Removing Vocal Fold Epithelium Impairs Vibration in an Excised Larynx Model

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INTRODUCTION

Objective: To determine the impact of selective epithelium removal in an excised larynx model.

Background:
- The epithelium forms a physical protective barrier for the deeper tissue layers. It is susceptible to trauma after continuous cycles of phonation.
- Most studies on phonation have focused on the deeper layers, such as neuromuscular control or the lamina propria.
- However, the role of the epithelium in phonation is unclear.
- In our study, we enzymatically removed the epithelium using trypsin and quantitatively and qualitatively assessed the impact of de-epithelialization in an excised larynx model.

METHODS

Cadaveric human larynges were studied on an excised larynx phonation apparatus:

- Air supply
- Expansion Chamber
- Microphone
- Pressure Transducer
- Flow meter
- Trachea
- Excised Larynx

Subglottal pressure was applied and the following aerodynamic parameters were measured: phonatory threshold pressure, flow rate, and fundamental frequency. High-speed video was used to assess vibrational symmetry and glottal closure. After baseline phonation, the epithelium was enzymatically removed from one vocal fold with trypsin and phonation was repeated. Phonation was repeated once more with both vocal folds decellularized.

RESULTS

High-Speed Video Analysis

- Baseline
- Right Trypsin-Treated
- Bilateral Trypsin-Treated

Above: Vibration was symmetric with complete glottal closure in untreated vocal folds. However, in both unilateral trypsin-treated and bilateral-trypsin treated vocal folds, vibration was asymmetric with incomplete glottal closure.

Aerodynamic Analysis

- Phonation threshold pressure decreased from 0.46kPa (baseline) to 0.3kPa after unilateral trypsin treatment, but increased back to 0.46kPa when both vocal folds were treated. Air flow rate required for sound generation increased with additional trypsin treatment. Fundamental frequency also increased with additional trypsin treatment.

DISCUSSION

- During normal phonation, the glottis completely closes at the end of each oscillation cycle and vibrates symmetrically.
- De-epithelialization results in asymmetric vibration with incomplete glottal closure.
- Subsequently, a greater flow rate was required to phonate, which resulted in a greater fundamental frequency.
- These results highlight the importance of the epithelium in normal phonation and may help explain voice changes after epithelial damage.
- Tissue engineers attempting to rebuild the vocal fold should consider the epithelium.