Bilateral Maxillary Molar Distalization with Sliding Mechanics: Keles Slider

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Aim: *To introduce a new intraoral appliance for molar distalization and to investigate its effect on distal tipping of Class II maxillary first molars and patient cooperation.* **Method**: *Two adolescent patients with Class II, Division 1 malocclusions were selected for study. The treatment plan for both subjects required molar distalization for correction of malocclusion. In one patient, the maxillary second molars were extracted for molar distalization. In the other patient, the maxillary third molars were extracted for molar distalization. A newly developed intraoral appliance was used for molar distalization. The Keles Slider is composed of two premolar and two molar bands, and the anchorage unit is composed of a wide Nance button. This appliance does not incorporate headgear or elastics, and it is not removable. To achieve bodily distal movement, the point of distal force application was carried toward the center of resistance of the maxillary first molar on the palatal side. Nickel titanium coil springs were used, and 200 g of distal force was applied to the Class II first molars.* **Results**: *Class II molars distalized bodily. There was minimal anchorage loss on premolars and little incisor proclination; however, during the 2-month stabilization period with the Nance button, the premolars drifted distally with the help of transeptal fibers.* **Conclusion**: *Unlike most other molar distalization mechanics, this device achieved parallel distal movement of the first molars. Distalization occurred more rapidly, and with less anchorage loss, in the patient with second molar extraction, when compared with the patient with third molar extraction.* World J Orthod 2002;3:57–66.

Over the past decade, nonextraction treatment and noncompliance therapies have become more popular in the correction of Class II malocclusions. Conventional treatment of Class II cases usually requires distal movement of the maxillary molars to achieve a Class I molar and canine relationship. However, if the maxillary molars are not distalized bodily and adequate anchorage is not established to move premolars and canines distally, anchorage will be easily lost. The literature shows that various devices have been developed for molar distalization; headgear has been used routinely for distal movement of maxillary molars.[1–3] However, headgear relies totally on patient cooperation. Lack of compliance reduces treatment success and increases treatment duration.

The difficulties involved with headgear wear and dependence on patient cooperation have stimulated many investigators to develop intraoral devices and techniques for distal movement of molars. Blechman et al,[4] Gianelly et al,[5] and Bondemark et al[6] used magnets for molar distalization; Gianelly et al[7] and Bondemark et al[8] used super-elastic nickel-titanium (Ni-Ti) alloy coil springs for distal movement of maxillary molars.

In 1992, Hilgers developed the pendulum appliance for distal movement of molars.[9] The appliance consisted of beta-titanium alloy (TMA) springs and a button on the palate. The appliance achieved popularity during the mid-1990s. Since 1996, numerous investigators have conducted studies on the pendulum appliance.[10–13] These pendulum studies demonstrated that the molars were distalized but that distal tipping also

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Fig 1 Occlusal view of the Keles Slider.

Fig 2 Palatal view of the Keles Slider.

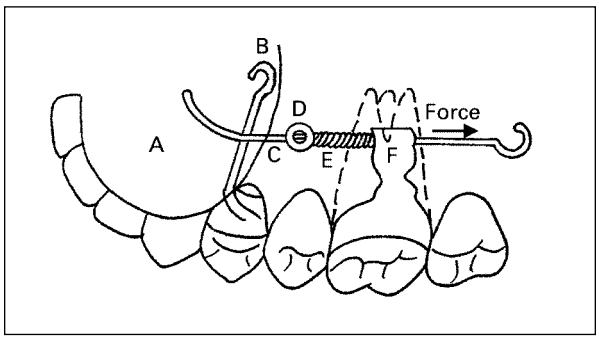

Fig 3 Biomechanics of force system of the Keles Slider. Distal force is applied at the level of the center of resistance of the maxillary first molar. A, acrylic anterior bite plane; B, retaining wire for maxillary first premolar; C, 0.036-inch diameter wire rod for distal sliding of maxillary first molar; D, adjustable screw for activation of the coil spring; E, 0.036-inch heavy Ni-Ti open coil spring; F, special tube soldered to the first molar band.

occurred. The amount of tipping in these pendulum studies varied from 6.07 degrees to 17.7 degrees.

