



Radiological anatomy of the cardiorespiratory

Objectives

- Recognize the different modalities utilized in imaging the chest & cardiovascular system.
- Recognize the basic technical factors affecting image quality.
- Recognize the radiological anatomy of chest and cardiovascular system.

Done By

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Color Coding

Important | Notes | Extra

[Editing](#)
[File](#)

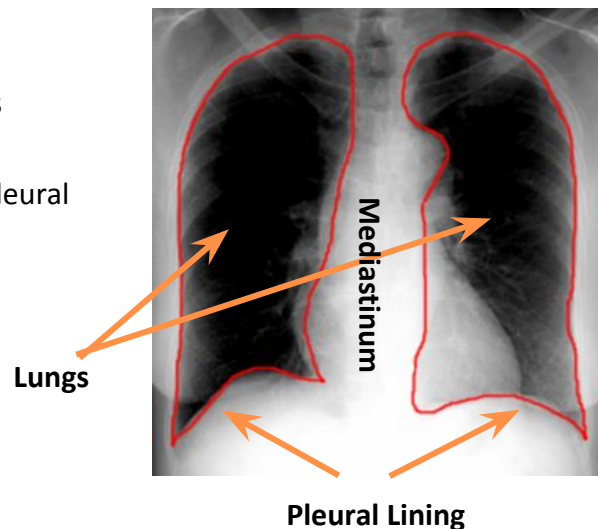


What do we mean by chest?

We mean study of thoracic cage contents and outlines (lung, great vessels, heart, ribs, sub-phrenic areas which beneath diaphragmatic cupola) “this is very important to be seen specially with a patient who came to ER, apply for them CXR and they discover that they have air under diaphragm due to perforated vesicles or bowel ischemia “.So chest radiology not only for chest diseases, but also done before operation and pre employment, because CXR is reflection of health and diseases.

The Lungs

- outline of lungs is pleural lining.
- Pleural lining is not visible when its healthy.
- We will be able to see in case of pleural diseases e.g. pleural effusion.



Basic Chest Exams

- Plain film = **chest x-ray (CXR)** **gold standard**
- **CT for chest and mediastinum** (with IV contrast)
- **CT for lung parenchyma HRCT “high resolution CT”** with no contrast
- **MRI** used rarely ex. Cardiac assessment and mediastinal masses
- **Angiograms** rare

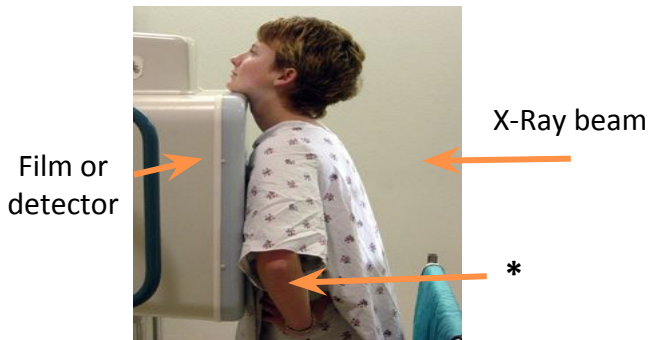
Basic Chest Exams for the heart

- Plain film = **chest x-ray (CXR)**.
- CT for heart and mediastinum.
- Angiograms.
- MRI.
- Ultrasound (echocardiogram).
- Isotopic scanning (A radionuclide **scan** (also known as a radioisotope **scan**) is an imaging technique used to visualise parts of the body by injecting a small dose of a radioactive chemical into the body).

Basic CXR Chest X-Ray

1. PA View:

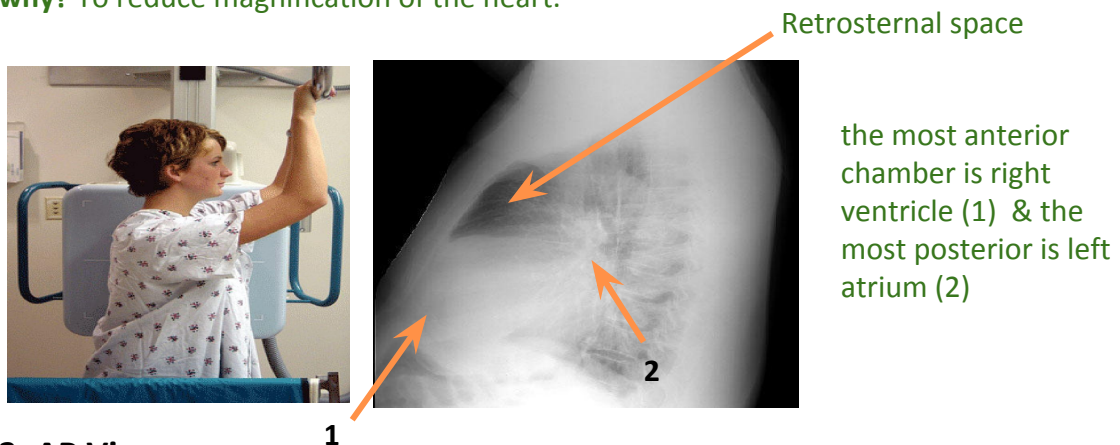
- Posterior anterior.
- Basic X-ray.
- Done when the patient's body is erect.



It should be 6 feet away from the patient to reduce photons diversions and false magnification.
 * We ask the patient to move her arms or hug the machine to move the scapula away.

2. Lateral View:

The left side of the body should be always against the device
why? To reduce magnification of the heart.

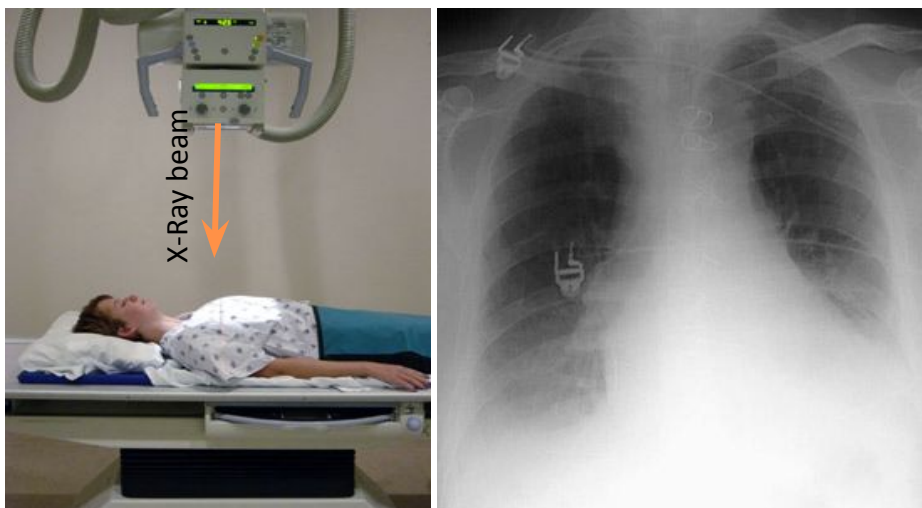


Retrosternal space

the most anterior chamber is right ventricle (1) & the most posterior is left atrium (2)


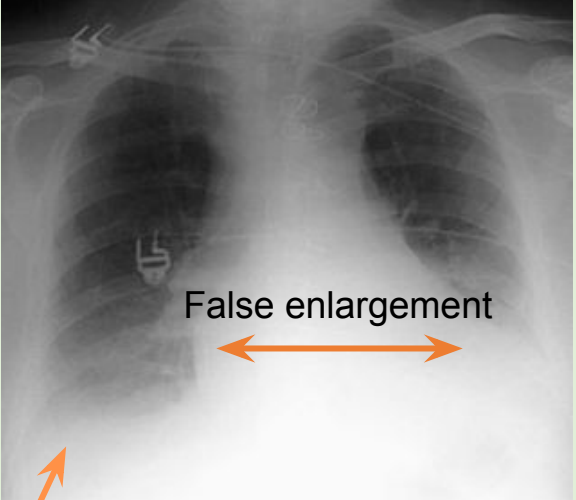
3. AP View:

- Anterior Posterior.
- Patients who can't stand erect. Eg, paralyzed, in ICU.



- Less quality than PA.
- Higher magnification because of close range '1m'.
- Gives false enlargement of the heart.

Anteriorposterior AP VS Posterioranterior PA

PA	AP
Heart outline is well defined and normal sized	False enlargement of the heart.
Costo-phrenic angle is visible and clear.	Costo-phrenic angle is not clear.
Ribs and clavicle are clearer. clavicles are V-shaped	Ribs and clavicles are not as clear as PA clavicles are straight
Patient can take full inspiration because gravity pull bowel down as the patient standing (allowing us to see more of the lung field)	<ul style="list-style-type: none"> •Patient is usually bed ridden so he can't take full inspiration •because bowl can't retract down by the gravity as the supine position (that will shorten the lung field)
Scapula is seen in periphery of thorax	Scapula are over the lung field
<ul style="list-style-type: none"> •Commonly used in clinical practice (standard) •Diaphragmatic cupola is clear and will defined 	Pleural effusion could be missed <ul style="list-style-type: none"> - lungs are blurry because it takes more time to take the picture and the lungs are moving
	

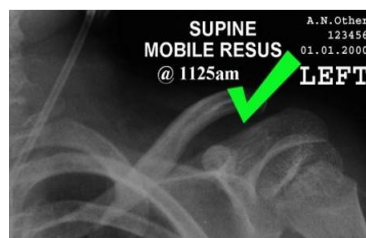
Costo-phrenic angle is not clear

Patient Data

The most important thing in patient's image is the details: **name, file number even radiation factors and time**

Also is it Left or Right very important

*All these done by the machine now.



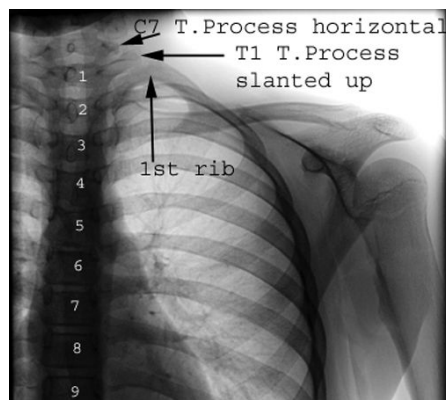
Technical Factors

Sometimes, technical issues can simulate pathology.

- Depth of inspiration.
- Visualization of pathology depends on contrast provided by air in the lungs.
- Count ribs!
- Make sure that Patient is not rotated.



[How to count chest ribs?](#)



An extra image to help you identify the 1st rib

Inspiration

- This greatly helps the radiologist to determine if there are **intrapulmonary abnormalities**.
- The diaphragm should be found at about the level of the **8th – 10th** posterior rib or **5th – 6th** anterior rib on good inspiration.

- If the diaphragm lies above the 8th rib it is hypo-inspiratory.
- If the diaphragm lies lower than the 10th rib it is hyper-inspiratory.

