ORIGINAL ARTICLE

Effects of the jasper jumper appliance in the treatment of Class II malocclusion

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ABSTRACT

Introduction: The Jasper Jumper is a fixed functional appliance which keeps the mandible in a protruded position by applying continuous light forces. Even though previous studies have revealed the clinical outcome of the appliance, there is still some debate about how much correction is achieved by skeletal changes vs. dentoalveolar changes. Objective: The objective of this study was to evaluate the skeletal and dentoalveolar effects of the treatment of Class II malocclusion with the Jasper Jumper appliance associated with fixed orthodontic appliances, compared to an untreated control group. **Material and Methods:** The sample comprised 47 subjects, divided into two groups: Group 1, with 25 patients at a mean initial age of 12.72 years, treated with the Jasper Jumper appliance for a mean period of 2.15 years; and Group 2 (Control), included 22 subjects at a mean initial age of 12.67 years, who were not submitted to any type of orthodontic treatment and presenting Class II malocclusion, observed by a mean period of 2.12 years. Lateral cephalograms before and after orthodontic treatment for group 1 and during the observational period for group 2 were evaluated. Initial and final dentoskeletal cephalometric variables and changes with treatment were compared between the groups by independent t tests. **Results:** When compared to the control group, the Jasper Jumper group presented greater restriction of anterior displacement of the maxilla and a greater maxillary retrusion, improvement of maxillomandibular relationship, reduction of facial convexity, greater protrusion and intrusion of mandibular incisors and a greater extrusion of mandibular molars, besides a greater reduction of overjet and overbite and improvement of molar relationship. **Conclusion:** The correction of the Class II in the group treated with the Jasper Jumper and fixed appliances was mainly due to restriction of maxillary growth, protrusion and intrusion of mandibular incisors and extrusion of mandibular molars.

Key-words: Class II malocclusion. Cephalometrics. Functional Appliance.

INTRODUCTION

When analyzing the prevalence of malocclusion, Class I is present in 55% of the Brazilian population and Class II, in 42%[25]. The latter is characterized by an anteroposterior discrepancy of skeletal bases, negatively influencing esthetics and self-esteem of patients, justifying the percentage of Class II patients who look for orthodontic

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treatment. Freitas et al.[9] verified that 54% of male patients and 58% of female patients that search for solutions for their dentoskeletal problems presented a Class II malocclusion. This malocclusion can be early detected, and compromises not only esthetics, but also some essential functions, like mastication, swallowing and speech[2].

Recent orthodontic researches concern mainly on the orthodontic treatment effects and not on the severity of malocclusion and the efficiency of treatment protocols[27]. This refers especially to the treatment of Class II malocclusion. For a treatment protocol to be efficient, it is not only desirable that it corrects a malocclusion, but that this correction is performed in a reasonable period of time, with the least patient and professional fatigue and respecting biological integrity[7]. Besides, the obtained result should be excellent. According to Baccetti et al.[3], this malocclusion can be early diagnosed by the presence of a distal step in the deciduous second molars, Class II canine relationship and accentuated overjet, and it does not self-correct. Henriques et al.[10] verified that the Class II skeletal discrepancy was maintained from the mixed to the permanent dentition. During this period, no self-correction of this malocclusion was observed, but an increase in overjet, due to a retrusion of mandibular incisors.

The actual tendency for correction of the Class II malocclusion without extractions, is the use of fixed functional orthopedic appliances that do not need patient compliance[13,24]. The Herbst appliance and its variations is the most used and investigated in the last years. Its effects in Class II treatment are: restriction of the anterior displacement of the maxilla; significant mandibular protrusion; intrusion and distalization of maxillary molars; distalization and extrusion of maxillary incisors; anterior movement of mandibular teeth through the alveolar bone (molars and incisors); intrusion of mandibular incisors and extrusion of mandibular molars, and a significant improvement of the maxillomandibular relationship[23,24]. However, the Herbst appliance has a relatively high cost.

More recently, in 1987, the Jasper Jumper was developed by James Jasper, with a mechanism similar to the Herbst appliance, with a lower cost[13]. This appliance consists of a new flexible device for mandibular advancement, composed by two flexible force modules that minimizes the problems caused by the rigidity of the Herbst appliance, providing the patient more freedom of mandibular movements, reducing the total treatment time, because the Jasper Jumper is used together with fixed appliances. This way, the treatment is accomplished in only one phase, not needing two phases, one orthopedic and other orthodontic, as it occurs with most of functional orthopedic appliances[13].

The Jasper Jumper is relatively new, and not much has been published regarding its use, mainly when compared to the vast literature regarding the Herbst appliance. However, there is a great agreement among studies regarding the effects of the Jasper Jumper[13]. These are similar to the effects promoted by the Herbst appliance, due to the equivalent action mechanism[24].

