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RESEARCH ARTICLE

Perception of smile attractiveness among laypeople and orthodontists regarding the buccal corridor space, as it is defined by the eyes. An innovated technique

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Abstract

Objective: To investigate whether there is a relationship between the distance between the iris and pupil with the ideal size of buccal corridors.

Materials and Methods: A full-portrait image of a male Caucasian was used to create a set of 11 digitally modified images with different buccal corridor space. A web-based cross-sectional study was designed and distributed via an online survey to 200 laypeople and 200 orthodontists to assess image attractiveness, using a Visual analogue scale. For the statistical analysis, Wilcoxon signed-rank and Mann–Whitney *U* tests were used. The significance level was set at $p < 0.05$.

Results: The response rate for laypeople was 70% ($n = 139$), while the rate for orthodontists was 73% ($n = 146$). For the layperson group, the maximum smile attractiveness score was 10% of buccal width reduction, compared to the iris-pupillary distance, while for the orthodontists, it was 20%. The attractiveness of the smile was significantly reduced in both groups when the buccal corridor width was increased in comparison to the iris-pupillary distance.

Conclusion: The length between the mesial part of the iris and the distal of the pupil, may constitutes a landmark for the estimation of the desired width of the buccal corridor.

Clinical Relevance: Inter iris-pupillary distance can be the starting point in the smile designing process, in order to perform a facial driven selection of buccal corridor size.

KEYWORDS
buccal corridors, eyes, facial landmark, iris, smile attractiveness, smile design

1 | INTRODUCTION

In recent years, many patients are seeking dental treatment in order to improve dentofacial esthetics, and potentially their quality of life regarding both functional aspects and appearance. Esthetic dental treatment aims to generate a natural, healthy appearance that will fulfill the patient's expectations.[1] A pleasant smile includes the harmonious interaction between teeth and lips, as well as their integration into the face composition.[2] Facial architecture is important in order to perform a detailed diagnosis and to initiate a comprehensive treatment plan, as dental esthetics has to be in balance with facial esthetics.[3] Patient's smile has to be designed, through an effective

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communication between all involved teams, in order to arrive at a satisfactory treatment plan.[4]

Recently, dental research is oriented towards the investigation of the thresholds of esthetic acceptability, for facial and dental esthetics in order to find out the minimum level of esthetic harmony that can be approved as pleasurable.[5] One of the key factors that seem to affect the attractiveness of a smile is the size of buccal corridors (BCs).[2,5] Having the appropriate amount of buccal corridor visible is a subject that has been addressed in smile esthetics excessively. According to the literature, small BCs increase the attractiveness of smiling.[6–8] Besides, although less attractive smiles frequently have excessive BCs, there is no consistency in the preferred dimensions. When calculated as a ratio of the length of the smile, the range of tolerance ranges from an absolute value of 5 to 16 mm and from 2%–17%.[9] Though some information regarding the appropriate buccal corridor width is available in the literature, the majority of it shows existing variations and general results.[8–10]

The determination of the size of BCs during the pre-operative designing of the smile is an important part that has to be performed before the initiation of any orthodontic or prosthodontic treatment.[5,6] A proper treatment plan can significantly improve the communication, between all involved team members, especially in multidisciplinary cases.[1] However, there has not been any clinically easy and objective reference criteria that can serve as a landmark, in order to assess whether a given amount of buccal corridor is pleasant.

The human eye is considered to be a unique biometric marker, and has been used even for personal identification. Digital acquirement of the iris is common today as iris-scanning technology and has become a standard feature in many smartphones. Potential correlations of the position and the width of the eyes, with the smile, have been investigated.[11–13] Iris to iris distance, horizontal aperture of the eye, and iris length are some of the dimensions that have been evaluated for potential correlations with structures of the smile. However, a possible correlation between buccal corridor width and the size of the eyes has not been yet evaluated.

The purpose of the present study was to analyze the relationship between the iris and pupil and the ideal size of BCs. The null hypotheses were that there is no difference in face attractiveness, for various sizes of the buccal corridor in relation to the distance between the mesial of the iris and distal surface of pupil (MIDP, Figure 1), between orthodontists and laypeople, between males and females and between younger and older observers.

