


# Basics of Clinical Radiology




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## Objectives

-  Participants will be able to explain different radiographic scans and their uses.
-  Participants will understand the role of different radiographic scans used around anesthesia practice.
-  Participants will be able to walk through a basic X-ray reading.

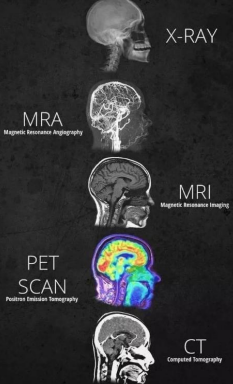
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## Radiology

- Science dealing with X-rays and other high-energy radiation, especially the use of such radiation for the diagnosis and treatment of disease

### BRAIN IMAGING



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## Diagnostic imaging

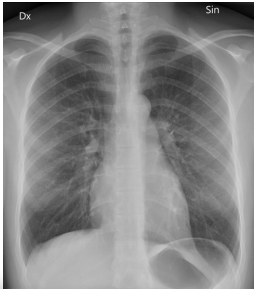
- X-Ray
  - Fluoroscopy
- MRI
- CT
- Ultrasound
- Angiography
- PET Scan

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## X-Ray

- Creates 2D images
- Used primarily to see bones and to detect cancers and pneumonia
- Most common & widely available
- Use radiation to produce images

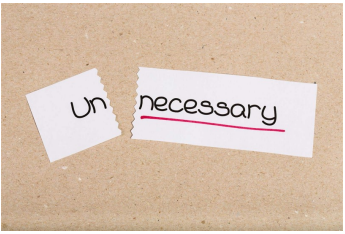


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## Preop Chest X-ray

- Used to “clear” pts for surgery
- Gives baseline view prior to intervention
- Increasing evidence that scan has little influence on pt management
- Unnecessary procedure?



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## PEDIATRICS (1977, 1981)

### Value of Preoperative Chest X-ray Examinations in Children ✓

Shashikant M. Sane; Robert A. Worsing, Jr.; Cornelius W. Wiens; Rajiv K. Sharma

### Value of the Chest X-Ray as a Screening Test for Elective Surgery in Children ✓

Robert A. Wood; Robert A. Hoekelman

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## Canadian Journal of Anaesthesia (1993)

### Value of routine preoperative chest x-rays: a meta-analysis

[Chantai Archer, Adrian R. Levy & Maurice McGregor](#)

[Canadian Journal of Anaesthesia](#) 40, 1022–1027 (1993) | [Cite this article](#)

- 21 reports from 1966-1992
- Abnormalities found in 10% preoperative X-rays
  - 1.3% abnormalities unexpected
  - 0.1% caused modification of management
- Assuming direct cost to the health care system of \$23 per scan, each finding which influenced management would cost \$23,000
- Concluded cost of this test is no longer justifiable

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## South Dakota Medicine Journal

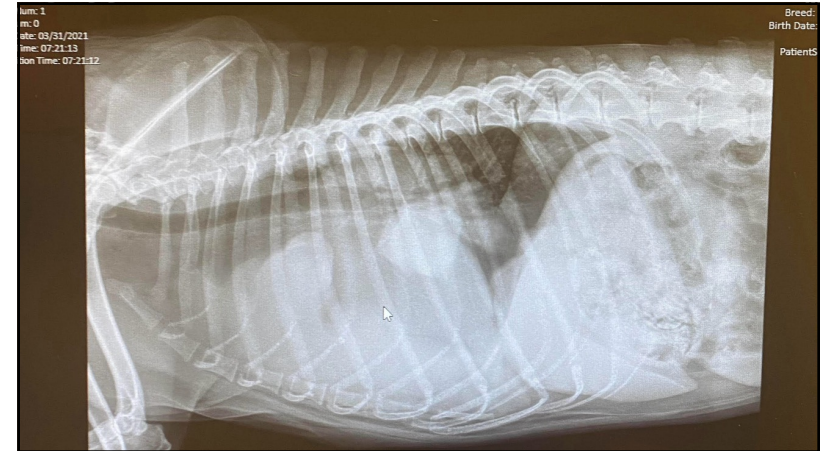
### Preoperative Chest Radiography in Elective Surgery: Review and Update

Ethan M Young <sup>1</sup>, Joel D Farmer <sup>2 3</sup>

- POCR frequently detects abnormalities; however, majority of abnormalities in patients with history of cardiopulmonary disease
- Frequency of POCR influencing perioperative mgmt low
- Evidence suggests clinical examination alone provides sufficient information to dictate any necessary changes in management

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## Magnetic Resonance Imaging (MRIs)

- Creates 3D images
- Used primarily to scan the spine, brain, breasts, muscles, abdomen and neck
- Use a powerful magnet and radio waves
- Create cross section images

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## Remote Location

- Confirm presence & function of anes equipment & monitors
- ASA, AANA, TJC developed standards and guidelines for remote locations
  - Oxygen
  - Suction
  - Scavenging system if volatile agents administered
  - Electrical outlets
  - ETCO2
- Resuscitation equipment immediately available
  - Defibrillator
  - Emergency drugs
  - CPR equipment

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### MRI Considerations


- Gauss line
- MRI compatible equipment
  - Function normally
  - Present no danger
  - Not affect imagine



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### MRI Considerations



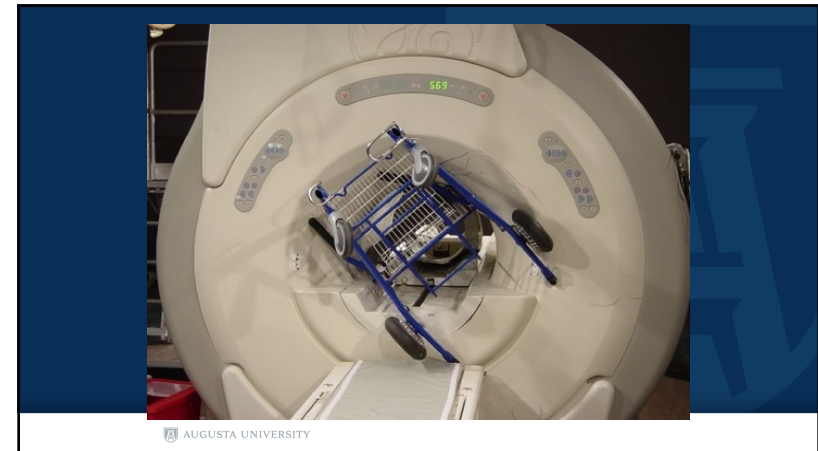
- IV poles
- Anesthesia machines
- Infusion pumps
- Monitors
- Laryngoscopes

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## Awake Craniotomy, Electrophysiologic Mapping, and Tumor Resection With High-Field Intraoperative MRI

### Intraoperative MRI

Intraoperative MRI, though time consuming and not always available, is a useful adjunct during resection of CMs and can account for brain shift, a limitation of frameless stereotaxy based on preoperative imaging.

From: *Image-Guided Neurosurgery*, 2015

©Gee<sup>2</sup>, John Huston III<sup>2</sup>, William J.

