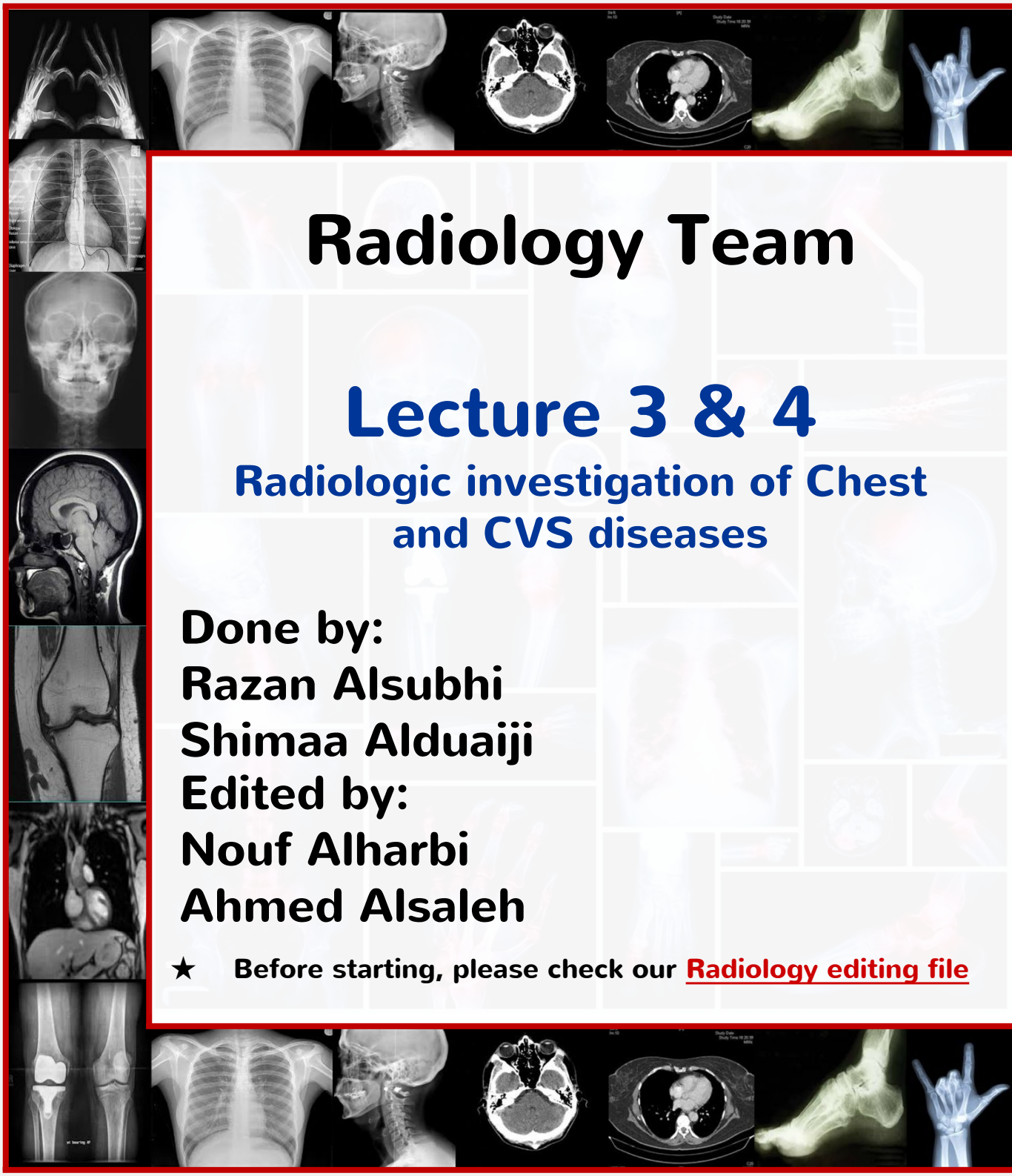


Radiology Team

Lecture 3 & 4

Radiologic investigation of Chest and CVS diseases

Done by:
Razan Alsubhi
Shimaa Alduaiji
Edited by:
Nouf Alharbi
Ahmed Alsaleh

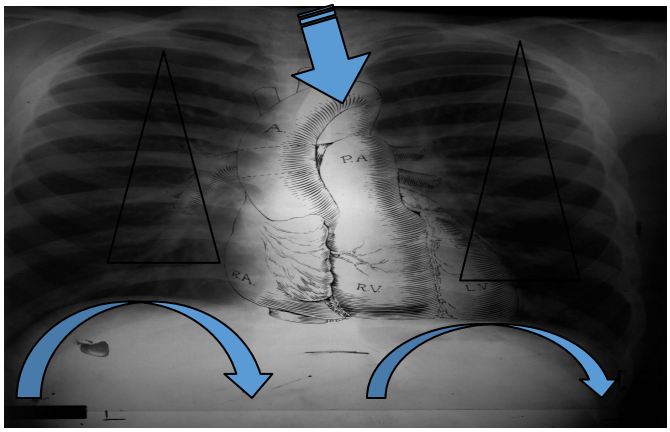
★ **Before starting, please check our Radiology editing file**

Color Index:

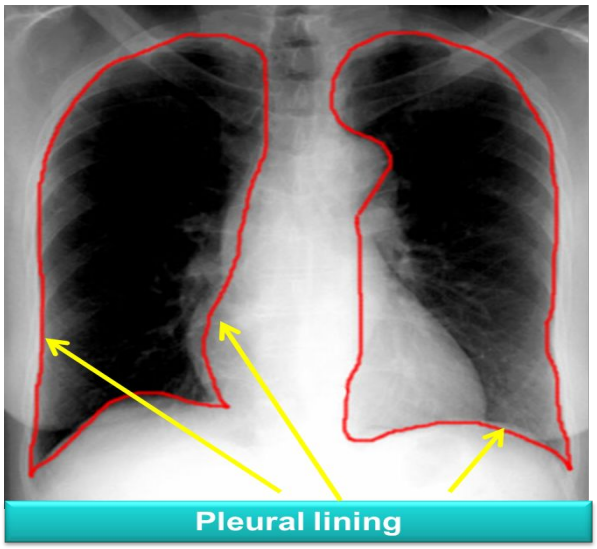
• **Important** • **Slides and Doctor's notes** • **Explanations**

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 copula " this is very important to be seen specially 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 also done before operation, pre employment because CXR is reflection of health and diseases.



- 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

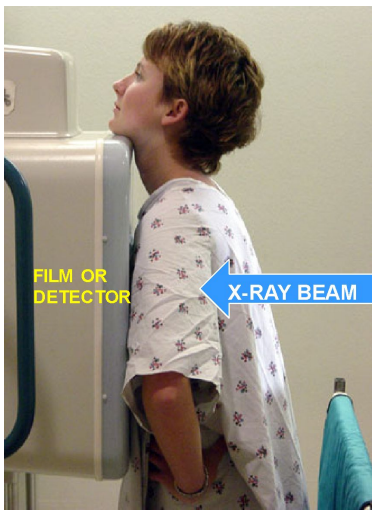
CT for chest and mediastinum with IV contrast

CT for lung parenchyma HRCT "high resolution CT" with no contrast

MRI used rarely ex. Cardiac assessment and mediastinal masses

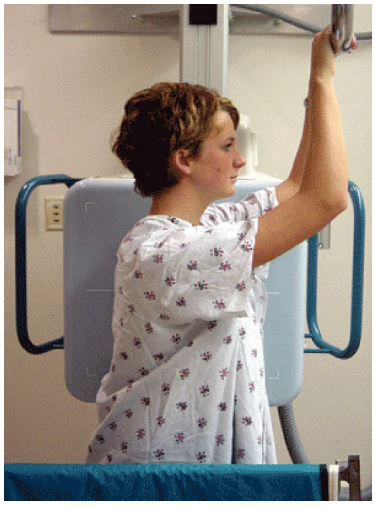
Angiograms rare

Basic CXR

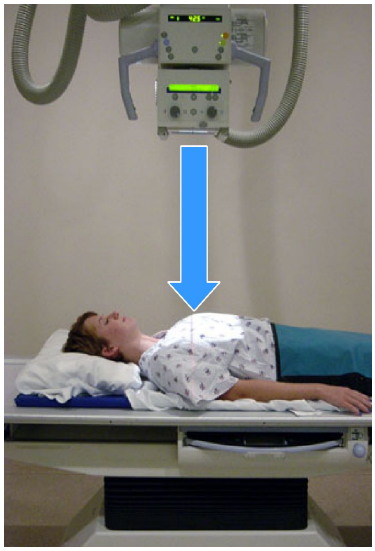


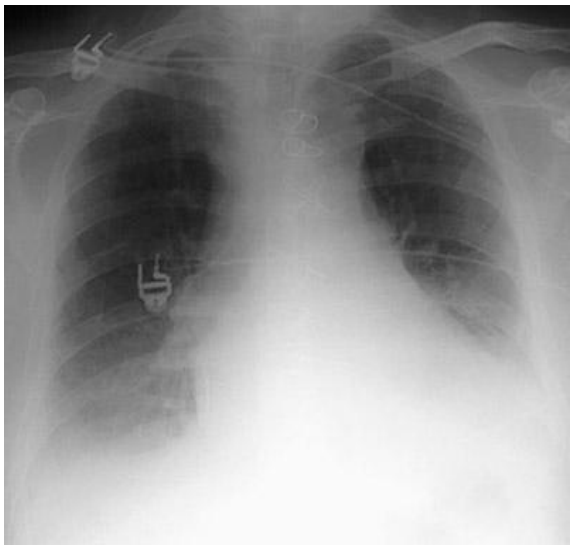
PA View:

- Basic X-ray
- Done when the patient is erect
- Posterior anterior



Lateral View



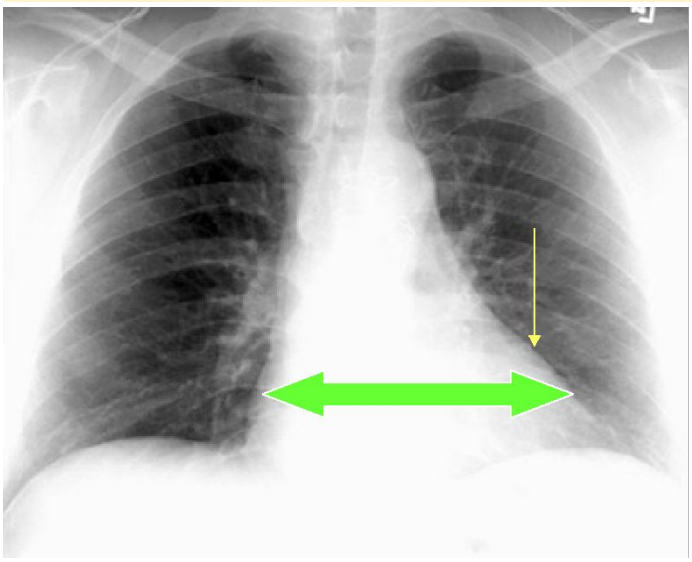


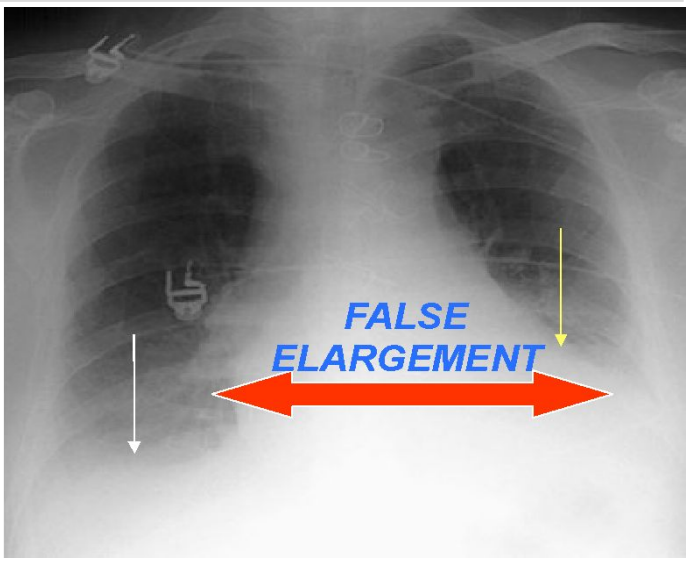
AP View:

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

anteriorposterior AP VS posterioranterior PA

PA	AP
Heart outline is well defined and normal sized • Costo-phrenic angle is visible and clear. • Ribs and clavicle are clearer. • Patient can take full inspiration because gravity pull bowel down as the patient standing (allowing us to see more of the lung field) • Scapula is seen in periphery of thorax • Commonly used in clinical practice (standard). •Diaphragmatic copula is clear and will defined	False enlargement of the heart. •Costo-phrenic angle is not clear. •Ribs and clavicles are not as clear as PA •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 are over the lung field . • Pleural effusion could be missed.

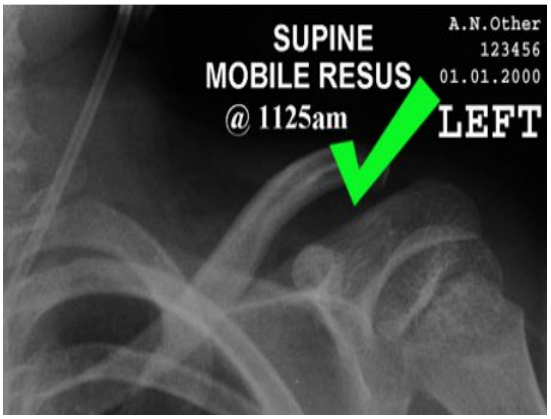




Inspiration while taking an image has benefits:
1- we can see as much as we can from lung paranchyma
2- the ribs are well separated so if there is a lesion between the ribs we will see it clearly but if the ribs is too close to each other we will not see it
• The patient should not be rotated we need to compare both side of the lungs

❖ 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 ,.



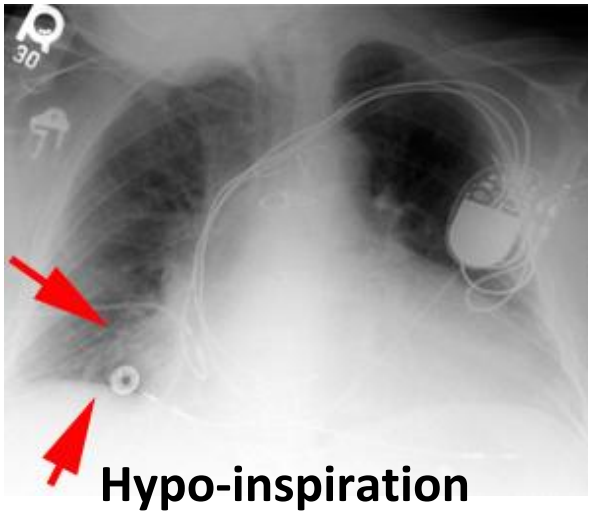
❖ Technical factors :

- Depth of inspiration
- Visualization of pathology depends on contrast provided by air in the lungs
- Count ribs
- Patient not rotated

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:

- 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.



