Evaluation of the determinants of facial profile aesthetics

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Abstract

Objective: To evaluate the influence of age, gender, sagittal occlusal relationship, facial pattern and 8 facial profile measures on profile aesthetics. **Methods:** Contingency tables, chi-square test and Cramer's coefficient were used to evaluate the possible association between the scores assigned by 32 examiners (14 orthodontists, 12 laypeople and 6 artists) to the aesthetics of the profile of 100 Brazilian Caucasian adults, all patients with lip seal competence, and age, gender, sagittal occlusal relationship, facial pattern and the variables of the numerical analysis of the facial profile. **Results:** No association was found between age, gender and sagittal occlusal relationship and the aesthetics of facial profile. An association was observed between profile scores and facial pattern, facial convexity angle and lower face angle. **Conclusions:** Among the factors evaluated in this study, facial profile convexity and anterior chin projection were the key determinants of facial profile aesthetics.

Keywords: Facial profile. Aesthetics. Orthodontic diagnosis.

INTRODUCTION

Since the early twentieth century Case[6] tried to establish the features responsible for a beautiful or perfect face:

- » Prominent chin with mild mentolabial furrow.
- » Lower lip slightly posterior to the upper lip.
- » Upper lip in balance with the cheek, malar prominence and nose.
- » Lip seal competence.

However, this concept of beauty is undergoing constant change.[2,17,18] Aesthetics can be defined as appreciation of beauty, or a combination of qualities that afford intense pleasure to the senses and the intellectual and moral faculties.[10] This appreciation of beauty is influenced by individual factors, such as sex, race and education, and by social factors, such as the environment and, nowadays increasingly advertising (media). It therefore varies across different populations and historical periods.[2,10,14,15,16]

Several studies have attempted to determine

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the facial features that account for a pleasant or unpleasant aesthetic appearance. Pleasant aesthetics is related to harmony and balance between the parts that make up the facial profile.[4,15] Arguably, in the female profile, the shape of the chin and, in men, the mouth and lips are instrumental in assessing aesthetics.[19]

Increases in profile convexity have been associated with unpleasant aesthetic appearance.[7] Apparently, the major components in evaluating facial esthetics would be, first and foremost, the mouth, followed by the eyes, facial structure, hair and nose, in the order given.[29]

The aim of this study was to assess the possible influence of age, gender, occlusal sagittal relationship,[1] facial pattern[5] and 8 facial profile measures on the aesthetic classification of facial profiles.

MATERIAL AND METHODS

Sample

The study sample consisted of 100 Brazilian Caucasian adults with competent lip seal, comprising 50 men and 50 women with a mean age of 23 years and 7 months, and ages ranging between 18 and 36 years.[13,20] The mean ages in the female and male groups were 23 years and 4 months and 23 years and 9 months, respectively. The criteria used for inclusion in the sample were adequate facial muscle balance, reflected in lip seal competence, no prior orthodontic treatment or facial surgery, and willingness to participate in this study. All individuals who agreed to participate in this study signed a consent form that stated the research objectives and the exams they would undergo. In the consent form, participants also authorized the disclosure of their facial photographs for teaching and research.

Standardized profile photographs were taken, and plaster models of the upper and lower dental arches were fabricated for each individual.[13,20]

Aesthetic Subjective Facial Analysis[23]

The sample was subjected to aesthetic subjective facial analysis through assessment performed by 32 individuals divided into 3 groups from different professional areas: Fourteen orthodontists (7 men and 7 women), 12 laypeople not linked to the dental area nor to any artistic activity (6 men and 6 women) and six female artists (one teacher and five postgraduate art students enrolled at the School of Fine Arts), all residing in the cities of São Paulo, São Bernardo do Campo or Santo André. Mean examiner age was 37 years and 6 months with a standard deviation of 9 years, ranging from 21 to 56 years.

Examiners were asked to provide their opinion by rating each photograph within 30 seconds. Scores should be given according to the following options:

a) Aesthetically pleasing: Scores 7, 8 and 9.
b) Aesthetically acceptable: Scores 4, 5 and 6.
c) Aesthetically unpleasant: Scores 1, 2 and 3.

With the purpose of assessing intra-examiner agreement in a subjective evaluation of the profile, 10 facial profile photographs were randomly selected and examiners asked to repeat the aesthetic classification with at least one week interval between the two ratings.

