

## *Morphological variations of the labial frenum, type of attachment and presence of diastemas: integrative review*

## *Variações morfológicas do freio labial, tipo de inserção e presença de diastemas: revisão integrativa*

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### ABSTRACT

**Objective:** The aim of the present literature review was to compile data on the frequency of morphological and attachment types of the upper and lower labial frenum in different populations and investigate the association between the attachment level of the upper labial frenum and the occurrence of diastemas. **Methods:** Searches were conducted between May and June 2021 in the Medline (via Ovid), Google Scholar and CAPES databases. Thirty-eight studies that evaluated frenum morphology, frenum morphology and attachment or frenum morphology, attachment and the occurrence of diastemas were selected for the extraction of data. **Results:** Based on the data compiled in this review, the most common morphological and attachment types were labial frenum normale and mucosal attachment. The papillary and papilla penetrating types of attachment were more associated with the occurrence of diastemas. **Conclusion:** Longitudinal studies are needed to investigate this correlation in children and adults.

**Indexing terms:** Anatomy. Diastema. Labial frenum.

### RESUMO

**Objetivo:** O objetivo dessa revisão de literatura é compilar dados referentes a frequência de tipos morfológicos e de inserção do freio labial superior ou inferior, em diferentes populações, além de avaliar a relação entre o nível de inserção do freio labial superior e a ocorrência de diastemas. **Métodos:** Foram consultadas as bases de dados Medline (via Ovid), o Google acadêmico e o portal

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periódicos CAPES. A pesquisa foi realizada no período compreendido entre os meses de maio e junho de 2021. Foram selecionados para a extração de dados 35 estudos, que avaliação a morfologia do freio ou morfologia e inserção ou morfologia, inserção e presença de diastemas. **Resultados:** A partir dos dados compilados por essa revisão, foi possível estabelecer que os tipos morfológicos e de inserção mais comuns foram freio labial simples e inserção em mucosa. Com relação ao tipo de inserção e a ocorrência de diastemas, os tipos papilar e papilar penetrante foram os mais associados à sua ocorrência. **Conclusão:** Há necessidade de estudos longitudinais que avaliem essa correlação em crianças e populações adultas.

**Termos de indexação:** Diastema. Anatomia. Freio labial.

## INTRODUCTION

The frenum is defined as a fold of the mucous membrane generally composed of muscle fibers that connects the lips and cheek to the alveolar mucosa and/or gingiva and underlying periosteum [1]. Histological analysis of this structure reveals the presence of epithelial, nerve and connective tissues as well as a percentage of skeletal muscle fibers [2].

Frena are more commonly found in the vestibular mucosa of the maxilla and mandible, normally on the midline and in the premolar region. A frenum in the mandible is found lingually to the central incisors in a connection with the body of the tongue [3]. The maxillary frenum originates as a remnant of tectolabial bands and connects the tubercle of the upper lip to the palatal papilla; its basic function is to provide stability for the upper lip [4].

The upper labial frenum is a dynamic structure submitted to variations in shape, size and position during the growth and development stages [5]. Changes in its shape and position are associated with the occurrence of diastemas as well as numerous anomalies and syndromes. The involvement of the upper labial frenum in the formation and promotion of gingival recessions of the maxillary incisors is not clear [5,6]. The attachment height of the frenum in the upper arch is apparently not associated with a greater accumulation of plaque or gingival inflammation when this factor is considered alone. However, the combination of a high frenum attachment and shallow vestibule can lead to greater plaque buildup and, consequently, gingivitis [7]. Moreover, diastemas larger than 2.5 mm are associated with labial frena with an abnormal typology in an inverse relationship with the attachment level ( $p < 0.01$ ) [8].

Studies have analyzed the morphology and/or attachment of the upper labial frenum [6, 9-16]. Knowledge of the most recurrent anatomical patterns is required to enable the identification of those that do not fit the pattern of normality and may be associated with functional harm, such as the persistence of diastemas in adulthood.

