Intracranial Hemorrhage (ICH) Model

Katherine Peterson (Leader), Michael McGovern (Communicator), Johnny Jansky (BPAG)
Jin Wook Hwang (BWIG), Zach Burmiester (BSAC)
Client: Dr. Walter Block Advisor: Dr. Paul Thompson

Abstract

Computed Tomography (CT) is currently the only imaging technique used to treat Intracranial Hemorrhage (ICH) [1]. The use of Magnetic Resonance Imaging (MRI) for guidance during ICH treatment is advantageous over CT due to the higher contrast and resolution provided. MR images allow a surgeon to find and drain plasma pockets in the clot in order to maximize the surface area interacting with the clot-busting rtPA. This can increase treatment speeds and reduce the devastating mental deficits caused by the hemorrhage.

Problem Definition

Motivation

- 10-15% of all strokes are caused by ICH
- ICH affects ~10,000 people in the U.S. each year [1,2]
- A clot as large as 60 mL forms in the parenchyma, causing massive loss of brain functionality
- Patients require assisted living for the remainder of life [3]

Current Treatment

- MISTIE Trials (CT guided) - the most successful treatment available, reduced clot volume by one half on average - but still variable [4,5]
- MRI guided treatments could make treatment faster and safer

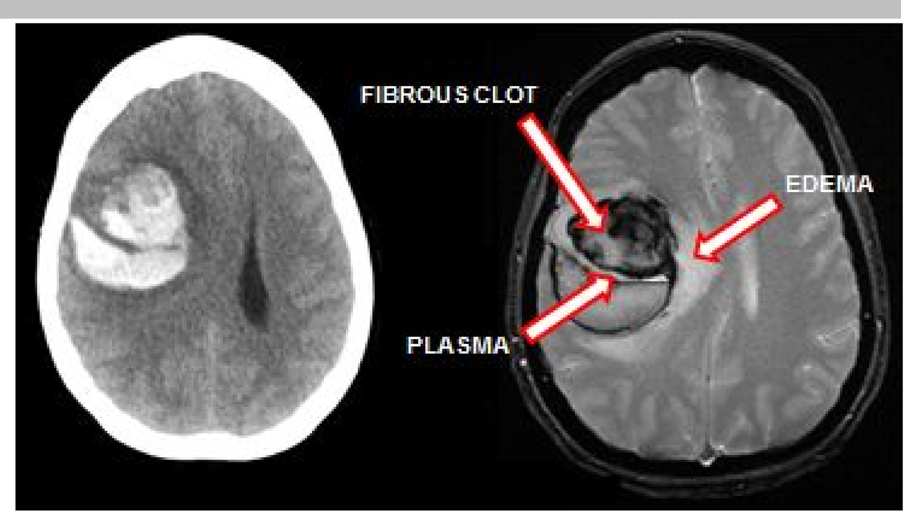


Figure 1: MR image (right) offers greater contrast and definition between the clot, plasma, and surrounding brain matter than CT (left). This allows for more personalized treatment [3]

Design Criteria and Constraints

- Surrounding material collapses around clot aspiration
- Appropriately models ICH in MRI
- Non-metallic materials
- Test and validate prototype
- Availability of blood, rtPA, and MRI scanner

