



Laryngeal Tissue Flap Fixation Device

Bryan Jepson- Team Leader

William Zuleger- Communicator

Ross Comer- BWIG

Christa Wille- BSAC

John Webster- Advisor, Department of Biomedical Engineering,
webster@engr.wisc.edu

Overview of Presentation

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

Client Information

Seth Dailey, MD

Otolaryngology, Dept. of Surgery

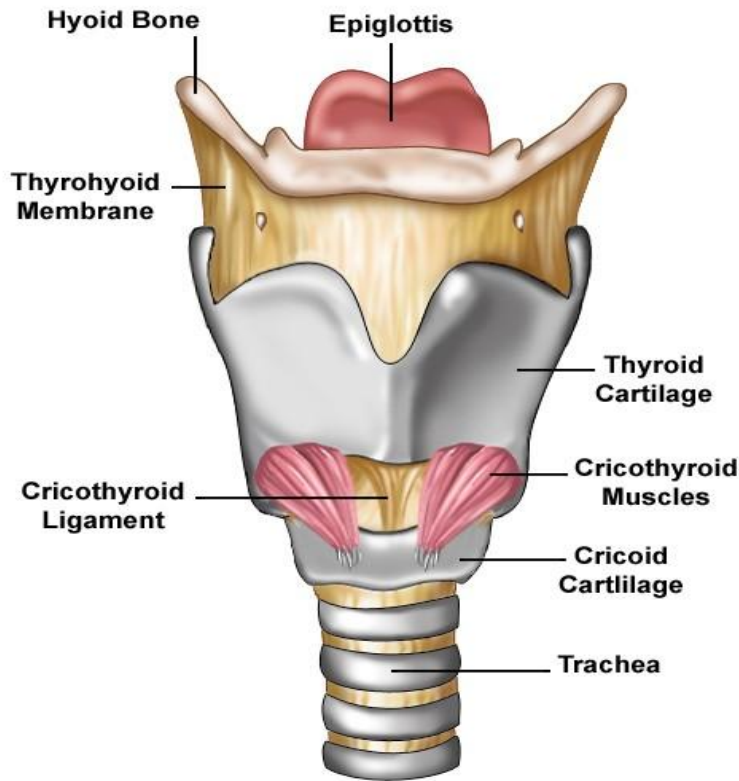
UW School of Medicine and Public Health

dailey@surgery.wisc.edu

UWHealth

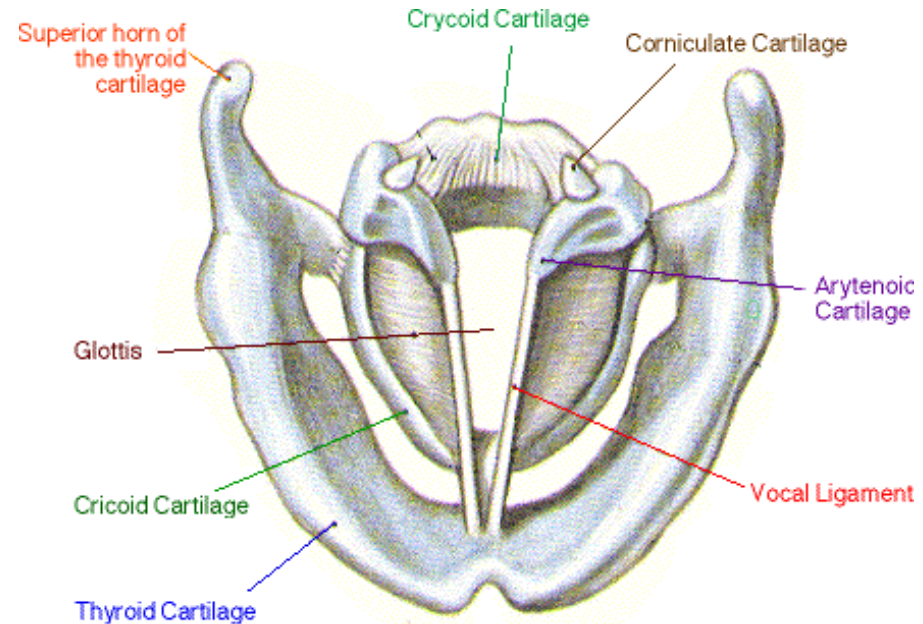
University of Wisconsin
Hospital and Clinics

