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Optimization of Class II Malocclusion Treatments Using the Forsus™ Fatigue Resistance Device and Its Post-Treatment Effect in Adult Patients: A Case Report

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Abstract

The use of fixed orthopedic functional appliances to treat Class II malocclusions, by mandibular retrusion in adult patients, made it easier the treatment of such malocclusions, when facial and periodontal biotypes allow dental compensation. In this regards, this research study aims at presenting a case report of a 21-year old male subject, presenting bilateral half Class II division 1 malocclusion, mild anterior upper and lower crowding, increased overbite and overjet, horizontal growth pattern and, as the main patient's complaint, lower anterior crowding and increased overbite. The treatment followed a conservative protocol, with no extractions, using corrective devices associated to the Forsus™ Fatigue Resistant Device, from 3M Unitek. Treatment time was twenty months followed by a 2-year post-treatment follow-up. The short and long-term efficiency of this treatment protocol was confirmed observing the stability of the Class II correction and the overbite and overjet. There were no significant changes in the patient's face and, consequently, in the skeletal pattern in short and long terms. The patient was satisfied with the results achieved during treatment due to device comfort and, after the completion of treatment, with the stability obtained with treatment.

Keywords: Class II malocclusion; Adult patient; Fixed orthopedic appliance

Introduction

In the past, treatments of Class II malocclusions, by mandibular retrusion in adult patients, was a challenge due to the belief that skeletal changes achieved at the end of treatment in young patients were more stable [1-4]. Such considerations occurred due to the lack of studies comparing the control group, presenting the same malocclusion, to the treated group [5,6], the lack of patient's cooperation [7-9], the use of removable orthopedic devices in growing patients [8], the high breakage rate of fixed orthopedic appliances [10-13], and, discomfort caused to patients by the use of removable and fixed orthopedic devices [10,11,13]. In the twenty-first century, the launch of the Forsus™ Fatigue Resistant Device brought a new proposal to treatments, considering patient comfort in the set-up day and along the treatment, due to the lack of mandibular postural change and easiness of performing the functional mandibular movements [7,11,14-17]. Additionally, there are also scientific evidences demonstrating that the impact on growth pattern is temporary after treatment as, in a long-term run, changes responding to growth pattern already exists genetically [3,16,18-25].

The Forsus hybrid functional appliance is not as stiff as the orthopedic devices such as the Herbst [10,22,26], the APM [27,28] and the Mara [29,30], furthermore, it is not as fragile as the "Jasper Jumper" [10,11,31]. It is a comfortable device [7], as it does not completely limit the mandible movement and, in the current version, it shows a very low breakage rate [10,14,32-34]. The Forsus appliance, when installed in the upper first molar tube in the lower leveling arch wire, at the distal of the cuspid bracket [3,11,15,17] or, at the distal of the lower first premolar [14], exerts a force of 220 g approximately in both jaws, in opposite directions [15,35]. And, the time it takes to completely correct a Class II malocclusion may vary from 5 - 8 months on average [6,14,15,17].

Short and long-term observations show that the Forsus appliance seems to skeletally promote an inhibition of the anterior maxillary growth [5,6,10,11,14,15], since in Angle Class II patients the maxilla tends to move forward [2]. The mandible may undergo anterior shift, improving the maxillomandibular relationship [1,3,5,6,11,13,15]. However, the effective growth of the mandible will rarely be considered an effect genuinely generated by the stimulus of the mandibular anterior growth [1,5,10,15,35,36], although there are authors that report some potential for effective growth in the mandibular body and ramus, when functional fixed devices are used in the pubertal growth peak stage [1,3,6,9,13].

In the literature, it has been shown that dentoalveolar changes overcome the skeletal changes when any fixed functional device is used [4-6,21]. The mechanism of the dentoalveolar action of such devices over the upper anterior [2,5-11,14,15,17,28,36,37] and posterior teeth [3,6,8-11,13,35,36] and over the lower anterior [5,6,8,9-11,13-15,17,28,35-37] and posterior teeth [3,8,9-11,14,17] are often responsible for the clockwise shift of the occlusal [5,9,10,16,17,35] and palatal [2] planes, generating a clockwise resultant on the mandibular plane [9-12,15] that can cause small increases on the facial height, especially in its lower anterior third [2,9,11,14].

Diagnosis and Etiology

A 21-year old patient looked for orthodontic treatment having as main complaint crowding of upper and lower teeth and a very

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large distance between the upper and lower teeth. The patient was in a good general health without oral habits and asymptomatic temporomandibular joint, presenting poor oral hygiene, however, with no history of periodontal diseases.

