

Esthetic Assessment of the Effect of Gingival Exposure in the Smile of Patients with Unilateral and Bilateral Maxillary Incisor Agenesis

Teresa Pinho, DDS, PhD,¹ Carlos Bellot-Arcís, DDS, PhD,² José María Montiel-Company, DDS, DMS, PhD,² & Manuel Neves, DDS³

¹Instituto Superior de Ciências da Saúde-Norte, CESPU, Instituto de Investigação e Formação Avançada em Ciências e Tecnologias da Saúde (IINFACTS), Gandra PRD, Portugal

²Stomatology Department, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain

³Private Practice, Porto, Portugal

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Correspondence

Teresa Pinho, Instituto Superior de Ciências da Saúde-Norte, CESPU, Instituto de Investigação e Formação Avançada em Ciências e Tecnologias da Saúde (IINFACTS), Rua Central de Gandra, 1317, 4585-116 Gandra PRD, Portugal. E-mail: teresa.pinho@iscsn.cespu.pt

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Abstract

Purpose: The aim of this study was to determine the dental esthetic perception of the smile of patients with maxillary lateral incisor agenesis (MLIA); the perceptions were examined pre- and post-treatment. Esthetic determinations were made with regard to the gingival exposure in the patients' smile by orthodontists, general dentists, and laypersons.

Materials and Methods: Three hundred eighty one people (80 orthodontists, 181 general dentists, 120 laypersons) rated the attractiveness of the smile in four cases before and after treatment, comprising two cases with unilateral MLIA and contralateral microdontia and two with bilateral MLIA. For each case, the buccal photograph was adjusted using a computer to apply standard lips to create high, medium, and low smiles. A numeric scale was used to measure the esthetic rating perceived by the judges. The resulting arithmetic means were compared using an ANOVA test, a linear trend, and a Student's *t*-test, applying a significance level of $p < 0.05$. The predictive capability of the variables, unilateral, or bilateral MLIA, symmetry of the treatment, gingival exposure of the smile, group, and gender were assessed using a multivariable linear regression model.

Results: In the pre- and post-treatment cases, medium smile photographs received higher scores than the same cases with high or low smiles, with significant differences between them. In all cases, orthodontists were the least-tolerant evaluation group (assigning lowest scores), followed by general dentists. In a predictive linear regression model, bilateral MLIA was the more predictive variable in pretreatment cases. The gingival exposure of the smile was a predictive variable in post-treatment cases only.

Conclusion: The medium-height smile was considered to be more attractive. In all cases, orthodontists gave the lowest scores, followed by general dentists. Laypersons and male evaluators gave the highest scores. Symmetrical treatments scored higher than asymmetrical treatments. The gingival exposure had a significant influence on the esthetic perception of smiles in post-treatment cases.

Among the Portuguese population, prevalence of maxillary lateral incisor agenesis (MLIA) has been estimated at 1.3%, with a slightly higher frequency in females.¹ Unilateral agenesis was found to be associated with dysmorphia or microdontia of the corresponding contralateral tooth,² which suggested that microdontia of maxillary lateral incisors was part of the same phenotype.³

The treatment of unilateral or bilateral agenesis of maxillary lateral incisors has proven to be challenging, commonly

involving different treatment approaches: accepting the existing spaces without changing them, creating sufficient space for posterior replacement of the missing lateral incisor with prosthetic units (a single-tooth, implant-supported all-ceramic restoration, and a tooth-supported restoration), or orthodontically closing the space with the maxillary canine so as to mimic the appearance of the lateral incisor. The three types of tooth-supported restorations available today are a resin-bonded fixed partial denture (FPD), a cantilevered FPD, and a

conventional full-coverage FPD; however, the primary consideration when deciding which option to choose is conservation of tooth structure.⁴

Smile esthetics has become a high concern for patients and clinicians and represents one of the main reasons patients seek orthodontic treatment.⁵ Studies of smile variables have been performed through the use of computer-based methodologies and highly sophisticated digital image manipulation.⁵⁻⁷

