Brain Injury

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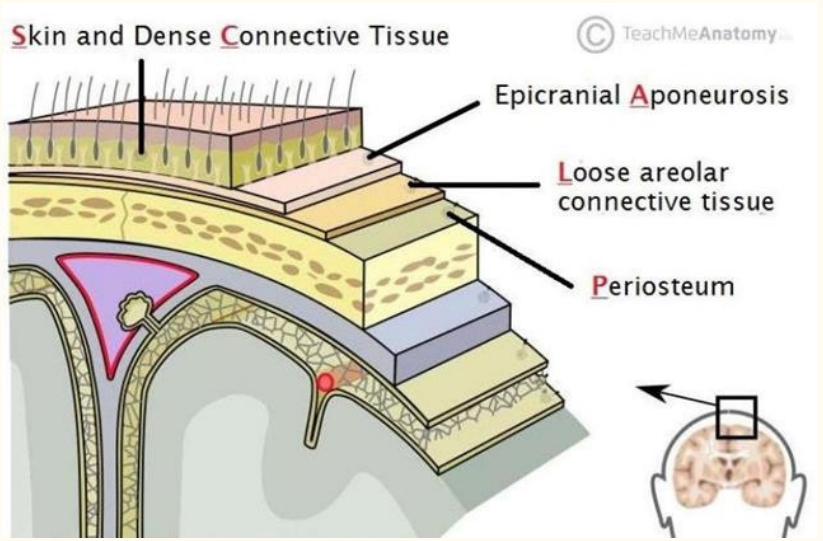
Scalp layers

S : skin
C : connective tissue
A: aponeurosis (galea)
L: loosearеolar tissue
P: pericranium



-Bleeding from scalp laceration can result in major blood loss in children.

Cerebrospinal Fluid

Cerebrospinal fluid (CSF) is a clear, colorless body fluid found within the tissue that surroundsthe brain and spinal cord of all vertebrates.

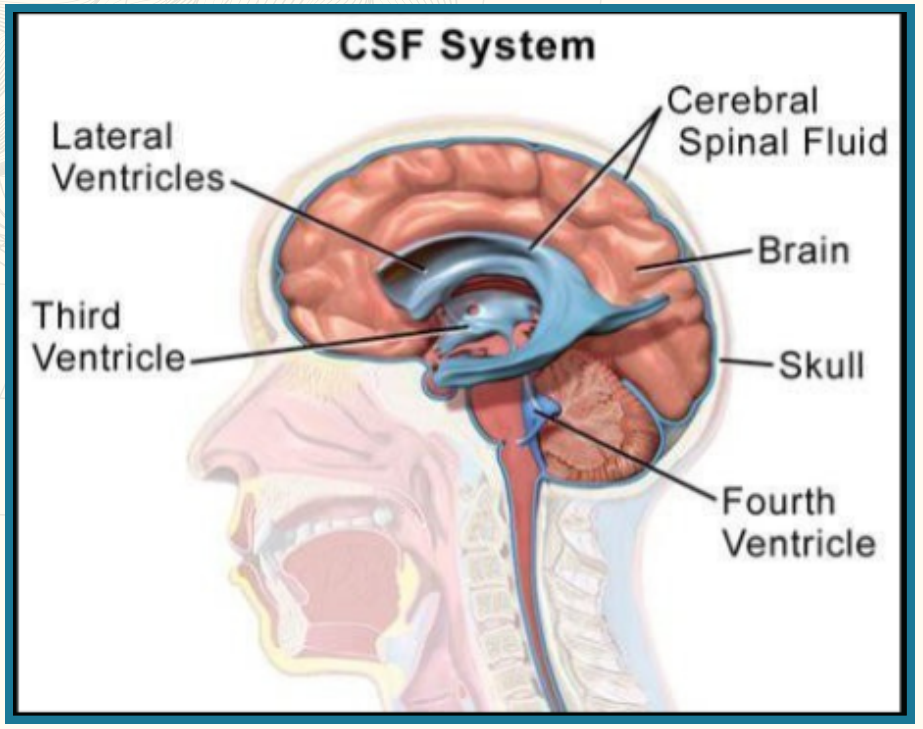
•It occupies the **subarachnoid space** (between the arachnoid mater and the pia mater) and the ventricular system around and inside the brain and spinal cord.

•It is produced by specialised ependymal cells in the choroid plexus of the ventricles of the brain,and absorbed in the arachnoid granulations.

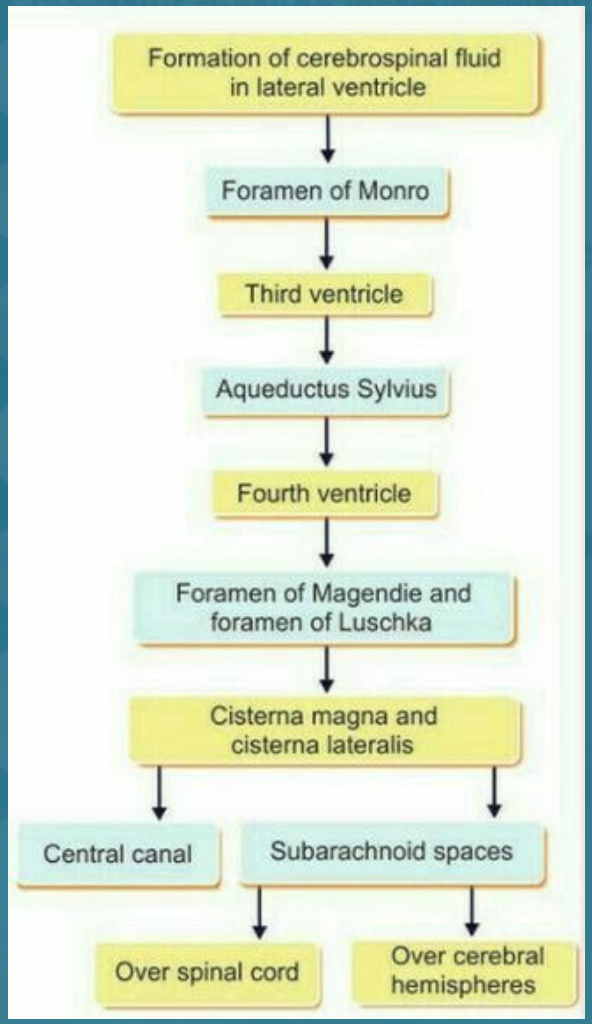
•The brain produces roughly 500 mL of cerebrospinal fluid per day at a rate of about 20 mL an hour.

