Original Article

Objective Measures as Indicators for Facial Esthetics in White Adolescents

R. M. A. Kiekens[a]; J. C. Maltha[b]; M. A. van 't Hof[c]; A. M. Kuijpers-Jagtman[d]

Abstract: The objective of this study was to examine the contribution of objective measures representing anterior-posterior and vertical characteristics, dental esthetics, or their combination that are used in daily orthodontic practice in the assessment of facial esthetics. A panel of 78 laymen evaluated facial esthetics of 32 boys and 32 girls, stratified over the four Angle classes, on a visual analogue scale. The relation between the objective parameters and facial esthetics was evaluated by backward multiple regression analysis. Dental esthetics as expressed by the Aesthetic Component of the Index of Orthodontic Treatment Need (AC/IOTN) appeared to be the most important indicator for facial esthetics. A new parameter, the ''horizontal sum'' was found to be a reliable variable for the anterior-posterior characteristics of the patient. Addition of this newly defined parameter to the AC/IOTN improved the prognostic value from 25% to 31%. (*Angle Orthod* 2006;76:551–556.)

Key Words: Anterior-posterior characteristics; Vertical Characteristics; Dental esthetics; Facial esthetics

INTRODUCTION

Orthodontic treatment for esthetic reasons is a sign of the times.[1] Orthodontic patients and their parents believe that well-aligned teeth are important for overall facial appearance.[2,3] They expect that orthodontic treatment will improve their dental, dentofacial, and facial esthetics[1,3–6] and consequently their popularity and social acceptance.[7–10] Therefore, over the last decades orthodontists focus their treatment plans more and more on improvement of facial esthetics.[11]

Our society seems to have an implicit standard for facial esthetics.[12] Both orthodontists and laymen are very well able to use VAS scores to judge facial esthetics from photographs in a more or less intuitive way although facial esthetics seems to be a subjective and not a well-defined variable.[13–17] For patients, to a large extent, the expectations of an orthodontic treatment depend on the perception of their own (dento)-facial esthetics[18] and on the constant judgment by their peers. The decision of teenagers to undergo orthodontic treatment seems to be motivated by social norms and the beauty culture in their reference group and the society in general.[1] This means that the opinions of laymen are the important parameter in determining the success of an orthodontic treatment.[11]

Orthodontists prefer to use objective parameters instead of opinions for their diagnosis, treatment plan, and evaluation of the outcome of their clinical intervention. Their treatment plans are often aimed at changing these objective parameters to meet standards of normality. Objective parameters used by orthodontists mainly focus on a quantitative description of anterior-posterior and vertical discrepancies and dental irregularities.

The most commonly used parameter for anterior-posterior characteristics is the Angle classification. It is a very rough estimate that consists of only four discrete classes. Not surprisingly, the use of this classification for facial appreciation has led to conflicting results.[15,17,19–24]

[a] Staff Scientist, Department of Orthodontics and Oral Biology, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands.

[b] Associated Professor, Department of Orthodontics and Oral Biology, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands.

[c] Professor, Department of Preventive and Curative Dentistry, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands.

[d] Professor and Department Chair, Department of Orthodontics and Oral Biology, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands.

Corresponding author: Dr. Jaap C. Maltha, Department of Orthodontics and Oral Biology, Radboud University, Nijmegen Medical Centre, PO Box 910l, 6500 HB Nijmegen, The Netherlands (e-mail: j.maltha@dent.umcn.nl)

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TABLE 1. Ranges of Facial Features Overjet, ANB Angle, SN-GoGn Angle, and AC/IOTN Over the Different Angle Classes Among the Sample (N = 64)[a]

Angle Class	Overjet (mm)	ANB (°)	Horizontal Sum	SN-GoGn (°)	AC/IOTN
Class I	0 to 7	−1 to 5	0 to 10	25 to 42	1 to 7
Class II division 1	6 to 14	4 to 8	11 to 19	24 to 47	1 to 9
Class II division 2	1 to 7	2 to 7	5 to 13	22 to 36	1 to 8
Class III	−3 to 5	−5 to 1	−7 to 3	28 to 44	2 to 9
Total	−3 to 14	−5 to 8	−7 to 19	22 to 47	1 to 9

[a] AC/IOTN indicates Aesthetic Component of the Index of Orthodontic Treatment Need.

