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TABLE OF CONTENTS

The Effect of Axial Midline Angulation on Dental Esthetics[*]

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ABSTRACT

The purpose of this study was to analyze the effect of various degrees of axial midline angulation on the attractiveness of a smile. We explored the influence of age, race, sex, direction of midline deviation, education, occupation, and dominant hand on each evaluator's perception of dental esthetics. Photographs of smiling subjects—one man and one woman—were altered to produce both left and right axial midline angulations in 5° increments. Fifty orthodontists and 50 laypeople evaluated these altered photographs by assigning both a numerical attractiveness rating and an acceptable or unacceptable rating to each. The results showed that attractiveness scores and acceptability ratings declined consistently as axial midline angulation increased. Statistical analysis showed that both sex of the subject and occupation of the judge were significant variables ($P < .05$) in the evaluation of the subjects. Age, race, sex of the judge, education level, direction of midline deviation, and dominant hand were not statistically significant. The mean acceptable midline angulation for the male subject was 6.6 ± 4.5° for orthodontists and 10.7 ± 6.2° for laypeople. For the female subject, the mean acceptable threshold was 6.4 ± 4.0° for orthodontists and 10.0 ± 6.1° for laypeople ($P < .001$). Discrepancies of 10° were unacceptable by 68% of orthodontists and 41% of laypeople.

KEY WORDS: Incisor crown angulation, Dental esthetics.

INTRODUCTION Return to TOC

One of the goals of orthodontic treatment is to achieve maxillary and mandibular midlines that are coincident—both with each other and with the facial midline. Coincident midlines serve both a functional[1] and an esthetic purpose.[2–5] Coincident midlines are an important functional component of occlusion and can be used as a clinical guide in establishing good buccal interdigitation.[1] Esthetically, the midline is the most important focal spot in the smile.[5]

Esthetics in dentistry has increasingly become a major concern for patients and often serves as a primary reason for seeking dental care. Dental esthetics can affect not only facial but also social attractiveness.[6] Shaw et al[6] showed that persons with normal incisor relationships were viewed as being more friendly, popular, intelligent, and in a higher social class than those with an abnormal dental arrangement.

Symmetry is an essential component in the perception of dental esthetics.[7] Although perfect bilateral symmetry seldom exists in living

organisms,[8] it is one of the most important factors in defining the attractiveness of a smile.[9] A properly placed midline contributes to the desirable effect of balance and harmony of the dental composition.

Several studies have been done to test how far the maxillary midline can laterally deviate from the facial midline before achieving an unacceptable esthetic result.[2–4] Beyer and Lindauer[2] and Johnston et al[3] found that a dental to facial midline discrepancy greater than two mm is esthetically unacceptable. In a similar investigation, Kokich et al[4] found that discrepancies of up to four mm could go undetected.

Fewer studies, however, have been done to evaluate the esthetic effect of axial inclination of the maxillary midline. Clinically, this improper angulation can often go unnoticed because of asymmetric wear of the incisal edge.[10] Kokich et al[4] evaluated incisor crown angulation by altering the axial angulation of the anterior teeth in a photographed smile. They concluded that all the groups surveyed found even minor deviations from the ideal unattractive.

Previous studies evaluated axial inclination of the maxillary midline by angulating the anterior teeth to one side only. Current orthodontic literature does not definitively state whether dental attractiveness is affected when teeth have been angulated to the left vs the right side. In addition, full facial photographs of the subjects have been underused. Adding this aspect to the investigation will be valuable because in real life situations, one rarely sees a mouth out of the context of the face. Facial photographs are commonly used for evaluation in both sociopsychological and other dental studies, and it has been shown that judgments of photographs are fairly consistent with those of real persons.[11]

The aim of this study was to address the effect of mediolateral axial dental midline inclination on the perceived attractiveness of the smile. The purpose of our investigation was to examine the following four factors for perception of midline deviation: (1) gender effect on use of facial photographs of both male and female subjects, (2) direction of midline deviation by axially inclining the maxillary anterior teeth both to the left and to the right, (3) effect of hemispheric dominance by evaluating left-handed vs right-handed judges testing the difference between the right and the left brain hemispheres in perception of beauty,[12] and (4) the angular threshold at which the orthodontist vs the general public begins to recognize a deviation from the ideal and to determine the esthetic significance of this deviation.

Therefore, it was hypothesized that the sex of the model and that of the judge, direction of the deviation, and dominant hemisphere will all have an effect on the dental attractiveness ratings of each subject. Also, orthodontists and orthodontic residents will be more critical in their evaluation of axial midline angulation, and their threshold of acceptability will be lower than that of the general public.

