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Orthodontists' and laypersons' aesthetic assessment of Class III subjects referred for orthognathic surgery

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SUMMARY This study was undertaken to compare laypersons' and professionals' perception of soft tissue profiles of Class III adults, and to evaluate which cephalometric variables are likely to influence the profile assessment score (PAS).

Lateral headfilms and coloured profile photographs of 18 skeletal Class III Caucasian adult patients (10 males, 8 females with a mean age of 24.5 years) prior to surgery, and nine adult Caucasian patients (four males, five females with a mean age of 27.4 years) with a dental Class I occlusion and no major skeletal discrepancy were included in the study. The headfilms were hand traced and digitized. Various cephalometric variables were calculated by computer software. Each printed profile photograph was evaluated aesthetically by 18 laypersons and 18 orthodontists using a 10-graded visual analogue scale (VAS) and a standard profile for calibration. Intra-observer reliability was tested and no significant error was found. Paired and unpaired *t*-tests were used to compare the scores. The association between various cephalometric variables and the PAS was tested.

In general, compared with orthodontists, laypersons were less critical in their evaluation of the Class III profiles (+0.3 grade on the VAS) as well as the reference profiles (+0.7). The reference profiles were found to be more attractive than the Class III profiles by both laypersons and orthodontists (+2.3 grades). The degree of facial concavity had a negatively predictive value for the orthodontists' and laypersons' evaluations. The degree of facial concavity together with the steepness of the mandibular plane were negatively predictive factors for the PAS given by the orthodontists.

Introduction

For Class III patients, aesthetics is often the chief complaint when seeking orthodontic treatment and thus of primary importance. Assessment of their actual situation by their peers and the possible improvement with orthognathic surgery are important considerations in the choice of treatment and must be taken into account. Therefore, it is important to know not only the opinions of professionals but also those of laypersons on the facial appearance of Class III patients. It is possible that skeletal discrepancies might not be perceived in the same manner by laypersons and professionals.

Some reports suggest that laymen and professionals perceive facial aesthetics differently (Lines *et al.*, 1978; Prahl-Andersen *et al.*, 1979), with the general public demonstrating the greatest variation in what they consider attractive (Cochrane *et al.*, 1999). On the other hand, Shelly *et al.* (2000) and Maple *et al.* (2005) reported agreement between laymen and professionals in their perception of facial aesthetics.

Concerning Class II profiles, it was found by Phillips *et al.* (1995) that patients and their peers, as well as orthodontists and oral surgeons, rated subjects with Class I profiles as more attractive than those with Class II profiles. In addition, Bishara and Jakobsen (1997) found that laypersons perceive the profile of normal adolescent patients more favourably than untreated patients with Class II division 1 malocclusions.

In contrast to many investigations on the evaluation of patients with a Class II profile, only one study was found in the literature investigating how photographs of the soft tissue profiles of 20 patients with a Class III malocclusion were perceived by laymen and professionals. Kerr and O'Donnell (1990) found that both dental professionals and laypeople rated subjects with a Class III malocclusion as less attractive than those with a Class I malocclusion. However, that study was based on a limited number of raters.

Similarly, it has been shown that photographs or profile silhouettes manipulated from Class I to Class III were less pleasing to both laymen and professionals (De Smit and Dermaut, 1984; Johnston *et al.*, 2005a; Maple *et al.*, 2005).

Until now no information regarding a possible association between unfavourable aesthetic assessments of Class III profiles and some cephalometric characteristics of these individuals is available.

The aim of this study was to analyse the aesthetic evaluation by laypersons and orthodontists of profile photographs taken of various untreated Class III patients referred for orthognathic surgery and to identify certain cephalometric variables which could be related to their rating.

The hypothesis that a difference between orthodontists and laypersons exists in the aesthetic evaluation of these patients was also examined.

Subjects and methods

Subjects

A sample of 18 Caucasian skeletal Class III adult patients, seeking treatment during the period 1984–2001 and treated with combined orthodontics and orthognathic surgery, was selected from the treatment files, independent of treatment outcome. Inclusion criteria were that the patients had a Class III malocclusion in centric relation, with a negative or zero overjet and an ANB angle of 1 degree or less, excluding patients with a cleft of the lip/palate, recognized syndromes, or facial trauma.

