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RESEARCH ARTICLE

CORRELATION BETWEEN FACIAL FORM AND BUCCAL CORRIDORS AND ITS INFLUENCE ON SMILE ESTHETICS

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ABSTRACT

The present study was conducted to determine whether buccal corridor width with the total smile width changes along with change in the facial form and also to substantiate the influence of buccal corridors on the smile esthetics when judged by lay persons. The sample comprised of photographs obtained from 60 patients (30 males and 30 females) with age range of 17-30 years. Out of the 60 subjects selected: 20 subjects had leptoposopic facial form, 20 subjects had mesoprosopic facial form and rest 20 subjects had euryprosopic facial form. Measurements of the frontal facial photographs, to determine the facial form accurately, were done following the method of Johnson and Smith using adobe photoshop cs6 version13.0. Standardized frontal facial photographs (to evaluate the facial form) and standardized frontal smile photographs (to determine the smile width and buccal corridor width) of the individuals selected were obtained. An album assembled with the 60 printed smile photographs, were given to 15 lay people for esthetic evaluation, using visual analog scale. All the results were statistically evaluated with the P value set at 0.05. The difference between the means were evaluated by Analysis of Variance (Tukey) Test. From the study it was concluded that in a normal population, the percentage of buccal corridor width with the total smile width does not change considerably with change in facial form and is not a significant factor affecting smile esthetics.

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INTRODUCTION

The smile is one of the most important facial expressions and is essential in expressing friendliness, agreement and appreciation. An attractive, well balanced smile definitely enhances the acceptance of an individual in our society by improving the initial impression in interpersonal relationships. Therefore, it is essential to control the esthetic effects caused by orthodontic treatment, which is only possible by knowing the principles that manage the balance between teeth and soft tissues during a smile. (Shaw *et al*., 1985; Peck and Peck, 1995) During a smile, bilateral spaces appear between the buccal surface of the most visible maxillary posterior teeth and the lip commissure called as the negative spaces, black spaces or the buccal corridor. (Ackerman and Ackerman, 2002; Frush and Fisher, 1958; Hulsey, 1970; Rufenacht, 1990; Johnson and Smith, 1995; McKeown *et al*., 2005) The purpose of this study was to verify whether buccal corridor width with the total smile width changes along with change in the facial form and also to substantiate the influence of buccal corridors on the smile esthetics, ie, whether individuals with larger or smaller negative spaces have altered esthetics because of this factor.

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MATERIALS AND METHODS

The present study was conducted using photographs obtained from 60 patients (30 males and 30 females) from the student population of K.V.G Dental college, Sullia. The subjects were in the age group of 17-30years.

Out of the 60 subjects selected:

1. 20 subjects had leptoprosopic facial form
2. 20 subjects had mesoprosopic facial form
3. 20 subjects had euryprosopic facial form

The subjects were selected only if they fulfilled the following criteria

1. Good dental alignment with a possible exception of moderate crowding/rotations in the lower arch and mild crowding/rotations in the upper arch which is not visible during smile.
2. Balance between the facial thirds
3. No history of orthodontic treatment.

All the subjects who participated in the study signed an informed consent form approved by the university ethics committee.

Photographs-Standardized frontal facial photographs (to evaluate facial form) and standardized frontal smile photographs (to determine the smile width and the buccal corridor width) of the individuals selected on the basis of the criteria outlined above, were obtained.

Standardised frontal facial photographs- frontal facial photographs of each subject were taken in order to determine the facial form. All photographs were taken in the same closed environment under standard conditions with a NIKON COOLPIX L820. Photographs were standardized according to the following criteria (McKeown *et al*., 2005)-

1. Camera- subject distance- 5 feet
2. Camera was fixed on the tripod in portrait position.
3. Camera height was kept the same as that of patient's face.
4. Camera flash in 3 o' clock position.
5. Focus on the nose tip of the patient.
6. Manual mode was used.
7. Aperture f= 3 to 5
8. Shutter speed = 1/800
9. Film speed= ISO 125
10. Maximum zoom was avoided to avoid capturing the surrounding.

Standardized frontal smile photographs- frontal view photographs of lower facial third, including the nose tip and chin were taken. All the subjects were photographed with a "natural smile". The distance from the subject to the camera was kept constant at 20 centimeters. Photographs were taken in the same closed environment under standard conditions with a NIKON COOLPIX L820.

