Vocal Fold Paresis and Paralysis Surgical Treatment

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Unilateral Vocal Fold Paralysis and Paresis
Options for Management

• Do nothing
• Voice Therapy
• Surgery
  – Injection laryngoplasty (IL)
  – Medialization laryngoplasty (ML)
  – Laryngeal reinnervation (LR)
Surgery for Paralytic Dysphonia
Short History

- Medialization laryngoplasty, Payr 1907
- Injection laryngoplasty, Brünings 1911
- Laryngeal reinnervation, Horsley 1909, Frazier 1924
Surgical Options in Unilateral Vocal Fold Paresis and Paralysis

• Medialization
  – Injection
    • Collagen/Cymetra®, Fat, Radiesse® Voice and Voice Gel, HA gels, Gelfoam,
  – Surgical implant
    • Gortex, silastic, titanium, hydroxylapatite

• Reinnervation
  – Ansa-RLN anastomosis, nerve-muscle pedicle, direct nerve implant, muscle-nerve-muscle graft
Phonosurgery Classification

- Vocal fold microsurgery
- Vocal fold injection laryngoplasty
  - Office or OR
- Laryngeal framework procedures
  - Medialization – type 1
  - Lateralization – type 2
  - Shortening – type 3
  - Lengthening (CT approximation/subluxation) – type 4
  - Arytenoid adduction
- Laryngeal reinnervation
Viscoelasticity

Why is it important for vocal fold injectables?
### TABLE II.
Dynamic Viscosity of Implantable Biomaterials and Human Vocal Fold Mucosal Tissues Measured at 10 Hz and Extrapolated to 100 Hz.

<table>
<thead>
<tr>
<th>Material Sample</th>
<th>Measured at 10 Hz</th>
<th>Extrapolated to 100 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polytetrafluoroethylene (Teflon)</td>
<td>116.144</td>
<td>10.186</td>
</tr>
<tr>
<td>Gelatin (Gelfoam)</td>
<td>21.297</td>
<td>2.335</td>
</tr>
<tr>
<td>GAX collagen (Phonagel or Zyplast)</td>
<td>12.844</td>
<td>1.480</td>
</tr>
<tr>
<td>Noncrosslinked collagen (Zyderm)</td>
<td>8.563</td>
<td>0.980</td>
</tr>
<tr>
<td>Human abdominal subcutaneous fat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(70-year-old woman)</td>
<td>3.026</td>
<td>0.296</td>
</tr>
<tr>
<td>Vocal fold mucosa (72-year-old man)</td>
<td>2.702</td>
<td>0.281</td>
</tr>
<tr>
<td>Vocal fold mucosa (62-year-old man)</td>
<td>0.897</td>
<td>0.099</td>
</tr>
</tbody>
</table>

Extrapolation was based on simple linear least-squares regression (see Equation 3).
Viscoelasticity of hyaluronan and non-hyaluronan based vocal fold injectables

- Hyaluronan-based materials better suited for superficial injection
- Non-hyaluronan materials better for muscle or paraglottic space injection

Caton, Thibeault, Klemuk, Smith Laryngoscope 2007
Radiesse® – hydroxyapatite microspheres in a gel suspension

- Radiesse Voice® - lasts 6-24 months
- Radiesse Voice Gel – lasts 1-2 months
- FDA approved implant
- Average length of benefit 18.6 months
- 3-20% complication rate due to mis-injection (too superficial or too deep)

Caroll and Rosen, Laryngoscope Feb 2011
Vocal Fold micronized acellular dermal matrix (Cymetra®) Injection

- Lasts 2-12 months (average 3-6 months)
- Office or OR procedure
- Can be repeated
Fat Injection Laryngoplasty

- **Advantages**
  - Viscoelastic properties close to vocal fold
  - No foreign material implant

