

Veress Needle Insertion Device & Tissue Detection System to Minimize Intraoperative Injuries



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Problem

Background

- ❖ Veress needle injuries due to blind insertion are rare (0.23%) but can lead to significant organ damage or hemorrhage.¹
- ❖ Current solutions do not account for operator variability during insertion, nor give the operator any additional information as to the position of the needle in the tissue.^{2,3}

Existing Gap:

- ❖ No current devices for closed insufflation provide a controlled insertion rate and or information on the needle tip position.

Proposed Solution

We propose a two component system that is compatible with current disposable Veress needles.

- ❖ Motor driven insertion system with electrode system to determine the location of the needle during insertion
- ❖ An electrode will be attached at the very end of the needle tip which will measure the electrical impedance of the surrounding tissue

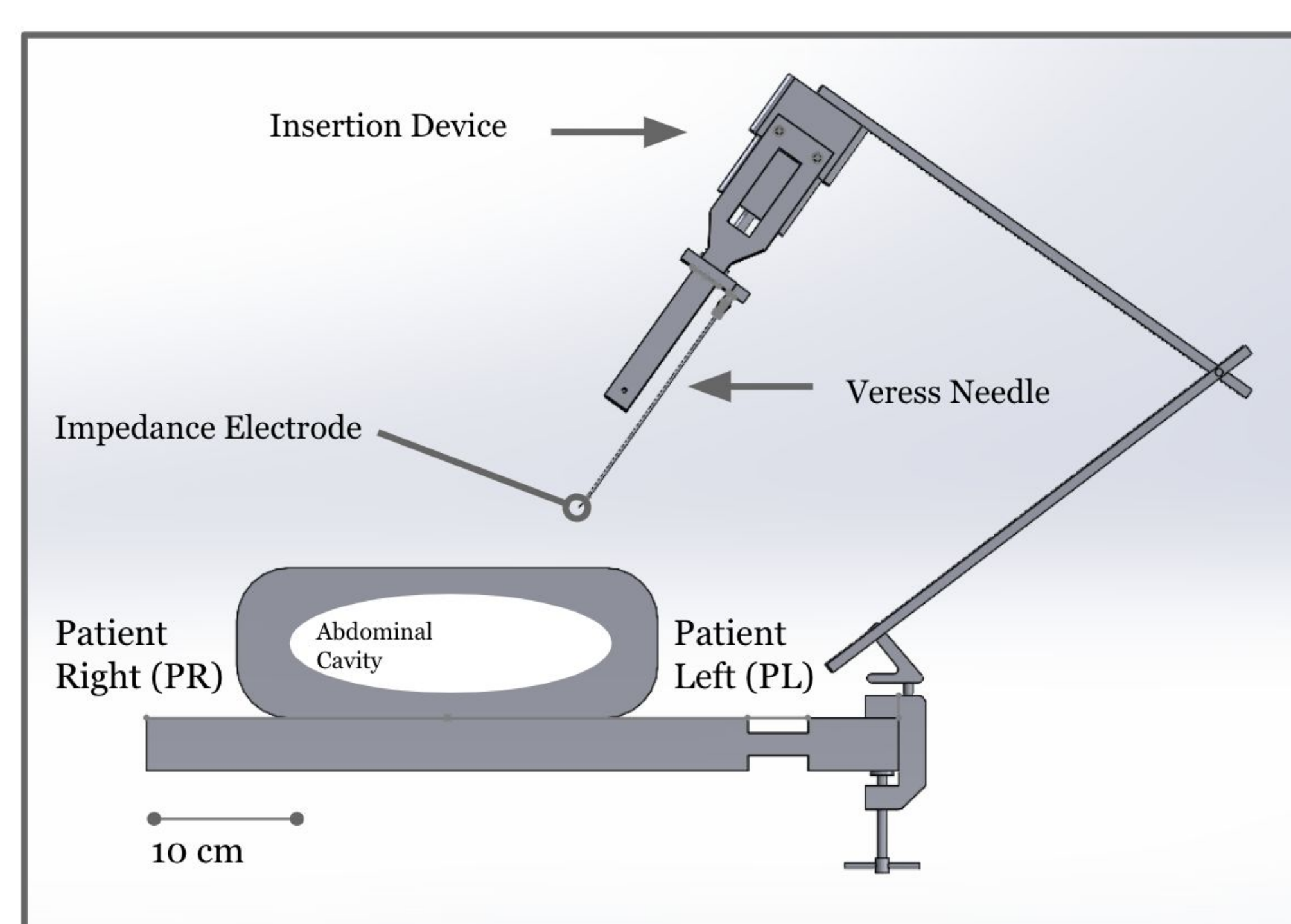


Figure 1: Concept CAD drawing with needle driver system mounted to operating table with mock patient.

