



# Perceptions of dental professionals and laypersons to altered dental esthetics: Asymmetric and symmetric situations

Vincent O. Kokich,<sup>a</sup> Vincent G. Kokich,<sup>b</sup> and H. Asuman Kiyak<sup>c</sup>

Seattle, Wash

**Introduction:** Previous studies evaluated the perception of laypersons to symmetric alteration of anterior dental esthetics. However, no studies have evaluated the perception of asymmetric esthetic alterations. This investigation will determine whether asymmetric and symmetric anterior dental discrepancies are detectable by dental professionals and laypersons. **Methods:** Seven images of women's smiles were intentionally altered with a software-imaging program. The alterations involved crown length, crown width, midline diastema, papilla height, and gingiva-to-lip relationship of the maxillary anterior teeth. These altered images were rated by groups of general dentists, orthodontists, and laypersons using a visual analog scale. Statistical analysis of the responses resulted in the establishment of threshold levels of attractiveness for each group. **Results:** Orthodontists were more critical than dentists and laypeople when evaluating asymmetric crown length discrepancies. All 3 groups could identify a unilateral crown width discrepancy of 2.0 mm. A small midline diastema was not rated as unattractive by any group. Unilateral reduction of papillary height was generally rated less attractive than bilateral alteration. Orthodontists and laypeople rated a 3-mm distance from gingiva to lip as unattractive. **Conclusions:** Asymmetric alterations make teeth more unattractive to not only dental professionals but also the lay public. (*Am J Orthod Dentofacial Orthop* 2006; 130:141-51)

The visual and entertainment media have gradually established esthetic standards for viewers by exposing them to beautiful faces and brilliant smiles. This has had a direct influence on cosmetic surgery and dentistry. Dale Carnegie described the smile as an important method of influencing people. Unfortunately, teeth are usually not in perfect balance with the surrounding facial structures. Does imbalance of the teeth relative to the face affect the esthetic appearance of the smile? Is tooth malposition considered unattractive by the layperson? If so, is it more acceptable for the discrepancy to be symmetric rather than asymmetric? Miller<sup>1</sup> stated that the trained and observant eye readily detects what is out of balance, out of harmony with its environment, or asymmetric. Few studies have evaluated anterior dental esthetics by investigating a person's perception of minor abnormalities.<sup>2-7</sup> Only 1 study has established threshold levels

for several specific esthetic criteria that can be used readily by orthodontists, periodontists, restorative dentists, and oral and maxillofacial surgeons to aid in treatment planning.<sup>8</sup> However, that study evaluated symmetric esthetic alterations.

The purpose of this study was to determine whether asymmetric and symmetric anterior dental discrepancies are detectable by various groups of evaluators. These data are invaluable in designing complex, interdisciplinary treatment plans. Is it necessary to establish ideal tooth proportion and gingival margin levels when positioning or restoring maxillary anterior teeth? Is 1 crown shape more desirable than another? Is symmetry important to the restoration or alignment of teeth in the esthetic zone? Finally, are asymmetric papillary heights unattractive when viewed by the orthodontist, general dentist, and layperson? No studies have attempted to compare the perception of symmetric versus asymmetric discrepancies. Kokich et al<sup>8</sup> previously evaluated the esthetic perception of altered tooth shapes. These researchers established group-specific threshold levels for each esthetic parameter. However, the changes were made by symmetrically altering crown length and width. Their data are interesting and practical but leave a major issue unexplored: asymmetric dental discrepancies.

Frequently, a patient has a central or lateral incisor

From the University of Washington, Seattle.

<sup>a</sup>Affiliate assistant professor, Department of Orthodontics.

<sup>b</sup>Professor, Department of Orthodontics.

<sup>c</sup>Professor, Department of Oral and Maxillofacial Surgery.

Reprint requests to: Vincent G. Kokich, Department of Orthodontics, University of Washington, Seattle, WA 98195; e-mail, vggkokich@u.washington.edu. Submitted, January 2006; revised and accepted, April 2006.

0889-5406/\$32.00

Copyright © 2006 by the American Association of Orthodontists.

doi:10.1016/j.ajodo.2006.04.017

that is shorter or narrower than the contralateral tooth. Do these asymmetric alterations in tooth shape and alignment affect the perception of anterior dental attractiveness differently from symmetric alterations? That question was explored in this investigation. The purpose of this study was to determine the perceptions of the layperson and dental professional to minor variations in anterior tooth size and alignment, as well as their relationship to the teeth and the supporting gingiva. We assessed the perception of asymmetric and symmetric alterations of the teeth and tissues, and compared these findings with the results of our previous study of symmetric alteration of tooth position.<sup>8</sup> The following hypotheses were tested: (1) orthodontists are more perceptive than general dentists in detecting asymmetric variations in ideal tooth position, (2) lay people are less perceptive than general dentists and orthodontists in detecting asymmetric variations in ideal tooth position, and (3) specific asymmetries of teeth and tissues are rated less attractive than symmetric discrepancies by all 3 groups of raters.

