

# Influence of Smile Arc and Buccal Corridors on Facial Attractiveness: A Cross-sectional Study

SHASHANK GAIKWAD<sup>1</sup>, HARSIMRAN KAUR<sup>2</sup>, ANNA C VAZ<sup>3</sup>, BALDEEP SINGH<sup>4</sup>, LAVINA TANEJA<sup>5</sup>, KS VINOD<sup>6</sup>, PRATEEK VERMA<sup>7</sup>

## ABSTRACT

**Introduction:** Two aspects of the smile: the Smile Arc (SA) and Buccal Corridors (BC) have been the interest of the orthodontist in recent years.

**Aim:** The present study was undertaken to evaluate the influence of the smile arc and buccal corridors on facial attractiveness as evaluated by orthodontists, general dentists and laymen.

**Materials and Methods:** Two subjects (one male & one female) were selected from the regional population fulfilling the criteria of an ideal smile arc and ideal buccal corridors. Frontal smile view photographs of these subjects were taken and modified by

using adobe photoshop 7.0 to create combination of three smile arc variance and three buccal corridors variations respectively which were shown to 25 orthodontists, 25 general dentists & 25 laymen, to rate the facial attractiveness of each image on a rating scale.

**Results:** All the three groups (laypersons, dentists and orthodontists) showed significant difference in ratings, indicating that they had different perceptions on the facial attractiveness.

**Conclusion:** Orthodontists were more precise in discerning the smile arc and buccal corridors compared to dentists and laypersons.

**Keywords:** Dental aesthetics, Orthodontists, Photographic analysis

## INTRODUCTION

The smile is one of the most effective means by which people convey their emotions. It is defined as 'a change of facial expression involving brightening of the eyes, an upward curving of the corners of the mouth with no sound and less muscular distortion of the features than in laugh that may express amusement, pleasure, tender, affection, approval, restrained mirth, irony, derision or any of various other emotions' [1]. The subject of the smile and facial animation as they relate to communication and expression of emotion is of great interest to orthodontists. It is important for orthodontists to make every effort to develop a harmonious balance that produces the most attractive smile for each person being treated. When an ugly smile is improved by orthodontic intervention, the person feels better and more confident. Out of eight components of a balanced smile, the smile arc and buccal corridors have been the concern of the orthodontist in recent years [2].

Down the pike, computers have become an essential tool in research arena. Different smile images can be created using computer softwares from images of natural smile by morphing. The Adobe Photoshop, enables us to morph and create different images in every chosen parameter of an aesthetic smile, keeping other parameters unchanged. This helps in the assessment of importance of every parameter. Digital imaging allows manipulation of the variables in a reliable and quantifiable manner. There has always been a difference in concept of smile and aesthetics among the orthodontist, general dentist and laypersons. Past studies have shown that there is a wide range of discrepancy in opinion of orthodontists and non orthodontists on acceptable smile arc and buccal corridors [3].

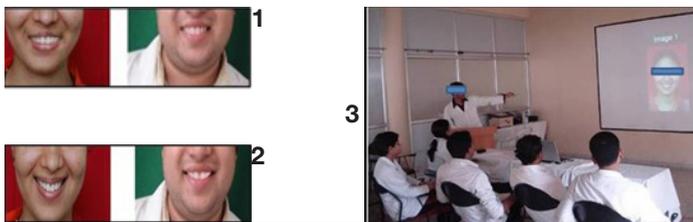
But these studies have evaluated smile arc and buccal corridors separately. Moreover, none of them have evaluated perceptions of orthodontists, general dentists and laypersons together in one study. Thus, the present study was undertaken to evaluate the combined effect of influence of the smile arc and buccal corridors on facial attractiveness as evaluated by orthodontists, general

dentists and layperson and to evaluate results of the above findings according to the gender of the subjects.

## MATERIALS AND METHODS

A cross-sectional study was carried out to find the conjugated effect of the smile arc and buccal corridors on attractiveness of face, as evaluated by orthodontists, general dentist and laypersons. After obtaining the ethical approval from the ethical committee of the institution, study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics, Bagalkot, Karnataka, India. The sample consisted of a male and a female subject who satisfied the eligibility criteria. Those subjects between the age of 18 and 25 years, with ideally aligned teeth and no history of orthodontic treatment and with ideal smile arc and minimal buccal corridors and who were willing to participate and gave a written consent as a participant, were selected for the study. The photographs were shot with Nikon D-40 digital camera (Nikon corporation, Japan) with Lens ED-18-55mm. Standardization of both the photographs were taken in auto mode of the camera with uniform distance from the subject. The captured images were transferred to a personal computer and image processing software (Adobe Photoshop 7.0) was used to digitally alter the images.

