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# Cerebral Palsy and Ankyloglossia: Improved Sleep, Speech, Swallowing, and Breathing After Tongue-Tie Release: A Case Series

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## ABSTRACT

**Aims:** To assess the impact of tongue-tie (ankyloglossia) and lip-tie release on functional outcomes in pediatric patients with cerebral palsy (CP) and explore the role of oral restrictions in hindering therapy progress.

**Methods:** Four female patients with CP, aged 10 months, 3 years, 6 years, and 7 years, underwent tongue-tie release with concomitant lip-tie and/or buccal-tie release. Pre- and postprocedure assessments focused on parental reports of quality of life improvements.

**Results:** All four patients demonstrated significant functional improvements following the release procedures. Reported improvements included better speech clarity, more effective swallowing, improved breathing, increased postural balance, reduced fascial tension, alleviation of gastrointestinal symptoms, and improved sleep patterns. These changes were observed consistently across all patients, suggesting a positive correlation between the release of oral restrictions and functional gains in children with CP.

**Conclusions:** Undiagnosed oral restrictions may impair mobility and development in children with CP. Addressing these restrictions may improve speech, swallowing, and other critical functions. Proper assessment of oral restrictions in children with CP or other comorbidities is essential to optimize therapeutic outcomes and enhance quality of life. This case series highlights the importance of considering oral restrictions in children with special healthcare needs and the ongoing need for further research.

## 1 | Introduction

Cerebral palsy (CP) encompasses a spectrum of permanent movement disorders characterized by injury to the developing brain with a heterogeneous presentation [1]. Patients with CP often have abnormal movement and posture, and many patients struggle with gross, fine, and oral motor movements [2]. Patients often have deficits in central motor control of speech and swallowing, which is a shared bilateral brain grid [3]. Due to impairments of this grid, children with CP may present with a wide array of oral sensory motor challenges that impact feeding and swallowing in childhood, which can worsen over time. Symptoms include but are not limited to oral phase dysphagia, extended mealtimes, bolus mobility challenges, leakage of food, choking, aspiration, self-limited diets, and texture restrictions [3, 4]. Studies have shown that up to 50.4% of children with CP present with swallowing disorders, 53.5% have feeding challenges, and 44% have drooling issues [5]. In addition, motor control for

speech and voice may be affected in patients with CP, resulting in dysarthria, which impacts speech intelligibility, voice quality, and resonance [6].

Patients with CP may be challenging to diagnose and treat through objective measures. First, standardized measures for pediatric oral motor-based feeding and swallowing in general are inconsistent from a quantitative point of view [7], and even fewer are validated for patients with CP. Second, while videofluoroscopic swallowing studies are ideal for these patients who have feeding and swallowing disorders [8], patients with CP may not always have access, financially or geographically, to clinics with specialized training and equipment. Lastly, despite evidence that motor-speech disorders such as dysarthria and childhood apraxia of speech can occur secondary to CP [6], studies tend to focus on assessment and qualitative/quantitative measures of voice rather than treatment of motor speech and/or oral sensory-based deficits. Parental report, therefore, may be one of the most valuable and perhaps only feasible methods of assessing treatment efficacy in this population.

Treatment of cerebral palsy involves a multidisciplinary team approach and intensive therapy [1]. Treatment options include speech, feeding, physical and occupational therapies, pharmacologic agents, and orthopedic surgical procedures [9]. For example, oral sensorimotor stimulation and neurodevelopmental therapy (NDT) have been shown to improve pediatric dysphagia in children with CP [3, 10]. Augmentative and alternative communication have also been successful when motor deficits severely impact the intelligibility of speech or when cognitive deficits exist [11]. However, these techniques may not be readily accessible or affordable.

Tongue-tie (TT) is common (but not normal) and may affect up to 10% to 32.5% of infants [12, 13], and estimates in children range from 17.5% to 26.1% [14, 15]. Also known as ankyloglossia, it is a condition of a restricted lingual frenum causing impaired tongue mobility, which exists on a spectrum. Some presentations may have complete restriction without functional implications, while other symptomatic patients have only a mild tongue restriction [13, 16].

