Chest X-rays
Basic to Intermediate Interpretation

Relative Densities

The images seen on a chest radiograph result from the differences in densities of the materials in the body.

The hierarchy of relative densities from least dense (dark on the radiograph) to most dense (light on the radiograph) include:

- Gas (air in the lungs)
- Fat (fat layer in soft tissue)
- Water (same density as heart and blood vessels)
- Bone (the most dense of the tissues)
- Metal (foreign bodies)

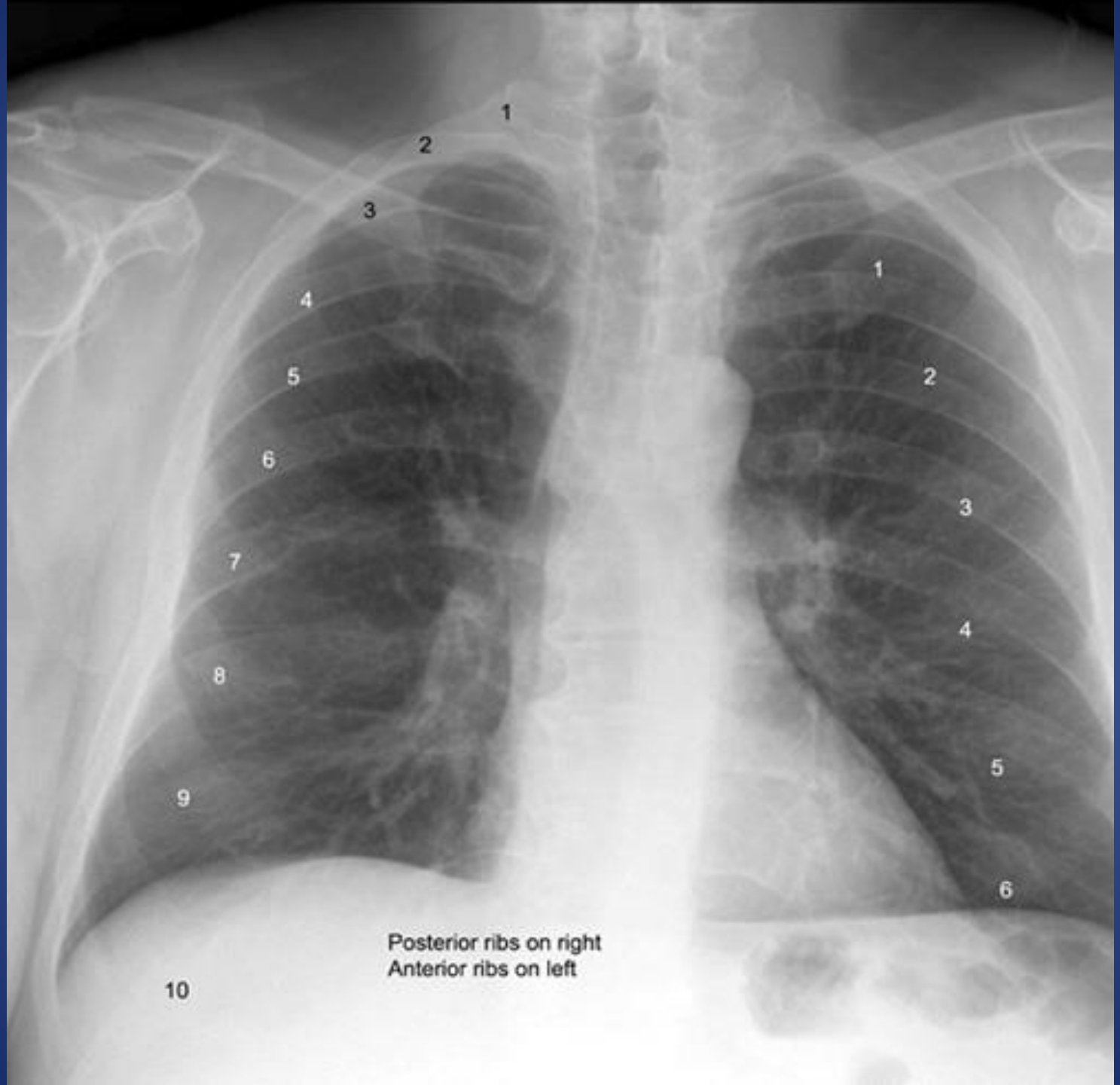
Three Main Factors Determine the Technical Quality of the Radiograph

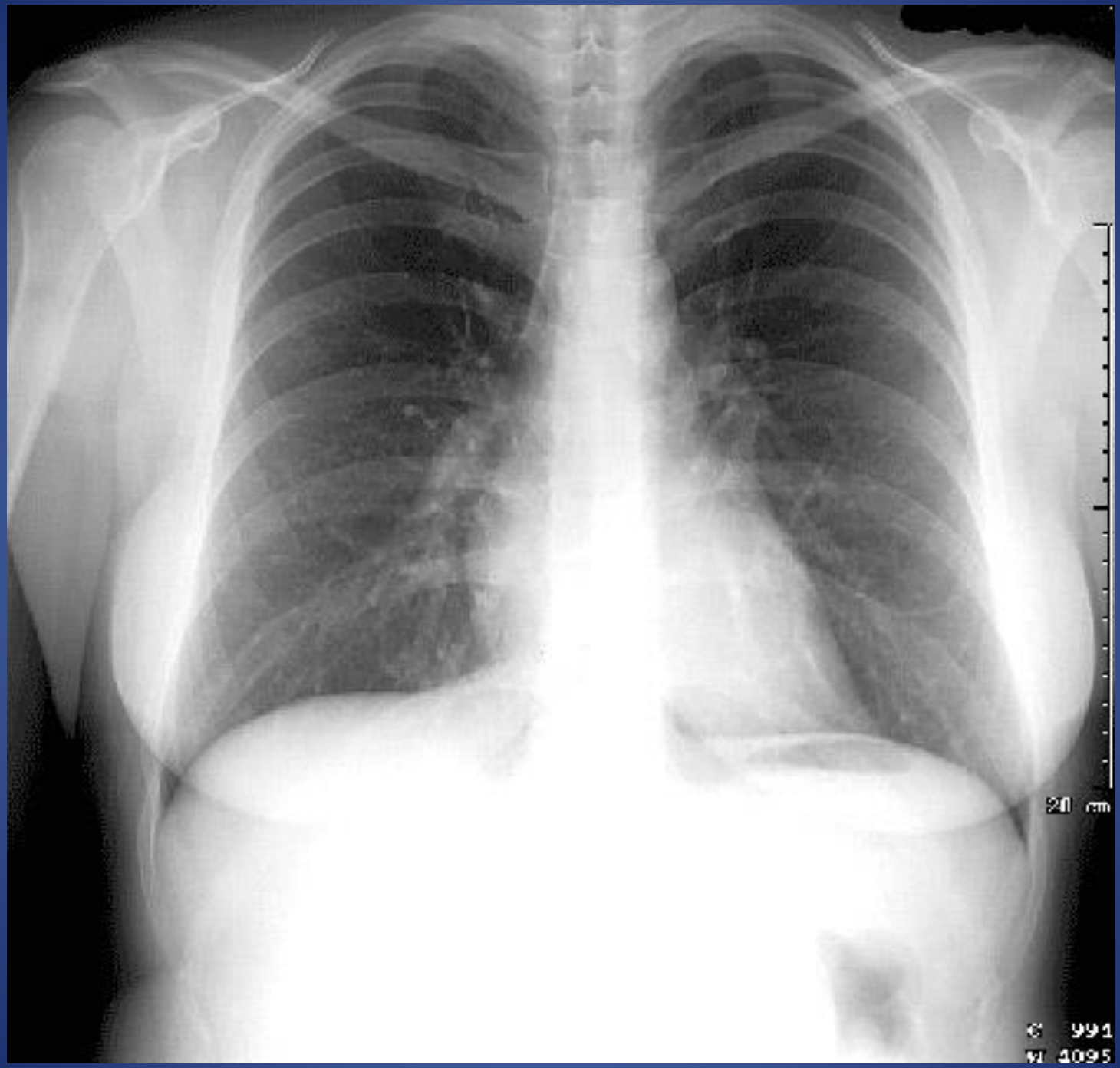
- Inspiration
- Penetration
- Rotation

Inspiration

The chest radiograph should be obtained with the patient in full inspiration to help assess intrapulmonary abnormalities.

At full inspiration, the diaphragm should be observed at about the level of the 8^{th} to 10^{th} rib posteriorly, or the 5^{th} to 6^{th} rib anteriorly.


1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
Posterior ribs on right
Anterior ribs on left


20 cm
C 991
W 4095

Penetration

On a properly exposed chest radiograph:

- The lower thoracic vertebrae should be visible through the heart
- The bronchovascular structures behind the heart (trachea, aortic arch, pulmonary arteries, etc.) should be seen

Underexposure

In an underexposed chest radiograph, the cardiac shadow is opaque, with little or no visibility of the thoracic vertebrae.

The lungs may appear much denser and whiter, much as they might appear with infiltrates present.

