Biomedical Transparent Skull

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Abstract

Spatial and temporal deformation in the brain is likely a cause of traumatic brain injury. Under extreme loading conditions, the brain will deform causing both stress and strain on the tissue resulting in injury. In an effort to study the effects of these mechanical inputs, the brain must be studied under various conditions. Many models lack a physiological system that is accurate in capturing what truly happens during a traumatic brain injury.

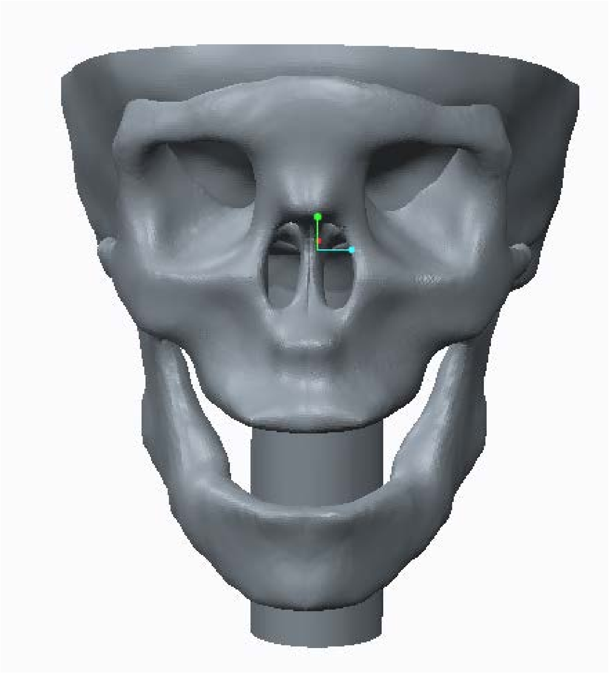
To accurately understand how the brain deforms, blunt trauma is simulated using a system consisting of a physiologically accurate brain and transparent skull. A 3D printed transparent skull was created out of VeroClear RGD810. Visual markers embedded on a brain mold can be tracked via high speed cameras when the skull is subjected to blunt trauma. Using these trackers, mechanical parameters such as principal tension, principal compression, and max shear can be measured.

