

# Influence of gingival display on smile aesthetics in Japanese

Hideki Ioi\*, Shunsuke Nakata\* and Amy L. Counts\*\*

\*Department of Orthodontics, Faculty of Dentistry, Kyushu University, Fukuoka, Japan and \*\*Dental School of Orthodontics, Jacksonville University, Florida, USA

Correspondence to: Hideki Ioi, Department of Orthodontics, Faculty of Dentistry, Kyushu University, 3-1-1 Maidashi, Higashi-ku, Fukuoka 812-8582, Japan. E-mail: ioi@dent.kyushu-u.ac.jp

**SUMMARY** The aim of this study was to evaluate the influence of the amount of gingival display on smile aesthetics as assessed by Japanese orthodontists and dental students. A coloured photograph of a smiling female, displaying the first molar to first molar, whose upper lip was tangent to the upper gingival margin of the upper central incisors (zero point), was constructed from different subjects. Gingival displays were modified by moving the teeth within the lip frame in 1 mm increments, from –5 to 5. Using a visual analogue scale (VAS), 31 Japanese orthodontists and 55 Japanese dental students rated the attractiveness of the 11 smiles with altered gingival display.

There was no significant difference when judging the effects of the gingival display on the smile attractiveness between the male and the female raters for both the orthodontists and dental students. Kruskal–Wallis tests revealed significant differences in the median aesthetic scores for both the orthodontists and dental students. For the orthodontists, the median aesthetic score increased gradually from –5 to 0 mm and then decreased from 0 to 5 mm. In particular, it decreased to become clinically significant (15 per cent VAS difference) from 0 to 3 mm. For the dental students, the median aesthetic score increased gradually from –5 to –2 mm and then decreased from –2 to 5 mm. The dental students were less tolerant of a more ‘gummy’ smile than the orthodontists.

## Introduction

Facial attractiveness has been suggested to have an influence on personality development and social interaction (Adams, 1977; Feingold, 1992; Thompson *et al.*, 2004). The smile plays an important role in facial expression. Facial attractiveness and smile aesthetics are strongly related to each other. Individuals mainly focus on another person’s eyes and mouth during interpersonal interaction (Miller, 1970), and the smile ranks second only to the eyes as the most important feature in facial attractiveness (Goldstein, 1969). Therefore, an attractive, well-balanced smile is a highly regarded treatment objective, along with creating a functional occlusion.

An attractive smile depends not only on components such as tooth size, shape, colour, and position but also on the amount of visible gingivae and the framing of the lips (Van der Geld *et al.*, 2007). A ‘gummy’ smile results from a combination of factors such as vertical maxillary excess, increased overjet, increased overbite, a short upper lip, and a short incisor crown length (Allen, 1988). However, Peck *et al.* (1992a,b) reported that upper lip length and incisor crown length did not appear to be associated factors.

Tjan and Miller (1984) divided the smile line into three types: a high smile line, revealing the complete maxillary incisors and a continuous band of the gingiva; an average smile line, revealing 75–100 per cent of the maxillary incisors; and a low smile line, revealing less than 75 per cent of the maxillary incisors. Excessive gingival display

can severely detract from an attractive smile. Although, in western society, it has been suggested that no more than 2 mm of the maxillary gingiva should be visible when a person smiles (Fricker, 1998), there has been no scientific evidence to support this view in the Asian community, particularly in the Japanese population.

What is beautiful or attractive to dental professionals, based on their experience and training, may not agree with the perceptions of other individuals (Giddon, 1995). Shaw *et al.* (1975) and Prahl-Andersen (1978) reported that dental professionals are conditioned to take an overly critical view of any deviation from normal occlusion. Although many orthodontists and surgeons have the opinion that a gummy smile is unattractive (Peck *et al.*, 1992a,b), the perception of the same for dental students as young adults may differ.

The aim of this study was to evaluate the influence of the amount of gingival display on smile aesthetics assessed by Japanese orthodontists and dental students.

