

Pediatric Hydrogel Phantom Model and Cauterizing Tool Design for Novel Neuroendoscopic Surgical Robot Evaluation

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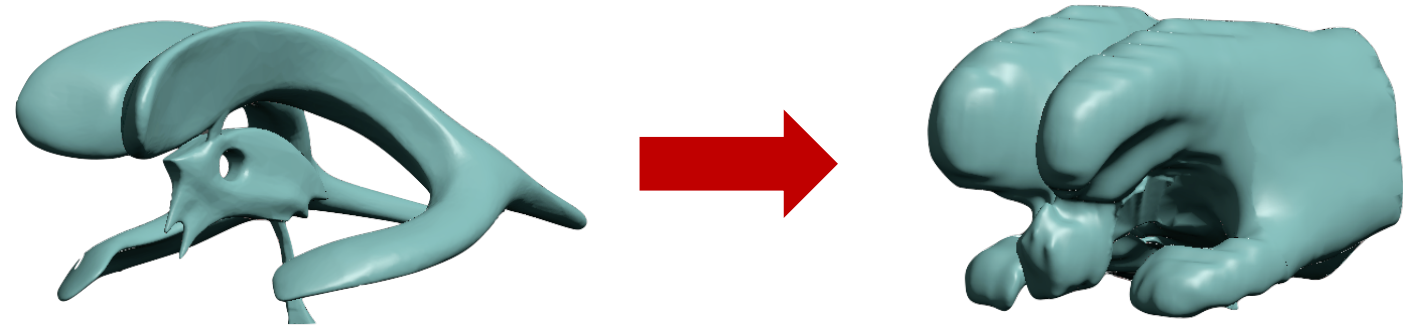


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Hydrocephalus

- CSF Build-up
- Effects of Hydrocephalus
- Pediatrics Population ¹

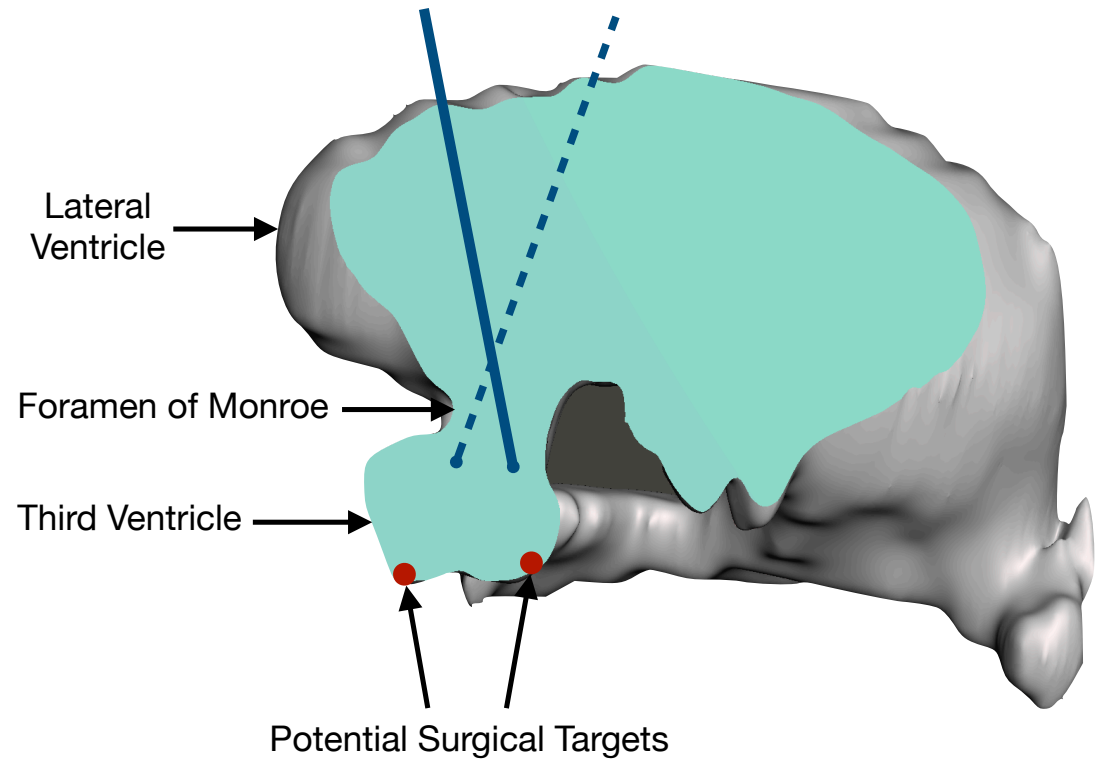


Endoscopic Third Ventriculostomy (ETV)