Hypo-inspiration

Is this a lesion or not?
Diaphragmatic cupula is high

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

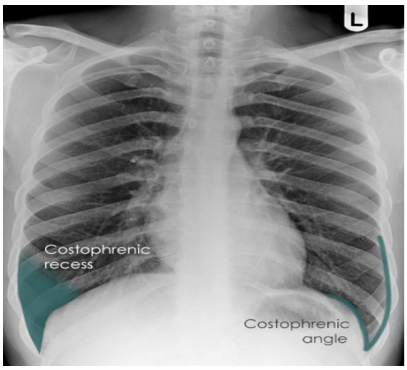
- diaphragmatic copula is high which means patient didn't take full inspiration.

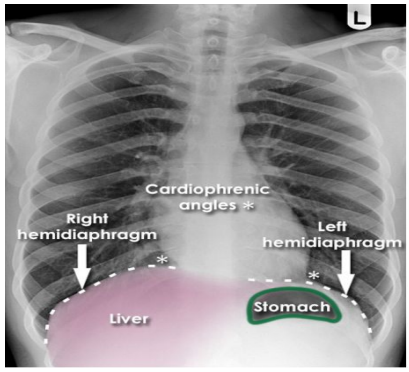
inspiration

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

We asked them to repeat the film with more inspiration . so you can see diaphragmatic cupula 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 copula 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 copula goes down.

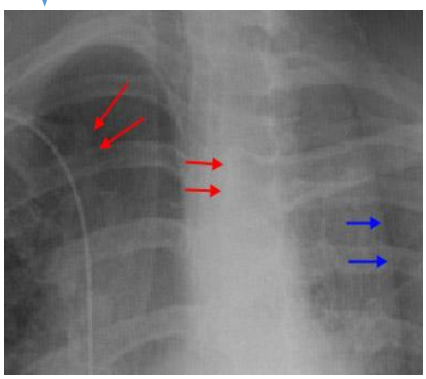
- **Right hemi-diaphragm is slightly higher than the left**
- **The liver is located immediately inferior to the diaphragm on the right**
- **The stomach bubble can be seen below the left hemidiaphragm**
- **If you look closely you can see lung markings below the diaphragm on both sides**
- **Medially 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**

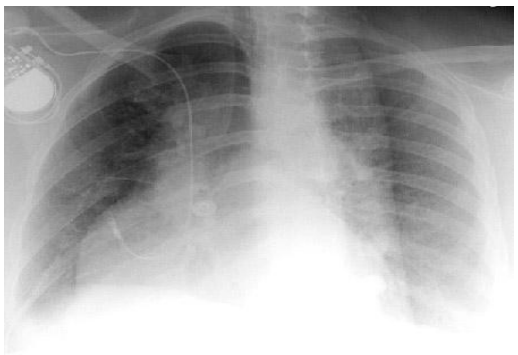


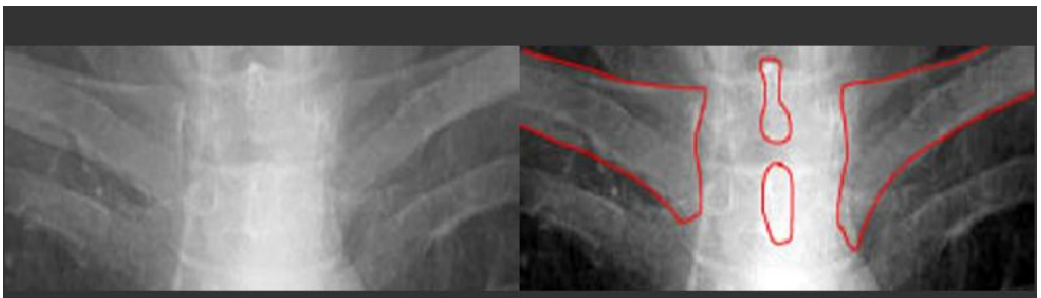


Rotation:

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

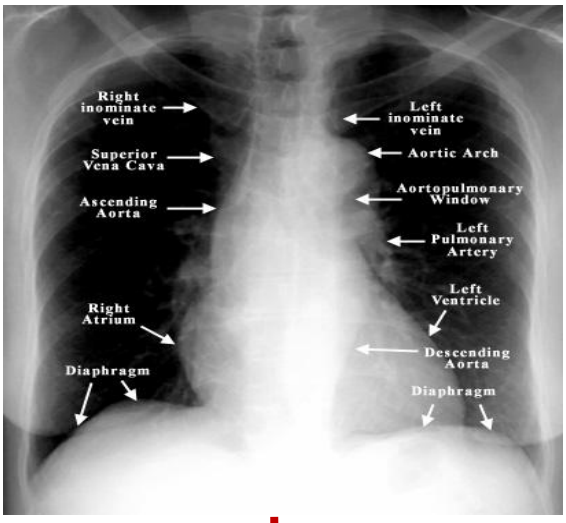


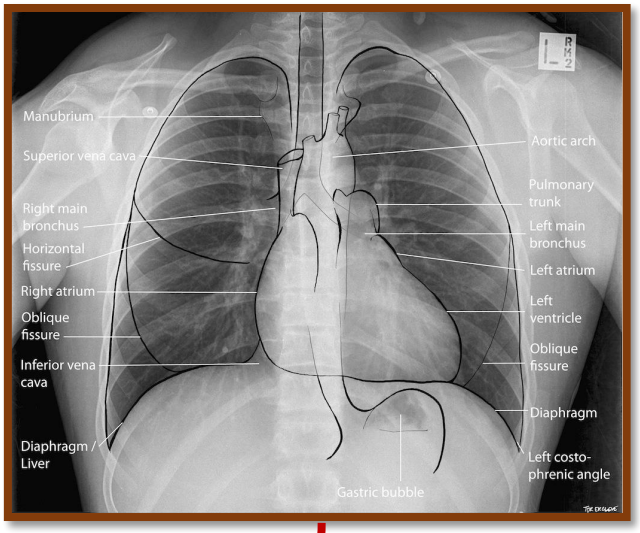




Magnification of clavicular head and spinous process alignment demonstrating a straight film.

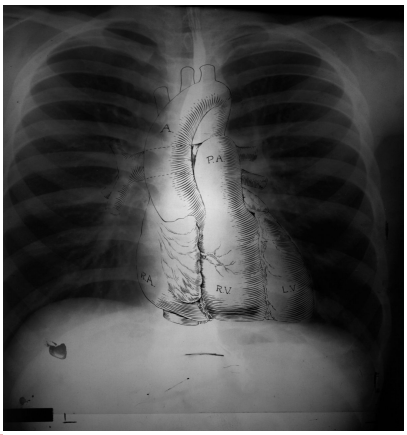
Anatomy on Normal Chest X-Ray:

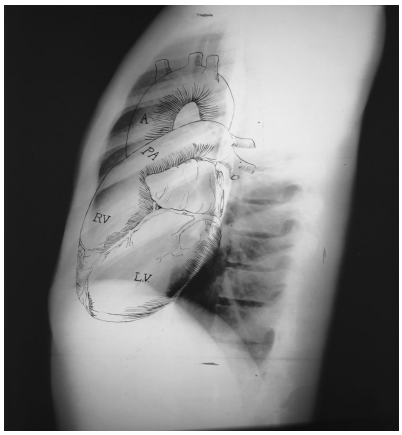


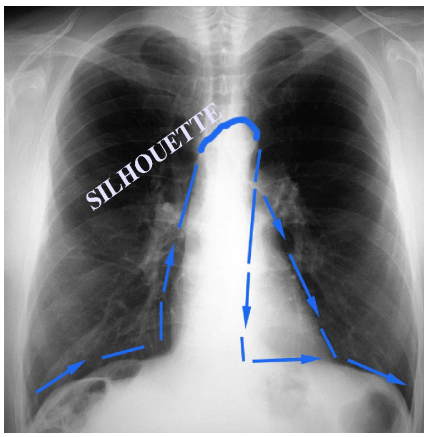


PA VIEW ANATOMY

Heart:

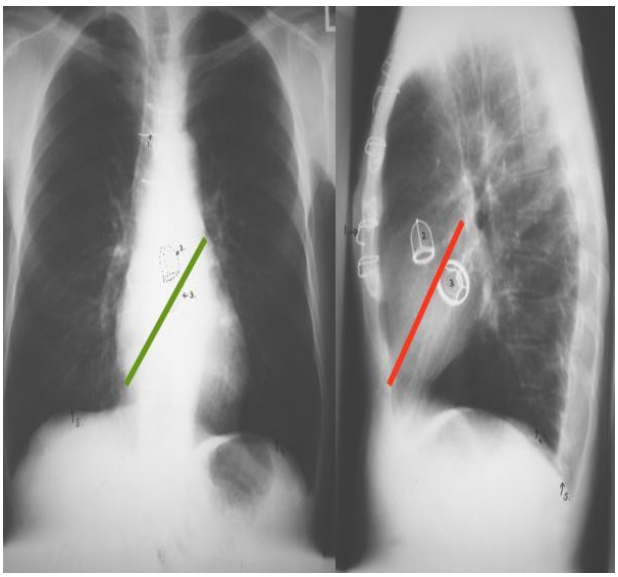






Heart borders and chambers of the heart on PA and lateral views.

Heart valves: the doctor skipped it



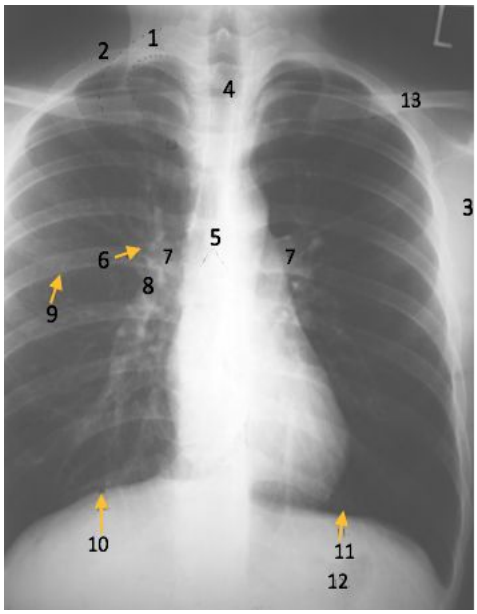
Key:

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

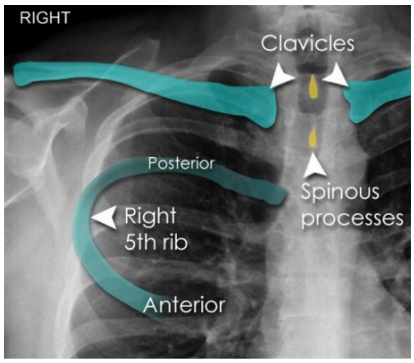
The patient in the pervious image had a malfunctioning mitral valve (between left atrium and left ventricle) and aortic valve (between left ventricle and aorta) and prosthetic valves were inserted (better seen on lateral)

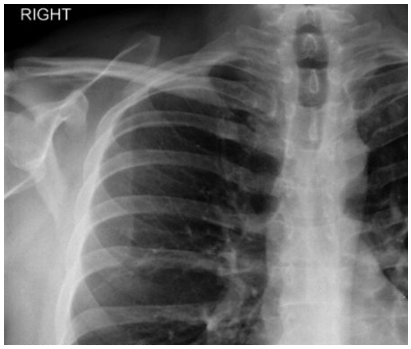
Cont. Anatomy on Normal Chest X-Ray:

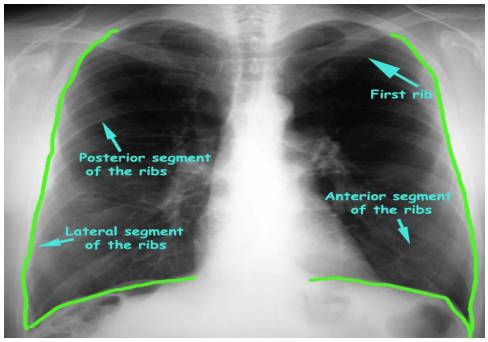
Key:			
1	Right 1st rib	8	Branch of right main descending pulmonary artery
2	Right 2nd rib	9	Right minor (horizontal fissure)
3	Scapula	10	Right hemi diaphragm
4	Trachea	11	Left hemi diaphragm
5	Carina	12	Gastric air bubble
6	Bronchus seen end on	13	Left clavicle
7	Bilateral hila		



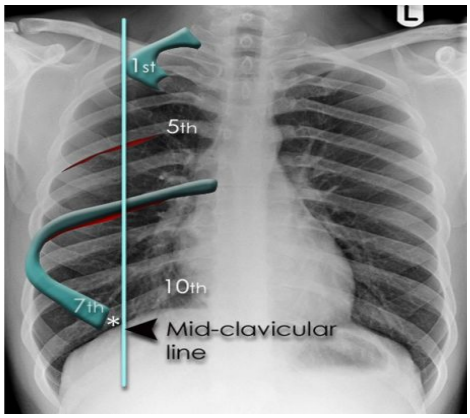
Ribs:

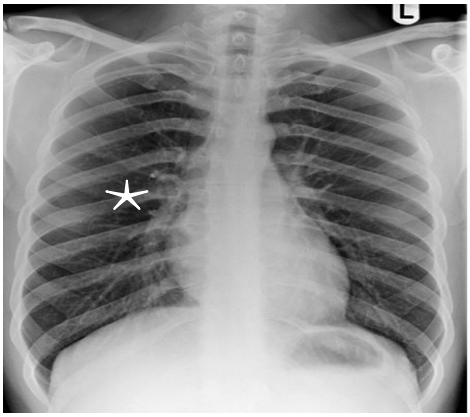






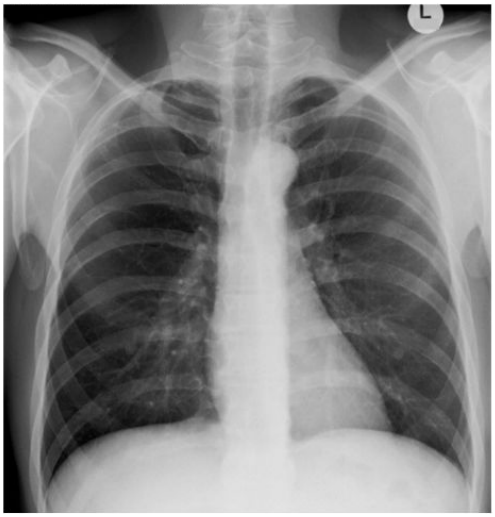
How to count the ribs ?
The first rib in the x-ray is rib number 1 , how can you know is it the 1st?
Cervical spine doesn't have ribs, it starts from thoracic spine



