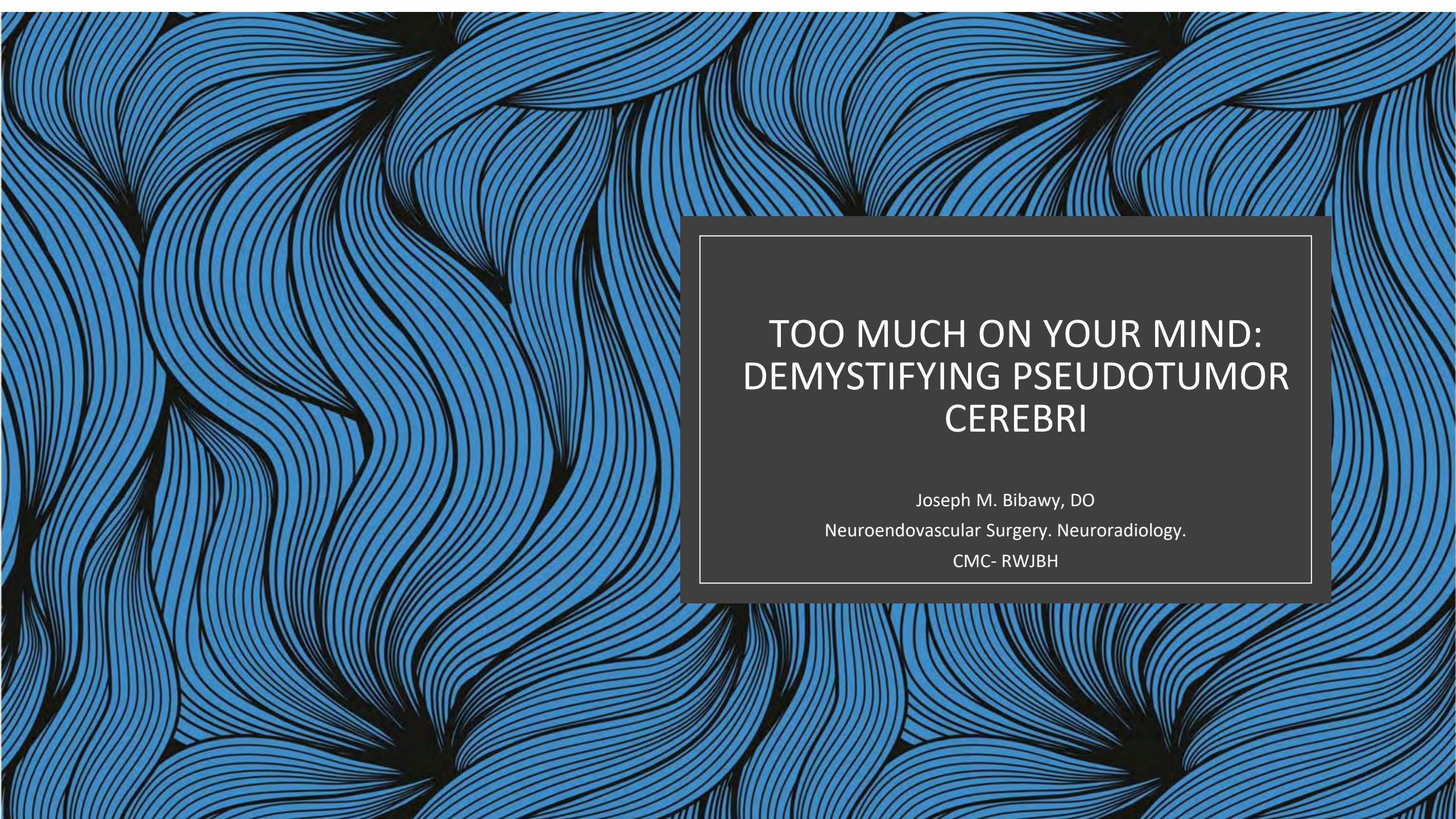




TOO MUCH ON YOUR MIND: DEMYSTIFYING PSEUDOTUMOR CEREBRI

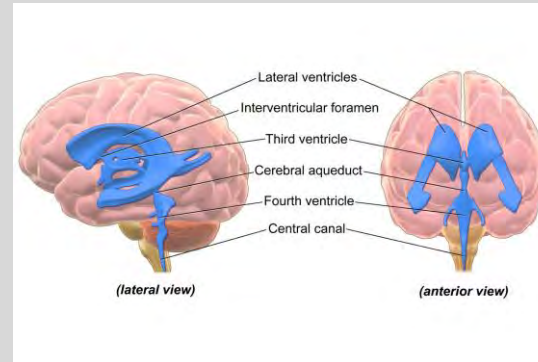
Joseph M. Bibawy, DO
Neuroendovascular Surgery. Neuroradiology.
CMC- RWJBH

IF I HAVE SEEN FURTHER,
IT IS BY STANDING
**ON THE SHOULDERS
OF GIANTS.**

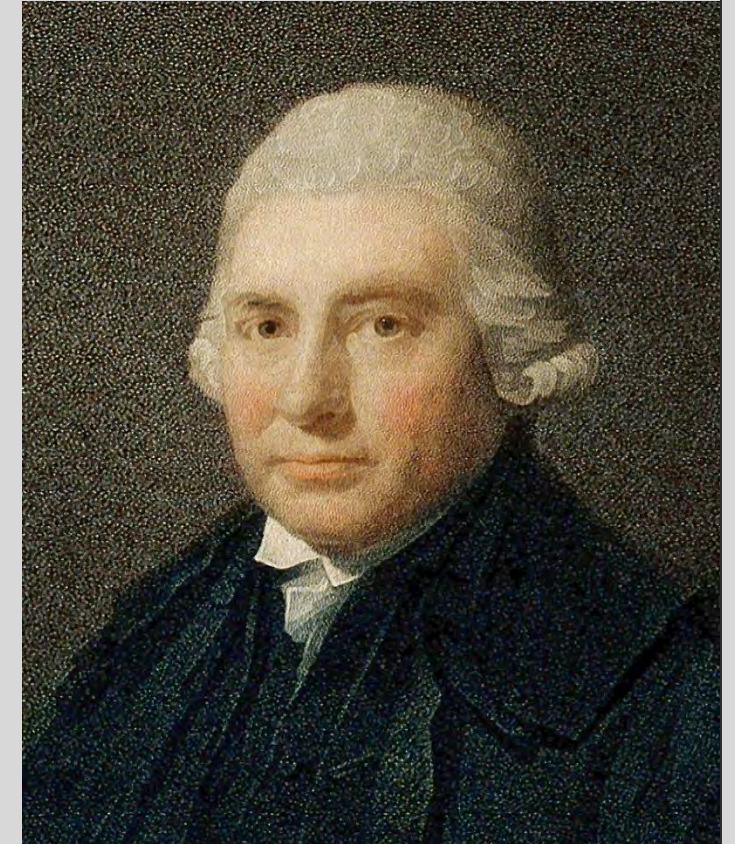
- ISAAC NEWTON



Blast from the past

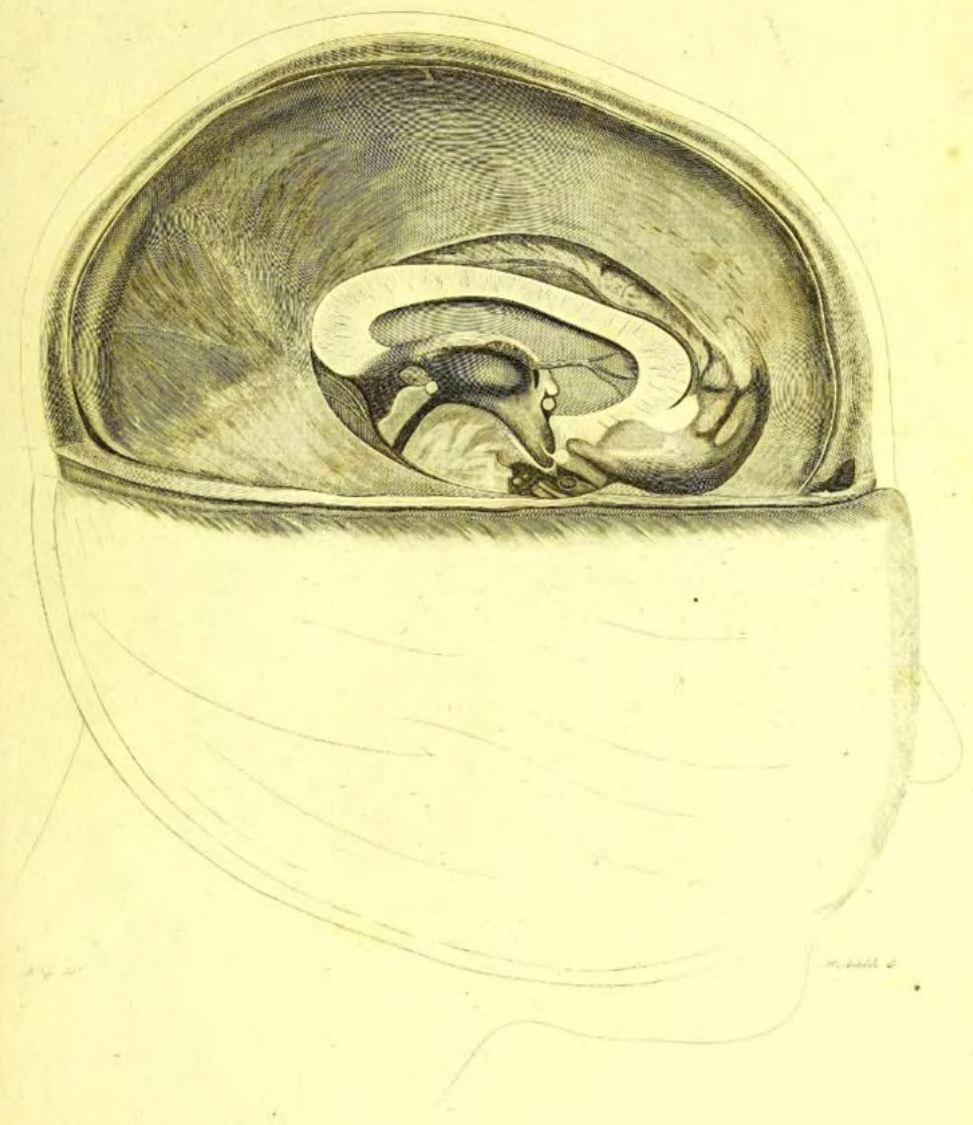


- Alexander Monro (1733 - 1817), secundus was a Scottish physician (never practiced surgery), professor and anatomist as was his father, Alexander primus and his son Alexander tertius
- Stomach pump
- Paracentesis
- Lymphatic system
- Most detailed elucidation of MSK system
- Interventricular foramen (of Monro) between the lateral ventricles of the brain
- **Monro–Kellie doctrine** on intracranial pressure, a hypothesis developed by Monro and his former pupil, George Kellie, who worked as a surgeon in the port of Leith





TAB. I.



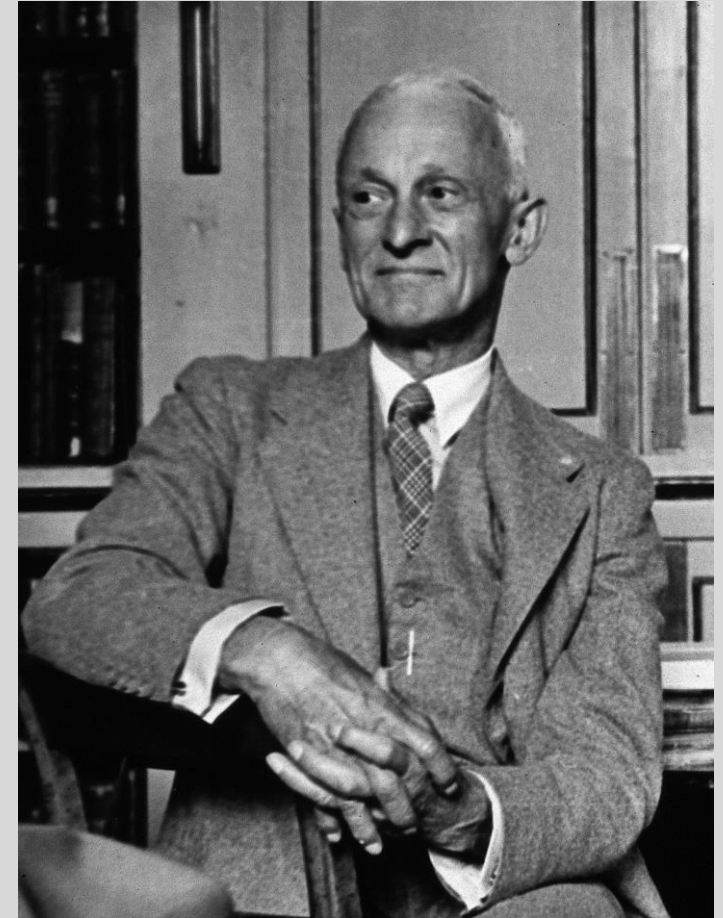
I have given Mercury. — Of these, Fifteen were Males, and Seven Females. — Twelve of them were under Seven years of age: Nine of them were from Eight to Fourteen years of age: One was Twenty-three years old. — Four of them lived Five Days only after I was called: Nine of them survived Seven or Eight Days: Three of them survived Ten Days: Five of them survived Thirteen or Fourteen Days: One, Six years of age, survived Four Months, without any sensible Enlargement of his Head.

In treating these cases, I generally began with the application of Leeches to the Temples. I then gave Calomel, in such quantity as to act as a brisk purgative. I applied a large Blister to the Top of the Head. In some cases, I kept a portion of the blistered part open as an Issue. In others, I applied Blisters in succession to different parts of the Head. In all of them, I directed, that strong Mercurial Ointment should be carefully rubbed upon the Skin of the Legs or Arms, morning and evening: And, in severals, I added Doses of Calomel by the Mouth; taking care not to give so much of it as to occasion purging. — In some cases, I combined the Powder of Squills with the Calomel; and in a few, the Powder of the *Digitalis Purpurea*.

