

Donald J. Ferguson, DMD, MSD¹
Aldo Carano, Dr Odont, MS, Spec Orthod²
S. Jay Bowman, DMD, MSD³
Edward C. Davis, DMD, MSD⁴
Maria E. Gutierrez Vega, DDS, MSD⁵
Sandra H. Lee, DDS, MSD⁶

A COMPARISON OF TWO MAXILLARY MOLAR DISTALIZING APPLIANCES WITH THE DISTAL JET

Aims: Previous studies on maxillary molar distalization have usually concentrated on only one appliance and featured small sample sizes. The purpose of this retrospective study was two-fold: (1) to determine the skeletal, dental, and soft tissue effects of 3 molar distalization appliances, 2 of which do not depend upon patient compliance (ie, distal jet and Greenfield molar distalizing appliance) and 1 that does (ie, sagittal appliance combined with cervical headgear); and (2) to determine differences in treatment effects among the 3 appliances.

Methods: Pretreatment and post-distalization cephalometric radiographs were obtained for each appliance (14 females and 11 males for the distal jet; 12 females and 13 males for the Greenfield molar distalizing appliance; and 17 females and 13 males for the sagittal appliance with headgear). **Results:** Pretreatment to transition evaluation showed significant distal movement of the first molars for the distal jet (3.4 mm), the Greenfield molar distalizing appliance (3.9 mm), and the sagittal appliance with headgear (2.1 mm). Distal tipping of the first molar was seen in all samples, but significantly more so in the Greenfield molar distalizing appliance (6.5 degrees \pm 6.6) and the sagittal appliance with headgear (13.5 degrees \pm 8.1) than in the distal jet (3.2 degrees \pm 2.8). **Conclusions:** Maxillary molar distalization was effective using the distal jet, the Greenfield molar distalizing appliance, and the sagittal appliance with headgear, but better control of molar bodily movement was reported with the distal jet. World J Orthod 2005;6:xx-xx.

¹Professor and Chairman, Department of Orthodontics, Boston University Goldman School of Dental Medicine, Boston, Massachusetts, USA.

²Adjunct Professor, Department of Orthodontics, University of Ferrara, Ferrara, Italy; Adjunct Professor, Department of Orthodontics, Saint Louis University, Saint Louis, Missouri, USA.

³Adjunct Associate Professor, Department of Orthodontics, Saint Louis University, Saint Louis, Missouri, USA.

⁴Private practice of Orthodontics, (AU: please provide name of town), South Carolina, USA.

⁵Instructor, Graduate Program in Orthodontics, Universidad Autonoma de Nuevo Leon, Monterrey, Mexico.

⁶Private practice of Orthodontics, Chicago, Illinois, USA.

CORRESPONDENCE

S. Jay Bowman, DMD, MSD
1314 West Milham Avenue
Portage, MI 49024, USA
E-mail: drjwyred@aol.com

One of the most common orthodontic problems is the Class II malocclusion. It is observed in 15% to 40% of the United States population and seen most often in Caucasians of Northern European descent. Researchers have developed numerous treatment modalities for Class II correction, including those that are patient-compliance dependent (eg, headgear) and those that are not dependent upon patient adherence (eg, intraoral devices that distalize the maxillary molars into a Class I relationship). Though effective, treatments requiring a

high level of patient cooperation are limited by the unpredictability of patient compliance. For instance, headgear is only effective if worn for 12 to 14 hours a day with heavy force placed to the dentition.¹⁻³ As children become more involved in organized activities, finding an extended period of time to wear the headgear is often problematic. Over the past decade, nonextraction treatments with noncompliance therapies have become popular in treating Class II malocclusions. While some therapies are designed to reposition the mandible

anteriorly,^{4,5} others are designed to push the maxillary molars distally into a Class I position (ie, molar distalization).⁶⁻¹² The number of different fixed and removable appliances available for practitioners is extensive. Magnets, incorporated into appliances with a Nance button framework, have been used with success⁷; unfortunately, the forces they produce diminish in proportion to the space created between the 2 magnets. Nickel-titanium (NiTi) coil springs produce more consistent forces than magnets¹³ and have been incorporated in many distalizing devices, such as the Jones jig,¹⁰ Wilson's bimetric-distalizing arch,¹⁴ the distal jet,⁶ and the Greenfield molar distalizing appliance.⁸