2 | MATERIALS AND METHODS

The present web-based cross-sectional study was designed and conducted in a dental school environment, between December 2020 and May 2021. The study was approved by the Ethical Committee of Marmara University, Faculty of Dentistry (21.12.2020, 2020/85, Istanbul, Turkey). Due to the regulation regarding Covid-19 pandemic, a questionnaire was decided to be shared via an online platform. For this purpose, an online survey was performed via an internet-based

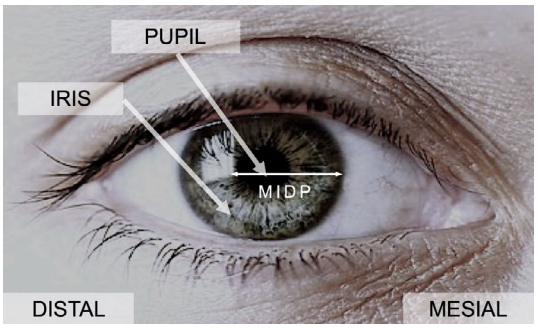

FIGURE 1 Distance between the mesial of the iris and distal surface of pupil (MIDP)

questionnaire. Based on previous studies, a power analysis was conducted implementing an online calculator (power calculator, University of Iowa), for an effect size of 0.85 at a conventional α level (0.05) and desired power (1-β) of 0.85.[14,15] According to the analysis, a sample of 280 participants (140 orthodontists/students in orthodontics and 140 laypeople) was necessary for the present study. The inclusion criteria for all the groups were age ≥25 and ≤70 years. Moreover, orthodontists should have at least 3 year of academic training.

A frontal view full portrait image of a 26-year-old individual, with a mesofacial type of face, a fairly good teeth alignment and a harmonious smile, was selected as a model. Implementing a digital camera (EOS 80D, Canon), a 100 mm macro lens (IS, USM Canon) and two wireless flashes (270EXII, Canon) a digital image of a full-portrait, with the individual in a full smile, showing his teeth was captured.

MIDP served as a reference. A photo editing and manipulation software (Adobe Photoshop CS 2015, Adobe), was used to modify the initial portrait image. To create the control image, two vertical lines on each side of the face were drawn as one tangent to the mesial of the iris and the other tangent to the distal of the pupil. The buccal corridor spaces, were digitally modified, in order their boundaries to coincide with the aforementioned lines. Afterwards modifications in the width of buccal corridors were performed, as a percentage of the initial MIDP distance. In this way control image was further manipulated to create five images with an increased buccal corridor width (+10%, +20%, +30%, +40%, +50%) and five images with a decreased buccal corridor width (−10%, −20%, −30%, −40%, −50%). Control image was duplicate in order to assess ratter's reliability. As result, a series of 12 images with varying buccal corridor space was created. The control image, along with the images, which represented maximum increase and decrease of buccal corridor space, compared to the control, are presented in Figure 2.

The online survey was forwarded, to 200 laypeople and 200 orthodontists, implementing a database of emails derived from Marmara University and Turkish Orthodontic Society respectively. The participants had to declare their age and gender at the beginning of the online survey. Subsequently, they were asked to evaluate the attractiveness of the presented smiles, without being informed about the digital manipulations of the images. The evaluation was performed via a Visual analogue scale VAS, ranging from point 0 (extremely

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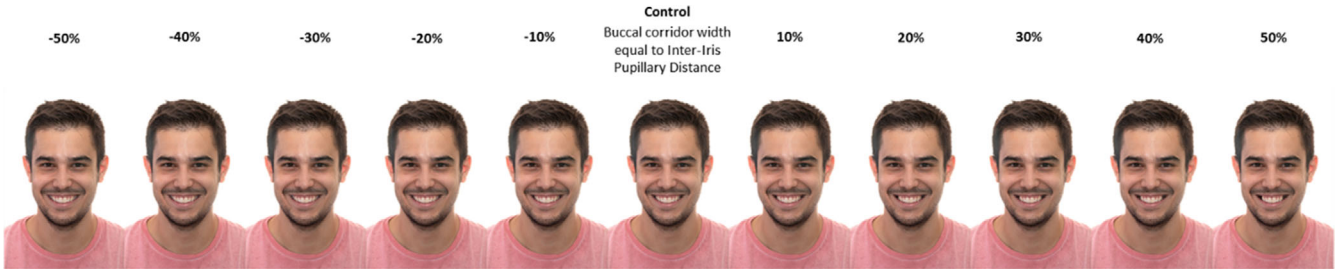

FIGURE 2 Digital modifications of buccal corridor width compared to the control.



FIGURE 3 Evaluation of the attractiveness of each presented smile via visual analogue scale (VAS)

unattractive) to point 100 (extremely attractive). The participants had to move a tab in the position of the visual analogue scale, which represented based on their perception, the attractiveness of each presented smile (Figure 3).