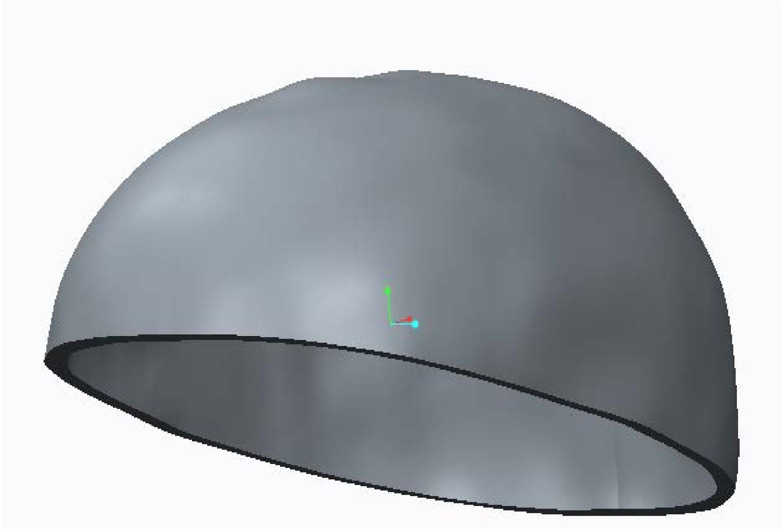
Customer Needs

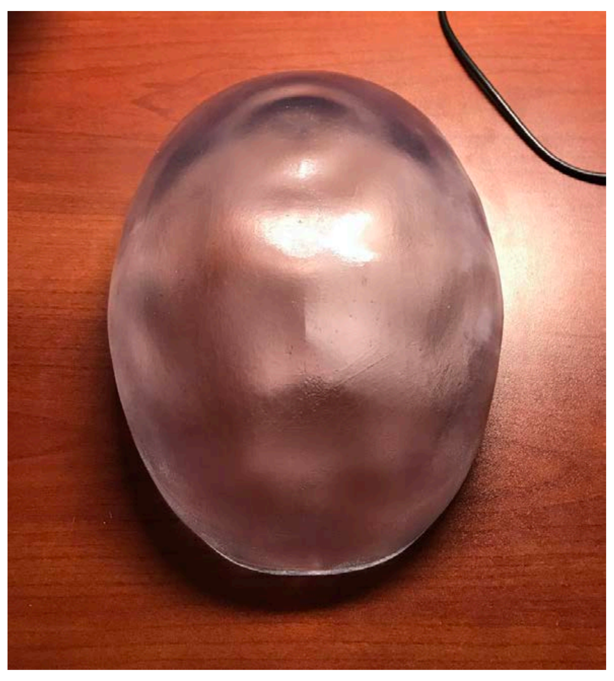
- Transparency
- Mechanical Properties Similar to bone
- Accurate physiological Property
- Feasible and cost effective

Design Concept

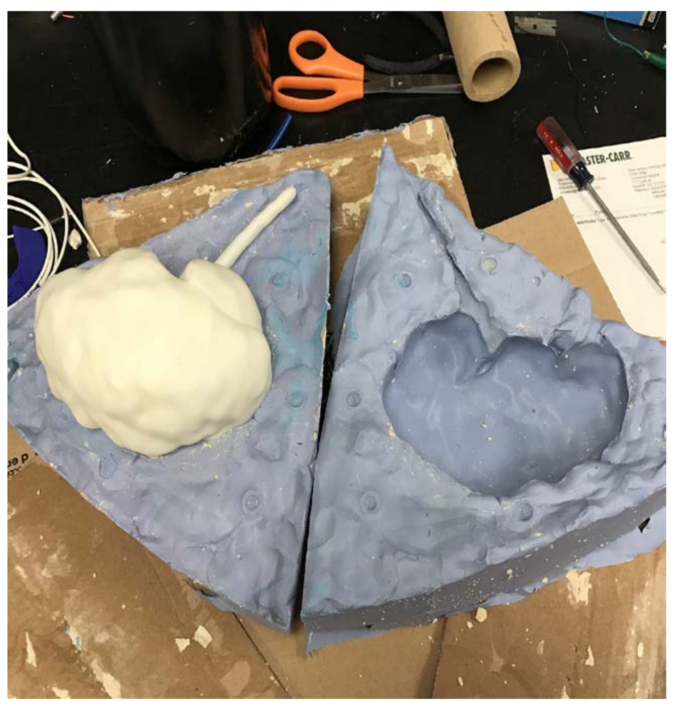
The 3D file was obtained by the Army Research Labs as it is the model of an 'average' human. The file was then 3D printed using VeroClear RGD810. A brain was casted using ballistic gelatin. Markers were then placed inside the brain and a camera can detect movement upon impact.







The brain was casted using a silicone mold called Oomoo 30. A 3D printed brain was used as the base for the mold. Ballistic gelatin was poured in to make a brain.



Impact testing was done using the CIBM^3 drop tower. Markers inside the skull were traced as the impactor hit the skull.

Test Plan

In order to test for properly test for the functioning of the Biomedical Transparent Skull, certain major categories needed to be addressed. These included: mechanical, physical, optical, volumetric, and system. The mechanical testing was completed via tensile testing, obtaining a value of 3.9 MPa. Optical testing yielded values of 87% for transmittance and 1.48 for the index of refraction. Physical testing was completed via the CAD file used to print, as this represented an average adult male skull, and therefore the dimensions were accurate to an actual skull. Volume testing could not be completed as this would require both halves of the skull to complete. However, this test is relatively simple, as the brain was designed to fit inside the skull. Finally, the system testing consisted of impact testing as well as visualization capability. The skull withstood the impact testing at 9 cm and 1.34 m/s, and markers were also able to seen using a backlight and reducing glare.

Acknowledgement

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References

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