Section A-Research paper
ISSN 2063-5346

"To evaluate changes in buccal corridor space before and after orthodontic treatment in constricted maxillary arch: A Photographic follow-up Study"

Dr. SantoshKumar Goje[1] and Dr. Niti Dharmendra Shah[2]
[1]Professor and Head, Dept of Orthodontics and Dentofacial Orthopaedics, K.M.Shah Dental College and Hospital,Piparia, Waghodia Vadodara, Gujarat, 391760.

[2]Third year post graduate, Dept of Orthodontics and Dentofacial Orthopaedics, K.M.Shah Dental College and Hospital,Piparia, Waghodia Vadodara, Gujarat, 391760.

CORRESPONDING AUTHOR: Dr. Niti Dharmendra Shah, third year post graduate, Dept of Orthodontics and Dentofacial Orthopaedics, K.M.Shah Dental College and Hospital,Piparia, Waghodia Vadodara, Gujarat, 391760. nitinol1305@gmail.com

ABSTRACT

Introduction: An essential aspect of facial attractiveness is dental appearance. The existence or absence of buccal corridors is a potential key aspect of a smile. They are the spaces that exist when a patient smiles between the corners of the lips and the facial surfaces of the back teeth, which significantly influence the aesthetics of smiles. It was found that changes in the buccal corridor due to palatal expansion was controversial.

Aim: To evaluate the changes in buccal corridor space and its effects on esthetics before and after orthodontic treatment in individuals with constricted maxillary arch.

Study Design: It was photographic follow up study which was carried out in 58 patients (33 females and 25 males) who had constricted maxillary arch. Records obtained were divided into three groups on the basis of time duration i.e pre-treatment, Post-treatment and follow up after 2 years of treatment.

Results: Significant difference can be seen wrt interlast visible maxillary teeth distance, Buccal corridor space wrt last visible maxillary teeth between pre-treatment, Post treatment and after two years ($P<0.05$) and a highly significant difference can be seen wrt total smile area on smile analysis($p<0.001$).

Along with this highly significant difference can be seen wrt intercanine width between pre and post treatment but difference in changes in inter-premolar and intermolar distance were highly significantly seen between pre and post treatment and between post treatment and after two years of follow-up($p<0.001$). Significant changes can even be seen in posterior rugae width between pre and post treatment. ($p<0.05$)

Conclusion: It can be concluded that cases of constricted maxillary arch treated with various expansion procedures show relapse after two years along with the change in buccal corridor space which directly affects the esthetics.

KEY WORDS: Buccal corridor space, Constricted maxillary arch, Palatal expansion

INTRODUCTION:

Beauty, according to Aristotle, is a better recommendation than any letter of introduction.

An appealing grin is therefore a benefit, while those with unpleasant smiles may experience a definite disadvantage in terms of their personal, social, and professional lives.[1] Dentists can create a stunning

smile by smile designing. Within anatomical, physiological, and psychological constraints, smile designing is a systematic technique that makes some modifications in hard- and soft-oral tissue. This has a favorable impact on facial aesthetics and a person's entire personality. Dentistry, which has the duty to create ideal smiles, should reevaluate the current aesthetic approach while taking historical facts into account. The teeth, gums, and quantity of gaps and crevices all contribute to a smile's beauty.[2]

The arc of the smile, the symmetry, and the ratio of the maxillary central incisors, the gingival design, gingival exposure, and the buccal corridor, the midline and angulation of the tooth, the colour of the tooth, and the anatomic shape and volume of the lip are all standards that affect the aesthetics of a smile.[3,4] It has been determined that a smile with limited gingival display is more aesthetically pleasing than one with high gingival display.[5,6,7] A smile that shows a curvature of the maxillary incisal edges (smile arc) parallel to the curvature of the lower lip is thought to be more attractive than one that has a flat relationship between the maxillary incisal margins, according to studies. [5,8,9]

