

## Does the aesthetic perception of protrusion correction change if the face is evaluated from the frontal or profile perspectives?

A percepção estética da correção da protrusão muda se a face for avaliada de frente ou de perfil?

¿Cambia la percepción estética de la corrección de protusión si se evalúa el rostro de frente o de lado?

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### Abstract

Objective: verify if reduction of facial convexity obtained with dental extractions promotes changes that are noticeable in frontal view. Compare whether the correction of different degrees of protrusion promotes distinct aesthetic perception in frontal and profile analysis. Methods: two brown female patients with dental class I malocclusion, incisors protrusion and convex profile were selected. Patients displayed initially different protrusion magnitude (moderate x excessive) and were both treated with premolars extraction and anterior teeth retraction. Two sets of images were composed enclosing frontal and lateral records at before and after treatment. Sample of 194 laypeople evaluated the images and answered following questions: (1) Can you notice any differences between the correspondent images presented? (yes or no). (2) Which image do you find most attractive? (3) Assign a score for each image from 0 to 10. Results: position of face had an influence on the perception of the moderate protrusion. In this case, less negative impact on aesthetics was evidenced when protrusion was evaluated frontally. In addition, changes resulting from treatment were more noticeable when analyzed from the profile perspective. Regarding excessive protrusion, no significant differences were observed when comparing frontal and profile views, indicating that protrusion and treatment effects can be perceived equally in both views. Conclusions: treatment with dental extractions in patients with moderate protrusion generates impacts that can be more easily noticed in the profile analysis. However, in patients with excessive protrusion, changes promoted by treatment are noticed in frontal analysis in the same way as in profile.

**Keywords:** Orthodontics; Face; Esthetics.

### Resumo

Objetivo: verificar se a redução da convexidade facial obtida por meio de extrações dentárias promove mudanças que são percebidas na vista frontal. Comparar se a correção de diferentes magnitudes de protrusão promove percepção estética distinta na análise frontal e de perfil. Métodos: duas pacientes mulheres pardas apresentando maloclusão de Classe I, incisivos protruídos e perfil convexo foram selecionadas. As pacientes apresentavam inicialmente diferentes magnitudes de protrusão (moderada x excessiva) e foram ambas tratadas com extração de pré molares e retração dos dentes anteriores. Dois grupos de imagens foram compostos incluindo o registro frontal e lateral antes e depois do tratamento. A amostra de 194 pessoas leigas avaliou as imagens e respondeu os seguintes questionamentos: (1) Você nota alguma diferença entre as imagens apresentadas? (Sim ou não). (2) Qual imagem você define como mais atraente? (3) Defina um escore de 0 a 10 para cada imagem. Resultados: a posição da face teve influência na percepção da protrusão moderada. Neste caso, um menor impacto negativo na estética foi evidenciado quando a protrusão foi avaliada frontalmente. Em adição, as mudanças resultantes do tratamento foram mais perceptíveis quando analisadas na perspectiva de perfil. Com relação a protrusão excessiva, nenhuma diferença significativa foi observada quando comparadas as perspectivas frontal e de perfil, indicando que a protrusão ou seu tratamento são perceptíveis igualmente quando analisados de frente os de perfil. Conclusões: tratamento com extrações dentárias em pacientes com protrusão moderada gera impacto que são facilmente percebidos na perspectiva de perfil. No entanto,

em pacientes com protrusão excessiva, as mudanças promovidas pelo tratamento são percebidas da mesma forma na vista frontal ou de perfil.

