

Model for Pre-Surgical Intracerebral Hemorrhage Planning

(Hemorrhage Team)

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BME 400

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Overview

- Problem Statement
- Background
- Design specification
- Design Matrix
- Future work
- Acknowledgements
- References



Client: Dr. Walter Block



Background- Siva

- Intracerebral hemorrhage (ICH) occurs when a blood vessel within brain tissue ruptures, causing internal bleeding.
- A brain phantom is used by neurosurgeons to compare the MR scans of the phantom with a scan of their patients' brains
- Current research is focused on removing the clot as much as possible to prevent spread
- The method used to remove is dependent upon the stiffness of the clots which are
 - Suction
 - Drug treatment and then suction

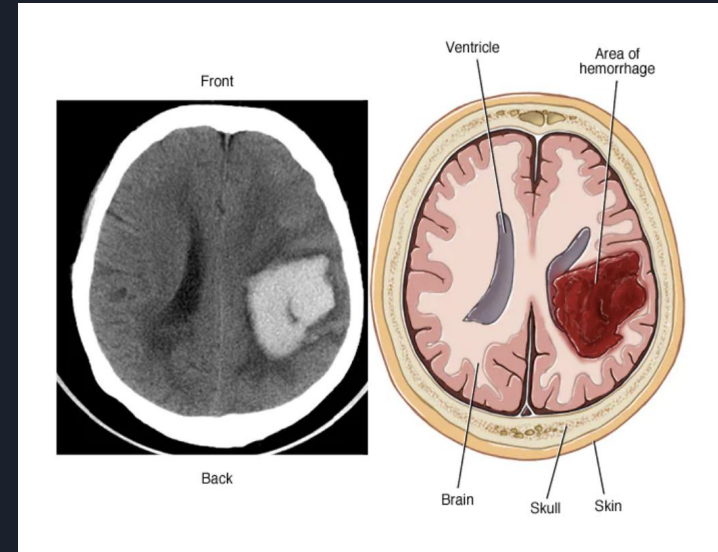


Fig.1 Intracerebral Brain Hemorrhage [9]



Problem Statement- Siva

- In the past, very little done for patients with intracerebral hemorrhaging
- Characteristics of different clots vary - differences in rigidity affect removal approach
- Goal for the first semester is to improve upon the phantom to simulate interior of brain with various clots to image and validate the effectiveness of mapping techniques and represent anatomical correctness
- Improve phantom skull model to cooperate better with scanner shape that would minimize wave interference

Previous Works and Competing Designs - Siva

- Switzerland - anatomically correct phantom that modeled the grey and white matter
- Hydrophobic sprays and wax barrier models
- Previous UW team
 - Polyacrylamide(PA) gel model phantom
 - Promising testing results



Fig.2 Switzerland phantom model [10]

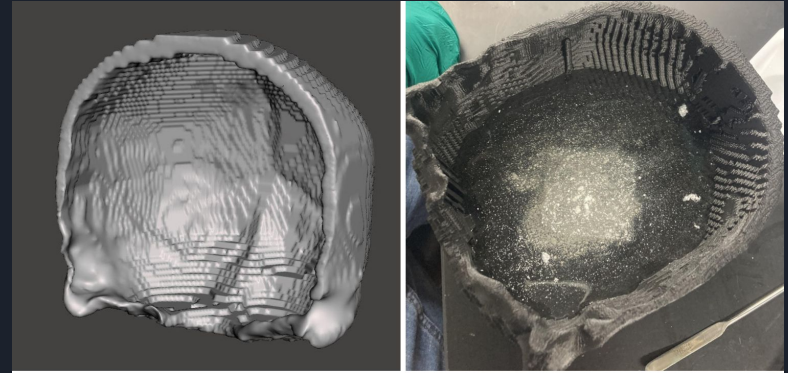


Fig.3 Phantom model by UW team

Project Design Specifications- Rush

- Skull model should be 3D printed and made of PLA
 - Anatomical features to accurately represent a head, such as air and fluid pockets
- Have a variety of stiffness polyacrylamide gels to create a database of known MR images to compare
- Have an in depth fabrication process so that it can be replicated for commercial purposes
- The phantom should be able to be scanned by MRI
- Enclose model to represent skull pressure