Student's t-test for paired samples was employed to determine evaluation error. There was no significant difference between the first and second scores assigned by the examiners at a significance level of 5% ($p>0.05$) (Table 1).

Table 1 presents the means, minimum and maximum values, and standard deviations for the first and second assessments.

The mean value for the 32 scores assigned by each individual in the sample was calculated for the present study.

Morphological Subjective Facial Analysis[22,23,24]

Photographs of the individuals in the sample were classified by two authors, according to the Analysis of Facial Morphology suggested by Capelozza Filho.[5] This author argues that faces

TABLE 1 - Evaluation of intra-examiner error in Subjective Facial Profile Analysis.

	Descriptive measures				p
	Measure	Minimum	Maximum	Mean	SD	
Profile	First	1.0	9.0	4.9	1.6	0.357n.s.
	Second	2.0	9.0	4.9	1.5	F = S

Note: p-value refers to Student's t-test for paired samples.
Captions: F - First evaluation; S - Second evaluation; n.s. - non-significant.

can be classified as Patterns I, II, III, Long Face or Short Face based on a direct evaluation of the face.

Pattern I consists of a normal face. Patterns II and III are characterized, respectively, by a positive and negative sagittal step between maxilla and mandible. The long face and short face patterns feature a vertical discrepancy.

The sample selection method excluded individuals with incompetent lip seal, which resulted in the exclusion of the long and short patterns in this study.

Numerical analysis of the facial profile[22,24]

Profile photographs were traced and measured by two examiners.

After demarcation of the soft tissue landmarks a numerical analysis of the facial profile was performed using the following measures:

1) Nasolabial Angle.
2) Mentolabial Sulcus Angle.
3) Interlabial Angle.[15]
4) Facial Convexity Angle.
5) Total Facial Convexity Angle.
6) Lower Face Angle.
7) Ratio between the mid anterior facial height and lower anterior facial height (MAFH/LAFH).
8) Lower Face Ratio.

In assessing the method, Student's t-test was used to evaluate systematic error (bias) and Dahlberg's to evaluate random error (Table 2).

A statistical difference was observed between measurements taken of the following angles: mentolabial sulcus, facial convexity, total facial convexity, lower face, and in the ratio between the mid- and lower face heights (Table 2). One should consider, however, that not only were the means found by the two raters for these variables very similar, but the random errors identified by Dahlberg's test justify using these measures in this study.

The values obtained for each of the variables for all individuals in the sample were used in this study.

TABLE 2 - Assessment of inter-observer error concerning variables of Numerical Analysis of Facial Profile.

Variables	Examiner A		Examiner B		P	Dahlberg
	Mean	SD	Mean	SD		
Nasolabial Angle	107.32°	10.71°	107.28°	10.83°	0.873	1.54°
Mentolabial Sulcus Angle	131.61°	10.91°	130.77°	11.01°	0.008**	2.23°
Interlabial angle	134.66°	13.37°	134.33°	12.55°	0.262	2.07°
Facial Convexity Angle	13.22°	4.97°	12.63°	5.07°	<0.001***	1.19°
Total Facial Convexity Angle	137.22°	4.72°	137.76°	4.73°	<0.001***	1.09°
Lower Face Angle	107.63°	9.43°	106.80°	9.75°	<0.001***	1.32°
MAFH/LAFH ratio	0.93	0.10	0.91	0.10	<0.001***	0.03
Lower Face Ratio	0.46	0.06	0.47	0.08	0.106	0.02

* p<0.05.
** p<0.01.
*** p<0.001.

Sagittal occlusal relationship[21]

The plaster casts of all sample individuals were assessed in occlusion with the primary objective of sorting them according to the classification proposed by Angle:[1]

» Normal occlusion.
» Class I malocclusion.
» Class II, Division 1 malocclusion.
» Class II, Division 2 malocclusion.
» Class III malocclusion.

Only those models were classified as belonging to the Normal Occlusion group which showed up to 3 mm of crowding, not located in any single region of the dental arches.

Statistical method

Contingency tables were constructed to perform the chi-square test and determine the influence of age, gender, sagittal occlusal relationship, facial pattern and the 8 variables of numerical analysis of the facial profile on the scores assigned to each subject in the evaluation of facial aesthetics.

