

Comparison of surgical techniques in lingual frenectomy: a systematic review of literature over the last 10 years

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Abstract

Aim: A short and fibrotic lingual frenulum can be the cause of a lack of breastfeeding, respiratory problems (OSAS), alterations of craniofacial development and malocclusions, atypical swallowing and alteration of body posture and of the tongue itself, also generating possible alterations of speech. The main goal of this work is to review the surgical techniques currently available for treating ankyloglossia and to compare them. **Methods:** Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a literature search was conducted of the PubMed/Medline, Scopus, and Web of Science databases; a total of 18 articles were selected to perform this review. **Results:** An altered lingual frenulum can be treated surgically with the traditional cold blade scalpel, electrosurgical and Laser. **Conclusion:** Lasers are superior for intra and post-operative benefits, both for the patient and the operator, in terms of speed of healing of the target tissue, fewer side effects and discomfort and better patient compliance. There is a learning curve to using the Laser technique, especially to calibrate power. To date, it is impossible to determine which type of Laser is superior to the others for treating ankyloglossia.

Keywords: Ankyloglossia, Lingual Frenulum, Frenectomy, Oral Surgery

Introduction

Ankyloglossia, also referred to as “tongue-tie,” is a congenital anomaly involving the tongue, characterized by a short or abnormal lingual frenulum. Although the frenulum is frequently described as a “submucosal cord” of connective tissue, anatomical dissection studies suggest that it is not an independent structural entity. Instead, it constitutes a dynamic, central fold formed by the tension of a fascial layer extending along the floor of the oral cavity during tongue protrusion movements.

The appropriate elevation and protrusion of the tongue are essential for a range of vital functions, including breastfeeding, feeding, swallowing, and speech articulation (4). A restricted lingual frenulum hampers these capabilities, potentially resulting in issues with developing dental arches. In the pediatric population, it has been identified as a prevalent phenotype associated with pediatric obstructive sleep apnea (4, 5).

Ankyloglossia predominantly affects males, with a male-to-female ratio of 3:1. The overall prevalence varies widely between 4% and 10.7% due to the diversity in diagnostic criteria (6). In newborns, while often isolated, it may also be a clinical sign of complex congenital malformation syndromes such as Simpson–Golabi–Behmel, Opitz,



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Beckwith–Wiedemann, oro-facio-digital syndromes, and cleft lip and palate (7).

Despite the numerous diagnostic scales and functional classifications proposed by authors such as Hazelbaker, Martinelli, and Marchesan, as well as the widespread application of quantitative measurements by Kotlow and Coryllos, no single system has attained universal acceptance for the identification of a pathological frenulum (8-13).

The primary modality of treatment for ankyloglossia with functional consequences is surgical intervention (14). Standard procedures encompass frenotomy (partial removal), frenulectomy (complete excision), and frenuloplasty (a reconstructive surgical method employing specialized sutures) (15, 16).

Recently, lasers have gained popularity in the surgical treatment of soft tissues. The term laser (Light Amplification by Stimulated Emission of Radiation) defines an amplification of light, which, depending on the active medium (solid, liquid, or gas), determines and classifies its type (17). The use of high-intensity lasers (such as Nd: YAG, Er: YAG, CO2, and diode lasers) exploits the specific absorption of light by the target tissue to cut, vaporize, or carbonize the tissue, allowing for excision or incision (18,19).

Laser techniques present substantial advantages compared to traditional methods, such as enhanced hemostasis and coagulation, thereby improving the operative field and frequently obviating the necessity for sutures. Additional benefits encompass a diminished risk of bacteremia, expedited healing, and reduced post-operative discomfort (20, 21).

The primary aim of this systematic literature review is to examine and compare various surgical techniques used in the management of ankyloglossia in pediatric patients. Specifically, the review will assess the efficacy, safety, and functional outcomes associated with scalpels, electrocautery, and different laser modalities. It seeks to furnish an up-to-date, evidence-based overview to inform the most appropriate therapeutic decision in clinical practice.

Materials and methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for meta-analyses (17).

The protocol for this review was prospectively

registered in the PROSPERO (International Prospective Register of Systematic Reviews) database under registration number CRD420251154549. Available from <https://www.crd.york.ac.uk/PROSPERO/view/CRD420251154549>.