## Subjects and methods

### Sample size

A sample size calculation was undertaken using nQuery Adviser (Version 6.01, Statistical Solutions, Cork, Ireland). According to a pilot study, the effect size was estimated at 0.385. On the basis of a significance level of alpha 0.050, the sample size was calculated to achieve a 90 per cent

power. The sample size calculation indicated that seven subjects for each group were necessary.

#### *Construction of a series of images*

A female frontal intraoral photograph of ideally aligned teeth and a female extraoral photograph that displayed aesthetic smiling lips were obtained from different subjects. These ideally aligned teeth and lips were combined to form a standard composite smile with all teeth displayed to the first molar and with the upper lip tangent to the upper gingival margin of the upper central incisors (zero point). The lower lip coincided with the curvature of the incisal edges of the maxillary incisors and canines. These images were modified using Adobe Photoshop CS2 (San Jose, California, USA) to create bilaterally symmetrical teeth and lips. The gingival display was modified by moving the teeth within the lip frame in 1 mm increments, from -5 to 5 to the 0 mm. When the border of the upper lip on smiling was greater than 0, the amount of gingival display in millimetres was assigned a positive value. When the upper lip border on smiling was less than 0, the measurement was assigned a negative value. Eleven images were arranged in order of the amount of gingival display, from the least to the most (Figure 1).

#### *Raters*

The smile raters were 31 Japanese orthodontists (14 males and 17 females; age  $32.8 \pm 7.6$  years) and 55 Japanese

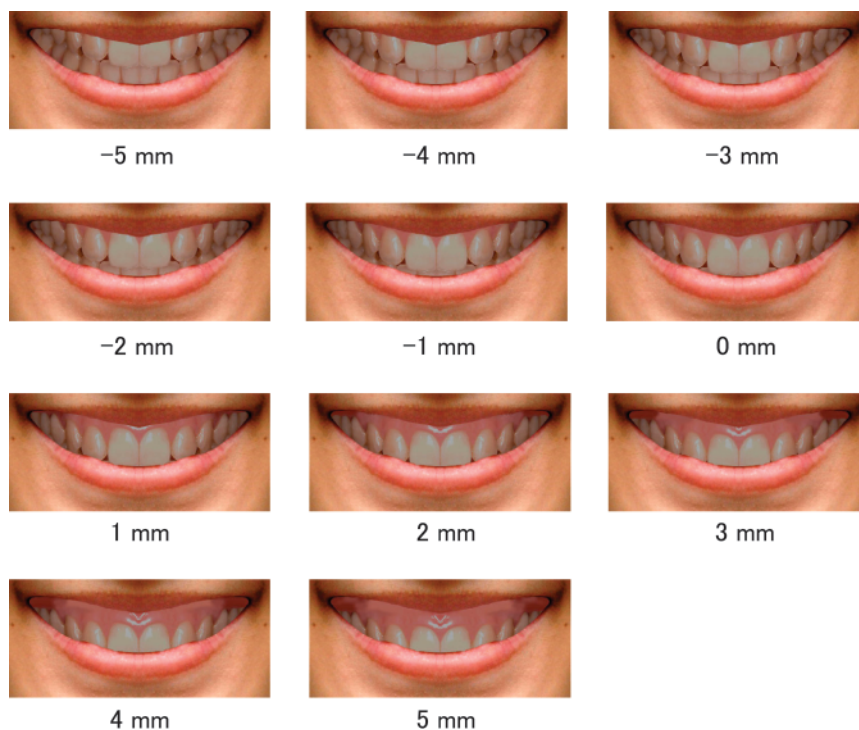
dental students in their fifth year of dental school (31 males and 24 females; age  $23.9 \pm 2.5$  years) from Kyushu University, Fukuoka, Japan. Determination of the subjective aesthetic value of each smile was accomplished using a visual analogue scale (VAS). This rating scale was designed for minimal constraints and the most freedom to express a personal response style. The VAS was 50 mm long and raters used their own aesthetic values to rank each smile from 'least attractive' to 'most attractive'. An aesthetic score was obtained by multiplying the distance between the least attractive (zero) and the hash mark by two. Namely, the aesthetic score was distributed from 0 to 100, 0 being the minimum and 100 the maximum aesthetic value.