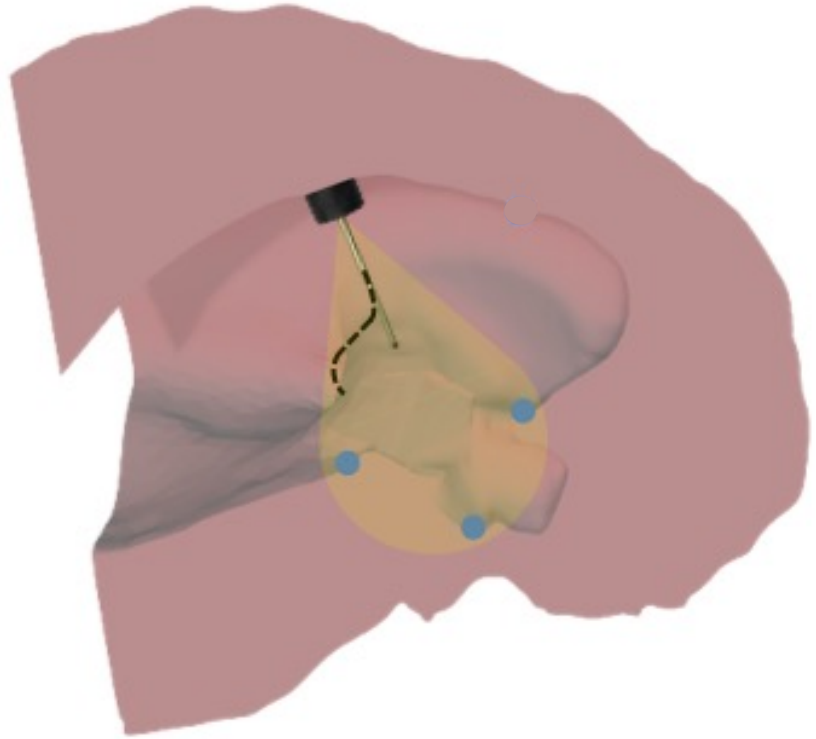
- The Procedure

- Problems

- Proposed Solution



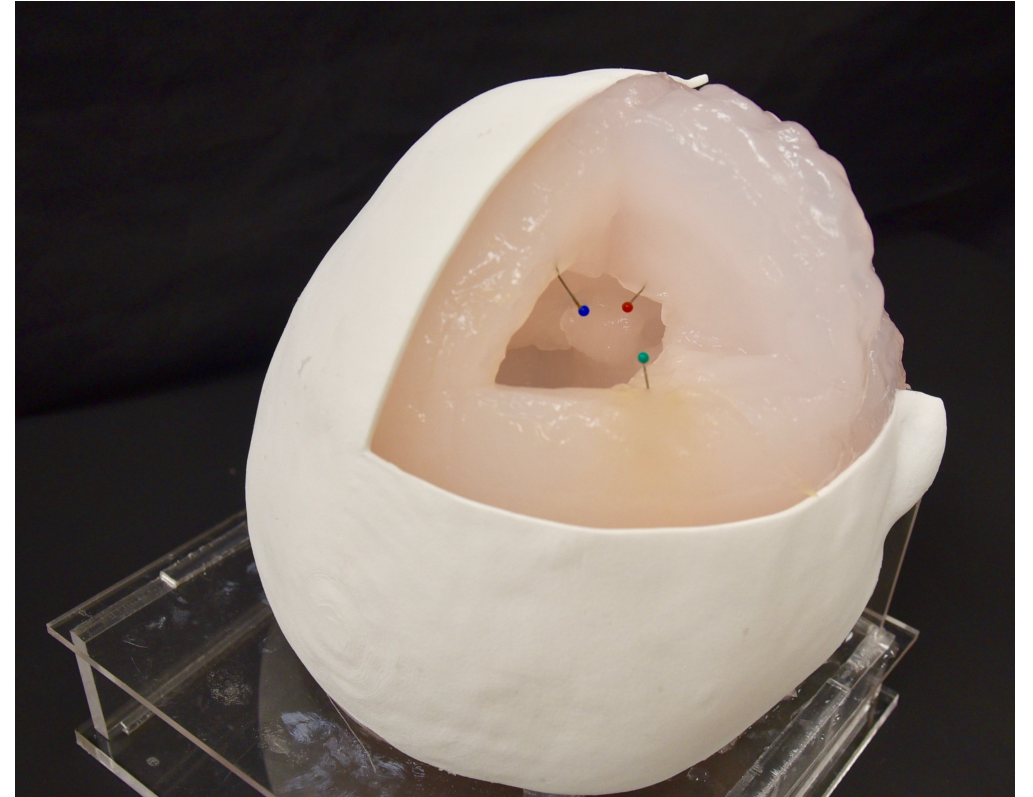
Robotic Pediatric Neuroendoscope Tool



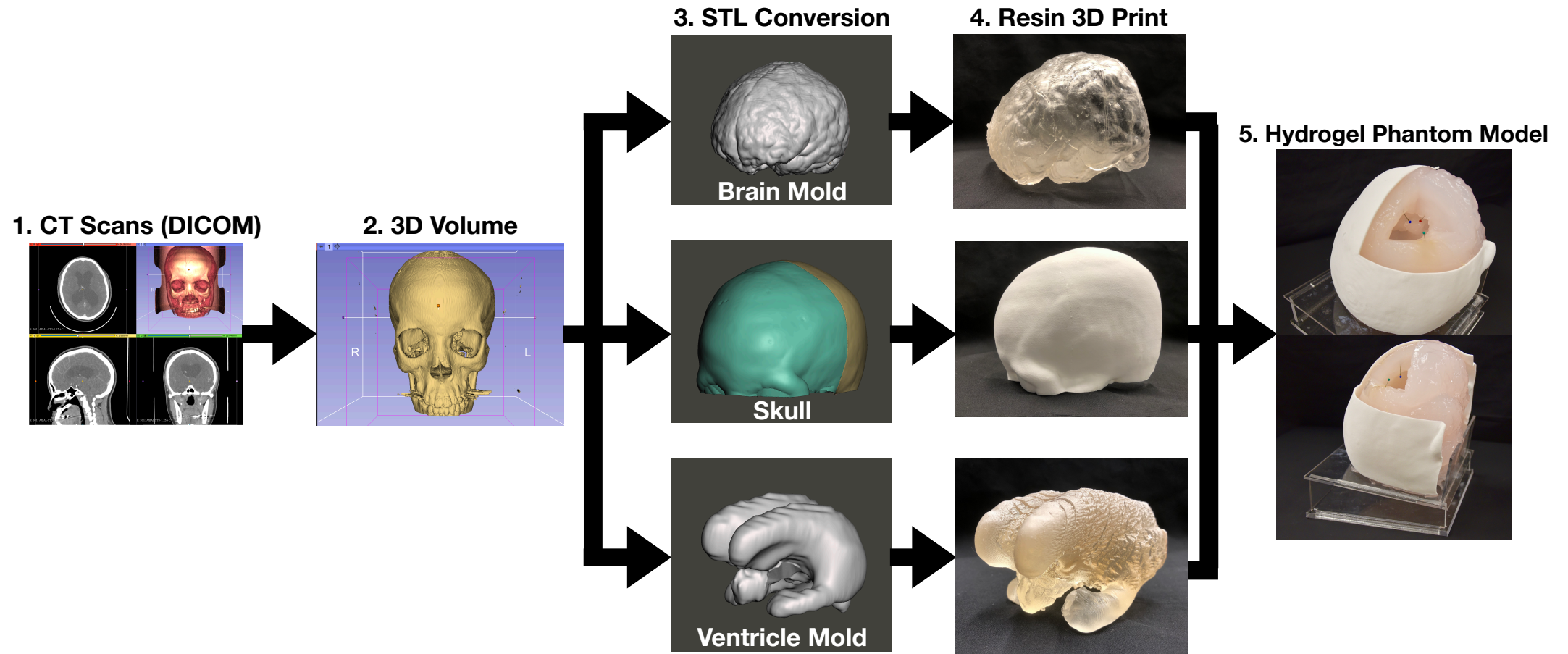