2.1 | Statistical analysis

Statistical software (SPSS v.23, IBM) was used for the analysis of the data. The normality of the data was assessed implementing Shapiro–Wilk test. The data were significantly different from the normal distribution. Therefore, differences in smile attractiveness were evaluated using multiple Wilcoxon signed-rank tests. Mann–Whitney *U* test was applied in order to assess the differences, based on the age group or the gender, for both type of observers. The significance level was set at $p < 0.05$.

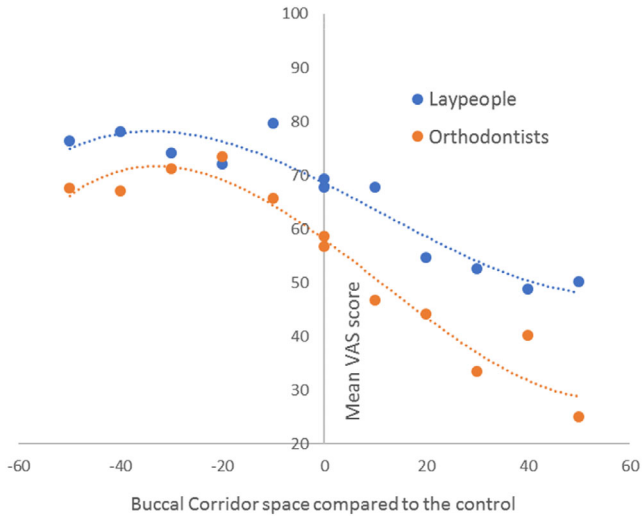

FIGURE 4 Graphical representation of the smile attractiveness, for the evaluated modifications in the width of buccal corridors, taking as a benchmark the distance from the mesial of the pupil to the distal of the iris.

3 | RESULTS

Laypeople presented a response rate of 70% ($n = 139$) and this rate was 73% ($n = 146$) for the orthodontists. Laypeople comprised of 78 male and 61 female participants with a mean age of 44, ranged from 18 to 87 years old. The orthodontist group was consisted of 79 male and 67 female participants, with a mean age of 46, ranged from 25 to 73 years old. Based on their ages, participants were divided into two age groups: 18 to 40 and 40 years old or over.

The smile attractiveness scores along with the correspondence evaluated buccal corridor widths are represented in Figure 4. In Table 1. the smile attractiveness scores for each type of observer are presented. For the laypeople group, the highest smile attractiveness score was achieved when buccal corridor width was 10% decreased compared to the control. There was no significant difference in smile attractiveness scores when the width of the buccal corridors was further reduced, however there was significant difference for a decrease of 10%–50% compared to the control.

For the orthodontist group, the highest smile attractiveness score was achieved when buccal corridor width was 20% decreased compared to the control. While, there was significant difference in smile

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TABLE 1 Mean smile attractiveness scores, based on visual analogue scale (VAS) for each type of observer

	% reduction of buccal corridor					Control/control	% expansion of buccal corridor				
Observers	- 50	- 40	- 30	- 20	- 10	Mesial of the iris to the distal of the pupil	10	20	30	40	50
Laypeople	76.3[a]	78.1[a]	74.2[a]	72[a]	79.6[a]	67.7[b] / 69.3[b]	67.7[b]	54.7[c]	52.59[d]	48.7[d.]	50.1[d]
Orthodontists	67.9[a]	67 [a]	71.2[b]	73.4[b]	65.6 [a]	56.7[c] / 58.7 [c]	46.6[d]	44.2[d]	33.44 [e]	40.2[f]	25[g]

Note: Same superscript letters in the same row show no statistical difference. *(p < 0.05).*

TABLE 2 Mean smile attractiveness scores based on visual analogue scale (VAS) for each gender

		% reduction of buccal corridor					Control/control	% expansion of buccal corridor				
Observers	Gender	- 50	- 40	- 30	- 20	- 10	Mesial of the iris to the distal of the pupil	10	20	30	40	50
Laypeople	Male	73.6[a]	77.7[a]	75.9[a]	72.1[a]	80[a]	67.2[a] / 67.8[a]	65.6[a]	53.2[a]	50.3[a]	45.6[a]	49.6[a]
	Female	74.9[a]	78.7[a]	76.9[a]	71.9[a]	79.1[a]	68.4[a] / 71.1[a]	70.6[a]	56.6[a]	55.4[a]	51[a]	50.8[a]
Orthodontists	Male	66.3[b]	67.2[b]	70.1[b]	72.5[b]	65.4[b]	54[b] / 56.7[b]	45.1[b]	42[b]	29.4[b]	38.5[b]	22.9[b]
	Female	70.3[c]	66.7[b]	73.4[b]	75.2[b]	66[b]	62[b] / 62.5[b]	49.7[b]	48.5[b]	41.4[b]	43.5[b]	28.9 [c]

