76	−0.46	0.55	.657
AFH, mm	108.27	9.08	109.58	8.69	1.31	1.36	0.39	2.22	.010*
LFH, mm	60.00	7.23	61.21	6.54	1.21	1.40	0.28	2.15	.016*
Facial height ratio	0.55	0.02	0.56	0.02	0.00	0.01	−0.001	0.01	.096
Dental measurements									
Mandibular central incisor									
L1 TQ, °	103.44	11.47	104.30	11.45	0.86	2.22	−0.63	2.35	.229
L1 AP, mm	67.70	5.01	67.76	5.05	0.06	1.45	−0.91	1.03	.895
Mandibular second molar									
L7 AP, mm	31.89	3.91	32.99	4.25	1.10	0.89	0.51	1.70	.002*
L7 MD, °	80.56	4.49	79.91	4.57	−0.65	3.06	−2.70	1.41	.499
L7 VER, mm	18.78	3.49	19.25	3.27	0.48	0.71	−0.004	0.95	.052
Maxillary canine									
U3 AP, mm	64.59	4.20	61.90	4.84	−2.68	1.90	−3.96	−1.41	.001*
U3 MD, °	76.45	4.66	81.88	4.92	5.43	3.12	3.33	7.53	<.001*
U3 VER, mm	13.89	3.06	15.38	3.02	1.49	0.49	1.16	1.82	<.001*
Maxillary first molar									
U6 AP, mm	44.57	3.39	42.01	4.06	−2.57	1.52	−3.29	−1.54	<.001*
U6 MD, °	84.73	2.71	80.98	5.37	−3.75	4.71	−6.92	−0.59	.025*
U6 VER, mm	12.02	2.90	11.69	2.52	−0.34	0.85	−0.91	0.24	.220
Other dental measurements									
Overjet, mm	7.70	1.51	6.96	2.13	−0.75	1.13	−1.50	0.01	.053
Overbite, mm	3.11	1.80	2.13	1.52	−0.98	0.89	−1.58	−0.38	.006*
U3 width tip, mm	29.94	1.19	31.79	1.26	1.84	1.29	0.98	2.71	.001*
U6 width tip, mm	49.88	2.50	49.45	2.78	−0.44	1.10	−1.17	0.30	.216

* Significant at $P \leq .05$. CI indicates confidence interval.

Table 6. Mean, Standard Deviation (SD) Values, and Results of Paired *t*-Test and Wilcoxon Signed-Rank Test for the Changes After Treatment in Essix Appliance Group

Variable	Pretreatment		Posttreatment		Change		95% CI for the Change		*P*-Value
	Mean	SD	Mean	SD	Mean	SD	Lower Bound	Upper Bound	
Skeletal measurements									
SNA, °	82.55	2.82	83.05	3.21	0.50	1.01	−0.15	1.14	.116
SNB, °	76.39	2.50	76.62	2.98	0.23	1.20	−0.53	1.00	.516
ANB, °	6.23	2.30	6.47	2.00	0.24	0.92	−0.34	0.82	.480
AFH, mm	110.34	6.02	111.20	5.97	0.86	1.06	0.19	1.53	.017*
LFH, mm	60.20	4.17	61.02	3.96	0.82	0.94	0.22	1.41	.012*
Facial height ratio	0.55	0.01	0.55	0.02	0.01	0.01	−0.002	0.01	.111
Dental measurements									
Mandibular central incisor									
L1 TQ, °	103.34	6.25	108.64	5.60	5.30	4.00	2.76	7.84	.001*
L1 AP, mm	68.30	4.45	70.50	4.44	2.20	1.43	1.29	3.11	<.001*
Mandibular second molar									
L7 AP, mm	32.32	3.19	34.45	3.45	2.13	1.43	1.23	3.04	<.001*
L7 MD, °	83.03	4.46	80.52	3.87	−2.52	2.67	−4.22	−0.82	.008*
L7 VER, mm	17.73	2.13	18.41	2.14	0.69	0.56	0.33	1.04	.001*
Maxillary canine									
U3 AP, mm	65.79	4.26	64.30	4.44	−1.49	0.92	−2.07	−0.91	<.001*
U3 MD, °	75.05	3.85	80.08	3.68	5.03	3.01	3.12	6.94	<.001*
U3 VER, mm	13.49	2.67	14.23	2.33	0.74	0.78	0.24	1.23	.007*
Maxillary first molar									
U6 AP, mm	44.93	3.71	43.41	4.06	−1.53	1.11	−2.23	−0.82	.001*
U6 MD, °	82.12	2.96	78.42	4.26	−3.71	3.59	−5.99	−1.42	.004*
U6 VER, mm	11.81	2.35	11.43	2.04	−0.38	0.75	−0.86	0.09	.104
Other dental measurements									
Overjet, mm	7.18	2.46	6.48	2.41	−0.70	1.41	−1.60	0.20	.114
Overbite, mm	3.86	2.21	2.37	1.81	−1.49	1.30	−2.32	−0.66	.010*
U3 width tip, mm	31.25	2.16	32.37	1.87	1.12	1.19	0.36	1.87	.008*
U6 width tip, mm	48.88	2.34	48.77	2.09	−0.11	2.17	−1.49	1.27	.867