This systematic literature review aims to analyze and compare surgical techniques used to treat ankyloglossia caused by anatomical and functional alterations of the lingual frenulum. Specifically, it intends to evaluate the efficacy, safety, and functional outcomes associated with procedures performed using a scalpel, electrosurgical unit, and various types of lasers (Diode, CO2, Er:YAG, Nd:YAG). The analysis seeks to provide an updated, evidence-based overview to inform the most appropriate therapeutic decision.

Eligibility criteria

All studies classified within the categories of case reports and those involving patients of any age were taken into account.

Studies were excluded if they were not published in English or were reviews, meta-analyses, editorials, case reports, or animal studies. Studies with missing data were also excluded; however, when necessary and possible, the authors were contacted to clarify missing or ambiguous data before exclusion.

Information Sources and Search Strategy

The systematic search was carried out across the PubMed, Scopus, and Web of Science databases, selecting original research studies published in English between January 2015 and September 2025.

The search incorporated controlled vocabulary and keywords pertinent to Ankyloglossia (e.g., “Ankyloglossia”, “Frenectomy”, “Lingual”, “Surgery”), employing Boolean operators to optimize sensitivity. A designated script is documented in Table 1.

Selection Process and Data Collection Process

During the initial selection phase, all studies were imported into Excel software. Two independent reviewers performed screening based on titles and abstracts in accordance with the eligibility criteria. In instances of disagreement, a third reviewer was consulted. The subsequent phase of the systematic review, encompassing full-text screening and the ultimate inclusion decision, was carried out collaboratively by the reviewers, complemented by a quality assessment.

Table 1. Search Strategy Summary.

Database	Search Terms	Limits/Filters	Results Retrieved	Date of Search
PubMed	(“Ankyloglossia” OR “Lingual frenulum”) AND (“Frenectomy” OR “Surgery”)	English language only	47	September 2025
Scopus	(“Ankyloglossia” OR “Lingual frenulum”) AND (“Frenectomy” OR “Surgery”)	English language only	45	September 2025
Web of Science	(“Ankyloglossia” OR “Lingual frenulum”) AND (“Frenectomy” OR “Surgery”)	English language only	87	September 2025

Data extraction was conducted independently by two reviewers utilizing a standardized, pilot-tested form in Microsoft Excel. The data considered for each study included the following: Author, Year, Country, population demographics (Sample Size, Age, Sex), Clinical Features, Surgical Technique, Thermal Damage, Cutting Precision, Bleeding and Visibility, Healing, Recurrence, and Follow-up.

Data Items

The primary outcome of interest was the association between PTSD and the incidence or prevalence of CAD. Secondary outcomes included the severity of CAD, cardiovascular events, and mortality related to CAD in PTSD populations. Where studies reported multiple time points or measures, all relevant data were extracted and considered.

Risk of Bias Assessment

Two authors independently evaluated the quality of

the included studies utilizing the “JBI Critical Appraisal Tools” (22). The checklist comprises eight questions, and for each item, one of the following judgments was assigned: Yes, No, Unclear, or Not Applicable. The risk of bias for each selected individual study was classified as follows: high (H) if the survey achieved a score with 49% “yes” judgments; moderate (M) if the percentage of “yes” judgments ranged between 50% and 69%; and low (L) when the proportion of “yes” judgments exceeded 70%.

Results

Study Selection

Initially, 179 articles were identified. A preliminary stock examination excluded 75 duplicate records. The remaining 104 articles were manually analyzed to select potential articles for qualitative analysis. Only 18 articles (22-39) met the eligibility criteria and were included in the systematic review (Figure 1).