Courtesy of Yash Chitalia

Phantom Modeling

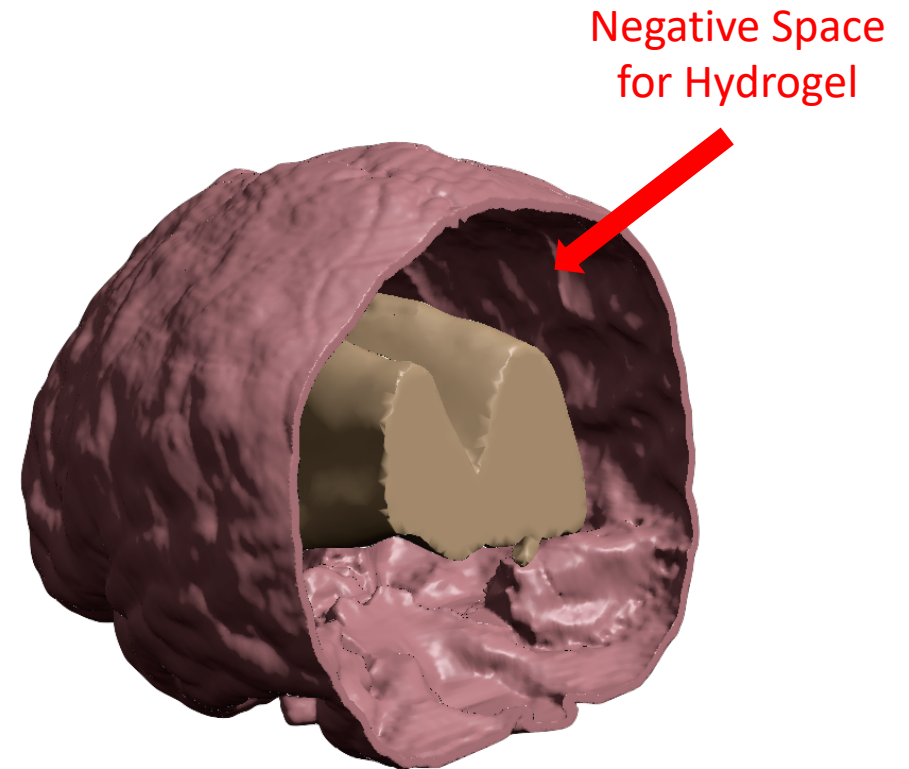
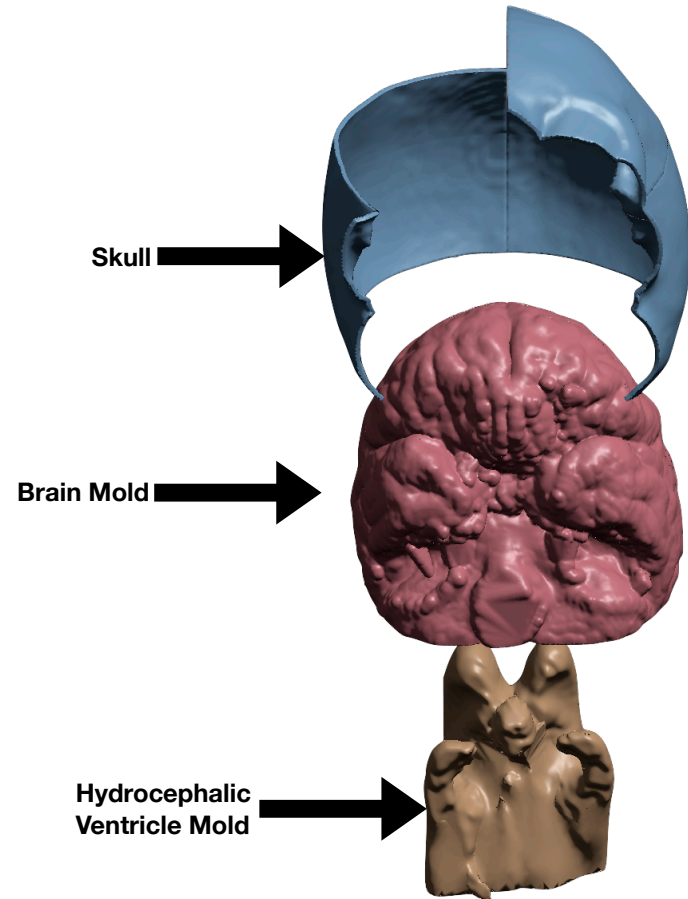
- Anatomically Correct
- Mechanical Properties
- Benefits
- Silicone/Hydrogel



