DEPARTMENT OF

Biomedical Engineering

UNIVERSITY OF WISCONSIN–MADISON

Intracranial Hemorrhage Model

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Dr. Paul Thompson - Advisor

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Dr. Walter Block - Client

Wisconsin Institute for Medical Research
Professor of Medical Imaging Physics
TherVoyant - Specialize in MRI Guidance


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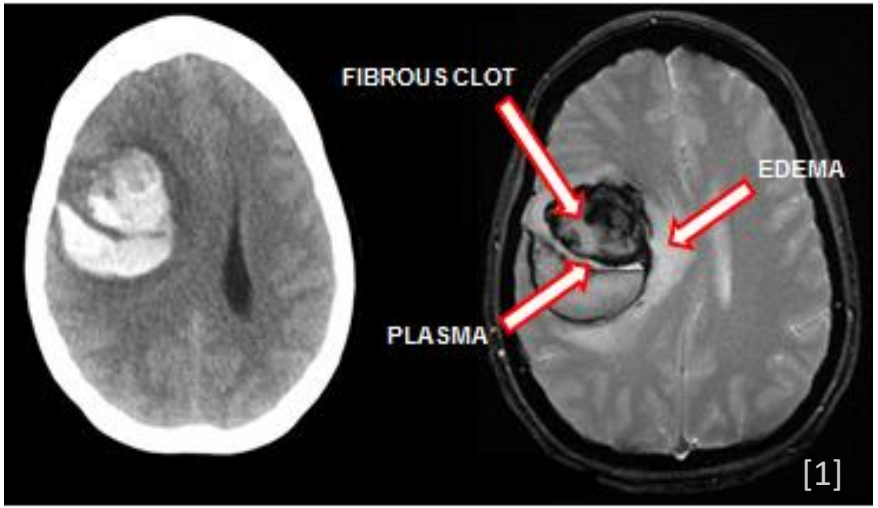
Problem Statement

Using MR imaging to monitor clot reduction therapies has potential to shorten the treatment duration, and increase the amount of clot removed. In order to validate ICH therapies with MRI, a brain model with a blood clot must be created which accurately replicates current procedures.