### MRI-Guided Focused Ultrasound Surgery

Annual Review of Medicine  
Vol. 60:417-430 (Volume publication date February 2009)  
<https://doi.org/10.1146/annurev.med.60.041707.170903>

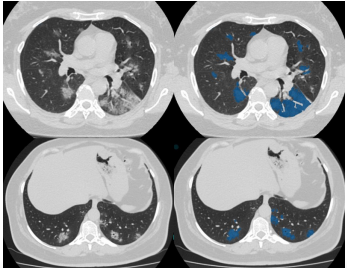
### MRI-guided cryotherapy

Paul R. Morrison MS ✉, Stuart G. Silverman MD, Kemal Tuncali MD, Servet Tatli MD

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## Computed Tomography (CT)

- Creates 3D images
  - series of X-ray images taken from many different angles
  - Related to slicing bread
- Used primarily to diagnose conditions in organs and soft tissues
- More powerful than an x-ray
- Take a 360-degree image



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## Anesthesia Considerations

- Remote location
  - Availability of resources and personnel
- Radiation safety considerations
  - Level of ionizing radiation high precludes the anesthesiologist from remaining in the room physically with the patient during the scan
  - "ALARA"
- CT scanner smaller than the MRI device
  - Access to the patient is less limited
- Much less time than MRI

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## European Journal of Radiology (2011)

### Percutaneous CT-guided biopsy of the musculoskeletal system: Results of 2027 cases

Eugenio Rimondi<sup>3</sup>, Giuseppe Rossi<sup>1</sup>, Tommaso Bartalena<sup>8</sup>, Rosanna Ciminari<sup>4</sup>, Marco Alberghini<sup>5</sup>, Pietro Ruggieri<sup>6</sup>, Costantino Errani<sup>4</sup>, Andrea Angelini<sup>4</sup>, Teresa Calabrò<sup>4</sup>, Caterina

- 2027 core needle biopsies
  - 1567 cases the correct diagnosis was made with first CT-guided needle biopsy
  - 408 cases the sample was not diagnostic
  - 52 inadequate
- This technique is reliable and safe and should be considered nowadays the gold standard for biopsies of the musculoskeletal system.

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## Ultrasound

- Imaging method that uses high-frequency sound waves to produce images of structures within your body
- Gives a “slice” of an image
- Images captured in real-time
- Show movement of the body’s internal organs as well as blood flowing through blood vessels
- No radiation

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## Angiography

- Used to diagnose and treat blood vessel-related diseases
  - Exams produce pictures of major blood vessels throughout the body
  - Contrast often used
- Performed using:
  - Fluoroscopy (x-rays) to help place catheters into blood vessels and inject contrast to help visualize them
  - Computed tomography (CT)
  - Magnetic resonance imaging (MRI)
- Magnetic Resonance Angiography (MRA), a powerful magnetic field, radio frequency waves and a computer are used to evaluate blood vessels and help identify abnormalities.

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## Angiography

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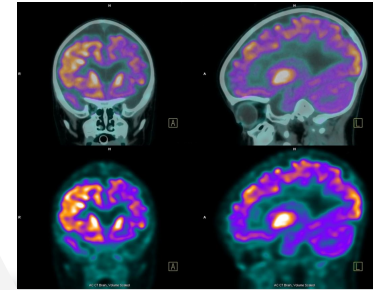
## Positron Emission Tomography (PET) CT Scan

- Helps to see the level of activity of certain body organs and tissues, along with their structure
  - Pt receives a substance called a "tracer" containing glucose with a little bit of radioactive material prior to scan
- Tracer travels through your body systems like a dye for the imaging scan to view
  - If high chemical activity in certain areas, more of the dye will be picked up, and it will show bright spots on the image, alerting of possible disease
- Tracer will be swallowed, inhaled or injected, depending on the examined body part
- Used for detecting heart problems, cancer and brain diseases

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## PET Scan



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## Fluoroscopy

- A type of medical imaging that shows a continuous X-ray image on a monitor
  - Live X-ray movie
- The image is transmitted to a monitor so the movement of a body part or of an instrument or contrast agent ("X-ray dye") through the body can be seen in detail



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## Reading Chest X-Rays

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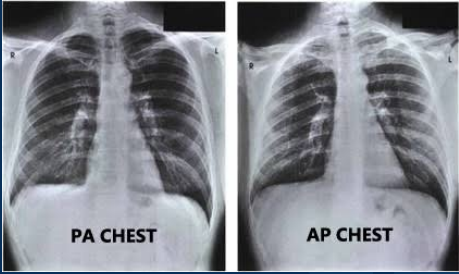
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## Basic Views

- **Posteroanterior view (PA view)**
  - Film against chest, x-ray shot from behind
  - Best view due to structures in the chest closer to the film
- **Anteroposterior view (AP View)**
  - Film against back, x-ray shot from the front
  - Used in pts in bed
  - Heart appears larger and borders are fuzzier
- **Lateral View**
  - Frequently taken with other view to localize lesions
  - If things hidden behind heart or diaphragm

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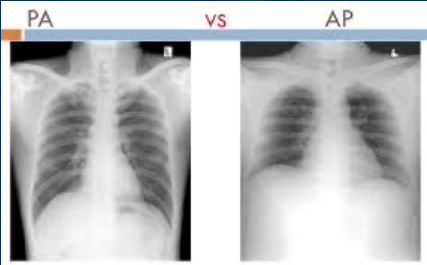
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Two chest X-rays are shown side-by-side. The left image is labeled 'PA CHEST' and the right image is labeled 'AP CHEST'. The PA view shows a more standard appearance of the heart and lungs, while the AP view shows a slightly larger heart silhouette and less distinct lung markings.

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Two chest X-rays are shown side-by-side, labeled 'PA' and 'AP' with 'vs' between them. The PA view shows a more standard appearance of the heart and lungs, while the AP view shows a slightly larger heart silhouette and less distinct lung markings.

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## Lateral



A lateral view of a chest X-ray showing the profile of the thoracic cavity, including the ribs, spine, and heart silhouette.

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## Chest

- Basic structures
  - Trachea
  - Lungs
  - Heart
  - Mediastinum
  - Diaphragm
  - Bony Thorax

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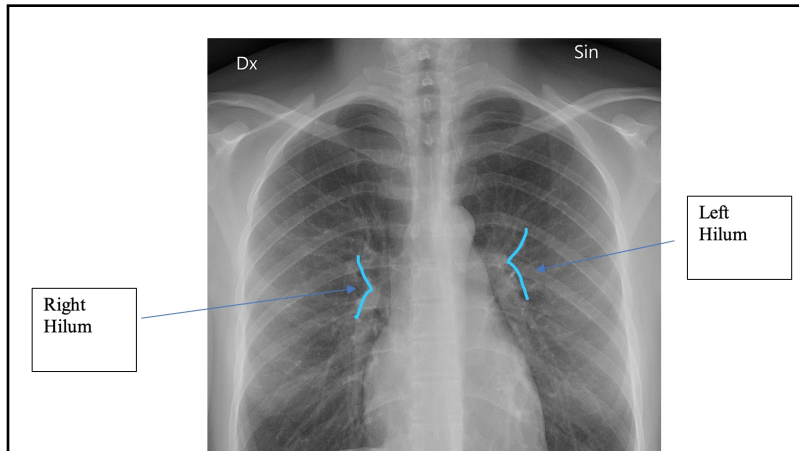
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## Mediastinum

