Distalization of maxillary molars with the bone-supported pendulum: A clinical study

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A modified pendulum appliance with 2 endosseus screws for anchorage in the palatal area was used for maxillary molar distalization in each of 15 patients (average age, 13 ± 2.1 years). Study models and lateral and panoramic x-rays were taken at the beginning and end of the movement to record the dental and skeletal changes. The mean treatment time was 7.8 ± 1.7 months, the average distal movement of the maxillary molars was 6 mm, and the inclination was 11.3° ± 6.2°. The second premolars were distalized an average of 4.85 ± 1.96 mm with inclinations of 8.6° ± 5°. The maxillary anterior teeth were retruded 0.5 ± 1.33 mm and palatally inclined 2.5° ± 2.98°. The mandibular plane rotated posteriorly 1.27° ± 1.1°. No loss of dental anchorage was observed during the distal movement. (Am J Orthod Dentofacial Orthop 2007;131:545-9)

Distal movement of the maxillary molars is often used in the correction of Class II malocclusions, and various tooth-borne appliances have been proposed. The pendulum appliance is a popular one.[1-8] The clinical use of this appliance, however, has some undesired effects, such as premolar mesialization and buccal movement of maxillary incisors. Although distal movement of the molars takes place, an adverse reaction of mesialization of the premolars of 1 to 2.5 mm and buccal tipping of maxillary incisors of 1.7° to 3.3° can occur[2-8]; therefore, on average, 55% to 80% of the space obtained comes from distalization of molars and 45% to 20% from mesialization of the premolars and buccal tipping of the incisors. This reaction can be interpreted as loss of anchorage, because the appliance has a system of support that uses the premolars as anchorage.

Several types of endosseus implants have been used in the palate to control anchorage during orthodontic treatment.[9-16] Limitations on the use of implants in orthodontics include the fact that some cannot be loaded immediately, and removal of the endosseous appliance sometimes requires additional surgical procedures. When used in conjunction with molar distalizing devices, the purpose of a palatal implant is to provide better anchorage to the appliance.[9-16] In this way, the distalizing appliance becomes bone-supported, thus presumably reducing the undesired side effects to the anterior dentition in the maxillary arch. Limited in-vitro and in-vivo information is available regarding the outcomes of bone-borne distalizing appliances.[12,14,16]

Our aim in this study was to describe the clinical effects of a bone-supported pendulum (BSP) in a sample of consecutively treated Class II patients.

SUBJECTS AND METHODS

This was a clinical descriptive study with a sample of 15 consecutively treated patients (9 male, 6 female), with an average age (at the beginning of treatment) of 13 ± 2.1 years, and a prevalent cervical stage 3 vertebral maturation that corresponds to the peak of skeletal maturation at the beginning of treatment.[17] The inclusion diagnostic criterion was a Class II malocclusion (full-cusp Class II molar relationship), requiring distalization of the maxillary molars with normal vertical relationships. The participating patients signed informed consent with the approval of their parents. This study was reviewed and approved by an ethics committee at the Institute of Health Sciences, CES.

A pendulum appliance of Hilgers[1] design with a double-loop modification[18] was used. A metallic bearing was included in the anterior part of the acrylic plate, and metallic attachments were placed on the premolar and the molar from the same side as the radiographic reference (Fig 1). All BSP appliances were placed by the same operator using 2 paramedial screws 2.0 × 11 mm (Mondeal Medical Systems, Tuttlingen, Germany)

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Fig 1. BSP appliance with double-loop modification and metallic bearing in anterior part of acrylic plate. Metallic attachments were placed on premolar and molar from same side as radiographic reference.

in the palate. The springs of the BSP were placed in the lingual sheaths of the first molars with a force of approximately 250 g. Nonsteroidal analgesics were prescribed for 1 day; patients were taught to maintain good oral hygiene and asked to use mouthwash regularly during orthodontic therapy.

At every appointment, the soft tissues around the BSP were checked, and the springs were reactivated if necessary.

Study models, lateral cephalograms, and panoramic x-rays were taken when the BSP was placed and at the end of the distalization movement. The distalization was continued until the Class II molar relationship was overcorrected clinically to a super Class l molar relationship. The device was then left in place as a retention appliance.

The vertical, sagittal, and angular changes of the first molars, second premolars, and maxillary incisors; the mandibular plane angle changes; and the positional changes of the appliance were observed (Fig 2). The interobserver and intraobserver calibration was done with an intraclass correlation coefficient of 0.984, indicating good correlation.

The rotation of the first molars and the intermolar distance were analyzed on the models with the AutoCAD program (Autodesk Inc, San Rafael, Calif) with an intraclass correlation coefficient of 0.999.

Statistical analysis

A descriptive statistical analysis was performed by using measurements of central tendency, measurements of dispersion, and the variation coefficient. A nonparametric test was used for paired data (Wilcoxon test) to compare inclinations, mesial distal displacements, and vertical changes of the central incisors, premolars, and molars during treatment. The Spearman correlation coefficient was used to establish whether there was any relationship between the inclination and the displacement of the molar at the end of the movement.