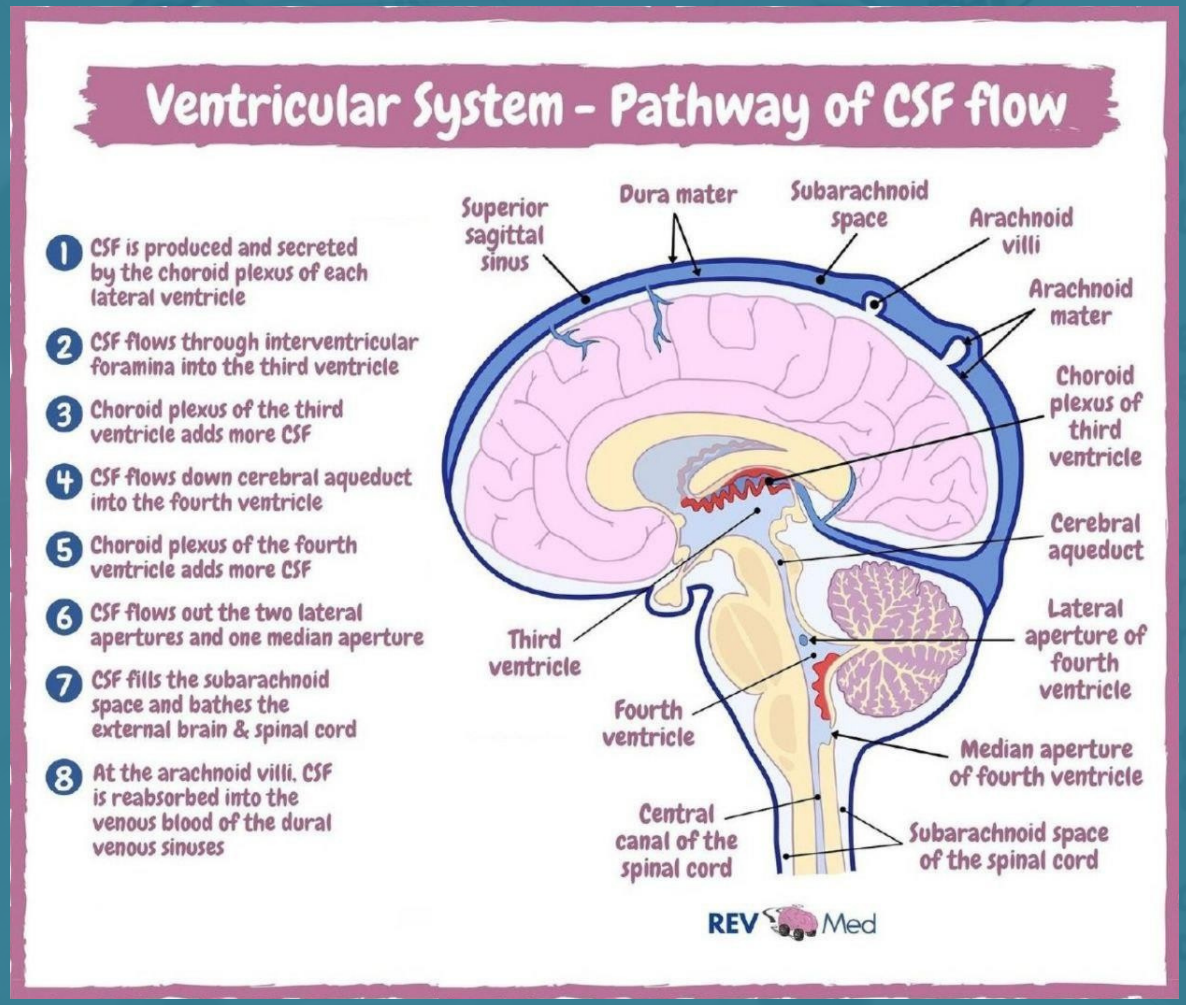
Functions of CSF

- Buoyancy
- Protection
- Prevention of brain ischemia
- Regulation
- Clearing waste



CSF CIRCULATION





Cerebral Blood Flow Regulation & Physiology

In normal person the **Autoregulation** maintain a constant CBF between MAP of 50 and 160 (mm Hg).

In head injured patient its severely disturbed.
MAP < 50 mm Hg → CBF declines steeply
MAP > 160 mm Hg → passive dilation of the cerebral vessels → increase in CBF

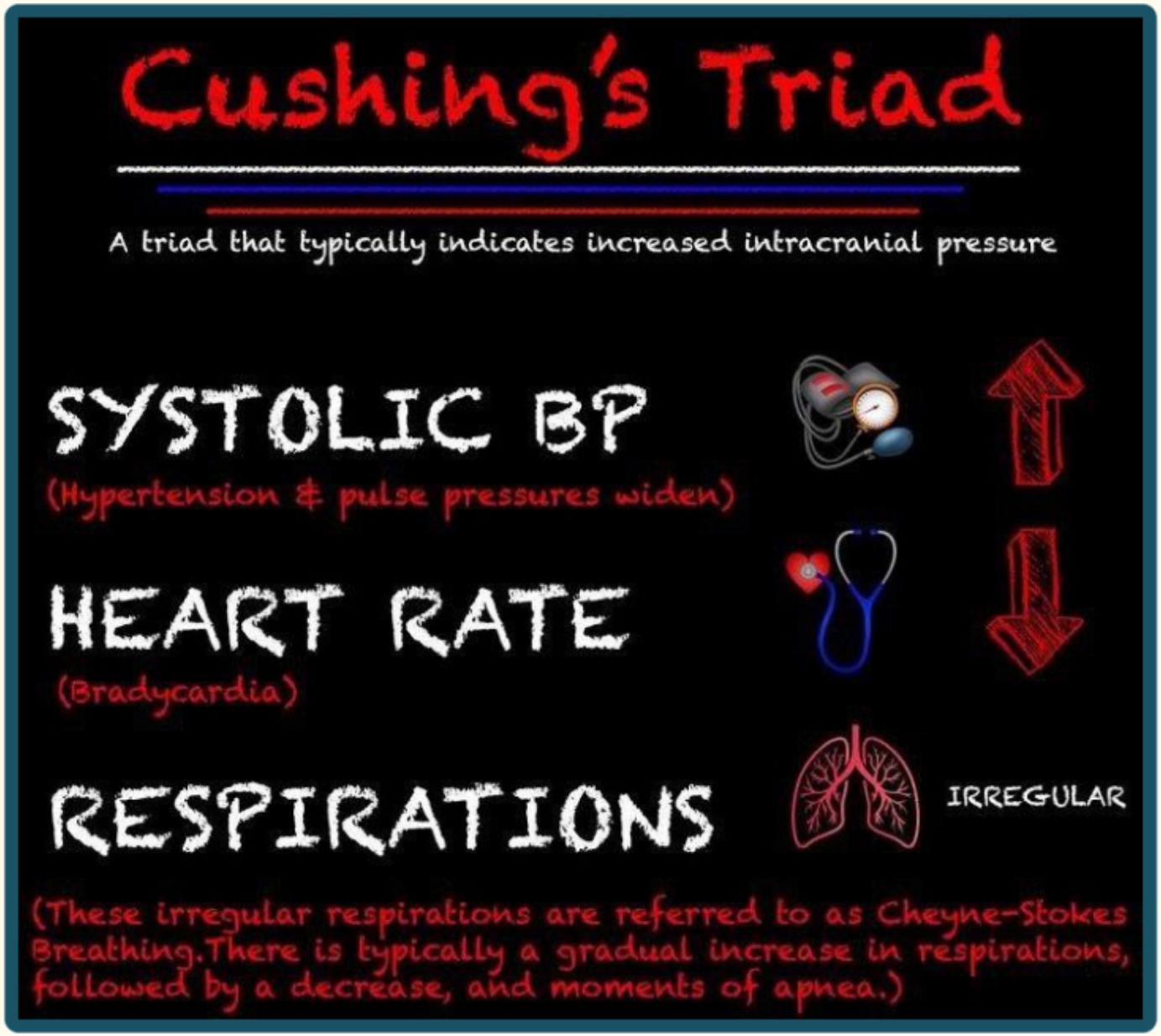
The normal average cerebral blood flow (CBF) in adult humans is about 50 ml / (100 g min)

Intracranial pressure

Several pathological processes that affect the brain can cause elevation of the intracranial pressure.
So elevated ICP not only indicate the presence of a problem but can often contribute to the problem:

- 10 mm Hg – normal ICP(in adult)
- 20 mm Hg – abnormal
- 40 mm Hg – sever elevation