A reference group of nine adult Caucasian orthodontically treated patients was selected from the post-retention files of the orthodontic department of the University of Geneva. These subjects presented a pre-treatment dental Class I occlusion with minor dental problems and no major skeletal discrepancy.

Both groups were of a similar age range and gender distribution (Table 1).

Methods

Lateral headfilms taken in the natural head position (NHP) and the lips in the rest position, and coloured facial profile photographs were obtained from the patients' records. For the Class III patients, the records taken prior to surgery were used, whereas for the reference group, the final records obtained after minor orthodontic treatment were analysed.

The lateral cephalograms were hand traced by the same examiner (MF) and the tracings digitized. A selection of angular and linear cephalometric variables as shown in Table 2, as well as the coordinates of the reference points shown in Figure 1, were calculated by computer using the OTP software (OTP for Windows, Version 8.5.4, Smith Micro Software, Inc., Aliso Viejo, California, USA).

The photographs were checked for adequate quality by one author (MF): each photograph had to show the profile in NHP with the lips in the rest position. For each subject, the profile photograph was presented on one printed page with a modified visual analogue scale (VAS) from 0 to 10 cm placed below (Figure 2).

Judges

A panel of 18 orthodontists (nine males, nine females) and 18 laypersons (4 males, 14 females) participated in the study.

Laypersons and orthodontists represented a wide age range with various levels of experience for the orthodontists. All were adults. The laypersons consisted of participants recruited from incidental contacts during the course of this investigation. They had a mixed socio-economic background and none of them was trained in dentistry or the facial arts.

The judges were instructed to aesthetically evaluate the photographs and to rate them by placing a mark along the VAS from 0 to 10, 0 being 'a very unattractive profile' and 10 'a very attractive profile' [profile assessment score (PAS)]. The judges were instructed to evaluate the profiles in the most objective way, without being influenced by factors such as make-up, eye colour, or hairstyle.

Evaluation procedure

To standardize the assessments of the judges, the study used the following calibration procedure. In a first round, the nine reference profiles were evaluated by the 36 judges. The subject with the least variance in the score served as the standard calibration profile. It was scored by the judges with a mean of 6.0 on the VAS.

In a second round, the 18 skeletal Class III profiles, together with the standard calibration profile, were submitted to the same 18 orthodontists and 18 laypersons for evaluation.

Statistical analysis

The aesthetic assessment score of each subject in the Class III and reference group was the mean of the PAS given by the group of orthodontists and the group of laypersons, respectively.

A paired *t*-test was used to evaluate differences in PAS of laymen and orthodontists and an unpaired *t*-test to determine differences in PAS between the reference and Class III profiles of each group of evaluators.

Correlation coefficient and multiple regression analysis were used to judge PAS in relation to the cephalometric variables.

Method error

To test intra-observer reliability, the 18 Class III profiles together with the standard calibration profile were re-evaluated with a minimum interval of 6 months by nine

Table 1 Demographic and clinical characteristics of the two study groups.

Group	*n*	Males	Females	Age mean/range (years, months)		ANB mean/range (degree)		Overjet mean/range (mm)	
Class III	18	10	8	24.5	17.5 to 38.4	−2.57	−6.37 to 0.80	−5.35	−10.46 to −0.39
Class I	9	4	5	27.4	23.10 to 31.9	3.24	0.50 to 5.86	2.99	1.74 to 4.64

Table 2 Correlation between the mean profile assessment score of all judges and the Class III cephalometric variables.

Cephalometric variables	*R*	*P*
Angles (°)		
ANB (point A–nasion–point B)	0.18	0.475
SN–MEGO (sella turcica–nasion/menton–gonion)	−0.18	0.482
Nasolabial angle* (ac–pc–sl: anterior columella–posterior columella–labrale superius)	0.38	0.123
Nasofacial angle† (g–pg: soft tissue glabella–soft tissue pogonion/line tangent to dorsum of nose)	0.27	0.277
Nasomental angle† (n–nt/nt–pg: soft tissue nasion–nasal tip/nasal tip–soft tissue pogonion)	−0.34	0.168
Facial contour angle‡ (g–pc/pc–pg: soft tissue glabella–posterior columella/posterior columella–soft tissue pogonion)	−0.58	0.011
Distances (mm)		
Overjet	0.36	0.145
Wits appraisal	0.18	0.464
Upper lip protrusion§ (sl to nt–pg: distance labrale superius to nasal tip–soft tissue pogonion line)	−0.31	0.212
Lower lip protrusion§ (ll to nt–pg: distance labrale inferius to nasal tip–soft tissue pogonion line)	−0.03	0.922
Upper face height‡ (E–pc: eye–posterior columella)	−0.01	0.991
Lower face height‡ (pc–me: posterior columella–soft tissue menton)	0.01	0.991
Upper lip length‡ (pc–s: posterior columella–stomion)	0.41	0.081
Lower lip length‡ (s–me: stomion–soft tissue menton)	−0.41	0.089
Ratios		
MEGO/ANS–PNS (menton–gonion/anterior nasal spine–posterior nasal spine)	0.21	0.396
Upper lip length/lower face height	0.52	0.028