Photographs were standardized according to the following criteria (McKeown *et al*., 2005)-

1. Photographs were taken in 'macro mode' (format-JPEG)
2. Focal length- 20 centimeters
3. Aperture size- maximum; f=8
4. Resolution- 16 mega pixel
5. Sensitivity- ISO 125

A. Euryprosopic face B. Mesoprosopic face C. Leptoprosopic face

Determination of the facial form- measurements of the frontal facial photographs, to determine the facial form accurately, were done using ADOBE PHOTOSHOP CS6. The faces were classified as mesoprosopic, euryprosopic or leptoprosopic based on the morphologic facial index by Martin and Saller (1957). The morphologic facial index was determined by dividing the morphologic facial height by the bizygomatic width. The morphologic facial height is defined as the distance between the nasion and the menton. The bizygomatic width is defined as the distance between the zygoma points. Subjects having a morphologic facial index value of 83.9% or below were classified as euryprosopic; subjects having a value between 84-87.9% were classified as mesoprosopic and subjects having a value 88% and above were classified as leptoprosopic.

Measurements of the smile photographs- measurements of the frontal smile photographs were done accurately following the method of Johnson and Smith using ADOBE PHOTOSHOP CS6.Maximum smile width was determined as the distance between the right and the left lip commissures. The right and the left buccal corridor spaces were determined as the distance between the most buccal surface of the visible, posterior most maxillary tooth on either side and the right and the left commissures respectively. On the basis of smile width, right buccal corridor space and left buccal corridor space measurements, the percentage of right and left buccal corridor spaces with the smile width during smile was determined.

Selection of esthetic smile- An album was assembled with the 60 printed photographs, showing only the mouth area, including the lips, teeth, and intraoral visible structures, to avoid interference from other facial structures, such as the nose and chin. The album was given to 15 lay persons for esthetic evaluation. The esthetic evaluation was carried out using VISUAL ANALOG SCALE (VAS) supplied along each photograph. The VAS varies progressively in values from esthetically very poor, poor, neutral and good to very good. Each examiner was asked to mark on the VAS a point on which the smile was closest to the corresponding value of the VAS. After each examiner completed the esthetic evaluations, the points marked on the VAS were converted into grades from 0 to 10, 0 being the minimum esthetic value and 10 being the maximum esthetic value.

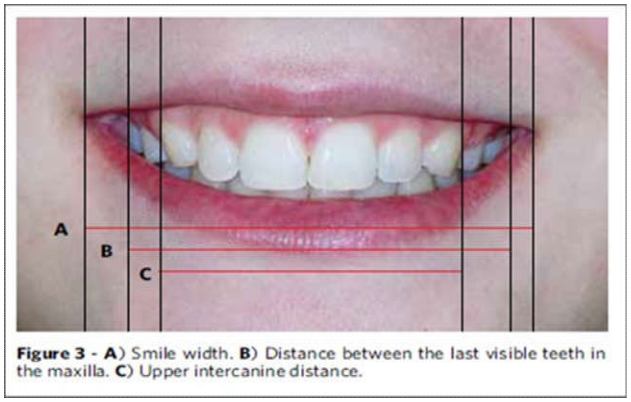

Figure 3 - A) Smile width. **B**) Distance between the last visible teeth in the maxilla. **C**) Upper intercanine distance.

Statistics- All the results were statistically evaluated with the P value set at 0.05. The differences between the means were evaluated by Analysis of Variance (Tukey) test.

RESULTS

An album with all the 60 photographs were distributed to 15 lay persons for evaluation of the smiles. The esthetic evaluation was done using Visual Analog Scale as described before. Mean of esthetic scores was determined for each photograph. Those photographs which received a mean esthetic score of 7 and above were considered as esthetic and were further selected for statistical analysis. According to 15 lay persons, out of a total of 60 smiles, 23 were esthetic and the percentages of buccal corridor with the total smile width for these 23 photographs are shown in Table 2.

Table 1. Percentage of the buccal corridor width with total smile width

	Leptoprosopic	Mesoprosopic	Euryprosopic
1	13.4	25.66	20.07
2	16.44	14.44	14.30
3	19.77	26.8	24.02
4	18.42	22.27	21.68
5	22.81	19.41	19.65
6	30.38	16.28	18.86
7	15.59	17.43	12.19
8	6.59	15.13	21.30
9	21.5	17.59	21.7
10	18.18	26.65	22.3
11	23.54	18.98	22.26
12	19.31	16.73	18.51
13	21.65	22.99	16.62
14	19.86	19.18	20.85
15	21.93	20.59	19.72
16	26.18	24.26	26.24
17	16.84	21.16	23.32
18	20.21	20.51	19.95
19	23.78	27.06	15.17
20	14.02	19.07	17.33
Mean	19.52	20.6	19.82

