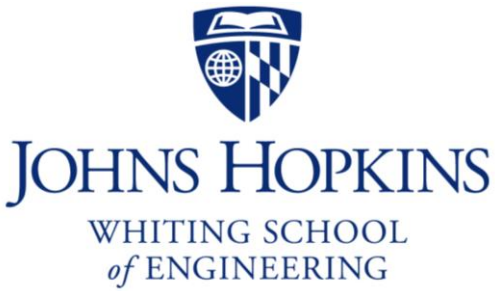
NSF Engineering Research Center for
Computer Integrated Surgical Systems and
Technology

Integration of Galen for Otology Applications

Joseph Peine, Mariah Schrum, Yunuscan Sevimli, Russell H. Taylor

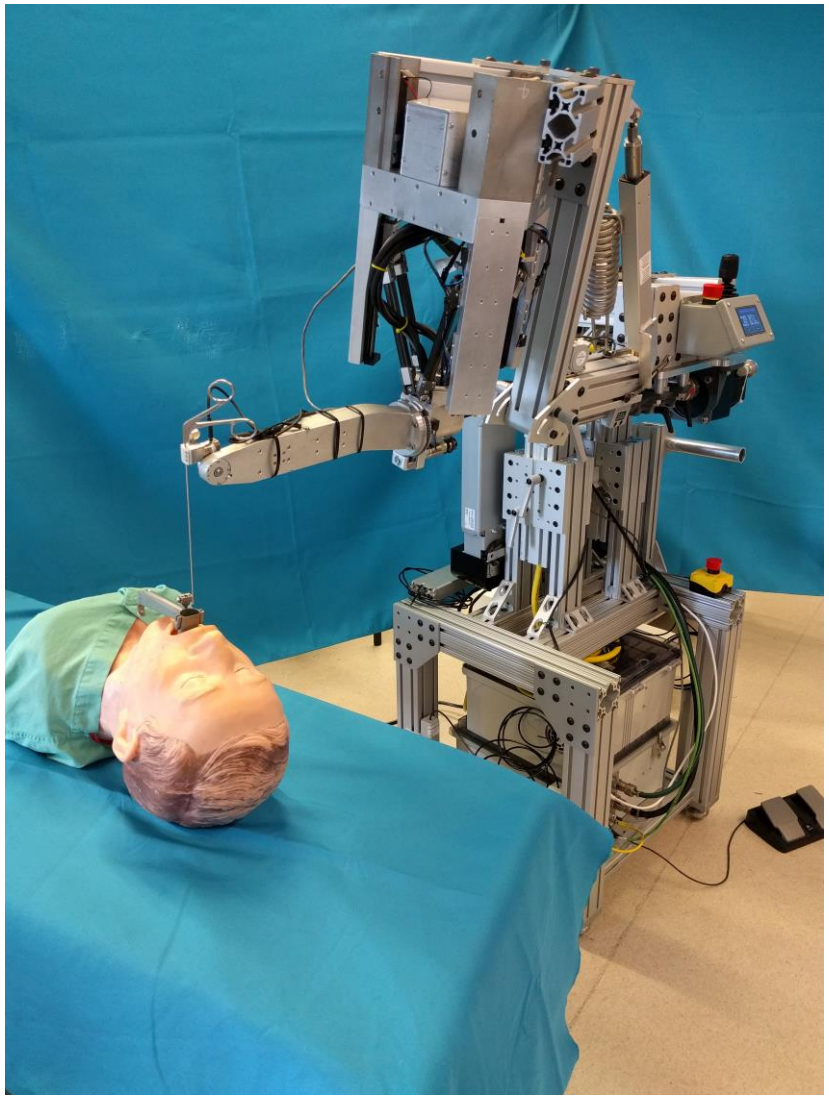


The Problem

- Ear surgery is delicate and the surgeon must be very precise.
- The surgeon must make sure to avoid dangerous areas such as the facial nerve.

