Surgical Treatment of Laryngomalacia

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Overview

- Laryngomalacia
  - Patient presentation and work-up
  - Medical management
  - Surgical intervention
Differential Diagnosis of Noisy Breathing

**TABLE 74.5. DIFFERENTIAL DIAGNOSIS OF COMMON CAUSES OF NOisy BREATHING IN CHILDREN**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Congenital</th>
<th>Inflammatory</th>
<th>Neoplastic</th>
<th>Neuromuscular</th>
<th>Traumatic</th>
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<tbody>
<tr>
<td>Nasal and nasopharynx</td>
<td>Choanal atresia or stenosis</td>
<td>Nasal polyps</td>
<td>Encephalocele</td>
<td>Dermoid</td>
<td>Foreign body</td>
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<td>Pyriform aperture stenosis</td>
<td>Rhinitis</td>
<td>Dermoid</td>
<td>Gioma</td>
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<td>Craniofacial anomalies</td>
<td>Retropharyngeal abscess</td>
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<td>Oropharynx/</td>
<td>Glossoptosis/macroglossia</td>
<td>Tonsil hypertrophy</td>
<td>Hypotonia, neurologic disease</td>
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<td>hypopharynx</td>
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<td>Lingual thyroid</td>
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<td>Valvular cyst</td>
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<tr>
<td>Supraglottic larynx</td>
<td>Laryngomalacia</td>
<td>Epiglottitis (supraglottitis)</td>
<td>Hemangioma</td>
<td>Lymphangioma</td>
<td>Foreign body</td>
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<td>Glottic larynx</td>
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<td>Granuloma</td>
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<td>Subglottic larynx</td>
<td>Stenosis</td>
<td>Croup (viral laryngotracheobronchitis)</td>
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<td>Cysts</td>
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<td>Stenosis</td>
<td>Foreign body</td>
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<td>Tracheobronchial</td>
<td>Stenosis/web</td>
<td>Membranous (bacterial tracheitis)</td>
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<td>Tracheomalacia</td>
<td>Bronchitis</td>
<td>Tumors</td>
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<td>Vascular ring/sling/complete tracheal rings</td>
<td>Asthma (reactive airway disease)</td>
<td>Thyroid</td>
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<td>Foreign body-tracheal or esophageal</td>
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<td>Foregut cysts</td>
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<td>Tracheoesophageal fistula</td>
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**Stridor**

- A harsh, high pitched musical sound that results from turbulent airflow through the upper airway
- Etiology may range from mild illness to severe, life-threatening situation
Stridor Etiology

- Congenital
- Inflammation
- Trauma
- Foreign bodies
Stridor Presentation

- Variable age of onset
- Patient typically presents with sudden onset of symptoms
- Acquired stridor (inflammation, trauma, foreign bodies) is more likely than congenital stridor to require airway intervention
Congenital Stridor

- Eighty-five percent of children under 2.5 years presenting with stridor have a congenital etiology
- Often not present at birth
- Typically presents prior to four months of age
Assessing Stridor

- Determination of respiratory phase in which sound is noted
  - Inspiratory
  - Biphasic
  - Expiratory
Inspiratory Stridor

• Result of supraglottic obstruction
• High-pitched
Biphasic Stridor

• Result of extrathoracic tracheal obstruction including
  – Glottis
  – Subglottis

• Intermediate pitch
Expiratory Stridor

• Result of intrathoracic tracheal obstruction

• Associated with retraction of
  – Sternum
  – Costal cartilage
  – Suprasternal tissue
Laryngomalacia

- a condition in which the tissues of the entrance of the larynx collapse into the airway when the patient inspires
- Secondary to continued immaturity of larynx
- Cause remains enigmatic
Laryngomalacia

• Most common cause of stridor in infancy
• Most common congenital laryngeal anomaly
• 2 males: 1 females
Contributing Factors of Laryngomalacia

• Anatomic
  – Shortening of aryepiglottic folds and anterior collapse of cuneiform and corniculate cartilage
  • Prospective case-control by Manning et al in 4/05 created a ratio of aryepiglottic fold length to glottic length
    – Severe laryngomalacia = 0.380
    – Control = 0.535
  – Floppy or tubular epiglottis
Contributing Factors of Laryngomalacia

