

Brain 

Injury

اللهم علمنا ما ينفعنا، وانفعنا
بما علمتنا، وزدنا علما

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Scalp layers

S : skin

C : connective tissue A:

aponeurosis (galea) L: loose
areolar tissue

P: pericranium(periosteum)

Layers of the scalp

= skin

= connective tissue

= aponeurosis of occipito

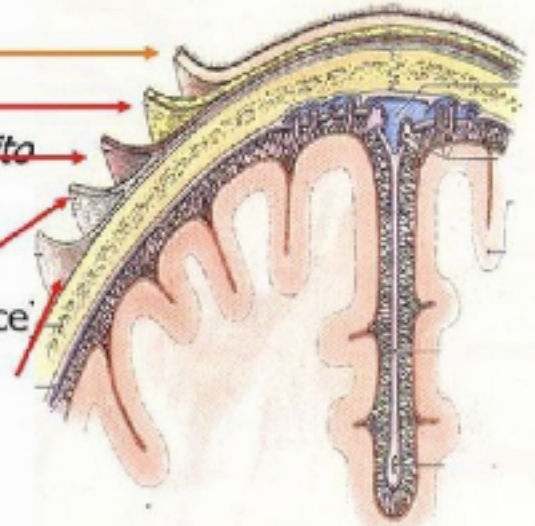
Frontalis

= loose areolar C.T.

(subaponeurotic space)

= pericranium

(periosteum)



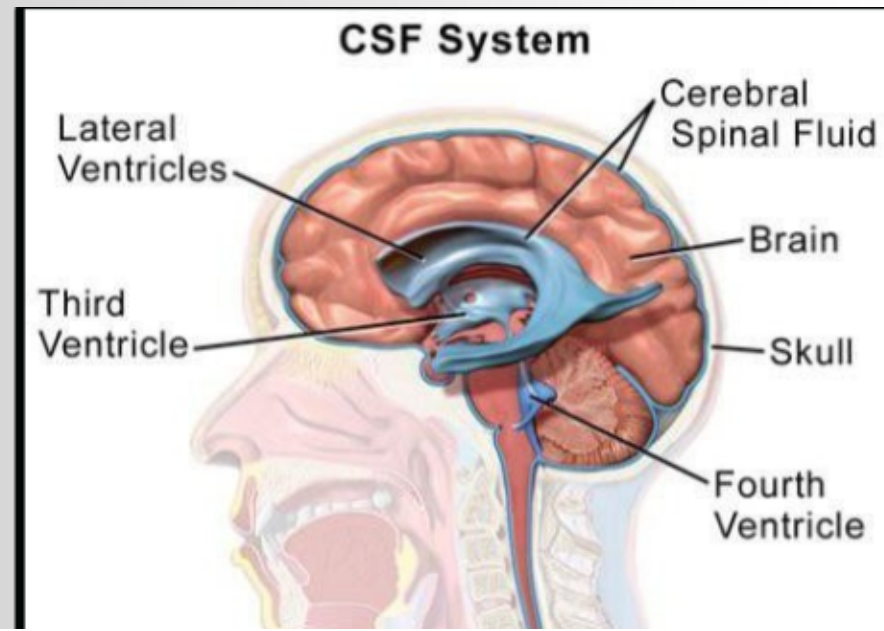
-Bleeding from scalp laceration can result in **major blood loss** especially in **children**.

Cerebrospinal Fluid

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

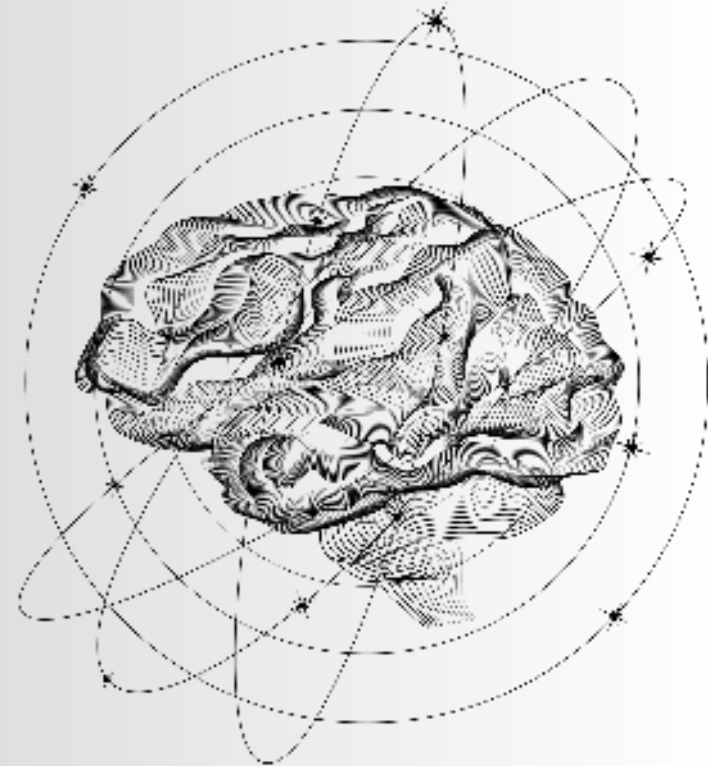
It occupies the subarachnoid space (between the arachnoid mater and the pia mater) and the ventricular system around and inside the brain and spinal cord.

