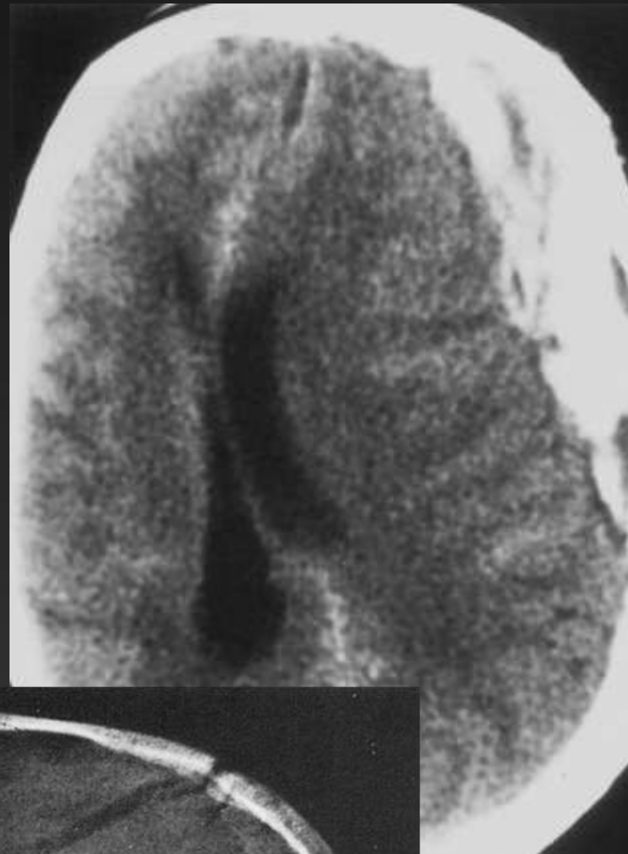
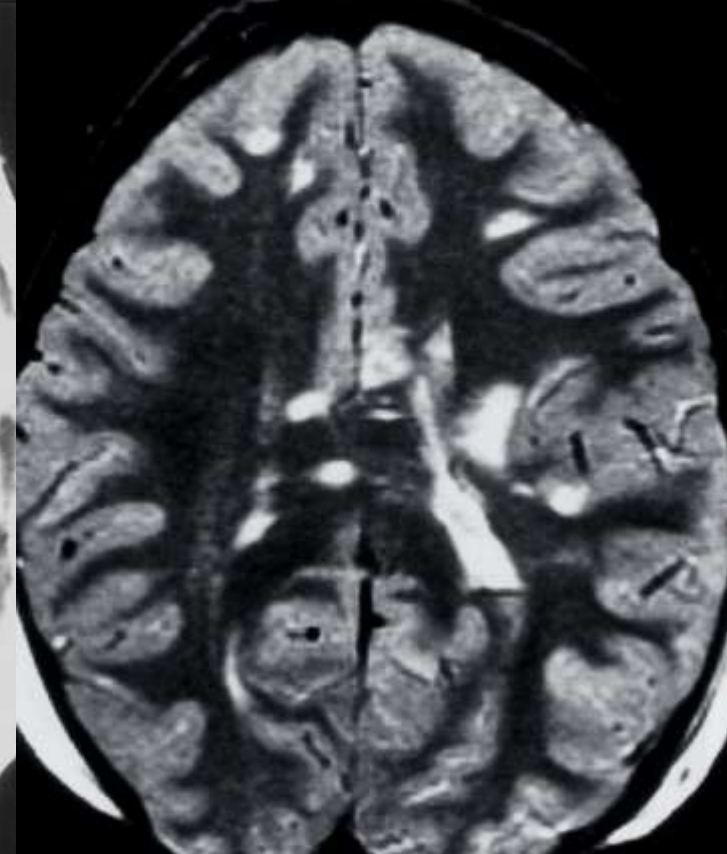
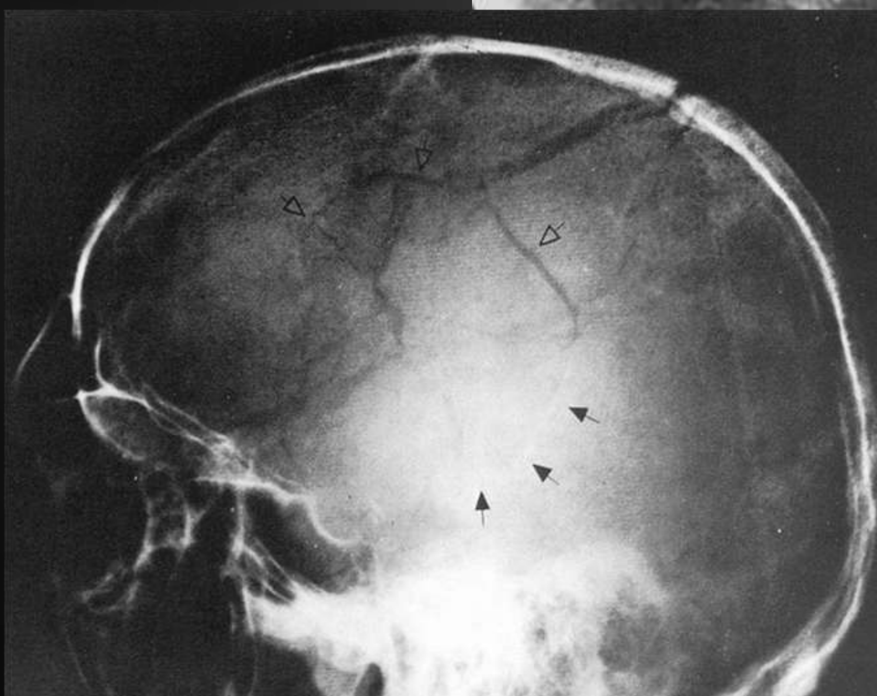






Neuroimaging
(emergency cases)

DRIA A. SUTIKNO

For neurology modul

INTRACRANIAL
SPECTRUM OF DISEASES

- CNS Trauma/ Traumatic Brain Injury (TBI)
- Cerebrovacular disease and nontraumatic hemorrhage
- Infection-AIDS-Inflammatory-Demyelinating and Metabolic Disease
- Neoplasma (Benign, Malignant)
- CF Disturbance
- Degenerative Disorders and Epilepsy

TBI Classification
based on injury mechanism

Closed head injury

- Vastly more common
- Blunt trauma : motor vehicle collision, assault, sport, industrial/workplace accident
- Blast injuries
- Non-accidental injury in children

Penetrating head injury

- High – velocity penetrating brain injury, eg: gunshot injuries
- Low-velocity penetrating, eg: stabbing

TBI Classification
based on GCS

Mild TBI
- GCS 14 - 15

Moderate TBI
- GCS 9 - 13

Severe TBI
- GCS 3 - 8

TBI Classification
based on location and mechanism of trauma

Direct TBI

- Extracranial : scalp & skull
- Intracranial :
  - Extraaxial : EDH, SDH, SAH
  - Intraaxial : ICH, DAI, cortical contusion, IVH

Secondary TBI

- Diffuse cerebral edema, infarct, infexion

IMAGING MODALITIES

- **X ray skull**

Bone, sinus

- **Brain CT scan**

Brain parenchyma, ventricular system, subdural space, and bone

- **Brain MRI**

Nonhemorrhagic lesions, eg: contusions and DAI

X RAY SKU

- Routine
  trauma
- Fracture   rious
- AP and


Original Article

Radiology section

Diagnostic Utility of Conventional Radiography in Head Injury

ABSTRACT

Background: Head injury is the frequent cause of morbidity and mortality and frequently encountered in emergency department. Radiological examination of the skull is an indispensable part in the management of patients suffering from head trauma.

Aim: To determine the accuracy of X-ray in detecting skull fractures, comparing the same with autopsy and CT evaluation.

Materials and Methods: The medico-legal cases that died of traumatic head injury and brought for autopsy over a period of two years were included in the study. Only those cases were selected who had underwent both X-ray and CT evaluation prior to death.

Results: When compared with autopsy, X-ray missed 19.1% of fractures while 11.9% fractures missed in contrast to CT scan.

Conclusion: Skull X-ray is of little benefit when a CT scan is obtained. It has no added advantage over CT scan. Whenever there is facility of CT scan is available, the patient of head injury should not underwent X-ray as it can only delay the diagnosis of an associated intracranial injury and exposes the already traumatised patient to harmful radiations.

Keywords: CT scan, Fracture, X-ray skull

INTRODUCTION

Head injury is a morbid condition resulting from structural changes in scalp, skull and/or contents of the skull, produced by the mechanical forces [1]. It is frequently encountered in road side accidents, assault, fall from height, sports injury, etc. [2]. Head injury creates substantial demand on health services as it is frequent cause of mortality and disability in young individuals. Nearly one quarter to one third of accidental deaths and two third of trauma related deaths are consequent to head injury [3]. Radiological examination of the skull is an indispensable part in the management of patients suffering from head trauma [4]. There has been revolution in the field of radiology with the invention of CT and MRI. Fracture of skull

management of patients in the acute stage of closed head injuries. Axial non-contrast CT scanning is the gold standard technique [8]. While MRI has proved to be more sensitive than CT scan in the detection cerebral pathology, still CT has upper hand in the management of closed head injury patients in acute stage, which is due to its cost effectiveness [8].

In developing countries, the facility of CT scan is not available at large. In India, the primary health centres and peripheral hospitals still lacks the CT scan facility. They largely depend on the X-ray for primary evaluation of head trauma. Even when, the facility of CT scan is available, X-ray skull still being done in routine in conjugation with CT scan. The study was intended to determine the accuracy of X-ray in detecting skull fractures, comparing the same with autopsy and CT evaluation.

MATERIALS AND METHODS

The present study was conducted in tertiary care institute of northern India. The medico-legal cases that died of traumatic head injury and brought for autopsy over a period of two years (September 2009 to August 2011) were included in the study. Only those cases were selected who had underwent both X-ray and CT evaluation prior to death. Victims with massive destruction of head and who had surgical intervention were excluded from the study.

A detailed examination and dissection of the head as per standard forensic autopsy procedure was carried out. After dissecting the scalp, temporal muscles and denuding the periosteum the fractures on outer table were noted down. The cranium was opened with an oscillating saw by making a circular cut round the cranium, a little above the eyebrow ridges, keeping close to the reflected flaps of scalp. After removal of the skull cap, the dura was cut with scissors along the line of sawing and reflected. Brain was removed and then the dura mater

STATISTICAL ANALYSIS

SPSS statistical software version 16.0 was applied to analyse the scientific data. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were determined by using 2 by 2 contingency tables for radiological (X-ray and CT) and autopsy, taking autopsy as gold standard and holding CT scan as gold standard while comparing with X-ray.

