Tongue tie from an osteopathic perspective

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Date of submission: 20.05.2023

Program: Doctor of Philosophy in Osteopathic Clinical Rehabilitation

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1. Introduction

The tongue plays a fundamental role in various bodily functions such as swallowing, breathing, speaking, and chewing, and is one of the human sensory organs. As part of the deep fascial chain and as part of the midline, it is directly connected to the hyoid, the mediastinum and the lungs, the diaphragm, the iliopsoas, the adductors, the popliteal fossa and, running on, the flexor digitorum longus and hallucis digitorum longus. Restrictions in tongue mobility can often be compensated for and masked by the body's adaptability, but mostly lead to significant functional restrictions in the immediate vicinity or in the compensating structures, in the short or long term.

In newborns a tongue restriction might be easily detectable due to issues with breast feeding, but due to controversy over the tongue-tie topic, many tongue-tied babies, who have not been treated or undergone surgical release, often experience symptoms as they grow older but fail to make the link to their restricted tongue. Those youth or adults might become patients in the osteopathic clinic because of, for example headaches, migraines, sinusitis, shoulder-neck problems or breathing difficulties. Therefore, it is important to assess the tongue's mobility as part of the regular patient assessment routine. Otherwise, symptoms are treated, but not the cause.

2. Background

Affecting 4-16% of all newborns, ankyloglossia (tongue-tie) is believed to be associated with breastfeeding issues such as insufficient latching and pain for the mother (Delgado et al., 2018; Ferres-Arnat et al., 2016; Wei et al, 2020). Boys are affected twice as often as girls (Khoo et al., 2009; Messner et al., 2000; Martinelli et al., 2016). Most cases are believed to be sporadic rather than genetic, and commonly it is an isolated anomaly (Becker and Mendez, 2021), ethnic differences do not exist (Maya-Enero et al., 2021), but often a familial accumulation can be observed (Han et al., 2012).

A restrictive lingual frenulum can limit the mobility of the tongue. The tongue plays an important role in speech, swallowing, sleep, and breathing and adequate tongue mobility is essential for optimal growth and development of the upper and lower jaws. Patients with very severe tongue tie can often present with swallowing or speech issues that can hopefully be identified and addressed early. On the other hand, patients with mild to moderate tongue-tie might often present in a less obvious fashion and so their tongue tie may go unrecognized for a long time. A restricted tongue can also present with almost no symptoms that the patients has noticed; they may have compensated for a long time already, their whole life, and do not know what is normal. Often, they are searching on other levels for a cure and explanation of their symptoms (for example stress, sleep disorders, burnout).

Because the mobility of the tongue is restricted in the tongue tie condition, the back of the tongue takes a posterior and inferior position which can block the airway and cause problems with sleep. These individuals often complain of difficulty sleeping on their back, snoring, or restless sleep and unrefreshing sleep. Compensation patterns during sleep may develop including open mouth breathing, teeth clenching, or predominant side-sleeping that can have secondary effects on maxillofacial development and temporomandibular health, and cause musculoskeletal posture issues. Similarly, compensation patterns such as forward head posture, anteriorly rolled shoulders, and other myofascial restrictions may also be adopted to offset the

limitations of a restricted upper airway in affected patients even while they are standing upright and awake.

The tongue, its direct surroundings and its function are almost neglected in osteopathic diagnostic systems and treatments, although it plays a fundamental role in several body functions, such as swallowing, breathing, speaking and chewing (Bordoni et al., 2018). The tongue tie can have severe consequences during breast feeding, amongst other things, and later for posture if missed. Very often, patients with chronic shoulder-neck issues, breathing difficulties, and bad posture have never been checked for tongue mobility restrictions.

It is therefore important to highlight the tongue's anatomy, embryology, its connections and functions in order to understand approaches to diagnoses and treatment.

3. Anatomy

The lingual frenulum is a dynamic structure along the median line formed by a fibro-mucosal fold that connects the inferior body of the tongue and the mucosa covering the floor of the oral cavity and consists of dense connective tissue and, occasionally, of the superior fibres of the musculus genioglossus.

The tongue is directly connected to the hyoid bone and has connections to the whole body through the fascial diaphragms and connective tissue all the way down to the feet (Stecco, 2014; Schultz and Feitis, 2013).

It is part of the stomatognathic system that consists of the temporomandibular joints, bones forming the oral cavity, soft tissue (gingiva, mucosa, tongue, cheeks, lips, and glands), muscles involved in chewing and swallowing, and teeth.