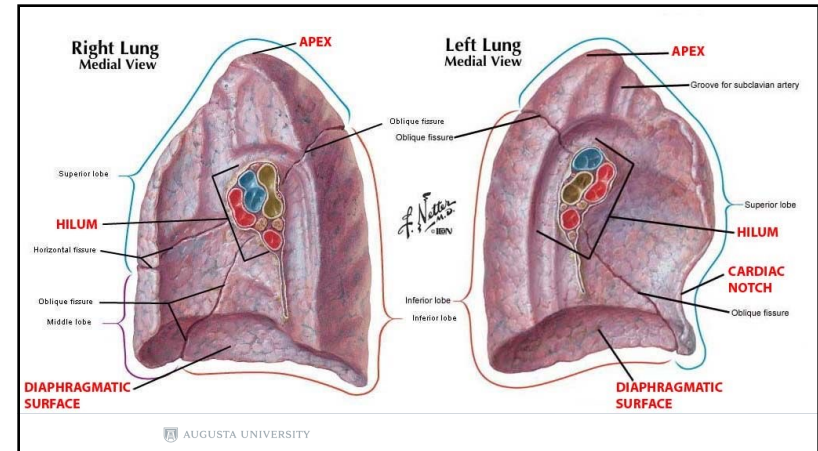
- Division of the thoracic cavity
- Contains the heart, the great vessels, portions of the esophagus and trachea, mainstem bronchi, and lymph nodes
- Connects to lung via bridge like structure called the *hilum*
  - Wedge shaped area on central portion of lung
  - Where bronchi, arteries, vessels, nerves enter and exit lung

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## CXR Interpretation

- ABCDE Approach
  - Airway
  - Breathing
  - Cardiac
  - Diaphragm
  - Everything else

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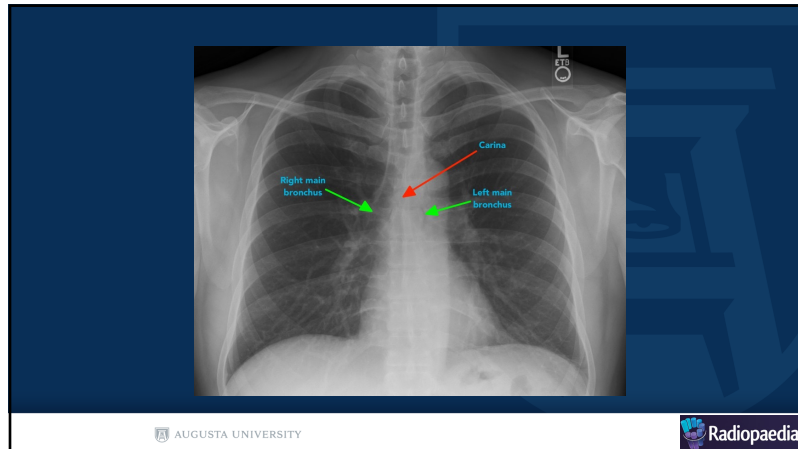
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## Airway

- Trachea
  - Is the trachea significantly deviated?
  - The trachea is normally located centrally or just slightly off to the right
  - If the trachea is deviated, look for anything that could be pushing or pulling at the trachea.
  - Also inspect for any paratracheal masses/lymphadenopathy

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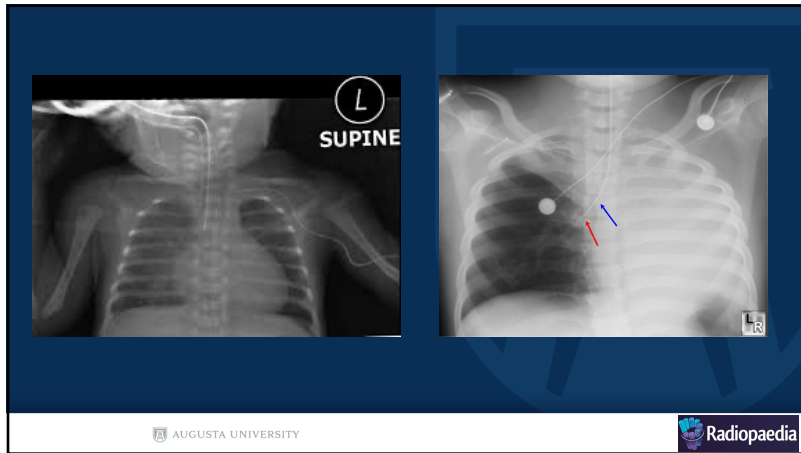
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## Airway

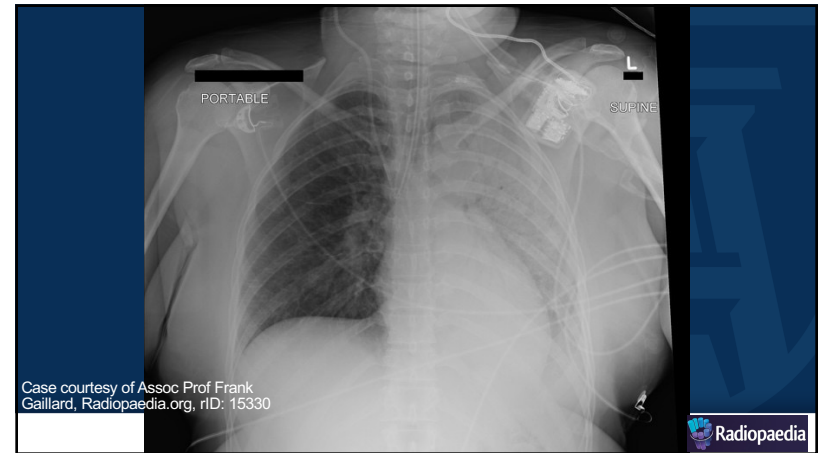
- ETT placement
  - Carina is usually projected over T5-T7
  - Desired position of an ETT is 3-5 cm above the carina
  - If carina cannot be visualized, ideal position of ETT is in the middle third of trachea at T2 to T4 level

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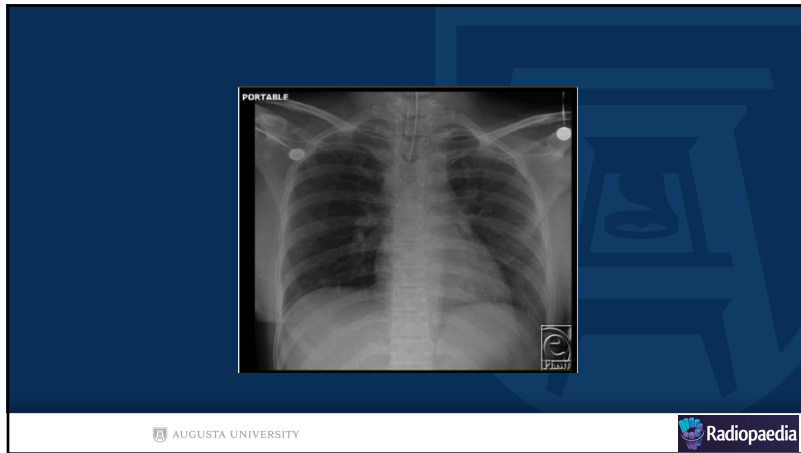
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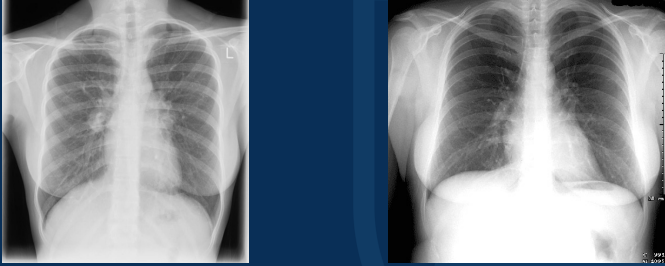