**Palavras-chave:** Ortodontia; Face; Estética.

### Resumen

Objetivo: verificar si la reducción de la convexidad facial obtenida a través de extracciones dentales promueve cambios que se perciben en la vista frontal. Compare si la corrección de diferentes magnitudes de protrusión promueve una percepción estética distinta en el análisis frontal y de perfil. Métodos: se seleccionaron dos pacientes del sexo femenino, morenas, con maloclusión Clase I, incisivos protruidos y perfil convexo. Los pacientes presentaban inicialmente diferentes magnitudes de protrusión (moderada x excesiva) y ambos fueron tratados con extracción de premolares y retracción de dientes anteriores. Se compusieron dos grupos de imágenes incluyendo registro frontal y lateral antes y después del tratamiento. La muestra de 194 laicos evaluó las imágenes y respondió las siguientes preguntas: (1) ¿Notas alguna diferencia entre las imágenes presentadas? (Sí o no). (2) ¿Qué imagen defines como la más atractiva? (3) Establezca una puntuación de 0 a 10 para cada imagen. Resultados: la posición de la cara influyó en la percepción de protrusión moderada. En este caso, se evidenció un menor impacto negativo en la estética cuando se evaluó frontalmente la protrusión. Además, los cambios resultantes del tratamiento fueron más notorios cuando se analizó desde una perspectiva de perfil. En cuanto a la protrusión excesiva, no se observó diferencia significativa al comparar las vistas de frente y de perfil, lo que indica que la protrusión o su tratamiento son igualmente perceptibles cuando se analizan de frente y de perfil. Conclusiones: el tratamiento con exodoncias en pacientes con protrusión moderada genera impactos que se perciben fácilmente en la perspectiva de perfil. Sin embargo, en pacientes con protrusión excesiva, los cambios promovidos por el tratamiento se perciben de igual forma en las vistas frontales o de perfil.

**Palabras clave:** Ortodoncia; Cara; Estética.

## 1. Introduction

The perception of beauty is subjective and relative to several variables, reflecting the cultural peculiarities of a population. It is assumed that beauty concepts are in constant change and actively influence social acceptance, popularity, interpersonal relationships and even professional career (Morosini et al., 2012; Gu et al., 2018; Gupta et al., 2014; Gago et al., 2012; Pithon et al., 2014). Lately, not only a good dental intercuspation has been the goal of professionals and patients in the orthodontic clinic, but also the promotion of a balanced and pleasant face (Kiekens et al., 2008; Pithon et al., 2014). Nevertheless, disagreement on the aesthetic perceptions may occur. Patients may pursue to meet media, social or cultural standards of beauty, while professionals have a trend to follow models defined by scientific studies (Borzabadi-Farahani, 2012). Hence, a relevant challenge is the correct approach to be addressed to dentofacial protrusion (Carneiro et al., 2018). The protruded face is determined by the anterior position and labial inclination of the maxillary and mandibular incisors in relation to the supporting bones and facial profile (Bills et al., 2005).

Protruded maxillary bones, teeth or lips are not seen as attractive features. Research that has accessed the aesthetic perception on face profile evidenced a preference for straight or slightly concave pattern, regardless of the skin color of the individual (black, brown or white) (Pithon et al., 2014; Carneiro et al., 2018). However, it is still not yet clear if patients presenting these morphological traits seek treatment to reduce their facial convexity. In this regard, extraction of premolars followed by anterior teeth retraction with posterior anchorage control is commonly an effective approach for straightening the face profile (Ruellas et al., 2010; Massahud & Totti, 2004).

In this context, it seems that the correlation of face convexity with the aesthetic perception has been extensively explored, yet the studies merely evaluate those impressions in the lateral view (anteroposterior direction). The objective of the present study is to verify whether the reduction in facial convexity obtained through dental extractions also promotes changes that are noticeable in a frontal view. It is also the purpose of this study to compare whether the correction of two different degrees of protrusion (moderate and excessive) differently affects the aesthetic perception in the frontal and lateral analysis.

## 2. Methodology

The present cross-sectional research was approved by The Ethics Committee of the Dental School of Bahia Federal University (n. 35868614.7.0000.5024). Two brown adult female individuals (with no growth potential) were selected from a collection of patients treated in the Orthodontics post-graduation program of Bahia Federal University. Patients agreed to participate and signed a consent form allowing the use of their images for research and publication purposes. Both patients displayed at pre-treatment Class I malocclusion with upper and lower incisor protrusion and convex profile. The Model patient 1 (Figure 1 A1/A2) presented the following initial cephalometric measurements: U1/NA= 2mm, U1/L1=149°, ULip/S-Line=3mm, LLip/S-line=4mm. Model patient 2 (Figure 2 A1/A2): U1/NA=8mm, U1/L1=116°, ULip/S-line=6mm, LLip/S-line=10mm (U=upper; L=lower; 1=incisor; Lip=lip prominence; N=nasion; A= point A; S-line=Steiner's S Line) (Steiner, 1960).

