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Frenula in the oral cavity – Impact on Craniofacial Development and Respiratory Disorders. Literature Review

Szymon Górski[1]

ORCID ID: 0009-0006-1411-6524

szymon.gorski13@gmail.com

Joanna Okupniarek[2]
ORCID ID: 0009-0007-2446-4810
asiaokup22@wp.pl

Michalina Bartosik[3]
ORCID ID: 0009-0008-8541-1998
michalinabartosik03@gmail.com

Jakub Miarczyński[2]
ORCID ID: 0009-0004-5746-4786
jakub.miarczynski1@gmail.com

Igor Jętasiewicz[2]
ORCID ID: 0009-0008-3351-6392
igor.jetasiewicz@icloud.com

Krzysztof Oborski[4]
ORCID ID: 0009-0004-4366-6897
krzysiek.oborski@wp.pl

Michał Oborski[2]
ORCID ID: 0009-0009-6170-6756
michal.oborski@wp.pl

1 WSPSP - 'Provincial Dentistry' L.L.C., ul. Zdrowotna 6, 85-826 Bydgoszcz, Poland
2 Ludwik Rydygier Collegium Medicum in Bydgoszcz Nicolaus Copernicus University in Toruń, Jagiellońska 13/15, 85-067 Bydgoszcz, Poland
3 Medical University of Łódź, al. Tadeusza Kościuszki 4, 90-419 Łódź, Poland
4 Department of Internal Medicine, Diabetology and Clinical Pharmacology of the Central Clinical Hospital of the Medical University of Łódź, ul. Pomorska 251, 92-213 Łódź, Poland

* Correspondence: szymon.gorski13@gmail.com

ABSTRACT

Introduction. Frenula of the oral cavity are small anatomical structures that play a significant role in the proper functioning of the stomatognathic system. Despite their relatively simple morphology, abnormalities in the structure, length, or attachment of oral frenula may influence feeding, speech, oral hygiene, occlusion, and craniofacial development. Disorders related to labial, lingual, and buccal frenula are observed in patients of all ages and may require interdisciplinary management involving dentistry, orthodontics, speech therapy, and oral surgery. Due to the wide spectrum of clinical consequences associated with abnormal frenula, a thorough understanding of their anatomy, classification, and clinical significance is essential.

Purpose of the work. The aim of this study was to review and summarize current literature concerning the anatomy, classification, and clinical significance of oral frenula, with particular emphasis on their impact on craniofacial development, stomatognathic system function, and dental treatment.

Material and methods. This study is a narrative literature review. Scientific articles, textbooks, and clinical guidelines concerning oral frenula were analyzed. The reviewed literature focused on the anatomy, embryology, classification systems, prevalence, and functional implications of labial, lingual, and buccal frenula, as well as indications for surgical and conservative management.

Results. The analysis of the literature indicates that abnormalities of oral frenula may significantly affect feeding, speech, oral hygiene, periodontal health, occlusion, and craniofacial development. Labial frenula are frequently associated with midline diastema and gingival recession, while lingual frenulum shortening (ankyloglossia) may contribute to breastfeeding difficulties, speech disorders, malocclusion, and sleep-disordered breathing. Buccal frenula, although less frequently discussed, can influence denture retention and gingival health. Numerous classification systems allow for standardized diagnosis and treatment planning. Proper assessment of frenulum morphology and function is essential for selecting appropriate therapeutic approaches.

Keywords: oral frenulum; ankyloglossia; labial frenulum; craniofacial development; stomatognathic system; frenectomy

Frenula are small but clinically significant structures in the oral cavity that every doctor should understand well – in terms of their anatomy, function and clinical significance (e.g. in speech therapy, prosthetics, dental surgery, orthodontics and paediatrics). A frenulum is a fold of mucous membrane that connects a movable part of the oral cavity (e.g. the tongue or lip) to a more fixed structure (e.g. the floor of the mouth or alveolar process).

Its function is to limit excessive movement while maintaining an appropriate range of mobility.

