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Ultrasound-Guided Suture Lateralization in Pediatric Bilateral Vocal Fold Immobility

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INTRODUCTION

Bilateral true vocal fold immobility (BVFI) is a rare clinical entity but is among the leading differential diagnoses for respiratory distress in neonates.1,2 The various etiologies for neonatal BVFI include birth trauma, neurologic disorders such as Arnold-Chiari malformation, hydrocephalus, cerebral palsy, hypoxia, cardiac surgery and idiopathic.1,3 Patients can be temporized with positive pressure ventilation to pneumatically stent the glottis or intubation may be performed to bypass the obstructive site.1 Since spontaneous return of function occurs in over 50% to 66% of cases, reversible interventions are favored to provide an adequate airway for ventilation while minimizing adverse effects such as aspiration and dysphonia.1,2

Traditionally a tracheostomy was performed, however, due to the morbidity and mortality associated with tracheostomy, alternative treatment options such as endoscopic anterior–posterior cricoid split and suture lateralization have been reported. Suture lateralization can either be performed under visualization endolaryngeally requiring a special lateralization instrument (which is not approved by the U.S. Food and Drug Administration) or can be performed exolaryngeally.2–6 A Lasso technique was devised but accurate prediction of needle trajectory is difficult and multiple approaches can result in tissue injury.5

The greatest challenge with the transcutaneous lasso technique is precise needle placement. Systemically, ultrasound technology has been applied to improve the accuracy of needle placement, particularly for difficult to identify or palpate regions or when great precision is required. Laryngeal anatomy is readily visualized on ultrasound and the technology is used in some protocols for diagnosing laryngeal pathology.7–12 Ultrasound-aided laryngeal intervention, however, is not widely reported in the literature. We describe a method of ultrasound-guided suture lateralization which helps in accurate prediction of the needle trajectory minimizing repeated attempts while reducing the operative time.

METHODS

The surgery is performed with the patient under spontaneous ventilation using a combination of Propofol and sevoflurane. A dose of intravenous dexmethylasone (0.5 mg/kg) and antibiotics is given prior to the start of the procedure. A direct laryngoscopy and rigid bronchoscopy are performed prior to suture lateralization to exclude any synchronous airway lesions. The appropriately sized Parsons laryngoscope (Karl Storz, Germany) is introduced for laryngeal exposure.12 The larynx is topicalized with 4% Lidocaine up to 4 mg/kg. After rigid bronchoscopy, the Parsons Laryngoscope is placed in suspension with the aid of a self-retaining laryngoscope holder (Karl Storz Endoscopy-America, Inc.) secured to a Mayo stand.

The neck is prepped and draped in standard sterile fashion. The Sonosite SII ultrasound machine (FUJIFILM Sonosite, Bothell, Washington, USA) is brought into the field and a sterile sleeve is applied to the L25 probe. Sterile ultrasound gel is applied over the anterior neck. The probe is used in short axis with identification of the upper tracheal rings, cricoid cartilage, thyroid cartilage, arytenoids, true vocal folds, ventricle and false vocal folds (Fig. 1). The ultrasound probe is positioned to provide an axial-plane view of the neck and larynx. This allows determination of the proper height of the neck incision, which should approximate the level of the true vocal fold. Lidocaine 1% with 1:100,000 Epinephrine is injected into the subcutaneous tissue 1–2 cm lateral to the midline on the side of the planned lateralized vocal fold. An incision of approximately 5 mm is performed. Blunt subcutaneous dissection continues to develop a pocket. The pocket should be wide enough to accommodate a custom-cut approximately 5 mm in diameter silicone disc (Bentec Medical Inc.,) to support suture knots.

