Quantitative evaluation of craniofacial changes with Jasper Jumper therapy

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The Jasper Jumper is a relatively new tooth-borne functional appliance. The appliance is flexible and can be attached between the maxillary and mandibular arches to produce rapid interarch changes through the application of either "headgear-like" forces, "activator-like" forces, or a combination of both.[1]

Jasper Jumper therapy has been prescribed for Class II patients with deep bites – it can be used with either extraction or nonextraction therapy.[1,2] The hypothesized mechanisms of Class II correction with the Jasper Jumper include: basal restraint of the maxilla, dento-alveolar retraction of the maxillary dentition, dento-alveolar protraction of the mandibular dentition, increased growth at the mandibular condyle, downward/forward glenoid fossa remodeling, and lateral expansion of the maxillary molars.[3]

In terms of appliance design and force vectors, the Jasper Jumper is most similar to the Herbst appliance.[3] Both appliances:

1. Use pushing mechanics with intrusive force vectors as side effects, which are beneficial since intrusion of lower incisors is usually necessary during the correction of Class II malocclusions.[1] The upward pressure on the maxillary molars minimizes extrusion due to treatment mechanics or habits that interfere with normal breathing and

Abstract

Although the Jasper Jumper is becoming a widely accepted orthodontic appliance, no quantitative guidelines exist for therapy. The purpose of this investigation was to describe the orthopedic and orthodontic changes associated with Jasper Jumper therapy. A sample of 31 consecutively treated Class II patients was collected from three orthodontic practitioners who were using the same procedures and methods. Lateral cephalograms were taken immediately before appliance placement and immediately after appliance removal (mean interval of 0.4 years). The sample was case matched to untreated controls based on age, sex, and mandibular plane angle. The cephalograms were superimposed using anterior cranial base, maxillary, and mandibular reference structures to distinguish between growth/displacement and tooth movement. The results show that the majority of Class II correction was due to dental, rather than skeletal change. The maxilla underwent significant posterior displacement. The maxillary incisors retroclined and the maxillary molars tipped distally. Clockwise or backwards rotation was evident for the mandible. The mandibular incisors proclined significantly and the mandibular molars translated and tipped mesially.

Jasper Jumper therapy is a valuable procedure for the correction of Class II dental malocclusions. Like all other treatment modalities, there are both indications and contraindications for its use.

Key Words

Jasper Jumper • Functional appliance • Cephalometrics • Class II malocclusion

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Figure 1
The Jasper Jumper appliance

