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Tomographic evaluation of dentoskeletal changes due to the treatment of class II malocclusion with Forsus appliance

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ABSTRACT

Purpose: This study evaluated dentoalveolar skeletal changes promoted by the Forsus appliance, associated to fixed orthodontic appliance, in the correction of Class II, division 1 malocclusion, from Computed Tomography (CT).

Methods: sample consisted of 10 youngsters (7 males and 3 females), with a mean age of 13.86 years. Two Forsus® models were installed after the alignment and leveling phase of the teeth. Two tomographic images of each patient, T1 and T2 (initial and immediately after removal of Forsus® appliance) were done to perform the anatomical tracings and obtain the variables of interest. The data were described by means and standard deviations. For the comparison between the initial and final phases, the paired "t" test was used and a significance level of 5% was considered ($p < 0.05$).

Results: small skeletal changes were observed, such as posterior maxillary displacement and a slight mandibular growth. Larger dentoalveolar changes occurred as extrusion, retrusion and lingualization of upper incisors; Intrusion, protrusion and vestibularization of the lower incisors; Mesialization and extrusion of lower molars.

Conclusion: Considering the patients evaluated in this study, Forsus® presented similar results to other mandibular propulsion appliances, with dentoalveolar effects that favored Class II correction, however, with very slight skeletal modifications.

1. Introduction

Among the main treatments of Class II malocclusion, there are those that aim at the correction of skeletal problems. The maxillary restriction can be performed by means of the extraoral appliance,[1] while the attempt to stimulate the mandibular growth can be done with the use of functional orthopedic appliances or mandibular propulsion appliances.[2]

The Forsus® appliance has shown some advantages over other mandibular propulsion devices due to its spring system, Which allows movements of continuous force of mandibular protrusion, without restriction of movement, and can be used together with the fixed apparatus, reducing the treatment time in relation to the propellants that need two phases of treatment.[2,3]

Cone-Beam Computed Tomography allows the orthodontist to accurately analyze specific regions, allowing more detailed visualization of bone and dental changes, with bi or three-dimensional cephalometric evaluations. The aim of this study was to evaluate the dentoalveolar and skeletal changes promoted by Forsus® (3 M, Unitek, Corp., Monrovia, California, USA), associated with fixed orthodontic appliance, in class II, division 1 malocclusion correction, From Computed Tomography.

2. Material and method

The sample consisted of 10 patients (7 males and 3 females), with Angle Class II malocclusion, division 1 (minimum ½ cusp), complete permanent dentition, without supernumeraries, agenesias or dental losses and without Orthodontic treatment. The facial pattern of the individuals was meso or brachyfacial, with no indication of exodontia or orthognathic surgery. The mean age was 13.86 years at the start of orthodontic treatment, 16.1 years at the time of installation of the Forsus® appliance and age of 16.82 years at the time of removal. Cone-Beam Computerized Tomography (CBCT) were performed on each patient prior to the installation of the Forsus® appliance (T1) and immediately after removal (T2).

Gemini™ brackets (3M-Unitek), MBT prescription, groove

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0.022″ × 0.028″ were used. The Forsus® appliance was installed with the rectangular wire (0.019″ × 0.025″), at the end of the alignment and leveling phase of the teeth. For better anchoring of the arches, the wire was folded into the distal of the second molar tube and the upper and lower arch was combined with anchoring wire and chain elastic was added to the lower teeth. Due to the incidence of force in the distal bracket of the Lower canine, these were attached individually with amarrho to avoid gyroversions.

Two Cone-Beam Computerized Tomography of each patient, T1 (immediately prior to the installation of Forsus®) and T2 (immediately after removal of Forsus®) were performed as evaluation method. During the examination, the patients were instructed to keep the lips at rest and the teeth occluded in position of maximum habitual intercuspation.

