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Advances in the Management of Pediatric Laryngotracheal Stenosis

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Objectives

At the end of this activity, the participant should be able to:

1. Review the causes of airway stenosis in children
2. Discuss the management of a child with airway stenosis
3. Review the role of a multidisciplinary approach in the management of children with complex airway issues

Introduction

Pediatric laryngotracheal stenosis encompasses a wide variety of congenital and acquired disorders resulting in narrowing of the airway. Acquired laryngotracheal stenosis is predominantly due to intubation related trauma to the airway. Despite improvement in techniques, a better understanding of the mechanism of airway injury, and the availability of better endotracheal tubes, post-extubation laryngotracheal stenosis is still common. Surgical procedures aimed at avoiding a tracheostomy are undertaken whenever possible as a tracheostomy has a strong negative impact on the quality of life of the family and the child. In children with a tracheostomy, early surgical intervention is performed in order to shorten the tracheostomy dependence. In this regard, these cases should be handled by multidisciplinary Aerodigestive centers with input from a Pediatric Otolaryngologist, Pediatric Pulmonologist, Pediatric Gastroenterologist, Speech Language Pathologist and General Surgeon.

Causes of Pediatric Laryngotracheal stenosis

Pediatric laryngotracheal stenosis can be Congenital or Acquired. Ninety percent of laryngotracheal stenosis is acquired. The most common cause is endotracheal tube-related airway trauma. Other acquired causes of laryngotracheal stenosis include laryngeal trauma, autoimmune disorders, such as Wegener's Granulomatosis and infections. Neonates requiring endotracheal intubation have an incidence of subglottic stenosis ranging from one to eight percent. The factors, which have been shown to be related to laryngotracheal stenosis secondary to intubation include duration of intubation, endotracheal tube size, number of intubations, traumatic intubations, movement of the endotracheal tube and infection.

Initial Assessment of a child with suspected laryngotracheal stenosis

The important points in the initial assessment of a child with laryngotracheal stenosis are detailed in Table 1. The major signs and symptoms related to laryngotracheal stenosis involve issues with feeding, the voice and the airway. The most common presentation of subglottic stenosis is progressive respiratory difficulty with biphasic stridor. Airway compromise may present only during respiratory tract infections such as recurrent croup. Since intubation-related airway trauma is the most common cause of laryngotracheal stenosis, a detailed intubation history is essential. Another factor which impacts the success of the treatment is the safety of swallowing. In patients with neurological swallowing impairment, airway lumen restoration may lead to worsening of aspiration.

TABLE 1: INITIAL ASSESSMENT OF A CHILD WITH SUSPECTED LARYNGOTRACHEAL STENOSIS

Presentation	Breathing difficulty Cyanosis Weak Cry Dysphonia Feeding: Oral/ Nasogastric/ G tube Recurrent chest infections
History of Endotracheal Intubation (if present)	Indication of intubation Duration of intubation Endotracheal tube size Difficulty of intubation Accidental extubation Multiple intubations Decannulation
Physical examination	Stridor Onset/Duration/Phase of respiration: Inspiratory, Expiratory, Biphasic Retractions Dysmorphic features Presence of Hemangioma Neurological impairment Pulmonary status

TABLE 2: WORK UP OF LARYNGOTRACHEAL STENOSIS

Direct Laryngoscopy & Rigid Bronchoscopy	• To access the site, degree and extent of Laryngotracheal Stenosis. • Grading of stenosis according to the Cotton Myer grading system • Glottic involvement: Posterior glottis stenosis and Vocal Cord Synaechia • Assessment of Tracheostomy Site: Suprastomal collapse, Granuloma, tracheomalacia and Tracheal Granuloma
Suspension Microlaryngoscopy	• In case of Vocal Cord Immobility, to differentiate vocal fold paralysis from post glottis stenosis with or without Cricoarytenoid joint dysfunction. • Arytenoid palpation
Flexible Bronchoscopy	• Bronchoalveolar lavage ◦ Lipid Laden macrophages for Chronic Aspiration ◦ Bacteriological analysis of Tracheal Aspirates
Oesophagoscopy	
Dual Probe pH monitoring	• To evaluate Gastroesophageal reflux: Reflux is significant if the time with pH less than 4 is greater than 5-10% at the lower probe and greater than 4% at the upper probe.
Nasal Swabs	• Rule out MRSA
Swallowing Assessment	• Functional Endoscopic Evaluation of Swallowing ◦ Laryngeal Mobility: Vocal cord motion/Laryngeal elevation ◦ Pharyngeal Transit ◦ Premature spillage ◦ Laryngeal penetration ◦ Aspiration ◦ Hypopharyngeal pooling • Videofluroscopic Evaluation of Swallowing • Clinical Dysphagia evaluation by a Speech Language Pathologist

