AESTHETIC PERCEPTION OF ORTHOGNATHIC SURGERY AND THREE-DIMENSIONAL VIRTUAL PLANNING OF ANGLE'S SKELETAL CLASS III MALOCCLUSIONS EVALUATED BY MAXILLOFACIAL SURGEONS, ORTHODONTISTS, AND LAY PEOPLE

PERCEPÇÃO ESTÉTICA DA CIRURGIA ORTOGNÁTICA E PLANEJAMENTO VIRTUAL TRIDIMENSIONAL DE MALOCCLUSÕES ESQUELÉTICAS DE CLASSE III DO ÂNGULO AVALIADAS POR CIRURGIÕES MAXILOFACIAIS, ORTODONTISTAS E LEIGOS

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ABSTRACT

The objective of this study was to assess how maxillofacial surgeons, orthodontists, and lay people rate the virtual planning of orthognathic surgeries and the postoperative outcomes of Angle's class III skeletal malocclusions. Data were collected using a questionnaire, which was e-mailed to 15,115 dental professionals of the Brazilian Association of Orthodontics and of which we received 279 replies (response rate of 1.84%) from 715 Maxillofacial surgeons and 48 answers (response rate of 6.71%) from 376 lay people. The sample size was sufficient for the detection of associations with an effect size of 0.05 in linear regressions with up to 10 independent variables, a level of significance of 5%, and statistical power higher than 80%. The results indicated significant differences in the analysis of the three-dimensional virtual planning of class III skeletal malocclusions between lay people (8.6), Orthodontists (7.8), and Maxillofacial surgeons (7.3) ($p<0.05$). However, there was no significant intergroup differences in the assessments of the surgical outcome, regardless of specialization, years of professional experience, sex, and age ($p>0.05$). Training time with respect to specialty, sex, and age was not associated with statistical differences. With respect to the analysis of virtual planning, dental professionals were more critical than lay people.

KEY-WORDS: Esthetics, Three-Dimensional Imaging, Angle Class III, Perception.

1. INTRODUCTION

Facial symmetry is associated with beauty and self-esteem; therefore, beauty is increasingly valued in dentistry, orthodontics, and maxillofacial surgery[1,2]. Orthodontists have studied facial profiles to establish the most appropriate diagnosis and treatment plan for achieving tooth alignment and facial symmetry[3-5].

An objective of orthodontics is to maintain good pre-existing facial characteristics and to improve other features when necessary, achieving good final facial symmetry. Orthodontic treatments and surgery are important because they can change the appearance of the face[6].

The study of facial aesthetics and orthodontics was pioneered by Edward H. Angle in the twentieth century [7]. Angle significantly contributed to the scientific and technological development of the diagnosis and treatment of dentofacial deformities[1]. Orthodontists need to address patient expectations and acknowledge that treatment is focused on improving facial aesthetics and smile and that facial analysis is the primary diagnostic tool[8,9]. Orthodontic treatment should prioritize the position of teeth in the bone and facial symmetry with optimal occlusion[10].

The concept of facial and soft tissue diagnosis, combined with advances in surgical techniques and virtual planning, has allowed orthodontists to develop plans that include surgery as a fundamental element for treating skeletal disorders. Therefore, surgical-orthodontic treatment, which is considered by orthodontists as the last treatment option, may be the best option for skeletal abnormalities[11,12].

A previous study highlighted the importance of facial analysis and the use of technology in surgical planning to increase predictability and patient satisfaction[13]. Orthodontists and Maxillofacial Surgeons need to understand the patients' perception of facial attractiveness and to account for this in their diagnosis and treatment plan, which may require more time to understand changes resulting more accurately from the surgical procedure[14]. Work by Arnett and Gunson indicated that occlusion indicates the problem, but facial

assessment guides the planning of the case[15]. Therefore, a treatment plan is developed so that the first step when examining a surgical patient is to identify what needs to be corrected, in other words, the aesthetic defects they present and, in addition, to identify the necessary approach to an ideal occlusion relationship[11].

However, the concept of beauty involves subjective factors related to individual preferences, cultural and social factors, fashion, media, race, and sex [16,17]. Considering these aspects, studies have established measures and values for standardizing the harmony of the facial profile [11,18,19]. However, aesthetics vary according to sex, geographical region, and profession.

