Benign Laryngotraheal Stenosis and Advances in Management

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Outline

- Anatomy
- Types of stenosis
- Causes of stenosis
- Clinical presentation
- Medical treatment
- Surgical management
- Research
Laryngeal and Tracheal Anatomy

- **Glottis**
  - Anterior glottis
    - Squamous epithelium
  - Posterior glottis
    - Respiratory epithelium
- **Subglottis**
  - Cricoid ring
    - Circumferentially surrounds the subglottic airway
  - Respiratory epithelium
- **Blood supply**
Laryngotracheal Stenosis Background

- **Locations**
  - Supraglottis
  - Glottis
  - Subglottis

- **Types**
  - Partial
  - Circumferential

- **Etiologies**
  - Congenital
  - Acquired
Etiology
- Failure of the laryngeal lumen to recanalize
- Results in various degrees of glottic/subglottic stenosis

Congenital subglottic stenosis: 5% incidence
- Diameter ≤ 4mm in full term infant w/o h/o intubation or surgical trauma
- Types: membranous, cartilaginous

Congenital laryngeal webs
- 5% of congenital laryngeal anomalies
- 75% at glottic level
- Rarely involve the supraglottis
Acquired Stenosis Etiologies

- Intubation trauma
- External trauma
- Infectious
- Autoimmune/Systemic
- Idiopathic
Pathophysiology of ETT injury

- **Mechanism**
  - Ischemic mucosal necrosis from pressure
  - Infection w/ mucosal ulceration leads to chondritis and cartilage resorption
  - Secondary intent causes submucosal fibrosis and scar contraction

- ETT Injuries occur primarily in the posterior glottis
Impact of reflux on laryngeal injury

- Variable epithelial resistance

- Additional posterior glottis susceptibility
  - Cilia beat material to posterior glottis causing longer exposure and more pronounced injury
Impact of reflux on laryngeal injury

- Decrease in pH
  - Alone, and with concurrent pepsin exposure decreases healing following laryngeal injury
Impact of reflux on laryngeal injury

- Decrease in pH
- Reduction in mucociliary transport may decrease resistance to infection and contribute to the pathogenesis of subglottic stenosis
Impact of reflux on laryngeal injury

- Bogdasarian and Olson 1980
  - Noted importance of GERD in posterior SGS
- Gaynor 1988
  - Lower pharyngeal pH in intubated patients
- Koufman 1991
  - 78% w/ stenosis showed LPR on 24-hour pH monitoring
- Toohill 1998
  - Confirmed findings with case controlled study
- Blumin et al. 2011
  - 59% of patients w/ ISS pepsin +, 0% of controls pepsin +
Patient Presentation

- Pediatrics
  - Failure to thrive and feeding problems
  - Recurrent or persistent croup
  - Hoarseness or weak husky cry, aphonia

- Adults
  - Dyspnea on exertion / at rest
  - Hoarseness
  - Stridor
Patient Presentation

- **History**
  - Assessment of dyspnea and stridor
    - Characteristics, time of onset, relieving/aggravating factors
  - Degree of subjective impairment
  - Questions to identify etiology
  - Evaluate for GERD/LPR

- **Exam**
  - Level of distress
  - Voice quality
  - Endoscopy
Studies

- Labs
- PFTs
- pH probe
- Genetic testing
Imaging

- Xray
- Airway fluoroscopy
- CT
Diagnostic Procedures

- DL and bronchoscopy
  - Outer diameter of largest ETT that can pass
  - Location, length, thickness, composition
  - Rule out secondary sites
  - Palpate arytenoids for cricoarytenoid joint fixation

- Biopsy
Staging Systems

- **Myers-Cotton:**
  - Grade I \( \leq 50\% \) obstruction
  - Grade II 51-70\% obstruction
  - Grade III 71-99\% obstruction
  - Grade IV 100\% obstruction
Type Specific Staging Systems

- Bogdasarian and Olson:
  - **Type I**
    - Interarytenoid scar w/ posterior sinus tract
  - **Type II**
    - Posterior commissure stenosis
  - **Type III and IV**
    - Posterior commissure scars involving cricoarytenoid joint unilaterally or bilaterally, respectively
Type Specific Staging System

- Cohen: classification of anterior webs
  - Type I: anterior web of 35% or less of the glottis
  - Type II: anterior web of 35-50% of the glottis
  - Type III: anterior web of 50-75% of the glottis
  - Type IV: web occluding 75-90% of the glottis
Prevention

- Appropriate ETT size and cuff pressure
- Sedation if needed to avoid tube movement
- Avoid unnecessary prolonged intubation
- Explore laryngeal fractures early to minimize sequela
- Avoid high tracheotomy and cricothyrotomy, if possible
Medical Treatment

- When due to infections or inflammatory disorders, appropriate antibiotics and/or steroids are important
- Treat GERD / LPR aggressively
- Symptomatic patients benefit from preoperative systemic steroids
- Humidified oxygen and airway monitoring in supervised setting if needed
Surgical History

