

Relationship between Maxillary Midline Diastema Width and Labial Frenum Attachment in a Sample of Nigerian Adolescents: A Cross-Sectional Study

Abiola Adigun¹, Tolulase Yemitan², Omolara Uti³

¹Department of Child Dental Health, Lagos State University Teaching Hospital, Ikeja, Lagos, ²Department of Child Dental Health, Lagos State University College of Medicine, Ikeja, Lagos, ³Department of Preventive Dentistry, Faculty of Dental Sciences, College of Medicine, University of Lagos, Lagos, Nigeria

Abstract

Background: The maxillary midline diastema is a space between both upper central incisors which is more than 0.5 mm in width, and there are varying factors attributed to its occurrence. **Aim:** The purpose of this study was to determine the relationship between maxillary midline diastema width and labial frenum attachment among secondary school students in a Nigerian rural community. The study also assessed the prevalence of maxillary midline diastema and the distribution of labial frenal morphology. **Materials and Methods:** A cross-sectional study was conducted among 200 adolescents in Southwestern Nigeria. Participants were selected using a three-stage stratified sampling technique, and structured questionnaires were employed. Intraoral examination was done to assess the presence of maxillary midline diastema, classify the morphology of the upper labial frenum and measure the width of the maxillary midline diastema. **Results:** The participants were aged between 10 and 17 years (mean age, 12.69 ± 2.1 standard deviation). The prevalence of maxillary midline diastema was 31.5% among participants with gingival attachment being the most prevalent frenal morphology. Participants with papillary frenal attachments had statistically significant wider maxillary midline diastema than those with gingival frenal attachments ($P < 0.05$). **Conclusions:** Among Nigerian adolescents, there was an association between the type of labial frenal attachment and width of maxillary midline diastema.

Keywords: Frenal morphology, midline diastema, papillary attachment

INTRODUCTION

The maxillary labial frenum is a mucous membrane fold that connects the upper lip to the alveolar mucosa, gingiva, and the underlying periosteum.^[1] It is one of the most variable anatomical structures present in the oral cavity and is superficial to muscle attachments.^[2] In infants, the frenum extends over the alveolar process and forms a raphe reaching the palatal papilla. As the alveolar process grows and tooth eruption occurs, the attachment of the frenum generally changes to assume the adult configuration at the alveolar mucosa.^[3]

The maxillary midline diastema is a space (or gap) between the maxillary central incisors which is more than 0.5 mm.^[4] The space can be a normal growth feature during the primary and mixed dentition and usually closes at the time of eruption of the maxillary canines.^[5] In some individuals; however, the diastema does not close spontaneously.^[4]

The main function of the maxillary labial frenum is the provision of support and stability of the upper lip. It also keeps the lip in harmony with the growing bones of the maxilla, thereby contributing to the regulation of the facial growth.^[3] The upper labial frenum has shown variations and anomalies depending on the attachment of fibers and structure of frenum.^[6] These variations have been classified in various ways,^[3,7,8] but the most widely accepted classification was proposed by Mirko *et al.*^[7] based on the frenal attachment site, namely mucosal frenal attachment, gingival frenal attachment,

Address for correspondence: Dr. Tolulase Yemitan,
Department of Child Dental Health, Faculty of Dentistry, Lagos State
University College of Medicine, Lagos, Nigeria.
E-mail: tolulaseyemitan@yahoo.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Adigun A, Yemitan T, Uti O. Relationship between maxillary midline diastema width and labial frenum attachment in a sample of Nigerian adolescents: A cross-sectional study. *Niger J Med* 2022;31:274-9.

Submitted: 17-Feb-2022

Revised: 20-Mar-2022

Accepted: 19-Apr-2022

Published: 24-Jun-2022

Access this article online

Quick Response Code:



Website:
www.njmonline.org

DOI:
10.4103/NJM.NJM_28_22

papillary frenal attachment, and papillary penetrating frenal attachment.