In 2000, Keles and Sayinsu[14] developed the intraoral bodily molar distalizer (IBMD) for molar distalization. The distalizing TMA (0.032 × 0.032 inch) spring design of the IBMD was composed of two pieces that enabled bodily movement of the molars. Their results showed that the molars distalized without tipping; however, anchorage loss also occurred.

The newly introduced intraoral distalization appliances developed in the last decade of the 20th century eliminated the need for patient cooperation. However, distal tipping of the molars and anchorage loss also occurred with most of these new appliances.

In this article, the authors assess the effectiveness of the newly developed Keles Slider (patent pending) (Great Lakes Orthodontics, Tonawanda, NY, USA) in adolescent patients.

MATERIAL AND METHODS

Appliance construction

Maxillary first molars and first premolars were banded. Tubes (0.45-inch diameter, Leone A 076-45; Leone, Italy) were soldered to the palatal side of the Class II first molar bands. First premolar bands were attached to a wide acrylic Nance button with 1.1-mm diameter stainless steel retaining wires (Fig 1). The acrylic button also consisted of an anterior bite plane. The purpose of creating an anterior bite plane was to disclude the posterior teeth, enhance the molar distalization, and correct the anterior deep bite. On the palatal side of the molars, 0.9-mm diameter stainless steel wires were embedded into the acrylic at about 5-mm apical to the gingival margin of the first molars. These wires passed through the tube and were oriented parallel to the occlusal plane (Fig 2). For molar distalization, a heavy Ni-Ti coil spring (2-cm long, 0.9-mm diameter, and 0.016-inch thick) was placed between the screw on the wire and the tube, in full compression. The amount of force generated with the full compression of the 2-cm open coil was about 200 g. This force system allows consistent application of force at the level of the center of resistance of the first molars. Biomechanics of the force system of the Keles Slider is presented in Fig 3. Patients were seen once a month, and the screw was activated with the use of a special wrench. Two months after the initial activation of the appliance, segmental arches with 30-degree toe-in bends were engaged on the buccal side between the first molars and the first premolars. This was done to prevent distobuccal rotation of the molars, due to

Fig 4 Extraoral views of patient 1 (P.A.) before treatment.

Fig 5 Intraoral views of patient 1 before distalization.

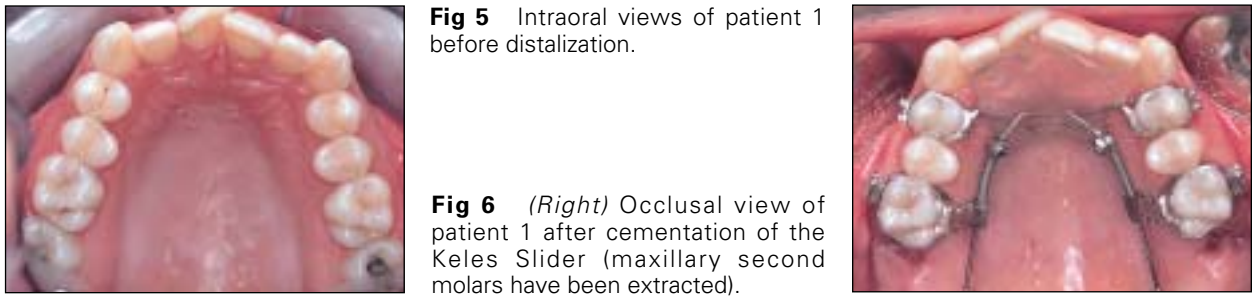

Fig 6 *(Right)* Occlusal view of patient 1 after cementation of the Keles Slider (maxillary second molars have been extracted).

force application from the palatal side. After distalization, the Keles Slider was removed and molars were stabilized with a Nance appliance for 2 months prior to second-phase orthodontic treatment; Nance appliance was maintained until the end of canine distalization.

Patient 1, P.A.