The results of studies on aesthetic perception varied between different groups of evaluators, including orthodontists, oral and maxillofacial surgeons, lay people, orthognathic patients, and clinicians. In addition, most studies evaluated two-dimensional facial images, and these analyses were not optimal [20-25].

The objective of this study was to evaluate the three-dimensional virtual planning and surgical outcome of Angle's Class III skeletal malocclusion by Orthodontists, Maxillofacial Surgeons, and lay people, and analyze recommendations for improving surgical planning using a questionnaire.

2. MATERIAL AND METHODS

Before the start of the study, the project was sent for analysis by the Ethics Committee of São Leopoldo Mandic Faculty of Dentistry and was approved under the protocol nº 69000617.9.0000.5374.

Study participants: The target populations of this cross-sectional descriptive analytical study were:
a) Brazilian dental surgeons specialized in Orthodontics;
b) Brazilian dental surgeons specialized in Maxillofacial surgery;
c) Brazilian people without specific knowledge of Dentistry.
Inclusion criteria:
a) Professional dentists specialized in Maxillofacial Surgery or Orthodontics;
b) Lay people with secondary education.
Surgical case: The surgical patient was a 34-year-old man who had undergone previous orthodontic treatment, which was discontinued, and a new orthodontic consultation was requested. The results of the examination showed that the patient had Angle's class III skeletal malocclusion with severe mandibular asymmetry (5 mm) to the right, anterior and posterior crossbite, anterior open bite, vertical growth pattern, and proclination of the upper incisors (Figure 1). Surgical treatment was performed in September 2016 in a hospital setting in Recife, Pernambuco, Brazil. The patient was informed about the study protocols and provided signed informed consent, including that for the use of data from the pre- and postoperative period for research purposes.

Figure 1. Preoperative extraoral images. Frontal view, smile, and lateral view before treatment. Source: Authors.

Preoperative planning: An online questionnaire containing five tomographic images of the initial face and five images of the preoperative three-dimensional planning generated by Dolphin Imaging and Management Solutions software version 11.95 premium (Chatsworth, CA) was sent to the evaluators. The participants completed the questionnaire using a visual analog scale on facial symmetry and made recommendations for improving surgical planning (Figure 2,3,4).

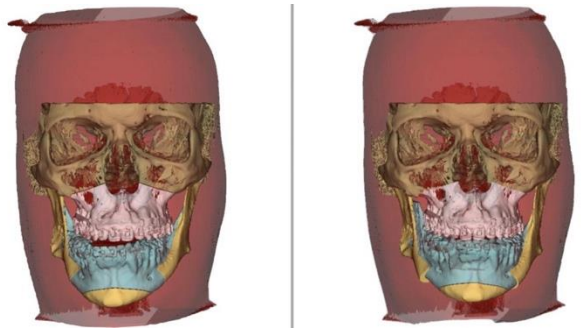

Figure 2. Virtual surgical plann. Frontal view before treatment and virtual surgical planning. Source: Authors.

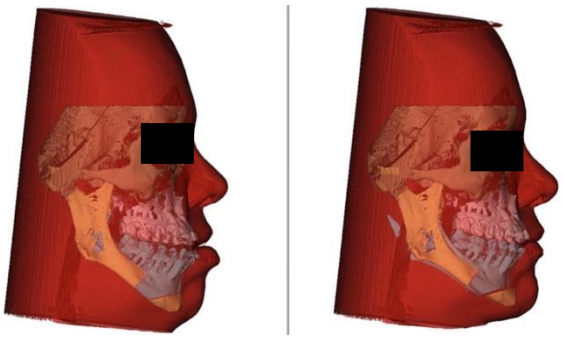

Figure 3. Virtual surgical planning. Lateral view before treatment and virtual surgical planning. Source: Authors.

