

# Radiologic investigation of Chest and CVS diseases

By

*Dr Mohamed Sherif El-Sharkawy*

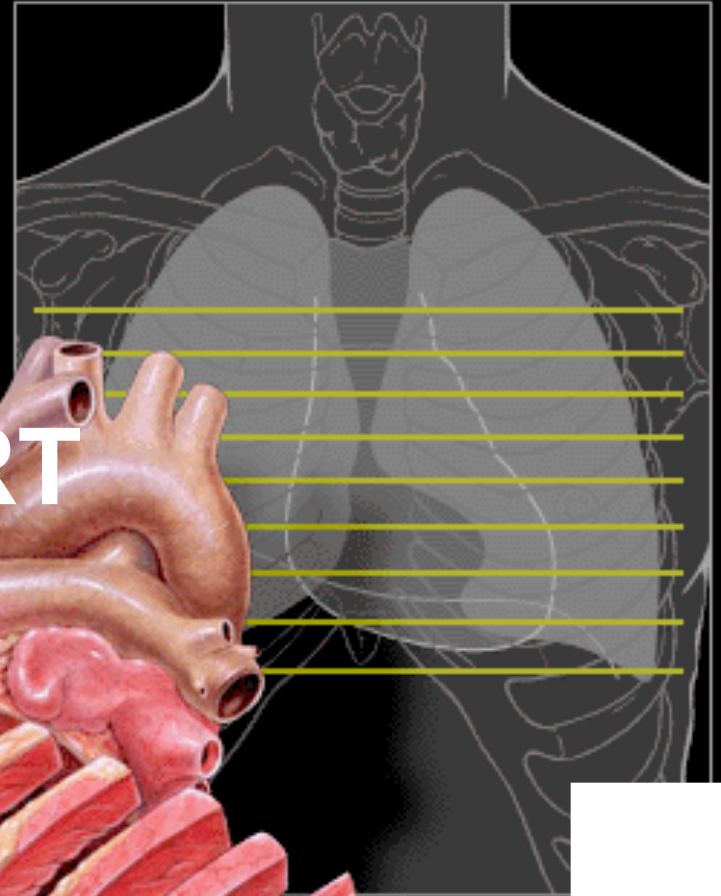
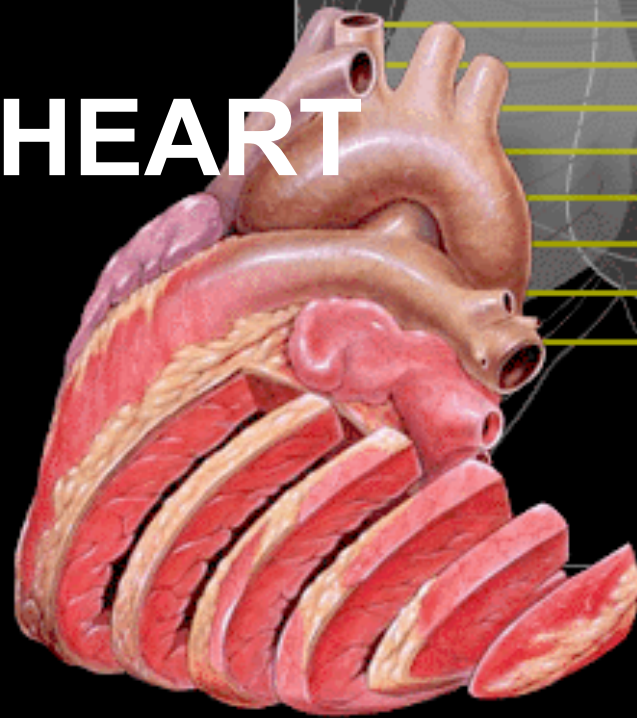
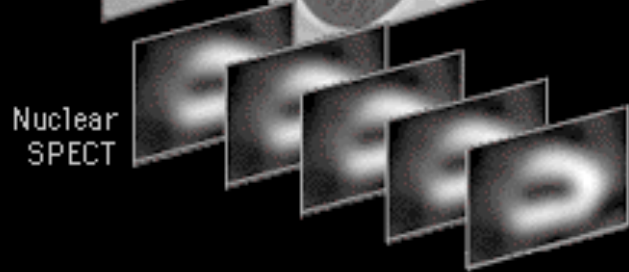
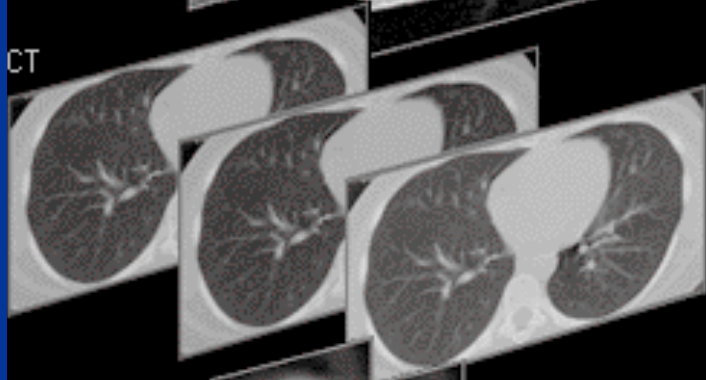
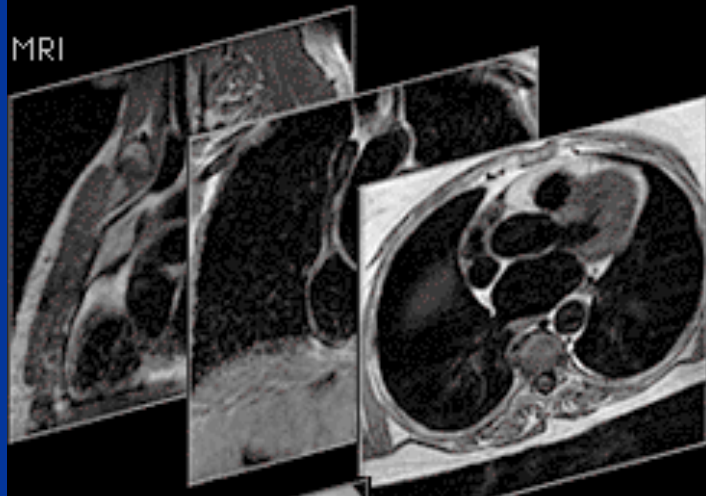
**ASSOCIATE PROF. and Consultant Radiologist**

**KKUH**

**KING SAUD UNIVERSITY**

LAST UPDATE  
SEPT 2020

# HEART

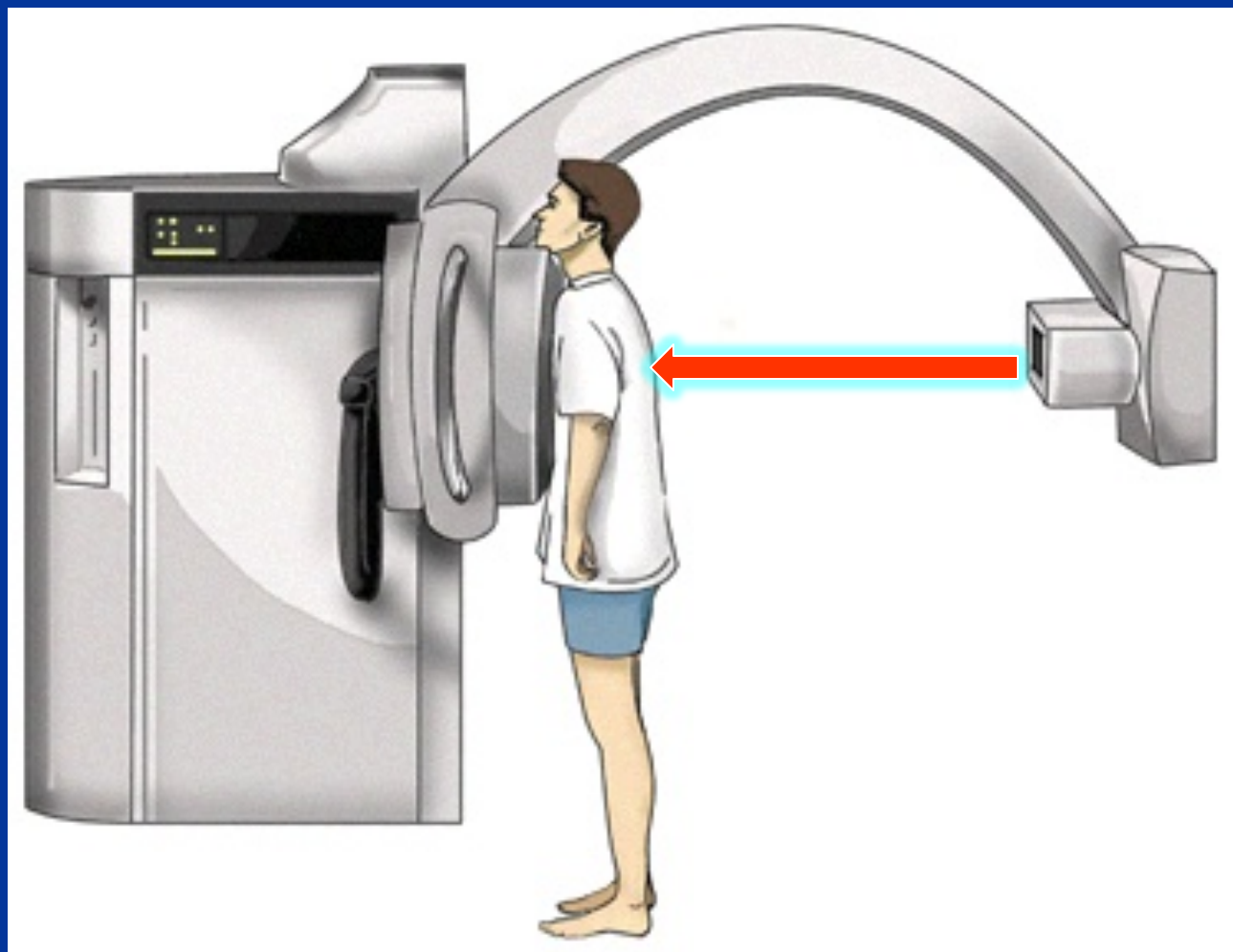




# BASIC CHEST EXAM FOR THE HEART AND GREAT VESSELES

- PLAIN FILM=CHEST X-RAY(CXR)
- CT FOR HEART AND MEDIASTINUM
- ANGIOGRAMS
- MRI
- ULTRASOUND  
(ECHOCARDIOGRAPHY)
- ISOTOPIC SCANNING

