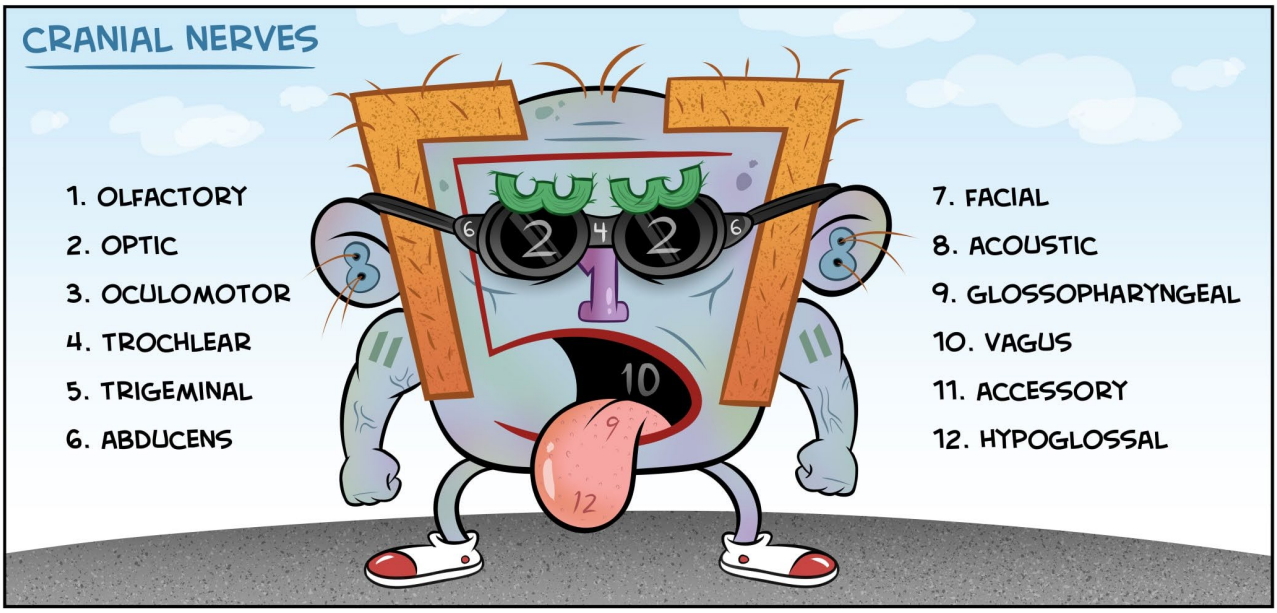


Head Injury

Patients who suffer head injuries should be managed according to ATLS principles and extra cranial injuries should be managed alongside cranial trauma. Inadequate cardiac output will compromise CNS perfusion irrespective of the nature of the cranial injury.

Intracranial Hemorrhage & Types of traumatic brain injury

Extradural haematoma	Bleeding into the space between the dura mater and the skull. Often results from acceleration-deceleration trauma or a blow to the side of the head. The majority of extradural haematomas occur in the temporal region where skull fractures cause a rupture of the **middle meningeal artery**. *Features* • Raised intracranial pressure • Some patients may exhibit a lucid interval
Subdural haematoma	• Bleeding into the outermost meningeal layer. Most commonly occur around the frontal and parietal lobes. May be either acute or chronic. • Risk factors include **old age** and **alcoholism**. • Slower onset of symptoms than a extradural haematoma.
Intracerebral haematoma	Usually hyperdense lesions on CT scanning. Arise in areas of traumatic contusion with fuse to become a haematoma. Areas of clot and fresh blood may co-exist on the same CT scan (Swirl sign). Large haematomas and those associated with mass effect should be evacuated.
Subarachnoid haemorrhage	Usually occurs **spontaneously** in the context of a ruptured cerebral aneurysm but may be seen in association with other injuries when a patient has sustained a traumatic brain injury
Intraventricular haemorrhage	Haemorrhage that occurs into the ventricular system of the brain. It is relatively rare in adult surgical practice and when it does occur, it is typically associated with severe head injuries. In **premature neonates** it may occur spontaneously. The blood may clot and occlude CSF flow, hydrocephalus may result. In neonatal practice the vast majority of IVH occur in the first 72 hours after birth, the aetiology is not well understood and it is suggested to occur as a result of birth trauma combined with cellular hypoxia, together with the delicate neonatal CNS.

