

Influence of canine vertical position on smile esthetic perceptions by orthodontists and laypersons

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Introduction: Our objectives were to verify the impact of alterations in the vertical position of the maxillary canines in smile esthetic perceptions and to determine whether exposure of the gingival margins directly affects laypersons' and orthodontists' perceptions. **Methods:** A smile photograph of a male subject showing gingival zeniths was selected, and the canine vertical positions were symmetrically modified in increments of 0.5 mm, creating 4 new images varying from 1.0 mm of intrusion to 1.0 mm of extrusion, with and without gingival exposure. The total of 10 images were evaluated by 60 orthodontists and 60 laypersons, who determined the level of attractiveness of each smile on a visual analog scale. **Results:** For both orthodontists and laypersons, the canine vertical position modifications had a statistically significant influence ($P < 0.0001$), and the gingival exposure had no significant influence on the smile esthetic evaluations. **Conclusions:** For both groups of evaluators, the most attractive smiles were the standard smile and the smiles with 0.5 mm of intrusion. The less attractive smiles were those with 1.0 mm of extrusion and 1.0 mm of intrusion. Orthodontists were more critical in their assessments. There were no differences in the esthetic evaluations of smiles with and without gingival margin exposure for both groups of evaluators. (Am J Orthod Dentofacial Orthop 2018;153:371-6)

The pursuit of excellence in smile and facial esthetics has become, in recent years, the main objective of patients consulting dental clinics. However, since the concept of beauty is subjective and wide, it is difficult to establish ideal standards.

According to recent literature, an esthetically pleasing smile should present some aspects such as proportion and symmetry between the central incisors,^{1,2} minimal gingival display,^{3,4} buccal corridor width from minimal to moderate,⁵ and anterior teeth with adequate gingival margins.^{6,7}

Several studies have indicated that, ideally, the gingival margins of the maxillary canines should be positioned on the same level as the central incisors and slightly above the margins of the lateral

incisors.^{6,8,9} It is not uncommon that, in an attempt to make the gingival contours harmonious or improve the functional aspect, orthodontists tend to change the vertical position of the maxillary canines; this inevitably alters the relationship of the incisal edges and gingival margins of anterior teeth and may create unattractive steps.

From a clinical standpoint, it is often cited that the closer to the dental midline, the greater the perception of any alterations in smiles; this justifies the many studies investigating the relationship between vertical position of the central incisors and a pleasant smile.^{10,11} Nevertheless, in relation to these changes in canines, the literature is still seldom explored. There are no articles evaluating the variables of incisal edges and gingival margins together considering a change in the canines' vertical position without modification of the dental crown size.

In this study, we aimed to evaluate, by observation of the symmetrical changes in the vertical position of the maxillary canines in a frontal smile, the canine positions that were more and less accepted, whether there was a statistically significant difference between the evaluations of laypeople and orthodontists, and the influence of gingival display in these perceptions.

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All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.

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MATERIAL AND METHODS

This study was approved by the research ethics committee of the University Hospital Antonio Pedro, Universidade Federal Fluminense, Niteroi, Brazil.

A male volunteer had his smile photographed, with exposure of gingival zeniths of the maxillary incisors and canines: ie, a “high smile.” This subject had no previous orthodontic treatment, no restorations in anterior teeth, and healthy teeth and periodontal tissues. The photograph was taken with the subject at rest position, standing with the Frankfort horizontal plane and the bipupilar line parallel to the ground. In addition, his mouth was slightly open to minimize the display of mandibular incisors and to promote the contrast of the maxillary teeth with a darker background. He signed a release form authorizing the use of his image in scientific research.

This photograph was digitally manipulated with Adobe Photoshop (version CS5; Adobe Systems, San Jose, Calif) to remove the stains and adjust color changes. In the resulting image, 1 side was mirrored to ensure smile symmetry. This image was defined as the standard smile, and considering a straight line touching the incisal edges of the maxillary central incisors, it showed the canine incisal edges positioned 0.5 mm above this line, the gingival margins of the canines and central incisors at the same level, and the lateral incisor gingival margins 0.5 mm below the central incisors and canines. The smile was considered harmonious in relation to the smile curve. This standard smile was the same as that used by Machado et al.¹²

