Original Article

Dental arch changes after anterior open bite treatment in the mixed dentition produced by miniscrew-supported palatal crib vs conventional fixed palatal crib:
A randomized clinical trial

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ABSTRACT

Objectives: To evaluate the dental arch changes produced by the miniscrew-supported palatal crib (MSPC) and the conventional fixed palatal crib (CFPC) after the treatment of patients with anterior open bite (AOB) attributed to the tongue-thrusting habit in the mixed dentition stage.

Materials and Methods: A total of 26 children aged 8 to 11 years with an AOB were randomly distributed into two equal groups; the MSPC group was treated using a palatal crib supported by two miniscrews inserted paramedially, whereas the CFPC group was treated using a conventional fixed palatal crib soldered to bands. Digital models were obtained pretreatment and after a follow-up duration of 9 months.

Results: The MSPC group included 12 participants (9 girls and 3 boys; mean age, 9.4 ± 0.75 years), and the CFPC group included 12 participants (10 girls and 2 boys; mean age, 9.0 ± 0.73 years). The amount of AOB closure was similar in both groups: 3.97 ± 1.44 mm in the MSPC group and 3.97 ± 0.89 mm in the CFPC group. There was significant mesial movement of the maxillary first molar in the CFPC (–1.42 ± 0.99 mm) compared with the MSPC group (–0.53 ± 0.32 mm).

Conclusions: Both appliances resulted in similar improvement in the amount of AOB closure. There was significantly more mesial movement of the maxillary first molars in the CFPC group compared with the MSPC group. (*Angle Orthod.* 2022;92:487–496.)

KEY WORDS: Open bite; Digital models; Early treatment; Palatal crib; Miniscrews

INTRODUCTION

Anterior open bite (AOB) can be defined as the absence of vertical overlap between the maxillary and mandibular anterior teeth when the posterior teeth are in occlusion.[1] It can be divided into two main categories: either dental or skeletal according to the etiology. Dental AOB can occur as a result of environmental causes such as tongue thrust or the tongue posture at rest, whereas the etiology of skeletal AOB is mainly related to genetic factors.[2]

Several options have been proposed to treat a dental AOB, mainly aiming at the cessation of the habit such as by the use of spurs,[3–6] quad helix/crib appliance,[7] or removable or fixed palatal crib.[4,6,8–10] A recent systematic review[11] concluded that crib therapy, regardless of the appliance design, was effective in the treatment of AOB. However, there are contradictory data as to whether crib therapy causes mesial movement of the maxillary first molar leading to a

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Table 1. Eligibility Criteria of Patients Included in the Study

Inclusion Criteria	Exclusion Criteria
• Children in the age range of 8 to 11 years	• Skeletal AOB extending further to the posterior region
• Dental AOB equal to or greater than 1 mm limited to the anterior segment within the area of incisors and canines	• Mouth breathing as a result of hypertrophic adenoids, prolonged upper respiratory tract, or tonsillar infection
• Tongue-thrust habit and/or high/horizontal tongue posture at rest	• Presence of posterior crossbites
• Skeletal Class I and Angle Class I relation	• Congenitally missing teeth or presence of any dental anomalies
• Upper arch with no or mild crowding	• Previous orthodontic treatment
• No sex predilection	• The presence of any systemic disease

Class II relationship and, thus, worsening the malocclusion.[7–9]

Miniscrews have proven to be an effective means of anchorage,[12] and a recent case report was published in which a miniscrew-supported palatal crib (MSPC) was able to correct AOB in a single patient.[13] The reported advantage of such a technique was its independence of molar support, so it could be used in cases with bonded molar attachments, when molar movement was planned, or in patients with multiple missing teeth.

No randomized clinical trial has evaluated the effectiveness of the MSPC in the closure of AOB, nor whether a conventional fixed palatal crib (CFPC) produced mesial movement of the maxillary first molar. Therefore, this study aimed to test the effectiveness of both appliances as well as their anchorage load. The null hypothesis was that there would be no difference in the effects between MSPC and the CFPC for treatment of patients with AOB and a tongue-thrust habit in the mixed dentition stage.

MATERIALS AND METHODS

Trial Design

The design of this randomized clinical trial was a parallel group, two-arm trial with a 1:1 allocation ratio. The trial was registered on the Pan African Clinical Trial Registry (PACTR201801002981142). 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 September 2018 to February 2020. The Research Ethics Committee of the Faculty of Dentistry, Cairo University approved this study. All patients were informed about the study procedures and signed informed consent. The patient eligibility criteria are shown in Table 1. At the start of treatment, a lateral cephalogram was obtained for each patient as well as upper and lower impressions. The impressions were poured, and the stone model was scanned using a 3Shape R500 laser scanner (3Shape A/S, Copenhagen, Denmark).