Functional division

Group	Example	Main function
Stabilising	lip and cheek frenula	They maintain the tension of the mucous membrane and stabilise the vestibule of the oral cavity
Movement	frenulum	Restricts and controls tongue movements during speech, swallowing, and sucking

There are four main types of frenula in the oral cavity, depending on their location:

1. Upper lip frenulum (frenulum labii superioris)

The upper lip frenulum is a fold of connective tissue that begins at the midline on the lower surface of the lip. It is located in the central zone of the oral vestibule. [1] It is formed by the mucous membrane of the alveolar process and, in embryological terms, it is a remnant of the tectolabial bands associated with the process of tooth eruption. [2] A thin, triangular fold of mucous membrane. It stabilises and limits the mobility of the upper lip. It helps to maintain the balance of muscle and mucosal tension in the oral vestibule.

The frenulum is mainly composed of collagen fibres, although it also contains elastic and reticular fibres. Its surface is covered with a multilayered squamous keratinising epithelium.

It is not certain whether muscle tissue is present in the structure of the frenulum, but it is currently believed that it is not an essential part of its structure. [3] In children, it may be thicker and extend between the medial incisors.

An abnormally shaped upper lip frenulum can affect both the aesthetics of the face and the functions of the oral cavity. It can cause pulling of the gum line, promote the formation of a midline diastema, and limit lip mobility. [1]

A short or low-attached frenulum may cause:
- diastema (gap between the central incisors) – transient diastema in mixed dentition is considered normal, especially in the absence of erupted permanent canines. First, the presence of supernumerary teeth or cysts should be ruled out, then a 'pull test' should be performed and the degree of ischaemia of the frenulum papilla should be assessed - the presence of these symptoms confirms the active role of the frenulum in the formation and maintenance of diastema. [4]
- difficulties with hygiene, gingivitis, articulation disorders, e.g. with the sounds 'f', 'w' and sibilants [5],
- problems with dentures in the anterior region - extensive resorption of the alveolar bone in edentulous patients causes the frenulum to be located in an area that is crucial for proper denture retention[4];
- complications in active lip movement - with a very short and inextensible frenulum associated with the presence of a thick fibrous connective tissue component [4];
- gingival recession in the upper central incisors [4].

In newborns, the upper lip frenulum is very often routinely cut. The main reason for performing these procedures is to facilitate and improve breastfeeding.

Kotlow attempted to classify the labial frenulum based on its appearance and attachment to the gingiva, distinguishing four degrees:

● Grade 1 – mucosal – attachment located within the mucosa of the alveolar process, with minimal extent,

● Grade 2 – gingival – the frenulum attaches mainly to the gingival tissue, at the junction of the free and attached gingiva,

● Grade 3 – papillary – the attachment is located just in front of the interdental papilla,

● Grade 4 – penetrating the papilla – the frenulum reaches the interdental papilla and may extend as far as the hard palate.

The author of this classification assumes that the higher the degree, the greater the severity of the so-called ‘lip tie’ (i.e. a shortened upper lip frenulum) and the stronger the association with breastfeeding problems. All newborns have some degree of upper lip frenulum attachment. In most children, this structure extends approximately halfway up the upper gum and to the interdental papilla, which corresponds to grades 2–3 in Kotlow's classification or type 2 in Stanford's classification. [6]

Researchers from New York University analysed available publications on the link between the upper lip frenulum (frenulum labii superioris) and the gap between the upper incisors, known as the midline diastema. Based on the research, it was found that certain types of frenulum – especially papillary and papillary-penetrating – are more likely to co-occur with diastema. However, most of these gaps are physiological and may close spontaneously after the lateral teeth erupt. For this reason, frenulum cutting (frenectomy) should not be performed on young children or before the permanent teeth have finished erupting. Only after a dental assessment and possible orthodontic treatment can surgical intervention be considered, especially when the diastema exceeds 2 mm or the frenulum causes tissue tension. [7] People with diastema are more likely to have an overgrown or low-attached upper lip frenulum than people without this gap between their teeth. [8]

A characteristic symptom of an abnormally structured frenulum, known as ‘pull syndrome’, is blanching (ischaemia) of the palatal papilla and the medial edges of the upper gingiva of the central incisors after lifting or pulling the upper lip. [9] The presence of this symptom qualifies the patient for surgery due to the detachment of the marginal gingiva.

