ORIGINAL ARTICLE

Buccal corridors and smile esthetics

Theodore Moore,[a] Karin A. Southard,[b] John S. Casko,[c] Fang Qian,[d] and Thomas E. Southard[e]
Iowa City, Iowa, and Loveland, Colo

Purpose: The purpose of this study was to determine the influence of buccal corridors on smile attractiveness when judged by lay persons. **Material:** Full-face color slides of 10 randomly selected smiling subjects (5 women, 5 men) were digitized. The maxillary posterior dentitions for all subjects were digitally altered to produce a range of smile fullness: narrow (28% buccal corridor), medium-narrow (22% buccal corridor), medium (15% buccal corridor), medium-broad (10% buccal corridor), and broad (2% buccal corridor). The 5 images of each subject were paired into 11 possible combinations, and the resulting 110 pairings were randomly projected to a panel of 30 adult lay persons who compared the 2 images in each pair for smile attractiveness. **Results:** Statistical analysis with the Wilcoxon signed-rank and rank-sum tests showed that (1) a broader smile (minimal buccal corridor) was judged by lay persons to be more attractive than a narrow smile (larger buccal corridors), and (2) no significant differences were found in judging between male and female subjects or between male and female judges. **Conclusions:** Having minimal buccal corridors is a preferred esthetic feature in both men and women, and large buccal corridors should be included in the problem list during orthodontic diagnosis and treatment planning. (Am J Orthod Dentofacial Orthop 2005;127:208-13)

The esthetics of a smile is influenced by such features as the amount of gingival display, the presence of a smile arc, and the shade of the teeth. A smile demonstrating minimal gingival display has been deemed more esthetic than a smile with excessive gingival display.[1-3] A smile demonstrating a curvature of the maxillary incisal edges (smile arc) that parallels the curvature of the lower lip is considered more esthetic[1,4,5] than a smile with a flat maxillary incisal edge relationship. Furthermore, coincidence of the maxillary midlines with the facial midline has been found to be important,[6] as has a light shade of teeth.[7]

Another potentially important smile feature is the presence or absence of buccal corridors. In 1958, Frush and Fisher[8] defined buccal corridors as the spaces between the facial surfaces of the posterior teeth and the corners of the lips when the patient is smiling. Their interest in buccal corridors derived from attempts to fabricate a more realistic-looking denture. They believed that a very broad denture (absence of buccal corridors) gave the patient an unnatural, "denture" appearance and that buccal corridors added to the illusion of a natural dentition. They stated that the size and shape of the buccal corridors were not important, as long as the buccal corridors were noticed. Finally, the presence or absence of buccal corridors can be influenced not only by the broadness of the denture, as discussed by Frush and Fisher, but also by the anteroposterior position of the maxilla relative to the lip drape.[4]

The esthetic values of today might differ from those of 50 years ago, when Frush and Fisher published their article. There has been an overall shift away from complete denture prosthetics as more people keep their teeth longer. Consequently, a full smile might no longer be perceived as a "denture smile." Additionally, the ethnic mix in the United States has changed dramatically. These trends could be redefining the influence of buccal corridors on smile esthetics. Dunn et al[7] concluded that, in terms of the actual number of teeth displayed, lay persons find having a greater number of teeth displayed during smiling is significantly more attractive than having fewer teeth displayed.

There is 1 frequently cited study of buccal corridors in the literature. In 1970, Hulsey[1] examined the influence of buccal corridors on smile attractiveness and concluded that variations in buccal corridors seemed to have no significance. However, Hulsey measured the ratio of the distance between the maxillary canines to the distance between the corners of the smile; that is not