RESULTS

Forty-two victims of head injury underwent both X-ray and CT evaluation prior to death. Out of 42 X-ray skulls, 20 (47.6%) showed fracture in skull; while during autopsy, fractures were found in 28 (66.7%) subjects indicating that 19.1% fractures were missed on X-ray [Table/Fig-1]. CT showed fractures in 25 cases which signify that only three fracture were missed on CT scan as compared to

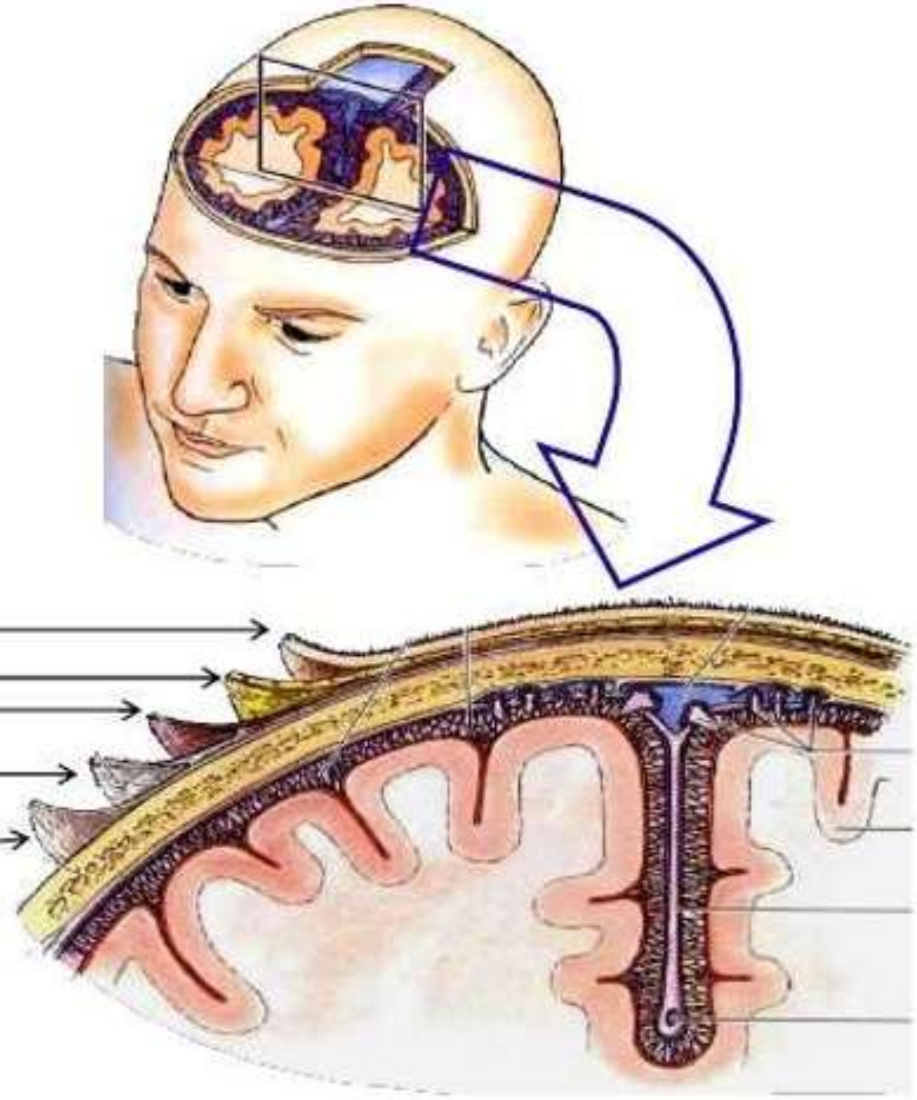
Investigation	No. of cases	Fracture	%	% Missed on X-ray
X-ray skull	42	20	47.6	19.1
Autopsy	42	28	66.7	

[Table/Fig-1]: Comparison of fracture skull [illegible]

Results: When compared with autopsy, X-ray missed 19.1% of fractures while 11.9% fractures missed in contrast to CT scan.

Scalp

- The scalp is a multilayered structure with layers that can be defined by the word itself:
  - **S**-skin
  - **C**-connective tissue (dense)
  - **A**-aponeurotic layer (galea aponeurotica)
  - **L**-loose connective tissue
  - **P**-pericranium



Evaluate:

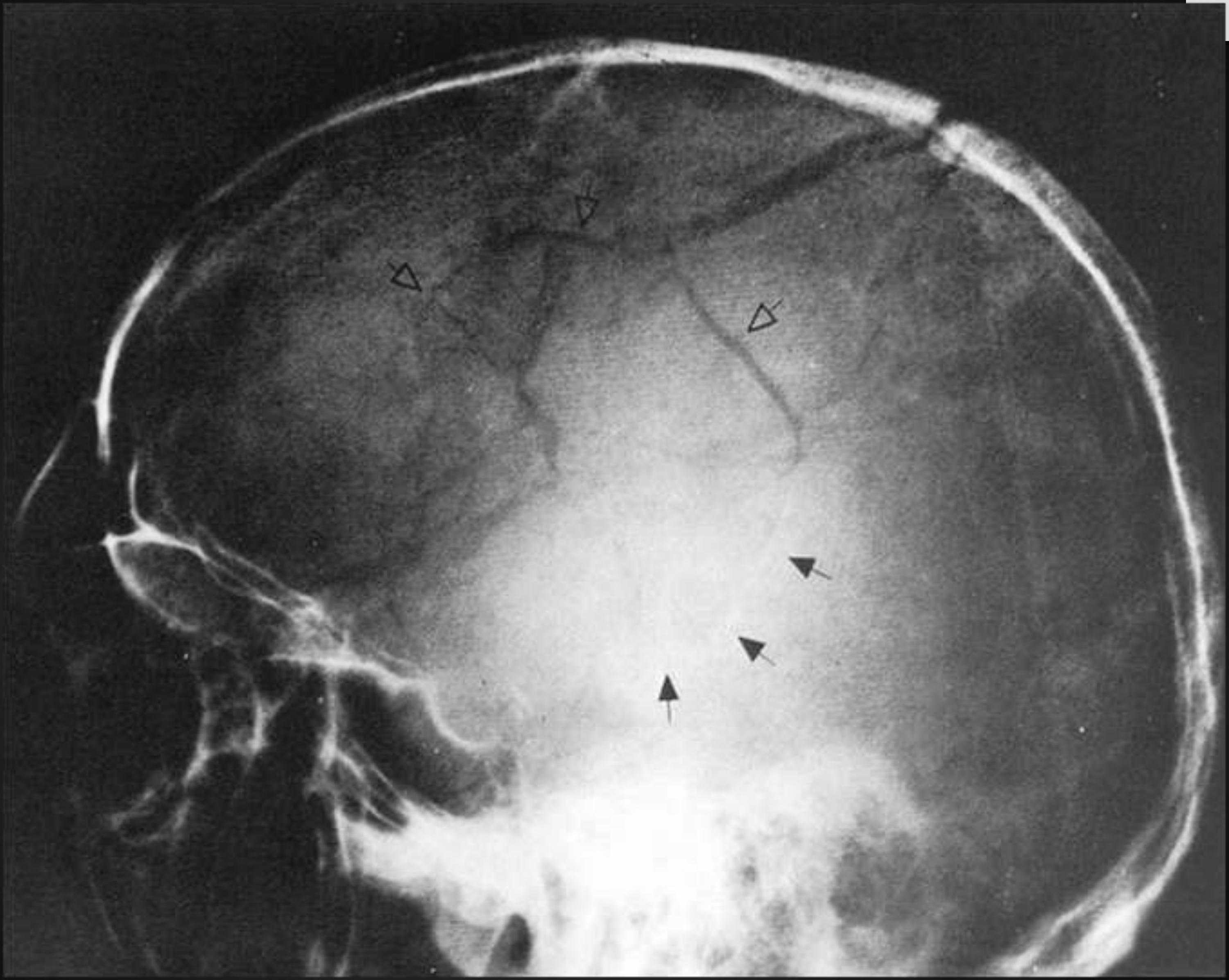
- Fracture.
- Vascular marking.
- Digital/convolutional marking.
- Sella tursica.

fractures

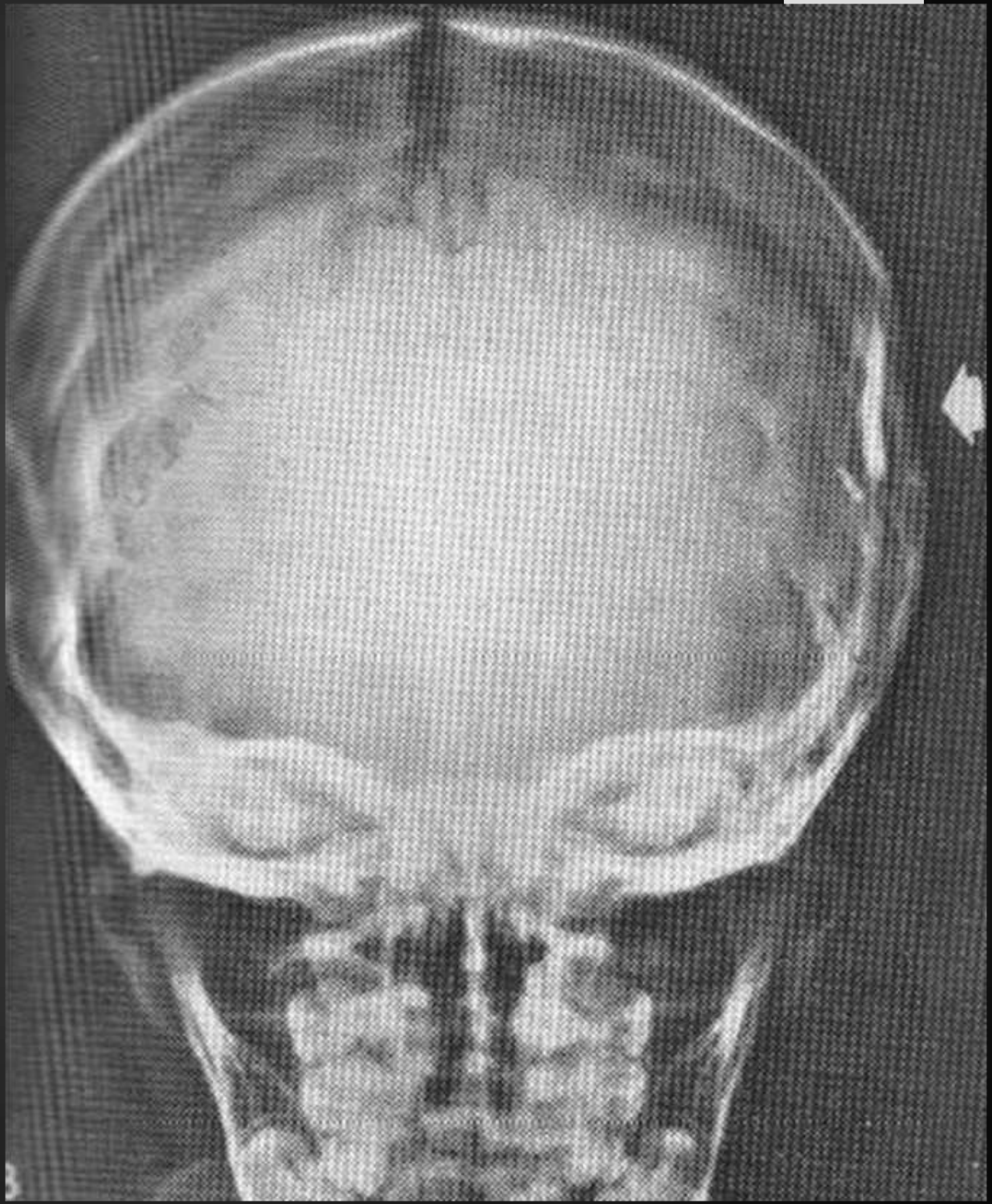
- Fractures may involve the cranial vault, the skull base, or both.
- Types of fracture:
  - Linier skull fracture : Stelata.
  - Impressed/ depressed skull fracture.
  - **Basillar fracture**
  - Diastasis.