# Basic Chest X-Ray



# The Cardiac Contours

Ascending Aorta

“Double density”  
of LA enlargement

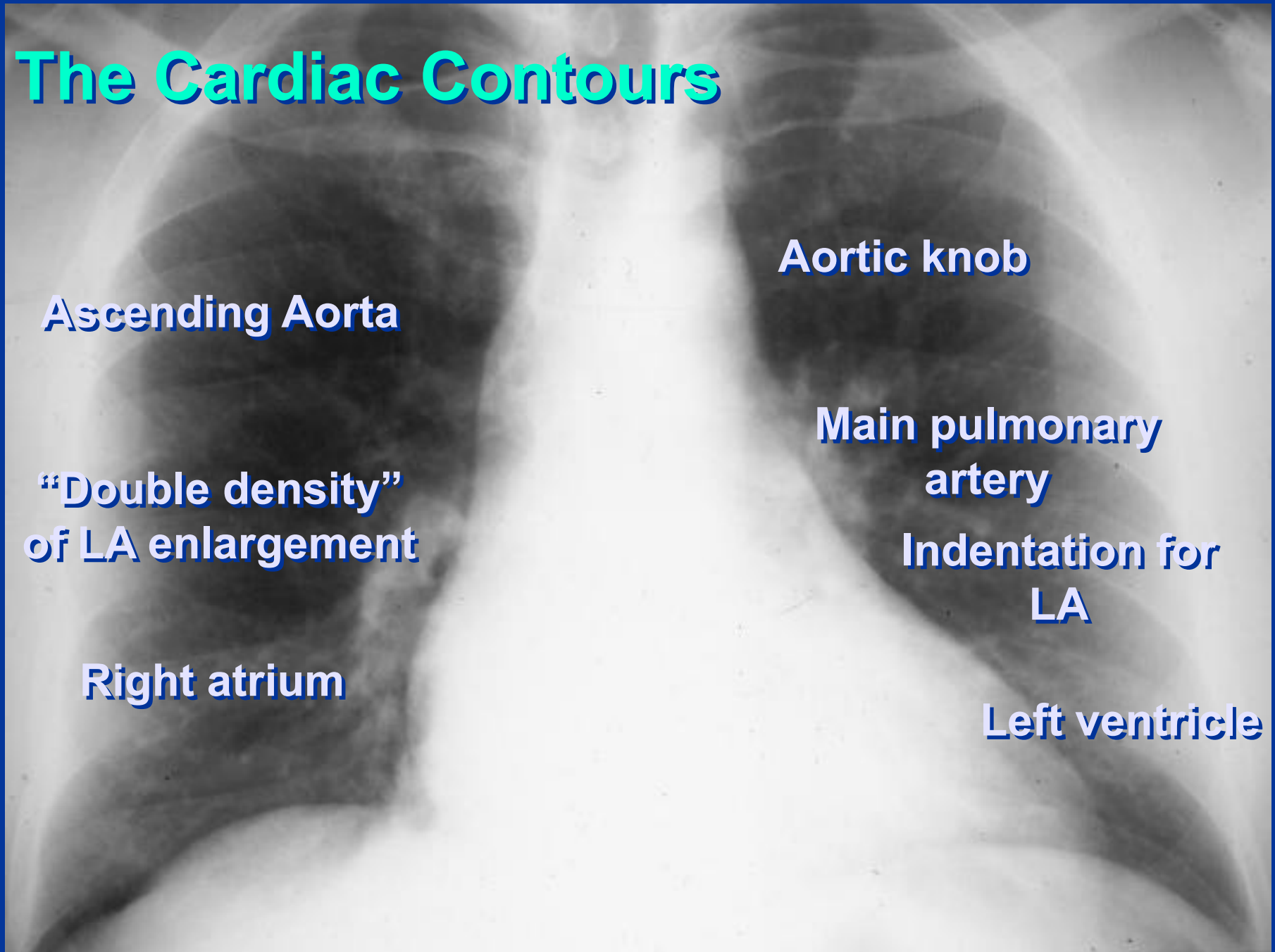
Right atrium

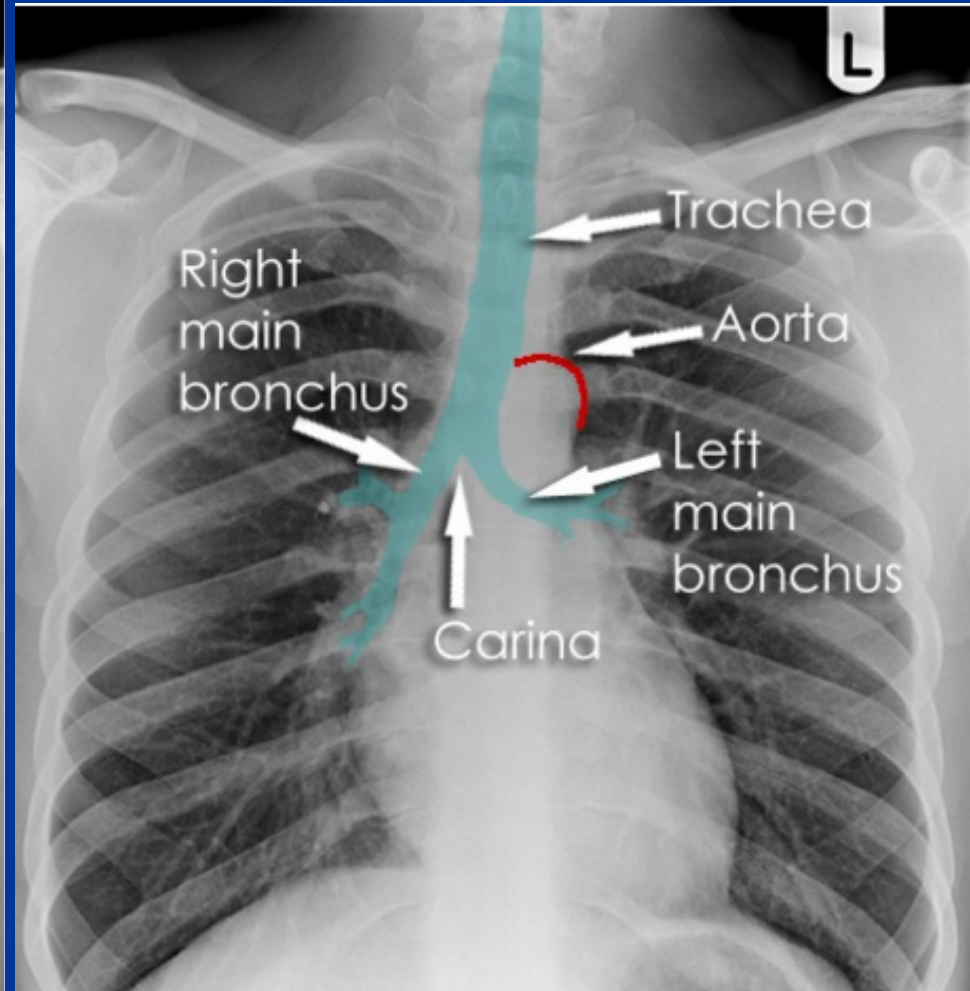
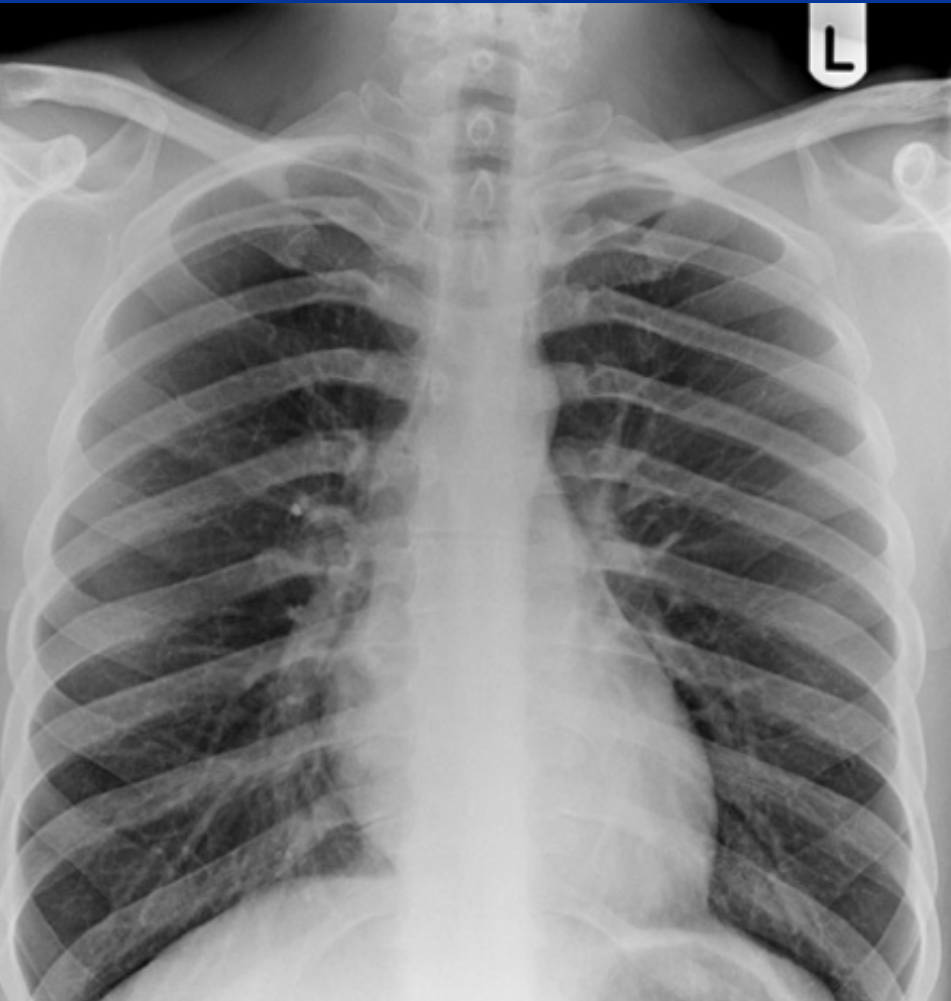
Aortic knob

Main pulmonary  
artery

Indentation for  
LA

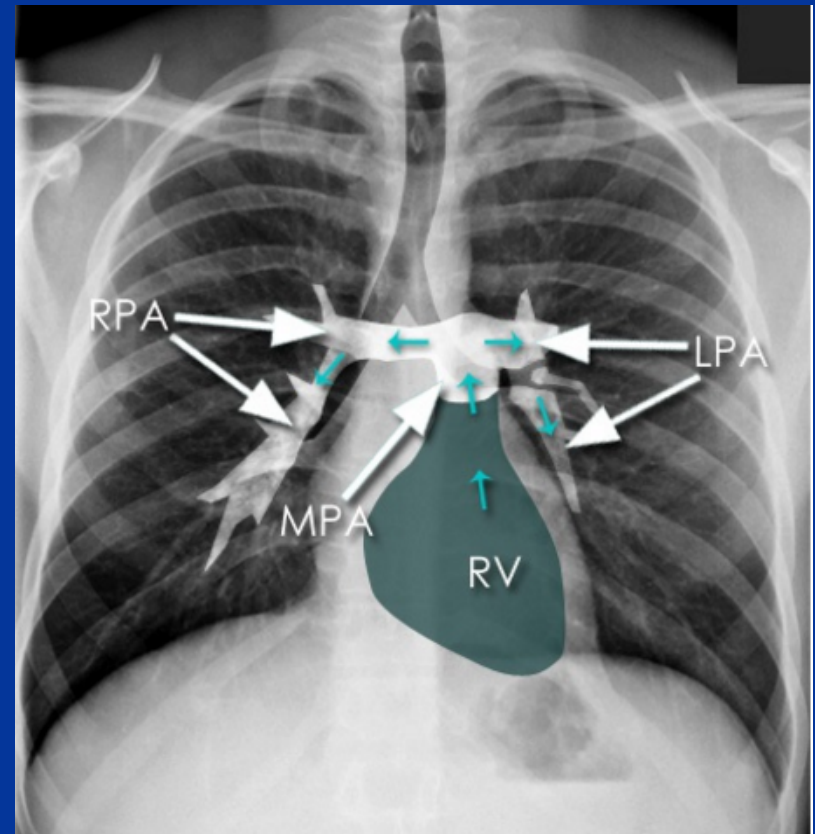
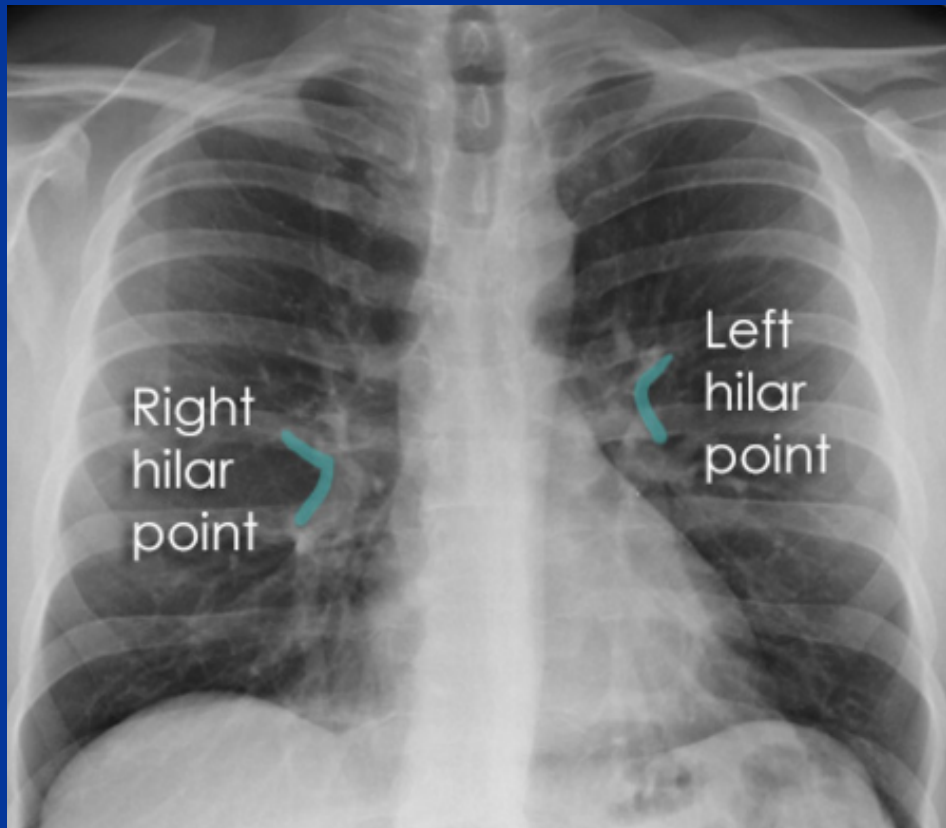
Left ventricle