From the University of Iowa, Iowa City.
[a]Former orthodontic resident; in private practice, Loveland, Colo.
[b]Professor, Department of Orthodontics.
[c]Professor, B.F. and Helen Dewel endowed chair in clinical orthodontics, Department of Orthodontics.
[d]Senior research assistant, Department of Preventive and Community Dentistry.
[e]Professor and head, Department of Orthodontics.
This research was supported by the Dr George Andreason Memorial Fund.
Reprint requests to: Dr Thomas E. Southard, University of Iowa, College of Dentistry, Department of Orthodontics, Iowa City, IA 52242; e-mail, tom-southard@uiowa.edu.
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an actual measure of buccal corridors. Frush and Fisher[8] more accurately defined buccal corridors as the distance from the posterior teeth to the corners of the lips. In other words, a smile typically includes not only the 6 anterior teeth but also the first (and sometimes second) premolars. Therefore, Hulsey's study, in which a measure of only the anterior teeth was used, did not examine the influence of true buccal corridors.

In a recent study, investigators examined the influence of buccal corridors on smile esthetics after orthodontic treatment with and without extraction of first premolars.[9] In this instance, the investigators measured buccal corridors as defined by Frush and Fisher. They found no relationship between extraction esthetics and variables related to the buccal corridors.

The purpose of this study was to determine the influence of buccal corridors on smile attractiveness when judged by lay persons. We also hoped to determine whether a threshold exists in the ability of lay people to perceive differences between degrees of buccal corridors.

MATERIAL AND METHODS

The overall plan was to alter the amount of visible dentition (and buccal corridor) in subjects' smiling images and to have these images judged for smile attractiveness by a panel of lay persons. Frontal, smiling, 35-mm color slides of 10 randomly selected people (5 women, 5 men) were acquired from records of the University of Iowa Orthodontic Department. All subjects had completed comprehensive orthodontic treatment within the past 12 months.

Because the original slides were made with slight variations in patient-to-film distances, exact linear measurement of buccal corridor widths and smile fullness widths was not possible. Instead, buccal corridor and smile fullness were calculated as percentages of the commissure width.

Additionally, because the lips themselves have a visible thickness at the commissures, we chose to define the inner commissure as the most medial aspect of the commissure and the outer commissure as the most lateral aspect (Fig 1). Because the dentition can maximally fill the smile only to the innermost aspect of the commissure, we chose to calculate and present buccal corridor and smile fullness as ratios of the inner commissure width.

Smile fullness was calculated as the visible maxillary dentition width divided by the inner commissure width, and buccal corridor was calculated as the difference between the visible maxillary dentition width and the inner commissure width divided by the inner commissure width. Both ratios were reported as percentages. The sum of the 2 ratios for a given image would equal 100%. Finally, we defined smile breadth as the percent ratio of the outer commissure width to the width of the face at the vertical level of the commissures.

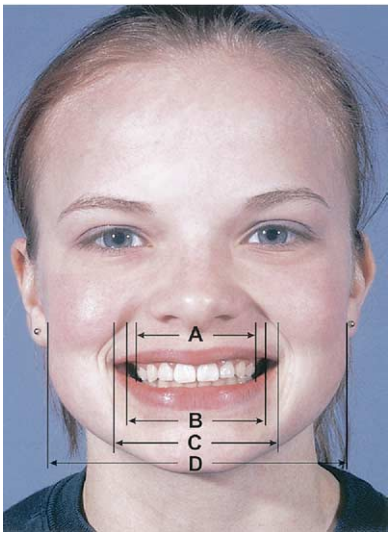

Fig 1. Measurement of buccal corridor, smile fullness, and smile breadth. Smile fullness was calculated as visible maxillary dentition width (*A*) divided by inner commissure width (*B*). Buccal corridor was calculated as difference between visible maxillary dentition width and inner commissure width divided by inner commissure width. Both ratios are reported as percentages. Smile breadth was defined as percent ratio of outer commissure width (*C*) to width of face at vertical level of commissures (*D*).

To produce the varying sizes of buccal corridors, each slide was first digitally scanned (Nikon Coolscan 4000; Melville, NY). The resulting images were imported into Adobe Photoshop version 7.0 (Adobe Systems, San Jose, Calif) and projected on a monitor, with all images set to the same magnification. To preserve a realistic appearance, it was decided to leave the intercanine width unaltered. This width was, on average, 72% of the inner commissure width.

