ORIGINAL ARTICLE

Impact of dental asymmetries on the perception of smile esthetics

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Introduction: The purpose of this study was to evaluate the impact of anterior tooth asymmetries on the perception of smile esthetics. **Methods:** Three pleasant female smiles were digitally altered to simulate several degrees of asymmetry of the gingival margin of a maxillary central incisor, wear of a maxillary canine cusp, and a dental midline shift. Three groups of 50 raters—laypersons, orthodontists, and prosthodontists—evaluated the original and the altered images and used a visual analog scale to score smile esthetics. **Results:** The threshold of the orthodontists and the prosthodontists for asymmetry of the gingival margin of a maxillary central incisor was 0.5 mm; the threshold for laypersons, who were less perceptive, was 2.0 mm. Wear of a maxillary canine cusp had no esthetic impact for any group of raters. Midline shifts became perceptible when equal to or greater than 1.0 mm for orthodontists and 3.0 mm for prosthodontists; laypersons saw no alteration. **Conclusions:** Laypersons, orthodontists, and prosthodontists have different perceptions of attractiveness when evaluating gingival margin height of a maxillary central incisor and a dental midline shift. These findings might help dental specialists to consider the patient's esthetic expectations when planning treatment. (Am J Orthod Dentofacial Orthop 2007;132:748-53)

Many esthetic concepts about the face and the smile are based on authors' opinions[1-6] rather than on sound scientific methods. This might be explained by the difficulty to qualify and quantify beauty and the close association between esthetics and the fine arts, which questions the validity of measuring beauty. However, the measurement of what is beautiful or the perception of beauty in dentistry is fundamental for providing scientific data that can guide diagnosis and treatment planning.

Physical attractiveness and social interaction are complex issues, and the role of the dentist or the orthodontist is to help patients to make decisions based on treatment needs.[7] The patient's self-image plays an essential role in clinical treatment decisions and in the dentist's esthetic judgment.[7,8] Also, a patient's anxiety about malocclusion is affected not only by his or her own perceptions, but also by the reactions of other people. Therefore, what is beautiful and attractive for the orthodontist might not be what the patient understands as a beautiful, attractive, and satisfactory clinical result.

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Several studies about esthetic perceptions found that dentists, particularly orthodontists, are less tolerant than the general public for some dental conditions.[9-13] Some dentists might, therefore, overestimate the need for orthodontic treatment.[9]

Although some studies suggest that repetitive visual training is all that is necessary to prepare dental specialists to understand esthetics,[3,6] esthetic problems should be the focus of methodologically sound studies. Several authors evaluated the esthetic perception of various malocclusions,[9,13-18] but little information is available about the perception of the effect of dental asymmetries on smile esthetics. Moreover, orthodontists often treat patients whose dental morphology and periodontal health are not ideal; adult patients usually have worn teeth, dental midline shifts, unequal gingival margins, and other problems that can affect dental esthetics after the removal of the orthodontic appliances.[19]

The purpose of this study was to evaluate the perceptions of laypersons, orthodontists, and prosthodontists on the impact of anterior tooth asymmetry on smile esthetics.

MATERIAL AND METHODS

This study was approved by the Internal Review Board of the University of Goiás.

Three pleasant smiles of young white women were digitally altered by using Photo-Paint software (version 10.0; Corel, Ottawa, Canada) and a personal computer.