## **MATERIAL AND METHODS**

Three groups of raters were used in this study: orthodontists, general dentists, and laypeople. The orthodontists and general dentists were graduates of the University of Washington School of Dentistry. They were selected randomly from lists from the dental school. The male-to-female ratios were 61:10 for the orthodontists, 45:20 for the dentists, and 26:40 for the laypeople, respectively. The lay group consisted of business people, lawyers, teachers, and others without dental backgrounds. Each rater was given as little information about the study as possible. A total of 300 questionnaires were distributed to the 3 groups. The response rates were 71% (71 of 100) for the orthodontists, 88% (66 of 75) for the laypeople, and 52.8% (66 of 125) for the general dentists. The orthodontists ranged in age from 26 to 62 years (mean, 44 years); the general dentists were 28 to 59 years (mean, 42.5 years); and the lay group ranged from 21 to 65 years (mean, 36.6 years).

### **Variables and measurements**

The 3 groups rated 7 esthetic discrepancies to test the hypotheses. The questionnaire consisted of 5 variations of 7 separate smiling photographs of women. The total number of images in the survey was 35. Each smile was intentionally altered with 1 of 7 common anterior esthetic discrepancies. The alterations were made incrementally. Four of the 7 (crown length; crown width with and without altered crown length; and papillary height: unilateral/asymmetric) were al-

tered asymmetrically. All 7 alterations were selected after consultation with clinically experienced orthodontists and general dentists. These alterations were chosen based on their frequency and clinical significance to the smile. They included variations in crown length; crown width, without altered crown length and with proportionally altered crown length; midline diastema; papillary height, with unilateral asymmetry and bilateral symmetry; and gingiva-to-lip distance.

The nose and chin were eliminated from the images to reduce the number of confounding variables. For the same reason, only female smiles were used, and similar skin tones were chosen. Each esthetic characteristic was altered with 4 progressive variations of the original smile. The smiles were altered with Adobe Photoshop (Adobe Systems Inc, San Jose, Calif). After alteration, the images were condensed or enlarged to achieve an image size that represented actual tooth size. Each esthetic characteristic was altered in varying increments. Some were altered asymmetrically, but all were altered in 0.5- or 1.0-mm increments.

The crown length of the maxillary left central incisor was altered. The crown was shortened in 0.5-mm increments by adjusting the level of the gingival margin (Fig 1). The reference points for these measurements were the most superior points on the labial gingival margin of the patient's adjacent lateral and central incisors. The incisal edges were maintained at the same level to simulate supereruption of the left central incisor and concomitant incisal wear.

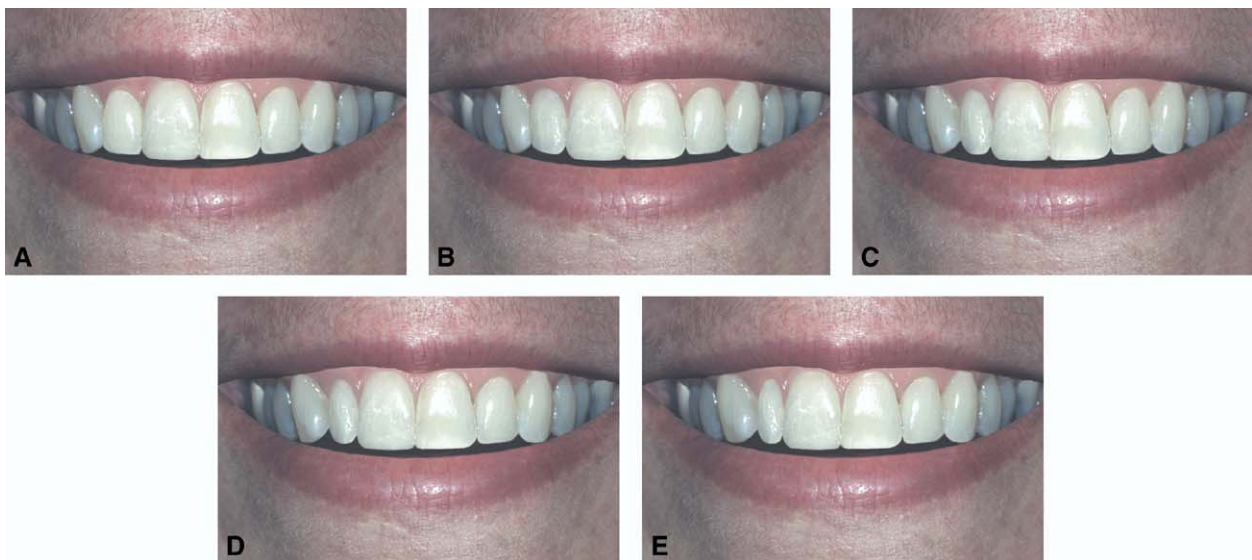
Because the most common variation in maxillary incisor crown width affects the size of the maxillary lateral incisors, the alterations of crown width were made to the maxillary right lateral incisor. Crown width was altered in 2 ways: with altered crown length, and with proportionally altered crown length. In the first case, the gingival margin was maintained at the same level, but the width of the right lateral incisor crown was decreased in 1.0-mm increments (Fig 2). The relative measurements were made at the widest part of the crown between the interproximal contact points. For the latter, the gingival margin was moved incisally as the width of the right lateral incisor crown was decreased in 1.0-mm increments (Fig 3). The measurements were made at the widest part of the crown between the interproximal contact points.

A midline diastema was created incrementally between the maxillary central incisors (Fig 4). It was widened progressively in 0.5-mm increments. The measurements were made at the interproximal contact points between the central incisor crowns.

