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THE FISCHELL DEPARTMENT of BIOENGINEERING

UNIVERSITY OF MARYLAND

Team B13: Transparent Clips for Surgical Treatment of Intracranial Aneurysms

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Motivation

Annually, 6.7 million people will have an intracranial aneurysm, with 30,000 of these people experiencing ruptures and bleeding in the brain. Currently, the best method of treatment involves surgically applying a titanium clip to the aneurysm neck to inhibit blood flow and prevent potential ruptures. However, there are several limitations associated with this method:

Limitations

- Difficulty placing clips accurately due to titanium being opaque and obstructing view of the surgical site
- Titanium clips appear as artifacts on MRI and CT angiograms of the patient's brain post-operation

Methods

Force Testing:

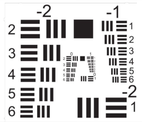
- Create circuit with force sensitive resistor (FSR)
- Place clip on the FSR
- Measure the voltage across the FSR

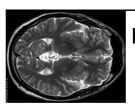
Light Transmission Testing:

- Create a series circuit with a photoresistor (PR)
- Place clear material on top of PR and shine flashlight
- Measure the voltage output across the PR

Resolution Testing:

- Place clear material on top of resolution test target
- Identify smallest line pair that can be seen
- Determine corresponding resolution to that line pair





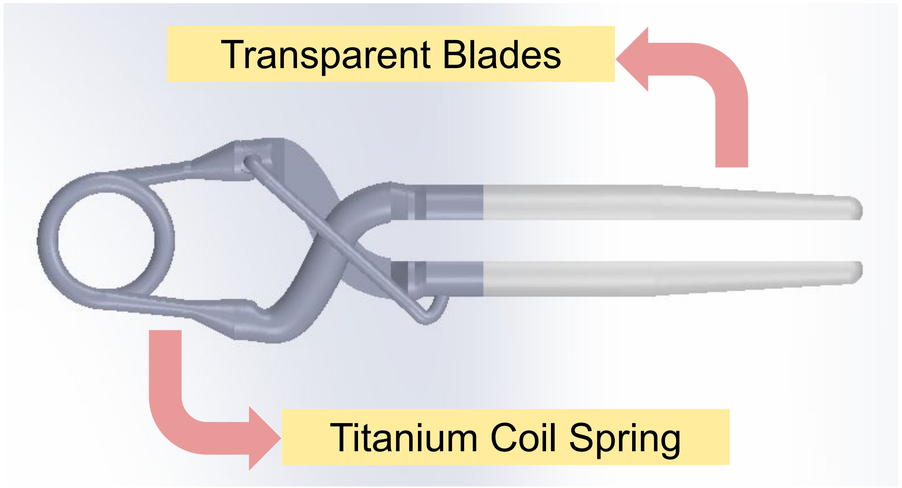
MRI Testing:

- Obtain MRI image of standard of care vs. our prototype
- Observe for the presence of imaging artifacts

Design Requirements

Table 1. The success criteria for developing transparent clips.

Specification	Requirement
Clip Closing Force	1.47-1.96 N
Clip Blade Length	4-20 mm
Light Transmission of Material	≥ 85%
Minimum Resolvable Distance	≤ 100 µm
Imaging Artifacts	Minimal MRI/CTA Artifacts



Results

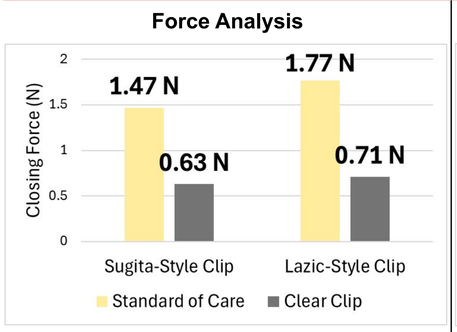


Figure 1. Closing force comparison between standard of care clips vs. our clips.

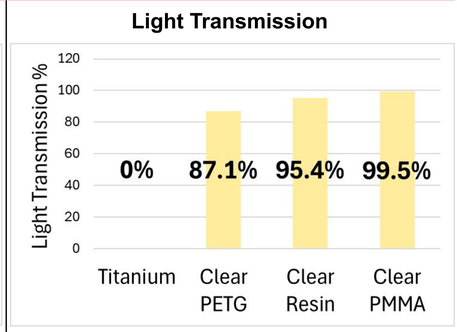


Figure 2. Light transmission comparison between titanium vs. different clear materials.

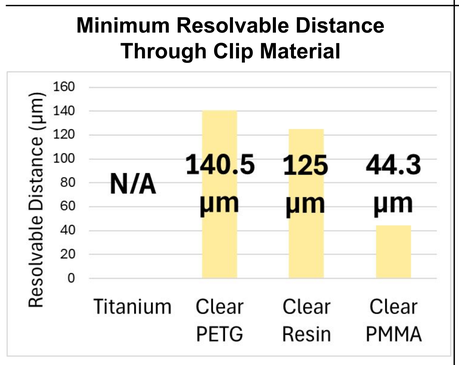


Figure 3. Resolvable distance comparison between titanium vs. different clear materials.

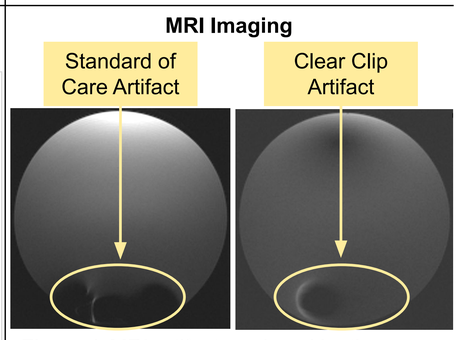


Figure 4. MRI artifact produced by the standard of care clips vs. our clips. The clear clip produces a significantly smaller artifact.

Bioethical Implications

This technology will have a significant societal impact:

Surgeons

- Improved visibility of surgical site
- Reduced imaging artifacts allows surgeons to easily assess if the operation was successful

Patients

- More accurate clip placement reduces complications
- Biocompatible materials ensures patient safety
- Titanium spring ensures aneurysm remains sealed

Conclusions

- The clear clip prototype performed well during testing and matched nearly all design requirements
- On average, this technology has a closing force that is 58% lower than the standard of care
- The transparent PMMA blades have a resolvable distance of 44.3 µm and light transmission of 99.5%
- This clip displays a minimized MRI artifact, which will improve postoperative aneurysm observation
- Overall, this device is functional and can be further developed and tested in future work

Future Work

In the future, several further steps should be taken:

Bonding Mechanism & Closing Force

- Investigate how to permanently bond titanium and PMMA to ensure a secure mechanism for operating
- Optimize closing force to match the standard of care

Testing

- Perform preclinical testing using simulated tissue
- Perform testing in animals with IACUC approval
- Perform clinical testing with IRB approval

Commercialization

- Overall goal is to commercialize this product to enhance surgeon ease of use, as well as increase the effectiveness of the treatment for patients

References

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