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



Functions of CSF

- Buoyancy (mechanical support)
- Protection (shock absorber)
- Prevention of brain ischemia
- Regulation
- Remove metabolites from the
- CNS



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

- 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**

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



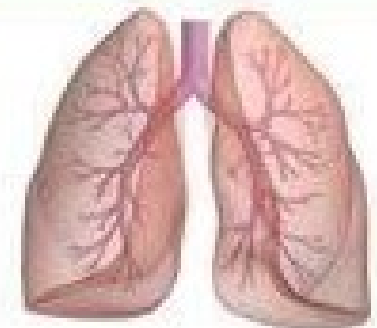
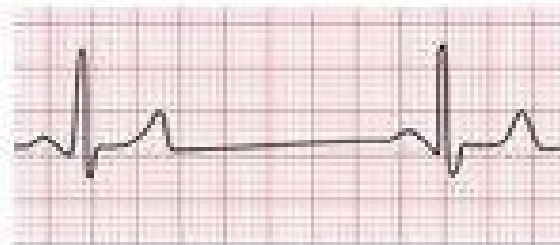
Cushing's Reflex

→ Increased Intracranial Pressure (ICP)

Hypertension

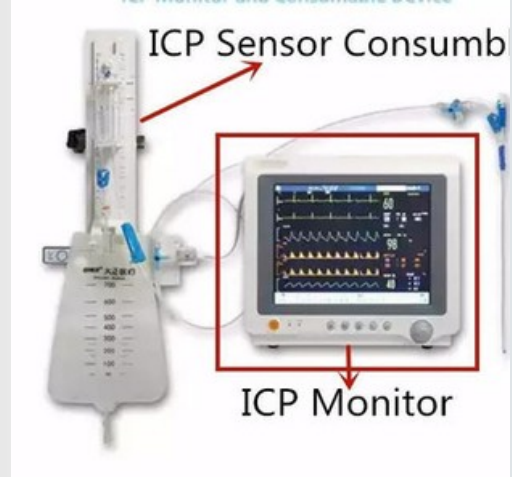
Bradycardia

Diminished
Respiratory Effort



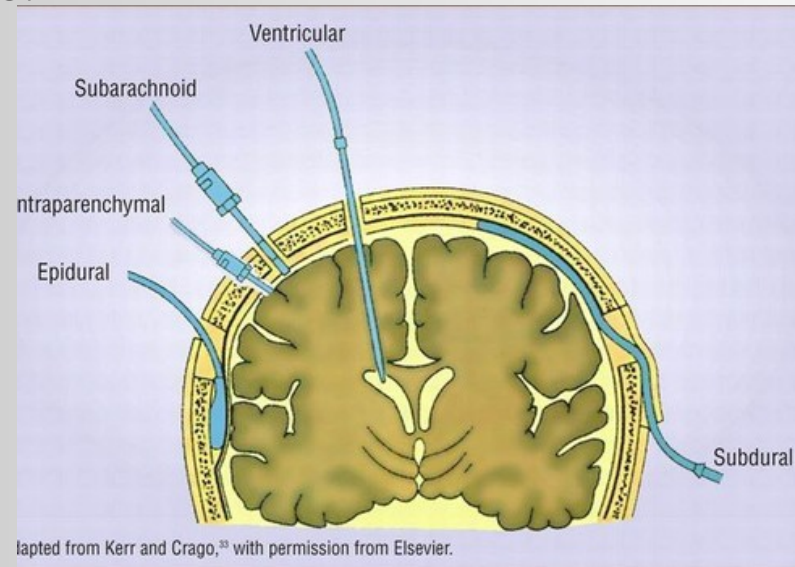
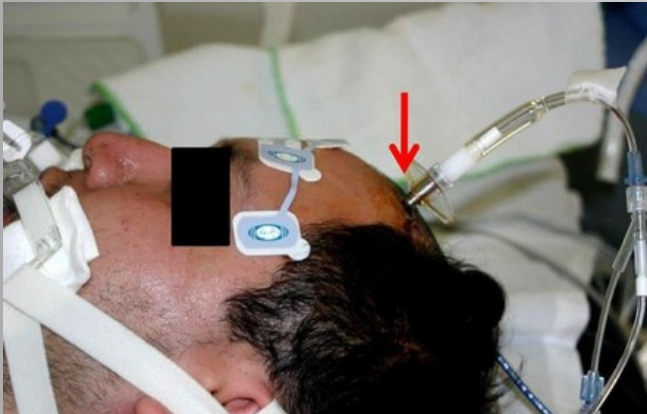
↑BP ↓HR

ICP Monitoring



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

The monitor senses the pressure inside the skull and sends measurements to a recording device.



mechanism
of injury

severity of
the injury
(GCS)

*classification of
head injuries*

morphology
of the injury



mechanism

Penetrating
injury

• Blunt injury

gunshot
wounds

• Low velocity
(fall, assault)

• High velocity
(Automobile)



MORPHOLOGY

Skull Fracture	<ul style="list-style-type: none">• Vault • Basilar	<ul style="list-style-type: none">• Linear vs. satellite• Depressed / nondepressed• Open / closed • With/without CSF leakage• With/without nerve palsy
Intracranial lesions	<ul style="list-style-type: none">• Focal • Diffuse	<ul style="list-style-type: none">• Epidural• Subdural• Intracerebral • Mild concussion• Classic concussion• Diffuse axonal injury

Skull fracture

FRACTURE VAULT OF SKULL
(CALVARIA \ CAPE)

BASAL SKULL FR.