The aims of the present literature review were to 1) compile data on the frequency of morphological and attachment types of the upper and lower labial frena in different populations and 2) evaluate the association between the attachment level of the upper labial frenum and the occurrence of diastemas.

## METHODS

The following were the research questions: What is the prevalence of morphological and attachment types of labial frena? Is there evidence to sustain a direct correlation between attachment level and the occurrence of diastema?

### Search Strategy

Searches for relevant articles published in English, Spanish and Portuguese were performed in the Medline (via Ovid), Google Scholar and CAPES databases using the search terms "labial frenum" AND "morphology" AND "diastema". No restriction was imposed regarding the year of publication. The searches were conducted in the period between May and June 2021.

## Eligibility Criteria and Synthesis of Data

To be included in the review, studies needed to report the prevalence of morphological types of upper and/or lower labial frena in individuals with diastemas. No restriction was imposed regarding the age of the participants. For standardization in the assessment of the studies, the classification proposed by Sewerin [9] was considered for the variation in morphological types and the classification proposed by Placek et al. [17] was considered for attachment types. Studies that used other classifications were excluded from the analysis.

The primary outcome was the prevalence of morphological and attachment types of frena in individuals with diastemas. For studies that published data in the form of absolute frequency, the relative frequency was calculated for the purposes of standardization. Articles were selected by two independent reviewers (LM and AM). Divergences of opinion regarding the inclusion or exclusion of articles were resolved by discussion between the reviewers. The extracted data were summarized and grouped in evidence tables.

## RESULTS

### Eligible studies

The search of the databases led to the retrieval of 101 records. After the reading of the abstracts and full texts, 40 articles were selected for the present review [6,8,9,11-46]. Among these 40 articles, 18 in 19 publications offered data on both the morphology and attachment of the frenum [8,11-13,15,16,21,22,25-28,41,43-45,47], nine offered data only on morphology [9,18,20,23,24,38-40,42] and twelve offered data only on attachment level [6,17,19,29,33-37,46,48]. The results of the 40 studies are summarized in tables 1 and 2.

The studies that evaluated the morphology or attachment of frena involved a total of 22,912 individuals. Seventeen studies were conducted in India [8,16,21-22,24,26,28,30-31,37-39,41,43,45-46]; five in Brazil [11-15]; five in Nepal [19,32,34,44,48]; two in Iraq [35,36]; one in Peru [18]; one in Denmark [9]; one in Ecuador [20]; one in Jordan [40]; one in Pakistan [25]; one in Malaysia [27]; one in the Czech Republic [17]; one in Poland [6]; one in Iran [29]; one in Turkey [47] and one in the United States of America [42].

## DISCUSSION

### Morphological Type of Frena by Age Group

The studies by Díaz-Pizán et al. [18], Braga et al. [12], Kakodkar et al. [39], Bervian et al. [15], Hammouri et al. [40], Thosar et al. [38], Jonathan et al. [8], Pandiyan et al. [27], Sekar, Mungara & Joseph [16], Biradar et al. [31] and Joshi et al. [45] classified frenal morphology from childhood to adolescence. Regarding morphological and attachment type, frenum normale (54.64 to 88.3%) and mucosal attachment (21.4 to 76%) were the most prevalent among the studies selected. Jonathan et al. [8] evaluated the association between morphological type and attachment level, reporting that frenum normale was more commonly attached to the gingiva and alveolar mucosa ( $p < 0.001$ ), whereas papilla penetrating attachment was more commonly associated with frenum tectolabiale persistens (90.5%,  $p < 0.001$ ).

Díaz-Pizán et al. [18] found that frenum tectolabiale persistens was the most prevalent morphological type among children from zero to six months of age (87%), whereas the normale type was the most prevalent at six years of age (73%). This finding was attributed to the vertical growth phenomenon of the alveolar process, eruption process of the primary dentition and intra-alveolar development of the permanent dentition, which enables the gingival attachment to change to a more apical position of the crest.

