Does a short lingual frenulum affect body posture? Assessment of posture in the sagittal plane before and after laser frenulotomy: a pilot study.

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The factors that characterize posture are neurophysiological, biomechanical, psychoemotional. Neurophysiological factors concern the modulation of tone, muscle tone is the result of a series of neuropsychological processes within the tonic-postural system. The tonic-postural system can become unbalanced for various reasons, including a tight lingual frenum. The aim of this pilot study was to evaluate the benefits of frenulectomy by laser on body posture and on the scapular (shoulders) anteroposterior movement. Twenty-four healthy subjects were selected, between the ages of 10 and 26 years (mean age 15.22) who presented a short lingual frenum and a low posture of the tongue and jaw. They were examined using the Marchesan Protocol for Lingual Frenum and the Spinometry® Formetric and underwent laser frenectomy by diode laser (Siro Laser Blu. 660 nm) without any post-surgery complications. The release of the frenulum immediately brought benefits to patients, reorganizing the physiological modulation, and the movement of the tongue within the normal parameters of temporomandibular kinematics which were within physiological parameters. Frenectomy improved the anterior-posterior flexion of the scapulas (shoulders) in the sagittal plane but a larger sample is required to have statistically significant results.

Although posturology has increasingly focused attention on the stomatognathic receptor in the modulation of the tonic-postural system, due to the anatomical relationships that connect the tongue / jaw / hyoid bone, in the implementation of physiological functions — primary and not — the correlation swallowing-chewing-occlusion-posture requires a multidisciplinary approach (Box 1).

Box 1. *Muscle, functional and postural alterations due to short lingual frenum*

Neurophysiological factors concern the modulation of tone, muscle tone is the result of a series of neuropsychological processes within the tonic-postural system. This system has specific inputs consisting of information from specific posture receptors: the foot, the eye, the stomatognathic

Key words: posture, short lingual frenulum, laser, frenectomy, tongue

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0393-974X (2020)

system, the skin, the musculoskeletal system. Biomechanical factors concern the relationships between bodily attitudes and the force of gravity. Psychoemotional factors can affect the postural system. (25-30)

In the case of a short lingual frenulum, which reduces the mobility of the tongue and its position, almost resting on the buccal floor, numerous and complex modifications of the physiological mechanisms are determined. The alterations in the physiological function of swallowing are widely documented in the literature. In particular, the difficulty in lactation / feeding in newborns with short lingual frenum often indicated surgical treatment. A rather small number of scientific studies have instead addressed the issue of the short lingual frenum in the young adult. The study aimed to investigate, by means of clinical and instrumental evaluation, whether in young adults there is a correlation between a short lingual frenulum and the tonic-postural system before and after a laser frenectomy. In particular, the measurements focused on the anterior-posterior flexion of the scapula (shoulder) in the sagittal plane (VP-DM) as anecdotal reports from patients mention

Table I. *Lingual Frenulum Protocol by Marchesan 2012.*

Measurements using a caliper. Larger or equal 50,1% (0) – Less or equal 50% (1) FINAL RESULT =

Take measurements from superior right or left incisive to the inferior right or left incisive. Consider the same tooth for all the measurements.	Value in millimeters
Open mouth wide	
Open mouth wide with the tongue tip touching the incise papilla	
Difference between the two measurements, in percentage	%

Alterations during tongue elevation (best result = 0 e worst result = 2) FINAL RESULT =

Open mouth wide; raise the tongue without touching the palate	NO	YES
1. Tip of the tongue's shape: oblong or square	(0)	(1)
2. Tip of the tongue's shape: like a heart	(0)	(1)

Frenulum fixation. Add A and B (best result = 0 e worst result = 3) Final result =

A – Mouth floor:	
Visible only from the sublingual caruncles	(0)
Visible from inferior alveolar crest	(1)

Fixation in another point: _____

B – Sublingual:	
In the middle of the tongue	(0)
Between the middle and the apex of the tongue	(1)
At the apex	(2)