**Source of data:** Two subjects (one male & one female) were selected from the regional population fulfilling the criteria of an ideal smile arc and ideal buccal corridor space. Smile view photographs of these subjects were taken. Two photographs were modified by using Adobe Photoshop 7.0 to create combination of three smile arc variance (flat, ideal, excessive) and three buccal corridor variations (none, ideal, excessive) respectively, thus, producing nine male & nine female images [Table/Fig-1,2]. These 18 images of the modified smiles were made and shown to 25 orthodontists, 25 general dentists & 25 laypersons. The altered images were arranged randomly for slide show using Microsoft Power Point 2007 and presented to evaluators comprising of 25 orthodontists, 25 dentists and 25 laypersons in separate sessions, (each image shown for 10 seconds) and the evaluators were not informed about the alterations made in the images [Table/Fig-3].



**[Table/Fig-1]:** Showing altered images with flat smile arc and normal buccal corridors space of female and male respectively.

**[Table/Fig-2]:** Showing altered images with excessive smile arc and buccal corridors space.

**[Table/Fig-3]:** presentation of slides to evaluators.

Variables	BETA	SE (Standard Error) of BETA	Reg. Coefficient	SE of Reg. Coefficient	t-value	p-level	Significance
Intercept			105.7712	2.1216	49.8554	0.0000	S
SA	-0.6950	0.1721	-5.5018	1.3627	-4.0375	0.0006	S
BC	-0.2601	0.1721	-2.0361	1.3475	-1.5110	0.1450	NS

**[Table/Fig-6]:** Regression analysis of scores given by orthodontists on smile arc and buccal corridors.

R=0.9360, R<sup>2</sup>=0.8761, Adjusted R<sup>2</sup>=0.8649, F=77.8470, p<0.001, S, Std. Error of estimate: 4.4659

Images	SS (Sum of squares) Effect	DF (Degrees of freedom) Effect	MS (mean Square) Effect	SS (Sum of squares) Error	DF (Degrees of freedom) Error	MS (mean Square) Error	f-value	p-value	Significance
Exc SA Exc BC (F)	43.2800	2	21.6400	120.8000	72	1.6778	12.8980	<0.0001	HS
Exc SA Exc BC (M)	101.1467	2	50.5733	125.5200	72	1.7433	29.0096	<0.0001	HS
Flat SA Exc BC (F)	56.7467	2	28.3733	161.4400	72	2.2422	12.6541	<0.0001	HS
Flat SA Exc BC (M)	51.5467	2	25.7733	217.1200	72	3.0156	8.5468	0.0005	HS
Ideal SA Exc BC (F)	5.6267	2	2.8133	185.7600	72	2.5800	1.0904	0.3416	NS
Ideal SA Exc BC (M)	36.0267	2	18.0133	192.6400	72	2.6756	6.7326	0.0021	HS
Exc SA No BC (F)	34.1600	2	17.0800	168.9600	72	2.3467	7.2784	0.0013	HS
Exc SA No BC (M)	89.3600	2	44.6800	154.3200	72	2.1433	20.8460	<0.0001	HS
Flat SA No BC (F)	44.2400	2	22.1200	224.8800	72	3.1233	7.0822	0.0016	HS
Flat SA No BC (M)	76.1867	2	38.0933	164.4000	72	2.2833	16.6832	<0.0001	HS
Ideal SA No BC (F)	46.9067	2	23.4533	137.8400	72	1.9144	12.2507	<0.0001	HS
Ideal SA No BC (M)	59.2800	2	29.6400	244.8000	72	3.4000	8.7176	0.0004	HS
Exc SA Idea BC (F)	48.3467	2	24.1733	146.4000	72	2.0333	11.8885	<0.0001	HS
Exc SA Idea BC (M)	83.7600	2	41.8800	199.9200	72	2.7767	15.0828	<0.0001	HS
Flat SA ideal BC (F)	78.0000	2	39.0000	165.5200	72	2.2989	16.9647	<0.0001	HS
Flat SA ideal BC (M)	54.1067	2	27.0533	177.6800	72	2.4678	10.9626	0.0001	HS
Ideal SA Ideal BC (F)	42.5867	2	21.2933	168.5600	72	2.3411	9.0954	0.0003	HS
Ideal SA Ideal BC (M)	39.3867	2	19.6933	190.8000	72	2.6500	7.4314	0.0012	HS

**[Table/Fig-4]:** Comparison of three groups by ANOVA test.

SA-Smile Arch, BC-Buccal Corridor, Exc-Excessive, F-Female, M-Male.

