Perception of Esthetic Impact of Smile Line in Complete Denture Wearers by Different Age Groups

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Abstract

Purpose: To evaluate esthetic perceptions based on tooth exposure when smiling of patients wearing complete dentures by evaluators in different age groups.

Materials and Methods: Alterations were made to a front view photograph of a smiling patient wearing complete maxillary and mandibular dentures. Alterations in the smile line were simulated to increase or decrease tooth exposure (increments of 0.5 mm). For this purpose, image manipulation software was used. After manipulation, images were printed on photo paper, attached to a questionnaire, and distributed to individuals in three age groups (n = 150). To evaluate the esthetic perception for each image, a visual analog scale was used, with 0 representing least attractive, 5 representing attractive, and 10 representing very attractive. Differences between examiners were analyzed using the Mann-Whitney test. All statistical analyses were performed with a degree of confidence of 95%.

Results: Two evaluators did not observe any differences between images. The images given the best and worst scores were E and O (alterations of 2 and 7 mm), respectively, in the 15- to 19-year-old group, B and O (alterations of 0.5 and 7 mm), respectively, in the 35- to 44-year-old group, and A and M (no alteration and 6 mm alteration), respectively, in the 65- to 74-year-old group. When the images were presented together (images 1 and 2), the unaltered image was selected by individuals of different age groups as the best, and the image with a change of 7 mm was selected as the worst.

Conclusion: In this study, complete dental prostheses with smile lines that coincided with the cervical margins of the anterior teeth were the most acceptable. Less exposure of the maxillary teeth when smiling corresponded with decreased attractiveness.

An attractive smile has been considered to be an important component of facial harmony.1,2 A pleasing appearance has been considered a factor of great relevance in social interaction, and evidence has suggested that an attractive smile plays a significant role in decisions made by the public.3

The esthetic appearance of a smile has been shown to be affected by, among other factors, the position of the lips and their curvature and relationship with the maxillary anterior teeth.3 In the analysis of the smile, this parameter, also known as the smile line or tooth exposure when smiling, is calculated as the difference between the height of the lip line and the tooth exposure.4,5

The goal of treatment with complete dentures has been described as the achievement of a smile that is esthetically and functionally as close as possible to the smile obtained with natural teeth.8 Therefore, when planning a complete denture, a careful and detailed analysis must be made of all the anatomic and prosthetic components to achieve an esthetically and functionally ideal smile.8

Facial beauty has been reported to be a subjective concept; thus, the precise diagnosis and consequent formulation of an optimal treatment plan involves a high degree of difficulty and complexity.9-11 The mouth may be considered the most dynamic part of the face, and the placement of a denture may result in pleasant or unpleasant facial features.12 The denture may occupy much or little vertical height in the smile line.13 Therefore, adequate planning according to the patient’s age and gender is necessary.

In this context, this study aimed to evaluate the perception of the esthetic appearance of smiles in images with different
Perception of Esthetic Impact on Smile Line in Complete Dentures

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Figure 1 Images evaluated in this study.

degrees of maxillary anterior tooth exposure using complete dental prostheses by systematically altering the photographs.

**Materials and methods**

The study was conducted with approval from the Research Ethics Committee. This study was conducted using a front view intraoral photograph of a 65-year-old patient with complete maxillary and mandibular dentures. The photograph, in which the teeth, gingiva, and lips were exposed, was obtained with a digital camera (Canon Rebel XTI; Canon, Tokyo, Japan) mounted on a tripod with lighting control and a fixed focal length of 50 cm.

Once the original photograph was obtained, the images were manipulated using a software program (Adobe Photoshop CS3; Adobe Systems Inc., San Francisco, CA). Changes were made only in the maxillary denture; the same mandibular position was maintained. With the intention of simulating alterations in the smile line of the teeth in the maxillary denture, the initial image was digitally manipulated to simulate the progressive upward and downward displacement of the maxillary teeth. Fifteen images were thus obtained, including the original. The manipulated images underwent progressive alterations of 0.5 mm (Fig 1).

