Head injury

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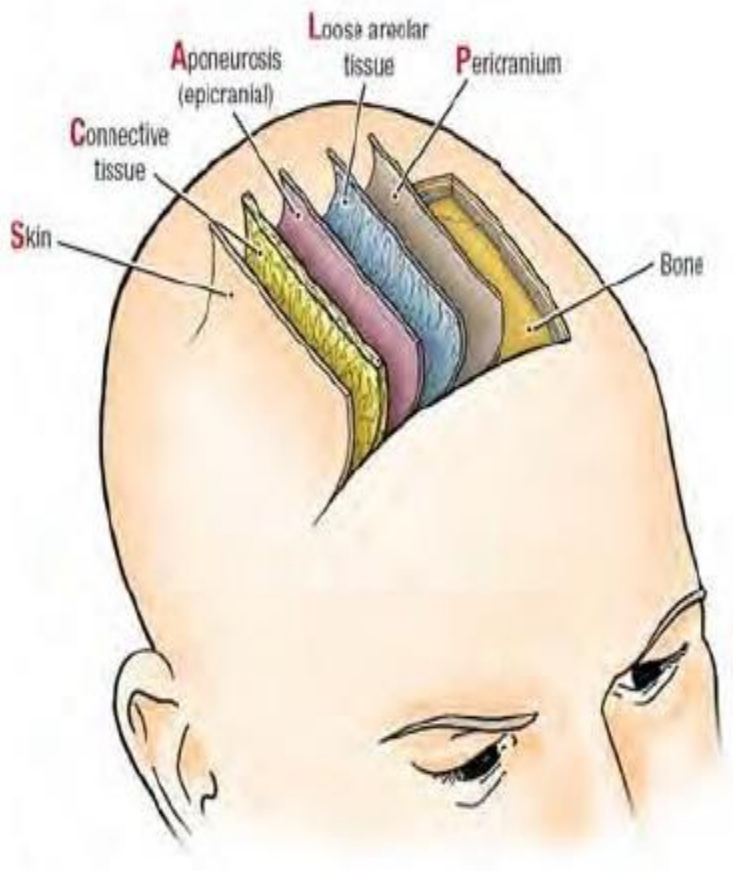
Introduction

- Head injury is any trauma that leads to injury of the scalp, skull, or brain
- Head trauma results in approximately 70,000 deaths, 80,000 long-term disabilities, and 60,000 new seizure disorders each year
- These injuries most often occur in individuals who are 15-24 years old and are twice as common in men
- Vehicular accidents (RTA) being most common in those under 25 years
- Falls in those over 75 years

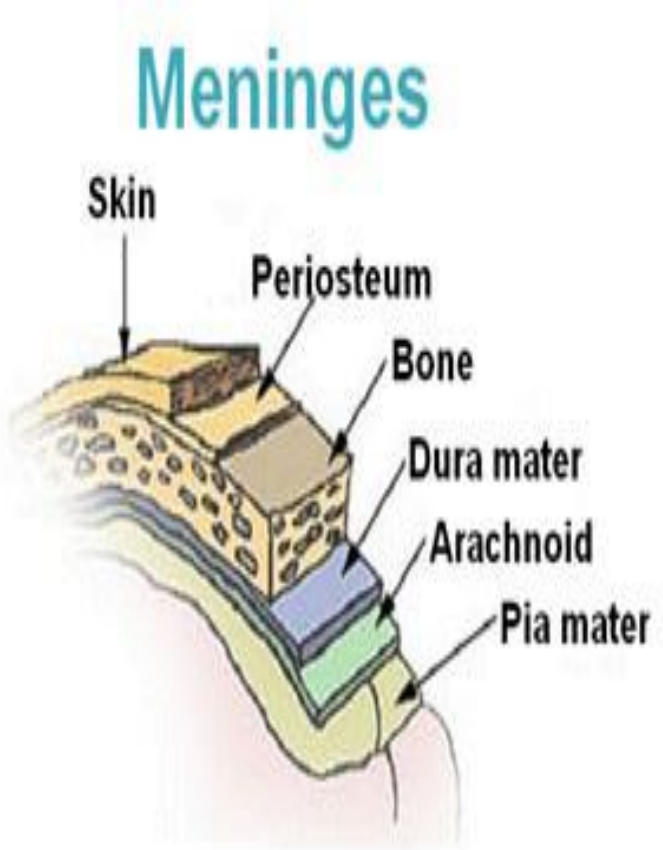
SCALP

- Skin
- Connective tissue
- Aponeurosis
- Loose connective tissue
- Periosteum

(Which covers the bone)



- Extradural space:
  - seperates dura from the skull
  - meningeal vessels run in this space
  - contains venous sinuses
- Subdural space
  - seperates arachnoid from dura

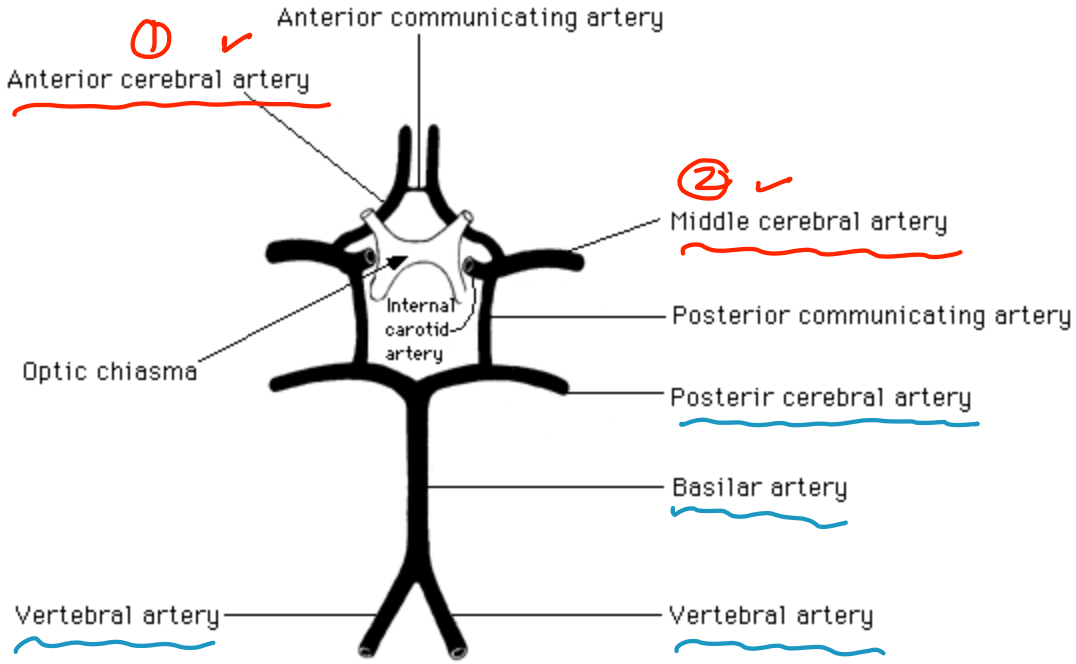


Dura mater -- outer layer lining skull
Arachnoid (mater) -- contains blood vessels
Subarachnoid space -- filled with CSF
Pia mater -- covers brain

- Common carotid a branches:
  - External carotid and internal carotid

Figure 3A. Schematic diagram of the arteries to the brain, and the circle of Willis.