*Arnett and Bergman, 1993. †Powell and Humphreys, 1984. ‡Worms *et al.*, 1976. §Ricketts, 1960.

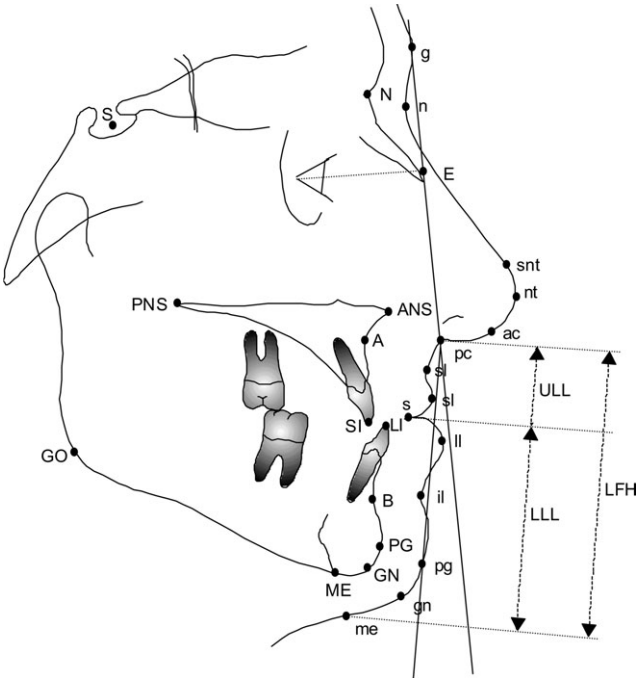

Figure 1 Reference points and lines used in the cephalometric analysis. Hard tissue points: S, sella turcica; N, nasion; ANS, anterior nasal spine; PNS, posterior nasal spine; A, point A; B, point B; PG, pogonion; GN, gnathion; ME, menton; SI, incision superius; LI, incision inferius; and GO, gonion. Soft tissue points: g, soft tissue glabella; n, soft tissue nasion; snt, superior nasal tip; nt, nasal tip; ac, anterior columella; pc, posterior columella; slc, superior labial sulcus; sl, labrale superius; s, stomion; ll, labrale inferius; il, infralabiale; pg, soft tissue pogonion; gn, soft tissue gnathion; and me, soft tissue menton. Constructed points: E, eye, the intersection of soft tissue glabella–posterior columella plane by a perpendicular line bisecting the eye (Worms *et al.*, 1976). LFH, lower face height; LLL, lower lip length; ULL, upper lip length.

Figure 2 The judges were asked to aesthetically score each photograph by placing a mark on the visual analogue scale (0 = very unattractive profile; 10 = very attractive profile).

orthodontists and nine laypersons. A paired *t*-test was used to detect possible systematic errors between the two occasions. No error was found either for the orthodontists or for the laypersons. A high correlation was found between the two evaluations ($R = 0.94$, $P < 0.01$).

The error of the method (standard error) was calculated using the formula of Dahlberg

$$SE = \sqrt{\frac{\sum d^2}{2n}},$$

where Σd^2 is the sum of the squared differences between the first and the second occasion and n is the number of subjects evaluated twice (Houston, 1983). The error of the method was found to be less than 0.17 units on the VAS both for the orthodontists and laypersons.

Tracing and point identification error was estimated by double measurement of 14 headfilms, randomly chosen from the two groups, which were re-traced and re-digitized by the same investigator (MF) on a second occasion (minimum 6 month interval). Dahlberg's formula was used to determine the random error between the duplicate measurements for overjet, ANB, SN–MEGO, nasolabial angle, nasofacial angle, facial contour angle, lower face height, and upper lip length (Figure 1, Table 2). The systematic error between the two sets of measurements was found to be low, 0.9 degree for the angular measurements (0.3–1.7 degrees) and 0.7 mm for the linear measurements (0.3–0.9 mm).