The main expected results with the use of the Jasper Jumper in Class II malocclusion cases are: restriction of the anterior displacement of the maxilla[18] and a significant mandibular protrusion[1], however other studies did not demonstrate any significant change in mandibular growth[5,22], an intrusion and distalization of maxillary molars[5]; distalization of maxillary incisors[1,4,5] and extrusion[5]; a slight tendency of clockwise rotation of the mandible[4,18]; anterior movement of mandibular teeth in the alveolar bone (molars and incisors)[1,4,5]; intrusion of mandibular incisors[4]; extrusion of mandibular molars[4,5]; expansion of maxillary molars (when not using anchorage). There is a significant improvement of the maxillomandibular relationship[22].

The dental changes result in a clockwise rotation of the occlusal plane[18], without a rotation of the mandibular plane[5]. Normally, there are no significant vertical changes[1,5,18]. Therefore, the correction of a Class II malocclusion is accomplished mainly due to dentoalveolar changes instead of skeletal changes, despite the use of methods to minimize these effects and to increase the skeletal effects[1,5,18].

The present study aimed to cephalometrically evaluate the skeletal and dentoalveolar changes in Class II malocclusion patients treated with the Jasper Jumper appliance, associated to fixed orthodontic appliances, and compare it to an untreated control group.

MATERIAL AND METHODS

Material

The sample comprised 94 lateral cephalograms of 47 young subjects, divided into 2 groups:

Group 1 – Jasper Jumper

Comprised by 25 patients, 13 males and 12 females, with initial Class II division 1 malocclusion and a mean initial age of 12.72 years (S.D. = 1.20), treated with the Jasper Jumper associated to fixed orthodontic appliances, for a mean total period of 2.15 years (S.D. = 0.29). All patients were treated in the Orthodontics Department of the Bauru Dental School, University of São Paulo, by orthodontic graduate students.

Group 2 – Control Group

Comprised by 22 patients, 12 males and 10 females, with untreated Class II division 1 malocclusion, at a mean initial age of 12.67 years (S.D. = 0.75) and observed for a mean period of 2.12 years (S.D. = 1.63).

These subjects were selected from the longitudinal sample of the Growth Center of the Bauru Dental School, University of São Paulo. All subjects were indicated for orthodontic treatment; however some of them opted for a late treatment or were not interested in treatment, enabling the formation of this control group.

The Jasper Jumper appliance

The Jasper Jumper appliance was developed by James Jasper[13], and consists of a bilateral flexible spring that exert continuous light forces to both arches. The upper end of the spring is attached posteriorly to the maxillary arch by a ball pin that is placed through the distal attachment of the spring and then extends anteriorly through the face-bow tube on the upper first molar band. The lower end of the spring is blocked by a small teflon ball positioned in the mandibular arch.

The Jasper Jumper is selected according to the manufacturer's instructions and it is available in seven lengths, ranging from 26 mm to 38 mm, in 2 mm increments (Figure 1).

For orthodontic therapy, 0.022" x0.030" Roth pre-adjusted brackets (Morelli, Sorocaba, SP) were used. All patients used a transpalatal arch to enhance maxillary anchorage, maximize the skeletal and minimize the dental effects. Both arches were leveled and the 0.018" x 0.025" stainless steel arch wires were engaged just before the insertion of the Jasper Jumpers. Both arches were cinched back to minimize the adverse effects of the functional appliance and to prevent slippage.

During appliance installation, bayonet bends are placed in the rectangular arch, distal to the mandibular canines and small teflon balls are slipped over the arch wire to provide an anterior stop. Anterior lingual crown torque is placed in the mandibular arch wire to minimize incisor

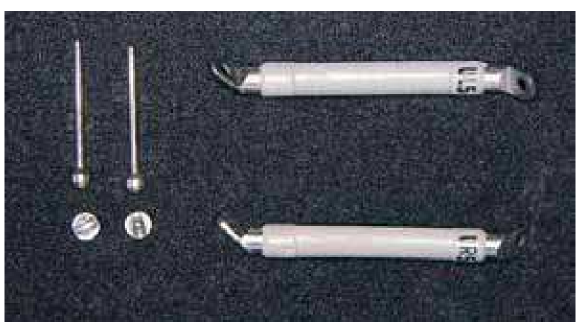

FIGURE 1 - Components of the Jasper Jumper appliance.

proclination. Subsequently, the Jasper Jumper flexible springs were selected and installed to correct the anteroposterior discrepancy

The size of the Jasper Jumper was selected accordingly to the length between the extra-oral tube entrance and the distal of the lower teflon ball. To obtain the spring size, 12 mm was added to this length (4 mm to compensate the tube length plus 4 mm of space that must exist between the pin-ball and the distal of the tube plus 4 mm that correspond to the appliance activation) (Figure 2). When the obtained length was an odd value, the next greater spring length was selected. The brackets of the lower first premolars were removed to allow a greater freedom of mandibular movement. In some patients, the lower first and second premolars brackets were removed. The pin-balls were placed through the distal hole in the force module and inserted into the face-bow tube on the maxillary first molar band, allowing the Jasper Jumper installation associated to the fixed appliance (Figure 3).

The patients were coached to practice opening and closing movements slowly at first and told to avoid excessive wide opening during eating and yawning. The clinician warned the patient against biting on the jumpers, as this would result in breakage.