P.A., a female 19 years 2 months of age, was diagnosed with a Class II, Division 1 malocclusion (Fig 4). Her primary complaint involved the buccally positioned maxillary canines (Fig 5). Dentally, she had a full cusp Class II molar and canine relationship with 7 mm of maxillary crowding (Fig 5). There was 80% overbite and a 3-mm overjet. She had large restorations and hypersensitivity of the maxillary second molars; maxillary third molars were unerupted. The treatment plan included extraction of the maxillary second molars and distalization of the first molars. The Keles Slider was cemented (Fig 6) in place. Following 7 months of treatment, the maxillary molars had distalized 5 mm on the right side and 6 mm on

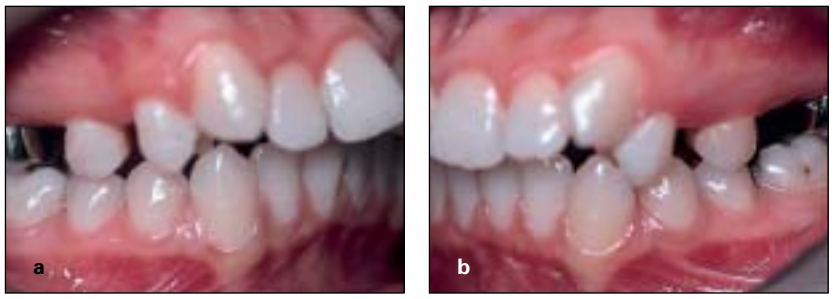

Fig 7 Intraoral views of patient 1 right after the removal of the Keles Slider. On the right side **(a)**, a Class I relationship on the molar was achieved and there was distal drift of the second premolars, achieved with the help of the transeptal fibers. On the left side **(b)**, a super Class I molar relationship was achieved, as well as distal drift of the second premolar was observed.

Fig 8 Intraoral views of patient 1 at 2 months after the removal of the Keles Slider. The Class I molar relationship was maintained, and distal drift of the first premolars and canines, as well as reduction of the overjet, was achieved without any mechanotherapy.

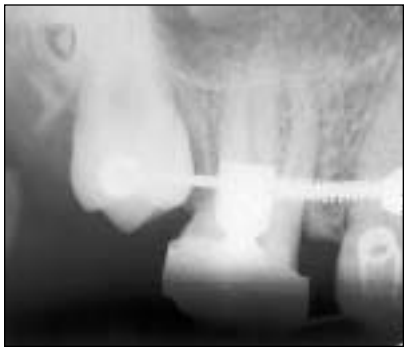

Fig 9 Periapical radiograph of patient 1 during distalization. Parallel distal migration of the first molars and the line of force application passing through the center of resistance of the first molars.

the left side, with each side achieving a super Class I molar relationship (Fig 7). There was 1-mm anchorage loss for the right first premolar and 2-mm anchorage loss for the left first premolar. Maxillary second premolars had drifted distally, with the help of the transeptal fibers. Maxillary incisors had slightly proclined. A Nance appliance was cemented immediately after the removal of the Keles Slider and was maintained for 2 months to prevent mesial relapse of molars. Two months later, during the Nance stabilization period, the first premolars and the canines had drifted distally to their initial positions. Therefore, anterior crowding was relieved (Fig 8). The molars were distalized in parallel fashion, and the maxillary third molars were erupting without any difficulty (Fig 9). Anterior deep bite was corrected with the help of the anterior bite plate. Class I molar and canine relationships were achieved on both sides at the end of fixed orthodontic treatment, overbite was reduced to 20%, and overjet was reduced to 2 mm (Figs 10 and 11). The maxillary third molars erupted without any difficulty (Figs 12a and 12b). The patient's smile was improved and her straight profile was maintained. The initial and final lateral cephalograms and superimpositions are presented in Fig 12, and the cephalometric measurements are recorded in Table 1.

Fig 10 Extraoral views of patient 1 at the end of fixed orthodontic treatment; note improved smile.

Fig 11 Intraoral views of patient 1 at the end of the fixed orthodontic treatment.