Based on the incidence and prevalence of both tongue-tie and CP, some patients may have a primary diagnosis of CP with concomitant tongue-tie. Tongue-tie is often undiagnosed, considered asymptomatic, or thought to be unrelated to speech or feeding difficulties [17]. Feeding and speech challenges are documented in patients with both CP and TT, as there is considerable overlap with similar symptoms, including feeding, swallowing, and speech challenges [18–20]. Therefore, professionals do not differentiate the functional implications of tongue-tie from the symptoms and struggles of the primary diagnosis. This is not unlike similar conditions such as prematurity, Down syndrome, Autism Spectrum Disorder, and cleft palate, where functional issues related to tongue-tie may be blamed on the primary diagnosis, and neither professionals nor patients/parents/caregivers recognize that an oral restriction (tongue-tie) could be impacting function and quality of life.

Tongue-tie is best treated with a multidisciplinary team approach and a functional or symptom-based assessment to avoid both undertreatment and overtreatment [18, 20–22]. Unfortunately, a restricted frenum does not stretch over time based on collagen and fascial fibers that intertwine with the genioglossus muscle sublingually [23]. Therefore, children with CP who present with overlapping symptoms and minimal progress in therapy should receive a structural assessment to rule out tongue-tie and other oral tethers (labial or buccal ties).

In this case series, the authors present four cases of children with CP and oral restrictions who saw unprecedented and previously unreported improvements (see Table 1 for synopsis). These results could lead to a new therapeutic option for patients with CP and tongue-tie who have experienced minimal improvements with traditional therapies. Patients with CP should be evaluated for oral restrictions as part of a multidisciplinary team, and tongue-tie should be considered a differential diagnosis if breathing, speech, feeding, swallowing, and/or sleeping issues are present. Tongue-tie treatment in other studies, and when performed correctly, is rapid, simple, and with minimal complications, especially when compared to invasive surgical interventions (salivary gland removal) or diagnostic tests patients with CP routinely undergo [9, 20, 24, 25]. Verbal and written consent was obtained from all caregivers to publish the following cases. IRB Exemption 2023/06/3 from Solutions IRB. This is a non-randomized case series of four patients that took place during the normal treatment of patients at our office.

### 1.1 | Case 1

Patient ER, a 7-year-old female with a history of Tetralogy of Fallot, surgical repair, and myocardial infarction at 6 months, requiring multiple life-saving surgeries and resultant hypoxic-ischemic encephalopathy (HIE), and CP. Her mother reported she had chronic congestion (snorting, noisy, distressed breathing) despite treatment with cetirizine since infancy. She reported that she choked and vomited multiple times daily when feeding. In addition, she exhibited tension throughout the face and body and was diagnosed with hip dysplasia. ER also presented with chronic constipation requiring daily suppositories. She was diagnosed with sleep-disordered breathing and mild OSA with snoring, gasping for air, frequent arousals, and mouth breathing. Mom reported, “All day, I’m just trying to feed her and have her not throw up.”

Upon referral from her feeding therapist, the family flew to our specialty clinic for an evaluation. A thorough examination revealed a Kotlow class 4 maxillary labial restriction, with a papillary penetrating maxillary labial frenum (lip-tie) and a restrictive Kotlow class 3 tongue-tie by location, moderately restricting the tongue. Baxter class 2 (gingival) buccal-ties were also present [26]. After a complete history, proper examination, and discussion with parents, it was decided she would benefit from releasing her lip-tie, tongue-tie, and maxillary buccal-ties under topical local anesthesia (no sedation or general anesthesia) (Figure 1). After release with the $CO_2$ laser (LightScalpel, Bothell, WA), 3 W 29 Hz, 80% duty, Non-SuperPulse, for 15 s per area, there was excellent hemostasis without bleeding and full range of motion of the oral tissues. Wound care stretches/massages were prescribed twice daily for 4 weeks to prevent wound reattachment and limited mobility.