The optimal characters of CXR: 2 important things you have to make sure:

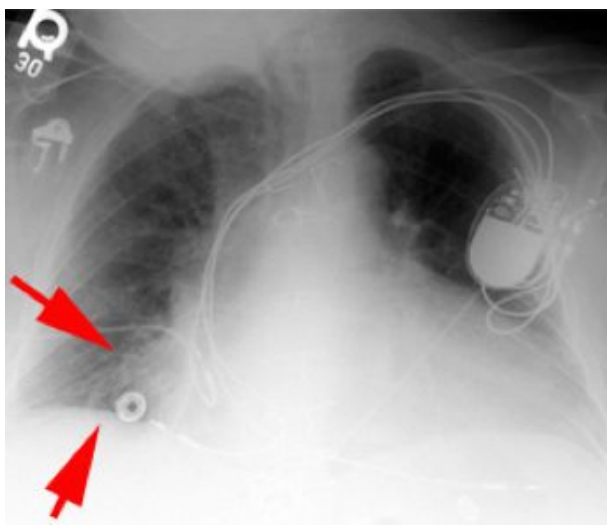
1- patient take full inspiration 2- be centralized (**not rotated**).

How can you know? For full inspiration if you see **the 10th rib posteriorly** it's mean patient took a full inspiration but if you count the ribs and you find **8** that's mean you have to repeat the image.

Inspiration while taking an image has benefits:

1. we can see as much as we can from lung parenchyma
 2. the ribs are well separated so if there is a lesion between the ribs we will see it clearly but if the ribs is too close to each other we will not see it.
- The patient should not be rotated we need to compare both side of the lungs.





Hypo-inspiration

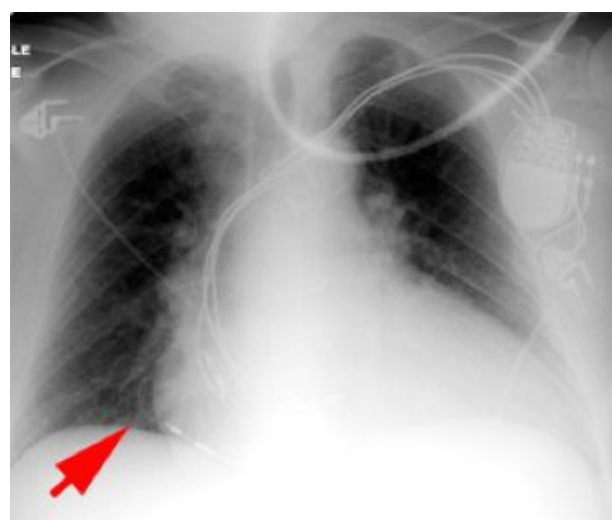
Is this a lesion or not?

Diaphragmatic cupola is high! It makes me think that there is lung collapse!

This patient in ICU has pacemaker. "AP view"
If they asked you is this image good? Or need to repeat it?

The quality of the image is not good but we have something "arrow" makes you think it's a lesion. Is it a lesion or not? Still we don't know.

- diaphragmatic cupola is high which means patient didn't take full inspiration.



Inspiration

After taking full inspiration, there is no lesion. The Diaphragmatic cupola descent.

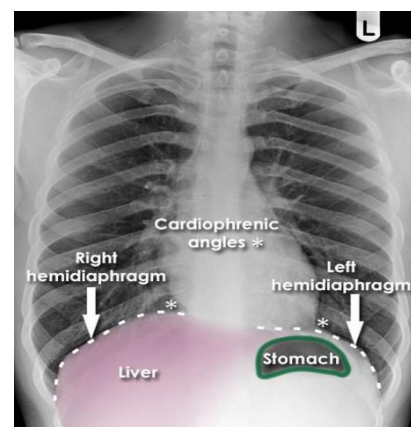
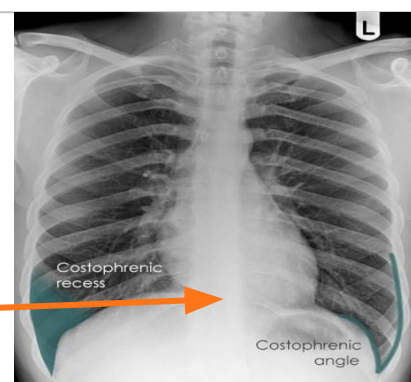
We asked them to repeat the film with more inspiration. So you can see diaphragmatic cupola is clear and the thing which we thought is lesion is not in the image anymore so this a good image to report.

If this not a lesion what is it?

Diaphragmatic cupola when it's high > liver will be high also > this area sub perfused "blood stagnant" That's why they ask patient to take deep inspiration > so lung stretched and diaphragmatic cupola goes down.

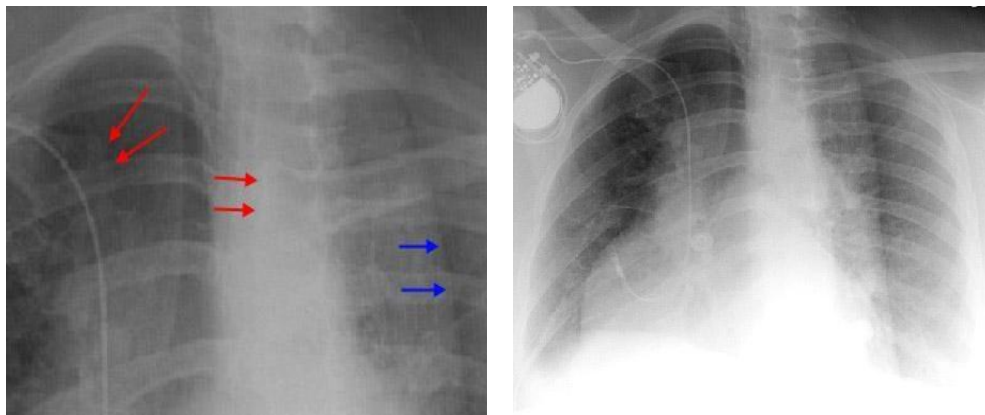
Normally

- Right hemi-diaphragm is slightly higher than the left.
- The liver is located immediately inferior to the diaphragm on the right.
- Silhouette -shadow-is why we can't see the central border of the diaphragm.
- The stomach bubble can be seen below the left hemidiaphragm.
- If you look closely you can see lung markings below the diaphragm on both sides.
- Medially the hemi-diaphragms form an angle with the heart: the cardio-phrenic angles (asterisks).
- On both sides the contour of the hemi-diaphragm should be seen passing medially as far as the spine.

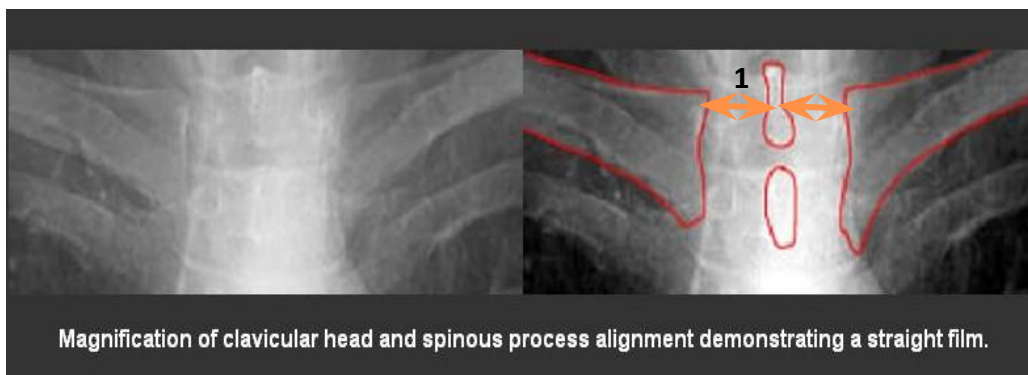


Rotation

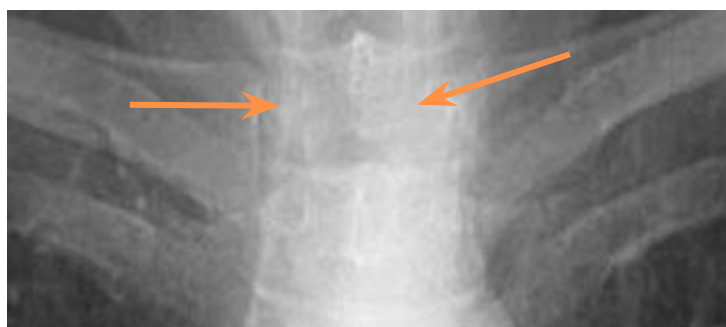
- The technologists: to x-ray patient flat against the cassette.
- If there is **rotation** the Mediastinum may look very unusual.
- Rotation: observing the medial clavicular heads whether they are equal distance from the spinous process of thoracic vertebrae.



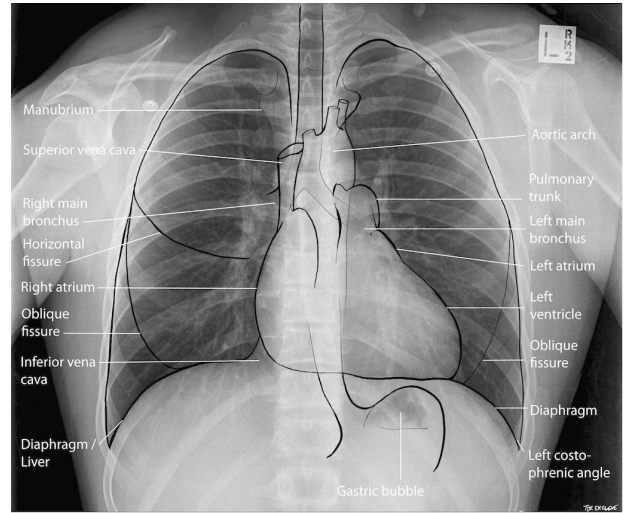
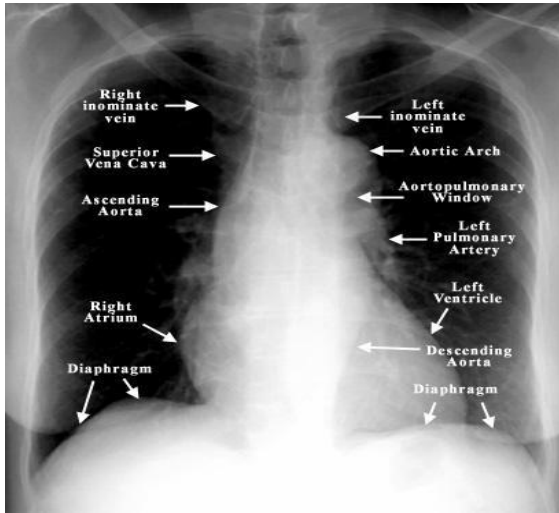
- In the upper rotated film skin folds can be mistaken for a tension pneumothorax (**blue arrows**). Notice the skewed positioning of the heads of the clavicles (**red arrows**) and the spinous processes.