Fig 12 Patient 1. **(a)** Cephalometric radiograph before treatment. **(b)** Cephalometric radiograph at the end of fixed orthodontic treatment. **(c)** Cephalometric superimposition.

Table 1 Cephalometric evaluation of both patients

	Patient 1		Patient 2	
Measurements	Initial	Final	Initial	Final
SN/mandibular plane (degrees)	30	30	38	39
Saddle angle (degrees)	127	126	123.5	124
Articular angle (degrees)	144	143.5	146	150
Gonial angle (degrees)	118	116	130	125.5
Σ total (degrees)	389	390.5	340	340
Jarabak ratio (%)	70	69	63.3	63.7
ANSMe/Nme (%)	53	54	54.3	54.8
FMA (degrees)	22	20	30	30
Y axis angle (degrees)	60.5	62	64	65
SNA (degrees)	81	81	78	77
SNB (degrees)	76	77	75	73
ANB (degrees)	5	4	3	4
Maxillary depth (degrees)	90	88	86	86
U1/SN (degrees)	114	115	93	91
I-NA (degrees)	33	24	15	12
I-NA (mm)	6	3	0	2
I-FH (degrees)	122	111	102	99
IMPA (degrees)	99	104	91	95
Ī-NB (degrees)	25	32	24	27
Ī-NB (mm)	3.5	5	3	4
Pog-NB (mm)	4	4	3	4
Holdaway	3.5/4	5/4	1/1	1/1
I-I (degrees)	119	120	137	135
Upper lip N perp (mm)	15	14	20	22
Nasiolabial angle (degrees)	108	115	132	133

Patient 2, O.O.

O.O. was a male, 16 years 7 months of age, diagnosed with a Class II, Division 1 malocclusion. He had thin and retruded lips (Fig 13). There was a Class II molar and canine relationship, with 6.5-mm maxillary and 2.8-mm mandibular crowding. Maxillary canines were out of the arch. A 3-mm maxillary midline deviation to the left, 20% overbite, and retroclined maxillary incisors were also present (Fig 14). The treatment plan was initiated with the distalization of the maxillary molars. Before the Keles Slider was cemented (Fig 15), the maxillary and mandibular third molars were extracted to allow space for distal movement of the first molars. After 5 months of distalization, the Slider was removed. The maxillary molars had distalized 3 mm on the right side and 4 mm on the left side (Fig 16). There was 2-mm anchorage loss on both sides at the first premolars. Maxillary second premolars had drifted distally without any orthodontic force, with the help of the transeptal fibers (see Fig 16). After the removal of the Keles Slider, the molars were stabilized with a Nance button. Two months later, during this stabilization period, the first premolars had drifted distally to their position before distalization (Fig 17). Panoramic and lateral cephalometric radiographs show that the molars were distalized in parallel fashion (Fig 18). After 2 months of Nance molar stabilization, fixed orthodontic treatment started. At the end of the second-stage treatment, Class I canine and molar relationships had been achieved on both sides and the profile was improved (Figs 19 and 20). Figure 21 shows the initial and final cephalometric radiographs and the cephalometric superimposition. Table 1 records the cephalometric measurements.

DISCUSSION

In this clinical application of the Keles Slider, two teenagers, 16 years 7 months of age and 19 years 2 months of age, were treated. The results show that maxillary molars distalized bodily in both patients, with minimal anchorage loss. The second molars were extracted in patient 1, and for every millimeter

Fig 13 Extraoral views of patient 2 (O.O.) before treatment; note retruded lips.

Fig 14 Intraoral views of patient 2 before distalization.

