Original Article

Dentoskeletal effects produced by a Jasper Jumper with an anterior bite plane

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ABSTRACT

Objective: The aim of this retrospective study was to evaluate the dentoskeletal effects produced by a modified Jasper Jumper with an anterior bite plane for the correction of Class II division 1 malocclusion.

Materials and Methods: A sample of 32 growing patients (mean age = 11.9 ± 1.4 years) with Class II division 1 malocclusion and increased overbite were treated with a modified Jasper Jumper (JJ) and anterior bite plane protocol and compared with a matched control group of 30 subjects with untreated Class II malocclusion (mean age 12.2 ± 0.8 years). Lateral cephalograms were taken before treatment (T1) and at the end of comprehensive treatment (T2). Mean treatment duration was 2.1 ± 0.4 years. The T1–T2 changes in the two groups were compared with Student's *t*-tests for independent samples.

Results: The JJ group was successfully treated to a Class I occlusal relationship with a significant reduction in overjet (–3.9 mm, $P < .001$) and overbite (–3.1 mm, $P < .001$). The JJ group exhibited a significant increase in mandibular length and a significant improvement in maxillomandibular sagittal skeletal relationships. The lower incisors were significantly proclined, while the lower first molars demonstrated significant movement in a mesial direction.

Conclusions: Use of a modified JJ appliance and anterior bite plane is an effective protocol for the treatment of Class II malocclusion with increased overbite and greater skeletal (75%) than dentoalveolar (25%) effects mainly at the mandibular level. (*Angle Orthod.* 2016;86:775–781.)

KEY WORDS: Class II malocclusion; Jasper Jumper; Bite plane

INTRODUCTION

Functional appliances are typically indicated for the treatment of Class II malocclusion associated with mandibular retrusion.[1] In contrast to removable functional appliances, fixed functional devices do not require the patient's collaboration and can be worn in association with multibracket therapy, so that Class II malocclusion can be corrected in a single-phase treatment. A recent systematic review and meta-analysis[2] showed that fixed functional appliances are effective in improving Class II malocclusion in the short term, although their effects seem to be mainly dentoalveolar rather than skeletal. The most well-described intermaxillary appliance for treatment of Class II division 1 malocclusions is the Herbst appliance.[3,4] The stiffness of that appliance and its limitation in achieving lateral movements of the lower jaw may be a disadvantage. To overcome these drawbacks, James Jasper[5] introduced the Jasper Jumper (JJ) appliance (American Orthodontics, Sheboygan, Wis) in 1987. The appliance design and clinical applications were reviewed in detail by Jasper and McNamara.[6]

The major effects of the JJ reported in the literature are dentoalveolar rather than skeletal.[7–14] The JJ generates an anteriorly directed force to the lower arch (mandible) and posterior forces to the upper molar regions. In addition, the JJ exerts intrusive forces to the

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anterior part of the mandibular arch and on the posterior part of the maxillary dentitions. According to several studies[7–17] the JJ appliance does not cause significant changes to the maxilla, although the forces are acting directly on the maxillary arch. However, none of the previous studies analyzed the use of an anterior bite plane, with its unlocking effect of the occlusion, in combination with fixed intermaxillary appliances for the correction of Class II malocclusion. The aim of the present retrospective study, therefore, was to evaluate the dentoskeletal effects produced by a modified JJ with an anterior bite plane in growing subjects with Class II and increased overbite.

SUBJECTS AND METHODS

Study Design

The present study was conducted in a private practice in Prato, Italy, between 2005 and 2013. All patients had Class II division 1 malocclusion and none underwent extraction. In addition, the following inclusion criteria were used for sample selection:

- Full permanent dentition
- Overjet >5 mm
- Overbite >4 mm
- Class II molar relationship with at least ½ cusp distal relation
- ANB greater than 4°
- Lateral cephalograms available at the beginning and end of treatment.

The patients were assigned to treatment with a specific treatment protocol with preadjusted fixed appliances in combination with a JJ appliance and an anterior bite plane (Figures 1 and 2). All the patients were treated consecutively by the same operator. The JJ appliance was fitted only at the end of the aligning and leveling phase of orthodontic treatment, when a 0.019-inch × 0.025-inch stainless steel archwire was inserted in both arches. Composite resin (extended up to 7 mm) was bonded on the palatal surface of the two upper central incisors at the same time the JJ was inserted, and debonded occurred at the same time the JJ was removed. The bite JJ appliance was activated with a stepwise advancement (every 60 days) rather than with one-step bite jumping. The size of the JJ appliance was determined following the manufacturer's instructions. Each spring was attached to the maxillary first molar using a ball pin inserted into the headgear tube. In contrast to the usual JJ protocol, the lower end of the spring was engaged to the mandibular arch between the canine and the first premolar, thus avoiding any contact with the canine bracket, by an auxiliary 0.7 mm stainless steel jig inserted into the hook of the lower molar band on the distal end.

