Original Article

Treatment Efficiency in Skeletal Class II Patients Treated with the Jasper Jumper

A Cephalometric Evaluation

Nazan Küçükkeleş[a]; Işıl İlhan[b]; İ. Ata Orgun[c]

ABSTRACT
Objective: To analyze the effects of the Jasper Jumper appliance during the treatment of skeletal Class II malocclusion.
Materials and Methods: Lateral cephalograms and hand-wrist radiographs were collected from 45 Class II growing patients (22 boys, 23 girls). Three sets of records (initial, before Jasper Jumper, after Jasper Jumper) from 25 patients were compared with 20 control subjects of similar skeletal developmental stage. Mean age of the treatment and control groups were 11.83 years and 11.3 years, respectively. The data were analyzed by using paired *t*-tests.
Results: The results demonstrated that the Jasper Jumper effectively corrected Class II malocclusion, but the changes were 80% dentoalveolar. The Jasper Jumper induced a clockwise rotation of the occlusal plane without much alteration in vertical dimension. Skeletally, the maxillary growth was restricted and pogonion moved forward, improving the profile.
Conclusion: The Jasper Jumper appliance may be an effective method to improve both the skeletal imbalance and the profile in growing patients.

KEY WORDS: Class II correction; Jasper Jumper; Functional treatment

INTRODUCTION

Class II division 1 malocclusion is frequently seen in orthodontic practice, and it constitutes 12% to 49% of all orthodontic problems.[1,2] According to McNamara,[3] the most common single characteristic of all Class II malocclusions is mandibular skeletal retrusion, rather than maxillary prognathism. Consequently, modification and redirection of mandibular growth is the main goal of most Class II treatment protocols. This method also forms the foundation of functional jaw orthopedics.[3] Both the skeletal imbalance and profile attractiveness in Class II patients can be improved with functional appliances.[4–6]

Functional treatment approaches and outcomes are related to the growth potential of the patient. This causes a problem when it comes to improving the profile in adolescents. Unlike removable functional appliances, fixed-bite jumping devices apply continuous light forces, thus eliminating patient cooperation and shortening treatment time. These devices can be categorized into two subgroups: semielastic (eg, Eureca Spring, Twin Force Bite Corrector, Jasper Jumper) and rigid (eg, Herbst, MARA) bite-jumping devices. Despite the increased patient acceptance and ease of application of the semielastic appliances, both groups demonstrate similar results regarding the dentoskeletal correction.[7–9]

One such semielastic fixed functional appliance is the Jasper Jumper. This intraoral appliance consists of bilateral flexible springs exerting continuous light forces to both arches. The device works through forward positioning of the mandible, using the patient's growth potential for correction of Class II malocclusions in a relatively short time. It is easy to use and mostly well tolerated by the patients, allowing free lateral jaw movements. It is also reported that in some borderline cases the Jasper Jumper can be used in older patients as an alternative to orthognatic surgery or extraction protocols.[10,11]

In the very first study about the Jasper Jumper,

[a] Professor, Department of Orthodontics, Marmara University, İstanbul, Turkey.
[b] Research Assistant, Department of Orthodontics, Marmara University, İstanbul, Turkey.
[c] Private practice, İstanbul, Turkey.
Corresponding author: Dr Işıl İlhan, Department of Orthodontics, Marmara University, Güzelbahce sokak no:6, İstanbul, 34365, Turkey (e-mail: ilhanisil@hotmail.com)

Accepted: June 2006. Submitted: March 2006.

Table 1. Age and Gender Distributions of the Subjects in the Study

Group	Gender		Total No.	Mean Age, y
	Boys	Girls		
Treatment	12	13	25	11.83
Control	10	10	20	11.3

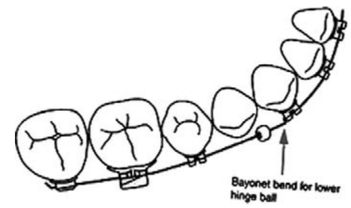


Figure 1. Engagement of the mandibular arch wire and the Teflon ball.

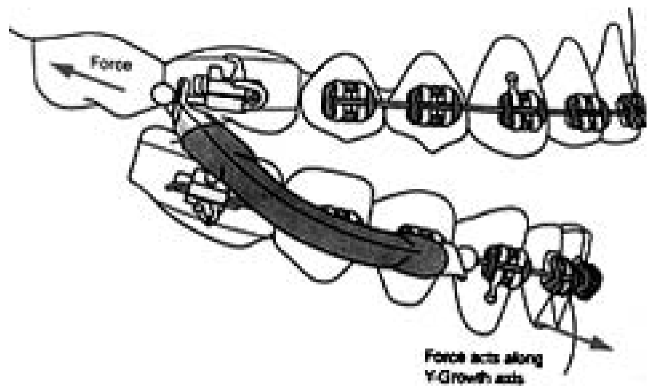


Figure 2. Forces generated by the Jasper Jumper appliance.