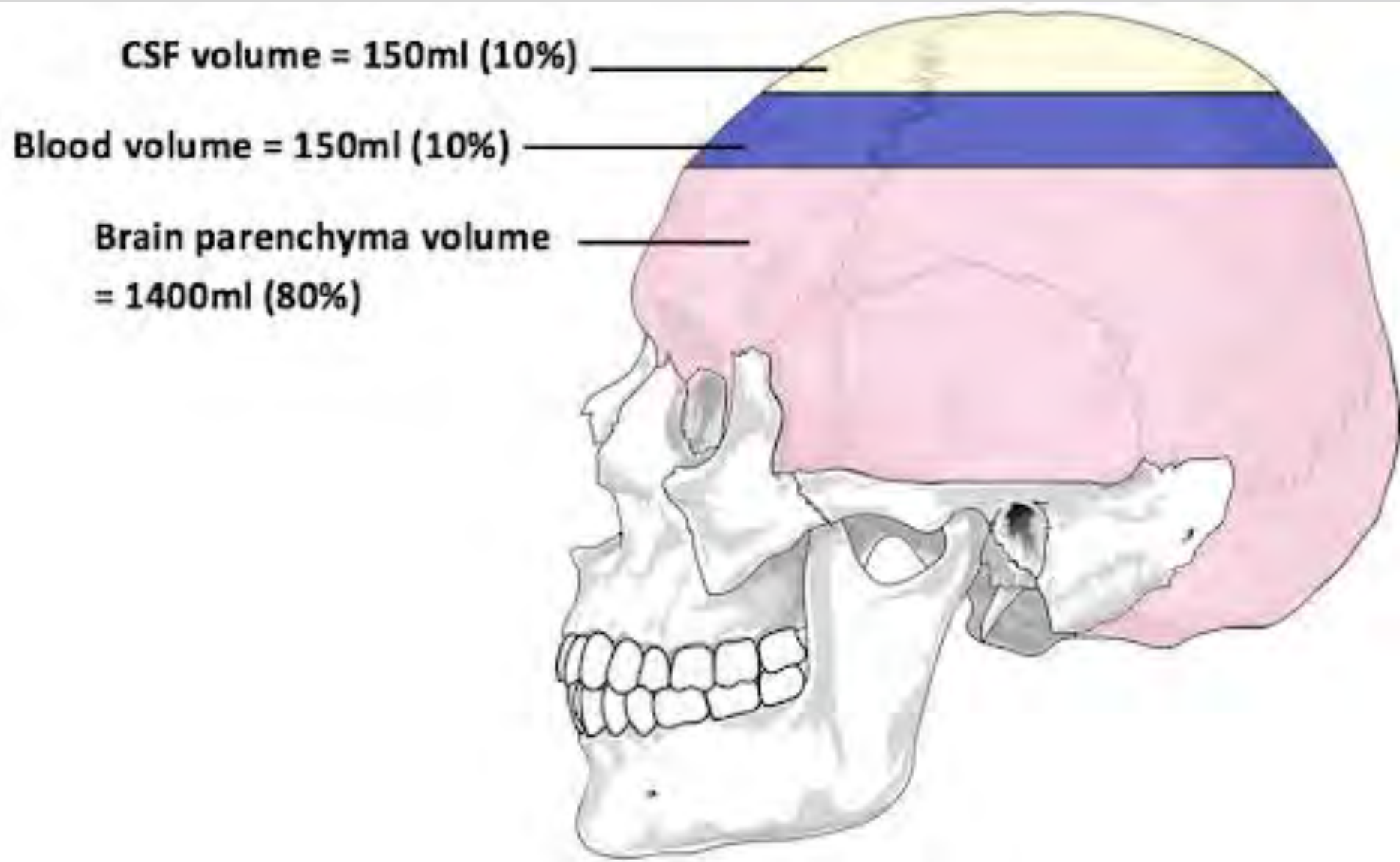
In

Monro- Kellie Doctrine

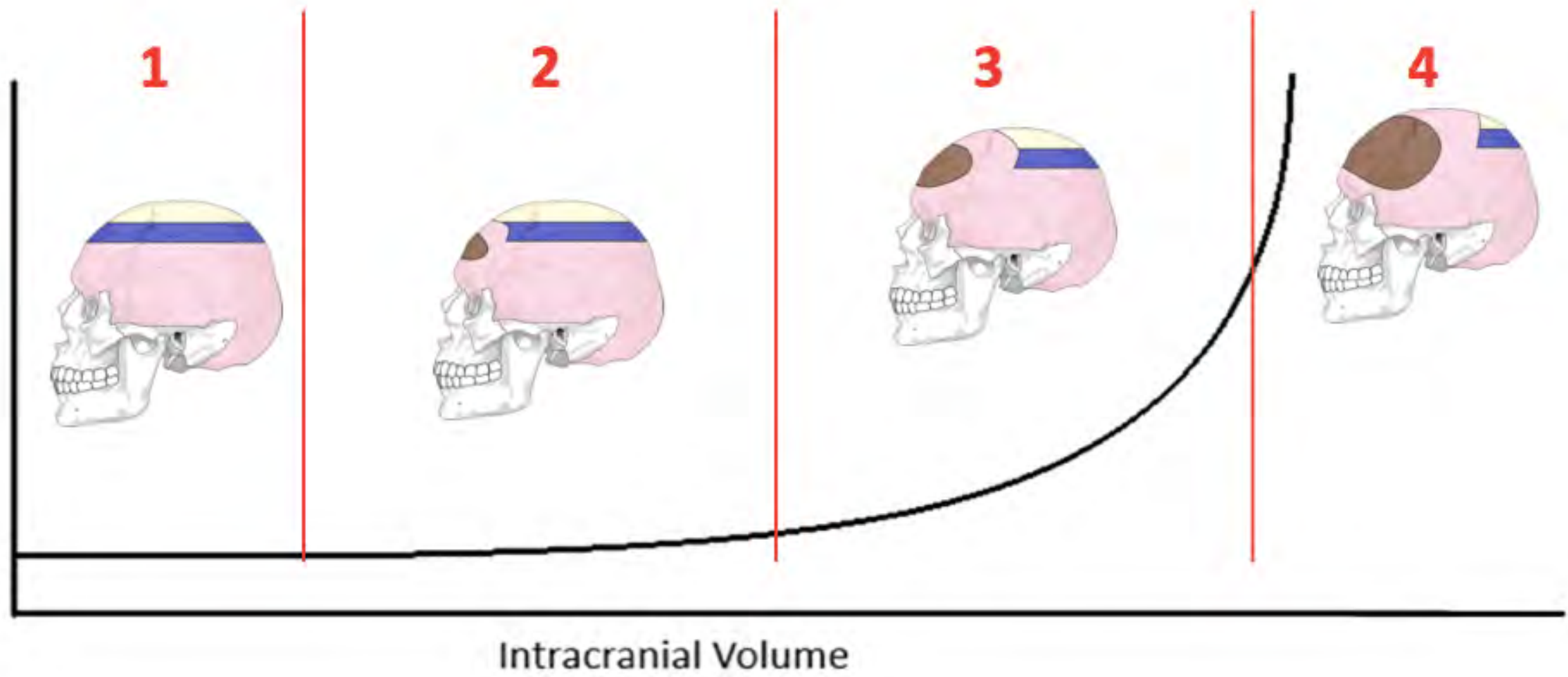
- The Monro-Kellie doctrine has been a fundamental principle of neurophysiology for >200 years. Its hypothesis is based on simple reasoning: **Within a rigid calvarial vault, the total volume of brain, CSF, and blood is constant. Any change in one of these elements results in an opposing compensatory response by the other 2 components.**
- **Harvey Cushing (1869- 1939)**- pioneer brain surgeon
- Per Cushing, the “**three element**”- **blood, nervous tissue and fluid** in the skull “**must always remain the same in bulk...any increase in blood volume, for example, can only take place at the expense of one of the other elements**”.
- CSF is produced at only 0.35mL/ min with a total volume ~75mL.

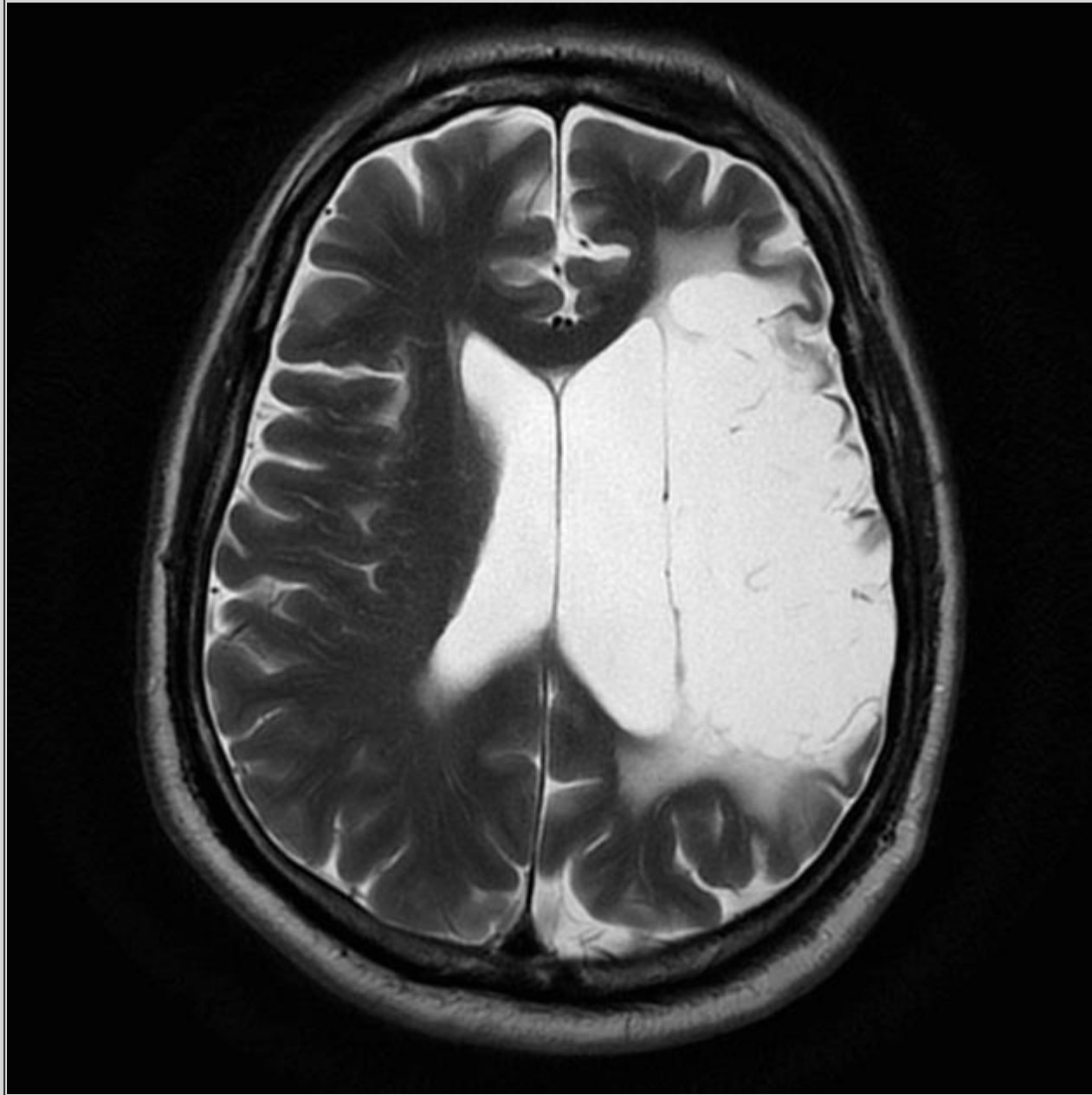


Back to Basics



Intracranial Pressure (ICP)

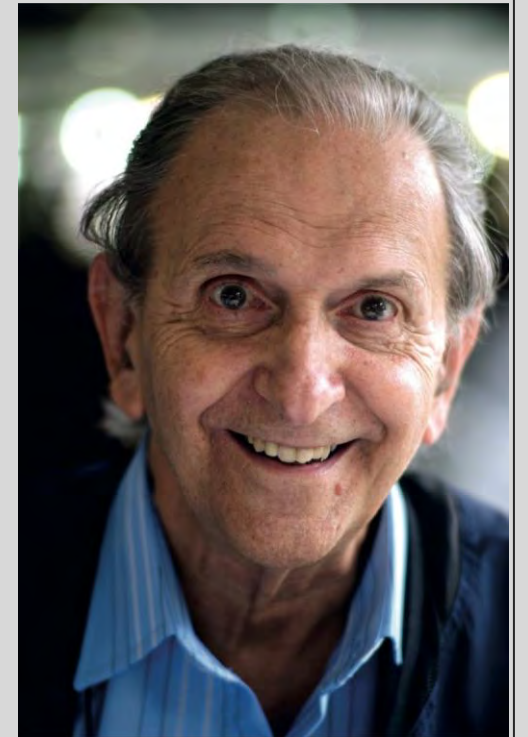
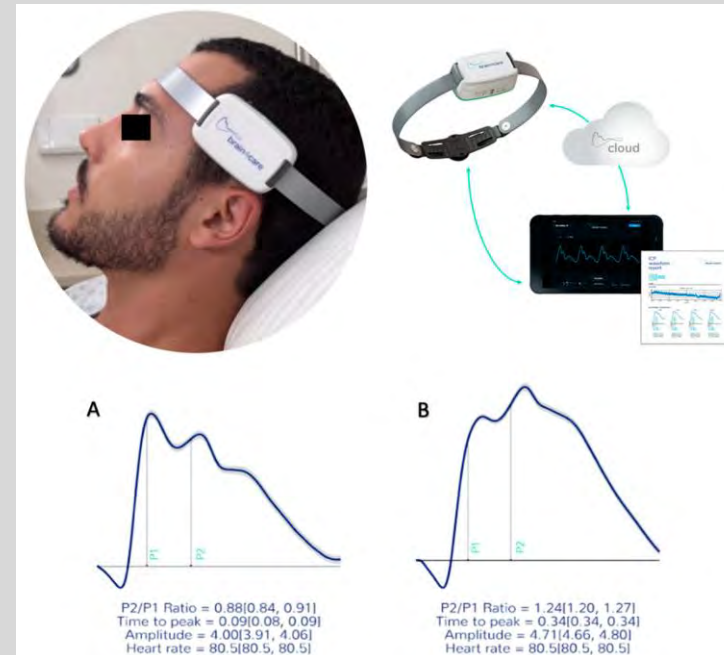
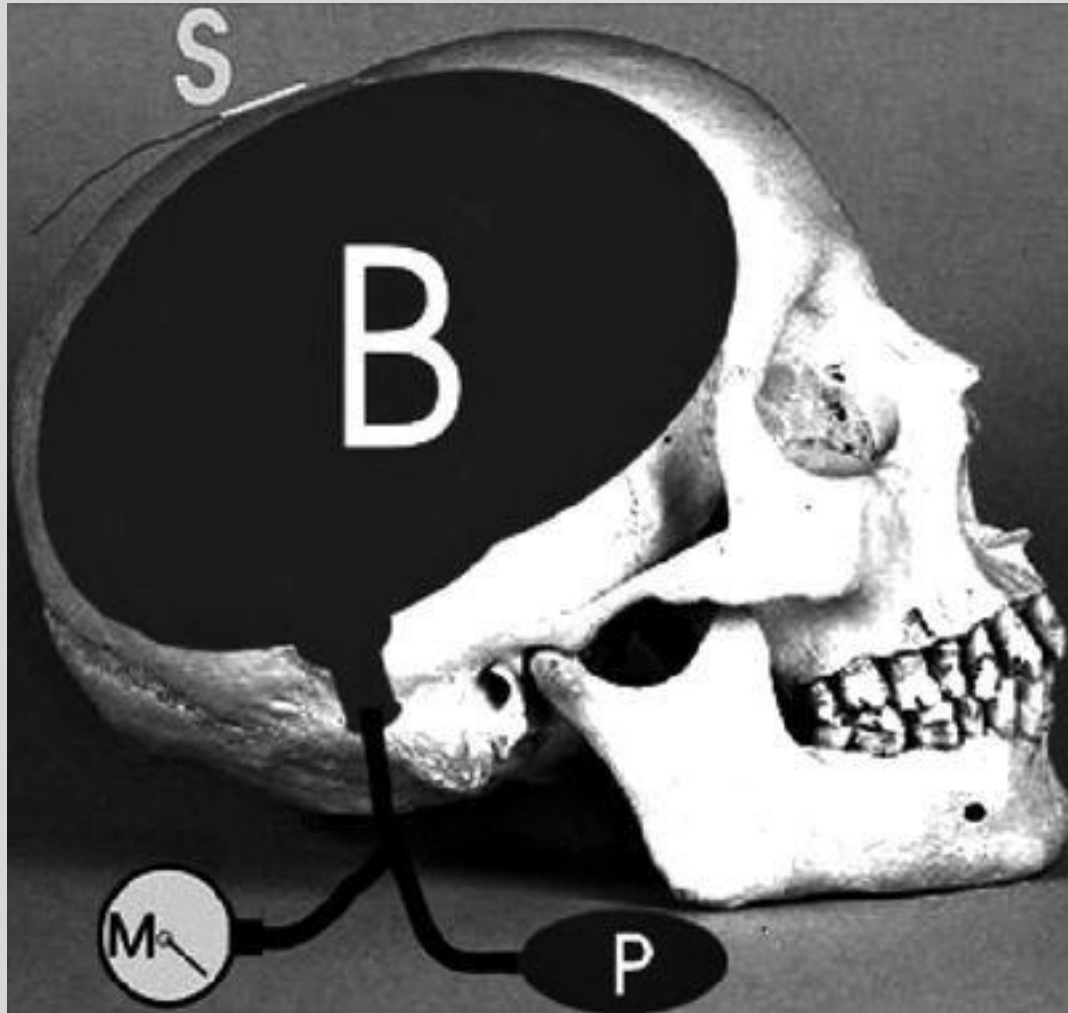




