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THE PREVALENCE OF VARIATIONS IN ATTACHMENT AND MORPHOLOGY OF MAXILLARY LABIAL FRENUM ON A SAMPLE OF ADULT EGYPTIAN POPULATION: A CROSS-SECTIONAL STUDY

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ABSTRACT

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Background: This cross-sectional study aimed at determining the prevalence of the various types of Maxillary Labial Frenum (MLF) attachment and morphology in a sample of adult Egyptian Patients.

Methods: 384 subjects, both males and females aged > 18 years attended the Diagnostic Center at the Faculty of Dentistry, Cairo University. After obtaining a written informed consent, clinical evaluation of the MLF attachment and morphology was performed. The frenum was examined visually, classified and described for MLF attachment and morphology. Periodontal parameters as papilla presence, gingival recession, midline diastema, width of keratinized gingiva, plaque index, and bleeding on probing were further evaluated.

Results: The prevalence of MLF gingival attachment was the most common (79.4%), followed by mucosal type (11.5%), and papillary penetrating type (7%), while the least prevalent was the papillary type (2.1%). Two-thirds of participants (68%) had simple frenum morphology, (12.8%) had simple frenum with appendix, and (11.5%) had simple frenum with nodules. New variant or multiple frenum, double frenum as well and persistent tectolabial were (7%) for each morphology. Bifid frenum was (1.3%) and the least prevalent was frenum with one or more variation (1%).

Conclusions: Gingival frenum attachment existed with the highest percentage, while the simple frenum was the most common form. A significant association was found between the papillary penetration frenum type and both maxillary diastema and width of the keratinized gingiva. This implies a careful assessment of the MLF during routine dental examinations.

KEYWORDS: Maxillary Labial Frenum, Frenum Attachment, Frenum Morphology.

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INTRODUCTION

The periodontium is composed of four main components, gingiva, alveolar mucosa, cementum, and periodontal ligament supporting the teeth in their alveolar bone sockets. Typically, the oral mucosa is seen during clinical inspection where the alveolar mucosa between the two maxillary incisors is connected to the upper lip by a mucous fold known as the maxillary labial frenum (MLF)^[1,2].

The MLF is a normal anatomical structure of the oral cavity. It is defined as a fold of collagenous fibrous tissue with the basic function to stabilize the upper lip and maintain a harmonious lipmaxilla relationship. It was observed that the MLF could exist at different attachment sites on the alveolar mucosa with a variety of morphological characteristics ^{[3].}

Although no uniform assessment has been established for the MLF, yet some general factors as the type of insertion, width of the frenulum, mechanical action on the gingival margin, and difficulty in performing dental care procedures have all been considered criteria for distinguishing a normal frenulum from a defective one. Moreover, several types of frenum were considered abnormal when no zone of attached gingiva existed along the midline, or if the interdental papilla (IDP) shifted with the extended frenum^[4].

An understanding of the anatomy of the oral cavity and its variations is essential for clinicians. As part of routine clinical practice, it is imperative to conduct comprehensive clinical examinations and carefully evaluate the frenum position. In this way, we can potentially reduce the risk of periodontal disease associated with high frenal attachments ^[5]. Accordingly several classifications were available in the literature but the most commonly used was that introduced by Placek et al. ^[6] for frenal attachments dividing them into mucosal, gingival, papillary and papillary penetrating. While Sewerin ^[7] introduced a classification based on the different morphologies of the frenum.

Population-based data are important for understanding the distribution of different MLF attachments, their morphology, and associated complications that affect the periodontium ^[8]. Therefore, this cross-sectional study was conducted to determine the prevalence of various types of MLF attachment and morphology among adult Egyptian outpatients attending the Diagnostic Center at the Faculty of Dentistry, Cairo University.

MATERIALS AND METHODS:

Ethical review:

This cross-sectional study was approved by the Ethics Committee of Scientific Research, Faculty of Dentistry, Cairo University [Approval NO. 10-3-22]. The detailed steps and aim of the study were clearly described to all subjects participating in this study who signed a written consent and fully agreed to participate in this work. This cross-sectional study was registered in U.S. National Institutes of Health Clinical Trials Registry (https://www.clini-caltrials.gov/) with Identifier ID: (NCT05593705 || 30-10-2022).