The pendulum appliance consists of a large acrylic Nance button that covers the midportion of the palate for anchorage, while posteriorly directed springs, made of 0.032-inch TMA wire, produce a distal-driving force.⁹ A 100-g NiTi wire, compressed between the maxillary first premolars and maxillary first molars with crimpable stops, has also been successfully used for molar distalization.¹¹

Most of the previously mentioned therapies utilize some variation of palatal coverage to provide anchorage from unwanted incisor flaring. Although research has described the dental and skeletal effects of nearly all of these methods, most studies have involved a single appliance or compare only similar appliances.^{1,12,14-19}

The present study was designed to compare 3 appliances for maxillary distalization: 2 that do not depend upon patient compliance (distal jet [DJ]⁶ and Greenfield molar distalization [GMD]⁸) and 1 that does rely upon patient cooperation (sagittal appliance combined with a cervical headgear [sagittal/headgear]²⁰).

MATERIAL AND METHODS

A sample of 80 patients with Class II malocclusions was selected for evaluation. Each patient had been treated with 1 of the 3 methods of molar distalization: 25 were treated with the DJ, 25 with

the GMD appliance, and 30 with the sagittal/headgear. Pretreatment (T1) and transition (T2) (ie, completion of molar distalization) cephalometric radiographs and study casts were obtained from 3 private orthodontic offices. The mean age of patients at T1 was 12.5 years for the DJ sample, 11.5 years for the GMD sample, and 13.3 years for the sagittal/headgear sample.

All patient records used for the study met the following criteria: (1) malocclusion with at least a half-step Class II molar relationship on one side of the arch; (2) nonextraction treatment plans; (3) 1 of the 3 molar distalizing devices (ie, DJ, GMD, sagittal/headgear) used in the first phase of orthodontic treatment to distalize maxillary molars into a Class I relationship; (4) good-quality diagnostic cephalometric radiographs taken at the beginning of treatment and after the completion of molar distalization.

The distal jet

The distal jet⁶ consists of a pair of 0.036-inch diameter bilateral tubes attached to an acrylic Nance appliance (Fig 1). NiTi coil springs of 240 g and locking activation collars were used to deliver the distalizing force. A wire extending from the Nance button was soldered to each of the premolar bands for anchorage support.

To construct the DJ, bands were fitted for the maxillary first molars and second premolars. These bands and the maxillary impressions were sent to a single orthodontic laboratory (Ortotec, Avegno, Italy) for the fabrication of the DJ appliance. Once positioned, the activation collars were pushed posteriorly to compress the superelastic coil springs and the collars were locked in place. To maintain proper force levels, the springs were reactivated every 4 weeks. Treatment with the DJ was terminated when the maxillary molars were in Class I position and the appliance was converted into a modified Nance "button" to maintain the new molar positions. No other orthodontic mechanics were accomplished during this part of treatment.

Fig 1 The distal jet appliance. This appliance consists of pairs of bands that are fitted to the maxillary first molars and first premolars. An acrylic palatal Nance appliance is connected to the premolar bands by bilateral .036-inch diameter stainless steel tubes. NiTi coil springs (240 g) are compressed and held by locking activation collars. The molar bayonet bends provide a linear force at each molar's center of resistance to reduce molar tipping.

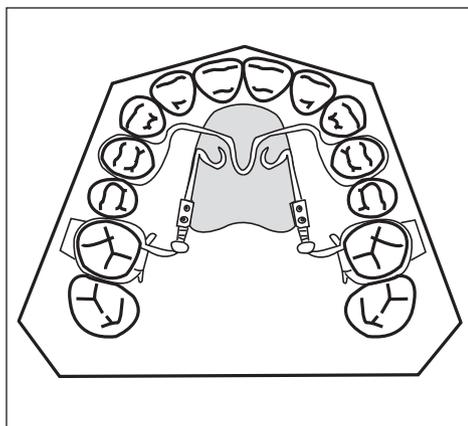


Fig 2 The active force component of the Greenfield molar distalizing appliance is a pair of pistons with NiTi open-coil springs (50 g) on both the buccal and lingual aspects of the first molars. An enlarged acrylic Nance button, attached to bands on maxillary premolars, provides anchorage support.

