Case Based Thoracic Trauma Imaging

Fabio Paes, MD, MBA

Director of Quality and Patient Safety – Department of Radiology
Associate Professor of Radiology – ER/Trauma Division
University of Miami - Jackson Memorial Hospital
Ryder Trauma Center

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Disclosures

I do not have any relationships to report with ACCME defined ineligible companies.

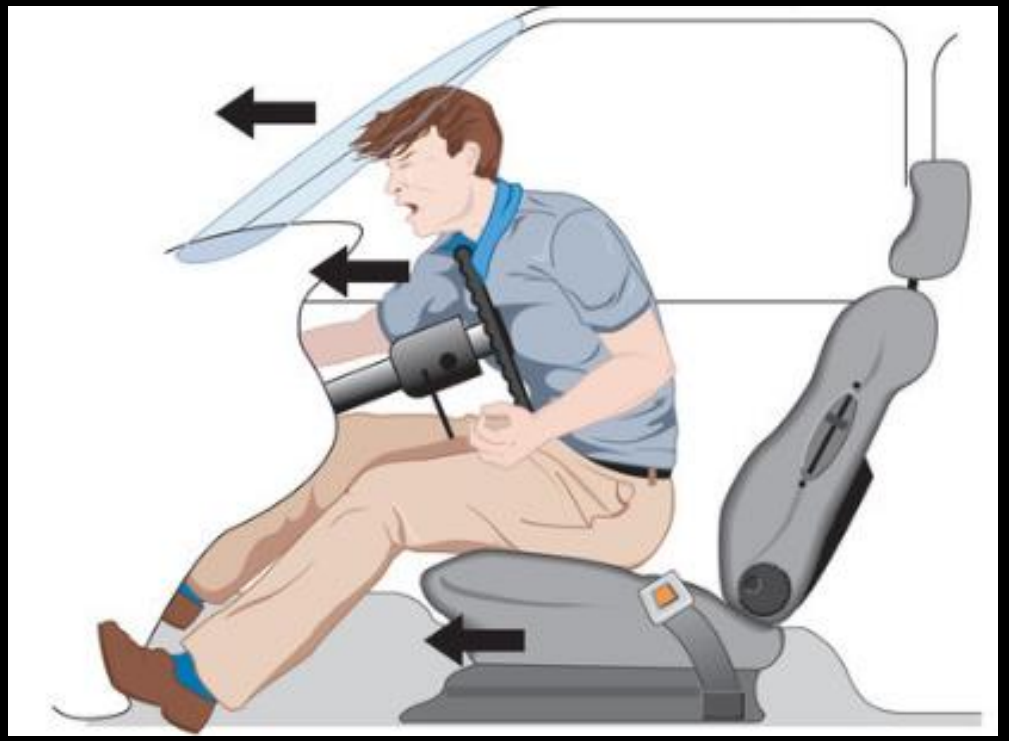
I will not be discussing unlabeled/investigational uses of medical devices or pharmaceuticals during this presentation.

Objectives

- Briefly present the epidemiology of thoracic trauma and role of MDCT.
- Review common findings and strategies for imaging diagnosis of thoracic injuries
- Present some interesting and challenging thoracic trauma cases.

Thoracic Trauma

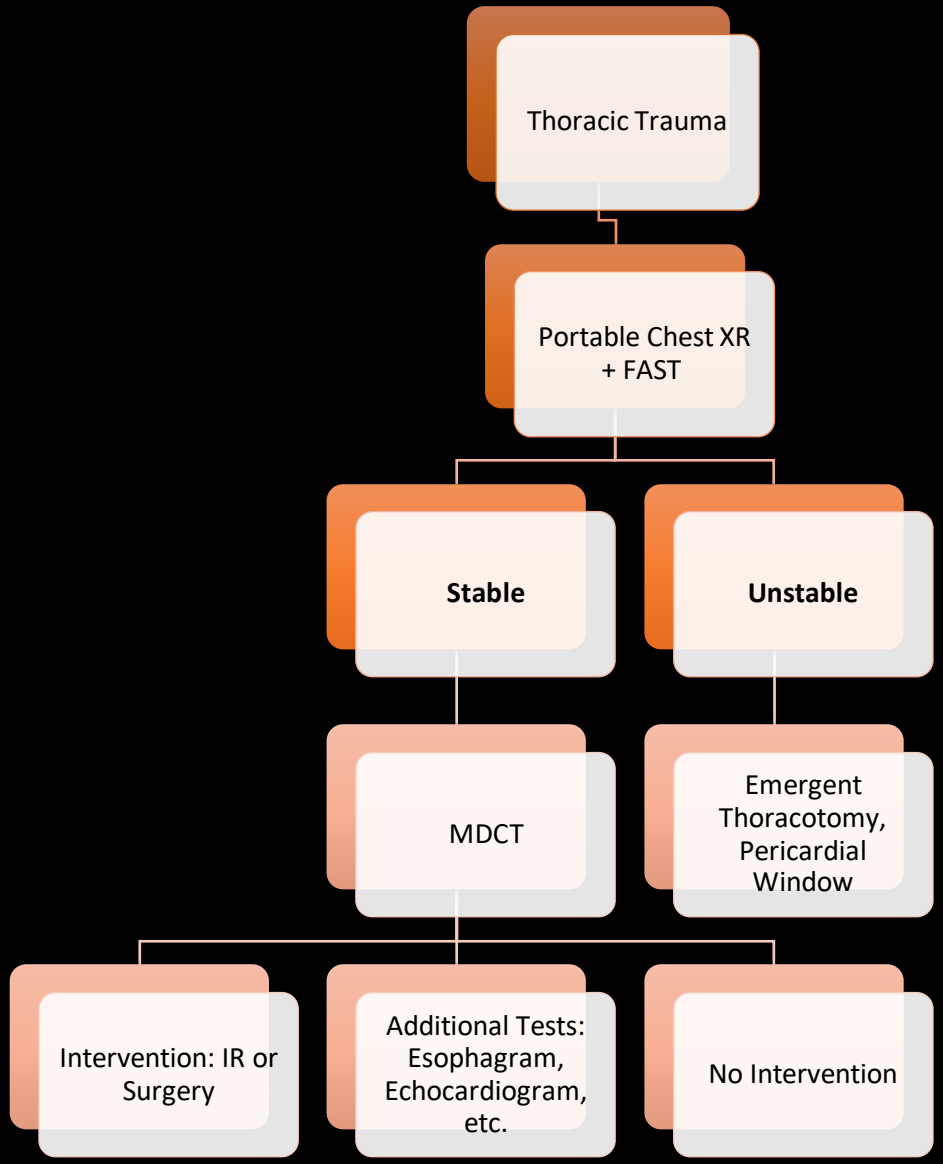
- Incidence: 20-25% all trauma and 60% of patients with polytrauma
- Mortality: wide-range, 10% overall
  - Blunt polytrauma + BL lung contusion + hemopneumothorax: ~50%.
  - Traqueobronchial injuries: >80% pre-hospital.
- Blunt (80%):
  - 2/3 MVC and 1/3 falls
- Penetrating (10-20%):
  - Higher thoracotomy and mortality rate
  - 95% of injuries are caused by knifes or guns



1. Multidetector CT for Penetrating Torso Trauma: State of the Art, David Dreizin and Felipe Munera, Radiology 2015 277: 2, 338-355
2. Firearm-Related Injury and Death in the United States: A Call to Action From the Nation's Leading Physician and Public Health Professional Organizations. McLean RM, Harris P, Cullen J, Maier RV, Yasuda KE, Schwartz BJ, Benjamin GC. Ann Intern Med 2019;171(8):573-577. doi: 10.7326/M19-2441

Triage and Role of Imaging

- Hemodynamically Unstable
  - High mortality (>60%) = Emergent Intervention
- Chest XR
  - Lines/tubes, large PTX, HTX, mediastinum shift/widening, severe diaphragmatic and bony abnormalities
- MDCT
  - High sensitivity and specificity for clinically significant injuries
  - Penetrating: Helps determine trajectory
  - CTA +/- venous/delay phase (area of interest)



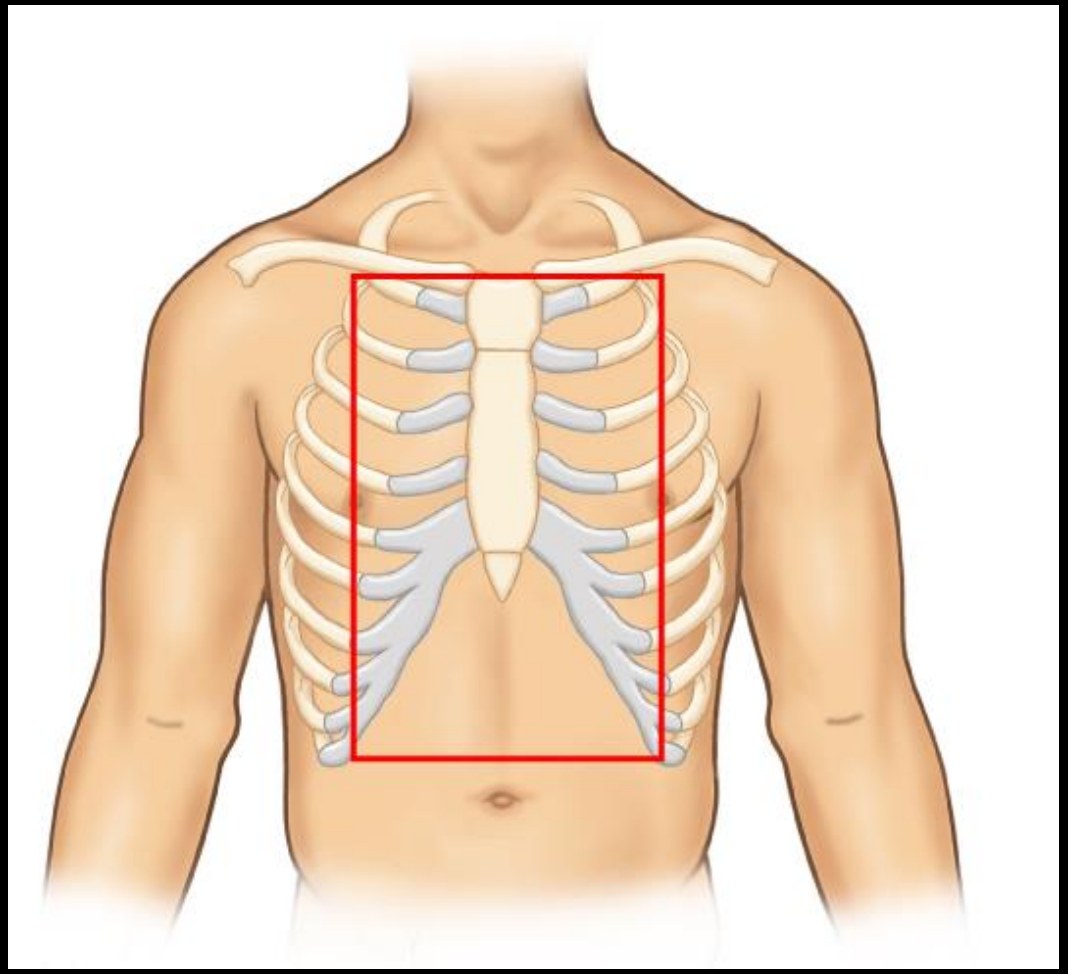
What to look for:

Visceral Injuries
- Ruptured diaphragm
- Pulmonary contusion
- Pneumothorax
- Hemothorax
- Tracheobronchial injuries
- Esophageal injury
- Pneumomediastinum

Cardiovascular Injuries
- Aortic rupture
- Caval injury
- Pericardial effusion/tamponade
- Subclavian artery injury
- Intercostal artery injury
- Cardiac laceration

Skeletal Injuries
- Flail chest
- Rib fracture
- Sternoclavicular fractures or dislocation
- Scapular fracture
- Clavicular fracture or dislocation
- Vertebral or spinal injury

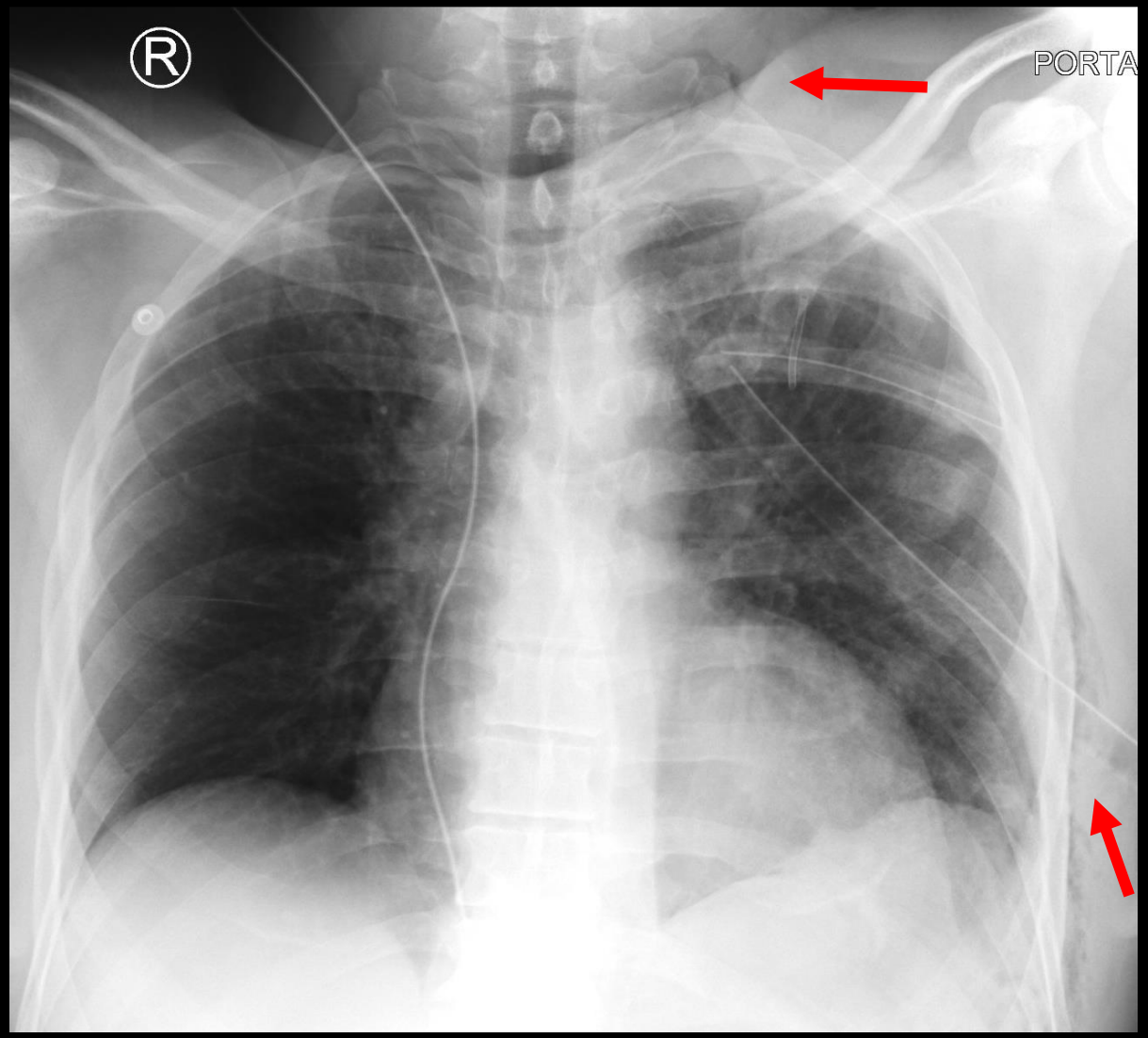
The "cardiac box" of penetrating injuries

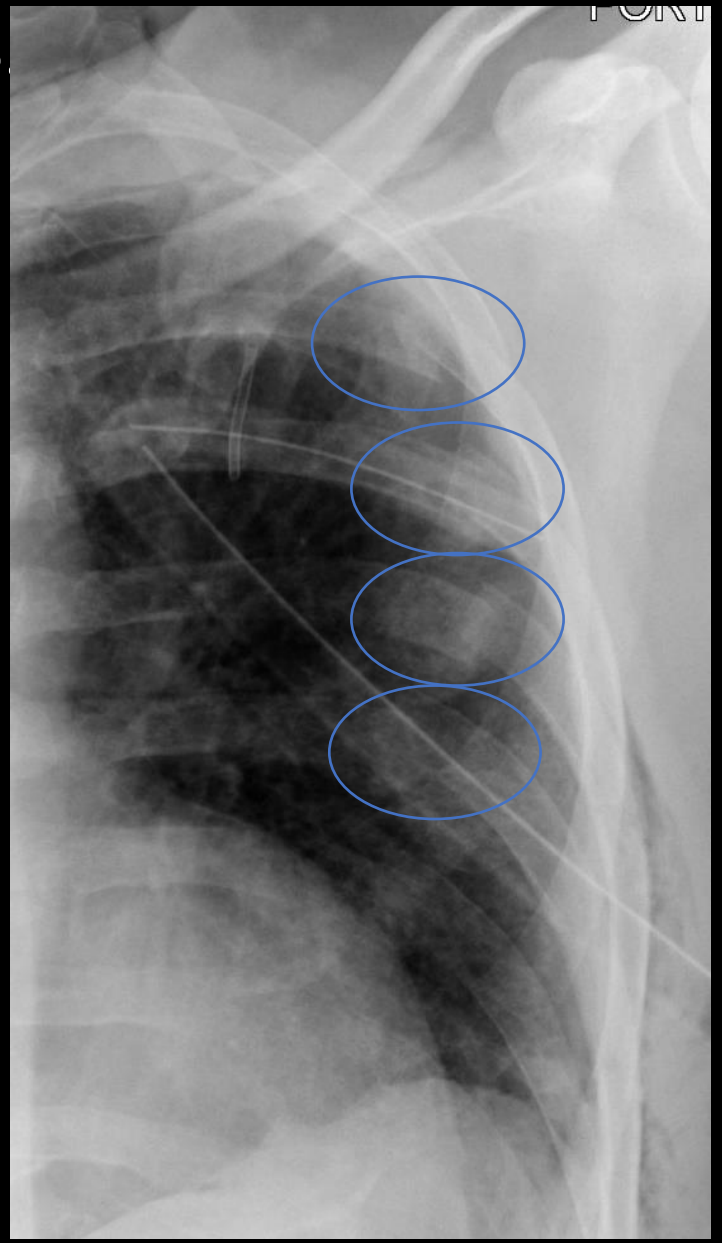


Trajectory is key!!!