Production Pipeline

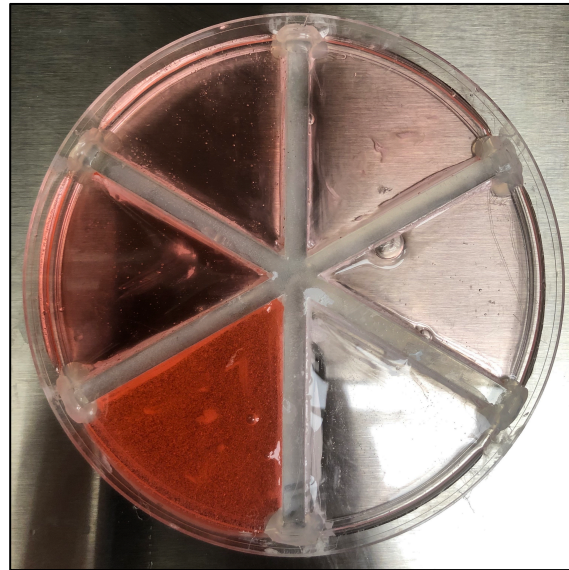


Molding Technique

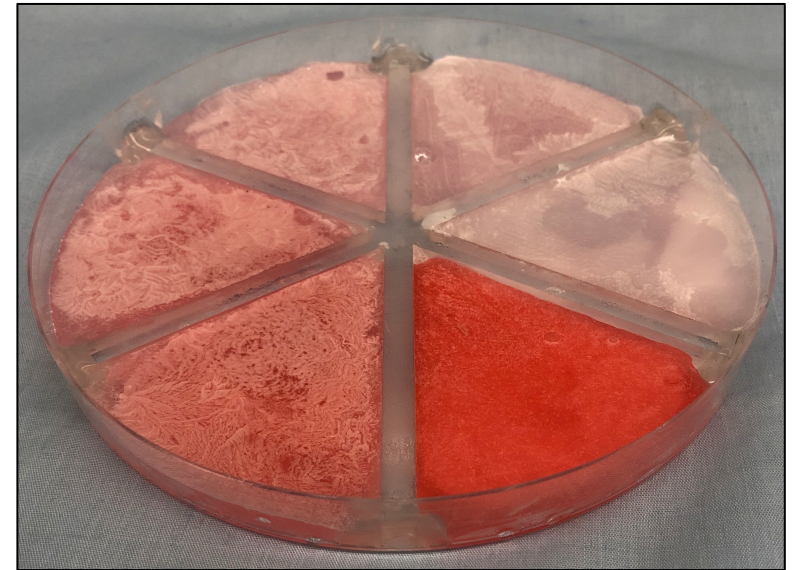


Hydrogel Production

7.0% Polyvinyl Alcohol (PVA)
+
0.85% Phytigel (PHY)
(1:1 Weight Ratio)²

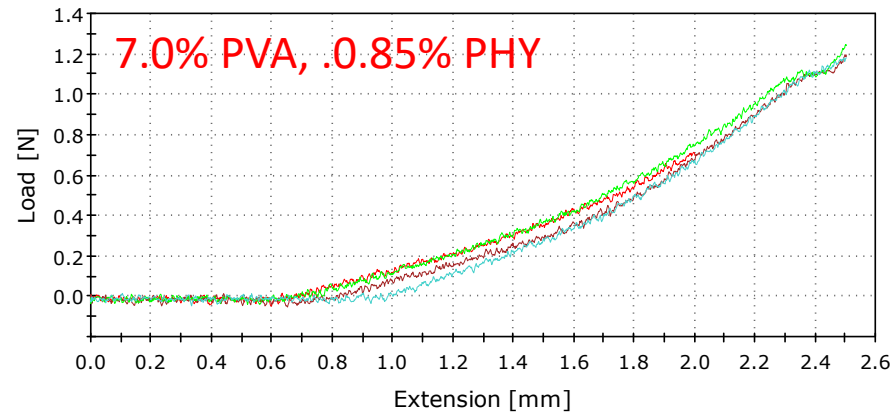


-10°C
24 hrs.

