Original Article

Initial Intrusion of the Molars in the Treatment of Anterior Open Bite Malocclusions in Growing Patients

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Abstract: The treatment of the hyperdivergent phenotype and/or anterior openbite is one of the common problems facing orthodontists. The purpose of this study is to present a new appliance (Molar Intruder) for molar intrusion and to determine its effects in the treatment of anterior openbite. The study group comprised 14 patients (eight girls and six boys), with a mean age of 10 years and 7 months. All presented anterior open bite malocclusions between the second premolars. The study was carried out on lateral head films taken before (T1) and after (T2) molar intrusion. Periapical radiographs, study models, and standard photographs of all the patients were also obtained before and after molar intrusion. The paired sample *t*-test was used to determine the differences between the parameters. The average treatment time with the Molar Intruder was five months. The mean intrusion of maxillary and mandibular molars was 1.86 mm and 1.04 mm, respectively. Maxillary incisors extruded 0.54 mm with a labial tipping of 1.46° and overbite increased by 4.00 mm. The mandibular plane angle was decreased by 1.57°, and the anterior face height was decreased by 1.86 mm on average. The mandible showed a counterclockwise rotation, the chin moved forward, and the posterior facial height/anterior facial height ratio was increased. Anterior openbites of the patients were significantly rehabilitated at the end of the intrusion period, simplifying further orthodontic treatment. (*Angle Orthod* 2004;74:454–464.)

Key Words: Molar intrusion; Anterior openbite; Hyperdivergency

INTRODUCTION

Openbites can be related to skeletal, dental, and soft tissue effects and generally contain a combination of these factors.[1] Sometimes it is possible to identify the specific etiologic factors,[2] but especially in open-bite cases of skeletal origin, the factors responsible for the malocclusion cannot be identified easily.[1,2] Skeletal openbites show more molar and incisor eruption than do dental openbites, and the excessive dentoalveolar heights increase the severity of the malocclusion.[3,4] It has been mentioned that a steep mandibular plane, an obtuse gonial angle, increased lower face height, and counterclockwise rotation of the palatal plane were parameters of skeletal anterior openbites. On the other hand, parameters of dentoalveolar openbites were divergent maxillary and mandibular occlusal planes, mesial inclination of posterior teeth, and lack of a normal curve of Spee in the lower arch.[5–11]

Treatment of patients with openbite must be performed early to be successful. Otherwise the opportunity for growth modification could be lost, leaving surgical correction as the only possible treatment. A favorable growth pattern in patients with a hyperdivergent phenotype include an increase in the posterior face height, a forward mandibular rotation, and enhanced condylar growth. Therefore, control of the vertical dimension is considered the most important factor in the treatment of open bite malocclusions.[12–15] Treatment should result in an increased posterior facial height/anterior facial height ratio and a forward autorotation of the mandible. Molar intrusion is the primary treatment objective to achieve these treatment goals.[15]

Various treatment modalities have been proposed for the correction of anterior openbites. A conventional approach is to inhibit the vertical maxillary growth or to intrude maxillary molars with headgear.[16–18] Other treatment devices reported include vertical-pull chincups,[19] vertical elastics,[18,20] functional appliances,[21] posterior bite-blocks,[22–25] tongue cribs,[26] transpalatal arches,[27] posterior magnets,[28–32] multiloop edgewise archwires (MEAW therapy),[10,33–35] miniplate anchorage,[36,37] orthodontic treatment and various orthognathic surgery combinations,[38–40] and any combination thereof.[20,41] Although orthodontists have attempted to limit

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Accepted: August: 2003. Submitted: June 2003.

increases in the vertical dimension by one or more of the above approaches, with the exception of posterior bite-blocks, many of these treatment approaches were not effective in rotating the mandible forward and producing more anterior condylar growth.[42]

The purpose of this study is to present the Molar Intruder (MI) appliance, which can be used to intrude molar teeth in the late mixed or early permanent dentition, and to evaluate the treatment effects of MI on the maxillofacial morphology.

MATERIALS AND METHODS

The study group comprised 14 patients (eight girls and six boys) with a mean age of 10 years and 7 months (range 9.2 to 12.4 years) with a hyperdivergent phenotype. All the patients were in late mixed or early permanent dentition and presented an anterior openbite to the second premolars with only the molars in occlusion. Sex and type of malocclusion were not considered in patient selection. Cases were selected on the basis of (1) mandibular plane angle greater than 35°; (2) anterior openbite through the second premolars; and (3) adequate transverse dimension in the maxillary dental arch. Lateral head films, periapical radiographs, study models, and standard photographs of the patients were obtained before treatment (T1) and after molar intrusion (T2).

Appliance construction

Impressions for working models were obtained from the patient. A construction bite exceeding the freeway space by two mm was taken using softened wax rims, and the rim was transferred to the working models. The working models were mounted on a fixator, and the bite was registered (Figure 1A). Buccal undercuts where clasps were planned were scraped (0.5 mm) with a spatula for extra retention. Adams clasps were bent (0.7-mm stainless steel wire) for the maxillary premolars (Figure 1B) or maxillary first molars if only the second molars were to be intruded (patient 1). Eyelet clasps (0.7 mm) were incorporated to reinforce the retention of the appliance. Molar intrusion springs were bent from 0.7-mm stainless steel wire. The design of the springs was altered if the second molars were erupted (Figure 1B,C). Upper springs were coated with modeling wax from the helixes to the occlusal rests and were fixed on the working model, whereas the lower springs were fixed on the model only at the occlusal rests. The acrylic of the appliance was formed filling the space between the teeth and polymerized in a pressure pot, after which the appliance was trimmed and polished (Figure 2).