Sample Size Calculation

Sample size was calculated using G*Power (University of Düsseldorf, Düsseldorf, Germany) for the AOB correction outcome. A similar study was used as a reference,[3] and the calculation indicated that, for a trial with a power of 80% and an α of 0.05, 10 participants were required per group. To account for patient loss to follow-up, a dropout rate of 25% was accounted for, and a sample size of 26 participants was selected.

Randomization

Simple randomization was performed by writing numbers from 1 to 26 in the first column and using Kutools for Excel (Microsoft, Redmond, Wash) to randomly sort the numbers. The first 13 numbers were assigned to the MSPC group, whereas the other 13 numbers were assigned to the CFPC group. The randomization numbers were written on opaque white papers that were folded three times to form sealed envelopes and kept inside a box. After acquiring diagnostic records, allocation of each patient to either group was done by selecting one envelope from the box.

Intervention

In the MSPC group, the insertion site of the miniscrew was planned virtually. The lateral cephalometric radiograph and the digital stereolithography (STL) file of the digital model were superimposed using DDS-Pro software (Uniontech Orthodontic Lab, Parma and Milan, Italy). A 3-dimensional image STL file of a Dentaurum miniscrew (Tomas, Dentaurum, Newtown, PA) was obtained and imported into the software library. The miniscrew was a mushroom-shaped head type and had the same dimensions as those to be placed (1.6 mm in diameter and 10 mm in length). The miniscrew position was determined paramedially on the digital model, and fine adjustments were set on the lateral cephalogram. The identified screw position was then marked on the stone model and sent to the laboratory for construction of the appliance.

Table 2. Digital Model Variables

Name	Abbreviation	Units	Definition
Dental relationship			
Overbite	Overbite	mm	The vertical linear distance between the mesiodistal midpoint of the incisal edge of the uppermost vertically erupted upper central incisors and a horizontal plane projected on the lower central incisor.
Overjet	Overjet	mm	The horizontal linear distance between the incisal edge of the most protruded upper central incisor and a frontal plane projected on the lower central incisor.
Molar relation	U6-L6	mm	The horizontal linear distance between the mesiobuccal cusp of upper first molar and mesiobuccal groove of lower first molar. The mean between the right and left sides was used.
Antero-posterior position of upper first molar	U6-rugae	mm	Linear distance between the mesial surface of the upper first molar and a line joining the medial end of the two third rugae. The mean between the right and left sides was used.
Vertical development			
Upper and lower anterior dentoalveolar vertical development	UVer LVer	mm	The perpendicular vertical distance from a point between the central incisors at the level of the alveolar process to the occlusal plane from the frontal view. The occlusal plane was determined by three points: mesiobuccal cusp tip of the right and left permanent first molars and the mesiobuccal cusp tip of the right primary first molar or first premolar.
Upper and lower central incisor clinical crown heights	U1 L1	mm	The vertical distance between the incisal edge and gingival margin of the central incisor along its labial surface. The mean between the right and left sides was used.
Arch dimension			
Upper and lower arch length	UAL LAL	mm	The perpendicular distance between a line connecting the mesial aspects of the permanent first molars and the contact point between the central incisors (or to a midpoint between them at the level of the gingival margin in the absence of the contact point).
Upper and lower arch perimeter	UAP LAP	mm	The sum of four segments: from the mesial surface of the permanent first molar to the mesial contact point of the primary canine and then to the contact point of the central incisors, measured on the right and left sides.
Upper and lower intermolar width	U6-6 L6-6	mm	Linear distance between right and left first permanent molar.
Little's Irregularity Index	LII	mm	The sum of the linear distances between the anatomical contact points of the mandibular incisors.

A wax template was designed to indicate the vertical and transverse dimensions of the crib.[14] The crib was planned to be located in the region between the two maxillary canines transversely and extending from the hard palate to 0.5–1 mm short of the floor of the mouth. The crib was fabricated from a 0.036-inch stainless steel wire along the custom-designed wax template, and it incorporated 5 to 7 loops depending on the intercanine width. An acrylic button (1.5 mm in thickness) was fabricated covering the base of the crib and two holes, 1.5 mm in diameter each, were drilled in the acrylic button at the planned site of miniscrew insertion.

In the CFPC group, a crib was fabricated using the same technique as the previous group. The crib was adapted and soldered to the palatal surface of the maxillary first molar bands. An acrylic button was fabricated covering only the base of the loops. The patients in both groups were trained to adapt to the new swallowing pattern. The patients were instructed to press their tongue against the acrylic part of the appliance, bring their teeth into centric occlusion, and close their lips to swallow. In each group, the appliance was removed 9 months after the start of treatment, and a posttreatment digital model was obtained.