Five altered images were produced (Fig 2) for each of the 10 subjects to produce a range of 5 smile fullnesses: narrow (28% buccal corridor), medium-narrow (22% buccal corridor), medium (15% buccal corridor), medium-broad (10% buccal corridor), and broad (2% buccal corridor). These 5 values were chosen after initial trial-and-error testing.

To attain each of these variations, the original image was first altered to produce a broad visible dentition. This was done by copying existing posterior

Fig 2. Representative subject illustrating range of smile fullness generated: narrow (28% buccal corridor), medium-narrow (22% buccal corridor), medium (15% buccal corridor), medium-broad (10% buccal corridor), and broad (2% buccal corridor).

teeth in the smile and "stretching" them to fill the buccal corridors. Some artistic editing was needed to maintain a realistic look. This broad posterior dentition image was then reduced to produce subsequent images with narrower and narrower dentitions (larger and larger buccal corridors).

The only difference between altered images of the same subject was the amount of buccal corridor (smile fullness). Consequently, the effect of all other variables (eg, minor differences in head position, amount of incisor display) was eliminated.

Next, each altered image was paired with another altered image of the same subject. In other words, a series of paired images of the same subject would be displayed to the lay panel; the only difference between the paired images was the amount of smile fullness (buccal corridor) present. There were 11 possible combinations of pairings for each subject: narrow vs medium-narrow, narrow vs medium, narrow vs medium-broad, narrow vs broad, medium-narrow vs medium, medium-narrow vs medium-broad, medium-narrow vs broad, medium vs medium-broad, medium vs broad, medium-broad vs broad, and randomly selected identical pairings, such as medium vs medium. The pairings were sorted with a random number generator for both sequence and left–right positioning. The pairings were then placed into a PowerPoint (Microsoft, Redmond, Wash) slide show for display to the lay panel.

The panel consisted of 15 men and 15 women, white American lay persons with no dental training. The slide show was presented with a digital projector (Notevision, model PG-C30XU, Sharp, Conshohocken, Pa) onto a white screen. Five "warm-up" slides, starting at 10 seconds per slide and gradually decreasing to 5 seconds per slide, were included at the beginning of the slide show. These 5 slides were not included in the data analysis. The remaining 110 image pairings were shown for 5 seconds each.

The judges were instructed to choose the smile they preferred from each pairing and mark their opinion as left much better, left better, same, right better, or right much better. A point system, based on response to each pairing, was used to establish a score for each increment of buccal corridor width. For example, assume that a pair of images for 1 subject was displayed with the left image showing medium smile fullness and the right image showing narrow smile fullness. If "left much better" was chosen by a judge, then the medium smile fullness image had 2 points added to its overall score, whereas the narrow smile fullness image had 2 points deducted from its overall score. If "left better" was chosen, then the medium smile fullness had 1 point added to its overall score and the narrow smile fullness image had 1 point deducted from its overall score. If "same" was chosen, then 0 points were added to both the medium and the narrow smile fullness image overall scores. The mean score was computed for each combination of subject image and judge. Descriptive and statistical tests were performed with these mean values. The information from the identical pairings was isolated and analyzed separately.

To compare the distributions of mean scores between the 2 photographs in a pairing, the nonparametric Wilcoxon signed-rank test was used. To compare the distributions of mean scores between male and female judges, and between male and female subjects, the nonparametric Wilcoxon rank-sum test was conducted. In all tests, $P < .05$ was used as the level of statistical significance.