The existence or absence of buccal corridors is a potential key aspect of a smile. Buccal corridors are the spaces that exist when a patient smiles between the corners of the lips and the facial surfaces of the back teeth, according to Frush and Fisher[10] in 1958. The buccal corridor is the area that forms between the corners of the lips and the buccal surface of the back teeth when the patient smiles. It was determined from the inferior portion of the lip's commissure to the mesial line angle of the maxillary first premolar. The terms lateral dark space, lateral negative space, and shadow tunnel are also used to describe this feature of grin aesthetics. According to Nascimento et al. and Abu Alhaija et al., the buccal corridor significantly influenced the aesthetics of smiles.[4,10] Buccal corridors were more precisely described by Frush and Fisher[10] as the distance between the back teeth and the corners of the lips. In other words, a smile normally consists of the first (and occasionally second) premolars in addition to the six anterior teeth. Hulsey[4] investigated how changes in buccal corridors would affect smile attractiveness in 1970 and came to the conclusion that they didn't appear to be significant.

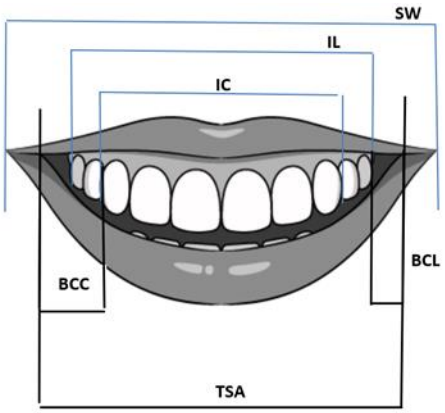
A frequent treatment method for correcting malocclusion in orthodontics is tooth extraction. Researchers have looked at the impact of buccal corridors on the aesthetics of smiles following orthodontic treatment, both with and without first premolar extraction. There is a disagreement over the aesthetics of smiles following extraction-based versus non-extraction orthodontic treatment. It was assumed that extraction would result in narrowed dental arches, which would then lead to wider buccal corridors and a less aesthetically pleasing grin. The investigators in this case measured buccal corridors according to Frush and Fisher's definition and discovered no connection between buccal corridor-related factors and extraction aesthetics.[11,12] Most of the studies discovered that no appreciable differences in smile aesthetics, aesthetic scores, or visible change in dentition was seen when a patient smiled.[11,13,14] On the basis of the available literature, it was found that changes in the buccal corridor due to palatal expansion was controversial,[15,16,17] where one study says that no change in buccal corridor can be observed after expansion while some says there is decrease in buccal corridor area. Hence this study was taken up to evaluate the changes in buccal corridor space and its effects on esthetics before and after orthodontic treatment in individuals with constricted maxillary arch.

MATERIALS AND METHODS:

This randomized clinical study was approved by the ethics committee of Sumandeep Vidyapeeth Deemed to be a University (approval no. SVIEC/ON/DENT/RP/June/22/64) to evaluate the changes in buccal corridor space and its effects on esthetics before and after orthodontic treatment in individuals with constricted maxillary arch. Sample size estimation was done using G Power Software and the estimated sample size was found to be 34. The effect size and power of the study were set at 0.80 with an alpha error of 0.05. The level of significance was also set at 5% and a p-value of ≤ 0.05 was considered to be