Clinical management

The MI was adjusted and controlled in the mouth in a passive state, and then the intrusion springs were activated

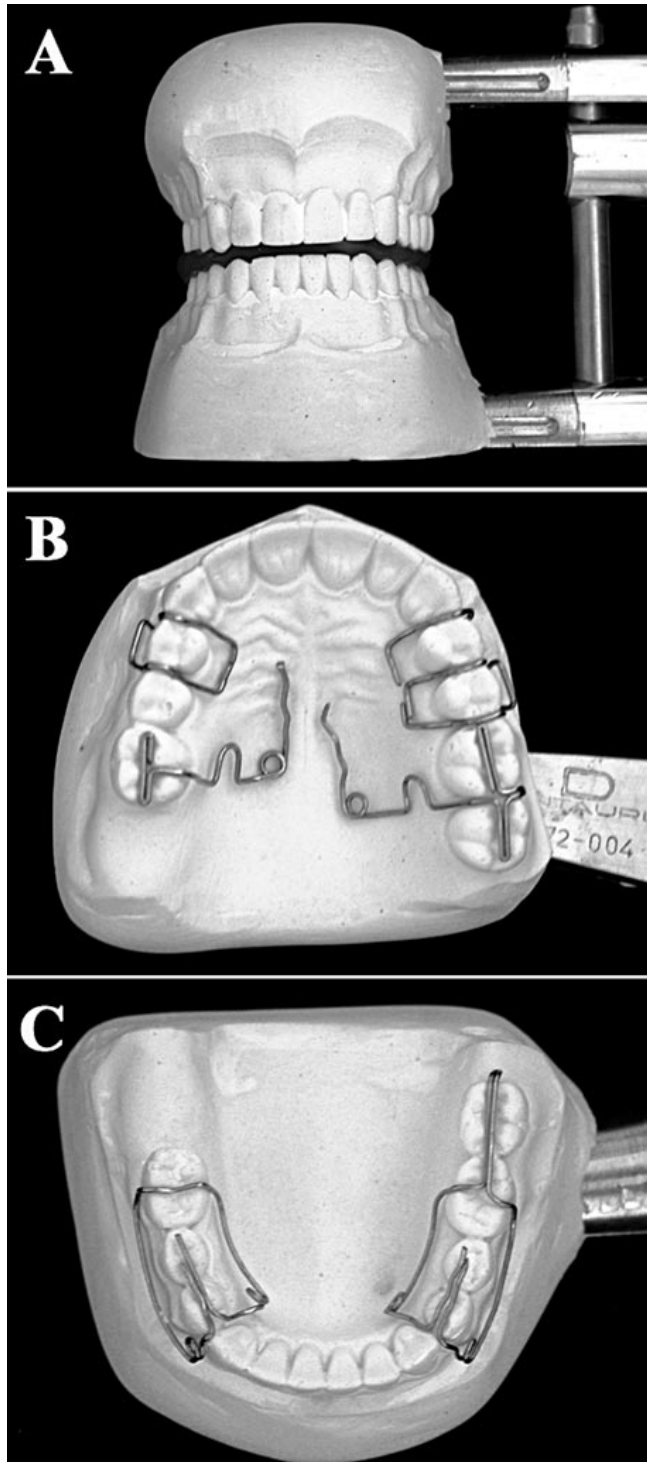


FIGURE 1. Bite registration and the intrusion springs of the MI appliance.

(Figure 2B). A 110-g force was applied on each first molar when the second molars were absent; however, if the second molars were in occlusion, 180 g of force was exerted to the molar teeth in every quadrant. The force was measured by pulling back the springs to their original positions using a gauge (Dentaurum 006-013-00). The upper springs

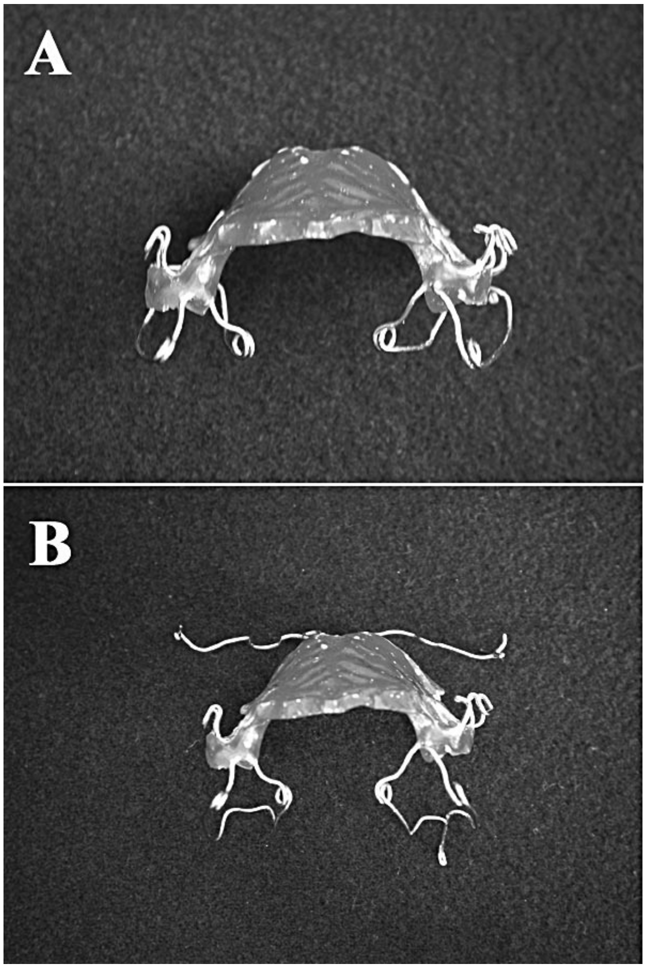


FIGURE 2. Passive (A) and active (B) forms of the MI appliance.

