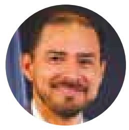
Treatment of ankyloglossia with dental laser in paediatric patients: Scoping review and a case report



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Abstract

Aim The two aims of this article were to conduct a scoping review of current knowledge regarding laser treatment of ankyloglossia in children and to report a case of a male paediatric patient with ankyloglossia treated with laser surgery.

Methods A comprehensive literature search was carried out on the following electronic databases: PubMed; Embase; Google Scholar; The Cochrane Library, and Dentistry and Oral Science Source (EBSCO).

Results The initial search identified 278 references. After the process of title/abstract screening, 61 articles received a full-text reading; finally, 17 articles were selected. According to this scoping literature review, lingual frenulectomy managed with laser surgery provides a more efficient and comfortable treatment for both the paediatric patient and the dentist compared with conventional scalpel/blades/suturing techniques. Nevertheless, further high-quality studies on the clinical efficacy of laser devices for lingual frenulectomy in paediatric populations are required.

Conclusion Early diagnosis and treatment of ankyloglossia are fundamental for the adequate functional oral development of paediatric patients. Laser surgery for lingual frenulectomy provides a more efficient and comfortable treatment for both the child and the paediatric dentist compared to traditional scalpel/blade methods.

KEYWORD Ankyloglossia, Children, Lingual frenulectomy, Laser surgery, Scoping review.

Introduction

The lingual frenulum is a fold of mucous membrane extending from the tongue's ventral surface above the oral floor [Maturo et al., 2013]. Ankyloglossia or tongue-tie is an uncommon congenital condition characterised by an abnormally short and thick lingual frenulum (partial ankyloglossia) in the genioglossus muscle, or the fusion of the tongue's underside to the floor of the mouth (total ankyloglossia), which impairs the mobility of the tongue tip [Lalakea and Messner, 2003; Lamba et al., 2015; Nicoloso et al., 2016; O'Shea et al., 2017; Walsh and Tunkel, 2017; AAPD, 2018 (1)]. This condition may cause difficulties in speech, sucking/swallowing, and feeding problems in infants (particularly in newborns) and young children, as well as skeletal development, malocclusions, anterior lingual gingival recessions, and social issues in school-aged children [Messner and Lalakea, 2000; Kupietzky and Botzer 2005; Ochi, 2014; Lamba et al., 2015; O'Shea et al., 2017]. The prevalence of ankyloglossia in the general population has been reported as between 0.02% and 11%, and is more common in males (2.5:1) [AAPD, 2018 (1)]. Ankyloglossia may occur as an isolated anatomic anomaly or may be associated with some congenital syndromes. An enhanced prevalence has been reported in newborns with antecedents of maternal cocaine abuse (Odds Ratio [OR] = 3.5) [Harris et al., 1992; Lalakea and Messner, 2003]. Different diagnostic classifications based on anatomical and functional criteria have been proposed for the condition, but none has been universally accepted [Horton et al., 1969; Itoh, 1988; Hazelbaker, 1993; Kotlow, 1999; García-Pola et al., 2002; Kupietzky and Botzer, 2005; Ruffoli et al., 2005; Segal et al., 2007; Suter and Bornstein, 2009; AAPD, 2018 (1)].

Management of ankyloglossia in children is usually multidisciplinary, involving the participation of specialists in paediatric dentistry, periodontics, oral surgery, otolaryngology, and speech therapy, among others [Kupietzky and Botzer, 2005; Ferrés et al., 2016]. It has been well-accepted worldwide that lingual frenectomy (frenulectomy, frenotomy, frenuloplasty) is the best approach to resolve the associated inconveniences of ankyloglossia [Messner and Lalakea, 2000]. The procedure consists of the surgical release of the abnormal frenulum to free the tongue's movements [Butchi-Babi et al., 2018]. Several