MATERIALS AND METHODS

One male and one female subject were selected for this study. The subjects were both white and 25 years of age. They were chosen based on their facial and dental symmetry. The subjects had an average smile line, revealing 75–100% of the maxillary anterior teeth.[13] Informed consent was obtained from the subjects, and their rights were protected. Frontal facial photographs were taken of both subjects, and these digital photographs were altered using Adobe Photoshop 5.0 to achieve varying degrees of dental midline angulation. The maxillary dental midlines were altered both to the left and to the right at 5°, 10°, 15°, and 20° angles from the facial midline. Only the positions of the teeth were altered; the soft tissues remained untouched. The images were condensed to 50% of life size (each 4.5 × 6 inches) and were then color printed on Hewlett-Packard premium glossy photo paper (8.5 × 11 inches). These photographs were placed in clear protective sheaths and set in a predetermined order for evaluation. Only the examiner knew this predetermined order. In addition to the 18 altered images (nine male and nine female), four images were duplicated and used to test for intraexaminer reliability. All 11 photographs of the male subjects were arranged first and were followed directly by the 11 photographs of the female subjects. A condensed version of the male photographs is shown in Figure 1 ⬤=.

Of the judges who evaluated the images, 50 were orthodontists or orthodontic residents and 50 were laypeople, both males and females. The laypeople consisted of patients, parents, and staff of the Harvard Dental Center. General dentists, dental hygienists, and dental assistants were not included among the laypeople. The judges selected were asked to state their age, race, sex, occupation, and dominant hand. None of the judges was aware of the aim of the study. Each judge was shown individually the various photographs in the predetermined order and asked to rate the attractiveness of the smile on a scale of 1 to 5, where 1 equals very attractive and 5 equals very unattractive. They were also asked whether the smile in each photograph was acceptable to them. The judges were able to flip through the notebook of photographs at their leisure but were not allowed to flip back and forth between photographs.

Data were analyzed with univariate and bivariate statistics. Descriptive statistics were calculated using means and frequencies where appropriate. To examine differences in the threshold levels of acceptability between male and female judges as well as between orthodontists and laypeople, t-tests were used. Chi-square analyses were performed to examine the effect of differences in degree of angulation and handedness between male and female judges as well as between orthodontists and laypeople on acceptability ratings. Multiple regression analysis was performed to determine the independent effects of sex of the judge and of the subject's sex, age, race, education level, direction of midline deviation, occupation, and dominant hand. Significance was determined by a P value of <.05. Data analysis was conducted with SPSS/10.0 PC.

RESULTS

The judges who participated in the survey consisted of 50 orthodontists or orthodontic residents and 50 laypeople. Fifty-seven of these judges were males, and 43 were females. The total mean age was 40.0 ± 15.3 years. The mean age of the orthodontists was 39.7 ± 14.6 years, and the mean age of the laypeople was 40.2 ± 16.1 years. Specific demographic data for the two groups of judges, including sex, race, educational level, and dominant hand, are given in Table 1 ⊙▬.

Interexaminer reliability was assessed by the kappa statistic. The results of the kappa statistic showed interexaminer reliability of 0.58, which indicates moderate agreement among different raters. This is something to be expected in such a study, taking into consideration the study design and the research questions asked. Multiple regression analysis showed that age, race, sex of judge, education level, direction of midline deviation, and dominant hand did not significantly affect the judge's ratings of each of the subjects. Therefore, these variables were removed from the remainder of the data analysis, and the judge's ratings for the direction of midline deviation (right vs left) were combined for each degree increment. Occupation of the judge and sex of the subject were both significantly associated with attractiveness and acceptability ratings in the regression analysis. The effect of degree of angulation on acceptability was compared for male vs female judges as well as for orthodontists vs laypeople by a chi-square analysis.

Attractiveness scores for the male subject and the female subject are summarized in Tables 2 ⊙▬ and 3 ⊙▬. The mean scores given by the judges are shown for right and left axial midline deviations. These data show that as the midline angulation increased, the altered images were consistently rated as less attractive. Comparisons of these attractiveness scores, as reported by orthodontists and laypeople, are shown in Figures 2 ⊙▬ and 3 ⊙▬. Statistically significant differences ($P < .001$) between these two groups were found for the 10°, 15°, and 20° angulations by using two sample t-tests.

Acceptability ratings for each of the altered images are summarized in Figures 4 ⊙▬ and 5 ⊙▬. The percentage of judges who rated each altered image as acceptable was lower for orthodontists than for laypeople. This difference was statistically significant ($t = -7.23$, $P < .001$) for the 10°, 15°, and 20° angulations.

