Original Article

Forsus Nitinol Flat Spring and Jasper Jumper Corrections of Class II division 1 Malocclusions

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ABSTRACT

Objective: To compare the effects of Forsus Nitinol Flat Spring (FNFS) and Jasper Jumper (JJ) in the correction of Class II division I malocclusions.

Materials and Methods: Our research was conducted on 48 adolescents, who had a normal or horizontal growth pattern and retrognathic mandible. The patients were divided into three equal groups randomly. First group was treated with FNFS, and the second group was treated with JJ appliances, whereas the third group was the control group. Lateral cephalograms and study models were obtained after the leveling phase and at time of the removal of the appliances.

Results: Cephalometric analysis revealed that both the appliances stimulated mandibular growth, increased the anterior face height because of the lower face, and elongated the posterior face height because of the growth of temporomandibular joint. Maxillary central incisors were extruded, retruded, and distally tipped. Contrarily, intrusion, protrusion, and labial tipping were observed in the mandibular central incisors. Distal movement and intrusion of the maxillary first molars and mesial movement and extrusion of the mandibular first molars were the other dental alterations. Overjet and overbite were decreased, and a Class I molar relationship and improvement in the profile were attained in both treatment groups. Cast model analysis showed expansion in the maxillary and mandibular dental arches.

Conclusions: Both the appliances were effective in the treatment of Class II malocclusion and revealed nearly same alterations in the skeletal, dental, and soft tissue parameters. (*Angle Orthod* 2006;76:666–672.)

KEY WORDS: Forsus Nitinol Flat Spring; Jasper Jumper; Fixed functional appliance; Cephalometric evaluation; Study model analysis

INTRODUCTION

Class II malocclusions are frequently observed in orthodontic practice. Droschl[1] found the frequency of Class II malocclusions to be 37% among the children between 6 and 15 years of age. Mc Namara[2] reported mandibular retrusion as the most common characteristic of Class II malocclusion. Removable or fixed functional appliances[3–9] should be used to advance the mandible.

Herbst was the first fixed functional appliance, introduced by Emil Herbst in 1905. However, it was not used until Pancherz[10] reintroduced it in the late 1970s. The studies of Pancherz,[5,10–12] Wieslander,[13] and Mc Namara et al[14] have reported both skeletal and dentoalveolar changes with the Herbst appliance. The disadvantages of this appliance were the rigidity of the mechanism and the requirement of complex laboratory stages.[14–16]

In 1987, Jasper[17] developed a new and more flexible fixed functional appliance, the Jasper Jumper (JJ). It has been observed in studies[17–22] that the module applies posterior forces to the maxillary dentition and reciprocal anterior forces to the mandibular dentition. Although the force module was rather large and sometimes caused wounds on the cheek, it was usually well

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tolerated by patients. The disadvantage of the appliance was the risk of breakage.[19] The soft gray synthetics, in which the open-coil spring was embedded, usually became deformed after about 3 months, and the appliance had to be changed to obtain continuous forward force on mandible.[20]

The Forsus Nitinol Flat Spring (FNFS) is another fixed functional appliance, developed by Bill Vogt in 2001.[23] It comprises spring bars (nickel-titanium) coated with a transparent plastic to prevent the cheek from bulging.

In the dental literature, the effects of FNFS appliance have not been compared with any other fixed appliance. The purpose of this study was to compare the dental and skeletal changes obtained by FNFS and JJ appliances.

MATERIALS AND METHODS

Case selection

This prospective study was carried out after the institutional approval for the use of humans was obtained from ethics committee of Gulhane Military Medical Academy. A total of 48 patients with Class II division I malocclusions were selected after the analysis of the pretreatment cephalograms. Records were selected according to the following criteria:

- Patients in active growth period;
- Normal or mildly prognathic maxilla;
- Retrognathic mandible;
- Horizontal or normal growth pattern;
- Class II molar relationship;
- Overjet not more than 7 mm;
- Minimum crowding in the dental arches;
- Permanent dentition; and
- Initial procedures.