Cope et al[12] reported that the overall changes were mostly dentoalveolar. Mandibular effects included significant protrusion of the lower incisors and mesial tipping of the mandibular molars, together with a clockwise rotation of the mandible itself. These findings were also confirmed in a more recent research from Nalbantgil et al.[13] In 1998, Stucki and Ingervall[14] studied the Jasper Jumper effects in young permanent dentition and found out that, in addition to the known dentoalveolar effects, only 60% of the achieved correction remained after a retention period of 7 months. Covell et al,[15] in a study involving 36 growing patients, revealed that only 3% of the overall changes were skeletal. Weiland and Bantleon,[16] however, found out that the skeletal effects of the Jasper Jumper were 40%, and the correction was restricted predominantly to the mandible.

In light of these controversial findings, our aim was to evaluate the treatment effects of the Jasper Jumper appliance and compare our findings with the existing literature.

MATERIALS AND METHODS

The sample consisted of the records from 45 growing patients (22 boys, 23 girls) exhibiting skeletal Class II malocclusion characterized by mandibular retrognathism. Twenty-five patients (12 boys, 13 girls) with a mean age of 11.83 years were treated with the Jasper Jumper appliance followed by standard edgewise mechanics. A control group was formed by the records of 20 skeletal Class II patients with a mean age of 11.3 years who were observed for 6 months before orthodontic treatment (Table 1). Approval for the study was obtained from Marmara University, Department of Orthodontics.

Patient selection criteria included the following: (1) Class II skeletal and dental relationship, (2) normal or reduced incisor-mandibular plane angle, (3) well-aligned lower arch, (4) patient at the peak stage of the growth curve, and (5) normal or low-angle growth pattern.

Appliance Design and Application

For orthodontic therapy, upper bands with triple attachments and 0.018-inch standard edgewise brackets were used. After the leveling (mean time 4.7 months), 0.017-inch $\times$ 0.025-inch stainless steel arch wires were engaged in both arches just before the insertion of the Jasper Jumpers (American Orthodontics, Sheboygan, Wis). Both arches were cinched back to minimize the adverse effects of the appliance and to prevent slippage. The size of the Jasper Jumper was selected according to the manufacturer's instructions with separate measurements on each side.[17] The upper end of the spring was attached to the maxillary molars via a pin-ball through the headgear tube. The lower first premolar brackets were debonded after the leveling, and a toe-out bending was performed distal to the canine brackets (Figure 1). The Jasper Jumper was then attached onto the mandibular arch wire, distal to the Teflon ball. A minimal gap of 8 mm was allowed from the pin-ball head to the distal of the headgear tube in maxilla to increase appliance efficiency (Figure 2). To ease patient adaptation, no activation was made at the first insertion. After 1 week, a 2-mm activation was performed, which was renewed once in 6 weeks. When an over–Class I relationship was achieved, treatment was continued by standard edgewise techniques.

Cephalometric Methods

Timing of treatment was established according to the skeletal age by means of hand-wrist radiographs, which were interpreted according to Grave's criteria. In the control group, lateral cephalograms were exposed for each patient at the beginning and at the end

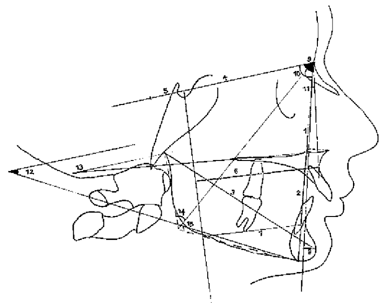


Figure 3. Skeletal linear and skeletal angular measurements: 1. N-Me, 2. ANS-Me, 3. Art.-Pg, 4. SL, 5. SE, 6. A ⊥ RL, 7. B ⊥ RL, 8. Pg ⊥ NB, 9. SNA, 10. SNB, 11. ANB, 12. MP-SN, 13. PP-SN, 14/15: gonial ratio.

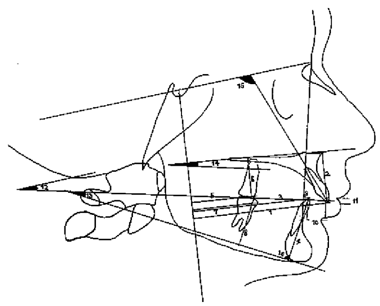


Figure 4. Dental linear and dental angular measurements: 1. UIT ⊥ RL, 2. UIT ⊥ PP, 3. LIT ⊥ RL, 4. LIT ⊥ MP, 5. U6M ⊥ RL, 6. U6T ⊥ PP, 7. L6M ⊥ RL, 8. L6T ⊥ MP, 9. LIT ⊥ NB, 10. overjet, 11. overbite, 12. OP-SN, 13. OP-MP, 14. PP-OP, 15. UI-SN, 16. IMPA (incisor-mandibular plane angle).

of the observation period. From the 25 Jasper Jumper patients, three sets of lateral cephalograms were taken: initial (T1), before Jasper Jumper insertion (T2), and after the removal of the appliance (T3).

