

## SYSTEMATIC REVIEW

# Beyond surgery: Pre- and post-operative care in children with ankyloglossia

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## Abstract

**Background:** Surgical intervention for tongue-tie, or ankyloglossia performed by paediatric dentists can alleviate symptoms and improve functional abilities in infants and children. Despite widespread practice, there are currently no established clinical guidelines or consistent approaches for pre- and post-operative care of children.

**Aim:** The aim of this study was to explore approaches to pre- and post-operative care for children with ankyloglossia having frenum surgery.

**Design:** A scoping review of peer-reviewed articles in four electronic databases was conducted. Intervention studies that reported on pre- or post-operative regimens for infants, children and adolescents (0 to 18 years) with a diagnosis of tongue-tie or ankyloglossia, who had surgical intervention such as frenotomy or frenectomy, were included and quality assessments performed.

**Results:** Twenty-three studies were identified, with seven studies incorporating both pre- and post-operative care, and 16 studies focussing solely on post-operative care. Tongue exercises were commonly prescribed, and only three studies examined the relationship between post-operative care and recovery outcomes. Considerable variability existed in study design, prescribed care and outcome measures.

**Conclusion:** There was substantial variability in pre- and post-operative care protocols, including dosage, frequency and duration of exercises and other care regimens for infants and children having frenum surgery. Further research is needed to determine the most effective course of pre- and post-operative care for children undergoing frenum surgery.

## KEYWORDS

active wound management, ankyloglossia, paediatrics, surgical outcomes, tongue-tie

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## 1 | INTRODUCTION

Ankyloglossia or tongue-tie is a congenital condition, which occurs when the lingual frenulum is short, tight or thick, leading to restricted tongue movements and associated functional limitations during feeding, swallowing, articulation and breathing.<sup>1,2</sup> Ankyloglossia is reported in approximately 7% to 10% of infants,<sup>3,4</sup> and surgical intervention is often recommended to release tension of the lingual frenulum to improve tongue mobility and function.<sup>5,6</sup> Surgical intervention may involve frenotomy (incision to the frenulum), frenectomy (frenulum is removed) or frenuloplasty (frenulum is elongated).<sup>7</sup> Historically, paediatricians, otolaryngologists and midwives would manage and treat ankyloglossia. In contemporary practice, there has been a significant increase in the use of laser-assisted dental surgery for labial or lingual frenectomy surgical procedures by paediatric dentists.<sup>8</sup> Although laser-assisted surgery is considered safe and effective to resolve ankyloglossia, it can be associated with complications, such as pain, scarring, infection and re-attachment of the lingual frenulum.<sup>1,9</sup> These complications may impact healing and outcomes for feeding and articulation.<sup>1</sup>

Pre- and post-operative care is reported to improve the wound healing process.<sup>9</sup> Wound healing has three phases: the inflammatory, proliferative and remodelling phases.<sup>10</sup> During these phases, primary or secondary wound healing occurs. Primary healing refers to the close approximation of wound edges leading to closure and healing with minimal scarring. The goal of post-operative wound care in ankyloglossia is to expedite complication-free healing, to achieve optimal tongue mobility to facilitate functional improvements for feeding.<sup>10</sup> Active wound management, in the form of stretching and strengthening exercises, can contribute to effective healing and reduce re-attachment, leading to improved function and tongue mobility.

Pre- and post-operative care regimens are reported to improve wound healing and subsequent symptom resolution. Merkel-Walsh and Overland<sup>11</sup> highlighted the importance of two phases of post-frenectomy care. The first stage includes active wound management by the surgeon to maintain wound integrity and prevent re-attachment of tissues back to the original anatomy. The second component is neuromuscular re-education, administered by therapists using different care regimens to help improve range of motion and reduce compensatory patterns due to fascial restrictions to subsequently reduce or resolve symptoms. Different types of care regimens include myofunctional exercises and therapy, stretching, chiropractic care, craniosacral therapy or bodywork and massage before and following surgery.<sup>1,9,12</sup> Nevertheless, given the lack of a universally accepted protocol, exercises are inconsistently described in the literature, with limited

### Why this paper is important to paediatric dentists

- There are currently no established standard regimen of pre- or post-operative care for children having ankyloglossia surgery, leading to inconsistent recommendations provided by paediatric dentists and other clinicians. This paper provides a summary and quality assessment of the studies available for pre- and post-operative care.
- This study reports a wide range of pre- and post-operative care protocols. This study adds to the evidence base of the published literature examining the relationship between care and recovery outcomes, contributing to optimisation of dental care practice.
- This paper will enable clinicians to recommend pre- and/or post-operative care for children undergoing ankyloglossia surgery with more confidence.
- The lack of standardised pre- and post-operative care, variability in care protocols and the need for further research highlight the importance for paediatric dentists to establish clear guidelines and evidence-based practices to ensure optimal care and improved outcomes for children undergoing ankyloglossia surgery.

high-quality evidence available to select the most suitable care regime.<sup>1,9</sup>

The lack of well-established protocols and the corresponding lack of outcomes are evident contribute to healthcare provider confusion, and undermine the confidence of healthcare professionals in the effectiveness and reliability of pre- and/or post-operative treatment plans. This makes it difficult for healthcare providers to assess the success or failure of these regimens, and hinders the ability to make informed decisions about patient care. A survey of paediatric otolaryngologists reported insufficient evidence to support any single post-operative care regimen. Some clinicians prescribed pre- and/or post-operative care regimens, whereas others did not, and the protocols prescribed by clinicians were inconsistent,<sup>9,13</sup> with no standard care regimen recommended.<sup>12</sup> Although there is general acknowledgement that pre- and/or post-surgical regimens may be effective to facilitate symptom resolution, there is a significant gap in knowledge and consensus with respect to the clinical protocols that are currently being utilised, as well as the accepted confidence and effectiveness of these various pre- and post-operative

care regimens. Previous reviews have discussed the outcomes of different surgical interventions for ankyloglossia<sup>7</sup>; no review to date, however, has amalgamated types of pre- and post-operative care in ankyloglossia management, including healing and recovery outcomes.

This scoping review aimed to summarise pre- and post-operative care for ankyloglossia described in the literature to guide paediatric dentists and clinicians supporting children with ankyloglossia.

## 1.1 | Objectives

The objectives of this review were as follows:

- a. To summarise pre- and post-operative care for paediatric clients who have undergone ankyloglossia surgery and
- b. To explore the relationship between pre- and post-operative care and recovery outcomes in paediatric patients.

## 2 | MATERIALS AND METHODS

A scoping review was conducted to identify studies describing pre- and/or post-operative care for ankyloglossia surgery in participants from birth to 18 years. A scoping review was selected as the most appropriate methodology to obtain an understanding of the diverse range of pre- and post-operative care described. This review was conducted using Arksey's and O'Malley's<sup>14</sup> five-stage framework and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).<sup>15</sup> Ethics approval was not required for this review.

### 2.1 | Search strategy

Four electronic databases were searched for articles published before August 2022, with no limit on the date of publication: Ovid Medline, ProQuest, Scopus, and Maternity and Infant Care. Search terms were tailored to the syntax requirements of each database, with keywords for the population age (e.g. 'newborn' or 'infant' or 'paediatric' or 'adolescent'), diagnosis (e.g. 'tongue-tie' or 'ankyloglossia' or 'sublingual restriction' or 'lingual restriction'), surgical intervention (e.g. 'frenotomy' or 'frenectomy' or 'frenuloplasty' or 'lingual-plasty'), and pre and post-operative care (e.g. 'pre-operative' or 'post-operative' or 'wound care' or 'stretch'). Forward and backward searches of reference lists were completed. A full search strategy is included in [Appendix 1](#).

