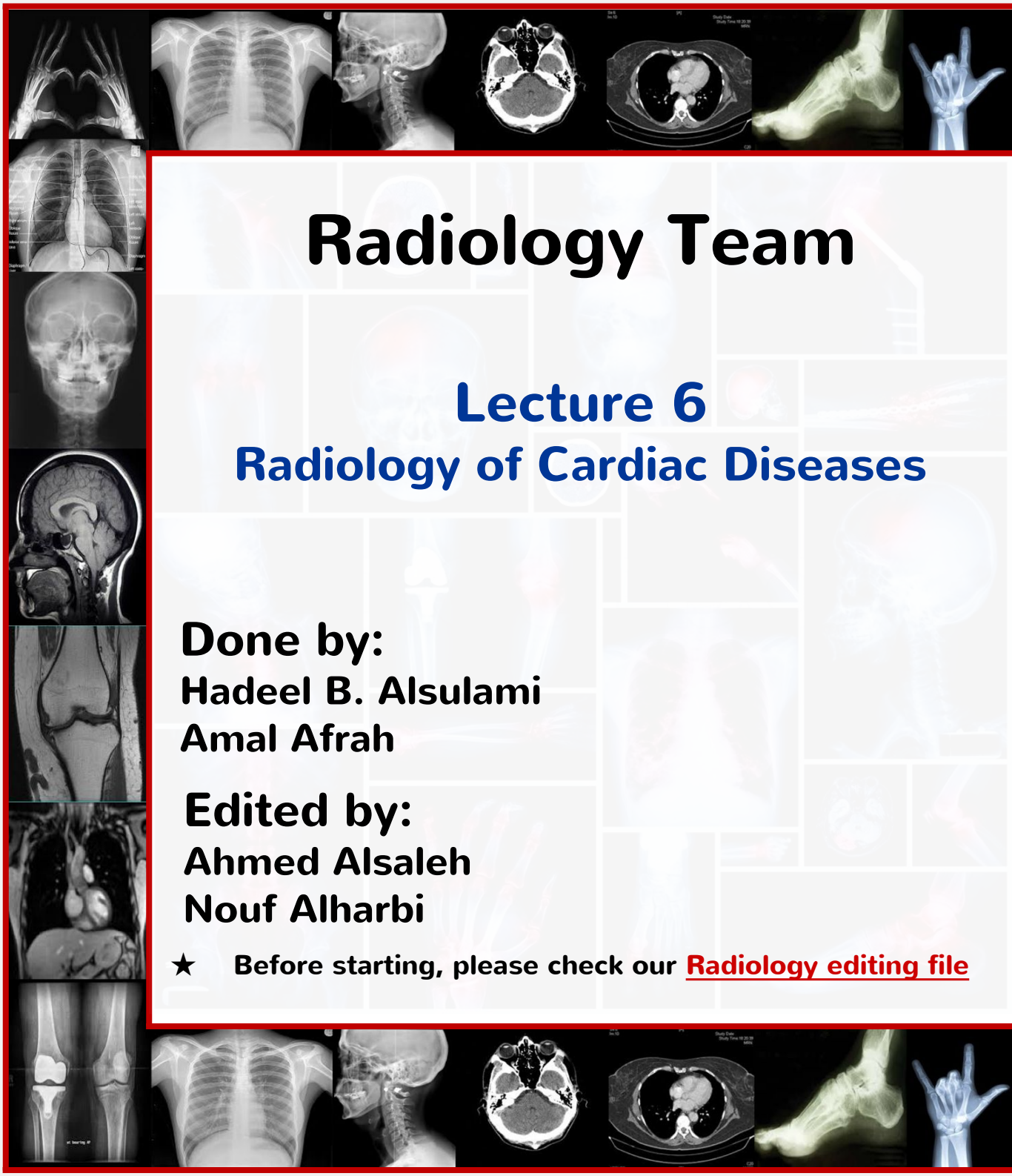
جامعة الملك سعود
King Saud University

RADIOLOGY TEAM 434



Radiology Team

Lecture 6
Radiology of Cardiac Diseases

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★ Before starting, please check our Radiology editing file

Color Index:

• Important • Females' notes • Males' notes • Explanations

Cardiac CT Angiogram

- When we need to do Chest CT? CT is done for chest once we have query of cardiac diseases.
- Examination for cardiac diseases always with I.V contrast
- **Advantages:** Safe, fast takes 5-10minutes, and **more accurate diagnoses.**
- Cardiac CT used commonly to diagnose **acute pulmonary embolism**, In the past they used angiography.
- In the past they used CXR to diagnose APE and in case of strong clinical suspicion they do catheter angiography " incise catheter through lower limb of patient and inject contrast in the pulmonary vessels, patient can develop cardiac arrest "20-30%" during examination and mortality rate in angiography 5-7% "
- Now they used to have indirect CT "inject IV contrast through antecubital vein then they do CT" very safe and contrast injection very fast + diagnosis more accurate.

Lung Window

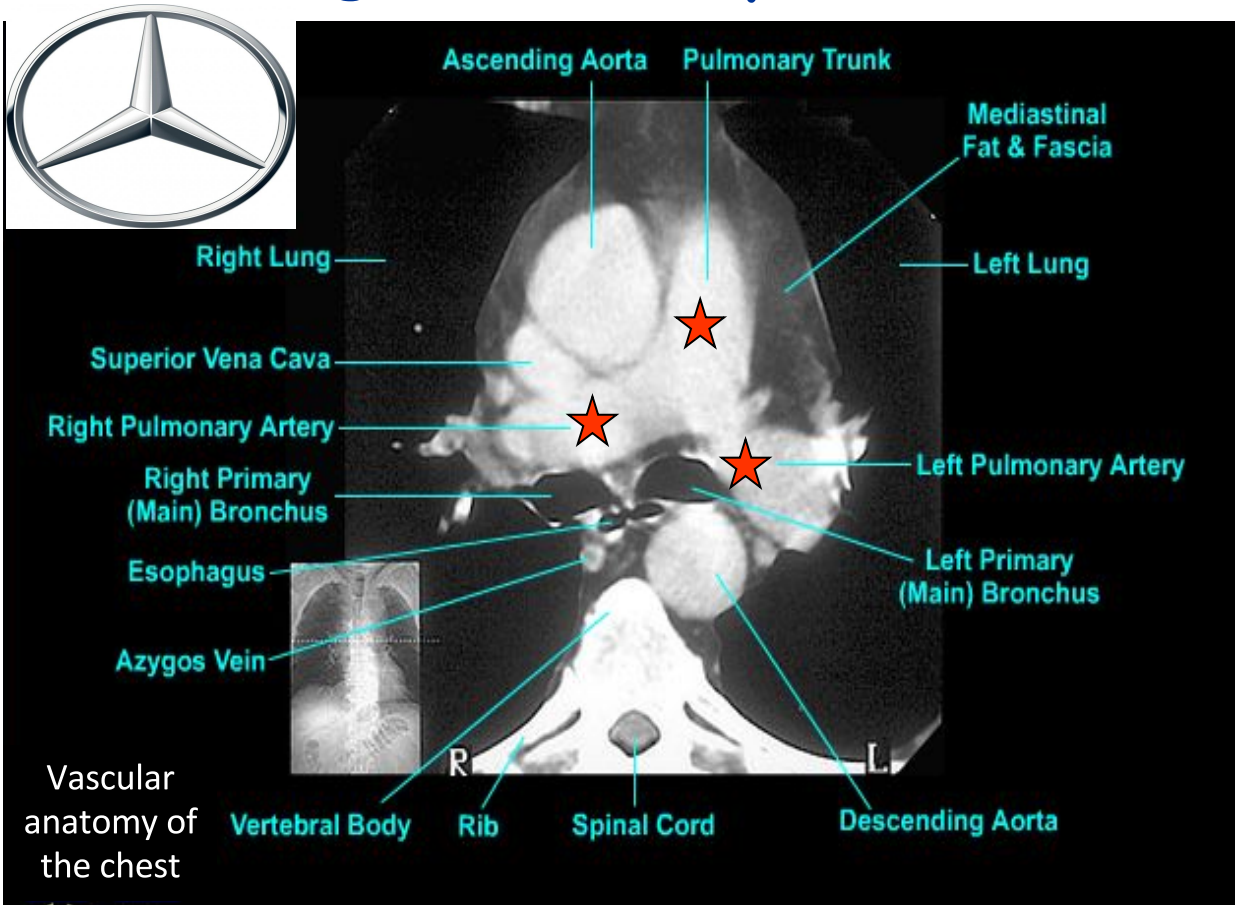
Mediastinal Window

Quick recall !

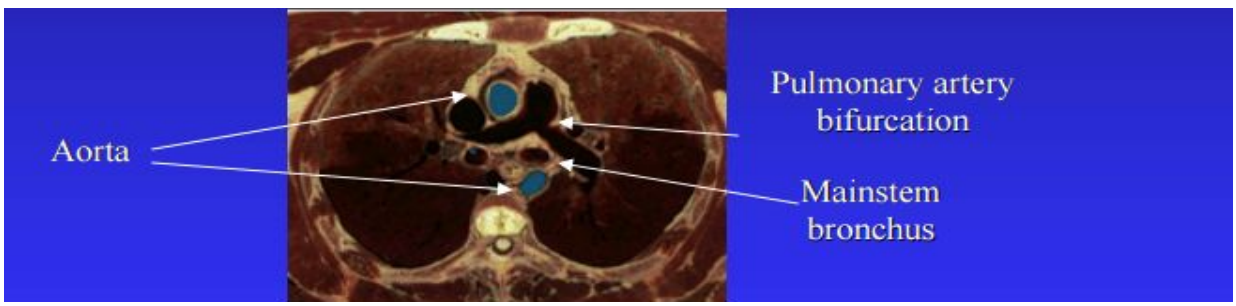
- There are two settings:

1. mediastinal window "structures"
2. lung window "able to see lungs clearly and the cardiac disease effect on the lungs"

Radiological Anatomy of the Chest



Vascular anatomy of the chest



- the most important thing when we see patient suspected to have pulmonary embolism is "to determine the level"
- **Scanogram:** is like CXR, this is examination at level of the hilar of the lungs " it's the most important level"

