Laryngotracheal Reconstruction with Rib Graft

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Laryngotracheal reconstruction is indicated for severe subglottic stenosis in infants with a tracheostomy. Infants requiring this type of surgery have typically been intubated during the neonatal period secondary to respiratory distress syndrome. Multiple or prolonged intubations often necessitate tracheostomy. Upper airway obstruction may present secondary to prolonged intubation or multiple intubations. Immediate treatment for this upper airway obstruction is attempted reintubation or tracheostomy. These infants may need to have a tracheostomy for years. Long-term corrective measures include progressive dilatation of the airway or reconstructive surgery. Usually reconstructive surgery is delayed until the infant’s respiratory condition can tolerate decannulation (removal of tracheostomy tube).

The occurrence of laryngotracheal stenosis has increased since the 1960s with the use of prolonged intubation in infants. This method of ventilatory support remains accepted as treatment for premature infants. However, this technique can lead to laryngotracheal injury, especially subglottic or tracheal stenosis. In 1974, Pearson and Cotton promoted the use of a autogenous cartilage graft to the larynx in order to create a safe, stable airway in the shortest time possible with the fewest complications.

Anatomic Overview
To understand laryngotracheal reconstruction, a review of the anatomy of the larynx, trachea, and costal cartilages is necessary. The larynx, located in the front and middle of the neck, extends from the base of the tongue to the trachea. Lined with mucous membranes, the larynx is a musculocartilaginous structure that acts primarily as a sphincter guarding the entrance to the trachea and functions secondarily as the organ of voice. It is composed of nine cartilages: thyroid, cricoid, epiglottis, two arytenoid, two corniculate, and two cuneiform cartilages, all of which are connected by ligaments.

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The trachea, beginning at the lower end of the larynx, branches into the right and left main bronchi. It is composed of transverse horseshoe-shaped cartilages in a fibro-elastic wall. Costal cartilages are flat structures of hyaline cartilage. They extend from the anterior end of the ribs and contribute to chest mobility and elasticity.

Preoperative Considerations
To determine the extent of the subglottic stenosis, the surgeon will perform a laryngoscopy and bronchoscopy. If a tracheostomy is not already in place, the surgical technologist should have a varying selection of endotracheal and tracheostomy tubes available in case a tracheostomy is needed. The pediatric endoscopic cart is brought into the operating room with several sizes of laryngoscopes and bronchoscopes. The surgeon will select the sizes of the individual pieces of equipment that he or she will use. The light source and suction should be checked by the surgical technologist prior to use. The surgeon may require a flexible laryngoscope to visualize the movement of the infant’s vocal cords. The endoscopy can be performed as a separate procedure; however, it will also be repeated immediately prior to the laryngotracheal reconstruction. Following the procedure, the endoscopic equipment should be cleaned according to manufacturer’s recommendations and hospital policy.

Operating Room Setup and Patient Preparation
Prior to the start of the laryngotracheal reconstruction, the operating room temperature must be elevated in order to maintain the infant’s temperature. In addition, a warming pad and/or heat lamps may be required. The room must have available suction and cautery. The infant is brought into the operating room with several sizes of laryngoscopes and bronchoscopes. The surgeon will select the sizes of the individual pieces of equipment that he or she will use. The light source and suction should be checked by the surgical technologist prior to use. The surgeon may require a flexible laryngoscope to visualize the movement of the infant’s vocal cords. The endoscopy can be performed as a separate procedure; however, it will also be repeated immediately prior to the laryngotracheal reconstruction. Following the procedure, the endoscopic equipment should be cleaned according to manufacturer’s recommendations and hospital policy.

Figure 1. Harvesting rib graft.
obtain a 4-cm length of costal cartilage (Figure 1). The cartilage is wrapped in saline soaked gauze until needed. A small amount of saline is placed in the chest wound to ensure that the parietal pleura is intact and no pneumothorax exists. When the surgeon is certain that the chest cavity has not been entered, the wound is closed with 4-0 chromic and 3-0 nylon sutures. At this time, sterile tape strips are applied and the chest site is covered with a towel.

