The Thrombectomers: Update 4

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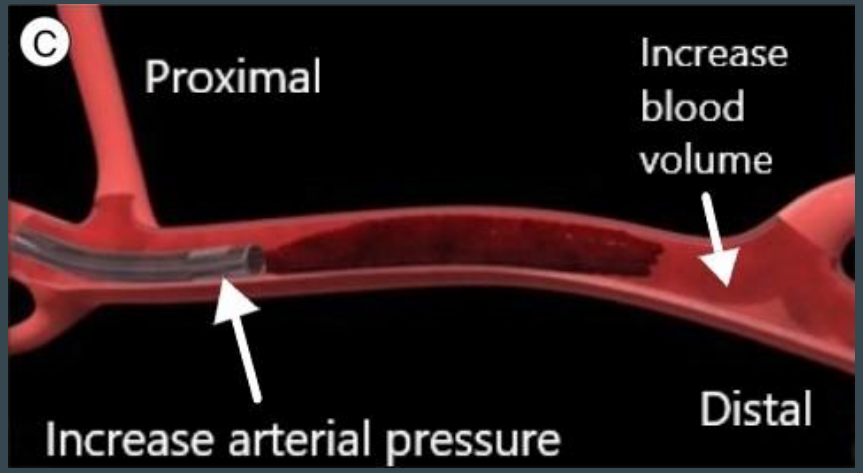
Problem Statement

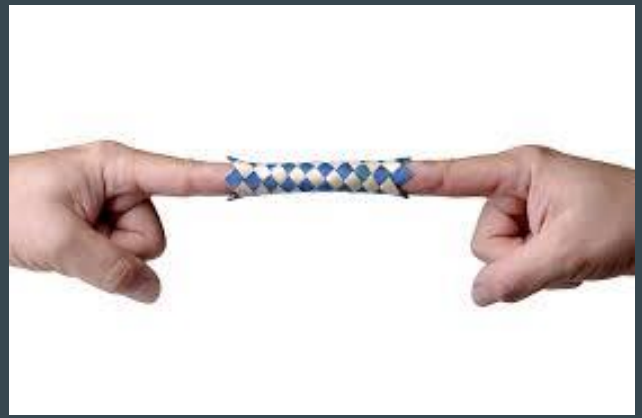
- Vacuum Thrombectomy: Procedure to remove cerebral thrombi using vacuum pressure
- There remains room for the procedure to be optimized.
    - Current success rate: 78%
- Need a physical model of the cranial cavity that accurately represents ICP, and allows pressure to be altered to determine the suction force at the tip of the catheter.

Movie

Our Theory

- Increase ICP by blocking jugular flow
  - Monro-Kellie doctrine: the cranial compartment is incompressible and the volume inside the cranium is fixed
- 2 mechanisms:
  1. Increase arterial pressure proximal to the clot
     a. Allows the surgeon to pull more vacuum pressure = more suction force
  2. Increase blood volume distal to the clot/reduce pressure gradient across the clot
     a. Similar to Chinese finger trap





Needs Assessment

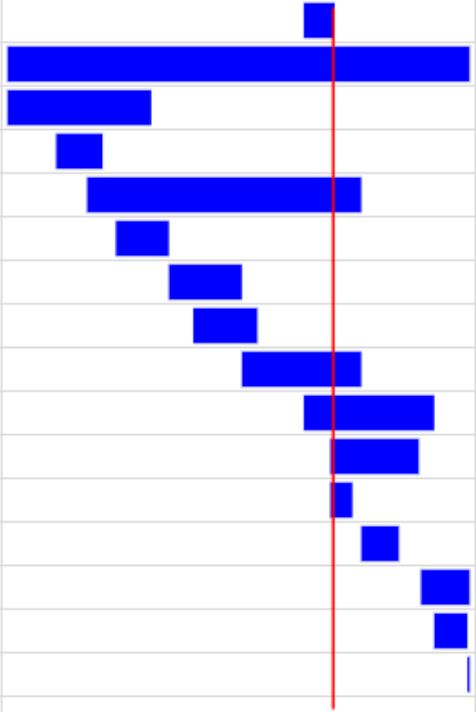
- Model Efficacy
  - Must accurately model and measure intracranial pressure (ICP)
  - Must accurately model blood vessel shape and size in which the vacuum catheter will be inserted
  - Must respond to an increase in ICP in a manner that accurately replicates physiology and anatomy
  - Must accurately 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

