Acute Chest—
ICU, ER, Trauma

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Educational Objectives

- Understand the importance of detailed inspection and accurate interpretation of the daily ICU chest radiograph
- Recognize the typical radiologic manifestation of thoracic trauma including injuries to the aorta, lungs, airways, esophagus, and diaphragm

Outline

- **ICU Chest:**
  - Lines and Tubes—Malpositioning and Complications
  - Abnormal Collections of Gas
  - Lobar Atelectasis
  - Acute Respiratory Distress Syndrome (ARDS)

Outline

- **ER/Trauma Chest:**
  - Traumatic aortic injury (TAI)
  - Lung injury
    - Contusion, Laceration, Hemo/Pneumothorax
  - Tracheobronchial injury
  - Esophageal injury
  - Diaphragmatic injury

Lines and Tubes—Malpositioning and Complications

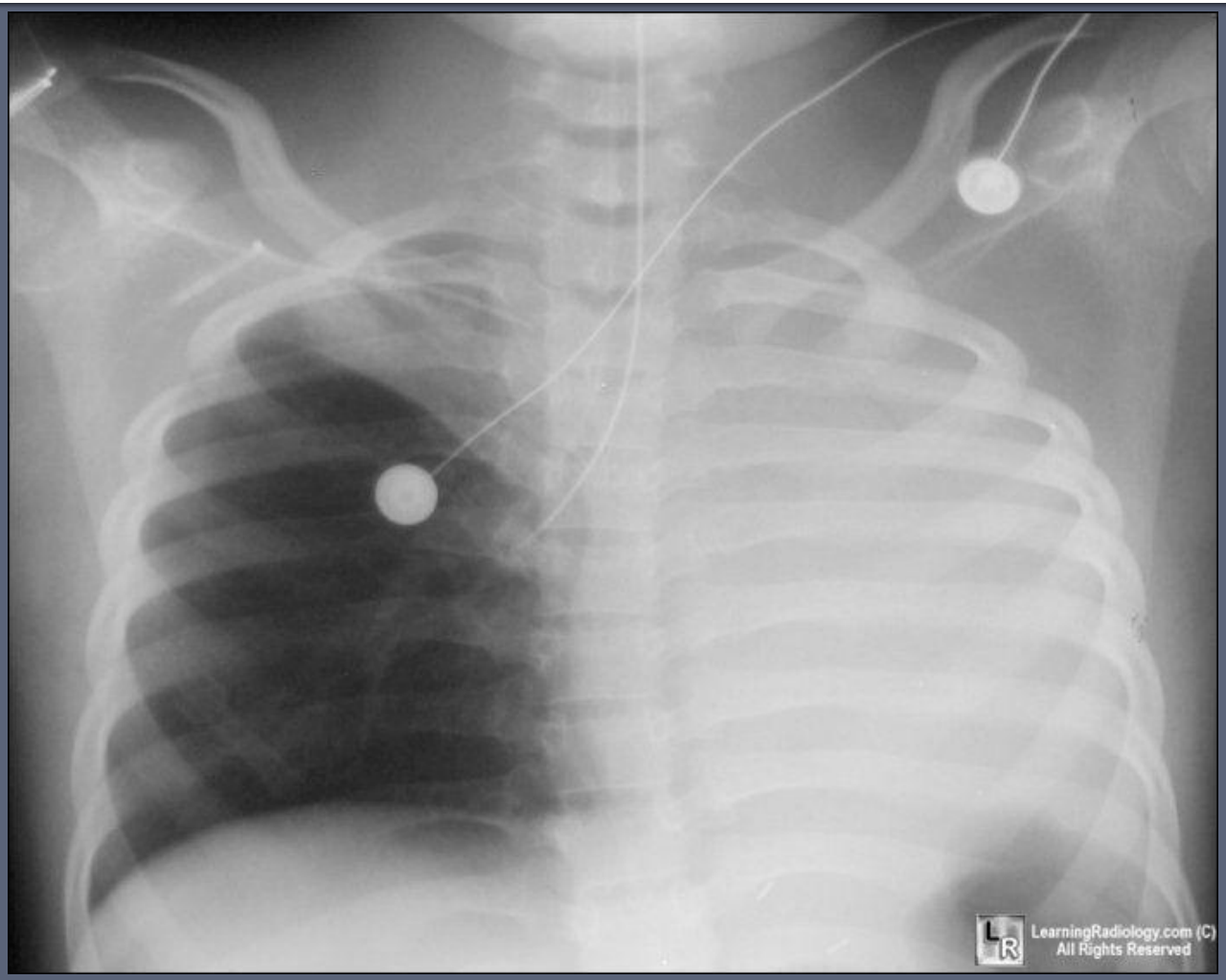
- Endotracheal tubes (ETT)
- Pulmonary artery/Swan-Ganz catheters
- Central venous catheters (CVC)
- Enteric tubes (nasogastric and feeding tubes)
- Intra-aortic balloon pump (IABP)

ETT

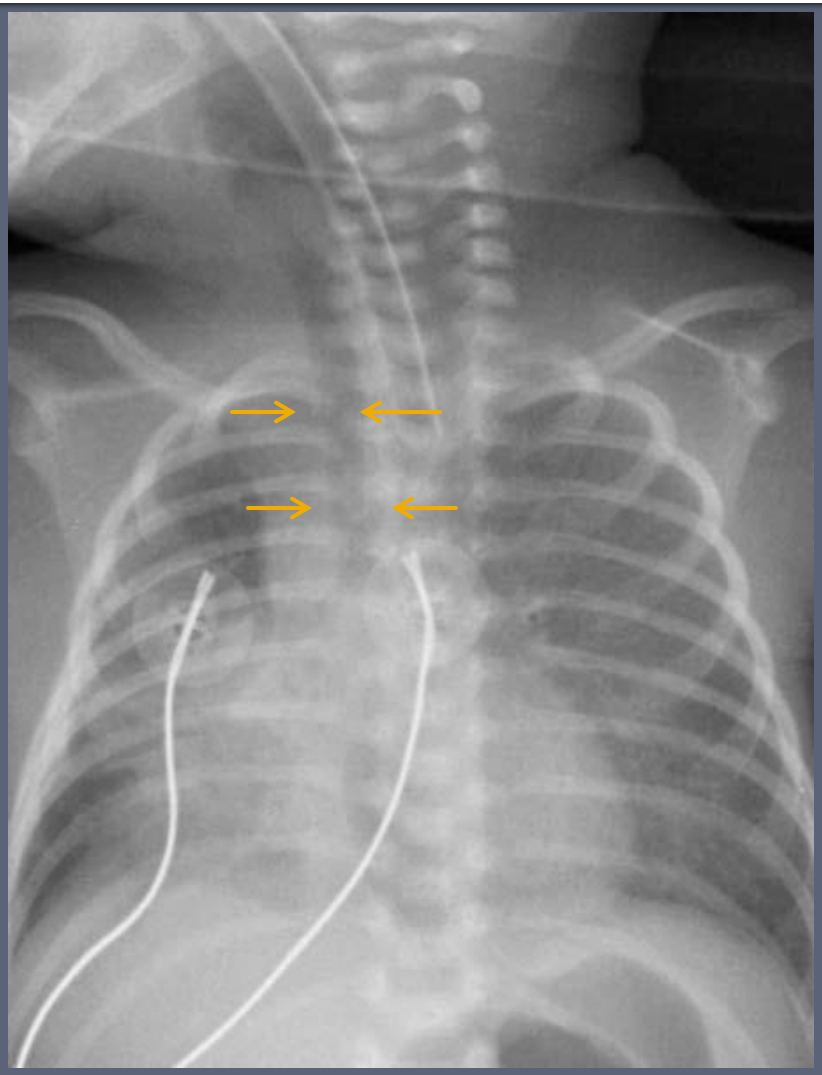
- **Ideal position**:
  - 5-7 cm above the carina (neutral position)
  - Flexion may displace ETT 2-4 cm caudally
  - Extension may displace ETT 2-4 cm cranially

- If ETT too distal (mainstem or lobar bronchus)→ ***lobar and/or total lung collapse***

Malpositioned ETT--bronchus intermedius



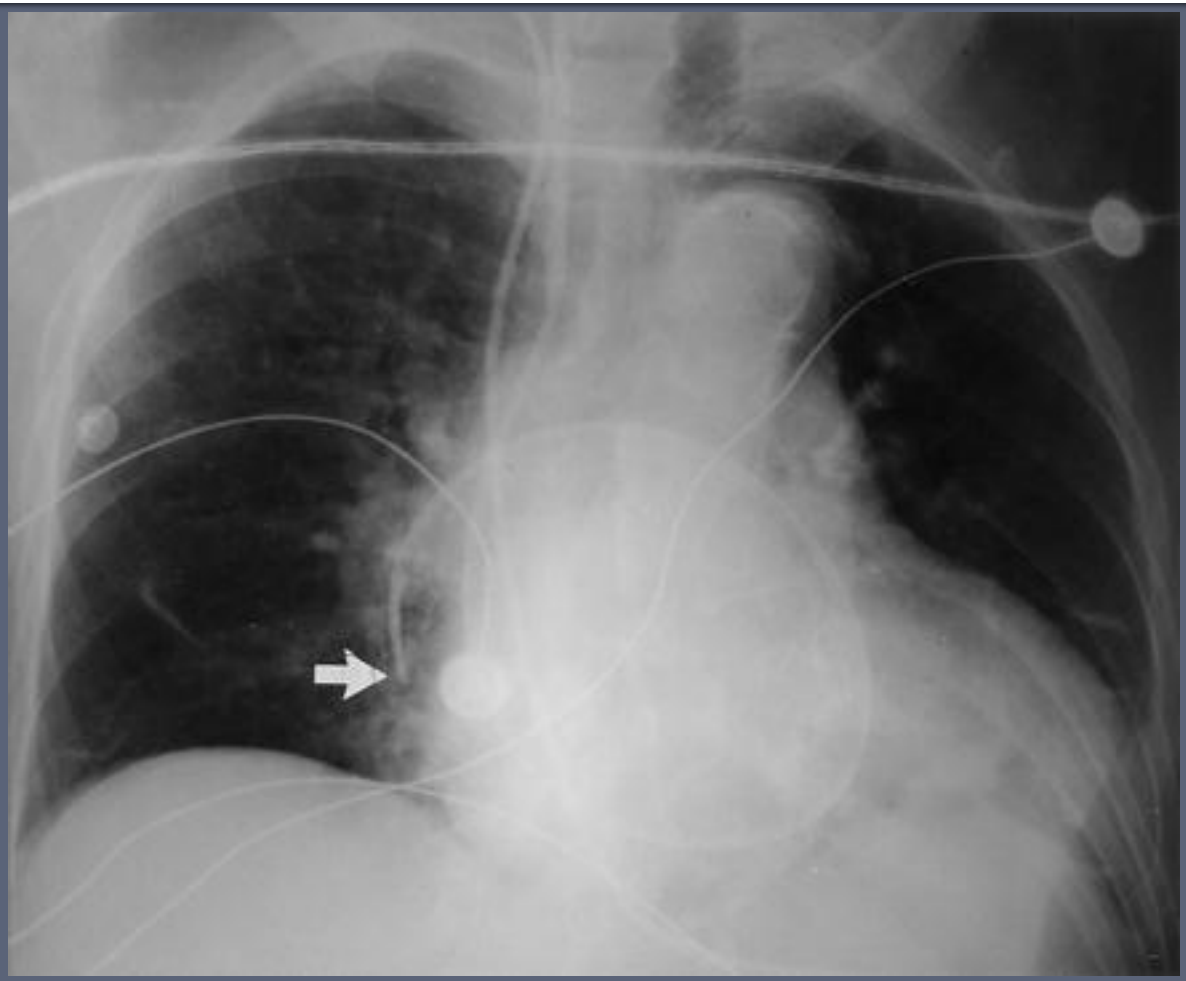
Malpositioned ETT--esophagus



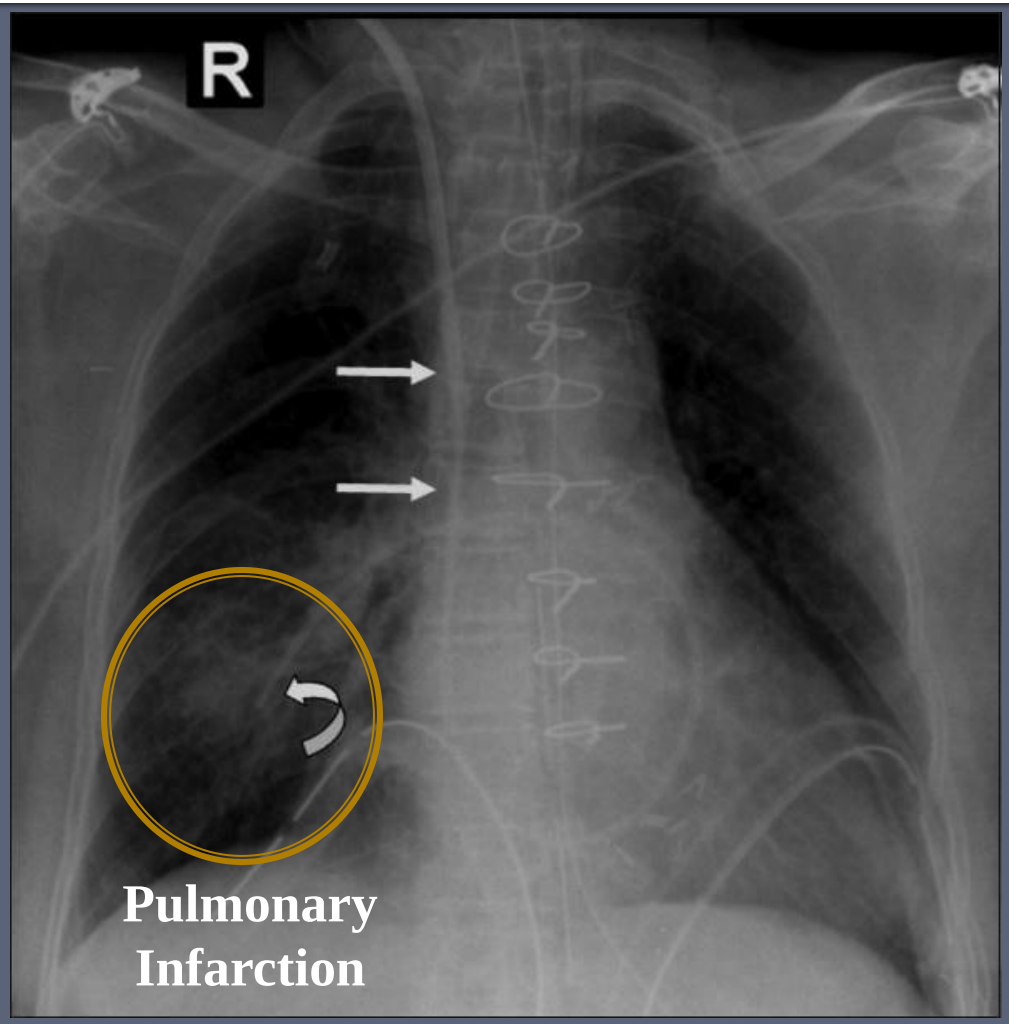
Swan Ganz Catheter

- **Ideal position:**
  - Large central pulmonary artery
- If Swan-Ganz catheter is too distal:
  - Thrombosis and pulmonary infarction
  - Pulmonary artery rupture and pseudoaneurysm formation (hemoptysis)

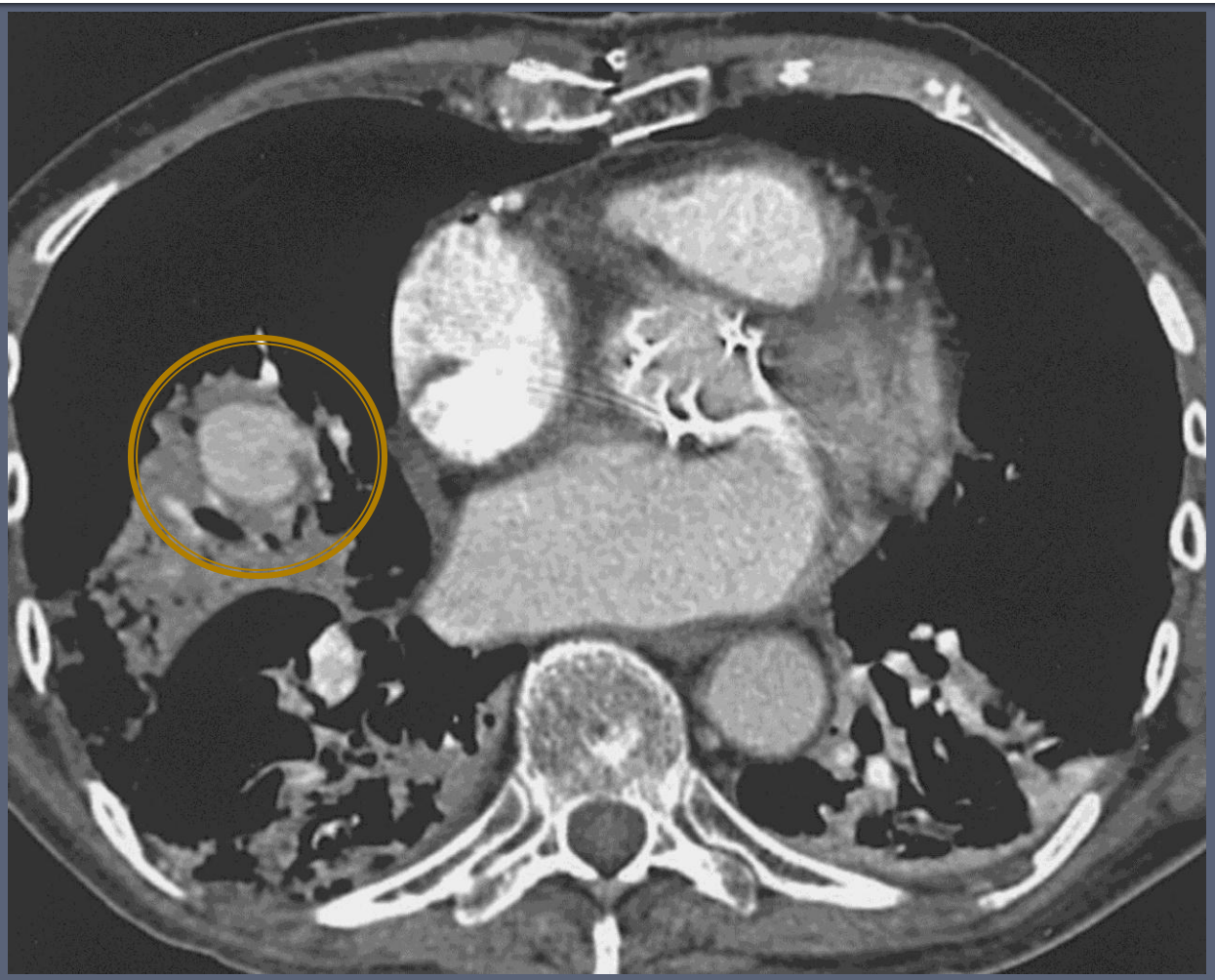
Malpositioned Swan-Ganz catheter-wedged in a RLL pulmonary artery



Malpositioned Swan-Ganz catheter-wedged in a RLL pulmonary artery



Pulmonary Artery Pseudoaneurysm



CVC

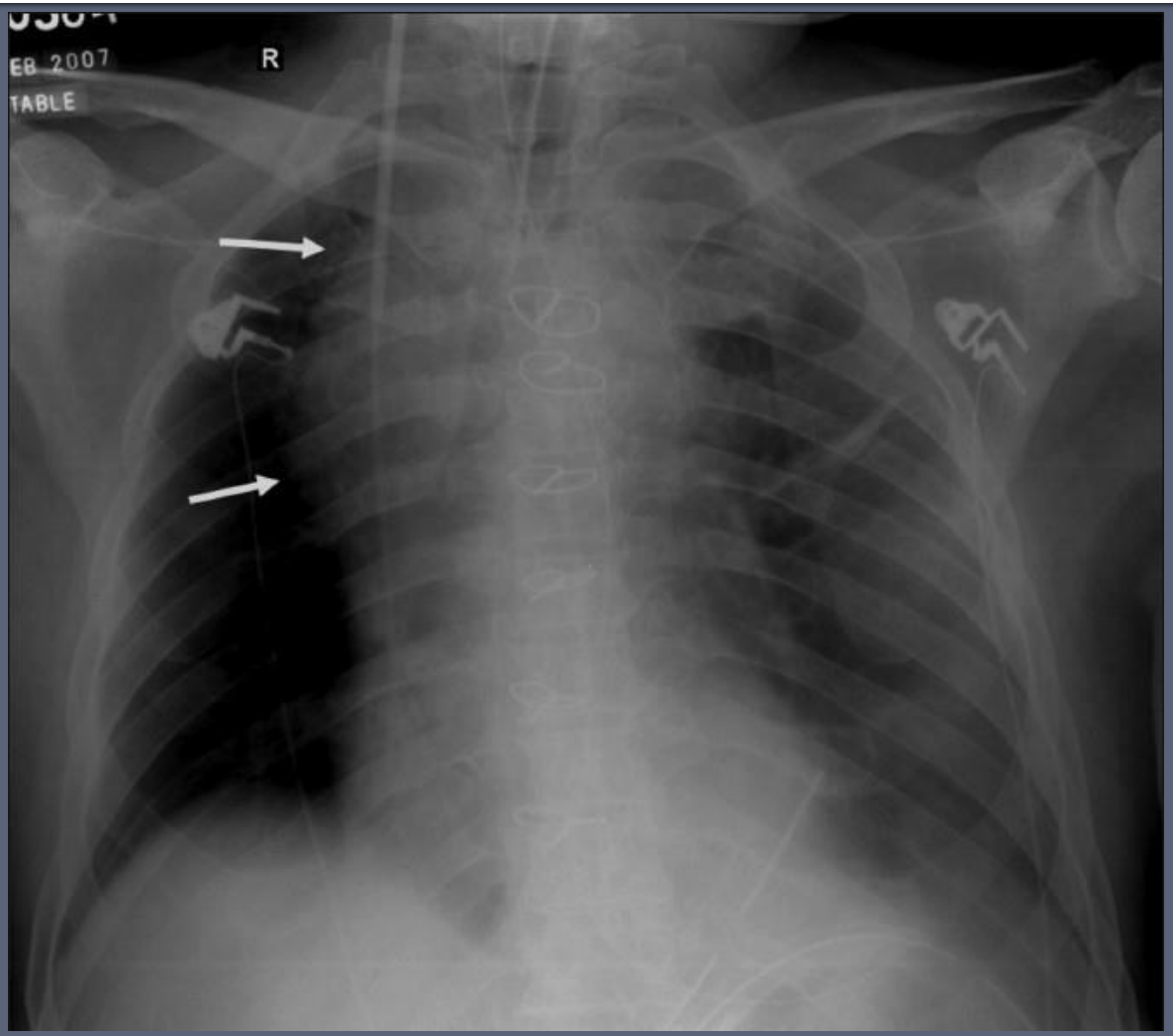
- **Ideal position**:
  - SVC
  - Tip should be central to valves (beyond the medial aspect of the 1st rib)
  - Tip should be above the cavo-atrial junction