The mean percentage of breakage to the present sample was 35.14%. The earliest breakage occurred after 2 months of appliance installation and the latest breakage occurred after 9 months. The appliance activations were performed by including new teflon balls in the lower arch.

After a mean period of 0.61 years of treatment, the maxillomandibular relation was overcorrected. The Jasper Jumper appliance was removed and treatment finishing and dental intercuspation were performed . During the finishing stage, all patients were submitted to an active retention protocol with Class II elastics for 10 hours/day. However, in some patients the Class II elastics were used for a longer period of time. After fixed appliances removal, a modified Hawley retainer was used in the maxillary arch and a 3 x 3 fixed retainer was bonded in the mandibular arch. A modified Bionator was used in a night-time wear protocol as active retention. This appliance exhibited less acrylic resin in the posterior region, without mandibular incisors coverage, and was used during one year.

Methods

Llateral cephalograms were evaluated before (T1) and after (T2) orthodontic treatment for each subject. The cephalograms were taken with lips in rest position and in centric occlusion.

Lateral cephalograms were manually traced, landmarks were digitized for a single investigator (RPH) and measurements were obtained with Dentofacial Planner 7.02 (Dentofacial Planner Software, Toronto, Ontario, Canada), which corrected the radiographic magnification (6 and 9.8%).

FIGURE 2 - Selection of the length of the Jasper Jumper appliance. In the example, the distance was 20 mm; adding to the recommende 12 mm = 32 mm (Jasper Jumper size 4).

FIGURE 3 - The Jasper Jumper installed.

FIGURE 4 - The Jasper Jumper installed.

Error study

After a month interval from the first measurement, thirty randomly selected cephalograms were retraced and re-measured by the same examiner (RPH). Casual errors were calculated according to Dahlberg's formula6 ($Se^2= \Sigma d^2/2n$) where Se^2 is the error variance and d is the difference between the two determinations of the same variable, and the systematic errors were evaluated with dependent t tests, for $P <.05$.

Statistical analysis

Inter-group compatibility for sex distribution and initial severity of Class II molar relationship were performed by Chi square tests. Inter-group compatibility for initial and final ages and treatment/observation time were performed by independent t tests.

Inter-group comparison of pretreatment (T1), posttreatment (T2) and changes between T1 and T2 (T2-1) were performed by independent t tests.

All statistical analysis was performed with the use of Statistica software (Statistica for Windows, Release 6.0, Copyright Statsoft Inc., 2001). Results were considered significant for $P<0.05$.

RESULTS

Table 1 shows the results of intraexaminer systematic and casual errors, performed by dependent t tests and Dahlberg formula[6], respectively. The errors verified are within acceptable values and can provide reliable results.

Table 2 presents the results of inter-group compatibility of initial and final ages and mean time of evaluation.

Table 3 shows results of Chi-square test for inter-group comparison of sex distribution. Table 4 shows results of Chi-square test for inter-group comparison of initial severity of the Class II molar relationship.

Results of inter-group comparison at pretreatment stage are shown in Table 5.

Table 6 presents the results of inter-group comparison of changes in cephalometric variables during treatment and observation time.

Table 7 shows the results of inter-group comparison of cephalometric variables at posttreatment stage.

DISCUSSION

Sample

The groups were similar regarding several parameters that could influence this comparison. Thus, a compatible control Class II group was used to evaluate the Jasper Jumper treatment changes. The control group was important to distinguish the treatment effects from the craniofacial growth changes. Besides, the groups were compatible regarding other parameters such as pretreatment age, treatment duration, severity of the anteroposterior malocclusion, gender distribution and initial chephalometric characteristics.

To improve inter-group compatibility Class II, division 2 patients were excluded. The possible influence of inherent characteristics of these patients on results and treatment time determined their sample exclusion[19]. Class II subdivision patients were also excluded because unilateral Class I molar relationship could also influence results and treatment time. Besides, studies that evaluated Class II subdivision malocclusion demonstrated that the main components of this malocclusion are dentoalveolar[12], requiring asymmetric mechanics or extraction protocols, that certainly are not the purpose of the present investigation.

Although sample size was not ideal, the number of subjects can be considered satisfactory to produce reliable results because similar studies with functional fixed appliances also used samples of similar sizes or smaller[17,18,20,30].

Inter-group Compatibility

The groups were similar regarding pre and posttreatment ages, treatment duration and gender distributions (Tables 2 and 3).

The inter-group compatibilities regarding ini-

TABLE 1 - Results of t test and Dahlberg's formula[6], applied to variables to estimate systematic and casual errors, respectively.