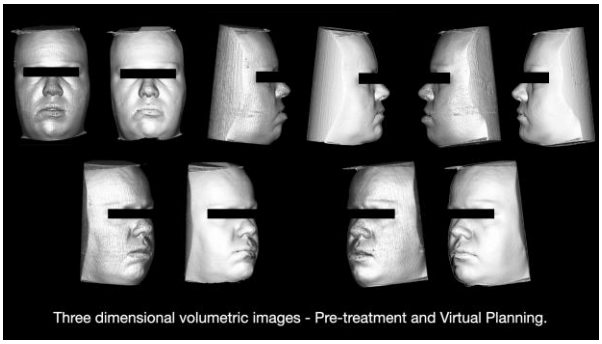

Figure 4. Three dimensional volumetric images – Pre-treatment. Source: Authors.

Surgical outcome: An online questionnaire containing five tomographic images of the initial face and five tomographic images acquired 12 months after surgery (generated by Dolphin Imaging and Management Solutions software version 11.95 premium (Chatsworth, CA) was sent to the evaluators. The participants completed the questionnaire using a visual analog scale on facial symmetry and made suggestions for improving surgical outcome (Figure 5,6,7,8).

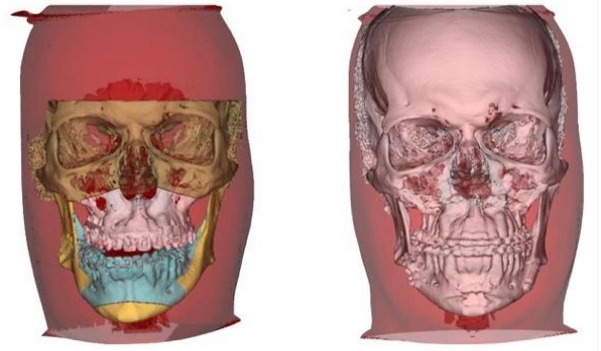

Figure 5. Postoperative outcome. Frontal view before treatment and postoperative outcome. Source: Authors.

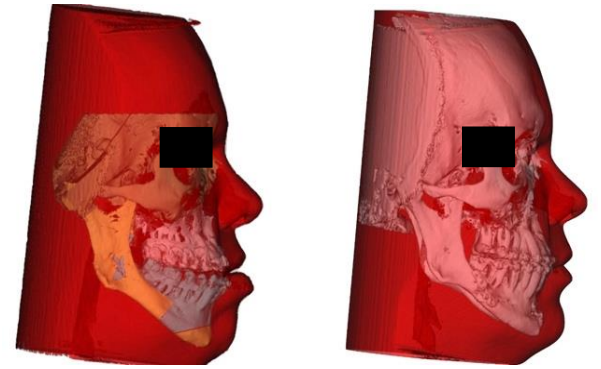

Figure 6. Postoperative outcome. Lateral view before treatment and postoperative outcome. Source: Authors.

Figure 7. Postoperative extraoral images. Frontal view, smile, and lateral view after surgery. Source: Authors.

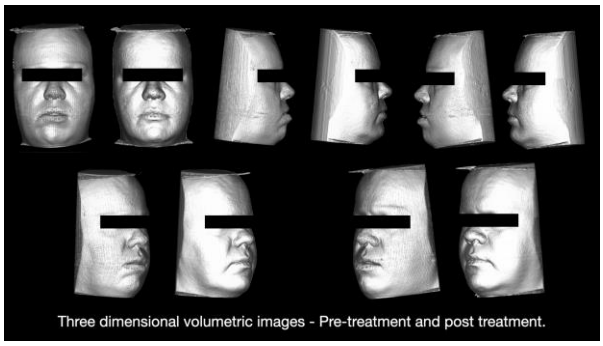

Figure 8. Three dimensional volumetric images. Sources: Authors.

Data collection: Data were collected using a survey administration app (Google Forms; Google Brasil Internet Ltda). The questionnaires were sent by email to 15,115 dental professionals of the Brazilian Board of Orthodontics and Facial Orthopedics (Brazilian Association of Orthodontics and Facial Orthopedics ABOR), with 279 replies; 715 oral and maxillofacial surgeons provided 48 answers, and 376 lay people provided 49 replies. The respondents were classified as group 1 (N = 279), group 2 (N = 48), and group 3 (N = 49), respectively.

Measuring instruments: Data were collected using an online questionnaire. The questionnaire was completed in three months. See link above: https://docs.google.com/forms/d/e/1FAIpQLSdLU4LxvWM6BGma-wuDgttAkjHXH75n52wffHIvM4PH2YmzrA/viewform?usp=sf_link.