Vault and base of skull



a) Bones of the calvarium

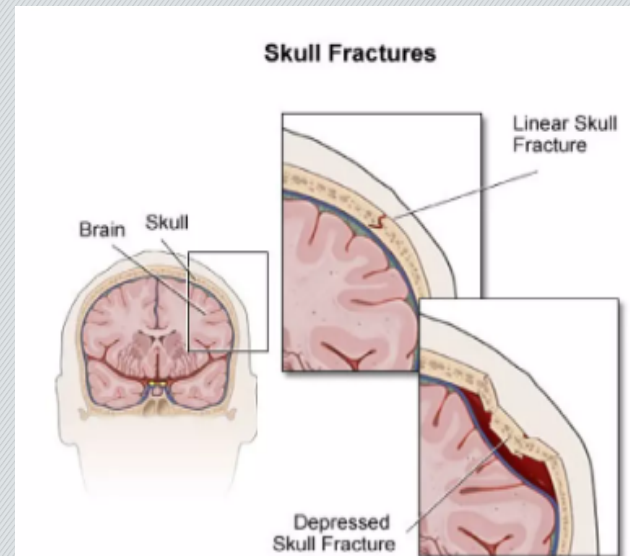
b) Bones of the cranial base

Fracture vault of skull

Fissure fracture :(in a straight line) This is a break in the bone, but the bone does not move out of place.

Depressed fracture A break in your skull that pushes part of the bone closer to your brain

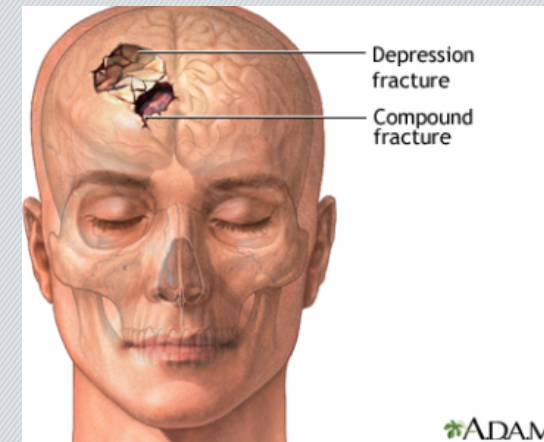
- linear vault fracture increase the risk of an intracranial heamatoma by about **400 times** in a conscious patient and by **20** in comatose patient.
- Fragment depressed more than the thickness of the skull require surgical elevation



Fracture vault of skull

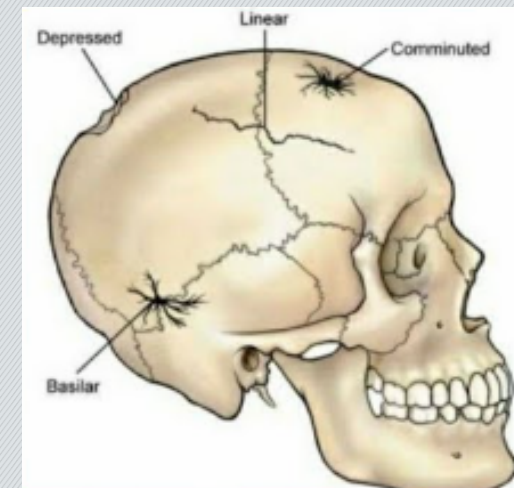
I) Simple fracture :(closed fracture) , not associated with scalp wound.

- This may be: 1. Fissure fracture. 2. Depressed fracture.



II) Compound fracture: (opened fracture) associated with a scalp wound.(has the potential for serious infection)

- This may be: 1. Fissure fracture. 2. Depressed fracture.



Clinical picture

Simple fissure fracture:

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

Simple depressed fracture.:

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

Compound fracture:

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

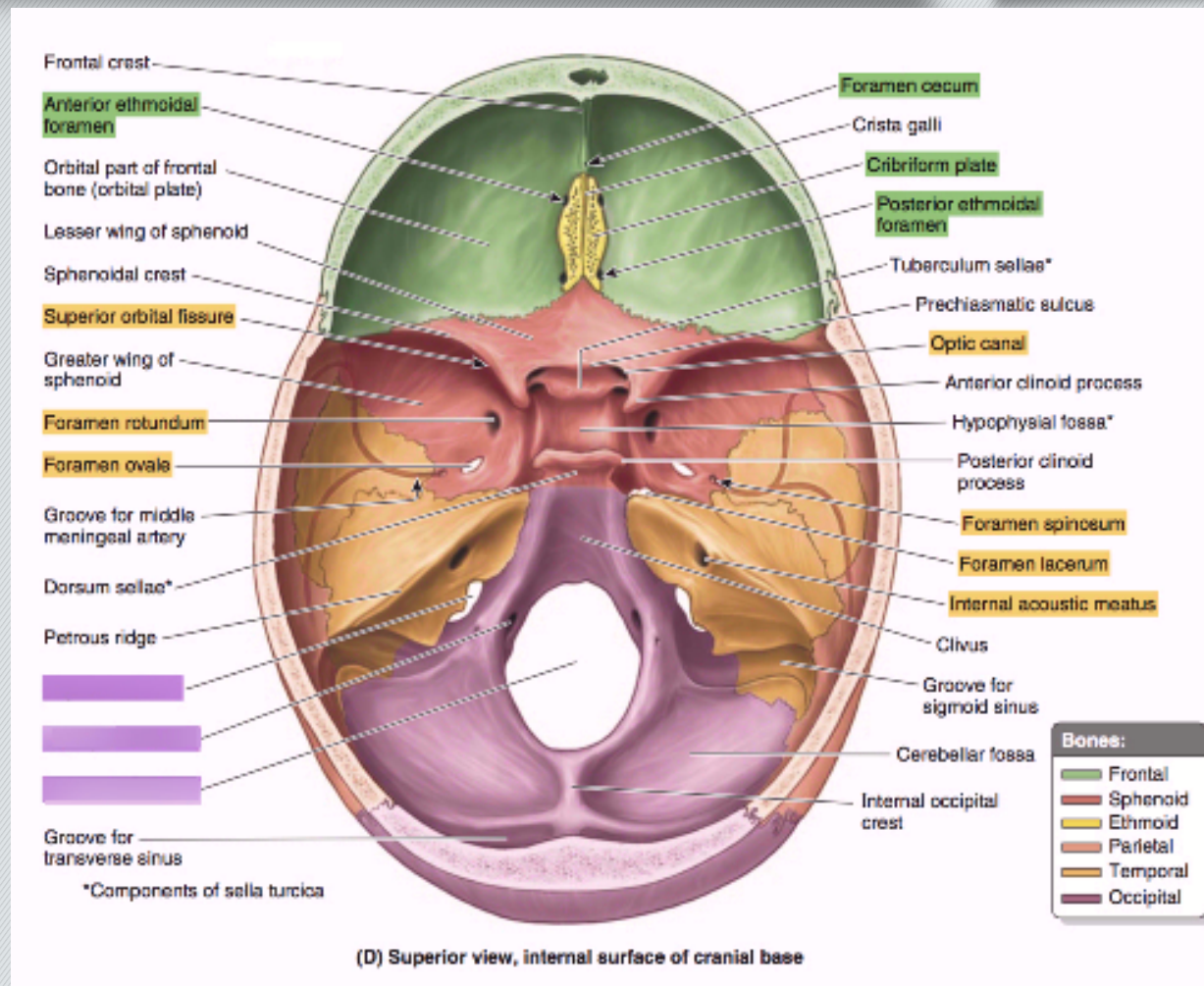
- Open or compound skull fracture require early surgical repair