RESULTS

Average values after distalization were tabulated and are shown in the Table. The device was worn for an average of 7.8 months. Two patients were excluded because of tissue inflammation and failure of the screw.

The average distalizations for the molar were of 6 ± 2.27 mm at crown level (U6mp–Y-axis) and of 4.15 ± 1.49 mm at furcation level (U6F–Y-axis), and the average inclination was 11.3° ± 6.2° (U6mp-FH) (P <.001) (see Fig 2 for definitions). The rotation of the molars and the intermolar width did not have significant changes.

The maxillary second premolar distalized on average 4.85 ± 1.96 mm (U5–Y-axis) (P <.001) and had a distal inclination of 8.6 ± 5.08° (U5⊥FH) (P <.002).

The maxillary central incisor was retruded an average of 0.5 ± 1.33 mm (U1–Y-axis) (not significant), palatally inclined 2.5° ± 2.98° (U1-FH) (P <.015), and extruded 1.15 ± 1.69 mm (U1-FH) (not significant) (Table). The mandibular plane rotated backward 1.27° ± 1.11° on average (MP-FH) (P <.007) (Table).

The BSP bearing moved anteriorly 0.62 ± 0.5 mm and vertically 0.42 ± 0.34 mm, showing a slight change of position of the acrylic plate.

DISCUSSION

In this study, we analyzed the clinical effectiveness of a non–tooth-borne appliance (BSP) designed to prevent the loss of anchorage generally associated with mesial movement of the premolars and labial movement of the maxillary incisors.

To obtain total anchorage control during the distalization movement, several endosseus appliances were developed that are efficient in the control of anchorage.[9-16] Most of these systems, however, need invasive surgical or additional laboratory procedures and, in some cases, cannot be loaded immediately. The device