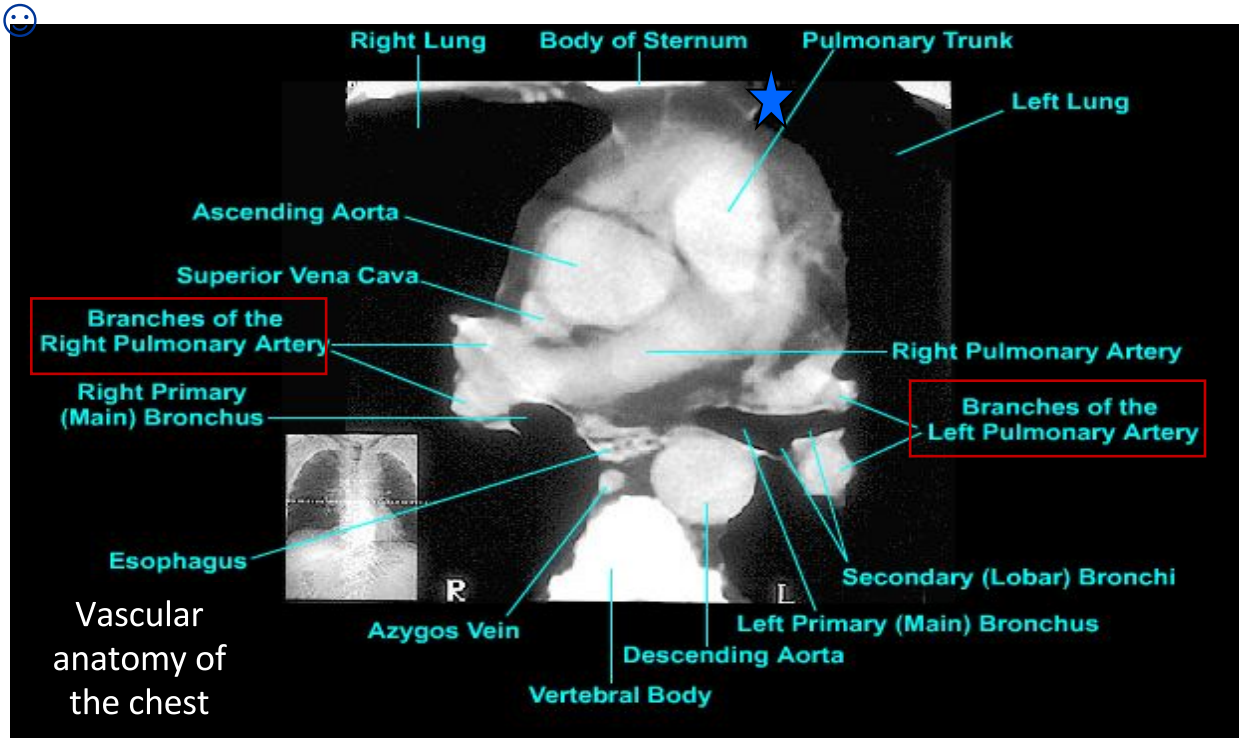
Mercedes area represents: " is one of important things you need to observe in the CT"

1- pulmonary trunk " main pulmonary artery"
2-Left pulmonary artery
3- Right pulmonary artery.

- The presence of embolus in these vessels known as massive embolus because this is major place ,If it occur periphrally it will be less massive.
- I.V contrast in optimal CT will show the vessles **homogenous white color** but in case of **embolus** or pulmonary thrombus it will be fully defected & **appears grey or black interraputing this homogenous contrast**
- shows the corresponding anatomy of CT "image in blue"

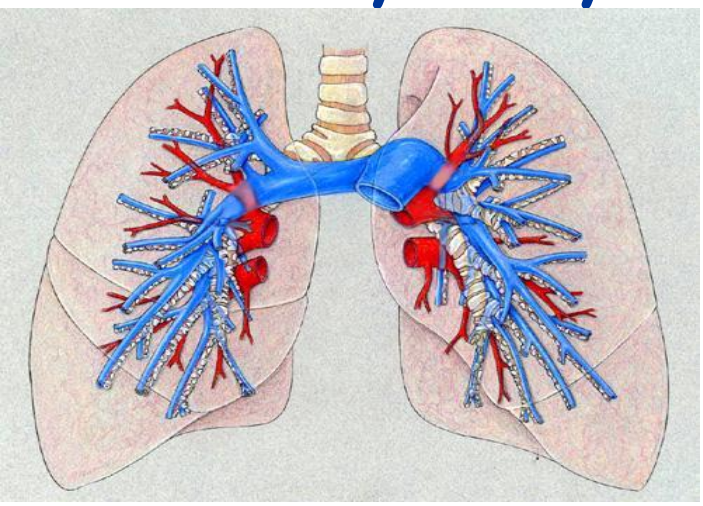
JUST Go throw this slide

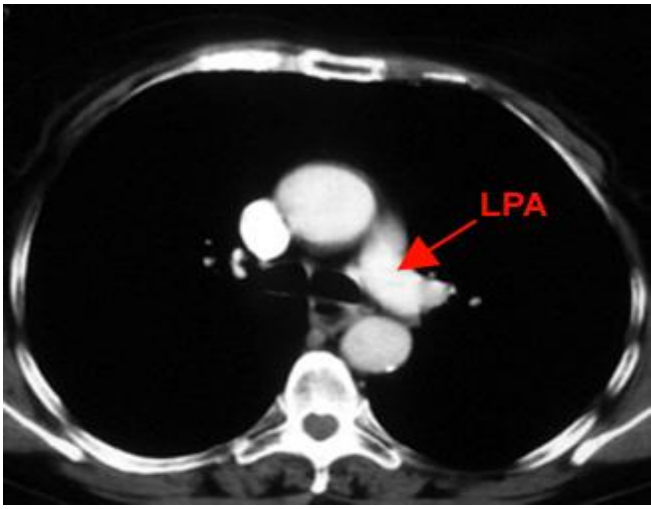
☺

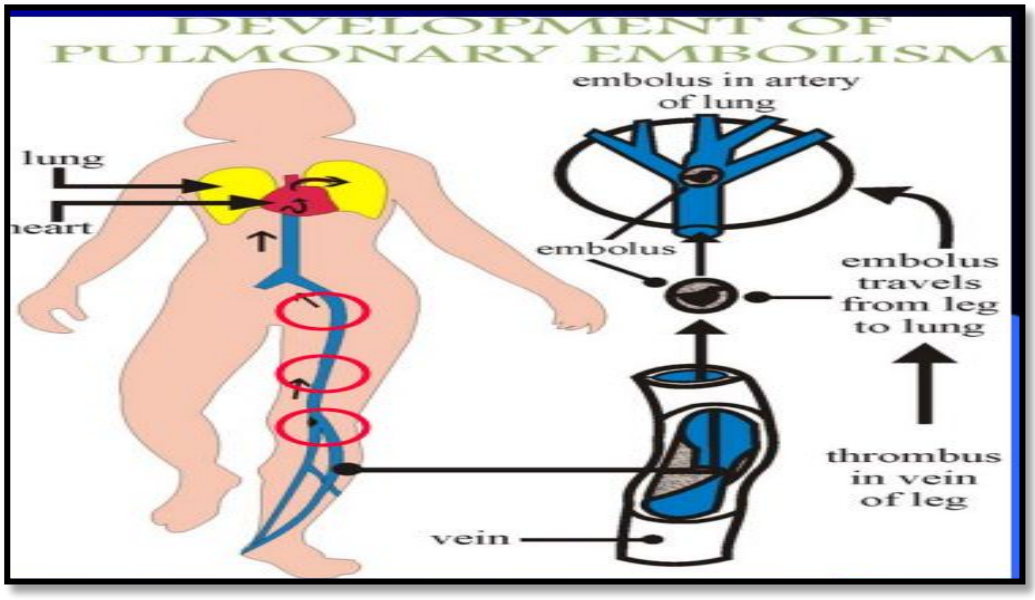


Vascular anatomy of the chest

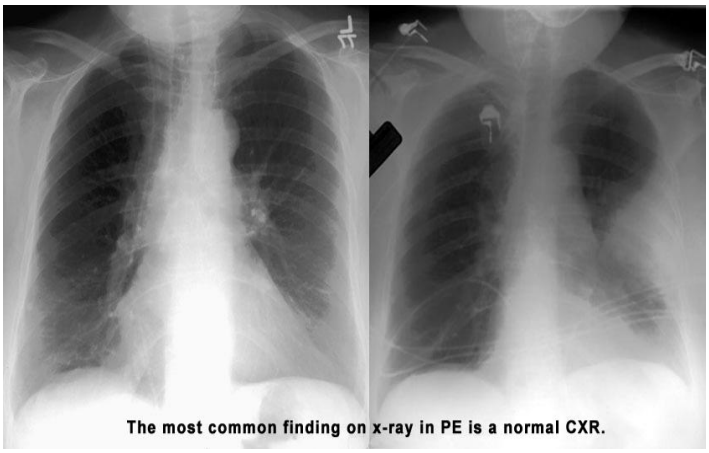
Pulmonary artery:



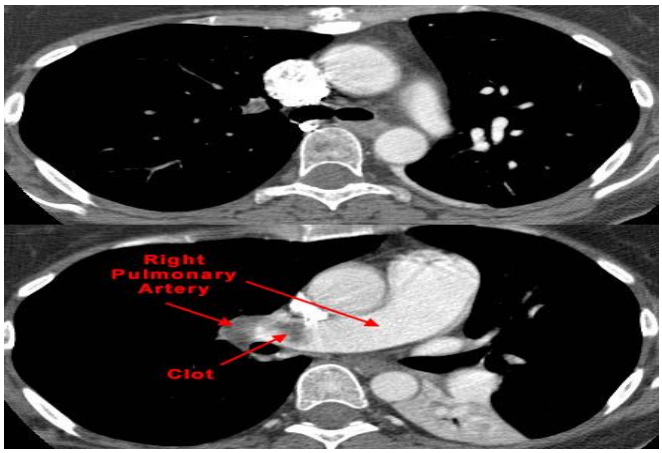




Pulmonary Embolism



Pic1 Pic2



Pic3

★**The gold standard to diagnose acute pulmonary embolism is CT angiography of chest.** "not angiography as before" .

But in Emergency the first thing done "for patients with chest problems is CXR, its **not diagnostic for Acute PE** "non specific signs" and the most common finding is **NORMAL CXR.**

Once we know that it will be normal on chest x-ray so why we do it ?!