Note: Same superscript letters letters in each column for each group of observers show no statistical difference. *(p < 0.05).*

TABLE 3 Mean smile attractiveness scores, based on Visual analogue scale (VAS) for each age group

		% reduction of buccal corridor					Control/control	% expansion of buccal corridor				
Observers	Age group	- 50	- 40	- 30	- 20	- 10	Mesial of the iris to the distal of the pupil	10	20	30	40	50
Laypeople	≤ 40	70.5[a]	77.9 [a]	74.2[a]	68.1[a]	80.1[a]	65.3[a] / 68.8[a]	66.2[a]	51.9[a]	49.9[a]	47.5[a]	44.1[a]
	> 40	79.8[b]	78.5 [a]	79.5[a]	78 [b]	79[a]	71.4 [b] / 69.9[a]	70[a]	59.1[b]	56.7[b]	50.7[a]	59.1[b]
Orthodontists	≤ 40	66.5[c]	65[b]	70.7[b]	74.5[c]	64.5[b]	55.7[c] / 58.9[b]	44.4[b]	44.4[c]	30.7[c]	41.2[c]	21.1[c]
	> 40	69.5[c]	70.3[b]	72[b]	71.7[c]	67.5[b]	58.2[c] / 58.2[b]	50.3[b]	43.9[c]	37.7[d]	38.6[c]	31.1[d]

Note: Same superscript letters in each column for each group of observers show no statistical difference. *(p < 0.05).*

attractiveness scores when the width of the buccal corridors was reduced 10%–50% compared to the control.

For the laypeople as well for orthodontists, when the buccal corridor width was increased compared to the control, the smile attractiveness of the face was significantly reduced. There was no significant difference in the average score, between the two identical images, which were served as a control, for both types of observers. Figure 3 shows a graphical depiction of the smile attractiveness scores for the evaluated modifications in the width of BCs.

Regarding the gender of the participants, there was no significant difference for any of the evaluated buccal corridor changes or the control in the laypeople group. However, male participants in the orthodontist group rated marginal buccal corridor changes (a 50% decrease or increase in buccal corridor width relative to the control) as less appealing than female observers (Table 2).

In terms of the observer's age group, younger orthodontists rated a 30% and 50% of decrease in the width of the buccal corridor relative to the control as significantly less appealing than elders. Younger laypeople evaluated a 50% decrease or a 50%, 30% and 20% increases in the width of buccal corridors compared to the control, as significantly less attractive than older laypeople (Table 3).

4 | DISCUSSION

In the present study, buccal corridor width, was evaluated in relation to the MIDP distance. The null hypothesis was rejected, as buccal corridor relation to MIDP distance, can significantly influence smile attractiveness. The eyes and the mouth are considered the most important features that determine the esthetic perception of the facial appearance.[16] Based on the literature; the position of the eyes seems to determine the most-preferred positions of other characteristics in the face. Iris to iris distance seems to dominate progressively larger facial structures, like the lips.[12] Foe example, while smiling, the commissure of the mouth moves from the mesial of the iris to the distal of the pupil.

Moreover, during interpersonal interactions, people primarily focus on the eyes and mouth, with minimal time spent on other facial

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characteristics.[17] This explains the fact that despite buccal corridor width being defined as a mini-esthetic feature of the smile, it is influenced by the macro-esthetics of the face.[18] Until now, the majority of studies have focused on mini-esthetic factors without a macro-esthetic context, which could result in inaccurate conclusions.[14,18–25]

Additionally, it is important to understand the potential different perceptions of smile esthetics between laypeople and clinicians and take this into consideration when setting the treatment goals. In the literature, no consensus has been achieved yet regarding the buccal corridor width, which should be present in a pleasant smile.[26] In addition, there is not a facial landmark in order to individualize the desired buccal corridor dimensions to each patient.

The eyes of the patient and more specifically the iris have been used in the past for various correlations with tooth dimensions.[11] Although there is a complex interaction between facial and dental structures in terms of facial esthetics, these interactions should be investigated further and holistically. In the present study when the length of the buccal corridor was more than the MIDP distance, the smile was evaluated as less pleasant. Conversely, the smile attractiveness was reached its maximum a little bit over this threshold and remained stable, regardless of the further decrease of buccal corridor size. It can be assumed that this correlation between the eyes and the buccal corridor width, is due to the entire concept of beauty being based on symmetries.[12,27]

Except for the difference in extremely reduced or increased buccal corridors size, the results of our study agree with the results of other studies concluding no gender or age difference in laypeople evaluating smile attractiveness.[6,19,27,28] In our study, orthodontists and laypeople shared more similarities than differences when evaluating the buccal corridor width in a macro-esthetic context. According to the results, both orthodontists and laypeople prefer smiles with narrower BC. In both groups, the most pleasant buccal corridor size was rated when it was smaller than the MIDP distance. This is in agreement with many other studies concluding that narrow BCs are more appealing.[5,27,29] Reduced buccal corridor dimension was pleasing to the both groups suggesting the importance of buccal corridor width in the smile esthetics of an individual. A narrow but still present symmetric amount of buccal corridor seems to improve smile's appearance.