The Galen Robot

- Surgeon manipulates tool while the robot stabilizes their movements.
- 6 Degrees of freedom
- Up to 0.25 mm precision
- 125x125x125 mm workspace



Galen Robot

Otology Applications

Stapedotomy

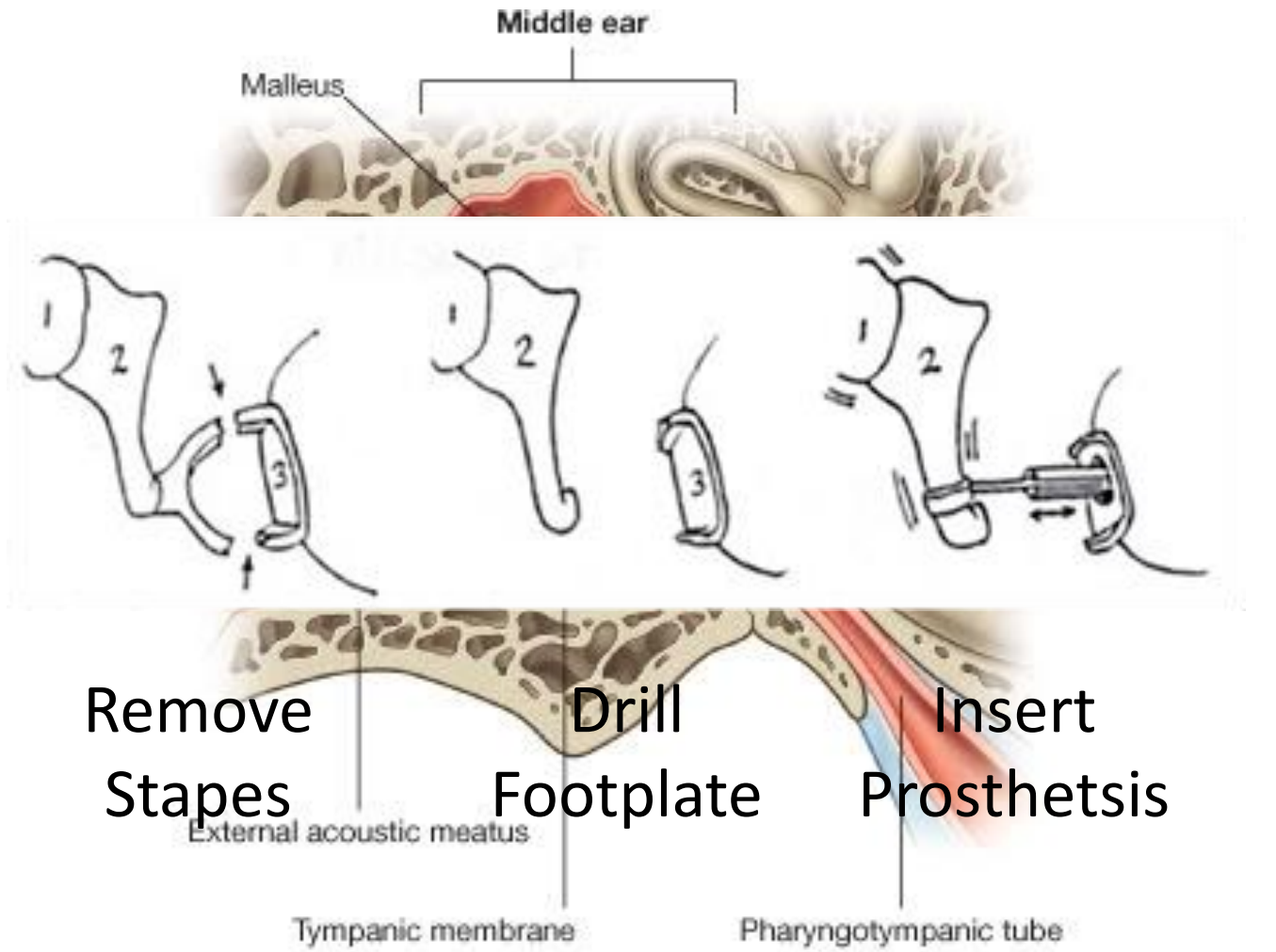
- Must show that the robot can accurately measure a distance.
- Must show that the procedure can be made safer using the limits set on the robot.

Mastoidectomy

- Must show that the robot can effectively avoid dangerous areas.

Stapedotomy

- Stapes footplate hardens which results in loss of hearing.
- Stapes must be removed.
- A small hole is drilled into the footplate.
- A prosthetic piston is placed around the Incus and is inserted into the hole in the footplate.