#### *Reliability*

Ten randomly selected raters from each group of orthodontists and dental students were asked to evaluate the 11 images twice to determine reliability. Paired sample tests showed that there was no method error in rating attractiveness for either group.

#### *Statistical analysis*

To compare the distributions of the median scores between the male and the female raters for each of the rater groups, a non-parametric Wilcoxon rank-sum test was used. Differences in the median aesthetic scores were analysed



**Figure 1** The series of 11 images in the order of the amount of gingival display from the least to the most. The determination of the subjective aesthetic value of each smile was accomplished using a visual analogue scale.

using the Kruskal–Wallis test. The minimum level of statistical significance was set at  $P < 0.05$ .

The VAS has been used for pain research and generally a minimum clinically significant difference ranges from 9 to 13 per cent of the VAS (Todd *et al.*, 1996; Kelly, 1998; Powell *et al.*, 2001). Parekh *et al.* (2006) applied a VAS difference of 15 per cent as clinically significant in order to evaluate attractiveness. A 15 per cent VAS difference to determine the clinical significance of the aesthetic scores was also used in the present study.

## Results

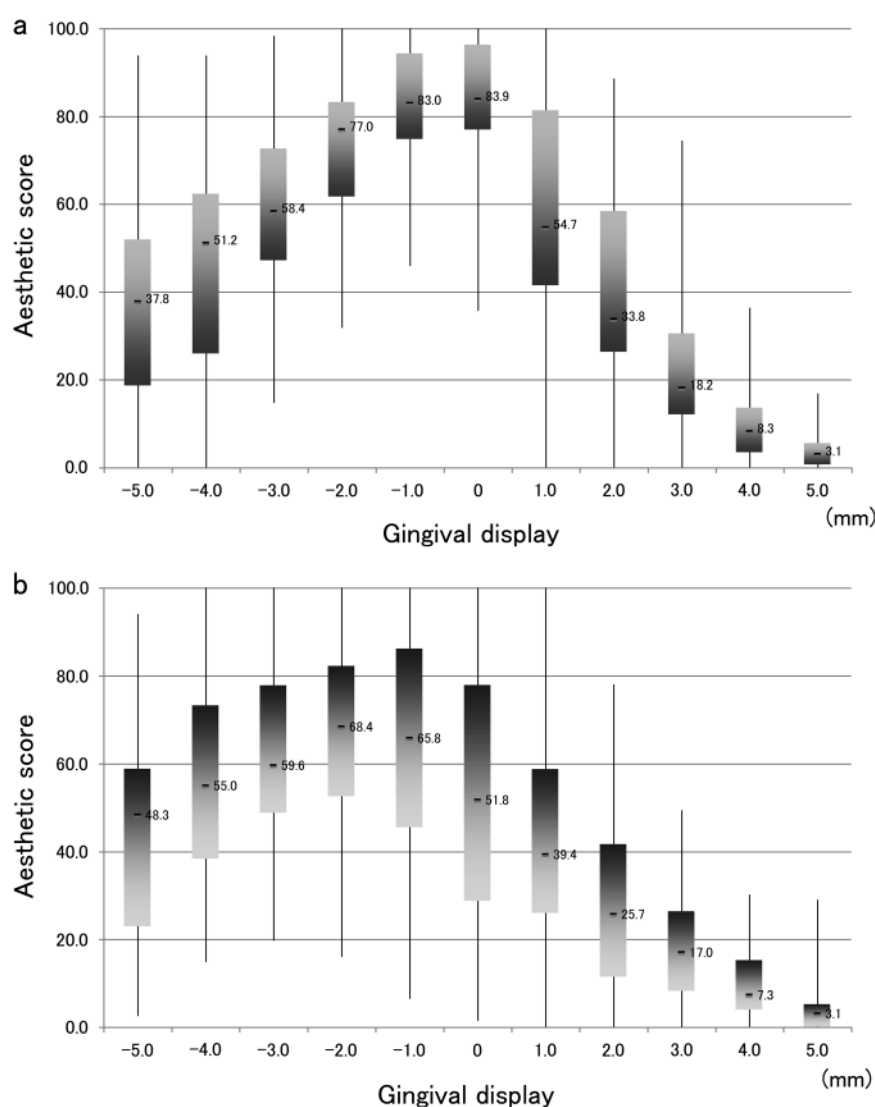
There was no significant difference when judging the effects of gingival display on the smile attractiveness between the male and the female raters for both orthodontists and dental students. Therefore, the pooled data for both male and female raters

