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# Maxillary unilateral molar distalization with sliding mechanics: a preliminary investigation

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SUMMARY Fifteen patients, eight males and seven females with a mean age of 13.32 years, were selected for unilateral molar distalization. Dentally, all presented with a unilateral Class II molar relationship. The subjects were all in the permanent dentition with second molars erupted and with a well aligned lower dental arch. For maxillary molar distalization a new intra-oral appliance was developed, the Keles Slider, which comprised two premolar and two molar bands. The anchorage unit was a Nance button with an anterior bite plane. From the palatal side, the point of distal force application was carried towards the level of centre of resistance of the maxillary first molar. A Ni–Ti coil spring was used and 200 g distal force was applied to the Class II first molar. Lateral cephalograms were taken and analysed before and 2 months after molar distalization.

The Class II molars were distalized bodily, on average, 4.9 mm ($P < 0.001$). Mesial migration of the Class II first premolars was 1.3 mm ($P < 0.05$), incisor protrusion was 1.8 mm ($P < 0.05$) and incisor proclination 3.2 degrees ($P < 0.05$). The overbite was reduced by 3.1 mm ($P < 0.001$) and the overjet increased 2.1 mm ($P < 0.01$). For stabilization, the corrected Class II unilateral molar relationship was maintained with a Nance button for 2 months. The results show that this newly developed device achieved bodily distal molar movement with minimum anchorage loss.

## Introduction

Over recent years non-extraction treatment approaches and non-compliance therapies have become more popular in the correction of Class II malocclusions (Cangialosi and Meistrell, 1988; Arvystas, 1991). A unilateral Class II relationship can be corrected by headgear with the application of asymmetric face bows (Haack and Weinstein, 1958; Osthuizen *et al.*, 1973; Baldini 1980). Many modifications have been designed and introduced, but the undesirable lateral forces that tend to move molars into crossbite were unavoidable. According to Siatkowski's (1997) review covering the effect of unilateral headgear, distal forces were found to exist on both sides, but were three times greater on the long outer bow side than on the short outer bow side and lateral forces existed which could result in a crossbite. He recommended that the use of this mechanism should be stopped if a crossbite begins to occur. In an *in vivo* study of the effects and side-effects of asymmetric face bows (Yoshida *et al.*, 1998), it was concluded that a force delivery system with a combination of an asymmetric face bow and a neck strap unavoidably produced lateral forces and the resultant transverse side-effects were clinically undesirable.

The difficulties of headgear wear, its dependence on patient co-operation and the undesirable side-effects of unilateral headgear, have stimulated investigators to develop new intra-oral devices and techniques for molar distalization.

Reiner (1992) introduced an intra-oral Nance appliance modified for unilateral molar distalization. His results showed that molars were distalized a mean of 0.19 mm/week, but the type of movement was not mentioned. From the point of the location of force application, the molars would tend to tip distally.

For bilateral molar distalization, Blechman and Smiley (1978), Gianelly *et al.* (1988) and

Bondemark and Kurol (1992) used magnets for molar distalization. Gianelly *et al.* (1991) used coil springs to move the molars distally. Hilgers (1992), who developed the pendulum appliance, used TMA springs for molar distalization. Bondemark *et al.* (1994) and Carano *et al.* (1996) used super-elastic Ni–Ti coil springs for distal movement of maxillary molars. Keles and Sayinsu (2000) developed the Intraoral Bodily Molar Distalizer for bilateral molar distalization. Their results showed that the molars distalized bodily and did not require headgear wear for molar root uprighting. Whilst non-compliance treatment modalities eliminated patient dependence, most could not achieve bodily molar distalization.

The aim of this study was to develop and investigate a new appliance, the Keles Slider (patent applied for), which would avoid distal tipping of maxillary Class II first molars, eliminate headgear wear and thus minimize patient co-operation.

