Original Article

Esthetic perception of facial profile changes in Class II patients treated with Herbst or Forsus appliances

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ABSTRACT

Objective: To evaluate the esthetic perceptions of orthodontists and laypersons for facial profile changes after orthodontic treatment using Herbst or Forsus appliances.

Materials and Methods: Pre- and posttreatment facial profile contour images of 20 Class II patients treated with Herbst (group H; n = 10) and Forsus (group F; n = 10) appliances were analyzed by 30 orthodontists and 30 laypersons, who graded them from 1 (unattractive) to 10 (very attractive) using a visual analog scale. Two assessments were carried out with a 15 day-interval. In the first evaluation, 40 images were presented in a random sequence. In the second evaluation, initial and final facial profile images of each patient were randomly presented side by side. To compare groups in relation to treatment method, Mann-Whitney tests were used. To evaluate differences between time points, Wilcoxon tests were used.

Results: In the first evaluation, there was a significant difference between initial and final images only for group H, for both laypersons ($P = .017$) and orthodontists ($P = .037$). There was also a significant difference between laypersons and orthodontists in their ratings of posttreatment Herbst appliance profiles ($P = .028$). There was no significant difference between initial and final facial profile images for group F and no significant differences between or within evaluator groups in their ratings of initial or final Forsus appliance profiles. In the second evaluation, there was a significant difference between appliance groups only for laypersons, who considered cases treated with the Herbst appliance more attractive than those treated with the Forsus ($P = .031$). Laypersons also considered Herbst profiles more attractive than did orthodontists ($P = .047$).

Conclusions: Class II malocclusion treatment using the Herbst appliance may produce a more esthetically improved facial profile silhouette compared with Forsus appliances. The magnitude of perceived changes may not be considered clinically relevant. (*Angle Orthod.* 2020;90:571–577.)

KEY WORDS: Angle Class II; Mandibular advancement; Corrective orthodontics

INTRODUCTION

Class II malocclusion can compromise facial esthetics. Usually, the mandibular deficiency produces a convex and retrognathic profile, with a chin prominence deficiency and a retruded lower lip in relation to the midface.[1–3]

The Herbst appliance has proved to be effective in Class II treatment of mild to moderate cases during growth spurts.[4,5] This appliance generates an upward

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and backward growth stimulation of the condyles. Consequently, it promotes an advancement of the mandibular body, adjusting skeletal and occlusal sagittal relationships.[6–8] The appliance also generates advancement of the soft tissue of the chin and of the lower lip, contributing to improvements of the facial profile esthetic.[3,9,10] Despite its clinical efficiency, the Herbst appliance has some disadvantages, such as the need for complex laboratory preparation, operator experience, and frequent repairs as well as initial soft tissue discomfort experienced by the patient.[11]

Currently, the Forsus device is an interesting alternative, since it has also been shown to be relatively efficient in Class II correction of mild-to-moderate cases.[12–14] The Forsus is a device with stainless steel springs that does not require a laboratory phase and can be used concomitantly with fixed appliances. Therefore, its clinical management is easier, and the installation time and total treatment time are shorter. The Class II correction and occlusion adjustment are performed simultaneously in a single phase.[15] However, the Forsus device does not seem to produce significant orthopedic effects, as it does not change the condylar position. However, patient comfort seems to be less of a burden of care. The effects of this appliance are basically dental changes, which can limit the impact on the facial esthetics of Class II correction.[14,16,17]

Both Herbst and Forsus appliances present satisfactory occlusal results during Class II correction, but they seem to promote different effects in terms of facial profile changes. However, no study has compared facial profile changes produced by these two approaches. Therefore, the aim of this study was to evaluate the esthetic perception of orthodontists and laypersons regarding the changes in facial profile produced by Herbst and Forsus appliances during Class II malocclusion treatment.

