Vocal Fold Augmentation

Nov 14, 2008
Bruce Tan, MD
Sofia Lyford-Pike, MD
CME Objectives

- Discuss the relevant anatomy and pathophysiology of glottic incompetence
- Discuss the use of injectable products for vocal fold medialization
- Discuss the surgical techniques available for vocal fold medialization
- Discuss the clinical outcomes of these procedures
- **SLN:** Cricothyroid muscle
- **RLN:** PCA, adductors and the thyroarytenoid
- **RLN** de-innervation results in immediate loss of vocal fold mass, abduction, and adduction producing glottic incompetence
Causes of glottic incompetence

- Vocal cord paralysis
- Sulcus vocalis
- Vocal fold atrophy
Symptoms of vocal fold incompetence

- Breathy, hoarse, raspy, diplophonic voice
- Decreased glottic efficiency
- Aspiration and potentially aspiration pneumonia.
Treatment Modalities

- Voice and swallowing therapy
- Vocal cord injection
- Surgery

Treatment Considerations

- Severity of symptoms
- Expected duration of impairment
- Patient co-morbidities, motivation
Injection Laryngoplasty

Sofia Lyford-Pike MD
Greater Baltimore Medical Center
Grand Rounds
Vocal Fold Pathology

- Cords that cannot adduct but maintain vibratory characteristics
  - Dysphonia and...
  - Aspiration, ineffective cough, dyspnea on exertion

- Cords move normally but have damaged vibratory membranes
  - (Atrophy, scarring, bowing)
  - Principal c/o Dysphonia
The Beginning

- 1911
  Bruening injects Parafin to medialize an immobile cord.
  -Cons: Inflammatory response, extrusion and migration

- 1950’s
  Arnold injects cartilage and bovine bone dust
  -Pro: Less inflammation
  -Con: Resorption

These 4 facets continue to currently be the limitations in the search for the ideal injectable.
TEFLON
1960’s
Use: Immobile Cord

**PROS**
Permanent

**CONS**
Inflammatory Response
→ Granulomas
Migration
Difficult Injection
(not viscous, large gauge needle)
BOVINE COLLAGEN
1980’s
Use: Immobile or Poor Vibration

**PROS**
- Mechanical and Physiologic Characteristics (both etiologies)
- Precise Administration

**CONS**
- Short Acting (6mos)
- Hypersensitivity (skin test b4 injection)
- Resorption (overinject 20-30% more)
AUTOLOGOUS COLLAGEN

Use: Immobile and Poor Vibration

**PROS**
- Mechanical and Physiologic (comparable to bovine)
- No Inflammatory Response

**CONS**
- Short Acting (6mos)
- Prohibitively Expensive (5cm2 skin → 1ml)
- Resorption
- Time Consuming (3mos from harvest to injection)
CADAVERIC COLLAGEN
(Cymetra, Alloderm)
Use: Immobile and Poor Vibration

**PROS**
- Great Physiologic Characteristics
- No Inflammatory Response
- Easy to Obtain

**CONS**
- Short Acting (6mos-9mos, may need boosters)
- Resorption
AUTOLOGOUS FAT
Use: Immobile and/or Poor Vibration

**PROS**
- Best Physiologic Characteristics
- No Inflammatory Response
- Abundant, uncomplicated harvest

**CONS**
- Unpredictable Duration (approx 3 mos)
- Resorption
Longer Duration Need
New Developments

- **Hydroxylapatite**
  - mineral component of bone
  - possible permanence of Teflon
    w/out immune response
  - carrier gel absorbs quickly, no need for
    overinjection, no resorption
  
  **Two Years**

- **Hyaluronic Acid**
  - organic molecule
  - viscoelasticity of vocal cord
  - recruits fibroblasts w/out immune response, softens scars
  - superior to bovine cartilage in maintaining vibratory characteristics

  **Two Years**
<table>
<thead>
<tr>
<th>Material</th>
<th>Location of injection</th>
<th>Amount injected</th>
<th>Duration</th>
<th>Viscosity</th>
<th>Needle gauge</th>
<th>FDA Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teflon</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Exact amount</td>
<td>Permanent</td>
<td>Low</td>
<td>18</td>
<td>Yes</td>
</tr>
<tr>
<td>Bovine collagen</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Overinject</td>
<td>6 months</td>
<td>High</td>
<td>27</td>
<td>No</td>
</tr>
<tr>
<td>Human collagen</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Overinject</td>
<td>6 months</td>
<td>High</td>
<td>27–30</td>
<td>No</td>
</tr>
<tr>
<td>Cymetra</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Overinject</td>
<td>6–9 months</td>
<td>Low</td>
<td>22</td>
<td>Yes</td>
</tr>
<tr>
<td>Fascia</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Overinject</td>
<td>3 months</td>
<td>High</td>
<td>18–22</td>
<td>NA</td>
</tr>
<tr>
<td>Fat</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Overinject</td>
<td>3 months</td>
<td>High</td>
<td>18–22</td>
<td>NA</td>
</tr>
<tr>
<td>Hydroxyapatite</td>
<td>Lateral to vocal ligament or in vibratory membrane</td>
<td>Slightly overinject</td>
<td>2 years</td>
<td>Low</td>
<td>26</td>
<td>Yes</td>
</tr>
<tr>
<td>Hyaluronic acid</td>
<td>In vibratory membrane</td>
<td>Slightly overinject</td>
<td>2 years</td>
<td>High</td>
<td>26</td>
<td>No</td>
</tr>
</tbody>
</table>
References

Isshiki Type I Thyroplasty

- Cervical incision to gain exposure of thyroid cartilage lamina
- Identify the true vocal line
- Design a window inferior to TVC about 5-10mm from anterior border ~5-6mm in height
- Remove cartilage window while preserving inner perichondrium
Choice of implant materials