Frenal attachment that impinges on the marginal gingiva distends the gingival sulcus, leading to plaque accumulation, increase in the progression rate of gingival recession, and resulting in relapse after orthodontic treatment.^[3] Papillary and papilla penetrating frena are clinically considered pathological and have been found to be associated with diastema, loss of papilla, gingival recession, brushing difficulty, malocclusion and it may also affect the denture fit or retention leading to psychological disturbances to the individual.^[9]

Previous studies reported a higher prevalence of diastema in Africans than in Caucasians.^[10,11] In Nigeria, various studies have reported the prevalence of diastema between 17% and 37% among school children.^[11-15]

The aetiology of midline diastema is multifactorial, including microdontia or hypodontia of upper lateral incisors, supernumerary teeth between upper central incisors, especially mesiodens, aberrant frenal attachment, periodontal disease, large tongue, improper position of tongue during rest or function, and genetic factors.^[4,9,16-19]

The midline diastema could create an unpleasant appearance and can interfere with speech depending on its width.^[20] However, Nigerian ethnic groups perceived maxillary midline diastema within 2–3 mm as an esthetic attribute.^[21]

The relationship between labial frenal attachment and the maxillary midline diastema has been investigated.^[22-26] Some of these studies concluded that persistent midline diastema can be attributed to the presence of an abnormal frenum.^[20,23] A significant inverse relationship between gingival insertion level of frenum and midline diastema was found.^[24] Conversely, other studies suggested that abnormal frenum is an effect of midline diastema rather than being its etiology.^[27,28]

Literature review found no previous study on the relationship between frenal attachment and diastema width among Africans. The objectives of this study were as follows: (1) to determine the prevalence of maxillary midline diastema, (2) examine the association between labial frenum attachment and width of maxillary midline diastema, (3) as well as investigate the association between gender and perception of esthetics of labial frenum attachments and sizes of maxillary midline diastema among secondary school students in a Nigerian rural community.

MATERIALS AND METHODS

Study design

This is a descriptive cross-sectional study among secondary school students in a Nigerian rural community.

Study location

The research was conducted at Pakoto town in Ifo Local Government Area of Ogun State, Southwest Nigeria.

Study population

Participants were 200 adolescents aged 10–19 years attending a secondary school at Pakoto town in Ifo Local Government Area of Ogun State in December 2019.

Inclusion criteria

1. Healthy Nigerian adolescents of both sexes aged 10–19 years who are willing to participate in the study with consent form signed by parents
2. Presence of healthy (no caries, no fractures, and not previously restored) maxillary anterior teeth
3. Presence of healthy gingiva
4. Normal occlusion or minimal dentoalveolar discrepancy (≤ 4 mm).

Exclusion criteria

1. Adolescents with congenital/developmental/acquired orofacial anomalies affecting the hard and soft tissues
2. History of trauma in the anterior portion of the maxilla
3. Adolescents with interproximal caries or restoration on the upper central incisors and/or any alterations in the size and shape of the incisors
4. Any oral habits and/or any previous orthodontic/periodontal treatments
5. History of surgical intervention in maxillary labial region
6. Those on medication which are known to cause gingival hyperplasia
7. Those with dentoalveolar disproportion > 4 mm.

Sample size determination

This was determined by applying the formula for the sample size determination using a prevalence of midline diastema of 10.2% from a previous study (Boutsi and Tatakis, 2011):

$$n = \frac{Z^2 pq}{d^2}$$

where n = the estimate of the population size

$Z = 1.96$ standard error at 95% level of confidence

d^2 = the precision level set at 0.05

P = prevalence of midline diastema = 10.2%

$q = 1 - p$

$q = 1 - p = 1 - 0.102 = 0.898$

$d = 0.05$

Therefore,

$$n = \frac{Z^2 pq}{d^2} = \frac{(1.96)^2 \times 0.102 \times 0.898}{(0.05)^2} = \frac{0.352}{0.0025} = 140.8$$

Addition of 30% for nonresponse: $140.8 + 42.24 = 183.04$

Minimum sample size was 200 participants.

Sampling technique

A three-stage stratified sampling technique was utilized with random selection by balloting of one private and one

government-owned secondary school from a list of all secondary schools in the town. One class arm was selected by simple random sampling technique from each class level in the selected schools. Within each class arm selected, participants that fit the selection criteria were selected using a simple random sampling technique.

Collection tool and ethical approval

The study was conducted using structured examiner-administered questionnaires and intraoral examination. Prior to questionnaire administration and examination, Ethical approval was obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital (ADM/DCST/HREC/APP/3375). Following approval from the school authorities, a written informed consent was obtained from parents/guardians of the selected subjects who were willing to participate in the research. Written assent was similarly taken from the participants below 18 years of age.