Figure 1. Jasper jumper appliance.

This type of insertion at the lower molar allowed to express a single mesial sagittal force closer to the molar CR avoiding any undesirable moment (Figure 1). Patients were controlled at 4-week intervals.

A total of 32 growing subjects (14 girls and 18 boys) were included in the JJ group. At baseline (T1), the mean age was 11.9 ± 1.4 years. The mean duration of the JJ active phase was 7.7 months. At the end of treatment (T2) mean age was 14.0 ± 1.5 years. All patients achieved Class I occlusion with normal overjet and overbite. The mean treatment time was 2.1 ± 0.4 years. The parents of all patients signed an informed consent form in which it was specified that the patents' deidentified demographic data and radiographic records could be used for clinical studies.

As a control group a sample of 30 subjects (14 girls and 16 boys) was selected from the American Association of Orthodontists Foundation Craniofacial Growth Legacy Collection (http://www.aaoflegacycollection.org, Michigan Growth Study, Denver Growth Study, and Oregon Growth Study). The control subjects were selected according to the same selection criteria at T1 as for the JJ group. The control subjects had a mean age of 12.2 ± 0.8 years at T1 and

Figure 2. Anterior bite ramps.

Table 1. Comparison of Cephalometric Values at T1 Between the Jasper Jumper Treated Group and the Control Group[a]

Cephalometric Measures	Treated Group (N = 32) Mean	SD	Control Group (N = 30) Mean	SD	Statistical Comparisons Difference	P Value		95% Confidence Interval Lower	Upper
Overjet is/OLp-ii/OLp (mm)	6.6	1.6	6.2	1.8	0.5	.282	NS	–0.4	1.3
Molar relation ms/OLp-mi/OLp (mm)	1.3	1.1	0.9	1.1	0.4	.142	NS	–0.1	1.0
Maxillary base A/OLp (mm)	71.7	3.5	72.3	4.5	–0.6	.567	NS	–2.6	1.5
Mandibular base Pg/Olp (mm)	74.6	4.1	74.7	4.9	–0.1	.928	NS	–2.4	2.2
Condylar head Co/Olp (mm)	8.7	2.1	10.0	3.6	–1.2	.098	NS	–2.7	0.2
Mandibular length Pg/OLp+ Co/Olp (mm)	83.4	4.3	84.7	4.4	–1.3	.227	NS	–3.5	0.9
Maxillary incisor is/Olp (mm)	78.7	4.1	79.4	4.6	–0.7	.544	NS	–2.9	1.5
Mandibular incisor ii/Olp (mm)	72.1	4.4	73.2	4.3	–1.1	.308	NS	–3.3	1.1
Maxillary molar ms/Olp (mm)	49.6	3.7	49.7	3.5	–0.2	.859	NS	–2.0	1.7
Mandibular molar mi/Olp (mm)	48.3	4.0	48.9	3.8	–0.6	.561	NS	–2.6	1.4
S-N to palatal plane (°)	7.1	2.7	6.4	3.6	0.8	.353	NS	–0.9	2.4
S-N to mandibular plane (°)	30.7	4.2	31.5	5.1	–0.8	.530	NS	–3.1	1.6
Palatal plane to mandibular plane (°)	23.6	4.4	25.1	5.4	–1.5	.230	NS	–4.0	1.0
Overbite (°)	4.2	1.1	3.6	1.8	0.6	.097	NS	–0.1	1.4
Upper incisor to palatal plane (°)	109.6	5.5	109.3	5.2	0.3	.852	NS	–2.5	3.0
Lower incisor to mandibular plane (°)	95.8	6.3	98.9	6.5	–3.1	.059	NS	–6.4	0.1

[a] SD indicates standard deviation; NS, not significant. * $P < .05$; ** $P < .01$; *** $P < .001$.

14.5 ± 0.7 years at T2, and the duration of the T1–T2 observation interval was 2.2 ± 0.5 years.