All cephalograms were traced manually on acetate paper by the same doctor. Cephalometric planes for hard and soft tissue measurements are illustrated in Figure 3. The reference plane was established according to *An Atlas of Craniofacial Growth*.[18] The perpendicular to a constructed horizontal line, 5.6° to SN plane, was taken as reference plane. Skeletal, dental, and soft tissue measurements are shown in Figures 3 through 5.

The data obtained from the cephalometric tracings were evaluated statistically by using the *t*-test. The method error was assessed with Dahlberg's formula after a random selection and retracing of 20 of 115 cephalograms.

RESULTS

During Jasper Jumper application, all the patients adapted quickly to the appliances. Appliance breakage was observed in four patients, in which cases the appliances were replaced immediately. All patients were

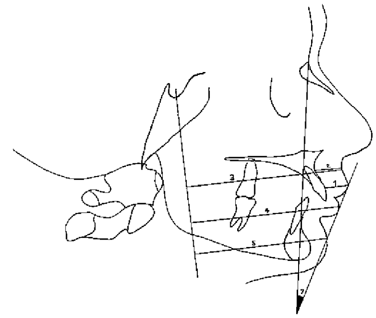


Figure 5. Soft tissue measurements: 1. upper lip thickness, 2. lower lip thickness, 3. Lab. sup. ⊥ RL, 4. Lab. inf. ⊥ RL, 5. Pg′ ⊥ RL, 7. H-angle.

corrected to a super–Class I relationship in a mean time of 6 months. Statistical data of the control and the treatment groups are illustrated in Tables 2 and 3, respectively, and comparisons between the control group and the treatment group during Jasper Jumper application (T3 - T2) are shown in Table 4.

Skeletal Changes

The skeletal values of the control and treatment groups did not show any significant differences. The treatment group, however, presented with significant changes during Jasper Jumper application. Art-Pg distance increased (2.8 ± 1.75 mm, $P < .001$), SNA decreased (−0.5 ± 0.52°, $P < .001$), and B-point moved forward (0.94 ± 1.79 mm, $P < .01$). The gonial ratio was the only parameter that changed significantly during the leveling stage (−2.78 ± 3.3, $P < .001$). Comparisons with the control group revealed a change in A-point location, which seemed to have moved posteriorly in the treatment group.

Dental Changes

Most of the significant dental changes in the control group were limited to the movements of the upper and lower incisors, whereas the occlusal plane changes were less significant.

During the leveling stage, overbite reduction and lower first molar extrusions were found to be the most significant. The increase in IMPA (incisor-mandibular plane angle) and mesial movement of the lower first molar were also important findings. During Jasper Jumper application, the dentoalveolar changes showed that the upper incisors uprighted (−4.1 ± 7.05°, $P < .01$) and extruded (1.24 ± 1.19 mm, $P <$ .001) and the lower incisors proclined (IMPA: 4.46 ± 5.05°, $P < .001$) and intruded (−1 ± 2.21 mm, $P <$ .01). In the posterior segment, the upper first molars moved distally (−0.72 ± 1.29 mm, $P < .01$) and intruded (−0.64 ± 0.67 mm, $P < .001$), whereas the lower first molars moved mesially (3.6 ± 1.89 mm, P

Table 2. Statistical Evaluation of Control Group During 6-mo Observation Period[a]

