Effects of Vertical Positions of Anterior Teeth on Smile Esthetics in Japanese and Korean Orthodontists and Orthodontic Patients

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ABSTRACT

Statement of Problem: The perception of a pleasing smile may differ between the countries in Asia or may be converging on a more internationally pleasing one.

Purpose: The aim of this study was to evaluate the influence of vertical positions of anterior teeth on smile esthetics as assessed by Japanese and Korean orthodontists as well as by orthodontic patients.

Materials and Methods: A standard composite smile was constructed from different females' intraoral and extraoral photographs. Vertical positions of anterior teeth were modified digitally in 1-mm increments, from 5 mm upper lip coverage of the incisors to 5 mm gingival exposure. Using a visual analog scale, 41 Japanese orthodontists and 96 Japanese orthodontic patients, 25 Korean orthodontists, and 72 Korean orthodontic patients rated the attractiveness of 11 smiles with altered gingival displays.

Results: Overall, the Japanese and Korean raters assigned similar esthetic scores between the corresponding groups. The male orthodontic patients assigned higher scores to the smiles with upper lip coverage of the teeth than the corresponding females did in both countries. The female patients assigned clinically significant higher scores to the smiles from 2 mm upper lip coverage of the teeth to 0 mm gingival exposure in both countries.

Conclusions: In both countries, the orthodontists and the female patients shared the similar preference in the smile evaluation of vertical positions of anterior teeth, whereas the male orthodontic patients were more tolerant of upper lip coverage of the anterior teeth than the orthodontists and the female patients.

CLINICAL SIGNIFICANCE

This study proposes 0 mm to 2 mm of upper lip coverage of the teeth as a threshold of acceptability for esthetic smile evaluations in female orthodontic patients. For male orthodontic patients, the paper proposes negative gingival display as a threshold of acceptability for esthetic smile evaluations.

INTRODUCTION

The World Health Organization's broader concept of health as a state of complete physical, mental, and

social well-being is widely embraced. For orthodontists and many other dental and medical specialists, this acceptance has shifted the greatest emphasis from function and performance to far more weight being

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placed on appearance.¹ Facial attractiveness is highly correlated with increased quality of life and interpersonal success.² Furthermore, it is suggested that attractiveness influences personality development and social interaction. The smile is one of the important contributing factors when evaluating facial appearance and expression. People tend to focus attention on the mouth as well as the eyes in social relationships.³ In particular, the smile is the second-most important factor, after the eyes, that is considered when estimating facial beauty.⁴ Thus, when making a treatment plan, clinicians should consider smile esthetics as a treatment objective in addition to creating a functional occlusion.

The smile line can be classified into three groups: a high smile line, an average smile line, and a low smile line.⁵ The high smile line, also known as a gingival smile line or a gummy smile, commonly provokes strong concern among clinicians. Recently, Van der Geld and colleagues⁶ noted that gingival display is a critical factor in satisfaction with smile appearance, and smiles with disproportional gingival displays are judged negatively and are correlated with personality characteristics. In Western societies, smiling with the teeth entirely displayed, including some gingival display, has been perceived as the most attractive.⁶ However, no scientific evidence has been reported for the Asian communities. Because several researches^{7–10} indicated that nationality and ethnicity do influence smile variables, it is rational to investigate the smile esthetics in different countries or ethnicities.

Dental professionals, including orthodontists, were found to be more critical of dental esthetics than laypeople in detecting minor discrepancies.¹¹ Although most orthodontists and surgeons tend to regard a gummy smile as unattractive,^{12–14} orthodontic patients' perception of the gingival display in smiling may differ. Thus, it is very important to evaluate the perceptions of smile esthetics in laypeople or orthodontic patients when the orthodontic treatment plan is determined.

Because Japan and Korea are geographically close, Japanese and Korean people are thought to share a common cultural background and population history. Currently, young adults tend to be exposed to mass media information. It is almost impossible to avoid being influenced by mass media, i.e., the Internet, television, movies, and magazines. Given these circumstances, Japanese and Korean people might have common preferences and perceptions of an attractive facial appearance or a pleasing smile. In light of these facts, this study aims to evaluate the influence of vertical positions of anterior teeth on smile esthetics as assessed by Japanese and Korean orthodontists as well as by orthodontic patients.

MATERIALS AND METHODS

This study was performed in accordance with the guidelines of the Helsinki Declaration revised in Seoul (2008). The research protocol was approved by Kyushu University Institutional Review Board for Clinical Research.

