Characterization of a posed smile and evaluation of facial attractiveness by panel perception and its correlation with hard and soft tissue

Smriti Malhotra, BDS, MDS
Maninder Singh Sidhu, BDS, MDS
Mona Prabhakar, BDS, MDS
Anuraj Singh Kochhar, BDS, MDS

Aim: To examine whether specific hard and soft tissue had any effect on smile characteristics and to ascertain the opinions of laypersons and clinicians in evaluating facial attractiveness among different occlusions. Method: Photographs of posed smiles, along with profiles and full faces, of 76 patients with different occlusions were captured, and a lateral cephalogram of each subject was traced. These photographs were judged by a panel of 10 clinicians and 10 laypersons on a 5-point visual analog scale. Quantitative measurements were carried out on the smile images for 14 smile characteristics. The effect of hard and soft tissue on these characteristics was also examined. Results: The upper vermilion lip thickness was affected by Pt.A-UI and E-line to upper lip, while the lower vermilion lip thickness was affected by lower anterior facial height. FMA had a significant positive effect on gingival display (P ≤ .05). This meant that an increase in FMA also caused the gingival display to increase. The nasolabial angle showed a significant positive effect on incisal display, while FMA showed a negative effect on intercanine width. Lower facial height and FMA had a significant negative effect on the smile index. A correlation was found between the judgments of clinicians and laypersons. Both judged Class I relationships to be the most attractive. Conclusion: FMA was found to have a positive effect on the amount of gingival display. It was also observed that patients with Class II Division 1 relationships had the thickest lips compared with patients having other types of occlusions. Class III patients exhibited no gingival display on smile. Patients with Class I showed the maximum smile width, while patients with Class III showed the least amount of buccal corridor. ORTHODONTICS (CHIC) 2012;13:34–45.

Key words: facial attractiveness, posed smile
A smile, defined as a facial expression characterized by upward curving of the corners of the mouth, is often used to indicate pleasure, amusement, or derision. Even without uttering a word, a smile can reveal affection, appreciation, and sympathy. There are two forms of smiles: the enjoyment or Duchenne smile and the posed or social smile. The posed smile is voluntary and not elicited by an emotion. In other words, it is reliably reproducible. This type of smile can be sustained as a static facial expression and does not appear strained. Posed smiles have therefore gained importance in orthodontic diagnosis and treatment planning. The unposed smile, on the other hand, is involuntary and induced by joy or mirth. It is a natural response that expresses authentic human emotion.

Smiles and facial attractiveness appear to be strongly connected. Modern society considers facial attractiveness to be an important physical attribute. We unconsciously tend to associate desirable personal qualities (such as intelligence) and social ability with attractive faces. In social situations, one’s attention is mainly directed toward the mouth and eyes of the speaker. As the mouth is the center of communication, the smile plays an important role in facial expression and appearance. However, it might be related to several factors such as ethnic group, age, sex, region, and professional background.

Orthodontic treatment aims to attain and preserve facial attractiveness with a well-balanced functional occlusion. Traditionally, orthodontic treatment has relied predominantly on dentoskeletal analysis, without taking any soft tissue features into account. However, soft tissue analysis, along with dentoskeletal factors, has become indispensable in orthodontic treatment planning.

Soft tissue can vary so greatly that the dentoskeletal pattern may be an inadequate guide to evaluate facial disharmony. Knowledge of soft tissue traits and their relationships with hard tissue and the smile can help determine a treatment plan designed to normalize a patient’s facial traits. Allowances can be made to maintain the variations in facial attractiveness while maintaining familial ethnic characteristics.

The objective of the study was to evaluate the different aspects of the smile by measuring different smile characteristics in patients with varying types of occlusions. It also aimed to correlate the effects of hard and soft tissue on smile characteristics.
Characterization of a posed smile and evaluation of facial attractiveness

METHODS

Seventy-six patients (38 males and 38 females) were selected from the Outpatient Department of Sri Govind Tricentenary Dental College, Hospital and Research Institute, Gurgaon, India. The subjects were divided into five groups: 30 patients with a Class I occlusion, 20 patients with a Class I relationship with mild crowding/spacing, 10 patients with Class II Division 1 occlusion, 10 patients with a Class II Division 2 relationship, and 6 patients with a Class III malocclusion. There were an equal number of males and females in each group. The number of patients in each group was based on the kind of malocclusion cases reporting to the department. A lateral cephalogram was taken of every patient, along with three photographs (full face, profile, and posed smile).