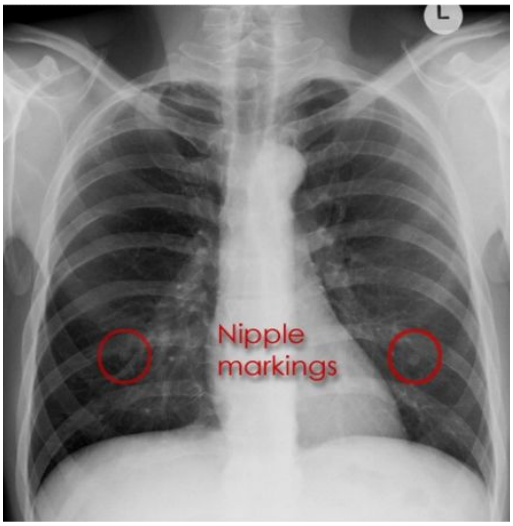


Which rib is this " labeled by star" ? 7th
When you complete counting you will have 10 ribs which means the patient has full inspiration

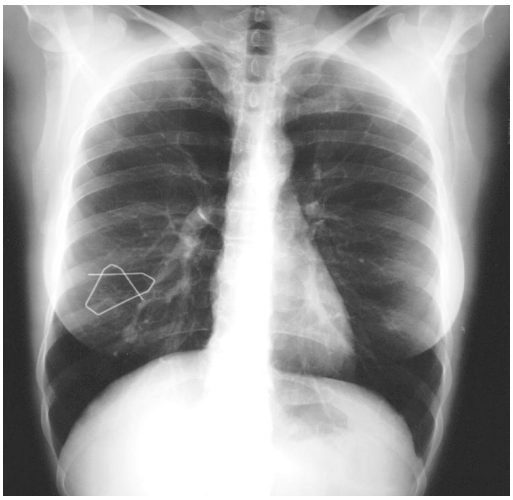
Nipple shadows:



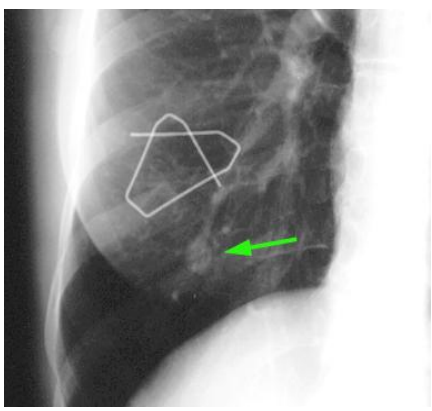
Is it nipple shadow or lesion?

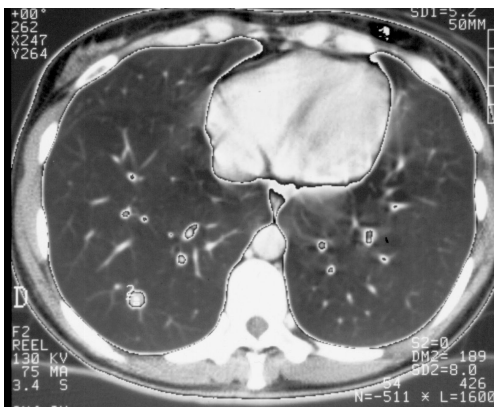


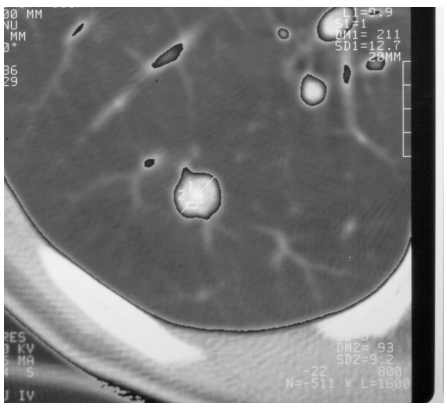
Put a metal on the nipple of the patient



Nodule or right nipple ?







so its not a nipple shadow its Intrapulmonary nodule: hamartoma

---

❖ For diagnostic reasons dividing lung fields:

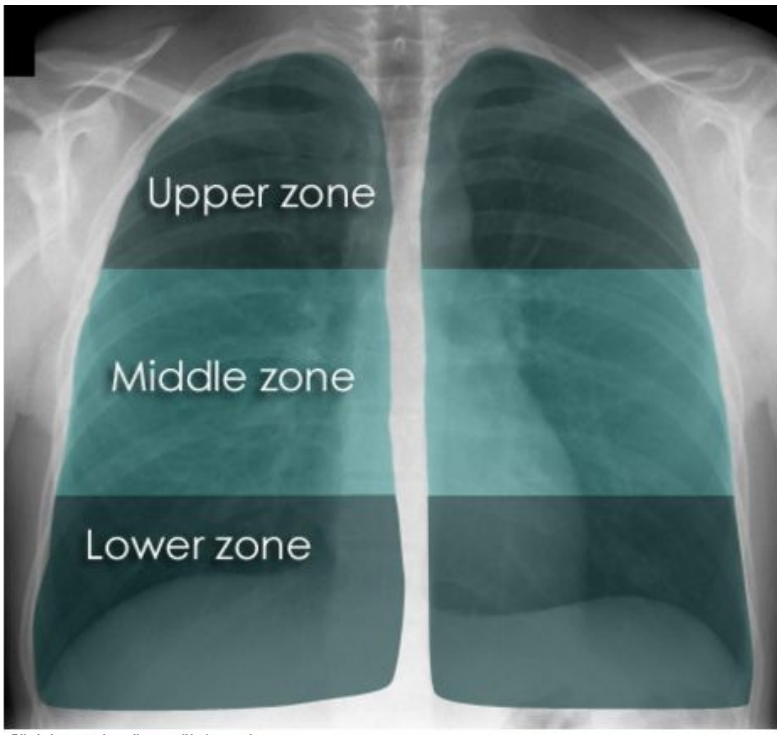
1-by zones	2-by lobes

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 (blacker). 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:**

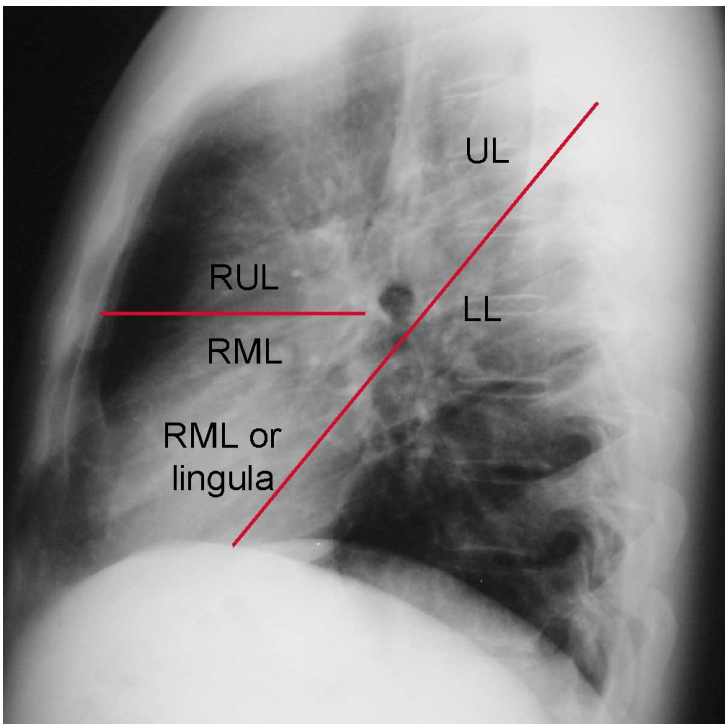
Dividing the lungs into zones allows more careful attention to be paid to each smaller area. If this is not done it is easy to ignore important abnormalities.
Note that the lower zones reach **below the diaphragm**. This is because the lungs pass behind the dome of the diaphragm into the posterior sulcus of each hemithorax. Normal lung markings can be seen below the well defined edges of the diaphragm.

2-By Lobes:

- **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)

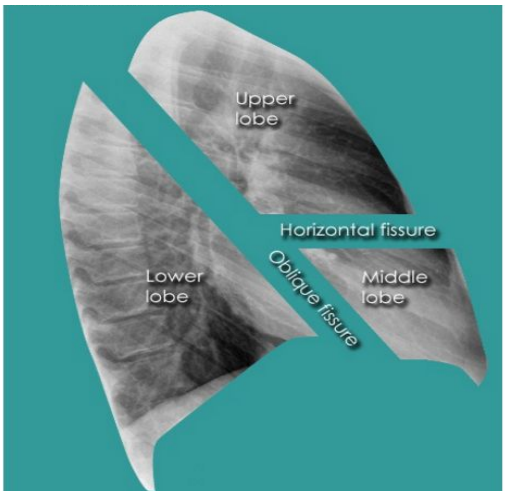
Diagram of lungs showing lobes:

- 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.

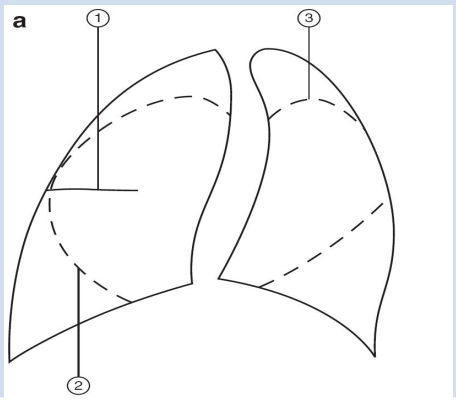


Lobes and fissures:

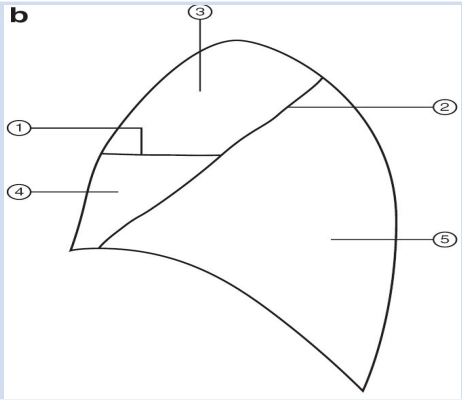
This cut-out of a lateral chest X-ray shows the positions of the lobes of the right lung
On the left the oblique fissure is in a similar position but there is usually no horizontal fissure, and so there are only two lobes on the left.



Lung Fissures:

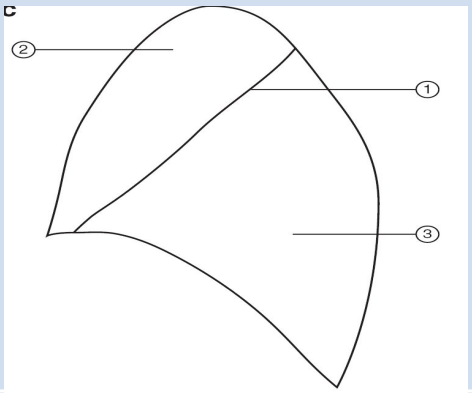


(1) Horizontal fissure
(2) Right oblique fissure
(3) Left oblique fissure.



Right lung:

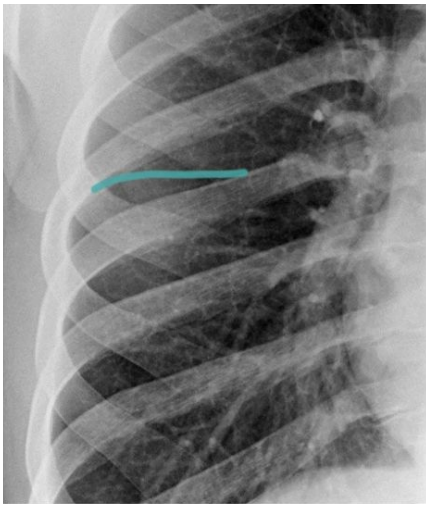
(1) Horizontal fissure
(2) Right oblique fissure
(3) Right upper lobe
(4) Right middle lobe
(5) Right lower lobe.



Left lung:

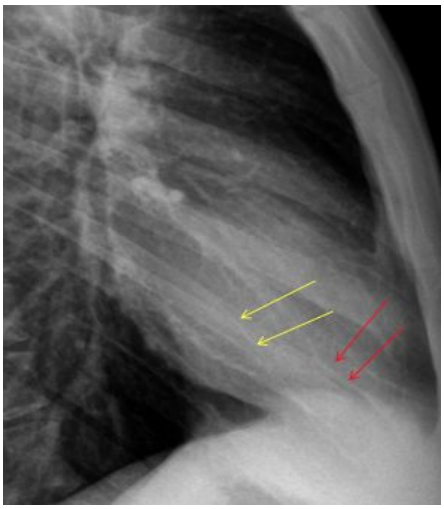
(1) Left oblique fissure
(2) Left upper lobe
(3) Left lower lobe.

