ORIGINAL ARTICLE

Evaluation of the Jones jig appliance for distal molar movement

C. David Brickman, DDS, MS,[a] Pramod K. Sinha, DDS, BDS, MS,[b] and Ram S. Nanda, DDS, MS, PhD[c]
Oklahoma City, Okla

The purpose of this study was to determine the effects of the Jones jig appliance on distal movement of maxillary molars and reciprocal effects on premolars and maxillary incisors. Cephalometric radiographs before and after orthodontic treatment of 72 consecutively treated patients, 46 females and 26 males, were measured to define treatment changes attributed to the Jones jig . Comparative measurements were made on a matched sample of 35 patients (20 females and 15 males) treated with cervical headgear by the same clinician. Both series of patients were treated to correct an Angle Class II molar relationship. The molar correction in the Jones jig patients consisted primarily of molar distal movement. Dental, soft tissue, and skeletal changes were evaluated and compared for significant differences between techniques. The results from the Jones jig sample showed the mean maxillary first molar distal movement was 2.51 mm, with distal tipping of 7.53°. The mean reciprocal mesial movement of the maxillary premolar was 2.0 mm, with mesial tipping of 4.76°. The maxillary first molar extruded 0.14 mm; the maxillary premolar extruded 1.88 mm. The maxillary second molars were also moved distally 2.02 mm and tipped distally 7.89°. The longitudinal assessment (initial to completion of orthodontic treatment) showed significant differences between the Jones jig sample and the cervical headgear sample for lower lip to E-line and SNA. The Jones jig sample showed a mean decrease in lower lip to E-line of 0.25 mm versus 1.20 mm ($P < .0212$) for the headgear sample. SNA decreased 0.40° for the Jones jig sample versus 1.20° ($P < .0093$) for the headgear sample. However, the Jones jig sample and cervical headgear sample did not show significant differences of the final position in either linear or angular measurements of the maxillary first molars and corresponding premolar-incisor anchor units. The Jones jig appliance demonstrated treatment results comparable with those of the sample treated with cervical headgear. The Jones jig sample demonstrated effective distal molar movement and maintenance of the Class I molar relationship. Advantages of the Jones jig include minimal dependence on patient compliance, ease of fabrication, and ease of buccal force application. (Am J Orthod Dentofacial Orthop 2000;118:526-34)

Nonextraction treatment plans for Angle Class II malocclusions often require the distal movement of maxillary molars. One common procedure has been to apply an external force via headgear to the maxillary molars.[1-13] However, the use of headgear requires patient compliance to be effective in Class II correction. With heightened awareness of balance and harmony of the facial profile combined with a need to treat patients with marginal space discrepancies, a variety of methods have been proposed to move molars distally with reduced dependence on patient cooperation.

Most of the fixed appliances used to move molars distally require the use of dental and palatal anchorage. The active components of force might be repelling magnets,[14-18] coil springs on a continuous archwire,[19] coil springs on a sectional archwire (distal jet and Jones jig),[20-24] coil springs on a removable appliance,[25] TMA helical springs in a pendulum appliance,[26-28] or super-elastic wires (K-loop).[29]

Anchorage loss during the process of moving maxillary first molars distally is a critical consideration. Reports in the literature have stated that the anchorage loss may range between 25% and 80% with different techniques and appliances. Most of the reports in the literature assessing molar change are based on single case analysis, on small sample sizes with findings based on only a few cephalometric measurements, or on a lack of long-term follow-up.[14-29]

The Jones jig (Fig 1) is an appliance for moving molars distally. Because it is fixed, it requires limited patient cooperation. Despite the apparent clinical success of the Jones jig for the correction of Class II malocclusions, no comprehensive study has been reported to evaluate distal molar movement and loss of anchorage during use of the appliance. Further, no study has evaluated results at the end of orthodontic treatment or compared this method with the use of extraoral force.

The purpose of this clinical study was to determine (1) the amount and type of maxillary molar movement,

From the University of Oklahoma, College of Dentistry, Department of Orthodontics.
[a]Former Graduate Student; currently in private practice, Edwardsville, Ill.
[b]Former Assistant Professor; currently Clinical Professor, St Louis University.
[c]Professor and Chair.
Reprint requests to: Pramod K. Sinha, DDS, BDS, MS, 7924 E Woodland Park Dr, Spokane, WA 99212; e-mail, yerbendr@hotmail.com.
Submitted, August 1999; revised and accepted, March 2000.