Figure 2
Cephalometric landmarks

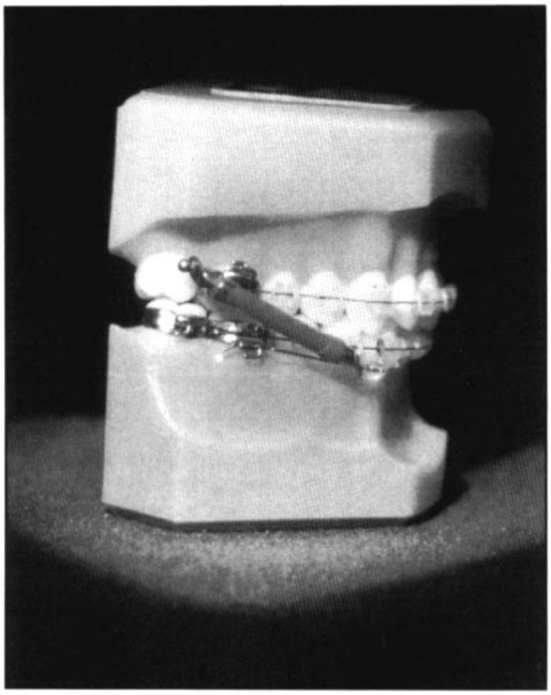

Figure 1

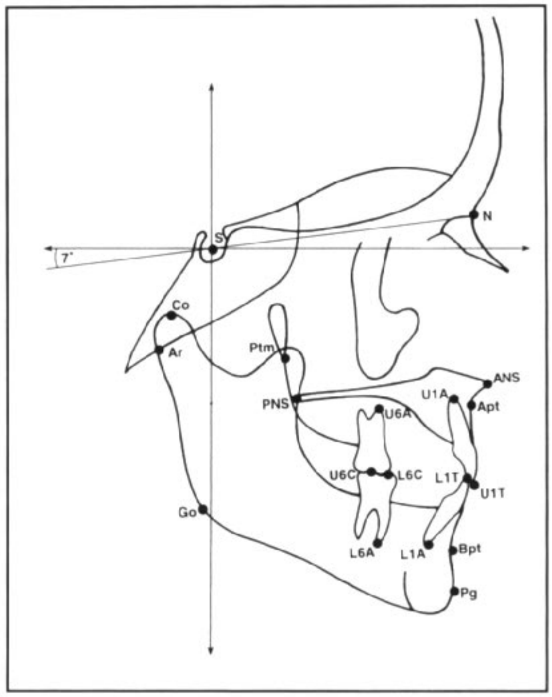

Figure 2

tongue posture.[1,4] Intrusive forces also tend to be expansive.[1,4]

2. Minimize the need for patient compliance.[1,3-7]

3. Produce forces that tend to parallel the normal downward and forward growth vector of the face.[1,3-4]

4. Provide a continuous force 24 hours a day.[1,3-7]

Herbst therapy results in both skeletal and dental changes. The skeletal changes include: restrained anteroposterior maxillary growth,[5-7,9] enhanced mandibular growth,[5-7,9-11] remodeling of the anterior glenoid fossa,[11] and proliferation of the posterior aspect of the fibrous articular disc.[11] The dental changes associated with Herbst therapy include: lateral expansion of maxillary molars,[9] distalization of maxillary molars leading to increased maxillary arch length,[5,9-10] and slight proclination of mandibular incisors.[5,9-10]

The literature pertaining to Jasper Jumpers is restricted to their application. Blackwood[4] described different methods of fixing the appliance intraorally, the clinical management of cases, sources of variation, and modifications that need to be considered to optimize treatment. Cash[2] presented a case where nonextraction Jasper Jumper therapy was selected over surgery in the treatment of an adult with an anterior openbite and Class II malocclusion. Rankin[8] abstracted clinically significant changes of both skeletal and dental components (40% and 60%, respectively) using the appliance. He noted that, compared with controls, mandibular length and lower facial height had significantly higher growth increments in patients treated with the Jasper Jumper. Most of the of Class II correction was obtained from mesial movement of the mandibular molars.

Despite favorable clinical reports regarding Class II corrections with Jasper Jumper therapy, no studies presently exist which evaluate the hypothesized effects[3] or provide quantitative guidelines for the clinical application of the appliance. It is particularly important to isolate those changes associated directly with Jasper Jumper therapy, thereby eliminating other sources of variation (i.e. leveling and finishing).

Materials and methods

The basic design of the Jasper Jumper used in this study (Figure 1) was an open-coil spring inside a plastic sleeve with metal off-set plates on either end. It was fixed between the maxillary and mandibular arches, such that when activated, the appliance bowed away from the occlusal plane to deliver a bilateral force of 250-300 grams, pushing the maxilla and mandible apart. The appliance was reactivated approximately every 5 weeks.

The Jasper Jumper was attached to the maxillary arch with a ball-pin attachment through the maxillary first molar band's headgear tube. It was attached to the mandibular arch using a .017" x .025" stainless steel sectional archwire with a ball stop.[4] The distal end (which has an out-set bayonette bend just mesial to the mandibular first molar band's auxiliary tube) of the sectional archwire was inserted into the auxiliary tube of the mandibular first molar band. The mesial end was looped over the main archwire just distal to the mandibular canine bracket with enough separation for the Jasper Jumper to avoid occlusal interference and to clear the premolar brackets as it slides along the sectional wire. Blackwood's method[4] has the added advantage of leaving the premolars bracketed during the Jasper Jumper phase of treatment, which prevents overeruption of the premolars and adds stability to the arch as one unit. Treatment was discontinued once an acceptable molar relationship was attained.

Jasper Jumper therapy was evaluated for consecutively treated cases from the private practices of three established orthodontists. The patients were chosen based on four criteria:

1) Class II dental and skeletal malocclusions;
2) Adolescents with growth potential;
3) The same intraoral fixation procedure had to have been used on all subjects and;
4) Cephalograms had to have been taken immediately before Jasper Jumper placement and immediately after removal.

