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

Sergio Andres Escobar,a Paola Andrea Tellez,a Cesar Augusto Moncada,a Carlos Alberto Villegas,b Carlos Mario Latourre,c and Giovanni Oberti4
Medellin, Colombia

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 occur2-8; 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 Hilgers1 design with a double-loop modification18 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)
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 regu-
larly 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 over-
corrected clinically to a super Class I 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 nonpara-
metric 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 displace-
ment 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 aver-
age 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 aver-
age 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 move-
ment of the maxillary incisors.

To obtain total anchorage control during the distal-
ization movement, several endosseus appliances were
developed that are efficient in the control of anchorage.
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

<table>
<thead>
<tr>
<th></th>
<th>Predistalization</th>
<th>Postdistalization</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>CV</td>
</tr>
<tr>
<td>U1-FH (°)</td>
<td>108.92</td>
<td>10.73</td>
<td>10</td>
</tr>
<tr>
<td>U5-FH (°)</td>
<td>82.88</td>
<td>3.54</td>
<td>4</td>
</tr>
<tr>
<td>U6-FH (°)</td>
<td>74.46</td>
<td>2.87</td>
<td>4</td>
</tr>
<tr>
<td>U1-Y-axis (mm)</td>
<td>74.00</td>
<td>6.19</td>
<td>8</td>
</tr>
<tr>
<td>U5-Y-axis (mm)</td>
<td>48.50</td>
<td>5.28</td>
<td>11</td>
</tr>
<tr>
<td>U6mp-Y-axis (mm)</td>
<td>38.42</td>
<td>5.31</td>
<td>14</td>
</tr>
<tr>
<td>U6f-Y-axis (mm)</td>
<td>41.73</td>
<td>5.17</td>
<td>12</td>
</tr>
<tr>
<td>U1-FH (mm)</td>
<td>53.15</td>
<td>4.87</td>
<td>9</td>
</tr>
<tr>
<td>U5-FH (mm)</td>
<td>48.81</td>
<td>4.06</td>
<td>8</td>
</tr>
<tr>
<td>U6mc-FH (mm)</td>
<td>47.35</td>
<td>3.58</td>
<td>8</td>
</tr>
<tr>
<td>U6-mp (mm)</td>
<td>45.62</td>
<td>3.75</td>
<td>8</td>
</tr>
<tr>
<td>MP-FH (°)</td>
<td>25.50</td>
<td>4.50</td>
<td>18</td>
</tr>
<tr>
<td>Right molar angle (°)</td>
<td>26.04</td>
<td>7.69</td>
<td>30</td>
</tr>
<tr>
<td>Left molar angle (°)</td>
<td>32.14</td>
<td>5.60</td>
<td>17</td>
</tr>
<tr>
<td>Molar width (mm)</td>
<td>46.00</td>
<td>2.76</td>
<td>6</td>
</tr>
<tr>
<td>Mb–Y-axis (mm)</td>
<td>60.81</td>
<td>6.05</td>
<td>10</td>
</tr>
<tr>
<td>Mb-FH (mm)</td>
<td>42.23</td>
<td>4.14</td>
<td>10</td>
</tr>
</tbody>
</table>

CV, Variation coefficient.

*P < .05; †P < .01; ‡P < .001.
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. 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, the mandibular plane rotated $1^\circ$ 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.

We thank the patients, the Institute of Health Sciences CES, Congregación Mariana Dentist Center, RPdental and Mondeal, and Imax, which contributed to this study, and Tiziano Baccetti and Diego Rey, who helped with the revision of this article.

REFERENCES


