

Original Article

Prevalence of Maxillary Labial Frenal Attachments Types and Midline Diastema in Egyptian Children with Fully Erupted Maxillary Permanent Canines: A Cross Sectional Study

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Abstract

Aim: The study aimed to evaluate the prevalence of maxillary labial frenal attachment types and midline diastema in a group of Egyptian children with fully erupted maxillary permanent canines. **Subjects and Methods:** A total of 264 patients aged from 12 to 18 years were examined by the principal investigator to evaluate the type of frenal attachment using the direct visual method, the blanching test, and the pull test. Midline diastema simplified oral hygiene index, gingival index, and attachment loss were evaluated for all participants. **Results:** The mucosal frenal attachment type was the most prevalent frenal type (74.6%) followed by the gingival type (23.1%). Regarding the midline diastema, 15.7% of the participants presented with a midline diastema while assessment of oral hygiene and gingival condition revealed that 80.6% had satisfactory oral hygiene, 48.5% had mild gingivitis, and only 2.2% of patients had a clinical attachment loss. With a statistically significant difference, patients with mucosal and gingival frenal types showed no midline diastema in 90% and 71% of participants, consecutively. **Conclusions:** In terms of maxillary labial frenum attachment type, mucosal and gingival frenal types were the most predominant types among the study sample with a low incidence of midline diastema and attachment loss.

Keywords: Attachment, children, Fully erupted canines, Maxillary labial frenum, Midline diastema

I. INTRODUCTION

A vertical strip of oral mucosa known as the maxillary labial frenum attaches the lips to the alveolar mucosa of the maxillary arches, restricting lip movement. The frenum develops from the remnants of vestibular lamina central cells, histologically made up of many elastic fibers, loose fibrous connective tissue, and a few striated muscle fibers coming from the muscular bundles of the lip on either side of the midline (Christabel and Gurunathan, 2015; Nandita, Bhat and Hedge, 2018).

The labial frenum's main functions are to support and stabilize the upper lip, maintain harmony between the lip and developing maxillary bones, and control facial development (Rajagopalan and Padmaprabha, 2019; Kotian and Jeevanandan, 2020). The maxillary frenum is vulnerable to change throughout the stages of human growth and development where it usually moves to an apical position with the growth of the alveolar process (Niazi et al., 2017; Nandita, Bhat and Hedge, 2018).

When the maxillary labial frenum attaches to the gingiva in a way that restricts lip mobility, retracts the gingival margin, or promotes the formation of diastema, it is deemed abnormal (Boutsi and Tatakis, 2011). Abnormal maxillary labial frenum has been associated with a variety of clinical problems, such as plaque retention and accumulation, and difficulty with efficient brushing of teeth that may cause the development and advancement of periodontal disease, making it even more difficult to control gingival recession. In addition to problems related to feeding and denture fit and retention (Divater et al., 2019).

So, the current study aimed to evaluate the prevalence of maxillary labial frenal attachment types and midline diastema in a group of Egyptian children with fully erupted maxillary permanent canines.

II. SUBJECTS AND METHODS

A. Study design

The current study was an observational cross-sectional study aimed to evaluate the prevalence of maxillary labial frenal attachment types and midline diastema in a group of Egyptian children with fully erupted maxillary permanent canines.

B. Sample size determination

Based on the results of Albarakati and Al-Dlaigan, 2011 who reported that 22% of the participants had a maxillary midline diastema, the calculated sample size was 264 patients using a finite population correction, a confidence interval of 95%, and a margin of error of 5% using Epi info for windows version 7.2.

C. Ethical approval

The Ethical Committee of the Faculty of Dentistry at Cairo University reviewed and approved the protocol regarding its scientific content and adherence to applicable research and human subjects' regulations on 31/3/2020 with an approval number of 20-3-6.

D. Study registration

ClinicalTrials.gov listed the trial protocol under the name "Prevalence of MLFA Types and MD in Egyptian Children with Erupted Canines" with the identifier NCT04244903.