Study design and settings:

The present cross-sectional study included 384 individuals (132 males and 252 females aged above 18 years). Recruitment of subjects was done from the Diagnostic Center at the Faculty of Dentistry, Cairo University between April 2022 to March 2023 meeting the following eligibility criteria: 1) Adult Egyptian patients above 18 years old; 2) Patient consulting in the outpatient clinic; 3) Patients who agreed to provide an informed consent. Exclusion criteria included: 1) Patients with orofacial anomalies^[9]; 2) History of trauma in the maxillary region^[10]; 3) History of orthognathic or frenal surgery ^[11]; 4) Missing one or both central incisors^[9]; 5) Patients who used any medication known to affect the gingiva as phenytoin ^[12]; 6) Syndromes associated with different frenal attachments [13] such as: Ehlers-Danlos syndrome, Infantile hypertrophic pyloric stenosis, Holoprosencephaly, Ellis-van Creveld syndrome, Oro-facial-digital syndrome.

Power and sample size calculation:

The power analysis for this study used the prevalence of variations in attachment of the MLF as the primary outcome. Based on the results of Rathod et al.^[14], the prevalence of gingival frenal attachment was 49,9%. Using an alpha (α) level of (5%), an acceptable margin of error of 5%, and an estimated total number of patients attending the Diagnostic Center at the Faculty of Dentistry (223200) patients per year; the minimum estimated sample size was 384 subjects. Calculation of sample size was performed using Epi Info 7.2.2.2.

Addressing potential sources of bias:

Non-respondent bias:

Patients who refused to participate were considered non-respondent in this study. However, they were asked about the cause of their refusal and received an explanation of their value to the study, even if they did not complain of any oral lesions.

Selection bias:

The participants were recruited in this observational cross-sectional study through a consecutive sequence of entry to the Diagnostic Center to avoid selection bias.

Study participants and data collection:

After explaining the aim of the study to the patients, their acceptance of participating in the survey was received. Demographic data were collected using a questionnaire that collected sociodemographic and medical information. These covariates included questions concerning, the patient gender, the patient age, personal information about the patient occupation and address, in addition to any habits such as nail biting, chewing pencils and pen, smoking frequency, duration of onset and type of smoking. The medical history of any chronic systemic diseases such as diabetes, hypertension, renal disease, and asthma were also collected.

Clinical and periodontal parameters:

The variations in MLF attachment were diagnosed on the basis of a proper history and clinical examination. Clinical examination was performed, and patients were examined in a supine position using direct visual method on the dental unit. Under adequate light, the upper lip was gently lifted with the index finger and thumbs of both hands. The attachment site of the frenum was examined through direct visual examination. Clinical examinations included the assessment of MLF attachment as the primary outcome. In addition to other secondary clinical outcomes as morphology of the MLF, papilla presence index (PPI), gingival recession (RD), presence of maxillary midline diastema (MMD), width of keratinized gingiva (WKG), plaque index (PI), and bleeding on probing (BOP).

The MLF attachment was examined by gently stretching the lip away from the alveolar process almost horizontally^[15] and the clinical classification of MLF insertion by Placek et al.^[6] (Fig.1) was used for identifying four types of frenum attachment which were defined as follows:

- Mucosal frenum attachment: the frenum is inserted up to and including the mucogingival junction (MGJ) with no evidence of crossing into the attached gingiva.
- Gingival frenum attachment: the frenum is inserted into the attached gingiva and not extending coronal to the line demarcating the base of the midline papilla.
- 3. The papillary frenum attachment: the frenum is inserted coronal to the line demarcating the base of the midline papilla without any visible evidence of frenum extension to the palatal aspect or blanching anywhere on the palatal

aspect of the midline papilla or incisive papilla, even when further tension was applied to the frenum.

4. Papillary penetration frenum attachment: the frenum insertion is coronal to the line demarcating the base of the midline papilla combined with visible evidence of frenum extension to the palatal aspect or blanching anywhere on the palatal aspect of the midline papilla or on the incisive papilla when further tension is applied to the frenum.

