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Types of the maxillary labial frenulum and median diastema in children: A cross-sectional study

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MAIN POINTS

- The most common frenulum type was found to be gingival frenulum, while the least common was papillary penetrating frenulum.
- There is a relationship between frenulum type and diastema.
- Papillary penetrating frenulum can cause median diastema.

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ABSTRACT

Aim: The aim of this study is to determine the frequency of different types of maxillary labial frenulum in children aged 4-13 years and whether they have an effect on median diastema.

Materials and Methods: This study is a cross-sectional study conducted on 723 children aged 4-13 years who applied to the Department of Pedodontics, Faculty of Dentistry, Inonu University for examination. The examination of the children participating in the study was performed by sitting them upright under normal light. The patient's frenulum type was determined by performing the blanch test. The diastema between the maxillary central teeth was measured with an orthodontic caliper and was recorded.

Results: The data were analyzed descriptively and analytically. 343 boys and 380 girls were examined in this study. The most common maxillary labial frenulum type in the examined children was found to be the gingival frenulum type (57%), and the least common maxillary labial frenulum type was the papillary penetrating frenulum type (2%). When we looked at the amount of diastema in our study, the median diastema was mostly between 0-2 mm in the primary dentition, while the median diastema was mostly not seen in the mixed and permanent dentition.

Conclusion: As a result, it was seen that there was a significant relationship between frenulum type and median diastema, but there was no significant relationship between gender and frenulum type.

Keywords: Median diastema, Maxillary labial frenulum, Children

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INTRODUCTION

The maxillary labial frenulum is a thin strip or fold of mucous tissue extending from the middle of the maxillary gum to the middle of the upper lip. The height and location vary from person to person [1]. During early childhood, it is small, wide, and positioned more cervical, but undergoes subsequent changes with the eruption of the deciduous incisors, development of the maxillary sinus, and increase in the alveolar vertical dimension [2, 3]. Alveolar crest height increases with new bone apposition during deciduous dentition, notwithstanding the consistent positioning of the frenulum. While the upper central incisors commonly erupt with a diastema in the mixed dentition period, the later pressure exerted by the lateral incisors and canines usually diminishes this gap, facilitating closer alignment of the central incisors [1].

The maxillary labial frenulum, despite being associated with multiple complications, most notably causes a median diastema. This diastema presents challenges for orthodontic treatment, potentially leading to relapse. Moreover, it has been shown to contribute to caries in breastfed infants and may impair future oral hygiene effectiveness [4, 5]. Dysfunction of the frenulum can further result in gingival recession, aberrant tooth positioning, papillary loss, and an elevated caries risk due to poor oral hygiene. This condition can also exacerbate periodontal issues and contribute to psychological disturbances [3, 6, 7].

Frenulum are classified according to their anatomical location [4, 5]. In the frenulum 1974, Placek et al. classified the frenulum into four types according to its location: mucosal, gingival, papillary, and papillary penetrating [9]. This classification gained acceptance among periodontists, orthodontists, and pediatric dentists and continues to be utilized [2, 3, 10]. The mucosal and gingival frenulum types are considered within the normal range, whereas the papillary and papillary pene-

trating types are deemed pathological. Notably, pathological frenula are implicated in greater papilla loss, gingival problems, diastema development, and challenges in maintaining interdental hygiene [11].

Existing literature includes several studies on the frequency of maxillary labial frenula in adults, adolescents, and children, employing diverse classification systems. However, the distribution of maxillary frenulum types and their association with median diastema in children specifically within the Malatya region has not been explored. Consequently, this cross-sectional epidemiological study was designed to ascertain the prevalence of different labial frenulum types and their relationship to median diastema in children across various dentition stages living in Malatya province. The study's null hypothesis (H0) posited no association between labial frenulum types and median diastema spacing, while the alternative hypothesis (H1) suggested a relationship between these variables.

MATERIALS AND METHODS

This observational, cross-sectional epidemiological study was conducted at the Pediatric Dentistry Clinic of the Faculty of Dentistry at Inonu University in Malatya, Türkiye. The study received approval from the Clinical Research Ethics Committee of Malatya İnönü University (2024/66), and written informed consent was obtained from the legal guardians of all participating patients. Between May 20, 2024, and October 20, 2024, 723 systemically healthy children aged 4-13 years who presented to the clinic for examination were included.

