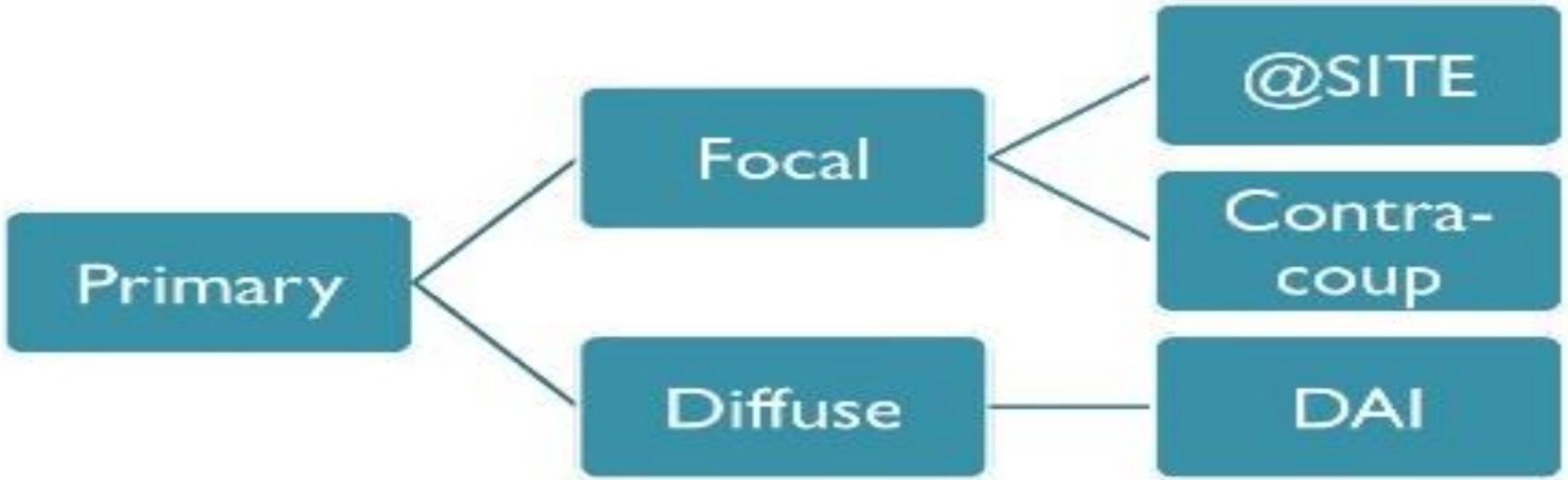
Primary Brain Injury



Classification of TBI

- Primary
  - Injury to scalp, skull fracture
  - Surface contusion/laceration
  - Intracranial hematoma
  - Diffuse axonal injury, diffuse vascular injury
- Secondary
  - Hypoxia-ischemia, swelling/edema, raised intracranial pressure
  - Meningitis/abscess

IMAGING TECHNIQUE

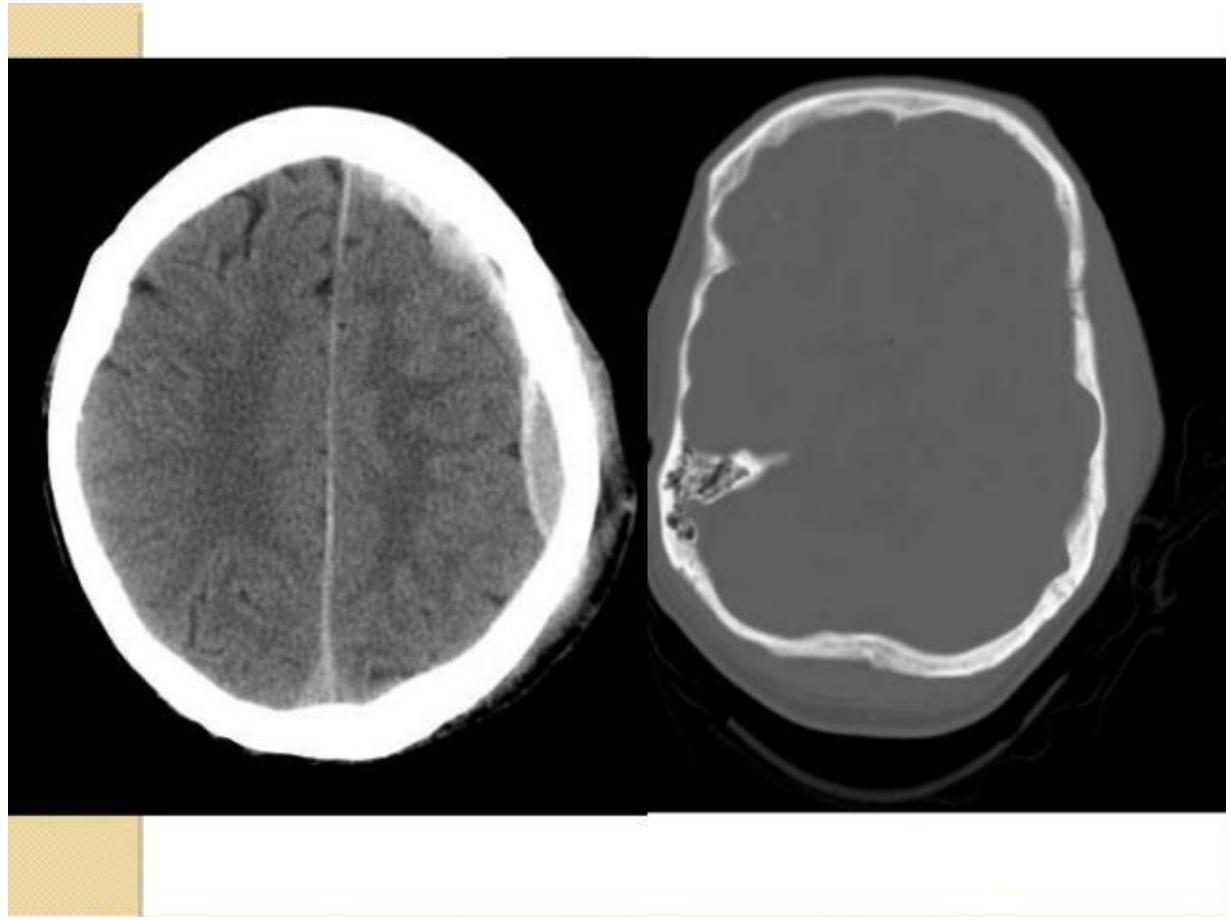
- CT without contrast is the modality of choice in acute trauma (fast, available, sensitive to acute subarachnoid hemorrhage and skull fractures)
- MRI is useful in non-acute head trauma (higher sensitivity than CT for cortical contusions, diffuse axonal injury, posterior fossa abnormalities)

Extraaxial fluid collections

- Subarachnoid hemorrhage(SAH)
- Subdural hematoma(SDH)
- Epidural hematoma
- Subdural hygroma
- Intraventricular hemorrhage

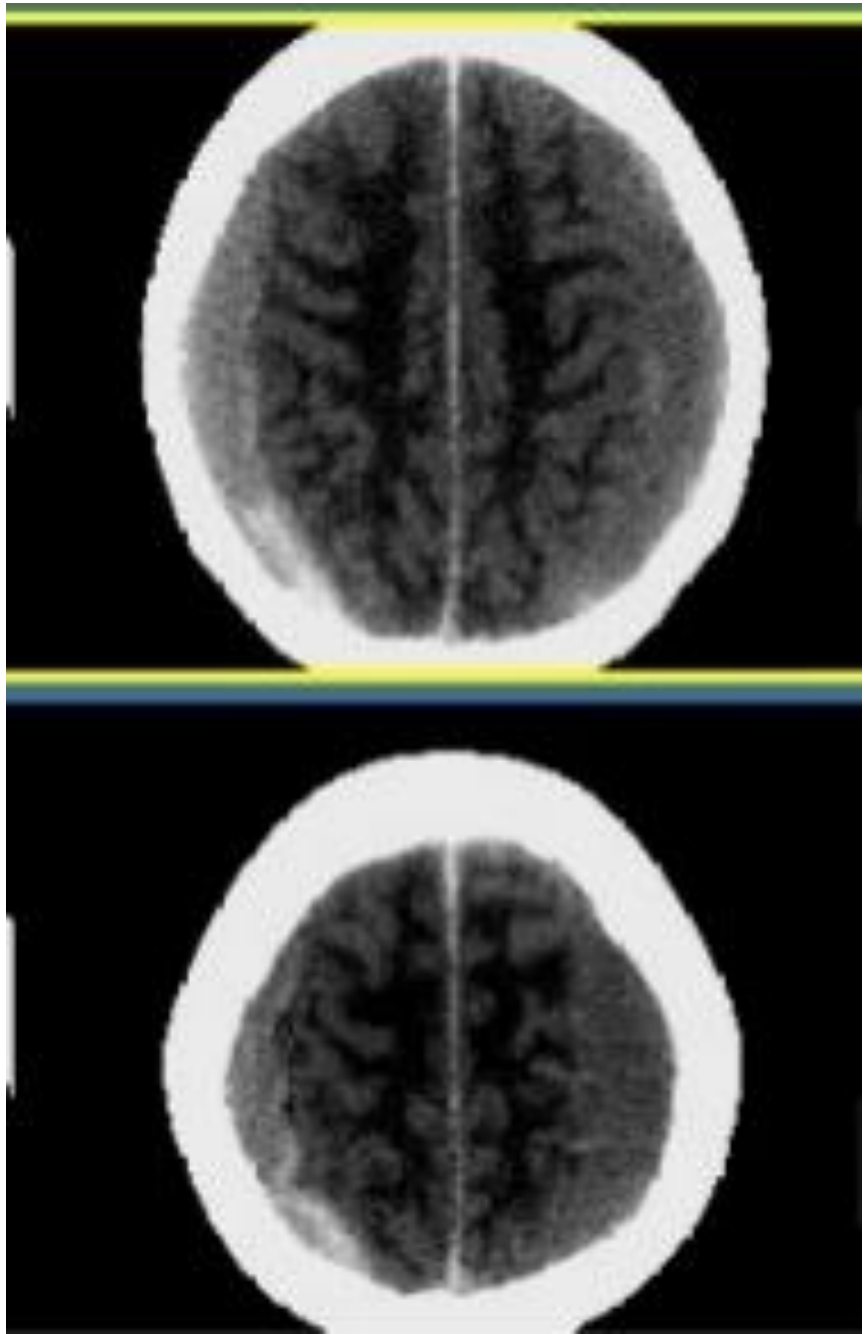
EPIDURAL HEMATOMA

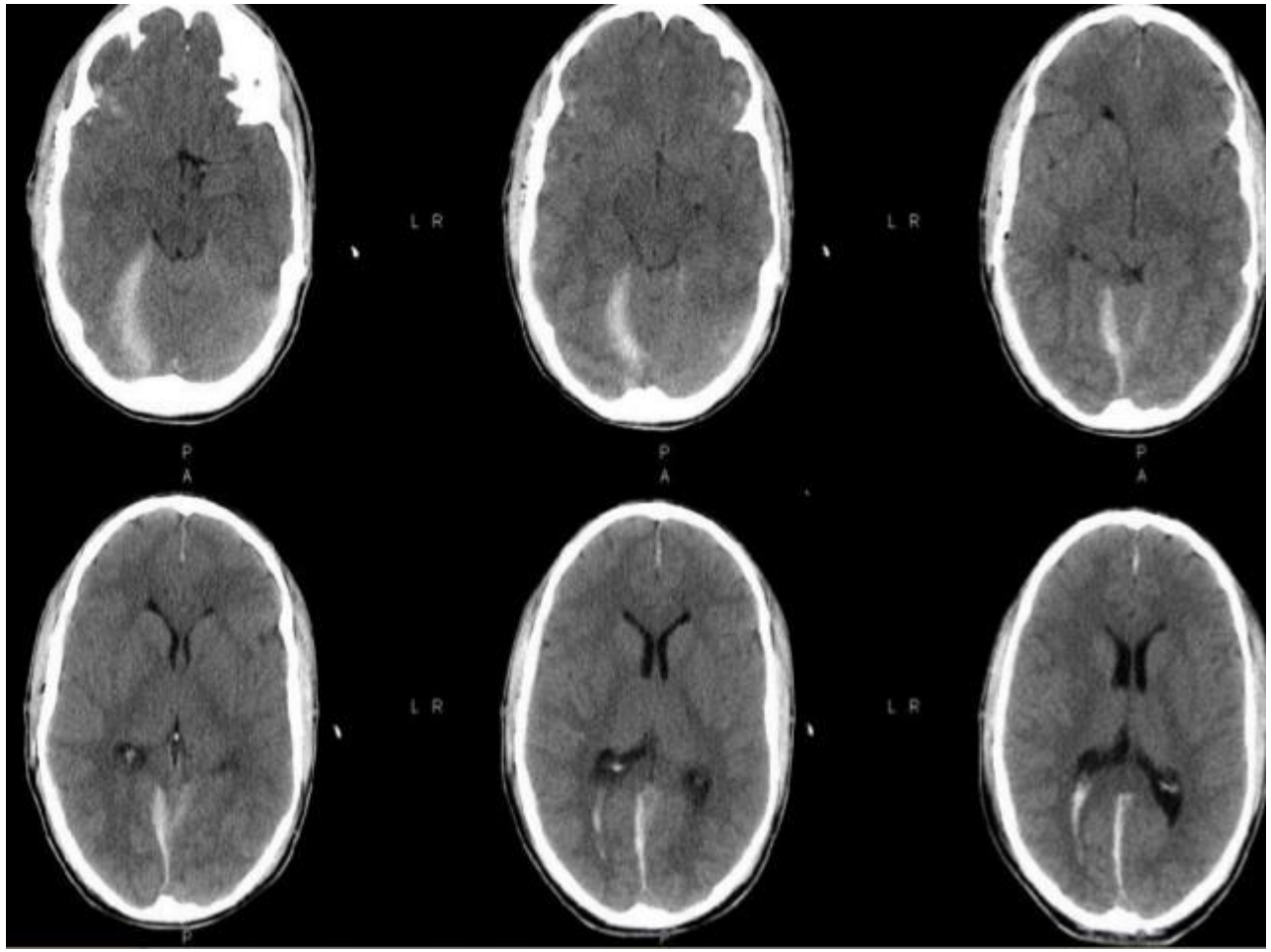
- Located between the skull and periosteum
- Due to laceration of the middle meningeal artery or dural veins
- Can cross dural reflections but is limited by suture lines
- Lentiform shape (but concave shape in SDH)



SUBDURAL HEMATOMA

- Occurs between the dura and arachnoid
- Can cross the sutures but not the dural reflections
- Due to disruption of the bridging cortical veins
- Hypodense(hyperacute, chronic), isodense(subacute), hyperdense(acute)

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Subarachnoid hemorrage

- Can originate from direct vessel injury, contused cortex or intraventricular hemorrhage.