Pathophysiology

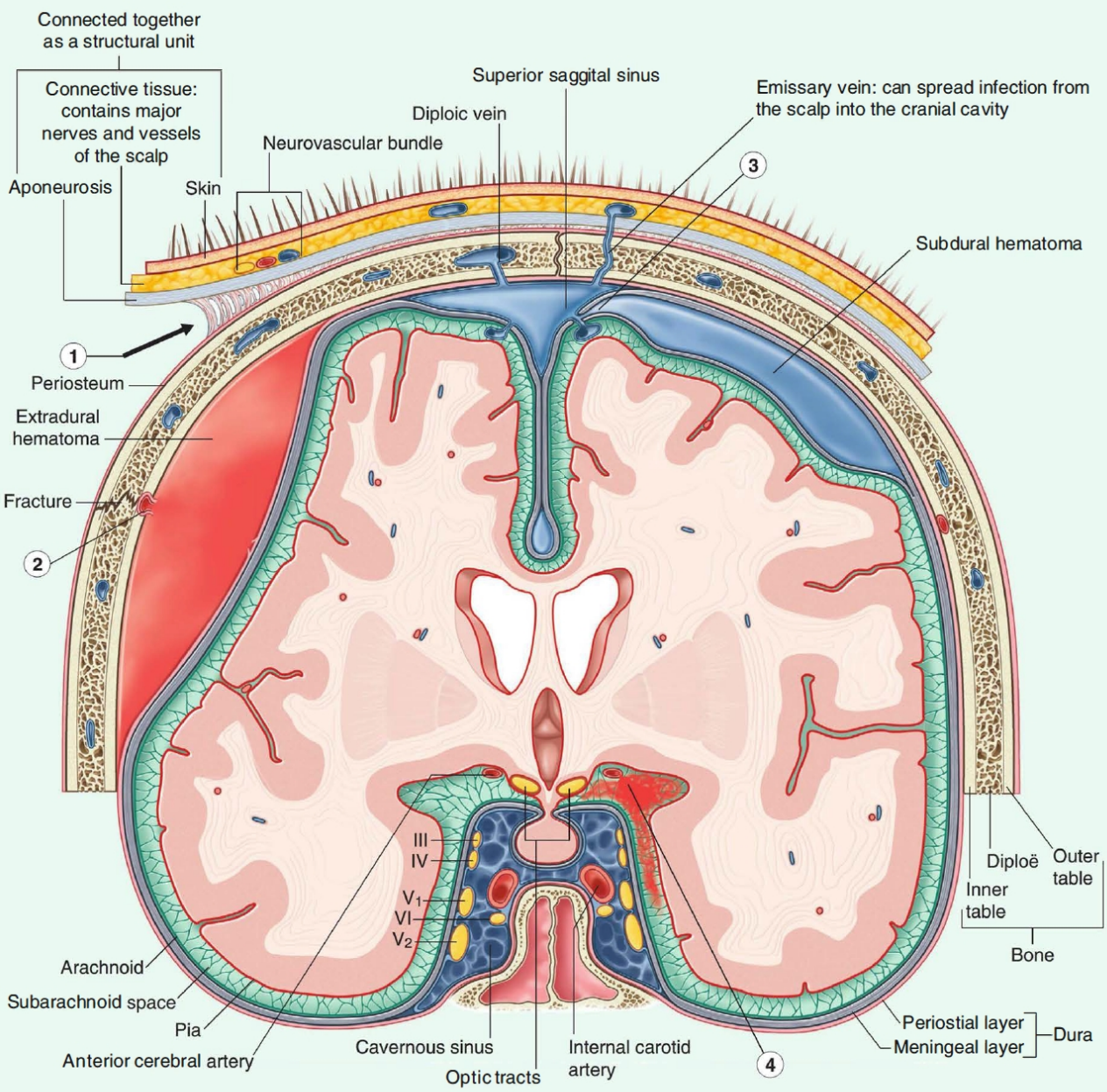
- Primary brain injury may be focal (contusion/ haematoma) or diffuse (diffuse axonal injury)
- Diffuse axonal injury occurs as a result of mechanical shearing following deceleration, causing disruption and tearing of axons
- Intra-cranial haematomas can be extradural, subdural or intracerebral, while contusions may occur adjacent to (coup) or contralateral (contre-coup) to the side of impact
- Secondary brain injury occurs when cerebral oedema, ischaemia, infection, tonsillar or tentorial herniation exacerbates the original injury. The normal cerebral auto regulatory processes are disrupted following trauma rendering the brain more susceptible to blood flow changes and hypoxia
- The Cushings reflex (hypertension and bradycardia) often occurs late and is usually a pre terminal event

Management

- Where there is life threatening rising ICP such as in extra dural haematoma and whilst theatre is prepared or transfer arranged use of IV mannitol/ frusemide may be required.
- Diffuse cerebral oedema may require decompressive craniotomy
- Exploratory Burr Holes have little management in modern practice except where scanning may be unavailable and to thus facilitate creation of formal craniotomy flap
- Depressed skull fractures that are open require formal surgical reduction and debridement, closed injuries may be managed non operatively if there is minimal displacement.
- ICP monitoring is appropriate in those who have GCS 3-8 and normal CT scan.
- ICP monitoring is mandatory in those who have GCS 3-8 and abnormal CT scan.
- Hyponatraemia is most likely to be due to syndrome of inappropriate ADH secretion.
- Minimum of cerebral perfusion pressure of 70mmHg in adults.
- Minimum cerebral perfusion pressure of between 40 and 70 mmHg in children.