Oral examination showed a satisfactory facial asymmetry within the normal standards, convex profile with passive lip seal and harmonious nasolabial angle. It was also observed a slight projection of the upper lip when compared to the lower lip, slightly reduced vertical proportion and midline shift to the right side when smiling (Figure 1). Intraoral analysis has shown bilateral Class II division 1 malocclusion, overbite (upper incisors covering 2/3 of the lower incisors), overjet (5.76 mm) and mild anterior upper and lower crowding (Figures 1 and 2).

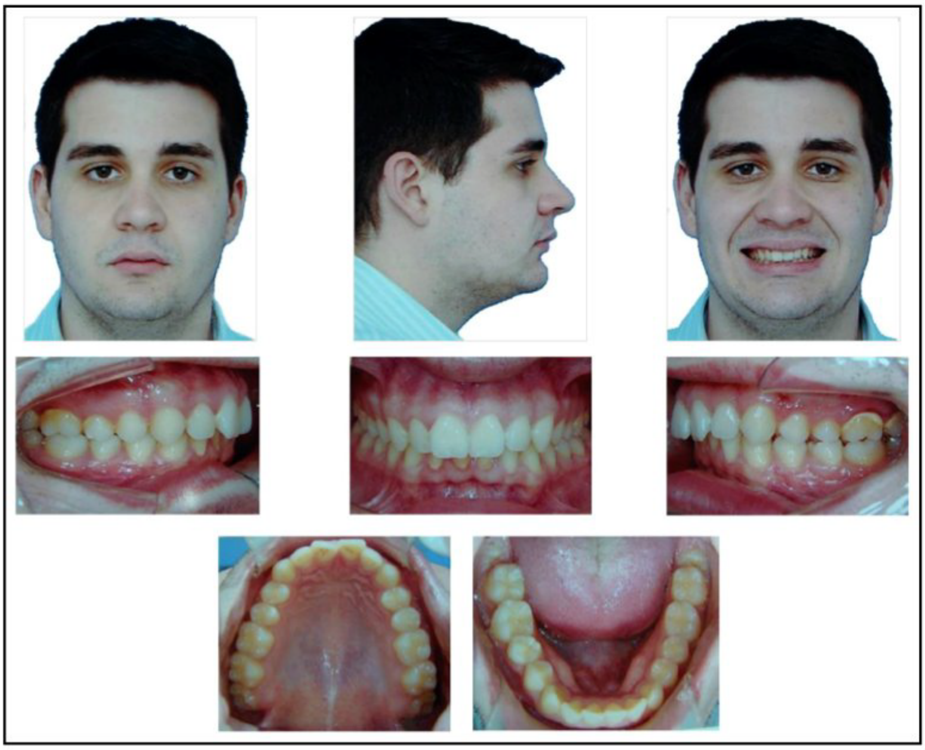

Figure1: Initial extra and intraoral pictures.

Figure 2: Pictures of initial models.

Panoramic x-ray has shown the presence of all permanent teeth with impacted lower third molars (Figure 3). The cephalometric analysis has shown the maxilla well positioned, the lower incisors tipped labially and protruded upper incisors. No other significant changes have been verified in the analysis of the lateral cephalometric x-ray (Figure 3).

Treatment Goal

The treatment goal aimed at correcting the dental crowding, the overjet and the overbite, with the consequent correction of the cuspid and the molar relationship, and the midline correction, establishing a stable functional occlusion and aiming at improving or keeping the satisfactory characteristics of the soft tissue profile at the end of treatment.

Treatment Options

The treatment goal for this patient was to eliminate crowding and reduce the overjet and overbite, achieving a stable and functional occlusion at the end of treatment. Based on this and supported by the literature, it was possible to consider and suggest some treatment options to the patient, such as a surgical-orthodontic treatment [20,38]; upper first molar extractions [39,40], the use of intermaxillary Class II elastics [24,41], which would need patient cooperation; and the use of fixed functional appliances-rigid [18,19,21-23,25], semi-rigid [8,11,12,37], but, mainly, hybrid appliances as the Forsus™ Fatigue Resistant Device [3,7,11,13-15,17,32-34,35]. The chosen protocol was to use the Forsus™ Fatigue Resistant Device that has shown to be an effective device, providing greater comfort to patients [7,11,14-17,33,34] and good resistance [10,13,15,35] when treating Class II malocclusions.

Treatment Progress

Treatment started with seven-month aligning and leveling stages, using 0.022x0.028 MBT brackets. Due to the deep overbite, this stage was initiated with the occlusal lifting of the upper first molars to allow the positioning of the lower brackets. The use of levelling arch wires presented the following sequence: 0.014", 0.016", 0.018" round nickel titanium superelastic Orthoform III arch wires; 0.018" and 0.020" coordinated stainless steel arch wires; 0.019 x 0.025" nickel titanium superelastic Orthoform III arch wires and 0.019x0.025" coordinated stainless steel arch wires. All arch wires were from 3MTM UNITEK brand.