0889-5406/2000/$12.00 + 0 **8/1/110332**
doi:10.1067/mod.2000.110332

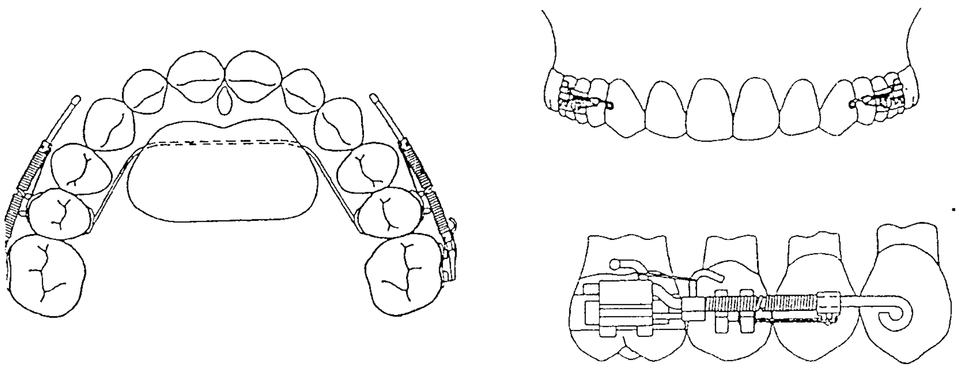

Fig 1. Jones jig appliance.

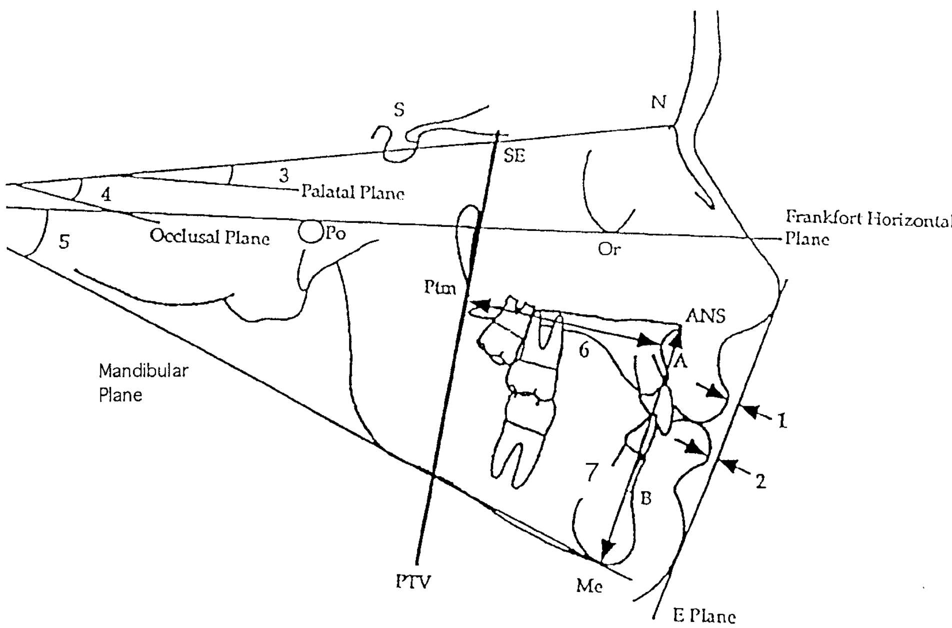

Fig 2. Cephalometric soft tissue and skeletal measurements used in the study: *1*, upper lip to E-plane; *2*, lower lip to E-plane; *3*, SN-palatal plane angle; *4*, SN-anatomic occlusal plane angle; *5*, Frankfort-mandibular plane angle; *6*, PTV to A point; *7*, ANS to menton; *8*, nasolabial angle; *9*, mentolabial angle.

(2) the extent of mesial movement of the maxillary premolars and incisors used as anchorage, (3) the treatment results at the completion of comprehensive care, and (4) the difference in treatment outcomes between patients treated with the Jones jig appliance and patients treated with cervical headgear.

MATERIAL AND METHODS

Cephalometric radiographs were obtained on 72 consecutively treated individuals from one practice. There were 46 females with a mean age of 14 years 1 month ± 4 years 3 months (range, 7 years 9 months to 32 years 1 month) and 26 males with a mean age of 13 years 4 months ± 4 years 3 months (range, 9 years 10 months to 31 years 1 month). All patients met the following criteria:

1. Nonextraction treatment plans.
2. The Jones jig was used as the first phase of orthodontic treatment for distal movement of maxillary molars to correct the Class II molar relationship.