VARIABLES	1ª MEASUREMENT (n = 30) Mean (s.d.)	2ª MEASUREMENT (n = 30) Mean (s.d.)	DAHLBERG	P
MAXILLARY COMPONENT				
SNA (°)	84.13 (2.01)	83.94 (1.99)	0.69	0.357
Co-A (mm)	87.13 (3.17)	86.37 (3.42)	0.70	0.187
A-Nperp (mm)	1.76 (2.86)	2.17 (2.80)	0.48	0.288
MANDIBULAR COMPONENT				
SNB (°)	78.51 (2.64)	77.90 (2.19)	0.88	0.167
Co-Gn (mm)	106.46 (4.73)	107.30 (4.36)	0.72	0.238
Go-Gn (mm)	70.51 (3.19)	71.32 (3.88)	0.56	0.190
P-Nperp (mm)	-2.53 (4.71)	-3.49 (4.29)	0.75	0.183
MAXILLOMANDIBULAR RELATIONSHIP				
ANB (°)	5.34 (3.08)	4.91 (2.96)	0.41	0.291
NAP (°)	9.87 (4.38)	8.65 (4.16)	0.93	0.136
Wits (mm)	1.47 (1.90)	0.76 (1.62)	0.84	0.062
VERTICAL COMPONENT				
FMA (°)	23.92 (4.85)	24.38 (4.93)	1.02	0.358
SN.GoGn (°)	30.45 (4.21)	30.92 (4.05)	1.01	0.330
LAFH (mm)	60.35 (4.73)	61.17 (4.11)	0.67	0.238
SN.PP (°)	7.23 (4.66)	6.18 (4.38)	0.96	0.186
SN.Ocl (°)	17.39 (3.90)	18.22 (3.77)	0.87	0.202
S-Go (mm)	70.42 (4.11)	69.15 (4.58)	0.70	0.131
MAXILLARY DENTOALVEOLAR COMPONENT				
1.PP (°)	114.29 (5.40)	113.63 (5.64)	1.25	0.322
1-PP (mm)	25.48 (4.28)	26.19 (4.35)	0.45	0.262
1.NA (°)	23.41 (5.60)	22.05 (5.79)	1.18	0.179
1-NA (mm)	3.71 (2.59)	4.52 (2.84)	0.43	0.113
6-PP (mm)	20.67 (3.19)	19.81 (3.56)	0.59	0.164
MANDIBULAR DENTOALVEOLAR COMPONENT				
IMPA (°)	96.09 (5.12)	98.43 (5.39)	1.36	0.045*
1.NB (°)	29.36 (5.21)	31.98 (5.80)	1.47	0.035*
1-NB (mm)	5.26 (2.49)	5.87 (3.01)	0.62	0.198
1-GoMe (mm)	37.49 (2.74)	38.02 (2.18)	0.58	0.205
6-GoMe (mm)	27.67 (2.33)	28.41 (2.25)	0.94	0.107
DENTAL RELATIONSHIPS				
Overjet (mm)	4.35 (2.19)	3.94 (2.56)	0.37	0.253
Overbite (mm)	3.89 (1.97)	3.22 (2.68)	0.41	0.137
Molar Rel. (mm)	1.15 (1.82)	0.98 (1.34)	0.25	0.340

* Statistically significant for $P < 0.05$.

TABLE 2 - Inter-group comparison of initial and final ages and evaluation time (independent t tests).

VARIABLES (Years)	GROUP 1 JASPER JUMPER (n = 25)		GROUP 2 CONTROL (n = 22)		P
	Mean	s.d.	Mean	s.d.	
Initial Age	12.72	1.20	12.67	0.75	0.869
Final Age	14.87	1.20	14.79	1.70	0.856
Evaluation Time	2.15	0.29	2.12	1.63	0.936

TABLE 3 - Inter-group comparison of sex distribution (Chi-square).

GROUPS	MASCULINE	FEMININE	TOTAL
1 (Jasper Jumper)	13	12	25
2 (Control)	12	10	22
TOTAL	25	22	47
$X^2 = 0.03$ df = 1 P = 0.861			

TABLE 4 - Inter-group comparison of initial severity of the Class II molar relationship (Chi-square test).

GROUPS	1/2-CUSP CLASS II	3/4-CUSP CLASS II	FULL-CUSP CLASS II	TOTAL
1 (Jasper Jumper)	4	9	12	25
2 (Control)	10	5	7	22
TOTAL	14	14	19	47
$X^2 = 3.47$ df = 2 P = 0.176				

tial age and treatment time were essential because these factors might influence the intensity of growth and chephalometric changes, influencing favorably or not the Class II malocclusion correction[8].

Initial malocclusion severity was verified in the study models. The Chi-square test demonstrated no inter-group differences regarding initial anteroposterior malocclusion severity distributions (Table 4). Although the experimental

TABLE 5 - Inter-group comparison of cephalometric variables at pre-treatment stage (T1) (independent t tests).