Value	Beginning		At 6 Months		Difference		Wilcoxon
	Mean	SD	Mean	SD	Difference	SD	*P* Value
SNA (°)	78.8	3.75	79	3.68	0.2	0.67	.286
SNB (°)	72.17	3.14	72.72	3.50	0.55	0.03	.020*
ANB (°)	6.62	1.47	6.32	1.48	−0.3	0.84	.169
A⊥RL (mm)	64.22	4.76	64.77	4.71	0.55	0.9	.021*
B⊥RL (mm)	50.1	6.49	51.1	7.24	1	0.2	.028*
Pg⊥NB (mm)	2.77	1.56	2.77	1.71	0	0.48	.968
ANSMe/N-Me (%)	55.43	2.07	55.98	1.84	0.55	1.41	.116
MP-SN (°)	37.72	4.29	37.92	4.22	0.2	0.93	.209
PP-SN (°)	8.65	2.34	8.92	2.75	0.27	1.67	.542
Gonial ratio (%)	69.11	6.18	68.42	6.58	−0.69	2.02	.126
SL (mm)	40.15	7.3	41.1	7.76	0.95	2.45	.187
SE (mm)	20.17	2.69	20.1	2.66	−0.07	0.74	.666
Art-Pg (mm)	97.25	4.13	98.37	4.27	1.12	1.07	.002**
UIT⊥RL (mm)	37.67	6.83	68.4	6.91	1.03	1.61	.008**
UIT⊥PP (mm)	28.27	2.06	28.7	2.2	0.43	0.69	.020*
UI-SN (°)	105.3	6.72	106.3	7.38	1	2.94	.163
LIT⊥RL (mm)	58.97	6.66	60.12	7.04	1.15	1.62	.005**
LIT⊥MP (mm)	39.4	2.45	40.02	2.17	0.62	0.88	.008**
IMPA (°)	93.45	8.88	93.55	7.14	0.1	3.11	.982
U6M⊥RL (mm)	35.7	5.29	36.5	5.27	0.8	2	.097
U6T⊥PP (mm)	21.02	1.74	21.62	2.01	0.6	1.86	.123
L6M⊥RL (mm)	32.05	5.84	33.05	6.35	1	2.12	.048*
L6T⊥MP (mm)	28.62	2.29	28.62	2.22	0	1.56	.924
LIT⊥NB (mm)	4.3	2.51	4.8	2.47	0.5	0.48	.002**
Overjet (mm)	9.45	3.17	9.67	2.94	0.22	1.3	.162
Overbite (mm)	3.47	2.75	3.82	2.35	0.35	0.77	.680
OP-SN (°)	19.67	4.21	18.45	3.89	−1.12	2.49	.046*
OP-MP (°)	17.95	3.48	18.87	3.10	0.92	1.84	.049*
PP-OP (°)	11.12	3.45	9.87	3.26	−1.25	2.17	.030*
Lab.sup⊥RL (mm)	78.17	6.42	79.87	6.08	1.7	2.23	.003**
Lab.inf.⊥RL (mm)	72.6	7.28	73.72	7.16	1.12	2.43	.070
Lip strain (mm)	2.62	2.12	2.95	2.14	0.33	0.9	.099
Pg′⊥RL (mm)	62.07	7.61	62.7	7.91	0.63	1.26	.074
H-ANB (°)	8.82	3.41	9.62	3.44	0.8	2.46	.171

[a] SD indicates standard deviation.

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

$< .001$) and extruded (1.54 ± 1.42 mm, $P < .001$). Consequently, the occlusal plane rotated in clockwise manner. Control group subjects, on the other hand, exhibited a mild counterclockwise rotation.

Soft Tissue Changes

An increase of 1.7 mm in upper lip position relative to the reference line was the only parameter that showed a significant change in the control group. Lower lip position, lip strain, soft tissue pogonion location, and H-ANB angle values remained relatively stable. On the other hand, the treatment group exhibited a significant forward movement of both the upper and lower lips during leveling, which was consistent with the dental changes. During Jasper Jumper application, the most significant differences were observed in the lower lip position, lip strain, and H-ANB angle, together with the soft tissue pogonion. In Table 4, Jasper Jumper effects were compared with the growth changes observed in the control group. The results indicated that upper lip position and H-ANB angle were the only parameters that changed significantly.

Application of the dentoskeletal contribution analysis, as used by Pancherz and Haag[19] and Pancherz,[20] showed that the molar correction was mainly achieved by dentoalveolar changes (80.3%), whereas skeletal correction was only 19.7%. Similarly, the improvement in the overjet was mainly due to the dental movements (80.6%), whereas skeletal contribution remained at 19.4% (Table 5).

DISCUSSION

No transpalatal arch or lingual arch was used during Jasper Jumper application. Although a lingual arch is commonly used for stabilization of the lower teeth, it is recommended only in cases where upper molar distalization is required.[21] Similarly, the transpalatal arch may not be beneficial in situations where the upper

Table 3. Statistical Evaluation of Treatment Group Indicating Changes During Leveling and Jasper Jumper Application Stages[a]