**Table 1.** Characteristics of studies and results according to morphological type.

Study	Country	Sample size	Age (years)	Location of frenum	Morphological Type of Upper Labial Frenum (%)							
					A	B	C	D	E	F	G	H
Sewerin (1971) [9]	Denmark	1430	0-60	UL	60.2	19.9	9.1	3	2.8	2.6	2.1	0.4
Ruli et al. (1997) [11]	Brazil	100	19-26	UL and LL	69	10	15	1	3	1	0	1
Braga et al. (2006) [12]	Brazil	300	7-10	UL	57.3	3.6	11.3	2.3	3.6	15	0.6	6
Díaz-Piñán et al. (2006) [18]	Peru	1355	0-6	UL	59	42	12	<1	<1	25	<1	<1
Kakodkar et al. (2008) [39]	India	1206	12-17	UL	70.6	3.9	17.6	<1	<1	6.6	<1	0
Gusmão et al. (2009) [13]	Brazil	261	18-72	UL and LL	79.7	11.1	7.7	0.4	0	0	0	1.1
Townsend et al. (2012) [42]	USA	284	3-74	UL	69.3	10.5	17.6	0.7	0.3	1.4	1	0
Estrada (2014) [20]	Ecuador	894	18-30	UL	74.8	19.7	4.3	0.2	0	0.5	0.2	0
Christabel & Gurunathan (2015) [21]	India	931	3-12	UL	97	0	2.6	0.4	0	0	0	0
Jindal et al. (2016) [22]	India	500	16-40	UL	77.6	9	12.41	0	0	0	0	0
Ribeiro et al. (2015) [14]	Brazil	385	10-72	UL and LL	82.6	4.5	10.4	0.7	0	0.5	1.3	0
Bervian et al. (2016) [15]	Brazil	304	0-6	UL	77.3	8.6	2.63	0.32	0	8.6	2.6	0
Sagar et al. (2016) [23]	India	60	15-25	UL	0	16.6	28.3	13.3	1.67	20	0	20
Dasgupta et al. (2017) [24]	India	1400	5-74	UL	67.78	11.9	16.5	0	0.8	1.7	0.07	1
Hammouri et al. (2017) [40]	Jordan	300	1-13	UL	54.6	9.6	25.6	2	0	4.3	0.3	3.33
Niazi et al. (2017) [25]	Pakistan	600	5-63	UL	54.3	6.3	3.1	0.1	1	34.6	0.1	0.1
Thosar et al. (2017) [38]	India	1000	3-14	UL	88.3	0.6	4.7	0.7	0.1	2.1	0.6	0.7
Jonathan et al. (2018) [8]	India	1200	3-12	UL	68.7	5	10.3	0	0	15.3	0.3	0.16
Manjunath (2018) [26]	India	100	18-50	UL	31.1	1.1	1.1	0	0	66.6	0	0
					65	19	8	4	1	0	2	0
					-	10.5	12.5	50	100	0	0	0