Linier skull fracture

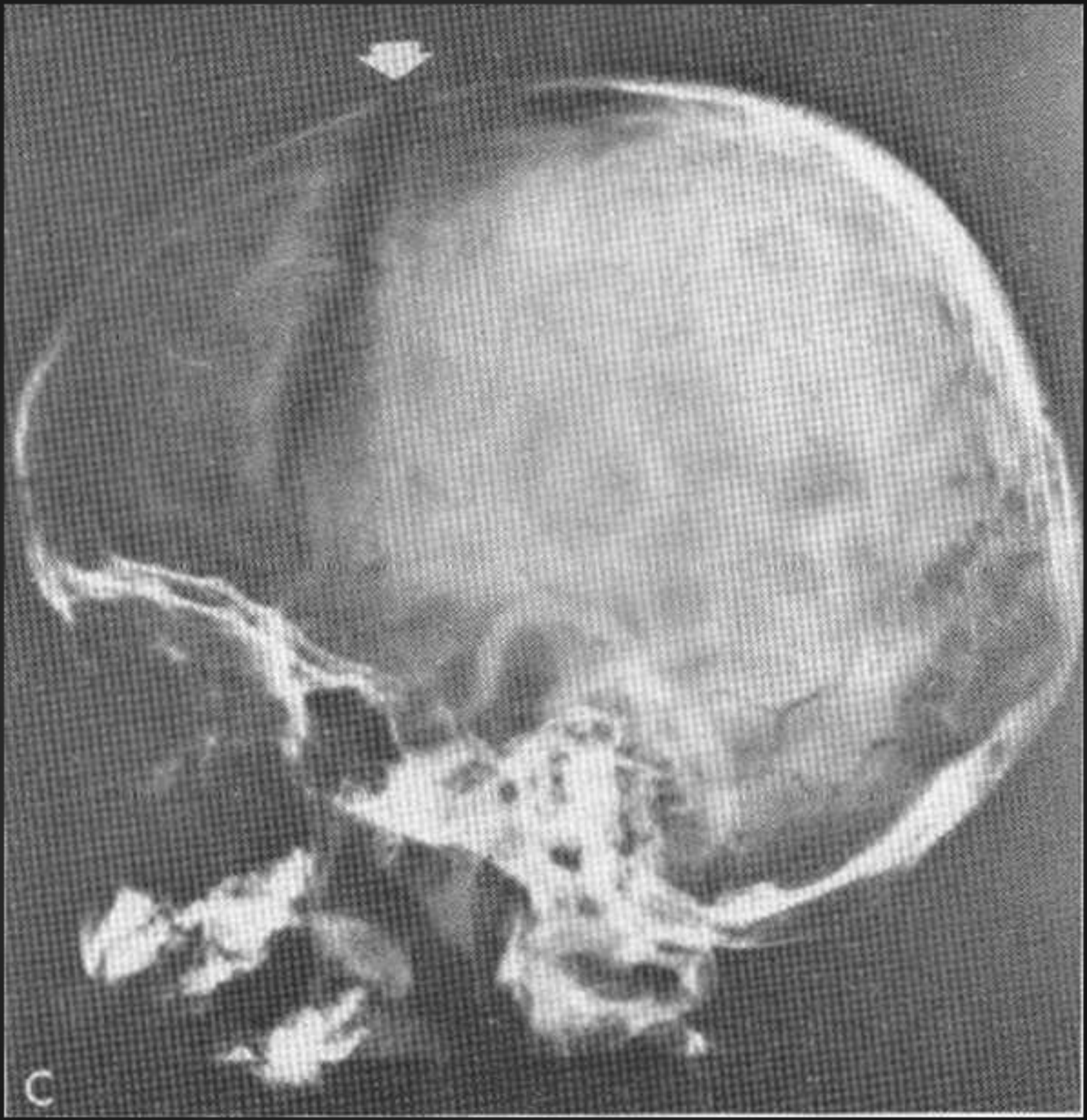
Stelate Fracture



Impressed/ Depressed Fracture



Diastasis Fraktur



Brain CT SCAN

- Modality of choice in acute head trauma
- **Un-enhanced CT (without contrast IV)**, unless there is unexplained mass effect or the scan is normal but the patient is comatose or lethargic or has a persistent neurologic deficit.
- Thin slices (3-5 mm)
- Gantri 360° → x ray → body → detector → images on the monitor

Brain CT SCAN

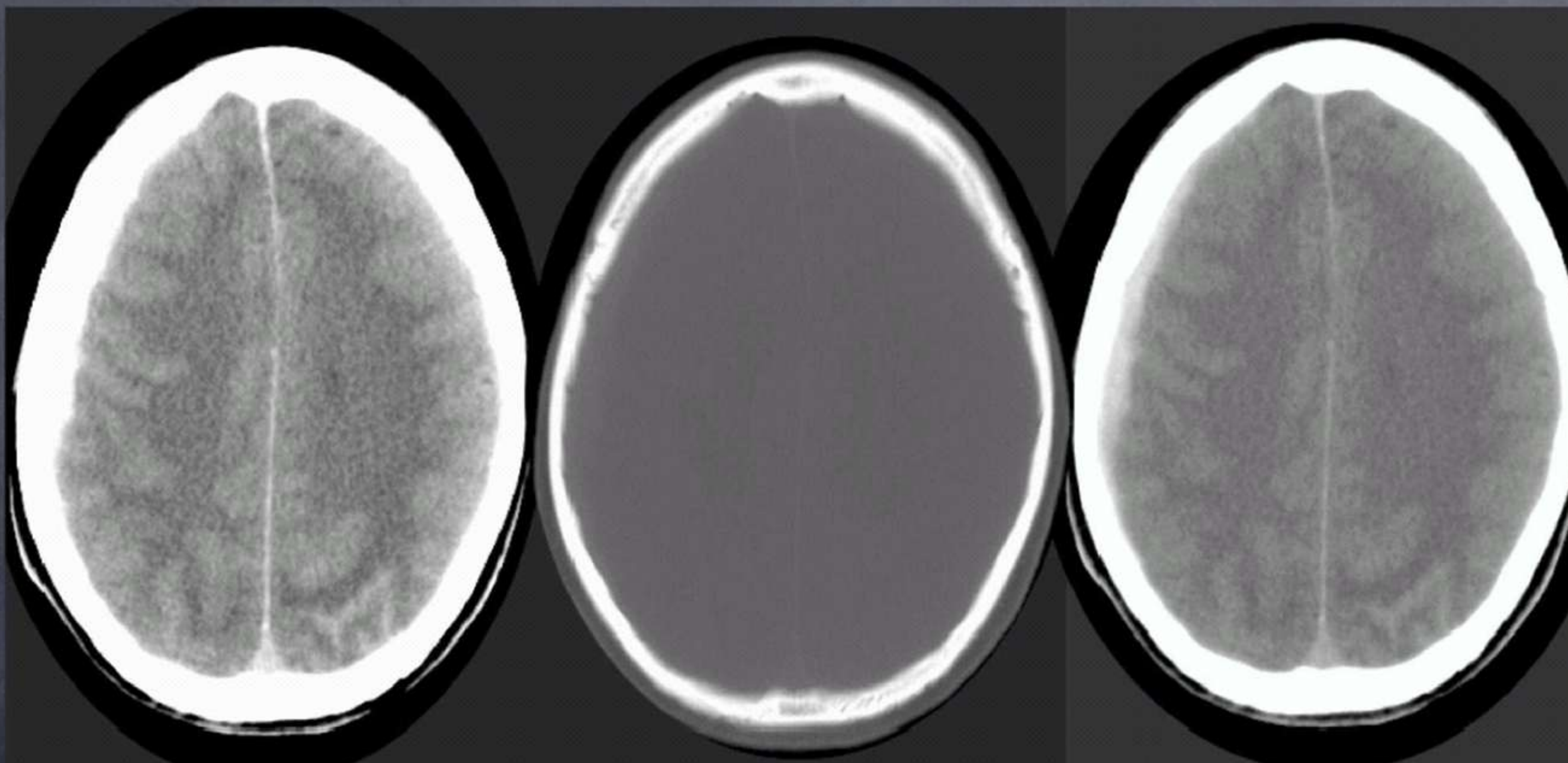
Evaluate:

- Location of hemorrhage
- Brain edema,
- Brain contusion,
- Parenchimal displacement (herniation),
- Ventricular system and subdural space involvement,
- Foreign body.

