ORIGINAL ARTICLE

Dentoskeletal changes induced by the Jasper jumper and cervical headgear appliances followed by fixed orthodontic treatment

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Introduction: The objective of this controlled clinical study was to compare the dentoskeletal effects of the Jasper jumper with those of cervical headgear, when both are used with edgewise appliances to correct Class II Division 1 malocclusion. **Methods:** Lateral cephalograms of 75 patients were divided into 3 groups of 25. The control group included untreated Class II children with an initial mean age of 11.82 years (range, 9.35-14.84 years); they were followed without treatment for a mean period of 1.95 years (range, 0.90-3.95 years). The Jasper jumper group had an initial mean age of 11.86 years (range, 9.45-14.94 years); they were treated for a mean period of 1.96 years (range, 0.93-3.98 years). The cervical headgear group had an initial mean age of 12.29 years (range, 9.95-15.24 years); they were treated for an average of 1.88 years (range, 0.95-3.95 years). Comparison of the initial measurements showed that the 3 groups were similar at pretreatment, thus allowing direct comparisons. Analysis of variance (ANOVA) and the Tukey test were applied for comparison of the groups. **Results:** Different appliances yielded specific effects on several components (skeletal and dentoalveolar) evaluated. Anterior maxillary growth was significantly restricted by the cervical headgear. Mandibular growth was similar in all 3 groups, although it was slightly greater in the Jasper jumper group. The experimental groups had similar improvements in maxillomandibular relationshipd. The pattern of craniofacial growth was not significantly different between groups. The most significant effect on the maxillary dentoalveolar component was retrusion of the maxillary incisors by the cervical headgear. The effects observed for the Jasper jumper group were primarily related to the mandibular dentoalveolar component, including labial tipping and protrusion of the mandibular incisors, and mesial movement and extrusion of the mandibular molars compared with the control group. **Conclusions:** The headgear appliance corrected the Class II malocclusion mostly by anterior maxillary restriction and maxillary dentoalveolar effects. Correction of the Class II malocclusion with the Jasper jumper appliance was largely due to mandibular dentoalveolar effects rather than skeletal effects. (Am J Orthod Dentofacial Orthop 2007;132:54-62)

Class II malocclusion is characterized by an incorrect relationship between the maxillary and mandibular arches because of skeletal problems, dental problems, or a combination of both.[1] This malocclusion has been studied extensively regarding skeletal and dental characteristics and timing and method of treatment. Class II Division 1 malocclusion is reported to constitute 12% to 49% of all orthodontic disorders[2,3] and usually causes esthetic and functional problems of varying severity, depending on the amount of anteroposterior discrepancy and its interaction with adjacent soft tissues.

McNamara[4] studied 277 children with Class II malocclusion and concluded that mandibular skeletal retrusion was the most common characteristic, whereas maxillary skeletal protrusion was not a common finding. A treatment approach aimed at modifying the direction and amount of mandibular growth rather than restricting maxillary development would therefore be indicated in many Class II patients. This concept plays a primary role in functional jaw orthopedics. However, for maxillary excess, orthopedic forces should be directed to the maxilla to inhibit further maxillary growth or to perform distalization. A simple appliance com-

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monly used by orthodontists for correction of Class II malocclusion is the cervical headgear. Several functional and mechanical orthopedic appliances are presented in the literature and are routinely used for the correction of Class II Division 1 malocclusion.[5-8]

Current orthopedic appliances include removable appliances such as the bionator, the activator, the Fränkel, and others. The treatment effects of these appliances are well known[6,7,9] and have proven to be effective in the correction of Class II malocclusion. Their major effects are dentoalveolar rather than skeletal.[6,9] The differences between these orthopedic appliances are mainly related to the technique of fabrication, constructive bites, and hours of wear rather than the related effect. Moreover, they are considered uncomfortable and unesthetic by many patients and require patient compliance because they are removable.