- Look in the interpeduncular cistern and Sylvian fissure
- Usually focal (but diffuse from aneurysm)
- Can lead to communicating hydrocephalus


Im: 13
R 37.
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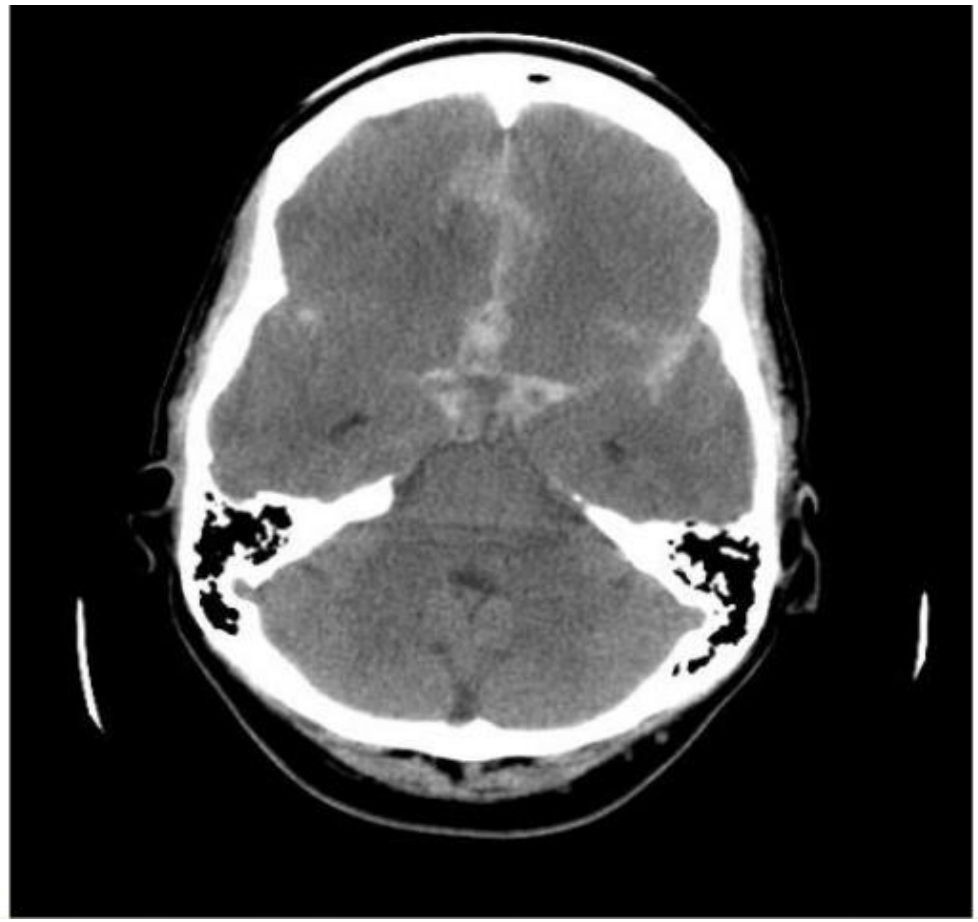
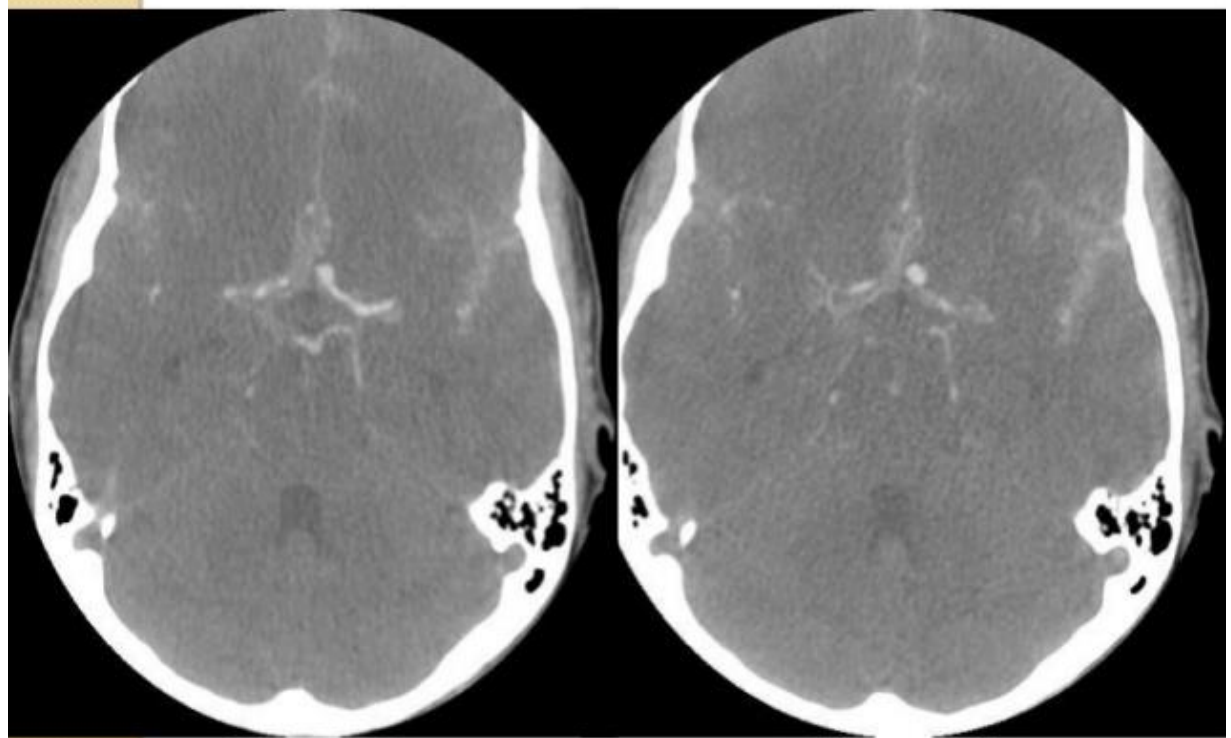
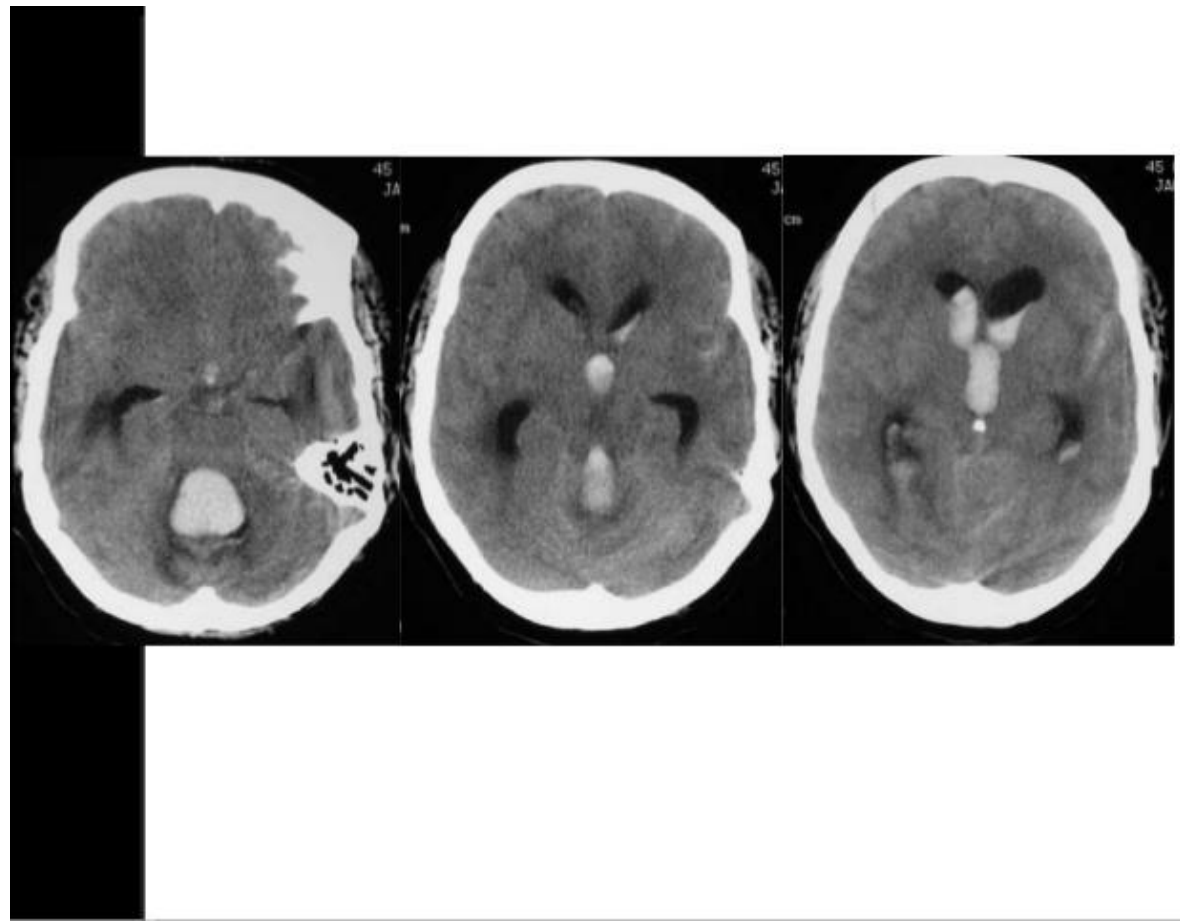
S 19.





Intraventricular hemorrhage

- Most commonly due to rupture of subependymal vessels
- Can occur from reflux of SAH or contiguous extension of an intracerebral hemorrhage
- Look for blood-cerebrospinal fluid level in occipital horns



INTRA-AXIAL INJURY

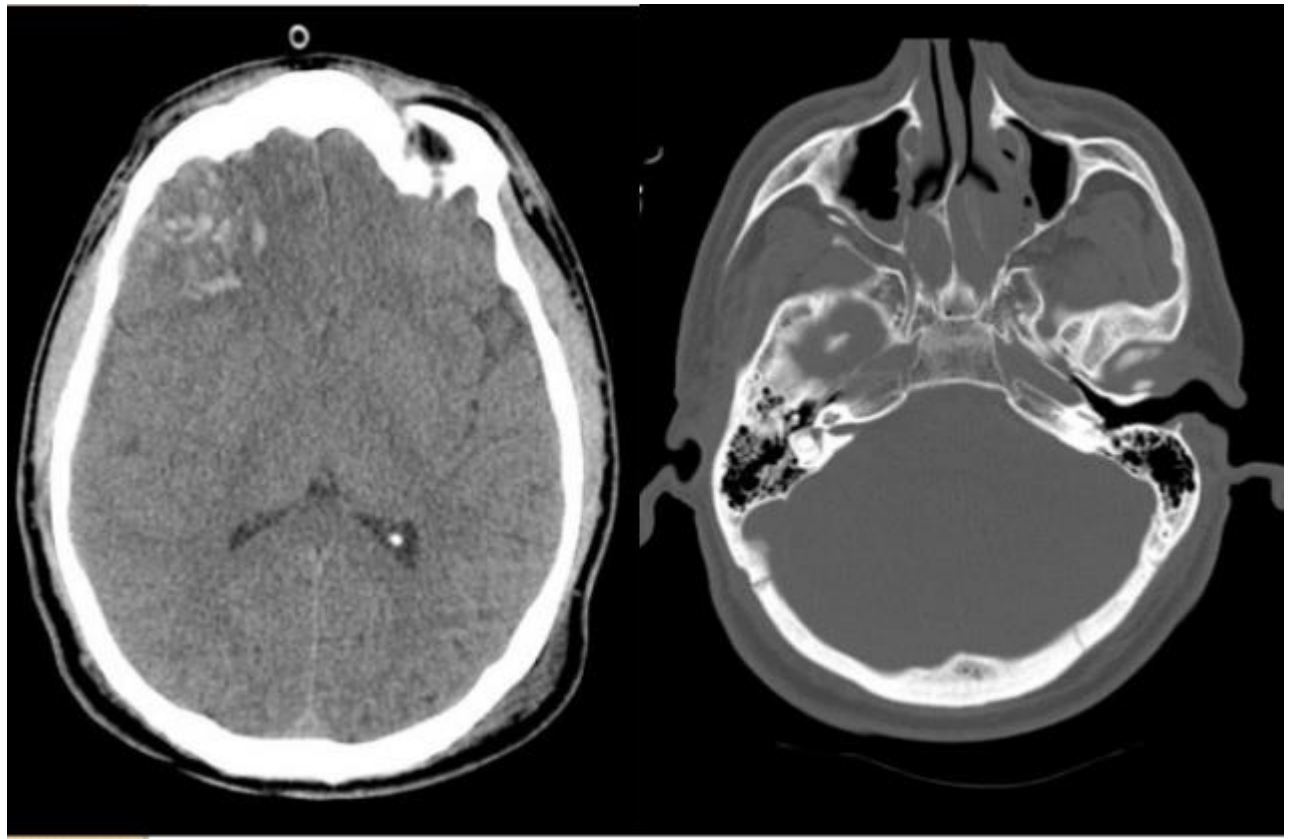
- Surface contusion/laceration
- Intraparenchymal hematoma
- White matter shearing injury/diffuse axonal injury
- Post-traumatic infarction
- Brainstem injury

CONTUSION/LACERATIONS

- Most common source of traumatic SAH
- Contusion: must involve the superficial gray matter
- Laceration: contusion + tear of pia-arachnoid
- Affects the crests of gyri
- Hemorrhage present ½ cases and occur at right angles to the cortical surface
- Located near the irregular bony contours: poles of frontal lobes, temporal lobes, inferior cerebellar hemispheres

Intraparenchymal hematoma

- Focal collections of blood that most commonly arise from shear-strain injury to intraparenchymal vessels.
- Usually located in the frontotemporal white matter or basal ganglia
- Hematoma within normal brain
- DDx: DAI, hemorrhagic contusion