Value	Beginning (T1)		Leveling (T2)		At 6 Months (T3)		T2 − T1		Wilcoxon	T3 − T2		Wilcoxon
	Mean	SD	Mean	SD	Mean	SD	Difference	SD	*P* Value	Difference	SD	*P* Value
SNA (°)	78.7	2.89	78.74	2.95	78.24	3.01	0.04	0.7	.616	−0.5	0.52	.001***
SNB (°)	73.06	2.96	73.2	3	73.68	3.29	0.14	1.16	.525	0.48	0.68	.001***
ANB (°)	5.6	1.79	5.54	1.68	4.6	1.78	−0.06	1.01	.878	−0.94	0.69	.000***
A⊥RL (mm)	66.8	4.4	67.22	4.33	66.7	4.49	0.42	1.11	.082	−0.52	0.56	.000***
B⊥RL (mm)	53.72	6.28	53.82	6.39	54.76	6.99	0.1	2.13	.708	0.94	1.79	.015**
Pg⊥NB (mm)	3.34	1.33	3.44	1.23	3.26	1.29	0.1	0.5	.352	−0.18	0.69	.112
ANSMe/N-Me (%)	55	2.5	55.47	2.29	55.37	2.24	0.47	1	.037*	−0.1	0.92	.384
MP-SN (°)	35.34	4.6	35.94	4.67	35.74	4.72	0.6	1.65	.053	−0.2	0.98	.331
PP-SN (°)	8.36	3.58	8.34	3.4	9	3.9	−0.02	1.23	.776	0.66	1.3	.021*
Gonial ratio (%)	70.06	5.92	67.28	5.73	66.81	6.78	−2.78	3.3	.000***	−0.47	2.85	.484
SL (mm)	43.82	7.24	43.66	7.09	44.19	7.8	−0.16	2.34	.715	0.48	1.91	.330
SE (mm)	21.44	2.55	21.3	2.73	21.58	3.29	−0.14	1.31	.881	0.28	1.29	.204
Art-Pg (mm)	103.58	4.20	104.6	3.96	107.4	4.02	1.02	1.97	.028*	2.8	1.75	.000***
UIT⊥RL (mm)	70.14	5.76	70.22	5.56	68.24	5.78	0.08	2.67	.986	−1.98	2.36	.000***
UIT⊥PP (mm)	29.22	2.09	29.1	2.61	30.34	2.31	−0.12	1.19	.778	1.24	1.19	.000***
UI-SN (°)	104.5	8.96	105.1	6.11	101	5.66	0.6	9.18	.443	−4.1	7.05	.005**
LIT⊥RL (mm)	62.6	5.8	63.2	5.82	65.54	5.83	0.6	1.92	.139	2.34	1.73	.000***
LIT⊥MP (mm)	41.1	2.78	41.16	2.6	40.16	3.67	0.06	1.4	.862	−1	2.21	.010**
IMPA (°)	94.72	4.89	97.84	5.13	102.3	3.73	3.12	4.1	.009**	4.46	5.05	.000***
U6M⊥RL (mm)	38.14	4.23	38.94	4.29	38.22	4.44	3.8	1.71	.033*	−0.72	1.29	.021**
U6T⊥PP (mm)	22.32	2.01	22.7	1.59	22.06	1.59	3.38	1.08	.102	−0.64	0.67	.000***
L6M⊥RL (mm)	34.6	4.89	35.92	4.9	39.52	5.11	1.32	1.71	.003**	3.6	1.89	.000***
L6T⊥MP (mm)	29.26	2	30.26	2.44	31.9	2.55	1	1.11	.000***	1.54	1.42	.000***
LIT⊥NB (mm)	5.02	2.18	5.94	2.5	7.9	2.15	0.92	1.33	.003**	1.66	1.17	.000***
Overjet (mm)	8.96	2.46	7.82	1.85	3.32	1.05	−1.14	2.43	.020*	−4.5	1.98	.000***
Overbite (mm)	4.72	2.19	2.82	1.75	1.9	1.47	−1.9	1.6	.000***	−1.42	1.39	.000***
OP-SN (°)	16.74	3.03	17.06	2.64	20.22	3.22	0.32	1.95	.668	3.16	2.28	.000***
OP-MP (°)	18	4.21	18.3	3.26	14.62	3.27	0.3	2.19	.560	−3.68	1.93	.000***
PP-OP (°)	8.94	3.35	8.7	3.51	11.64	3.4	−0.24	2.08	.830	2.94	1.95	.000***
Lab.sup⊥RL (mm)	82.28	5.2	83.36	5.38	83.24	5.27	1.08	1.89	.023*	−0.12	1.54	.889
Lab.inf.⊥RL (mm)	76.66	6	77.92	5.45	79.24	6.31	1.26	2.36	.023*	1.32	1.93	.005**
Lip strain (mm)	2.4	2.5	1.44	2	0.42	1.31	−0.96	2.36	.068	−1.02	1.85	.008**
Pg′⊥RL (mm)	67.18	7.13	67.42	7.13	68.42	8.1	0.24	2.66	.692	1	2.34	.040*
H-ANB (°)	8	3.56	8.5	3.99	7.12	2.95	0.5	1.9	.383	−1.38	2.45	.010**

[a] SD indicates standard deviation.

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

arch is too narrow relative to the forward-positioned mandible. That is precisely the case in most of the Class II subjects with mandibular retrognathism. To counteract the maxillary expansion effect of the Jasper Jumper appliance, the upper arch wire was formed narrowly, and buccal root torque was incorporated in the posterior region. For the anterior teeth, palatal root torque was included to stop the upper incisors from uprighting too much. No labial root torque was incorporated to the mandibular incisor area, for standard edgewise brackets already have an uprighting effect on lower anterior teeth because of their slot designs.