Some authors focus on dental measurements such as molar relationships or overjet as separate parameters. Because the molar relationship is not reflected in the face, overjet seems to be the most appropriate measure related to facial attractiveness.[25] Other authors focus on skeletal measurements, the ANB angle in particular, as determinants for anterior-posterior characteristics. This angle shows a wide range of values over the different Angle classes because it is not only related to the position of point A and B, but also to the position of point N and the rotation of the jaws relative to the SN-line.[26] For a proper evaluation of the anterior-posterior characteristics of a patient, a combination of overjet and ANB angle might be indicated.

The effect of vertical characteristics on facial attractiveness has mainly been studied on constructed profiles[19,27] or manipulated photographs,[24,28,29] but their contribution in profile preferences is still unclear. Most orthodontists use the SN-GoGn angle for the evaluation of vertical dimensions in daily clinical practice, but as far as we know, this parameter has never been related to facial attractiveness.

The importance of dental irregularities or dental relationships in whole facial attractiveness has been illustrated by many authors.[2–10] Some of them evaluated the social attractiveness of children as judged on photographs in which they had manipulated the arrangement of the front teeth using computer techniques.[2,8] Faces with a normal dental appearance were judged to be the most attractive. Nowadays, the Aesthetic Component of the Index of Orthodontic Treatment Need (AC/IOTN) as described by Evans and Shaw[30] is widely accepted for the evaluation of dental esthetics.

Despite extensive research on facial esthetics, no attempt has been made to relate the layperson's perception of facial esthetics to objective facial and dental parameters. This seems to be important because esthetics is the main reason to seek orthodontic treatment. Therefore, the aim of this study was to determine which objective measures used in daily orthodontic practice are related to facial esthetics as perceived by laymen. These measures represent dental and skeletal anterior-posterior characteristics (overjet and ANB angle, respectively), skeletal vertical characteristics (SN-GoGn angle), and dental esthetics (AC/IOTN) separately or in combination.

MATERIALS AND METHODS

Patient selection

The 1990–2000 files of the Department of Orthodontics and Oral Biology of the Radboud University Nijmegen Medical Centre, The Netherlands, were searched for White children meeting the following inclusion criteria: age 10 to 16 years, without dental or facial trauma or known congenital defects, and not wearing glasses. Suitable pretreatment records should be available: dental casts, cephalograms, intraoral and extraoral color photographs (including frontal, lateral, and three-quarter smiling).

A total of 764 patients (366 males and 398 females) met the inclusion criteria. From this group, 64 patients were randomly selected after stratification to have about eight boys and eight girls for each of the four Angle Classes. This stratification was performed to have a wide range of dental/skeletal variation. The Angle Classes were defined as follows: Angle Class I, neutro-occlusion and neutro-relationship of the jaws; Class II division 1, disto-occlusion and disto-relationship of the jaws, with proclined upper incisors; Class II division 2, disto-occlusion and disto-relationship of the jaws, with retroclined upper incisors; and Class III, mesio-occlusion and mesio-relationship of the jaws.

Facial esthetics

Facial esthetics was judged by a panel of 78 adult laymen (38 men and 40 women, mean age: 51 ± 10.3 years; range 28 to 76 years). The panel members had different professional backgrounds and a high social-economical status. This panel judged facial attractiveness of the selected patients as described previously.[17] In brief, for each individual, a set of digital images was prepared, simultaneously showing a frontal, a three-quarter smiling with visible front teeth and a profile view. These sets of pictures, presented in random order as a slide show, were to be assessed on a visual

TABLE 2. Mean ± SD of the Esthetic Scores Given by Laymen on the VAS According to Sex and Angle Class of the Subjects[a]

	Boys (n = 32)		Girls (n = 32)	
Angle Class	n	Mean ± SD	n	Mean ± SD
Class I	8	52.6 ± 7.8	7	56.8 ± 6.1
Class II division 1	9	55.8 ± 11.0	9	51.9 ± 11.0
Class II division 2	8	60.4 ± 4.6	8	55.2 ± 4.3
Class III	7	51.7 ± 9.4	8	47.2 ± 11.0
Total	32	55.3 ± 8.9	32	52.6 ± 9.5

[a] SD indicates standard deviation; VAS, visual analogue scale.

analogue scale (VAS) from 0 (= very unattractive) to 100 (= very attractive) in relation to reference sets, one for boys and one for girls on which the predetermined VAS values were indicated.