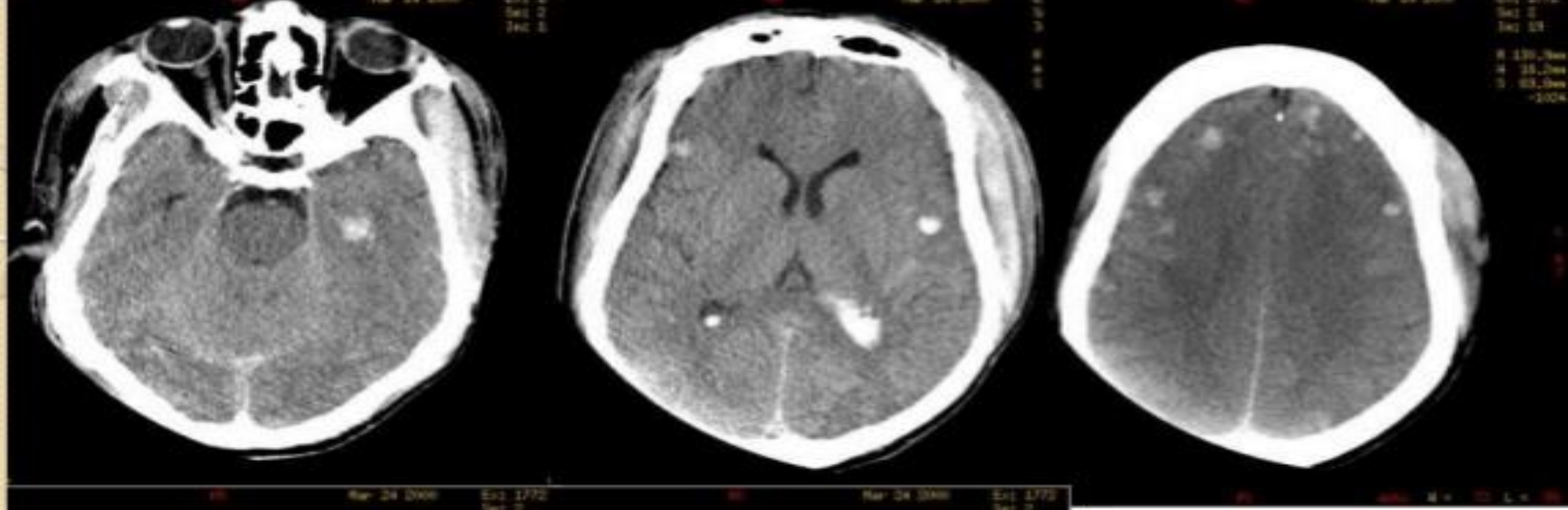


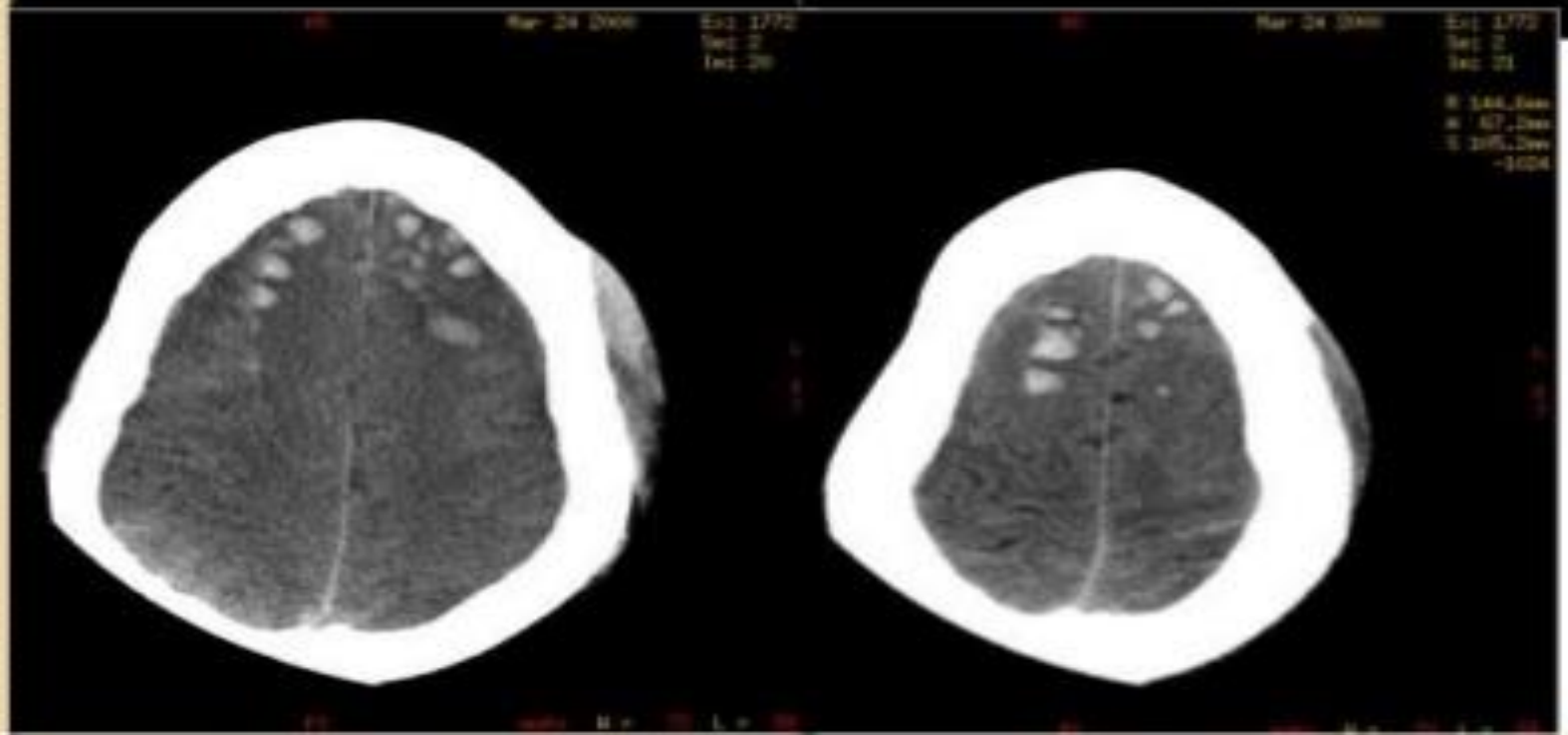
DIFFUSE AXONAL INJURY

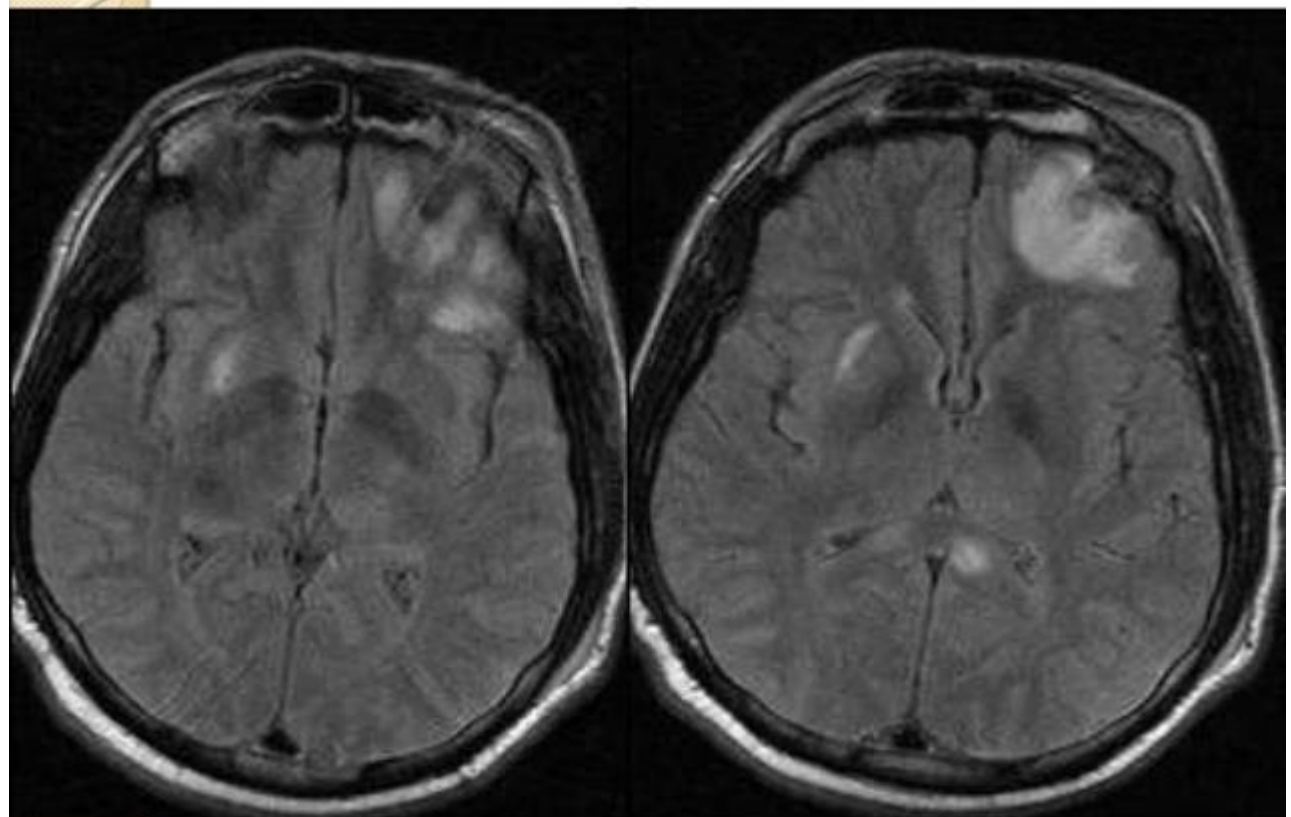
- Rarely detected on CT (20% of DAI lesions are hemorrhagic)
- MRI: T1, T2, T2 GRE, SWI

DAI

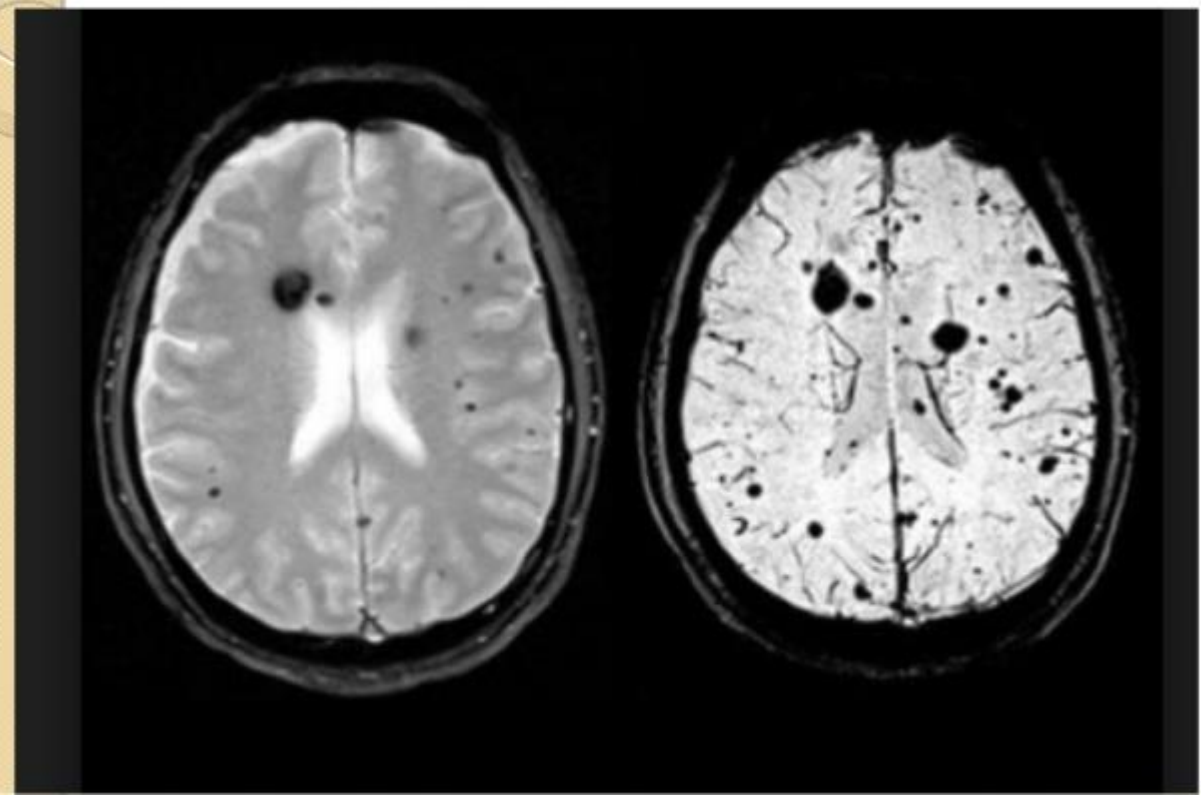
- Due to acceleration/deceleration to whtie matter + hypoxia
- Patients have severe LOC at impact
- Grade 1: axonal damage in WM only -67%
- Grade 2: WM + corpus callosum (posterior > anterior) – 21%
- Grade 3: WM + CC + brainstem







T2 * & SWI

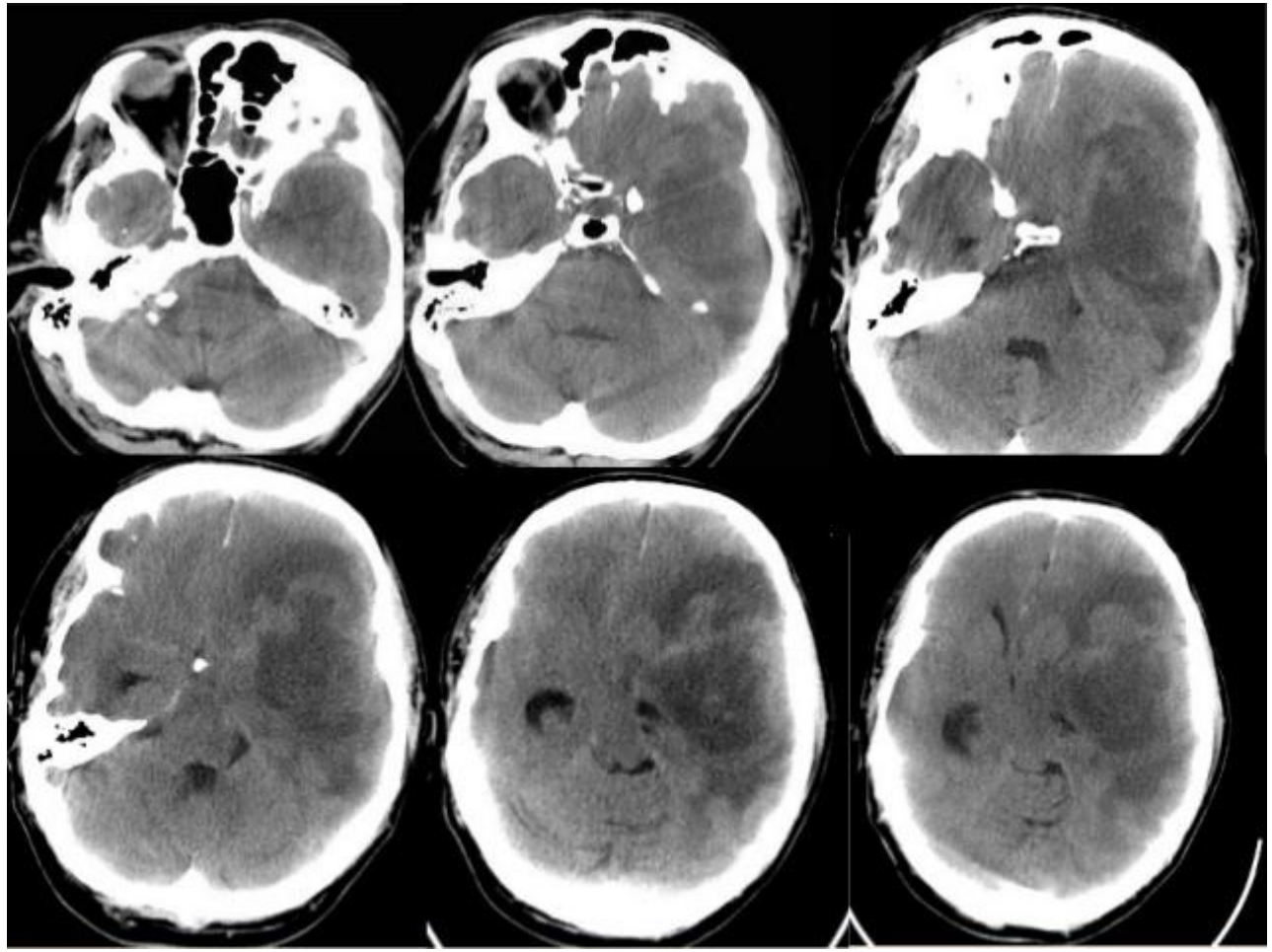


BRAINSTEM INJURY

- By direct or indirect forces
- Most commonly associated with DAI
- Involves the dorsolateral midbrain and upper pons and is usually hemorrhagic
- Duret hemorrhage is an example of indirect damage: tearing of the pontine perforators leading to hemorrhage in the setting transtentorial herniation
- <20% of brainstem lesions are seen on CT