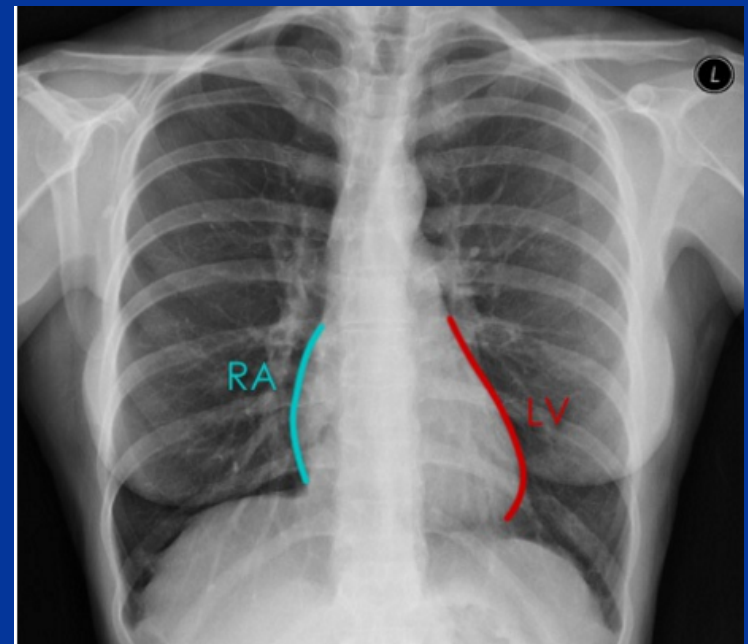
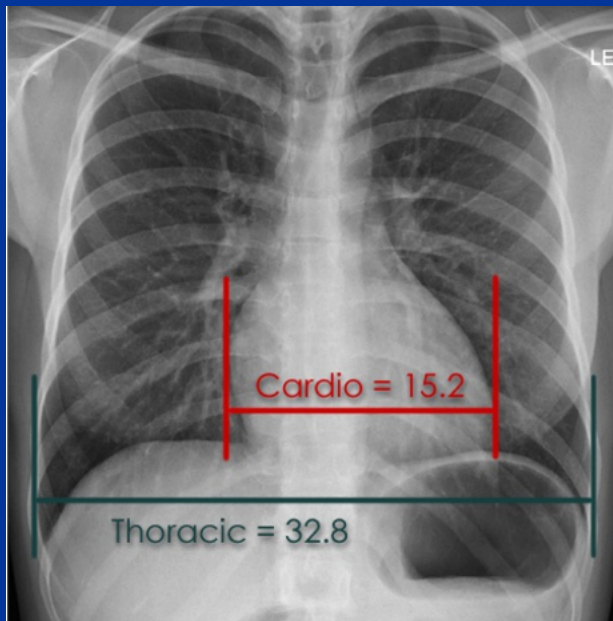
# Hilar levels

- 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.