Starting from the standard smile, new manipulations were made in the smile by changing the canine vertical positions symmetrically, making them more extruded or intruded in increments of 0.5 mm in relation to the line tangent to the central incisors' edges. Variations were made by movements of 1 canine in the cervical or occlusal direction in relation to this line, without changing the length or the proportion between width and height; moreover, this image was mirrored to ensure perfectly symmetrical changes. The images obtained were 0.5 mm of extrusion, 1 mm of extrusion, 0.5 mm of intrusion, and 1 mm of intrusion. For movement graduation, the volunteer's maxillary central incisors were measured directly in the mouth with a digital caliper (Lotus, Serra, Espírito Santo, Brazil), and the measurements were used as a reference for the calibration of a ruler in the software, from which the increments of 0.5 mm were made. Furthermore, an upper lip displacement was performed creating a low smile, which was reproduced for all the previously described images to hide the gingival margins. The same vertical changes in the maxillary canines were maintained, resulting in 5 new images with a low smile

(standard smile, 2 intrusion smiles, and 2 extrusion smiles). The manipulations were performed by the same operator (R.M.M.). Finally, a set of 10 images composed the sample to be assessed (Fig).

These 10 images were assembled into a presentation, using PowerPoint software (version 12.0; Microsoft, Redmond, Wash). An initial slide was displayed for 20 seconds with all smile images, grouped by the type of smile (with or without exposure of gingival margins) and in sequential order of vertical position of the canines. Moreover, the same pictures were presented one by one, in random order defined by sorting, with automatic transition and 15 seconds of display time for each image. The evaluators were not allowed to return to previous photos for reevaluation, and they were not told that the model was male.

To assess the attractiveness of each smile, visual analog scales were used. The evaluators were given a sheet of paper containing 10 scales, with each scale measuring 100 mm and graded from 0 to 10, numbered according to the order of the pictures, but without identifying any characteristics. They were instructed to make a perpendicular line on the scale at any point, corresponding to the desired score, considering 0 as unattractive and 10 as very attractive. The evaluators were not aware of the subject of the research. A digital caliper (Starrett 779; Itu, São Paulo, Brazil) was used to measure the scores in millimeters and adjust for possible printing distortions.

Evaluators included laypeople and orthodontists. A sample size calculation was performed using the formula described by Pandis,¹³ considering an 80% test power, $\alpha = 0.05$, standard deviation described by Machado et al,¹ and a difference of 10 scores to be detected. The calculation showed that 57 subjects per group would be enough. Therefore, 60 laypeople and 60 orthodontists were selected for this research.

Inclusion criteria were age between 18 and 60 years, both men and women; lay people should have a university degree, no training in dentistry, and a 5-year gap from the last orthodontic treatment, if any; orthodontists should be specialists in orthodontics and work with the fixed orthodontic technique. Orthodontic patients, dental clinic staff, dentists who were not orthodontists, and dentistry students were excluded. Evaluations were made consecutively, regardless of sex or age distribution.

Statistical analysis

BioEstat software (version 5.0; Mamiraua Institute, Tefé, Amazonas, Brazil) was used for statistical analysis. The normality of the data was tested by the Lilliefors test. Because the sample data did not have a normal distribution, descriptive statistics were presented through