- If the CXR is **normal** and there's high clinical suspicion and the history is supporting the theory we proceed to CT angiography of chest. **"to exclude PE"**
- If the patient is having PE and we rely only on normal chest X ray **(pic1)** the patient will come after about 24 hours with "massive pulmonary infarction" **(Pic2)** and that what happened to the patient.
- So CXR is done to rule out other causes of symptoms: "Pneumothorax, CHF, rib fracture".

We mentioned before normally blood vessels with contrast would appear homogenously enhancing "white". in this image **(Pic3)** we can see that there is part unwell enhanced this considered blood clot or thrombus or "**acute pulmonary embolism".**

We can diagnose PE by taking a good history and see the patient symptoms:

Hx: DVT, Bed ridden, long standing, pregnancy, OCP "oral contraceptive"

Symptoms: Dyspnea, orthopnea, sudden pleuritic chest pain.

Patient has predisposing factors such as " bedridden for long time or patient did pelvic operation and didn't move from the bed" causes thrombosis in lower limb: Deep venous thrombosis "DVT"

Thrombus in lower limb or pelvis dislodged into pulmonary vessels, **the most dangerous and fetal part that the thrombus could affect is pulmonary vessels.**

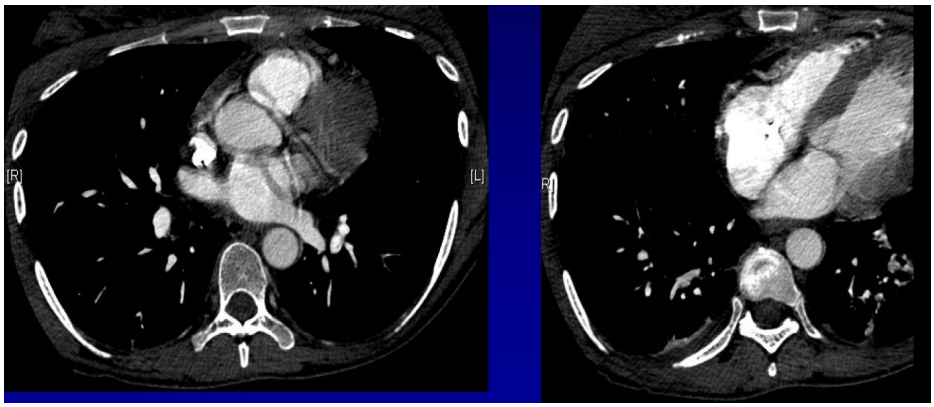
History of patient make differences " which highly important" e.g. patient came to ER either male or female presenting with:chest pain, difficulty in breathing

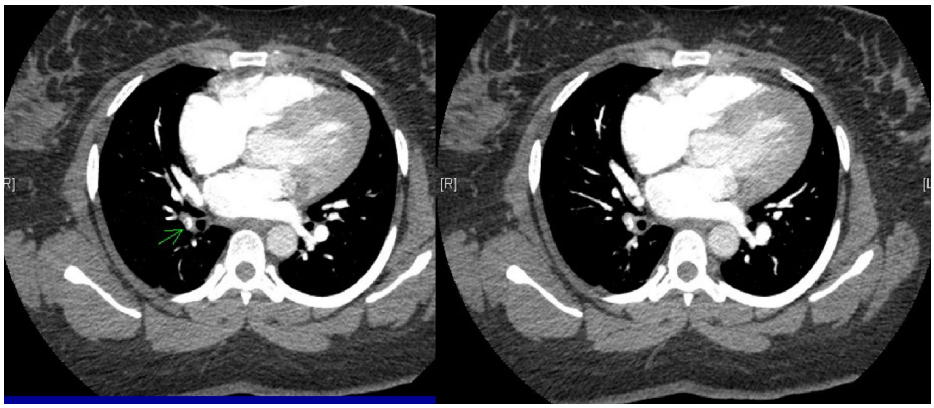
once you take history you discover that patient has predisposing factors : " bedridden or take any medication that increase coagulation of blood" so we need to do CT angiography to be able to see location of embolus.

These images are taken from base of lung up to the neck.

pulmonary vessels clearly enhancing "clear enhancing pattern", so if there is thrombus it will be very clear.

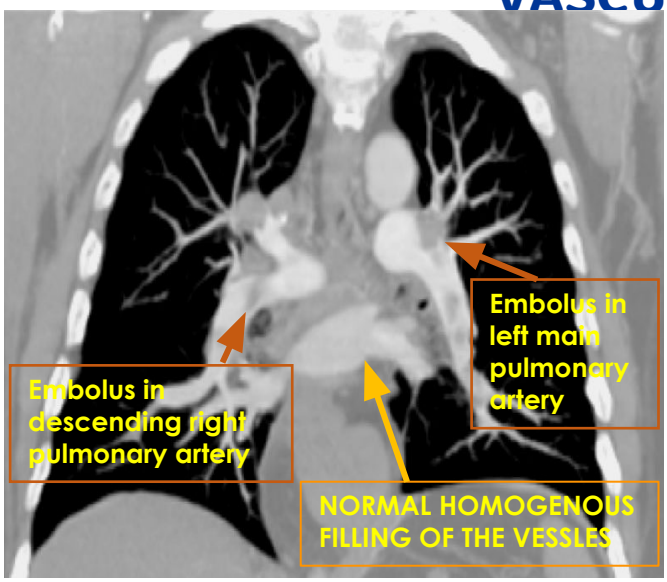
In the great vessels there is no thrombus but the thrombus is in the small peripheral arteries

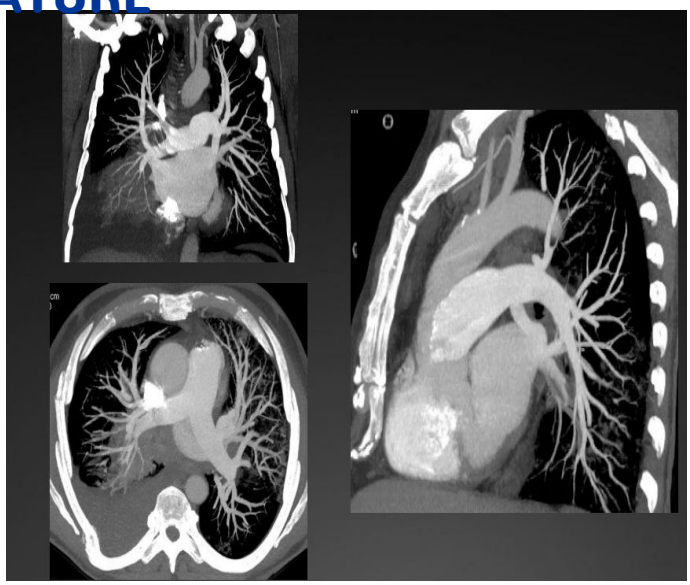




This illustrate what we can see in CT, after axial cut we can change setting to see vessels in details also we can change it into coronal image "as X-ray" also we can see sagittal images .**This is axial section**

CTA PULMONARY VASCULATURE



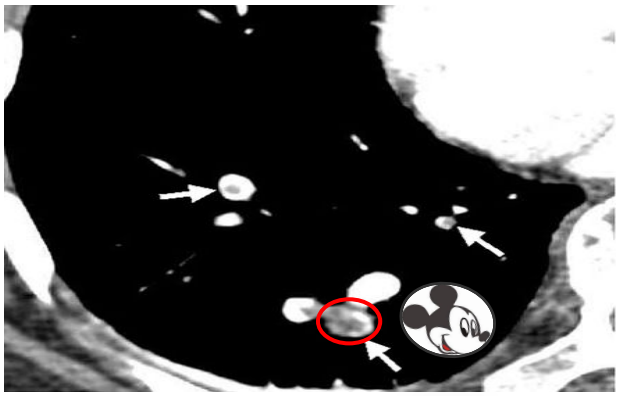


- Massive PE "in the major vessels, involve more than one side and even peripheral vessels".
- Coronal CTA filling defect = defect in contrast enhancement.

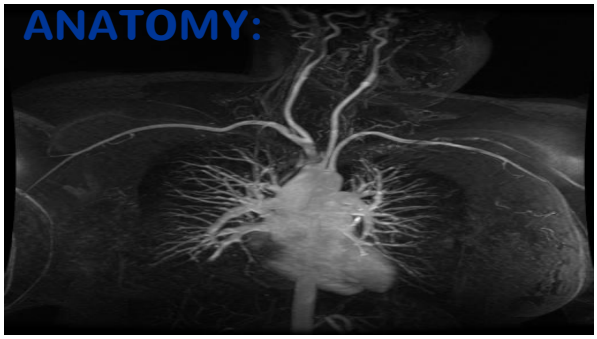
coronal section in CT angiography. (both above images).

CT Angiogram:

- By using CT angiogram we able to "zoom" and see peripheral small vessels.
- In this image we have **filling defect** of the contrast which **means PE**.
- **White = contrast**, **grey = embolus** or pulmonary thrombus which can be peripheral, central or all

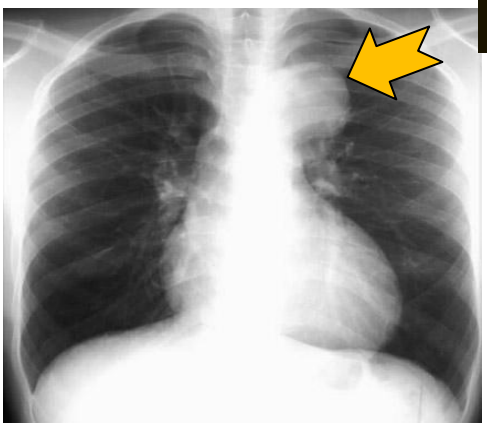


AORTIC ARCH ANATOMY:



We can use MRI (MR angiography) for examining great vessels, we can do it even without given IV contrast, but if we want clear images we will use IV contrast.
But there's **disadvantages:**
1- if we didn't give contrast we are not going to see small vessels peripherally
2- Takes 45 mins, cannot be done for a patient with acute PE (orthopnea & dyspnea)
3- Patients with cardiac devices such as pacemaker can't do it.

