Surgical Treatment of Laryngomalacia

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Grand Rounds Presentation
June 15, 2005
Overview

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

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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
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 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
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

Main causes of laryngomalacia

- Supraglottoplasty
  - Inspiratory collapse of hyperplastic mucosa
- Incision of the aryepiglottic folds
  - Shortened aryepiglottic folds

Posterior displacement of the epiglottis

Epiglottopexy
Epiglottopexy
In 2005, Zalzal et al. presented a new technique for supraglottoplasty by making use of the microdebrider. Case series of five patients was conducted. 

**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 had 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
Bibliography