- **Disadvantages**
  - General anesthetic procedure
  - Donor site morbidity
  - Extrusion of fat
  - Difficult to judge how much to inject
  - High incidence of resorption, need for secondary procedure (33-50%)

# Vocal Fold Injectables in 2011

<table>
<thead>
<tr>
<th>Material</th>
<th>Viscoelasticity</th>
<th>Duration</th>
<th>Office/OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiesse Voice</td>
<td>----</td>
<td>6-24 months</td>
<td>Favor OR</td>
</tr>
<tr>
<td>Radiesse Voice Gel</td>
<td>+/-</td>
<td>6-12 wk</td>
<td>Both</td>
</tr>
<tr>
<td>MAD / (Cymetra)</td>
<td>----</td>
<td>2-12 mo</td>
<td>Both</td>
</tr>
<tr>
<td>Human Collagen (Cosmoplast)</td>
<td>----</td>
<td>2-12 mo</td>
<td>Both</td>
</tr>
<tr>
<td>Bovine collagen (Zyplast)</td>
<td>--</td>
<td>2-4 mo</td>
<td>Both</td>
</tr>
<tr>
<td>HA gels</td>
<td>++</td>
<td>2-4 mo</td>
<td>Both</td>
</tr>
<tr>
<td>Fat</td>
<td>+++</td>
<td>2-12 mo</td>
<td>OR</td>
</tr>
</tbody>
</table>
When to consider an injection laryngoplasty?

- In the 1st three months after symptom onset
- When spontaneous improvement is possible, e.g., nerve is intact after surgical procedure, or nerve integrity unknown
- Patient is symptomatic – breathy dysphonia, short MPT, aspiration
- Known metastatic cancer w vocal fold paralysis
- Office vs. OR
  - Patient preference and ability to tolerate office procedure
  - Patient co-morbidities
  - Surgeon preference, experience, equipment
  - Patient anatomy
Office vs. OR Injection
Office Injection Laryngoplasty Techniques

- Thyroid notch
- Trans-cartilage
- Crico-thyroid

peroral

Rigid or Flexible scope
Injection Laryngoplasty
Effect on need for subsequent treatment

- Two recent studies – retrospective reviews
  - 54 patients with UVP (Yung et al, 2011)
    - 19 had temporary injection medialization, five subsequently had thyroplasty (35%)
    - 35 were followed conservatively, 23 subsequently had thyroplasty (65%)
  - 35 patients with UVP who all had office injection laryngoplasty (Friedman et al, 2010)
    - 32 patients injected < 6 months after onset, 12 required subsequent thyroplasty (37.5%)
    - 3 patients injected > 6 months after onset, 3 required subsequent thyroplasty (100%)

- Message: Early injection laryngoplasty after UVP onset may reduce the need for later permanent treatment
Medialization Laryngoplasty
A Variety of Implants and Techniques

- Silastic
- Hydroxylapatite
- Titanium
- Gortex
Arytenoid Adduction Laryngoplasty

- Treatment of the posterior glottis
- Can do under general or local
- Can combine with reinnervation or thyroplasty
Arytenoid Adduction
Medialization Laryngoplasty

Pitfalls

• Implant too high
• Implant too anterior
• Undercorrection
• Overcorrection
• Extrusion
• Persistent posterior gap
  – Failure to do AA
• Gortex may settle
• Fibrous capsule around implant stiffens vocal fold
• Atrophy of TA/LCA muscle
Thyroplasty and Arytenoid Adduction Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Thyroplasty I (n=98)</th>
<th>Thyroplasty I + AA (n=96)</th>
<th>Total</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
Laryngeal Reinnervation with Ansa Cervicalis Nerve Transfer

• Ansa cervicalis branch – first proposed by Jackson and reported by Frazier – 1924
• Crumley (1980’s-1990’s) – youngest patient 8 years old
• Chhetri et al (1999) combined with AA
• Lorenz et al (2008) large series of 43 patients
• Paniello et al (2011) randomized surgical trial
Ansa-RLN Reinnervation in Adolescents
Perceptual Assessment