Scalp and meninges

Summary of relationships and clinical significance of the scalp and meninges



1 Loose connective tissue (danger area)
- In scalping injuries, this is the layer in which separation occurs.
- Infection can easily spread in this layer.
- Blunt trauma can result in hemorrhage in this layer (blood can spread forward into the face, resulting in "black eyes").

2 Rupture of the middle meningeal artery (branches) by fracture of the inner table of bone results in extradural hematoma. Under pressure, the blood progressively separates dura from the bone.

3 Tear to cerebral vein where it crosses dura to enter cranial venous sinus can result in subdural hematoma. The tear separates a thin layer of meningeal dura from that which remains attached to the periosteal layer. As a result, the hematoma is covered by an inner limiting membrane derived from part of the meningeal dura.

4 Aneurysm
- Ruptured aneurysms of vessels of the cerebral arterial circle hemorrhage directly into the subarachnoid space and CSF.

Sub Arachnoid Haemorrhage

Spontaneous intracranial haemorrhage

Most commonly sub arachnoid haemorrhage. It is due to intra cranial aneurysm in 85% cases. Approximately 10% of cases will have normal angiography and the cause will remain unclear. Patients with inherited connective tissue disorders are at higher risk although most cases are sporadic.
>95% cases will have headache (often thunderclap)
>15% will have coma

Investigation

CT scan for all (although as CSF blood clears the sensitivity declines)
Lumbar puncture if CT normal (very unlikely if normal)
CT angiogram to look for aneurysms.

Management

Supportive treatment, optimising BP (not too high if untreated aneurysm) and ventilation if needed.
Nimodipine reduces cerebral vasospasm and reduces poor outcomes.
Untreated patients most likely to rebleed in first 2 weeks.
Patients developing hydrocephalus will need a V-P shunt (external ventricular drain acutely).
Electrolytes require careful monitoring and hyponatraemia is common.

Subarachnoid hemorrhage. Axial CT scan of brain.

Treatment of aneurysm

>80% aneuryms arise from the anterior circulation
Craniotomy and clipping of aneurysm is standard treatment, alternatively suitable lesions may be coiled using an endovascular approach. Where both options are suitable data suggests that outcomes are better with coiling than surgery.

Extradural hematoma. Axial CT scan of brain

Chronic (low-density) subdrual hematoma. Axial CT scan of brain

Interpretation of Pupillary Findings in Head Injuries

Pupil size	Light response	Interpretation
Unilaterally dilated	Sluggish or fixed	3rd nerve compression secondary to tentorial herniation
Unilaterally dilated or equal	Cross reactive (Marcus - Gunn)	Optic nerve injury
Bilaterally dilated	Sluggish or fixed	• Poor CNS perfusion • Bilateral 3rd nerve palsy
Bilaterally constricted	May be difficult to assess	• Opiates • Pontine lesions • Metabolic encephalopathy
Unilaterally constricted	Preserved	Sympathetic pathway disruption

Third Nerve Palsy

Features

- Eye is deviated 'down and out'
- Ptosis
- Pupil may be dilated (sometimes called a 'surgical' third nerve palsy)

Causes

- Diabetes mellitus
- Vasculitis e.g. temporal arteritis, SLE
- False localizing sign* due to uncal herniation through tentorium if raised ICP
- **Posterior communicating artery** aneurysm (pupil dilated, painful)
- Cavernous sinus thrombosis
- Weber's syndrome: ipsilateral third nerve palsy with contralateral hemiplegia - caused by midbrain strokes
- Other possible causes: amyloid, multiple sclerosis

**This term is usually associated with sixth nerve palsies but it may be used for a variety of neurological presentations*

Head Injury and Hematoma

Risk of haematoma (requiring removal) in adults attending accident and emergency units following head injury.

Injury	Conscious level	Risk of haematoma requiring removal
Concussion, no skull fracture	Orientated	1 in 6000
Concussion, no skull fracture	Not orientated	1 in 120
Skull fracture	Orientated	1 in 32
Skull fracture	Not orientated	1 in 4

Glasgow Coma Scale (GCS)

Modality	Options
Eye opening	• Spontaneous • To speech • To pain • None
Verbal response	• Orientated • Confused • Words • Sounds • None
Motor response	• Obeys commands • Localises to pain • Withdraws from pain • Abnormal flexion to pain (decorticate posture) • Extending to pain • None

Von Hippel-Lindau Syndrome

Von Hippel-Lindau (VHL) syndrome is an autosomal dominant condition predisposing to neoplasia. It is due to an abnormality in the VHL gene located on short arm of chromosome 3

Features

- Cerebellar haemangiomas
- Retinal haemangiomas: vitreous haemorrhage
- Renal cysts (premalignant)
- Phaeochromocytoma
- Extra-renal cysts: epididymal, pancreatic, hepatic
- Endolymphatic sac tumours

Notes & Mnemonics

PITS (**P**arietal-**I**nferior, **T**emporal-**S**uperior)
Superior quadranopia = temporal lobe lesion
Inferior quadranopia = parietal lobe lesion

Painful third nerve palsy = posterior communicating artery aneurysm