Grading system for Laryngotracheal stenosis

The most commonly used system for assessing Laryngotracheal stenosis is the Cotton Myer grading system. The system is based on the degree of correctional luminal stenosis as documented by a standard endotracheal tube.

Grade Based Management Strategy

1. Grade I Subglottic stenosis:

Not all Grade I subglottic stenosis needs treatment. Usually a thin scar with less than fifty percent obstruction is amenable to radial incision which can be done with either laser or cold steel instruments with subsequent balloon dilation.

2. Grade II Subglottic stenosis:

For a thick scar, anterior costal cartilage graft is preferred. With significant glottis involvement an anterior-posterior graft with a period of stenting is recommended. In the presence of comorbidities, a double stage laryngotracheal reconstruction (LTR)is preferred as compared to a single stage LTR.

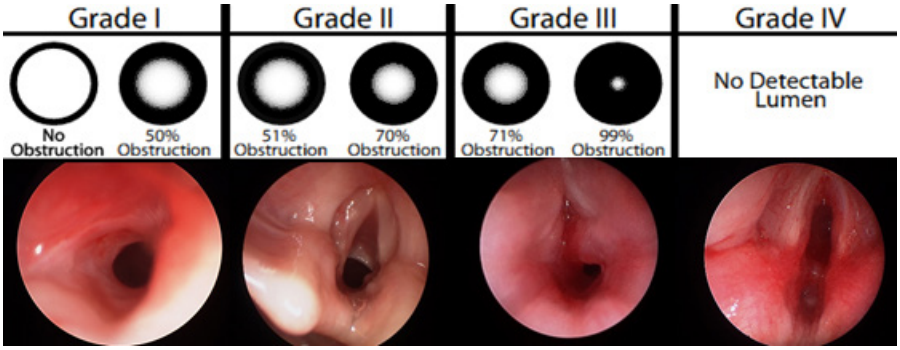

FIGURE 1
The Cotton Myer Grading System for Laryngotracheal stenosis

TABLE 3: TREATMENT OPTIONS FOR LARYNGOTRACHEAL STENOSIS

GRADE OF STENOSIS	TREATMENT
Grades I & II (<70%):	Endoscopic – cold, laser, balloon
Grades II, III & IV (>50%)	**Expansion Techniques** Anterior graft Posterior graft Anterior + posterior grafts **Resection** Partial Cricotracheal resection(PCTR) Slide Tracheoplasty (cervical / thoracic) **Expansion and Resection** Extended Partial Cricotracheal resection: PCTR+Posterior cartilage graft