Papillary height was altered unilaterally and bilaterally. For the unilateral images, the papillary height



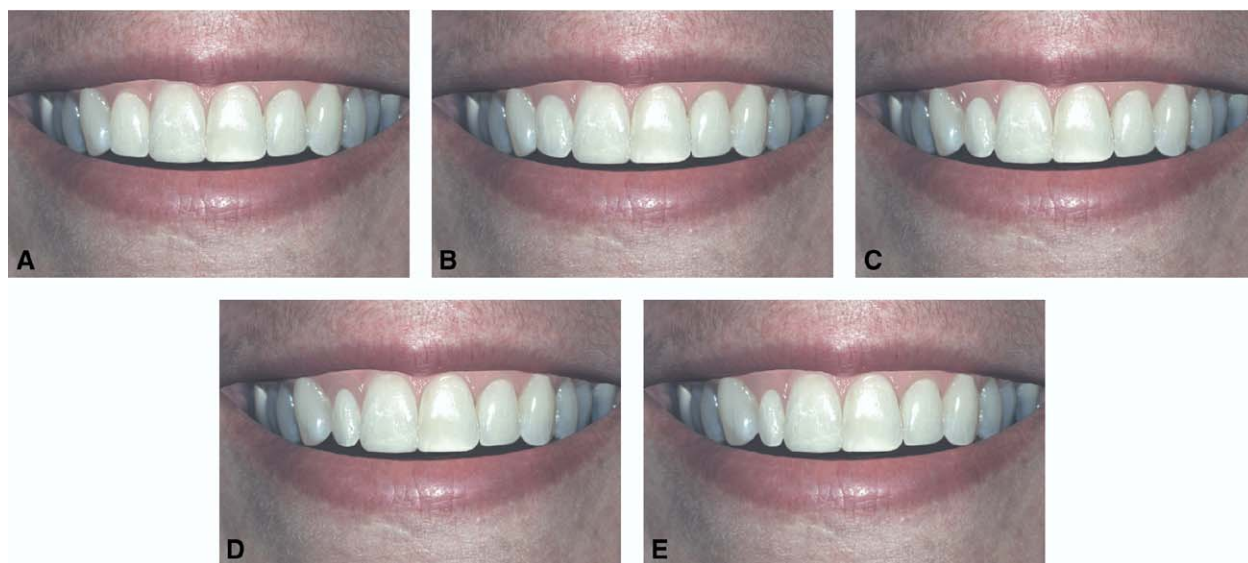
**Fig 1.** Crown shortened in 0.5-mm increments by adjusting level of gingival margin (**A**, control; **B**, 0.5 mm; **C**, 1.0 mm; **D**, 1.5 mm; **E**, 2.0 mm). Reference points for measurements were most superior points on labial gingival margin of patient's adjacent lateral and central incisors. Incisal edges were maintained at same level to simulate supereruption of left central incisor and concomitant incisal wear.



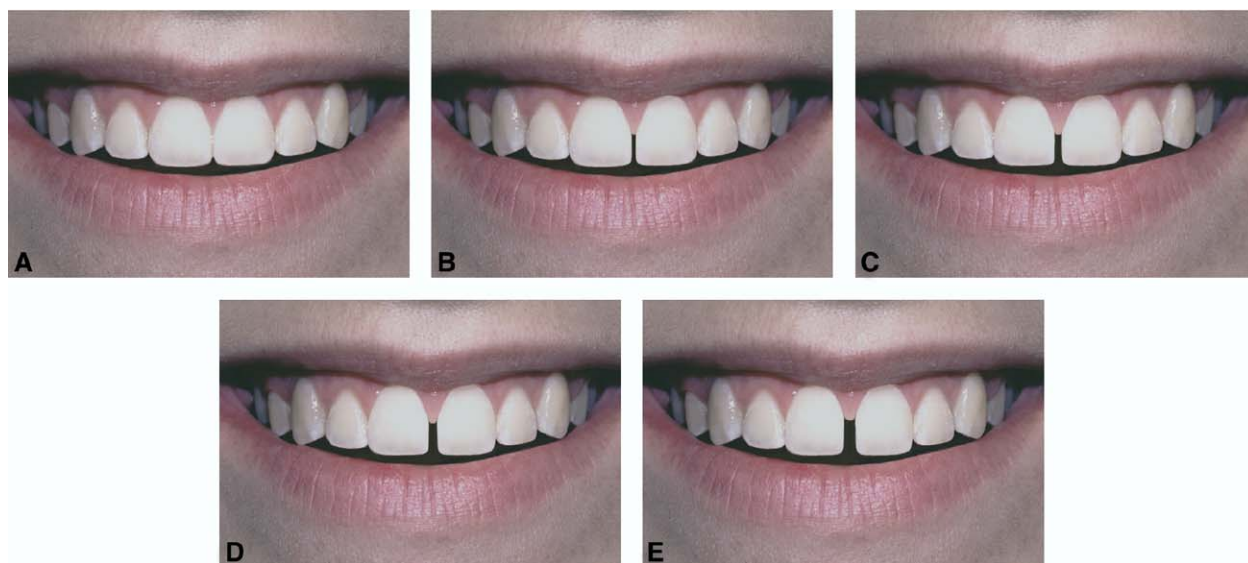
**Fig 2.** Gingival margin maintained at same level, but width of right lateral incisor crown was decreased in 1.0-mm increments (**A**, control; **B**, 1.0 mm; **C**, 2.0 mm; **D**, 3.0 mm; **E**, 4.0 mm). Relative measurements were made at widest part of crown between interproximal contact points.

between the maxillary left central and lateral incisors was progressively lengthened by increasing the interproximal contact point between the teeth in 0.5-mm increments in a gingival direction (Fig 5). All attempts were made to maintain natural tooth shape and papillary form. For the bilateral images, the papillary heights

between the maxillary anterior teeth were altered uniformly by progressively lengthening the interproximal contact points in 0.5-mm increments in a gingival direction between all maxillary anterior teeth (Fig 6). All attempts were made to maintain natural tooth shape and papillary form.