To build the contingency tables, the mean of the subjective facial analysis for Pattern I individuals was calculated and served as a normality benchmark to study individuals with discrepancy.[24] This mean was 4.8.

Distribution of the sample individuals was then carried out for each of the features which had been assigned a facial aesthetic score above and below 4.8.

By means of the chi-square test, the frequency observed for each individual was noted in all groups where these features were being rated for gender, facial pattern and sagittal occlusal relationship with those whose scores for facial aesthetics were above and below 4.8 with the expected frequency.

For age and the 8 measures of numerical analysis of the facial profile, three groups were obtained for each variable, given the mean and standard deviation of the Pattern I sample.[24] The groups were divided into scores that fell below, above or within a standard deviation derived from a given mean. The same assessment described above was performed for each variable, i.e., the frequency observed for subjects in each group whose facial aesthetic scores fell above and below 4.8 were compared with the expected frequency (Table 3).

In cases where the Chi-square test identified dependency relationship between the aesthetics of the profile and the factors studied, Cramer's test was applied to identify the strength of the association. Cramer's coefficient ranges from 0 to 1. The closer a coefficient is to 1, the stronger the association (Table 3).

The choice of this statistical method was based on the assumption that the measures of facial profile could negatively influence profile aesthetics when such measures diverged more or less from the standard deviation of Pattern I. This would not be applicable to other statistical methods that evaluate association between variables.

RESULTS

The results of this study showed an association between the score assigned to each individual for esthetic facial profile and facial pattern classification, facial convexity angle and lower face angle (Table 3).

No association was found between age, gender or sagittal occlusal relationship and the aesthetic evaluation of facial profile.

DISCUSSION

Aesthetics is the appreciation of beauty, or a combination of qualities that give pleasure to the senses.[10] Several authors have attempted to determine the facial features that evoke pleasure and are therefore recognized as pleasant, or unpleasant, creating an unsightly appearance. The aim of this investigation was to highlight the facial features considered unpleasant by the population while providing guidance to professionals in the fields of orthodontics and surgery, as well as areas

TABLE 3 - Chi-square test and Cramer's coefficient results for all variables in relation to subjective facial analysis scores.

	Score <4.8 Obs.freq. (exp.freq)	Score> 4.8 Obs.freq. (exp.freq)	X^2	P	Cramer
Pattern I	22 (31.50)	28 (18.50)			
Pattern II	33 (25.83)	8 (15.17)	15.71	0.000	0.39
Pattern III	8 (5.67)	1 (3.33)			
Gender 1	31 (31.50)	19 (18.50)	0.04	0.836	
Gender 2	32 (31.50)	18 (18.50)			
Age <269m	26 (27.72)	18 (16.28)			
Age 269 to 329	25 (26.46)	17 (15.54)	3.60	0.165	
Age > 329	12 (8.82)	2 (5.18)			
NLA < 98.38	12 (10.71)	5 (6.29)			
NLA 98.38 to 117.88	40 (42.21)	27 (24.79)	0.96	0.619	
NLA > 117.88	11 (10.08)	5 (5.92)			
MSA < 122.55	16 (15.12)	8 (8.88)			
MSA 122.55 to 142.19	30 (34.65)	25 (20.35)	4.72	0.094	
MSA > 142.19	17 (13.23)	4 (7.77)			
ILA <124.21	14 (14.49)	9 (8.51)			
ILA 124.21 to 146.49	40 (39.69)	23 (23.31)	0.06	0.970	
ILA > 146.49	9 (8.82)	5 (5.18)			
FC < 8.39	11 (10.08)	5 (5.92)			
FC 8.39 to 16.25	32 (37.80)	28 (22.20)	6.88	0.032	0.26
FC > 16.25	20 (15.12)	4 (8.88)			
TFC < 133.77	18 (14.49)	5 (8.51)			
TFC 133.77 to 141.93	35 (38.43)	26 (22.57)	3.12	0.209	
TFC > 141.93	10 (10.08)	6 (5.92)			
LFA < 95.29	2 (3.78)	4 (2.22)			
LFA 95.29 to 111.53	33 (39.69)	30 (23.31)	15.24	0.000	0.39
LFA > 111.53	28 (19.53)	3 (11.47)			
MAFH/LAFH <0.83	8 (8.19)	5 (4.81)			
MAFH/LAFH 0.83 to 1.03	42 (44.73)	29 (26.27)	2.74	0.253	
MAFH/LAFH > 1.03	13 (10.08)	3 (5.92)			
LFR < 0.39	6 (6.30)	4 (3.70)			
LFR 0.39 to 0.51	46 (46.62)	28 (27.38)	0.28	0.866	
LFR > 0.51	11 (10.08)	5 (5.92)			
SOR 1	5 (5.04)	3 (2.96)			
SOR 2	28 (29.61)	19 (17.39)			
SOR 3	21 (22.05)	14 (12.95)	3.68	0.450	
SOR 4	6 (4.41)	1 (2.59)			
SOR 5	3 (1.89)	0 (1.11)			