Study (Author, year)	Design	Patient characteristics (gender, age)	Sample size	Type of laser	Main findings
Kotlow [2004]	Literature narrative review	Neonates, young children, and teenagers	-	Erbium:YAG	• The author provides a suggested classification for ankyloglossia in children • This classification is based on the distance (mm) from the insertion of the lingual frenum to the tip of the tongue: › Normal (16 mm) › Class I or mild (12 mm) › Class II or moderate (8-12 mm) › Class III or severe (4-8 mm) › Class IV or complete (0-4 mm)
Fornaini et al. [2007]	Clinical case report	8 years old girl	-	N:YAG and Diode	• Some limitations on the use of laser in pediatric oral surgery: › Understanding the laser's physical characteristics and safe measurements, to avoid damage › An adequate training of the practitioner and staff to follow safety rules › The cost of laser devices is higher than that of traditional surgical techniques with blades
Kato and Wijeyeweera [2007]	Prospective therapeutic cohort	1 to 15 years old	20 patients indicated for lingual frenulectomy	CO_2	• The laser device was employed in the non-contact mode, with a maintained distance of about 1 mm between the laser tip and frenulum surface • None of the patients required sutures • After 1 and 2 weeks, the postoperative results (no infection and no wound contracture/scarring) were rated as excellent
Boj et al. [2011]	Literature narrative review	-	-	Argon, Diode, Nd:YAG, Nd:YAP, CO2, Er-Cr:YSGG, Er:YAG	• All these lasers have been approved by the US FDA for oral surgery in children • Each type of laser emits light at a specific wavelength, determined by the medium (solid, liquid, or gas) • The effects of the laser beam depend on the amount of light absorbed by the irradiated tissue, the laser wavelength, and the tissue's optical properties • The laser effects on oral soft tissues are different according to the pre-specified emission parameters in the laser device
Kotlow [2011]	Literature narrative review	Infants	-	Er:YAG, Diode	• Dentists must have a complete knowledge in laser physic and safety, together with an exhaustive training, before using any laser device in children • During the frenulectomy laser procedure in infants, care should be undertaken to stay away from salivary glands and vessels located in the mouth's floor
Martens [2011]	Literature narrative review	-	-	Argon, CO_2, Diode, Nd:YAG	• The author provides a complete description and discussion on laser physic fundamentals
Olivi et al. [2012]	Literature narrative review	-	-	Erbium:YAG	• Lasers work on the vascular and aqueous (hydroxyl radical) components of the collagen fibrotic tissue of the frenulum • Particular attention should be placed to the laser device parameters applied and the exposure time, considering the different penetration depth of the specific wavelength
Chiniforush et al. [2013]	Clinical case report	12 years old boy	-	CO_2	• Due to laser capability of sterilisation of the surgical site, the risk of local infection is reduced, which avoids the use of antibiotic therapy
Butchi-Babu et al. [2014]	Randomized controlled clinical trial	Healthy teenagers with ankyloglossia	10 participants, randomly assigned to two study groups (scalpel vs laser)	Diode	• Perception of pain (VAS score at 1, 3 and 7 postoperative days), related with tongue movements following frenulectomy was significantly lesser when laser surgery was employed, compared with scalpel surgery ($p<0.002$) • These results suggest that the use of laser surgery inhibits the conduction of nerve fibers and the stimulation of β endorphins on C fibers; lasers also produce a reversible conformational change in the voltage-gated Na-K channels • Lasers reduce the levels of histamine, bradykinins, and substance P, thus decreasing the local inflammation

