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Research Article

Perception of facial profile changes after treatment with Forsus fatigue-resistant device in Class II patients

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ABSTRACT

Objective: This study was aimed to evaluate the perception of changes in soft tissue profile by comparing profile silhouettes before and after treatment with the Forsus appliance, assessed by laypersons, orthodontists and patients.
Methods: The sample included 18 Class II patients (3 girls and 15 boys; mean age: 12.16 years) treated with the Forsus fatigue resistance device combined with fixed orthodontics. A set of images containing the before and after treatment profile silhouettes based on the lateral cephalograms of the patients were randomly prepared and presented to 135 examiners as a single page. Three groups of examiners assessed the images: G1, laypersons (n = 45); G2, orthodontists (n = 45); and G3, Class II orthodontic patients (n = 45). Each examiner rated the aesthetics of each facial profile using a visual analogue scale. Comparisons between before and after treatment silhouettes and among the three groups of examiners were performed using Wilcoxon and Kruskal-Wallis tests, respectively. A significance level of 5% was used.
Results: The after treatment profile silhouettes were preferred by G2 and G3. The higher scores were given by the patients. The outcomes were not influenced by sex.
Conclusions: Orthodontic treatment performed with the Forsus fatigue resistance device combined with fixed orthodontics had a positive outcome according to orthodontists and patients. The better attractive profile rates scored by patients may suggest a higher acceptance of the Class II facial characteristics. These data may guide orthodontists to discuss the treatment goals with patients considering their expectations and esthetic perceptions.

1. Introduction

Class II malocclusion is one among the most common reasons for seeking orthodontic treatment. Correction of this type of malocclusion with orthodontics is challenging due to the different etiologies and clinical manifestations that may be involved. Skeletal deficiency is often detected in these patients, and justifies the use of several therapeutic systems, from orthopedic to orthodontic and from removable to fixed appliances [1–4].

To enhance the effectiveness and reduce the treatment time, orthodontists often resort to therapeutic approaches that require less patient cooperation. In this context, fixed functional appliances have become an important tool in the clinical orthodontic practice. During the past decades, these appliances have been the subject of many investigations [1,5–9].

Combined with fixed appliances, the Forsus fatigue resistance device (FRD) has emerged as a versatile alternative for the correction of Class II malocclusion. In general, this system works more intensely in the dentoalveolar region. It also restricts maxillary growth and promotes increased mandibular length in young patients. The biomechanics involved in this process culminate in optimal skeletal relations, reduction in overjet, and improvement in molar relationship [5].

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Considering the biomechanics of the Forsus FRD, attention is given to its influence on the alteration of facial aesthetics in patients with Class II malocclusion. Complaints of a convex facial profile are often reported by patients affected with this type of malocclusion. Improving facial harmony plays an important part in the quality of life of patients with Class II malocclusion, especially to bring back self-confidence and social acceptance [10]; however, the therapeutic effects on facial aesthetics may depend on the individual characteristics of each patient and each treatment approach [11–14].

Most of the scientific investigations of the improvement of soft tissues in Class II–treated patients are based on cephalometric measurements. The assessment of aesthetic changes with photographs outlining facial profiles is a promising and alternative approach, especially as cephalometric measurements do not reliably represent facial anatomy [15–20].

Investigations of facial attractiveness using profile silhouettes were previously performed in Class II patients treated with Herbst [20], a mandibular protraction appliance (MPA) [19], and premolar extractions [21]. The opinion of the positive influence on facial aesthetics of these therapeutic approaches differs among laypersons, dentists, and orthodontists. Apart from the technical perception of dentists (including orthodontists), knowing the opinion of laypersons on this subject is relevant to understand how society judges the aesthetics of orthodontically treated patients.

The perception of changes induced by the Class II treatment with Forsus FRD are not yet investigated, especially in the view of individuals affected with the same malocclusion. Based on that, the present study was designed to verify the soft tissue effects caused by the treatment with the Forsus FRD combined with fixed orthodontics according to orthodontists, laypersons, and patients with Class II under treatment.

2. Material and methods

This retrospective study was conducted after approval of the Committee of Ethics of Sagrado Coração University, Bauru - SP, Brazil (CAAE: 51772715.9.0000.5502). A sample calculation was performed to determine the number of examiners necessary in each group for a confidence level of 95% and a maximum error of 0.3 standard deviations between groups. The sample calculation suggested a minimum of 45 examiners in each group.

For the profile evaluation, a sample of 18 patients (15 boys and three girls, mean age: 12.15 years) with skeletal Class II treated with the Forsus FRD combined with fixed orthodontic appliances was selected from the files of orthodontic clinics at the Sagrado Coração University.