Design Constraints

Availability of blood and rtPA

Availability of MRI scanner

Non-metallic materials

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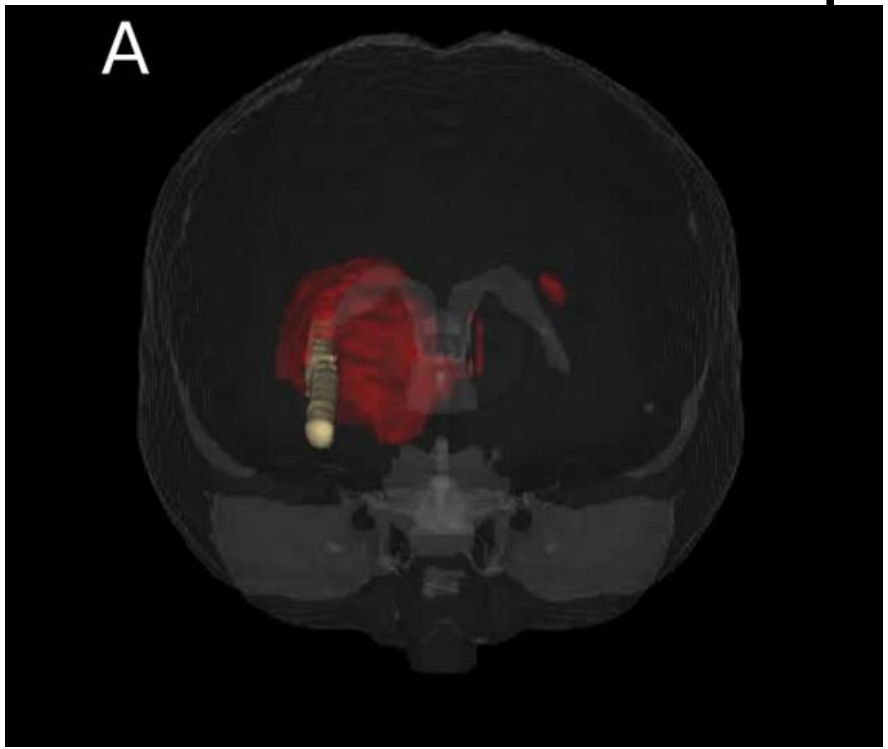
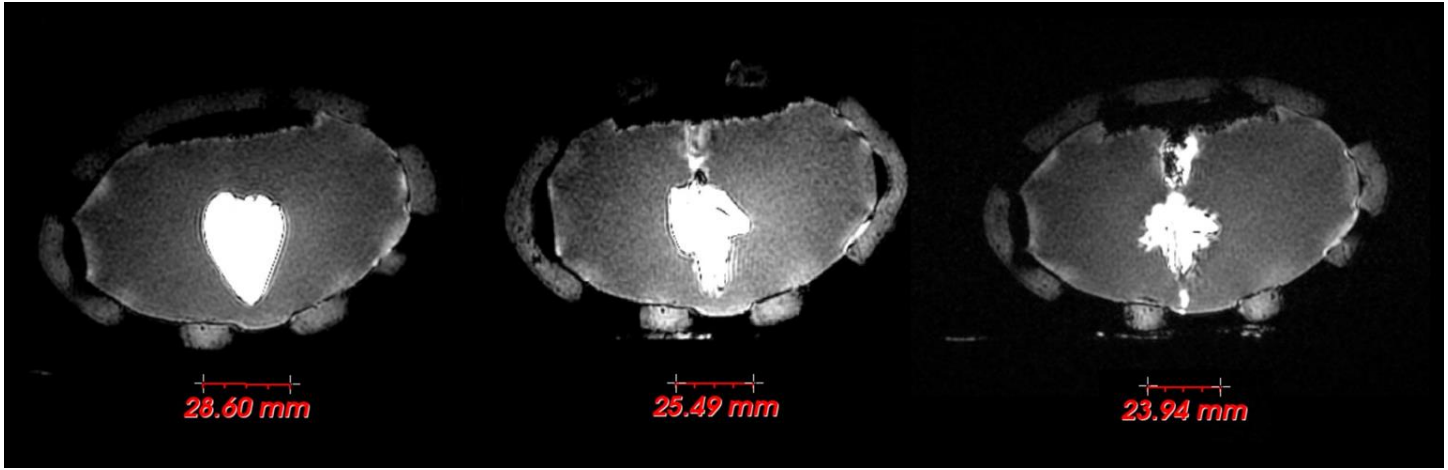
ICH Treatment Technique

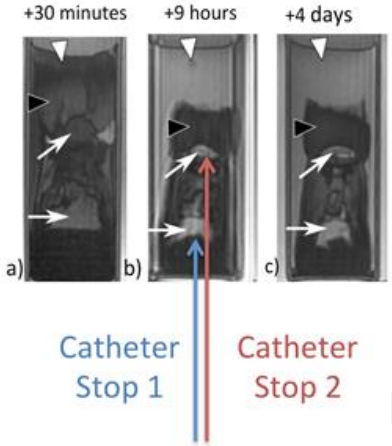


Prior Work



Timeline of Achievement

MR guidance Platform → **Plasma Extraction** → rtPA Tracing → Procedure Simulation with final Brain Model



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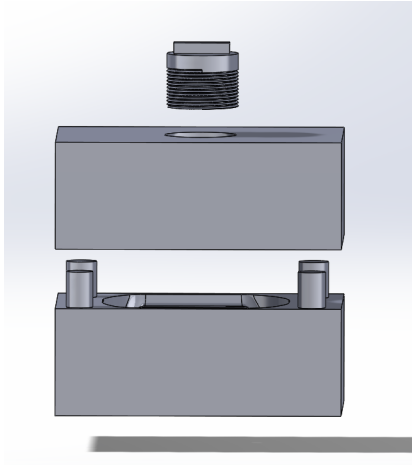