Evaluation of surgical planning: Surgical planning was assessed through the item: "Using the visual analogue scale, rate the degree of satisfaction with the planning of Angle's class III malocclusion treatment".

Evaluation of surgical outcome: Surgical outcome was assessed through the item: "Using the visual analogue scale, rate the degree of satisfaction with the outcome of Angle's class III malocclusion treatment".

Improvements in surgical planning and outcome proposed by professionals: Possible improvements in surgical planning and outcomes were evaluated using tested and validated items. The items contained technical language for professionals and explanations that could be easily understood by lay people.

Sociodemographic variables: Data on specialization, years of professional experience, sex, and age were collected through questionnaire items.

Statistical analysis: Sample calculation

Sample power was calculated a posteriori using GPower software version 3.0.1 for Windows. A sample of 376 participants allowed for the detection of associations with an effect size of 0.05 in linear regressions with up to 10 independent variables, a level of significance of 5%, and statistical power higher than 80%.

Statistical description: The Stata statistical package (Stata Corp LP, College Station, TX, USA) version 16.0 for Windows was used for data analysis. A level of significance of $p \leq 0.05$ was adopted in inferential analyses. Descriptive analyses were performed using measures of frequency distribution, central tendency (means), and dispersion (standard deviation [SD]), and an independent t-test was used to assess possible differences in the assessment of surgical planning and outcome. Linear regression was used to evaluate the association between sex, age groups (20–30, 31–45, 46–60, and >60 years), specialization (lay person, oral and maxillofacial surgery, and orthodontics), professional experience (1–4, 5–10, or >10 years), and the ratings of surgical planning and outcomes. The results of the regression analysis are presented as mean scores and

95% confidence intervals.

2. RESULTS

Of the 376 participants, 184 (48.9%) were women. The minority (3.5%) was older than 60 years, and 21.8% were aged 20 to 30 years. Of the respondents, 13% were laypeople, 12.8% were Maxillofacial Surgeons, and the 74.2% were Orthodontists. Among dental professionals, 22.9% had 1 to 4 years of experience and 49.1% had more than 10 years of experience (Table I).

Table 1. Absolute and relative frequencies of sociodemographic data, education and time since graduation (specialization) of all study participants.

Variable	N	%
Sex		
Female	184	48.9
Male	192	51.1
Age group		
20 to 30 years	82	21.8
31 to 45 years	160	42.6
46 to 60 years	121	32.1
>60 years	13	3.5
Education		
Lay person	49	13.0
Oral and Maxillofacial Surgeon	48	12.8
Orthodontist	279	74.2
Time since graduation (specialization)		
1 to 4 years	75	22.9
5 to 10 years	92	28.0
>10 years	161	49.1

Lay people assigned higher scores to the planning of class III malocclusion treatment (8.56) than oral and maxillofacial surgeons (7.27) and orthodontists (7.79). Among dental professionals, specialization and years of professional experience were not associated with the ratings of surgical planning. Similarly, there were no significant differences in the ratings between the sexes and age groups (p>0.05) (Table II).

Table 2. Scores for the surgical planning of a class III malocclusion by sex, by age group, by education and by time since graduation (specialization) of study participants

Variables	Aesthetic perception of the surgical planning Crude model		
	Score, in points	(IC 95%)	p
Sex			
Female	7.92	(7.68: 8.17)	REF
Male	7.72	(7.48: 7.96)	0.255
Age group			
20 to 30 years	7.71	(7.34: 8.08)	REF
31 to 45 years	7.87	(7.60: 8.13)	0.486
46 to 60 years	7.86	(7.56: 8.16)	0.533
> 60 years	7.62	(6.69: 8.54)	0.857
Education			
Lay person	8.56	(8.09: 9.03)	REF
Oral and Maxillofacial Surgeon	7.27	(6.80: 7.73)	<0.001*
Orthodontist	7.79	(7.60: 7.99)	0.003*
Time since graduation (specialization)			
1 to 4 years	7.69	(7.30: 8.08)	REF
5 to 10 years	7.60	(7.24: 7.95)	0.722
>10 years	7.79	(7.52: 8.06)	0.692

* p<0.05 (significant difference)

There were no significant differences in the assessment of surgical outcomes according to sex, age group, specialization, or professional experience (p>0.05) (Table III).