**TABLE 1** | Improvements in sleep, feeding, speech, movement, and breathing.

| Patient | Sleep improvements | Feeding improvements | Speech improvements | Musculoskeletal improvements | Breathing improvements |
|---|---|---|---|---|---|
| Case 1 | Sleeping deeper, more refreshed, less mouth breathing, less snoring, less gasping for air | Less choking on foods, less constipation, less reflux | Says "dada" now and vocalizes more. | Less neck and shoulder tension, hips looser, less TMJ popping, increased lip mobility (easier to brush teeth) | Less daytime mouth breathing, less nasal resistance to breathing, decreased congestion |
| Case 2 | None reported | Less frustration, faster eating, increased volume of food, trying new foods, less spitting out food, less constipation, finishing meals better | None reported | Increased lip mobility (easier to brush teeth) | Less mouth breathing, decreased nasal resistance (easier to breathe through nose) |
| Case 3 | Less mouth breathing (sleep-disordered breathing) during sleep | Eating faster, less choking and gagging, less spitting out food ("actually swallowing now" per mother), chewing on the right side now, lateralizing tongue to the right, less reflux, and weaned off reflux medications, less constipation | Easier with "g" sounds, talking more often. | Sitting up longer on knees, using hands better, sat for 20 min unassisted on the couch (never done before), able to pull toys closer and play with toys | Less mouth breathing during the day |
| Case 4 | None reported | Faster weight gain, less clicking noises, less gassy, less anterior loss of milk, less frustration with bottle, less constipation (more frequent, was q2-3d before, now every day, and less straining) | Vocalizing more | Increased range of motion of lips, and they flip out better for feeding | None reported (infant) |

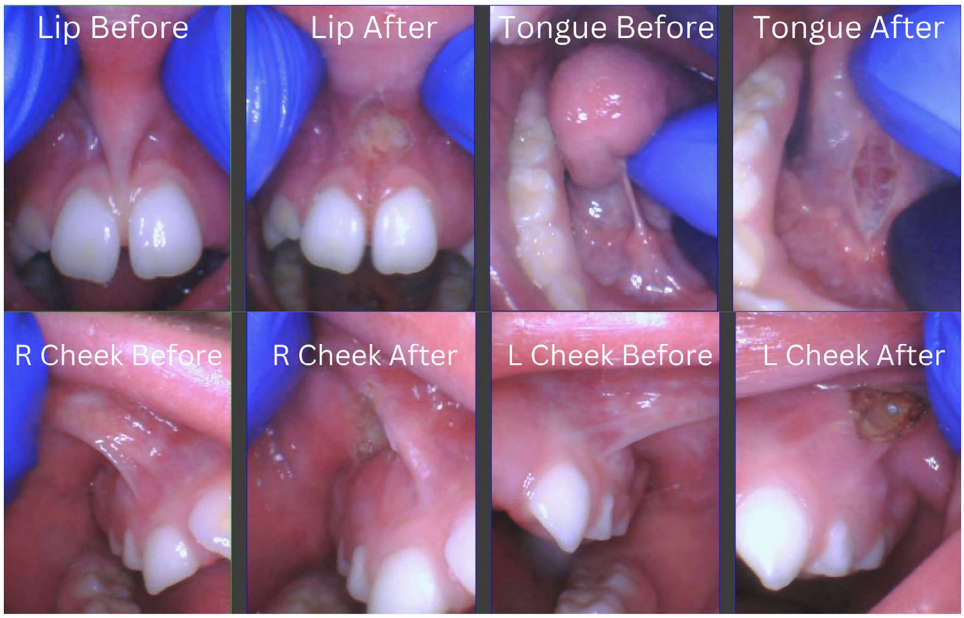


**FIGURE 1** | Case 1 restricted lip, tongue, and maxillary cheek with $CO_2$ laser release, immediate postoperative photo showing full release of restricted tissue.