More specifically, laypeople seem to prefer smiles with minimal buccal corridors. The most pleasant smile was assessed at a buccal corridor length, 10% reduced compared to the control, which clinically is closer to the iris tangential line or the end of the second premolar. However, no significant differences were identified between the scores of reduced buccal corridor size or in terms of teeth between the distal surface of the second premolar and first molar in laypeople group. Our results agree with the findings of Martin et al. concluding that laypeople prefer smiles that often end at the distal surface of the second maxillary premolar.[19]

However, orthodontists presented a 10% more reduction compared to laypeople limit for maximum buccal corridor width, which often clinically corresponds to the mesial side of the first maxillary molar. This result comes in agreement with previous studies regarding the assessment of buccal corridor size among laypeople and orthodontists, as orthodontists tend to prefer a reduced width of buccal corridors compared to laypeople.[19] Also, orthodontists seem to be able to detect smaller deviations in digitally altered smiles, than laypeople, probably due to the fact that orthodontists are educated to focus on smiles and having a greater experience in assessing smiles than laypeople.[30]

The aforementioned results come in contrast with the findings of Martin et al.,[19] reporting that orthodontists prefer a smile which ends at the distal side of the first maxillary molar. As a result, it can be concluded that both groups consider as an attractive smile, the one further than the distal surface of the second maxillary premolar and in between MIDP distance, as in our research, there was not a difference in smile attractiveness, between 20%–50% reduction of buccal corridor width.

Based on the knowledge of the authors, this was the first study that investigated the correlation of a facial landmark to the size of buccal corridors. Finding facial landmarks to estimate buccal corridor width, is of paramount importance especially in the diagnostic phase when a smile is designed. In the present study, the impact of the correlation between the eyes and buccal corridor width was evaluated. The MIDP distance can be the starting point, in order to individualize buccal corridor dimensions, to the patient's face. The results of the present study can be transferred to a digital smile design software, in order via an automated procedure to inform the designers and the patients, about the limits within the size of buccal corridors do not reduce the attractiveness of the smile.

The results of our study are based on an adult model. However, they can be applied, also in younger individuals, when their eyes have reached the maximum of their size.[13,31] The examination of the eyes and the orbits begins with the measurement of the intercanthal and interpupillary distances. These values are set at around 6 to 8 years of age and do not change significantly after this age, as the growth in the size of the eyes has almost completed.[13,31] Also, the size of the pupil of the eyes can be change, as the eyes accommodate to the lighting of the environment surrounding the subject.[13,31] Dental clinics usually, provide an efficient amount of lighting, so pupil dimensions are remaining stable.

Finally, it is important to emphasize the limitations of the present study. The participants of the current survey, represented a subset of the general population, both for laypeople and orthodontists. Orthodontics is a dentistry specialty, that is especially concerned regarding the size of buccal corridors, as their therapy can significantly influence their dimension. Thus, the findings of the current research, may not represent laypeople's preferences from different cultures or other dental specialties, besides orthodontics. Digitally altered images were used in the present study. Images constitute a static in vitro representation of real faces, which lack the dynamic nature of the smile, that can be observed in vivo. The characteristics of the model, which was implemented in the study could also influence the way, that the observers perceive the buccal corridor in the esthetics of the face. In addition, the posterior teeth of our model were slightly inclined to palatal. More studies, implementing models with a variety of age, gender

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and skin color have to be conducted, in different locations around the world to verify the results of our research. Also, face scan technology could in the future replace the images and assist in a better approach of the in vivo observation of the face.

5 | CONCLUSION

Within the limitations of this study, it can be considered, that the length between the mesial of the iris and the distal of the pupil, constitutes a landmark for the estimation of the desired width of the buccal corridor. Inter iris-pupillary distance can be the starting point in the smile designing process, in order to perform a facial driven selection of buccal corridor size. Buccal corridor width has to be kept at least equal or less than the inter iris-pupillary distance, as a smaller buccal corridor can significantly reduce the attractiveness of the smiling face. Buccal corridor width equal or smaller, than the MIDP distance is related to attractive smiling faces.

DISCLOSURE

The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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