Laryngeal Tissue Flap Fixation Device

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Overview of Presentation

- Background material
- Problem Statement
- Competition
- Design Alternatives
- Design Matrix
- Final Design
- Future Work
- Conclusion
Client Information

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Larynx Anatomy

Anterior view of the Larynx

(Biology Corner)

View of Larynx along the Transverse Plane

(Singing Voice)
Function of Vocal Folds

- **Vibrate**
  - modulate air flow expelled from lungs during phonation
- **Open during inhalation**
- **Closed when holding breath**
- **Scaring prevents closure of vocal folds and inhibits oscillation**

Scarred Vocal Folds
(Ectropic Interactive)
Surgical Procedure
Minithyrotomy

Removal of the perichondrial flap with attached adipose tissue (Dailey)

Larynx with holes cut into the thyroid cartilage (Dailey)
Insertion of Tissue Flap

Insertion of tissue flap (arrow) into the superficial layer of the lamina propria (Balasubramanian)

Anatomical layers of vocal fold (Balasubramanian)
Problem Statement

- Develop a device to secure a soft tissue flap into place during vocal fold reconstruction
- Device should endure typical laryngeal movements that may dislodge the soft tissue flap
Current Techniques

Implants

- Hard materials inserted to displace vocal fold medially
- Does not address stiffening of lamina propria
- Requires cutting the epithelial layer

Top view of Larynx
(Wikipedia)
Current Techniques

Injections

- Autologous fat, fascia, or collagen injected endoscopically lateral to lamina propria layer
- Requires separate harvest site
- No vasculature to support injected material
Previously Attempted Devices

(Dailey)
Design Idea #1

Improved Corkscrew

- Gets rid of need to pre-twist flap
- Provides very strong anchor in Arytenoid
- Many ways to attach flap to anchor
Design Idea #2

Barbed Nail

- May be pulled through cartilage
- Possibly absorbable material
- Simplified delivery
- Narrow
Design Idea #3

**Soft Tissue Glue**

- Avoids disruption of arytenoid cartilage
- Already manufactured on large scale
- May disrupt viscoelastic properties of layer

Nexaband soft tissue glue

(Waltz)
Design Idea #4
“Gecko” Tape

- Developmental stages at MIT
- Absorbable
- Avoids Arytenoid
- Designed for moist tissue environment

Surgical tape covered with small pillars mimicking structures on geckos’ feet

(Technology Review)
## Design Matrix

<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
<th>Soft Tissue Glue</th>
<th>Improved Corkscrew</th>
<th>Barbed Nail</th>
<th>Gecko Tape</th>
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<tr>
<td>Size</td>
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<td>3</td>
<td>4</td>
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<tr>
<td>Ease of Delivery</td>
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<td>2</td>
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Final Designs

Soft Tissue Glue & Barbed Nail

• Simple, accurate delivery
• Could be absorbable
• No rotation of tissue flap
Future Work

Barbed Nail

- Material selection
  - Titanium
  - Stainless steel
  - Biodegradable polymer
- Fabrication
- Testing
  - Develop criteria
  - Canine models
  - In vivo

Canine larynx testing (Dailey)
Future Work

**Soft Tissue Glue**

- Acquire Nexaband glue
- Develop application technique
- Test various application methods
  - Develop criteria
  - Canine models
  - In vivo

NexaBand glue kit
(World Precision Instruments Ltd)
Conclusion

- Limit damage to vasculature of tissue flap
- Allow easy fixation of flap
- Restore vocal fold function
- Maintain improvement long-term

References

- Dailey SH, Gunderson M, Welham NW, Chan R, Bless DM. Local Vascularized Flaps for Augmentation of Reinke's Space. Laryngoscope.
Acknowledgements

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