According to Sewerin ^[7] (Fig.2), the frenum variations in morphology were classified into eight different types as:

- 1. Simple frenum.
- 2. Simple frenum with appendix.
- 3. Simple with nodule
- 4. Persistent tectolabial

- 5. Double frenum.
- 6. Bifid frenum.
- 7. Frenum with nichum.
- 8. Frenum with one or more variation.

Also, another variant not included in Sewerin classification was found in 7 participants which is the triple frenum.

Periodontal parameters

Clinical periodontal parameters were measured for all participants and included Papilla Presence Index (PPI), where the positional relationship of the IDP, cementoenamel junction (CEJ) and adjacent teeth were assessed according to Cardaropoli et al. ^[16]. PPI 1 when the papilla was completely present and coronally extended to the contact point to completely fill the interproximal embrasure, PPI 2 when the papilla was not completely present, lay apical to the contact point and the embrasure



Fig. (1) Types of MLF attachments (1a) Mucosal type, (1b) Gingival type, (1c) Papillary type, (1d) Papilla penetrating type.

no longer completely filled. Both scores could be complicated by the presence of buccal gingival recession and classified as PPI 1r and PPI 2r. PPI 3 in which the papilla was moved more apical and the interproximal CEJ became visible while in PPI 4 the papilla lies apical to both the interproximal CEJ and buccal CEJ and patient aesthetics are significantly compromised. The gingival recession depth was assessed on both labial and interproximal sites of the two maxillary central incisors using (UNC-15) periodontal probe ^[17]. The presence or absence of midline diastema was examined to assess the presence of diastema with different MLF attachment types and morphology. Visual examination was used to evaluate the continuity of the tissue fibers of the MLF through diastema to the palatine papilla. This test was performed by lifting the upper lip upward and forward until the frenum was tightly stretched. If the procedure produced a blanching or change in contour in this area, the frenum was considered abnormal^[18].

The width of keratinized gingiva was measured from the gingival margin to the MGJ at the midbuccal aspect of the related tooth using the (UNC-15) periodontal probe. The four central incisors teeth were dried with a blast of air, and the presence of visible dental plaque and supragingival calculus was recorded ^[19]. Gingival bleeding was also assessed via gentle probing of the gingival crevice orifice of the two upper central incisors using (UNC-15) periodontal probe ^[20].



Statistical Analysis

Qualitative data were presented as frequencies and percentages. Quantitative data were presented as mean, standard deviation (SD), 95% Confidence Interval (95% CI) for the mean value, median and range values. Chi-square test or Fisher's Exact test were used for comparisons regarding qualitative variables. Quantitative data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Age data showed normal distribution while KTW and PI data showed non-parametric distribution. For parametric data; one-way ANOVA test followed by Bonferroni's post-hoc test was used to compare between groups. For non-parametric data; Kruskal-Wallis test followed by Dunn's test was used to compare between groups. The significance level was set at $P \le 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

RESULTS

The mean (\pm SD) age values in the tested population (n=384) were 35.3 (\pm 10.8) years with a minimum of 18 and a maximum of 67 years old. While the gender distribution included 132 (34.4%) males and 252 (65.6%) females. The medical history among 384 participants, 340 (88.5%) were medically-free, while diabetes was the most common disease (5.7%) followed by hypertension (1.8%). (21.1%) of the participants were smokers, moreover 66 (17.2%) had bruxism. Descriptive statistics for KTW and PI scores showed a mean (\pm SD) for KTW among the study population of 6.4 (\pm 1.6) mm with a median (range) 6 (3-11) mm. While the mean (\pm SD) PI scores were 2.1 (\pm 0.9) with a median (range) of 2 (0-3).

The MLF attachment type and morphology are represented in **Table** (1). Most participants had gingival type (79.4%) followed by mucosal type (11.5%) then papillary penetrating type (7%), while the least prevalent was papillary type (2.1%). However, about two-thirds of participants (68%) had simple frenum, (12.8%) had simple frenum with appendix, (11.5%) had simple frenum with nodule. New variant (triple frenum), double frenum as well as persistent tectolabial frenum morphologies were observed in (7%) of participants for each morphology, respectively. Bifid frenum was observed in (1.3%) of participants while the least prevalent morphology was frenum with one or more variation (1%).