Later that day, a video from her mother (see Supplemental Video) documented the immediate changes they noticed, including clearer breathing, reduced nasal congestion, decreased fascial tension, looser hips, and improved bowel movements (less constipation) on the same day as the procedure.

A virtual follow-up was performed because the patient lived out of state. Still, a week after the procedure, her mother reported improvements in sleep, morning wakefulness, cosmetic smile (with incisor show), toothbrushing, and nasal breathing during the day. She also reported decreased night wakings, TMJ clicking, choking on foods, neck and shoulder tension, and constipation after the procedure.

Eight months postprocedure, the improvements were sustained, and her mother reported that she "hardly throws up" anymore. She has had consistent daily bowel movements, vocalized more, and even said "dada" multiple times.

### 1.2 | Case 2

Patient EB, a 6-year, 10-month-old female with a history of prematurity, was born at 4.5 lbs and adopted at 2 days old. As an infant, she presented with reflux, excessive gas, clicking noises when feeding, aerophagia, and "colic." She had long-standing frustrations with communication and feeding skills. She never babbled, and is considered nonverbal except for screaming, and had received speech therapy for 5 years at school without improvement. History also included challenges transitioning to solid foods, expulsion of food, persistent reflux, G-tube feeds since age 4, and persistent discomfort from constipation, with excessive straining during bowel movements. She received clearance for oral feeds from her feeding team and was somewhat successful with thickened purees. Additional symptoms included neck and shoulder tension, hypersensitive gag reflex (unresolved infantile reflex), and daytime mouth-breathing. Sleep patterns were also reported as remarkable. Parents noted that she sleeps in the fetal position, moves and kicks throughout the night, exhibits mouth breathing, bruxism, wakes easily, arouses approximately 2–3 times a night, suffers from enuresis, and is not potty trained during the day. Dental symptoms included challenges brushing her maxillary incisors, an atypical smile (maxillary dentition is not visible), and a diastema between her maxillary incisors. Mobility is supported with a walker.

Upon examination, she presented with a Kotlow class 4 maxillary labial restriction, with a papillary penetrating maxillary labial frenum (lip-tie), and a Kotlow class 4 tongue-tie by location, severely restricting her tongue. Buccal frena were a Baxter Class 1, non-restrictive. A laser release of the restricted tissues under topical anesthesia with the $CO_2$ laser at 3 W 29 Hz, 80% duty, Non-SuperPulse, for 15 s per area, provided full range of motion to her lip and tongue (Figure 2). She tolerated the procedure well, with minimal distress (crying), excellent hemostasis, and minimal bleeding. Wound care stretches/massages were prescribed twice daily for 4 weeks to prevent wound reattachment and limited mobility. A team approach with her various therapists continued to follow up with her after the procedure.

At her 10-day follow-up appointment, her mother reported she had a "huge change" in her eating with less frustration, improved swallowing, decreased length of meals, and increased volume and variety of meals. She started trying new foods, had less constipation with more consistent bowel movements, and spitting out food decreased. Additionally, mouth breathing and open mouth posture decreased during daytime hours, and brushing her top teeth and nasal breathing improved.

Eight months later, the improvements were sustained, and she eats lunch and snacks at school by mouth and is "regulated and calm, making many sounds and excellent progress in all areas," according to her mother.

### 1.3 | Case 3

Patient CL is a 3-year-old female with a history of CP, non-verbal communication, and impaired motor skills. Feeding history included G-tube feedings, absent mastication, and tongue lateralization. Despite these reported feeding challenges, she was cleared for oral feeds by a feeding specialist. She did not/cannot crawl, had difficulty holding her head up, and had limited arm movements. Oral dysfunction included a chronic open-mouthed posture and mouth breathing. Sleep disturbances such as restless sleep, frequent arousals, lengthy night awakenings (1–4 h), bruxism, and open-mouthed posture while sleeping were reported by her mother.