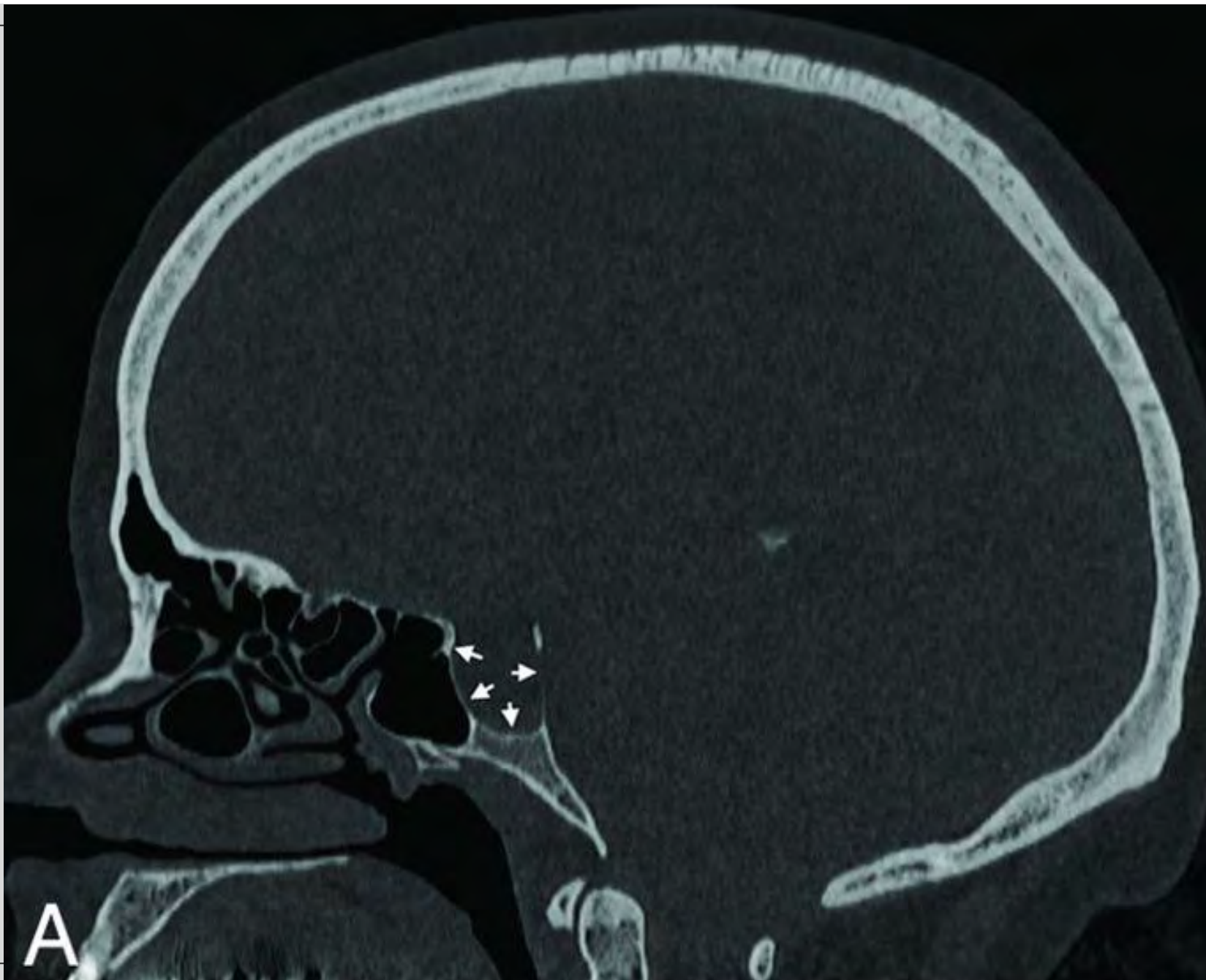
Call for Revision

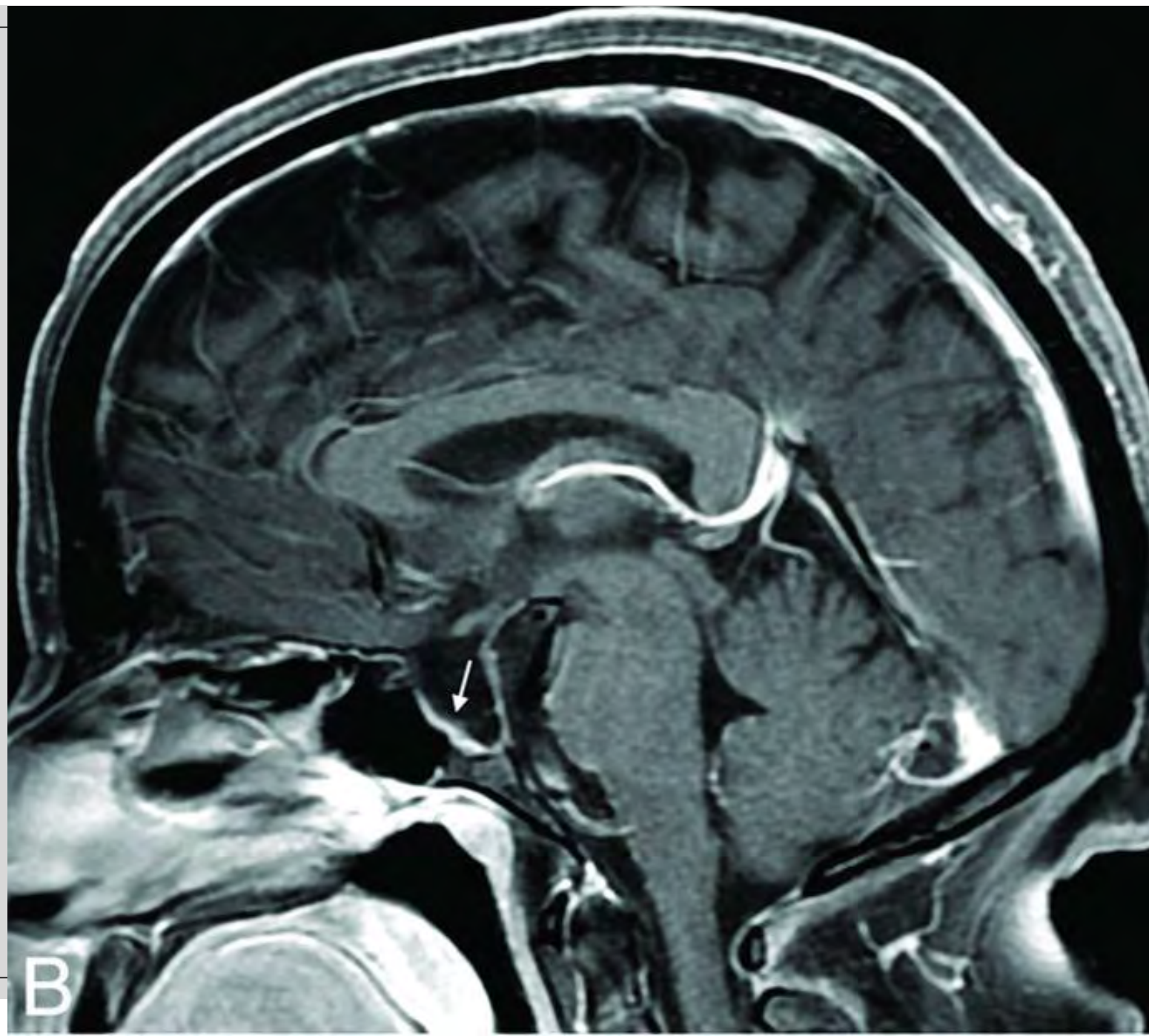
- Monro- Kellie doctrine assumes a **rigid, unadaptable calvaria**
- Recent studies and now frequently encountered and recognizable patient cases have disproven this assumption
- The skull expands and grows in response to the pathologic changes in intracranial pressure

Call for Revision



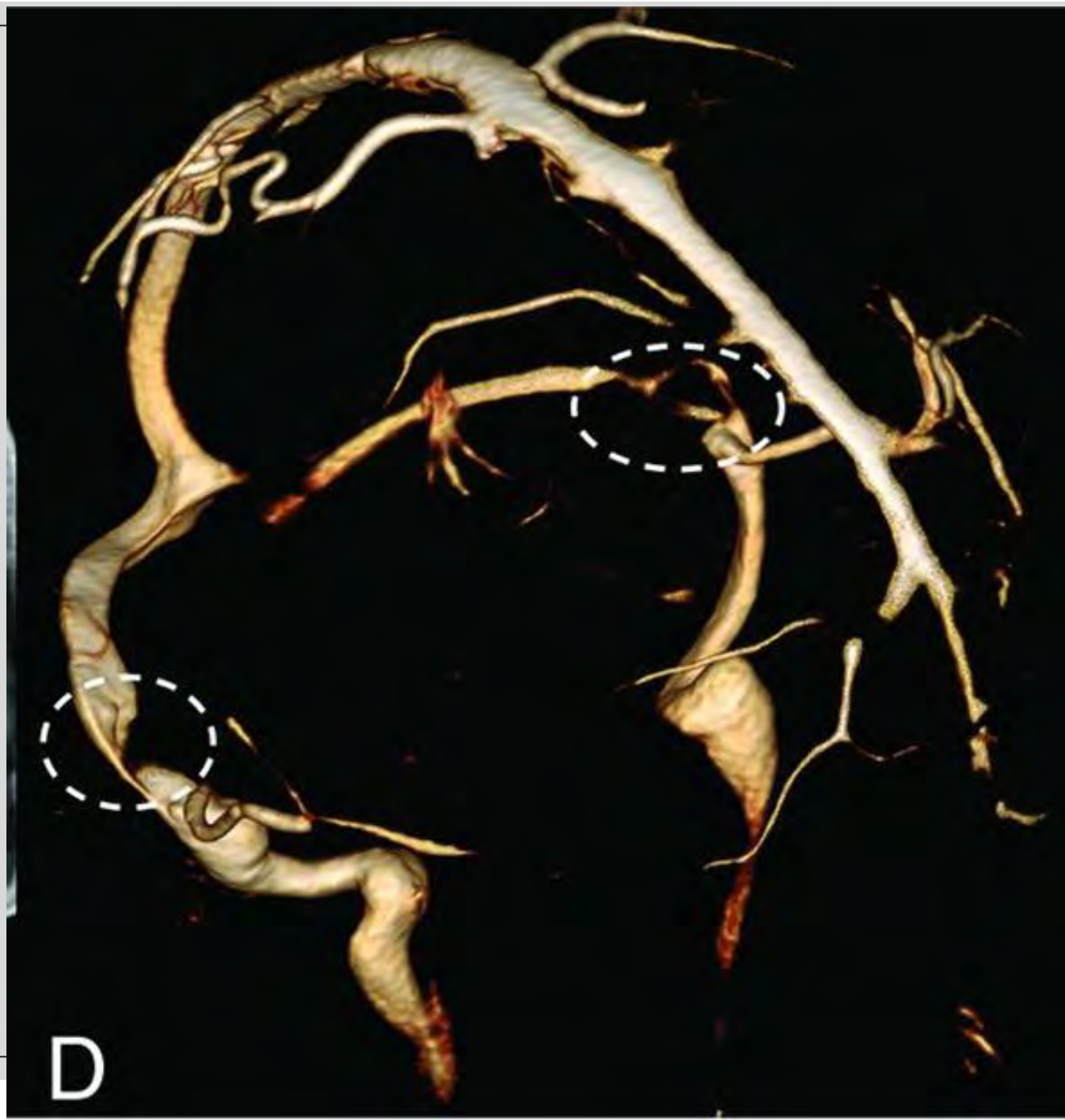
Sergio Mascarenhas



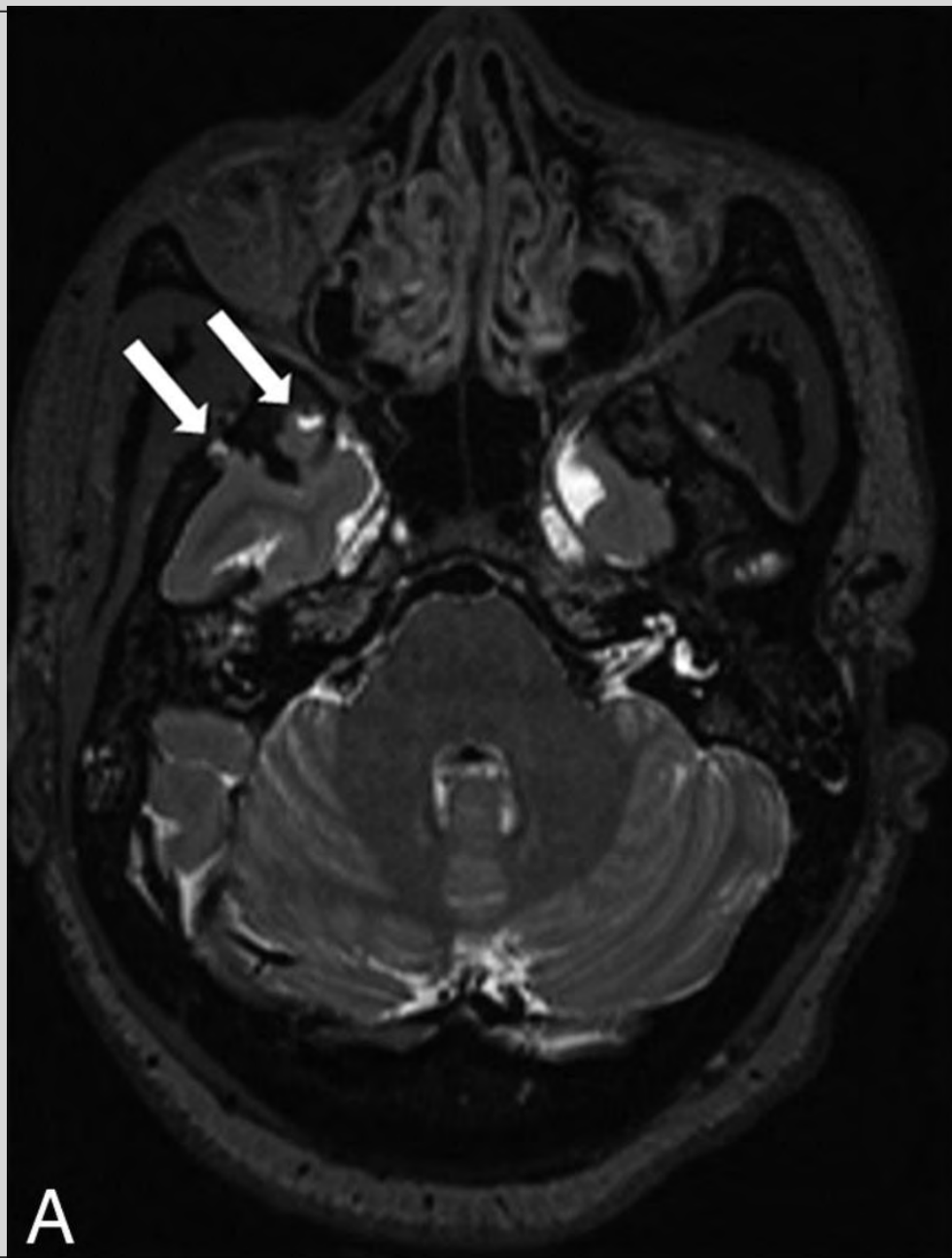




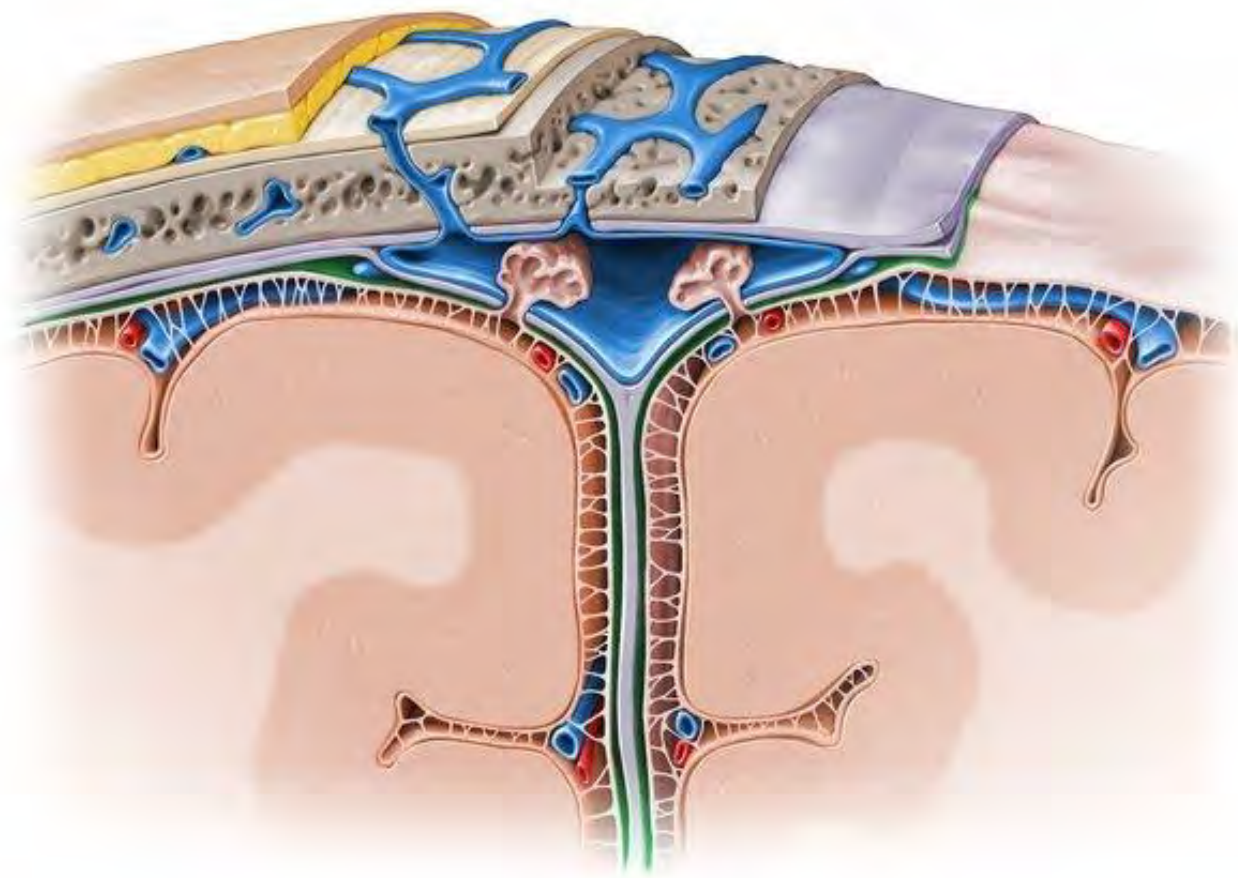
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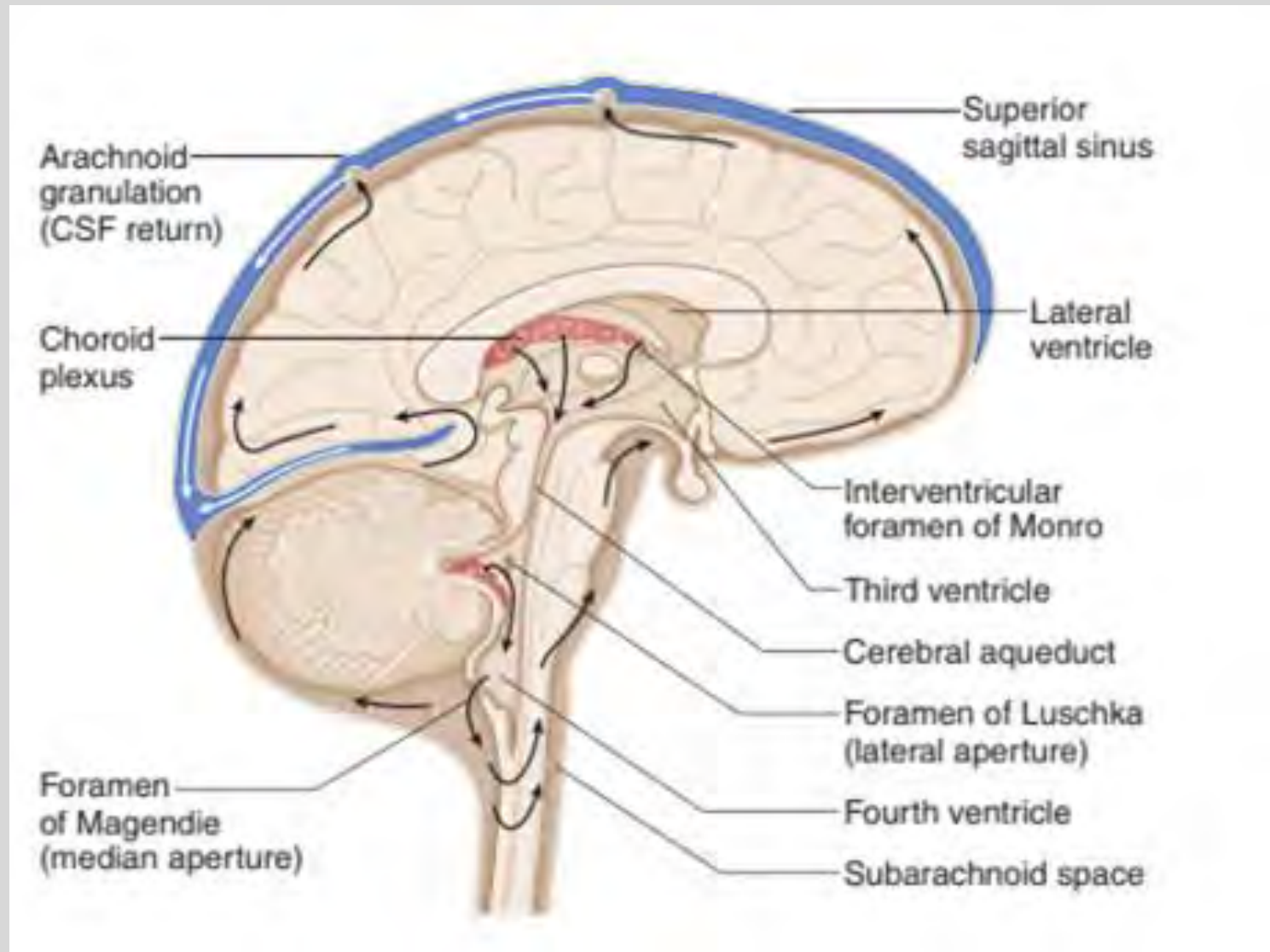