CVC

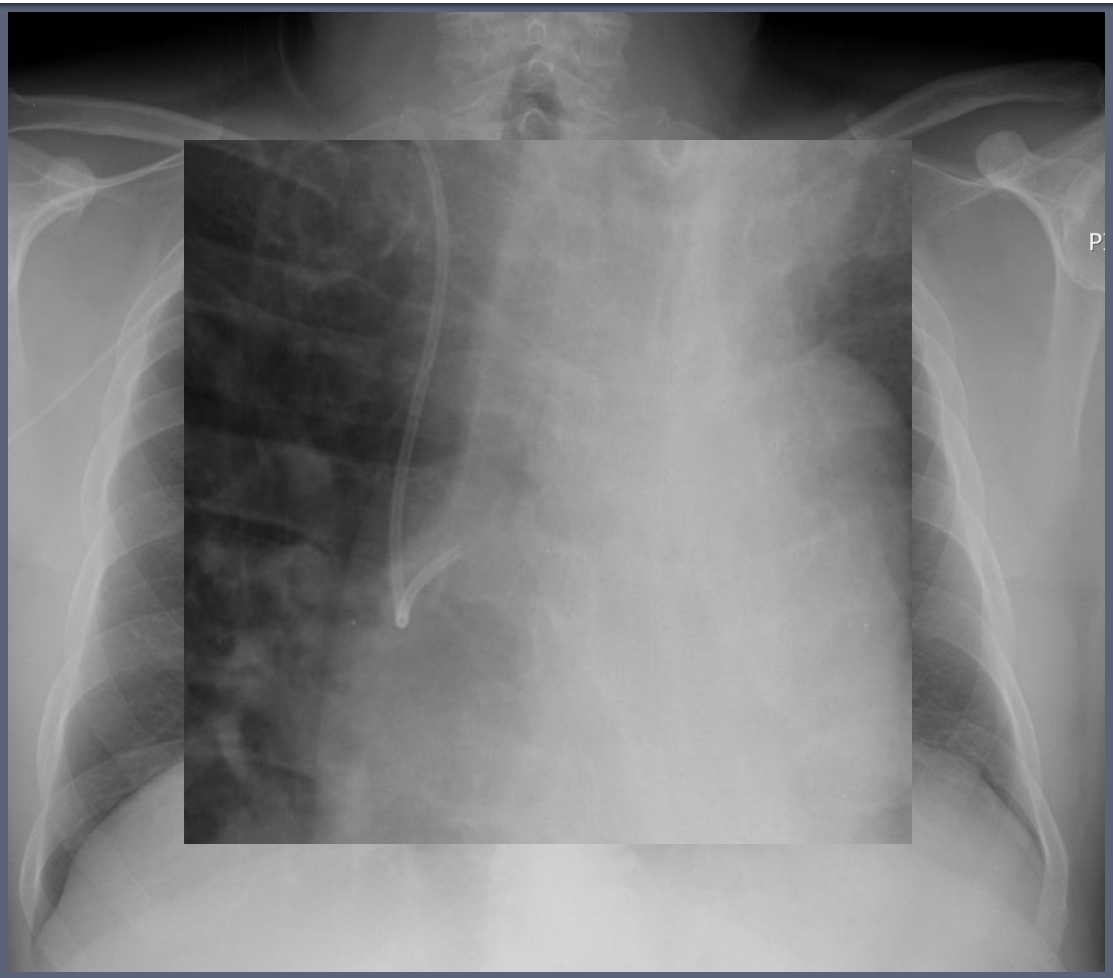
- **Complications:**
  - PTX/hemothorax
  - Mediastinal hematoma
  - Mediastinal or pleural infusion
  - Venous thrombosis
  - Vessel/right atrial perforation
  - Catheter embolization
  - Arrhythmia
- **Malposition:**
  - Azygos vein
  - Superior intercostal vein
  - Carotid artery
  - Subclavian artery
  - Pleural space

Complication of CVC—PTX

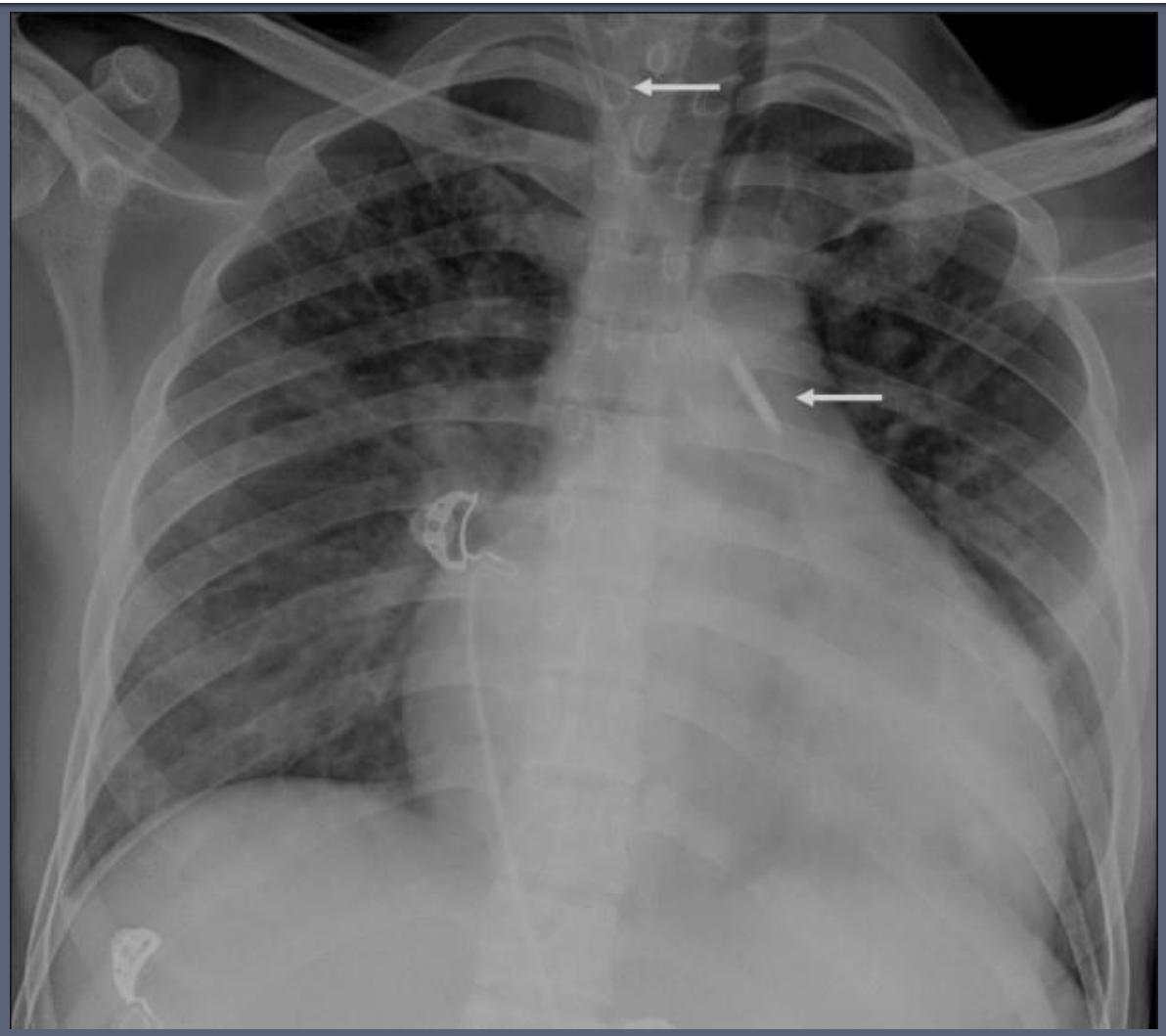
Complication of CVC—Mediastinal hematoma



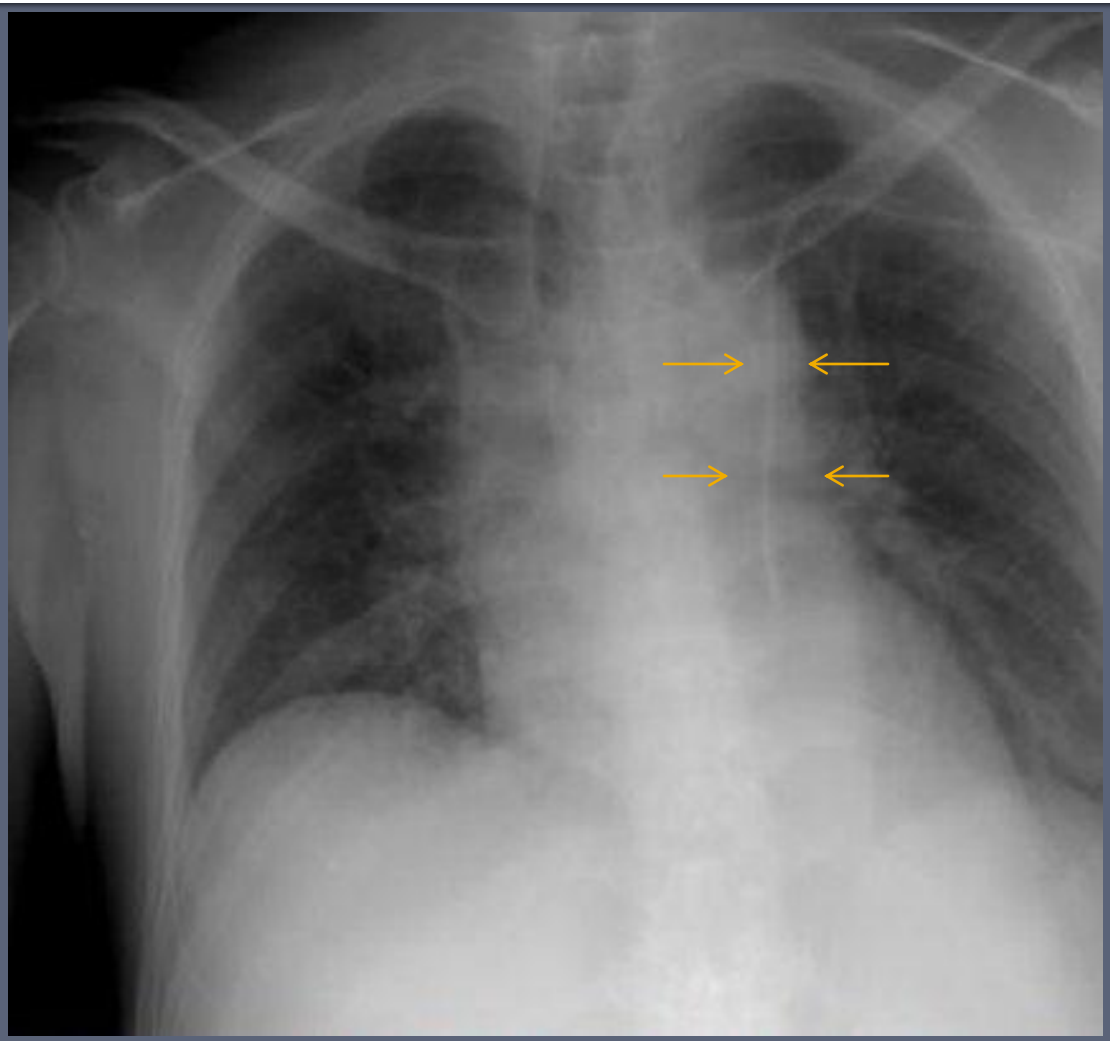
Malpositioned CVC—Azygos vein



Malpositioned CVC—Carotid artery



CVC in Persistent Left SVC

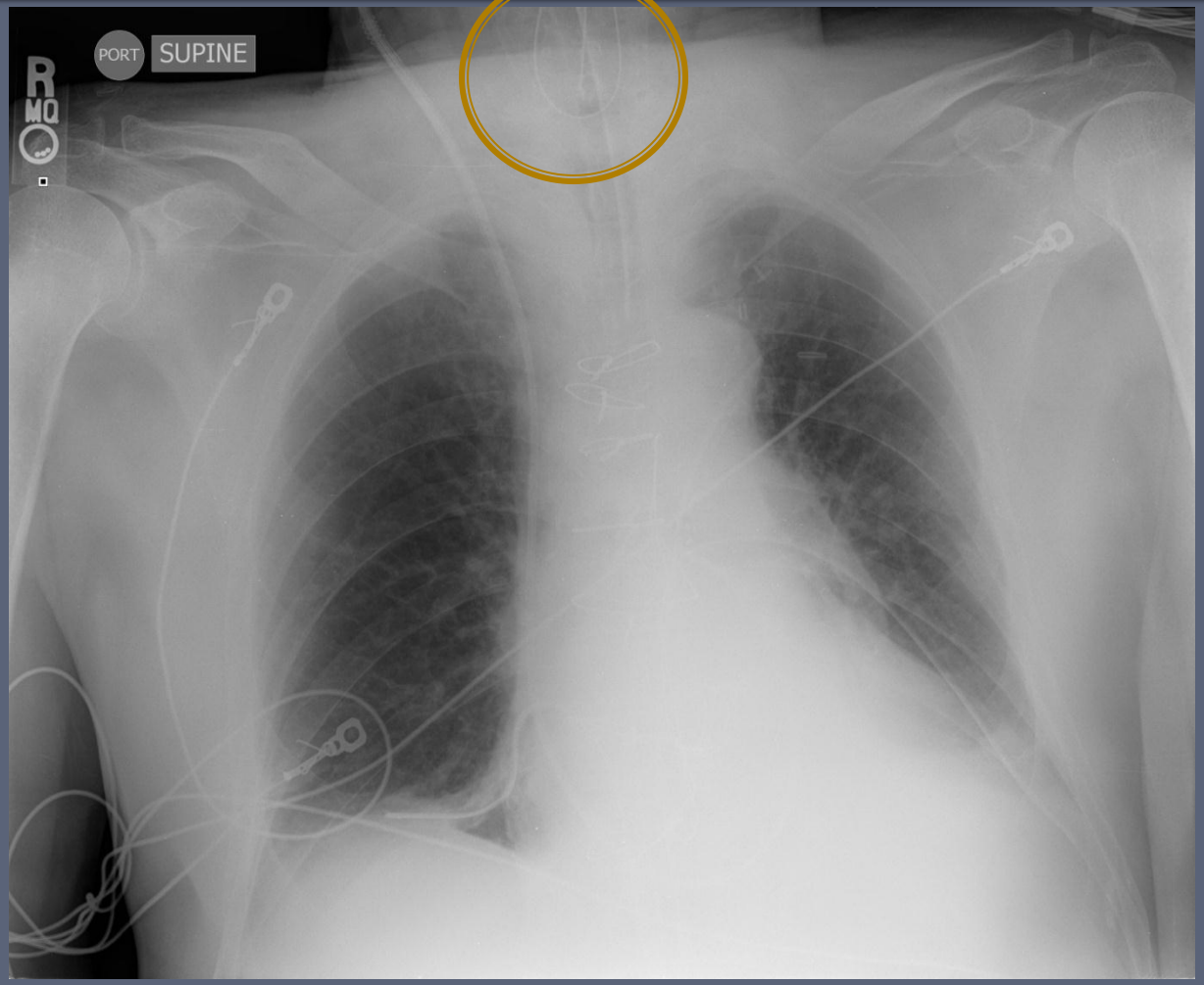


Enteric Tubes

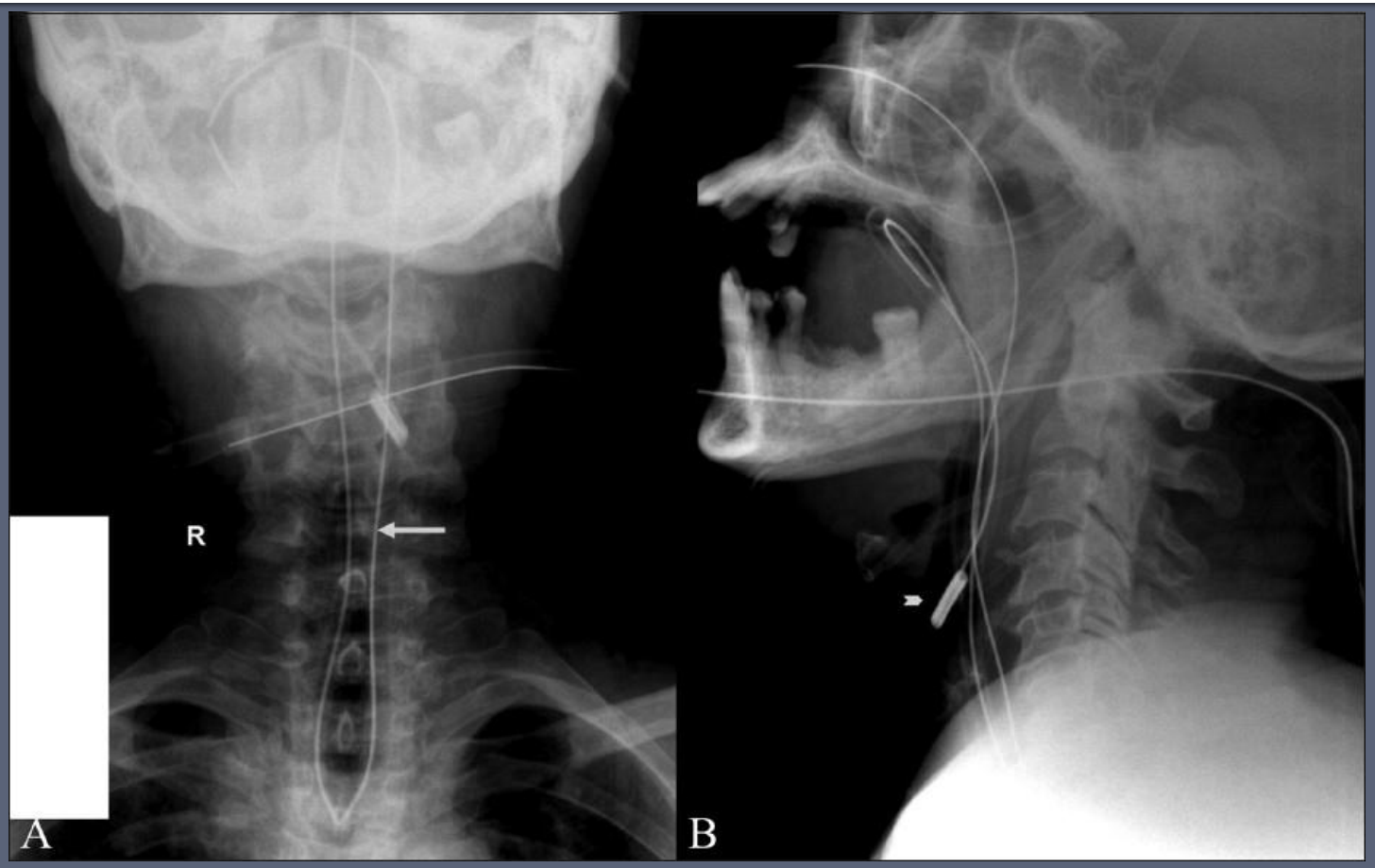
- **Feeding tube**:
  - Tip should be post-pyloric
- **Nasogastric tube**:
  - Tip should be at least 10 cm distal to the GE junction to ensure side-hole is beyond the GE junction

Malpositioned Feeding Tube—right lower lobe bronchus

Malpositioned NGT—coiled in pharynx/upper esophagus



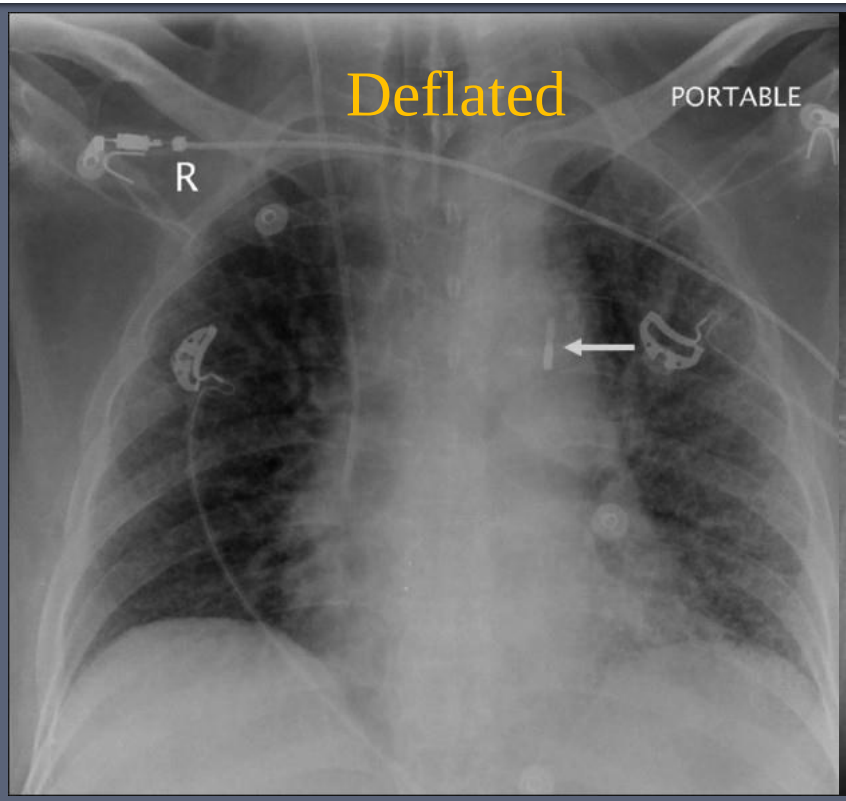
Malpositioned NGT—
coiled in upper esophagus with tip in hypopharynx