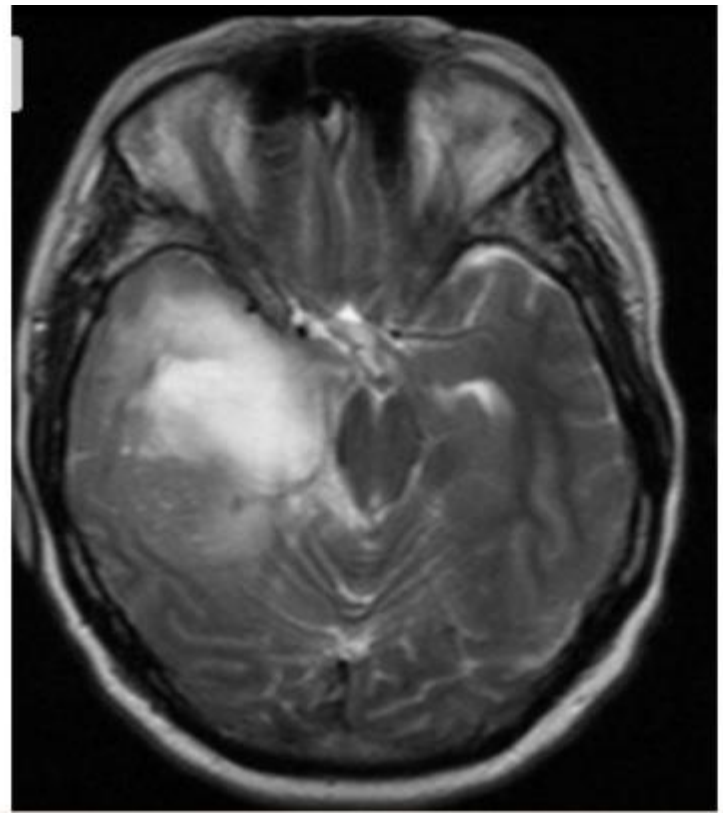
SUBFALCIAL HERNIATION

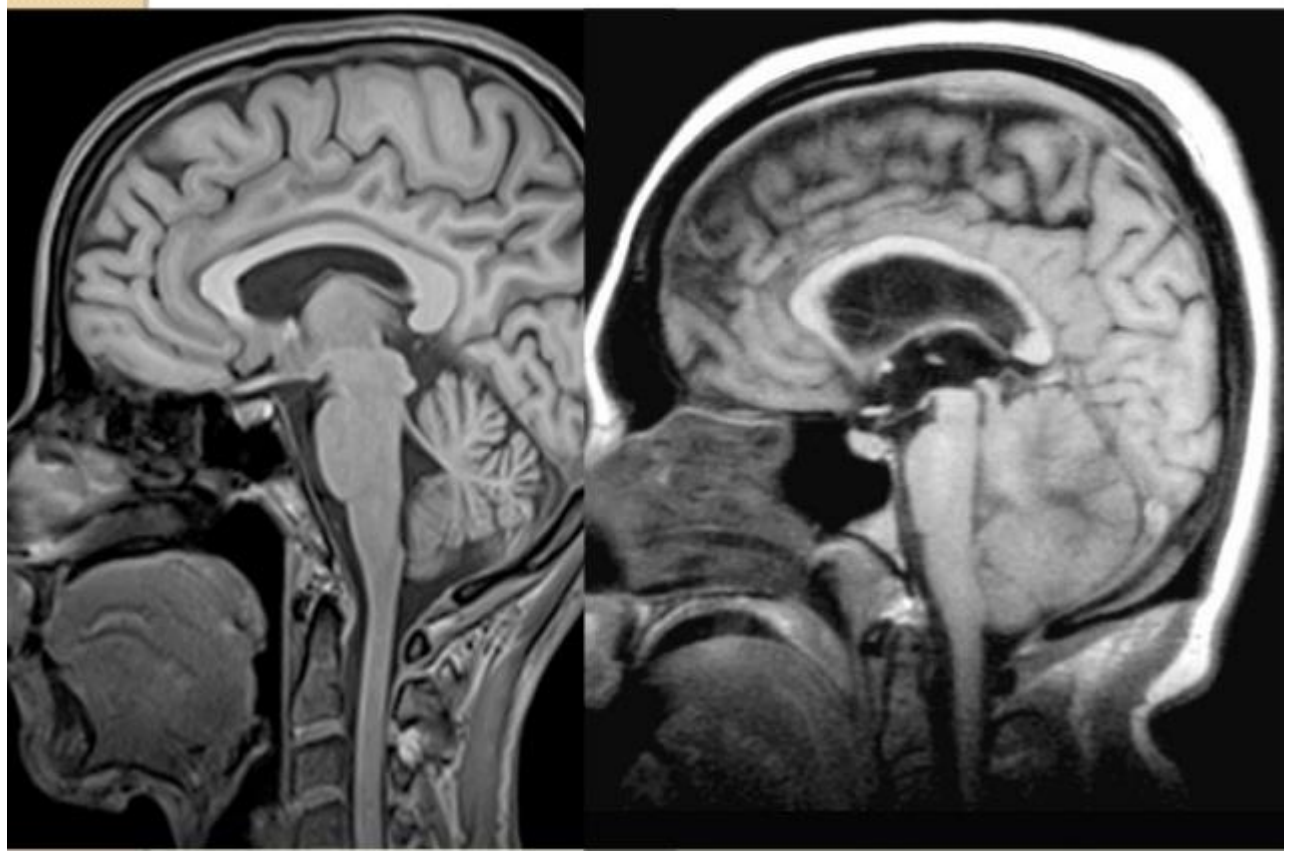
- Subfalcial: displacement of the cingulate gyrus under the free edge of the falx along with the pericallosal arteries.
- Can lead to anterior cerebral artery infarction



UNCAL HERNIATION

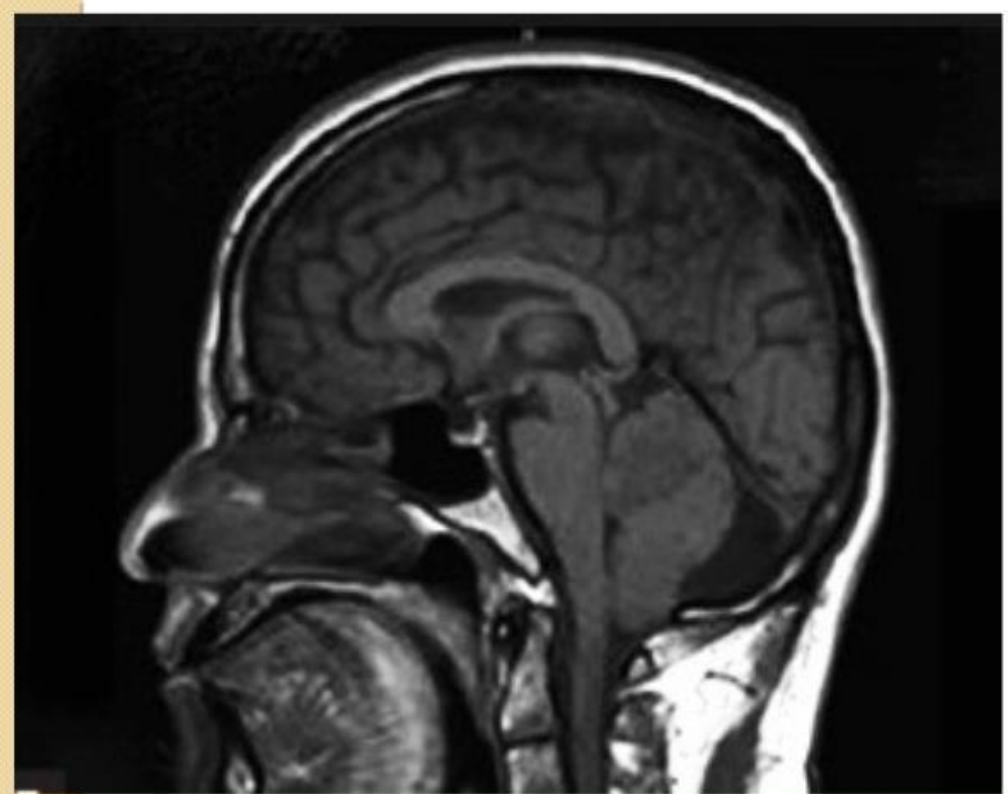
- Displacement of the medial temporal lobe through the tentorial notch
- Displacement of the midbrain
- Effacement of the suprasellar cistern
- Displacement of the contralateral cerebral peduncle against the tentorium
- Widening of the ipsilateral cerebello pontine angle
- Compression of the posterior cerebral artery





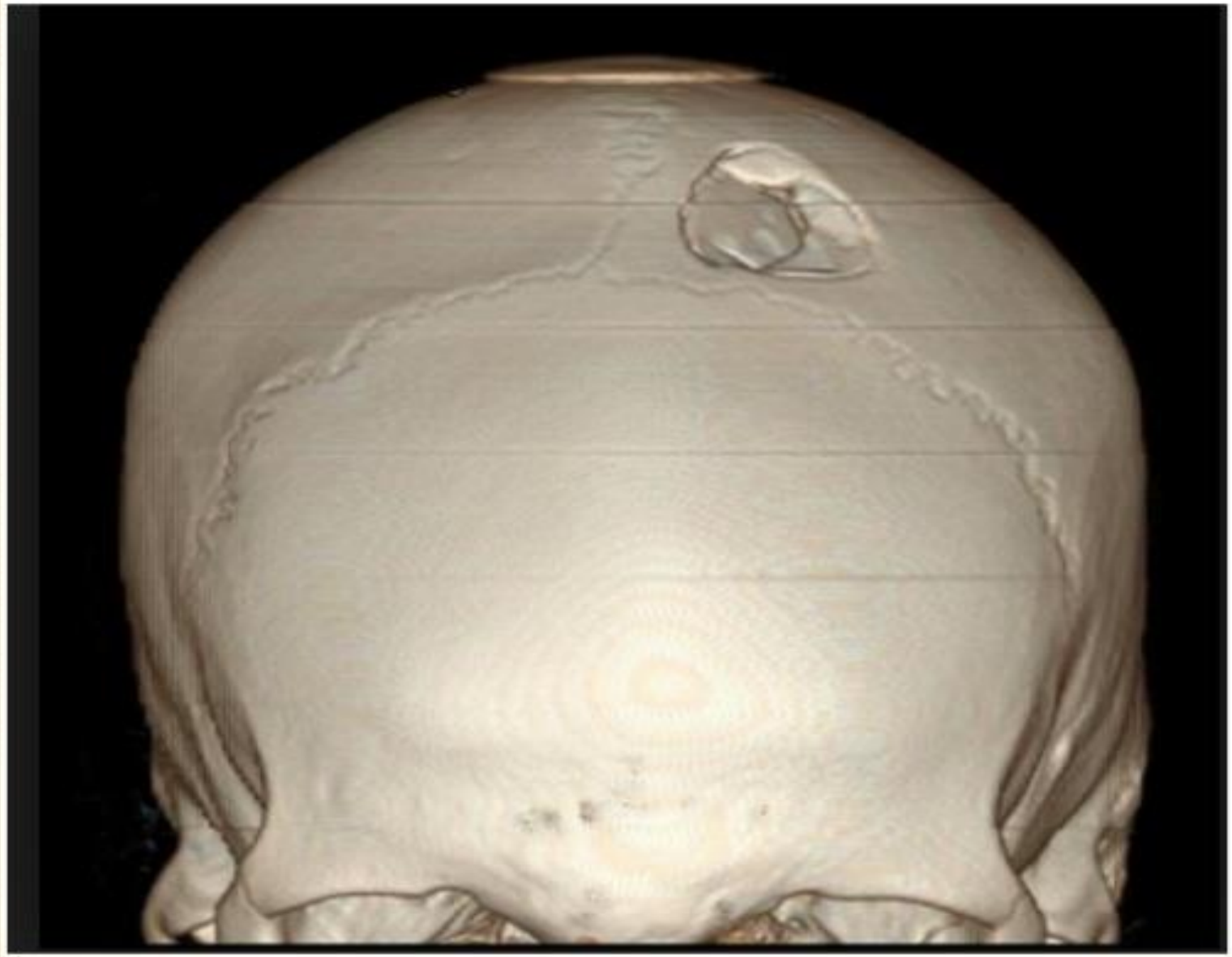
TONSILLAR HERNIATION

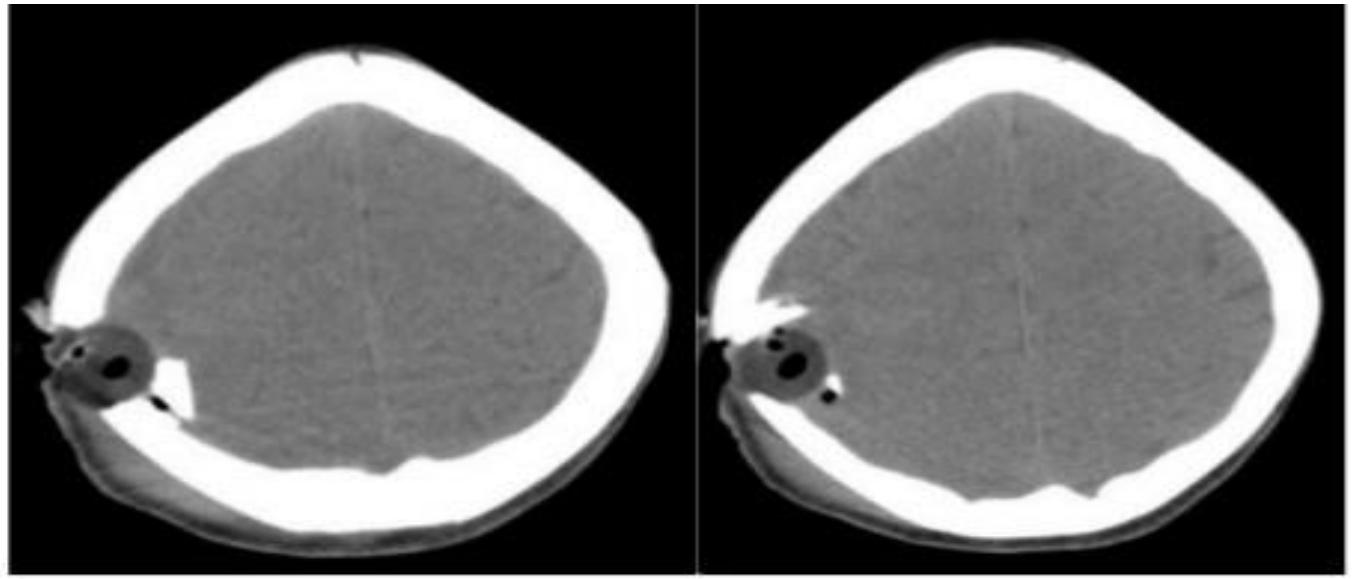
- Inferior displacement of the cerebellar tonsils through the foramen magnum
- Can lead to posterior cerebellar artery infarction

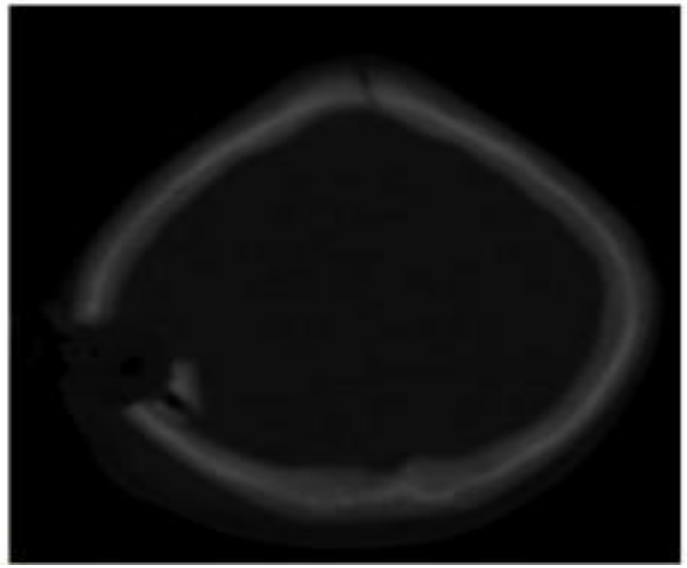


SIGNIFICANT SKULL FRACTURES

- "Depressed": inner table is depressed by the thickness of the skull.
- Overlie major venous sinus, motor cortex, middle meningeal artery
- Pass through sinuses
- Look for sutural diastasis (lambdoid)