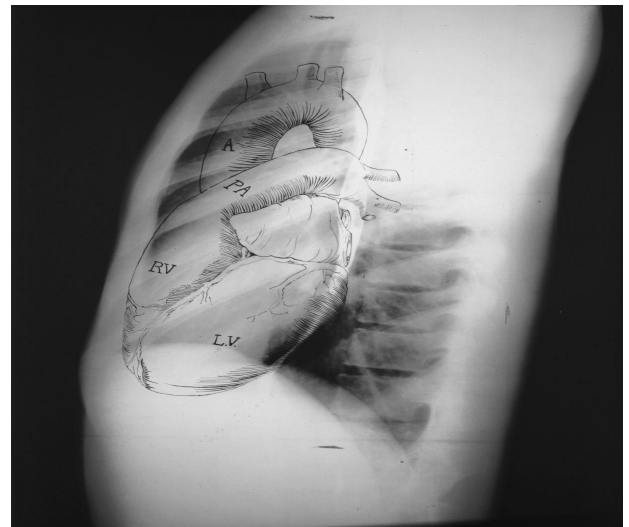
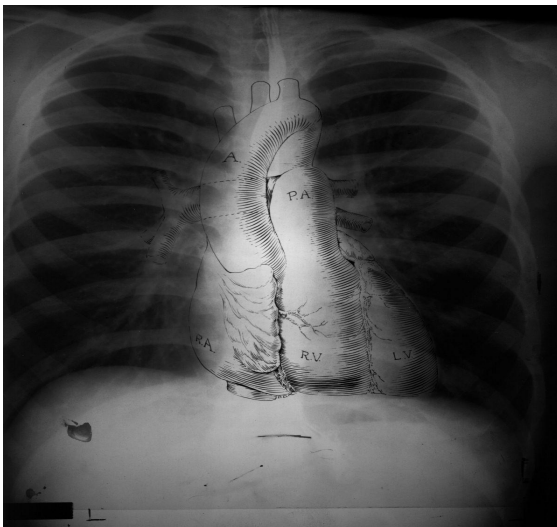
- (1) Notice that the distance between the medial head of the clavicle and the spinous process is equal, so there is no rotation. If there is any variation in the distance between the two sides, it means there is rotation.



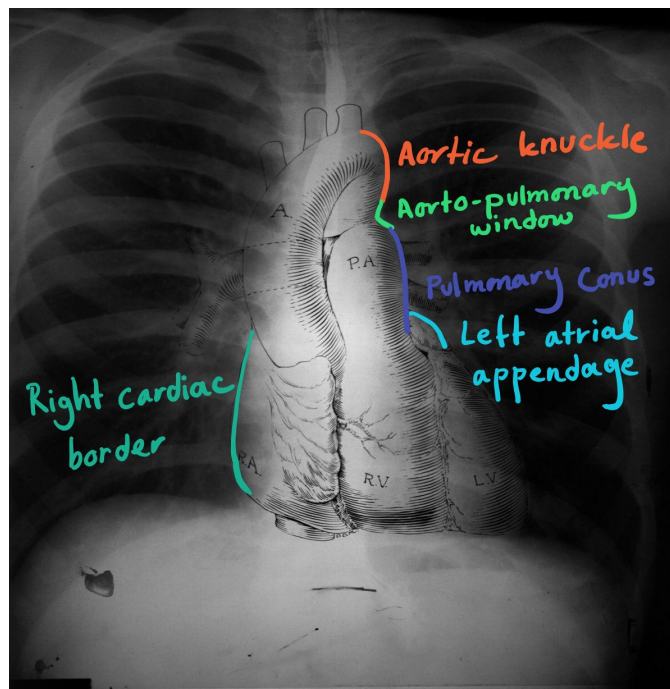
Anatomy on Normal Chest X-Ray



PA VIEW ANATOMY Extra



Heart borders and chambers of the heart on PA and lateral views.



Extra

Penetration

- Penetration is the degree to which X-rays have passed through the body.
- The energy of x-ray photon if they are weak or good energy.
- If you have a film over penetration soft tissue will be dark like air.
- If you have film under penetration the soft tissue will be white like bones.

So you want something in between!

1. The way to asses that by looking at dorsal spine behind the heart if you can see it and you can see the shadow of details, desk spaces, the contour. It means that we have good penetration.
2. If you can't see it, it is under penetration.
3. If you can see super details of the dorsal spine and tubercle, It is over penetration.

Over penetration



Extra

Under penetration



Extra

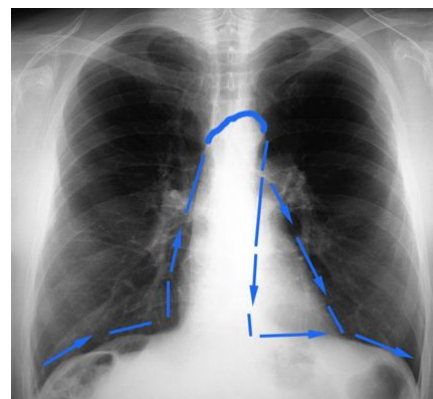
Silhouette Sign

If two objects of the same radiographic density touch each other, the edge or margin between them disappears and it will be impossible to tell where one object begins and the other ends.

- We usually use it to localize diseases.

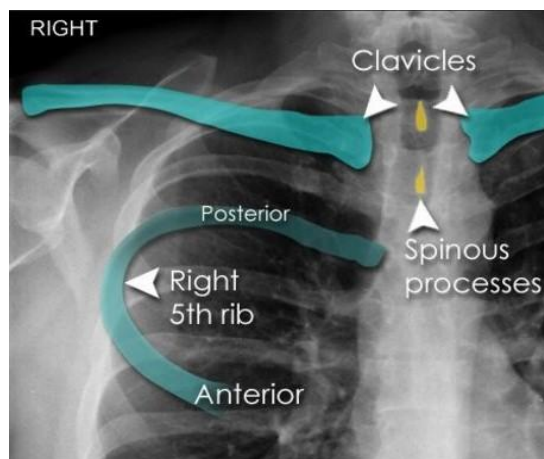
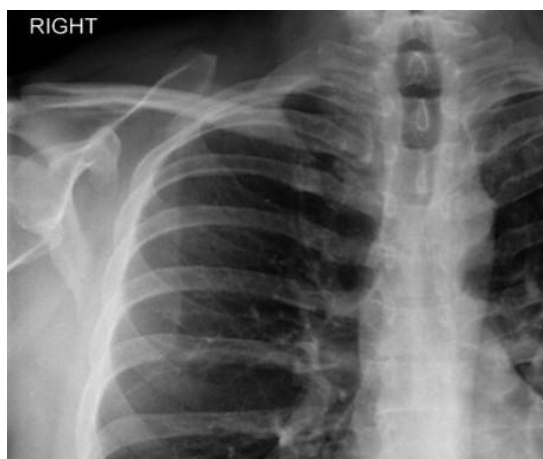
Why the diaphragm is not continuous all the way to the other side?

Because heart and diaphragm have similar density they silhouette each other.



See Section on the
Silhouette Sign

Ribs

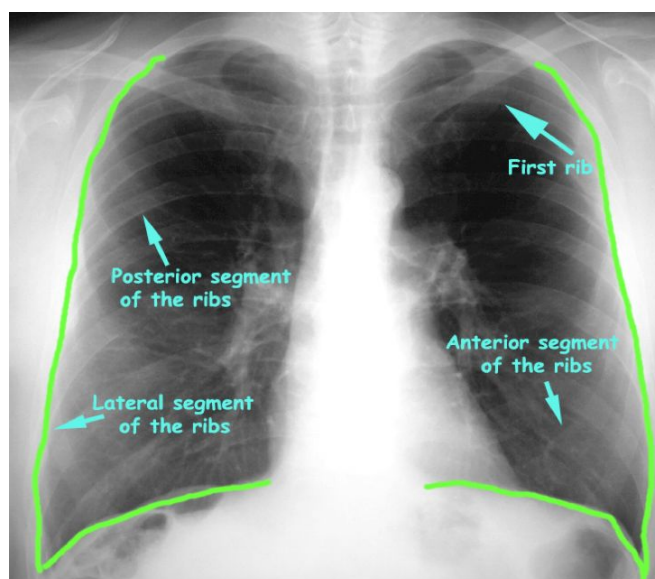
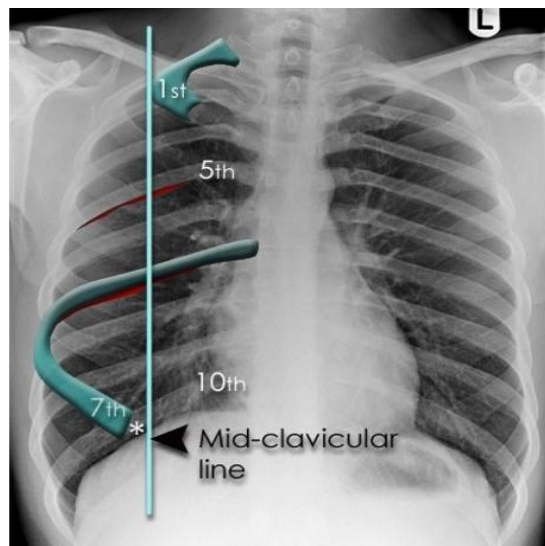


How to count the ribs ?

The first rib in the x-ray is rib number 1, how can you know is it the 1st ?

Cervical spine doesn't have ribs, it starts from thoracic region of the spine.

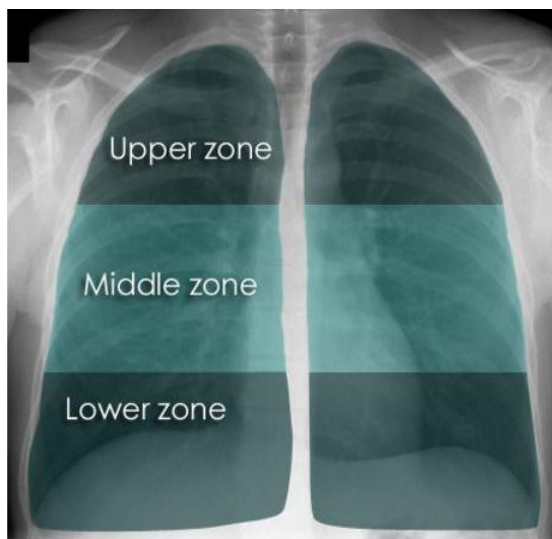
Notice that the posterior ribs are more obvious than the anterior.



For Diagnostic reasons lungs fields are divided:

- 1- By Zones. usually in x-rays
- 2- By Lobes. usually in CT

1- By Zones



Upper zone to the aortic knob.