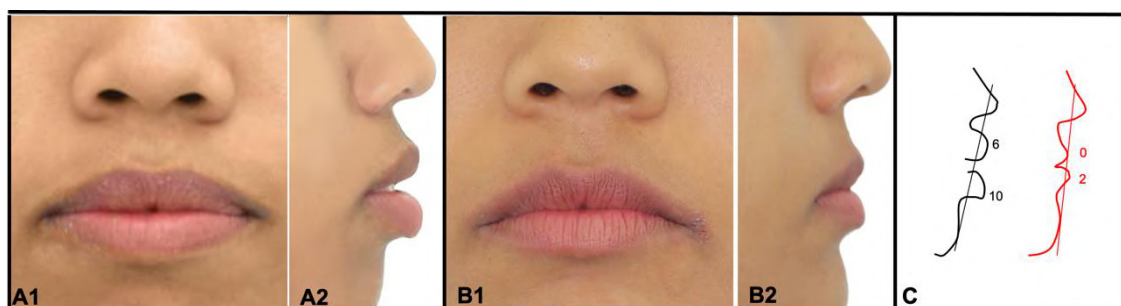
According to Steiner's analysis, a straight profile is achieved when upper and lower lips prominences touch S-Line (0,0 mm), yet a deviation of  $\pm 2,0$  mm is considered within the normal standard (Steiner, 1960). Based on this metric, our study group has previously tested several retrusion and protrusion configurations using intervals of 2,0 mm (from - 4,0 mm to + 6,0 mm). Protrusions of +2, +4 and +6,0 mm were then considered as slight, moderate, and excessive, respectively (Carneiro et al., 2018). In the present study, a moderate protrusion (model 1) and an excessive protrusion (model 2) were tested. Treatment was performed with first premolars extraction and retraction of anterior teeth with posterior anchorage control. The final outcome revealed a significant impact on the reduction of facial convexity, obtaining a straight profile for both patient models (Figure 1 B1/B2 and Figure 2 B1/B2, respectively). With the purpose of comparing the effect of the treatment on the tegument profile, the initial (black) and final (red) outlines are presented (Figures 1C and 2C).

**Figure 1** - Moderate protrusion model. (A1) Frontal before treatment; (A2) Profile before treatment. (B1) Frontal after treatment; (B2) Profile after treatment. (C) Initial (black) and final (red) profile outlines.



Source: Authors.

**Figure 2** - Excessive protrusion model. (A1) Frontal before treatment; (A2) Profile before treatment. (B1) Frontal after treatment; (B2) Profile after treatment. (C) Initial (black) and final (red) profile outlines.



Source: Authors.

Photos were taken and the images were edited for color uniformity and defect removal with the Photoshop CS6 image editing program (Version 13.0, San Jose CA, USA). No modification was done on the facial outline or structure positions. Two photographic series were composed for each model, one obtained before treatment and another at the end of the treatment. Each set consisted of a frontal and profile image. The photos were then assembled in an album and given for evaluation. In the present study, 194 laypeople were asked to fill in a survey developed originally for the research. Participants were randomly selected in public places such as metro/bus stations, supermarkets, hospitals, schools or shopping centers of the city of Salvador, northeast region of Brazil. The entire content of the research was explained and those who agreed to participate signed an informed consent. Individuals from other cities, less than eighteen years old and those who informed professional connection with health care field were not eligible to participate.

The following method was used for image analysis: at first, a condition (pre or posttreatment) was randomly selected. Evaluators received no information about the condition status (pre or post). Then, each photo of the selected condition was evaluated separately, one at a time, starting with the frontal image followed by the profile one. No time limit was set for evaluation. Subsequently, evaluators were informed about the condition change and the photos of the second condition were given for evaluation using the same method previously mentioned. Finally, the following questions were asked to be responded: (1) Can you notice any difference between the correspondent images presented? (Yes or No). (2) Which image do you find most attractive? (3) Assign a score for each image from zero to ten (0 to 10). Data were tabulated in an electronic spreadsheet and sent for statistical treatment.