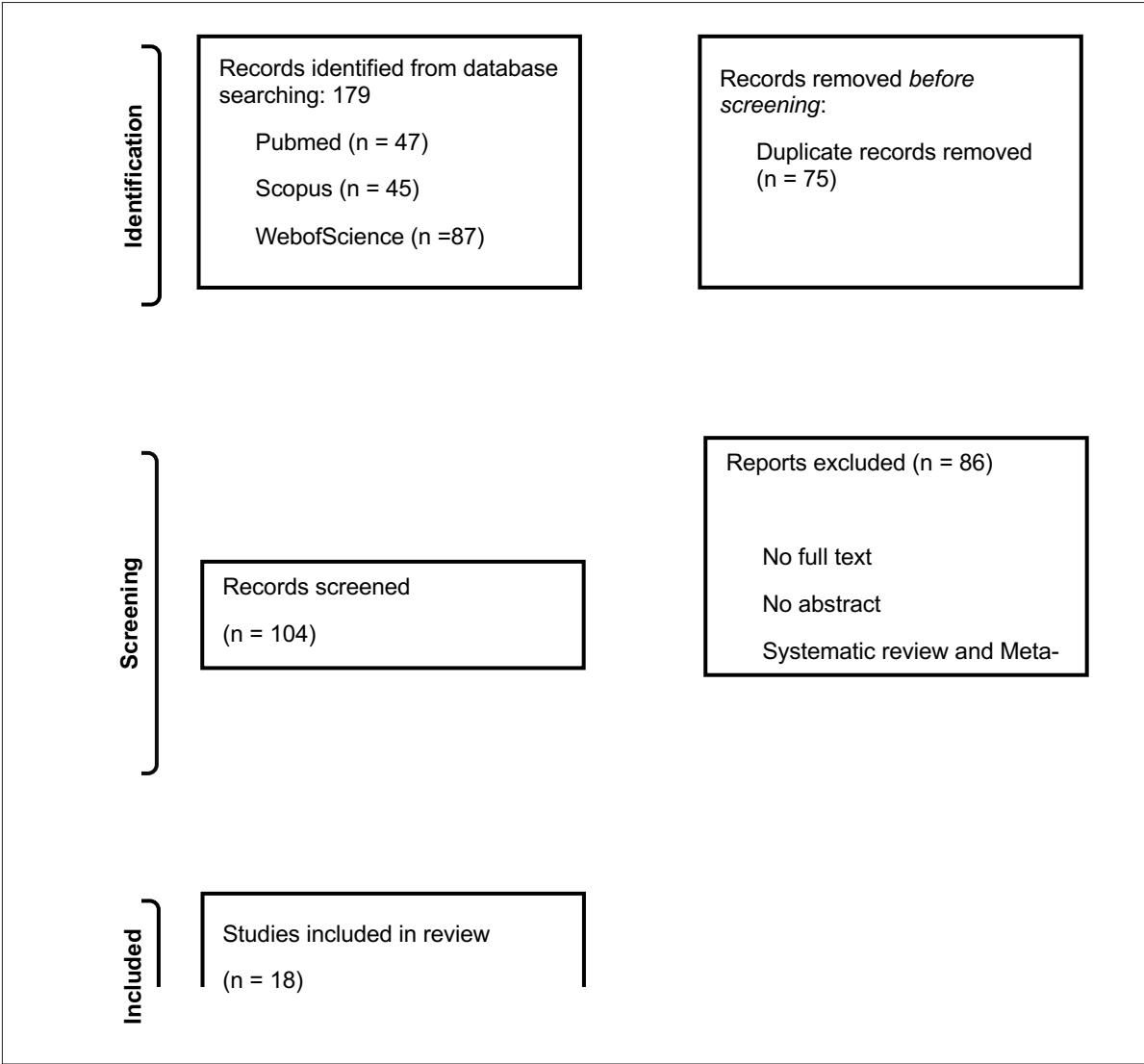


Figure 1. PRISMA flow diagram.

Results of the study

The 18 articles included in the qualitative analysis analyzed 546 cases.

The following table (Table 2) shows the general characteristics of the included studies.

Age and gender distribution of the patients

Based on the case reports, when the specific requested data were available, 23 case studies for which complete age and sex information was provided (excluding larger groups with incomplete or unspecified data) were analyzed. The following was revealed: the average age among the analyzed cases was approximately 17.93 years, and the predominant sex among the cases with specified sex was male, with 13 cases compared to 7 female cases.

Clinical Features

The typical clinical manifestations of ankyloglossia encompass impediments in tongue mobility, frequently evidenced by a “W”-shaped tongue during protrusion, along with a shortened lingual frenulum classified as Kotlow types II or III. These manifestations can result in articulation challenges for certain phonemes, including “s,” “z,” “ch,” “zh,” “r,” “l,” “t,” and “d.” Additionally, infants may experience difficulties with breastfeeding, which can lead to maternal nipple trauma and gastroesophageal reflux. Furthermore, functional disturbances such as mouth breathing, snoring, and myofascial tension may be observed. Oral anomalies including diastema, gingival recession, and plaque buildup may also be present.