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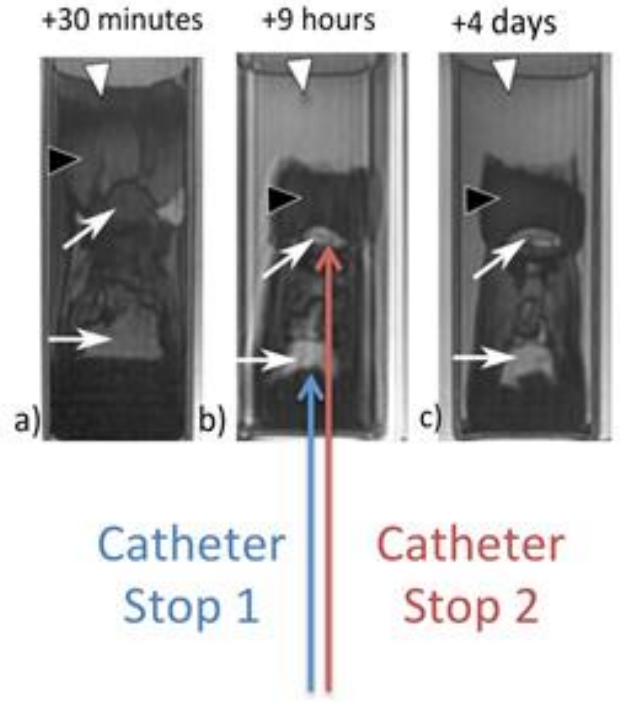
Plasma Extraction: Significance

- Plasma must be removed as first step in actual procedure
- This provides fast, temporary relief to patient by reducing pressure
- Maximizes rtPA clot lysing effectiveness



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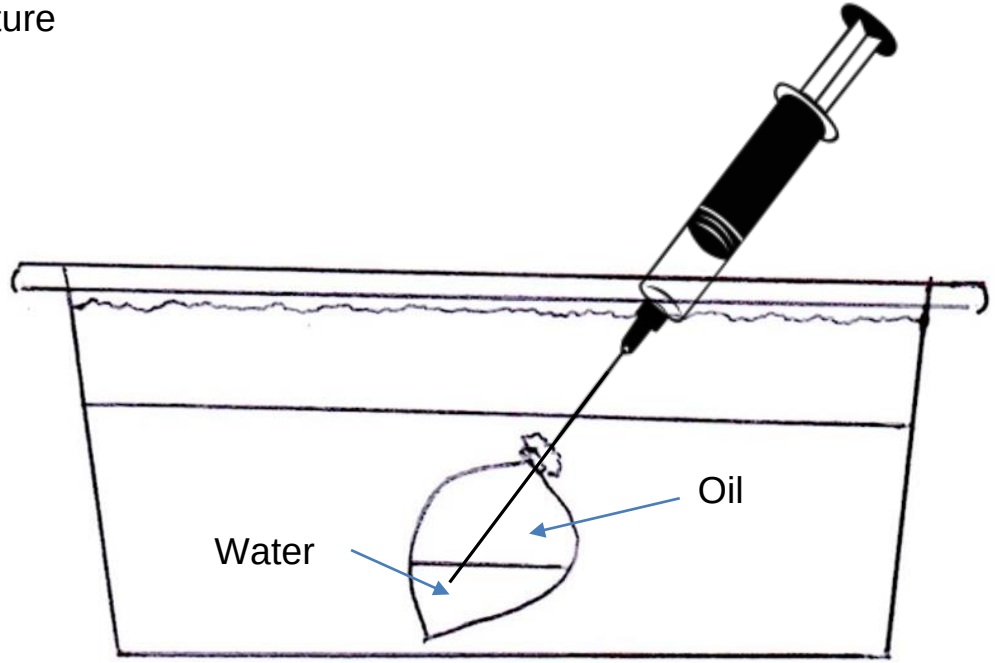
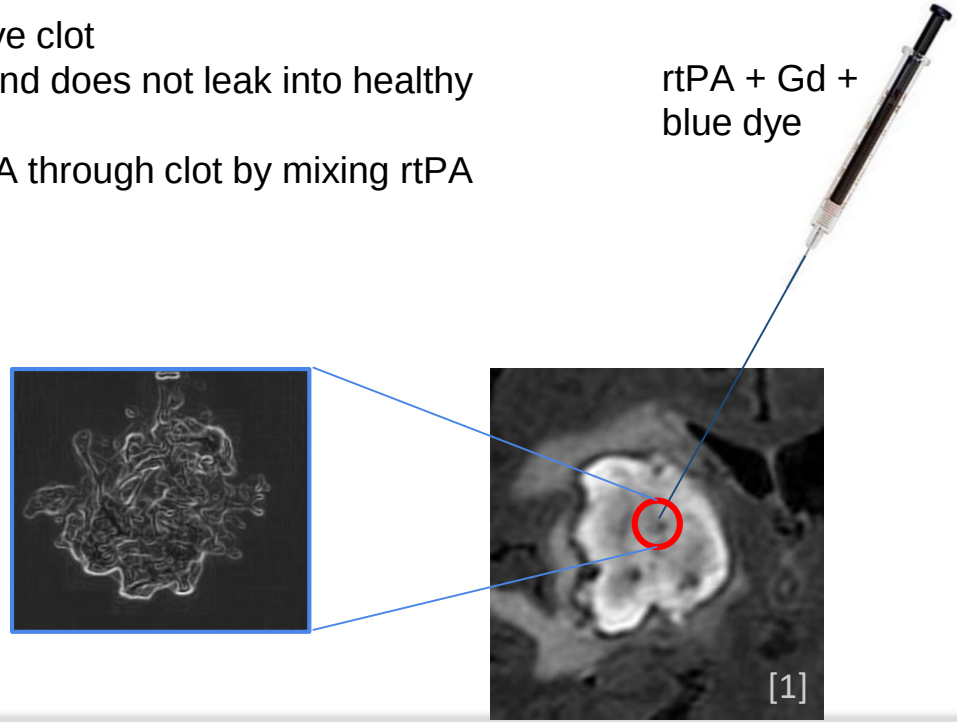
Plasma Extraction: Experiment