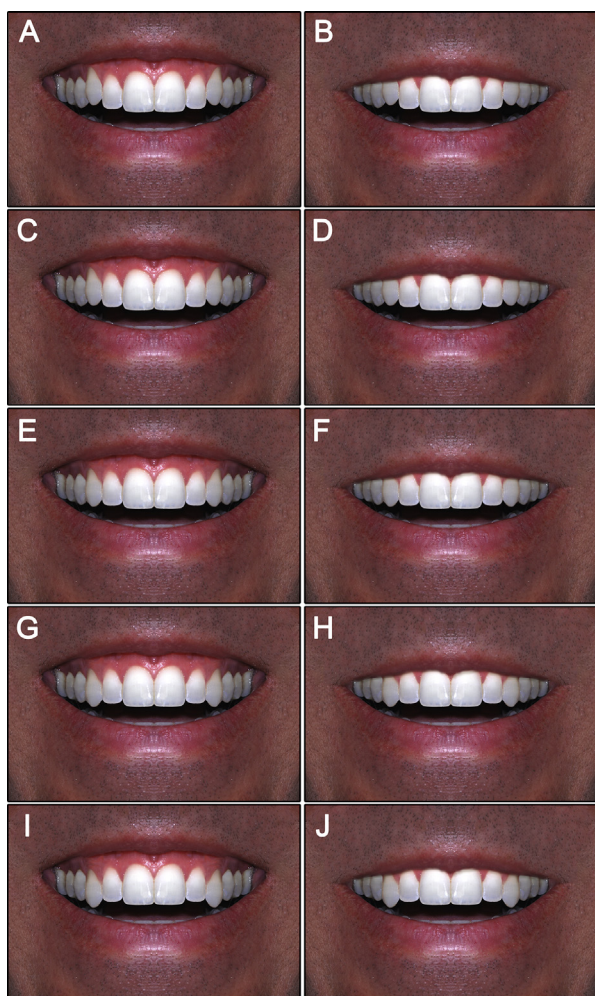


Fig. Smiles after manipulation of canine vertical positions with (*left column*) and without (*right column*) gingival exposure: **A** and **B**, 1.0 mm of intrusion; **C** and **D**, 0.5 mm of intrusion; **E** and **F**, standard smile; **G** and **H**, 0.5 mm of extrusion; **I** and **J**, 1.0 mm of extrusion. (E and F are used with permission¹²).

medians, interquartile ranges, and confidence intervals. Two-way analysis of variance (ANOVA) was used to detect the influence on scores attributed to the factors of kind of smile and vertical changes of the canines. Intragroup differences were evaluated using the Kruskal-Wallis test along with the Dunn posttest, and the intergroup differences were evaluated using the Mann-Whitney test for each image.

Three evaluators from each group reassessed the 10 photos with a minimum interval of 2 months after the first evaluation. Reliability was tested using the intraclass correlation coefficient. A good correlation coefficient of 0.767 was obtained, ensuring reliability.

RESULTS

The sample of evaluators comprised 60 orthodontists (38 women, 22 men) with a mean age of 32.58 years (SD, 6.43) and 60 laypeople (46 women, 14 men) with a mean age of 30.26 years (SD, 8.73).

Based on the analysis of smiles with gingival display, the highest scores for both orthodontists and laypeople were given to the standard smiles (medians, 80.24 and 90, respectively) and the smile with a 0.5-mm intrusion (medians, 74.60 and 83.79, respectively). The lowest scores were given to the smiles with a 1-mm extrusion (medians, 32.13 and 50.00, respectively) and a 1-mm intrusion (medians, 39.93 and 57.46, respectively) for both groups (Table).

The analysis of smiles without a gingival display showed that orthodontists and laypeople gave the highest scores to the standard smiles (medians, 79.77 and 89.28, respectively) and the smile with a 0.5-mm intrusion (medians, 70.12 and 88.58, respectively). The lowest scores were given to the smiles with a 1-mm extrusion (medians, 37.12 and 47.63, respectively) by both groups of evaluators and a 1-mm intrusion (median, 51.78) only by the orthodontists (Table).

The 2-way analysis of variance results showed that, for both orthodontists and laypeople, the influence of the canine vertical position on the scores was considerable (28.53% and 24.33%, respectively; $P < 0.0001$). The influence of the type of smile (0.15% and 0.28%, respectively; $P > 0.05$) and the interaction between both factors (0.81% and 1.66%; $P = 0.1520$ and $P = 0.0105$, respectively) were irrelevant.

When the scores were compared between groups, statistically significant differences were observed for all photos, and the scores given by orthodontists were lower.

DISCUSSION

The canine vertical position is a relevant factor in smile esthetics and occlusion functionality, since well-established canine guides are essential for a balanced masticatory system.

Some authors have claimed that other components such as eyes, nose, and shape of the face do not influence the perception of the smile.^{4,14} Other studies have suggested that the perception of smile details may be considered more relevant when close-up images are used rather than full-face images,^{15,16} and this method may decrease the distractions of facial characteristics and lead to a better focus on dental alterations. In this study, since Nascimento et al¹⁴ found no differences in scores for full-face and close-up views, we opted only for close-up images.