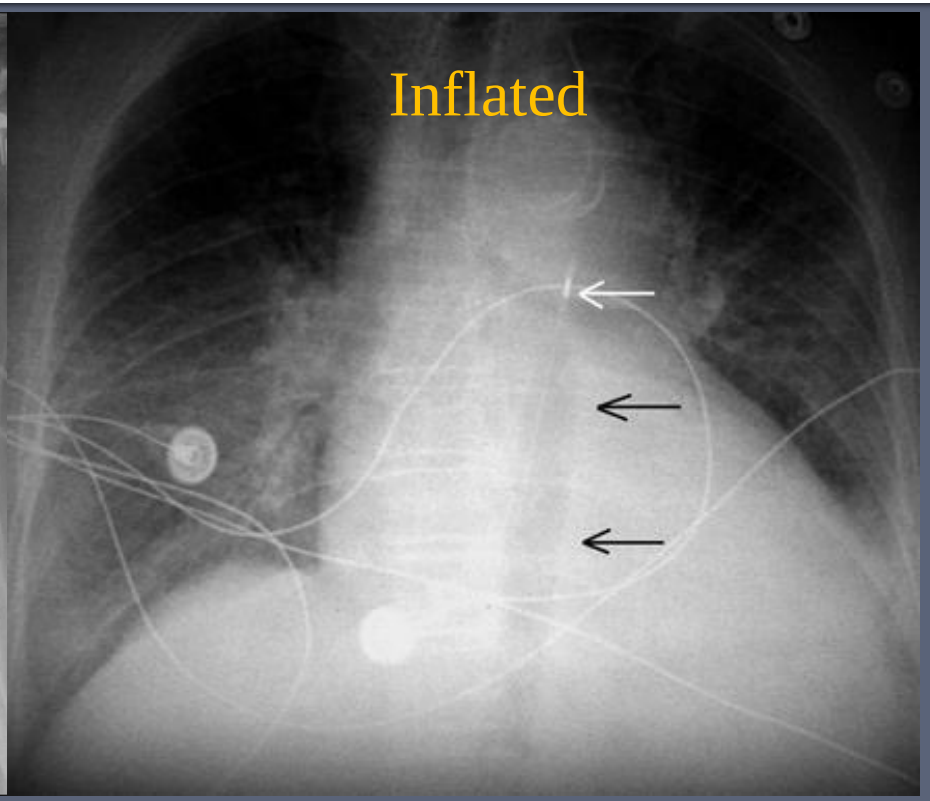


IABP

- **Ideal position:**
  - Just distal to origin of left subclavian artery
  - Tip should be ~ 2-4 cm below level of aortic arch
    - Too high—may occlude great vessels
    - Too low—may occlude renal or mesenteric arteries

IABP—normal position





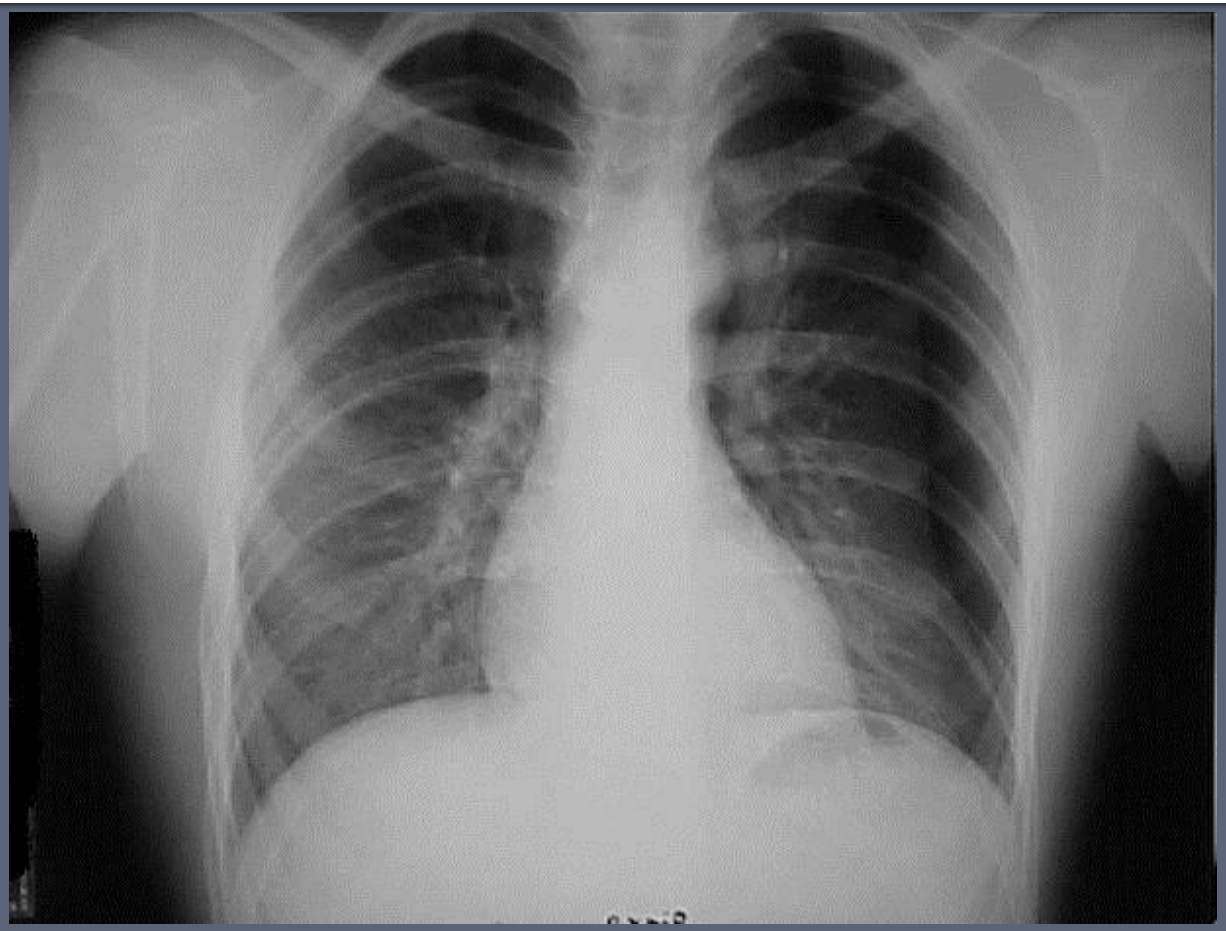
Abnormal Collections of Gas

- PTX
- Pneumomediastinum
- Pneumopericardium
- Pneumoperitoneum

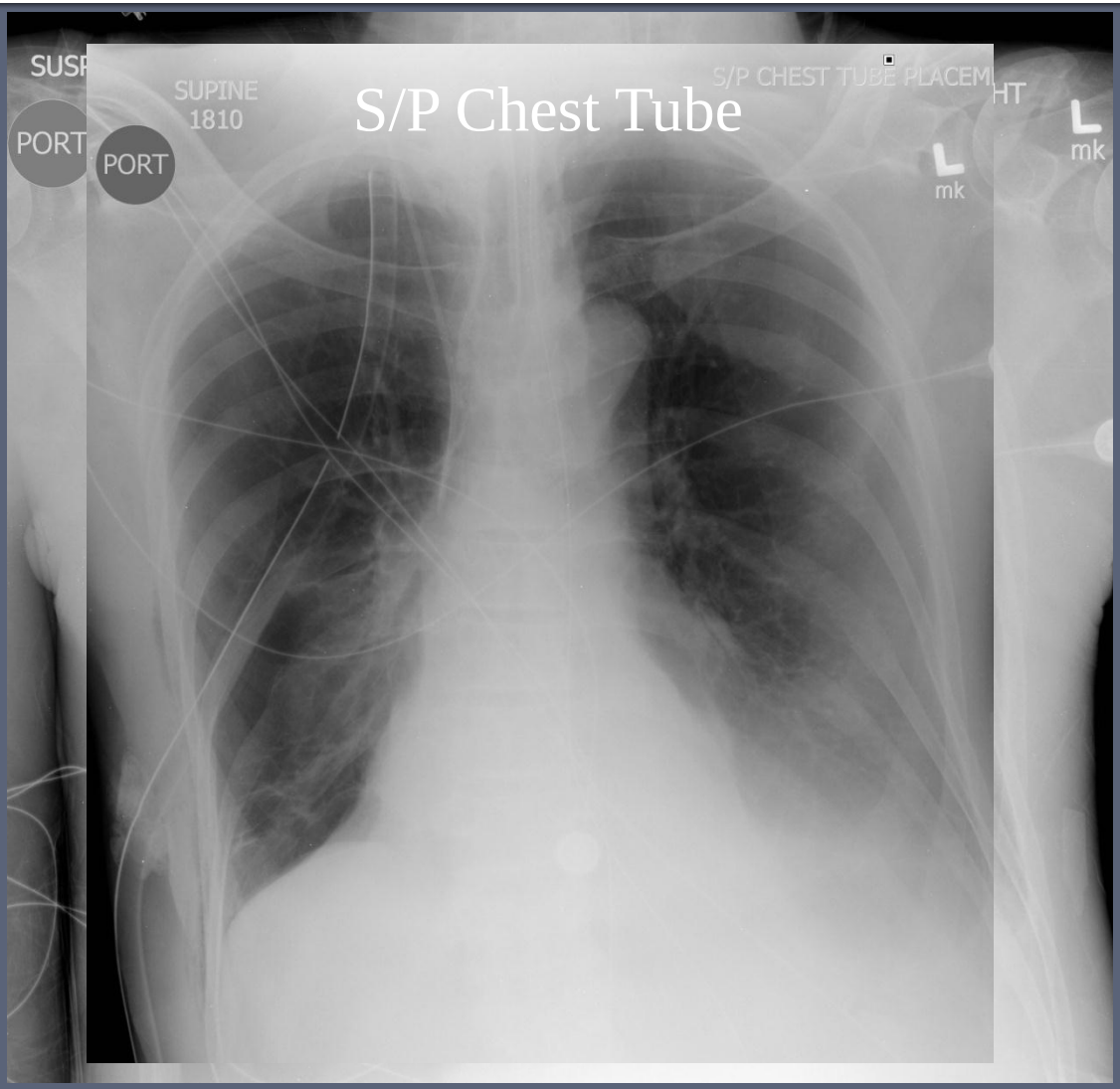
Pneumothorax

- Causes:
  - Spontaneous
    - Primary—no underlying lung disease
    - Secondary—underlying lung disease (emphysema, fibrosis, cavitary lung disease, cystic lung disease)
  - Traumatic/Iatrogenic
- Size:
  - Small (< 2 cm pleural separation)
  - Large (>2 cm pleural separation)
- Imaging recommendation:
  - Lateral/decubitus views if equivocal

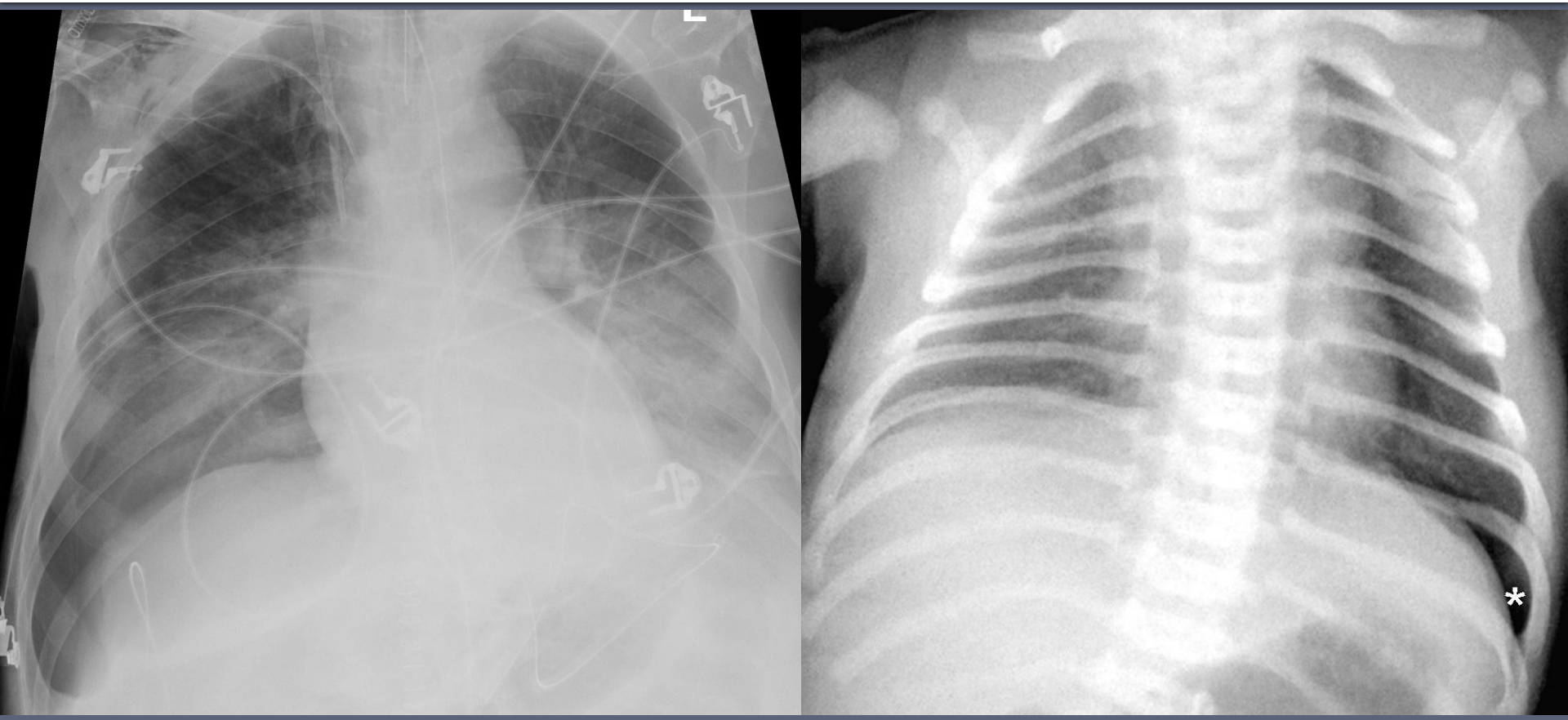
PTX



Tension PTX


SUPINE
1810
PORT
PORT
S/P CHEST TUBE PLACEM
HT
L
mk
L
mk
S/P Chest Tube

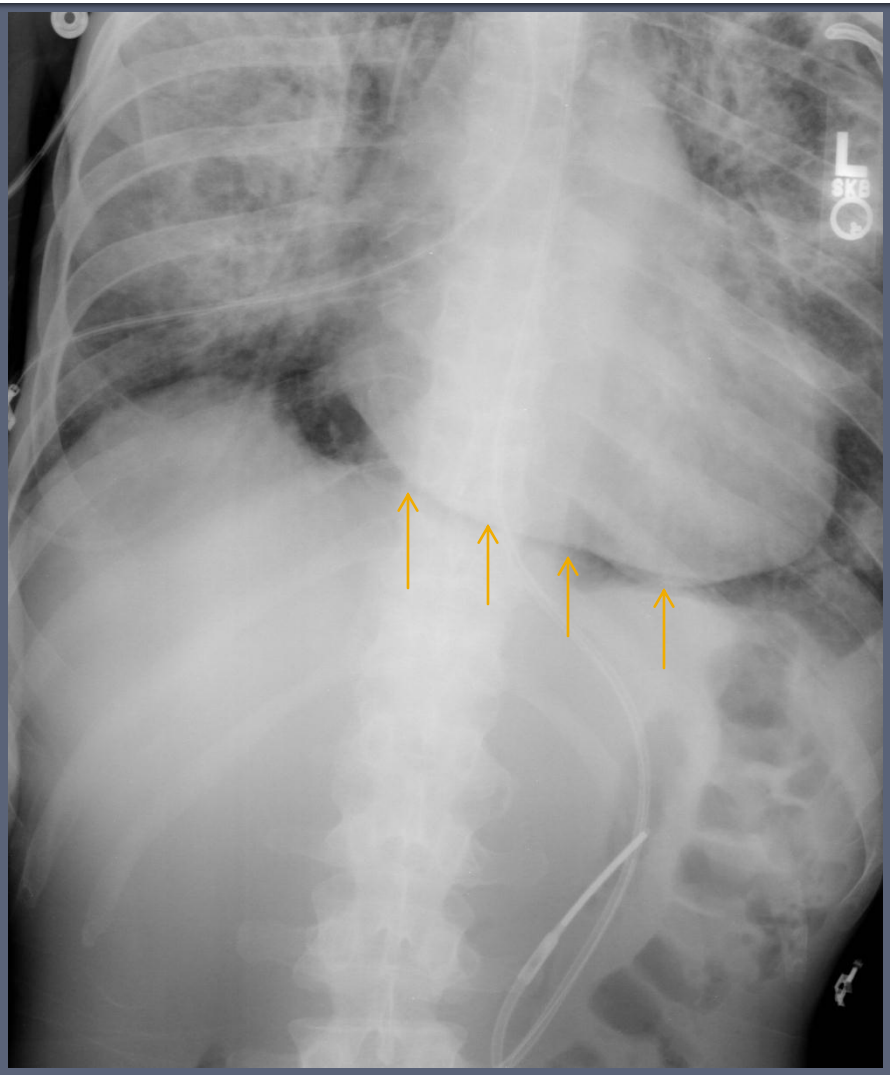
PTX--Deep Sulcus Sign (supine CXR)



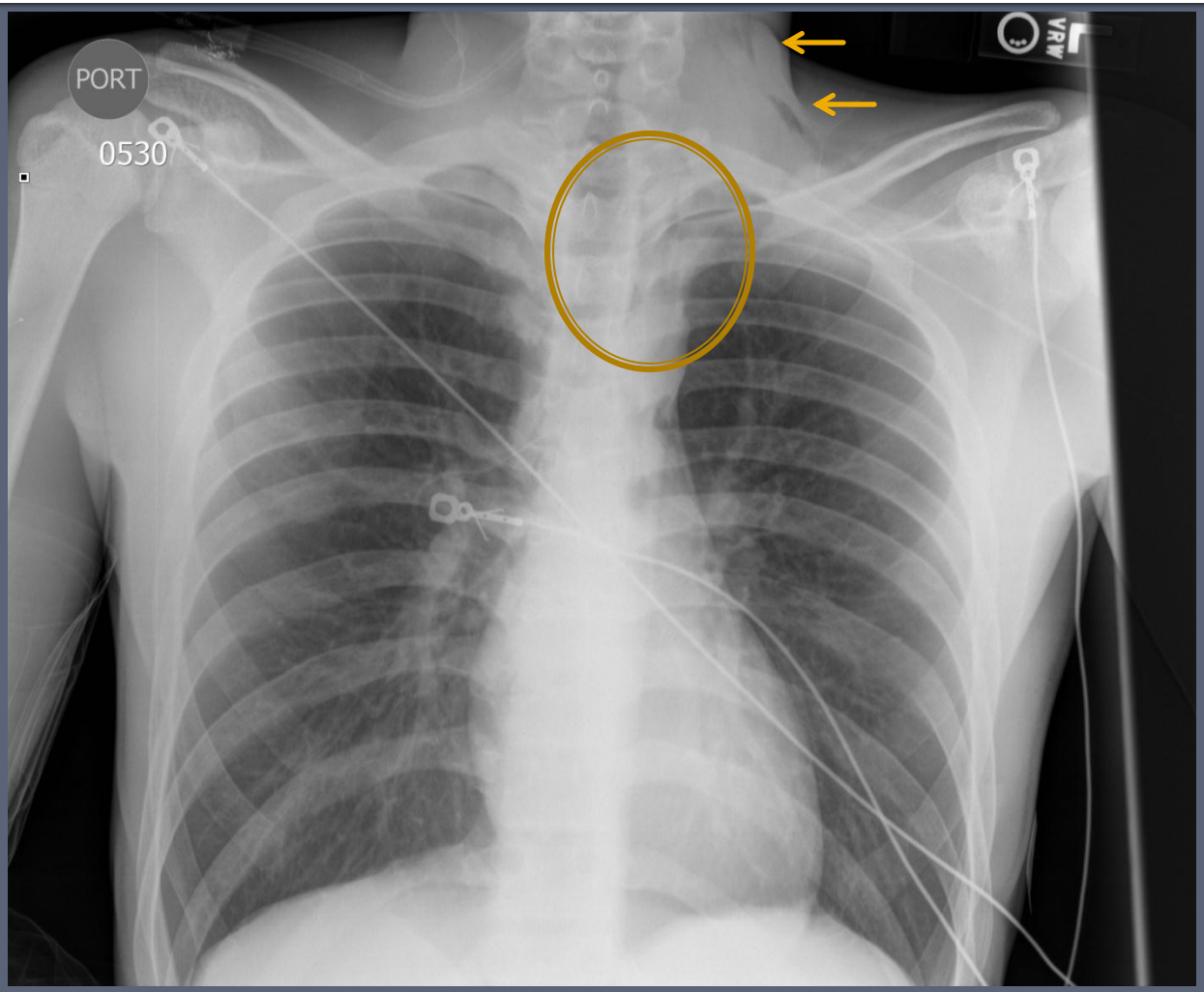
Pneumomediastinum

- Causes:
  - Spontaneous
    - Sustained Valsalva maneuver predisposes to alveolar rupture
    - e.g. asthma, cough, straining, marijuana or inhalational drugs
    - ***Macklin effect***: Alveoli rupture, air then tracks through pulmonary interstitium, and decompresses into the mediastinum
  - Traumatic
    - Blunt chest trauma, tracheobronchial tear, esophageal tear, mechanical ventilation

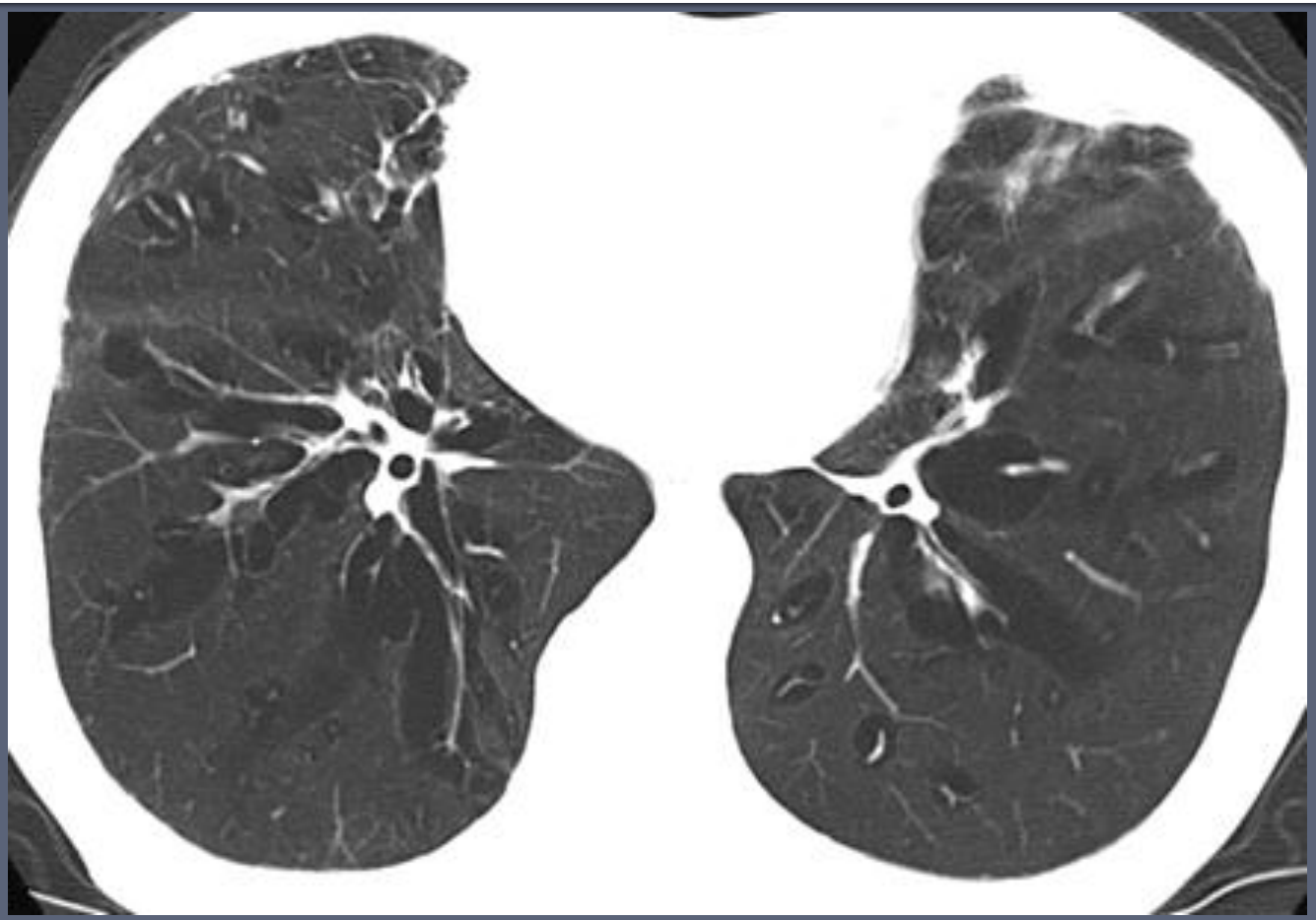
Pneumomediastinum—Continuous Diaphragm Sign