The mean thresholds for the highest acceptable percentage of maxillary midline angulations are shown in Table 4 ⊙▬. The threshold for each judge was established by taking their highest recorded acceptable rating (either right or left). Separate thresholds were determined for each subject. The mean thresholds were determined by averaging the thresholds of each judge. For the male subject, the mean acceptable threshold was $6.6 \pm 4.5°$ for orthodontists and $10.7 \pm 6.2°$ for laypeople. For the female subject, the mean acceptable threshold was $6.4 \pm 4.0°$ for orthodontists and $10.0 \pm 6.1°$ for laypeople. These differences between the orthodontist's and the layperson's thresholds were statistically significant ($P < .001$).

DISCUSSION Return to TOC

The aim of this study was to evaluate how dental esthetics is affected by varying degrees of axial maxillary midline angulation. A series of altered photographs was generated of a male subject and a female subject with axial midline angulations at 0°, 5°, 10°, 15°, and 20° increments both to the left and to the right of the facial midline. The judges were instructed to rate the attractiveness of the smile in each of the photographs on a scale of 1 to 5, where 1 equals very attractive and 5 equals unattractive. They were also asked to state whether each smile was acceptable to them. "Acceptable" indicated that there was no need to seek orthodontic treatment for the appearance of the smile.

Our first goal was to test whether there was a gender effect by using both male and female judges and subjects. Our analysis revealed that the sex of the judge was not significant but that the sex of the subject did play a role in perceived attractiveness of the altered images. The female subject received both lower attractiveness scores and a lower threshold of acceptability than did the male subject. This difference is evident for both orthodontists and laypeople. This could be due to several factors. It may mean that people are less tolerant of axial midline deviations in women than in men. This finding is consistent with that of Beyer and Lindauer,[2] who reported a lower acceptability threshold for female subjects on altering lateral midline deviation. It also may be due to the idea that people are generally more critical of physical attractiveness in women.[14] Another explanation might be the baseline attractiveness of each of the subjects' photographs. The attractiveness scores and acceptability levels of even the 0° photograph were lower for the female subject than for the male subject. This may be one disadvantage of using facial photographs. A further discrepancy occurred in the 0° photographs between orthodontists and laypeople. The baseline female acceptability ratings were lower for the orthodontic group than for the laypeople, whereas the smile of a male subject at 0° was acceptable to 98% of both groups. This may be due to esthetic issues other than the midline that can draw the attention of the orthodontist before the layperson. The design of this study attempted to eliminate the confounding influences of variations in background facial appearance by using computer-generated images with only the dentition of the subjects altered. However, the results of this study seem to indicate that conducting a pilot study with the baseline photographs might have helped to ensure equally attractive male and female subjects before generating the axial angulations.

Our second and third hypotheses were related to the direction of the midline deviation. We were interested in investigating whether the direction of deviation played a role in the evaluation of each subject and, if so, whether this direction was related to the dominant brain hemisphere of each judge. Mead and McLaughlin[15] showed that right-handed (and therefore right hemisphere dominant) people prefer photographs with the important content on the right side. We found no significant data to show that either direction of deviation or dominant hand had an effect on the perceived attractiveness of the photographs. One limitation to this evaluation is that only 14% of the judges

stated that they were left handed. It might be interesting to follow up on this aspect of the study with a larger group of left-handed evaluators.

Our fourth and final hypothesis aimed to evaluate the difference between orthodontists and laypeople in their evaluation of axial midline angulation. We found significant differences in both attractiveness scores and angular thresholds between the two groups. For example, 91% of orthodontists found a 15° axial midline angulation unacceptable on the male subject, whereas only 64% of laypeople found this unacceptable. For the female subject, 93% of orthodontists and 70% of laypeople found a 15° angulation unacceptable. The mean thresholds of the orthodontists for the male subject and the female subject were 6.6° and 6.4°, respectively, whereas these thresholds were 10.7° and 10.0°, respectively, for the laypeople. This difference of 4° was consistent for both subjects and shows that the orthodontic group is more critical of axial deviations than is the general public.

CONCLUSIONS Return to TOC

This study found that increasing the axial maxillary midline angulation consistently decreases the attractiveness of a smile. Discrepancies of 10° were unacceptable by 68% of orthodontists and 41% of laypeople. Axial midline angulations of 10° or greater are generally unacceptable and should be assessed for orthodontic treatment.

Because of the design of the current study, the differences in the background attractiveness of the male and female facial pictures used in this study limit the extent of any comparative analysis of how male vs females faces were rated.

This study also helps in identifying the problems associated with conducting research on gender differences in facial attractiveness by using fullface photos. In using fullface photographs, it is difficult to achieve identical facial features in a male and a female model. Perhaps this can be done using computer-generated faces, but this study did not attempt to explore that approach.