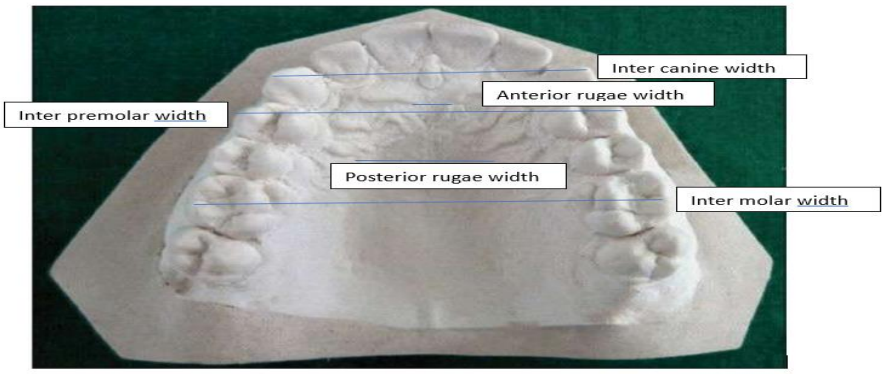
significant. Hence, a total of 58 participants were included in the study. Participants with permanent dentition, of either gender between 15 to 30 years with constricted maxillary arch who got treated orthodontically with expansion screw two years back and having smiling frontal photographs were included in the study. Syndromic patients, Incomplete records, and Patients who underwent any facial esthetic surgery were excluded. Pre-treatment and Post-treatment study models and smiling frontal photographs of those individuals who have already undergone the orthodontic treatment 2 years before were obtained from the archives of the department. And these individuals were recalled for obtaining study models and smiling frontal photographs of present stage i.e after 2 years of treatment. Posed smiles were recorded while taking smiling frontal photographs. A written informed consent form was obtained from the participants and participant information sheet was even given to the individuals who have agreed voluntarily to participate in the study. The collected records was divided into following time periods: T0 – pre treatment smiling photographs and study models, T1 - post treatment smiling photographs and study models and T2 – post treatment smiling photographs and study models after two years. All the frontal smiling photographs of different time periods were imported in the Dolphin Cephalometric software 11.3. and the following parameters were evaluated.

Table I : BUCCAL CORRIDOR PARAMETERS	
IC (intercanine distance)	The distance between the most distal surfaces of the canines.
IL (interlast visible maxillary teeth distance)	The distance between the most distal surfaces of the last visible maxillary teeth to give the width of the visible dentition.
SW (smile width)	The intercommissural width.
BCC (buccal corridor area in relation to the canines)	The bilateral area bordered by the most distal surface of each canine and the inner vermilion border of the lips.
BCL (buccal corridor area in relation to the last visible maxillary teeth)	The bilateral area bordered by the most distal surface of the last visible maxillary tooth on either side and the inner vermilion border of the lips.
TSA (total smile area)	The total area bordered by the inner vermilion border of the lips.



The following parameters were evaluated on study models at different time periods :

TABLE II : PARAMETERS EVALUATED ON STUDY MODELS	
Anterior rugae width	Distance between the medial point of the first rugae
Posterior rugae width	The distance at the conjunction of the last lateral, and medial rugae
Inter canine width	Arch width from buccal cusp tip from one side to other
Inter premolar width	Arch width from buccal cusp tip of first premolar from one side to other
Inter molar width	Arch width from mesiobuccal cusp tip of first molar from one side to other



Statistical Analysis:
The data collected were entered in Microsoft Excel and subjected to Descriptive and inferential statistical analysis using Statistical Package for Social Sciences (SPSS, IBM version 20.0). The level of significance was fixed at 5% and $p \leq 0.05$ was considered statistically significant.

RESULTS:
The present study was carried out to evaluate the changes in buccal corridor space and its effects on esthetics before and after orthodontic treatment in individuals with constricted maxillary arch.
The results are based on an analysis of 58 patients. Figure 1 shows the demographic characteristics of study participants. A major proportion of the study participants were females (56%). The mean age of the male and female participants was found to be 21.55 ± 2.06 and 21.20 ± 1.28 years, respectively.
As shown in Table 1: Significant difference can be seen wrt interlast teeth and buccal corridor space wrt interlast teeth between pre and post treatment and between post treatment and after 2 years of follow up while highly significant difference can be seen wrt total smile area between pre and post treatment and between post treatment and after 2 years of follow up.