Table. Descriptive statistics of orthodontists' and laypersons' scores and intragroup and intergroup comparisons

	Orthodontists			Laypersons			Difference
	Median	IQR	Intragroup comparison*	Median	IQR	Intragroup comparison*	Intergroup comparison (P value)
Full smile							
1 mm intrusion	39.93	29.01	A	57.46	35.32	AB	<0.001†
0.5 mm intrusion	74.6	22.34	C	83.79	20.83	C	0.003†
Standard smile	80.24	21.88	C	90	20.85	C	0.009†
0.5 mm extrusion	59.67	27.66	B	68.21	29.92	B	0.023†
1 mm extrusion	32.13	29.58	A	50	29.85	A	<0.001†
Smile without gingival display							
1 mm intrusion	51.78	25.84	AB	75.21	27.26	B	<0.001†
0.5 mm intrusion	70.12	24.22	C	88.58	19.24	C	<0.001†
Standard smile	79.77	21.39	C	89.28	18.42	C	0.005†
0.5 mm extrusion	59.86	29.99	B	64.87	20.53	B	0.018†
1 mm extrusion	37.12	29.93	A	47.63	29.15	A	<0.001†

IQR, Interquartile range.

*Different letters mean statistically significant differences (same column); †different letters mean statistically significant difference (same row).

In this study, a 20-second preview slide containing all images was provided to the evaluators to minimize bias, since examiners tend to assign central scores in comparative studies when they do not know what the next images will be.¹⁷

A recent study assessed the posttreatment 3-dimensional maxillary canine position and tested whether this position influences esthetic perceptions.¹⁸ No correlation was found between the canine 3-dimensional position and esthetic perceptions of 9 orthodontic residents. However, differing from this study, the methodology for obtaining the reference points was based on bone tissues, and different posttreatment smiles were used for evaluations. Such differences make it difficult to observe the position of the canines from the same perspective.

Our study shows that, in general, extreme changes were considered more unpleasant, with extrusion alterations receiving the lowest scores. For both groups, the standard smiles were given the highest scores, followed by smiles with intrusion of 0.5 mm, corroborating the study by Correa et al,¹⁹ who stated that changes up to 0.5 mm and 1.0 mm in the gingival margins of canines are not harmful to the esthetics of smiles assessed by orthodontists and laypersons, respectively. A trend toward greater rejection of extruded canines when compared with intruded ones was observed in our study.

When the objective is not to modify the tooth crown size, any changes in the canine vertical position will inevitably lead to changes in the positioning of both gingival margins and incisal edges. In this study, we aimed to evaluate the changes in the canine vertical position in smiles, with and without gingival display, with the main objective of obtaining smiles with exposure or hiding of the gingival margins due to lip modification.

No attempt was made to quantify the amount of exposed gums or the esthetics directly related to it.

According to the literature, a slight gingival display makes the smile more attractive.^{16,20} In general, for both groups, the scores of pictures with gingival margin exposure were not significantly different from their counterparts that had a lower lip position, suggesting little influence from gingival display in the esthetic evaluation. This was confirmed by the absence of a significant influence of the smile type in the evaluations of both orthodontists and laypeople with 2-way analysis of variance. These results differed from our expectations of lower scores for images with gingival display since they allow visualizing both the gingival margins and the incisal edges at the same time; this could potentialize unpleasantness to the evaluators. Nevertheless, although every effort was made in this study to standardize the smile, some elements such as the shape of the lips may have interfered with the scores and may have been evident once there was no gingival display.

Although there were no statistically significant differences between smiles with and without gingival display in both groups of evaluators, the difference in scores was important when the image with 1 mm of intrusion was considered. In this case, lower scores were attributed to the smile with gingival display, possibly due to the high visibility of gingival contour variations, generated by intrusion of the canines. This change was probably considered unesthetic because it broke the harmony of the gingival margins' alignment.^{21,22} The literature shows that asymmetries greater than 0.5 mm at the gingival margin of the maxillary canines are considered unesthetic¹⁹ and that symmetric changes of this kind are more acceptable

than asymmetric alterations.²³ When hidden by the lip, only the steps created between the incisal edges of the canines and adjacent teeth are visible, making them relevant to the smile esthetic evaluation. However, based on the results from this study, this difference did not significantly influence the scores.

From the laypeople's point of view, despite the lack of statistically significant differences between smiles with and without gingival display and the same canines' alterations, the intrusion of 1 mm proved to be statistically different from the most unpleasant image (1 mm of extrusion) only in the smile without exposure.