Neena et al. [2015]	Literature narrative review	-	-	Nd:YAG, CO_2, Argon	• Cautions for laser therapies: › Epileptic patients › Use on the thyroid gland › Benign tumors with malignant tendency › Patients with lupus › Patients treated with substances sensible to light • Laser health risks: › Wound surrounding tissues, eyes, and lungs › Fire, combustion, and explosion › Electrical shock › Equipment
Crippa et al. [2016]	Clinical case report	2 years old girl	-	Diode	• Infants with ankyloglossia and their mothers may experience difficulties with breastfeeding, including sore nipples, blocked ducts, local infections, low milk supply, bad sleeping, and inadequate weight gain • The laser device tip should not be held in the same place for too long to avoid thermal damage to the lingual frenulum • To prevent a profuse bleeding, frenulectomy should be carried out in a protected clinical setting, where adequate systems for hemostasis are available • Those predictably difficult cases should be treated by an oral surgeon rather than a paediatric dentist
Nicoloso et al. [2016]	Clinical case report	9 years old male	-	Diode	• Interactions between the laser and soft tissues (vaporisation and cauterisation) minimise the possibility of tongue tie recurrence • The laser surgery must be carried out with caution because the laser beam interacts with eyes and tissues adjacent to the surgical wound
Hanna and Parker [2016]	Prospective therapeutic cohort	Healthy children (4–15 years old)	13 cases of lingual frenulectomy, followed-up for 2 weeks	CO_2	• None of the patients reported postoperative complications (pain, intra/extra oral swelling, infection, bad taste, and redness) • The use of minimal operating parameters and thermal relaxation help reduce postoperative pain • Patient's perception and acceptance were rated as very good
Kumar et al. [2017]	Literature narrative review and clinical case report	1-year-old girl	-	Er,Cr:YSGG	• After application of Erbium lasers, the healing process is faster as they have a lower thermal effect • This type of laser is ideal for oral soft tissue surgeries in pediatric patients because of the high content of water in their structures
Olivi et al. [2017]	Literature narrative review	-	-	Diode, Nd:YAG, Er:YAG, Er,Cr:YSG, CO2	• The laser wavelengths have an optical affinity for haemoglobin and water, the main chromophores in the oral soft tissues • Medium and far infrared lasers are highly absorbed in aqueous media, providing efficient incision and vaporisation of oral soft tissues • Infrared lasers offer excellent coagulation and bleeding control during surgery
Komori et al. [2017]	Retrospective therapeutic cohort	Hospital patients under 15 years old	15 patients, followed-up for a mean time of 4.6 years.	CO_2	• 7 patients were attended under general anesthesia • No trans-operative adverse events were reported • Frenulum re-adhesion was noted in one patient
AAPD [2018]	Policy on the use of lasers for pediatric dental patients	-	-	Diode (450-655 nm and 810-980 nm), Er,Cr:YSGG, CO2 (9300 nm and 10600 nm)	Lasers are an alternative and complementary method for providing surgical procedures in oral soft tissues for infants, children, adolescents and persons with special health care needs Before applying this technology, dentists should receive didactic and experiential education and training on its use Paediatric dentistry practitioners should research, implement, and utilise the optimal laser type for the indicated procedure AAPD endorse using protective eyewear during laser treatments

TABLE 1 Characteristics and principal findings/outcomes of the selected individual studies.

surgical techniques have been proposed [Tuli and Singh, 2010; Lamba et al., 2015; Tsaousoglou et al., 2016], such as simple clipping with blades in newborns (also known as frenotomy), z-frenuloplasty, electrocauterisation (argon plasma, monopolar or bipolar diathermy), cryosurgery, and lasers.

Laser (an acronym of Light Amplification by Stimulated Emission of Radiation) is defined as an electromagnetic and monochromatic radiation propagated at various wavelengths. Lasers deliver a concentration of energy in the form of an intense beam of light, at InfraRed (IR) and UltraViolet (UV) electromagnetic spectra ranges that can be used in minor oral soft-tissue surgeries [Parkins, 2000; Gutknecht et al., 2005; Olivi et al., 2009; Asnaashari and Zadsirjan, 2014; Nicoloso et al., 2016; Seifi and Matini 2017]. They can be classified as low- or high-intensity lasers [Nicoloso et al., 2016]. Since the first studies in the 1960s and 1970s [Adelaimi and Mahmood 2014; Sulewsky, 2016; Seifi and Matini 2017], CO_2, erbium, neodymium, and diode lasers have been widely employed for soft-tissue excisions in paediatric maxillofacial surgery due to their reliability, versatility, handiness, and simple set-up [Nazemisalman et al., 2015; Caprioglio et al., 2017; Ambika and Suchithra, 2018]. Further, this treatment option has demonstrated diverse therapeutic properties, including anti-inflammatory, biostimulant, and regenerative effects with satisfactory postoperative results, improving and accelerating wound healing with less scarring [Komori et al., 2017; Kumar et al., 2017; Ambika and Suchithra, 2018]. In children, laser surgery offers additional advantages, including the reduction of operating time, minimal amounts of local anaesthesia, enhanced haemostasis, no need for sutures, and less prescription of post-operative drugs; therefore, this faster treatment option may decrease the psychological distress of paediatric patients associated with conventional surgical procedures [Ballard et al., 2002; Olivi et al., 2011; Tsaousoglou et al., 2016; Komori et al., 2017; Ambika and Suchithra, 2018]. Although surgical oral laser is a user-friendly technique, it requires an appropriate training period. In this regard, some harmful adverse reactions have been reported mainly due to its inadequate use, including tissue carbonisation or melting and protein denaturation, with the subsequent synthesis of toxic substances causing structural changes in the irradiated tissues [Pick et al., 1995; Lamba et al., 2015].