Anteroposterior Findings

The results of the comparisons between the treatment and control groups indicated that the Jasper Jumper appliance rotated the occlusal plane in the opposite direction from normal growth changes. In this regard, our results were similar to the Herbst appliance changes reported by Pancherz and Haag[19] and Pancherz.[20] The upper and lower teeth were engaged in a thick and rectangular wire, forming one unit. 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 occlusal plane. This so-called pendulum movement of the appliance was reported in many other studies.[13,15,16]

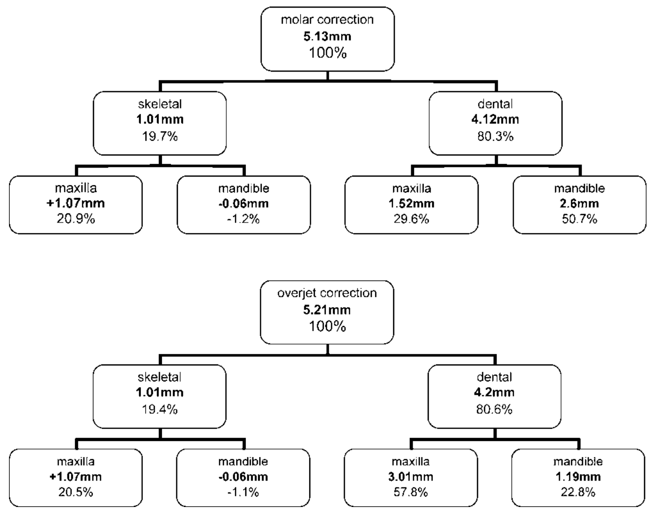
The decrease in the SNA angle and the backward relocation of the A-point indicated that the appliance also had a skeletal effect on the maxilla. Furthermore, the uprighting effect of the Jasper Jumper on the upper incisors led to a forward relocation of the A-point because of appositional changes at that alveolar area. This may camouflage the restrictive effect of the Jasper Jumper on the maxilla. Other researchers also reported A-point location related to the incisor inclina-

Table 4. Control and Treatment Group Statistical Comparisons[a]

Value	Control Group Difference	Control Group SD	Treatment Group (T3 − T2) Difference	Treatment Group (T3 − T2) SD	Mann-Whitney *P* Value
SNA (°)	0.2	0.67	−0.5	0.52	.001***
SNB (°)	0.55	0.03	0.48	0.68	.630
ANB (°)	−0.3	0.84	−0.94	0.69	.002**
A⊥RL (mm)	0.55	0.9	−0.52	0.56	.000***
B⊥RL (mm)	1	0.2	0.94	1.79	.864
Pg⊥NB (mm)	0	0.48	−0.18	0.69	.272
ANSMe/N-Me (%)	0.55	1.41	−0.1	0.92	.160
MP-SN (°)	0.2	0.93	−0.2	0.98	.143
PP-SN (°)	0.27	1.67	0.66	1.3	.283
Gonial ratio (%)	−0.69	2.02	−0.47	2.85	.672
SL (mm)	0.95	2.45	0.48	1.91	.757
SE (mm)	−0.07	0.74	0.28	1.29	.177
Art-Pg (mm)	1.12	1.07	2.8	1.75	.000***
UIT⊥RL (mm)	1.03	1.61	−1.98	2.86	.000***
UIT⊥PP (mm)	0.43	0.69	1.24	1.19	.010**
UI-SN (%)	1	2.94	−4.1	7.05	.002**
LIT⊥RL (mm)	1.15	1.62	2.34	1.73	.010**
LIT⊥MP (mm)	0.62	0.88	−1	2.12	.001***
IMPA (°)	0.1	3.11	4.46	5.05	.000***
U6M⊥RL (mm)	0.8	2	−0.72	1.29	.003**
U6T⊥PP (mm)	0.6	1.86	−0.64	0.67	.000***
L6M⊥RL (mm)	0.1	2.12	3.6	1.89	.000***
L6T⊥MP (mm)	0	1.56	1.54	1.42	.002**
LIT⊥NB (mm)	0.5	0.48	1.66	1.17	.000***
Overjet (mm)	0.22	1.3	−4.5	1.98	.000***
Overbite (mm)	0.35	0.77	−1.42	1.39	.000***
OP-SN (°)	−1.12	2.49	3.16	2.28	.000***
OP-MP (°)	0.92	1.84	−3.68	1.93	.000***
PP-OP (°)	−1.25	2.17	2.94	1.95	.000***
Lab.sup⊥RL (mm)	1.7	2.23	−0.12	1.54	.005**
Lab.inf.⊥RL (mm)	1.12	2.43	1.32	1.93	.493
Lip strain (mm)	0.33	0.9	−1.02	1.85	.028*
Pg′⊥RL (mm)	0.63	1.26	1	2.34	.464
H-ANB (°)	0.8	2.46	−1.38	2.45	.008**

[a] SD indicates standard deviation.
* $P < .05$; ** $P < .01$; *** $P < .001$.