MATERIALS AND METHODS

This research was approved by the Institutional Review Board at Universidade Positivo, Curitiba, PR, Brazil (protocol No. 1.140.940). The sample consisted of 20 patients with Class II malocclusion successfully treated with Herbst or Forsus appliance. Inclusion criteria were molar Class I relationship and overjet (distance between incisal edges) between 1 and 3 mm at the end of the treatment, initial ANB $\geq 5°$, and initial FMA between 20° and 30°. Patients with agenesis or loss of permanent teeth, supernumerary or impacted teeth, and lower incisor crowding >6 mm were excluded. Cases were selected from two private practice clinics and were treated between January 2010 and December 2015. The first 10 patients of each group who met the inclusion criteria were selected. The sample was divided into two groups.

Group H consisted of 10 patients (eight boys and two girls, mean age 11.3 $\pm$ 1.9 years) treated with Herbst appliance with lower acrylic splint[18] for 12 months and, in a second phase, with fixed appliances (022-inch MBT preadjusted brackets, 3M Unitek, Monrovia, Calif). In group H at the beginning of the treatment, three patients showed cervical vertebral maturation[19] of stage II and eight patients of stage III. Initial lateral cephalograms were taken before installing the Herbst appliances, and final lateral cephalograms were taken after fixed appliance removal. The average time between radiographs was 44 $\pm$ 6 months. The average age at the time of the final radiograph was 15.1 $\pm$ 1.7 years.

Group F included 10 patients (four boys and six girls, mean age 12.7 $\pm$ 1.5 years) treated with fixed appliances (022-inch MBT preadjusted brackets, 3M Unitek) and a Forsus device (3M Unitek) with the rod inserted distal to the lower canine brackets. In group F, seven patients showed cervical vertebral maturation of stage III and three patients of stage IV at the beginning of treatment. On average, the Forsus appliances were used for 6 months. Initial lateral cephalograms were taken before the installation of fixed appliances, and final lateral cephalograms were taken after their removal. The average time between the radiographs was 32 $\pm$ 11 months. The average age at the time of the final cephalogram was 15.4 $\pm$ 1.6 years.

Evaluations of facial profiles were made from tracings of the soft tissue contour obtained from the lateral cephalograms from the G′ point to the Me′ point. Tracings were scanned in JPEG format, at a 1:1 ratio, with 300 dpi, using an Officejet 6500 scanner (HP, Jundiai, Brazil). The Frankfurt plane was oriented parallel to a true horizontal plane, and tracings were filled with black color using Photoshop CS6 software (Adobe Systems, San Jose, Calif), as shown in Figure 1A,B.

Invitation to take part in this study was sent by e-mail to 78 orthodontists selected from the Brazilian Association of Orthodontists website. The first 30 responses of orthodontists with more than 10 years of clinical experience were considered. The same invitation was sent to 84 laypersons aged within the same limits established for the group of orthodontists, selected from an e-mail list of patients' parents who were receiving orthodontic treatment at the university where this study took place. The first 30 responses were considered.

The orthodontist group was composed of 15 men and 14 women with mean age of 45.6 $\pm$ 10 years. Average clinical experience was 16.6 $\pm$ 6.2 years. The

Figure 1. (A) Initial and (B) final facial profile contours of a patient of this study.

layperson group included five men and 25 women with a mean age of 40.2 ± 10.5 years.

Two assessments of facial profile images were performed with a minimum interval of 15 days. The evaluators were requested to assign a value from 1 (unattractive) and 10 (very attractive) on a 10-point visual analog scale according to their perception of facial profile esthetics of the provided silhouettes. During the first assessment, the 40 images were randomly presented, independent of time points (initial or final) or treatment method (Figure 2). In the second assessment, initial and final silhouettes of each patient were presented side by side; however, the order was randomly distributed in relation to the treatment group (Figure 3).

The results were described as mean, median, minimum, and maximum values and standard deviations. To compare the groups in relation to the treatment method, the nonparametric Mann-Whitney test was used. To evaluate the differences between time points, the nonparametric Wilcoxon test was used. Values of $P < .05$ were considered statistically significant. Data were analyzed with IBM SPSS v.20 software (Armonk, NY).