E. Subject selection

The principal investigator screened 264 children aged between 12 and 18 years, who were visiting the Outpatient Clinic of the Pediatric Dentistry and Dental Public Health Department, Faculty of Dentistry, Cairo University, to ensure compliance with the eligibility criteria.

F. Eligibility criteria

Inclusion criteria:

- Egyptian children with fully erupted canines.
- Children with intact maxillary anterior teeth.
- Apparently healthy children.

Exclusion criteria:

- Children having orofacial deformities or congenital abnormalities.
- Children with a history of trauma or surgery in the anterior portion of the maxilla or area of the labial frenum.
- Children who suffer from any syndromes or take drugs that are believed to affect the gingiva (e.g., phenytoin).
- Children with orthodontic appliances.

G. Informed consent

The study's goals, the dental treatments in detail, the direct benefit to participants, and any potential negative effects were explained to children and their parents. Each parent provided written informed consent, and each child verbally agreed to participate in the study.

H. Clinical Examination

Children were examined lying in a supine position under appropriate lighting by the principal investigator. All patient data including patient name, age, gender, address, medical history, and dental history was recorded in the patient assessment chart.

Using Placek's classification, the type of frenal attachment was assessed using the direct visual method, the blanching test, and the pull test, as shown in figure (1). Using the direct visual method, the type of frenal attachment was determined according to Sekar, Mungara and Joseph, 2019 where the upper lip was gently lifted upwards away from the alveolar process and a sterilized mouth mirror was used to view the palatal surfaces of the teeth.

Using the blanching test, the type of frenal attachment was determined according to Seraj et al., 2019 where tension was applied over the labial frenum, producing blanching in the area of frenal attachment. Using the pull test, the type of frenal attachment was determined according to Seraj et al., 2019 where the upper lip was pulled with the handle of a metal mirror to see the movement of the attachment point.

A digital caliper was used to measure the distance between the midpoints of the mesial surfaces of both central incisors to evaluate the midline diastema according to Ghimire et al., 2013, and a periapical x-ray was performed for each patient to detect any caries or abnormality according to Mallya et al., 2019.

Patient oral hygiene was evaluated using the simplified oral hygiene index by Greene and Vermillion, 1964 based on quantitative assessments of debris and calculus discovered on six selected tooth surfaces including two upper first permanent molars buccal surfaces, two lower first permanent molars lingual surfaces, and upper right and lower left central incisors labial surfaces using a periodontal probe.

The gingival conditions were evaluated using the gingival index by Loe and Silness, 1963 based on the visual evaluation of the gingival color and consistency, and the evaluation of bleeding on probing of six maxillary and mandibular anterior teeth using a blunt probe. The evaluation of periodontal condition according to Glavind and Loe, 1967 based on the diagnosis of attachment loss that had been given to the patient whose probing depth is greater than 3 mm using a periodontal probe.

I. Statistical analysis

With the aid of Microsoft Excel 2016 and GraphPad Prism, statistical analysis was carried out. The Shapiro-Wilk Normality test was used to determine the normality of all quantitative data, which were then given as means and standard deviation (SD) values. All qualitative data were expressed as frequency and percentage, and the Chi-square test was used for all comparisons.

III. RESULTS

A. Descriptive data

Patients who participated in the present study were aged between 12-18 years old with a mean \pm standard deviation of 13.85 ± 1.48 . Regarding the gender distribution, males represented 49.3% of the participants, while females represented 50.7%, with no statistically significant difference between them (P-value > 0.05).

In terms of labial frenum attachment types, the prevalence of the mucosal type was 74.6%, the gingival type was 23.1%, the papillary type was 1.5%, and the papillary penetrating type was 0.7% with a statistically significant difference between them (P-value < 0.0001).

Concerning the distribution of midline diastema, 84.3% of patients presented with no midline diastema while 11.2% presented with

mild midline diastema, 3.7% presented with moderate midline diastema, and 0.7% presented with severe midline diastema with a statistically significant difference between them (P -value < 0.0001).

Regarding the distribution of gingivitis among the study sample, 48.5% of the participants presented with mild gingivitis, 26.9% presented with moderate gingivitis, and 8.2% presented with severe gingivitis while 16.4% of the participants had normal gingiva with no sign of gingivitis with a statistically significant difference between them (P -value < 0.0001).