Greenfield molar distalization appliance

The Greenfield molar distalizing appliance⁸ also utilizes an enlarged Nance button reinforced with a 0.040-inch stainless steel wire. The GMD is a fixed-piston appliance with 0.036-inch stainless steel tubing soldered to the first premolars and 0.030-inch stainless steel wires soldered to the first molars. Each side has 2 telescopic units, 1 on the buccal surface and the other on the lingual surface of the maxillary teeth (Fig 2). The active force component is comprised of a pair of 0.055-inch internal diameter NiTi open-coil springs that deliver a 50-g force on both the buccal and lingual surfaces of each first molar.

The GMD appliance was cemented and allowed to settle passively for 2 weeks before beginning activation of the distalizing components. The appliance was activated every 2 months by adding 2-mm split ring stops to the mesial of the buccal and lingual tubes to compress the springs on each piston assembly. Once the distal movement of the maxillary molars was completed, a newly fabricated Nance appliance was inserted to maintain the Class II correction before beginning retraction of the anterior dentition with a fixed edgewise appliance. The majority of patients in this sample underwent concurrent mandibular arch treatment with a lip bumper and orthopedic treatment for a Class II skeletal pattern with headgear.

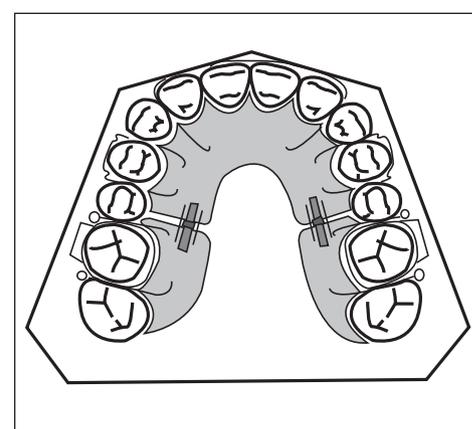
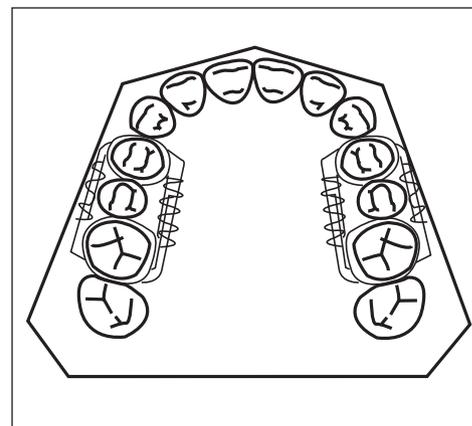


Fig 3 The removable acrylic sagittal appliance consists of 2 jackscrews oriented to the sagittal plane and placed to produce distal force on the maxillary first molars. An Adams clasp is constructed on the first premolars for retention. The labial bow retains the incisors in the pretreatment position. The sagittal appliance was combined with a cervical headgear in an attempt to reduce molar tipping.

Sagittal/headgear appliance

The sagittal appliance²⁰ consists of a removable retainer with 2 jackscrews, 1 positioned on each side of the arch (Fig 3) to produce a distalizing force to the first molars. The patients were instructed to activate the jackscrews twice a week for 0.25-mm advancement each activation. Bands for the cervical headgear were fitted to the maxillary first molars and submitted in a maxillary impression to an orthodontic laboratory (Zac Orthodontic,

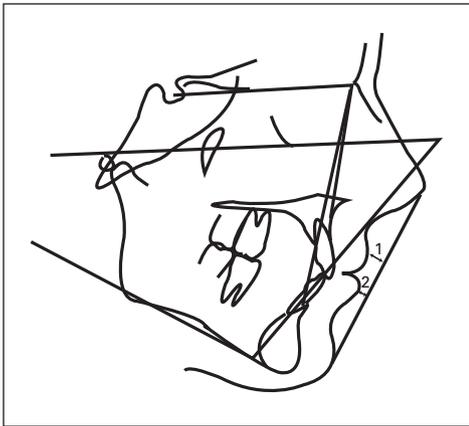


Fig 4 Soft tissue and skeletal cephalometric analysis including FMA, upper lip to E-line (1), and lower lip to E-line (2).