*ICA enters the brain and give:



CSF

- Produced in the choroid plexus of the lateral 3rd and 4th ventricles
- **Flow** is from the lateral to the 3rd to the 4th ventricle via cerebral aqueduct
- Then flows into subarachnoid space via 2 foramen of Luschka and the single foramen of magendie
- **Absorbed** back into the blood stream via the arachnoid villi which project into the sagittal sinus

Physiology

* ICP ↑↑ → ↓ MAP → brain tissue إلى الجزء الذي لا يصل الدم للنسيج
* So may be leading to ischemia.
* But there is autoregulation

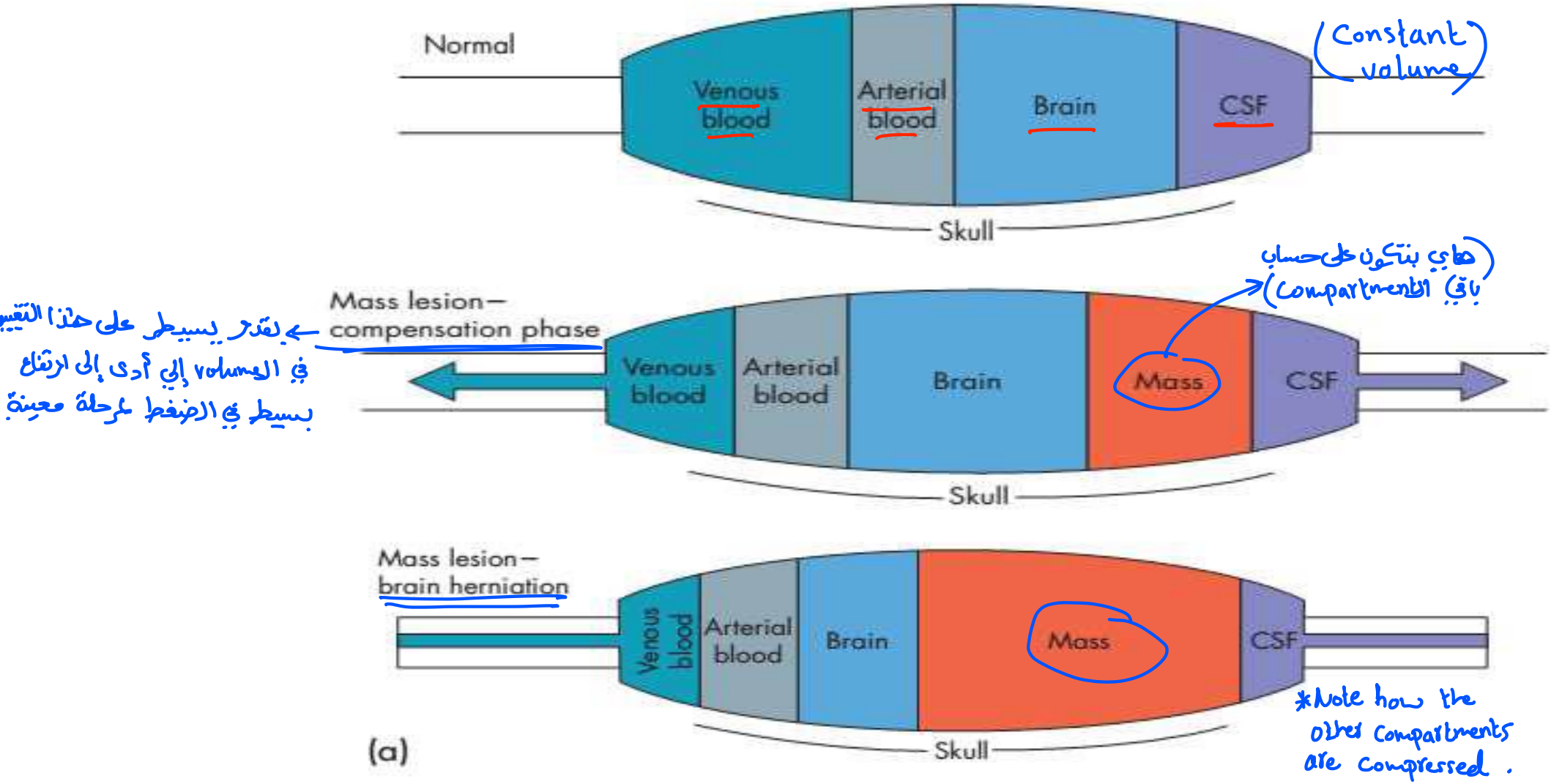
- **Cerebral perfusion pressure (CPP) = MAP – ICP** → It depends on these two:
- Normal cerebral blood flow (CBF) = 55 mL/minute for every 100 g of brain tissue
- Less than 20 mL/min means brain ischaemia
- **Cerebral perfusion** is kept constant across a range of perfusion pressures by the process of autoregulation.
- Autoregulation is compromised in the injured brain.
  - CPP ↓ → ischemia

Monro-Kellie doctrine

- The **cranial compartment** is incompressible
- The **volume** inside the cranium is a fixed volume
- Its constituents namely blood, CSF, and brain tissue create a state of volume equilibrium
- **Any increase in volume of one of the cranial constituents must be compensated by a decrease in volume of another**.

لكن لمرحلة معينة
بعد هاي المرحلة ← بصير rapid deterioration ، ما بقدر جسم المريض إنه يحاول يتعامل مع
هاي الزيادة في الضغط ، ممكن يزيد الـ ICP لدرجة إنه يصير Herniation of the brain stem
ويأدي لـ respiratory failure و Death.

Monro-Kellie doctrine



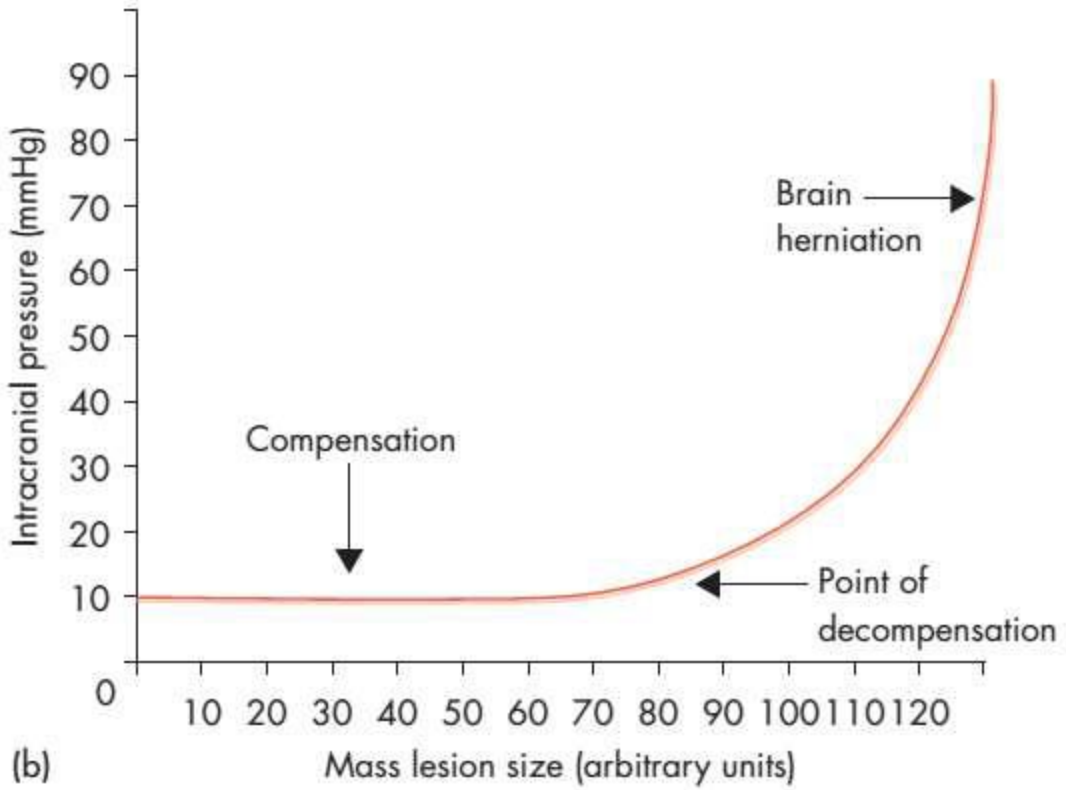
(Constant volume)

هاي بتتكون على حساب باقي (compartments)

بيقدر يسيطر على هذا التغيير في الحسام إلي أدى إلى ارتفاع بسيط في الضغط لمرحلة معينة

*Note how the other compartments are compressed.