were used for the subsequent analysis. The median values and ranges of the aesthetic scores of each gingival display rated by the orthodontists and dental students are shown in Figure 2a and 2b. The Kruskal–Wallis test showed that there were significant differences in the median aesthetic scores for both the orthodontists and dental students ( $P < 0.001$ ).

For the orthodontists, the median aesthetic score increased gradually from –5 to 0 mm and then decreased from 0 to 5 mm. In particular, it decreased to become clinically significant from 0 to 3 mm. For dental students, the median aesthetic score increased gradually from –5 to –5 mm and then decreased from –2 to 5 mm.

## Discussion

In order to obtain reliable results, it is important that the statistical power is as high as possible. The sample size



**Figure 2** The median values and ranges of the aesthetic scores for each gingival display rated by (a) the orthodontists and (b) the dental students (median, 25th and 75th percentiles, minimum and maximum).

calculation revealed that a sample of seven subjects for each group was sufficient to achieve a 90 per cent power. Since the views of 31 Japanese orthodontists and 55 Japanese dental students were analysed in this study, the power was sufficiently high.

The VAS has been utilized to assess pain intensity and has been shown to be a valid, reliable, and reproducible method of measuring subjective pain (Ohnhaus and Adler, 1975). As many investigators (Roden-Johnson *et al.*, 2005; Ritter *et al.*, 2006; Martin *et al.*, 2007; Krishnan *et al.*, 2008) utilized the VAS method to judge attractiveness, use of the VAS method in scoring aesthetics should also provide simple, rapid, and reproducible results.

In this study, the attractiveness of different levels of gingival display from 5 mm upper lip coverage of the upper central incisors (−5 mm) to 5 mm of gingival display were compared. In previous studies that evaluated the influence of maxillary gingival exposure on smile attractiveness, the images were modified from −2 to 4 mm (Hunt *et al.*, 2002) or −4.6 to 3.3 mm (Geron and Atalia, 2005) of gingival exposure. The range evaluated in this research was sufficiently wide for comparison with previous studies.

To date, there has not been sufficient evidence to support what is aesthetically attractive in the smiles of the Japanese population. This study is the first report that focuses on the effects of gingival display on smile attractiveness when judged by Japanese orthodontists and dental students.

There was no significant difference in aesthetic scores between the male and the female raters for both the orthodontists and dental students. On the other hand, Geron and Atalia (2005) reported that male and female raters scored images with upper gingival exposure differently, suggesting that female raters are more tolerant of upper gingival exposure. This might be because females possess the characteristics of a gingival smile line in a 2:1 ratio over males (Vig and Brundo, 1978).