Thoracic Trauma Cases

Case 1: 55 y/o fell from ladder. GCS 15





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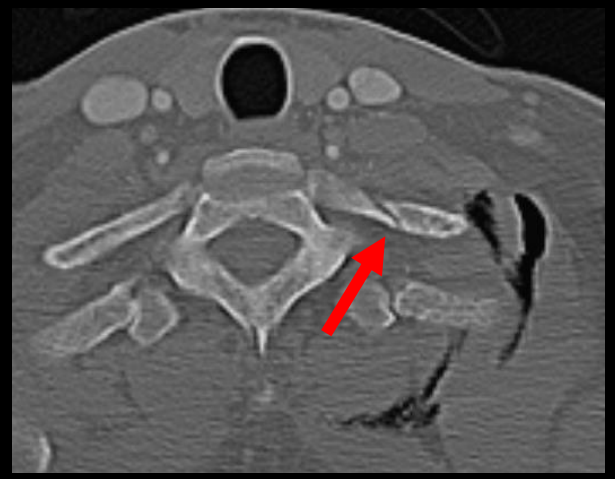

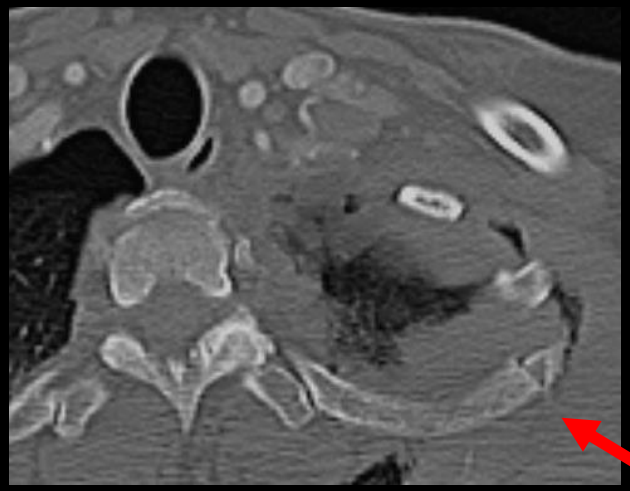

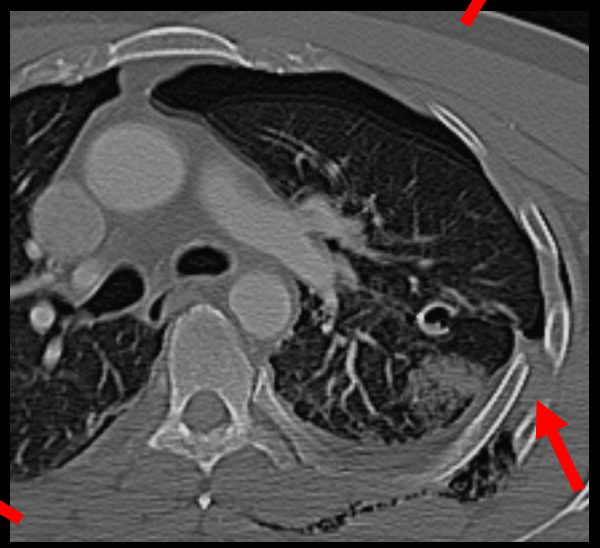

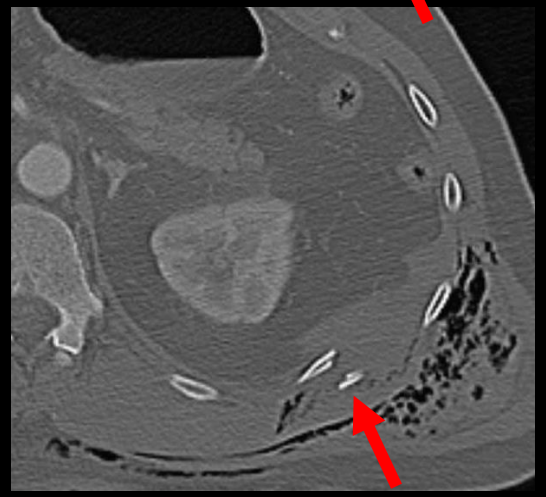

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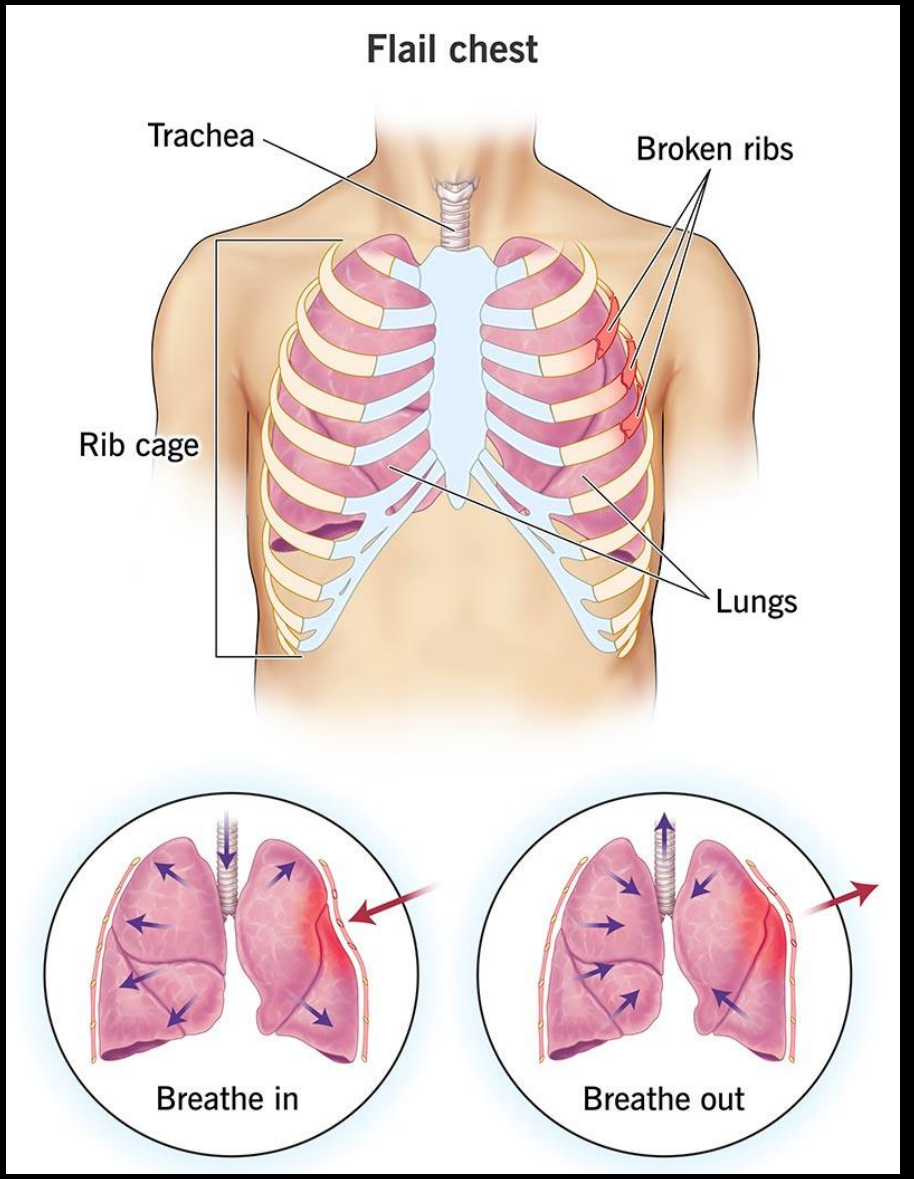
Multiple Rib Fx - "Flail Chest":

- Definition: Paradoxical motion of a segment of the chest causing disturbance in respiratory function.
- Condition: Two or more continues ribs are fractured in at least 2 places (segmental).
- Prevalence: 7% of chest Traumas
- Mortality: 10-20%, due to associated injuries (contusion, PTX, HTX, etc.)
- Morbidity: Longer hospital course, proportional to the number of ribs fractured. *Mortality increases with each additional rib fractured, approaching 40% if > 6 ribs are fractured.



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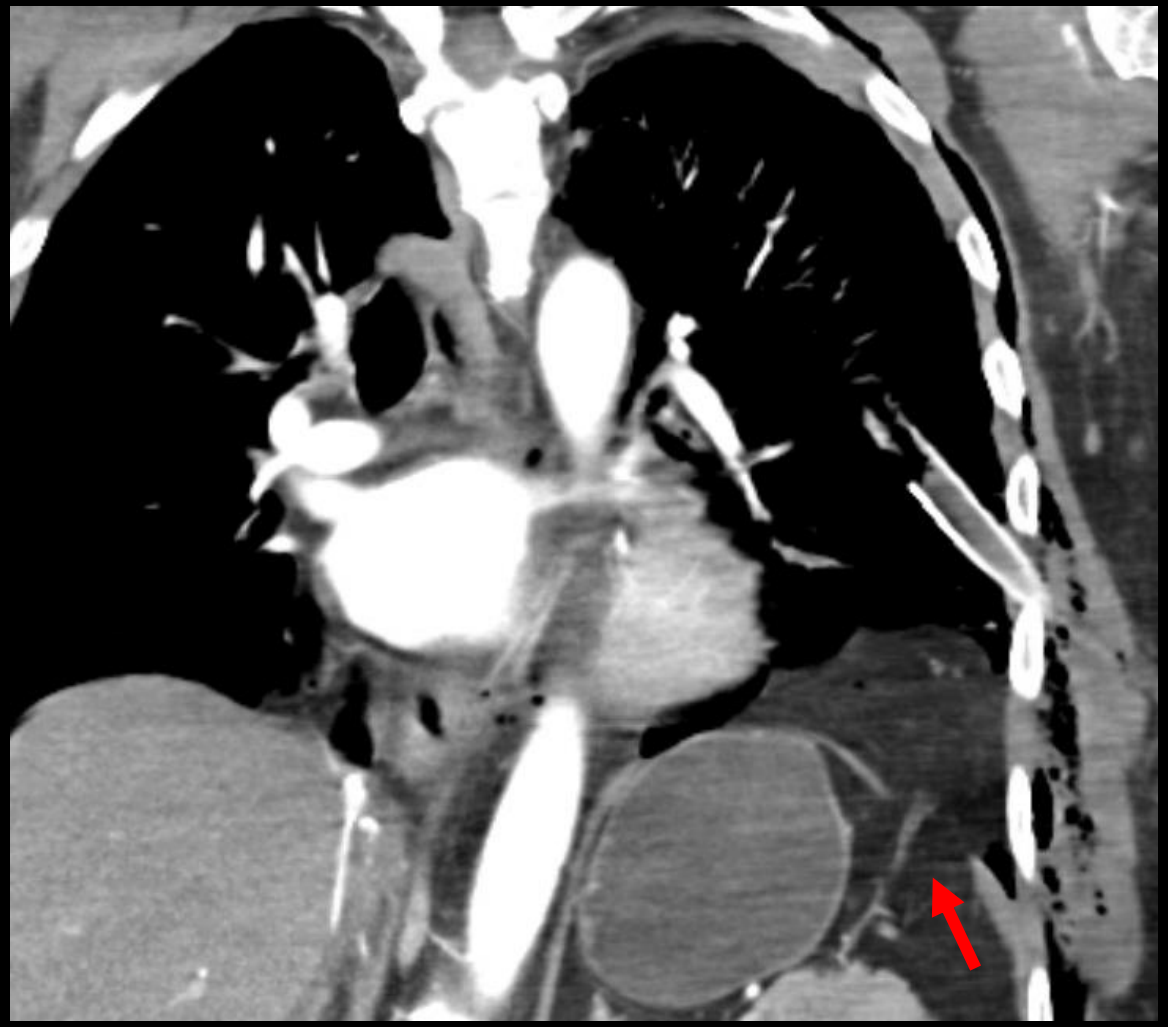