## Subjects and method

### *Case selection*

Seven females and eight males who had registered for orthodontic treatment at the Department of Orthodontics, Marmara University, were selected. For boys, the ages ranged from 10.9 to 15.1 (average 13.1) and for girls, from 11.1 to 15.3 years (average 13.7). The mean age for the study group was 13.32 years. All the patients presented with a unilateral Class II molar relationship, a well-aligned lower dental arch and maxillary second molars fully erupted. High angle patients with a SN mandibular plane angle, greater than 40 degrees were excluded from the study.

### *Appliance construction*

The maxillary first molars and premolars were banded and a 1.1 mm diameter tube was soldered on the palatal side of the first molar band (Leone A 076-45, Firenze, Italy). Class I molar and first premolar bands were attached with 1.1 mm diameter stainless steel retaining wires to the Nance button. 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 molar distalization and correct the anterior deep bite (Figure 1a). Stainless steel wire, 0.9 mm in diameter, was embedded in the acrylic approximately 5 mm apical to the gingival margin of the first molar, which passed through the tube and was orientated parallel to the occlusal plane (Figure 1b). For molar distalization, heavy Ni–Ti coil spring (G&H Wire Company, IN, USA) 2 cm in length and with a diameter of 0.9 mm was placed between the screw on the wire and the tube in full compression. The amount of force generated with full compression of the 2 cm open coil was approximately 200 g. Another screw was placed on the distal side of the tube in order to make the appliance inactive before cementation (Figure 2). After cementation, the screw on the distal side of the tube was removed. This system aimed to apply consistent distal force at the level of centre of resistance of the first molar (Figures 3). The patients were seen monthly and the screw was reactivated with a special

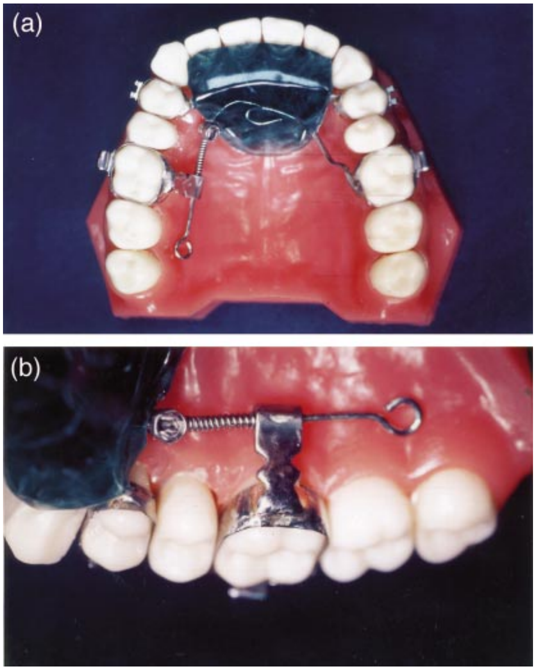


**Figure 1** The appliance design. (a) Occlusal; (b) Palatal view.

**Figure 2** Activation of the appliance (screw on the distal of the tube is removed).

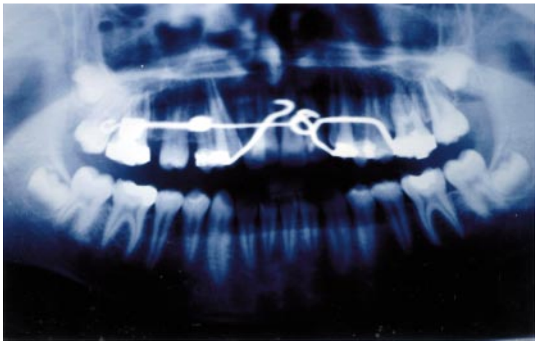

**Figure 3** A DPT view showing appliance *in situ*.

screwdriver. After distalization the appliance was removed and the molars were stabilized by a Nance appliance for 2 months, before the second phase of orthodontic treatment, and maintained until the end of canine distalization. Biomechanics of the force system are presented in Figure 4.