### **Sample calculation**

Sample was calculated considering the following parameters: effect size=0.3 (average effect size),  $\alpha=0.05$ , power=0.95 and degree of freedom =1 (two comparison groups). Thus, a minimum sample size of 145 individuals was estimated. A 30% increase was made to compensate any losses. The final sample size estimated for the present study was 189 individuals. Data from 194 participants were collected. The sample calculation was performed using G\* Power (Version 3.1.9.2, Germany).

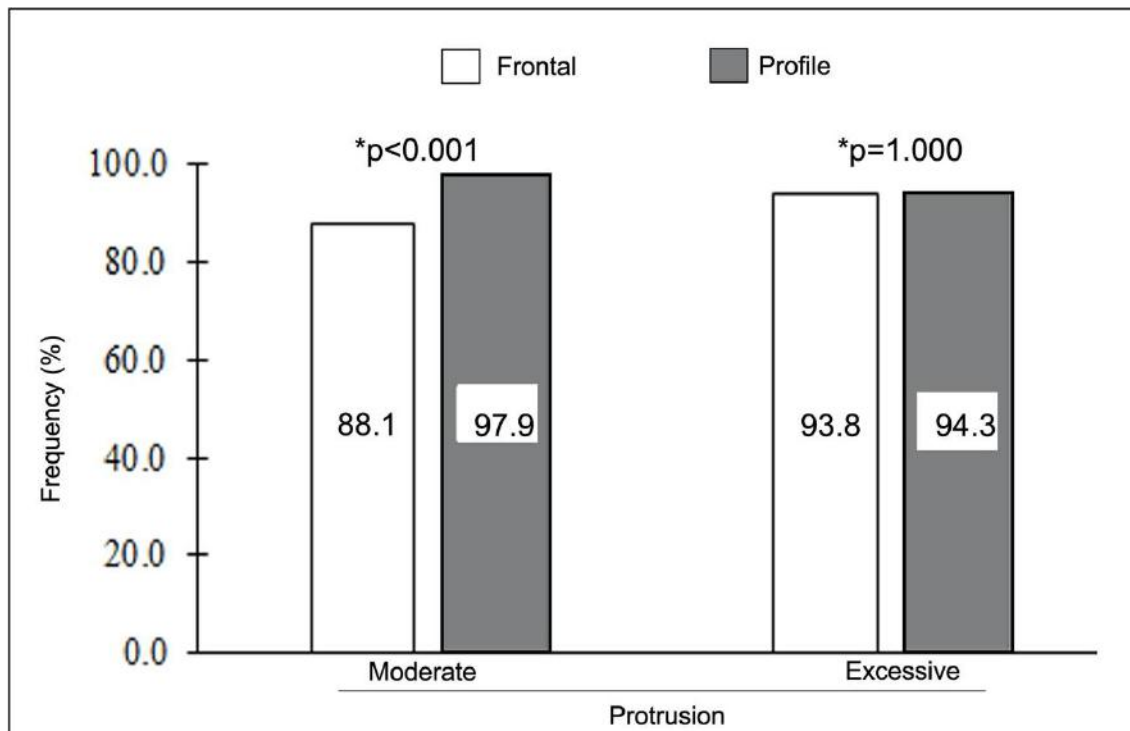
### **Statistical Procedure**

Descriptive statistics procedures were used to express the results as relative frequencies (proportions), means, medians, standard deviations and interquartile ranges. The frequencies were compared using the chi-square test. The normality of the quantitative data (scores attributed to the images) was tested by Kolmogorov-Smirnov test, while the differences between the positions of the photographs (frontal and profile) and before and after treatment were verified using the Wilcoxon test. The level of significance adopted was 5% ( $\alpha=0.05$ ). The data were tabulated and analyzed using IBM SPSS Statistics for Windows (IBM SPSS. 21.0, 2012, Armonk, NY: IBM Corp. USA).