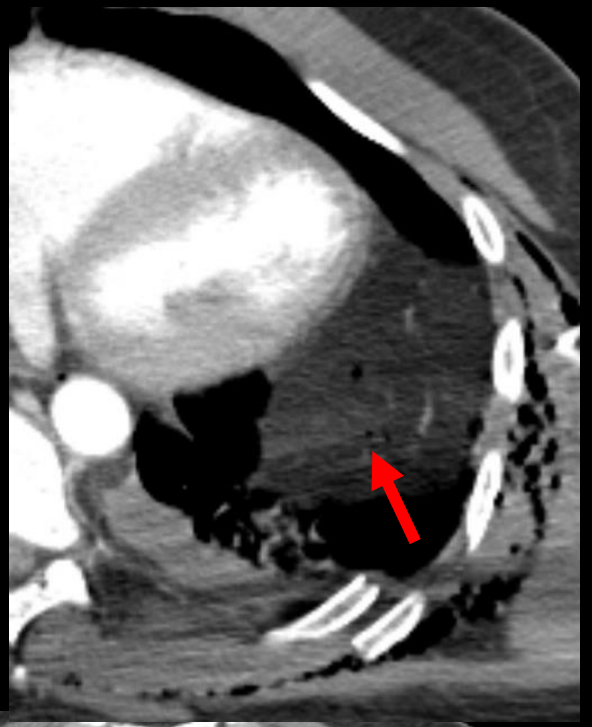

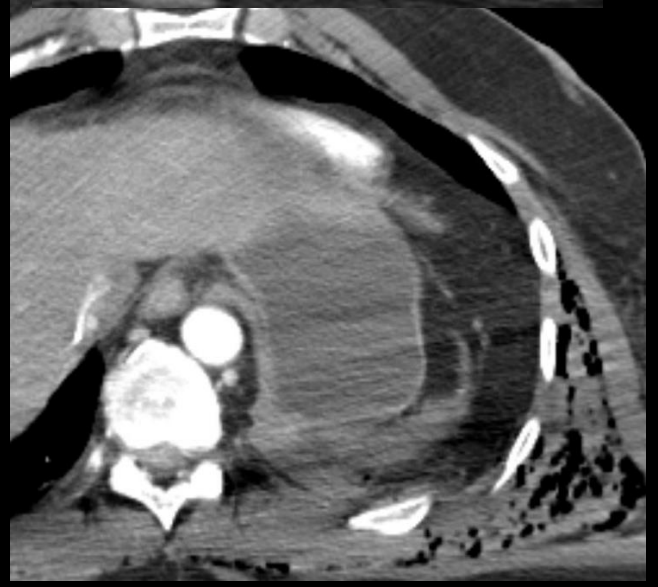

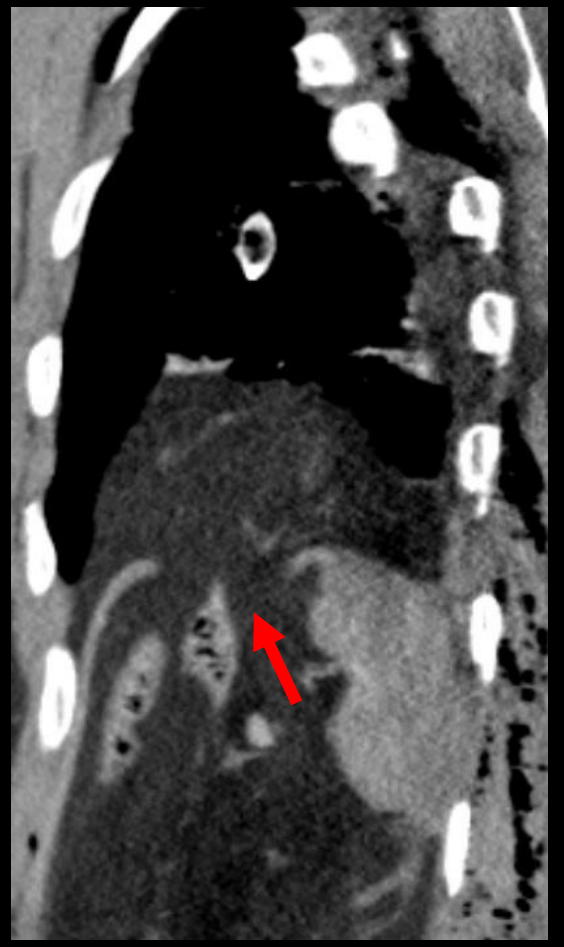

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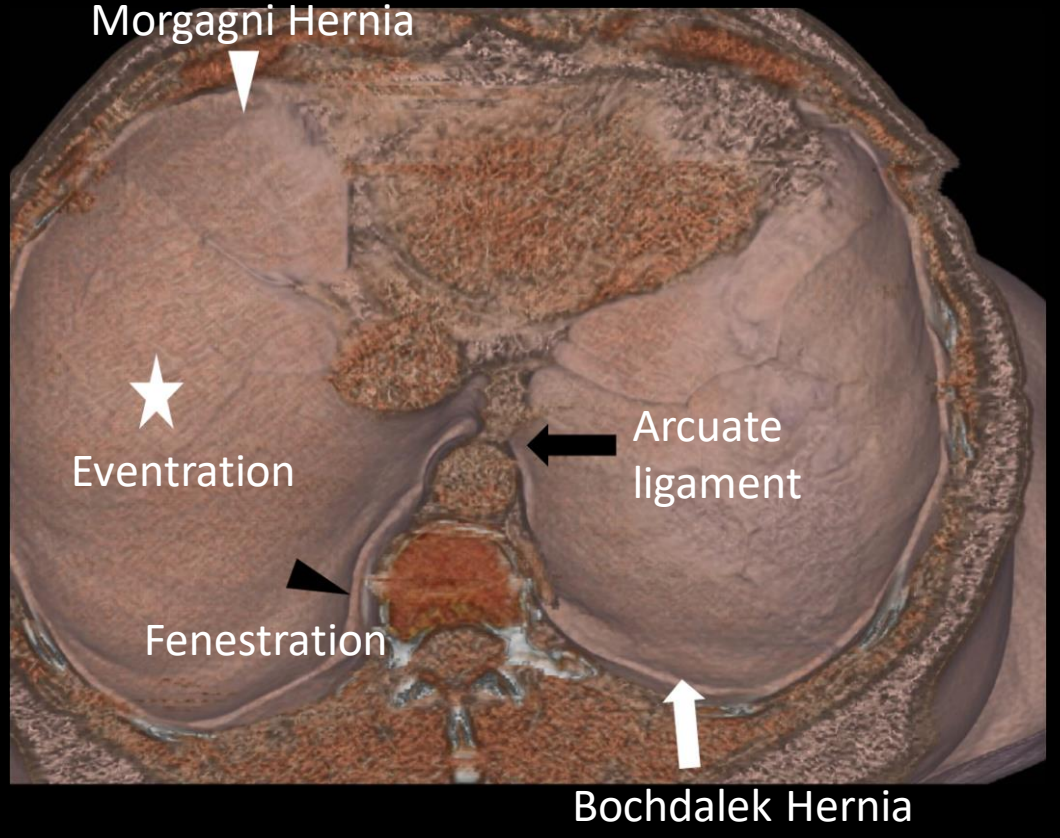
Diaphragmatic Injury/Rupture:

- Incidence:
  - Approximately 0.8-8% in blunt trauma and 10-15% in penetrating injuries
- Blunt injuries: large (about 10–15 cm defect), involves the left diaphragm (56–86% of cases) and have radial morphology.
- Penetrating injuries: often small (averaging less than 2 cm in 85% of cases) and difficult to detect in the early post-traumatic assessment period
- Missing Rate on CT: 12%-63%
  - Later presentation of intrathoracic viscera herniation and strangulation -> 30-60% mortality.

Pitfalls



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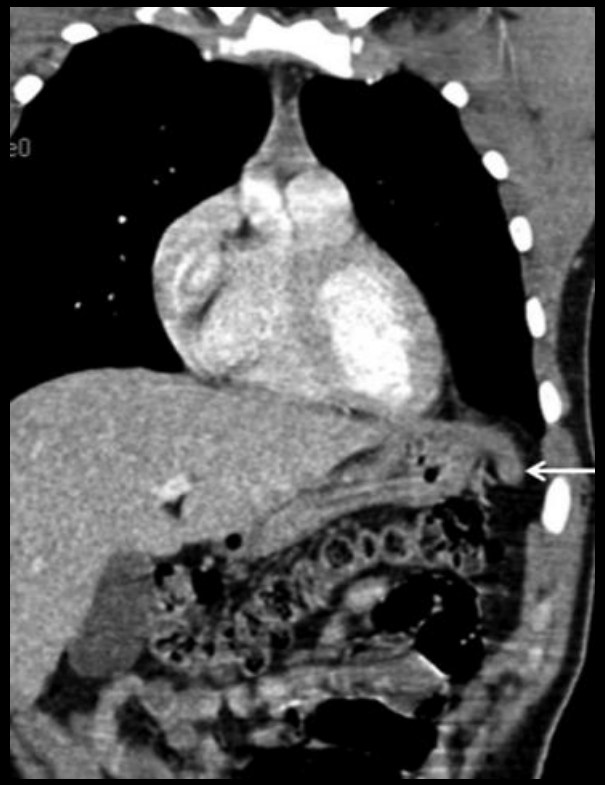
Diaphragmatic Injury - Signs:

"Clear Cut or Direct Discontinuity Sign"



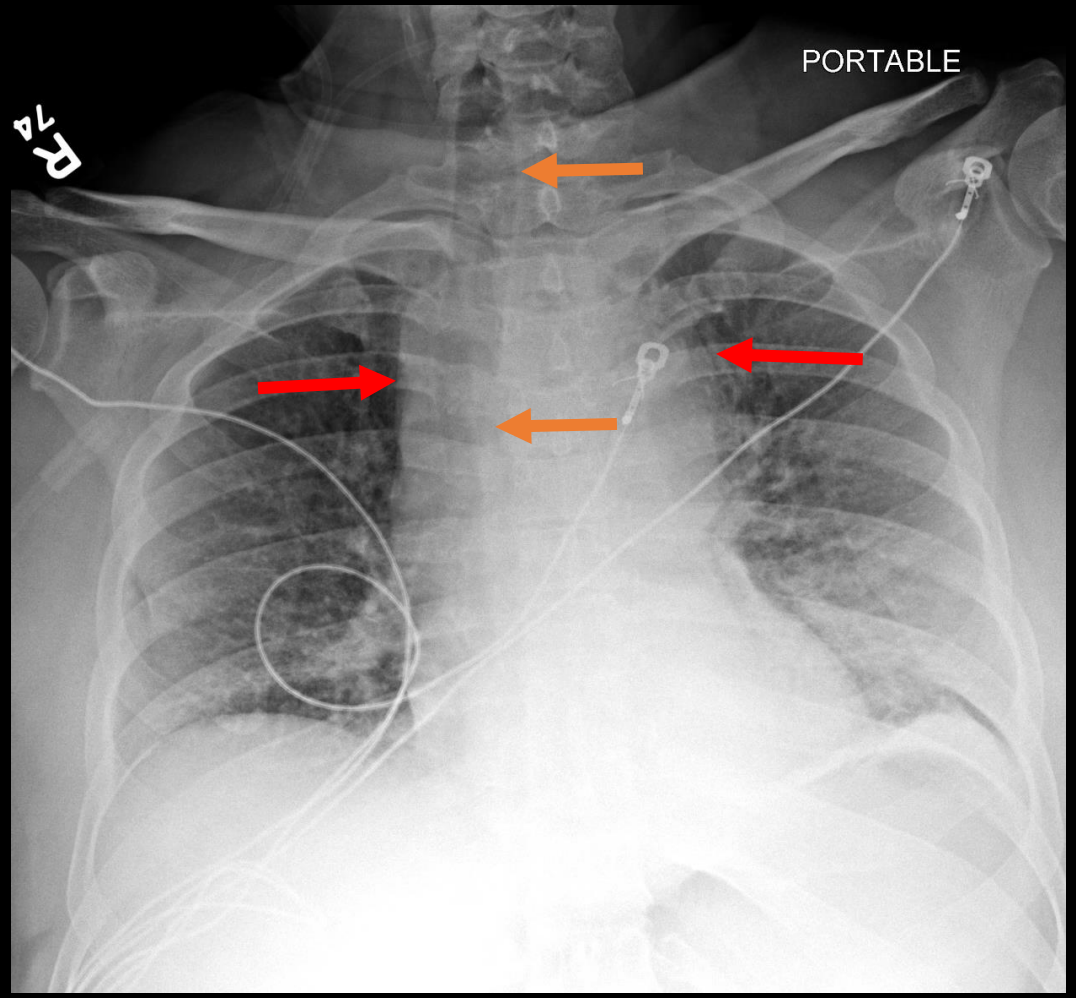
"Dangling Diaphragm Sign"

"Collar Sign"

"Dependent Viscera Sign"

Case 2:

42 y/o restrained driver involved in a motor vehicle collision. No LOC. GCS 15. Patient reports chest pain and is hypotensive.



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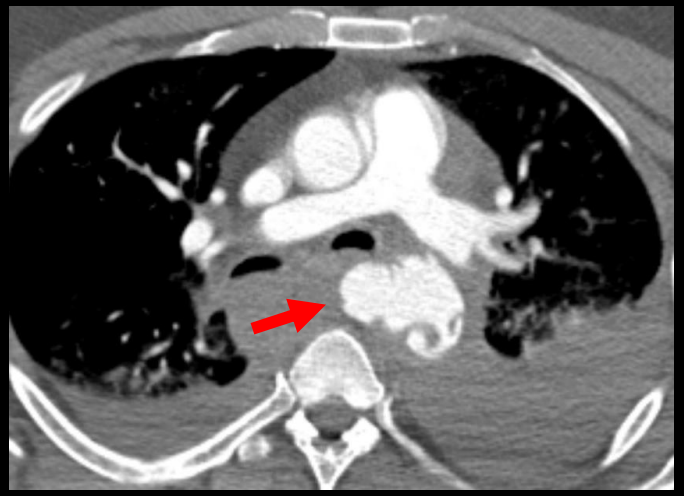

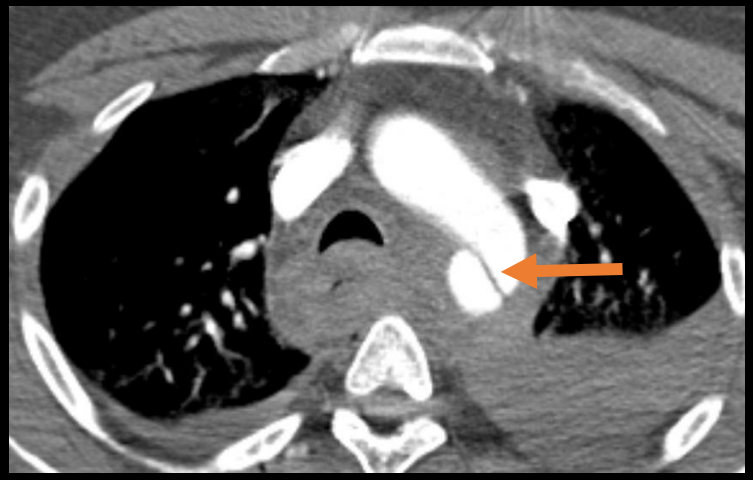

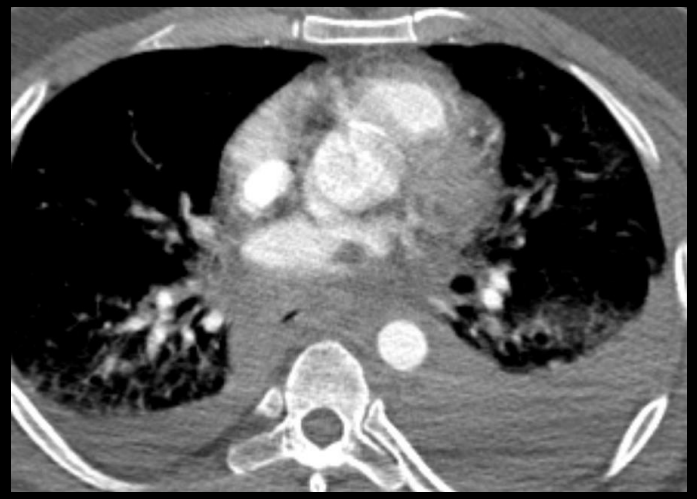

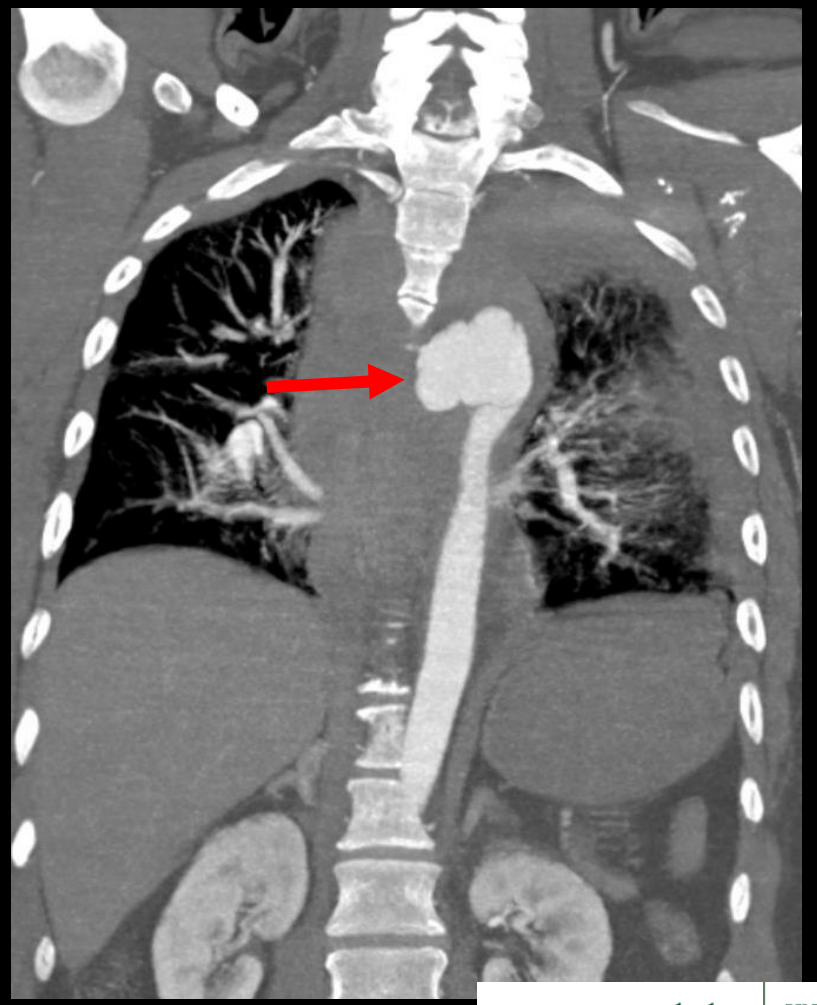

Traumatic Aortic Injury – Rupture/Pseudoaneurysm

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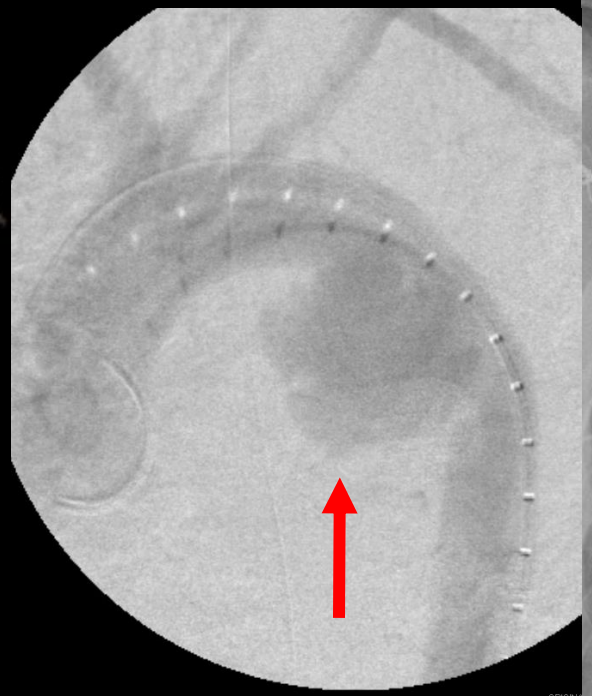