**Fig 3.** Gingival margin was moved incisally as width of right lateral incisor crown was decreased in 1.0-mm increments (**A**, control; **B**, 1.0 mm; **C**, 2.0 mm; **D**, 3.0 mm; **E**, 4.0 mm). Measurements were made at widest part of crown between interproximal contact points.



**Fig 4.** Midline diastema was created incrementally between maxillary central incisors (**A**, control; **B**, 0.5 mm; **C**, 1.0 mm; **D**, 1.5 mm; **E**, 2.0 mm). It was widened progressively in 0.5-mm increments. Measurements were made at interproximal contact points between central incisor crowns.

The gingiva-to-lip relationship was increased incrementally to produce a “gummy smile” (Fig 7). The smile was altered by progressively moving the upper lip superiorly to alter the distance from the lip to gingival margin. The labial gingival margins of the maxillary central incisors were used as reference points for measurements. The upper lip was positioned at this

level and called the 0-mm level. Sequential lip positions were 1.0, 2.0, 3.0, and 4.0 mm superior to this level.

The smiles were grouped randomly but in such a way that different variables were presented on each page of the questionnaire. Each page consisted of 4 randomly assigned images arranged in 2 columns.



**Fig 5.** Papillary height between maxillary left central and lateral incisors was altered (**A**, control; **B**, 0.5 mm; **C**, 1.0 mm; **D**, 1.5 mm; **E**, 2.0 mm) by progressively lengthening tooth contact in 0.5-mm increments in gingival direction between these teeth. All attempts were made to maintain natural tooth shape and papillary form.



**Fig 6.** Papillary heights between maxillary anterior teeth were altered uniformly (**A**, control; **B**, 0.5 mm; **C**, 1.0 mm; **D**, 1.5 mm; **E**, 2.0 mm) by progressively lengthening interproximal contact points in 0.5-mm increments in gingival direction between all maxillary anterior teeth. All attempts were made to maintain natural tooth shape and papillary form.

Copies of the original questionnaire were arranged randomly in 10 different ways. An equal number of each of the 10 forms was distributed to each group of raters. Each image was coded for identification with a 2-letter combination such as “CR” or “FC.” Respon-

dents were asked to omit any identifiable marks such as a printed name or signature.

A 50-mm visual analog scale appeared under each image in the questionnaire and was used for the ratings. It was labeled at both ends according to extremes of



**Fig 7.** Gingiva-to-lip relationship was increased incrementally to produce “gummy smile” (A, control; B, 0.5 mm; C, 1.0 mm; D, 1.5 mm; E, 2.0 mm). Smile was altered by progressively moving upper lip superiorly to alter distance from lip to gingival margin. Labial gingival margins of maxillary central incisors were used as reference points for measurements.

attractiveness, from “least attractive” near zero on the left to “most attractive” near 50 mm on the right. Each rater marked a point along the scale according to his or her perception of dental esthetics. Each rating was measured in millimeters with an Ultra-Cal Mark III (Fred V. Fowler, Newton, Mass) digital caliper to determine the respondent’s score.

#### Analysis of data

To test the 3 hypotheses, a series of parametric and nonparametric statistics were applied to the raw data. Hypothesis 2 stated that laypeople would be less able to discriminate between asymmetric levels of discrepancies than dentists and orthodontists. One-way repeated analysis of variance tests (ANOVA) were conducted within each group to assess how the groups rated each level of deviation. Significant overall tests were followed with a series of post-hoc multiple comparisons to test hypotheses 1 and 2. Multiple comparisons between each level of variation were used to determine the level of deviation at which each group discriminated between esthetic and less esthetic dental features. Furthermore, to compare the 3 groups’ ratings, 2-way repeated ANOVAs with group (1 vs 2 vs 3) as the crossed factor and levels of discrepancy (0 through 4 mm) as the repeated factor were conducted on each type of dental discrepancy.

Analysis of covariance (ANCOVA) also was used to test the effect of years of dental or orthodontic

**Table.** Threshold levels of significant difference (mm)

	Orthodontists	Dentists	Laypeople
Crown length	0.5	1.5-2.0	1.5-2.0
Crown width	2.0	2.0	2.0
Crown width and length	3.0	3.0	4.0
Midline diastema	1.0-1.5	2.0	2.0
Unilateral papillary height	0.5-1.0	0.5	ND
Bilateral papillary height	1.0	ND	1.5
Gingiva-to-lip distance	3.0	ND	3.0

ND, Not detectable.

practice on ratings, categorized as 1-10 years vs 11-20 vs  $\geq 21$  years of dental or orthodontic practice. This permitted a test of the impact of practice experience on dentists’ and orthodontists’ ratings of the 7 dental discrepancies.

#### RESULTS

In this section, we report the levels of discrepancy at which each group could distinguish between the “ideal” smiles and deviations from the ideal (Table). These 1-way ANOVAs represent a test of hypotheses 1 and 2. When possible, a comparison of the asymmetric results to similar symmetric conclusions will be included.