The smile with 0 mm of gingiva was considered to be the most attractive by the orthodontists while the smile with 2 mm upper lip coverage of the upper central incisors was considered to be the most attractive by the dental students. Geron and Atalia (2005), who investigated the influence of gingival display on the perception of smile aesthetics in lay people, also reported that the most attractive smile images were those with upper lip coverage of the central incisors around 0–2 mm. If the assumption is made that unattractive smiles are as those with aesthetic scores from 0 to 50 and attractive smiles are those with scores from 51 to 100, the orthodontists considered smiles within 4 mm upper lip coverage and 1 mm gingival display to be attractive and smiles with 5 mm of upper lip coverage and over 2 mm of gingival display to be unattractive. On the other hand, the dental students considered within 4 mm of upper lip coverage and 0 mm of gingival display to be attractive and smiles with 5 mm of upper lip coverage and over 1 mm of gingival display to be unattractive. Although the orthodontists and

dental students showed similar tendencies in rating the preferences of gummy smiles, the dental students had a more critical opinion of gummy smiles than the orthodontists. In this study, the dental students were categorized as the non-experts or young adults who were potential candidates for orthodontic treatment. This was because the dental students had received no prior education regarding the evaluation of smile aesthetics. Orthodontists, as dental professionals, are trained to believe that patients should display the full height of the incisor plus 1–2 mm of gingiva when smiling (Margolis, 1997). Moreover, a high smile line with 1–2 mm of gingival exposure is predominant in females (Tjan and Miller, 1984; Peck *et al.*, 1992a,b) making them appear younger. This bias and knowledge of the orthodontists may have contributed to their tolerance of more gingival display. Both the orthodontists and dental students agreed that over 2 mm of gingival exposure was unattractive. This result is similar to previous studies. Peck *et al.* (1992a,b) determined that the gingival smile was very prominent when 2 mm or more of maxillary gingiva was exposed above the central incisors during maximum smiling. Geron and Atalia (2005) also reported that 1 mm above the gingival border of the maxillary central incisors was scored as unattractive during maximum smiling by lay people. Kokich *et al.* (1999) evaluated female smiles and found that 3 mm of gingival display was considered as unaesthetic by lay people. However, clinicians should bear in mind that according to the present results, Japanese young adults might consider even 1 mm exposure of gingiva to be unaesthetic and might not be satisfied with their results if gingival display remains after treatment. Although the median aesthetic score of 1 mm of gingival display for the orthodontists was 54.7, the score sharply decreased from 83.9 with 0 mm of gingival display. A difference of only 1 mm from 0 to 1 mm gingival display caused a clinically significant change (15 per cent VAS difference) in the preference of smile aesthetics for the orthodontists. Considering these results, a threshold of over 1 mm of gingival display is proposed as a threshold between more and less attractive smiles when evaluating gingival smiles.

The perception of laypersons in evaluating gingival display may be different from that of orthodontists. Additional research that includes lay people as raters appears to be warranted. If the orthodontist's perception of aesthetics is not congruent with the patient's perception, the result might not be acceptable to the patient. Therefore, it is important for patients to participate in the decision-making process of orthodontic treatment planning.

In addition to the amount of gingival display, other aspects of smile aesthetics have recently received attention: the presence of the smile arc and buccal corridor spaces (Roden-Johnson *et al.*, 2005; Parekh *et al.*, 2006; Ritter *et al.*, 2006; Martin *et al.*, 2007; Krishnan *et al.*, 2008). The influence these factors on smile aesthetics in Japanese should be investigated.



## Conclusions

1. No significant difference was found when judging the effects of gingival display on the smile attractiveness between the male and the female raters for both orthodontists and dental students.
2. There were significant differences in the median aesthetic scores for both orthodontists and dental students. The smile with 0 mm of gingiva was considered to be the most attractive by the orthodontists while a smile with 2 mm of lip coverage of the upper central incisors was considered to be the most attractive by the dental students.
3. The dental students were less tolerant of a more gummy smile than the orthodontists.