Monro-Kellie doctrine



Initial evaluation and management

Resuscitation performed according to ATLS guidelines

A, Airway with cervical spine protection (Jaw - thrust - maneuver)

B, Breathing and ventilation

C, Circulation with haemorrhage control

D, Disability: neurological status

E, Exposure: completely undress the patient and assess for other injuries

History

- Paramedics may give vital information on the:
  - **pre-injury state** (fits, alcohol, chest pain)
  - **energy involved** in the injury (speed of vehicles, height fallen)
  - **conscious** state and **haemodynamic** stability of the patient after the accident
  - **length** of time taken for **extrication**
  - the length of retro- and antegrade **amnesia**
  - **medication history**, especially anticoagulants

→ Give hint about the severity of the injury.

*Or any allergy.

Examination: Primary survey

*Simultaneously while I'm doing ABCD ...

- Ensure adequate oxygenation and circulation
- Check pupil size* and response and GCS as soon as possible
- Check for focal neurological deficits before intubation if possible
- Check blood sugar for hypoglycaemia

If he has muscle weakness; can't move the upper or the lower limb ...
lower limb أو
(Maybe it's the cause, and it's reversible.)

Examination: secondary survey

*Examine the patient from head to toe.

A full secondary survey will be required.

- Particular attention must be paid to the head, neck and spine.

*Always pay attention to the cervical spine ; always in any RTA or falling down we consider that there is cervical spine injury until proven otherwise.

Box 15.2 Physical signs of skull fractures

Anterior fossa

- Nasal bleeding
- Orbital haematoma (see text)
- Cerebrospinal fluid rhinorrhoea
- Cranial nerve injuries, nerves I–VI

Middle fossa

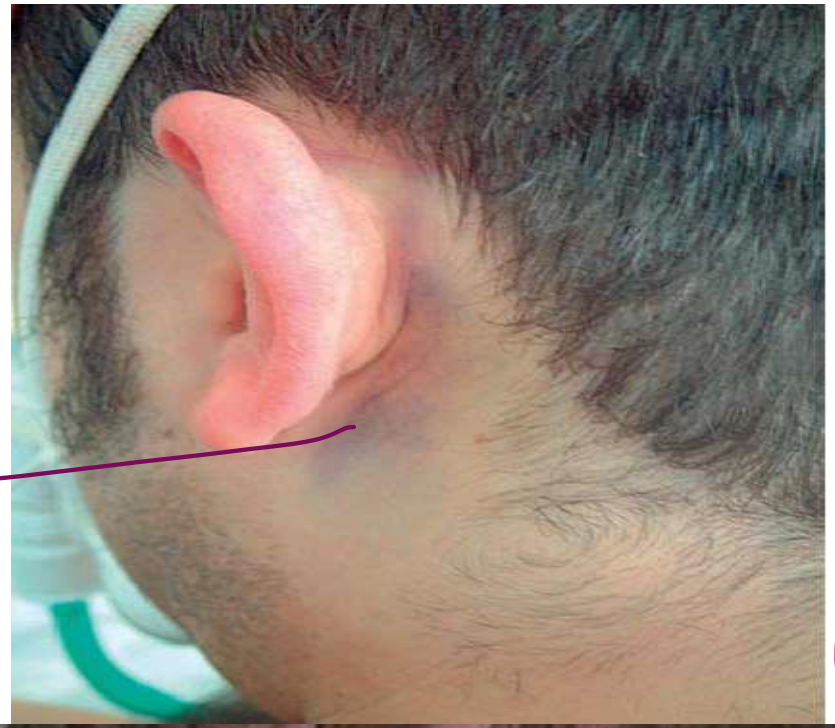
- Orbital haematoma
- Bleeding from the ear
- Cerebrospinal fluid otorrhoea (rare) (from the ear)
- Cranial nerve injuries, nerves VII and VIII

Posterior fossa

- Bruising over the suboccipital region, which develops after a day or two (Battle's sign[1])
- Cranial nerve injuries – nerves IX, X and XI (rare)

Head

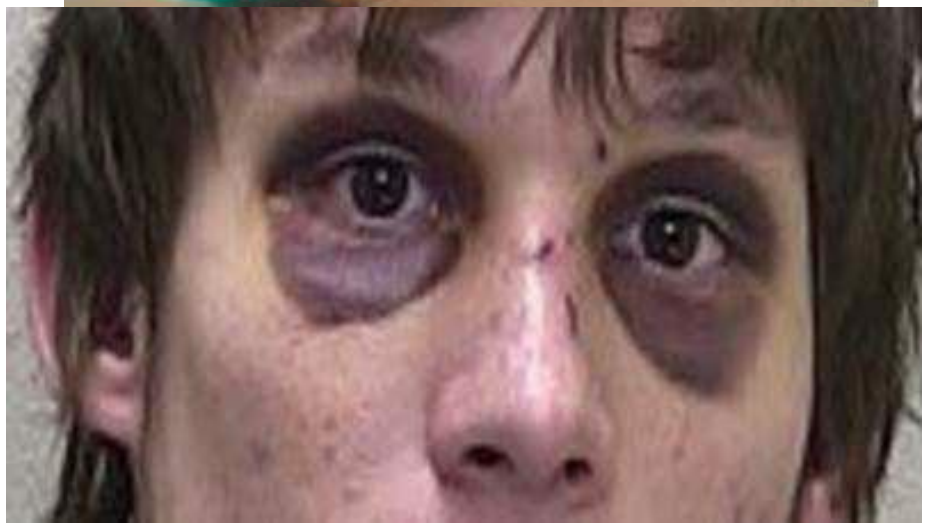
- Look and feel over the whole skull and face for cuts, bruises and fractures. (Check signs of basal skull fracture)
- Check for fractured base of skull by looking for blood in the ears, nose or mouth and Battle's sign.