Clinical periodontal parameters

The results of the PPI score showed that the most prevalent was Score (2) (PPI 2) in 37.5% of participants followed by Score (1) (PPI 1) in 35.2% then Score (2r) (PPI 2r) in 18.5%. However, score (1r) (PPI 1r) showed lower prevalence (4.2%) followed by Score (4) (PPI 4) in 3.6% of participants. The least prevalent score was Score (3) (PPI 3) in 1% of participants. In sum 101 from a total 384 of study participants had gingival recession with a frequency of (26.3%). The most common type was (RT1) which was found in 87 subjects (86.1%) while (RT3) showed the lowest prevalence (5.9%). Diastema was observed in 68 subjects (17.7%) and BOP was observed in 332 subjects (86.5%) (Table 1).

TABLE (1) Frequencies (n), percentages (%) for MLF attachment type and morphology among the study participants (n = 384).

Frenum attachment and morphology	n (Frequency %)
Frenum attachment type	
Gingival	305 (79.4%)
Mucosal	44 (11.5%)
Papillary penetrating	27 (7%)
Papillary	8 (2.1%)
Frenum morphology	
Simple	261 (68%)
Simple with appendix	49 (12.8%)
Simple with nodule	44 (11.5%)
New variant – Multiple frenum	7 (1.8%)
Double frenum	7 (1.8%)
Persistent tectolabial	7 (1.8%)
Bifid frenum	5 (1.3%)
Frenum with one or more variation	4 (1%)

Frenum attachment and morphology	n (Frequency %)			
Papilla presence index (PPI)				
PPI 1	35.2%			
PPI 1r	4.2%			
PPI 2	37.5%			
PPI 2r	18.5%			
PPI 3	1%			
PPI 4	3.6%			
Gingival recession				
RT1	87 (86.1%)			
RT2	(7.9%)			
RT3	(5.9%)			
Diastema	68 (17.7%)			
Bleeding on Probing (BOP)	332 (86.5%)			

The data analysis of this study found a statistically significant association (*P*-value <0.001, Effect size = 0.227) between MLF attachment types and MLF morphology (Table 2). Regarding the association between MLF attachment type and different variables (Table 3) a statistically significant association was found between PPI and MLF attachment types (*P*-value = 0.040, Effect size = 0.150). As regards gingival recession no statistically significant association was found with MLF attachment type (*P*-value = 0.155, Effect size

= 0.094), in addition to no statistically significant association with BOP (*P*-value = 0.983, Effect size = 0.011). However, a statistically significant association was found between diastema and MLF attachment types (*P*-value <0.001, Effect size = 0.596). also, the correlation between KTW and the MLF attachment type revealed a statistically significant association (*P*-value <0.001, Effect size = 0.115). However, pair-wise comparisons revealed no statistically significant difference between gingival, mucosal and papillary types; all showed statistically significantly higher KTW than papillary penetrating type.

The association between frenum morphology and other variables (Table 4) showed no statistically significant association with all variables except for PPI (*P*-value <0.001, Effect size = 0.169). PPI 1 was associated with double frenum (71.4%), PPI 1r was associated with simple frenum with nodule (11.4%), PPI 2 was associated with frenum with one or more variation (100%), while PPI 2r was associated with bifid frenum (40%). As for PPI 3, it was associated with two morphologies; new variant multiple frenum (14.3%), and persistent tectolabial frenum (14.3%) and PPI 4 was associated with tectolabial frenum (14.3%).

TABLE (2) Descriptive statistics and results of Fisher's Exact test for comparison between frenum morphologies in patients with different frenum attachment types.