Evaluation of the oral frena revealed a Kotlow class 3 maxillary lip-tie and a Kotlow class 2 tongue restriction by location, moderately restricting her tongue. Her maxillary buccal frena were a Baxter class 2, gingival restriction. Full mobility was restored after the release of both the maxillary labial frenum and lingual frenum, and the buccal frena with the $CO_2$ laser (Figure 3). She tolerated the procedure well, with no bleeding and minimal distress. No sedation or general anesthesia was utilized, only topical anesthetic (10% lidocaine, 10% prilocaine, 10% tetracaine, 5% phenylephrine). Wound stretches were prescribed twice daily for 4 weeks, and follow-up with her therapists was encouraged.

After the procedure, at her follow-up visit, her mother noted she could make the /g/ sound better, she had reduced open mouth posture while sleeping, decreased mouth breathing during the day, improved chewing on the right side, ate faster, suffered less choking on foods, diminished coughing when eating solids, swallowing proficiently, and spitting out foods decreased as well. Reflux subsided, and subsequently, she was able to wean off the reflux medication she had taken her entire life. The mother also reported she was using her hands better, sitting up longer on her knees, and was able to pull toys closer to play with them. She even sat for 20 min on the couch without falling off, which she had never had the balance or ability to do before (See Supplemental Video).

Nine months postprocedure, her mother reported the effects were sustained, and she is still eating better, talking more, and has less constipation.

### 1.4 | Case 4

JS is a 10-month-old female with a history of CP and hypoxic-ischemic encephalopathy (HIE) who presented with failure to


**FIGURE 2** | Case 2 restricted lip and tongue with $CO_2$ laser release, immediate postoperative photo showing full release of restricted tissue.

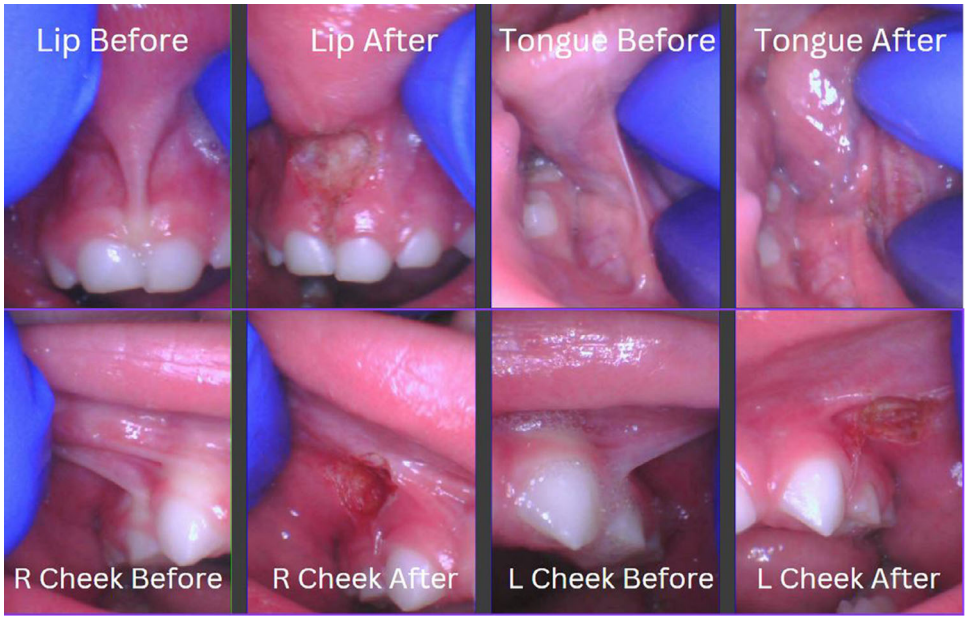


**FIGURE 3** | Case 3 restricted lip, tongue, and cheeks with $CO_2$ laser release, immediate postoperative photo showing full release of restricted tissue.