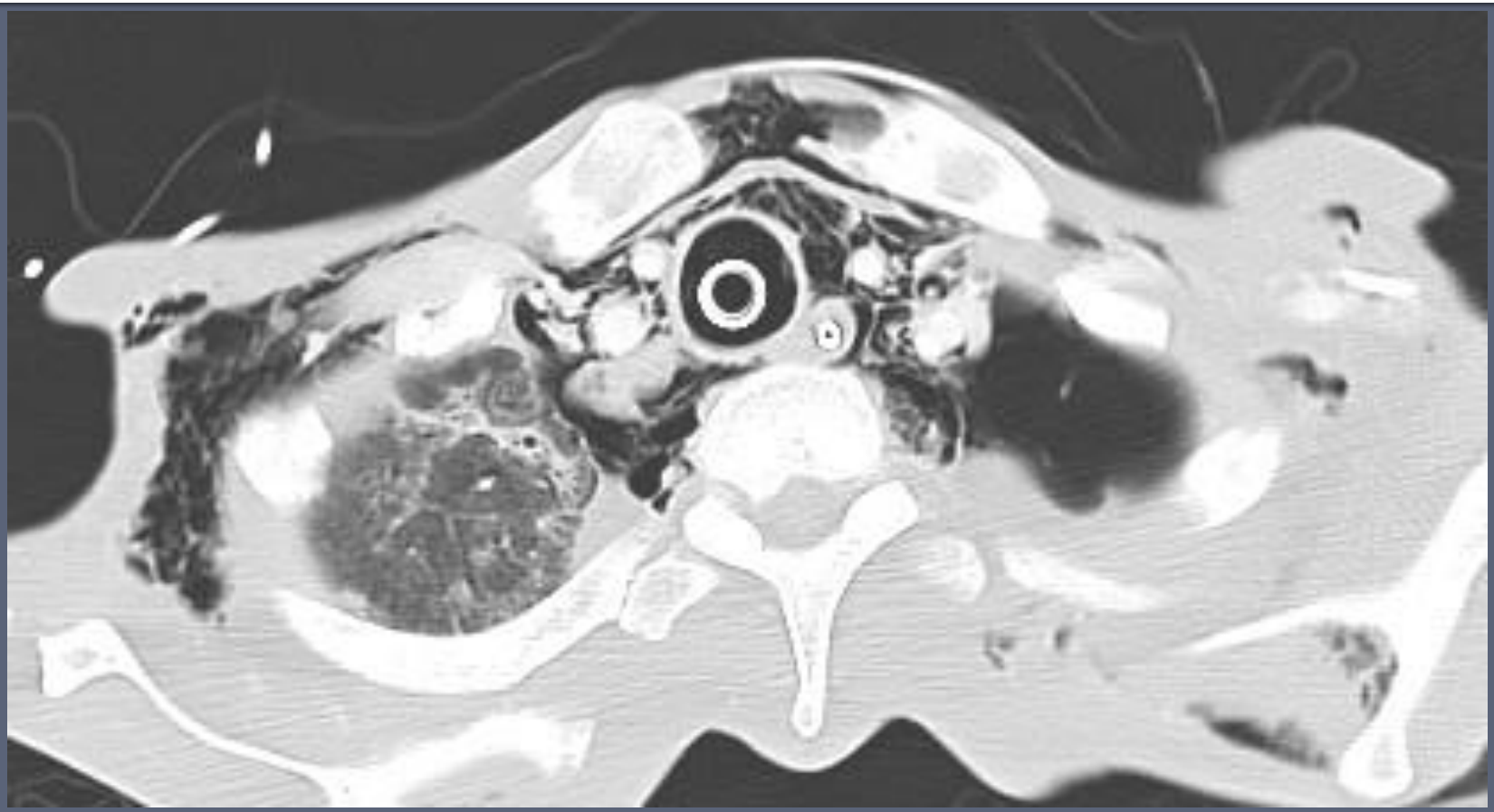
Pneumomediastinum



Pulmonary Interstitial Emphysema



PTX and Pneumomediastinum



PTX and Pneumomediastinum

PTX and Pneumomediastinum

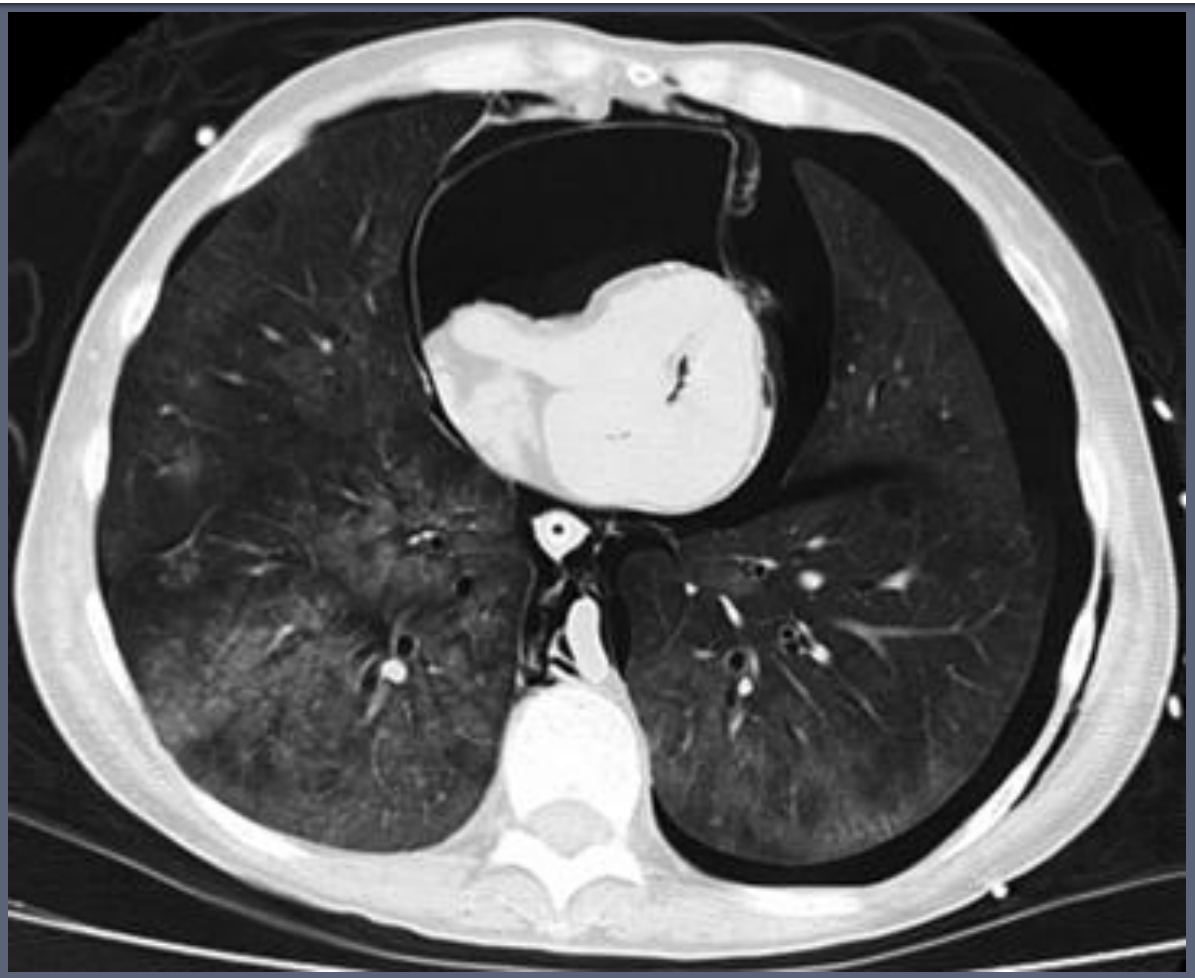
PTX and Pneumomediastinum

Pneumopericardium

- Cause:
  - Traumatic (penetrating, surgery, or barotrauma)
- Imaging features:
  - Air does not extend above mid-ascending aorta
  - Air moves on decubitus radiographs (pneumomediastinum does not shift)
  - Tension pneumopericardium
    - Small heart sign

Pneumopericardium

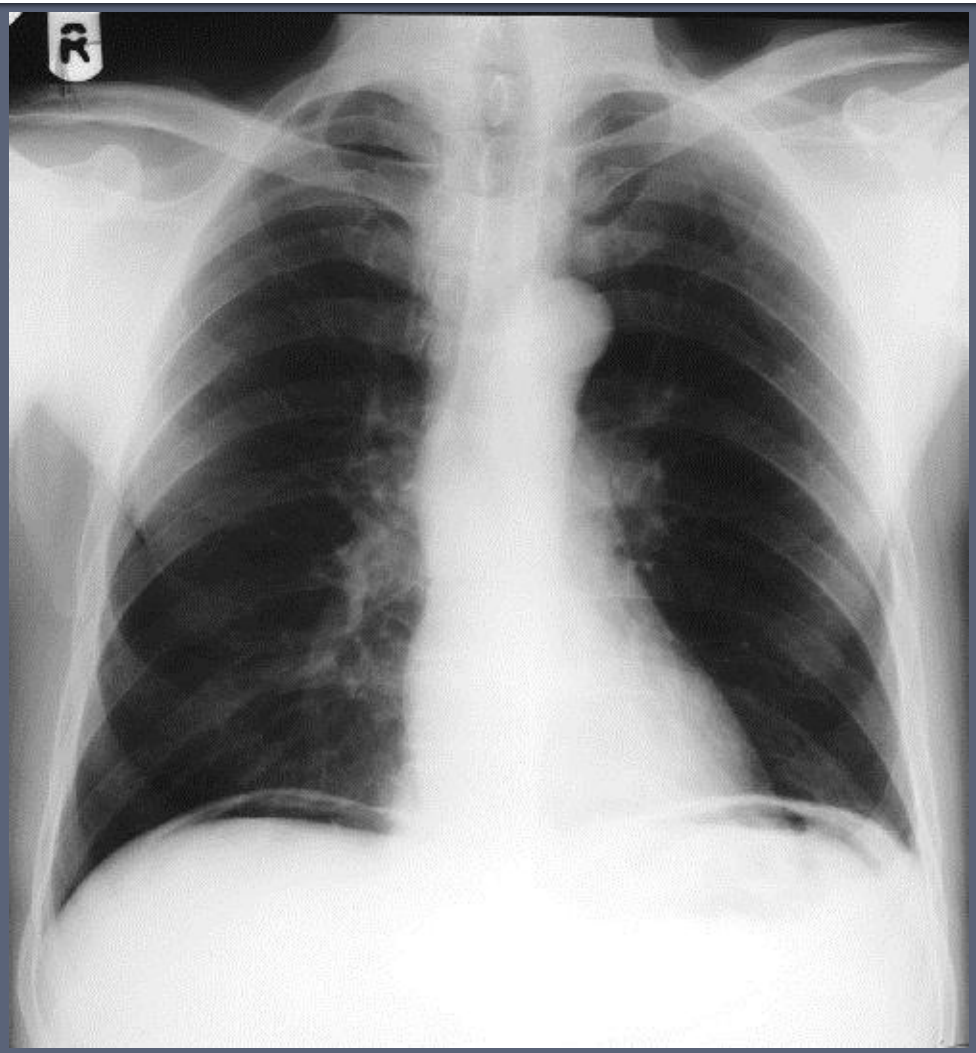
Tension Pneumopericardium



Pneumoperitoneum

- Causes:
  - Post-operative
  - Duodenal/Gastric Ulcers
  - Diverticulitis
  - Appendicitis
  - Trauma

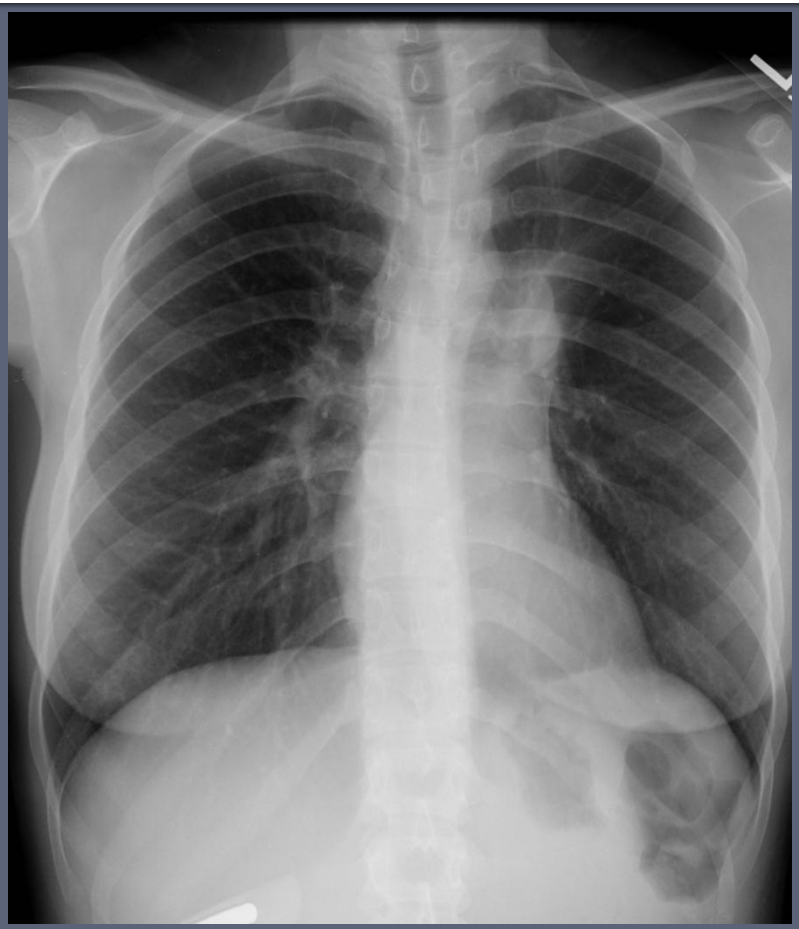
Pneumoperitoneum

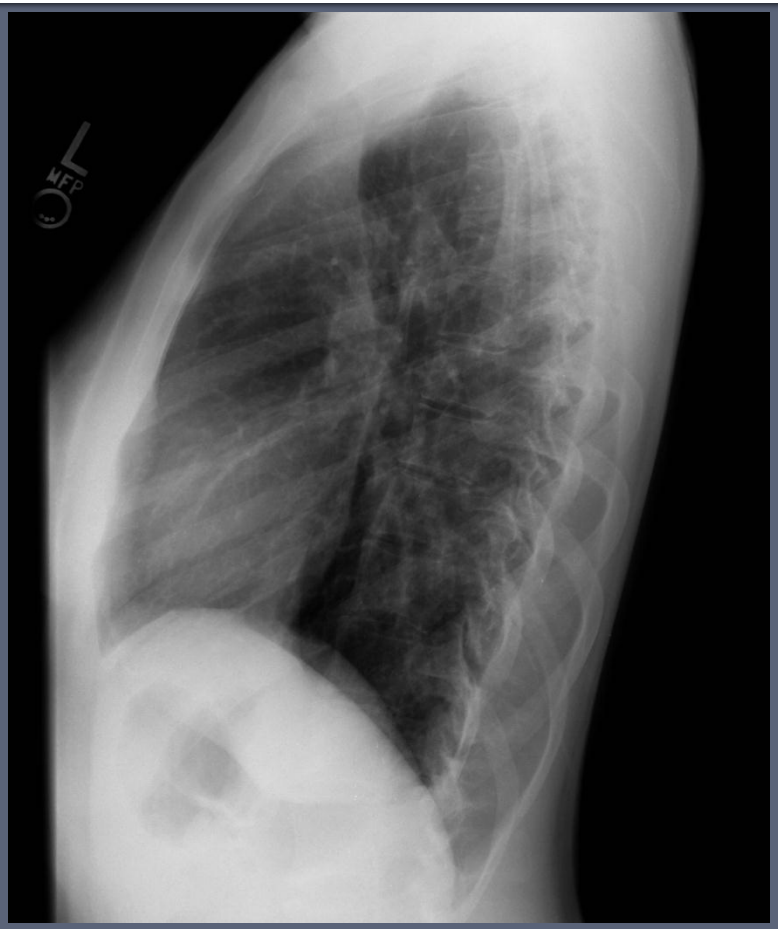


Lobar Atelectasis

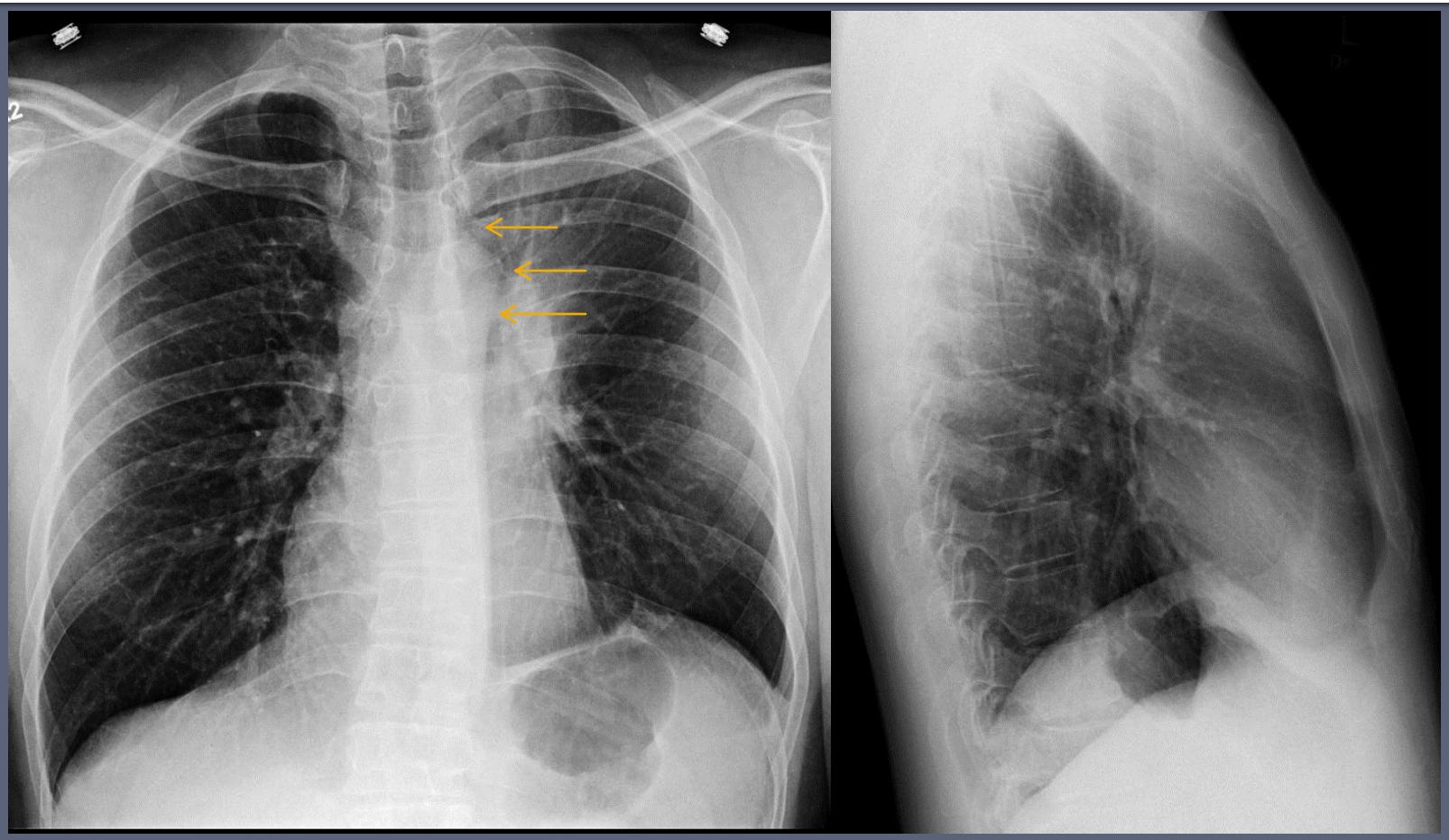
- Causes:
  - **Malpositioned ETT**
  - **Bronchial obstruction:** neoplasm (bronchogenic ca, carcinoid, etc.), LAD, mucus plug, foreign body
  - **Cicatricial scarring**: pulmonary fibrosis, sequela of infection (MAC, TB)
- Types:
  - LUL
  - LLL
  - RUL
  - RML
  - RLL
  - Combined (e.g. RML and RLL)