All patients presented lateral cephalometric radiographs taken before (BT) and after orthodontic treatment (AT). In addition, as inclusion criteria, only patients with minimal mandibular/lower crowding, a convex facial profile and a half cusp (1/2) Class II malocclusion bilaterally were included. Exclusion criteria were the presence of agenesis or loss of permanent teeth, supernumerary or impacted teeth, and dental anomalies such as tooth size or shape. The initial cephalometric measurements of the sample are described in Table 1. The skeletal pattern of the patients indicated a normal growth tendency with mean FMA (Frankfort mandibular plane angle) of 23.29° and SN.Go-Gn (sella nasion.gonion-gnathion) of 30.44°, and the mean ANB angle (angle formed by the intersection of lines from points A and B to point N) of 4.63°, characterizing the Class II relationship.

All patients were treated with the Forsus FRD for a mean period of 6.94 months, until achieving a Class I molar relationship and a reduction of overjet. The Forsus appliance was installed only after full alignment and progressing up to 0.019 × 0.025-inch stainless steel wire. After Forsus removal, a 0.018-inch stainless steel archwire was placed in the lower arch to keep the lower incisor proclination obtained with the propulsive mechanics. After this period, the treatment was continued with fixed orthodontic appliances (Fig. 1). The mean complete treatment period (Forsus FRD and fixed orthodontic appliances) was 30.77 months.

Table 1
Initial cephalometric measurements, mean and standard deviations (SD), of the patients from the sample

Measurements	Mean	SD
SNA°	80.59	3.85
SNB°	75.98	3.10
ANB°	4.63	2.51
Sn.GoGn°	30.44	3.73
Sn.GoMe°	32.67	3.78
FMA°	23.29	4.34
Overjet (mm)	6.78	2.50

ANB, angle formed by the intersection of lines from points A and B to point N; FMA, Frankfort mandibular plane angle; SNA, sella nasion point A; SNB, sella nasion point B; Sn.GoGn, sella nasion.gonion-gnathion; Sn.GoMe, angle between anterior cranial base and mandibular plane.

The lateral cephalometric radiographs were imported into Radiocef 4.0 software (Radio Memory, Belo Horizonte, Minas Gerais, Brazil). The magnification factor was 2.3% in order to standardize measurements because the radiographs were taken in different clinics. After tracing the soft tissue profile of each patient performed by one researcher (FAB), Adobe PhotoShop (Adobe Systems, San Jose, CA) was utilized to fill the profile silhouettes. An album containing the facial profiles BT and AT was assembled. The two profile silhouettes for each patient were placed randomly on the

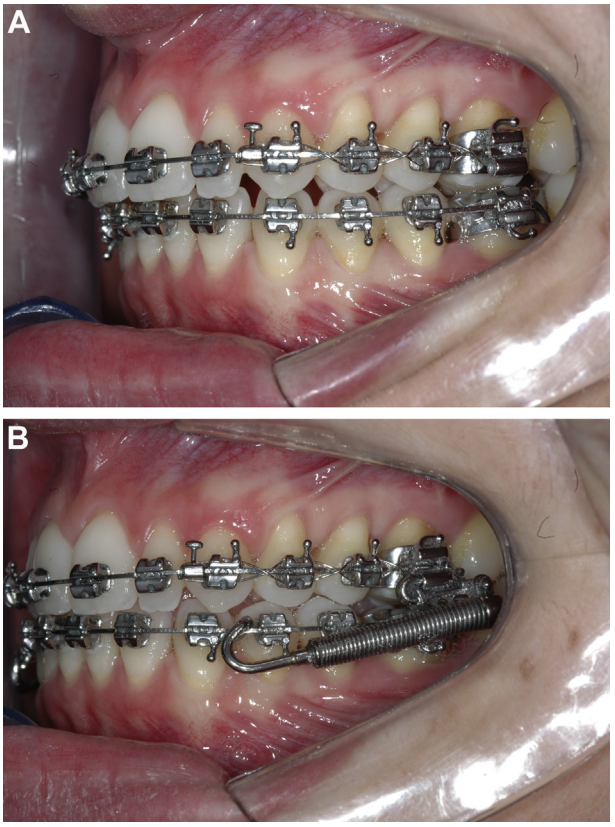

Fig. 1. Intraoral photograph in lateral view before (A) and after (B) the installation of the Forsus appliance.