خلف الـ ear

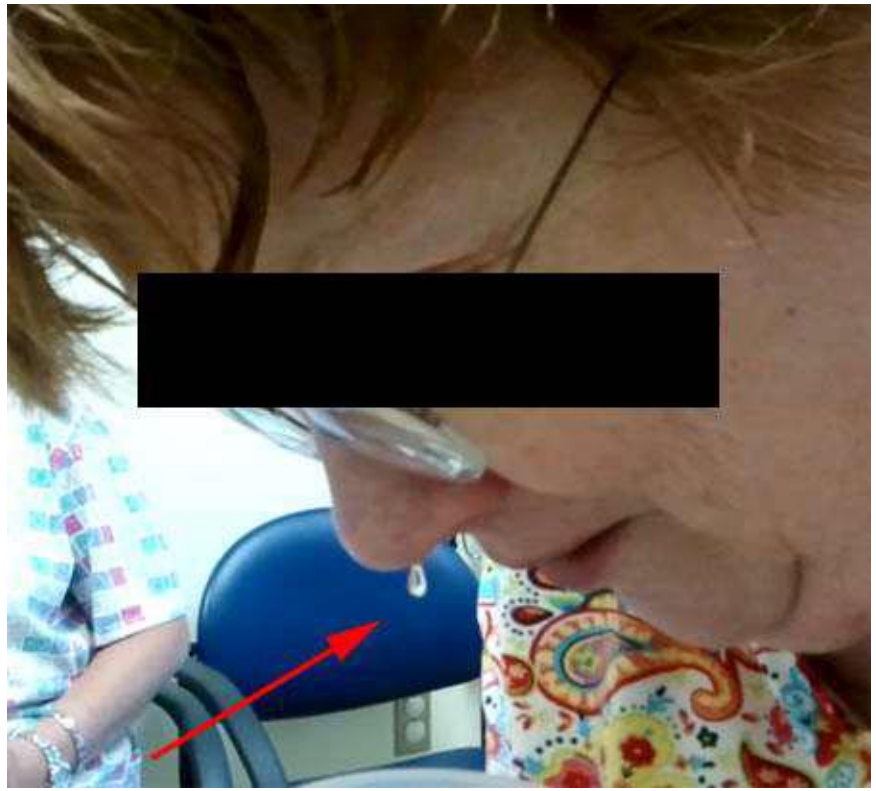
- Battle's sign : A skull base fracture may be associated with bruising over the mastoid process.

(Typical for Basal skull fracture)



- Racoon Eyes or Panda Eye Sign

↳ Anterior cranial fossa tumor.



CSF Rhinorrhoea

↳ clear fluid

↳ hint that the patient may has basal skull fracture.

Cervical spine immobilisation

*لأنه لو تحرك بطريقة غلط ممكن يأذي
Fracture in these vertebrae كان في
cut in the spinal cord leading to ممكن تأدي لـ
quadriplegia or even death (depends on where the cut occur)

Attempt **full cervical spine immobilisation** for patients who have sustained a head injury and present with any of the following risk factors unless other factors prevent this:

- GCS less than 15 on initial assessment by the healthcare professional.
- Neck pain or tenderness.
- Focal neurological deficit.
- Paraesthesia in the extremities.
- Any other clinical suspicion of cervical spine injury.

Examination of the whole patient in head injury

- Cervical spine injury is common in patients with head injuries.
- Even obtunded patients should move all four limbs.
- Check and record power, tone and sensation in the peripheral nerves.
- Log roll to check the whole spine for steps and tenderness.
- Perform a rectal examination to check for anal tone and anal wink.
- Check for priapism.

Neurologic Assessment

- GCS score
- Brainstem examination – Pupillary examination, ocular movement examination, corneal reflex, gag reflex
- Motor examination
- Sensory examination
- Reflex examination

Glasgow Coma Scale (GCS)

- **Severe** head injury : GCS score is 3 to 8 (* 8 or less ⇒ patient needs to be in ventilations to secure the airway.)
- **Moderate** head injury : GCS score is 9 to 12
- **Mild** head injury :GCS score is 13 to 15

Eyes open	Spontaneously	4
	To verbal command	3
	To painful stimulus	2
	Do not open	1
Verbal	Normal oriented conversation	5
	Confused	4
	Inappropriate/words only	3
	Sounds only	2
	No sounds	1
Motor	Obeys commands	6
	Localises to pain	5
	Withdrawal/flexion	4
	Abnormal flexion	3
	Extension	2
	No motor response	1

Pupillary examination

- Essential at the initial clinical assessment and during further observation.
- **Increase ICP** leads to temporal lobe herniation and compression of the 3rd nerve then pupillary dilatation (initially on the side of the raised pressure)
- As the ICP increases contralateral hemiparesis will appear.
- **Direct trauma** to the eye leads to traumatic mydriasis.

Motor and sensory examination

- Motor :
  - Limited to an assessment of asymmetry
  - Difference in muscle tone between the left and right sides. (مثل دماغة)
  - Indicative of a hemispheric injury and raises the possibility of a mass lesion.
- Sensory :
  - Asymmetric response to central pain stimulation
  - Often difficult.
  - Unable to cooperate with sensory testing.
  - Findings not reliable in patients who are intoxicated or comatose.

- Peripheral reflex examination
  - Identify gross asymmetry in the neurologic examination.
  - Indicate the presence of a hemispheric mass lesion.

*إذا المريض عنده mass أو hematoma على الـ rt في
↓
بيؤثر على الباقي

*Therefore the sensation at the rt side of the upper and lower limb is intact, but the contralateral side has paresthesia.

Classification

- Open and closed
- Vault and base of skull
- Linear, comminuted and depressed (Fractures)
- Intracranial bleeding: extradural, subdural, subarachnoid and intraparenchymal
- Brain tissue causes: diffuse, blunt (direct, coup–contrecoup) and penetrating

Criteria for performing a CT head scan

- **For adults**, CT head scan **within 1 hour** of the risk factor being identified
  - GCS <13 on initial assessment in the emergency department.
  - GCS <15 at 2 hrs after the injury on assessment in the emergency department.
  - Suspected open or depressed skull fracture.
  - Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign).
  - Post-traumatic seizure.
  - Focal neurological deficit.
  - **More than 1** episode of vomiting.

injury أو intracranial bleeding في (نسبة إنه يكون عالية جدًا)

Criteria for performing a CT head scan

For adults, CT head scan **within 8 hours** of the head injury:

- Age 65 years or older.
- Any history of bleeding or clotting disorders.
- Dangerous mechanism of injury (a pedestrian or cyclist struck by a motor vehicle, an occupant ejected from a motor vehicle or a fall from a height of greater than 1 meter or 5 stairs).
- More than 30 min retrograde amnesia of events immediately before the head injury.

MRI

- Limited role in the evaluation of acute head injury.
- Extraordinary anatomic detail, but (ممكن بعد ٤ أيام أو أسبوع)
- Long acquisition times
- Difficulty in obtaining MRIs in persons who are critically ill
- Used in the subacute setting in patients with unexplained neurologic deficits.

Investigating injuries to the cervical spine

*Usually they do trauma series → chest ~~abdomen~~ pelvis-CT xrays with C-spine view xrays.

*مش بكل المرضى بنسويلهم spine CT

*لكن في مرضى لازم نسويلهم brain CT بالإضافة الى spine CT

CT cervical spine scan within 1 hour of the risk factor being identified:

- GCS < 13 on initial assessment.
- The patient has been intubated. → (فإذا ما بقدر أقيم المريض أو أشوف لو عنده أي Tenderness)
- Plain X-rays are technically inadequate.
- Plain X-rays are suspicious or definitely abnormal.
- A definitive diagnosis of cervical spine injury is needed urgently (before surgery).
- The patient is having other body areas scanned for head injury or multi-region trauma.

