Treatment stability after total maxillary arch distalization with modified C-palatal plates in adults

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Introduction: The purpose of this study was to evaluate skeletal, dentoalveolar, and soft tissue changes at 3 years posttreatment in patients with Class II Division 1 malocclusion treated with modified C-palatal plates (MCPPs). **Methods:** The sample consisted of 69 lateral cephalograms of 23 patients Class II Division 1 malocclusion (9 men, 14 women; average age, 20.1 years) who underwent bilateral distalization of their maxillary dentition. The lateral cephalograms were taken immediately before the placement of the MCPPs (T1); at the end of orthodontic fixed appliance therapy (T2); and at the posttreatment observation period (3 years posttreatment; T3). Twenty-three variables were measured. Repeated measures ANOVA followed by post hoc analysis using Bonferroni test was used to identify significant differences between time points. **Results:** Maxillary first molars showed a distal movement of 3.44 ± 1.08 mm ($P < 0.001$) distal crown tipping of 2.35° ± 6.74°, and intrusion of 1.42 ± 1.12 mm from T1 to T2. However, from T2 to T3, there was an average of 0.41 ± 0.25 mm of mesial movement, 0.50 ± 0.46 mm of extrusion, and insignificant mesial crown tipping (0.92° ± 2.46°; $P = 0.06$). The nasolabial angle increased 9.36° ± 6.04° from T1 to T2 ($P < 0.001$) but then decreased 1.55° ± 1.54° from T2 to T3. **Conclusions:** MCPPs are a viable treatment option for maxillary total arch distalization with minimal changes in treatment effects 3 years posttreatment. (Am J Orthod Dentofacial Orthop 2019;156:832-9)

The goal of orthodontic treatment is to achieve proper function, esthetics, and stability, but unstable treatment results can affect the function and esthetics. Hence, the stability of treatment should be the primary concern of clinicians and patients. However, posttreatment stability remains a significant challenge for orthodontists, as it is difficult to achieve.[1,2]

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Several studies have evaluated the treatment effects, and the posttreatment changes after various mechanics were used to treat Class II malocclusions,[3-6] but there is some discrepancy in the results regarding the stability of the treatment of Class II malocclusion, possibly owing the wide ranges of patient ages and the different types of malocclusions.

Concerning the stability of Class II treatment with Herbst appliances, relapse was more frequent in adults (39%) than in early adolescents (5%).[7] Mihalik et al[8] compared the outcomes of orthodontic camouflage treatment with orthognathic surgery in adults and found that surgery patients were nearly twice as likely to have a long-term increase in overjet. Melsen and Dalstra[9] reported that molars distalized with cervical headgear had a strong tendency to return to their initial sagittal position.

Temporary skeletal anchorage devices (TSADs) showed to be effective in the treatment of Class II malocclusions. They have been applied to support distalizers such as bone-anchored pendulum appliances and skeletal frog appliances.[10,11] In addition, they have been placed into the interradicular spaces to support the distalization of maxillary dentition via elastics.[10,12] Kuroda et al[13] reported that the occlusion and profile

were maintained after 5-year postretention in a patient with Class II malocclusion treated using TSADs. Furthermore, Ishihara et al[14] reported that the treatment outcome in a patient with Class II malocclusion treated using TSADs was stable with a small increase in the overbite 4 years posttreatment. Nevertheless, there have not been any studies on the assessment of the stability of the Class II treatment outcome using TSADs.

Research has shown that modified C-palatal plates (MCPPs) had been effectively used to distalize the maxillary dental arches in adolescent and adult patients with Class II molar relationship.[12,15,16] These studies reported that distalization with MCPPs resulted in bodily molar movement with minimal tipping and without molar extrusion. Therefore, treatment with MCPPs has been recommended for Class II Division 1 treatment. Although improvement can be achieved through orthodontic treatment, many studies have reported that there is a tendency for relapse to the original malocclusion after the appliance is removed.[9,17,18]

No data on the stability of MCPPs have yet been reported. Therefore, this study aimed to evaluate the skeletal, dentoalveolar, and soft tissue changes associated with MCPP treatment and assess the stability of the treatment effects after 3 years of posttreatment.

