Assessment of Diverse Frenal Morphology in Primary, Mixed, and Permanent Dentition: A Prevalence Study

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ABSTRACT

Aim: The maxillary labial frenum is a normal anatomic structure with inherent morphological variations. It has various morphologies and types depending on the attachment of fibers. This study was conducted to access the frenal morphology and frenal attachment in primary, mixed, and permanent dentition.

Materials and methods: This study includes 1,800 patients, in which 969 were males and 831 females, with 3–17 years of age and is equally divided into primary, mixed, and permanent according to age and dentition of patients. Morphology of maxillary labial frenum was examined and classified according to Sewerin's frenum typology and type of frenal attachment according to Placek's attachment. Data collected were entered into SPSS version 16 and were subjected to statistical analysis.

Results: Simple frenum is most prevalent in all the age groups followed by persistent tectolabial frenum (PTF) in primary dentition, frenum with a nodule in mixed dentition, and frenum with an appendix in permanent dentition. Type III frenal attachment is found in primary dentition followed by type II and type I in mixed and permanent dentition, respectively. There is a highly statistically significant difference in the type of frenal morphology and frenal attachment in all groups of dentition.

Conclusion: The prevalence of simple frenum is increasing from primary dentition to permanent dentition, whereas PTF decreases as age increases. This study reveals a high prevalence of gingival attachment followed by papillary attachment.

Clinical significance: The examination of frenal morphology and attachment is important before planning for any dental procedures to rule out the misdiagnosis and unnecessary surgical interventions.

Keywords: Labial frenum, Mixed dentition, Permanent dentition, Primary dentition, Syndromes.

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INTRODUCTION

The labial frenum is a mucosal fold that attaches the lip to alveolar mucosa, gingiva, and periosteum¹ and it is defined as "a fibrous band of tissue attached to the bone of the mandible and maxillae, and it present superficial to muscle attachments."² Histologically, it is made of loose connective tissue fibers, an abundance of elastic fibers, and mucous glands in the subcutaneous tissue on either side of the central artery and vein.³ Few striated muscle fibers also arise from the muscle bundles of the lip on either side of the midline.⁴

The frenum has its origin from the remnant of central cells of the vestibular lamina, and it is dynamic in its structure and often changeable in shape, size, and position during growth and development.⁵ It provides support and stability to the lip and to keep the lip in harmony with the growing bones of the maxilla. Hence, it plays an important role in the regulation of facial growth.^{6–8}

The maxillary labial frenum has fibrous tissue moving in an anteroposterior direction and merges with the submucosal fibers of the upper lip.⁹ It also encloses the septopremaxillary ligament that serves as a means of transmitting the septal growth force to the premaxilla. It also encompasses a few striated fibers of the nasolabial muscles.¹⁰ Inadequate muscular reconstruction and mutilation of the labial frenum could result in facial growth abnormalities.¹¹

Aberrant frena can be detected by applying tension to see the movement of papillary tip or blanching produced on it. Clinically, papillary and papilla penetrating frena will be considered as pathological as it is associated with midline diastema, gingival recession, loss of papilla, interdental bone loss, poor lip mobility,

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difficulty in brushing, malalignment of teeth, closure of diastema during orthodontic treatment, more retention of plaque may lead to periodontitis and reoccurrence after periodontal treatment, it may also prejudice the denture fit or retention leading to psychological disturbances to the individual.^{12,13}

Abnormal maxillary frenal attachments may act as a hindrance for the tongue and upper lip from the seal, thus making it difficult

for the children in breastfeeding which may lead to nutritional deficiency of the child.¹⁴

In the early stage of growth, the frenum is generally wide and thick, and during growth, it becomes thin and narrow.^{12,15} The thick labial frenum may not be able to place the bristles of brushes properly; hence, plaque control will be difficult and may lead to caries and periodontal lesions.¹⁶

There are various syndromes associated with different frenal attachments: Ehlers–Danlos syndrome,¹⁷ infantile hypertrophic pyloric stenosis,¹⁸ holoprosencephaly,¹⁹ Ellis–van Creveld syndrome,²⁰ and orofacial-digital syndrome.²¹ Each syndrome exhibits relatively specific frenal abnormalities, ranging from multiple, hyperplastic, hypoplastic, or absence of frena.