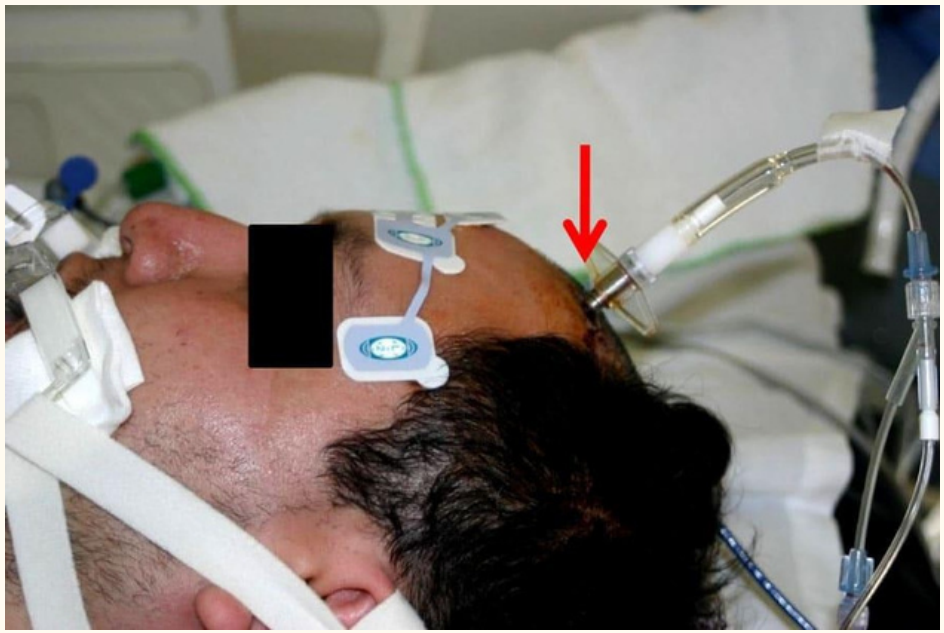
Cushing's Triad

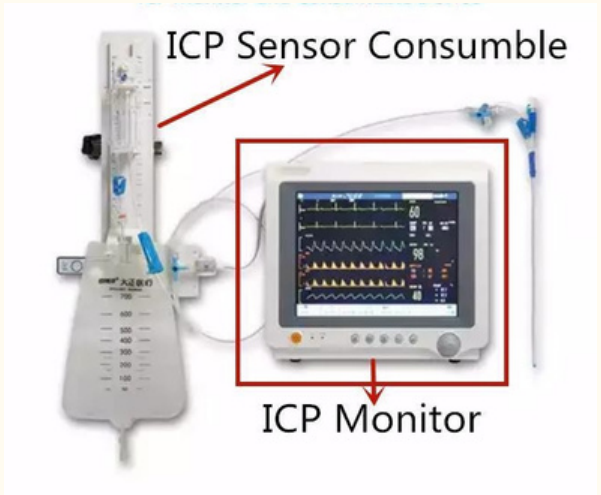


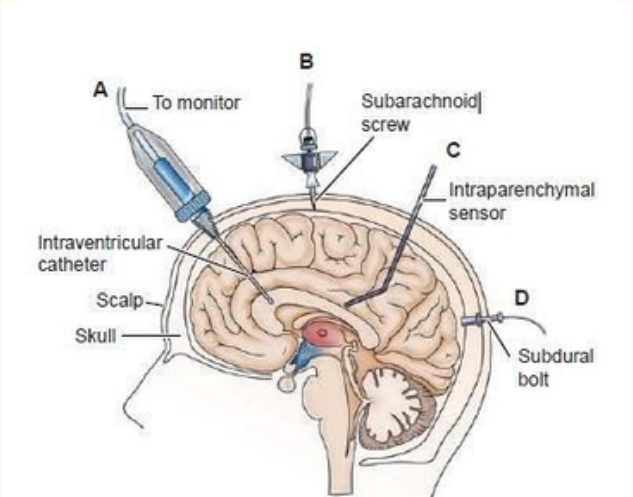
ICP Monitoring

Intracranial pressure (ICP) monitoring uses a device placed inside thehead.

•The monitor senses the pressure inside the skull and sends measurementsto a recording device







Classification of head injury

classified according to:

1)Mechanism of injury.

2)severity of the injury.

3)Morphology of theinjury

MECHANISM

Brain injury

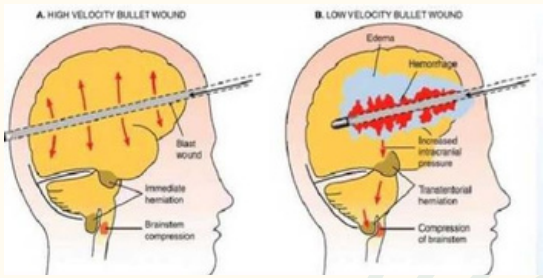
Blunt injury

- High velocity
  - Automobile
- Low velocity
  - (fall, assault,sport injuries)

Penetrating injury

- High velocity
  - Gunshot
- Low velocity
  - Kinfe,arrows

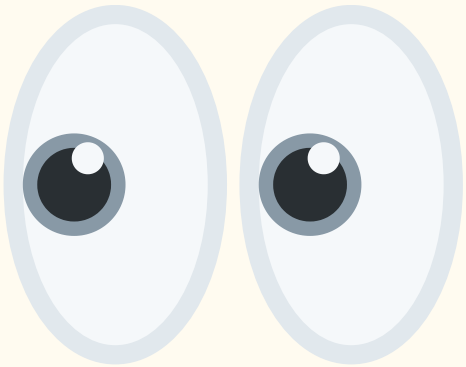
result from rapid deceleration of the head causing the brain to come contact with bonyprotuberance within the skull



Brain injury

According to GCS

- **Mild** (GCS score 14-15)
- **Moderate** (GCS score 9-13)
- **Severe** (GCS score 3-8)



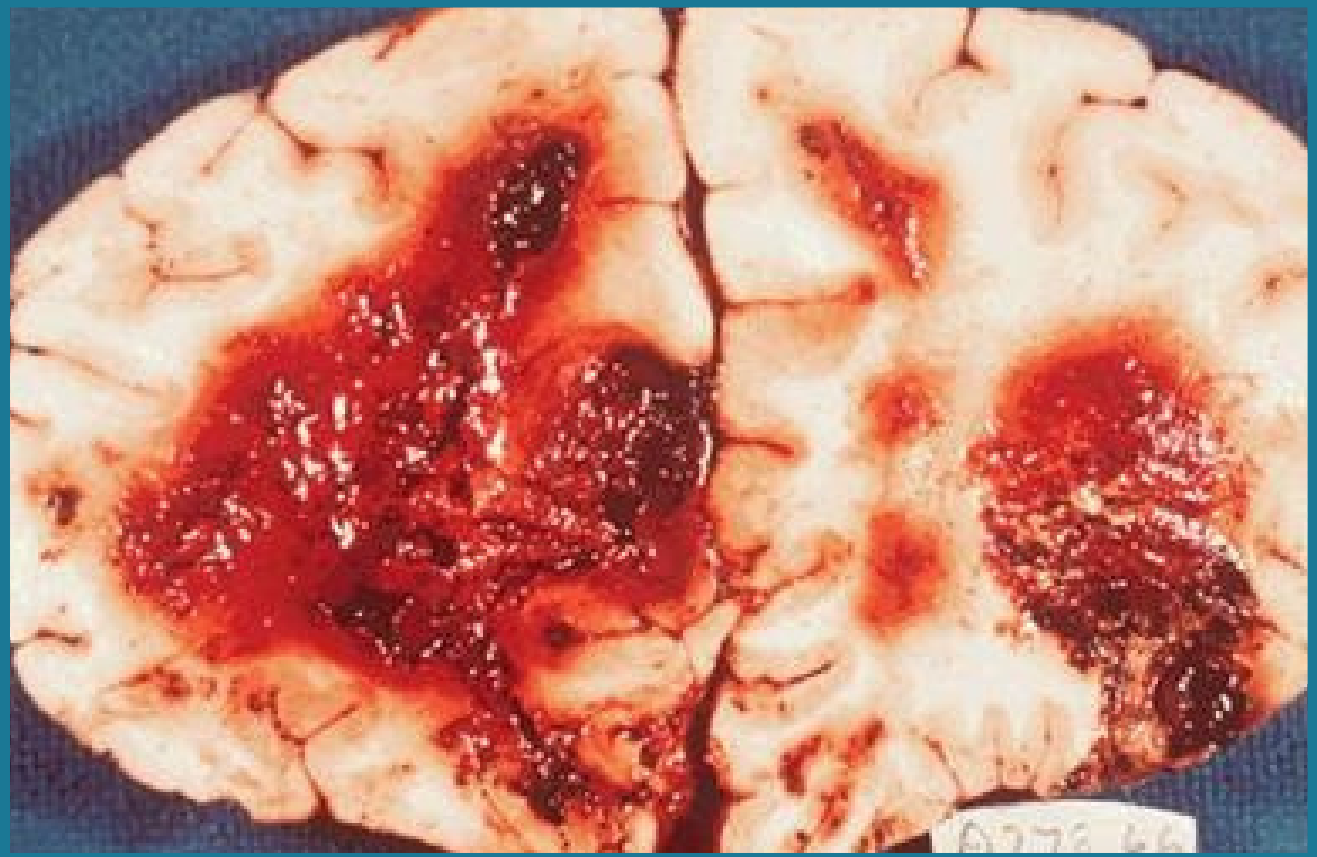
SEVERITY

Type	Stimulus	Type of Response	Points
Eyes	Open	Spontaneously	4
		To verbal command	3
		To pain	2
		No response	1
Best Motor Response	To verbal command	Obeys	6
	To painful stimulus	Localized pain	5
		Flexion-withdrawal	4
		Flexion-abnormal	3
		Extension	2
		No response	1
Best Verbal Response		Oriented and converses	5
		Disoriented and converses	4
		Inappropriate words	3
		Incomprehensible sounds	2
		No response	1

MORPHOLOGY

Skull Fracture	• Vault	•Linear vs. satellite •Depressed / nondepresed •Open / closed
	• Basilar	•With/without CSF leakage •With/without nerve palsy
Intracranial lesions	•*Focal*	•Epidural •Subdural •Intracerebral
	•*Diffuse*	•Mild concussion •Classic concussion •Diffuse axonal injury