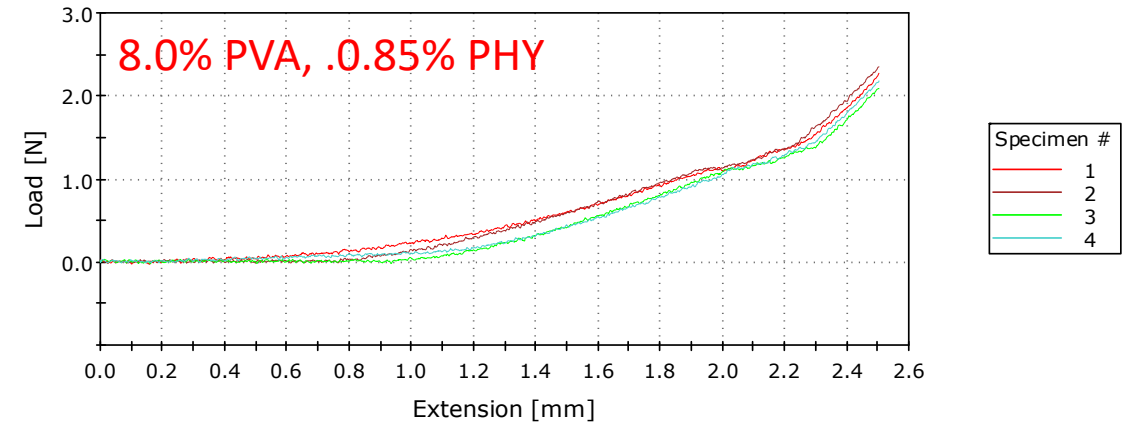


Indentation Testing

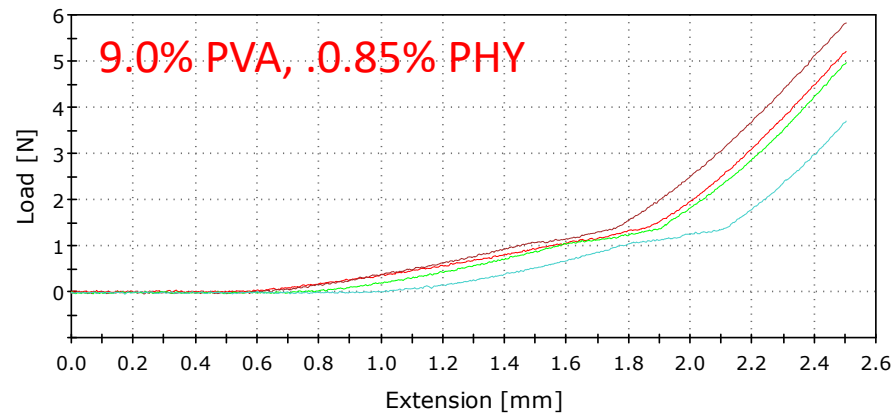
Specimen 1 to 4



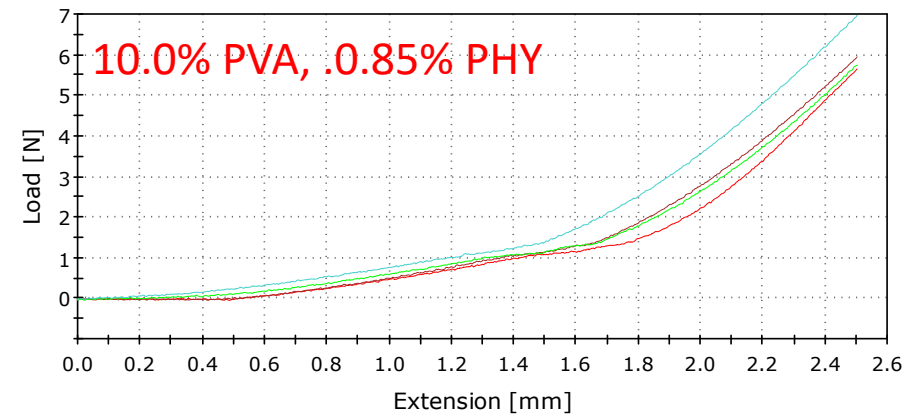
Specimen 1 to 4



Specimen 1 to 4



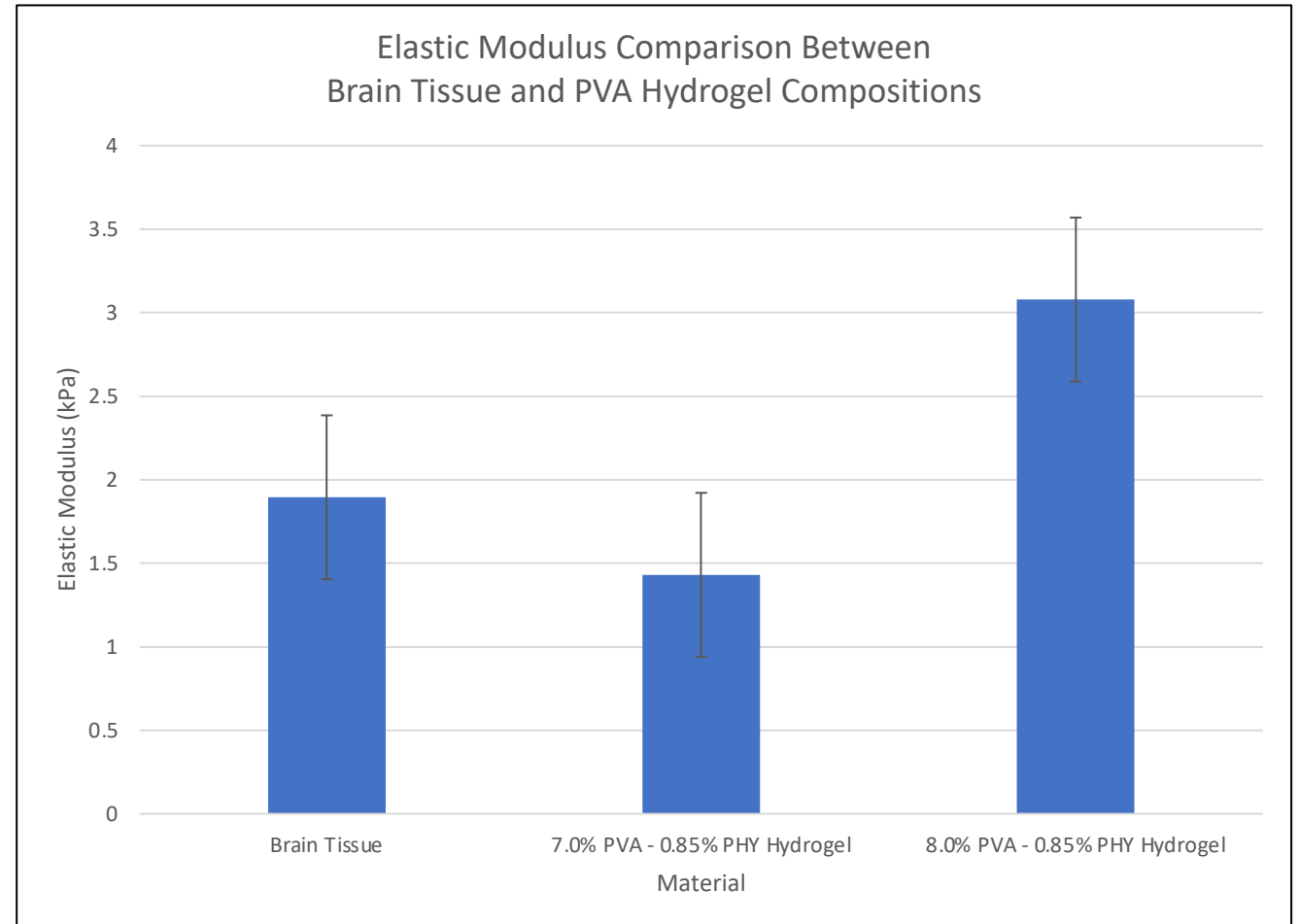
Specimen 1 to 4



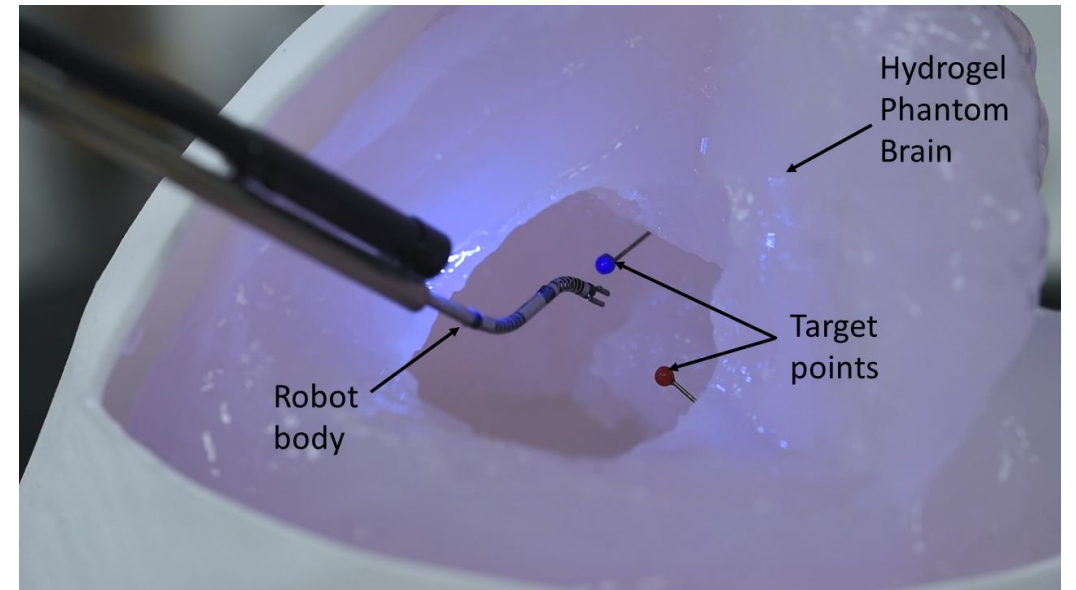
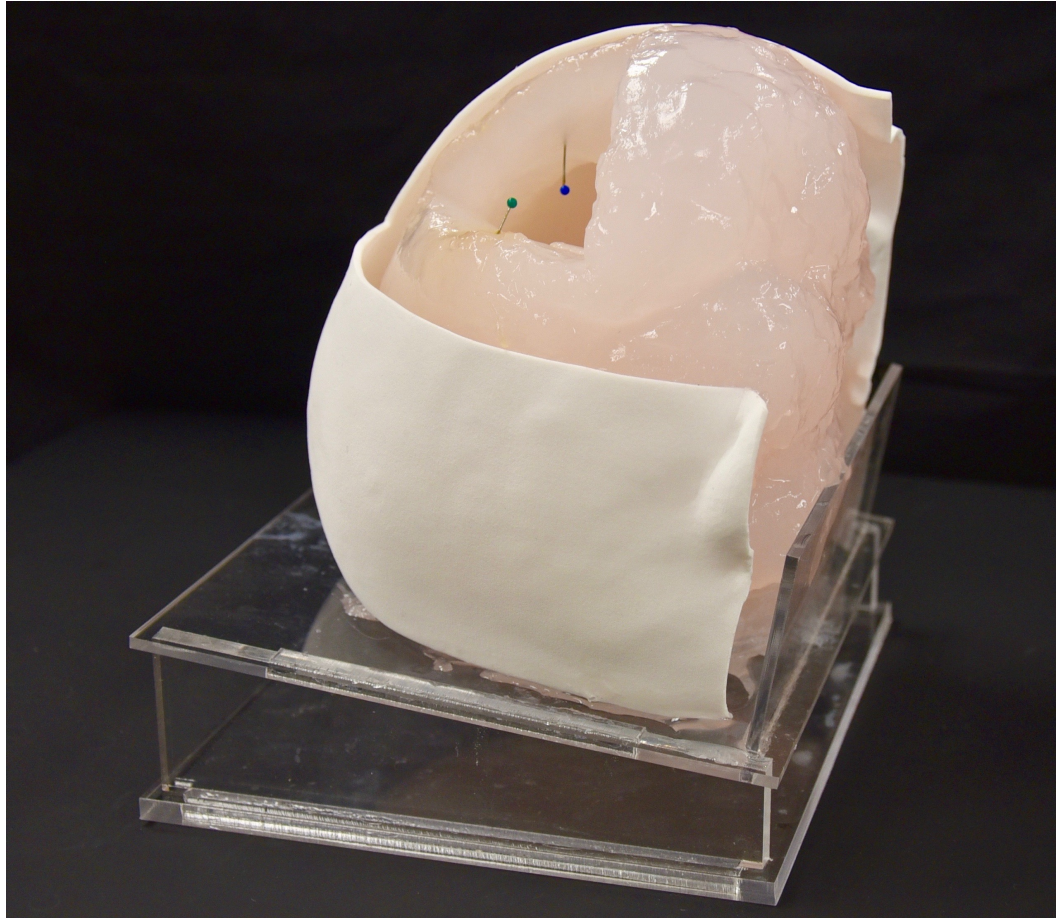
Elastic Modulus Results