Overall Mean= 19.98 (N =60)

Table 2. Percentage of the buccal corridor width with total smile width of 23 patients with aesthetically pleasing profile

	Leptoprosopic	Mesoprosopic	Euryprosopic
1	19.77	25.66	14.3
2	18.42	26.8	21.68
3	21.5	22.27	21.30
4	20.21	19.41	21.7
5	23.78	16.28	22.3
6	14.02	17.59	18.51
7		18.98	
8		19.18	
9		20.59	
10		20.51	
11		19.07	
Mean	19.61	20.57	19.96

Overall mean = 20.16 N=23

Out of these 23 subjects, 6 had leptoprosopic facial form, 11 had mesoprosopic facial form and 6 had euryprosopic facial form.

Table 3. Comparison of means of percentage of buccal corridor with the total smile width

Face type	N	Minimum	Maximum	Mean	Std. Deviation
Leptoprosopic	20	6.59	30.38	19.52	5.09075
Mesoprosopic	20	14.44	27.06	20.60	3.93103
Euryprosopic	20	12.19	26.64	19.82	3.46769
Total	60	6.59	30.38	19.98	4.17235

p>0.05. Anova (Tukey) test was used.

There was no statistically significant difference between the means of the percentage of the buccal corridor width with the total smile width of 20 leptoprosopic, 20 mesoprosopic and 20 euryprosopic individuals. The differences between the means of percentage of buccal corridor (BC) and total smile width (TSW) in esthetic smiles, of leptoprosopic, euryprosopic and mesoprosopic individuals were statistically evaluated using Anova (Tukey) test.

Table 4. Comparison of means of percentage of BC and TSW in esthetic smiles in the 3 facial form types (groups)

Type of face	N	Mean	Standard deviation	Anova(Tukey) Test
Leptoprosopic	6	19.61	3.2866	p>0.05
Mesoprosopic	11	20.57	3.2086	
Euryprosopic	6	19.96	3.0788	
Total	23	20.16	3.0767	

There was no statistically significant difference between the means of percentage of buccal corridor and total smile width in esthetic smiles, of leptoprosopic, mesoprosopic and euryprosopic individuals as evaluated by the lay persons.

Table 5. Comparison of overall means of percentage of buccal corridor and total smile width in esthetic smiles, as evaluated by lay persons and the overall mean of the sample selected

	N	Mean	Standard deviation
Lay persons	23	20.16	3.0767
Overall	60	19.98	4.1723

There was no statistically significant difference between the overall means of percentage of buccal corridor and total smile width in esthetic smiles, as evaluated by lay persons and the overall mean of the percentage of buccal corridor width and total smile width of the sample selected (p>0.05).

DISCUSSION

It has been suggested by various researchers in the past that facial form has an effect on arch width with leptoprosopic individuals having narrow arch form and euryprosopic individuals having broad arch form (Rakosi *et al*., 1993; Izard, 1927; Graber, 1966; Ricketts, 1982; Kageyama *et al*., 2006; Kanashiro and Vigorito, 2000; Rigsbee *et al*., 1988). This should have resulted in increased buccal corridor in subjects with leptoprosopic facial form and decreased buccal corridor in subjects with euryprosopic facial form. However this study showed that there is no difference between the means of percentage of the buccal corridor width with the total smile width in leptoprosopic, mesoprosopic and euryprosopic subjects. This may be explained by referring to the work done by Rigsbee *et al*. (1988). According to their study, upon smiling, width of the mouth increases by as much as 30% in males. Also Sabri (2005), suggested that transverse lip extension during a smile may have a role to play in the amount of buccal corridor. So it can be stated that, the amount of increase in the width of the mouth during a smile is in harmony with the facial form and the arch form associated with it i.e. this increase is less in leptoprosopic individuals, moderate in mesoprosopic individuals and more in euryprosopic individuals, in order to develop a harmonious buccal corridor. In other words, the dental arch develops in line with the facial form such that the width of the face, the dental arches and the buccal corridors become propotional to each other. The mean percentage of the buccal corridor width with the total smile width for the sample selected in this study was found to be 19.98%. This value is larger than the values found out by Johnson and Smith (1995). According to their study the mean percentage of the buccal corridor width with the total smile width was found out to be 9% for cases treated with extraction of premolars and 8% for cases treated without extractions. The large difference between the results of this study and the findings of Johnson and Smith can be attributed to the difference in the light conditions under which the photographs were taken. The less iluminated the photograph, the larger will be the buccal corridor because fewer teeth will be observed, thus reducing the arch width, whereas the smile width is the same.