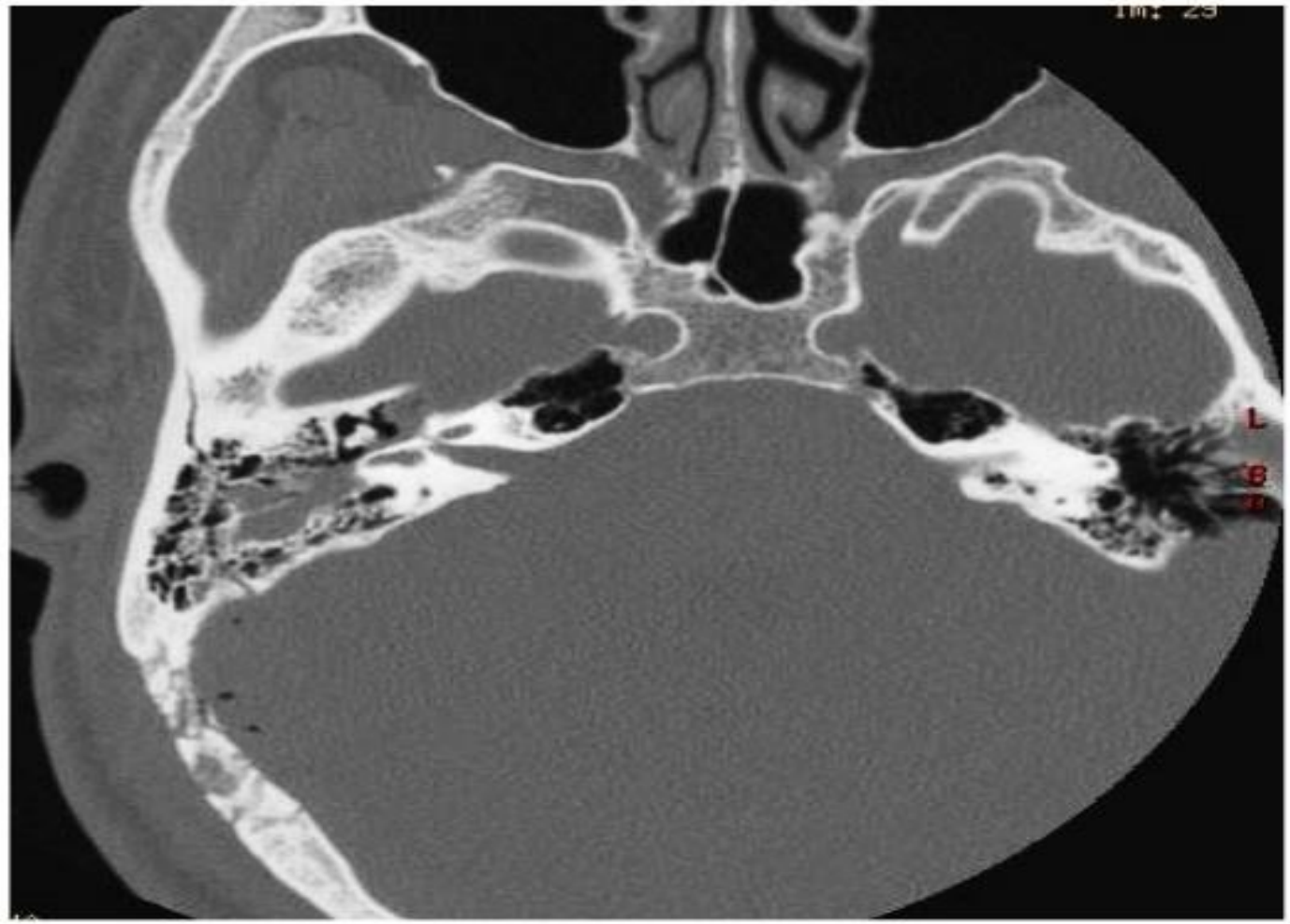




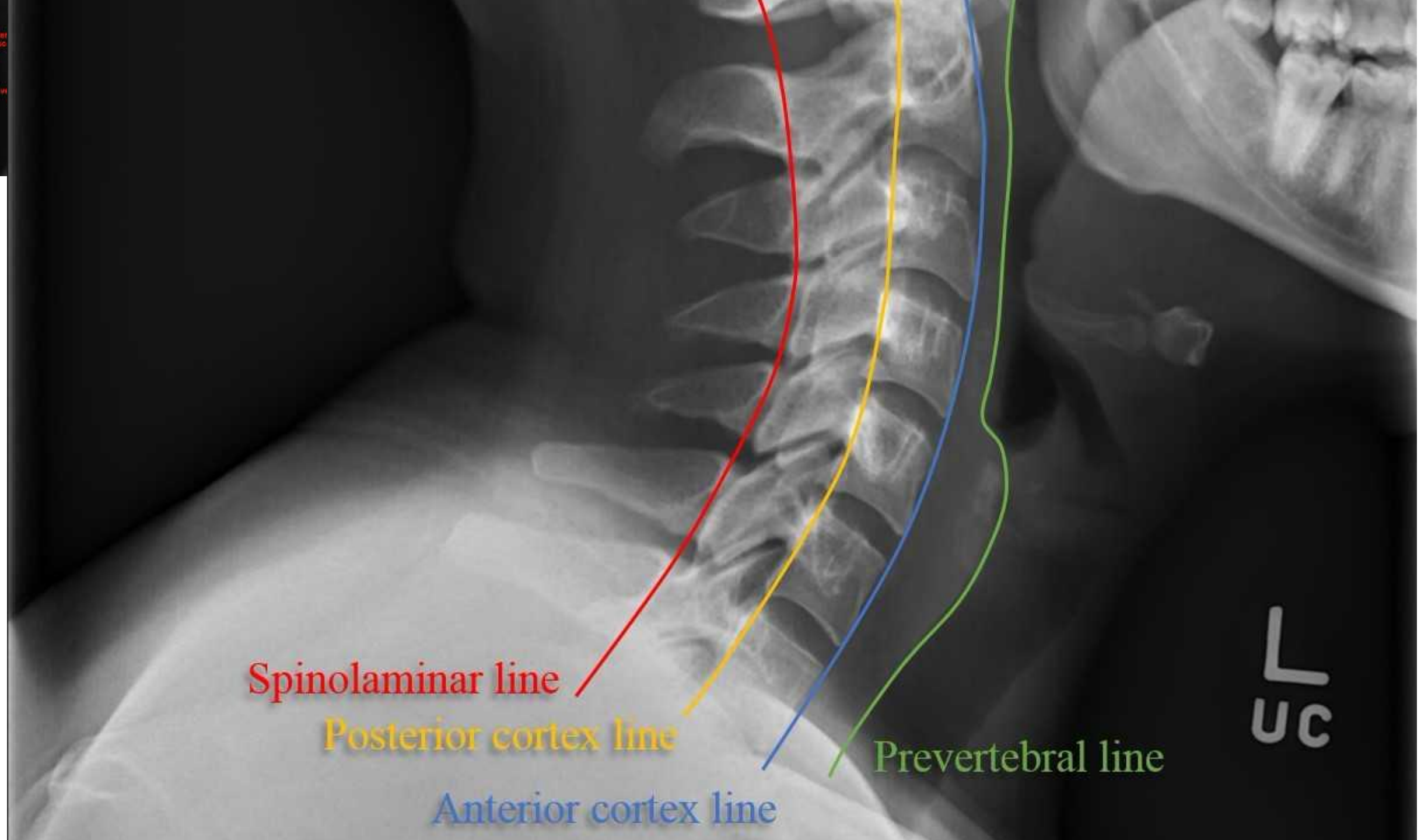


TEMPORAL BONE FRACTURES

- Look for opacification of the mastoid
- Longitudinal: 70%, parallel to long axis of petrous bone, conductive hearing loss (from ossicular dislocation), facial nerve paralysis (20%)
- Transverse: 20%, sensorineural hearing loss, facial nerve paralysis (50%)
- Complex
- Complications: meningitis, abscess

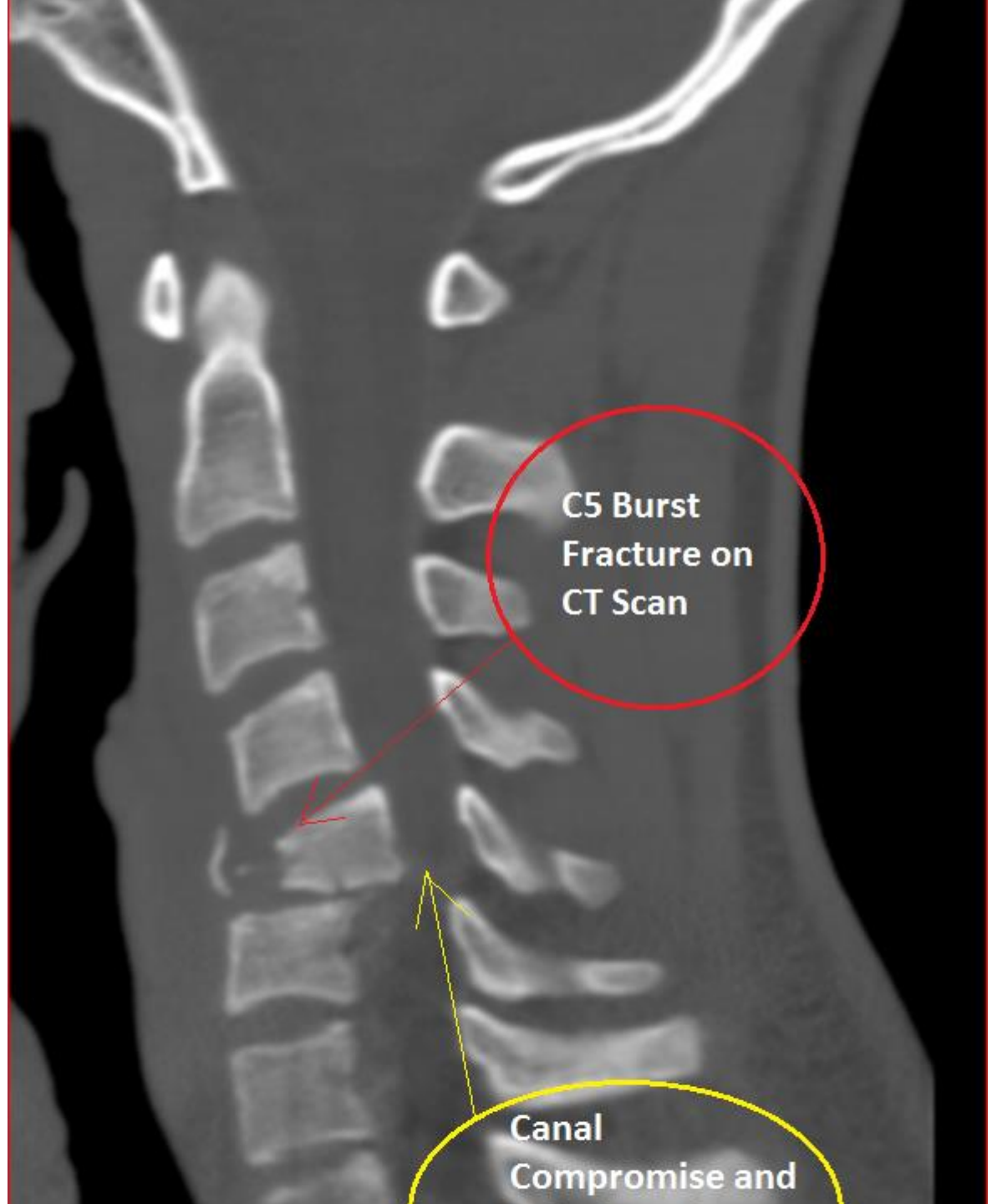


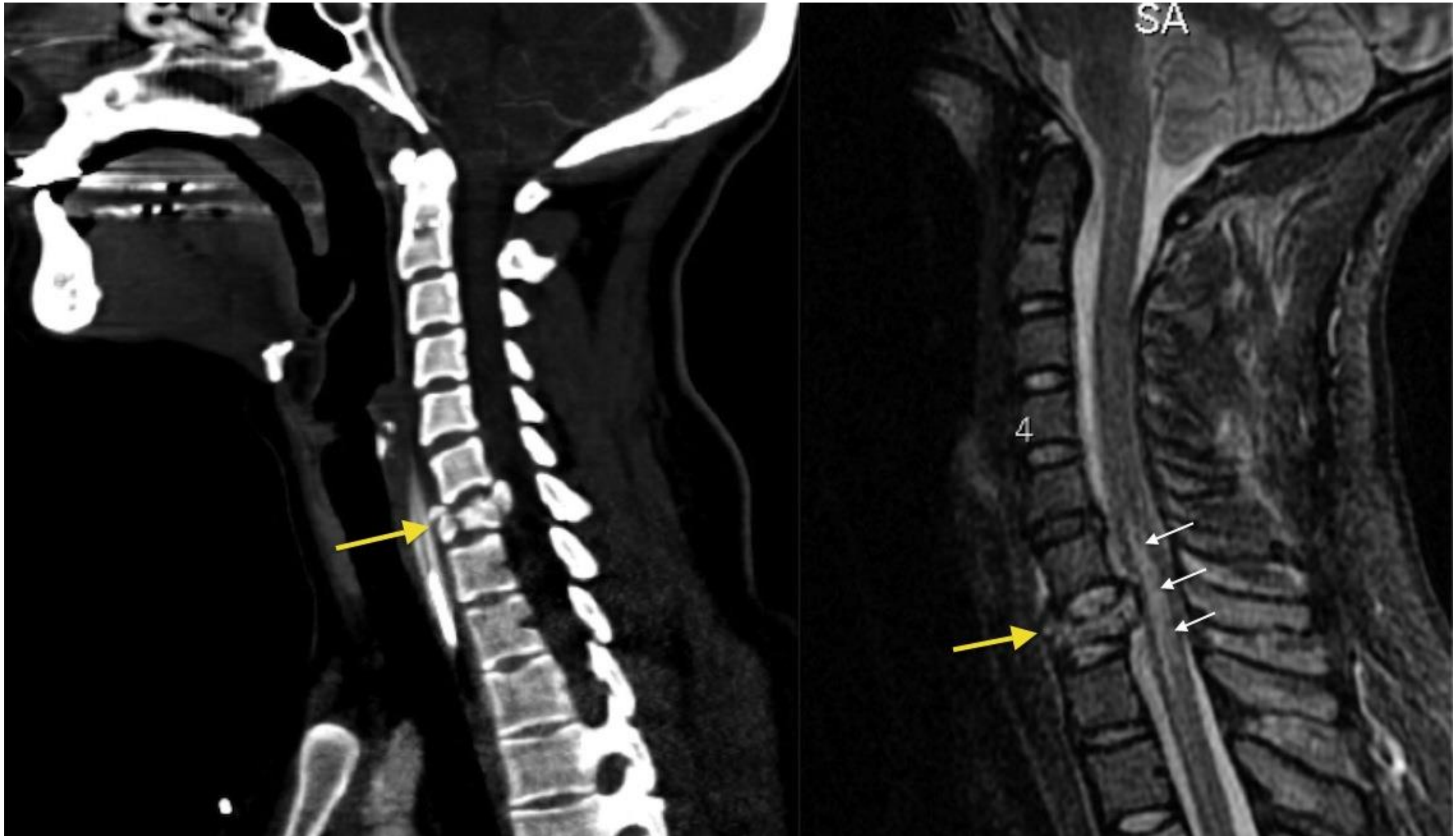

anterior cortical line
lateral mass
facet joint
lamina
spinous process
pedicle


Spinolaminar line
Posterior cortex line
Anterior cortex line
Prevertebral line
L
UC