MLF morphology	Gingival (n = 305)	Mucosal (n = 44)	Papillary (n = 8)	Papillary penetrating (n = 27)	<i>P</i> -value	Effect size (v)
	n (%)	n (%)	n (%)	n (%)	-	
Simple	223 (73.1%)	23 (52.3%)	2.3%) 3 (37.5%) 12 (44.4%)		<0.001*	0.227
Simple with appendix	35 (11.5%)	8 (18.2%)	1 (12.5%)	5 (18.5%)		
Simple with nodule	30 (9.8%)	8 (18.2%)	2 (25%)	4 (14.8%)		
New variant – Multiple frenum	5 (1.6%)	2 (4.5%)	0(0%)	0 (0%)		
Double frenum	4 (1.3%)	2 (4.5%)	0(0%)	1 (3.7%)		
Persistent tectolabial	3 (1%)	0 (0%)	2 (25%)	2 (7.4%)		
Bifid frenum	3 (1%)	0 (0%)	0(0%)	2 (7.4%)		
Frenum with one or more variation	2 (0.7%)	1 (2.3%)	0(0%)	1 (3.7%)		

	Gingival (n = 305)	Mucosal (n = 44)	Papillary (n = 8)	Papillary penetrating (n = 27)	<i>P</i> -value	Effect size (v)	
	n (%)	n (%)	n (%)	n (%)			
Female	204 (81%)	24 (9.5%)	5 (2%)	19 (7.5%)	0.405	0.087	
Male	101 (76.5%)	20 (15.2%)	3 (2.3%)	8 (6.1%)			
Bruxism	49 (16.1%)	12 (27.3%)	1 (12.5%)	4 (14.8%)	0.294	0.097	
No bruxism	256 (83.9%)	32 (72.7%)	7 (87.5%)	23 (85.2%)			
Smoking	62 (20.3%)	12 (27.3%)	1 (12.5%)	6 (22.2%)	0.684	0.062	
No smoking	243 (79.7%)	32 (72.7%)	7 (87.5%)	21 (77.8%)			
PPI 1	119 (39%)	12 (27.3%)	0 (0%)	4 (14.8%)	0.040*	0.150	
PPI 1r	11 (3.6%)	4 (9.1%)	1 (12.5%)	0 (0%)			
PPI 2	111 (36.4%)	14 (31.8%)	6 (75%)	13 (48.1%)			
PPI 2r	52 (17%)	11 (25%)	1 (12,5%)	7 (25.9%)			
PPI 3	3 (1%)	1 (2.3%)	0 (0%)	0 (0%)			
PPI 4	9 (3%)	2 (4.5%)	0 (0%)	3 (11.1%)			
No recession	233 (76.4%)	27 61.4%)	6 (75%)	17 (63%)	0.155	0.094	
RT1	63 (20.7%)	15 (34.1%)	2 (25%)	7 (25.9%)			
RT2	5 (1.6%)	1 (2.3%)	0 (0%)	2 (7.4%)			
RT3	4 (1.3%)	1 (2.3%)	0 (0%)	1 (3.7%)			
Diastema	33 (10.8%)	6 (13.6%)	2 (25%)	27 (100%)	<0.001*	0.596	
No diastema	272 (89.2%)	38 (86.4%)	6 (75%)	0 (0%)			
BOP	264 (86.6%)	38 (86.4%)	7 (87.5%)	23 (85.2%)	0.983	0.011	
No BOP	41 (13.4%)	6 (13.6%)	1 (12.5%)	4 (14.8%)			

TABLE (3) Association between MLF attachment types and gender, bruxism, smoking, PPI, GR, Diastema and BOP.