After obtaining lateral teleradiography images, by computer tomography, Dolphin 3D software or software, Software for use (Dell) with Radiocef Studio 2 software (Radio Memory, Belo Horizonte, Brazil) for an accomplishment of anatomical traces, resources to obtain the variables of interest. After 30 days of performing these procedures, all CT scans were again plotted and measured to investigate the error of the intra-examiner method, using the paired *t*-test ($p < 0.05$). In the determination of the casual error the error calculation proposed by Dahlberg was used. All calculations were performed in the Statistica v.5.1 program (StatSoft Inc., Tulsa, USA). No error was found for the Dahlberg test and in the systematic error test only the 6a-PTV variable showed a significant difference.

3. Results

The changes promoted by orthodontic treatment with the Forsus® appliance were obtained by the difference between the initial and final mean measures of the treated patients (Table 1). The paired "t" test was used and the significance level was set at 5% ($p < 0.05$).

4. Discussion

This study evaluated the dentoskeletal changes, using conical beam computed tomography (CBCT) in a sample that used the Forsus® appliance for a mean period of 7.16 months. A lateral cephalogram was constructed from the orthogonal projection of CBCT in 1: 1 projections, so that the cephalometric measurements were compared without amplifications.

To check the behavior cephalometric measures SNA and Co-A were evaluated. The SNA magnitude showed a statistically significant decrease, demonstrating that the Forsus propellant promoted a limitation of the anterior displacement of the maxilla, corroborating with the findings of some studies.[4–6]

In the mandibular analysis, the SNB, Go-Gn and Co-Gn measurements were used. Similar to other propellant devices,[7,8] these three magnitudes showed increase, but only Co-Gn presented a statistically significant increase. It is important to consider the pubertal growth phase in which the individuals in this sample were, since the mean age was almost 14 years, differing from the mean age of propellant installation in patients from other studies.[9–13] The increase in mandibular length soon after removal of the Forsus® appliance was also verified by Karacay et al.[6] andJones et al.,[14] in agreement with the studies that studied the effects of the Herbst apparatus.[9–13] In a study by Ruf and Pancherz[15] the authors concluded that the increase of the fixed functional post-therapy mandible may be the result of joint remodeling of the condyle and joint fossa.

The comparison between the maxilomandibular sagittal relation was performed by ANB cephalometric magnitude analysis. This variable showed a statistically significant decrease, indicating a remarkable improvement in the maxillomandibular relation, corroborating with several studies.[5,6]

The vertical changes were studied by means of seven cephalometric variables: SN.PP, SN.GoMe, FMA, FACIAL AXIS, AFPI, AFAI and SN.PLO. There was a mandibular rotation counterclockwise, with decrease of SN.GoMe, of FMA and more increase in postero-inferior facial height than in antero-inferior facial height. In turn, the occlusal plane underwent a clockwise rotation, with increase of the angle SN.PLO. In relation to the palatal plane (SN.PP), this did not suffer a statistically significant alteration, suggesting that the Forsus® appliance does not alter the inclination of the maxilla, considering the short time of use.[6]

By evaluating the changes occurring in the upper incisors, by means of the variables 1.NA, 1.PP, 1-NA, 1-PTV, 1a-PTV and 1-PP, there is considerable linguisticalization of these teeth, agreeing with the findings of others Studies that have also evaluated Forsus[5,6] and other mandibular propulsion appliances.[7,16] Extrusion of these teeth was also observed. The behavior of the maxillary molars was verified by measurements 6-PP, 6-PTV and 6a-PTV, with distalization occurring. The literature is controversial about the effect of the Forsus® appliance on the maxillary molars, as Heinrichs et al.[4] stated that there was distalization, whereas Jones et al.[14] verified that there was a mesialization, but in less quantity than in the lower molars.

The vertical changes of the lower incisors were analyzed by measurements 1-NB, 1-PTV and 1a-PTV, showing statistically significant differences after the use of the Forsus® appliance, with an intrusion of 1.43 mm on average, which can be explained by the Force vectors (in and out) that this apparatus exerts on the lower arch in the anterior region.