The sample included 12 boys and 19 girls. All patients were treated with a normal edgewise protocol, including an initial leveling phase lasting 6-9 months, a Jasper Jumper phase of 3-7 months, and a finishing/detailing phase of 6-9 months. The mean age of the sample at the start of Jasper Jumper therapy was 12.9 years; treatment lasted an average of 0.4 years.

A control group of 31 untreated, nonorthodontic subjects collected by the Human Growth Research Center at the University of Montreal,[12] was case-matched to the Jasper Jumper group based on age, sex, and mandibular plane angulation. While some size differences might exist between the Jasper Jumper and control groups, the comparison was based on rates of change for which less difference might be anticipated.

The pretreatment (T1) and posttreatment (T2) lateral cephalograms were randomly traced onto matte acetate by one examiner. Where right and left structures were identified, the midline of the two was used. Using stable anatomic reference structures,[13,14] the two tracings were superimposed to distinguish growth/displacement from dental movements. The anterior cranial base and cranial structures were superimposed to evaluate the total changes that occurred during Jasper Jumper therapy. The maxilla and mandible were superimposed to assess the "pure" movements of the incisors and molars. By subtracting the dental changes from the total changes, the changes due to growth/displacement were estimated. The superimpositions provide the only means by which the total observed change can be broken down into its component parts.

Table 1
Random Method Errors (mm) of the 17 Cephalometric Landmarks

Landmark	Abbreviation	Method Error Horizontal	Method Error Vertical
Anterior Nasal Spine	ANS	0.61	0.58
A Point	Apt	0.54	0.71
Posterior Nasal Spine	PNS	0.52	0.34
Pterygomaxillare	Ptm	0.40	0.48
B-Point	Bpt	0.63	0.54
Pogonion	Pg	0.85	0.64
Gonion	Go	0.57	0.43
Articulare	Ar	0.32	0.46
Condylion	Co	0.60	0.45
Upper Incisor Tip	U1T	0.62	0.42
Upper Incisor Apex	U1A	0.65	0.50
Upper Molar Cusp	U6C	0.62	0.36
Upper Molar Apex	U6A	0.11	0.36
Lower Incisor Tip	L1T	0.64	0.49
Lower Incisor Apex	L1A	0.73	0.57
Lower Molar Cusp	L6C	0.66	0.40
Lower Molar Apex	L6A	0.65	0.42

A total of 19 hard-tissue landmarks (Figure 2) were identified based on established definitions.[15] Following superimpositioning, the sella-nasion minus 7° (SN-7°) reference axis was transferred from the T_1 to the T_2 tracing. Using sella for registration, horizontal changes of the landmarks were measured parallel to SN-7°; vertical changes were measured from sella perpendicular to SN-7°. Positive values represent downward or forward movement; negative values represent upward or backward movement.

Each cephalogram was traced twice, superimposed twice and two sets of landmarks were identified for each subject. To reduce technical error, the average of the two measurements of each landmark was used. Replicate analyses showed no significant systematic differences. Method errors[16] ranged between 0.11 mm and 0.85 mm (Table 1).

Annual rates of change were calculated by $(X_2-X_1)/(A_2-A_1)$, where X and A refer to the measure and exact age in years, respectively at T_1 and T_2. Annualization of rates was necessary to standardize durations for the treated and untreated samples. Since the duration of treatment was substantially less than one year, it must be emphasized that annualization will inflate the degree treatment response. To determine the type of statistical procedures to be used (parametric versus nonparametric) for describing and comparing the measures, the skewness and kurtosis statistics of each distribution were evaluated. Of the 100