The tongue forms the end of the anterior deep fascial train which connects it with the lung, the mediastinum, the diaphragm, the musculus quadratus lumborum, the musculus psoas major and iliacus, attached to the symphysis pubis, the adductors, the knee capsule and the musculus popliteus, the deep posterior compartment, the musculus flexor digitorum longus, the musculus tibialis posterior and the musculus flexor hallucis longus fascial (Myers, 2020). Therefore, tension and/or restriction in tongue mobility might affect all of these structures and may place tension on the deep front line of fascia, among other connective tissue networks, and contribute to neck tension, pain and postural dysfunction (Scoppa, 2005).

The complex tongue derivation is the reason for the complex innervation of this structure that involves the 5^{th} (N. trigeminus), the 7^{th} (N.fascialis), the 9^{th} (N.glossopharyngeus), the 10^{th} (N.vagus) and the 12^{th} (N.hypoglossus) pairs of cranial nerves.

4. Embryology

The tongue originates from the first, second and third pharyngeal arches during the fourth week of gestation. In this phase, grooves are formed laterally to the structure, so that it can move freely, except for the region which adheres to the lingual frenulum, initially at the apex of the tongue. As development occurs, the cells of the frenulum undergo apoptosis and tend to migrate

distally to the medial region of the lingual dorsum. At this point, interferences in cell control may result in their incomplete, or non-migration, establishing the condition of ankyloglossia (Pompeia et al., 2017).

The tongue is a key organ in the growth and development of bone structures that are influenced by the forces activated during these stages (Dezio et al., 2015).

5. Function

One of the osteopathic principles – structure governs function (and vice versa) – highlights the issue of restricted tongue mobility. The short frenulum as a structure impedes the normal function and normal development of its connected structures.

The un-tethered mobility of the tongue is required for optimal speech, chewing, swallowing, oral hygiene, and breathing functions (Yoon et al., 2017, a), as well as for development of the maxillofacial complex and upper airway (Yoon et al., 2017, b). Key movements of the tongue include lift, extension, cupping and lateralization (Wilson-Clay and Hoover, 2019). Because the tongue plays such an important role in so many functions, restricted mobility of the tongue muscle may lead to dysfunctional compensations that may negatively affect nasal breathing and snoring, due to low tongue posture, or contribute to chronic stress on the other muscles of the head and neck (Zaghi et al., 2019).

The position of the tongue influences the whole body. If the tongue is positioned against the palate, the parasympathetic system will reduce its systemic activity, but if it is positioned against the soft palate the sympathetic system will reduce its activity (Schmidt et al., 2009). When resting against the hard palate, the tongue acts as a natural orthodontic expander, serving as a guide for maxillary growth (Cockley and Lehman, 2015).

The tongue plays an important role in the development of craniofacial structures. At rest, the light and constant pressure of the tongue against the hard palate, counterbalanced by the pressure provided by proper lip sealing, serves as a guide for maxillary growth and expansion (Cockley and Lehman, 2015; Genovez et al., 2016).

Praetzel et al. (1997) concluded that the growth and development of the face depend on the correct functional performance of the entire stomatognathic system, and by analogy, dysfunctions in respiration, suction, swallowing, chewing and phonation are closely related to changes in the shape of the arches and their relationship with their respective bone bases.

Several studies have been published relating ankyloglossia to breastfeeding difficulties (Berry et al., 2015; Buryk et al., 2011; Hogan et al., 2005), sucking (Martinelli et al., 2015), chewing and speech, as well as sleep related breathing disorders and craniofacial growth.

The anterior part of the tongue is considered important for non-respiratory activities, while the posterior part is important for respiration (Zaidi et al., 2013).

Factors related to lingual shape and functionality are, the posture of the cervical spine, especially in the atlanto-occipital hinge, lip seal and breathing, the TMJ and relationships with the intermaxillary bones (Dezio et al., 2015).

Di Vico et al. (2013) investigated the acute effect of tongue position in healthy people on knee isokinetic test performance. The study showed a significant improvement with the tongue in the up high/palatine position compared to mid or low position. The improvements were visible at both, low and high speed, power and acceleration and might indicate a relationship between the tongue and central nervous system path referable to phasic activity.

6. Definition of tongue tie

The terms "tongue tie" (TT) and "ankyloglossia" are used synonymously to represent a condition where movement of the tongue is assessed as being limited (Mills et al., 2019). It is a condition of altered tongue mobility due to the presence of restrictive tissue between the under-surface of the tongue and the floor of the mouth (Zaghi et al., 2019).