Prototype and Testing

MR Image of Prototype

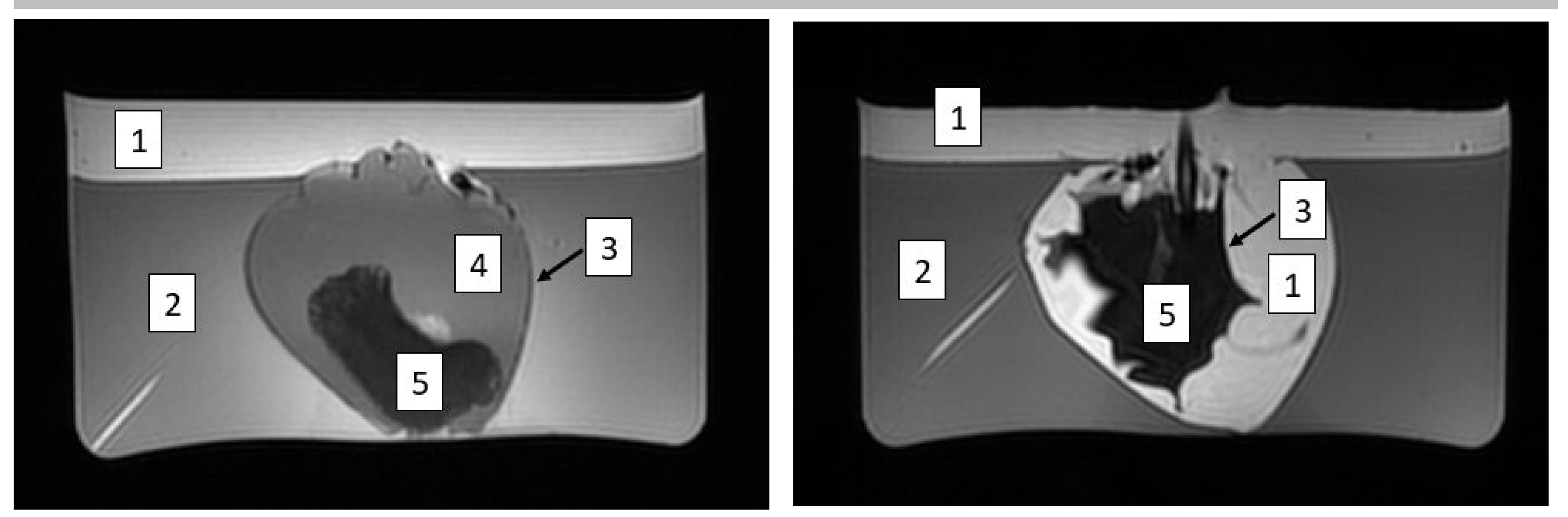


Figure 2: MR image of prototype before clot aspiration (left) and after aspiration (right). Hydrogel(1) filling in the void as plasma aspiration is visible. Materials of the images are as following :
1) Hydrogel 2) Agarose gel 3) LDPE membrane 4) Plasma 5) Fibrous clot