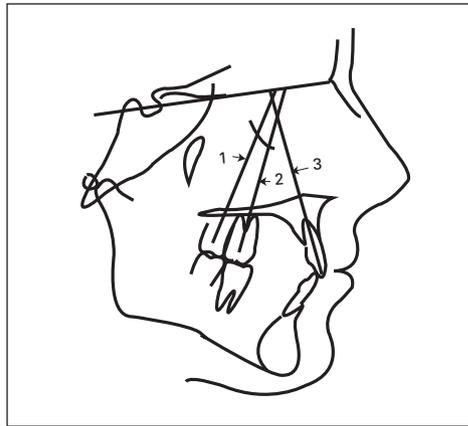


Fig 5 Dental angular measurements: (1) upper 7 to sella-nasion (SN); (2) upper 6 to SN; (3) upper 1 to SN.

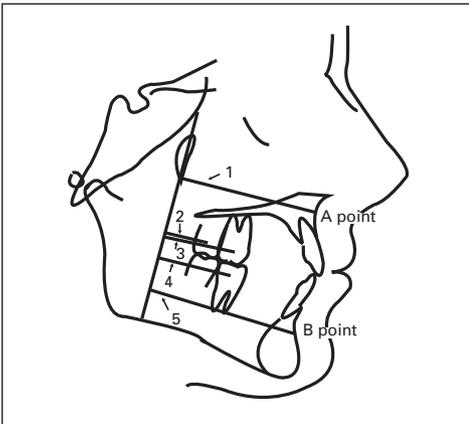


Fig 6 Dental linear measurements. Anteroposterior: (1) PTV to A point; (2) PTV to upper 7 centroid; (3) PTV to upper 6 centroid; (4) PTV to lower 6 centroid; (5) PTV to B point.



Fig 7 Dental linear measurements. Vertical: (1) palatal plane (PP) to upper 7 centroid; (2) PP to upper 6 centroid; (3) PP to upper 1 tip; (4) lower 6 centroid to Mn plane.

Evansville, Indiana, USA) for fabrication. The sagittal appliance was constructed with Adams clasps for the first premolars and ball clasps around the bands on the first molars. A labial bow extended from canine to canine and a bite plate was added to free the occlusion.

The patients were instructed to wear the removable sagittal appliance 24 hours a day, except when eating, and the 2 jackscrews were activated once per week. In addition, the patients were asked to wear a cervical headgear 12 to 14 hours a night to aid in the bodily translation of the maxillary molars and to keep the molar roots upright. Treatment was terminated when the maxillary molars achieved a slight Class III position. A transpalatal bar was then placed after distalization to maintain molar position.

Cephalometric analysis

Lateral cephalometric analysis of the sample was performed using radio-

graphs taken before and after molar distalization treatment (Figs 4 to 7):

- Centroid points were determined for the crowns of the maxillary first molars and premolars at the midpoint between the greatest mesial and distal convexity of the crowns, as seen on the cephalometric radiograph. The amount of horizontal movement of the maxillary premolar and molar was calculated by measuring along a line perpendicular to the pterygoid vertical plane (see Fig 6). The long axis of the maxillary premolars and molar was obtained by drawing a perpendicular to the midpoint of a line connecting the most convex points on the crowns of those teeth. Angular changes were assessed in the relationship of the long axes of the teeth to the sella-nasion plane. Due to a constant 8% enlargement, no adjustment of linear measurements among the 3 sample groups was required.
- The cephalograms were digitized in an x-y coordinate system using a digitiza-

Table 1 Descriptive measurements for the distal jet appliance

N	25			
Initial age of patient	12 y 6 m			
Treatment time	8 m			
Compliance	Independent			
Measurements	T1	T2	T2-T1	SD
Upper lip to E-plane (mm)	-0.7	-1.4	-0.7	2.3
Lower lip to E-plane (mm)	-0.9	-0.4	0.5	3.1
FMA (degrees)	24.8	24.7	-0.1	5.4
ANS-Me (mm)	66.4	67.0	0.6	1.9
Upper 1 to SN (degrees)	100.0	100.9	0.6	5.3
Upper 4 to SN (degrees)	80.7	77.6	-3.1*	4.0
Upper 6 to SN (degrees)	67.7	64.5	-3.2*	2.8
PTV - A point (mm)	53.2	53.6	0.4	1.6
PTV - B point (mm)	45.8	46.6	0.8	1.8
PTV - upper 4 centroid (mm)	37.9	38.9	1.0*	1.5
PTV - upper 6 centroid (mm)	21.7	18.3	-3.4*	1.4
Overjet (mm)	3.8	3.9	0.1	1.1
Overbite (mm)	3.0	2.9	-0.1	0.8
Palatal plane to upper 1 tip (mm)	28.3	28.6	0.3	0.9
Palatal plane to upper 4 centroid (mm)	20.9	21.3	0.4	1.6

Probability values from paired *t* tests are provided.