RESULTS

There were no statistically significant differences between the two groups in relation to maxillomandibular sagittal relationships (ANB: group H = 6.04° ± 0.88°; group F = 6.09° ± 0.77°; SNA: group H = 80.56° ± 3.51°; group F = 80.77° ± 3.87°; SNB: group H = 74.56° ± 3.4°; group F = 74.68° ± 2.99°) and vertical patterns (F.PP: group H = 23.47° ± 3.39°; group F = 22.9° ± 3.49°) at the beginning of the treatment, showing that the groups had similar skeletal patterns. The initial mean ages (group H = 11.3 ± 1.9 years; group F = 12.7 ± 1.5 years) were also similar.

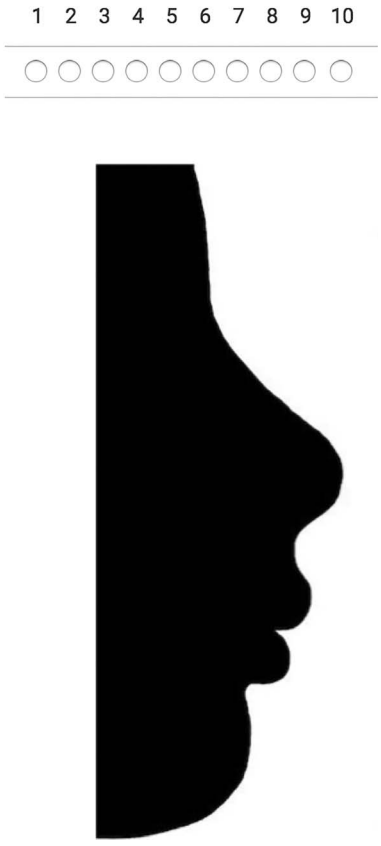

Figure 2. Example of image shown to evaluators in the first evaluation.

Table 1 shows the means and standard deviations of scores obtained in the first assessment. For both examination groups, a significant difference was observed when comparing the silhouettes of the initial and final profiles from the Herbst group ($P = .017$, laypersons; $P = .037$, orthodontists). There was no significant difference ($P > .05$) between initial and final silhouettes within the Forsus group for both laypersons and orthodontists. Comparing laypersons and orthodontists, there was a significant difference only for the ratings of posttreatment Herbst appliance profiles, which were considered to be more attractive by laypersons ($P = .028$) There was no significant difference in ratings between treatment groups ($P > .05$) by either evaluator group, regardless of the period (initial or final).

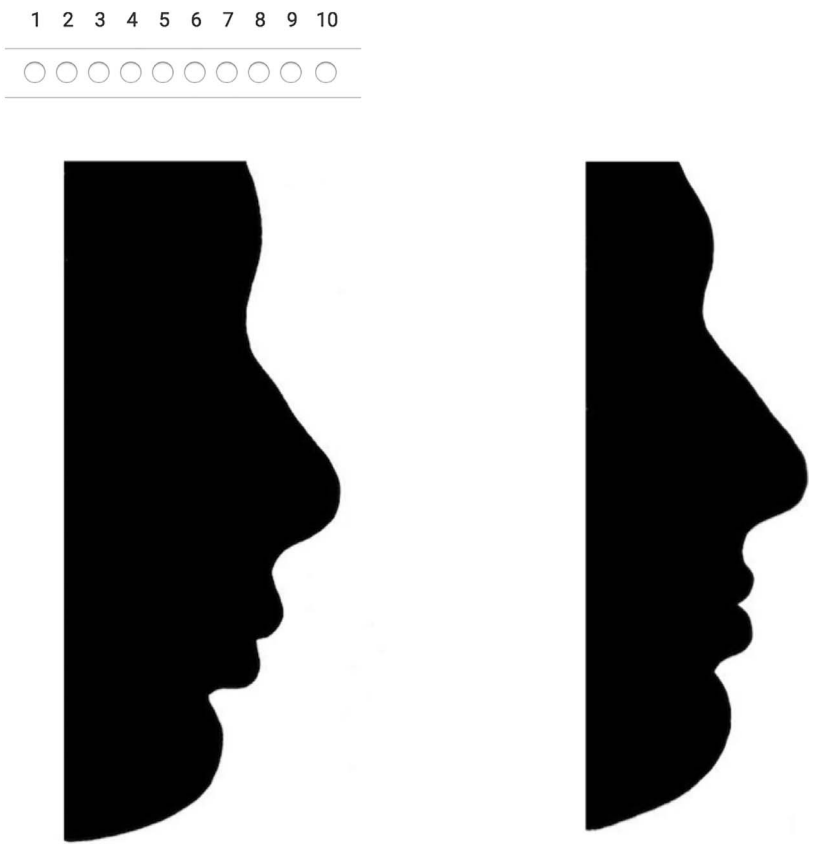

Figure 3. Example of image shown to evaluators in the second evaluation.