Restricted tongue mobility may be caused by a short mucosal lingual frenulum and/or by submucosal myofascial fibres of the underlying genioglossus muscle that are fibrosed and impair optimal oral functions (Horton and Crawford, 1969). In a lingual frenulum with ankyloglossia the high proportion of type 1 collagen fibres in deep areas may explain the restriction in tongue movement (Martinelli, 2014). In examples of anterior lingual frenulum and short frenulum with anterior fixation, fewer bundles of elastic fibres were observed. Ankyloglossia may also be attributed to scar tissue from a prior surgical procedure or other trauma. It may also be associated with a range of malformation syndromes (Wilson-Clay and Hoover, 2019).

7. Diagnostics

Discussion of tongue tie is complicated by the lack of universally accepted, standardized diagnostic procedures for identifying cases in which there is a problem. Several observation-based assessment tools have been developed. They are centred on the appearance of the lingual frenulum, and where it attaches to the tongue and the floor of the mouth (Coryllos, 2004). Functional aspects of movement and sucking as well as appearance are also assessed (Hazelbaker, 2017). The Bristol Tongue Assessment Tool (BTAT) was developed with reference to the Hazelbaker Assessment Tool for Lingual Frenulum Function (ATLFF) and provides a more simplified assessment (Wilson-Clay and Hoover, 2019). Ingram et al. (2015) developed TABBY – a picture tongue assessment tool for the visual screening of form and functionality.

The diagnosis of restricted tongue mobility consists of three parts: visual and manual testing, an active test for tongue mobility, and third, an assessment of functionality that is mostly conducted using a validated questionnaire or screening tool.

An attachment of the lingual frenulum closer to the tip of the tongue, the more classically recognized appearance, is now commonly referred to as an anterior tongue tie. The term posterior tongue tie has been used more recently to describe a short, thick, or fibrous cord of

tissue at the base of the tongue that limits the ability of the tongue to lift. Very often the appearance is submucosal and not really visible, with tension or restriction in the floor of the mouth needing to be palpated for diagnosis (Chu and Bloom, 2009; Hong et al., 2010; O`Callahan et al., 2013; Pransky et al., 2015; Ghaheri et al., 2017). Hong et al. (2010) reported a female predominance amongst posterior tongue ties. Anatomically, it might be easier to classify types of tongue-tie as anterior, posterior and middle part of a tongue-tie.

The absence of documentation of a relationship between the current tongue tie grading systems and the presence and/or severity of functional restriction (Messner et al., 2000; Hong et al., 2010) strongly suggests that other variables must also impact on tongue function other than this feature alone. Symptoms are more important than appearance (Baxter et al., 2020).

The osteopathic assessment, besides the general structural and functional assessment of the tongue, looks at all structures that affect, nourish and stimulate structures of the tongue, and also, all structures of the deep anterior fascia. The midline needs to be assessed for signs of tension or limitation as the tongue is part of the midline.

8. Symptoms in daily clinic

In the presence of ankyloglossia, the lingual frenulum hinders the coupling of the tongue at rest against the hard palate (Martinelli et al., 2016), resulting in a high and narrow palate (Cockley and Lehman, 2015; Huang et al., 2015). Thus, an incorrect tongue positioning must not be neglected, as it interferes with orofacial growth, which is fast in the first years of life, as widely stated in the literature (Huang et al., 2015).

Swallowing in mature individuals is the result of the combined action of masticatory and lingual muscles, and it never involves mimic muscles; if facial muscles are visible, a functional imbalance is probably present. Swallowing in a newborn is different from that of a typical adult: it is defined as swallowing with lingual push and occurs according to the sucking-swallowing-breathing scheme, when the diet is liquid.

The shortness of the lingual frenulum can affect the physiological posture of the tongue and its neuromuscular behaviour (Dezio et al., 2015).

A short frenulum causes lingual dysfunction, especially on the sagittal plane. Different types of malocclusion are related to the length of the frenulum and the neuromuscular action. In the case of tongue tie, the tongue is positioned low in the mouth, and if there is also dental interposition and a hypertonic lip seal, there will be an open bite. A hypotonic lip seal will lead to a grade 2 or 3 malocclusion with adaptations in the development of mandibular and maxillary bone. The pushing of the tongue between the superior and inferior teeth can cause a retrusion of the inferior teeth.