Table 3. Scores for the surgical outcome of a class III malocclusion by sex, age group, education and time since graduation (specialization) of study participants

Variables	Aesthetic perception of the surgical outcome Crude model		
	Score, in points	(95% CI)	p
Sex			
Female	9.24	(9.08: 9.40)	REF
Male	9.10	(8.95: 9.26)	0.229
Age group			
20 to 30 years	9.01	(8.78: 9.25)	REF
31 to 45 years	9.18	(9.01: 9.35)	0.253
46 to 60 years	9.27	(9.08: 9.47)	0.095
>60 years	9.08	(8.49: 9.67)	0.842
Education			
Lay person	9.29	(8.98: 9.60)	REF
Oral and Maxillofacial Surgeon	9.19	(9.06: 9.31)	0.133
Orthodontist	9.96	(8.66: 9.26)	0.535
Time since graduation (specialization)			
1 to 4 years	8.99	(8.73: 9.24)	REF
5 to 10 years	9.15	(8.93: 9.38)	0.337
>10 years	9.23	(9.06: 9.40)	0.117

There were no significant differences in the evaluation of surgical outcomes between the participants, regardless of specialization and years of professional experience (p>0.05). As outlined in Figure 9.

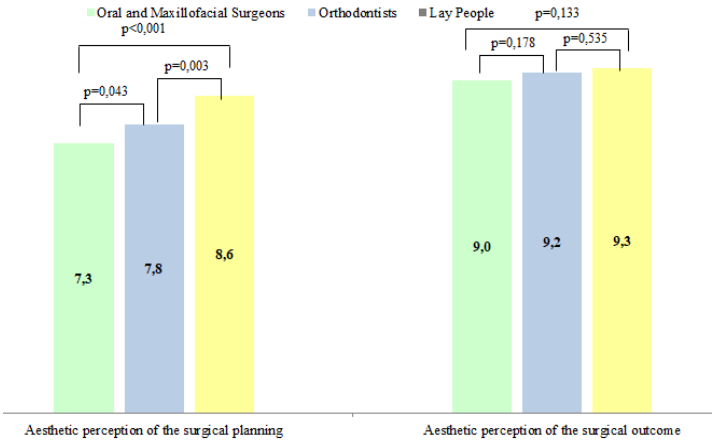

Figure 9. Assessment of the planning and outcome of class III malocclusion treatment by oral and maxillofacial surgeons, orthodontists, and lay people. Source: Authors.

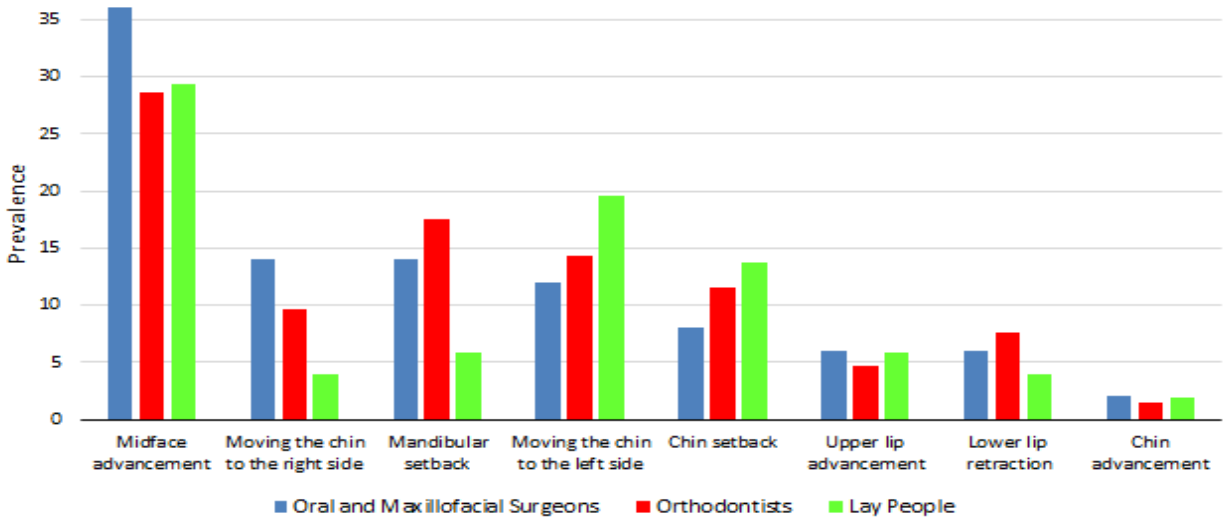

Figure 10. Approaches recommended by oral and maxillofacial surgeons, orthodontists, and lay people to improve the planning of class III malocclusion treatment. Source: Authors.