Larynx Anatomy



Anterior view of the Larynx

(Biology Corner)

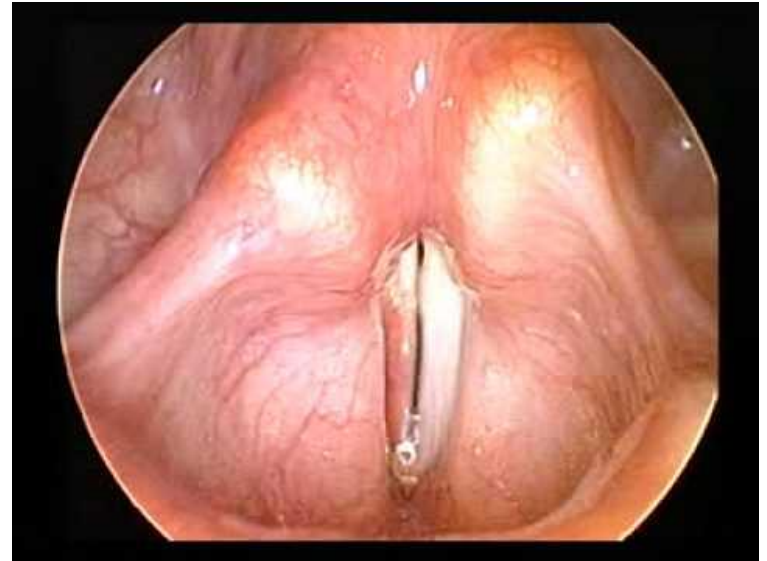


View of Larynx along the Transverse Plane

(Singing Voice)

Function of Vocal Folds

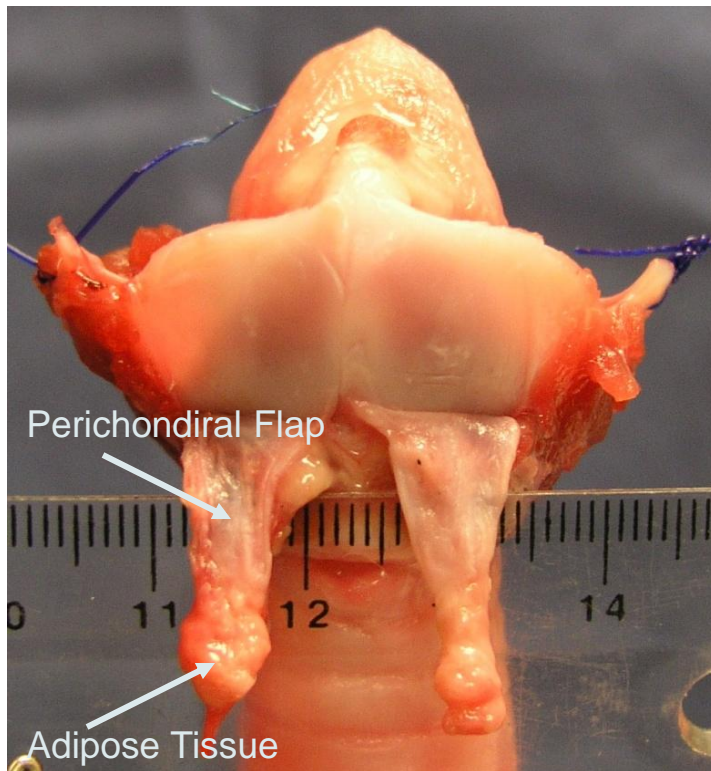
- Vibrate
 - modulate air flow expelled from lungs during phonation
- Open during inhalation
- Closed when holding breath
- Scarring prevents closure of vocal folds and inhibits oscillation