	Simp Simple wit apper		Simple Simple New variant le with with – Multiple frenur appendix nodule frenum		Double frenum	Persistent Bifid tectolabial frenum		Frenum with 1 or more variation	<i>P</i> -	Effect size
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n n (%) (%)		value	(v)
Female	173 (68.7%)	30 (11.9%)	32 (12.7%)	5 (2%)	4 (1.6%)	3 (1.2%)	2 (0.8%)	3 (1.2%)	0.640	0.114
Male	88 (66.7%)	19 (14.4%)	12 (9.1%)	2 (1.5%)	3 (2.3%)	4 (3%)	3 (2.3%)	1 (0.8%)		
Bruxism	48 (72.7%)	6 (9.1%)	9 (13.6%)	1 (1.5%)	1 (1.5%)	1 (1.5%)	0 (0%)	0 (0%)	0.958	0.094
No bruxism	213 (67%)	43 (13.5%)	35 (11%)	6 (1.9%)	6 (1.9%)	6 (1.9%)	5 (1.6%)	4 (1.3%)		
Smoking	51 (63%)	14 (17.3%)	8 (9.9%)	1 (1.2%)	4 (4.9%)	1 (1.2%)	1 (1.2%)	1 (1.2%)	0.302	0.146
No smoking	210 (69.3%)	35 (11.6%)	36 (11.9%)	6 (2%)	3 (1%)	6 (2%)	4 (1.3%)	3 (1%)		
PPI 1	91 (34.9%)	16 (32.7%)	16 (36.4%)	4 (57.1%)	5 (71.4%)	1 (14.3%)	2 (40%)	0 (0%)	<0.001*	0.169
PPI 1r	8 (3.1%)	3 (6.1%)	5 (11.4%)	0 (0%)	0 (0%))	0 (0%)	0 (0%)	0 (0%)		
PPI 2	101 (38.7%)	18 (36.7%)	13 (29.5%)	2 (28.6%)	1 (14.3%)	4 (57.1%)	1 (20%)	4 (100%)		
PPI 2r	48 (18.4%)	11 (22.4%)	9 (20.5%)	0 (0%)	1 (14.3%)	0 (0%)	2 (40%)	0 (0%)		
PPI 3	2 (0.8%)	0 (0%)	0 (0%)	1 (14.3%)	0 (0%)	1 (14.3%)	0 (0%)	0 (0%)		
PPI 4	11 (4.2%)	1 (2%)	1 (2.3%)	0 (0%)	0 (0%)	1 (14.3%)	0 (0%)	0 (0%)		
No recession	194 (74.3%)	34 (96.4%)	29 (65.9%)	7 (100%)	6 (85.7%)	6 (85.7%)	3 (60%)	4 (100%)	0.515	0.125
RT1	56 (21.5%)	14 (28.6%)	14 (31.8%)	0 (0%)	1 (14.3%)	0 (0%)	2 (40%)	0 (0%)		
RT2	7 (2.7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (14.3%)	0 (0%)	0 (0%)		
RT3	4 (1.5%)	1 (2%)	1 (2.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)		
Diastema	43 (63.2%)	7 (10.3%)	9 (13.2%)	1 (1.5%)	1 (1.5%)	4 (5.9%)	2 (2.9%)	1 (1.5%)	0.152	0.164
No diastema	218 (69%)	42 (13.3%)	35 (11.1%)	6 (1.9%)	6 (1.9%)	3 (0.9%)	3 (0.9%)	3 (0.9%)		
BOP	232 (69.9%)	44 (13.3%)	31 (9.3%)	6 (1.8%)	6 (1.8%)	5 (1.5%)	5 (1.5%)	3 (0.9%)	0.091	0.175
No BOP	29 (55.8%)	5 (9.6%)	13 (25%)	1 (1.9%)	1 (1.9%)	2 (3.8%)	0 (0%)	1 (1.9%)		

TABLE (4) Association between MLF morphology and gender, bruxism, smoking, PPI, GR, Diastema and BOP.

*: Significant at $P \le 0.05$

DISCUSSION

The MLF is a structure that connects the alveolar mucosa to the upper lip and could be inserted into the alveolar mucosa, gingiva, and underlying periosteum at different insertion sites in the anterior maxilla, between the two central incisors [21]. Understanding the role of the MLF for the gingival health is important since it is considered a local environmental factor that may harm gingival health. Abnormal MLF attachment may cause several problems that contribute to periodontal tissue health, including diastema, loss of papilla, gingival recession, and distension of the gingival sulcus. These abnormalities may in turn promote plaque accumulation and increase the severity of periodontal pockets via creating difficulty in brushing. Also, abnormal frenal attachment may lead to irregular alignment of teeth, and psychological problems^[22].

Knowledge of the different attachments and morphologies of MLF observed in routine dental practice enables clinicians to differentiate between pathological and normal conditions to avoid unnecessary treatment. Furthermore, it has been reported in the literature that comprehensive clinical oral examination, including MLF, is valuable in determining the presence of an abnormal frenum as a characteristic of various syndromes. These syndromes may be associated with the absence or sometimes hyperplasia of the MLF^[23]. Thus, the current prevalence survey was conducted on 384 adult Egyptian patients aged above 18 years, with a gender distribution of 252 (65.6%) female and 132 (34.4%) males to determine the prevalence of different levels of attachment and morphological variations in the MLF among both genders and in different age groups.