Perceptual Ratings by Blinded Listeners

Mean: pre-op 50, post-op 82

Smith, Roy, Stoddard  IJPORL 2008
Ansa-RLN Reinnervation in Adolescents – Case Examples

12 yo female w UVP after intubation for TA 1 year earlier
Comparison Studies
Surgery for Vocal Fold Paralysis

- LR vs. IL-Teflon, Crumley et al, 1988
- ML-silastic vs. IL-Teflon, D’Antonio et al, 1995
- IL-Teflon vs. ML-silastic, Dejonckere, 1998
- LR vs. LR+AA, Chhetri et al, 1999
- ML-silastic vs. IL-fat, Shaw & Searl, 2001
- IL/ML vs. ML+AA, Mortensen et al, 2009
- IL-CaHA/MAD vs. ML+/-AA, Vinson et al, 2010
Ansa-Reinnervation vs. Medialization Laryngoplasty

- Controlled, randomized prospective surgical trial involving 9 centers
- 24 patients – 12 in each group
- Under 52 years reinnervation group
  - The best results
  - Untrained listeners rated voices in normal range
  - GRBAS ratings normal
  - Patient-based quality of life ratings normal

Paniello et al, Laryngoscope 2011
Medialization versus reinnervation for unilateral vocal fold paralysis: A multicenter randomized clinical trial
Medialization versus reinnervation for unilateral vocal fold paralysis: A multicenter randomized clinical trial

The Laryngoscope 2011, 121(10):2172-2179
Medialization versus reinnervation for unilateral vocal fold paralysis: A multicenter randomized clinical trial
Medialization versus reinnervation for unilateral vocal fold paralysis: A multicenter randomized clinical trial

The Laryngoscope 2011;121(10); 2172-2179
Paniello Study, 2011
Medialization (ML) vs. Reinnervation (LR)

- Small Study – 24 patients
- however, *prospective randomized (high evidence level 1b)*
- Both groups improved – overall no differences
- However, *LR group under 52 years significantly improved compared with over 52 group*
- *Best overall voice quality – close to normal*
- ML group – no age difference in outcomes
- Maximum phonation time longer in ML group but not well correlated with voice quality
Laryngeal Reinnervation at The University of Utah

- First four cases in 2001, now approaching 100 cases
- Participated in St. Louis multi-center prospective surgical trial 2004-2005
- Pediatric unilateral vocal fold paralysis
  - 13 cases in children under 10 years (eight in the last 12 months)
Reanimation of the Paralyzed Larynx
Restoring Vocal Fold Mobility

- Laryngeal pacing
- Laryngeal “re-wiring” via separate reinnervation of adductors and abductors
Surgical Treatment of Paralytic Dysphonia

Summary

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Laryngoplasty</td>
<td>Office vs. OR</td>
<td>No perfect injectable implant</td>
</tr>
<tr>
<td></td>
<td>Early results</td>
<td>No perfect injectable implant</td>
</tr>
<tr>
<td></td>
<td>Temporary</td>
<td>Variable resorption</td>
</tr>
<tr>
<td>Medialization Laryngoplasty</td>
<td>Outpatient surgery</td>
<td>Increased surgical risks</td>
</tr>
<tr>
<td></td>
<td>Permanent</td>
<td>Increased surgical risks</td>
</tr>
<tr>
<td></td>
<td>Early results</td>
<td>Doesn’t prevent atrophy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long-term implant effects?</td>
</tr>
<tr>
<td>Laryngeal Reinnervation</td>
<td>Permanent</td>
<td>Delay to improvement</td>
</tr>
<tr>
<td></td>
<td>Potential for best voice</td>
<td>Delay to improvement</td>
</tr>
<tr>
<td></td>
<td>No implant</td>
<td>Delay to improvement</td>
</tr>
</tbody>
</table>