MATERIAL AND METHODS

The sample for this retrospective study consisted of 69 lateral cephalograms of 23 patients with Class II Division 1 malocclusion (14 females and 9 males; mean age: 20.1 years [range, 16-30]) who were treated by maxillary arch distalization using MCPPs. All patients had their skeletal growth completed at the time of treatment initiation (cervical vertebral maturation stage 5 and 6). All patients were treated at Seoul St Mary's Hospital in Seoul, South Korea. The Class II molar relationships were of various severities; 16 sides had a quarter cusp, 13 had a half cusp, 12 had a three-quarters cusp, and 5 had a full cusp. The inclusion criteria for this retrospective study were as follows: (1) dental Class II Division 1 molar relationship, (2) bilateral distalization using only MCPP appliances (3) adult subjects older than 16 years, and (4) the presence of lateral cephalometric images taken immediately before distalization, at the end of orthodontic fixed appliance therapy and at an average of 3.5 years (range, 2.0-7.2) posttreatment. The exclusion criteria were as follows: (1) the presence of systemic disease or syndrome and (2) poor-quality radiographs. Approval to conduct this study was granted by the Institutional Review Board of the Catholic University of Korea (KC11RASI0790), and informed consent was obtained according to the Declaration of Helsinki.

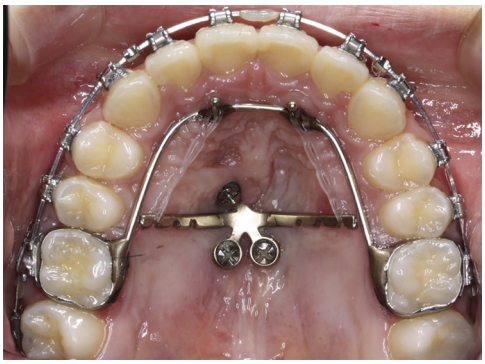

Fig 1. The MCPPs were connected to the hooks on the palatal wire via power elastics. The direction of the force can be changed according to the notches on the arms of the palatal plate.

The MCPPs (Fig 1) were inserted by a single operator using three 8.0-mm-long and 2.0-mm-diameter miniscrews (Jeil Corporation, Seoul, Korea) in the paramedian area. A palatal bar with 2 hooks extending along the gingival margins of the teeth was bonded to the maxillary first molars. Distalization was started by engaging elastics between the MCPP arm notches and the hooks on the palatal bar, applying approximately 300 g of force per side.[19]

Fixed appliance with straight wire technique and 0.022-inch-slot brackets were used. MCPPs were usually delivered early during the leveling and alignment phase. The size of the archwire was increased up to 0.018 × 0.025 or 0.019 × 0.025-inch stainless steel.[20] Distalization periods were calculated from the patient's records. All patients were treated successfully to achieve a super Class I molar relationship with normal overjet and overbite. Retention after the end of orthodontic fixed appliance therapy was performed using removable maxillary and mandibular Hawley retainers for 1 year in combination with a fixed mandibular canine-to-canine retainer in all subjects. Figure 2 compares the pretreatment and posttreatment intraoral photographs and lateral cephalograms of 1 patient.

Lateral cephalograms were taken by Dimax3 (Promax, Planmeca, Helsinki, Finland) with 70 kVp and 11 mAs at the start of distalization (T1); the end of orthodontic fixed appliance therapy (T2); and after 3 years posttreatment (T3). The cephalograms were digitized by 1 examiner using V-Ceph software (version 3.5; Cybermed, Seoul, Korea). The magnification range of the cephalostat was 8%-13%. The cephalograms were corrected and standardized to 1:1 ratio via the software using a 45-mm metal ruler image captured in the digital film as a reference. A 2-dimensional coordinate system