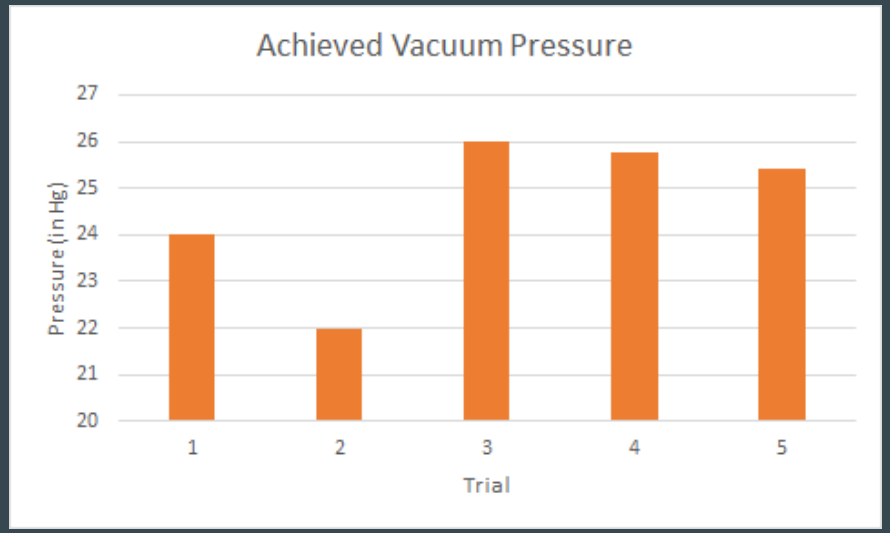
Task	Start Date	End Date	Timeline	Hours
Overall time period	9/26	4/23		
Time Period of work for this presentation	2/7	2/21		
Meet with Dr. Froehler weekly	9/26	4/23		160
Brainstorm ideas for initial prototypes	9/26	11/30		60
Settle on initial model design	10/18	11/8		30
Order Parts	11/1	3/5		60
Build first prototype	11/14	12/8		32
Evaluate efficacy of first model	12/8	1/10		20
Improve upon first model	12/19	1/17		20
Create second prototype and iteratively improve	1/10	3/5		120
Collect and analyze data	2/7	4/7		40
Run experiments with direct aspiration catheter	2/19	3/31		30
Create System for evaluation of suction force tests	2/19	3/1		12
Finalize model	3/5	3/22		10
Put together poster for Design Day	4/1	4/23		40
If applicable begin marketing and trials	4/7	4/22		40
Present at Design Day	4/22	4/23		15