Surgical Technique

The provided data enumerates various surgical techniques and approaches to correct ankyloglossia (short lingual frenulum), including studies that compare or employ these methodologies. The frenectomy or frenulotomy techniques are classified into two primary categories: Laser Techniques and Conventional Techniques (frenectomies performed with a scalpel or blade, scissors and suture, harmonic scalpel, and monopolar electrosurgery).

Thermal Damage and Bleeding, and visibility

The provided information implicitly compares the outcomes of different surgical instruments (diode laser and harmonic scalpel) utilized for frenectomy across three scholarly articles. Due to their coagulation properties, both devices are effective in facilitating rapid and minimally invasive procedures (without bleeding).

Cutting Precision

The report examines the application of the diode laser as a preferred and highly effective surgical tool for the excision of the lingual frenulum, highlighting the technical parameters and the conclusions concerning its superior efficacy.

From a technical perspective, laser applications have been extensively documented across various configurations, encompassing the utilization of different wavelengths and the application of specific power output protocols. The excision procedure was detailed

comprehensively, involving the use of a fiber-optic tip and the implementation of a technique referred to as a “brushing stroke” for tissue ablation.

Concerning efficacy, although the documentation does not furnish explicit metrics concerning “cutting precision,” the sources consistently emphasize that surgical intervention employing the diode laser is “the most effective” overall, thereby implicitly highlighting its superiority in comparison to traditional surgical techniques.

Healing and Recurrence

The assessment of post-operative clinical outcomes following frenectomy procedures typically demonstrates favorable results. Tissue healing was consistently characterized as swift, satisfactory, or excellent, with complete resolution observed as early as the seventh day. Notably, the absence of scar formation (fibrosis) was documented in numerous cases. Furthermore, a comparative analysis between techniques revealed more rapid, immediate healing when employing laser technology in contrast to traditional surgical approaches.

Regarding the recovery of functional mobility, a significant improvement in tongue movement was documented. In one quantified case, this resulted in an increase in the “free tongue” length to over [The number is missing in the original text, but I will translate the structure as is] mm following the implementation of post-operative exercises. Patients were advised to perform these exercises to prevent fibrosis and optimize the long-term outcome. However, an observation indicated that, despite improvements in mobility, dysarthria—particularly in the pronunciation of the letter “r”—could persist three months post-procedure.

Finally, the analysis did not reveal the reporting of any immediate complications in the examined cases. The recurrence (re-occurrence of ankyloglossia) was not explicitly addressed in most of the documentation, suggesting it was not a significant issue during the short-term follow-up considered by the sources.

3.2.8 Follow-up

Post-operative monitoring of patients undergoing frenectomy or frenuloplasty is systematically organized through a schedule of follow-up appointments. This timetable ensures the effective observation of the acute healing phase while facilitating the assessment of long-term functional recovery.

Short-term evaluations primarily concentrate on the initial weeks subsequent to the procedure. The majority of investigations arrange follow-up appointments within the first week (typically at 7 or 8 days) and a subsequent assessment between the second week and the first month (at 14, 15, or 30 days). It has been documented that complete tissue healing may occur as early as the seventh postoperative day.

The long-term monitoring phase prolongs the duration of observation, with scheduled assessments at three months, six months, and, on average, approximately nine months. The most extended documented observation periods have encompassed ten months, noting improvements in overall growth, and, in