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The needle is then advanced in-plane to the ultrasound probe (Fig. 2). This permits real-time assessment of the entire course of the needle for rapid and precise placement. A 4 mm, zero-degree, Hopkins Rod telescope (Karl Storz) is introduced into the Parsons laryngoscope along with an alligator grasper. A 22-gauge needle with pre-threaded 3–0 prolene suture (polypropylene; Ethicon, Somerville, NJ) extending to nearly the bevel of the needle is prepared. It is placed into the neck incision site and advanced along the axial plane under ultrasonographic guidance through the cricothyroid membrane or thyroid cartilage to a target location immediately inferior to the true vocal fold at the level of (or just anterior to) the vocal process (Fig. 3A). The entire needle course and destination can be visualized simultaneously during placement permitting exact and efficient placement. Further, the great vessels are easily visualized sonographically. Once the needle is identified endoluminally, the suture is pushed through the needle. It is drawn superiorly with the grasper until taken out through the laryngoscope (Fig. 3B). A segment of suture is maintained exiting the neck at the puncture site. The needle is removed, and a clamp holds the suture in place. Next, a 19-gauge needle with a 3–0 prolene suture loop threaded inside the bevel of the needle is placed through the thyrohyoid membrane or thyroid cartilage into the laryngeal ventricle at the level of the vocal process, under ultrasound guidance (Fig. 3C). The suture loop is advanced, grasped and removed through the laryngoscope (Fig. 3D). The 19-gauge needle is removed, and the two free ends of the suture are clamped at the neck. The single prolene suture is threaded into the loop by the laryngoscopist who then holds tension on the single suture while the surgeon at the neck pulls the loop and threaded single suture out of the upper puncture site (Fig. 3E). Once the loop exits the neck, the laryngoscopist releases the single stitch and it is taken out the neck, leaving a single loop precisely placed around or immediately anterior to the vocal process. Two small puncture holes are made in a custom trimmed 0.040” thickness silicone disc (Bentec Medical Inc.,). The disc is placed within the wound pocket and the suture knot is tied onto the disc while observing the lateralization effect endoscopically (Figs. 3F and 4). The skin is re-approximated.

Patients are treated with prophylactic antibiotics, antireflux medications and steroids. Extubation is performed on postoperative day one. A swallow study is recommended after lateralization.

RESULTS

With the assistance of ultrasound, we were able to complete the procedure in a single needle pass for each step of the technique. In our experience with this technique in three neonates we have found the use of laryngeal ultrasound and the visualization of the landmarks to be easy and user friendly.

DISCUSSION

We describe a modification to the lasso technique of suture lateralization using real-time ultrasound guidance. While the palpable landmarks of adult patients and larger airway size have been reported to permit an adequate level of accuracy, ultrasound-guided placement provides more certain needle trajectory. This facilitates rapid and precise placement while minimizing risk to surrounding vascular structures, tissue trauma, swelling and scarring. This technique is applicable to adults as well as children and infants who can present with more difficult to identify landmarks.

Endoscopic vocal fold lateralization was first reported in 1979 with multiple subsequent reports. Two general techniques are described, use of an endoscopic instrument to pass the needle blindly from endolaryngeal position exiting the neck skin and a lasso technique utilizing external puncture and suture threading. The endolaryngeal technique allows for
precise placement but does not allow identification of surrounding vascular structures or position of the needle through/around the thyroid cartilage. Accessibility also remains limited in some countries and routine purchase of the instrument might be unnecessary due to the infrequency of such procedures. Blind external needle placement is technically difficult and multiple attempts may be required. A recent article describing the lasso surgical technique, highlights to the general sentiment among airway surgeons that precise placement is “simply described but difficult to complete”.

We describe a technique of ultrasound guided suture laterization which we believe not only helps in accurate needle placement, but also avoids multiple passes and unnecessary trauma to the delicate larynx and takes away speculative needle placement. Future studies using it with larger sample size and outcome analysis regarding the operative time, tissue impact, and technical ease.
should be undertaken to demonstrate the effectiveness of this technique.

CONCLUSION
Ultrasound examination of the larynx is technically feasible and provides valuable information to direct needle placement for suture lateralization in pediatric patients.

BIBLIOGRAPHY