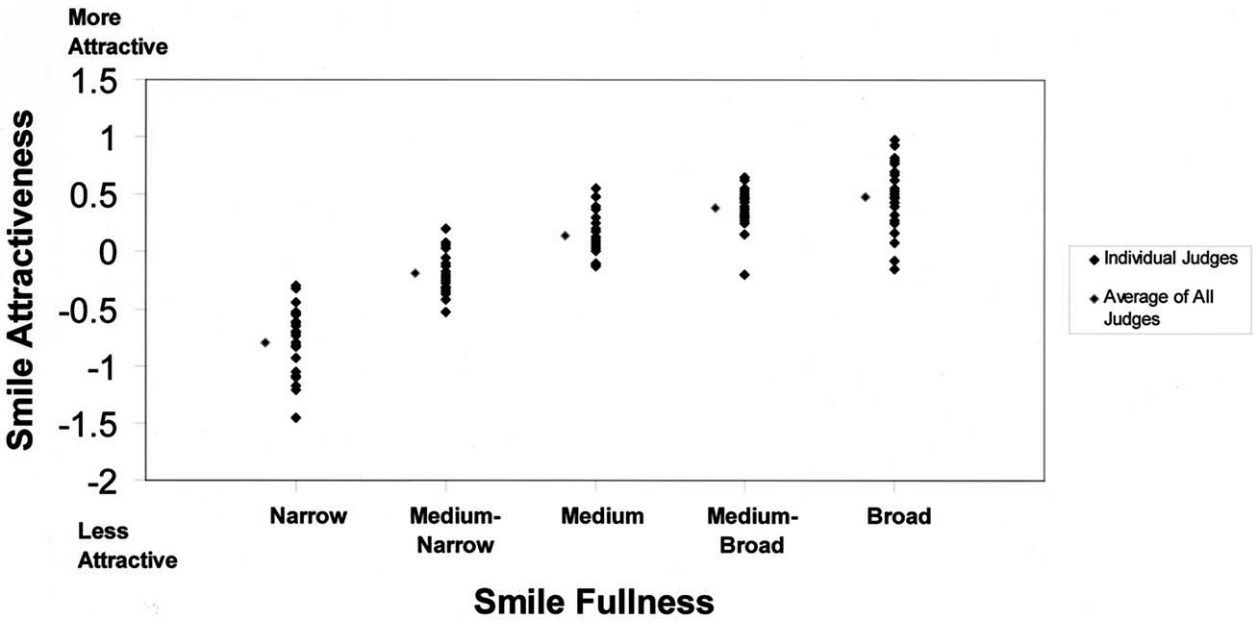

Fig 3. Smile attractiveness related to smile fullness and buccal corridor. Mean scores represent average from 30 judges. Smile fullness ranged from narrow (28% buccal corridor) to broad (2% buccal corridor).

RESULTS

A consistent relationship between smile fullness (buccal corridor) and smile attractiveness was shown in this study (Fig 3). The broader the smile (the smaller the buccal corridor), the more attractive the panel judged the smile to be. Similarly, the narrower the smile (the larger the buccal corridor), the less attractive the smile. On average, broad smile fullness (2% buccal corridors) was rated the best, followed by medium-broad fullness (10% buccal corridors), medium fullness (15% medium buccal corridors), and medium-narrow smile fullness (22% buccal corridors). Narrow smile fullness (28% buccal corridors) was rated least attractive.

Furthermore, the results from pairwise comparison by Wilcoxon signed-rank tests showed that the group of male judges and the combined group of male and female judges could detect differences ($P < .05$) between all degrees of smile fullness, except between medium-broad and broad smile fullness. The group of female judges could detect differences ($P < .05$) between all degrees of smile fullness. However, the data provided no evidence of a significant difference between female and male judges for any of the images by Wilcoxon rank-sum tests ($P > .27$).

This trend was also seen when the scores were separated into groups for male and female subjects. The nonparametric Wilcoxon rank-sum test detected no significant differences ($P > .11$) between male and female subjects at any degree of smile fullness when judged by all lay persons. Likewise, this trend was also seen when the scores were separated into groups for male and female judges. Analysis did not demonstrate any differences, at any degree of smile fullness, in grading between male and female judges ($P > .08$).

For the identical image pairings, 8 of the 10 subjects were correctly graded as the same by at least 22 of the 30 judges. For the other 2 subjects, 21 of the 30 judges correctly graded 1 subject's identical paring as the "same," whereas 17 of the 30 judges correctly graded the other subject's identical pairing as the "same."