PVA Composition (%)	Avg. Elastic Modulus (kPa)
7.0	1.431 ± 0.295
8.0	3.079 ± 0.428
9.0	9.904 ± 0.377
10.0	10.221 ± 0.513

Material	Avg. Elastic Modulus (kPa)
Brain Tissue	1.895 ± 0.592^3
7.0% PVA – 0.85% PHY	1.431 ± 0.295
8.0% PVA – 0.85% PHY	3.079 ± 0.428



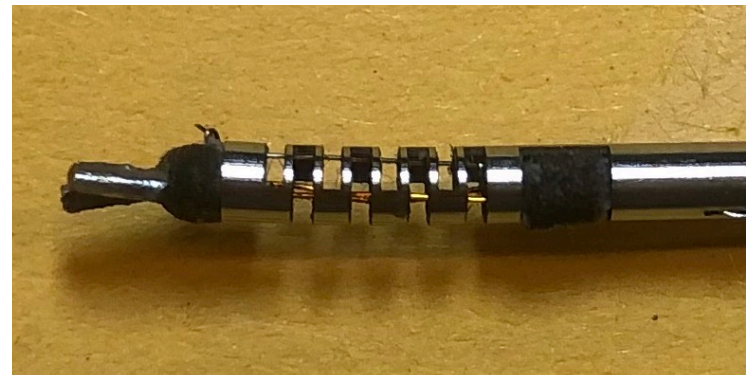
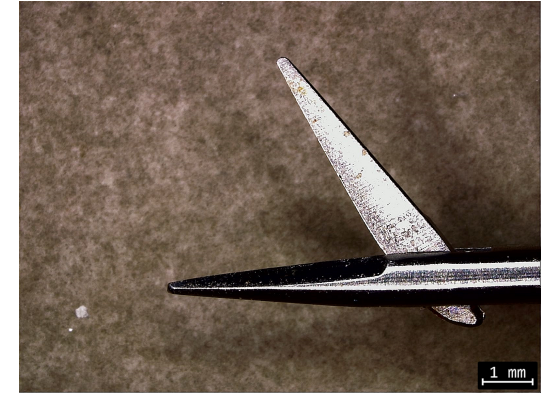
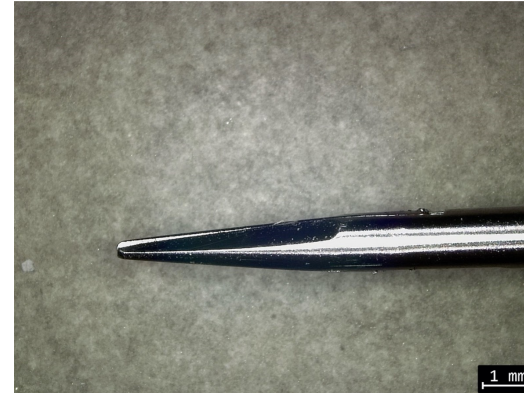
Final Hydrogel Phantom Model