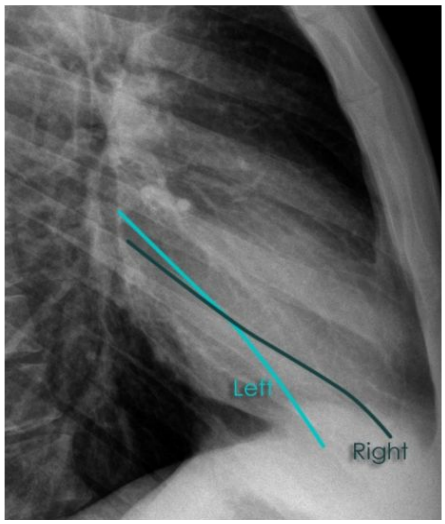
Transverse fissure
Only in the right lung



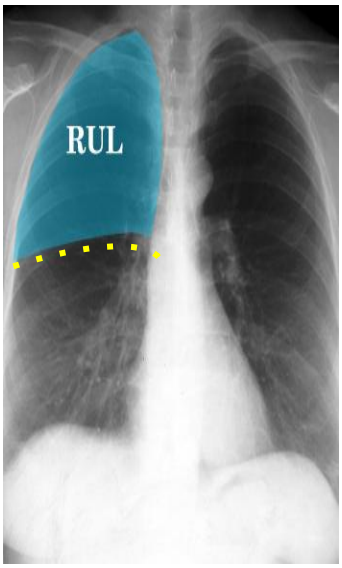
Oblique fissure
You can see both oblique fissures in the lateral view

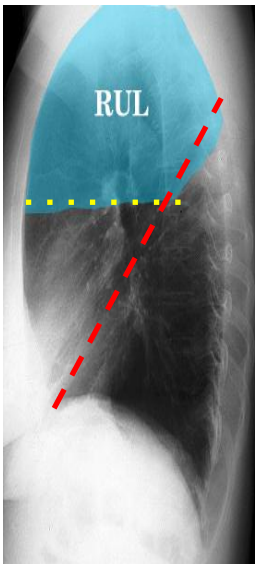
yellow arrow is left oblique fissure, red arrow is right oblique fissure

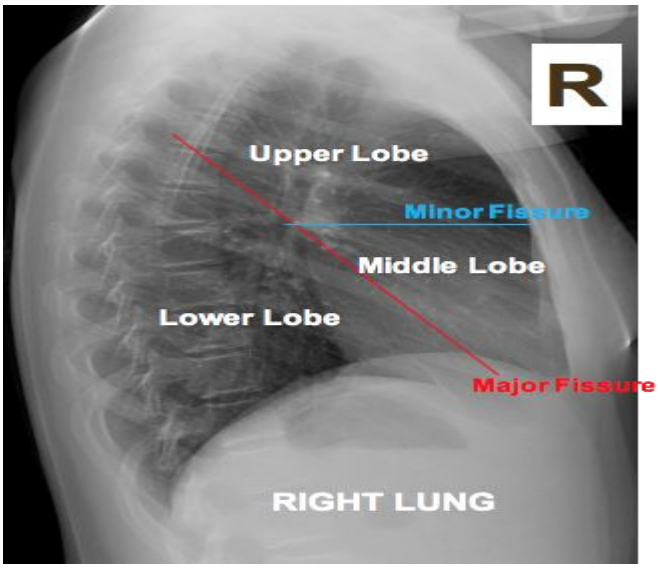


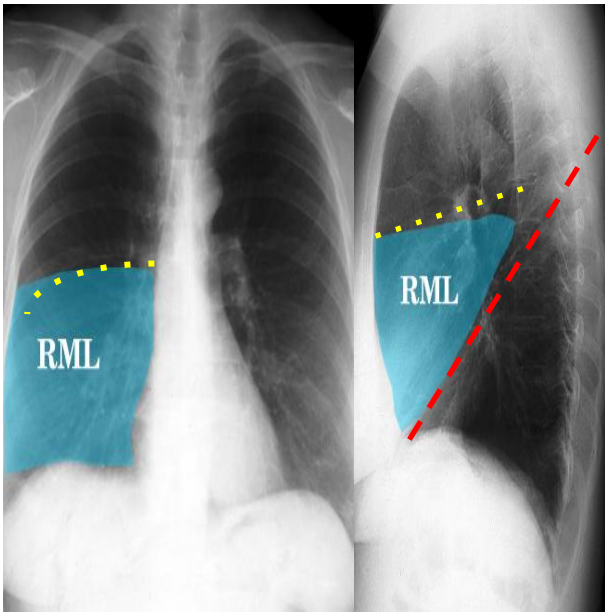


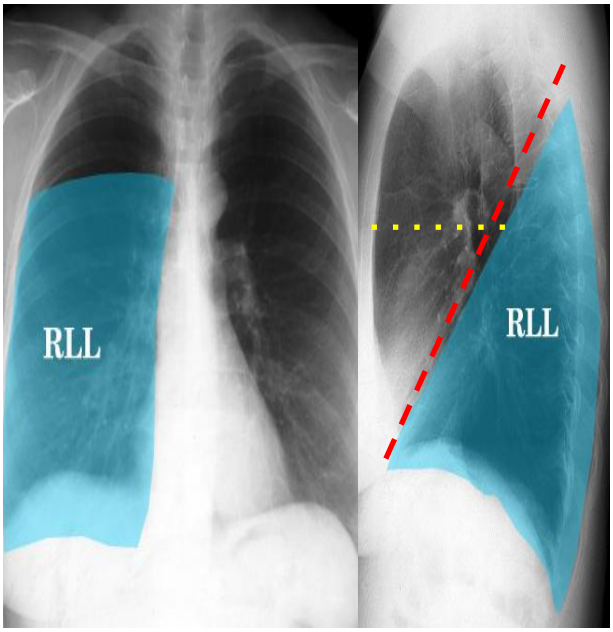
Fissures and Lobes of The Right Lung

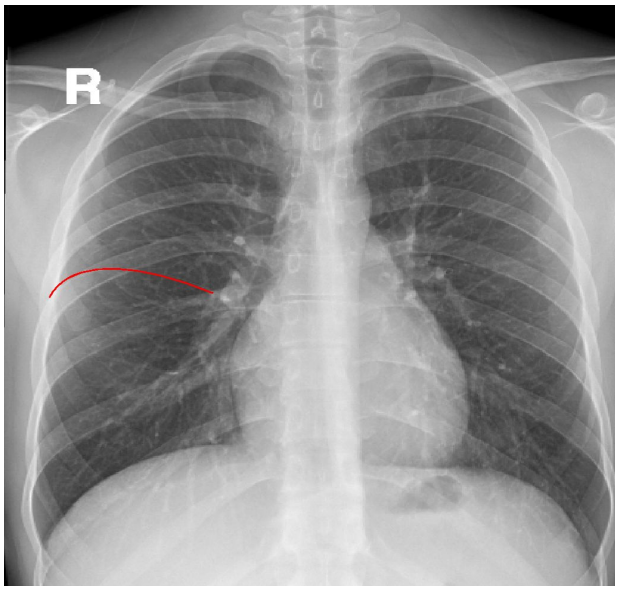






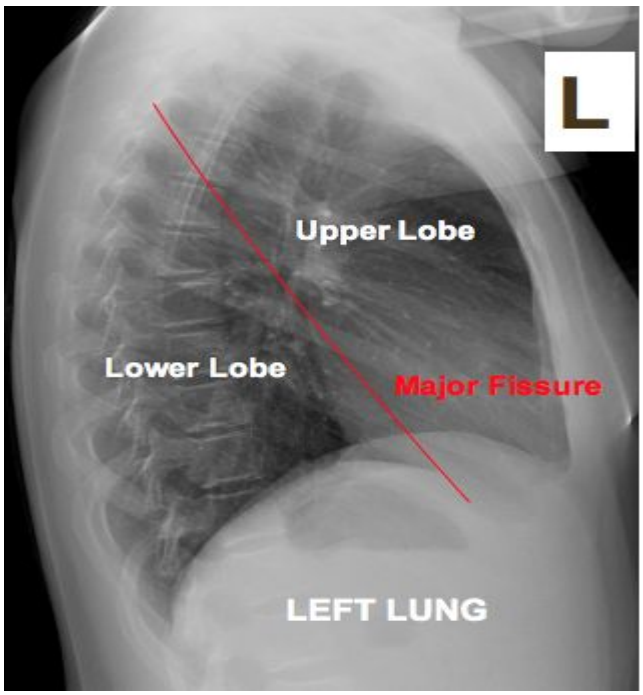






RUL = Right Upper Lobe
RLL = Right Lower Lobe
RML = Right Middle Lobe
= Horizontal fissure
= Oblique fissure

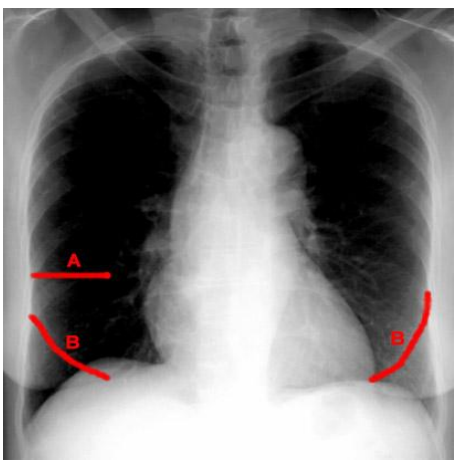
Fissures and Lobes of The left Lung

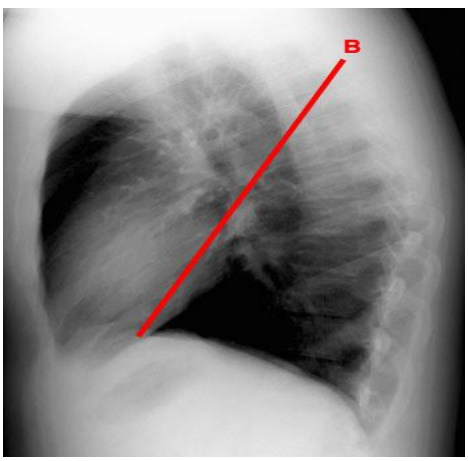


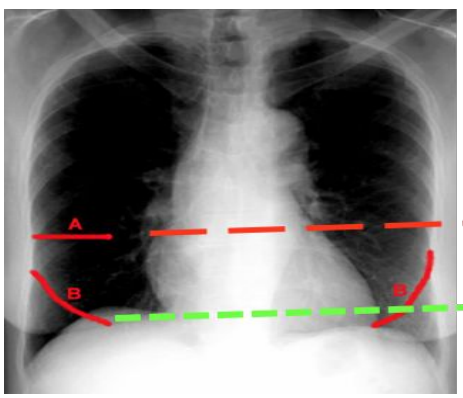
Lung Fissures in diseased lung (Localizing disease by fissures)

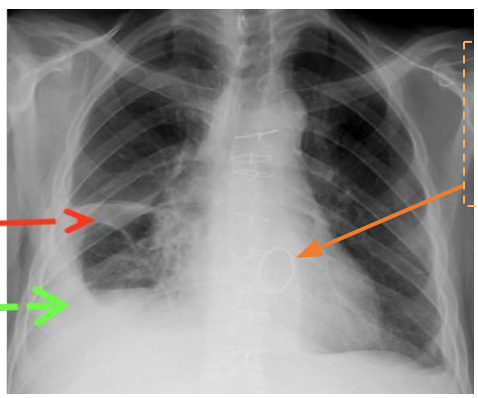
B = Oblique fissure

A = Horizontal fissure







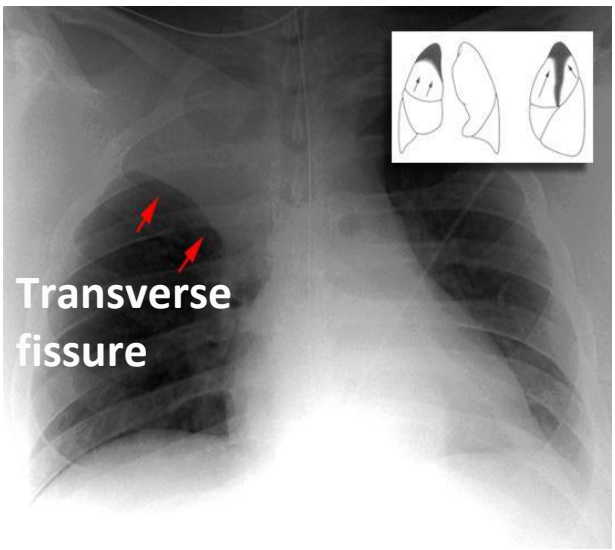


Notice the replaced mitral valve

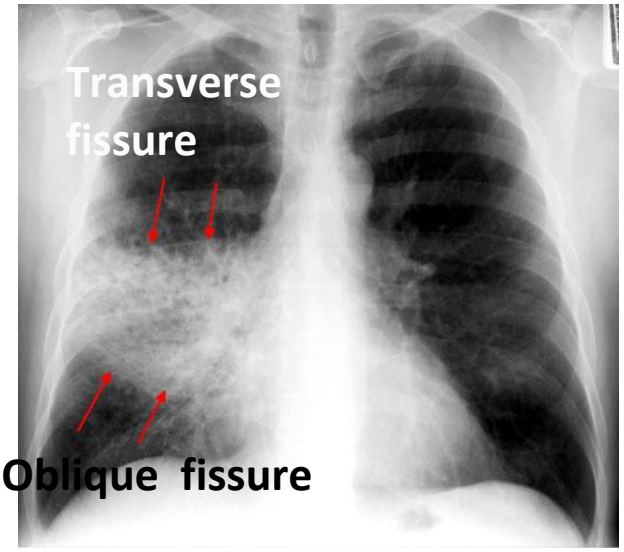
normal

Encysted effusion of the fissure
(Interstitial Pleural effusion)

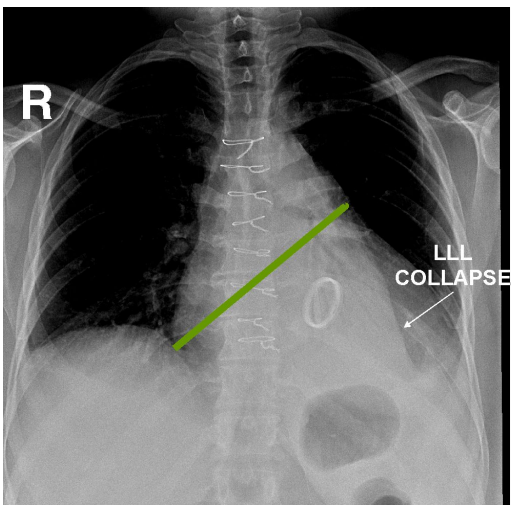
Lung Fissures in diseased lung (Localizing disease by fissures)



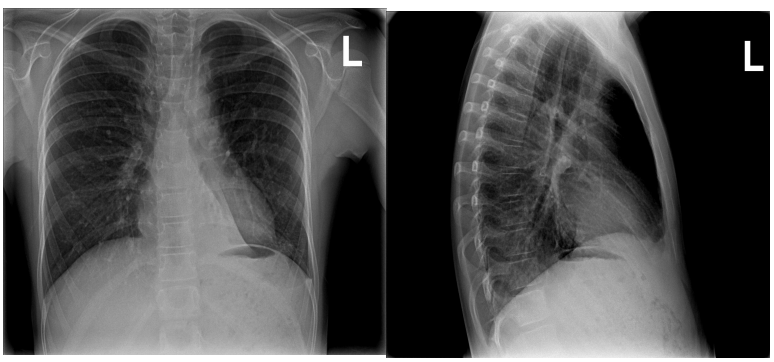
ATELECTASIS, in lung collapse the fissures move up