Table 2
Annual Changes (mm/yr) of the Skeletal Landmarks

Measure	Jasper Jumper Mean	Jasper Jumper S.D.	Controls Mean	Controls S.D.	Group Comparisons T-Value	Group Comparisons Prob
Horizontal Changes						
Maxillary						
ANS	-0.91[1]	-3.33, 1.20	0.71	1.68	290.50[2]	0.008
Apt	-0.60	3.23	0.20	1.65	-2.49	0.017
PNS	-0.96	4.10	-0.51	1.21	-0.44	0.664
Ptm	-0.60	2.36	-0.30[1]	-0.93, 0.50	392.50[2]	0.215
Mandibular						
Bpt	-0.35	4.32	0.10	1.75	-1.45	0.156
Pg	-1.57	4.89	0.30	1.98	-1.71	0.095
Go	-2.00	3.73	-0.95	1.29	-1.45	0.156
Co	1.71[1]	-2.50, 4.00	-0.51	1.24	311.00[2]	0.017
Ar	-1.33	2.91	-0.61	1.03	-0.20	0.844
Vertical Changes						
Maxillary						
ANS	1.00	-0.83, 3.69	0.90	0.99	463.50[2]	0.811
Apt	2.91	6.03	1.09	2.13	1.56	0.126
PNS	0.80[1]	-1.97, 2.56	0.69	1.03	469.50[2]	0.876
Ptm	0.91[1]	-1.22, 4.56	0.72	0.97	474.00[2]	0.927
Mandibular						
Bpt	3.80	7.70	1.39	2.24	0.84	0.409
Pg	2.38[1]	0.08, 4.66	1.43	1.72	394.00[2]	0.223
Go	0.69	3.47	1.31	1.66	-0.85	0.398
Co	-0.59	5.21	-0.10	1.44	-1.12	0.268
Ar	-0.12[1]	-1.74, 2.40	0.10	0.85	455.50[2]	0.725

[1]Median and interquartile range for descriptive statistics
[2]Mann-Whitney U. for group comparison

distributions evaluated, 32 demonstrated significant departures from normality. Consequently, central tendencies were described with means or medians; dispersion was described with standard deviation or interquartile ranges. Student's t-test or Mann-Whitney U was used to compare the control and Jasper Jumper (JJ) groups.

Results

Table 2 describes the yearly changes of the skeletal landmarks. There were significant group differences for the horizontal changes of the two anterior maxillary landmarks (ANS and Apt). The control group demonstrated anterior movement for these landmarks whereas the JJ group showed posterior displacement. The posterior maxillary landmarks (PNS and Ptm) also displayed greater posterior movements for the JJ than control sample, but the differences were not statistically significant.

The mandibular corpus (Bpt, Pg, and Go) consistently showed posterior displacement for the JJ group. In contrast, Bpt and Pg of the control group, remained relatively stable, while Go showed a slight posterior displacement. Due to the between-subject variability of the JJ group, differences for these measurements closely approached but did not attain significance levels. Interestingly, the condyle displayed a significant group difference, with forward movement for the JJ group and backward movement for the control group.

Vertical changes of the four maxillary landmarks were similar for the two groups. The mandibular changes suggest a clockwise or backwards rotation of the JJ group. The anterior corpus (Bpt and Pg) showed considerably more downward movement than Go. The corpus of the control group followed a more parallel descent. Again, group differences approached, but did not attain statistical significance.

The maxillary incisal tip of the JJ group moved distally 5.7 mm/yr, with dental movement through