Regarding the MLF attachment type, according to Placek et al. ^[6] classification, the present study demonstrated that the gingival type of frenal attachment was the most prevalent, with a frequency of (79.4%), followed by the mucosal attachment type (11%) which agrees with KILINÇ et al. ^[24] who observed a higher rate of gingival MLF, but doesn't agree with Patel et al. ^[25] who found a higher prevalence of mucosal type (56.9%), followed by gingival type (23.7%), while the papillary penetrating attachment type had frequency (7%) and the least prevalent was the papillary type (2.1%).

Numerous cross-sectional studies were conducted on the morphology of the MLF and revealed diversity in the patterns of morphological variations in this structure. According to Sewerin's classification [7] data analysis showed that the simple frenum type was predominant representing twothirds of the participants (68%) which coincides with the observations of Jindal et al.^[26]. While the least prevalent morphology was the frenum with one or more variations (1%). Nevertheless, in the current study, frenum with a nichum was absent and did not exist in the studied population. This can be explained by the fact this type of frenum morphology is considered rare and usually associated with developmental anomalies of the jaws or facial region while the subjects studied in this survey included healthy individuals ^[7, 27].

Interestingly, the present survey revealed a new variant of frenum morphology which was presented as a triple simple frenum and was observed in (7%) of the participants. Although this variant was not included in the Sewerin classification, yet this type was mentioned by Mohan et al.^[28] who proposed a classification for MLF based on morphology. This finding confirms that MLF is a highly variant anatomical structure present with different morphologies among different populations where other frenal morphologies could not be documented within Sewerin classification explaining why some studies expressed this anatomical structure via different classifications.

In this observational study, the correlation between frenum attachment type and frenum morphology was evaluated and revealed a statistically significant association. Meanwhile, and the frenum comprehensive review of the relevant literature not possible to failed to identify any prior investigations pertaining to the potential relationship between the various MLF attachments and their associated morphological characteristics. MLF tends to shift apically to reach the alveolar mucosa as the jaw grows with age ^[21]. However, similar to Dahal et al. ^[29], the present study did not clearly demonstrate this concept since no statistically significant association between the mean age values of patients with different frenum types and morphology were detected.

study did not clearly demonstrate this concept since no statistically significant association between the mean age values of patients with different frenum attachment types and morphology were detected. In contrast, the findings by Rathod et al.^[14] and Rijal et al.^[5] were different and this variation can be interpreted by the fact that the result of this study were obtained from a relatively small sample size, particularly among adult subjects in contrary to previous studies conducted among different age groups. Although no association was found between MLF attachment type, morphology, and gender yet, the gingival attachment type was found to be more prevalent among females (81%), while the mucosal type was the major type in males (15.2%) which are supported by various studies [25, 29, 30]. On the other hand, different findings were presented by Khursheed et al. [31], who showed an association between MLF attachment and gender.

The statically significant association in this study between the frenum attachment and diastema presence showed the highest prevalence of diastema (100%) with papillary penetrating type, these findings were supported by a recent systematic review ^[32] which documented that the midline diastema was associated with two types of frenum, papillary and papillary penetrating. However, no significant association was found between the midline diastema and frenum morphology.

In some cases, MLF may attach directly to the IDP, potentially affecting its size, shape, and health [34]. This study observed a significant association of the IDP present between the two central incisors

and the frenum attachment level, however, it was not possible to compare this correlation to other studies since no study in the literature was found to explore the potential relationship between MLF and IDP health. Moreover, gingival recession is another variable that was related to frenal type, because the unesthetic root exposure caused by abnormal frenum types must be eliminated as early as possible to prevent further progression [35]. Although gingival recession was observed in (26.3%) of subjects in this study, yet the type of gingival recession was not significantly associated with neither the type of maxillary frenum attachment nor its morphology. This is opposed by Vandana^[36] who observed the maximum gingival recession with the maxillary labial gingival type.