This design minimizes the chance for Veress needle associate injury by:

- (1) **Maintaining the initial insertion position and angle** to avoid laceration and puncture of abdominal structures.¹
- (2) **Controlling needle advancement through the abdominal lining** to prevent overshoot into organs and vessels.¹
- (3) **Reading impedance values of the tissue at the needle tip** to identify tissue layers and entrance into the peritoneal cavity.⁴

Final Design: Insertion Device

- ❖ The needle driver with motor housing was mounted directly to the positioning arm using a series of 3D printed PLA parts.
- ❖ We tested the ability to of the motor to puncture tissue approximating the abdominal lining (pork belly).

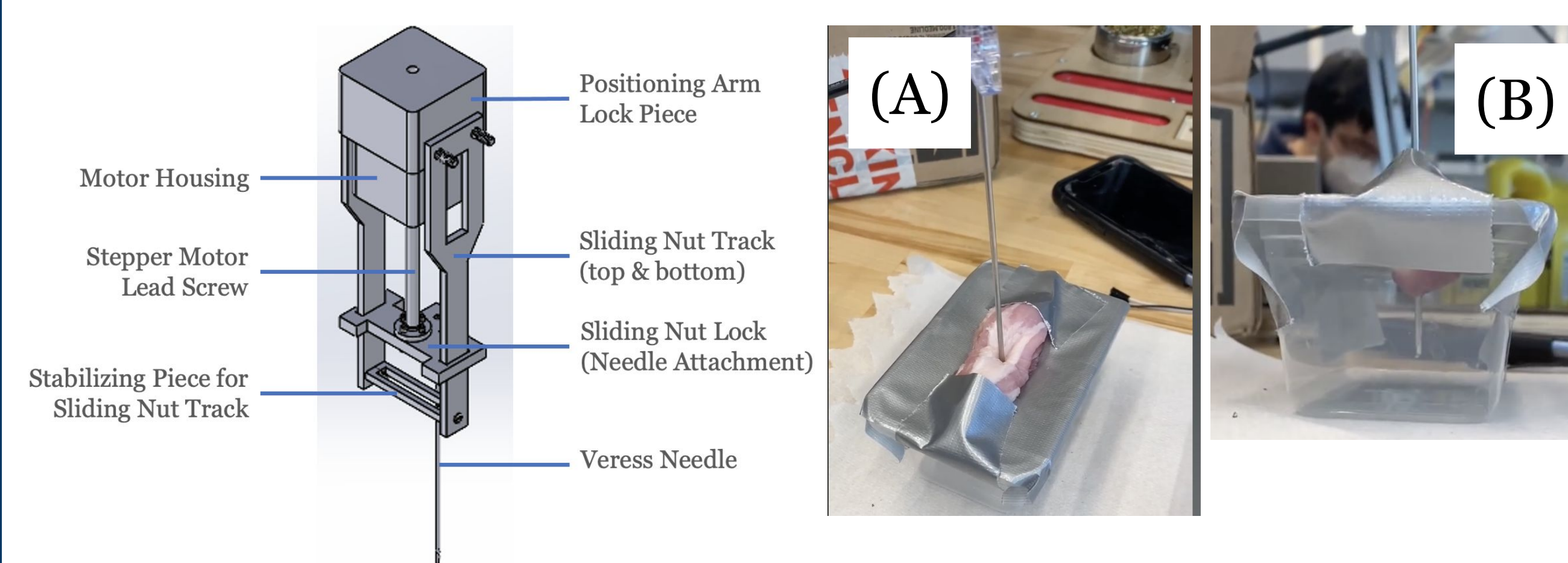


Figure 2: Labeled diagram of complete needle driver system.

The insertions tests confirm that this setup can penetrate abdominal tissue, but the motor control step size was reduced to prevent overshoot into abdominal tissue.