Aortic aneurysm:



Aortic knob/knuckle

- Right cardiac border is formed by right atrium and left border by Left ventricle and the apex.
- Aortic knuckle is part of aortic arch so if there is **pouch** it's called **aortic aneurysm**

It is enlarged if there's:
1. Increased pressure
2. Increased flow
3. Change in aortic wall

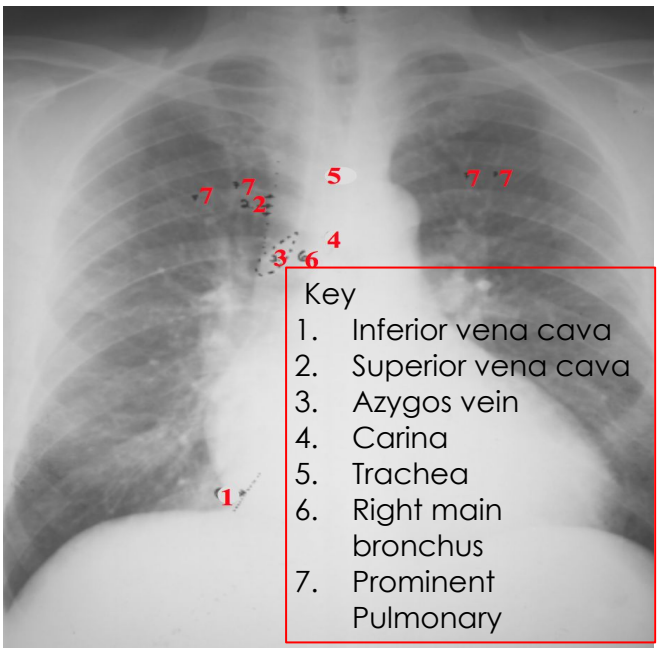
Note: the doctor didn't explain this, just go throw it.

Heart & Vessels:

Any and or all heart chambers may enlarge when the heart becomes diseased. Cardiomegaly = a big heart.

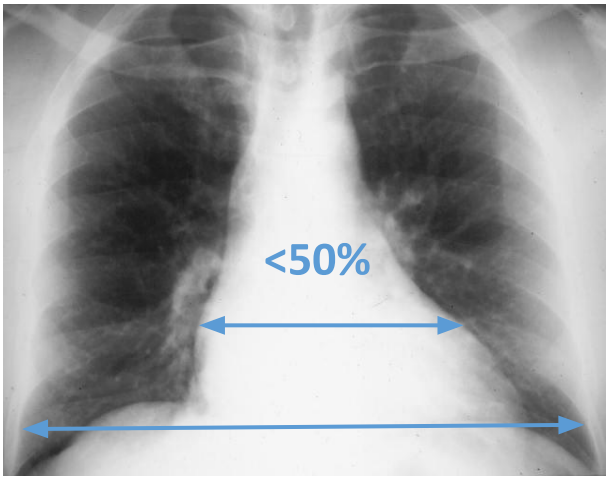
A patient's heart enlarges due to a number of diseases e.g. valve disease, high blood pressure, congestive heart failure.

If the heart fails, the lung often become congested. Early on the pulmonary vessels appear more prominent as in this case. More advanced failure can result in a condition of pulmonary edema which is fluid flooding into the alveoli of the lungs causing the patient marked shortness of breath.



Key
1. Inferior vena cava
2. Superior vena cava
3. Azygos vein
4. Carina
5. Trachea
6. Right main bronchus
7. Prominent Pulmonary

Cardiothoracic Ratio:



The only modality to know if the heart is enlarged or not is by calculating the **cardiothoracic ratio**. **How to do it?**
We take a **transverse line at the widest part of the rib cage** (just above costopherenic angle), and an **other transverse line at the widest part of the heart** and we **divided these two lines.** it should be less than the half of chest diameter **(<50%).**
Now, we do echocardiography to know if the heart is enlarged or not.

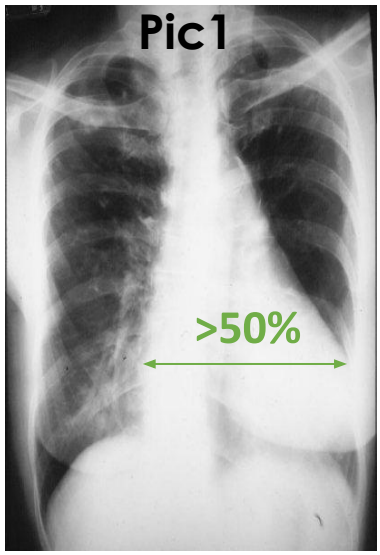
***sometimes Cardiothoracic Ratio >50% but heart is Normal "false Positive"** e.g. patient with depressed sternum which means the heart displayed " spread" so **Cardio-thoracic Ratio** will be abnormal while in reality it's normal

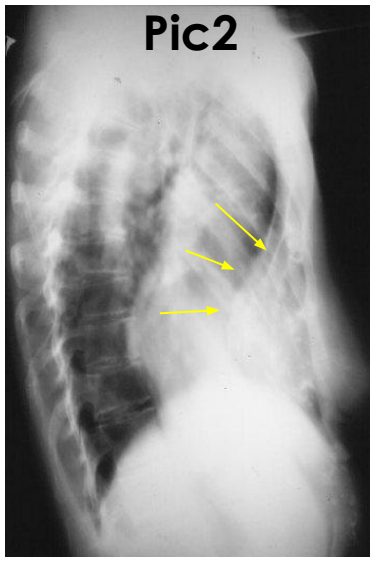
***sometimes Cardiothoracic Ratio <50% but heart is Abnormal " false Negative"** e.g. patient has cardiac problem such as Mitral Stenosis left atrium will be enlarged "has nothing to do with borders" so in CXR not enlarged but in reality it's enlarged"

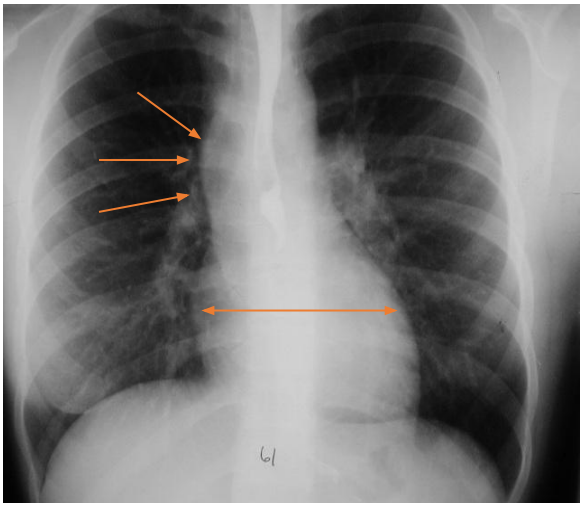
Extracardiac causes of cardiac Enlargement:
Portable AP films, Obesity,Pregnancy, Ascites, Straight back syndrome, **Pectus excavatum**

CTR >50% but heart is normal, this is because there is an **extra-cardiac** cause for the apparent cardiomegaly (Pic1)

On the lateral film(Pic2), the arrows point to the inward displacement of the lower sternum in a pectus excavatum deformity.





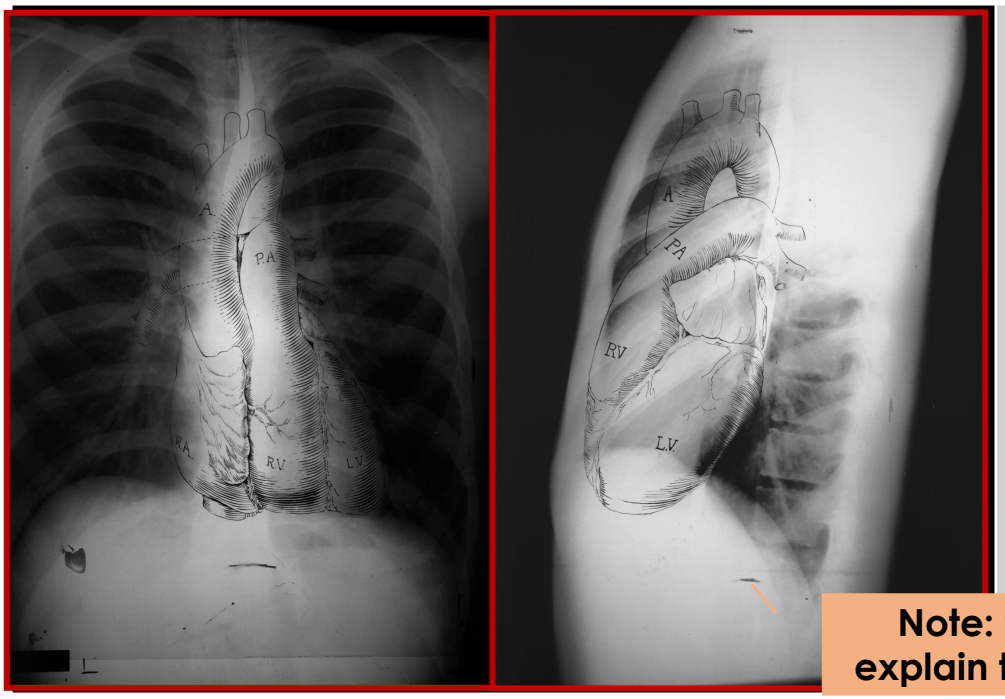


Note: the doctor didn't explain this, just go throw it.

- Obstruction to outflow of the ventricles e.g.:
- ventricular hypertrophy
- We must look at cardiac contours

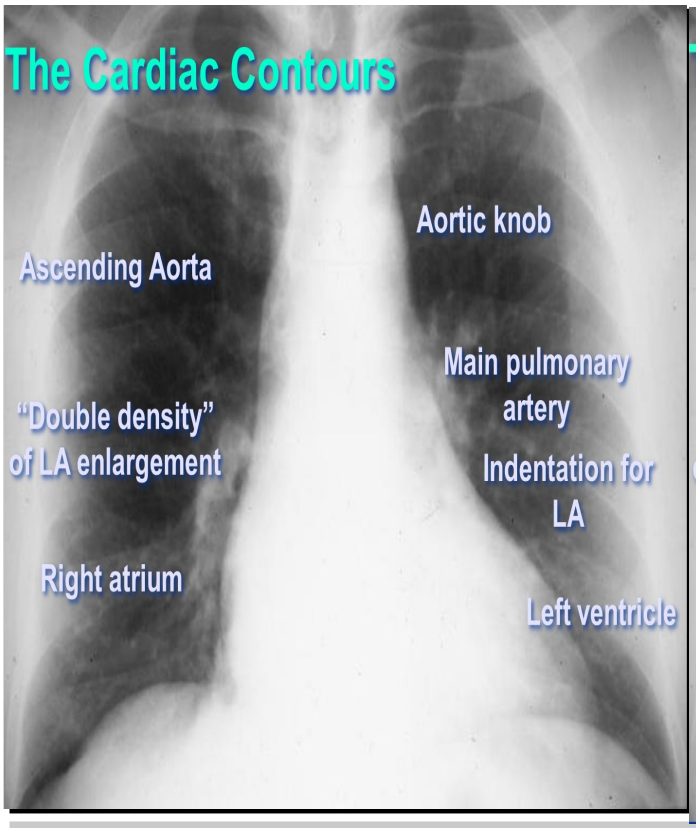
Here is an example of a heart which is less than 50% of the CTR in which the heart is still abnormal. This is recognizable because there is an abnormal contour to the heart (arrows).

