



Presentation and Management of Raised Intracranial Pressure

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Neurosurgery



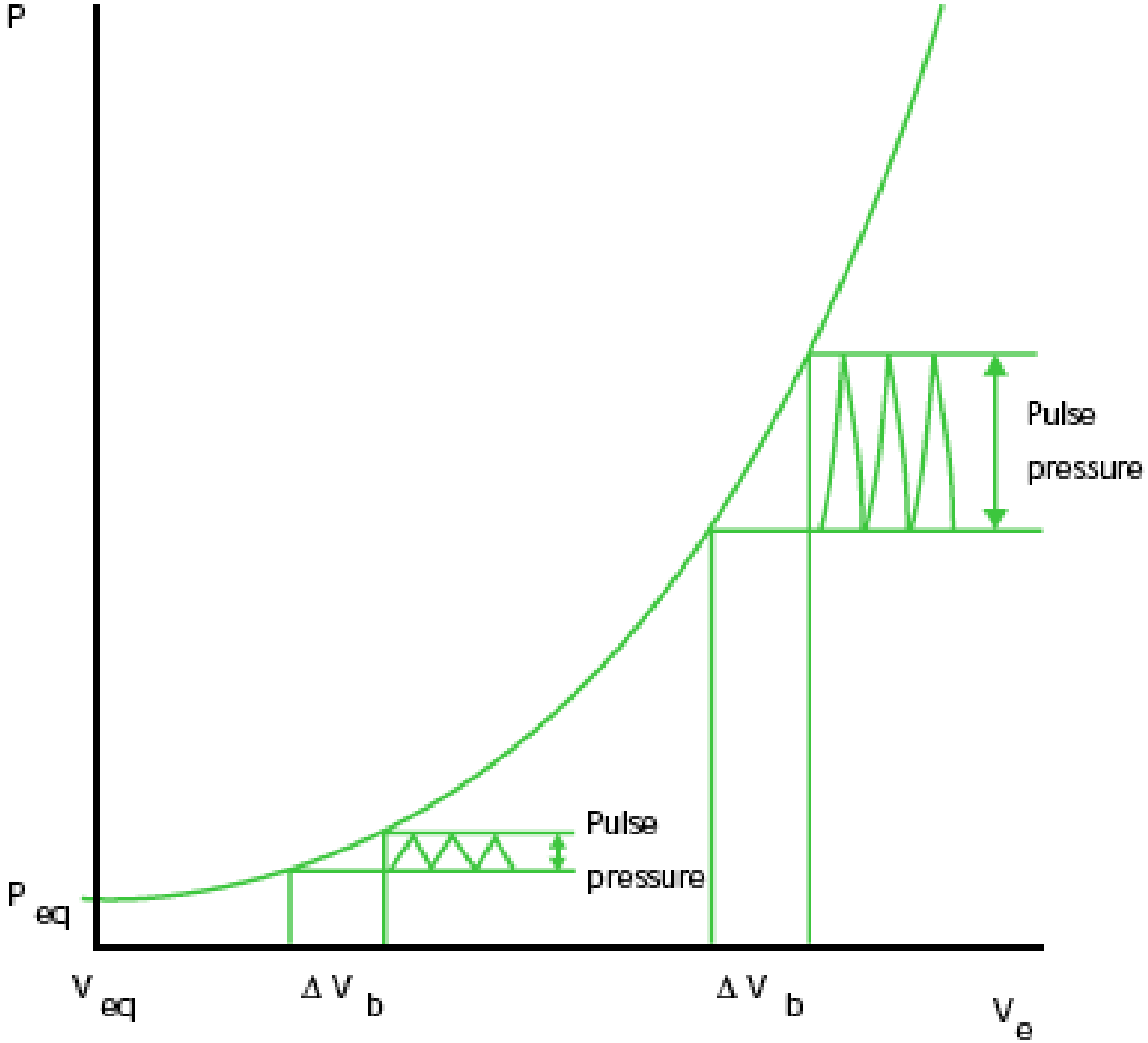
Basics

- Components of cranium
 - Brain 1400 ml
 - CSF 75-100 ml
 - Blood 75ml
- Monro-Kellie Doctrine
 - These contents are incompressible
 - Therefore, change in volume of the brain is associated with change in CSF or blood volume