The survey was conducted with a questionnaire [Appendix 1] with section 1 on sociodemographic variables such as age, sex, and academic level of the participants. Section 2 included a question on family history of diastema, while section 3 had three-colored pictures [Figure 1a-c] showing three frenal attachment types and diastema sizes. Participants were asked to choose which picture they perceived as most esthetic.

The questionnaire was validated in a pilot study with 20 dental students at the College of Medicine of the University of Lagos, who assessed the questionnaire's clarity, language, and content. The results of the pilot study were not included in the main study results. The reliability of method was calculated using paired sample correlation of measurements of maxillary diastema width taken two weeks after the initial measurement by the same examiner. Intra-observer agreement of $r = 0.999$ ($P < 0.000$) was obtained.

Intraoral examination was carried out on each participant by the principal researcher. With the students seated upright on a class chair under natural light, direct visual method of examination was done by lifting the upper lip with the index finger and thumb of both hands using disposable examination gloves. This allowed observation and classification of the labial frenum attachment level and assessment of midline diastema. The midline diastema width was measured by determining the distance in millimeter between the midpoints of the mesial surfaces of both central incisors using a pair of autoclavable dividers (dbOrtho, West Yorkshire, UK) and transferred to a meter rule.^[21] The dividers were sterile before use, and the meter rule was disinfected with 1:10 dilution of sodium hypochlorite after each participant.

The frenal attachment level classification by Placek *et al.*^[29] was used as follows:

1. Mucosal attachment of the frenum: an attachment of the frenum to the mucogingival junction
2. Gingival attachment: an attachment of the frenum to the attached gingiva

3. Papillary attachment: an attachment of the frenum to the papilla
4. Papillary penetrating attachment: the attachment of the frenum passes right up to the papilla, while inserting into attached gingiva.

Data analysis

Data were analyzed with the IBM Statistical Package for the Social Sciences for Windows version 23.0. (IBM Corp., Armonk, NY, USA). Numeric data with normal distribution were presented as means and standard deviations. The categorical data were displayed using frequencies and percentages. Pearson's Chi-square test was analyzed differences between the subgroups of categorical variables. Student's *t*-test compared mean between two groups, while the analysis of variance (ANOVA) compared more than two means with Tukey's *post hoc* tests. Statistical significance was put at a 5% level and a Confidence interval of 95%.

RESULTS

Sociodemographic characteristics

In this study, 200 adolescents participated, of which 51% were female and 49% were male. They were aged 10–17 years with a mean age of 12.69 ± 2.10 . The respondents' characteristics are shown in Table 1.

Prevalence of maxillary midline diastema

The prevalence of upper midline diastema among the adolescents who participated in the study was 31.5% [Table 2], with no gender difference ($P > 0.05$).

Association between labial frenum attachment and width of maxillary midline diastema

The distribution of frenal attachment types showed that mucosal attachment was found in 6.3% ($n = 4$), gingival attachment in 47.6% ($n = 30$), and papillary attachment in 46.0% ($n = 29$). Papillary penetrating frenal attachment was not found among the sample examined. Results of tests of association by the ANOVA revealed a statistically significant association ($P < 0.05$) between the width of maxillary midline

Table 1: Sociodemographic characteristics of participants

Variable	Categories	n (%)
Gender	Male	98 (49.0)
	Female	102 (51.0)
Age (years)	10-12	94 (47.0)
	13-15	88 (44.0)
	>16	18 (9.0)
Academic level	JS1	71 (35.5)
	JS2	26 (13.0)
	JS3	20 (10.0)
	SS1	54 (27.0)
	SS2	19 (9.5)
	SS3	10 (5.0)
Total		200 (100.0)

JS: Junior secondary, SS: Senior secondary

diastema and maxillary labial frenal attachment [Table 3]. Individuals with frenal fibers inserted into their interdental papilla had wider maxillary midline diastema.

Tukey's *post hoc* tests [Table 4] revealed that the mean width of maxillary diastema for respondents with gingival frenal attachment (1.67 mm) was significantly smaller ($P < 0.05$) compared to those with papillary frenal attachment (2.55 mm).

Association between gender and perception of esthetics

Majority of respondents (62%) perceived small diastema and mucosal frenum attachment as most attractive, while only 3% ($n = 6$) found large diastema and papillary penetrating frenum attachment as most attractive. There was no significant difference observed based on gender ($P > 0.05$) [Table 5].