Basal skull fracture

- A) Usually due to indirect trauma to the vault, face or chin.
- B) Direct trauma: Rare, through the nose, mouths, orbit

Note :The base of skull is rigid and weakened by multiple foramina

→Fracture base is irregular fissure running between these foramina

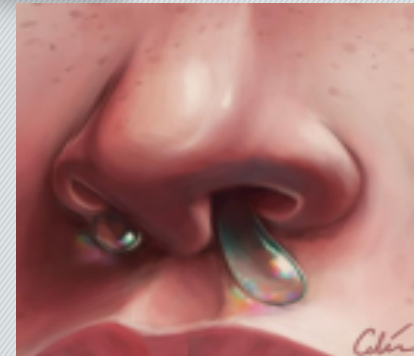


anterior cranial fossa fracture:

1.- **Epistaxis**

2.- **rhinorrhea**: CSF leakage from the nose

3. **Periorbital ecchymosis** → Panda or raccoon sign.



• Cranial nerves injury :

▪ The olfactory nerve (1st. cranial nerve)
→ partial anosmia

▪ oculomotor nerve (3rd) (produced dilated fixed pupil)

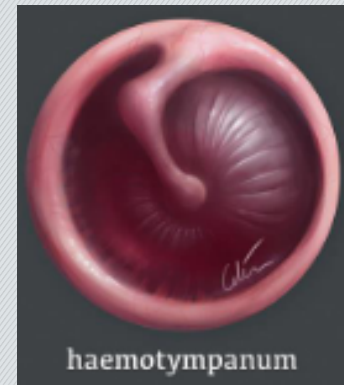


4th, ophthalmic division of 5th and 6th cranial nerves

middle cranial fossa fracture :

1. **(otorrhea)** : Escape of blood and C.S .F from the ear

2. **Hemotympanum** : presence of blood in the middle ear cavity.



3. **(Battle's sign)** Injury of mastoid antrum
discoloration behind the auricle over the
mastoid process



Cranial nerves

: Injury of mandibular and maxillary division
of 5th, 7th and 8th
cranial nerves

posterior cranial fossa fracture :

- . Extravasation of blood → suboccipital haematoma
- . Injury of 9, 10,11, cranial nerves

** COMPLICATIONS of basal skull fracture :

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

Intracranial lesions



Focal

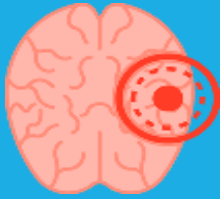
Diffuse (most common type of head injury)

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 axonal damage.

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 hemorrhage ?

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

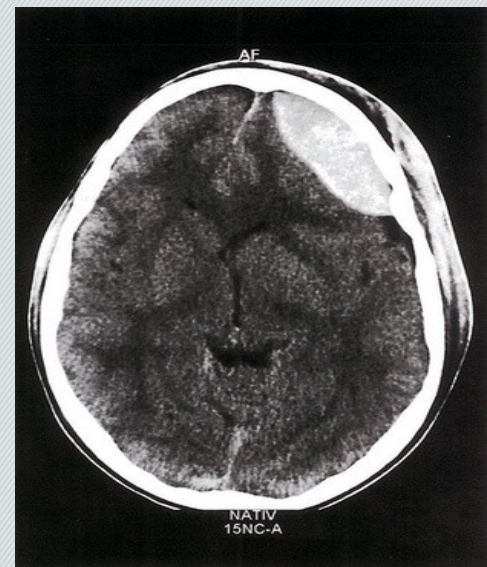
Epidural Hematoma

Is accumulation of blood between the dura matter and skull
Due to rupture 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