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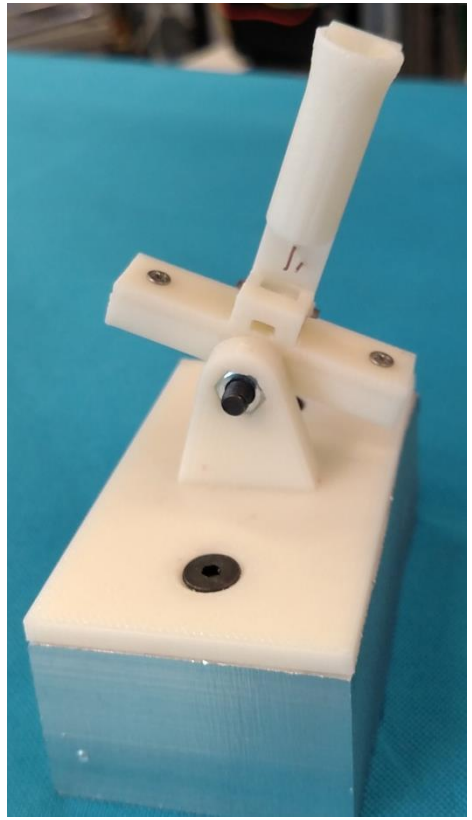
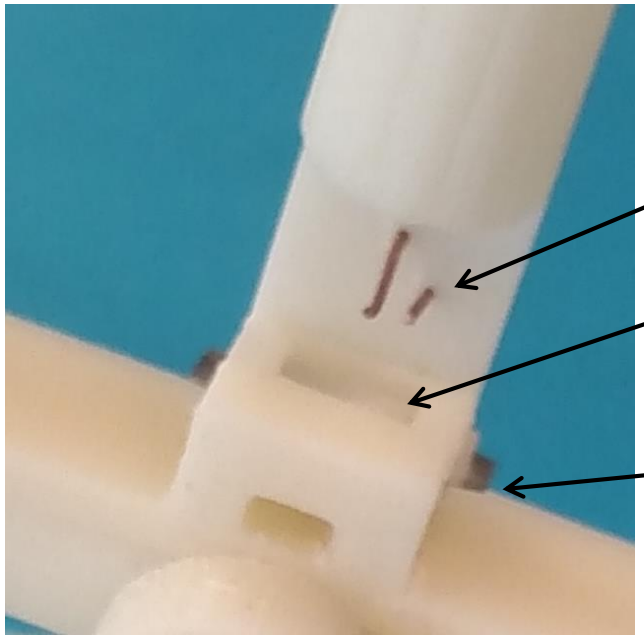
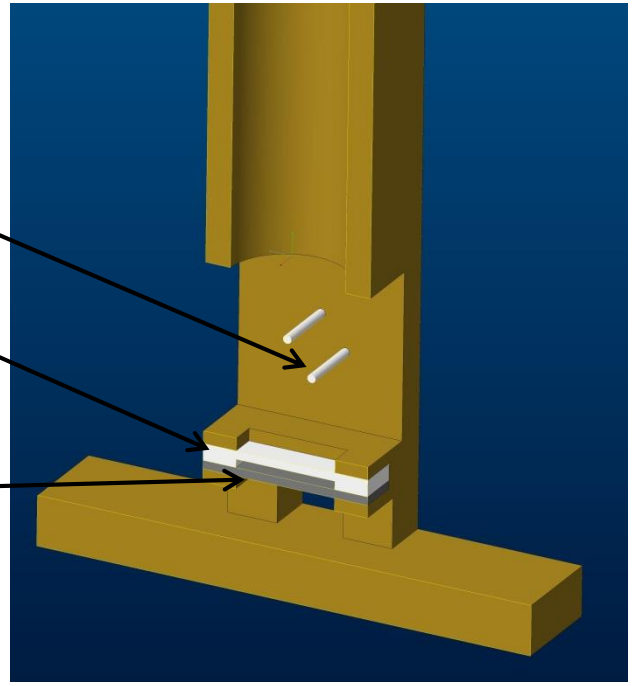
Stapedotomy Phantom