The presence of a frenulum classified as abnormal can often be observed in disease syndromes such as: oral-facial-digital syndrome, Ellis-Van Creveld syndrome, Ehlers-Danlos syndrome and others. [10]

Papillary and penetrating attachments require surgical correction. [11]

2. Lower lip frenulum (frenulum labii inferioris): Between the inner surface of the lower lip and the mandibular alveolar process, in the midline. Analogous to the upper lip frenulum.
It stabilises the lower lip and limits its excessive lifting. A frenulum that is too short may: - pull the gum and cause gum recession at the lower incisors - especially if they are associated with a narrow or absent keratinised zone [12]; - make it difficult to maintain the lower denture.

Lower lip frenula can sometimes also cause gum recession, create a central interdental gap, limit lip mobility and affect aesthetics [1] Incorrect positioning of the lower lip frenulum can lead to a shallower oral vestibule, limited lip mobility, which negatively affects its function during speech, and also promotes the development of malocclusion. [13]

Lip frenula are classified morphologically (according to shape and attachment) – classification according to Placek (Placek et al., 1974):

Type	**Frenulum attachment**	**Clinical characteristics**
Mucosal type	It ends in the vestibule mucosa, does not reach the gums	Correct, physiological
Gingival type	It attaches to the edge of the movable gum	May cause pulling of the mucous membrane when moving the lip
Interdental papillae (papillary type)	Reaches the interdental papilla	It is often associated with diastema and gum tension.
Penetrating (papilla penetrating type)	It penetrates between the incisors and passes through the papilla to the palate.	Pathological – requires surgical treatment

Kotlow classification - lip frenulum

Class (grade)	The place where the frenulum attaches	Characteristics/description
Type I – Mucosal	The attachment ends within the mucous membrane of the oral vestibule.	Correct, does not cause tissue tension or spreading of the gingival papillae.
Type II – Gingival (gum)	The frenulum reaches the gum but does not extend beyond the interdental papilla.	It may slightly tighten the tissues, sometimes affecting the aesthetics or the gap between the incisors.
Type III – Papillary (papillary)	The frenulum attaches to the interdental papilla.	It is usually associated with a gap between the teeth (diastema).
Type IV – Papillary penetrating (penetrating the papilla)	The frenulum passes between the incisors, penetrating deep into the papilla and palate.	Considered pathological – often causes diastema, gum recession, feeding and articulation problems.

The author of the classification indicates that a higher score corresponds to a greater severity of the problem and a stronger association with breastfeeding difficulties. [14]

The literature describes numerous morphological variants of labial frenula, including forms with a nodule, cases of double or multiple frenula, as well as frenula with a high attachment point. [15,16,17] Usunięcie wędzidełka wargowego może być zalecane w ramach leczenia protetycznego, ortodontycznego lub periodontologicznego. [18]

A high attachment of the lower lip frenulum is one that reaches as far as the alveolar part of the mandible. Its occurrence is facilitated by a shallow oral vestibule. [19] During chewing, movements of the lower lip can cause tension in the fibres penetrating the marginal or free gingiva. A frenulum that is attached too high on the lip can make it difficult to clean the teeth properly, which promotes the accumulation of bacterial plaque and poor oral hygiene. As a

result, connective tissue attachment may be lost, pathological periodontal pockets may form, and gingival recession may occur. [20]

3. Tongue frenulum (frenulum linguae): The mucous membrane covering the lower surface of the tongue transitions into the mucous membrane of the floor of the mouth, forming a fold running in the median plane, which stretches when the tongue is lifted upwards. This is the lingual frenulum (frenulum linguae). [21] The lingual frenulum is a vestigial embryonic structure with a mainly fibrous structure, formed as a result of the fusion of the tongue with the floor of the mouth during embryogenesis. The genetically regulated process of apoptosis is responsible for separating the tongue from the primitive throat. [22,23]. The lingual frenulum affects the development and growth of the tongue both prenatally and after birth [24] The sublingual ducts (plica sublingualis) are visible at the back. A thin, translucent fold of mucous membrane. It contains connective tissue, sometimes small muscle fibres from the genioglossus muscle.