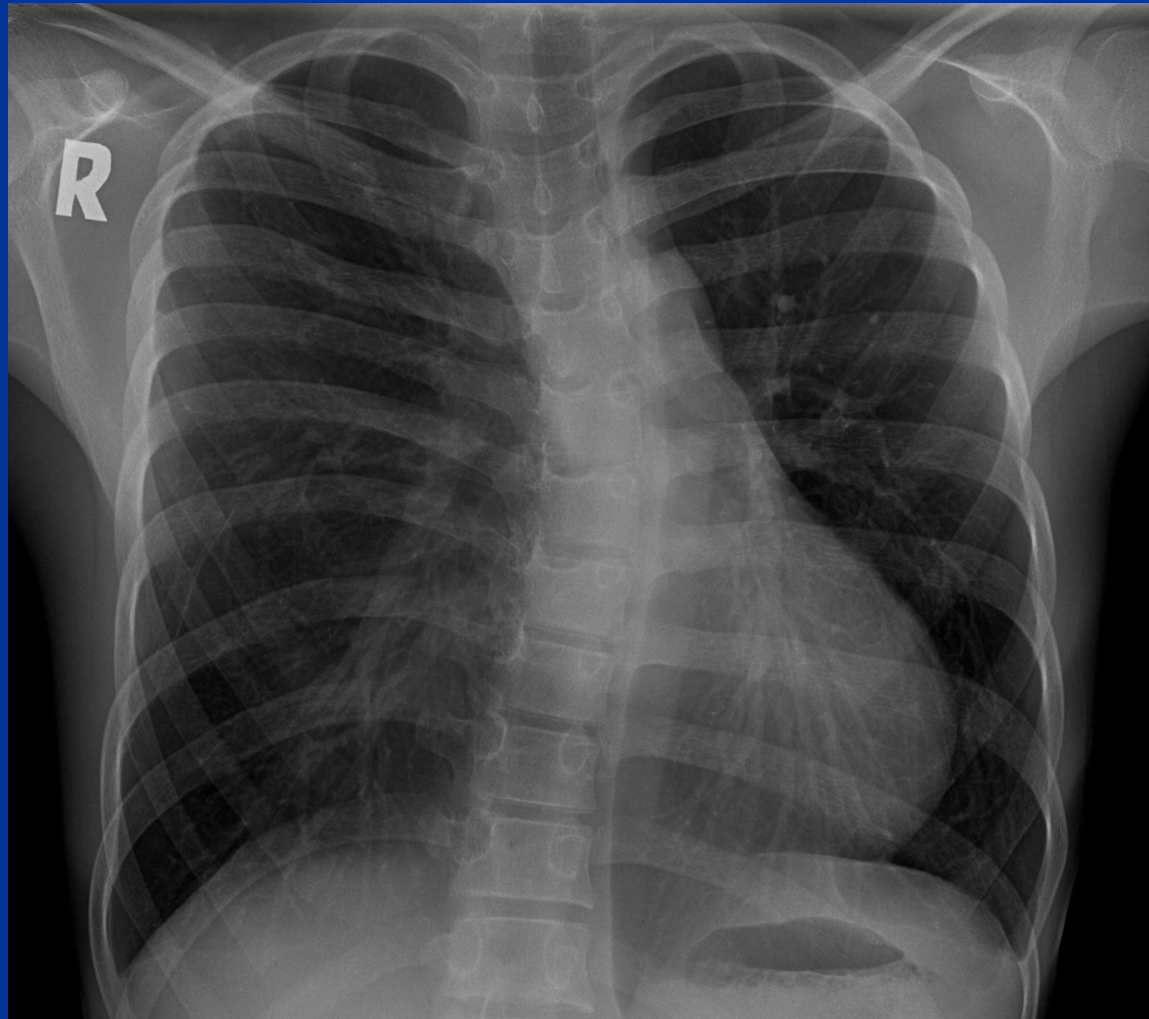




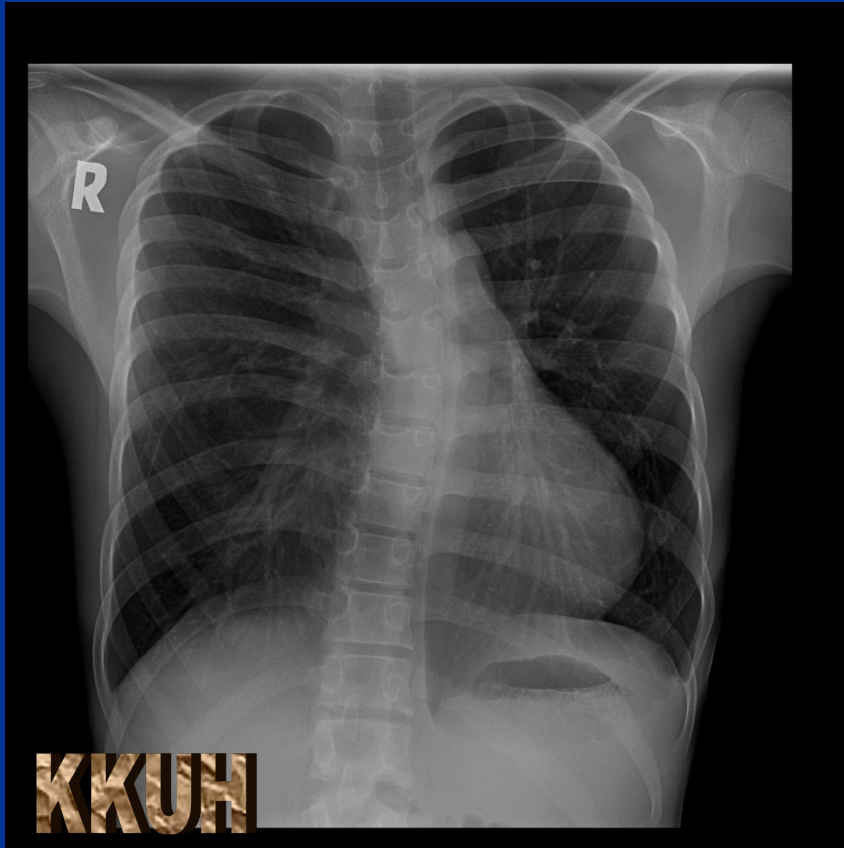
# Cardiac contours



# Cardiac displacement

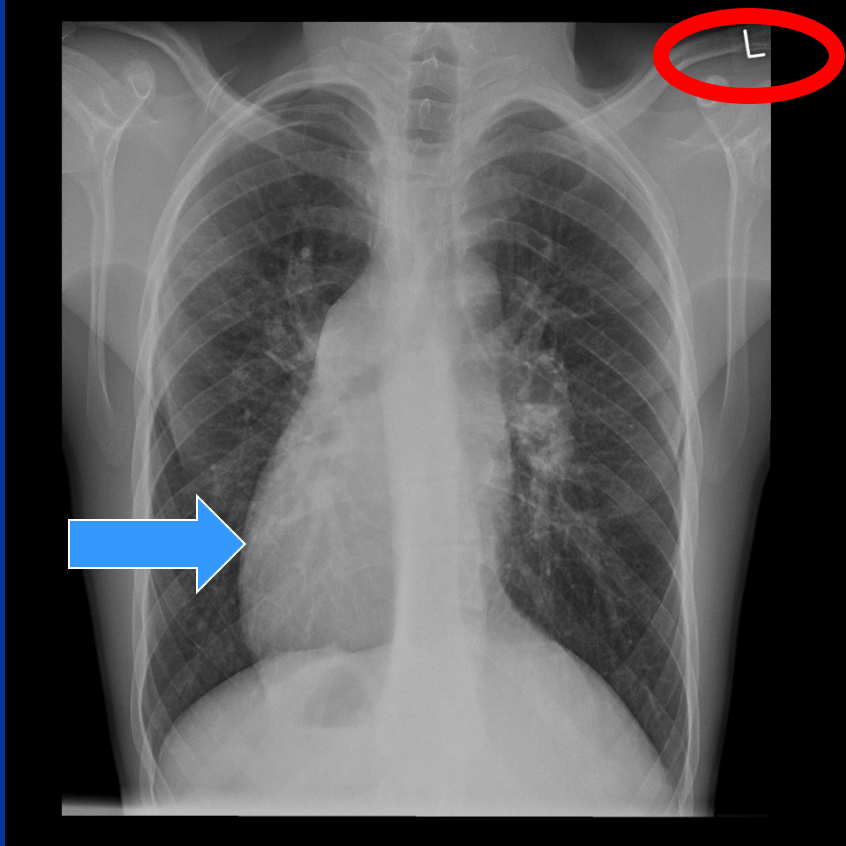


# Cardiac displacement



Pectus excavatum

# DEXTROCARDIA



# HEART

Intravascular  
Ultrasound

Optical  
Coherence  
Tomography

Cardiac Computed  
Tomography

## Anatomy

Cardiac Magnetic Resonance  
Imaging

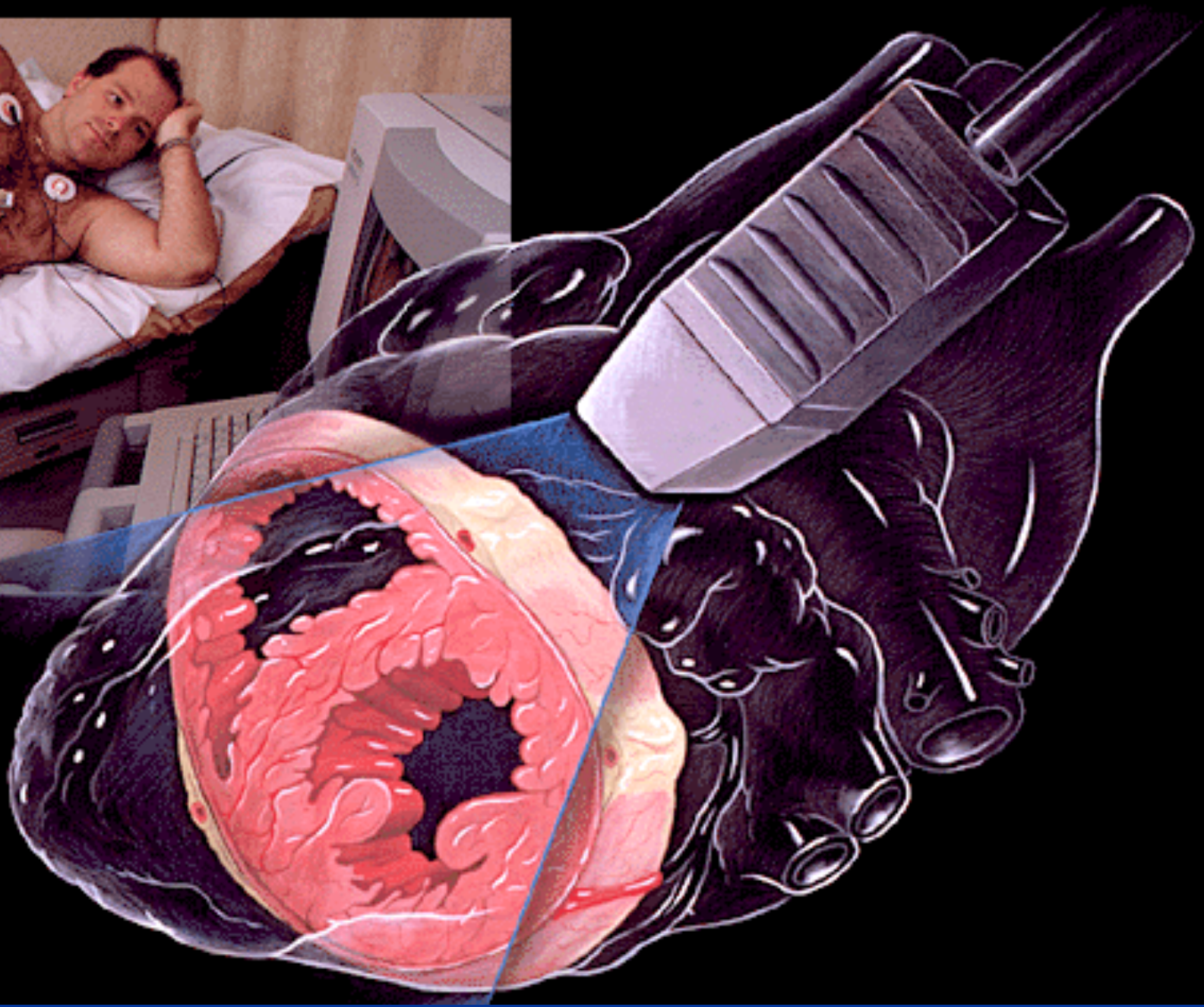
Echocardiography  
TEE/TTE

## Function

Intracardiac  
Echocardiography

Nuclear Imaging





# Echocardiography Methods

- Transthoracic echocardiography
- Transesophageal echocardiography
- Intracardiac echocardiography
- Intravascular echocardiography



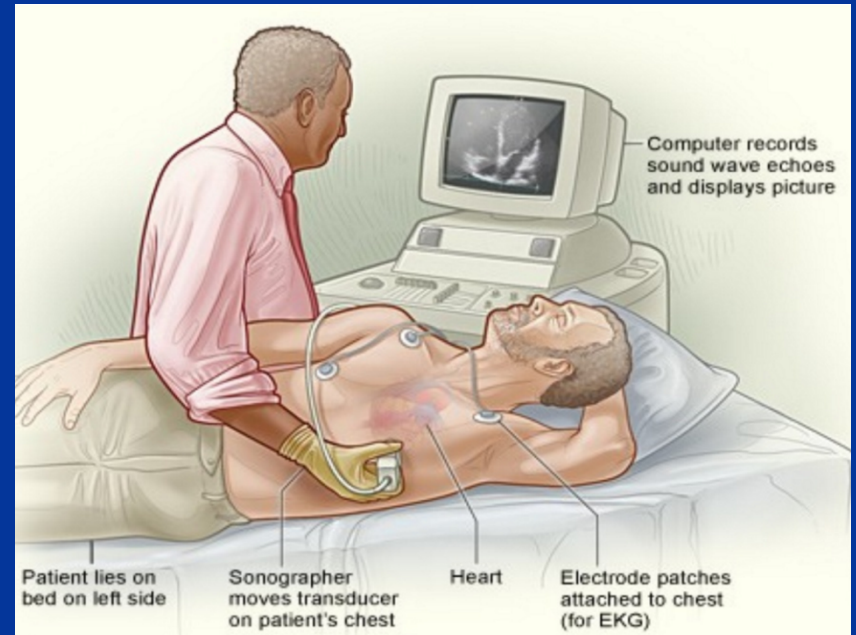
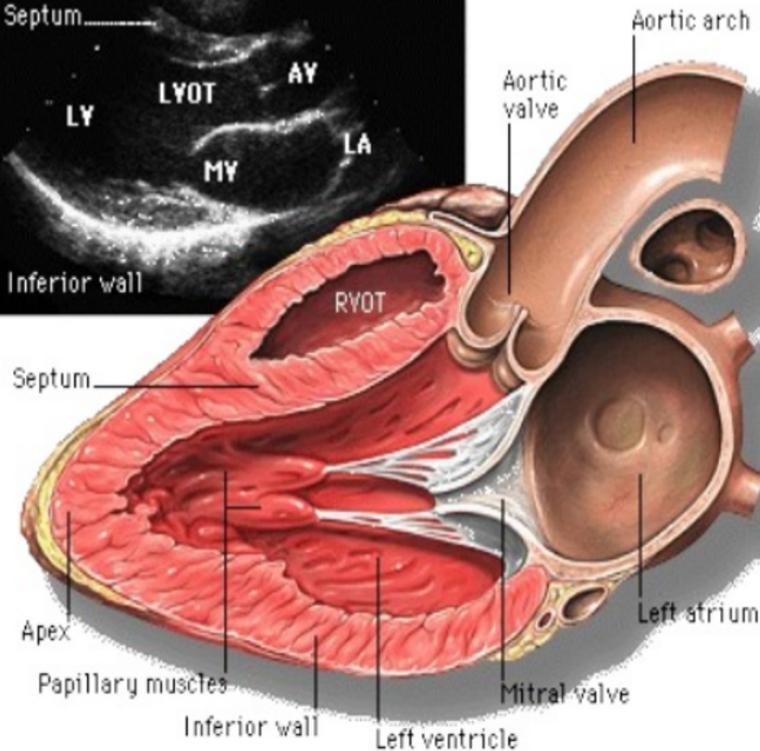
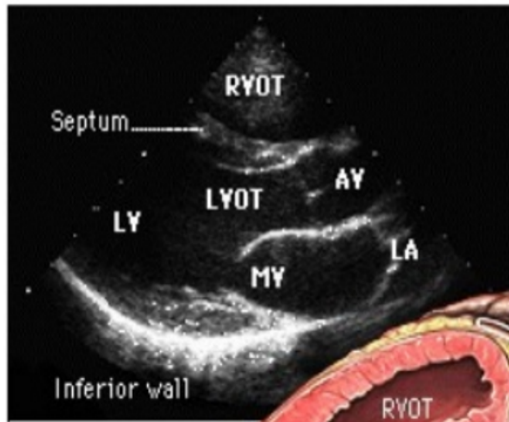
# Transesophageal Echocardiography