Noncompliance of patients in general is increasing,[10] a trend that does not exclude orthodontics. Consequently, a primary advantage of fixed functional appliances is their independence of cooperation. One of the most useful fixed appliances today is the Herbst, which is effective in treating Class II Division 1 malocclusions.[11] To improve the technique of mandibular advancement with fixed appliances, James Jasper[12] introduced, in 1987, the Jasper jumper appliance (American Orthodontics, Sheboygan, Wis). The appliance design and clinical applications were reviewed in detail by Jasper and McNamara.[13]

Many studies in the literature seem to support the assumption that the major effects of the Jasper jumper are dentoalveolar rather than skeletal.[14-19] To our knowledge, only 2 Jasper jumper studies in the English literature have compared the initial treatment effects for Class II patients.[20,21] However, one of these studies included no control group in the report, which was primarily technical.[21] Sari et al[20] concluded that the activator-headgear appliance was more effective on the mandible, whereas the jumper appliance was mainly active on the maxilla. Weiland et al[21] conducted a study of 72 Class II patients treated with either the Herren activator, an activator associated with headgear, or the Jasper jumper appliance. Correction of overjet and molar relationship was more evident in patients treated with the Jasper jumper compared with the activator.

Even though many previous studies focused on the clinical outcome of the Jasper jumper, its treatment effects followed by fixed comprehensive therapy must be clarified.[12-21] No previous clinical investigation has evaluated the overall effects of the Jasper jumper and compared it with cervical headgear followed by edgewise therapy in the treatment of Class II malocclusion. Therefore, the purpose of this clinical study was to investigate the dentoskeletal changes in 2 groups of patients with Class II Division 1 malocclusion treated without extractions, either with the Jasper jumper appliance followed by fixed comprehensive treatment, or with cervical headgear associated with a fixed appliance. These groups were compared with a control group of untreated subjects with similar malocclusions.

MATERIAL AND METHODS

This was a controlled clinical trial on the effects of 2 approaches for Class II correction, with randomization in the assignment of the 2 treatment regimens. The study sample comprised 75 subjects (50 treated, 25 untreated) with skeletal and dental Class II malocclusions. Fifth consecutively treated patients were evaluated in this clinical study. Sample selection was based exclusively on the initial anteroposterior molar relationship, regardless of any other dentoalveolar or skeletal cephalometric characteristics. All patients met the following inclusion criteria: (1) Angle Class II molar relationship (52 patients with full Class II molar relationship, 23 with one half Class II molar relationship); (2) early permanent dentition with all permanent first molars, and first and second premolars; (3) Class II Division 1 with no subdivision malocclusion; (4) no craniofacial syndromes or systemic diseases; and (5) no tooth agenesis or missing permanent teeth.

The control group (group 1) was a historical sample obtained from the files of University of São Paulo, Bauru Dental School (São Paulo, Brazil) (Longitudinal Growth Study). This group comprised 25 subjects (13 boys, 12 girls) with Angle Class II Division 1 malocclusion with no orthodontic treatment, at an initial mean age of 11.82 years (range, 9.35-14.84 years) and a final mean age of 13.77 (SD 4.80), who were longitudinally followed for a mean period of 1.95 years (range, 0.90-3.95 years). These subjects had an initial ANB angle of 4.47° (SD ± 2.08°) and a mean overjet of 6.05 mm (range, 4.15-8.93 mm).

The Jasper jumper group (group 2) included 25 subjects (13 boys, 12 girls) treated with fixed appliances and the force modules of the Jasper jumper appliance. All patients were in the early permanent dentition with all permanent first molars, and first and second premolars. Their initial mean age was 11.86 years (range, 9.45-14.94 years), and their final mean age was 13.82 (SD 5.77); they were treated for a mean period of 1.96 years (range, 0.93-3.98 years). These subjects had an initial ANB angle of 5.47° (SD 1.85°) and a mean overjet of 6.35 mm (range, 4.38-9.03 mm). This sample of 25 children was collected by 1 operator (J.N.O., Jr) and was treated at Lavras Dental School (Lavras, Brazil) by 1 operator (J.N.O.).

The cervical headgear group (group 3) of 25 subjects (13 boys 12 girls) was treated with fixed appliances and cervical headgear. All patients were in the early permanent dentition with all permanent first molars, and first and second premolars. This sample had an initial mean age of 12.29 years (range, 9.95-15.24 years) and a final mean age of 14.18 (SD 4.61), and was followed for a mean period of 1.88 years (range, 0.95-3.35 years). These subjects had an initial ANB angle of −4.98° (SD ± 1.80°) and a mean overjet of 5.97 mm (range, 4.05-8.52 mm). This sample was collected by random evaluation and was treated at the University of São Paulo, Bauru Dental School.