The patients were randomly divided into three groups. The FNFS group consisted of 16 patients (nine males and seven females), with a mean age of 13.6 ± 1.2 years. The mean age of the 16 patients in the JJ group (10 males and six females) was 14.0 ± 1.9 years. Another 16 patients were the control group, with a mean age of 13.8 ± 1.4 years. Cephalometric radiographs of the control group were retaken 6 months later to determine the alterations because of growth of the patients, and their orthodontic treatment began after that.

Fixed edgewise appliances with 0.018-inch slot were attached. After the leveling phase, 0.017 × 0.025–inch stainless steel archwires were engaged and cinched back in the upper and lower appliances. Buccal root torque was incorporated to the maxillary archwire to control the transverse expansion of maxillary first molars.

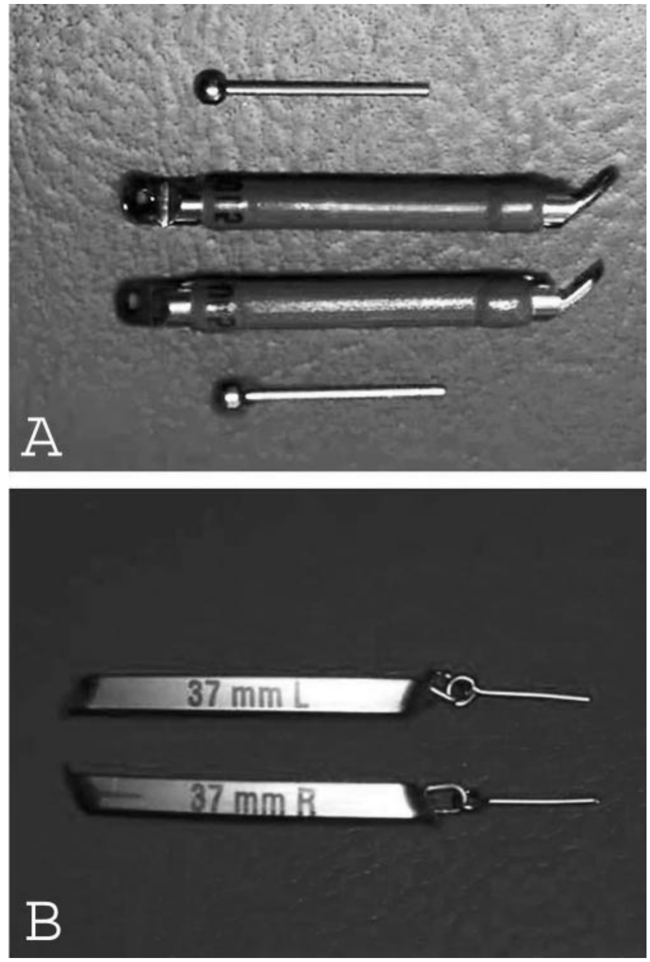

FIGURE 1. (A) Jasper Jumper and (B) Forsus Nitinol Flat Spring.

Clinical application of FNFS and JJ

The FNFS (3M Unitek, St Paul, Minn) is produced in four different lengths, 28, 31, 34, and 37 mm. The JJ (American Orthodontics, Sheboygan, Wis) (Figure 1A,B) is produced in seven different lengths, 26, 28, 30, 32, 34, 36, and 38 mm. Size of the appliances was determined by adding 12 mm to the distance between the mesial edge of the headgear tube and the distal edge of the mandibular canine bracket when the patient was in centric occlusion: 4 mm for activation, 4 mm for the length of headgear tube, and 4 mm for the distal extension of the ball pin.

Appliances were attached to headgear tubes of maxillary first molars through ball pins and to the mandibular archwire by an auxiliary arch. The distal end of the auxiliary arch was attached to the second tube of the first molar band and cinched back. The mesial end was hooked over the mandibular archwire between the canine and the first premolar brackets.