OPEN MOUTH VIEW

- Adequacy: must show peg
  C2 and lateral masses of C


C5 Burst
Fracture on
CT Scan
Canal
Compromise and


SA
4

Flail Chest

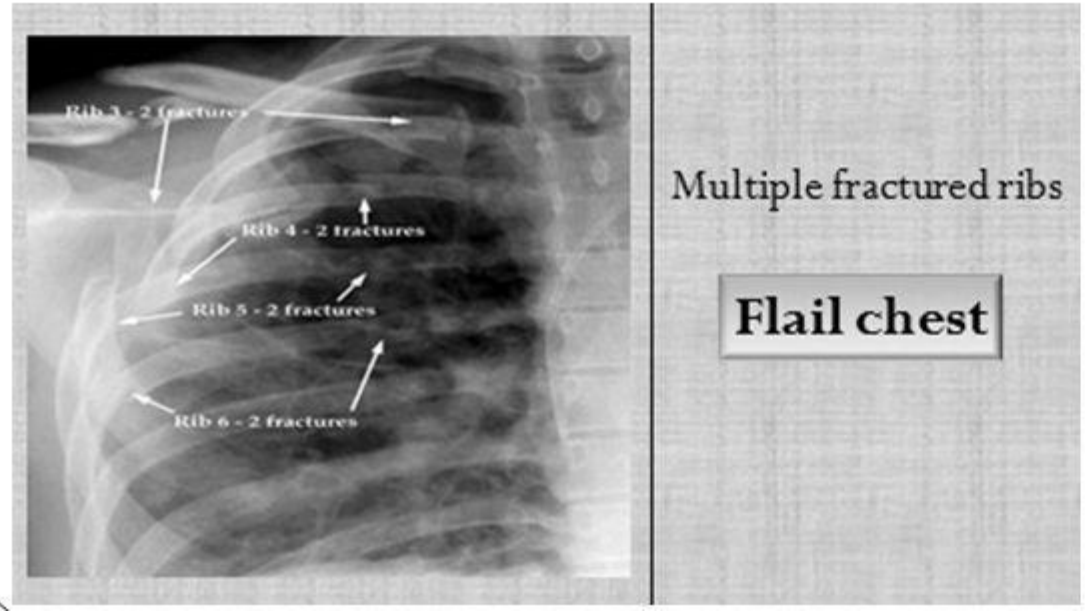
F

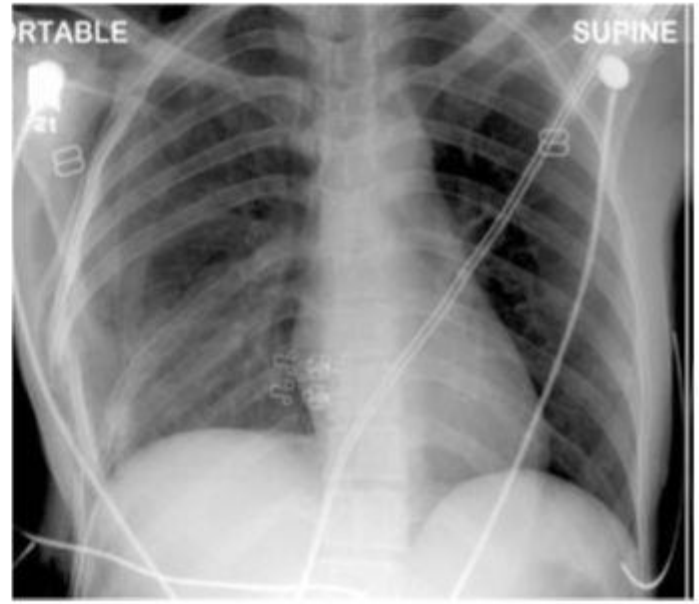
Rib fractures

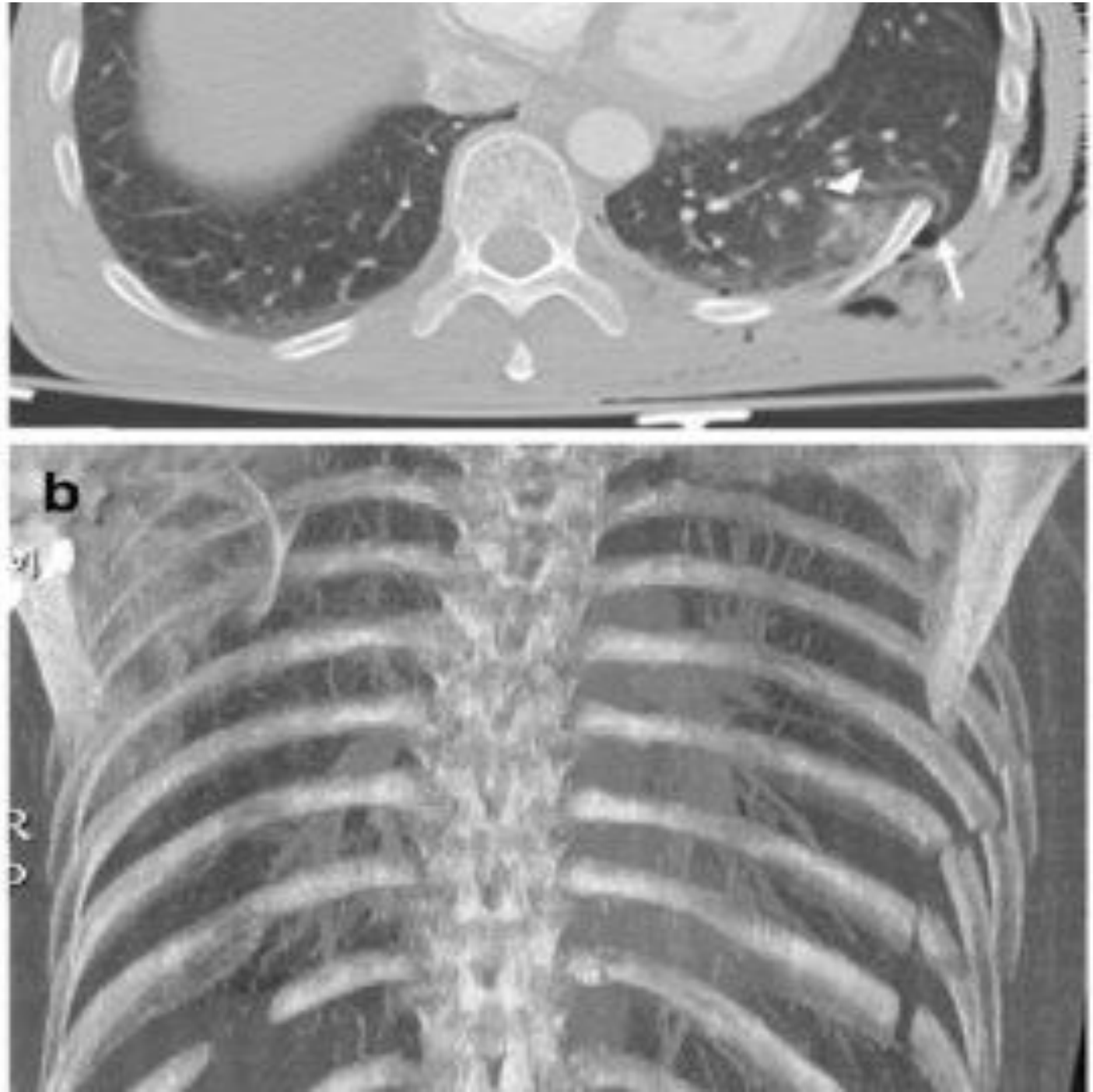
- Most common findings after blunt chest trauma
- CXR sensitivity 18-50%
- Most common = rib 4-9
  - Rib 1-3 → neurovascular injury
  - Rib 9-12 → liver, spleen, kidney
- Absence of fracture lines:
  - In adults >65 years may warrant rib series.
  - In children, it does not mean mild injuries because of pliable ribs

Flail chest

- A condition of multiple rib fractures produce a mobile fragment which moves paradoxically with respiration
- Usually traumatic with two or more ribs fractured in two or more places..
- Always consider underlying lung injury (pulmonary contusion).
- Underlying lung contusion are likely to contribute to the patient's hypoxia.
- The main Clinical features are: Dyspnoea, Tachycardia, hypoxia ,Cyanosis and Hypotension






b


C

Figure 6. CXR Revealing Right Hemothorax

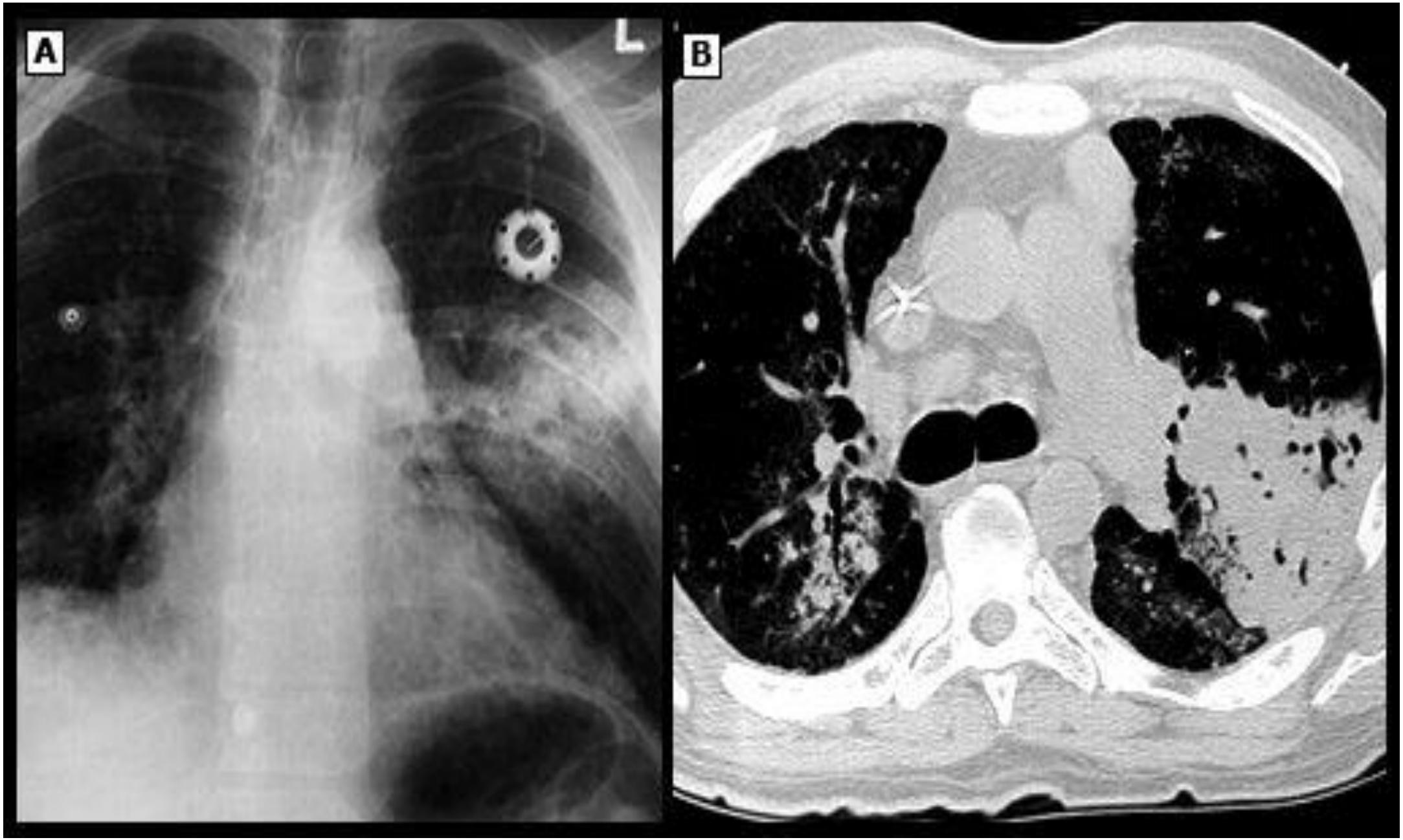
Tension Pneumothorax

- Death may occur relatively rapidly due to combination of HYPOXIA and HYPOTENSION
- HYPOXIA due to V/Q Mismatch
  - Ipsilateral lung collapse
  - Mediastinal shift →contralateral lung collapse
- HYPOTENSION due to positive intra-thoracic pressure
  - Impaired venous return
  - Reduced stroke volume → reduced cardiac output → hypotension

This is a Clinical Diagnosis

- Findings on chest X-ray suggestive of a pulmonary contusion include focal or diffuse homogenous opacification on multiple lung segments and lobes, particularly when the opacities are outside the bounds of normal anatomical limits

Kwon A, Sorrels DL, Kurkchubasche AG, et al. Isolated computed tomography diagnosis of pulmonary contusion does not correlate with increased morbidity. *J Pediatr Surgery 2006;41:78-82.*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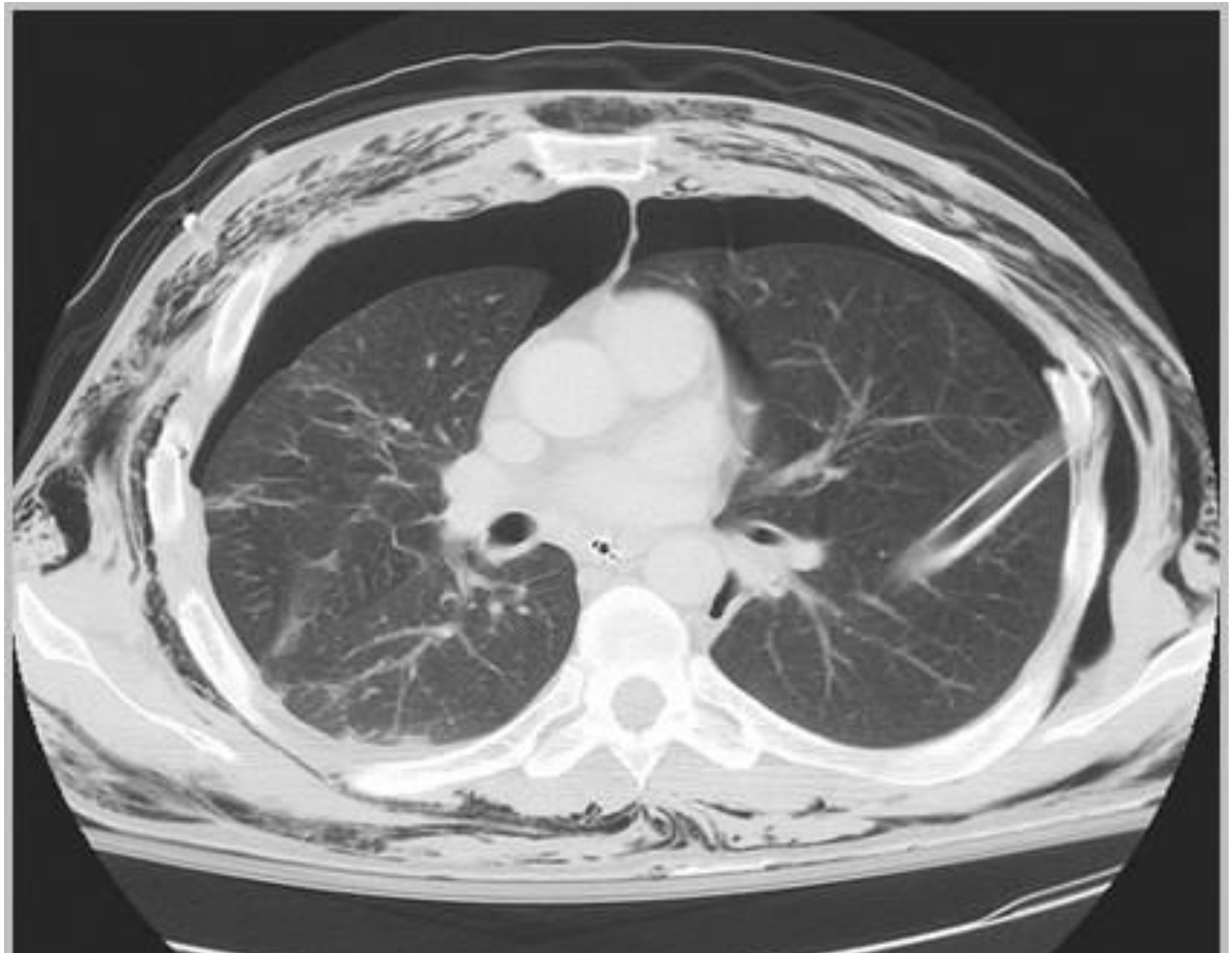
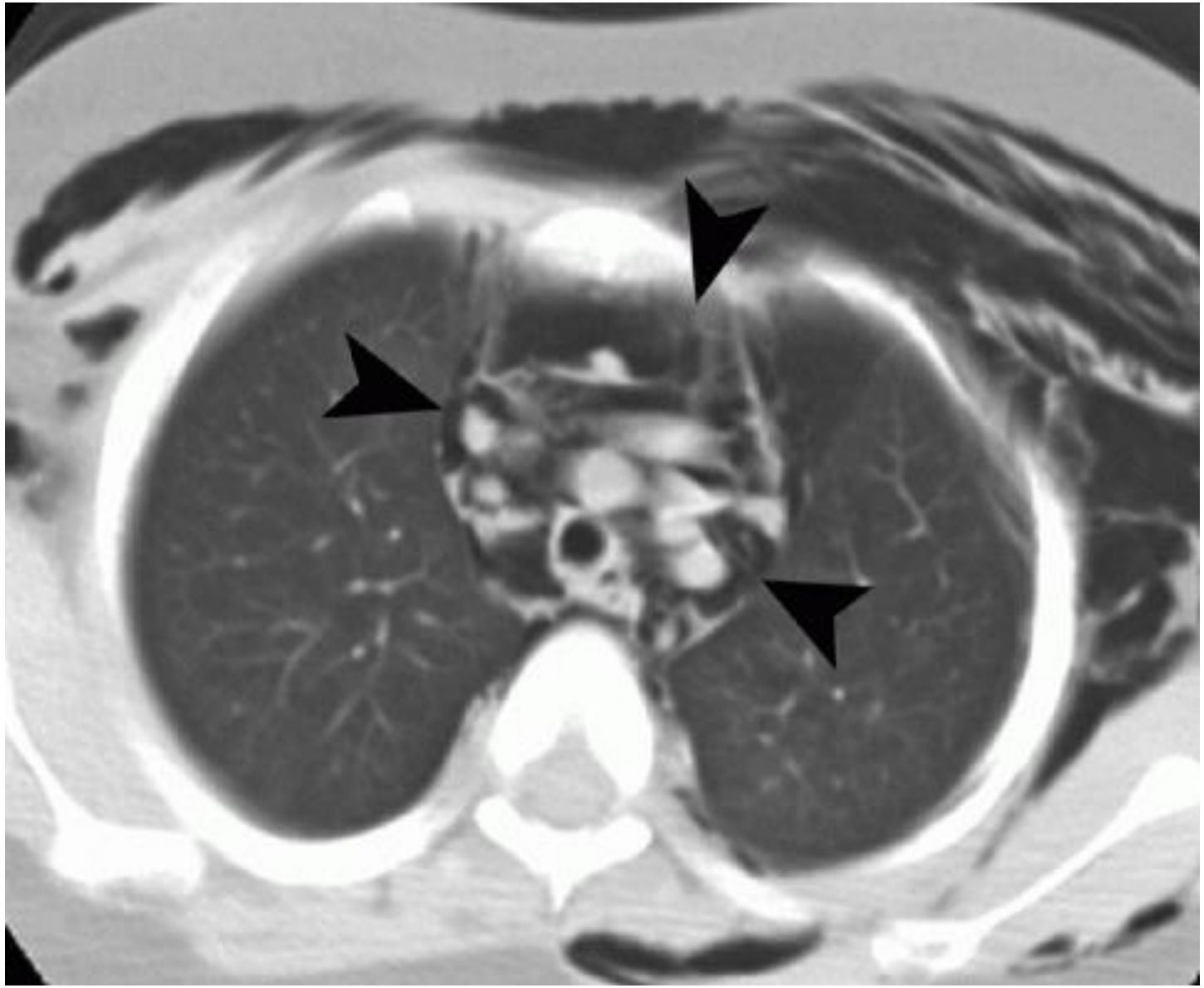