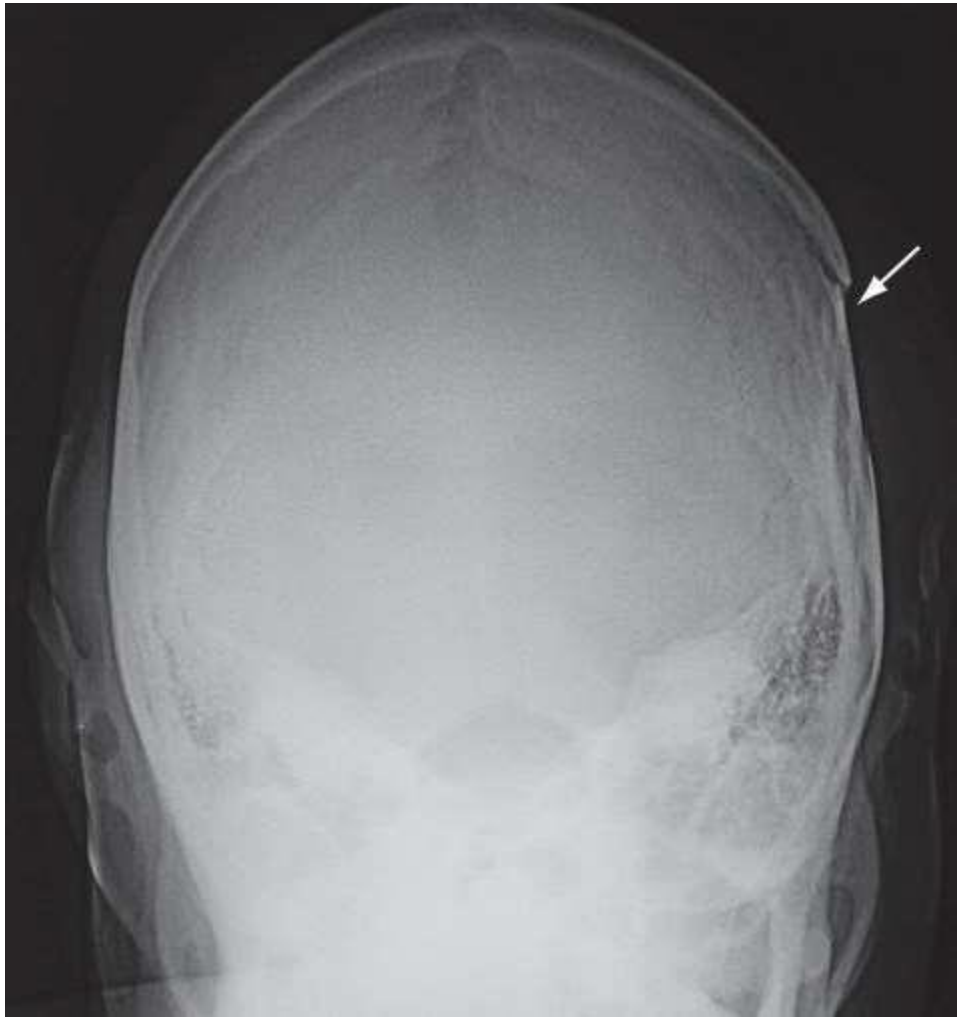
- **The patient is alert and stable**, there is clinical suspicion of cervical spine injury and any of the following apply:
  - age 65 years or older
  - dangerous mechanism of injury (fall from a height of greater than 1 meter or 5 stairs; axial load to the head, for example, diving; high-speed motor vehicle collision; rollover motor accident; ejection from a motor vehicle; bicycle collision)
  - focal peripheral neurological deficit
  - paraesthesia in the upper or lower limbs.

Standard skull X-ray

- NICE guidelines, CT is the investigation of choice for the diagnosis of clinically significant head injury.
- Skull radiographs have little role **in the diagnosis** and may be indicated in some instances, for example suspected non-accidental injury in children or lack of access to CT.
- *'Do not use plain X-rays of the skull to diagnose significant brain injury without prior discussion with a neuroscience unit.*
- *Useful as part of the skeletal survey in children presenting with suspected non-accidental injury.*

NICE National Institute for Health and Care Excellence

- This shows a depressed fracture in the left parietal bone (arrowed).
- The segment of bone is depressed by more than the thickness of the skull and therefore needed surgically elevating.



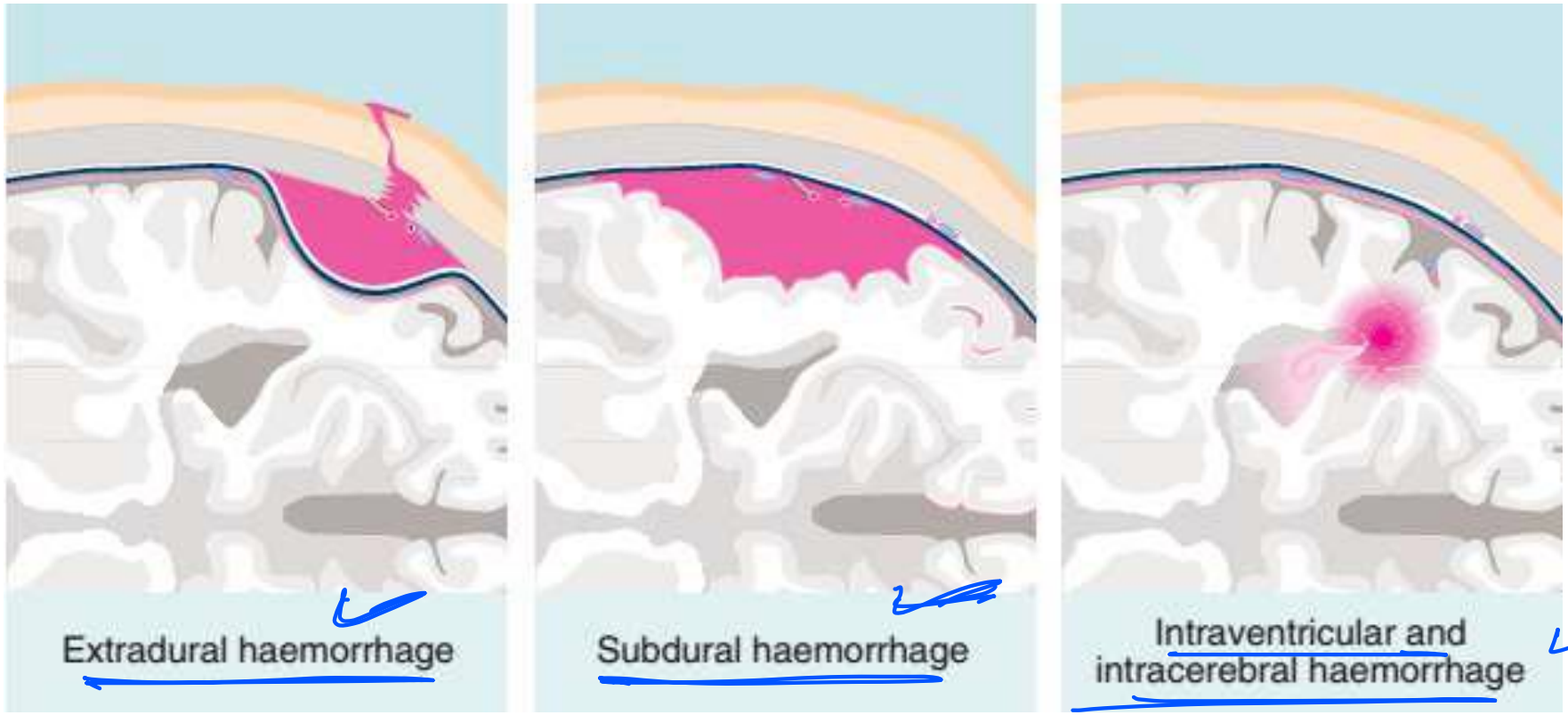
Indications for surgery

- Although **no strict guidelines** exist for defining surgical lesions in persons with head injury, **most Neurosurgeons** consider **any of the following** to represent indications for surgery in patients with head injuries:
  - Extra-axial hematoma with midline shift > 5 mm
  - Intra-axial hematoma with volume > 30 mL
  - An open skull fracture
  - A depressed skull fracture with > 1 cm of inward displacement
  - Any temporal or cerebellar hematoma that is **> 3 cm** in diameter

Involving the neurosurgical department

- Regardless of imaging, other reasons for discussing a patient's care plan with a neurosurgeon include:
  - Persisting coma (GCS 8 or less) after initial resuscitation.
  - Unexplained confusion which persists for > 4 hrs.
  - Deterioration in GCS score after admission (greater attention should be paid to motor response deterioration).
  - Progressive focal neurological signs.
  - A seizure without full recovery.
  - Definite or suspected penetrating injury.
  - A CSF leak.