Each reference set had been selected previously as the median of a panel evaluation performed by 49 dental students (aged 18 to 26 years). For this selection, 40 photographs of boys and 40 photographs of girls were used, which were randomly selected from the files of the Department of Orthodontics and Oral Biology of the Radboud University Nijmegen Medical Centre, The Netherlands, and who met the inclusion criteria. This scoring method with one reference set for boys and one for girls has been shown to be valid and reproducible.[17] Each face was shown for 15 seconds. To evaluate the reproducibility of the measurements, six duplicate sets of pictures were randomly inserted into the series.

Objective parameters

For each individual, the following objective parameters were determined on the available patient documentation.

- Overjet was measured on the dental casts as the anterior-posterior distance between the maxillary and mandibular central incisors at the most labial point of the most prominent incisor.
- ANB angle and SN-GoGn angle were measured on tracings of the lateral head films.
- AC/IOTN was determined according to the guidelines of Evans and Shaw[30] on the intraoral pictures by mutual agreement between two independent observers.

Statistics

The VAS scores of two panel members were not used for statistical analysis because of missing data. For the remaining panel members, the random error of the six duplicated pictures was calculated by Dahlberg statistics.

For each individual set of pictures, the mean and standard deviation (SD) of the ratings on the VAS were calculated as the final esthetic score.

Initial analysis revealed a colinearity (Pearson's correlation coefficient = 0.74) of the two parameters describing the anterior-posterior characteristics, namely overjet and ANB angle, on the VAS scores, leading to noninterpretable influences. Therefore, the two variables were combined into a new parameter for the estimation of horizontal characteristics. This new parameter was defined as the sum of ANB (in degrees) and overjet (in millimeters), and is called ''horizontal sum.'' Cronbach's alpha was calculated to determine the reliability of this horizontal sum. Cronbach's alpha is a useful coefficient for assessing internal consistency. The reliability of a scale is generally regarded as satisfactory if its value is ≥ 0.80.[31]

The relation between horizontal sum, SN-GoGn angle, and AC/IOTN at one side and the VAS score at the other side was analyzed by backward multiple regression analysis. Because horizontal sum and SN-GoGn angle may have an optimal value, quadratic regression analysis also was performed for these parameters. The explained variance (adjusted r^2) was calculated.

RESULTS

The parameter horizontal sum, which was the sum of overjet in millimeters and ANB angle in degrees, constituted a reliable scale for the horizontal characteristics of a patient (Cronbach's alpha $\alpha = 0.84$).[31] The ranges of the objective parameters overjet, ANB angle, horizontal sum, SN-GoGn angle, and AC/IOTN as determined in the different Angle Classes are summarized in Table 1.

The random error of the VAS scores in the duplicate sets of photographs varied from two to 17 VAS points. The median random error was 6.8 VAS points. The median individual reliability was sufficiently high (0.68). Means and SDs of the esthetic scores on the VAS according to sex and Angle Class are summarized in Table 2.

Backward multiple regression analysis showed that SN-GoGn angle was not significantly correlated with the VAS scores ($P = .70$). The parameter AC/IOTN showed a significant negative correlation with the VAS scores (adjusted $r^2 = 0.25$; $P < .001$) (Figure 1). Horizontal sum ($P = .002$) and its quadratic value ($P = .005$) together showed a significant influence on the VAS scores (adjusted $r^2 = 0.13$, $P = .006$). The corresponding parabola showed a maximum at 8.6 (95% confidence interval 5.6–11.6) (Figure 2).

If all three parameters (horizontal sum, quadratic horizontal sum, and AC/IOTN) were taken together, the explained variance amounted to 31%.