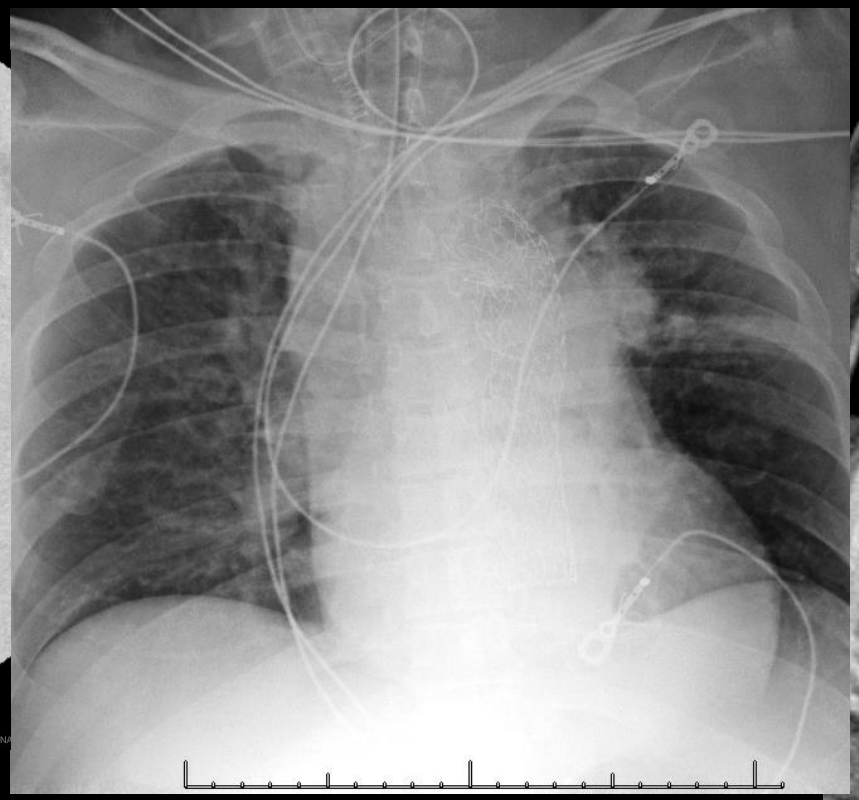

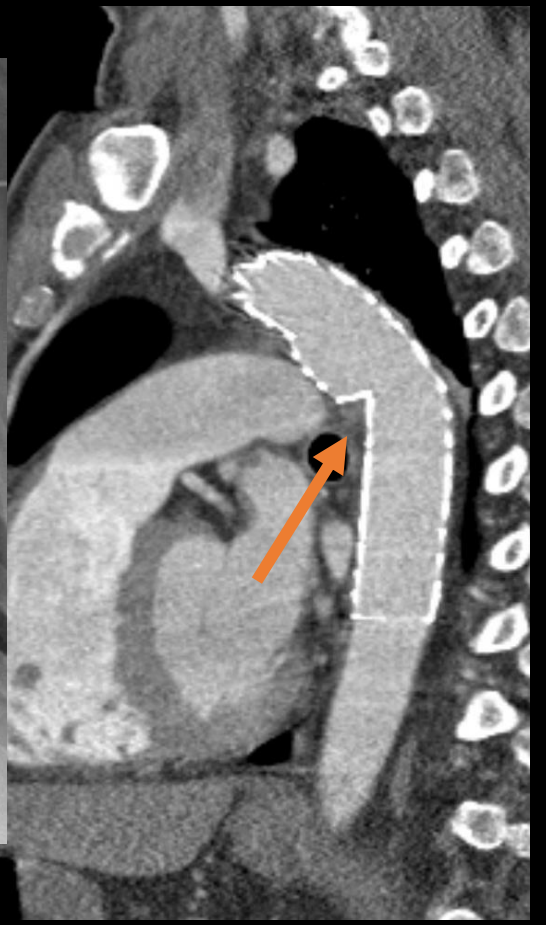

Traumatic Aortic Pseudoaneurysm - EVAR

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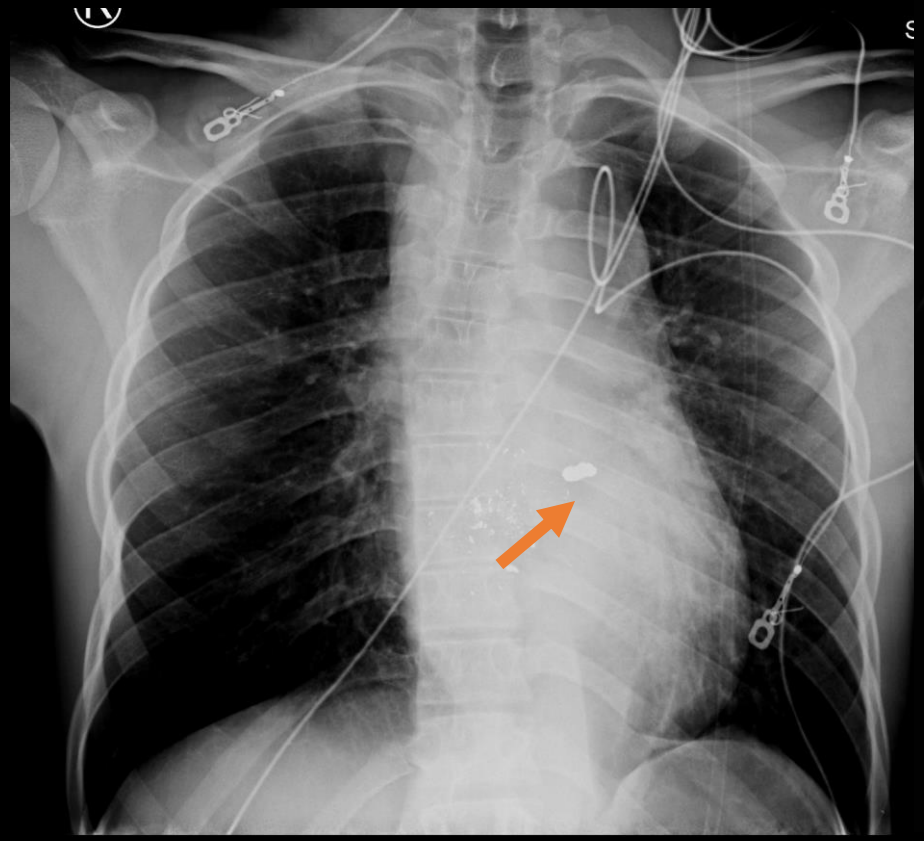
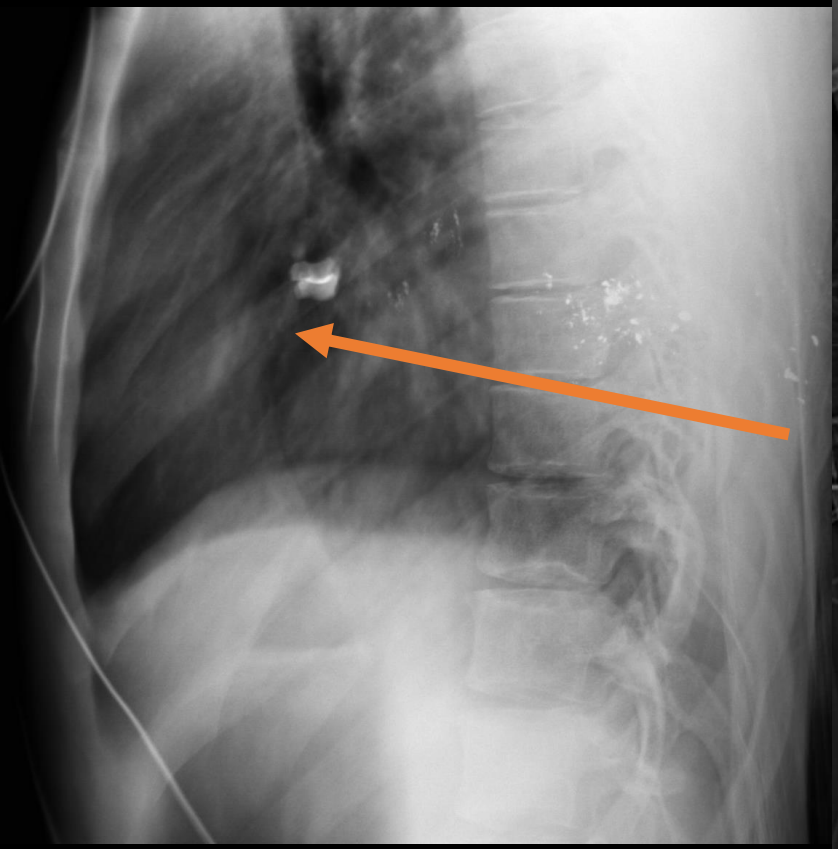
Case 3:

41 y/o shot in the back. No exit wound. Volatile BP on arrival. Holding BP after fluid resuscitation





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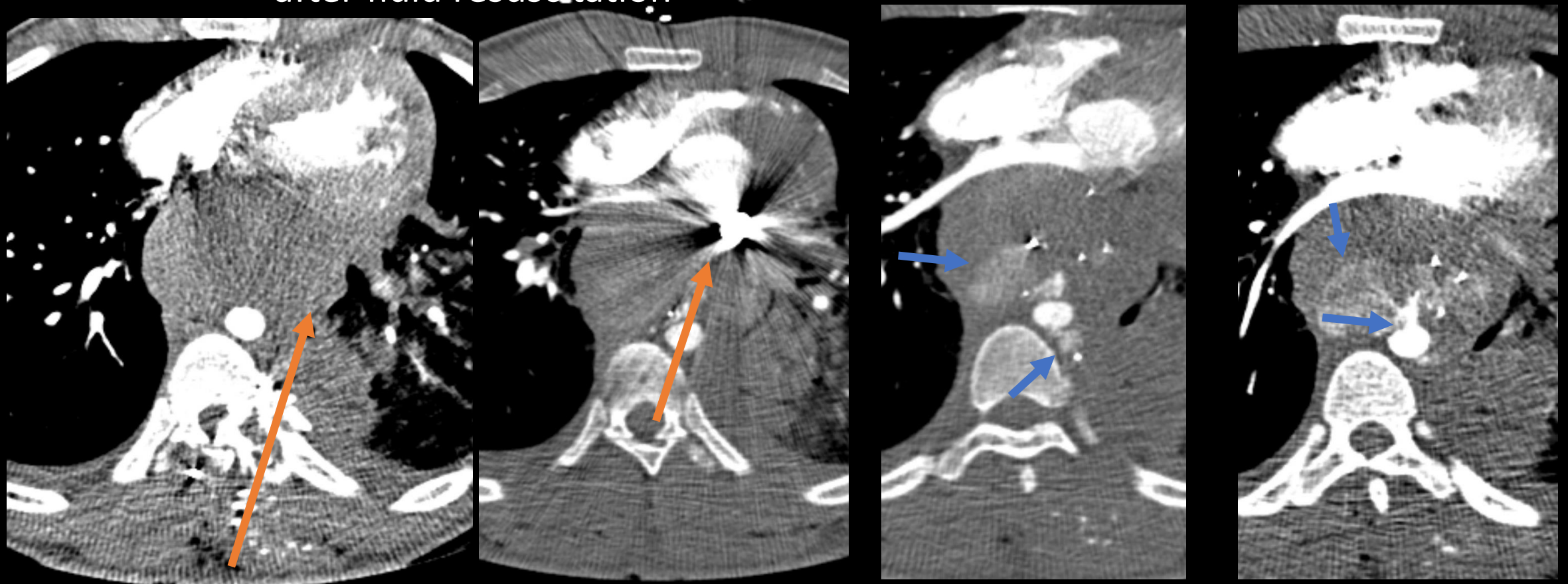

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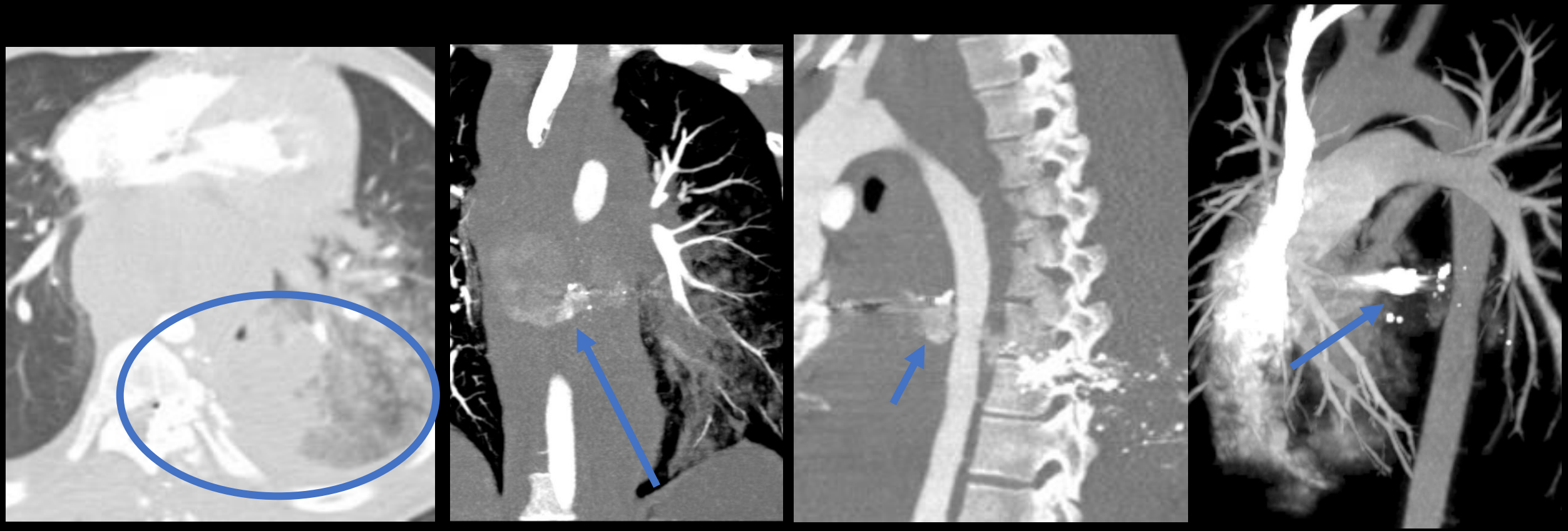