Sample Size

A sample size calculation was undertaken using nQuery Adviser (Version 6.01, Statistical Solutions, Cork, Ireland). According to our pilot study, the effect size was estimated at 0.975. On the basis of significance level of alpha 0.05, the sample size was calculated to achieve 80% power. The sample size calculation showed that 21 subjects for each group were necessary.

Construction of a Series of Images

A standard composite smile was constructed from different females' intraoral and extraoral photographs. This standard composite smile had the following features: ideally aligned teeth, displayed to the first molar; esthetic smiling lips; and harmonization of the lower lip curvature to the curvature of the incisal edges of the maxillary incisors and canines. When the upper lip was positioned at the upper gingival margin of the maxillary central incisors, we defined this level as the zero point (0 mm). The vertical positions of anterior teeth were altered by progressively moving the teeth up and down within the lip frame in 1.0-mm increments, from -5.0 mm to 5.0 mm with respect to the zero point. These image modifications were performed using Adobe Photoshop CS4 (San Jose, CA, USA). A positive value was assigned when a continuous band of the gingiva was revealed. A negative value was assigned when the upper lip covered the maxillary central incisors. The images were allocated from -5.0 mm to 5.0 mm with respect to the zero point on the A4 paper (Figure 1).

Raters

The Japanese raters consisted of 41 Japanese orthodontists (18 males, 23 females; mean age \pm SD 31.5 ± 7.2 years) and 96 Japanese orthodontic patients (36 males, 60 females; age range 15-29 years; mean age \pm SD 21.5 \pm 3.8 years) from Kyushu University Hospital in Fukuoka, Japan. The Korean raters consisted of 25 Korean orthodontists (12 males, 13 females; mean age \pm SD 27.9 \pm 2.3 years) and 72 Korean orthodontic patients (33 males, 39 females; age range 15-29 years; mean age \pm SD 22.2 \pm 3.2 years) from Pusan National University Dental Hospital in Pusan, Korea. A 50-mm-long visual analog scale (VAS) was placed below each smile to allow raters to evaluate the attractiveness of each smile independently. Each rater was asked to mark on the VAS the point that corresponded best to his or her judgment of the smile's attractiveness in sufficient time. After each rater completed the esthetic evaluations, the points marked on the VAS were converted into an esthetic score from 0 to 100.

Reliability

To ensure the reliability of the methodology, we randomly selected 10 raters from each group of the Japanese and Korean orthodontists and orthodontic patients and asked them to assess the smile esthetics of 11 images twice at least 2 weeks later. Intraclass correlation coefficients (ICC) were used for detecting the intra-rater agreement. High levels of reliability were found because all of the ICCs were greater than or equal to 0.7.

Statistical Analysis of the Data

The Mann–Whitney *U*-test was used to compare the median scores between the male and female raters for each group. The statistical significance level was set at 5%.

The VAS has been demonstrated to be reliable and valid for pain research. Kelly¹⁵ found a minimum clinically significant difference in the VAS pain score to be 9%. Todd and colleagues¹⁶ found the minimum clinically significant difference to be 13% of the VAS scale. To differentiate smile attractiveness, Parekh and colleagues¹⁷ used a 15% VAS difference as the clinically significant difference. In this research, a 15% VAS difference was used as the minimum clinically significant difference.

RESULTS

There was no significant difference in the effect of vertical positions of anterior teeth on perceived smile attractiveness between the males and females for both the Japanese and Korean orthodontists. Therefore, the pooled data for both the male and female raters for the Japanese and Korean orthodontists were used for the following analysis. The median values and ranges of the esthetic scores for each vertical position of anterior teeth, as assessed by the Japanese and Korean orthodontists, are shown in Figure 2. For the Japanese orthodontists, the median esthetic scores increased gradually from -5 mm to 0 mm and then decreased from 0 mm to +5 mm; particularly, the scores decreased significantly from -2 mm to -3 mm and 0 mm to +3 mm in every 1-mm step. For the Korean orthodontists, the median esthetic scores also increased gradually from -5 mm to 0 mm and then decreased from 0 mm to +5 mm; particularly, the scores decreased significantly from -1 mm to -4 mm and from 0 mm to +4 mm in every 1-mm step.