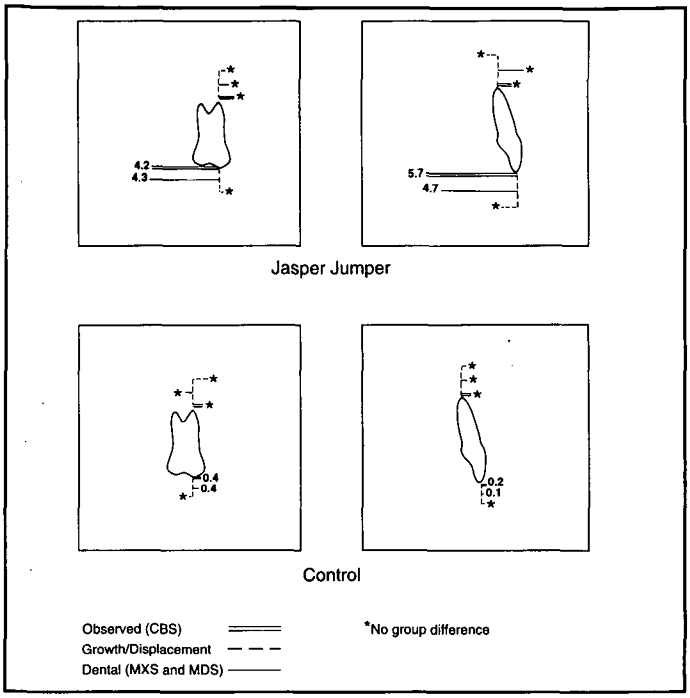

Figure 3

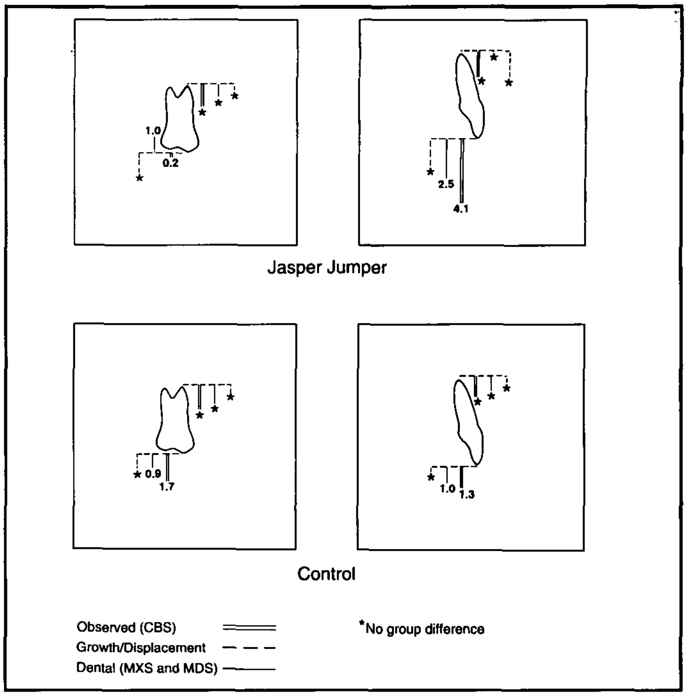

Figure 4

Figure 3
Horizontal changes of maxillary dentition (mm/yr)

Figure 4
Vertical changes of mandibular dentition (mm/yr)

Table 3
Annual Changes (mm/yr) of the Maxillary Incisors and Molars

Measure		Jasper Jumper Mean	Jasper Jumper S.D.	Controls Mean	Controls S.D.	Group Comparisons T-Value	Group Comparisons Prob
Horizontal Changes							
U1T	Total	-5.71	4.60	0.20	1.67	-8.05	<0.000
	Dental	-4.70	5.08	0.10	1.48	-6.64	<0.000
U1A	Total	0.86	3.17	0.50	1.63	-0.15	0.883
	Dental	1.55	4.58	0.30	1.14	-0.55	0.584
U6C	Total	-4.20[1]	-6.07, -1.40	0.40[1]	-0.11, 1.80	114.00[2]	<0.001
	Dental	-4.33[1]	-7.02, -1.21	0.42[1]	-0.78, 1.43	118.00[2]	<0.001
U6A	Total	0.90	3.25	0.57	1.79	0.93	0.356
	Dental	0.61	4.21	-0.40	1.71	0.87	0.390
Vertical Changes							
U1T	Total	4.14[1]	1.91, 6.79	1.31[1]	0.69, 1.94	204.00[2]	<0.001
	Dental	2.50[1]	1.36, 4.78	1.03[1]	0.20, 1.98	194.00[2]	<0.001
U1A	Total	1.29[1]	-2.00, 3.71	1.24[1]	0.83, 1.92	441.50[2]	0.583
	Dental	0.00[1]	-1.67, 2.30	0.81[1]	0.10, 1.82	379.50[2]	0.155
U6C	Total	0.17[1]	-2.83, 1.49	1.70[1]	0.59, 1.96	258.00[2]	0.002
	Dental	-1.00[1]	-2.77, 0.48	0.89[1]	0.00, 1.62	219.50[2]	<0.001
U6A	Total	1.21[1]	-0.65, 2.87	1.60[1]	0.93, 1.92	462.00[2]	0.795
	Dental	0.78[1]	-1.20, 1.55	1.10[1]	-0.21, 1.52	411.00[2]	0.328

[1]Median and interquartile range for descriptive statistics
[2]Mann-Whitney U. for group comparison

bone accounting for 4.7 mm. Growth or displacement accounted for the remainder (Table 3, Figure 3). The JJ group also showed significant posterior movement of the molar cusp, while the control group demonstrated little or no change. There were no group differences for movements of the incisor apex or molar apex. Importantly, the group differences observed were almost entirely due to dental movements associated with the JJ. There were no group differences in growth.