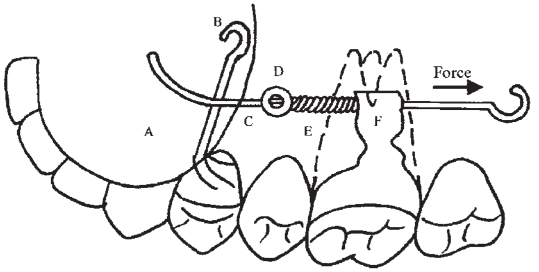


**Figure 4** Biomechanics of the force system. Distal force is applied at the level of the centre of resistance of the maxillary first molar. A, Acrylic anterior bite plane; B, Retaining wire for maxillary first premolar; C, 0.036 inch diameter wire rod for distal sliding of maxillary first molar; D, Screw for activation of the coil spring; E, 0.036 inch heavy Ni–Ti open coil spring; F, Tube soldered to the first molar band.

### *Cephalometric analysis*

To analyse the maxillary dental changes, the method developed by Keles and Sayinsu (2000) was used. Normally it is difficult to identify the inclination of the right and left molars and premolars on cephalometric radiographs because of the superimposition of the right side on the left side. Wire markers 0.8 mm were orientated vertically and retained in acrylic caps, constructed for the maxillary first molar, premolar and central incisor (Figure 5). The markers were temporarily cemented and lateral cephalometric radiographs were taken and analysed before and 2 months after removal of the appliance (Figure 6). The cephalometric measurements used are shown in Figure 7.

**Figure 5** Construction of the markers for cephalometric analysis.

### *Statistical method*

A non-parametric Wilcoxon signed rank test was used for statistical evaluation. The amount of difference over time was evaluated. The method error was calculated with correlation analysis.

## Results

The cephalometric results showed that the maxillary first molars were distalized bodily on

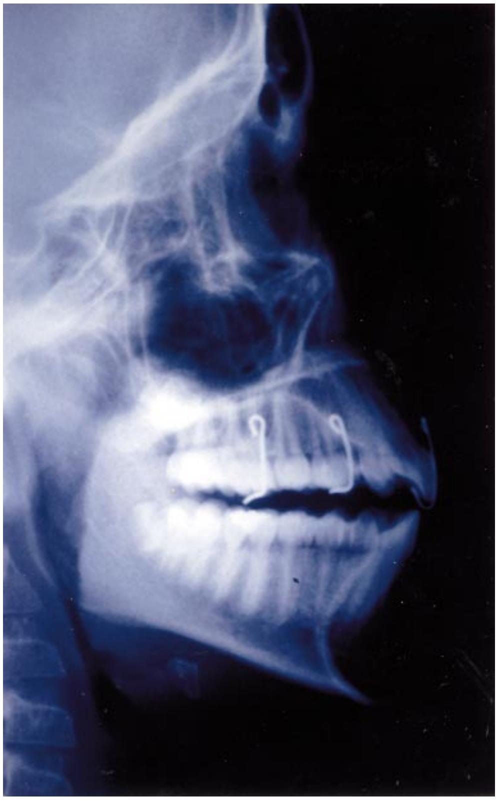

**Figure 6** Lateral cephalometric radiograph showing the wire markers.

average 4.9 mm ($P < 0.001$) (Table 1, Figure 8). Distal tipping and molar extrusion were not observed during distalization. A Class I molar relationship was achieved on average in a period of 6.1 months. The maxillary first premolars moved forward bodily 1.3 mm ($P < 0.05$), the incisors protruded 1.8 mm ($P < 0.05$) and proclined 3.2 degrees ($P < 0.05$). The overjet was increased 2.1 mm ($P < 0.05$) and the overbite was reduced by 3.12 mm ($P < 0.001$) on average. Intra-oral photographs of Case II pre- and post-distalization and at the end of the second phase of treatment are shown in Figures 9–11. After removal of the device, the anteriorly protruded incisors and mesially migrated first premolar spontaneously relapsed distally during the stabilization period (Figure 12). Clinically, a slight distobuccal rotation on the distalized maxillary first molar was observed. During the stabilization period with a Nance button the distobucccal rotation was corrected by inserting an anti-rotation bend on the Nance retaining wire. The cephalometric evaluation of the effect of the Keles Slider is presented in Table 1. The superimposition, drawn from the mean values, represents the effect of the appliance on the maxillary dentition (Figure 13).