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## Airway

- **Hilar Structures**
  - The hilar consist of the main pulmonary vasculature and the major bronchi.
  - Each hilar also has a collection of lymph nodes which aren't usually visible in healthy individuals
  - The left hilum is often positioned slightly higher than the right
  - Asymmetry should raise suspicion of pathology
  - The hilar point is also a very important landmark

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Which demonstrates Hilar Adenopathy?

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### Breathing: Lungs

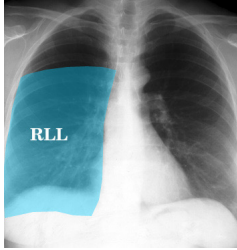
- Inspect the lungs
  - When looking at a CXR we divide each of the lungs into 3 zones, each occupying 1/3 of the height of the lung.
  - These zones do not equate to lung lobes (e.g. the left lung has 3 zones but only 2 lobes).
  - Inspect each of the zones of the lung first ensuring that lung markings occupy the entire zone.
  - Compare each zone between lungs, paying close attention for any asymmetry

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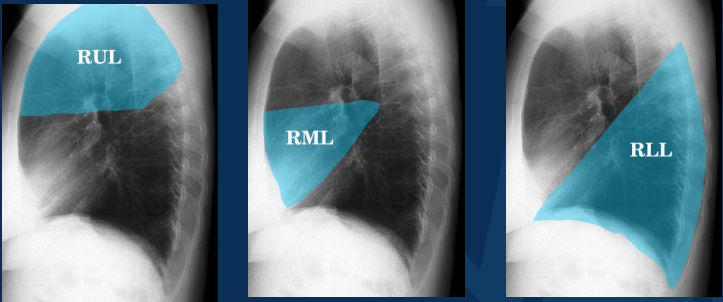
### Lung Anatomy on CXR: Right Lobe

- The right lower lobe is the largest of all three lobes, separated from the others by the major fissure
- Posteriorly, the RLL extend as far superiorly as the 6th thoracic vertebral body, and extends inferiorly to the diaphragm
- Review of the lateral plain film surprisingly shows the superior extent of the RLL



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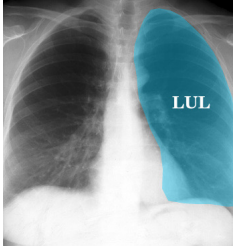
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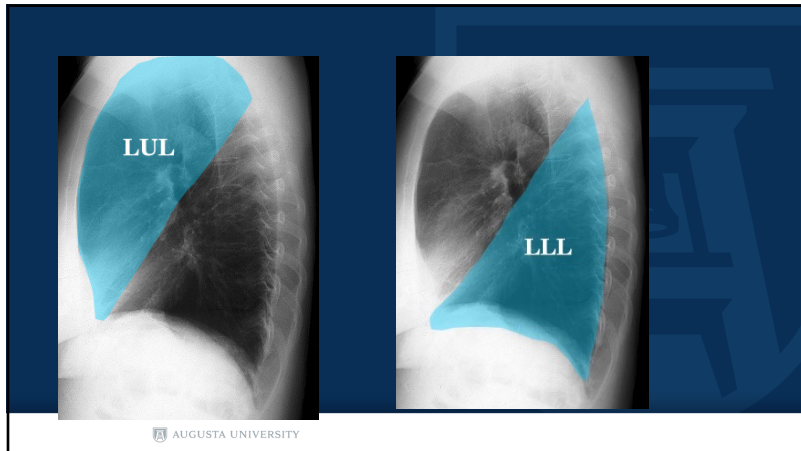
### Lung Anatomy on CXR: Left Lobe

- The lobar architecture of the left lung is slightly different than the right
- Because there is no defined left minor fissure, there are only two lobes on the left; the left upper



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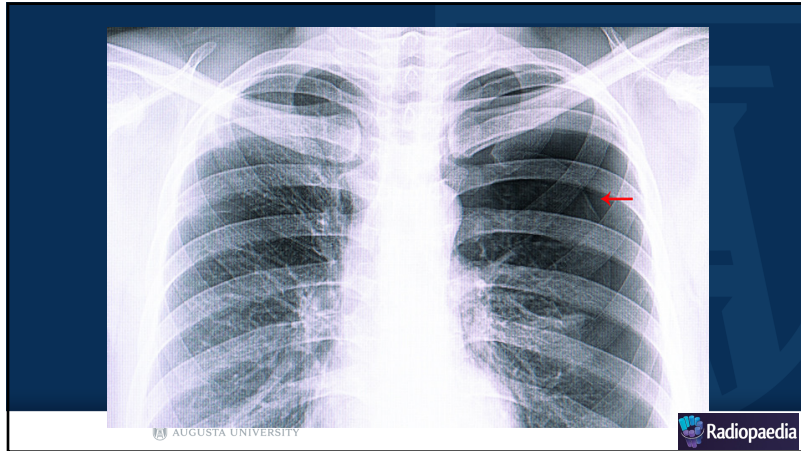
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### Breathing: Pleura

- The pleura are not normally visible in healthy individuals, unless there is an abnormality such as pleural thickening.
- Inspect the borders of each of the lungs to ensure lung markings extend all the way to the edges of the lung fields

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## Cardiac

- Assess heart size
  - In a healthy individual the heart should occupy no more than 50% of the thoracic width
  - This rule only applies to PA chest x-rays
  - If the heart occupies more than 50% of the thoracic width (on a PA CXR) then this suggests abnormal enlargement (cardiomegaly)

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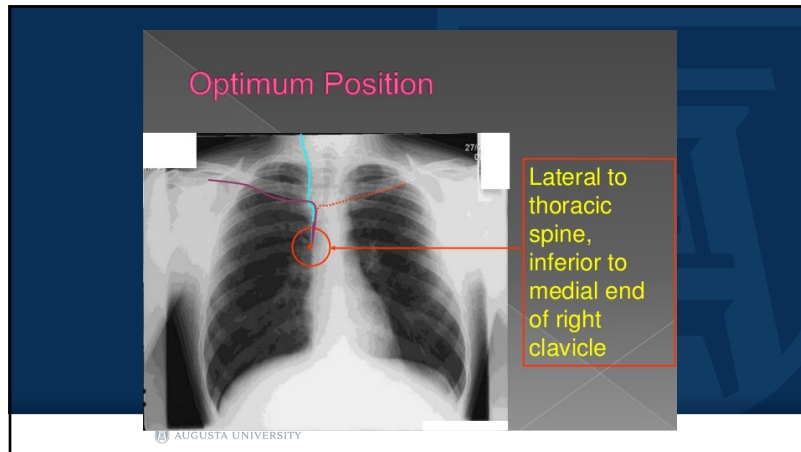
## Cardiac