T1, pretreatment; T2, post-distalization; T2 - T1, change; SD, standard deviation.

**P* < .05

tion program (Dentofacial Planner 7.0, Dentofacial Software, Toronto, Canada). Ten randomly selected radiographs were re-traced and re-digitized to determine the error of measurement (0.5 mm and 0.5 degrees); there was no statistically significant tracing error for any of the measurements.

Statistical analysis

Descriptive statistics, mean and standard deviations, were calculated for the sample at both T1 and T2. The data were imported into a SAS (SAS Institute, Cary, North Carolina, USA) data set. A paired *t* test was used to analyze within group differences between pretreatment and post-distalization cephalometric variables to determine any significant changes among the 3 appliances: DJ, GMD, and sagittal/headgear. Comparisons between groups were analyzed; the DJ sample was compared to both the GMD appliance sample and to the sagittal/headgear sample using Student's *t* test.

RESULTS

Average treatment time was 31.5 ± 8.3 weeks for the DJ, 41.6 ± 7.3 weeks for the GMD appliance, and 30.9 ± 7.1 weeks for the sagittal/headgear.

The distal jet

In the DJ sample, distalization of the first molar was 3.4 ± 1.4 mm with distal tipping of 3.2 degrees ± 2.8 degrees. The maxillary first premolar moved to the mesial 1.0 ± 1.5 mm and tipped to the distal 3.1 degrees ± 4.0 degrees. There was no significant increase in overjet as edgewise appliances were not placed until after completion of distal molar movement. The lower anterior facial height increased only 0.6 ± 1.9 mm and there were no significant soft tissue changes (Table 1).

Table 2 Descriptive measurements for the Greenfield molar distalization appliance

N		25			
Initial age of patient		11 y 6 m			
Treatment time		11 m			
Compliance		Independent			
Measurements	T1	T2	T2-T1	SD	
Upper lip to E-plane (mm)	-2.2	-1.1	1.1	2.1	
Lower lip to E-plane (mm)	-1.6	-1.0	0.6	2.3	
FMA (degrees)	23.0	23.3	0.3	5.5	
ANS-Me (mm)	62.5	65.4	2.9*	2.3	
Upper 1 to SN (degrees)	102.7	104.3	1.6*	4.1	
Upper 4 to SN (degrees)	82.1	82.3	0.2	7.0	
Upper 6 to SN (degrees)	68.2	61.7	-6.5*	6.6	
PTV - A point (mm)	52.7	53.8	1.1*	1.7	
PTV - B point (mm)	50.4	51.6	1.2	2.0	
PTV - upper 4 centroid (mm)	39.7	42.6	2.9*	2.7	
PTV - upper 6 centroid (mm)	21.9	18.0	-3.9*	1.8	
Overjet (mm)	5.7	6.1	0.4	1.2	
Overbite (mm)	4.7	3.6	-1.1*	1.4	
Palatal plane to upper 1 tip (mm)	27.6	28.0	0.4	1.3	
Palatal plane to upper 4 centroid (mm)	19.1	21.8	2.7	3.0	

Probability values from paired *t* tests are provided.

T1, pretreatment; T2, post-distalization; T2 - T1, change; SD, standard deviation.

**P* < .05

Greenfield molar distalizing appliance

The mean distal movement of the maxillary first molar was 3.9 ± 1.8 mm for the GMD, whereas the mesial movement of the first premolar was 2.9 ± 2.7 mm. The maxillary first molar tipped distally an average of 6.5 degrees \pm 6.6 degrees and the maxillary first premolar tipped mesially 0.2 degrees \pm 7.0 degrees. There was a significant mean extrusion of the first premolar of 2.7 ± 3.0 mm, but minimal anterior flaring (1.6 degrees \pm 4.1 degrees). The lower anterior facial height increased 2.9 ± 2.3 mm, but there were no significant soft tissue changes (Table 2).