Outcomes

The primary outcome was to assess the amount of AOB closure, whereas the secondary outcomes were to evaluate the amount of permanent maxillary first molar antero-posterior movement as well as other dental changes. AOB was considered corrected if the overbite was zero (end-to-end vertical incisor relationship) or had a positive value. The treatment effects were assessed using measurements obtained on the pretreatment and posttreatment digital models using DDS-Pro software by a single blinded assessor. All measured variables and their references are defined in Table 2 and Figure 1.

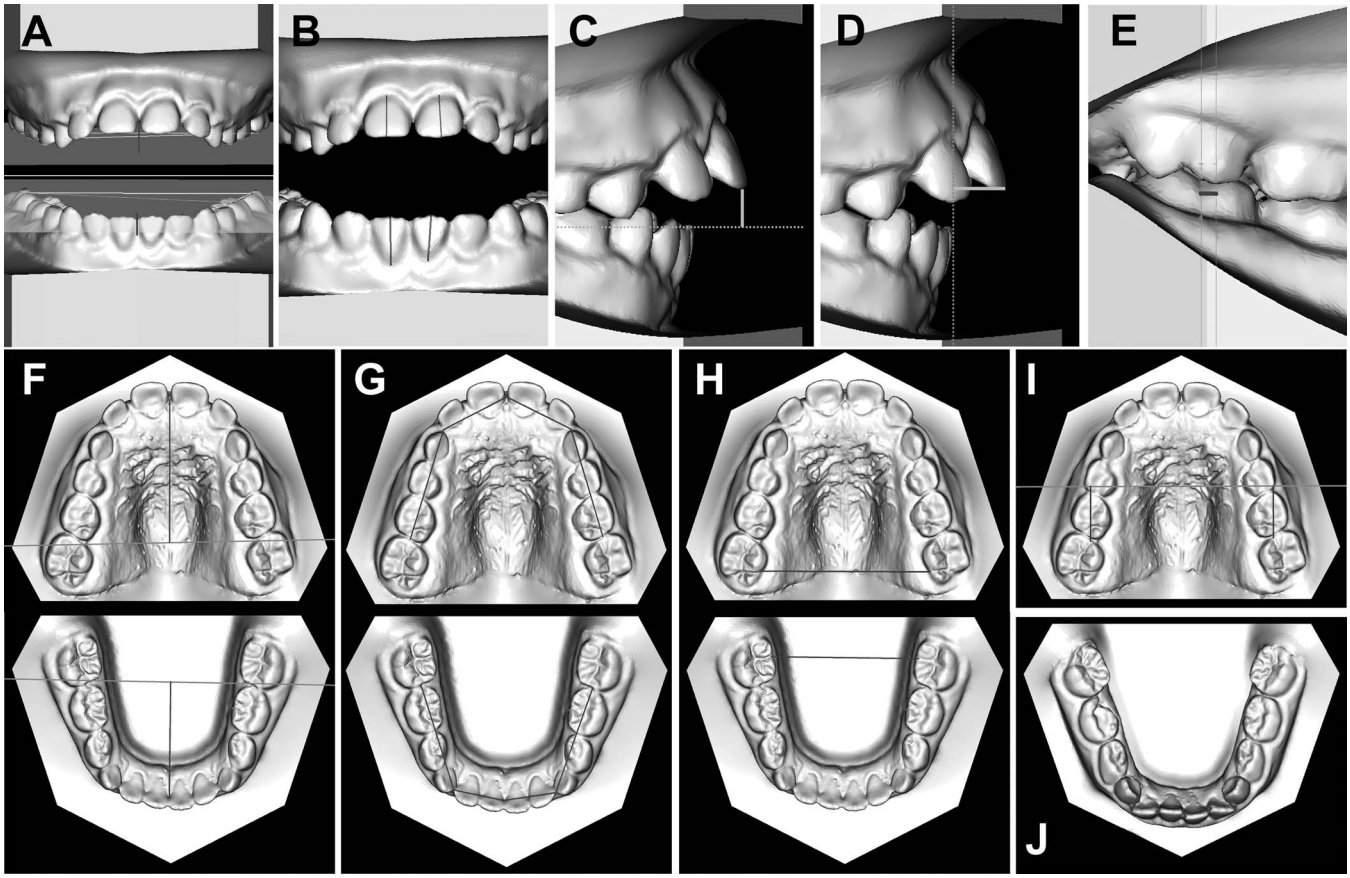

Figure 1. (A) Measurement of dentoalveolar vertical development. (B) Clinical crown height. (C) Overbite. (D) Overjet. (E) Molar relationship. (F) Arch length. (G) Arch perimeter. (H) Intermolar width. (I) Antero-posterior position of U6. (J) Little's Irregularity Index.