## Discussion

These results show that the maxillary molars distalized bodily 4.9 mm in 6.1 months. According to Gianelly (1998), one factor that influences the rate of distal molar movement is the type of movement. Slow movement occurs when the molar is moved bodily distally. The dental changes related to the anchor teeth were 1.3 mm at the first premolars and anchorage loss of 1.8 mm on the maxillary incisors. In this study for every millimetre of distalization, 0.26 mm anchorage loss was observed on the first premolars. It may be that the support taken from a wide acrylic button and to include the first molar on the other side to the anchorage unit explain this minimal anchorage loss. After distalization, the molars were stabilized by a Nance appliance for 2 months prior to the second stage of orthodontic treatment. A spontaneous distal drift of first and second premolars with the help of transseptal fibres during the stabilization period with the Nance button was observed. After molar distalization, Gianelly (1998) recommended at least a 4–5 months stabilization period prior to bracket alignment.

For guided molar distalization 0.9 mm stainless steel wire was used, and the coil spring activated monthly. The use of a heavy rod for molar distalization allowed control of the direction of force and also achievement of bodily distalization with sliding mechanics. A constant distal force at the level of the centre of resistance moved the maxillary first molar bodily. However, a slight distobuccal rotation was observed on the distalized first molars. This could be due to the interplay between the 1.1 mm diameter tube and 0.9 mm wire. The other factor that would explain the distobuccal rotation was the point of force application. Vertically the force was applied at the level of the centre of resistance of the