1st indirect laryngoscopy

Improved illumination

1st direct laryngoscopy

1st suspension laryngoscopy

Successful tracheal intubation

Endoscopic laryngeal surgery

Microlaryngoscopy

Laser

1854 1857 1868 1909 1913 1940 1960 1970

1850 1900 1950 2000
CO$_2$ Laser

- **Advantages**
  - Delayed formation/maturation of collagen
  - Minimal deep tissue injury
  - Mucosal preservation

- **Limitations**
  - Risk of airway fire
  - Risk of laser plume with infectious lesions
  - Control of thermal injury
Goals for Surgery

- Establish a satisfactory airway

- Preservation of:
  - Phonation
  - Airway protection
  - Glottic closure
Candidacy for Surgery

- GERD/asthma control essential prior to treatment
- Pulmonary status must be maximized
  - Tracheotomy PRN until reserve optimized
- Weight > 10 kg before laryngotracheal reconstruction
- Patients with a need for ventilatory support are generally poor surgical candidates
Surgical Planning

- First consideration
  - Establish intact, appropriately shaped skeletal framework to provide a scaffold for the airway

- Second consideration
  - Establishment of a completely epithelialized lumen
Surgical Approaches

- Endoscopic
  - MDL, laser excision, dilation

- Endoscopic with indwelling stent

- External expansion procedure
  - Laryngotracheoplasty with cartilage grafting

- External cricotracheal resection with anastomosis
Stenting

- **Indications**
  - Support for cartilage/bone grafts
  - Splint displaced cartilage
  - Immobilize epidermal grafts
  - Separate opposing raw surfaces
  - Allow required scar formation

- Internal stenting can increase the risk of local infection, mucosal ulceration, and granulation tissue, which is directly related to the duration of stenting
Adjuncts

- Mitomycin C
  - Antineoplastic alkylating agent
  - Inhibits DNA synthesis, cell division, protein synthesis, and fibroblast proliferation

- Animal studies show statistically significant reduction in restenosis after lysis & mitomycin C
Adjuncts

- Injected corticosteroids
  - Advantage in decreased scar formation
  - Disadvantage in delayed wound healing with hindrance of epithelial migration to resurface denuded areas can predispose the surgical area to infection
Current recommendations

- Treatment of mild stenosis (Cotton-Myer I & II) with endoscopic techniques

- Postoperative management
  - Antibiotics for 1 - 3 weeks
  - Antireflux management
  - Endoscopic wound reassessment

- Currently, failure of initial endoscopic technique listed as associated with
  - Previous surgery
  - Circumferential scarring
  - Loss of cartilaginous support
  - Exposure of cartilage leading to chondritis
  - Posterior inlet scarring with subsequent arytenoid fixation
Research Rotation: Management of Idiopathic Stenosis

- ISS pattern of stenosis
  - Isolated lesions in ISS vs. multi-level stenosis with SGS due to other causes

- Available literature shows paucity of reports for endoscopic management of ISS in over twenty patients
  - Those available report different techniques, levels of efficacy and morbidity showing a need for further studies with larger volumes of patients included
Endoscopic Management of Idiopathic Tracheal Stenosis

Jeanne-Marie Perotin, MD, Thierry Jeanfaivre, MD, Yoann Thibout, MD, Stéphane Jouneau, MD, PhD, Hervé Lena, MD, Hervé Dutau, MD, Philippe Ramon, MD, Christine Lorut, MD, Marc Noppen, MD, PhD, Jean-Michel Vergnon, MD, PhD, Hervé Vallerand, MD, Jean-Claude Merol, MD, Charles-Hugo Marquette, MD, PhD, François

Idiopathic Subglottic Stenosis: An Evolving Therapeutic Algorithm

Fabien Maldonado, MD; Andrea Loiselle, MD; Zachary S. DePew, MD; Eric S. Edell, MD; Dale C. Ekborn, MD; Michael Malinchoc; Clinton E. Hagen; Eran Alon, MD; Jan L. Kasperbauer, MD
Current Study

- Addition to the available literature
  - Greater than 20 patients during condensed time when surgical technique shows minimal variation
  - Experience at one institution

- Specific areas under investigation
  - View that circumferential scarring indicated endoscopic management wound not be successful
  - Goal for endoscopic management as sole technique vs. a temporizing measure for open intervention
  - ID characteristics related to interval of recurrence
Current Study

- Demographic / Clinical presentation information
- Medical management
  - Steroid/anti-inflammatory and anti-reflux regimen
- Stenosis details
  - Grade, location, length, type and biopsy findings
- Surgical management
  - Number of procedures, steroid / mitomycin C application, longest interval achieved between procedures
  - Tracheostomy or open procedure including laryngotracheoplasty / laryngotraheal resection
- Outcomes
  - Duration between procedures, need for open resection
  - Status of tracheostomy / symptoms following intervention
Endoscopic management

- Video bronchoscopy
  - MAC with light sedation and topical airway anesthetic
  - Laser radial incisions through video bronchoscope
  - Balloon dilation performed
Endoscopic management

- MDL with flexible bronchoscopy
  - Laryngoscope introduced and placed into suspension
  - Intermittent apneic anesthesia utilized
  - Video bronchoscope used for laser radial incision
  - Balloon dilation then completed
Pharmaceutical adjuncts