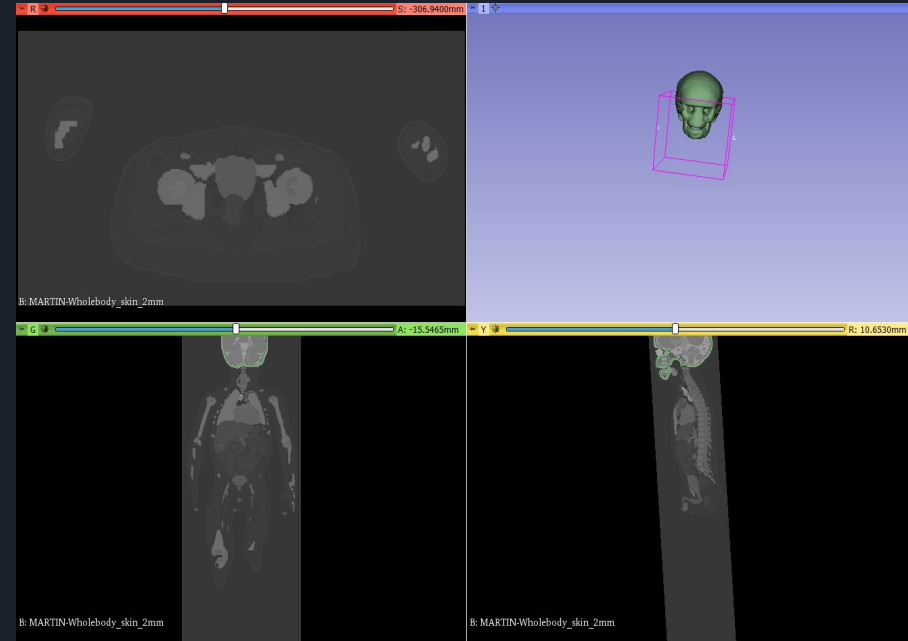


Fig.4 3DSlicer Dicom Images

Polyacrylamide Gel Synthesis- Rush

- Use photopolymerization to propagate polyacrylamide gel
 - Light, UV or visible light, to initiate polymerization reaction forms polymer structure
- Based on timing under light, gels will have different consistencies
 - Different shear and elastic modulus modeling actual clots
- Previous group found this gel will best work due to superior biomimicry and fabrication ability
- Striations of the sulci and gyri will be made through cuts in gel to match surface area

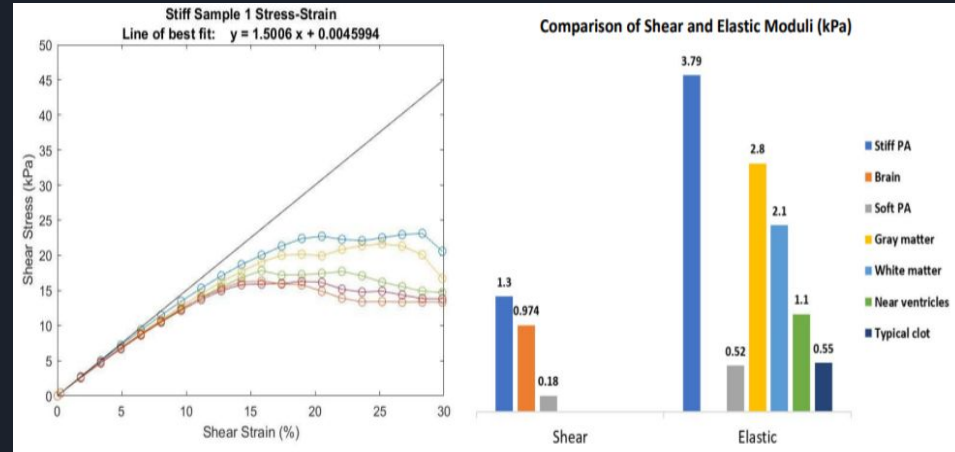


Fig.5 Previous Team Gel Data

Full Skull Pressurized- Rush

- The entire skull will be fabricated
- Pressurized system will be developed
 - Pressurized by increasing gas volume
 - Blood vessels will be driving force
- Will be most accurate to an actual brain model
- Disadvantage:
 - Complex hardware with pressurized system
 - The cost will not be efficient in commercial reproduction

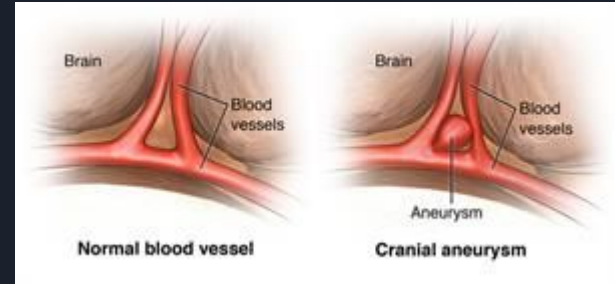


Fig. 6 Pressurized system [7]