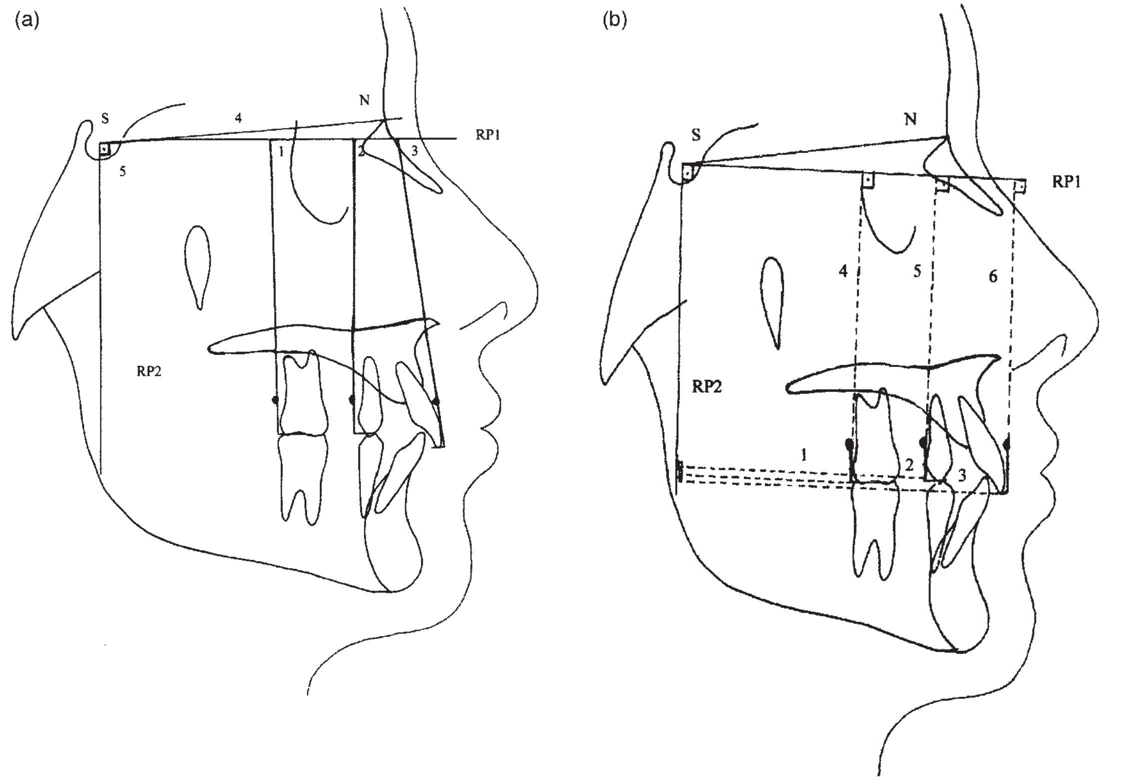


**Figure 7** (a) Angular measurements used in the cephalometric analysis. 1, The anterior angle between the wire marker of the Class II first molar and true horizontal (RP1); 2, The anterior angle between the wire marker of the Class II first premolar and true horizontal (RP1); 3, The anterior angle between the wire marker of the maxillary incisor on the Class II side and true horizontal (RP1); 4, True horizontal (RP1) drawn 7 degrees from the SN plane; 5, Perpendicular line (RP2), drawn to RP1; (b) Linear measurements used in the cephalometric analysis. 1, 4: The perpendicular distance between the wire marker of the Class II first molar and RP2 and RP1; 2, 5: The perpendicular distance between the wire marker of the Class II first premolar and RP2 and RP1. 3, 6: The perpendicular distance between the wire marker of the maxillary incisor and RP2 and RP1.

**Table 1** Mean, standard deviation, minimum and maximum values for changes in cephalometric dental measurements.

| Measurement | Mean | SD | Minimum | Maximum | *P* value | Probability |
|---|---|---|---|---|---|---|
| **Dental–Angular (degrees)** | | | | | | |
| Maxillary first molar–RP1 | 0.89 | 4.99 | –3 | 9 | 0.2179 | NS |
| Maxillary first premolar–RP1 | –1.25 | 3.07 | –13.2 | 12.9 | 0.3151 | NS |
| Maxillary incisor–RP1 | –3.28 | 2.91 | –10 | 3 | 0.0229 | * |
| **Dental–Linear (mm)** | | | | | | |
| Maxillary first molar–RP2 | 4.92 | 1.77 | 0.9 | 7 | 0.0000 | *** |
| Maxillary first premolar–RP2 | –1.31 | 1.32 | –1.3 | –11 | 0.0112 | * |
| Maxillary incisor–RP2 | –1.84 | 1.03 | –1.5 | –7.5 | 0.0829 | * |
| Maxillary first molar–RP1 | 0.31 | 1.56 | –1.5 | 2 | 0.4643 | NS |
| Maxillary first premolar–RP1 | 1.86 | 1.29 | –1 | 5 | 0.3935 | NS |
| Maxillary incisor–RP1 | 0.92 | 2.22 | –4.4 | 5.1 | 0.5529 | NS |
| Overjet | 2.11 | 1.04 | 1 | 4 | 0.0032 | * |
| Overbite | –3.12 | 1.03 | 4 | –1 | 0.0000 | *** |

Negative values imply intrusion or mesialization or mesial or buccal tipping.
$*P < 0.05$; $***P < 0.001$; NS, non-significant.