usually needed readjustment after activation. The ''U'' bends were narrowed, and the occlusal rests were readjusted with pliers. The MI was seated in place, and the patient was told to close his/her mouth slowly. The lower springs were guided with forefingers during mouth closure and seated in place. The patient was instructed how to guide the lower springs and advised to wear the appliance all day except during meals.

The patients were seen at three-week intervals to adjust and reactivate the springs if necessary. The average treatment time with the MI was five months. After the appliance was removed, orthodontic treatments of the patients were carried out with edgewise mechanics and multiloop archwires.[10,34,35] Extraoral and intraoral photographs of two patients treated with the MI are presented in Figures 3–6.

Cephalometric analysis

Lateral cephalograms were performed with the Frankfort Horizontal plane parallel to the floor and the teeth in centric occlusion. The radiographs were taken using the same cephalostat with standardized settings and traced by one investigator using a 0.3-mm pointed pencil. The other authors examined the tracings and verified all landmarks. In instances of disagreement, the structure in question was retraced to the mutual satisfaction of the investigators. When a double image of the molars was present all measurements were made from the distal and smaller image.

Seventeen landmarks and 21 parameters were used in the study (Figure 7). Three authors measured every parameter twice at different times (a total of six measurements for every parameter), and the mean values of the findings were used in statistical evaluation. Treatment effects were also determined by superimposing the lateral cephalograms on the cranial base, palatal plane, and mandibular plane (Figure 8).

Statistical method

The statistical analyses were performed using the SPSS 10.0 (SPSS Inc., Chicago, Ill) statistical program. Using the tests of normality we observed that the variables were distributed normally. Therefore, the ''Paired Sample *t*-test'' was used to determine the differences between the parameters. The Mann-Whitney *U*-test was used for the comparison of intrusion movements of the single and two molars. The descriptive statistics are shown as arithmetic means $\pm$ standard deviation. P values less than or equal to .05 were evaluated as being statistically significant.

RESULTS

The treatment changes of the group are shown in Table 1. The SNB angle was increased by 1.571° ($P = .001$), and the ANB angle was decreased by 1.29° ($P = .01$). The Y axis was decreased by 1.36° ($P < .001$), the SN/MP angle was decreased by 1.57° ($P = .001$), and the gonial angle was decreased by 1.50° ($P = .001$). The NV-Pog distance was also decreased, by 1.214 mm.

The anterior face height was decreased by 1.86 mm, and the ramus length was increased by 0.46 mm. The posterior facial height/anterior facial height ratio showed an increase of 2.25%. The U6-FH distance was decreased by 1.86 mm, and the L6-MP distance was decreased by a mean of 1.04 mm. The U1-FH distance and the U1/SN angle were increased by 0.54 mm and 1.46°, respectively. The occlusal plane angle was decreased by 2.25° ($P < .001$), and the overbite was increased by 4.00 mm ($P < .001$). Finally, the mandibular sulcus contour (MSC) was decreased by 3.571 mm ($P < .001$).

When the intrusion movements of the single and two molars were compared, single molar intrusion was statistically significant both in the maxilla ($P < .012$) and mandible ($P < .029$) (Table 2).

DISCUSSION

It is generally agreed that treatment of skeletal anterior open bite malocclusion is difficult. An adult skeletal open-