DISCUSSION

This study revealed that the type of upper lip frenum attachment has an impact on the size of diastema in this present study. The insertion of frenal fibers into the interdental papilla in the

present study was associated with wider maxillary midline diastema compared to those who had frenal attachment into their attached gingiva. This result aligns with a previous study which found that large frenum attachment classified as Type III (papillary) or IV (penetrating to the papilla) significantly occurred more often in patients with diastema.^[29] Another study found that patients with oversized frenum had bigger diastema than patients with normal frenum.^[30] A higher prevalence of mucosal and gingival type of frenum was found in a group of adult Caucasian patients with small diastema of ≤ 2 mm while large diastema of > 2 mm was associated with papillary and penetrating to the papilla frenum.^[26] The diastema has been attributed to the insertion of labial frenum into a notch in the alveolar bone, leaving a band of heavy fibrous tissue between the central incisors which creates a bony cleft separating the two central incisors as they erupt.^[22] However, Tait^[19] in his study reported that frenum is an effect and not a cause for the incidence of diastema.

In Nigeria, several studies have reported the prevalence of midline diastema in varying age groups.^[11-15] In the present study, the prevalence of maxillary midline diastema was 31.5% among respondents. This is similar to findings of a study conducted among school children aged 12–16 years, where the prevalence of midline diastema was 31%.^[12] This may be due to similarities in the age of the respondents and methodology. Another study among a similar age group in Southwestern Nigeria reported a prevalence of 37%.^[11] The present result however differs from lower prevalence values obtained in other studies.^[13,14] These differences could be due to the differences in methodology such as the exclusion of diastema sizes < 2 mm in width.

Although respondents' perception of dental aesthetics of types of frenal attachments and maxillary midline diastema sizes based on gender was not statistically significant, most respondents perceived small diastema (< 1 mm) and mucosal

Table 2: Prevalence of maxillary midline diastema

Maxillary midline diastema	Female, n (%)	Male, n (%)	Total, n (%)
Present	29 (14.5)	34 (17.0)	63 (31.5)
Absent	73 (36.5)	64 (32.0)	137 (68.5)
Total	102 (51.0)	98 (49.0)	200 (100.0)

$\chi^2=0.908, P=0.341$

Table 3: Test of association between maxillary midline diastema width (in millimeters) and frenal morphology

Frenal morphology	MMD mean width	F	P
Gingival attachment	1.67	10.420	0.000***
Mucosal attachment	1.75		
Papillary attachment	2.55		

***Significant at $P < 0.000$. MMD: Maxillary midline diastema

Table 4: Tukey *post hoc* pairwise comparison

Model effect	Mean difference	SE	CI	P
Mucosal versus gingival attachment	0.083	0.404	-0.89-1.05	0.977
Mucosal versus papillary attachment	-0.802	0.405	-1.77-0.17	0.126
Gingival versus papillary attachment	-0.885*	0.198	-1.36-0.41	0.000***

***Significant at $P < 0.000$. CI: Confidence interval, SE: Standard error

Table 5: Comparison of perception of dental esthetics of variations in maxillary midline diastema and frenal attachments based on gender

Diastema size and frenal type	Gender		Total, n (%)
	Female, n (%)	Male, n (%)	
Small diastema and mucosal frenum	60 (30.0)	60 (30.0)	124 (62.0)
Medium diastema and gingival frenum	39 (19.5)	31 (15.5)	70 (35.0)
Large diastema and papillary penetrating frenum	3 (1.5)	3 (1.5)	6 (3.0)
Total	102 (51.0)	98 (49.0)	200 (100.0)

$\chi^2=0.964, P=0.618$

frenum as aesthetic while only 3% perceived large diastema with papillary penetrating frenum attachment as aesthetic. Previous studies reported that a midline diastema of 2 mm was regarded as an aesthetic limit of smile attractiveness and diastema of ≥ 2 mm was negatively perceived by Brazilian adolescents^[31] and diastema > 1 mm was observed as a defect that required correction.^[26,32] In contrast, maxillary midline diastema was found acceptable and seen as a sign of beauty among Africans, such that it was common among some Africans to either desire to maintain the midline diastema when present or to demand for artificially created midline diastema.^[33,34] However, a study among Nigerian undergraduate students found that the width of a diastema tends to affect the esthetic acceptability of the diastema. While the diastema width rated as most attractive was 1 mm, the least attractive diastema width was 4 mm.^[35] However, in a Saudi population, maxillary midline diastema of any width was perceived as unattractive, thus requiring corrective intervention.^[36]