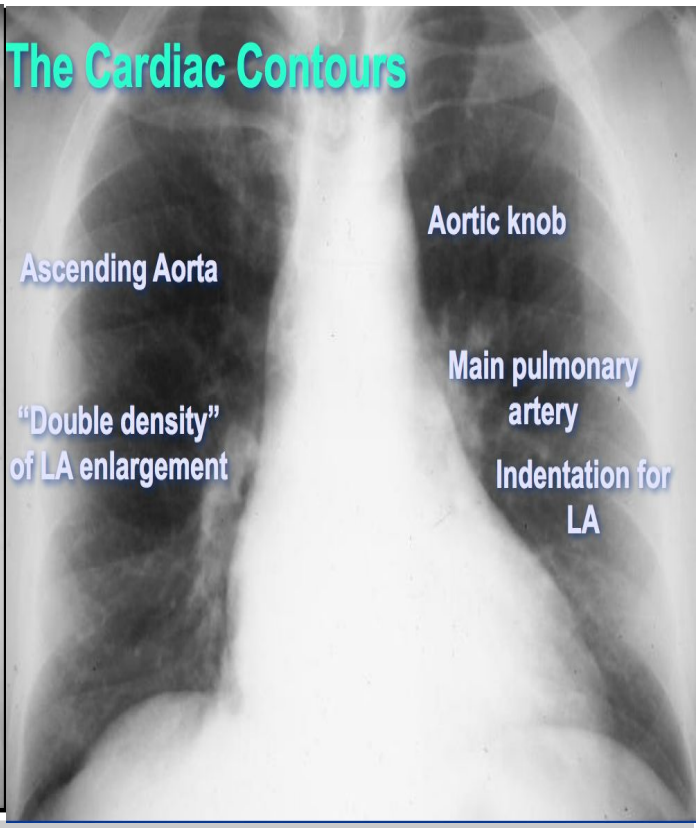
Anatomy on Normal Chest X-Ray



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

Note: the doctor didn't explain this, just go throw it.



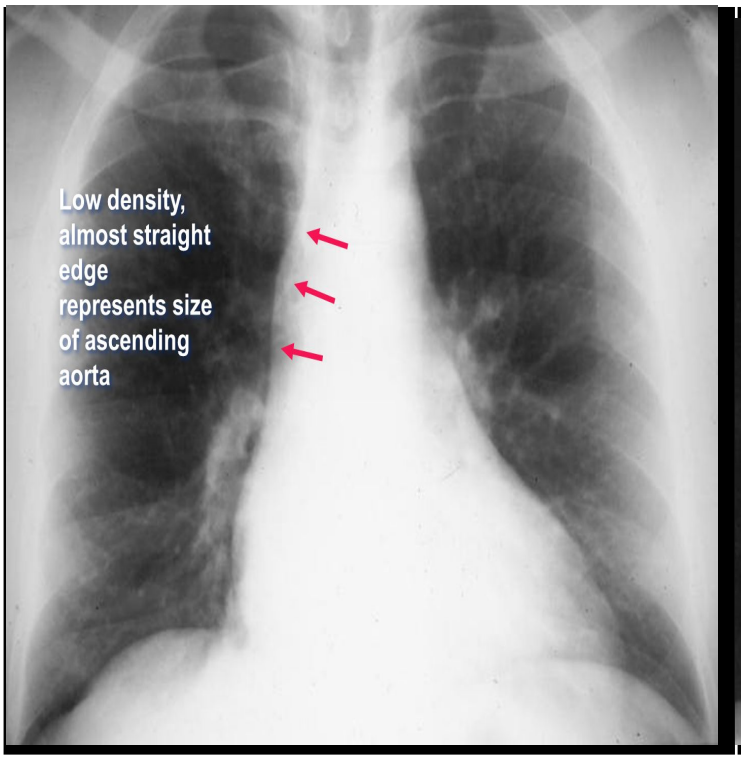


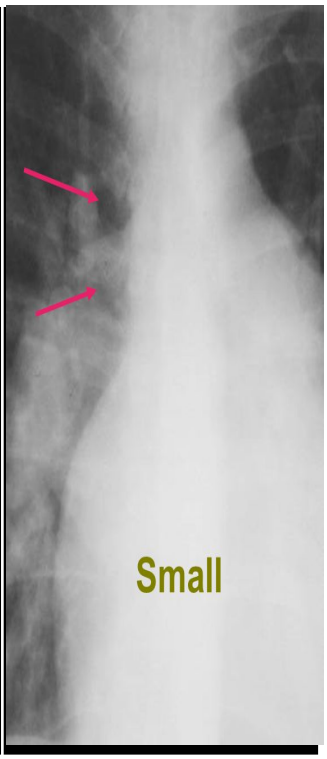
There are 7 contours to the heart in the frontal projection in this system. (left pic)
But only the top five are really important in making a diagnosis.(right pic)

Note: the doctor didn't explain these images, just go throw it.

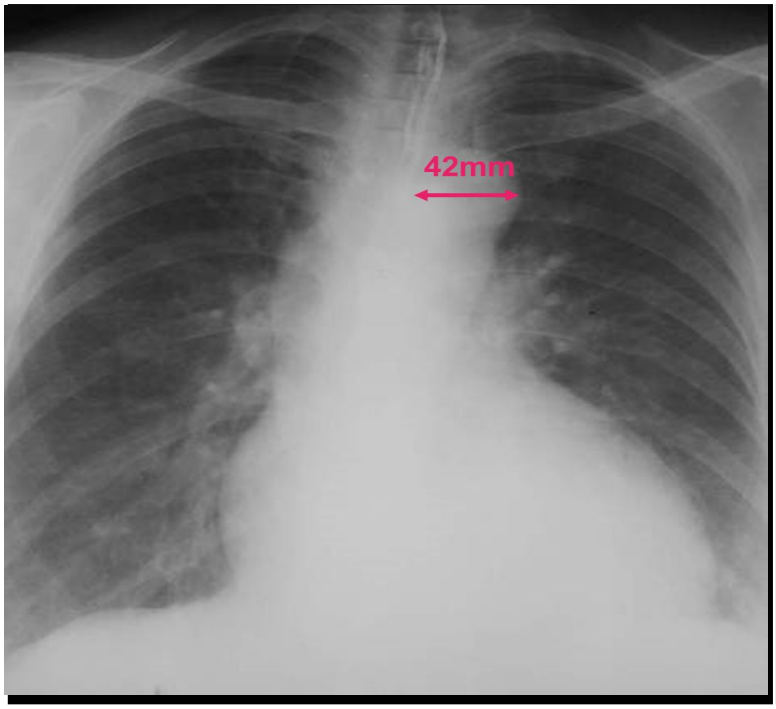
Ascending Aorta

Note: the doctor didn't explain this, just go throw it.





Know the site and if it'd dilated or not

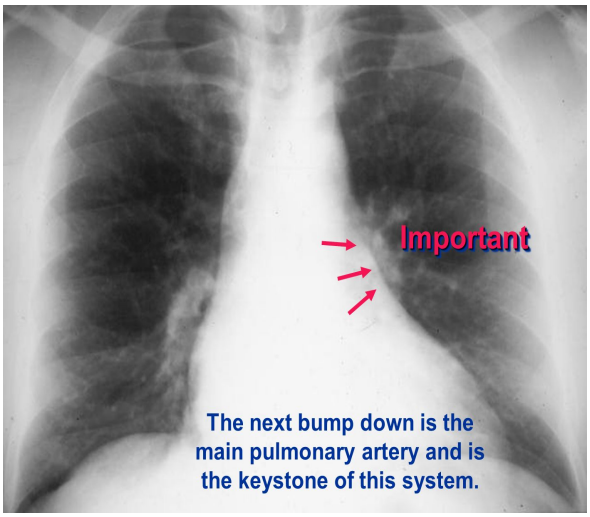


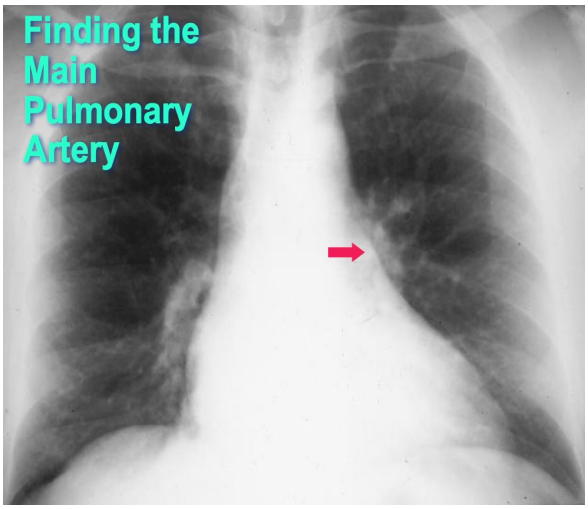
Enlarged with:

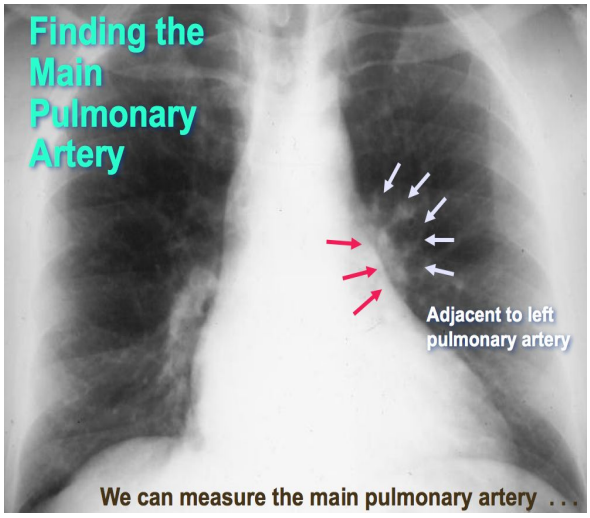
- Increased pressure
- Increased flow
- Changes in aortic wall

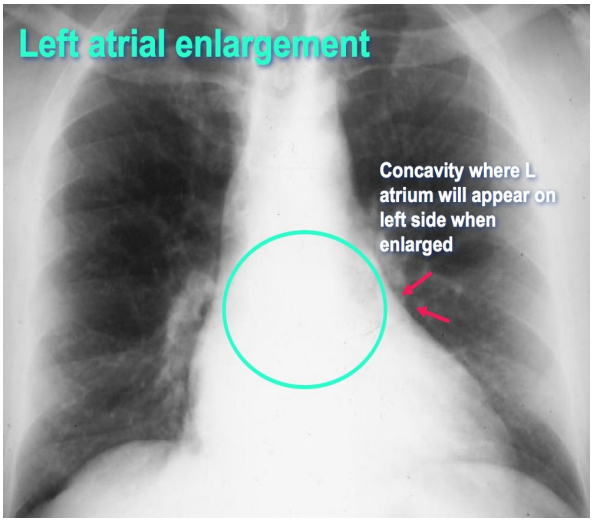
Note: the doctor didn't explain this, just go throw it.

