Assessment of objective and subjective measures as indicators for facial esthetics

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Abstract

Background: The study mentioned was aimed to examine the contribution of the objective measures representing anterior-posterior (AP) and vertical characteristics, dental esthetics, or their combination that are used in daily orthodontic practice in the assessment of the facial esthetics. Materials and Methods: A panel of 64 laypersons evaluated the facial esthetics of 32 boys and 32 girls, stratified over four different angle classes, on a visual analog scale. The relationship between the objective parameters and facial esthetics was evaluated by the backward multiple regression analysis. Results: Dental esthetics, expressed by the esthetic component of the index of orthodontic treatment need (AC/IOTN), appeared to be the most vital indicator for facial esthetics. The horizontal sum, a variable for AP characteristics of the patient, could be a better variable when compared with the overjet. Conclusion: Addition of this newly defined parameter to the AC/IOTN improved the prognostic value from 25% to 35%.

Key words: Anterior-posterior characteristics, dental esthetics, facial esthetics, vertical characteristics

Introduction

Concern regarding facial esthetics is one of the most probable reasons to seek orthodontic and/or surgical orthodontic treatment. The dentition and the occlusal relationship play a vital role in determining...
the overall perception of facial esthetics. The degree of anteroposterior (AP) discrepancy, either dental or skeletal, often serves as an indicator of malocclusion, and by inference the need for the treatment. The treatment plan, orthodontics and/or orthognathic surgery, for patients with more severe problems is frequently dictated in part by esthetic concerns. Orthodontic patients and their parents believe that well-aligned teeth are important for an overall pleasing appearance. The decision to undergo orthodontic treatment seems to be motivated by social norms and the beauty culture in their reference group. Therefore, the opinion of the laymen is an important parameter in determining the success of orthodontic treatment. Orthodontists, however, 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 focused at changing these parameters to normality. The objective parameters used by the orthodontists usually include quantitative descriptions of AP, vertical discrepancies, and dental irregularities. Studies carried out to relate the layperson’s perception of facial esthetics to the orthodontist’s objective parameters of facial and dental value are scarce. It is postulated that laypeople will vary in their subjective viewpoints, and this would be dependent upon the environment that they are exposed to. Hence, this study was done to determine the objective parameters used in daily orthodontic practice related to facial esthetics, as perceived by the laypeople in the selected district. The objective parameters used represented AP characteristics (overjet and ANB angle), vertical characteristics (SN-GoGn angle), and dental esthetics esthetic component of the index of orthodontic treatment need (AC/IOTN). This study examined and correlated the contribution of the objective measures representing AP and vertical characteristics, dental esthetics, or their combination that are used in daily orthodontic practice with subjective measures in the assessment of facial esthetics for the test group population.

**Materials and Methods**

Inclusion criteria for subjects for the collection of data are as follows:
- The age is between 10 and 25 years
- Had no dental or facial trauma
- Had no history of orthodontic treatment
- Had no congenital defects
- Not been wearing glasses
- The panel of laypeople should be from different professional backgrounds.

About 64 patients were randomly selected after stratification, from the records of the Department of Orthodontics of a Dental Hospital. Eight boys and eight girls each, in angles Class I; Class II Division I; Class II Division II; Class III malocclusions, were shortlisted. The objective parameters were obtained from the pretreatment records (dental casts, cephalograms, extraoral and intraoral color photographs) [Figures 1-3] of these patients. Subjective parameters: 64 laypeople (32 males and 32 females) were chosen from professional colleges in the area. Each subject was given a Performa having 64 patients’ names and a visual analog scale (VAS) (A VAS, operationally, a measurement instrument with horizontal line, which is 100 mm in length, anchored by 0 in beginning and 100 at the end representing least attractiveness and most attractiveness parameters marked, respectively. The subject marks on the line, the point that they feel represents their perception of the variable under consideration. The VAS score is then determined by measuring the length of the line marked, in millimeters, from the left-hand end of the line to the point that the subject had marked against each patient.

