Mechanical model for neuro-endoscopic surgery simulation

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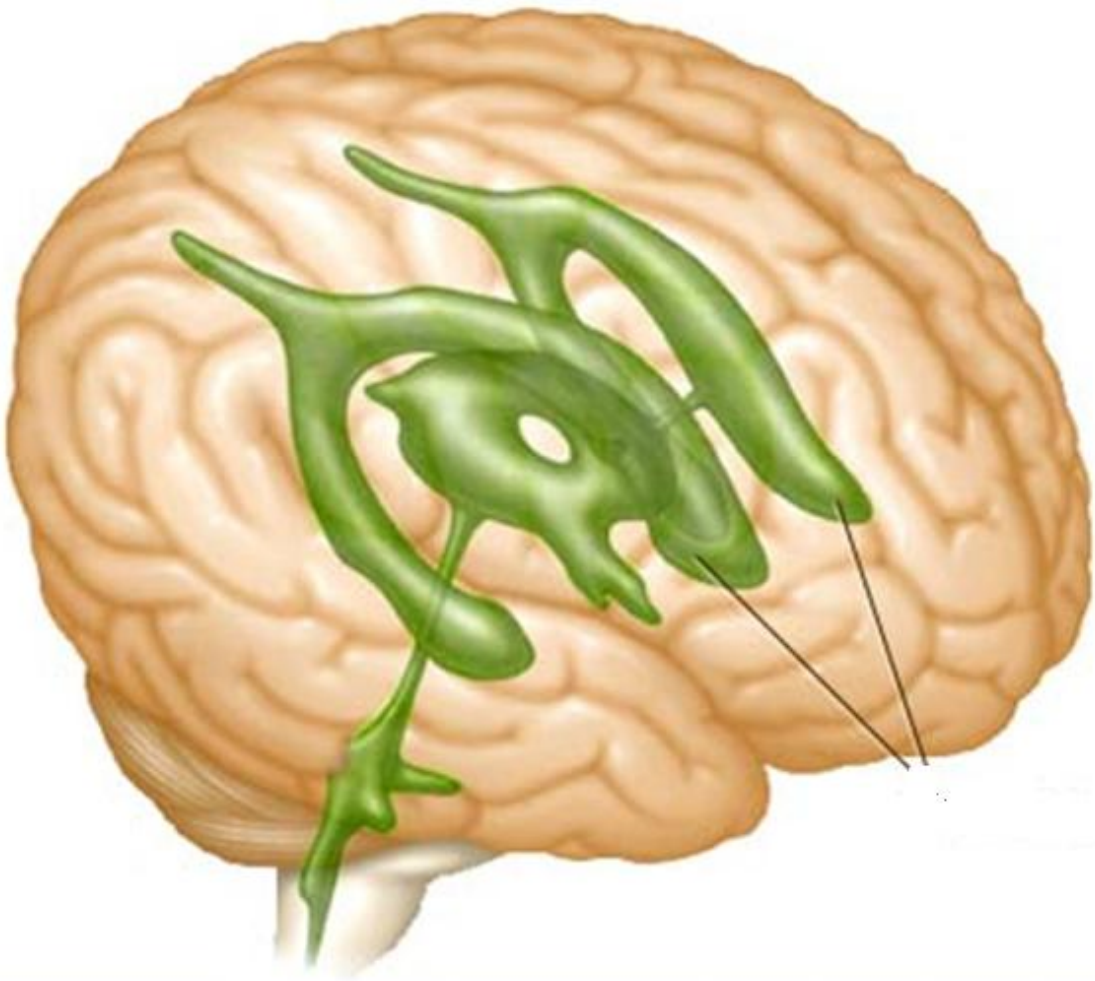
Overview

- Background and Motivation
- Client Requirements
- Problem Statement
- Force Sensor Design
- Injection Mold Ventricle System
- Fluid Filled Ventricles
- Final Design Selection
- Future Work