Middle zone below the hilum.

Lower zone reaches below the diaphragm.

- Each zone is **compared** with its **opposite side** paying attention to any asymmetry.
- If the lungs appear asymmetrical, it should be determined if this can be explained by asymmetry of **normal structures, technical factors such as rotation, or lung pathology**.
- If there is genuine asymmetry, decide which side is abnormal. Often a dense (whiter) area is abnormal, but some diseases cause reduced density (blackier). If there is an area that is different from the surrounding ipsilateral lung, then this is likely to be the abnormal area.
- You should also be aware that some diseases result in **bilateral** lung abnormalities, making comparison of left with right difficult. In these cases it is still important to assess each zone in turn, to avoid missing subtle abnormalities on the background of abnormal lung.
- **Lung zones:**

Dividing the lungs into zones allows more careful attention to be paid to each smaller area. If this is not done it is easy to ignore important abnormalities.

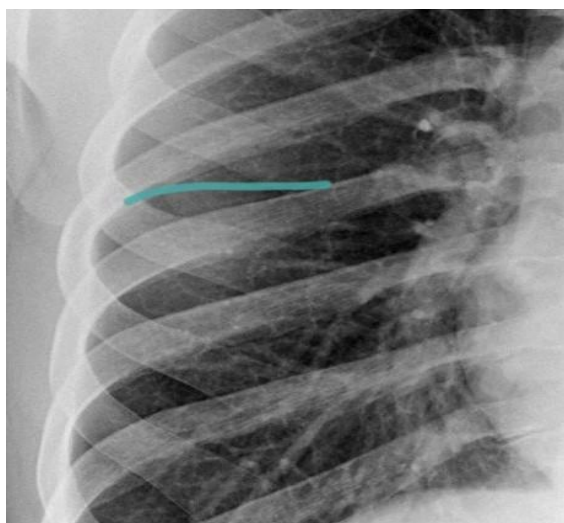
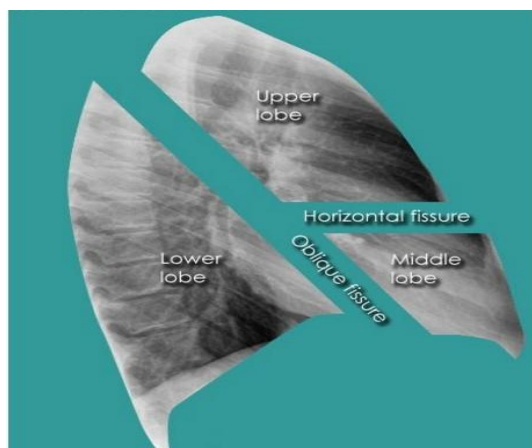
Note that the lower zones reach **below the diaphragm**. This is because the lungs pass behind the dome of the diaphragm into the posterior sulcus of each hemithorax. Normal lung markings can be seen below the well defined edges of the diaphragm.

2- By Lung Lobes (And fissures)

- The surface of the visceral pleura that covers the lung, is continuous with the visceral pleura that covers the fissures.
- The left lung is divided into **two** lobes, upper and lower. These lobes have their own pleural covering and these lie together to form the **oblique (major) fissure**.
- In the right lung there is an **oblique fissure** and a **horizontal fissure**, separating the lung into **three lobes** - upper, middle, and lower. Each lobe again has its own visceral pleural covering.
- **Lateral chest X-rays are helpful in demonstrating the oblique fissures** (also known as the major fissures)

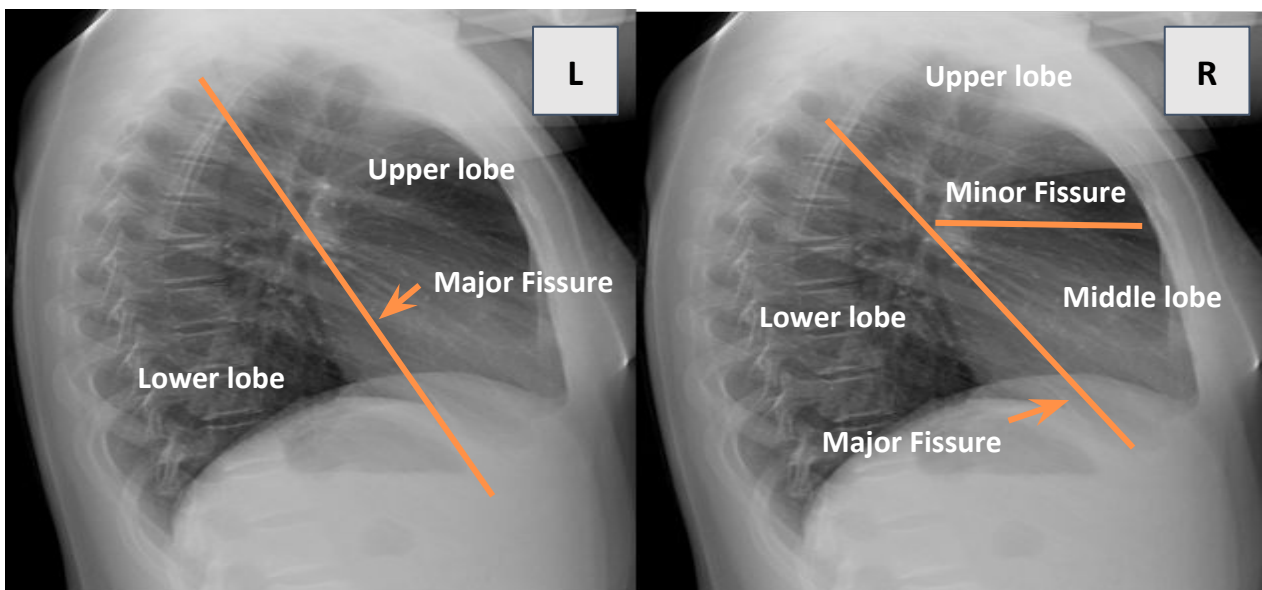
Lobes and fissures:

- This cut-out of a lateral chest X-ray shows the positions of the lobes of the right lung.
- On the left the oblique fissure is in a similar position but there is usually no horizontal fissure, and so there are only two lobes on the left.



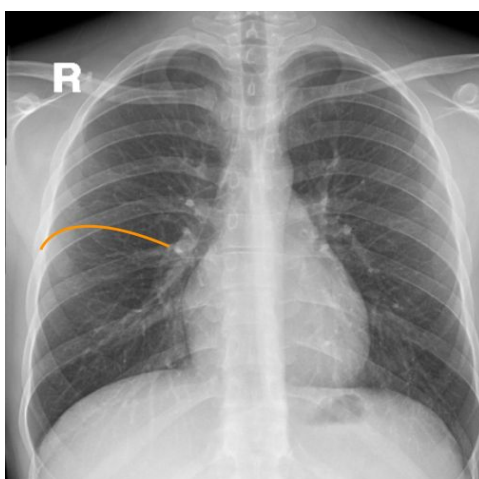
Transverse fissure

Only in the right lung



Left Lung

Right Lung



Transverse fissure

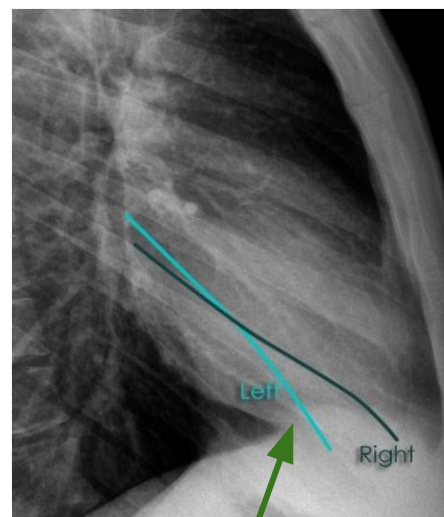
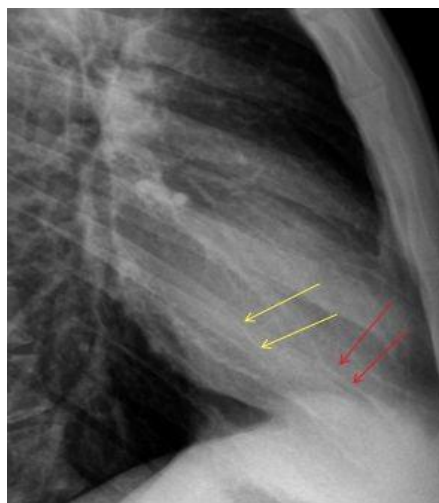


[Identifying lung lobes on CXR](#)

Oblique fissure

You can see both oblique fissures in the lateral view

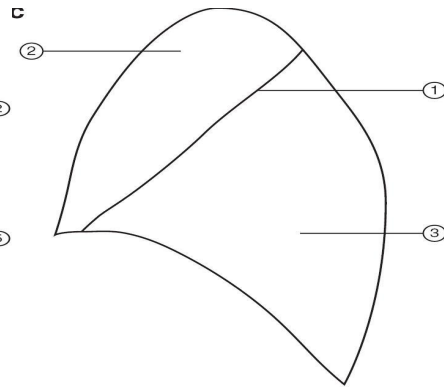
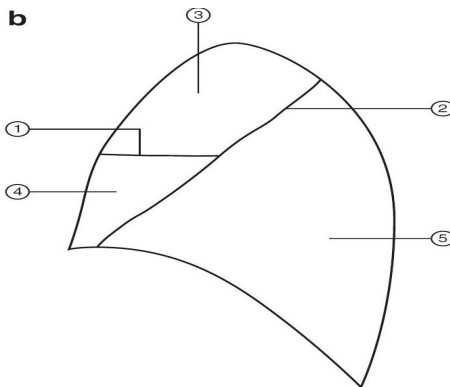
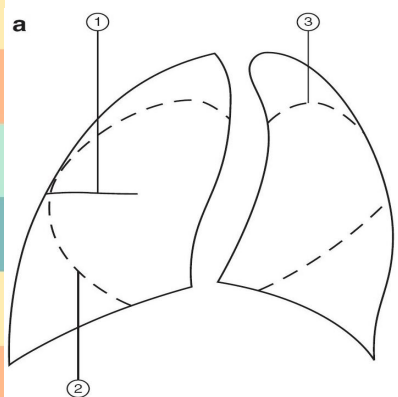
yellow arrow is left oblique fissure, **red arrow** is right oblique fissure



The heart pushes the left oblique fissure posteriorly

Lung Lobes And fissures (cont.)

The **right** lung has **three** lobes, upper, middle and lower. These are separated by the oblique and horizontal fissures. The **left** lung has **two** lobes, upper and lower separated by the oblique fissure.