Patients were observed at 3-week intervals, and the appliances were activated as needed. Average treatment period of FNFS and JJ appliances were 5.28 ±

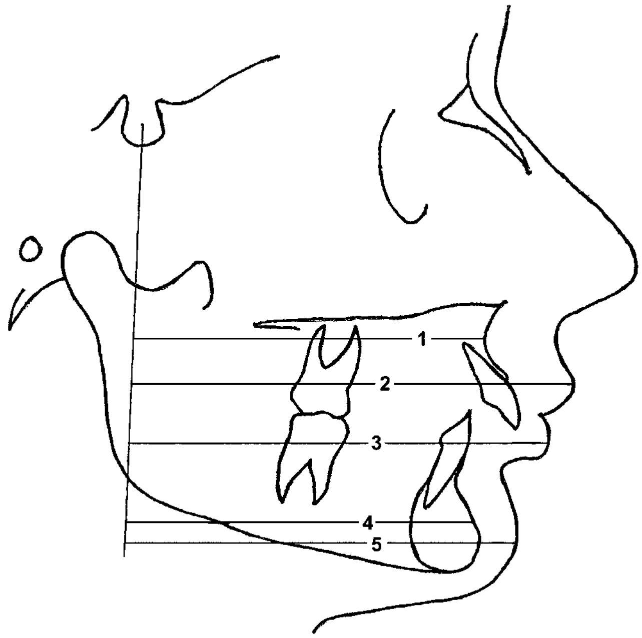

FIGURE 2. Skeletal and soft tissue parameters. (1) A-OLP, (2) LS-OLP, (3) LI-OLP, (4) Pog-OLP, and (5) StPog-OLP.

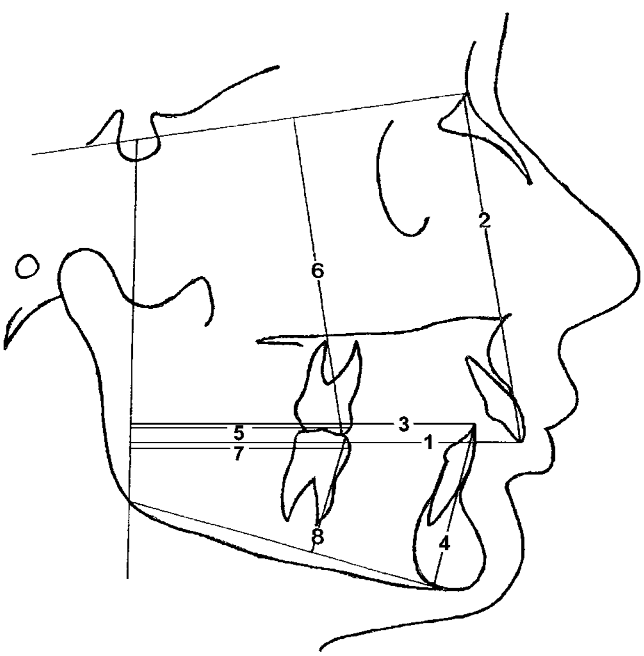

FIGURE 3. Dentoalveolar parameters. (1) U1I-OLP, (2) U1I-SN, (3) L1I-OLP, (4) L1I-MP, (5) U6M-OLP, (6) U6O-SN, (7) L6M-OLP, and (8) L6M-MP.

1.18 months and 5.23 ± 1.2 months, respectively. After Class I molar relationship was obtained, the appliances were removed, and treatments were carried out with Class II elastics for retention of the treatment results. Lateral cephalograms and study models were taken before attachment and just after removal of FNFS or JJ.