Background

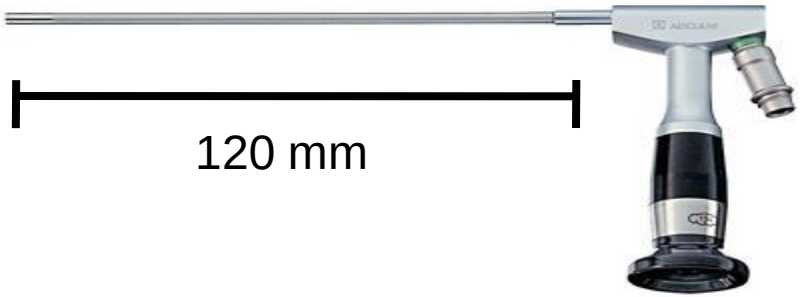
- Ventricular System
  - Located in cerebrum
  - 4 ventricles
  - Cerebral aqueduct
- Function
  - Produces CSF

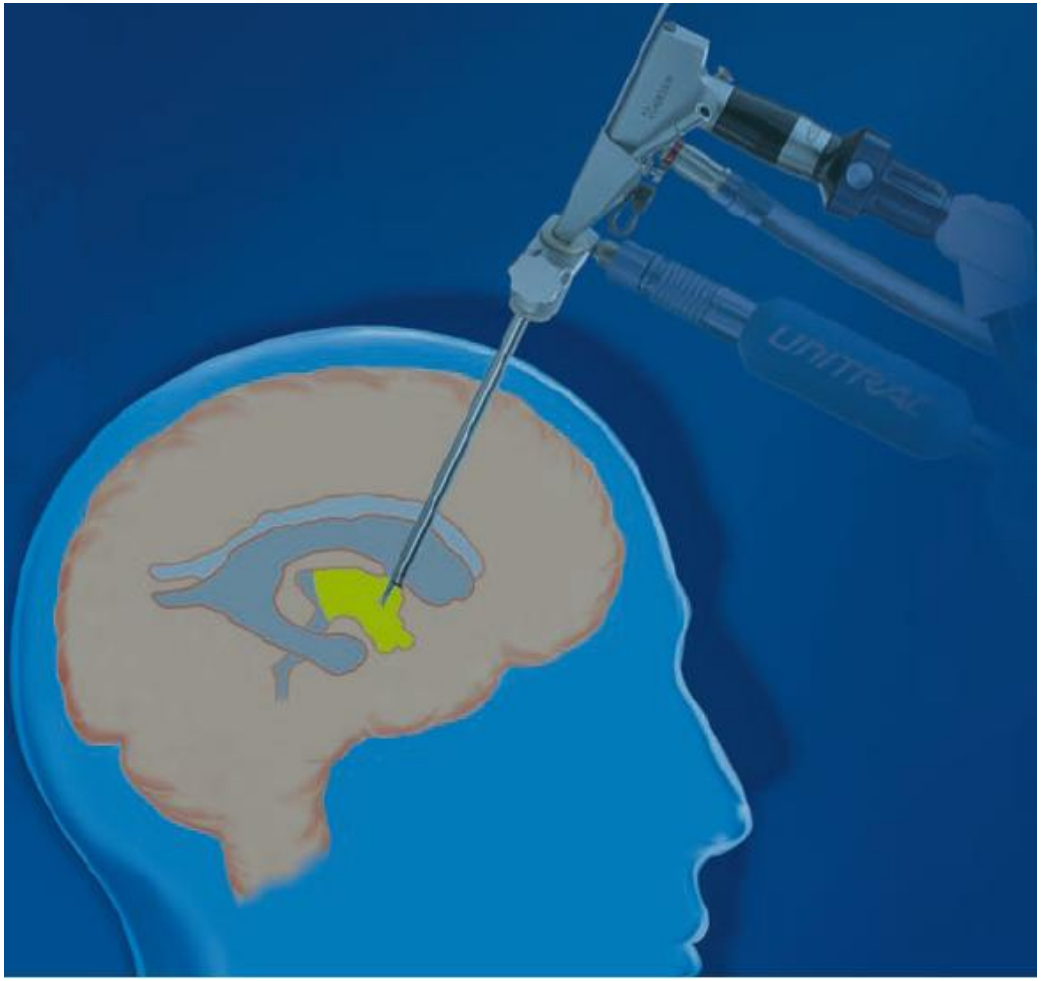


Endoscopic Third Ventriculoscopy

- Removes blockage in cerebral aqueduct

Endoscope





Reasons for Surgery

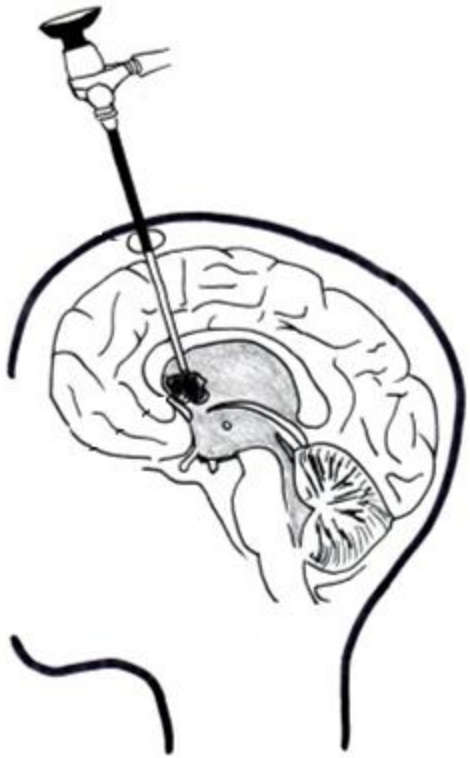
- Hydrocephalus
  - Fluid buildup in brain
  - Results in swelling
- Blockages of cerebral aqueduct
  - Swelling
  - Tumor
  - Edema

Motivation

- Current method for surgical practice
  - Cadavers
  - First surgery on patients
