Surgical Management of Tracheal Stenosis
Overview

- Tracheal stenosis
  - Grading systems
- Surgical management of tracheal stenosis
- Tracheal stents
- Tracheal anastomosis
- Case study
The J.C. Goodwin Lecture Series in Laryngology

- Benign Laryngeal Lesions
- Glottic/Subglottic Stenosis
- Laryngeal Reflux
- Laryngeal Carcinoma
- Laryngeal/Tracheal Stenosis
- Hypopharyngeal Carcinoma
Historical aside

Chevalier Quixote Jackson
Chevalier Jackson (1863-1958)
From western Pennsylvania
Apocryphal story
Began his work with esophagoscopy
  - Designed the earliest esophagosopes
Later branched to laryngology
Chevalier Jackson

- Pioneer in foreign body removal of esophagus and tracheobronchial tree.
- Pioneer in the surgical technique of tracheotomy
- Prolific innovator and instrument designer
- Championed public health laws
Tracheal Anatomy

- 10-13 cm in length (adult)
- 13-16 mm width (females) and 16-20 mm width (males)
- 14-20 horseshoe shaped cartilages
- With extension of neck 50% of trachea is cervical
Blood supply

- Cervical trachea supplied by superior and inferior thyroid arteries
- Mediastinal trachea supplied by bronchial arteries
- Extensive dissection around trachea causes ischemia
Causes of Stenosis

Box 71.1

Causes of Adult Laryngeal and Upper Tracheal Stenosis

**Trauma**
External laryngotracheal injury
  - Blunt neck trauma
  - Penetrating wound of the larynx
Internal laryngotracheal injury
Prolonged endotracheal intubation
  - Tracheotomy
  - Surgical procedure
  - Irradiation therapy
  - Endotracheal burn
    - Thermal
    - Chemical

**Chronic Inflammatory Disease**
Bacterial diphtheria
Syphilis
Fungal histoplasmosis
Tuberculosis
Leprosy
Sarcoidosis
Scleroma

**Benign Neoplasms**
Intrinsic
  - Papillomas
  - Chondromas
  - Minor salivary gland
  - Neural
Extrinsic
  - Thyroid
  - Thymus

**Malignant Neoplasms**
Intrinsic
  - Squamous cell carcinoma
  - Minor salivary gland
  - Sarcomas
  - Lymphoma
Extrinsic
  - Thyroid

**Collagen Vascular Diseases**
Wegener's granulomatosis
Relapsing polychondritis
Other
Considerations

- History of neck/laryngeal trauma
- History of intubation
- History of tracheotomy
- Rheumatologic diseases
- Radiation history
- Thyroid disease
Grading Systems for SGS

- Cotton-Myer
- McCaffrey
- Lano

<table>
<thead>
<tr>
<th>Classification</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>No Obstruction</td>
<td>50% Obstruction</td>
</tr>
<tr>
<td>Grade II</td>
<td>51% Obstruction</td>
<td>70% Obstruction</td>
</tr>
<tr>
<td>Grade III</td>
<td>71% Obstruction</td>
<td>99% Obstruction</td>
</tr>
<tr>
<td>Grade IV</td>
<td>No Detectable Lumen</td>
<td></td>
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</table>
Grading Systems for SGS

- McCaffrey

Grading Systems for SGS

- **Lano**
  - Based on subsites involved (glottis, subglottis, trachea)
  - Does not take into account length of stenosis or lumen diameter
    - Stage I – one subsite involved
    - Stage II – two subsites involved
    - Stage III – three subsites involved
  - Lano showed correlation between this staging and likelihood for successful decannulation
    - I: 94%, II: 78%, III: 20%

Goal of surgery is to provide a satisfactory airway and eventually decannulate patient.

Surgical procedures to improve airway often compromise other laryngeal functions.