Distal jet versus Greenfield molar distalizing appliance

There were no significant differences in horizontal distal movement of the molars when the DJ was compared to the GMD. The GMD produced greater distal tipping of the molars (6.5 degrees versus 3.1 degrees), anchorage loss (2.9 mm versus 1.0 mm), extrusion of the premolars (2.7 mm versus 1.0 mm), and increase in lower anterior facial height (2.9 mm versus 0.6 mm).

Sagittal appliance with cervical headgear

The first maxillary molars were moved to the distal 2.1 ± 3.3 mm with the sagittal/headgear. In addition, the molars were tipped towards the distal 13.5 degrees \pm 8.1 degrees. Mandibular molar extrusion, measured from first mandibular molar centroid to mandibular plane, was significant (1.6 ± 1.8 mm), as was the increase in lower anterior face height (3.3 ± 1.7 mm); there were, however, no significant soft tissue changes (Table 3).

Distal jet versus sagittal appliance

Differences in the soft tissue parameters between the DJ and sagittal/headgear appliance were not statistically significant. Lower anterior face height increased 2.3 mm more for the sagittal/headgear and tipping of the maxillary first molars was significantly greater in the sagittal/headgear (13.5 degrees) than that observed with the DJ (3.1 degrees).

Table 3 Descriptive measurements for the sagittal appliance

N	30			
Initial age of patient	13 y 4 m			
Treatment time	7 m			
Compliance	Dependent			
Measurements	T1	T2	T2-T1	SD
Upper lip to E-plane (mm)	-3.8	-4.3	-0.5	12.6
Lower lip to E-plane (mm)	-2.4	-2.3	0.1	1.9
FMA (degrees)	25.7	26.1	0.4	5.1
ANS-Me (mm)	63.7	66.9	3.3*	1.7
Upper 1 to SN (degrees)	98.1	100.6	2.5*	6.6
Upper 4 to SN (degrees)	82.9	83.4	0.5	5.6
Upper 6 to SN (degrees)	66.8	53.5	-13.5*	8.1
PTV - A point (mm)	52.1	52.5	0.4	2.7
PTV - B point (mm)	49.3	51.3	2.0*	3.5
PTV - upper 4 centroid (mm)	36.7	38.8	2.1*	3.3
PTV - upper 6 centroid (mm)	20.8	18.7	-2.1*	3.3
Overjet (mm)	3.6	3.7	0.1	1.1
Overbite (mm)	5.0	1.2	-3.8*	1.5
Palatal plane to upper 1 tip (mm)	28.9	28.4	-0.5	1.6
Palatal plane to upper 4 centroid (mm)	16.8	17.0	0.2	1.9

Probability values from paired *t* tests are provided.

T1, pretreatment; T2, post-distalization; T2 - T1, change; SD, standard deviation.

**P* < .05

DISCUSSION

The distal movement of the maxillary first molars into a Class I relationship has become a popular technique for Class II correction. Several methods have been advocated including the use of extraoral force, intraoral appliances combined with Class II elastics, and removable appliances. Some of these treatment modalities require varying degrees of patient compliance. In the past decade, new designs for noncompliance appliances have provided for more efficient delivery of distalizing forces with more predictable outcomes. The development of appliances for distal movement of maxillary molars requiring limited patient compliance has included repelling magnets, compressed coil springs, compressed superelastic wires, and appliances featuring TMA springs.

The present retrospective clinical study examined a sample of 80 patients: 25 with the DJ, 25 with the GMD, and 30 with the sagittal/headgear. All 3 appliances effectively moved the maxillary molars into a Class I occlusion. The DJ produced 3.4 mm of distal first molar movement and anchorage loss of 1.0 mm as the first premolar moved mesially. The DJ demonstrated, however,

less distal tipping of the first molar (3.1 degrees) than has been reported in previous investigations involving fixed appliances.^{12,16-19} For example, Ghosh and Nanda¹⁸ observed 8.4 degrees of molar distal tipping, and Bussick and McNamara¹⁶ reported 10.6 degrees tipping for the pendulum appliance.

On average, the first premolar tipped toward the distal with the DJ, which contrasts to mesial tipping of the first premolar in both the GMD and sagittal/headgear samples. This difference in the DJ is attributed to a biomechanical couple that directs forces closer to the center of resistance of the first molar, thereby producing a rotational force on the supporting Nance button.