The clinician may misdiagnose the frenal morphology during the early stages of growth and development; during growth, it tends to decrease in size and lose its clinical importance. During the routine clinical examination, the frenal attachment and frenal morphology may go unnoticed; however, it has been seen that abnormal frenal attachment can be an indicator of some pathology or may be associated with few syndromes.

Hence, this study aims to access the frenal morphology and frenal attachment in primary, mixed, and permanent dentition.

CLASSIFICATION

Sewerin's Maxillary Labial Frenum Classified based on the Morphology²²

- Simple frenum
- Persistent tectolabial frenum (PTF)
- Simple frenum with an appendix
- Simple frenum with a nodule
- Double frenum
- Frenum with a nichum
- Frenum with two or more variations at the same time.

Placek's Frenum Classification based on the Attachment Site²³

- Type I—mucosal frenal attachment; the frenal fibers are attached up to the mucogingival junction.
- Type II—gingival frenal attachment; the fibers are inserted within the attached gingiva.
- Type III—papillary frenal attachment; the fibers extend into interdental papilla.
- Type IV—papillary penetrating frenal attachment; the frenal fibers cross the alveolar process and extend up to palatine papilla.

MATERIALS AND METHODS

This cross-sectional study was conducted using a convenient sample size of 1,800 patients, in which 969 were male and 831 female patients aged about 3–17 years were included and equally divided into primary, mixed, and permanent dentition. The study cases were selected in the north Karnataka region irrespective of race and ethnicity. Ethical approval for the study was obtained from Al-Badar Dental College and Hospital Gulbarga. Informed consent was obtained, and the explanation of the procedure was done to parents before the examination. The study was conducted without violating the guidelines of the Declaration of Helsinki.

Three study groups were made, which includes group I: children with only primary dentition (3–6 years), group II: children with mixed dentition (7–14 years), and group III: children with complete permanent dentition (15–17 years).

Children exhibiting with congenital anomalies, systemic diseases, trauma, surgery in the maxillary anterior region, and history of previous hard and soft tissue corrective treatments were excluded from the study.

All examinations were performed by the direct visual method under the natural light by retracting the upper lip with the index finger and thumb of both hands by a single examiner. A thorough intraoral examination was carried out to assess the morphology of the maxillary labial frenum and the type of frenal attachment (Figs 1 and 2).

The types of frenal attachments were classified according to the Sewerin's²² and Placek's²³ types of frenal attachment.

STATISTICAL DATA ANALYSIS

Data collected were entered into SPSS version 16 and were subjected to statistical analysis. The genderwise distribution of frenal morphology and types of attachment were evaluated in an individual group and in between the groups.

RESULTS

In group I (primary dentition), a total of 327 male and 273 female children were examined. Among the morphological types of frenal attachment, the most prevalent frenum type found was the simple frenum (60.2%) followed by PTF (19.4%) and simple with nodule (17.8%). No significant differences between different types of frenum attachment were found in male and female children ($p = 0.97$; Table 1; $\chi^2 = 0.26$, $p > 0.97$, not significant).

In group II (mixed dentition), a total of 319 male and 281 female children were examined. The most prevalent frenum type found was the simple type (70.2%) followed by simple with nodule (17.9%). No significant differences between different types of frenum attachment were found in male and female children ($p = 0.97$; Table 2; $\chi^2 = 0.854$, $p > 0.913$, not significant).

In group III (permanent dentition), a total of 323 male and 277 female children were examined. The most prevalent frenum type found was the simple frenum (77.9%) followed by simple frenum with appendix (14.1%). No significant differences between different types of frenum attachment were found in male and female children ($p = 0.97$; Table 3; $\chi^2 = 2.591$, $p = 0.462$, not significant).

The comparison of the incidence of individual labial frenum was made between each group. It has shown a high statistically significant difference of frenal attachment within the groups (Table 4).

Based on the attachment of frenum, the comparison of the incidence of individual labial frenum was made between each group. Type III (50.7%) frenal attachment was most prevalent followed by type II (32%) in group I children. Type II (51.7%) frenal attachment was most prevalent followed by type III (32.3%) in group II children. Type II (42.3%) frenal attachment was most prevalent followed by type III (36.5%) in group III children. As the age advances, the frenum becomes thin and narrow and is shifted apically. There is a highly statistically significant difference of frenal attachment within the groups (Table 5; $\chi^2 = 32.8$, $p < 0.001$).