Finding the Main Pulmonary Artery









Note: the doctor didn't explain these images, just go throw it.

The Pulmonary Vasculature

Pulmonary vasculature is an indirect sign of the status of the heart.
This means if the patient is having cardiac disease like mitral stenosis it will reflect on the pulmonary vasculature.

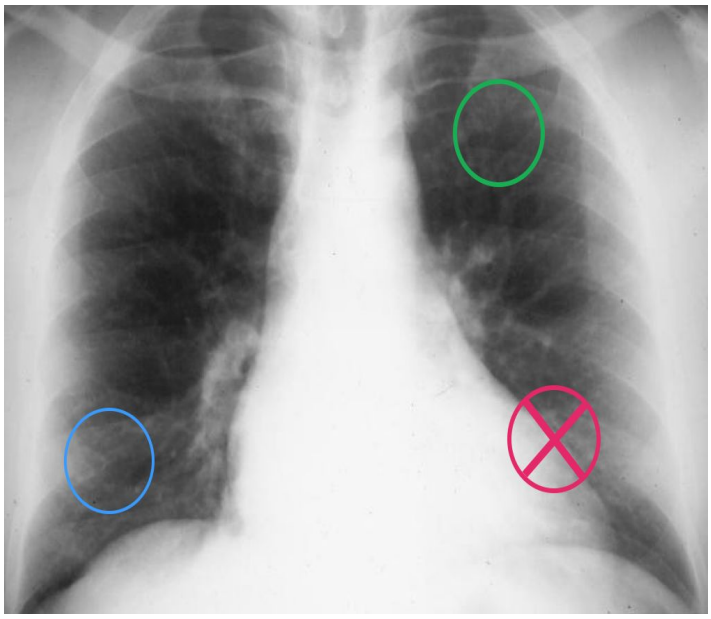
Five States of the Pulmonary Vasculature:

- Normal
- Pulmonary venous hypertension
- Pulmonary arterial hypertension
- Increased flow
- Decreased flow - mostly unrecognizable even when it is present

What to evaluate ?

1- Normal distribution of flow (upper vs. lower lobe):

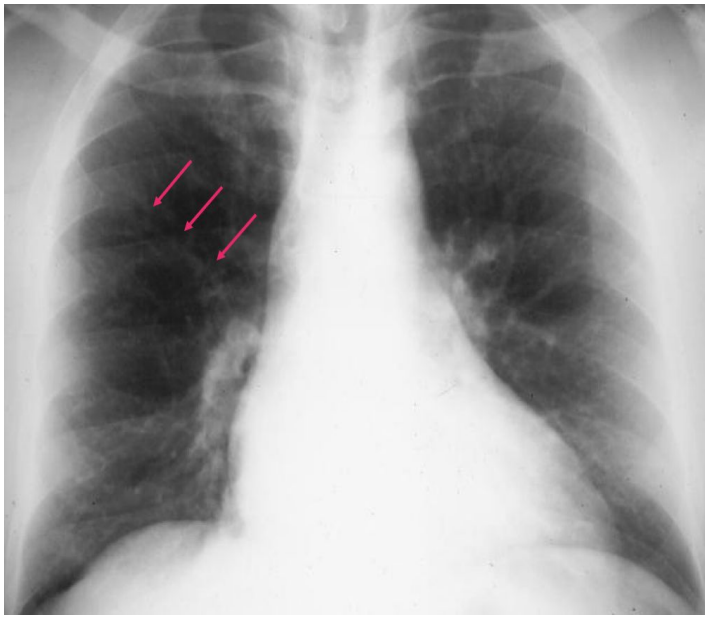
- In erect position, blood flow to bases **(blue circle)** > than flow to apices **(green circle)** because the Size of vessels at bases is normally > than size of vessels at apex.
- You can't measure size of vessels at the left base because the heart obscures them



Note: the doctor didn't explain this, just go throw it.

2- Normal distribution of flow (Central Vs peripheral):

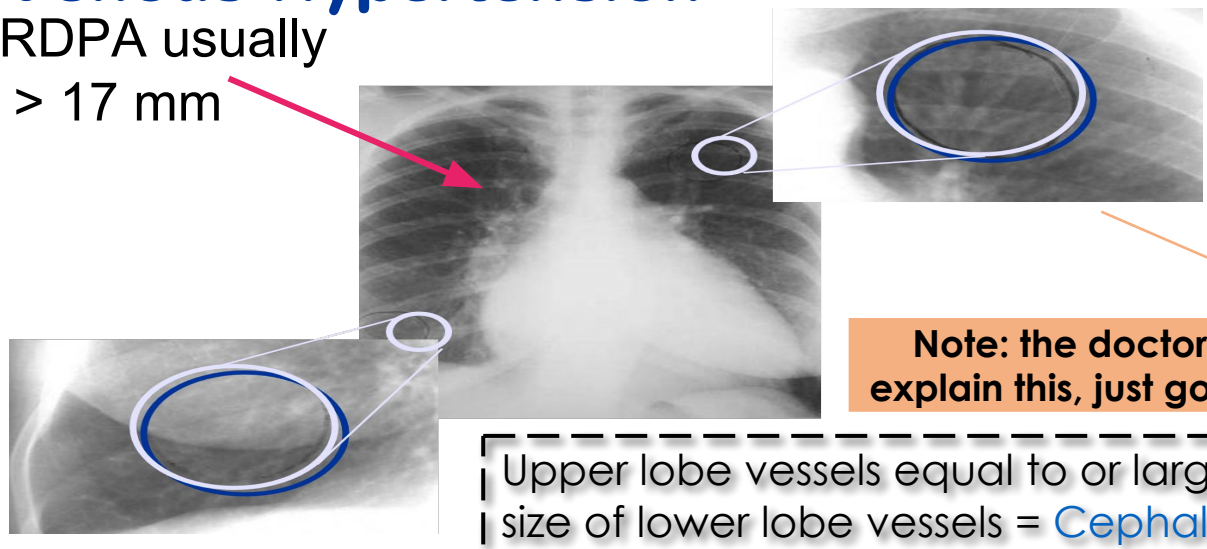
- Central vessels give rise to progressively smaller peripheral branches
- Normal tapering of vessels from central to peripheral



Note: the doctor didn't explain this, just go throw it.

Venous Hypertension

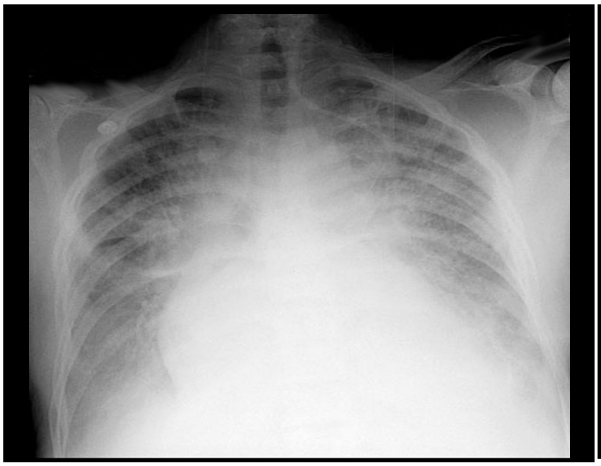
RDPA usually
> 17 mm



Note: the doctor didn't explain this, just go throw it.

Upper lobe vessels equal to or larger than size of lower lobe vessels = Cephalization

CHF



- Patient present with **dyspnea** in ER, and did CXR.

What is abnormal in this CXR?

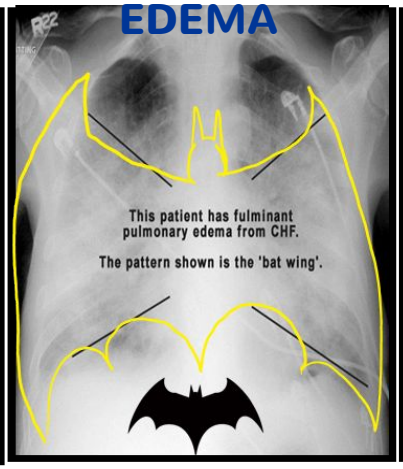
1-Consolidation "air space disease" Is it taking the shape of the lobe or diffused ? Diffused

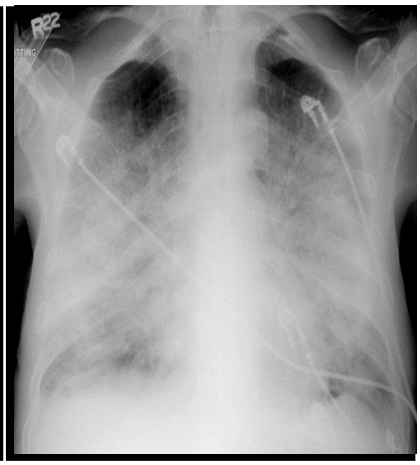
Not diffused completely it has low distribution because it's diffused when the patient has massive heart failure

2-Cardiomegaly " do you see the borders?" the right is clear but the left not clear because there is fluid in the lung "blurred" or congested"

3- Costopherinc angle not clear " because this image done while the patient is semi supine, However. The patient has pleural effusion"

ACUTE PULMONARY EDEMA





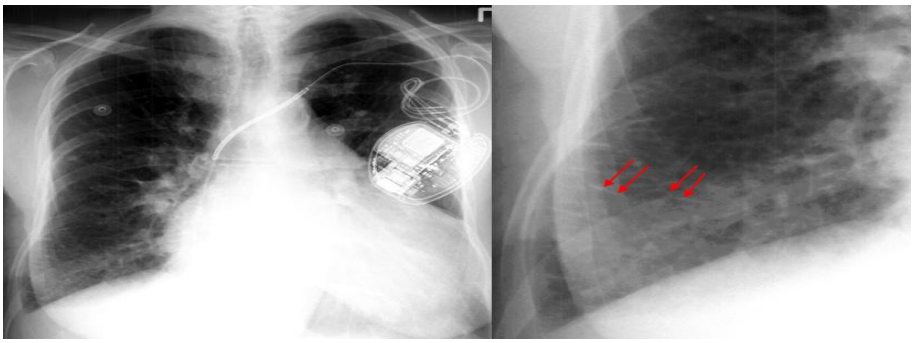
- Butterfly area "as it coming out from the hilum " the area of consolidation **"bat"**

Scenario:

2 doctors argue: **DR.1** said consolidation due to infection and **Dr.2** said patient has cardiac failure, In this case **History** helps. patient who has **infection** has **fever** & patient with **HF has dyspnea and orthopnea** so there are differences in clinical presentation.