Table 1: Comparison of the intercanine distance, smile width, interlast visible maxillary teeth distance, buccal corridor area in relation to the canines, buccal corridor area in relation to the last visible maxillary teeth and total smile area in terms of {Mean (SD)} at different time intervals using Repeated measures ANOVA test

Time interval	***N***	**IC** ***Mean ± SD***	**SW** ***Mean ± SD***	**IL** ***Mean ± SD***	**BCC** ***Mean ± SD***	**BCL** ***Mean ± SD***	**TSA** ***Mean ± SD***
Pre treatment	58	41.66 ± 6.09	64.593 ± 14.73	50.916 ± 7.034	11.893 ± 3.0345	8.157 ± 2.527	61.767 ± 8.618
Post treatment	58	42.06 ± 5.36	65.072 ± 14.49	50.997 ± 7.090	11.569 ± 3.0387	7.821 ± 2.233	61.234 ± 8.619
After 2 years	58	41.87 ± 5.48	65.036 ± 14.50	50.855 ± 7.187	11.566 ± 2.9428	7.740 ± 2.082	61.553 ± 9.097
P value		0.099	0.273	**0.045***	0.268	**0.025***	**<0.001****

As shown in Table 2: no statistically significant difference can be seen wrt comparison of the ratio of intercanine distance to smile width, ratio of interlast visible maxillary teeth distance to smile width, ratio of buccal corridor area in relation to the canines to total smile area and ratio of buccal corridor area in

relation to the last visible maxillary teeth to total smile area in terms of at different time intervals (i.e pre-treatment, post-treatment and after 2 years of follow up).

Table 2: Comparison of the ratio of intercanine distance to smile width, ratio of interlast visible maxillary teeth distance to smile width, ratio of buccal corridor area in relation to the canines to total smile area and ratio of buccal corridor area in relation to the last visible maxillary teeth to total smile area in terms of {Mean (SD)} at different time intervals using Repeated measures ANOVA test

Time interval	***N***	**IC:SW** ***Mean ± SD***	**IL:SW** ***Mean ± SD***	**BCC:TSA** ***Mean ± SD***	**BCL:TSA** ***Mean ± SD***
Pre treatment	58	0.6688 ± 0.1382	0.7997 ± 0.1081	0.1928 ± 0.0279	0.1325 ± 0.0379
Post treatment	58	0.6715 ± 0.1440	0.8173 ± 0.1878	0.1890 ± 0.0453	0.1282 ± 0.0359
After 2 years	58	0.6688 ± 0.1425	0.8153 ± 0.1869	0.1882 ± 0.0433	0.1266 ± 0.0339
P value		0.116	0.140	0.550	0.056

As shown in Table 3: highly significant difference can be seen wrt interpremolar and intermolar width between pre-treatment, post treatment and after 2 years of follow-up. While significant difference can be seen wrt intercanine and posterior rugae width between pre and post treatment.

Table 3: Comparison of the ratio of intercanine width, inter premolar width, inter molar width, anterior rugae width and posterior rugae width in terms of {Mean (SD)} at different time intervals using Repeated measures ANOVA test

Time interval	***N***	**Intercanine** ***Mean ± SD***	**Inter premolar** ***Mean ± SD***	**Inter molar** ***Mean ± SD***	**Anterior rugae** ***Mean ± SD***	**Posterior rugae** ***Mean ± SD***
Pre treatment	58	33.71 ± 2.662	29.86 ± 2.551	31.62 ± 2.519	2.707 ± 0.9273	5.612 ± 1.1044
Post treatment	58	33.91 ± 2.695	32.31 ± 2.349	33.84 ± 2.361	2.733 ± 0.9469	5.664 ± 1.0612
After 2 years	58	33.83 ± 2.602	32.23 ± 2.340	33.81 ± 2.354	2.707 ± 0.8936	5.638 ± 1.0378
P value		**0.007***	**<0.001****	**<0.001****	0.207	**0.009***

DISCUSSION:

A lot of patients in contemporary dental practice are demanding treatment outcomes that are really aesthetically pleasing. In terms of facial appearance, a smile is essential. It also affects how one perceives their psychological traits.[1,18] Negative alterations may affect a person's IQ, emotional stability, personality, dominance, and sexuality.Indirectly, a patient seeking dental care for their primary aesthetic concern seeks therapy for the psychological problems brought on by an unattractive smile. Thus, in order to enhance the patient's psychological condition and quality of life, a thorough examination of the factors affecting smile is necessary.[1,2]

Many research investigating smile aesthetics have evaluated the significance of many influencing factors such as smile line, gingival display, and facial and dental midline, but very few have attempted to analyze BCSs. The way the smile was presented differed widely in terms of aesthetics. Some authors have used full-face photographs in which just a little portion of the mouth was visible.[19,20,12].