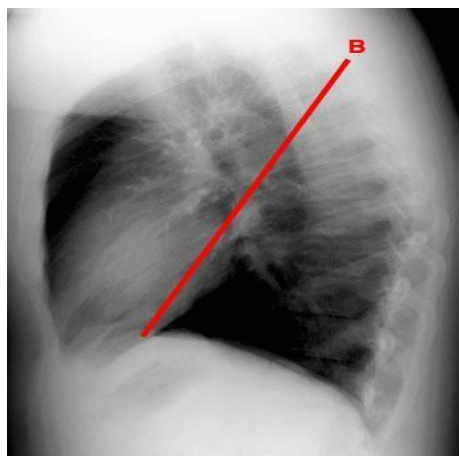
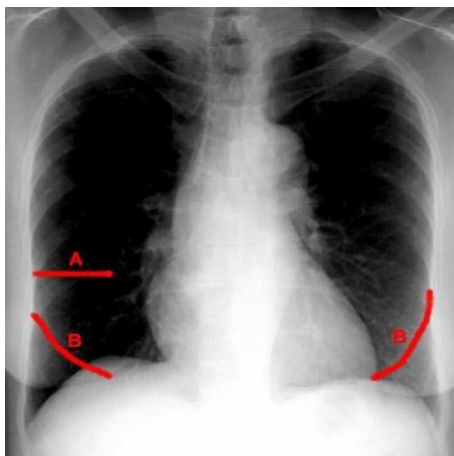
Right lung:

1. Horizontal fissure
2. Right oblique fissure
3. Left oblique fissure.

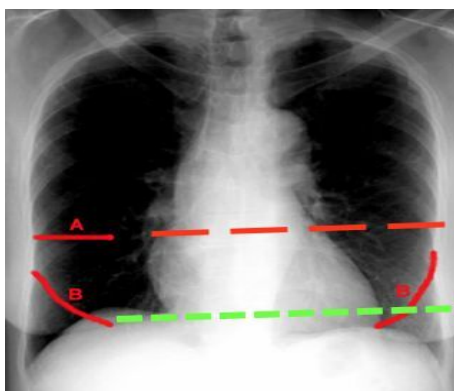
1. Horizontal fissure
2. Right oblique fissure
3. Right upper lobe
4. Right middle lobe
5. Right lower lobe.

Left lung:

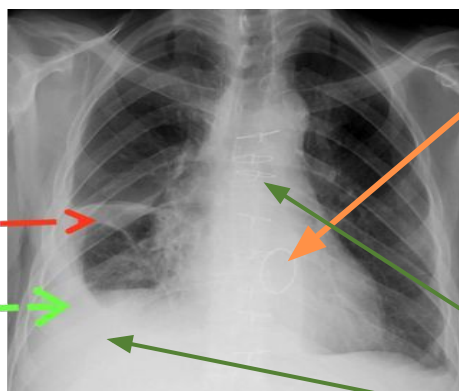
1. **Left oblique fissure**
It is better seen in lateral view.
2. Left upper lobe.
3. Left lower lobe.



A = Horizontal fissure
B = Oblique fissure



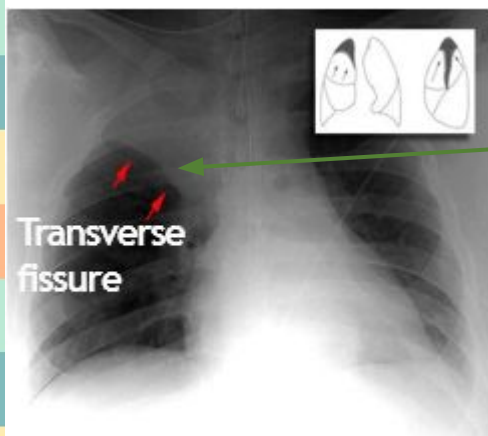
Normal



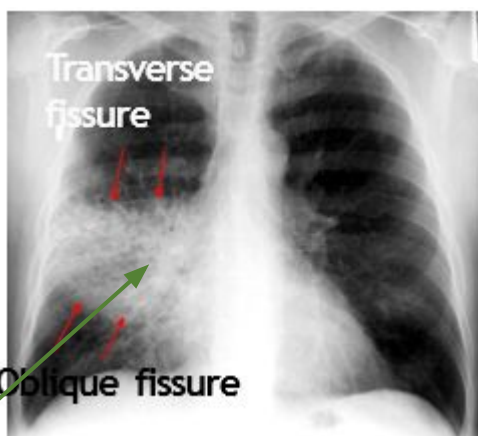
Encysted effusion of the fissure (Interstitial Pleural effusion)

Notice the replaced mitral valve
the patient has : -
- cardiomegaly
- cardiac valve repair.
- sternotomy wires
- costophrenic angle is missing

Lung Fissures in diseased lung (Localizing disease by fissures)



Right middle lobe expanded because the upper lobe collapsed

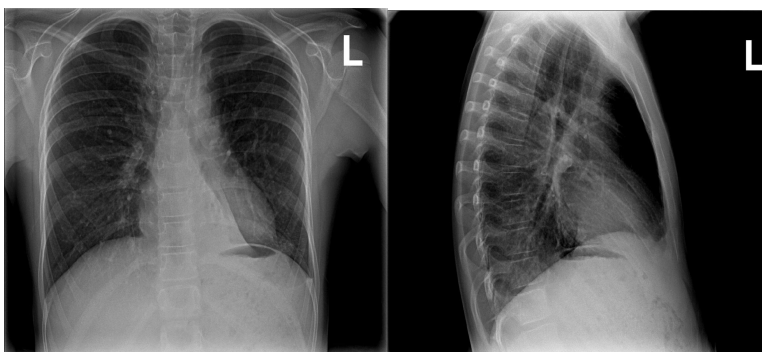


Notice the consolidation in the right middle lobe

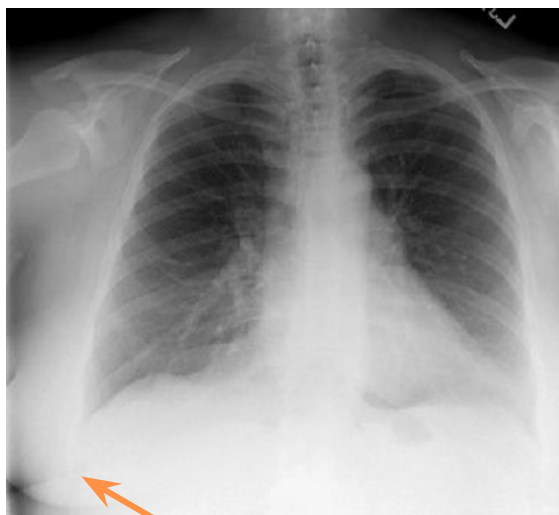
Right middle lobe pneumonia
(Air spaces filled with something other than air)

ATELECTASIS, in lung collapse the fissures move up

Lung collapse reduces the lobe volume so it pulls up the fissures



LLL COLLAPSE
LLL= Left lower lobe

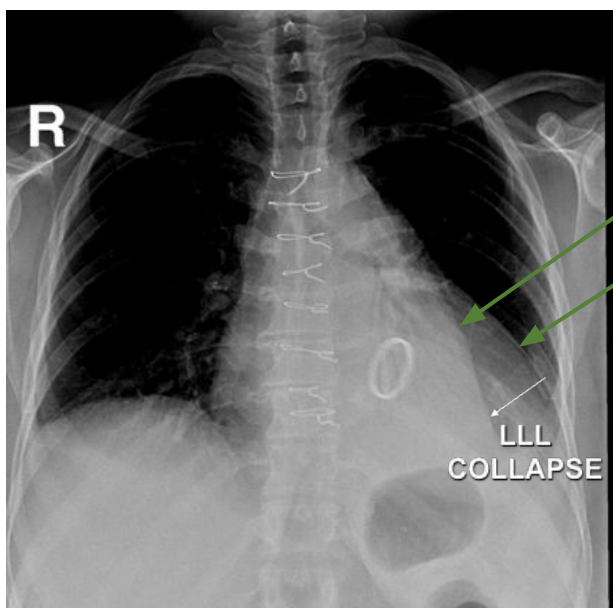


Breast shadow
Normal manifestation among female population



How to read Frontal Chest X-Ray?
Always divide and compare.

Cardiac Valves



MITRAL VALVE REPLACEMENT

The left upper lobe has expanded here

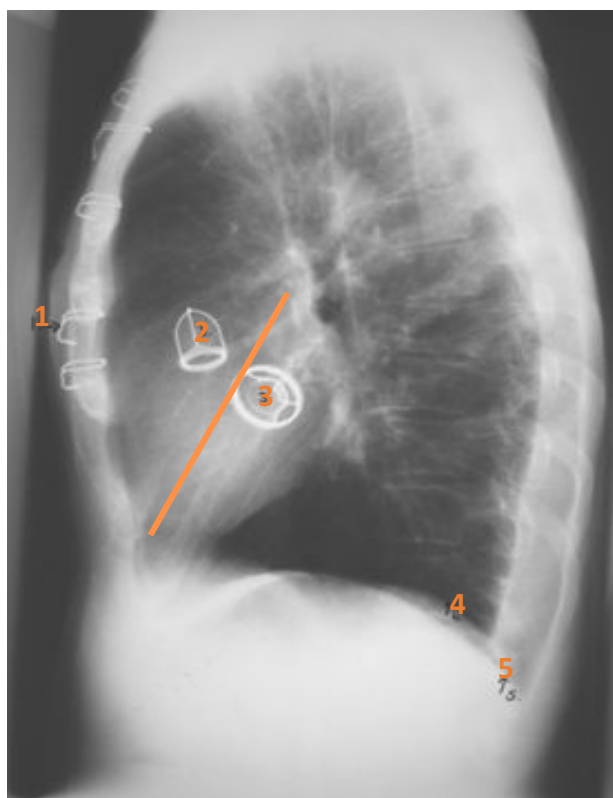
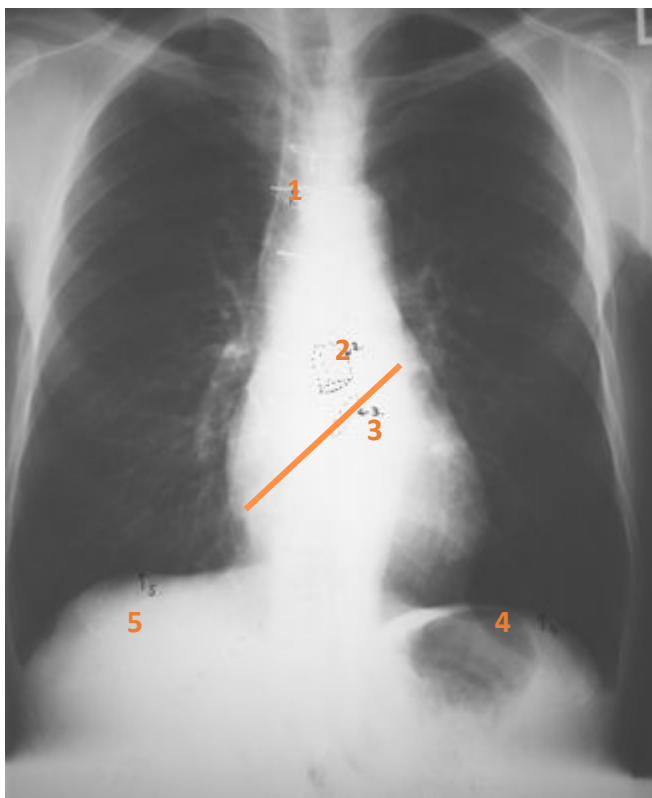
The oblique fissure

The heart border

A Trick used to localize the valves of the heart :
Draw a perpendicular line to the sternum all the way down, it will divide the heart into two structures. And draw another line from right hilum to left hilum.