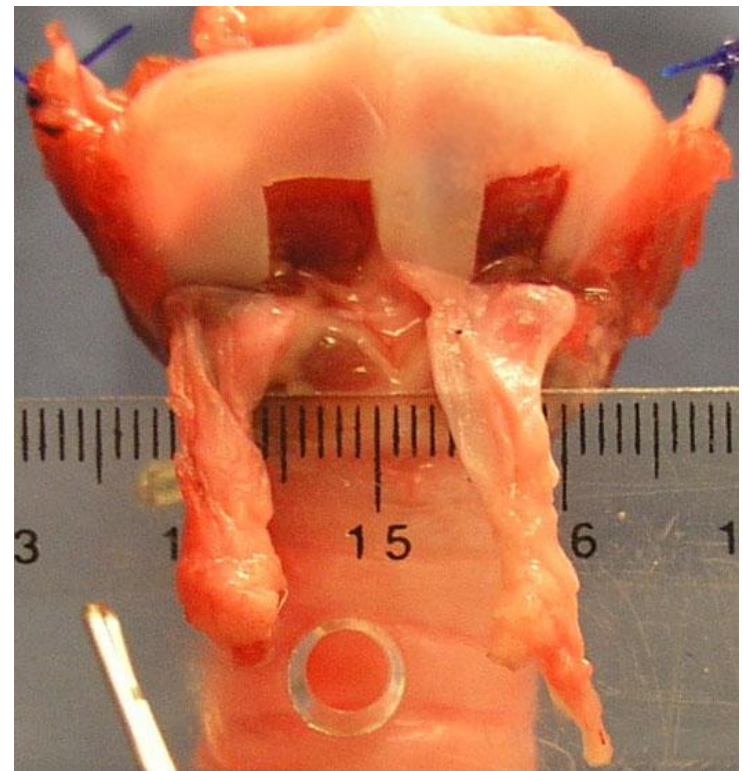
Scarred Vocal Folds
(Ectropic Interactive)

Surgical Procedure

Minithyrotomy

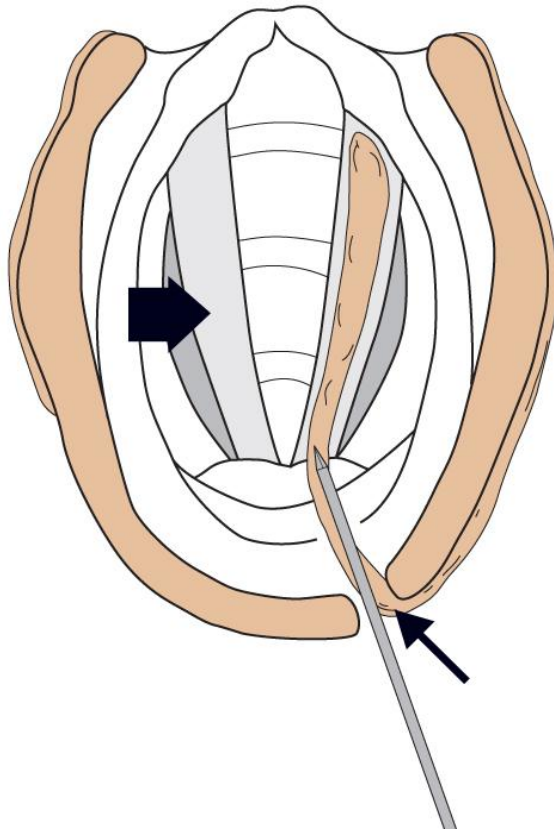


Removal of the perichondrial flap with attached adipose tissue (Dailey)