Since the buccal corridor is actually two-dimensional on frontal view and can be seen differently according to light condition, quantification of the smile from the frontal photographs can be done using linear measurements, proportions [9,5,12,21] and a mesh diagram with the extrapolation method.[5,9]
Linear (IC:SW, LV:SW) and area (BCC:TSA, BCL:TSA) measurements were made and calculated as ratios according to the methods of Hulsey[5] Johnson and Smith[12] and Ritter et al[21](Table II). The area measurements were taken according to the methods described by Yang et al[22].

Conventionally, arch widths have been measured between the cusp tips of the canines, premolars, and molars [23,24,25,26,27]. However, this method does not give a true representation of arch width change at the same point in the arch because it does not account for any anteroposterior dental movements of teeth during orthodontic treatment[18]. Despite this, this same measurement method was used in this study to compare our results with the findings of previous investigations. Measurements of this nature should be taken at a constant reference point; for this reason, we also included arch width measurements using the palatal rugae[28].

Numerous criteria that affect smile aesthetics show that orthodontists and laypeople generally like smiles with no or small BCs over those with many BCs. This supports the notion that small BCs are more attractive, as held by many other authors (Dierkes, 1987[29]; Blitz, 1997[30]; Morley and Eubank, 2001[31]; Sarver, 2001[8]; Sarver and Ackerman, 2003)[9], as well as the findings of Moore et al. (2005)[12] that laypeople choose smiles with no or small BCs. The first scientific study by Martin et al[15] demonstrates that orthodontists also favor smiles with smaller or no BCs.

Maulik and Nanda[16] studied the connection between the expansion of the upper arch using a palatal expander and buccal corridor/smile esthetics. They found that buccal corridor results to be significantly different between the expanded (9.6%) and non-expanded (11%) groups. The group that underwent orthodontic treatment with a palatal expander showed significantly fewer buccal corridors on smiling. Carvalho et al[17] also tested how palatal expanders affect smile esthetics and found that expanders did not statistically significant decrease for buccal corridors. Results for the buccal corridors in the last 2 studies contradict each other. Comparing these two studies, Maulik and Nanda's[16] study was a cross-sectional study with a sample size of 230 subjects and used videos to evaluate their results. The age of the participants was between 14 and 35 years. On the other hand, Carvalho et al's[17] study was a cohort. They used a smaller sample size of 27 people but evaluated results in three different time frames: T1, before expansion; T2, 3 months after expansion; and T3, 6 months after expansion. The mean age of this group was 10 years and 3 months. In addition, only for this study do we have information on the patient's initial severity of the transverse dimension. All patients included in Carvalho et al's[17] study presented with initial unilateral or bilateral cross-bite. A systematic review published in 2011 evaluated the buccal corridors and smile. Two articles concluded no correlation between buccal corridors and smile attractiveness. Eight articles concluded that less attractive smiles will result from large buccal corridors.[32]
In the study done by Carvallo et al[17] found that despite using RME as its primary mechanics, which would have raised expectations of a considerable drop in the buccal corridor, only the right buccal corridor between T1 and T2 and T1 and T3 experienced a statistically significant decline. However, given the degree of extension (mean 5.96 mm), changes of 1.29 mm (T1 -T2) and 1.13 mm (T1 -T3) do not appear to be clinically significant. While in our study we found that a statistically significant difference was found in buccal corridor space wrt visible interlast maxillary teeth between pre, post, and after 2 years of orthodontic treatment. Changes seen between T1-T0 is 0.336mm and between T2-T1 is 0.081mm and between after 2 years and pre-treatment is T2-T0 is 0.417mm inferring that between post and pre-treatment buccal corridor space have decrease but difference between after two years of follow up and post shows mild increase in buccal corridor space concluding that there is relapse during the retention period while Carvallo et al[17] in his article concluded that between baseline and 3 months and between