Group differences in vertical movement of the maxillary teeth were significant for the incisor tip and molar cusp only (Table 3, Figure 4). The incisor of the JJ group displayed more downward movement than expected. The downward growth of the JJ molar was counteracted by upward dental movement, resulting in little or no observed changes.

Jasper Jumper therapy had opposite and greater effects on the mandibular teeth. The mandibular incisors in the JJ group showed uncontrolled forward tipping; the tip moved forward and the apex moved backward (Table 4, Figure 5). There was also significant forward tipping of the molar of the JJ group. Both the molar apex and cusp demonstrated greater anterior movement than observed for the controls. The incisors and molars of the JJ group showed more anterior dental movement than total movement, which may be attributed to clockwise mandibular rotation.

Group differences in vertical movements of the lower teeth were most pronounced for the incisor tip and apex (Table 4, Figure 6). Whereas the control group showed superior dental eruption, the JJ group displayed a large amount of inferior movement. Finally, the molar apex of the JJ group showed significantly more superior dental movement than expected from normal eruption.

Discussion

The results identify significant treatment effects of Jasper Jumper therapy. It is clear that the primary effects are due to dental rather than skeletal changes. Most of the observed changes might be expected from biomechanical considerations.

The Jasper Jumper not only holds, but actually displaces the maxilla backward; the anterior maxillary skeletal landmarks moved posteriorly and the posterior landmarks showed more than expected posterior movement. On that basis, we might expect SNA angle to decrease, which would compare favorably with previous reports of cervical traction,[17] the Herbst[5-7,9] and the activator appliance.[20]

Vertical changes of the four maxillary skeletal landmarks are remarkably similar for the two groups. There is no indication of maxillary rotation with the Jasper Jumpers as was previously reported with cervical traction.[17] The larger vertical drop for A point of the Jasper Jumper group may be related to the retroclination the maxillary incisors. McNamara[10] reported a similar treatment effect with Herbst therapy.

The Jasper Jumper has little or no orthopedic effect on horizontal mandibular growth. In this regard, it differs from the Herbst[5-7,9-11] and Fränkel[19] appliances which have been reported to stimulate mandibular growth. The Jasper Jumper does tend to rotate the mandible; the symphyseal landmarks moved downward and backward and condylion moved forward, suggesting backward rotation around a center between articulare and condylion. Backward, or clockwise rotation of the mandible has also been reported for other functional appliances.[17-18]

The maxillary dentition of the JJ group was tied together as a unit. Both the molars and incisors displayed controlled posterior tipping around their apices. This indicates that the line of force application of the JJ is below and behind the unit's center of resistance. The posterior tipping of the JJ molar cusp is similar in direction, but of greater magnitude than found with the Herbst[9-10,23] and cervical traction,[18] which ranged between -1.4 mm to -2.6 mm. The maxillary incisor tip also showed approximately -5.4° of posterior tipping. Again, this is similar in direction, but of greater magnitude than the posterior tipping reported for the Herbst appliance.[10,23] The 4.8 mm of maxillary incisor retraction reported by Derringer[18] compares favorably with the 4.7 mm observed here.

The mandibular dentition was also tied together as a unit, with both the molars and incisors affected by Jasper Jumper therapy. The mandibular molars underwent significantly more anterior bodily translation and tipping than observed for the controls, suggesting that the line of force is directed close to but slightly above the molar's center of resistance. Comparable changes have been reported for the Herbst[9-10,23] and cervical traction.[18] The mandibular incisors were proclined approximately 6.37°, which parallels the proclination (6.6°) produced with a Herbst.[6] Somewhat lesser changes, ranging between 2.9°-5.2°, have been reported with lip bumper therapy.[21,22]

The Jasper Jumper causes relative intrusion of the maxillary molars. While the maxilla continues its normal descent the molar is intruded. Pancherz[6] reported similar findings with the Herbst. Considering that the line of force is below and behind the molar's center of resistance, its eruption might be expected to be slowed, stopped, or even re-