VARIABLES	GROUP 1 JASPER JUMPER (n = 25) Mean (s.d.)	GROUP 2 CONTROL (n = 22) média (s.d.)	P
MAXILLARY COMPONENT			
SNA (°)	82.60 (3.36)	81.93 (3.15)	0.486
Co-A (mm)	85.34 (4.44)	86.01 (4.65)	0.616
A-Nperp (mm)	1.17 (3.80)	1.19 (2.85)	0.984
MANDIBULAR COMPONENT			
SNB (°)	77.30 (2.39)	77.70 (3.76)	0.665
Co-Gn (mm)	106.30 (4.99)	106.04 (6.09)	0.871
Go-Gn (mm)	70.56 (3.83)	69.43 (4.30)	0.349
P-Nperp (mm)	-4.83 (4.89)	-3.35 (4.33)	0.281
MAXILLOMANDIBULAR RELATIONSHIP			
ANB (°)	5.30 (3.06)	4.23 (1.97)	0.167
NAP (°)	8.76 (7.66)	7.17 (5.28)	0.417
Wits (mm)	1.62 (2.45)	-0.45 (2.43)	0.005*
VERTICAL COMPONENT			
FMA (°)	24.62 (3.92)	23.80 (2.72)	0.419
SN.GoGn (°)	31.12 (4.05)	30.86 (4.76)	0.840
LAFH (mm)	61.27 (4.93)	59.75 (4.10)	0.262
SN.PP (°)	4.06 (16.36)	8.05 (3.49)	0.267
SN.Ocl (°)	18.92 (3.77)	19.58 (5.75)	0.643
S-Go (mm)	69.38 (5.09)	68.86 (5.44)	0.736
MAXILLARY DENTOALVEOLAR COMPONENT			
1.PP (°)	110.63 (7.11)	113.26 (5.60)	0.494
1-PP (mm)	25.95 (4.48)	25.97 (2.57)	0.981
1.NA (°)	23.95 (7.50)	23.27 (6.53)	0.745
1-NA (mm)	4.49 (2.86)	3.32 (1.94)	0.112
6-PP (mm)	19.22 (8.56)	20.13 (2.13)	0.629
MANDIBULAR DENTOALVEOLAR COMPONENT			
IMPA (°)	97.66 (7.39)	94.77 (4.68)	0.121
1.NB (°)	28.22 (5.80)	25.58 (5.01)	0.104
1-NB (mm)	4.98 (2.11)	3.94 (1.54)	0.064
1-GoMe (mm)	38.18 (2.83)	37.18 (2.57)	0.212
6-GoMe (mm)	27.71 (2.25)	27.25 (2.20)	0.478
DENTAL RELATIONSHIPS			
Overjet (mm)	6.14 (2.30)	4.68 (1.52)	0.015*
Overbite (mm)	4.99 (1.69)	4.78 (1.73)	0.676
Molar Rel. (mm)	-1.33 (1.22)	0.71 (1.13)	0.000*

* Statistically significant for P<0.05.

TABLE 6 - Results of intergroup comparison of cephalometric changes (independent t tests).

VARIABLES	GROUP 1 JASPER JUMPER (n = 25) Mean (s.d.)	GROUP 2 CONTROL (n = 22) Mean (s.d.)	P
MAXILLARY COMPONENT			
SNA (°)	-1.42 (2.31)	0.73 (2.59)	0.004*
Co-A (mm)	0.58 (2.20)	2.95 (2.59)	0.001*
A-Nperp (mm)	-1.28 (2.89)	0.78 (3.29)	0.026*
MANDIBULAR COMPONENT			
SNB (°)	0.02 (1.07)	0.48 (2.19)	0.350
Co-Gn (mm)	4.17 (2.91)	4.11 (3.55)	0.950
Go-Gn (mm)	2.86 (2.46)	3.10 (2.19)	0.722
P-Nperp (mm)	-0.06 (4.34)	0.92 (4.97)	0.473
MAXILLOMANDIBULAR RELATIONSHIP			
ANB (°)	-1.42 (1.67)	0.23 (1.36)	0.000*
NAP (°)	-3.20 (3.76)	0.53 (3.11)	0.000*
Wits (mm)	-1.72 (3.10)	1.15 (2.29)	0.000*
VERTICAL COMPONENT			
FMA (°)	0.78 (2.62)	-0.02 (1.91)	0.239
SN.GoGn (°)	0.70 (1.83)	-0.28 (2.30)	0.110
LAFH (mm)	4.30 (2.65)	2.86 (2.58)	0.068
SN.PP (°)	3.56 (15.72)	0.17 (1.90)	0.320
SN.Ocl (°)	-0.13 (2.75)	-1.48 (3.86)	0.169
S-Go (mm)	3.73 (2.57)	2.78 (3.13)	0.262
MAXILLARY DENTOALVEOLAR COMPONENT			
1.PP (°)	0.54 (17.22)	0.31 (3.45)	0.952
1-PP (mm)	2.18 (3.71)	0.61 (1.17)	0.064
1.NA (°)	-1.62 (8.35)	-0.60 (3.58)	0.598
1-NA (mm)	-0.61 (3.03)	-0.21 (1.31)	0.571
6-PP (mm)	1.89 (8.99)	1.66 (1.22)	0.904
MANDIBULAR DENTOALVEOLAR COMPONENT			
IMPA (°)	2.43 (5.95)	-0.10 (4.14)	0.102
1.NB (°)	3.28 (5.75)	0.39 (4.36)	0.061
1-NB (mm)	1.63 (1.56)	0.38 (1.54)	0.008*
1-GoMe (mm)	0.47 (1.32)	1.51 (1.99)	0.039*
6-GoMe (mm)	3.26 (1.24)	1.17 (1.85)	0.000*
DENTAL RELATIONSHIPS			
Overjet (mm)	-3.70 (2.38)	-0.08 (1.39)	0.000*
Overbite (mm)	-2.90 (1.33)	-0.60 (1.90)	0.000*
Molar Rel. (mm)	3.42 (1.18)	-0.24 (1.42)	0.000*

* Statistically significant for P<0.05.