After the images were obtained, they were randomly numbered and printed all together on photo paper. On another sheet, the order and numbering of these images were randomly rearranged. Upon being shown these images, the evaluators were asked to state whether they were able to differentiate the images and to select which images they thought were the most and least attractive. The second sheet, with all the printed images in a different order, served to verify the reliability of the responses obtained using the first sheet.

Finally, the 15 images were printed individually and were randomly presented to the evaluators along with an attached visual analog scale (VAS). This stage enabled the evaluators to attribute scores to the esthetic appearance of each particular image. On this scale, the score 0 corresponded to a minimally attractive image, 5 to an attractive image, and 10 to a very attractive image. The evaluators had a maximum of 60 seconds to analyze each image.

The evaluations were performed by 150 laypersons from three population groups, individuals aged 15 to 19 years, 35 to 44 years, or 65 to 74 years, as recommended by the WHO/FDI. Before the study began, a pilot study was conducted to verify the sample size required. The sample size calculation was performed using nQueryAdviser (v.6.01; Solution Statistics, York, Ireland). Based on a 5% ($\alpha = 0.05$) significance level, the sample size was calculated to achieve a statistical power of 80%. The sample size calculation revealed that 40 to 120 individuals would be needed for each group. In this study, the evaluations were conducted with 50 evaluators in each age group.

Included individuals were healthy and were not missing any of their permanent teeth. Evaluators were excluded from the study if they had any visual deficiencies or had difficulty in understanding and completing the questionnaires.

The frequencies of replies provided by the participants in each age group (15 to 19, 35 to 44, and 65 to 74 years) were compared using the chi-square test. In cases in which the expected frequency was less than five ($n < 5$), Fisher’s exact test was used. The point scores awarded to each photograph were compared using the Kruskal-Wallis test, and comparisons between pairs were performed using the Mann-Whitney test. The mean score awarded to each photograph by each group was calculated, and Spearman correlation coefficients were determined to evaluate the similarity between perceptions based on age group. The level of significance was set at 5% ($\alpha = 0.05$). The data were tabulated and analyzed using BioEstat (v.5.0; Belém-PA, Brazil).

**Results**

Of the 150 participants, 68% were women, but the sex distribution differed between the age groups, with men accounting for only 10% of the participants in the 65- to 74-year-old group (Table 1). Table 2 presents the research participants’ perceptions of the differences and their preferences recorded for images 1 and 2. Among the participants who noted differences
between the photographs, there was a significant difference among the groups in terms of the least preferred image but not the most preferred image.

### Table 1: Demographic data of study participants per group

<table>
<thead>
<tr>
<th>Features</th>
<th>Age group (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 to 19 (n = 50)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21 (42.0%)</td>
</tr>
<tr>
<td>Female</td>
<td>29 (58.0%)</td>
</tr>
</tbody>
</table>

The mean scores awarded to each photograph are shown in Table 3. Image O (alteration of 7 mm) was awarded the worst score by individuals in the 15 to 19 and 35 to 44 age groups; however, individuals in the age range of 65 to 74 years attributed the worst score to image M (alteration of 6 mm). Only the scores awarded to photographs E and O were significantly different between the age groups. The correlations between the scores given by the three age groups were significant and strong (r > 0.9).

### Discussion

The three main determinants of the acceptability of a prosthetic treatment are comfort, function, and esthetics. Among these

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*Answered only by individuals who perceived differences between the images.*

*Chi-square test.*

*Exact Fisher test.*

n = number of participants.
The smile line is defined as the line between the curvature of the maxillary anterior teeth and the curvature of the top edge of the bottom lip.\textsuperscript{16} Some authors define the smile line as the “arch of the smile,” emphasizing that the ideal shape of the incisal edges of the maxillary anterior teeth creates a convex arch.\textsuperscript{17} Reestablishing the patient’s ideal smile line is one of the goals of any dental treatment, whether it is achieved using orthognathic surgical procedures or restorative procedures, as is the case with prosthetic rehabilitation in edentulous patients. Various studies\textsuperscript{9,11,18,19} have evaluated the esthetic preferences related to the smile line in orthodontic and/or surgical patients. Until now, however, there have been no published scientific studies evaluating this esthetic component in patients who wear complete dentures. Based on this premise, this study aimed to evaluate the perception of the esthetic appearance of the smile in cases of different degrees of tooth exposure in patients wearing complete dental prostheses.