There were significant differences in the effect of the vertical positions of anterior teeth on perceived smile attractiveness between the males and females for both the Japanese and Korean orthodontic patients. The



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FIGURE 1. Series of 11 generated images illustrating the range of vertical positions of anterior teeth: -5.0 mm (5.0 mm upper lip coverage of the maxillary central incisors), -4.0 mm, -3.0 mm, -2.0 mm, -1.0 mm, 0 mm (standard composite smile, whose upper lip was tangent to the upper gingival margin of the maxillary central incisors), 1.0 mm (1.0 mm gingival display above the maxillary central incisors), 2.0 mm, 3.0 mm, 4.0 mm, 5.0 mm.

median values and ranges of the esthetic scores for each level of vertical position of anterior teeth, as assessed by the Japanese and Korean male orthodontic patients, are shown in Figure 3. For the Japanese male orthodontic

patients, the median esthetic score was relatively high (an esthetic score of >50) in the smiles with upper lip coverage of the teeth, and then it decreased from -1 mm to +5 mm; particularly, the score decreased



FIGURE 2. The median values and ranges of the esthetic scores for each vertical position of anterior teeth. A, The Japanese orthodontists; B, the Korean orthodontists (median, 25th and 75th percentiles, minimum and maximum). *Clinically significant.



FIGURE 3. The median values and ranges of the esthetic scores for each vertical position of anterior teeth. A, The Japanese male orthodontic patients; B, the Korean male orthodontic patients (median, 25th and 75th percentiles, minimum and maximum). *Clinically significant.

significantly from -1 mm to 0 mm and 0 mm to +1 mm. For the Korean male orthodontic patients, the median esthetic score was relatively high in the smiles with upper lip coverage of the teeth, and then it decreased from 0 mm to +5 mm; particularly, the score decreased significantly from 0 mm to +3 mm in every 1-mm step.

The median values and ranges of the esthetic scores for each level of vertical position of anterior teeth, as assessed by the Japanese and Korean female orthodontic patients, are shown in Figure 4. For the Japanese female orthodontic patients, the median esthetic score gradually increased from -5 mm to -1 mm, and then it decreased from -1 mm to +5 mm; particularly, the score decreased significantly from -2 mm to -3 mm, 0 mm to +1 mm, and +1 to +2 mm. For the Korean female orthodontic patients, the median esthetic score tended to increase from -5 mm to 0 mm,



FIGURE 4. The median values and ranges of the esthetic scores for each vertical position of anterior teeth. A, The Japanese female orthodontic patients; B, the Korean female orthodontic patients (median, 25th and 75th percentiles, minimum and maximum). *Clinically significant.

and then it decreased from 0 mm to +5 mm; particularly, the score decreased significantly from -2 mm to -3 mm, 0 mm to +1 mm, and +1 to +2 mm.

DISCUSSION

In this study, we utilized a lower-face view instead of a full-face view for the evaluation of smile esthetics. Although people might evaluate facial attractiveness by overall facial view, the full-face perspective mimics the effects of dental variables on smile esthetics. Moreover, Springer and colleagues¹⁸ concluded that there was little difference between the full-face and lower-face perspectives in the ratings of esthetic variables for the smile. Considering these facts, we focused on evaluating the influences of vertical positions of anterior teeth on smile esthetics using lower-face images.

The sample size calculation showed that a sample of 21 subjects for each group was necessary to achieve 80% power. Because 41 Japanese orthodontists, 96 Japanese orthodontic patients, 25 Korean orthodontists, and 72 Korean orthodontic patients were included in this study, the statistical power was considered to be high enough to reveal reliable results.

There was no significant difference in the esthetic scores between the male and female raters for both the Japanese and Korean orthodontists. On the other hand, the Japanese and Korean male orthodontic patients tended to assign clinically significant higher scores to low smile lines than did the corresponding females. These results suggest that the male patients were more tolerant of upper lip coverage of the anterior teeth than were the females in both countries. It is very interesting to note that no clinically significant gender difference was found for judging positive vertical positions of anterior teeth, i.e., gummy smiles. Geron and Atalia¹⁹ reported that excessive upper gingival display is more accepted by female evaluators. They hypothesized that the perception of esthetics is dependent on the development of a "form concept"; that is, the more frequently we observe a particular facial pattern, the more likely we perceive it as "correct." In fact, Tjan and Miller,⁵ Peck and colleagues,¹³ and Vig and Brundo²⁰ stated that a high smile line is a predominantly female characteristic (2-to-1 female-to-male ratio).

The main finding of this study was that overall, the Japanese and Korean raters had a common preference in the evaluation of smile esthetics with regard to the vertical positions of anterior teeth between the corresponding groups. However, we found a few differences in preference between the two countries. The Korean raters tended to assign higher scores to the high gingival smile line (+1 mm and +2 mm gingival exposure) than the corresponding Japanese raters for both the orthodontists and the orthodontic patients. On the other hand, the Japanese raters tended to assign higher scores to the low smile line compared with the corresponding Korean raters.