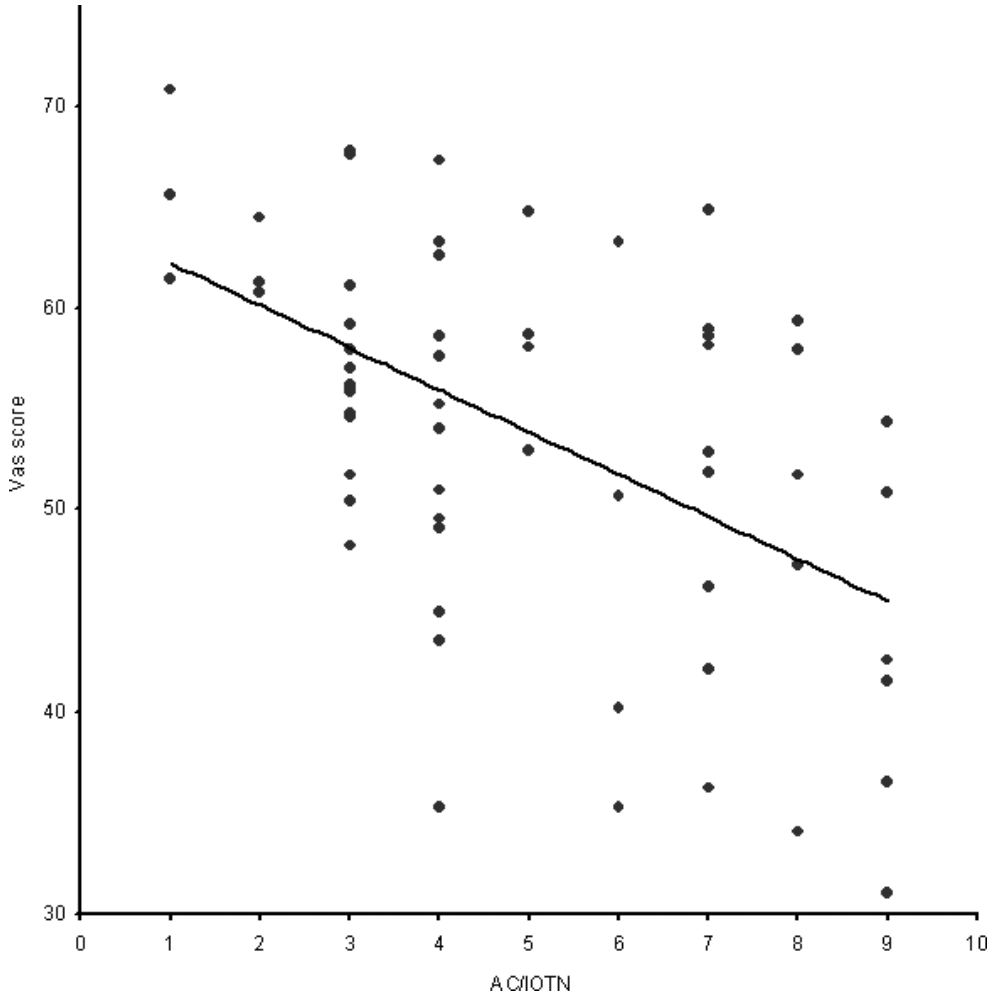

FIGURE 1. Relation between AC/IOTN and VAS scores. VAS indicates visual analogue scale; AC/IOTN, Aesthetic Component of the Index of Orthodontic Treatment Need.

DISCUSSION

Facial esthetics was judged on a series of sets of three pictures of 64 patients according to Kiekens et al.[17] The judgments were performed by a panel of laymen with a relatively high social-economical status. These men and woman were considered as representative for the part of the general public, that shows the highest orthodontic treatment demand.[32,33]

The stimulus used in this study consisted of a stratified sample of Angle Class I, II/1, II/2, and III patients. This stratification was only performed to have a wide range of dental/skeletal variation, covering the whole spectrum of orthodontic patients. The objective parameters used in this study showed wide overlapping ranges for the different Angle classes. This indicates that none of them was decisive for the Angle classification. Also, the VAS scores showed a wide and overlapping range in all the Angle Classes.