The shortening of such a frenulum is called ankyloglossia. It is a congenital abnormality of the tongue, consisting of its shortening - this defect can lead to limited mobility of the tongue (partial ankyloglossia) or complete fusion of the tongue with the floor of the mouth (complete ankyloglossia). [25] Ankyloglossia is more common in boys than in girls, with a sex ratio of approximately 3:1. In the general population, the prevalence ranges from 4% to 10.7%, [26,27, 28]. Other studies estimate a prevalence of approximately 5% in the infant, child and adolescent population and 7% among live births [29]. Ruffoli et al. [30] observed no difference between boys and girls. Pavithra et al. [31] reported a prevalence of 16.4% in the Indian population. Most cases were classified as grade I (48%), followed by grade II (30%), grade III (15%) and grade IV (8.85%) according to Kotlow's classification. To assess the attachment and position of the tongue at rest. The assessment of tongue function includes the ability to perform various manoeuvres, such as touching the tip of the nose and chin with the tip of the tongue, forming a ‘cigar’ when protruding the tongue, touching the centre of the lingual frenulum with the mouth wide open, and observing whether the upper jaw closes during these activities, as well as the ability to correctly articulate selected letters and vowels. [32] Walker and colleagues observed that in newborns, the average distance from the tip of the tongue to the attachment of the lingual frenulum at the base of the tongue is 9 to 10 mm. [33]

In newborns, a shortened lingual frenulum can cause sucking and swallowing disorders in the early stages of a child's life. [34,35,36,37] It enables proper articulation, swallowing and

sucking. Studies have shown that ankyloglossia, or a shortened lingual frenulum, breastfeeding [33], while its cutting often leads to improved efficiency of latching the baby to the breast [38], malocclusion, narrowing of the jaw, anterior open bite, gaps between the lower incisors [39]. Guilleminault points out that a shortened frenulum often occurs as a phenotype in children with sleep apnoea [40,41,42,43,44]. In older children, untreated shortened lingual frenulum can lead to articulation and speech problems [45,46,47], often causing difficulties in pronouncing certain consonants ('r', "l", 't') [48,49]. Chiapasco [4] It also draws attention to disorders in the phonation and pronunciation of dental-lingual-pharyngeal consonants, i.e. d, l, n, r, s, t, z, and an increased risk of decay in the lower molars due to poorer self-cleaning as a result of reduced tongue mobility. Studies have also shown that it leads to mouth breathing, changes in tongue position and secondary orthodontic problems, including anterior and posterior crossbite, disproportionate mandibular growth and abnormal maxillary development. [45,47,50]. A shortened lingual frenulum may restrict tongue mobility, leading to a lowered tongue position. A low tongue position, in turn, exerts anterior and inferior pressure on the anterior mandible, which affects the development of facial structures, promoting narrowing of the maxillary arch and the occurrence of posterior crossbite and anterior open bite. [51] Jang and colleagues found that individuals with Class III malocclusion are characterised by a longer lingual frenulum. In addition, they observed that as the length of the frenulum increases, the range of mouth opening decreases. [52].

Kotlow's classification – classification of ankyloglossia

Class (grade)	Length of the frenulum attachment (from the end of the tongue to the attachment point)	Description/interpretation
Class I – typical (mild)	12–16 mm	Correct length, no restrictions on tongue mobility.
Class II – moderate (moderate)	8–11 mm	A slight shortening may slightly affect the function of the tongue.

Class III – severe	3–7 mm	The frenulum clearly restricts tongue mobility; problems with lifting and protruding the tongue.
Class IV – complete (complete)	<3 mm	A very short or almost invisible frenulum, significantly impeding tongue movement and functions such as sucking, swallowing and speaking.

The author of the classification indicates that a higher score corresponds to a greater severity of the problem and a stronger association with breastfeeding difficulties. [14] Speech therapy, which involves eliminating restrictions in tongue mobility and performing specialised exercises, can support the improvement of articulation and overall speech skills in people with ankyloglossia. [53] Some studies indicate that the presence of a high palate and an elongated soft palate may correlate with tongue tie. [54] Guilleminault points out that a shortened lingual frenulum often occurs as a phenotype in children with sleep apnoea. Numerous literature studies have shown an improvement in sleep quality in patients after frenectomy. [40,41,42,43]. Another recognised anomaly is the complete absence of the lingual frenulum. It may occur sporadically or coexist with other disorders [55]. It is often observed in patients with Ehlers-Danlos syndrome, and the literature suggests that its absence may be a simple method for early diagnosis of this syndrome [56,57].