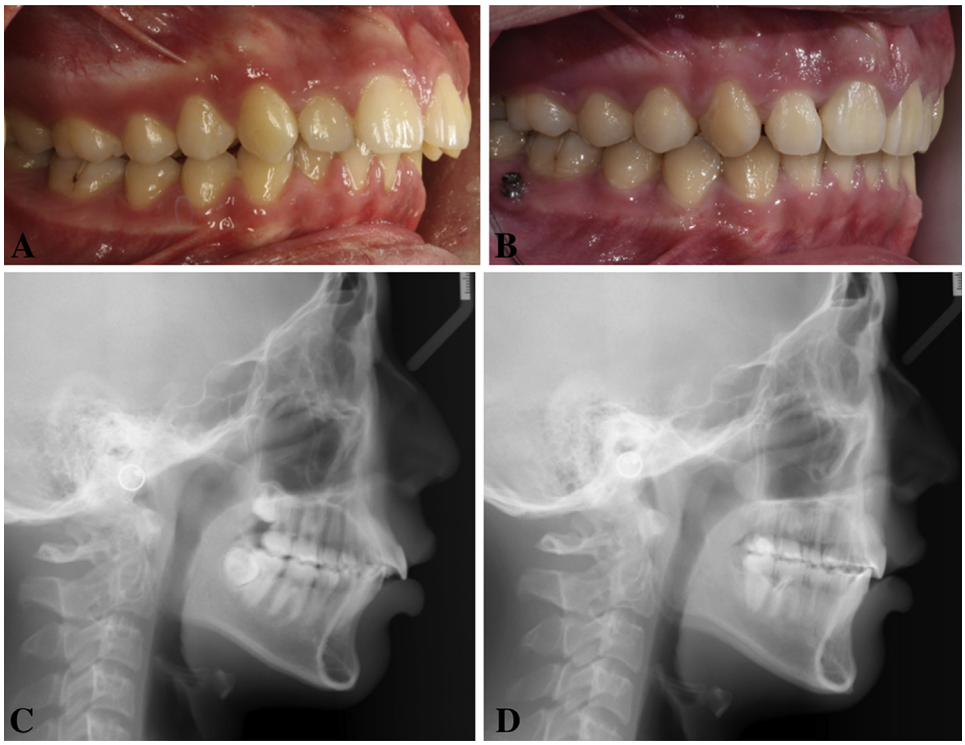

Fig 2. Pretreatment and posttreatment intraoral lateral photographs (**A** and **B**) and lateral cephalograms (**C** and **D**) of a patient.

was created; the horizontal reference line was the Frankfort horizontal plane, and the vertical reference line was a perpendicular line passing through the pterygoid. Twenty-three linear and angular variables were measured, including horizontal and vertical distances from the crown and root of first and second molars to the reference lines (Figs 3 and 4). The molar landmarks were placed on the most distal point of the crown and the distal root apex with no attempt to differentiate between the right and left sides. Differences between T1, T2, and T3 were calculated.

Records of 10 randomly selected patients were retraced and analyzed 2 weeks later by the same examiner. Intraexaminer reliability was assessed for all variables by the intraclass correlation coefficient, which showed that the measurements were reliable (>0.90).

Statistical analysis

Data analysis was performed using SPSS software (version 23; IBM, Armonk, NY). The distribution of the data was examined using the Kolmogorov-Smirnov test of normality and was found to be parametric distribution. Repeated measures ANOVA followed by post hoc analysis using the Bonferroni test was applied for comparisons. The confidence interval was set to 95%, and the acceptable margin of error was set to 5%. Results were considered significant as $P < 0.05$.

RESULTS

The mean and standard deviation of the changes in skeletal, dental, and soft-tissue measurements relative to T1-T2, T1-T3, and T2-T3 are summarized in Tables I and II, respectively.

SNA and ANB angle decreased significantly by 1.74° ± 1.21° and 1.36° ± 1.51°, respectively between T1 and T2 ($P < 0.001$ and $P = 0.001$, respectively). In addition, the occlusal plane angle increased −6.36° ± 4.10°, whereas, the palatal plane angle decreased 1.75° ± 2.02° ($P < 0.001$ and $P = 0.001$, respectively). During the retention period, there were no significant changes in sagittal and vertical skeletal measurements except for SNA, which increased by 0.48° ± 0.48°. In addition, the mandibular plane angle showed no significant change during treatment and retention periods (Table II).