Smile height was defined in this study as the quantity of vertical maxillary central incisor tooth and gingival tissue exposed while smiling in relation to the location of the upper lip. As a general rule, acceptable esthetics is achieved when the upper lip covers the gingival margin of the maxillary central incisors. This typically results in total cervico-incisal exposure of the maxillary central incisors along with the interproximal gingiva. A high smile may be defined as a high lip line exposing all the crowns of the anterior teeth and presents a contiguous band of gingival tissue (more than 3 mm), whereas for a low smile, a low lip line displays less than 75% of the maxillary anterior teeth.^{5,8}

Despite the absence of consensus on the degree to which gingival exposure influences smile esthetics,^{5,9,10} large (>3 mm) gingival exposure has been reported as esthetically undesirable by clinicians, researchers, and laypersons.¹¹⁻¹³ Many MLIA patients are, above all, interested in improving their smiles, but high smiles are not easily altered with orthodontic treatment only.¹⁴

MLIA orthodontic treatment can be performed by creating a space in the missing lateral incisor area or by orthodontically moving the canines into the places of missing lateral incisors; however, if the treatment plans dictate that the spaces should be enlarged; prosthetic rehabilitation could be alternatively applied in the premolar region. Regarding the perception of esthetic smiles, some authors have concluded that laypersons are less rigorous and have been reported to give higher scores than oral health professionals.⁵ Moreover, it has been observed that women have higher standards than men when judging smile esthetics.¹⁵

The main purpose of this study was to compare the perception of smile attractiveness between orthodontists, general dentists, and laypersons in patients with MLIA treated with space closure or with prosthetic units, considering symmetry and gingival exposure.

Materials and methods

The study was approved by the Human Research Ethical Committee of the Instituto Superior de Ciências da Saúde-Norte, Portugal and the Human Research Ethical Committee of the University of Valencia (approval number H1396425836238). The study sample consisted of 381 adults, 244 (64%) women and 137 (36%) men. The fieldwork was carried out between January and March 2013. Three groups were considered in the sample of this study: 80 orthodontists (21%), 181 general dentists (47.5%), and 120 laypeople (31.5%).

With consent from the selected subjects and their parents, 4 orthodontic MLIA patients treated with different approaches were selected for this study:

Case 1: Unilateral MLIA, with contralateral conoid. Treated orthodontically with closing space and reshaped canines (asymmetrical treatment).

Case 2: Unilateral MLIA, with contralateral conoid. Treated orthodontically with opening space, rehabilitation with an implant, and direct restoration of contralateral incisor (asymmetrical treatment).

Case 3: Bilateral MLIA, treated orthodontically, with closing space and bilateral reshaped canines (symmetrical treatment).

Case 4: Bilateral MLIA, treated orthodontically with opening space, followed by a resin-bonded FPD (symmetrical treatment).

In the post-treatment cases, unilateral treatments consisting of lateral incisor restoration or reshaped canines were considered as “asymmetrical treatments,” and bilateral treatment of lateral incisor restorations, reshaped canines, or adhesive prostheses after opening or closing spaces in bilateral MLIA were considered “symmetrical treatments.” In all four cases, a buccal photograph was taken before and after treatment/rehabilitation. These eight photographs were integrated on the same lips. The smiles were altered with Adobe Photoshop (Adobe Systems Inc, San Jose, CA) to present more or less gingival exposure. To reduce the number of confounding variables, these images only included a smile framework, with no other parts of the face. For the same reason, the gingiva and tooth tones were adjusted. To minimize the influence of buccal corridors on smile attractiveness,⁷ only the anterior teeth up to the first premolar were exposed.

The eight smiling photographs were digitally altered to create three images with high, medium, and low smiles according to previous studies (a total of 24 photos were obtained).^{9,16,17} For these alterations, the gingival margins of the maxillary central incisors were used as reference points. The upper lip was adjusted at this reference point and was considered a “medium smile” (Figs 1, 2). The smile was altered by progressively raising the upper lip by 3 mm (high smile), and lowering the upper lip by 3 mm (low smile) (Figs 1, 2).