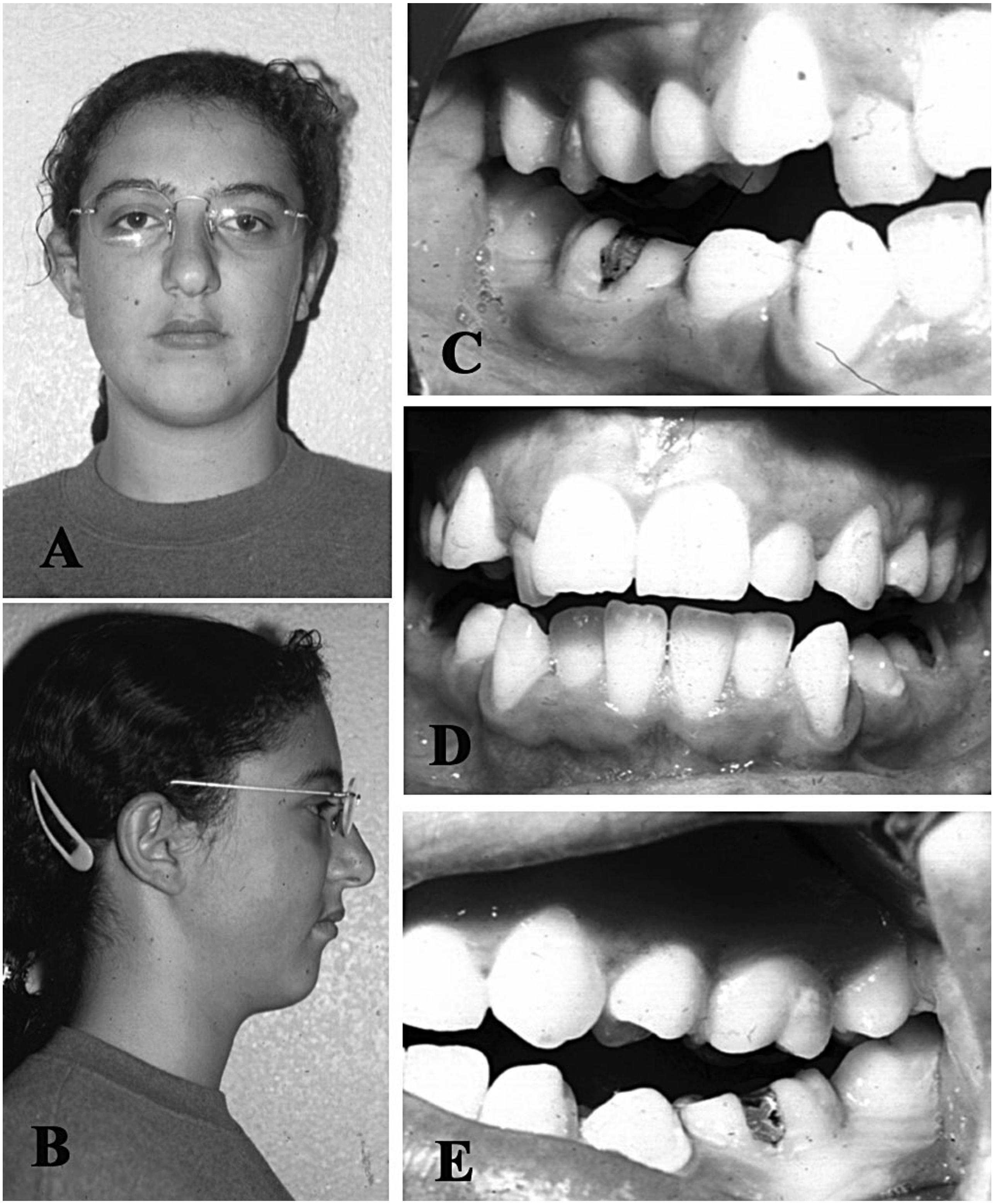


FIGURE 3. Extraoral and intraoral photographs of patient 1 before treatment.