Children exhibiting orofacial anomalies (including cleft lip and palate), a history of maxillary labial surgery, use of medications causing gingival overgrowth, congenital upper lip and oral muscle deformities, or absence of maxillary central incisors were excluded. Additionally, children with interproximal caries or fillings in the upper central incisors, those with size or shape alterations of the upper central incisors, a history of corrective orthodontic treatment, excessive rotation of the upper central incisors, or the presence of supernumerary teeth (mesiodens), odontomas, or other conditions in the upper central region that could cause diastema were also excluded.

The required sample size was calculated using G Power 3.1.9 software. Based on a prior study by Seraj et al. [12], which reported a low effect size (0.010–0.20) when examining maxillary labial frenulum types and median diastema in 3–6-year-old children, an a priori power analysis with an assumed effect size of 0.20, a type I error rate (α) of 0.05, and a desired power ($1 - \beta$) of 0.99 indicated a minimum sample size of 542. Of the 2,454 patients who visited the pedodontics clinic between May 20 and October 20, 2024, 840 were examined, and 117 were excluded due to not meeting the inclusion criteria, resulting in a final sample of 723 participants. Clinical examinations were performed under unit light by two experienced investigators. Frenulum classification followed Placek et al.'s method [9], involving stretching the upper lip with the index and thumb of both hands. A frenulum attachment above the mucogingival junction was classified as mucosal; attachment in the attached gingiva apical to the papilla base was gingival; attachment coronal to the papilla base but not palatally was papillary; and a frenulum extending palatally into the papilla was papillary penetrating. In cases of median diastema, the spacing was measured in millimeters using an orthodontic caliper. Patient age, gender, and dentition stage were also recorded. Diastema size was categorized as 0 mm (absence), 0-2 mm (normal), and ≥2 mm (pathological) [2].

Statistical analysis

All data were analyzed using IBM SPSS Statistics for Windows, version 22.0 (IBM, Armonk, NY, USA). Descriptive statistics included percentages for gender, age, and frenulum type. The relationships between variables were examined using appropriate statistical tests. The Pearson Chi-square test was used to assess the association between upper lip frenulum type, gender, and dentition period. The Fisher-Freeman-Halton Exact Test was used to analyze the relationship between median diastema and dentition period, as well as frenulum types. The significance level for all analyses was set at $p<0.05$.

RESULTS

A total of 723 children participated in this study, comprising 343 males and 380 females, with an age range of 4 to 13 years (mean age ± standard deviation: 9.4 ± 2.3 years). The prevalence of maxillary labial frenulum types is illustrated in Figure 1. The most frequently observed type was gingival (57%), followed by mucosal (37%), papillary (4%), and papillary penetrating (2%). No statistically significant correlation was found between maxillary frenulum type and sex (p = 0.063) (Table 1).

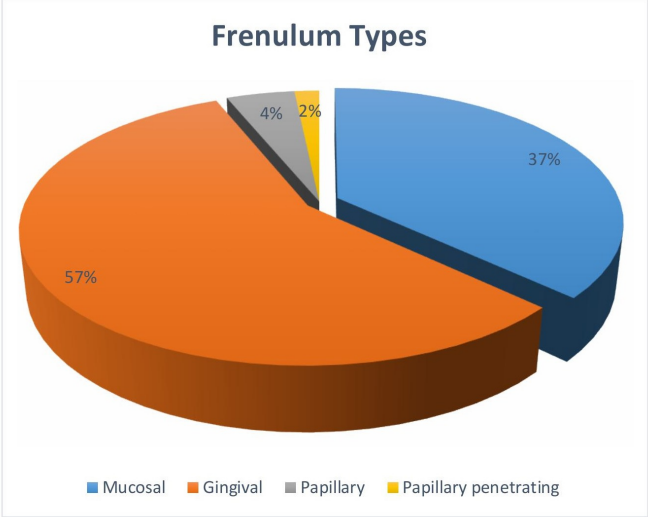

Figure 1. Distribution of maxillary labial frenulum types.

