The Thrombectomers: Update 3

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Problem Statement

- Vacuum Thrombectomy: Procedure to remove cerebral thrombi using vacuum pressure
- There remains room for the procedure to be optimized.
    - Current success rate: 78%
- Our theory: Increasing ICP will alter pressure gradients in the vessel system and increase the success rate of direct aspiration thrombectomy.
- Need a physical model of the cranial cavity that accurately represents ICP, and allows pressure to be altered to determine the suction force at the tip of the catheter.

Needs Assessment

- Model Efficacy
  - Must accurately model and measure intracranial pressure (ICP)
  - Must accurately model blood vessel shape and size in which the vacuum catheter will be inserted
  - Must respond to an increase in ICP in a manner that accurately replicates physiology and anatomy
  - Must accurately model blood flow through vessels in the brain during normal conditions as well as during elevated ICP conditions.

- Cost Efficacy
  - Model should be reusable and affordable

- Medical Provider Compatibility
  - Ability for physicians and students to practice thrombectomy on the model

Gantt Chart

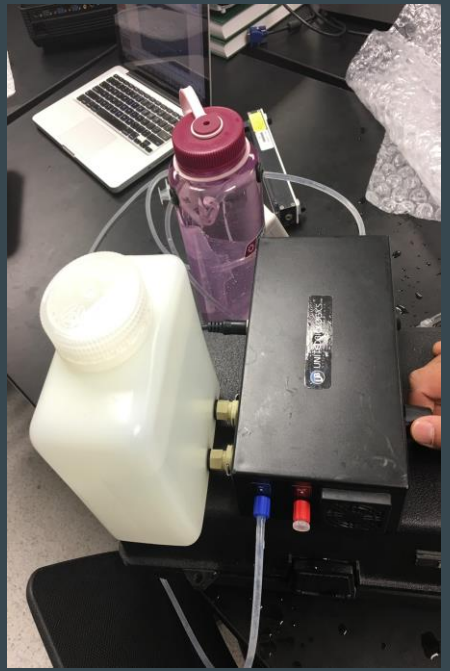
Task	Start Date	End Date	Timeline	Hours
Overall time period	9/26	4/23		
Meet with Dr. Froehler weekly	9/26	4/23		160
Brainstorm ideas for model design	9/26	11/21		240
Settle on initial model design	10/18	11/8		30
Order Parts	11/1	11/29		12
Build first prototype	11/14	12/8		32
Evaluate efficacy of first model	12/8	1/10		40
Improve upon model	12/19	3/5		20
Iteratively improve model until it matches our desired function	1/10	3/5		30
Finalize model	3/5	3/22		10
Run experiments with direct aspiration catheter	3/5	3/31		10
Collect and analyze data	3/20	4/7		40
Put together poster for Design Day	4/1	4/23		40
Present at Design Day	4/22	4/23		15

Review of Previous Accomplishments

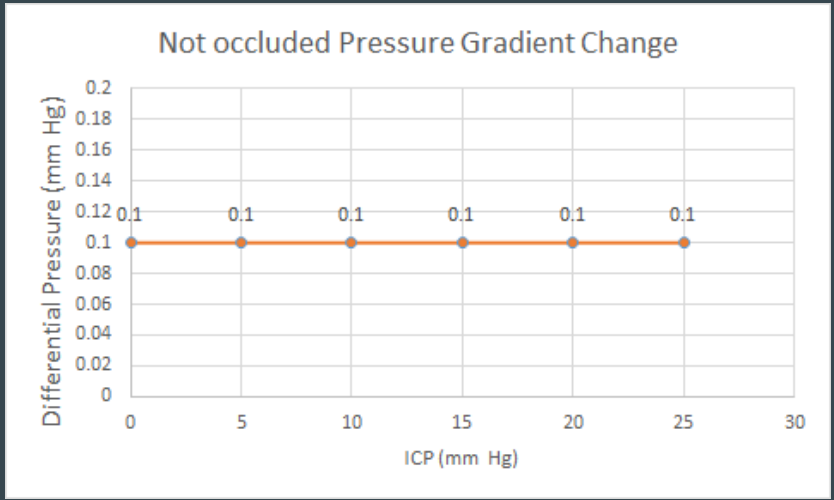
- Construction of 2nd prototype
  - Advantages
    - Higher MCA in and out ports for better access to clot
    - Higher ICP pressure controller input
    - Pressure gauge measuring difference between ICP and atmosphere
  - Disadvantages
    - Lack of differential pressure gauge to measure pressure across occlusion
    - Need for thinner-wall tubing to better mimic arterial features
    - Unsealed leaks allowed for losses in pressure transduction