TABLE 7 - Inter-group comparison of cephalometric variables at post-treatment stage (T2) (independent t tests).

VARIABLES	GROUP 1 JASPER JUMPER (n = 25) Mean (s.d.)	GROUP 2 CONTROL (n = 22) média (s.d.)	P
MAXILLARY COMPONENT			
SNA (°)	81.18 (3.28)	82.67 (3.35)	0.132
Co-A (mm)	85.92 (4.95)	88.96 (4.21)	0.029*
A-Nperp (mm)	-0.11 (4.79)	1.97 (3.27)	0.091
MANDIBULAR COMPONENT			
SNB (°)	77.32 (2.59)	78.18 (3.79)	0.363
Co-Gn (mm)	110.47 (5.31)	110.15 (6.45)	0.852
Go-Gn (mm)	73.42 (3.98)	72.54 (4.16)	0.463
P-Nperp (mm)	-4.89 (6.35)	-2.43 (5.86)	0.176
MAXILLOMANDIBULAR RELATIONSHIP			
ANB (°)	3.88 (2.80)	4.46 (1.34)	0.378
NAP (°)	5.56 (7.44)	7.70 (3.91)	0.234
Wits (mm)	-0.10 (2.88)	0.70 (2.63)	0.329
VERTICAL COMPONENT			
FMA (°)	25.41 (4.72)	23.78 (3.19)	0.180
SN.GoGn (°)	31.82 (4.34)	30.58 (4.89)	0.361
LAFH (mm)	65.57 (4.66)	62.62 (4.91)	0.040*
SN.PP (°)	7.63 (3.06)	8.23 (3.41)	0.525
SN.Ocl (°)	18.79 (3.75)	18.09 (4.82)	0.579
S-Go (mm)	73.12 (5.48)	71.65 (5.34)	0.359
MAXILLARY DENTOALVEOLAR COMPONENT			
1.PP (°)	111.18 (6.22)	113.58 (6.90)	0.215
1-PP (mm)	28.14 (2.95)	26.59 (2.85)	0.075
1.NA (°)	22.32 (7.88)	22.67 (6.70)	0.871
1-NA (mm)	3.88 (3.05)	3.10 (1.95)	0.312
6-PP (mm)	21.12 (3.72)	21.80 (2.13)	0.455
MANDIBULAR DENTOALVEOLAR COMPONENT			
IMPA (°)	100.10 (6.93)	94.67 (4.48)	0.003*
1.NB (°)	32.51 (5.78)	25.97 (4.98)	0.001*
1-NB (mm)	6.62 (2.63)	4.33 (2.06)	0.001*
1-GoMe (mm)	38.66 (2.82)	38.69 (2.73)	0.965
6-GoMe (mm)	30.98 (2.27)	28.42 (2.43)	0.000*
DENTAL RELATIONSHIPS			
Overjet (mm)	2.44 (0.57)	4.60 (1.87)	0.000*
Overbite (mm)	2.08 (0.81)	4.17 (1.52)	0.000*
Molar Rel. (mm)	2.08 (0.64)	0.47 (1.42)	0.000*

* Statistically significant for P<0.05.

group (Jasper Jumper) exhibited more subjects presenting full cusp and ¾ cusp Class II molar relation, this difference between groups were not statistically significant. The number of severe Class II subjects included in the control group was smaller than in the experimental group because, due to ethical concerns, patients with severe Class II could not be observed without intervention until 15 years-old. Possibly, they would be in a favorable age to begin treatment[6]. Moreover, a similar study[11] also used control groups with milder Class II characteristics than the experimental group.

Initial Cephalometric Characteristics

In a gold-standard study, groups that will be compared should exhibit similar cephalometric Class II characteristics at the pretreatment stage (T1).

In the present study, 26 of 29 variables evaluated exhibited no inter-group differences at pretreatment. Thus, there were no inter-group differences in 89.65% of the cephalometric variables analyzed at T1. Probably, these small differences were result of a control group with milder cephalometric Class II characteristics than experimental group at the pretreatment stage.

Subjects from experimental and control groups presented similarity in their cephalometric characteristics regarding maxillary and mandibular components, growth pattern, maxillary and mandibular dentoalveolar components (Table 5).

During the maxillomandibular component analysis, only the Wits measurement exhibited significant differences between experimental and control groups at T1 (Table 5). The dental component exhibited significant inter-group differences in the amount of initial overjet and molar relation (Table 5), when evaluated at T1.

