

# Effects of the Pendulum Appliance on the Dentofacial Complex

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**W**ith the recent trend toward nonextraction treatment, many appliances have been advocated for maxillary molar distalization.<sup>1-20</sup> Although the Pendulum appliance as described by Hilgers<sup>10</sup> is one of the most commonly used for this purpose, its effects on the dentofacial complex have not been well documented.

The purpose of this study was to determine the effects of the Pendulum molar distalization appliance on the dentition and facial form.

## Materials and Methods

The sample consisted of 26 patients who were treated with the Pendulum appliance. The patients, 10 boys and 16 girls, ranged in age from 7 years, 3 months, to 15 years, 5 months, with a mean age of 11 years, 2 months, at the start of treatment. All patients met the following criteria:

- End-to-end or greater Class II molar relationship at the start of treatment.
- Use of the Pendulum appliance for molar distalization in the first phase of treatment.
- Nonextraction treatment plan.
- Absence of other molar distalization procedures during the Pendulum appliance period.

The second molars were erupted in 11 pa-

tients and unerupted in 15 patients. The mandibular plane angle ranged from 17.0° to 29.5°, with a mean of 24.1°. All patients were treated in Dr. Chaqués-Asensi's office.

The basic design of the Pendulum appliance used in this study is shown in Figure 1. The distalizing arms, made from .032" TMA\* wire, were activated 80° prior to insertion in the mouth. The appliance was not reactivated during treatment, and the distalizing arms were not modified at any time. Treatment time ranged from four to nine months, with a mean of 6.5 months, and patients were seen at monthly intervals.

## Cephalometric Analysis

Lateral cephalograms were taken prior to treatment (T1) and at the end of molar distalization (T2). Standard cephalometric tracing and measurement techniques were used, as described by Ghosh and Nanda<sup>15</sup> (Fig. 2). Unilateral centroid points were constructed for the maxillary first and second molars and first premolar, using the midpoint of the crown's greatest mesiodistal

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**Fig. 1** A. Pendulum appliance used in this study, with palatal acrylic button attached to first premolars by retaining wires soldered to bands, and .032" TMA distalizing springs activated 80°. B. Appliance seated in mouth. C. After six months of treatment with Pendulum appliance.

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diameter.<sup>15,17</sup> The amount of horizontal movement of the molars, premolar, and central incisor was determined by superimposing tracings on the pterygoid vertical plane (PTV), and vertical movement by superimposing on the palatal plane (PP).<sup>15</sup>

All radiographs were traced and measured by one author. To determine the error of measurement, 10 cephalograms were retraced and measured. The combined error was found to be less than  $.5^\circ$  and  $.5\text{mm}$ .

The mean and standard deviation were calculated for each measurement. Student's t-tests were performed to determine the significance of differences between the pretreatment (T1) and post-treatment (T2) measurements (Table 1).

## Results

The maxillary first molars moved distally 5.3mm, as measured by the position of the cen-

teroid ( $p < .001$ ), tipped distally  $13.1^\circ$  ( $p < .001$ ), and intruded 1.2mm ( $p < .001$ ).

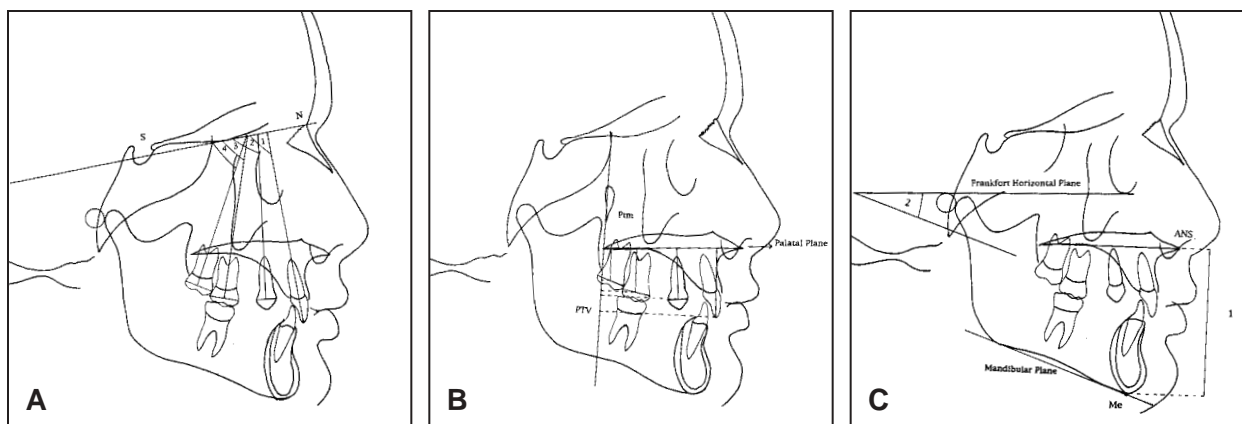
The maxillary first premolars or deciduous first molars advanced 2.2mm ( $p < .001$ ), tipped mesially  $4.8^\circ$  ( $p < .001$ ), and extruded 1.2mm ( $p < .001$ ). The maxillary central incisors advanced 2.1mm ( $p < .001$ ), and their inclination increased by  $5.1^\circ$  ( $p < .001$ ).

Overjet increased by 1.8mm ( $p < .001$ ), and overbite decreased by 1.8mm ( $p < .001$ ).

Lower facial height (ANS-Me) increased by 2.8mm ( $p < .001$ ), while the mandibular plane angle increased by  $1.3^\circ$  ( $p < .01$ ).