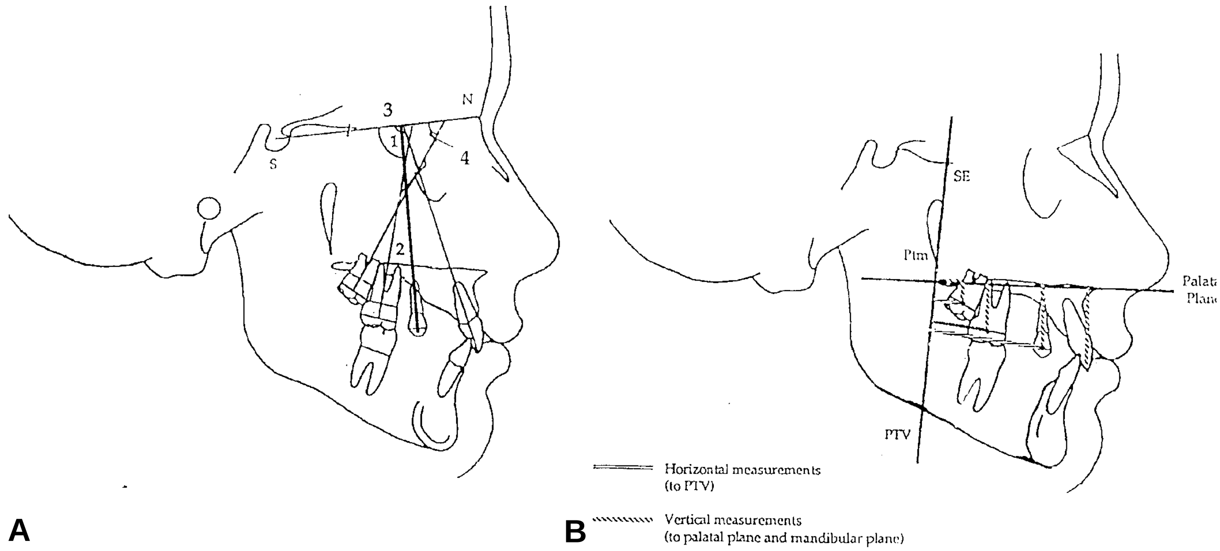

Fig 3. A, Cephalometric dental angular measurements: *1*, SN-maxillary incisor; *2*, SN-maxillary second premolar; *3*, SN-maxillary first molar; *4*, SN-maxillary second molar. **B**, Cephalometric dental linear measurements. Vertical measurements to the maxillary incisor tip and maxillary premolar and molar centroids were made from the palatal plane. Horizontal measurements to the premolar and molar centroids were made from pterygoid vertical (PTV) plane.

3. A history of good oral hygiene and no damage to the appliance.
4. Good quality diagnostic cephalometric radiographs with corresponding good visualization of landmarks taken at the beginning of treatment, immediately after removal of the appliance, and immediately after completion of orthodontic treatment.

The comparison treatment sample consisted of matched nonextraction Class II patients from the same office who were treated with Kloehn headgear and Class II elastics. There were 20 females with a mean age of 12 years 3 months ± 1 year 4 months (range, 10 years 3 months to 15 years 0 months) and 15 males with a mean age of 12 years 3 months ± 1 year 7 months (range, 10 years 1 month to 15 years 5 months). The samples used in this comparison were matched by cephalometric values and hence resulted in 72 patients for the Jones jig sample and 35 patients in the cervical headgear sample.

Cephalometric Analysis

Cephalometric radiographs were obtained on all patients before treatment. Soft tissue and skeletal measurements are shown in Fig 2 and dental measurements are shown in Fig 3. Centroid points were constructed for the crowns of the maxillary first and second molars and premolars as the midpoint between the greatest mesial and distal convexity of the crowns of these teeth as seen on the cephalometric radiograph. Table I shows the measurements made and summary statistics of the Jones jig sample and matched headgear sample before the initiation of orthodontic treatment.

The Jones Jig Appliance

All patients received the Jones jig appliance as described by Jones (personal communication, December 1996) and Jones and White[21] and shown in Fig 4. The palatal button was 0.5 inch in diameter and was anchored to the maxillary second premolars with a 0.036 inch stainless steel wire. After cementation of the modified Nance, one arm of the Jones jig was fit into the 0.045 inch headgear tube and the other arm was fit into the slot of the first molar band. After fitting the Jones jig into the corresponding tube and slot, the appliance was activated by tying the activation loop back with an 0.010 inch ligature off of the anchor tooth bracket.

The appliance uses palatal anchorage and an applied force of 70 to 75 g delivered by a 0.040 inch nickel titanium spring to move the maxillary first molars distally. The coils were reactivated at 4 to 5 week intervals until the desired change in relationship was achieved. When a Class I molar relationship was achieved, the Jones jig was removed and a stopped archwire was placed to maintain the desired molar position.

Twenty-eight patients did not have erupted maxillary second molars past the level of the cementoenamel

Table I. Comparison of Jones jig and headgear samples based on measurements made on pretreatment cephalometric radiographs