- Assess heart borders
  - Inspect the borders of the heart which should be well defined in healthy individuals:
    - The right atrium makes up most of the right heart border
    - The left ventricle makes up most of the left heart border

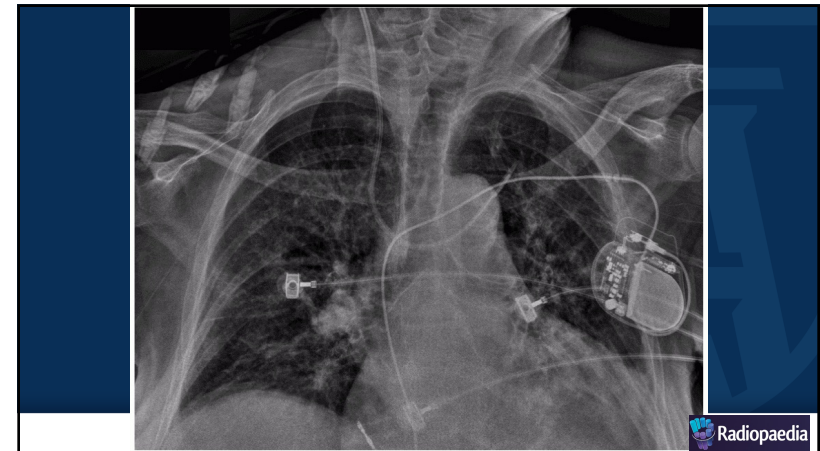
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## Cardiomegaly

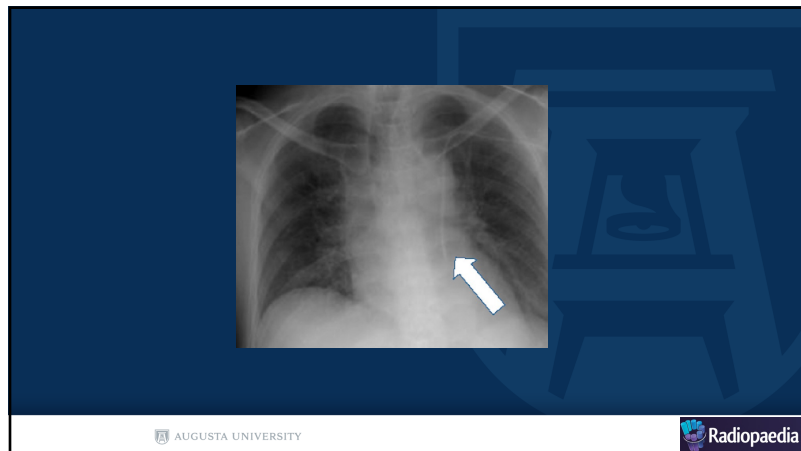
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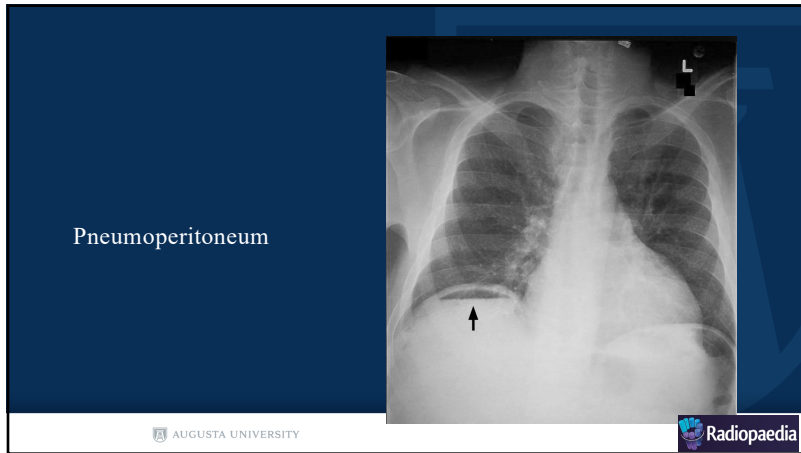
## Diaphragm

- The right hemi-diaphragm is in most cases higher than the left in healthy individuals
- The stomach underlies the left hemi-diaphragm and is best identified by the gastric bubble located within it.
- The diaphragm should be indistinguishable from the underlying liver in healthy individuals on an erect CXR, however if free gas is present (often as a result of bowel perforation), air accumulates under the diaphragm

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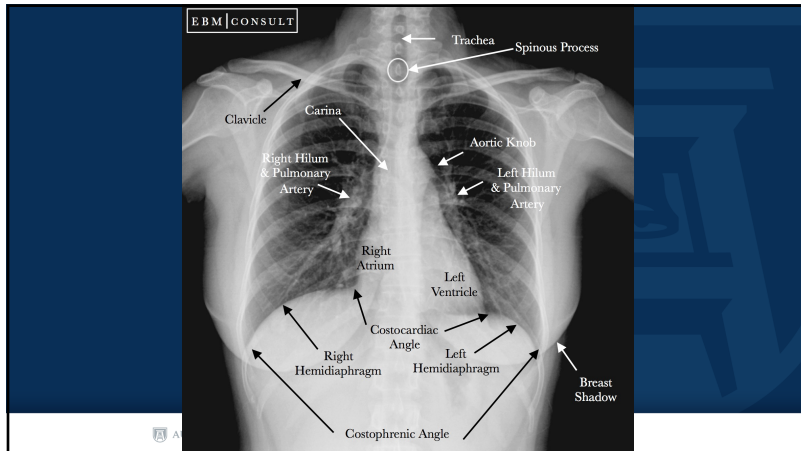
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### Costophrenic Angles

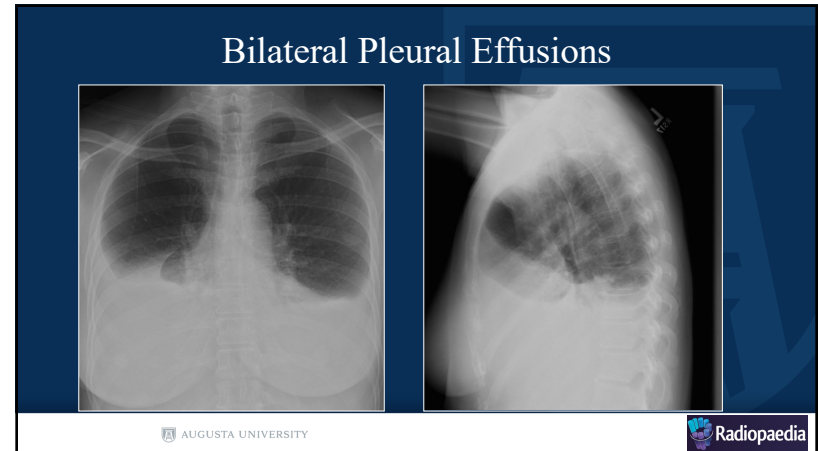
- The costophrenic angles are formed from the dome of each hemidiaphragm and the lateral chest wall.
- In a healthy individual the costo-phrenic angles should be clearly visible on a normal CXR as a well defined acute angle.