The 24 smile photos were uploaded onto an online survey platform and were sent to 605 people (dentists and laypersons), who were asked to rank them according to their preferences concerning the esthetic perception using a 10-cell numeric scale. The participants were asked to place a check mark on the numeric scale next to each image to define its attractiveness, 1 indicating the least attractive smile, and 10 indicating the most attractive smile. The 24 images were randomly shown one by one. Social variables such as age and gender were considered in this online questionnaire. Of a total of 500 questionnaires, 119 questionnaires (24.8%) were rejected because there were missing answers. Forty people repeated the questionnaire after receiving a second e-mail to evaluate the reliability (Intraclass Correlation Coefficient 0.92). Study variables were: gender (male, female), pretreatment cases (bilateral MLIA, unilateral MLIA), post-treatment cases (symmetrical treatment, asymmetrical treatment), height of the smile (low, medium, high), and group (orthodontists, general dentists, laypersons).



Figure 1 Pretreatment cases (1, 2, 3, 4) with high, medium, and low gingival exposure in the smile, digitally modified.



Figure 2 Post-treatment cases (1, 2, 3, 4) with high, medium, and low gingival exposure in the smiles, digitally modified.

Statistical analysis

SPSS v.19.0 (SPSS Inc., Chicago, IL) was used for data analysis. The scores of esthetic perception were obtained using a 10-cell numeric scale, and the resulting arithmetic means were compared using the Student’s *t*-test and an ANOVA test. In addition, the linear trend between the categories was assessed. A linear regression model was used for the analysis of the predictive capability of the study variables. The significance level was established at *p* < 0.05. The existence of linear trends between the different categories and the predictive capability of the variables were analyzed through the use of a linear regression model.

Results

When analyzing the pre- and post-treatment cases, mean values of 3.58 (IC 95% 3.47-3.70) and 6.69 (IC 95% 6.54-6.84) were obtained, respectively, with a statistically significant difference between the means (*p* < 0.001). Table 1 presents the mean scores of the four pre- and post-treatment cases depending on the gingival exposure of the smile (high smile, medium smile, low smile). In pretreatment cases, medium smiles typically received higher scores than the same cases with high smiles or low smiles, with a significant difference between them (*p* < 0.05). In post-treatment cases, the high smile cases received the lowest scores, and the medium smiles the highest. A Student’s *t*

Table 1 Pre- and post-treatment cases mean scores (CI 95%) in the esthetic perception depending on the gingival exposure in the smile

	Gingival exposure in the smile			Student <i>t</i> test <i>p</i> value
	High mean (IC 95%)	Medium mean (IC 95%)	Low mean (IC 95%)	
Pretreatment				
Case 1	2.07 (1.96-2.18)	2.15 (2.03-2.26)	2.34 (2.21-2.46)	High vs. medium: 0.051 Medium vs. low: 0.000* High vs. low: 0.000*
Case 2	3.74 (3.57-3.91)	3.90 (3.73-4.07)	3.69 (3.53-3.86)	High vs. medium: 0.003* Medium vs. low: 0.002* High vs. low: 0.352
Case 3	3.25 (3.11-3.40)	3.36 (3.22-3.50)	3.21 (3.06-3.35)	High vs. medium: 0.040* Medium vs. low: 0.015* High vs. low: 0.487
Case 4	5.10 (4.90-5.29)	5.30 (5.10-5.49)	4.89 (4.70-5.08)	High vs. medium: 0.001* Medium vs. low: 0.000* High vs. low: 0.001*
Post-treatment				
Case 1	6.06 (5.88-6.24)	6.88 (6.72-7.05)	6.65 (6.46-6.85)	High vs. medium: 0.000* Medium vs. low: 0.009* High vs. low: 0.000*
Case 2	6.43 (6.26-6.61)	7.02 (6.86-7.19)	6.60 (6.40-6.79)	High vs. medium: 0.000* Medium vs. low: 0.000* High vs. low: 0.034*
Case 3	6.20 (6.01-6.39)	7.06 (6.89-7.22)	6.41 (6.22-6.61)	High vs. medium: 0.000* Medium vs. low: 0.000* High vs. low: 0.005*
Case 4	6.72 (6.52-6.92)	7.16 (6.98-7.35)	7.12 (6.91-7.32)	High vs. medium: 0.000* Medium vs. low: 0.553 High vs. low: 0.000*

*The mean difference is significant at the 0.05 level.

test was applied, and a significant difference ($p < 0.05$) was observed, depending on the gingival exposure of the smile.