It is well documented that the frenulum is abnormal if it is unusually broad leaving no or little attached gingiva in the midline, and if the IDP can be stretched ^[34]. In the present study findings, the mean KTW was (6.4) and the analyzed data showed a statistically significant association between KTW and frenum attachment types. The gingival, mucosal, and papillary types all showed statistically significantly higher KTW than the papillary penetrating type. However, this study did not find a correlation between KTW and frenum morphology. Also, no statistically significant association was estimated between frenal attachment types, morphology, and BOP in this survey, which is consistent with Addy et al.^[39]. A recent review ^[41] demonstrated that the attachment height of the frenum in the upper arch was apparently not associated with greater plaque accumulation or gingival inflammation when this factor was considered alone. These findings validate the observations of the current study in which no statistically significant association was observed between plaque index scores and frenum attachment type or morphology.

This observational cross-sectional study covered different important points regarding the frenum

attachment and morphology and correlated them to different variables, yet some limitations were faced. One of these limitations is the narrow age group of the patients studied (age > 18 years), that was not able to represent the whole population. MLF exhibit changes in size, configuration, and location throughout different stages of development; thus, multiple age groups should be included to observe these differences. Also, a small sample size may not accurately represent a wider population. Therefore, a larger sample size, including siblings or twins, is required to evaluate the genetic and racial variations in the morphology and attachment site of the labial frenum. In addition, the lack of standardized tools may result in different studies using different criteria or tools for assessing frenum characteristics, making comparisons difficult, and subjective assessment with visual assessment of frenum morphology and attachment may be subjective and prone to variations between examiners. Moreover, poor oral hygiene can mask the true frenum characteristics and its potential impacts besides the difference in effect between maxillary versus mandibular high frenal attachment over periodontal health.

CONCLUSIONS

Within the limitations of this study, it could be concluded that:

- Among adults, the majority of frenal attachments are the gingival type, while the least common type is papillary attachment.
- The simple frenum has the highest frequency in MLF morphology and the least prevalent is the frenum with one or more variations. A new frenum morphology (triple simple frenum) was observed which indicated high diversity in frenum morphology among the different populations.
- The highest prevalence of midline diastema are in patients with papillary penetration frenum type, and the significant association observed

with KTW as the gingival, mucosal, and papillary types showed higher KTW than the papillary penetrating type.

- No definitive research established a correlation between MLF attachment or morphology and the interdental papilla presence between the two centrals incisors.
- The association between the abnormal frenal attachment and morphology can be detected in the mandible more than the maxilla and maybe related to the narrow zone of keratinized gingiva in the mandible.

RECOMMENDATIONS

- Further studies considering a diverse and larger sample of both children and adults are needed to explore the potential differences between developing and mature dentition, since the frenum characteristics can change over time.
- Expanded research to investigate the potential relation between MLF attachment and morphology with other anatomic structures that may have an impact the periodontal health such as gingiva biotype and vestibule depth would be beneficial.
- Further investigations are needed to address other undocumented MLF morphologies and introduce a more comprehensive classification, using standardized methods to assess frenum attachment and morphology such as calibrated instruments.
- Further research is necessary to investigate the prevalence of mandibular labial frenum attachment and morphology and its impact on the periodontal health.

List of abbreviations:

BOP: Bleeding on probing CI: Confidence Interval

(1429)

IDP: Interdental papilla ILS: Incisivus labii superioris KG: Keratinized gingiva KGW: Keratinized gingival width KTW: Keratinized tissue width MGJ: Mucogingival junction MLF: Maxillary labial frenum MMD: Maxillary midline diastema **OO:** Orbicularis oris PD: Probing depth PDL: Periodontal ligament PI: Plaque index PPI: Papilla presence index **RD:** Recession depth **RT:** Recession type SD: Standard deviation UNC 15: University of North Carolina-15 probe WKG: Width of keratinized gingiva

Declarations

Human Ethics and Consent to Participate declarations:

Approval for the study design was provided by the Research Ethics Committee at Cairo University, Egypt (CREC) on 29 March 2022 (Approval number: 10-3-22). The study was implemented following the ethical principles stated in the World Medical Association Declaration of Helsinki. Accordingly, informed consent to participate was obtained from all the participants in the study before the trial commenced.

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- 2. Measuring and recording the outcomes of the study
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