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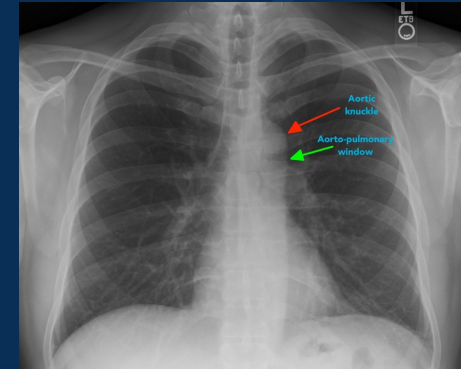
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## Everything Else!

- Mediastinal contours
- The mediastinum contains the heart, great vessels, lymphoid tissue and a number of potential spaces where pathology can occur.
  - Aortic knuckle:
    - Left lateral edge of the aorta as it arches back over the left main bronchus.
    - Loss of definition of the aortic knuckles contours can be caused by an aneurysm.
  - Aorto-pulmonary window:
    - The aorto-pulmonary window is a space located between the arch of the aorta and the pulmonary arteries.
    - This space can be lost as a result of mediastinal lymphadenopathy

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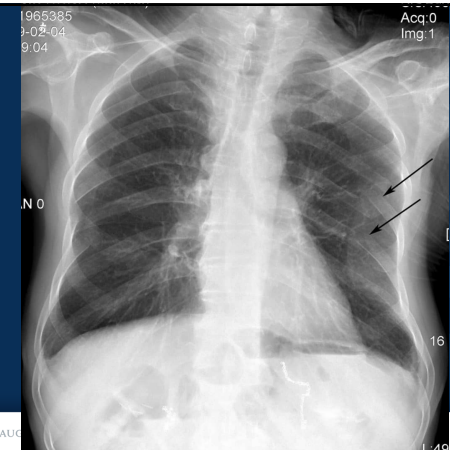
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## Everything else!

- Bones
  - Inspect the visible skeletal structures looking for any abnormalities (e.g. fractures / lytic lesions).
- Soft tissues
  - Inspect the soft tissues for any obvious abnormalities (e.g. large hematoma).
- Tubes / Valves / Pacemakers
  - Tubes – nasogastric tubes are something you'll often be asked to assess on a chest x-ray to confirm it is safe for feeding
  - Lines (e.g. central line / ECG cables).
  - Artificial valves (e.g. aortic valve replacement).
  - Pacemaker (often located below the left clavicle).

