BME Design-Spring 2022 - RUSHABH TOLIA
Complete Notebook

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SIVA SUBRAMANIYAN RAMALINGAM

on

Mar 21, 2022 @04:08 PM CDT

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Team contact Information

John Puccinelli - Dec 19, 2013, 11:28 AM CST

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		Advisor			
		Client			
		Leader			
		Communicator			
		BSAC			
		BWIG			
		BPAG			

Project description

John Puccinelli - Aug 14, 2013, 12:01 PM CDT

Course Number:

Project Name:

Short Name:

Project description/problem statement:

About the client:

2022/03/20-Assesment of clot size

RUSHABH TOLIA - Mar 21, 2022, 3:12 AM CDT

Title: Determine the clot size that is occurring within a brain

Date: 3/21/22

Content by: Rushabh Tolia

Present: N/A

Goals: To understand how clot size is observed within a brain and how different clot sizes appear within a brain and if they are dependent on certain factors affecting an individual.

Content:

- If a stroke has occurred, the cause (bleeding or blood clot) must be determined so that the appropriate treatment can be started. Prompt medical treatment can help limit damage to the brain, which will improve your chance of recovery

- Surgery may be needed in the following situations:

- Bleeding (hemorrhage) may require immediate decompression of the brain to release pooled blood and relieve pressure. Decompression may be done through a burr hole procedure (drilling a hole in the skull to allow blood drainage), a craniectomy incision (partial removal of the skull to allow the swelling brain to expand), or a craniotomy (opening of the skull cavity).
- A cerebral aneurysm that has not ruptured may require clipping or filling ("sealing off") of the aneurysm through a craniotomy surgical procedure, or an angiography-type procedure to prevent a future rupture.
- An arteriovenous malformation (AVM) that has not ruptured is treated by direct removal of the AVM through surgery, use of computer-guided radiation to close off the abnormal vessels or use of a special glue or other filler to block the blood flow from smaller blood vessels into the AVM or the vessels that supply the AVM.
- Some brain hemorrhages do not require surgery. The decision depends on the size, cause and location of the bleed and other factors.

- Is there anything I can do to reduce my risk of a brain bleed?

  Steps you can take to reduce your risk include:

- Control your blood pressure.
- Lowering your cholesterol level.
- Lose excess weight.
- Limit alcohol and stop smoking.
- Eat a healthy diet.
- Get regular exercise.
- Control blood sugar levels if you have diabetes.

- Overall health, there can be lasting effects from a brain bleed. These affects can include:

- Inability to move part of the body (paralysis).
- Numbness or weakness in part of the body.
- Difficulty swallowing.
- Vision loss.
- Difficulty speaking or understanding spoken or written words.
- Confusion, memory loss or poor judgment.
- Personality change and/or emotional problems.
- Seizures.
- Headaches.

- However, over time and with a lot of effort and determination in rehabilitation (physical, occupational and speech therapy), you can regain some of these lost functions. This is especially true if your general health is otherwise good.

  Unfortunately, some patients who remain in a coma, or have been severely paralyzed after an intracranial or cerebral hemorrhage may need permanent, long-term care typically provided in a nursing home. Depending on the type, location and extent of the brain bleed, many patients do not survive the initial bleeding event.

  Remember though, if you suspect a brain bleed, the sooner you can get to the emergency room the better your chance of survival. Time between the start of symptoms and start of a bleed and between start of a bleed and confirmation of a bleed are critical time points. The earlier a brain hemorrhage is found, the earlier a treatment decision can be made. Don’t hesitate. Let a healthcare professional determine if you have a brain emergency.

- A non-contrast computer tomography (CT) scan of brain is the diagnostic study of choice. CT or magnetic resonance (MR) angiogram is recommended (once the patient is stabilized).

  Some patients may experience delayed deterioration due to re-bleeding, swelling, hydrocephalus (accumulation of fluid due to blood or brain swelling blocking natural drainage pathways) and seizures.

- Candidates for non-surgical treatment are patients with:

- Minimal symptoms;
- Minimal chance of a favorable outcome (large hemorrhage, poor neurologic condition, advanced age, bleeding disorder); and

- Non-surgical treatments include:

- Clotting factor administration, if patient was on blood thinners;
- Blood pressure control to reduce risk of more bleeding; and
- Measuring and controlling ICP (pressure on brain tissue due to clot).

- Candidates for surgical treatment are patients:

- Less than 50 years of age (tolerate surgery better than an elderly patient);
- With a hemorrhage location in a favorable location for surgical evacuation, including in the lobar, cerebellar, external capsule and non-dominant hemisphere; and
- For whom surgery may lower issues with re-bleeding, edema and necrosis, but rarely causes neurologic improvement.

- Surgical treatments include:

- A craniotomy involves removing a piece of the skull bone and exposing the brain to remove the clot. It is useful when the clot is close to the surface of the brain or if the clot is associated with an underlying brain lesion.
- Stereotactic clot aspiration is a minimally invasive technique to evacuate a clot located deep inside the brain. This is possible with use of neuronavigation technology, which works similar to GPS in cars.
-
- A hemorrhage location (basal ganglia or thalamic hemorrhage, where surgery is no better than medical management).