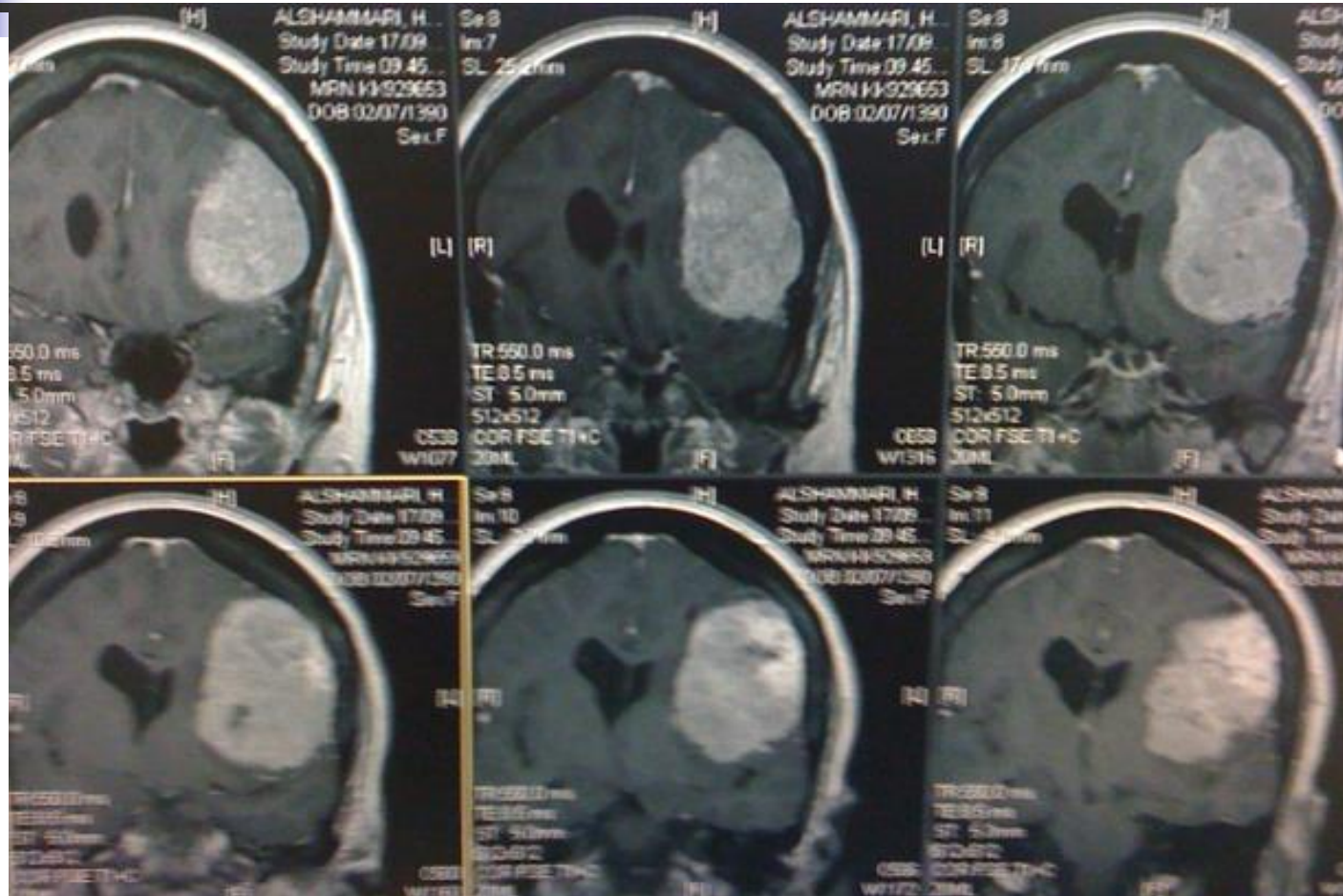


Pressure-Volume

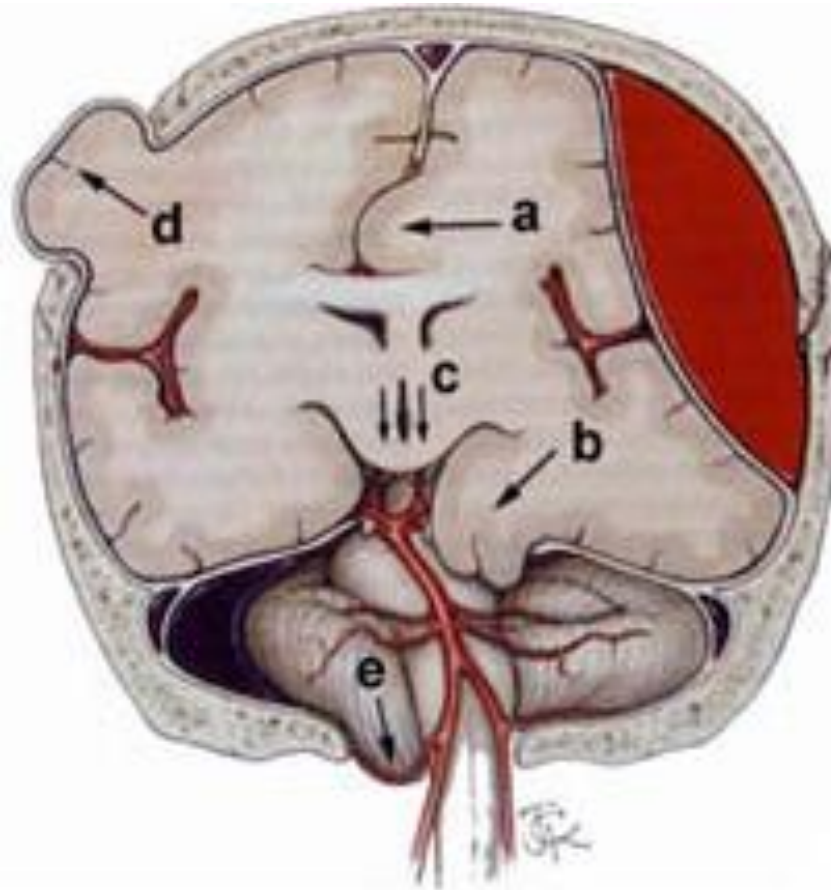
- Increase in volume in one compartment leads to change in volume in the other ones.
 - E.g. brain tumor ---> CSF volume ↓ then blood volume ↓
- For how long could this go on?



Can somebody walk around with a raised ICP?

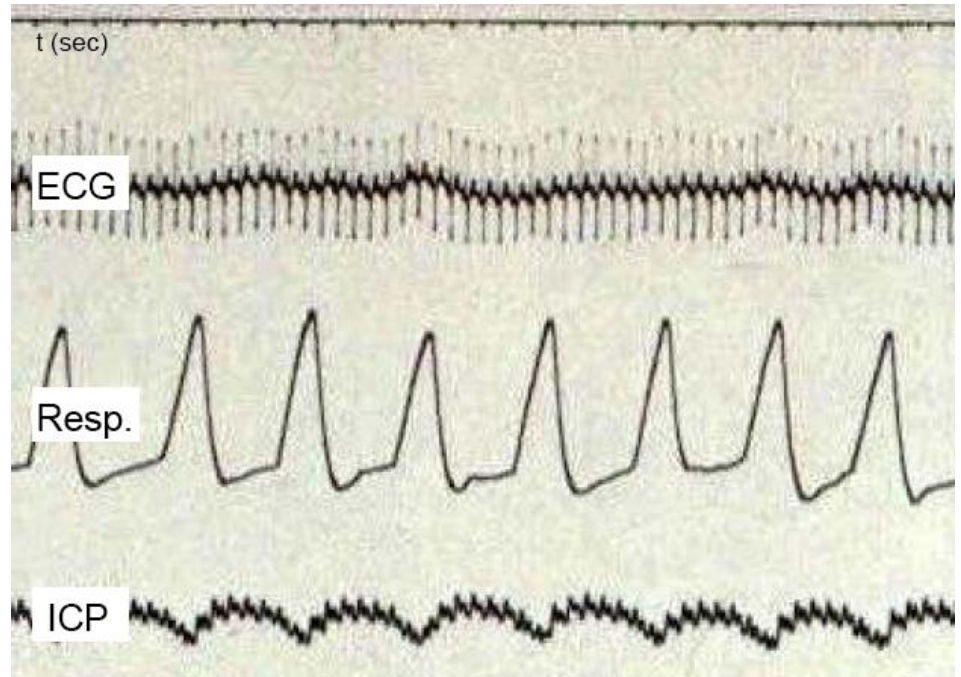
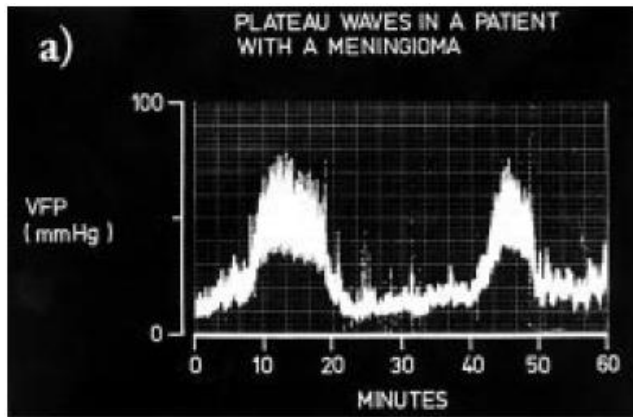


Raised ICP and brain shift



- A. **Cingulate herniation**
- B. **Uncal herniation**
- C. **Central herniation**
- D. **Outside herniation**
- E. **Tonsillar herniation**

ICP waveform





Normal ICP

Table 1 Normal intracranial pressure values

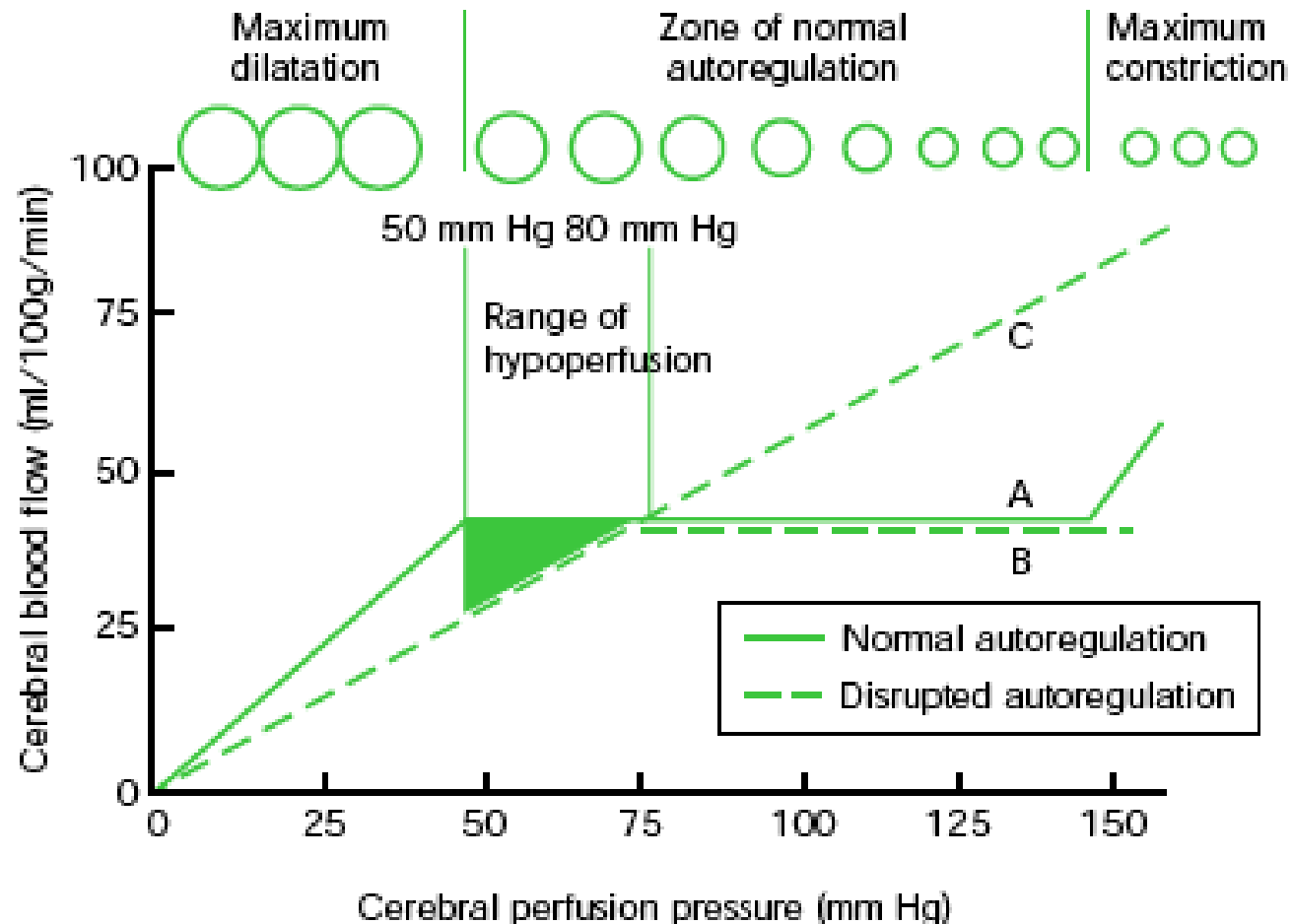
| Age group | Normal range (mm Hg) |
|--------------|----------------------|
| Adults | <10-15 |
| Children | 3-7 |
| Term infants | 1.5-6 |



- Cerebral autoregulation

- Ability of cerebral vessels to maintain cerebral perfusion within strictly determined limits
 - Rise in SBP ----> Constriction of cerebral arteries
 - Low SBP ----> cerebral vessels dilate to accommodate
- Loss of autoregulation: Change in cerebral blood flow with the change in BP

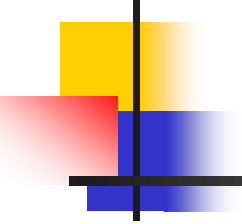
Cerebral Autoregulation

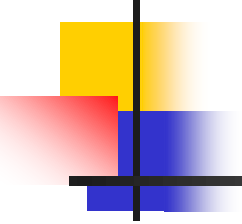




BP and CBF

- If ICP goes up, how does the brain get perfusion?
 - Process of autoregulation
 - $CPP = MAP - ICP$
 - If:
 - $MAP = 85 \text{ mmHg}$
 - $ICP = 15 \text{ mmHg}$
 - $CPP ?$

- 
-
- CPP 50-140 mmHg

- 
-
- 20 year old man. Had car accident (MVC) as unrestrained driver.

He presented with BP 75/30, HR 125 bpm. Unconscious, with right hemiplegia.

What is going on?



Possible Causes

- VITAMEN D
- Other:

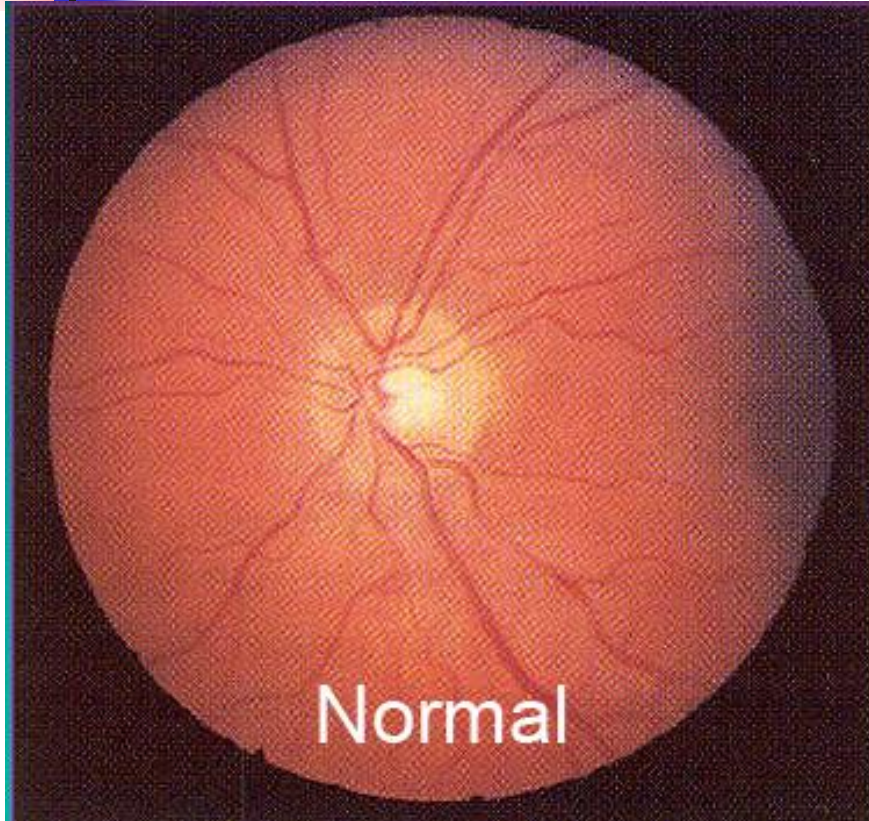
Table 2 Examples of causes of raised intracranial pressure

| Pathological process | Examples |
|-------------------------------------|---|
| Localised mass lesions | Traumatic haematomas (extradural, subdural, intracerebral) Neoplasms (glioma, meningioma, metastasis) Abscess Focal oedema secondary to trauma, infarction, tumour |
| Disturbance of CSF circulation | Obstructive hydrocephalus Communicating hydrocephalus |
| Obstruction to major venous sinuses | Depressed fractures overlying major venous sinuses Cerebral venous thrombosis |
| Diffuse brain oedema or swelling | Encephalitis, meningitis, diffuse head injury, subarachnoid haemorrhage, Reye's syndrome, lead encephalopathy, water intoxication, near drowning |
| Idiopathic | Benign intracranial hypertension |

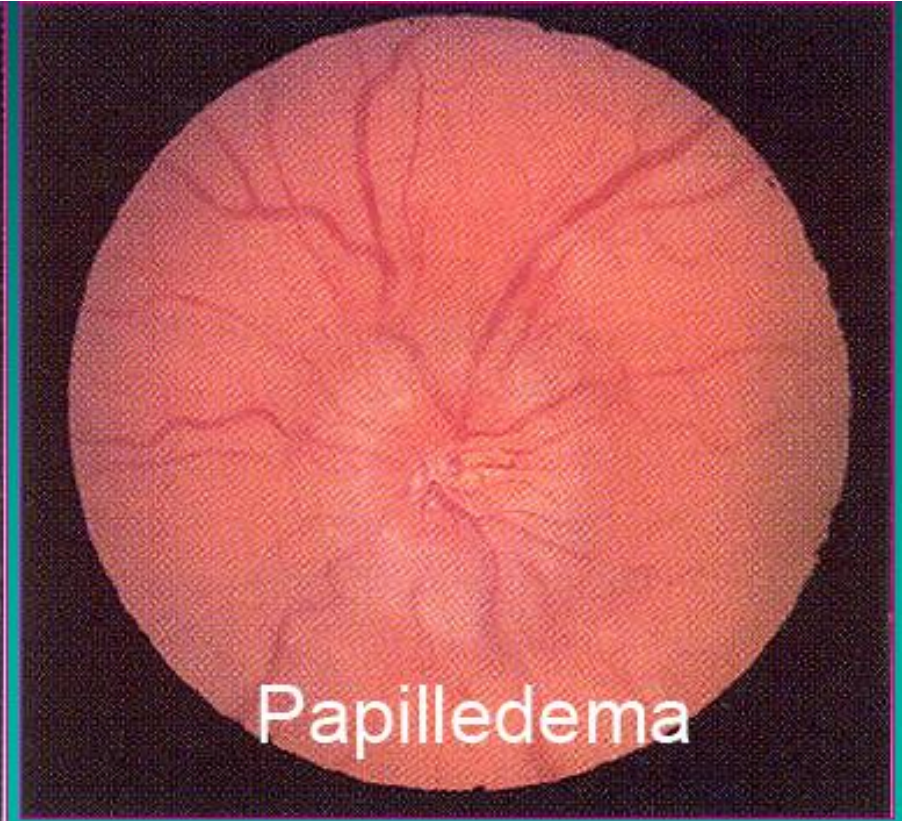


Clinical Presentation of raised ICP

- Headache, vomiting, papilloedema
 - Headache
 - Early morning
 - Throbbing / Bursting
 - ↑ sneezing, coughing
 - Papilloedema
 - Reliable but may take several days
 - Associated fundal hge indicates acute and severe rise in ICP



Normal



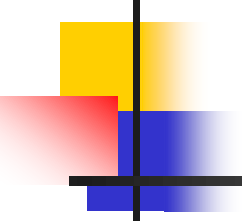
Papilledema

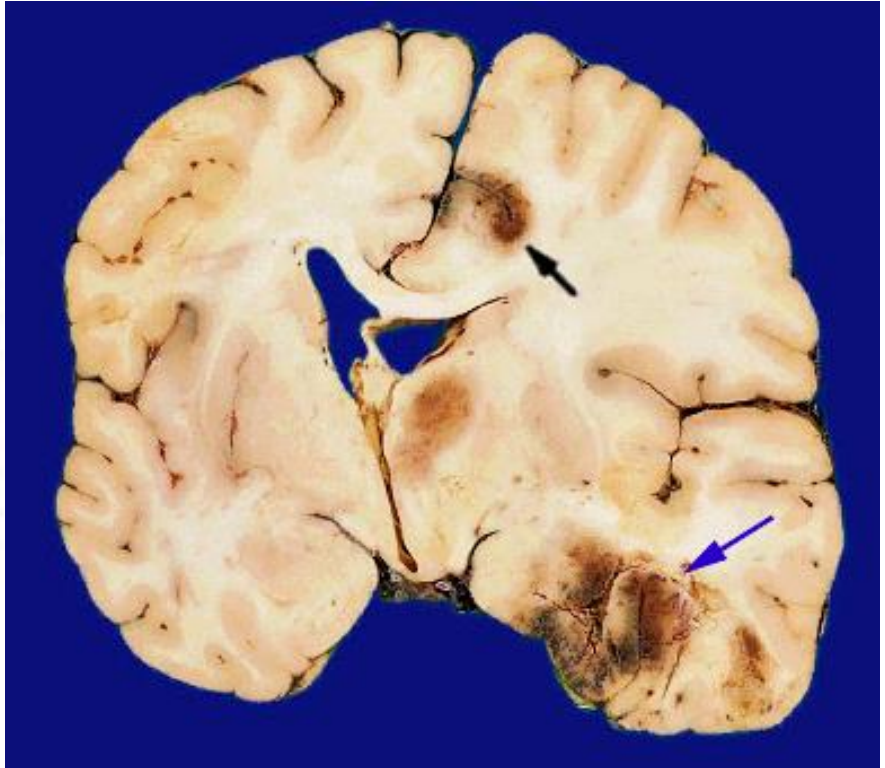
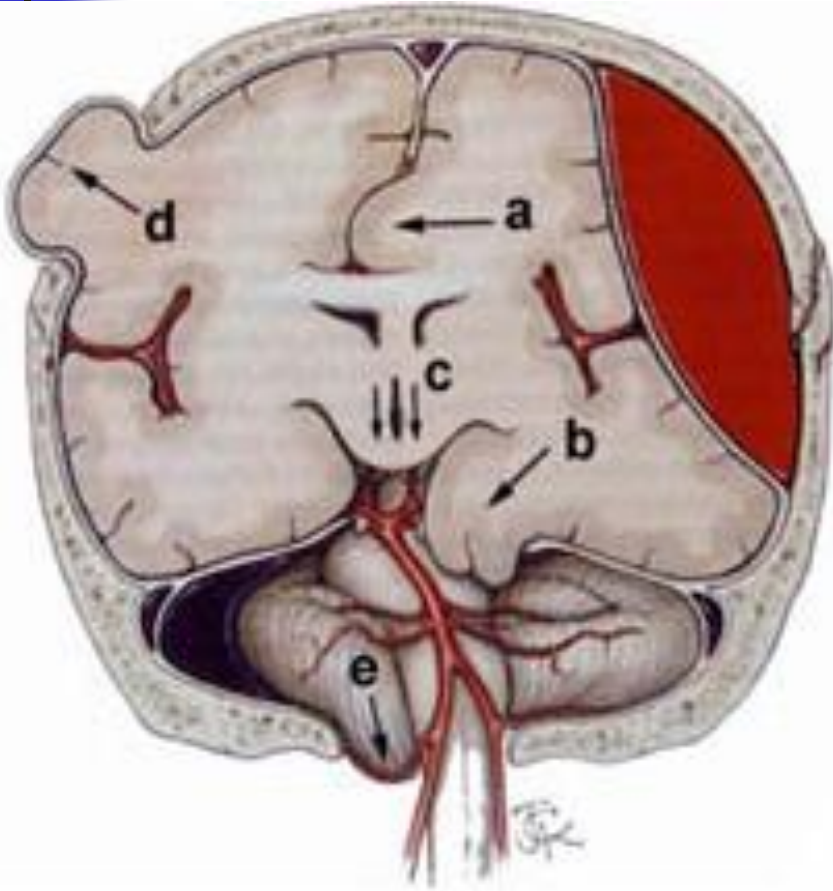
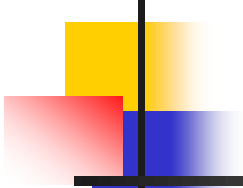


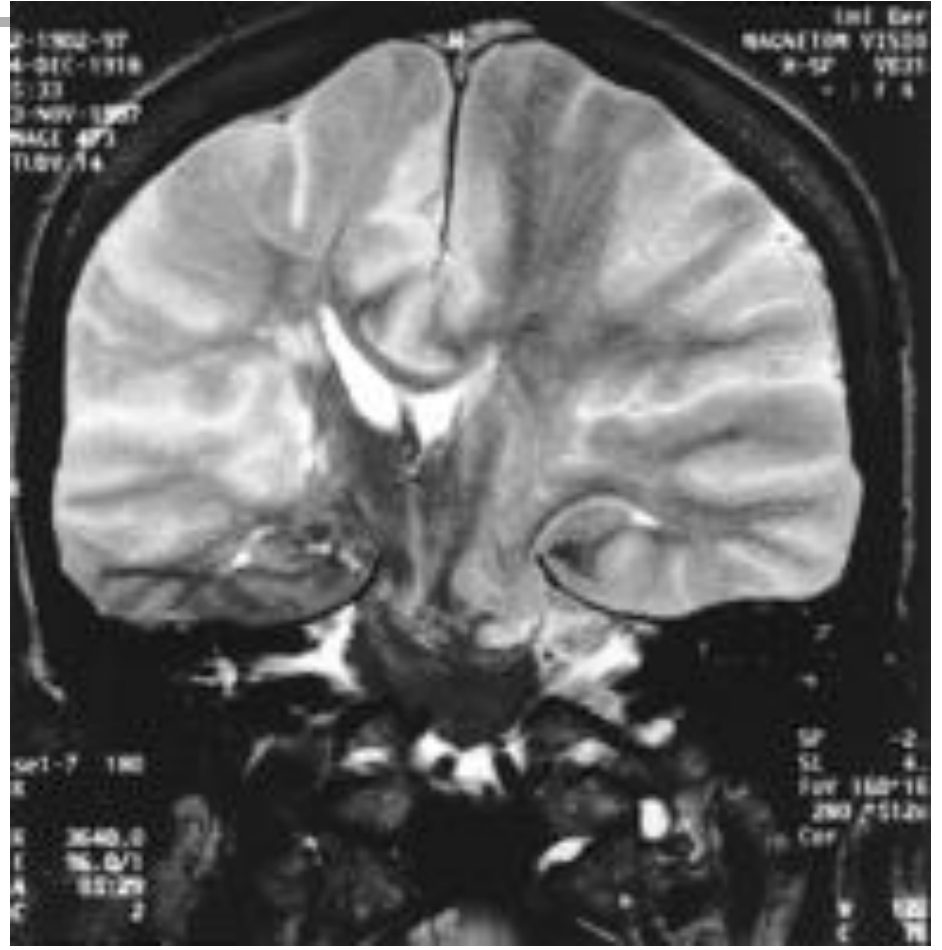
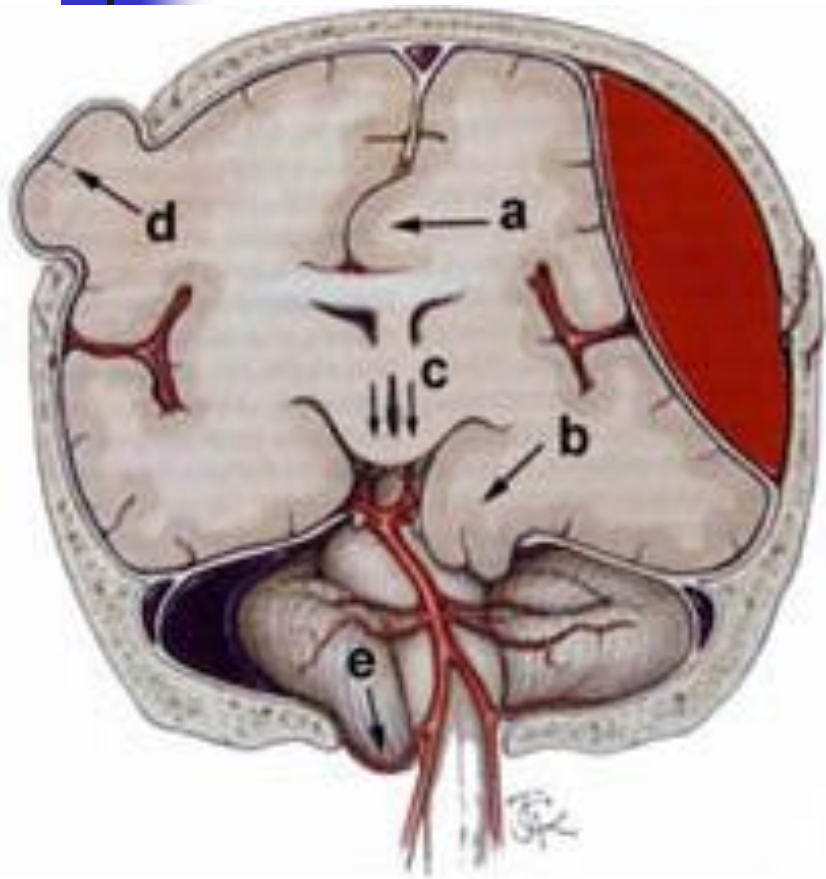
GCS

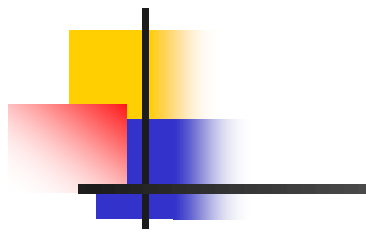
| Glasgow Coma Score | | |
|--|--|--|
| Eye Opening (E) | Verbal Response (V) | Motor Response (M) |
| 4=Spontaneous 3=To voice 2=To pain 1=None | 5=Normal conversation 4=Disoriented conversation 3=Words, but not coherent 2=No words.....only sounds 1=None | 6=Normal 5=Localizes to pain 4=Withdraws to pain 3=Decorticate posture 2=Decerebrate 1=None |
| | | Total = E+V+M |

Decreased Level of Consciousness

- 
-
- Neurological:
 - Pupillary dilation
 - Hemiplegia
 - Cranial nerve deficit







Middle cranial fossa (location of temporal lobe)

Posterior cerebral artery (PCA)

Oculomotor nerve (CN III)

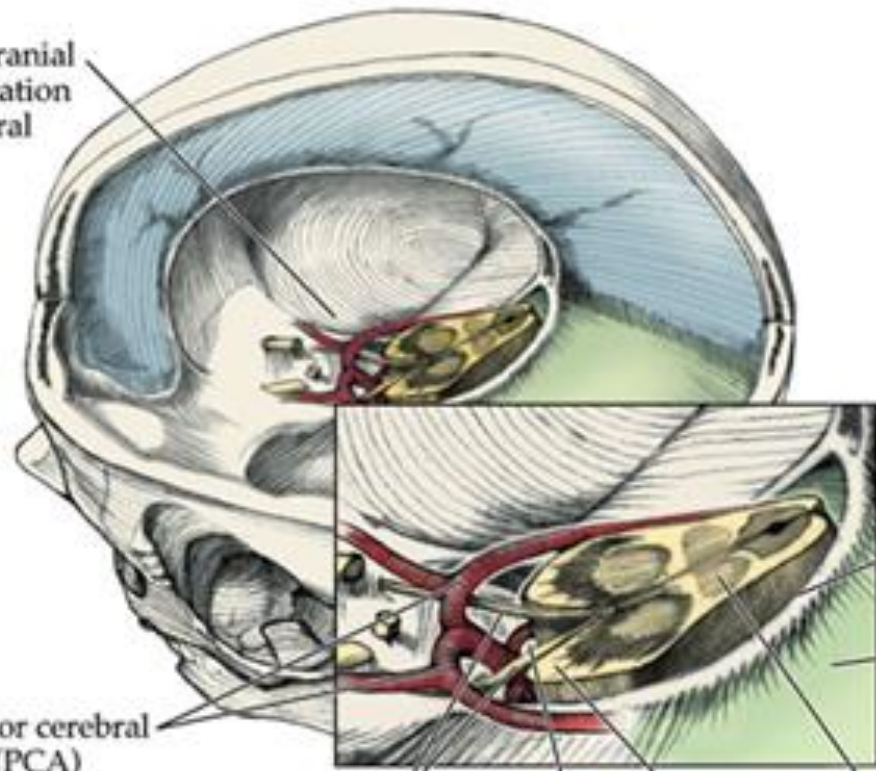
Interpeduncular fossa

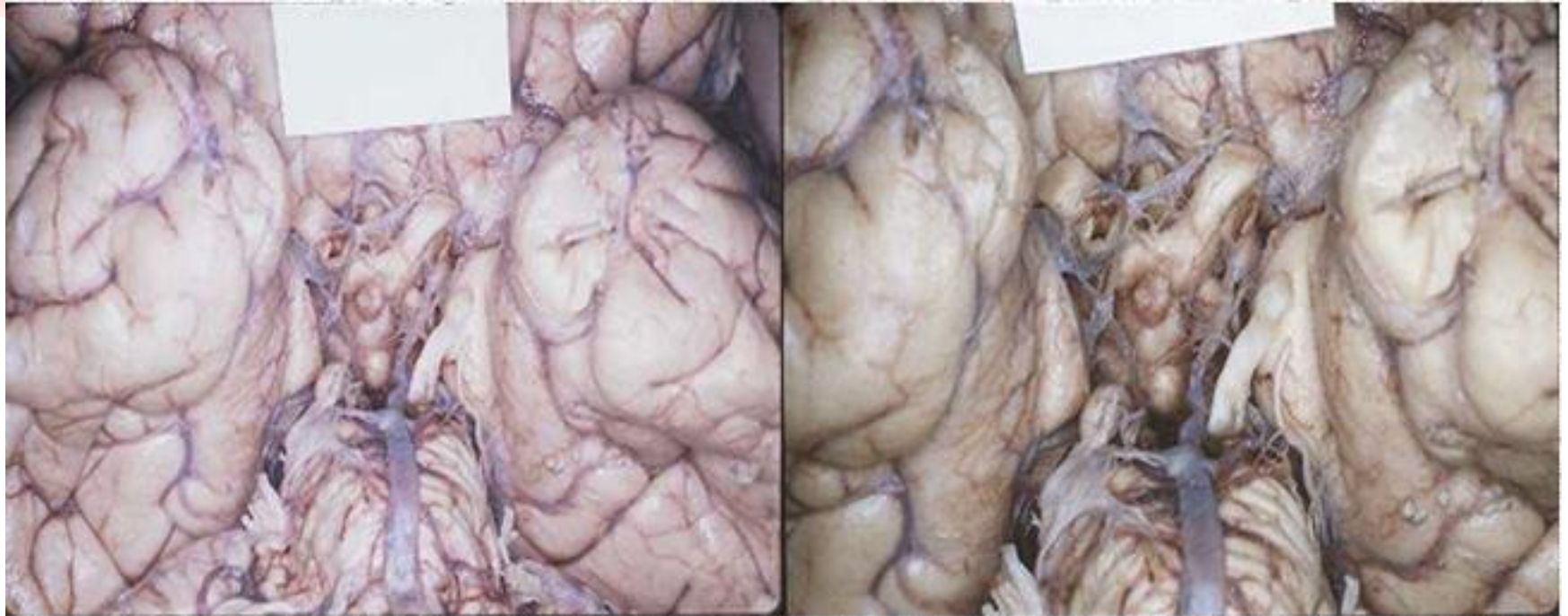
Cerebral peduncle

Midbrain reticular formation

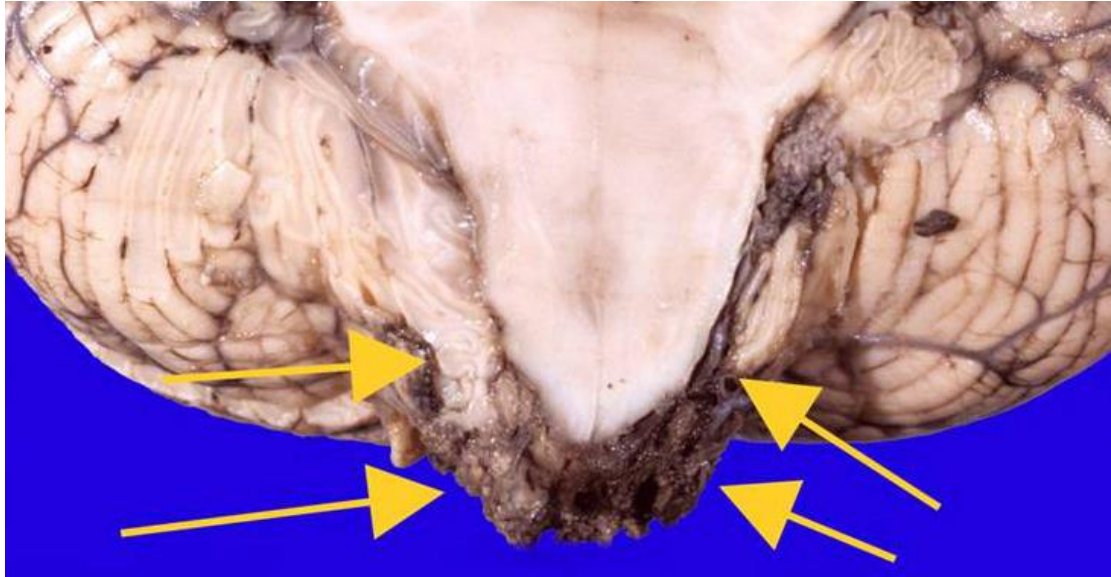
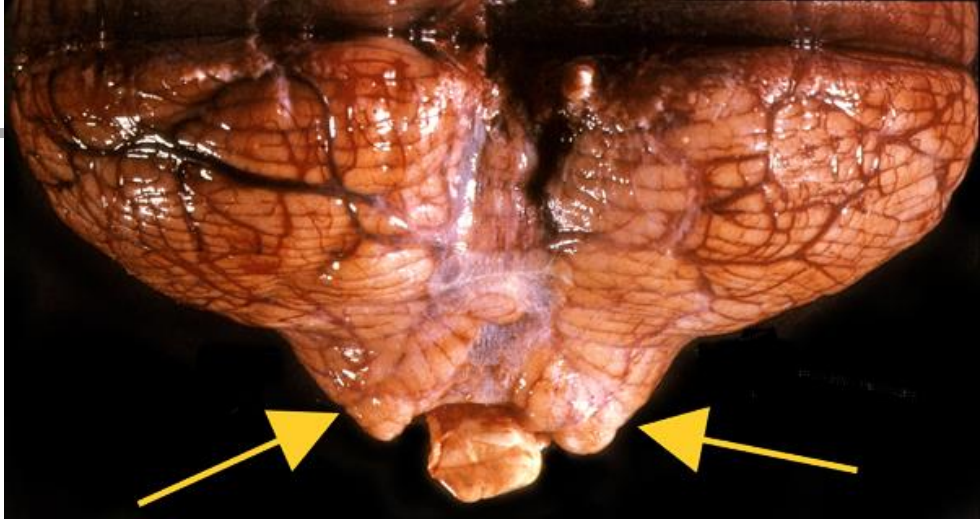
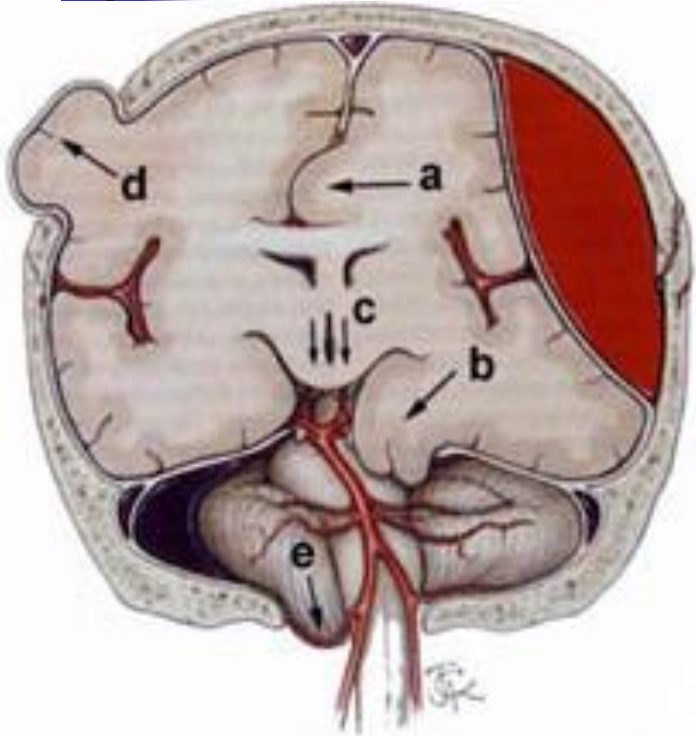
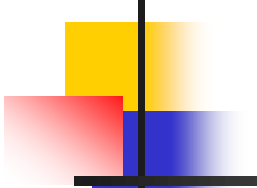
Tentorial incisura (tentorial notch)

Tentorium cerebelli



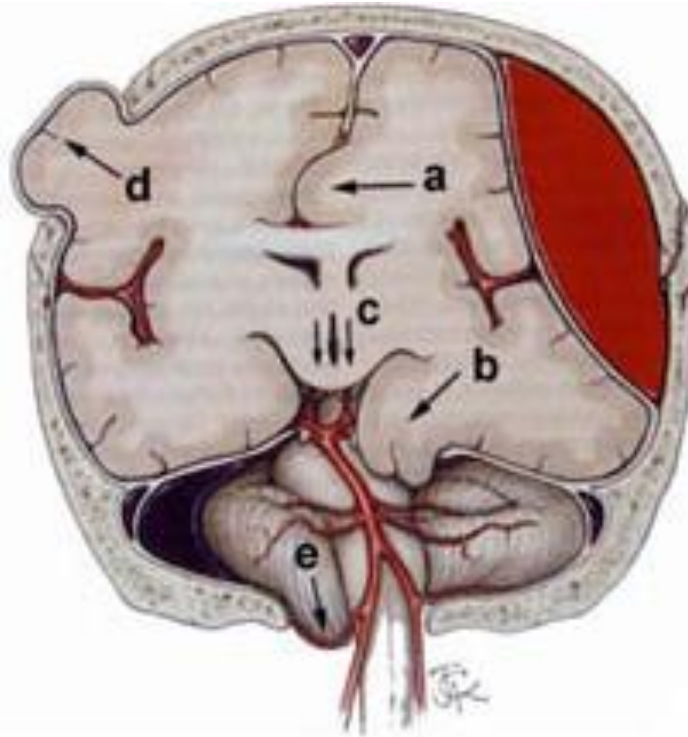


Trans-tentorial herniation: - Ipsilateral dilated pupil
- Contra-lateral weakness



False localization

- Kernohan's notch





- Systemic:

- Raised BP (recall: $CPP = MAP - ICP$)

- Respiratory change:

- Cheyne-Stokes breathing:

- Oscillating periods of apnea-tachypnea
- Respiratory centers compromise



Raised ICP in infants

- Widened sutures
- Increased Head circumference
- Dilated head veins
- “Sun set” eyes

Macrocephaly





Investigations

- URGENT CT head
- NO Lumbar Puncture



What is the treatment of high ICP?

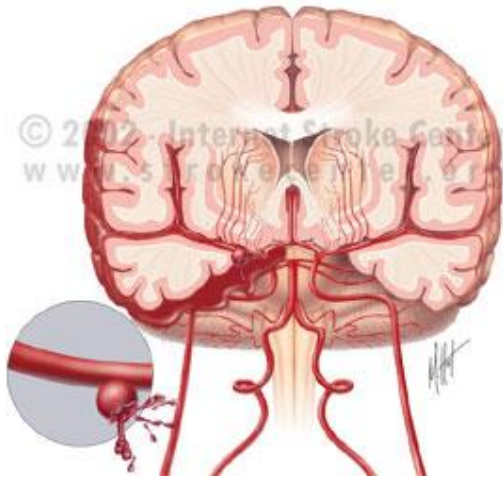
- General measures:
 - Head elevation (30 degrees)
 - No neck compression
 - Mannitol for patients who have decreased LOC (or Furosemide)
 - Steroids (Dexamethazone) for tumors
 - Hyperventilation: controlled to PCO₂ 35-40 mmHg
 - Sedation, muscle relaxants
 - Hypothermia
 - Barbiturates: terminal option



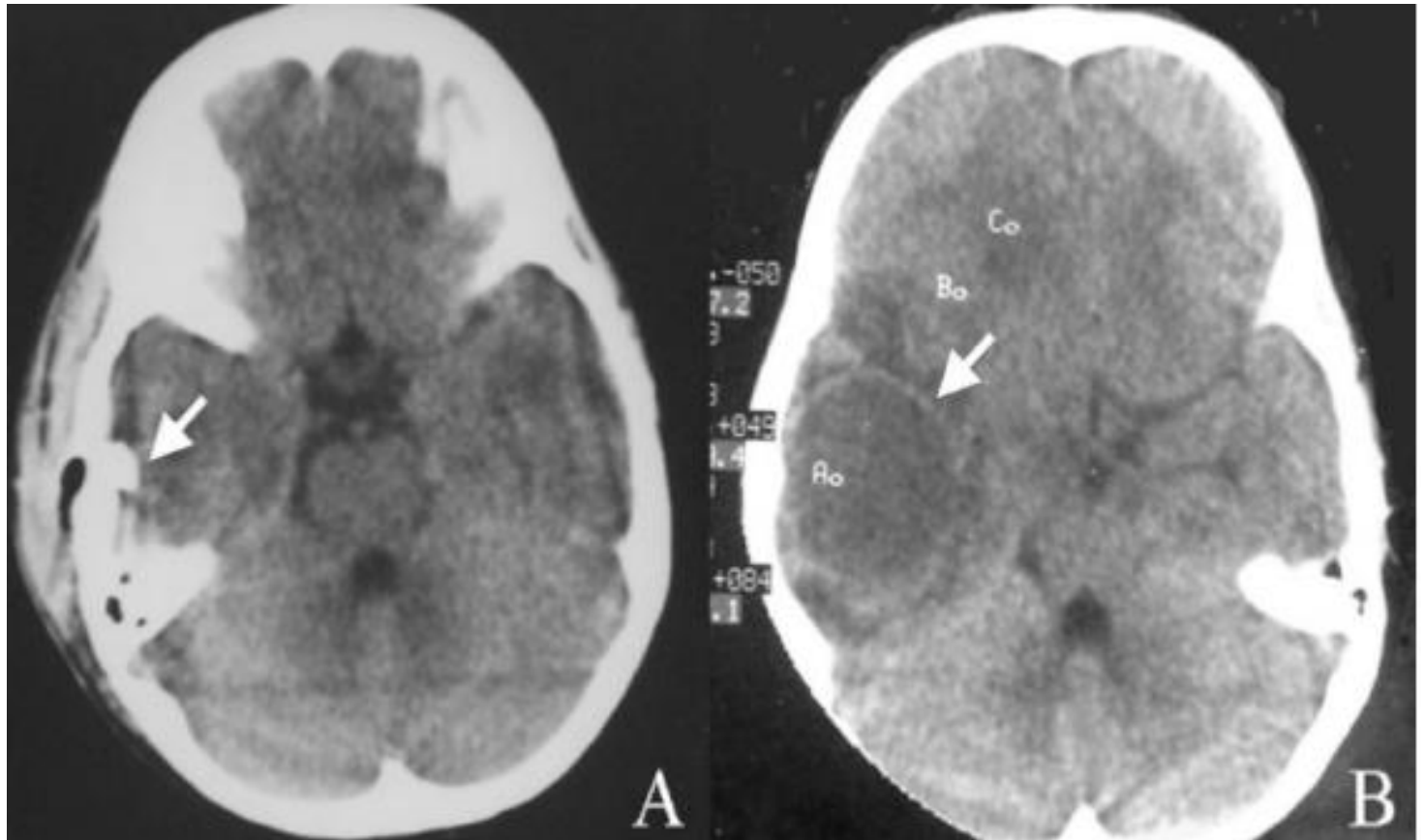
What is the treatment of high ICP?

- Specific treatment:
 - Depends on the cause
 - VITAMEN D

Vascular - SAH / ICH

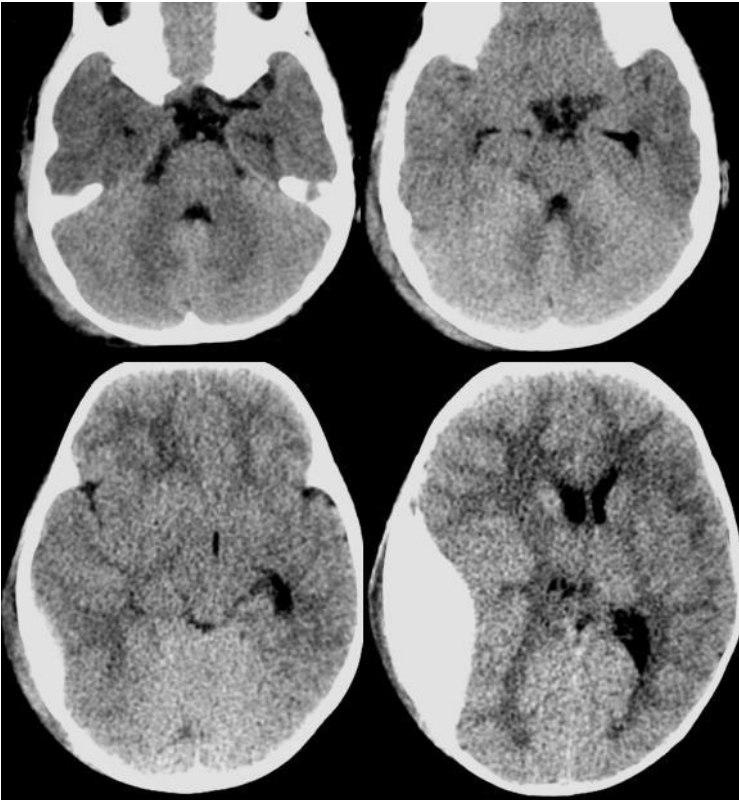


Infection - Abscess



Trauma

- Localized



Epidural Hematoma



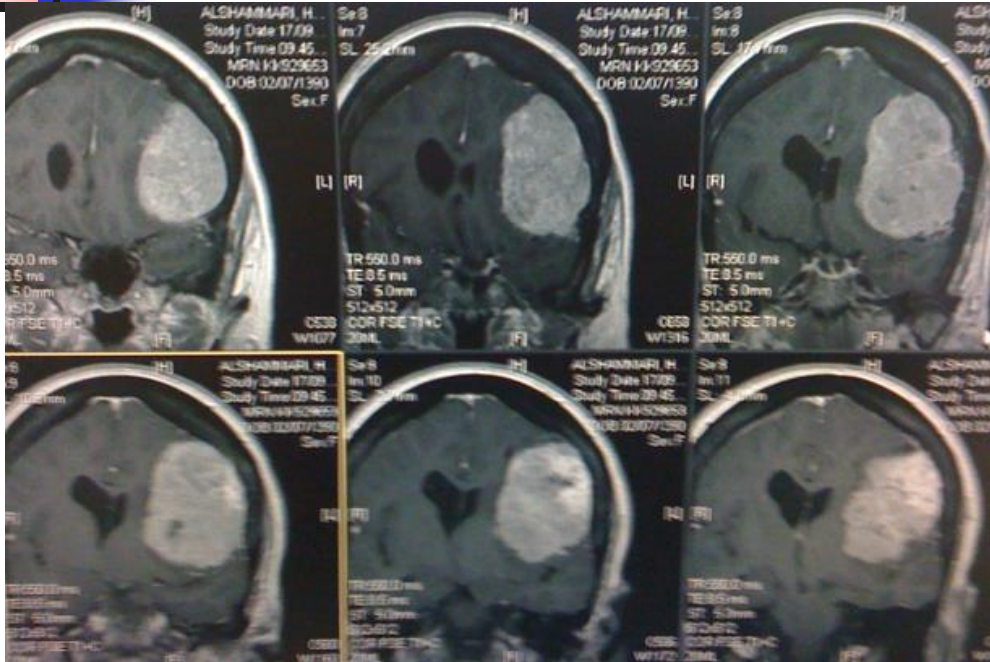
Subdural Hematoma

Trauma

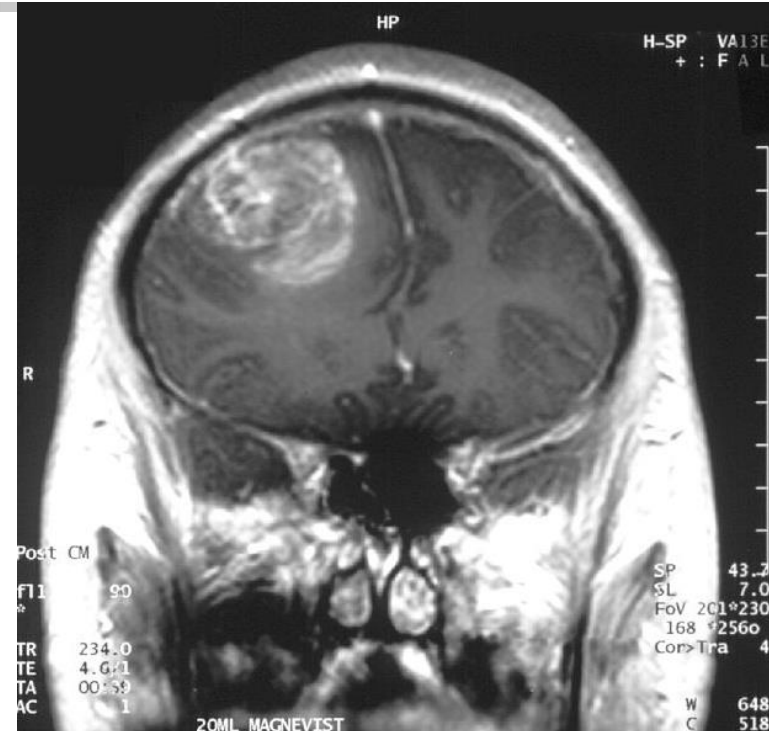
- Diffuse



Tumor

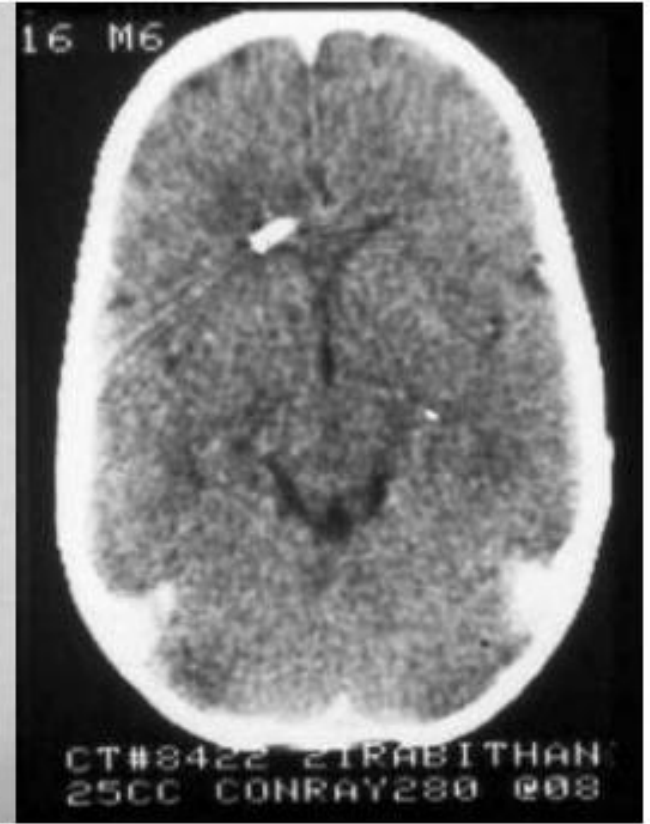
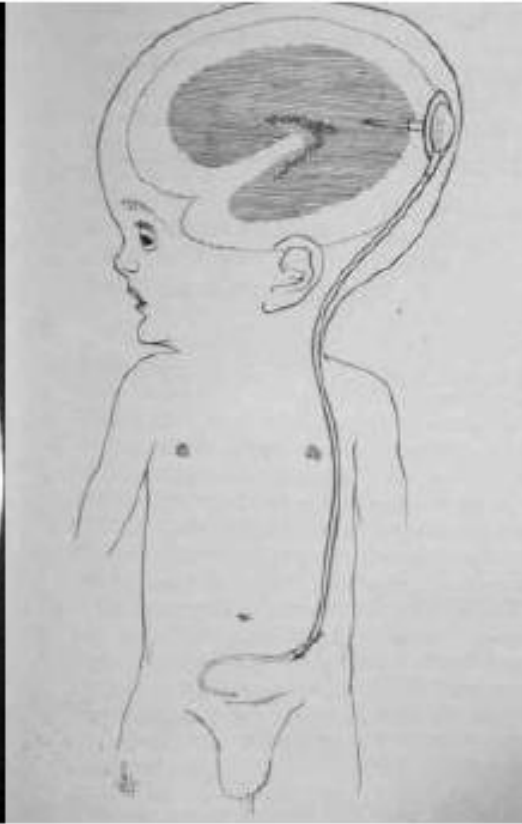
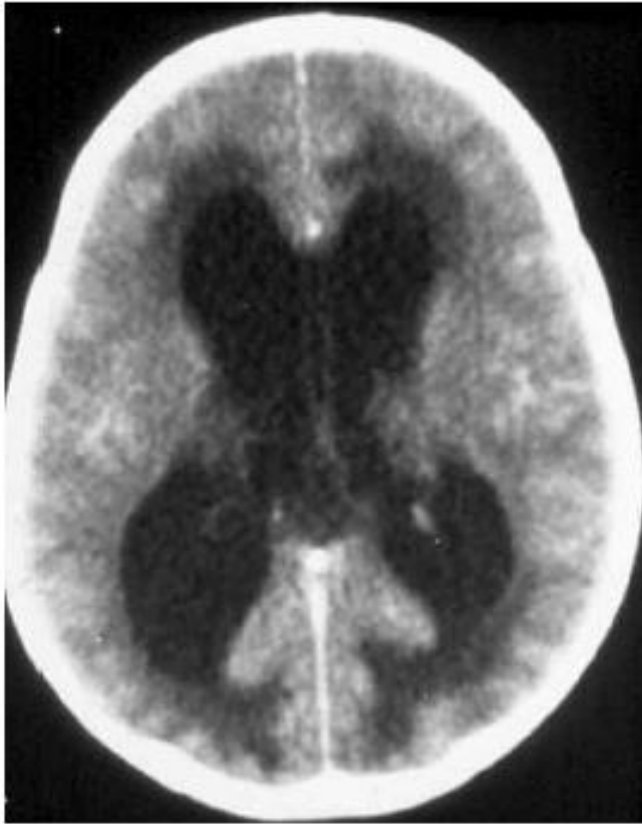


Meningioma



Glioblastoma Multiforme

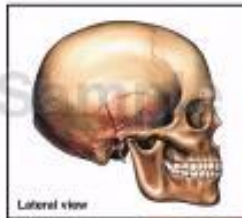
Hydrocephalus



Can we monitor ICP?

Brain Surgery - Ventriculostomy and Placement of Intracranial Pressure (ICP) Monitor Bolt

Multiple comminuted skull fractures involving the occipital bone, mastoid bone, squamous part of temporal bone, and parietal region



Communicating hydrocephalus of ventricular system

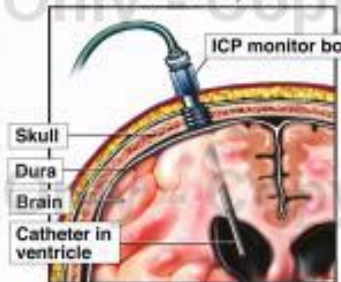
A. A coronal skin incision is made into the right side of the head to expose the skull



B. A hole is burred into the right frontal area of the skull.



Anterior cut-away view



D. The catheter is inserted into the right ventricle of the brain and the ICP monitor bolt is locked into place in the skull.