Vocal Fold Function
- Protect the airways
- Constrict airways for phonation

Phonation
- Positive air pressure from the lungs momentarily forces the vocal folds open
- The high velocity air causes a decrease in pressure, causing closure of the folds
- The frequency of this repeated vibration cycle relies on the integrity of the superficial lamina propria

Motivation
- Damage or scarring to the vocal folds severely limits their pliability, inhibiting proper phonation
- Asymmetric scarring of vocal folds can cause inconsistencies in closure
- Increased tension caused by scarring in one vocal fold can prevent proper closure
- Asymmetric scarring of vocal folds can cause inconsistencies in closure leading to breathy phonation and vocal inhibiting proper phonation
- Increased tension caused by scarring in one vocal fold can prevent proper closure
- Asymmetric scarring of vocal folds can cause inconsistencies in closure leading to breathy phonation and vocal inhibiting proper phonation

Our client has requested that we develop a device or a method to affix a fat tissue flap to the anterior and posterior attachment of the arytenoid cartilage.

Increased tension caused by scarring in one vocal fold can prevent proper closure

An increased tension caused by scarring in one vocal fold can prevent proper closure

Perichondrial Flap
- Matches the viscoelasticity of the lamina propria
- Serves to restore oscillatory function of the damaged or scarred vocal fold

Perichondrial Tissue
- Functions to vascularize the adipose tissue
- Provides increased surface area for fixation

Background

Anatomy
- Lamina Propria
- Thyroid Cartilage
- Arytenoid Cartilage
- Vocal Fold
- Vocal Process

Vocal Fold Function
- Protect the airways
- Constrict airways for phonation

Phonation
- Positive air pressure from the lungs momentarily forces the vocal folds open
- The high velocity air causes a decrease in pressure, causing closure of the folds
- The frequency of this repeated vibration cycle relies on the integrity of the superficial lamina propria

Problem Statement
- Our client has requested that we develop a device or a method to affix a soft tissue flap within the lamina propria of a scarred vocal fold.
- The implanted fat tissue of the flap will match the viscoelasticity of the lamina propria and, therefore, allow enhanced oscillation of the scarred or damaged vocal fold.

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Surgical Procedure

Adipose Tissue
- The superficial lamina propria is critical for proper oscillation

Implants and Injections
- Collagen, Radiesse™, Adipose, Teflon, GoreTex
- Do not directly address lamina propria deficiencies
- Complications include: high cost, extrusion and infections
- Improve medial displacement of the vocal fold

Alternatives Design

Barbed nail, may pull through arytenoid cartilage.

Screw nail combination, places unwanted twisting strain on flap

Design Criteria
- Overall strength of fixation
- Fixation maintained—1 to 2 weeks post-operative
- Biocompatibility
- Limited stress on tissue flap
- Must improve and not inhibit oscillation of vocal folds
- Short preparation time
- Ease of implantation

Competitors

- Collagen, Radiesse™, Adipose, Teflon, GoreTex
- Do not directly address lamina propria deficiencies
- Complications include: high cost, extrusion and infections
- Improve medial displacement of the vocal fold

Future Work
- Future testing of Evicel will reveal the most effective glue application method
- Variables that will be tested include:
  - Time of adhesion (2 or 5 min)
  - Applying pressure during adhesion
  - Types of tissue connected (perichondrium, cartilage, muscle, adipose)
  - Amount of glue applied (1 or 2 drops)
  - Application of glue before or after flap insertion
  - Field drying mechanism: Week-Cell®

References