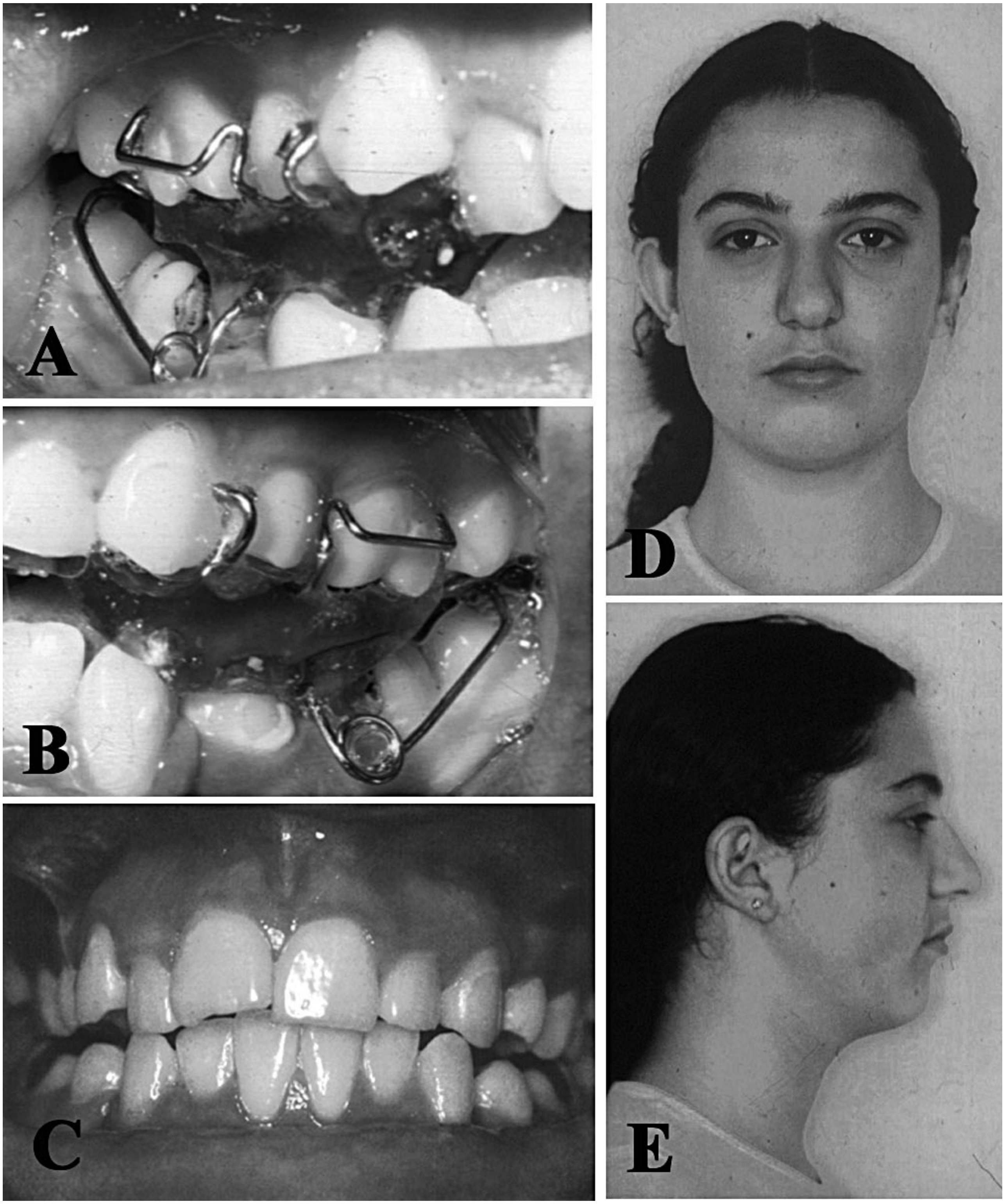


FIGURE 4. Intraoral views of the MI appliance (A, B), the bite closure (C), and extraoral photographs of the patient after MI use (C–E).

bite case is ideally corrected with a combination of orthodontics and orthognathic surgery[43] because the relapse after surgery is usually less than that seen with nonsurgical treatment alone.[44] On the other hand, early treatment of hyperdivergent cases with anterior openbites not only eliminates the risks associated with orthognathic surgery but also improves a child's self-esteem by improving the appearance.[15]

In this study, the mean age of the sample was 10 years

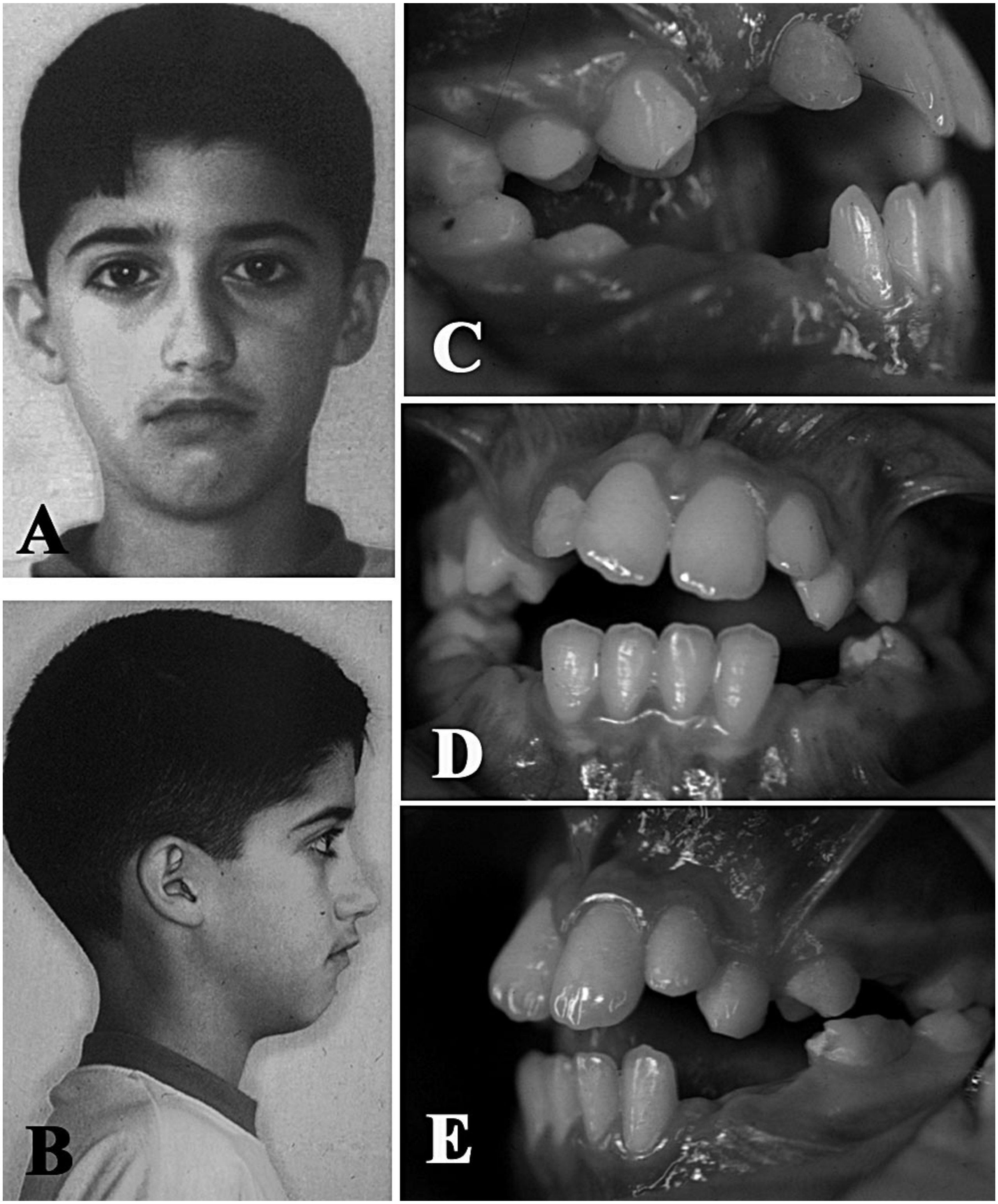


FIGURE 5. Extraoral and intraoral photographs of patient 2 before treatment.