- Mitomycin C
  - 1 mg per mL soaked cottonoid pledgets at area of resection
  - Left in place for 4 minutes, removed
  - Cottonoid pledgets soaked in saline used to wipe the area clear

- Decadron
  - 4mg/mL injection of 0.3-0.5mL to stenotic area
Cricotracheal Resection & Anastomosis

- Short segment of severe stenosis
  - With a segment of normal lumen for at least 10mm below the glottis
### Results

<table>
<thead>
<tr>
<th>Authors</th>
<th>No. of patients</th>
<th>Length (years)</th>
<th>Endoscopic patients</th>
<th>Open procedure patients</th>
<th>Tracheostomy dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maldonado et al. 2013</td>
<td>110</td>
<td>20</td>
<td>110</td>
<td>9</td>
<td>1 (0.9%) t-tube</td>
</tr>
<tr>
<td>Dedo &amp; Catten 2001</td>
<td>52</td>
<td>34</td>
<td>50</td>
<td>3</td>
<td>13 (26%)</td>
</tr>
<tr>
<td>Giudice et al. 2002</td>
<td>30</td>
<td>17</td>
<td>30</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>McKee-Cole at al. 2013 (current study)</td>
<td>25</td>
<td>10</td>
<td>25</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Perotin et al. 2011</td>
<td>23</td>
<td>NS</td>
<td>23</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Valdaz &amp; Shapsay 2002</td>
<td>16</td>
<td>15</td>
<td>14</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Benjamin et al. 1997</td>
<td>15</td>
<td>15</td>
<td>12</td>
<td>1</td>
<td>4 (27%)</td>
</tr>
<tr>
<td>Maronian et al. 2001</td>
<td>9</td>
<td>8</td>
<td>NS</td>
<td>0</td>
<td>NS</td>
</tr>
</tbody>
</table>
# Results

<table>
<thead>
<tr>
<th></th>
<th>Current Study</th>
<th>Available Literature w/ greater than 20 patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg age at diagnosis</td>
<td>50.84 yrs</td>
<td>48.84 yrs</td>
</tr>
<tr>
<td>Range of age at diagnosis</td>
<td>31-73 yrs</td>
<td>15 - 83 yrs</td>
</tr>
<tr>
<td>Smoking status</td>
<td>92% never smoker, 8% former smoker (5-10 pack year range)</td>
<td>97.15% never smoker*, 2.85% smoker*</td>
</tr>
<tr>
<td>GERD / LPR symptoms</td>
<td>24%</td>
<td>29.27%*</td>
</tr>
<tr>
<td>Avg. grade of stenosis</td>
<td>2.15 Myers-Cotton</td>
<td>Not available</td>
</tr>
<tr>
<td>Range grade of stenosis</td>
<td>1-3 Myers-Cotton</td>
<td>Not available</td>
</tr>
<tr>
<td>Circumferential</td>
<td>36%</td>
<td>Not available</td>
</tr>
<tr>
<td>Avg. # endoscopic procedures</td>
<td>4.08</td>
<td>6.13*</td>
</tr>
<tr>
<td>Range # endoscopic procedures</td>
<td>1 - 14</td>
<td>1-25</td>
</tr>
<tr>
<td>Intraoperative adjunct</td>
<td>28% topical mitomycin C, 12% decadron injection</td>
<td>Not available</td>
</tr>
<tr>
<td>Average time between procedures</td>
<td>680.58 days (1.86 years)</td>
<td>Not available</td>
</tr>
<tr>
<td>Range time between procedures</td>
<td>18-2947 days (8.07 years)</td>
<td>Not available</td>
</tr>
<tr>
<td>Open procedures</td>
<td>2 (8%)</td>
<td>10.87%*</td>
</tr>
<tr>
<td>Tracheostomy at home institution</td>
<td>3 (16%)</td>
<td>19.50%*</td>
</tr>
<tr>
<td>Decannulation</td>
<td>100%</td>
<td>92.17%</td>
</tr>
<tr>
<td>Average follow-up</td>
<td>43.81 months</td>
<td>51.62 months</td>
</tr>
<tr>
<td>Range of follow-up</td>
<td>2.4 – 124.4 months</td>
<td>0.23 – 300 months</td>
</tr>
</tbody>
</table>

* = data not available in all studies
Preliminary Results

- **Mitomycin C**
  - 4.39 times longer interval between procedures

- **Circumferential stenosis**
  - 1.84 times longer interval between procedures

- **Age**
  - With circumferential stenosis every 1 year increase in age at diagnosis increased longest interval by 1.07 times
  - Without circumferential stenosis every 1 year increase in age at diagnosis decreased the longest interval to 93% of expected
Conclusion

- Benign laryngotracheal stenosis
  - Multiple etiologies
  - Active steps in prevention are necessary
  - Steroids and anti-reflux rx critical to management
- Surgical management
  - Has made continued advancement
  - Range from endoscopic to open expansion or resection procedures
- Further research
  - Needed to define the etiology of ISS
  - To help define the patient population in which endoscopic management will be most successful
Thank you
References

References

Questions