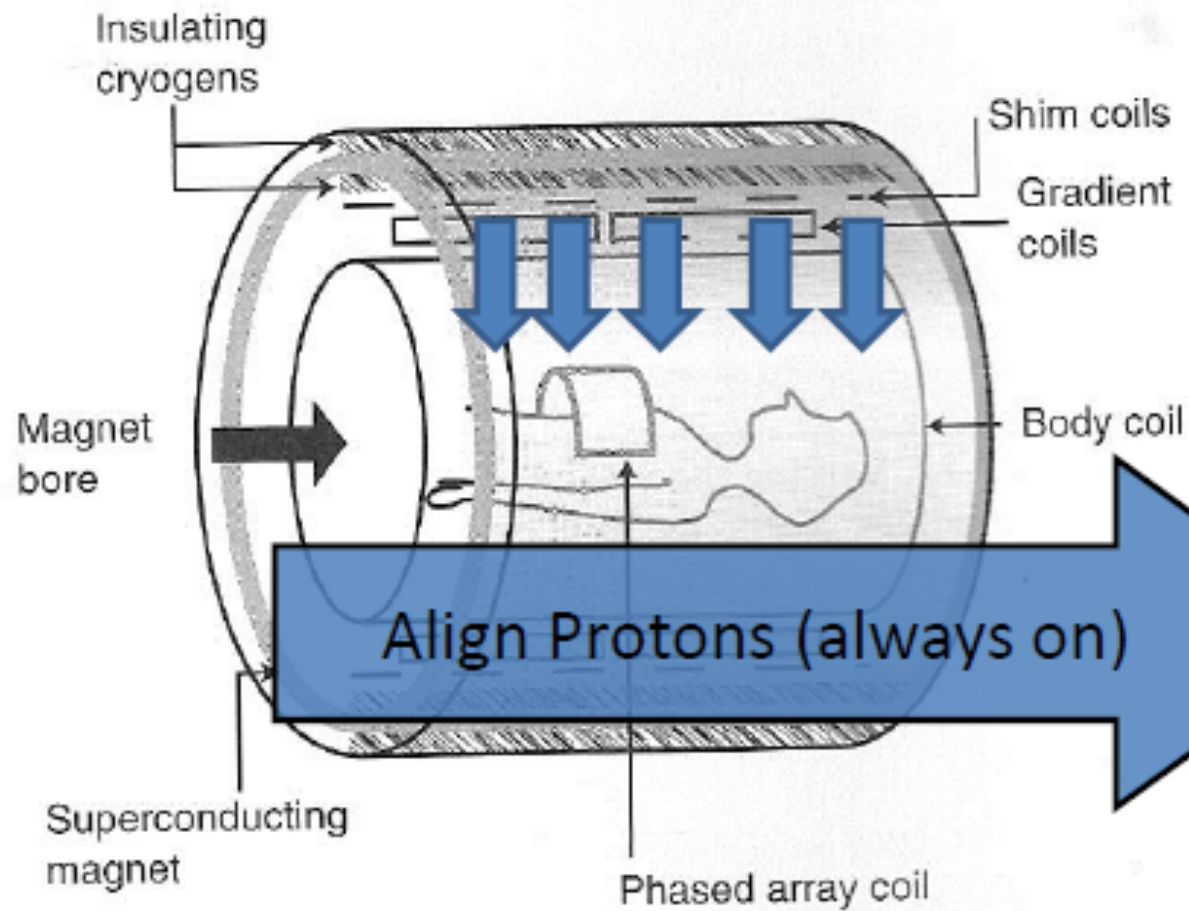
- Evaluate for cardiac source of embolism (36%)
- Endocarditis (14%)
- Prosthetic valve function (12%)
- Valvular disease, aortic dissection or aneurysm, tumor, mass or thrombus (6-8% each).
- Congenital heart disease (4%)
- Interventional cardiology guidance
- Intraoperative evaluation cardiothoracic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