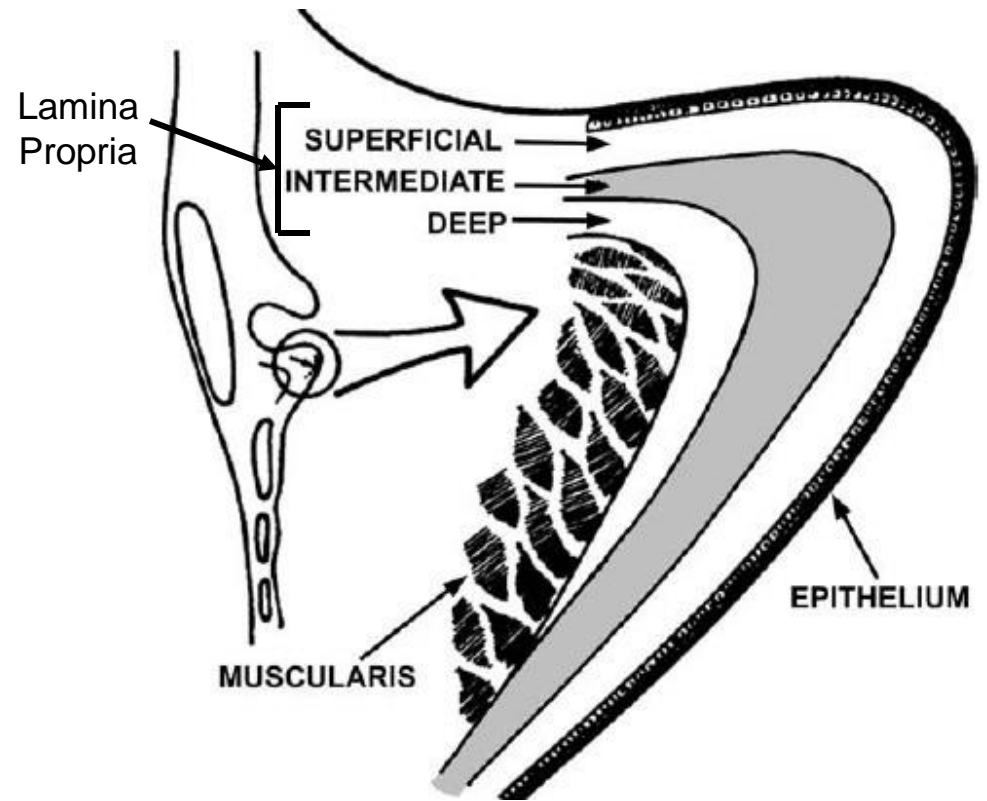


Larynx with holes cut into the thyroid cartilage (Dailey)

Insertion of Tissue Flap



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



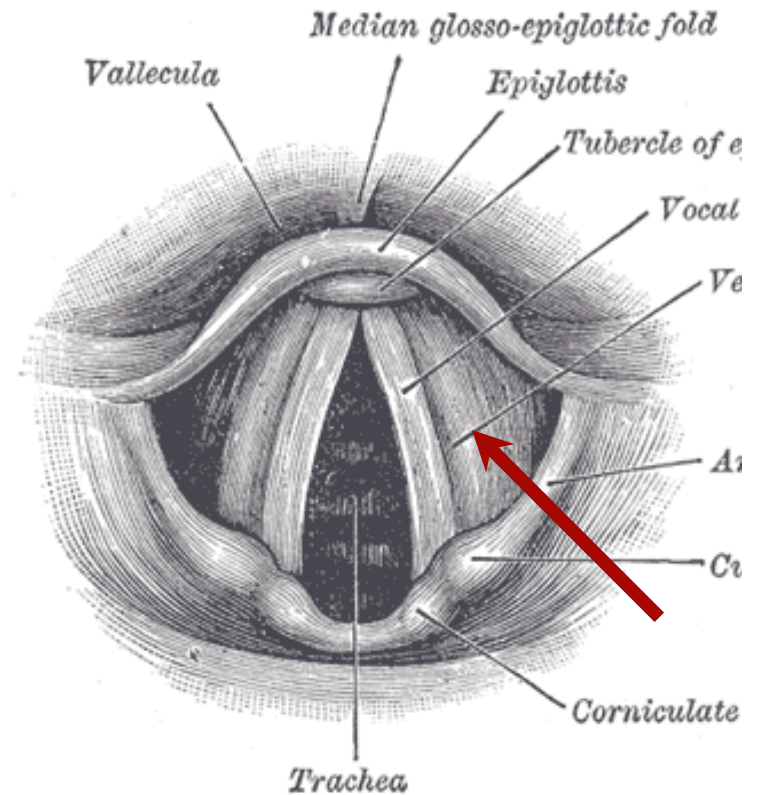
Anatomical layers of vocal fold (Balasubramanian)