Interestingly, all of the smile breadth measurements, which were unaltered, fell into a very small range. The percent ratios of outer intercommissure width to width of the face at the vertical level of the commissures ranged from 53% and 57%. No further analyses were performed on this portion of the data because of the lack of variability.

DISCUSSION

The representative subject in Figure 2 demonstrated smile attractiveness scores that closely matched the average for all 10 subjects. Her smile attractiveness ranged from −0.83 for narrow smile fullness (relatively poor smile attractiveness, 28% buccal corridor) to

+0.52 for broad smile fullness (excellent smile attractiveness, 2% buccal corridor). This subject also demonstrates the principal finding of this study: broad smile fullness (minimal buccal corridor) was judged by lay persons to be more attractive than narrow smile fullness (larger buccal corridors). That is, lay persons prefer smiles that are visibly filled with the dentition, commissure to commissure. Smiles with large buccal corridors are considered less attractive.

These findings contrast sharply with those of Hulsey,[1] who reported that lay persons had no preference regarding buccal corridor width and that width variations seemed to be of no significance in determining smile attractiveness. However, as stated earlier, Hulsey calculated the intercanine width/smile width ratio and did not take into account any visible dentition distal to the maxillary canines. Frush and Fisher[8] defined buccal corridors as the spaces between the buccal surfaces of the posterior teeth and the corners of the mouth when smiling; Hulsey did not actually examine buccal corridors as defined by Frush and Fisher. Also, Hulsey used pictures limited to mouths. We used pictures of the entire face and can conclude that the size of buccal corridors influences smile attractiveness when the entire face is taken in context. The findings of the present study parallel a trend noted by Dunn et al[7]: lay people considered more teeth displayed to be more attractive.

Has the public's perception of smiles changed since Frush and Fisher[8] suggested that the presence of buccal corridors was valuable in creating a more realistic denture? Does the public now consider a broader smile, with minimal or no buccal corridors, a projection of youth and health? Considering the aging character of our population and its preoccupation with youth, an affirmative answer to both of these questions is a distinct possibility.

Lay persons were able to discriminate, to a statistically significant extent ($P < .05$), between all 5 degrees of smile fullness except between broad (2% buccal corridor) and medium-broad (10% buccal corridor). This finding demonstrates the ability of humans to detect subtle variations in a smile, even when those features are seen in the context of the entire face.

How do these results translate into clinical practice? The only difference between altered images of a smiling subject in our study was the broadness of the smile (size of the buccal corridor). In other words, although this study points to the importance of minimizing buccal corridors in maximizing smile esthetics, fullness of the smile is but one feature that determines smile attractiveness. Tooth shade, if not the most important factor, is a very significant element in smile attractiveness.[7] Other features, such as the amount of incisal and gingival display, along with tooth length and shape, also play important roles.[1-3,10-12]

Finally, although this study establishes the importance of 1 esthetic feature in the art of orthodontics, its findings should not be interpreted as advocating wholesale maxillary arch expansion. At least as important as the art of orthodontics is the science of orthodontics. Maxillary expansion, orthopedically or surgically achieved, to correct a maxillary transverse deficiency might be a rational treatment option; and the reduction of large buccal corridors in such a case will improve esthetics and should be a consideration in treatment planning. However, reduction of buccal corridors should not be considered the rationale for maxillary expansion in an otherwise normal maxilla.

CONCLUSIONS

- When the only difference between altered images of a smiling subject was the broadness of the smile, the presence of broad smile fullness (minimal buccal corridors) was consistently judged by lay persons to be more attractive than narrower smile fullness (larger buccal corridors).
- No significant differences were found in judging smile attractiveness with varying levels of smile fullness between either male and female subjects or between male and female judges.
- Having minimal buccal corridors is a preferred esthetic feature for both men and women, and large buccal corridors should be included in the problem list during orthodontic diagnosis and treatment planning.

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