Laryngeal Bioreactor

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**Abstract**

Tissue engineered organs have the potential to overcome several obstacles associated with organ donation, such as limited supply and immune rejection. We have created a novel bioreactor for the decellularization and recellularization of laryngeal tissue composed of polycarbonate and other sterizable materials. It is fitted with electronics that have been seen to consistently control pumps that supply the bioreactor with media, and turn the larynx to vary its exposure to media and air. We have verified the efficacy of the use of the bioreactor through modeling, and have seen its competence in vitro decellularization protocols. Future work with this device involves investigating recellularization procedures and improving modeling techniques.

**Background & Motivation**

**Larynx and Therapies**
- Larynx: complex organ in an airway that houses vocal cords
- Laryngeal cancer affects 136,000 individuals worldwide each year (1)
- Very low success of complete larynx transplant due to immune rejection of the allograft (2)

**Laryngeal Tissue Engineering Background**
- No known occurrence of tissue engineered larynx
- Tissue engineered tracheal cartilages and vocal folds grown in vitro and implanted (4,5)

**Device Modeling**

**Background**
- Use of ANSYS-Fluent CFD software
- Created mesh of laryngeal lumen in SolidWorks
- Based on MRI data
- 37x 0.5mm slices joined together
- K-ε model: turbulent kinetic energy and kinetic dissipation
- Set for viscosity, density of 1% SDS flowing through inner lumen
- Tested at 1, 15 and 50 mL/min volumetric flow rates

**Results**
- At 1 mL flow cases, no turbulent flow regimes seen within larynx; most portions also see laminar flow at 15 and 50 mL/min cases
- Velocities reach 4.7 m/s near vocal folds in 50mL/min case; 6 times in vivo stresses seen (6)

**Discussion**
- Greatest stress occurs near vocal folds: experimental fluid velocities used must account for stresses in these areas
- Based on normal in vivo conditions, a flow rate of at or below 15 mL/min or less is recommended (6)

**Prototype Redesign**

**Changed Prototype Features**
- **Accessibility Changes**
  - Bioreactor dimensions enlarged from 25x12x15 to 25x12x20 (cm)
  - Cage lengthened from 13cm to 17cm
  - Drainage site moved from bottom to the side
- **Stability and Durability Changes**
  - Legs removed for stability
  - Superior sealant used
  - Removable cage attachment added to bioreactor wall
- **Accuracy of Fabrication Changes**
  - Pieces cut with mill instead of band saw
  - Custom O-ring created

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