### 2.2 | Inclusion and exclusion criteria

Peer-reviewed articles reporting on human participants aged between birth and 18 years who had undergone ankyloglossia surgery were considered for inclusion. Studies were required that described pre- and/or post-operative care prescribed to participants and reported quantitative or qualitative outcomes. There were no limitations on classification or type of ankyloglossia, surgical approach, post-surgery duration or type of care prescribed, to ensure that the present review captured all articles related to pre- and post-operative care. Studies were required to provide specific details about the course of care prescribed to ensure that findings could be accurately synthesised, for example stating that 'A course of lingual exercises was prescribed' was not considered sufficient. No limits were placed on study location or date of publication. All peer-reviewed intervention or experimental studies were included to ensure all forms of pre- and post-operative care were included. Only papers written in English were considered for inclusion due to associated translation costs. Commentary articles, letters, animal studies and review papers were excluded.

### 2.3 | Data extraction

Following title and abstract, then full-text screening, articles that met criteria were independently analysed by two members of the research team. For each paper, the following data were extracted and charted: authors, date, study location, study design (including whether the relationship between care and outcomes was tested), sample population and size, length of time post-surgery, type of pre- and post-operative care, pre- and post-operative care adherence, data collection methods, outcome measures, key results, conclusions drawn regarding the relationship between pre- and post-operative care and outcomes, and study limitations.

### 2.4 | Assessment of methodological quality

The quality of each study was independently assessed by two members of the research team using the *Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields*.<sup>16</sup> This tool allows for appraisal of primary studies using a 14-item checklist for quantitative studies, and a 10-item checklist for qualitative studies.<sup>16</sup> Each item is scored according to whether it is present in the article, as 'yes' (2), 'partial' (1), 'no' (0) or not applicable.<sup>16</sup> A summary score was then calculated

for each study following the removal of all 'not applicable' items by dividing the sum of scores by the total possible score and converting this into a percentage.<sup>16</sup> Overall study quality was described as strong (>80%), good (70% to 80%), adequate (50% to 70%) or limited (<50%). Any discrepancies between the two raters were resolved through consultation with a third member of the research team.

### 3 | RESULTS

Following duplicate removal, 597 unique articles were identified through database searches, illustrated in Figure 1.<sup>17</sup> Reference lists of identified studies and reviews were manually searched, and no additional studies were identified. Following screening of titles, abstracts and full texts, 23 articles met the inclusion criteria.<sup>5,9,18–38</sup> The primary reasons for exclusion at full-text screening were articles containing no information regarding pre- or post-operative care or containing extremely limited descriptions of the care prescribed ( $N=138$ ), focussing on irrelevant topics such as lip-tie rather than ankyloglossia ( $N=61$ ), or sampling from an adult population ( $N=16$ ).

#### 3.1 | Study characteristics

Participants from the 23 included studies were recruited from 10 different countries (Italy, United States, India, Spain, United Kingdom, Brazil, Mexico, Malaysia, Canada and Switzerland). All studies were quantitative, including

prospective cohort studies ( $N=10$ ), case reports ( $N=6$ ), case series ( $N=2$ ), transversal descriptive studies ( $N=2$ ), randomised controlled trials ( $N=2$ ) and retrospective cohort studies ( $N=1$ ). The 23 studies included a total of 1296 paediatric participants who underwent ankyloglossia surgery, ranging in age from birth to 18 years. Eight studies examined infants under 12 months of age,<sup>9,22,23,25–27,31,35</sup> and the remaining 15 studies explored children aged one to 18 years.<sup>5,18–21,24,28–30,32–34,36–38</sup>

#### 3.2 | Pre- and Post-operative protocols

A wide range of pre- and post-operative care protocols were reported. A full description of pre- and post-operative protocols is outlined in Table 1. Of the 23 included intervention studies, seven incorporated a course of both pre- and post-operative care, whereas the remaining 16 studies included post-operative care only. Adherence rates to pre- and post-operative care were reported for five studies only<sup>5,9,19,21,30</sup> and ranged from 43.5% to 100%. Across studies, pre-operative care included (either individually or in combination) lingual exercises/myofunctional therapy ( $N=5$ ), wound massage ( $N=2$ ) and breastfeeding sessions ( $N=3$ ). Post-operative care included (individually or in combination) lingual exercises/myofunctional therapy ( $N=22$ ); application of antiseptic, gauze or analgesics ( $N=8$ ); wound massage ( $N=7$ ); speech therapy ( $N=5$ ); breastfeeding sessions ( $N=3$ ); and generic oral hygiene and dietary recommendations ( $N=2$ ). Forms of post-operative care incorporating lingual exercises or

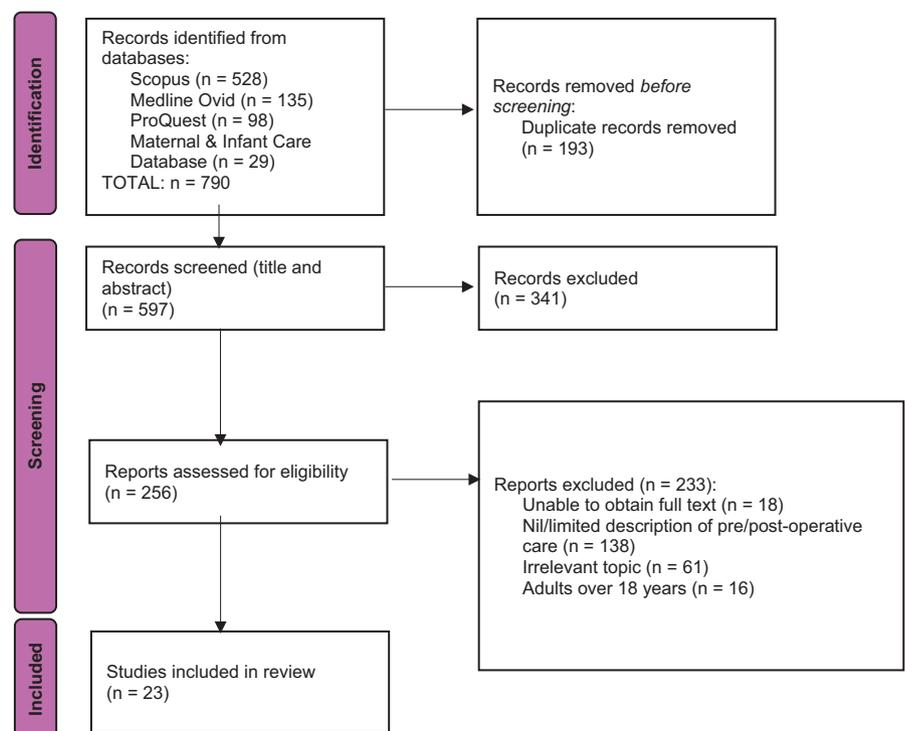


FIGURE 1 Flow diagram of study selection process based on PRISMA.<sup>17</sup>

TABLE 1 Description of surgery type, pre- and post-operative care protocols ordered by age of participants.