thrive (weight gain in the 6th percentile at 15 lb 11 oz). JS presented with bottle-feeding challenges, including a shallow latch, popping off the bottle teat, gagging, choking, fatigue, drowsiness, and clicking. Associated symptoms of feeding challenges were "colic," reflux, excessive gas, anterior loss of milk, nasal congestion, constipation (1 bowel movement per 3 days), and hard stools. She participated in ongoing weekly speech, occupational, and physical therapies. Her current therapists referred her for a tongue-tie evaluation.

After reviewing the symptoms and evaluating the oral cavity, the maxillary labial frenum presented as a papillary-penetrating Kotlow class 4, the tongue was a less obvious but still partially restrictive Kotlow class 2 (by location), and the maxillary buccal ties were determined to be restrictive extending to the alveolar ridge, Baxter class 3. After a discussion of risks, benefits, and alternatives, the parents elected to proceed with surgical treatment. Full mobility was restored after releasing the maxillary labial frenum, lingual frenum, and maxillary buccal frena with the $CO_2$ laser (Figure 4). The four areas were released without general anesthesia or sedation and only with topical anesthetic without bleeding or complications and minimal distress. The patient was bottle-fed immediately afterward. Wound care stretches were prescribed three times daily for four weeks, and follow-ups with her therapists were encouraged.

At a 9-day follow-up, the mother reported she had reduced lingual clicking, decreased aerophagia, and less constipation. The mother also reported JS presented with less strain and distress during feeds. She increased daily bowel movements, presented with improved labial flanging and mobility, reduced anterior loss of milk, exhibited decreased frustration with bottle-feeding, and demonstrated quicker feeds at a normalized pace of 15–20 min per bottle (when she previously took 2–3 h to finish a bottle). The mother was very relieved after the procedure and subsequent functional improvements. Weight gain also improved with an 11oz gain in 9 days (16 lb 6oz, 9 days after the procedure, baseline 15 lb 11oz).

At a 5-week follow-up, the symptoms steadily improved, with less gas, decreased constipation, improved weight gain, improved mood, increased sleep duration, and decreased anterior loss of milk. However, feeding time had increased to 20–45 min per bottle. Upon inspection, the tongue had some reattachment, so a firm manual wound care stretch under the tongue was performed. Increased mobility was noted thereafter. The