Table 1
Comparison between the Initial and Final phases of the measures evaluated.

Measure	Initial		Final		Difference	p
	Mean	dp	Mean	dp		
Maxilar component						
SNA	82,62	3,42	82,11	3,43	−0,51	0,040 *
Co-A	86,28	5,27	86,83	4,96	0,54	0,172 ns
Mandibular component						
SNB	77,45	3,17	77,93	3,78	0,48	0,066 ns
Co-Gn	111,51	7,65	112,81	8,21	1,30	0,006 *
Go-Gn	72,01	7,06	72,58	7,09	0,57	0,051 ns
Maxilomandibular relation						
ANB	5,17	2,16	4,18	1,99	−0,98	0,001 *
Vertical component						
SN.PP	6,90	3,69	7,64	3,83	0,75	0,056 ns
SN.GoMe	33,40	6,61	31,99	6,60	−1,41	0,002 *
FMA	21,73	6,30	20,38	5,99	−1,36	0,006 *
Eixo Facial	88,62	3,17	89,43	3,75	0,81	0,084 ns
AFPI	45,27	5,55	46,48	5,44	1,21	0,007 *
AFAI	64,90	6,22	64,87	6,47	−0,02	0,922 ns
SN.PLO	13,03	4,09	17,48	4,17	4,45	< 0,001 *
Dentoalveolar component						
1.NA	29,10	4,82	23,44	5,98	−5,66	< 0,001 *
1-NA	5,66	2,25	3,63	2,39	−2,03	< 0,001 *
1.PP	61,58	4,54	67,09	6,04	5,50	< 0,001 *
1-PP	27,31	3,09	28,16	3,59	0,85	0,004 *
1-PTV	60,11	5,96	58,16	6,06	−1,95	< 0,001 *
1a-PTV	47,24	4,51	47,80	4,68	0,56	0,091 ns
6-PP	21,93	2,80	22,05	2,76	0,12	0,563 ns
6-PTV	29,58	4,87	28,71	4,62	−0,87	0,025 *
6a-PTV	28,60	4,40	29,23	4,01	0,63	0,081 ns
IMPA	100,31	5,09	107,98	4,45	7,67	< 0,001 *
$\bar{1}$.NB	31,17	3,63	37,90	4,26	6,73	< 0,001 *
$\bar{1}$-NB	6,45	2,06	8,01	2,19	1,56	< 0,001 *
$\bar{1}$-PM	39,38	3,29	37,94	3,73	−1,43	0,002 *
$\bar{1}$-PTV	53,96	5,86	56,80	6,37	2,84	< 0,001 *
$\bar{1}$a-PTV	44,15	5,37	44,68	5,80	0,52	0,446 ns
$\bar{6}$-PM	29,94	3,06	31,02	2,74	1,07	0,007 *
$\bar{6}$-PTV	27,56	4,51	30,40	5,04	2,84	< 0,001 *
$\bar{6}$a-PTV	24,06	4,89	25,55	5,93	1,49	0,010 *

Ns - statistically significant difference.
*- statistically significant difference ($p < 0.05$).
dp - standard deviation.
p - difference by paired *t*-test.

The linear magnitudes 6-PTV and 6a-PTV showed significant increases in their values, demonstrating the mesialization of the lower molars, a result similar to that found by Jones et al.[14]

5. Conclusions

Considering the methodology used in this study, the evaluation of the dentoalveolar and skeletal effects of the Forsus® appliance, associated to the fixed orthodontic appliance, showed that:

1 Maxillary retraction.
2 Increased mandibular length.
3 Correction of Class II malocclusion.
4 Increased lower posterior facial height, with mandibular rotation counterclockwise.
5 Retrushing and extrusion of maxillary incisors and distalization of maxillary molars.
6 Vestibularization, protrusion and intrusion of the lower incisors, besides mesialization and extrusion of the lower molars.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jobcr.2019.06.005.

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