A





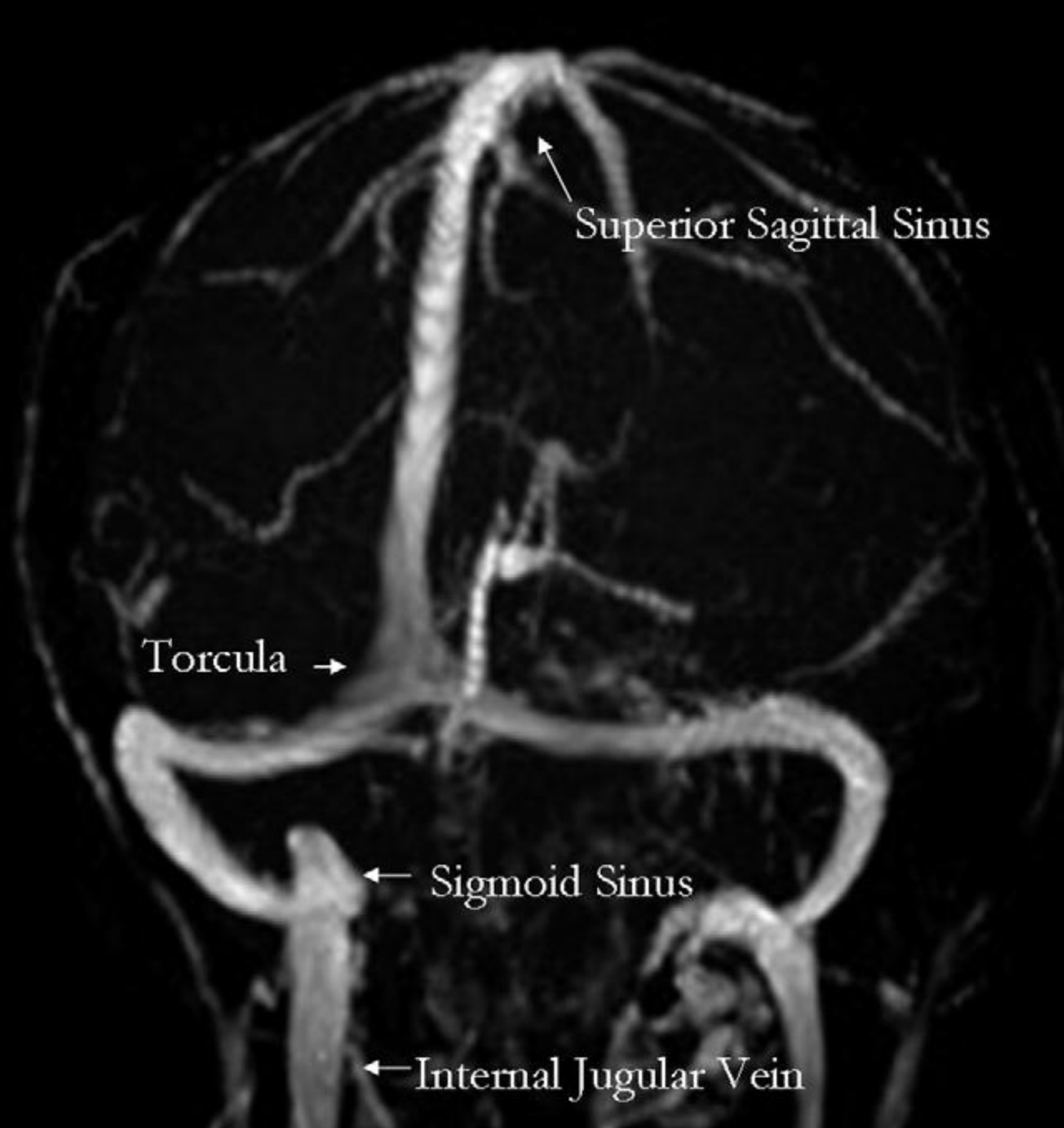
Cerebral venous and LP pressures

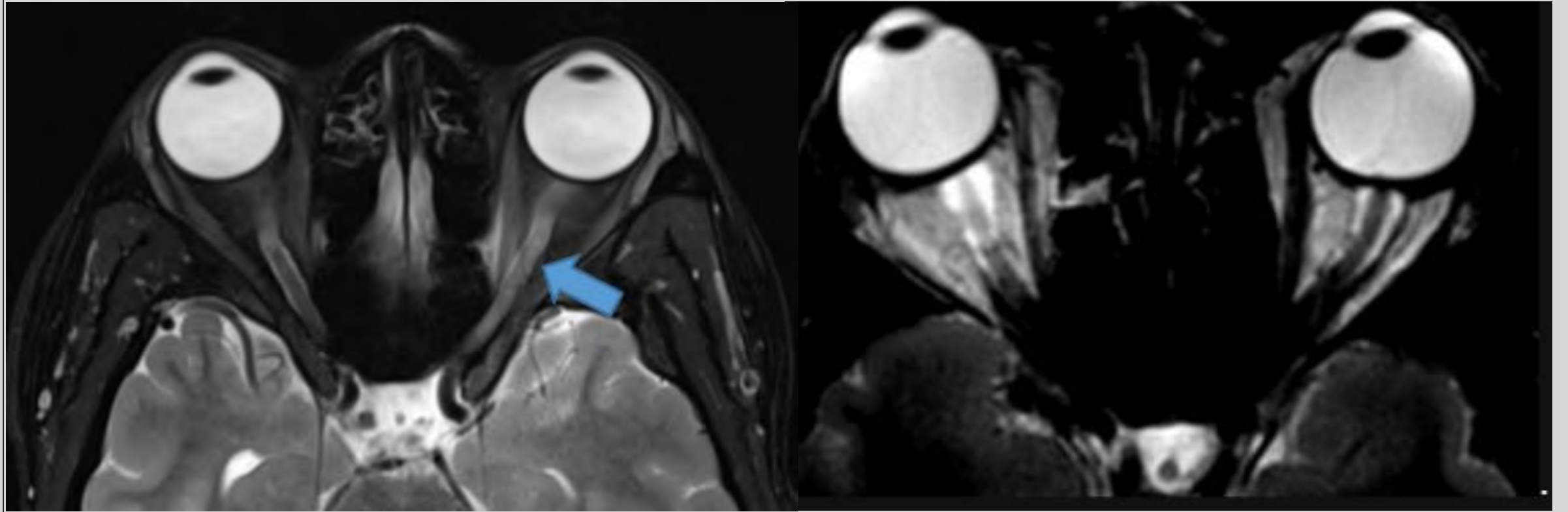
- 2021: Wake Forest compared cerebral venous pressures to LP pressure
 - 47 pts were reviewed and found that lumbar puncture opening pressure significantly predicted transverse sinus, torcula and superior sagittal sinus pressures.
 - Torcular pressures (mm Hg) were accurately predicted by OP (cm H₂O) in a nearly one- to- one relationship
- 2024: Montpellier University Hospital (France)
 - ICP measured at LP is correlated and concordant with torcular pressure in patients with IIH

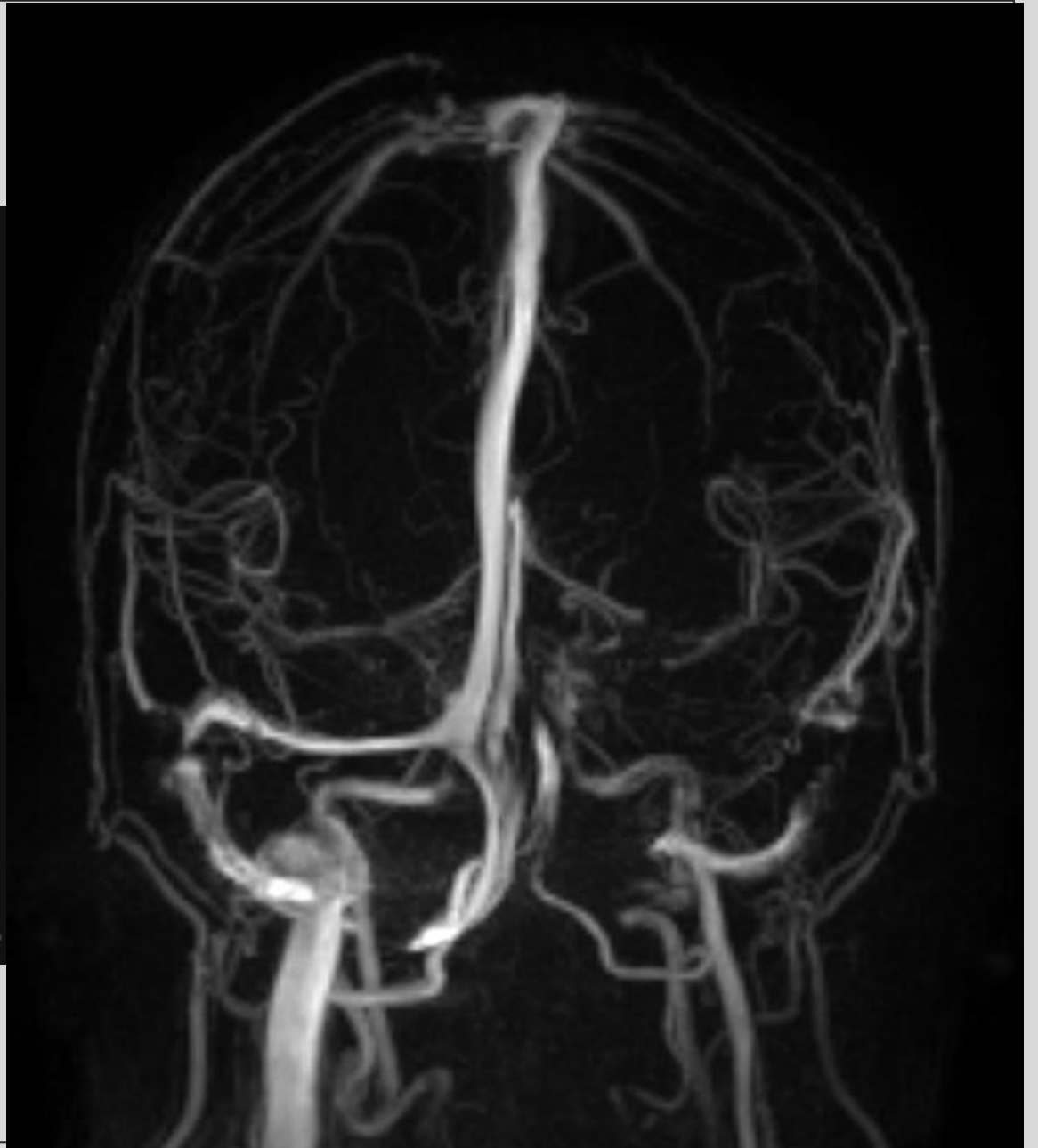
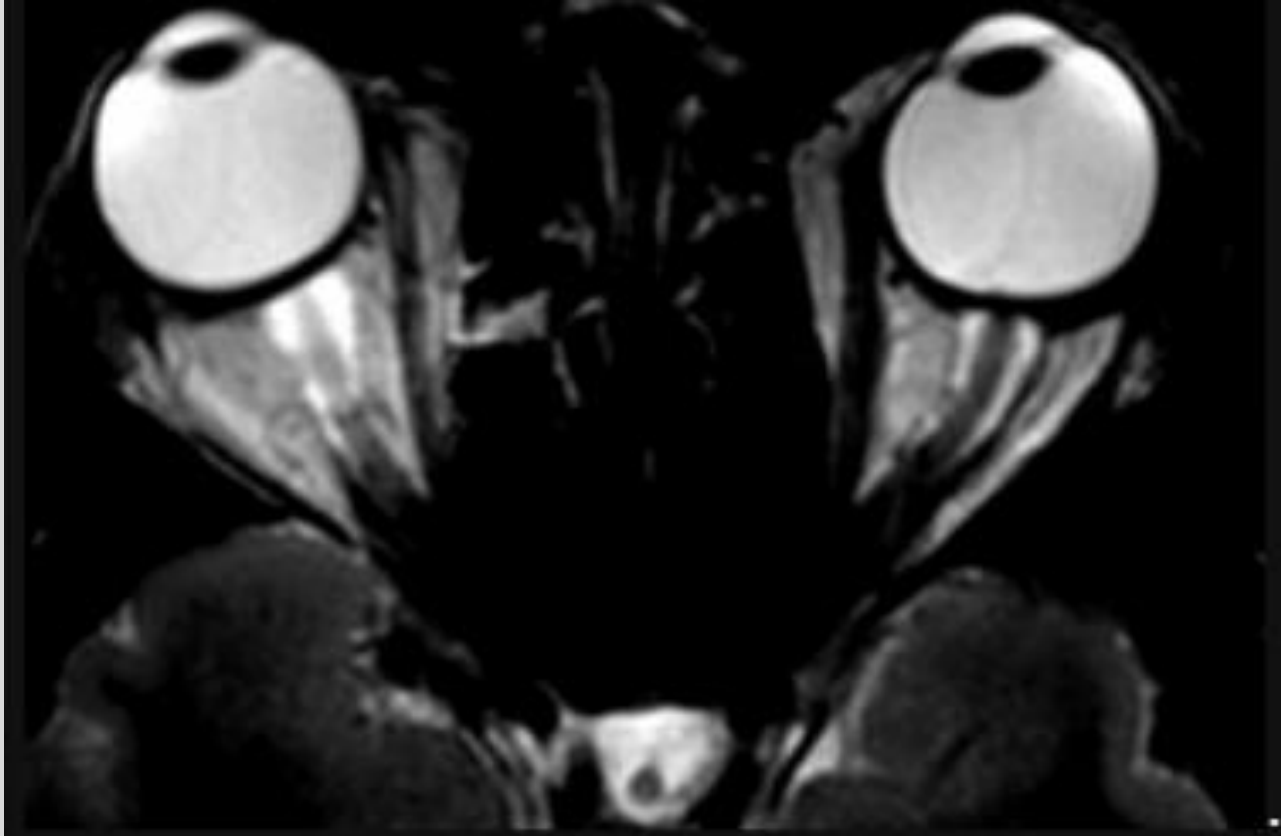
A day in the shoes

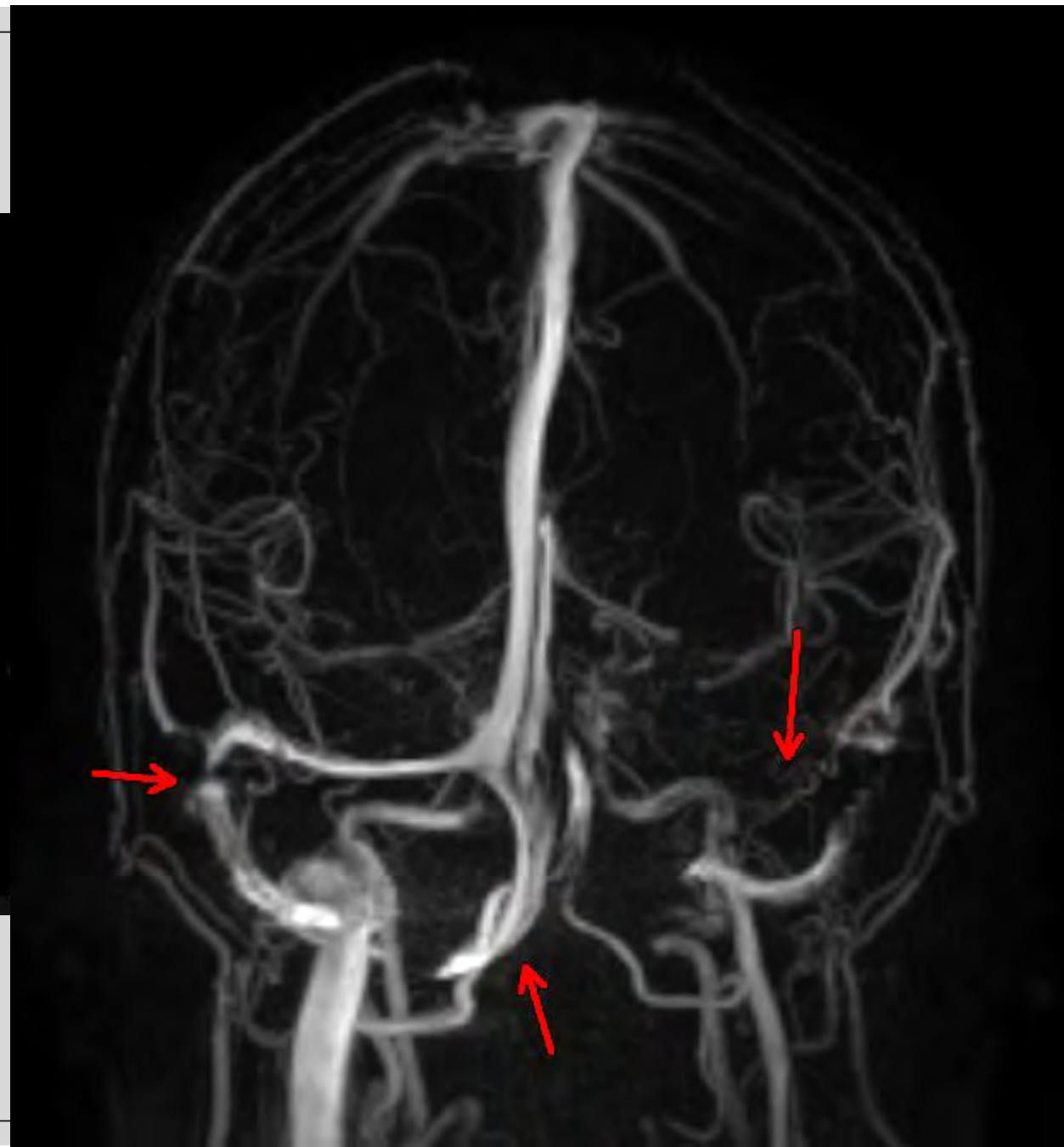
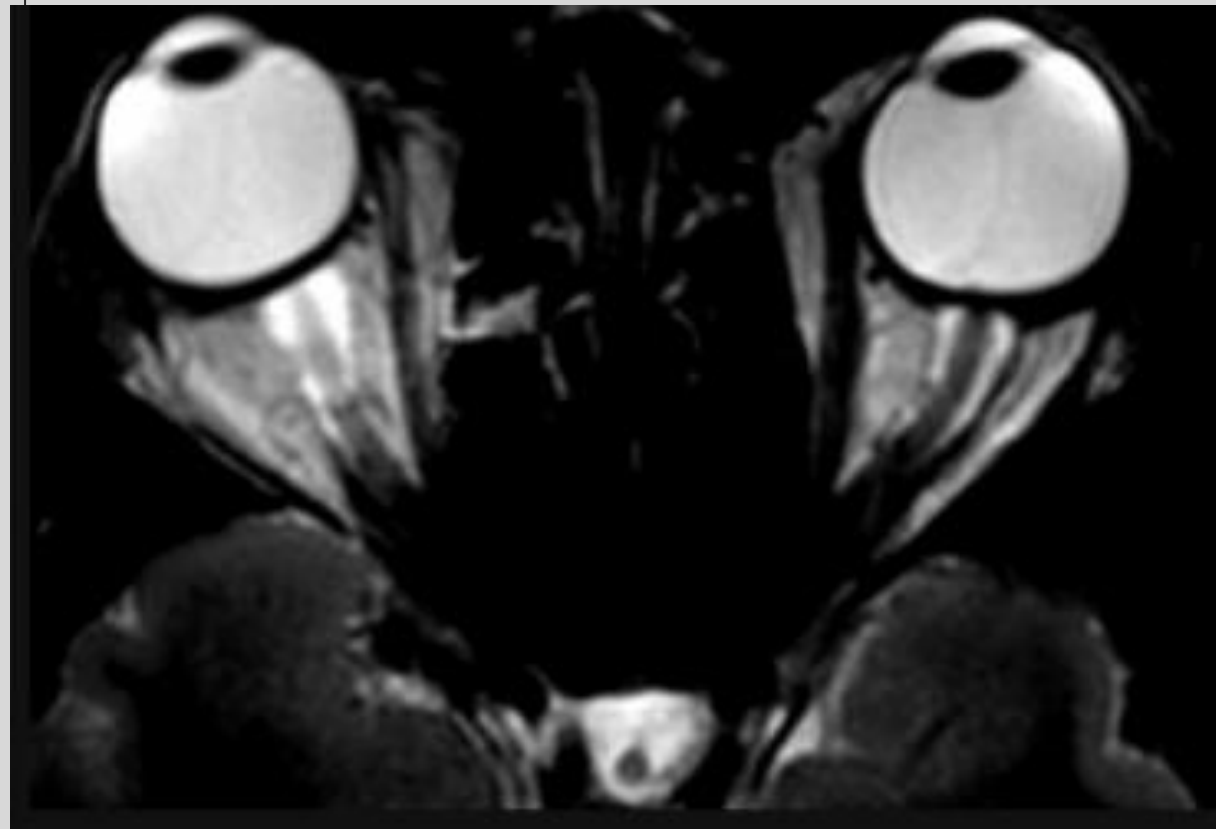