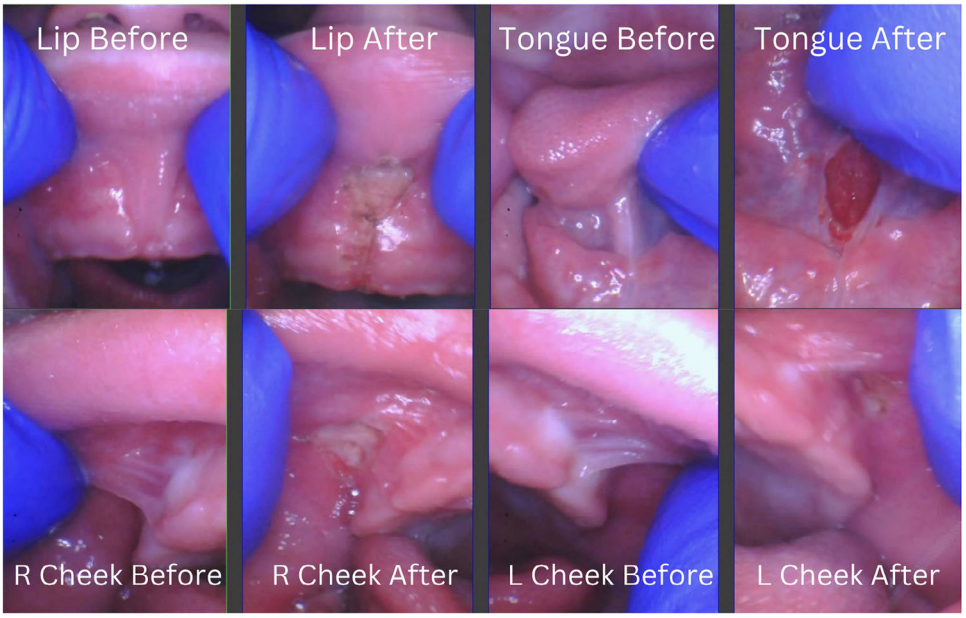


**FIGURE 4** | Case 4 restricted lip, tongue, and maxillary cheek with $CO_2$ laser release, immediate postoperative photo showing full release of restricted tissue.

infant fed better after the surgeon performed a slow, firm stretch.

Stretches were prescribed for an additional three weeks. Five months later, the improvements were sustained, and her mother reported that she still takes her bottles well, can eat purees, vocalizes, and smiles a lot. She still has some delays in gross motor skills, but is improving in therapy.

## 2 | Discussion

Four patients in this case series underwent a tongue-tie release, which released all restricted oral tissues under their tongue. Some patients also had upper lip-tie or cheek-tie releases (if restricted). The improvements seen in this group of patients who struggled with activities of daily living, and whose parents were trying any and all interventions to help their children, should bring awareness of this common condition. Tethered oral tissues of the lingual, labial, and/or buccal frena may be affecting a specific subpopulation of children with CP (or other developmental disabilities), in which the comorbidity of oral restrictions is not considered or even assessed.

Current research suggests that tongue-ties mainly play a role in breastfeeding issues [13, 24, 27, 28]. However, emergent research suggests additional issues can evolve over time, such as speech, feeding, sleeping, and airway issues [16, 19, 20]. In many cases, oral restrictions can have lifelong impacts, even into adulthood [25, 29]. All four patients in this case series saw improvements in constipation and feeding, as well as sleep, breathing, speech, and musculoskeletal improvements, as noted by parents, who often serve as the most reliable informants in these cases (Table 1).

Tongue-tie is often undiagnosed, and it is not uncommon to see older patients and even adults with a to-the-tip tongue-tie that was never discovered. Additionally, a less apparent mid-tongue restriction (also called posterior tongue-tie), as seen in this case series and other studies [16, 20, 27, 30], is even less commonly recognized and requires specialized inspection [12, 31]. Tongue-tie and resultant limited tongue mobility are highly individualized and can have detrimental effects on speech, feeding, sleeping, breathing, and other functions based on presenting symptoms and individual variability [14, 20].

Children with developmental or neurological deficits (i.e., CP) with a restricted tongue could have compounded functional limitations because of the comorbidity of oral sensory-motor deficits and neurological deficits that impact neuroplasticity and compensatory adaptations. In this study, tongue-tie may be limiting the compensatory mechanisms in CP patients, thereby exacerbating their feeding and speech difficulties. Improved tongue mobility may therefore facilitate improved oral sensory-motor skills that are prerequisites for improved articulation and swallowing coordination. These children with special healthcare needs must be screened and assessed for lingual restrictions, maxillary labial, and maxillary buccal restrictions to maximize therapeutic outcomes and functions of daily living.

The author (Dr. Baxter) has treated a dozen patients with CP and tongue-tie and has not had any adverse events or complications intra-operatively or post-operatively, other than minor discomfort, minor bleeding, and slight reattachment of the wound. The procedure should be considered safe when performed by an experienced provider and does not require general anesthesia or sedation when using a $CO_2$ laser.

The second author (Ms. Merkel-Walsh) concurs that many of her patients who present with special needs such as CP, who have undergone lingual frenectomy, have experienced functional gains at a much more timely rate than before the oral tethers were discovered and treated, without adverse side effects. The

most common problem observed through clinical data collection was non-compliance with wound care protocols. This issue can be resolved with encouragement of the surgeon, a wound care support specialist (such as a nurse working with the surgeon), or behavior modification strategies and sensory-motor techniques implemented by a well-trained and licensed therapist or bodyworker to aid neuromuscular re-education. Additionally, specialized tools or vibrating tools can be used to lift the tongue [32].