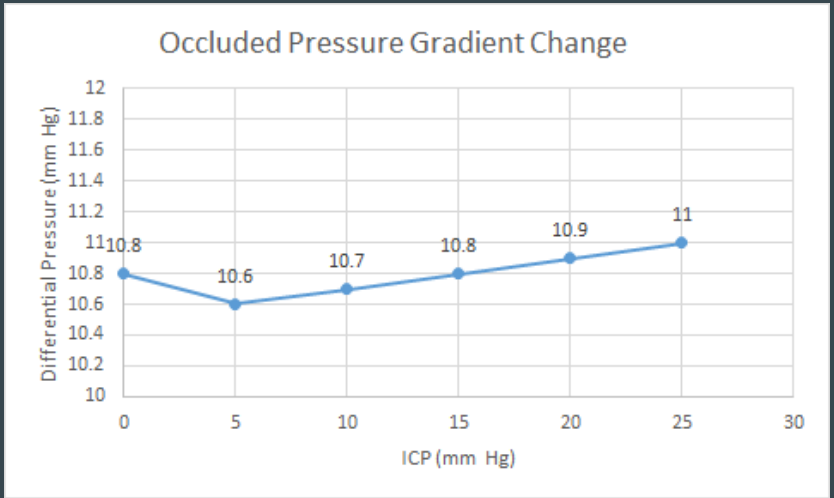
New Developments

- New pressure gauge across the occlusion
- Preliminary experiment looking at pressure difference change due to ICP change in flow and no flow conditions
- Received from Dr. Froehler:
  - Pump
  - Connectors
  - Tubing



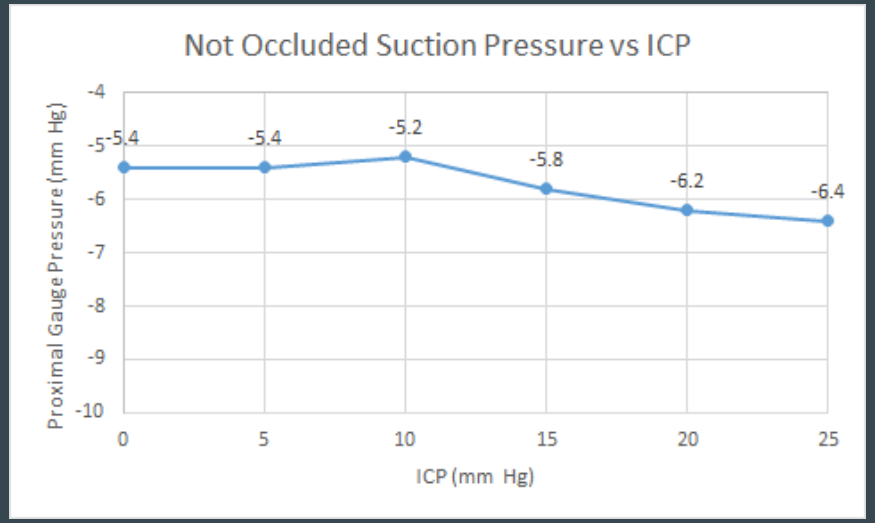
Experimental Data: Differential Pressure

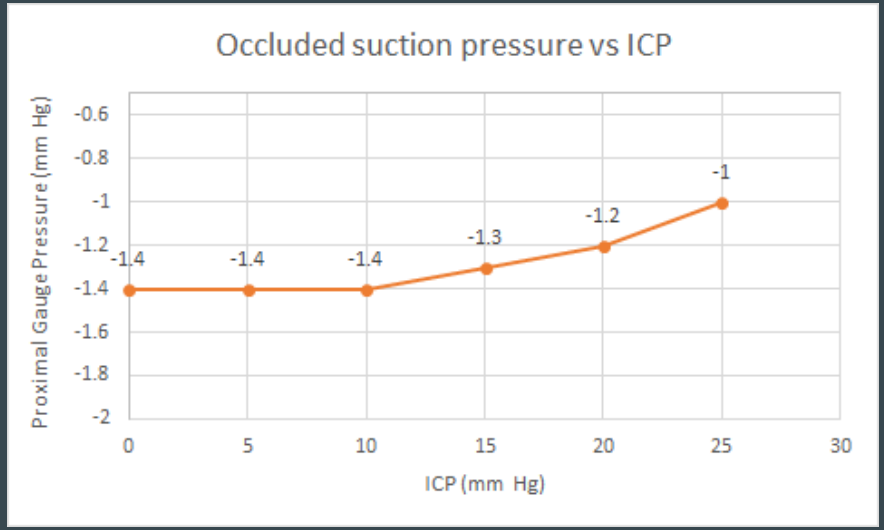




- No large correlation between ICP and pressure across the clot

Experimental Data: Ideal Suction Pressure





1 mm hg * (Suction surface Area) $=2.8 \times 10^{-4}$ pounds force

- No large correlation between proximal gage pressure and ICP in our preliminary data

Future Directions

- Completely seal model - no leaks
- Install thinner walled tubing
  - Longer length of tubing inside the compartment
- Conduct more controlled experiments
- Investigate effect of pressure on vacuum pressure at catheter tip
- Add capillary bed resistance valve
- Improve model with new parts