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Table 1. The association between maxillary labial frenulum types and gender.

Gender	Frenulum types					P value
	Mucosal n (%)	Gingival n (%)	Papillary n (%)	Papillary penetrating n (%)	Total n (%)	
Girl	125 (46.8)	226 (55)	22 (66.7)	7 (58.3)	380 (52.6)	0.063
Boy	142 (53.2)	185 (45)	11 (33.3)	5 (41.7)	343 (47.4)	
Total	267 (36.9)	411 (56.8)	33 (4.6)	12 (1.7)	723 (100)	

Pearson Chi square test. Shows statistically significant differences at p<0.05.

Table 2. The association between maxillary labial frenulum types and dentition period.

Frenulum types	Dentition period				P value
	Deciduous dentition n (%)	Mixed dentition n (%)	Permanent dentition n (%)	Total n (%)	
Mucosal	9 (17.6)	159 (33.5)	99 (50)	267 (36.9)	0.00
Gingival	36 (70.6)	281(59.3)	94 (47.5)	411 (56.8)	
Papillary	4 (7.8)	25 (5.3)	4 (2)	33 (4.6)	
Papillary penetrating	2 (3.9)	9 (1.9)	1 (0.5)	12 (1.7)	
Total	51 (7.1)	474 (65.6)	198 (27.4)	723 (100)	

Pearson Chi square test. Shows statistically significant differences at p<0.05.

Table 3. The association between median diastema and dentition period.

Median diastema	Dentition period				P value
	Deciduous dentition n (%)	Mixed dentition n (%)	Permanent dentition n (%)	Total n (%)	
There is no diastema	16 (31.4)	241 (50.8)	169 (85.4)	426 (58.9)	0.00
0-2 mm between diastema	28 (54.9)	119 (25.1)	23 (11.6)	170 (23.5)	
2 mm and above diastema	7 (13.7)	114 (24.1)	6 (3)	127 (17.6)	
Total	51 (7.1)	474 (65.6)	198 (27.4)	723 (100)	

Fisher's Freman Halton Exact Test. Shows statistically significant differences at p<0.05.

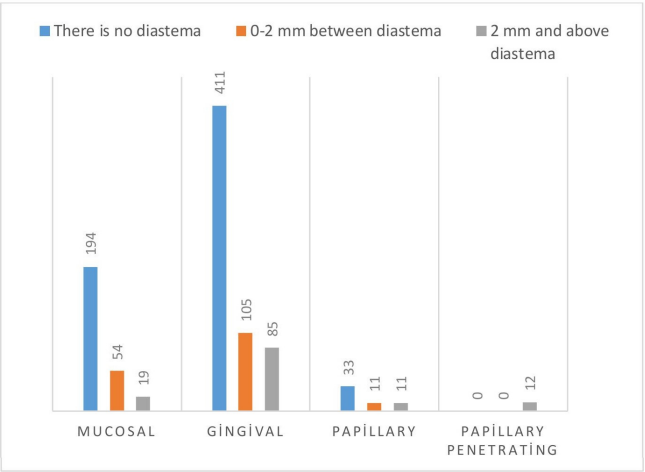

Figure 2. Relationship between maxillary labial frenulum types and maxillary median diastema.

Table 2 presents the relationship between maxillary frenulum type and dentition period, revealing a statistically significant correlation (p<0.001). The association between maxillary labial frenulum type and diastema spacing is depicted in Figure 2, which also demonstrates a statistically significant relationship (p<0.001). The relationship between diastema spacing and dentition period is detailed in Table 3.

DISCUSSION

This study investigated the prevalence of maxillary labial frenulum types, median diastema spacing, and their relationship in 723 children aged 4-13 years in Malatya, Türkiye. Our findings indicate that the most common frenulum type was gingival (57%), and the least common was papillary penetrating (2%). These prevalence rates are generally consistent with studies conducted in other Turkish regions, such as İzmir (Kılınç et al. [13]), Bolu (Güler et al. [10]), and Istanbul (Taran et al. [14]), which also reported gingival frenulum as the most prevalent (43.7%, 43%, and 45.8%, respectively) and papillary penetrating as the least prevalent (7.2%, 11%, and 13.1%, respectively). Boutsi and Tatakis [4] in their study found a similar high prevalence of gingival frenulum (41.6%), but a higher prevalence of papillary frenulum (22.1%) compared to our findings. Placek et al. [9], whose classification we adopted, reported mucosal frenulum as the most common (46.5%), followed by gingival (34.3%). These variations

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in prevalence across studies might be attributed to differences in ethnic origin or geographical location.

