Development of a Model for Trapped Lung to Test Surgical Devices
Avery Cartwright, Biomedical Engineering
Mentor: Olivia Burnsed, PhD.
School of Biological and Health Systems Engineering

Background
There are ~100,000 cases of pleural effusion per year that can lead to fibrothorax, a condition in which the lung becomes ‘trapped’ by a layer of fibrous tissue [1]. This tissue must be removed through a decortication procedure that currently has poor standardization, leading to increased likelihood of complications (in about 40% of patients) [2].

Research Overview
There are currently no surgical devices designed specifically for decortication. In order to test novel surgical devices, a model was developed to model and detect the fibrous tissue to mimic a trapped lung.

1. Determining Material Composition
For the model to be effective, the material used to mimic a trapped lung should have similar mechanical properties to fibrous tissue.

![Fig 2. Materials compared (& combined) to mimic fibrous tissue: (A) rubber cement (B) school glue (C) gelatin (D) silicone (E) spray adhesive.]

2. Modeling “Trapped Lung”
Silicone and pig skin were selected as the two most relevant models due to their mechanical properties, accessibility, & ease of use in testing.

![Fig 3. Silicone (applied in three different thicknesses) and pig skin were applied to inflated balloon to model the fibrous tissue of trapped lungs in vitro.]

3. Validating Tissue Thickness & Detection
Silicone and pig skin were then both used in proof of concept testing for an ultrasound component to determine the amount of model fibrous tissue quantitatively in real time by laying them over a latex balloon.

![Fig 4. Tissue detection proof of concept platform. (A) Vevo 3100 Preclinical Imaging System FUJIFILM VisualSonics [3]. (B) MX Transducer (MX250/250S) used with a center transmit of 21MHz and axial resolution of 75um [4]. (C) Images taken with ultrasound imaging of the silicone layer applied to the surface of a balloon and pig lung.]

![Fig 5. Efficacy of the ultrasound component looking at the (A) Balloon Model and (B) Pig Model. One-way ANOVAs (alpha = .05) with post hoc multiple comparisons were run (adjusted alpha = .0167) to determine the relative difference between the ultrasound and caliper measurements in both models. Conclusion: Ultrasound detects tissue with a tolerance of less than +/- 1mm.]

4. Using the Model to Test Novel Surgical Devices
The tissue models were then used in testing of various mechanisms for the surgical device to remove the fibrous tissue. Further testing is forthcoming.

![Table 3. Tissue removal testing on the Balloon Model of trapped lung with qualitative observations to determine optimal blade requirements]

References

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