- Existing devices not specific for Endoscopic Third Ventriculoscopy

Client Requirements

- Simulate endoscopic 3rd ventriculoscopy
- Anatomically correct
- Up to 6.2 mm diameter endoscope
- Withstand daily use
- Compatible with current equipment



Problem Statement

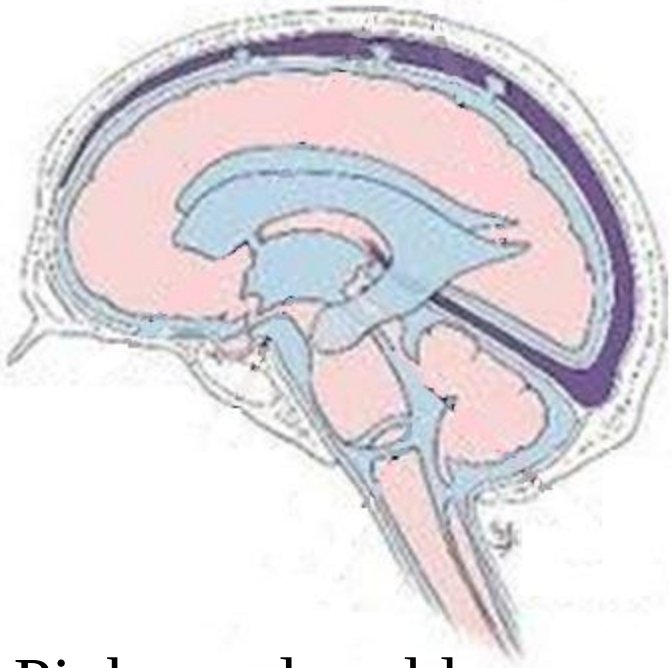
- Need surgical simulator for Endoscopic Third Ventriculoscopy

- Model ventricular system
  - Practice surgeries
  - Patients not subject to initial trial surgeries

- Model must:
  - Be anatomically correct
  - Allow practice control of fine motor skills
  - Practice angle of endoscope insertion into the brain