Penetrating Traumatic Injury – Transection/Rupture

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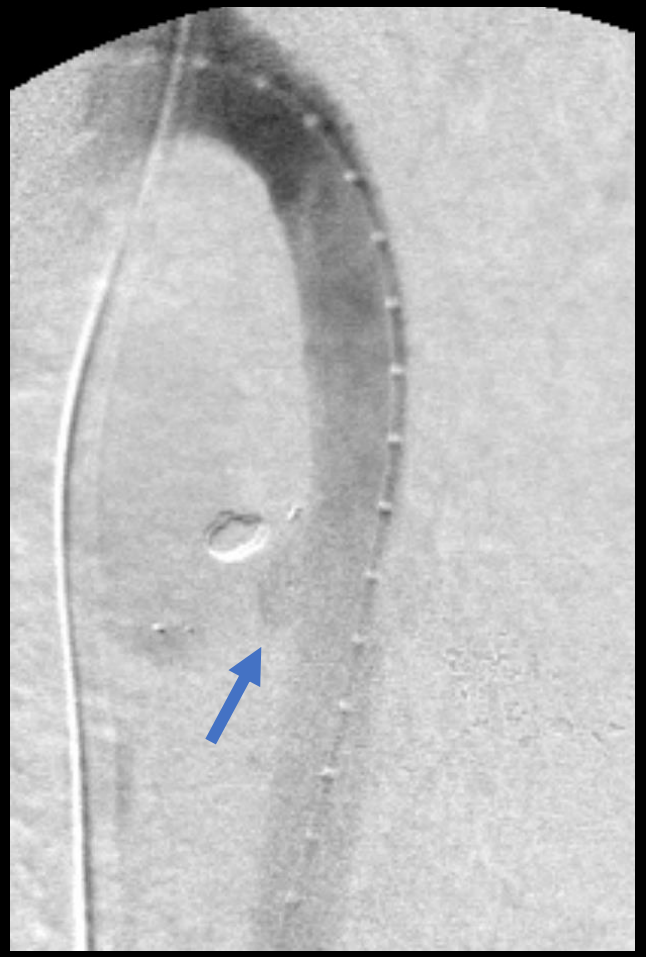
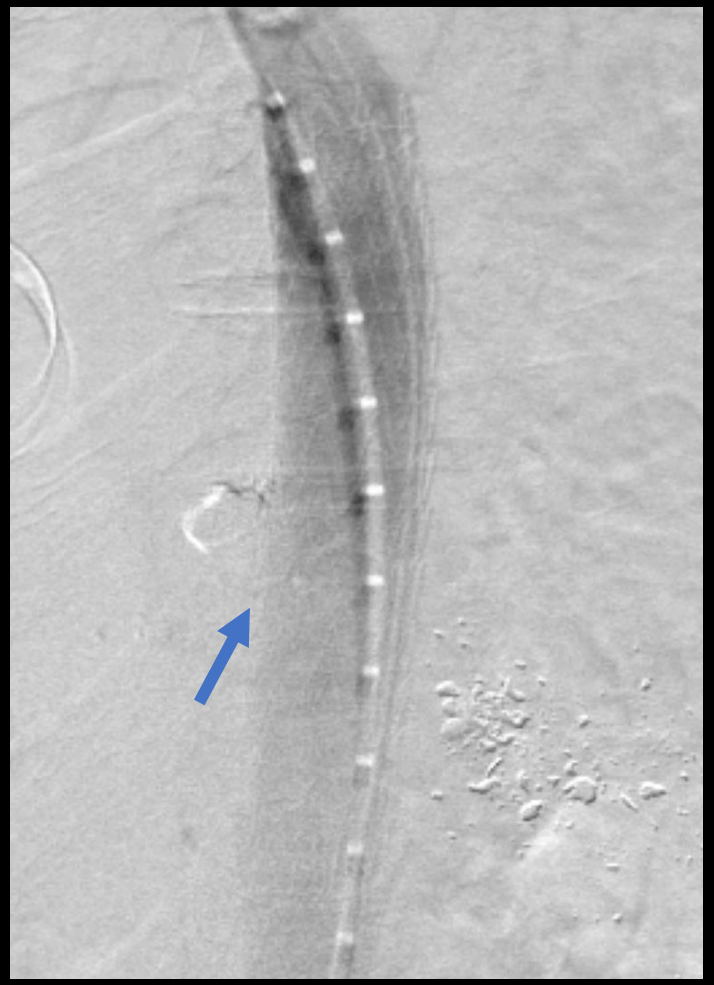
Penetrating Aortic Injury Repair:





Traumatic Aortic Injury:

- Demographics:
  - 80-90% die at the scene
    - 30% die in the first 6hs, 49% in 24hs.
  - MVC accounts for most cases (75-80%)
    - 0.5%–2% of all nonlethal MVC
  - 60%–80% of pts who reach the hospital alive survive following definitive therapy
- Common locations of injury:
  - Blunt: aortic isthmus, aortic root, diaphragm ("fixed segments").
  - Penetrating: trajectory dependent

Injury Types - Grading System

Grade 1 – Intimal tears
Grade 2 – Intramural Hematoma
Grade 3 – Pseudoaneurysm
Grade 4 – Transection/Free Rupture

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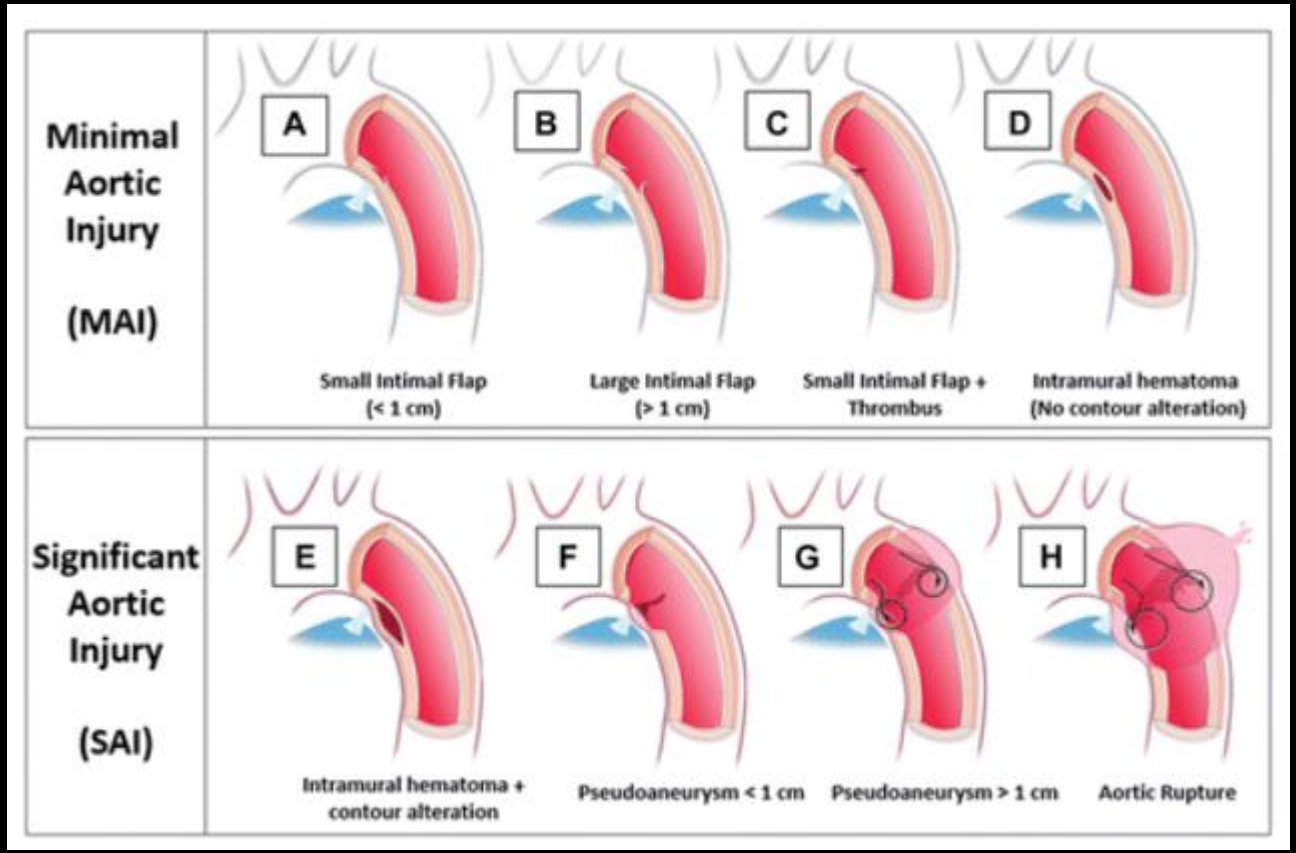
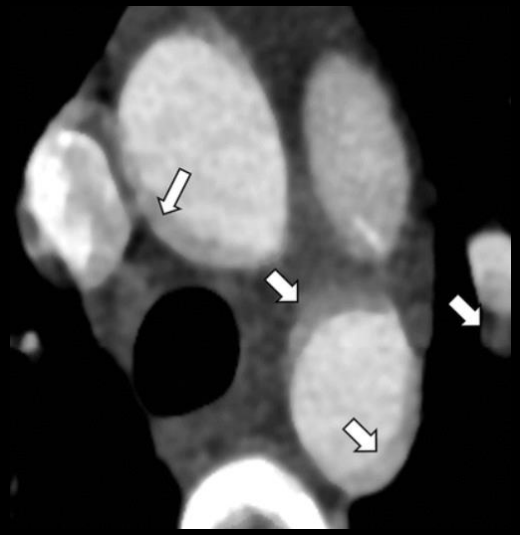
Traumatic Aortic Injury:

- Classification:
  - Absence or presence of external aortic wall abnormality
- Minimal Aortic Injury (MAI):
  - 10%–30% of all blunt aortic injuries
  - Conservative management
  - < 10%–15% of cases showing progression at follow-up
- Significant Aortic Injury (SAI):
  - Emergent Intervention

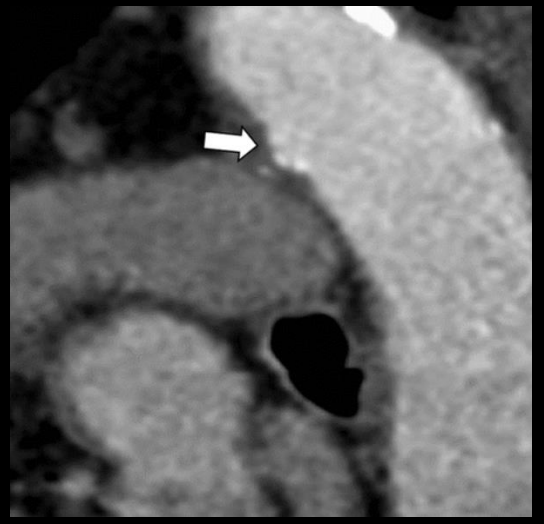


Traumatic Aortic Injury – Pitfalls and mimics:

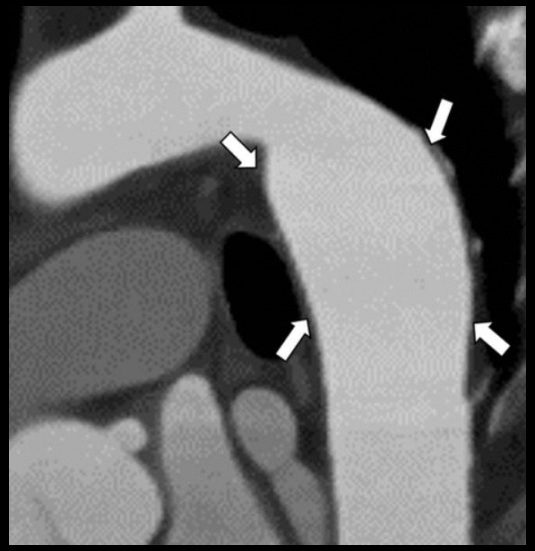


"Motion Artifact"

"Streak and Contrast Mixing"



"Ductus bump"



"Aortic Spindle"

"Vascular Infundibulum"

"Atheroma"

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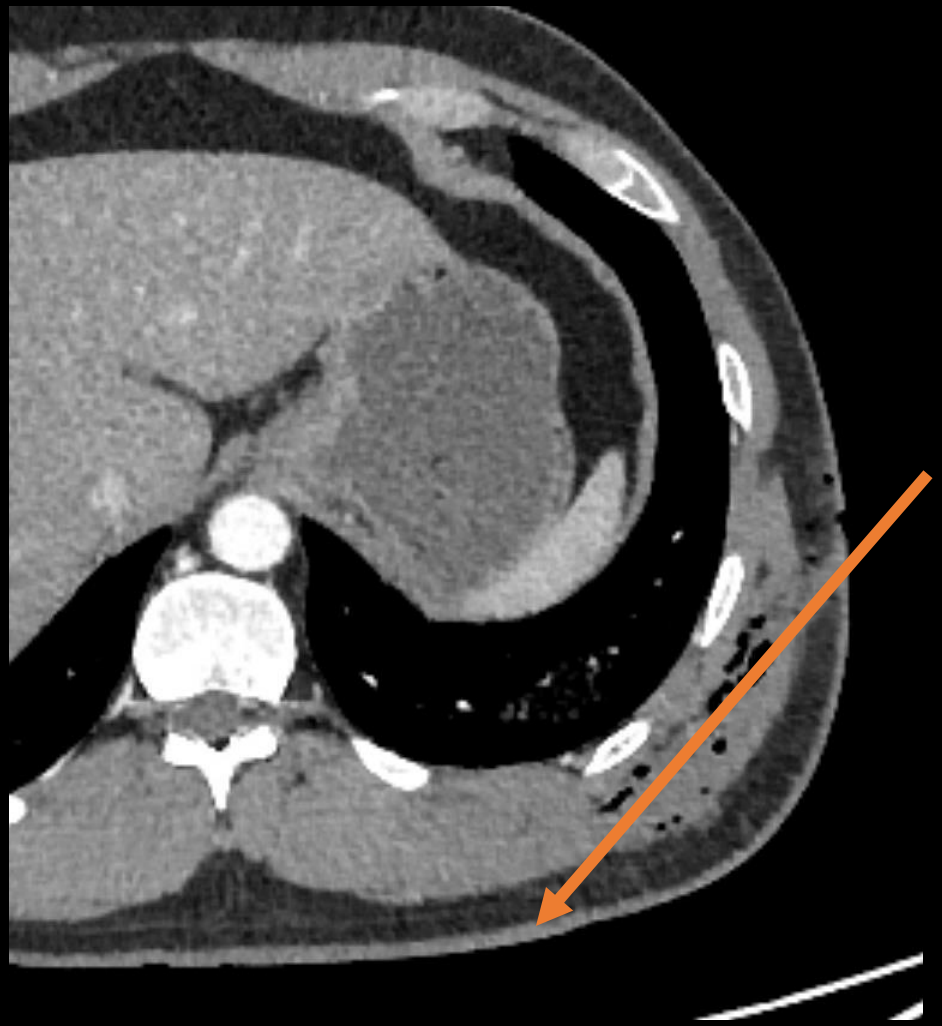
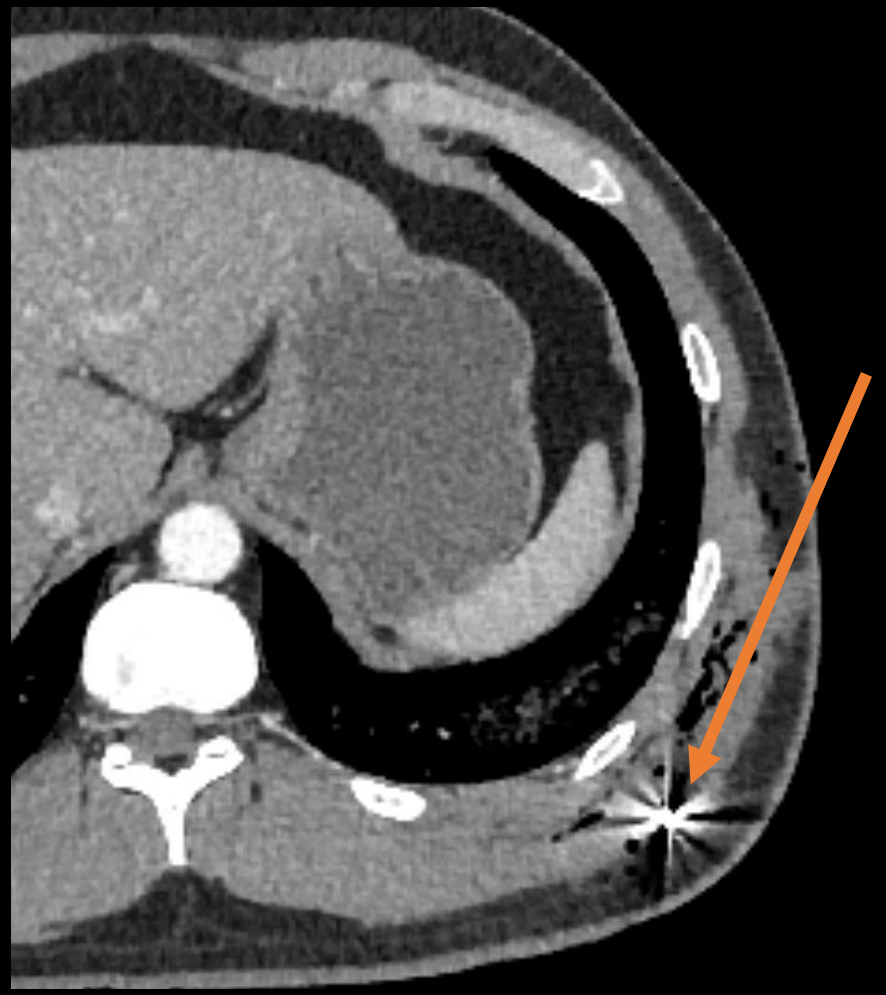
Case 4: 22 y/o single GSW. Openings in the left lower chest wall. No exit wound