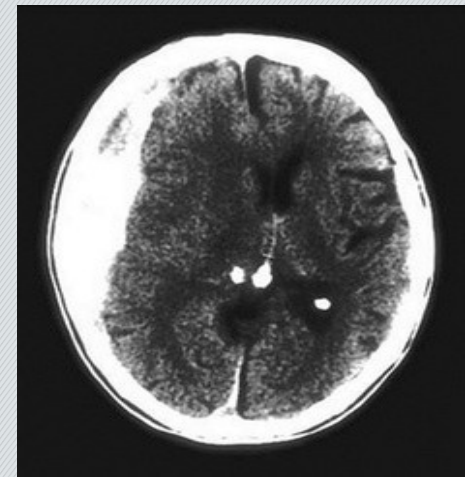
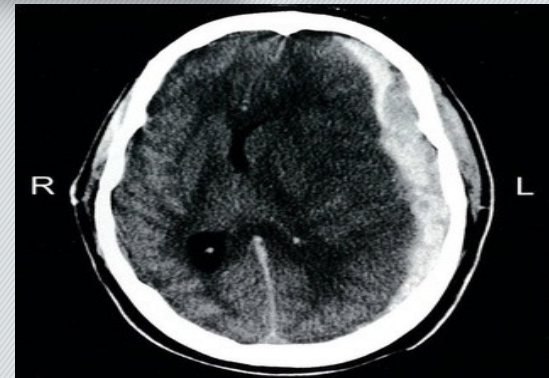
Collection of blood within the subdural space (between dura & arachnoid matter)

- Head trauma → RUPTURE OF BRIDGING VEINS

- multiple veins could rupture 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

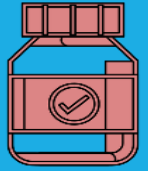


Concave, Crescent-shaped, Hyperdense lesion Crosses the suture line

Signs & Symptoms

1. Altered mental status
 2. LOC
 3. Focal neurological signs
 - (ipsilateral mydriasis - Failure of the ipsilateral pupil to react to light)
 - 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:

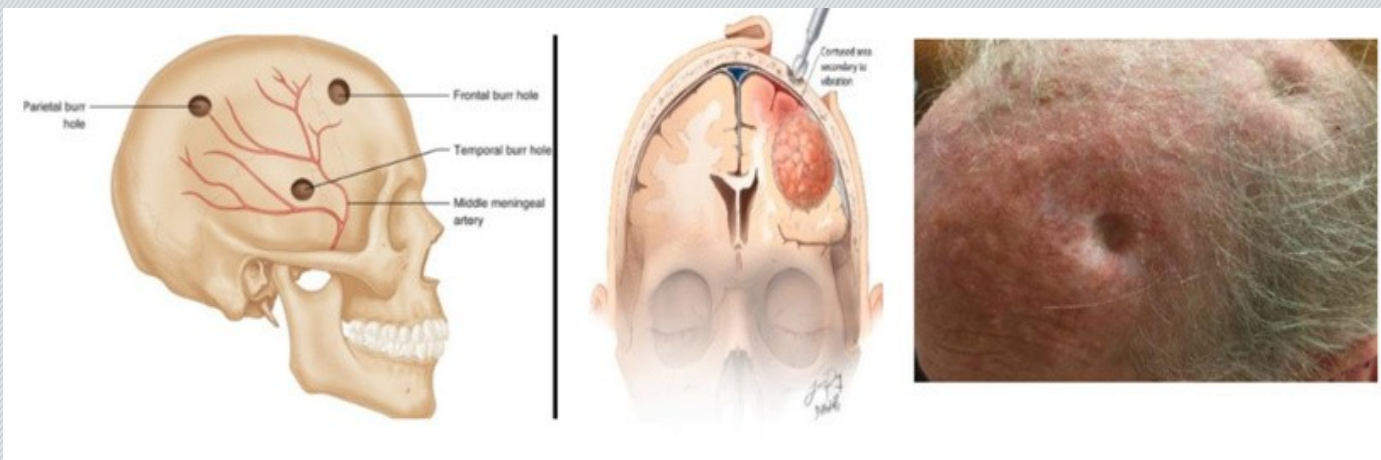
Surgery for acute SDH consists of trauma craniotomy flap is often performed, where by a large opening in the skull is created to evacuate the haematoma and relieve the associated mass effect (centered over the thickest portion of the clot) to:

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

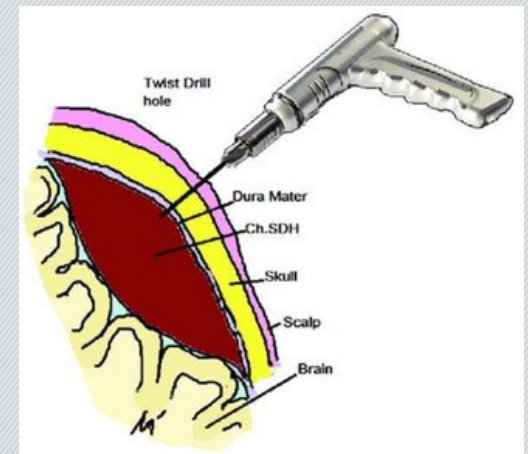
...Management

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)