Orthodontists were more critical than dentists and laypeople when evaluating asymmetric crown-length discrepancies. The orthodontic group first detected a

0.5-mm decrease in crown length ( $P < .001$ ). The dental and lay groups were less discriminating of minor alterations. They could not detect unilateral crown-length discrepancies until the crown was 1.5 to 2.0 mm shorter than the contralateral incisor (dentists,  $P < .001$ ; laypeople,  $P < .01$ ; Table). These results support hypothesis 1.

When compared with similar symmetric data, these asymmetric conclusions indicated that orthodontists could detect minor unilateral discrepancies in crown length at a higher level of distinction than similar bilateral alterations; this supports hypothesis 3. Conversely, dentists and laypersons demonstrated no significant difference in perception between asymmetric and symmetric discrepancies.

All 3 groups could identify a unilateral crown width discrepancy at the same level, 2.0 mm narrower than the width of the contralateral lateral incisor. However, crown length was not altered in any variation. The level of significance for each group varied (orthodontists,  $P < .01$ ; dentists,  $P < .05$ ; laypeople,  $P < .001$ ; Table), whereas the lay group was better than the 2 dental groups in discriminating between ideal and a 2.0-mm discrepancy. These results do not support hypothesis 1 or 2. This was verified by the mean difference in ratings: laypeople, 7.37; orthodontists, 5.87; dentists, 5.47. A higher mean difference indicates a greater distinction between levels of discrepancy for that group of raters.

All 3 groups detected a unilateral discrepancy involving 1 lateral incisor earlier than the same discrepancy involving both lateral incisors. This comparison of asymmetric and symmetric data supports hypothesis 3.

When crown width was altered with a proportional change in length, the results differed from those seen with isolated crown-width discrepancies. A mesiodistal dimension 3.0 mm narrower than the ideal lateral incisor crown width was required before it was rated significantly less attractive by orthodontists ( $P < .001$ ) and dentists ( $P < .0001$ , Table). A 4.0-mm proportional narrowing of mesiodistal width was necessary for laypersons to rate it noticeably less attractive ( $P < .01$ ). These results support hypothesis 2. General dentists were better than orthodontists at distinguishing between the ideal proportional crown dimensions and a 3.0-mm discrepancy. This was confirmed by the mean difference in ratings: dentists, 7.51; orthodontists, 5.46. However, the difference in ratings does not support hypothesis 1.

Comparison of the bilateral crown width data with the unilateral crown width and length results showed no significant differences. The orthodontists and the dentists did not consider the discrepancy unattractive until

the lateral incisor crown width was reduced by 3.0 mm. The lay group could not detect a discrepancy until it reached 4.0 mm.

A small amount of space between the maxillary central incisors was not rated as unattractive by any group. However, the orthodontists were more discriminating than the other 2 groups. Orthodontists were most critical of changes between 1.0 and 1.5 mm ( $P < .001$ , Table). Dentists and laypeople did not rate a midline diastema as unattractive until the distance between the contacts of the central incisors was 2.0 mm ( $P < .0001$ ). These results support hypothesis 1.

Orthodontists rated a unilateral papillary height discrepancy unattractive when it was 0.5 to 1.0 mm more coronal than the adjacent papillae ( $P < .001$ , Table). However, dentists were more discerning than orthodontists; this does not support hypothesis 2. General dentists rated a 0.5-mm decrease in papillary height ( $P < .01$ ) as unattractive. In contrast, the layperson group did not perceive a significant difference in attractiveness even when evaluating the maximum 2.0-mm deviation in papillary height.

The orthodontic group rated a 1.0-mm uniform reduction in papillary height from canine to canine as less attractive than the ideal smile with normal papillary heights ( $P < .001$ , Table). The layperson group was less critical than orthodontists. They required a decrease in papillary height of 1.5 mm before they rated it as significantly less attractive ( $P < .01$ ). The dentists could not detect a significant decrease in papillary height even when uniformly reduced by 2.0 mm. These findings are consistent with hypothesis 1.

Orthodontists and laypeople perceived a change in attractiveness when the distance from gingiva to lip was 3.0 mm or greater ( $P < .01$ , Table). However, dentists did not rate excess gingival display as unattractive even with the maximum 4.0 mm. These results do not support hypothesis 1 or 2.

ANCOVA was used to determine the association between number of years in practice and perception of esthetic discrepancy. The ranges were 1.5 to 33 years for orthodontists and 2 to 29 years for general dentists. Despite this wide range for both groups, years of professional experience had no effect on esthetic perceptions.

ANOVA was used to investigate a possible association between sex and perception of discrepancy. No significant sex differences were seen across the groups. However, the women generally gave slightly higher ratings for most of the discrepancies.

## DISCUSSION

The threshold for unattractiveness of unilateral crown length discrepancies was less for orthodontists than both the general dentist and layperson groups. Orthodontists found that a 0.5-mm unilateral discrepancy in central incisor crown length was unattractive. The general dentist and layperson groups did not find the discrepancy in unilateral crown length unattractive until it was 1.5 mm. In a previous study, Kokich et al<sup>8</sup> evaluated the perceptions of the dental professional and the layperson to bilateral crown length alterations. In that study, the threshold for unattractiveness was 1.0 mm for orthodontists, 1.5 mm for general dentists, and 2.0 mm for laypeople. Although the results were generally similar, it seems that each group regards unilateral alteration in crown length as more unattractive than bilateral alteration in crown length. In other words, asymmetric esthetic discrepancies are more perceptible than symmetric discrepancies. When a patient has a unilateral discrepancy in the length of the maxillary central incisors, the clinician could use the information from this study as an aid to determine whether to recommend treatment to the patient.