A slide show presenting the digital images in the (a) frontal view, (b) three-quarter smiling view, and (c) profile view of each patient was prepared. Each face was shown for 15 s [Figure 4].

**Objective parameters**

The following objective parameters were obtained from the records:
- Overjet was measured on the dental casts as the AP distance between the maxillary and mandibular central incisors at the most labial point of the most prominent incisor [Figure 1]
- ANB angle and SN-GoGn angle were measured on tracing of lateral head film [Figure 2]
- The horizontal sum obtained as the summation of the overjet in millimeters and ANB in degrees
- AC/IOTN was determined on intraoral pictures [Figure 5] by mutual agreement between two independent observers (as per the guidelines of Shaw WC).

After the collection of data on the varied objective and subjective criteria, the data were subjected to statistical analysis. The normality of the data was clarified by Kolmogorov–Smirnov Z test. Then, the data were analyzed by one-way analysis of variance (ANOVA) test to find out the significant difference between more than two groups followed by Tukeys multiple post hoc procedures for pairwise comparison. Further, the multiple linear regression was performed to see the influence of independent variables on the dependent variable. The statistical analysis was performed by using statistical software IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. The statistical significance for One way ANOVA was set at 5% level of significance (P < 0.05).

**Results**

The values and standard deviations of the various objective parameters obtained and segregated into angle’s classes [Table 1]. One-way ANOVA test done to compare
various classes with respect to the different objective parameters indicated that all the parameters, except the vertical parameter (SN-GoGn; \( P = 0.1758, (P > 0.05) \) not significant), showed a statistically significant variation between different classes. Overjet, ANB, IOTN, and horizontal sum were significantly correlated with \( P \) value of 0.0000, 0.0001, 0.0040, and 0.0008, respectively [Table 2]. It was deduced that the value of each parameter was significantly different from the same parameter in other class. The esthetic scores (VAS scores) given by male and female reviewing laypeople were compared [Table 3]. It was observed that the comparison of different classes with respect to VAS scores given by male and female laypeople was found to be nonsignificant. Multiple regression analysis of the subjective parameter, the VAS scores (dependent variable) with the objective parameters taken, indicated that though the overjet, horizontal sum, and AC (IOTN) negatively correlated with the objective parameters, only the AC (IOTN) showed a statistically significant negative correlation [Table 4]. A backward stepwise multiple regression analysis of VAS scores according to the total sample of laypersons showed a significant correlation between subjective VAS score with the AC (IOTN) [Table 5].

**Discussion**

The most commonly used parameter for AP characteristics is Angle classification, which is a rough estimate having four discrete classes.\(^7\) For proper orientation of the jaw, combination of ANB and overjet has been indicated.\(^5\) The effect of the vertical on facial attractiveness has been studied on constructed profiles or manipulated photographs.\(^6,8\) Most orthodontists use SN-GoGn angle for the evaluation of vertical dimensions in daily clinical practice, but the relation of this parameter to facial attractiveness has been debatable.\(^4\) The AC/IOTN have been widely used.\(^9\) Both orthodontists and laymen are well able to use VAS scores to judge facial esthetics from photographs in a more or less intuitive way.
way although facial esthetics seem to be subjective and not a well-defined variable.\cite{footnote} When the various classes of Angle's classification were compared to different objective parameters, all the parameters, except the vertical parameter SN-GoGn, showed significant variation between the different classes. These parameters were distinctly different despite overlapping ranges for different classes as indicated by the one-way ANOVA test done between the classes. However, no difference was found between two sexes of patients, when their objective parameters were compared. Kiekens et al. observed that the objective parameters used in his study showed