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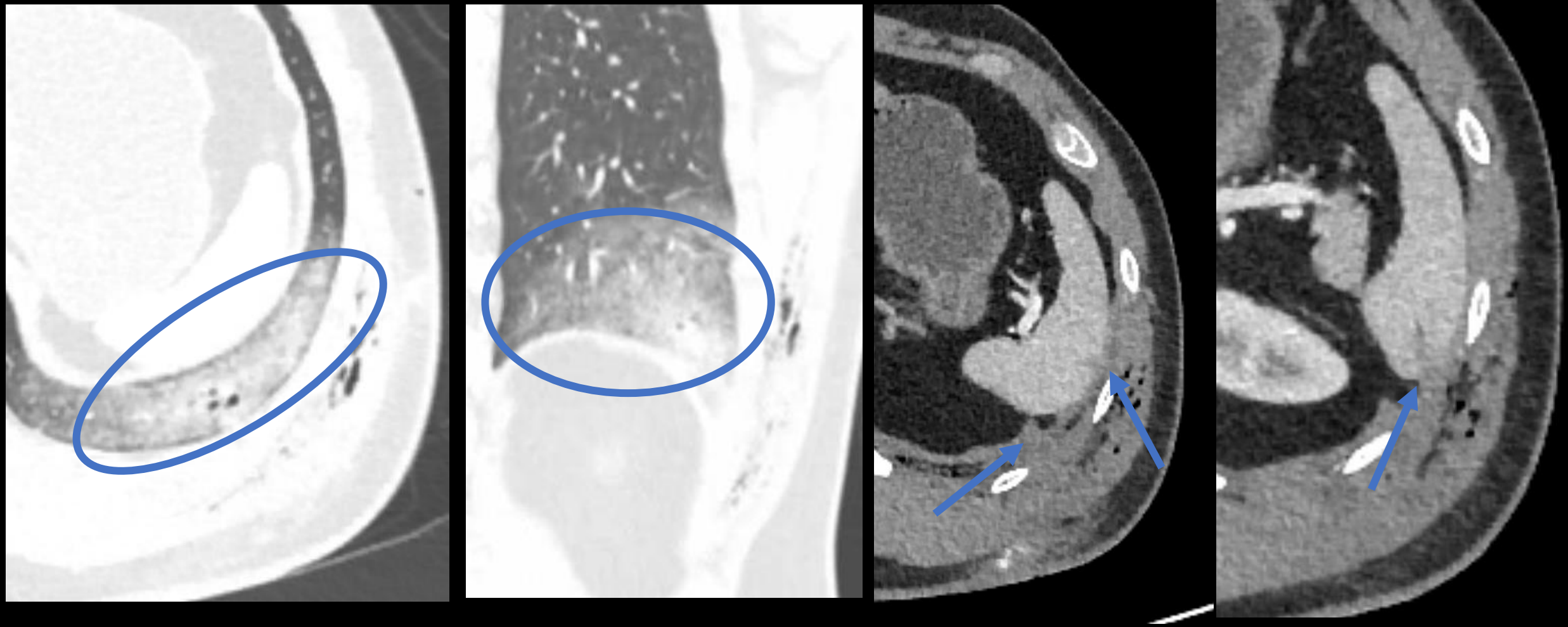

Pulmonary contusion + splenic laceration

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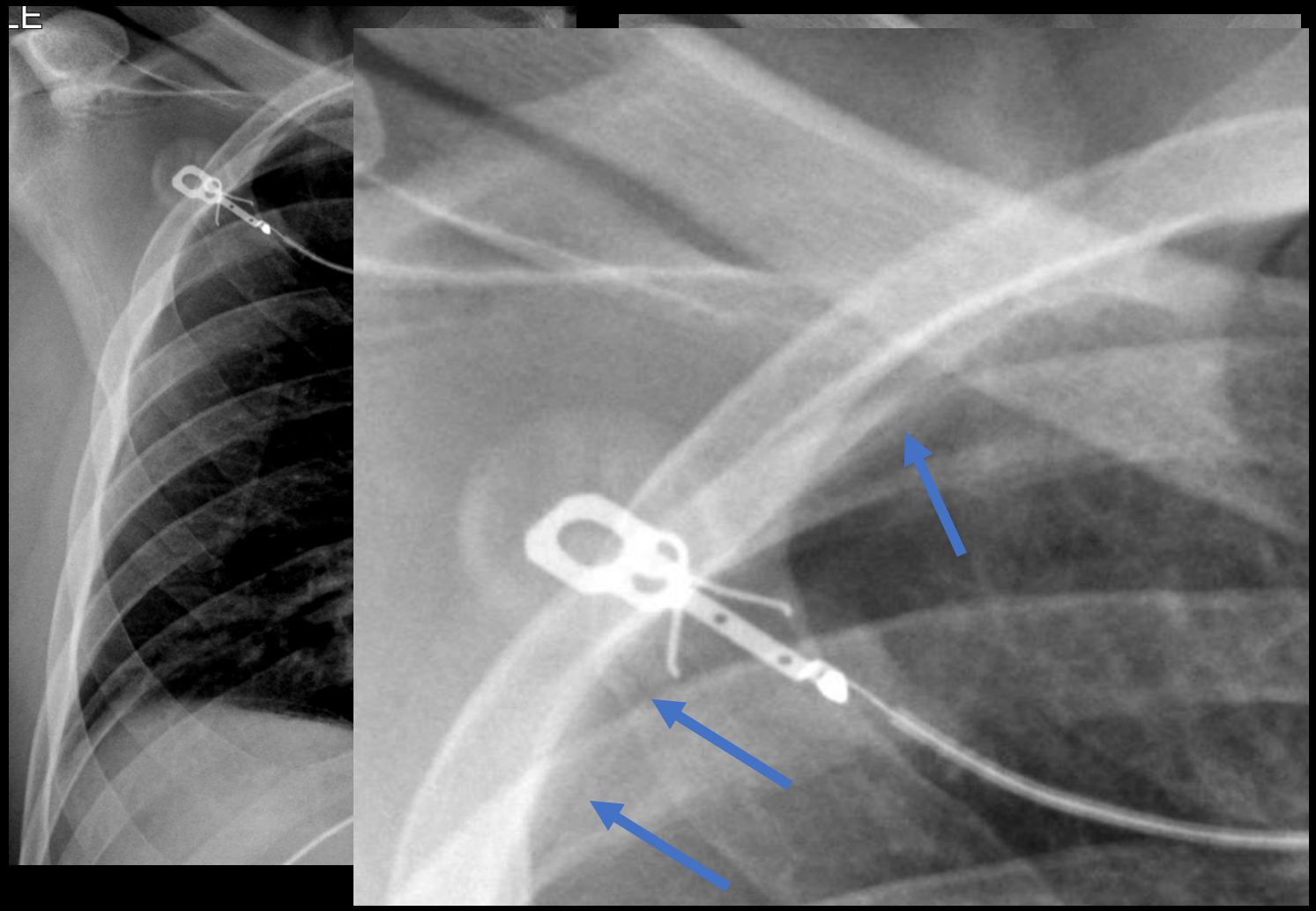
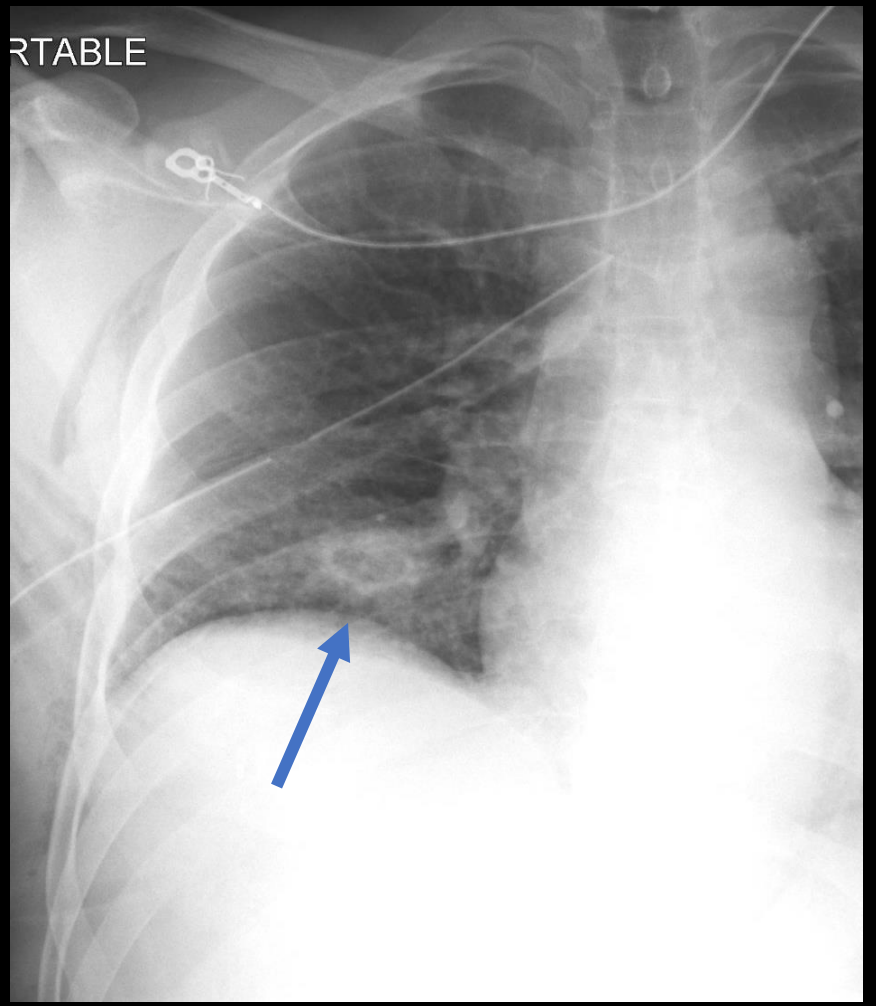
Case 5: 29 y/o single stab wound in the anterior right lower chest.





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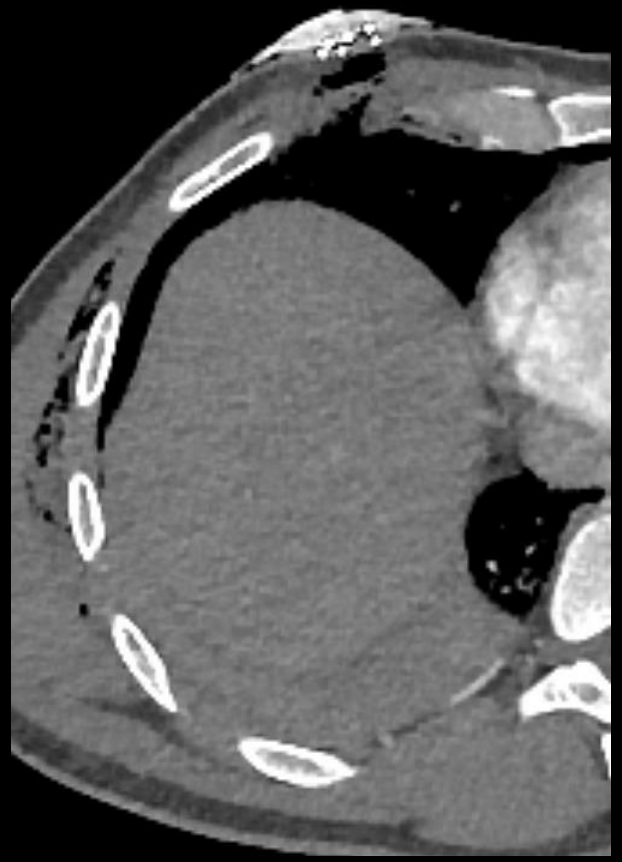