	T1 Jones jig	*T1 Headgear*	
Measurement	*Mean*	*Mean*	*P value*
Soft tissue			
Upper lip to E-plane (mm)	–1.92 ± 2.95	–1.32 ± 2.11	.2310
Lower lip to E-plane (mm)	–0.56 ± 3.46	–0.13 ± 2.80	.5221
Nasolabial angle (°)	113.20 ± 9.25	110.80 ± 6.83	.1757
Mentolabial angle (°)	115.87 ± 13.75	119.26 ± 12.17	.2176
Skeletal			
SN-palatal plane angle (°)	7.38 ± 3.09	6.60 ± 2.99	.2186
SN-occlusal plane angle (°)	16.34 ± 4.95	15.80 ± 3.73	.5714
Frankfort-mandibular plane angle (°)	22.28 ± 5.12	22.35 ± 4.70	.9473
PTV-A point (mm)	51.98 ± 2.80	52.79 ± 2.64	.1537
SNA	80.67 ± 3.65	81.13 ± 3.69	.5445
ANS-Menton (mm)	64.29 ± 5.15	63.81 ± 5.73	.6654
Percent lower anterior facial height	56.21 ± 2.14	56.27 ± 2.51	.8854
Dental-angular (°)			
SN-maxillary incisor	103.33 ± 9.54	103.92 ± 8.32	.7556
SN-maxillary premolar	75.01 ± 6.44	76.45 ± 6.67	.2849
SN-maxillary first molar	66.50 ± 5.59	66.42 ± 4.00	.9071
SN-maxillary second molar	55.95 ± 8.40	59.07 ± 6.24	.0540
Dental-linear (mm)			
PTV-maxillary premolar centroid	33.40 ± 3.97	33.95 ± 3.94	.5022
PTV-maxillary first molar centroid	22.12 ± 3.41	22.45 ± 2.69	.6164
PTV-maxillary second molar centroid	12.53 ± 2.82	12.51 ± 2.10	.9738
PP-maxillary incisor tip	27.96 ± 2.72	27.86 ± 2.82	.8588
PP-maxillary premolar centroid	19.29 ± 2.72	18.73 ± 2.42	.3009
PP-maxillary first molar centroid	16.87 ± 2.75	16.54 ± 2.60	.5518
PP-maxillary second molar centroid	10.26 ± 5.11	10.65 ± 4.46	.7025
Overjet	6.07 ± 2.34	6.25 ± 2.41	.7097
Overbite	4.65 ± 2.34	5.03 ± 1.57	.3232

$^*P < .05$; $^{**}P < .01$; $^{***}P < .001$.

junction of the adjacent maxillary first molars. Forty-four patients had erupted maxillary second molars that were neither banded nor bonded with any attachments. The eruption of the maxillary second molars was evaluated to determine whether they affected the amount and type of maxillary first molar movement and premolar/incisor anchorage loss.

A second cephalometric radiograph was taken just after removal of the Jones jig. The mean treatment time from the initial radiograph to the immediate post-Jones jig radiograph was 6.35 months ± 2.75 months. A third radiograph was taken at the completion of all orthodontic treatment. The mean total treatment time from initial radiograph to the posttreatment radiograph was 30.40 months ± 9.53 months. All radiographs were traced on acetate paper with a 0.5 mm pencil by one author and digitized with a COMPLOT series 7000 Digitizer. To determine the error of measurement, 10 radiographs were retraced and digitized. There was no statistically significant tracing error for any of the measurements.

The long axis of the maxillary premolars and molars 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 by changes in the relationship of the long axes of the teeth to the sella-nasion plane (Fig 3 *A*). The amount of horizontal movement of the maxillary premolar and molars was determined by superimposing cephalometric radiographic tracings on the pterygoid vertical plane[30] (DH Enlow, personal communication, December 1996; Fig 3 *B*). Vertical changes were assessed by superimposing on the palatal plane (Fig 3 *B*).

Statistical Analysis

The means and standard deviations of the changes in the various measurements were obtained. The data were imported in a SAS data set and analyzed in the following manner: (1) within-group comparisons of treatment changes at different times were made with paired *t* test, (2) between-group comparisons were completed using individual sample *t* tests, and (3) for groups of 3 or

Fig 4. Initial appliance and effects of appliance on 1 patient.

more, an analysis of variance (ANOVA) was completed followed by a Student-Newman-Keuls procedure.

RESULTS

Changes from Pretreatment to Post-Jones Jig (T1- T2)

The mean, standard deviation, and statistical significance of the cephalometric changes of the soft tissue and skeletal and dental measurements from the start to immediate post-Jones jig are summarized in Table II. The maxillary first molar tipped distally an average of 7.53° ± 4.57°, whereas the maxillary second premolar tipped mesially 4.76° ± 4.74°. The mean distal movement of the maxillary first molar was 2.51 ± 1.35 mm, whereas the mesial movement of the premolar was 2.0 ± 1.99 mm.

Extrusion of the maxillary first molar was not significant, with a mean change of 0.14 mm. The maxillary premolars showed an extrusion of 1.88 ± 1.56 mm. The upper and lower lips protruded during treatment an average of 0.03 mm and 0.68 mm, respectively. Minimal tipping of the palatal, anatomic occlusal, and mandibular planes occurred. Lower anterior facial height (ANS to menton) increased insignificantly, 1.46 ± 1.61 mm.

Pretreatment to Posttreatment Changes in the Jones jig sample (T1-T3)

The mean, standard deviation, and statistical significance of the cephalometric changes of the soft tissue and skeletal and dental measurements from start to completion of orthodontic treatment are summarized in Table II. The maxillary first molar was seen to upright an average of 2.66° ± 4.96°, whereas the maxillary premolar was seen to upright 0.36° ± 5.43°. The mean maxillary first molar mesial movement was 1.58 ± 2.50 mm, whereas mesial movement of the second premolar was 1.57 ± 2.39 mm.