LUL Collapse

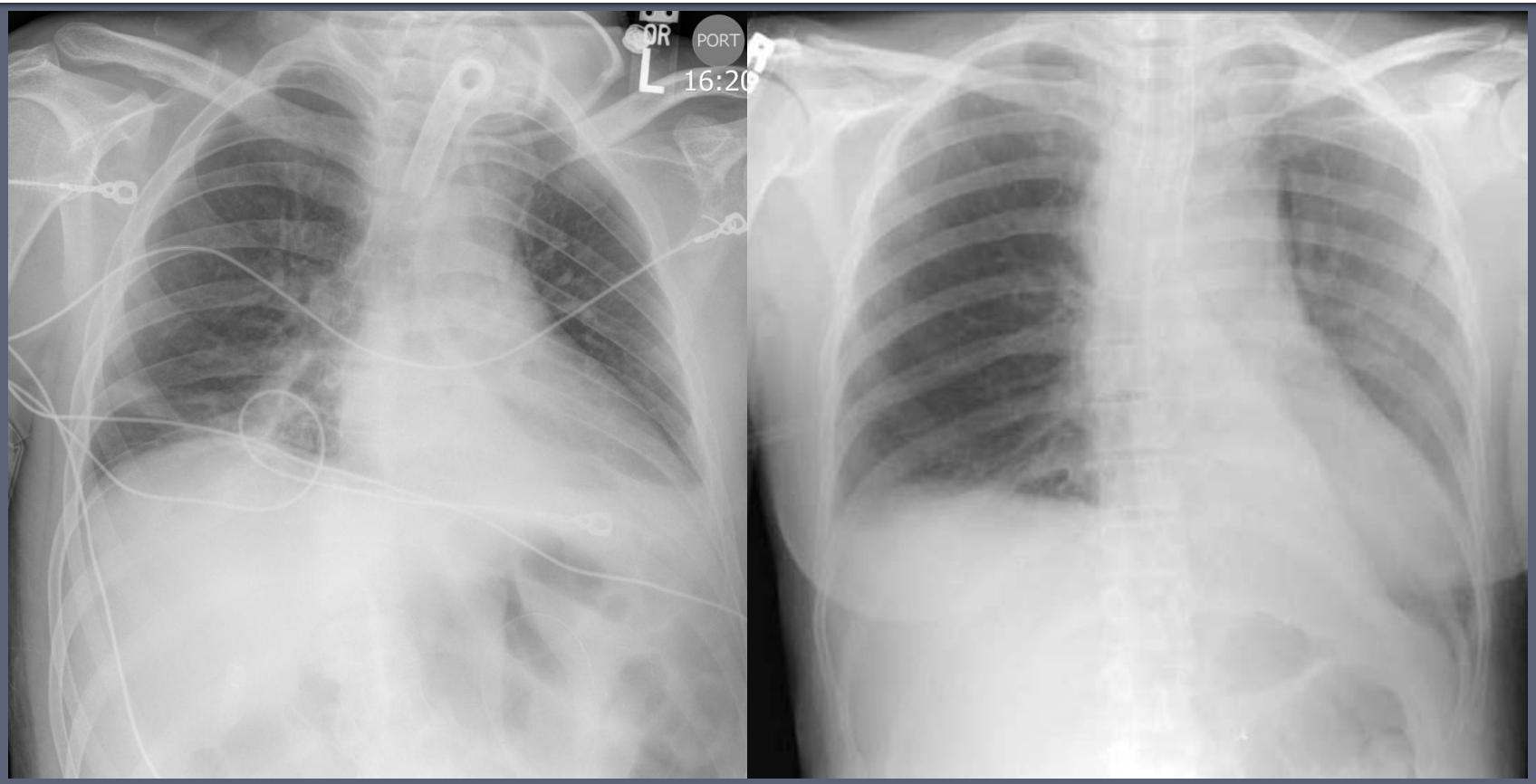




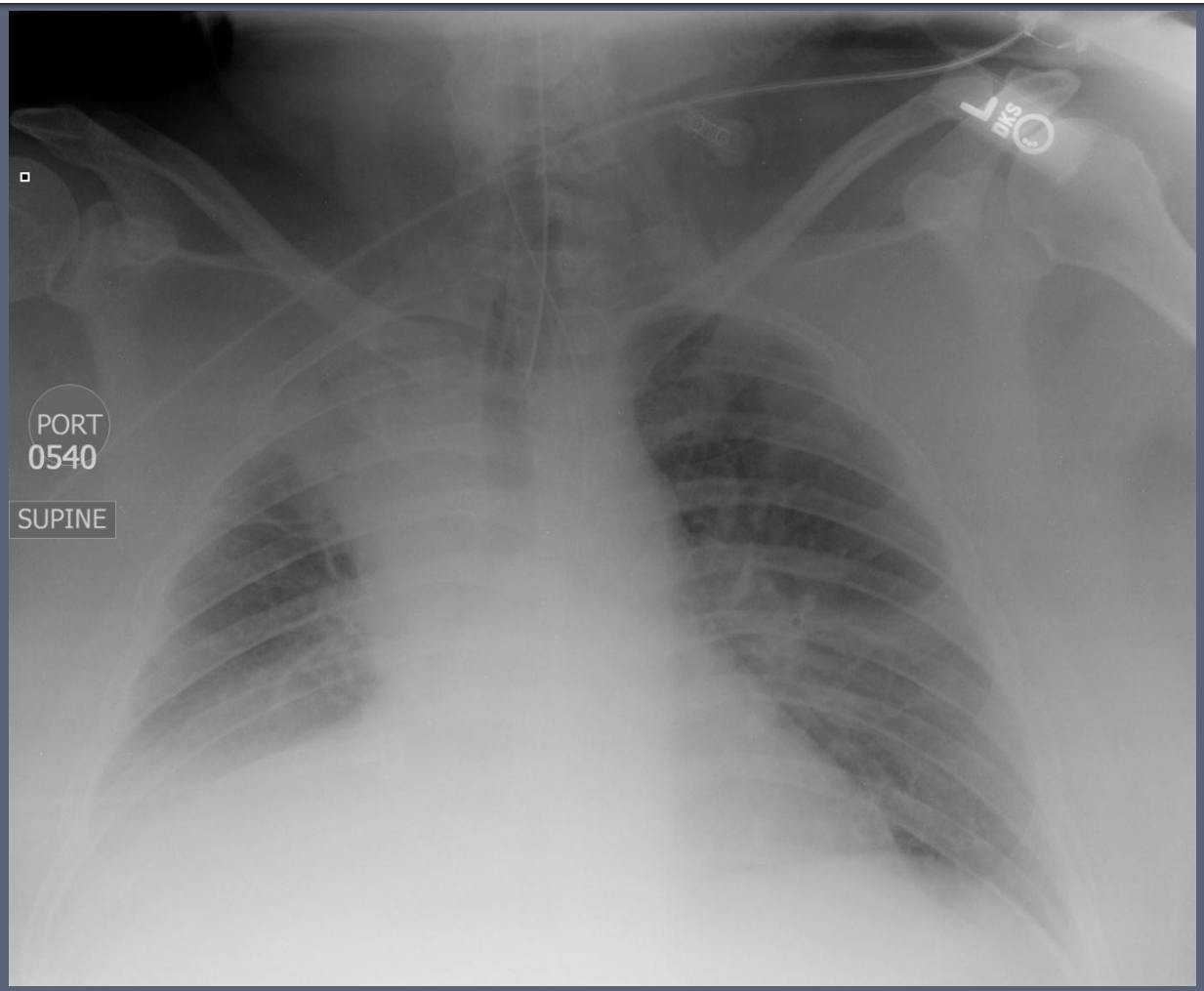
LUL Collapse with the "Luftsichel sign"



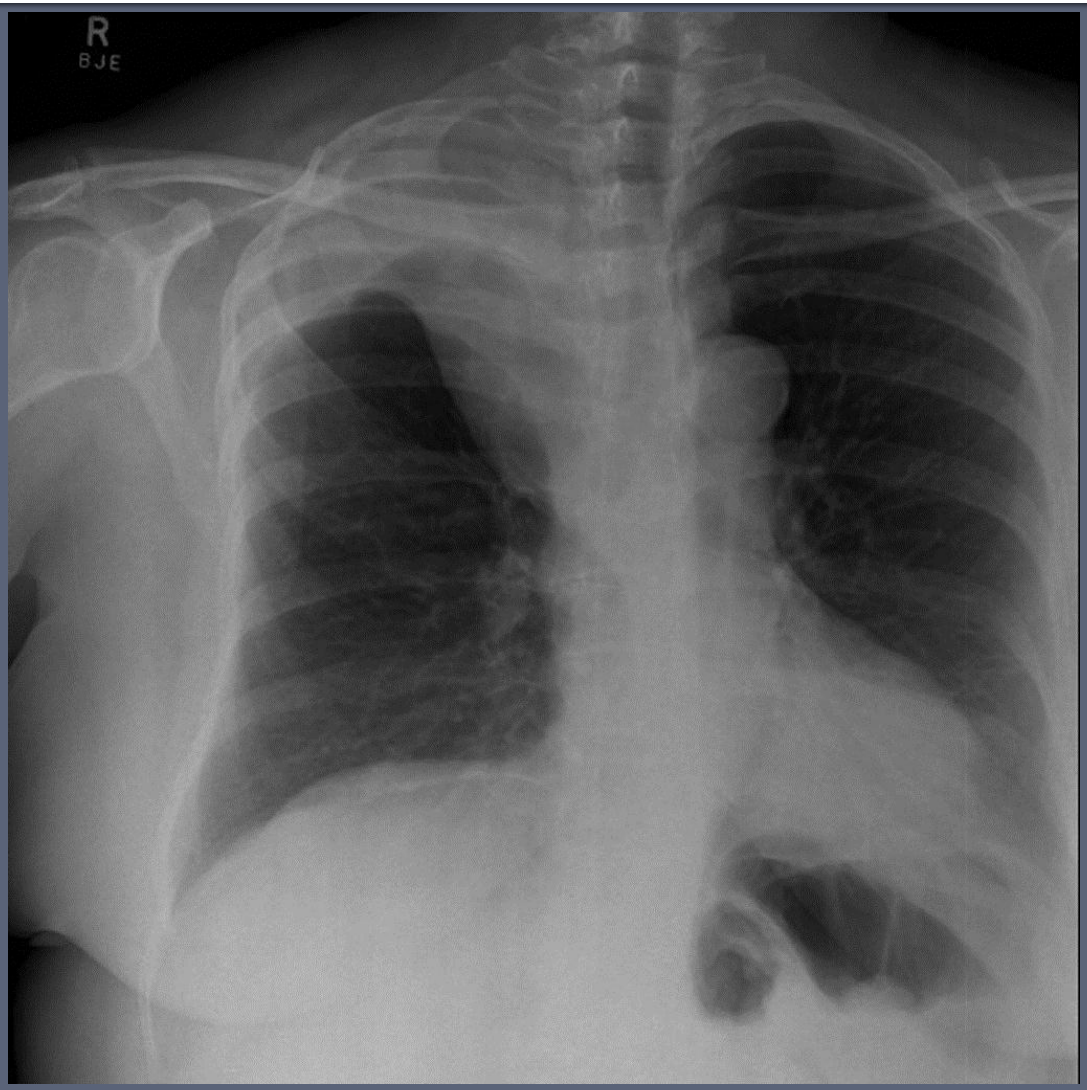
LLL Collapse



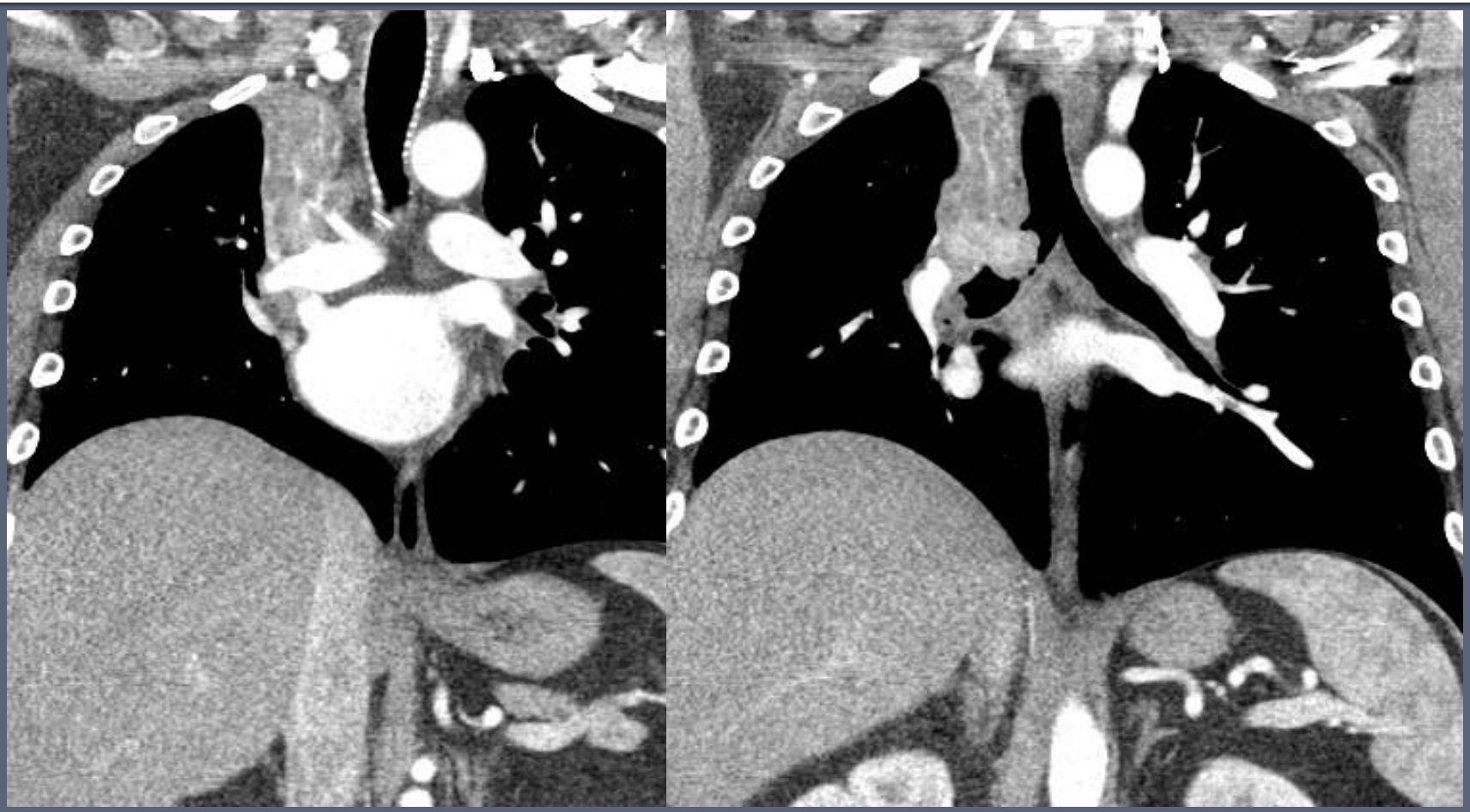
RUL Collapse



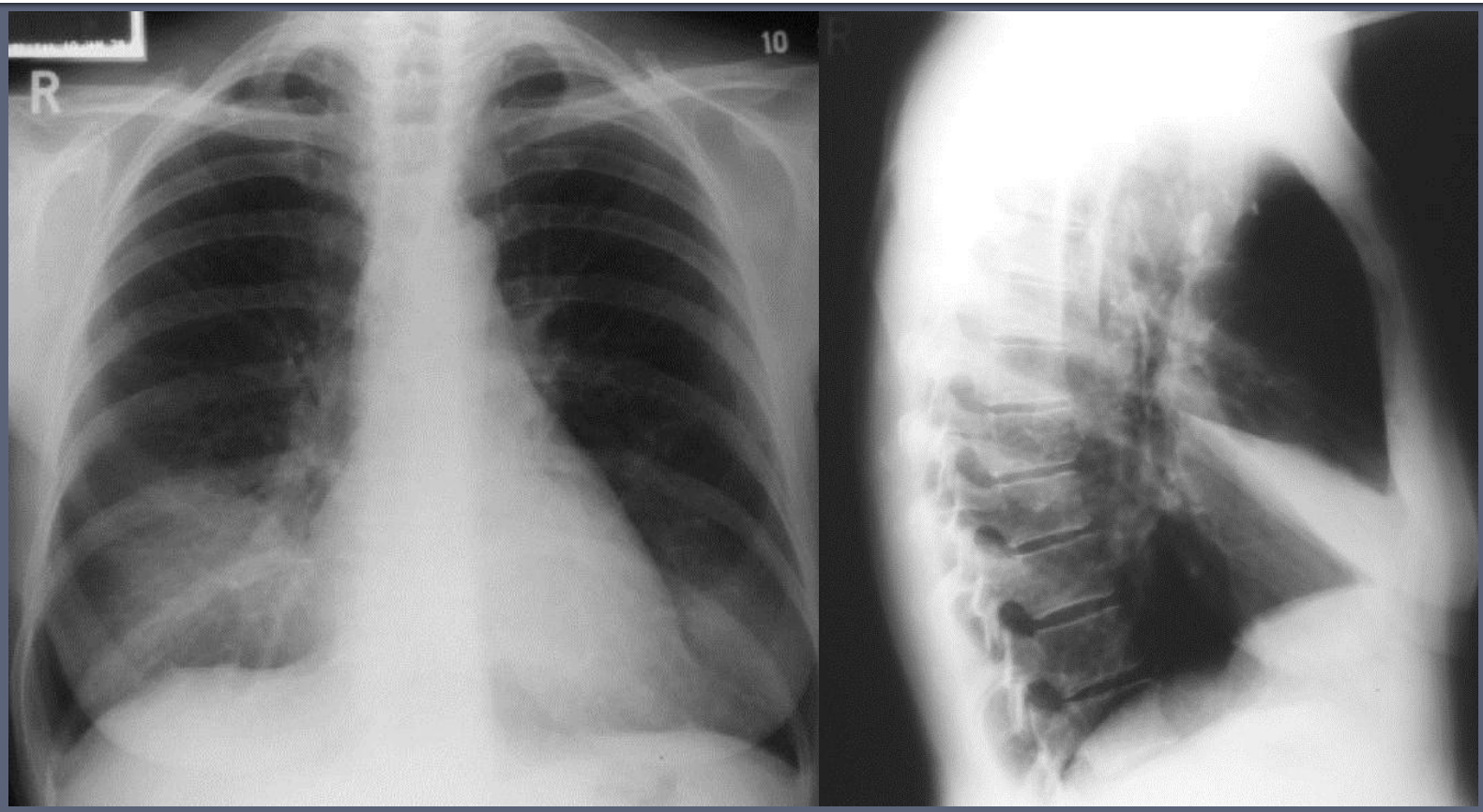
RUL Collapse due to right hilar mass: ”Golden’s S Sign”



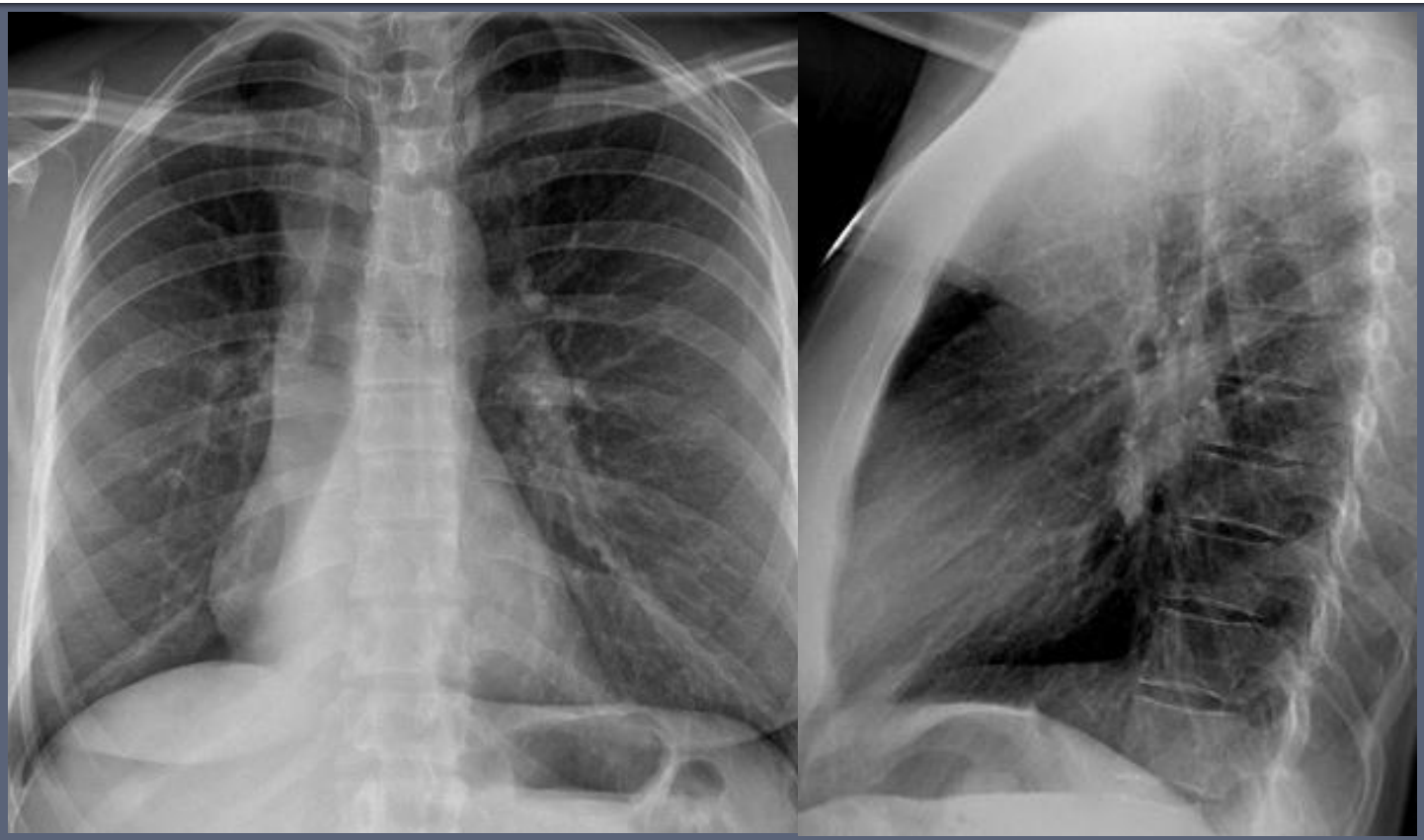
“Golden’s S Sign” on CT



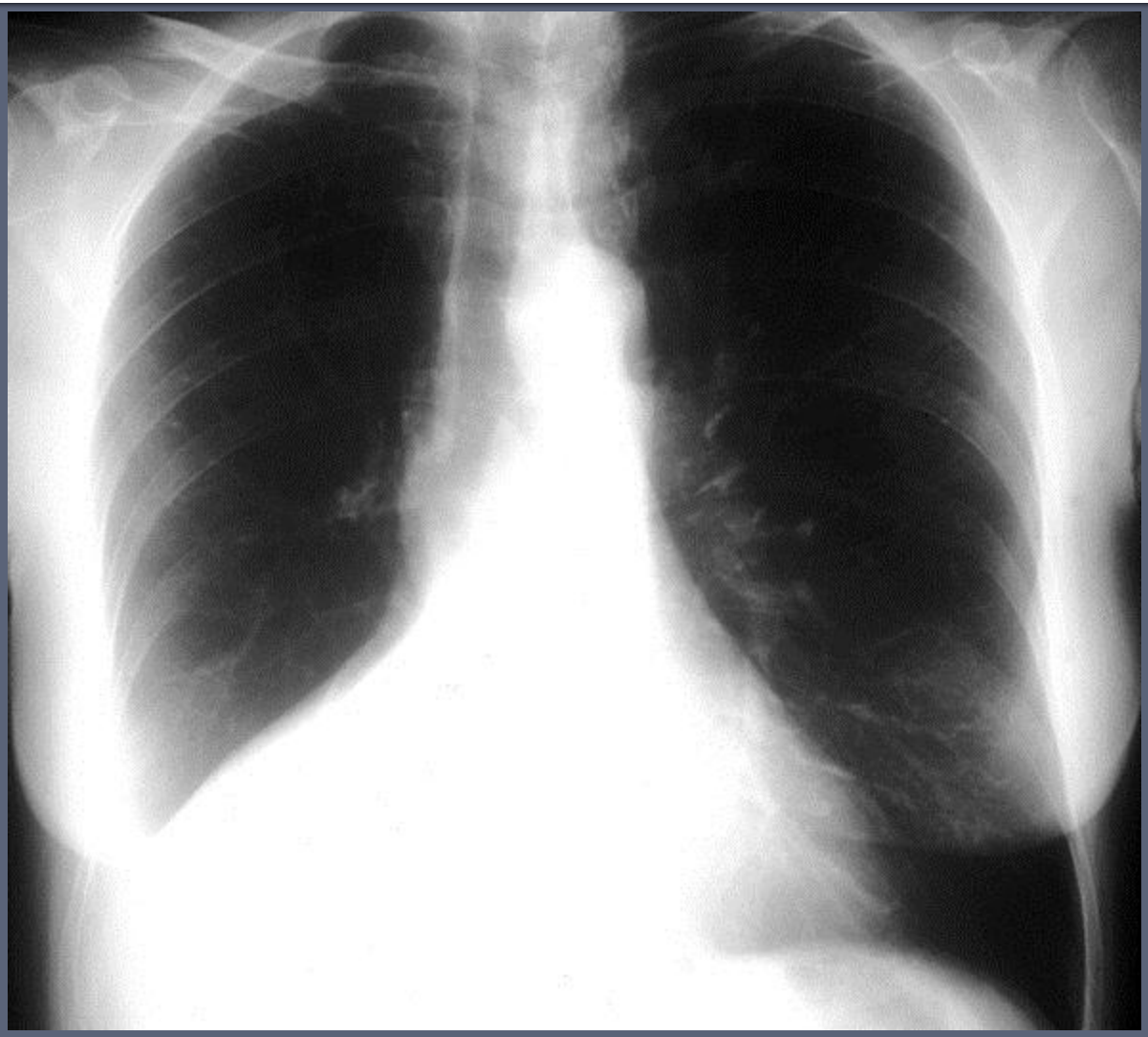
RML Collapse



RLL Collapse



Combined RML and RLL Collapse



Acute Respiratory Distress Syndrome (ARDS)