Figs 1A to G: (A) Simple frenum; (B) Persistent tectolabial frenum; (C) Simple frenum with an appendix; (D) Simple frenum with a nodule; (E) Double frenum; (F) Frenum with a nichum; (G) Frenum with two or more variations

Figs 2A to D: (A) Type I frenum; (B) Type II frenum; (C) Type III frenum; (D) Type IV frenum

DISCUSSION

The labial frenum is a mucosal fold that attaches the lip to alveolar mucosa, gingival, and periosteum. Many morphological variations and types of frenal attachment are observed in primary, mixed, and permanent dentition.

This study was conducted in 1,800 children, in which 969 male and 831 female children with age group of 3–17 years were examined, and according to the age and dentition, they are equally divided into primary, mixed, and permanent dentition. The study included all racial and ethnical group children in the

Table 1: Incidence of labial frenum morphology by gender in group I (primary dentition)

Maxillar labial frenum type	Gender				Total	
	Male		Female			
	No.	%	No.	%	No.	%
Simple frenum	201	61.5	160	58.6	361	60.2
PTF	61	18.7	55	20.1	116	19.4
Simple frenum with an appendix	3	0.9	4	1.5	7	1.2
Simple frenum with a nodule	57	17.4	50	18.3	107	17.8
Double frenum	2	0.6	2	0.75	4	0.6
Frenum with a nichum	3	0.9	2	0.75	5	0.8
Frenum with two or more variations at the same time	0	0.0	0	0.0	0	0.0
Total	327	100.0	273	100.0	600	100.0

Table 2: Incidence of labial frenum morphology by gender in group II (mixed dentition)

Maxillar labial frenum type	Gender				Total	
	Male		Female			
	No.	%	No.	%	No.	%
Simple frenum	223	69.9	198	70.5	421	70.2
PTF	26	8.2	25	8.9	51	8.4
Simple frenum with an appendix	5	1.6	4	1.4	9	1.5
Simple frenum with a nodule	57	17.9	50	17.7	107	17.9
Double frenum	3	0.9	1	0.4	4	0.7
Frenum with a nichum	3	0.9	2	0.7	5	0.8
Frenum with two or more variations at the same time	2	0.6	1	0.4	3	0.5
Total	319	100.0	281	100.0	600	100.0

Table 3: Incidence of labial frenum morphology by gender in group III (permanent dentition)

Maxillar labial frenum type	Gender				Total	
	Male		Female			
	No.	%	No.	%	No.	%
Simple frenum	252	78.0	214	77.3	466	77.7
PTF	20	6.2	16	5.8	36	6.0
Simple frenum with an appendix	45	14.0	40	14.4	85	14.1
Simple frenum with a nodule	1	0.3	3	1.1	4	0.7
Double frenum	3	0.9	2	0.7	5	0.8
Frenum with a nichum	0	0.0	0	0.0	0	0.0
Frenum with two or more variations at the same time	2	0.6	2	0.7	4	0.7
Total	323	100.0	277	100.0	600	100.0

north Karnataka region and have followed the classification according to morphological attachment, Sewerin's frenal attachment, and according to frenal attachment site, Placek's frenal attachment.^{16,24,25}

The most prevalent type of frenal attachment is simple frenum in all the three groups about 60.2, 70, and 77.2% in group I, group II, and group III, respectively, and these results are in accordance with Bervian et al.,²⁶ Christabel and Gurunathan,²⁷ and Townsend et al.⁹

The simple frenal attachments were followed by PTF in primary dentition of 19.4%, mixed dentition of 8.4%, and permanent dentition of 6.0%. The prevalence of simple frenum increases from primary dentition to permanent dentition, whereas PTF decreases

as age increases, and these results are in accordance with Deepa,²⁸ Lindsey,²⁹ and Placek et al.³⁰

The prevalence of PTF is higher in younger individuals than in adults because as age advances, there is a vertical growth of alveolar process, maxillary sinus development, and intra-alveolar eruption of the permanent maxillary incisors. This change in position during the child growth from primary to permanent dentition was believed to be caused by the frenum's static position while the surrounding structures grow.³¹

The simple frenum with a nodule in mixed dentition is 17.9% and in primary dentition is 17.8%, and frenum with appendix is more commonly found in permanent dentition and is about 14.1%; these results are in accordance with Nagveni and Umashankar.³²

Table 4: Comparison of incidence of individual labial frenum morphology in different groups (primary dentition, mixed dentition, and permanent dentition)