• **Neurologic**
  - Immature neuromuscular control and movement

• **Inflammatory**
  - Reflux can induce posterior supraglottic edema and secondarily laryngomalacia
Symptoms of Laryngomalacia

- Onset typically days to weeks after birth
  - Most commonly within the first 2 weeks of life
- Inspiratory stridor
  - Low pitch with a fluttering quality
    - secondary to circumferential rimming of the supraglottic airway and aryepiglottic folds
- More prominent when child is
  - Supine
  - Agitated
- Louder quality with more forceable inspiration
- Often associated with general noisy respiration
Diagnosis of Laryngomalacia

• Clinical assessment
  – Suspect laryngomalacia in a neonate with auscultation of inspiratory stridor
  – Confirm suspicion with flexible laryngoscopy
Flexible Laryngoscopy

• Best performed with
  – Unanesthetized child
  – Upright position
  – 1.9mm laryngoscope

• Scope should be passed through both nasal passages

• Evaluate vocal cord mobility
Flexible Laryngoscopy
Findings with Laryngomalacia

• Cyclical collapse of supraglottic larynx with inspiration
• Short aryepiglottic folds
  – Draw the cuneiform and corniculate cartilages forward over the laryngeal inlet resulting in prolapse during inspiration
Laryngomalacia Seen by Flexible Laryngoscopy
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Laryngomalacia Seen by Flexible Laryngoscopy
Laryngomalacia Classification

- **Type I**: inward collapse of the aryepiglottic folds
Laryngomalacia Classification

• **Type II**: long tubular epiglottis which curls on itself
  - Often occurs with type I laryngomalacia
Laryngomalacia Classification

- **Type III**: anterior, medial collapse of corniculate and cuneiform cartilages
Laryngomalacia Classification

- **Type IV**: posterior inspiratory displacement of the epiglottis against the posterior pharyngeal wall or inferior collapse to the vocal folds
Laryngomalacia Classification

- **Type V**: short aryepiglottic folds
Radiographic Evaluation

- Unnecessary
- Inspiratory plain film with neck extension
  - May show medial and inferiorly displaced arytenoids and epiglottis
- Fluoroscopy
  - May demonstrate collapse of supraglottic structures with inspiration
Medical Management of Laryngomalacia

• Reassuring parents of favorable prognosis
  – Condition is usually self-limiting
• Position adjustments
  – More prominent when supine or agitated
• Consider reflux precautions
• Frequent evaluation by pediatrician to assess:
  – Growth
  – Feeding
  – Breathing
Surgical Management of Laryngomalacia

- Rarely necessary as condition is self-limiting
- Severe symptoms are surgical indications
  - Life-threatening airway obstruction
  - Inability to feed orally
  - Cor pulmonale
  - Failure to thrive
Surgical Management of Laryngomalacia

- Prior to 1980s, tracheotomy was treatment
- Tracheotomy bypassed area of obstruction until supraglottic pathology spontaneously resolves
- Today, this strategy only employed in severely affected infant
Surgical Management of Laryngomalacia

• Supraglottoplasty
  – Addresses area of obstruction directly
  – May be performed with several instruments
    • Microlaryngeal instruments
    • Carbon dioxide laser
    • Microdebrider
  – Unilateral should be considered initially
Surgical Management of Laryngomalacia

- Direct laryngoscopy and bronchoscopy should be considered prior to surgery
  - In 1996, Mancuso et al performed a retrospective study to determine necessity of rigid endoscopy in management of laryngomalacia and associated synchronous airway lesions
    - Synchronous airway lesions (SALs) – 18.9%
    - Clinically significant SALs – 4.7%
    - SALs requiring intervention – 3.9%
Tissue Targeted by Supraglottoplasty
Surgical Management of Laryngomalacia

• Post-operative management
  – Usually left intubated overnight
  – Antibiotics should be given at least 5 days post-operatively
  – Antireflux precautions
    • Medication
    • Positioning
Overview of Literature Review

