Effect of the interproximal contact level on the perception of smile esthetics

Wpływ miejsca kontaktu międzyzębowego na odbiór estetyki uśmiechu

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Abstract

Background. Many dental and facial components affect smile esthetics, and dental professionals' opinions regarding dental esthetics may not always coincide with the perceptions and expectations of the patients.

Objectives. This work is designed to determine the dimensions of the interproximal contact areas that are considered the most or least attractive according to a group of laypersons, dentists and technicians.

Material and methods. Two photographs of female and male smiles showing a full smile were taken with a Nikon® camera and digitally altered using Adobe® Photoshop. The length of the interproximal contact areas was altered to generate 2 sets of images (3 images of the female and 3 images of the male smile in each set). A group of 40 laypersons, 40 dentists and 40 dental technicians were asked to select the most and the least attractive image in each set.

Results. An interproximal contact ratio of 50:40:30 [%] was the most attractive arrangement (40.00% and 38.33% for the female and male smiles, respectively). The 'reversed' ratio of 30:40:50 [%] was the least attractive to the participants (57.50% and 44.17% for the female and male smiles, respectively). There were differences in the rankings of the most and the least attractive smiles among the 3 groups of evaluators.

Conclusions. The 'ideal' interproximal contact ratio of 50:40:30 [%] is perceived to be the most attractive. However, the smile esthetics perception among dental professionals is not always in agreement with the perception of laypersons.

Key words: esthetics, dental, proximal, smile attractiveness

Słowa kluczowe: estetyka, zębowy, proksymalny, atrakcyjność uśmiechu

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Introduction

Smile is a significant determinant of dental and facial esthetics. Several dental and facial components affect smile esthetics, and a harmonizing esthetic smile requires the successful integration of dental and facial composition.¹ Esthetic treatment should always be preceded by a thorough analysis of both facial and dental composition.²

The perception of esthetics is influenced by one's social environment, culture and individual experiences. Considering dental professionals' scientific and professional background, their opinions regarding dental esthetics may differ from the expectations of their patients.^{3–11} Thus, it is imperative for dental professionals to continuously study changes in the perception of smile esthetics in their communities.¹²

The length and sequence of the interproximal contact area – an area where 2 adjacent teeth appear to touch – in the maxillary anterior teeth have been considered important factors affecting dental esthetics.¹³ Normally, the interproximal contact area between the 2 central incisors is located at the incisal third. The level of the interproximal contact area moves apically as we move posteriorly.¹⁴ For the most attractive smile, the 50:40:30 rule has been proposed, in which the contact area between the maxillary central incisors constitutes 50% of the length of the central incisors; the contact area between the maxillary lateral incisor and the central incisor is 40% of the length of the central incisor; and the contact area between the maxillary canine and the maxillary lateral incisor is 30% of the length of the central incisor.¹⁵ However, further studies are needed to investigate the impact of the length and sequence of the proximal contact area on the perception of smile esthetics.

Therefore, this study aimed to investigate which interproximal contact area dimensions are considered the most attractive among laypersons, dentists and techni-

cians. Furthermore, this study assessed whether there are any differences in the smile esthetic perception between dental professionals and laypersons.

Material and methods

Ethical approval was obtained from the institutional review board of Riyadh Elm University, Saudi Arabia, before conducting the study (approval No. RC/IRP/2016/398). The sample size calculation was done using the free software G*Power, v. 3.1.9.213 (<http://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html>). Assuming the significance level of alpha at ≤ 0.05 and an effect size of 0.26, the sample size required to achieve 90% power was 120 subjects (40 in each group).

Two photos were taken with a professional Nikon® camera (D5200; Nikon Corp., Shinagawa, Tokyo, Japan), 1 for a male smile and 1 for a female smile. The photos were then altered digitally using the Adobe® Photoshop CS6 software (Adobe Systems Inc., San Jose, USA) to produce standard, bilaterally symmetrical images. The standard images were modified to produce 2 sets of smile images in order to evaluate the effect of the interproximal contact area on perceived smile esthetics.