It will give me four quadrants:

- Right upper-> Aortic valve.
- Left upper-> Pulmonary valve.
- Right lower ->Tricuspid valve.
- Left lower-> Mitral valve.

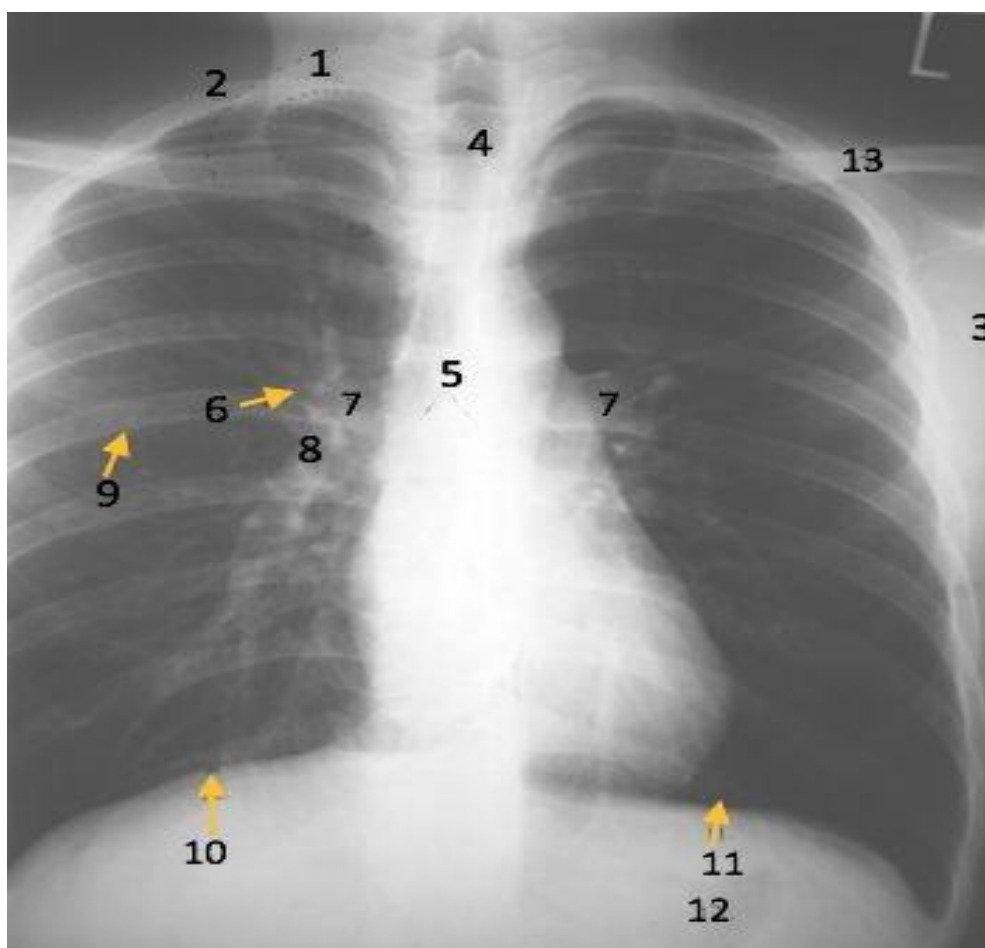


This patient had a malfunctioning mitral valve (between left atrium and left ventricle) and aortic valve (between left ventricle and aorta) and prosthetic valves were inserted (better seen on lateral).

Key:

1. Suture material used for repair of vertical incision through sternum (median sternotomy).
2. Aortic valve prosthesis. 3. Mitral valve prosthesis.
4. Left hemi-diaphragm. 5. Right hemi-diaphragm.

Radiological Anatomy of The Chest

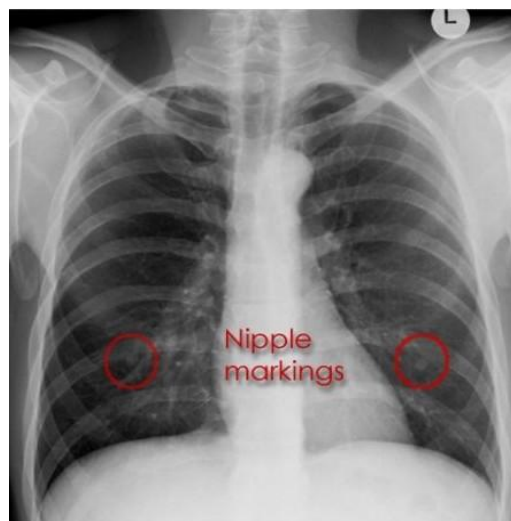


Key:			
1	Right 1 st rib	8	Branch of right main descending pulmonary artery
2	Right 2 nd rib	9	Right minor (horizontal fissure)
3	Scapula	10	Right hemi diaphragm
4	Trachea	11	Left hemi diaphragm
5	Carina	12	Gastric air bubble
6	Bronchus seen end on	13	Left clavicle
7	Bilateral hila (Hilum)		

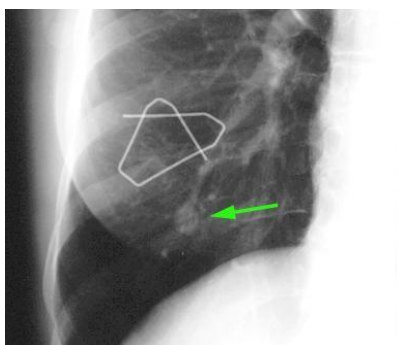
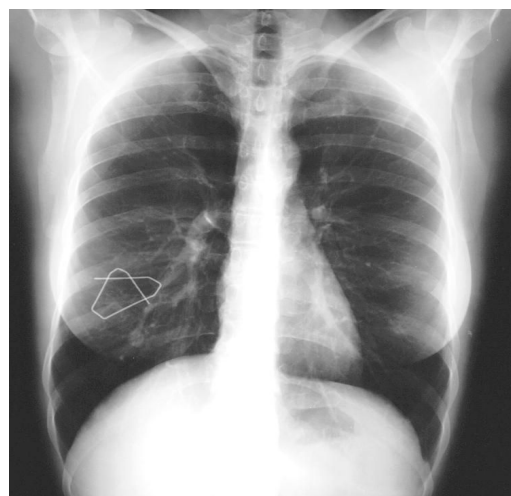
Nipple Shadow



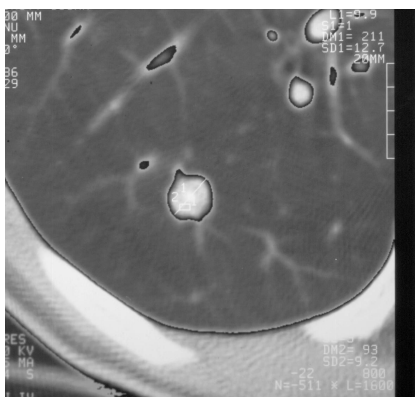
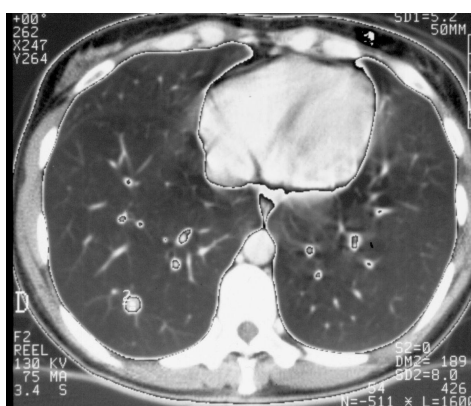
1. Is it nipple shadow or lesion?



2. Put a metal on the nipple of the patient

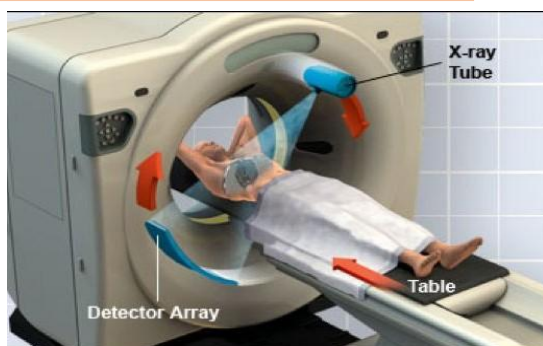


3. It's out of the lined region, so it is a lesion. We need a CT scan for further investigations.



4. CT showed that's it's an Intrapulmonary nodule: **hamartoma** (is a benign (noncancerous) tumorlike malformation made up of an abnormal mixture of cells and tissues found in areas of the body where growth occurs)

Chest CT



- CT machine has x-rays tube as it rotates there is a detector or film rotates at the same time on the opposite side for each movement we will have the exposure then collect them together.
- Some lung lesion needs CT e.g. **cancer and pneumonia** for unknown reason.

Scanning techniques:

1. Standard examination
2. High resolution (HRCT)

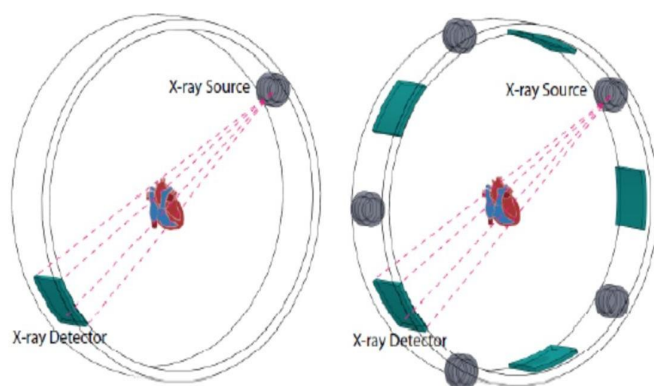
The new one it's different from the old by:

- having many detectors and x-ray tubes so as tube moves around x-ray will hit a detector.
- It moves very fast and take many images then collect them together very fast.

Third generation CT

There are five generations of the CT scanners, 4 & 5 generations are not used any more, while the 3rd generation is the commonly used one. There are many scanning techniques by the 3rd generation scanners, like: Standard and HRCT.