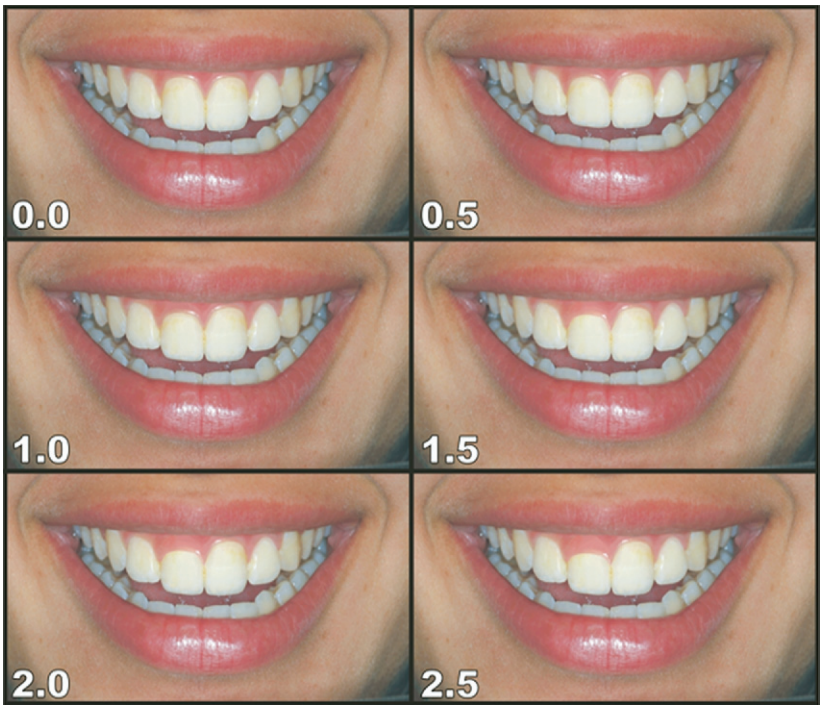

Fig 1. Shortening of gingival margin of maxillary right central incisor. Numbers in each panel indicate the amount of shortening of the gingival margin in milimeters.

The changes made to the original images were gingival margin height of the maxillary central incisor,[20-22] wear of the maxillary canine cusp,[19,20,23] and a midline shift. Several studies suggest various treatments for gingival asymmetries and dental wear, but little was found about the measurement of the esthetic perception of these changes. A midline shift was included in the study because of its clinical importance to orthodontists.

To standardize size and resolution changes, a millimeter ruler was placed away from the field to be evaluated. After the changes were made, the nose, the chin, and the ruler were erased to reduce the number of variables on the images. In the pictures with dental midline shifts, however, part of the nose was kept to help evaluation of the facial midline.

Four or 5 progressive deviations from the original photographs were made for each characteristic under study; this generated 13 digitally altered photographs. Together with the 3 original images, 16 photographs were evaluated (Figs 1-3).

The length of the clinical crown of the maxillary right central incisor was shortened in 0.5-mm increments by changing the free gingival margin. The changes are shown in Figure 1.

The maxillary left canine underwent progressive cusp wear in 0.5-mm increments. The changes made to the original photographs are shown in Figure 2.

The maxillary dental midline was shifted toward the patient's right in 0.5-mm increments, and the mandibular dental midline was shifted to the patient's left also in 0.5-mm increments, for a 1.0-mm change in each altered image. In this group, the adjacent soft tissue was kept intact. These changes are shown in Figure 3.

Color photographic quality prints were obtained and randomly grouped in a smile album.

Fifty orthodontists, 50 prosthodontists, and 50 laypersons—senior students in law (n = 20), business administration (n = 15), and tourism (n = 15)—rated the photographs.

The dental specialists were randomly selected from the list of the Regional Council of Dentistry, and the students were from 2 universities in Brasília, Brazil.

Each rater received the smile album and an evaluation sheet with a 100-mm visual analog scale, as in previous studies.[13,15,16,24,25] Each rater had 20 minutes to complete the evaluation sheet. The straight lines on the left-most position indicated "very unattractive" and, on the right-most position, "very attractive." The raters were told not to compare smiles in the album. The evaluation sheet was filled out in the presence of at least 1 author.

Fig 2. Wear of the maxillary left canine cusp. Numbers in each panel indicate the amount of wearing of the canine in milimeters.

The scores were measured by 1 researcher (S.P.) with a digital caliper (code 500-784; Mitutoyo, Suzano, Brazil) positioned on the left-most point of each line and opened to the mark made by the rater. All values obtained in millimeters were registered as scores.

Statistical analysis

Statistical analysis software (version 8.1; SAS, Cary, NC) was used for the statistical analysis of data. An outlier case in the prosthodontist group was excluded from analysis. Descriptive statistics were reported as means and standard deviations. Repeated measures analysis of variance (ANOVA) was used for the statistical analysis of each type of alteration. The hypothesis that there was no difference between the various digitally altered smiles for each group of raters was tested, and, when necessary, Newman-Keuls multiple comparisons were conducted as post-hoc analyses. The level of significance, adjusted by the Bonferroni correction, was established at 1%.

Measurement error was calculated by the formula $\sqrt{\frac{\Sigma d^2}{2n}}$, where d is the difference between 2 measurements made by the same observer within a 2-week interval, and n is the size of the sample. Fifteen percent of the answers were randomly selected for this evaluation. Error was 0.09 mm.