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Ferres-Amat et al. (2016b), Spain <sup>22</sup>	N = 1. Age: 17 days. 1/1 male	Lingual frenotomy <ul style="list-style-type: none"> <li>Scissors, 12-cm Metzzenbaum dissecting</li> <li>Grooved probe</li> </ul>	Hand hygiene or use of gloves in preparation for session Exercises conducted by the family (repeated 6 times, 3×/day pre-operatively). Duration and time frame prior to surgery not stated Extraoral exercises: <ul style="list-style-type: none"> <li>Stimulate masseter: pressure placed on masseter muscles with index fingers and thumb in circular form</li> </ul>	Exercises conducted by the family (repeated 6 times, 2×/week for 1-month post-operatively). Duration and time frame post-surgery not stated Extraoral exercises: <ul style="list-style-type: none"> <li>Stimulate masseter: pressure placed on masseter muscles with index fingers and thumb in circular form</li> <li>Stimulate rooting reflex in the perioral region: alternating forward movements on the upper and inferior lip with thumbs and index fingers, and movement around and on lips with fingers</li> </ul> Intraoral exercises <ul style="list-style-type: none"> <li>Stimulate sucking reflex: stimulation of palate, tongue, inner surface of cheeks and sucking reflex itself via rotational movements, whereas newborn sucks index finger</li> </ul> Immediately followed by breastfeeding (to ensure correct nursing posture and latch) Myofunctional therapy sessions (20 min, 2×/week for 1 month) followed by breastfeeding sessions
Ghaheri et al. (2017), USA <sup>25</sup>	N = 237. Age: M = 4.4 weeks. 133/237 male	Lingual frenotomy <ul style="list-style-type: none"> <li>Diode laser: 1064 nm with variable pulsed wave 300-µm-diameter fibres</li> <li>Wattage: 0.7–0.8 pulsed watts (200 µs on and 100 µs off—0.47–0.53 watts)</li> </ul>	Intraoral exercises <ul style="list-style-type: none"> <li>Stimulate sucking reflex: stimulation of palate, tongue, inner surface of cheeks and sucking reflex itself via rotational movements, whereas newborn sucks index finger</li> </ul> Immediately followed by breastfeeding (to ensure correct nursing posture and latch)	1. Stretching exercises (4–6×/day for several weeks) <ol style="list-style-type: none"> <li>Gently elevate tongue and massage wound</li> </ol> 2. Analgesic (acetaminophen) as needed for 1–2 days

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Srinivasan et al. (2019), Canada <sup>35</sup>	N = 30 Age: <12 weeks (M = 37.9 days). 20/30 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Scissors</li> <li>• Main incision with two accessory incisions</li> </ul>		Stretching exercises 3×/day by parents, prescribed the evening of the surgery (manually performed by parents) <ol style="list-style-type: none"> <li>1. Lift and stretch the baby's tongue using fingers on either side of the incision (~5 s)</li> <li>2. Gently apply pressure at the site of the incision (~5 s)</li> </ol> No details provided for repetitions and duration post-surgery
Hand et al. (2020), Italy <sup>27</sup>	N = 132. Age: 1–12 weeks (M = 43 days). 67/132 male	Lingual, labial and/or buccal frenotomy <ul style="list-style-type: none"> <li>• Diode laser: 1470 or 980 nm</li> <li>• Operative microscope</li> </ul>		<ol style="list-style-type: none"> <li>1. Stretching exercises (elevation of the site) (3×/day) by gently massaging the wound</li> <li>2. Gentle elevation of the lip/tongue/cheeks (depending on the surgery completed) for 3 weeks</li> </ol> Intraoral stretching for 3 weeks <ol style="list-style-type: none"> <li>1. Place a finger under the tongue and push into the centre of the wound while moving side to side</li> <li>2. Stimulate the cheek and palate with rotational finger movements</li> </ol> Details for the number of repetitions and frequency per day not provided
Jamani et al. (2020), Malaysia <sup>31</sup>	N = 3. Age: 6–15 weeks. 2/3 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Scissors</li> </ul>	Breastfeeding sessions (correct positioning)	
Ghaheri et al. (2018), USA <sup>26</sup>	N = 54. Age: M = 8.3 weeks. 28/54 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Diode laser: 1064 nm with variable pulsed wave, 300-µm-diameter fibres</li> <li>• Wattage: 0.7–0.8 pulsed watts (200 µs on and 100 µs off—0.47–0.53 watts)</li> </ul>		<ol style="list-style-type: none"> <li>1. Stretching exercises (4–6×/day for several weeks) <ol style="list-style-type: none"> <li>a. Gently elevate tongue and manual wound massage</li> </ol> </li> <li>2. Analgesic (acetaminophen) as needed</li> </ol>
Bhandarkar et al. (2022), UK <sup>9</sup>	N = 194 (SG = 92, CG = 102). Age: <60 days. NR/194 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Scissors</li> </ul>		<ol style="list-style-type: none"> <li>1. Massage from 24 h of post-surgery (2×/day for 7 days). Rubbing across the raw under surface of the tongue to break down newly formed adhesion</li> <li>2. Parents advised not to stretch the tongue in any way</li> </ol>

(Continues)

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Ferres-Amat et al. (2017), Spain <sup>23</sup>	1. N = 88. Age: <6 months. 62/88 male	Lingual frenotomy <ul style="list-style-type: none"> <li>Scissors, 12-cm Metzenbaum dissecting</li> <li>Grooved probe</li> <li>Rhomboidal plasty using a horizontal-rhomboidal incision</li> <li>Submucous dissection (5 mm) of the margins and dissection of the two genioglossus muscles</li> <li>Various myotomies at various levels in both muscles</li> <li>Simple stitches</li> </ul>	Treatment in the Suction Pathology Unit (CELERE) <ol style="list-style-type: none"> <li>Breastfeeding sessions: If ineffective sucking after 3 sessions, refer to myofunctional therapy <ol style="list-style-type: none"> <li>Extraoral and intraoral exercises. Repetitions, frequency and duration not stated</li> </ol> </li> <li>Myofunctional therapy</li> </ol>	<ol style="list-style-type: none"> <li>Breastfeeding sessions. Frequency and duration not stated</li> <li>Myofunctional therapy <ol style="list-style-type: none"> <li>Extraoral and intraoral exercises. Repetitions, frequency and duration not stated</li> </ol> </li> </ol>
Crippa et al. (2016), Italy <sup>20</sup>	N = 1. Age: 2 years. 1/1 female	Lingual frenotomy <ul style="list-style-type: none"> <li>Diode laser wavelength 980 nm with flexible quartz fibre</li> <li>Wattage: 1.8–2.0 watts average power in continuous wave mode, for 5–10 s with a mean fluence of 11–22 J/cm<sup>2</sup></li> <li>Optical fibre of 320 µm</li> <li>Topical anaesthesia provided (lidocaine spray 15%)</li> <li>Intravenous sedation</li> </ul>	<ol style="list-style-type: none"> <li>No antibiotics or anti-inflammatory analgesics were prescribed</li> <li>Chlorhexidine gel (0.2%) (2×/day). Duration not stated</li> <li>Exercises and speech therapy reported during 14 days of post-procedure. No details of frequency, repetitions and duration reported</li> </ol>	<ol style="list-style-type: none"> <li>No antibiotics or anti-inflammatory analgesics were prescribed</li> <li>Chlorhexidine gel (0.2%) (2×/day). Duration not stated</li> <li>Exercises and speech therapy reported during 14 days of post-procedure. No details of frequency, repetitions and duration reported</li> </ol>
Baxter et al. (2020), USA <sup>18</sup>	N = 37. Age: 13 months – 13 years (M = 4.2 years). 23/37 male	Lingual frenotomy <ul style="list-style-type: none"> <li>CO<sub>2</sub> laser</li> <li>Horizontal beginning in the middle of the frenum</li> <li>Wattage: 2 watts, 29 Hertz, 72.5% duty</li> <li>Released until fascia tension removed, and diamond shape evident</li> </ul>	<ol style="list-style-type: none"> <li>Ibuprofen/acetaminophen (pain). Dosage not stated</li> <li>Manual stretching of wound (2–3×/day). Duration not stated</li> <li>Myofunctional exercises if the child can follow commands. Frequency and duration not stated</li> </ol>	<ol style="list-style-type: none"> <li>Ibuprofen/acetaminophen (pain). Dosage not stated</li> <li>Manual stretching of wound (2–3×/day). Duration not stated</li> <li>Myofunctional exercises if the child can follow commands. Frequency and duration not stated</li> </ol>