- Confirm clot stability during puncture
- No air bubbles induced
- Visually confirm lack of air
- Measure input/output volumes



rtPA Tracking: Significance

- rtPA lyses fibrinogen in order to dissolve clot
- Must ensure rtPA remains inside clot and does not leak into healthy surrounding tissue
- Possible solution:Track diffusion of rtPA through clot by mixing rtPA with gadolinium



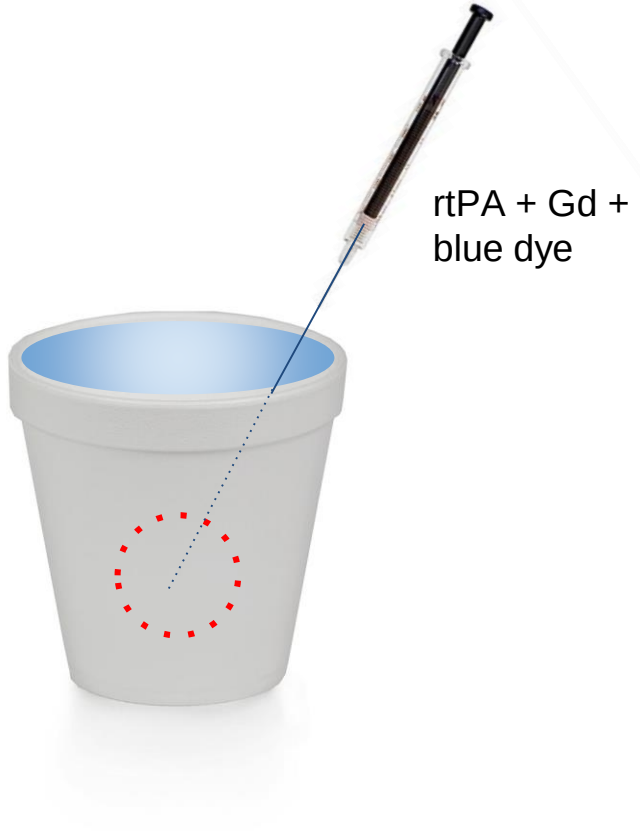
rtPA Tracking: Experiment

Experiment:

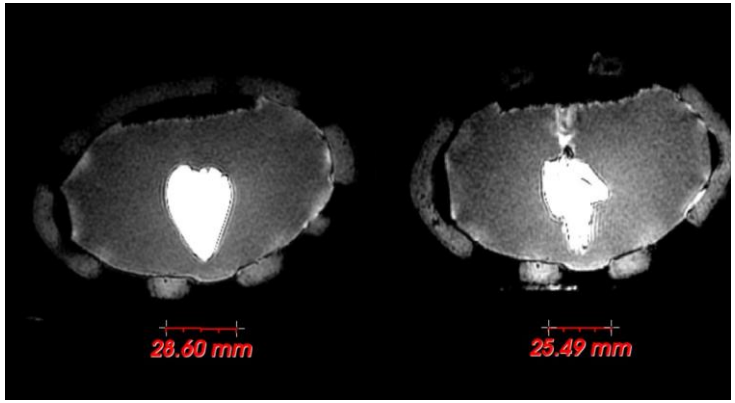
- Hydrogel in a styrofoam cup
- Inject rtPA + Gd + Blue dye, allow to diffuse
- MRI cross sections
- Freeze and Cross section and determine accuracy of tracking rtPA with Gd, compare with MRI images