Appliance design

In the Jasper jumper group, standard edgewise brackets with a 0.022-in slot were used, and bands were placed with a transpalatal arch in the maxillary arch to increase stability. To perform the leveling and aligning, the sequence of wires used was as follows: nickel-titanium 0.016 in, stainless steel 0.018 in, 0.020 in, and 0.019 × 0.025 in rectangular arch. This leveling and aligning phase lasted 7 to10 months. During the use of the Jasper jumper, a rectangular arch, 0.021 × 0.025 in stainless steel, was used in both arches. The mandibular arch was tied back to the first or second molars. In the maxillary arch, the jumper was attached to the headgear tube of the first molars as prescribed by the manufacturer with a ball-pin attachment. In the mandibular arch, the jumper was attached into the rectangular arch 0.021 × 0.025 in steel arch with a ball-pin attachment over the mandibular canine bracket from the distal side. Jasper jumpers were selected according to the manufacturer's instructions. The patients were seen every 4 weeks, and the appliances were activated every 8 weeks. The appliance was removed when a Class I or overcorrected Class I canine and molar relationship was achieved. The mean treatment time with the Jasper jumper was 6 months (range, 3-12 months). After removal of the jumpers, the teeth were retained with 5/16-in Class II elastics for a mean period of 4 months (range, 1-8 months). After removal of the fixed orthodontic appliance, conventional Hawley and 3 × 3 retainers were placed, and the final cephalometric films were taken (T2).

Appliance design

In the cervical headgear group, treatment with fixed appliances did not include extractions; thus, the appliance used to help correct the molar relationship and reduce the overjet was limited to cervical headgear. It was used at the beginning of treatment simultaneously with a fixed appliance until the molar relationship was established (Angle Class I). To distalize the maxillary molars, the cervical headgear was used for 8 to 12 months. The cervical headgear was used with the outer bows tilted 15° to 20° upward from the occlusal plane exerting 150 to 300 g of force in each side with an average wear of 14 to 16 hours per day. A standard edgewise orthodontic appliance was placed to begin leveling and aligning, as follows: nickel-titanium 0.016 in, stainless steel 0.018 in, 0.020 in, and 0.019 × 0.025-in rectangular arch. During use of the 0.019 × 0.025-in rectangular arch, sequential retraction of the second premolars followed by the first premolars was initiated with elastics and cervical headgear worn only at night. At this stage, in addition to the cervical headgear, 5/16-in Class II elastics were also used to retain the molar relationship and reduce the overjet. After retraction of the maxillary anterior teeth, 0.021 × 0.025-in ideal archwires were placed for intercuspation and completion of treatment. After removal of the fixed orthodontic appliance, conventional Hawley and 3 × 3 retainers were placed, and the final cephalometric films were taken (T2).

Cephalometric analysis

Two lateral cephalograms of each patient were used, considered as the initial (T1) and final (T2). An acetate paper was placed over each cephalogram, and tracings were manually performed on a light box by the investigator (J.N.O., Jr) and checked by the supervisor (R.R.A.). A digitizing table (DT-11, Houston Instruments, Austin, Tex), connected to a computer, transferred the location of points on the cephalograms to the cephalometric software (version 7.0, Dentofacial Planner Software, Toronto, Ontario, Canada), on which the measurements were processed in degrees and millimeters of the cephalometric measurements determined between lines and planes. However, since the lateral cephalograms (T1 and T2) were made in different machines, radiographic image magnification had to be corrected. The magnification factors were calculated and determined at 6%, 9.3%, 9.8%, and 9.9% for the T1 and T2 lateral headfilms. All reference points, lines, and planes used for the cephalometric analysis in this study were previously described.[9] The angular and linear measurements are shown in Figures 1 through 3.

Statistical analysis

All statistical analyses were performed with Statistica software (statistical software for Windows, version 5.0, Statsoft, Tulsa, Ok). Analysis of variance (ANOVA) was used to compare the values of the 3 groups for mean age at T1 and T2 and duration of observation. The data from the initial cephalometric