Cephalometric Analysis

Lateral cephalograms at T1 and T2 for both the JJ and control groups were analyzed with a customized digitization regimen and analysis provided by cephalometric software (Viewbox, version 3.0, dHAL Software, Kifissia, Greece). All lateral head films were taken with the same radiographic equipment (Orthoralix 9200 DDE/CEPH, Gendex Dental Systems, Hatfield, Pa) with the patient's Frankfort horizontal plane parallel to the floor. A customized cephalometric analysis containing measurements from the analyses by Bjork[18] and Pancherz[19] was used to analyze dentoskeletal changes. The lateral cephalograms of all treated and untreated subjects were corrected to match a 0% enlargement factor. To calculate the method error, lateral cephalograms at T1 and T2 of 30 randomly selected patients were retraced, and redigitized by the same examiner. Systematic error[20] was calculated with a paired-sample *t*-test. No systematic error was found for any of the cephalometric variables. Random error was evaluated with the Dahlberg formula.[21] For the angular measurements the error ranged from 0.21° (SN to palatal plane) to 0.64° (upper incisor to palatal plane); for the linear measurements the error ranged from 0.19 mm (overjet) to 0.43 mm (Pg/Olp).

Statistical Analysis

Descriptive statistics (mean and SD) were calculated for all cephalometric parameters in both groups. Normal distribution of the data was assessed for all cephalometric data for both the values at T1 (starting forms) and for the T2-T1 changes (Kolmogorv-Smirnov test). Statistical comparisons with Student's *t*-tests for independent samples were performed at T1 (starting forms) and on the T2-T1 changes. The power of the study was calculated on the basis of the sample size of the two groups and of a clinically significant change in overjet of 1.5 mm with a standard deviation of 1.6 mm.[12] The power exceeded 0.95 at an alpha level of 0.05. All statistical computations were carried out with statistical software (Statistical Package for the Social Sciences, SPSS, Version 12, Chicago, Ill).

RESULTS

Descriptive statistics and statistical comparisons of pretreatment craniofacial cephalometric measurements are reported in Table 1. With respect to the starting forms, no significant differences for any of the pretreatment variables were found between the two groups.

The statistical comparison on the T1-T2 changes for the skeletal measurements between the two groups (Table 2) showed statistically significant differences both in the sagittal and vertical dimensions. While the mandibular base (Pg/OLp) increased significantly (+2.5 mm) together with the mandibular length (Pg/OLp+ Co/OLp, +2.0 mm) in the JJ group, the maxillary base remained unchanged in the control group. With regard to changes in vertical skeletal dimension the JJ group showed significantly greater increases of +1.2 mm in the inclination of the mandible both to the cranial base and to the palatal plane versus the

Table 2. Comparison of the T2–T1 Differences Between the Jasper Jumper Treated Group and the Control Group[a]

Cephalometric Measures	Treated Group (N = 32)		Control Group (N = 30)		Statistical Comparisons				
								95% Confidence Interval	
	Mean	SD	Mean	SD	Difference	*P* Value		Lower	Upper
Overjet is/OLp-ii/OLp (mm)	–4.1	1.6	–0.2	0.9	–3.9	.000	***	–4.5	–3.2
Molar relation ms/OLp-mi/OLp (mm)	–3.8	1.1	–0.3	1.3	–3.5	.000	***	–4.1	–2.9
Maxillary base A/OLp (mm)	1.1	1.5	1.4	2.0	–0.3	.556	NS	–1.2	0.6
Mandibular base Pg/OLp (mm)	3.8	2.8	1.3	2.6	2.5	.001	***	1.1	3.8
Condylar head Co/OLp (mm)	0.3	1.8	0.7	2.1	–0.4	.399	NS	–1.4	0.6
Mandibular length Pg/OLp+ Co/OLp (mm)	4.1	2.6	2.1	2.7	2.0	.003	**	0.7	3.4
Maxillary incisor is/OLp minus A/OLp (mm)	0.6	1.8	0.0	1.2	0.6	.459	NS	–0.5	1.1
Mandibular incisor ii/OLp minus Pg/OLp (mm)	1.9	1.9	0.2	1.3	1.7	.168	NS	–0.2	1.3
Maxillary molar ms/Olp minus A/OLp (mm)	1.3	1.7	1.0	1.6	0.3	.000	***	0.8	2.5
Mandibular molar mi/OLp minus Pg/OLp (mm)	2.3	1.5	1.3	1.5	1.0	.007	**	0.3	1.8
S-N to palatal plane (°)	0.2	2.0	0.1	2.1	0.0	.933	NS	–1.0	1.1
S-N to mandibular plane (°)	0.1	1.8	–1.1	1.8	1.2	.011	*	0.3	2.1
Palatal plane to mandibular plane (°)	0.0	2.1	–1.2	1.8	1.2	.024	*	0.2	2.2
Overbite (°)	–3.0	1.5	0.1	0.9	–3.1	.000	***	–3.7	–2.5
Upper incisor to palatal plane (°)	–1.0	5.2	0.3	2.8	–1.4	.209	NS	–3.5	0.8
Lower incisor to mandibular plane (°)	5.3	5.2	0.9	2.8	4.4	.000	***	2.2	6.5