* Significant at $P \leq .05$. CI indicates confidence interval.

some instability in the connection between the tooth and wire as a result of the composite bonded to the tooth surface.[13,14] Additionally, since the miniscrew was connected indirectly to the molar, and the molar moved mesially, there is a possibility that the miniscrew moved mesially as well.[15] Regarding the lower incisors, in the absence of any mechanics that would have united all the incisors as one unit, it was noted that some of the incisors were proclined slightly, while some were retroclined slightly because of the crowding that took place. The summation of the right and left incisors thus gave an almost 0-mm average of mesial movement.

The amount of distal movement of the upper molar was higher in the miniscrew group than in the Essix appliance group, although there was no statistically significant difference. Maxillary canine distal movement was statistically significant in both groups and almost equal to the amount of distal movement of the molar. The amount of distalization was similar to that reported in previous studies.[8,9,11] However, when compared to other skeletal anchorage distalizing appliances (5.35 mm) or conventional anchorage appliances (4.25 mm), the amount of distalization was much less.[16] On the other hand, with the other conventional distalizing appliances anchorage loss was expressed as mesial movement of the upper premolars along with mesial movement and proclination of the upper incisors. This resulted in round tripping and loss of the amount of distalization achieved during the second phase of treatment, in which space closure and retraction of the premolars, canines, and incisors took place. With the use of the CMA, there was no anchorage loss in the upper premolar area, and instead the canine was distalized as well, meaning that the loss of the amount of distalization achieved would be minimized during upper incisor retraction.

It had been claimed[2] that the addition of a ball-and-socket joint in the molar pad would lead to pure bodily distalization of the maxillary molar without distal tipping. However, in the current RCT, the amount of maxillary molar distal tipping was statistically significant and very similar in both groups. In the miniscrew group, the molar tipped 3.75°, while in the Essix appliance group the molar tipped 3.71°. On the other hand, this degree of tipping was less than the amount of tipping produced by skeletal anchorage distalizing appliances (8.44°) and that produced by conventional anchorage appliances (8.31°).[16] Therefore, the ball-

Table 7. Mean, Standard Deviation (SD) Values, and Results of Mann-Whitney *U*-Test for the Comparison Between Changes in the Two Groups