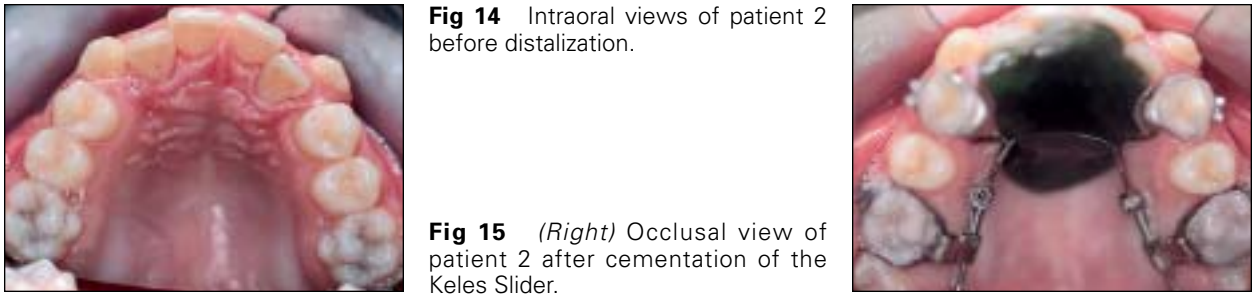

Fig 15 *(Right)* Occlusal view of patient 2 after cementation of the Keles Slider.

Fig 16 Intraoral views of patient 2 right after the distalization and removal of the Keles Slider (a super Class I relationship was achieved, and distal drift of the second premolars was achieved with the help of transeptal fibers).

Fig 17 Intraoral views of patient 2 at 2 months after stabilization with a Nance. The super Class I molar relationship was maintained, and there was distal drift of first premolars to their initial positions. Anterior crowding was reduced, as is evident in the occlusal view.

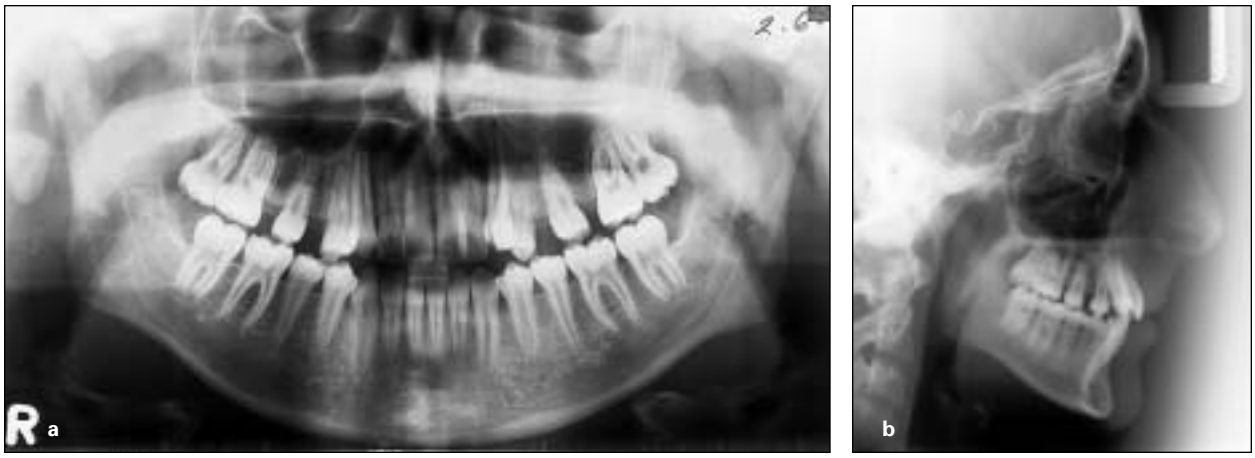

Fig 18 Patient 2. **(a)** Panoramic radiograph of patient 2 after distalization (parallel distalization of the first molars). **(b)** Cephalometric radiograph of patient 2 after distalization (parallel distalization of the first molars).

of distalization there was 0.3-mm anchorage loss observed right after appliance removal. The third molars were extracted in patient 2, and for every millimeter of distalization there was 0.5-mm anchorage loss observed right after appliance removal. However, to make an accurate assessment about anchorage loss, the number of observed patients should be increased.