SPEC TYPES OF HEAD INJURY



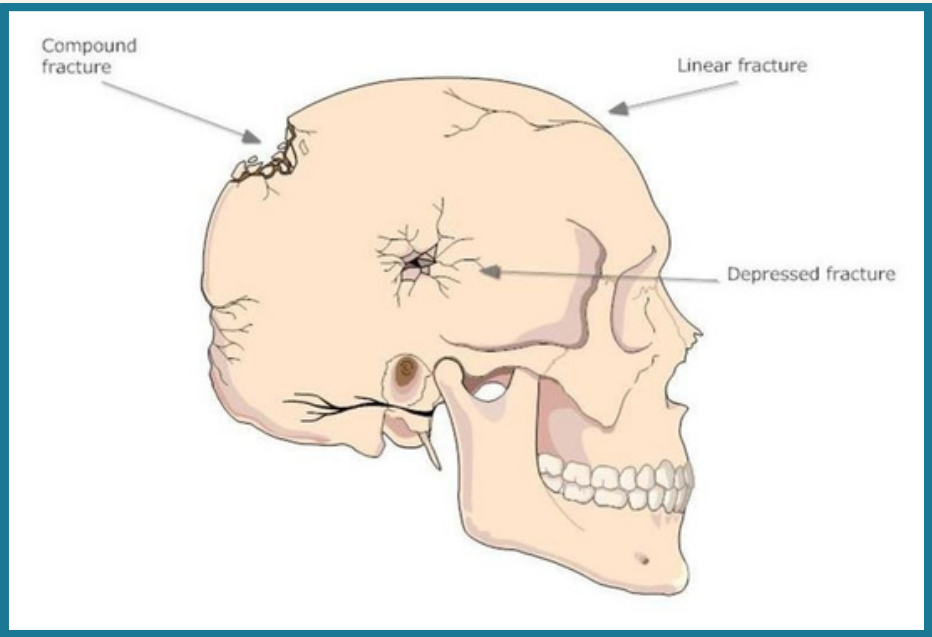
Skull fracture

- FRACTURE VAULT OF SKULL (CALVARIA\ CAPE)
- BASAL SKULL FRACTURE

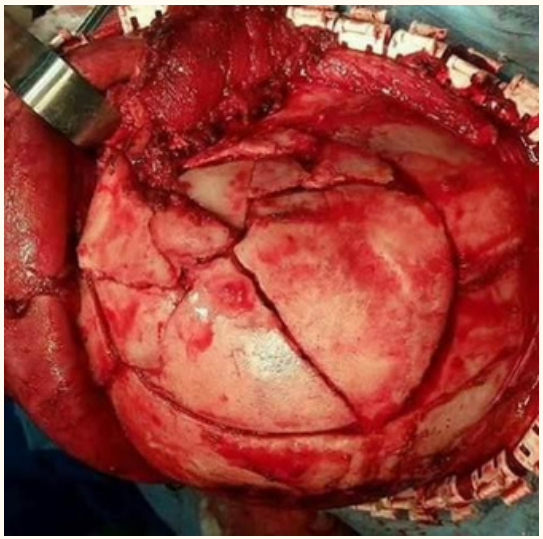
Fracture Vault of Skull (Calvaria\ Cape)

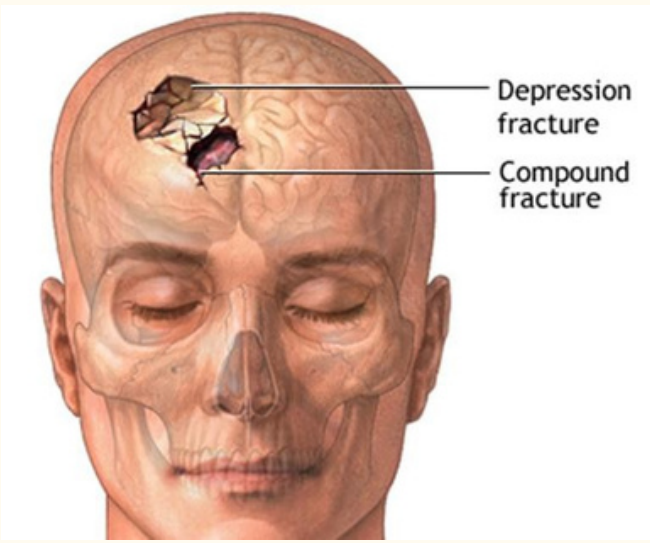
Classifications :

- **Closed** (Simple) :
  not associated with scalp wound (intact).
- **Open** (Compound) :
  associated with scalp wound (Not intact).
- **Fissure** fracture
- **Depressed** fracture



The significance of skull fracture should not be underestimated since it takes considerable force to fracture the skull.
linear vault fracture increase the risk of an intracranial hematoma by about 400times in a conscious patient and by 20 in comatose patient.
Fragment depressed more than the thickness of the skull require surgical elevation
Open or compound skull fracture require early surgical repair





CLINICAL PICTURE

SIMPLE FISSURE FRACTURE:

•There is a haematoma over the fracture.
•The fissure cannot be felt through the intact scalp.
•Manifestations of brain injuries are rare.

SIMPLE DEPRESSED FRACTURE:

•There is a haematoma over the fracture.
•The depressed fracture may be felt through the intact scalp
•Signs of brain injuries are not common.

COMPOUND FRACTURE:

•There is escape of blood, C.S.F. & brain through scalp wound
•The fissure or depression can be seen and felt.
•Signs of associated brain injuries are common.

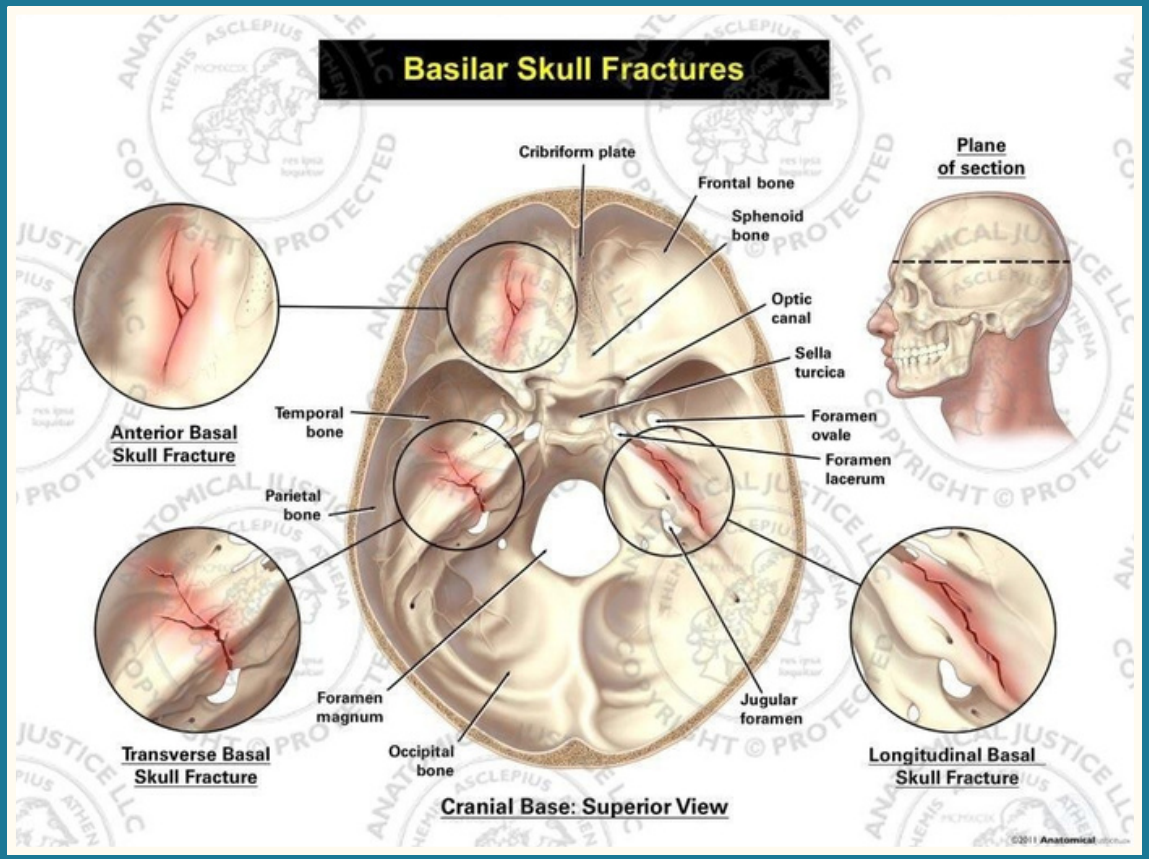
Basal Skull Fracture

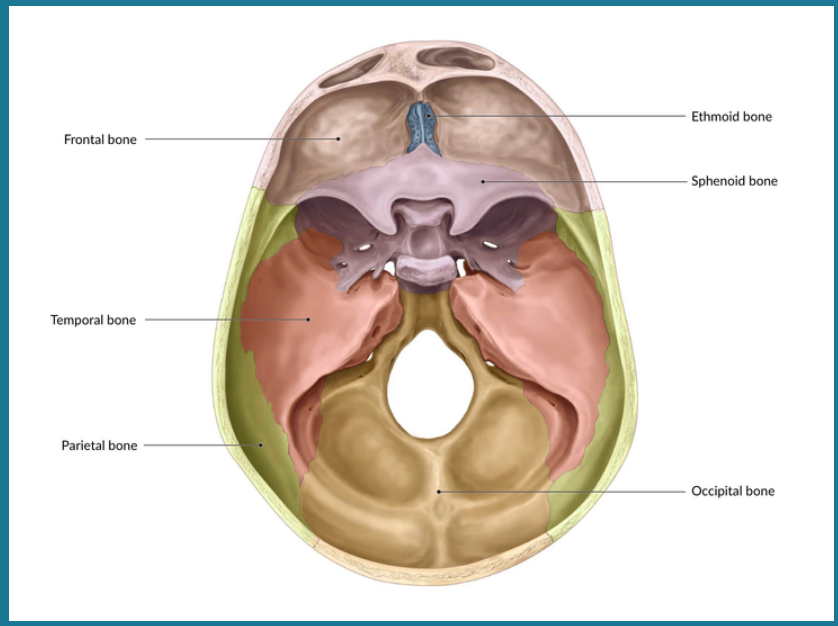
Etiology :