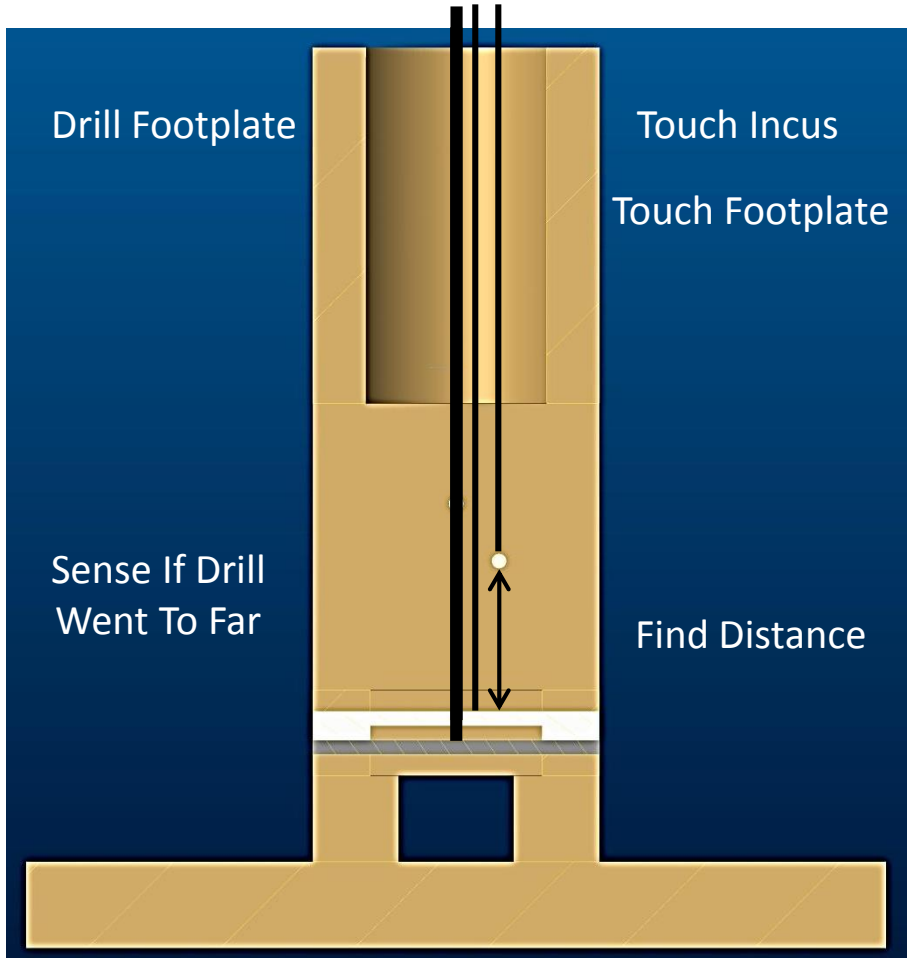
Latest Stapedotomy Phantom



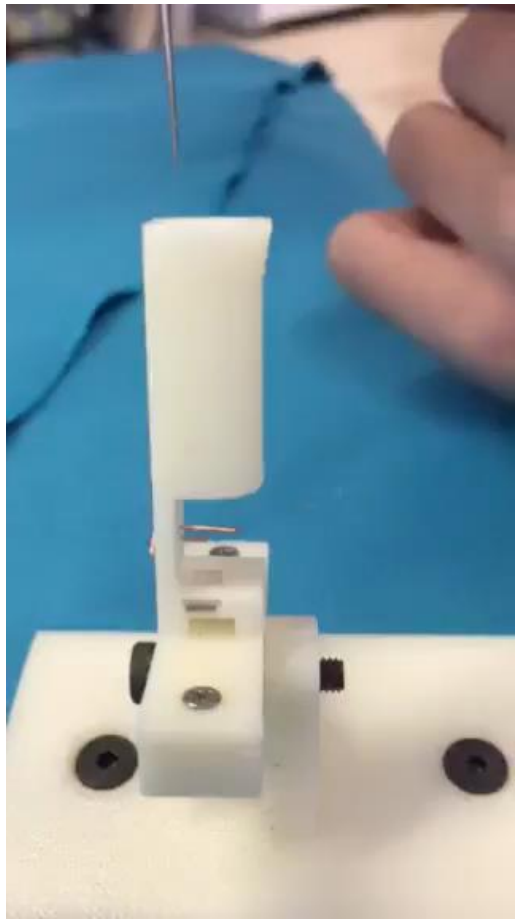


CAD Model of Stapedotomy Phantom

Experimental Procedure

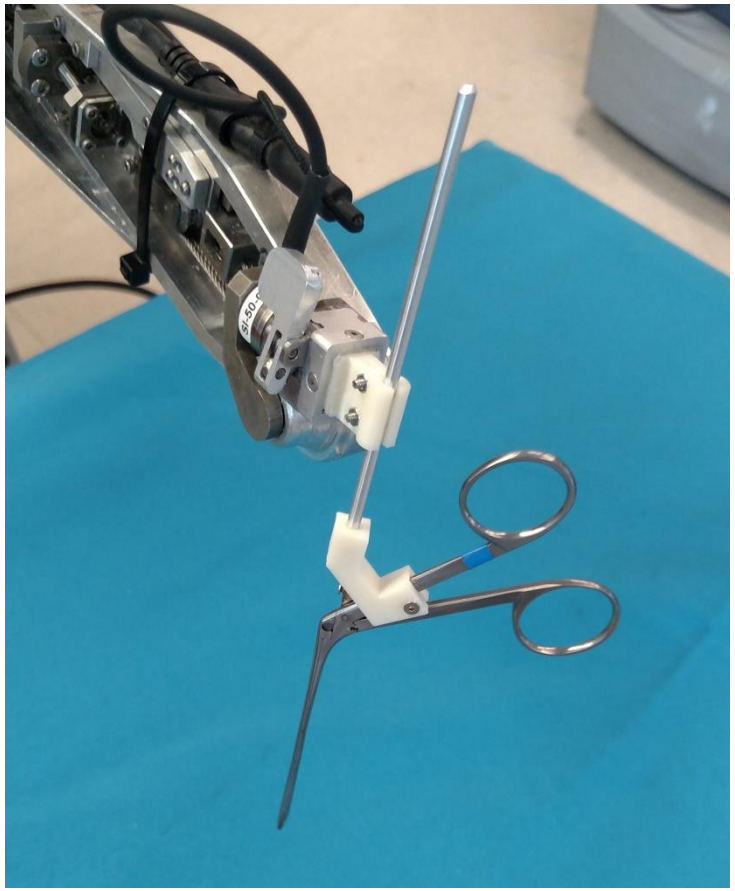


CAD Model of Stapedotomy Phantom



Video of Finding Distance Between Incus and Footplate

Stapedotomy Tool Attachments