Conclusions/action items:

The following findings indicated that intracebral hemorrhaging can occur for a variety of reasons, but is most likely to occur in individuals that have pre-existing medical conditions like diabetes or high blood pressure. For this reason, the clots usually do not occur in a select region of the brain, but can occur throughout the brain wherever an artery that is continuously passing blood can be blocked leading to the original symptoms. In this case, the team can try to design a model in which, the hemorrhage does not necessarily have to be in one exact position, but can occur through a variety of different places. Additionally, clots can move through the brain as it is being affected, which can also be added to the design eventually.,

Intracerebral hemorrhage. AANS. (n.d.). Retrieved March 21, 2022, from https://www.aans.org/en/Patients/Neurosurgical-Conditions-and-Treatments/Intracerebral-Hemorrhage

Polito, V., La Piana, R., Del Pilar Cortes, M., & Tampieri, D. (2017, December). *Assessment of clot length with multiphase CT angiography in patients with acute ischemic stroke*. The neuroradiology journal. Retrieved March 21, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5703140/

2022/03/20-How the pressure within a brain works

RUSHABH TOLIA - Mar 21, 2022, 3:40 AM CDT

Title: How does the pressure of the brain take place

Date: 03/20/22

Content by: Rushabh Tolia

Present: N/a

Goals: How does the pressure within the brain work at different levels, for instance during a hemorrhage vs. at normal levels during the day as opposed to other points of their life.

Content:

1. A brain injury or some other health problem can cause growing pressure inside your skull. This dangerous condition is called increased intracranial pressure (ICP). It can lead to a headache. It can also further injure your brain or spinal cord.
2. Causes of increased ICP are:

    Hydrocephalus, which is an abnormal buildup of cerebrospinal fluid. This is the fluid around your brain and spinal cord.

    Bleeding into the brain

    Swelling in the brain

    Aneurysm

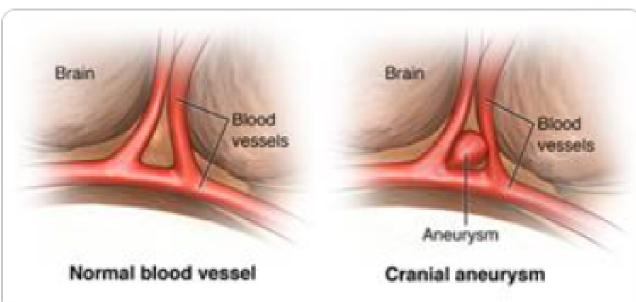
    Blood pooling in some part of the brain

    Brain or head injury

    Brain tumor

    Infections such as encephalitis or meningitis

    High blood pressure

3. 

    1. Image of the cranial bleeding
4. These are the most common symptoms of increased ICP:

    Headache

    Blurred vision

    Confusion

    High blood pressure

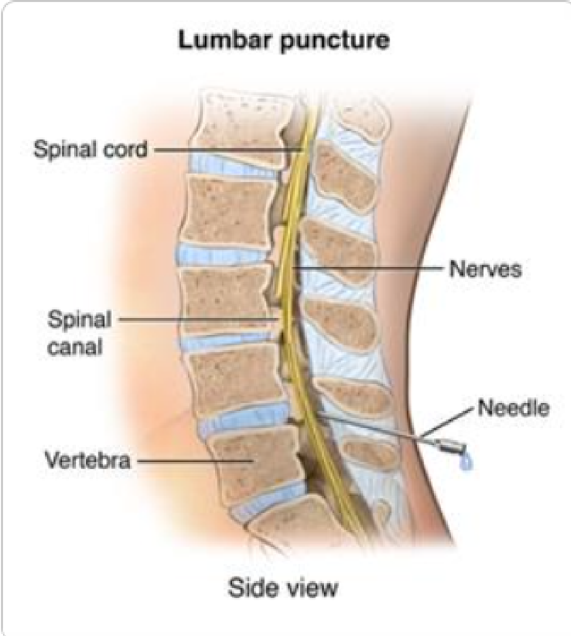
    Shallow breathing

    Vomiting

    Changes in your behavior

    Weakness or problems with moving or talking

    Lack of energy or sleepiness

5. 

   1. The image of how the pressure is visualized
6. **Intracranial pressure** (**ICP**) is the pressure exerted by fluids such as cerebrospinal fluid (CSF) inside the skull and on the brain tissue. ICP is measured in millimeters of mercury (mmHg) and at rest, is normally 7–15 mmHg for a supine adult
7. The body has various mechanisms by which it keeps the ICP stable, with CSF pressures varying by about 1 mmHg in normal adults through shifts in production and absorption of CSF
8. **Intracranial hypertension** (**IH**), also called **increased ICP** (**IICP**) or **raised intracranial pressure** (**RICP**), is elevation of the pressure in the cranium. ICP is normally 7–15 mm Hg; at 20–25 mm Hg, the upper limit of normal, treatment to reduce ICP may be needed.

Conclusions/action items:

The point of this research was to look into the brain's pressure and how it normally affects an individual versus how it affects an individual afflicted with intracebral hemorrhaging. This research shows that if a pressure pump was to developed using a vacuum pump, it must be able to go from 7mmHg for a normal individual to roughly 25 mmHg, upper limit, of when the individual is actually experiencing the hemorrhage. For this reason, we will need a powerful vacuum pump that is able to switch quickly between the two ranges, or use a pump that remains constant when a patient is undergoing an intracerebral hemorrhage and go back to a 0 mmHg pressure when the surgery is complete, to indicate a successful procedure.