Five pretreatment and posttreatment digital models were analyzed again by the same external assessors to assess intra- and interobserver reliability using Cronbach's α reliability coefficient and intraclass correlation coefficients (ICCs). There were no outcome changes after commencement of the trial.

Blinding

Blinding was not possible for the principal operator as well as the participants. Only the outcome assessor was blinded and performed measurements independently.

Statistical Analysis

Statistical analysis was performed using SPSS (Version 20.0; IBM, Armonk, N.Y.). Data were explored for normality by checking the data distribution using the Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed a parametric distribution, and a paired *t*-test was used to study the changes after treatment within each group, whereas independent *t*-tests were used to compare pretreatment measurements and changes between the two groups. Qualitative data were presented as frequencies (n) and percentages, and the χ^2 test was used in comparisons.

RESULTS

Participant Timeline

Recruitment began in September 2018 and continued until February 2020. A total of 26 patients were recruited and randomly assigned in a 1:1 ratio to either the MSPC group ($n = 13$) or the CFPC group ($n = 13$). All treatment follow-ups were completed by June 2021. A Consolidated Standards of Reporting Trials (CONSORT) flow diagram shows the progression of the participants in the clinical trial (Figure 2).

One participant from each group dropped out as they did not come for follow-up visits because of the outbreak of the COVID-19 pandemic. Therefore, the data from 12 of 13 participants for each group were included in the analysis.

Baseline Data

The baseline characteristics (Table 3) as well as pretreatment cephalometric variables (Table 4) were

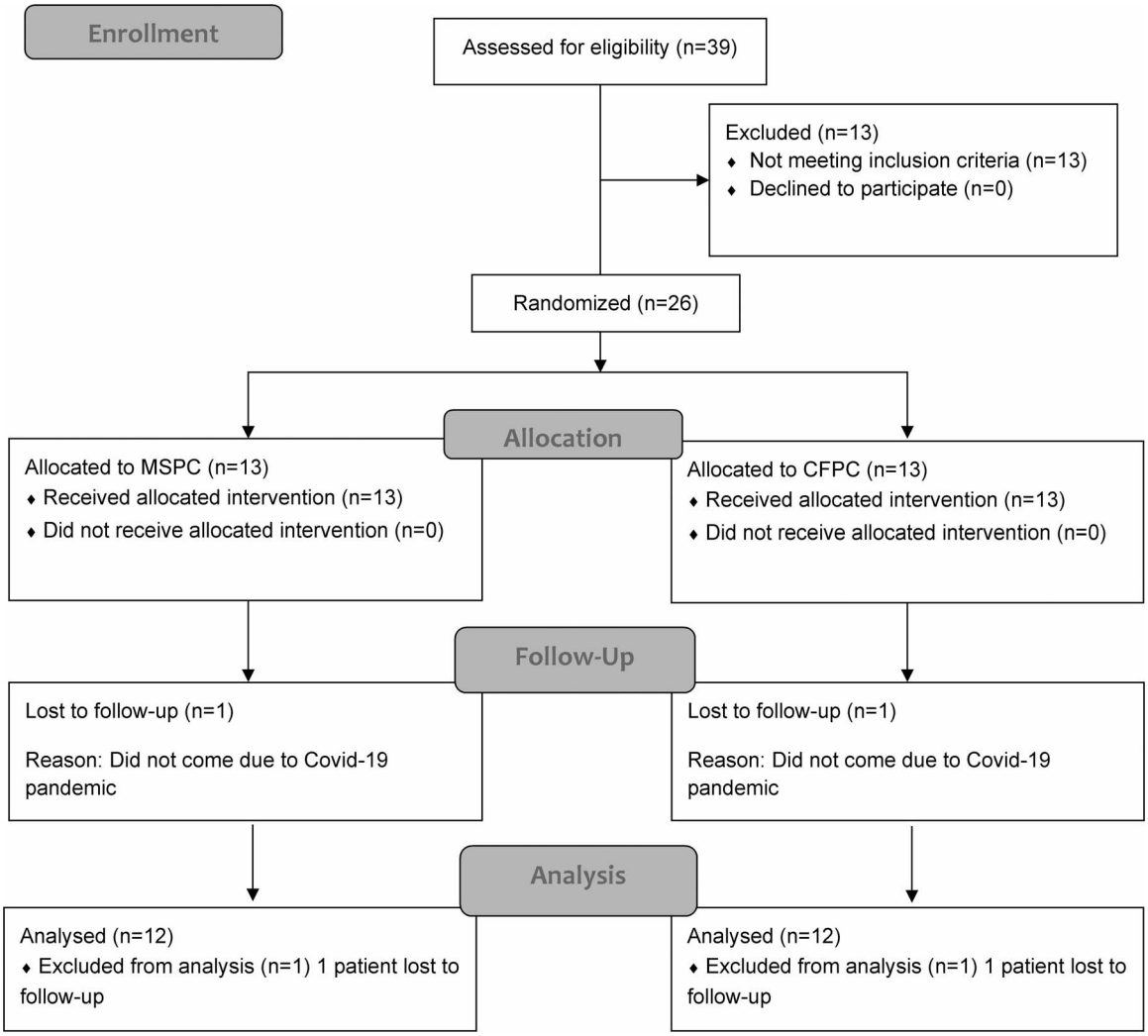

Figure 2. CONSORT flow diagram.

similar in the two groups at the start of treatment as there were no statistically significant differences between them.