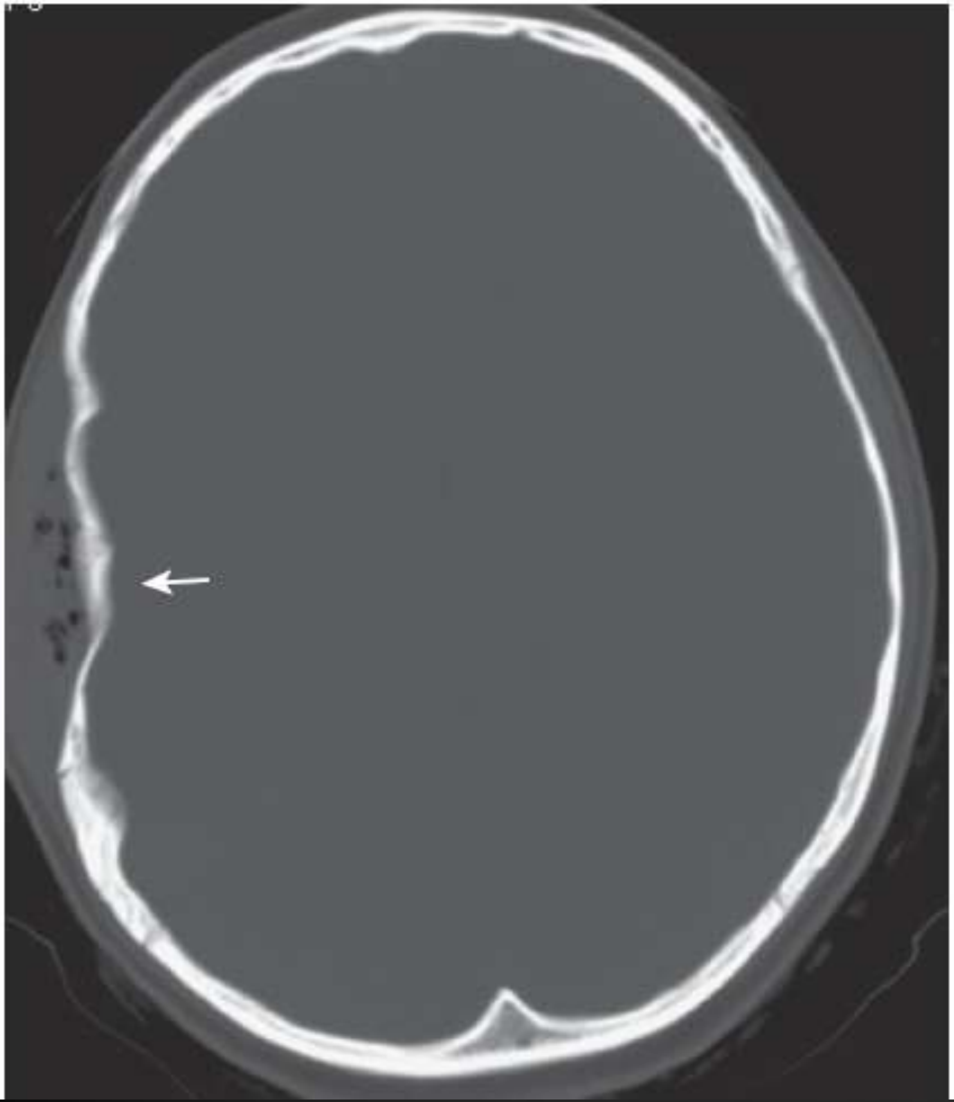

Sensation Cardiac


ORIGIN
Industries

Window

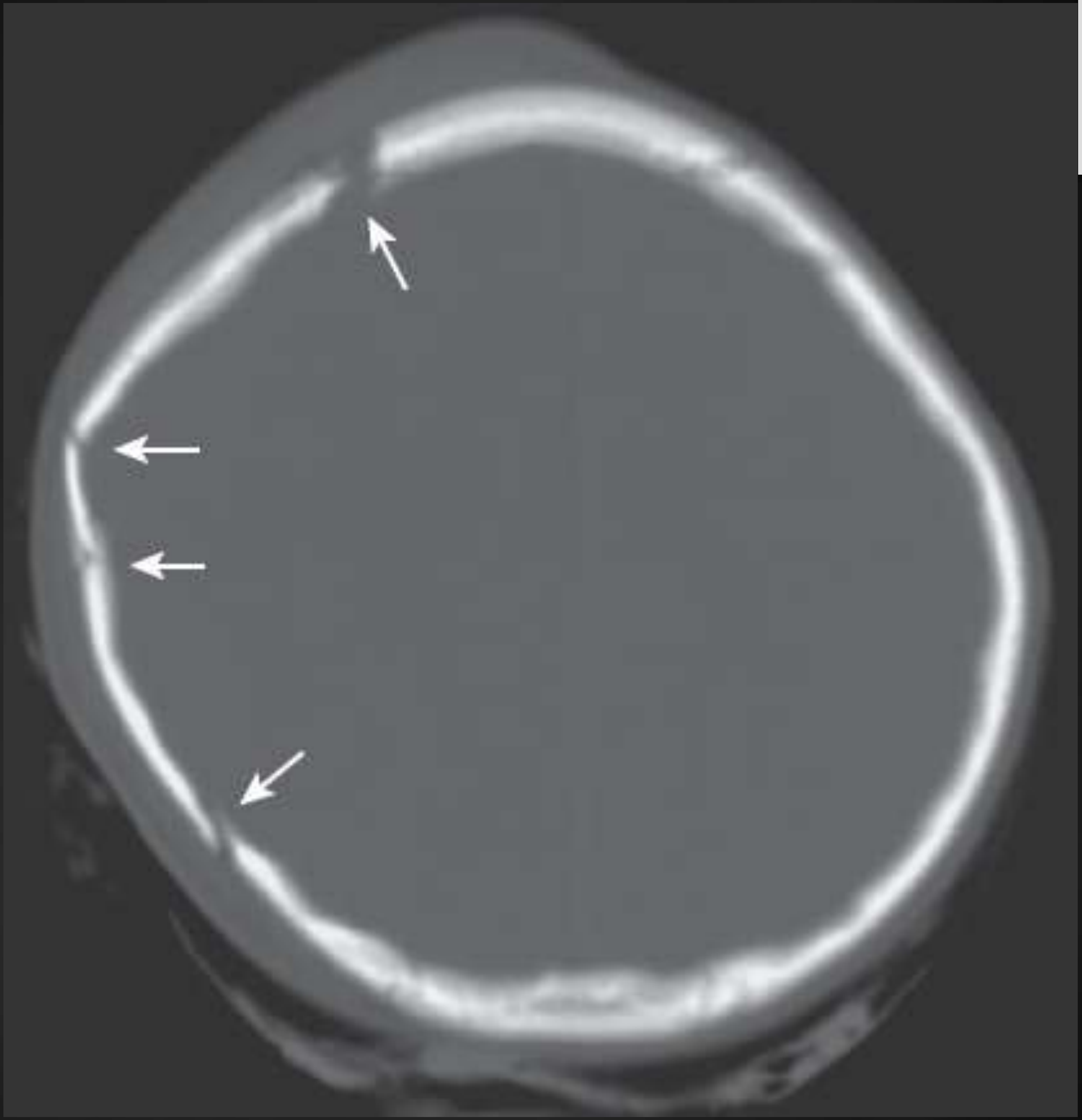


Soft tissue window   Bone window   "Subdural" window

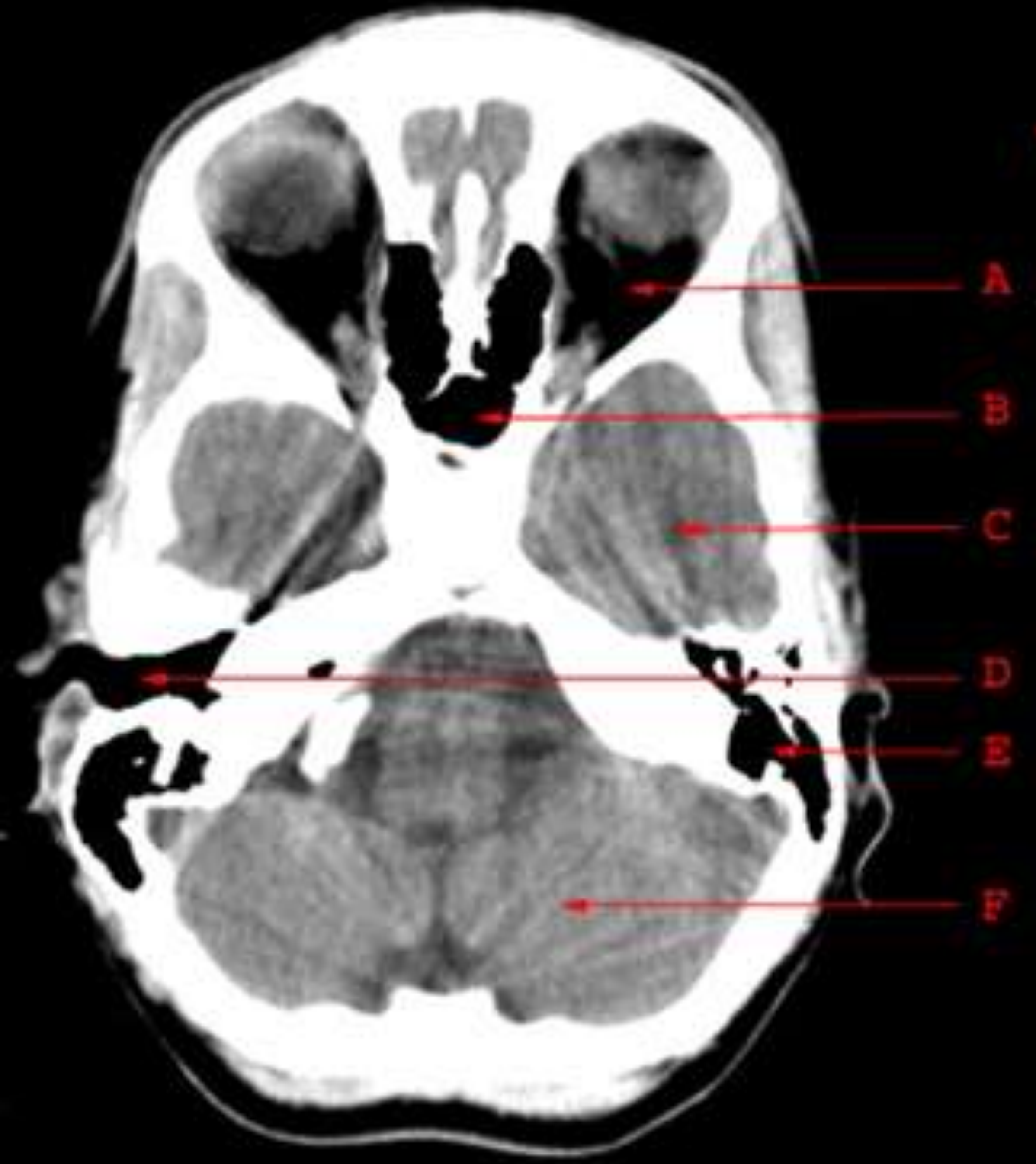


Depressed fracture

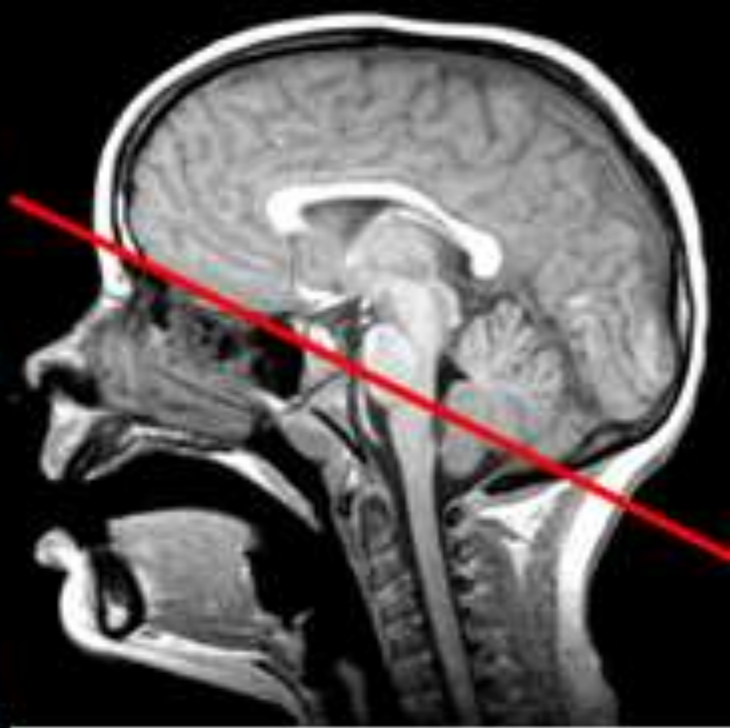
Pneumocephale



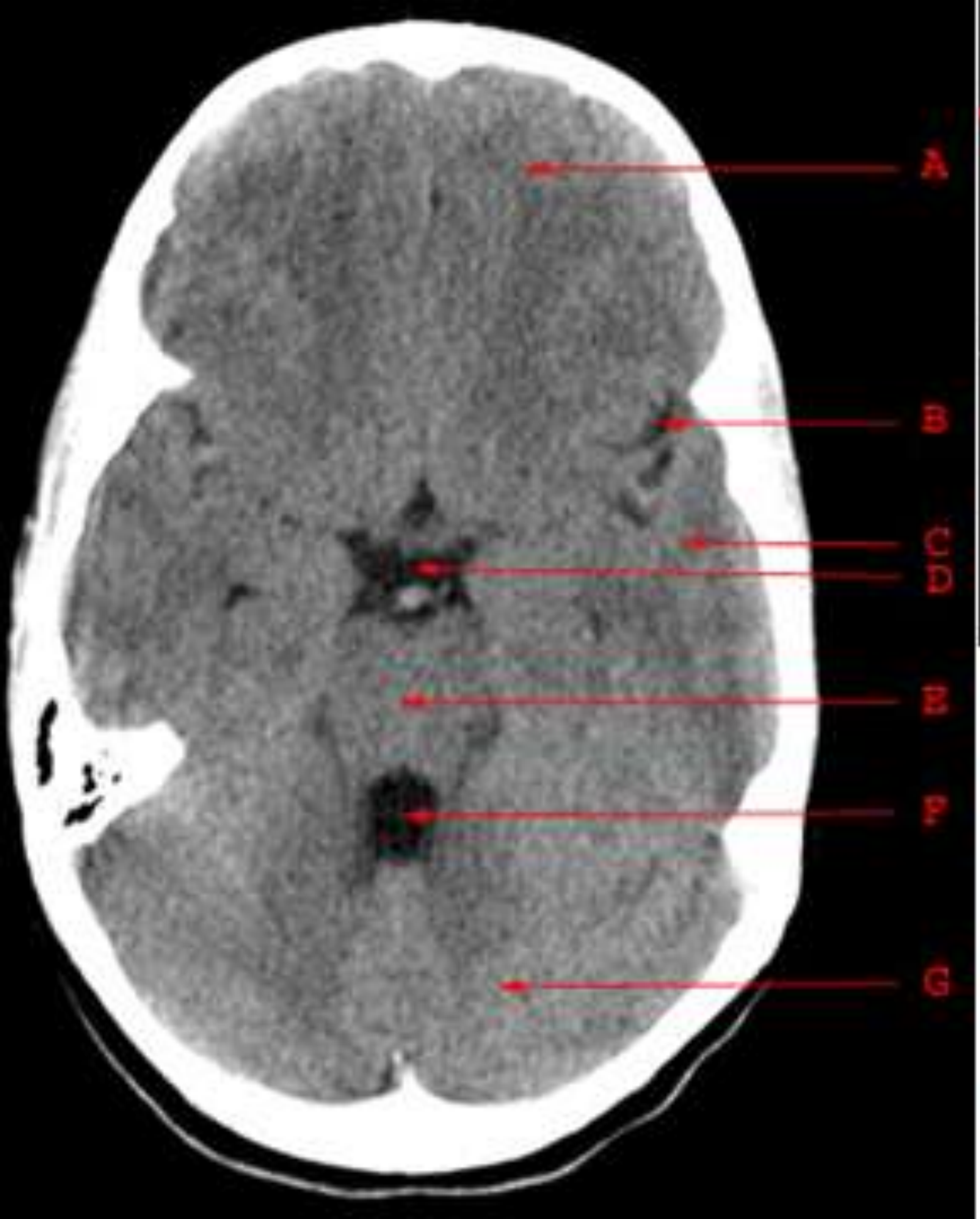
Multiple linier fracture

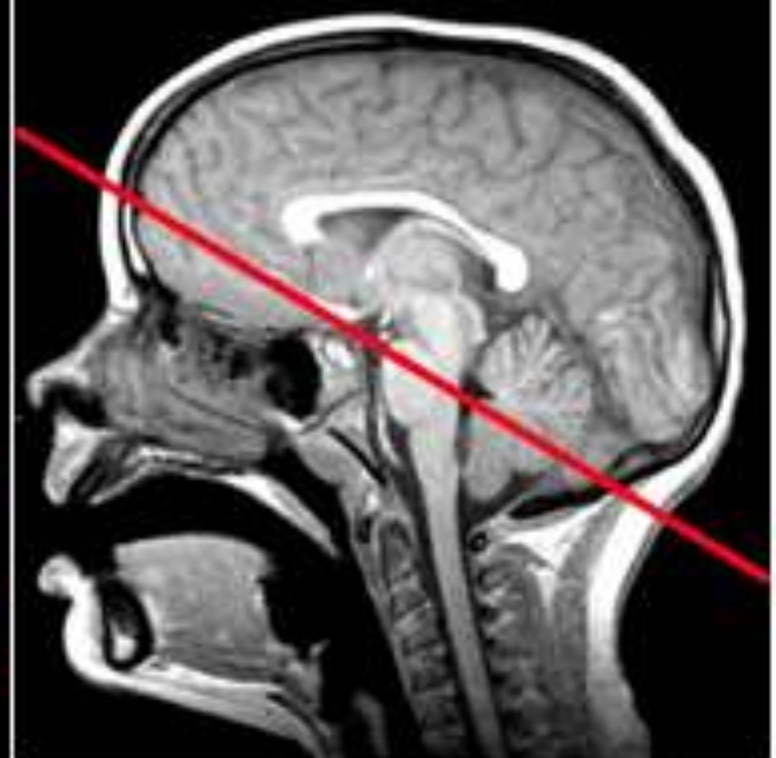


- A. Orbit
- B. Sphenoid Sinus
- C. Temporal Lobe
- D. External Auditory Canal
- E. Mastoid Air Cells
- F. Cerebellar Hemisphere