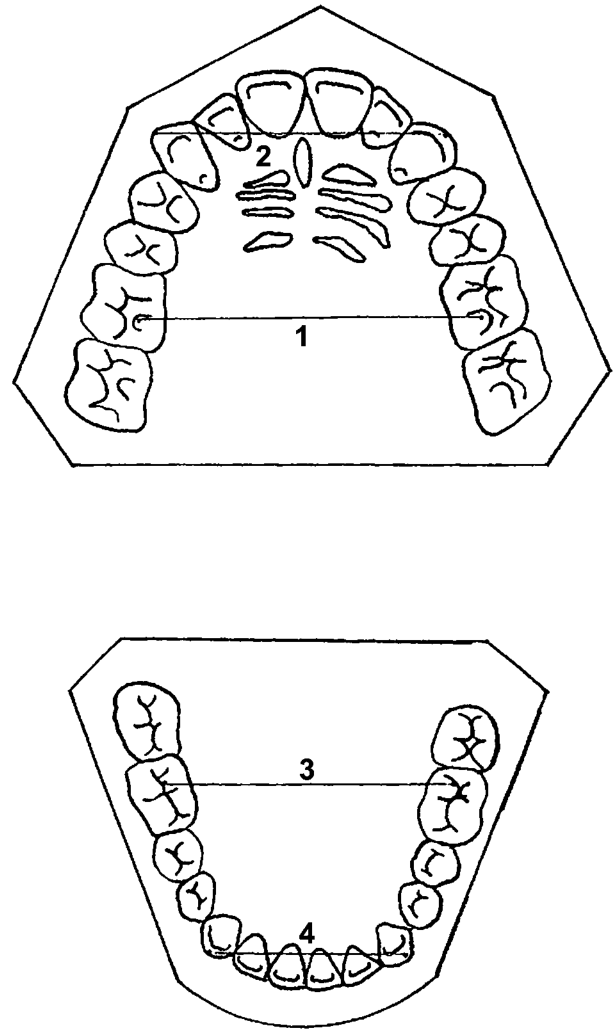

FIGURE 4. Study model parameters. (1) U6DP-U6DP′ (2) U3C-U3C′ (3) L6DL-L6DL′ (4) L3C-L3C′

Cephalometric analysis

Cephalograms were traced by one investigator with verification of anatomic outlines and landmarks by the other three. The suspicious structures and landmarks were retraced to the mutual satisfaction of the investigators. A single average tracing was made in instances of bilateral structures.

The analysis of anteroposterior linear changes was carried out using the method of Pancherz.[10–12] A coordinate system consisting of the occlusal line (OL), and a perpendicular to this line through the point sella (OLP) was drawn on the cephalogram taken after the leveling phase. These reference lines were transferred to the final cephalogram by superimposing on the cranial base. The cephalometric points, planes, and parameters are shown in Figures 2 through 4.

TABLE 1. Descriptive Statistics of Cephalometric and Study Model Measurements at T2 and T3 for All Groups