2022/03/20- Designing an optimal Phantom Model

RUSHABH TOLIA - Mar 21, 2022, 3:26 AM CDT

Title: Understanding on how to design an optimal Phantom Model

Date: 03/20/22

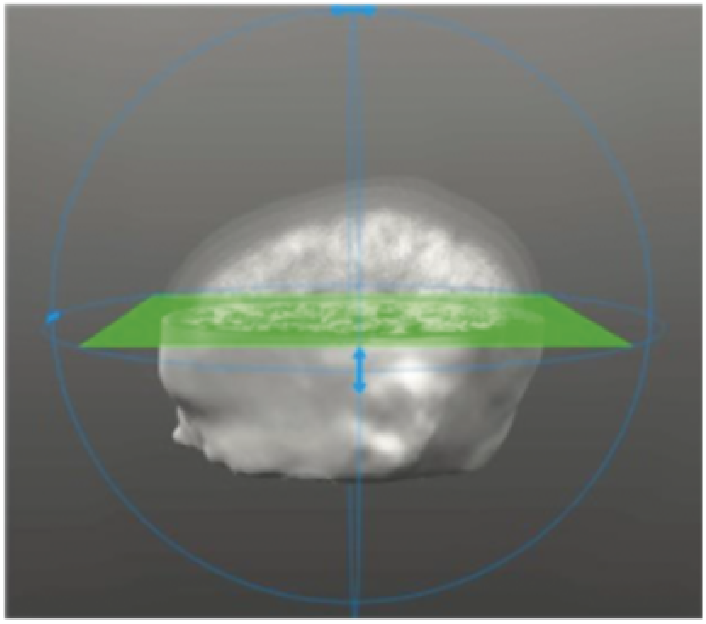
Content by: Rushabh Tolia

Present: N/A

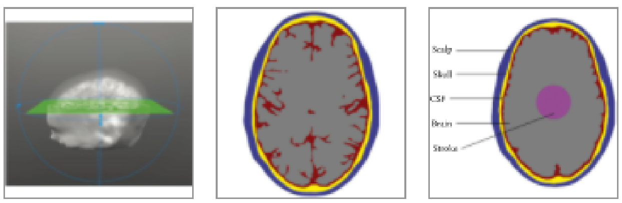
Goals: To look at potential skull phantom models that can accurately mimic the conditions of a human intracebral hemorrhage, without causing the artery to close in on itself due to the pressure of the jello.

Content:

1. The mechanical response of several candidate phantom materials, including hydrogels and emulsions, was characterized and compared to porcine brain tissue under similar strains and strain rates
2. Such as emulsions that mimic the high content of lipids. Others, like silicone, were included since these are currently used as phantom materials. The mechanical response of the emulsion was closer to that of the native porcine brain tissue than the other candidates
3. The emulsions, created by addition of oil to a hydrogel, were able to withstand compressive strain greater than 40%. The addition of lipids in the emulsions also prevented the syneresis typically seen with hydrogel material
4. 2.5D physical phantom was designed using a representative anatomical image of the human head, which was simplified into 5 different layers that mimic the scalp, skull, cerebrospinal fluid, brain, and stroke regions in terms of anatomy and dielectric properties
5. The brain phantom, all other layers consist of a mixture of polyurethane rubber, graphite powder, and carbon black powder. The brain phantom is in the liquid form to facilitate the insertion of different stroke models (ischemic or hemorrhagic) with different positions and shapes
6. designed with dielectric properties valid within the frequency range 0.5–3.0 GHz, which is relevant for microwave stroke detection and classification. Molds for casting individual parts of the phantom were printed in 3D



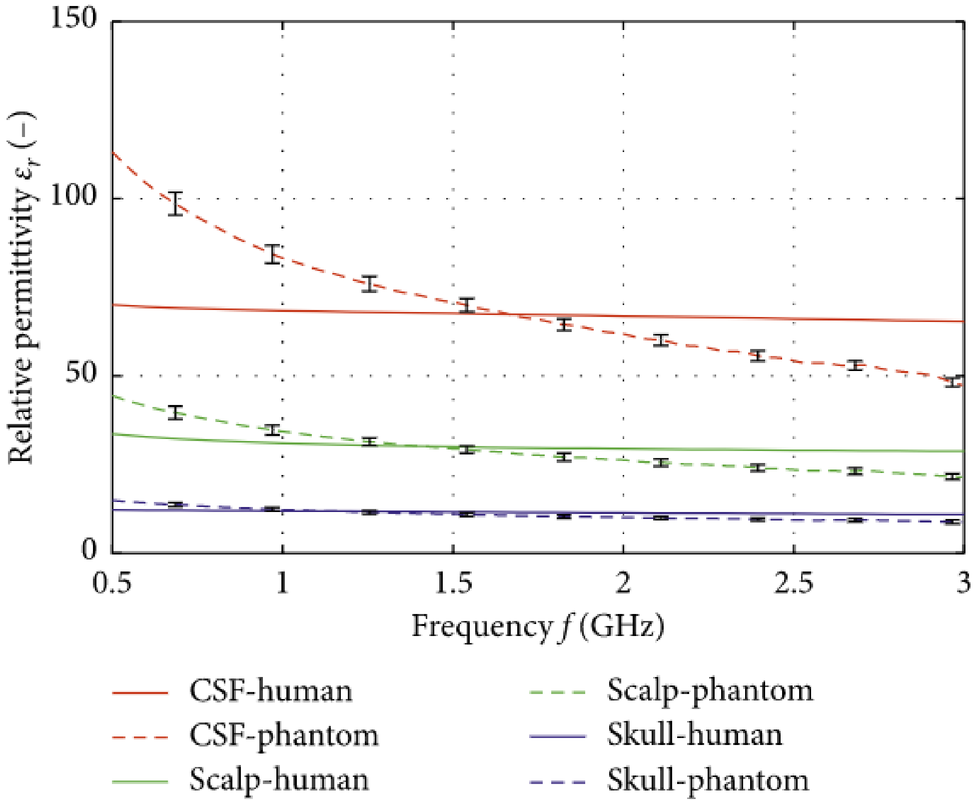
(a)