In the 1st set, the levels of the interproximal contact areas of maxillary anterior teeth in the standard images were altered to produce 3 images for the female and 3 images for the male smiles with a different order of the proximal contact lengths (Fig. 1):

- ideal – the ratio of the interproximal contact areas followed the 50:40:30 rule;
- equal – the interproximal contact areas were equal (50:50:50);
- reversed – the ratio of the interproximal contact areas was reversed (30:40:50).

Fig. 1. The 1st set of images with a different order of the proximal contact lengths

A1 and A2 – 'ideal' 50:40:30 [%] ratio, female and male smiles, respectively; B1 and B2 – 'equal' 50:50:50 [%] ratio, female and male smiles, respectively; C1 and C2 – 'reversed' 30:40:50 [%] ratio, female and male smiles, respectively.

In the 2nd set, the levels of all interproximal contact areas in the standard images were modified apically or coronally to produce 3 images for the female and 3 images for the male smiles with different proximal contact lengths (Fig. 2):

- reduced – the ratio of the interproximal contact areas was decreased (40:30:20);
- ideal – the ratio of the interproximal contact areas followed the 50:40:30 rule;
- exaggerated – the ratio of the interproximal contact areas was increased (60:50:40).

The ratios of interproximal contact lengths in all images were based on the length of the left maxillary central incisor.

The images were presented to the participants as slides, with 3 smile images on each slide, on a Samsung tablet screen, 8.4 inches, LTE (Galaxy Tab S; Samsung, Seoul, South Korea). Data collection was conducted via a secured online research platform (<https://www.qualtrics.com>). One hundred and twenty participants consented to participate in the study. The participants were divided into 3 groups: 40 laypersons; 40 dentists; and 40 dental technicians. Among all participants, 79 were males (M) and 41 were females (F). Their age ranged between 20 and 60 years with a median age of 31 years. The group of laypersons consisted of adults undergoing prosthodontic or restorative esthetic treatment (veneers or crowns). Only dentists practicing esthetic dentistry were included in the 2nd group. The group of technicians comprised only ceramist technicians. Any participants complaining of visual impairment were excluded from the study.

The smile images were examined by each participant under adequate standard light and they were given enough time to render their final decision regarding their preference.

The statistical analysis of their responses was performed using the IBM SPSS Statistics for Windows software, v. 22.0 (IBM Corp., Armonk, USA). The χ^2 tests were carried out to test for significant differences between the groups. The significance level was set at $p \leq 0.05$.

Results

For the 1st set of images, the order of the proximal contact ratios was changed. The results show that the ‘ideal’ 50:40:30 ratio was considered the most attractive to the majority of the participants (40.00% and 38.33% for the female and male smiles, respectively). The ‘reversed’ 30:40:50 ratio was the least attractive arrangement to the participants (57.50% and 44.17% for the female and male smiles, respectively) (Table 1).

The majority of the dentists and technicians selected the ‘ideal’ 50:40:30 ratio as the most attractive, both in the female and male smiles (F: 52.5%; M: 35.0% and F: 42.5%; M: 45.0%, respectively). However, more laypersons selected the ‘equal’ 50:50:50 ratio for the female smile (F: 42.5%) and the ‘reversed’ 30:40:50 ratio for the

Table 1. Smile esthetics perceived by the participants in terms of the interproximal contact area sequence ratio

Sequence ratio	Most attractive	Middle	Least attractive	Total
Female smile				
ideal 50:40:30 [%]	48 (40.00)	47 (39.17)	25 (20.83)	120
reversed 30:40:50 [%]	28 (23.33)	23 (19.17)	69 (57.50)	120
equal 50:50:50 [%]	44 (36.67)	50 (41.66)	26 (21.67)	120
Male smile				
ideal 50:40:30 [%]	46 (38.33)	44 (36.67)	30 (25.00)	120
reversed 30:40:50 [%]	40 (33.33)	27 (22.50)	53 (44.17)	120
equal 50:50:50 [%]	34 (28.34)	49 (40.83)	37 (30.83)	120

Data presented as number (percentage).