For the actual reconstruction, the surgeon makes a horizontal incision superior to the stoma (Figure 2). The underlying neck muscles are separated in the midline to expose the larynx and trachea (Figure 3). In addition, the cricoid cartilage must be split in the middle anteriorly and occasionally posteriorly with a 6700 Beaver blade (Figure 4). Careful inspection of the larynx and trachea must be done to determine the extent of the stenosis. If necessary, the initial neck incision may be lengthened at this time. After the inspection, these structures are divided precisely in the midline. A cottonoid sponge with long-acting nasal spray solution may be used in the lumen for vasoconstriction purposes. Another cottonoid may be used in the tracheal lumen, around the endotracheal tube, to prevent escape of anesthetic and aspiration of blood and secretions into the lower airway. The surgeon trims the costal cartilage graft to match the needed expansion using a No. 15 blade and scalpel. The perichondrium side of the graft is placed toward the lumen (Figure 5). Choices of suture include 5-0 polyglyconate (Maxon) or polybutester

room and routine monitoring is performed by anesthesia. After general anesthesia is induced, the infant is positioned with the neck extended and the trachea exposed. A foam donut and shoulder roll may be used to achieve enhanced visualization. A 0.5% lidocaine with epinephrine 1:200,000 will be injected horizontally to the proposed incision site immediately above the tracheostomy stoma. Sterile drapes (Steri-drapes) are used to cover the anesthesia circuit and outline the operative field. The anterior neck and mid-chest are surgically prepped and draped. The surgical technologist should be prepared for a laryngoscopy in case the surgeon needs to ensure the precise location and extent of the stenosis prior to the surgical incision. The following surgical equipment should be available:

1. Pediatric minor instruments
2. No. 15 blade
3. 3 x 3 sponges
4. Crile retractors
5. Bipolar and pencil cautery
6. Marking pen
7. Pediatric Doyen costal elevators (right and left blades)
8. Small rib cutter
9. Heavy curved Mayo scissors
10. Freer double-ended elevator
11. 6700 Beaver blade and handle
12. 1/2 inch cottonoids
13. Rubber band drains
14. Steri-drape (2-1000)
15. Small transparent adhesive film (Op-site)
16. Split sheet and towels
17. 1/2 sterile tape strips (Steristrips)
18. Double-ended costal periosteotome
19. Surgical prep (iodophor)
20. Surgeon’s headlight and light source
21. Foam donut and/or shoulder roll

**Operative Procedure**

The surgeon makes the initial incision into the right chest in order to

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**Figure 2. Surgical field with rib graft and larynx exposed.**

**Figure 3. Laryngeal exposure.**

**Figure 4. Stenosis divided.**

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The sutures are tagged with rubber-shod hemostats prior to locating the graft into position (Figure 6). The graft is positioned in the laryngotomy and the sutures are secured (Figure 7). The neck incision is then closed with 4-0 chromic. A rubber band is secured for a drain, after which the skin is closed with 5-0 plain. No dressing is necessary.

The chest is inspected and dressed with a small gauze sponge and transparent adhesive film. A tracheostomy tube is positioned over the stoma. Upon decision of the anesthesia team, the endotracheal tube is replaced with the tracheostomy tube.

Postoperative Care and Complications
The infant is transported to the postanesthesia care unit (PACU) with oxygen. The infant’s length of stay in the intensive care unit is approximately 2 to 7 days. The patient may then be moved to the general floor for 4 days. The patient is released home with weekly office follow up visits.

More extensive surgery must be performed if stenosis is present anteriorly and posteriorly. In these cases, a stent is needed. Other possible complications include postoperative infections, aspiration, puncture of the pleural cavity, and occlusion of the tracheostomy tube. With home care, parents are instructed to meticulously suction and clean the inner cannula, to use humidification regularly, and to maintain the infant’s hydration. Occasionally, an altered diet may be indicated if aspiration is a persistent problem. The need for speech therapy should be evaluated according to the infant’s age and mental development.

Laryngotracheal stenosis may be a surgical challenge for the surgical technologist due to the potential airway complications and the infrequency of the procedure. However, the procedure offers the promise of an improved lifestyle and health for patients and their families.

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References

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