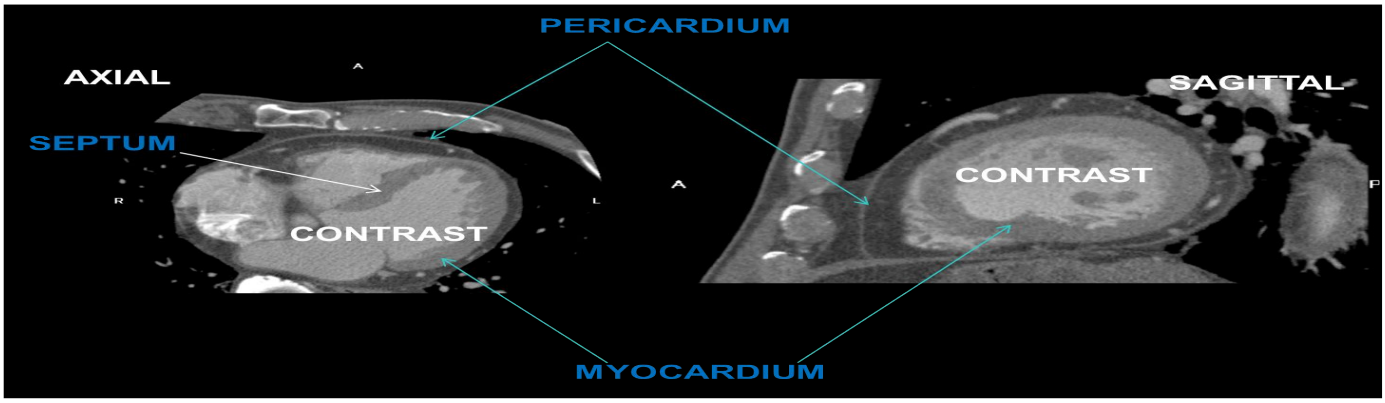
- if patient has **HF** there will be dramatic change in CXR within 1 hour after taking medication. However, if it's **infection** won't be any improvement within 1hour even with massive antibiotics
- So this is defiantly indication for **Acute pulmonary edema.**

KERELY'S B-LINES:

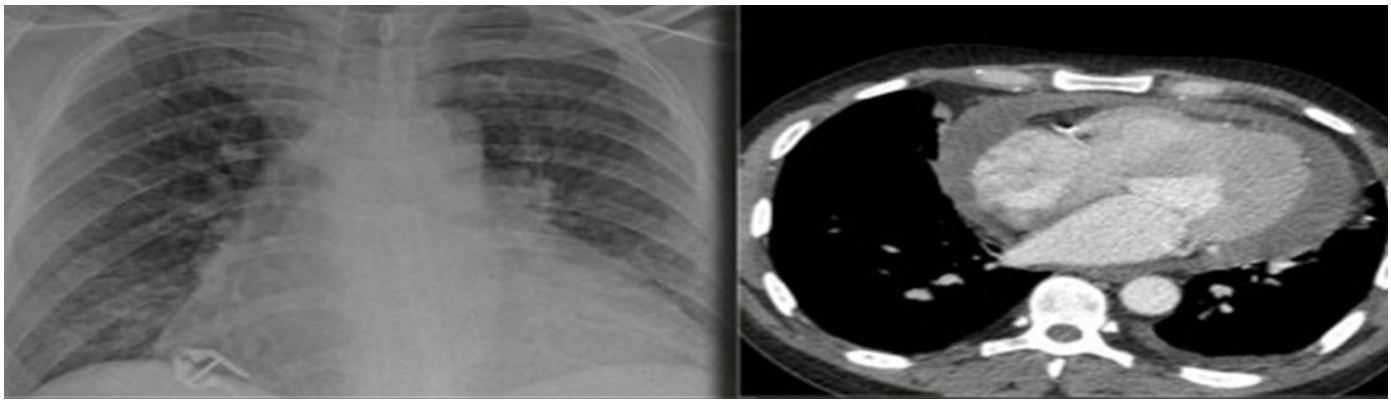


seen when the interlobular septa in the pulmonary interstitium become prominent.
caused by **pulmonary edema**

Cardiac CT:

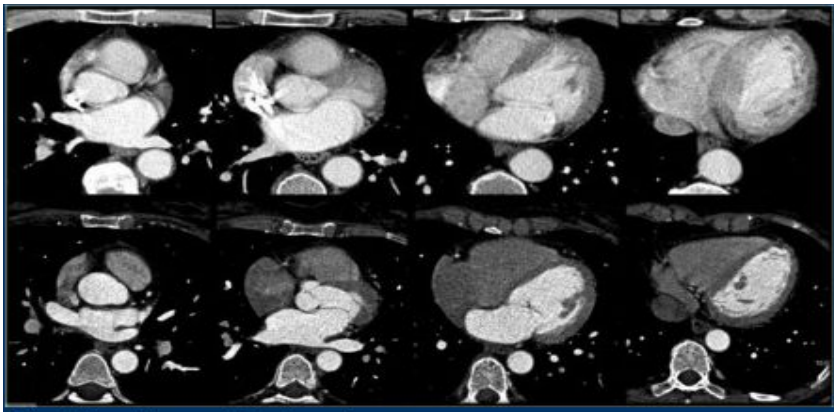


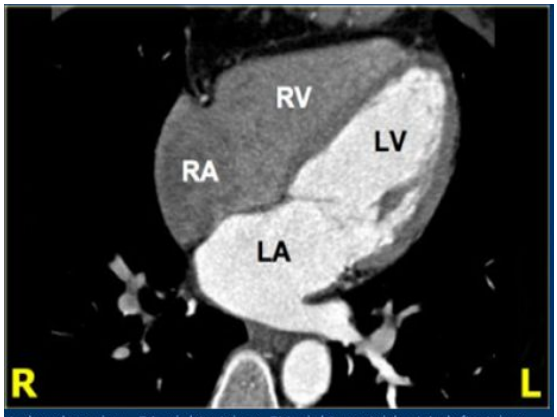
- Coronary is better to be seen in CT: limited time, IV contrast " a lot of details you will be able to see" .
- Will take Sagittal, axial and coronal images.
- **Notice the clear details:** muscle of the heart, lumen, chambers and septum also the fat between cardiac muscle and pericardium "very thin line ", space between pericardium and heart supposed to be filled with fat if it's filled with water we call it **pericardial effusion** "sometimes after trauma rather than fluid you find blood".



- Whenever we **encounter a large heart figure** , we should always be aware of the possibility of **pericardial effusion** simulating a large heart.
- On chest x ray it looks as if this patient has dilated heart while on CT it is clear, that it is the pericardial effusion is responsible for the enlarged heart figure.
- Why isn't cardiac Tamponade ? Different history
- In chest x-ray we see cardiac enlargement

CARDIAC CHAMBERS CT:


Axial slices through the heart



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

we able to see chambers, different phase of contrast , left side and right side, cardiac mobility " pulsating heart".

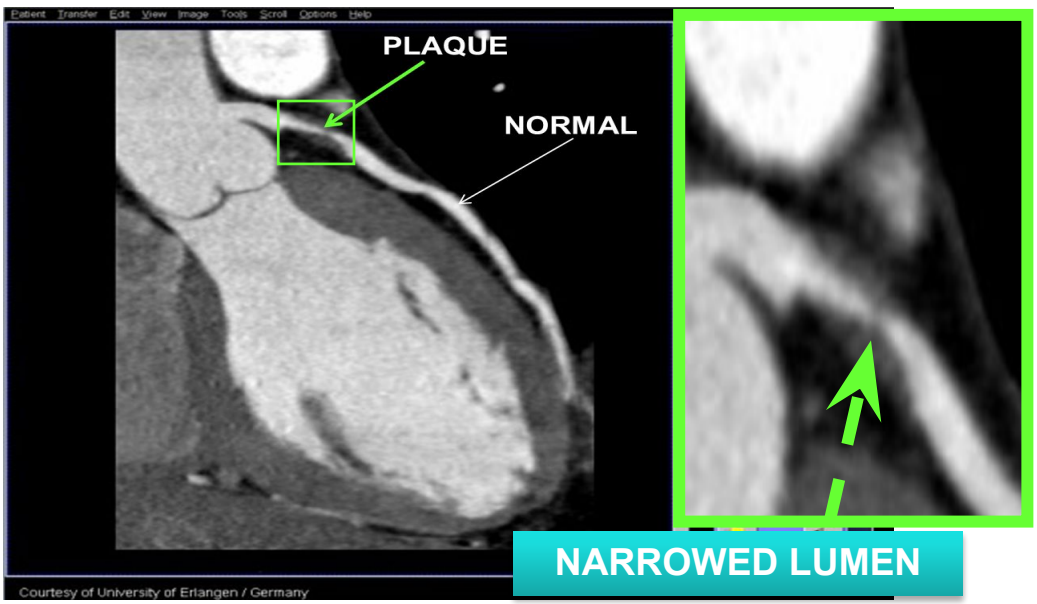
Maximum Intensity Projection

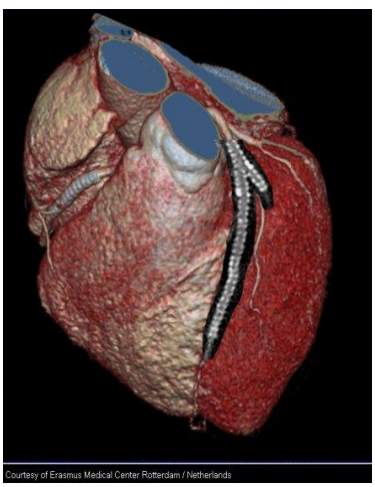
Soft Plaque in Proximal LAD

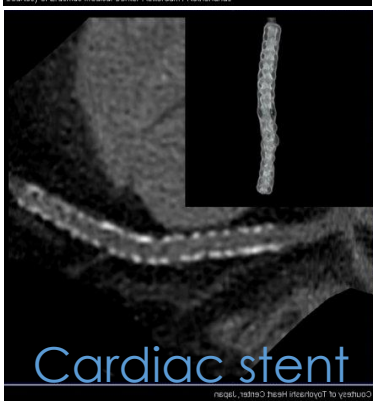
CT Coronary angiography " a true revolution in cardiac imagining "