- History of supraglottoplasty
- Severe laryngomalacia and expected treatment outcomes
- Unilateral versus bilateral
- Surgical techniques
- Failures and complications
History of Supraglottoplasty
History of Supraglottoplasty

• 1922: Dr. Iglauer described endoscopic removal of supraglottic tissue with nasal snare
• 1984: Dr. Lane described removal of corniculate cartilage and redundant arytenoid mucosa
• 1985: Dr. Seid described CO2 laser for treatment of laryngomalacia in 3 patients
Severe Laryngomalacia and Expected Treatment Outcomes
Severe Laryngomalacia Defined

- In 1995, Roger et al published a retrospective study of 115 patients s/p resection of aryepiglottic folds with or without CO2 laser
- Success rate of 98% with 30 month follow-up
- Two children required tracheotomies (failed supraglottoplasty)
- Seven patients required revision surgery
Severe Laryngomalacia Defined

- Established criteria defining severe laryngomalacia: presence of 3 is indication for endoscopic surgery
  - dyspnea at rest and/or severe dyspnea during effort
  - feeding difficulties
  - height and weight growth rate stagnation
  - sleep apnea or obstructive hypoventilation
  - uncontrollable gastroesophageal reflux
  - history of intubation for obstructive dyspnea
  - effort hypoxia (10% higher than the normal values for the same age group)
  - effort hypercapnia (10% higher than the normal values for the same age group)
  - abnormal polysomnography with an increased apnea/obstructive hypoventilation index
Resolution and Intervention for Laryngomalacia

• In 1999, Olney et al performed a retrospective chart review to determine
  – Outcome of infants who do not undergo routine direct laryngoscopy and bronchoscopy
  – Age at which laryngomalacia resolves
  – Outcome of supraglottoplasty as a function of the type of laryngomalacia and the presence of concomitant disease
Alternate Classification of Laryngomalacia
Resolution and Intervention for Laryngomalacia

- Olney Results
  - direct laryngoscopy and bronchoscopy as part of the routine evaluation of laryngomalacia is not warranted and should only be performed when there is clinical and physical evidence of a concomitant airway lesion
  - median time to resolution of isolated laryngomalacia was 36 weeks, and by 72 weeks, 75% of infants were free of stridor
Resolution and Intervention for Laryngomalacia

- Olney results (cont.)
  - Supraglottoplasty was determined to be necessary in approximately 15-20% of affected infants
    - Apneic episodes
    - Failure to thrive
Unilateral Versus Bilateral
Unilateral Supraglottoplasty

• In 1995, Kelly et al evaluated effectiveness of unilateral supraglottoplasty

• Retrospective review of 18 patients with severe laryngomalacia treated with unilateral CO2 laser supraglottoplasty
  – 3 patients required contralateral supraglottoplasty
  – Obstructive symptoms relieved in 94%
  – Patient without obstructive relief had tracheomalacia secondary to prior tracheotomy
Unilateral Versus Bilateral Supraglottoplasty

• In 2001, Reddy et al evaluated the efficacy of unilateral versus bilateral supraglottoplasty

• Retrospective review of 106 patients
  – 59 patients with bilateral supraglottoplasty
  – 47 patients with unilateral supraglottoplasty
Unilateral Versus Bilateral Supraglottoplasty

- **Reddy Results**
  - 96% with resolution of clinically significant laryngomalacia
  - 15% of unilateral supraglottoplasty patients required contralateral supraglottoplasty
  - 3% of bilateral supraglottoplasty developed supraglottic stenosis
  - No patients undergoing unilateral supraglottoplasty developed supraglottic stenosis
Surgical Technique
Epiglottoplasty

- In 1987, Zalzal et al described epiglottoplasty as a new procedure
- 10 patients
- Using a laryngoscope, excised redundant mucosa from:
  - Lateral edges of epiglottis
  - Aryepiglottic folds
  - Arytenoids
Epiglottoplasty

• “All patients had complete relief”
  – One patient had to undergo repeat excision

• Indications for operating
  – Severe stridor with:
    • Failure to thrive
    • Cor pulmonale
    • Feeding difficulties
    • Apnea
  – Inability to view vocal cords due to laryngeal inlet collapse
CO2 Laser Supraglottoplasty