## **3. Results**

The vast majority of the evaluators was able to perceive differences between the two conditions regardless of the degree of protrusion of the models. It should be noted that the position of the face in the photograph (frontal or profile) influenced the interviewees' perception only in relation to the reduction of the moderate protrusion. In this case, the difference was more clearly noticed in the profile image. In contrast, the position of the face did not influence the participants' perception when evaluating the difference between the two conditions of the excessive protrusion (Figure 3).

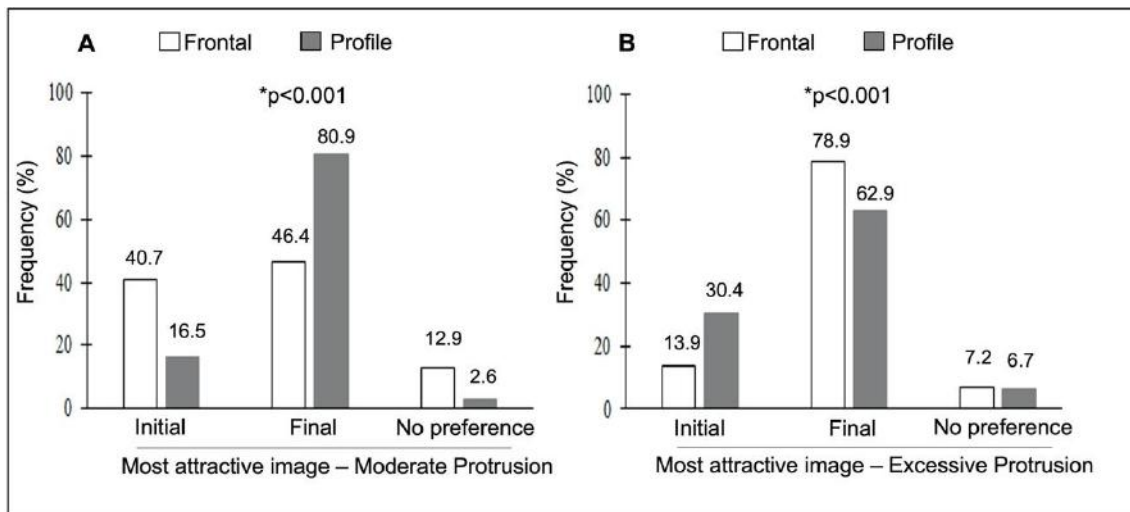
**Figure 3** - Perception of difference between before and after treatment according to the position of the face and the degree of protrusion of the models.



\*Chi-square test. Source: Authors.

According to the position of the face in the photograph, a significant difference was observed in the perception of the attractiveness between the two conditions for the model with moderate (Figure 4A) and excessive (Figure 4B) protrusion. The results of the model with moderate protrusion indicated a greater preference for the image representing the after-treatment when the photographs were evaluated in the profile position, while a greater preference for the image representing the initial condition (prior to treatment) or the absence of preference were most prevalent when photographs were evaluated in frontal position. On the other hand, the data of the model presenting excessive protrusion demonstrated a greater preference for the image representing the after-treatment condition when the photographs were evaluated in the frontal position, while the preference for the image representing the initial condition was more prevalent when images were evaluated in the profile position. No statistical difference was identified for the absence of preference between the frontal and profile images for the model with excessive protrusion.

