

## Laryngotracheal Reconstruction (LTR)

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### 1. General Considerations

- a. Single vs. double-stage reconstruction
  - Single-stage reconstruction (no trach or removal of trach at time of reconstruction)
    - Advantages
      - Avoidance of trach or immediate decannulation
      - Address suprastomal collapse
    - Disadvantages
      - Safety and ICU resource considerations for
        - i. Postoperative sedation for younger children
        - ii. Longer hospitalization
        - iii. Risk of accidental/unplanned extubation
      - Potential replacement of trach if airway still compromised after extubation
  - Double-stage reconstruction (existing tracheotomy remains in place or a tracheotomy is performed during reconstruction)
    - Advantages
      - Can address multi-level airway obstruction
      - Safer in difficult-to-intubate patients, poor pulmonary function, significant neurologic deficits, previous reconstructive failure
      - Safer in conditions/settings where sedation, ICU hospitalization may be challenging
    - Disadvantages
      - Granulation tissue
      - Difficult to address suprastomal collapse
      - Stent-related complications
      - Second admission for decannulation
- b. Indications for anterior cricoid split
  - Congenital subglottic stenosis with normal pulmonary function
  - +/- Thyroid ala cartilage graft
- c. Indications for anterior cricoid cartilage graft
  - Suprastomal collapse
  - Acquired or congenital subglottic stenosis (SGS) (Cotton-Myer Grades III-IV)
  - Tracheal A-frame

- May be performed in conjunction with posterior cricoid split +/- graft
- d. Indication for posterior graft
  - Subglottic stenosis (Cotton-Myer Grades III-IV where anterior graft alone does not provide sufficient distraction)
  - Posterior glottic stenosis
    - Well-suited to endoscopic approach
- e. Contraindications
  - Severe cardiopulmonary disease
- f. Alternatives: [maintain] tracheotomy
- g. Complications
  - Graft failure
  - Aspiration
  - Dysphonia
  - Re-trach
- h. Pertinent Anatomy
  - Hyoid bone
  - Thyroid cartilage
    - Avoid complete laryngofissure except in select cases
    - Obtain graft (if applicable) from inferolateral cartilage to avoid disruption of the anterior commissure
  - Cricoid cartilage
  - Trachea
  - Recurrent laryngeal nerve
  - Strap muscles
  - Costal cartilage: maintain perichondrium on anterior surface.  
Neurovascular bundle is located in the costal groove in the undersurface of each rib between the internal and innermost intercostal muscle. Do not violate parietal pleura (some surgeons dissect chest-side perichondrium down as additional layer of protection).

## 2. Preoperative Preparations

- a. Evaluation:
  - History: stridor, recurrent croup, chronic cough, aphonia, dysphonia, tolerance of speaking valve (for patients with tracheotomy)
  - Office flexible laryngoscopy to assess vocal cord function
  - Swallow evaluation (videofluoroscopic swallow study and a fiberoptic endoscopic evaluation) to assess swallowing function and risk of aspiration
  - Triple scope:
    - Flexible bronchoscopy with bronchoalveolar lavage (evaluate for tracheomalacia, bronchomalacia; cultures)
    - Direct laryngoscopy and bronchoscopy (assess and size airway)
      - Do not operate on an inflamed or "active" larynx!
    - Esophagogastroduodenoscopy with biopsy (evaluate for GERD, eosinophilic esophagitis)

- Screen for MRSA and Pseudomonas
  - Contraindications to sedation or anesthesia
- b. Consent for surgery
  - Potential complications:
    - Early postoperative: subcutaneous emphysema, pneumothorax, wound infection, aspiration, pneumonia
    - Intermediate postoperative: graft failure, graft displacement, dislodged stent, extubation failure; trach [re-]insertion
    - Late postoperative: poor voice, supraglottic compromise, tracheocutaneous fistula, re-stenosis, tracheal A-frame, possible additional major airway surgery (particularly for severe grade III and grade IV SGS)

### 3. Nursing Considerations

- a. Instrumentation and Equipment
  - Separate back table for neck (clean/clean contaminated) and chest (clean) vs DLB (clean contaminated)
- b. Prep
  - Place patient supine with neck extended (shoulder roll)
  - Rotate bed with left arm towards anesthesia (head, neck, right chest exposed)
  - EKG leads on back
  - Headlights
  - Direct laryngoscopy, bronchoscopy setup