The maxillary first molars showed a distal movement of 3.44 ± 1.08 mm, distal crown tipping of 2.35° ± 6.74° and intrusion of 1.42 ± 1.12 mm between T1 and T2. The maxillary second molars had 3.37 ± 1.36 mm of distalization, 1.08 ± 1.54 mm of intrusion, and 1.36° ±

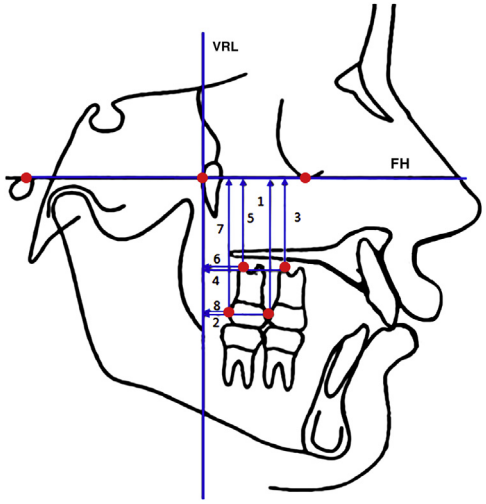

Fig 3. The following linear variables were calculated: (1) vertical distance from maxillary first molar crown to FH; (2) horizontal distance from maxillary first molar crown to VRL; (3) vertical distance from maxillary first molar root apex to FH; (4) horizontal distance from maxillary first molar root apex to VRL; (5) vertical distance from maxillary second molar root apex to FH; (6) horizontal distance from maxillary second molar root apex to VRL; (7) vertical distance from maxillary second molar crown to FH; and (8) horizontal distance from maxillary second molar crown to VRL. *FH*, Frankfort horizontal; *VRL*.

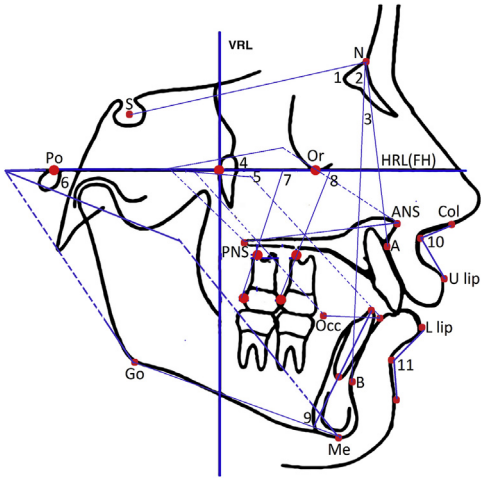

Fig 4. The following angular variables were measured: (1) SNA; (2) SNB; (3) ANB; (4) FH/ANS-PNS; (5) FH/OP; (6) FH/Go-Me; (7) maxillary second molar inclination; (8) maxillary first molar inclination; (9) IMPA; (10) nasolabial angle; and (11) mentolabial fold angle. *SNA*, Angle determined by points S, N, and A; *ANB*, angle determined by points A, N, and B; *FNA*, angle formed by the FH plane and the mandibular plane; *FH*, Frankfort horizontal; *ANS-PNS*, palatal plane angle; *OP*, occlusal plane angle; *GoMe*, mandibular plane angle; *IMPA*, incisor mandibular plane angle.

7.24° of distal tipping between T1 and T2. After 3 years posttreatment, the maxillary first molars moved mesially 0.41 ± 0.25 mm (P <0.001) and extruded 0.50 ± 0.46 mm (P = 0.004; Table II; Fig 5).

The nasolabial angle increased 9.36° ± 6.04°, and the upper lip was retracted 4.31 ± 1.98 mm between T1 and T2 (P <0.001). However, there were no significant changes in the follow-up period (T2-T3; Table II).