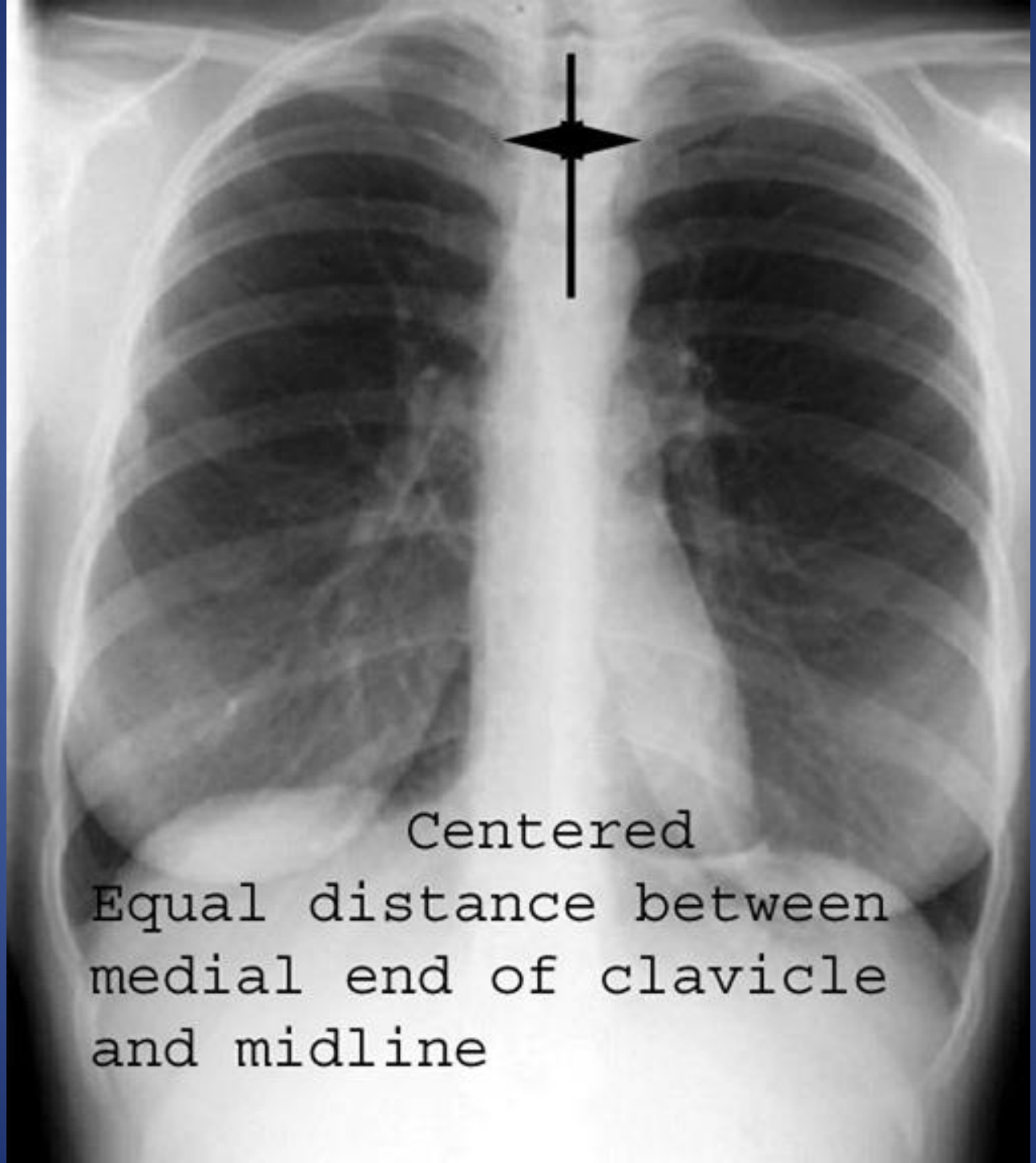
Overexposure

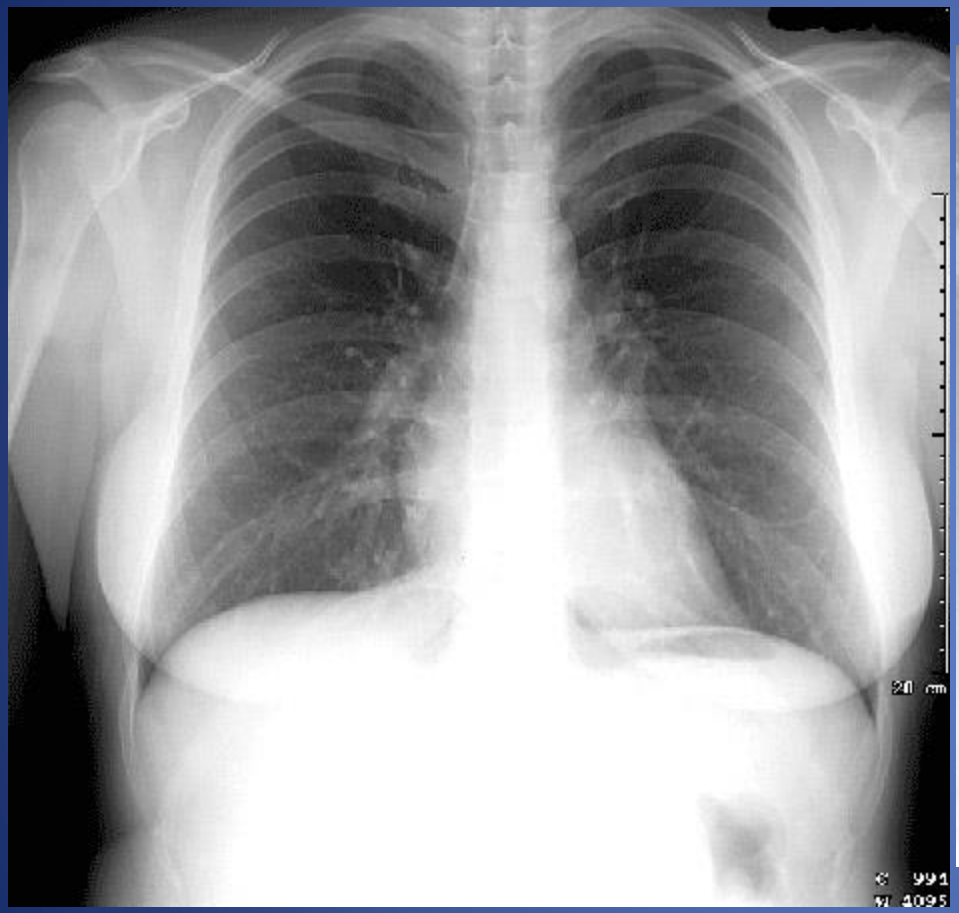
With greater exposure of the chest radiograph, the heart becomes more radiolucent and the lungs become proportionately darker.

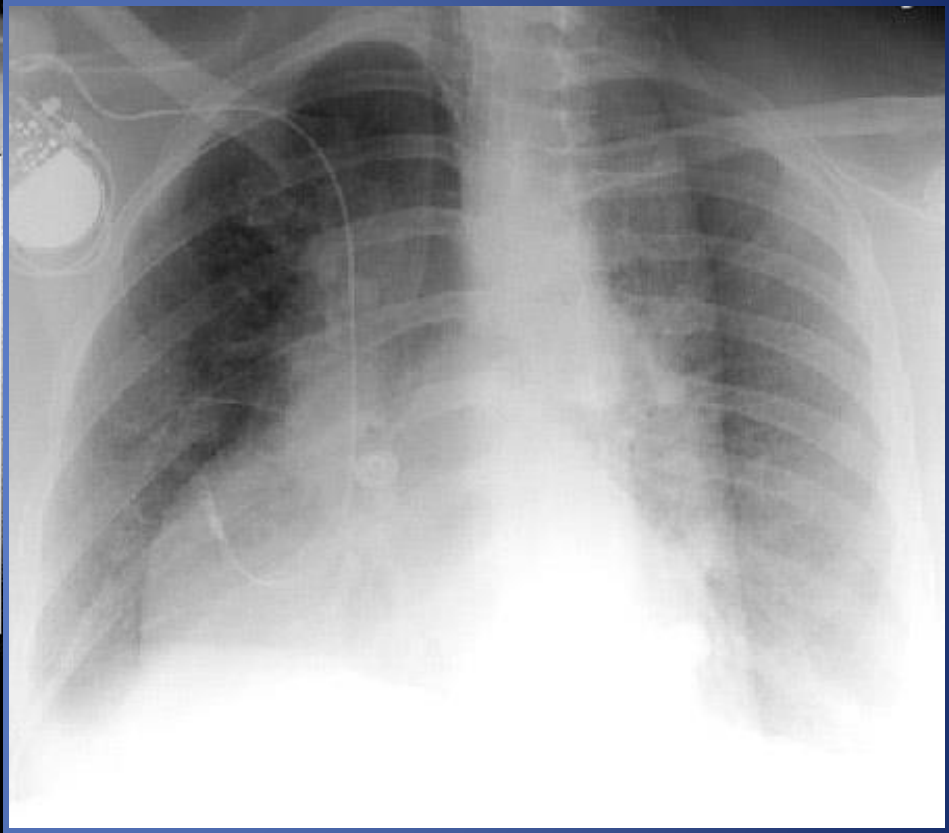
In an overexposed chest radiograph, the air-filled lung periphery becomes extremely radiolucent, and often gives the appearance of lacking lung tissue, as would be seen in a condition such as emphysema.

Rotation

Patient rotation can be assessed by observing the clavicular heads and determining whether they are equal distance from the spinous processes of the thoracic vertebral bodies.


Centered
Equal distance between
medial end of clavicle
and midline


20 cm

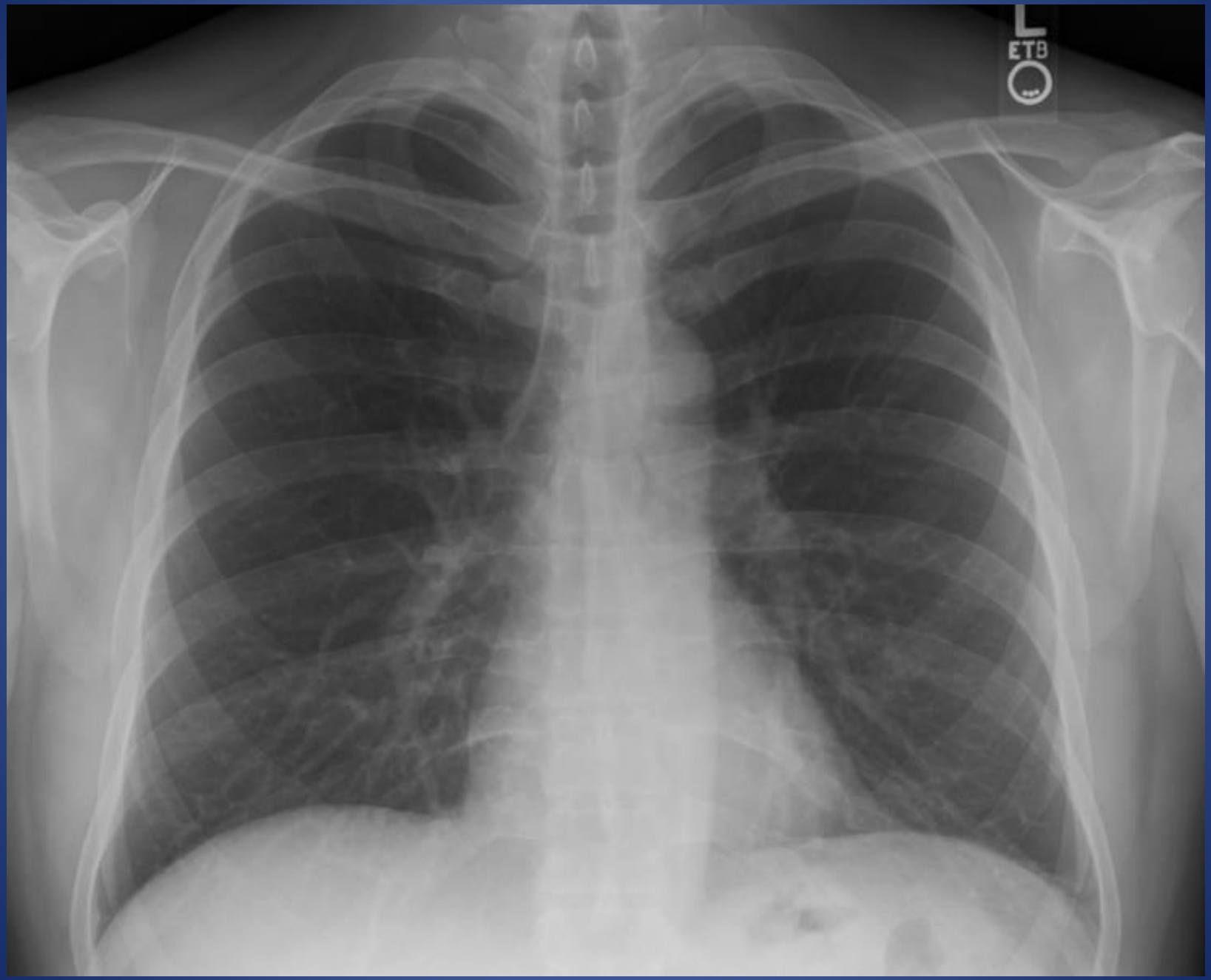


Four major positions are utilized for producing a chest radiograph:

- Posterior-anterior (PA)
- Lateral
- Anterior-posterior (AP)
- Lateral Decubitus