Clot Aspiration

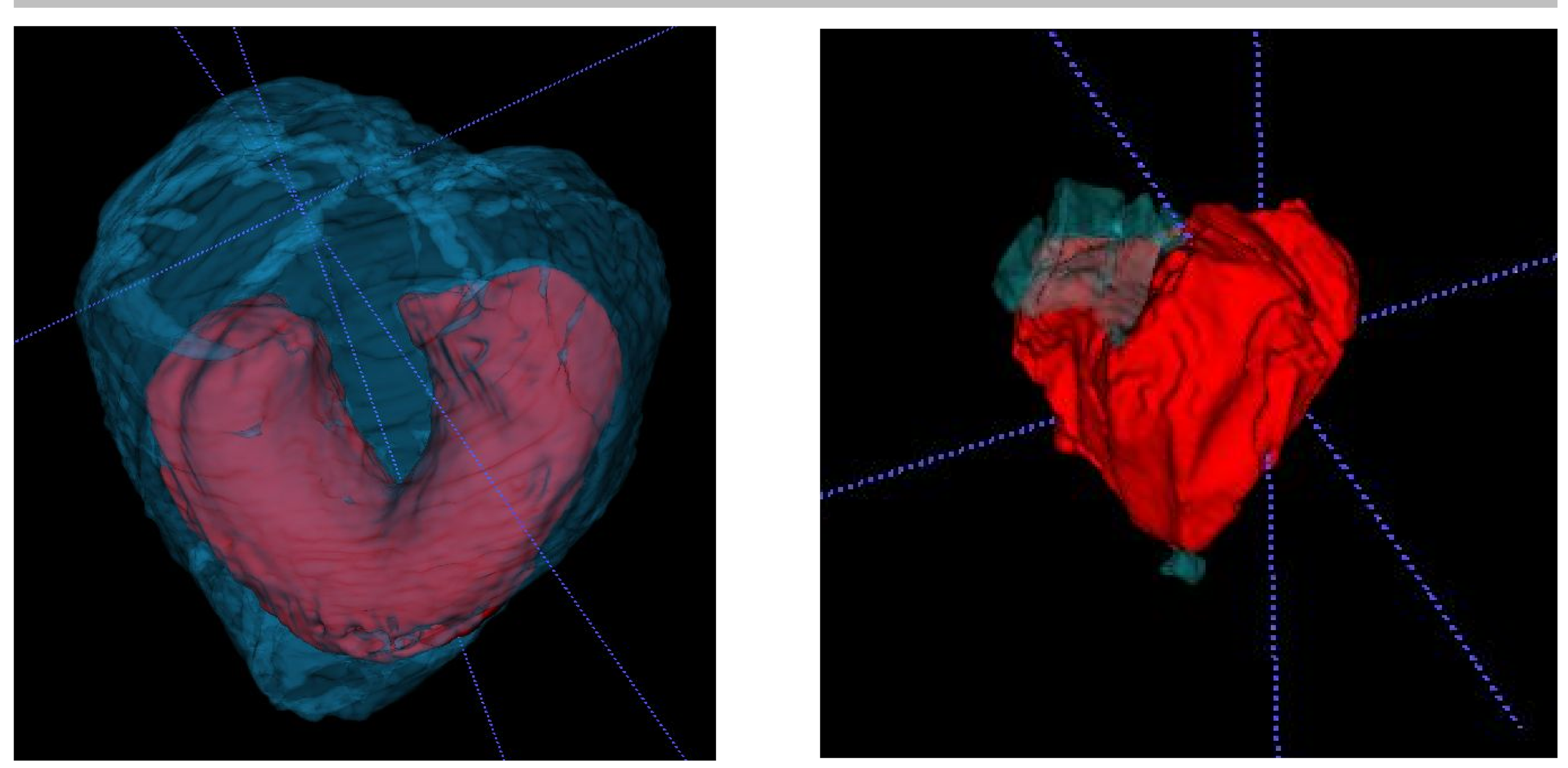
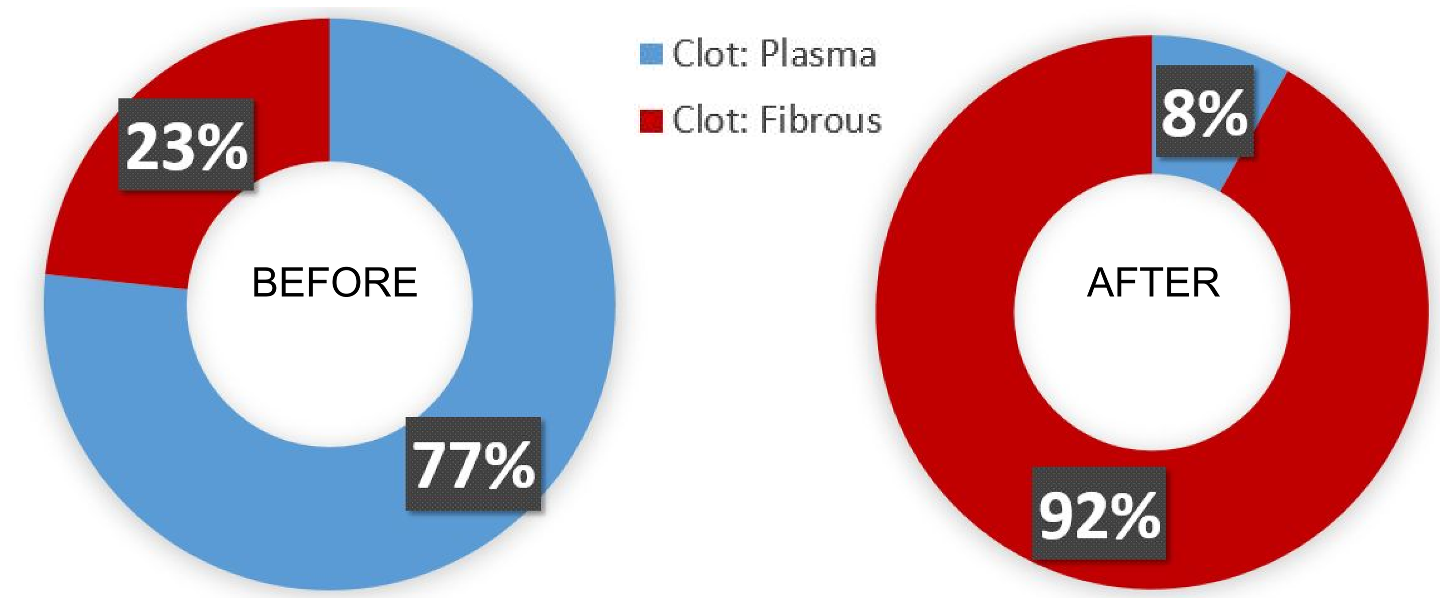


Figure 3: Visualization of before (left) and after (right) the clot aspiration using ITK snap. The red portion illustrates the fibrous clot while transparent blue represents the plasma. Clot shrinkage is apparent with reduced plasma after the aspiration