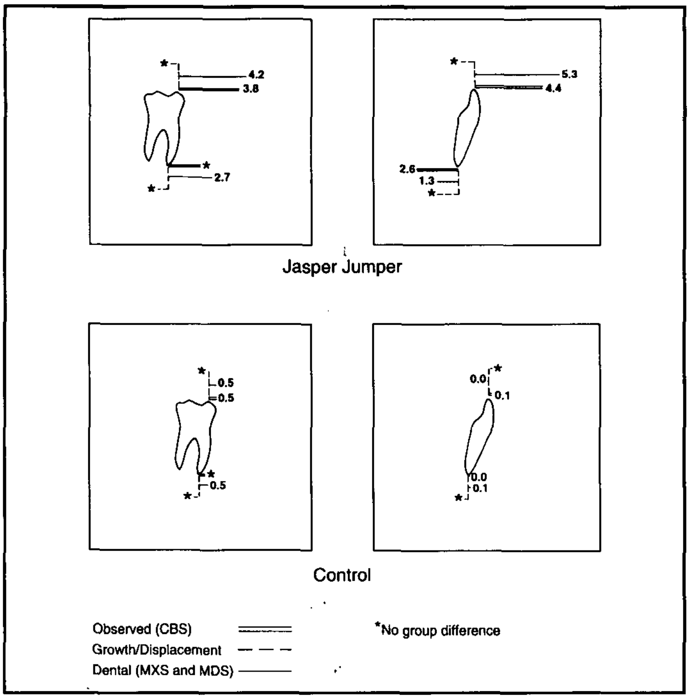

Figure 5

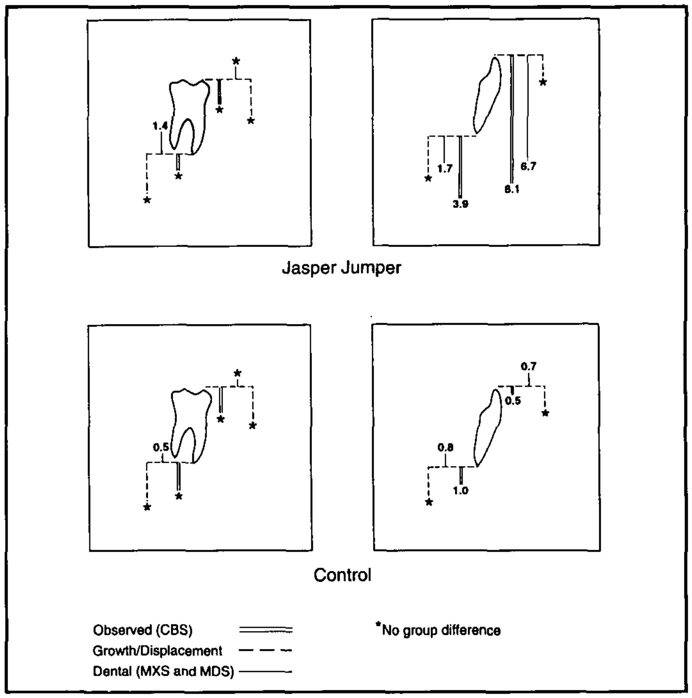

Figure 6

Figure 5
Horizontal changes of mandibular dentition (mm/yr)

Figure 6
Vertical changes of mandibular dentition (mm/yr)

Table 4
Annual Changes (mm/yr) of the Mandibular Incisor and Molars

Measure		Jasper Jumper Mean	Jasper Jumper S.D.	Controls Mean	Controls S.D.	Group Comparisons T-Value	Group Comparisons Prob
Horizontal Changes							
L1T	Total	4.38	5.57	0.10	1.71	3.27	0.002
	Dental	5.29	3.05	0.00	0.70	7.48	<0.001
L1A	Total	-2.60	4.97	0.00	1.88	-3.28	0.002
	Dental	-1.27	3.39	0.10	0.88	-3.33	0.002
L6C	Total	3.79	4.55	0.50	1.48	3.41	0.002
	Dental	4.24	2.87	0.52	0.95	7.07	0.001
L6A	Total	2.07	4.86	0.30	2.17	1.91	0.063
	Dental	2.69	2.59	0.51	1.06	5.35	<0.000
Vertical Changes							
L1T	Total	8.09	5.40	0.54	1.25	7.09	<0.001
	Dental	6.66	4.44	-0.71	0.65	9.02	<0.001
L1A	Total	3.91	5.16	0.99	1.06	3.28	0.002
	Dental	1.71[1]	1.00, 4.52	-0.81	0.85	8.70[2]	<0.000
L6C	Total	1.52	4.29	1.62	1.29	-0.92[2]	0.364
	Dental	-0.71	2.90 -0.41	0.91	-0.63 0.533		
L6A	Total	1.00[1]	0.60, 1.81	1.72	0.31, 2.27	355.50[2]	0.078
	Dental	-1.40[1]	-3.73, 0.00	-0.52	-1.11, -0.10	331.50[2]	0.036