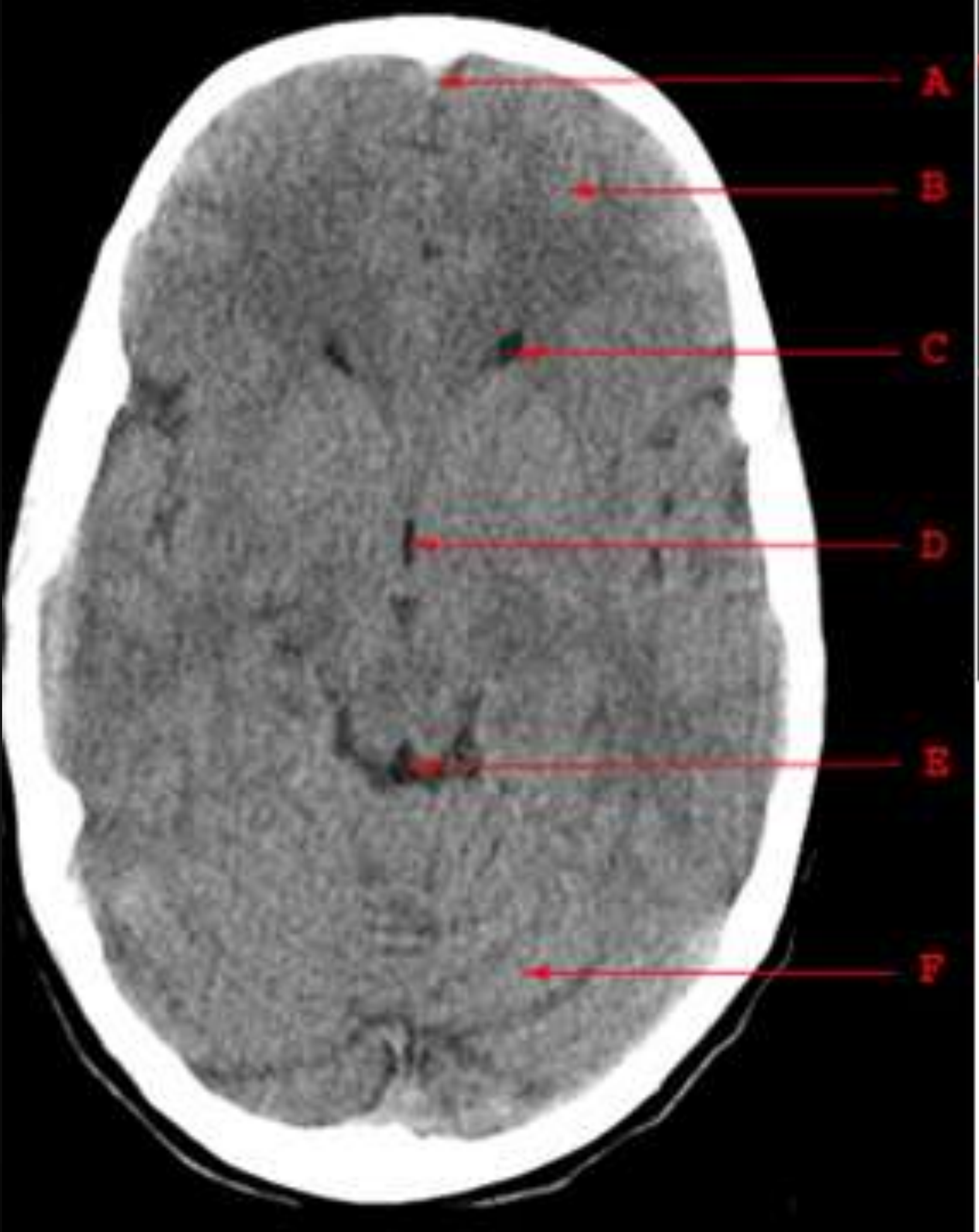


- A. Frontal Lobe
- B. Frontal Bone (Superior Surface of Orbital Part)
- C. Dorsum Sellae
- D. Basilar Artery
- E. Temporal Lobe
- F. Mastoid Air Cells
- G. Cerebellar Hemisphere

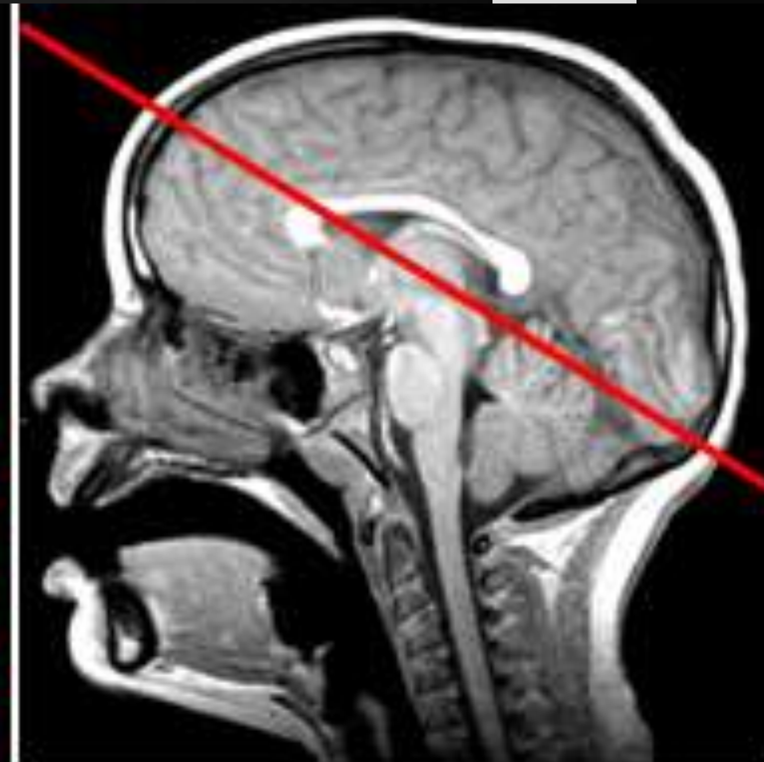




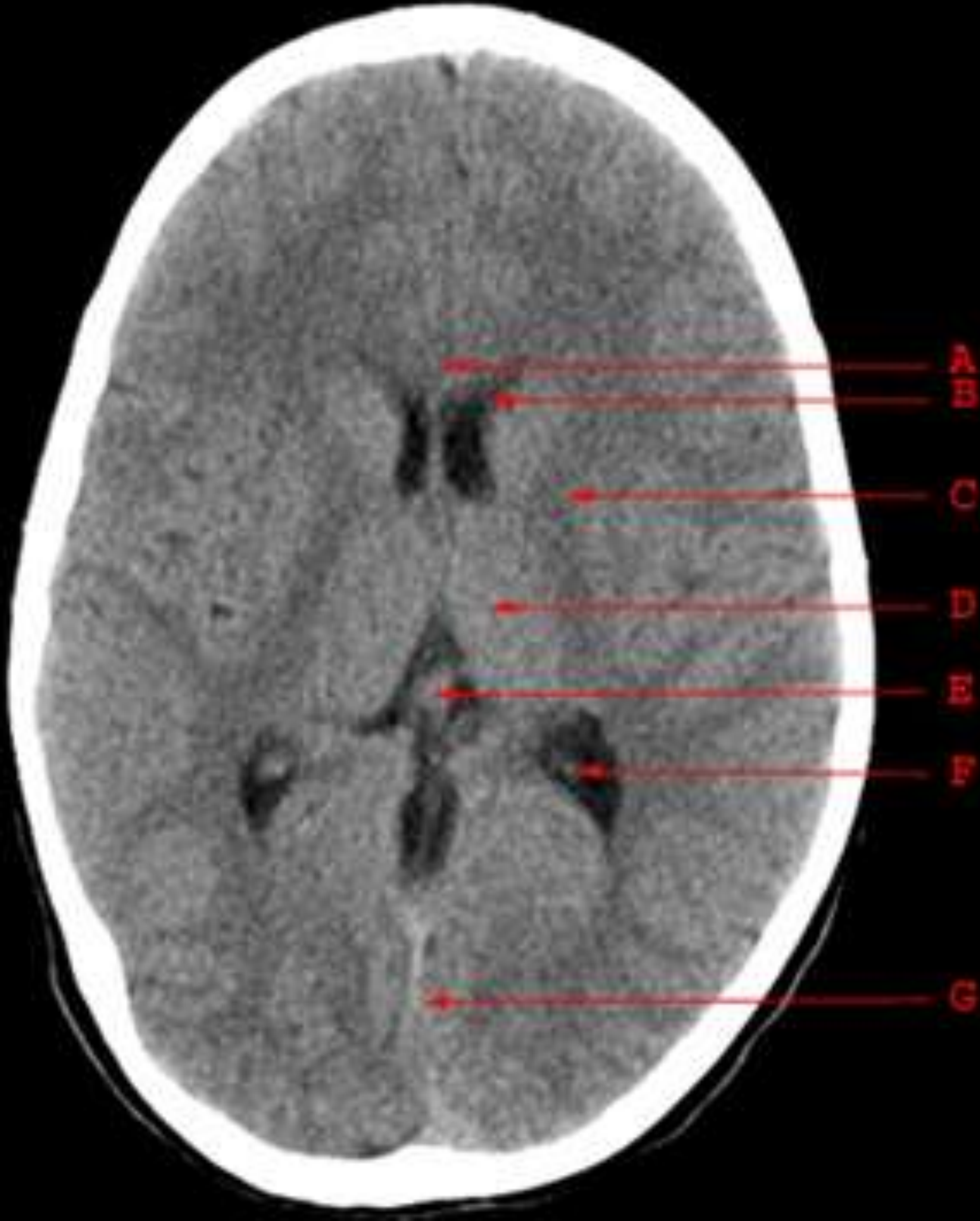
- A. Frontal Lobe
- B. Sylvian Fissure
- C. Temporal Lobe
- D. Suprasellar Cistern
- E. Midbrain
- F. Fourth Ventricle
- G. Cerebellar Hemisphere



- A. Falx Cerebri
- B. Frontal Lobe
- C. Anterior Horn of
- Lateral Ventricle
- D. Third Ventricle
- E. Quadrigeminal Plate
- Cistern
- F. Cerebellum