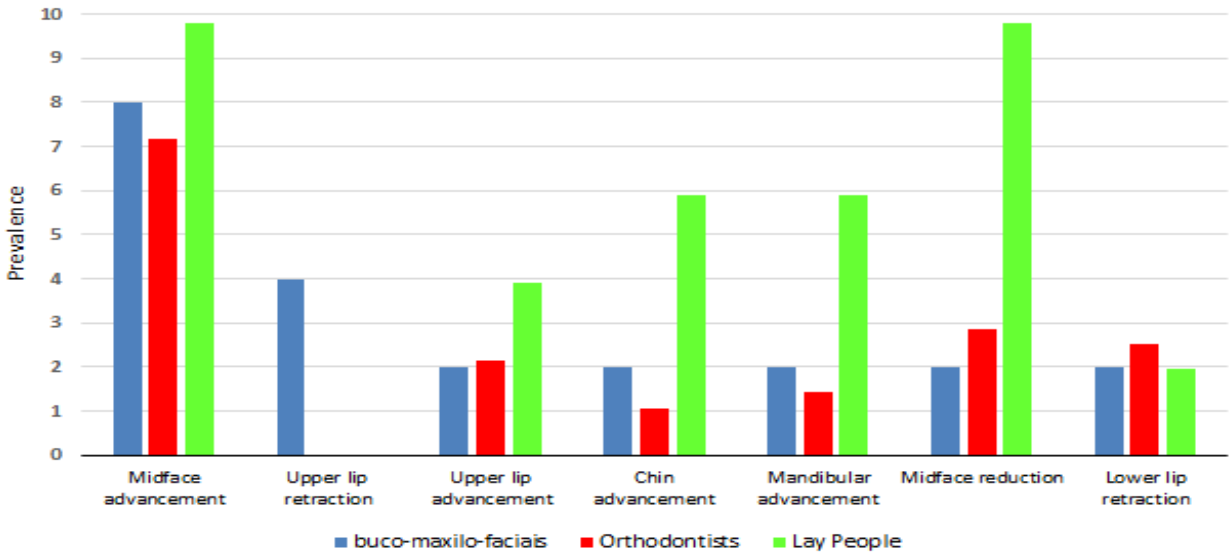

Figure 11. Approaches recommended by oral and maxillofacial surgeons, orthodontists, and lay people to improve the outcome of class III malocclusion treatment. Source: Authors.

Midface advancement was the approach most recommended to improve the planning of class III malocclusion treatment, whereas chin advancement was the least common recommendation (Figure10). Midface advancement was the approach most recommended by the study groups to improve the outcome of class III malocclusion treatment, whereas upper lip retraction was the procedure least recommended by orthodontists and lay people (Figure 11).

These results demonstrate significant differences in the evaluation of treatment planning between the groups, although the recommendations made by the three groups for improving planning were similar.

In turn, there were no significant differences in the assessment of treatment outcome between the three groups, although the recommendations made by the groups for improving outcome were different.

3. DISCUSSION

The impact of occlusion on oral function, aesthetics, and the psychological effects of the facial profile have long been recognized as critical in social relationships and are directly related to self-esteem and quality of life [1,12,26].

The concept of beauty is subjective and differs between individuals. Furthermore, the assessment of satisfactory and attractive differs between professionals and lay people [9,14,21]. The results showed that the study groups positively rated the planning and outcomes of surgical-orthodontic correction.

Orthodontists and Maxillofacial surgeons receive training on cephalometric radiography, tomography, and software applications, and are more critical than lay persons [22,23,27], as in the present study in which lay people were more satisfied and less critical than dental professionals. Even with a numerical difference between

the groups, the power of the sample is statistically significant.