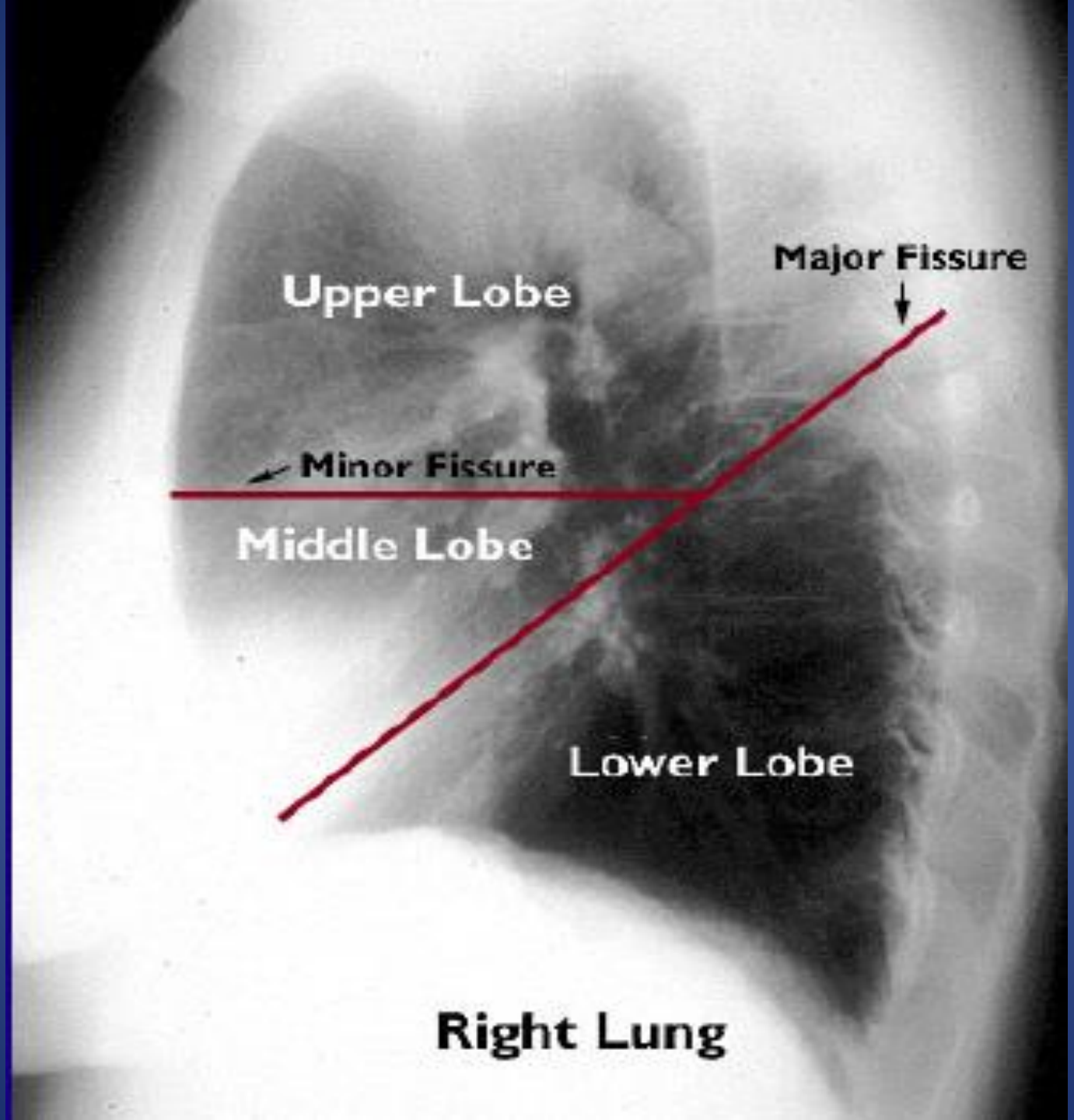
Posterioranterior (PA) Position

- The standard position for obtaining a routine adult chest radiograph
- Patient stands upright with the anterior chest placed against the front of the film
- The shoulders are rotated forward enough to touch the film, ensuring that the scapulae do not obscure a portion of the lung fields
- Usually taken with the patient in full inspiration
- The PA film is viewed as if the patient is standing in front of you with his/her right side on your left


L
ETB

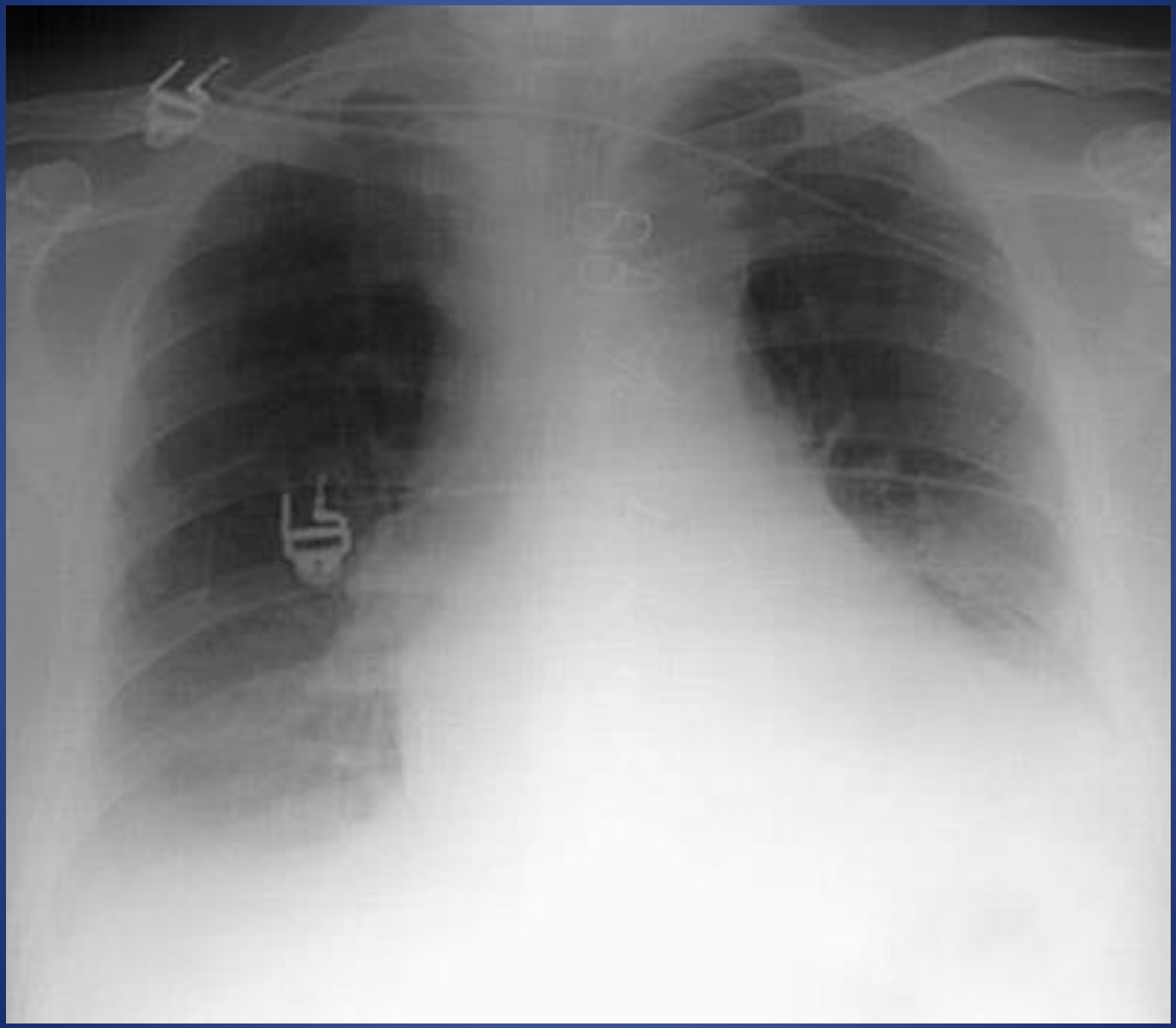
Lateral Position

- Patient stands upright with the left side of the chest against the film and the arms raised over the head
- Allows the viewer to see behind the heart and diaphragmatic dome
- Is typically used in conjunction with a PA view of the same chest to help determine the three-dimensional position of organs or abnormal densities


Upper Lobe
Major Fissure
Minor Fissure
Middle Lobe
Lower Lobe
Right Lung

Anteriorposterior (AP) Position

- Used when the patient is debilitated, immobilized, or unable to cooperate with the PA procedure
- The film is placed behind the patient's back with the patient in a supine position
- Because the heart is a greater distance from the film, it with appear more magnified than in a PA
- The scapulae are usually visible in the lung fields because they are not rotated out of the view as they are in a PA



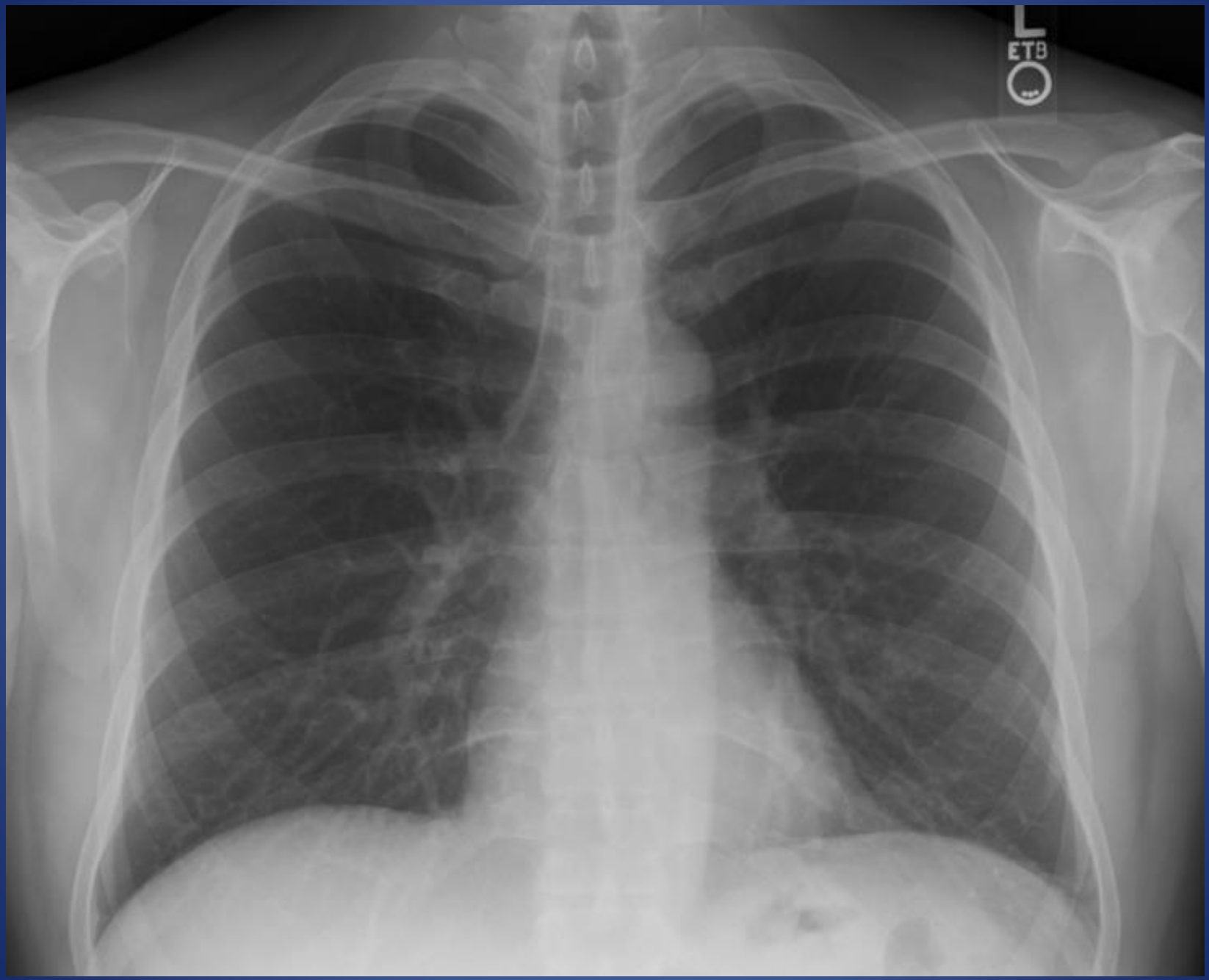
Lateral Decubitus Position

- The patient lies on either the right or left side rather than in the standing position as with a regular lateral radiograph
- The radiograph is labeled according to the side that is placed down (a left lateral decubitus radiograph would have the patient's left side down against the film)
- Often useful in revealing a pleural effusion that cannot be easily observed in an upright view, since the effusion will collect in the dependent postion