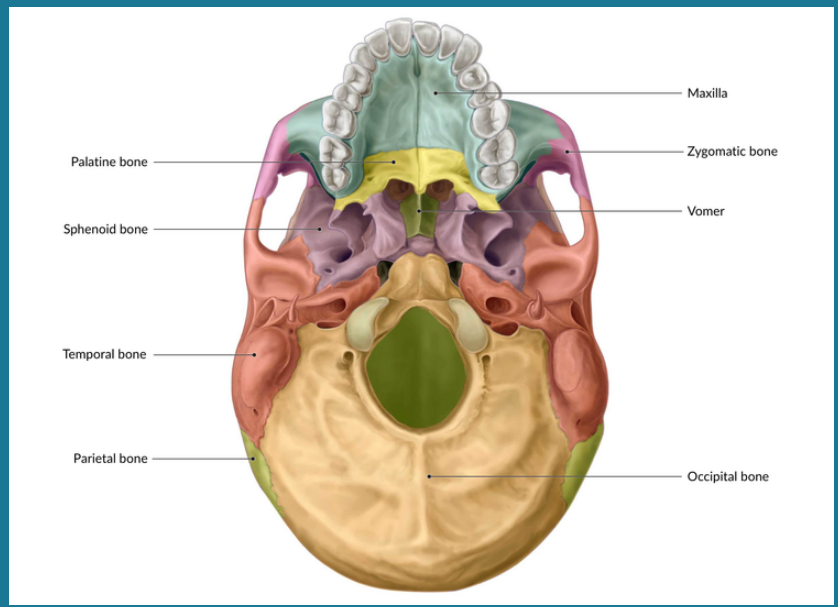
usually due to indirect trauma to the vault, spine, face or chin
The base of skull is rigid and weakened by multiple foramina
* Fracture base is irregular fissure running between these foramina.

COMPLICATIONS :

(1)escape of intracranial contents (blood ,CSF and brain)
(2)infection (meningitis , encephalitis..)
(3)brain injuries are very common
(4)cranial nerve injury


Basilar Skull Fractures
Cribriform plate
Frontal bone
Sphenoid bone
Optic canal
Sella turcica
Foramen ovale
Foramen lacerum
Jugular foramen
Occipital bone
Foramen magnum
Parietal bone
Temporal bone
Plane of section
Anterior Basal Skull Fracture
Transverse Basal Skull Fracture
Longitudinal Basal Skull Fracture
Cranial Base: Superior View


Frontal bone
Ethmoid bone
Sphenoid bone
Temporal bone
Parietal bone
Occipital bone


Maxilla
Palatine bone
Zygomatic bone
Vomer
Sphenoid bone
Temporal bone
Parietal bone
Occipital bone

Clinical picture

sence of clinical signs of basal skull fracture should increase the index of suspicion and help in its identification:

A)Fracture Anterior cranial fossa :

epistaxis

Rhinorrhea : CSF leakage from the nose

Raccoon sign : bilateral Periorbital ecchymosis

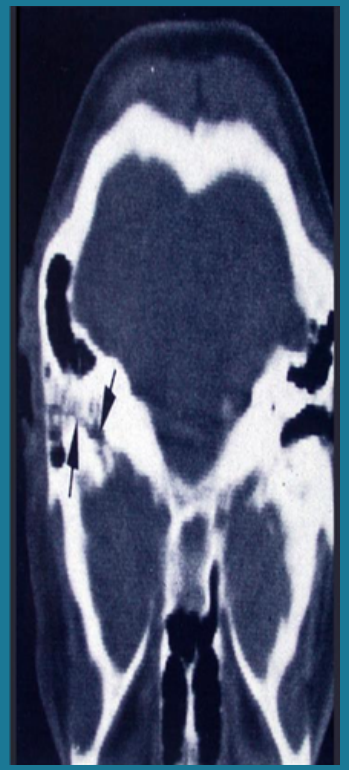
B)Fracture middle cranial fossa :

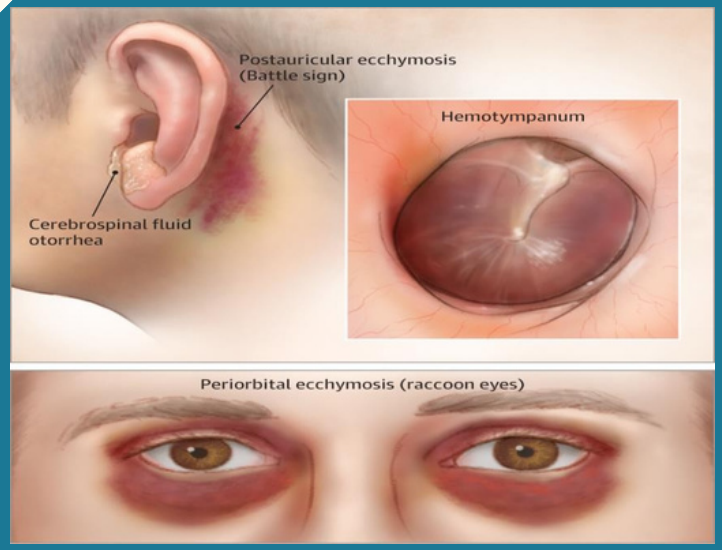
Otorrhea : CSF leakge from the ear

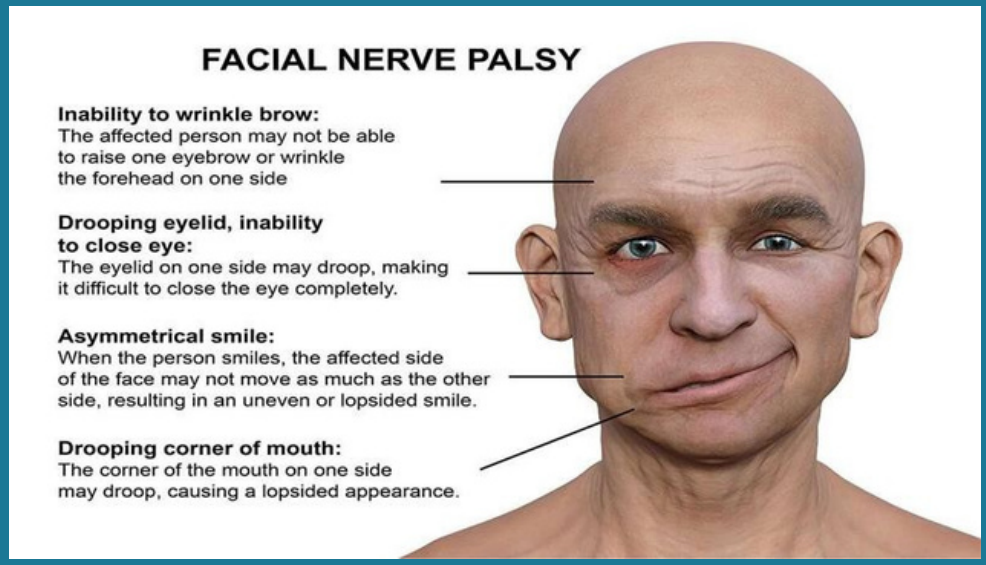
Hemotympanum :presence of blood in the middle ear cavity