Table 2 shows the means and standard deviations of scores obtained after the second assessment. Comparing the images of the initial and final profiles side by side, a significant difference between the Herbst and the Forsus appliances could be observed for laypersons, who considered the silhouettes of cases treated with the Herbst appliance more attractive than those treated with the Forsus appliance ($P = .031$). There was no significant difference between the devices in the second assessment by orthodontists ($P = .218$). Comparing the laypersons' and orthodontists' assessments in the second evaluation, a significant difference was found only for the Herbst group ($P = .047$). Laypersons attributed higher scores (more attractive) to Herbst cases than the orthodontists did. In the Forsus group, there was no significant difference in the esthetic perception among laypersons and orthodontists for any of the silhouette's ratings ($P = .074$).

DISCUSSION

Facial esthetics likely play an important role in social inclusion[20] and may influence the quality of life of patients.[21] Therefore, the facial profile esthetic result is also one of the criteria that must be evaluated when it is necessary to opt for one treatment approach over another.

To estimate treatment time, the dates of the initial and final radiographs were considered, which may explain the relatively large treatment time in both groups (group H = 44 ± 6 months, group F = 32 ± 11 months), especially for group H. The longer treatment

Table 1. Scores (Mean ± SD) Obtained in the First Evaluation of Facial Profiles Carried out by Laypersons (n = 30) and Orthodontists (n = 30)

	Laypersons (L)			Orthodontists (O)		
Appliance	Initial (I)	Final (F)	*P* Value** (I × F)	Initial (I)	Final (F)	*P* Value** (I × F)
Herbst (H)	4.0 ± 1.0	5.3 ± 1.1	**.017**	3.8 ± 1.2	5.0 ± 1.0	**.037**
Forsus (F)	4.2 ± 0.9	4.7 ± 1.1	.314	4.1 ± 0.8	4.6 ± 1.2	.203
P value* (H × F)	.600	.241		.393	.684	
P value* (L × O)	.074 (H)	**.028 (H)**		.646 (F)	.799 (F)	

* Mann-Whitney test, $P < .05$. Power of test = 0.81.
** Wilcoxon test, $P < .05$. Power of test = .74.

Table 2. Scores (Mean ± SD) Obtained After the Second Evaluation of Facial Profiles Carried out by Laypersons (n = 30) and Orthodontists (n = 30)

Appliance	Laypersons	Orthodontists	*P* Value** (Laypersons × Orthodontists)
Herbst (H)	6.6 ± 0.8	5.8 ± 1.4	.047
Forsus (F)	5.6 ± 1.0	5.1 ± 1.3	.074
P value* (H × F)	.031	.218	

* Mann-Whitney test, $P < .05$. Power of test = 0.75.
** Wilcoxon test, $P < .05$. Power of test = 0.8.

(12 months) in the group treated with Herbst appliances for Class II correction was likely related to the need for an additional stage for treatment with fixed appliances.

To evaluate facial changes produced during Class II treatment with Herbst and Forsus appliances, facial profile silhouettes were used instead of photos to avoid the influence of other characteristics such as sex, skin texture, hair style, and eye color.[22–24] The profile analysis was performed by orthodontists and laypersons. As esthetic judgment may vary between different ethnicities and age groups,[25,26] the layperson's age was matched with the average age of the participating orthodontists.

The purpose of the first assessment was to eliminate any tendency to intuitively consider the final results of the treatment as better. The objective of the second assessment was to allow the evaluators to compare the final results based on the initial condition for each patient. For both evaluations, neither initial malocclusion nor methods of treatment employed were communicated. This blinding process was aimed at avoiding a subjective evaluation of the treatment methods used, especially as considered by orthodontists.