R4

Anatomical Structures in the Chest

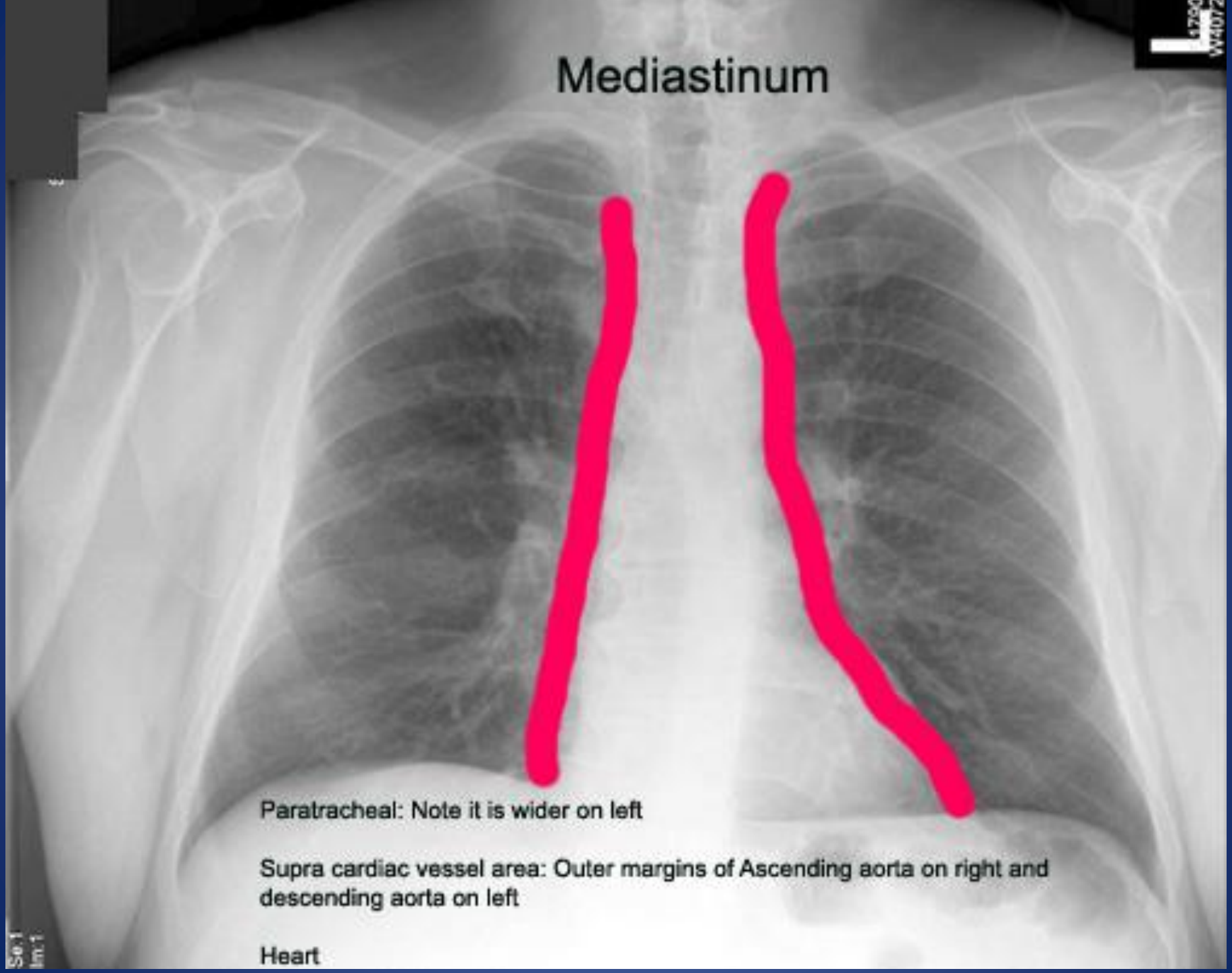
- Mediastinum
- Hilum
- Lung Fields
- Diaphragmatic Domes
- Pleural Surfaces
- Bones
- Soft Tissue


L
ETB

Mediastinum

- The trachea should be centrally located or slightly to the right
- The aortic arch is the first convexity on the left side of the mediastinum
- The pulmonary artery is the next convexity on the left, and the branches should be traceable as it fans out through the lungs
- The lateral margin of the superior vena cava lies above the right heart border

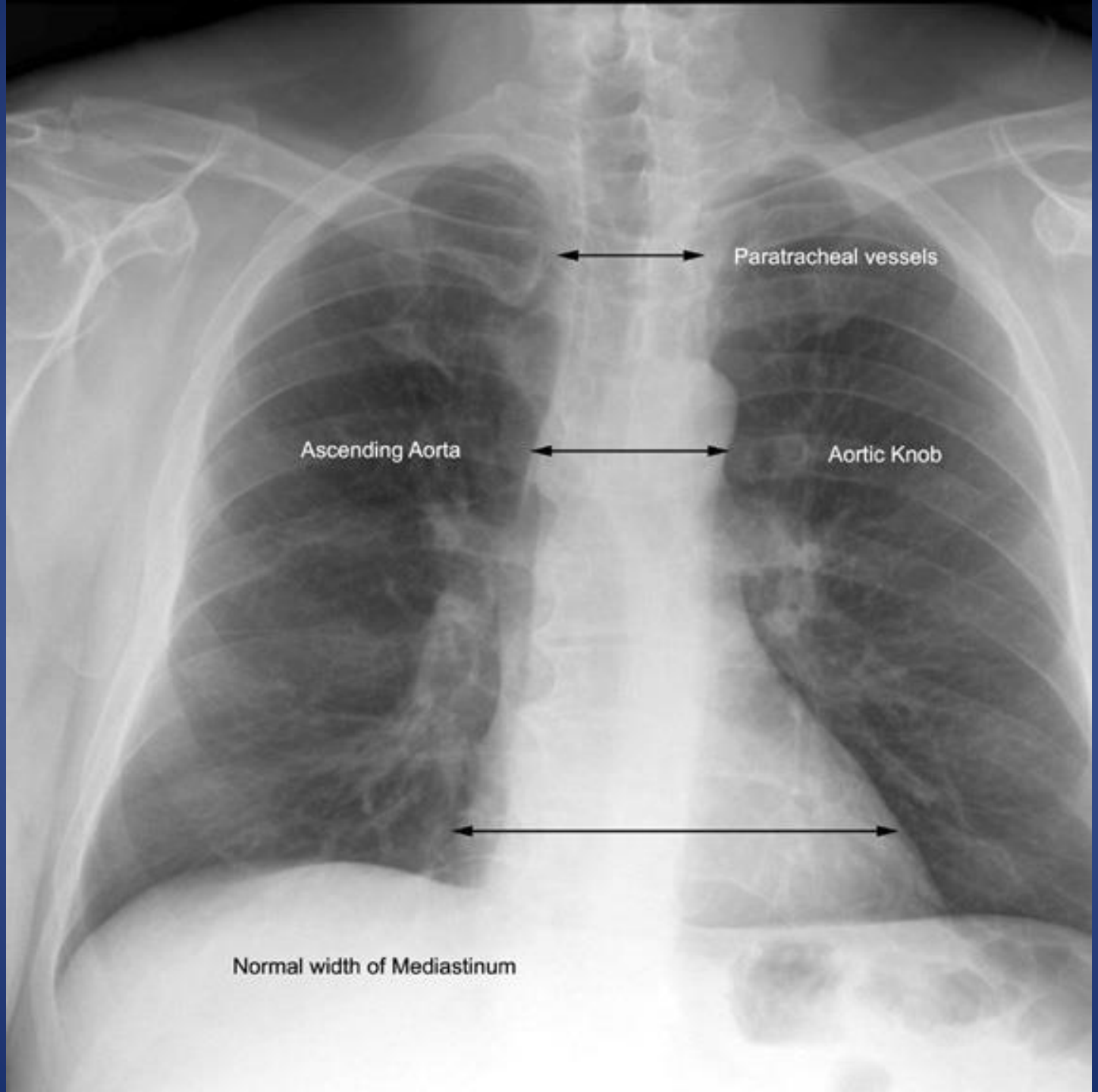
Mediastinum



Paratracheal: Note it is wider on left

Supra cardiac vessel area: Outer margins of Ascending aorta on right and descending aorta on left

Heart

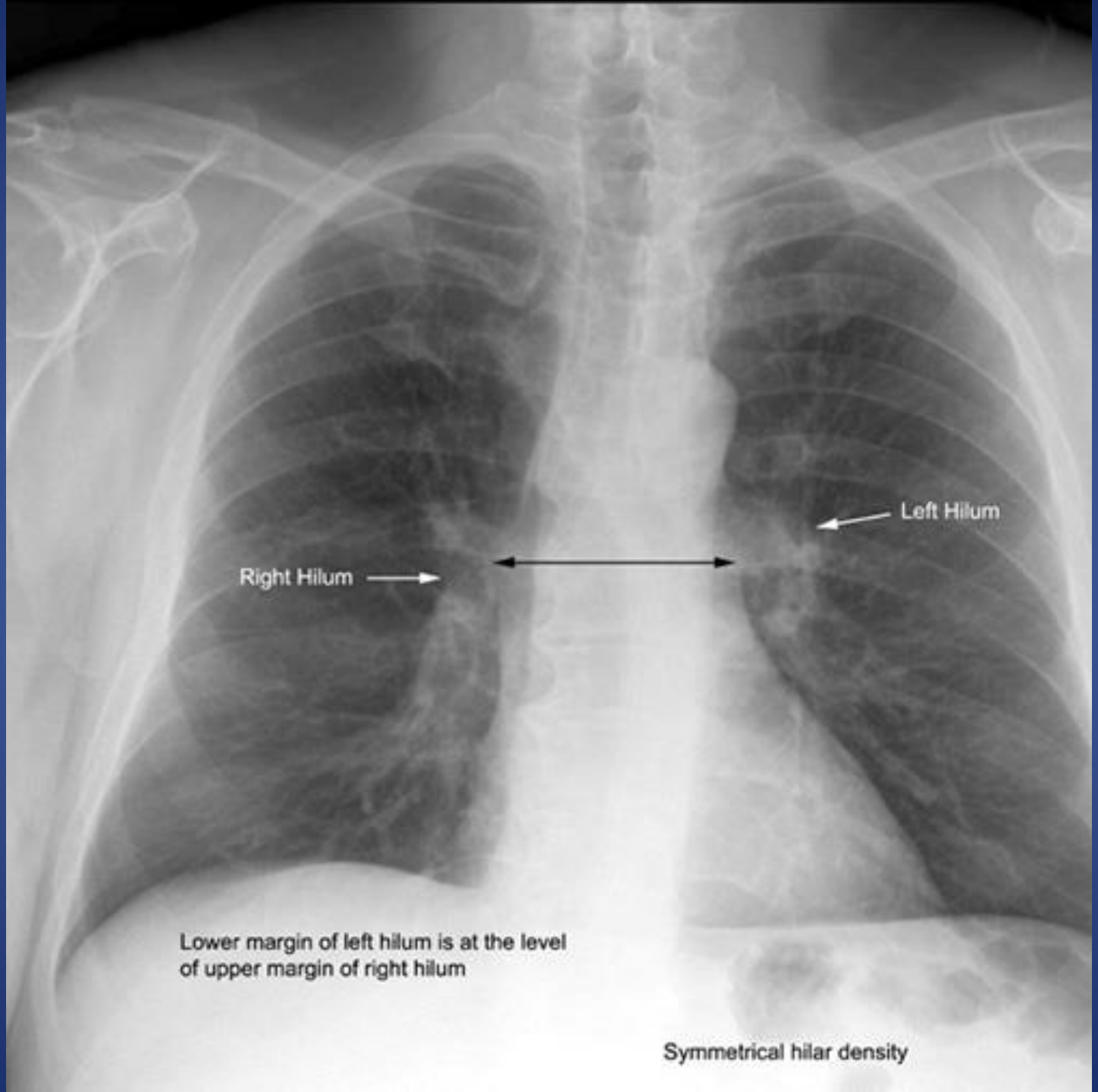

Paratracheal vessels
Ascending Aorta
Aortic Knob
Normal width of Mediastinum

The Heart

- Two-thirds of the heart should lie on the left side of the chest, with one-third on the right
- The heart should take up less that half of the thoracic cavity (C/T ratio < 50%)
- The left atrium and the left ventricle create the left heart border
- The right heart border is created entirely by the right atrium (the right ventricle lies anteriorly and, therefore, does not have a border on the PA)

Hilum

- The hila consist primarily of the major bronchi and the pulmonary veins and arteries
- The hila are not symmetrical, but contain the same basic structures on each side
- The hila may be at the same level, but the left hilum is commonly higher than the right
- Both hila should be of similar size and density