related to facial aesthetics, in making plans that are consistent with the expectation of patients, and result in treatments whose aesthetic benefits can be perceived by all.

Whereas 80% of patients seek orthodontic treatment for aesthetic purposes, regardless of their functional condition,[10] evaluation of facial aesthetics should be a routine in orthodontic practice, not only in the diagnostic phase but during and after orthodontic treatment.

During diagnosis, professionals should try to identify unpleasant facial features that can be changed through orthodontic treatment. Pleasant features, however, should be preserved and where possible, enhanced by treatment. It is important to note, however, that this evaluation is performed in light of the ethnical and individual characteristics of each patient while endeavoring to apply the same aesthetic parameters embraced by the patient and his/her society.

This study found no association between gender and subjective analysis of facial profile. However, in assessing the distribution of individuals in the groups rated as aesthetically pleasing (scores 7, 8 or 9), acceptable (scores 4, 5 or 6) and unpleasant (scores 1, 2 or 3) it became clear that all those rated as aesthetically pleasing were women, while 6 of the 8 classified as aesthetically unpleasant (75%) were men. This finding may be explained by a higher frequency of male individuals in Patterns II (63.4%) and III (66.7%).[22] These patients presented with sagittal skeletal discrepancies that negatively impacted on the assessment of facial profile aesthetics. Sixty-four percent of the individuals in the Pattern I group, which comprised patients with a balanced face, were women. This finding reinforces the association between facial pattern and aesthetics, but not between gender and aesthetic evaluation of the profile.

No association was found between gender and facial aesthetics in the literature. Meta-analysis of published studies on facial beauty found that the determinants of attractiveness would be the same for women and men in all cultures.[25] These factors are related to symmetry, characteristics that emphasize sexual dimorphism and faces with features similar to the average population, construed as signs of health and quality that guide both genders in choosing a spouse.[25]

Older individuals in this sample did not receive lower scores for facial profile aesthetics than younger patients.

As previously reported, mean sample age was 23 years and 7 months, ranging between 18 and 36 years. The sample was divided into three age groups (Table 3) for statistical analysis.

However, in order to better visualize the distribution of individuals between maximum and minimum ages, the sample was divided into six age groups (Group 1 - 18 to 21 years, Group 2 - 21 years and 1 month to 24 years, Group 3 - 24 years and 1 month to 27 years, Group 4 - 27 years and 1 month to 30 years, Group 5 - 30 years and 1 month to 33 years and Group 6 - 33 years and 1 month to 36 years). It was found that 20% of the sample belonged to Group 1, 49% to Group 2, 15% to Group 3, 12% to Group 4, 0% to Group 5 and 4% to Group 6. The small dispersion of individuals found in all groups, with greater concentration in the younger age groups may explain the lack of association between age and facial aesthetics. Further studies with more homogeneous distribution of the sample across different age groups should be conducted to substantiate the findings of this study.

A clear tendency was noted, however, of those individuals rated as aesthetically pleasing to be concentrated in the younger groups while the percentage of unattractive individuals increased in the older sample groups (Table 4), in agreement with longitudinal studies, which showed that attractiveness tends to decrease with age from 11 to 31 years. However, people tend to keep their relative level of attractiveness over their life time.[28]

The correlation between facial aesthetics and sagittal occlusion relationship has been

TABLE 4 - Distribution of aesthetically pleasing, acceptable and unpleasant individuals in age groups.