7 months. The first molars of eight patients, the second molars of one patient (64.3%), and both the first and second molars of five patients (35.7%) were intruded by the MI appliance. Although Burstone[45] recommended an intrusive force of 20 g for incisors, the optimum magnitude of force has not been established to intrude posterior teeth or large segments of teeth. Kalra et al[28] applied 90 g of intrusive force per tooth with fixed magnetic appliances. Umemori

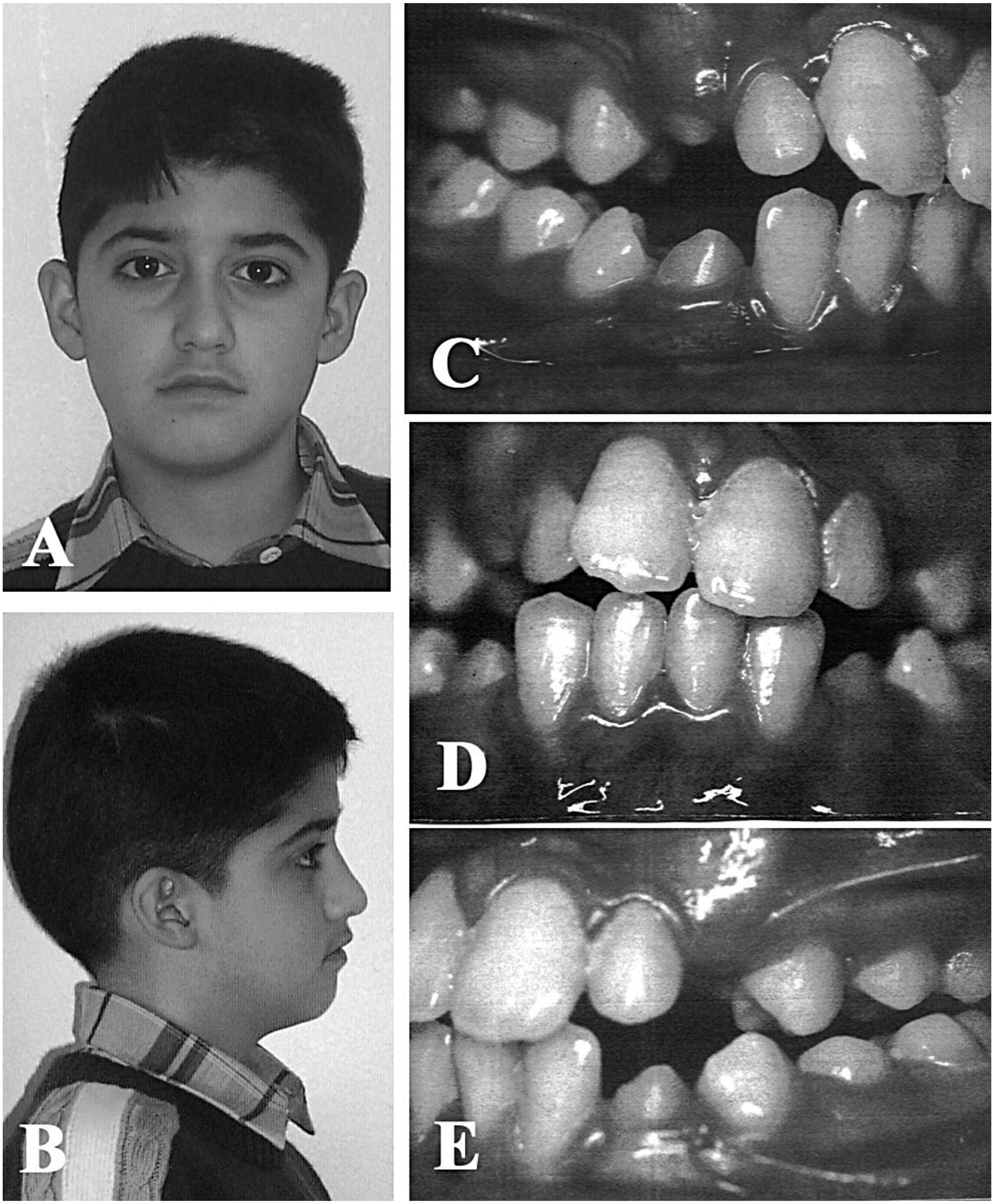


FIGURE 6. Extraoral and intraoral photographs of patient 2 after molar intrusion.