Regarding oral hygiene, 80.6% of examined patients showed satisfactory oral hygiene, 10.4% had good oral hygiene, and 9% had poor oral hygiene with a statistically significant difference between them (P -value < 0.0001).

Regarding attachment loss, the majority of examined patients demonstrated no attachment loss, while only (2.2%) presented with attachment loss with a statistically significant difference between them (P -value < 0.0001).

B. Analytical data

Regarding the association between labial frenum attachment types and age, there was a statistically significant difference with a P -value < 0.001 where patients with the age range of 13-15 y showed a higher distribution of mucosal and gingival frenal types, while 12 years old children showed a higher distribution of papillary frenal type.

While the association between labial frenum attachment types and gender showed a statistically significant difference with a P -value < 0.001 where males showed a higher prevalence of mucosal type (57%) than females (43%). However, gingival (71%), papillary (100%), and papillary penetrating (100%) frenal types were more common in females.

In terms of the association between labial frenum attachment types and midline diastema, patients with mucosal and gingival frenal types showed no midline diastema in 90% and 71% of patients, respectively with a statistically significant difference (P -value < 0.001), as shown in figure (2).

Concerning the association between frenal type and gingivitis, there was a statistically significant difference with a P -value < 0.001. Patients with mucosal and gingival frenal types showed a higher percentage of mild gingivitis (48%, and 51.6%, respectively), as presented in figure (3).

Regarding the association between labial frenum attachment types and oral hygiene, patients with mucosal, gingival, and papillary frenal types showed a higher percentage of satisfactory oral hygiene with a statistically significant difference (P -value < 0.001), as presented in figure (4). The majority of patients with mucosal, gingival, and papillary frenal types had no attachment loss, as shown in table (1).

Regarding the correlation between oral hygiene and gingivitis, there was a statistically significant correlation with an r -value = - 0.52 and a P -value < 0.001. Patients with poor oral hygiene had severe (58.3%) and moderate (41.7%) gingivitis, while those with satisfactory oral hygiene showed mild (53.3%), moderate (29%), and no gingivitis (14%), with a small percentage of severe gingivitis (3.7%), while patients with good oral hygiene showed only mild or no gingivitis.

The correlation between oral hygiene and clinical attachment loss showed a statistically significant correlation with a P -value < 0.001 where 16.7% of patients with poor oral hygiene showed attachment loss while only 0.9% of patients with satisfactory oral hygiene and no patients with good oral hygiene showed attachment loss.