		Forsus		Jasper		Control	
		X	SD	X	SD	X	SD
SNA	T2	78.6	3.9	80.7	3.5	77.5	4.1
	T3	78.3	3.6	80.5	3.4	77.9	3.9
SNB	T2	73.0	3.6	75.4	3.2	72.1	3.6
	T3	75.1	3.9	76.7	3.3	72.3	3.3
ANB	T2	5.7	1.2	5.3	1.4	5.4	1.3
	T3	2.8	2.2	3.7	1.5	5.7	1.3
S	T2	127.0	5.2	130.6	10.8	128.7	5.5
	T3	127.1	6.5	127.2	4.3	128.8	5.4
Ar	T2	146.1	3.0	146.0	3.5	144.7	3.8
	T3	146.3	5.0	144.8	2.9	144.8	3.8
Go	T2	123.8	6.0	121.1	4.5	123.4	4.6
	T3	123.7	5.8	121.5	6.3	123.5	4.7
SN/PP	T2	8.3	3.0	8.5	2.5	8.0	3.2
	T3	7.6	3.4	8.6	2.5	8.1	3.2
SN/MP	T2	34.8	6.2	34.2	3.7	35.7	6.2
	T3	34.7	6.5	33.5	3.7	35.8	6.2
SN/Occ	T2	18.1	2.9	18.6	3.6	17.6	3.4
	T3	20.4	3.0	21.3	4.3	17.1	3.1
y-axis	T2	62.4	2.5	60.4	2.0	62.2	2.5
	T3	65.0	2.9	63.5	2.3	62.5	2.7
PP/MP	T2	27.0	6.9	25.0	3.5	27.7	5.8
	T3	26.8	7.0	24.6	3.2	27.8	5.8
U1/SN	T2	101.3	4.3	105.1	5.2	100.6	4.5
	T3	96.4	4.0	100.1	6.9	100.8	4.5
L1/MD	T2	103.1	3.6	99.5	9.2	102.0	3.5
	T3	107.6	4.2	106.1	7.0	101.6	3.5
Co-A	T2	92.4	5.2	91.7	2.9	91.6	4.7
	T3	96.5	5.3	95.8	3.1	92.8	4.4
Co-Gn	T2	113.8	6.2	112.8	4.4	113.1	5.6
	T3	117.1	6.3	116.8	4.4	112.6	5.5
A-OLP	T2	77.2	7.3	78.5	3.2	74.8	7.4
	T3	77.2	7.3	78.7	3.4	75.0	7.6
Pog-OLP	T2	74.0	8.2	77.8	3.3	68.9	7.7
	T3	74.9	8.7	78.6	3.5	68.7	7.6
N-ME	T2	126.4	8.1	122.1	4.5	123.6	7.2
	T3	131.3	8.2	126.4	4.5	123.4	7.4
S-Go	T2	82.5	9.5	78.0	3.7	80.4	4.9
	T3	86.9	9.5	83.8	3.4	79.9	4.8
N-ANS	T2	56.3	3.8	55.5	3.7	55.7	3.6
	T3	56.4	3.8	55.6	3.7	55.8	3.8
ANS-Me	T2	73.7	6.1	73.6	5.8	73.7	6.7
	T3	78.7	6.2	78.9	6.6	73.8	6.8
U1-OLP	T2	84.9	6.8	86.4	2.8	76.7	6.4
	T3	83.5	7.0	85.0	2.7	76.7	6.5
L1-OLP	T2	78.3	6.9	80.4	3.5	73.6	5.2
	T3	80.3	6.9	81.9	3.3	73.6	5.2
U6-OLP	T2	52.8	6.2	53.1	3.8	45.3	4.7
	T3	50.9	6.4	52.0	3.6	45.4	4.7
L6-OLP	T2	50.8	7.0	52.4	3.5	45.9	4.2
	T3	52.7	7.2	54.9	3.7	46.0	4.1
U1-SN	T2	87.2	5.2	83.9	3.3	81.7	4.9
	T3	88.3	4.8	85.4	3.1	81.8	5.0
U6-SN	T2	74.7	3.3	72.2	3.4	66.4	2.4
	T3	70.9	3.1	68.9	3.1	66.5	2.5
L1-MP	T2	43.2	3.2	41.0	1.8	36.9	1.8
	T3	40.2	3.7	38.5	2.0	37.0	1.8
L6-MP	T2	33.7	3.6	31.9	1.8	31.1	2.7
	T3	34.9	3.8	33.4	1.8	31.2	2.7
Overjet	T2	6.6	1.3	6.4	1.5	6.9	1.6
	T3	2.9	1.1	3.2	0.9	7.0	1.6
Overbite	T2	3.4	1.0	3.0	0.7	3.2	1.0
	T3	2.4	1.4	2.3	0.8	3.6	0.9
UL-OLP	T2	97.5	7.6	99.0	3.1	95.2	7.7
	T3	97.6	7.5	98.7	3.4	95.4	7.6
LL-OLP	T2	95.1	7.7	95.5	3.2	90.8	7.9
	T3	96.4	8.2	96.6	3.6	90.1	8.0
StPog-OLP	T2	87.3	9.1	90.3	4.5	81.2	6.0
	T3	88.7	9.8	91.4	5.0	81.0	5.9
U6DP-U6DP′	T2	42.8	2.1	41.8	3.1	42.8	2.7
	T3	46.8	2.8	45.8	2.9	43.1	2.8
U3C-U3C′	T2	33.9	1.1	33.8	1.1	34.3	0.8
	T3	35.5	0.7	35.9	1.1	34.6	0.9
L6DL-L6DL	T2	38.5	2.9	37.3	3.9	38.4	3.4
	T3	42.7	3.0	41.7	3.5	38.2	3.3
L3C-L3C′	T2	27.4	2.0	27.3	1.4	27.4	1.5
	T3	30.3	2.1	30.0	2.1	27.7	1.7

Study model analysis

Study model analysis was carried out to determine the expansion effects of the appliances. Intermolar and intercanine widths were measured to quantify the changes in the anterior and posterior arch width of maxilla and mandible (Figure 4).

Statistical method

Cephalograms and study models of 13 patients were randomly chosen for examination of the measurement error. These materials were remeasured after 1 month, and the error of the method was calculated. The reliability of a single measurement was calculated using Dahlberg's formula of method error and was found to be 0.179.