Extrusion of the maxillary first molar was a mean of 1.95 ± 1.86 mm. The maxillary premolars extruded 1.57 ± 2.39 mm. The upper and lower lips retruded during treatment an average of 1.71 mm and 0.17 mm, respectively. Minimal tipping of the palatal and anatomic occlusal plane occurred, whereas the mandibular plane decreased a mean 0.75°. The increase in lower anterior facial height (ANS to menton) was insignificant at 3.23 ± 2.68 mm.

Comparison Between the Jones Jig and Cervical Headgear Samples (T1-T3)

The mean, standard deviation, and statistical significance of the differences of cephalometric changes of soft tissue, skeletal and dental measurements from start to completion of orthodontic treatment for the Jones jig sample and the comparison treatment headgear sample are summarized in Table III. There were no statistically significant differences in the changes of final position of the maxillary first molars, premolars, and incisors between the cervical headgear and Jones jig sample. However, the Jones jig sample finished with a mean 2.11° versus 0.23° increased angulation of the maxillary incisor position relative to SN plane. Compared with the Jones jig, the headgear sample showed the following significant changes: an increased change in lower lip to E line (P = .0212) due to the decrease in the A point measurement of the headgear sample, a decrease in SNA (P = .0093), and a decreased change in maxillary second molar to SN (P = .0001). Overjet and overbite changes were similar and showed no significant differences between the samples (P = .6183).

DISCUSSION

The distal movement of the maxillary first molars into a Class I relationship is a difficult hurdle in the correction of Angle Class II malocclusions without the extraction of teeth. Several methods[14-29] have previously been advocated including the use of extraoral force, Wilson mechanics combined with Class II elastics,[31] and removable appliances.[32] All these treatment modalities require varying degrees of patient compliance. The development of appliances for distal movement of maxillary molars requiring limited patient compliance has included repelling magnets, compressed coil springs, superelastic nickel titanium wires, TMA loops, and the Jones jig appliance.

This clinical retrospective study examined a sample of 72 consecutively treated patients. In the articles reviewed in preparation for this report, we found that studies of molar distal movement have consisted of case reports or included small samples ranging from 8 to 19 patients. Conclusions based on limited sample sizes may not be accurate because of individ-

Table II. Changes in measurements from start to immediate post-Jones jig, and from start to completion of treatment

Measurement	Pretreatment to immediate post-Jones jig (T1-T2)		Pretreatment to completion of treatment (T1-T3)	
	Mean change	*P value*	*Mean change*	*P value*
Soft tissue				
Upper lip to E-plane (mm)	–0.03 ± 1.59	.8014	1.71 ± 1.89	.5704
Lower lip to E–plane (mm)	–0.68 ± 1.66	.9799	0.17 ± 1.89	.5633
Nasolabial angle (°)	2.96 ± 8.08	.5471	0.70 ± 7.49	.2219
Mentolabial angle (°)	1.01 ± 10.91	.2972	–3.83 ± 13.33	.1389
Skeletal				
SN–palatal plane angle (°)	–0.32 ± 1.14	.1594	–0.33 ± 1.28	.0521
SN–occlusal plane angle (°)	1.20 ± 2.56	*.0434	–1.40 ± 3.41	.3857
Frankfort–mandibular plane angle (°)	0.06 ± 1.31	.5342	0.75 ± 1.66	*.0495
PTV–A point (mm)	–0.30 ± 1.12	*.0345	–0.83 ± 1.28	.2213
SNA (°)	–0.21 ± 1.38	.2969	0.57 ± 1.12	.1151
ANS–Menton (mm)	–1.46 ± 1.61	.1870	–3.23 ± 2.68	.1902
Percent lower anterior facial height	–0.23 ± 0.85	.2093	–0.12 ± 1.04	.3634
Dental–angular (°)				
SN–maxillary incisor	–2.40 ± 3.46	.5244	–2.76 ± 7.69	.2016
SN–maxillary premolar	4.76 ± 4.74	***.0010	–0.36 ± 7.69	.1136
SN–maxillary first molar	–7.53 ± 4.57	*.0468	2.66 ± 7.69	.3669
SN–maxillary second molar	–7.89 ± 7.02	.5032	4.75 ± 7.69	.8266
Dental–linear (mm)				
PTV–maxillary premolar centroid	–2.00 ± 1.99	**.0004	–1.57 ± 2.39	.2997
PTV–maxillary first molar centroid	2.51 ± 1.35	**.0055	–1.58 ± 2.50	.2319
PTV–maxillary second molar centroid	2.02 ± 1.44	* .0331	–1.25 ± 2.35	.9300
PP–maxillary incisor tip	–0.14 ± 0.87	.3878	–1.51 ± 1.74	.9037
PP–maxillary premolar centroid	–1.88 ± 1.56	.2968	–1.89 ± 1.79	.6245
PP–maxillary first molar centroid	–0.14 ± 1.39	.9374	–1.95 ± 1.86	.5213
PP–maxillary second molar centroid	–0.43 ± 1.92	*.0437	–4.75 ± 3.70	.0635
Overjet	–0.45 ± 1.95	.2299	1.60 ± 2.46	**.0173
Overbite	1.28 ± 1.54	.7983	2.28 ± 2.03	.1649

$^*P < .05$; $^{**}P < .01$; $^{***}P < .001$.

ual variability that can skew the data. The results of this study indicate that the Jones jig sample showed changes similar to the headgear sample from pretreatment to posttreatment.