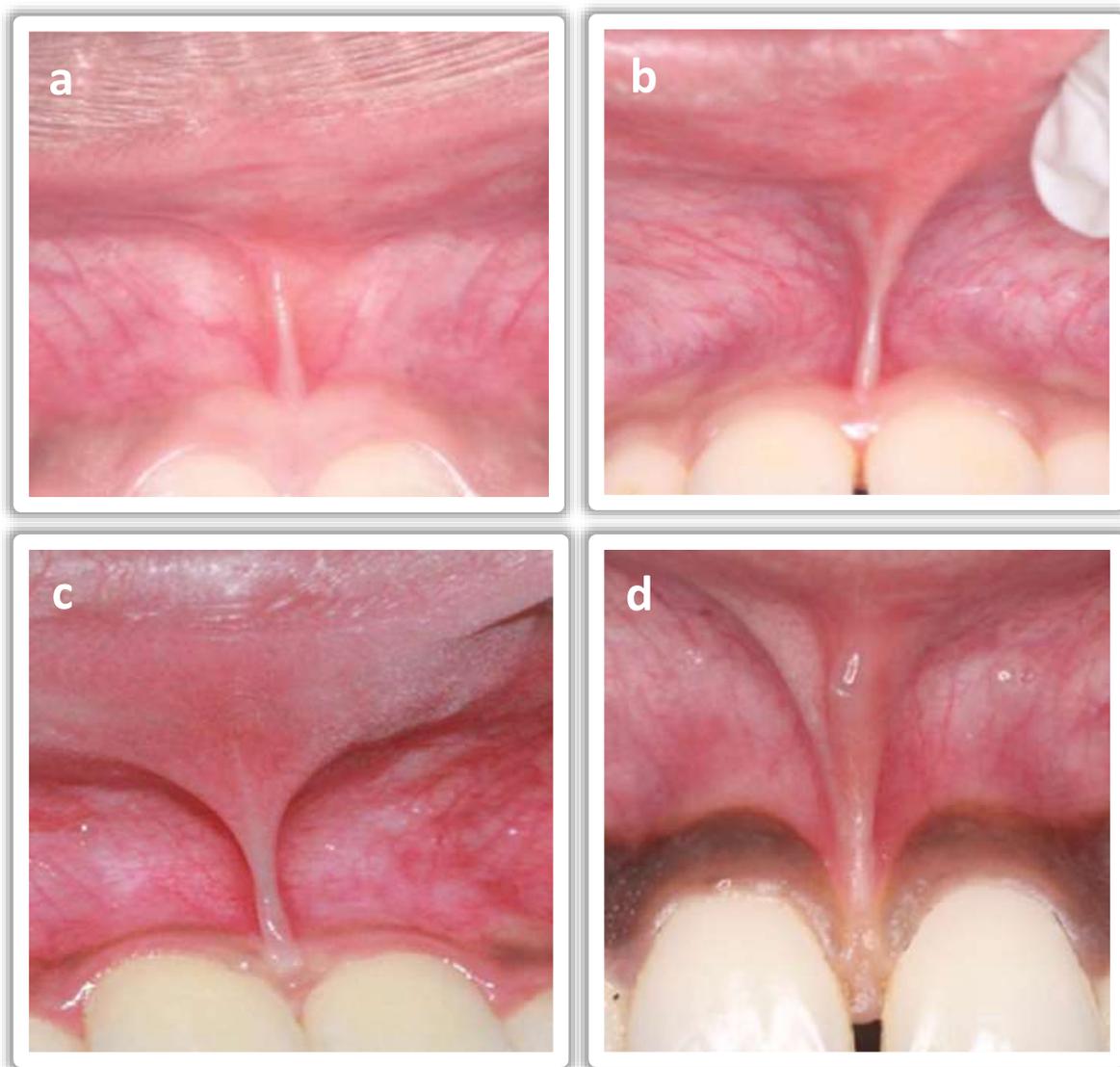


Figure (1): Types of frenal attachment according to Placek's classification
a. Mucosal type **b.** Gingival type **c.** Papillary type **d.** Papillary penetrating type

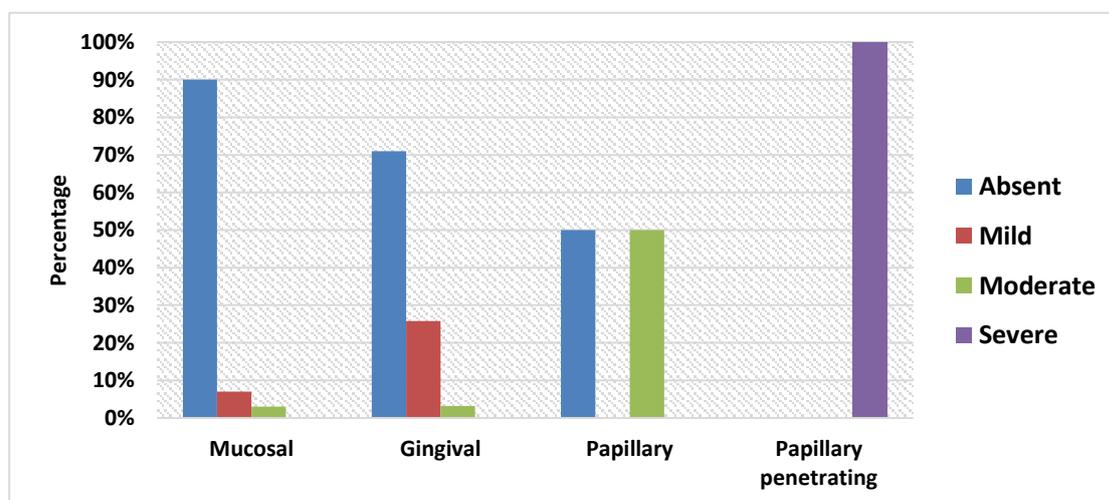


Figure (2): Bar chart showing the association between labial frenum attachment types and midline diastema among the study sample