The statistical analysis was performed using SPSS (SPSS Inc, Chicago, Ill) statistical program. Descriptives were shown as mean + SD. Differences between pre- and posttreatment were calculated. One-way analysis of variance test was used to compare these differences (Bonferroni and Dunnett tests were used as posthoc tests). P value was set at $P \leq 05$.

RESULTS

Cephalometric findings

A Class I molar relationship was achieved, and the overjet was decreased with both the fixed functional appliances. Cephalometric findings of the treatment groups and the control group are shown in Table 1.

Skeletal parameters revealed similar alterations in both the treatment groups. ANB was decreased because of the retrusion of maxilla and protrusion of the mandible (SNA decreased and SNB, Pog-OLP, and Co-Gn increased). Although the maxilla was retarded, effective maxillary length (Co-A) increased because of the changes in the condyle, which also increased the posterior face height (S-Go). Significant posterior rotation of the mandible (increase in the y-axis) elongated the anterior facial height because of the lower anterior face (increase in N-Me and ANS-Me) (Table 2).

Dental alterations denoted that upper incisors were retruded, extruded, and distally tipped (U1I-OLP, U1IA/SN decreased, and U1I-SN increased), whereas the lower incisors were protruded, intruded, and labially tipped (L1I-OLP, L1IA/MP increased, and L1I-MP decreased). Upper molar teeth were distalized and intruded (decreased U6M-OLP and U6O-SN). Contrarily, lower molars were moved to the mesial and extruded (L6M-OLP and L6O-MP increased). Dental changes included not only decreased overjet and overbite but also posterior rotation of the occlusal plane (SN/Occ increased). Improvement in the profile was attained with both the appliances because of the protrusion of lower lip and soft tissue pogonion (increase in LI-OLP and StPog-OLP) (Table 2).

When the cephalometric findings of the treatment groups were compared, decrease in ANB and increase in S-Go was found statistically significant.

Study model findings

Model findings of the treatment groups and the control group are shown in Table 1. Increases in the upper and lower intermolar and intercanine widths occurred in both the treatment groups. The between-group differences of the two treatment groups showed no statistically significant differences. When the variables were compared with the control group, all the alterations were significant again (Table 2).

DISCUSSION

Removable or fixed functional appliances should be used in the treatment of Class II malocclusion if the etiology is retrognathia of the mandible. In 2001, Vogt introduced a fixed functional appliance, ‘‘Forsus Nitinol Flat Spring,’’ and this study was aimed at comparing the effects of the FNFS and JJ appliances.

Decrease at the SNA angle was found statistically significant, showing the appliances were effective in restraining the forward growth of the maxilla. However, the distance between point A and OPL did not change. It is a known fact that point A is influenced by the dentition. When the upper incisors are retruded, labial tipping of the roots can shift the point A anteriorly. In our opinion, although maxilla was retruded, backward displacement of point A was masked because of the dental alterations. An increase in the Co-A distance was significant, and it was probably because of the adaptive growth in the condyle. Growth of the condyle also increased the posterior face height.

Regarding the maxilla, our results were conflicting with the studies of some authors.[20,21,23,24] However, in some studies of the Herbst appliance[12,15,25] and the JJ,[19,26] it has been reported that maxillary growth was inhibited, similar to our results. Sari et al[8] used the JJ combined with highpull headgear and reported maxillary retrusion.

Forward displacement of the mandible was found in both the treatment groups. The appliances applied a forward and downward force to the mandible and caused a slight posterior rotation. This increase also elongated the lower anterior face height.

Heinig and Göz,[23] Stucki and Ingervall,[20] Weiland and Bantleon,[21] and Weiland et al[24] have reported increases in the mandibular length. Similar effects on the mandible were detected also in the studies with Herbst appliance.[5,12,14] On the other hand, Cope et al[19] and Covell et al[26] concluded that the JJ had no orthopedic effect on the mandible.

Dentoalveolar changes were also similar in both groups. The maxillary first molars were significantly intruded and distalized because the vector of force was below and behind the ‘‘center of resistance’’ of the maxillary dentition. This highpull headgear effect also influenced the incisors through the archwire, and maxillary centrals were extruded and retruded with significant palatal tipping. However, palatal tipping of the upper centrals was not significant in the JJ group compared with the control. It was believed to be because of the close posttreatment mean values of the JJ and control groups.