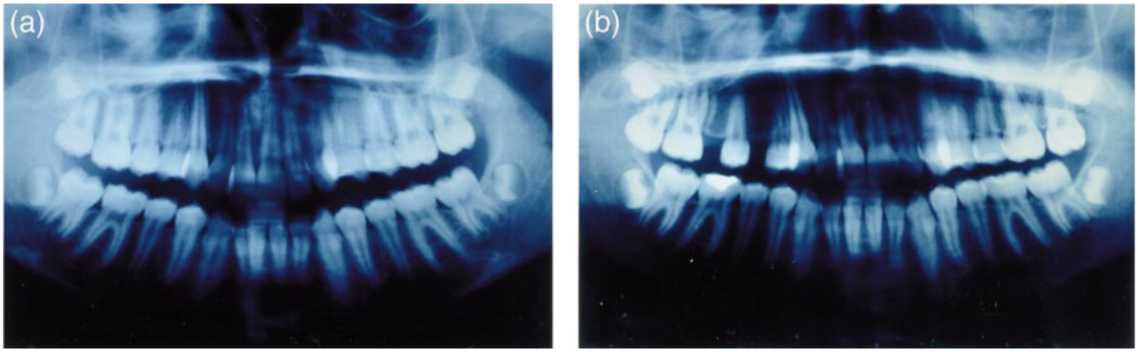


**Figure 8** DPT radiographs of Case I (a) before and (b) after distalization (bodily distalization of Class II first molar).


**Figure 9** Intra-oral photographs of Case II before distalization. (a) right; (b) left; (c) anterior; (d) occlusal; (e) appliance cemented in the mouth.