RESULTS

The original smile and those with deviations of the maxillary central incisor gingival margin were different for orthodontists ($F_{5,294} = 29.46$; $P < .0001$), prosthodontists ($F_{5,288} = 38.6$; $P < .0001$), and laypersons ($F_{5,294} = 9.44$; $P < .0001$). Orthodontists and prosthodontists gave esthetic scores significantly lower for changes equal to or greater than 0.5 mm. Laypersons were less sensitive to changes in gingival margin and perceived only changes that were equal to or greater than 2.0 mm. Means, standard deviations, and the results of the Newman-Keuls test are shown in Table I.

The original smile and those with various levels of maxillary canine cusp wear were not different for orthodontists ($F_{4,245} = 1.68$; $P = .15$), prosthodontists ($F_{4,240} = 1.83$; $P = .12$), and laypersons ($F_{4,245} = 0.49$; $P = .74$). None of the raters perceived the change in the maxillary canine cusp. Mean values and standard deviations are shown in Table II.

The original smile and those with various midline shifts were different for orthodontists ($F_{4,245} = 19.00$; $P < .0001$), prosthodontists ($F_{4,240} = 16.15$; $P < .0001$), and laypersons ($F_{4,245} = 2.08$; $P = .0842$). The orthodontists were more sensitive to midline shifts and rated changes equal to or greater than 1.0 mm as less esthetically pleasing. The prosthodontists perceived

Fig 3. Midline shift. Numbers in each panel indicate the amount of midline shifting in milimeters.

Table I. Statistical values for altered gingival margin of a maxillary right central incisor

Altered gingival margin (mm)	*Orthodontists*			*Prosthodontists*			*Laypersons*		
	Mean	*SD*	*Newman-Keuls**	*Mean*	*SD*	*Newman-Keuls**	*Mean*	*SD*	*Newman-Keuls**
0	64.9	20.9	A	65.5	17.7	A	41.5	21.1	A
0.5	44.7	18.9	B	47.3	17.2	B	40.2	21.0	A
1.0	40.8	20.2	B	33.8	17.8	C	36.4	17.8	A
1.5	30.1	18.5	C	30.1	19.4	CD	34.0	19.7	A
2.0	28.7	20.4	C	25.1	17.6	D	26.0	16.8	B
2.5	24.3	17.2	C	24.4	18.0	D	20.9	15.2	B

*Smiles with the same letter did not differ from each other.

Table II. Statistical values for wear of maxillary left canine cusp

Canine cusp wear (mm)	*Orthodontists*		*Prosthodontists*		*Laypersons*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
0	54.6	18.4	56.6	18.5	48.5	17.2
0.5	54.5	18.4	53.5	18.9	51.2	17.6
1.0	51.5	20.6	57.6	19.8	52.8	20.6
1.5	48.1	20.4	51.2	20.0	52.3	18.2
2.0	47.0	18.1	48.5	20.4	49.4	19.4

only changes that were equal to or greater than 3.0 mm, and the laypersons noticed no changes. Means, standard deviations, and the Newman-Keuls test results are shown in Table III.

DISCUSSION

Although the horizontal continuity of the gingival contour, teeth, and upper lip has been considered essential for esthetics,[21] asymmetries of up to 1.5 mm in the free gingival margin of the maxillary central

Table III. Statistical values for dental midline shifts

Midline shift (mm)	Orthodontists			Prosthodontists			Laypersons		
	Mean	SD	Newman-Keuls*	Mean	SD	Newman-Keuls*	Mean	SD	Newman-Keuls*
0	63.7	22.7	A	68.8	15.6	A	54.1	21.2	A
1.0	59.8	19.8	B	64.5	16.2	A	53.4	17.9	A
2.0	51.5	24.9	B	64.8	21.4	A	54.5	18.5	A
3.0	38.0	18.2	C	48.8	23.4	B	46.9	19.5	A
4.0	33.9	20.2	C	41.4	25.2	B	46.8	19.7	A

*Smiles with the same letter did not differ from each other.

incisors seemed to be acceptable and not perceived by the laypersons who participated in this study. Our results suggest that some therapeutic approaches to correct asymmetries of gingival margins of the maxillary central incisors between 0.5 and 1.5 mm, such as periodontal surgeries[20-22] or orthodontic tooth movement complemented by composite restorations,[19,20,23,26] might reflect an exaggerated concern by dental specialists rather than an esthetic need. However, such procedures might be justifiable when fully discussed with the patient because the treatment should respect the patient's self-image and wishes.