The installation of the Forsus appliance was made with the insertion of 0.019 × 0.025" rectangular stainless steel arch wires in both dental arches. Metal ligatures were used in the lower cuspids, providing stability during the mechanics, and bends were applied distal to the upper and lower second molar tubes, ensuring the increase of anchorage on the mandibular arch. In the upper arch, tie-backs were used to keep the anchorage and, in the lower ar ch, a transpalatal bar was set to increase the transversal anchorage11. The Forsus FRD-EZ (32 mm) was, then, installed in order to establish the anterior mandibular advancement (Figure 4).

After the third month of use, the spring was activated by the use of an expansion ring in both sides. The total time of use was 9 months, being 7 months the active time of the device. The device was held in place for retention and to keep the stability of results for two more months. At the end of this stage, a satisfactory overbite and overjet were achieved and the midline corrected (Figure 5).

The Forsus was, then, removed and the finishing stage was started to detail the final occlusion (Figure 6). At this stage, intermaxillary Class II (1/4 medium) elastics were used to reinforce the anchorage and improve the final occlusion.

The total treatment time, counting the three appointments in which the patient did not come in to the office, was twenty months. After the appliance removal, the functional movements in centric relation were measured and the fixed retainer bonded on the lower arch, sitting in both right and left cuspids. Hawley modified removal retainer was used in the upper arch (Figure 7).

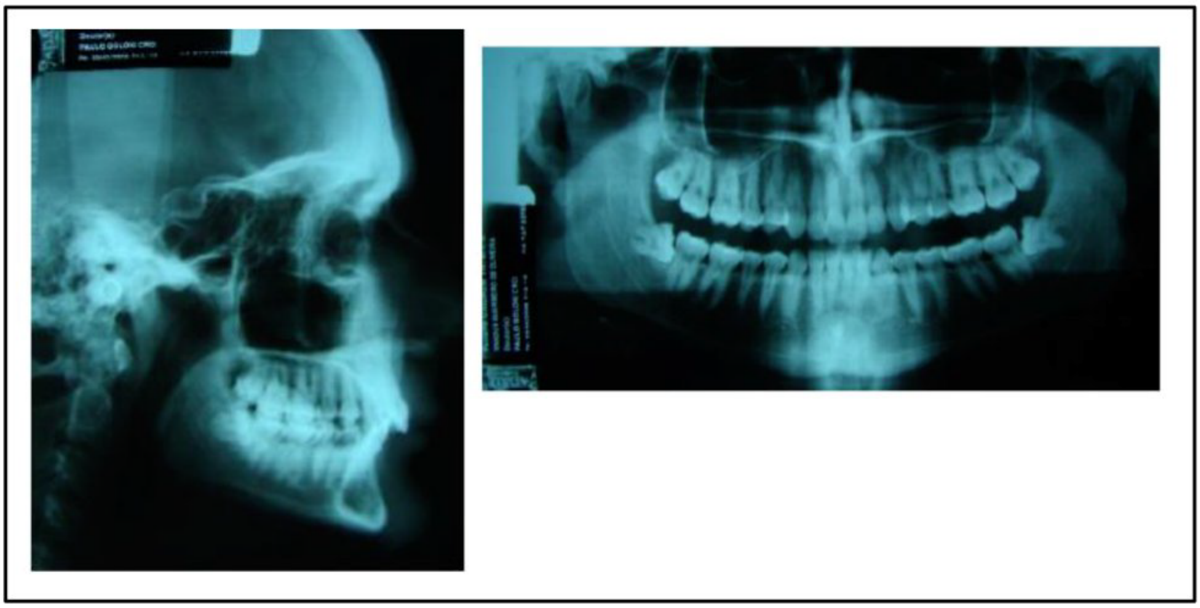

Figure 3: Initial panoramic and cephalometric x-rays.

