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

Sharashchandra M Biradar1, Ambika Y Patil2, Santosh S Kotnoor3, Shradanand Bacha4, Shobha C Bijjaragi5, Puttaraj Tukaram Kattimani6

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 frenum 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 periosteum 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.” 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. Few striated muscle fibers also arise from the muscle bundles of the lip on either side of the midline.

The frenum has its origin from the remnants 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. 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. 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.

The maxillary labial frenum has fibrous tissue moving in an anteroposterior direction and merges with the submucosal fibers of the upper lip. 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. Inadequate muscular reconstruction and mutilation of the labial frenum could result in facial growth abnormalities.

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

Abnormal maxillary frenular 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.15,16 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
\((p = 0.97; \chi^2 = 0.26, p > 0.97, \text{not significant})\).

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
\((p = 0.97; \chi^2 = 0.854, p > 0.913, \text{not significant})\).

In group III (permanent dentition), a total of 332 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 \((p = 0.97; \chi^2 = 2.591, p = 0.462, \text{not significant})\).

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 \((\chi^2 = 32.8, p < 0.001)\).
**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
Diverse Frenal Morphology in Primary, Mixed, and Permanent Dentition

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

<table>
<thead>
<tr>
<th>Maxillary labial frenum type</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Simple frenum</td>
<td>201</td>
<td>61.5</td>
<td>160</td>
</tr>
<tr>
<td>PTF</td>
<td>61</td>
<td>18.7</td>
<td>55</td>
</tr>
<tr>
<td>Simple frenum with an appendix</td>
<td>3</td>
<td>0.9</td>
<td>4</td>
</tr>
<tr>
<td>Simple frenum with a nodule</td>
<td>57</td>
<td>17.4</td>
<td>50</td>
</tr>
<tr>
<td>Double frenum</td>
<td>2</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>Frenum with a nicheum</td>
<td>3</td>
<td>0.9</td>
<td>2</td>
</tr>
<tr>
<td>Frenum with two or more variations at the same time</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>327</td>
<td>100.0</td>
<td>273</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Maxillary labial frenum type</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Simple frenum</td>
<td>223</td>
<td>69.9</td>
<td>198</td>
</tr>
<tr>
<td>PTF</td>
<td>26</td>
<td>8.2</td>
<td>25</td>
</tr>
<tr>
<td>Simple frenum with an appendix</td>
<td>5</td>
<td>1.6</td>
<td>4</td>
</tr>
<tr>
<td>Simple frenum with a nodule</td>
<td>57</td>
<td>17.9</td>
<td>50</td>
</tr>
<tr>
<td>Double frenum</td>
<td>3</td>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>Frenum with a nicheum</td>
<td>3</td>
<td>0.9</td>
<td>2</td>
</tr>
<tr>
<td>Frenum with two or more variations at the same time</td>
<td>2</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>319</td>
<td>100.0</td>
<td>281</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Maxillary labial frenum type</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Simple frenum</td>
<td>252</td>
<td>78.0</td>
<td>214</td>
</tr>
<tr>
<td>PTF</td>
<td>20</td>
<td>6.2</td>
<td>16</td>
</tr>
<tr>
<td>Simple frenum with an appendix</td>
<td>45</td>
<td>14.0</td>
<td>40</td>
</tr>
<tr>
<td>Simple frenum with a nodule</td>
<td>1</td>
<td>0.3</td>
<td>3</td>
</tr>
<tr>
<td>Double frenum</td>
<td>3</td>
<td>0.9</td>
<td>2</td>
</tr>
<tr>
<td>Frenum with a nicheum</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Frenum with two or more variations at the same time</td>
<td>2</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>323</td>
<td>100.0</td>
<td>277</td>
</tr>
</tbody>
</table>

north Karnataka region and have followed the classification according to morphological attachment, Sewerin’s frenum attachment, and according to frenum attachment site, Placek’s frenum attachment.16,24,25

The most prevalent type of frenum 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 frenum 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
Diverse Frenal Morphology in Primary, Mixed, and Permanent Dentition

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

<table>
<thead>
<tr>
<th>Maxillary labial frenum type</th>
<th>Group I (primary dentition)</th>
<th>Group II (mixed dentition)</th>
<th>Group III (permanent dentition)</th>
<th>( \chi^2 ) test, p value and significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Simple frenum</td>
<td>361</td>
<td>60.2</td>
<td>421</td>
<td>70.2</td>
</tr>
<tr>
<td>PTF</td>
<td>116</td>
<td>19.4</td>
<td>51</td>
<td>8.4</td>
</tr>
<tr>
<td>Simple frenum with an appendix</td>
<td>7</td>
<td>1.2</td>
<td>9</td>
<td>1.5</td>
</tr>
<tr>
<td>Simple frenum with a nodule</td>
<td>107</td>
<td>17.8</td>
<td>107</td>
<td>17.9</td>
</tr>
<tr>
<td>Double frenum</td>
<td>4</td>
<td>0.6</td>
<td>4</td>
<td>0.7</td>
</tr>
<tr>
<td>Frenum with a niche</td>
<td>5</td>
<td>0.8</td>
<td>5</td>
<td>0.8</td>
</tr>
<tr>
<td>Frenum with two or more variations at the same time</td>
<td>0</td>
<td>0.0</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>600</td>
<td>100.0</td>
<td>600</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Type</th>
<th>Group I (primary dentition)</th>
<th>Group II (mixed dentition)</th>
<th>Group III (permanent dentition)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>1</td>
<td>28</td>
<td>4.6</td>
<td>84</td>
</tr>
<tr>
<td>2</td>
<td>192</td>
<td>32</td>
<td>310</td>
</tr>
<tr>
<td>3</td>
<td>304</td>
<td>50.7</td>
<td>194</td>
</tr>
<tr>
<td>4</td>
<td>76</td>
<td>12.7</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>600</td>
<td>100.0</td>
<td>600</td>
</tr>
</tbody>
</table>

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 niche, 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.,36 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.35 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 access 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.

References
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