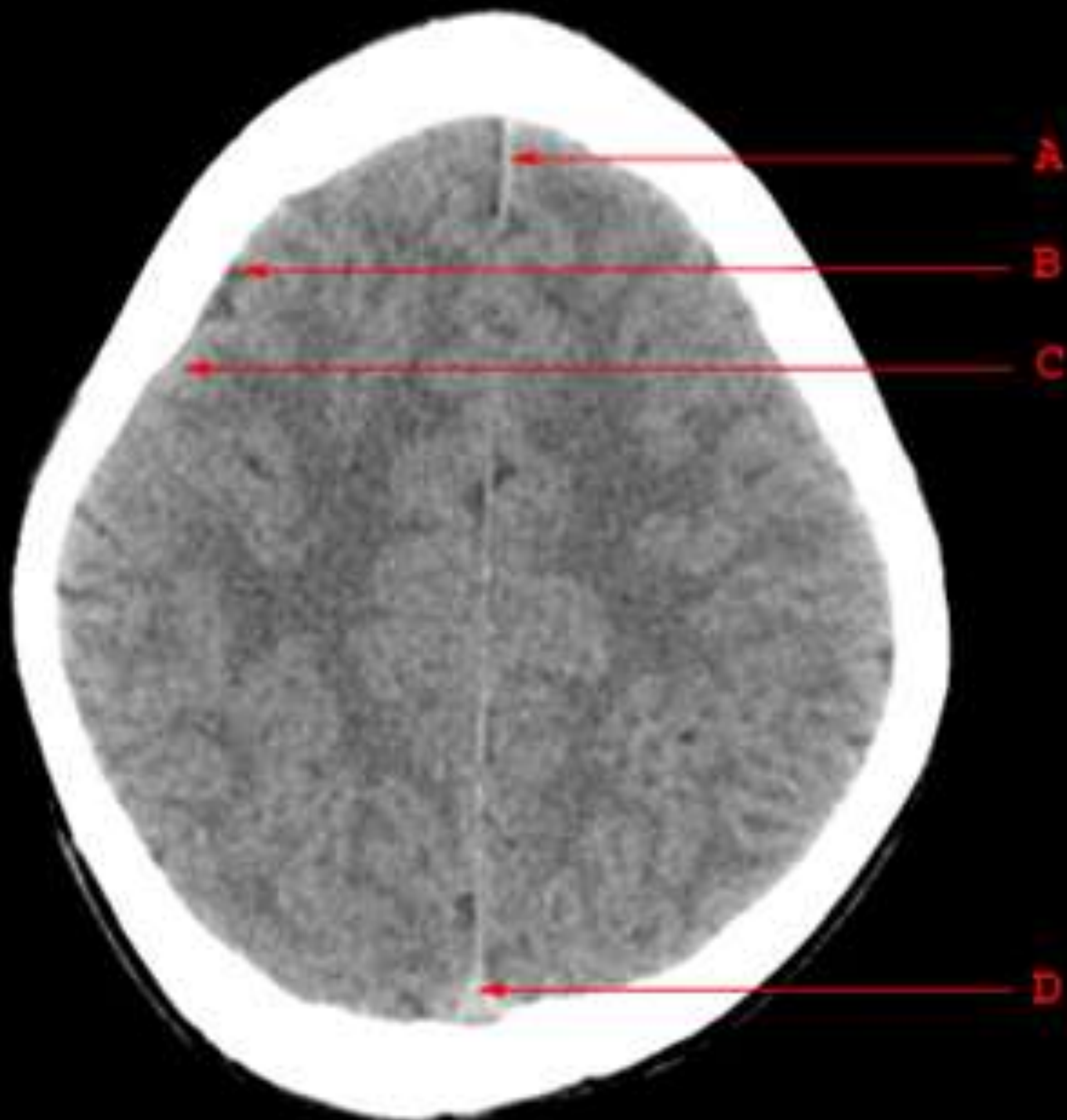


- A. Anterior Horn of the Lateral Ventricle
- B. Caudate Nucleus
- C. Anterior Limb of the Internal Capsule
- D. Putamen and Globus Pallidus
- E. Posterior Limb of the Internal Capsule
- F. Third Ventricle
- G. Quadrigeminal Plate Cistern
- H. Cerebellar Vermis
- I. Occipital Lobe



- A. Genu of the Corpus Callosum
- B. Anterior Horn of the Lateral Ventricle
- C. Internal Capsule
- D. Thalamus
- E. Pineal Gland
- F. Choroid Plexus
- G. Straight Sinus

- A. Falx Cerebri
- B. Frontal Lobe
- C. Body of the Lateral Ventricle
- D. Splenium of the Corpus Callosum
- E. Parietal Lobe
- F. Occipital Lobe
- G. Superior Sagittal Sinus



- A. Falx Cerebri
- B. Sulcus
- C. Gyrus
- D. Superior Sagittal Sinus

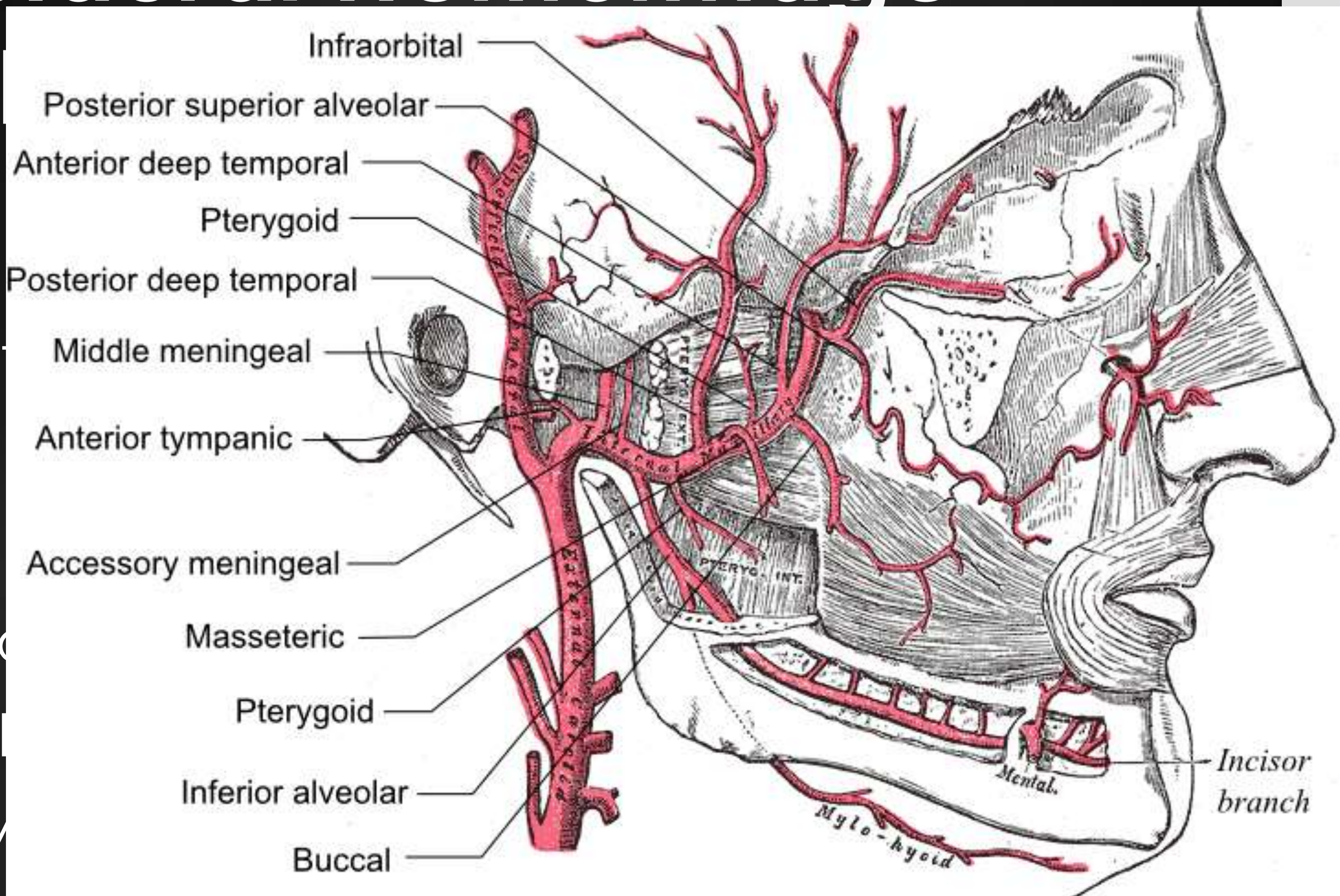
Indication of brain CT

- Moderate and severe TBI
- Mild TBI if :
  - Focal neurological deficite, seizure
  - Pupil anisokor ≥ 1 mm.
  - GCS keep decreasing ≥ 2, within observation period.
  - Depressed fracture, penetrating injury
  - Elder patient, fall from height, GCS keep < 15 within 24 hr.

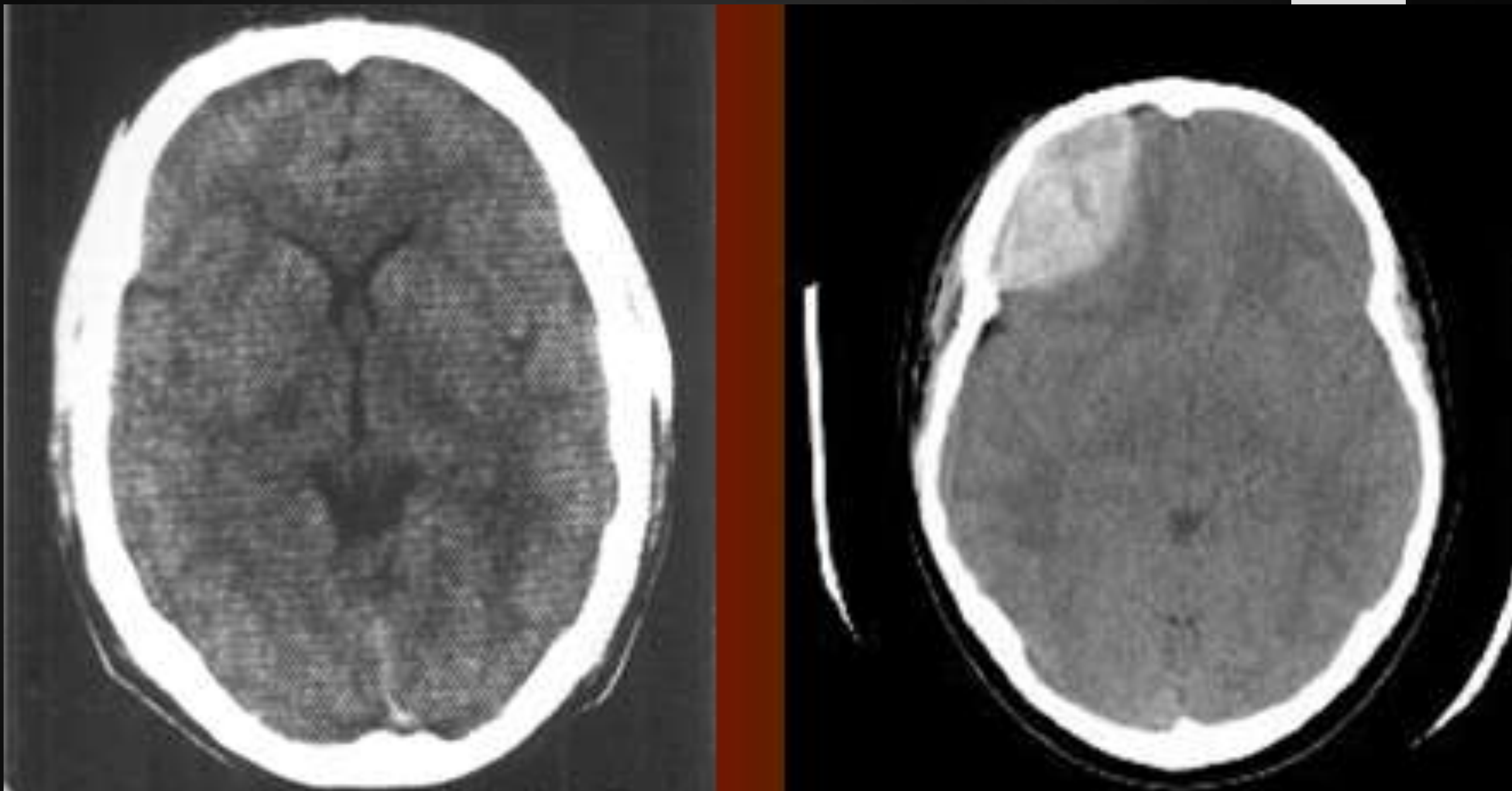
Intracranial Hemorrhage

- Epidural Hemorrhage (EDH)
- Subdural Hemorrhage (SDH)
- Intracerebral Hemorrhage (ICH)
- Intraventricular Hemorrhage (IVH)
- Subarachnoid Hemorrhage (SAH)