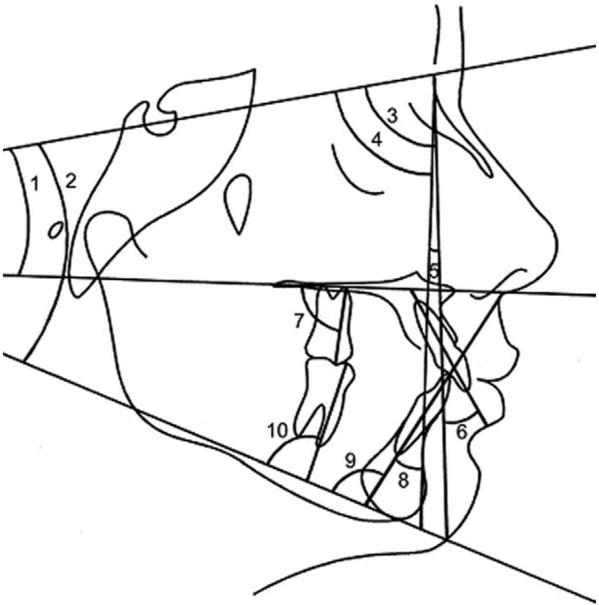

Fig 1. Skeletal and dental angular measurements: *1,* SN.PP (palatal plane-SN line); *2,* SN.GoMe (mandibular plane-SN line); *3,* SNA angle (sella-nasion-A); *4,* SNB angle (sella-nasion-B); *5,* ANB angle (maxillary-mandibular relationship); *6,* U1.NA (angle between maxillary incisor long axis-NA line); *7,* U6.PP (angle between maxillary first molar long axis-palatal plane); *8,* L1.NB (angle between mandibular incisor long axis-NB line); *9,* IMPA (mandibular incisor long axis-mandibular plane angle); *10,* L6.MP (angle between mandibular first molar long axis-mandibular plane).

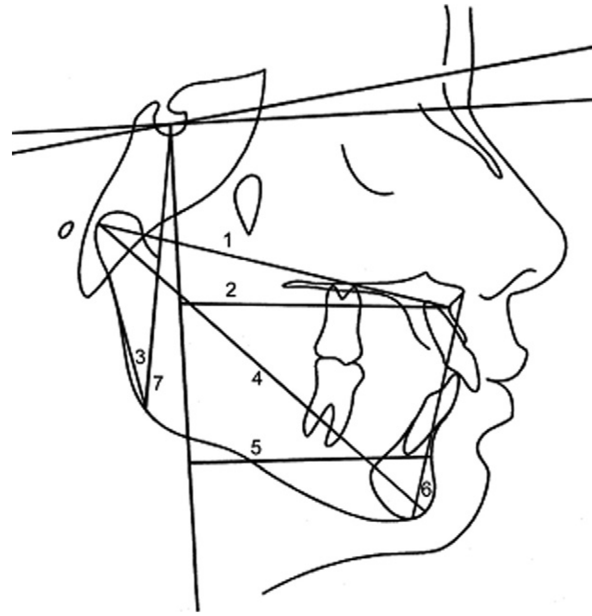

Fig 2. Skeletal linear measurements: *1,* Co-A (distance between points Co and A); *2,* A-FHp (perpendicular distance between Point A to Frankfort horizontal plane); *3,* Ar-Go (distance between points articulare and Go); *4,* Co-Gn (distance between points Co and Gn); *5,* B-FHp (perpendicular distance between Point B to Frankfort horizontal plane); *6,* ANS-Me (lower anterior face height); *7,* S-Go (distance between points S and Go).

measurements for the 3 groups were calculated with ANOVA, complemented by the Tukey test, to determine the degree of similarity of the study groups as to their cephalometric values at T1. This procedure was also conducted for differences in initial and final mean ages between the 3 groups for evaluation of the dentoskeletal changes from the appliances and from growth. Intragroup analysis was performed with the Student *t* test for measurable variables to check for dimorphism between the sexes. In both analyses, results with $P \leq .05$ and $P \leq .01$ were considered statistically significant.

Error study

To determine the reliability of the results, 30 lateral cephalograms were randomly selected from the 3 study groups. All radiographs were retraced and redigitized by 1 operator (J.N.O., Jr) after 4 weeks. The difference between the first and second measurements of each lateral cephalogram was determined; the Dahlberg formula was applied for observation of the casual error; and the paired *t* test was used for detection of systematic errors. No casual errors were found, even though 1 cephalometric measurement was statistically significantly different at $P < .05$ (LAFH); however, this difference was smaller than 1 mm and without clinical relevance. The largest accidental errors were 0.84° and 0.96 mm.

RESULTS

ANOVA of the 3 groups' mean age values at T1 and T2 and length of observation showed no significant differences among the groups.

To evaluate the influence of sex on the sample, the means of cephalometric differences between boys and girls of each group were compared with the Student *t* test. The results demonstrated that, in group 1, only lower anterior facial height was significant; it was greater for the boys ($P \leq .05$). In group 2, the measurement L6-MP was also greater in the boys ($P \leq .05$). The other measurements did not show statistically significant differences.