Güler et al. [10] observed a higher prevalence of gingival frenulum during the deciduous and mixed dentition periods. Our study aligns with this, finding gingival frenulum most common in these stages, while mucosal frenulum was more prevalent in the permanent dentition. Clinically, mucosal and gingival frenula are considered normal, whereas papillary and papillary penetrating types are pathological and associated with papilla loss, gingival problems, diastema, and difficulties in interdental cleaning [11].

In our study, no statistically significant relationship was found between frenulum type and sex or age ($p = 0.063$), which is consistent with the findings of Kılınç et al. [13] and Placek et al. [9]. While Güler et al. [10] and Kılınç et al. [13] did not find a significant association between frenulum type and dentition period, our study revealed a statistically significant relationship ($p<0.001$).

A diastema is defined as a gap exceeding 0.5 mm between teeth [9], and while common in deciduous and mixed dentition, these gaps often close with the eruption of canines [15]. A persistent median diastema can be attributed to the maxillary labial frenulum attachment [16]. In such cases, clinical and radiographic evaluation is crucial. For frenulum-induced diastema in pediatric patients, treatment aims to close the gap and eliminate the causative frenulum [17]. Careful examination of the frenulum is essential in pediatric dental assessments. While a diastema during the "ugly duckling stage" of mixed dentition (typically up to 2 mm) is often physiological, gaps wider than 2 mm warrant consideration of the etiology, as spontaneous closure is less likely, potentially requiring orthodontic intervention [2].

In our study, we examined frenulum types and measured median diastema spacing. Diastema gaps were most frequently between 0 and 2 mm in the primary dentition and often absent in the mixed and permanent dentition. Notably, all children with the papillary penetrating frenulum type had a median diastema of 2 mm or more. We found a statistically significant relationship between frenulum type and diastema gap ($p<0.001$), which is consistent with the findings of , Seraj et al. otherwise ($p=0.014$) and Sękowska et al. ($p<0.05$), but contrasts with the findings of Sagar et al. [12,16, 17]. These discrepancies may arise from variations in frenulum classifications and the age ranges of the studied populations. We opted for Placek et al.'s classification due to its ease of use for periodontists, orthodontists, and pediatric dentists.

Clinicians should utilize the blanch test to aid in the visual detection of abnormal frenula [14]. For patients with frenulum-related concerns, monitoring until around 10 years of age is advisable, at which point frenectomy (surgical blade or laser) can be considered. In the absence of issues, regular follow-up is recommended [18].

A limitation of this study is its focus on a single city in eastern Türkiye. Future research should encompass a broader geographical range to provide a more comprehensive understanding of the relationship between frenulum type and diastema spacing in Turkish children across different regions.

CONCLUSION

In conclusion, while prior research has documented frenulum prevalence in various populations, this study identified gingival frenulum as the most common and papillary penetrating as the least common type in our Malatya cohort. Importantly, we found a significant association between frenulum type and median diastema. Therefore, meticulous frenulum examination by dentists, particularly pediatric dentists, is crucial. Patients should be educated about frenula potentially contributing to diastema. A key implication of this study is the need for timely and accurate frenulum assessment by orthodontists and pediatric dentists, facilitating collaborative intervention in cases of diastema caused by frenulum morphology.

Ethics Committee Approval: The study was approved by the Clinical Research Ethics Committee of Malatya İnönü University (2024/66).

Informed Consent: Written informed consent was obtained from the legal guardians of all participating patients.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept: Z.S.G.; Design: Z.S.G.; Supervision: Z.S.G.; Materials: Z.S.G.; Data Collection and/or Processing: S.M.Y.; Analysis and/or Interpretation: S.M.Y.; Literature Review: Z.S.G.; Writing: S.M.Y.; Critical Review: S.M.Y.

Conflict of Interest: The authors declare no competing interests.

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