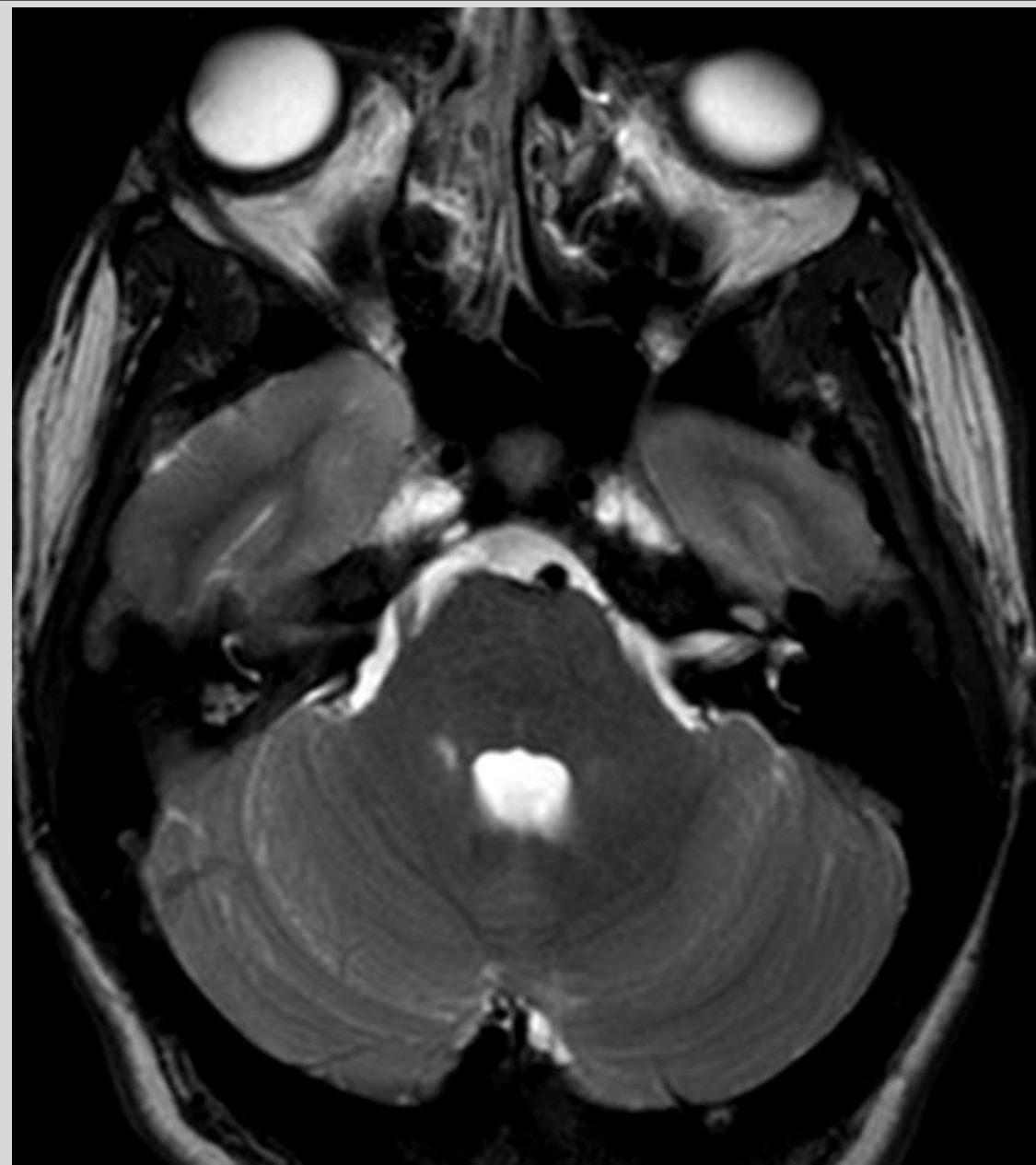
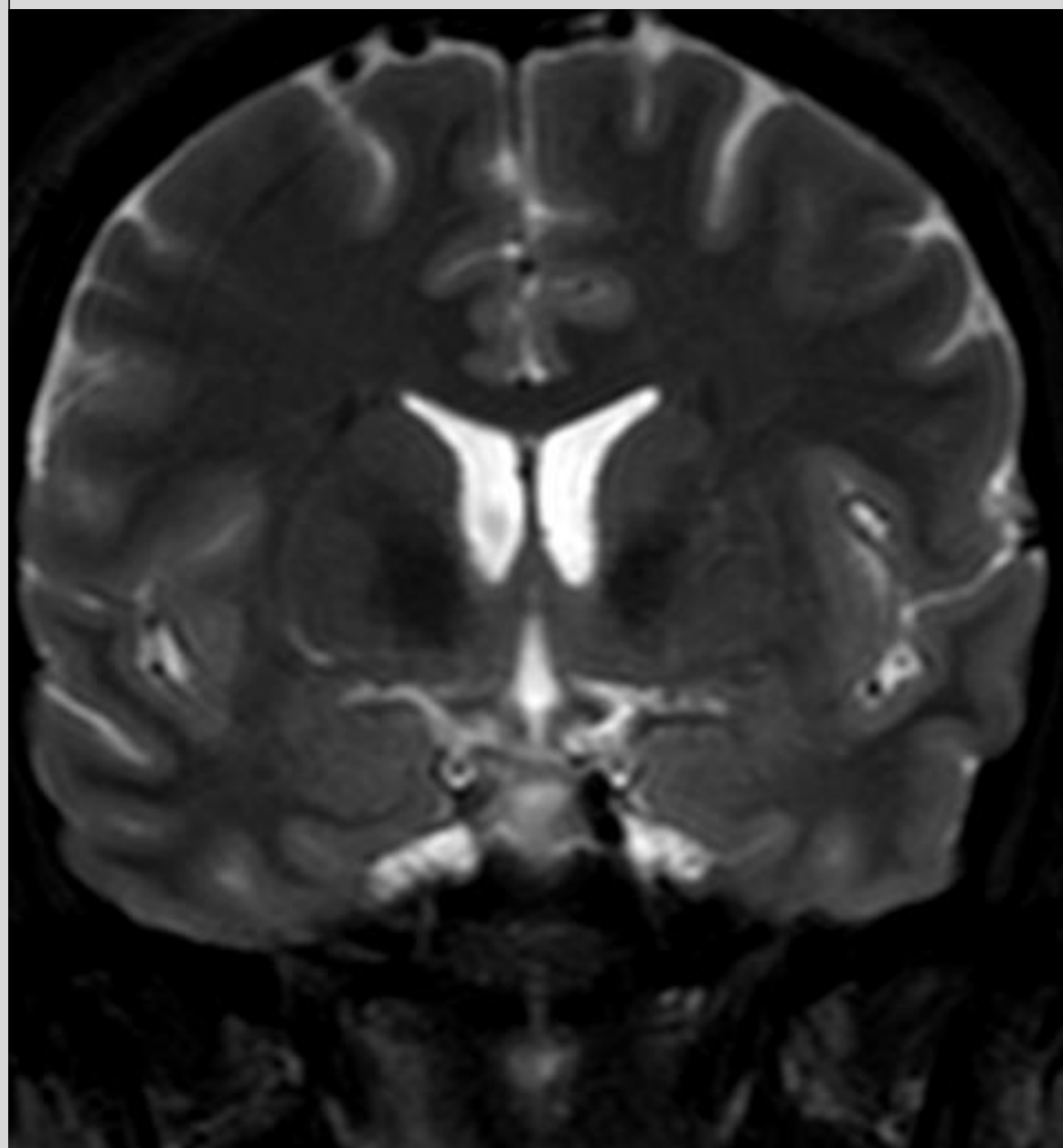
- 28 year old hairdresser with reported history **HTN**.
- Presents with **1 week of acutely severe blurry vision** and **diplopia**.
- Further questioning finds that she currently **vapes, drinks** and has remote **history of cocaine abuse**. She also reports a long history of **migraines** since childhood and **pre-eclampsia** during her **pregnancy**.
- Further ROS demonstrated that she also has “**whooshing**” and “**ringing**” of the right more than left ear that is relieved by **holding pressure on her right upper neck (IJ)**.
- PE: Normal BMI, severe blurry vision, diplopia, and on EOM exam demonstrated **partial CN 6 (abducens) palsy**- she had incomplete control with abduction.
- Imaging: Head CT, MRI, MRA, MRV- Negative except of for **basilar artery stenosis** (see history)
- Ophtho: Visual Acuity without correction (SC) 20/25 right eye (OD), 20/50 left eye (OS), optic nerves were “WNL”
- Ophtho/ Neuro: Diplopia secondary to partial CN 6 palsy

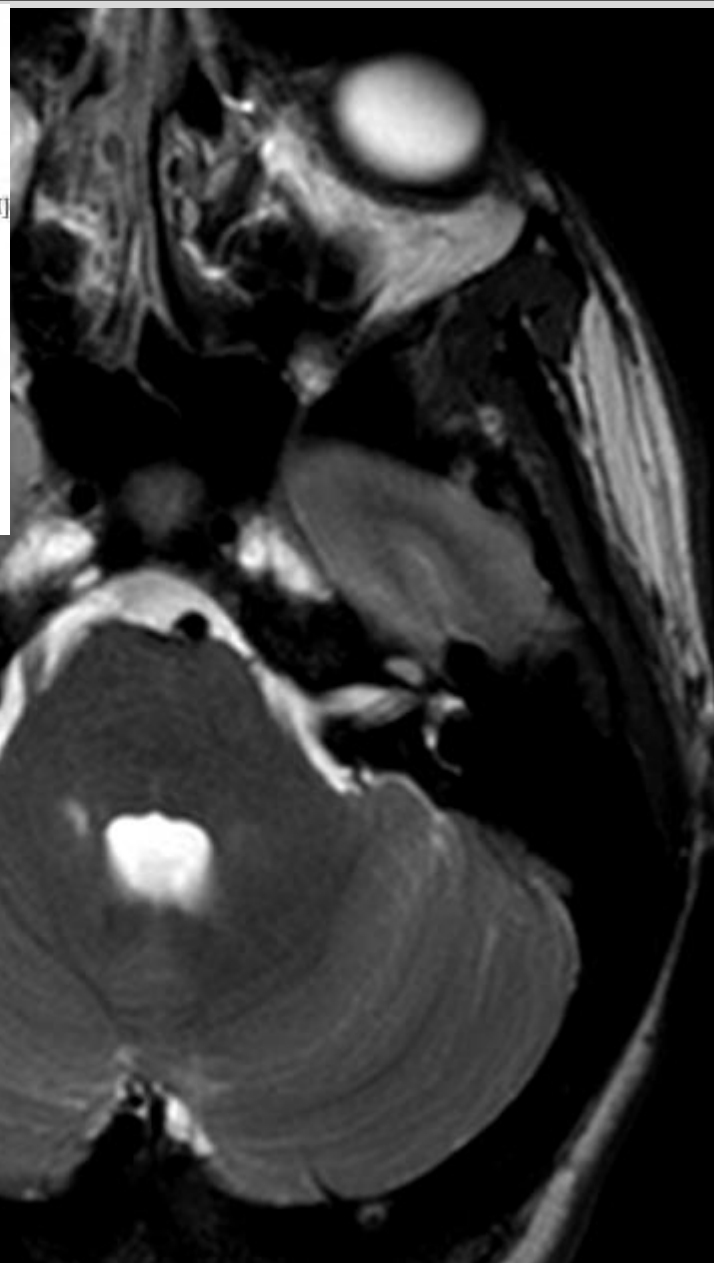
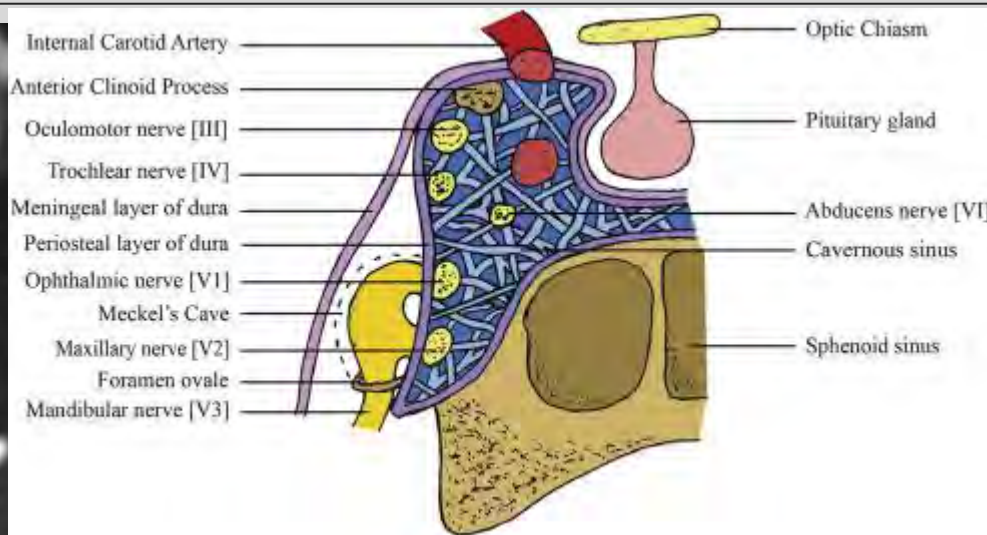
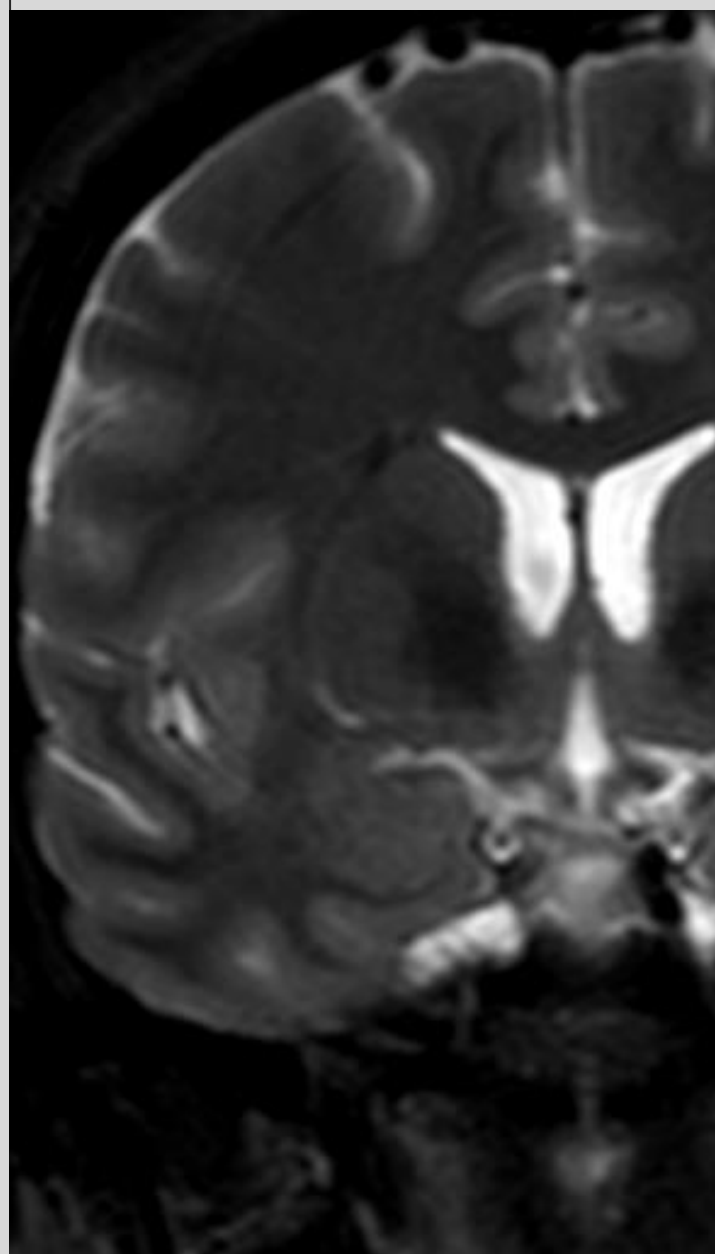