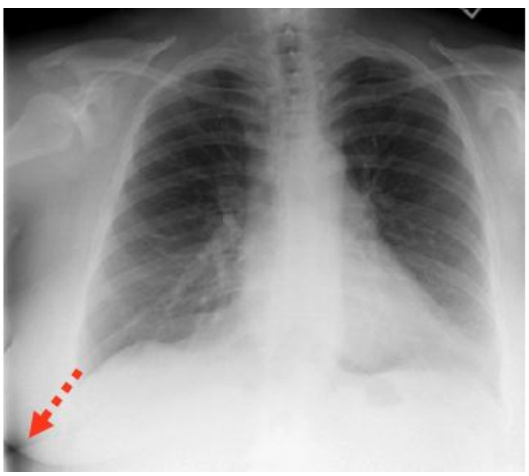
Right middle lobe pneumonia



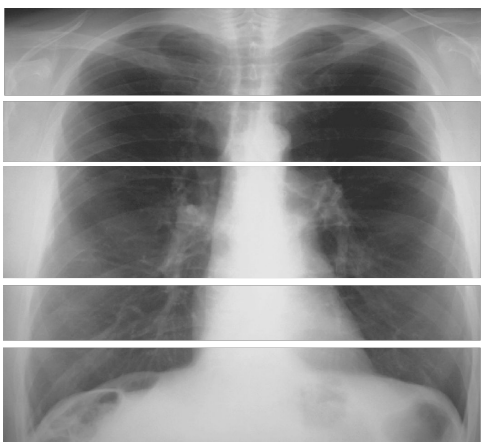
MITRAL VALVE REPLACEMENT



LLL COLLAPSE



Breast shadow



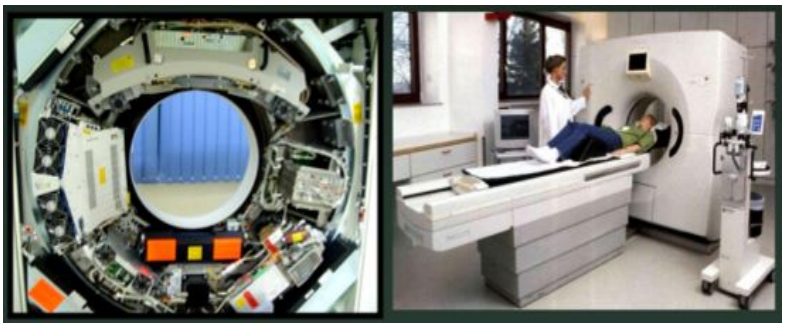
How to read Frontal Chest X-Ray?
Always divide and compare

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)

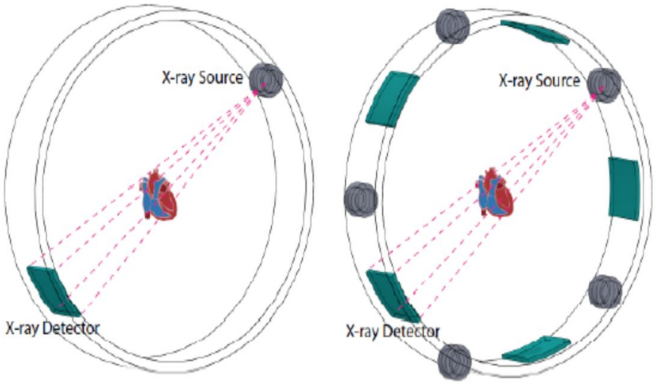


The new one it's different from the old by:

- 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

- 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.

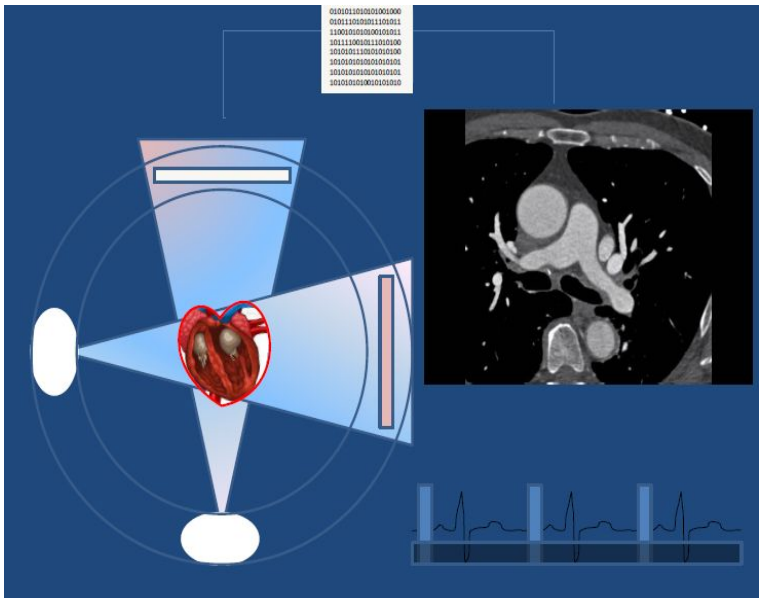


They developed it more to have something known dual CT "2 tubes of x-ray" to be able to take CT for the heart .

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"

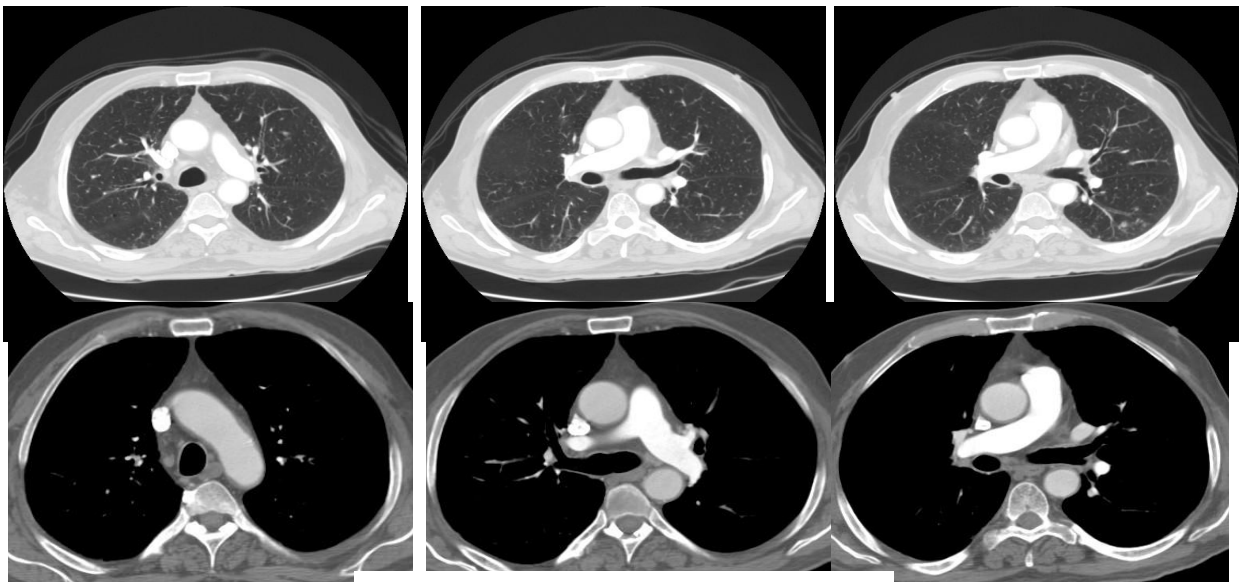
Theses tubes take images very fast and has **trigger** once heart rate slows down take the image immediately.

Collect theses images could reach to thousands they able to see coronary artery and can do assessment to the myocardium



Radiological Anatomy of the Chest:

Lung Window

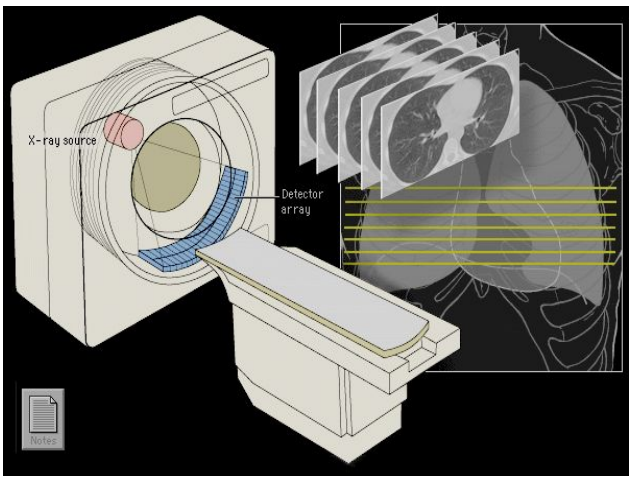


Mediastinal Window

- 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..

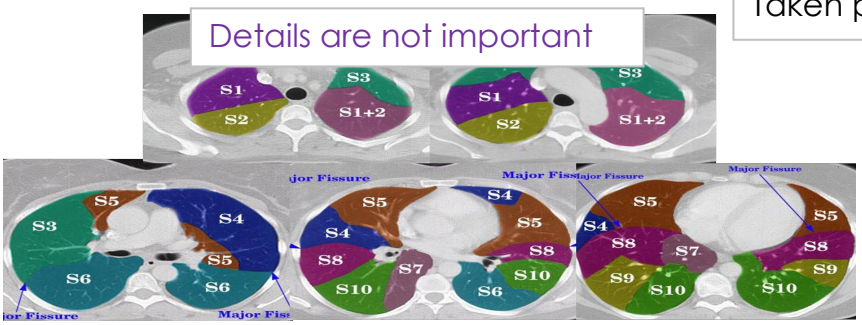
High Resolution CT Scan:

- 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.



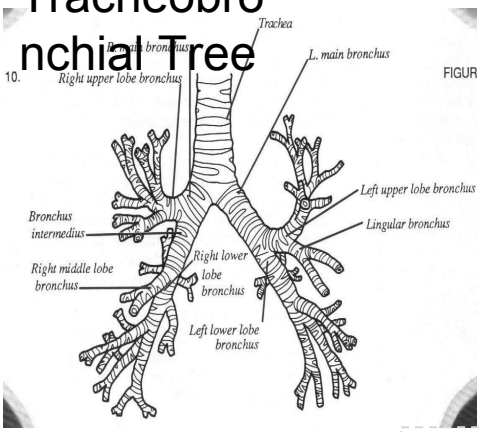
Thousands of pictures are taken and that will make us able to see the coronary artery ,aorta ,the dynamic assessment of the heart and vasculature of the heart
Taken pictures from different dimensions

Details are not important

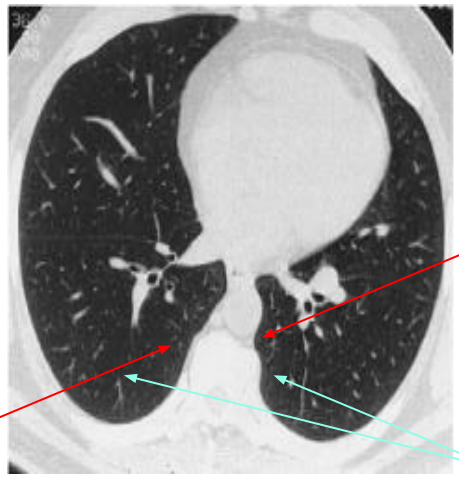


Normal Lung Anatomy

Tracheobronchial Tree



Normal lung at inferior

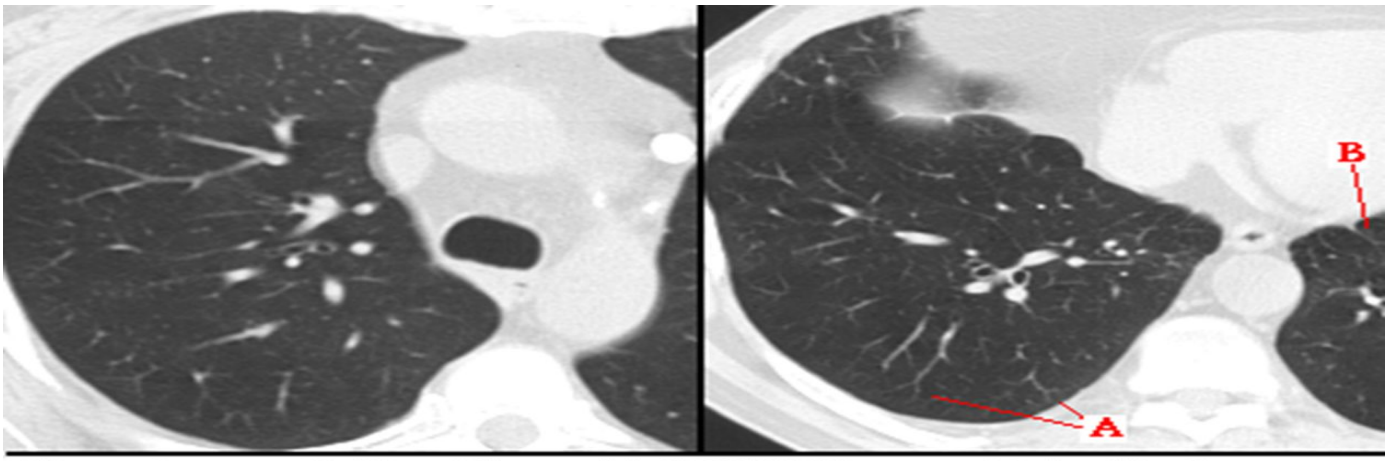


Left inferior pulmonary vein

Right inferior pulmonary vein

Lower lobe bronchi

Normal HRCT:

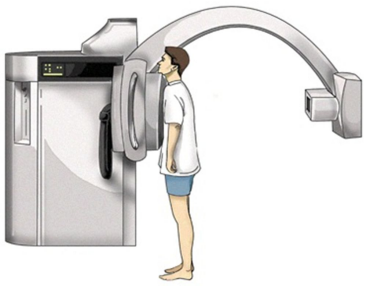


Normal upper (left) and lower (right) HRCT scans obtained in the prone position. The center of a pulmonary lobule is defined by the presence of a distal pulmonary artery (A). The faint outline of a distal interlobular septum is noted in the lower lobes (B). A subpleural clear space is normally present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

Basic chest exam for the heart and great vessels

- PLAIN FILM=CHEST x-ray(CXR) same as chest x ray
- CT FOR HEART AND MEDIASTINUM with I.V contrast, to see coronary has different rate of contrast injection
- ANGIOGRAMS radiology department don't do this
- MRI very good to use
- Ultrasound (echocardiography) depend on indication
- Isotopic scanning

Basic Chest X-Ray



Modalities for anatomy and function of heart:

Intravascular ultrasound use prob of u/s inserted to see vessels

Optical Coherence Tomography

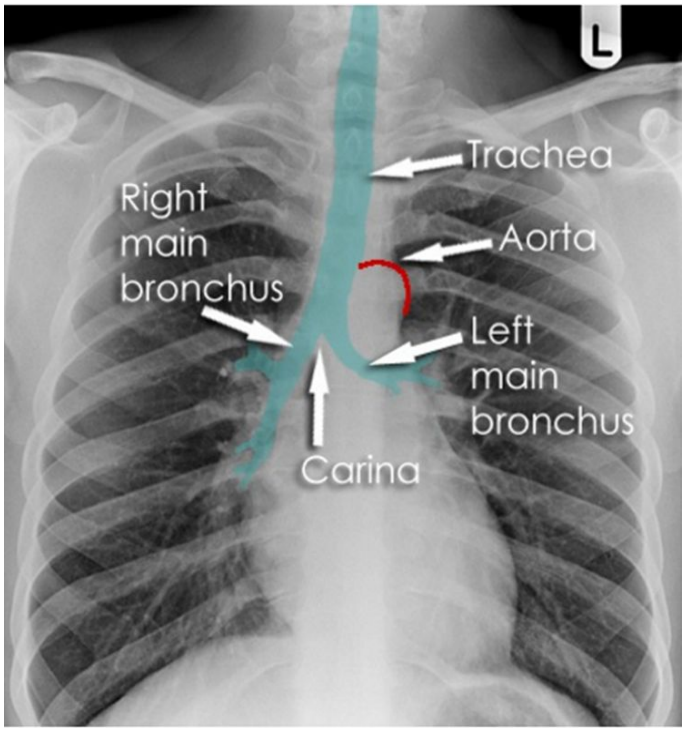
Cardiac CT

Echocardiography TTE/TEE

Cardiac MRI

Intracardiac Echocardiography

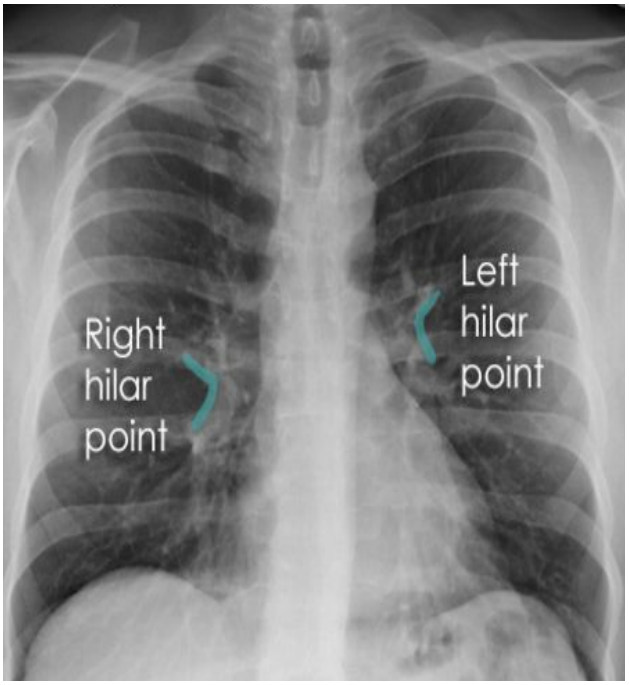
Nuclear imaging

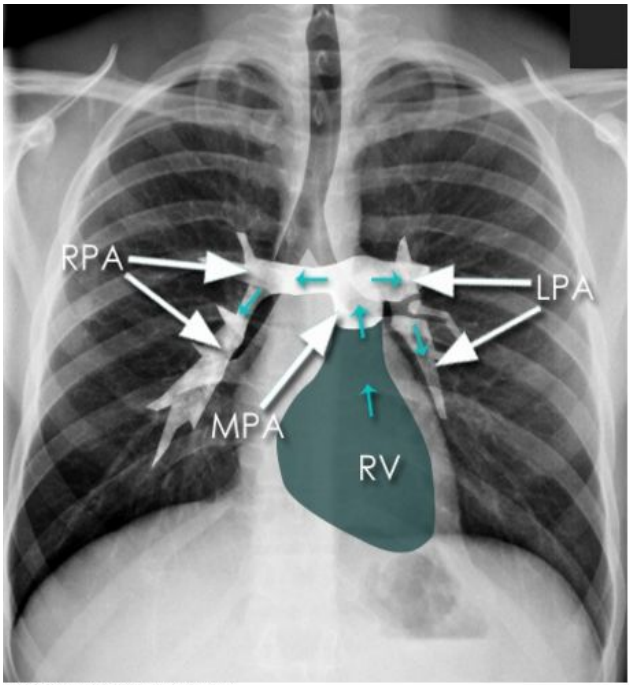


This is the cardiac shadow, and part of cardiac shadow is aortic knuckle "knob". It is very important because sometimes you have **aortic aneurysm diseases** and If you don't know what is normal appearance " which is very small" you might miss the lesion in case of aneurysm.

Hilar levels:

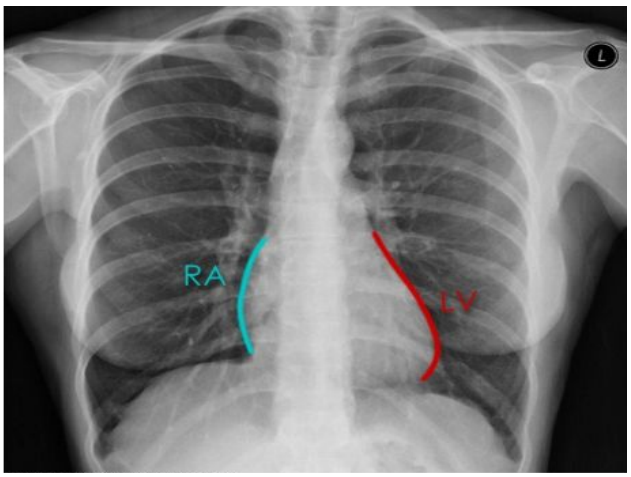
look for increase in density as well as size. If the hila are out of position, ask yourself if they are pushed or pulled, just as you would when assessing the trachea.

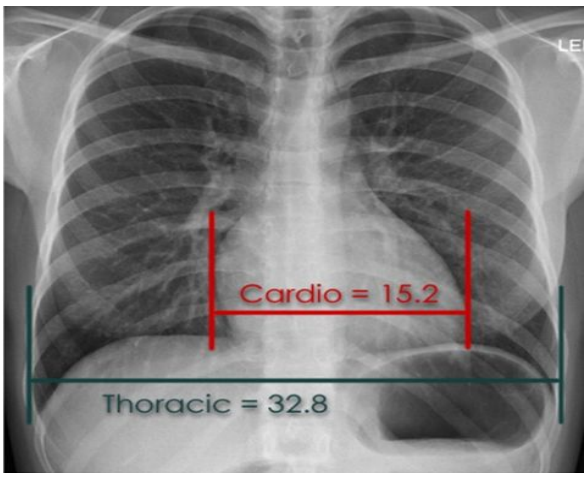




- One of important structures they use for diagnosis is the hilar shadow, there are right hilum and left hilum of lung, the right hilum is lower than left.
- These levels very important because it will be affected in case of diseases of lung and sometimes in diseases of heart.

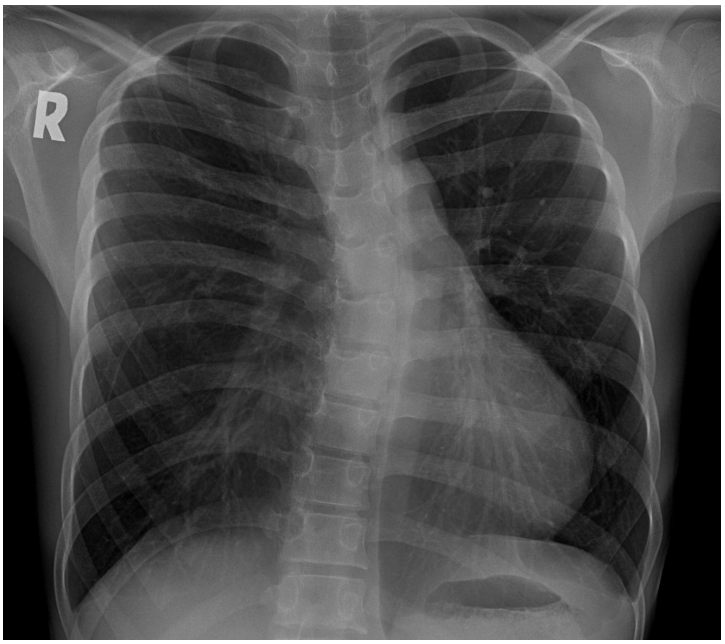
Cardiac contours:

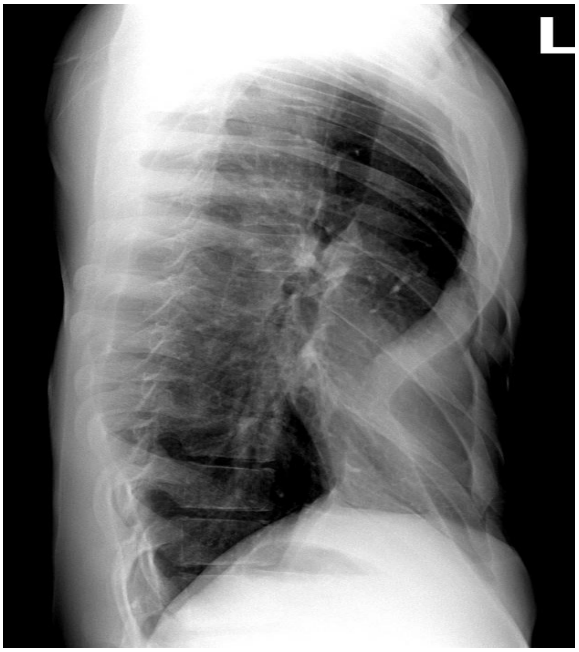




Contour of right side of heart is mainly formed by **right atrium** and the contour of left side of heart is formed mainly by **left ventricle** Simply we use them to measure **Cardiothoracic ratio** " will be discussed more in coming lectures "

Cardiac displacement:





❖ **What is abnormal here ?**
1-Scoliosis
2-heart is deviated < due to displacement

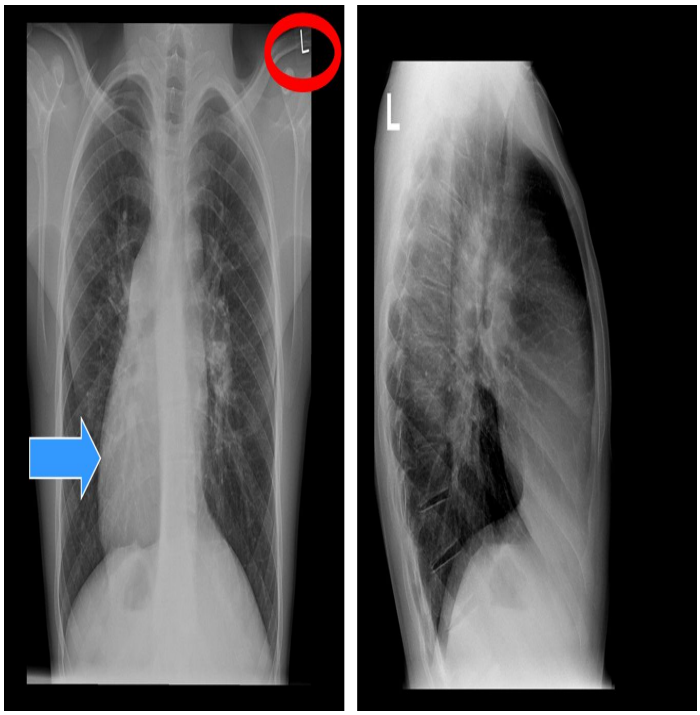
- ❖ Thoracic cage is formed by 2 main structures sternum anterior & vertebral spine posterior and the heart in between.
- ❖ in case of Scoliosis vertebral spine won't move right or left only it also cause a compression anteriorly.
- ❖ heart can't tolerate this compression and this leads to displacement of the heart.
- ❖ So this image shows displacement not enlargement .

Is heart normal? Yes most of cases but some cases 10-12% they have abnormality such as congenital heart diseases.

Pectus excavatum

In the lateral view it's clear that there is compressed sternum which wasn't clear in PA view heart wouldn't be comfortable so will deviate to right side or left

DEXTROCARDIA

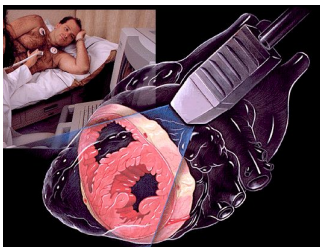


- **Important to put a mark on left shoulder** because in this image notice the mark on left shoulder but where is the heart ? On right side!
- Most cases of Dextrocardia have Situs inversus which means not only the heart being in the opposite side also liver and other organs transposed to the opposite side of the body.
- The problem in this case if patient came to ER with sever pain in the left lower quadrant and we thought it's an ovarian problem so we send patient home then she will come again with perforated appendix. This tell us the importance of CXR if we did it will show us it's Situs inversus or even if we did U/S or CT . This is very rare BUT if it happend onceor to this patient it 's a desaster.

Is thers any deformity in this image ? Mild scoliosis and observe strnum curved anteriorly.also if you do U/S ,CT and EKO you will find many things abnormal.

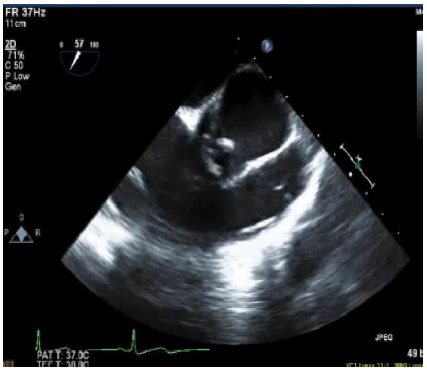
Echocardiography Methods:

- Transthoracic Echocardiography
- Transesophageal Echocardiography
- Intracardiac Echocardiography
- Intravascular Echocardiography. All these aren't in Radiology department even EKO, they only do MRI for the heart

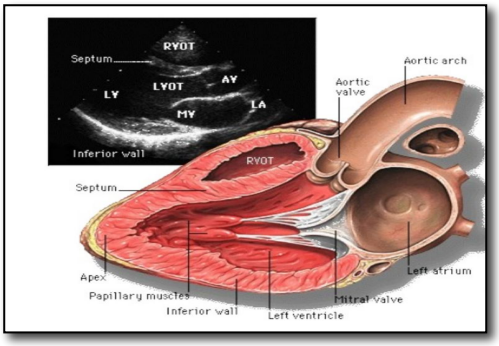


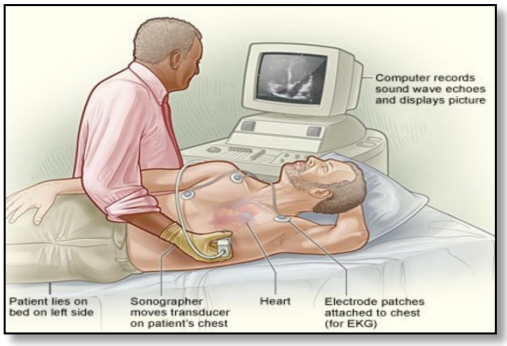
Transesophageal Echocardiography:

- Evaluate for cardiac source of embolism (36%)
- Endocarditis (14%)
- Prosthetic valve function (12%)
- Valvular diseases, aortic dissection or aneurysm, tumor, mass or thrombus (6-8%)
- Congenital heart diseases (4%)
- Interventional cardiology guidance
- Intraoperative evaluation cardiothoracic surgery



TRANS-THORACIC ECHOCARDIOGRAPHY:



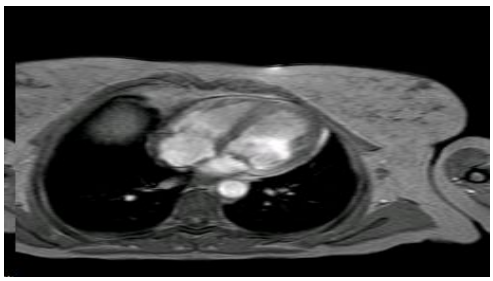


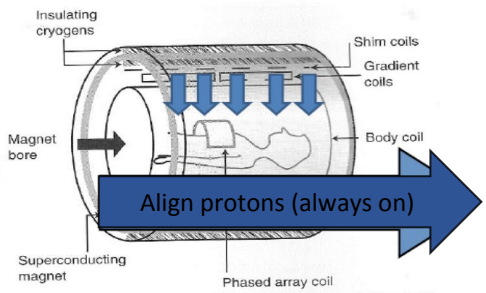
The doctor didn't explain these pics

- Transthoracic echocardiography Probe on the chest of the patient
- Transesophageal echocardiography Probe through the esophagus

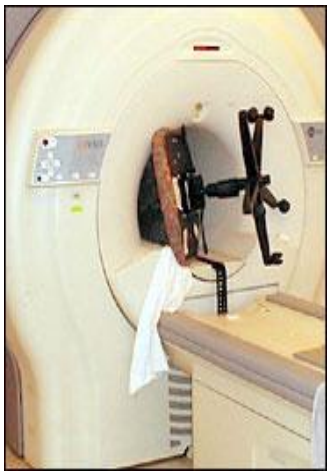
Cardiac Magnetic Resonance:

Features of MR of heart: ability to see details of heart, heart contraction, measure excursion of systolic value of heart " amount of blood ejected", motility and function of myocardium also thickness and infarction.