Table 2. General characteristics of the included studies

S. No	First Authors Name/ Year of Publication/ Country of Origin [Reference Number]	Number of Cases	Age and Sex of Patients	Clinical Features	Surgical Technique	Thermal Damage	Cutting precision	Bleeding and Visibility	Healing and Recurrence	Follow-Up
1	Jaikumar et al. (23)	2	1st - 14-year-old male	Both patients had speech difficulties, particularly with pronouncing "s," "z," "ch," and "zh" sounds. Oral examination showed a "W"-shaped tongue upon protrusion and a free tongue length of 11 mm and 10 mm, respectively. These measurements indicated Kotlow's class II ankyloglossia (moderate).	Diode laser-assisted lingual frenectomy.	The article doesn't explicitly mention "thermal damage" caused by the laser, but it does state that the diode laser has a coagulating action that prevents bleeding.	The study doesn't describe "cutting precision". However, it does describe the excision of the lingual frenum with a diode laser using a fiber-optic tip and a "brushing stroke" technique.	Bleeding during the laser procedure was almost negligible. This allowed for better visibility compared to using a scalpel, which can cause considerable bleeding and requires sutures.	Post-operative healing was satisfactory. A significant increase in tongue mobility was noted after starting the post-operative exercises. The "free tongue" length increased to over 16 mm, compared to the initial 10-11 mm. The laser showed faster healing in the immediate post-operative phase compared to the scalpel method. Recurrence was not mentioned.	The patients were followed up after one week and again after four weeks.
			2nd - 20-year-old male							
2	Verma et al. (24)	1	39-year-old male	Difficulty moving the tongue and articulating words due to a short lingual frenulum. The patient was diagnosed with severe ankyloglossia (Kotlow's class III).	Diode laser lingual frenectomy at a wavelength of 445 nm.	-	Diode laser with a wavelength of 445 nanometer, highlighting its effectiveness and the comparison with traditional surgery.	-	The surgical area showed satisfactory healing without scar formation after 15 days, no recurrence.	Follow-up was performed at one week and 15 days after the surgery.
3	Dare et al. (25)	1	24-year-old female	The patient had difficulty speaking and was unable to fully protrude her tongue. She was diagnosed with moderate ankyloglossia (Kotlow's class II).	Laser lingual frenectomy.	-	The use of a diode laser with a wavelength of 880 nm and a power of 0.8 W.	No intraoperative bleeding was observed.	The healing was quick and uncomplicated, but it doesn't provide specific details on recurrence.	The patient was followed up at one week, one month, and three months after the surgery.

To be continued

4	Belmehdi et al. (26)	2	1st - 15-year-old male 2nd - 13-year-old male	Both patients had limited tongue mobility and difficulty speaking. They were both diagnosed with Kotlow's class II ankyloglossia.	Scalpel frenectomy	-	-	The report states that the post-operative period was uneventful and there were no complications from hemorrhage.	The article states that there were no complications and tongue mobility improved, but it does not provide specific details on recurrence.	The patients were followed up for 3 months after the surgery.
5	Jadhav et al. (27)	1	15-year-old male	The patient presented with "limited tongue movement and difficulty speaking." After a conventional frenectomy, he developed a submucosal hematoma.	Conventional lingual frenectomy.	-	-	The report focuses on managing a post-operative complication: a submucosal hematoma.	The patient improved significantly within 48 hours and completely healed by the seventh day. The article does not mention recurrence.	The patient had a complete recovery by the seventh day after the surgery.
6	Rakhunde et al. (28)	1	13-year-old male	The patient presented with "limited tongue mobility due to a 'too thick and short' lingual frenulum."	Laser-Assisted Frenectomy with Diode Laser.	-	Yes	The use of lasers has the advantages of "little to no swelling." This implies better visibility and reduced bleeding compared to traditional surgery.	Faster recovery and the absence of scarring, but it doesn't provide specific details on recurrence.	-
7	Tseng et al. (29)	1	A one-month-old infant	The infant presented with "tied oral tissues, commonly known as a labial or lingual frenulum, otherwise known as ankyloglossia."	Conventional lingual frenectomy.	-	-	-	-	A 4-week postsurgical follow-up visit was utilized.
8	Bargiel et al. (30)	6	33-year-old female 26-year-old female 21-year-old male 22-year-old male 37-year-old female 18-year-old male	Ankyloglossia	Scalpel frenectomy	-	-	-	-	In two out of four patients, thereafter the procedure. The mean follow-up was 9 months.