The present report has two aims: to carry out a scoping review of studies to explore current knowledge and applications of surgical laser for ankyloglossia in paediatric dentistry, and to describe the relevant clinical case of an eight-year-old male patient exhibiting ankyloglossia who underwent a laser surgical procedure and his corresponding close follow-up.

Methods

A review of the literature was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) statement checklist [Moher et al., 2010]. We also implemented the Arksey and O'Malley [2005] methodological framework with recommendations for this type of review. A study protocol was developed adhering to the framework proposed by the Joanna Briggs Institute [Peters et al., 2015]. The scoping systematic review consisted of the following five steps: structuring the research question; literature search and study screening/identification; study selection; data extraction/charting, and summarising the results.

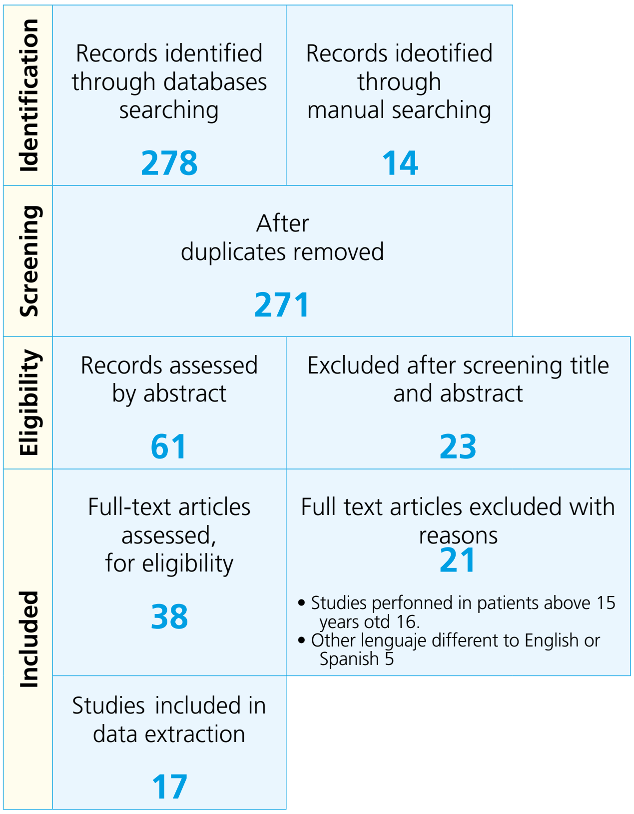

FIG. 1 Modified PRISMA flowchart of the study search strategy. Taken and modified from Vaughan et al. [2018].

1. Research question. For the treatment of ankyloglossia in paediatric patients, what is the most relevant information regarding lingual frenectomy performed with laser technology?
2. Study eligibility criteria. Publications available online in English and Spanish during the last 25 years (since 1993) focused on the most recent advances in laser surgery, for paediatric patients between 0 and 12 years of age, without restriction to a specific methodological design or study location. Grey literature was excluded. Search strategy. A comprehensive search process was carried out from August 1 to October 15, 2018, on five relevant electronic databases: PubMed; Embase; Google Scholar; The Cochrane Library, and Dentistry and Oral Science Source (EBSCO). The main key search words and MESH terms were as follows: paediatric patients; ankyloglossia (and its synonyms); frenulectomy (and its synonyms); oral surgery, and laser. Terms were written alone or combined with Boolean operators. This search strategy was adapted to fit each database.
3. Study screening and selection. Two independent authors (DH-B and IP-A) carefully reviewed the most up-to-date reference lists obtained from each database in order to identify potentially relevant study titles and abstracts according to the eligibility criteria. Both authors were previously calibrated for their level of inter-observer agreement using the Cohen kappa test (kappa = 0.86). All articles identified for possible inclusion were then retrieved in full-text. An additional hand search was performed on the corresponding reference lists of these articles to identify further pertinent studies. Duplicates and irrelevant titles were removed. Any discrepancy in study inclusion between reviewers was resolved through discussion with

FIG. 2 Initial intraoral views.

a third author (VF-S) to reach consensus.