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Heller et al. (2005), USA <sup>28</sup>	N = 16 SG1 n = 11. M = 5.7 (2.14). 7/11 male SG2: n = 5. M = 5.56 (1.52). 2/5 male	4-flap Z-frenuloplasty: <ul style="list-style-type: none"> <li>• Blade scalpel and scissors</li> <li>• Scalpel used to make initial incision, scissors to separate the deep tissue to release the tight muscular layers</li> <li>• Closed with interrupted 4–0 chromic sutures</li> <li>• Horizontal to vertical frenuloplasty</li> </ul>		Post-operative tongue exercises <ol style="list-style-type: none"> <li>1. Push tongue in and out of the mouth</li> <li>2. Open the mouth as wide as possible and attempt to touch the tip of the tongue to the back of the upper teeth</li> <li>3. Move the tongue from one side of the mouth to the other, without moving the jaw</li> <li>4. Place the food of choice on one side of the mouth between the cheek and back teeth. Using the tongue, move the food from one side of the mouth to the other and then back again</li> <li>5. Consonant sounds of /f, v, t, d, n, l, sh, s, zh, r, z/ in repetitions of 5, 3–5×/day</li> </ol> Duration to continue exercises was not stated
Carminatti et al. (2022), Brazil <sup>19</sup>	N = 40 (SG = 20, CG = 20). Age: 6–12 years. 25/40 male	Lingual frenectomy <ul style="list-style-type: none"> <li>• Scalpel</li> </ul>		Isotonic tongue exercises (3×/day for 14 days from Day 15 to Day 29 post-surgery) based on Webb and Hong <sup>39</sup> and Silva <sup>40</sup> . <ol style="list-style-type: none"> <li>1. Run the tongue around the closed lips and teeth</li> <li>2. Touch four points outside the mouth with the tip of the tongue</li> <li>3. Pronounce the sounds /l/ and /n/ alternately</li> </ol> Repetition of this sequence not stated. Patients recorded the frequency and dates of practice on a table designed by the researchers, which included a description of how to do the exercise

(Continues)

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Ferres-Amat et al. (2016a), Spain <sup>21</sup>	N = 101. Age: 4–14 years (M = 8.5). 63/101 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Scissors, 12-cm Metzzenbaum dissecting</li> <li>• Grooved probe</li> <li>• Rhomboidal plasty using a horizontal-rhomboidal incision</li> <li>• Submucous dissection (5 mm) of the margins and dissection of the two genioglossus muscles</li> <li>• Various myotomies at various levels in both muscles</li> <li>• Simple stitches</li> </ul>	Orofacial rehabilitation begins 1 week before surgery Lingual exercises: 1. 1-week pre: 1x/day (15 'sequences or repetitions')	Lingual exercises: 1. In the 24 h of post-surgery: 2x/day (15 repetitions) 2. 24–48 h of post-surgery: 3x/day (15 repetitions) 3. Day 3 to Day 15 of post-surgery: 3x/day (15 repetitions) 4. Day 16 to Day 45 of post-surgery: 1x/day (15 repetitions) Repetitions, frequency and duration were reported. No details provided for what lingual exercises were prescribed and who implemented them
Sfasciotti et al. (2020), Italy <sup>34</sup>	N = 125 (4 × SGs = 25 each, CG = 25). Age: 4–14 years (M = 8.37). 66/125 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Diode laser</li> </ul>	Oral myofunctional therapy following Ferres-Amat et al.'s <sup>22</sup> protocol (1-week pre-operatively)	<i>Study Groups A &amp; C</i> : Sterile iodoform gauze (length 3 cm, rolled up in a rotund way) was affixed with a suture (4.0 Vicryl®); removed by the oral surgeon 4 days post-operatively <i>Study Groups A &amp; B</i> : Speech therapy was prescribed (with the same therapist) in addition to functional exercises. All exercises were individualised for each patient, starting to mobilise the tongue and then adding movements for the perioral muscles. Repetitions, frequency and duration not stated <i>Study Groups—Control Group</i> : Myofunctional exercise protocol from Ferres-Amat et al., <sup>22</sup> 3x/day for 1 month Each patient received a diary that contained a representation of the prescribed myofunctional exercises up to 28 days of post-surgery. After the operation

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Tecco et al., (2015), Italy <sup>36</sup>	N = 24 SG1: n = 13. Age: M = 7.0 (2.5) 9/13 male SG2: n = 11. Age: M = 7.0 (0.8) 9/11 male	Lingual frenulectomy <ul style="list-style-type: none"> <li>• Diode laser</li> <li>• 400 µm fibre</li> <li>• Wattage: 3 watts of power in continuous mode</li> </ul>	Orofacial myofunctional exercises or tongue exercises by patient (10–20 times, 3×/day) during the daytime. No specific details provided for the type of exercises and when commenced pre-surgically	Orofacial myofunctional therapy re-education protocol provided with tongue exercises (repeated 10–20 times, 3×/day 4–5 weeks post-operatively) <ol style="list-style-type: none"> <li>1. Move the apex of the tongue forward and up as much as possible near to the nose, then to the bottom of the chin, then laterally towards the labial commissure, first to one side then to the other, turning the tip of the tongue at the bottom and the top of the lower third of the face</li> <li>2. Perform circular movements of the tongue in clockwise and counterclockwise directions, and on the labial surface of the teeth and outside the lips</li> <li>3. Protrude the tongue until it takes on either a large form or a pointed form</li> <li>4. Place the tongue on the palatal landmarks (with a rubber band), then, keeping it in position, without pushing against the teeth, open and close the mouth</li> <li>5. Lift the tip of the tongue just behind the incisive papilla. Stick the back of the tongue to the palate. Suck air between the tongue and palate to create a vacuum and increase adhesion. Slowly open the mouth to strongly stretch the lingual frenulum, also trying to stretch it (the frenulum should be tight; check this position in front of a mirror). Remove the tongue from the palate, producing an explosive sound similar to a CIAK ['ʃak']</li> <li>6. Open the mouth slowly, touch the retro incisor papilla with the tip of the tongue and try to do it faster and faster</li> <li>7. Place the tip of the tongue at the retro incisor papilla, then slide the tongue on the palate in the anterior–posterior direction until it touches the uvula, then forward again, repositioning it on the papilla</li> </ol>

(Continues)