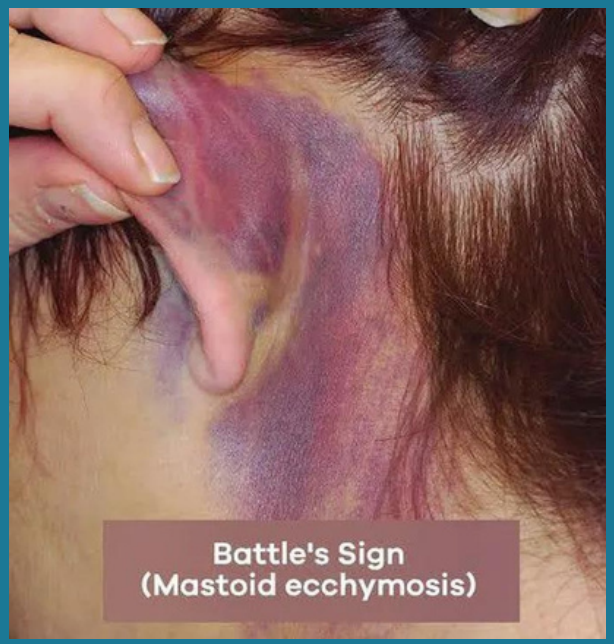
Battle's sign: Retroocular ecchymosis

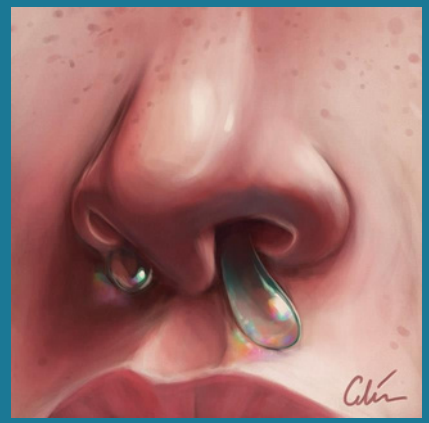
CN VII palsy : Bell's palsy




Postauricular ecchymosis
(Battle sign)
Hemotympanum
Cerebrospinal fluid
otorrhea
Periorbital ecchymosis (raccoon eyes)


FACIAL NERVE PALSY
Inability to wrinkle brow:
The affected person may not be able to raise one eyebrow or wrinkle the forehead on one side
Drooping eyelid, inability to close eye:
The eyelid on one side may droop, making it difficult to close the eye completely.
Asymmetrical smile:
When the person smiles, the affected side of the face may not move as much as the other side, resulting in an uneven or lopsided smile.
Drooping corner of mouth:
The corner of the mouth on one side may droop, causing a lopsided appearance.


Battle's Sign
(Mastoid ecchymosis)



Intracranial lesions

- **Focal**
- **Diffuse** (most common type of head injury)

although the two forms frequently coexist.

represent a continuum of brain damage produced by increasing amounts of acceleration-deceleration forces.

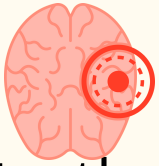
- In general they have a normal CT scan but demonstrate altered sensorium or even deep coma.
- Based on the depth and duration of coma, diffuse injuries may be classified

-Mild concussion

-Classic concussion

-Diffuse axonaldamage.

Focal brain injury:



is a traumatic injury to the brain that occurs in a single location, however there could be multiple areas affected by the event
Focal brain injury refers to areas of localized damage and includes contusions and lacerations

Contusions are multiple small hemorrhages in the surface layers of the brain (i.e. bruises).

Lacerations are tears to the brain tissue caused by penetrating objects or the sharp edges of fractured skull bones.

What are the most common arteries involved in intracranial haemorrhage?
The middle meningeal artery underlying the temporoparietal region of the skull.

Intra- Cranial Haemorrhage

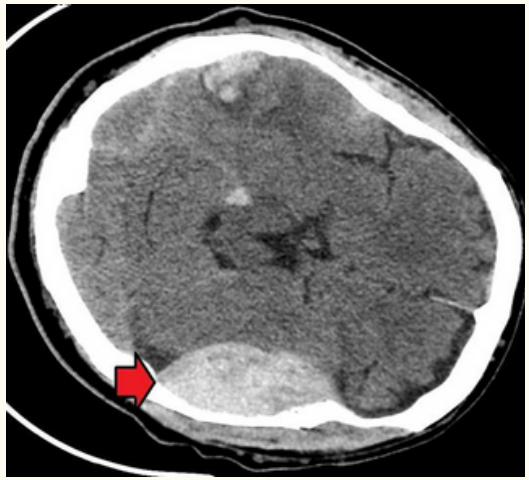
Broad term describes any bleeding within the skull

Hematoma

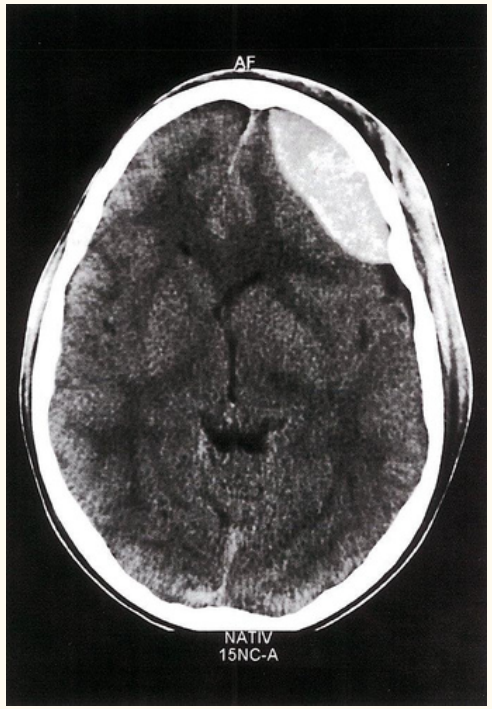
Is a mass of clotted blood within a tissue, organ or a body space due to broken blood vessel

Epidural Hematom

Is accumulation of blood between the dura matter and skull
•Due to rapture of Middle Meningeal Artery (MMA) secondary to head trauma involving pterion (thinnest area of lateral skull)
•It cause rapid collection of blood (30-50ml > symptoms)



•Most common site:
I.Temporal region
II.Temporoparietal region



IMAGING
CT scan without IV contrast Findings:
- Biconvex, lenticular shaped hyperdense lesion
- Limited by suture lines

Clinical picture

1.immediate loss of consciousness
2. Followed by regain of consciousness= Lucid interval
•Lucid interval: is the interval between the regain of consciousness and the onset of brain compression (development of neurological signs)
•could takes minutes to hours
•Due to slowly accumulation of blood
3. Rapid deterioration: +ve neurological symptoms due to expansion of hematoma
CN III palsy
•Rapid increase of ICP might lead to trans-tentorial herniation
•In children can occur in the absence of skull fracture due to temporary displacement of skull bones leading to lacerations of a vessel.
•In traumatic EDH Hematoma forms extremely fast Within 10 – 20 minutes after injury.

Management

Conservative therapy:

•If the lesion is asymptomatic & small: close observation and serial CT scans and frequent neurological examinations

•Surgical intervention for asymptomatic EDH with:

• Blood volume > 30ml

• Thickness: 10 mm in adults – 5 mm in children

• Midline shift beyond 5 mm

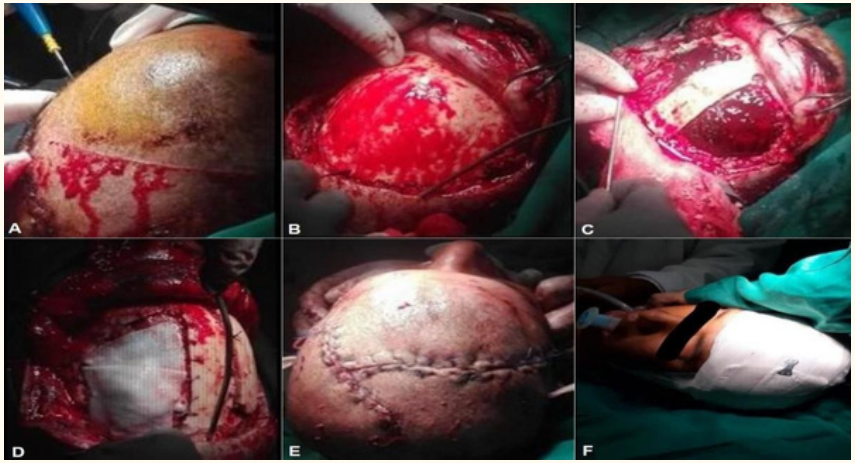
-as most patients with such an EDH experience a worsening of the conscious state and/or exhibit lateralizing signs.