The equivalence of the starting form was deter-

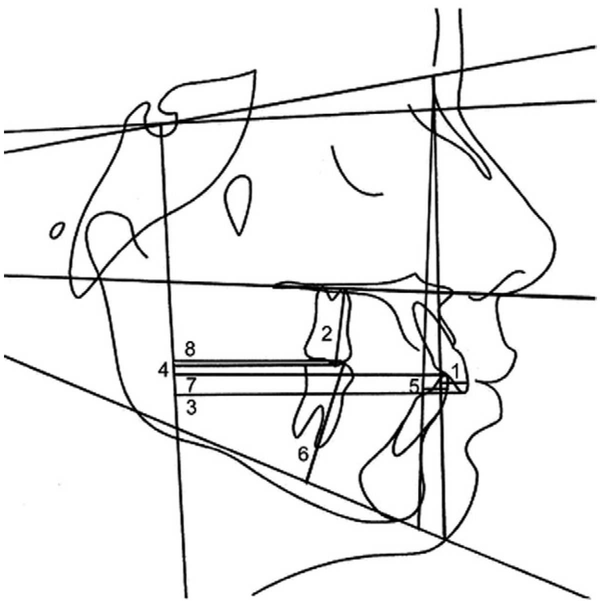

Fig 3. Dental linear measurements: *1,* U1-NA (distance between most anterior point of maxillary central incisor and NA line; positive value was assigned when structure was posterior to line); *2,* U6-PP (perpendicular distance from the first upper molar mesial point to palatal plane); *3,* U1-FHp (perpendicular distance between point of most inferior point of maxillary central incisor to Frankfort horizontal plane); *4,* U6-FHp (perpendicular distance between mesial tip of maxillary molar and Frankfort horizontal plane); *5,* L1-NB (distance between most anterior point of mandibular central incisor and NB line; positive value was assigned when structure was posterior to line); *6,* L6-MP (perpendicular distance from mandibular molar mesial point to mandibular plane); *7,* L1-FHp (perpendicular distance between most superior point of mandibular central incisor to Frankfort horizontal plane); *8,* L6-FHp (perpendicular distance between mesial tip of mandibular molar and Frankfort horizontal plane).

mined by comparing pretreatment cephalometric values of the 3 groups (Table I). Only 2 variables differed significantly before treatment. Maxillary and mandibular sagittal positions compared favorably in the 3 groups, as well as the resulting ANB angle. However, the mandible (SNB angle) was more retrusive in the Jasper jumper group than that in the 2 other groups ($P \leq .05$). Growth direction was predominantly horizontal in the 3 groups. The maxillary incisors were more proclined in the headgear group than in the control and Jasper jumper groups, but the mandibular incisors were not statistically significantly different for any of the measurements used. Thus, nearly 92% of the variables did not have statistically significant differences, with great similarity between the dentoskeletal patterns of all 3 study groups.

The results of comparison between groups of the differences between the initial and final means and between T1 and T2 are given in Table II. This evaluation was conducted by ANOVA and complemented by the Tukey test. During treatment, the SNA angle decreased in all 3 groups with a significant change between the headgear and control groups ($P \leq .05$). In addition, the linear measurement Co-A had a slight increase in the headgear group that was minor (0.56 mm) compared with the control group (2.80 mm) ($P \leq .05$). Mandibular protrusion and mandibular size, evaluated by SNB angle, B-FHp, and Ar-Go, however, increased similarly in the 3 groups. The effective mandibular length (Co-Gn) increased 4.40 mm in the control group, 6.15 mm in the Jasper jumper group, and 5.09 mm in the headgear group. Overall, the Jasper jumper and headgear therapies produced larger, but not significant, effects on growth and position of the mandible than in the controls. Considering the maxillomandibular measure (ANB angle), both therapies produced a significant ($P \leq .01$) and similar reduction in the sagittal Class II discrepancy, whereas the control group remained basically unchanged. Mandibular plane orientation and the palatal plane were unaffected by treatment. No differences in lower anterior face height were noted between the 3 groups or in total posterior facial height (S-Go). There was a significant retraction of the upper incisors (U1-FHp) in the headgear group compared with the controls. The maxillary molars did not differ significantly when extrusion (U6-PP) and angulation (U6.PP) in relation to the palatal plane were evaluated. The mandibular incisors (IMPA) proclined significantly in the Jasper jumper group about 4° more than in the control and headgear groups, or about 1.5 mm (L1-NB), 3 mm (L1-FHp), depending on the variable evaluated. The mandibular first molars (6-FHp) moved mesially in the Jasper jumper group almost twice as much as in the headgear group ($P \leq .01$). The mandibular first molars (L6-MP) extruded significantly more in the Jasper jumper group compared with the controls ($P \leq .01$).