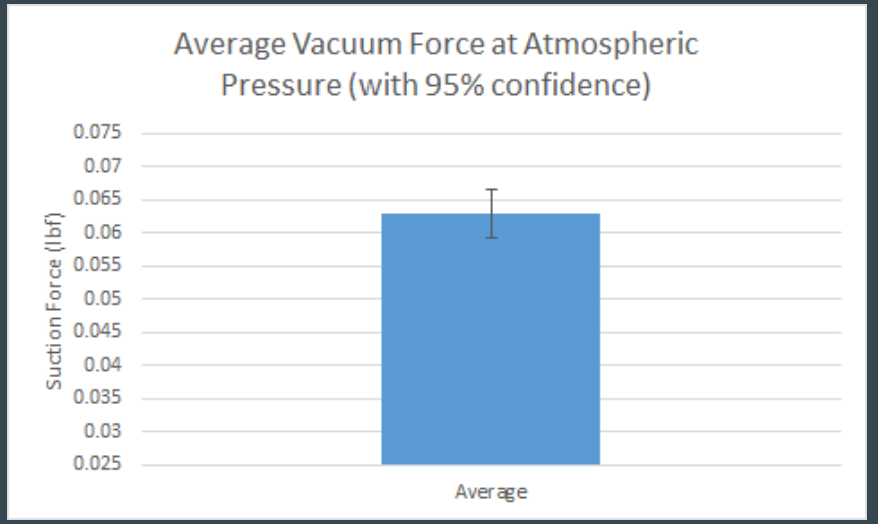


Review of Last Prototype

- Accomplishments:
  - Addition of pressure gauge across occlusion
  - Preliminary experiments involving relationships between intracranial pressure and arterial pressure of tubular structure.
  - Use of electric pump to mimic semi-pulsatile flow in arteries.
- Drawbacks:
  - Lack of sealant to take care of leaks.
  - Need for thinner walled tubing that is a more accurate model of the cranial arteries

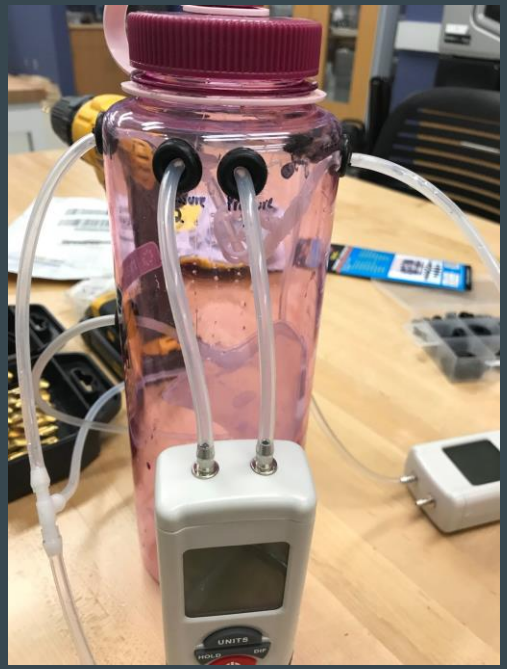
Atmospheric Suction Force Tests



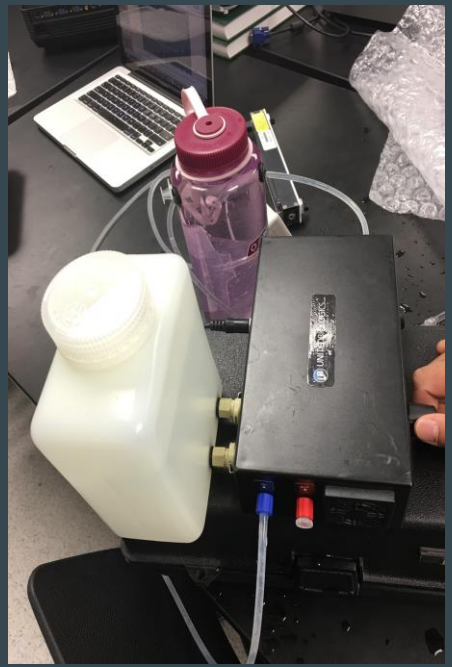


Current issues with pump tests

Low Sampling Rate



Imprecise Flow Rate



Endeavors in the Making

- Pursuit of thinner walled tubing
  - Communication with CELA
    - No bueno
  - Search for viable dealers
  - Construction of cloth-based tubing reservoir
  - Potential for mechanical testing to compare tubing with actual arteries.
- Methods to investigate effect of ICP on vacuum pressure
  - Inserting catheter tip into area of ICP control, then measuring negative pressure through rotating hemostatic valve.
- Looking for small strain gauge to measure catheter suction force

Hey Josh,

We do not have anything that depicts/simulates the cranial arteries. The best we have is an IV/arterial arm trainer. The tubing that is used is regular rubber tubing.

Mujtaba