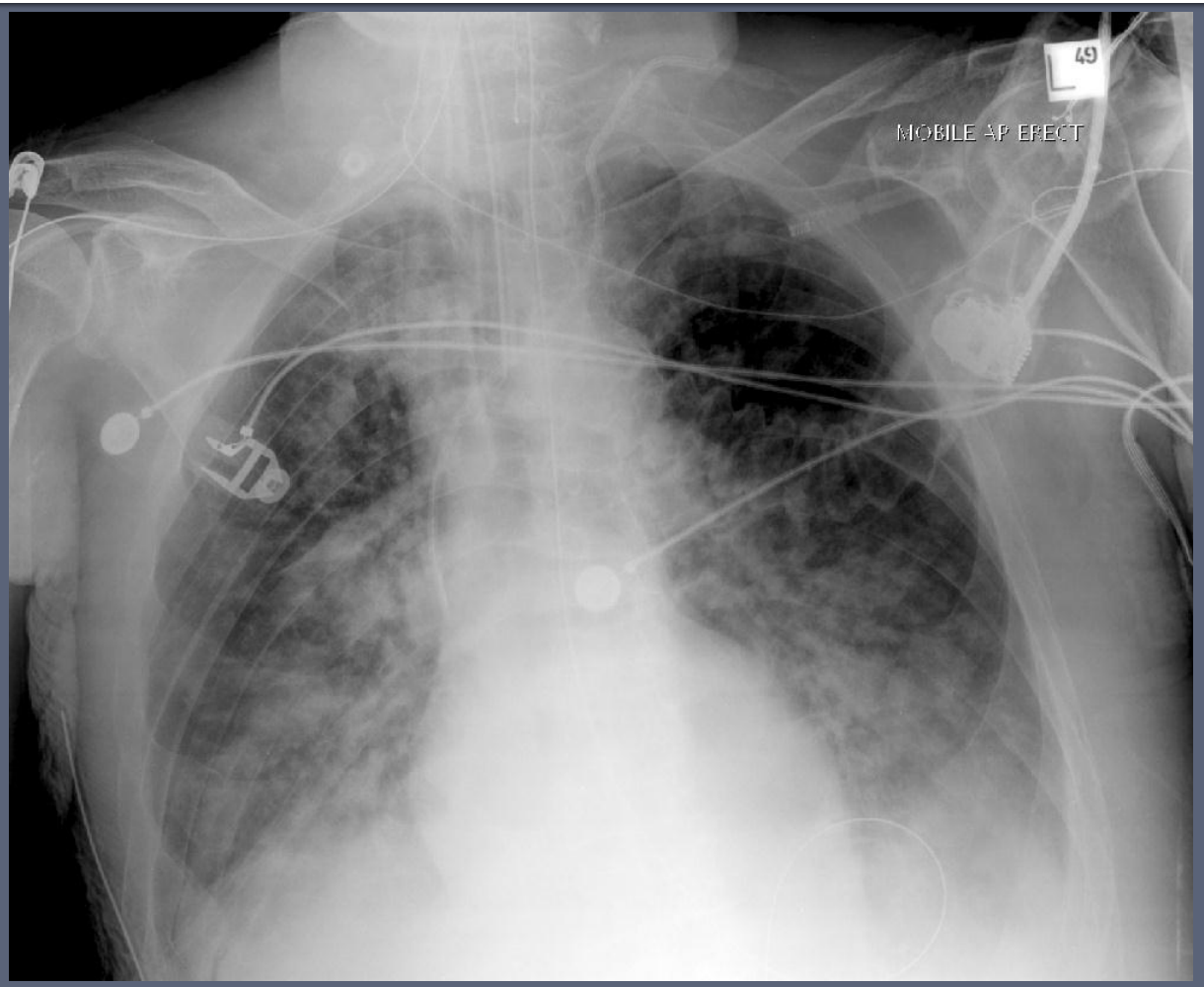
- **Synonyms**:
  - Diffuse alveolar damage (DAD)
  - Noncardiogenic pulmonary edema
  - Acute lung injury (ALI)
  - Acute interstitial pneumonia (AIP)--idiopathic ARDS

- **Causes:**
  - D**irect** (primary or pulmonary ARDS)
    - E.g. Severe pulmonary infection, massive aspiration, toxic fume inhalation, oxygen toxicity
  - I**ndirect** (secondary or extrapulmonary ARDS)
    - E.g.: Sepsis, pancreatitis, surgery

Acute Respiratory Distress Syndrome (ARDS)

- **Imaging: (non-specific)**
  - Intense pulmonary opacification (**IPO**) in dependent lung
  - Ground-glass opacities (**GGO**) layered on top of IPO
  - Normal lung (if present) occupies most non-dependent lung
- **DDx:**
  - Cardiogenic Edema
  - Diffuse Infection
  - Diffuse Alveolar Hemorrhage

ARDS—2/2 sepsis



ARDS—2/2 severe necrotizing pancreatitis

ARDS

Traumatic Aortic Injury--TAI

- Aortic laceration or rupture due to sudden *horizontal* (MVA) or *vertical* (fall from great height) deceleration
- Survival:
  - 85% exsanguinate before reaching hospital
  - 15-20% initial survival rate (of those, 60-70% survive after surgery)
- Treatment:
  - surgical repair
  - endovascular stent grafting

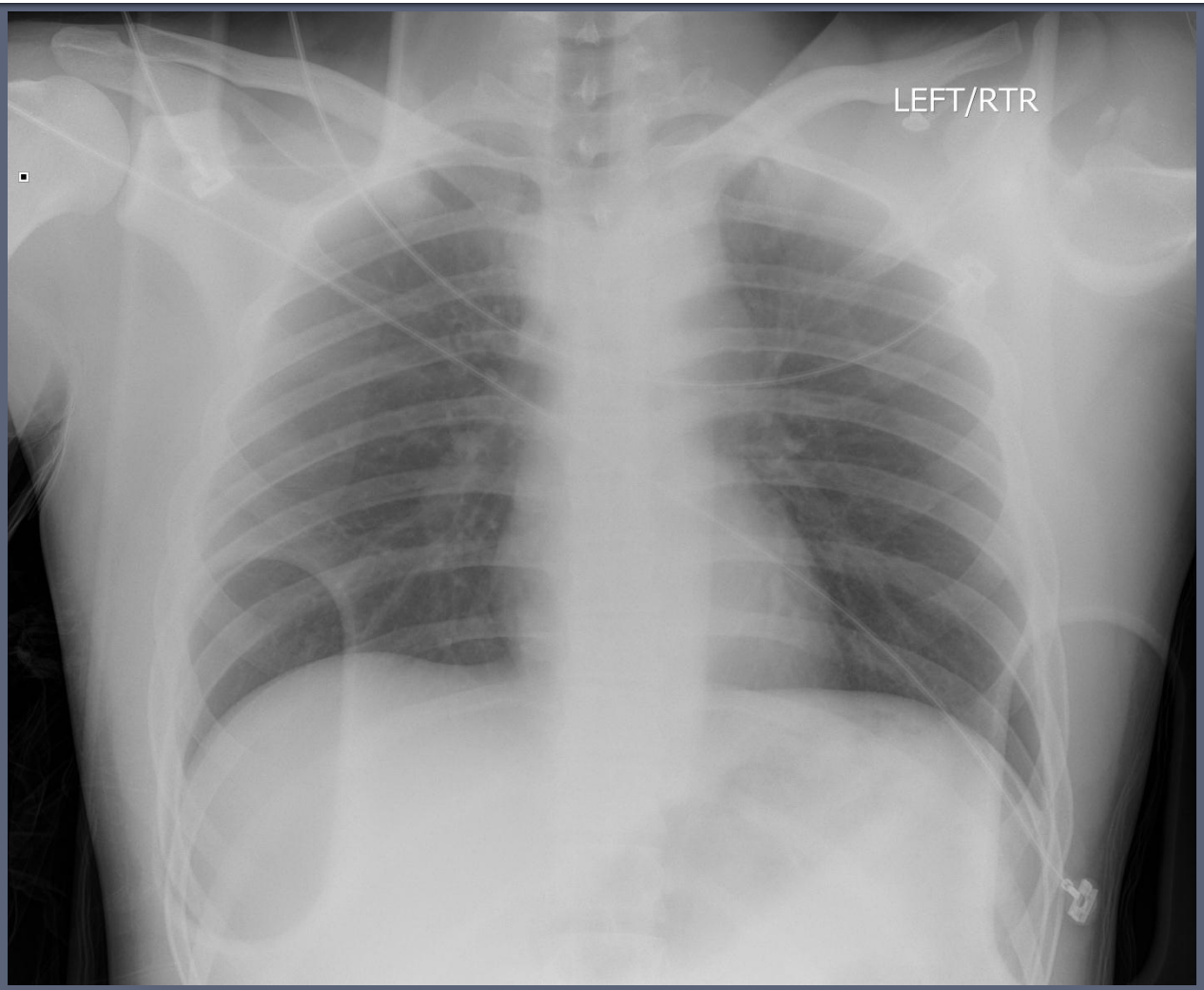
Traumatic Aortic Injury--TAI

- Imaging:
  - **88% aortic isthmus** (just distal to takeoff of L SCA)
  - CXR:
    - **mediastinal widening** > 8 cm
    - indistinct aortic outline
    - right paratracheal soft tissue density
    - NG tube deviation to right
    - tracheal displacement to right
    - apical pleural cap
  - CT (neg CT has nearly 100% neg predictive value):
    - **abrupt change of aortic contour**
    - **intimal flap (focal)**
    - **pseudoaneurysm**
    - intraluminal filling defects
    - mediastinal hemorrhage

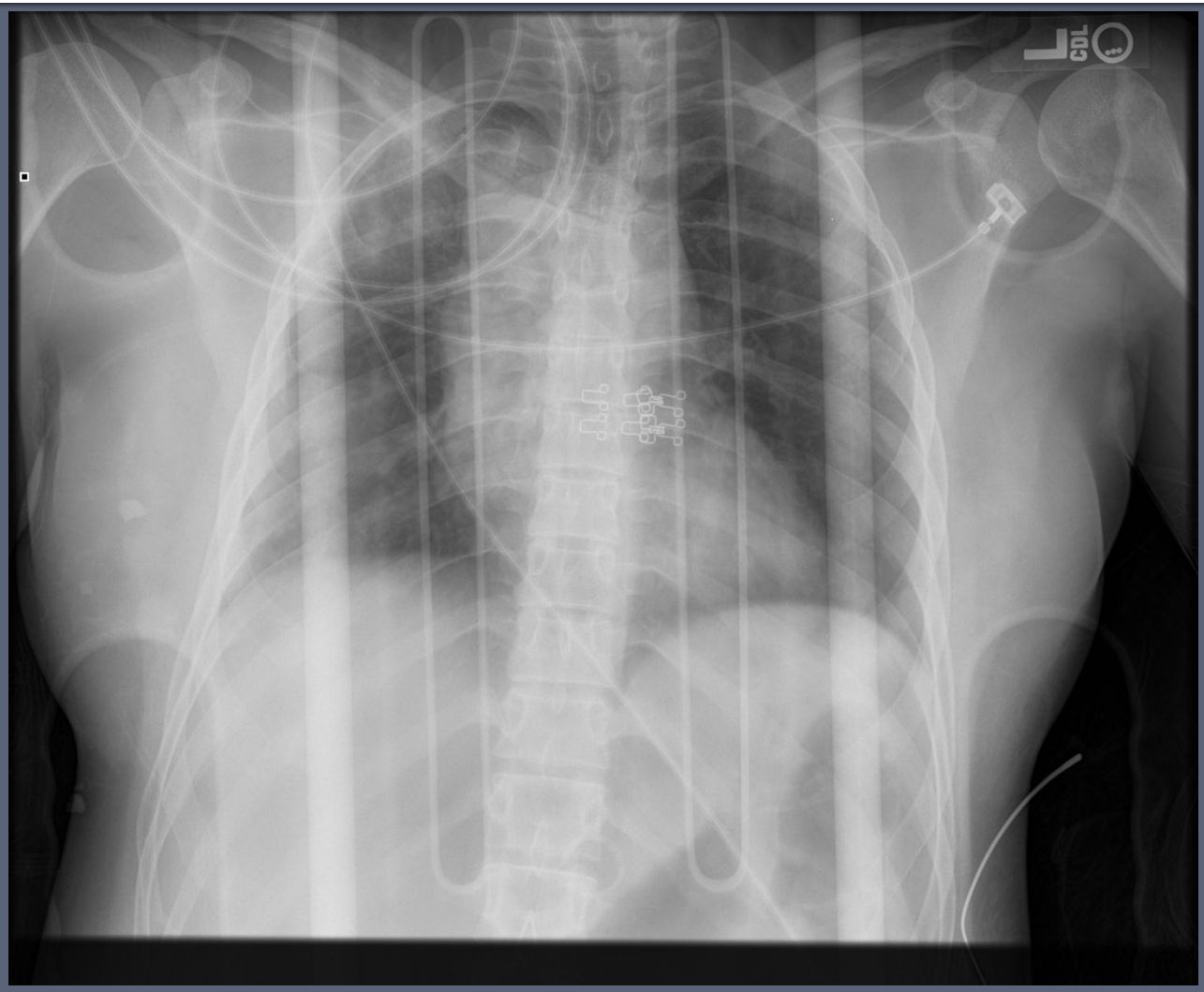
TAI

- DDX:
  - Ductus diverticulum (10% of normal population, smooth contour with obtuse margin, broad-based outpouching, no intimal flap or tear)
  - Penetrating atherosclerotic ulcer (usually different location, associated calcified atherosclerotic plaque)

TAI



TAI



TAI—pseudoaneurysm and intraluminal thrombus

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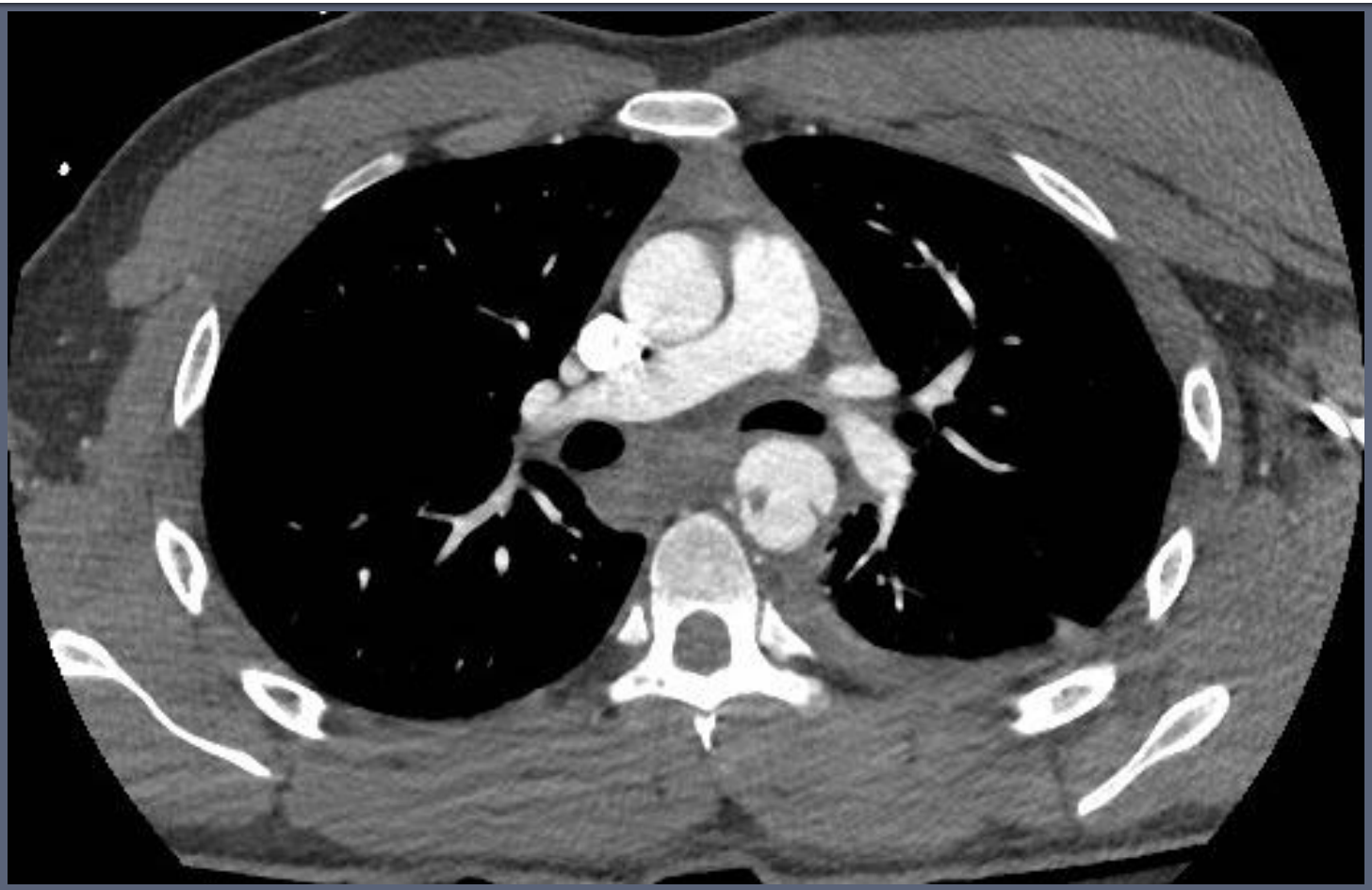
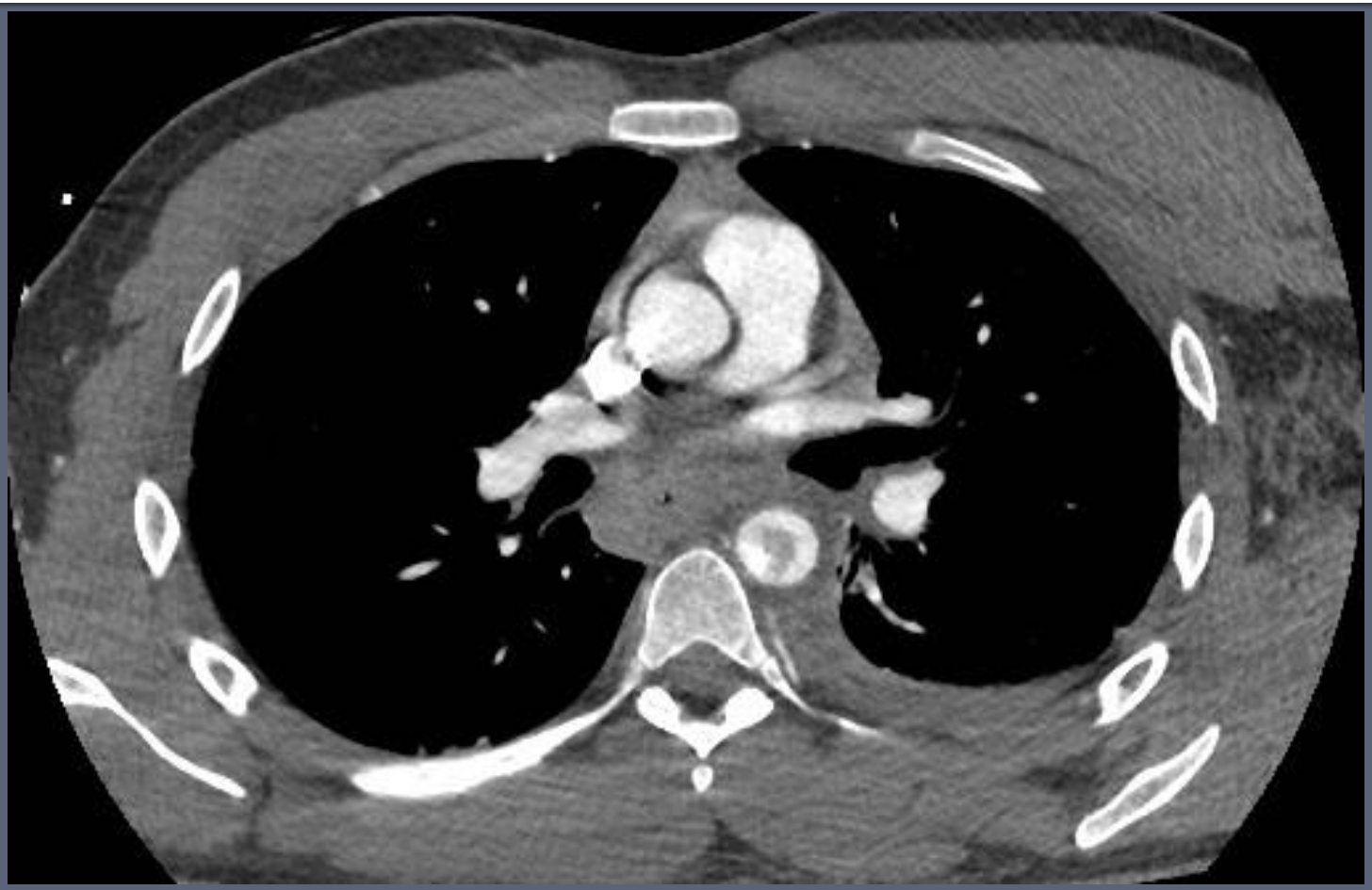
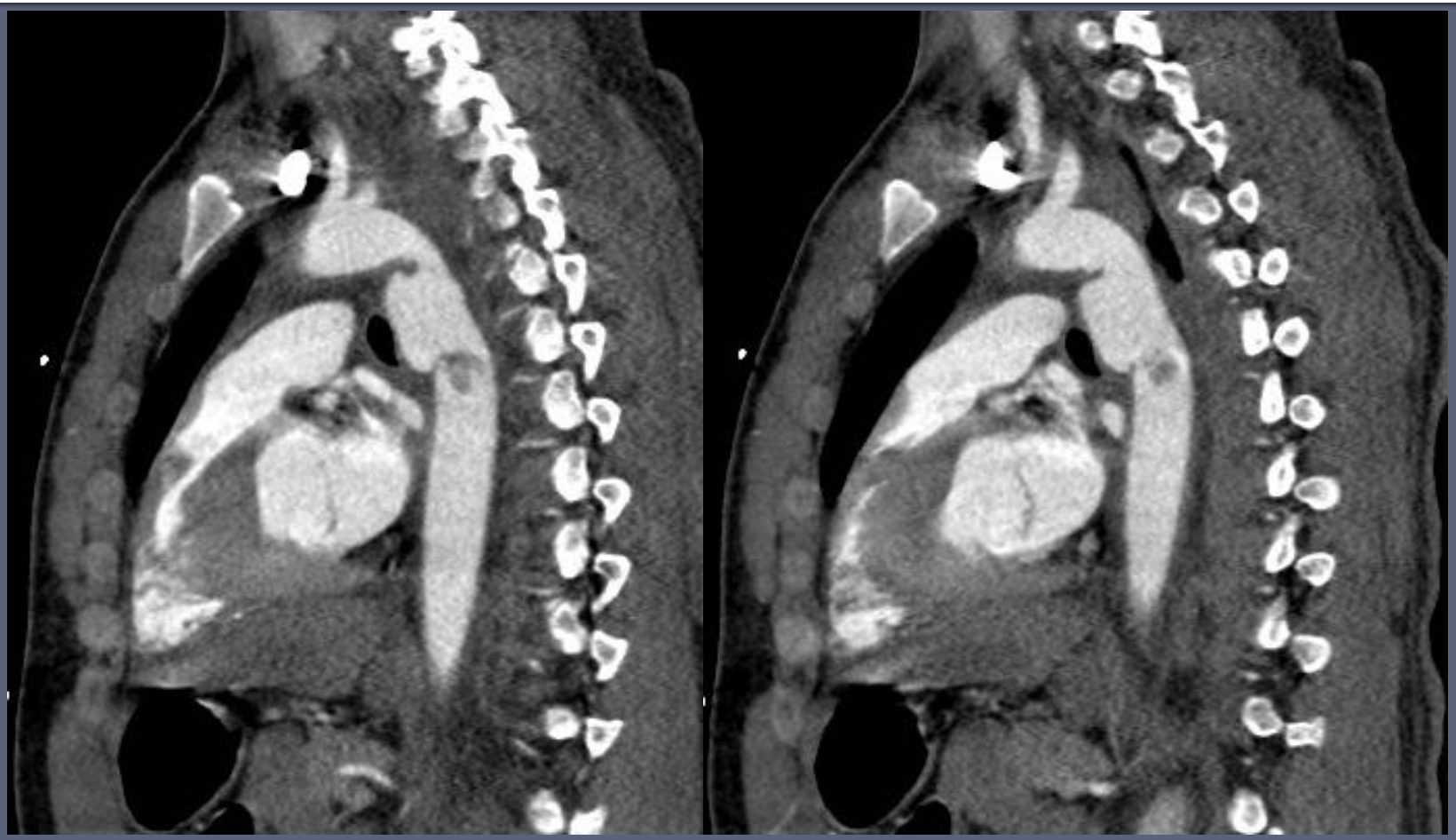