The mandibular incisors were significantly protruded and intruded with labial tipping. Both FNFS and JJ appliances applied downward and forward forces to the mandibular dentition, and because of this effect, the mandibular molars were extruded and showed mesial movement. Intrusion of the upper molars also allowed for eruption of the mandibular molars. As a result of these changes, significant posterior rotation was observed in the occlusal plane. The overjet and overbite were decreased significantly in both the groups, mainly because of the dentoalveolar changes and to a lesser extent to the increase in mandibular length. These dentoalveolar findings are similar with nearly all the previous studies[10–12,18–24] carried out with fixed functional appliances.

It was determined that the profile improvement in both the groups was because of the changes observed in the lower lip and soft tissue pogonion that were influenced from the forward displacement of the mandible and protrusion of the mandibular incisors. This finding was similar with those of Weiland et al[24] and Pancherz[10–12] but was contrary to the results of

TABLE 2. Comparison of the Between Group Differences for Cephalometric and Study Model Measurements at T2–T3[a]

	Forsus vs Jasper				Forsus vs Control				Jasper vs Control			
	Mean Difference	Standard Error	*P*	Significance	Mean Difference	Standard Error	*P*	Significance	Mean Difference	Standard Error	*P*	Significance
SNA	−0.125	0.173	1.000	NS	−0.656	0.173	0.001	***	−0.531	0.173	0.007	**
SNB	0.750	0.350	0.113	NS	1.969	0.350	0.001	***	1.219	0.350	0.002	**
ANB	−1.188	0.404	0.015	*	−3.125	0.404	0.001	***	−1.938	0.404	0.001	***
S	3.469	2.118	0.326	NS	−0.094	2.118	0.999	NS	−3.563	2.118	0.174	NS
Ar	1.313	1.008	0.599	NS	0.000	1.008	1.000	NS	−1.313	1.008	0.332	NS
Go	−0.563	0.822	1.000	NS	−0.250	0.822	0.935	NS	0.313	0.822	0.901	NS
SN/PP	−0.781	0.403	0.177	NS	−0.750	0.403	0.123	NS	0.031	0.403	0.996	NS
SN/MP	0.563	0.503	0.807	NS	−0.250	0.503	0.837	NS	−0.813	0.503	0.196	NS
SN/Occ	−0.375	0.412	1.000	NS	2.813	0.412	0.001	***	3.188	0.412	0.001	***
Y-axis	−0.531	0.295	0.235	NS	2.281	0.295	0.001	***	2.813	0.295	0.001	***
PP/MP	0.125	0.367	1.000	NS	−0.375	0.367	0.493	NS	−0.500	0.367	0.302	NS
U1/SN	0.156	1.007	1.000	NS	−5.094	1.007	0.001	***	−5.250	1.007	0.001	***
L1/MP	−2.094	1.520	0.526	NS	4.875	1.520	0.005	**	6.969	1.520	0.001	***
Co-A	0.000	0.697	1.000	NS	2.813	0.697	0.001	***	2.813	0.697	0.001	***
Co-Gn	−0.688	0.327	0.123	NS	3.813	0.327	0.001	***	4.500	0.327	0.001	***
A-OLP	−0.188	0.235	1.000	NS	−0.250	0.235	0.468	NS	−0.063	0.235	0.950	NS
Pog-OLP	0.000	0.226	1.000	NS	1.031	0.226	0.001	***	1.031	0.226	0.001	***
N-Me	0.563	0.342	0.320	NS	5.031	0.342	0.001	***	4.469	0.342	0.001	***
S-Go	−1.406	0.393	0.003	*	4.906	0.393	0.001	***	6.313	0.393	0.001	***
N-ANS	0.031	0.088	1.000	NS	−0.031	0.088	0.913	NS	−0.083	0.088	0.702	NS
ANS-Me	−0.125	0.291	1.000	NS	4.875	0.291	0.001	***	5.000	0.291	0.001	***
U1-OLP	0.094	0.408	1.000	NS	−1.438	0.408	0.002	**	−1.531	0.408	0.001	***
L1-OLP	0.531	0.305	0.265	NS	2.156	0.305	0.001	***	1.625	0.305	0.001	***
U6-OLP	−0.813	0.345	0.069	NS	−1.969	0.345	0.001	***	−1.156	0.345	0.003	**
L6-OLP	−0.625	0.452	0.520	NS	1.750	0.452	0.001	***	2.375	0.452	0.001	***
U1-SN	−0.375	0.203	0.214	NS	1.031	0.203	0.001	***	1.406	0.203	0.001	***
U6-SN	−0.531	0.285	0.206	NS	−3.938	0.285	0.001	***	−3.406	0.285	0.001	***
L1-MP	−0.469	0.394	0.720	NS	−3.088	0.394	0.001	***	−2.619	0.394	0.001	***
L6-MP	−0.344	0.221	0.381	NS	1.125	0.221	0.001	***	1.469	0.221	0.001	***
O.jet	−0.406	0.275	0.439	NS	−3.688	0.275	0.001	***	−3.281	0.275	0.001	***
O.bite	−0.375	0.281	0.564	NS	−1.406	0.281	0.001	***	−1.031	0.281	0.001	***
UL-OLP	0.406	0.237	0.279	NS	−0.094	0.237	0.893	NS	−0.500	0.237	0.073	NS
LL-OLP	0.250	0.652	1.000	NS	2.083	0.652	0.005	**	1.813	0.652	0.015	*
StPog-OLP	0.313	0.519	1.000	NS	1.625	0.519	0.006	**	1.313	0.519	0.028	*
U6DP-U6DP	−0.063	0.341	1.000	NS	3.656	0.341	0.001	***	3.719	0.341	0.001	***
U3C-U3C	−0.563	0.240	0.070	NS	1.375	0.240	0.001	***	1.938	0.240	0.001	***
L6DL-L6DL	−0.188	0.310	1.000	NS	4.000	0.310	0.001	***	4.188	0.310	0.001	***
L3C-L3C	0.125	0.348	1.000	NS	2.531	0.348	0.001	***	2.406	0.348	0.001	***