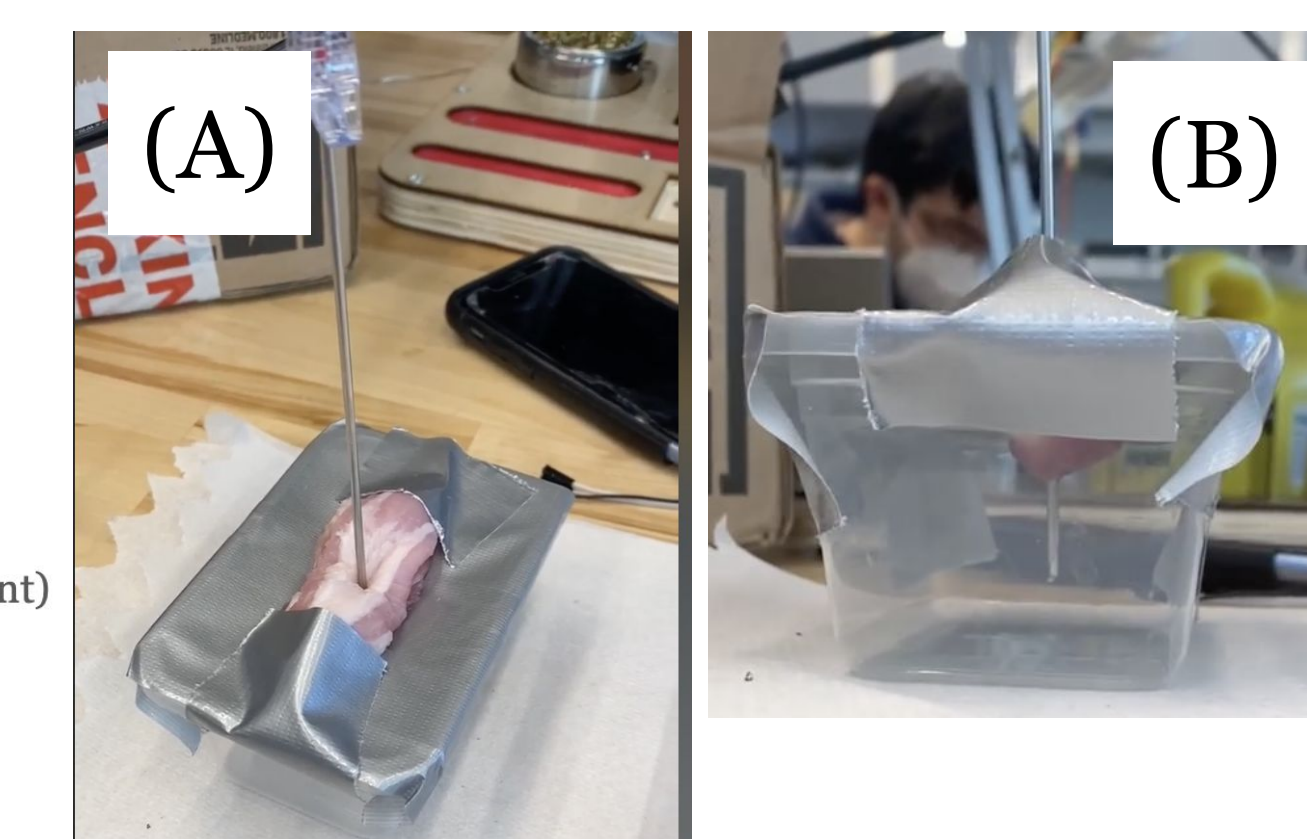


Figure 3: (A) Above view of Veress needle after traversing porcine tissue. (B) View of needle overshoot through tissue with large motor step size.

Final Design: Needle Electrode

- ❖ We fabricated a microscale interdigitated electrode attached to a 10 mm diameter rod to test impedance values during insertion through tissue layers.
- ❖ The impedance values were evaluated at different frequencies using an Arduino-powered function generator and an oscilloscope