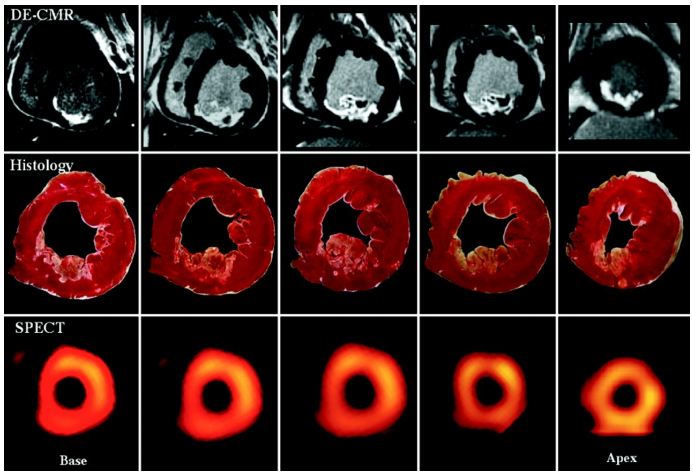
Hazards of MRI:
Magnet-Seeking Projectiles



Contraindicated with:
- Claustrophobia
- pacemaker

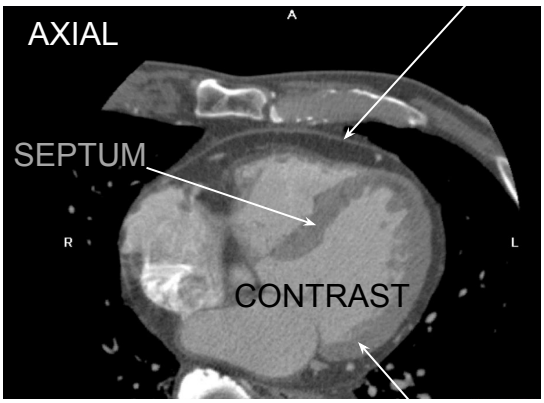
You can see the chair pulled inside because they forgot it near to the magnet, So you have to be caution.

Viability Assessment:
CMR Delayed Hyper-Enhancement



CARDIAC CT
FOR THE HEART AND CRONARY VESSLES:

PERICARDIUM



MYOCARDIUM

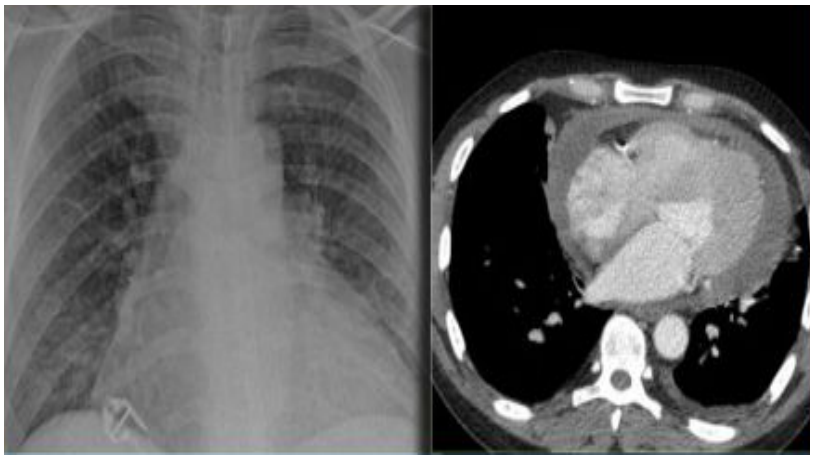
Inject I.V contrast which represent very clear image, we can see:
- the **contrast in the lumen** of the heart
- and we able to see muscle
- The fat around the muscle which is between the muscle and the surrounding structures is **"pericardium"**
- so in case of pericardial effusion there will be fluid rather than fat.
- Also we can see cardiac septum and other details of the heart.

If you take 5000 images rather than 200 you can see contractility

Pericardial effusion

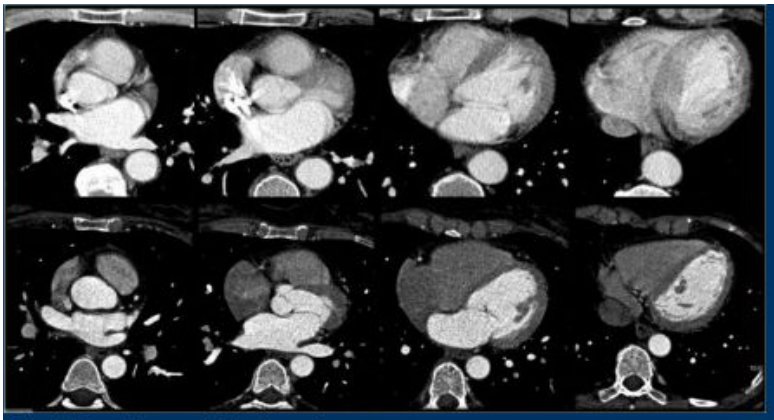
Whenever we encounter a large heart figure, we should always be aware of the possibility of pericardial effusion simulating a large heart.

On the chest x-ray it looks as if this patient has a dilated heart while on the CT it is clear, that it is the pericardial effusion that is responsible for the enlarged heart figure.

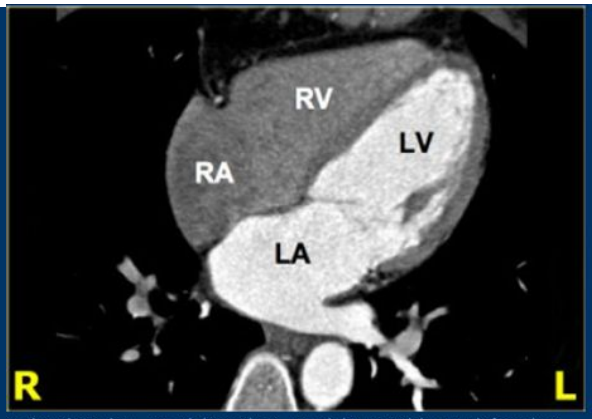


This defiantly indication the patient have pericardial effusion
Which is didn't appear in CXR

Cardiac chambers:



Axial slices through the heart

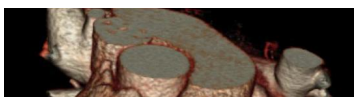


4-chamber view. RA=right atrium, RV=right ventricle, LA=left atrium, LV=left ventricle

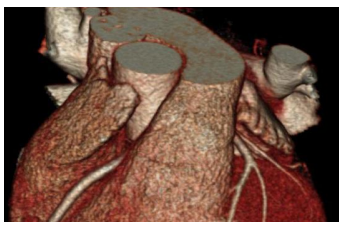
- We able to see chamber of the heart, in different faces
- Notice the contrast transfer to the other side of the heart which you can see pulmonary vessels in details.
- So we can use similar thing but with different protocol in case of acute pulmonary embolism.

4 to 64 Slice Scans: Five Heart Beats

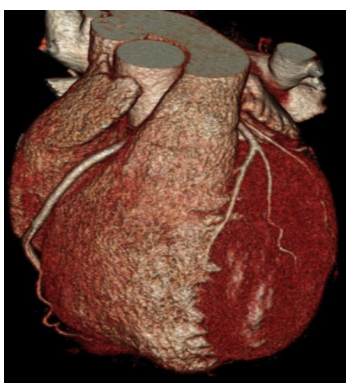
10 mm detector
Pitch ~0.25
3 cm in 5 sec



20 mm detector
Pitch ~0.25
6.2 cm in 5 sec



40 mm detector
Pitch ~0.25
12.5 cm in 5 sec



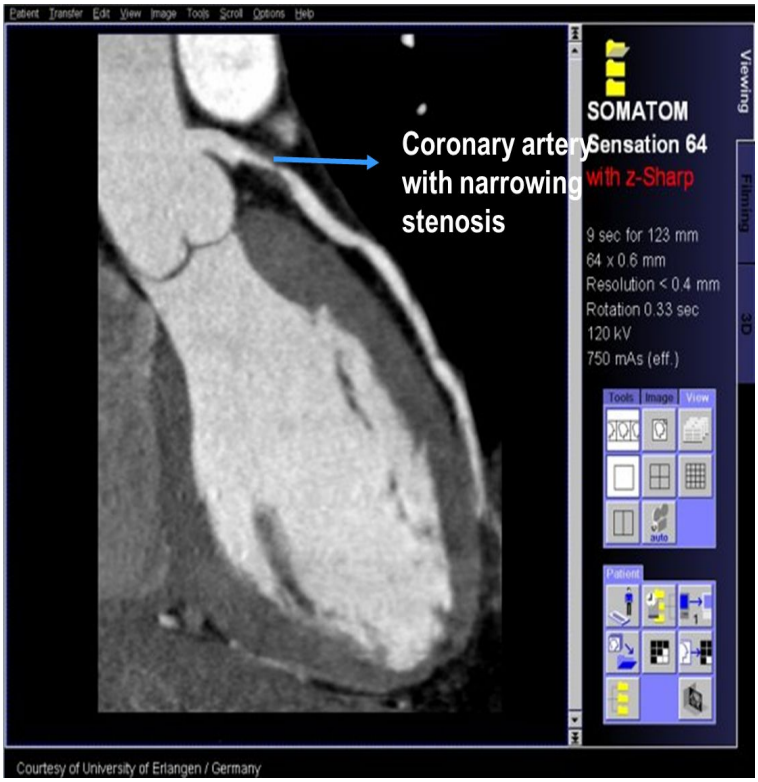
3-D Volume Rendered Image

Collect images to maximum projection " 3D " of the heart, to see it's contraction and more details

Maximum Intensity Projection:

Soft Plaque in Proximal LAD

- The coronary artery is very clear so no need for Cardiac Cath which used in the therapeutic lesions
- This is the vessels and area of narrowing which is area of stenosis in coronary artery .

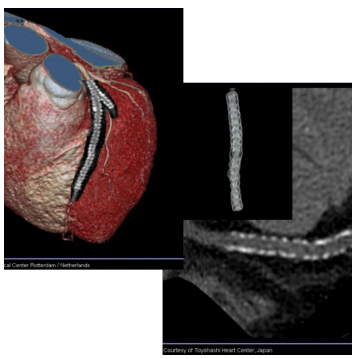


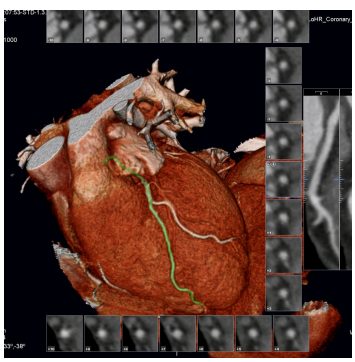
Cardiac Cath you can see vessels only But here you can see:

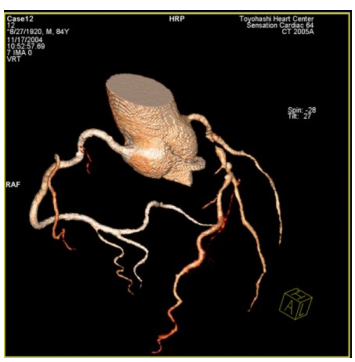
- muscle and vessels
- Contractility
- follow branches of vessels and make it in 3D
- Stent and measure narrowing in case of stenosis
- Congenital cardiac disease as septal defect

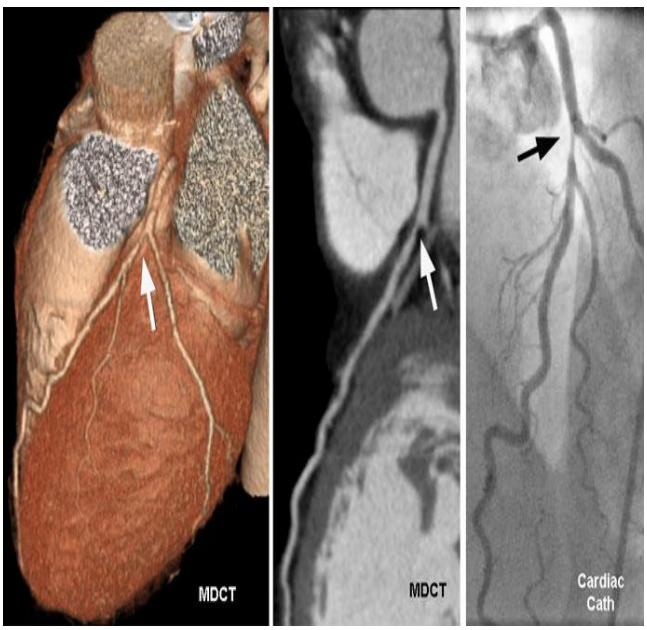
Curved Planar Image:

Stent



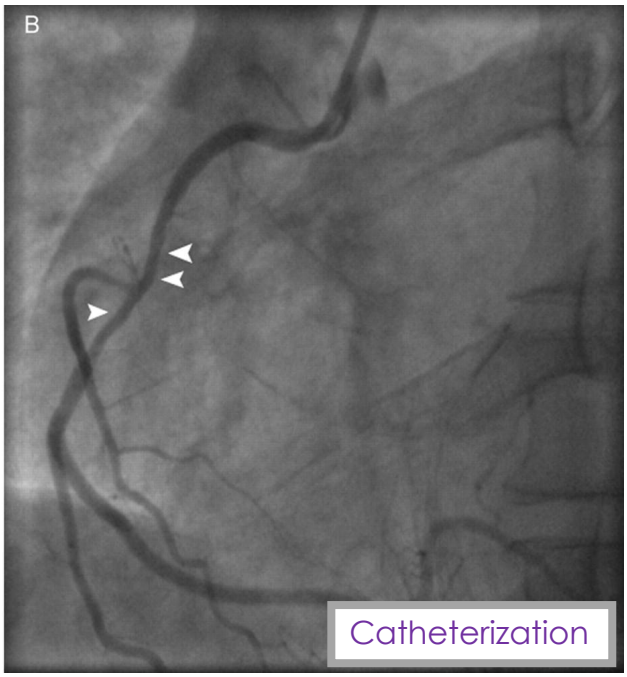


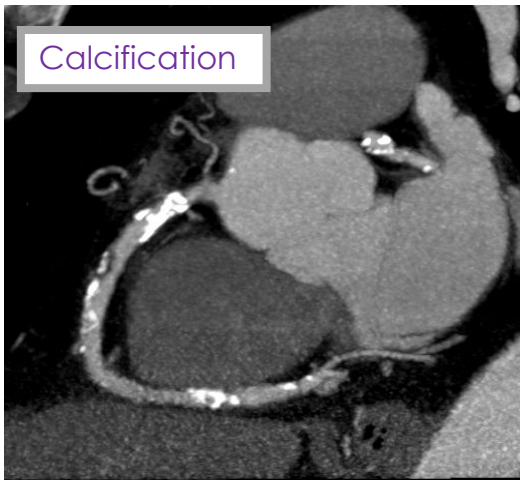


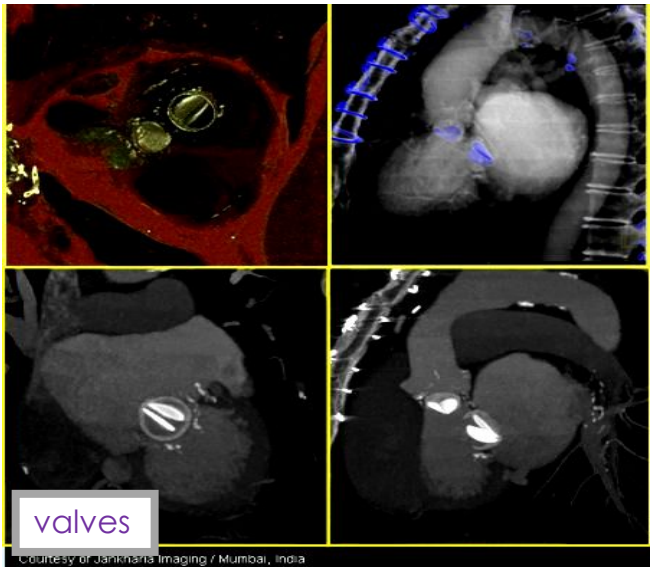


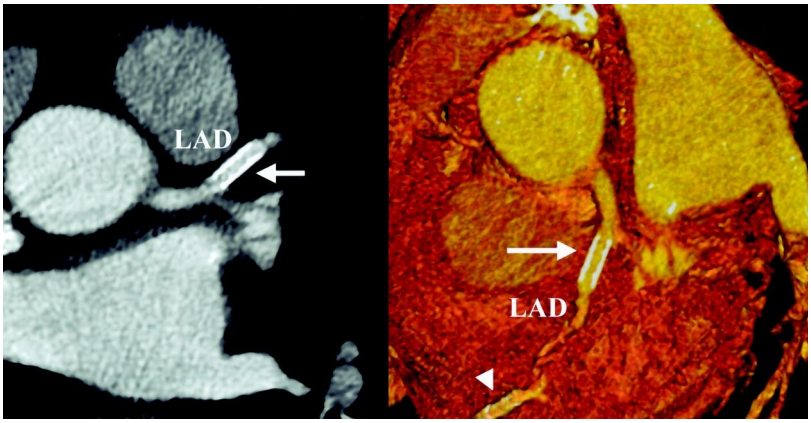
- Area of stenosis
- Around vessels soft "not Calcified plaque " black arrow.
- Hard plaque" calcified" white arrow.

Soft Plaque Visualization:



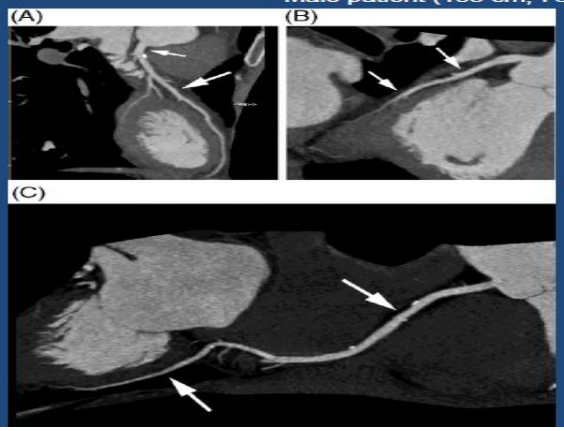




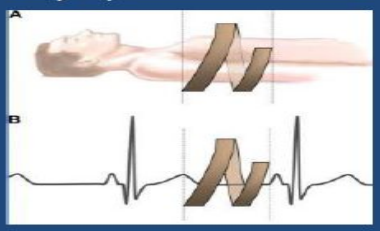


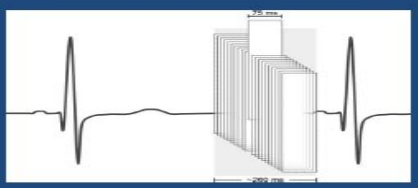
High Pitch Coronary CT Scanning

Male patient (183 cm, 78 kg, heart rate 54 b.p.m.).

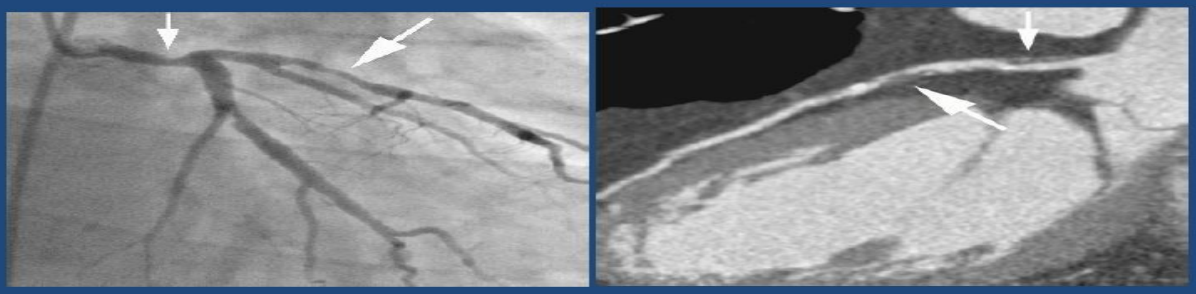


0.89 mSv

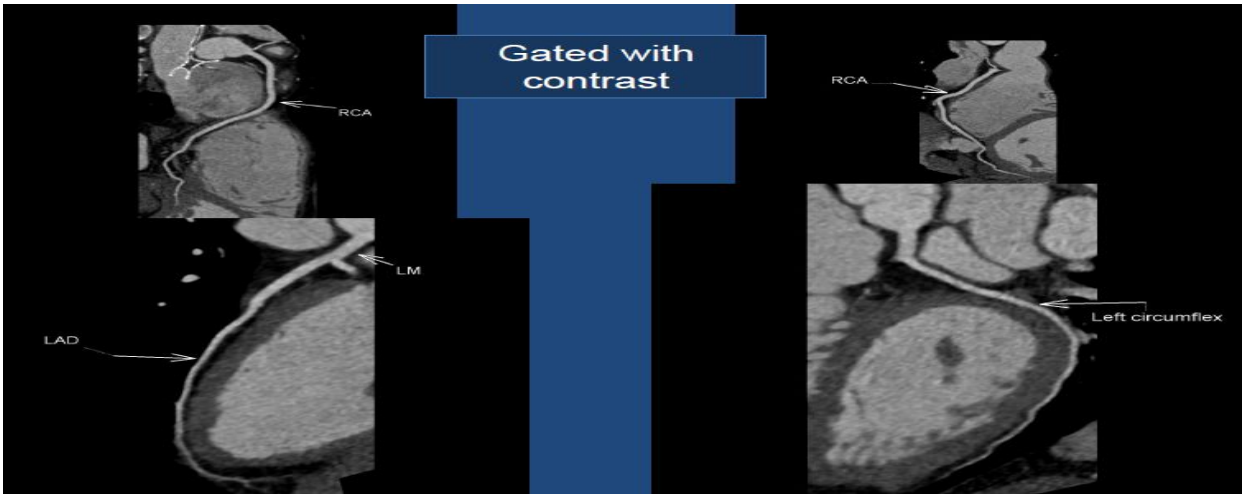




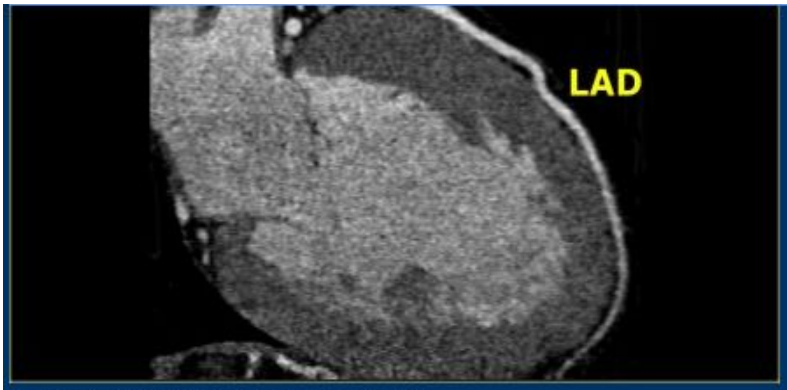
Plaque visualization



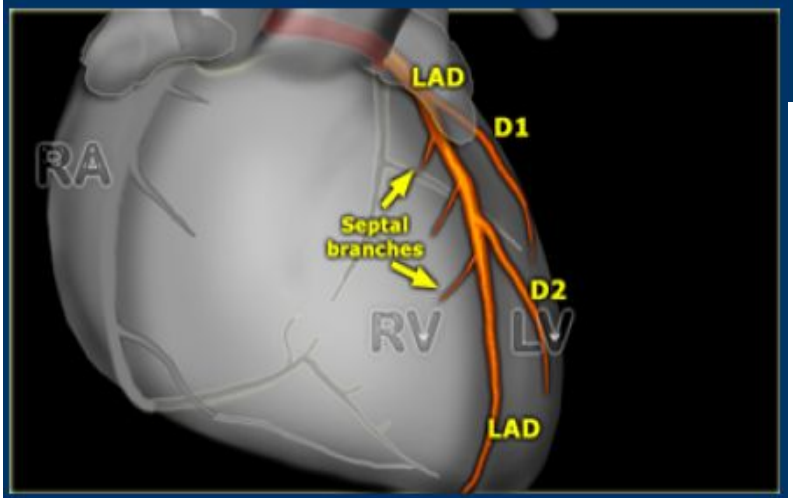
Gated with contrast

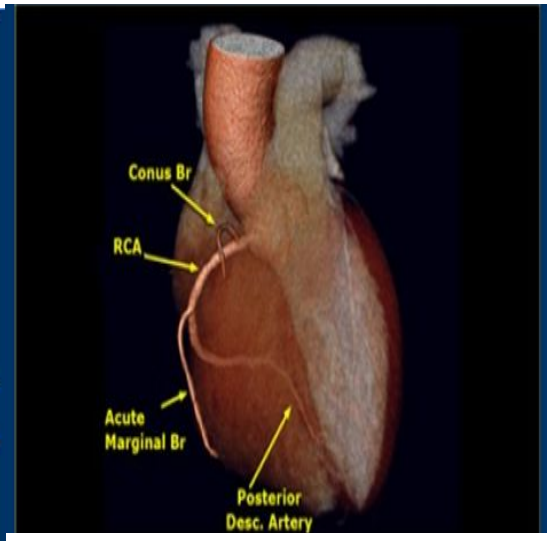


- **Knowledge of normal anatomy will allow for ideal imaging planes and sections.**
- **Knowledge of normal anatomy will allow for the identification of pathology and proper CT scan interpretation.**



CT image of the LAD in RAO projection

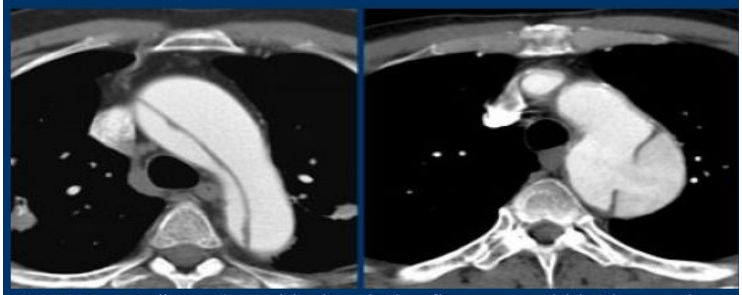




Branches of the vessels

AORTIC DISSECTION:

Classic Aortic Dissection



LEFT: Type A dissection with clear intimaflap seen within the aortic arch.RIGHT: Type B dissection. Entry point distal to left subclavian artery.

Before they couldn't give contrast in prober way to see clear image but NOW it's Very well defined Classical aorta dissection, blood goes throw intima .. So we can diagnose aorta with dissection very clear

MCQs

- 1 Advantages of HRCT

A. Enables us to see reversible and irreversible damage
B. Doesn't have radiation
C. Can be used with pregnant women

- A

- 2 transesophageal echocardiography

A. Evaluate for cardiac source of embolism
B. Lung parenchyma
C. Heart 3d image

- A

- 3 MRI Contraindicated with

A. children
B. Patient with pacemaker
C. Patient with previous exposure

- B

- 4we can see vessels narrowing by (best one)

A. X-ray
B. catheterization
C. CT

- C

Answers: 1.A 2.B 3.B 4.C

MCQs

- 5 the rib marked here is number:

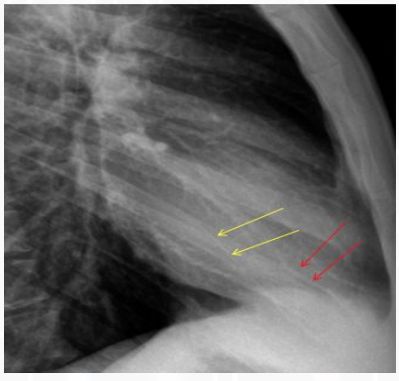
a. 6
b. 7
c. 8
d. 9

- 6 which of the following view is Commonly used in clinical practice (standard)?

a. AP
b. PA
c. Lateral

- 7 pointed with the yellow arrow is:

a. Left oblique fissure
b. Left transvers fissure
c. Right oblique fissure
d. Right transvers fissure



Answers: 5.C 6.B 7.A