Location, length, composition, extent, structural integrity, functional impairment:

- Direct laryngoscopy and bronchoscopy is required
- Radiology Imaging
- PFT
- GI/Swallow evaluation
Treatment of Laryngotraheal Stenosis

- **Endoscopic**
  - Laser
  - Microdebrider
  - Dilation
  - ± Steroid injection, Mitomycin-C application

- **Stenting**

- **Open Surgical**
  - Primary resection and anastomosis
  - Laryngotracheoplasty (LTP)
    - Grafts (cartilage, mucosa)
    - Stenting
    - Single stage versus multistage
Stents
Stent indications

- Should be used only if no other surgical alternative exists
- Failed surgeries
- Unfit for surgery
- Use in conjunction with airway surgery to maintain graft, promote healing, etc.

Table 1. Indications for Central Airway Stents

- Airway obstruction from intrinsic or extrinsic compression in patients with disease or co morbid ailments precluding surgery
- Tumor in growth despite frequent laser treatments
- Adjunct to laser or photodynamic therapy to maintain lumen patency after treatment
- Loss of cartilaginous support
- Treatment of tracheoesophageal fistula
- Relief of postobstructive pneumonia for better cancer staging and may permit parenchyma-sparing surgery
- Relief of postobstructive pneumonia in septic patient allowing for inclusion in chemotherapy protocols

### Table 3. Types of Stents

<table>
<thead>
<tr>
<th>Stent Type</th>
<th>Subtypes</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone</td>
<td>Montgomery T tube,</td>
<td>Removable/exchangeable, resist external compression, minimal granulation, inexpensive T stents advantageous for disease with carinal involvement</td>
<td>Requires general anesthesia and rigid bronchoscopy, migrates, adherence of secretions, unfavorable wall to inner diameter ratio, unable to conform to irregular airways, interference with mucociliary mechanisms</td>
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<tr>
<td></td>
<td>Dumon, Hood, Reynders,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Dynamic, Polytex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balloon-dilated metal stent</td>
<td>Strecker, Palmaz</td>
<td>Less migration, thinner so inner diameter is bigger, less migration, less interference with cilia</td>
<td>Needs balloon dilation of the stent, rigid bronchoscopy and general anesthesia, difficult to remove, tumor in growth along the length of the stent, radial force may cause necrosis of mucosa and fistula formation. May collapse if external force too great</td>
</tr>
<tr>
<td>Self-expanding metal stent</td>
<td>Gianturco, Ultraflex</td>
<td>Can be placed with flexible bronchoscopy in an outpatient setting, less migration, thinner so inner diameter is bigger, less interference with cilia</td>
<td>Difficult to remove, radial force may cause necrosis of mucosa and fistula formation, tumor in growth along the length of the stent, may collapse if external force too great</td>
</tr>
<tr>
<td>Covered self-expanding metal stent</td>
<td>Ultraflex, Wallstent, Alveolus</td>
<td>No tumor in growth along the length of the stent, thinner so inner diameter is bigger, easier than bare metal stents to remove or exchange, less migration, less interference with cilia</td>
<td>Placed with flexible bronchoscopy, radial force may cause necrosis of mucosa and fistula formation, may collapse if external force too great, granulation tissue at ends, may block bronchus</td>
</tr>
</tbody>
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*Endoxane, Novatech SA (Grasse, France). Hood Corp (Pembroke, MA). Reynder’s Medical Supply (Lennik, Belgium). Dynamic and Polytex (Rusch, Duluth, GA). Boston Scientific (Natick, MA). Cordis Corp (Miami Labs, FL). William Cook (Bjaeverskov, Denmark). Ultraflex and Wallstent (Boston Scientific, Natick, MA).*
Montgomery T Tube
Dumon tube
Polyflex stent

**Figure 1** - Example of self-expanding stent made of polyester mesh with silicon coating (Polyflex®).

**Figure 2** - Polyflex® stent within the trachea.
Stent complications

- Migration
- Granulation – especially at ends
- Collapse
- Mucosal necrosis
- Impaired mucociliary clearance
- Difficult to remove
Tracheal resection