### 4. Anesthesia Considerations

- a. General anesthesia

### 5. Operative Procedure

- a. Preparation
  - 1000 drape to chin (to separate secretions from the neck)
  - Betadine neck and right chest
- b. Procedure
  - Direct laryngoscopy bronchoscopy
  - Induce anesthesia via ETT in tracheostoma (if applicable) vs oral intubation
  - Incision/approach:
    - Horizontal skin incision over cricoid, incorporating superior aspect of tracheostoma if applicable
    - Divide midline raphe
  - Anterior cricoid split
    - Vertically in midline, from inferior border of thyroid cartilage through upper tracheal ring(s)
    - Consider endoscopic guidance, particularly in revision procedures to minimize risk to the vocal folds

- Incise intraluminal scar and lining mucosa along the length of the stenotic segment, strictly in midline. No attempt is made to remove the scar
- Anterior cricoid cartilage graft
  - Assess graft dimensions (height, width, depth) required using spacer (cut age appropriate ETT) and calipers. Lateral edges of the costal cartilage graft are beveled and mortised to prevent the graft from settling into the lumen (like a boat or teardrop)
  - Without thinning, the graft is placed, perichondrium facing toward the lumen.
  - Secure with 4-0 PDS mattress (knots positioned laterally over the tracheal cartilage rather than the graft). Bare surface of the graft exposed to strap muscles for blood supply (imbibition).
- Posterior cricoid cartilage graft
  - Inject posterior cricoid plate
  - Divide vertically in midline. Carefully inspect interarytenoid space for complete division
  - Perichondrium faces airway lumen. Bevel lateral edges of graft
  - Safety suture during placement (in case of distal migration)
  - Graft held in place by tension (sutureless)
- Cartilage graft harvest
  - Costal (rib): inframammary crease
    - Incise skin. Dissect overlying subcutaneous fat and musculature using electrocautery.
    - Incisions are made both superiorly and inferiorly with a No. 15 blade into the perichondrium of the rib near the bony cartilaginous junction. The underlying perichondrium is then elevated from the rib using Cottle and Freer elevators and Doyen retractors (optional, however, it is crucial not to violate the pleura). The rib is then divided at the bony cartilaginous junction. (Tip — sitting down or raising operating table can be helpful)
    - Check for air leak
    - Closure over Penrose drain
  - Thyroid ala
    - Harvest from inferolateral thyroid cartilage
    - Appropriate for short segment “cap” grafts
- Single- vs double-staged procedures, stents and T-tubes
  - Single-staged procedure: nasotracheally intubated
  - Double-staged procedure: tracheotomy (usually with stent) or T-tube
- Closure
  - Irrigate neck

- Apply fibrin sealant (such as Tisseel) around edges (not top) of graft
- Close strap muscles over graft with small gap for air egress
- Layered closure over penrose drain
- Immediate postop bronchoscopy can be performed to assess increase in airway diameter.
- Flexible bronchoscopy to suction blood clot / mucous and assess ETT depth for single-stage procedures

## 6. Postoperative Care

- a. ICU
- b. Chest x-ray to assess for pneumothorax and ETT position (if applicable)
- c. Avoid systemic or topical steroids
- d. PPI
- e. Antibiotics: oral flora (ampicillin/sulbactam) + culture-directed
- f. Remove chest drain POD 2, neck drain POD 3
- g. Single-stage reconstruction:
  - Nasal intubation (or extubate in OR immediately postoperatively)
  - 1 week post op: DLB, extubation in OR
  - 2 weeks post op: DLB, possible dilation
  - Then discharge
  - Repeat DLB 2-4 weeks
- h. Double-stage reconstruction
  - Discharge after drain removal (as early as postoperative day 3)
  - 4-12 weeks post op: DLB with stent removal, psb granulation tissue removal
  - 7-10 days later: DLB, possible dilation
  - Repeat every 4-6 weeks PRN up to 3-4 times
  - Trach capping (consider sleep study)
  - Decannulation
- i. Continue follow-up to assess appropriate growth of airway with the child (every week, 3 weeks, 6 weeks, 3 months, 6 months, yearly)
- j. Long-term voice and swallowing outcomes

## 7. Suggested Readings/Additional Information

- a. CPT Codes (2017 update)
  - 31551 Laryngoplasty; for laryngeal stenosis, with graft, without indwelling stent placement, younger than 12 years of age
  - 31552 Laryngoplasty; for laryngeal stenosis, with graft, without indwelling stent placement, age 12 years or older
  - 31553 Laryngoplasty; for laryngeal stenosis, with graft, with indwelling stent placement, younger than 12 years of age
  - 31554 Laryngoplasty; for laryngeal stenosis, with graft, with indwelling stent placement, age 12 years or older

- 31580 Laryngoplasty; for laryngeal web, with indwelling keel or stent insertion
- 31587 Laryngoplasty, cricoid split Laryngoplasty, cricoid split, without graft placement