DISCUSSION

We reported the results of 50 patients consecutively treated with the Jasper jumper appliance or the Kloehn headgear appliance followed by fixed edgewise therapy. Records at T1 and T2 were analyzed. Several investigations[14-21] evaluated the efficacy of the Jasper jumper appliance for correction of Class II molar

Table I. Comparison of starting forms

Cephalometric measurements	Control group 1			Jasper jumper group 2			Cervical headgear group 3			Significance		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	1-2	1-3	2-3
Maxillary skeletal												
SNA angle (°)	25	81.59	3.85	25	80.24	3.52	25	81.96	3.16	NS	NS	NS
Co-A (mm)	25	84.96	4.80	25	84.16	5.77	25	85.96	4.61	NS	NS	NS
A-FHp (mm)	25	65.58	4.77	25	64.14	4.56	25	65.49	3.38	NS	NS	NS
Mandibular skeletal												
SNB angle (°)	25	77.14	3.92	25	74.78	3.55	25	77.00	2.98	*	NS	NS
Ar-Go (mm)	25	40.39	3.35	25	40.22	4.21	25	41.32	3.02	NS	NS	NS
Co-Gn (mm)	25	103.98	5.75	25	101.54	6.59	25	105.25	5.34	NS	NS	NS
B-FHp (mm)	25	57.86	6.88	25	54.52	6.09	25	57.19	5.32	NS	NS	NS
Maxillary/mandibular												
ANB angle (°)	25	4.47	2.08	25	5.47	1.85	25	4.98	1.80	NS	NS	NS
Vertical skeletal												
SN.GoMe (°)	25	32.90	4.91	25	32.36	5.20	25	32.93	4.83	NS	NS	NS
SN.PP (°)	25	6.61	2.91	25	6.54	3.28	25	7.32	3.99	NS	NS	NS
LAFH (mm)	25	59.07	4.58	25	58.12	5.09	25	58.92	5.26	NS	NS	NS
S-Go (mm)	25	67.67	5.16	25	66.71	4.99	25	67.88	4.55	NS	NS	NS
Maxillary dentoalveolar												
U6.PP (°)	25	78.03	3.91	25	76.43	3.90	25	78.60	4.65	NS	NS	NS
U1.NA (°)	25	21.22	6.35	25	22.36	9.58	25	26.31	7.15	NS	NS	NS
U1-NA (mm)	25	4.59	1.70	25	5.00	2.82	25	6.37	2.20	NS	*	NS
U6-PP (mm)	25	19.75	2.00	25	19.27	2.21	25	20.53	1.75	NS	NS	NS
U1-FHp (mm)	25	68.48	5.60	25	67.06	6.78	25	70.64	3.96	NS	NS	NS
U6-FHp (mm)	25	36.28	4.94	25	35.02	5.20	25	36.83	3.80	NS	NS	NS
Mandibular dentoalveolar												
IMPA (°)	25	95.65	4.68	25	97.71	7.75	25	98.06	6.06	NS	NS	NS
L6-MP (mm)	25	86.15	4.03	25	87.92	4.39	25	87.15	4.51	NS	NS	NS
U1.NB (mm)	25	25.67	4.62	25	24.86	7.42	25	28.00	6.80	NS	NS	NS
L1-NB (mm)	25	4.56	1.71	25	4.20	1.98	25	5.16	1.94	NS	NS	NS
L6-MP (mm)	25	26.42	2.23	25	26.17	2.09	25	26.14	1.99	NS	NS	NS
L1-FHp (mm)	25	63.21	5.94	25	60.11	6.31	25	63.43	4.28	NS	NS	NS
L6-FHp (mm)	25	37.69	5.07	25	34.96	5.46	25	37.83	3.95	NS	NS	NS

NS, Not significant.
*Significant ($P \leq .05$).

relationship, yet only 2 studies[20,21] compared the Jasper jumper with another appliance. However, these studies assessed only the initial effects of the appliances, thus not allowing a more detailed analysis of overall treatment effects.[20,21]

With regard to the maxilla, the results showed that cervical headgear restricted maxillary anterior growth, as also demonstrated by other authors.[10,22-30] The Jasper jumper appliance did not cause significant changes in the maxilla, even though its force modules are directly fixed on the maxillary arch, and thus it might have an effect similar to that of cervical headgear, as reported in the studies of Cope et al,[14] Covell et al,[18] Nalbantgil et al,[19] and Weiland et al.[21] However, the retrusion of the maxillary incisors from the Jasper jumper appliance might lead to bone remodeling and posterior displacement of Point A, causing reevaluation of the appliance's effect on the maxilla. The Class II elastics used in both groups might have influenced these results.