# TRANS-THORACIC ECHOCARDIOGRAPHY

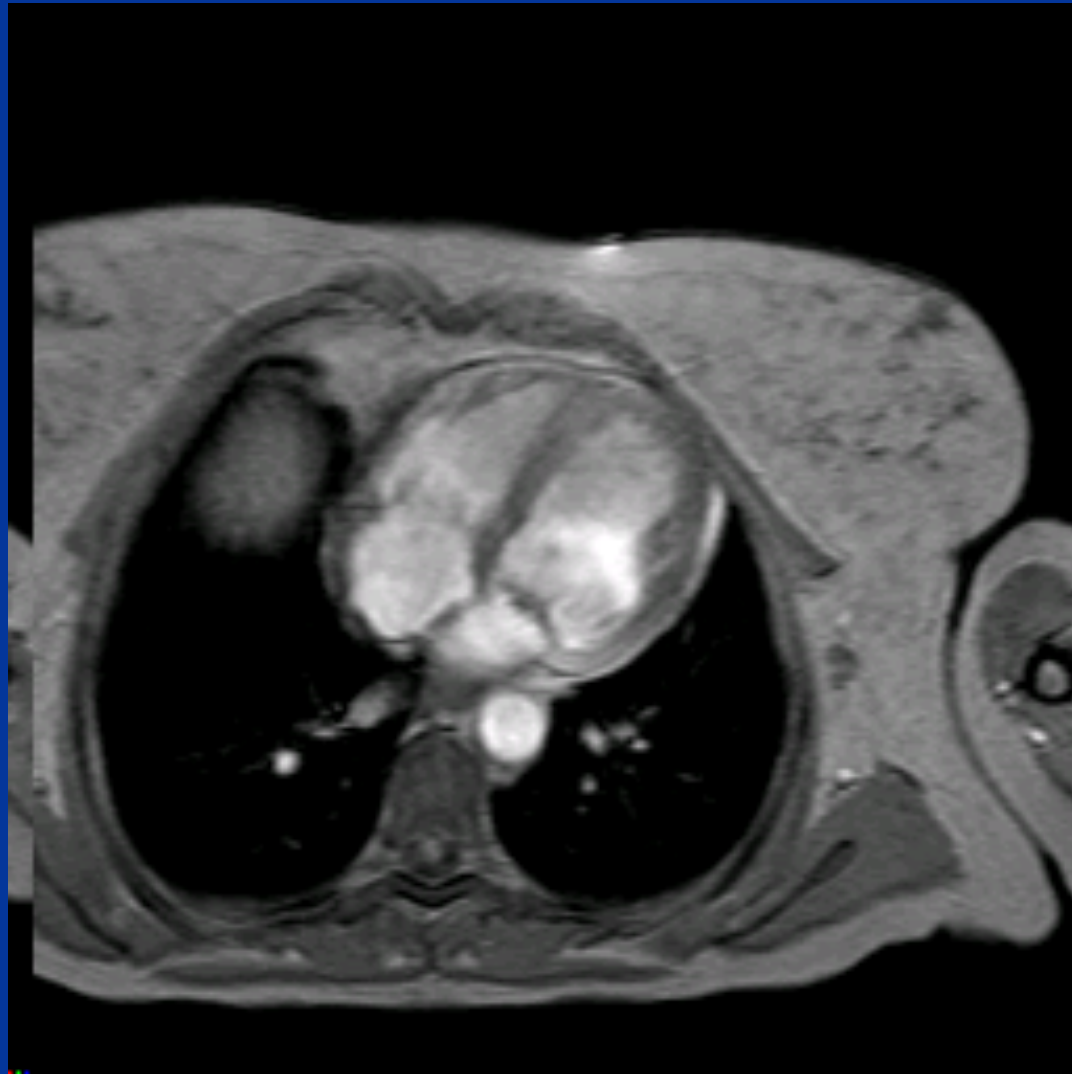


# MRI



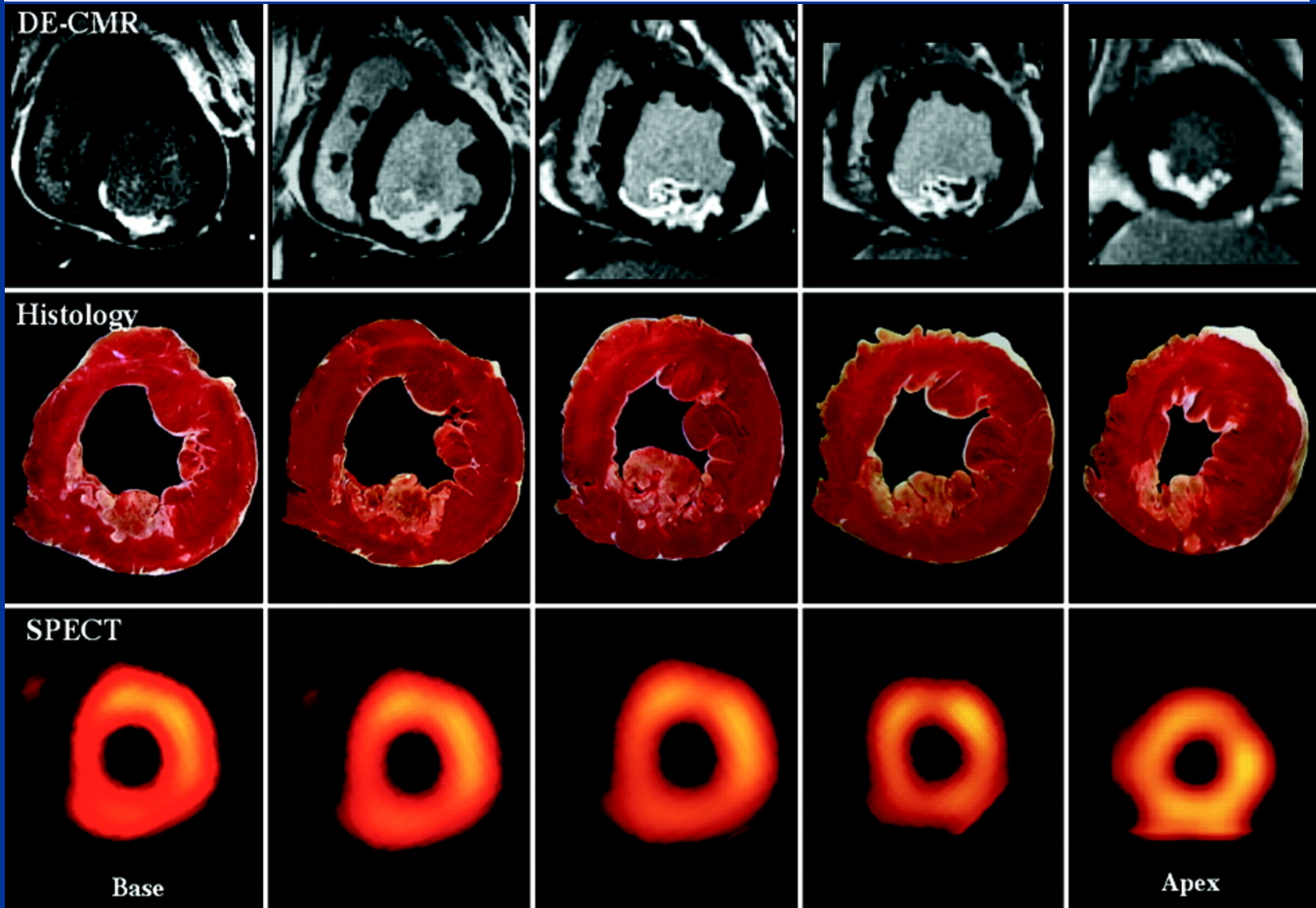


# Cardiac Magnetic Resonance



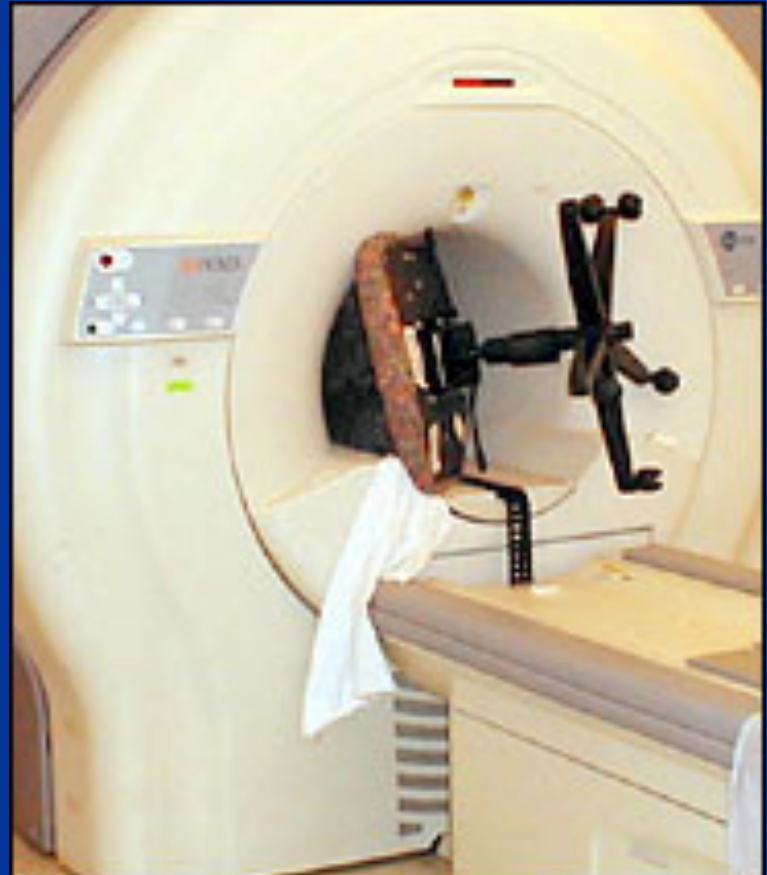
# Viability Assessment

## CMR Delayed Hyper-Enhancement



# Hazards of MRI

## Magnet-Seeking Projectiles



**CARDIAC CT**  
**FOR THE HEART AND CRONARY**  
**VESSLES**

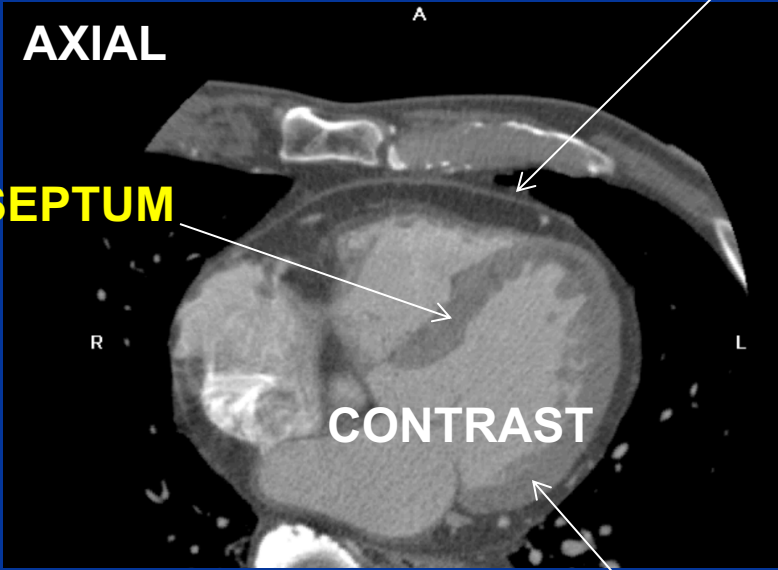
# PERICARDIUM

PERICARDIUM

AXIAL

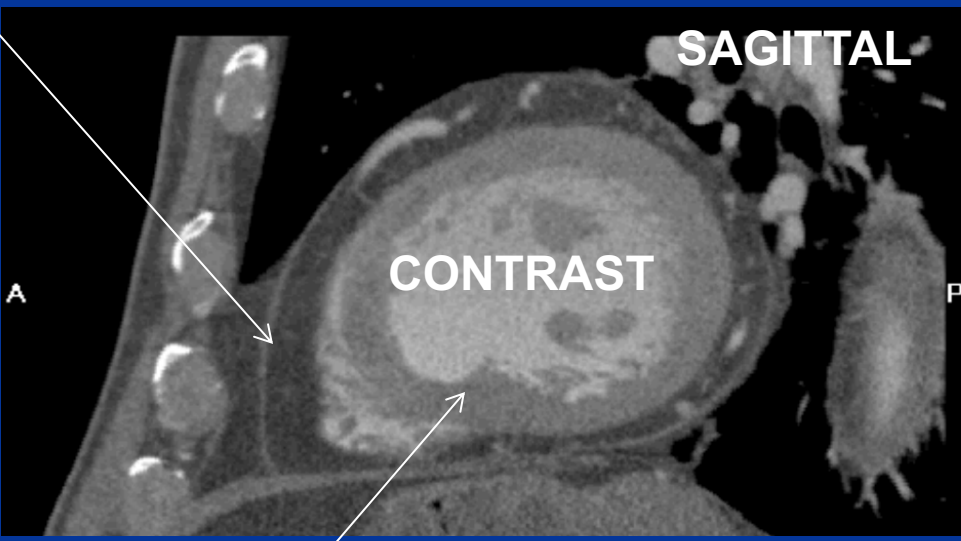
SEPTUM

CONTRAST



SAGITTAL

CONTRAST



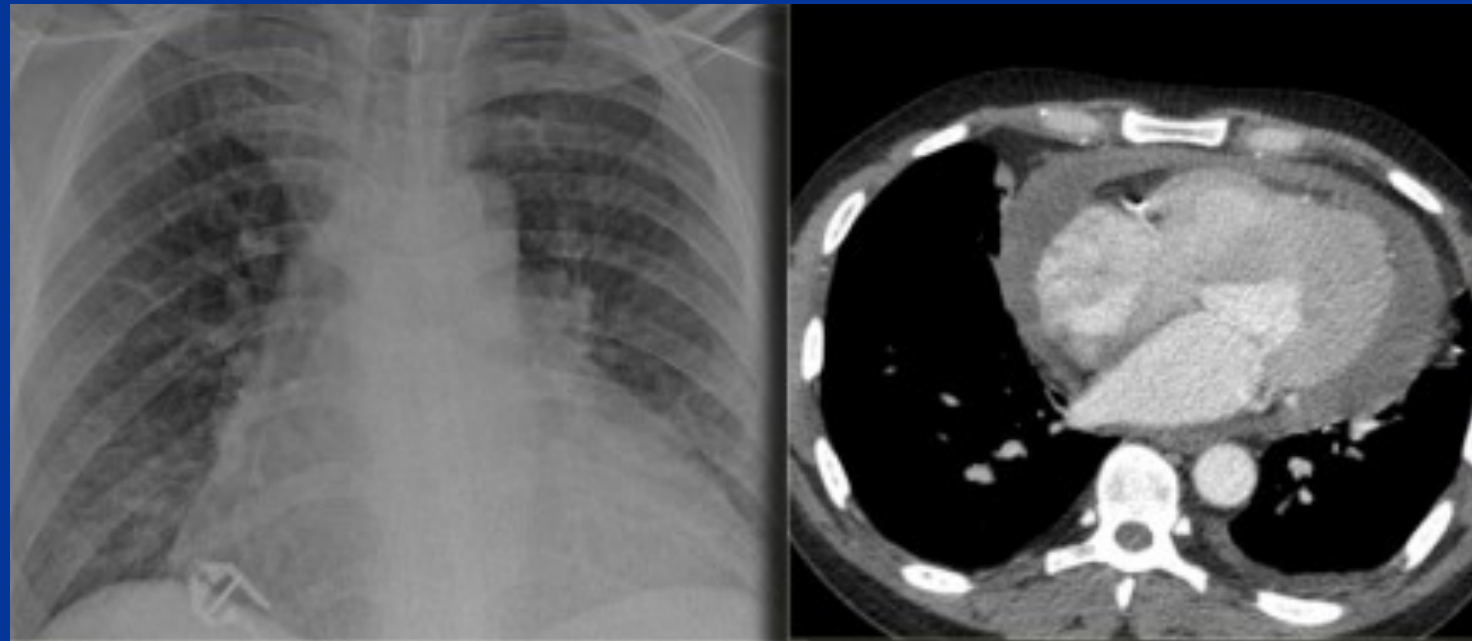
MYOCARDIUM



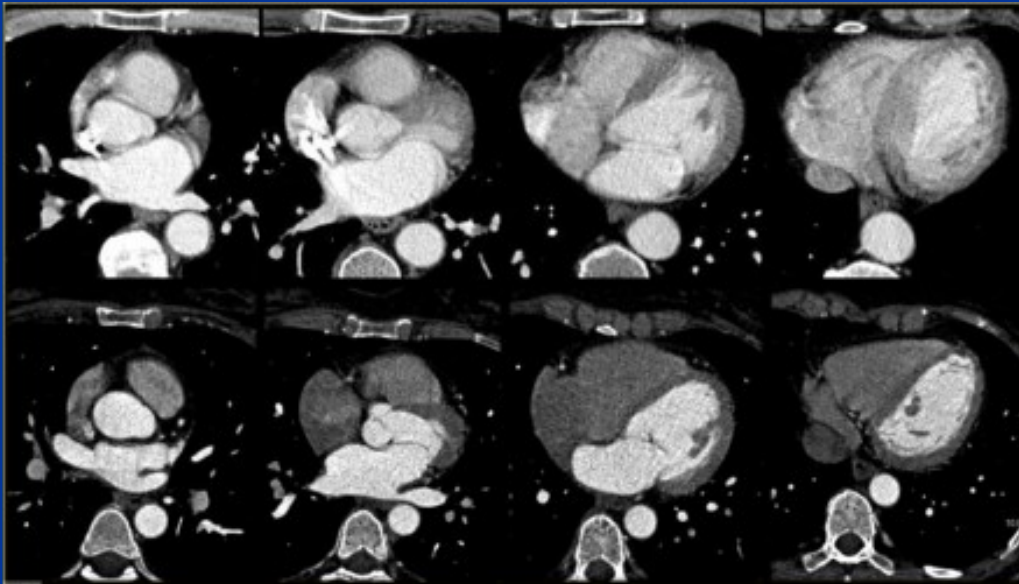
## Pericardial effusion

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

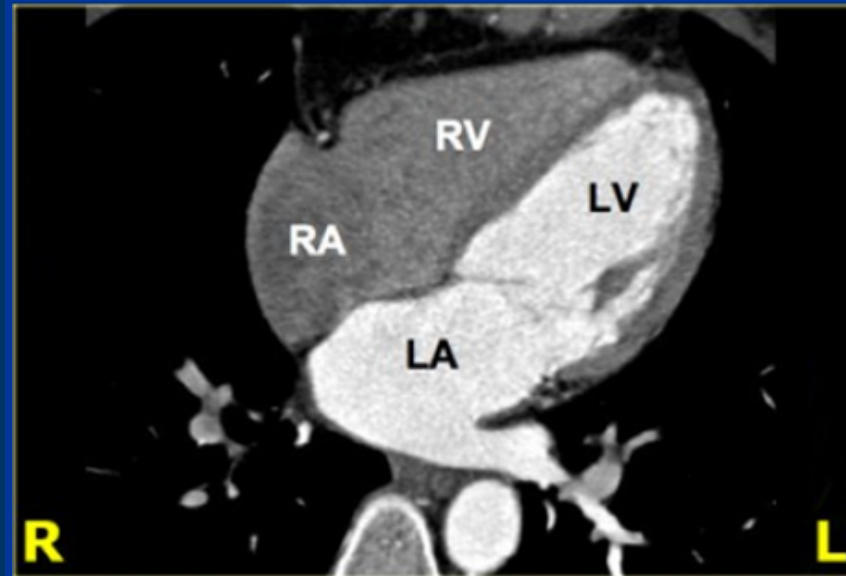
On the chest x-ray it looks as if this patient has a dilated heart while on the CT it is clear, that it is the pericardial effusion that is responsible for the enlarged heart figure.