4. Cheek frenulum (frenulum buccae): It occurs on both sides of the vestibule of the mouth (vestibulum oris). It connects the mucous membrane of the cheek with the mucous membrane of the alveolar process of the maxilla and mandible, usually in the area of the molars or premolars [12]. It is a fold of the mucous membrane, similar in structure to the labial frenula, but shorter and thinner, and may contain clearly palpable fibrous elements [12]. On each side, two small folds can sometimes be seen – upper and lower, corresponding to the attachments of the cheek mucosa to the alveolar processes. Covered with stratified squamous keratinising epithelium (continuation of the oral mucosa). In the centre: fibrous connective tissue, small vessels, collagen and elastic fibres. In the vicinity are: the buccinator muscle (m. buccinator),

the parotid duct (ductus parotideus) - its opening is located nearby (parotid papilla, papilla parotidea), which is of surgical importance. It stabilises the cheek mucosa in relation to the alveolar process. It limits excessive mobility of the mucosa during chewing and facial expressions. It helps to maintain the proper tension of the tissues of the oral vestibule, which is important for chewing and swallowing. In rare cases, the buccal frenulum may interfere with the retention of dentures - in such cases, it should be removed or repositioned [12].
Another author stated that cheek frenula can sometimes contribute to gum recession and hinder the proper use of dentures [1], with this phenomenon being more pronounced in the mandible than in the maxilla [58]. Cheek and lip frenula play an important role when taking impressions for complete dentures. [59,60]

Cheek ties help maintain the correct position of the lips and cheeks. When they are too tight or restrictive, they can hinder free movement during activities such as eating, speaking or smiling. [61]

There are reports describing the anatomical and histological structure of the frenulum [62,63,64,65]. The results of these studies currently form the scientific basis for surgical procedures in cases of high frenulum attachment. [66,67]

Frenulum adhesions can cause feeding problems and air swallowing in infants, and in children and adults they can contribute to difficulties in maintaining oral hygiene, tooth decay, gum recession, speech disorders and other conditions related to facial tissue tension. [68]
Oral surgery/periodontology: In patients with a thin gingival biotype, frenulum tension can cause gingival recession in the posterior teeth and make it difficult to maintain hygiene in this area. If necessary, surgical repositioning or incision is performed. In children: It can be a source of pain or injury during brushing if it is too short. However, it usually does not require treatment unless it causes functional limitations.

Discussions

Although small in size, the oral frenula play a significant role in the development of the facial skeleton and the functioning of the stomatognathic system. Their structure, length and point of attachment can significantly influence processes such as breathing, swallowing, sucking, speech and the development of the bite. Abnormalities of the frenula – particularly the lingual frenulum (ankyloglossia) and the upper lip frenulum – can lead to feeding difficulties in infants, articulation problems, difficulties in maintaining oral hygiene, as well as malocclusions and

abnormal growth of the craniofacial structures. Limited tongue mobility affects its resting position, which may result in a narrow jaw, an open or crossbite, and promote mouth breathing. In the context of respiratory disorders, a link has been demonstrated between a shortened lingual frenulum and the occurrence of mouth breathing and obstructive sleep disorders, including sleep apnoea. Abnormal tongue position and altered dental arch morphology may affect upper airway patency. Lip frenula, on the other hand, may contribute to the development of diastema, gingival recession, and aesthetic and functional problems. Buccal frenula, although less frequently analysed, are significant in the context of periodontal health and prosthetic treatment. It is emphasised that proper diagnosis should include both morphological and functional assessment. Treatment - whether conservative or surgical - should be individualised. It is emphasised that proper diagnosis should include both morphological and functional assessments. Treatment - whether conservative or surgical - should be tailored to the individual and often requires interdisciplinary collaboration (dentistry, orthodontics, speech therapy, surgery). Excessive or premature surgical interventions are not recommended without clear functional indications.

Author's Contributions:

Conceptualization: Szymon Górski, Joanna Okupniarek, Michalina Bartosik, Igor Jętasiewicz
Formal analysis: Michał Oborski, Krzysztof Oborski, Igor Jętasiewicz, Jakub Miarczyński
Investigation: Joanna Okupniarek, Michalina Bartosik, Jakub Miarczyński
Writing rough preparation: Szymon Górski, Joanna Okupniarek, Michalina Bartosik, Igor Jętasiewicz, Krzysztof Oborski, Michał Oborski, Jakub Miarczyński
Writing review and editing: Szymon Górski, Igor Jętasiewicz

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