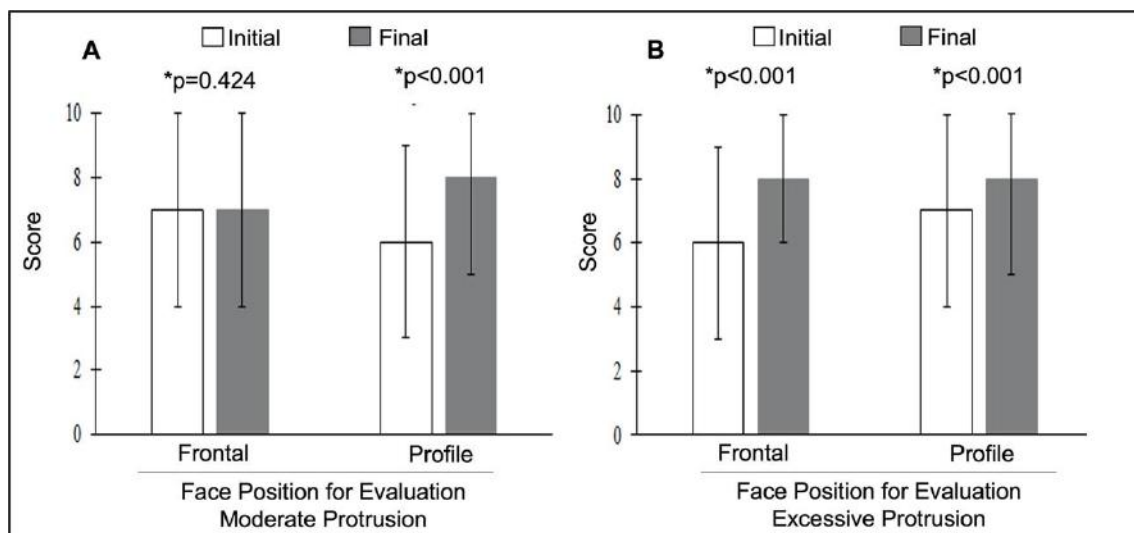
**Figure 4** - Attractiveness perception of images before and after treatment according to the position of the face of the models with moderate (A) and excessive (B) protrusion.



\*Chi-Square test. Source: Authors.

Comparisons of scores between the initial and final images of the patient with moderate protrusion showed that, after treatment, a score increase was observed when the model image was assessed in profile, but not from the frontal view (Figure 5A). The results of the patient with excessive protrusion indicated that after treatment a score improvement occurred regardless of the position of the face (Figure 5B).

**Figure 5** - Scores attributed to the initial (before treatment) and final (after treatment) images according to the position of the face of the models with moderate (A) and excessive (B) protrusion.



\*Wilcoxon test Source: Authors.

Comparative analyzes of the scores of initial and final images showed statistical differences between the frontal and profile positions in both models. For the model with moderate protrusion, treatment outcome was better evaluated in the profile image. On the other hand, for the model with excessive protrusion, the treatment outcome was better evaluated on the frontal image (Table 1).

**Table 1** - Changes (delta) of the scores between initial (before treatment) and final (after treatment) images according to the position of the face of the models and the degree of protrusion. Results are expressed as mean  $\pm$  standard deviation.

Protrusion Degree	Face Position for Evaluation		*p-value
	Frontal	Profile	
Moderate	0.12 $\pm$ 2.84	2.14 $\pm$ 2.73	< 0.001
Excessive	1.55 $\pm$ 2.26	1.02 $\pm$ 2.58	0.001

\*Wilcoxon test. Source: Authors.

#### 4. Discussion

The desire for a pleasant appearance and social acceptance has greatly contributed to a growing search for orthodontic treatment (Morosini et al., 2012; Kiekens et al., 2008). Smile aesthetics have become a wide field of study; however, face attractiveness is not only restricted to smile. This understanding has inspired the execution of various research that aims at identifying the best composition of the incisors and lips within the facial architecture, both in smile and rest positions (Pithon et al., 2014; Carneiro et al., 2018).

According to the literature accessed, the best aesthetic position of the lips in face is still object of discussion. Studies have advocated that, within normal limits, more prominent lips are seen as more attractive (Denize et al., 2014). A slight convex facial profile was also considered the most aesthetic option for an African American group (Yehezkel & Turley, 2004). On the hand, many other studies have shown that, regardless of the ethnic morphological background of the individual, the most aesthetic setting is the straight or even the slightly concave profile (Pithon et al., 2014; Carneiro et al., 2018; Soares et al., 2012; De Oliveira et al., 2015; Souza et al., 2022).

The authors of the present study believe that the reason for this divergence is the fact that there is commonly a misunderstanding regarding the concepts of lip protrusion and lip volume. In addition, research exhaustively explore the aesthetic perception on the lateral view, a design that do not really assist in resolving the matter. Accessing the best aesthetic appearance of the lips in the frontal view seems to be a necessary contribution for the facial/lip aesthetic field of study.