The greater rejection of images with greater disharmonies of gingival margins can guide some decisions in orthodontic treatment. In clinical practice, changes in the canine gingival margins can be noticed in gingival hyperplasia, gingival recession, overeruption, changes in shape and tooth size, and after traction of an included canine.¹⁹ In case of absence of the maxillary lateral incisors, which are more common unilaterally, a possible plan is the replacement of the missing incisor by the canine, which has its space occupied by the premolar.²⁴ After the new dental positioning, the gingival contour of the premolar, which becomes more visible, is generally below the gingival margin of the contralateral canine, which generates an esthetic discomfort. The literature suggests that patients with such changes should be helped by periodontal plastic surgery,^{6,25} intrusion and restoration of premolar incisal edges,²⁵⁻²⁷ or extrusion of the contralateral canine and incisal wear.²⁵

In more complex cases in which canines are impacted, there is great concern from orthodontists about the periodontal conditions after traction. Canines located labially seem to have a more critical periodontal condition compared with canines impacted by the palatine.²⁸ Such condition may indicate a higher risk of gingival esthetic commitment of these dental elements at the end of treatment.

Occasionally, during orthodontic treatment finishing, the strategy to extrude the canines can be used to obtain better canine guides. These mechanics can cause esthetic prejudice because the gingival margin accompanies the extrusive movement, generating a lack of harmony in the gingival contour that can be observed mainly when there is gingival display while smiling. In addition, the canine cusps turn out to be more prominent, which may result in a smile with incisal edges of the central incisors above the canine cusps and a reverse or straight smile, unpleasant for not presenting vertical dominance of the central incisors.^{9,29,30} According to this study, even relatively small extrusions were considered unpleasant by both groups of assessors;

this was opposite to the data obtained by Pinho et al,¹⁰ which showed that changes up to 2 mm in the cusps of the canines are not perceptible to laypeople and orthodontists. Therefore, when extrusion of canines is necessary to achieve greater functionality of occlusion and may be considered unesthetic, it should be performed in the mandibular canines, which have a lower esthetic value.

Orthodontists should be aware that, during bonding of the appliance or wire bending during finishing to promote lateral functional guidance, canine extrusion may negatively impact smile attractiveness. Depending on the anatomy of the maxillary canines, grinding of the cusps may easily promote favorable esthetic results in certain patients. The purpose of this article was to determine esthetically acceptable limits for canine vertical position, and orthodontists may use that information to their favor when it is possible to adjust function without sacrificing esthetics.

The medians obtained for all images in the group of laypeople were greater than those obtained in the group of orthodontists. According to Davis,⁸ most studies based on esthetic evaluation of anterior teeth show a more careful perception by orthodontists that may be explained because they are more discerning of occlusal aspects, whereas laypeople may evaluate more general aspects of smiles such as form, proportion, and tooth color.

Variables such as size and shape of teeth and lips, inclinations and color of teeth, and aspects of gum tissue can influence the general perception of an esthetic smile. Therefore, more studies addressing this topic are needed.

Moreover, a limitation of this study was the difficulty in defining a reference line to change the position of the canines, since the smile harmony line is curved, which makes its use unfeasible for the vertical changes proposed in this research.

A relevant point of this study was use of a male subject's smile in the evaluation of the different proposed aspects. In a previous study, the male model's smile pictures had a more standardized evaluation than did the female ones, which had more variations, and that was 1 reason that led to the choice of male subject's pictures in our study.¹² Additionally, studies assessing esthetic smile characteristics use, in most cases, a female smile model^{15,17}; the use of a male smile model was proposed in this study since the demand for orthodontic treatment has increased in this group, and more studies evaluating the esthetics of these smiles are needed. Other studies have used only male³¹ or female models.^{15,17} The results from our study are, therefore, valid for smiles of male patients and should not be extrapolated.

In clinical practice, the changes in the studied variable, when observed or needed in patients seeking orthodontic treatment, should be carefully evaluated. The problem should be explained to patients, and possible treatments and outcomes should be discussed to determine whether the treatment can achieve their expectations, especially when the changes do not cause functional impairment.

CONCLUSIONS

1. Both orthodontists and laypeople rated the standard smiles (considered harmonious with respect to the smile line) and the smiles with 0.5 mm of intrusion as the most attractive.
2. In general, smiles with 1 mm of extrusion and 1 mm of intrusion were found to be less attractive by both groups.
3. Orthodontists were more critical in their assessments, giving significantly lower scores for all images evaluated.
4. There were no significant differences in the esthetic evaluations of smiles, with and without gingival margin exposure, by either group of evaluators.

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