A common problem in the adult orthodontic patient is wear or abrasion of the maxillary incisors causing uneven gingival levels and unequal crown lengths of the adjacent central incisors.<sup>9,10</sup> The treatment for this problem could consist of periodontal crown lengthening to level the gingival margins,<sup>11,12</sup> orthodontic extrusion of the longer central incisor,<sup>13</sup> or intrusion and restoration of the short tooth or teeth.<sup>14-17</sup> To diagnose this problem adequately, the clinician must first evaluate the labial sulcular depths of the maxillary incisors. If the sulcular depths are uniformly 1 mm, then the discrepancy in gingival margins might be due to uneven wear or trauma of the incisal edges of the anterior teeth. In these situations, the clinician must decide whether the amount of gingival discrepancy will be noticeable. In other words, is it greater than 1.5 mm and does the patient show the gingival margins when smiling? If so, bracket placement and alignment of these teeth must be accomplished in a way that improves the esthetics and restorability of the abraded teeth. In these situations, the gingival margins are used as a guide in tooth positioning, not the incisal edges.<sup>18</sup> As the gingival margins are aligned, the discrepancy in the incisal edges becomes more apparent. These incisal discrepancies are restored with composite restorations temporarily and then restored permanently with porcelain veneer restorations after the teeth have stabilized. If the gingival margin discrepancies are corrected by leveling the gingival margins orthodontically, these

tooth positions should be maintained for at least 6 months to avoid relapse.<sup>19</sup> As teeth are intruded, the orientation of the periodontal fibers changes and becomes more oblique. It typically takes at least 6 months for these fibers to reorient themselves in a horizontal position and stabilize the tooth position.<sup>20</sup>

In this study, orthodontists, general dentists, and laypeople found that an asymmetric crown width discrepancy between the maxillary lateral incisors was unattractive when the difference was 2.0 mm. This uniformity in opinion was unique. Not often in this study or the previous study did the groups agree on attractiveness. In the previous study of symmetric alterations in crown width, Kokich et al<sup>8</sup> found that bilateral alteration in lateral incisor crown width was not perceived as unattractive to general dentists and orthodontists until the width was 3.0 mm narrower than normal. For the lay group, the bilateral crown width was not perceived as unattractive until it was 40 mm narrower.<sup>8</sup> Again, this comparison suggests that dental and tissue discrepancies are potentially much more unesthetic when they are asymmetric rather than symmetric. This finding is clinically important to orthodontists, who might treat patients with either unilateral or bilateral peg-shaped maxillary lateral incisors.

In the past, the "golden proportion" has been applied to the relative widths of the maxillary anterior teeth to establish ideal esthetics. One of the first to describe the golden proportion and its importance in restorative dentistry was Lombardi.<sup>21</sup> Since then, others, including Levin,<sup>22</sup> Brisman,<sup>23</sup> and Qualtrough and Burke,<sup>24</sup> have reinforced its application to anterior esthetics. Kokich<sup>25</sup> applied the rule to orthodontics by describing the proper restoration of peg-shaped lateral incisors in orthodontic patients. The golden proportional value for the lateral incisor is 0.618 or about two-thirds the width of the adjacent maxillary central incisor. However, in our previous study of bilateral symmetric narrowing of lateral incisors, no panelist regarded the narrow incisor as unattractive until it was 3 to 4 mm narrower than ideal.<sup>8</sup> This phenomenon suggests that the golden proportion might be incorrect, especially with bilateral symmetric narrowing of maxillary lateral incisors.

If the lateral incisor crowns are bilaterally narrower than normal and the discrepancy in crown width is only 2.0 mm or less than a normal lateral incisor, it might be best to simply ignore the discrepancy. If the lateral incisors have normal crown form and are not peg shaped, it might be more prudent to simply align the teeth and adjust the tooth-size accordingly. Either leaving the patient in an end-to-end canine relationship or reshaping and reducing the widths of the mandibular



teeth could provide a satisfactory occlusion. If bilaterally narrow maxillary lateral incisors are not unattractive, why commit the patient to 2 restorations that could eventually need to be replaced?

If the crown width discrepancy between the maxillary lateral incisors is asymmetric, the better choice could be to restore the malformed tooth to its correct dimension. Based on the data from this study, the clinician should first measure the difference in width between the maxillary lateral incisors. If the discrepancy is 1.0 mm or less, restoration is probably not necessary, because it will likely not be recognized. If the difference is 2.0 mm or greater, the narrower tooth should be restored. If there is sufficient space, a composite restoration can be placed before orthodontic treatment.<sup>25</sup> However, in most situations, there is insufficient space to restore the malformed lateral incisor. Therefore, orthodontics is often necessary to create space to build up a peg-shaped lateral incisor. The space is usually obtained by placing open-coil springs on either side of the lateral incisor. This will create space on the mesial and distal surfaces for future restoration. It is generally advantageous to position the tooth closer to the central incisor than the canine, so the emergence profile of the restoration on the mesial surface is flat and matches the adjacent incisors.<sup>16</sup> In this way, most overcontouring is on the distal surface, which is less obvious esthetically.