When asymmetry of the gingival margin of a maxillary central incisor is equal to or greater than 2.0 mm, various approaches can be adopted. Despite the development of periodontal plastic surgery,[19-22] orthodontic treatment combined with restorative procedures might obtain better esthetic results than restorative procedures alone or other esthetic dental procedures.[27] A benefit of orthodontic tooth movement is that the supporting tissues—bony structure, periodontal ligament, and soft-tissue components—move along with the teeth.[21,27-29] Therefore, any intrusive or extrusive tooth movement can be used to obtain gingival margin symmetry without surgery.[19,20,21,23,26-28]

No studies about the esthetic impact of wear of a maxillary canine cusp were found in the literature. No group of raters in our study detected this type of smile asymmetry when evaluating the frontal photographs. However, this discrepancy might be perceivable on profile and oblique photographs, in which the canine tends to gain relative esthetic importance.

The reestablishment of the natural anatomy of a worn maxillary canine cusp might be associated with basic mandibular movements. It has been suggested that patients with canine guidance have a more adjusted masticatory model, and that the activity of the anterior temporal muscle is reduced during the laterotrusive movement.[30] However, all laterotrusive contacts could be obtained by means of group function. Recent studies indicate that group disclusion causes less electromyographic activity of the anterior temporal muscle when the mandible is in the resting position.[31]

The orthodontists were less tolerant in their evaluation of dental midline discrepancy and rated 1.0-mm shifts as less attractive. In contrast to our findings, another study reported that orthodontists classified smiles as least attractive only when midline shifts reached 4.0 mm.[13] Our results were closer to findings that a dental midline shift of 2.0 mm was perceived by 83% of the orthodontists.[12]

The lack of perception of dental midline asymmetries by laypersons in our study was similar to findings in other studies.[13] It has been suggested that midline shifts greater than 2.0 mm are perceived by most people, and that orthodontists and general dentists are the least tolerant to this esthetic discrepancy.[11] One study found that 56% of laypersons noticed 2.0-mm midline shifts.[12]

These discrepant results might be explained by differences in the methodologies used for the digital manipulation of photographs, by different data collection instruments or different statistical tests, or different sociocultural aspects.

Midline asymmetries receive special attention in orthodontic diagnosis and treatment planning[11] because orthodontists often treat patients with dental or facial midline asymmetries.[32] Coincident midlines are an important component of functional occlusion and can be used as a clinical guide to establish ideal intercuspation.

Although our results show that dental midline shifts less than 4.0 mm have no impact on the esthetic perceptions of laypersons, greater discrepancies might have other implications. Midline asymmetries are associated with posterior occlusion, and, when malocclusion is corrected, midlines usually become coincident.[33]

Esthetic principles should be studied to provide measurements that the dentist can use to create or imitate a smile that is pleasing and satisfactory to the patient. Dental specialists need more objective and

quantitative data to guide their decisions accurately and to promote better communication with patients when planning treatment that responds to the patient's needs.

Dental specialists seem to be less tolerant in their evaluations, and these differences in perception should be discussed with the patient when planning the treatment. The patient can be helped to see the importance of symmetry in the harmony and balance of the dentofacial complex and, at the same time, understand that the visual perception of some dental deviations by laypersons is different from that of the dental specialist. Patients thus can form their own understanding of the esthetic meaning of discrepancies.

Perceptions of smile esthetics by using oblique or profile photographs and dynamic visualizations should be studied further.

CONCLUSIONS

1. Orthodontists, prosthodontists, and laypersons had different perceptions of smile esthetics when evaluating smiles with deviations in gingival margin height of a maxillary central incisor and dental midline shifts.
2. Orthodontists and prosthodontists classified smiles as least attractive when asymmetries of the gingival margin of a maxillary central incisor were equal to or greater than 0.5 mm; for laypersons, this threshold was 2.0 mm.
3. The wear of a canine cusp had no esthetic impact for any group of raters.
4. Midline shifts were perceived at 1.0 mm by orthodontists and 3.0 mm by prosthodontists; laypersons did not notice midline shifts.

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