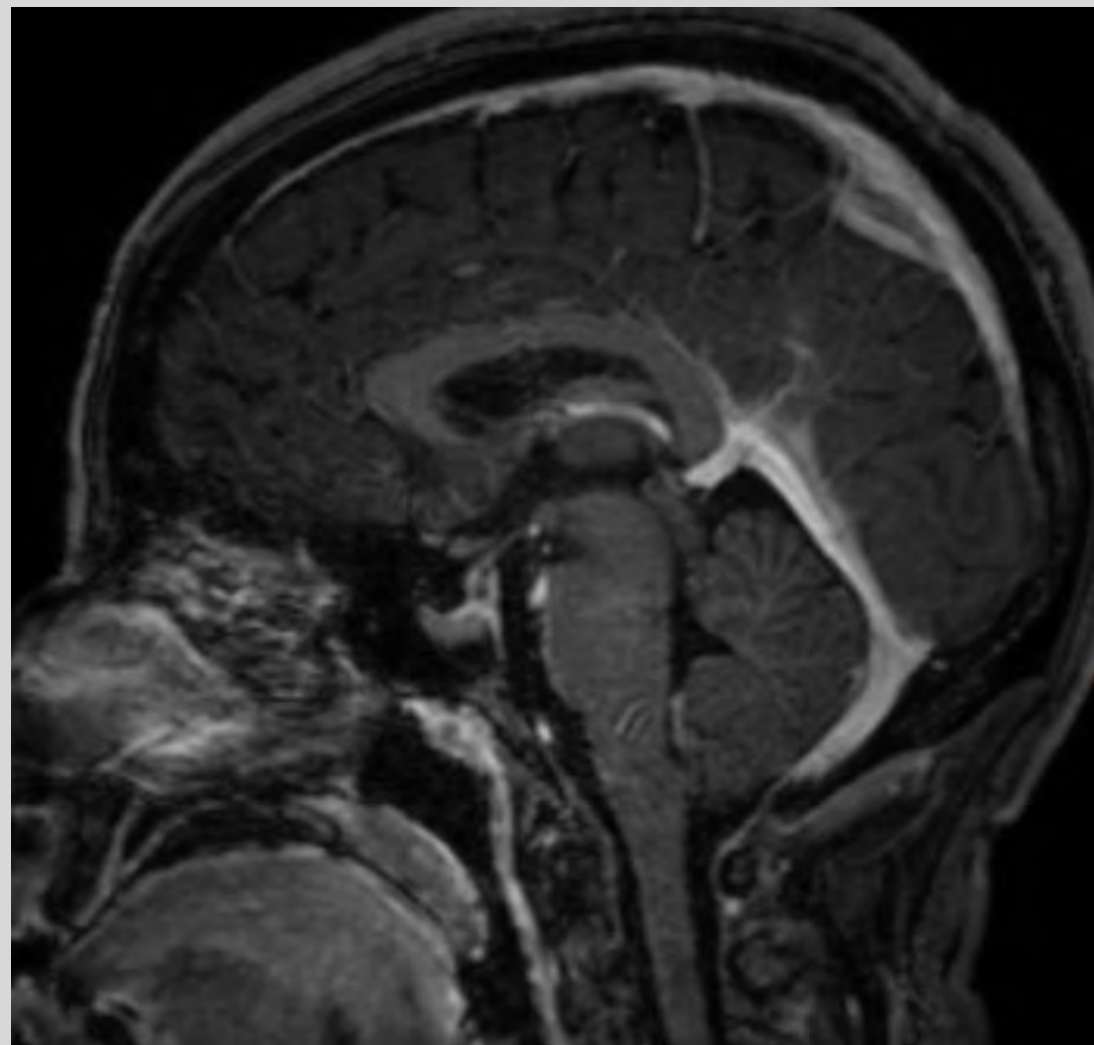
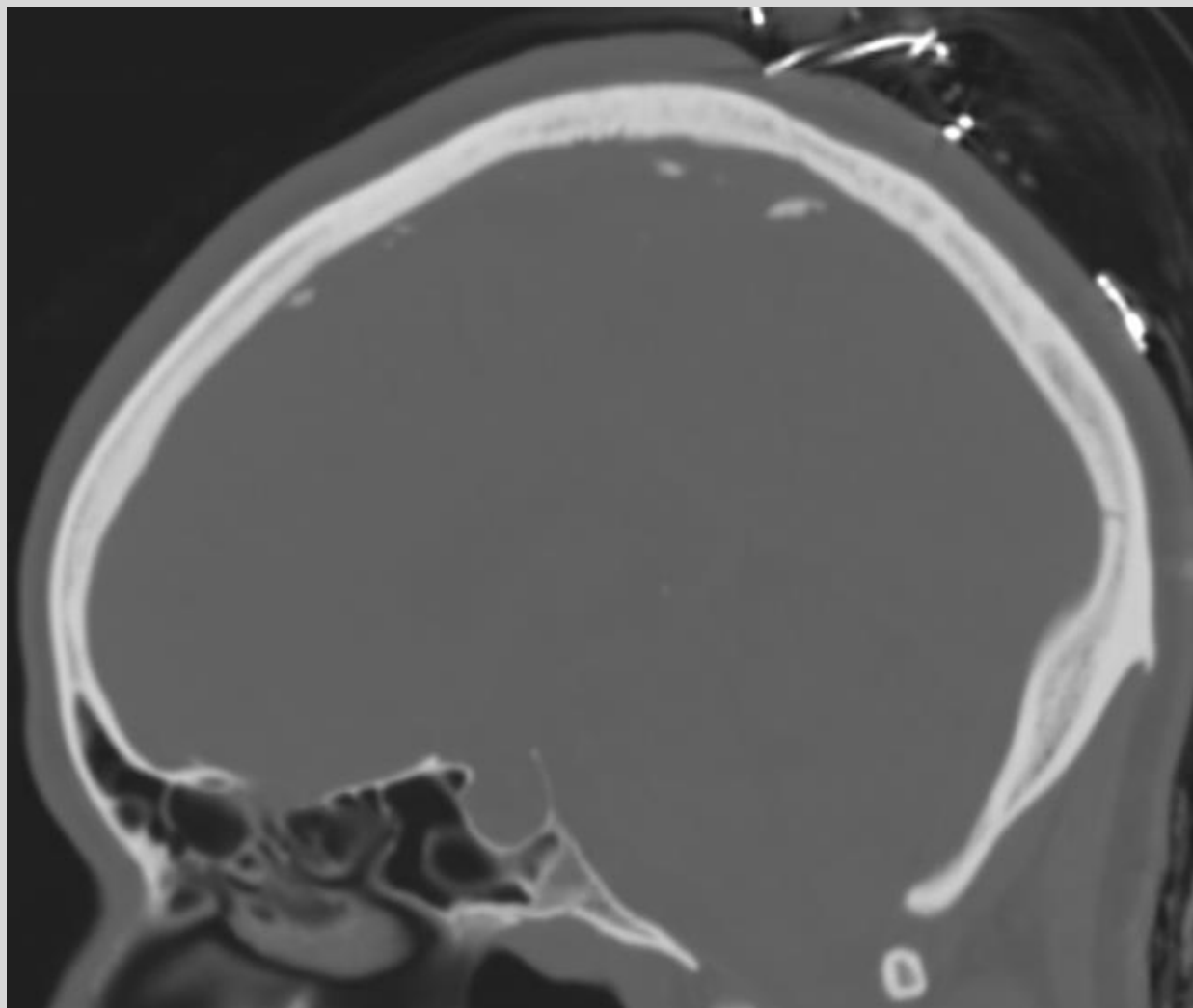


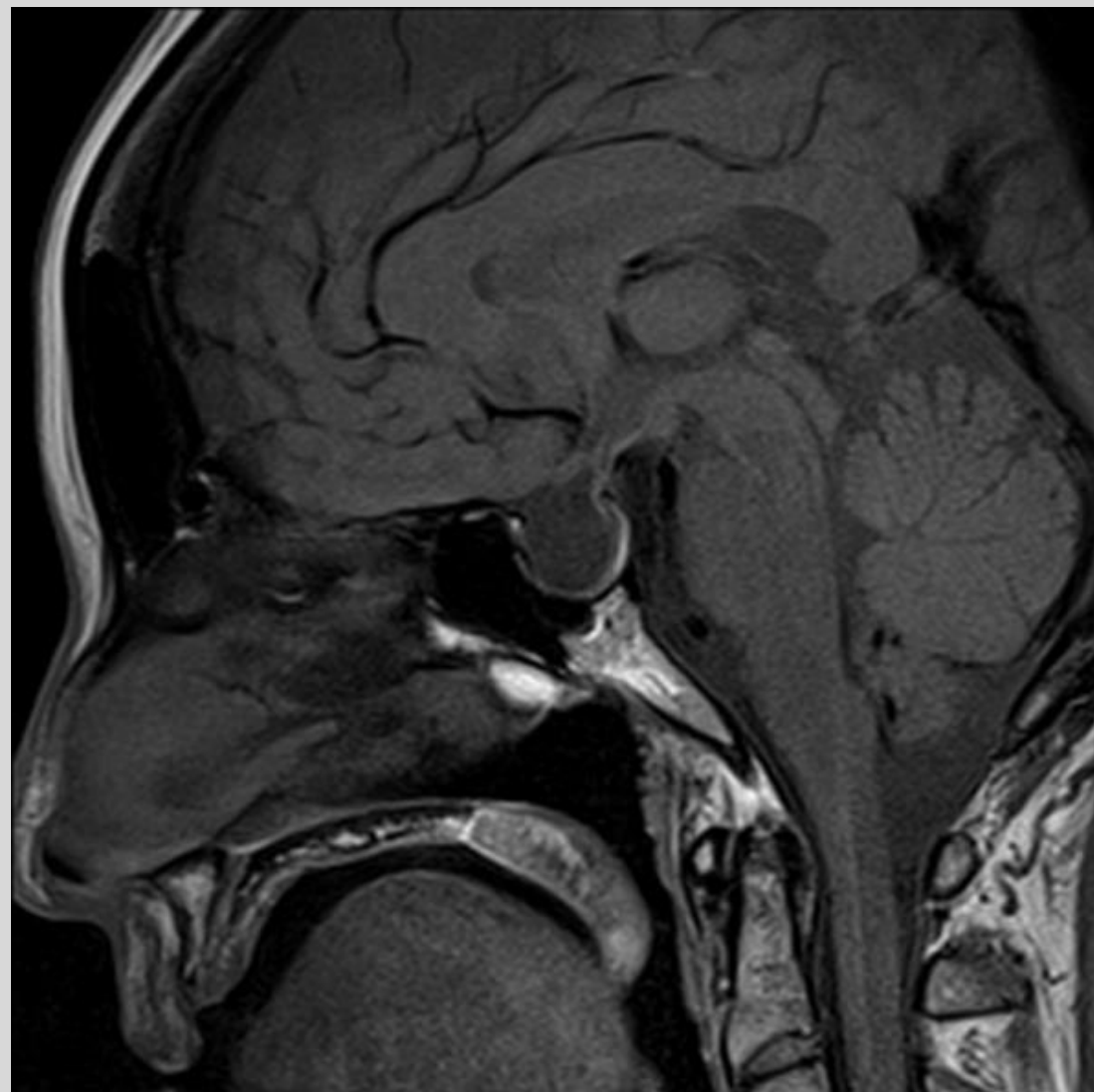
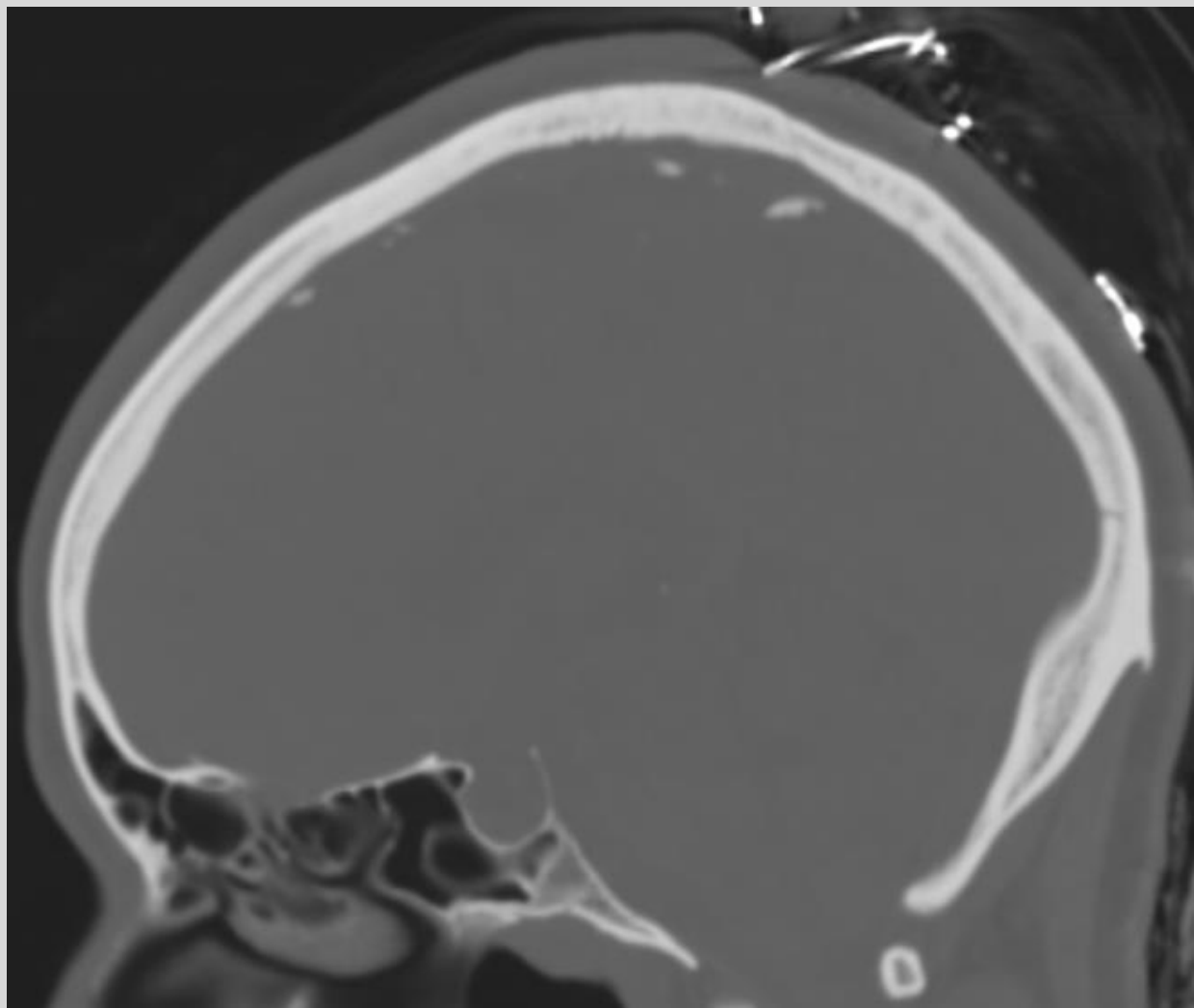