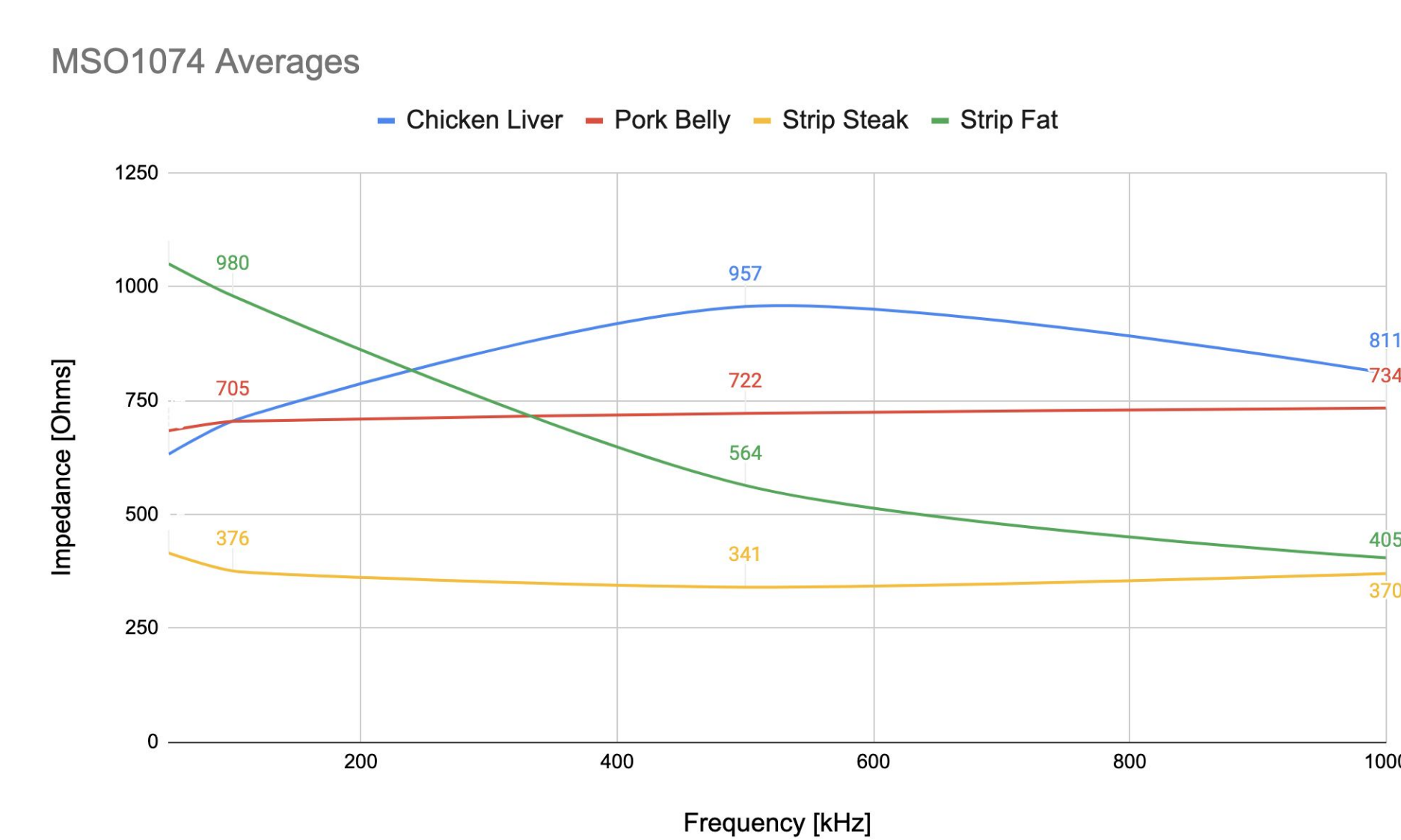


Figure 4 (left): Graph of electrical impedance for a variety of tissues over frequencies generated by a MSO 1074 oscilloscope.

Figure 5 (below): Semiflexible interdigitated electrode attached to probe.

Our impedance testing with the probe electrode was similar to our baseline results.

Based on this data, We recommend analyzing the tissues impedance at 50 kHz. This frequency gives the greatest separation between fat, muscle, and organ (liver) impedance values.



Conclusion

Current Patents:

US8523817B2 (2010): Veress needle with illuminated guidance and suturing capability.

- ❖ This is the primary patent in the space of modified Veress needles. It only covers the addition of optical information.

There are no current patents for impedance testing at needle tips (published literature).

Cost to Patent & Manufacturing:

- ❖ With minimal material modifications and more sophisticated processing techniques, we predict an overall bulk manufacturing price greater than \$40. Additions such as sterilizable titanium oxide, more powerful motor, and sophisticated impedance system could significantly increase this estimate.
- ❖ Costs to the patient could increase by around \$100 assuming a 250% markup after production.

Reimbursement & Device Status

- ❖ The Veress needle is not a conventional medical device. They are surgical instruments for laparoscopic surgery. These procedures covered by Medicare/Medicaid will support the use of the modified Veress needle system.

Acknowledgement

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