DISCUSSION

The treatment effects achieved with MCPPs showed high stability with only small changes at T3. The maxillary first and second molars showed 3.44 mm and 3.37 mm distal movement, respectively, during the treatment period (T2-T1). Only 0.41 mm and 0.38 mm of mesial movement were detected, respectively, during the 3 years posttreatment period (T3-T2), suggesting that about 88% of the distal movement was maintained. This high stability of the distal movement of the molars could be attributed to the physical nature of the tooth movement achieved during distalization with MCPPs. In our study, the first and second molars showed only 2.35° and 1.36° of distal tipping, respectively. This reduced tipping was achieved by choosing the proper plate notch to control the force vector that produced bodily movement. However, other investigations showed 8.8°-10.9° of distal tipping of the maxillary first molars after distalization using miniscrew-supported appliances.[10,21]

Several studies suggested that there is a tendency of relapse to the original malocclusion during the postretention period.[9,17,18] Ghosh and Nanda[22] reported distal tipping of maxillary first and second molars at the end of the distalization period of 8.4° and 12.0°, respectively with the pendulum appliance. They stated that a tipping movement of the molars could correct the molar relationship, but during retraction of the incisors, retention would be questionable. Chiu et al[23] and Burkhardt et al[24] found that nearly 90% and 87% of the molar distalization obtained during the first phase of treatment with Pendulum appliances was lost during the second phase of treatment.

Similarly, Caprioglio et al[25] reported that the first molars were distalized 4 mm with 10° of tipping with the pendulum appliance, but almost half of the patients had relapsed during the fixed appliance treatment. However, most of these studies were performed on growing-patients, and therefore, the mesial movement of the molars might be attributed in part to the growth of the nasomaxillary complex. Furthermore, in our study,

Table I. Cephalometric measures at T1, T2, and T3

Variables	*T1 (pretreatment)*	*T2 (posttreatment)*	*T3 (3 years posttreatment)*
SNA (°)	83.13 ± 4.13	81.39 ± 4.56	81.88 ± 4.47
ANB (°)	4.19 ± 2.94	2.84 ± 2.35	3.16 ± 2.43
FMA (°)	29.69 ± 7.85	30.27 ± 7.99	30.50 ± 7.67
Palatal plane angle (°)	1.87 ± 4.43	0.11 ± 4.32	-0.41 ± 3.71
Occlusal plane angle (°)	5.40 ± 6.44	11.76 ± 6.28	11.98 ± 6.38
Upper first molar crown (U6Cr)-VRL (mm)	17.16 ± 4.41	13.72 ± 4.87	14.13 ± 4.83
Upper first molar root (U6Rt)-VRL (mm)	22.46 ± 4.18	19.80 ± 4.24	20.05 ± 4.30
Upper first molar crown (U6Cr)-FH (mm)	44.23 ± 4.31	42.81 ± 4.41	43.31 ± 4.33
Upper first molar root (U6Rt)-FH (mm)	29.84 ± 3.54	28.79 ± 3.91	29.15 ± 3.88
Upper first molar (U6 axis)-FH (°)	110.79 ± 8.86	113.14 ± 9.22	112.22 ± 9.02
Upper second molar crown (U7Cr)-VRL (mm)	8.79 ± 3.58	5.42 ± 3.71	5.80 ± 3.76
Upper second molar root (U7Rt)-VRL (mm)	15.20 ± 2.96	12.49 ± 3.67	12.74 ± 3.73
Upper second molar crown (U7Cr)-FH (mm)	40.65 ± 5.08	39.57 ± 5.26	39.95 ± 5.08
Upper second molar root (U7Rt)-FH (mm)	28.46 ± 3.78	27.40 ± 3.73	27.80 ± 3.74
Upper second molar (U7 axis)-FH (°)	118.94 ± 11.50	120.30 ± 9.82	120.18 ± 8.49
IMPA (°)	90.74 ± 8.14	89.86 ± 9.81	89.32 ± 8.83
Overjet (mm)	5.13 ± 2.56	2.39 ± 1.11	2.55 ± 1.12
Overbite (mm)	2.52 ± 2.57	3.40 ± 1.28	3.47 ± 1.42
Nasolabial angle (°)	88.51 ± 8.21	97.87 ± 8.75	96.32 ± 8.88
Mentolabial fold (°)	131.52 ± 6.90	130.95 ± 6.51	129.68 ± 7.18
Upper lip (Ls)-VRL (mm)	67.99 ± 6.49	63.67 ± 6.96	64.06 ± 6.78
Upper lip (Ls)-TVL (mm)	6.48 ± 2.31	4.18 ± 2.27	4.46 ± 2.36
Lower lip (Li)-TVL (mm)	3.97 ± 3.66	3.27 ± 2.77	3.29 ± 2.84