\*S-Significant, HS-Highly Significant, NS-Non Significant

[A] Among laypersons and dentists-Ideal SA exc BC [F], ideal SA ideal BC [M], ideal SA ideal BC [F]. B] Among laypersons and orthodontists-Flat SA exc BC [F], ideal SA exc BC [F], exc SA no BC [F], flat SA no BC [F] C] Among dentists and orthodontists-Flat SA exc BC [F], flat SA exc BC [M], ideal SA exc BC [F], ideal SA exc BC [M], flat SA no BC [M], ideal SA no BC [F], ideal SA no BC [M], exc SA ideal BC [F], exc SA ideal BC [M] Flat SA ideal BC [F].

Evaluators were provided with a rating sheet and asked to score the attractiveness of each image on a numerical scale of 1 to 10, with 1 being the least attractive and 10 the most attractive. The rating sheets from these evaluators were collected and data was statistically analysed using One-way ANOVA and regression analysis.

## RESULTS

Mean, standard deviation and analysis of variance test (ANOVA) revealed that for all photographs, there was statistically highly significant difference among the laypersons, dentists and orthodontists except for ideal SA(smile arc), excessive BC (buccal corridors) {F} image in which no statistically significant difference was found [Table/Fig-4]. Correlation coefficient was done to find the correlation between the smile arc and buccal corridor scores with the ratings of smile arc (-0.9292, -0.5448 and

Scores of	Prevalence of xerostomia in %	Significance	BC (Buccal Corridor)	Significance
Orthodontists	-0.9292	S	-0.8857	S
Dentist	-0.5448	S	-0.3499	NS
Layman	-0.0316	NS	-0.0988	NS

**[Table/Fig-5]:** Correlation coefficient between smile arc and buccal corridors with ratings of layperson, dentists and orthodontists.

The test applied is Spearman correlation test

-0.0316 for orthodontists, dentists and laypersons) and buccal corridor (-0.8857,-0.3499,-0.0988 for orthodontists, dentists and laypersons) on facial attractiveness with orthodontist showing the highest, i.e., as the smile arc steepened and buccal corridor increased, the ratings decreased among all the three groups [Table/Fig-5]. Regression analysis done to know the combined influence of the smile arc and buccal corridor on the evaluators in each group, depicted negative correlation between the facial attractiveness and the smile arc and buccal corridor, i.e., as the smile arc steepened and buccal corridors increased, the ratings decreased across all the three groups. (Orthodontists- reg coefficient of - 5.5018, -2.0361, Dentists – reg coefficient of -8.2447,-4.9806 and laypersons – reg coefficient of -2.7531, -3.3418). The correlation was statistically

Variables	BETA	SE of BETA	Reg. Coefficient	SE of Reg. Coefficient	t-value	p-level	Significance
Intercept			85.4895	4.0181	21.2763	0.0000	S
SA	-1.2101	0.3788	-8.2447	2.5808	-3.1946	0.0042	S
BC	0.7393	0.3788	-4.9806	2.5521	1.9516	0.0638	NS

**[Table/Fig-7]:** Regression analysis of scores given by dentists on smile arc and buccal corridors.

R=0.6328, R<sup>2</sup>=0.40053, Adjusted R<sup>2</sup>=0.3460, F=7.3497, p<1.01, S, Std. Error of estimate: 8.4581

Variables	BETA	SE of BETA	Reg. Coefficient	SE of Reg. Coefficient	t-value	p-level	Significance
Intercept			102.5580	6.8526	14.9663	0.0000	S
SA	0.3019	0.4826	-2.7531	4.4014	0.6255	0.5381	NS
BC	-0.3705	0.4826	-3.3418	4.3525	-0.7678	0.4508	NS

**[Table/Fig-8]:** Regression analysis of scores given by laypersons on smile arc and buccal corridors.  
R=0.1645, R<sup>2</sup>=0.0270, F=0.30608 p>0.05, NS, Std. Error of estimate: 14.425

significant for the orthodontist group) 'p' value of 0.006-SA and 0.1450-BC) and dentist group (p-value of 0.0042-SA and 0.0638-BC). But the correlation was not statistically significant for laypersons (p-value of 0.5381 for smile arc and 0.4508 for buccal corridor) [Table/Fig-6-8].