- Silastic
- Gore-Tex strip
- Hydroxyapatite
- Titanium

- Key to long term success is initial OVERCORRECTION
Commercially available thyroplasty implants

VoCom Thyroplasty system (Hydroxyapatite)

Montgomery Thyroplasty system (Silastic)
Arytenoid Adduction

- Requires more extensive dissection to expose muscular process of arytenoid
- Enables closure of posterior glottic chink
- Unable to correct bowing or cord atrophy
- Often used in conjunction with medialization thyroplasty
## Results

<table>
<thead>
<tr>
<th></th>
<th>Thyroplasty I (n = 98)</th>
<th>Thyroplasty I With Arytenoid Adduction (n = 96)</th>
<th>Total (n = 194)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean vocal fold gap* (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preop</td>
<td>1.6 (n = 93)</td>
<td>1.7 (n = 73)</td>
<td>1.6 (n = 166)</td>
</tr>
<tr>
<td>Postop</td>
<td>0.2 (n = 98)</td>
<td>0.1 (n = 96)</td>
<td>0.1 (n = 194)</td>
</tr>
<tr>
<td>Delta</td>
<td>1.4 (n = 93)</td>
<td>1.6 (n = 73)</td>
<td>1.5 (n = 166)</td>
</tr>
<tr>
<td>Symptom improvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoarseness</td>
<td>90</td>
<td>88</td>
<td>178</td>
</tr>
<tr>
<td>Aspiration</td>
<td>39</td>
<td>49</td>
<td>88</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>34</td>
<td>43</td>
<td>77</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>22</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td>Overall</td>
<td>92 (94%)</td>
<td>89 (93%)</td>
<td>181 (93%)</td>
</tr>
</tbody>
</table>

Abraham et al. Laryngoscope 2001
# Objective Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean (SD)</th>
<th>Difference</th>
<th>( \alpha )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Absolute</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>PR (smt.)</td>
<td>M</td>
<td>15.4 (7.0)</td>
<td>22.6 (7.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.1 (5.5)</td>
<td>19.9 (3.8)</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>19.8 (5.6)</td>
<td>29.7 (8.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18.8 (5.1)</td>
<td>30.7 (6.2)</td>
</tr>
<tr>
<td>IR (dB)</td>
<td>M</td>
<td>179.4 (133.8)</td>
<td>419.3 (223.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>129.8 (88.2)</td>
<td>324.9 (122.6)</td>
</tr>
<tr>
<td>S\text{PG} (dB*smt.)</td>
<td>M</td>
<td>8.1 (6.6)</td>
<td>16.8 (11.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.8 (4.1)</td>
<td>13.3 (4.0)</td>
</tr>
<tr>
<td>MPT (s)</td>
<td>M</td>
<td>5.1 (4.6)</td>
<td>9.6 (6.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.2 (4.5)</td>
<td>11.7 (8.1)</td>
</tr>
</tbody>
</table>

*Statistically significant difference

Uloza et al. Eur Arch Otorhinolaryngology 2005
Complications

<table>
<thead>
<tr>
<th></th>
<th>Thyroplasty I (n = 98)</th>
<th>Thyroplasty I With Arytenoid Adduction (n = 96)</th>
<th>Total (n = 194)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient edema</td>
<td>6</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Hematoma/seroma</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Infection</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Extrusion</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Airway</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Tracheotomy</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Overall*</td>
<td>14 (14%)</td>
<td>18 (19%)</td>
<td>32 (16%)</td>
</tr>
</tbody>
</table>

Abraham et al. Laryngoscope 2001
Conclusions

- Glottic incompetence results in disabling and possibly debilitating problems for the patient.
- Injectable or surgical means of augmenting glottic closure can significantly improve glottic competence.
- The choice of technique for vocal fold augmentation should depend on the severity of symptoms, the expected duration of glottic incompetence and patient factors.
CASE STUDY: WL

- Hx of right true vocal cord paralysis and persistent hoarseness.
- Vocal cord paralysis onset: 7-8 years ago following a prolonged intubation secondary to medical complications from sepsis.
- Underwent a tracheostomy and PEG procedure while on the ventilator and attended intense rehabilitation.
- Decannulated/PEG removed w/in one year.
WL

- No residual swallowing problems reported
- Hoarseness persisted due to Right vocal cord paralysis.
- A right sided laryngoplasty 2004 without significant vocal improvement.
- A Cymetra injection 6/07 with significant short-term vocal improvement. Due to the effects of the injection, patient underwent Radiesse injection in 8/08, but no change in hoarse voice quality was achieved.
- Patient no longer works due to his vocal hoarseness.
1. No mass or ulcer
2. Right TVC immobile, erythematous, with rigid vibratory activity noted during phonation
3. Limited excursion of left true vocal cord noted; vibratory activity on the left WNL
4. Supraglottic erythema
5. Anterior-posterior compression noted during phonation indicative of hyperfunctional voice use, although this may be compensatory secondary to right TVC paralysis
6. Abnormal measures of perturbation with regard to frequency and amplitude; consistent vocal asthenia, strain and roughness
00:56:12 (6:1) - Fully adducted position, medial gap noted at modal pitch
RECOMMENDATIONS:
1. Continue GERD Rx and dietary and behavioral management of reflux
2. Voice therapy trial, 1x/week for 4-6 weeks, to maximize vocal strength and reduce hyperfunctional laryngeal behaviors.
CASE STUDY: JE

- JE is a 52 year-old male
- Right true vocal cord paralysis, idiopathic
- s/p bilateral medialization thyroplasty with right arytenoid pexy.
POSSIBLE BEGINNING SIGNS OF EXTRUSION OF IMPLANT