Clinical frenulum classification (best result = 0 e worst result = 2) Final result =

Normal	(0)	Borderline	(1)	Altered	(2)

If the frenulum was considered altered it would be because:

The frenulum seems normal but it is attached between the middle and the apex of the tongue	The frenulum is short	The frenulum is short and it is fixed between the middle and the apex of the tongue	
Ankyloglossia (frenulum attached to apex of the tongue)		Another reason	Unsure

Measurements using a caliper. Larger or equal 50,1% (0) – Less or equal 50% (1) FINAL RESULT =

Take measurements from superior right or left incisive to the inferior right or left incisive. Consider the same tooth for all the measurements.	Value in millimeters
Open mouth wide	**46,00**
Open mouth wide with the tongue tip touching the incise papilla	**37,55**
Difference between the two measurements, in percentage	**81,63%**

that right after the frenectomy they feel that they can stand up straighter and the "shoulders open". The parameter spinometry of the antero-posterior plane (VP-DM) indicates retroflection and it was chosen because it refers to (31-33):

VP = prominent vertebrae;

DM = midpoint of the straight line join;

DR and DL = right and left dimples (Michaelis' dimples).

MATERIALS AND METHODS

Twenty-four patients were selected, between the ages of 10 and 26 years (mean age 15.22) who present with ankyloglossia as defined as: a short lingual frenulum, or a frenulum with an anterior insertion closer to the dental arch, or a short one with an anterior insertion. All participants provided the informed consent to the study.

The study was conducted according to the principles outlined in the Declaration of Helsinki and in accordance with the principles outlined by the scientific commission of the biomedical sciences department of the University of Sassari, Italy. The study was approved by the scientific commission of the Department of Biomedical Sciences, University of Sassari, Italy.

The subjects were evaluated using a portion of the "Lingual Frenulum Protocol" by Marchesan 2014 (Table I) which was considered sufficient to diagnose the condition. Measurement of the lingual frenum (Fig. 1) was taken with a digital caliper, as per protocol instructions, and expressed in mean millimeters +DS. It was performed by asking the patient to open his/her mouth wide and the distance between the upper and the lower incisors was registered. Then the patient was asked to elevate the tip of the tongue and touch the retro-incisor papilla (often clinically referred to as the "spot") and a second measurement was taken between the upper and the lower incisors. Then a difference between the two measurements was calculated, in percentage. A difference of less or equal 50% was assigned a score of 1 while a percentage of 50.1% and above was assigned a score of 0. The limit score for that section was equal to/greater than 3 on a maximum score of 8 (worse score, suggesting a significant ankyloglossia). Best score for this section of the protocol would be 0, suggesting an anatomically normal lingual frenum.

For body postural evaluation, all subjects underwent instrumental evaluation by using the Spinometry® Formetric 4D (Fig. 2, 3). This is an analysis system that performs a detailed and extensive (without the use

Fig. 1. *Steps to evaluate the tongue elevation in the presence of a short lingual frenum, before and after surgical laser frenulum release.*