Groups	Age Group	N (%)	Aesthetically pleasing(%)	Aesthetically acceptable (%)	Aesthetically unpleasant (%)
1	18y – 21y	20	10	90	0
2	21y1m – 24y	49	2	90	8
3	24y1m – 27y	15	0	93	7
4	27y1m – 30y	12	0	83	17
5	30y1m – 33y	0	0	0	0
6	33y1m – 36y	4	0	75	25

investigated since the beginning of the last century, when Angle[1] noted that the effect of malocclusion on the facial lines produced distinct deformities, which allowed orthodontists to classify malocclusion based on facial assessment alone. Angle also found that the quality of facial balance would be commensurate with normal occlusion.

Further studies have contradicted these observations by concluding that aesthetically pleasing features could be present in individuals with normal occlusion or malocclusion, suggesting that individuals belonging to the same occlusal class could exhibit considerably different faces.[6,7] Further investigation found that the Class I malocclusion is associated with a more pleasant face, and Class III with the worst facial aesthetics, suggesting that the sagittal position of the mandible influences raters' opinions on profile aesthetics.[9]

In this study no association was observed between the sagittal occlusal relationship and the score assigned to facial profile aesthetics. One should take into account the fact that this result may have been influenced by the sample selection method, which excluded all individuals with dental or skeletal discrepancies that might compromise lip seal competence. It can therefore be argued that the Class II and Class III subjects found in the sample had dental and skeletal discrepancies of small magnitude. The latter were naturally well balanced and not always noticeable on the face as they did not compromise facial profile aesthetics.

Also noteworthy is the fact that the selected sample was comprised of individuals whose socioeconomic status allowed them to undergo orthodontic treatment in case their malocclusion made them feel somehow aesthetically or functionally uncomfortable. It can be inferred therefore that the need for such treatment went unnoticed until adulthood due to dental and skeletal compensations that masked the malocclusion and ensured lip seal competence.[21]

One must consider, however, that facial pattern had a bearing on the score assigned to the profile (Table 3), indicating the presence of individuals in the sample who had sagittal skeletal errors that marred their profile aesthetics. It can be concluded that the lack of association between beauty and sagittal occlusal relationship found in this study reinforces the findings of Bittner and Pancherz,[3] i.e., that occlusal discrepancies are only partially reflected in the face. Many Class II or III malocclusions have a dental origin only and are not associated with any skeletal discrepancy, while other Class I patients exhibit skeletal errors that are adequately offset by occlusion. Diagnosis must begin in the face so as to avert errors likely to occur when priority is given to

the dental relationship. Normal occlusion alone is not indicative of profile attractiveness. Patients with Class II and Class III malocclusions, on the other hand, may display a balanced face with dental malocclusions only.[30]

Among the profile variables assessed in this study, the only association was found to exist between the scores for facial profile aesthetics and facial convexity and lower face angles.

Facial convexity angle is extremely sensitive to sagittal skeletal discrepancies. Patterns II and III individuals showed this angle to be, respectively, increased and decreased in relation to the same angle in Pattern I individuals.[22,24]

In this study, most individuals whose facial convexity angles were above 16.25° or below 8.39° (1 SD above and below the sample mean for Pattern I) were given scores lower than 4.8 for facial profile aesthetics (mean of scores assigned to Pattern I individuals). It can be deduced that profiles whose convexity is increased or decreased in relation to balanced profiles (Pattern I) are considered less aesthetically pleasing.

One hundred percent of individuals rated as aesthetically pleasing showed the value of this angle within a standard deviation equivalent to Pattern I patients (12.32±3.93°), while 62.5% of those classified as aesthetically unpleasant had this angle either above (37.5%) or below (25%) the standard deviation of balanced patients.

Thus, a direct relationship exists between profile convexity and unpleasant aesthetic appearance.[26] The preferred facial profile for women is slightly convex, whereas in men, preference is given to a straight profile.[8]

Lower face angle enables assessment of chin protrusion relative to the midface. Evaluation of this angle is essential in planning the correction of sagittal skeletal discrepancies.[22,24] This study disclosed that any increase in this angle above the standard deviation of the mean found for Pattern I individuals was associated with a reduction in the score assigned to profile aesthetics. This increase in the angle is related to a smaller anterior projection of the chin, typical of Class II patients or of sub-mandibular tissue excess.[22,24] Among the individuals in the sample classified as unattractive 62.5% had this angle above the standard deviation of the mean value. All these individuals were male. It can be inferred therefore that men with lower anterior projection of the chin are particularly less attractive, very often requiring surgical intervention associated with orthodontic correction to improve their profile.