To be included in the study, patients had to be between the ages of 15 and 35 years. There had to be no history of any orthodontic treatment or maxillofacial surgery, a complete permanent dentition (except for third molars), and no missing or malformed teeth. Sex was not given preference.

A digital camera was used to take all the pictures. To standardize the technique, subjects were seated with their head in a natural head position. Each patient was asked to hold a metallic ruler, so that it was captured in the frame along with the oral aperture (Fig 1). The ruler was placed to avoid any measurement errors that might occur due to image magnification. A metallic ruler was chosen with a division of 0.5 mm to enable ease of measurement. The digital camera was mounted over the camera support stand and set at a fixed distance from the subject in the record room. The lens was positioned parallel to the true perpendicular of the face in natural head position. For the smiling photographs, the camera was raised to the level of the patient's lower facial third.

The photography and tracing of the cephalograms were all performed by a single examiner.

Each photographic triplet (full face, profile, and posed smile) was identified by a patient number and imported into a Microsoft PowerPoint presentation. The identification number appeared on each slide. The photographs were divided into two groups (males and females; each \( n = 38 \)). The evaluations were made by 10 clinicians and 10 laypersons (all of Indian origin). For the current study, a clinician was defined as a person who had completed training in dentistry, and a layperson was defined as someone with no formal education in dentistry or dental hygiene and had a good socioeconomic status (well-educated).

Fig 1 Photographs of posed smiles with metallic rulers.
Each evaluator was given a Performa to complete that contained a visual analog scale (VAS)—a horizontal line, 100 mm in length, anchored by word descriptors. The five factors of attractiveness were evaluated with the help of a 5-point Likert scale (from 1 being very unattractive to 5 being very attractive). The Likert scale has been used in the evaluation of dentofacial and facial esthetics to reduce the variation of values seen in VAS scale. It deliberately guides the evaluator to lean toward a point to reach a decision.

The panelists were given a chart with a VAS to rate the overall appearance of the face. The VAS was briefly explained to the panel members, with illustrations. For the evaluation, each photographic triplet was projected for 25 seconds, and the ratings were tabulated.

After determining which face was more attractive, quantitative measurements were made from the images of the posed smile of all 76 individuals.

**Smile analysis**

Digimizer Image Analysis 3.7.0.0 (Medcalc Software) was used to analyze the smiles. With the help of the Unit Line tool in this software and the metallic ruler in the photograph, actual life-sized measurements could be calibrated by the computer. Since the photograph was taken on a 1:1 ratio, there was no length-width discrepancy.

The following smile attributes were measured in millimeters (Fig 2):

- **Right and left buccal corridors**: the horizontal distance from the distal aspect of the canine to the respective outer commissure
- **Right and left posterior corridors**: the horizontal distance from the distal aspect of the most posterior tooth visible on smile to the respective outer commissure
- **Upper vermilion lip thickness**: the vertical distance from the most superior peak of the lip to the most inferior portion of the tubercle of the upper lip
Characterization of a posed smile and evaluation of facial attractiveness

- **Lower vermilion lip thickness**: the vertical distance from the deepest midline point on the superior margin of the lower lip to the most inferior portion of the lower lip
- **Maxillary intercanine width**: the distance from the distal aspect of the right canine to the distal aspect of the left canine
- **Width of all visible maxillary teeth**: the distance from the distal aspect of the most posterior visible tooth on the right to the most posterior visible tooth on the left side of the maxilla
- **Amount of gingival display**: the distance from the cervical margin of the maxillary central incisor to the most inferior point of the upper lip
- **Amount of incisal display**: the distance from the cervical margin of the maxillary central incisor to the most inferior point of the upper lip
- **Smile width**: the distance from outer commissure to outer commissure on smile
- **Interlabial gap**: the distance from most inferior margin of the upper lip to the most inferior margin of the lower lip on smile
- **Smile index**: smile width/interlabial gap
- **Smile arc (consonant, flat, reverse)**: the curvature of the maxillary incisal edges and canines relative to the curvature of the lower lip on smile
- **Buccal corridor ratio**: intercanine width/smile width
- **Posterior corridor ratio**: visible maxillary teeth width/smile width