- In 2001, Senders et al evaluated use of CO2 laser in supraglottoplasty and role of associated anomalies on outcome
- Retrospective chart review of 23 patients
- Results
  - Patients without associated anomalies
    - 78% with immediate resolved symptoms
    - 100% with symptom resolution in a week
  - Unfavorable immediate results and long-term surgical failure all had associated anomalies
    - Arnold-Chiari
    - Cerebral Palsy
    - CHARGE Association
    - Rieger syndrome
Endoscopic Aryepiglottoplasty

- In 2001, Toynton et al evaluated the affect of endoscopic aryepiglottoplasty on severe laryngomalacia
- Retrospective review of 100 patients
- Surgical criteria
  - Oxygen saturation below 92%
  - Failure to thrive
Endoscopic Aryepiglottoplasty

• Toynton Results
  – 94% of patients had improvement of stridor within one month
    • 55% of these patients were completely without stridor
  – Patients with slower progression of improvement were found to have serious neurological condition
  – 72% of patients with preoperative feeding difficulties improved their feeding
Aryepiglottic Fold Division

- In 2001, Loke et al examined effect of simple division of aryepiglottic fold
- Retrospective review of 32 cases
- Results
  - 69% showed complete resolution of symptoms
  - 22% showed partial resolution of symptoms without further surgical intervention required
  - 6% required additional procedure
  - 1 patient required tracheotomy
Epiglottopexy

- In 2002, Werner et al addressed isolated posterior displacement of epiglottis
- 6 patients underwent epiglottopexy
  - 4 solely epiglottopexy
  - 2 with epiglottopexy and transection of aryepiglottic folds
- All patients with significant airway improvement and no effect on deglutition
Epiglottopexy Treatment Algorithm

- supraglottoplasty
  - inspiratory collapse of hyperplastic mucosa
- incision of the aryepiglottic folds
  - shortened aryepiglottic folds
- main causes of laryngomalacia
  - posterior displacement of the epiglottis
  - epiglottopexy
Epiglottopexy
Microdebrider Supraglottoplasty

- In 2005, Zalzal et al presented new technique to supraglottoplasty by making use of the microdebrider
- Case series of five patients
- Technique
  - Dividing the aryepiglottic fold with microlaryngeal scissors
  - Aryepiglottic folds are resected with microdebrider
    - anteriorly to the lateral edge of the epiglottis
    - posteriorly to the arytenoids cartilage
  - Redundant supraarytenoid mucosa removed with microdebrider
- All patients with post-op resolution of stridor and no complications
Pre-operative Laryngomalacia
Division of Aryepiglottic Fold
Post-operative Laryngomalacia
Pre and Post-operative Laryngomalacia
Complications and Failures
Failures and Complications

• In 2003, failures and complications in supraglottoplasty were analyzed by Denoyelle et al.

• Retrospective review of 136 patients
  – 102 with isolated laryngomalacia
  – 34 with additional congenital anomalies
    • Pierre Robin
    • Psychomotor retardation
    • CHARGE Association
    • Down syndrome
Failures and Complications

• **Outcome measures**
  – Persistence of dyspnea
  – Sleep apnea
  – Failure to thrive
  – Need for additional treatment
  – Presence of granuloma, edema, or web
  – Supraglottic stenosis
Supraglottic Stenosis
Failures and Complications

• Results
  – Failure or only partial improvement of symptoms was only seen in patients with additional congenital anomalies (8.8%)
  – need for revision surgery was 4.4%
  – minor complications (granuloma, edema or web) occurred in 3.7%
  – supraglottic stenosis occurred in 4.4%
Recommendations
Recommendations

• Conservative management with close follow-up
• Use technique that surgeon feels most comfortable with for surgical intervention
• Reasonable to treat unilaterally
• Cotton RT. Practical Pediatric Otolaryngology. 1999: 497-501.
• Iglauer S. Epiglottidectomy for the relief of congenital laryngeal stridor, with report of a case. Laryngoscope. 1922; 32: 56-59.