## DISCUSSION

Smile is one of the most primordial forms of facial expression and plays a vital role in enhancing the personal attractiveness. In recent times, due to ever advancing technology, ways to achieve an ideal and alluring smile has undergone paradigm shift. Various parameters like: the smile arc, dental alignment, tooth colour and shape, incisal edge regularity, amount of incisor and gum display, and buccal corridor has been identified as important components of smile [4-6]. The smile arc is defined as the relationship of the contour of the incisal edges of the maxillary anterior teeth relative to the curvature of lower lip during a social smile [7].

On the basis of this relationship, smile lines have been delineated into three types. Consonant smile arc- has the curvature of incisal edges of the maxillary anterior teeth parallel to the upper border of the lower lip [8]. Straight smile arc is that in which the incisal edges of the maxillary anterior teeth are in a straight line to the upper border of the lower lip. Reverse or non-consonant smile arc is the one in which the incisal edges of the maxillary anterior teeth are curved in reverse to the upper border of the lower lip [9,10]. Reverse smile arc occurs when the central incisors are shorter than the canines along the incisal plane which can be due to occlusal malfunction or loss of vertical dimension [11].

Reverse smile profile was less aesthetic than parallel and straight smiles. Since the smile arc depends upon occlusal plane inclination and second order crown angulations in the upper anterior teeth, there are some constraints to the achievement of this ideal smile arc on every patient. A feasible objective is to prevent a flat or reverse smile arc and to obtain some degree of curvature that resembles, one found in the lower lip [12].

Hulsey, the first to quantify the smile arc, disclosed that orthodontically treated patients had lower smile ratios (i.e., flatter smile arcs) than untreated patients [1]. Another conceit-the buccal corridor spaces, given by Frush and Fisher [10] emerged during the 50's in concern with ensuring natural looking dentures. This component of smile aesthetics, also known as lateral dark space, lateral negative space or "shadow tunnel," consists of the existing dynamic space that appears, when a person smiles, between the labial surface of maxillary posterior teeth and the inner mucosa of the soft tissues that form the corners of the mouth and the cheeks. This space arises from the dark background of the mouth, and depends on the shape and width of the upper dental arch and the facial muscles responsible for the breadth of the smile [13]. In spite of little information on the ideal buccal corridor size, available in the literature, the scientific studies that addressed this issue have revealed controversial disclosures [14]. On the contrary, Hulsey found that buccal corridor spaces did not contribute significantly to smile aesthetics [1]. Some of the parameters that have been studied by various authors have been mentioned in the [15-17] [Table/Fig-9] much disparity, as revealed by past research

Author	Objective of the studies
Peck S, Peck L, Peck S, Peck L, Kataja M	Evaluated and quantified the upper lip soft tissue changes in the vertical dimensions both at rest and at maximum smile, and to examine the correlation between upper labialvestibular attachment height and maxillary gingival exposure on healing [15].
Zachrisson BU	Studied and discussed some new concepts of the desirable characteristics of tooth display during normal conversation and smiling, and to provide guidance on how to analyse aesthetic factors by viewing the patient from the front [16].
Sarver	Gave the concept of smile arc and its relation to orthodontics, treatment planning and mechanics to enhance the appearance of smile [17].

**[Table/Fig-9]:** Some studies done in the past [15-17].

[13,18,19]. Since, there are very few Indian studies reported in such context; the mentioned study was undertaken to evaluate such a response from general dentists, orthodontist and lay persons. The subjects between the ages of 18 to 25 years were chosen so that the nature's compensation in the development of soft tissue could be studied.

The main criterion for selecting the samples was that they should have acceptable smiles and not have undergone any kind of orthodontic treatment, so that none of the naturally compensating smile parameters would have been altered. Digital photographs of the samples were modified using the commercially available Adobe Photoshop software-Version 7, as this software offers a free hand manipulation of the facial features in a very simple way and has been built in tools to match the colour and tone of the tooth, gingiva, mucosa, lip and skin [3,20,21].