9	Mezzapesa et al. (31)	2	-	The patients had a lingual frenulum that was "thick, very tense, and/or limiting tongue movements."	Laser-Assisted Frenectomy with Diode Laser.	-	The article does not mention the cutting precision, but it indicates that diode laser surgery is "the most effective."	The study states that bleeding during the laser-assisted frenectomy procedure was almost negligible.	-	-
10	Zaghi et al. (32)	420	Age ranging from 29 months to 79 years. Sex is not specified.	The patients presented with impaired tongue mobility due to restrictive tissue. Symptoms included mouth breathing, snoring, teeth grinding, and myofascial tension.	Lingual Frenuloplasty with scissors and suture technique.	-	-	-	The article explores the "safety and effectiveness" of lingual frenuloplasty, but it does not provide specific details on healing or recurrence in this excerpt.	The follow-up were conducted at least 2 months after the frenuloplasty procedure.
11	Ferrés-Amat et al. (33)	101	-	Ankyloglossia in pediatric patients.	The study describes a multidisciplinary management protocol for the treatment of ankyloglossia in pediatric patients. It does not focus on a single surgical technique.	-	-	-	-	-
12	Pereira et al. (34)	1	10-year-old male	The clinical case aims to verify the effect of lingual frenectomy on the functional anatomical aspects of the tongue, on phonetic-acoustic characteristics, and on the range of tongue movement.	Lingual frenectomy.	-	-	-	-	The patient was re-examined 7 and 14 days after the surgery.

To be continued

13	de Gutierrez et al. (35)	1	12-year-old female	The article discusses lingual frenectomy for a patient with Juvenile Idiopathic Arthritis and Attention Deficit Hyperactivity Disorder.	Conventional lingual frenectomy with scissors, performed under local anesthesia. An absorbable 3-0 suture was used to avoid a second operation for its removal.	-	-	-	-	The patient underwent speech therapy for six months after the surgery. A second speech therapy evaluation was performed 14 months after the operation.
14	Susanto et al. (36)	1	25-year-old female	The patient had limited tongue mobility, difficulty pronouncing specific letters ("t," "l," "th," "s"), and could not extend the tip of their tongue past the edge of the lower lip. The clinical examination revealed a low and taut lingual frenulum, and the distance between the frenulum and the tip of the tongue was 4-7 mm, classifying the anomaly as Kotlow's Class III. Diastema, gingival recession, and plaque accumulation were also noted on the lower central incisors.	A conventional frenulectomy was performed using a No. 15 scalpel blade and the "two hemostats method" to control bleeding. After the incision, which removed the frenulum tissue leaving a diamond-shaped wound, the muscle fibers were sectioned to eliminate tension, and the wound was closed with a 5-0 resorbable nylon suture.	-	-	The "two hemostats method" was used specifically to prevent excessive bleeding during the procedure. The document does not provide specific details about visibility during the surgery.	One week after the surgery, the patient had no complaints and the surgical area appeared reddish. After three months, the patient had no complaints, the surgical area was no longer reddish, and tongue mobility had improved, although the pronunciation of the letter "r" was still unclear.	Post-operative check-ups were conducted at 1 week and 3 months after the surgery. The patient was advised to continue rehabilitation with speech therapy to further improve pronunciation.

To be continued

15	Filfilan et al. (37)	1	10-year-old female	The patient presented at the clinic complaining of "misaligned front teeth." The intraoral examination revealed the presence of two lingual frenula connecting the tongue to the floor of the mouth. There were no other intraoral anomalies. The parents reported that the child did not pronounce the letters D, T, and Th correctly until the age of 7, but had not received any previous interventions. The two frenula did not restrict normal tongue function.	No surgical intervention was performed.	-	-	-	-	-	-
16	Adil et al. (38)	1	Two-month-old infant	Congenital bifid tongue, cleft palate, and lingual and palatal hamartomas. Manifestations included difficulty with breast or bottle feeding, excessive drooling, and repeated coughing during or after feeding attempts.	A multidisciplinary surgical approach was used. For the bifid tongue and hamartomas, a monopolar electrosurgical scalpel in cutting mode was used for the excision and Vicryl sutures for the repair. The palate repair was left to heal by secondary intention.	-	-	-	-	-	The patient was followed up at one month and ten months post-surgery. At the one-month follow-up, the wound had completely healed, and tongue movements were normal. At the ten-month follow-up, the patient had significant weight gain and improved overall growth.