**Table 1.** Characteristics of studies and results according to morphological type.

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Study	Country	Sample size	Age (years)	Location of frenum	Morphological Type of Upper Labial Frenum (%)										
					A	B	C	D	E	F	G	H			
Pandiyani et al. (2018) [27]	Malaysia	200	2-15	UL	73	5	11.5	7.5	0	2.5	0	0	0.5		
Rajani et al. (2018) [28]	India	150	13-30	UL	45.33	6	12	19.3	2.6	1.3	1.3	4			
Bowsiyaand & Arjankumar (2019) [41]	India	500	20-70	UL and LL	79.6	2	16.4	0.8	1.2	0	0	0			
Sekar et al. (2019) [16]	India	951	03-14	L and I	86.4	6.3	4.6	0	0	2.4	0.2	0			
Biradar et al. (2020) [31]	India	1.800	3-17	UL	22.9	18.3	20.5	0	0	39.1	50	0			
Rathod et al. (2020) [43]	India	400	20-40	UL	69.33	5.61	12.11	-	0.55	11.27	0.72	0.38			
Chaulagain et al. (2021) [32]	Nepal	102	≤10-60	UL	77.44	1.75	15.79	0.50	1.75	0.50	0.75	1.50			
Joshi et al. (2021) [44]	India	1000	18-30	UL	72.5	7.8	19.6	0	0	0	0	0			
Patel et al. (2021) [45]	India	302	06-16	UL	-	-	-	-	-	-	-	-			
Kilinc et al. (2021) [51]	Turkey	1023	2-65	UL	83.2	6.5	7.3	0.3	1.2	1.5	0	0			
					84.3	3.5	8.3	0	0	0.2	3.7	0			
					66.9	17.0	5.7	8.8	0.9	0.3	0.4	-			

Note: A - normale; B - normale cum nodulo; D - bifidum; E - cum recessu; F - tectolabiale persistens; G - duplicatio frenuli; H - coincidence of two or more variations or abnormalities. UL - upper lip; LL - lower lip; L - labial; I - lingual. \*Only groups with frenum normale evaluated. NA - not assessed; USA - United States of America.

**Table 2.** Characteristics of studies and results according to attachment type.

Study	Country	Sample size	Age (years)	Location of frenum	Frenal attachment (%)			
					Diastema (%)			
					1	2	3	4
Placek et al. (1974) [17]	Czech Republic	465	15-40	UL and LL	46.5	34.3	3.1	16.1
					-	-	-	-
Ruli et al. (1997) [11]	Brazil	100	19-26	UL and LL	15	77	7	1
					-	-	-	-
Braga et al. (2006) [12]	Brazil	300	7-10	UL	46	32	18.6	3.3
					-	-	-	-
Gusmão et al. (2009) [13]	Brazil	261	18- 72	UL and LL	60.9	34.1	4.2	0.8
					-	-	-	-
Boutsis & Tatakis (2011) [33]	Greece	226	1-18	UL	10.2	41.6	22.1	26.1
					-	-	-	-
Upadhyay & Ghimire (2012) [19]	Nepal	198	1-14	UL	13.6	61.1	17.2	8.1
					-	-	-	-
Christabel & Gurunathan (2015) [21]	India	931	3-12	UL	38.8	49.5	9.8	1.9
					-	-	-	-
Khursheed et al. (2015) [35]	Iraq	279	10-30	UL	12.5	68.8	16.4	2.1
					-	-	-	-
Ribeiro et al. (2015) [14]	Brazil	385	10-72	UL and LL	75.8	19.2	1.8	3.2
					-	-	-	-
Bervian et al. (2016) [15]	Brazil	304	0-6	UL	21.4	51	21	6.6
					-	-	-	-
Jindal et al. (2016) [22]	India	500	16-40	UL	66	28.4	2.4	3.2
					-	-	-	-
S kowska & Chałas (2016) [6]	Poland	102	-	UL	41.1	28.4	14.7	15.6
					17.3	25	26.9	30.8
Niazi et al. (2017) [25]	Pakistan	600	5-63	UL	38.8	58.5	2.1	0.5
					-	-	-	-
Karam et al. (2018) [36]	Iraq	307	15-19	UL	35.1	57.9	4.8	1.9
					-	-	-	-
Rajkarnikar et al. (2018) [34]	Nepal	356	1 - > 35	UL	70.5	28.4	0.8	0.3
					-	-	-	-
Jonathan et al. (2018) [8]	India	1200	3-12	UL	47.5	38.1	0	14.2
					12.2	22.2	0	65.5
Nandita et al. (2018) [37]	India	100	18-40	UL and LL	70	30	0	0
					-	-	-	-
Manjunath (2018) [26]	India	100	18-50	UL	16	15	24	9
					56.2	66.6	62.5	100
Rajani et al. (2018) [28]	India	150	13-30	UL	42	34	20	4
					-	-	-	-
Pandiyan et al. (2018) [27]	Malaysia	152	2-15	UL	76	12	7.5	4.5
					-	-	-	-
Varghese et al. (2018) [46]	India	90	15-30	UL	42.2	33.33	21.11	3.33
					-	-	-	-
Bowsiyaand & Arjunkumar (2019) [41]	India	500	20-70	UL and LL	90.4	8.4	1.2	0
					-	-	-	-
Sekar et al. (2019) [16]	India	951	03-14	UL and LL	63.3	26.8	7.2	2.6
					28	31.6	27.6	47.1
Seraj et al. (2019) [29]	Iran	639	3-6	UL	19.9	52.9	18.8	8.5
					-	-	-	-
Divater et al. (2019) [30]	India	300	13-18	UL	39	28.3	23.7	9
					-	-	-	-
Biradar et al. (2020) [31]	India	1.800	3-17	UL	11.98	41.95	39.78	6.27
					-	-	-	-
Rathod et al. (2020) [43]	India	400	20-40	UL	29.8	49.9	16.5	3.8
					-	-	-	-