In the present study, reduction of face convexity promoted by the treatment improved the aesthetic perception of both evaluated patients (moderate and excessive protrusion). The outcome (straight profile) was statistically more attractive than the initial situation. This finding corroborates with previous studies, according to which straight facial profile is better accepted (Pithon et al., 2014; Carneiro et al., 2018; Almeida et al., 2010). It is worth mentioning, that the information “initial” or “final” status of the treatment was not shared with the interviewed participants. It is believed that this care is essential for not influencing the results.

Meanwhile, the present study also brings the perception according to the position of the face during evaluation (frontal or profile). The purpose was to answer whether the reduction in facial convexity also promotes improvements that are noticeable in a frontal view. The results proved that the position of the face during the evaluation had an influence on the sensitization of the interviewees with regard to changes produced by the treatment. The image of the treated moderate protrusion showed to produce more pleasantness in the lateral examination. In contrast, the treatment of the excessive protrusion promoted similar sensitization in both frontal and profile evaluation. This finding allowed the authors to infer that, in cases of excessive protrusion, the frontal image caused a discomfort for the interviewees that was not observed in the moderate protrusion situation. In other words, the excessive protrusion, as well as its correction, are easily perceived regardless of the position of the face during the evaluation.

Previous reports have analyzed the face aesthetics in frontal and lateral perspectives, yet most psychometric beauty research relies on the proportions of facial landmarks solely or in relation to each other (Bashour, 2006; Bashour, 2006). Although it is intuitive that there is an association between frontal and lateral facial attractiveness, the premise needs to be scientifically explored. A relative recent paper used an image morphing software to explore if there is an association between frontal and lateral facial attractiveness. The authors found a strong correlation between frontal and facial attractiveness. The research has also identified asymmetrical features, long lower third, high hairline, protruding chin, thin upper lip, and dorsal nasal hump as key factors for the discordance between frontal and lateral attractiveness perception (Gu et al., 2018). In the present study, the magnitude of protrusion seemed to be a correlative factor for attractiveness perception, since similar treatment outcome was not equally observed between the conditions evaluated (moderate and excessive protrusion) when observed from different perspectives.

It is worth pointing out that the results found in the present study were collected in a sample of laypeople. An even more definitive result could be probably extracted from a sample composed by evaluators with trained perception on facial aesthetics, such as dentists, plastic surgeons, painters, artists, media professionals and fashion-related jobs.

It should also be emphasized that the reduction in facial convexity documented in this study was achieved through real orthodontic treatment, performed with dental extractions and planned after a complete evaluation of the face of each patient, exactly as suggested for protrusion treatment protocols (Ruellas et al., 2010; Massahud & Totti, 2004). Most of the aesthetic profile studies (Pithon et al., 2014; Carneiro et al., 2018; Almeida et al., 2010) use computer-based treatment simulations, which may not quite correspond to the reality, as well as may include artificial features. In the present study, the clinical procedures adopted were based on the patients' needs and requests.

It is assumed that different results could be achieved when using male patient models or accessing sample from distinct geographic areas. Certainly, more comprehensive or comparative assessments between regions or countries are necessary, since distinct perception has already been characterized as dependent on the region historical and cultural background (De Oliveira et al., 2015). In addition, sociodemographic aspects were not considered in the present research, which could bring interesting insights about the correlation of facial attractiveness perception with social status, income and educational level. It is assumed that better comprehension of the sample-related demographic aspects is important for appropriate comparisons with previous published studies or research to come.

Finally, the results of this study reinforce the need for professionals to take into account that orthodontic treatment with dental extractions impacts the facial aesthetic perception in a three-dimensional way, and the goals should be cautiously discussed with patients to define the treatment that best contemplates the expectations and therapeutic possibilities.

## 5. Conclusion

It is suggested that the perspective of the face during the evaluation (frontal or profile) influences the perception of differences after the treatment of moderate protrusion, and the changes were more noticeable when analyzed from the profile view. Treatment for the excessive protrusion was equally noted in both perspectives.

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