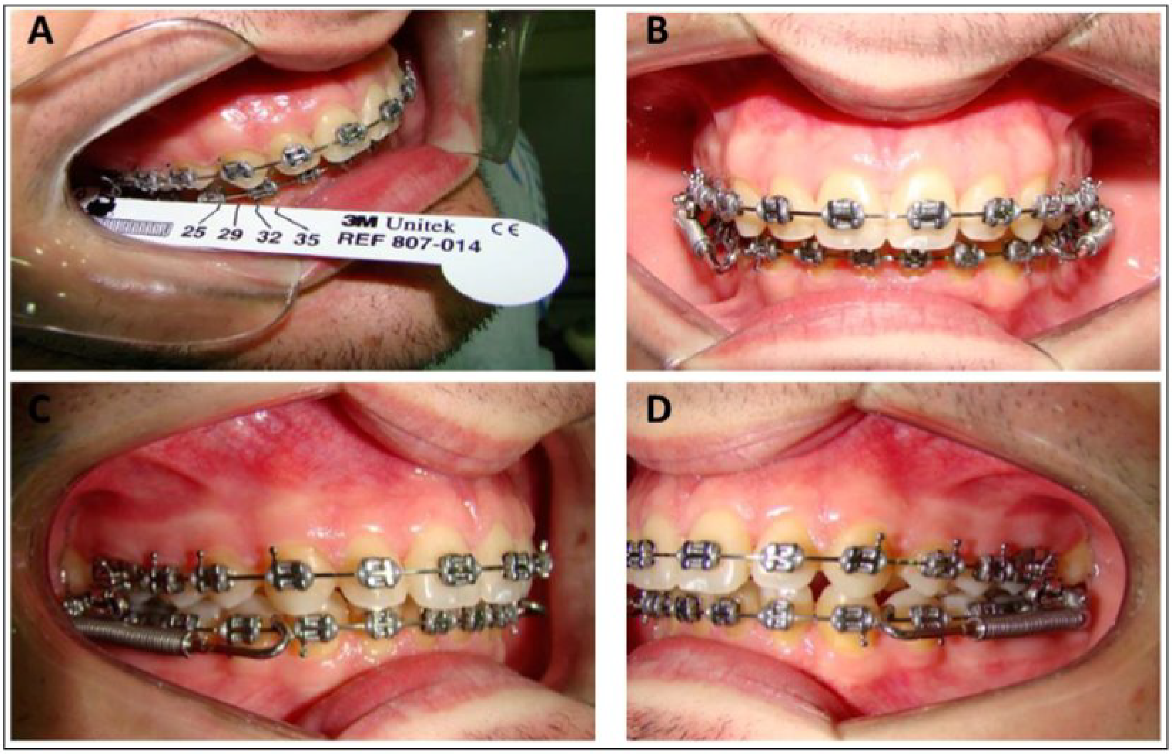

Figure 4: 32 mm “Forsus EZ” Installation. (A) The size was selected with the aid of a specific ruler (3M UNITEK).

Figure 5: Final phase of the use of the “Forsus EZ” with overbite, overjet and medium line adjusted.

Figure 6: Releveling and realignment after the end of the use of the "Forsus EZ".

Figure 7: Final extra and intraoral pictures.

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Treatment Results

In order to evaluate the short and long-term dentoskeletal effects, cephalometric evaluations were performed in three stages: (T1) pretreatment, (T2) post-treatment (T3) and two years after the end of treatment (Figure 8). The evaluated cephalometric variables and the results obtained in the three stages of treatment are described in Tables 1 and 2.

The pretreatment cephalometric analysis (T1) confirms the existence of a sagittal Class II division 1 Angle malocclusion with a minor overbite, well-related bone basis and horizontal growth pattern.

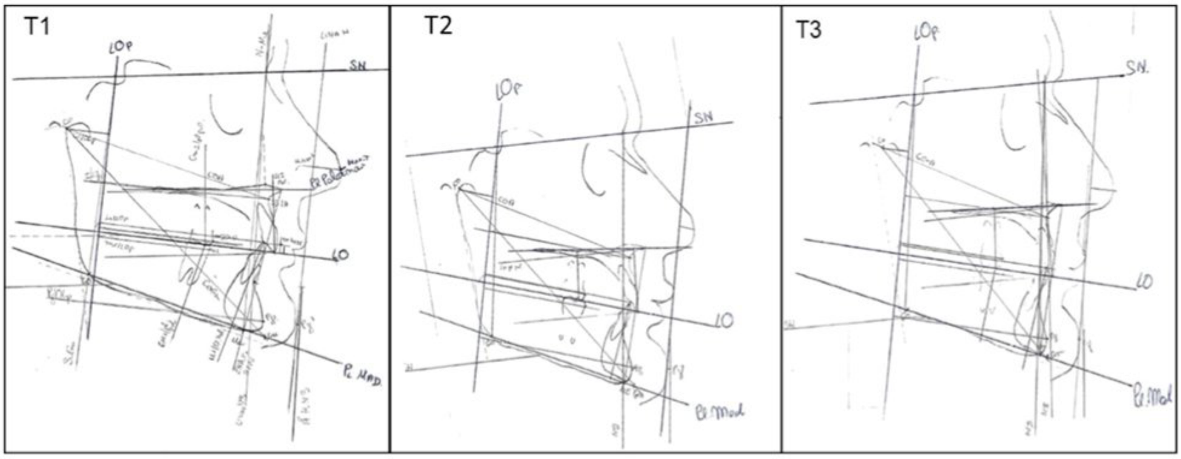

Figure 8: Cephalometric evaluations were performed in three stages: (T1) pretreatment, (T2) post-treatment and (T3) two years after the end of treatment.