There was no statistically significant association between gender and the choice of the most attractive diastema width and frenum attachment width. This finding is similar to previous reports^[36,37] but differs from previous studies that reported that women were more critical of midline diastema.^[38]

CONCLUSIONS

The following conclusions were derived from the results of the study:

1. The prevalence of upper midline diastema among the adolescents who participated in the study was 31.5% with no gender difference
2. There is a statistically significant association between the diameter of maxillary midline diastema and maxillary labial frenal attachment
3. The perception of esthetics of types of frenal attachments and maxillary midline diastema sizes compared based on gender was not statistically significant among respondents.

Limitations of the study

The study limitations include that this study did not test the effects of other factors with possible effects on the perception of midline diastema and labial frenal attachment such as cultural norms and social predisposition. Further investigations are needed to examine the potential effects of these factors.

Acknowledgment

The authors would like to acknowledge the support of Oyewunmi Boluwatife.

Financial support and sponsorship

This research did not receive any specific grant from any funding agency in the public, commercial or not-for-profit sector.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kotlow L. Diagnosis and treatment of ankyloglossia and tied maxillary fraenum in infants using Er:YAG and 1064 diode lasers. *Eur Arch Paediatr Dent* 2011;12:106-12.
2. Zarb GA, Bryant SR. Preprosthetic surgery: Improving the patients denture-bearing areas and ridge relations. In: Zarb GA, Bolender CL, editors. *Prosthodontic Treatment for Edentulous Patients, Complete Dentures and Implant-Supported Prosthesis*. 12th ed. Amsterdam: Elsevier; 2004.p. 103.
3. Priyanka M, Sruthi R, Ramakrishnan T, Emmadi P, Ambalavanan N. An overview of frenal attachments. *J Indian Soc Periodontol* 2013;17:12-5.
4. Umar H, Ali A, Muhammad F. Etiology and treatment of midline diastema: A review of literature. *POJ* 2013;5:27-33.
5. Baum AT. The midline diastema. *J Oral Med* 1966;21:30-9.
6. Townsend JA, Brannon RB, Chermie T, Hagan J. Prevalence and variations of the median maxillary labial frenum in children, adolescents, and adults in a diverse population. *Gen Dent* 2013;61:57-60.
7. Mirko P, Miroslav S, Lubor M. Significance of the labial frenum attachment in periodontal disease in man. Part I. Classification and epidemiology of the labial frenum attachment. *J Periodontol* 1974;45:891-4.
8. Sewerin I. Prevalence of variations and anomalies of the upper labial frenum. *Acta Odontol Scand* 1971;29:487-96.
9. Anubha N, Chaubey KK, Arora VK, Narula IS. Frenectomy combined with a laterally displaced pedicle graft. *Indian J Dent Sci* 2010;2:47-51.
10. Brunelle JA, Bhat M, Lipton JA. Prevalence and distribution of selected occlusal characteristics in the US population, 1988-1991. *J Dent Res* 1996;75:706-13.
11. Onyeaso CO. Prevalence of malocclusion among adolescents in Ibadan, Nigeria. *Am J Orthod Dentofacial Orthop* 2004;126:604-7.
12. Anosike AN, Sanu OO, da Costa OO. Malocclusion and its impact on quality of life of school children in Nigeria. *West Afr J Med* 2010;29:417-24.
13. Emmanuel OA. Prevalence of malocclusion among school children in Benin City, Nigeria. *J Med Biomed Res* 2008;7:58-65.
14. Isiekwe MC. Maxillary midline diastema in Nigerians. *Nig Dent J* 1983;2:60-7.
15. Omotoso G, Kadir E. Midline diastema amongst south-western Nigerians. *Internet J Dent Sci* 2009;8:2.
16. Gass JR, Valiathan M, Tiwari HK, Hans MG, Elston RC. Familial correlations and heritability of maxillary midline diastema. *Am J Orthod Dentofacial Orthop* 2003;123:35-9.
17. Huang WJ, Creath CJ. The midline diastema: A review of its etiology and treatment. *Pediatr Dent* 1995;17:171-9.
18. Kapusevska B, Dereban N, Zabokova-Bilbilova E, Popovska M. The influence of etiological factors in the occurrence of diastema mediana. *Pril (Makedon Akad Nauk Umet Odd Med Nauki)* 2014;35:169-77.
19. Tait CH. The median frenum of the upper lip and its influence on the spacing of the upper central incisor teeth. *Dent Cosmos* 1934;76:991-2.
20. Akinboboye B, Umesi D, Ajayi Y. Transcultural perception of maxillary midline diastema. *Int J Esthet Dent* 2015;10:610-7.
21. Jonathan PT, Thakur H, Galhotra A, Galhotra V, Gupta N. Maxillary labial frenum morphology and midline diastema among 3 to 12-year-old school going children in Sri Ganganagar city: A cross-sectional study. *J Indian Soc Pedod Prev Dent* 2018;36:234-9.
22. Diaz-Pizán ME, Lagravère MO, Villena R. Midline diastema and frenum morphology in the primary dentition. *J Dent Child (Chic)* 2006;73:11-4.
23. Kaimenyi JT. Occurrence of midline diastema and frenum attachments amongst school children in Nairobi, Kenya. *Indian J Dent Res* 1998;9:67-71.
24. Popovich F, Thompson GW, Main PA. The maxillary interincisal diastema and its relationship to the superior labial frenum and intermaxillary suture. *Angle Orthod* 1977;47:265-71.
25. Rajakumar S, Jayanthi M, Joseph E. To determine the prevalence of maxillary labial and mandibular lingual frenum and it's relationship between the upper midline space and to clinically assess the maxillary labial frenum morphology in 3 to 14 years children of Chennai city. *Glob J Res Anal* 2019;8:2.
26. Sękowska A, Chafas R. Diastema size and type of upper lip midline