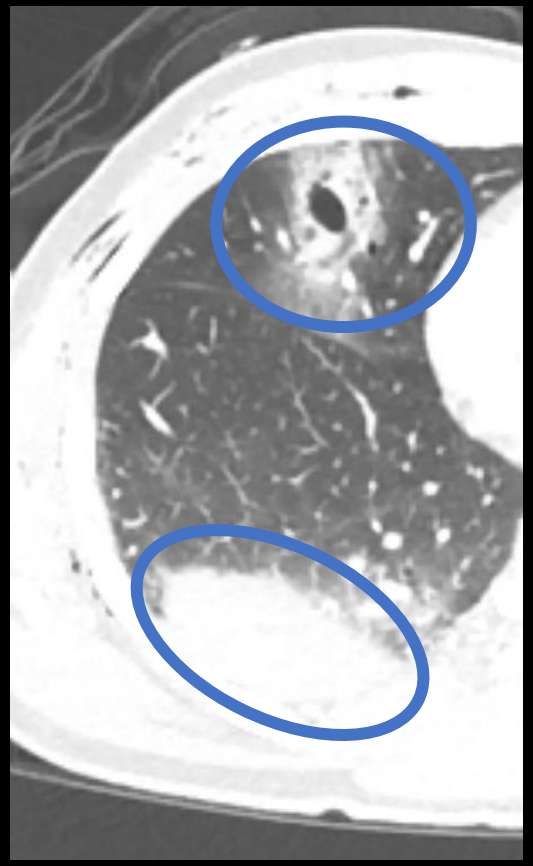

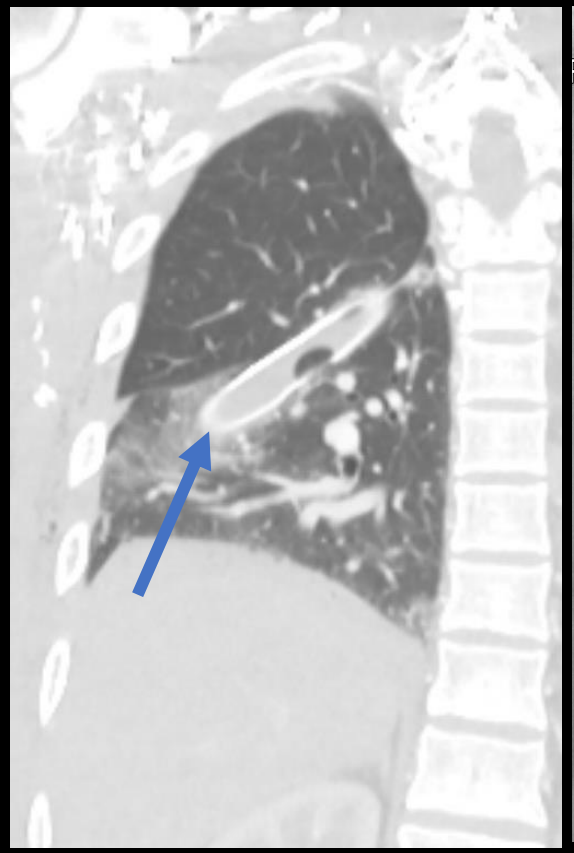

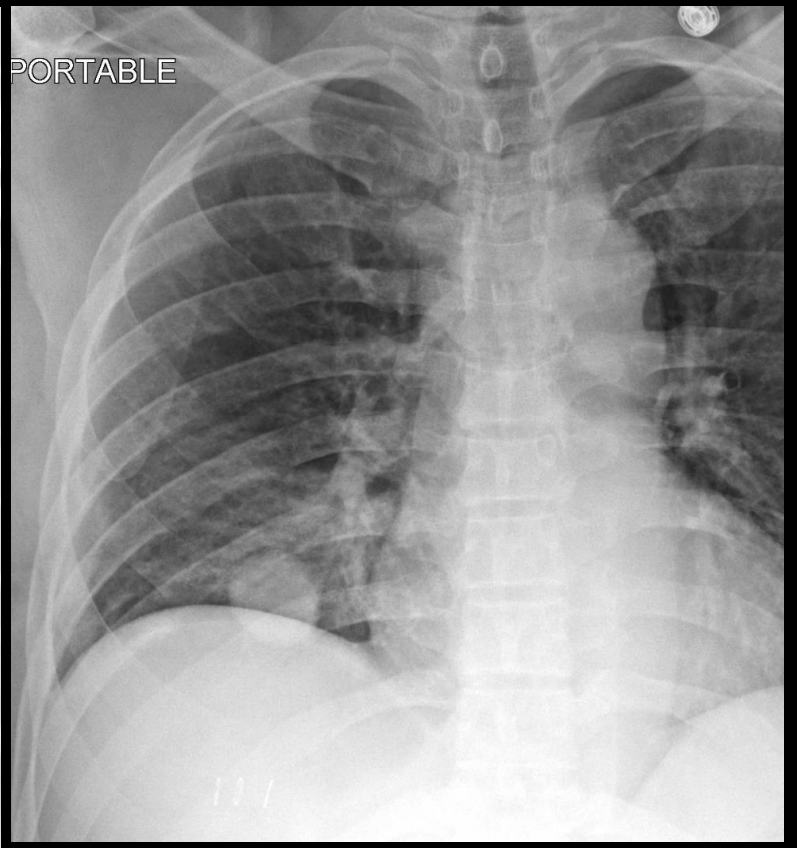

Pulmonary laceration + Hematoma + Hemothorax

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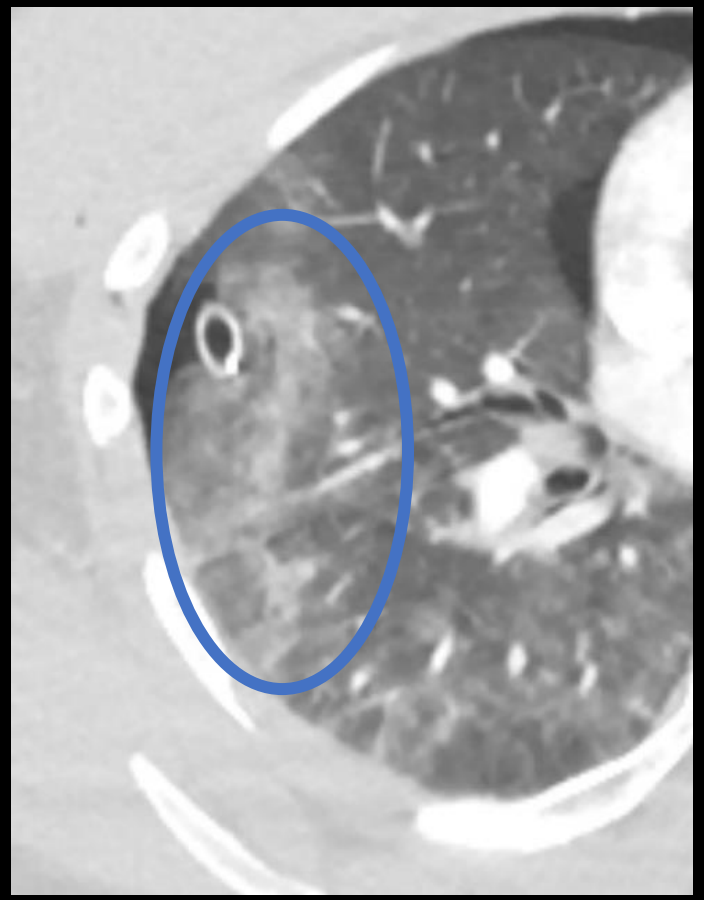
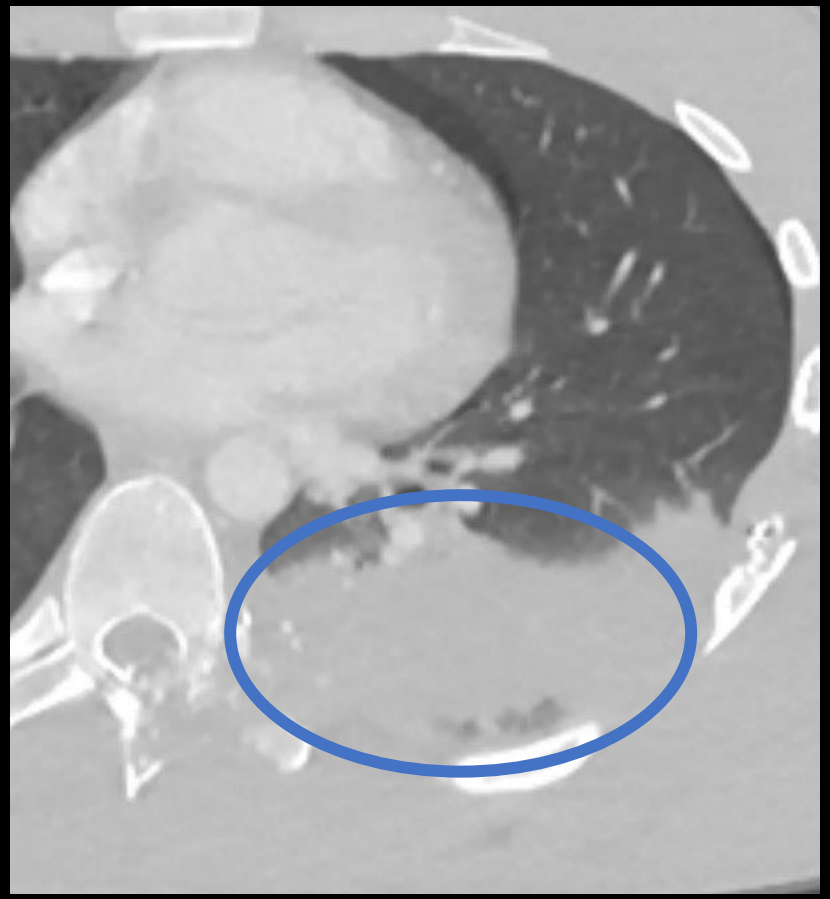
Pulmonary Parenchymal Injury:

- Contusion:
  - 75% in blunt trauma
  - Patchy or diffuse ground-glass or airspace opacites
  - May not be visible in the first 6hs, peak in conspicuity within 48–76hs. Resolve within 1–2 weeks at radiography
- Hematoma:
  - Confluent region of intraparenchymal blood
  - Dense consolidation with convex borders
- Laceration:
  - 12% in blunt trauma, more common in penetrating
  - Elliptical or spherical cavity, may be obscured by surrounding contusions and hemorrhage
  - Can be filled with air (pneumatocele), blood (hematocele or hematoma), or both (hematopneumatocele).
  - Appearance range from a solitary cavity (most common) to numerous small ones that produce a Swiss cheese appearance

Pulmonary Parenchymal Injury:



"Pulmonary Contusion"

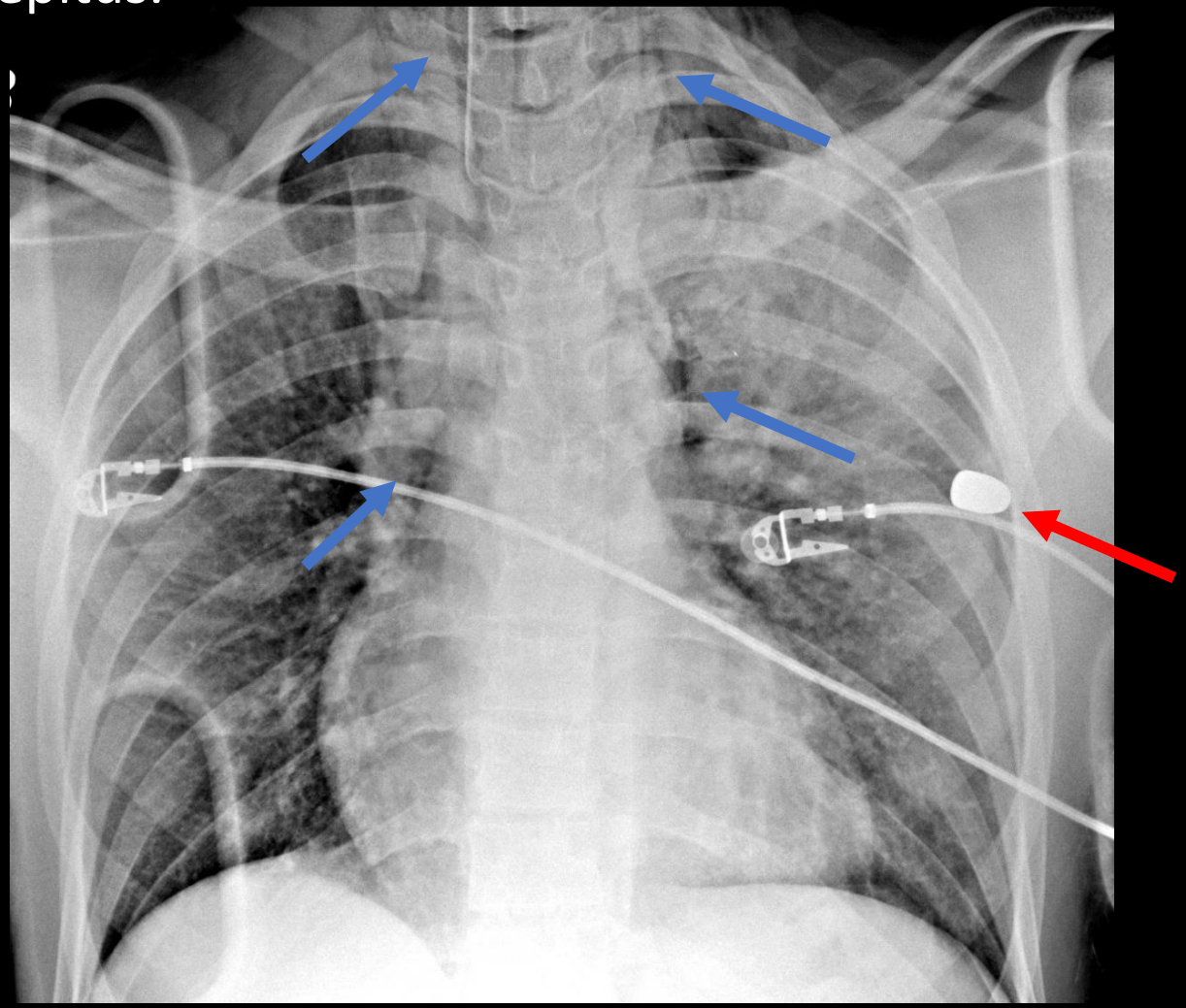


"Pulmonary Hematoma"

"Pulmonary Laceration"

Case 6:

24 y/o single GSW in the upper chest above the sternum notch. SOB and crepitus.



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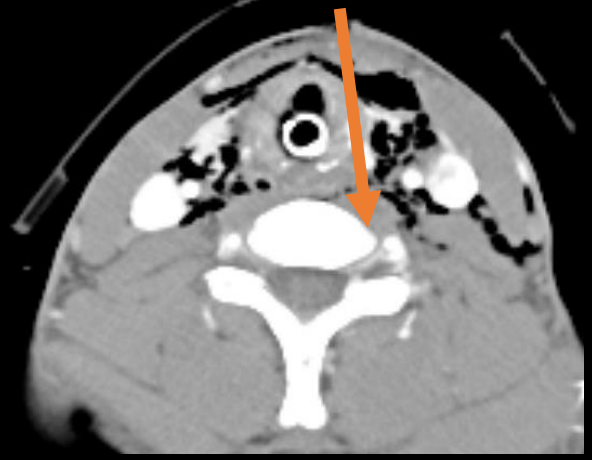

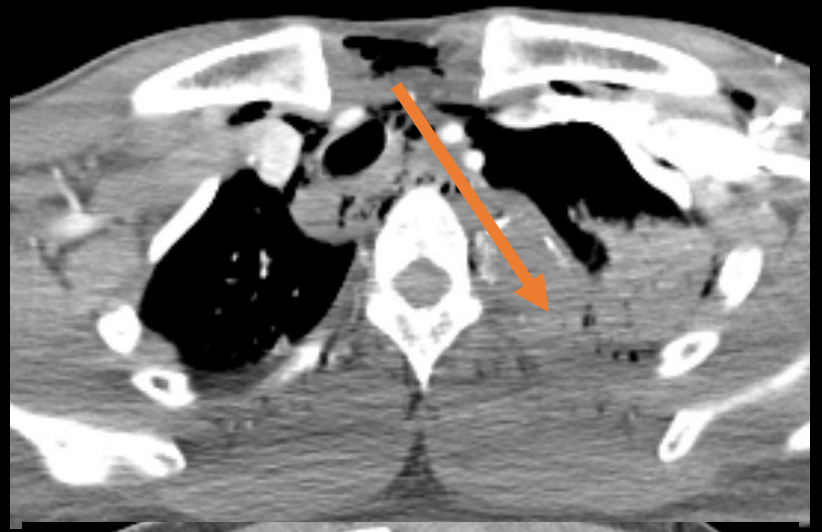

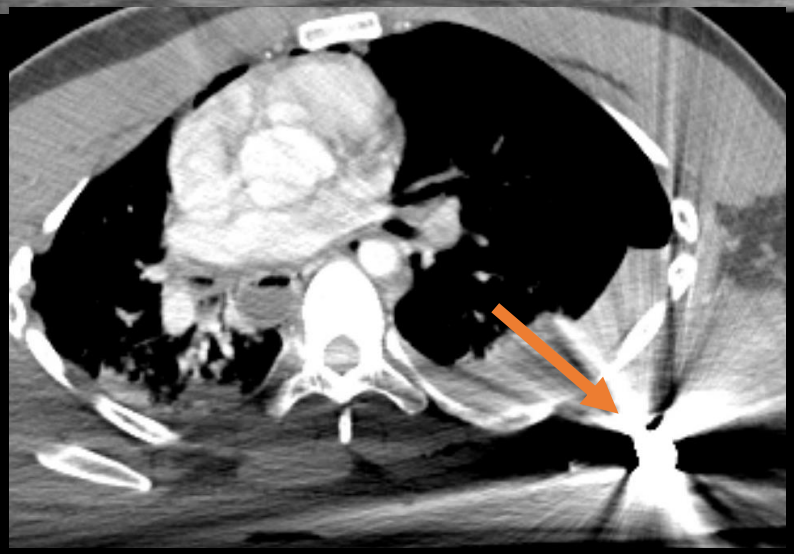

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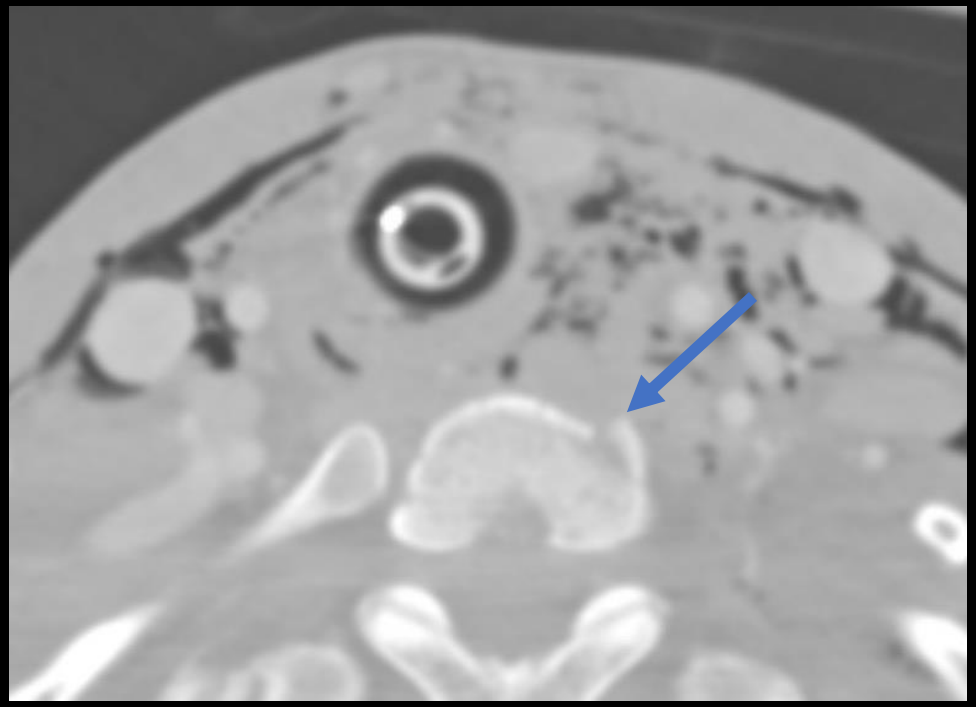