MAXILLARY COMPONENTS	
SS/LOp (mm)	Distance from point (SS) to line (OLp), establishing the position of the base of the maxilla.
Co-A (mm)	Effective length of the maxilla.
MANDIBULAR COMPONENTS	
Pg/LOp (mm)	Distance from point (Pg) to line (Olp), establishing the position of the base of the maxilla.
Co/Lop (mm)	Perpendicular distance from point (Co) to line (Olp), establishing the position of the condyle head.
Pg/Olp + Co/Lop (mm)	Distance between (Pg/Olp) along with distance (Co/Olp), establishing the total length of the mandible.
Co-Gn (mm)	Effective length of the mandible.
MAXILLOMANDIBULAR RELATIONSHIP	
DMM(mm)	Maxillomandibular difference.
GROWTH PATTERN	
SN.GoMe (°)	Mandibular plane angle, establishing the difference between the upper and lower horizontal planes of the face. Inclination of the mandibular plane in relation to the cranial base.
ENA-Me (AFAI) (mm)	Lower anterior facial height.
CRANIOFACIAL RELATIONSHIP	
SN.Pl. Palatino (°)	Angle between the SN line and the palatal plane, establishing the inclination of the palatal plane in relation to the anterior cranial base.
N-Me (mm)	It has established the anterior facial height.
S-Go (mm)	It has established the posterior facial height.
UPPER DENTOALVEOLAR COMPONENT	
is/LOp (mm)	Perpendicular distance from point (is) to line (OLp), establishing the position of the upper central incisor.
ms/LOp (mm)	Perpendicular distance between point (ms) to line (OLp),establishing the sagittal position of the upper first molar.
Ils/pl. palatino (mm)	Linear distance from the upper incisor edge perpendicular to the palatal plane, establishing the vertical position of the upper incisor.
Cms/Pl.palatino (mm)	Linear distance from the tip of the mesiobuccal cusp of the upper first molar, perpendicular to the palatal plane, representing the vertical position of the upper first molar.
LOWER DENTOALVEOLAR COMPONENT	
ii/LOp (mm)	Perpendicular distance from point (ii) to line (OLp), establishing the sagittal position of the lower central incisor.
mi/LOp (mm)	Perpendicular distance from point (mi) to line (OLp), establishing the sagittal position of the lower first molar.
Ili/pl. mandibular (mm)_	Linear distance from the lower incisor edged perpendicular to the mandibular plane, establishing the vertical position of the lower incisor..
Cmi/Pl.mandibular (mm)	Linear distance from the mesiobuccal cusp edge of the lower first molar perpendicular to the mandibular plane. It represents the vertical position of the lower first molar.
INTERMEDIARY RELATIONSHIP	
is/LOp – ii/Lop (mm) Overjet	Values of (is/LOp) subtracted from the value of (ii/LOp), defining theoverjet.

ms/LOp – mi/LOp (mm)	The value of (ms/LOp) subtracted from the value of (mi/LOp), indicating the molar relationship.
Overbite (mm)	Linear measurement representing the vertical relation between the incisal edges of the upper and lower incisors in the occlusal plane.
DENTOSKELETAL RELATIONSHIP	
is/OLp - SS/Lop (mm)	Value of (is/OLp) subtracted from the value of (SS/OLp), determining the change in position of the upper central incisor in the maxilla.
ii/OLp - Pg/LOp (mm)	The value of (ii/OLp) subtracted from the value of (Pg/LOp), determining the change in position of the lower central incisor in the mandible.
ms/LOp - SS/LOp (mm)	Value of (ms/LOp) subtracted from the value of (SS/LOp), determining the change in position of the upper first molar in the maxilla.
mi/LOp - Pg/LOp (mm)	The value of (mi/LOp) subtracted from the value of (Pg/LOp), determining the change in position of the lower first molar in the mandible.
SN.LO (°)	Occlusal plane angle.
TEGUMENTARY COMPONENTS	
H.NB (°)	Angle formed by the intersection of the NB line with H line, indicating the convexity level of the facial soft tissue.
H-Nariz (mm)	Distance between point Pn and line Pg'Ls.
Ls-E(mm)	Linear distance between ENA and the most inferior point of the upper lip.
Li-E(mm)	Linear distance between the lower lip point and the aesthetic plane.

Table 1: Evaluated Cephalometric measurements.