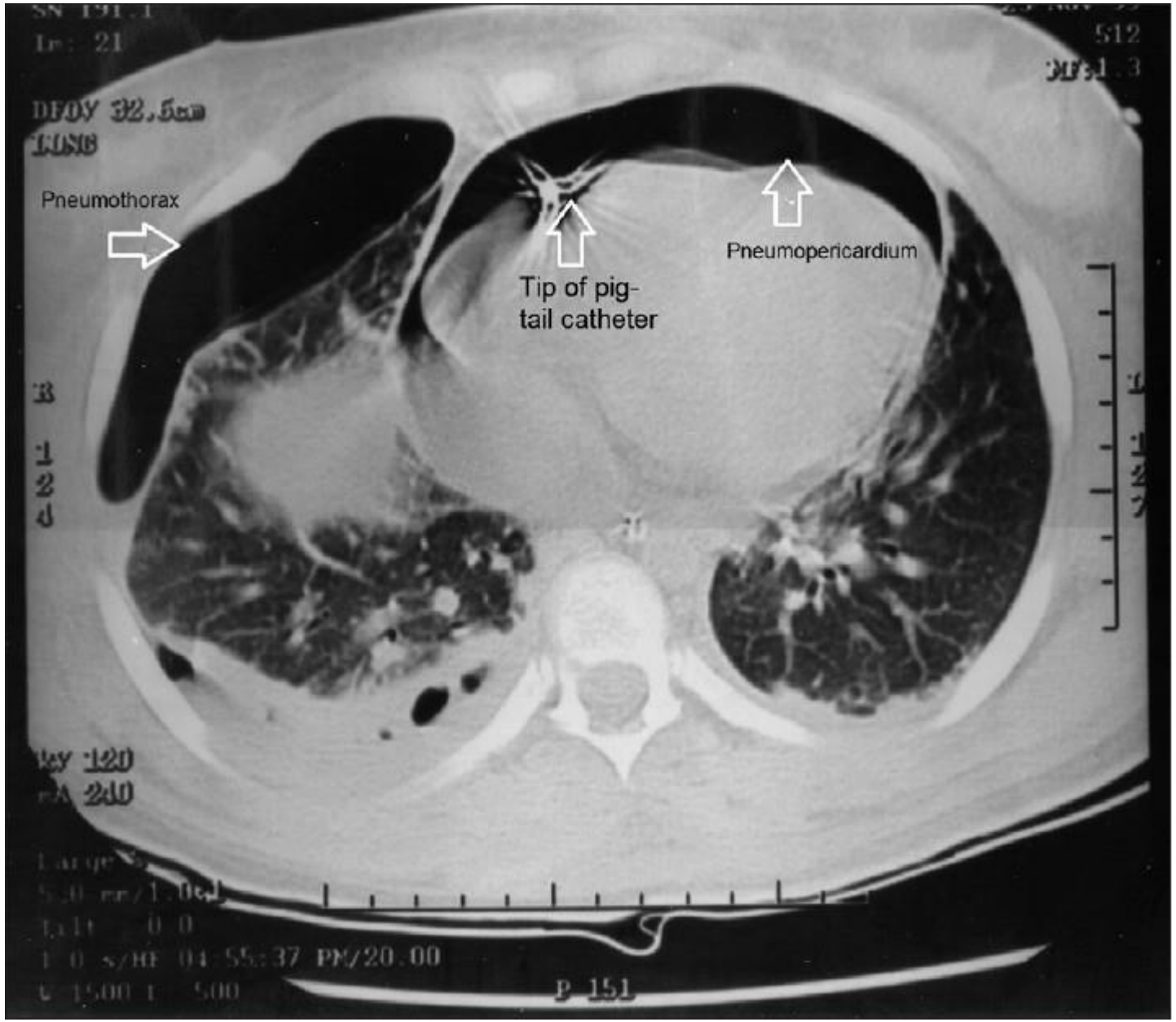
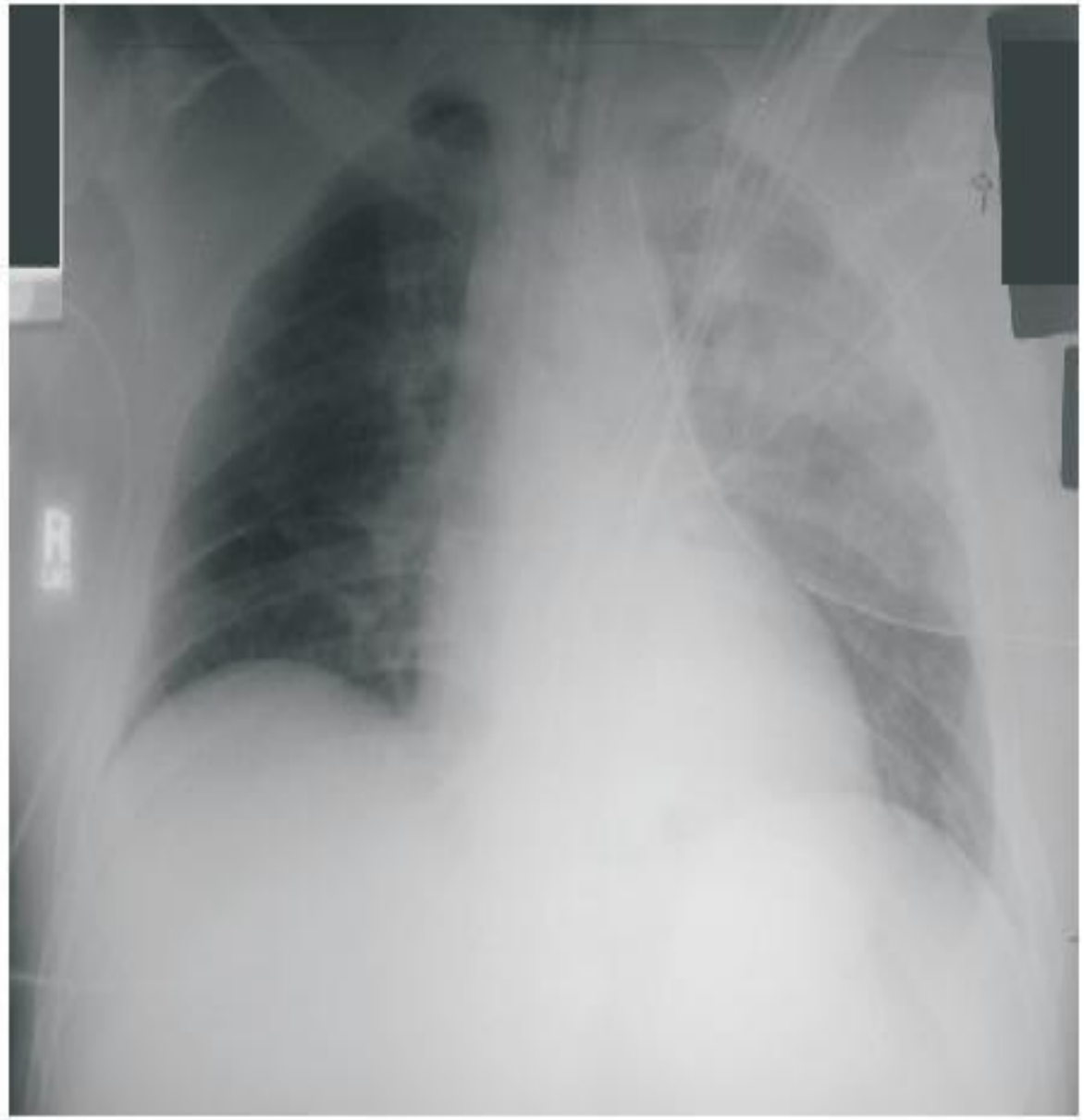
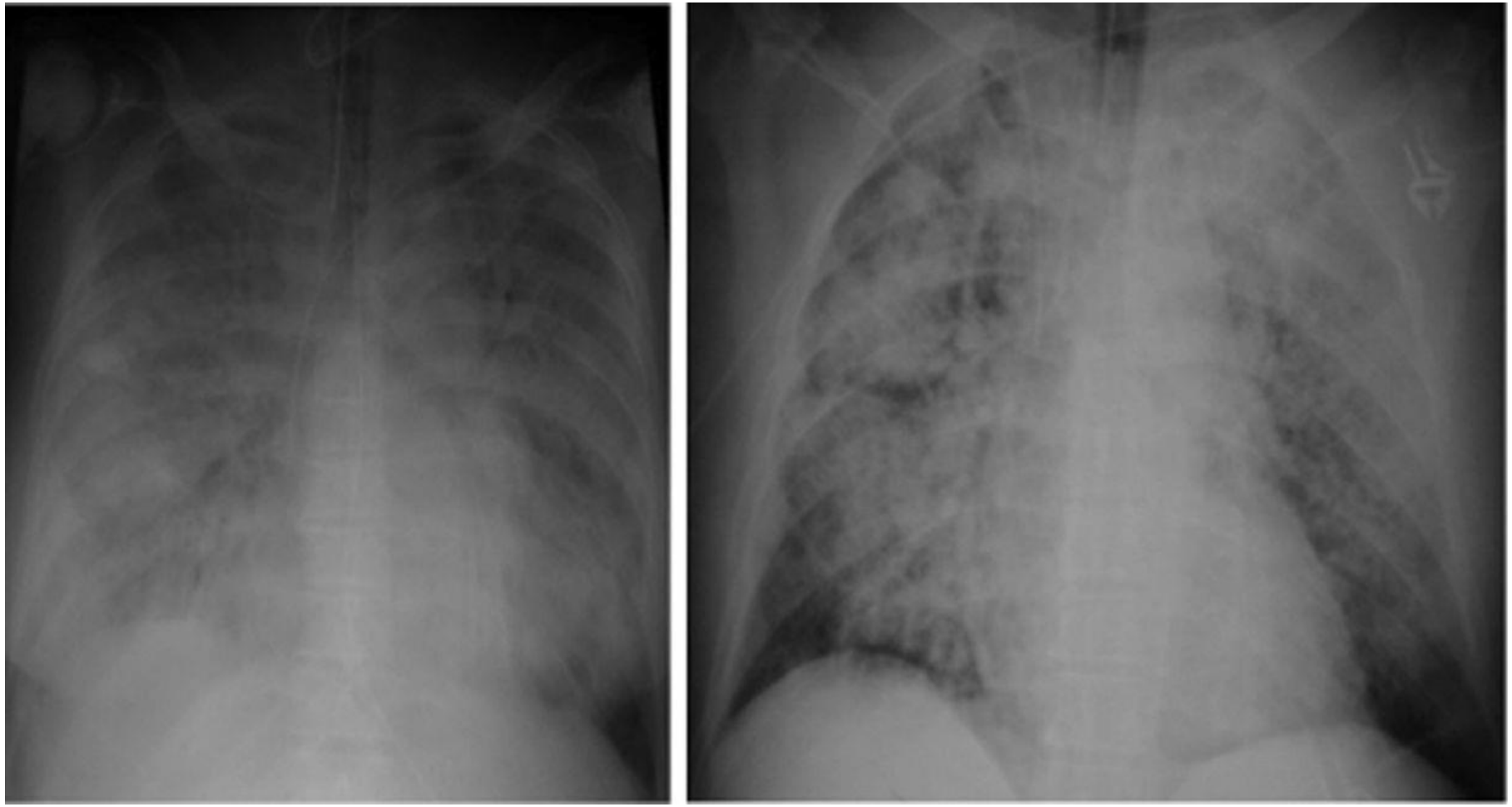
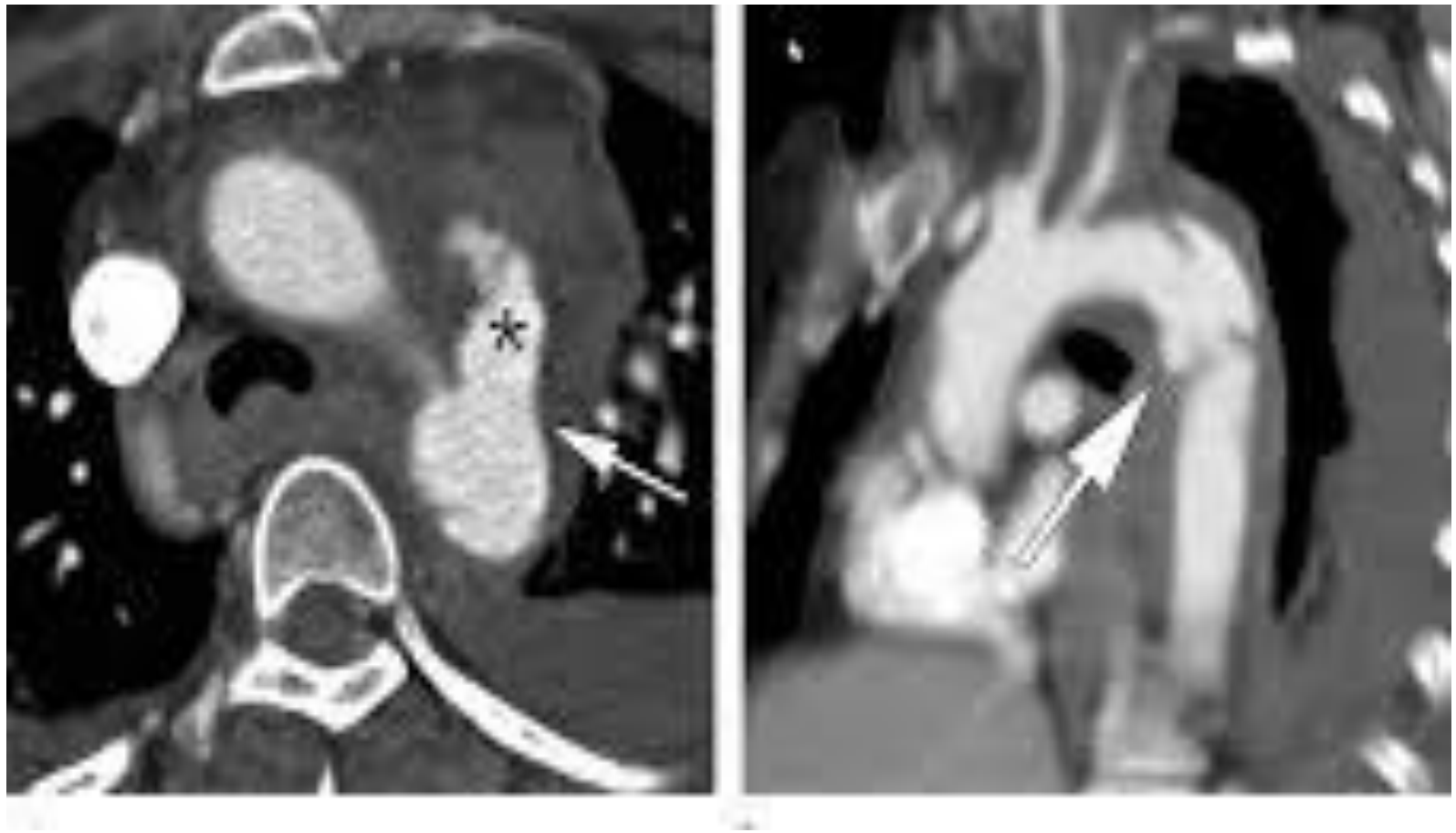