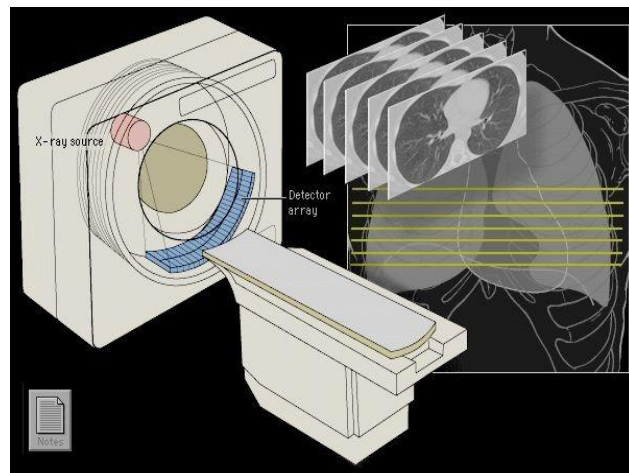
- Arc of detector elements
- Wider fan beam
- Translation of tube and detector
- Faster scan speed
- Third-generation CT scanner. There are a large number of X-ray beams (approximately 500 to 700) in a wide fan configuration. Both the X-ray tube and the detectors rotate.



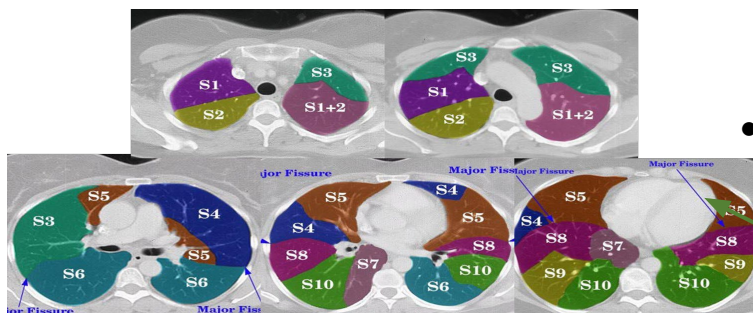
- They developed it more to have something known dual CT "2 tubes of x-ray" to be able to take CT for the heart.
- To see heart and vessels we don't take image while it's contracting, we suppose to take image during relaxation "which is very short duration"
- These tubes take images very fast and has trigger once heart rate slows down take the image immediately.
- Collect these images could reach to thousands they able to see coronary artery and can do assessment to the myocardium.

High Resolution CT Scan

- HRCT uses very thin slices (1mm) to achieve better spatial resolution & precision.
- HRCT is indicated after normal CXR in a symptomatic patient - the setting of high clinical suspicion of disease.
- Advantages:
- High sensitivity for adenopathy, infiltrates, and architectural distortion
- HRCT can identify areas of reversible vs. irreversible lung damage.



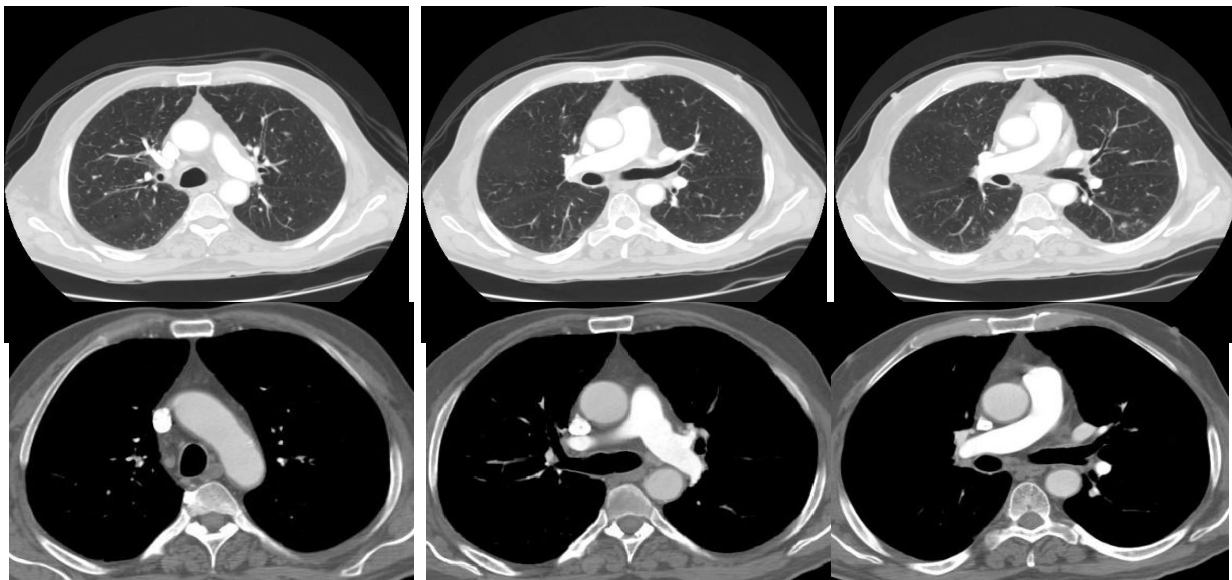
- Thousands of pictures are taken and that will make us able to see the coronary arteries, aorta & the dynamic assessment of the heart and vasculature of the heart
- Taken pictures from different dimensions.



“I don’t expect you to know it”

Radiological Anatomy of the Chest/CT Scan

Lung Window

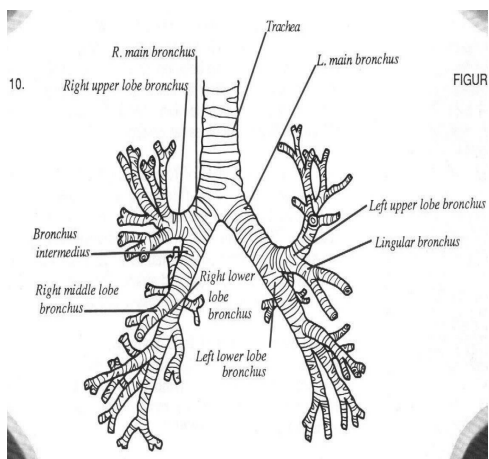


Mediastinal Window

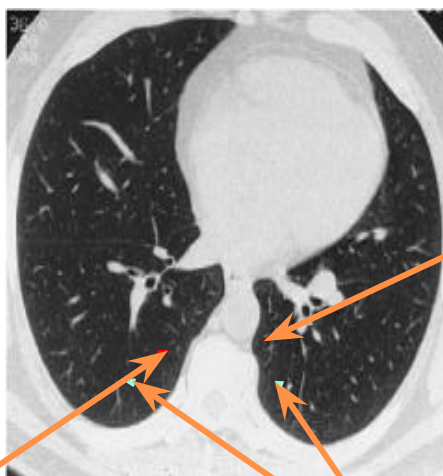
Recall:

- Lung window: is **wide** window to visualize lung parenchymal structures including bronchi, vessels and alveoli.
- Mediastinal window: is **narrow** window to visualize mediastinal structures including major vessels, heart..