[a] NS indicates not significant.
* $P < .05$.
** $P < .01$.
*** $P < .001$.

Cash[27] who observed a significant change in the sagittal position of the upper lip.

In the comparison of treatment groups, no significant difference was found between any cephalometric measurements except the ANB and S-Go, emphasizing that the skeletal, dental, and soft tissue effects were nearly the same. This was probably related to the similar strength of the appliances. The Herbst,[5,12,14] MARS,[28] and MARA[7] are also fixed functional appliances that work with same biomechanical principles, but they are more rigid than the FNFS and JJ. Rigidity restricts the lateral movements of the mandible, but at the same time, it provides stimulation of mandibular growth by causing more forward positioning of the mandible.

It has been reported that the force applied by fixed functional appliances has three vectors, ie, the sagittal, intrusive, and buccal.[17,22,23] Study model analysis showed that the anterior and posterior width of the upper and lower dental arches were expanded. The appliances created not only sagittal and intrusive forces, but also buccal forces, which were the causes of the posterior maxillary width expansion. This influenced the anterior part of the maxillary arch through the archwire. The mandibular arch was also expanded as a result of interdigitation with the upper jaw. This effect has also been reported by various authors.[23] In our study, buccal root torque was not adequate to eliminate the expansion of the upper jaw.

CONCLUSIONS

- The FNFS and JJ stimulated the mandibular growth and inhibited the maxillary growth.
- Both the appliances cause significant incisor and molar movements, and these dentoalveolar changes are more effective than the skeletal changes in attaining Class I molar relationship.
- The FNFS and JJ change the inclination of the occlusal plane and also expanded the dental arches during the treatment. If this expansion effect is needed to be controlled, more precautions, such as inserting a transpalatal arch, should be considered.
- The skeletal, dental, and soft tissue effects of the appliances are nearly the same. Being the last generation of fixed functional appliance, the FNFS does not have an advantage over JJ.
- Treatment period with the fixed functional appliances was not an uncomfortable experience, and the patients got used to these appliances in a few days. During the treatment period, two of the JJ and one of the FNFS appliances were broken, and they were renewed.

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