(a) (b) (c)

7.
    1. Cross section of an MRI human model

8. The physical molds were printed on a 3D printer (Prusa i3 MK2, Prusa Research, Czech Republic) with 0.35 mm resolution in the longitudinal (Z) direction using polyethylene terephthalate glycol (PETG) as the base material



(a)

9.
    1. Dielectric constants of the phantom developed model
10. The phantom contains 5 different layers including the scalp, skull, CSF, brain regions, and a reconfigurable stroke model
11. outermost three layers and the internal stroke model are made with solid mixtures that can be as thin as 1 mm
12. brain phantom was made in the liquid form to allow the insertion of different stroke models (ischemic or hemorrhagic) with different positions and shapes
13. resulting structure of this head phantom resulted in a continuous multilayer environment without plastic walls between the different layers, making the phantom more dielectrically realistic
14. the phantom is time-stable and thus suitable for obtaining large measured data sets for testing new algorithms for stroke detection and classification based on machine learning methods

Conclusions/action items:

In conclusion, based on the above guidelines for building a phantom model, to have a model that more accurately models an actual human skull would require a design that contained the exact specifications for an actual human model with actual parameters of brain matter and brain contents, so that the model can be used for more complicated intracebral hemorrhaging surgeries. Additionally, the team can add in the future, a more ordered internal structure, so there was a clear distinction between the different parts of the brain that could be distinguished during a scan. Lastly, for the collapsible material that would hold the blood, a deterrent can be used in a way, where it collapses based on the pressure or weight of the material.

Navarro-Lozoya, M., Kennedy, M. S., Dean, D., & Rodriguez-Devora, J. I. (2019, August 16). *Development of phantom material that resembles compression properties of human brain tissue for training models*. Materialia. Retrieved March 21, 2022, from https://www.sciencedirect.com/science/article/abs/pii/S2589152919302340

Pokorny, T., Vrba, D., Tesarik, J., Rodrigues, D. B., & Vrba, J. (2019, August 25). *Anatomically and dielectrically realistic 2.5d 5-layer reconfigurable head phantom for testing Microwave Stroke Detection and classification*. International Journal of Antennas and Propagation. Retrieved March 21, 2022, from https://www.hindawi.com/journals/ijap/2019/5459391/