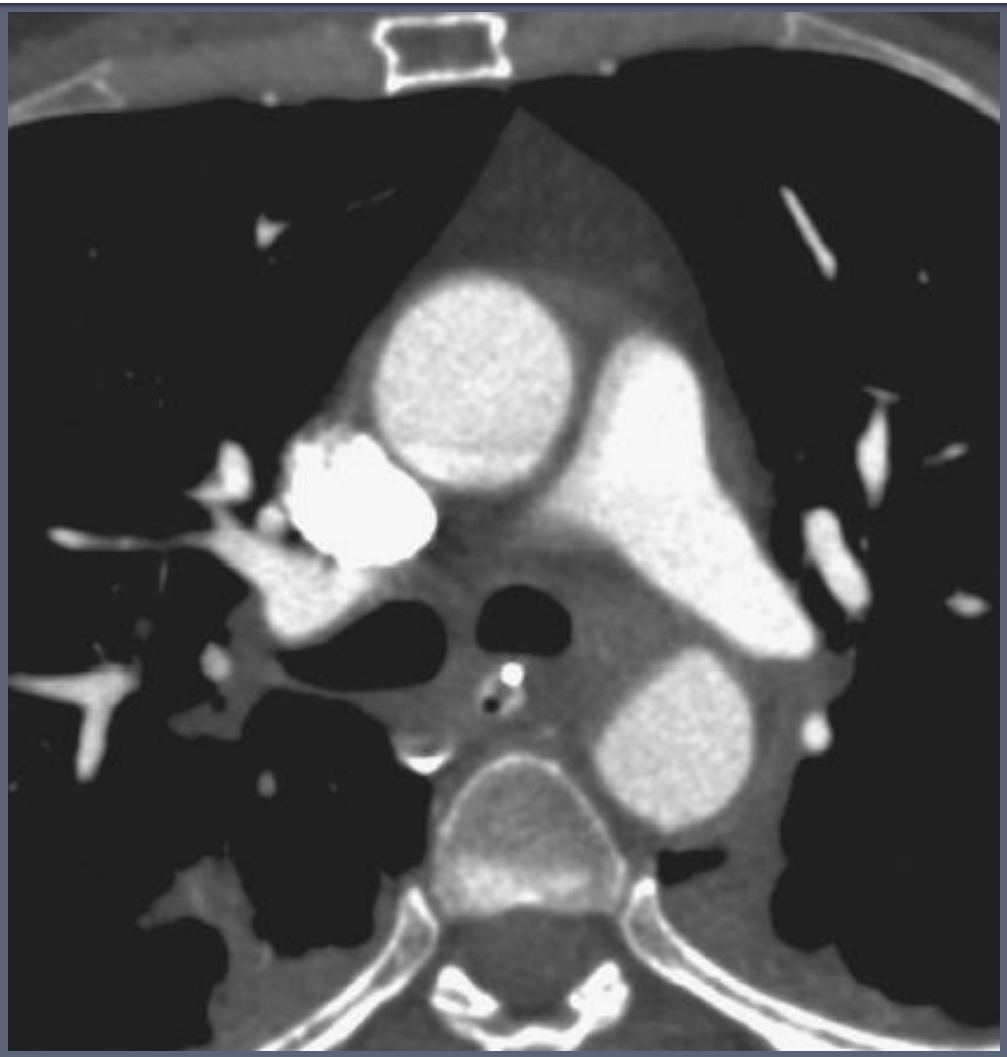
TAI—pseudoaneurysm and intraluminal thrombus



TAI—pseudoaneurysm and intraluminal thrombus



TAI—change in aortic contour



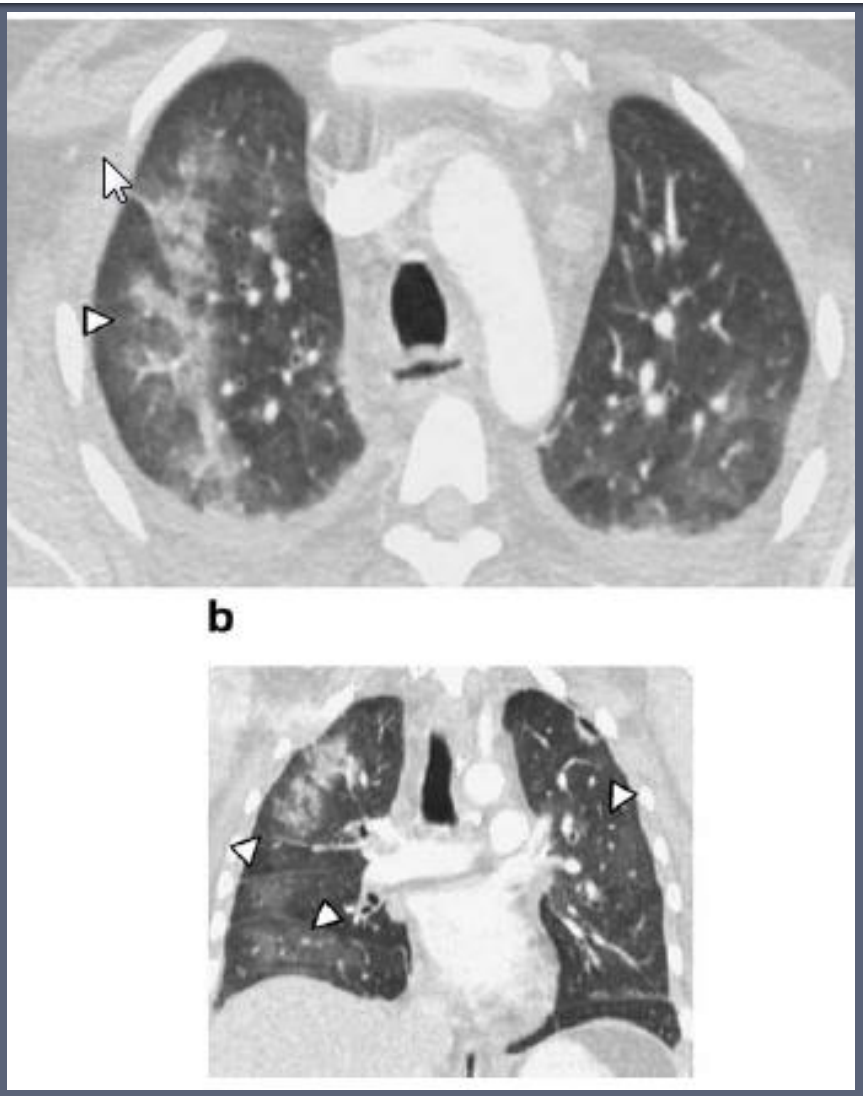
Ductus Diverticulum

- Ductus arteriosus normally closes after birth
- Ductus diverticulum is remnant of infundibular part of ductus arteriosus
- Located at transition from transverse aorta to fixed descending aorta

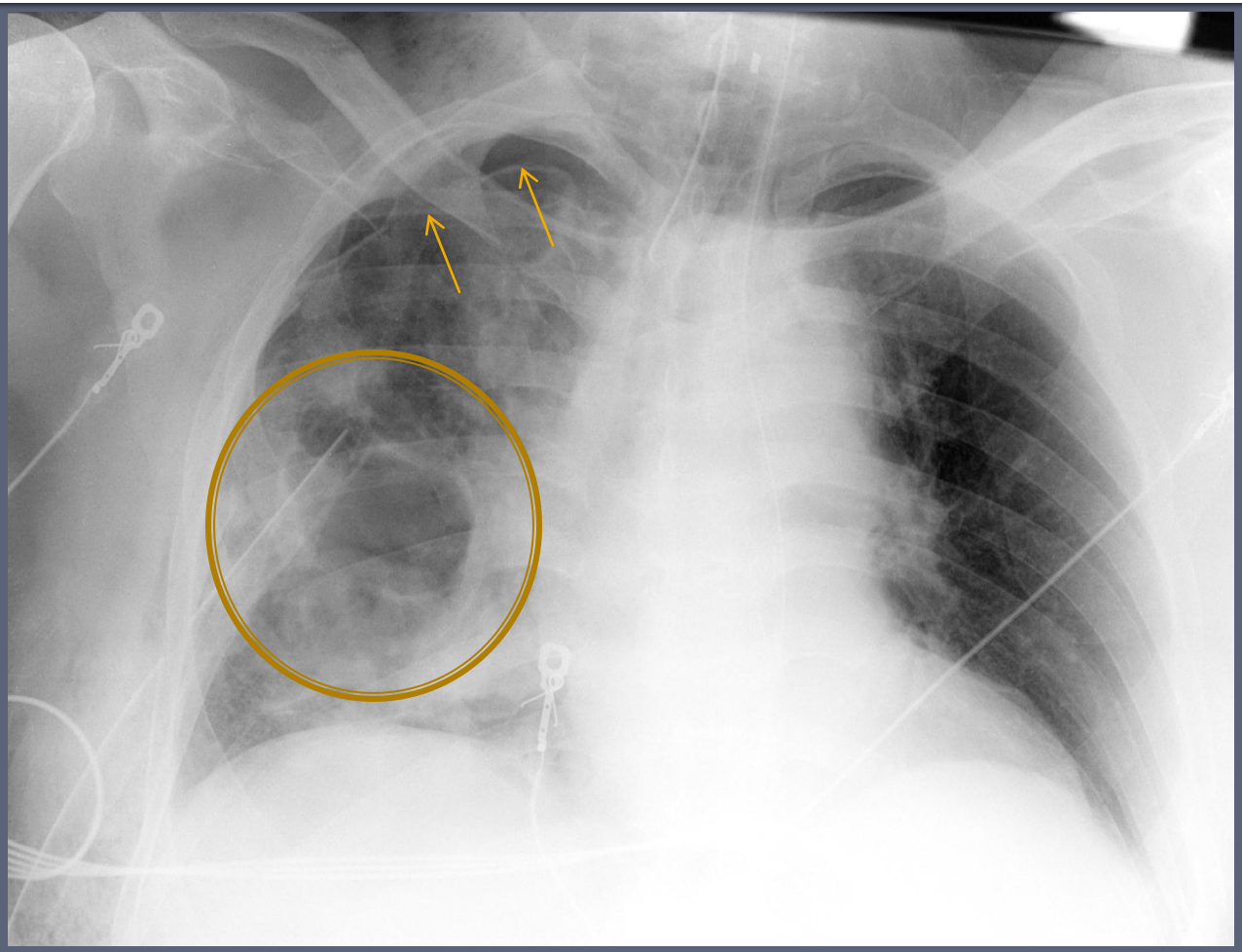
Lung Injury

- Terminology:
  - **Contusion**: pulmonary hemorrhage filling airspaces
  - **Laceration:** linear tear leading to radial retraction of parenchyma
- Key points:
  - Contusion: peripheral homogeneous consolidation, often in posterior location (60%), often adjacent to ribs or vertebral bodies
  - **Contusions usually resolve within 24-48 hours**
  - **If "contusion" persists or worsens consider superimposed pneumonia, aspiration ,or developing ARDS**
  - Lacerations:
    - Type 1 laceration: Intraparenchymal pneumatocele or air-fluid level
    - Type 2 laceration: Paravertebral pneumatocele or air-fluid level
    - Type 3 laceration: Peripheral pneumatocele adjacent to rib fracture