Injection Mold Ventricle System

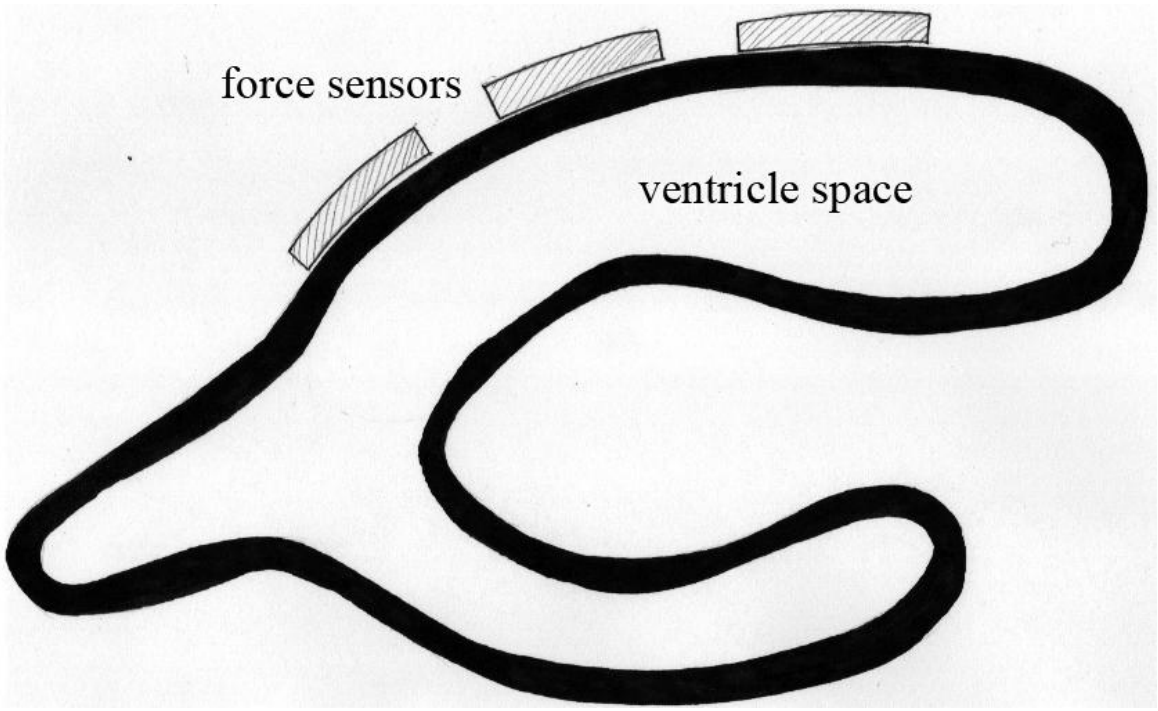
- Mold from a cast of the ventricles
  - 3D rendering from MRI
  - Cast from Rapid Prototyping
- Liquid Injection
  - Gel mold
- Ability to be mass-produced