Another esthetic issue we investigated was the relationship of crown width and length discrepancies relative to the maxillary lateral incisors. Peg-shaped maxillary lateral incisors are often short as well as narrow. Is this unique crown shape less attractive than the peg-shaped lateral incisor that has the correct length but is simply narrower? Not according to our current research. When width and length were altered proportionally, neither orthodontists nor general dentists considered these teeth unattractive until they were 3.0 mm narrower than the ideal width. Similarly, the lay group did not find the asymmetric alteration unattractive until there was a 4.0-mm proportional decrease in width. When these values were compared with the width-only measurements, it was evident that all 3 groups recognized isolated crown width alterations before proportional crown width discrepancies. The lay group, which found unilateral crown width discrepancy unattractive at 2.0 mm, did not rate proportional width and length discrepancy as unattractive until it was 4.0 mm. This information verifies the importance of tooth proportion when treating patients with these types of dental discrepancies orthodontically or restoratively.

Midline diastemas usually are consolidated during routine orthodontic treatment.<sup>26</sup> Ironically, orthodon-

tists did not rate a diastema as unattractive until it was 1.0 to 1.5 mm wide. For general dentists and laypeople, the threshold was 2.0 mm. Actually, a midline diastema is probably most noticed by the orthodontic patient who experiences some relapse or space reopening after the orthodontic appliances have been removed. When we improve anterior dental esthetics either orthodontically or restoratively, we probably atypically sensitize our patients and make them more aware of minor esthetic problems. Although relapse of diastemas can occur after orthodontic treatment,<sup>27</sup> according to our study, the space will not be rated as unattractive if it is less than 1.0 mm.

Previous research by Kurth and Kokich<sup>28</sup> showed that, in periodontally healthy adults with well-aligned, nonabraded, nonrestored maxillary anterior teeth, the maxillary incisor embrasure should consist of half papilla and half tooth contact. Furthermore, the papillae should all be aligned at the same level. However, in some clinical situations, it is impossible to achieve this goal. Will uneven papilla heights be regarded as unesthetic? In this study, both dentists and orthodontists rated unilateral papillary height discrepancies as unattractive. However, the lay group did not find unilateral papilla discrepancies of 2.0 mm unattractive. So perhaps altered papillary heights are not an esthetic handicap when observed by the general public.

Another papillary relationship that often is altered is the amount of tooth contact relative to papilla height in a patient who has had periodontal bone loss. To compensate for the shortened papilla, the restorative dentist must increase the length of the contact to avoid an unesthetic open embrasure. This effect was simulated in our study by moving the papilla apically and increasing the length of the contact bilaterally. In this situation, although the contacts were progressively lengthened bilaterally, the change was not regarded as unattractive until it was positioned 1.0 mm or more apically. Interestingly, the general dentists did not rate a 2.0-mm lengthening of the contact as unattractive. Perhaps bilateral papilla heights generally are not as critical to the esthetic perception of teeth as previously believed.

In our previous study, the gingiva-to-lip distance was evaluated to determine when a "gummy smile" becomes unattractive.<sup>8</sup> Those results showed that orthodontists rated 2.0 mm of gingiva as unattractive, whereas general dentists and laypeople rated the 4.0-mm example as unattractive. However, there was no assessment of 3.0 mm in that study. In this investigation, we increased the distance from gingival margin to lip in 1.0 mm increments up to 4.0 mm. The lay and orthodontic groups rated the 3.0-mm distance as unat-

tractive in this study. The general dentists had a higher threshold. It is clear that, based on both studies of the amount of gingiva showing during smiling, at least 1 or 2 mm is not generally regarded as unesthetic. This is an important point. It is probably better for the patient to show some gingiva during smiling than none at all. With aging, less of the maxillary anterior teeth show,<sup>21,29</sup> and, with loss of tonicity in the facial muscles, the lip will move less.<sup>30,31</sup> So, as people get older, they show less gingiva on smiling. Treatment of this esthetic issue should be performed judiciously and probably err on the side of leaving a greater distance between the lip and gingival margin.

In this study, we used a computer to alter dental and soft tissues to simulate natural dental anomalies. Although this is not a perfect method, at least by using the same image and only modifying 1 variable, we isolated and accurately compared the judgments of various groups of raters. However, therein lies a potential problem. We are not suggesting that the results of our research should be interpreted as anything other than the average assessment of each group of raters. The problem with using averages is that it is difficult to apply this information directly to a patient in your dental chair, when you are contemplating a change in his or her dental esthetics. Thus, you must interpret this information carefully and apply it cautiously. A better approach would be to customize this method of evaluation by allowing each patient to rate the same photos that were viewed by our raters. In this way, perhaps the clinician could determine each patient's level of awareness. This could result in a more educated and informed approach in the treatment of each patient. That project is still on the drawing board.

## CONCLUSIONS

In this investigation, we evaluated the perceptions of orthodontists, general dentists, and laypeople to intentionally altered dental esthetics. In our previous study, we altered esthetics symmetrically.<sup>8</sup> In this study, we sought to determine whether asymmetric alteration of teeth and tissues would have a greater negative impact on the attractiveness of a patient's smile. In general, asymmetric alterations make teeth more unattractive to not only dental professionals but also the lay public. Symmetric alterations might appear unattractive to dental professionals, but the lay group often did not recognize some symmetric alterations. Clinicians should use this information and our previous study as a guide when planning treatment to modify existing relationships in their patients. As clinicians, we must remember that not everything that we believe should be corrected in the name of esthetics will be

perceived by most of the lay public. Our concluding words should probably be: alter tooth position and restore with caution.