The comparison of facial asymmetries between different groups, including lay people, dentists not specialized in orthodontics, and orthodontists showed that the diagnoses of lay people were less accurate than those of the other groups, whereas orthodontists made the most accurate diagnoses and identified even subtle facial changes [20-23]. These findings corroborate our results.

Ng et al. investigated the opinions of Orthodontists, art students, and lay people on the facial attractiveness of patients with class II malocclusion before and after surgical mandibular advancement and found that the ratings of surgical outcomes were positive, which corroborates the findings of our study [28]. However, the aesthetic improvement was large by orthodontists but small by art students, suggesting that the exaggerated satisfaction with outcomes among orthodontists may not result in patient satisfaction.

With the increased research on aesthetic improvement, soft tissue evaluation has become fundamental in surgical planning; the treatment plan should address functionality and facial harmony; therefore, 3D analysis is used to predict outcomes [29].

Surgical procedures can have a significant effect on the patient's perception because soft tissues usually assist in the movements performed by hard tissues, causing significant facial alteration; however, the ability of software to predict these movements differs, and this fact is overlooked by some professionals [30-33].

Making changes in the infraorbital and paranasal region (midface) was the most common recommendation for improving surgical planning (29.8%) and outcome (7.7%).

The second most frequent recommendation for improving surgical planning was mandibular setback, demonstrating that this factor was directly related to the midface and can improve facial symmetry in cases in which midface advancement did not occur. Therefore, this recommendation is directly correlated with the first, indicating that this issue is affect by the same factor, based on the analysis of this study, possibly highlighting a deficiency in the 3D software [30,31,33,34]. Considering the above, the degree of satisfaction with the planning and outcomes of class III malocclusion treatment was above 7.0, which shows the efficiency of the software, despite this observation. The degree of satisfaction with outcomes was higher than that with planning ($p<0.05$). Soft tissue should be evaluated by 3D analysis because facial soft tissue changes three dimensionally [30-33]. The results demonstrated that the study groups had different opinions regarding treatment plans and outcomes [20-25].

Few studies have evaluated the perception of facial attractiveness by different groups of evaluators using 3D images [35,36]. Notwithstanding, these studies showed that the evaluators agreed on treatment outcomes, like our findings. In our study, the opinions on surgical planning were significantly different between the groups of evaluators.

Another study found that the assessment of orthognathic surgery by the analysis of 3D images was different between oral and maxillofacial surgeons and lay people and between orthodontists and lay people, but not between surgeons and orthodontists [37], contradictory to the results of this study, wherein there were no significant differences in the assessment of surgical outcomes between evaluators.

Additional studies using different methodologies are necessary to determine the perceptions of facial aesthetics between evaluators [2,9,23]. Few studies have investigated the assessments of facial profiles, soft tissue, and malocclusion by lay people. The assessment of facial profile is affected by mandibular protrusion and facial attractiveness, which can modify the effect of mandibular protrusion on visual attraction. Therefore, acknowledging the opinions of lay people in treatment decisions is crucial [2,38]. Conversely, Naini et al. assessed the effect of the perception of mandibular advancement between orthognathic patients, clinicians, and lay people, and found that orthognathic patients were more critical than lay people, demonstrating the need to understand the opinions of these patients [39].

The results suggest that 3D imaging studies are necessary for the assessment of faces by different groups (professionals, laypeople, and orthognathic patients) and improve the planning and treatment in orthodontics and oral and maxillofacial surgery (orthognathic surgery).

4. CONCLUSIONS

There were significant differences in the evaluation of surgical planning between oral and maxillofacial surgeons, orthodontists, and lay people, with the latter group being less critical.

However, there were no significant differences in the assessment of surgical outcomes between the study groups.

Among the three groups of evaluators, midface advancement was the most common recommendation for improved surgical planning (29.8%) and outcomes (7.7%). Although the differences in the assessment of planning between the three groups were significant, the recommendations made by these groups for improving planning were similar. Conversely, there were no significant differences in the assessment of surgical outcomes between the study groups, although the recommendations made by these groups for improving this parameter were different.

There were no significant differences in the assessment of surgical outcomes according to sex, age, and years of professional experience.

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