Pink = gel mold
Blue = ventricle spaces

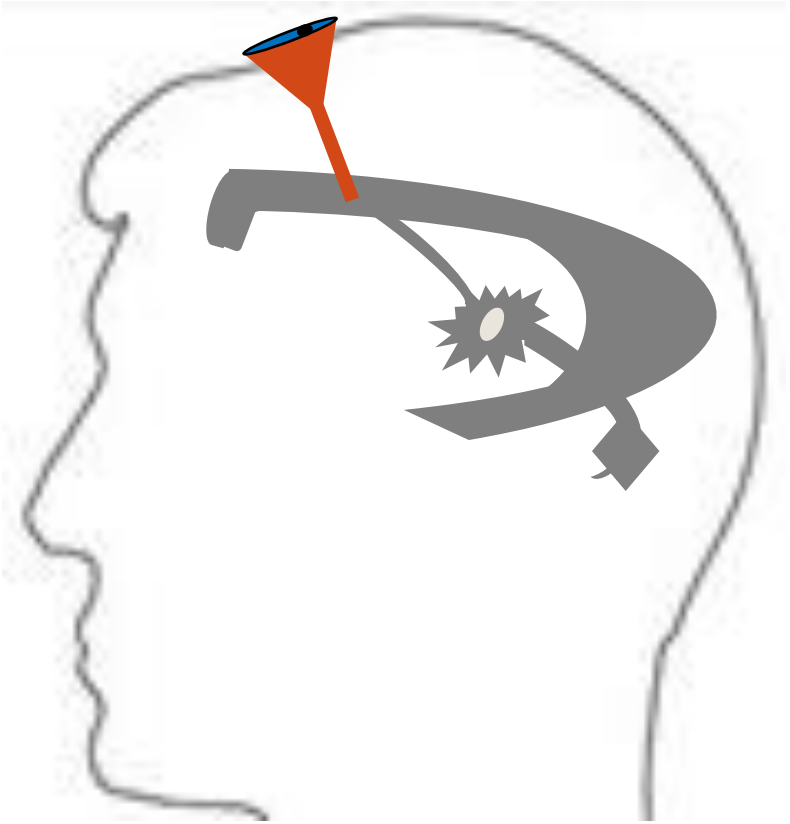
Force Sensor Design

- Rapid prototype cast of ventricles
  - Thin walls
  - Supporting gel outside force sensors
- Force sensors on outside walls
  - Threshold force
  - Buzzer
- Immediate feedback to surgeon



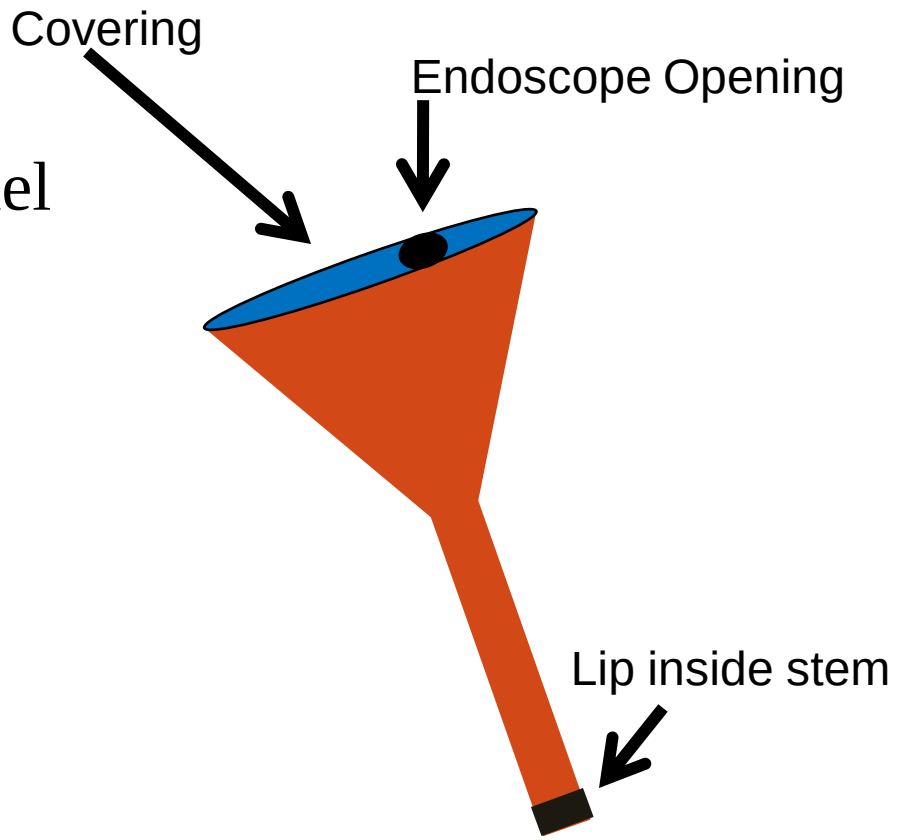
Fluid Filled Ventricles

- Rapid Prototype Ventricle cast
- Funnel Guide Entry
  - Practice proper entry angle into ventricles
- Fluid filled
  - Siphoning and replacing CSF
  - Researching mineral oil
- Insertion of material to simulate blockage in cerebral aqueduct



Funnel Entry Guide

- Funnel Guide Entry
  - Material covering top of funnel
  - Small opening for inserting endoscope
  - Lip edge secures endoscope
  - Stem diameter = 6.2 mm