baseline and 6 months, there was a statistically significant increase in the transverse dimension of the smile, which is evaluated between the labial commissures. The transverse dimension of the smile, however, remained steady during the retention phase (3-6 months) whereas Maulik c et al and Nanda et al[16] in their article found out that the buccal corridor on smiling was noticeably reduced in the RME group. This provides evidence that supports the accepted belief that RME reduces buccal corridor.[16]
Here, a highly significant difference can be seen wrt inter canine width between pre and post-treatment inferring an increase in the width at the canine area and it remains stable after two years of orthodontic treatment. While inter premolar and intermolar width shows a highly significant difference between pre and post-treatment inferring an increase in the width and between after two years of follow-up and post-orthodontic treatment inferring a decrease in the width than before indicating relapse. These results supports the study done by Maulik et al[16] that RME reduces buccal corridor. Mah et al [33] did not find a significant change of the smile arc due to an increase of the inter-canine distance, whereas Sarver and Ackerman[9] suggested that the smile arc is also expected to flatten after an increase of the inter-canine distance.

CONCLUSION:

Changes can be seen wrt interpremolar and intermolar width and in buccal corridor space wrt interlast teeth and total smile area on models and on smile analysis. From this it can be concluded that cases of constricted maxillary arch treated with various expansion procedures show relapse after two years along with the change in buccal corridor space which directly affects the esthetics.

REFERENCES:

1. Pisulkar SK, Agrawal R, Belkhode V, Nimonkar S, Borle A, Godbole SR. Perception of buccal corridor space on smile aesthetics among specialty dentist and layperson. J Int Soc Prev Community Dent. 2019;9(5):499–504
2. Armalaite J, Jarutiene M, Vasiliauskas A, Sidlauskas A, Svalkauskiene V, Sidlauskas M, Skarbalius G. Smile aesthetics as perceived by dental students: a cross-sectional study. BMC oral health. 2018;18(1):1-7.
3. Machado AW. 10 commandments of smile esthetics. Dental Press J Orthod. 2014;19(4):136–57.
4. Nascimento DC, Santos ÊR, Machado AW, Bittencourt MA. Influence of buccal corridor dimension on smile esthetics. Dental Press J Orthod. 2012;17:145-50.
5. Hulsey CM. An esthetic evaluation of lip-teeth relationships present in the smile. Am J Orthod.1970;57(2):132-44.
6. Mackley RJ. An evaluation of smiles before and after orthodontic treatment. Angle Orthod. 1993;63(3):183-9.
7. Kokich VO, Asuman Kiyak H, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Restor Dent.1999;11(6):311–24.
8. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. Am J Orthod Dentofacial Orthop.2001;120(2):98–111.
9. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: Part 2. Smile analysis and treatment strategies. Am J Orthod Dentofacial Orthop.2003;124(2):116–27.
10. Jameson WS. Dynesthetic and dentogenic concept revisited. J Esthet Restor Dent. 2002;14(3):139–48.
11. Johnson DK, Smith RJ. Smile esthetics after orthodontic treatment with and without extraction of four first premolars. Am J Orthod Dentofacial Orthop.1995;108(2):162-7.
12. Moore T, Southard KA, Casko JS, Qian F, Southard TE. Buccal corridors and smile esthetics. Am J Orthod Dentofacial Orthop.2005;127(2):208-13.