Fig. 2. The 2nd set of images with different proximal contact lengths

A1 and A2 – ‘reduced’ 40:30:20 [%] ratio, female and male smiles, respectively; B1 and B2 – ‘ideal’ 50:40:30 [%] ratio, female and male smiles, respectively; C1 and C2 – ‘exaggerated’ 60:50:40 [%] ratio, female and male smiles, respectively.

male smile (M: 42.5%) as the most attractive. On the other hand, the majority of the dentists perceived the 'reversed' 30:40:50 ratio as the least attractive (F: 70.0%; M: 55.0%), as did the majority of the technicians (F: 57.5%; M: 47.5%). However, a higher percentage of laypersons selected both the 'ideal' 50:40:30 and 'equal' 50:50:50 ratios as the least attractive male smile.

No statistically significant differences in the ranking were found among the 3 groups ($p = 0.093$ for the female smiles; $p = 0.507$ for the male smiles) (Table 2).

In the 2nd set of images, the length of the interproximal contact areas was different. The 'ideal' 50:40:30 contact area length was considered the most attractive by the majority of the participants (F: 50.83%; M: 38.33%). The 'exaggerated' 60:40:50 length was the least attractive arrangement for the female smile (F: 61.66%), whereas the 'reduced' 40:30:20 length was the least attractive for the male smile (M: 44.17%) (Table 3).

Table 2. Univariate analysis for the association between perceived smile esthetics in terms of various interproximal contact area ratios and the type of respondent

Factor	Respondent type			p-value
	dentist (n = 40)	layperson (n = 40)	technician (n = 40)	
MA (F)				
ideal 50:40:30 [%]	21 (52.5)	10 (25.0)	17 (42.5)	0.093
reversed 30:40:50 [%]	5 (12.5)	13 (32.5)	10 (25.0)	
equal 50:50:50 [%]	14 (35.0)	17 (42.5)	13 (32.5)	
MA (M)				
ideal 50:40:30 [%]	14 (35.0)	14 (35.0)	18 (45.0)	0.507
reversed 30:40:50 [%]	13 (32.5)	17 (42.5)	10 (25.0)	
equal 50:50:50 [%]	13 (32.5)	9 (22.5)	12 (30.0)	
LA (F)				
ideal 50:40:30 [%]	6 (15.0)	13 (32.5)	6 (15.0)	0.109
reversed 30:40:50 [%]	28 (70.0)	18 (45.0)	23 (57.5)	
equal 50:50:50 [%]	6 (15.0)	9 (22.5)	11 (27.5)	
LA (M)				
ideal 50:40:30 [%]	9 (22.5)	14 (35.0)	7 (17.5)	0.139
reversed 30:40:50 [%]	22 (55.0)	12 (30.0)	19 (47.5)	
equal 50:50:50 [%]	9 (22.5)	14 (35.0)	14 (35.0)	
MA (F)				
ideal 50:40:30 [%]	22 (55.0)	18 (45.0)	21 (52.5)	0.054
exaggerated 60:50:40 [%]	2 (5.0)	11 (27.5)	4 (10.0)	
reduced 40:30:20 [%]	16 (40.0)	11 (27.5)	15 (37.5)	
MA (M)				
ideal 50:40:30 [%]	14 (35.0)	14 (35.0)	18 (45.0)	0.507
exaggerated 60:50:40 [%]	13 (32.5)	9 (22.5)	12 (30.0)	
reduced 40:30:20 [%]	13 (32.5)	17 (42.5)	10 (25.0)	
LA (F)				
ideal 50:40:30 [%]	3 (7.5)	7 (17.5)	4 (10.0)	0.017*
exaggerated 60:50:40 [%]	29 (72.5)	16 (40.0)	29 (72.5)	
reduced 40:30:20 [%]	8 (20.0)	17 (42.5)	7 (17.5)	
LA (M)				
ideal 50:40:30 [%]	7 (17.5)	7 (17.5)	5 (12.5)	0.079
exaggerated 60:50:40 [%]	25 (62.5)	16 (40.0)	27 (67.5)	
reduced 40:30:20 [%]	8 (20.0)	17 (42.5)	8 (20.0)	

Data presented as number (percentage).

MA – most attractive; LA – least attractive; F – female smile; M – male smile;

* statistically significant ($p \leq 0.05$); the χ^2 test.