In his technique, Gianelly recommends a stabilization period of at least 4 to 5 months after molar distalization, prior to bracket alignment and premolar, canine, and incisor retraction.[15] In the present study, 2 months post-first molar distalization, after stabilizing the first molars with a Nance button, the first premolars drifted distally to their original positions. Ghosh and Nanda[10] have questioned the stability of distally tipped molars, and their use as anchorage to retract anterior teeth, following the use of the pendulum appliance. After molar distalization, molar positions were retained with either Nance or utility arches. Ghosh and Nanda suggested that posterior anchorage may be improved by uprighting the molars with headgear. After the distalization of molars with coil springs, Gianelly has recommended uprighting the distally tipped molars with a passive (0.016 × 0.022 inch) archwire with stops at the molars and high-pull headgear.[15] However, headgear requires patient cooperation.

In 1998, Gianelly reviewed distal movement of molars.[16] He claimed that distal tipping of molars could be achieved at a rate of 1 mm per month. If the molars moved distally in a more bodily fashion, 0.5 mm per month distalization can be achieved. The authors of the present article achieved an average 4-mm distalization in 6 months. Gianelly observed distalization in the late mixed dentition period, where second molars were not near eruption, and for every millimeter distalization there was 0.5-mm anchorage loss. In the adolescent, when the first molars are moved distally after the eruption of second molars, they tend to move more slowly and anchorage loss increases. Third molars that have

Fig 19 Extraoral views of patient 2 at the end of fixed orthodontic treatment; note improved smile.

Fig 20 Intraoral views of patient 2 at the end of fixed orthodontic treatment.

Fig 21 Patient 2. **(a)** Cephalometric radiograph at the beginning of treatment. **(b)** Cephalometric radiograph at the end of fixed orthodontic treatment. **(c)** Cephalometric superimposition.

erupted, or are close to eruption, tend to impede the distal movement of first and second molars. For this reason, Gianelly recommended removal of third molars when possible. The authors support the removal of third molars prior to distalization, if the second molars are in good condition and position.

A philosophy of intraoral distalization similar to that seen with the Keles Slider was introduced by Carano et al.[17] However, there are significant differences in appliance design. In the Keles Slider, there is a helix included at the distal tip of the lingual wire, which determines the amount of distalization and prevents detachment of the tube from the rod. With the Distal Jet (PROfessional Positioners, Racine, WI, USA), after a certain amount of distalization, there is a risk of detachment of the bayonet wire from the tube. The use of heavy 0.9-mm stainless steel wire in the Keles Slider allows the molars to slide distally in a controlled manner and with less friction, without buccal and distal tipping. In the Distal Jet, the bayonet wire is inserted into a long tube, which results in an increased frictional surface area contact between the tube and the wire. In the Distal Jet appliance, parallel distal translation is claimed; however, periapical radiographs showed that distal force level does not pass through the trifurcation point of the first molars. In fact, a recent study carried out by Ngantung et al[18] in 2001 on the effect on the distal jet appliance showed that maxillary molars tipped 3.3 degrees ± 3.7 degrees ($P < .001$) distally on average and also they observed for every millimeter of first molar distalization there was 1.2 mm anchorage loss on the second premolars. In the Keles Slider, the level of distal force application passes through the center of resistance of the maxillary first molars (see Fig 9). The wide acrylic plate in the Keles Slider is effective in minimizing anchorage loss and the anterior bite plate allows opening of the bite, enhancing the distal drift of molars by discluding the posterior teeth. Rather than connecting the appliance to the second premolars, as described with the Distal Jet, the first premolars are banded and connected to the acrylic unit. This design difference enables the second premolars to drift distally with the help of the transeptal fibers.

CONCLUSION

The results show that the Keles Slider is an effective appliance to bodily distalize molars. Class I molar relationships can be established in a short period of time, and there is little anchorage loss in comparison with the other intraoral distalization mechanics. The appliance is effective in deep bite correction. The Keles Slider can also be used for correction of unilateral Class II molar relationships. According to a unilateral molar distalization study by Keles, unilateral bodily molar distalization was achieved.[19] Another advantage of this appliance is the ease of activation; chair time for activation is short and simple. Guided consistent distal force at the level of the center of resistance allows the molars to slide distally without the expense of tipping, excessive anchorage loss, and questionable patient cooperation.

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