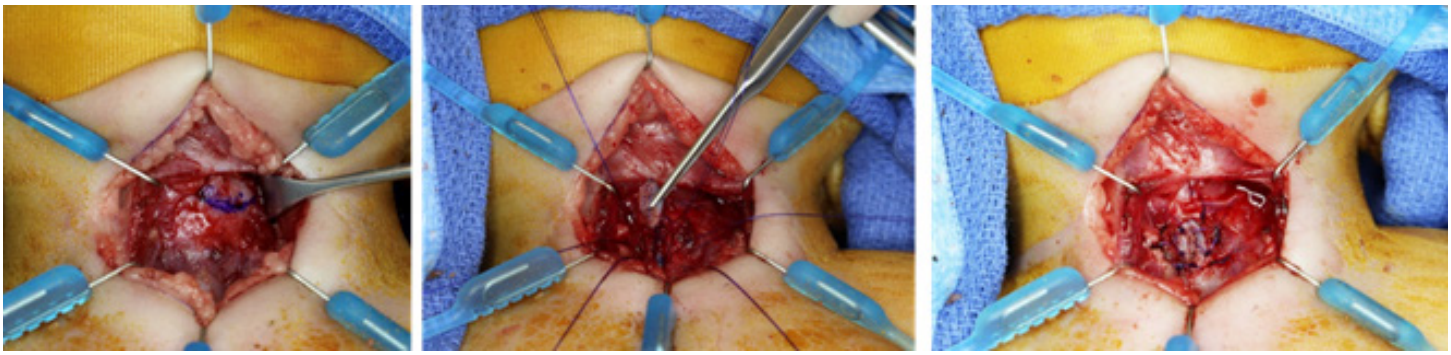

FIGURE 2
A single stage anterior laryngotracheal reconstruction in a patient, 28 weeks premature, at 3 months of age for subglottic stenosis using a thyroid ala graft. The infant was successfully extubated. A: The proposed site of harvest of the thyroid ala graft. B: Insetting the graft. C: Graft in position

3. Grade III and Grade IV Subglottic stenosis:

Higher grade stenosis is usually associated with thick scarring and endoscopic approaches have limited efficacy in the management of these lesions. Open airway procedures are relied on for the management of such higher grades of stenosis. Thicker scars, greater than five millimeters, may benefit from laryngotracheal reconstruction with anterior and posterior cartilage grafts and endoluminal stenting. Partial cricotracheal resection is an option for severe grades of laryngotracheal stenosis. For a cricotracheal resection, a three to four millimeter stenotic-free area below the cords is usually recommended, although it can be combined with a posterior cricoid split, which results in an extended PCTR in cases of posterior glottis stenosis associated with Grad three to four subglottic stenosis.

In the presence of severe glottis involvement, two treatment options are double stage anterior-posterior graft with stenting and extended partial cricotracheal resection with stenting. Extended PCTR involves full resection for the diseased airway segment with a posterior cricoid grafting.

Anterior Laryngotracheal Reconstruction (LTR)

Though a variety of grafts have been used for an Anterior LTR, two grafts are widely used; the thyroid ala graft and the costal cartilage graft. The thyroid ala graft is excellent for anterior LTR in infants and neonates, as it is easy to harvest and does not require another incision for harvesting the graft. The costal cartilage is the workhorse of anterior Laryngotracheal reconstruction.

Partial Cricotracheal Resection (pCTR)

The basic principal of cricotracheal resection is to resect the diseased segment of the airway and connect the superior and the inferior segments. The indications for a partial cricotracheal resection include severe Grade III or IV stenosis with concentric scarring. PCTR is also used as a salvage procedure after failed laryngotracheal reconstruction. A contraindication of PCTR would be stenosis involving the vocal cords and Grade I or II stenosis. The best candidates for PCTR are Grade III or Grade IV stenosis with a clear margin, greater than three millimeters, between the stenosis and the vocal folds. In patients without comorbidities, single stage PCTR can be done for isolated severe Grade III or IV SGS. A double-stage PCTR can be done in severe Grade III or IV SGS in patients with comorbidities.

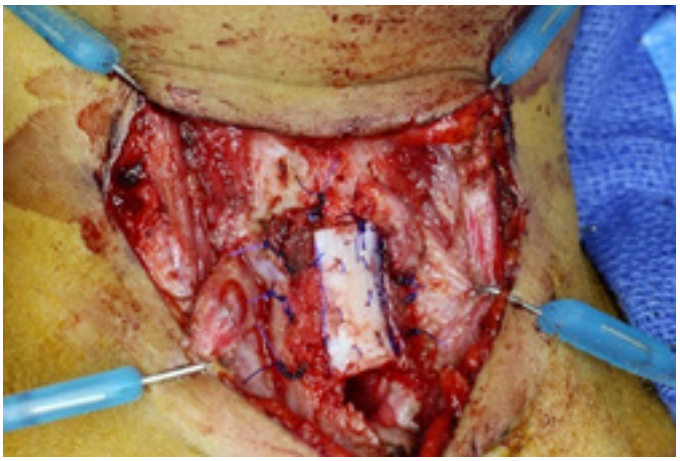

FIGURE 3
A laryngotracheal reconstruction using costal cartilage graft in a 4-year-old child with subglottic stenosis. Notice the graft abutting the stoma.