Numbers Analyzed

After a 9-month follow-up period, all participants showed improvement in the amount of AOB closure. However, two patients in the MSPC group and three in the CFPC group still had some AOB. Figures 3 and 4 show photos of corrected AOBs in each group.

Table 3. Baseline Information Regarding Age and Sex in Each Group

Demographic Data	MSPC	CFPC	*P* Value
Sex, n (%)			
Male	3 (25)	2 (16.7)	.591
Female	9 (75)	10 (83.3)	.632
Age, y, mean ± SD[a]	9.4 ± 0.75	9.0 ± 0.73	.190

[a] SD indicates standard deviation.
* Significant at $P \leq .05$.

In the MSPC group, there was a statistically significant increase in the amount of overbite and overjet by 3.97 ± 1.44 mm and 0.96 ± 0.83 mm, respectively. The maxillary first molar moved mesially by 0.53 ± 0.32 mm; however, the molar relationship almost stayed the same. The maxillary and mandibular incisors were significantly extruded by 1.94 ± 1.66 mm and 1.06 ± 0.71 mm, respectively. Also, there was a significant increase in the clinical height of the maxillary and mandibular central incisors by 0.49 ± 0.63 mm and 0.76 ± 0.32 mm, respectively. Finally, there was a significant increase in Little's Irregularity Index by 1.84 ± 1.85 mm.

In the CFPC group, there was a statistically significant increase in the amount of overbite and overjet by 3.97 ± 0.89 mm and 1.07 ± 1.15 mm, respectively. The maxillary first molar moved mesially by a significant 1.42 ± 0.99 mm, leading to a significant change in the molar relationship by 0.59 ± 0.54 mm. The maxillary and mandibular incisors were signifi-

Table 4. Comparison of Pretreatment Cephalometric Variables Between the Two Groups

Pretreatment Variables (°)	MSPC		CFPC		95% CI		*P* Value
	Mean	SD	Mean	SD	Lower Bound	Upper Bound	
SNA	81.21	3.80	81.43	3.19	−3.20	2.75	.877
SNB	76.78	3.30	76.88	3.34	−2.92	2.7	.937
ANB	4.43	1.58	4.55	2.58	−3.06	2.77	.895
SN/PP	7.81	1.89	6.66	3.28	−3.46	3.79	.304
SN/MP	39.7	4.43	39.53	4.13	−4.50	2.67	.925
PP/MP	31.73	3.95	32.89	5.41	−3.59	2.44	.555
U1/PP	120.63	5.20	118.47	6.37	−3.18	1.85	.373
L1/MP	99.59	5.37	97.35	5.60	−4.07	0.54	.328
Nasolabial angle	106.51	9.54	108.39	8.99	−2.21	1.33	.624

[a] CI indicates confidence interval.
* Significant at $P \leq .05$.
SNA; Sella-Nasion-A point; SNB: Sella-Nasion-B point; ANB: A point-Nasion-B point, SN: Sella-Nasion, PP: Palatal Plane, MP: Mandibular Plane, U1: Upper central incisor, L1: lower central incisor

cantly extruded by 2.00 ± 1.09 mm and 1.22 ± 1.16 mm, respectively. In addition, there was a significant increase in the clinical height of maxillary and mandibular central incisors by 0.65 ± 0.44 mm and 0.99 ± 0.66 mm, respectively. Finally, there was a significant increase in Little's Irregularity Index by 1.87 ± 2.75 mm.

There was no statistically significant difference between the two groups regarding all measurements except for the change in the antero-posterior position of the maxillary first molar and in the molar relationship. Tables 5 through 7 show the changes after treatment in each group and compared together.

Harms

A few harms were observed during the trial, although none led to major damage. Despite continuous instructions and training by the principal operator, it was noticed that a few patients in both groups could not adapt to the new pattern of swallowing. These patients would instead press their lower lip between the mandibular and maxillary anterior teeth to achieve an oral seal.

In addition, of a total of 24 miniscrews inserted, 6 failed. The appliance remained in place; however, the two miniscrews became loose. This was discovered during the follow-up visit in each of the three cases. The miniscrew was removed and reinserted after 2 to 3

Figure 3. (A) Pretreatment intraoral photos of a patient in the MSPC group. (B) Mid-treatment photos. (C) After treatment.