TABLE 5. Distribution of the Dentoskeletal Changes That Contributed to Molar and Overjet Correction (Treatment "Effect" of the Jasper Jumper Relative to the Control Group)



tion.[16,22] The movement of the A-point may also be correlated to the clockwise rotation of the palatal plane, caused by the intrusive effect of the Jasper Jumper in the posterior region. Our conclusions are similar to the findings of Cope et al,[12] who described this restrictive phenomenon as the "headgear effect."

In this study, the mandibular length, represented by the Art-Pg distance, increased more during Jasper Jumper application than could be expected from normal growth (2.8 mm and 1.12 mm, respectively). The pogonion might have moved forward as a result of the mandibular length increase or mesial relocation of the mandible as a whole.[16] The latter may be the result of the remodeling processes in the articular fossa area.[23–26] Art-Pg distance increase was also seen during the leveling stage. This might be attributed to the backward movement of articulare during mandibular posterior rotation, caused by the extruded molars during the leveling. However, because no significant difference in either the lower anterior face height or the mandibular plane angle was observed throughout the Jasper Jumper application, the reason for the length increase should be the change in the pogonion location.

Pancherz and Haag[19] stated that the younger the patient, the greater the potential for mandibular growth. Weiland and Bantleon,[16] however, reported the skeletal effects to be only 40%, though the mean age of their study sample was 11 years 4 months. Stucki and Ingervall[14] reported that the Jasper Jumper appliance showed the same amount of skeletal effects in younger and older patients. Again, their results with the Jasper Jumper were mostly dentoalveolar at a mean age of 14 years 8 months. Even though the average patient age in our study was 11.83 years, we came to the same conclusion that dentoalveolar changes were almost four times larger than the skeletal effects induced by the Jasper Jumper (80.3% and 19.7%, respectively).

The reduction in overjet was found in both the leveling and the Jasper Jumper application stages. During leveling, the reduction was related to the incisor angulation changes, whereas during Jasper Jumper therapy many factors led to the change, including the headgear effect of the appliance, the consequent retraction in upper incisors, and the proclination of the lower incisors. Pancherz and Haag,[19] Pancherz,[20] Wieslander,[27] and Aksoy and Ciğer[28] reported similar findings with the Herbst appliance, but they stated the reduction in overjet to be mainly due to forward mandibular movement. Our findings indicated that more than 80% of the reduction in overjet was dental (Table 5).

Vertical Findings

During the active phase of the treatment, the mandibular plane and palatal plane remained relatively stable, but the occlusal plane rotated clockwise between these two. Changes in the lower anterior face height were also minimal in both the experimental and the control groups. The only significant increase in lower anterior face height was during leveling, which can be attributed to the extrusion of the posterior teeth. The findings of Pancherz and Haag[19] and Aksoy and Ciğer[28] also support our results because they all reported minimal vertical changes during Herbst therapy. Ülgen[29] stated the reason for the stability in the vertical dimension was the horizontal growth.

Overbite was significantly reduced in the leveling and Jasper Jumper application stages as expected, whereas an insignificant increase was seen in the control group. The reduction during leveling might have happened because of the incisor movements.

Soft Tissue Findings

Analysis of the soft tissue changes indicated that upper incisor retraction and upper lip position are interrelated. Lip strain and Lab. sup.-RL distance (Figure 5) were decreased during Jasper Jumper application because the upper incisors were uprighted during the process. During leveling, however, subjects presented with increased lip strain because the upper teeth moved labially. The lower lip also moved forward because of the changes in the lower lip position. As for the soft tissue, a significant forward movement of the pogonion (Pg′) was found in the treatment group compared with the controls. Our findings are supported by Cope et al,[12] who stated that the Jasper Jumper appliance promotes horizontal growth at the pogonion area and that the overlying soft tissue reflects that change.

CONCLUSIONS

a. The maxillary restriction effect of the Jasper Jumper outweighs its skeletal mandibular effect.
b. Most of the correction was achieved by dentoalveolar changes, with not much alteration in the vertical dimension.
c. The achieved correction was followed by the soft tissues, improving the profile.
d. Because of its predominantly dentoalveolar effects, the Jasper Jumper can also be used in nongrowing Class II patients.