Results

Evaluation of PAS of laypersons and orthodontists

In general, laypersons gave somewhat higher scores than orthodontists for the Class III profiles as well as for the reference profile (Figure 3). The laypersons scored the reference profile (mean of 0.66, $P < 0.05$) as well as the Class III profiles (mean of 0.32, $P < 0.001$) more positively.

The reference profiles were found to be more attractive than the Class III profiles by both laypersons ($P < 0.001$) and orthodontists ($P < 0.001$) separately and when the two groups of evaluators were combined, this resulted in a difference of 2.3 units on the VAS ($P < 0.001$).

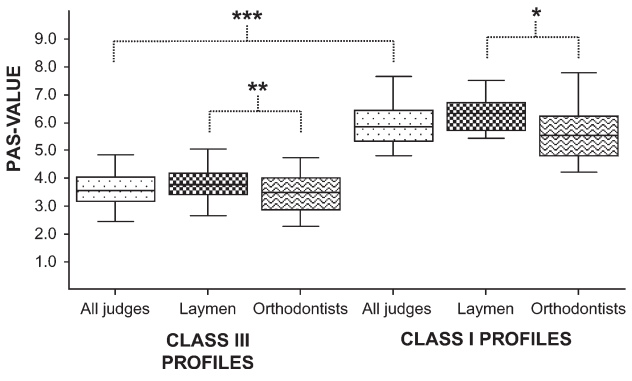

Figure 3 Profile assessment score (PAS) given by laypersons and orthodontists. *$P < 0.05$, **$P < 0.001$, ***$P < 0.001$. Each box represents the data from the 25th to 75th percentile, the line within the box the median and the ends of the vertical lines (whiskers) indicate the extreme values (Tuckey, 1977).

Evaluation of PAS for Class III profiles in relation to cephalometric variables

Individuals with a higher degree of facial concavity were given a lower score. A significant negative correlation was observed between the facial contour angle and the scores given for the Class III profiles by orthodontists ($R = -0.60$, $P = 0.008$), laypersons ($R = -0.55$, $P = 0.018$), and when both groups of judges were combined ($R = -0.58$, $P = 0.011$).

A high correlation was observed between the ratio upper lip length/lower face height and the PAS given for the Class III subjects by laypersons ($R = 0.54$, $P = 0.021$), as well as when both groups of evaluators were combined ($R = 0.52$, $P = 0.028$; Table 2).

Multiple regression analysis of the cephalometric variables used showed that the facial contour angle together with the SN–MEGO angle was negatively correlated with the PAS values given by the orthodontists ($P = 0.001$ and $P = 0.032$, respectively). The combination of these two cephalometric variables explained 47.5 per cent of the variance observed in the orthodontists' evaluation of the Class III profiles (Table 3).

None of the other cephalometric variables could explain the results according to the regression model.

Discussion

The present study has shown that untreated skeletal Class III subjects are found to be less attractive than individuals with a Class I profile as assessed both by orthodontists and laypersons.

The degree of facial concavity had a negatively predictive value on their aesthetic assessment. The degree of facial concavity, together with the steepness of the mandibular plane, were the two negatively predictive factors for the PAS given by orthodontists.

The results of this study are in concordance with Kerr and O'Donnell (1990) who found that both dental professionals and laypersons rated the facial appearance of subjects with a Class III malocclusion as significantly less pleasing than those

Table 3 Multiple regression analysis to test the significance of the facial contour angle and the SN–MEGO angle on the profile assessment score given by orthodontists. Multiple regression analysis Class III group ($n = 18$): $Y = b_0 + b_1$ facial contour angle + b_2 SN–MEGO; dependent variable (Y): PAS by orthodontists, $Y = 5.129 + b_1$ facial contour angle + b_2 SN–MEGO.