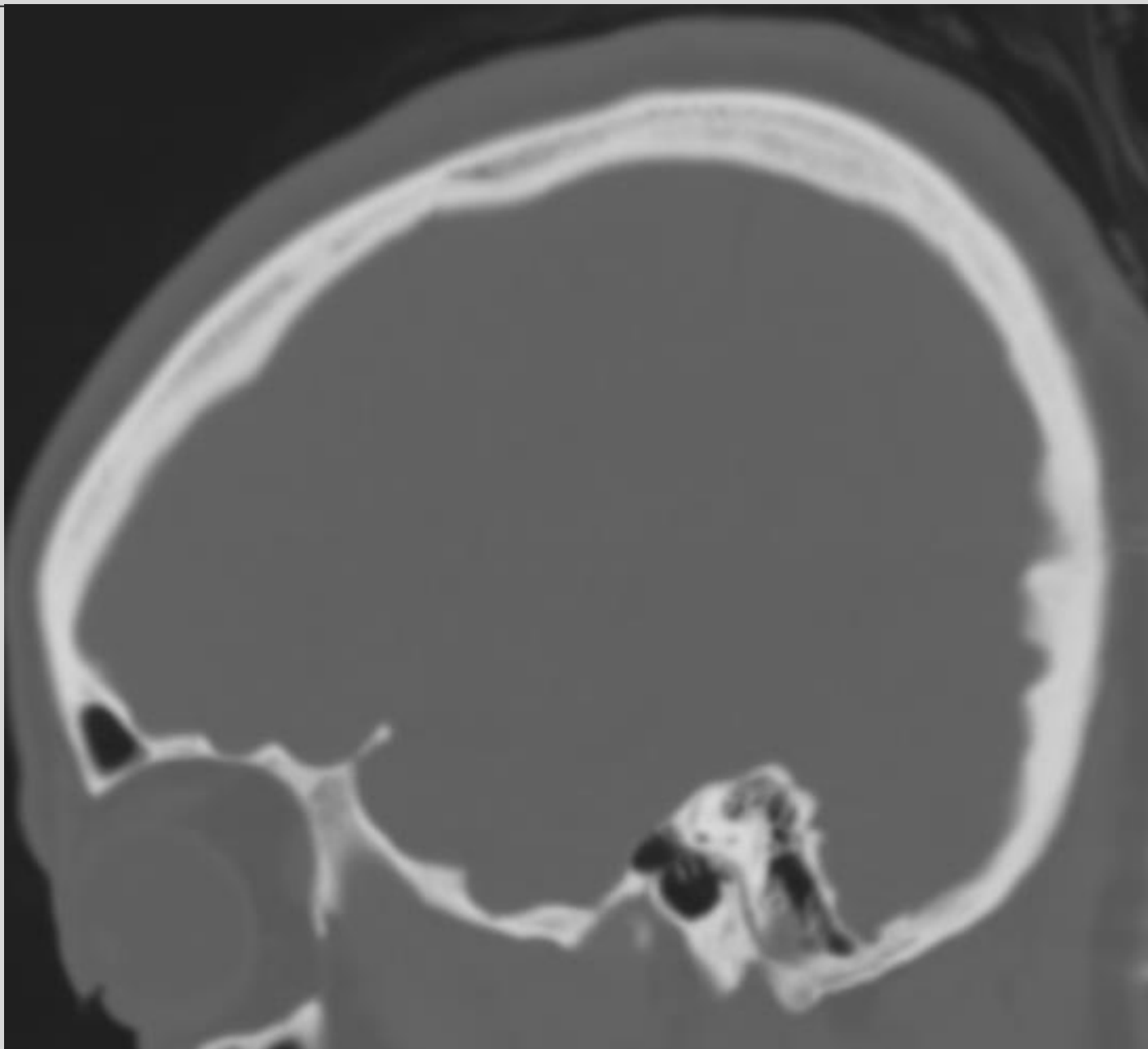






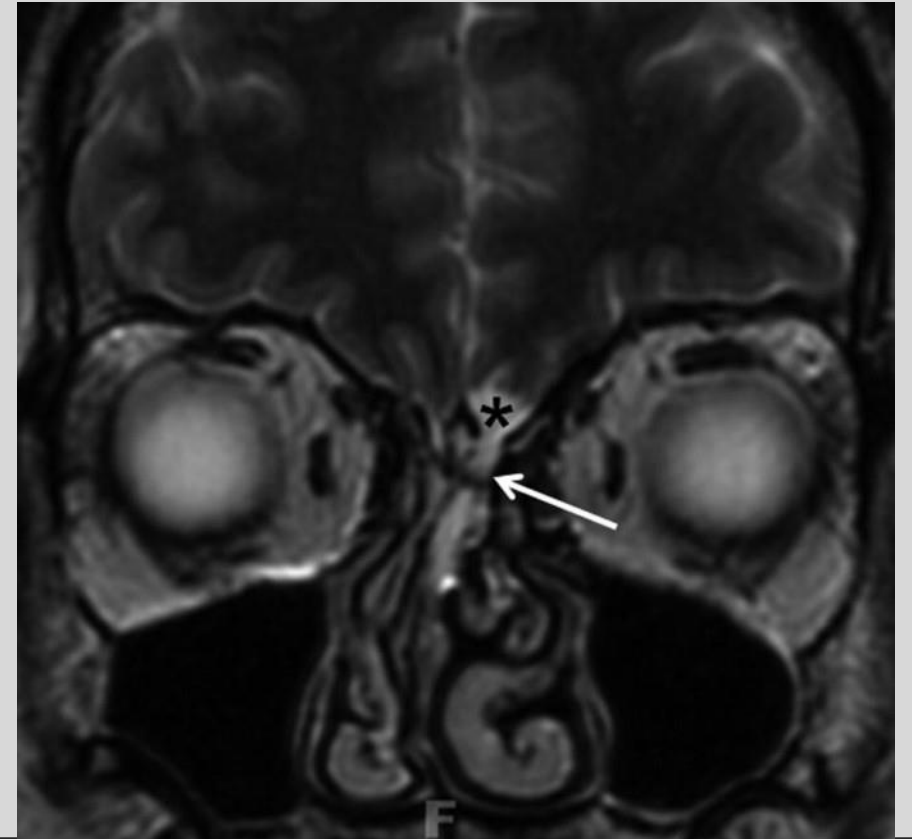
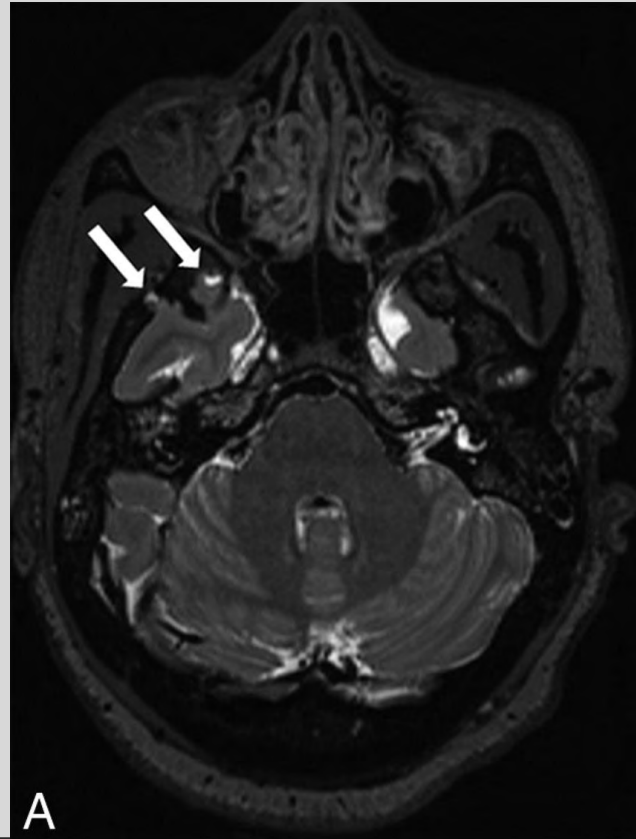
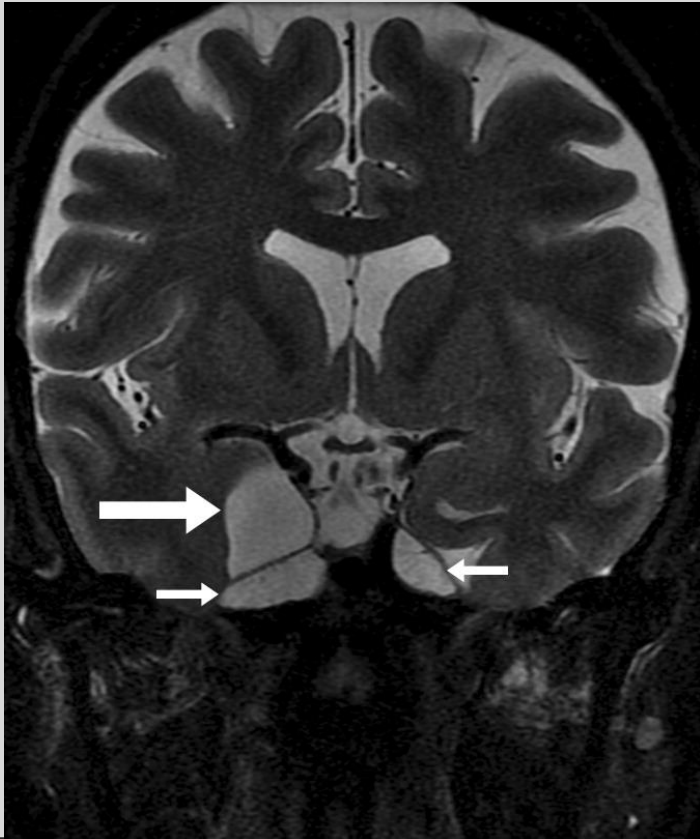






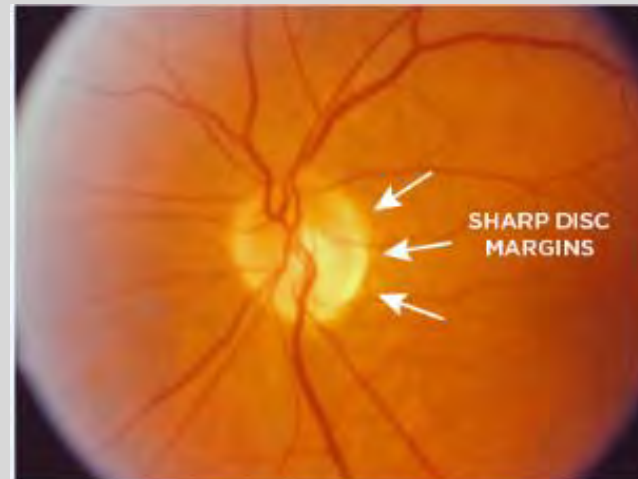
Other imaging sequelae (not present)

- cerebellar tonsillar herniation, meningoceles/encephaloceles, and spontaneous CSF leakage (then leading to cerebral hypotension)

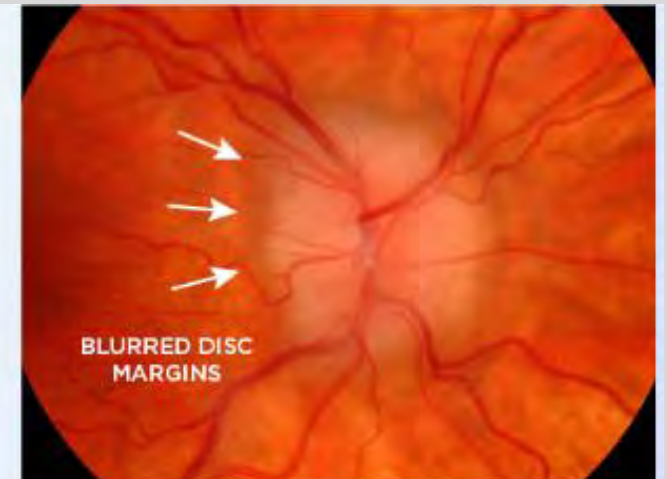


IIH Sequelae of Findings

- Acute blurry vision
- CN 6 (abducens) palsy
- Chronic migraines
- Tinnitus
- Hx of Preeclampsia
- What's missing:
 - Ophtho eval demonstrating papilledema
 - LP demonstrating elevated opening pressure



Normal Optic Disc



Papilledema

False brain tumor- say it ain't so

- In 1904, Max Nonne first used this term “pseudotumor cerebri” to describe intracranial HTN related to alteration in CSF secretions
- In 1955, John Foley suggested this be termed “benign intracranial hypertension”

Treatment options

- **Low- sodium weight reduction diet**
 - (2021) Molan et al found that Bariatric surgery was superior to conventional weight loss attempts at reducing weight and led to significantly greater reductions in intracranial pressure with improvement in pressures over 2 years
- **Medical management: Acetazolamide (Diamox)**
 - carbonic anhydrase inhibitor developed in the 1950s works by decreasing CSF fluid production thereby decreasing intracranial pressure
 - Meta- analysis (2020) evaluated the number needed to treat for harm (number of patients needed to be treated for one additional patient to be harmed) ranged from 2.3 for paraesthesias to 18 for dysgeusia, fatigue, diarrhea being 11, nausea 13, tinnitus 15, depression 17
 - Pregnancy Category C- animal evidence of teratogenicity but no adequate human studies
- **Surgical:** Optic nerve sheath fenestration- relieves optic nerve pressure; Ventriculoperitoneal (VP) shunt- relieve the ventricular CSF pressure, therapeutic lumbar punctures.
- **Endovascular option**



Table 4 Risk of side effects expressed as RR and NNTH

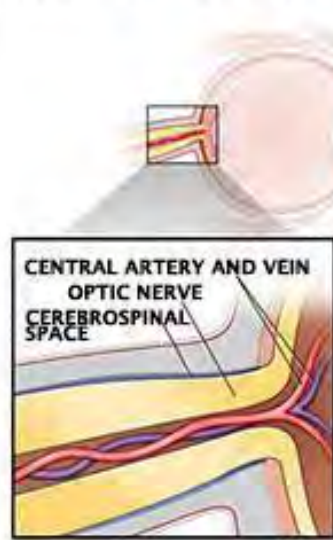
Side effects	RR	(95% CI)	NNTH	(95% CI)	Event rate		
					Placebo	Acetazolamide*	
					%	%	(95% CI)
Primary outcomes							
Paraesthesia	6.5	(5.6 to 7.3)	2.3	(NNTH 2 to 2.7)	7.9	51.4	(44.2 to 57.7)
<400mg	5.3	(4.1 to 6.6)	2.9	(NNTH 2.3 to 4.1)	7.9	41.9	(32.4 to 52.1)
400–600mg	7.0	(5.6 to 8.4)	2.1	(NNTH 1.7 to 2.7)	7.9	55.3	(44.2 to 66.4)
>600mg	8.9	(6.4 to 10.7)	1.6	(NNTH 1.3 to 2.3)	7.9	70.3	(50.6 to 84.5)
Dysgeusia	4.0	(2.4 to 6.4)	18.3	(NNTH 10.1 to 38)	1.8	7.2	(4.3 to 11.5)
<400mg	0.8	(0.2 to 3.3)	NNTB 275	(NNTH 24 to ∞ to NNTB 66)	1.8	1.4	(0.4 to 5.9)
400–600mg	3.4	(1.8 to 6.4)	22.3	(10.1 to 70.1)	1.8	6.1	(3.2 to 11.5)
>600mg	8.4	(3.2 to 19.1)	7.4	(3 to 25)	1.8	15.1	(5.8 to 34.4)
Polyuria	1.8	(1.3 to 2.5)	17.0	(NNTH 9.1 to 49)	7.5	13.5	(9.8 to 18.8)
Fatigue	5.9	(3.3 to 10)	11.1	(NNTH 6.1 to 24)	1.8	10.6	(5.9 to 18)
Secondary outcomes							
Nausea	2.6	(1.6 to 3.9)	13.0	(NNTH 7 to 37)	4.9	12.7	(7.8 to 19.1)
GERD	2.6	(1.2 to 5.3)	16.6	(NNTH 6.3 to 141)	3.7	9.6	(4.4 to 19.6)
Diarrhoea	4.8	(1.2 to 10.2)	11.6	(NNTH 4.8 to 229)	2.2	10.6	(2.6 to 22.4)
Depression	4.0	(1.5 to 9.6)	17.6	(NNTH 6 to 107)	1.9	7.6	(2.9 to 18.2)
Dizziness	1.2	(0.6 to 2.2)	100.3	(NNTH 16.3 to ∞ to NNTB 49)	5.3	6.4	(3.2 to 11.7)
Rash	1.7	(0.8 to 3.6)	89.4	(NNTH 23 to 246)	1.6	2.7	(1.3 to 5.8)
Drowsiness	4.1	(0.9 to 17.3)	30.1	(NNTH 5.7 to 663)	1.1	4.5	(1 to 19)
Tinnitus	2.3	(1 to 5)	15.8	(NNTH 5.3 to 2204)	4.8	11.0	(4.8 to 24)
Dyspnoea	2.6	(0.9 to 6.4)	18.7	(NNTH 5.3 to 299)	3.4	8.8	(3.1 to 21.8)
Dry mouth	4.7	(0.9 to 21.4)	38.9	(NNTH 7 to 1599)	0.7	3.3	(0.6 to 15)

NNTH/(NNTB), number of patients needed to be treated for one additional patient to be harmed (or benefit).²⁷ RR and NNTH/NNTB were calculated based on odds ratio and event rate in placebo arms of included trials (see methods for details).

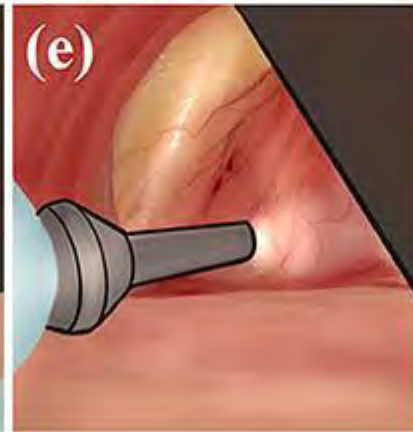
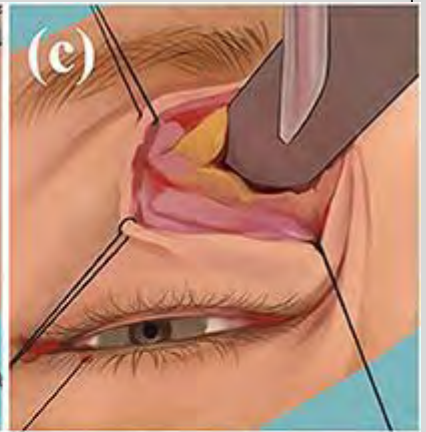
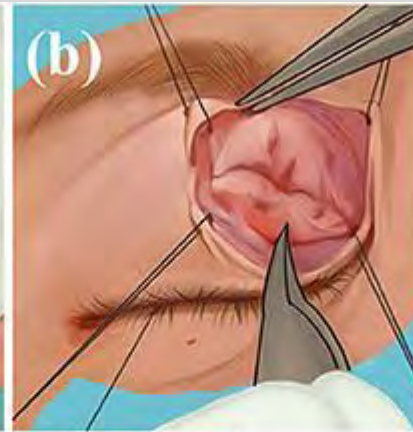
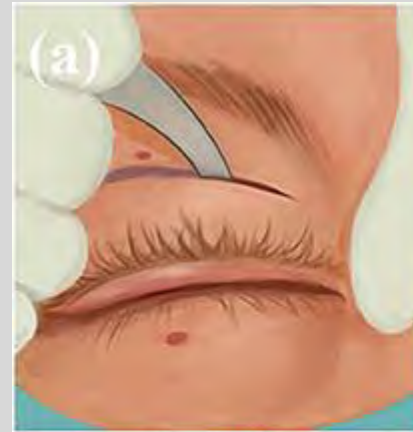
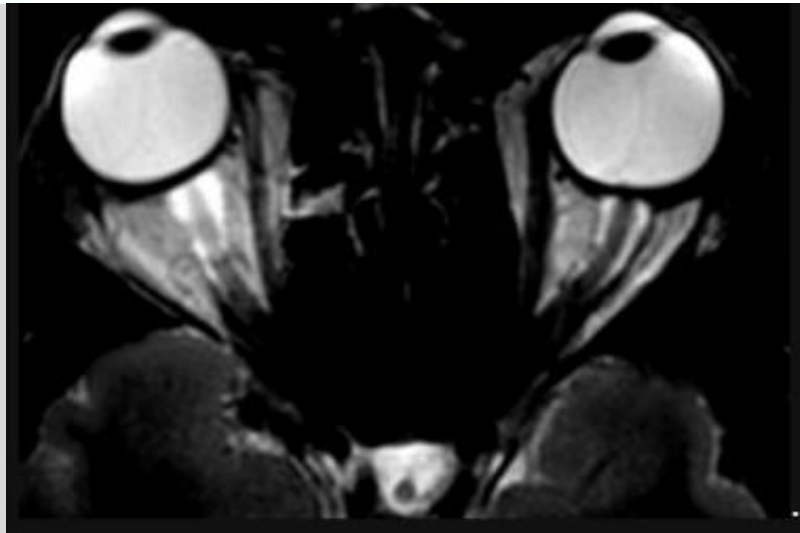
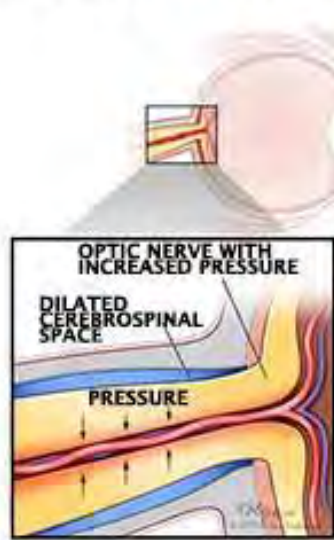
*Calculated as placebo event rate × RR (95% CI).