The Jasper jumper appliance did not influence the mandibular growth that might have occurred because the appliance delivers an anterior force component on the mandible through the mandibular arch. Similar results were found by Cope et al[14] and Covell et al.[18] On the other hand, Weiland and Bantleon,[15] Weiland et al,[21] and Stucki and Ingervall[31] demonstrated mandibular protrusion with the Jasper jumper appliance. However, their results were observed without a control group, whereas cervical headgear also had no significant effect on the mandible, with a similar increase as that found for our control group and also shown by other authors.[23,24,28,29,32]

Evaluation of the maxillomandibular relationship showed a significant decrease in the ANB angle, demonstrating that both appliances, cervical headgear

Table II. Difference in mean changes (T1 to T2)

Cephalometric measurements	Control group 1			Jasper jumper group 2			Cervical headgear group 3			Significance		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	1-2	1-3	2-3
Maxillary skeletal												
SNA angle (°)	25	−0.26	3.02	25	−1.46	3.52	25	−1.60	2.76	NS	*	NS
Co-A (mm)	25	2.80	5.00	25	2.32	5.77	25	0.56	5.61	NS	*	NS
A-FHp (mm)	25	0.87	4.16	25	0.72	4.56	25	−0.08	4.38	NS	NS	NS
Mandibular skeletal												
SNB angle (°)	25	0.01	3.25	25	0.58	3.55	25	0.43	2.44	NS	NS	NS
Ar-Go (mm)	25	2.24	4.21	25	3.58	4.82	25	3.78	3.02	NS	NS	NS
Co-Gn (mm)	25	4.40	6.59	25	6.15	5.33	25	5.09	5.34	NS	NS	NS
B-FHp (mm)	25	0.81	6.09	25	2.17	6.67	25	1.65	5.32	NS	NS	NS
Maxillary/mandibular												
ANB angle (°)	25	−0.27	1.85	25	−2.05	1.44	25	−2.04	1.80	†	†	NS
Vertical skeletal												
SN.GoMe (°)	25	−0.08	5.20	25	−0.08	5.55	25	0.15	4.83	NS	NS	NS
SN.PP (°)	25	0.40	3.28	25	0.75	2.33	25	0.48	3.99	NS	NS	NS
LAFH (mm)	25	2.31	5.09	25	3.54	5.87	25	3.62	5.26	NS	NS	NS
S-Go (mm)	25	3.44	4.99	25	4.92	4.22	25	5.01	4.55	NS	NS	NS
Maxillary dentoalveolar												
U6.PP (°)	25	1.04	3.90	25	2.36	4.60	25	2.48	4.65	NS	NS	NS
U1.NA (°)	25	0.95	9.58	25	0.18	9.11	25	−3.75	7.15	NS	NS	NS
U1-NA (mm)	25	0.33	2.82	25	−0.26	3.98	25	−0.86	2.20	NS	NS	NS
U6-PP (mm)	25	1.58	2.21	25	1.52	2.85	25	1.90	1.75	NS	NS	NS
U1-FHp (mm)	25	1.23	6.78	25	−0.04	6.18	25	−1.86	3.96	NS	†	NS
U6-FHp (mm)	25	1.00	5.20	25	1.63	5.49	25	−0.14	3.80	NS	NS	NS
Mandibular dentoalveolar												
IMPA (°)	25	−0.93	7.75	25	4.25	7.41	25	0.73	6.06	†	NS	NS
L6-MP (mm)	25	−0.31	4.39	25	−3.09	4.44	25	−6.62	4.51	*	†	†
U1.NB (mm)	25	−1.00	7.42	25	4.73	6.33	25	1.29	6.80	†	NS	NS
L1-NB (mm)	25	0.02	1.98	25	1.55	1.58	25	0.43	1.94	†	NS	*
L6-MP (mm)	25	1.25	2.09	25	3.11	2.90	25	2.29	1.99	†	NS	NS
L1-FHp (mm)	25	0.90	6.31	25	3.81	5.13	25	1.99	4.28	†	NS	*
L6-FHp (mm)	25	1.38	5.46	25	4.63	4.78	25	2.24	3.95	†	NS	†