Types of post-traumatic intracranial bleeding



Extradural haemorrhage

Radiology: 70% temporoparietal, 90% with fractures and underlying **middle meningeal artery injury** (The cause of bleeding)

- Lenticular, convex shape
- May have delayed enlargement
- Rarely associated with other brain injury (in comparison to acute subdural hematoma)
- Underlies the fracture (that may have been seen on the skull X-ray)
- Underlies a boggy swelling on the skull

Outcome: 5% mortality , 10–30% delayed enlargement

Presentation: Most have history of severe head trauma

- Classically have a "**lucid interval**" with resolving confusion after initial injury and then neurological decline (actually occurs in < 30%)
- Ipsilateral pupil dilatation
- Contralateral hemiparesis, 85% of cases

Treatment: Surgical evacuation versus observation (if small and asymptomatic)

++ Conservative

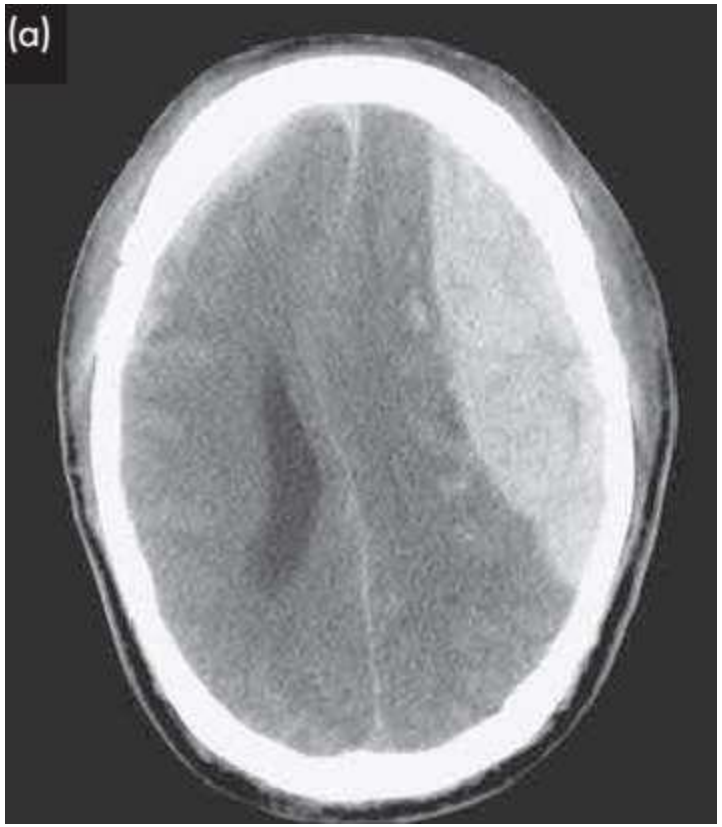
- A large left extradural haematoma

biconvex shape

*Shifting toward the Lt side.

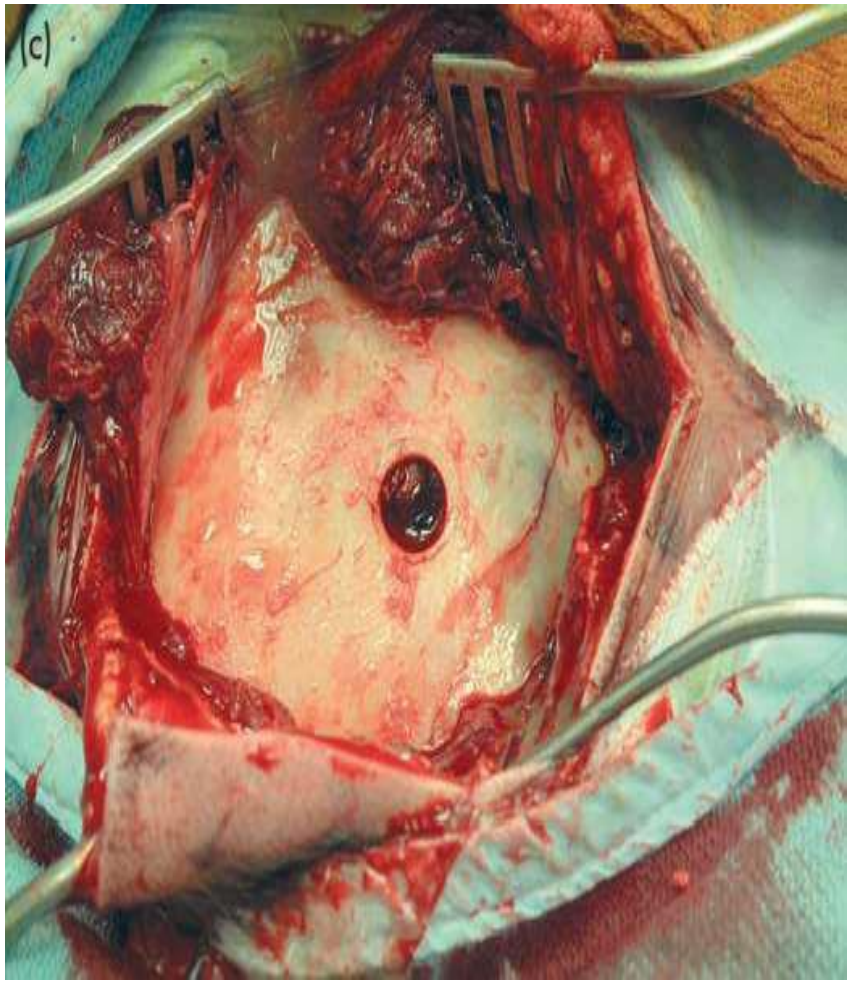
exerts a mass effect

- A smaller right acute subdural haematoma is also evident.



- A surgical temporal bone exposure showing a linear skull fracture with underlying extradural haematoma visible through a burr hole.

*They do evacuation.