To be continued

17	Mir et al. (39)	1	37-year-old male	The patient presented with Type II ankyloglossia (Coryllos scale) and Class III (Kotlow assessment). They had difficulty protruding their tongue and pronouncing specific consonants and sounds such as "z," "t," "d," "l," "dg," and rolling the "r."	A frenotomy was performed with an harmonic scalpel (Ethicon harmonic scissors). The procedure was performed on an outpatient basis, under local infiltration anesthesia.	Harmonic scissors use ultrasonic vibrations to cut and coagulate tissue. The document does not mention thermal damage but describes the procedure as "rapid and bloodless."	-	Rapid and bloodless	Post-operative healing was "excellent." The patient was advised to perform post-operative exercises to prevent fibrosis and achieve optimal healing. Recurrence is not mentioned.	The patient was followed up for a period of six months. Specifically, check-ups were performed at 7 and 14 days after the surgery, with the final one at six months.
18	Dias et al. (40)	2	One-month-old infant 8-year-old male	Difficulty breastfeeding, gastroesophageal reflux, maternal nipple trauma, noisy swallowing, and an inability to latch correctly. Anterior crossbite and an alteration of the lingual frenulum that negatively affected tongue mobility and the functions of chewing and speech.	Diode laser lingual frenotomy	The diode laser ensured excellent cauterization.	-	The diode laser technology was used for "better hemostasis control" and allowed for no stitches due to excellent cauterization.	There were no complications. Recurrence is not mentioned.	The follow-up appointment was scheduled eight days after the procedure. The patient was also referred to a speech therapist to improve healing and tongue function.

Table 3. Risk of bias evaluation of the included.

S. N.	First Authors Name/ Year of Publication	1. Were the Patient's Demographic Characteristics Clearly Described?	2. Was the Patient's History Clearly Described and Presented as a Timeline?	3. Was the Current Clinical Condition of the Patient on Presentation Clearly Described?	4. Were Diagnostic Tests or Assessment Methods and the Results Clearly Described?	5. Was the Intervention or Treatment Procedure Clearly Described?	6. Was the Post-Intervention Clinical Condition Clearly Described?	7. Were Adverse Events (Harms) or Unanticipated Events Identified and Described?	8. Does the Case Report Provide Take-away Lessons?	The Overall Risk of Bias
1	Jaikumar et al. (23)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	L
2	Verma et al. (24)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	L
3	Dare et al. (25)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	L
4	Belmejdi et al. (26)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	L
5	Jadhav et al. (27)	Yes	Yes	Yes	Yes	No	Yes	Yes	No	L
6	Rakhunde et al. (28)	Yes	No	Yes	Yes	Yes	No	Yes	No	L
7	Tseng et al. (29)	No	Yes	Yes	Yes	Yes	Yes	Yes	No	L
8	Bargiel et al. (30)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	L
9	Mezzapesa et al. (31)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L
10	Zaghi et al. (32)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L
11	Ferrés-Amat et al. (33)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L
12	Pereira et al. (34)	No	Yes	Yes	Yes	Yes	No	Yes	Yes	L
13	de Gutierrez et al. (35)	No	Yes	Yes	Yes	Yes	Yes	Yes	No	L
14	Susanto et al. (36)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	L
15	Filfilan et al. (37)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L
16	Adil et al. (38)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L
17	Mir et al. (39)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L
18	Dias et al. (40)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	L

conjunction with functional rehabilitation, extending up to 14 months post-surgery.

It is customary to incorporate a speech therapy program alongside surgical intervention. This rehabilitative therapy may span substantial durations (e.g., six months) to enhance pronunciation and lingual functionality, with speech pathology assessments possibly persisting beyond the concluding surgical follow-up period.

Risk of bias

All studies show a low risk of bias (Table 3).

Discussion

The management of ankyloglossia (tongue-tie), a congenital anomaly characterized by a short or thick lingual frenulum that impedes tongue mobility, aims to restore full functional capability. This function is vital for breastfeeding in infants, swallowing, speech articulation, and oral hygiene (1, 23, 32). The selection of the surgical approach, which may include frenotomy, frenulectomy, or frenuloplasty, along with the choice of instrument (scalpel, electrocautery, or laser), is essential to optimize efficacy, ensure safety, and enhance the patient's post-operative experience (8, 26, 30, 32).

The choice of approach must be rigorously personalized and anchored to a detailed anatomical and functional classification, such as those proposed by Kotlow and Coryllos (1, 14, 16). The most severe cases, classified as Kotlow Class III (or less than 4 mm of free tongue length) or Class IV, or as Coryllos Type III and IV, are associated with the most significant functional deficits and indicate the need for interventions that involve deep dissection to release the genioglossus myofascial complex (GMC) (1, 16, 31).