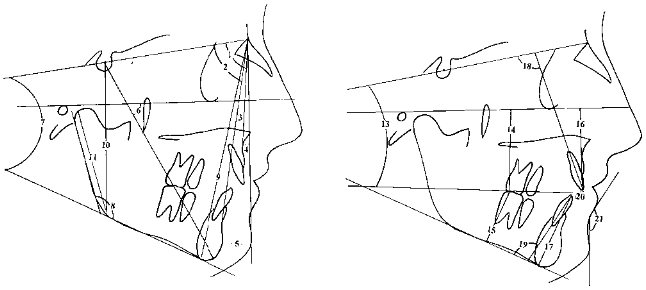
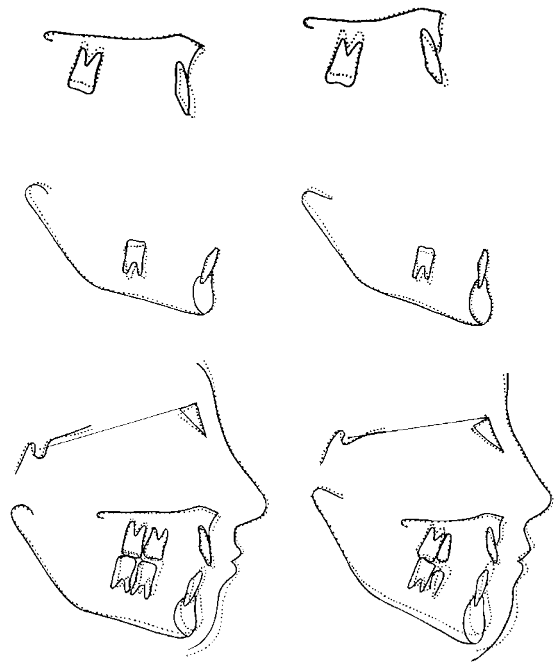


FIGURE 7. Linear and angular measurements used in the study. (1) SNA, (2) SNB, (3) ANB, (4) NV-A, (5) NV-Pog, (6) Y axis angle, (7) SN/MP: mandibular plane angle, (8) gonial angle, (9) N-Me, (10) S-Go, (11) Co-Go: ramus height, (12) S-Go/N-Me ratio, (13) SN/ Occ: occlusal plane angle, (14) U6-FH: the perpendicular distance of maxillary first molar to Frankfort horizontal plane (FH), (15) L6-MP: the perpendicular distance of mandibular first molar to mandibular plane (MP), (16) U1-FH: the perpendicular distance of maxillary central to FH, (17) L1-MP, (18) U1/SN: the angle between maxillary central and cranial base, (19) L1/MP, (20) overbite, (21) MSC: mandibular sulcus contour.



A B

FIGURE 8. Superimpositions of the pretreatment (-) and post intrusion (. . .) tracings of patients 1 (A) and 2 (B).

et al[37] intruded the lower molars with a force greater than 90 g using titanium miniplates. In our study, the intrusive force for molars ranged between 110 and 180 g, depending on whether only one or two molars were to be intruded in every quadrant.

Labiolingual springs were incorporated to the MI appliance in 4 patients (Figure 4A,B) to improve anterior crowding before fixed treatment, but they were not activated until the final cephalograms were obtained. It is difficult to use the upper springs of the MI with expansion screws. However, they can be used if precise readjustments are made during expansion. Because the lower springs can never be used during maxillary expansion, patients presenting a transverse maxillary deficiency were not included in this study. The retention of the appliance was satisfactory because all the patients in the study group had adequate crown

TABLE 1. Descriptive Statistics of Cephalometric Measurements at T1, T2, and T2-T1

	T1		T2		T2-T1		
Measurements	Mean	SD	Mean	SD	Mean	SD	Significance[a]
SNA (°)	81,214	4,154	81,357	4,144	0.143	0.770	NS
SNB (°)	77,643	3,201	79,214	2,723	1,571	1,343	***
ANB (°)	3,571	2,681	2,286	2,494	−1,286	1,590	**
NV-A (mm)	1,643	3,522	1,679	3,268	0.036	0.634	NS
NV-Pog (mm)	7,500	4,570	6,286	4,084	−1,214	0.893	***
Y axis (°)	64,214	2,991	62,857	3,207	−1,357	0.886	***
SN/MP (°)	38,071	4,376	36,500	4,052	−1,571	0.936	***
Go (°)	136,214	3,867	134,714	3,361	−1,500	1,286	***
N-Me (mm)	130,429	9,163	128,571	8,993	−1,857	1,406	***
S-Go (mm)	81,071	6,367	81,571	6,248	0.500	0.941	NS
Co-Go (mm)	55,929	4,827	56,393	4,817	0.464	0.458	**
S-Go/N-Me (%)	0.621	0.029	0.635	0.029	0.014	0.013	***
SN/Occ (°)	18,000	5,189	15,750	4,669	−2,250	1,696	***
U6-FH (mm)	51,786	5,327	49,929	5,196	−1,857	0.770	***
L6-MP (mm)	31,000	3,258	29,964	3,290	−1,036	0.536	***
U1-FH (mm)	53,929	4,376	54,464	4,530	0.536	0.820	*
L1-MP (mm)	38,429	3,131	38,571	2,986	0.143	0.691	NS
U1/SN (°)	105,786	6,507	107,250	6,210	1,464	0.634	***
L1/MP (°)	88,929	5,622	88,714	5,283	−214	0.699	NS
Overbite (mm)	−2,714	1,069	1,286	1,490	4,000	0.877	***
MSC (°)	142,500	9,630	138,929	11,364	−3,571	2,848	***

[a] * $P < .05$; ** $P < .01$; *** $P < .001$.

FIGURE 9. Periapical radiographs of patient 2 after MI use. Minimal root resorption was observed at the apex of the palatinal root of the maxillary left first molar (B).