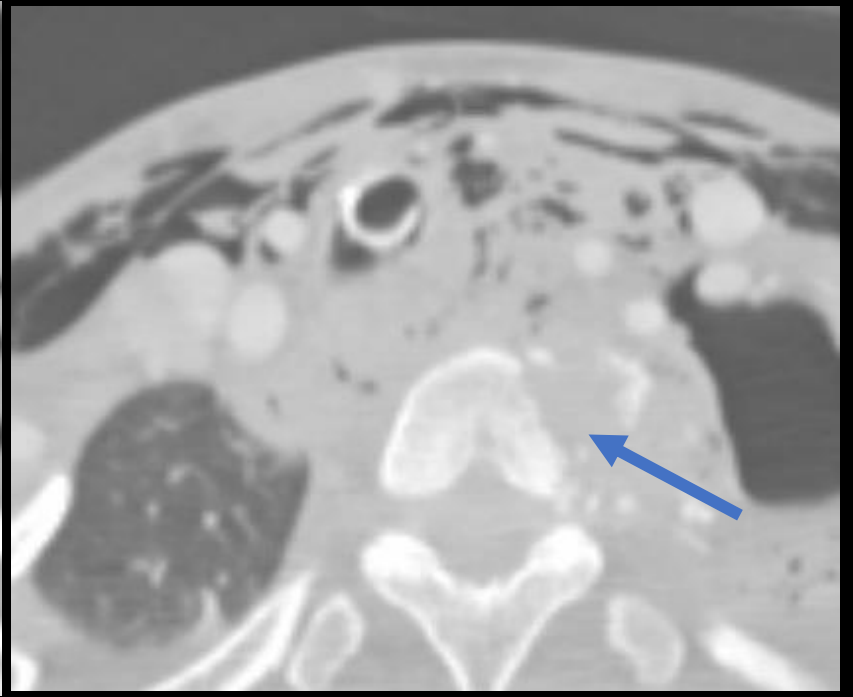

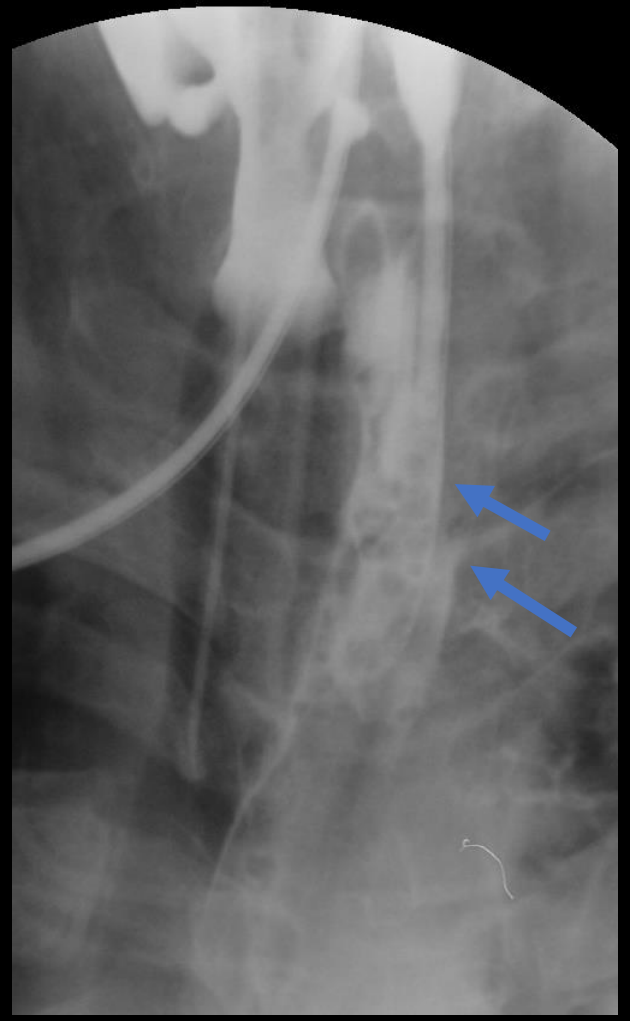

Esophageal injury - Pneumomediastinum

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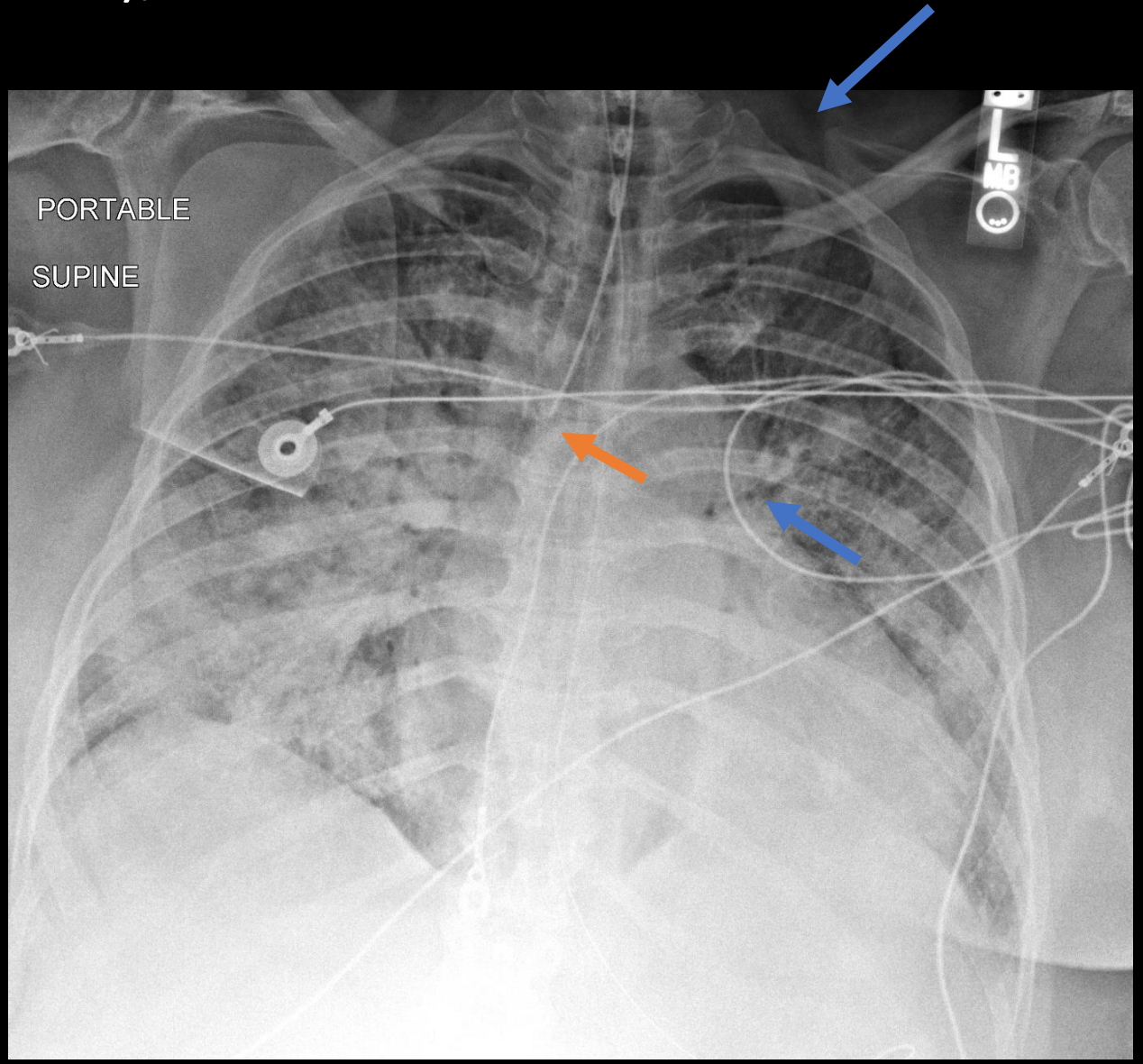
Case 7:

57 y/o found down on the street. Intubated and resuscitated on the field.



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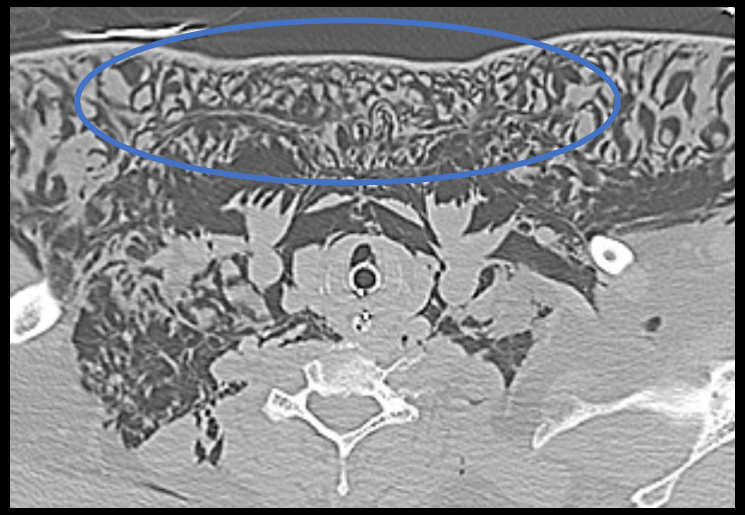
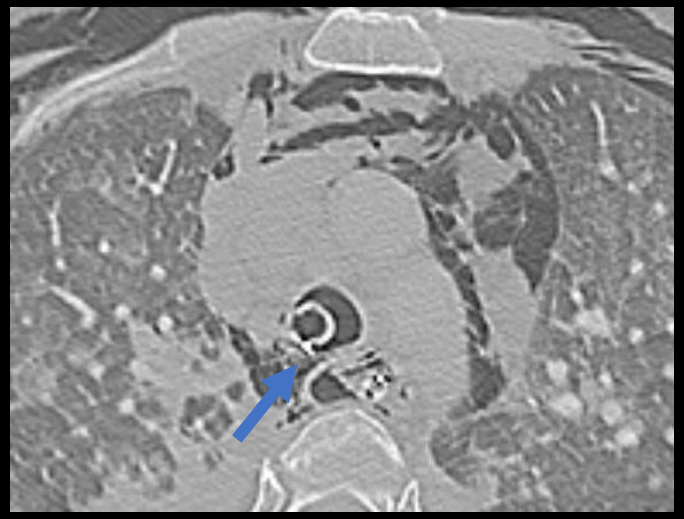

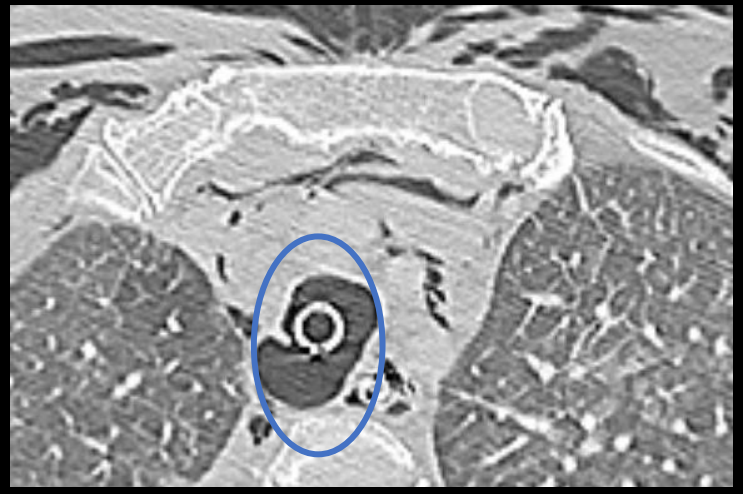
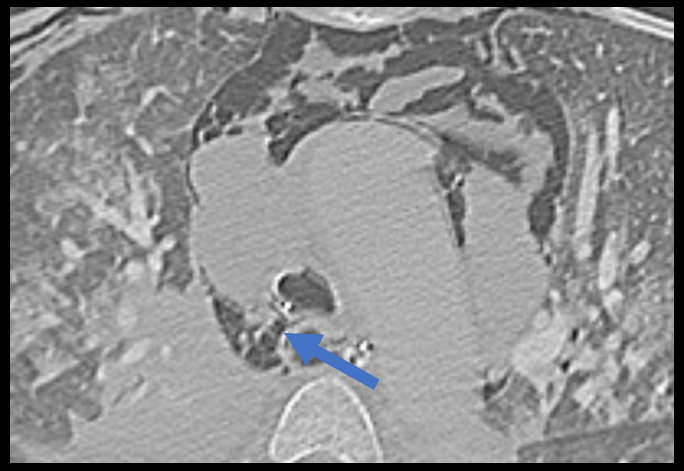
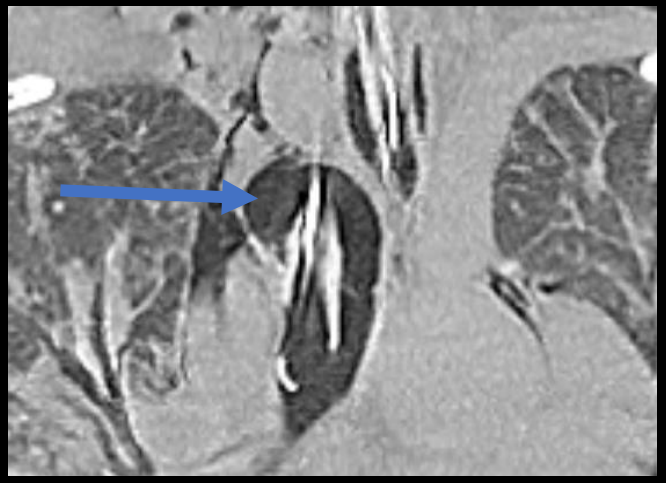

Airway/Traqueal injury - Pneumomediastinum

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Airway and Esophageal Injury:

- Airway:
  - Rare, associated with surrounding structures injury.
  - Pneumomediastinum
  - Blunt > Penetrating
    - Around carina and central bronchi, R>L
    - Membranous > Cartilaginous
  - Penetrating
    - Cervical trachea and larynx
- Esophageal:
  - Rare, Penetrating > Blunt (10:1)
  - Most common cause: Iatrogenic
  - Pneumomediastinum: lower volume, around esophagus
  - FL Esophagram: water soluble, 10% FN
  - CT Esophagram: as good as FL Esophagram
    - Sensitivity 59-100%
    - Specificity 80-100%
  - Cervical and Thoracic Esophagus – Conservative management

Take Home Points

1. Thoracic injury is a prevalent source of morbidity and mortality in trauma patients, particular in those with polytrauma.
2. Penetrating thoracic trauma has higher mortality and higher rate of vascular, traqueobronchial and cardiac injuries. Trajectory is Key!
3. Be aware of mimics and pitfalls of traumatic aortic injury: ductus diverticulum, vascular infundibulum, aortic spindle, motion, atheroma, etc.
4. Prefer CT esophagogram - accuracy at least equal to fluoroscopic esophagography.

Thank You!

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