REFERENCES

1. Ingerval B. Prevalence of dental and occlusal anomalies in Swedish conscripts. *Acta Odontol Scand.* 1974;32:83–92.
2. Kim YH. A comparative cephalometric study of Class II div 1 nonextraction and extraction cases. *Br J Orthod.* 1979;49:77–84.
3. McNamara JA. Components of Class II malocclusion in children 8–10 years of age. *Angle Orthod.* 1981;51:177–202.
4. Bishara SE, Ziaja RR. Functional appliances: a review. *Am J Orthod Dentofacial Orthop.* 1989;95:250–258.
5. Woodside DG. Do functional appliances have an orthopedic effect? *Am J Orthod Dentofacial Orthop.* 1998;113:11–14.
6. Quintao C, Brunharo IH, Menezes RC, Almeida MA. Soft tissue facial profile changes following functional appliance therapy. *Eur J Orthod.* 2006;28:35–41.
7. Stromeyer EL, Caruso JM, DeVincenzo JP. A cephalometric study of the Class II correction effects of the Eureka Spring. *Angle Orthod.* 2002;72:203–210.
8. Lai M, McNamara JA Jr. An evaluation of two phase treatment with the Herbst appliance and preadjusted edgewise therapy. *Semin Orthod.* 1998;4:46–58.
9. Pangrazio-Kulbersh V, Berger JL, Chermak DS, Kaczynski R, Simon ES, Haerian A. Treatment effects of the mandibular anterior repositioning appliance on patients with Class II malocclusion. *Am J Orthod Dentofacial Orthop.* 2003;123:286–295.
10. Weiland FJ, Droschl H. Treatment of a Class II, Division 1 malocclusion with the Jasper Jumper: a case report. *Am J Orthod Dentofacial Orthop.* 1996;109:1–7.
11. Pancherz H, Ruf S. When is the ideal period for Herbst therapy—early or late? *Semin Orthod.* 2003;9:47–56.
12. Cope JB, Bushang PH, Cope DD, Parker J, Blackwood HO. Quantitative evaluation of craniofacial changes with Jasper Jumper therapy. *Angle Orthod.* 1994;64:113–122.
13. Nalbantgil D, Arun T, Sayınsu K, Işık F. Skeletal, dental, and soft-tissue changes induced by the Jasper Jumper appliance in late adolescence. *Angle Orthod.* 2005;75:426–436.
14. Stucki N, Ingervall B. The use of the Jasper Jumper for the correction of Class II malocclusion in the young permanent dentition. *Eur J Orthod.* 1998;20:271–281.
15. Covell DA, Trammell DW, Boero RP, West R. A cephalometric study of Class II division 1 malocclusions treated with the Jasper Jumper appliance. *Angle Orthod.* 1999;69:311–320.
16. Weiland FJ, Bantleon HP. Treatment of Class II malocclusions with the Jasper Jumper appliance-a preliminary report. *Am J Orthod Dentofacial Orthop.* 1995;108:341–350.
17. Blackwood HO. Clinical management of the Jasper Jumper. *J Clin Orthod.* 1991;25:755–760.
18. Riolo ML, Moyers RE, McNamara JA, Hunter WS. *An Atlas of Craniofacial Growth: Cephalometric Standards From the University School Growth Study, the University of Michigan.* Ann Arbor, Mich: Center for Human Growth and Development, The University of Michigan; 1974.
19. Pancherz H, Haag U. The Herbst appliance—its biologic effects and clinical use. *Am J Orthod.* 1985;87:1–20.
20. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment: a cephalometric investigation. *Am J Orthod.* 1982;82:104–113.
21. American Orthodontics. Jasper Jumper: fixed functional appliance. *American Orthodontics Instructional Pamphlet.* 1996;1:1–16.
22. Gianelly AA, Arena SA, Bernstein L. A comparison of Class

II treatment changes noted with the light wire, edgewise and Fränkel appliances. *Am J Orthod.* 1984;86:269–276.
23. Stöckli PW, Willert HW. Tissue reactions in the temporomandibular joint resulting from anterior displacement of the mandible in the monkey. *Am J Orthod.* 1971;60:142–155.
24. Birkebaek B, Melsen B, Terp S. A laminographic study of the alterations in the temporo-mandibular joint following activator treatment. *Eur J Orthod.* 1984;6:257–266.
25. Woodside DG, Metaxas A, Altuna G. The influence of functional appliance therapy on glenoid fossa remodeling. *Am J Orthod Dentofacial Orthop.* 1987;92:181–198.
26. Arat ZM, Gökalp H, Erdem D, Erden İ. Changes in the TMJ disc-condyle-fossa relationship following functional treatment of skeletal Class II division 1 malocclusion: a magnetic resonance imaging study. *Am J Orthod Dentofacial Orthop.* 2001;119:316–319.
27. Wieslander L. Intensive treatment of severe Class II malocclusions with a headgear-Herbst appliance in the early mixed dentition. *Am J Orthod.* 1984;86:1–13.
28. Aksoy AÜ, Ciğer S. Herbst apareyi uygulanan sınıf II bölüm 1 maloklüzyonlu bireylerde, dentofasial sistemdeki değişikliklerin sefalometrik olarak incelenmesi. *H.Ü Dişhek Fak Derg.* 1985;2:72–79.
29. Ülgen M. Angle Class II div 1 anomalilerde aktivatör ve servikal headgear tedavisinin diş, çene yüz iskeletine etkilerinin sefalometrik olarak incelenmesi ve karşılaştırılması. [In Turkish]. *Doçentlik tezi*, Ankara, Turkey: 1978.