[a] SD indicates standard deviation; NS, not significant; * $P < .05$; ** $P < .01$; *** $P < .001$.

untreated control subjects. When comparing the dentoalveolar changes, the JJ group showed a significant reduction in the overjet (–3.9 mm), the overbite (–3.1 mm), and the molar relationship (–3.5 mm). Significantly more protruded positions of the upper (mi/OLP minus Pg/OLp) and lower (ms/OLP minus A/OLp) molars were found in the JJ group, but the sagittal positions of the upper and lower incisors presented no significant differences between the two groups. The lower incisors (L1-ML) in the JJ group showed a significantly greater proclination (+4.4°) than the control group.

The relationship between dental and skeletal changes to the significant Class II correction in the overjet (3.9 mm) and molar relationship (3.5 mm) are shown in Figures 3A and B, respectively. Treatment produced larger skeletal than dental contributions in the correction of overjet and molar relationships. The dentoskeletal contributions to overjet and molar corrections were greater in the mandible than in the maxilla.

DISCUSSION

Several investigations[7–17] evaluated the efficacy of the JJ appliance for correction of Class II molar relationship, and yet only two studies[15,17] compared the JJ with another appliance. No study, however, has analyzed the efficacy of anterior bite plane in Class II division I malocclusion treated with a JJ applied with sectional mandibular arches.

Peculiar features of this study were the analysis of patients treated consecutively by a single operator and the use of untreated control subjects with Class II malocclusion who were very similar to the study group in terms of age, gender distribution, and time of observation of. While not ideal, the use of historical control subjects with untreated Class II malocclusions was due mainly to the ethical issue involved in leaving subjects with full-cusp Class II malocclusions without orthodontic treatment during the pubertal and postpubertal stages of development, a biological period that has been demonstrated[22,23] to be associated with the most favorable treatment effects in patients with Class II malocclusion. A limitation of this study was its retrospective nature. The investigators tried to control selection bias by analyzing all patients treated consecutively by same operator between 2005 and 2013. All patients included in this study, adapted well to the JJ and anterior bite plane protocol, and it was not necessary to remove it during active treatment. All subjects in the study group were successfully treated to Class I molar and canine relationships and to a normal overjet and overbite.