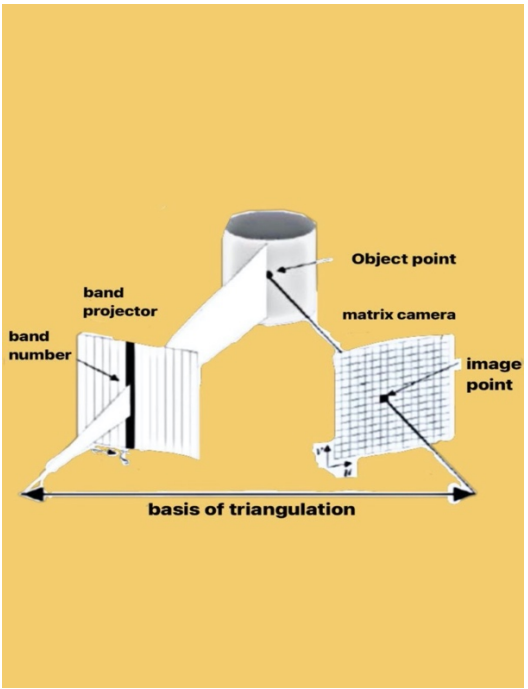

Fig. 2. *Principles of the Spinometry® Formetric 4D, an analysis system that performs a detailed and extensive, non-invasive, three-dimensional optical detection, static and dynamic, of the entire vertebral column and pelvis, providing precise quantitative data (error less than 0.2 mm).*

of markers) non-invasive three-dimensional optical detection (without X-rays and without any side effects), static and dynamic (in motion), of the entire vertebral column (rachis) and pelvis, providing precise quantitative data (error less than 0.2 mm) and repeatable with graphic representations of numerous postural problems. The subject is positioned standing 2 meters away from the system which projects halogen light on the back side of the body surface in the form of a special grid with horizontal lines. Thanks to this optical scan, the formetric system automatically detects the anatomical landmarks (C7 or prominent cervical vertebra, sacrum, lumbar vertebrae, or the Michaelis' dimples of the lower back), the midline (line of symmetry) of the spine and the rotation of each segment. The landmark considered more relevant for analysis in this study was the scapular anteroposterior flexion or retroflexion.

All postural and oral objective evaluations were made before and after frenectomy. The frenectomy was performed using a diode laser 660 nm (Siro Laser Blu). The frenectomy was performed on all patients by the same operator.

In addition, all patients underwent a period of orofacial myofunctional therapy using a specific protocol (Saccomanno 2019), for one month, with a frequency of 3 office visits per week, which included the assignment of home exercises specifically designed to improve tongue mobility prior to surgery and after frenectomy (Table II). The myofunctional protocol requires the exercises to be repeated 3 times a day for 15 minutes a day (5 min x 3) for 1 month before and 3 months after the surgery.

Data distribution was tested for normality (kurtosis and asymmetry) confirming normal distribution and thus before and after surgery were tested with Student T test for paired samples. All data were processed using Statistical Package for the Social Sciences (SPSS 25.0, SPSS Inc., Chicago, USA). The sample size was calculated acknowledging a preoperative mean of 18.67±22.28 mm in order to assess a minimum difference of 10% with an alpha of 0.05 and an 80% power using formula for continuous paired samples indicating an ideal sample size of 787 patients.

RESULTS

The results show that laser frenectomy positively influenced the tongue movement and the overall clinical aspect (Table III). The intervention with the diode laser resulted in frena release without bleeding and therefore with primary healing that avoids the formation of scar bridles. Our study confirmed

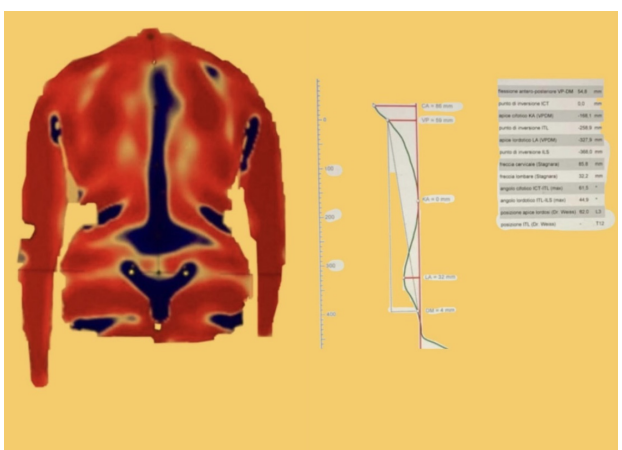

Fig. 3. A-B *Analysis of the spinometric image of a patient's back, shoulders and hips.*