While less well studied, labial frenectomy is more challenging in elucidating the effects of a release, as seen in this case series and the clinic. Analysis of internal clinical data reveals that adult and pediatric patients report improved nasal breathing (the same day of lip-tie release), decreased nasal congestion, and improved nasal breathing after a maxillary labial (lip-tie) release. The sensation likely arises because the fascia is released from under the nose, muscles are more relaxed and released, and the effect is similar to a Cottle maneuver or a nasal strip on the nose, which can open the nasal passages. Improved oral posture and airway dynamics could also enhance nasal breathing and ease of inspiration.

Restricted maxillary buccal frena are less well understood than the restricted maxillary labial frenum. However, a reduction in fascial tension from releasing these restrictive bands of tissue in the upper cheeks was noted among the parents in this case series and warrants further investigation for children with significant fascial tension throughout the head and neck. Reduced oral tension may lead to less compensatory strain in facial and neck musculature. A recent survey and scoping review article included a rating scale and treatment criteria for buccal frena [26].

It is also important to note the importance of therapeutic assessments and interventions for these patients. Pre- and post-operative care has been documented in the literature to aid the success of the frenectomy [32, 33]. In the CP caseload, in particular, considerations of neuroplasticity and the impact of pain are also imperative as these patients navigate post-op care [34]. The oral sensory-motor system may not respond like neurotypical patients, and speech pathologists with a specialized skill set in children with special needs, dysphagia, feeding, and swallowing are imperative [34].

## 3 | Conclusion

Four children with concomitant CP and oral restrictions were referred for evaluations with suspected functional implications of tongue-tie, lip-tie, and buccal-ties. Previous therapeutic interventions fell short of long-term progress and gains in daily living skills in speech, swallowing, breathing, and/or movement. This case series explored pre- and postsurgical outcomes, with all four children improving functional skills such as oral transit time and/or decreasing problematic symptoms such as constipation and night wakings. Limitations of the study include parent bias and a small sample. However, in this population, objective measures would be difficult to obtain, and parental reports are perhaps the most valuable and feasible method of assessment. Implications for future research include standardized preoperative and postoperative assessments to reduce parent bias and collect data prospectively on measurable treatment outcomes. Tongue-tie release procedures may be helpful to patients who have tried various treatments and are not progressing, and suffer from symptoms commonly associated with oral restrictions.


### Acknowledgments

Thank you to the parents of the children featured in this study for allowing us to share their stories and trusting their instincts to search for alternative explanations for their children's feeding struggles.


### Ethics Statement

Verbal and written consent was obtained from all caregivers prior to treatment. Our institution does not require ethical approval for reporting individual cases or case series. However, we also have an IRB Exemption 2023/06/3 from Solutions IRB.

### Consent

Informed consent was obtained before treatment, and caregivers consented to publish these cases and supplemental videos.

### Conflicts of Interest

Dr. Baxter is the sole owner of the Alabama Tongue-Tie Center and Shelby Pediatric Dentistry, two private practices. He is the author of *Tongue-Tied: How a Tiny String Under the Tongue Impacts Nursing, Speech, Feeding, and More*, instructor of Tongue-Tied Academy, and the royalties from the book and courses are donated to charity. Mrs. Merkel-Walsh is the owner of Diamond Myo, a school-based SLP, a speaker for Talk Tools, and on the board of the non-profit ICAP.

### Data Availability Statement

Since this is a case series, no statistical dataset was created, and data is not publicly available. Any questions about the paper or cases can be directed to the corresponding author, and we would be happy to answer those questions.

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**Supporting Information**

Additional supporting information can be found online in the Supporting Information section.