Note. All values are mean ± standard deviation.
SNA, Angle determined by points S, N, and A; *ANB*, angle determined by points A, N, and B; *FNA*, angle formed by the FH plane and the mandibular plane; *Ls*, labrale superius; *Li*, labrale inferius; *VRL*; vertical reference line; *FH*, Frankfort horizontal; *IMPA*, incisor mandibular plane angle; *TVL*, true vertical line.

the distal tipping of the first molars showed the most significant relapse (39.1%), which might suggest that the high relapse with other appliances might be because they induced more significant tipping compared with other studies.

There is a strong tendency for molars to return to the key ridge with cervical headgear, and there is no evidence that the Class I relationship achieved by extraoral traction is more stable than that achieved with intramaxillary or functional appliances.[9]

Overjet in our study changed significantly and was reduced by 2.74 mm during the treatment period, and there was only a 0.16-mm relapse during the retention period (T2-T3). Mihalik et al[8] compared long-term results after surgical treatment of adult Class II malocclusion with camouflage treatment and discovered that surgical patients were nearly 2 times more likely to have a long-term increase in overjet. On the other hand, Cassidy et al[26] reported a slightly larger overjet relapse in adult Class II Division 1 orthodontic patients (1.3 mm) than in surgery patients (0.9 mm). However, a sizeable overjet relapse (because of condylar resorption) was found only in the surgical patients.[26]

Previous investigations found that distal molar movement is followed by an increase in the lower facial height and vertical facial dimension.[22,27,28] However, in our study, maxillary molars were distalized with 1.42 mm of intrusion. The intrusion of the molars during the distal movement could help maintain the anterior facial height. Despite the significant relapse in the vertical position of the molars (35% of the achieved intrusion) during the follow-up period, the mandibular plane angle showed no changes. This relapse in the molar intrusion could have been due to the absence of residual growth to accommodate the posttreatment vertical changes as the participants in this study were adults.

The follow-up period evaluation showed no significant skeletal or soft tissue relapse. An essential factor explaining the stability of our treatment results is the treatment duration. Some authors claimed that more significant relapse is associated with shorter treatment time.[29,30] Sar et al[10] stated that the average distalization time was 8.2 and 10.2 months with 2 implant-supported molar distalization systems, whereas, Chiu et al[23] reported 10 months with distal jet appliances. The total distalization duration in our study was 12.2 months.

Table II. Changes in skeletal, dental, and soft tissue measurements at T1-T2, T1-T3, and T2-T3