Distal Movement of Maxillary Molars in Class II Nonextraction Treatment

The major premise of nonextraction treatment of Class II patients with average to low FMA involves either moving the molar maxillary first molars distally or restricting the growth and mesial migration of the mandibular first molars. The Jones jig acts specifically to move the maxillary first molars into a Class I molar relationship. The maxillary first molars were observed to move distally a mean of 2.51 mm. This change was similar to that reported in studies examining molar movement via the Herbst appliance,[33-35] Wilson mechanics,[31] repelling magnets,[14-18] and the pendulum appliance.[28] The vertical change in molar relationship was insignificant. The maxillary first molars tipped distally an average 7.53°.

There was a statistically significant correlation between the amount of change in molar position and the amount of maxillary first molar tipping (r = .5495). Posterior teeth that have tipped distally are of limited use for retraction of the anterior segment; therefore the molar position should be maintained with either a Nance holding arch appliance, utility archwire, or stopped archwire, while the premolars drift distally due to the pull of transseptal fibers. Short Class II elastics may also be used to move the premolar incisor segment distally.

The maxillary second molar teeth were moved distally a mean 1.79 mm, tipped 8.03°, and extruded 0.71 mm. There was a statistically significant correlation between the amount of distal movement and the amount of maxillary second molar tipping (r = .5045, P < .0001). The greater extrusion of the maxillary second molars can probably be attributed to the

Table III. Comparison of measurements from pretreatment to completion of orthodontic treatment for Jones jig and headgear samples

Measurement	*Jones jig (T1–T3)* *Mean*	*Headgear (T1-T3)* *Mean*	*Jones jig vs headgear* *P value*
Soft tissue			
Upper lip to E–plane (mm)	1.74 ± 2.00	2.62 ± 2.22	.0573
Lower lip to E–plane (mm)	0.25 ± 2.09	1.20 ± 1.78	*.0212
Nasolabial angle (°)	0.36 ± 7.53	1.15 ± 7.73	.6268
Mentolabial angle (°)	–2.13 ± 12.57	–2.37 ± 12.47	.9284
Skeletal			
SN–palatal plane angle (°)	–0.56 ± 1.36	–1.15 ± 3.03	.0746
SN–occlusal plane angle (°)	–1.51 ± 3.49	–0.03 ± 3.16	*.0377
Frankfort–mandibular plane angle (°)	0.51 ± 1.65	0.26 ± 1.85	.5170
PTV–A point (mm)	–0.99 ± 1.35	–0.86 ± 1.77	.7244
SNA (°)	0.40 ± 1.31	1.28 ± 1.65	**.0093
ANS–Menton (mm)	–3.56 ± 2.59	–4.27 ± 2.94	.2358
Percent lower anterior facial height	–0.16 ± 1.04	–0.16 ± 0.88	.9974
Dental–angular (°)			
SN–maxillary incisor	–2.11 ± 7.67	0.23 ± 7.75	.1578
SN–maxillary premolar	–0.86 ± 5.26	–0.83 ± 4.59	.9727
SN–maxillary first molar	3.08 ± 4.59	3.12 ± 3.94	.9601
SN–maxillary second molar	4.79 ± 6.17	–0.36 ± 5.83	***.0001
Dental–linear (mm)			
PTV–maxillary premolar centroid	–1.50 ± 2.35	–0.63 ± 2.78	.1255
PTV–maxillary first molar centroid	–1.89 ± 2.37	–1.43 ± 2.25	.3413
PTV–maxillary second molar centroid	–1.29 ± 2.15	–0.99 ± 2.18	.5290
PP–maxillary incisor tip	–1.59 ± 1.57	–1.10 ± 1.31	.1043
PP–maxillary premolar centroid	–1.92 ± 1.67	–2.71 ± 2.14	.0658
PP–maxillary first molar centroid	–2.00 ± 1.77	–2.86 ± 2.31	.0600
PP–maxillary second molar centroid	–5.53 ± 3.75	–5.10 ± 4.04	.6078
Overjet	1.98 ± 2.50	2.83 ± 2.76	.1376
Overbite	2.42 ± 1.95	2.24 ± 1.58	.6183

*P < .05; **P < .01; ***P < .001.

difference in stage of eruption between the maxillary first and second molars.

Anchorage Loss During Class II Nonextraction Treatment

The use of force to move the maxillary first molars distally has a corresponding reciprocal force that must be effectively resisted in order to maintain the maxillary molars in the desired Class I relationship. However, often the premolar-incisor segment cannot fully resist the reciprocal force and is subsequently moved mesially. The aim of all intraoral nonextraction Class II treatment modalities is to correct the malocclusion with minimal adverse effects. Many of the current nonextraction Class II treatment modalities produce adverse effects on lower incisor position during correction of the molar relationship. These include treatment with Class II elastics, Wilson mechanics, and the Herbst appliance. An alternative treatment plan to consider is to move the maxillary first molars distally with intramaxillary mechanics with as minimal a force as necessary. The Jones jig appliance utilized a 75 g nickel titanium distalization spring and friction-free mechanics to effectively distalize maxillary molars with minimum side effects.