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

Implants

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



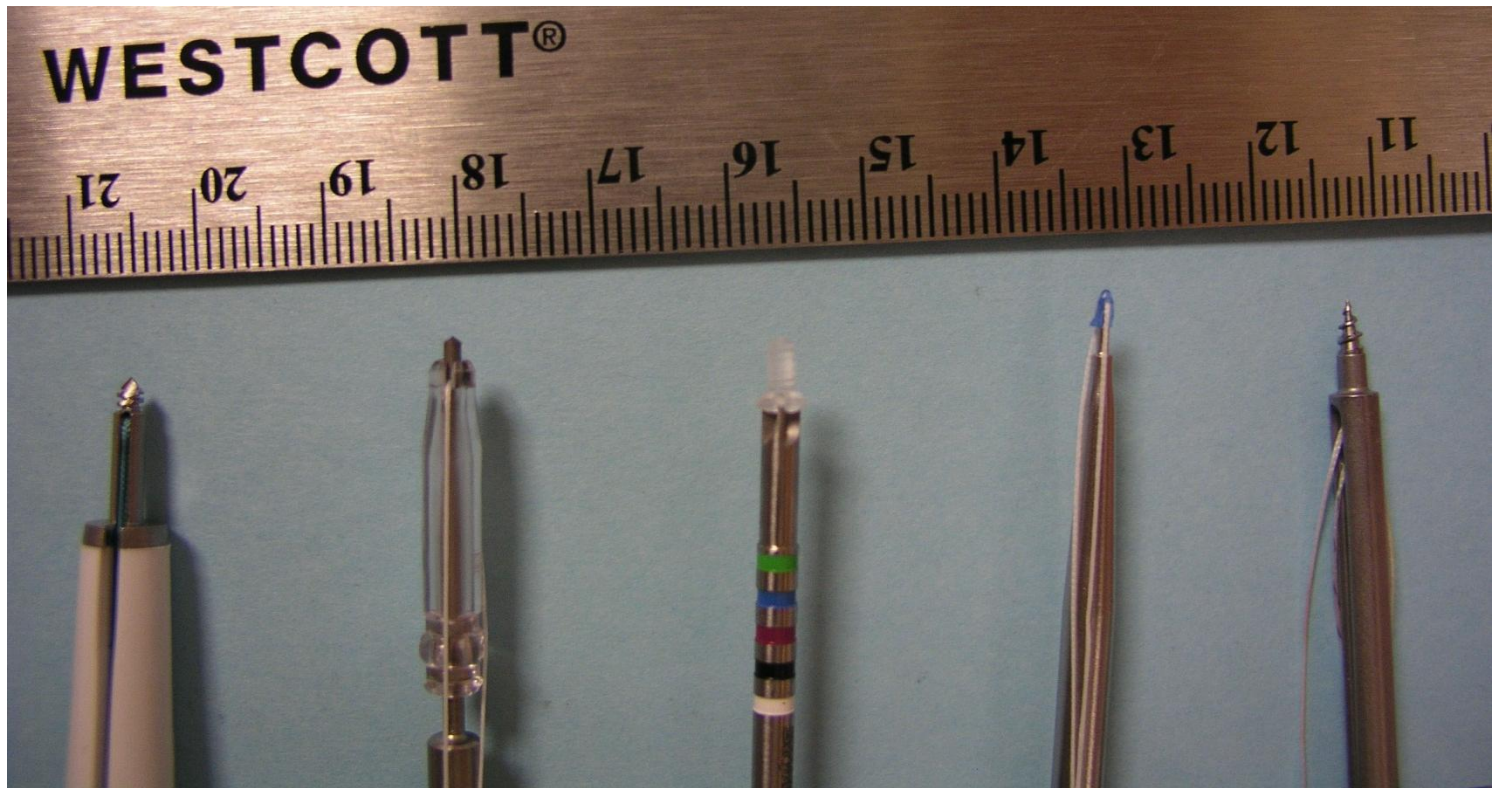
Top view of Larynx
(Wikipedia)