Epidural Hemorrhage
(E

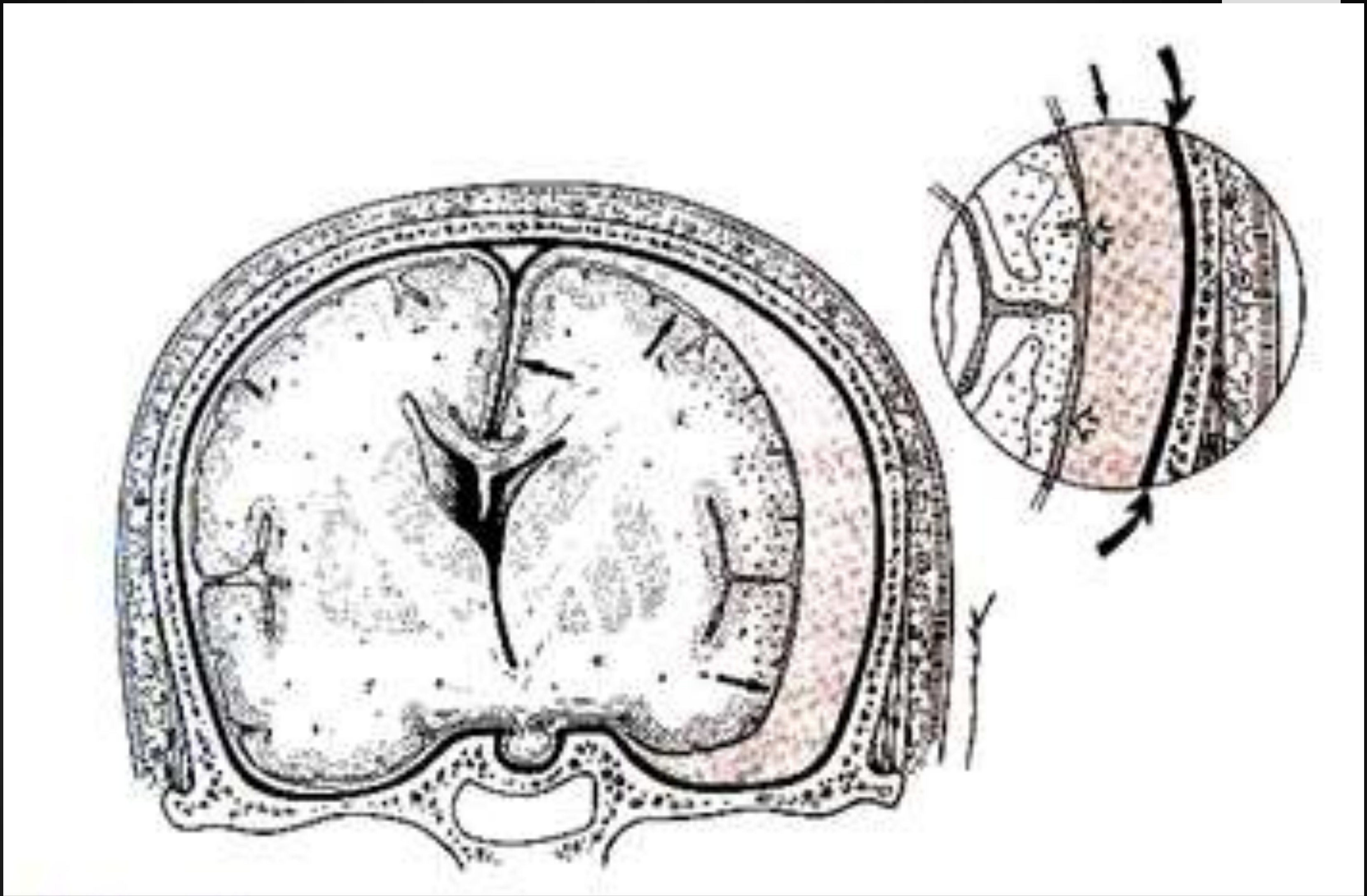


- Et
- Lo e)
- Sl
- M
- **CT :** biconvex lenx - shaped hyperdensity.

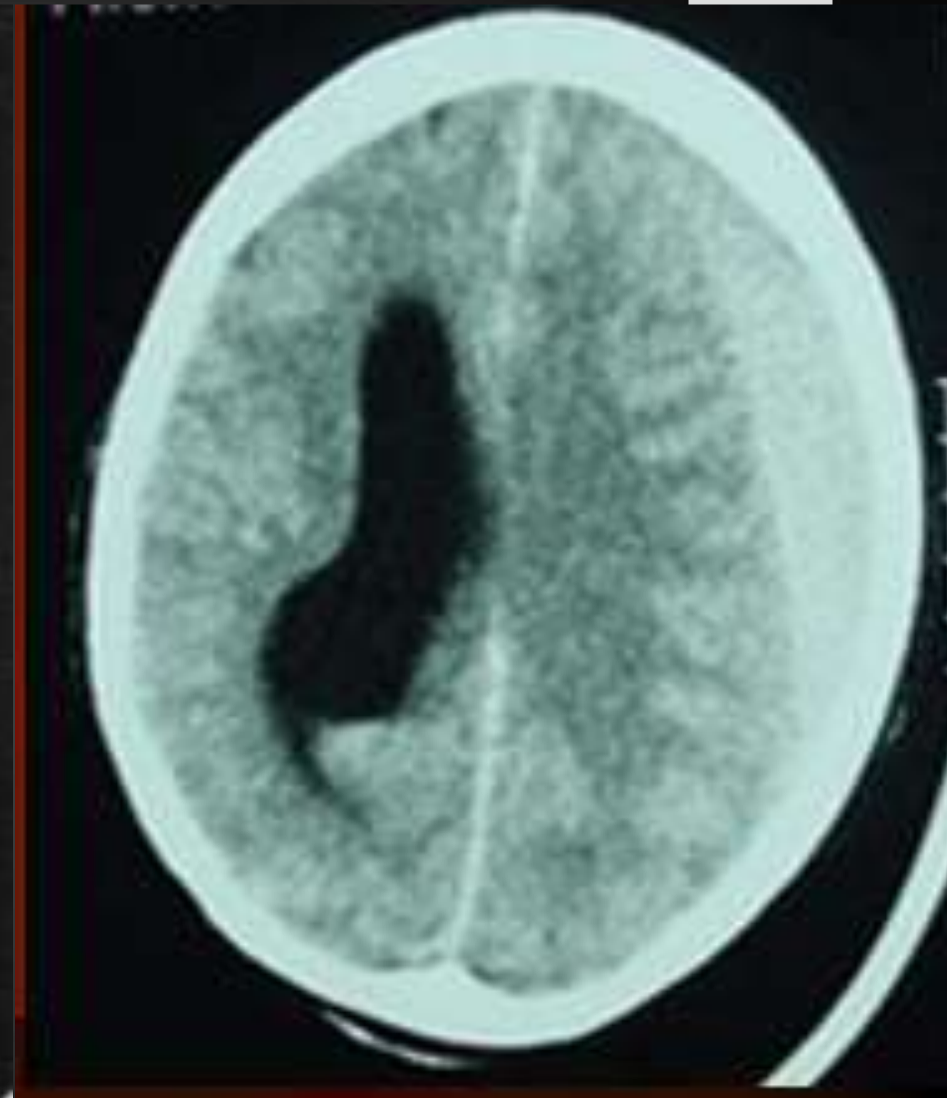


Subdural Hemorrhage (SDH)

- Etiology : **bridging vein rupture** (cerebral cortex – venous sinuses).
- Location : **subdural space (duramater – arachnoid)**
- More common, skull fracture (+/-)
- Mechanism : deceleration injury, secondary to fall
- **CT :** crescent shaped hyperdensity.

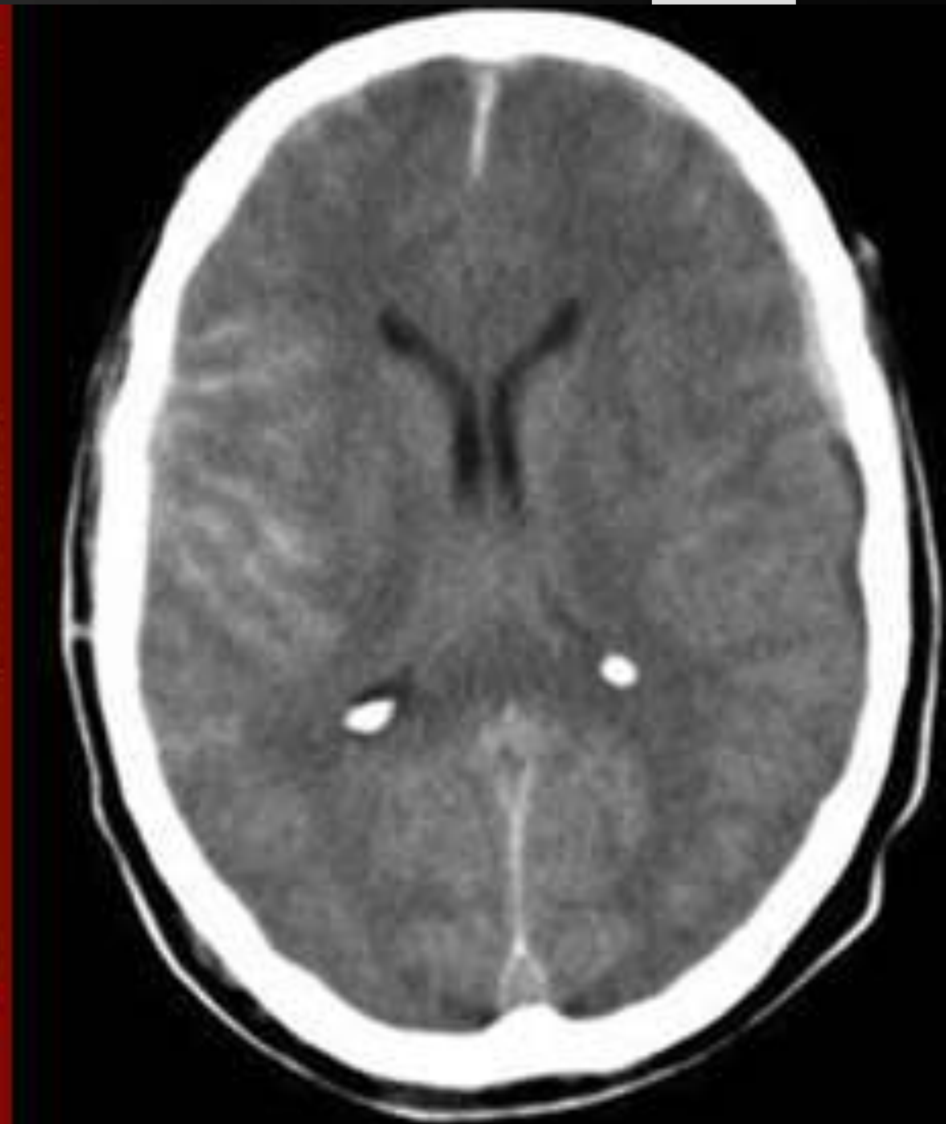


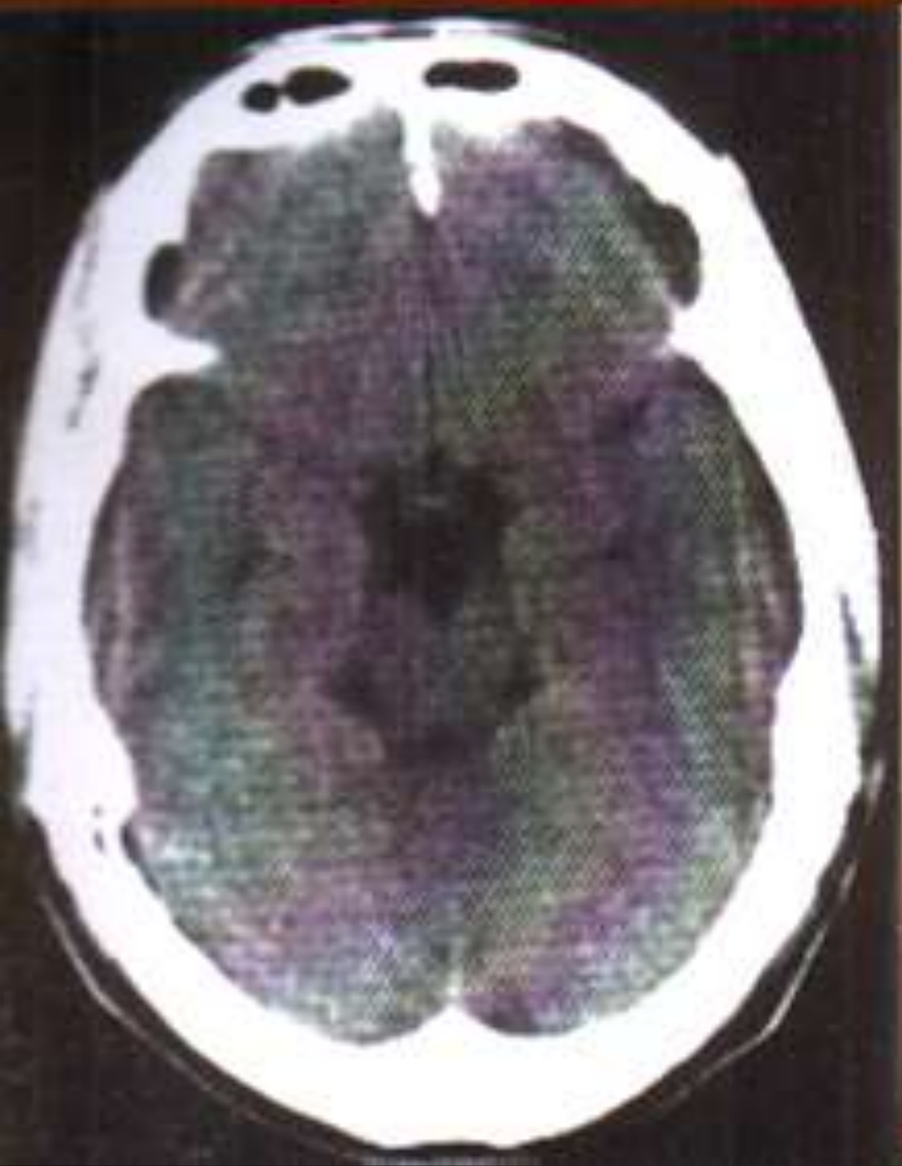
May cross suture line, but do not cross mid line !