TABLE 2. Comparison of the Intrusion Movement of Single Molar vs Two Molars

Measurements	Single Molar T2-T1		Two Molars T2-T1		Significance[a]
	Mean	SD	Mean	SD	
U6-FH	−2,222	0.618	−1,200	0.570	*
L6-MP	−1,278	0.441	−0.600	0.418	*

[a] * $P < .05$; ** $P < .01$; *** $P < .001$.

length with buccal undercuts. Patient compliance problems due to dislodgement were not observed, but we did consider that MI may pose dislodgement problems in the patients with deficient crown length and buccal undercuts.

Although counterclockwise rotation of the mandible by intruding the molars is most favorable[15] in the treatment of open bite cases, it has been shown[10,33–35] that anterior openbites can also be treated successfully by correcting the cant of occlusal planes and uprighting the posterior teeth (MEAW therapy). However, because this technique deals with the dentoalveolar parameters of anterior openbite, counterclockwise rotation of the mandible was not reported and the findings of these studies were, in general, contrary to our findings.

The results of this study showed that the mean maxillary and mandibular molar intrusion was 1.86 and 1.04 mm, respectively. However, when both the first and second molars were intruded, the average molar intrusion was reduced by nearly half. It was considered that 180 g of force might be insufficient for simultaneous intrusion of two molars.

The findings of molar intrusion were similar to the findings of several studies in which vertical chincups,[19] magnetic bite-blocks,[28,30] miniplate anchorage,[36,37] and high-pull headgear + bite-block[41] were used. Mandibular incisors were stable after the MI was used, but the maxillary incisors were extruded an average of 0.54 mm with a labial tipping of 1.46°. This was attributed to the anterior force vector of the lower springs, affecting the acrylic plate of the appliance. The occlusal plane angle was decreased by 2.25°, and overbite was increased by 4.00 mm, matching the findings of Sherwood et al[36] and Umemori et al.[37]

Sankey et al[42] treated 38 patients with vertical skeletal dysplasia using a bonded palatal expander and a crozat/lip bumper, intraorally. A high-pull chincup was added to the treatment regimen in 16 patients. They reported that the increase in SNB was insignificant, whereas the decrease in ANB was found to be statistically significant. We also found a 1.29° decrease in ANB, but contrary to the experience of Sankey et al,[42] SNB increased significantly by 1.57°. This was related to absolute molar intrusion of the MI and was supported by a decrease (1.21 mm) in the NV-Pog distance.

Insoft et al[24] and Umemori et al[37] have also noted similar findings at SNB and ANB in their case reports. The Y axis (1.36°), mandibular plane (1.57°), and gonial (1.50°) angles were significantly decreased. Anterior face height was decreased by 1.86 mm, whereas ramus length was increased by 0.46 mm. As a result, the posterior to anterior face height ratio increased 2.25%. These findings indicated mandibular autorotation resulting in reduction of anterior face height. Controlling the vertical dimension requires much effort, and it was suggested in a number of studies[42,46–48] that it was hard to achieve this goal with high-pull headgear, extraction therapy, or a combination of both because of compensatory eruption of posterior teeth. However, mandibular autorotation was also reported in the studies carried out with vertical-pull chincups,[19] active bite-blocks,[28,30] miniplate anchorage,[36,37] and high-pull headgear + bite-blocks.[41]

Sankey et al[42] did not find a decrease in the anterior face height with their treatment regimen, but they mention that molar eruption was controlled and mandibular autorotation was achieved with a significant decrease in ramus length as in our study. In contrast, Baumrind et al[49] reported that the growth of ramus length was reduced with high-pull headgear treatment.

Although significant treatment results were observed with magnetic bite-blocks, it was reported that they might create asymmetric mandibular posture and subsequent unilateral crossbites because of the shearing forces of the repelling magnets.[25,31] Such side effects were not observed in the other effective treatment methods[19,36,37,41] and in our study. However, when periapical radiographies were evaluated, minimal root resorption was observed in the maxillary first molars (Figure 9B) of three patients. Maxillary second molars were in occlusion in one of the patients and not erupted in the remaining two. The resorption rate was minimal, but this finding was more or less similar to the findings of Melsen et al,[25] who demonstrated increased root resorption with the use of magnetic bite-blocks caused by extended periods of intrusive forces.

The long-term effects of the treatment have not been established. However, it was mentioned in several studies[22,28,50] that relapses of varying degrees were found in the vertical position of the molars, in the overbite, the gonial angle, and the forward rotation of the mandible after openbite treatment. Further studies are needed to evaluate the long-term stability of the treatment effects of the MI appliance.

CONCLUSIONS

1. The intrusion springs of the MI were effective in intruding the molars and in reducing the anterior openbite. Overbite and occlusal plane angle were decreased and maxillary incisors were extruded with a significant labial tipping after MI use.
2. Mandibular plane and gonial angles were decreased. Anterior face height was reduced, and anteroposterior chin position was significantly improved with the forward rotation of the mandible. As a result, the SNB angle was increased, whereas the ANB angle was decreased.
3. The intrusive effect of the MI springs almost doubled in the absence of second molars, and this should be taken into consideration in the treatment planning of open bite cases when second molars are in occlusion. It must also be kept in mind that MI use may be difficult in the patients presenting deficient crown length.
4. Overerupted maxillary molars can sometimes be in contact with the alveolar mucosa of the mandible, inhibiting the eruption of mandibular molars. In many of these cases a posterior vertical dentoalveolar excess accompanies the malocclusion. Our clinical practice with such cases showed that the MI is also effective in selective molar intrusion in the treatment of these malocclusions.

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