Emergent surgical evacuation of hematoma:

•Craniotomy

•Suction of EDH

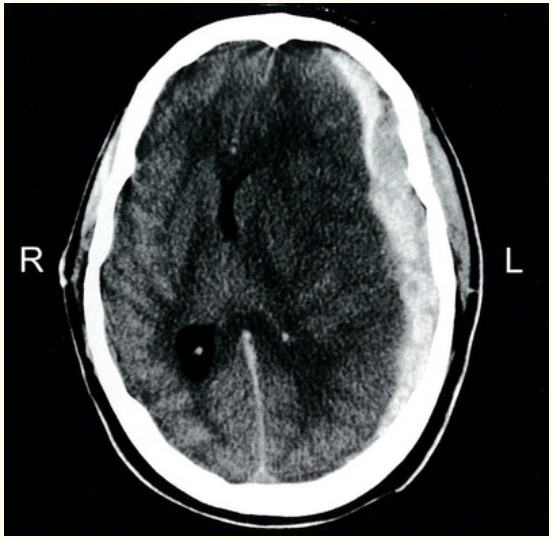
•Control of bleeding: MMA is coagulated or underrunstiches

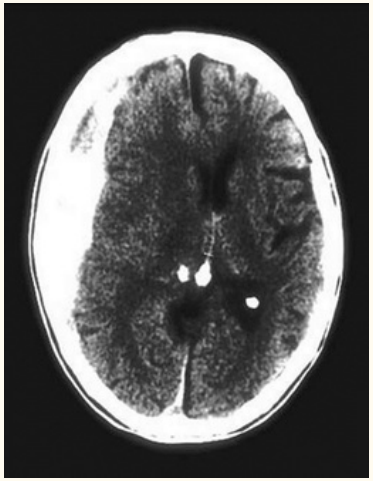


Subdural hematoma

Collection of blood within the subdural space (between dura & arachnoid matter)
- Head trauma→RUPTURE OF BRIDGING VEINS
-multiple veins could rapture causing multiple SDH, normally cover the entire surface of hemisphere

-High risk group: elderly – chronic alcohol overuse due to:
1)Cerebral atrophy
2)Stretching of bridging veins





Concave, Crescent-shaped, Hyperdenselesion
Crosses the suture line

Signs & Symptoms

1.Altered mental status
2.LOC
3.Focal neurological signs
(ipsilateral mydriasis - Failure of the ipsilateral pupil to react to light)
4.Contralateral hemiparesis
5.Headache – Nausea – Vomiting
-Usually associated with severe diffuse injury, immediate deep coma from moment of impact
-Extreme neurosurgical emergency.
30% mortality, 30% good outcome.

Management

Conservative:

-Small acute SDHs less than 5 mm thick on axial CT images, without sufficient mass effect to cause midline shift or neurological signs & can be followed clinically.

-Increased ICP can be treated by diuretic (ex. Mannitol)

Surgical:

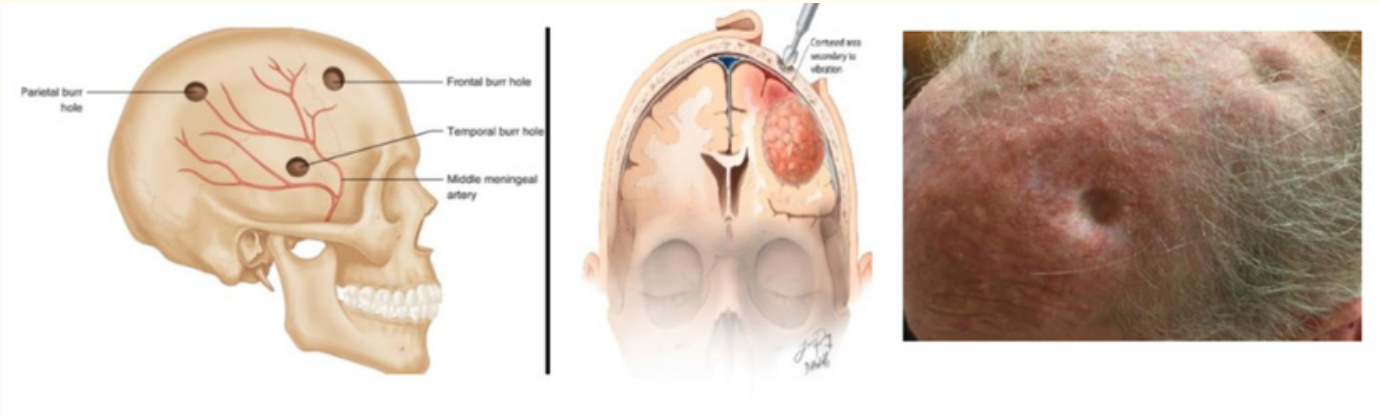
Surgery for acute SDH consists of trauma craniotomy flap is often performed, where by a large opening in the skull is created to evacuate the haematoma and relieve the associated mass effect (centered over the thickest portion of the clot) to:

1. Evacuation of hematoma
2. Decompress the brain
3. Stop any active subdural bleeding.

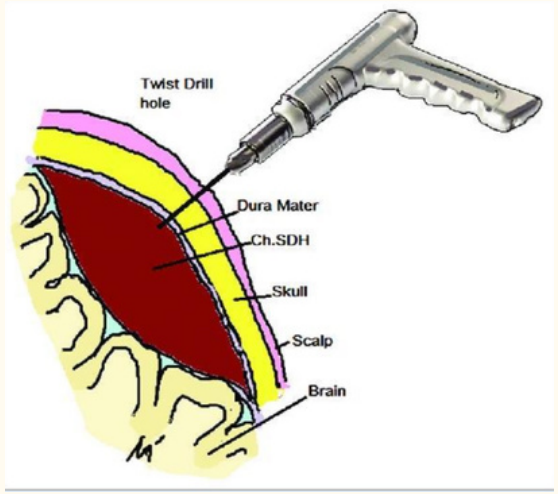
...Management

Surgical :

For chronic SDH, surgical intervention can be either a burr hole craniotomy with irrigation or a twist-drill craniostomy with drain placement. Using a drain has been shown to decrease recurrence rates and mortality without increasing complications.



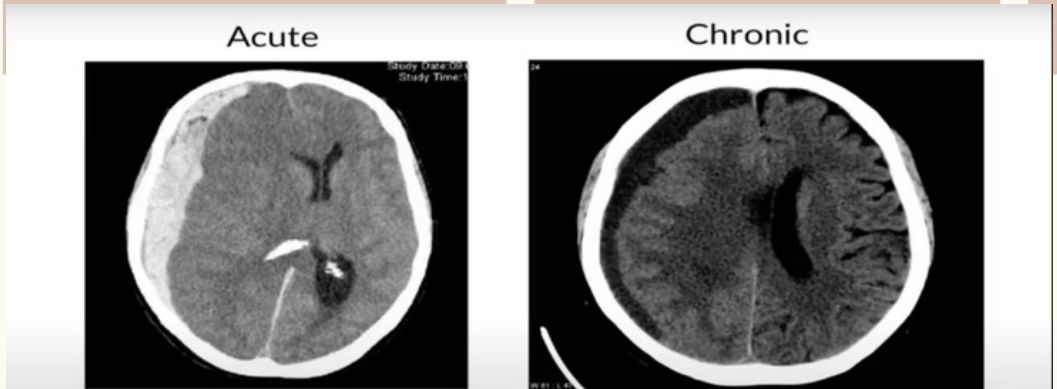
Burr Holes



Twist Drill Craniostomy (TDC)

Classification
-Depending on the length of time between onset of symptoms & the event:

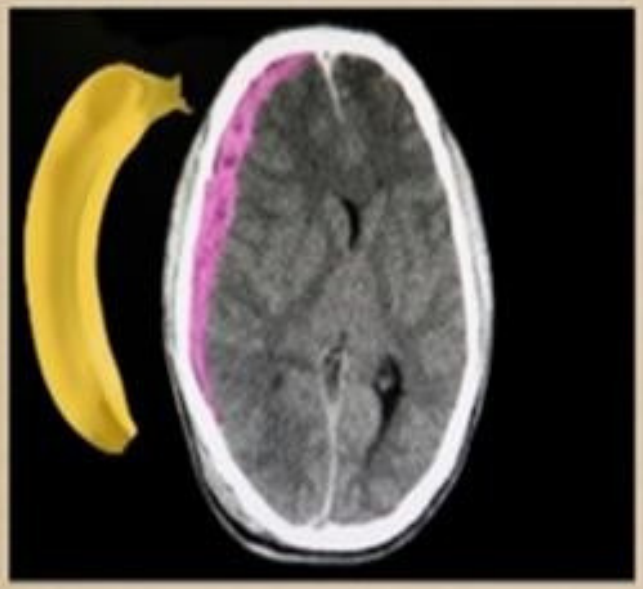
	Acute	Subacute	Chronic
Duration to symptom onset	**Within 3 days**	**4- 20 days**	**≥21 days** **-associated with mild trauma –** **alcoholic – elderly**
CT	**Hyperdense** compared to the brain	**Isodense** compared to the brain	**Hypodense** compared to the brain



EDH VS SDH

EDH	SDH
Usually Mild trauma	Usually Sever trauma
Associated with lucid interval	Mainly NO Lucid interval □ persistent coma
Mild brain injury	Sever brain injury
Usually unilateral	Usually bilateral
Early surgery is successful	Worse outcome (high mortality)
--	Slower progression
--	More common