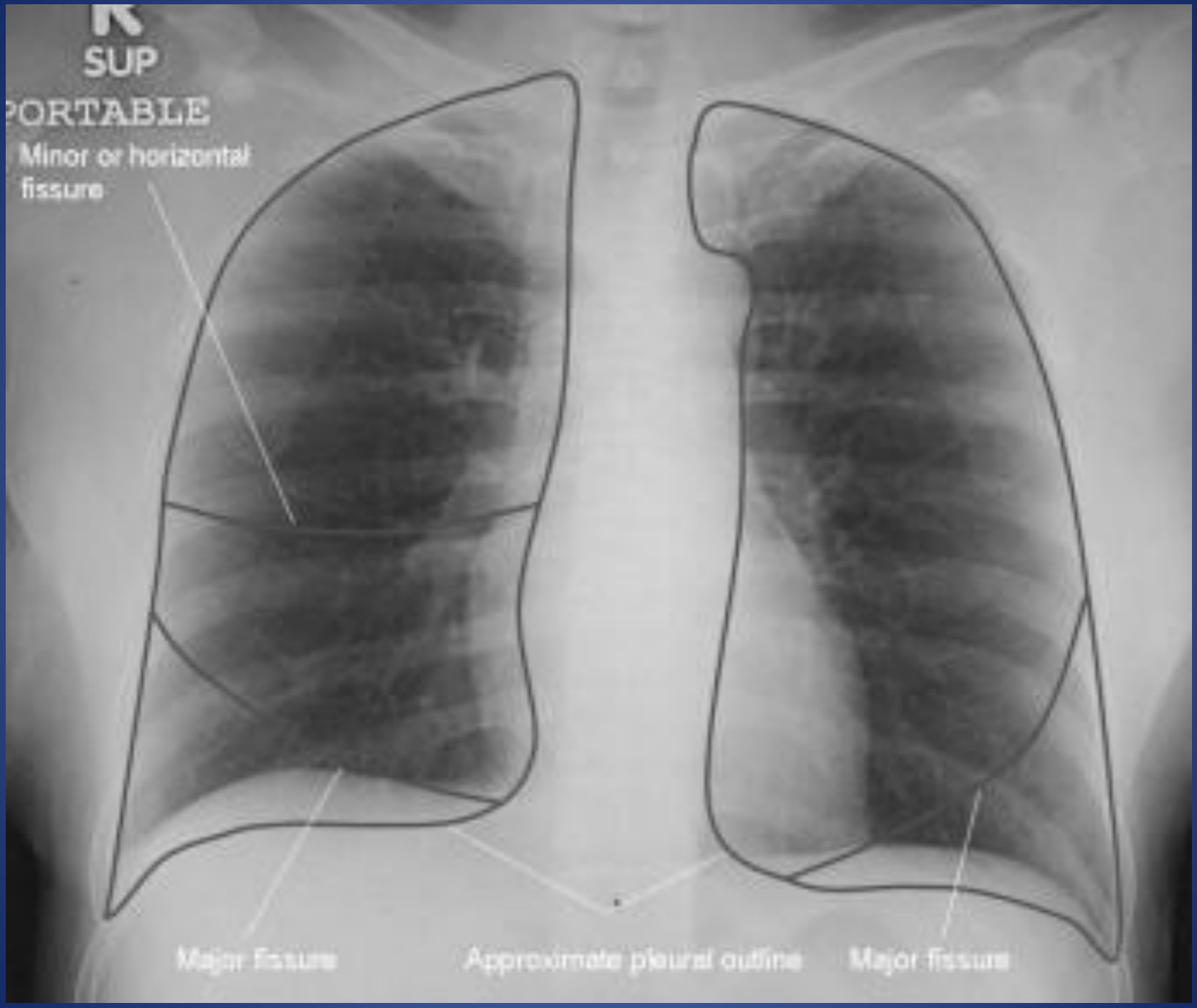

Left Hilum
Right Hilum
Lower margin of left hilum is at the level
of upper margin of right hilum
Symmetrical hilar density

Lungs

- Normally, there are visible markings throughout the lungs due to the pulmonary arteries and veins, continuing all the way to the chest wall
- Both lungs should be scanned, starting at the apices and working downward, comparing the left and right lung fields at the same level (as is done with ascultation)

Lungs

- On a PA radiograph, the minor fissure can often be seen as a faint horizontal line dividing the RML from the RUL.
- The major fissures are not usually seen on a PA view because they are being viewed obliquely.


SUP
PORTABLE
Minor or horizontal fissure
Major Fissure
Approximate pleural outline
Major fissure

Diaphragm

- The left dome is normally slightly lower than the right due to elevation by the liver, located under the right hemidiaphragm.
- The costophrenic recesses are formed by the hemidiaphragms and the chest wall.
- On the PA radiograph, the costophrenic recess is seen only on each side where an angle is formed by the lateral chest wall and the dome of each hemidiaphragm (costophrenic angle).

What determines position of diaphragm?

Pleura

- The pleura and pleural spaces will only be visible when there is an abnormality present

- Common abnormalities seen with the pleura include pleural thickening, or fluid or air in the pleural space.

Soft Tissue

Thick soft tissue may obscure underlying structures:

- Thick soft tissue due to obesity may obscure some underlying structures such as lung markings
- Breast tissue may obscure the costophrenic angles

Lucencies within soft tissue may represent gas (as observed with subcutaneous air)

Bones

The bones visible in the chest radiograph include:

- Ribs
- Clavicles
- Scapulae
- Vertebrae
- Proximal humeri

The bones are useful as markers to assess patient rotation, adequacy of inspiration, and x-ray penetration.

Describing Abnormal Findings on a Chest Radiograph

- When addressing an abnormal finding on a chest radiograph, only a description of what is seen, rather than a diagnosis, should be presented (a chest radiograph alone is not diagnostic, but is only one piece of descriptive information used to formulate a diagnosis)
- Descriptive words such as shadows, density, or patchiness, should be used to discuss the findings

Common Abnormal Findings on Chest Radiographs

Silhouette Sign

- The loss of the lung/soft tissue interface due to the presence of fluid in the normally air-filled lung
- If an intrathoracic opacity is in anatomic contact with a border, then the opacity will obscure that border
- Commonly seen with the borders of the heart, aorta, chest wall, and diaphragm

Air Bronchogram

A tubular outline of an airway made visible due to the filling of the surrounding alveoli by fluid or inflammatory exudates

Conditions in which air bronchograms are seen:

- Lung consolidation
- Pulmonary edema
- Non-obstructive pulmonary atelectasis
- Interstitial disease
- Neoplasm
- Normal expiration

Consolidation

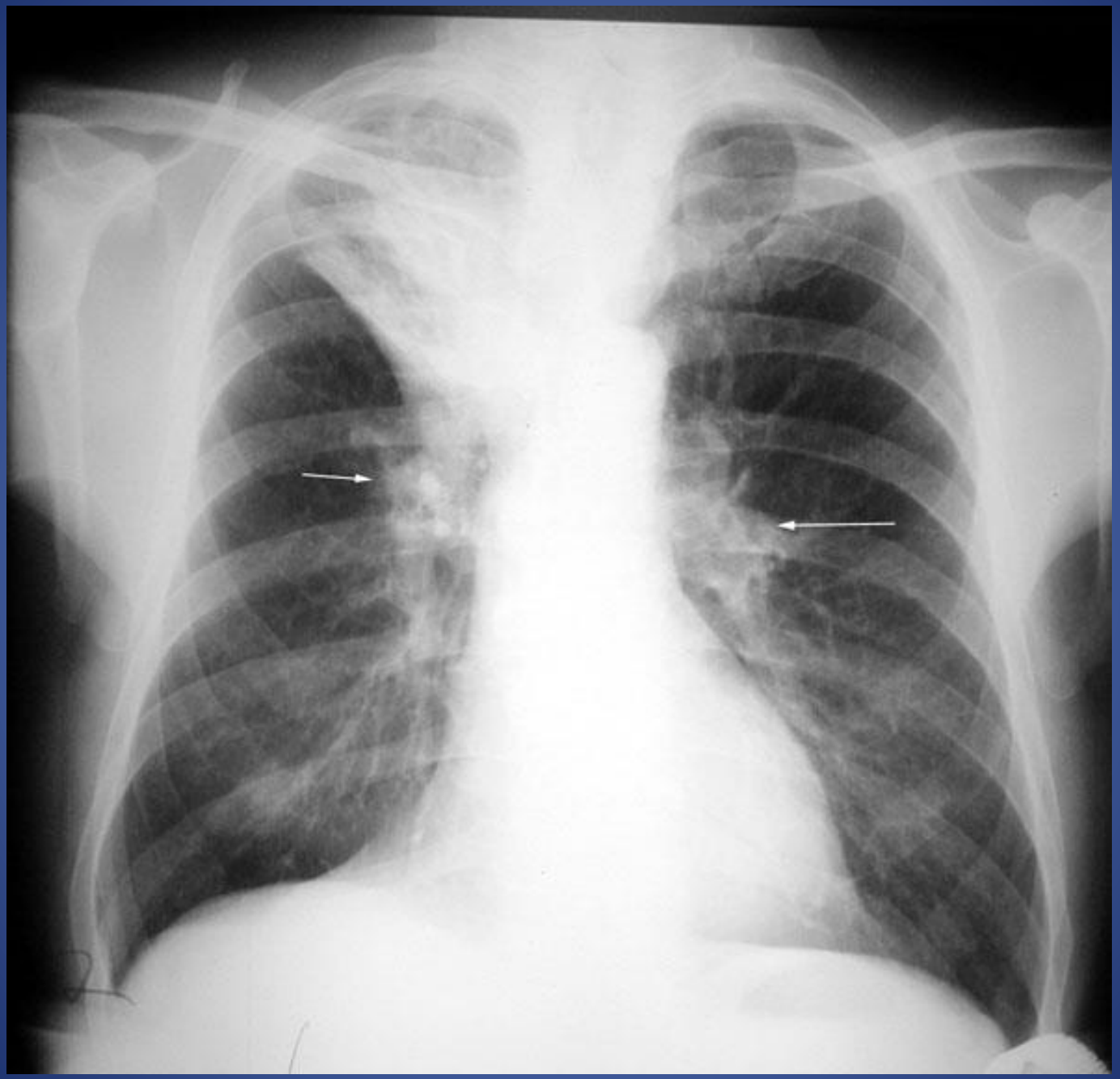
The lung is said to be consolidated when the alveoli and small airways are filled with dense material.

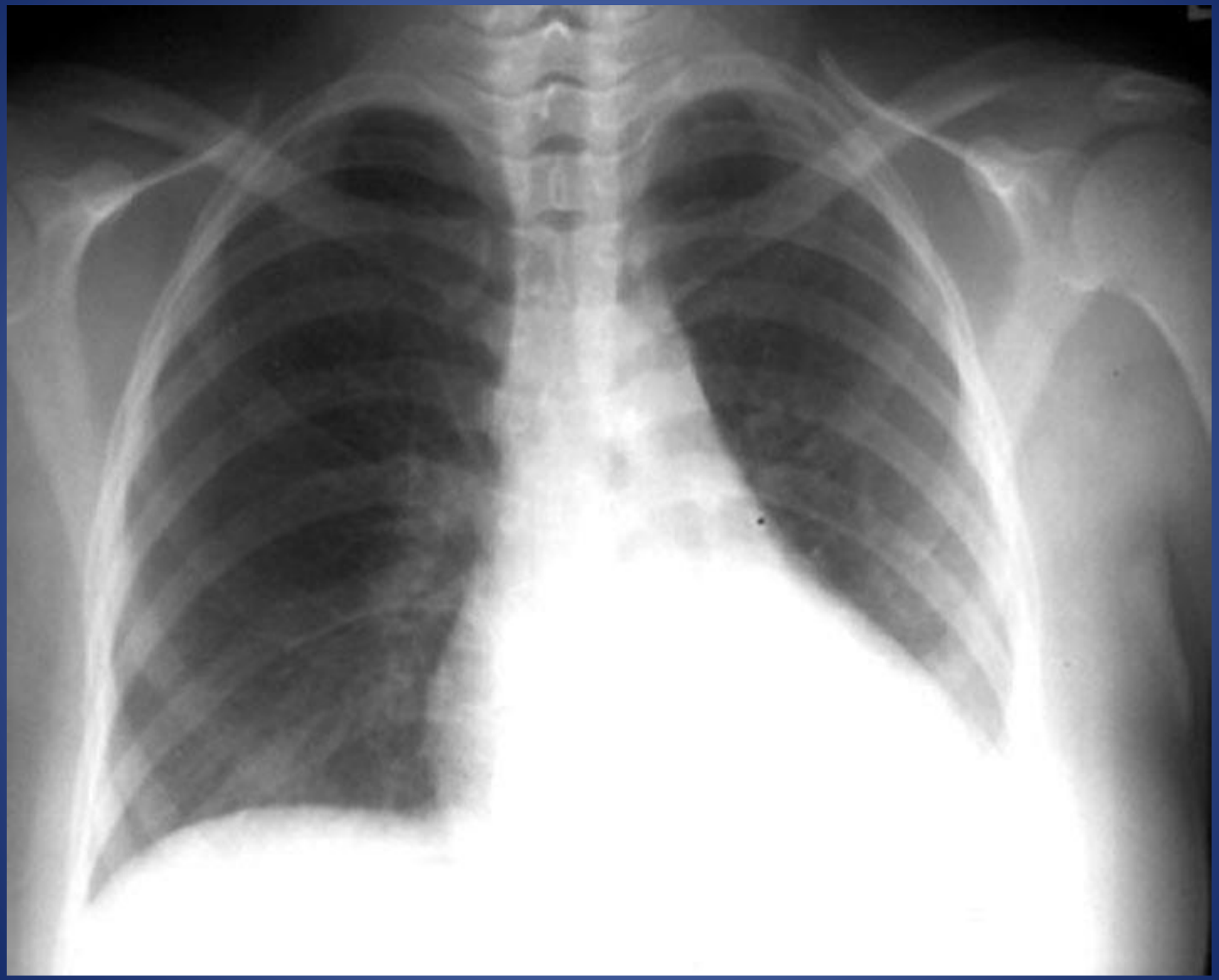
This dense material may consist of:

- Pus (pneumonia)
- Fluid (pulmonary edema)
- Blood (pulmonary hemorrhage)
- Cells (cancer)

Atelectasis

- Almost always associated with a linear increased density due to volume loss
- Indirect indications of volume loss include vascular crowding or mediastinal shift toward the collapse
- Possible observance of hilar elevation with an upper lobe collapse, or a hilar depression with a lower lobe collapse





Pneumonia

Typical findings on the chest radiograph include:

- Airspace opacity
- Lobar consolidation
- Interstitial opacities

Pleural Effusion

On an upright film, an effusion will cause blunting on the lateral costophrenic sulcus and, if large enough, on the posterior costophrenic sulcus.