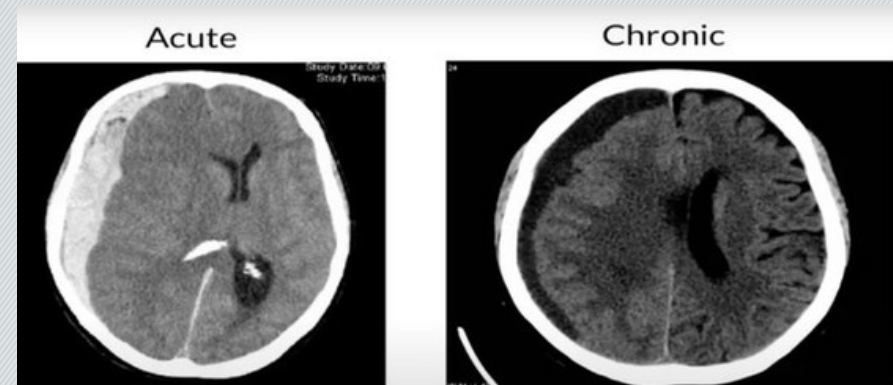
Classification

-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

Hyperdensity on a CT head may be due to the presence of blood, thrombus

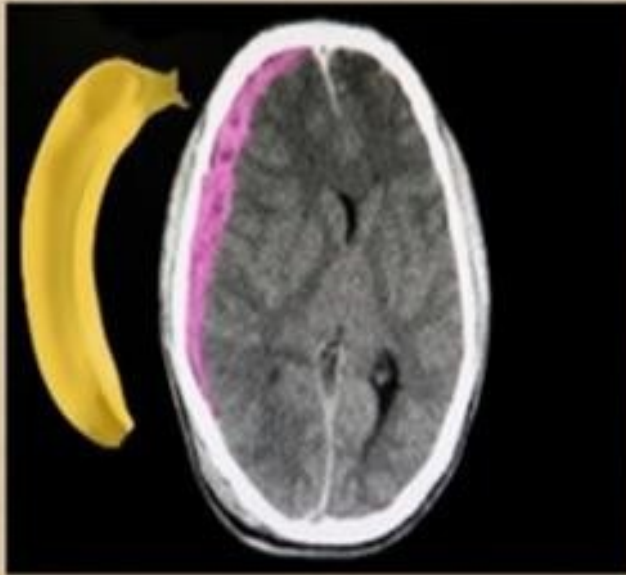
Hypodensity on a CT head may be due to the presence of air, oedema



EDH VS SDH

EDH	SDH
Usually Mild trauma	Usually Sever trauma
Associated with lucid interval	Mainly NO Lucid interval <input type="checkbox"/> persistent coma
Mild brain injury	Sever brain injury
Usually unilateral	Usually bilateral
Early surgery is successful	Worse outcome (high mortality)
--	Slower progression
--	More common

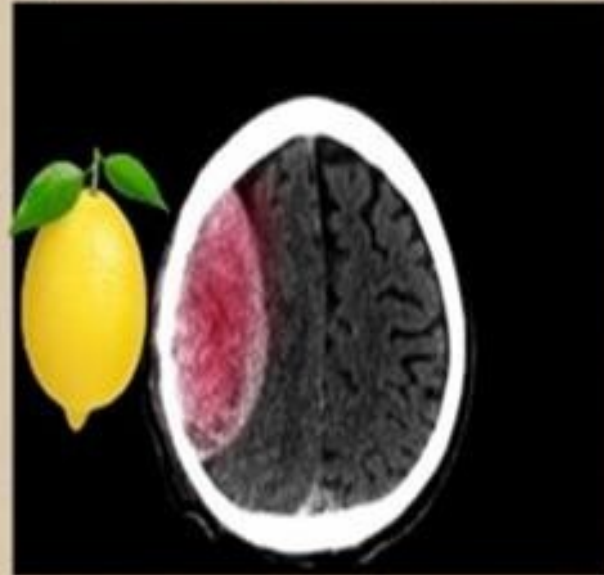
Subdural Hematoma



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

suB = Banana

Epidural Hematoma

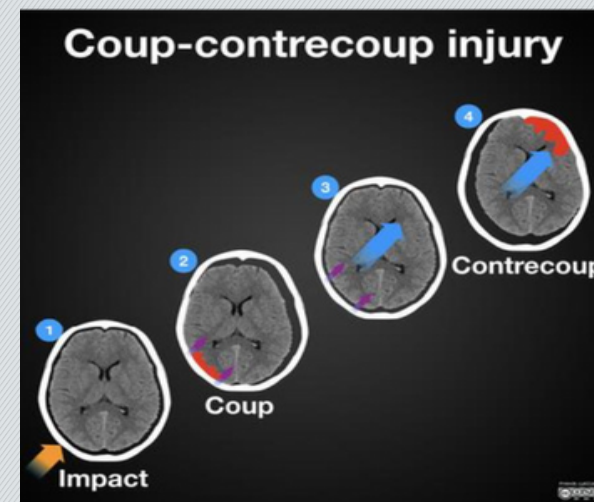
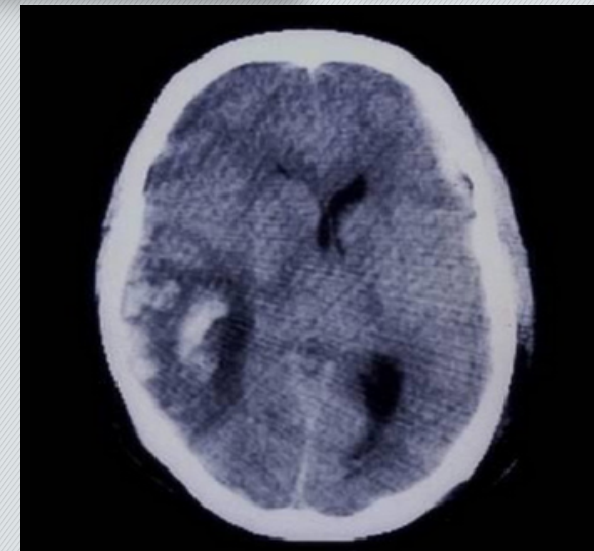