Analyzing the results of the first assessment, it was possible to observe that, for both groups, initial scores were relatively low for both the laypersons (group H = 4.0 ± 1.0, group F = 4.2 ± 0.9) and orthodontists (group H = 3.8 ± 1.2, group F = 4.1 ± 0.8), with no difference between groups. This may indicate that the initial Class II malocclusion soft tissue characteristics negatively affected esthetic judgment.

Although laypersons and orthodontists were not able to identify significant differences when comparing the esthetic profile results obtained with the Herbst and the Forsus appliances, both evaluator groups judged that the final facial profile silhouettes produced by the Herbst appliance were more attractive. However, it must be considered that this esthetic improvement at the end of treatment was mild compared with baseline scores for both laypeople (group H = 5.3 ± 1.1, group F = 4.7 ± 1.1) and orthodontists (group H = 5.0 ± 1.0, group F = 4.6 ± 1.2).

During the second assessment, only laypersons identified an improvement in the final facial profile produced in the Herbst treatment group. No significant facial changes were identified when the treatment was carried out with the Forsus appliance.

In summary, there was a preference for facial profile silhouettes produced by Herbst treatment by laypersons. This finding can be explained by the fact that the combination of dentoalveolar and skeletal effects of Herbst appliances may have produced the most significant changes in the relationship of the upper and lower lips with the nose and chin. The magnitude of the changes was relatively small, as the final profiles were still in the middle of the scale range, implying a somehow average esthetic perception.

Barroso et al.,[27] evaluating the ability of laypersons and orthodontists to identify mandibular advancement in Class II cases with mandibular deficiency, observed that, while orthodontists were able to identify mandibular advancements larger than 2.0 mm, laypersons identified mandibular advancements only larger than 4.0 mm. In this study, the soft tissue chin (Pg′) had a small anteroposterior step forward in the face, being slightly higher in group H (1.81 mm ± 3.81 mm) than in group F (0.53 mm ± 2.94 mm). Probably, the preference of the laypersons for the facial profile silhouettes produced by the Herbst appliance were more related to the harmonization of lips with the nose and chin than any mandibular advancement per se.

De Almeida et al.[9] also concluded that the improvement in profile with Herbst appliances occurred because of changes observed in the upper lip and, to a lesser extent, to the lower lip and to the soft tissue of the chin. The results of the systematic review of Flores-Mir et al.[28] reinforced this reasoning. The authors concluded that, despite the fact that fixed functional appliances produced statistically significant changes in soft tissue profiles, the magnitude of the changes should not necessarily be perceived as clinically meaningful. Along these lines, LaHaye et al.[29] stated that changes in the chin position produced by Herbst appliance treatment were not predictable.

In a very similar study in which the effects on facial silhouettes produced by a mandibular protraction appliance were also evaluated, Molina de Paula et al.[30] found that, based on the evaluators' judgments, treatment with the mandibular protraction appliance had a positive effect on the facial silhouette, and the laypeople perceived this effect better than orthodontists did.

The clinical implications of this study were that, although the results of this study could not categorically imply that the Herbst appliance produced better

facial profile esthetic results than the Forsus appliance, the fact that laypersons were able to perceive a more esthetic result with the Herbst appliance should be discussed with prospective patients.

Limitations

The longer treatment time (around 1 year) for the H vs the F group may be considered a study limitation regarding facial profile changes between treatment vs normal facial growth changes (T2–T1). The extent to which normal growth changes accounted for profile improvements is unknown. As the final age between the two groups at T2 was similar, this should not be an issue for facial profile comparison between groups at T2.

The opinions of these perceived changes were from orthodontists and laypersons from a specific cultural and socioeconomic environment. Hence, caution should be considered when extrapolating the results to other environments.

CONCLUSIONS

- Class II malocclusion treatment using the Herbst appliance may produce a more esthetically improved facial profile silhouette compared with using the Forsus appliance.
- The magnitude of the perceived changes may not be considered clinically relevant.
- The perceived changes improved the esthetic assessment only to the middle of the esthetic range.

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