**Lateral cephalogram analysis**

For the correlation of the cephalometric analysis with the smile analysis, six angular measurements and seven linear measurements in hard tissue and four angular measurements and six linear measurements in soft tissue were measured on the lateral cephalogram. They were hand traced with no attempt to standardize the magnification, because all cephalograms were taken on the same machine.
The 14 hard tissue measurements identified were SNA, SNB, UI-SN, facial angle, FMPA, IMPA, UI-LI, Point A–Na perp, Pog-Na perp, UI-APog, N-ANS, ANS-Me, N-Me, and Na perp-UI. The 10 soft tissue measurements were the nasolabial angle, soft tissue facial angle, Z angle, H angle, E-line to upper and lower lip, S-line to upper and lower lip, maxillary sulcus contour, and upper lip strain (Figs 3 and 4).

Statistical analysis
Descriptive statistical analysis (means and standard deviation [SD]) was carried out for all groups in this study. Regression analysis was performed for hard and soft tissue and smile characteristics. The chi-square test was done to determine the type of smile arc in males and females. The paired t test was performed for the ratings of facial attractiveness given by dental specialists and laypersons to determine which occlusion was most attractive.

RESULTS
Descriptive statistics were calculated for all cephalometric and smile characteristics. The measurements were statistically analyzed by calculating their means and SDs (Table 1). It was observed that the upper and lower lip thickness was greater in Class II Division 1 occlusions. Gingival display was at a maximum in Class II Division 1 and least in Class III relationships, whereas smile width and smile index was highest in Class I malocclusions.

Regression analysis was done for 14 smile characteristics to see the relationship of specific hard and soft tissue parameters (Table 2) that supposedly affect the particular smile characteristic (Table 3). Among the specific hard tissue parameters selected pertaining to upper lip thickness, only Point A–UI showed a positive significant effect (P < .05). Among the soft tissue, E-line to upper
Characterization of a posed smile and evaluation of facial attractiveness

The lip had a significant positive effect ($P < .05$). In case of the lower vermilion lip thickness, lower facial height (ANS-Me) showed a significant positive effect ($P < .05$). The hard tissue parameter that had a significant positive effect on gingival display was FMA ($P < .05$). This meant that an increase in FMA caused the gingival display to increase, as well. Among the soft tissue effect on incisal display.
display, the nasolabial angle showed a significant positive effect ($P < .05$). Among the hard tissues that were analyzed pertaining to the intercanine width, FMA had a negative significant effect ($P < .05$). Among the hard tissues that were analyzed pertaining to the right buccal corridor, N-Me showed a positive significant effect ($P < .05$). Anterior facial height had a positive significant effect ($P < .05$), and lower facial height (ANS-Me) showed a negative significant effect ($P < .05$) on the left buccal corridor. Overjet showed a significant negative effect ($P < .05$) on the posterior corridor ratio. From the hard tissue, lower facial height (ANS-Me) and FMA showed a negative significant effect ($P < .05$) on smile index, while the rest of the soft tissues did not show any significant effect on smile index.