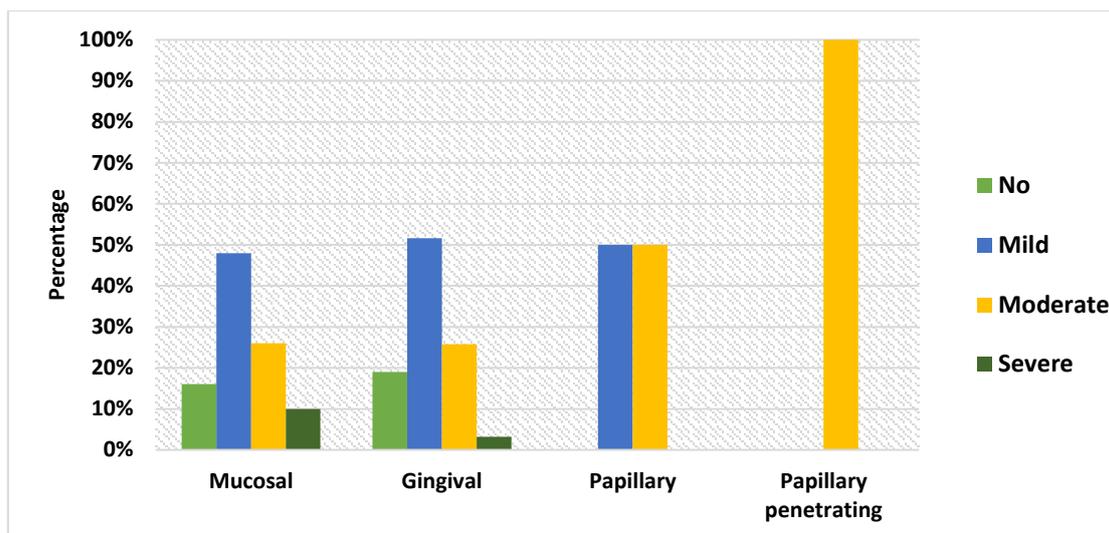


Figure (3): Bar chart showing the association between labial frenum attachment types and gingivitis among the study sample

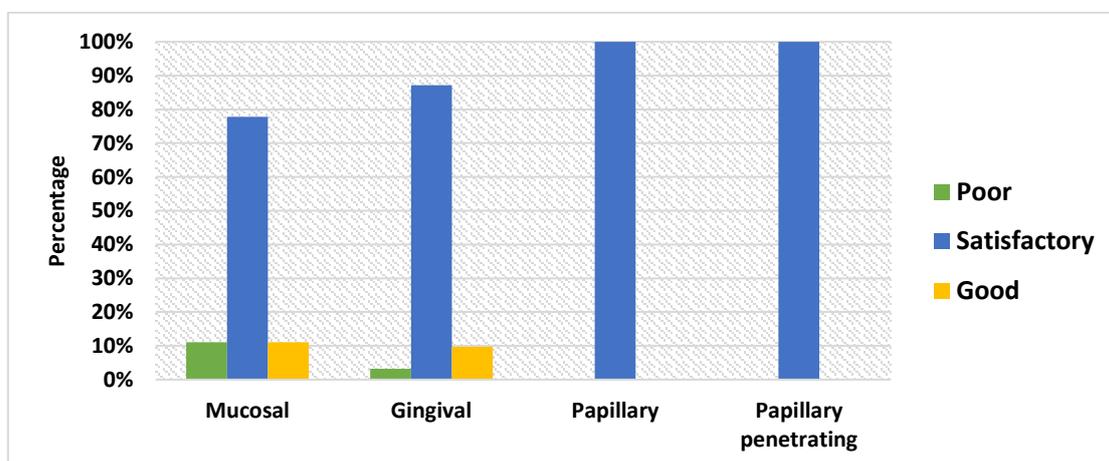


Figure (4): Bar chart showing the association between labial frenum attachment types and oral hygiene among the study sample