No association was found between profile aesthetics and the angles that measure upper and lower lip protrusion (nasolabial, mentolabial sulcus and interlabial angles). It should be noted that this finding is not surprising since all individuals in the sample had lip seal competence and therefore no major imbalances in lip positioning.

Total facial convexity angle, which takes into account nasal projection, was also not associated with profile aesthetics. In an attempt to speculate why this angle showed no association, similarly to what was observed in the facial convexity angle, one should start by reasoning that the only difference between them is that the first takes into account nasal projection. The facial convexity angle is directly related to the maxillomandibular sagittal relationship, i.e. facial pattern, and therefore any changes in its measurement are directly related to sagittal discrepancies between maxilla and mandible. Total facial convexity angle, however, provides an evaluation of the nose projection in relation to the chin and forehead. Changes in its convexity can be related not only to skeletal discrepancies but also a larger or smaller nasal projection, which seemed not to influence in the same manner the aesthetic evaluation of the profile. This finding contradicts an earlier study with this same sample, in which examiners reported that the main factors responsible for an unpleasant aesthetics of the profile were the nose, in 38.35% of cases, and chin, for 18.9%.[23]

Subjective Morphological Facial Analysis classifies patients' faces as Patterns I, II and III, Long Face and Short Face.[5] Pattern I individuals are characterized by normal vertical and sagittal facial proportions. Any malocclusion in these patients will necessarily have a dental origin. Patterns II and III patients present with sagittal discrepancies, with positive and negative steps between the maxilla and mandible, respectively. The Long and Short Face patterns are characterized by excess and deficiency in vertical face growth, with several studies published in the literature referring to them as Long Face and Short Face Syndromes. Malocclusions present in patients with skeletal discrepancies (Patterns II, III, Long Face and Short Face) usually result from these imbalances.

The method for selecting subjects for this sample excluded patients with Long Face, Short Face as well as Patterns I, II or III with no lip seal competence.

This study therefore revealed that 50% of patients were Pattern I, 41% Pattern II and 9% Pattern III.[22, 24]

After distributing the individuals in a Contingency Table and applying the chi-square test, an association was found between the score assigned to facial aesthetics and facial pattern ($p<0.001$). Cramer's coefficient found a 0.396 association (Table 3).

In evaluating the distribution of Patterns I, II and III individuals, who were assigned facial aesthetics scores below and above 4.8, it was observed that among Pattern I patients, 56% received scores above 4.8. For those classified as Class II this percentage was reduced from 19.5% to 11.1% among Pattern III patients.

The most simplistic explanation for this finding corroborates several authors who found that, from a strictly aesthetical viewpoint, balanced profiles are the most widely preferred, followed by Pattern II profiles, whereas Pattern III profiles were considered the least aesthetic. The literature also suggests that Pattern III individuals are more likely to accept orthognathic surgery than Patterns II patients due to the impact of this discrepancy on facial aesthetics.[11,27]

A published study[22] showed, however, that Pattern III individuals in this sample exhibited more striking discrepancies in their profile than those with Pattern II, when compared with Pattern I individuals. This may be one of the reasons why Pattern III individuals received lower scores than Pattern II.

In distributing aesthetically pleasing, acceptable and unpleasant individuals among Patterns I, II and III, it was noted that all subjects in the sample who were classified as having an aesthetically pleasing pattern belonged

to Pattern I. Moreover, 85.4% of Pattern II individuals were rated as aesthetically acceptable, and 14.6% as aesthetically unpleasant, all of whom were men. Regarding Pattern III, 88.9% were considered aesthetically acceptable and 11.1% unsightly, all of whom were women. All Pattern II women and all Pattern III men were considered aesthetically acceptable, showing that a reduction in the facial convexity of women, and an increase in men's are aesthetically acceptable.

CONCLUSIONS

An association was observed between scores for facial profile aesthetics and facial convexity angle, lower face angle and facial pattern. Increases in facial convexity in men and decreases in women resulted in a aesthetically unpleasant appearance, which might require surgical procedures combined with orthodontics to enhance aesthetics.

There was no association between profile aesthetics and age, gender, sagittal occlusal relationship, lip protrusion and total facial convexity angle.

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