The chi-square test was performed to determine smile arc between males and females (Table 4). The chi-square value was 12.25 ($P = .002$). The result showed a significant difference in smile arc among sex—i.e., males had flatter smiles, whereas females had more consonant smiles. Table 5 and Fig 5 show the mean and SD of each occlusion as judged by clinicians and laypersons. The paired $t$ test was done, which showed that Class I ideal ($P < .05$) was preferred by the clinicians as well as the laypersons in judging facial attractiveness. Hence, according to both the clinicians and laypersons, Class I ideal had the highest mean score followed by Class I mild crowding and then Class III. Class II Division 1 received the lowest score, meaning that it was the least preferred of all malocclusions.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Showing significant factors affecting smile characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smile characteristic</td>
<td>Significant parameters</td>
</tr>
<tr>
<td>Upper vermilion lip thickness</td>
<td>Hard tissue</td>
</tr>
<tr>
<td></td>
<td>Soft tissue</td>
</tr>
<tr>
<td>Lower vermilion lip thickness</td>
<td>Hard tissue</td>
</tr>
<tr>
<td>Gingival display</td>
<td>Hard tissue</td>
</tr>
<tr>
<td>Incisal display</td>
<td>Soft tissue</td>
</tr>
<tr>
<td>Intercanine width</td>
<td>Hard tissue</td>
</tr>
<tr>
<td>Buccal corridor (right)</td>
<td>Hard tissue</td>
</tr>
<tr>
<td>Buccal corridor (left)</td>
<td>Hard tissue</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior corridor ratio</td>
<td>Hard tissue</td>
</tr>
<tr>
<td>Smile index</td>
<td>Hard tissue</td>
</tr>
<tr>
<td></td>
<td>Hard tissue</td>
</tr>
</tbody>
</table>

* $P < .05$, statistically significant.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Chi-square test for comparing smile arc between sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smile arc</td>
<td>Consonant</td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
</tr>
<tr>
<td>Female</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
</tr>
</tbody>
</table>
DISCUSSION

Quantitative measurements included upper and lower vermilion lip thickness, maxillary intercanine width, width of all visible maxillary teeth, right and left buccal corridors, right and left posterior corridors, smile width, smile index and smile arc. In contrast to this study, several cephalometric studies have been done5–8 taking these measurements into consideration.

Structural correlations during a posed smile

FMA was found to have a significant effect on gingival display, and the nasolabial angle showed a significant effect on incisal display. McNamara et al4 found no correlation between gingival display and smile esthetics.

Table 5  Means and SD of each malocclusion as judged by clinicians and laypersons

<table>
<thead>
<tr>
<th>Occlusion</th>
<th>n</th>
<th>Clinicians</th>
<th>Laypersons</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I ideal</td>
<td>30</td>
<td>3.05 ± 0.45</td>
<td>2.66 ± 0.53</td>
<td>4.31</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Class I mild crowding</td>
<td>20</td>
<td>2.95 ± 0.77</td>
<td>2.38 ± 0.47</td>
<td>4.595</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Class II Division 1</td>
<td>10</td>
<td>2.4214 ± 0.41</td>
<td>2.06 ± 0.37</td>
<td>2.663</td>
<td>.02</td>
</tr>
<tr>
<td>Class II Division 2</td>
<td>10</td>
<td>2.6625 ± 0.51</td>
<td>2.21 ± 0.55</td>
<td>5.775</td>
<td>.001</td>
</tr>
<tr>
<td>Class III</td>
<td>6</td>
<td>2.8167 ± 0.59</td>
<td>2.23 ± 0.44</td>
<td>2.655</td>
<td>.045</td>
</tr>
</tbody>
</table>

SD, standard deviation. *P < .05, statistically significant.

Fig 5  The means and SD of each malocclusion as judged clinicians and laypersons.
In our study, N-Me showed a significant positive effect on the right buccal corridor. Upper anterior facial height (N-Me) also had a significant positive effect, while lower facial height (ANS-Me) had a significant negative effect on left buccal corridor. The posterior corridor ratio was found to be affected by overjet. Lower facial height (ANS-Me) and FMA showed a significant negative effect on smile index. Yang et al\textsuperscript{9} found that among the lateral cephalometric and dental cast variables, FMA, lower anterior facial height, U1 exposure, U1 to facial plane, L1 to mandibular plane, L1-NB, Sn to Me', Sn to stomodium superius (stms), stms to Me', and interpremolar width were significantly negatively correlated with buccal corridor area ratio.

The studies described have possibly been the only ones to correlate hard tissue with smile characteristics. However, in this study, we observed the effects of hard and soft tissue on various smile characteristics.

Smile arc
Sarver\textsuperscript{2} stated that the maxillary incisal edge curvature should ideally be parallel to the curvature of the lower lip for good smile esthetics. This parallel relationship was referred to as a “consonant smile.” In the present study, 30 females had consonant smiles, compared with 14 consonant smiles and 22 flat smiles in males.