Table (2): The association between labial frenum attachment types and clinical attachment loss among the study sample

Clinical attachment loss	labial frenum attachment types							
	Mucosal		Gingival		Papillary		Papillary penetrating	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
No	196	98.0%	60	96.8%	4	100.0%	2	100.0%
Yes	4	2.0%	2	3.2%	0	0.0%	0	0.0%
P-value	< 0.0001*		< 0.0001*		0.008*		0.08	

P: probability level which is statistically significant at $P \leq 0.05$

IV. DISCUSSION:

A maxillary labial frenum is a mucous membrane in the midline of the maxilla that connects the lip with the alveolar process. It is a dynamic structure that is prone to alteration throughout the growth and development of the individual. Any aberrations in the frenum's size and position might act as a local anatomic factor that interferes with effective tooth brushing leading to local plaque accumulation which has been considered detrimental to periodontal health, resulting in loss of interdental papilla and gingival recession (Delli et al., 2013; Thirumagal, Varghese and Jain, 2020; Peeran and Ramalingam, 2021).

Besides, it leads to functional problems involving feeding and speech, and esthetic problems related to midline diastema that necessitates surgical intervention. Therefore, an early diagnosis and treatment of abnormal frenum attachment can prevent the development of future problems and improve treatment prognosis (Divater et al., 2019).

In the current study, the mean and SD of age among the participants was (13.85 ± 1.48) years which was in accordance with Rashid and Khalifa, 2021 and can be attributed to the age of eruption of maxillary permanent canine (Divater et al., 2019). Regarding the gender distribution, 50.7% of participants were females and 49.3% were males which were consistent with Khursheed et al., 2015 and can be attributed to females tend to seek dental treatment more than males (Hamasha et al., 2018; Songur et al., 2019).

Regarding the distribution of frenal attachment types, the mucosal frenal type was the most common attachment type, followed by the gingival, the papillary, and the papillary penetrating types which were in agreement with Jonathan et al., 2018; Rajani, Biswas and Emmatty, 2018; Alwan, 2020 and can be justified by the tendency for the frenal attachment to move to a more apical location from age 9 to 16 years (Divater et al., 2019).

As for midline diastema, it was noticed that midline diastema was found in 15.7% of participants which was in agreement with Ocaña Caluña and Macías Ceballos, 2021; Rashid and Khalifa, 2021. This finding can be justified by the gradual closure of midline diastema after the clinical eruption of the maxillary permanent canine (Liu, Hsu and Chen, 2013).

The majority of examined patients showed satisfactory oral hygiene which was consistent with Raju et al., 2015; Pawlaczyk-Kamińska, Torlińska-Walkowiak and Borysewicz-Lewicka, 2018 and can be explained by the increased sugar intake, and inattention to oral hygiene procedures. Besides, children become more independent and toothbrushing may become less of a priority (American Academy of Pediatric Dentistry, 2020).

Regarding the distribution of gingivitis among the study sample, 48.5% of the participants had mild gingivitis and 26.9% had moderate gingivitis which complied with Folayan et al., 2021 and can be clarified by the elevated levels of circulating sex hormones which affect the gingiva causing gingival inflammation even with the absence of dental plaque (Pari et al., 2014).

The majority of children had no clinical attachment loss which was in agreement with Vadiakas et al., 2012; Margaritis, Mamai-Homata and Koletsi-Kounari, 2016 which can be explained by satisfactory oral hygiene, good dietary habits, and regular dental checkups (Silveira et al., 2019).

The distribution of frenal attachment types according to age showed that mucosal and gingival frenal types were noticed in patients aged between 13-15 y, while 12 years old children had a higher distribution of papillary frenal types. These results conformed with Divater et al., 2019; Zakirulla et al., 2021 and can be related to the tendency of the labial frenum to migrate more apically with aging (Pandiyan and Hedge, 2018).