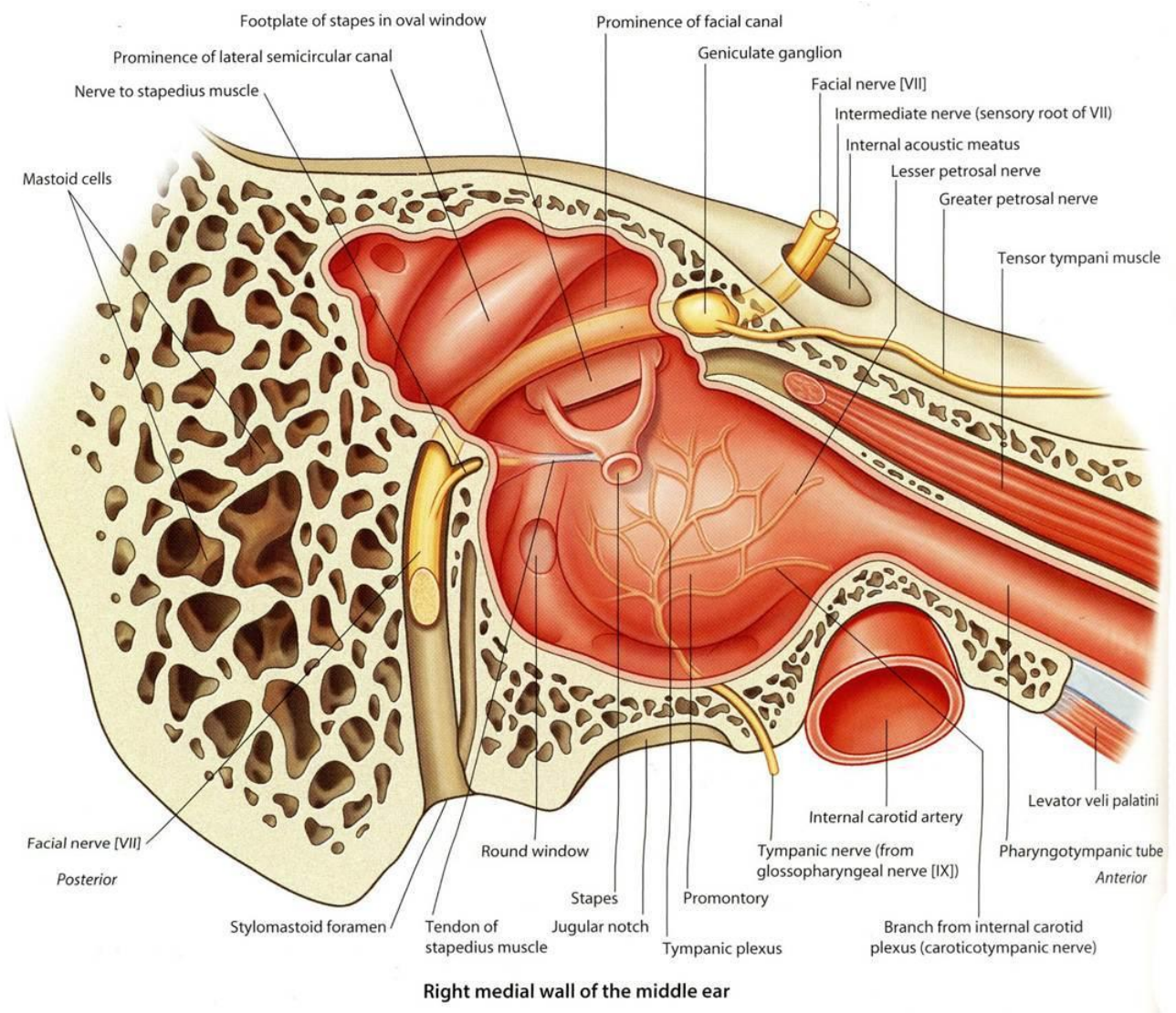
Tool Holder for Alligator Forceps

Stapedotomy Results

- Went through multiple iterations of design.
- Most improvements were correcting for anatomy.
- Surgeons felt the newest version of the stapedotomy phantom was anatomically accurate.
- They liked that you could angle the phantom to match the angle of the patient head during surgery.