4. Data extraction and charting. Another two authors (AJP-G and AG-R) separately assessed the selected articles and extracted the most relevant data. The extracted information was then entered into a specifically designed Microsoft Excel 2013 sheet. These two reviewers were also pre-calibrated (kappa = 0.81). Again, any disagreement was resolved by discussion with the same third author (VF-S). Extracted data included the following: article information (authors, publication year, and journal); methodological design; patient characteristics (gender, age, and ethnicity); sample size: type of laser device, and main outcomes and findings. According to previously referenced scoping review guidelines, only a narrative assessment was performed for each eligible article. The methodological quality (risk of bias) was not evaluated. When necessary, the original authors were contacted to retrieve additional information.
5. Summarising results. Finally, the data were summarised and tabulated.

Results

The initial electronic database search identified 278 references. After title/abstract screening under the specified eligibility criteria and the removal of duplicates, 47 potential articles were retrieved and 14 additional studies were identified by searching the reference lists of these articles. In total, 61 articles underwent a full-text reading. Finally, 17 articles were selected for the present scoping review as follows: five case reports or case series reports [Fornaini et al., 2007; Chiniforush et al., 2013; Crippa et al., 2016; Nicoloso et al., 2016; Kumar et al., 2017]; eight narrative reviews [Kotlow, 2004; Boj et al., 2011; Kotlow, 2011; Martens, 2011; Neena et al., 2015; Olivi et al., 2012; Olivi et al., 2017; AAPD, 2018 (2)]; three therapeutic cohorts, retrospective [Hanna and Parker, 2016] and prospective [Kato and Wijeyeweera 2007; Komori et al., 2017], and one randomised controlled clinical trial [Butchi-Babo et al., 2018]. These studies were published between 2004 and 2018, reporting a mix of child participants of various ages (under 15 years), of both genders, and from a range of ethnic/cultural backgrounds. Surgical procedures for ankyloglossia were carried out in private practices or university settings. Figure 1 presents the flowchart of the article identification/selection process. Characteristics and principal findings/outcomes of the selected individual studies are summarised in Table 1.

Case report

In early May, 2018, an 8.5-year-old systemically healthy (ASA I) male patient presented to the Paediatric Dentistry Postgraduate Programme Clinic because of speech difficulties since birth, especially for sounds such as "z", "r", "l", and "d". Medical history was non-contributory. On intraoral examination, the patient exhibited a short thick lingual frenulum or tongue-tie (Kotlow class II) (Table 2). The tongue showed bifid appearance, and its mobility was restricted so that the child's tongue was unable to reach the upper incisors and beyond the lower lip (Fig. 2); atypical deglutition was also noticeable. The parents were very concerned about the condition.

After a detailed explanation of the surgical procedure, parental written informed consent was obtained. The frenulectomy was performed using an Er, Cr: YSGG dental laser (Waterlase Biolase®; Biolase Tech, San Clemente, CA, USA) with a wavelength of 2,780 nm under bilateral local anaesthesia (one cartridge of 2% Lidocaine with Epinephrine 1:100,000), following the recommended precautions of laser oral surgery [Ambika and Suchithra, 2018]. The operating parameters employed were as follows: S mode; pulse duration, 140–200 μs; 25 Hz frequency, and energy density per pulse of 26.5 J/cm^2; power settings were 1.5 W, 12% water/8% air, and spot of 0.6 mm in diameter by means of a G-4 tip (600 μm). The child and the operator were protected with appropriate eyeglasses for the wavelength utilised. Initially, the tip of the tongue was caught and firmly immobilised. Then, the frenulum was completely dissected and released with a diamond-shaped incision using the laser beam guided by an optical fibre; the muscle fibres were separated from their attachment to the floor of the mouth in order to increase the amplitude of movement. The soft-tissue surfaces were cooled using an air/water spray delivered by the laser handpiece; high-speed suction was also employed. Haemostasis was achieved normally; however, multiple resorbable sutures were placed as a precaution to prevent potential bleeding in the near future. The patient's cooperation was considered excellent.