Table 3. Smile esthetics perceived by the participants in terms of the interproximal contact area length ratio

Sequence ratio	Most attractive	Middle	Least attractive	Total
Female smile				
ideal 50:40:30 [%]	61 (50.83)	45 (37.50)	14 (11.67)	120
exaggerated 60:50:40 [%]	17 (14.17)	29 (24.17)	74 (61.66)	120
reduced 40:30:20 [%]	42 (35.00)	46 (38.33)	32 (26.67)	120
Male smile				
ideal 50:40:30 [%]	46 (38.33)	44 (36.67)	30 (25.00)	120
exaggerated 60:50:40 [%]	34 (28.34)	49 (40.83)	37 (30.83)	120
reduced 40:30:20 [%]	40 (33.33)	27 (22.50)	53 (44.17)	120

Data presented as number (percentage).

The majority of the dentists and technicians selected the 'ideal' 50:40:30 ratio as the most attractive, both in the female and male smiles (F: 55.0%; M: 35.0% and F: 52.5%; M: 45.0%), whereas the majority of laypersons selected the 'ideal' 50:40:30 ratio in the female smile and the 'reduced' 40:30:20 ratio in the male smile as the most attractive (F: 45.0%; M: 42.5%). No statistically significant differences in the ranking were found between the 3 groups ($p = 0.054$ for the female smiles; $p = 0.507$ for the male smiles) (Table 2).

In terms of the least attractive smiles, the 'exaggerated' 60:40:50 length ratio was selected by both the dentists (F: 72.5%; M: 62.5%) and the technicians (F: 72.5%; M: 67.5%), whereas more laypersons selected the 'reduced' 40:30:20 length ratio as the least attractive (F: 42.5%; M: 42.5%). The analysis revealed statistically significant differences in the ranking of the 2nd set of images of the female smile between the 3 groups ($p = 0.017$) (Table 2).

Discussion

Presenting images of smiles to participants in order to investigate their perception of attractiveness regarding smile esthetics is a method which can be frequently found in the literature, though the specifics vary from study to study. In the current study, cropped images, showing only the subjects' smiles were used in order to eliminate the potential distraction of the evaluator's perception.¹⁶

The results show that the 'ideal' interproximal contact area ratio arrangement proposed by Morley and Eubank – 50:40:30 – is considered the most attractive among dentists and dental technicians.^{acc.15} On the other hand, a higher percentage of laypersons selected the 'equal' arrangement for the female smile and the 'reversed' one for the male smile as the most attractive. Similarly, in examining the ratio of the length of the interproximal contact areas, the majority of the participants ranked the 'ideal' ratio (50:40:30) as the most attractive. One exception was the rating of the male smile by the layperson group, where a higher percentage found the 'reduced' ratio (40:30:20) to be the most attractive.

In agreement with previous studies, our findings revealed variations in the preferences of dental professionals and laypersons regarding smile esthetics.^{3,5,6,10,11} These variations, although minor, highlight the need for effective communication between dentists and dental technicians to ensure that the planned esthetic treatment meets the individual patient's expectations.

The interproximal contact areas can be altered by esthetic gingival surgeries, orthodontic treatment, or designing and contouring dental restorations. Moreover, when replacing missing teeth, the interproximal contact area represents the connector that joins pontics and retainers. It is common practice to increase the length of the connector area to ensure the strength and rigidity of fixed dental prostheses and to compensate for the recession of the interproximal papilla, which often follows tooth extraction. However, these alterations in the proximal contact area must be carefully planned to make sure they are within the acceptable esthetic range.⁵

The perception of esthetics could be affected by the interaction of multiple variables. In the current study, as with similar ones which preceded it, standardized photographs were used and only 1 esthetic variable was changed per set of images. This was done to isolate each variable and to investigate its individual effect on the perception of smile esthetics. Nevertheless, this limitation should be taken into consideration when interpreting the results of the current study.

Conclusions

The 'ideal' interproximal contact ratio (50:40:30) regarding the sequence and length is perceived as the most attractive arrangement, whereas the 'reversed' sequence ratio (30:40:50) and 'exaggerated' length ratio (60:50:40) are perceived as the least attractive arrangement. There are differences in perception between dental professionals and laypersons regarding the attractive order and length of proximal contact areas.

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