# CARDIAC CHAMBERS



Axial slices through the heart



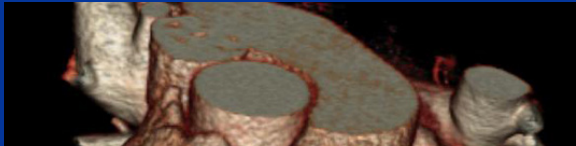
4-chamber view. RA=right atrium, RV=right ventricle, LA=left atrium, LV=left ventricle

# 4 to 64 Slice Scans

## Five Heart Beats

10 mm detector  
Pitch ~0.25

*3 cm in 5 sec*



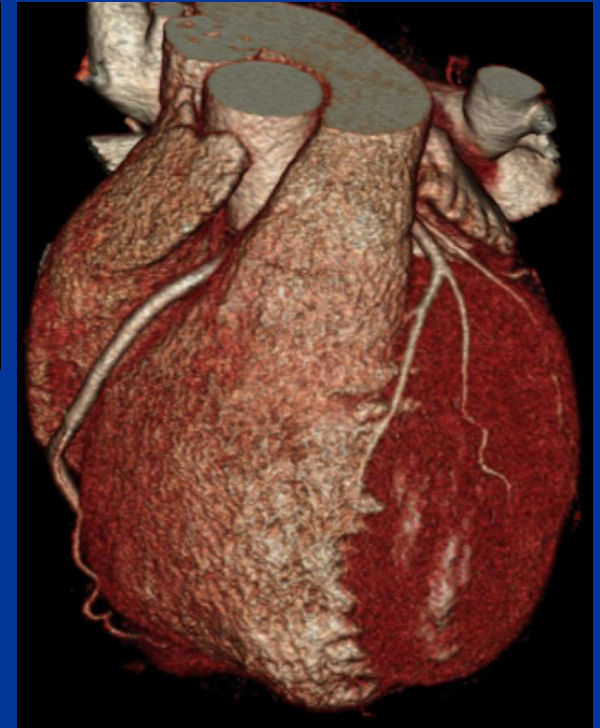
20 mm detector  
Pitch ~0.25

*6.2 cm in 5 sec*

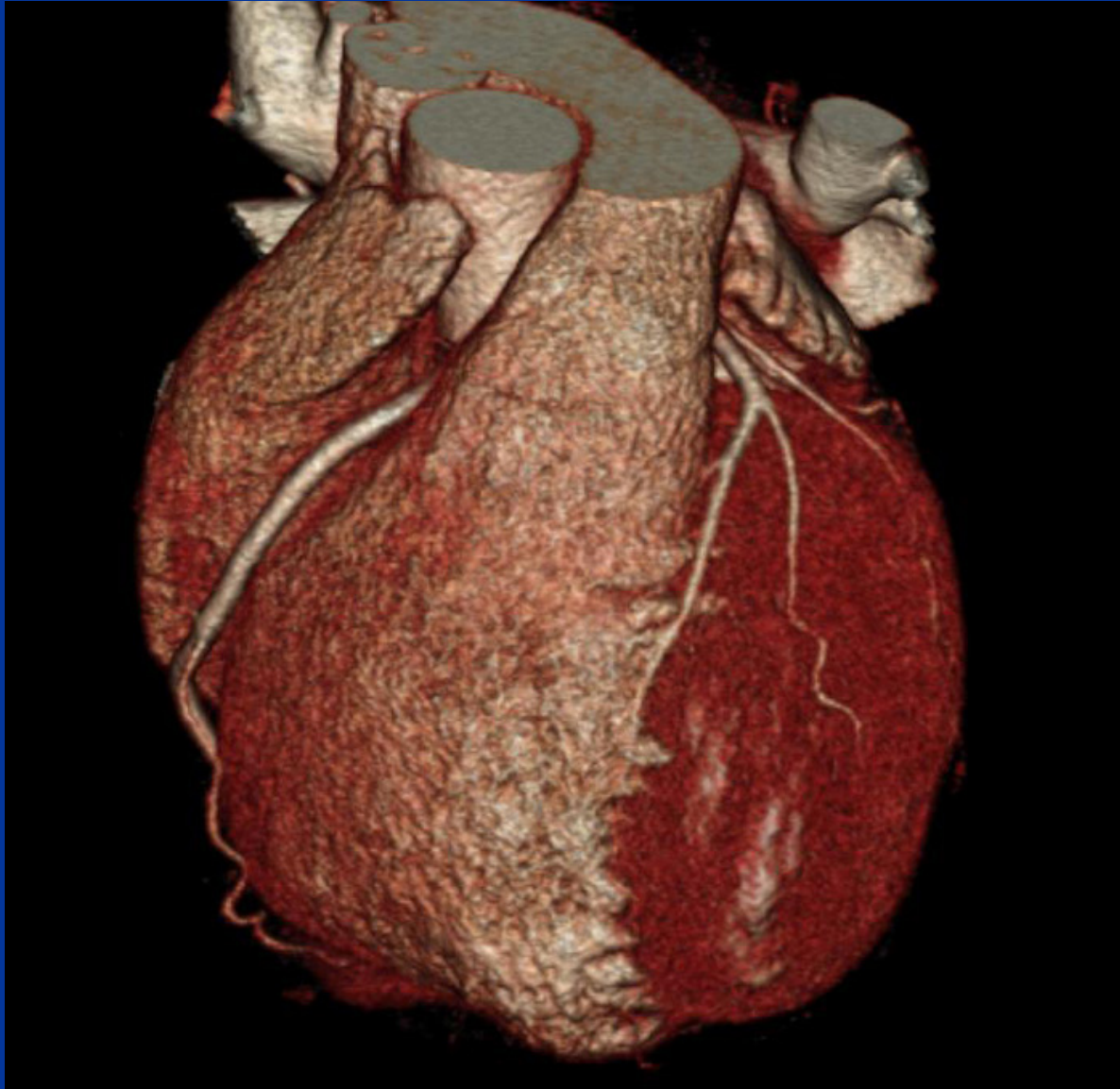


40 mm detector  
Pitch ~0.25

*12.5 cm in 5 sec*



# 3-D Volume Rendered Image



# Maximum Intensity Projection

## Soft Plaque in Proximal LAD





# Curved Planar Image

05.01.14-09:07:53-STD-1.3.12.2.1107.5.1.4.54056

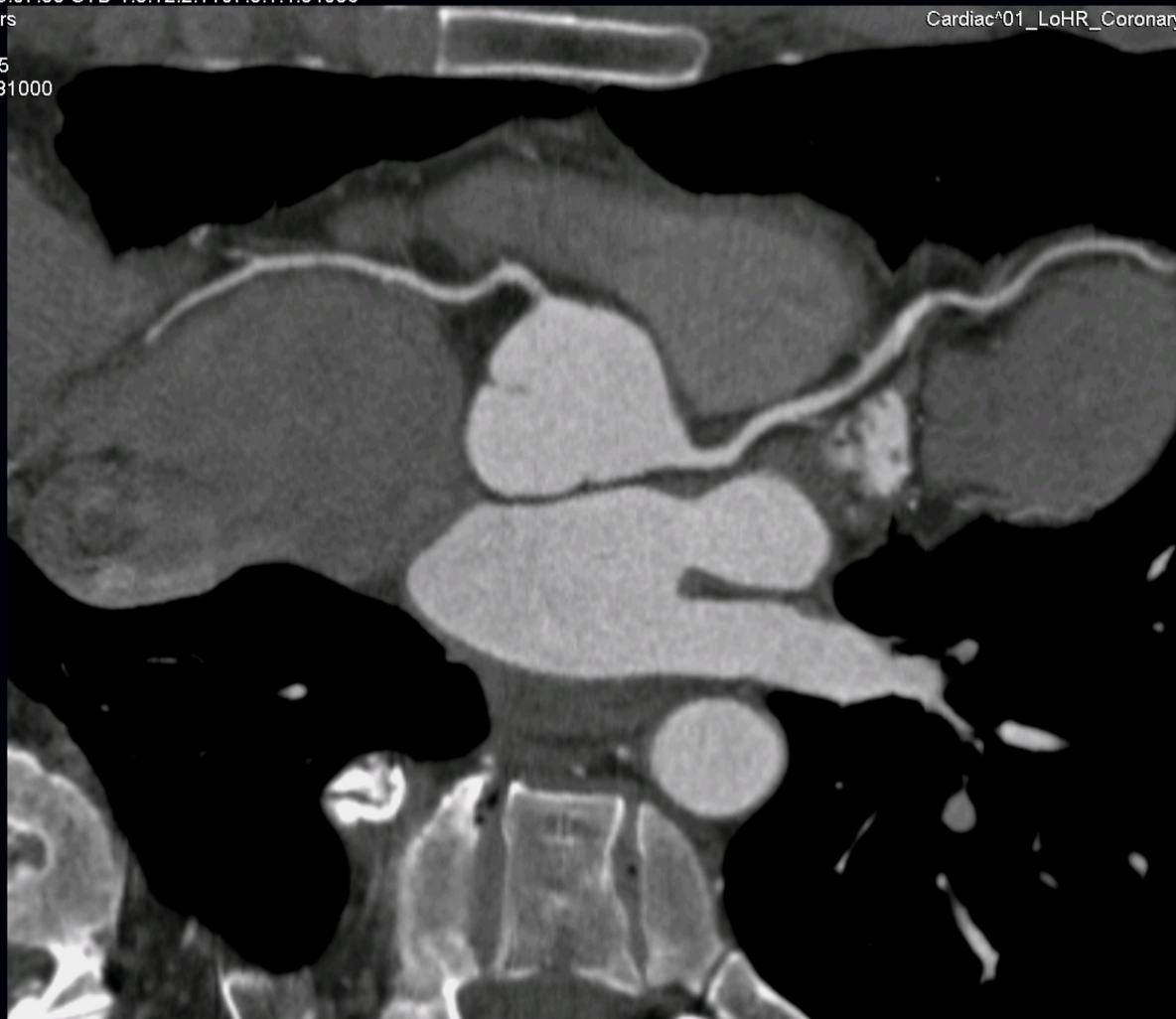
Age:47 years

M

14 Jan 2005

09:07:53.781000

CT  
Cardiac^01\_LoHR\_Coronary\_CTA (Adult)