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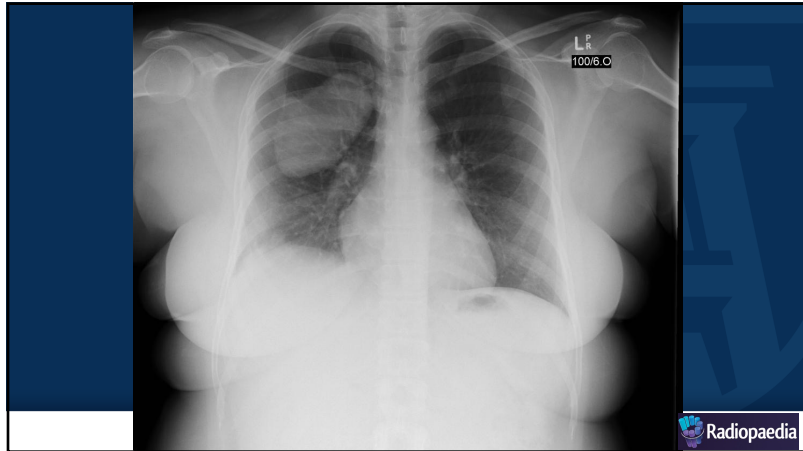
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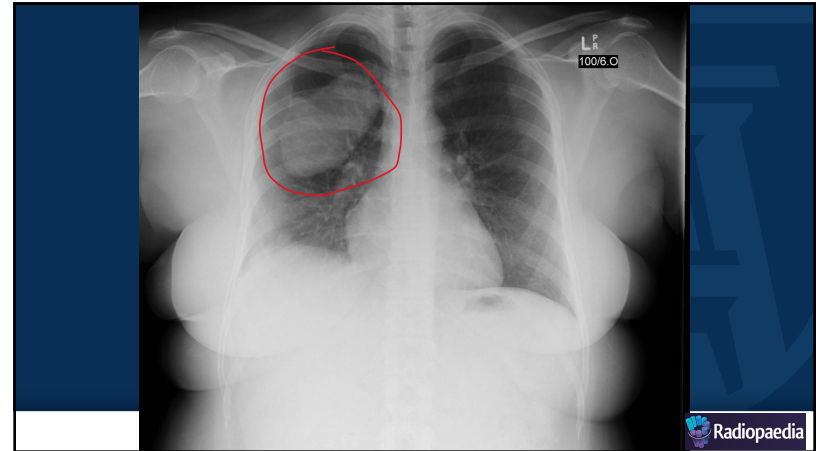
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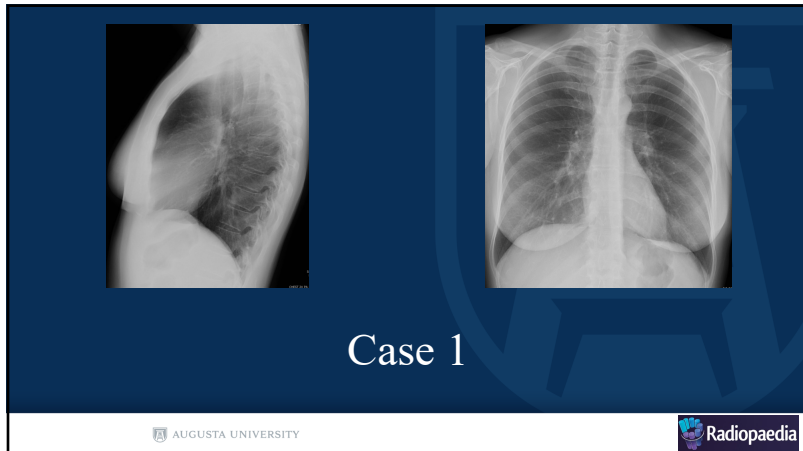
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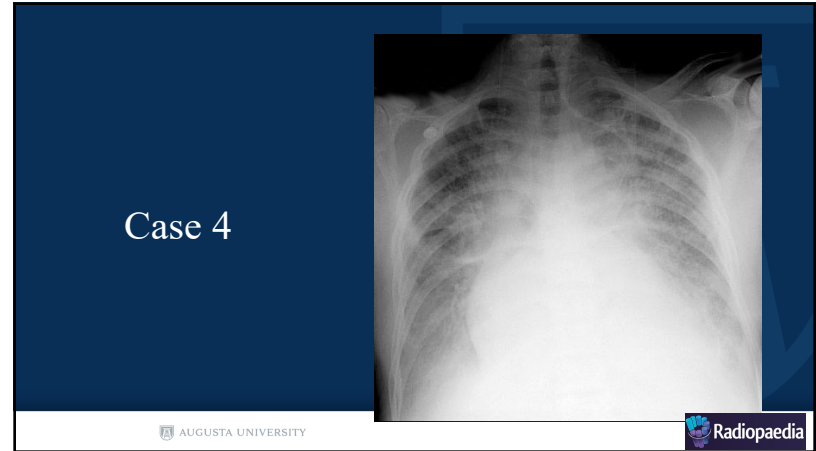
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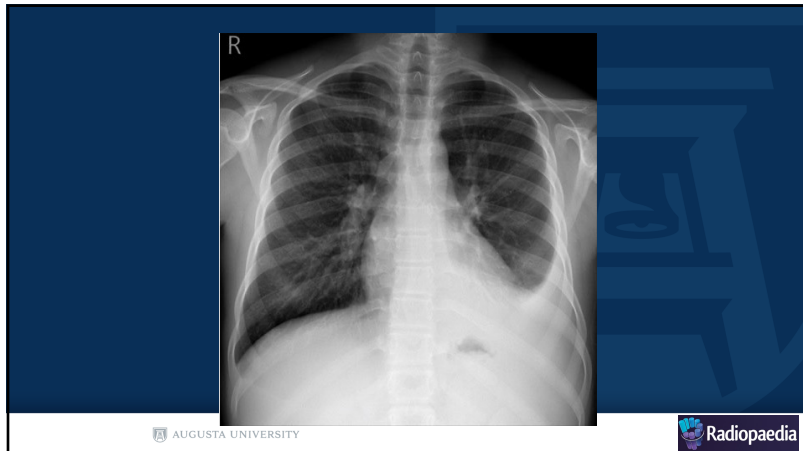
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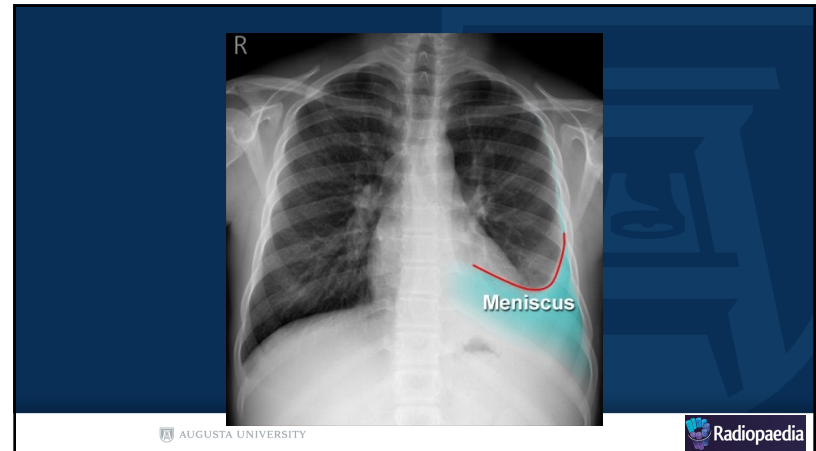
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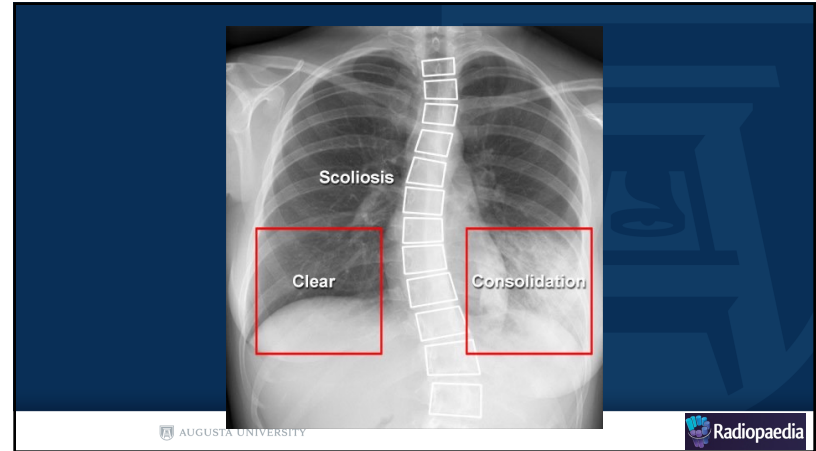
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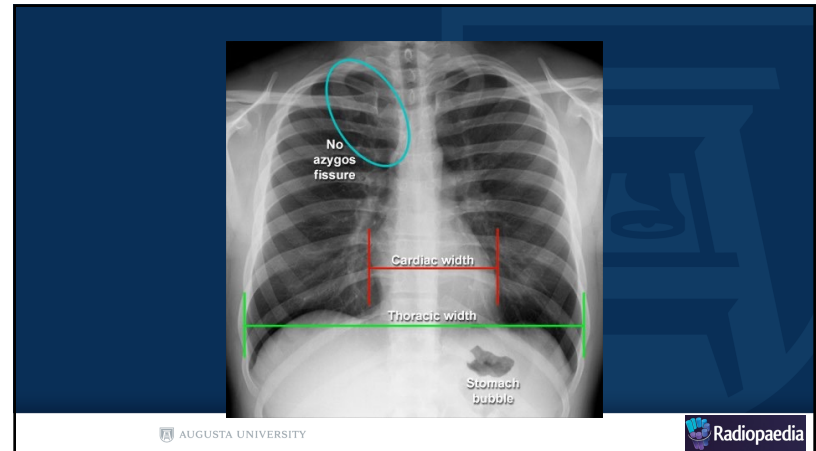
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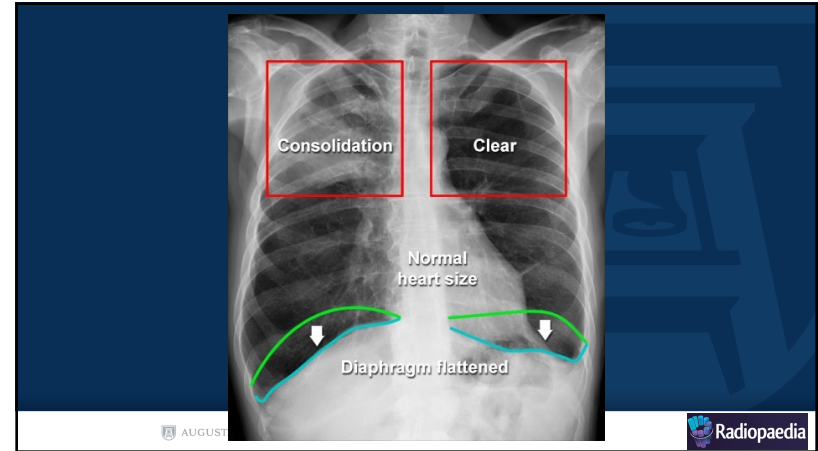
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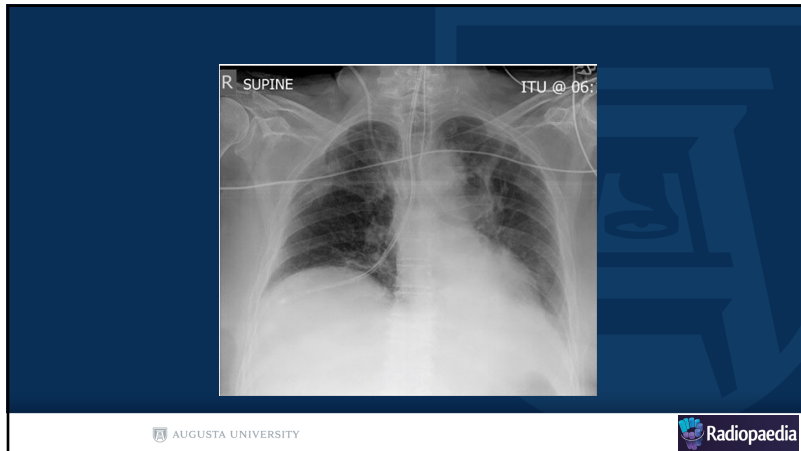
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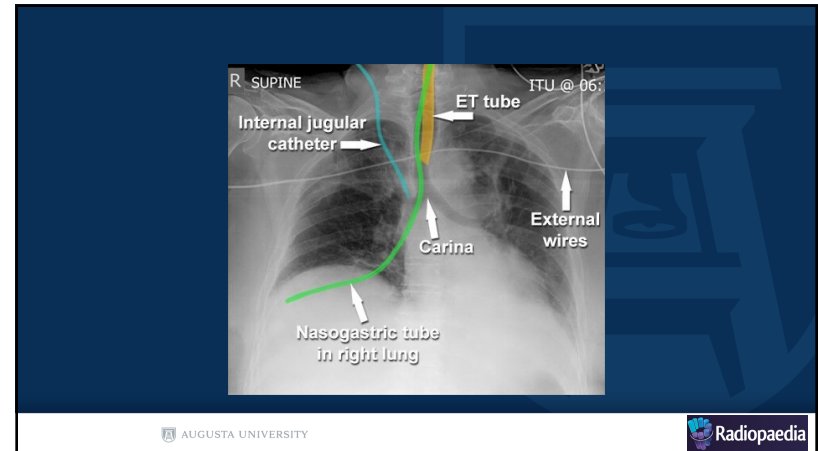
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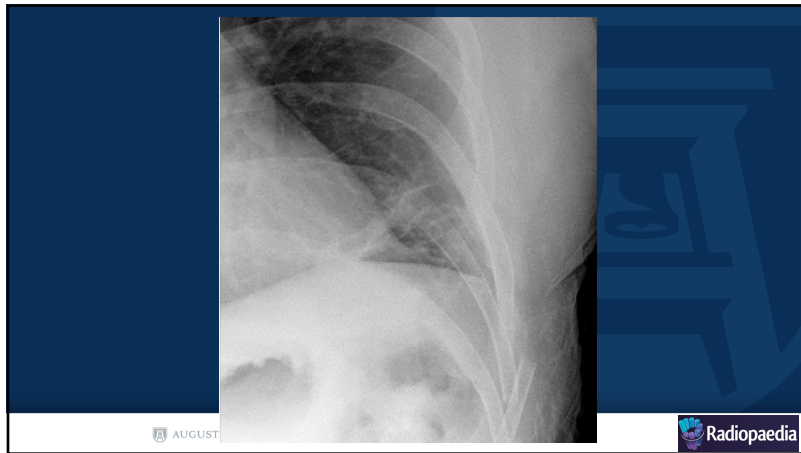