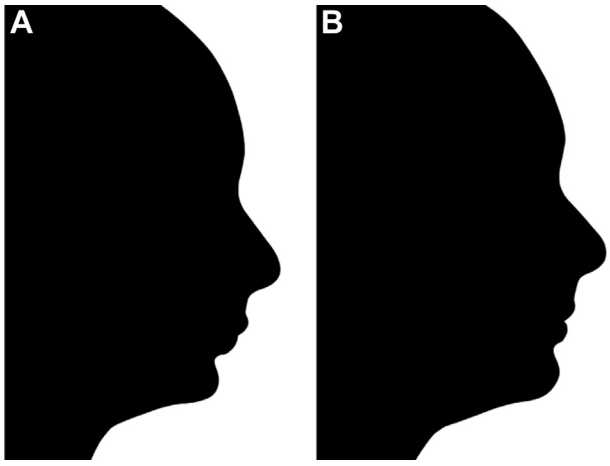

Fig. 2. Facial silhouette of one patient before (A) and after (B) orthodontic treatment.

same sheet, rather than positioning the pretreatment silhouette on either the right or left side of the sheet (Fig. 2).

The album with the images BT and AT was presented to three groups of 45 evaluators each; G1 comprised 24 male and 21 female laypersons; G2, 22 male and 23 female orthodontists; and G3, 22 male and 23 female Class II patients undergoing orthodontic treatment. The mean ages of the examiners in groups G1, G2, and G3 were 36.22, 36.86, and 19.15 years old, respectively. The examiners analyzed the profile silhouettes and rated the profile attractiveness using the Visual Analogue Scale (VAS). The VAS was defined as a 100-mm line, where zero at the leftmost end indicated a very unattractive profile silhouette, and the opposite end, on the right, indicated the opposite, a very attractive profile (Fig. 3). The evaluators marked a vertical stripe between the left and right ends of the line to indicate their scores of profile attractiveness. Each examiner scored the facial profiles of each patient, BT and AT. This reliable method to subjectively measure different perceptions of facial attractiveness have been used in many studies previously published [19–21].

To determine the method error, all evaluators reanalyzed all the profile silhouettes 30 days after the first evaluation and the paired *t*-test was applied.

2.1. Statistical analysis

Based on the results, the sample of 18 patients showed a power of 80.5% to detect a minimum difference of 2.7 points in the VAS scores between the pre- and posttreatment evaluation. All the data from the VAS scores were not normally distributed according to the Kolmogorov-Smirnov test. The Wilcoxon test was performed to compare the VAS scores BT and AT. The Kruskal-Wallis test was used to compare the VAS scores among the three groups of examiners. The Mann-Whitney test was used for comparisons based on sex. Statistical tests were performed using the Statistica 13.0 software package (StatSoft Inc., Tulsa, OK) with a significance of 5%.

Fig. 3. Visual analogue scale (VAS).

Table 2
Median, 1st quartile, 3rd quartile and the comparison between scores before and after treatment and between the different groups of examiners

Examiner	Before treatment (BT)			After treatment (AT)			P_{BTxAT}
	Median	1st Q	3rd Q	Median	1st Q	3rd Q	
Layperson	31	17	52	32	20	52	0.865
Orthodontist	29	15	43	31	19	45	<0.001[a]
Patient	35	19	53	44	28	60	<0.001[a]
P LxO	<0.001[a]			0.027			
P LxP	0.174			<0.001[a]			
O OxP	<0.001[a]			<0.001[a]			

Patients are those with Class II malocclusion; 1st Q: 1st quartile; 3rd Q: 3rd quartile. BT: LxO, laypeople versus orthodontists; LxP, laypeople versus patients; OxP, orthodontists versus patients; Q, quartile.
[a] Statistically significant difference ($P < 0.05$).

3. Results

The findings regarding the method error indicated that significant differences among G1 ($P = 0.32$), G2 ($P = 0.23$), and G3 ($P = 0.76$) were not observed.

All the groups of evaluators preferred the profile silhouettes AT. Significant outcomes were observed in G1 and G3 ($P < 0.05$). The analysis between groups considering the silhouettes BT revealed significant differences between G2 and G3 ($P < 0.05$) and G1 and G2 ($P < 0.05$), whereas the analysis AT revealed significant differences among all groups (Table 2).

Significant differences were not observed between scores given by female and male examiners (Table 3).

4. Discussion

Fixed functional appliances have been largely used for the treatment of Class II patients. The correction of the malocclusion occurred based on skeletal and mainly dentoalveolar effects, such as proclination of mandibular incisors and retroclination of maxillary incisors, which can potentially alter the lip profile relationship. Cephalometric analysis is usually performed to assess changes in the facial profile of patients who undergo treatment for Class II malocclusion [4,5,8,13,16]; however, this technique is limited when quantifying facial distances without considering the general morphology of human soft tissue.