Experimental Data

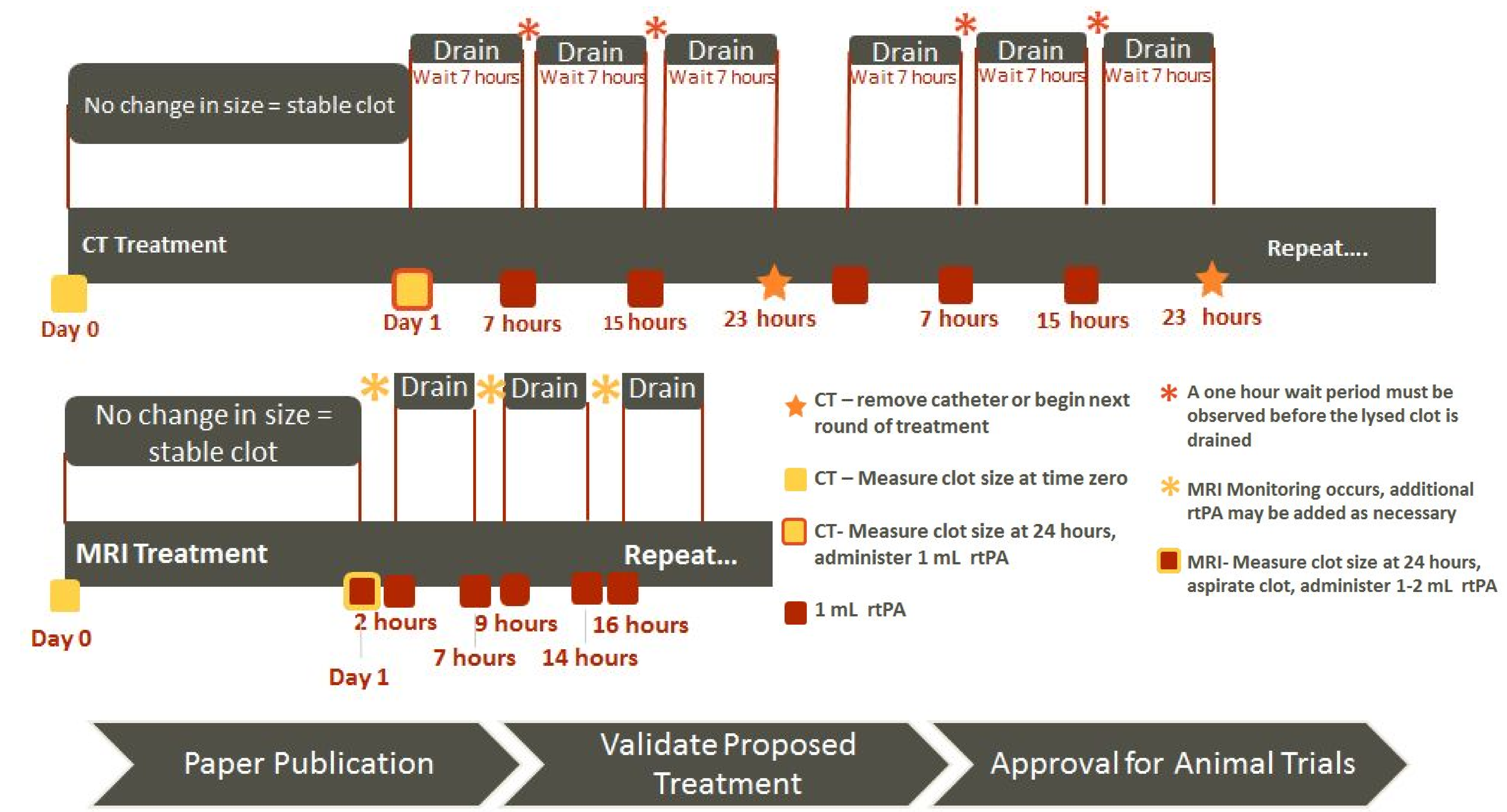
Clot Composition Before and After Plasma Aspiration



Procedures	Total	Plasma	Fibrous
Before Plasma Aspiration (mL)	58.89	45.16	13.73
After Plasma Aspiration (mL)	13.251	1.081	12.17
Decrease in Volume (%)	77.5	97.6	11.4

Figure 4: Only one trial was performed using the prototyped model. The circle graphs show that aspiration was effective at removing excess plasma, leaving behind only 8% of removable plasma. The volumes were calculated using computer analysis of the MR images.

Future Work



References

[1] Roger VL, Go AS, et. al. as cited in Walter Block's "Stroke Summary Aims," unpublished.
[2] Fan JS, Huang HH, Chen YC, Yen DH, Kao WF, Huang MS, Huang CI, Lee CH as cited in Walter Block's "Stroke Summary Aims," unpublished.
[3] Walter Block. "Stroke Summary Aims," unpublished.
[4] Mendelow AD, Gregson BA, Fernandes HM, Murray GD, Teasdale GM, Hope DT, Karimi A, Shaw MD, Barer DH as cited in Walter Block. "Stroke Summary Aims," unpublished.