Loss of anchorage was measured at the maxillary premolars and central incisors. The anchor unit consisted of a modified Nance holding arch attached to the premolars with acrylic button coverage the size of a quarter in the depth of the palate. The anchor unit was unable to completely resist the reciprocal mesial force of the Jones jig appliance. The maxillary premolar was moved mesially 2.0 mm, tipped mesially 4.76°, and extruded 1.88 mm. There was a statistically significant correlation between the amount of mesial tooth movement and the amount of maxillary premolar tipping (r = 0.6277, P < .0001). There was also a statistically significant correlation between the amount of maxillary first molar distal movement and maxillary premolar mesial movement (r = 0.5634, P < .0001). The maxillary second premolar-anchorage tooth movements were similar to findings when analyzing the pendulum appliance.[28]

The overjet increased 0.45 mm and the overbite decreased 1.28 mm during molar correction with the Jones jig. Overjet was statistically correlated with the mesial change of the maxillary premolar ($r = 0.3530$, $P < .01$)) and incisor proclination ($r = 0.5917$, $P < .0001$). The overjet increase was less than the 1.30-mm increase seen with the pendulum appliance,[28] and the 1.60-mm and 1.20-mm increases seen with repelling magnets.[17,18]

The maxillary central incisor was proclined an average of 2.21° relative to the SN line during Jones jig activation. This was less than the 6° of labial proclination reported by Bondemark and Kurol[17] but similar to the labial tipping of 3.8° reported by Itoh et al[18] with repelling magnets and the 2.40° of labial tipping reported by Ghosh and Nanda[28] with the pendulum appliance.

The overjet increase and incisor flaring seen with the Jones jig appliance is not as severe as that seen with other noncompliant appliances designed to move molars distally. Clinically, this reduces the loss of anchorage during the recovery of the extra 1 mm of overjet increase associated with other techniques. It is well known that mesial tipping of the maxillary premolars will self-correct or upright with the placement of full orthodontic appliances. To reinforce anchorage with any of the molar distalization techniques, it might be advantageous to use J-hook headgear or Class II elastics attached to anterior teeth to help maintain anchorage control.

Jones Jig Treatment Versus Cervical Headgear and Class II Elastic Treatment

The Jones jig sample showed no statistically significant differences from the matched headgear sample when maxillary first molar, maxillary central incisor angulation, and linear position were evaluated. Overjet and overbite were not significantly different between the 2 groups. Hence, treatment with the Jones jig offers the practitioner a nonextraction treatment modality for Class II malocclusion that minimizes patient compliance yet delivers final results consistent with known treatment modalities, including cervical headgear.

Longitudinal Evaluation of Jones Jig Patients

The amount of molar extrusion was not beyond what would be expected during the normal period of growth when compared with untreated Class I controls.[36] The males in the Jones jig sample showed a mean 3.17 ± 1.79 mm of extrusion and females showed 1.33 ± 1.38 mm of extrusion during the total treatment time. The males in an untreated Class I sample showed 4.1 ± 3.1 mm of extrusion and the females showed a 1.9 ± 2.2 mm of extrusion over the same amount of time.[36] Several studies[3,7] have noted extrusion of the maxillary permanent molars above and beyond normal growth when using cervical headgear treatment.

The maxillary first molar was seen to move mesially 1.58 mm from initial radiograph to completion of orthodontic treatment radiograph. This change was similar to that seen in untreated Class I patients over the same time period.[36]

The upper incisors as well as the premolars, which were initially proclined and mesially tipped, had reverted to their original pretreatment positions when evaluated longitudinally. The maxillary first and second molars were also seen to upright after longitudinal assessment. The Jones jig corrected the Class II molar relationship to a Class I molar relationship that was subsequently maintained during the course of growth.

CONCLUSIONS

1. The Jones jig appliance can effectively achieve distal movement of the maxillary first molars.
2. A Class I molar relationship can be maintained if proper anchorage and anterior retraction mechanics are used.
3. Full palatal coverage combined with the use of short Class II elastics to reinforce posterior anchorage could possibly minimize the reciprocal anchorage loss of the molar anchor units.
4. The Jones jig appliance offers a viable clinical option for dental correction of a Class II malocclusion for noncompliant patients.
5. The degree of variability of the changes is high, a factor that should be included when considering treatment options.