In the present study, an original photograph was manipulated with the aid of a software program, Adobe Photoshop CS3. Various published studies have used this methodology.\textsuperscript{6,7} This method makes it possible to standardize the image and change only the property one wishes to evaluate. Another potential method involves the use of various patients with different smile lines; however, this approach may make it difficult to make comparisons. To verify that the evaluators were able to perceive the differences between the images, all the images were presented simultaneously, and then the evaluators were asked whether they observed differences between the images. The results obtained for the first image, in which all the photographs were presented together, suggested that almost all the individuals, irrespective of age group, perceived differences between the images when they were able to compare the photographs directly. In this first case, they were also asked to select which images they considered the most and least attractive. The responses were significantly different among the groups with respect to the least-preferred image but not regarding the most preferred image. The original image (A, no alteration, 0 mm) was the most accepted image in all the groups. That is, 24.5\% of the 15- to 19-year-old group, 42.9\% of the 35- to 44-year-old group, and 30.0\% of the 65- to 74-year-old group considered the best image to be the one in which the original esthetic and functional profile was respected. Regarding the least attractive image, there was perfect agreement in the two younger groups: 34.7\% of these individuals chose the image with 7 mm of tooth exposure (displacement of the smile line). This image or the image with a 5 mm displacement was chosen as least attractive by 14\% of the individuals in the 65 to 74 age group.

When the image order was randomized, the original image (O, complete maxillary tooth exposure) was preferred by 27.7\% of the 15- to 19-year-old group, 34\% of the 35- to 44-year-old group and 14\% of the 65- to 74-year-old group, thus constituting a consensus opinion. With regard to the least attractive image, agreement was once again established. For 31.9\% of the individuals between 15 and 19 years old, 32\% of those between 35 and 44 years old, and 18\% of those 65 years of age or older, the image with a 7 mm displacement of the smile line was the least attractive.

These results corroborate those of other studies, which affirm that certain factors, such as age, influence the perception of esthetics of the smile.\textsuperscript{9,17,20,21} In this study, there was agreement in the images chosen as the most and least attractive. Nevertheless, there was a significant difference among the age groups in the percentage of individuals who chose each image.

In the second part of the study, the 14 individually printed images were evaluated for attractiveness with the aid of a VAS. This method consists of an absolute scoring scale from 0 to 10, in which 0 represents “hardly attractive,” 5 represents “attractive,” and 10 represents “very attractive.” The VAS analyses indicated that there were differences in the esthetic evaluations made by the different age groups. The images with displacements of 2 or 0.5 mm and the original image were scored as the most attractive by the 15- to 19-year-old, 35- to 44-year-old, and 65- to 74-year-old groups, respectively. All the groups were capable of defining the most and least attractive photographs. There was a strong positive correlation between the three age groups, suggesting agreement between the scores and the image preferences.

Notably, 90\% of the evaluators in the 65- to 74-year-old group were women. Women pay more attention to detail when making evaluations related to the esthetic appearance of teeth, and this phenomenon may have caused this group to rank the unaltered image as the best.\textsuperscript{22,23} A limitation of this study was the fact that only exhibition of the incisors of the maxillary anterior teeth was diminished. In addition, the gingival margins of the maxillary anterior teeth and exposure of the mandibular teeth were not altered. It is worth emphasizing the importance of these alterations in future

### Table 3

Mean scores (standard deviation) attributed to photographs by the study participants, according to age group