The new parameter, horizontal sum as introduced in this study, is a reliable and simple measurement for the horizontal components related to the dentition (overjet) measured on the dental casts and to the skeleton (ANB angle) measured on the lateral radiographs. Laymen gave the highest VAS scores on faces with a horizontal sum value of 8.6. Because orthodontists consider an overjet of 2 mm and an ANB angle of 2° as normal in Caucasians, laymen apparently prefer slightly convex faces.

The fact that for the variable horizontal sum, degrees and millimeters are summed, might be surprising, but it appears to be a reliable parameter (Cronbach's alpha = 0.84). The Wits-appraisal[26] that is measured in millimeters could have been used as an alternative to the ANB angle. However, it has the drawback that it is measured as a distance on cephalograms and that its value therefore depends on the magnification of the radiographs. On the other hand, the Wits-appraisal measures exclusively the horizontal characteristics, whereas the horizontal sum, which comprises the ANB angle, is also influenced by the

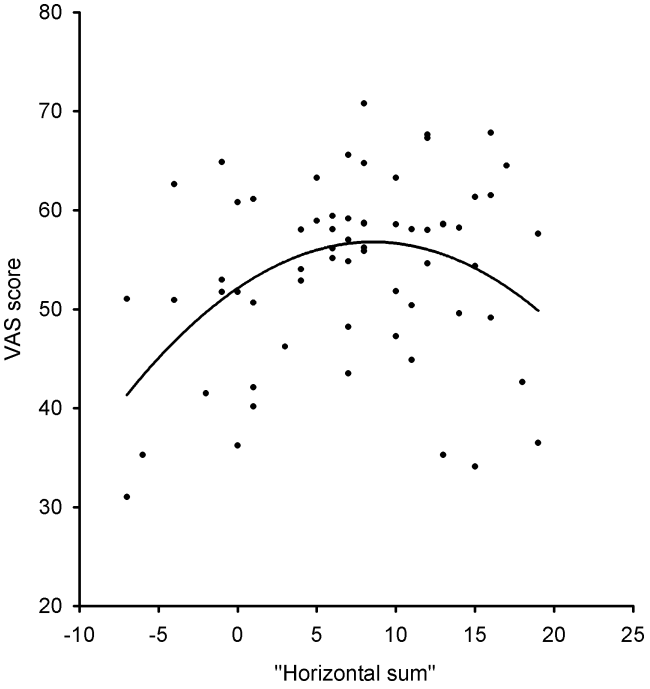

FIGURE 2. Relation between ''horizontal sum'' and VAS scores with top of regression line at 8.6. VAS indicates visual analogue scale.

vertical position of the points N, A, and B.[26] For a same position of point A and B, a lower position of point N, results in a larger ANB angle. The fact that a horizontal sum value of 8.6 was preferred could indicate that in case of a short face (lower position of point N, larger ANB angle) laymen prefer faces with a small overjet. However, in long faces (higher position of point N, smaller ANB angle) they may prefer larger overjets.

The SN-GoGn angle was not significantly related to the esthetic scores. SN-GoGn angle is often used as an indicator for facial height, but in fact it is a measure for mandibular rotation or growth direction, not for facial height. Lundström et al[34] found patients with a vertical growth direction the least attractive. However, the N-S-Gn angle as an indicator for growth direction[34,35] is also influenced by the vertical as well as the horizontal position of the chin (Gn). Facial convexity and facial height are mutually related, which is probably why in some investigations as well as in our investigation, the contribution of facial height to facial attractiveness is a matter of discussion.[23,28,29]

The AC/IOTN, which is a measure for dental esthetics, appears to be the most important contributor to the appreciation of facial esthetics because this parameter alone leads to an explained variance of 25%. The other parameters used in this study were less important. The addition of the horizontal sum to the AC/IOTN resulted in an increase of the explained variance from 25% to 31%. Although this improves the prognostic value, it is important to realize that the remaining 69% of the variance is left unaccounted for by these parameters and probably has to be attributed to other facial features such as eyes, skin, and hair.

CONCLUSIONS

- Of the parameters used in this study, dental esthetics as expressed by the AC/IOTN appeared to be the most important indicator for facial esthetics.
- Addition of newly defined parameter horizontal sum improved the prognostic value from 25% to 31%.

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