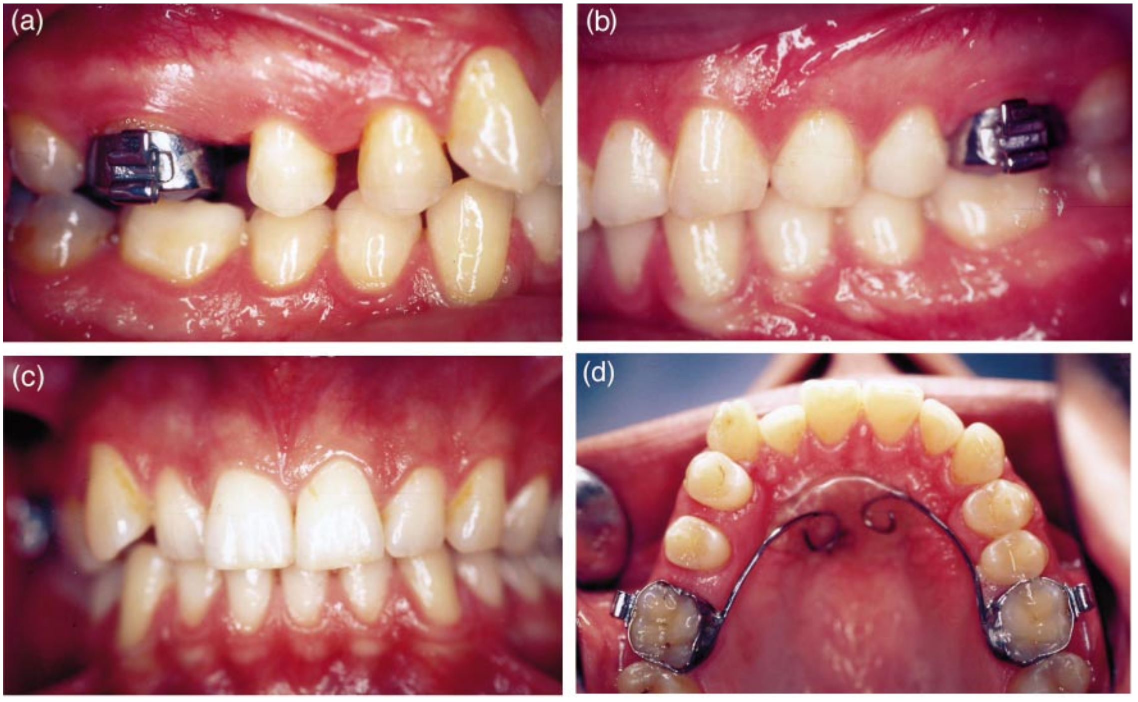


**Figure 10** Intra-oral views of the same subject after distalization. (a) right; (b) left; (c) anterior; (d) occlusal.

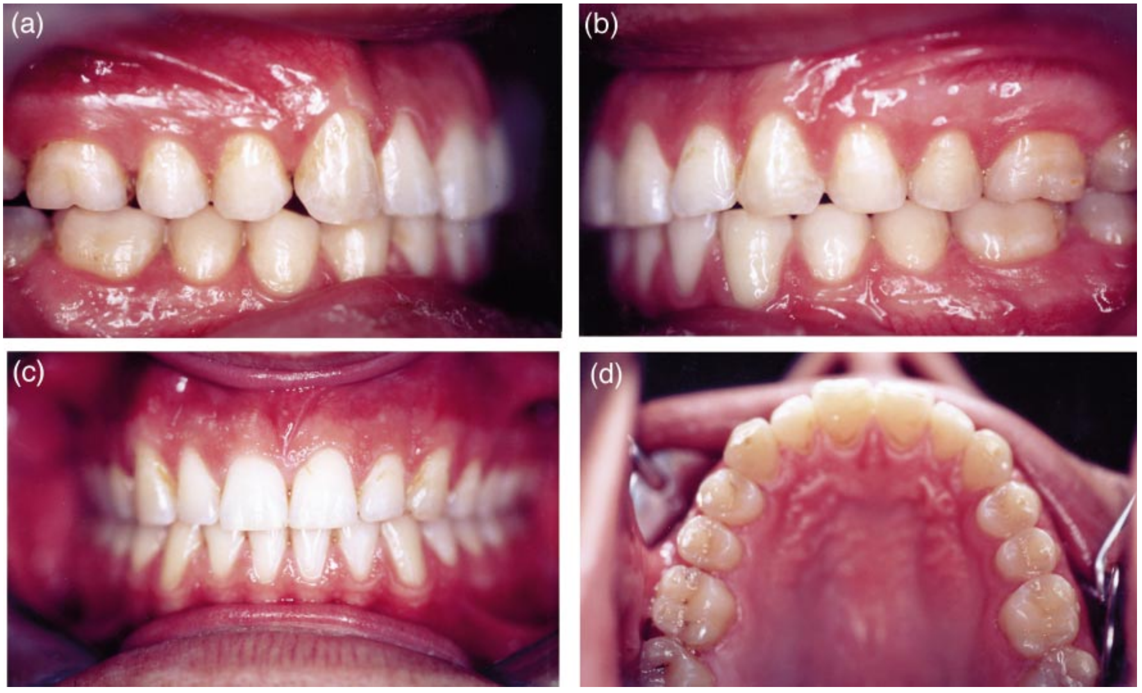


**Figure 11** Intra-oral views of the same subject at the end of treatment. (a) right; (b) left; (c) anterior; (d) occlusal.