Subdural Hematoma



- Concave/Crescent-Shaped
- Bridging Veins
- Elderly, Alcoholics

suB = Banana

Epidural Hematoma

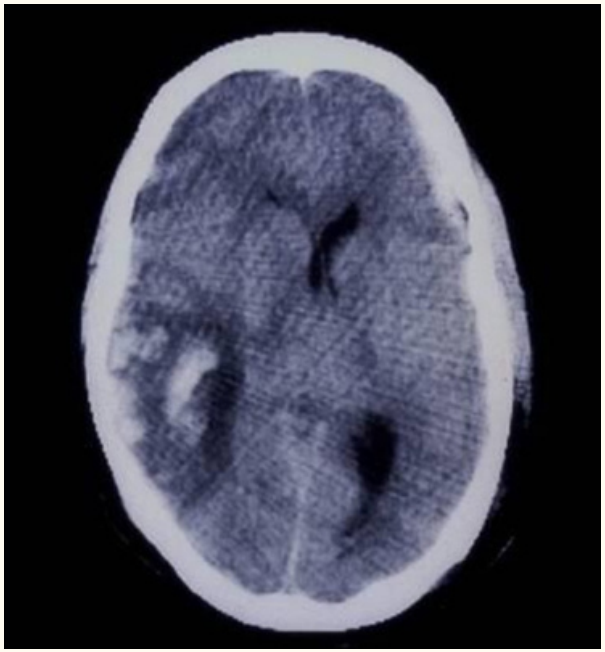
- Convex/Lens-Shaped
- Middle Meningeal Artery
- "Lucid Interval"

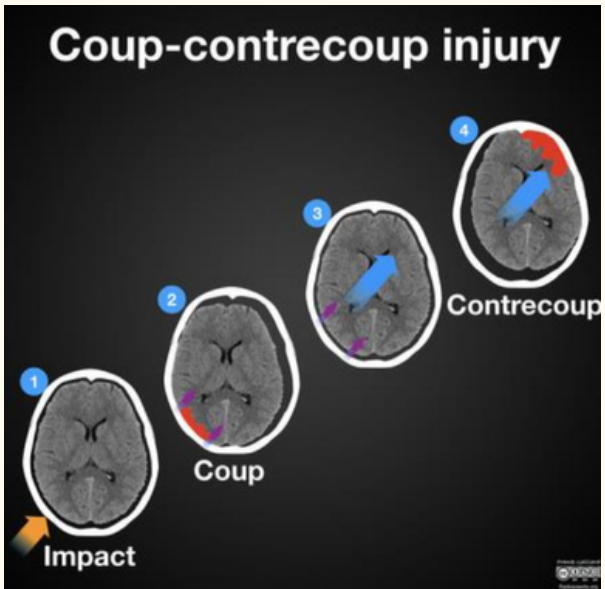
Epi = Pie = Lemon

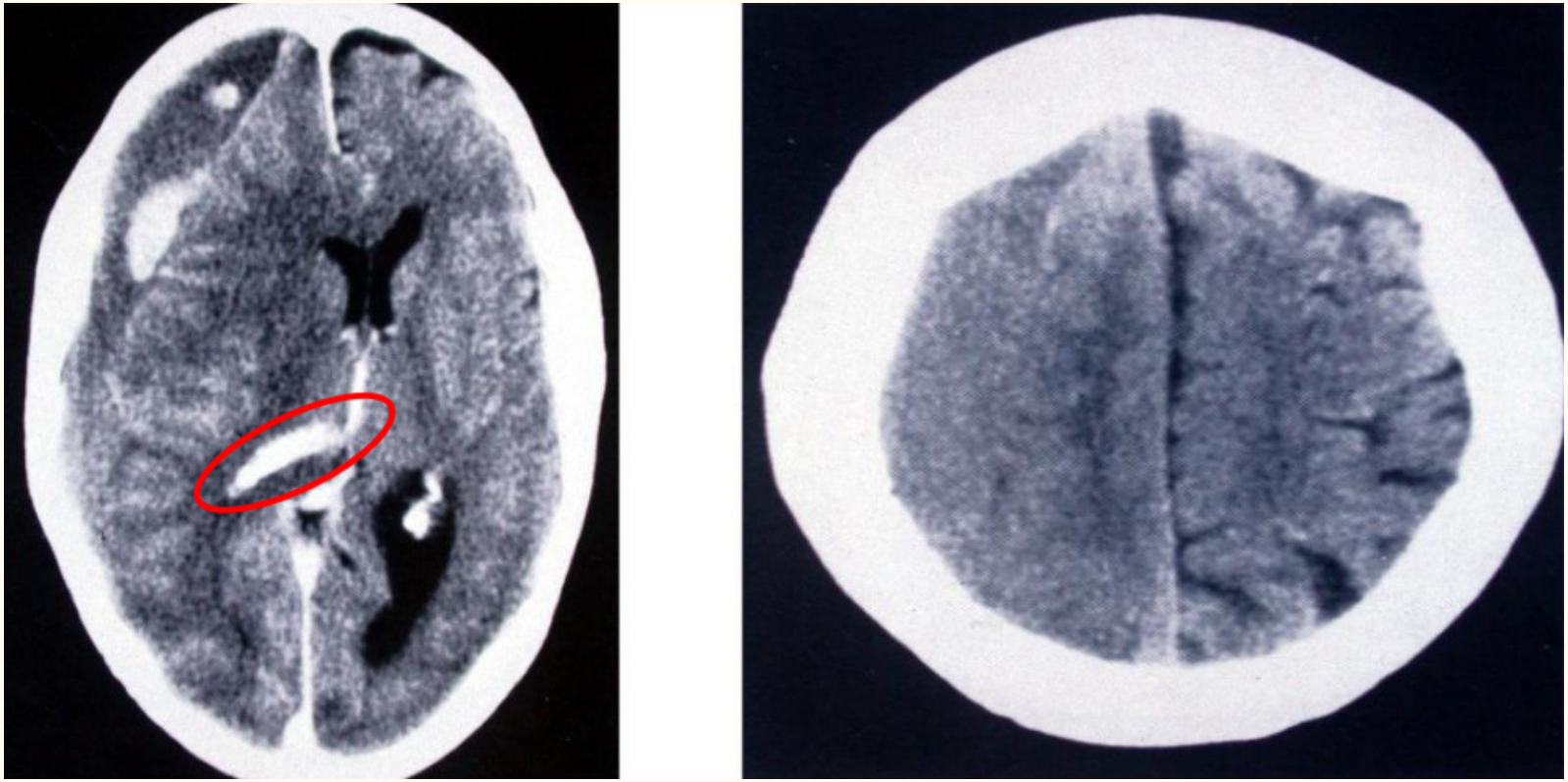
FOCAL Cerebral contusion: intracerebral hematoma ICH

- Area of focal tissue injury. Neurological deficit depends on area injured.
- Commonly occur in coupe/contra coupe pattern
  eg. frontal /occipital
- 20% of contusions may expand into surgical hematoma

- Management: Observe patients in ICU, repeat head CT scan within 24 hours







- Hyperdense foci of hemorrhage

ICH

Management of traumatic brain injury
Prehospital care

- ABC's (Airway, breathing, circulation).
- Fluid resuscitation to reverse shock, hypotension.
- Spine precautions:

5-10% of head trauma patients have unstable spine injury.

•Initial evaluation and resuscitation;

Rapid neurological examination (1-3 minutes)

Assess GCS, pupil function, doll's eyes, cough, gag & corneal reflex

• Empiric management of elevated ICP;

Intubations , ventilation, sedation, mannitol, head elevation

• Secondary injury survey;

Examine head, ears, eyes, nasopharynx, mouth for injury, facial fractures

C-spine x-rays

Evaluate for peripheral injury

• STAT head CT scan ;

Diagnostic procedure of choice for all patients with suspected traumatic brain injury

• Repeat neurological exam frequently

Definitive management of traumatic brain injury:

- Immediate surgery for evacuation of hematoma, if necessary.
- Monitor ICP with implanted pressure gauge.
- Medically manage cerebral edema to maintain cerebral perfusion pressure > 70 mmHg .
- Perform serial head CT scans:

As 20% of cerebral contusions may enlarge to surgical hematoma.

Indications for admission:

- GCS below 15.
- Abnormal CT –scan.
- Neurological symp.&signs.
- Difficulty of assessing the patient.
- Other medical conditions: Epilepsy...

Complications of head injury

Early
(within a week)

- Hypoxia
- I.C. haematoma
- Cerebral edema & Herniation
- Early epilepsy
- Electrolytes disturbances
- Meningitis
- Pyrexia

Delayed

- Hydrocephalus
- Late epilepsy
- Post concussion syndrom

Thank you

اللهم لا يهزم جندك