Post-operative analgesics (Paracetamol 200 mg) and 0.2% chlorhexidine rinses, but no antibiotics, were prescribed. In addition to quiet rest for that day, the parents were instructed to provide their son with a soft and cold diet, avoiding spicy foods, for the next 3 days. Adequate oral hygiene was maintained. The immediate follow-up period (1 week) was uneventful, with no delayed haemorrhage and normal wound scarring (with surface re-epithelization and the formation of granulation

Class I	Mild ankyloglossia: 12 – 16 mm
Class II	Moderate ankyloglossia: 8 – 11 mm
Class III	Severe ankyloglossia: 3 – 7 mm
Class IV	Complete ankyloglossia: < 3 mm

TABLE 2 Kutlow's morphological classification of ankyloglossia according to the frenulum lenght (Kutlow, 2004).

FIG. 3 One-week postoperative control.

FIG. 4 Six-months postoperative follow up.

tissue) (Fig. 3); only slight pain was manifested during the next day. Following the post-operative evaluation session, 1 week later, the patient was referred for special speech therapy and tongue functional re-education with special exercises. The last control appointment was on November, 2018 (5 months later) (Fig. 4). The tongue exhibited good healing, with normal movements and typical appearance; the patient's speech had significantly improved.

Discussion

The diagnosis and clinical management of paediatric ankyloglossia or tongue-tie continues to be controversial [Messner and Lalakea, 2000]. Ankyloglossia management is based not only on the patient's age, but also on the location, degree of tongue motion restriction, and related functional limitations [Lamba et al., 2015]. It has been well-accepted that surgical laser is an excellent and predictable alternative to traditional scalpel or blade methods for paediatric frenulectomies [Kara, 2008; Adelaimi and Mahmood, 2014]. While all laser wavelengths can be used on oral soft tissues, the selection of a specific therapeutic laser for paediatric oral surgery depends on its photothermal interaction and optical absorbability for water, and on the haemoglobin, melanin, or collagen (called chromophores) that are contained in these tissues [Gontijo et al., 2005; Kato and Wijeyeweera, 2007; Olivi et al., 2009; Neena et al., 2015; Caprioglio et al., 2017; Olivi et al., 2017]. For example, diode, Nd:YAG, and CO_2 possess excellent properties for soft-tissue cutting/incision/contouring, vaporization of deep fibres, coagulation/haemostasis, and wound decontamination when applied to vascular lesions that are rich in haemoglobin; therefore, in these procedures, sutures are nearly never needed; on the other hand, erbium-family lasers are more effective for frenula, gingiva, and mucosa because of the good absorption due to their water content, and sutures are sometimes placed [Nazemisalman et al., 2015]. In any case, the local temperature rise is limited, avoiding carbonization or necrosis of the surrounding tissues and over-extension of the surgical wound [Gutknecht et al., 2005; Olivi et al., 2009]. Furthermore, some technical parameters of the laser device should be carefully selected, including power/energy density, continuous or pulse mode, exposure time, and spot size, in order to achieve the most effective and least harmful surgical procedure [Kara, 2008; Adelaimi and Mahmood, 2014]. The principal lasers employed for lingual frenulectomy in children are briefly described in Table 3.

The main four types of laser surgical devices applied to pediatric patients for lingual frenulectomy are the following.

- Carbon dioxide (CO_2) [Kato and Wijeyeweera, 2007; Boj et al., 2011; Chiniforush et al., 2013; Hanna and Parker, 2016; Komori et al., 2017]. This laser beam exhibits uniform activity depth and cauterisation of nerve endings, with less risk of post-operative pain, swelling, infection, and oedema. Bleeding is decreased, providing a drier surgical site and minimal wound contraction/scarring. Some disadvantages of the CO_2 laser are that it can generate great heat and can burn tissue fast; used properly, the beam can penetrate to a maximal depth of 0.2 mm, sometimes giving rise to slight thermal damage around the irradiated site with a minimal