SKELTAL-MAXILLARY CHANGES			
	T1	**T2**	**T3**
SS/LOp (mm)	70.85	71.10	72.50
Co-A (mm)	100.20	98.2	98.7
SKELETAL- MANDIBULAR CHANGES			
	T1	**T2**	**T3**
Pg/LOp (mm)	80.10	79.00	79.50
Co/LOp (mm)	20.00	20.00	17.50
Pg/LOp + Co/LOp (mm)	100.10	99.00	97.00
Co-Gn (mm)	131.5	131.40	130.25
MAXILLOMANDIBULAR RELATIONSHIP			
	T1	**T2**	**T3**
DMM (mm)	31.30	33.20	31.55
GROWTH PATTERN			
	T1	**T2**	**T3**
SN.GoMe (°)	22.5°	24°	21.5°
(AFAI) ENA-Me(mm)	68.75	67.5	65.00
CRANIOFACIAL RELATIONSHIP			
	T1	**T2**	**T3**
SN.Palatal Plane (°)	2°	4°	3.5°
N-Me (mm)	121.00	122.60	120.80
S-Go (mm)	90.00	88.5	87.00
UPPER DENTOALVEOLAR RELATIONSHIP			
	T1	**T2**	**T3**
is/LOp (mm)	84.00	81.00	81.50
ms/LOp (mm)	53.50	50.00	52.00
Ils/Palatal Plane (mm)	20.9	23.90	23.10
Cms/Palatal Plane (mm)	25.00	23.50	25.00
LOWER DENTOALVEOLAR RELATIONSHIP			
	T1	**T2**	**T3**
ii/LOp (mm)	77.00	79.20	79.40
mi/LOp (mm)	50.50	52.20	52.30
Ili/Mandibular Plane (mm)	42.00	39.00	38.00
Cmi/Mandibular Plane (mm)	30.50	30.00	30.70
INTERDENTAL RELATIONSHIP			
	T1	**T2**	**T3**
Overjet = is/LOp - ii/LOp (mm)	6.00	1.80	2.10
ms/LOp - mi/LOp (mm)	3.00	1.80	2.70
Overbite (mm)	4.00	2.75	3.10
DENTOSKELETAL RELATIONSHIP			
	T1	**T2**	**T3**
is/LOp- SS/LOp (mm)	13.15	5.7	5.0
Ii/LOp - Pg/LOp (mm)	-3.10	0.20	-0.10

ms/LOp - SS/LOp (mm)	-17.35	-21.10	-21.50
mi/LOp - Pg/LOp (mm)	-29,60	-30.80	-30.20
SN.LO (°)	11°	12°	14°
TEGUMENTARY CHANGES			
	T1	**T2**	**T3**
H.NB (°)	3.1°	4.7°	4.5°
H-Nose (mm)	14.00	10.00	11.00
Ls-E (mm)	27.90	26.75	27.30
Li-E (mm)	-8.36	-6.12	-6.53

Table 2: Cephalometric measurements in T1,T2 eT3.

Figure 9: Pictures of final models.

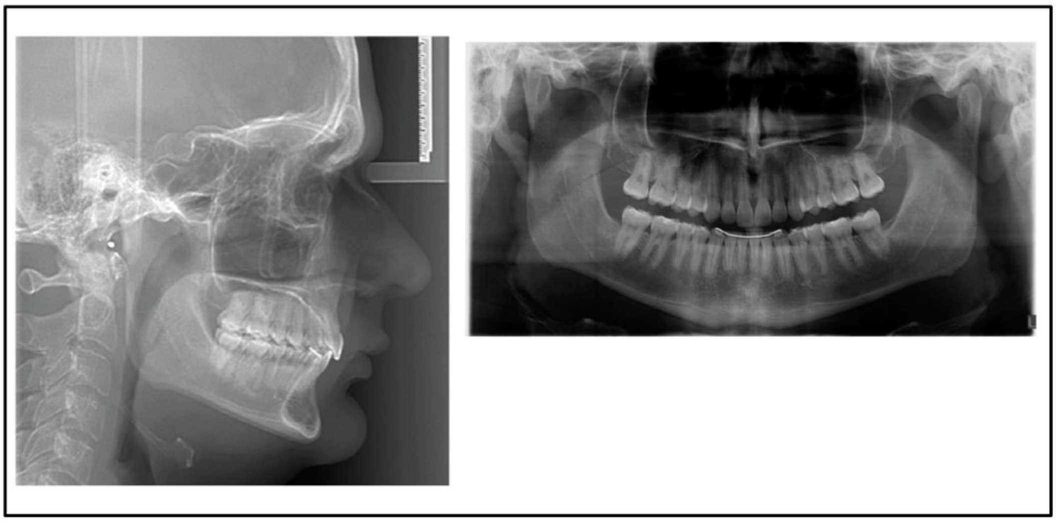

Figure 10: Final panoramic and cephalometric x-rays.