[1]Median and interquartile range for descriptive statistics
[2]Mann-Whitney U for group comparison

Table 5
Clinical Indications and Contraindications of Jasper Jumper Therapy

Indications:
1. Dental Class II malocclusion.
2. Skeletal Class II with maxillary excess as opposed to mandibular deficiency
3. Deepbite with retroclined mandibular incisors.

Contraindications:
1. Cases predisposed to root resorption
2. Dental and skeletal openbites
3. Vertical growth with high MPA and excess lower facial height.

versed. Since the dentition was tied together, it follows that the maxillary incisor might be expected to show more than the normal amount of downwards and backwards movement (i.e., see-saw effect of a Class I lever), which is precisely what happens. Similar effects, although again of lesser magnitude, have been noted for the Herbst, Fränkel appliances and cervical traction.[10,18]

The mandibular molar apex also displayed more than expected vertical movement, which was primarily due to anterior molar tipping. It is important to note that although the point of force application of the Jasper Jumper upon activation appears to be at the canine, it is actually closer to the molar, where the auxiliary wire is bound. Mandibular molar tipping has been reported for the Herbst (+1.2°).[9] Pancherz[6] also found that the Herbst enhances the eruption of the mandibular molar.

As expected from the foregoing, there was also significant intrusion of the mandibular incisor (i.e., "whip-lash effect" of a Class III lever). Intrusion of the mandibular incisors has been reported with the Herbst,[6,10] although not of the magnitude observed with the JJ. Importantly, the actual amount of intrusion of the apex that occurred with JJ therapy was approximately 1.7 mm/yr, which translates to approximately 0.7 mm over the course of treatment. Approximately 84% of the subjects displayed some degree of intrusion during Jasper Jumper therapy. Although Dermaut and DeMunck[24] found no significant relationship between the amount of root resorption and achievable intrusion, others[25] have demonstrated an association. Given the indicators of "resorption potential" which exist prior to treatment[25] (i.e., short roots before treatment and bottleneck roots), it follows that individuals predisposed to root shortening should probably forego Jasper Jumper therapy.

Conclusions and implications

While Jasper Jumper therapy does correct selected Class II cases, it should not be considered a new Class II panacea: Jasper Jumpers produce results similar to other functional appliances, with the advantage of providing the operator with more control and thereby more predictable treatment results. Importantly, the JJ can be used as an effective approach for noncompliant cases.

Jasper's[3] "theory of two's" suggests that a Class II correction with Jasper Jumper therapy can be equally partitioned between five components, as follows:

1.) 20% due to maxillary basal restraint
2.) 20% due to backward maxillary dento-alveolar movement
3.) 20% due to forward mandibular dento-alveolar movement
4.) 20% due to condylar growth stimulation
5.) 20% due to downward/forward glenoid fossa remodelling

The results of this study demonstrate that the Class II correction was accomplished primarily by dento-alveolar movement and, secondarily, by basal maxillary restraint. We could not substantiate stimulation of condylar growth or fossa remodeling. Given the complexity and observed variability, it is premature to assign specific weights to the components identified. However, it is clear that most of the response was due to dental movement. We conclude that

1. The maxilla underwent limited posterior displacement and continued its normal inferior descent.

2. While the mandible showed little or no growth stimulation or downward/forward glenoid fossa remodeling, it did rotate backward (clockwise) slightly.

3. The maxillary molars underwent significant posterior tipping and relative intrusion.

4. The maxillary incisors underwent significant posterior tipping and extrusion/eruption.

5. The mandibular molars underwent significant anterior bodily movement and tipping, and eruption/extrusion.

6. The mandibular incisors underwent significant uncontrolled forward tipping and intrusion.

Finally, more studies need to be done in order to fully understand how to control the unwanted effects. Follow-up studies are also necessary to establish the long-term stability of Jasper Jumper therapy.

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