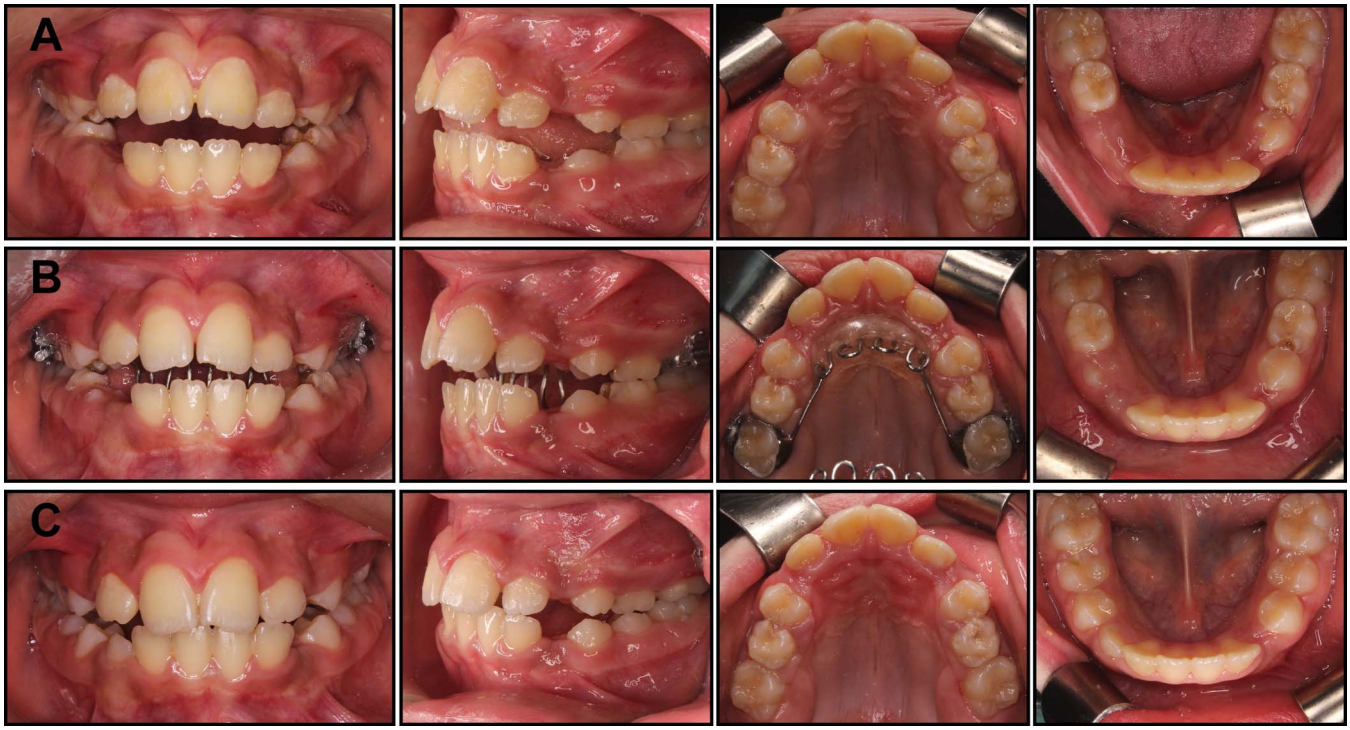

Figure 4. (A) Pretreatment intraoral photos of a patient in the CFPC group. (B) Mid-treatment photos. (C) After treatment.

weeks of healing. In the CFPC group, two of the solder joints broke and were sent back to the laboratory for repair.

Error of the Method

Cronbach's α reliability coefficient and ICC were used for the analysis of method error, and the range of values was greater than 0.7, indicating very good inter- and intraobserver agreement.

DISCUSSION

Various habit-breaking appliances have been used, with a recent systematic review[11] concluding that the use of the palatal crib, regardless of the appliance design, was effective in treating AOB. However, there

Table 5. Means, SD Values, and Results of Paired *t*-Tests for the Changes After Treatment in the MSPC Group