Pneumothorax
Tip of pig-tail catheter
Pneumopericardium

Figure 13. Pulmonary Contusion






L
SUPINE



Diaphragmatic Injury

Specific signs

- Herniation of abdominal viscera into thorax
- CT "collar" sign

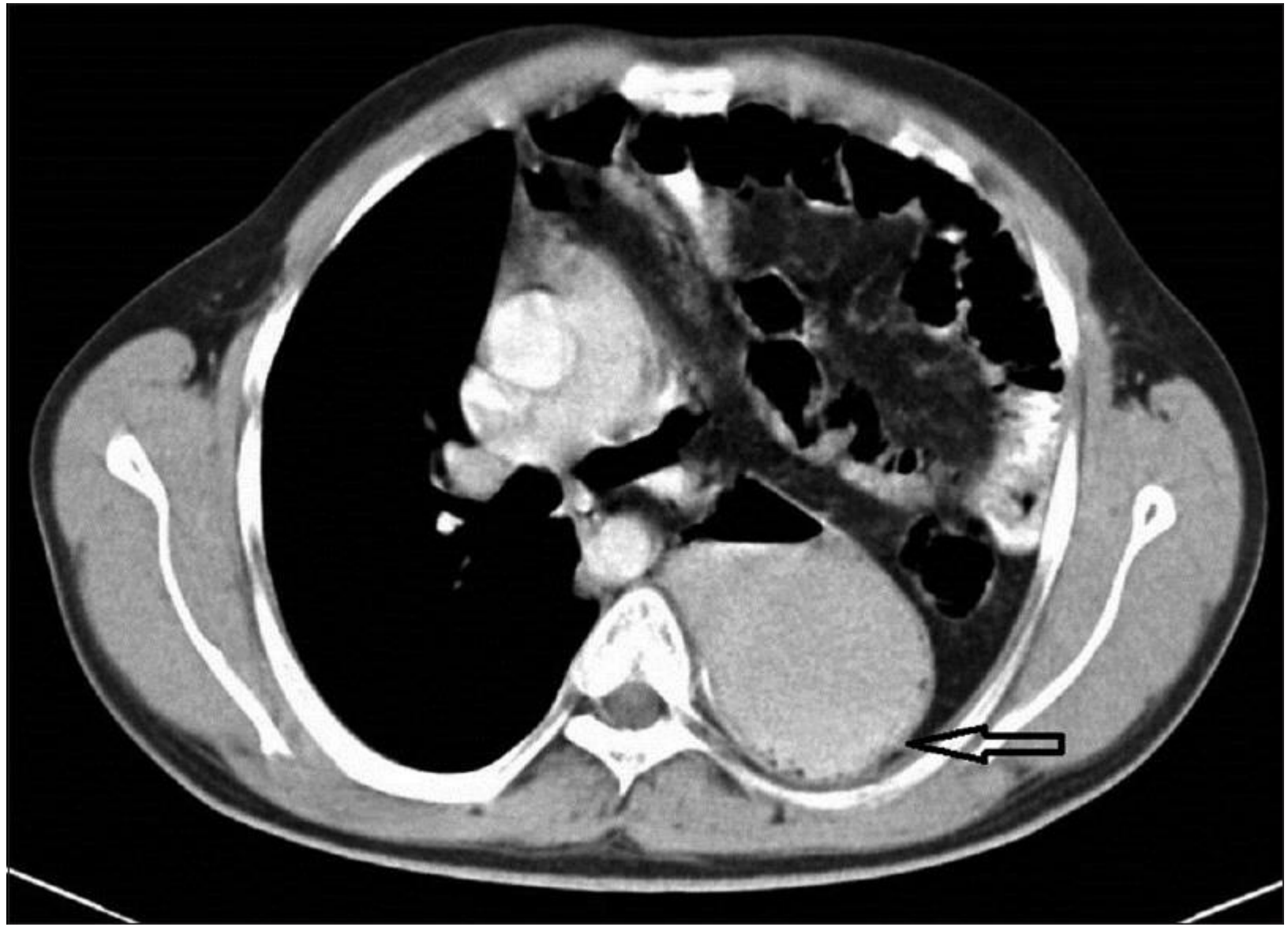
Non-specific signs

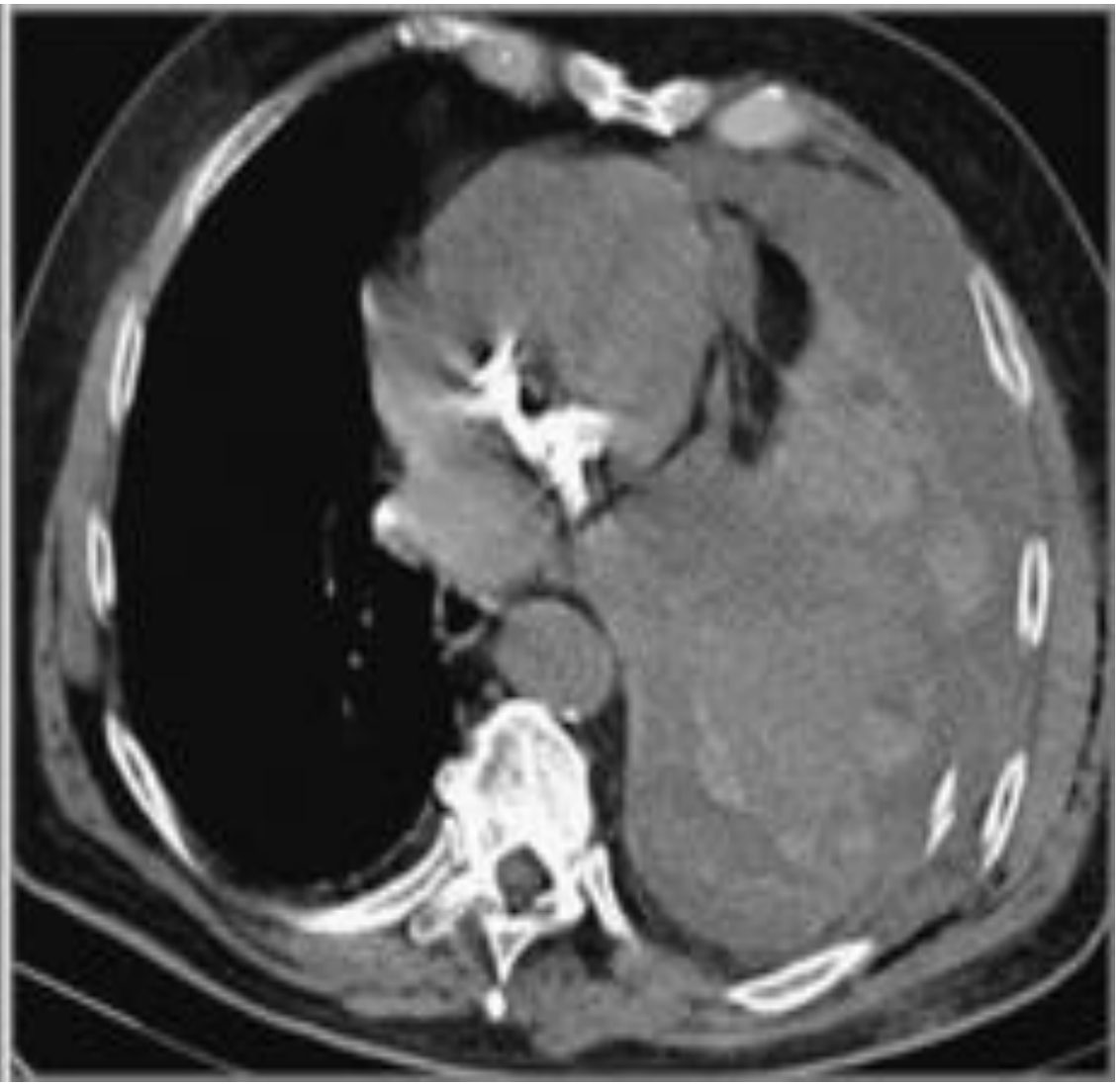
- Discontinuity of the crus
- Thickening of the diaphragm
- "Dependent viscera" sign

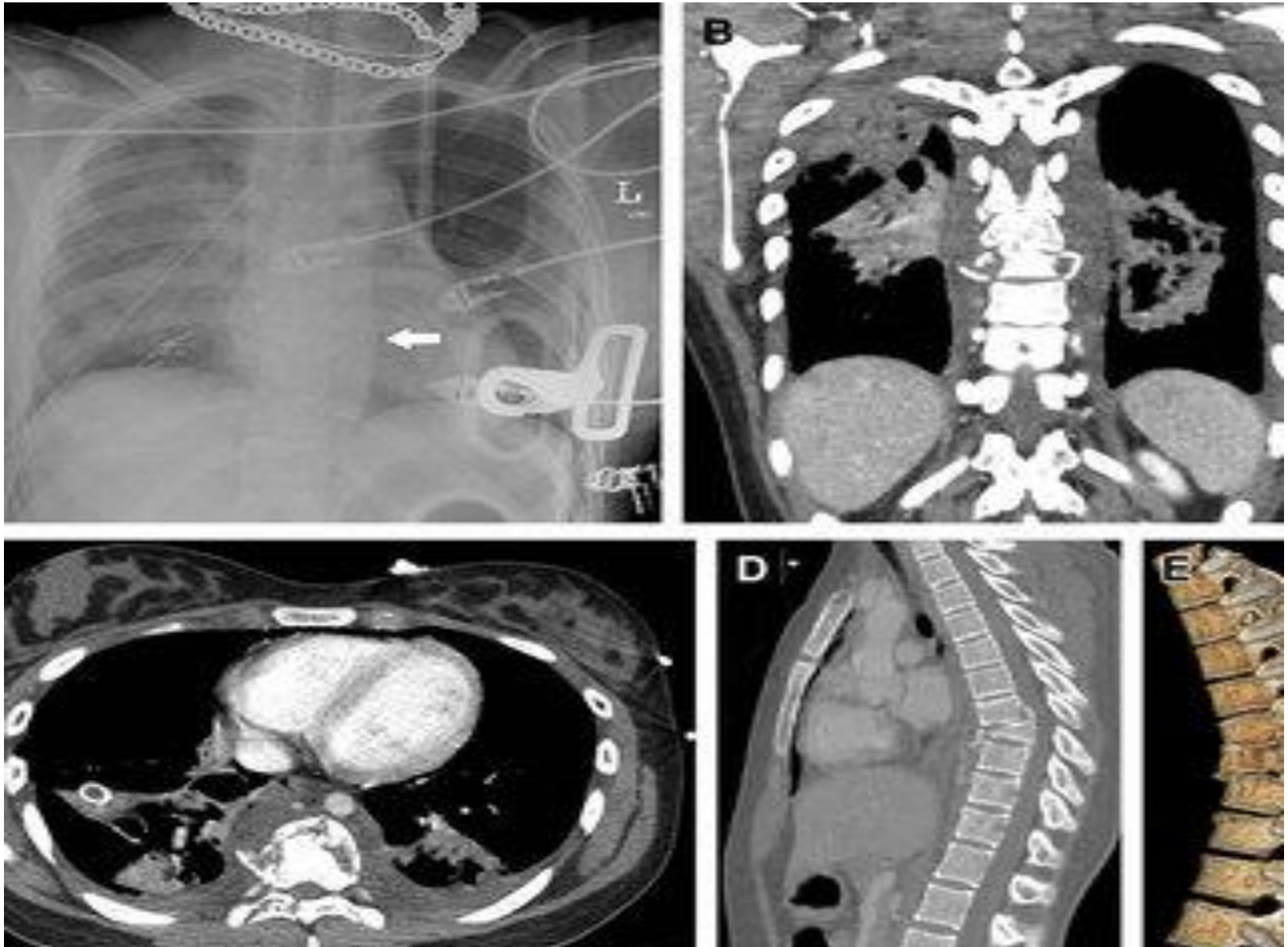
Diaphragmatic Trauma

D

CXR Signs
Diaphragmatic elevation
Abdominal organ in thorax
NG tube in thorax
Basilar lung opacities/ hemothorax
Mediastinal shift
Distorted diaphragm contour
Lower rib fracures



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Trauma Panel Classification Scheme[28]	
Major Clinical Significance	**Minor Clinical Significance**
- Aortic/great vessel injury - Ruptured diaphragm - Pneumothorax requiring evaluation procedure - Sternal fracture receiving surgical intervention - Multiple rib fractures requiring surgical intervention or epidural - Pulmonary contusion requiring mechanical or non-invasive ventilation within 24 hours of presentation for management - Thoracic spine fracture requiring surgical intervention - Scapular fracture requiring surgical intervention - Mediastinal or pericardial hematoma requiring drainage - Esophageal injury requiring surgical intervention - Tracheal or bronchial injury requiring surgical intervention	- Pneumothorax without evacuation but observation for > 24 hours - Hemothorax without drainage but observation for > 24 hours - Sternal fracture without surgical intervention - Multiple rib fractures without surgical intervention or epidural - Pulmonary contusion or laceration without a requirement for respiratory support - Thoracic spine fracture without a requirement for surgical intervention - Scapular fracture without requirement for surgical intervention - Mediastinal or pericardial hematoma without a requirement for surgical drainage - Esophageal injury without a requirement for surgical intervention - Tracheal or bronchial injury without a requirement for surgical intervention