2022/03/21- Adding a material that will collapse by pressure

RUSHABH TOLIA - Mar 21, 2022, 8:22 AM CDT

Title: Adding a collapsible material from the pressure of the jello

Date: 03/21/22

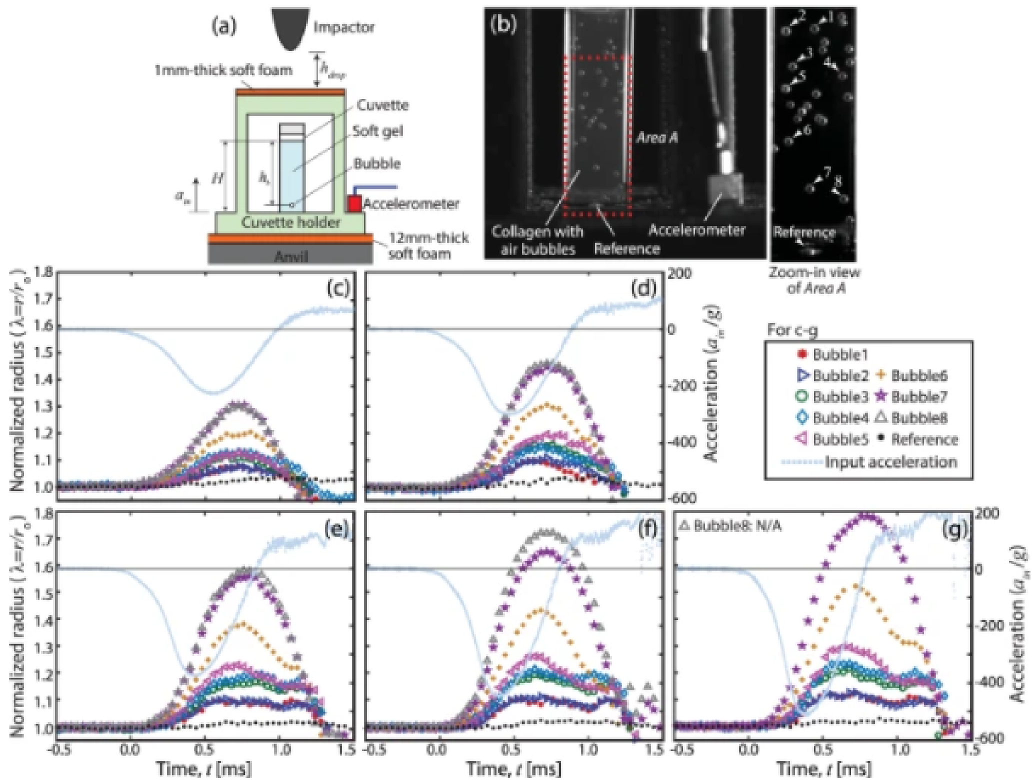
Content by: Rushabh Tolia

Present: N/a

Goals: To develop a collapsible material that would hold the coagulated blood and spill the contents, to act as a clot, once the intracerebral hemorrhage occurs

Content:

1. Biodegradable stent prototypes were produced from poly L-lactic acid polymers with different molecular weights
2. effects of molecular weight, drug incorporation and stent design on the collapse pressure of the stents were evaluated
3. When cavitating bubbles grow in a soft material followed by a violent collapse under the influence of a far-field pressure, they generate secondary pressure pulses of higher magnitude and potentially induce damage to the near-field material
4. During the bubble collapse, the surrounding material also experiences a high strain rate and shear deformation
5. Several experimental and analytical observations have shown that the bubble dynamics are highly dependent on the magnitude of the far-field pressure, the volume fraction of non-condensable gas, and material properties
6. propose a damage parameter as the efficiency of cavitation damage and perform several numerical simulations varying the factors mentioned above to establish a correlation with the damage efficiency
7. efficiency of cavitation damage is defined as the ratio of the energy deposited to the surrounding medium and the energy released by the collapsing bubbles
8. consider both isotropic (volumetric) and deviatoric (shear) energy deposition, and in doing so, we can separately identify the intensity of both damage mechanisms
9. we have integrated the viscoelastic Kelvin-Voigt constitutive model with a commercially available solver
10. Significant findings of the numerical simulations are (1) bubble collapse becomes more violent with the increase of far-field pressure, (2) collapse pressure and intensity decrease with increasing non-condensable gas content, (3) materials elasticity reduces the collapsing velocity, and eventually, the collapsing pressure, (4) viscosity plays a minor role in the first collapse and becomes significant for the subsequent rebounds and collapses

11. 

    1. Deformation of air bubbles in a soft gel due to acceleration-induced pressure gradient during mechanical impact
12. Soft gels that mimic properties of biological samples are increasingly utilized as tissue simulants for the assessment of potential damage, e.g., blunt injuries, to a human body against rapid mechanical input
13. We have characterized collagen samples with macro air bubbles (about 0.5 mm in radius) and monitored the dynamic response of individual bubbles during impact
14. In addition, our experimental approaches have the potential for clinically- and biologically-relevant studies that require use of 3-dimentional (3D) extracellular matrix (ECM) such as collagen and agarose

Conclusions/action items:

From the following articles it was found that the a potential biomaterial such as agarose or a collagen filled gel sac should work successfully as a material that would collapse due to the pressure of the jello. Depending on the surface volume and area of the sac that would hold the coagulated blood, the sac would then need the appropriate pressure from the surrounding jello to be high enough, so it would be able to collapse and allow the contents to spill so, that the blood can be removed by the neurosurgeon.

Kang, W., & Raphael, M. (2018, October 26). *Acceleration-induced pressure gradients and cavitation in soft biomaterials*. Nature News. Retrieved March 21, 2022, from https://www.nature.com/articles/s41598-018-34085-4

Venkatraman S;Poh TL;Vinalia T;Mak KH;Boey F; (n.d.). *Collapse pressures of biodegradable stents*. Biomaterials. Retrieved March 21, 2022, from https://pubmed.ncbi.nlm.nih.gov/12628831/

Hasan, F., Al Mahmud, K. A. H., Khan, M. I., Patil, S., Dennis, B. H., & Adnan, A. (n.d.). *Cavitation induced damage in soft biomaterials*. NASA/ADS. Retrieved March 21, 2022, from https://ui.adsabs.harvard.edu/abs/2021MulSE...3...67H/abstract