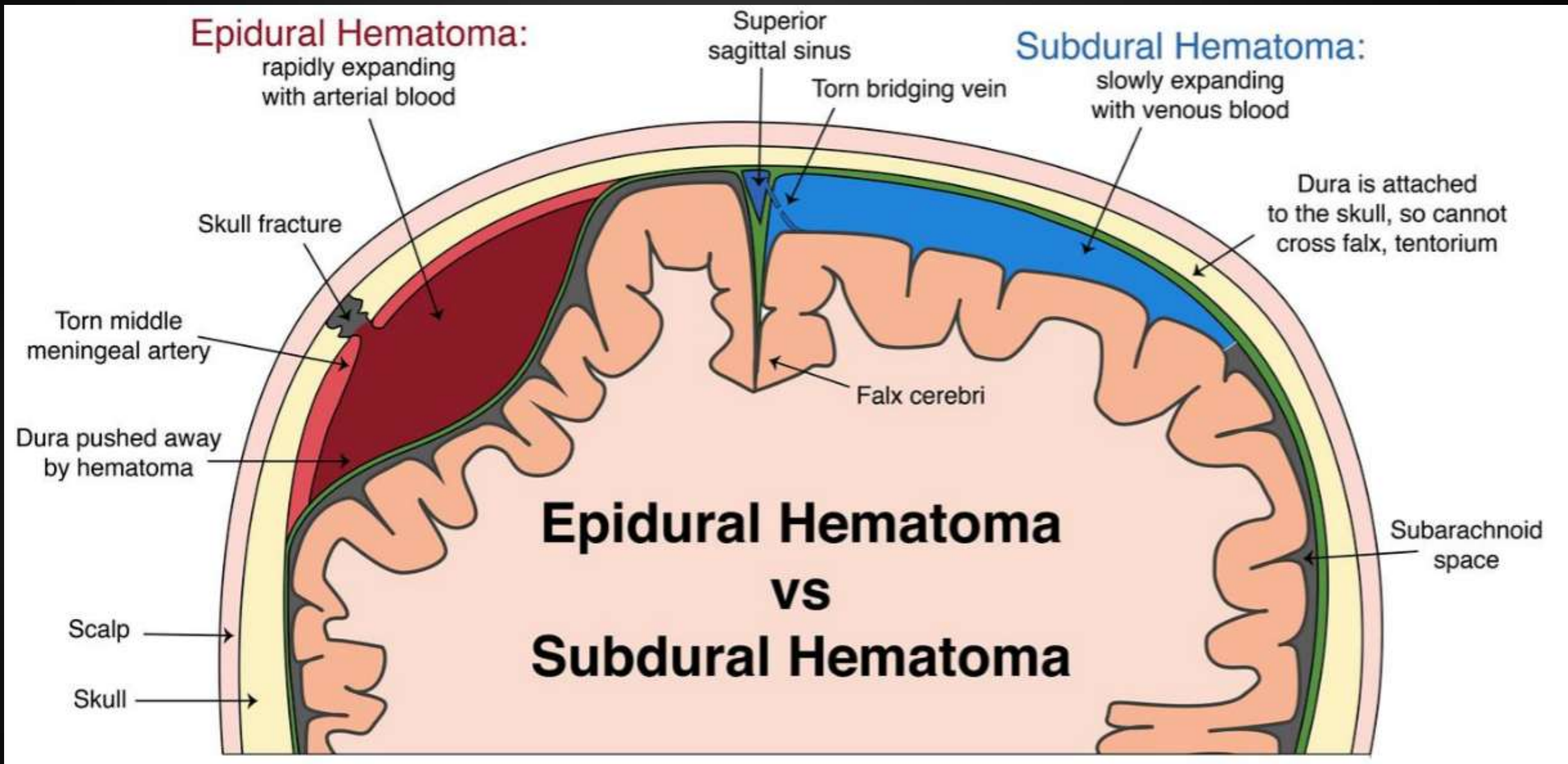



Subarachnoid Hemorrhage (SAH)

- Etiology : damage of the **pia-arachnoid vessels**
- Location : **subarachnoid space (arachnoid – piamater)**
- often associated with ICH → rupture → ventricular system → foramina of Magendie and Luschka → SAS.
- **CT :** hyperdensity in the cortical sulci, sylvian fissures, basal cisterns, and interhemispheric fissure
- The hemorrhage is rapidly cleared from the subarachnoid space ~ 1 week.





Epidural Hematoma:
rapidly expanding
with arterial blood
Superior
sagittal sinus
Torn bridging vein
Subdural Hematoma:
slowly expanding
with venous blood
Skull fracture
Dura is attached
to the skull, so cannot
cross falx, tentorium
Torn middle
meningeal artery
Falx cerebri
Dura pushed away
by hematoma
Epidural Hematoma
vs
Subdural Hematoma
Subarachnoid
space
Scalp
Skull

Cortical Contusion

- Location : peripheral (white and grey metter)
- Characterized by hemorrhage, necrosis, and edema.
- Mechanism : coup and contrecoup lesion.

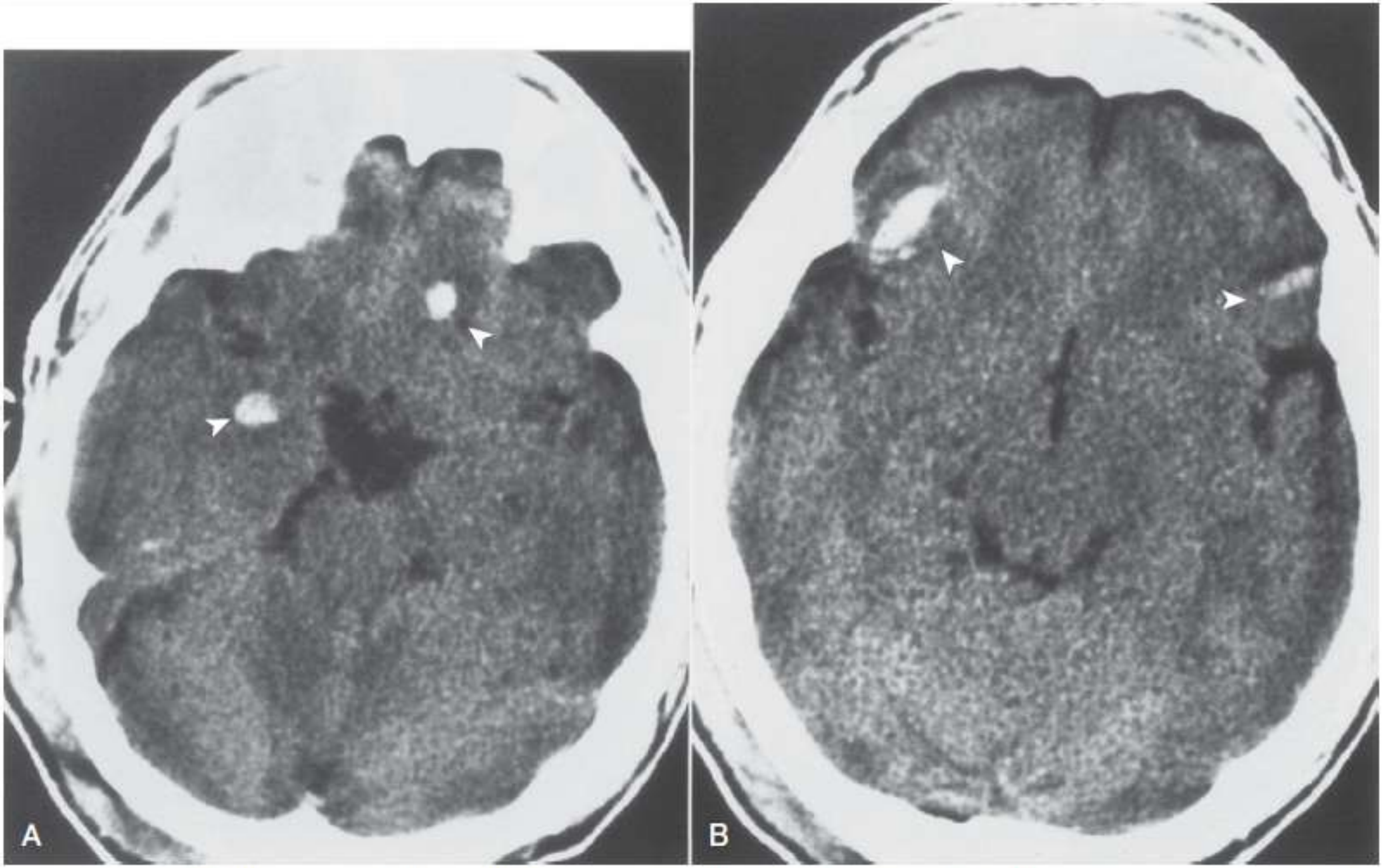


Figure 6-32. **A,** Hemorrhagic contusions with surrounding edema are evident in the inferior left frontal and anterior right temporal lobe *(arrowheads)*. **B,** CT scan at higher level reveals additional cortical hemorrhagic contusions in the frontal lobe *(arrowheads)*.

Cr: Haaga J.R, Boll D. CT and MRI of The Whole Body, 5th edition, volume 1, Part 1 : Brain and Meningens. 2008. Mosby Elsevier.

Diffuse Axonal (Shear) Injury

- Prolonged coma following head trauma.
- Poorest prognosis
- Acceleration/ decelerated forces duffusely injure axons deep to the cortex → unconsciousness from the moment of injury.
- Motor vehicle acc.
- CT findings may normal or similar to ICH.
- MRI is more sensitive than CT in the detection of DAI:
  - Small petechial lesion
  - Corpus callosum most affected

Figure 6-39. Diffuse axonal injury. CT scan demonstrates small hemorrhagic diffuse axonal injuries in the deep white matter and corpus callosum.

Figure 6-40. Diffuse axonal injury. Axial T2-weighted (2500/80) MR image demonstrates typical locations of diffuse axonal injury: subcortical white matter, corpus callosum, and corona radiata.

Cr: Haaga J.R, Boll D. CT and MRI of The Whole Body, 5th edition, volume 1, Part 1 : Brain and Meningens. 2008. Mosby Elsevier.

Alhamdulillah

THANK YOU

References

- Haaga J.R, Boll D. CT and MRI of The Whole Body, 5th edition, volume 1, Part 1 : Brain and Meningens. 2008. Mosby Elsevier.
- Kowal D.J. Learning Radiology, 2nd edition, Chapter 25: Recognizing Some Common Causes of Intracranial Pathology. Philadelpia. 2012. Mosby Elsevier.
- Chawla H, Malhotra R, Yadav R.K, Griwan M.S, Paliwal P.K, Aggarwal A.D. Diagnostic Utility of Conventional Radiography in Head Injury. Journal of Clinical and Diagnostic Research. Vol-9(6). 2015.