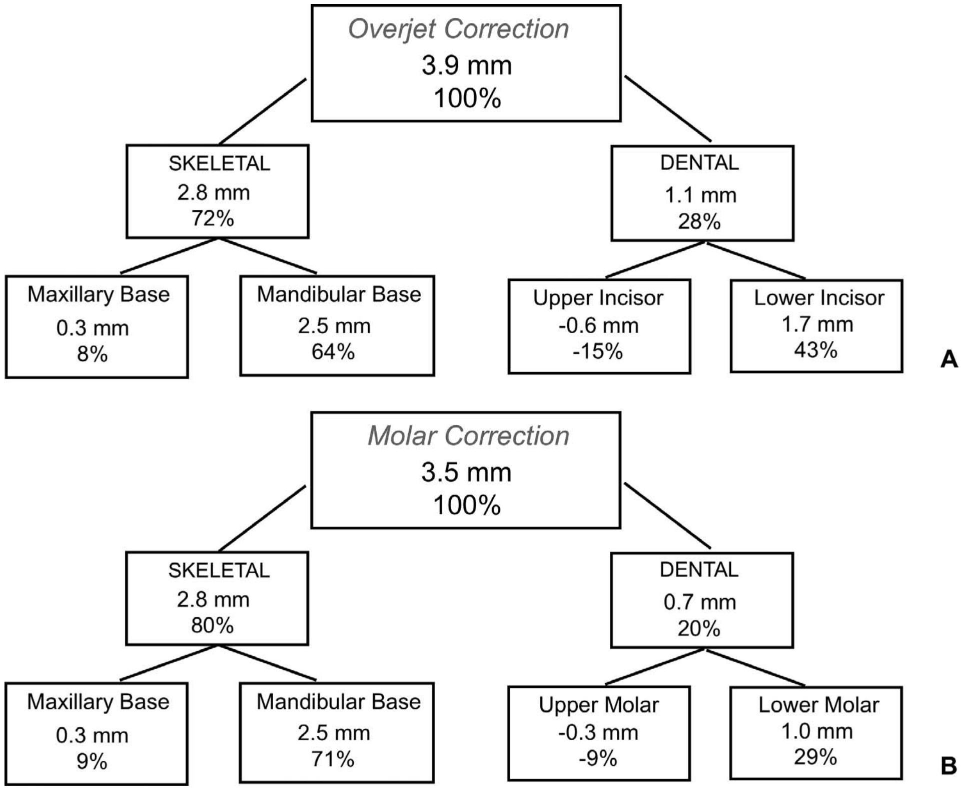

Figure 3. Diagrams of maxillary and mandibular skeletal and dentoalveolar changes contributing to sagittal (A) overjet correction and (B) molar correction.

The treatment regimen proved to be effective on occlusal parameters. A net reduction of –3.9 mm and of –3.1 mm was recorded for the overjet and the overbite, respectively, while a net improvement of 3.5 mm was achieved for the molar relationship.

The most relevant skeletal effect occurred at the mandibular level, which showed a significant improvement of the sagittal position of the mandibular base of 2.5 mm (Pg/OLp) and a significant increase of 2.0 mm in total mandibular length (Pg/OLp+Co/OLp) with respect to untreated control subjects. With regards to the maxillary base (A/OLp), a small reduction in the sagittal position was found in treated group. This favorable skeletal change, however, was not statistically significant. Stucki and Ingervall,[8] Weiland and Bantleon,[16] and Weiland et al.[17] also reported increases in the mandibular length. On the other hand, Cope et al.[7] and Covell et al.[11] concluded that the JJ had no orthopedic effect on the mandible. The dentoalveolar changes were highly significant at the maxillary and mandibular arches when considering the molar position, while it was not the case for the incisor position. On the other hand, the lower incisors in the treatment group exhibited a significant proclination of 4.4°. These outcomes are similar to those reported by Weiland and Bantleon[16] when treating Class II malocclusions with a JJ.

A general overview of the effects of Class II treatment with the modified JJ protocol leads to the consideration that the majority (75%) of the overall correction was due to the skeletal component. One of the main outcomes of this protocol consists of a significant increase in the sagittal position of the mandible. These findings, though to those reported by Weiland et al.,[17] contradict findings of other studies[7,10,11] that previously reported a restraint in the sagittal position of maxilla as the main skeletal effect. A possible explanation for these results can be found in the use of a bite plane that disarticulates the lower arch thereby facilitating growth of the mandible while it is kept in a forward position (24 hours a day, 7 days a week for 7 months) with the JJ. Another possible explanation is that the records taken at T2 in the present study are relative to end of treatment and not immediately after the JJ dismissal. This difference would allow the maxilla, constrained during appliance wear, to grow naturally in a forward and downward direction thereby negating the headgear effect produced by the appliance as it has been reported previously for the JJ appliance[11] for the Herbst appliance in combination with fixed appliances at puberty,[24] and for the Forsus device.[25]

The changes at the dentoalveolar level (25% of the total) showed a similar pattern with respect to the skeletal changes. The upper incisor exhibited modest changes, while the mandibular dentition displayed highly significant modifications. The JJ protocol produced a large amount of mesial movement of the lower arch, with proclination of the lower incisors of 4.4°, which is a relevant amount, although definitively smaller compared with findings (5.3°–7.5°) of similar studies.[7,10–12] A possible explanation for the smaller amount of incisor inclination in the current investigation could be related to the fact that the sagittal force was exerted directly to lower molars, and not to the canines, due to the design of the lower jig. Another factor that probably contributed to the relatively smaller amount of incisor proclination was the unlocking of the occlusion that facilitated the mandibular forward positioning. In order to prevent lower incisor proclination the use of larger mandibular rectangular archwires (0.021-inch × 0.025-inch) or 0.020-inch slots in the anterior teeth could be considered.[26] Recently, a mini-screw anchorage in the lower anterior region has been suggested with an effectively minimized proclination of the mandibular incisors.[27]

CONCLUSIONS

The results suggested that in growing subjects a modified JJ appliance can be an effective device in the treatment of Class II division 1 malocclusions with somewhat deep overbite.

The addition of an anterior bite plane could have a positive mandibular skeletal effect in both the sagittal and vertical planes. In particular, 75% of the sagittal correction was due mainly to mandibular skeletal changes while the remaining 25% of the correction was due to mainly to lower incisor proclination.

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