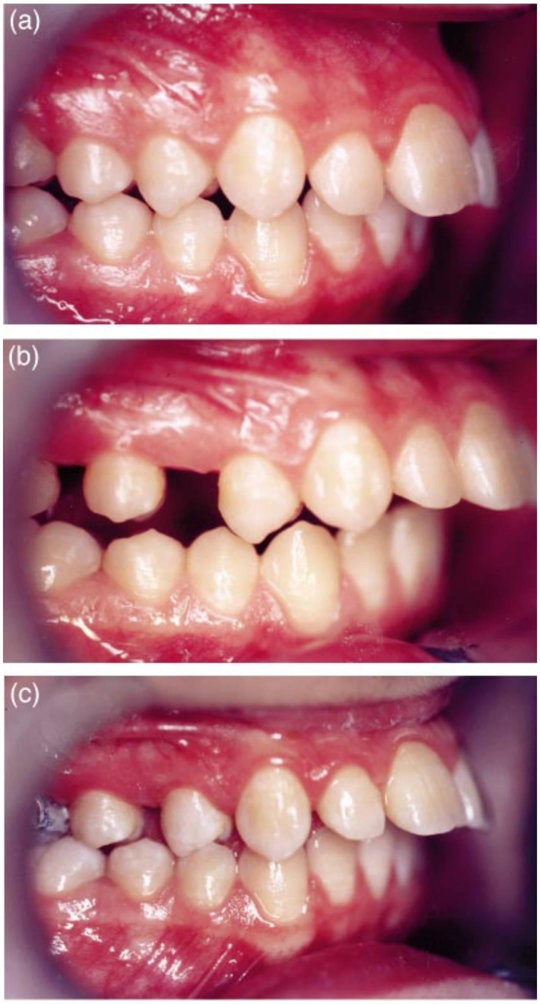

**Figure 12** Intra-oral photographs of Case III which shows the distal relapse mechanism during the stabilization period with the Nance button. (a) before distalization; (b) after distalization; (c) two months after (distal relapse of the premolars and canine).

maxillary first molars; however, transversally it was on the palatal side. At the time of stabilization with the Nance button the rotation was corrected with an anti-rotation bend built into the Nance retaining wire and also with toe-in bends included in the buccal arch wires.

A similar philosophy of intra-oral bodily distalization was introduced by Carano *et al.* (1996). They claimed that the molars moved bodily without tipping with the Distal Jet appliance, but there is no qualitative and quantitative evidence that the molars were distalized bodily. In fact the periapical radiographs of the case reports show that the distal force application did not pass at the level of the centre of resistance of the first molars.

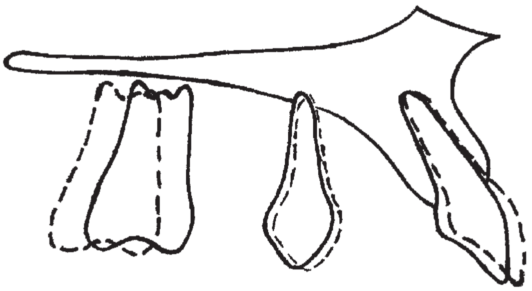

**Figure 13** Composite cephalometric superimposition showing the effect of the Keles Slider on the maxillary dentition. ——— Before treatment - - - - - - After treatment

In the Keles Slider, a helix was included at the distal tip of the steel rod, which determined the amount of distalization and prevented detachment of the tube from the rod. With the Distal Jet after certain amount of distalization there is a risk of detachment of the bayonet wire from the tube. The use of a heavy 0.9 mm stainless steel rod in the Keles Slider allowed the molars to slide distally without tipping in a controlled manner with less friction. With the Distal Jet the bayonet wire is inserted into a long tube resulting in an increased surface area in contact between the tube and the wire and an increase in the amount of friction. The wide acrylic plate in the Keles Slider is effective in minimizing anchorage loss and the anterior bite plate allows opening of the bite and enhances distal drift of molars by discluding the posterior teeth. Rather than connecting the appliance to the second premolars, as with the Distal Jet, the first premolars are banded and connected to the acrylic unit. This design difference enabled the second premolars to drift distally with the help of the transseptal fibres.

## Conclusions

The results show that the Keles Slider is a very effective fixed device to distalize molars bodily.

The unilateral Class II relationship was corrected in all patients. Guided constant distal force at the level of the centre of resistance allowed the molars to move distally without tipping and excessive anchorage loss. The other advantage of this appliance is the short chair side time and ease of reactivation. The Keles Slider can also be used bilaterally for molar distalization. The anchorage loss in bilateral distalization could be greater; however, stabilizing the molars with a Nance button would allow the premolars to drift with the help of transseptal fibres. Further studies at the end of the second stage of orthodontic treatment are required to examine the stability of the distally translated molars when correcting the Class II canine relationship and reducing the overjet.

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