After the end of treatment, additionally to dental aligning and leveling, it was seen the correction of the Class II molar relationship, establishing the cuspid key and overbite and overjet reductions, achieving a good intecuspation and midline correction (Figures 7 and 9). The comparative cephalometric analysis in T1 and T2 shows that the post-treatment results were obtained exclusively by dentoalveolar changes, with the stability of the occlusal and palatal planes (Table 2) and minor change on the facial soft tissue, however, with improvement in its convexity (Figures 7 and 9).

Results have also shown stability in the positioning of the condyles and a small increase in the anterior facial height.

Roots parallelism and no sign of damage to them and the supporting structures can be seen in the final panoramic x-rays (Figure 10). Final radiography show an improvement in the maxillomandibular sagittal relationship (Figure 10).

Clinical and cephalometric controls, between T2 and T3 (Table 2), conducted two years after the end of treatment (Figures 11-13) show that the treatment goals were fully achieved, giving to the patient a long-term functional and stable occlusion.

Figure 11: Extra and intraoral pictures after two years of the end of the treatment.

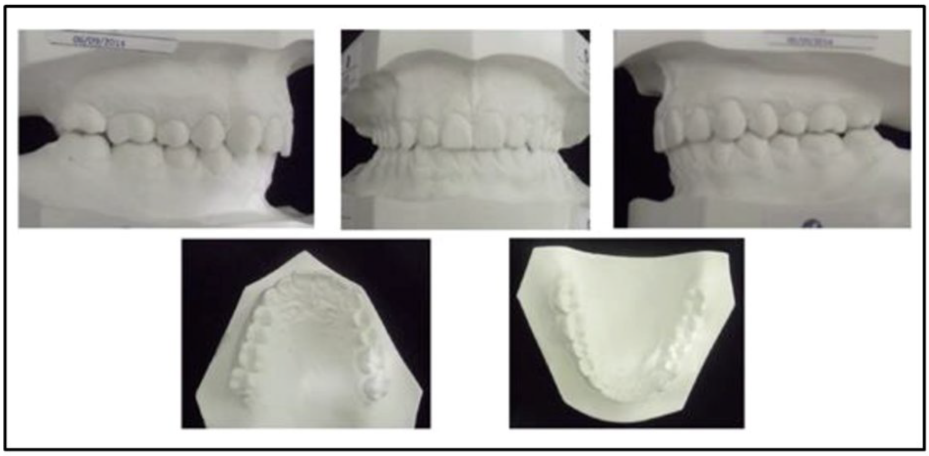

Figure 12: Models pictures - a two years control after the end of the treatment.

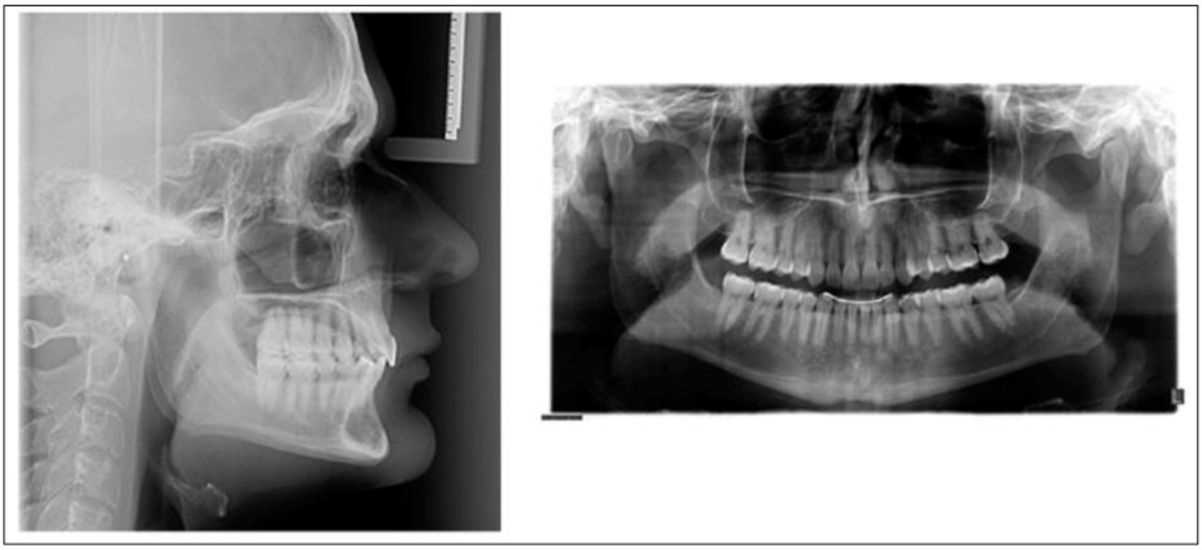

Figure 13: Panoramic and cephalometric x-rays – ptwo years after the end of the treatment.