- Surgeons liked the alligator forceps tool adapter because it gave them good stability while still having the ability to rotate freely.

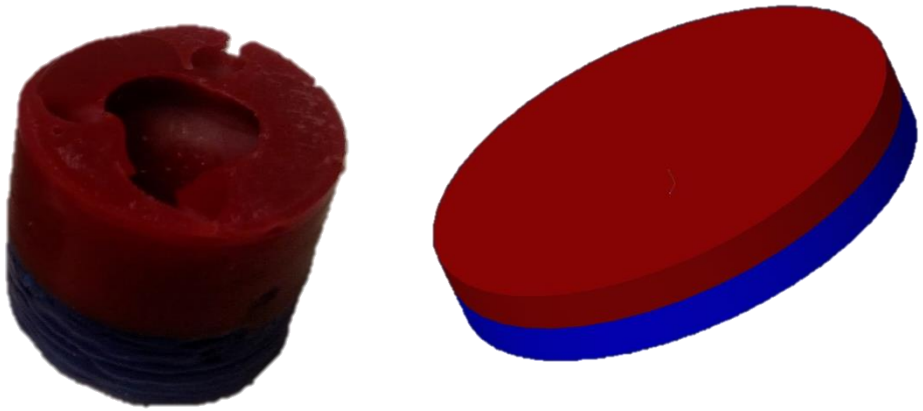
Mastoidectomy

- Drill away bone directly behind the ear.
- Dangerous because of proximity to facial nerve.