Measurement:

- Gadolinium does not bind directly to rtPA
- In progress



Testing

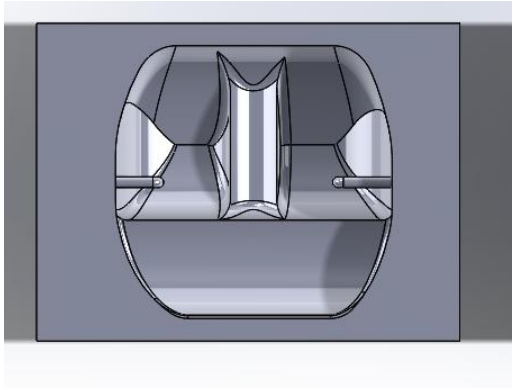


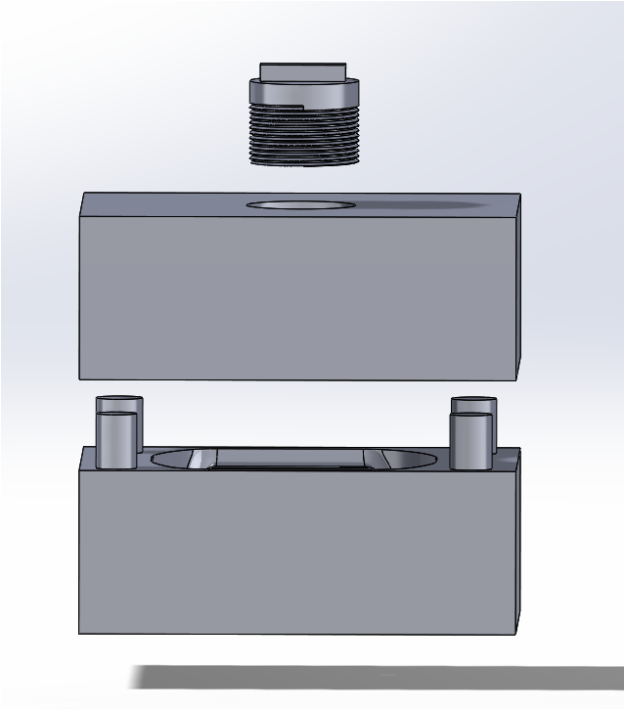
ICH Simulation: Final test

Qualities	CT Treatment	MRI Treatment
Clot Visualization	✗	✓
Fast Imaging	✓	✗
No Radiation Exposure	✗	✓
Precise Guidance	✗	✓
Customized Drug Dosage	✗	✓
Outcome Variability	✗	✓

Improvements

- Need the ability to keep the clot stable
- Port where we can fill hydrogel
- Access point to “complete” procedure





Final Product

Kit of required materials to create the model

- Main shell
- Hydrogel
- Clot

User Manual

- Assembly of model and clot
- Testing protocol and setup
- Material Safety Data Sheet

Budget

Material	Quantity	Cost
Dispensing Needles	5	$ 7.99
Syringe with blunt needle	10	$ 7.99
Quick Fill Balloon	30	$ 12.99
Water Balloon	30	$ 5.99
Plasti Dip Clear	1	$ 12.68
Rubber Shell	2	$ 15.26
Sodium Polyacrylate	50 g	$ 8.15
LDPE bags	30	$ 3.99
Twine/Rubber Band	20 feet	$ 5.99
Gadolinium*	10g	$101.99
rtPA*	100uL	$329.00
MRI Rent*	1 hr	$225.00
Total		$737.02

Acknowledgements

Dr. Walter Block
Dr. Ethan Brodsky - WIMR
Miles Olson – WIMR
Dr. Paul Thompson

References

[1] Walter B. “Stroke Summary Aims,” unpublished.
[2] https://www.google.com/siemens-magetom-aera-1-5-t
[3] https://www.google.com/whole-blood-clotting-test-
[4] http://www.3ders.org/articles/20160201-3d-printed-brain-model-reveals-physics-of-how-human-brains-fold.html. 2016.
[5] R. Pomfret, G. Miranpuri, and K. Sillay, “The Substitute Brain and the Potential of the Gel Model,” Annals of Neurosciences, vol. 20, no. 3, Jan. 2013.