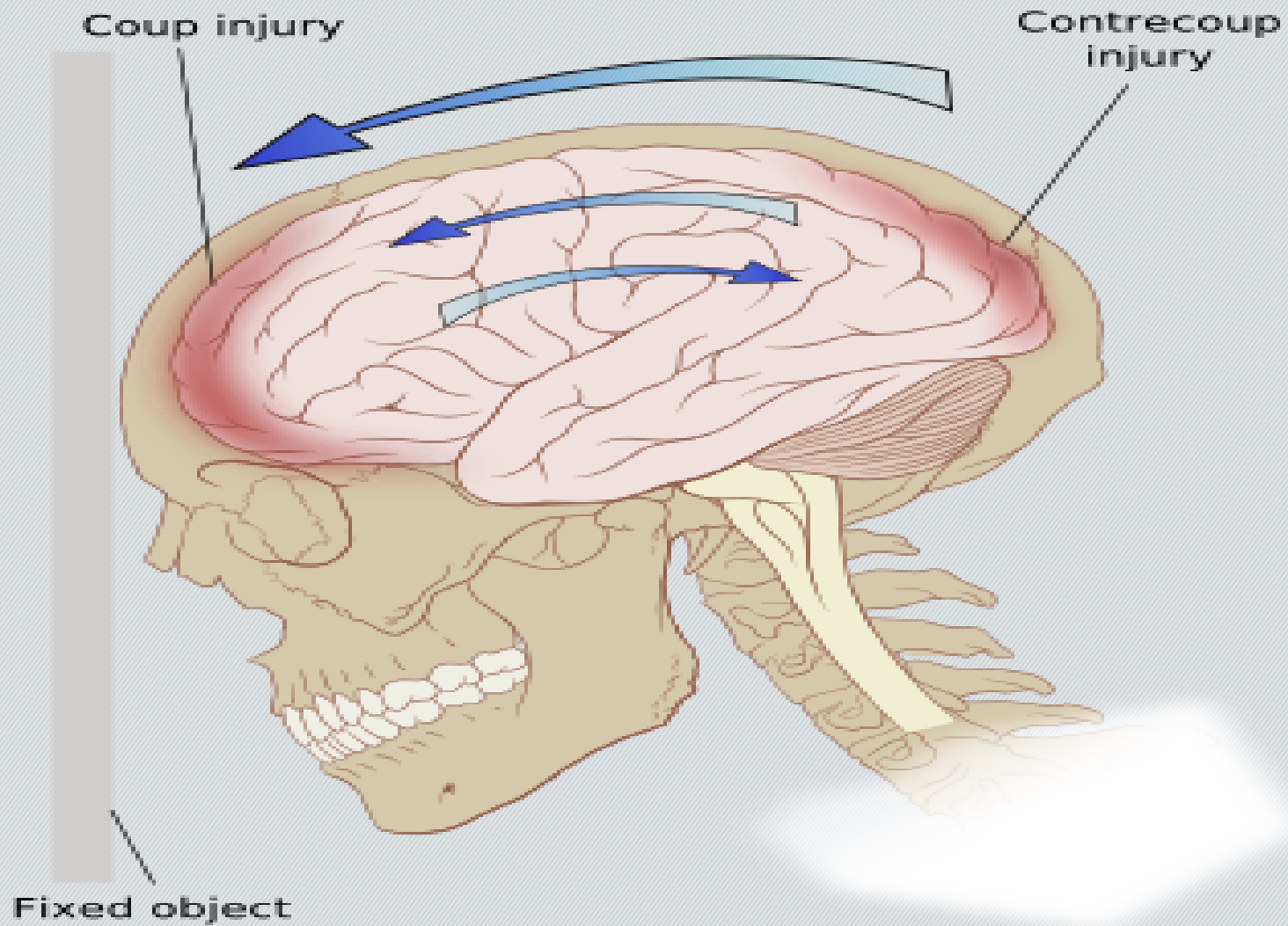
- Convex/Lens-Shaped
- Middle Meningeal Artery
- "Lucid Interval"