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

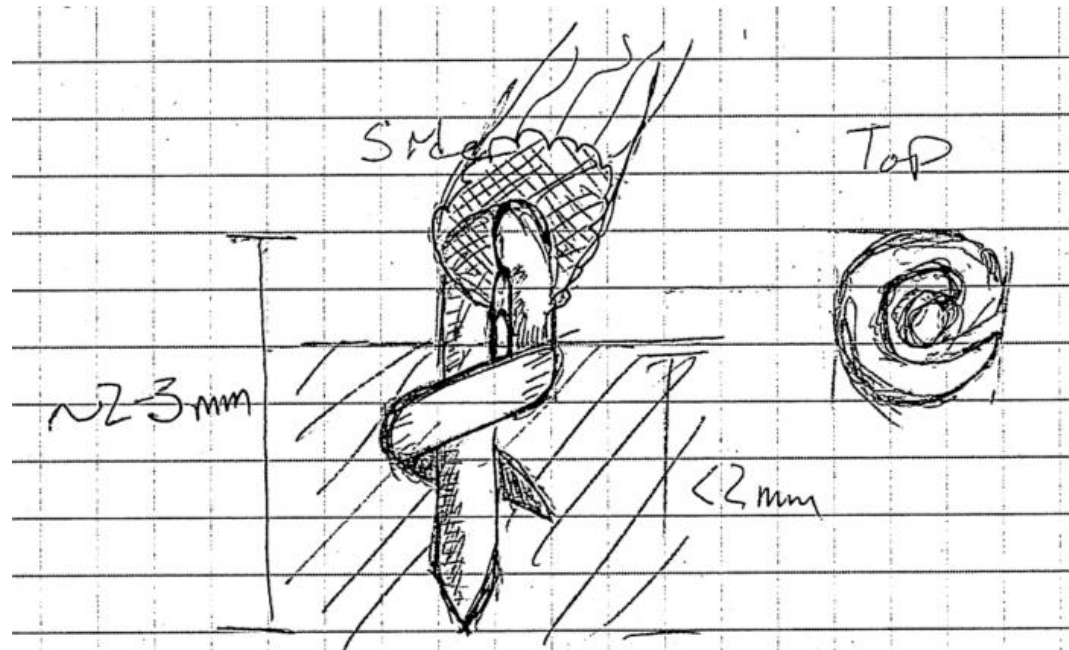


(Dailey)