	Miniscrew Group (A)		Essix Appliance Group (B)		95% CI for the Difference		
Variable	Mean	SD	Mean	SD	Lower Bound	Upper Bound	*P*-Value
Skeletal measurements							
SNA, °	−0.08	1.06	0.50	1.01	−1.48	0.32	.241
SNB, °	−0.08	1.01	0.23	1.20	−1.28	0.66	.663
ANB, °	0.04	0.76	0.24	0.92	−0.93	0.53	.608
AFH, mm	1.31	1.36	0.86	1.06	−0.61	1.50	.619
LFH, mm	1.21	1.40	0.82	0.94	−0.63	1.42	.130
Facial height ratio	0.00	0.01	0.01	0.01	−0.01	0.01	.865
Dental measurements							
Mandibular central incisor							
L1 TQ, °	0.86	2.22	5.30	4.00	−7.28	−1.60	.003*
L1 AP, mm	0.06	1.45	2.20	1.43	−3.39	−0.88	.003*
Mandibular second molar							
L7 AP, mm	1.10	0.89	2.13	1.43	−2.07	0.01	.051
L7 MD, °	−0.65	3.06	−2.52	2.67	−0.61	4.35	.057
L7 VER, mm	0.48	0.71	0.69	0.56	−0.77	0.34	.235
Maxillary canine							
U3 AP, mm	−2.68	1.90	−1.49	0.92	−2.47	0.08	.079
U3 MD, °	5.43	3.12	5.03	3.01	−2.27	3.06	.379
U3 VER, mm	1.49	0.49	0.74	0.78	0.19	1.32	.007*
Maxillary first molar							
U6 AP, mm	−2.57	1.52	−1.53	1.11	−2.19	0.11	.079
U6 MD, °	−3.75	4.71	−3.71	3.59	−3.66	3.56	.951
U6 VER, mm	−0.34	0.85	−0.38	0.75	−0.65	0.74	.667
Other dental measurements							
Overjet, mm	−0.75	1.13	−0.70	1.41	−1.16	1.07	.990
Overbite, mm	−0.98	0.89	−1.49	1.30	−0.47	1.48	.130
U3 width tip, mm	1.84	1.29	1.12	1.19	−0.35	1.80	.122
U6 width tip, mm	−0.44	1.10	−0.11	2.17	−1.84	1.19	.833

* Significant at $P \leq .05$. CI indicates confidence interval.

and-socket joint helped minimize molar tipping but did not prevent it completely.

There were neither clinically nor statistically significant skeletal changes in either group, which was due to the sample comprising postpubertal patients. The only significant change was an increase in lower facial height in both groups. This was due to extrusion of the mandibular second molar as well as distalization of the upper molars, leading to an increase in the mandibular plane angle.

The mean treatment time in both groups was greater than that reported in other studies.[8–11] This could have been due to the current study being conducted on postpubertal patients with increased bone density as well as to the presence of the maxillary second molar, which was not the case in some of the other studies. However, when compared with skeletal anchorage distalizing appliances or conventional anchorage appliances (8.23 and 7.95 months, respectively), the treatment duration was shorter.[16]

When the appliance was first introduced, it was called the Carrière Distalizer.[2] The name of the appliance was later changed to the Carrière Motion Appliance. The results of this trial help explain why; there was a reciprocal force between the maxillary arch and mandibular arch, trying to distalize the maxillary teeth and produce mesial movement of the mandibular arch. This was evident by the fact that the mean amount of total anteroposterior change was similar in both groups. Changing anchorage control in the mandibular arch with the addition of miniscrews helped to shift the balance in favor of maxillary distalization. The Essix appliance group showed more mesial movement of the lower dentition, especially the incisors.

Limitations

Though the treatment modality could not be blinded to the patients in this study, the results were most likely not affected by the absence of patient blinding, since both of the techniques used were new to them. On the other hand, the absence of the operator blinding may have led to performance bias by favoring one intervention over the other. However, this was minimized by bonding the CMA before allocating the participants to an intervention group. In addition, an external evaluator blindly assessed the outcomes to avoid any detection bias. Another limitation of the study was that it was conducted only on female participants.

Finally, this study was limited to the first phase of treatment in which the CMA was used and did not involve observation of the patients during the second phase of treatment, which involved anterior segment retraction.

Generalizability

The generalizability of this study may be limited because the trial was conducted at only one dental center and because only one postgraduate student carried out the procedures. Finally, the study was done on one ethnic group and only with female patients.

CONCLUSIONS

- Compared to the Essix appliance, miniscrews led to a decrease in the amount of anchorage loss expressed in the mandibular incisors in terms of anterior movement and proclination.
- There was similar distal movement and distal tipping of the maxillary first molar and canine observed in both groups that was not significantly different between the miniscrew and Essix modes of anchorage.

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