- Approximately 200 ml of fluid are needed to detect an effusion in a PA film, while approximately 75 ml of fluid would be visible in the lateral view

In the AP film, an effusion will appear as a graded haze that is denser at the base

A lateral decubitus film is helpful in confirming an effusion as the fluid will collect on the dependent side

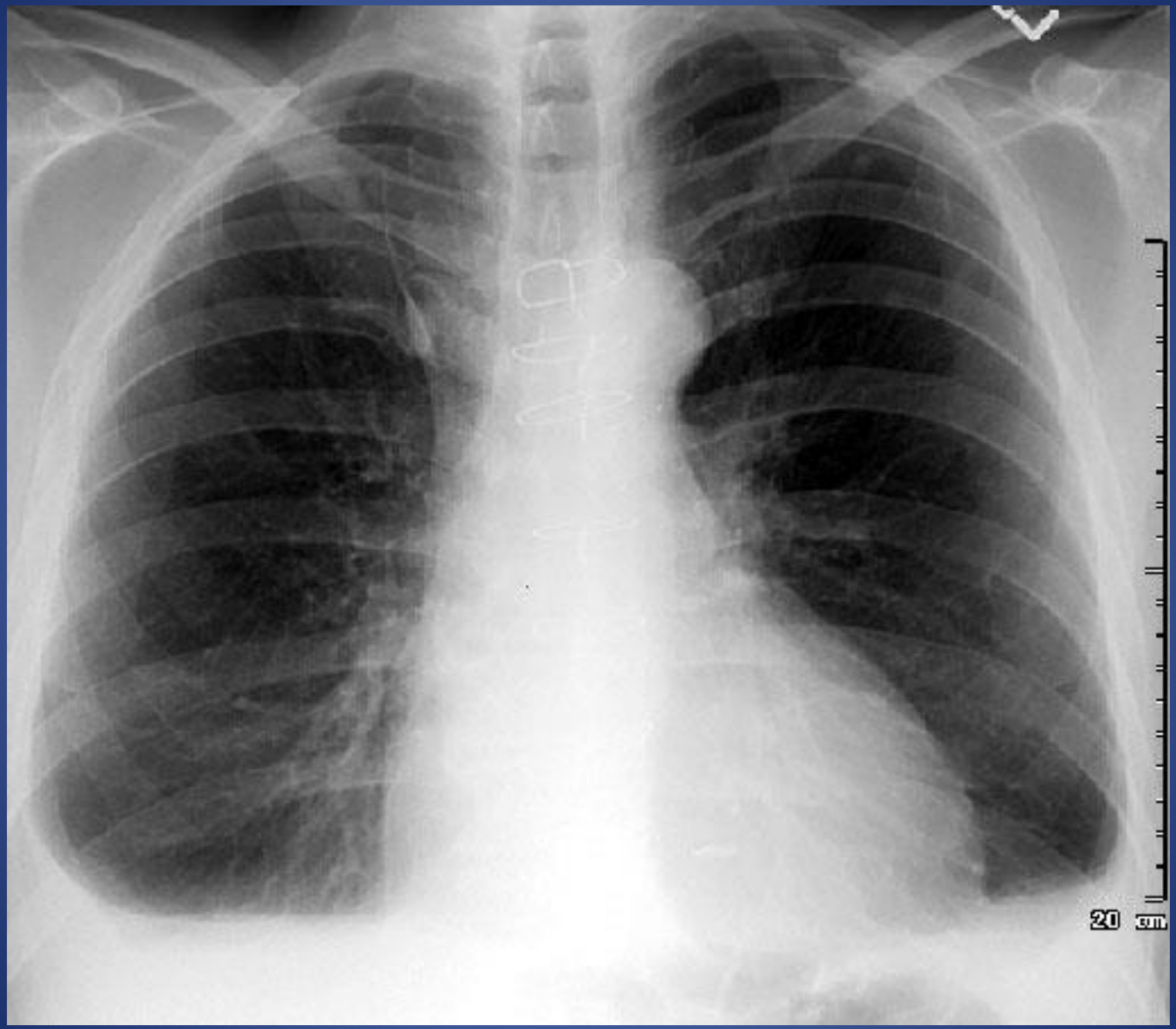
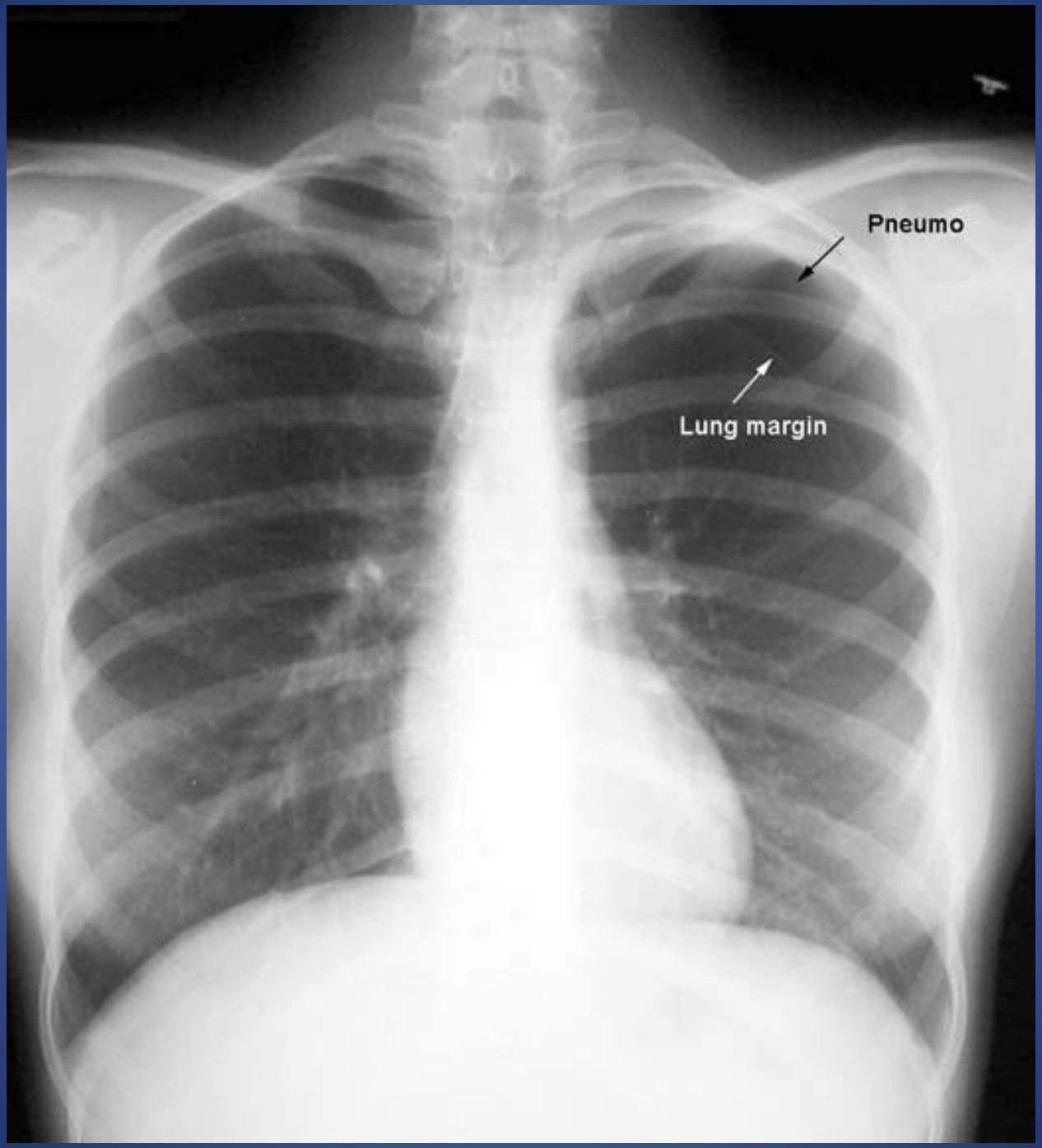

20 cm

Figure-1: Posteroanterior chest X rays demonstrated a significant right pleural effusion.

Pneumothorax

- Appears in the chest radiograph as air without lung markings
- In a PA film it is usually seen in the apices since the air rises to the least dependent part of the chest
- The air is typically found peripheral to the white line of the visceral pleura
- Best demonstrated by an expiration film


Pneumo
Lung margin

Emphysema

Common features seen on the chest radiograph include:

- Hyperinflation with flattening of the diaphragms
- Increased retrosternal space
- Bullae
- Enlargement of PA/RV (cor pulmonale)

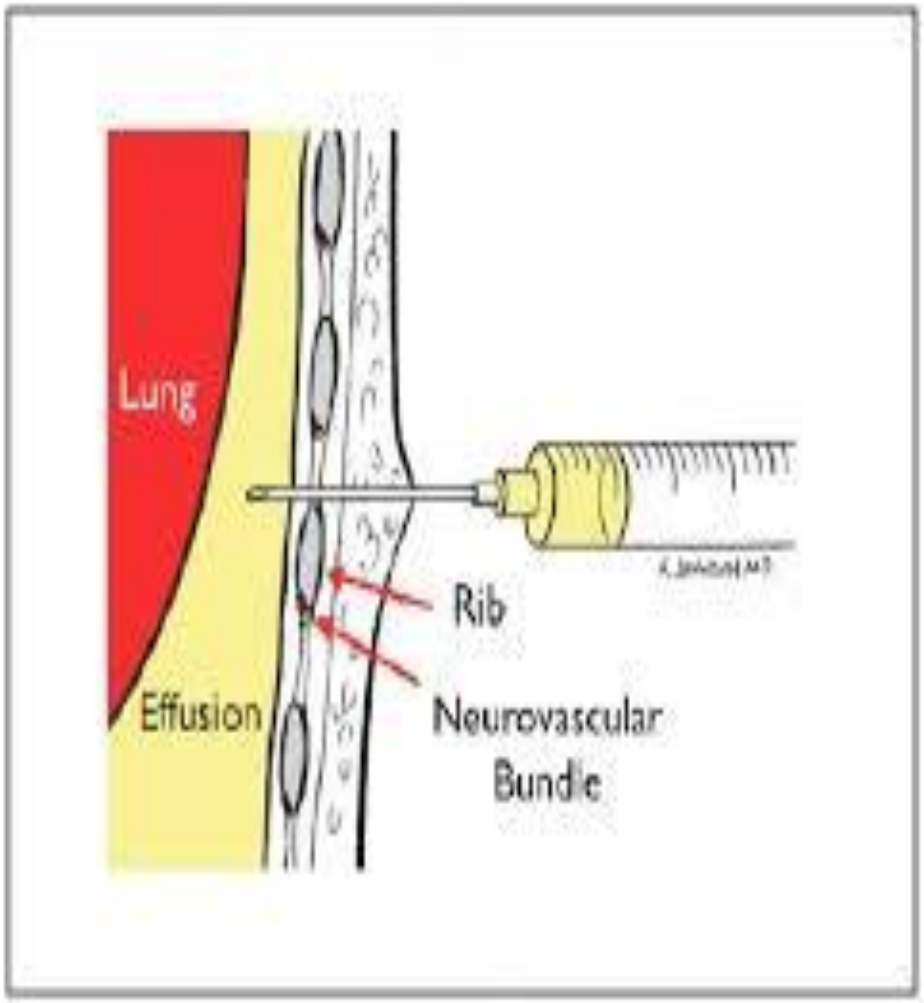

L

Lung Mass

A lung mass will typically present as a lesion with sharp margins and a homogenous appearance, in contrast to the diffuse appearance of an infiltrate.