- frenulum attachment. *Folia Morphol (Warsz)* 2017;76:501-5.
27. Boutsis EA, Tatakis DN. Maxillary labial frenum attachment in children. *Int J Paediatr Dent* 2011;21:284-8.
 28. Mohan R, Soni PK, Krishna MK, Gundappa M. Proposed classification of medial maxillary labial frenum based on morphology. *Dent Hypotheses* 2014;5:16-20.
 29. Placek M, Skach M, Mrklas L. Significance of the labial frenum attachment in periodontal disease in man. Part I. Classification and epidemiology of the labial frenum attachment. *J Periodontol* 1974;45:891-4.
 30. Shashua D, Artun J. Relapse after orthodontic correction of maxillary median diastema: A follow-up evaluation of consecutive cases. *Angle Orthod* 1999;69:257-63.
 31. Marques LS, Filogônio CA, Filogônio CB, Pereira LJ, Pordeus IA, Paiva SM, *et al.* Aesthetic impact of malocclusion in the daily living of Brazilian adolescents. *J Orthod* 2009;36:152-9.
 32. Witt M, Flores-Mir C. Laypeople's preferences regarding frontal dentofacial esthetics: Tooth-related factors. *J Am Dent Assoc* 2011;142:635-45.
 33. Arigbede AO, Adesuwa AA. A case of quackery and obsession for diastema resulting in avoidable endodontic therapy. *Afr Health Sci* 2012;12:77-80.
 34. Sackeyfio J, Quartey-Papafio N, Fleischer HNA, Manu D, Ndanu T. Perceptions and views about midline diastema among adults in two rural communities in Ghana. *Ghana Dent J* 2020;17:21-4.
 35. Enabulele JE, Ehis A. How attractive is the maxillary midline diastema? Perception of undergraduate students attending a Nigerian University. *J Dent Oral Biol* 2020;5:1158.
 36. Mokhtar HA, Abuljadayel LW, Al-Ali RM, Yousef M. The perception of smile attractiveness among Saudi population. *Clin Cosmet Investig Dent* 2015;7:17-23.
 37. Talic N, Alomar S, Almaidhan A. Perception of Saudi dentists and lay people to altered smile esthetics. *Saudi Dent J* 2013;25:13-21.
 38. Bolas-Colvee B, Tarazona B, Paredes-Gallardo V, Arias-De Luxan S. Relationship between perception of smile esthetics and orthodontic treatment in Spanish patients. *PLoS One* 2018;13:e0201102.