We use it to see:

- Coronary arteries narrowing and vessels in general
- Valves
- Heart muscle thickness



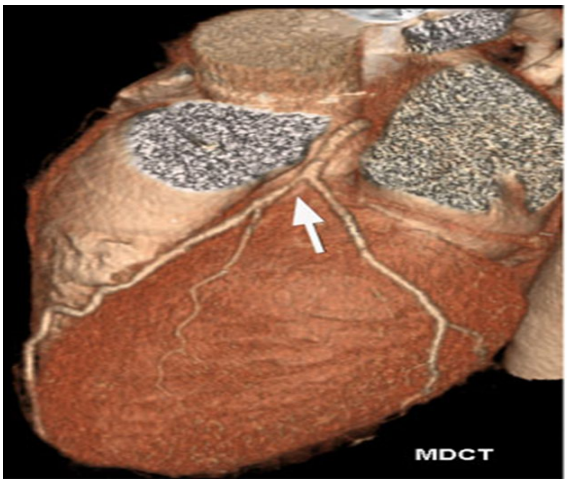

Courtesy of Erasmus Medical Center Rotterdam / Netherlands

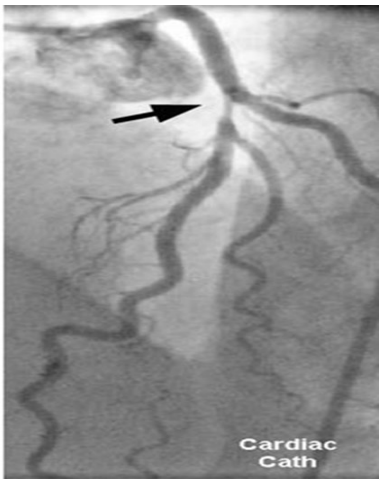


- The narrowing of the vessel is called area of stenosis or plaque
- If the intensity of narrowed vessel is similar to muscle it called soft plaque
- Treated by placement of stent through cardiac catheter angiography

also called balloon angiography or **Angioplasty**

Plaque visualization





PLAQUE = VASCULAR NARROWING

We able to determine where is the narrowing and insert cardiac cath to put stent in the narrowing area, we can see clearly stenotic area and which vessel has stenosis and the degree.

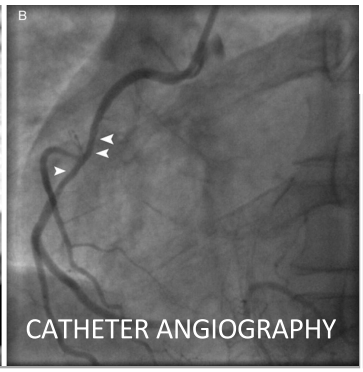
This appearance we used to have it only by catheter angiography, and we do this procedure only when the patient needs dilatation of the narrowing or replacement of stent.

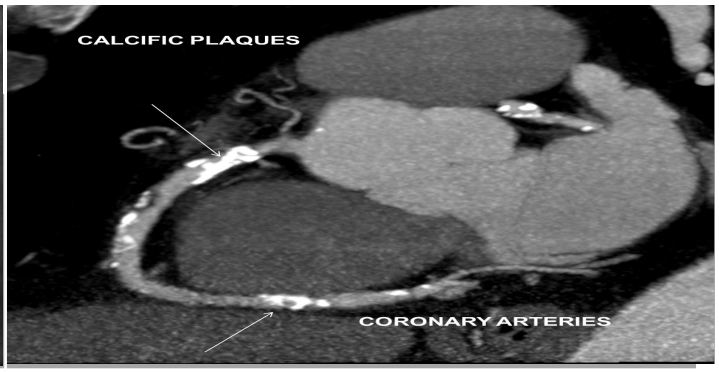
But if you need shorter technique do this one "MDCT"* you can see stenosis very clear as angiography , we can determine the site, measure the length or see it in 3D image.

After applying stent no need to see how is it by cardiac cath, just follow up with CT.

How we able to see the whole vessel although it has stenosis?

As the vessel not blocked totally the contrast will pass.





Soft Plaque Visualization:

- Another example of soft plaque "not calcified", in this case they can apply balloon dilatation and put stent.
- by CT : muscle, lumen of the heart, vessels, cause of narrowing

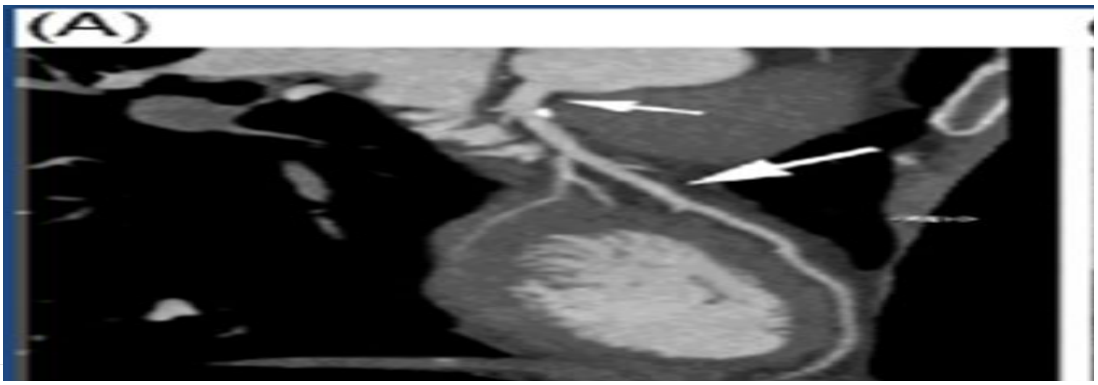
While you can't see all these in "catheter angiography"

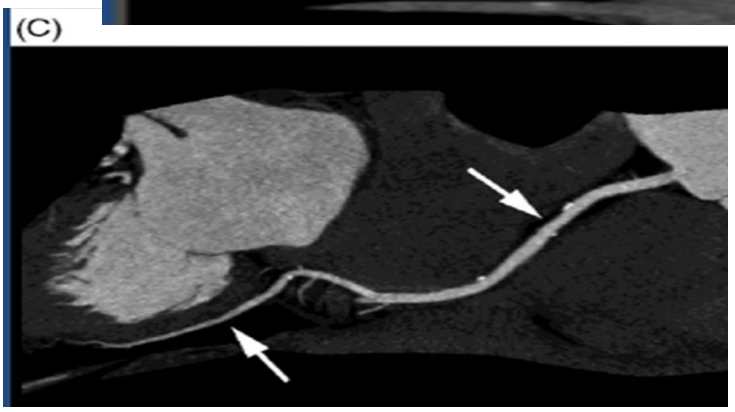
Calcific plaque "hard":
very dense, you able to see the site in different parts of coronary vessels.

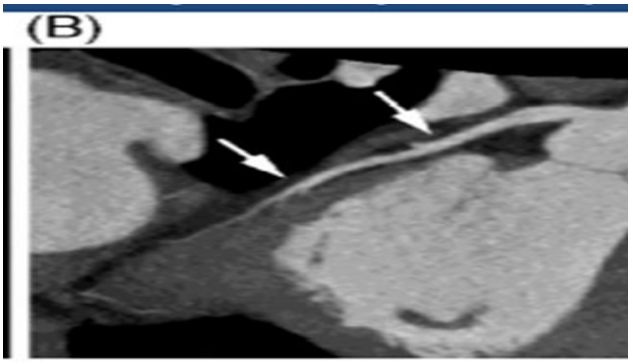
- you can see details of plaque and measure them also by computer you can see vessels spread out

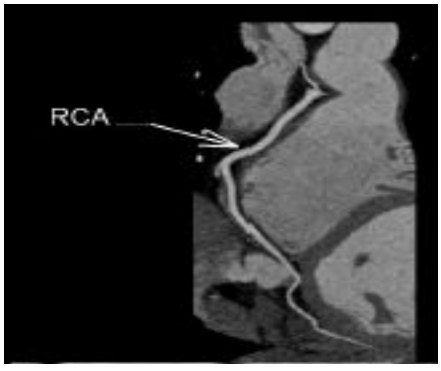
*MDCT: Multidetector computed tomography

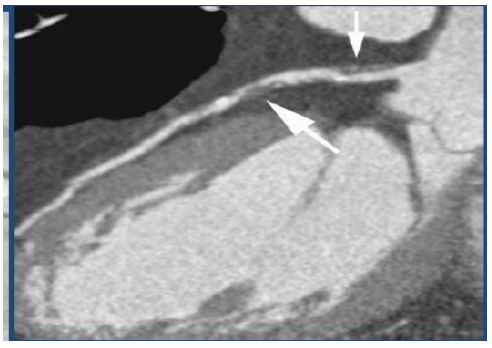
Visualization of vessels with CT + contrast

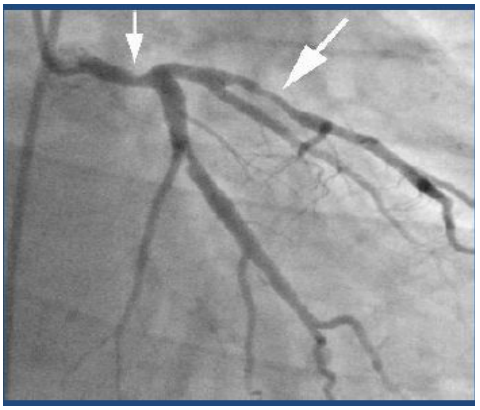












Note: the doctor didn't explain these images, just go throw it.