Normal Lung Anatomy



Tracheobronchial Tree



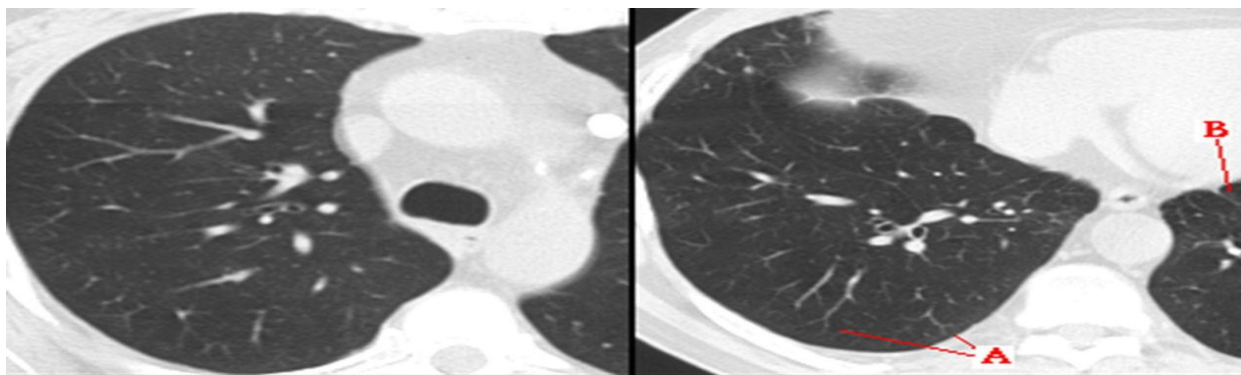
Right inferior pulmonary vein

Normal lung at inferior

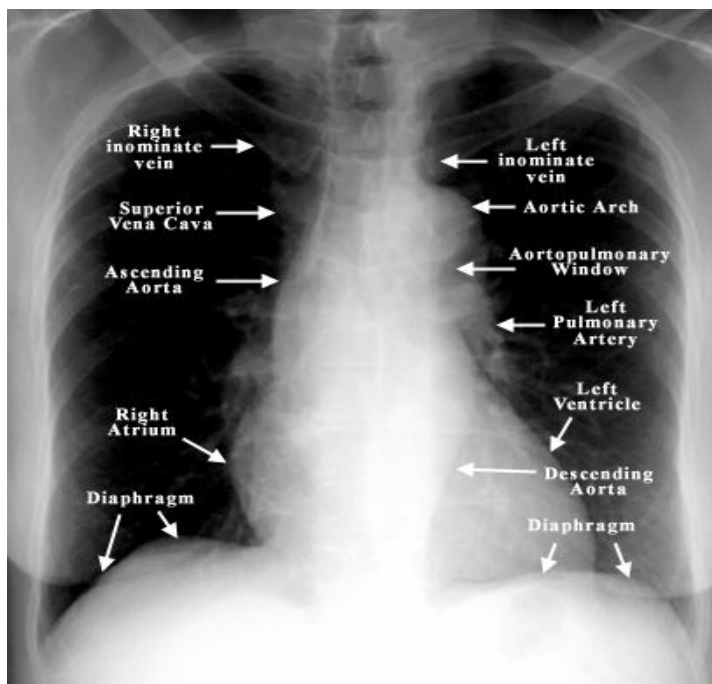
Left inferior pulmonary vein

Lower lobe bronchi

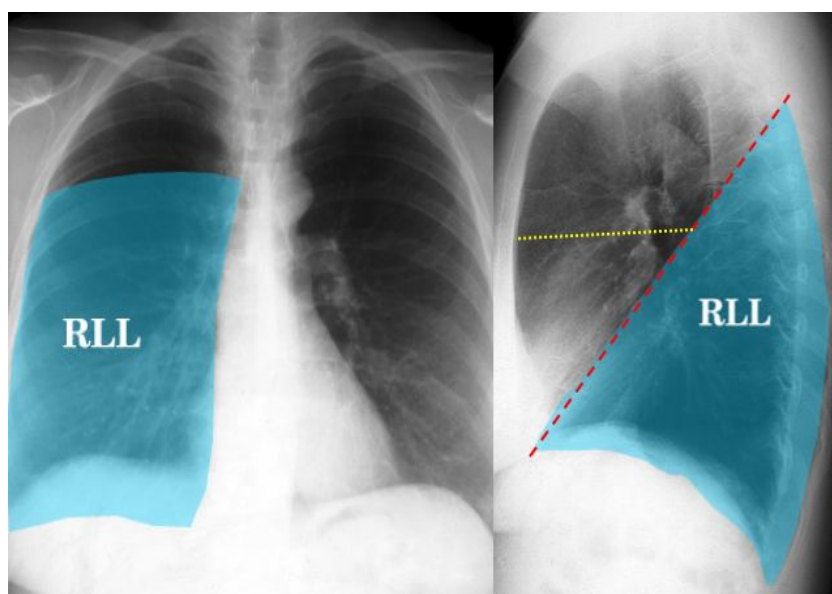
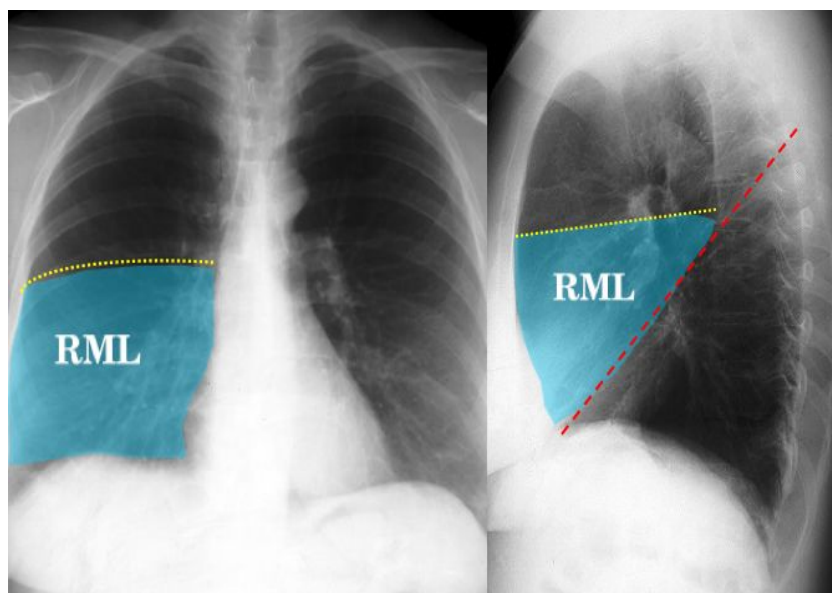
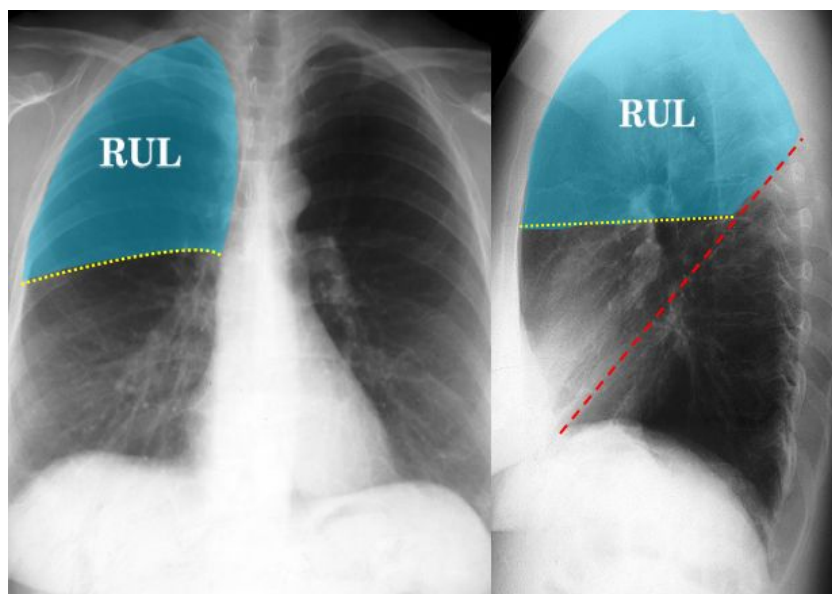
Normal HRCT



Normal upper (left) and lower (right) HRCT scans obtained in the prone position. The center of a pulmonary lobule is defined by the presence of a distal pulmonary artery (A). The faint outline of a distal interlobular septum is noted in the lower lobes (B). A subpleural clear space is normally present in the nondependent lung.



For More Understanding



Summary

Technical Factors : for Chest x-ray

- Inspiration: The diaphragm should be found at about the level of the 8th – 10th posterior rib or 5th – 6th anterior rib on good inspiration.
- Rotation: observing the medial clavicular heads whether they are equal distance from the spinous process of thoracic vertebrae.
- penetration: is the degree to which X-rays have passed through the body .

Anterior Posterior AP VS Posterior Anterior PA

P.A view	A.P view
Heart outlines is well defined and normal sized	False enlargement of the heart
Ribs and clavicles are clearer	Ribs and clavicles are not as clear as P.A
Scapula is seen in periphery of thorax	Scapula are over the lunges filed

For diagnostic reasons lungs divided

1. Zones *usually in x-rays*

- **Upper** zone to the aortic knob.
- **Middle** zone below the hilum.
- **Lower** zone reaches below the diaphragm.

2. Lobes *usually in CT*

- **The right** lung has three lobes, upper, middle and lower. These are separated by the oblique and horizontal fissures.
- **The left** lung has two lobes, upper and lower separated by the oblique fissure.

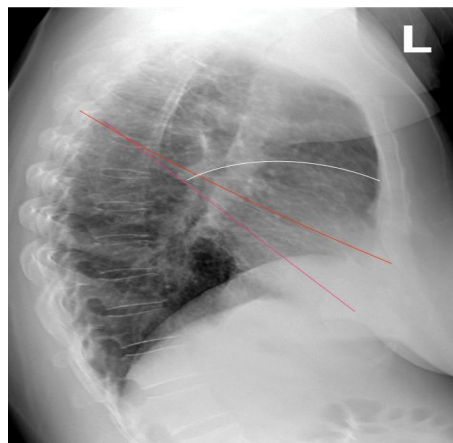
Chest CT Scanning techniques

- Standard examination.
- High resolution (HRCT).

Quiz

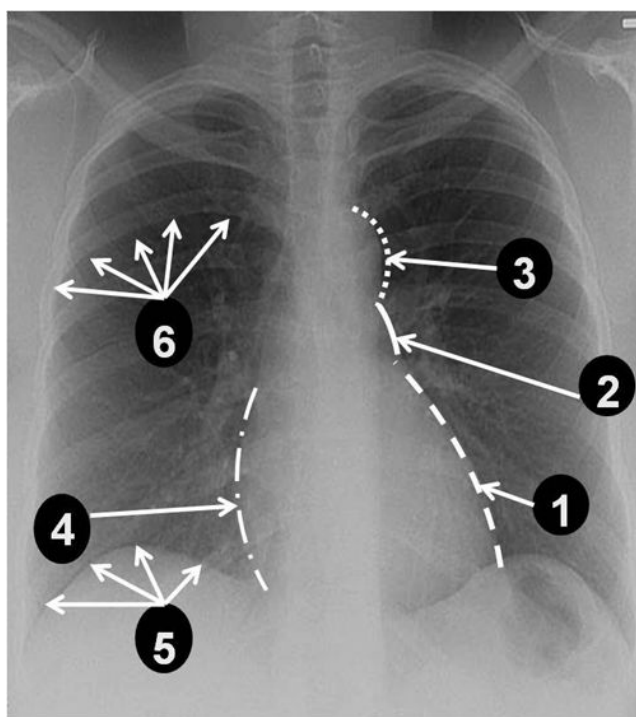
Q1: which of the following is true regarding the anatomical landmark related to this lateral chest X-ray?

- A- The left hemidiaphragm is seen complete from anterior to posterior aspect
- B- The dashed pink line refers to left oblique fissure.
- C- The right oblique fissure is posterior to the left one
- D- Horizontal fissure is not seen

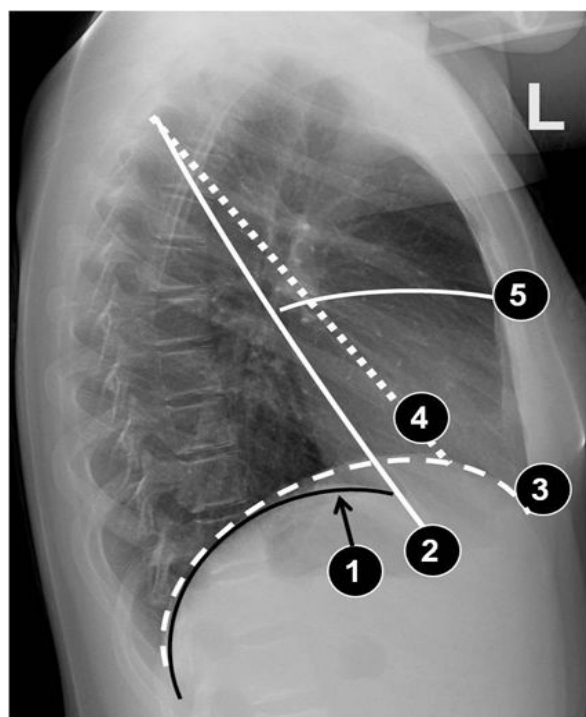


Q2: which of the following is true regarding the anatomical landmark related to this lateral chest X-ray?

- A- The heart touches the the lower third of the sternum
- B- The right and left hemidiaphragm are normally superimposed
- C- The oblique fissure is better seen in the frontal PA view
- D- Retrocardiac area appears normally opaque.



1. Left ventricle
2. Pulmonary trunk
3. Aortic arch
4. Right atrium
5. Right hemidiaphragm
6. Posterior right rib



1. Left hemidiaphragm
2. Left oblique fissure
3. Right hemidiaphragm
4. Right oblique fissure
5. Horizontal fissure

Quiz

Q3: Which of these choices correlates with PA view :

- A- Clavicles are straight.
- B- Scapula are over the lung field.
- C- Images are blurry.
- D- Costo-phrenic angle is visible and clear.

Q4: If the right upper lobe collapsed the right middle lobe will :

- A- Collapse.
- B- Expand.
- C- stays the same.

Q5: The left oblique fissure can be seen in PA view :

- A - True.
- B - false.

Answers:
1. B.
2. A.
3. D.
4. B.
5. B.

WE NEED
YOUR
FEEDBACK