Laser type	Wavelength (nm)	Mode
Diode	400 – 655 810 – 980	Pulse or continuous-wave
Er:YAG (Erbium-doped yttrium aluminium garnet)	2940	Pulse
Er,Cr:YGSS (Erbium, chromium doped yttrium scandium gallium garnet)	2780	Pulse
CO_2	9300 10600	Pulse or continuous-wave
Nd:YAG (neodymium-doped yttrium aluminium garnet	1064	Pulse

TABLE 3 Most commonly used lasers for pediatric lingual frenulectomy [Nazemisalman et al., 2015; AAPD, 2018 (2)].

delay in healing. It has been demonstrated that this laser causes less invasion of myofibroblasts in the wound than occurs with the scalpel technique, resulting in minimised scar formation; furthermore, the risk of disseminating cancer cells or producing bacteraemia is virtually nil. This laser has been employed for lingual frenulectomy in children with an emission wavelength of 10,600 nm under a continuous mode, an irradiation output power of 1.6–3 W, with a maximal total irradiation time of 2 min.

- Diode [Fornaini et al., 2007; Boj et al., 2011; Kotlow, 2011; Maturo et al., 2013; Adelaimi and Mahmood, 2014; Crippa et al., 2016; Nicoloso et al., 2016; Ambika and Suchithra 2018]. Diode lasers possess a beam delivery system that employs an optical flexible fibre handpiece, with a simple set-up. It is a solid-state semi-conductor laser associated with aluminium, gallium, and arsenic, highly absorbed by haemoglobin but poorly absorbed by water. Diode lasers have significant ability to seal capillaries by means of protein denaturation and the stimulation of clotting factor VII production. Furthermore, these lasers have disinfection properties and are well-indicated for oral soft-tissue surgeries close to dental structures that do not involve excessive bleeding. However, they may cause rapid temperature increases if time of application on the irradiated tissue is prolonged; therefore, water cooling is imperative. For lingual frenulectomy with diode laser, the following parameters have been recommended: wavelength = 810–980 nm; fibre = 320–400 μm; power = 1.8–3 W, and energy dose = 272 joules, in continuous mode. It is usually applied without local anaesthesia or only with topical anaesthesia application. Diode lasers require less input power for soft-tissue excision than do erbium-family lasers.
- Erbium family [Kotlow, 2011; Olivi et al., 2012; Sarkar et al., 2013; Kumar et al., 2017]. Two host crystals consisting of yttrium, aluminium, and garnet (Er:YAG) and chromium-doped yttrium, scandium, gallium, and garnet (Er,Cr:YSGG) are added to the erbium base. These lasers are well-absorbed by structures with a high content of water and collagen, including oral soft tissues. The Er:YAG laser is particularly selective for hydroxyl-radical fibrotic tissue, such as in the lingual frenulum. Erbium lasers are considered "ideal" for paediatric oral surgery for non-extensive wounds because they deliver high device-tip control and operating efficiency for clean incisions, with very little haemostasis. They must be employed with an air-water spray. Er:YAG emits IR optical energy (mid-IR electromagnetic spectrum) through a sapphire conical tip. It is suggested that it be used employing a wavelength of 2,940 nm, power of 1–3 W, and a frequency of 20 Hz, power density up to 600 microns, and low energy (50–80 mJ). In pulse mode, incision of the frenulum is performed with frequencies ranging from 10-30 pulses per s and a pulse duration of 300–600 micros. On the other hand, Er,Cr:YAG has been applied with a wavelength of 2,780 nm, power of 1.5 W, and a frequency of 25 Hz. This laser beam is not well-absorbed by haemoglobin; thus, it possesses limited haemostatic and vessel-shrinkage abilities; therefore, it cannot be used on vascular lesions.
- Neodymium family [Fornaini et al., 2007; Boj et al., 2011; De Santis et al., 2013; Sulijaya and Sunarto, 2015]. Nd-YAG-assisted lingual frenulectomy has been utilised in paediatric dentistry since 1970. Its active medium is a crystal of yttrium aluminium garnet, in which some molecules are substituted with atoms of neodymium. They are characterised by a high absorption level by haemoglobin, melanin, and collagen; however, Nd:YAG is poorly absorbed by water. These lasers exhibit adequate penetration in oral soft tissues, exerting coagulation/haemostatic and thermal effects, with simultaneous disinfection/bactericidal action in surgical wounds, thus providing excellent clinical outcomes and low morbidity. Neodymium lasers can operate at low and high output powers, between 0.3 and 5 K, a wavelength of 1,064 nm, a frequency of 40 Hz, and a power density of 6,229 microns, in pulse mode, delivered by an optical fibre of 320 μm. Their cutting efficiency is similar to that of diode lasers but they are slightly slower than CO_2 lasers.
- Another less-often-used type of laser for lingual frenulectomies in children is the argon beam for electrosurgery, the only high-power laser that emits visible light [Verco, 2007; Boj et al., 2011]. All of these laser devices have been approved by the United States Federal Drug Administration (USFDA) for dental clinical applications in humans.