Table II. *The myofunctional therapy protocol's home assignment list.*

Exercise #1	Raise your tongue up onto the "spot" (retro-incisive papilla), repeat X times
Exercise #2	Lift the tip of the tongue just behind the spot, repeat X times
Exercise #3	Place the tip of the tongue on the spot, hold it there and close your mouth, repeat X times
Exercise #4	Hold the tip of your tongue on the spot and open your mouth, repeat X times
Exercise #5	Stick your tongue out, repeat X times
Exercise #6	Make circular movements with the tongue first to the right then to the left following the inner surface of the teeth, repeat X times
Exercise #7	Make circular movements with the tongue first to the right then to the left on the outer surface of the teeth, repeat X times
Exercise #8	Move the tip of your tongue as close as you can to your nose, repeat X times

Table III. *Tongue elevation improvement (open mouth, tongue on the retro-incisive papilla) and scapular anteroposterior movement (shoulder opening) expressed in mean millimeters (± standard deviation) as measured with the Spinometry.*

	Before surgery	After surgery	Significance
Average lingual frenulum protocol score	4.7±1.1	0.5±0.7	P<0.01 (Significant)
Max mouth opening	18.7±22.2	17.7±19.0	N.S.
Tongue to palate with mouth open	21.0±22.5	18.9±19.1	N.S.

previous findings that laser frenectomy avoids bleeding, use of sutures and post-surgical pain (6); furthermore, the release of the frenulum and the immediate post-operative support of myofunctional rehabilitation of the tongue mobility showed improvement of the range of motion and movement pattern of the tongue, possibly related to the neuroplastic influence of repeating new movements with the tongue now freer to move in all planes of space.

Regarding posture, unfortunately the small sample showed no statistical significance although in all of the patients the spinometry revealed "shoulder opening" (Table III-IV), a change to the anterior-posterior flexion in the sagittal plane of the reference anatomical landmarks previously described. The pre- and post-operative comparison of measurements taken by spinometry, during tongue elevation to the retro-incisive papilla, via paired samples showed a mean base of 18.67±22.8 vs 17.67±19.02 and a

value during tongue elevation of 21.08± 22.52 before surgery versus 18.91±19.17 after surgical release. Both differences showed no statistical significance as mentioned above for the sample size which is small.

DISCUSSION

We know that an alteration of the lingual frenulum can affected the normal function and development of the orofacial complex. The presence of a short lingual frenum in children and adults has been linked to problems in swallowing, sleep breathing as well as posture, and often it requires a surgical release. Our study confirmed the utility of laser frenectomy and even though this is a pilot study and has some limitations due to the limited sample, it allowed us

Table IV. *Overview of individual results.*

Patient	SEX	Frenulum protocol test results pre - frenectomy (worse 8, best 0)	Frenulum protocol test results post - frenectomy (worse 8, best 0)	VP-DM Shoulder Retroflexion pre-frenectomy measure in mm	VP-DM Shoulder Retroflexion post -frenectomy measure in mm
L.L.	M	5	0	-14	-11
C.M.	F	6	1	35	55
D.M.	F	6	1	51	55
D.A.	M	7	1	-27	-22
P.A.	M	5	0	-3	13
O.M.	M	4	0	22	26
F.W.	M	3	0	26	34
C.F.	M	5	0	-8	5
C.M.	F	4	0	-11	5
D.L.	F	6	2	34	54
F.L.	M	4	0	29	37
G.A.	M	4	0	25	34
D.E.	F	4	0	38	46
F.L.	M	4	0	-12	0
I.A.	M	5	1	7	18
I.F.	M	3	0	-11	8
M.V.	M	3	0	-3	9
M.D.	M	4	0	27	30
P.S.	M	7	2	32	38
S.L.	M	5	1	37	47
T.M.	F	6	2	31	33
T.L.	F	5	1	-12	0
T.E.	M	4	0	-11	8
S.L.	F	4	0	2	4

to develop a protocol for future studies that could clarify the effects of frenectomy on overall posture.