Table 2 shows the differences in perception between the three groups (orthodontists, general dentists, laypersons) depending on the gingival exposure of the smile (pre- and post-treatment cases). Orthodontists were the least-tolerant group, giving lower scores, followed by general dentists. Higher scores were given by laypersons. In the linear trend test, significant differences were observed between the groups ($p < 0.05$).

The capability of the variables of uni- or bilateral MLIA, symmetrical or asymmetrical treatment, gingival exposure of the smile, group, and gender in the prediction of the scores for esthetic perceptions was assessed, using a linear regression model (Table 3). In the pretreatment cases, the gingival exposure of the smile did not affect the judgment of the respondents; however, the variable bilateral MLIA was a predictive variable (beta coefficient 1.002). The variable group (dentists/orthodontists vs. lay people) and gender (male vs. female) were also predictive variables (beta coefficients -0.275 and 0.302 , respectively).

In post-treatment cases, the gingival exposure of the smile and symmetrical treatment affected the judgment of the respondents, but the gingival exposure of the smile was the more important of the two (beta coefficient 0.510 and 0.174 , respec-

tively). The variable group (orthodontists/general dentists vs. lay people) was also a predictive variable in the model (beta coefficient -0.980), orthodontists/general dentists giving lower scores than lay people. Gender was also a predictive variable (beta coefficient 0.226), men giving higher scores than women.

Discussion

Kokich et al⁹ evaluated the esthetic perception of altered tooth shapes, symmetrically altering crown length and width and asymmetric dental discrepancies. They established group-specific threshold levels for each esthetic parameter. The changes were made by symmetrically altering crown length and width. Otherwise, few studies have considered the esthetic perception of oral health professionals and laypeople in MLIA cases regarding the gingival exposure of the smile.¹⁸

According to Paula et al¹³ the excessive anterior maxillary teeth displayed while smiling may potentially influence the self-perceived psychosocial impacts of malocclusion in adolescents, depending on the malocclusion severity levels and self-reported satisfaction with one's dental appearance. An obvious expectation from orthodontic treatment in MLIA cases is to create a pleasant esthetic appearance after therapy. Despite an ideal treatment result regarding tooth alignment, without

Table 2 Pre- and post-treatment scores in esthetic perception, between the three groups depending on the gingival exposure in the smile

		Orthodontists	General dentists	Lay people	ANOVA's test
		Mean (IC 95%)	Mean (IC 95%)	Mean (IC 95%)	Linear trend test
Pretreatment	High smile	3.18 (2.94-3.41)	3.55 (3.37-3.72)	3.77 (3.53-4.01)	0.004* 0.000*
	Medium smile	3.52 (3.25-3.79)	3.64 (3.46-3.81)	3.84 (3.62-4.07)	0.152 0.000*
	Low smile	3.25 (3.02-3.48)	3.55 (3.37-3.74)	3.69 (3.43-3.94)	0.062 0.000*
Post-treatment	High smile	5.80 (5.47-6.12)	6.13 (5.90-6.36)	7.07 (6.77-7.36)	0.000* 0.000*
	Medium smile	6.45 (6.17-6.73)	6.82 (6.62-7.02)	7.75 (7.50-8.01)	0.000* 0.000*
	Low smile	6.29 (5.91-6.67)	6.49 (6.23-6.75)	7.28 (6.94-7.63)	0.000* 0.000*

*The mean difference is significant at the 0.05 level.

Table 3 Predictive models of the scores in the esthetic perception in pre- and post-treatment cases

Dependent variable	R ²	Predictive variables	Model equation
Esthetic perception in pretreatment cases	0.072	Bilateral MLIA: Beta coeff. = 1.002, $p = 0.00^*$ Dentist/orthodontist: Beta coeff. = -0.275, $p = 0.00^*$ Male: Beta coeff. = 0.302, $p = 0.00^*$	Score = 3.329 + (Bilateral MLIA) × 1.002) - (Dentist/orthodontist × 0.275) + (Male × 0.302)
Esthetic perception in post-treatment cases	0.082	Symmetrical treatment: Beta coeff. = 0.174, $p = 0.00^*$ Dentist/orthodontist: Beta coeff. = -0.980, $p = 0.00^*$ Medium height: Beta coeff. = 0.510, $p = 0.001$ Male: Beta coeff. = 0.226, $p = 0.00^*$	Score = 7.034 + (Symmetric treatment × 0.174) + (Medium height × 0.510) + (Dentist/orthodontist × -0.986) + (Male × 0.226)

*The mean difference is significant at the 0.05 level.

diastemas (caused by the MLIA), the patient might not be satisfied with the esthetic outcome (e.g., the gingival exposure of the smile). A smile analysis involves different variables of the esthetic perception that should contribute to building a harmonious smile.¹⁹ In this study, gingival exposure of the smile was not as important in pretreatment cases, being more relevant in post-treatment cases.