Overall, more males had a flat smile, whereas more females had consonant smiles. This finding is supported by the results of Maulik and Nanda\textsuperscript{10} and Krishnan et al\textsuperscript{11} who found that females showed higher anterior and posterior smile heights and more parallel smile arc.

Esthetic correlations
In this study, there was agreement in the opinions of dental specialists and laypersons in judging facial attractiveness. Both groups agreed that Class I ideal occlusion was the most attractive and that Class II Division 1 was the least attractive. Previous studies have disagreed on this topic. Tedesco et al\textsuperscript{12} found that laypersons were more sensitive to dentofacial impairments than those with orthodontic training whereas Johnson et al\textsuperscript{13} and Kokich et al\textsuperscript{14} found that clinicians were more sensitive to minor dental disharmonies.

The high correlation between clinicians and laypersons also goes against most previous research.\textsuperscript{15-24} Soh et al\textsuperscript{25} found a difference in the perceptions of dental esthetics of Asian orthodontists and laypersons. Orthodontists perceived Class III occlusions with reverse overjet to be less esthetically pleasing, which was similar to the study by Isiksal\textsuperscript{24} who concluded that orthodontists on the average were more critical of dental esthetics than laypeople in detecting minor discrepancies.

The findings of the present study corroborate with studies done by McNamara et al,\textsuperscript{4} Flores-Mir et al,\textsuperscript{26} Hall et al,\textsuperscript{27} Peerlings et al,\textsuperscript{28} and Krishnan et al.\textsuperscript{11} McNamara et al\textsuperscript{4} concluded that their findings may be a result of specialists considering their past experiences in treating various occlusions when rating smile esthetics.

In this study, we used a close-up view of the smile rather than a full smiling face to see how a smile by itself would have an effect on the overall facial attractiveness. This was similar to the study done by Flores-Mir et al,\textsuperscript{26} who concluded that it was particularly relevant that laypeople appeared to be more aware of dental esthetics when represented as a close-up view rather than a full smiling face.

Judges used a 5-point visual grading scale (1 being very unattractive and 5 being very attractive) to rate the images as it provided a simple and rapid method for them to rate attractiveness. This was similar to the studies done by Isiksal et al,\textsuperscript{24} Gul-e-Erum and Fida,\textsuperscript{29} and Ong et al.\textsuperscript{30}
The present study was conducted to judge facial attractiveness by the opinions of dental specialists and laypersons of patients with different types of occlusions. McNamara et al.4 also included patients who had no history of orthodontic treatment, but did not consider occlusion a separate criteria. In another study by Kiekens et al.,31 a panel of 78 laymen evaluated facial esthetics of 32 boys and 32 girls stratified over the four Angle Classes. A limitation of this study was that we randomly selected the subjects as per the availability in the department. However, the power of the test to determine the number of sample would have been a more appropriate way of conducting the study. Further research needs to be conducted to determine the strength of the sample.

CONCLUSION

The results of this study pointed to the following conclusions:

1. The upper vermilion lip thickness was affected by Point A-UI and E-line to upper lip. The lower vermilion lip thickness was affected by lower anterior facial height.
2. FMA had a significant effect on gingival display. The nasolabial angle showed an effect on incisal display.
3. Intercanine width was found to be significantly affected by FMA.
4. The right buccal corridor was affected by N-Me, the left buccal corridor was affected by N-Me and ANS-Me, and the posterior corridor was affected by overjet.
5. Lower facial height and FMA had a significant effect on smile index.
6. Patients with Class II Division 1 occlusions have the thickest lips compared with patients having other types of malocclusions. Class III patients exhibited no gingival display on smile. Patients with Class I showed the maximum smile width, while patients with Class III showed least amount of buccal corridor.
7. In terms of the smile arc, males were found to have flat and reverse smile arcs while females showed consonant smiles.
8. There was agreement between the perceptions of clinicians and laypersons in evaluating facial attractiveness. Both the specialists and laypersons found Class I ideal to be the most attractive and Class II division 1 subjects to be the least attractive.

REFERENCES