Compared with traditional surgery with scalpels or blades, laser procedures applied for lingual frenulectomy are thought to be superior in general, according to the child-patient's perceptions, for example, in terms of associated post-operative pain and discomfort and functional complications (speaking and chewing) [Haytac and Ozcelik, 2006; Kara, 2008; Aras et al., 2010]; furthermore, lasers are capable of performing precise and safe surgical incisions. Conversely, scalpel surgery exhibits some risks in this type of surgery due to the close proximity of the submandibular gland ducts, the richly vascular mouth floor, and tongue hypermobility. It has been reported that the manipulation and suturing of the lingual ventral surface after scalpel frenulectomy may occasionally cause obstruction of Warton's duct, damage to lingual nerve branches or sublingual blood vessels, and numbness of the tongue tip [Butchi-Babu et al., 2018; Neena et al., 2015; Crippa et al., 2016]. Furthermore, these techniques usually require more than 15 min to completely perform a lingual frenulectomy in children, including the necessary haemostasis and suturing, while laser surgery may be carried out in less than 10 min [Sulijaya and Sunarto, 2015; Kumar et al., 2017]. On the other hand, prior to the various laser applications in paediatric dentistry, there is required additional training and education, and its implementation requires a financial investment to purchase the equipment. It is also imperative that the practitioner and auxiliary team adhere strictly to safety rules (e.g., use of goggles) and infection control protocols [Fornaini et al., 2007], for example, the use of high-speed suction, as the aerosol emitted during the surgery usually contains virulent soft-tissue particles, particularly when patients with special health care needs and/or immunosuppressed children are treated [Ambika and Suchithra 2018].

As a part of the integrated management of ankyloglossia in paediatric patients, it is recommended, as a complementary therapy, that the patient initiate tongue exercises on the same day or the day after the surgery to allow the tongue to adapt to its new position and movement range, thus improving the child's speech ability [Lalakea and Messner, 2003; Maturo et al., 2013; Tsaousoglou et al., 2016]. According to Tsaousoglou et al. [2016], these exercises should be performed three to five times daily for a period of 30 days.

Limitations

Some limitations can be mentioned regarding the present review because of the broad nature of our research question. First, and related to the literature-retrieval process, grey literature was not considered, and only English/ Spanish-language articles were included. Therefore, we may have dismissed other relevant studies. Second, a thematic analysis was nearly impossible due to the heterogeneity of the methodological designs and the lack of clarity of result reported in the screened studies. Finally, the selected studies were, most commonly, observational designs, narrative reviews, or case reports, which are prone to selection bias and confounders; consequently, the synthesized evidence was not of high quality.

Conclusions

From the present scoping review it can be concluded that early diagnosis and treatment of ankyloglossia are fundamental for the adequate functional oral development of paediatric patients. Second, lingual frenulectomy by laser surgery provides a more efficient and comfortable treatment for both the child patient and the paediatric dentistry practitioner compared to traditional scalpel/blade methods. Nevertheless, there is a strong necessity for further research through the conduction of high-quality studies, including clinical randomised controlled trials with adequate sample sizes, comparing the various laser-beam approaches with conventional surgical techniques, including cost-benefit analyses, for lingual frenulectomy in newborns, infants, children, and young adolescents.

Conflict of interest

The authors declare that they have no conflicts of interest.

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