	Pretreatment		Posttreatment		Change		95% CI for the Change		
Variable	Mean	SD	Mean	SD	Mean	SD	Lower Bound	Upper Bound	*P* Value
Dental relationship, mm									
Overbite	−3.96	1.34	0.01	1.26	3.97	1.44	3.05	4.89	<.001*
Overjet	3.09	1.79	4.05	1.98	0.96	0.83	0.43	1.49	.002*
Molar relationship	0.90	0.59	0.92	0.53	0.02	0.29	−0.16	0.20	.902
U6-rugae	8.48	1.36	7.95	1.33	−0.53	0.32	−0.73	−0.33	<.001*
Vertical development, mm									
UVer	8.70	1.89	6.76	1.55	−1.94	1.66	−2.99	−0.89	.002*
LVer	5.11	0.47	4.05	0.61	−1.06	0.71	−1.51	−0.61	<.001*
U1	8.02	0.74	8.51	0.73	0.49	0.63	0.09	0.89	.019*
L1	6.32	0.88	7.08	0.70	0.76	0.32	0.56	0.96	<.001*
Arch dimension, mm									
UAL	28.31	2.25	27.81	2.47	−0.50	0.56	−0.85	−0.15	.009*
LAL	24.75	2.62	22.59	2.52	−2.16	1.40	−3.05	−1.27	<.001*
UAP	77.06	4.55	76.45	4.69	−0.61	1.01	−1.25	0.03	.061
LAP	70.79	4.18	66.70	4.79	−4.09	2.68	−5.79	−2.39	<.001*
U6-6	36.49	2.42	36.70	2.62	0.21	0.82	−0.31	0.73	.401
L6-6	33.89	1.69	34.14	1.75	0.25	0.37	0.01	0.49	.036*
Little's Irregularity Index	2.96	3.16	4.80	2.22	1.84	1.85	0.67	3.01	.005*

* Significant at $P \leq .05$.

Table 6. Means, SD Values, and Results of Paired *t*-Tests for the Changes After Treatment in the CFPC Group

	Pretreatment		Posttreatment		Change		95% CI for the Change		
Variable	Mean	SD	Mean	SD	Mean	SD	Lower Bound	Upper Bound	*P* Value
Dental relationship, mm									
Overbite	−3.92	2.16	0.05	2.04	3.97	0.89	3.40	4.54	<.001*
Overjet	2.98	2.13	4.05	1.73	1.07	1.15	0.34	1.80	.008*
Molar relationship	0.64	0.54	1.23	0.70	0.59	0.54	0.24	0.94	.003*
U6-rugae	8.97	1.50	7.55	1.34	−1.42	0.99	−2.05	−0.79	<.001*
Vertical development, mm									
UVer	8.26	1.54	6.26	1.87	−2.00	1.09	−2.69	−1.31	<.001*
LVer	5.15	1.78	3.93	2.00	−1.22	1.16	−1.96	−0.48	.004*
U1	7.74	0.90	8.39	0.80	0.65	0.44	0.37	0.93	<.001*
L1	6.25	0.72	7.24	0.80	0.99	0.66	0.57	1.41	<.001*
Arch dimension, mm									
UAL	27.90	1.68	27.00	1.91	−0.90	1.39	−1.78	−0.02	.046*
LAL	24.04	1.71	21.37	1.59	−2.67	1.29	−3.49	−1.85	<.001*
UAP	76.37	3.15	75.31	2.98	−1.06	1.96	−2.30	0.18	.087
LAP	70.26	2.85	65.54	2.63	−4.72	1.69	−5.79	−3.65	<.001*
U6-6	36.58	1.13	36.74	1.28	0.16	0.61	−0.23	0.55	.413
L6-6	33.73	1.49	34.11	1.46	0.38	0.39	0.13	0.63	.006*
Little's Irregularity Index	2.88	1.55	4.75	2.90	1.87	2.75	0.13	3.61	.004*

* Significant at $P \leq .05$.

is contradictory data as to whether those appliances cause mesial movement of the maxillary first permanent molar.[7–9] A recent case report suggested a new design for the crib appliance: anchoring it to the palate using two miniscrews.[13] However, no study has evaluated its treatment effects on a large sample of patients. Hence, the aim of this study was to evaluate the effectiveness of the MSPC and to assess whether the CFPC produced mesial movement of the maxillary first molars.

The null hypothesis of this trial was rejected. Although the amount of AOB closure was similar in both groups, there was a tendency for greater mesial movement of the maxillary first molar in the CFPC group. The intermittent forces produced during swallowing as well as the considerable continuous force produced by the tongue with its rest position being caged behind the loops were transferred to the maxillary first molars in the CFPC group. These combined forces caused mesial movement of the first molar that led to a statistically significant difference between the two groups regarding the change in molar relationship.