Subdural haemorrhage

- *Epidemiology:* Occurs in 15% of severe head trauma
- Chronic subdurals are often seen in elderly with minor trauma especially when on anticoagulation (so they have bleeding tendancy)
- **Predisposition** with conditions that cause brain atrophy and therefore, increased tension on **bridging veins** (e.g. alcohol abuse, dementia)
- *Etiology:* **Shear injury to bridging cortical veins** (e.g., trauma, intracranial hypotension, severe atrophy, birth trauma)
- *Radiology (CT):*
  - Acute → hyperintense (can be isointense with low hematocrit or rapidly expanding lesions)
  - Subacute → isodense
  - Chronic (> 3 wks) → hypodense

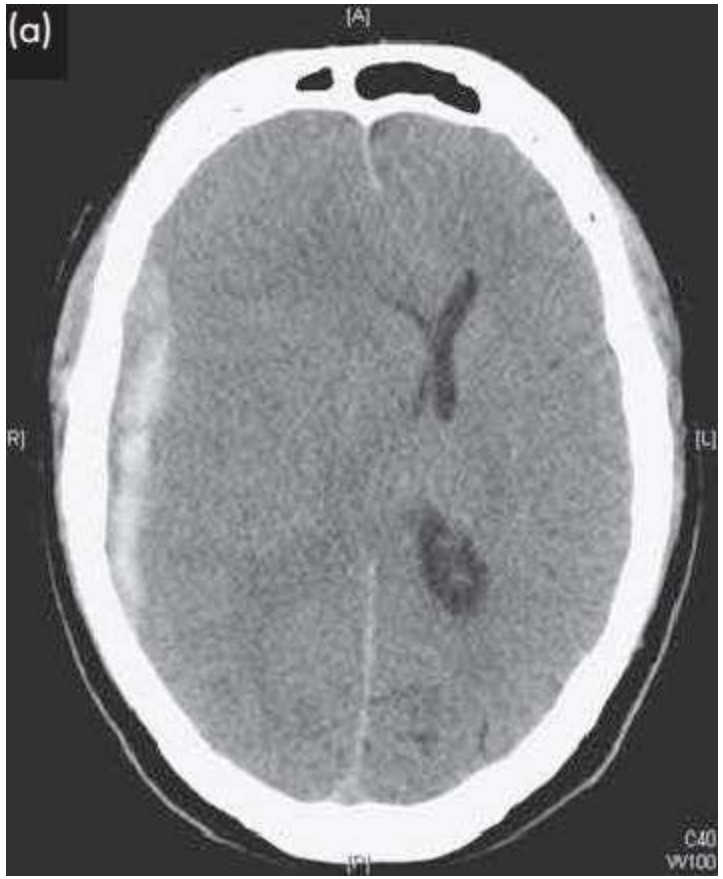
repetitive

*With age, brain tissue is atrophied and the CSF decreases, so forming a space between the brain tissue and the bone.

- ***Treatment***: Patients with symptomatic SDH with midline shift should be **surgically evacuated**
- **Acute** SDH requires a trauma craniotomy; **chronic** SDH may be amenable to evacuation with 0

  ↳(Might be conservative)
- *Outcome:* 35–90% mortality, depending on chronicity, patient age, and comorbidities
- Reaccumulation of chronic SDH occurs in up to 45%

- Right-sided acute subdural haematoma
- The substantial midline shift reflects brain swelling as well as bleeding: this is a high energy injury.



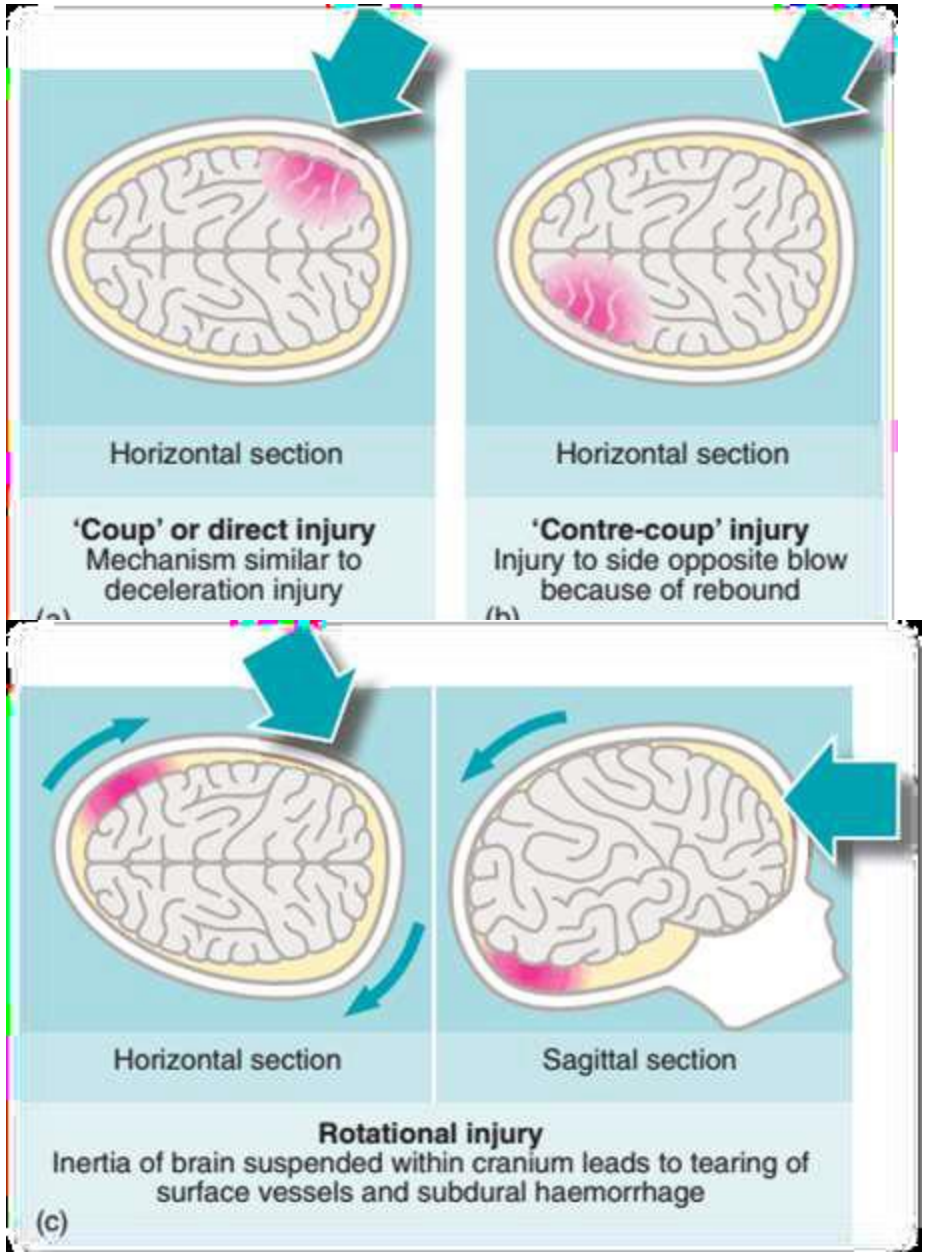
Subarachnoid haemorrhage

- Trauma is the most common cause of Subarachnoid haemorrhage
- Bleeding occurs between the arachnoid and pia mater.. SAH may be **complicated by hydrocephalus.**
- **Confusion** can sometimes arise between SAH due to trauma and due to a ruptured aneurysm or arteriovenous malformation (AVM); the patient may collapse and hit their head as a result of a bleed and the history (from the patient or a witness) is important.