ICP

SIVA SUBRAMANIYAN RAMALINGAM - Mar 21, 2022, 1:29 AM CDT

Title: Intracranial pressure

Date: 02/18/22

Content by: Siva Ramalingam

Present: Individual work

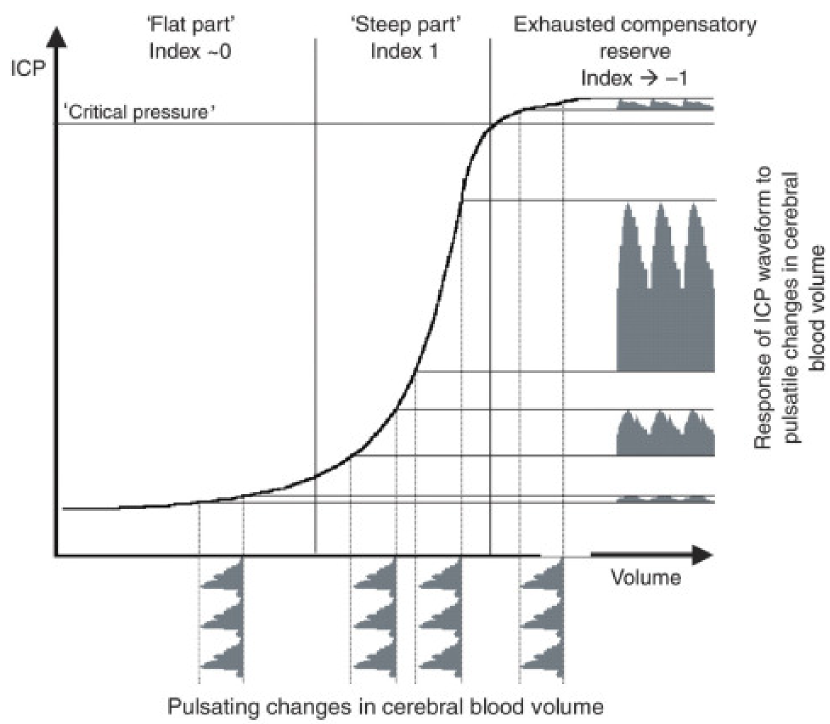
Goals: Understand and get an estimate for the intracranial pressure in an adult

Content:

The cranium is a rigid structure that contains three main components: brain, cerebrospinal fluid, and blood. Any increase in the volume of its contents will increase the pressure within the cranial vault. The Monroe-Kellie Doctrine states that the contents of the cranium are in a state of constant volume. That is, the total volumes of the brain tissues, cerebrospinal fluid (CSF), and intracranial blood are fixed. An increase in the volume of one component will result in a decrease in volume in one or two of the other components. The clinical implication of the change in volume of the component is a decrease in cerebral blood flow or herniation of the brain.

It is measured in two ways. One way is to place a small, hollow tube (catheter) into the fluid-filled space in the brain (ventricle). Other times, a small, hollow device (bolt) is placed through the skull into the space just between the skull and the brain. Both devices are inserted by the physician either in the intensive care unit (ICU) or in the operating room. The ICP device is then attached to a monitor that gives a constant reading of the pressure inside the skull. If the pressure goes up, it can be treated right away. While the ICP device is in place, you will be given medication to stay comfortable. When the swelling has gone down and there is little chance of more swelling, the device will be removed.

The pressure in the cranial vault is measured in millimeters of mercury (mm Hg) and is normally less than 20 mm Hg. The cranium is a rigid structure that contains 3 main components: brain, cerebrospinal fluid, and blood. Any increase in the volume of its contents will increase the pressure within the cranial vault. An increase in the volume of one component will result in a decrease in volume in one or two of the other components. The clinical implication of the change in volume of the component is a decrease in cerebral blood flow or herniation of the brain.



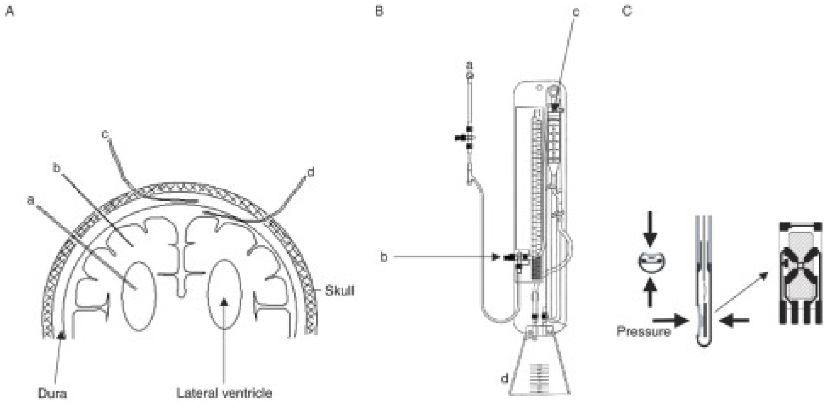


Fig 2 ICP monitoring. (A) Possible sites of ICP monitoring: a: intraventricular drain; b: intraparenchymal probe; c: epidural probe; d: subarachnoid probe. (B) Typical system for ICP measurement via an intraventricular drain: a: connection with drain; b: zero (should be positioned at height of patient's ear) and three-way stopcock for connection with pressure transducer; c: drip chamber, adjustable in height over zero for CSF drainage. Depending on stopcock position (b) either pressure measurements or CSF drainage are possible; and d: CSF reservoir. (C) Possible configuration for intraparenchymal probe. Pressure is sensed at the tip of the probe by a miniature sensor consisting of piezo-elements or other pressure sensitive elements arranged as a Wheatstone bridge.

L. A. Steiner and P. J. D. Andrews, "Monitoring the injured brain: ICP and CBF," *British Journal of Anaesthesia*, vol. 97, no. 1, pp. 26–38, 2006.