Full Skull Non-Pressurized- Rush

- Illustrates the full skull of an adult
- No pressurized system will be encompassed
- Will allow full imaging of the brain
 - Require no excess hardware
- Disadvantages:
 - Will require more time in Slicer to develop model
 - Will be difficult to for surgeon to focus on during surgery as not completely open



Fig.7 Full Skull[8]

Half Skull - Logan

- Only contains half the skull, the front half
 - Everything post the brain stem from a lateral view will not be present
- Allows easy access to all parts of the brain
- Disadvantages
 - Less biomimicry to an actual brain
 - Will not be able to be pressurized in the future

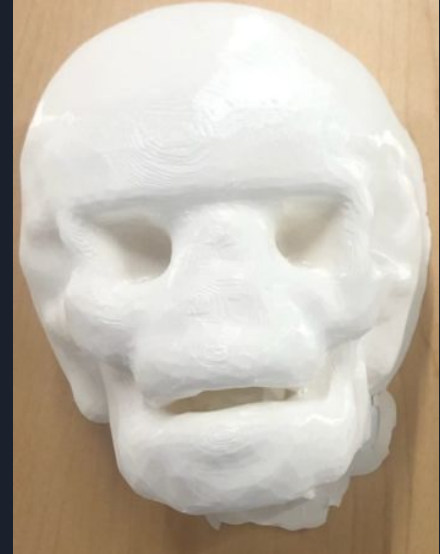
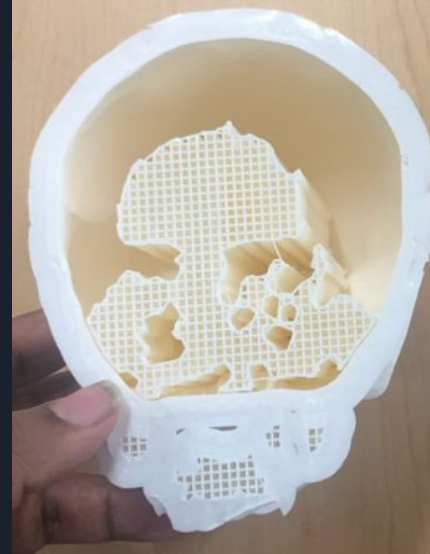


Fig.8 Half Skull [9]

Design Matrix -Logan

Criteria	Weight	Full Skull Pressurized		Full Skull Non-Pressurized		Half Skull	
Ease of Fabrication	30	1/5	6	3/5	18	4/5	24
Biomimicry	25	5/5	25	4/5	20	2/5	10
Durability	20	2/5	8	3/5	12	3/5	12
Replicability	15	1/5	3	3/5	9	4/5	12
Cost	5	1/5	1	3/5	3	4/5	4
Safety	5	5/5	5	5/5	5	5/5	5
Total	100	48		67		67	

Fig.9 Design Matrix

Future Works -Logan

- Materials
 - a. Perform procedure with Polyacrylamide to obtain ideal biomimicry
 - b. Test skull model with polyacrylamide
- Container
 - c. Adjust slicer model for 3D printing in MeshMixer
 - d. Add pockets for sinuses, ear canals, and hemorrhage
- Pitfalls
 - Pressurizing skull for MRI imaging
 - Drying Out

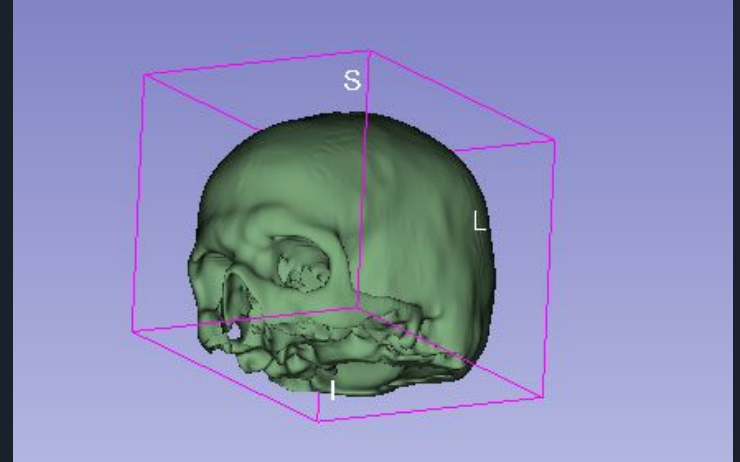


Fig.10 Current Working Design



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Citations

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