Ankyloglossia prevents affected individuals from touching the hard palate or buccal mucosa with their tongues or protruding them (Baxter et al., 2020). This allows the tongue, especially during sleep, to "fall" into the pharynx and restrict or obstruct the airway and leads to sleep disordered breathing or sleep apnoea (Zahi et al., 2019; Baxter et al., 2018) in children (Guilleminault et al., 2016; Huang et al., 2015) and adults (Chien and Guilleminault, 2017).

Studies have also reported that low tongue mobility prevents some simple activities such as licking ice-cream, removing food leftovers from teeth after deglutition, moistening lips, French kissing or playing wind instruments, and may cause social embarrassment (Lalakea and Messner, 2003a; Vieira et al., 2004).

Speech impairments and articulation disorders can be caused by ankyloglossia. The letters t, d, n, l, s and z require an elevation of the tongue. A restricted tongue may cause mispronounced phonemes (Lichnowska and Kozakiewicz, 2021).

Often a restricted tongue is hidden in visual testing by a compensatory lifting of the floor of the mouth. The salivary glands are lifted as well and triggered to produce saliva which leads to more saliva than usual.

Possible symptoms of tongue mobility limitation in newborns/babies

- difficulty breastfeeding
- cannot keep baby pacifier in the mouth
- gassy, suffers from colic
- poor growth and poor weight gain
- restless, anxious, stressed babies
- mum suffers nipple pain, pinched nipple, mastitis, milk flow limited, not enough milk, milk stasis, reduced milk ejection reflex, uses a nipple shield
- poor latch, white tongue (not thrush), clicking noises while sucking, pinching, poor seal, suction bladder, two-toned-lips, back-and-forth movement on breast
- short duration but high frequency breastfeeding
- gagging, choking
- frequent hiccups (as well in the womb)
- obstipated or diarrhoeal
- reflux
- asymmetric face
- preferred rotation cervical to one side (restricted rotation cervical)
- restricted mouth opening
- restricted tongue mobility
- characteristic tongue form: heart-shape on the tip, dent, slide, pointed, broad,
- retrograde mandibulae
- low tongue-position
- avoiding prone and supine position
- delayed development in prone position, delayed turning supine prone position
- high, narrow or arched palate
- mouth breathing
- excessive drooling in side lying position

Possible symptoms of tongue mobility restriction in youths/adults

- poor posture (head translated anteriorly, OAA-tension, shoulders translated anteriorly, hyper lordosis, thoracic tension-kyphosis)
- chewing with open mouth
- eat noisily, slurp, gobble
- frequent choking, gagging

- frequent hiccups
- pain chewing
- TMJ problems
- OAA-tension
- using compensatory muscle activity to open mouth (for example wide eye opening)
- headaches
- cervical pain
- cervical-thoracic pain
- shoulder-neck pain, chronic shoulder-neck tension
- thoracic pain
- SI-joint problems, knee pain, foot pain (insoles?)
- general stiffness
- concentration problems
- problems at school or work
- tiredness
- ADHD symptoms
- frequently visits dentist, dental issues
- malocclusion
- orthodontics
- frequent coughing
- frequent infection: ear, nose, throat, sinuses
- suffers from polyps
- enlarged tonsils
- pneumonia
- suffers from allergies
- sensitive skin
- endurance activities limited (sport tend to concentrate more on strength/fitness)
- mouth breathing
- breathing difficulties (asthmatic difficulties)
- diaphragmatic dysfunctions
- snoring
- waking up at night
- tooth clenching/biting
- drooling in prone or side lying position
- teeth marks on tongue
- difficulty playing wind instruments
- scared to swallow medication/pills, scared to visit dentist
- speech impairments, articulation disorders
- has used a speech therapist
- food trapped in the cheeks
- others in family are tongue tied

9. Therapy modalities

The treatment of ankyloglossia after assessment is surgical (CO^2 -laser, laser, scissor), since the histological constitution of the lingual frenulum does not allow it to rupture alone or to be stretched by means of exercises (Martinelli et al., 2014). Its benefits for breastfeeding have been

reported in several studies (Berry et al., 2011; Buryk et al., 2011; Hogan et al., 2005; Emond et al., 2014; Martinelli et al., 2015). However, exclusive breastfeeding is recommended only until the 6th month of life and may extend up to 2 years, while chewing, swallowing, breathing and speech are functions performed throughout life and highly influenced by craniofacial growth.