<table>
<thead>
<tr>
<th>Photograph</th>
<th>15 to 19</th>
<th>35 to 44</th>
<th>65 to 74</th>
<th>p-value(^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image A (unchanged)</td>
<td>6.74 (2.2)</td>
<td>7.13 (2.1)</td>
<td>6.75 (3.1)</td>
<td>0.679</td>
</tr>
<tr>
<td>B (0.5 mm)</td>
<td>6.60 (1.7)</td>
<td>7.23 (2.0)</td>
<td>5.83 (3.0)</td>
<td>0.054</td>
</tr>
<tr>
<td>C (1.0 mm)</td>
<td>6.31 (1.8)</td>
<td>6.84 (1.8)</td>
<td>6.16 (2.7)</td>
<td>0.355</td>
</tr>
<tr>
<td>D (1.5 mm)</td>
<td>6.93 (1.9)</td>
<td>6.67 (2.0)</td>
<td>6.26 (2.4)</td>
<td>0.499</td>
</tr>
<tr>
<td>E (2.0 mm)</td>
<td>7.05 (1.6)</td>
<td>6.53 (2.0)(^a)</td>
<td>5.79 (2.4)(^b)</td>
<td>0.030</td>
</tr>
<tr>
<td>F (2.5 mm)</td>
<td>6.33 (2.2)</td>
<td>6.14 (2.0)</td>
<td>5.74 (2.6)</td>
<td>0.558</td>
</tr>
<tr>
<td>G (3.0 mm)</td>
<td>6.02 (1.9)</td>
<td>5.77 (1.8)</td>
<td>5.74 (2.8)</td>
<td>0.845</td>
</tr>
<tr>
<td>H (3.5 mm)</td>
<td>5.77 (2.0)</td>
<td>5.60 (1.8)</td>
<td>5.69 (2.5)</td>
<td>0.889</td>
</tr>
<tr>
<td>I (4.0 mm)</td>
<td>5.48 (2.4)</td>
<td>5.13 (2.0)</td>
<td>5.30 (2.6)</td>
<td>0.705</td>
</tr>
<tr>
<td>J (4.5 mm)</td>
<td>5.50 (2.9)</td>
<td>4.88 (2.2)</td>
<td>5.22 (2.6)</td>
<td>0.548</td>
</tr>
<tr>
<td>K (5.0 mm)</td>
<td>5.28 (2.8)</td>
<td>4.44 (1.9)</td>
<td>5.13 (2.7)</td>
<td>0.271</td>
</tr>
<tr>
<td>L (5.5 mm)</td>
<td>4.47 (2.3)</td>
<td>4.09 (2.0)</td>
<td>4.56 (2.8)</td>
<td>0.585</td>
</tr>
<tr>
<td>M (6.0 mm)</td>
<td>4.72 (2.4)</td>
<td>3.88 (2.2)</td>
<td>4.39 (2.7)</td>
<td>0.155</td>
</tr>
<tr>
<td>N (6.5 mm)</td>
<td>3.94 (2.4)</td>
<td>3.64 (2.3)</td>
<td>4.44 (2.8)</td>
<td>0.292</td>
</tr>
<tr>
<td>O (7.0 mm)</td>
<td>3.44 (2.7)(^a)</td>
<td>3.26 (2.6)(^a)</td>
<td>4.50 (2.6)(^b)</td>
<td>0.026</td>
</tr>
</tbody>
</table>

\(^*\)The scores of points were compared by means of the Kruskal-Wallis test.
\(^a\)Values with different superscript letters are significantly different (Mann-Whitney test).
studies, because with these images, the visualization would be closer to reality.

One of the effects of aging on an individual’s face is reduced exposure of the teeth and smile line. To rehabilitate an adult individual with the smile line of a younger individual, or vice versa, may introduce an esthetic conflict that is easily perceptible by any layperson. The results obtained in the present study revealed the need to respect the esthetic characteristics appropriate for the patient’s age, thereby preventing negative esthetic effects.

Conclusion

This study provided the following conclusions:

1. Complete dental prostheses that present a smile line coinciding with the cervical lines of the teeth were the most acceptable.
2. Less exposure of the maxillary teeth corresponded with reduced attractiveness.

References