**Table 2: Comparison of classes with respect to different objective measurements by one-way ANOVA**

| Variable | Source of variation | Degrees of freedom | Sum of squares | Mean sum of squares | F     | P     | Significance |
|----------|---------------------|--------------------|---------------|---------------------|-------|-------|-------------|
| Over jet | Between classes     | 3                  | 488.9180      | 162.9727            | 13.6085| 0.0000| S           |
|          | Within classes      | 60                 | 718.5469      | 11.9758             |       |       |             |
|          | Total               | 63                 | 1207.4648     |                     |       |       |             |
| ANB      | Between classes     | 3                  | 371.0000      | 123.6667            | 8.4631| 0.0001| S           |
|          | Within classes      | 60                 | 876.7500      | 14.6125             |       |       |             |
|          | Total               | 63                 | 1247.7500     |                     |       |       |             |
| HS       | Between classes     | 3                  | 428.5430      | 142.8477            | 6.4127| 0.0008| S           |
|          | Within classes      | 60                 | 1336.5469     | 22.2758             |       |       |             |
|          | Total               | 63                 | 1765.0898     |                     |       |       |             |
| SN-GoGn  | Between classes     | 3                  | 185.7969      | 61.9323             | 1.7038| 0.1758| NS          |
|          | Within classes      | 60                 | 2180.9375     | 36.3490             |       |       |             |
|          | Total               | 63                 | 2366.7344     |                     |       |       |             |

NS: Not significant, S: Significant, IOTN: Index of orthodontic treatment need

**Table 3: Comparison of the different angle’s classes (I, II Division I, II Division II, III) with respect to visual analog scale scores given by male and female laypersons**

| Layperson | Source of variation | Degrees of freedom | Sum of squares | Mean sum of squares | F     | P     | Significant |
|-----------|---------------------|--------------------|---------------|---------------------|-------|-------|-------------|
| Male      | Between classes     | 3                  | 58.7604       | 19.5868             | 0.9313| 0.4313| NS          |
|           | Within classes      | 60                 | 1261.9652     | 21.0328             |       |       |             |
|           | Total               | 63                 | 1320.7256     |                     |       |       |             |
| Female    | Between classes     | 3                  | 41.2886       | 13.7629             | 0.9002| 0.4465| NS          |
|           | Within classes      | 60                 | 917.3193      | 15.2887             |       |       |             |
|           | Total               | 63                 | 958.6079      |                     |       |       |             |

NS: Not significant

**Table 4: Multiple regression analysis of visual analog scale scores according to the total laypersons (male and female laypersons) (dependent variable) with objective measurements (independent variables)**

| Input variables | Beta coefficient | SE of beta coefficient | Regression coefficient | SE of regression coefficient | t     | P level | Significance |
|-----------------|------------------|------------------------|------------------------|-----------------------------|-------|---------|-------------|
| Intercept       | 75.0207          | 6.0664                 | 75.0207                | 6.0664                      | 24.8146| 0.0000  | S           |
| Over jet        | -0.1014          | 0.4320                 | -0.1014                | 0.4320                      | -0.4529| 1.2803  | NS          |
| ANB             | 0.1304           | 0.2838                 | 0.1243                 | 0.2706                      | 0.9196| 1.2948  | NS          |
| Sn-GoGn         | 0.0228           | 0.2596                 | 0.0115                 | 0.1798                      | 0.1826| 1.5414  | NS          |
| IOTN            | -0.3454          | 0.2622                 | -0.6420                | 0.5142                      | -2.5563| 0.6742  | S           |
| HS              | -0.2827          | 0.4573                 | -0.2234                | 0.3667                      | -1.2385| 1.0812  | NS          |

R=0.4604, R²=0.0778, F (5, 58)=0.8539, P>0.05, NS, standard error of estimate: 6.8073. NS: Not significant, IOTN: Index of orthodontic treatment need, HS: Highly significant