Variables	*T1-T2*	*T1-T3*	*T2-T3*
SNA (°)	1.74 ± 1.21*	1.25 ± 1.17*	−0.48 ± 0.48*
ANB (°)	1.36 ± 1.51*	1.04 ± 1.36*	−0.32 ± 0.79†
FMA (°)	−0.57 ± 1.69†	−0.80 ± 1.53†	−0.23 ± 0.94†
Palatal plane angle (°)	1.75 ± 2.02	2.27 ± 2.04*	0.52 ± 1.26†
Occlusal plane angle (°)	−6.36 ± 4.10*	−6.58 ± 3.52*	−0.22 ± 2.16†
U6Cr–VRL (mm)	3.44 ± 1.08*	3.03 ± 1.03*	−0.41 ± 0.25*
U6Rt–VRL (mm)	2.66 ± 1.44*	2.41 ± 1.36*	−0.25 ± 0.22*
U6Cr–FH (mm)	1.42 ± 1.12*	0.92 ± 0.72*	−0.50 ± 0.46*
U6Rt–FH (mm)	1.05 ± 1.02*	0.70 ± 0.66*	−0.36 ± 0.59*
U6 axis–FH (°)	−2.35 ± 6.74†	−1.43 ± 4.23†	0.92 ± 2.46†
U7Cr–VRL (mm)	3.37 ± 1.36*	2.99 ± 1.13*	−0.38 ± 0.28*
U7Rt–VRL (mm)	2.71 ± 1.44*	2.46 ± 1.38*	−0.25 ± 0.26*
U7Cr–FH (mm)	1.08 ± 1.54*	0.69 ± 1.09†	−0.38 ± 0.65*
U7Rt–FH (mm)	1.06 ± 1.32*	0.66 ± 0.83*	−0.40 ± 0.44*
U7 axis–FH (°)	−1.36 ± 7.24†	−1.24 ± 6.36†	0.12 ± 3.43†
IMPA (°)	0.88 ± 10.21†	1.42 ± 8.23†	0.54 ± 3.09†
Overjet (mm)	2.74 ± 2.35*	2.58 ± 2.52*	−0.16 ± 0.56†
Overbite (mm)	−0.87 ± 2.17†	−0.94 ± 2.17†	−0.07 ± 0.88†
Nasolabial angle (°)	−9.36 ± 6.04*	−7.81 ± 6.07*	1.55 ± 1.54*
Mentolabial fold (°)	0.57 ± 5.39†	1.85 ± 6.79†	1.28 ± 5.23†
Ls–VRL (mm)	4.31 ± 1.98*	3.93 ± 1.73*	−0.38 ± 0.70*
Ls–TVL (mm)	2.30 ± 0.99*	2.01 ± 0.90*	−0.28 ± 0.41*
Li–TVL (mm)	0.70 ± 2.95†	0.67 ± 2.70†	−0.02 ± 0.88†

Note. All values are mean ± standard deviation.
SNA, Angle determined by points S, N, and A; *ANB*, angle determined by points A, N, and B; *FNA*, angle formed by the FH plane and the mandibular plane; *Ls*, labrale superius; *Li*, labrale inferius; *VRL*; vertical reference line; *FH*, Frankfort horizontal; *IMPA*, incisor mandibular plane angle; TVL, true vertical line.
*$P < 0.05$ (statistically significant); †$P > 0.05$ (statistically not significant).

This longer distalization time might have played a role in improving the posttreatment stability.

In our study, despite a significant distal movement of all maxillary dentition including second molars (T1-T2), no significant changes occurred during the retention period (T2-T3). Thus, our results are at odds with those of other investigators who reported that the higher the treatment changes, the higher the posttreatment relapse.[17,31,32]

Although the average posttreatment period assessed in this study was only 3.5 years with a minimum of 2 years, it is considered to be the most critical period for retention. Several studies reported that most posttreatment changes occur in the year immediately after treatment and occlusion tends to stabilize after that, except for mandibular incisors' contact point displacement, which tends to increase over the years.[33,34] Moreover, in a 10-year follow-up study, Al Yami et al[35] stated that the maximum movement takes place during the first 2 years posttreatment.

Several factors might affect the stability of the orthodontic treatment outcome. These include gender, skeletal maturity, age, habits, muscular functions, bite force, growth patterns, initial occlusion, treatment modality, changes in arch form, and posttreatment occlusion.[36-38] However, no consensus was reached because studies have shown contradictory conclusions.[39]

Maniewicz Wins et al[40] reported in a systematic review that the only 2 factors found to be predictive of relapse were significant treatment changes in molar and canine relationships, but the evidence was limited. In addition, they reported that 14 factors were found to not affect relapse, again with limited evidence. These factors were divided into (1) pretreatment characteristics (molar relationship, overbite, incisor inclination, SNA, SNB, ANB, and maxillary, mandibular, and intermaxillary plane angles); (2) treatment characteristics (treatment timing, length of treatment, retention time, and length of follow-up); and (3) posttreatment characteristics (overjet and molar relationships). In addition, they also showed that severe pretreatment dental sagittal relationship, extraction, and significant treatment changes (except for molar and canine relationships) exhibited no conclusive evidence regarding their effect on relapse.