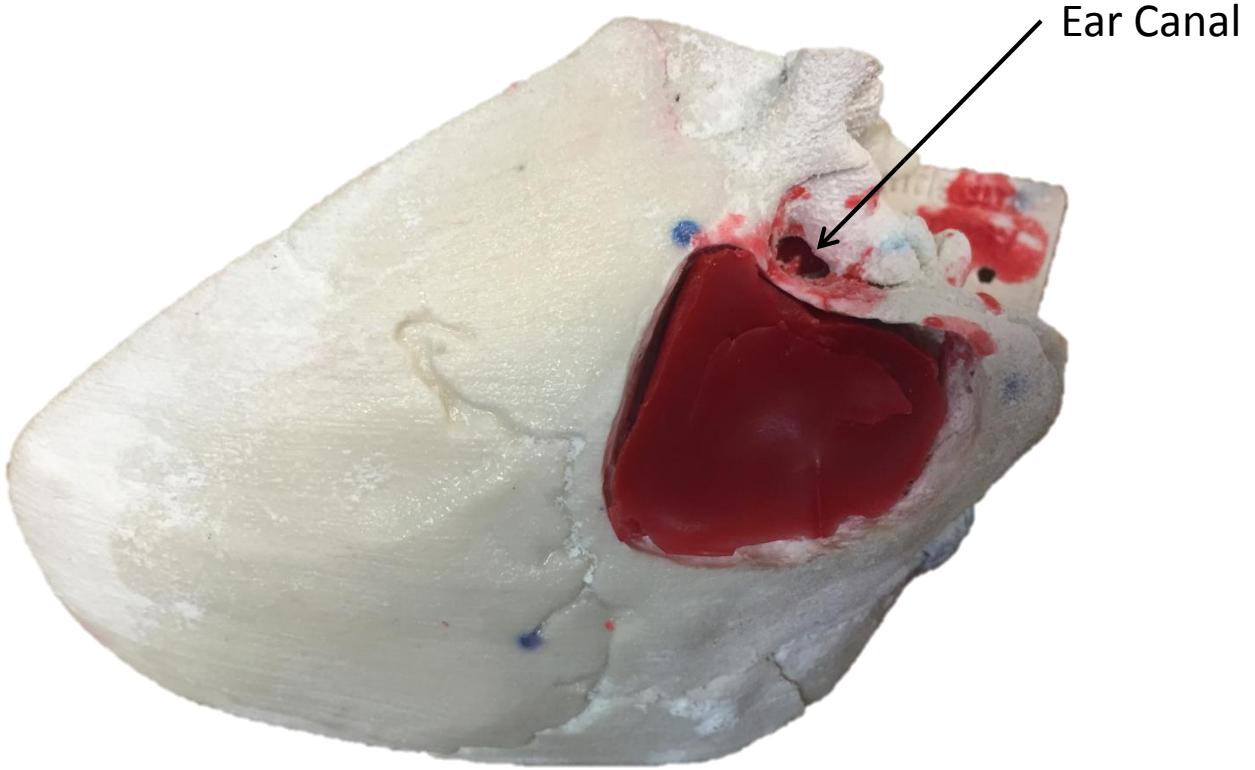


Right medial wall of the middle ear

Mastoidectomy Phantom

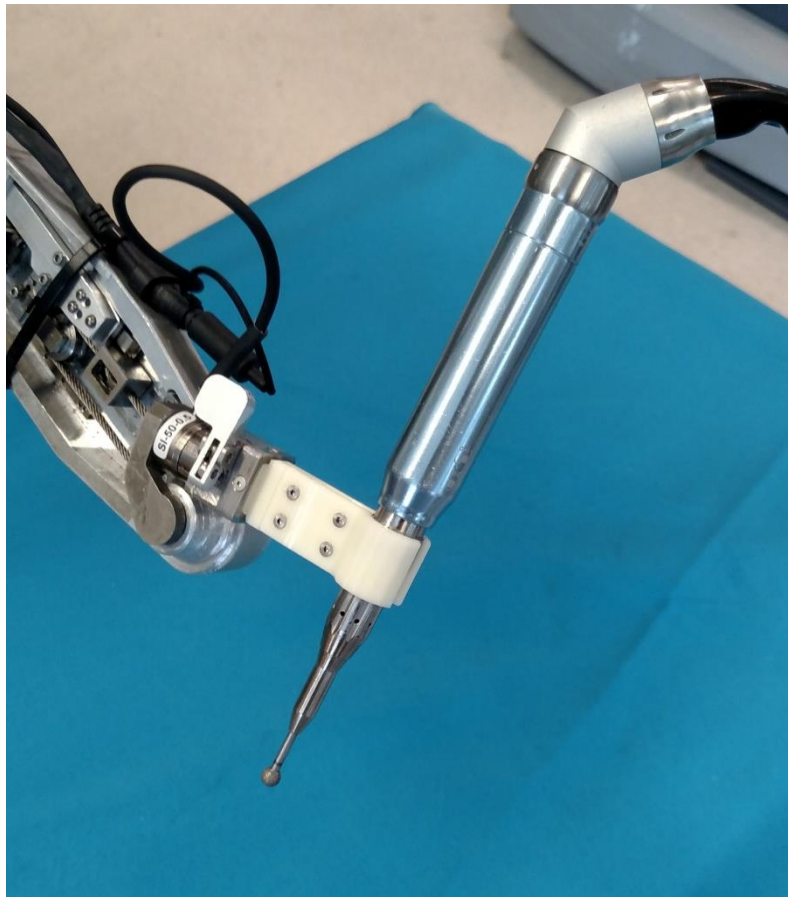


Layered Wax Model

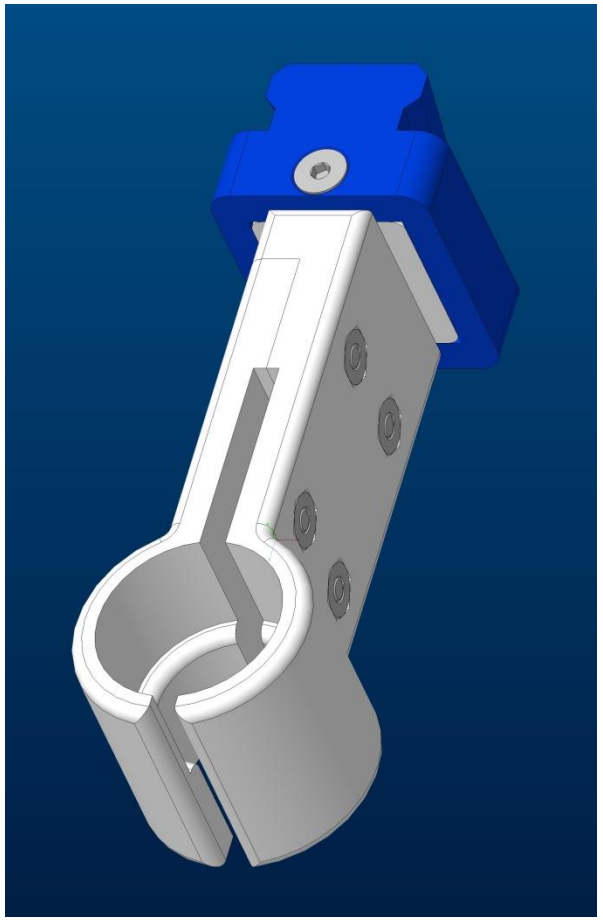


Temporal Bone with Wax Insert

Mastoidectomy Tool Attachments

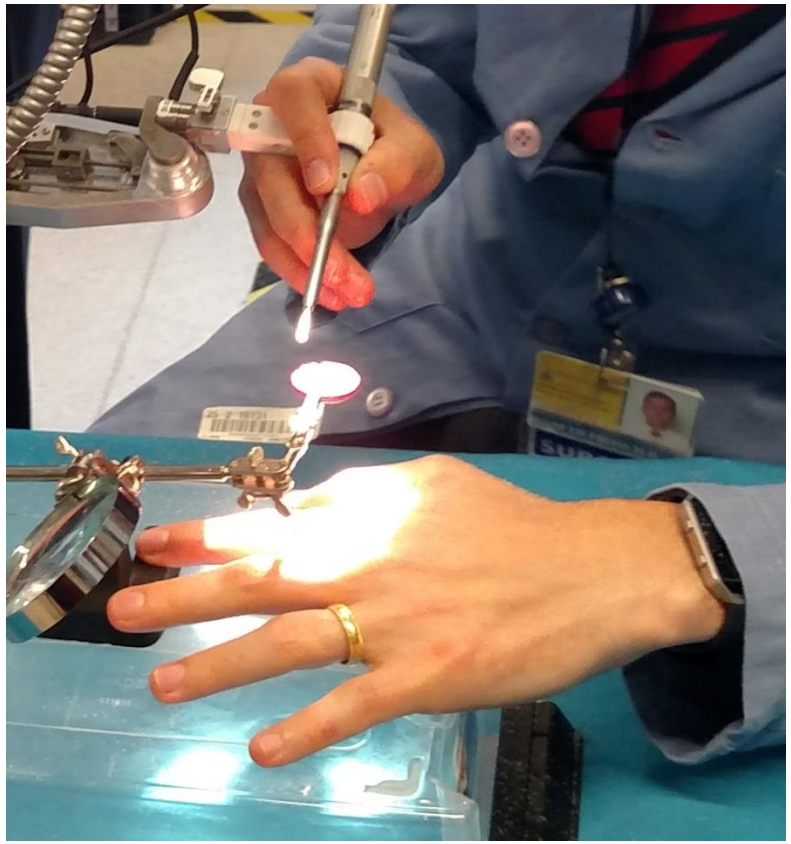


Surgical Drill Tool Attachment



CAD Model of Surgical Drill Tool Attachment

Experimental Procedure



Surgeon Removing Top Layer of Wax

Video of Removing Top Layer of Wax

Mastoidectomy Results

- Had surgeons test cutting through multiple materials.
- Surgeons thought the wax material was acceptable to use to simulate bone.
- Surgeons really like the idea of defining virtual fixtures to avoid dangerous areas they don’t want to drill.

Discussion and Future Work

- This robot will have a large impact for Ear, Nose, and Throat surgery and has the potential to improve safety in many applications.
- Throughout the next semester we will have surgeons perform these otology experiments using the developed phantoms.
- We are also developing phantoms and tool adapters for other applications such as laryngeal surgeries.

Acknowledgements

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- Yunuscan Sevimli
- Dr. Russell Taylor
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