Maxillary labial frenum type	Group I (primary dentition)		Group II (mixed dentition)		Group III (permanent dentition)		χ^2 test, p value and significance
	No.	%	No.	%	No.	%	
Simple frenum	361	60.2	421	70.2	466	77.7	$\chi^2 = 56.61, p < 0.001$ and VHS
PTF	116	19.4	51	8.4	36	6.0	$\chi^2 = 82.53, p < 0.001$ and VHS
Simple frenum with an appendix	7	1.2	9	1.5	85	14.1	$\chi^2 = 241.7, p < 0.001$ and VHS
Simple frenum with a nodule	107	17.8	107	17.9	4	0.7	$\chi^2 = 123.4, p < 0.001$ and VHS
Double frenum	4	0.6	4	0.7	5	0.8	$\chi^2 = 0.34, p > 0.05$ and NS
Frenum with a nichum	5	0.8	5	0.8	0	0.0	$\chi^2 = 1.256, p > 0.05$ and NS
Frenum with two or more variations at the same time	0	0.0	3	0.5	4	0.7	$\chi^2 = 0.972, p > 0.05$ and NS
Total	600	100.0	600	100.0	600	100.0	1,800 (100.0%)

NS, nothing significant; VHS, very highly significant

Table 5: Comparison of incidence of individual labial frenum based on the attachment of frenum in different groups (primary dentition, mixed dentition, and permanent dentition)

Type	Group I (primary dentition)		Group II (mixed dentition)		Group III (permanent dentition)	
	No.	%	No.	%	No.	%
1	28	4.6	84	14	104	17.3
2	192	32	310	51.7	254	42.3
3	304	50.7	194	32.3	219	36.5
4	76	12.7	12	2	23	3.9
Total	600	100.0	600	100.0	600	100.0

Frenum with nodule and appendix is considered as developmental remnants that show no pathological potential and do not need any investigation and treatment procedures.³³ The other frenal morphologies like frenum with a nichum, double frenum, and frenum with two or more variables are found to be nil or less than 1%.

There is no significant association of frenal type with gender. Both male and female children had more or less equal distribution, and these results are in accordance with Kotlow³⁴ and Lindsey.²⁹

Although many kinds of literature exist on the prevalence of types of frenal attachment, there was no association made with the type of dentition.^{12,33,35} In this study, the association was evaluated based on the attachment of frenum among the dentition. Type III (50.7%) frenal attachment was most prevalent in group I (primary dentition) children, type II (51.7%) in group II (mixed dentition) children, and type II (42.3%) in group III (permanent dentition) children. In the similar studies done by Jindal et al.,³⁶ the prevalence of mucosal frenal attachment was found to be most common (66.0%) with gingival frenal attachment as second (28.4%) followed by papillary penetrating (3.2%) with papillary type (2.40%) least common, and the study done by Mirko et al.,³⁰ the prevalence was found to be as mucosal (46.6%), gingival (34.3%), papillary (3.1%), and papillary penetrating (16.1%). The difference in results in this study when compared with Jindal et al.³⁶ and Mirko et al.³⁰ could be due to the diversity of population and dentition.

The presence of abnormal frenum can lead to frenal pull which, in turn, leads to accumulation of plaque, gingival recession, periodontitis, interference with the retention of a denture, midline diastema formation, difficulty in the closure of diastema

during orthodontic treatment, difficulty in brushing, improper pronunciation, and interference with breastfeeding by infants.^{12–16}

The few abnormal frena may be associated with syndromes such as Ehlers–Danlos syndrome, infantile hypertrophic pyloric stenosis, holoprosencephaly, Ellis–van Creveld syndrome, and orofacial-digital syndrome.^{17–21} Mutations in the genes in these syndromes would prevent cells from making enough functional protein, which disrupts the normal development of frenum.^{17–21} A syndrome associated with abnormal frenum varies according to geographical distribution and race. The child with abnormal frenum which is associated with syndromes is not found in this region.

The study with more sample size is required to assess the frenal morphology and attachments in various race and ethnic group of children in this region, and a study with only syndromic patients with a large sample size is required to assess the detail about aberrant frena.

CONCLUSION

The frenum is a tiny structure but has a diverse morphology and attachment types, so it is important to assess the normal and abnormal frena before planning for any dental procedures. A thorough examination of the frenum is important to rule out the misdiagnosis and unnecessary surgical interventions.

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