Regarding the association between the frenal attachment type and gender, the mucosal frenal type was more common in males while the

gingival, papillary, and papillary penetrating frenal types were more common in females. This finding was consistent with Zakirulla et al., 2021 which can be explained by the tendency of females to attend dental clinics regularly and being more critical of esthetics (Nasir and Vu, 2022).

Concerning the association between frenal attachment types and midline diastema, the majority of patients with mucosal and gingival frenal types showed no diastema. On the contrary, about 50% of the patients with papillary frenal type had no or moderate diastema, while all patients with papillary penetrating frenal type showed severe diastema which conformed with Jonathan et al., 2018; Ocaña Caluña and Macías Ceballos, 2021; Yemitan, Adigun and Uti, 2022 and can be attributed to the attachment of labial frenum into a notch in the alveolar bone, leaving a heavy fibrous tissue band between the central incisors which creates a bony cleft separating the two central incisors as they erupt (Yemitan, Adigun and Uti, 2022).

On the contrary, Luqman et al., 2011; Rashid and Khalifa, 2021 reported highly attached frenum as the second most prevalent cause of midline diastema which might be justified by the lateral incisors and canines eruption that hinders spontaneous closure of diastema as a normal pathway of occlusion development, this make it difficult for the highly attached frenum to change its position and migrate nasally with age (Rashid and Khalifa, 2021).

When the frenal type was associated with gingivitis, results showed that patients with papillary penetrating frenal type had the predominance of moderate gingivitis, and half of the patients with papillary frenal type showed mild and moderate gingivitis. These results were consistent with Kokoceva-Ivanovska et al., 2018 and can be linked to the fact that crestal frenal insertion near the incisor's gingival margin, could detach the marginal gingiva or papilla, hence contributing to the development of gingival and periodontal diseases (Zakirulla et al., 2021).

In terms of the association of frenal type with oral hygiene and attachment loss, patients with mucosal, gingival, and papillary frenal types showed a higher percentage of satisfactory oral hygiene with no attachment loss. This finding agrees with Lertpimonchai et al., 2017; Divater et al., 2019 and can be justified by interference with oral hygiene measures, and the accumulation and retention of plaque. Besides, the opened periodontal pocket, made it easier for food particles to enter (Rathod et al., 2020)

In terms of the association between oral hygiene and gingivitis, patients with poor oral hygiene had severe and moderate gingivitis, while those with satisfactory oral hygiene showed mild, moderate, and no gingivitis. These results were in agreement with Pawlaczyk-Kamieńska, Torlińska-Walkowiak and Borysewicz-Lewicka, 2018 and can be linked to the amount of bacterial plaque accumulated on the tooth surface which initiates the inflammatory process in the gingiva that increases the likelihood of gingivitis (Pawlaczyk-Kamieńska, Torlińska-Walkowiak and Borysewicz-Lewicka, 2018).

Our results showed that the majority of patients with poor oral hygiene had more clinical attachment loss than patients with satisfactory or good oral hygiene. This finding was in line with Lertpimonchai et al., 2017 and can be explained by the fact that oral hygiene is the primary prevention method to control dental biofilm that is the leading factor in periodontal destruction and attachment loss (Zimmermann et al., 2015).

V. CONCLUSIONS

- Among children aged between 12-18 years, the mucosal type of frenal attachment was the most predominant frenal type, followed by the gingival type while the papillary and papillary penetrating types were significantly the lowest.
- Concerning the midline diastema, 15.7% of the participants presented with a midline diastema.

- Patients with mucosal and gingival frenal types showed no midline diastema in 90% and 71% of patients, respectively with a statistically significant difference.
- Oral hygiene was strongly correlated with gingivitis and clinical attachment loss, regardless of the maxillary labial frenum attachment types.

VI. CONFLICT OF INTEREST

The authors don't have any stated conflicts of interest.

VII. SOURCE OF FUNDING

There was no funding supplied by any public, private, or nonprofit organizations for this study.

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