

## **3D Simulation Model for Training in Minimally Invasive Parafascicular Surgery for Intracerebral Hemorrhage Removal**

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### Background:

Advances in minimally invasive neurosurgery demand that residents receive effective, realistic training. Simulation models foster skill development through hands on, low risk practice. Minimally Invasive Parafascicular Surgery (MIPS) is a surgical technique that reduces damage to the brain by using sulci as corridors, brain imaging to avoid white matter tracts, and a tubular retractor to access subcortical regions. Several studies support MIPS for Intracerebral Hemorrhages (ICH) clot evacuation. We developed a 3D model to emulate this procedure to provide residents with the necessary practice in a low acuity environment.

### Methods:

Three-dimensional skull and brain models were digitally designed. The brain model was used to design, and 3D print a mold to create brain gels of phytigel (PHY), polyvinyl alcohol (PVA), cornstarch, agar, and water. Gel texture was compared with soft tofu due to their textural resemblance and strength was tested by inserting a tubular retractor. After initial testing by the researcher, formulations demonstrating optimal texture and strength were selected for resident evaluation. Different clot solutions were then created and inserted into the gels.

### Results:

Brain gels were cooled in the freezer for 15 minutes before inserting the clot solution into the gel. Twenty-seven gels were produced, differing in composition. The five formulations that didn't break apart and most closely matched tofu texture were selected. Additionally, we designed and 3D printed a larger brain mold to better accommodate the tubular retractor.

### Future Directions:

After finalization of the brain gel, the priority will be modeling the dura as well as 3D printing and testing the skull and replaceable skull cap. We will evaluate sausage casing as an analog for dura in future tests. Chiefly, this simulation platform aims to enhance resident proficiency and confidence in minimally invasive ICH procedures