A recent study[41] showed that the number of years without retention and not wearing a fixed retainer had a significant increase in the risk of lower incisor alignment instability. It also concluded that a high posttreatment Peer Assessment Rating score and premolar extractions are predictive variables that significantly increase the risk of midline instability.[41]

Raucci et al[42] reported that the predictors of stability of mandibular dental arch dimensions after treatment with lip bumper followed by fixed appliance were the increases in intermolar and interpremolar widths during lip bumper therapy. Meanwhile, the predictor of relapse in maxillary dental arch dimensions after treatment with transpalatal arch followed by fixed appliances was pretreatment maxillary crowding.[43]

The inclusion of an untreated control group in our study was deemed unnecessary because our sample consisted of adult patients, and the main objective of the study was to assess the stability of treatment effects. Changes occurring in adults because of aging were expected to be small and clinically insignificant over 3 years. Bishara et al[44,45] reported maxillary dental arch changes ranging between 0.2 and 1.0 mm, whereas cephalometric changes of dental and skeletal variables ranged between 0.0° and 2.7° for angular

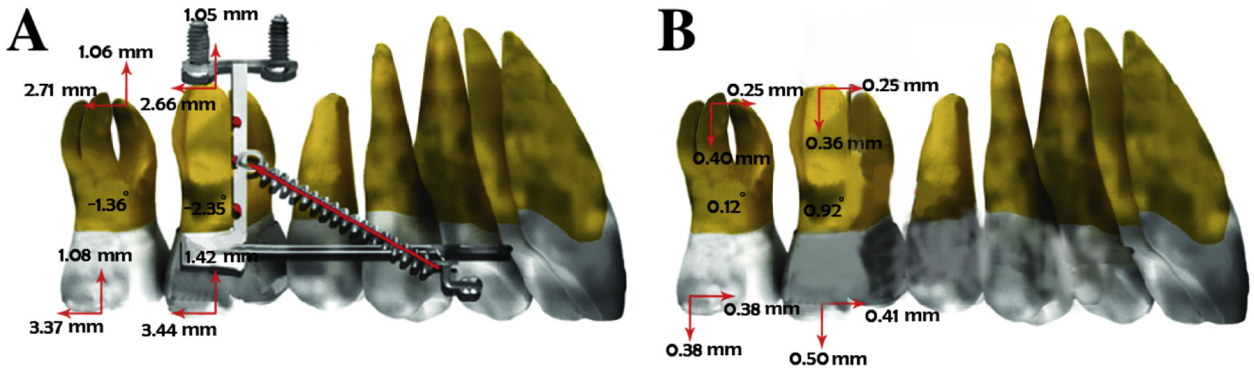

Fig 5. Summary of mean maxillary dental changes after distalization (**A**) and after 3 years posttreatment (**B**).

variables and between 0.0 mm and 2.0 mm for linear variables over 20 years.

Our study showed possible relapse tendencies and provided important information because no data have yet been reported on the stability of MCPPs in adult patients with dental Class II Division 1 malocclusion. The outcome of this investigation suggests that MCPPs can be considered an effective and stable protocol for the treatment of Class II malocclusion in the absence of severe skeletal discrepancies. It also implies that the distal bodily movement of maxillary molars has good stability over time. However, further long-term, prospective studies are needed to confirm our results.

CONCLUSIONS

1. The dental, skeletal, and soft-tissue treatment effects with the application of MCPPs showed minimal changes after 3 years of posttreatment in adult patients.
2. Relapse in the maxillary first molars was only 12% of the achieved distalization and 35% of the intrusion.
3. MCPPs are a viable treatment option for maxillary total arch distalization with minimal loss in treatment effects 3 years posttreatment.

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