There are many methods for the assessment of facial aesthetics. The facial profile analysis performed in this study excludes aspects that influence facial attractiveness, such as sex, age, and skin and

Table 3
Comparison between the groups of examiners based on sex

Treatment	Group	Sex	Median	1st Q	3rd Q	*P*[a]
Before	Layperson	F	31	13	54	0.222
		M	32	20	51	
	Orthodontist	F	30	15	46	0.199
		M	28	16	41	
	Patient	F	40	18	57	0.081
		M	33	20	49	
After	Layperson	F	32	17	51	0.094
		M	33	21	52	
	Orthodontist	F	31	19	48	0.931
		M	31	19	44	
	Patient	F	44	23	63	0.850
		M	44	31	57	

Patients are those with Class II malocclusion.
F, female; M, male; Q, quartile.
[a] Statistically significant at $P < 0.05$.

hair color [19,22], and enables the analysis of the general morphology of the human face in a lateral view.

Class II patients were evaluated with respect to profile changes BT and AT by three groups of evaluators, and to assess the opinion of patients affected with the same malocclusion, G3 was composed of Class II patients undergoing orthodontic treatment. In addition, the opinion of patients was compared with the judgment of orthodontists and laypersons. Using this approach, the importance of the perception of facial changes in cases of Class II malocclusion is explored from both clinical and social perspectives.

The outcomes showed that orthodontists (G2) and patients (G3) preferred facial profiles AT. Laypersons (G1) showed the same preference, but it was not significant. Similar findings have been previously reported [19–21]. Specifically, facial profiles were analyzed in patients treated with premolar extractions [21] and AT with MPA [19] and Herbst [20] appliances. The latter studies presented similar methodology, applying profile silhouettes for the analyses of profile attractiveness.

The preference of the three groups for posttreatment profiles may be explained not only by the facial alterations that resulted from treatment, but also by further craniofacial growth. The latter is justified based on the mean age of the patients (12.16 years old), which indicates that further growth should be expected, and by the percentage of boys in the sample (83.33%), as boys experience growth later than girls.

The mean scores of pre- and posttreatment profiles given by each group of examiners were compared. Significant differences were observed between all groups BT and AT, except between G1 and G3 in the analysis of pretreatment profiles. It is important to note that higher scores were given by G3, both BT and AT. It indicates that even with the same malocclusion, patients tend to be more tolerant when judging attractiveness.

Similar outcomes to the disagreement between orthodontists and laypersons on facial attractiveness have been reported previously [23,24]. In the present study, orthodontists gave the lowest scores both BT and AT, and their scores differed from laypersons and Class II patients. Paula et al. [19] compared the perception of orthodontists and laypersons and showed that the former perceived fewer changes in the facial profile AT with the MPA. In accordance, Rego et al. [20] observed that orthodontists perceived fewer changes, followed by general clinicians and laypersons. These outcomes suggest that orthodontists more critically analyze profiles AT, which may be explained by their higher technical knowledge of facial aesthetics. On the other hand, O'Neill et al. [16] observed the lack of a significant difference between dentistry students and relatives of patients under orthodontic treatment concerning attractiveness BT and AT.

The age of the examiners may have an important role in the results because the G3 examiners were patients under orthodontic treatment and were considerably younger than the subjects in other groups. The patient group better rated the facial profiles, especially AT. However, the influence of age on the perception of facial aesthetics must be explored in additional field studies.

Based on a previous study that suggested that female individuals tend to better perceive aesthetic facial changes [19], the influence of sex when judging facial attractiveness was also evaluated. However, no differences were observed between male and female individuals in the present study.

Despite being discrete, the facial profile changes AT were perceived more evidently by the patient group. This finding is the most relevant clinical point of our study, considering that the view of individuals affected with the same malocclusion may be different. The idea that Class II patients are more tolerant with the convex profile inherent to this type of malocclusion may influence our goals. We must leave the protagonism of this treatment to the patients, considering their opinion and expectations as the main objective.

5. Conclusions

Based on the results, it is possible to conclude the following:

- The Forsus FRD combined with fixed orthodontic appliances promotes positive changes in the facial profile that were perceived by orthodontists and patients.
- The three groups of examiners differently perceived facial profile attractiveness BT and AT. An exception was observed between laypersons and patients in the pretreatment evaluation.
- The group of evaluators composed of Class II patients better rated the profile attractiveness, which may show an increased acceptance of the Class II facial profile.
- Male and female evaluators provided similar profiles attractiveness scores.

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