**Table 2.** Characteristics of studies and results according to attachment type.

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Study	Country	Sample size	Age (years)	Location of frenum	Frenal attachment (%)			
					Diastema (%)			
					1	2	3	4
Chaulagain et al. (2021) [32]	Nepal	102	≤10-60	UL	100	-	-	-
Joshi et al. (2021) [44]		340	6-16	UL	60	29.7	6.2	4.1
Patel et al. (2021) [45]	India	1000	18-30	UL	56.9	23.7	11.9	7.5
Kilinc et al. (2021) [47]	Turkey	1023	2-65	UL	26.3	55.2	14.0	4.5
Dahal et al. (2022) [48]	Nepal	140	12-71	UL	59.3	32.9	6.4	1.4

Note: 1. mucosal; 2. gingival; 3. papillary; 4. papilla penetrating; UL- upper lip; LL- lower lip.

Nine other studies [11,13,20,22,23,26,32,41,44-45] involved individuals from adolescent to adulthood. The most prevalent morphological type was frenum normale (65 to 79.7%) and the most common type of attachment was mucosal (60.9 to 90.4%), followed by gingival (77%) and papillary (24%).

The studies conducted by Sewerin [9], Townsend et al. [42], Ribeiro et al. [14], Niazi et al. [25], Dasgupta et al. [24], Rajani et al. [28], Chaulagain et al. [32], Kilinc et al. [51] and Dahal et al. [52] involved participants from childhood to adulthood. The sample in the study by Sewerin [9] had an age range of zero to 60 years and frenum normale was the most prevalent morphological type (60.2%). The most widely known morphological classification was developed from this study.

Townsend et al. [42], Niazi et al. [25] and Rathod et al. [43] stratified their results by sex, finding that frenum normale was the most prevalent morphological type in both sexes. Niazi et al. [25] examined 600 individuals ranging in age from five to 63 years, reporting that the frenum tectolabiale persistens was the second most prevalent type (found in 208 participants). Frenum normale cum appendice and frenum cum nodulo were found in only 38 and 19 individuals, respectively, with the rare occurrence of other morphological types.

Ribeiro et al. [14] stratified their results according to sex and location (upper or lower lip). The normale type was the most prevalent morphological type for both the upper (82.6%) and lower (100.0%) labial frenum and attachment to the alveolar mucosa was the common attachment type in both the upper (75.8%) and lower (99.0%) labial frenum.