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Naik et al. (2014), India <sup>32</sup>	N = 1. Age: 8 years. 1/1 male	Lingual frenotomy <ul style="list-style-type: none"> <li>Scissors</li> </ul>		<p><b>Post-operative care</b></p> <ol style="list-style-type: none"> <li>1. Oral-motor exercises (blowing, water holding and whistling)</li> <li>2. Tongue exercises (push-ups, wags, tongue-to-nose-to-chin and curling)</li> <li>3. Counting 60–70</li> <li>4. Speech therapy classes (TalkTools Therapy) to improve speaking abilities</li> </ol> <p>No details provided for repetitions of each exercise, frequency and duration post-surgery</p>
Olivi et al. (2021), Italy <sup>33</sup>	N = 30. Age: 8–18 years. NR/30 male	Lingual frenotomy <ul style="list-style-type: none"> <li>Erbium YAG laser (2940 nm)</li> <li>Sapphire conical tip (600 micron)</li> <li>Wattage: energy ranging from 120 to 160 megajoule, at 15 Hertz frequency. Adjustable pulse duration from 300 to 600 <math>\mu</math>s</li> </ul>		<ol style="list-style-type: none"> <li>1. Myofunctional therapy</li> <li>2. Simple tongue mobilisation and stretching several times a day</li> </ol> <p>Discussion states that myofunctional therapy and tongue mobilisation were completed, but no details provided for repetitions of each exercise, frequency and duration post-surgery</p>
Garrocho-Rangel et al. (2019), Mexico <sup>24</sup>	N = 1. Age: 8.5 years. 1/1 male	Lingual frenulotomy <ul style="list-style-type: none"> <li>Erbium YAG laser (2780 nm)</li> <li>Operating parameters: S mode</li> <li>Wattage: pulse duration 140–200 <math>\mu</math>s, 25 Hertz, energy density per pulse of 26.5 J/cm squared; power settings 1.5 watts, 12% water/8% air, and spot of 0.6 mm in diameter by means of a G-4 tip (600 <math>\mu</math>m)</li> </ul>		<ol style="list-style-type: none"> <li>1. Analgesics (paracetamol 200 mg) and chlorhexidine (0.2%) rinses</li> <li>2. Provide a soft, cold diet and avoid spicy foods for 3 days of post-surgery</li> <li>3. Oral hygiene</li> <li>4. Speech therapy and tongue exercises (3–5<math>\times</math>/day for 30 days from 1-week post-surgery). No details provided for specific details of each exercise</li> </ol>
Tripodi et al. (2021), Italy <sup>37</sup>	N = 180. Age: 6–12 years (M = 9.1). 90/180 male	Lingual frenulectomy <ul style="list-style-type: none"> <li>Diode laser</li> <li>Fibre 320 <math>\mu</math>m Wattage: 4 watts</li> <li>Local anaesthesia</li> </ul>		<p>Every patient received precise instructions about 3 months of post-surgery speech therapy rehabilitation exercises. No details provided for what comprised of these exercises, repetitions and frequency post-surgery</p>

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Tsaousoglou et al. (2016), Switzerland <sup>38</sup>	N = 3. Age: 8–12 years. 2/3 male	Lingual frenuloplasty <ul style="list-style-type: none"> <li>• Tool unspecified</li> <li>• Incision with horizontal to vertical technique</li> <li>• Local anaesthesia</li> <li>• Sutures (type unspecified)</li> </ul>	Oral exercises suggested 1-week pre-operatively. No specific details whether these are the same as post-operative exercises and differences in repetitions and frequency	Oral exercises—from 1-week post-operatively in 5 repetitions of each exercise 3–5×/day for 30 days <ol style="list-style-type: none"> <li>1. Push tongue in and out of the mouth</li> <li>2. Open the mouth as wide as possible and attempt to touch the tip of the tongue to the back of the maxillary teeth</li> <li>3. Move the tongue from one side of the mouth to the other, without moving the jaw</li> <li>4. Place the food of choice on one side of the mouth between the cheek and back teeth. Using the tongue, move the food from one side of the mouth to the other and then back again</li> <li>5. Consonant sounds of /f, v, t, d, n, l, sh, s, zh, r, z/</li> </ol>
Sbricoli et al. (2019), Italy <sup>5</sup>	N = 32. Age: 3–18 years (M = 10.5). 19/32 male	Lingual frenectomy <ul style="list-style-type: none"> <li>• Diode laser continuous mode</li> <li>• Wattage: 3.0 watts</li> <li>• Topical anaesthesia under tongue</li> </ul>		<ol style="list-style-type: none"> <li>1. Application of 0.2% chlorhexidine gel for three days of pain management.</li> <li>2. Paracetamol (500 mg 3×/day) for pain management.</li> <li>3. Tongue stretching exercises. No details provided for what comprised of these exercises, repetitions, frequency and duration post-surgery.</li> </ol>
Jaikaria et al. (2021), India. <sup>29</sup>	N = 1. Age: 11 years. 1/1 male	Lingual frenotomy <ul style="list-style-type: none"> <li>• Scissors</li> <li>• Blunt dissection of lingual and alveolar insertions</li> <li>• Surgical wound sutured with catgut suture 4/0</li> </ul>		<ol style="list-style-type: none"> <li>1. Tongue exercises performed at least 3×/day (prescribed at the 1-week post-operative evaluation). No details provided for what comprised of these exercises, repetitions, frequency and duration post-surgery</li> <li>2. Referral to a speech therapist for tongue movement and speech articulation</li> <li>3. Analgesics. No dosage and duration provided</li> <li>4. Mouthwash (containing chlorhexidine). No dosage and duration provided</li> <li>5. Diet recommendations and maintaining good oral hygiene</li> </ol>

(Continues)

TABLE 1 (Continued)

First author (year), country (Citation)	Participants	Type of surgery	Pre-operative care	Post-operative care
Jaikumar et al. (2022), India <sup>30</sup>	N = 1. Age: 14 years. 1/1 male	Lingual frenectomy <ul style="list-style-type: none"> <li>• Diode laser (980 nm)</li> <li>• Fibre-optic tip (400 µm)</li> <li>• Wattage: 2 watts in continuous mode</li> <li>• Local anaesthesia</li> </ul>		<ol style="list-style-type: none"> <li>1. Analgesia (paracetamol 500 mg) if needed</li> </ol> Tongue exercises given one-week post-surgery in front of a mirror. Repeated 15 times, 3x/day for 4 weeks. Simplified protocol based on Tecco <sup>36</sup> : <ol style="list-style-type: none"> <li>1. Protrude the tongue as much as possible</li> <li>2. Move the tip of the tongue forwards and upwards as much as possible, trying to touch the tip of the nose</li> <li>3. Protrude the tongue outside the mouth and rotated to perform circular movements, first clockwise and then anti-clockwise</li> <li>4. Position the tip of the tongue on the incisive papilla, and while in that position, and then open and close the mouth</li> <li>5. Repeat the above exercise, the tongue position secured in the mid-palate and posterior palate</li> <li>6. Push the entire tongue against the palate and create a vacuum by sucking the air. Now, the mouth is opened slowly to the maximum extent possible, until the tongue is released from its position</li> </ol>

Abbreviations: %, per cent; CG, control group; cm, centimetre; J/cm<sup>2</sup>, Joules per square centimetre; M, mean; mm, millimetre; nm, nanometre; N, sample size; SG, study group; µm, micrometre; µs, microsecond.

myofunctional therapy were typically the most comprehensively described across studies. Protocols also differed significantly in the exercise dosage, frequency and duration of care prescribed.

### 3.3 | Quality assessment

There was significant variability in the quality of the 23 papers. Quality assessment scores ranged from 36% to 96%, with 11 studies rated as 'strong', two rated as 'good', seven rated as 'adequate' and three rated as 'limited'<sup>16</sup> and are outlined in Table 2. Shared areas of weakness across studies included lacking information regarding data collection methods and/or poorly defined outcome measures, such as lacking descriptions of how adherence data was collected or how 'good healing' was defined. Other areas of weakness included lacking specific details of the care prescribed, small sample sizes, lacking consideration of confounding variables (e.g. post-operative care adherence) and/or lacking a control group to draw appropriate conclusions regarding the effectiveness of pre- and post-operative care.