- First described in 1953, refined through 70s
- Treatment of choice for isolated tracheal stenosis
- Can also be done with partial cricoid resection for SGS
- Single stage and multistage procedures
- Can resect up to 50% of trachea
- Most series report success rates (decannulation) in 90+%
Tracheal resection

**INDICATIONS**
- High grade stenosis (C-M III and IV)
- Loss of structural integrity
- Failed LTR
- Up to 50% of trachea length

**CONTRAINDICATIONS**
- Length from vocal cords (typically need ~4mm)
- >50% length of trachea
- Maximize GERD management
Tracheal resection

- Intubate patient through stoma
- Initial exposure as you would on a thyroidectomy
- Expose trachea from cricoid to sternal notch
- Find stenotic segment
- Rentention sutures around inferior segment
- Enter the airway
  - Vertical vs horizontal approach
- Remove stenotic segment
  - Incorporate trach stoma site into resected area on single stage procedure
Figure 2  The airway is entered by performing an anterior cricoid split that is extended to the inferior edge of the stenosis (A). Lateral incisions may be performed to remove the anterolateral stenotic airway (B). A horizontal incision is made above the stenosis through the posterior cricoid mucoperichondrium (C). The posterior cricoid mucoperichondrium is reflected off the cricoid cartilage from superior to inferior (D).
Perform anastomosis
Releasing maneuvers

- Tracheal or laryngeal release maneuvers may be required with larger gaps
  - 3 cm, maybe shorter in older patients
- Annular ligament release
- Mobilization of distal trachea from thorax
- Laryngeal release
  - Suprahyoid vs infrahyoid release
- Generally not required (<10%)
**Annular ligament release**

- Annular ligament is circular fibrous tissue between cartilage rings
- Adds up to 1.5 cm
- Must be done in staggered fashion to avoid disruption of tracheal blood supply
Laryngeal release

- Suprahypoid release (Montgomery)
  - Muscle attachments to the superior aspect of hyoid bone are severed and central hyoid cut
  - Larynx and cervical trachea allowed to drop inferiorly
  - Can give up to 2-3 cm in length
  - Significant post-op dysphagia a possible major complication compared to infrahyoid release
Suprahyoid release

FIGURE 24-19 (CONTINUED) Suprahyoid laryngeal release. C, The lesser cornua of the hyoid with the chondroglossus muscles are transected. The digastric muscle slings attaching to the hyoid are left intact. The hyoid itself is divided on both sides anterior to the digastric attachments and lateral to the lesser cornua. D, The suprahyoid membrane is opened and the preepiglottic space entered.
Laryngeal release

- Infrahyoid release (Dedo)
  - Inferior attachments to the hyoid are severed
  - Especially the thyrohyoid muscle and thyrohyoid membrane
  - Can add up to 2.5 cm length
Infrahyoid release
Grillo stitch

- Stitch from chin to sternum to keep neck in flexion postoperatively
Video

- http://www.youtube.com/watch?v=iOXrFOfo3Uw
Complications

- Restenosis (10%)
- Dehiscence (4-7%)
- Granulation (up to 25%)
- Dysphagia (up to 20%)
  - Some higher reports with laryngeal release
- RLN damage (2%)
- Large number will require adjuvant procedures
Case

- 28 yo gentleman presents to clinic with complaints of aphonia and wants to speak again
PMH

- GSW to face in 2007. Trach placed at that time
- Decannulated, however needed repeat trach
- Voice steadily declined until now aphonic
- Has had several attempts in the past to try to open airway – laser treatments
- Underwent tracheal resection with anastomosis
- 7 days later returned for granulation tissue debridement
This was a very non-compliant patient
Lost to follow up
Hidden in records was the fact that he had stenosis as a child due to prolonged intubation and had a prior tracheal resection
Intubation and tracheotomy are both common causes of stenosis.

Variety of methods available to treat stenosis from minimally invasive to open procedures.

Tracheal resection with anastomosis for isolated tracheal stenosis.