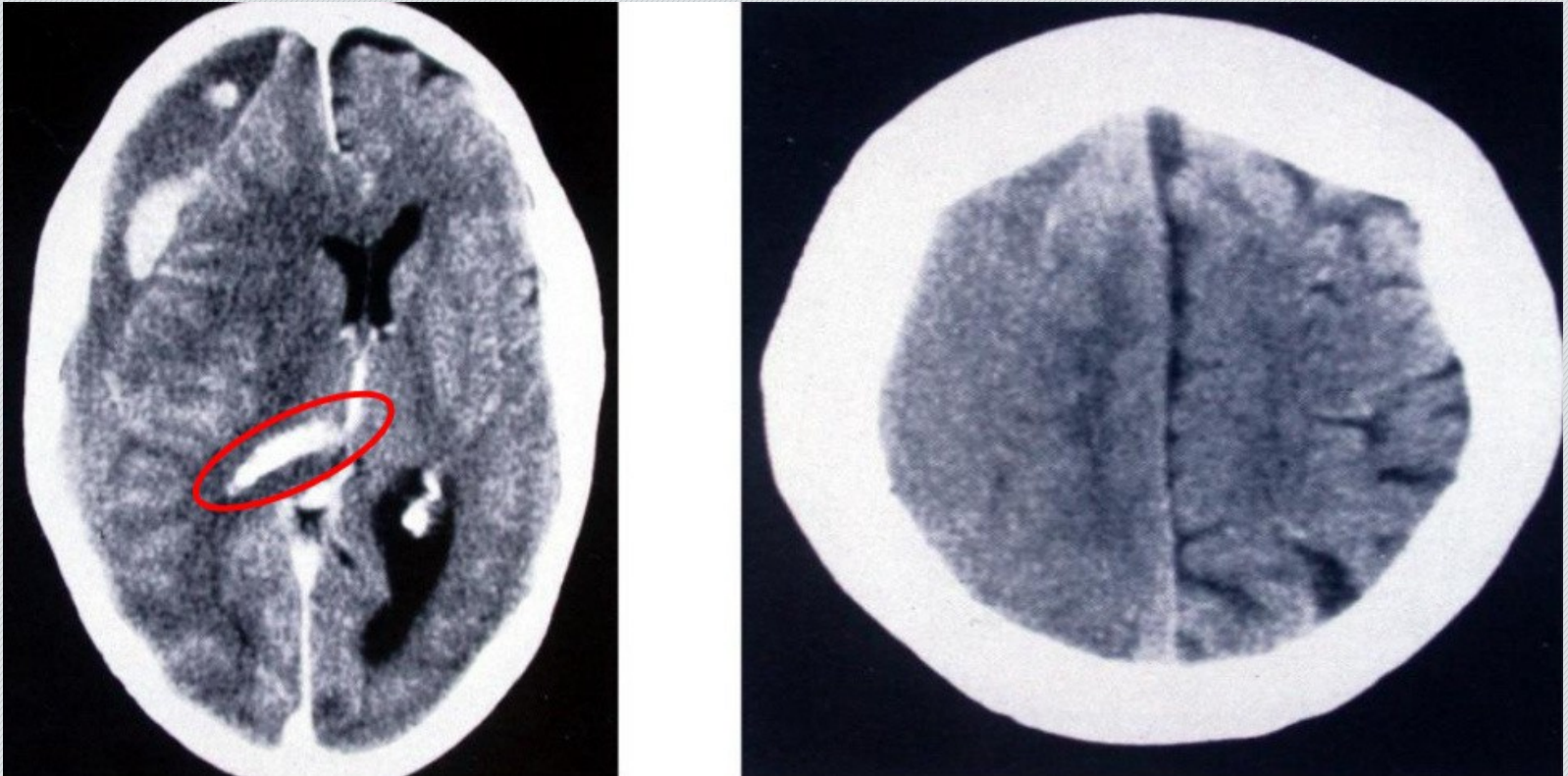
Epi = Pie = Lemon

FOCAL Cerebral contusion: intracerebral hematoma ICH

- A focal cerebral contusion is a type of brain injury characterized by localized bruising of brain tissue. It typically occurs due to trauma, such as a blow to the head or an impact during an accident.
- 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

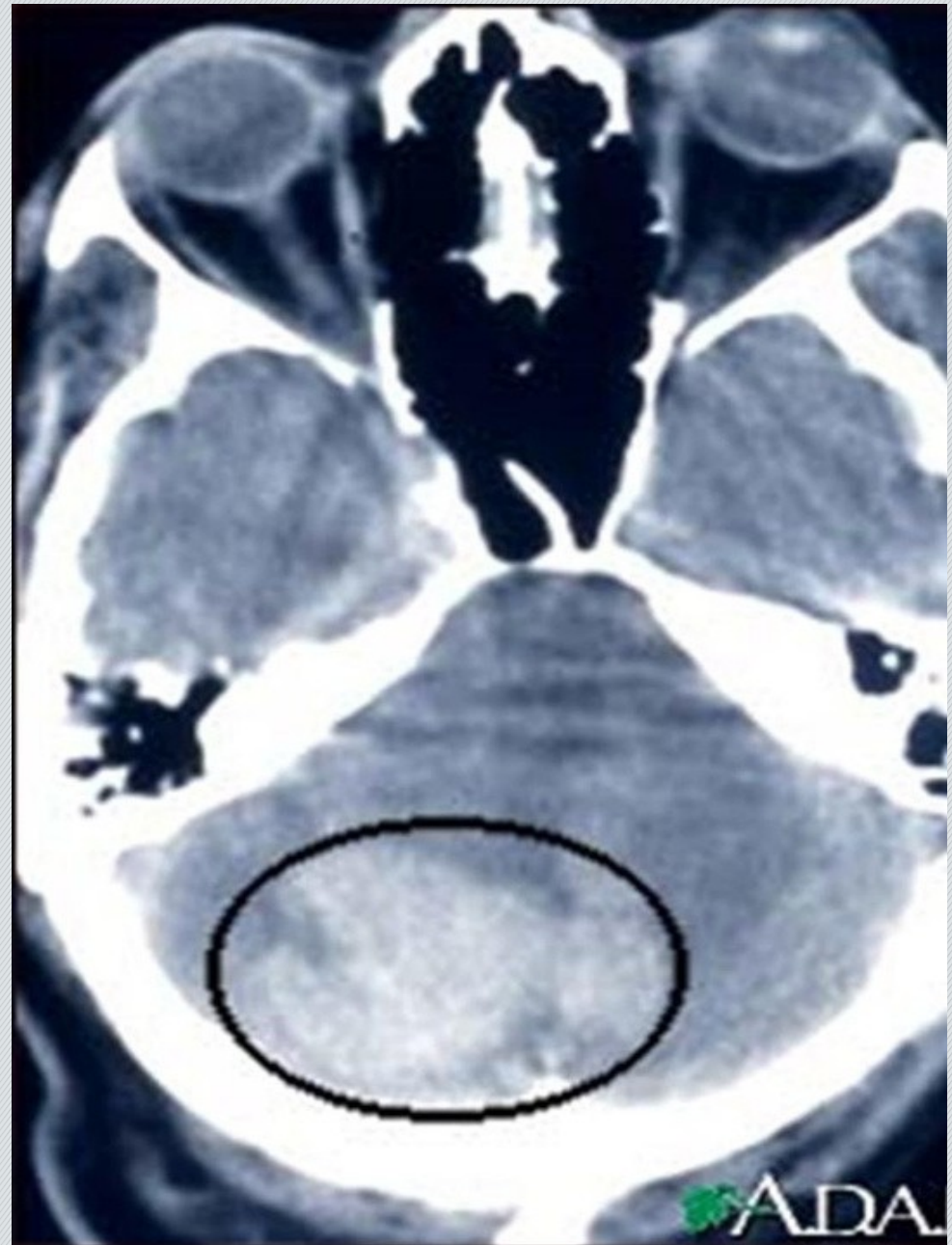






Hyperdense foci of hemorrhage

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