ACKNOWLEDGMENTS

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TABLES Return to TOC

TABLE 1. Demographic Information of Judges

A. Judge Sex	Male (%)	Female (%)
Orthodontists (n = 50)	68	32
Laypeople (n = 50)	44	56
Total (n = 100)	56	44

B. Judge Dominant Hand	Right (%)	Left (%)
Orthodontists (n = 50)	90	10
Laypeople (n = 50)	82	18
Total (n = 100)	86	14

C. Highest degree of education completed	High School (%)	Some College (%)	College (%)	Graduate (%)
Orthodontists (n = 50)	N/A	N/A	N/A	100
Laypeople (n = 50)	10	20	30	40
Total (n = 100)	5	10	15	70

D. Judge Race	White (%)	Asian (%)	African-American (%)	Hispanic (%)	Other (%)
Orthodontists (n = 50)	76	16	0	2	6
Laypeople (n = 50)	70	8	12	4	6
Total (n = 100)	73	12	6	3	6

TABLE 2. Attractiveness Scores for Male Subject

		Degree and Direction of Midline Angulation[a]								
		20°L[b]	15°L[b]	10°L[b]	5°L	0°	5°R	10°R[b]	15°R[b]	20°R[b]
Total surveyed (n = 100)	Mean	4.62	3.98	3.47	2.65	2.00	2.33	3.70	4.23	4.52
	SD	0.78	0.99	0.99	1.09	0.98	0.94	0.99	0.95	0.73
Total orthodontists (n = 50)	Mean	4.76	4.24	3.70	2.63	1.90	2.20	3.96	4.48	4.66
	SD	0.52	0.89	0.89	1.02	0.76	0.86	0.75	0.69	0.63
Total laypeople (n = 50)	Mean	4.48	3.72	3.24	2.67	2.10	2.46	3.44	3.98	4.38
	SD	0.95	1.03	1.04	1.17	1.16	1.01	1.13	1.11	0.81

[a] Scores are based on a five-point scale—1 being very attractive and 5 very unattractive.
[b] Statistically significant differences, $P < .001$.

TABLE 3. Attractiveness Scores for Female Subject

		Degree and Direction of Midline Angulation[a]								
		20°L[b]	15°L[b]	10°L[b]	5°L	0°	5°R	10°R[b]	15°R[b]	20°R[b]
Total surveyed (n = 100)	Mean	4.44	4.16	3.87	2.77	2.47	2.69	3.36	4.36	4.54
	SD	0.82	0.83	0.90	1.00	0.98	0.99	0.94	0.82	0.78
Total orthodontists (n = 50)	Mean	4.58	4.34	4.04	2.92	2.50	2.53	3.52	4.55	4.74
	SD	0.67	0.77	0.83	0.99	1.05	0.89	0.79	0.64	0.49
Total laypeople (n = 50)	Mean	4.30	3.98	3.70	2.63	2.44	2.85	3.20	4.16	4.34
	SD	0.93	0.84	0.93	1.01	0.91	1.07	1.05	0.94	0.96

[a] Scores are based on a five-point scale—1 being very attractive and 5 very unattractive.
[b] Statistically significant differences, $P < .001$.

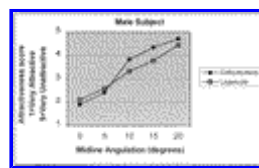**TABLE 4.** Threshold of Acceptable Maxillary Midline Angulation

|	Male Subject (°)	Female Subject (°)
Orthodontists	6.6 ± 4.5	6.4 ± 4.0
Laypeople	10.7 ± 6.2	10.0 ± 6.1

FIGURES [Return to TOC]

Click on thumbnail for full-sized image.

FIGURE 1. Male subject. a) 0;dg angulation b) 5;dg left c) 10;dg left d) 15;dg left.
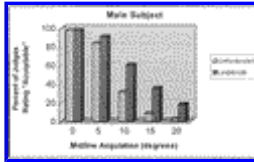

Click on thumbnail for full-sized image.

FIGURE 2. Comparison of orthodontists versus laypersons attractiveness scores for each degree of maxillary midline angulation
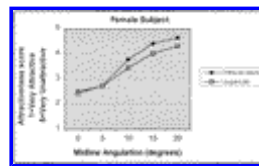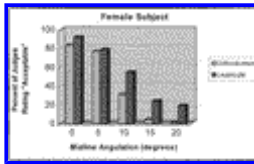

Click on thumbnail for full-sized image.

FIGURE 3. Comparison of orthodontists versus laypersons attractiveness scores for each degree of maxillary midline angulation

FIGURE 4. Percentage of judges rating each altered image ``acceptable''

FIGURE 5. Percentage of judges rating each altered image ``acceptable''

* Use of human subjects in this project was approved by Harvard Medical School/Harvard School of Dental Medicine Committee on Human Studies.

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