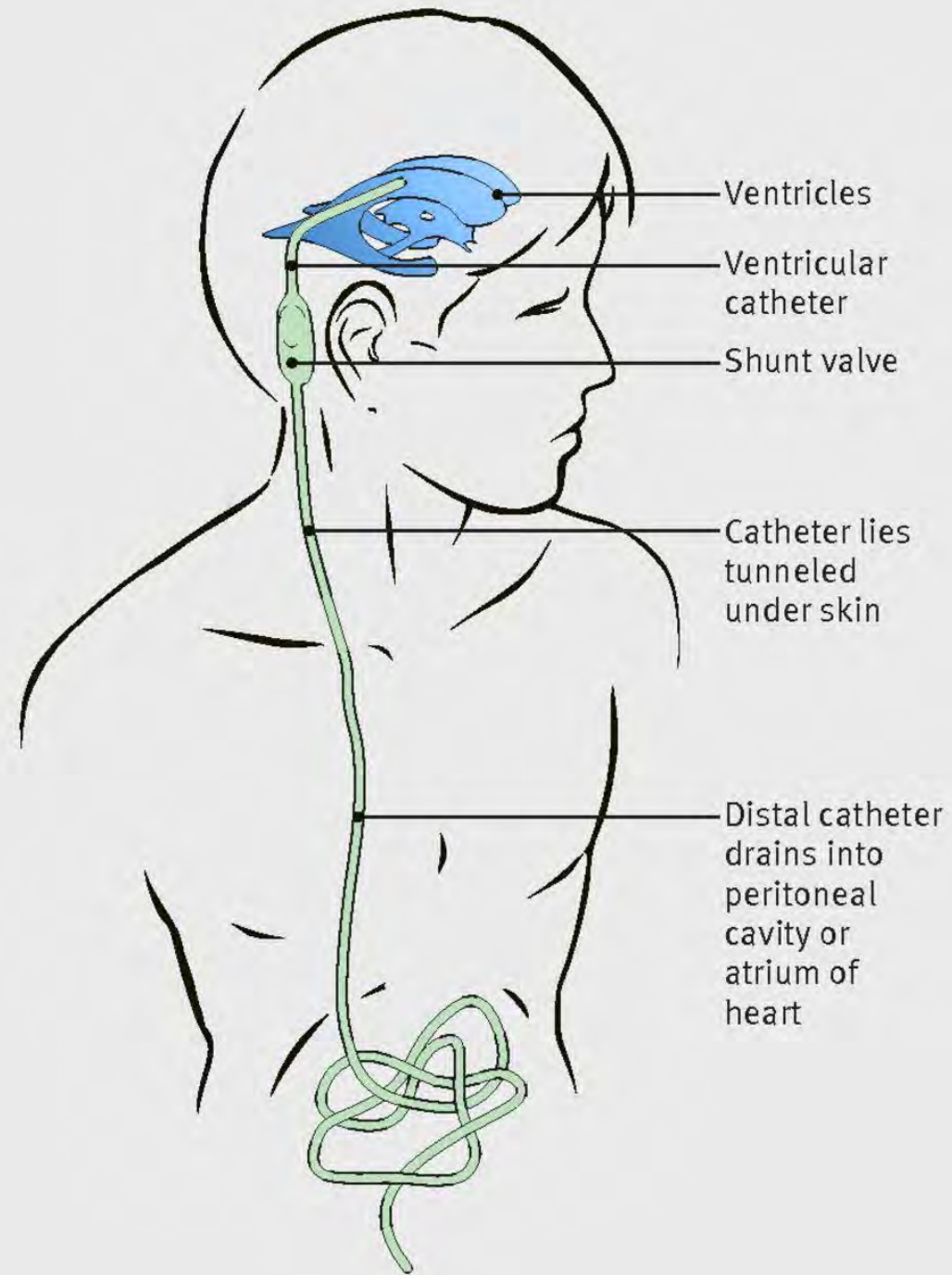
GERD, gastro-oesophageal reflux disease; RR, risk ratio.

NORMAL PRESSURE

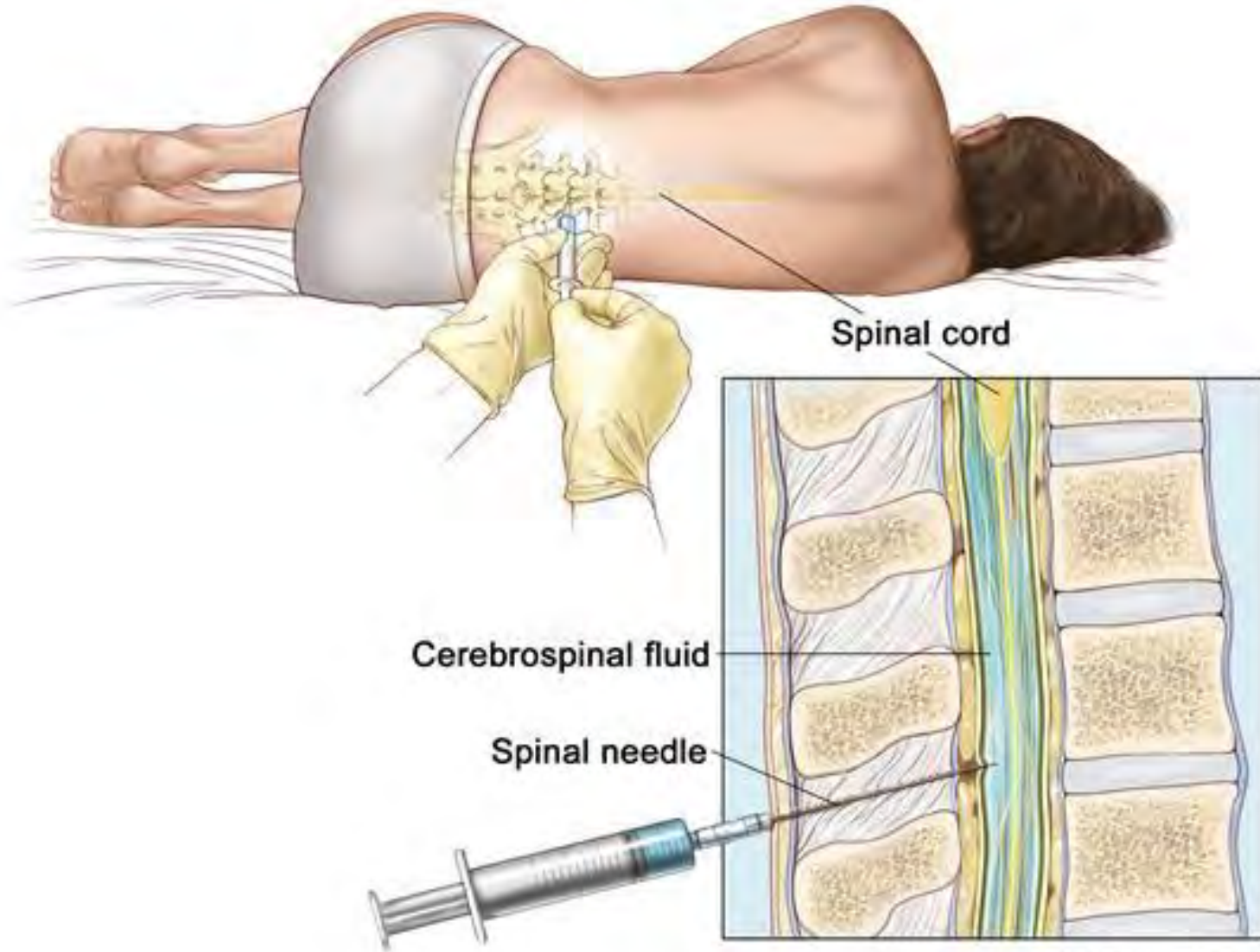


INCREASED PRESSURE





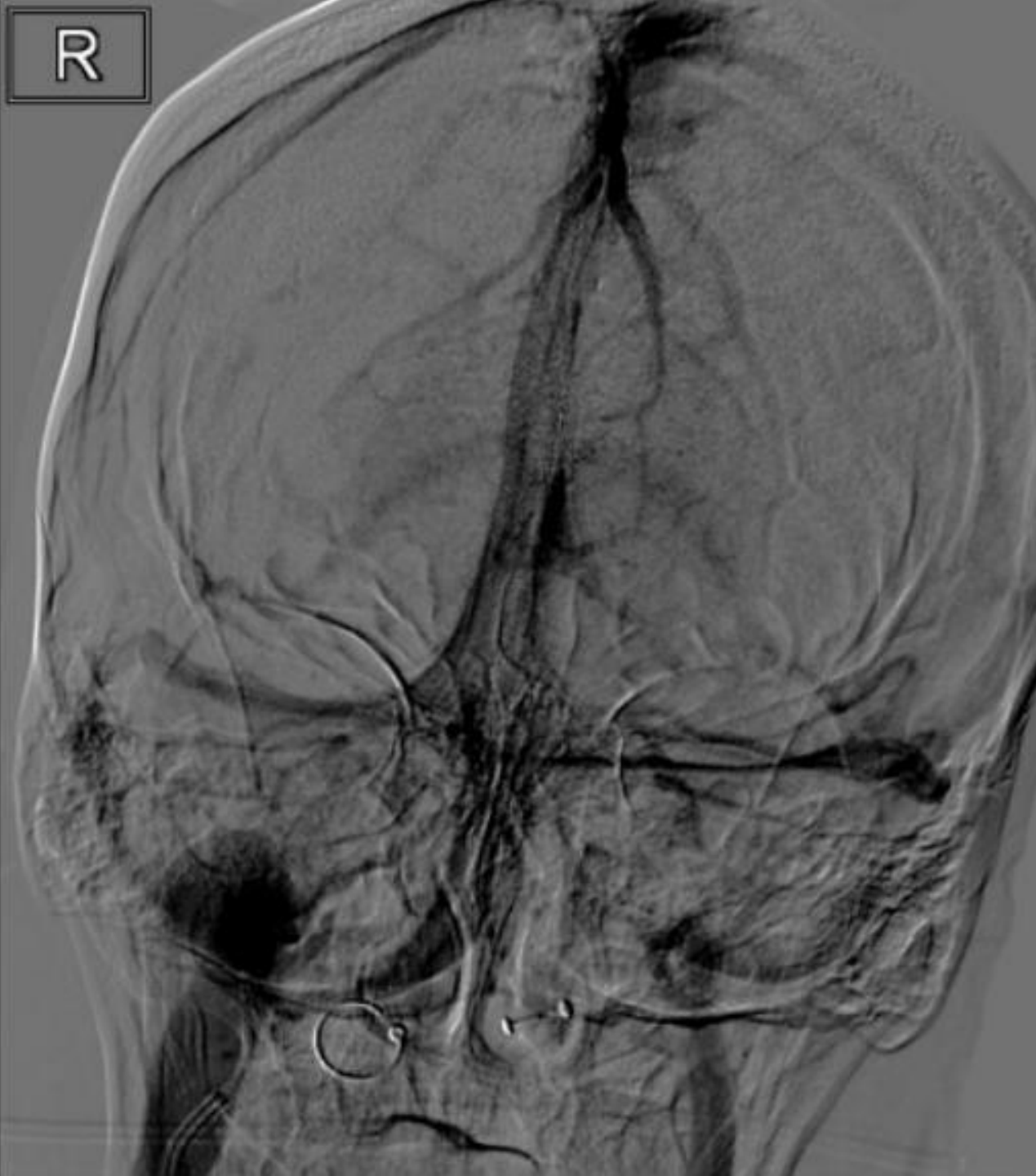
Lumbar Puncture

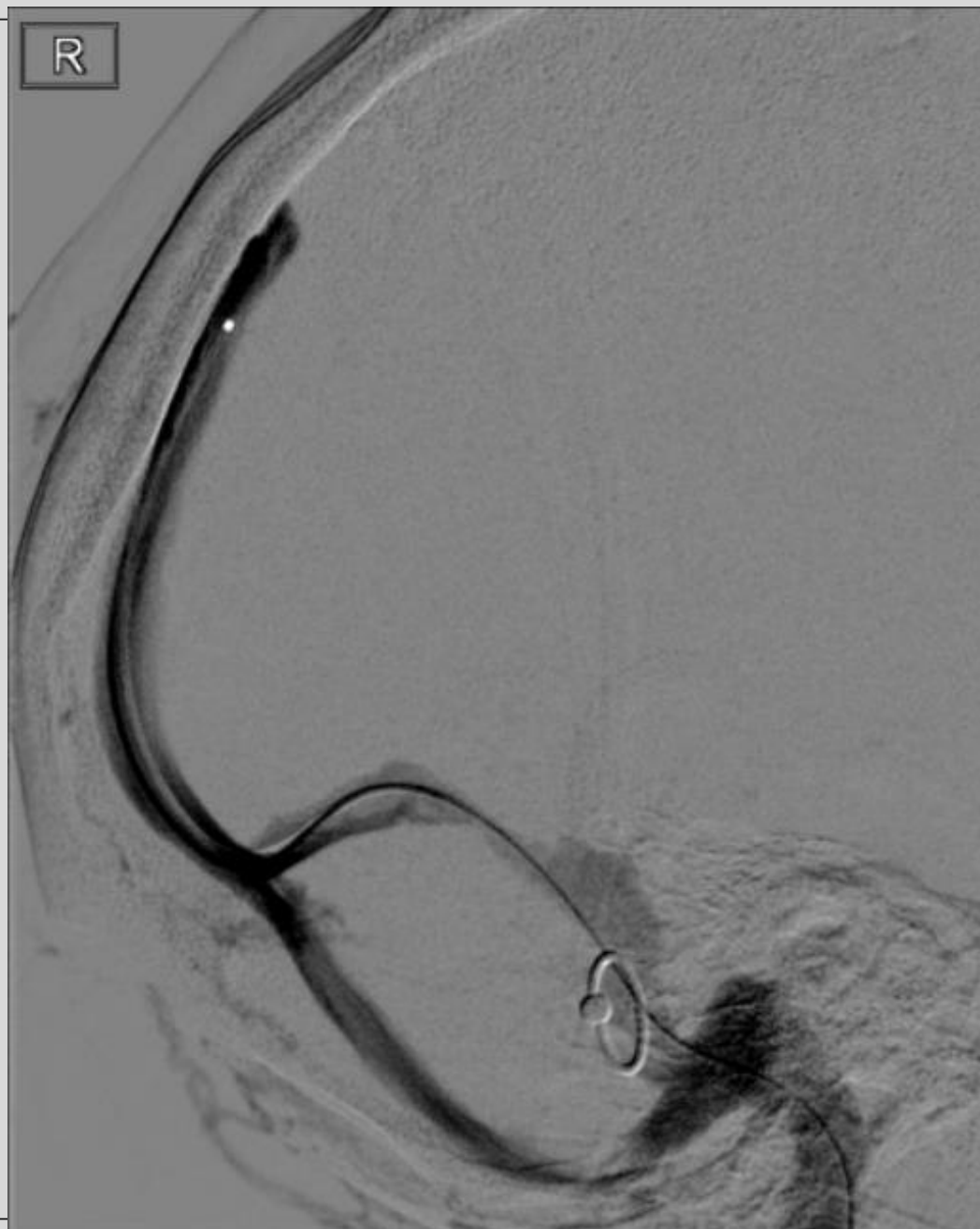


LP risks

- Pain
- Post- LP Headache requiring blood patch
- Spinal cord injury
- Cerebellar tonsil herniation
- CSF leak
- CSF venous fistula

R







Venous Pressure

- Superior sagittal sinus: 24 mmHg
- Proximal Right transverse sinus proximal to stenosis: 27 mmHg
- Distal Right transverse sinus proximal to stenosis: 33 mmHg
- Right sigmoid sinus: 7 mmHg
- Right internal jugular vein: 7 mmHg





Right



Post Stenting Venous pressures:

- Superior sagittal sinus: 10 mmHg
- Right proximal transverse sinus (proximal to stent): 9 mmHg
- Distal mid transverse sinus (proximally within the stent): 9 mmHg
- Sigmoid sinus: 8 mmHg
- Internal jugular vein: 7 mmHg



Delayed diagnosis

- 2024: Retrospective single centre cohort study performed at a specialized quaternary hospital (Royal Victorian Eye and Ear Hospital) with 24/7 Neuro-ophthalmologist
 - During the period from September 1, 2022, to September 1, 2023, there were 42,891 triaged patients in the ED. A total of **162** patients were identified as having a working diagnosis of IIH of which **51** ultimately had a final diagnosis of IIH.
 - **90% female predominance**
 - **Mean age: 29.4**
 - **82% overweight (BMI >30); 4% morbidly obese (MI>40)**
 - **Headaches and visual disturbance** were the most common symptoms at ED presentation (**88% and 58%**)
 - All the patients had **papilloedema**
 - Average time to symptom onset to ED presentation was 132 days (**4 months**)
 - Final diagnosis of IIH was achieved for 65% of patients within **1 month**
 - Average time to symptom onset to IIH diagnosis was 163 days (**5 months**)

Regardless, the overall delayed time to diagnosis from symptom onset emphasizes the need for high suspicion and appropriate referral for workup of this condition to enable an expedient diagnosis, especially in overweight young females with headache and visual symptoms.

Take home points

- IIH is a severely underdiagnosed debilitating disease that can lead to irreversible blindness
- Most commonly affected population are overweight women of childbearing age
- Most common acute symptoms are vision changes
- Most common chronic symptoms are chronic headaches and fatigue
- Review of MRI/ MRV imaging by a trained Neuroradiologist with appropriately high suspicion is key
- Eval with Ophthalmology (preferably a Neuro-ophthalmologist) to evaluate for papilledema
- Appropriate involvement of a Neuroendovascular Specialist for vetting and treatment of these patients