As a general rule, in this study, laypersons gave higher scores in all cases, indicating that dental practitioners, particularly orthodontists, were the less tolerant group, assigning lower scores. These results have been observed in previous studies.⁵

In this study, the images of a posed smiling photograph before treatment were digitally altered to create three images with medium, high, and low smiles. The same procedure was carried out for the smiling photograph after treatment. As it is well

known that having minimal buccal corridors is a preferred esthetic feature in both men and women,⁷ the anterior teeth until the first premolar were exposed, and the posterior teeth were partially obscured in all 24 smiles to minimize the influence of corridors on the smile attractiveness.

This study does have several limitations. The fact that each respondent rated the photos on a different screen could have influenced the results. Moreover, the participants evaluated digitally altered smiles based on partial information (the photos were integrated on the same lips, included a smile framework and no other parts of the face). We consider that these methodologies could have increased the number of confounding variables.

The evaluation was done using a numeric scale, which, according to Howells and Shaw,²⁰ already has accepted reliability and comparability for epidemiologic studies. In addition, as this

method is both fast and cost-effective, it is suitable for assessing tooth forms.

In this study, smiles were altered by progressively moving the upper lip 3 mm superiorly. This was based on the studies of Kokich *et al*⁹ who suggested this measure as the threshold of acceptability when evaluated by laypersons and dentists collectively; however, the raters of this study did not appear to be tolerant of this gingival exposure in MLIA cases. This might indicate that gingival exposure is not confined to just the maxillary central incisor area, but it is more a global evaluation of the maxillary arch.

The shape of the anterior teeth, mainly the maxillary ones, which are displayed during smile and speech, substantially contribute to fulfilling the patient's expectations from orthodontic treatment and has considerable influence on smile esthetics.¹⁷ According to Anderson *et al*²¹ laypersons tended to be less critical, and their preferences differed from those of dental professionals when considering the shape of the anterior teeth. This is in accordance with our results, which showed that laypersons, on average, were less discriminating and had a larger range of acceptability in all different MLIA treatment approaches.

The cases in which a symmetric final result was attained were better assessed, and this is also in accordance with other studies.^{9,22} For some authors, the major advantages of orthodontic space closure for young patients with lateral incisor agenesis and a coexisting malocclusion are the permanence of the finished result and the possibility to complete treatment in early adolescence.^{23,24} These conclusions differ from the results of this study that obtained higher scores for opening spaces symmetrically to replace both missing maxillary incisors than closing the same spaces orthodontically. Notwithstanding, clinicians should keep in mind that opening spaces in young patients sometimes implies that patients have to continue a long time with a provisional treatment, until a definitive treatment can be performed.⁴

This study revealed that numerous factors influence esthetic perception. Higher scores were obtained in those cases where the selected treatment consisted in opening spaces, creating a symmetrical smile by replacing the missing maxillary incisor. This is in agreement with previous reports, which showed that an esthetic smile is formed by a combination of numerous factors.^{16,25,26}

It was concluded that symmetry was an important variable in the pretreatment cases, but gingival exposure in the smile was not. This may be due to the malocclusion itself that deflects the attention. Both gender and profession have an influence on esthetic perception, orthodontists and women being more rigorous smile evaluators. On the other hand, in post-treatment cases both symmetrical treatment and gingival exposure in the smile were predictive variables, but the latter obtained a higher beta coefficient.

Conclusion

According to the results of this study, medium smile cases had a higher attractiveness. In all cases, orthodontists assigned the lowest scores, followed by general dentists. Laypersons and male evaluators assigned the highest scores. Symmetrical treatments scored higher than asymmetrical treatments. Gingival

exposure had a significant influence on the esthetic perception of the smiles in the post-treatment cases.

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