Design Idea #1

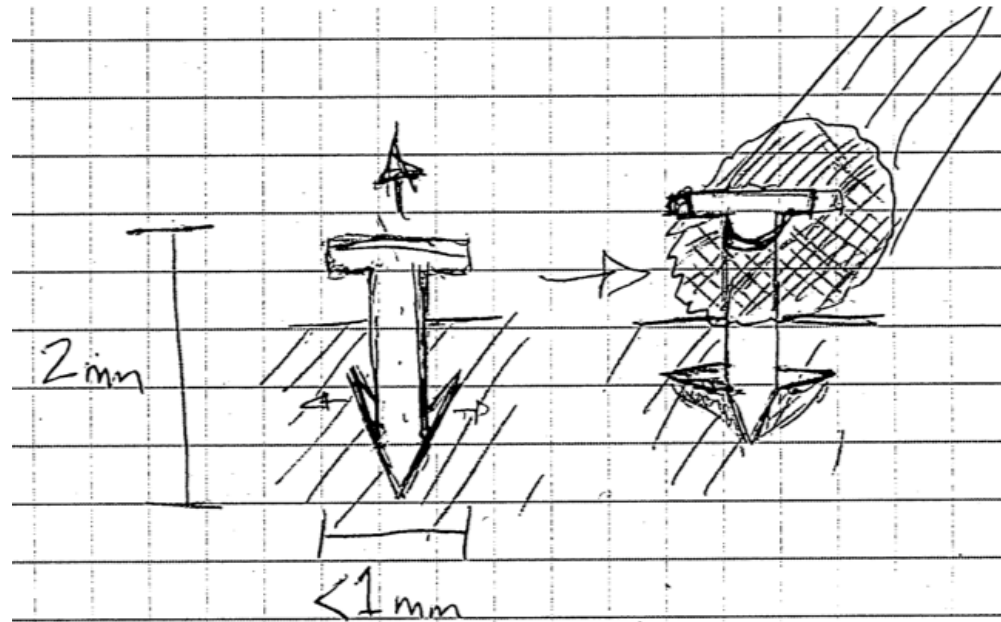
Improved Corkscrew

- 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



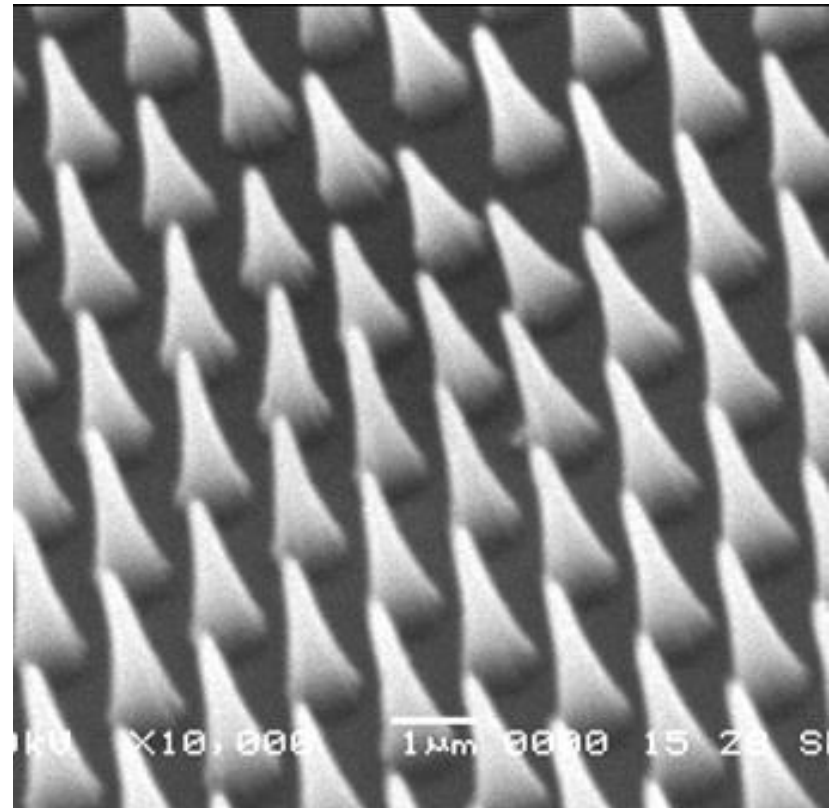
Nexaband soft tissue glue

(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)

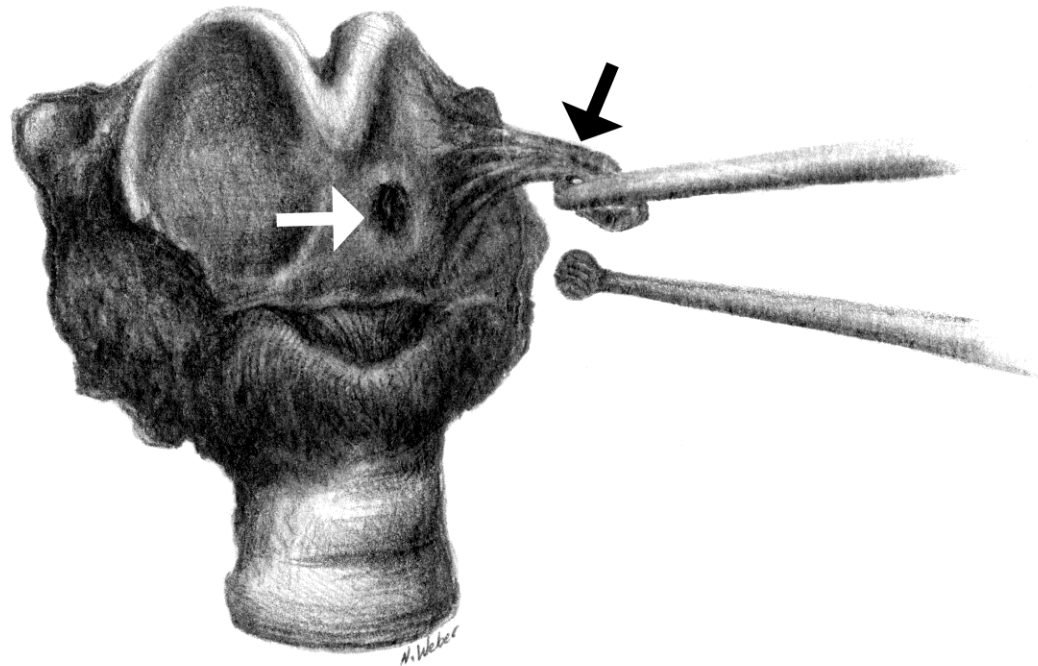
Design Matrix

	Weight	Soft Tissue Glue	Improved Corkscrew	Barbed Nail	Gecko Tape
Size	15	5	2	3	4
Ease of Delivery	25	3	2	4	2
Strength	15	3	5	3	3
Biocompatibility	20	2	3	3	4
Minimize Tissue Damage	20	4	2	3	4
Cost	5	2	4	4	0
Total	100	3.25	2.75	3.3	3.15