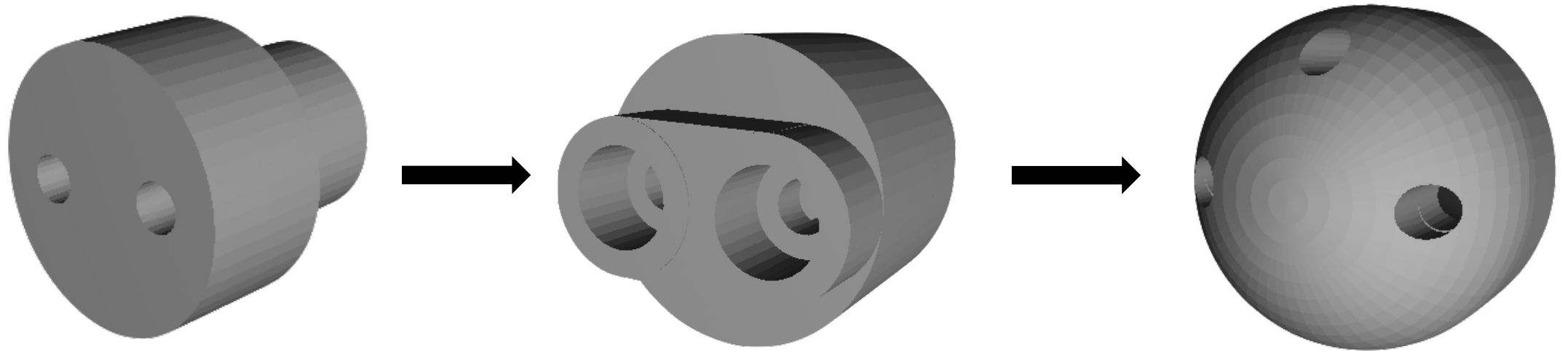
Courtesy of Yash Chitalia

Tool Tip Design

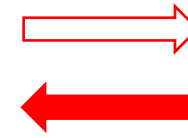
- Multi-DOF Robot
- Tool Types



Electrocautery Tip Design



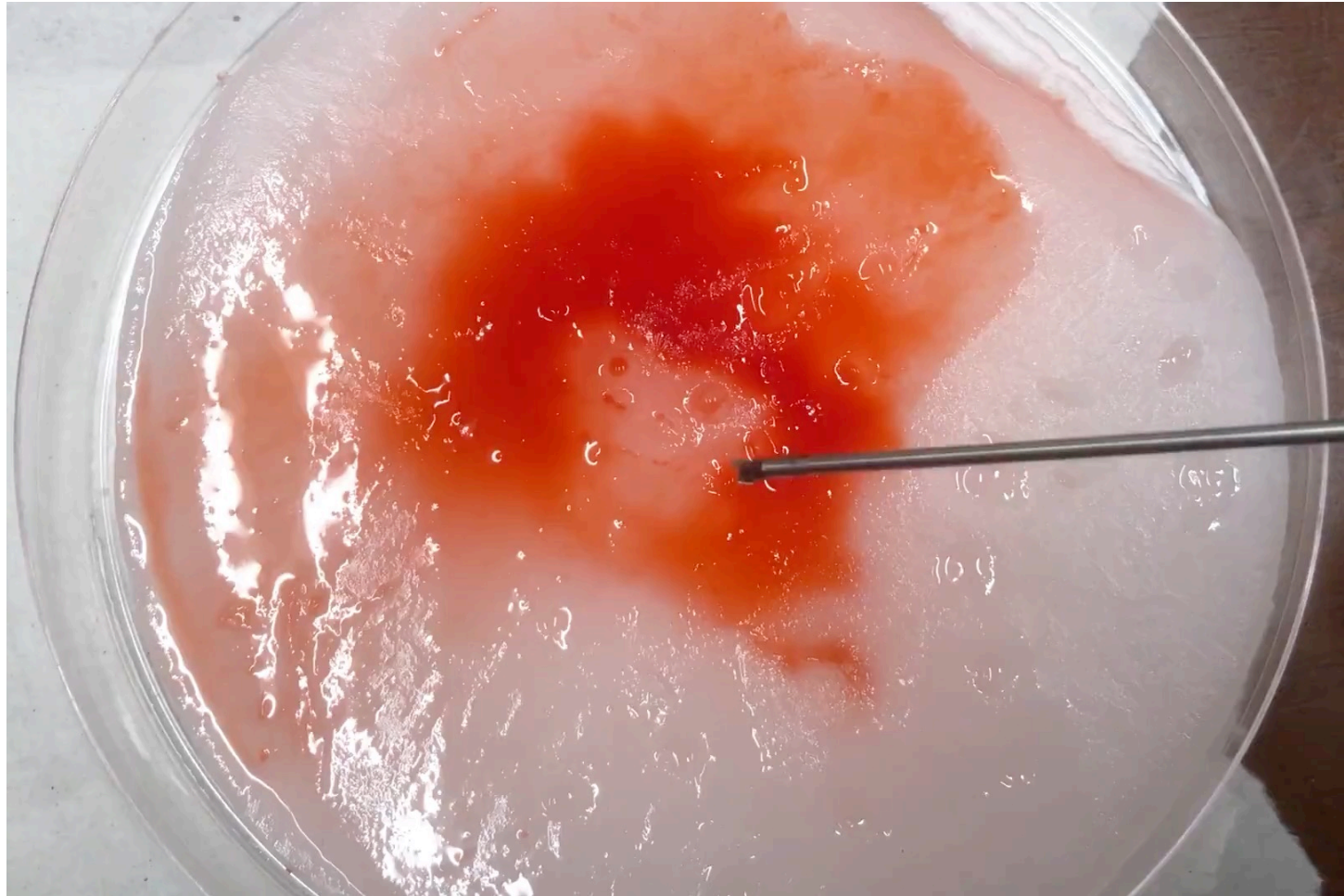
Robotic Tool Integration



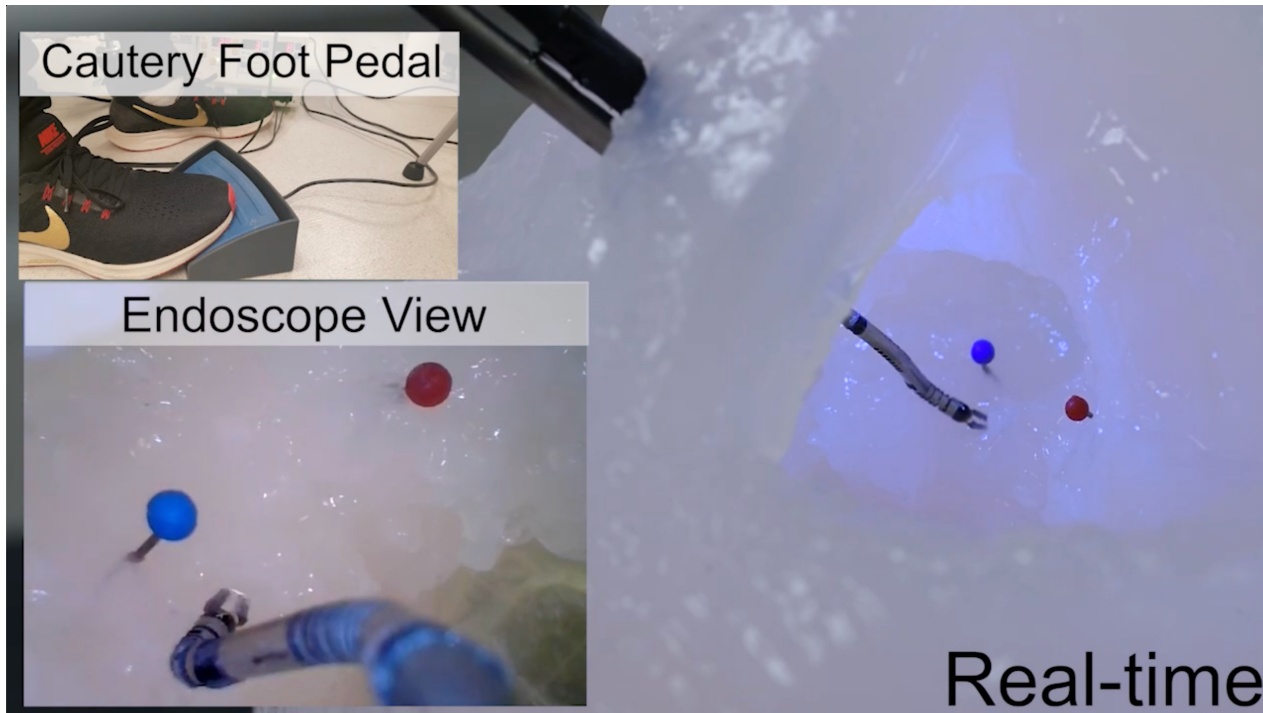
Bovie Aaron 3250 Digital
Electrosurgical Generator



Electrocautery Testing

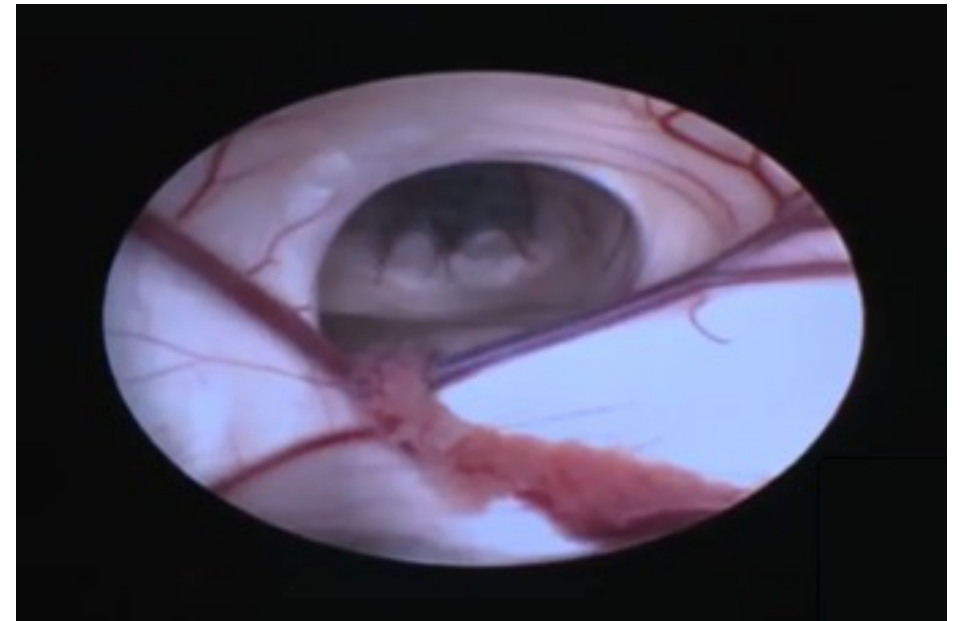


Summary



Future Research

- Phantom Model Reevaluation
- Grasper Design
- Pre-clinical Assessment



Courtesy of Joshua Chern

Acknowledgements



Yash Chitalia



Seokhwan Jeong



Joshua J. Chern



Jaydev P. Desai

References

[1] Tervonen, J., Leinonen, V., Jääskeläinen, J. E., Koponen, S., & Huttunen, T. J. (2017). Rate and risk factors for shunt revision in pediatric patients with hydrocephalus—a population-based study. *World Neurosurgery*, *101*, 615-622. doi:10.1016/j.wneu.2017.02.030

[2] Forte, A. E., Galvan, S., Manieri, F., Rodriguez y Baena, F., & Dini, D. (2016). A composite hydrogel for brain tissue phantoms. *Materials & Design*, *112*, 227-238. doi:10.1016/j.matdes.2016.09.063

[3] Budday, S., Nay, R., De Rooij, R., Steinmann, P., Wyrobek, T., Ovaert, T. C., & Kuhl, E. (2015). Mechanical properties of gray and white matter brain tissue by indentation. *Journal of the Mechanical Behavior of Biomedical Materials*, *46*, 318-330. doi:10.1016/j.jmbbm.2015.02.024

Thank You!

Any questions?