Regression analysis showed that the correlation was negative to the facial attractiveness across all the three groups. As the smile arc and buccal corridor increased, the scores decreased. The correlation was statistically significant for the orthodontist group and dentist group. But the correlation was not statistically significant for laypersons. These findings suggest that orthodontists and dentists were more precise in judging the smile arc and buccal corridors as compared to laypersons. The difference in opinions could again be attributed to the professional training of the vocations involved in assessing a face. Synonymous results were obtained for evaluation of buccal corridor in the study by Sabrina Elisa Zange et al., and Huma Kiania et al., also revealed same results between orthodontist and laypersons [22,23]. While a study by Farhan Zaib et al., revealed contrast results to the mentioned study with regard to buccal corridor [18].

With relation to smile aesthetics, no difference in rating was found between the orthodontist and laypersons [24]. This study found that the highest ratings were given to that image where in lower lip was just touching and parallel to the incisal edges of upper incisors i.e., ideal SA by orthodontists, dentists and laypersons. This is in agreement with the previous studies [1,8,25-27]. But some studies concluded that 'the patients whose lower lips touched or did not touch the incisal edges had a higher aesthetic score than those whose incisal edges were slightly covered', was not in accordance with our findings [28,29], because the samples where lower lip was just touching and parallel to the incisal edges of upper incisors i.e., ideal SA were given highest rating by orthodontists, dentists and layperson. All the evaluators in the present study agreed that minimal buccal corridors are essential for a pleasing smile. This observation was in concordance with the research conducted by Moore, Parekh SM, Fields HW, Beck M & Rosenstiel S and Dunn et al., [3,13,30]. However, studies done by Jeryl English, Krishnan V, Daniel S, Lazer D and Asok A were not in congruence with the present study [31].

## LIMITATION

- Less sample size.
- Other parameters for smile aesthetics not considered.

**Clinical implications:** The concept of smile analysis should be incorporated in orthodontic treatment planning. It is therefore emphasized that all the above discussed elements of smile analysis should be considered as reference points for beginning aesthetic evaluation, treatment planning and subsequent orthodontic treatment. The findings of these studies should be applied with caution, taking into account, in particular, the individual characteristics of each patient and their aesthetic expectations.

This information becomes a vital tool for orthodontist, as it will aid in a more coherent decision on the necessity of treatment of buccal corridor and smile arc along with the patient's complaint for misalignment.

**Future implications:** Ever increasing technology may create software in future, which will create the ideal smile image of an individual and also will provide the orthodontist and the dentist - the mechanisms and restorative treatment to achieve the same.

## CONCLUSION

Vitality, all the three groups tended to agree that, as the smile arc and buccal corridor increased, the facial attractiveness decreased. Orthodontists were more precise in discerning the smile arc and buccal corridor compared to dentists and laymen. Thus, it can be concluded that everyone has got different perceptions and it varies from professional to individual. Hence, a detailed clinical examination of smile parameters should be included in the orthodontic protocol before planning any orthodontic treatment.

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### PARTICULARS OF CONTRIBUTORS:

1. Reader, Department of Orthodontics, Bharti Vidyapeeth Dental College, Navi Mumbai, Maharashtra, India.
2. Reader, Department of Pedodontics and Preventive Dentistry, Kothiwal Dental College and Research Center, Moradabad, Uttar Pradesh, India.
3. Professor Department of Orthodontics, Al Badar Dental College, Gulbarga, Karnataka, India.
4. Reader, Department of Orthodontics and Dentofacial Orthopedics, Rama Dental College and hospital, Kanpur, Uttar Pradesh, India.
5. Reader, Department of Oral Medicine and Radiology, Faculty of Dental Sciences, SGT University, Gurgaon, Haryana, India.
6. Reader, Department of Oral Pathology and Microbiology, Triveni College of Dental Sciences, Hospital and Research Centre, Chhattisgarh, India.
7. Consultant in Orthodontics (MDS), Rastogi Dental Hospital, Allahabad, Uttar Pradesh, India.

### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Harsimran Kaur,  
Department of Pedodontics, Kothiwal Dental College and Research Centre (Near cosmos Hospital),  
Moradabad, Uttar Pradesh, India.  
E-mail: drsim2006@yahoo.co.in

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