REFERENCES

1. Graber TM. Extraoral force-facts and fallacies. Am J Orthod 1955;41:490-505.
2. Gould E. Mechanical principles in extraoral anchorage. Am J Orthod 1857;17:319-33.
3. Klein PL. An evaluation of cervical traction on the maxilla and the upper first permanent molar. Angle Orthod 1957;27:61-8.
4. Newcomb MR. Some observations on extraoral treatment. Angle Orthod 1958;28:131-48.
5. Kloehn SJ. Evaluation of cervical anchorage force in treatment. Angle Orthod 1961;31:91-104.
6. Wieslander L. The effect of orthodontic treatment on the concurrent development of the craniofacial complex. Am J Orthod 1963;49:15-27.
7. Wieslander L, Buck DL. Physiologic recovery after cervical traction therapy. Am J Orthod 1974;66:294-301.
8. Greenspan RA. Reference charts for the controlled extraoral force application to the maxillary molars. Am J Orthod 1970;58:486-91.
9. Holland GN, Wallace DA, Mordino BJ, Cole SH, Ryan SJ. Severe ocular injuries from orthodontic headgear. J Clin Orthod 1985;19:819-25.
10. Cangialosi TJ, Meistrell ME, Leung MA, Ko JY. A cephalometric appraisal of edgewise Class II nonextraction treatment with extraoral force. Am J Orthod 1988;93:315-24.

11. Hubbard GW. An evaluation of nonextraction cervical headgear treatment in Class II malocclusions [master's thesis]. University of Oklahoma Department of Orthodontics, 1992.
12. Hubbard GW, Nanda RS, Currier GF. A cephalometric evaluation of nonextraction cervical headgear treatment in Class II malocclusions 1994;64:359-70.
13. Tullouch JFC, Phillips C, Proffit WR. The effect of early intervention on skeletal pattern in Class II malocclusion: a randomized clinical trial. Am J Orthod 1997;111:391-400.
14. Blechman AM. Magnetic force systems in orthodontics. Am J Orthod 1985;87:201-10.
15. Gianelly AA, Vaitas AS, Thomas WM, Berger DG. Distalization of molars with repelling magnets. J Clin Orthod 1988;22:40-4.
16. Gianelly AA, Vaitas AS, Thomas WM. The use of magnets to move molars distally. Am J Orthod 1989;96:161-7.
17. Bondemark L, Kurol J. Distalization of maxillary first and second molars simultaneously with repelling magnets. Eur J Orthod. 1992;14:264-72.
18. Itoh T, Tokuda T, Kiyosue S, Hirose T, Matsumoto M, Chaconas SP. Molar distalization with repelling magnets. J Clin Orthod 1991;25:611-7.
19. Gianelly AA, Bednar J, Dietz VS. Japanese NiTi coils used to move molars distally. Am J Orthod 1991;99:564-6.
20. Locatelli R, Bednar J, Dietz VS, Gianelly AA. Molar distalization with superelastic NiTi wire. J Clin Orthod 1992;26:277-9.
21. Jones RD, White JM. Rapid Class II molar correction with an open-coil jig. J Clin Orthod 1992;26:661-4.
22. Carano A, Testa M. The distal jet for upper molar distalization. J Clin Orthod 1996;30:374-80.
23. Gulati S, Kharbanda OP, Prakash H. Dental and skeletal changes after intraoral molar distalization with sectional jig assembly. Am J Orthod Dentofacial Orthop 1998;114:319-27.
24. Runge ME, Martin JT, Bukai F. Analysis of rapid molar distal movement without patient cooperation. Am J Orthod Dentofacial Orthop 1999;115:153-7.
25. Jeckel N, Rakosi T. Molar distalization by intra-oral force application. Eur J Orthod 1991;13:43-6.
26. Hilgers JJ. A palatal expansion appliance for non-compliance therapy. J Clin Orthod 1991;25:491-7.
27. Hilgers JJ. The pendulum appliance for Class II non-compliance therapy. J Clin Orthod 1992;26:706-14.
28. Ghosh J, Nanda RS. Evaluation of an intraoral maxillary molar distalization technique. Am J Orthod 1996;110:639-46.
29. Kalra V. The K-loop molar distalizing appliance. J Clin Orthod 1995;29:298-301.
30. Enlow DH, Moyers RE, Hunter WS, McNamara JA. A procedure for the analysis of intrinsic facial form and growth. Am J Orthod 1969;56:6-23.
31. Muse DS, Fillman MJ, Emmerson WJ, Mitchell RD. Molar and incisor changes with the Wilson rapid molar distalization. Am J Orthod 1993;104:556-65.
32. Cetlin NM, Ten Hoeve A. Nonextraction treatment. J Clin Orthod. 1983;17:396-413.
33. Pancherz H. Treatment of Class II malocclusions by jumping the bite with the Herbst appliance: a cephalometric investigation. Am J Orthod 1979;76:423-42.
34. Pancherz H, Anehaus-Pancherz M. The headgear effect of the Herbst appliance: a cephalometric long-term study. Am J Orthod 1993;103:510-20.
35. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment: a cephalometric investigation. Am J Orthod 1982;82:104-13.
36. Riolo ML, Moyers RE, McNamara JA, Hunter WS. An atlas of craniofacial growth. Cephalometric Standards from the University School Growth Study, The University of Michigan, 1974.