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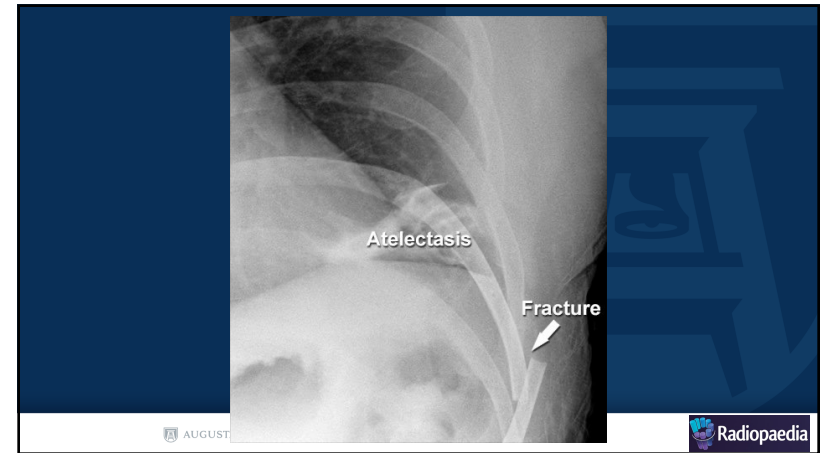


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### References

- Ali IS, Khan M, Khan MA. Routine preoperative chest x-ray and its impact on decision making in patients undergoing elective surgical procedures. *J Ayub Med Coll Abbottabad*. 2013 Jan-Jun;25(1-2):23-5.
- Archer, C., Levy, A. R., & McGregor, M. (1993). Value of routine preoperative chest x-rays: a meta-analysis. *Canadian Journal of Anaesthesia*, 40(11), 1022-1027.
- Barash, P. G. (2013). *Clinical anesthesia* (7th ed.). Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins.
- Bryson, E. O., & Frost, E. A. (2009). Anesthesia in remote locations: radiology and beyond, international anesthesiology clinics: CT and MRI. *International Anesthesiology Clinics*, 47(2), 11-19.
- Jolesz, F. A. (2009). MRI-guided focused ultrasound surgery. *Annual review of medicine*, 60, 417-430.
- Miller, Ronald D. *Miller's Anesthesia*. 7th ed. Philadelphia, PA: Churchill Livingstone/Elsevier, 2010.

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## References

- Morgan, G. E., Mikhail, M. S., & Murray, M. J. 1. (2006). *Clinical anesthesiology* (4th ed.). New York: Lange Medical Books/McGraw Hill Medical Pub.
- Morrison, P. R., Silverman, S. G., Tuncali, K., & Tatti, S. (2008). MRI-guided cryotherapy. *Journal of Magnetic Resonance Imaging: An Official Journal of the International Society for Magnetic Resonance in Medicine*, 27(2), 410-420.
- Parney, I. F., Goerss, S. J., McGee, K., Huston III, J., Perkins, W. J., & Meyer, F. B. (2010). Awake craniotomy, electrophysiologic mapping, and tumor resection with high-field intraoperative MRI. *World neurosurgery*, 73(5), 547-551.
- Sane, S. M., Worsing Jr, R. A., Wiens, C. W., & Sharma, R. K. (1977). Value of preoperative chest X-ray examinations in children. *Pediatrics*, 60(5), 669-672.
- Wood, R. A., & Hoekelman, R. A. (1981). Value of the chest X-ray as a screening test for elective surgery in children. *Pediatrics*, 67(4), 447-452.
- Young, E. M., & Farmer, J. D. (2017). Preoperative Chest Radiography in Elective Surgery: Review and Update. *South Dakota Medicine*, 70(2).