The mean value of the percentage of the buccal corridor with the total smile width as found out by Rigsbee *et al*. (1988) was 40% in an orthodontically treated group and 42% in a non

orthodontically treated group. The large difference between the results of this study and the findings of Rigsbee can be attributed to the fact that these authors measured the buccal corridor by Hulsey's method (Peck and Peck, 1995) considering the distance between the maxillary canines as the lateral limit of the maxillary arch. The mean value of the percentage of the buccal corridor with the total smile width as found out by Ritter *et al*. (2006) was 19.20%. Our study is in accordance with their study wherein the mean value of the percentage of the buccal corridor with the total smile width was found out to be 19.98%. There was no statistically significant difference between the overall means of percentage of buccal corridor width and total smile width in esthetic smiles as evaluated by the evaluators and the overall mean of the percentage of the buccal corridor width and total smile width of the sample selected which is representative of normal population (Table 5). This means that the esthetic smiles were judged to be "esthetic" on the basis of other criteria such as the lip line (Hulsey, 1970; Johnson and Smith, 1995; Ricketts, 1982; Kageyama *et al*., 2006; Dong *et al*., 1999; Peck *et al*., 1992), smile line (Frush and Fisher, 1958; Hulsey, 1970; Tjan *et al*., 1984; Zachrisson, 1998; Miller, 1989), smile symmetry (Hulsey, 1970; Graber, 1966; Miller, 1989), upper lip curvature (Hulsey, 1970; Sabri, 2005; Mathews, 1978), dental and the gingival components. (Sabri, 2005; Mathews, 1978; Lombardi, 1973) This is a significant finding because it can conclude that in a normal population, width of the buccal corridor does not play a significant role in smile esthetics. Therefore it can be stated that the width of the buccal corridor does not affect smile esthetics if it is in the normal range of variation. This statement is in accordance with conclusions of Frush and Fisher (1958) and Johnson and Smith (1995). These authors agree that size of the buccal corridor is not esthetically critical, provided its within typical limits of individual differences. In contrast with our study, Moore *et al*. (2005) found out that lay persons were able to discriminate between the degrees of smile fullness and that they preferred smiles which were visibly filled with dentition, commissure to commissure. This difference can be explained by the fact that in their study, sample from a normal population was not evaluated. Instead one smile was digitally altered to produce a wide range of variation in the width of buccal corridor. Our study is in agreement with the study done by Roden-Johnson *et al*. (2005). This study showed that when digital alteration of the smile photographs was not done to extremes, it did not affect the ratings of the smile as evaluated by the lay persons. Parekh *et al*. (2006) in their web based survey concluded that both lay persons and orthodontists preferred smiles in which the smile arc paralleled the upper lip and buccal corridors were minimum. However these results cannot be compared with the results obtained from our study as the effect of smile arc is not evaluated by us which may be an important factor in smile esthetics. The results of the current study are in harmony with the results of Hulsey (1970) and Ritter *et al*. (2006). In his study, Hulsey studied the effect of buccal corridor by establishing a ratio between the distance between the upper canines and corners of the smile. The smile scores were found to be completely independent of the buccal corridor ratio. This could be because, the actual buccal corridors (Frush and Fisher, 1958) of his subjects would have in the normal range of variation. In the study done by Ritter *et al*, the buccal corridors were 19.20% of the total smile width.

A study was conducted by Hideki loi *et al*. (2009) in Japanese population, to test the hypothesis that the buccal corridor has no influence on smile evaluations of orthodontists and dental students. One photograph of a smiling female, displaying first molar to first molar, was constructed. Buccal corridors were modified digitally in 5% increments, from 0% to 25%buccal corridor compared with the inner commissural width. Using a visual analog scale (VAS), 32 Japanese orthodontists and 55 Japanese dental students rated the attractiveness of six smiles with altered buccal corridors. The results was that there was no significant difference in judging the effects of buccal corridors on the smile attractiveness between the male and female raters for both the orthodontists and dental students. Extensive research is required towards the verification of the aforementioned statement, that is the dental arch develops in line with the facial form such that the width of the face, the dental arches and the buccal corridors become propotional to each other, wherein dimensions of the dental arch, movements of the corners of the mouth and the amount of buccal corridor for each facial type should be determined.

Conclusion

- The percentage of the buccal corridor width and the total smile width does not change along with change in the facial form.
- The buccal corridor space did not influence the esthetic evaluations of the smile photographs.
- Lay people did not consider the buccal corridor space as an important factor influencing their esthetic evaluations.
- The percentage of buccal corridor width and the total smile width as evaluated in "esthetic smiles" is the same as that found in the normal population.

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