### 3.4 | Post-surgical outcomes

A variety of outcome measures, including speech articulation, breastfeeding, sleep, tongue structure and function, wound healing, weight gain, pain, reflux, posture and post-surgical complications, were used to assess the effectiveness of pre- and post-operative care across studies (Table 3). Frenotomy in combination with pre- and/or post-operative care was associated with post-surgical improvements in functional outcomes such as breastfeeding (e.g. duration, breastmilk intake and maternal nipple pain), speech articulation, sleep, tongue mobility, tongue structure (e.g. degree of ankyloglossia and frenulum length), weight gain, reflux, wound healing and posture. Of the 23 included studies, only three were designed to explicitly investigate the relationship between post-operative care and post-surgical outcomes through the inclusion of a control group who did not engage in pre- or post-operative care.<sup>9,19,37</sup> One of these studies was conducted in infants under 60 days old,<sup>9</sup> and the other two were in children aged 6 to 12 years.<sup>19,37</sup> Across these three studies, study groups engaging in post-frenotomy wound massage (5), isotonic tongue exercises<sup>19</sup> and speech therapy rehabilitation in the form of lingual exercises<sup>37</sup> achieved better recovery outcomes than control groups who received frenectomy only. The remaining 19 studies did not explicitly evaluate the relationship between pre- or post-operative care and ankyloglossia surgery outcomes.

Most studies provided recommendations for implementing post-operative care, regardless of whether the relationship between care and post-surgical outcomes had been explicitly evaluated. Only one article recommended against the use of post-operative care (massage) due to a nonsignificant difference between the study and control groups.<sup>9</sup>

Amongst the studies in this review, few negative outcomes were reported following ankyloglossia surgery in combination with pre- and/or post-operative care, with low ankyloglossia recurrence rates and minor complications such as infection. Although Ferres-Amat et al.<sup>21</sup> did not set out to examine the link between orofacial rehabilitation and frenotomy outcomes, a portion of participants did not adhere to post-operative care recommendations (21.8%). Lacking adherence was found to be the only statistically significant predictor of poorer recovery outcomes.<sup>21</sup>

## 4 | DISCUSSION

This scoping review delineates the diverse range of pre- and post-operative care provided for infants and children undergoing ankyloglossia. Several types of surgical methods were used, and seven main types of pre- and post-operative care were reported, including speech-language pathology, myofunctional therapy/lingual exercises/stretching, application of antiseptic, gauze or analgesics, massage, breastfeeding, and generic oral hygiene and dietary recommendations.

There was significant variability in the age of participants, assessment of compliance and pre- and post-operative care regimens, including exercise dosage, frequency, duration and specific care procedure implemented or the types of exercises. Post-operative care was prescribed in all studies, whereas pre-operative care was only prescribed in seven studies. The most common and comprehensively form of care described was myofunctional therapy or lingual exercises. Improvements in outcomes such as breastfeeding, speech or articulation, sleep, tongue structure/function, weight gain, reflux, wound healing and posture were reported following frenotomy in combination with all types of pre- or post-operative care. Frenotomy in combination with all types of pre- and post-operative care was associated with low ankyloglossia recurrence rates and only minor post-operative complications.

Significant heterogeneity in study designs, outcome measures and care protocols leads to challenges in drawing comparisons across studies. All studies included in this review explicitly examining the link between care and frenotomy outcomes prescribed post-operative care only. It is therefore difficult to determine whether the addition

TABLE 2 Pre- and post-operative care by discipline and treatment including adherence and quality ratings by age of participants.

First author (year), country	Participants	Study design	Quality score	Pre- (°) and post- (•) op. care						Pre-/Post-op. care adherence
				SLP	MT	AN	MA	BF	GE	
Ferres-Amat et al. (2016b), Spain <sup>22</sup>	N = 1. Age: 17 days. 1/1 male	Case report	58% (adequate)	°	°	°	°	°	°	NR
Ghaheri et al. (2017), USA <sup>25</sup>	N = 237. Age: M = 4.4 weeks. 133/237 male	Prospective cohort	91% (strong)	•	•	•	•	•	•	NR
Srinivasan et al. (2019), Canada <sup>35</sup>	N = 30 Age: <12 weeks (M = 37.9 days). 20/30 male	Prospective cohort	86% (strong)	•	•	•	•	•	•	NR
Hand et al. (2020), Italy <sup>27</sup>	N = 132. Age: 1–12 weeks (M = 43 days). 67/132 male	Prospective cohort	95% (strong)	•	•	•	•	•	•	NR
Jamani et al. (2020), Malaysia <sup>31</sup>	N = 3. Age: 6–15 weeks. 2/3 male	Case series	83% (strong)	•	•	•	•	•	•	NR
Ghaheri et al. (2018), USA <sup>26</sup>	N = 54. Age: M = 8.3 weeks. 28/54 male	Prospective cohort	86% (strong)	•	•	•	•	•	•	NR
Bhandarkar et al. (2022), UK <sup>9</sup>	N = 194 (SG = 92, CG = 102). Age: <60 days. NR/194 male	Retrospective	42% (limited)	•	•	•	•	•	•	43.5%
Ferres-Amat et al. (2017), Spain <sup>23</sup>	N = 88. Age: <6 months. 62/88 male	Transversal descriptive	86% (strong)	°	°	°	°	°	°	NR
Crippa et al. (2016), Italy <sup>20</sup>	N = 1. Age: 2 years. 1/1 female	Case report	58% (adequate)	•	•	•	•	•	•	NR
Baxter et al. (2020), USA <sup>18</sup>	N = 37. Age: 13 months – 13 years (M = 4.2 years). 23/37 male	Prospective cohort	86% (strong)	•	•	•	•	•	•	NR
Heller et al. (2005), USA <sup>28</sup>	N = 16 SG1 n = 11. M = 5.7 (2.14). 7/11 male SG2: n = 5. M = 5.56 (1.52). 2/5 male	Prospective cohort	64% (adequate)	•	•	•	•	•	•	NR
Carminatti et al. (2022), Brazil <sup>19</sup>	N = 40 (SG = 20, CG = 20). Age: 6–12 years. 25/40 male	Randomised controlled trial	96% (strong)	•	•	•	•	•	•	100%
Ferres-Amat et al. (2016a), Spain <sup>21</sup>	N = 101. Age: 4–14 years (M = 8.5). 63/101 male	Transversal descriptive	82% (strong)	°	°	°	°	°	°	78.2%

TABLE 2 (Continued)