13. Prasad V, Tandon P, Singh GK, Nagar A, Maurya RP. Comparison of smile esthetics after extraction and non-extraction orthodontic treatment. IP Indian Journal of Orthodontics and Dentofacial Research. 2020;4(4):182–9.
14. Martin AJ, Buschang PH, Boley JC, Taylor RW, McKinney TW. The impact of buccal corridors on smile attractiveness. Eur J Orthod.2007;29(5):530–7.
15. Christou T, Betlej A, Aswad N, Ogdon D, Kau CH. Clinical effectiveness of orthodontic treatment on smile esthetics: a systematic review. Clin Cosmet Investig Dent.2019;11:89–101.
16. Maulik C, Nanda R. Dynamic smile analysis in young adults. Am J Orthod Dentofacial Ortho.2007;132(3):307–15.
17. Carvalho APMC de, Goldenberg FC, Angelieri F, Siqueira DF, Bommarito S, Scanavini MA, et al. Assessment of changes in smile after rapid maxillary expansion. Dental Press J Orthod. 2012;17(5):94–101.
18. Omar D, Duarte C. The application of parameters for comprehensive smile esthetics by digital smile design programs: A review of literature. The Saudi dental journal. 2018 Jan 1;30(1):7-12.
19. Flores-Mir C, Silva E, Barriga MI, Lagravere MO, Major PW. Lay person's perception of smile aesthetics in dental and facial views. Journal of orthodontics. 2004 Sep 1;31(3):204-9.
20. Nimbalkar S, Oh YY, Mok RY, Tioh JY, Yew KJ, Patil PG. Smile attractiveness related to buccal corridor space in 3 different facial types: A perception of 3 ethnic groups of Malaysians. The Journal of prosthetic dentistry. 2018 Aug 1;120(2):252-6.
21. Ritter DE, Gandini Jr LG, Pinto AS, Locks A. Esthetic influence of negative space in the buccal corridor during smiling. The Angle Orthodontist. 2006 Mar;76(2):198-203.
22. Yang IH, Nahm DS, Baek SH. Which hard and soft tissue factors relate with the amount of buccal corridor space during smiling?. The Angle Orthodontist. 2008 Jan;78(1):5-11.
23. McNamara L, McNamara Jr JA, Ackerman MB, Baccetti T. Hard-and soft-tissue contributions to the esthetics of the posed smile in growing patients seeking orthodontic treatment. American journal of orthodontics and dentofacial orthopedics. 2008 Apr 1;133(4):491-9.
24. Gianelly AA. Arch width after extraction and nonextraction treatment. American journal of orthodontics and dentofacial orthopedics. 2003 Jan 1;123(1):25-8.
25. Akyalcin S, Erdinc AE, Dincer B, Nanda RS. Do long-term changes in relative maxillary arch width affect buccal-corridor ratios in extraction and nonextraction treatment?. American journal of orthodontics and dentofacial orthopedics. 2011 Mar 1;139(3):356-61.
26. Işık F, Sayınsu K, Nalbantgil D, Arun T. A comparative study of dental arch widths: extraction and non-extraction treatment. The European Journal of Orthodontics. 2005 Dec 1;27(6):585-9.
27. Kim E, Gianelly AA. Extraction vs nonextraction: arch widths and smile esthetics. The Angle Orthodontist. 2003 Aug;73(4):354-8.
28. Hoggan BR, Sadowsky C. The use of palatal rugae for the assessment of anteroposterior tooth movements. American Journal of Orthodontics and Dentofacial Orthopedics. 2001 May 1;119(5):482-8.
29. Dierkes JM. The beauty of the face: an orthodontic perspective. The Journal of the American Dental Association. 1987 Dec 1;115:89E-95E.
30. Blitz N 1997 Criteria for success in creating beautiful smiles. Oral Health 87 : 38 – 42.
31. Morley J, Eubank J. Macroesthetic elements of smile design. The Journal of the American Dental Association. 2001 Jan 1;132(1):39-45.
32. Janson G, Branco NC, Fernandes TM, Sathler R, Garib D, Lauris JR. Influence of orthodontic treatment, midline position, buccal corridor and smile arc on smile attractiveness: A systematic review. The Angle Orthodontist. 2011 Jan;81(1):153-61.
33. Mah M, Tan WC, Ong SH, Chan YH, Foong K. Three-dimensional analysis of the change in the curvature of the smiling line following orthodontic treatment in incisor class II division 1 malocclusion. European Journal of Orthodontics. 2014 Dec 1;36(6):657-64.

Section A-Research paper
ISSN 2063-5346