Final Designs

Soft Tissue Glue & Barbed Nail

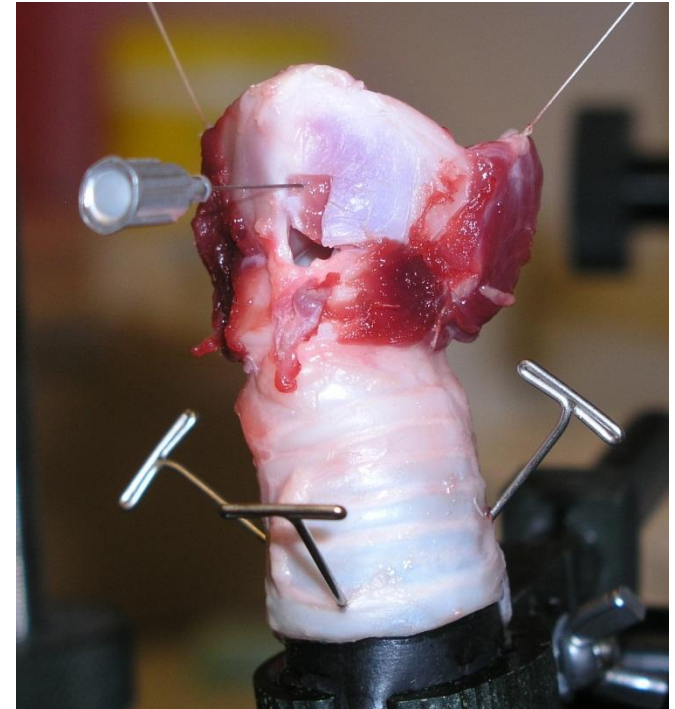
- Simple, accurate delivery
- Could be absorbable
- No rotation of tissue flap



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



http://blog.silive.com/weather/2009/04/planetary_alignment_decreases.html

References

- Balasubramanian, T. Anatomy of Larynx. http://www.drtdbalu.co.in/ana_inx.html. 2011, February 27.
- Biology Corner. Respiratory System Images. http://www.biologycorner.com/anatomy/respiratory/resp_images.html. 2011, February 8.
- Dailey SH, Gunderson M, Welham NW, Chan R, Bless DM. Local Vascularized Flaps for Augmentation of Reinke's Space. *Laryngoscope*.
- Ectropic Interactive. Acute Vocal Fold Hemorrhage. <http://ectropicinteractive.com/index.php?key=vocal+fold+oedema>. 2011, March 2.
- Gray SD, Bielamowicz SA, Titze IR, Dove H, Ludlow C. Experimental approaches to vocal fold alteration: introduction to the minithyrotomy. *Ann Otol Rhinol Laryngol*. 1999. 108:1-9.
- SingingVoice. Anatomy. <http://www.singingvoice.net/anatomy.html>. 2011, February 8.
- Sulica L. Vocal Fold Scar. Voice Medicine. http://www.voicemedicine.com/vocal_fold_scar.htm. 2011, March 2.
- Wikipedia. Vocal Folds. http://en.wikipedia.org/wiki/Vocal_folds. 2011, March 1.
- Waltz A, Baldwin N. It is a good idea to keep your rat medicine cabinet stocked! <http://www.ratballs.com/RatTails/Tails022.html>. 2011, March 2.
- World Precision Instruments. Adhesives. http://www.wpi-europe.com/en/products/laboratory_supplies/adhesives.shtml. 2011, March 2.

Acknowledgements

- Seth Dailey, MD
- McLean Gunderson, DVM
- Ben Bauer
- John Kao, PhD
- John Webster, PhD