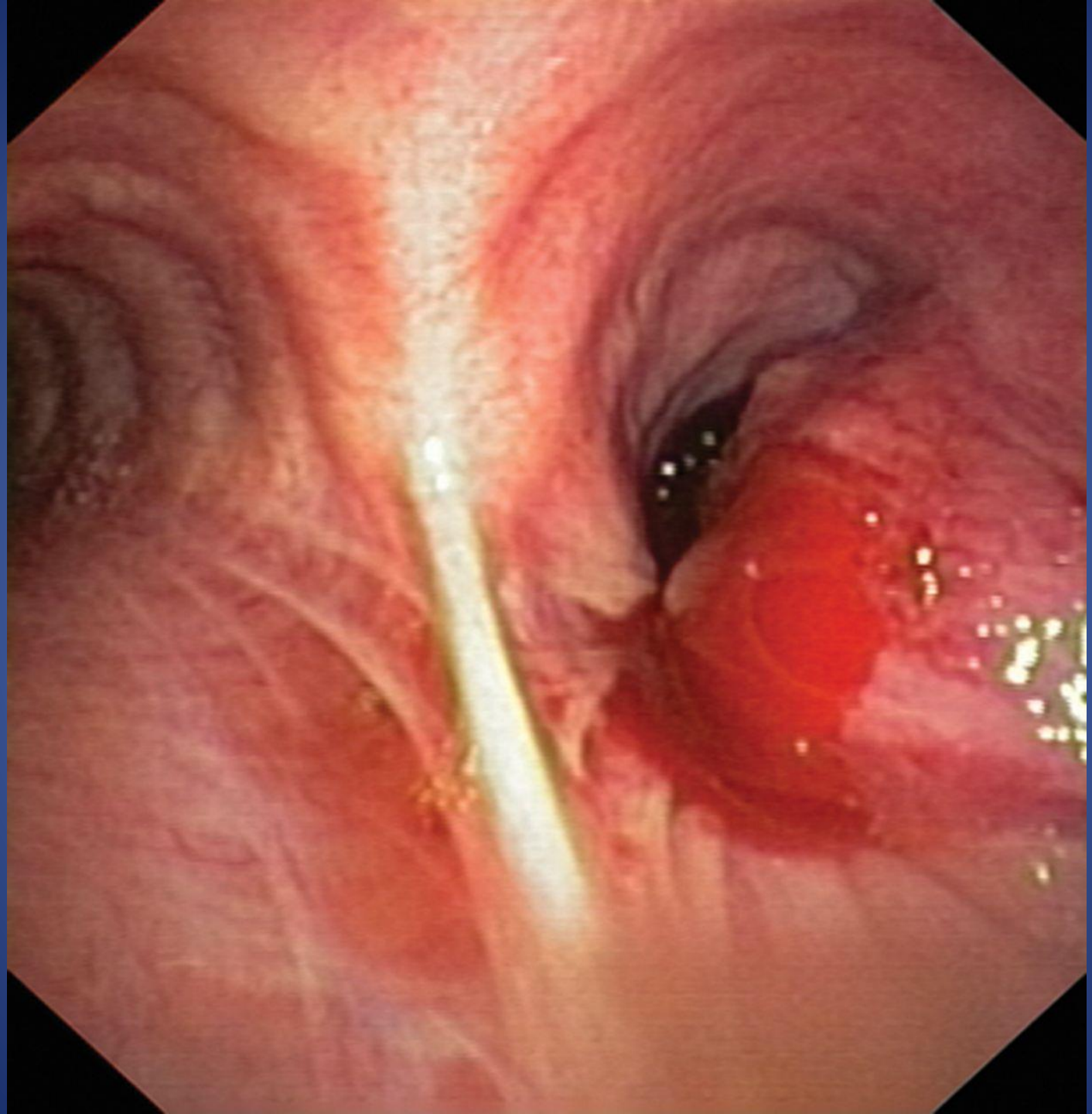

J.R-J

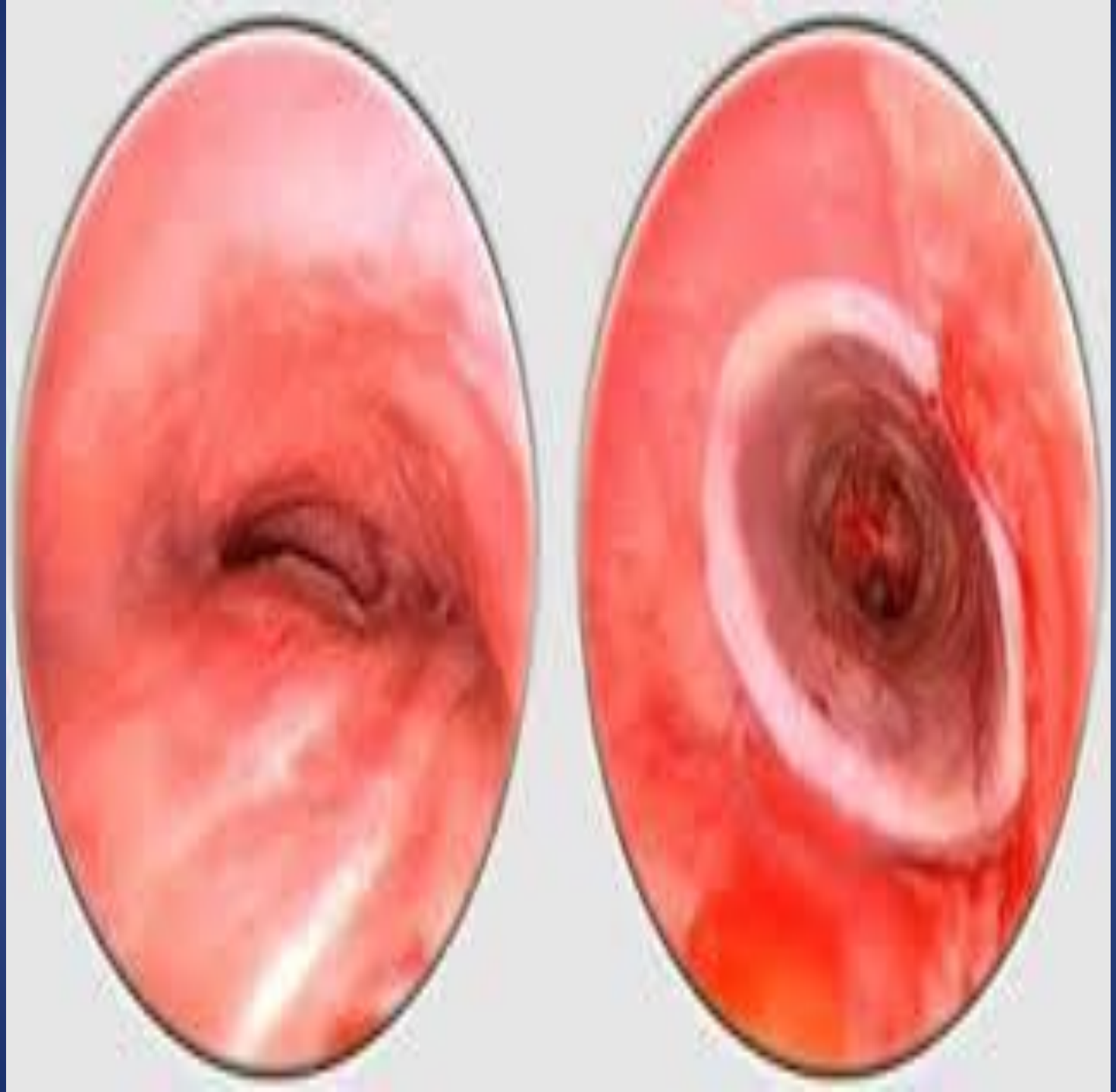
Thoracocentesis



Closed pleural biopsy

Rigid bronchoscopy





Ct guided biopsy

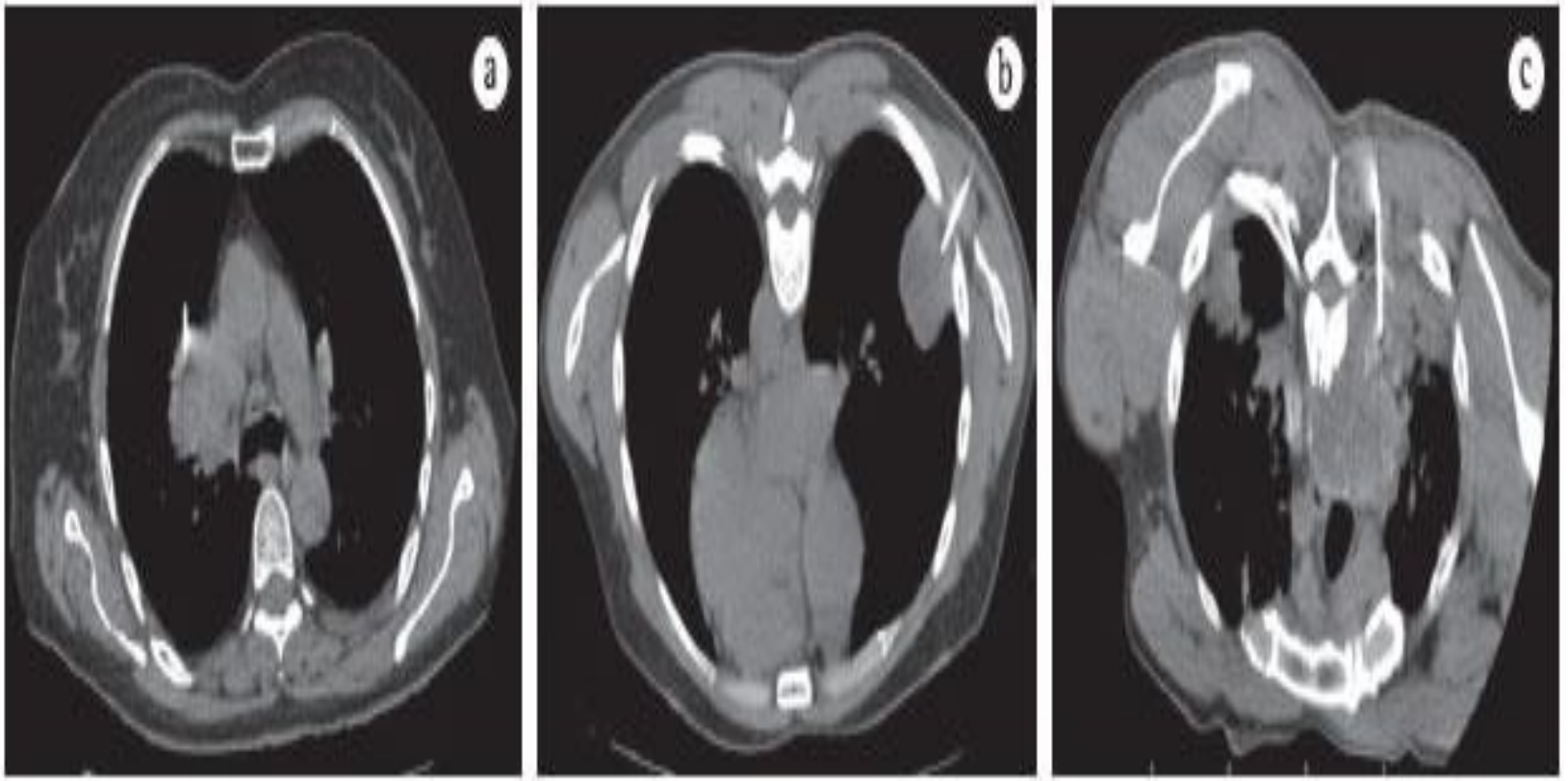
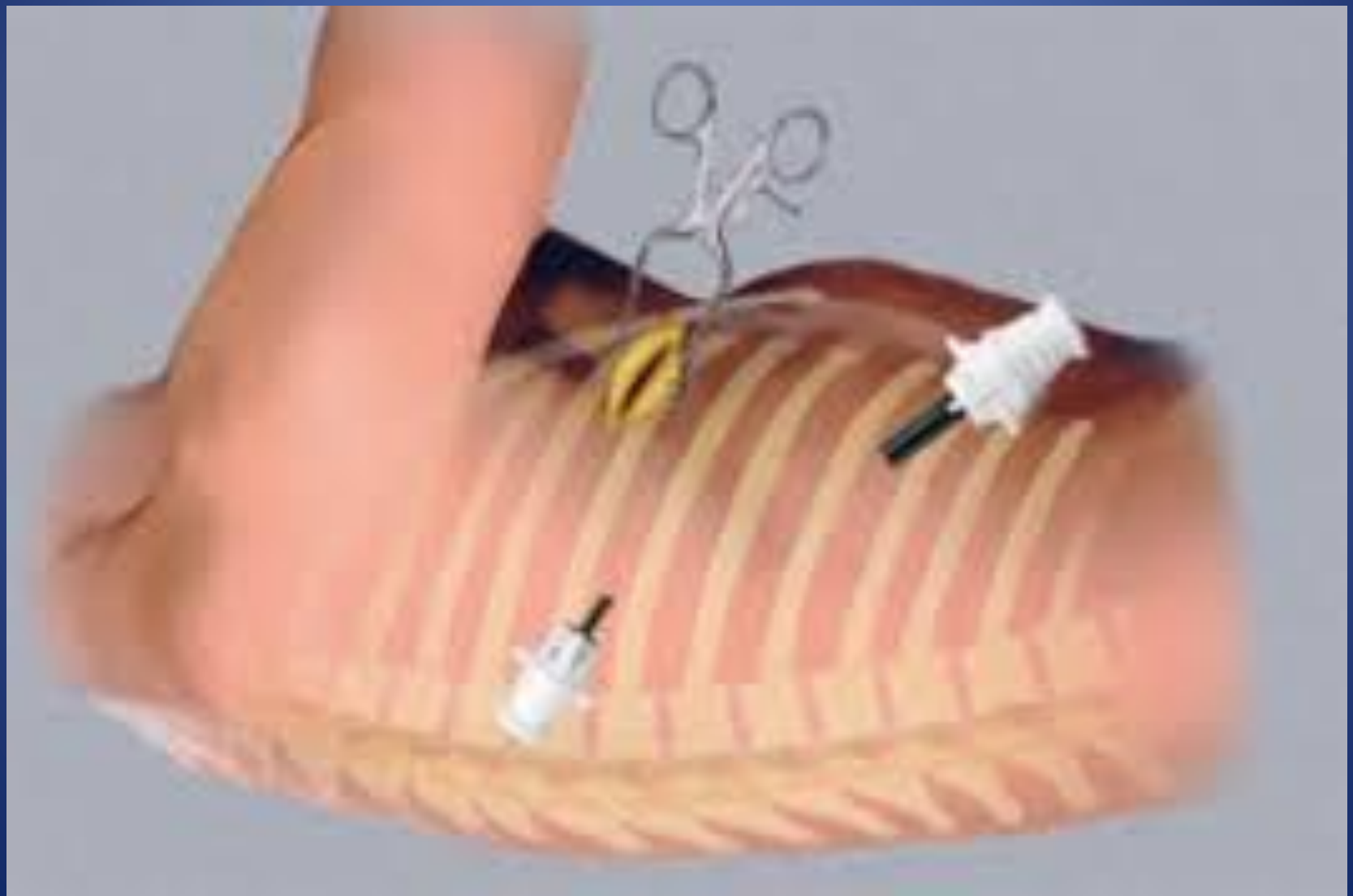
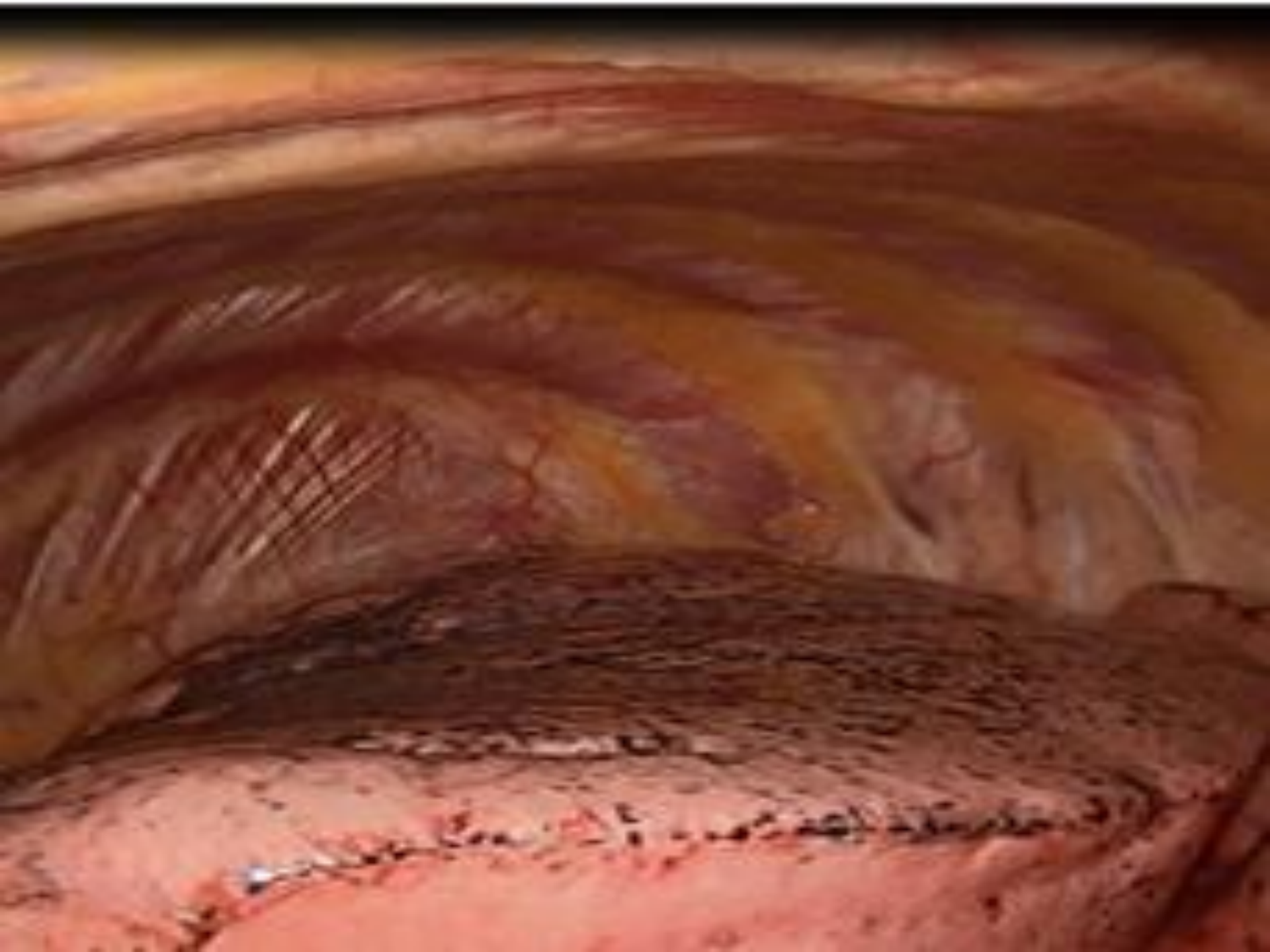


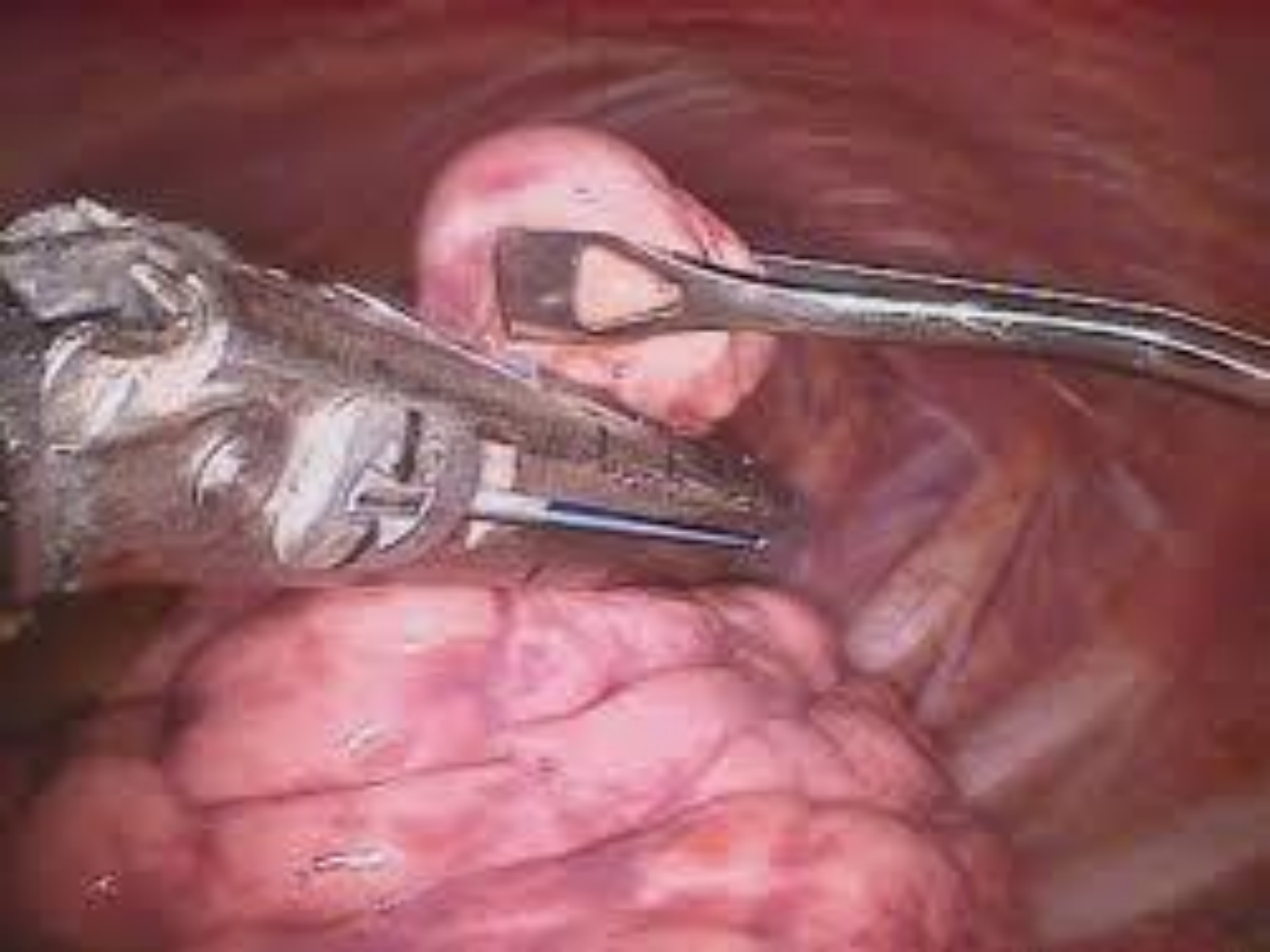
Figure 2 - CT images of patients with diagnoses of benign lesions, as established by biopsy: chondroid hamartoma (2a); pulmonary cryptococcosis with positive results on direct mycological examination (2b); and pulmonary tuberculosis with positive culture (2c).

Ct guided biopsy

VATS







Questions?