The relationship between tongue mobility and body posture is evident when considering the tonic-postural system, where a dysfunction on the sagittal plane manifests itself as a protraction of the scapular plane, more rarely a retraction (backward position), with respect to the pelvic plane, in proportion to the degree of restriction of the lingual frenulum (34-40). The forward projection of the line of gravity with respect to the pubic symphysis produces a cascade of postural compensations with tensions that are particularly evident at the cervical or lumbar level. At the cervical level, we may encounter superior crossed neuromuscular imbalance in the presence of hypertonic muscles (scalene, superior trapezius and levator scapulae; pectoralis major and minor muscle; suboccipital and paravertebral neck muscles) which is countered by a weakness of their respective antagonists. Moreover, the postural pattern is expressed with a flexion of the atlas-occipital joint, cervical hyperlordosis and anteriorized protracted scapular plane. At the lumbar level, the inferior cruciate neuromuscular imbalance is present when the hypertonicity of some muscles (iliopsoas, paravertebral, loin quadrant and tensor fascia lata) is accompanied by weakness of the antagonist muscles. In postural terms, hyperlordosis is a highlighted lumbar position with an anterior rotation of the pelvis. All these changes can be documented by the Spinometry® Formetric diagnostic system (41-50).

A lingual frenectomy may have a positive impact on swallowing as well. During the first phase of swallowing, the oral preparatory phase, if the tongue is restricted in its movements by a short lingual frenum or by a true ankyloglossia, compensatory movements develop to process the food bolus in the oral cavity and eventually propel it towards the pharynx and the esophagus. If the apex of the tongue cannot reach the retro-incisive papilla due to the short lingual frenulum, even in adulthood, the pattern of forward tongue position anteposition towards the incisors is maintained. Considering the risk of postoperative scars that can limit tongue mobility and require subsequent surgeries, we suggest that a rehabilitation treatment is implemented both pre- and post-surgery. The histological structure of the lingual frenulum is characterized by type I collagen fibers, also present in ligaments and tendons, which have a high tensile strength but do not stretch, therefore myofunctional therapy is indirectly very useful on the lingual frenulum as it repatterns the musculature of the tongue. A previous research confirmed that the frenectomy associated with myofunctional therapy improves orofacial and nasal functions by way of muscle tone and increase of tongue mobility.

Our limited sample size pilot study allowed us to verify that the release of the frenulum acts on the posture, specifically on the antero-posterior plane of the shoulders, as measured with spinometry. Future studies should include measurements of movements of other anatomical landmarks such as hips, neck, head etc. (51-55).

This study suggests that it is useful to evaluate and treat a short frenulum not only in children but also in young adults, especially because it affects posture and therefore it may trigger many other studies on scoliosis and other skeletal deformities as well.

Today spinometry represents a very interesting diagnostic method, noninvasive and helpful to study the entire vertebral column. We propose future studies on restricted frenula, before and after laser release, with larger samples analyzing other parameters of the spinal column; future studies on the effect of myofunctional therapy and the restoration of swallowing and breathing on various postural body landmarks; or studies on the spinometric aspects on patients suffering from various orofacial dysfunctions and obstructive sleep apnea (OSA). It would also be interesting to evaluate in growing patients whether an orthodontic pathology or orthodontic treatments may affect posture. We often talk about the correlation occlusion-posture but given that there are only a few studies on this subject we propose spinometry as an instrumental diagnostic to investigate this aspect (56-63).

Even with a small sample size, the question “does a short lingual frenulum affect body posture?” the answer is yes, at least anecdotally. The assessment of the tonic-postural system, in particular the scapular retroflexion (shoulder opening) before and after frenectomy by laser showed a small but measurable

difference in favor of surgically released lingual frenulum. This aspect in very interesting for future studies. This study also confirmed the efficiency of a laser frenectomy on tongue mobility and pattern of movements, which eventually improves all other orofacial functions that depend on it.

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