Conclusions/action items:

ICP is measured in millimeters of mercury (mmHg) and at rest, is normally 7–15 mmHg for an adult.

We could use one of these pressure monitoring devices to monitor in the pressure in the phantom

Phantom model for physiological ICP

SIVA SUBRAMANIYAN RAMALINGAM - Mar 21, 2022, 3:35 PM CDT

Title: Phantom Model of Physiologic Intracranial Pressure and Cerebrospinal Fluid Dynamics

Date: 2/22/22

Content by: Siva Ramalingam

Present: Individual work

Goals: Understand the construction and working principle of the phantom and see if it could be applied to the project at hand

Content:

ventricular system in a silicone brain was modeled using the following approach: A 3-D reconstruction of MRI data acquired on a 27-year-old healthy male provided the anatomical reference to design the ventricular domain of the phantom. The ventricular system was simplified to obtain a sagittal symmetry suitable for casting: The lateral ventricles were merged to a single ventricle representation using computer-aided design software were unified into a single connector to the third ventricle; the foramina of Luschka and Magendie were also merged into a single channel. A negative of this simplified ventricular domain was manufactured in two sagittal symmetric halves by 3-D printing on an Eden350V photopolymer printer.

After obtaining a positive of the ventricle space, a 2-mm inner diameter silicone tube was inserted into the cerebral aqueduct to avoid its deformation during the phantom construction. For simulation of CSF production in the ventricles, an access port was established at the top of the ventricular system. The same access port was also used for the initial filling of the CSF space. Two access points for pressure sensing were established at the top and bottom of the cerebral aqueduct. The adapted ventricular system is seen in the figure below

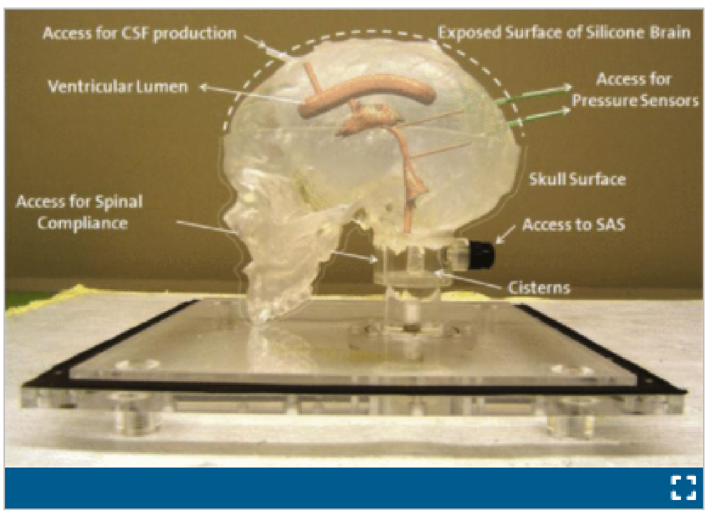


Fig. 1.
Cranial domain of the phantom. A silicone brain is contained in a plastic human skull. The lumen of the simplified ventricular system is shown as superimposition of the CAD model.

Compliance *C* of the cranio-spinal system is defined as the change of its volume *V* in response to a variation in its pressure *P*:

$$C=dV/dP$$

Compliance can be measured by infusion testing. The physiologic pressure–volume relation from which compliance can be derived follows approximately

$$ICP=P_0e^{kv}+P1$$

where $P_r = P_0 + P_1$ is the resting intracranial pressure (ICP) level prior to infusion and K the brain elastance coefficient. K has been reported to range between 0.0886 and 0.177 ml in healthy humans, with a corresponding physiological compliance between 0.56 and 1.13 ml/mmHg for undisturbed ventricular volume and healthy resting pressure of P_r = 10 mmHg.

Two compliance boxes filled with water and air are used to reproduce physiologic compliance values. Their overall design is based on the assumption of ideal gas behavior with adiabatic compression and expansion according to

$$PV^{1.4}=\text{constant}$$

The boxes were calibrated experimentally to yield overall compliance of 1 ml/mmHg at the phantom's operating conditions. They connect to the cisternal and SAS compartments, respectively. The former represents spinal compliance (35% of the overall compliance), and the latter cranial compliance.

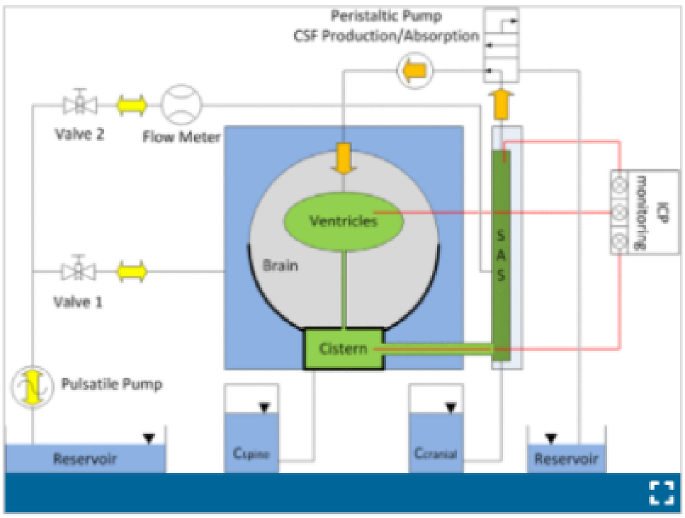


Fig. 3.
Schematic of the phantom setup. Ventricles are enclosed in a silicone brain and connected to the cisternal and SASs. CSF production and absorption rates can be controlled. Spinal and Cranial compliance units are connected to the cisternal and SASs, respectively. Pulsatile flow and ICP are monitored at the indicated locations. Black triangles indicate water–air interfaces.