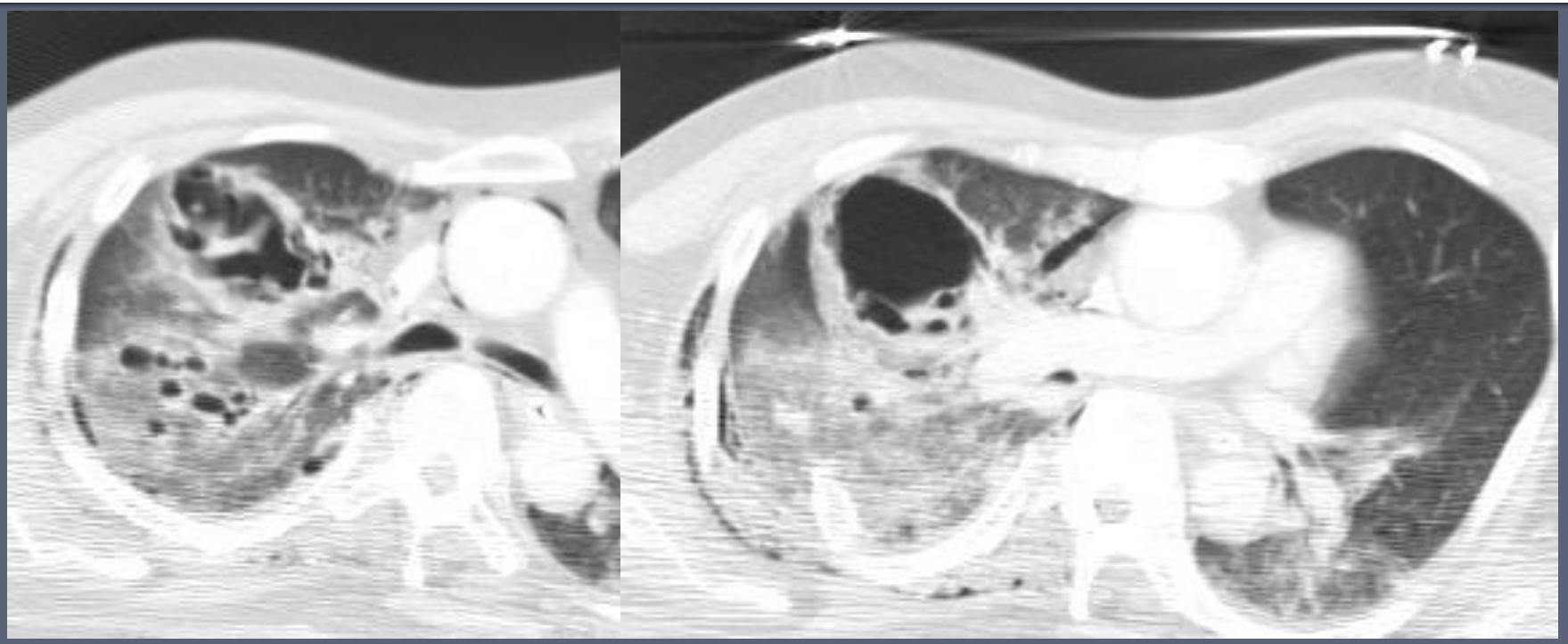
Pulmonary Contusion



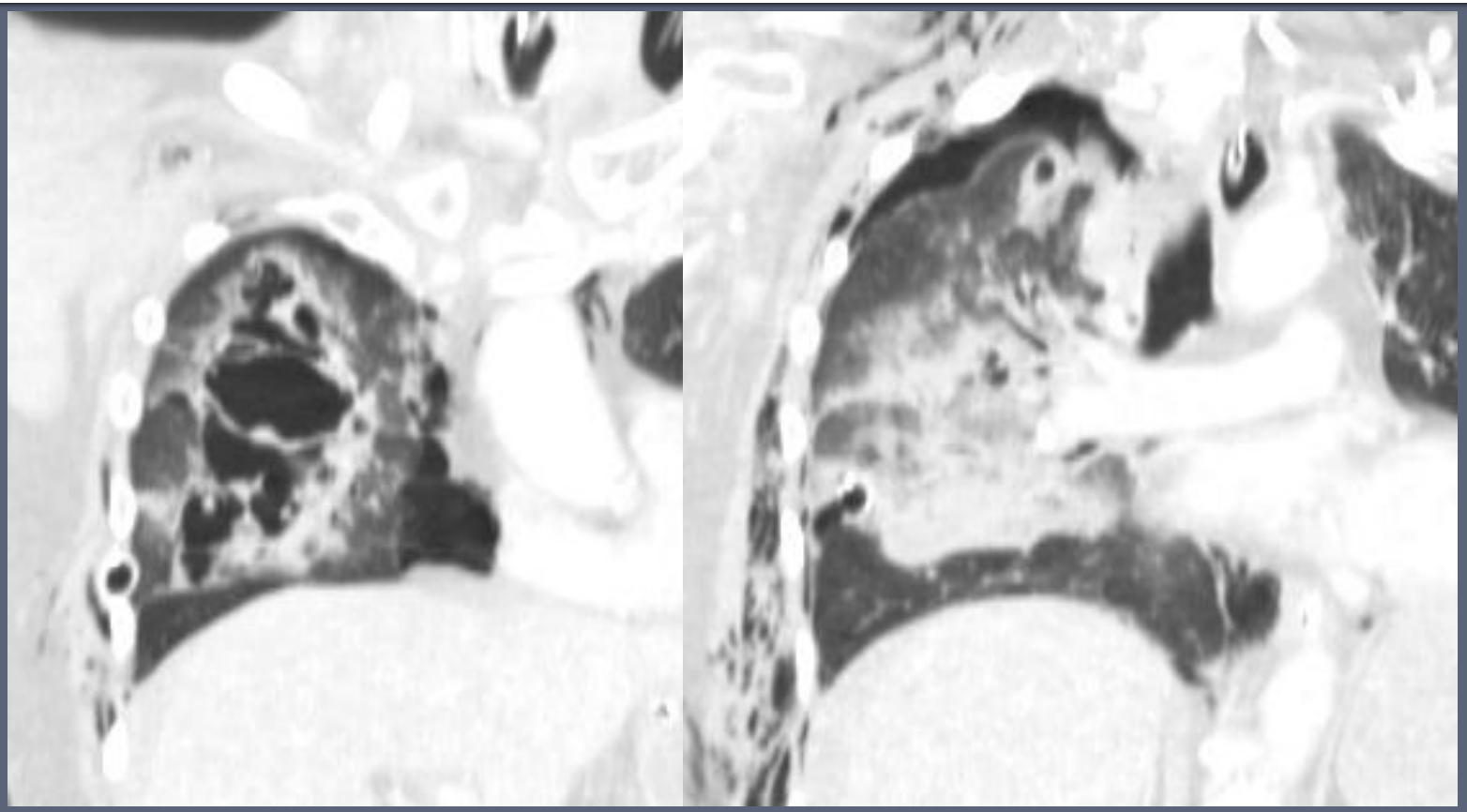
Pulmonary Laceration—type I



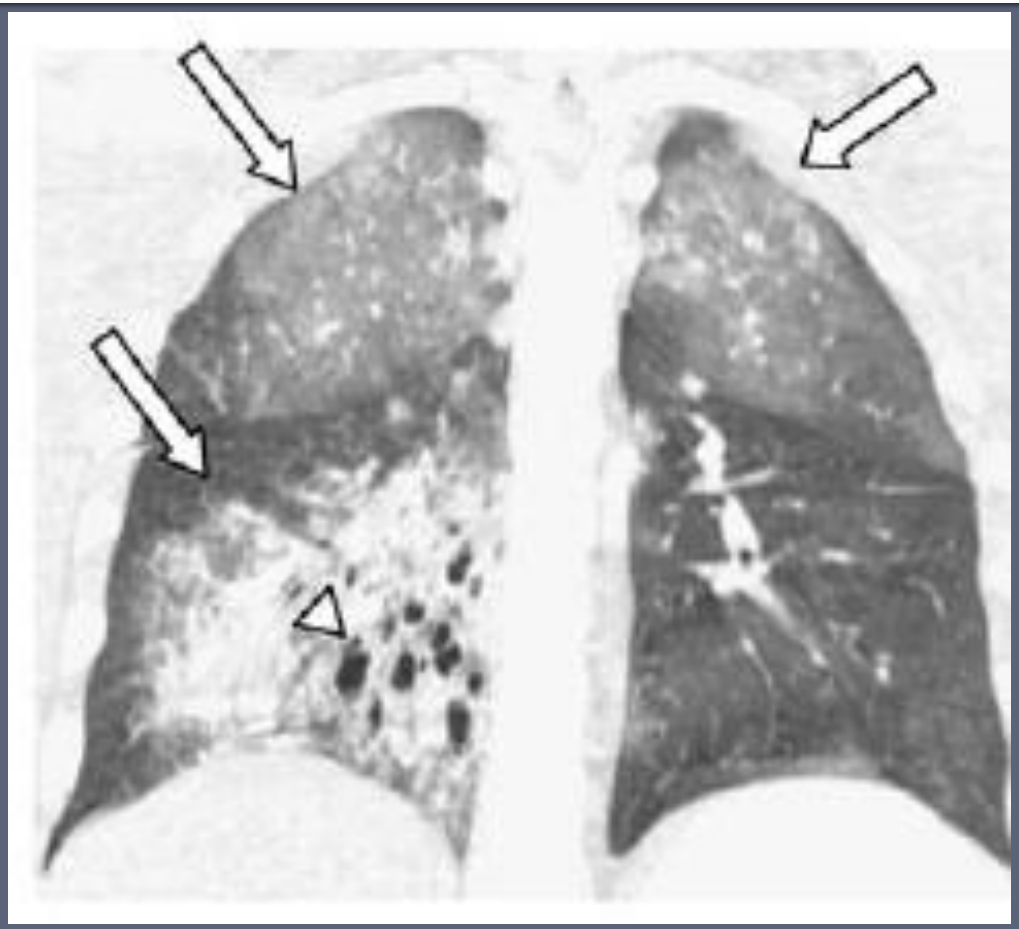
Pulmonary Laceration—type I



Pulmonary Laceration—type I

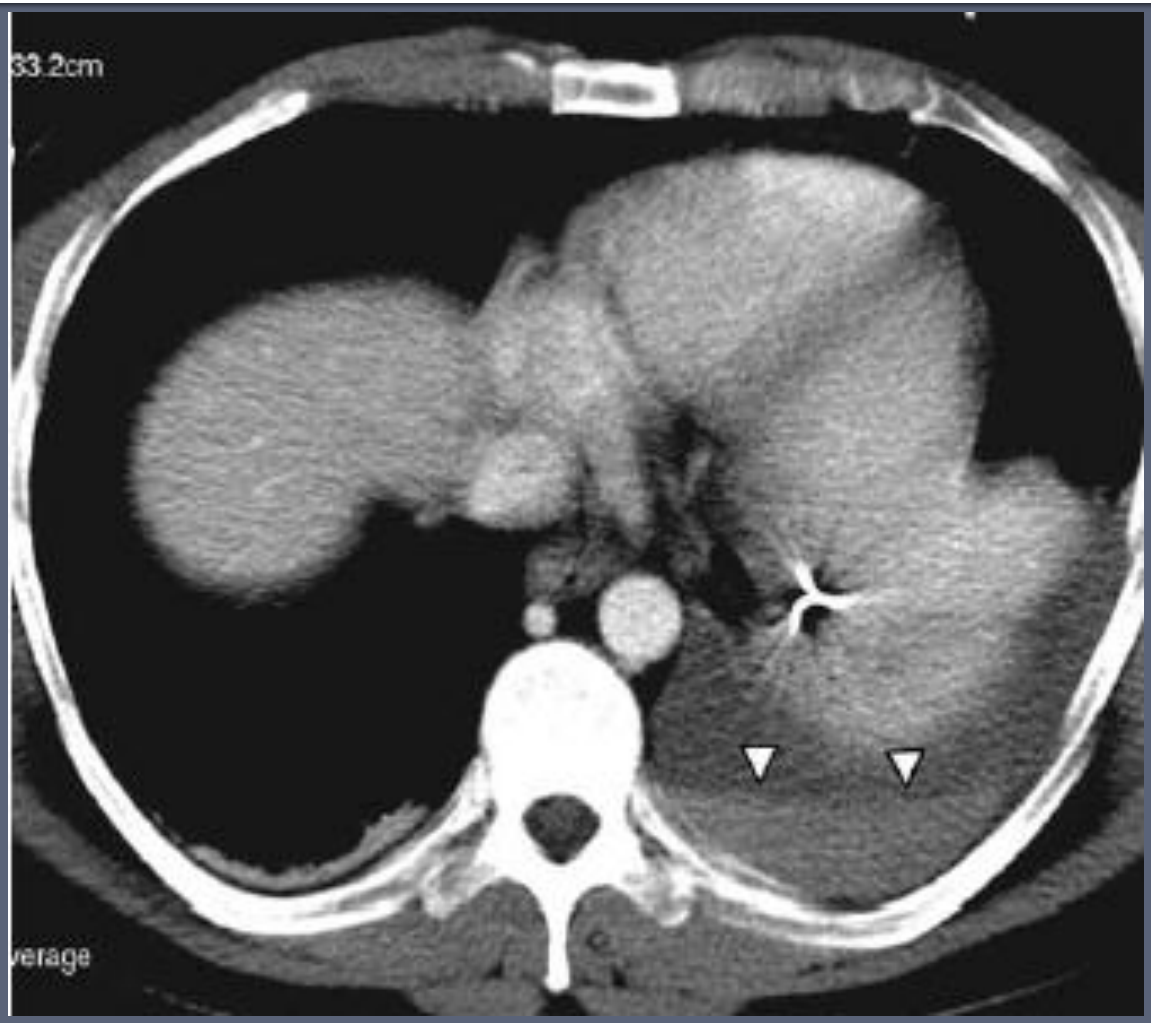


Pulmonary Laceration—type II



Pulmonary Laceration—type III

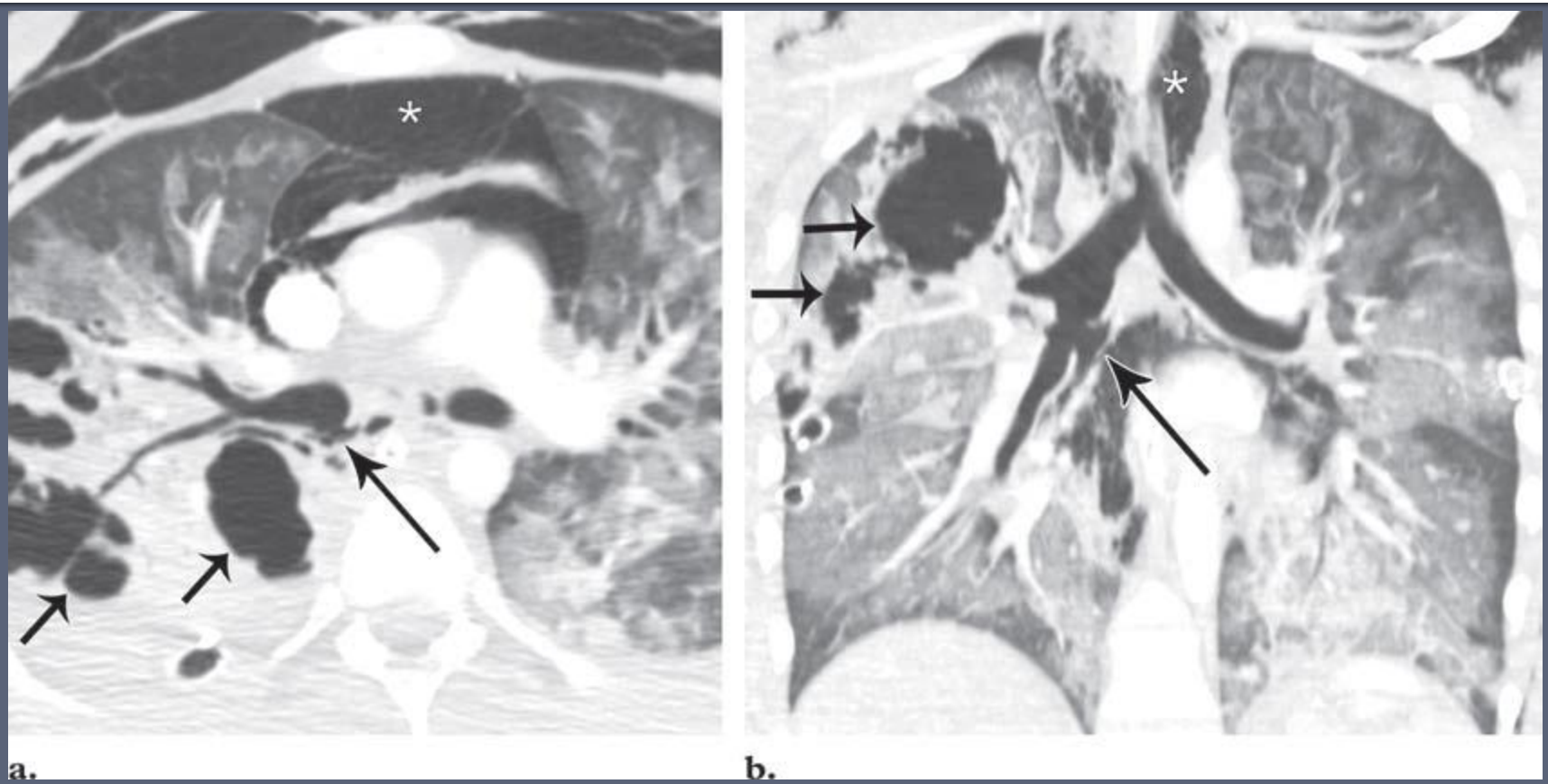
Hemothorax



Tracheobronchial Injury

- *Persistent or progressive* pneumothorax or pneumomediastinum despite chest tubes
- Key points:
  - Usually within 2.5 cm of the carina
  - Often unable to detect actual site of tear
  - “Fallen lung" sign
    - Lung falls away from hilum into a gravitationally dependent position

Bronchial Laceration



“Fallen Lung” sign

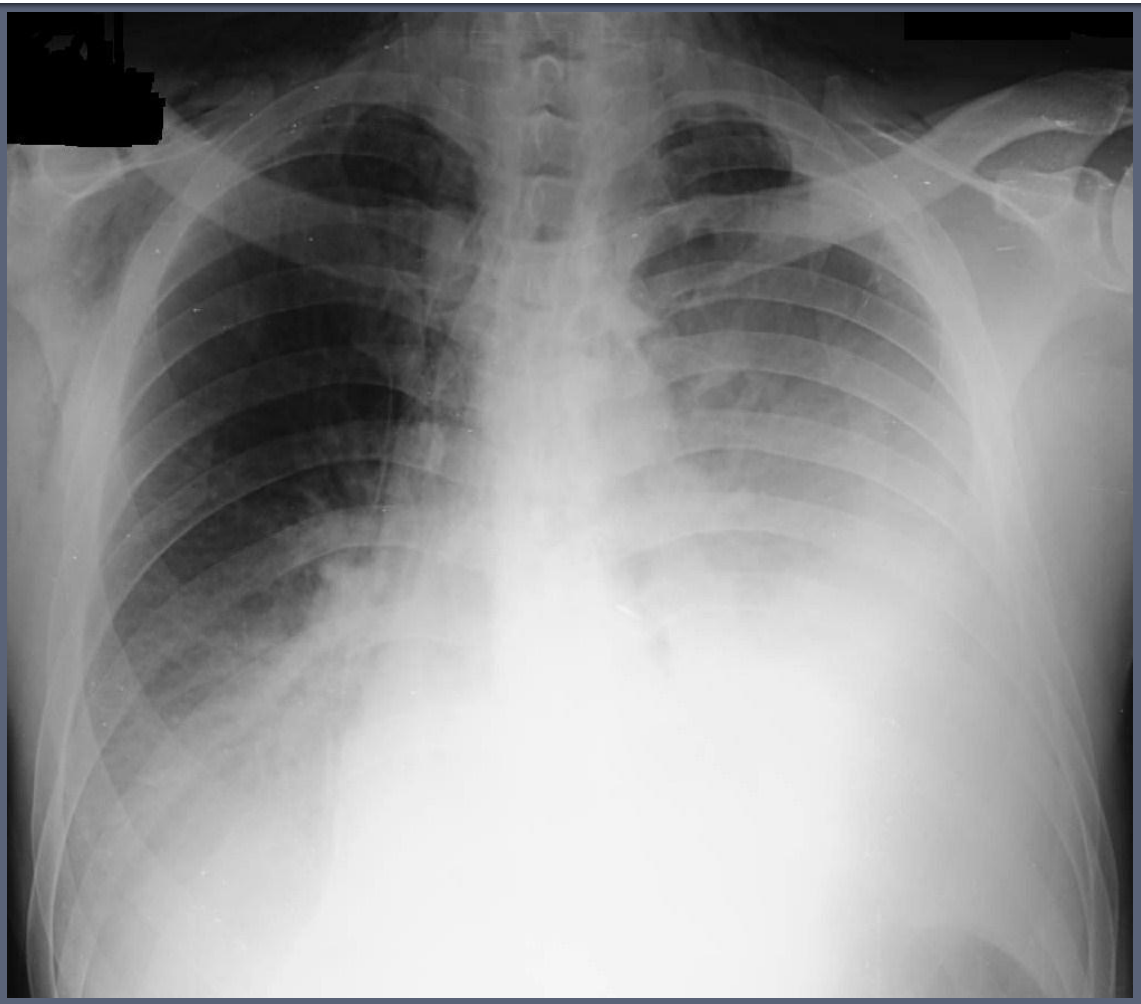
Esophageal Injury

- Esophageal tears are often overlooked--have high index of suspicion!
- Usually due to *penetrating trauma*
  - Iatrogenic (biopsy, dilation), knife/bullet wounds, ingested foreign bodies
- Imaging:
  - May be normal early on (10%)
  - Pneumomediastinum may be subtle--localization in left costovertebral angle (CXR) or around esophagus (CT) should raise suspicion
  - **V-sign of Naclerio**—V shaped air lucency in the left lower mediastinum
  - **Pneumomediastinum + pleural effusion + opacified lung**

Esophageal Injury

- **Esophagram**— *procedure of choice* to determine site/extent of tear
  - Start with nonionic water-soluble contrast
  - If no leak, follow with barium
  - **Gastrografin should be avoided** because of risk of aspiration

Esophageal Rupture



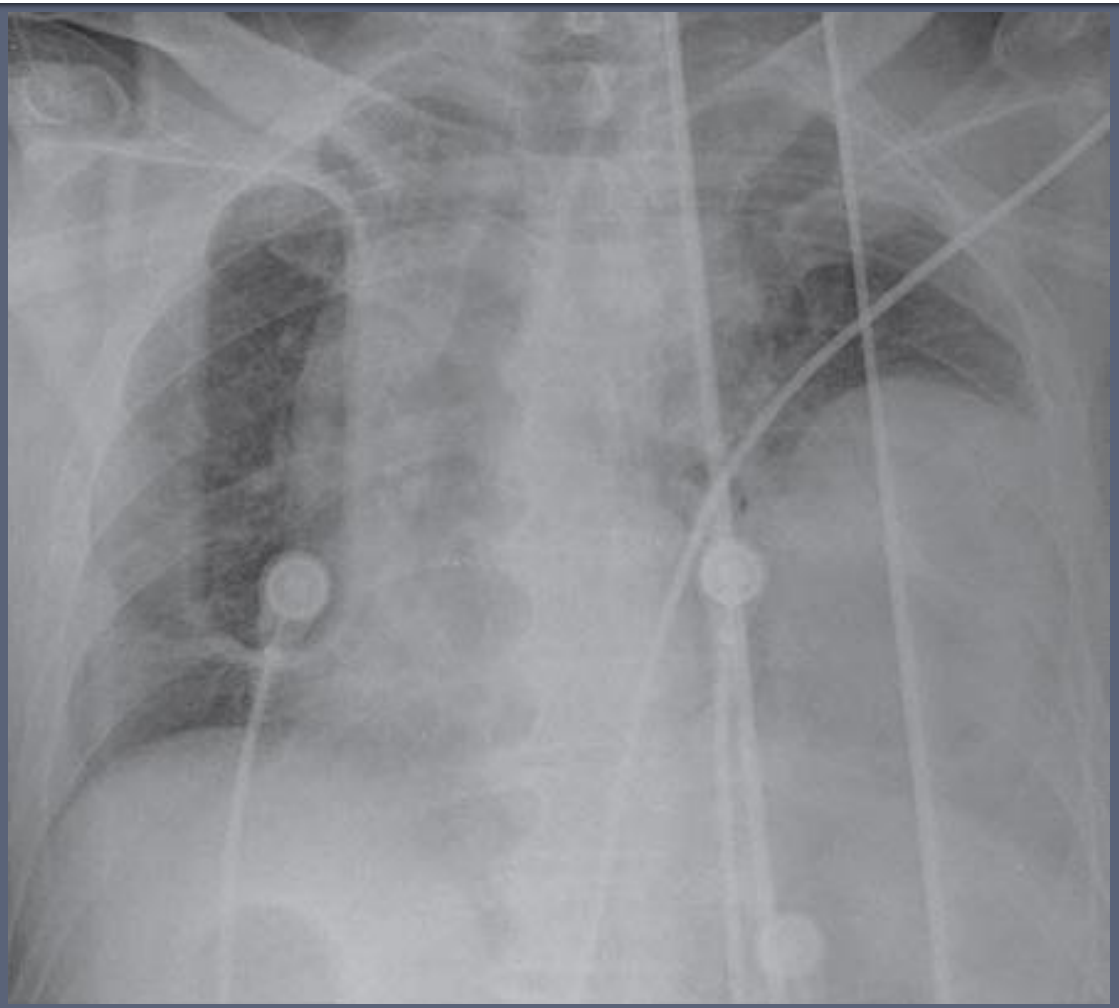
Esophageal Rupture

Esophageal Rupture

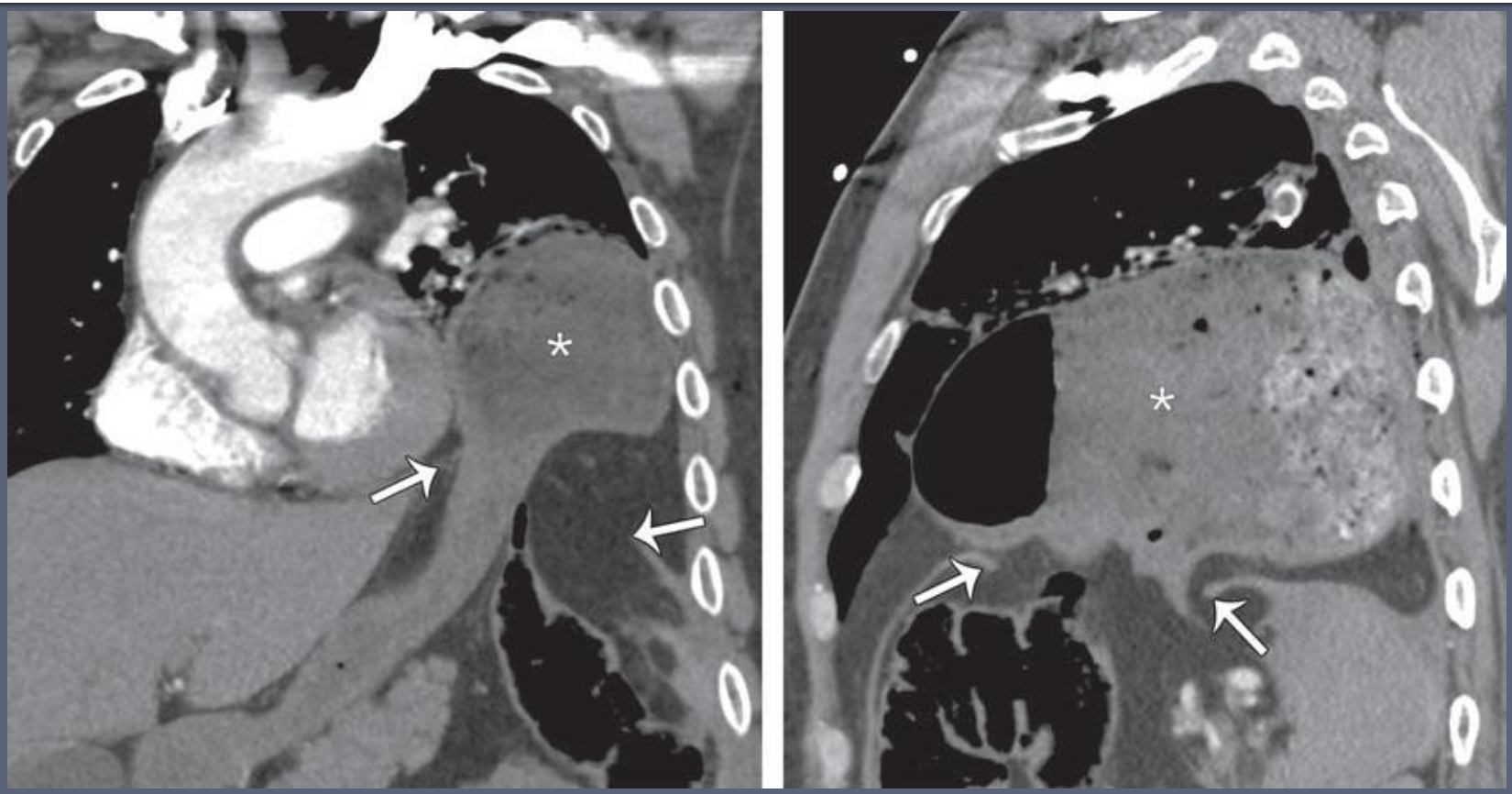
Diaphragmatic Injury

- Imaging:
  - Air filled bowel above hemidiaphragm
  - NG tube above expected position of hemidiaphragm
  - Contralateral mediastinal shift
  - **Dependent viscera sign--**in supine position, herniated bowel or viscera lie dependently
  - **Collar sign--**focal constriction of bowel or liver at level of hemidiaphragm
  - **Remember to look at reformats--**increase sensitivity for diaphragmatic tears (sagittal > coronal > axial)!!

Diaphragmatic Rupture



Diaphragmatic Rupture



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