Independent variables	Coefficient b	SE (degree)	P
Facial contour angle (°)	−0.091	0.023	0.001
SN–MEGO (°)	−0.055	0.023	0.032

Significance of the model: $R = 0.733$, $R^2 = 53.7\%$, adjusted $R^2 = 47.5\%$, $P < 0.003$.
SE, standard error; b_0, constant, b_1, and b_2, regression coefficients; R, correlation coefficient; R^2, percentage of explained variance.

with a Class I malocclusion, as shown also by manipulated photographs and profile silhouette studies (De Smit and Dermaut, 1984; Johnston *et al.*, 2005a; Maple *et al.*, 2005).

The fact that hyperdivergence negatively affects facial attractiveness was observed by Johnston *et al.* (2005b) in which even laypeople noticed differences in vertical relationships. Images with a reduced lower facial proportion were rated more attractive and less likely to be judged as needing treatment than corresponding images with an increased lower facial proportion. Moreover, Michiels and Sather (1994) found that profiles with increased vertical dimensions were more often rated as below average than profiles with decreased vertical dimensions by a group of orthodontists and maxillofacial surgeons. De Smit and Dermaut (1984) concluded that vertical profile characteristics could be more important than antero-posterior features and that a reduced lower facial proportion was more acceptable to dental students than an increased lower facial proportion.

As initially hypothesized, laypersons gave higher scores than orthodontists for the Class III profiles as well as the reference profiles, i.e. laymen were less critical in profile evaluation than orthodontists, but the difference in the PAS was rather small.

In the study of Kerr and O'Donnell (1990), art student and parent panels were also less critical in their appraisal of facial attractiveness compared with orthodontists and dental students. The present results are in agreement with the findings of Johnston *et al.* (2005a) which indicate that for laypeople, there is a wider range of acceptable skeletal discrepancy than orthodontists might suppose.

The findings that laypersons were somehow less critical than orthodontists could be explained by the fact that orthodontists frequently perceive facial aspects that may appear unimportant to laymen. Burcal *et al.* (1987) reported that orthodontists and oral surgeons focused more on the chin whereas laypersons focused more on the lips. Orthodontists tend to focus on the profile and on different portions of the face. Laymen, in contrast, tend to view facial aesthetics as a whole (Cochrane *et al.*, 1999).

In the present study, the gender distribution both of the Class III and I groups and of the assessors was not identical. However, it is not considered that this influenced the aesthetic assessments of the judges since De Smit and Dermaut (1984) found no significant difference between male and female participants in aesthetic preference for the gender of a profile.

The present study confirmed that the VAS is a reliable method in aesthetic evaluation. Subjectivity, however, remains a problem. In order to reduce this, the judges were instructed to evaluate the profiles in the most objective way, without being influenced by any possible external factor. Silhouette images or profile outlines instead of photographs could reduce this difficulty since distracting variables such as hairstyle, make-up, facial blemishes, and age would be eliminated and the judges could focus more on the profile. However, these profile outlines represent an unrealistic situation, and it was considered that total facial appearance would provide a better perspective to evaluation procedures. Another option to counterbalance these external distracting variables would be the use of only one model altered by computer, which could provide digital images with a more realistic representation than profile outlines. The inconvenience of this facial aesthetic evaluation procedure, however, is that it does not allow further analysis of skeletal discrepancies which may contribute to a negative assessment. Therefore, 18 different patients representing a sample of individuals with skeletal Class III relationship of varying severity in their morphology were included in the analysis.

While the sample size was relatively small, this was considered acceptable to allow the inclusion of a larger number of assessors but without discouraging them by presenting too many profiles to evaluate.

Although it would have been of interest for professionals to study a sample with a larger spectrum of severity of Class III malocclusions that also included mild cases, it is still considered that the present study is clinically relevant in elucidating answers to the questions raised.

The findings of this investigation have shown how skeletal Class III profiles are estimated by laypersons. Orthodontists should consider peer opinion on the patient's facial appearance when planning orthognathic surgery since they are somewhat less critical than professionals, and the latter should always weigh up the possible aesthetic improvement versus the surgical risks.

The question as to how laymen perceive changes after different surgical procedures is another point of interest in treatment planning and merits further research.

Conclusions

1. Both laypersons and orthodontists consider subjects with Class I profiles as more attractive than those with Class III profiles.
2. When assessing the aesthetics of Class III profiles, laypersons are not as critical as orthodontists.
3. The degree of concavity has a negatively predictive value for orthodontists' and laypersons' evaluations of Class III profiles. For orthodontists, a concave profile, combined with increased hyperdivergency, negatively influences profile assessment.

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