Conventional surgical procedures, performed using a scalpel or scissors, represent a well-established and effective practice for achieving anatomical release (1, 23). However, these techniques are associated with significant invasiveness and typically require the use of sutures for primary wound closure, which are regarded as essential for optimal healing and the prevention of re-adhesion (1, 23). Studies involving large patient cohorts undergoing frenuloplasty with scissors and suture techniques have documented a high satisfaction rate of 98.6%, along with an improvement in quality of life in 80% of cases, particularly for conditions such as clenching, mouth breathing, and myofascial tension (1). The safety profile of these procedures is favorable, with minor complications—such as prolonged pain or temporary numbness of the tongue tip—occurring in fewer than 1% of cases (1). Nonetheless, potential complications include intraoperative hemorrhage, postoperative edema, and, in rare instances, injury to the lingual nerve, which may result in paresthesia. Serious complications encompass the formation of retention cysts (ranulas) or sublingual hematomas, which pose a risk of airway obstruction (23). In complex cases, conventional surgical techniques allow and sometimes require the deliberate dissection of the median lingual septum and the myofascial fibers of the genioglossus muscle (GMC) to ensure comprehensive

functional release, as emphasized in myofrenuloplasty protocols (1, 26, 31).

In contrast to the scalpel approach, the use of energy-based methodologies, particularly laser-assisted frenulectomy (often with a diode laser), has gained increasing clinical consensus and is considered an optimal therapeutic strategy, with several studies suggesting its position as the gold standard (1, 8, 24–26, 33). Lasers offer substantial advantages derived from the simultaneous ability to cut and coagulate (hemostasis), which minimizes intraoperative bleeding and reduces or eliminates the need for sutures, simplifying the procedure and optimizing patient comfort (1, 24, 25, 28, 33). Furthermore, the laser's photothermal interaction seals nerve endings, resulting in a distinct reduction in post-operative pain and edema and promoting faster healing with a lower propensity for the formation of contracture scars compared to the conventional technique (1, 24, 25, 28). These characteristics make the laser technique particularly advantageous for early intervention in newborns (20). Electrocautery, while improving hemostasis compared to the scalpel, does not achieve the same levels of post-operative pain and edema management offered by the laser (1, 25). Although diode lasers are often preferred for their cost-effectiveness, research suggests that other wavelengths, such as Er,Cr:YSGG, may promote faster tissue healing, although no significant difference in perceived pain or surgical time compared to diode lasers was found in some applications (3). An emerging technique is the use of the harmonic scalpel (harmonic scissors), which, using ultrasonic energy, allows for rapid and bloodless release with a reduced risk of collateral thermal damage, proving to be safe and effective even for high-grade ankyloglossia in adults (1, 19).

Regardless of the surgical technique adopted, achieving a complete and lasting functional outcome requires integration with Myofunctional Therapy (MFT) and specific post-operative tongue exercises (1, 24). This multimodal approach is an essential predictor of success, especially in adult and adolescent patients, where ankyloglossia has rooted compensatory motor patterns (muscle memory) that must be retrained (1, 24). MFT, often initiated in the pre-operative phase, is crucial post-operatively for preventing recurrence associated with scar retraction (1, 23). Clinical evidence clearly demonstrates that, although surgery releases the anatomical restriction, integration with MFT can increase the functional correction rate from 50% to a significant 90% in pediatric patients; in this context, the patient's lack of cooperation with the exercises was found to be the only statistically significant predictor of therapeutic failure (1). The effectiveness of MFT can be objectively measured through instrumental methods such as ultrasonography and acoustic analysis, which have allowed for measuring the increase in the tongue's verticalization and anteriorization during the production of complex phonemes (1, 14). The improved post-operative comfort offered by laser techniques is a crucial indirect facilitator, as it promotes the patient's rapid adherence to the exercise protocol, thereby maximizing the long-term therapeutic outcome (1, 28).

Conclusion

Although the conventional approach utilizing scissors and sutures, particularly with extended submucosal dissection (myofrenuloplasty), remains effective and necessary for the most complex cases, laser-assisted frenulectomy has emerged as the preferred option in the majority of clinical scenarios due to its superior profile in terms of safety and patient comfort. Regardless of the technique selected, the therapeutic decision must always be tailored to the classification of ankyloglossia and the patient's anatomy, and must invariably include a commitment to the post-operative targeted functional rehabilitation program to ensure the comprehensive and enduring success of the treatment.

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