Frenectomy indication criteria, however, depend on the expert's profession and knowledge about the condition (Morisso et al., 2012). Caloway et al. (2019) emphazise the need for multidisciplinary assessment, and support the need for collaborative work to ensure careful selection of those who might benefit from frenectomy.

Findings from Martinelli at al. (2021) support the importance of early diagnosis and treatment of ankyloglossia, not only to deal with breastfeeding difficulties, as recommended by some governmental guidelines, but also to prevent the down tongue position, which interferes with orofacial growth and the correct positioning of both the tongue and lips at rest (Buryk et al., 2011; Berry et al., 2012).

In addition to the negative effect of functional imbalances caused by ankyloglossia during the growth and development of the stomatognathic system, correction of the resting position of the tongue improves the positioning of the hyoid bone, reducing negative muscle pull on the mandible, thus avoiding occlusal alterations (Pompeia et al., 2017).

Osteopathy is important in the treatment of the whole of the tongue and stomatognathic system influencing structures independent of the degree of restriction. Possible aims are:

- Improvement of the range of motion of the OAA-complex
- Improvement of mouth opening
- Harmonisation of diaphragms (tentorium cerebelli, floor of mouth, thoracic inlet, abdominal diaphragm, urogenital diaphragm, plantar aponeurosis)
- Improvement of thoracic and thoraco-lumbar mobility
- Harmonisation of the deep anterior fascia to support the stomatognathic system
- Harmonisation of all neurologic and vascular structures of the stomatognathic system
- Release of cranial tension and compression to enhance blood flow and circulation
- Monitoring of the tongue and its symptoms for possible future interdisciplinary interventions

Rational treatment is based upon an understanding of the basic principles of body unity, self-regulation, and the interrelationship of structure and function.

10. Osteopathic literature

Potential implications of restricted tongue mobility (such as mouth breathing, snoring, dental clenching and myofascial tension) remain underappreciated due to limited peer-reviewed evidence (Zaghi et al., 2019).

There is still limited research relating to treatment of ankyloglossia among children (Ferres-Amat et al., 2016), adolescents (Lalakea and Messner, 2003, a) and adults (Chinnadurai et al., 2015; Lalakea and Messner, 2003, b; Lichnowska and Kozakiewicz, 2021).

The subject of tongue-tie is almost untouched by contemporary osteopathic studies, but research into the older literature revealed several relevant articles from the late 1800s, and early 1900s. It shows that the structural restriction of the tongue was already known about at that time and treated by AT Still, his students and MDs.

11. Discussion

Existing tongue ties can present with a wide variety of manifestations and symptoms. A professional and precise examination is the basis for deciding which therapy is appropriate.

Osteopathy can play a major role in diagnostics and therapy, both without and before and after surgery. Paediatric osteopaths see and treat large numbers of newborns and babies each day, and are often amongst the professionals who could identify tongue ligament problems early in their patient's life if the appropriate expertise were available. Conspicuous tongue ligaments are best loosened as early as possible, or the other option is to treat the surrounding area as early as possible in order to determine whether the symptoms will abate and normal development can be supported and enhanced with osteopathy and an interdisciplinary team approach.

In children, adolescents and adults, it is important to carry out an assessment of the mouth and swallowing system, especially if there is a conspicuous medical history. It is often realised too late that doctors, specialists or dentists – especially neonatal practitioners – could have checked for the presence of tongue tie, but early detection is not always facilitated by current practice.

12. Conclusion

There is a consensus among authors concerning the negative anatomical and functional effects that the lingual frenulum can have on craniofacial growth and development. Opinions about early surgical intervention, however, are not unanimous (Pompeia et al., 2017).

Due to the high prevalence of tongue ties and its strong influence on growth, development and function, the osteopathic assessment of the tongue and its function should be part of a general osteopathic screening, whether in newborns or in youths or adults, especially if symptoms are present.

The therapy and diagnostics of the frenulum tongue ligament and its parts are sometimes controversially discussed by the medical disciplines in everyday clinical practice and in scientific literature (Simon, 2021). A correct diagnosis and timely therapy can save mothers and newborns from major breastfeeding problems. Therefore, this relevant and treatable obstacle to breastfeeding should be considered in maternity clinics, in paediatric assessments and in osteopathic newborn check-ups and baby treatments.

Whilst confirming the presence of a lingual ligament does not provide information about its functional impairment or otherwise, the functional restriction of anterior and posterior tongue ligaments can cause significant problems. The use of functional diagnostics of tongue mobility is therefore preferable to inspection of the sublingual region alone.

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