First author (year), country	Participants	Study design	Quality score	Pre- (°) and post- (•) op. care						Pre-/Post-op. care adherence
				SLP	MT	AN	MA	BF	GE	
Sfasciotti et al. (2020), Italy <sup>34</sup>	N = 125 (4 x SGs = 25 each, CG = 25). Age: 4–14 years (M = 8.37). 66/125 male	Randomised controlled trial	89% (strong)	•	°	•	•	•	•	NR
Tecco et al., (2015), Italy <sup>36</sup>	N = 24 SG1: n = 13. Age: M = 7.0 (2.5) 9/13 male SG2: n = 11. Age: M = 7.0 (0.8) 9/11 male	Prospective cohort	75% (good)	°	•					NR
Naik et al. (2014), India <sup>32</sup>	N = 1. Age: 8 years. 1/1 male	Case report	50% (adequate)	•	•					NR
Oliivi et al. (2021), Italy <sup>33</sup>	N = 30. Age: 8–18 years. NR/30 male	Prospective cohort	36% (limited)	•	•					NR
Garrocho-Rangel et al. (2019), Mexico <sup>24</sup>	N = 1. Age: 8.5 years. 1/1 male	Case report	40% (limited)	•	•	•	•	•	•	NR
Tripodi et al. (2021), Italy <sup>37</sup>	N = 180. Age: 6–12 years (M = 9.1). 90/180 male	Prospective cohort	65% (adequate)		•					NR
Tsaousoglou et al. (2016), Switzerland <sup>38</sup>	N = 3. Age: 8–12 years. 2/3 male	Case series	92% (strong)		•					NR
Sbricoli et al. (2019), Italy <sup>5</sup>	N = 32. Age: 3–18 years (M = 10.5). 19/32 male	Prospective cohort	64% (adequate)		•					93.8%
Jaikaria et al. (2021), India <sup>29</sup>	N = 1. Age: 11 years. 1/1 male	Case report	67% (adequate)	•	•	•	•	•	•	NR
Jaikummar et al. (2022), India <sup>30</sup>	N = 1. Age: 14 years. 1/1 male	Case report	75% (good)		•					100%

Abbreviations: AN, analgesics/antiseptic/gauze; BF, breastfeeding; GE, generic oral hygiene and dietary recommendations; MA, massage; M, mean; MT, myofunctional therapy/lingual exercises/stretching; NR, not reported; N, sample size; Op., operative; SLP, speech-language pathology.

TABLE 3 Summary of post-surgical outcome for participants in included studies by age of participants.

First author, (year), country	Summary of post-surgical outcomes
Ferres-Amat et al. (2016b), Spain <sup>22</sup>	Improvements in weight gain (2970→5414 g), parent-reported VAS pain score (10→1) + breastfeeding duration (>60 min→15 min) from pre- to 9 weeks of post-operative
Ghaheri et al. (2017), USA <sup>25</sup>	Improvement pre- to 1-month post-operative in breastfeeding (BSES-SF)*, reflux (I-GERQ-R)* + VAS pain scores. Mean breastmilk intake increased 155% 1-week post-operative. 3.4% (8/237) revision surgeries required
Srinivasan et al. (2019), Canada <sup>35</sup>	Improvements in LATCH score 14-day post-operative*, reduced median nipple pain score (numeric rating scale) post-operative*, parent-reported breastfeeding improvements immediately post-operative in 90% of mothers +83% 14-day post-operative*. Minor bleeding was reported during stretches for 8 patients 1-week post-operative +1 patient 2-week post-operative
Hand et al. (2020), Italy <sup>27</sup>	Improvement pre- to 1-month post-operative in breastfeeding (BSES-SF)*, reflux (I-GERQ-R)* + VAS pain scores*. The difference in VAS scores between anatomical tongue class distinctions*
Jamani et al. (2020), Malaysia <sup>31</sup>	Improved Hazelbaker <sup>41</sup> ATLF structure and function scores, and parent-reported nipple pain, latch + sucking 4-week post-operative
Ghaheri et al. (2018), USA <sup>26</sup>	Improvement pre- to 1-month post-operative in breastfeeding (BSES-SF)*, reflux (I-GERQ-R)* + VAS pain scores*. No revision surgeries required*
Bhandarkar et al. (2022), UK <sup>9</sup>	Improvements in parent-reported BF questionnaire for 96.7% of SG and 92.1% of CG. Difference NSS between groups. A tongue-tie recurrence rate of 0.66%
Ferres-Amat et al. (2017), Spain <sup>23</sup>	Improvements in weight gain, parent-reported VAS pain scores ( $M = 5.33 \rightarrow 0.81$ ) + BF duration across patients from pre- to post-operative
Crippa et al. (2016), Italy <sup>20</sup>	Increase in lingual mobility immediately +14-day post-operative, and perfect wound healing 14-day post-operative. (observational)
Baxter et al. (2020), USA <sup>18</sup>	Improvements in parent-reported symptom questionnaire on speech by 90% (9/10 items)*, feeding 55.5% (5/9 items)*, sleep 77.8% (7/9 items)* and other symptoms 87.5% (7/8 items)* 1 week +1-month post-operative. Poorer speech, sleep and/or feeding outcomes were noted for 1 patient 1-week post-operative +4 patients 1-month post-operative
Heller et al. (2005), USA <sup>28</sup>	Increase in SG tongue mobility*, maximum mouth opening* and tongue tip touching incisory papilla measurements 30-day post-operative*, & difference between SG and CG*
Carminatti et al. (2022), Brazil <sup>19</sup>	Ankyloglossia degree based on tongue mobility had improved in 28% of patients before commencing orofacial rehabilitation. Degree improved in 96% of patients following orofacial rehabilitation (45 days post-operative.). Minor post-operative complications (4 tongue bites, 1 haemorrhage, 2 infections)
Ferres-Amat et al. (2016a), Spain <sup>21</sup>	At 4-week post-operative, similar improvements in Kotlow <sup>42</sup> measurement in all groups except CG, a numerical pain rating scale score of 0 in all groups, a similar increase in tongue protrusion measurements for all groups, increase in MIO measurements for all groups except gauze only*, largest an increase in MOTTIP measurements in groups with speech therapy only, gauze only + no gauze or speech therapy
Sfasciotti et al. (2020), Italy <sup>34</sup>	Improved Kotlow <sup>42</sup> score post-operative. (3–4 to 0–1) with improved observed tongue mobility. Masseter, sub-mental, and anterior temporalis muscles of SG reached similar sEMG values as CG (differences at rest + during test tasks pre-op*). NSS changes for CG (did not receive frenotomy)
Tecco et al. (2015), Italy <sup>36</sup>	Complete healing + good tongue mobility observed 1-week post-operative. Tongue length increased approx. 1–3 cm
Naik et al. (2014), India <sup>32</sup>	Increased tongue mobility + function 3-weeks +2-month post-operative as per Martinelli et al.'s <sup>43</sup> protocol and Kotlow's <sup>42</sup> classification in 96.7% (29/30) patients. Improvements in posture from frontal and lateral view in 60% (18/30) patients*. Mild-to-severe patient-reported pain during stretches first few days post-operative only in 93.3% (28/30) patients who felt comfortable 1-week post-operative
Olivi et al. (2021), Italy <sup>33</sup>	Observational: Slight pain, no delayed haemorrhage + normal scarring 1-week post-operative. Good healing, normal tongue movements, typical appearance + speech improvements 6-month post-operative

TABLE 3 (Continued)

First author, (year), country	Summary of post-surgical outcomes
Garrocho-Rangel et al. (2019), Mexico <sup>24</sup>	Improvements in SG maximum mouth opening measurements 3 months, 6 months, 12 months of post-operative*. Larger increases for SG than CG at all time points
Tripodi et al. (2021), Italy <sup>37</sup>	Improvement in tongue elevation and protrusion measurements 1-week, 1 month +3 months of post-operative across cases*
Tsaousoglou et al. (2016), Switzerland <sup>38</sup>	Improvements in Ruffoli's <sup>44</sup> measurement 24-week post-operative*. NSS improvements in Kotlow <sup>42</sup> and total tongue measurements 24-week post-operative
Sbricoli et al. (2019), Italy <sup>5</sup>	Improved Hazelbaker <sup>41</sup> ATLFF tongue mobility scores 1-week, 1-month +3-months of post-operative
Jaikaria et al. (2021), India <sup>29</sup>	Limited increase in observed tongue mobility 1-week post-operative. A significant increase in observed tongue mobility + speech articulation 4-weeks of post-operative. After initiating tongue exercises. Free tongue length increased from 11 to >16 mm by 5-week post-operative

Note: [NB] All participants had previously undergone frenotomy before participation (i.e. all procedures in this study were revisions).