The GMD appliance moved the maxillary molar 4 mm posteriorly. There was reciprocal mesial movement of the first premolar (2.9 mm) that was slightly more than the anchorage loss shown in the DJ group (1.0 mm). The maxillary first molar tipped distally 6.5 degrees, twice as much tipping as with the DJ (3.2 degrees), but comparable to studies conducted on other molar distalization appliances utilizing nitinol coil springs.^{15,18,19} Mesial tipping of the first premolar in the GMD sample was insignificant; however, there was pronounced extrusion of the

first premolar (2.7 mm) that has also been reported, to a lesser degree, with similar devices.^{15,18,19}

The sagittal/headgear produced less molar distalization (2.1 mm) than both the DJ and GMD, but demonstrated similar anchorage loss (2.1 mm) at the first premolar. The first molars tipped much more (13.5 degrees) than with the DJ or GMD and were also extruded 1.6 mm. Ghosh and Nanda¹⁸ advocated using cervical headgear in combination with the sagittal appliance to provide additional anchorage during retraction of the remaining teeth after distalization and, more importantly, to upright the molars during that process. Unfortunately, significant reduction in molar tipping did not result in this study. Success is absolutely dependent upon patient compliance when using this combination of 2 devices (ie, the sagittal and the headgear). Consequently, the hypothesis that extraoral traction, when combined with the sagittal appliance, will reduce molar tipping is questionable.

Although all 3 appliances produced an increase in lower anterior facial height (as measured by the distance between Anterior Nasal Spine and Menton), the DJ exhibited the smallest change (0.6 mm) when compared to the GMD (2.9 mm) and sagittal/headgear (3.3 mm). Perhaps tipping of the crown of the first molar tends to prop open the bite. Those appliances with less molar tipping, like the DJ, would be expected to produce less change in lower anterior face height.

This study has demonstrated that all 3 appliances are capable of distalizing maxillary molars into a Class I molar relationship; there are, however, pros and cons associated with each device. For instance, both the DJ and the GMD require minimal patient compliance, as they are placed and activated by the orthodontist. Although the DJ and GMD were equally effective in distalizing maxillary molars, the GMD produced greater molar tipping and increase in lower anterior face height.

The amount of anchorage loss was comparable among the 3 appliances. In addition, similar anchorage loss has

been reported with other popular devices for molar distalization (eg, pendulum appliance and Jones jig).^{15,16,19}

In contrast, the sagittal appliance and associated cervical headgear are both removable devices and, as such, are more hygienic. The bite plate incorporated into the design of the sagittal appliance assists in leveling of the mandibular dentition and in interrupting occlusal contact between the dental arches. The combination of the headgear and this bite plane produce a functional appliance. Unfortunately, this combination resulted in the greatest amount of distal tipping of the 3 devices examined, despite the hypothesis that the addition of the cervical headgear would reduce this adverse effect. Ghosh and Nanda¹⁸ recommended that a headgear should be used at the transition period with the pendulum appliance to upright molars that had been significantly tipped (10 degrees) during distalization. Runge et al¹² also suggested the headgear as a remedy for the significant molar tipping resulting from use of the Jones jig. The factor of patient compliance appears to be a significant limitation of the sagittal/headgear combination or of even using a headgear to correct molar tipping as seen with other fixed devices. If compliance is poor, distal movement and/or molar uprighting may be unsuccessful. If, however, the patient is cooperative with only the sagittal appliance and not the headgear, the treatment could result in dramatic molar tipping, adverse bite-opening, and/or clockwise rotation of the mandible.

CONCLUSION

This retrospective study examined the dental, skeletal, and profile effects of 3 maxillary molar distalization appliances used for correction of Class II malocclusions (ie, GMD, sagittal/cervical headgear combination, and the DJ). Treatment times were similar, but the effects were somewhat different for each appliance. The DJ requires minimal patient cooperation, delivers a constant force to the molars, and results in less molar tip-

ping during distal molar movement than the other devices. The GMD also requires minimal patient compliance, delivers a constant force to the molars, but produces more molar tipping and a marginal increase in anterior face height than the DJ. The removable sagittal/headgear combination is a more hygienic method, but its effectiveness is wholly dependent upon patient cooperation. The bite plane portion of the sagittal appliance assisted in concurrent leveling of the mandibular dentition and removal of occlusal interferences between the 2 dental arches. However, the sagittal/headgear exhibited the greatest amount of maxillary molar tipping and of increase in lower anterior face height.