The amount of AOB closure was similar in both groups and was attributed to extrusion of the maxillary and mandibular incisors along with an increase in their

Table 7. Means, SD Values, and Results of Independent *t*-Tests for the Comparison of Changes Between the Groups

	MSPC		CFPC		95% CI for the Difference		
Variable	Mean	SD	Mean	SD	Lower Bound	Upper Bound	*P* Value
Dental relationship, mm							
Overbite	3.97	1.44	3.97	0.89	−1.02	1.01	.989
Overjet	0.96	0.83	1.07	1.15	−0.95	0.75	.813
Molar relationship	0.02	0.29	0.59	0.54	−0.94	−0.20	.003*
U6-rugae	−0.53	0.32	−1.42	0.99	0.27	1.51	.007*
Vertical development, mm							
UVer	−1.94	1.66	−2.00	1.09	−1.13	1.24	.922
LVer	−1.06	0.71	−1.22	1.16	−0.66	0.97	.690
U1	0.49	0.63	0.65	0.44	−0.61	0.31	.513
L1	0.76	0.32	0.99	0.66	−0.67	0.20	.280
Arch dimension, mm							
UAL	−0.50	0.56	−0.90	1.39	−0.50	1.29	.374
LAL	−2.16	1.40	−2.67	1.29	−0.64	1.64	.372
UAP	−0.61	1.01	−1.06	1.96	−0.86	1.78	.478
LAP	−4.09	2.68	−4.72	1.69	−1.26	2.53	.496
U6-6	0.21	0.82	0.16	0.61	−0.56	0.67	.850
L6-6	0.25	0.37	0.38	0.39	−0.45	0.20	.427
Little's Irregularity Index	1.84	1.85	1.87	2.75	−1.96	2.02	.975

* Significant at $P \leq .05$.

clinical crown heights. The crib changed the posture of the tongue as well as prevented it from thrusting forward between the maxillary and mandibular anterior teeth. As a result, the only forces acting on these teeth were produced from the labial side by the action of the upper and lower lips. The amount of AOB closure in this trial was similar to that reported previously in the literature[4,10] and slightly higher than that reported in a recent systematic review (3.1 mm).[11] Whereas bonded spurs have been shown to result in an increase in the amount of overbite achieved by 3.09–4.38 mm.[4,5]

A few of the patients could not adapt to the new tongue position during swallowing and instead would press their lower lips between the maxillary and mandibular front teeth to form an oral seal. This led to increased lip pressure being applied to the mandibular incisors, resulting in a significant increase in Little's Irregularity Index and overjet in both groups. Thus, it can be recommended that a lip bumper be placed in conjunction with the palatal crib to remove such pressure.

The arch perimeter and length decreased similarly in both groups, with a greater decrease observed in the mandibular arch compared with the maxillary arch. This may have been attributed to the loss of Leeway space that occurred in most of the patients as a result of exfoliation of the primary molars and canines; the Leeway space is greater in the mandible.[15]

AOB was considered to be corrected only if the overbite was zero (end-to-end vertical incisor relationship) or had a positive value. Accordingly, the success rate was 83.3% in the MSPC group and 75% in the CFPC group. This may have been attributed to the slightly short follow-up period that, if extended, could have shown better progress. Another reason may have been that the amount of AOB to start with in those patients who did not achieve positive overbite was considerably large.

The failure rate of the paramedian miniscrews in this trial was 25%, which is considerably higher than that reported in the literature (5.5%).[16] This could be attributed to the heavy intermittent forces produced by the tongue during swallowing as well as a continuous force at rest. Another factor to be considered was the participant's age; most of the studies were conducted on adolescents or adults, whereas in this trial the patients were still young, and the palatal bone might not have been dense enough.[17]

In summary, the results of this clinical trial revealed that both the CFPC and the MSPC appliances resulted in similar improvement in the amount of AOB closure that occurred as a result of the extrusion of the incisors. A few patients developed a lip-trap habit, which led to an increase in the amount of overjet as well as the amount of crowding in the mandibular anterior segment. Finally, the main difference between the two groups was that the maxillary first molar moved mesially more in the CFPC group compared with the MSPC group.

Limitations

The addition of an untreated control group would have helped to differentiate between the treatment effects of both appliances and normal growth changes. However, this was not done because of the ethical concerns of leaving children without treatment despite their need for immediate intervention. Another limitation of the trial was that it included both sex groups and was not restricted to one specific sex type, with an unequal number of girls and boys.

Generalizability

The generalizability of the results of this clinical trial should be confined to children with AOBs who have similar age and dentoskeletal characteristics. The study was conducted on one race (Caucasians), was limited to only one dental center, and, finally, only one postgraduate student carried out the procedures.

CONCLUSIONS

- The MSPC is a viable treatment for the management of AOB attributed to a tongue-thrusting habit, with comparable results with the CFPC.
- Both appliances resulted in similar improvements in the amount of AOB closure, which was attributed to maxillary and mandibular incisor extrusion.
- Both appliances resulted in an increase in the amount of overjet as well as an increase in Little's Irregularity Index in the mandibular arch.
- There was statistically significant mesial movement of the maxillary molars in the CFPC group compared with the MSPC group; however, the clinical significance of this was minor.

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