*Very severe headach.
*spontaneous bleeding.
(Common Cause)(berry aneurysm)

Mechanisms of brain injury

- The mechanism of '**coup' or direct injury** is similar to a deceleration injury.
- A '**contre-coup' injury** affects the side opposite to the blow because of rebound (horizontal section).
- In **rotational injury** the brain suspended within the cranium leads to the tearing of surface vessels and subdural haemorrhage (horizontal and sagittal sections)

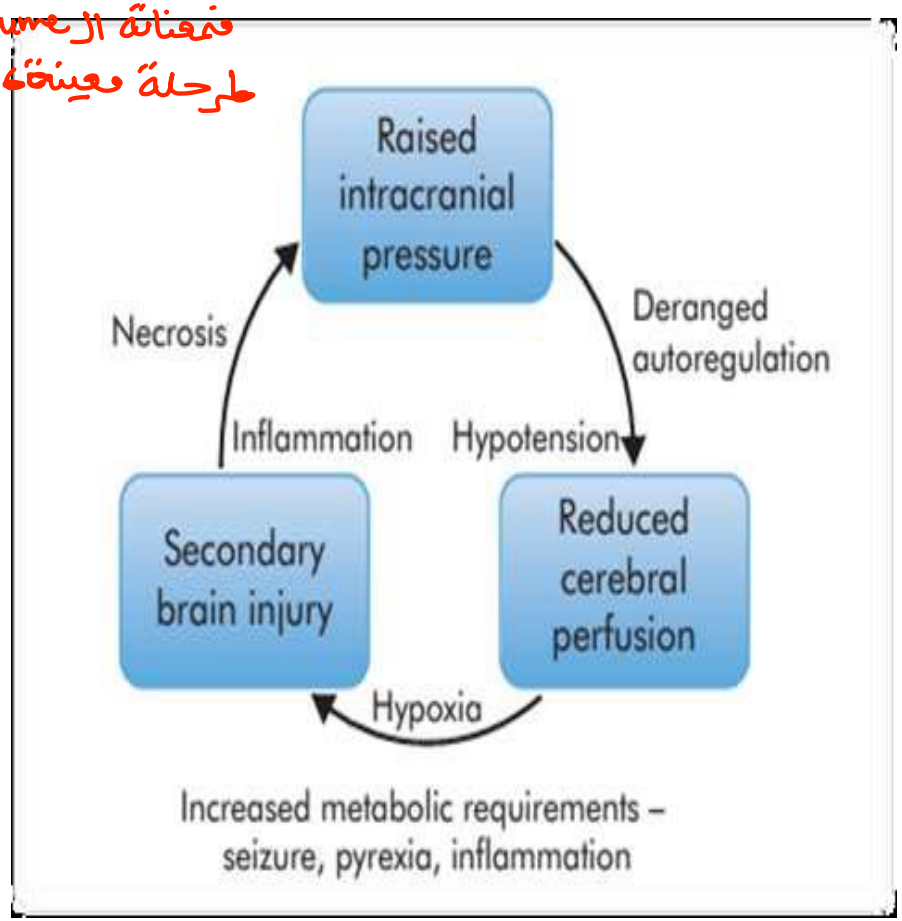


Types of brain injury

- Apparent traumatic subarachnoid haemorrhage may actually be a spontaneous subarachnoid haemorrhage which then led to the fall.
- **Diffuse axonal** injury results from high energy injury.
- Carotid dissection may be a delayed complication of skull base fracture.
- Non-accidental injury in children: beware **delayed presentation**

Secondary brain injury

- Brain **swelling** and **mass** lesions leads to raised intracranial pressure and **compromises perfusion** then secondary brain injury & further swelling.

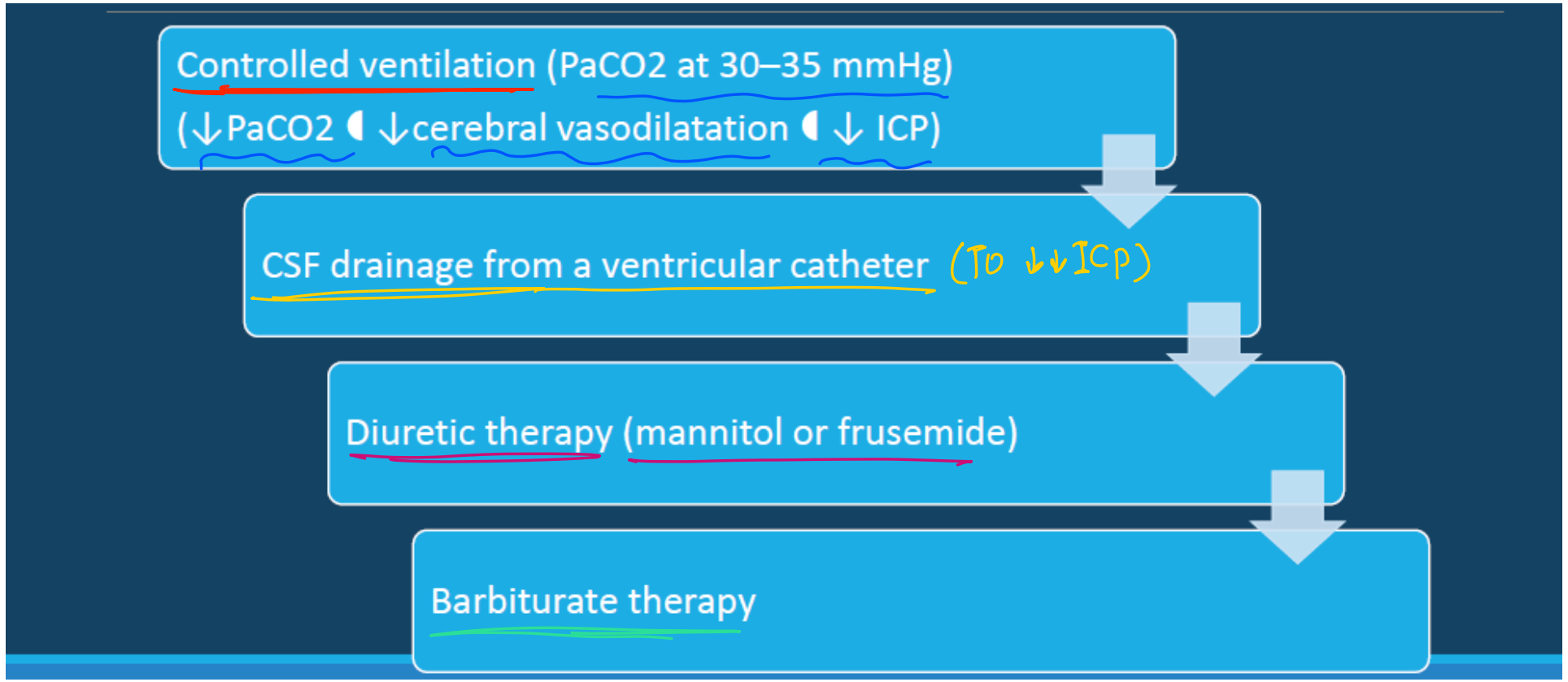


- CT scan shows an intracranial haematoma and shift of the underlying brain structures should be **evacuated** immediately.
- Non surgical lesion, or following the operation: Measures to decrease brain swelling:
  - Careful management of the airway
  - Adequate oxygenation and ventilation.(Hypercapnia leads to cerebral vasodilatation and brain swelling
  - Elevation of the head of the bed 20°
  - Fluid and electrolyte balance.

(Any fluid overload may lead to ↑↑ICP)

*Once there is CO_2 retention, there will vasodilatation, so volume overload in the vessels → ↑ICP.
✓(So patient should be hyperventilated)

*هدول المرضى طايبين عندهم Head injury ممكن يتأثر الـ Respiratory centers وبيبين عندهم Hypoventilation ← VD ← ICP↑↑.



- Maintain SBP > 90 < 160 (depending on baseline blood pressure and ICP), place arterial line and central line
- Intubation if required (sometime the patients are agitated)
- Ulcer prophylaxis (PPI) (#stress ulcer)
- Foley catheter (monitor urine output)
- *Blood transfusion if needed*
- Antibiotic prophylaxis if a bolt or external ventricular drain (EVD) is in place; tetanus, hemophilus, pneumococcus vaccine if indicated
- NPO, isotonic saline (0.9% NaCl) with goal of euvolemia, check electrolytes, mannitol to temporize elevated ICP for refractory intracranial hypertension (to be held for serum osm > 320), hypertonic saline (goal of Na > 145)

Thank you