The following treatment effects were observed: (1) the DJ, GMD, and sagittal/headgear produced nearly equivalent amounts of maxillary molar distalization; (2) the GMD and sagittal/headgear appliances produced significantly more distal tipping (6.5 degrees and 13.5 degrees, respectively) than the DJ (3.1 degrees); (3) there was significant reciprocal loss of mesial anchorage with all 3 distalizing devices (the amount and type of loss was comparable among the 3 appliances); and (4) better control of anterior facial height and molar tipping was found with the DJ.

ACKNOWLEDGMENTS

The authors wish to acknowledge the diligent efforts of Drs Maria E. Gutierrez Vega, Sandra H. Lee, and Edward C. Davis in the scientific contribution to this article as requirements for their degrees of Master of Science in Dentistry at Saint Louis University, Saint Louis, Missouri, USA.

REFERENCES

1. Ferro F, Monsurro A, Perillo L. Sagittal and vertical changes after treatment of Class II Division 1 malocclusion according to the Cetlin method. *Am J Orthod Dentofacial Orthop* 2000;118:150-158.
2. Graber TM. Extra-oral force: Facts and fallacies. *Am J Orthod* 1955;41:490-505.
3. Proffit WR. *Contemporary Orthodontics*, ed 2. St Louis: Mosby, 1993:434-444.
4. Jasper JJ, McNamara JA Jr. The correction of interarch malocclusions using a fixed force module. *Am J Orthod Dentofacial Orthop* 1995;108:641-650.
5. Pancherz H. The Herbst appliance: Its biological effects and clinical use. *Am J Orthod Dentofacial Orthop* 1985;87:1-20.
6. Carano A, Testa M. The distal jet for upper molar distalization. *J Clin Orthod* 1996;30:374-390.
7. Gianelly AA, Vaitas AS, Thomas WM, Berger DG. Distalization of molars with repelling magnets. *J Clin Orthod* 1988;22:40-44.
8. Greenfield RL. Fixed piston appliance for rapid Class II correction. *J Clin Orthod* 1996;29:174-183.
9. Hilgers JJ. The pendulum appliance for Class II non-compliance therapy. *J Clin Orthod* 1992;26:706-714.
10. Jones R, White JM. Rapid Class II molar correction with an open-coil jig. *J Clin Orthod* 1992;26:661-664.
11. Locatelli R, Bednar J, Dietz VS, Gianelly AA. Molar distalization with superelastic NiTi wire. *J Clin Orthod* 1992;26:277-279.
12. Runge ME, Martin JT, Bukai F. Analysis of rapid maxillary molar distal movement without patient cooperation. *Am J Orthod Dentofacial Orthop* 1998;115:153-157.
13. Gianelly AA, Bednar J, Dietz VS. Japanese NiTi coils used to move molars distally. *Am J Orthod Dentofacial Orthop* 1991;99:564-566.
14. Muse DS, Filhnan MJ, Emerson WJ, Mitchell RD. Molar and incisal changes with the Wilson rapid molar distalization. *Am J Orthod Dentofacial Orthop* 1993;104:556-565.
15. Brickman CD, Sinha P, Nanda RS. Evaluation of the Jones jig appliance for distal molar movement. *Am J Orthod Dentofacial Orthop* 2000;118:526-534.
16. Bussick TJ, McNamara JA Jr. Dentoalveolar and skeletal changes associated with the pendulum appliance. *Am J Orthod Dentofacial Orthop* 2000;177:333-343.
17. Byloff FK, Darendeliler MA, Clar E, Darendeliler A. Distal molar movement using the pendulum appliance. Part 2: The effects of maxillary molar root uprighting bends. *Angle Orthod* 1997;67:261-270.
18. Ghosh J, Nanda RS. Evaluation of an intraoral maxillary molar distalization technique. *Am J Orthod Dentofacial Orthop* 1996;110:639-646.
19. Haydar S, Uner O. Comparison of Jones jig molar distalization appliance with extraoral traction. *Am J Orthod Dentofacial Orthop* 2000;117:49-53.
20. Witzig JW, Spahl TJ. The clinical management of basic maxillofacial orthopedic appliances. Vol 1: Mechanics. Littleton, CO: PSG Publishing, 1987:217-277.