NS, Not significant.
*Significant ($P \leq .05$).
†Significant ($P \leq .01$).

and Jasper jumper, had positive effects for correction of the Class II malocclusion, as also observed by authors investigating the Jasper jumper[14,15,18,19,21,31] and headgear.[10,22-30,32] On the other hand, the vertical relationship (SN.GoMe, SN.PP, LAFH, S-Go) did not show an increase for either appliance, as demonstrated by other authors for the Jasper jumper[15,18,19,21,31] and headgear.[24,25] The vertical increase is more expected in the group wearing the cervical headgear, due to extrusion of the maxillary teeth and the consequent clockwise rotation of the palatal and mandibular planes, as demonstrated by Blucher,[23] Sandusky,[26] Wieslander,[27] Haydar and Üner,[29] Kirjavainen et al,[30] and Kim and Muhl.[32] However, the study of Kim and Muhl[32] was 6 years after treatment; they observed counterclockwise rotation of these planes, indicating return of the craniofacial growth pattern.

Therefore, it can be concluded that correction of the Class II malocclusion in the treated groups occurred primarily from the maxillary and mandibular dentoalveolar effects. This occurred because the forces of both appliances are directly delivered to the tooth structures. The cervical headgear, which delivers force on the maxillary molars and consequently on the maxillary arch, caused significant retrusion and retroclination of the maxillary incisors[24,26,29,33] and distalization of the maxillary molars.[24,27,29,30,33] On the other hand, the Jasper jumper, which delivers force on both arches, promoted protrusion and inclination of the mandibular incisors and mesialization and extrusion of the mandibular molars. These effects of the Jasper jumper were found by several authors and occurred because of its force direction.[14,15,18,19,21,31] However, due to the support of the Jasper jumper on the maxillary arch, several authors found retroclination of the mandibular incisors and distalization of the maxillary molars, as demonstrated for cervical headgear,[14,15,17-19,31] yet our study did not show any remarkable effect on the maxillary arch, because treatment finalization with fixed appliances might have led to relapse of the effects produced by the force modules of the Jasper jumper.

Clinical implications

The results of statistical tests demonstrated a difference between the effects of appliances used for treatment of the study groups and the effects of growth for the control group with no orthodontic treatment. However, from a clinical perspective, treatment with both the Jasper jumper and cervical headgear provided satisfactory outcomes for correction of Class II malocclusion. To our surprise, there was no positive skeletal effect on mandibular length or protrusion from the Jasper jumper as found in other investigations.[15,21,31] Numerically, but with no statistically significant differences, treatment with the Jasper jumper allowed slightly greater mandibular advancement (1-1.5 mm) than in the other 2 groups. Moreover, it caused significant effects on the dentoalveolar components, especially the mandibular teeth. Thus, it seems that the greater dental effects of the Jasper jumper represent a positive aspect for correction of the Class II malocclusion. However, patients treated with cervical headgear had greater effects on the maxilla and the maxillary dentoalveolar component based on restriction of anterior maxillary growth, distal movement of the maxillary molars, and uprighting of the maxillary incisors. Since it is a removable appliance, the results greatly depend on patient compliance. On the other hand, fixed appliances such as the Jasper jumper require less patient compliance and thus directly influence outcome and treatment time. Our results cannot be applied to other age ranges—ie, after craniofacial growth and development are completed. Further investigation will be performed to follow the long-term stability of correction of the Class II malocclusion by the Jasper jumper and the cervical headgear appliances.

CONCLUSIONS

1. The Jasper jumper group did not show changes in maxillary development compared with the control and cervical headgear groups. The cervical headgear group had significant changes, indicating restriction of anterior maxillary growth compared with the control group.
2. The Jasper jumper and cervical headgear appliances associated with fixed appliances did not alter mandibular development.
3. Both the Jasper jumper and cervical headgear yielded significant improvements in maxillomandibular relationships, with reduction in ANB angle.
4. Craniofacial growth patterns did not differ significantly between the study and control groups.
5. The cervical headgear group had significant retrusion of the maxillary incisors compared with the control group for only 1 measurement, U1-FHp. However, the Jasper jumper group did not demonstrate any significant change in the maxillary dentoalveolar component when compared with either the control or the cervical headgear groups.
6. The Jasper jumper group had labial tipping and protrusion of the mandibular incisors, as well as uprighting, mesial movement, and extrusion of molars. The cervical headgear group exhibited more significant uprighting of the mandibular molars than the other 2 groups.

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