The experimental group had a significantly greater maxillomandibular discrepancy when compared to the control group, resulting in a significantly greater overjet and molar relation discrepancy. This fact may be justified due to the milder severity of initial malocclusion of subjects from the control group, with few subjects presenting full-cusp Class II. Since control group comprised Class II patients, not submitted to orthodontic intervention, this group exhibited subjects with milder Class II malocclusions. Patients with severe Class II malocclusions, if present in this group, could not be observed longitudinally without intervention due to ethical concerns. Other studies have also used control groups with milder Class II cephalometric characteristics than the experimental group[11,19,21].

Inter-group Comparisons

Maxillary Component

There were significant differences between the groups for the variables that described the maxillary component (Table 6). The inter-group comparisons showed that the Jasper Jumper therapy resulted in significant retrusion and forward growth restriction in the maxillary complex.

The Jasper Jumper appliance promoted greater restriction in maxillary forward displacement when compared to the normal growth changes. This result is in agreement with previous studies that also found significant restriction of maxillary growth during Jasper Jumper therapy[1,4,5,14,17-21,26].

Some similar investigations found some restrictive effect, particularly when SNA angle was evaluated. The studies pointed out that this restrictive effect could be related to some changes that are similarly observed when extra-oral appliances are used for Class II malocclusion correction as maxillary molars distalization and intrusion[4,17,18]. This phenomenon is described as the "headgear effect."

During treatment with Jasper Jumper associated to fixed appliances, the maxillary and mandibular teeth were engaged in a thick and rectangular wire, forming one unit[18]. As a result, when the distal directed force of the Jasper Jumper caused upper molar intrusion and distalization, the consequent effects on the upper anterior region were incisor elongation and uprighting. The overall result was a clockwise rotation of the palatal plane[17,18]. The distal directed force of the Jasper Jumper possibly induced retrusion and forward growth restriction of the maxillary complex during treatment.

At the end of active treatment, the effective length of the maxilla was significant greater in the control group. However, the maxillary complex positioning was similar between groups (Table 7).

Mandibular Component

No significant inter-group differences were found for the mandibular component analysis (Table 6). There was no mandibular protrusion or increments in mandibular size due to treatment. The mandibular changes were inherent to the mandibular normal growth, corroborating previous reports[4,5,16,19-22]. However, some studies described some mandibular protrusion during treatment with Jusper Jumper appliances[1,14,17,26,29,30].

The treatment with orthopedic appliances typically results in a temporary and rapid change in mandibular posture. Mandibular condyle growth in the direction of the glenoid fossa compensates this rapid change in mandibular posture[15]. Voudouris and Kuftinec[28] related that the mandibular protrusion due to the functional appliance approach stretches the retrodiscal tissues, stimulating bone remodeling of this anatomic region. After appliance removal, the stimulation loses intensity until it reaches basal levels. This fact may explain the lack of significant changes in the mandibular component of the experimental group when compared to the control group (Table 7).

Maxillomandibular Relationship

During treatment, the maxillomandibular relationship, evaluated by ANB angle and Wits appraisal, showed significant improvement. There was a significant reduction in facial convexity in the experimental group when compared to the control (Table 6), in accordance to previous reports[5,17-22,26,29,30].

The maxillomandibular relationship changes observed in the experimental group seem to have resulted primarily from restriction in maxillary forward displacement, as previously discussed, to mandibular normal growth changes and also to some dentoalveolar effects[19].

However, there were no differences between the groups regarding maxillomandibular relationship after treatment (Table 7). This fact may have occurred because the experimental group exhibited a more severe discrepancy in the maxillomandibular relationship at pretreatment.

Vertical Component

This study demonstrated that Jasper Jumper appliances do not change the craniofacial growth pattern (Table 6). The growth pattern remained relatively stable in both groups.

Previous findings indicate that the Jasper Jumper may induce vertical changes and clockwise mandibular rotation[4,17-19,21,29], however, other studies did not show significant changes on growth pattern[1,16,20,22], confirming the results of the present study.

A significant increase in the lower anterior face height (LAFH) was observed in the experimental group (Table 7). The LAFH was significantly greater in patients treated with Jasper Jumper when compared to the control group.

The LAFH was greater (but not statistically significant) in the experimental group at T1 and had a significantly greater increase during treatment when compared to the control group.

Maxillary Dentoalveolar Component

The amount of changes in the maxillary dentoalveolar component were similar in both groups. None of the variables that described this component exhibited significant differences between experimental and control groups (Table 6).

Retrusion of the upper incisors was not observed in the experimental group. However, other previous studies related significantly maxillary incisor retrusion during Jasper Jumper therapy[4,17-19,21,29,30]. Perhaps, the greater maxillary retrusion of the experimental group when compared to the control group influenced the positioning of the NA line and, consequently, the linear evaluation of the maxillary incisor[21]. Some studies also verified no significant retrusion and palatal tipping of maxillary incisors after treatment with Jasper Jumper and fixed appliances[5,22,26]. Besides, the lack of maxillary incisor tipping changes may be attributed to the anterior torque incorporated in the Roth pre-adjusted brackets[21].