## REFERENCES

1. Miller CJ. The smile line as a guide to anterior esthetics. *Dent Clin North Am* 1989;33:157-64.
2. Chalifoux PR. Perception esthetics: factors that affect smile design. *J Esthet Dent* 1996;8:189-92.
3. Flores-Mir C, Silva E, Barriga MI, Lagravere MO, Major PW. Lay person's perception of smile aesthetics in dental and facial views. *J Orthod* 2004;31:204-9.
4. Johnston DC, Burden DJ, Stevenson MR. The influence of dental to facial midline discrepancies on dental attractiveness ratings. *Eur J Orthod* 1999;21:517-22.
5. LaVacca MI, Tarnow DP, Cisneros GJ. Interdental papilla length and the perception of aesthetics. *Pract Proced Aesthet Dent* 2005;17:405-12.
6. Moore T, Southard KA, Casco JS, Qian F, Southard TE. Buccal corridors and smile esthetics. *Am J Orthod Dentofacial Orthop* 2005;127:208-13.
7. Thomas JL, Hayes C, Zawaideh S. The effect of axial midline angulation on dental esthetics. *Angle Orthod* 2003;73:359-64.
8. Kokich VO Jr, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. *J Esthet Dent* 1999;11:311-24.
9. Kokich VG, Kokich VO. Orthodontic therapy for the periodontal-restorative patient. In: Rose L, Mealey B, Genco R, Cohen D, editors. *Periodontics: medicine, surgery, and implants*. St Louis: Mosby-Elsevier; 2004. p. 718-44.
10. Kokich VG. Adult orthodontics in the 21st century: guidelines for achieving successful results. *World J Orthod* 2005;6(Suppl): 14-23.
11. Kokich VG. Anterior dental esthetics: an orthodontic perspective I. Crown length. *J Esthet Dent* 1993;5:19-23.
12. Kokich V, Spear F, Mathews D. Inheriting the unhappy patient: an interdisciplinary case report. *Adv Esthet Interdisc Dent* 2005;1:12-22.
13. Kokich VG. Anterior dental esthetics. An orthodontic perspective II. Vertical relationships. *J Esthet Dent* 1993;5:174-8.
14. Kokich VG. Esthetics and vertical tooth position: the orthodontic possibilities. *Compendium Cont Ed Dent* 1997;18:1225-31.
15. Kokich VG. Esthetics: the orthodontic-periodontic restorative connection. *Semin Orthod* 1996;2:21-30.
16. Kokich VG, Spear F. Guidelines for managing the orthodontic-restorative patient. *Semin Orthod* 1997;3:3-20.
17. Chiche G, Kokich V, Caudill R. Diagnosis and treatment planning of esthetic problems. In: Pinault A, Chiche G, editors. *Esthetics in fixed prosthodontics*. Hanover Park, Ill: Quintessence; 1994. p. 33-52.
18. Kokich VG, Spear FM, Kokich VO. Maximizing anterior esthetics: an interdisciplinary approach. In: McNamara JA Jr, editor. *Frontiers in dental and facial esthetics*. Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, University of Michigan; 2001. p. 1-18.
19. Kokich VG, Kokich VO. Interrelationship of orthodontics with periodontics and restorative dentistry. In: Nanda R, editor. *Biomechanics and esthetic strategies in clinical orthodontics*. St Louis: Elsevier; 2005. p. 348-73.
20. Reitan K. Tissue rearrangement during retention of orthodontically rotated teeth. *Angle Orthod* 1959;29:105-13.

21. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. *J Prosthet Dent* 1973; 29:358-82.
22. Levin EI. Dental esthetics and the golden proportion. *J Prosthet Dent* 1978;40:244-52.
23. Brisman AS. Esthetics: a comparison of dentists' and patients' concepts. *J Am Dent Assoc* 1980;100:345-52.
24. Qualtrough AJ, Burke FJ. A look at dental esthetics. *Quintessence Int* 1994;25:7-14.
25. Kokich VG. Anterior dental esthetics: an orthodontic perspective III. Mediolateral relationships. *J Esthet Dent* 1993;5: 200-7.
26. Kokich VG. Enhancing restorative, esthetic and periodontal results with orthodontic therapy. In: Schluger S, Yuodelis R, Page R, Johnson R, editors. *Periodontal therapy*. Philadelphia: Lea and Febiger; 1990. p. 433-60.
27. Sullivan TC, Turpin DL, Årtun J. A postretention study of patients presenting with a maxillary median diastema. *Angle Orthod* 1996;66:131-8.
28. Kurth J, Kokich VG. Open gingival embrasures after orthodontic treatment in adults: prevalence and etiology. *Am J Orthod Dentofacial Orthop* 2001;120:116-23.
29. Vig RG, Brundo GC. The kinetics of anterior tooth display. *J Prosthet Dent* 1978;39:502-4.
30. Mackley RJ. An evaluation of smiles before and after orthodontic treatment. *Angle Orthod* 1993;63:183-90.
31. Janzen EK. A balanced smile—a most important treatment objective. *Am J Orthod* 1977;72:359-72.