Tracheal Resection

Isolated tracheal stenosis is rare in the pediatric age group and management of tracheal stenosis has been challenging. Endoscopic approaches with the use of a CO2 Laser and airway balloons are the initial treatment and especially useful for short, web-like cicatricial stenosis.

However, for Grade III to IV stenosis with multiple failures of endoscopic treatment, tracheal resection and end-to-end anastomosis remains the gold standard.

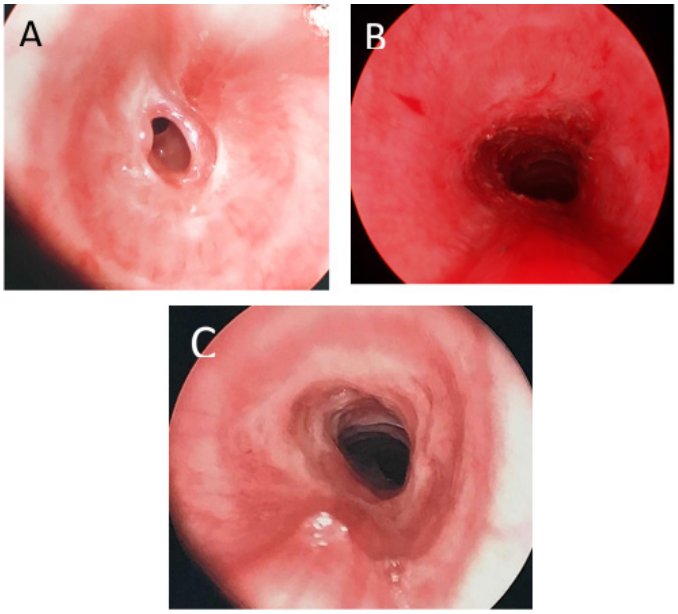

FIGURE 4
(A) A 13-year-old boy with tracheal stenosis. (B) Initial laser incision and balloon dilatation. (C) One month postoperatively.

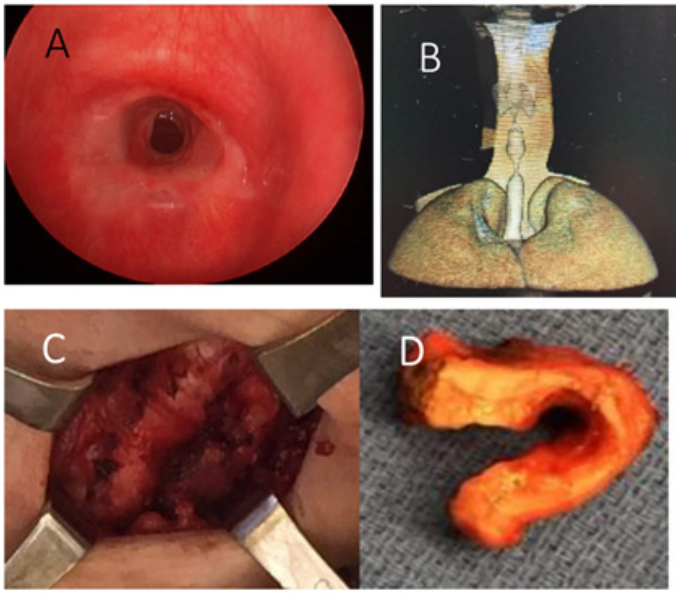

FIGURE 5
(A) A 15-year-old with tracheal stenosis following intubation. (B) A 3D reconstructed CT scan of the patient showing the tracheal stenosis. (C) Exposure from the tracheal resection. (D) Resected tracheal segment.

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