Dasgupta et al. [24] examined a sample of 1400 individuals stratified by sex (700 men and 700 women) and age group. Age of the participants ranged from five to 74 years. The authors reported that the participants were randomly selected but failed to describe how the selection process was performed. The groups were divided by age in ten-year periods (Group I: 5-14 years; Group II: 15-24 years; Group III: 25-34 years; Group IV: 35-44 years; Group V: 45-54 years; Group VI: 55-64 years; Group VII: 65-74 years). Frenum normale was the most prevalent in all groups (67.78%). Rajani et al. [28], Chaulagain et al. [32] and Kilinc et al. [47] also found that frenum normale (45.3 to 72.5%) and mucosal attachment (42 to 100%) were predominant among the participants. More recent studies consider frenum normale to be the normal morphological type and other variations are considered abnormal types.

## Morphology of Frenum, Attachment Type and Occurrence of Diastemas

Díaz-Pizán et al. [18], Jonathan et al. [8], Rajani et al. [28], Manjunath [26], Sekar et al. [16] and Patel et al. [45] investigated the association between frenal morphology and attachment type and the occurrence of diastema. The most

recurrent attachment types of the upper labial frenum were papillary (27.6 to 62.5%) and papilla penetrating (47.1 to 100%). No association was found between a specific morphological type and the occurrence of diastema in most studies.

However, Jonathan et al. [8] found that the frenum tectolabiale persistens was more common among children between three and 12 years of age with diastemas consisting of an interincisal space  $> 2.5$  mm (66.6%,  $p < 0.001$ ). Regarding attachment type, papillary and penetrating attachments were more associated with the occurrence of diastemas [8,16,26,28, 45]. Rathod et al. [43] found that this attachment type was more prevalent in women and that the occurrence of diastemas was more common in this group.

Children have diastemas with larger interincisal spaces that tend to diminish with age and an inverse correlation is found between the level of gingival attachment and diastema [18, 8,45,49,50]. Therefore, the frenum can affect the presence and magnitude of diastema in childhood in the presence of other conditions, such as a broad maxilla, small teeth, hypodontia and dental caries, but is not necessarily the most important determinant factor [18]. In many individuals, the closure of diastemas occurs between 14 and 19 years of age [49].

Pereira et al. [51] evaluated the spontaneous closure of diastemas in individuals submitted to frenectomy during the mixed dentition phase. The authors found a reduction in diastemas in 80% of cases, with complete closure within an average period of two years in 36% of the individuals. A clinical study [52] evaluated the distance between the central incisors as well as periodontal variables before and after frenectomy in a group of individuals ranging in age from 13 to 53 years. Frenectomy was associated with a significant reduction in periodontal pocket depth ( $p = 0.001$ ), bleeding ( $p = 0.006$ ) and gingival recession in the mandible ( $p = 0.010$ ).

## Limitations of study

The present study has limitations inherent to its design (analysis of secondary data presented in previous studies). The main purpose of this review was to compile data on the frequency of morphological and attachment types of labial frena. Despite a certain uniformity in the methods employed in the different studies, such as the same types of classifications, there are issues that should be taken into consideration for the interpretation of the results. The first regards how the examinations were performed (directly through a clinical examination or indirectly through the analysis of photographs). It was not possible to establish whether how this evaluation was performed affected the results of the studies. Another factor to consider is the difference in samples sizes among the studies, as a large portion did not describe the sample calculation. Less prevalent morphological and attachment types may not be found in studies with a small sample size.

## CONCLUSION

Based on the data compiled in this review, the most common morphological and attachment types were labial frenum normale and mucosal attachment. The papillary and papilla penetrating types of attachment were more associated with the occurrence of diastemas. Longitudinal studies are needed to investigate this correlation in children and adults.

## Collaborators

A Santos, study design, data collection, data analysis and interpretation and manuscript writing. LM Silva conception and design of the study, writing of the manuscript and review of the manuscript. LML Oliveira, conception and design of the study, data analysis and interpretation, writing of the manuscript and review of the manuscript. BCF Vajgel, conception and design of the study, analysis and interpretation of data, writing of the manuscript and review of the manuscript. R Cimões, conception and design of the study, analysis and interpretation of data, writing of the manuscript and review of the manuscript.

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