Discussion

The decision to treat this case using the Forsus hybrid functional appliance was taken due to the patient's main complaint, the characteristics of the malocclusion and, mainly, the facial features that have shown facial asymmetry within the normal standards, i.e., convex profile, but with passive lip seal, harmonic nasolabial angle and horizontal growth pattern [1,2,4-6,8,9,12,25,28,30,33,34,35]. Other treatment options were considered unfavorable due to the presented clinical condition and the patient's main complaint and treatment choice. The first alternative, which was conducting an orthodontic-surgical treatment [20,28], was not accepted by the patient, furthermore, it was an extremely invasive treatment to the intra and extra-oral characteristics presented at the clinical examination and diagnosis. The second alternative, which considered extractions of upper first premolars [39,40], was also seen unfavorable due to an skeletal, not just dental, error and, also, because the patient presented a well-positioned jaw, harmonic nasolabial angle and prominent soft tissue. Dental extractions could harm the harmony of the facial profile, as well as bringing unsatisfactory results [39] due to the mandibular skeletal error. The third option, which was using intermaxillary elastics [24,41], would be a favorable choice due to the malocclusion characteristics and the long-term dentoalveolar effects [24], when compared to the fixed functional appliances. However, due to the need of patient's cooperation [24], another treatment option was considered. The treatment option was, then, the use of the Forsus fixed functional appliance because it is easy to instalatt [10,11,13] and, mainly, because it provides comfort to patient, allowing greater freedom to the eccentric and centric mandible movements [7,11-17,33,34], and, also, better resistance [10,13] and performance with light forces (average of 220 to 250g) [15,35]. Other functional appliances, such as the Herbst and the Jasper-jumper, provide, in a long-term run, the same dentoskeletal results as the hybrid appliances [8,11,12,18,19,21-23,25]. However, the Herbst appliance, because it is stiff and restricts mandibular move, it is considered extremely uncomfortable to adult patients, in addition to presenting high breakage levels and complex installation [10,22,26]. The semi-rigid devices, as the Jasper-Jumper, although it allows greater freedom to the functional movements, its flexibility increases the breakage risks [10,11,31].

By using the "Forsus" appliance along with fixed orthodontic appliances, all treatment goals were achieve. Although the long-term results have not been found in the literature [5,6,9], these resources have been widely used by orthodontists as it is a practical device, providing comfort to patients and long and medium-term [5-7,9,17] satisfactory results. The action mechanism of these devices, mainly the dentoalveolar one [5,6,21], have favored the results achieved.

Regarding the results presented at the end of treatment, the cephalometric analysis (Table 2) [18] show that there were dentoalveolar changes consistent with the ones already known in the literature, i.e., buccal inclination and intrusion of lower incisors [5,6,8-11,13-15,17,28,35,36,37], lingual inclination and extrusion of upper incisors [2,5,6,8,9-11,14,15,17,28,36,37], distalization and slight intrusion of upper molars [3,6,8,9-11,13,15,36]. Lower molars were mesialized [3,6,8-11,13,14,17], however, unlike some studies [3,8,9,11,14,17], there was no extrusion of such teeth due to the increased control of the biomechanics and inclusion of the lower second molars in the treatment since its beginning. The palatal plane presented a slight clockwise rotation [2] and, unlike studies from Flores et al. [37], who have reported a shift of the occlusal plane in a counterclockwise direction, the results achieved in this research study have shown a slight clockwise rotation, corroborating with other studies that also have used the Forsus™ Fatigue Resistant Device appliance [5,9,10,17,35,36].

Regarding skeletal changes, results have shown that there was no effective growth of the bone bases in the sagittal direction, being in agreement with the studies that claim the existence of some effective growth only in the pre-peak and pubertal growth peak [1,3-6,9,10,13,15,35,36]. Vertical changes have not been observed, although, the rotation of the occlusal and palatal planes, in addition to the dentoalveolar changes, have contributed to a slight clockwise rotation of the mandibular plane [9-12,15], showing a small increase of the anterior facial height [2,3,8,9,11,12,14,21]. Unlike Ruf et al. [21], who have also reported increase in the posterior height of the face when using the Herbst appliance, this measurement remained stable in our patient, showing that there was no significant vertical skeletal changes at the end of treatment.

The cephalometric analysis have also shown that the condyles did not change in position between T1 and T2, a fact that, along with the absence of any kind of joint discomfort reported by the patient, confirms the results of several studies that show no damage to the TMJs during the therapy with functional fixed appliances, even in the post-peak growth stage [1,9,10,11,21].

Conclusion

The Forsus hybrid functional appliance has shown to be an effective treatment option when treating Class II malocclusion in adult patients with healthy periodontal biotypes and horizontal growth. Dental corrections were sovereign, being stable and functional at the end of treatment and the post-treatment stages.

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