## References

- Adams G R 1977 Physical attractiveness research: toward a developmental psychology of beauty. *Human Development* 20: 217–239
- Allen E P 1988 Use of mucogingival surgical procedures to enhance esthetics. *Dental Clinics of North America* 32: 307–330
- Feingold A 1992 Good-looking people are not what we think. *Psychological Bulletin* 111: 304–341
- Fricker J P 1998 Orthodontics and dentofacial orthopedics. Tidbinilla Pty Ltd Publishers, Canberra
- Geron S, Atalia W 2005 Influence of sex on the perception of oral and smile esthetics with different gingival display and incisal plane inclination. *Angle Orthodontist* 75: 778–784
- Giddon D B 1995 Orthodontic applications of psychological and perceptual studies of facial esthetics. *Seminars in Orthodontics* 1: 82–93
- Goldstein R E 1969 Study of need for esthetics in dentistry. *Journal of Prosthetic Dentistry* 21: 589–598
- Hunt O, Johnston C, Hepper P, Burden D, Stevenson M 2002 The influence of maxillary gingival exposure on dental attractiveness ratings. *European Journal of Orthodontics* 24: 199–204
- Kelly A M 1998 Does the clinically significant difference in visual analog scale pain scores vary with gender, age, or cause of pain? *Academic Emergency Medicine* 5: 1086–1090
- Kokich V O Jr, Kiyak H A, Shapiro P A 1999 Comparing the perception of dentists and lay people to altered dental esthetics. *Journal of Esthetic Dentistry* 11: 311–324
- Krishnan V, Daniel S, Lazar D, Asok A 2008 Characterization of posed smile by using visual analog scale, smile arc, buccal corridor measures, and modified smile index. *American Journal of Orthodontics and Dentofacial Orthopedics* 133: 515–523
- Margolis M J 1997 Esthetic considerations in orthodontic treatment of adults. *Dental Clinics of North America* 41: 29–48
- Martin A J, Buschang P H, Boley J C, Taylor R W, McKinney T W 2007 The impact of buccal corridors on smile attractiveness. *European Journal of Orthodontics* 29: 530–537
- Miller A G 1970 Role of physical attractiveness in impression formation. *Psychological Science* 19: 241–243
- Ohnhaus E E, Adler R 1975 Methodological problems in the measurement of pain: a comparison between the verbal rating scale and the visual analogue scale. *Pain* 1: 379–384
- Parekh S M, Fields H W, Rosenstiel S F, Beck F M 2006 Attractiveness of variations in the smile arc and buccal corridor spaces as judged by orthodontists and laymen. *Angle Orthodontist* 76: 557–563
- Peck S, Peck L, Kataja M 1992a Some vertical lineaments of lip position. *American Journal of Orthodontics and Dentofacial Orthopedics* 101: 519–524
- Peck S, Peck L, Kataja M 1992b The gingival smile line. *Angle Orthodontist* 62: 91–100
- Powell C V, Kelly A M, Williams A 2001 Determining the minimum clinically significant difference in visual analog pain score for children. *Annals of Emergency Medicine* 37: 28–31
- Prahl-Andersen B 1978 The need for orthodontic treatment. *Angle Orthodontist* 48: 1–9
- Ritter D E, Gandini L G, Pinto Ados S, Locks A 2006 Esthetic influence of negative space in the buccal corridor during smiling. *Angle Orthodontist* 76: 198–203
- Roden-Johnson D, Gallerano R, English J 2005 The effects of buccal corridors spaces and arch form on smile esthetics. *American Journal of Orthodontics and Dentofacial Orthopedics* 127: 343–350
- Shaw W C, Lewis H G, Robertson N R 1975 Perception of malocclusion. *British Dental Journal* 138: 211–216
- Thompson L, Malmberg J, Goodell N, Boring R 2004 The distribution of attention across a talker's face. *Discourse Processes* 38: 145–168
- Tjan A H, Miller G D 1984 Some esthetic factors in a smile. *Journal of Prosthetic Dentistry* 51: 24–28
- Todd K H, Funk K G, Funk J P, Bonacci R 1996 Clinical significance of reported changes in pain severity. *Annals of Emergency Medicine* 27: 485–489
- Van der Geld P, Oosterveld P, Van Heck G, Kuijpers-Jagtman A M 2007 Smile attractiveness. Self-perception and influence on personality. *Angle Orthodontist* 77: 759–765
- Vig R G, Brundo G C 1978 The kinetics of anterior tooth display. *Journal of Prosthetic Dentistry* 39: 502–504