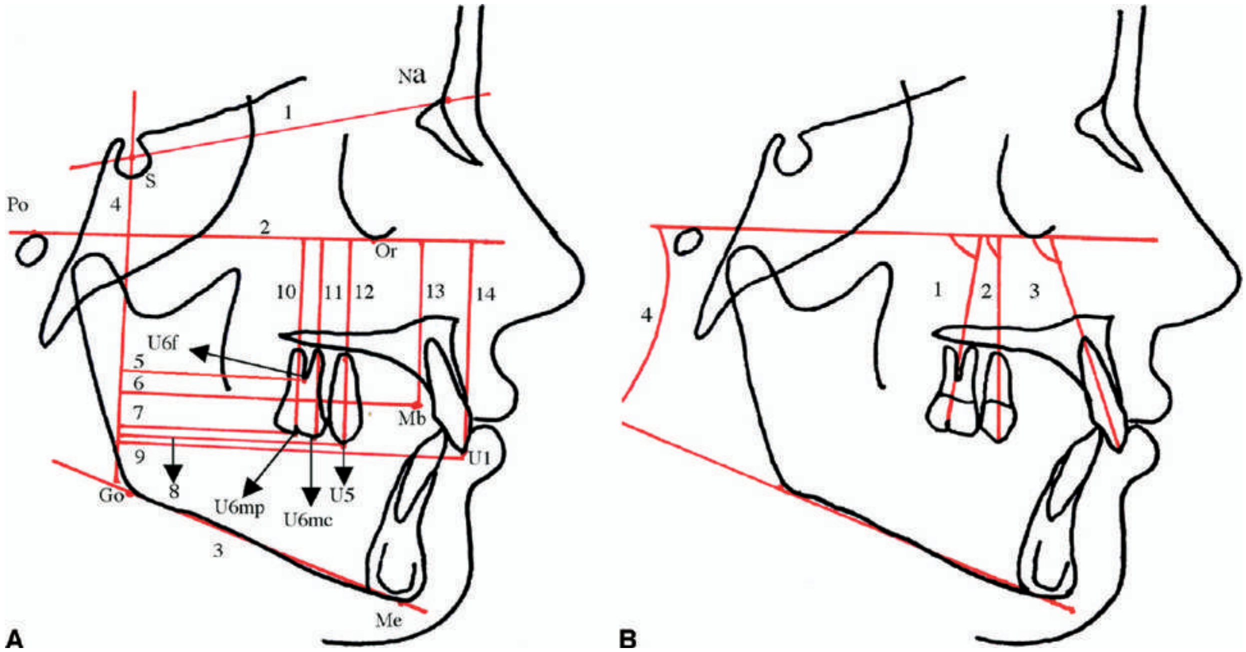

Fig 2. A, Cephalometric landmarks, planes, and sagittal and vertical measurements. Landmarks: *S,* sella; *Na,* nasion; *Go,* gonion; *Me,* mention; *Or,* orbitale; *Po,* porion; *U1,* incisal tip of maxillary central incisor; *U6mp,* occlusal midpoint of maxillary first molar; *U6mc,* mesiovestibular cusp of maxillary first molar; *U6f,* furcation point of maxillary first molars; *U5,* vestibular cusp tip of maxillary second premolar; *Mb,* midpoint of metallic bearing. Planes: *1,* S-Na; *2,* Frankfort horizontal (FH); *3,* mandibular (MP); *4,* Y-axis perpendicular to FH from S. Sagittal measurements: *5,* U6f to Y-axis; *6,* Mb to Y-axis; *7,* U6mp to Y-axis; *8,* U5 to Y-axis; *9,* U1 to Y-axis. Vertical measurements: *10,* U6mp-FH; *11,* U6mc-FH; *12,* U5-FH; *13,* Mb-FH; *14,* U1-FH. **B,** Angular measurements: *1,* U6mp-FH; *2,* U5-FH; *3,* U1-FH; *4,* MP-FH.

Table. Dentoalveolar and skeletal effects of BSP appliance

	Predistalization			*Postdistalization*			*Differences*		P value
	Mean	*SD*	*CV*	*Mean*	*SD*	*CV*	*Mean*	*SD*	
U1-FH (°)	108.92	10.73	10	106.42	9.88	9	2.50	2.98	.015*
U5-FH (°)	82.88	3.54	4	74.27	3.30	4	8.62	5.08	.002†
U6-FH (°)	74.46	2.87	4	63.15	5.99	9	11.31	6.22	.001‡
U1–Y-axis (mm)	74.00	6.19	8	73.46	5.78	8	0.54	133	.182
U5–Y-axis (mm)	48.50	5.28	11	43.65	5.26	12	4.85	1.96	.001‡
U6mp–Y-axis (mm)	38.42	5.31	14	32.42	5.78	18	6.00	2.27	.001‡
U6f–Y-axis (mm)	41.73	5.17	12	37.58	5.47	14	4.15	1.49	.001‡
U1-FH (mm)	53.15	4.87	9	54.31	3.79	7	−1.15	1.69	.039*
U5-FH (mm)	48.81	4.06	8	49.27	3.50	7	−0.46	1.61	.347
U6mc-FH (mm)	47.35	3.58	8	47.85	3.33	7	−0.50	1.73	.232
U6-mp (mm)	45.62	3.75	8	45.58	3.64	8	0.04	2.25	.968
MP-FH (°)	25.50	4.50	18	26.77	4.42	17	−1.27	1.11	.007†
Right molar angle (°)	26.04	7.69	30	26.90	11.22	42	−0.86	11.64	.701
Left molar angle (°)	32.14	5.60	17	36.71	11.03	30	−4.57	9.91	.152
Molar width (mm)	46.00	2.76	6	45.99	4.09	9	0.01	3.44	.972
Mb–Y-axis (mm)	60.81	6.05	10	62.42	5.31	9	−1.62	1.75	.000‡
Mb-FH (mm)	42.23	4.14	10	41.81	4.10	10	0.42	0.64	.000‡

CV, Variation coefficient.
*$P < .05$; †$P < .01$; ‡$P < .001$.

Fig 3. Mild tissue irritation on palatal mucosa occured when screws and BSP were removed manually. Irritation resolved several days later without treatment.

described here, the BSP, offers a simple way to obtain the anchorage control needed for distalization, and it has advantages such as minimally invasive surgical procedures for placement and removal, and the ability to be loaded immediately.

The BSP behaved similarly to the tooth-supported pendulum regarding the distal movement of the molars.[2-8] Similar to the findings of Kircelli et al,[16] we found significant differences in anterior movement of the premolars and the incisors from the tooth-borne pendulum appliance compared with the BSP. Simultaneous distalization of the premolars was observed during molar distalization, thus facilitating spontaneous improvement of anterior crowding and resulting in a decrease of total treatment time with fixed appliances. The appliance was also left as retention during the retraction, eliminating the need for a Nance holding arch as anchorage.

Similar to the results of several pendulum studies,[2-8] the mandibular plane rotated 1° in a posterior direction. This might be due to the inclination and rotation of the molars that create premature contacts with a tendency to open the bite.

Another interesting finding was that the BSP moved in the maxillary-anterior direction. This could be explained by the generation of movement as a reaction to the force of the springs located in the molars; this produces a fulcrum effect on the screws, causing the acrylic plate to slightly embed against the palate. Despite this, there was no loss of anchorage effect, and the amount of displacement of the appliance was minimal (<1 mm).

When the screws and the BSP were removed manually, without the need for anesthesia, mild tissue irritation was detected on the palatal mucosa, similar to when a Nance button is removed. This is because of the difficulty of maintaining optimal hygiene. It was resolved in a few days without treatment (Fig 3).

CONCLUSIONS

The BSP proved to be a valid clinical option for the distalization of the maxillary first molars when efficient anchorage is desired. The favorable consequences are decreased treatment time due to the self-improvement of anterior crowding and the spontaneous distal migration of the premolars.

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