Final Design Selection

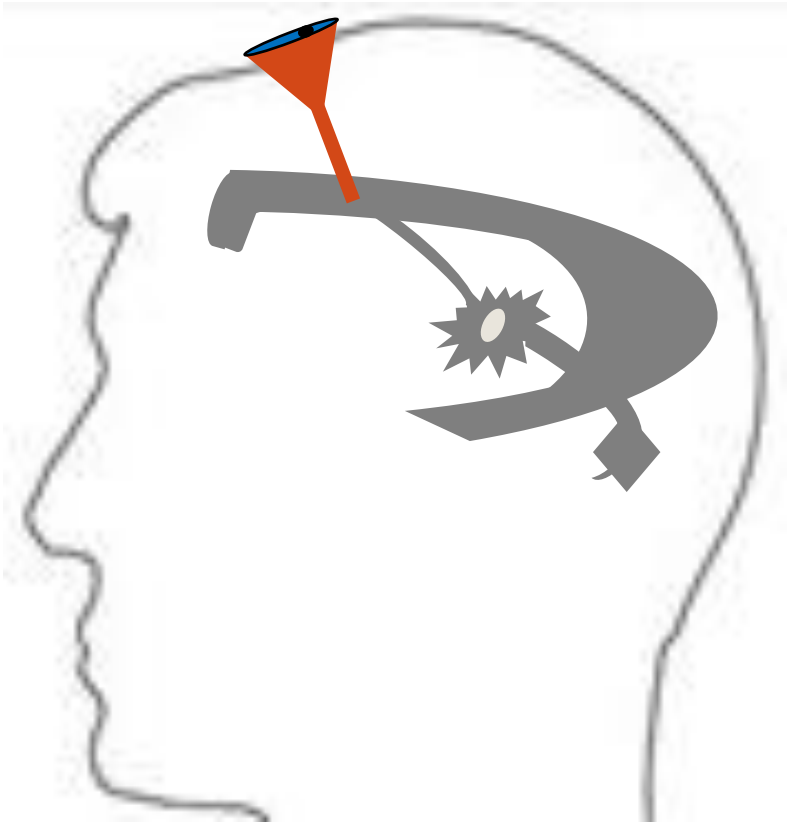
Design	Anatomical accuracy	Teaching Effectiveness	Durability	Feasibility	Cost	Total score
Force Sensor Design	**4**	**4**	**3**	**1**	**3**	**15**
Injection Mold Ventricle System	**3**	**3**	**1**	**4**	**2**	**13**
Fluid Filled Ventricles	**4**	**4**	**4**	**5**	**5**	**22**

Materials Selection

Material	Durability	Representative of Brain Tissue Properties	Fluid Compatibility	Total
Fullcure 720	**5**	**1**	**5**	**11**
Tango Black	**5**	**3**	**4**	**12**
DuraForm Flex Plastic	**4**	**5**	**5**	**14**
Tango Plus Fullcure 930	**4**	**5**	**4**	**13**

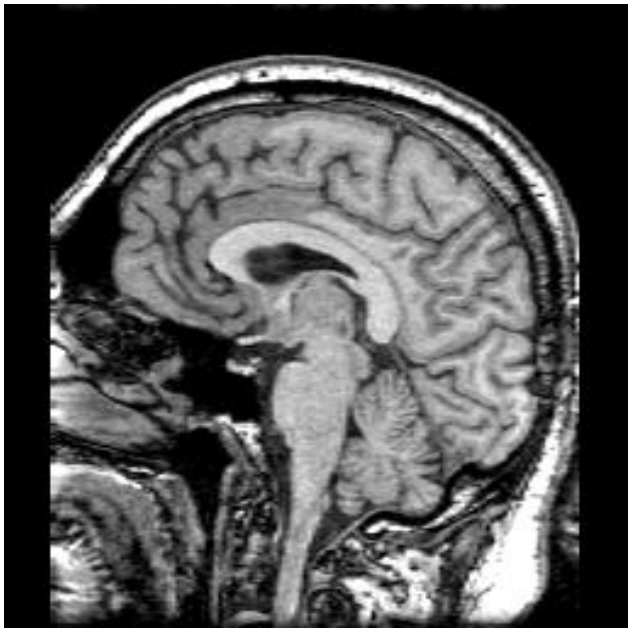
Final Design

- Fluid Filled Ventricles
  - Funnel guided entry practice
  - Fluid filling to imitate CSF
  - Head shaped container
- DuraForm Flex Plastic for rapid prototyping of the model



Future Work

- Build the funnel guide
- Reconstruct 3-D image of the ventricles
  - MRI scans of brain
- Obtain rapid prototype of image
- Assemble model
- Test model
  - Client and medical student will use and give feedback



Questions?

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