Abbreviations: ATLFF, Assessment Tool for Lingual Frenulum Function; BSES-SF, Breastfeeding Self-Efficacy Scale; CG, control group; I-GERQ-R, Infant Gastroesophageal Reflux Questionnaire; M, mean; MIO, maximal interincisal mouth opening; MOTTIP, mouth opening with tongue tip to incisive papilla; NSS, not statistically significant; P, partially (link discussed but not directly attributed to study results); SEMG, surface electromyography; SG, study group; VAS, Visual Analogue Scale.

\*Statistically significant.

of pre-operative care may be beneficial in maximising any positive outcomes, although it appears that pre-operative care does not result in any negative effects. Pre-operative care may well have significant nonfunctional effects on parental readiness, comfort of the infant or child with manual manipulation of the tongue and other factors that could make post-frenotomy care easier, and this review did not consider those studies. Therefore, our conclusion does not say that pre-surgery care is not beneficial, only that the current literature does not provide evidence to say that pre-operative care is essential. Sfasciotti's study of four- to 12-year-old children included different forms of post-frenectomy care across groups (myofunctional therapy only, or combined with speech therapy and/or gauze), and compared them with a control group (no surgery or care regimen), making it impossible to separate out the therapeutic effects of the frenectomy from that of post-surgical care.<sup>34</sup>

In addition to variability in the types of post-operative care prescribed, the timing of post-operative care varied and was not sufficiently reported. Post-operative care time periods ranged from days to 3 months of post-surgery, with some studies reporting 'several weeks' of care. Although repetitive post-operative care is often recommended as best practice, there is a lack of consensus regarding the most efficacious timing, frequency, type and intensity of post-operative care. Future studies should utilise standardised outcome measures at key time points before, during and after pre-operative care, surgery and post-operative care. Consistent and standardised data collection would demonstrate the clinical effectiveness of such treatments alone, or in conjunction with one another, and would clarify whether adjunctive therapies are necessary

before surgery only, after surgery only or both before and after frenotomy surgery.

The age of participants is a crucial factor to consider because the cooperation and ability of the subjects is relevant to the success of the pre- or post-operative care regimen. Eight studies examined infants under 12 months of age, and 15 studies explored children aged one to 18 years. Of the three studies examining the link between post-operative care and outcomes, two supported the use of post-operative care following frenotomy.<sup>19,37</sup> Both studies found that groups engaging in post-frenotomy care (lingual exercises) performed significantly better in measures of lingual function than control groups receiving frenotomy only.<sup>19,37</sup> In contrast, Bhandarkar et al. recommended against post-operative wound massage, due to nonsignificant differences in breastfeeding outcomes between the study and control groups.<sup>9</sup> Age of the participants is one explanation for this lack of congruence in these studies. Better outcomes were obtained for participants who could comply with instructions, for example children aged four to 16 years compared with infants under 60 days old. Future studies should employ designs that address the quality of efficacious post-operative care for age and may reveal varying degrees of improvement based on the child's age, as older children may have a higher capacity to adhere to therapy compared with infants.

Another key factor is compliance of the parents, therapists and patients with the administration of active wound management, which can significantly affect functional outcome measures. Parents play a critical role in pre- and post-operative care, as they are responsible for ensuring that the child follows prescribed

exercises and reporting any adverse reactions, and pre- and post-operative care requires close collaboration between therapists and parents. Therapists play a crucial role in providing professional expertise and guidance, whereas parents provide daily care and support. Within Bhandarkar's wound massage group, 56.6% of parents did not adhere to post-operative massage recommendations.<sup>9</sup> Reasons cited for nonadherence included uncertainty regarding massage-related harms, lacking information about the benefits of massage and conflicting advice received from healthcare professionals surrounding post-frenotomy massage.<sup>9</sup> Other studies did not report compliance rates related to administration of post-operative care. Since there are currently no clear standards for pre- and post-operative care, inconsistent recommendations are being provided by clinicians, with some recommending no care at all.<sup>13</sup> This highlights the impact that a lack of evidence and inconsistent recommendations may have on patients and the need for further research to develop consistent clinical guidelines. It also highlights the confounding role parent compliance and post-operative care quality may play in outcome measurement. Future studies should focus on quantifying parental compliance and assessing the actual quality of the care regimen delivered.

This review did not specifically assess the appropriateness of surgical interventions for ankyloglossia but aimed to transparently document the surgical technique used alongside pre- and post-operative care. Despite reported positive outcomes, the absence of standardised findings underscores the imperative for future research to ascertain the efficacy and necessity of various surgical procedures combined with pre- and/post-operative care for the treatment of ankyloglossia in paediatric patients.

Preliminary research indicates that pre- and post-operative care may influence frenotomy outcomes, but further research is needed to explore this relationship. The inclusion criteria specified the necessity for studies to detail pre- or post-operative care procedures, potentially introducing bias by excluding articles demonstrating successful outcomes without such care. This selective inclusion may have also limited the comprehensiveness of the observed frenotomy outcomes, since papers with vague descriptions of care protocols were excluded. Therefore, the true frequency of each care type may be underrepresented. This highlights the need for more comprehensive descriptions of pre- and post-operative care protocols within future publications, to allow for evaluation and replication.

This review highlights that pre- and post-frenotomy care regimens can positively influence frenotomy outcomes and does not lead to negative outcomes; further

research, however, is needed to clarify the significance of these effects. This review found that the timing of pre- and post-surgical care, age of participants, severity of ankyloglossia, and parental compliance and adherence as three significant variables that should be considered in future studies and the potential inter-relatedness of variables require further exploration. Further research is also needed to determine the most optimal combination of pre- and post-operative care in conjunction with frenotomy, with the inclusion of a control group that does not receive any pre- or post-operative care (surgery-only control group). This would help determine which form of care is most effective in improving healing and functional outcomes following frenotomy. This will assist the development of evidence-based clinical guidelines for pre- and post-operative care, to ensure patients receive consistent recommendations that lead to optimal post-frenotomy outcomes.

#### AUTHOR CONTRIBUTIONS

R.T. and S.S. conceived the idea; H.G. collected the data; H.G., S.S. and R.T. analysed the data; and S.S., H.G. and R.T. contributed to the writing.

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## APPENDIX 1

### Full search strategy

Population	(newborn* OR neonate* OR infant* OR bab* OR child* OR p?ediatric OR "pre?school*" OR "school?age*" OR teen* OR adolescen*) AND
Diagnosis	(tongue?tie OR ankyloglossia OR "lingual restriction" OR "sublingual restriction") AND
Surgical intervention	(fren* OR rhomboid?plasty OR lingual?plasty OR surgery OR electrosurgery OR electrocautery OR scissors OR laser OR scalpel) AND
Pre- and post-operative care	(pre?operati* OR post?operati* OR pre?surg* OR post?surg* OR "wound care" OR "wound heal*" OR rehab* OR myofunctional OR exerci*e* OR stretch* OR suck* OR "neuromuscular re?education" OR speech OR "lingual physiotherap*" OR analgesics OR mouth?wash OR "oral hygiene" OR diet* OR bodywork OR chiropractic* OR craniosacral OR "fascia release" OR sweep* OR massage)