Pressure and flow are monitored at selected locations in the phantom. ICP is recorded in the ventricles, cisterns, and SAS. Following the gold standard for clinical ICP monitoring, microtip pressure transducers and a corresponding control unit are used to acquire ICP

The phantom was validated by comparison to physiologic CSF flow and pressure values reported in the literature.

S. Bottan, D. Poulikakos, and V. Kurtcuoglu, “Phantom model of physiologic intracranial pressure and cerebrospinal fluid dynamics,” *IEEE Transactions on Biomedical Engineering*, vol. 59, no. 6, pp. 1532–1538, 2012.

Conclusions/action items:

The study shows was able to effectively model ICP in the their brain model. However, the method they used was with the help of water and air. this might not be completely viable for our project. We mimght need to look into a vacuum system that would not collapse the gelatin brain model.

Incase we decide to change the model of the brain, silica gel could also be an effective replacement

Pressure monitored during CED techniques

SIVA SUBRAMANIYAN RAMALINGAM - Mar 21, 2022, 4:07 PM CDT

Title: The relation between catheter occlusion and backflow during intraparenchymal cerebral infusions

Date: 3/15/2022

Content by: Siva Subramaniyan

Present: Individual work

Goals: Understand that backflow could occur during CDE techniques which could tamper with the ICP

Content:

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4540694/

Content:

There is a large pressure spike in the beginning of drug delivery using the CDE delivery method. This paper addressed this issue and looked into potential solutions to prevent it in the hope that it will increase the accuracy of drug administration and clot removal

- Showed the pressure spike occurred due to coring when inserting the catheter.
- Pressure built up in the catheter until it was able to eject the brain matter clogging the tip
- Attempted two methods to prevent this issue:
    - "Capped Tip"
    - Outflow of fluid to prevent build up
- Capping method worked well to prevent increase in the pressure spike
- Outflow method did not have much effect on the pressure spikes and did not work well.

Conclusions/action items:

It seems that the best way to prevent the spike in pressure would be to use mechanical prevention vs changes in technique. This is something that

Citation: Brady, M., Raghavan, R., Block, W., Grabow, B., Ross, C., Kubota, K., Alexander, A. and Emborg, M. (2015). The Relation between Catheter Occlusion and Backflow during Intraparenchymal Cerebral Infusions. *Stereotactic and Functional Neurosurgery*, 93(2), pp.102-109.

Smart capsule

SIVA SUBRAMANIYAN RAMALINGAM - Mar 21, 2022, 3:57 PM CDT

Title: capsule for blood clot

Date: 2/28/2022

Content by: Siva Ramalingam

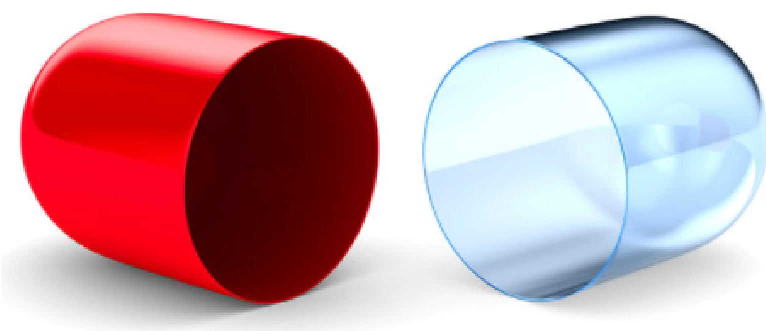
Present: Individual Work

Goals: To understand the principles of soluble capsule that could encompasses the blood clot

Content:

Scientists have combined a hydrophobic material polylactic acid and a biodegradable polymer calcium carbonate to encapsulate water-soluble drugs

“However, when using these technologies fluids leak into the ‘package’ of our drug. As a result, when it comes into contact with aqueous media in the body, its water-soluble components begin to dissolve and the treatment is not efficient. We were tasked to improve the retention of the loaded cargo inside capsules and prevent the ingress of fluids into them"



Another way would be using gelatin capsules that should be be homogenous in the brain material we intend to use

Roll over image to zoom in

PurecapsUSA – Empty Clear Gelatin Capsules - Fast Dissolving and Easily Digestible - Preservative Free with Natural Ingredients - (1,000 Joined Capsules) - Size 000

Visit the PureCaps USA Store

1,584 ratings

| 44 answered questions

Amazon's Choice for "000 c...

Capsules dissolve by absorbing and adsorbing water into their polymer matrix. Gelatin capsules start with well over 10% water content when "dry" and increase that rapidly when immersed in a wet environment. It takes about 10–20 minutes for the matrix to soften, distort and disintegrate.

Conclusions/action items:

This could be a viable way to implant the blood clot in the phantom. However the swine blood would need to be clotted prior to implantation.

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: