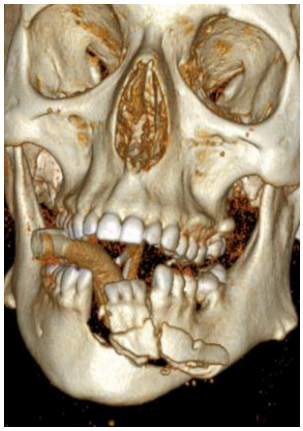
Learning Outcomes

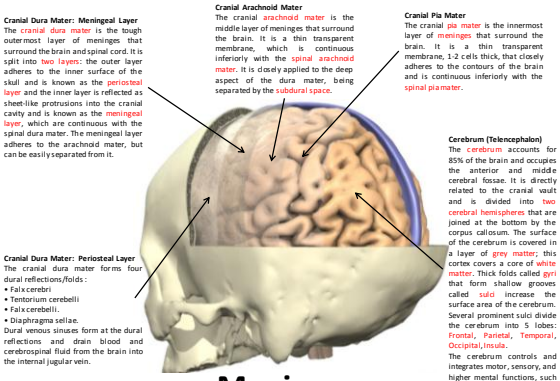
- The Cranial Fossae
  - Anterior
  - Middle
  - Posterior
- The Meninges
  - Pia Mater
  - Arachnoid Mater
  - Dura Mater
- The Dural Folds
- The Venous Sinuses
- Intracranial Bleeds
  - Spontaneous
    - SAH
  - Traumatic
    - Extradural Haematoma
    - Subdural Haematoma
    - Intracerebral Haematoma



Cranial Fossae, Meninges, Sinuses, Intracranial Bleeds

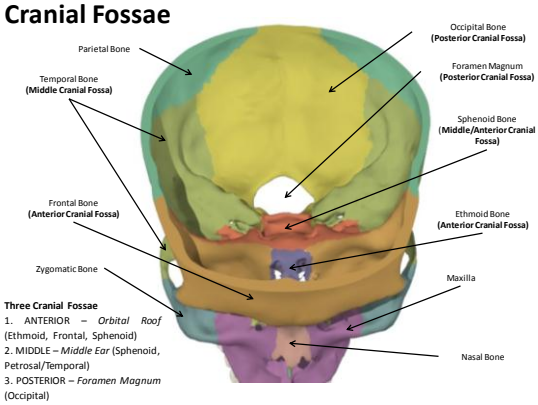
Mohammed A Al-Muharraqi
MBChB, BDS, MSc,
MRCS Glas, FFD RCS Irel, MFDS RCS Eng

e-mail: almuharraqi@doctors.org.uk



Meninges

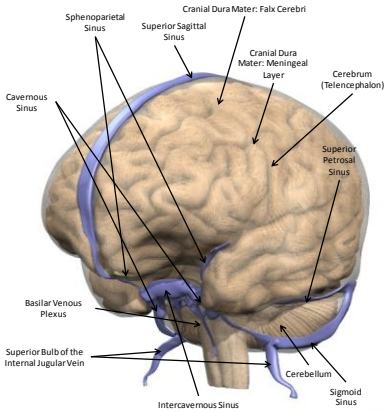
Cranial Fossae



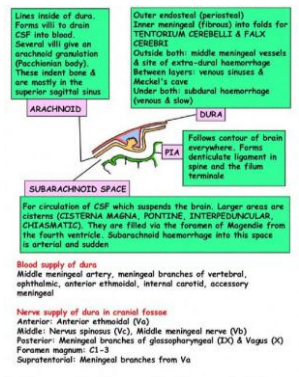
Three Cranial Fossae

1. ANTERIOR – *Orbital Roof* (Ethmoid, Frontal, Sphenoid)
2. MIDDLE – *Middle Ear* (Sphenoid, Petrosal/Temporal)
3. POSTERIOR – *Foramen Magnum* (Occipital)

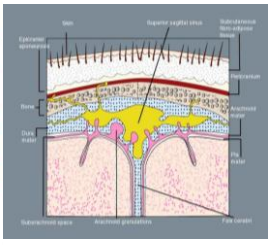
Meninges

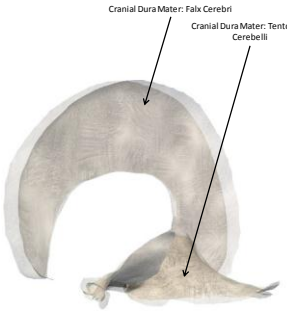


Meninges



Meninges

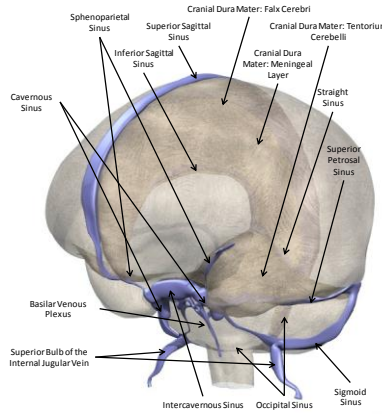




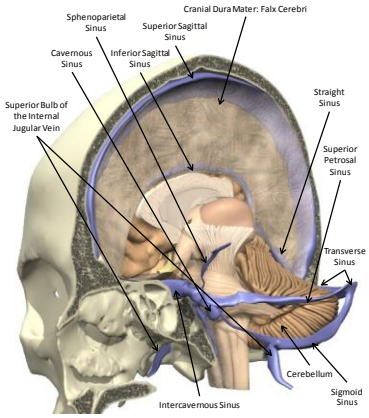
Dural Folds

The falx cerebri is a sickle-shaped fold of dura that lies along the median sagittal plane in the longitudinal cerebral fissure between the two cerebral hemispheres. Anteriorly, it is attached to the crista galli. It arches backwards; it's attachment to the skull continuing supero-posteriorly along the margins of the superior sagittal venous sinus to the internal occipital protuberance. It is continuous with the tentorium cerebelli.

The tentorium cerebelli lies between the cerebellum and the occipital lobes. Anteriorly its free edge forms a hiatus/notch around the brainstem and attaches to the dorsum sellae of the sphenoid bone. This notch is called the 'tentorial incisure'. The margin is named the 'free border of the tentorium'. The lateral edges attach to the occipital bone and enclose the transverse sinuses. The anterior lateral edges are attached to the upper borders of the petrous parts of the temporal bones and contain the superior petrosal sinuses.

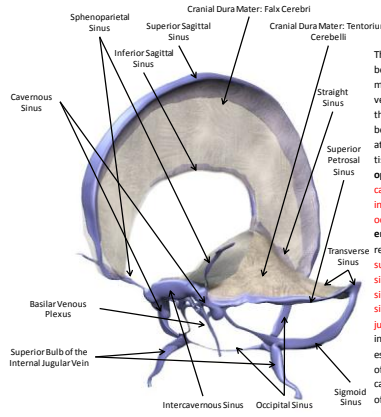


Meninges



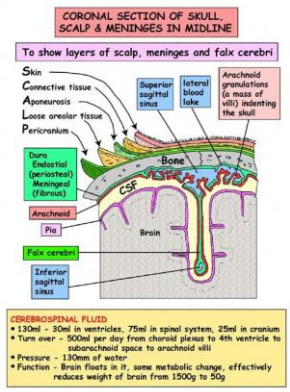
Sinuses

Blood from the **deep central portions of the brain**, collects into the internal cerebral vein (great vein of Galen) and meets with the inferior sagittal sinus posteriorly to form the straight sinus. The inferior sagittal sinus is positioned in the lower free margin of the falx cerebri, and the straight sinus runs from anterior to posterior between the dural layers in the midline of the tentorium cerebelli. Blood draining **from the superolateral surfaces of the brain** collects into cortical veins, which extend across the subarachnoid space to drain into the superior sagittal sinus, which conveys blood posteriorly to an anastomosis with the posterior end of the straight sinus, formed when the inferior sagittal sinus unites with the internal cerebral vein. This region, where the superior sagittal sinus and the straight sinus meet, is known as the confluence of sinuses.



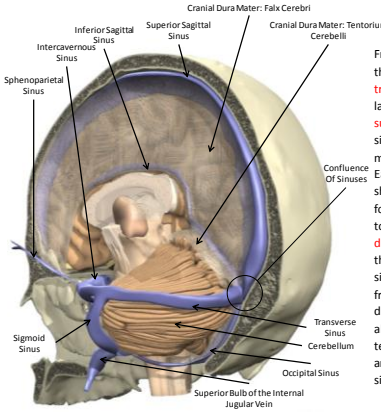
Sinuses

The venous sinuses are encased between the two layers of the dura mater. Sinuses differ from ordinary veins in having no smooth muscle in their walls and maintain their patency, because their walls are held by attachments to surrounding connective tissue. Important sinuses located **opposite the base of the brain** are the cavernous sinus, the superior and inferior petrosal sinuses, and the occipital sinus. Important sinuses **embedded in the dura lining** the remainder of the cranial vault are the superior sagittal sinus, inferior sagittal sinus, straight sinus, confluence of sinuses, transverse sinus, and sigmoid sinus. Drainage converges on the jugular bulb. The jugular bulb is located in the jugular foramen. Venous blood, especially that from the anterior base of the brain, drains through the cavernous sinus anteriorly to the veins of the face.



Sinuses

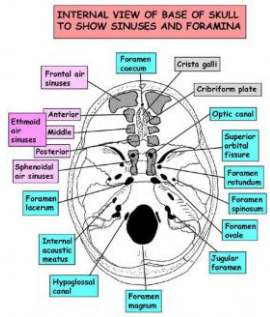
The venous sinuses in the superolateral parts of the dura mater, especially the superior sagittal sinus, are invaginated by tufts of the nearby layers of arachnoid mater. These tufts of arachnoid membrane, called arachnoid granulations, actually protrude into the centre of the lumen of the sagittal sinus, and it is at these sites that cerebrospinal fluid from the subarachnoid space diffuses back into the venous circulation. Sinuses in the superolateral part of the cranial cavity have connections through small emissary veins with the vascular spaces between the two layers of the skull, and thence to the scalp. The importance of these veins is that infections in the scalp can potentially spread to the venous sinuses inside the cranial cavity and lead to meningitis. Infections of the scalp should always be treated aggressively to avoid this potential complication.

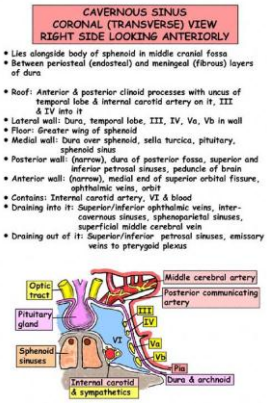


Sinuses

From the confluence of sinuses, there originates a pair of transverse sinuses, extending laterally in grooves on the inner surface of the skull. The transverse sinuses are located in the posterior margins of the tentorium cerebelli. Each transverse sinus then turns sharply toward the anterior to form a sigmoid sinus, which travels toward the jugular foramen to drain into the jugular bulb. Where the transverse sinus becomes the sigmoid sinus, it receives drainage from the superior petrosal sinus, a diagonal venous channel travelling along the petrosal ridge of the temporal bone, connecting anteriorly with the cavernous sinus.

Structures Piercing the Dura in the Base of the Skull

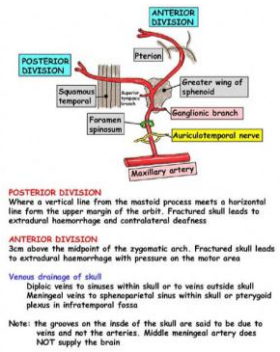




Cavernous Sinus

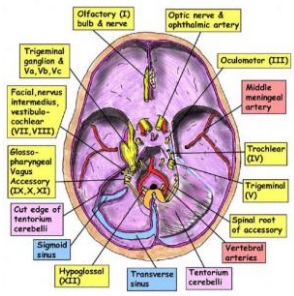
The cavernous sinuses are blood-filled spaces between the two layers of dura mater located on each side of the central portion of the sphenoid bone, surrounding the sphenoid sinus and the sella turcica. The interior is criss-crossed by lacy connective tissue filaments, and blood flow through the cavernous sinuses is slow and prone to thrombus formation. In the centre of the cavernous sinus are found the internal carotid artery and the abducent nerve (VI). Lateral to the cavernous sinus are found, from superior to inferior, the oculomotor (III), trochlear (IV), ophthalmic (V1) and maxillary (V2) nerves. All of these structures appear to be embedded in the cavernous sinus but are outside the vascular endothelium and not truly within the cavernous sinus.

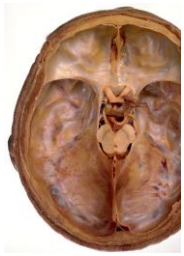
Middle Meningeal Artery



The middle meningeal artery is a branch of the maxillary and is the largest of the meningeal arteries. It travels through the foramen spinosum. Once inside the skull, it follows a groove on the temporal bone and divides into frontal (anterior) and parietal (posterior) branches. The frontal branch crosses the greater wing of the sphenoid and divides into branches. The branches travel in-between the dura mater and the cranium, where they travel to the vertex and the occipital region. The parietal branch bends backwards where it divides into five named branches to supply the posterior portions of the cranium and cranial dura mater. The branches anastomose with each other as well as the anterior and posterior meningeal arteries. It supplies the facial nerve and ganglion in the tympanic cavity. Additional branches are the superior tympanic artery, which supplies tensor tympani via its canal and an anastomotic branch enters the superior orbital fissure to anastomose with the recurrent branch of the lacrimal artery. There are the ganglionic branches, which supply the trigeminal ganglion.

Structures Piercing the Dura in the Base of the Skull





SAH

- Bleeding into the Subarachnoid Space
- Incidence of spontaneous SAH 6/100,000/yr
- Potentially fatal if diagnosis missed
- Even with treatment 46% 30 day mortality
  - 10% die at scene
  - 20% die in first week
  - 50% die in first month
  - 50% survivors have major disability
  - 66% of 'successful' patients never return to their previous occupation
- Usually underlying berry aneurysm
- Sometimes AVM or no underlying cause found

Spontaneous Intracranial Haemorrhage

1. Subarachnoid Haemorrhage (SAH)
2. Intracerebral Haemorrhage (ICH)
3. Intraventricular Haemorrhage

Investigating SAH

- CT Scan
  - May be negative if >3days post ictus
  - Negative in 15% of patients who *have* bled
- Lumbar Puncture
  - Safe in alert patient with no focal neurological deficit and no papilloedema, or after normal CT scan
  - Bloodstained or xanthochromic CSF (6-48hr)
  - Differentiate from 'traumatic tap'
- Cerebral Angiography
  - Seldinger technique via femoral artery
  - 4 vessel angiography with multiple views
  - Gold standard but may miss an aneurysm due to vasospasm
  - MRI techniques developing

SAH

1. Sudden Onset Severe Headache 'Hit by Bat'
2. Collapse
3. Vomiting
4. Neck Pain/Stiffness
5. Photophobia
6. ↓ Conscious Level
7. Focal Neurological Deficit (Dysphasia, Hemiparesis, CNIII Palsy)
8. Fundoscopy – Retinal or Vitreous Haemorrhage

Differential Diagnosis:

- Subarachnoid Haemorrhage
- Thunderclap Headache
- Benign Coital Cephalgia

Traumatic Intracranial Haemorrhage

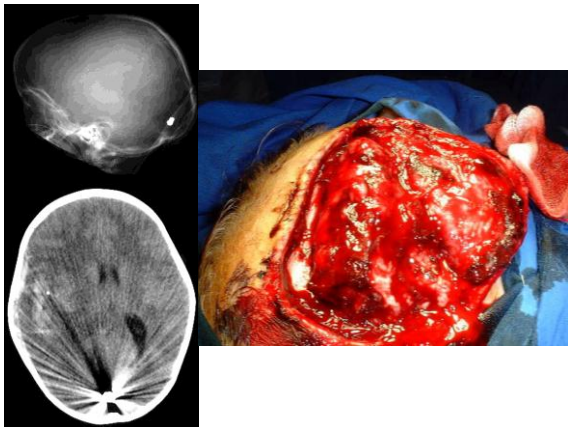
Head Injury – UK 1983

- 1,000,000 patients / year seen in A&E
- 100,000 admitted to hospital for observation
- 10,000 admitted to neurosurgical unit

Trauma is the leading cause of death under 45 years – About half of these deaths are from a head injury

Complications of SAH

- Re-bleeding
  - Often fatal
  - 20% risk in first 14 days, 50% risk in first 6 months
  - Aneurysm clipping
  - Endovascular techniques
- Delayed Ischaemic Neurological Deficit (DIND)
  - Days 3-12
  - altered conscious level or focal deficit
  - Vasospasm
  - Nimodipine
  - High fluid intake 'Triple H therapy'
- Hydrocephalus
  - Increased intracranial CSF pressure
  - 6% symptomatic
  - Increasing headache or altered conscious level
  - Treatment - CSF drainage - LP, EVD, Shunt
- Seizures
- Hyponatraemia
  - SIADH or 'cerebral salt wasting'
  - Do not fluid restrict
  - Supplement Sodium Intake
  - Fludrocortisone



Head Injury

It is really "Brain Injury"

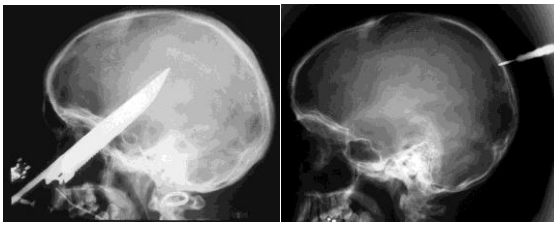
- **Primary** from time of injury
  - At the site of trauma
    - Direct disruption of brain
    - Shearing of axons
    - Intracerebral haemorrhage
  - Opposite the site of trauma
    - Contre-coup
- **Secondary** due to consequences of injury *partly preventable*
  - Brain oedema → ↑ICP, ↓BP → Cerebral Ischemia

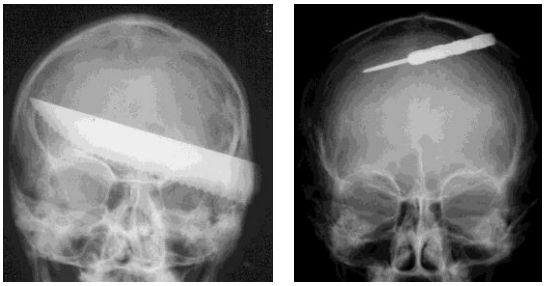
Types of Head Injury

- Open = Missile = Penetrating

or

- Closed = Non-Missile





Physical Findings in Head Injury

- Scalp swelling / laceration
- Skull Vault Fracture
  - Linear (Simple)
  - Depressed
  - Compound
- Basal Skull Fracture
  - CSF Rhinorrhoea, Blood behind eardrum
  - Anterior Cranial Fossa "Raccoon" or "Panda" Eyes
  - Middle Cranial Fossa "Battle Sign"

Types of Traumatic Intracranial Haematoma

1. Extradural Haematoma
   Middle Meningeal Artery bleeds into Extradural Space
2. Subdural Haematoma
   Cortical Veins 'ooze' into Subdural Space
3. Traumatic Subarachnoid Haemorrhage
4. Intracerebral Haematoma
   Most common
5. Intracerebral Contusion
6. Intraventricular Haemorrhage

Head Injury

Assessment of Consciousness

↓

Glasgow Coma Scale (GCS)

- Eye opening (4)
  - Spontaneously
  - To Command
  - To Pain
  - None
- Best Motor Response (6)
  - Obeys Commands
  - Localises Pain
  - Flexes to Pain
  - Abnormal Flexion
  - Extension
  - None
- Verbal Response (5)
  - Orientated
  - Confused
  - Inappropriate Words
  - Incomprehensible Sounds
  - None

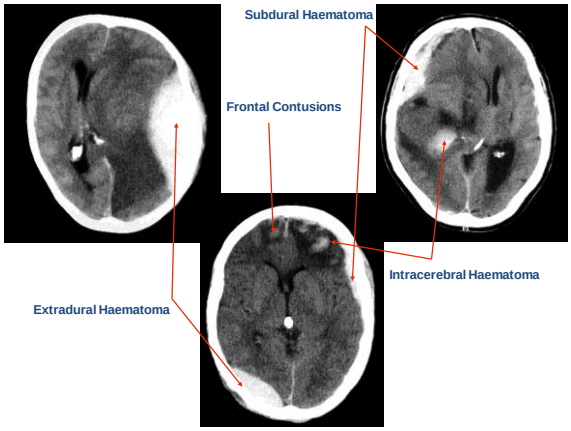
GCS of **3** Means the Patient is Dead (or close to it)!

Intracranial Pressure (ICP)

Monro-Kellie Doctrine

- Skull is an inelastic closed box
- Volume inside skull is constant and has 3 components
  - Brain
  - Blood (mainly in venous phase)
  - CSF
- An increase in volume of one component must produce a decrease in another component otherwise ICP will rise

Adult ICP is normally 12 -15 cm H_2O



What Kills Patients With Head Injury?

- Hypoxia → ventilatory support/mechanical ventilation
- Hypotension → ionotropic support, pushing fluids
- Raised ICP → evacuation of haematoma or shunting hydrocephalus, forced ventilation

Cerebral Perfusion Pressure (CPP)

- CPP = MAP - ICP

Cerebral Perfusion Pressure = Mean Arterial Pressure – Intracranial Pressure

- Hypotension has a major influence on CPP
- Blood pressure is much easier to measure and control
- Aim for CPP of > 70mmHg after head injury, i.e., MAP > 90mmHg

Cerebral Protection Following Injury

- Mannitol – Improves micro-perfusion
- Steroids – CRASH trial 2005, no evidence
- Hypothermia – weak evidence
- Barbiturates – weak evidence
- Hyperbaric therapy – weak evidence

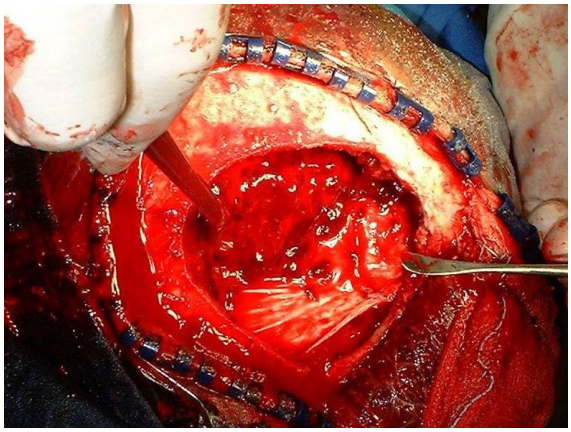
Why are ABC's important in Head Injury?

- Brain is only 2% of body weight but uses;
  - 15% of cardiac output
  - 20% of carried oxygen
  - 12% of carried glucose

Irreversible Neuronal Damage Within 5 Minutes of Circulatory Arrest

Late Effects of Head Injury

- Epilepsy — early
  late
- CSF leak — into nose
  into middle ear
- Cognitive problems – post concussion syndrome. Can affect 30% of all head injured patients



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