## Discussion

Use of the Pendulum appliance resulted in a 5.3mm distalization of the maxillary first molars in 6.5 months, at a rate of  $.8\text{mm}$  per month. Gulati and colleagues reported the same rate of distalization using a sectional jig assem-



**Fig. 2** A. Cephalometric dental angular measurements: 1. SN-maxillary incisor; 2. SN-maxillary first premolar; 3. SN-maxillary first molar; 4. SN-maxillary second molar. B. Cephalometric dental linear measurements: Vertical measurements (solid lines) to first molar, second molar, and first premolar centroids and central incisal edge from palatal plane (PP); horizontal measurements (dashed lines) to first molar, second molar, and first premolar centroids and central incisal edge from pterygoid vertical plane (PTV). C. Cephalometric skeletal measurements: 1. Lower anterior facial height (ANS-Me); 2. Mandibular plane angle (FH-MP).

**TABLE 1**  
**CEPHALOMETRIC CHANGES FROM TREATMENT**  
**WITH PENDULUM APPLIANCE (N = 26)**

	Mean	S.D.	Minimum	Maximum	
<i>Dental Horizontal (mm)</i>					
PTV-U1 incisal edge	2.09	0.72	1.00	5.50	***
PTV-U4 centroid	2.21	1.30	-1.00	5.00	***
PTV-U6 centroid	-5.31	1.52	-3.00	-8.00	***
PTV-U7 centroid	-2.30	1.41	-1.00	-5.00	***
Overjet	1.78	1.10	0.00	5.50	***
<i>Dental Vertical (mm)</i>					
PP-U1 incisal edge	0.75	1.12	-1.00	3.00	**
PP-U4 centroid	1.18	1.36	-1.00	4.00	***
PP-U6 centroid	-1.20	1.37	-5.50	1.50	***
PP-U7 centroid	-0.90	1.93	-4.00	3.50	*
Overbite	-1.81	1.60	-4.00	3.00	***
<i>Dental Angular (°)</i>					
SN-U1	5.14	4.01	2.00	14.00	***
SN-U4	4.84	3.84	-1.00	11.00	***
SN-U6	13.06	7.52	-3.50	30.00	***
SN-U7	14.23	8.63	-2.50	32.00	***
<i>Skeletal</i>					
ANS-Me (mm)	2.75	1.47	0.00	4.00	***
FH-MP (°)	1.31	1.94	-2.00	7.00	**

\*p < .05; \*\*p < .01; \*\*\*p < .001.

bly.<sup>17</sup> Similarly, Bondemark and Kurol,<sup>8</sup> using magnets, and Gianelly,<sup>19</sup> using a nickel titanium coil spring, reported a rate of about 1mm per month of first molar distalization.

The Pendulum appliance also caused substantial distal molar tipping. Ghosh and Nanda reported that the Pendulum resulted in 3.4mm of distalization and 8.4° of distal tipping of the first molar.<sup>15</sup> Considering both their results and ours, one would expect the maxillary first molar to tip distally about 2.5° for every 1mm of distalization. Because distally tipped molars do not provide effective anchorage for retracting the teeth anterior to them, anchorage should be vigorously reinforced during retraction.

In the present study, despite the use of

Nance buttons, the maxillary first premolars or deciduous first molars came forward 2.2mm, and the overjet increased by 1.8mm. This mesial movement amounted to 30% of the space created between the first molar and first premolar. Ghosh and Nanda reported an even greater anchorage loss—about 40%.<sup>15</sup> Either finding emphasizes the need for conservative selection of patients for Pendulum treatment.

Since the Nance button alone did not prevent anterior movement of the first premolars, additional methods of reinforcing anchorage may be necessary, including extraoral traction to the first molars, inclusion of the canines and incisors in the anchor unit by means of archwires, uprighting springs on the first premolars,

and Class II elastics.<sup>5,10,15,19</sup>

The amount of first molar distalization and inclination was about the same in the 15 patients in whom the second molars had erupted, compared to the 11 patients in whom they had not erupted. Ghosh and Nanda reported similar results.<sup>15</sup> The amount of anchorage loss, however, as measured by anterior movement of the first premolars and incisors, was .5mm greater in the patients with erupted second molars ( $p < .05$ ).

In our measurements of facial form, lower anterior facial height increased by 2.8mm, the mandibular plane angle increased by  $1.3^\circ$ , and overbite decreased by 1.8mm during 6.5 months of treatment with the Pendulum appliance. Similarly, Ghosh and Nanda reported a 2.8mm increase in lower anterior facial height, a  $1.1^\circ$  increase in the mandibular plane angle, and a 1.4mm decrease in overbite during six months' treatment with the Pendulum.<sup>15</sup> The increased lower facial height and mandibular plane angle could have resulted from driving the molars back into the "wedge".<sup>15</sup> These results suggest that the Pendulum may be contraindicated in patients with excessive lower facial height and/or minimal overbite.

### Conclusion

Treatment with the Pendulum molar distalizing appliance appears to produce the following changes:

- Considerable distal movement of the molars.
- Considerable distal tipping of the molars.
- A substantial amount of anchorage loss, resulting in anterior movement of the first premolars and incisors.
- Some increase in lower facial height and reduction in overbite.

The presence of erupted second molars does not seem to affect distalization of the first molars, but it does slightly increase the mesial movement (anchorage loss) of the first premolars.

The Pendulum appliance is effective in distalizing molars. As with other molar distalization appliances, however, one should be conservative

in choosing patients for treatment with the Pendulum. Long-term studies evaluating the net gain in molar distalization at the completion of orthodontic treatment are indicated.

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