Some other authors found significant extrusion of maxillary central incisors and intrusion of upper first molars in patients treated with Jasper Jumper appliance[4,5,17,19], however, this was not confirmed in this research. Perhaps, the transpalatal arch may have inhibited maxillary molar intrusion. The present study demonstrated a greater extrusion of maxillary incisors of 1.5 mm in the experimental group when compared to the control group (Table 6).

There were not significant inter-group differences in mean values obtained for the variables that described the maxillary dentoalveolar component after treatment (Table 7).

Mandibular Dentoalveolar Component

The mandibular incisors presented more buccal inclination during treatment with the Jasper Jumper, but the differences between experimental and control groups were not statiscally significant (Table 6). However, after treatment the mandibular incisors were more proclined in the experimental group than in the control group (Table 7).

The present findings regarding mandibular incisor inclination after treatment with Jasper Jumper appliance agree with previous reports[21].

Probably, the tendency of mandibular incisor proclination during treatment was minimized due to the anterior lingual crown torque placed in the mandibular arch wire[14,19,22]. Covell Jr et al.[5] observed mandibular incisor proclination after fixed appliances removal. Thus, the author stated that fixed appliances do not improve mandibular incisor inclination. Stucki and Ingervall[26] noted a significant incisor proclination during Jasper Jumper therapy, however, the authors verified some incisor uprighting after appliance removal. According to the authors, only 30% of incisor proclination that occurred during Jasper Jumper treatment remained after fixed appliances removal[26]. The residual effect of the treatment consists in moderate mandibular incisor proclination. In the present study, this phenomenon may also have occurred due this natural tendency of relapse in incisors inclination[26].

The mandibular incisors were significantly protruded during treatment (Table 6). After treatment, mandibular incisors were more protruded in the experimental group (Table 7). These findings are in line with previous reports[1,4,5,16-19,21,22,26,29,30].

Vertical development of mandibular incisors was inhibited during treatment, with significant differences between experimental and control groups (Table 6). The intrusion of mandibular incisors occurred because the Jasper Jumper appliances apply downward and forward forces to the mandibular dentition[17]. Mandibular incisor intrusion during Jasper Jumper treatment was also reported by some authors[4,5,17,18,20,26,30].

The experimental group exhibited statistically significant greater extrusion of mandibular molars during treatment (Table 6). However, after treatment, the mandibular molars in the experimental group were not more extruded than in the control group (Table 7).

The mandibular molar extrusion noted in the experimental group during treatment was expected because previous reports also described these effects after Jasper Jumper therapy[4,5,17-19,26,29,30].

Dental Relationships

During treatment, the experimental group (Jasper Jumper) exhibited significant decreases in overbite and overjet and significant molar relation improvement, when compared to the control group (Table 6).

The overjet correction using Jasper Jumper appliances was previously reported[4,5,17-21,26,29,30].

In the experimental group, the overjet correction was obtained due to restriction of forward displacement of the maxilla, mandibular incisor protrusion and mandibular normal growth.

The pretreatment overbite was similarly increased in both groups at T1, however, after treatment with the Jasper Jumper, the patients that comprised the experimental group exhibited significant decreases in the overbite, resulting in its normalization. The mandibular incisor intrusion may have contributed to overbite correction in the experimental group[20,29,30]. Besides, the mandibular molar extrusion during treatment may also have contributed to overbite correction.

At T2, the control group exhibited significantly greater overjet and overbite (Table 7). The molar relation was significantly better in the experimental group (Table 7). These results were expected because both groups exhibited Class II malocclusion at pretreatment, but only the experimental group had the molar relation corrected by Jasper Jumper appliances. Consequently, there were overjet and overbite decreases.

CLINICAL CONSIDERATIONS

The present study has shown that the Jasper Jumper is an efficient protocol to Class II, division 1 malocclusion correction. The results revealed that the appliance corrected Class II discrepancies mostly through dentoalveolar changes[1,4,5,16-18,20,22]. Because of its predominantly dentoalveolar effects, the Jasper Jumper can also be used in nongrowing Class II patients[18,21].

The inter-group comparisons showed that the Jasper Jumper therapy resulted in significant retrusion and forward growth restriction of the maxillary complex and other significant dentoalveolar changes. The mandibular incisors were significantly protruded and mandibular molars were extruded during treatment. Based on the current results, it can be inferred that Jasper Jumper appliances should be mainly indicated in Class II malocclusions presenting maxillary protrusion.

The treatment planning consists in one of the most important phases during an orthodontic approach. The numerous studies that evaluated the effects of different appliances must be used to help clinicians in the decision of which treatment protocol would be more adequate for specific malocclusions.

CONCLUSIONS

In comparison to the control group, the Jasper Jumper group presented a greater restriction of the anterior displacement of the maxilla and a greater maxillary retrusion, improvement of the maxillomandibular relationship, reduction of the facial convexity, greater protrusion and intrusion of the mandibular incisors and greater extrusion of mandibular molars, apart from a greater reduction of overjet and overbite and greater improvement of the molar relationship.

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