**Table 5: Backward stepwise multiple regression analysis of visual analog scale scores according to the total sample of laypersons (male and female laypersons) (dependent variable) with index of orthodontic treatment need**

| Input variables | Beta coefficient | SE of beta coefficient | Regression coefficient | SE of regression coefficient | t     | P level | Significance |
|-----------------|------------------|------------------------|------------------------|-----------------------------|-------|---------|-------------|
| Intercept       | 37.9567          | 0.7828                 | 37.9567                | 0.7828                      | 48.4894| 0.0000  | S           |
| IOTN            | -0.2332          | 0.1235                 | -0.2439                | 0.1292                      | -1.8885| 0.0636  | S           |

R=0.2332, R²=0.05439, Adjusted R²=0.0391, F (1, 62)=3.5663 P<0.06384 SE of estimate: 4.4881, IOTN: Index of orthodontic treatment need, SE: Standard error, S: Significant
In this study, showed significant and negatively correlated and individually parameters taken, indicated that only the AC (IOTN) was the VAS scores (dependent variable) with the objective parameters, negatively. objective parameters, only the AC (IOTN) significantly correlated with the objective parameters, negatively. However, when the esthetic values given by males and female laypersons were compared with the objective measurements, the AC (IOTN) and the horizontal sum showed significant negative correlation with the objective parameters. The horizontal sum showed significant negative correlation with the objective measurements, the AC (IOTN) and the scores given by male and female laypersons were compared with the objective parameters. The horizontal sum, introduced by Kiekens et al., appeared to be a valuable indicator of facial esthetics and attractiveness. The highest grades on the scale were considered to be the most unattractive, whereas the lower scales were more attractive. The AC/IOTN, a measure of dental esthetics, appears to be the most vital contributor of facial esthetics and attractiveness. The AC/IOTN and horizontal sum increased the explained variance to 35. This increases the diagnostic value of the AC/IOTN and horizontal sum when used in combination in evaluating facial esthetics, but the remaining 65% of the variance is left unaccounted for by these parameters and could probably be attributed to other facial features such as the eyes, skin, and hair.

Conclusion

The abovementioned study revealed that objective measurement showed overlapping between different Angle classes, but the differences were statistically significant for wide overlapping ranges for different classes and none of them was decisive for Angle classification. In our study, however, the objective parameters were distinctly different between the classes but did not differ between the male and female subjects.

The comparison of different classes with respect to VAS scores given by male and female laypeople did not show significant differences, so it could be deduced that the laypeople were not appreciative of facial beauty with respect to different Angle classes. In this study, Class I and Class II/Division I malocclusions were rated lower than the Class II/Division II and Class III malocclusions as against the previous studies which rated Class II and Class III lower than Class I malocclusions. This could be interpreted that the laypeople of the area under study are more appreciative of a protrusive profile as against a straight or retrusive profile. The male laypeople gave higher esthetic scores than female laypeople showing that females were more critical in evaluating both male and female subjects than the males. However, this observation should be subjected to further research. When the esthetic scores given by male and female laypeople were compared with the objective parameters, the AC (IOTN) and the horizontal sum showed significant negative correlation with the subjective parameters. The horizontal sum, introduced by Kiekens et al., appeared to be a useful parameter to measure the horizontal discrepancy. It is related to the dentition (overjet) measured from the dental cast and to the skeletal parameter - ANB angle, measured on the lateral radiograph. However, when the esthetic values given by males and females separately were compared with the objective parameters, only the AC (IOTN) significantly correlated with the objective parameters, negatively. A multiple regression analysis of the subjective parameter, the VAS scores (dependent variable) with the objective parameters taken, indicated that only the AC (IOTN) was significant and negatively correlated and individually only female laypersons were negatively correlated and significant.
each Angle classes. Correlation between esthetic scores done by male and female laypersons together with objective measurements showed that only AC/IOTN was negatively correlated and a statistically significant parameter. The prognostic value of the AC/IOTN increased when used with the horizontal sum in evaluating facial esthetics. Thus, horizontal sum was found to be a reliable variable for AP characteristics of the patient.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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