Assuming that unattractive smiles are those with esthetic scores of 0 to 50 and that attractive smiles are those with scores of 51 to 100, the Japanese and Korean female orthodontic patients considered smiles from 2 mm of upper lip coverage to 0 mm of gingival display to be attractive. Furthermore, the esthetic scores decreased significantly from these corresponding values. It is highly important to note that this small, 1-mm difference between 0 mm to +1 mm gingival exposure or 2 mm to 3 mm upper lip coverage caused a clinically significant difference (15% VAS score difference) in the preference for smile esthetics. From the earlier results, for the female orthodontic patients, we propose 0 mm to 2 mm of upper lip coverage of the teeth as a threshold of acceptability for esthetic smile evaluations. These results imply that orthodontists should take into consideration the vertical positions of anterior teeth when they treat Asian female patients with more than 1 mm gingival exposure or 3 mm upper lip coverage. Hunt and colleagues²¹ reported that more attractive ratings were awarded to those smiles in which the amount of gingival exposure was within the range of 0 to 2 mm. Kokich and colleagues²² first reported that ± 4 mm of gingival display represented the threshold of acceptability but modified it to be ± 3 mm using smaller increments.²³ The more recent study⁷ in the United States found that the acceptable range of gingival display was ± 4 mm. In the Canadian laypeople, a narrower range of ± 3 mm is within the range of acceptability.¹⁰ These studies suggest that there might be ethnic and national differences in the preference of smile preferences, and Asian people might be sensitive to a smile line, particularly to a high smile line. However, with aging, people show less gingiva on smiling.^{20,24} Thus, the results should be interpreted with caution. Other considerations of the evaluations of

smile esthetics would be the demarcations of acceptability. In this study, we utilized 50 esthetic scores as an evaluation criterion of smile esthetics, because 50 esthetic scores are regarded as a simple majority of 100 maximum esthetic scores. However, Parekh and colleagues²⁵ used 67% as a supermajority acceptability threshold. Further studies considering the acceptability threshold would be necessary when we evaluate the smile esthetics using the VAS scores.

For the male orthodontic patients, the Japanese and Korean raters shared similar preferences of smiles. They found a range from 5 mm upper lip coverage to 0 mm gingival display to be attractive. Upper lip coverage of the teeth does not seem to be a crucial factor for the evaluation of smile esthetics in Asian male patients. This might be because low smile lines are predominantly a male characteristic, with a 2.5-to-1 ratio over females.¹³ The esthetic scores decreased significantly from 0 mm to +1 mm gingival exposure in both the Japanese and Korean male orthodontic patients. From these results, we propose negative gingival display (-5 mm-0 mm) as a threshold of acceptability for esthetic smile evaluations in Asian male patients.

The Japanese and Korean orthodontists shared similar preferences for smiles. They found a range from 2.0 mm upper lip coverage to 1.0 mm of gingival display to be attractive. Given that the female orthodontic patients preferred smiles from 2.0 mm upper lip coverage to 0 mm gingival display, the orthodontists and the female patients appeared to share a similar preference in the smile evaluation of gingival display. However, the orthodontists granted relatively higher scores to the high smile line, with 1 mm and 2 mm of gingival exposure, compared with the orthodontic patients. Orthodontists typically learn in the course of their education that high smile lines are predominant in females^{5,13,20} and that a high smile line makes women appear younger. The acceptability of the gingival smile might be due to the orthodontists' educational knowledge. This study suggests that clinicians should recognize gender differences in the preference for upper lip coverage and consider the perceptions of their patients when determining orthodontic treatment goals. Additional research on the issue of evaluating smile esthetics, specifically regarding lip morphology, including vermilion lip height and smile arc, appears to be warranted.

CONCLUSIONS

- 1 There was no significant gender difference in the effects of vertical positions of anterior teeth on perceived smile attractiveness for both the Japanese and Korean orthodontists.
- 2 In both countries, the orthodontists and the female patients shared a similar preference in the smile evaluation of vertical positions of anterior teeth, whereas the male orthodontic patients were more tolerant of upper lip coverage of the anterior teeth than the females.
- 3 Overall, the Japanese and Korean raters had a common preference in the evaluation of smile esthetics with regard to the vertical positions of anterior teeth between the corresponding groups.
- 4 We propose that 0 mm to 2 mm of upper lip coverage of the teeth as a threshold of acceptability for esthetic smile evaluations in female orthodontic patients. For male orthodontic patients, we propose negative gingival display as a threshold of acceptability for esthetic smile evaluations.

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