kVP:120  
mA:542

Case12  
12  
\*8/27/1920, M, 84Y  
11/17/2004  
10:52:57.69  
7 IMA 0  
VRT

HRP

Toyohashi Heart Center  
Sensation Cardiac 64  
CT 2005A

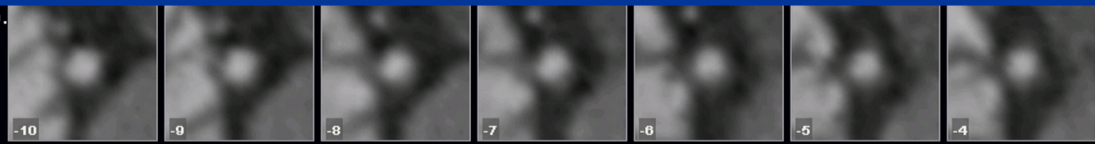
Spin: -28  
Tilt: 27

RAF

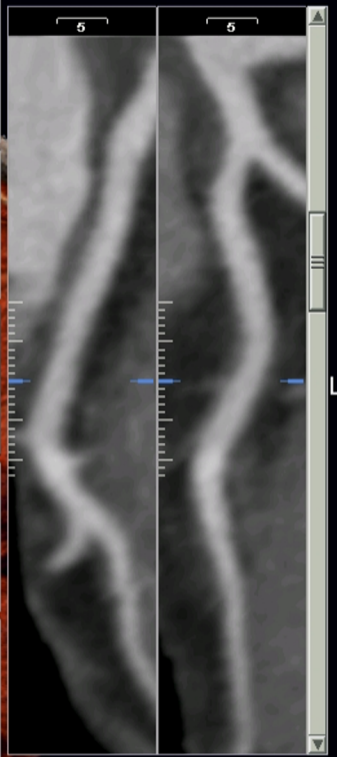
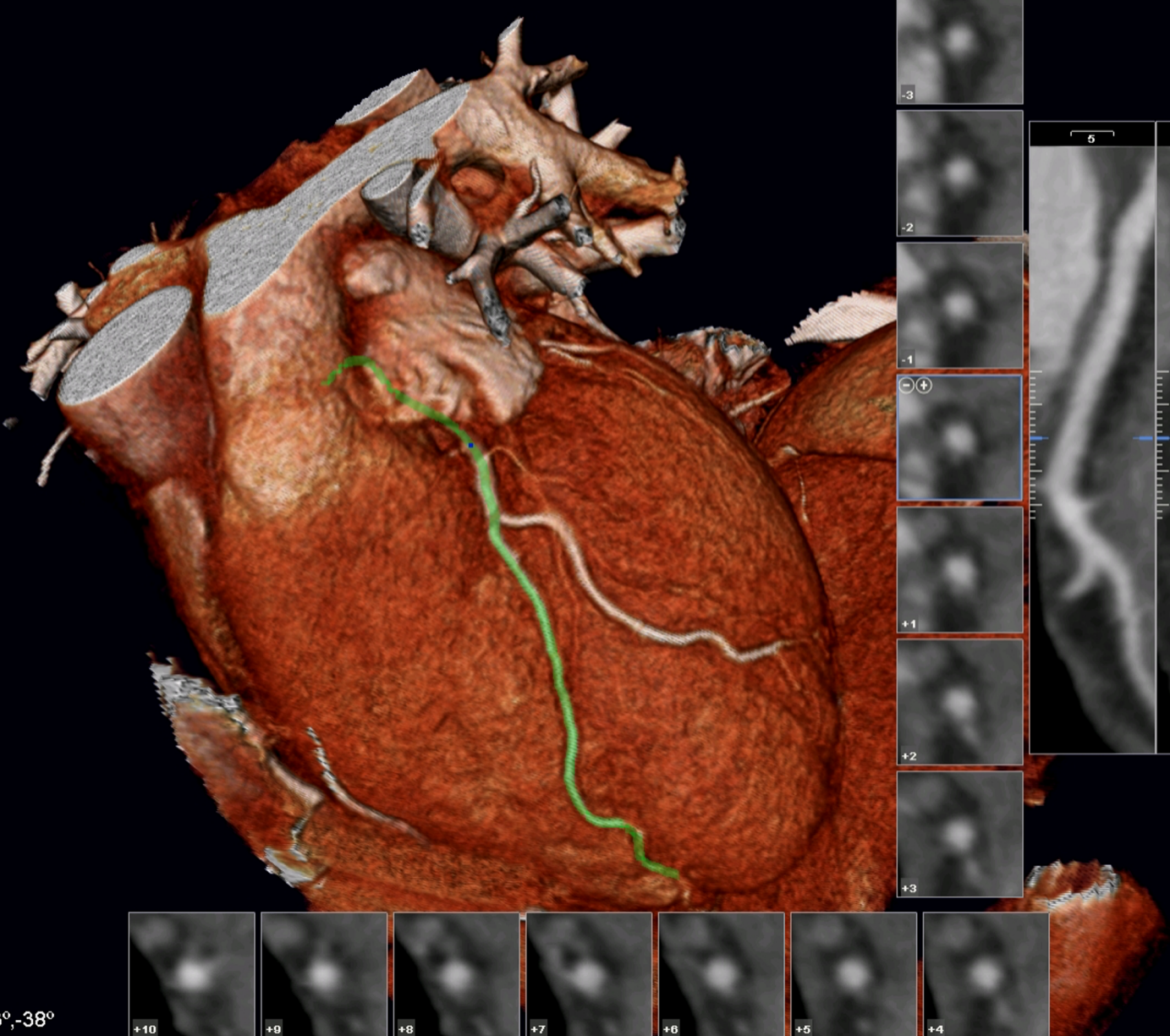


05.01.14-09:07:53-STD-1.3  
Age:47 years  
M  
14 Jan 2005  
09:07:53.781000

CT  
\_oHR\_Coronary\_CTA (Adult)



R



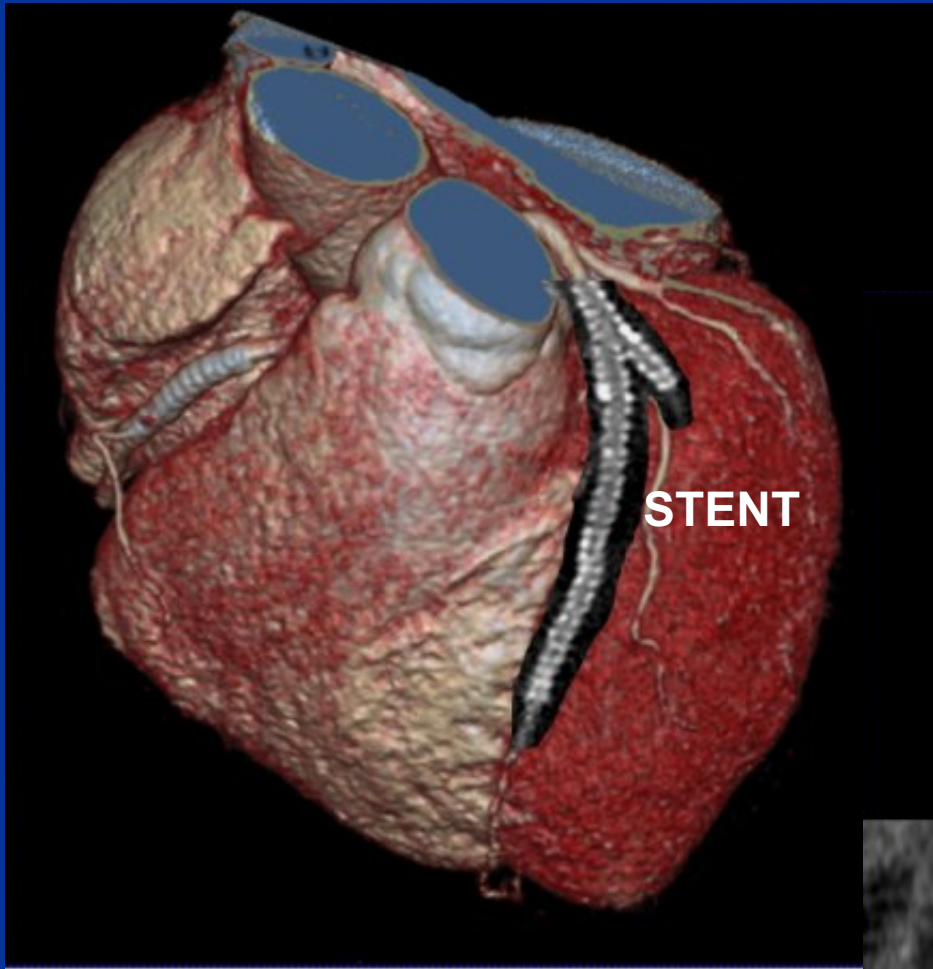
kVP:120  
mA:542  
msec:270  
mAs:850  
Thk:0.75 mm  
Sensation 64  
Orient: -43°,33°,-38°



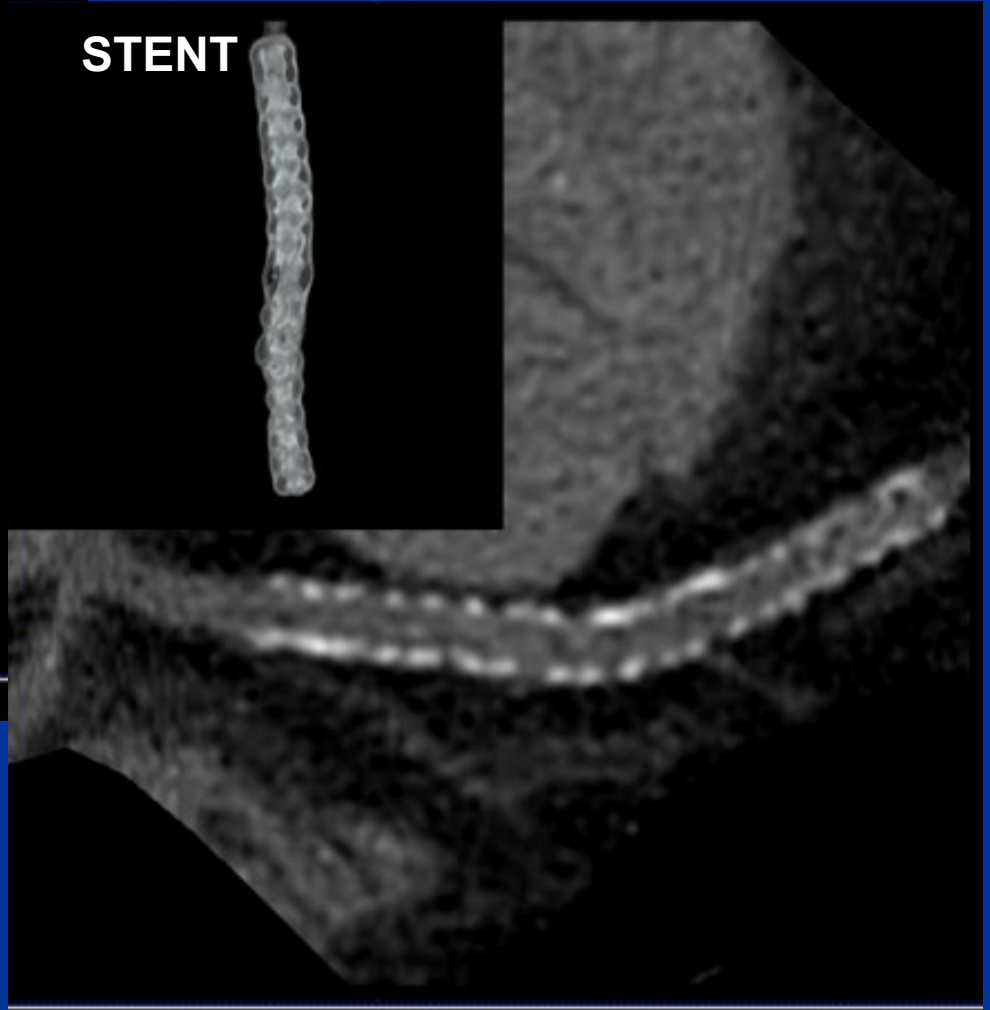
Vitrea®  
W/L:250/100  
Segmented  
Vessel 1







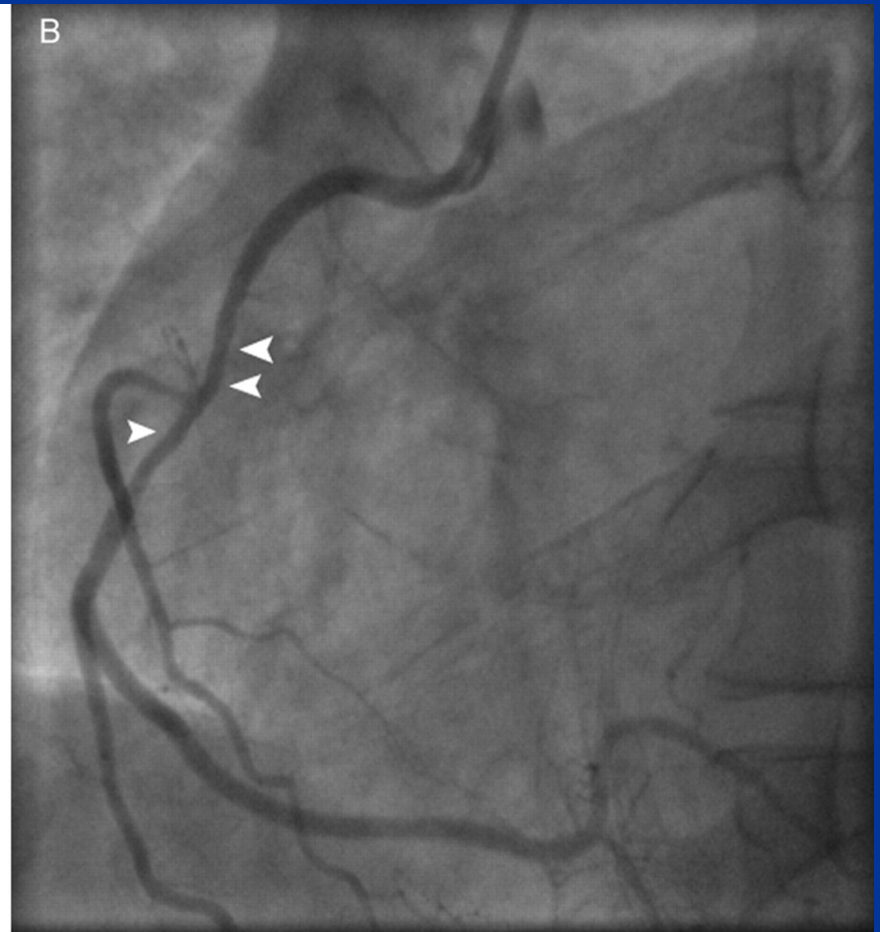
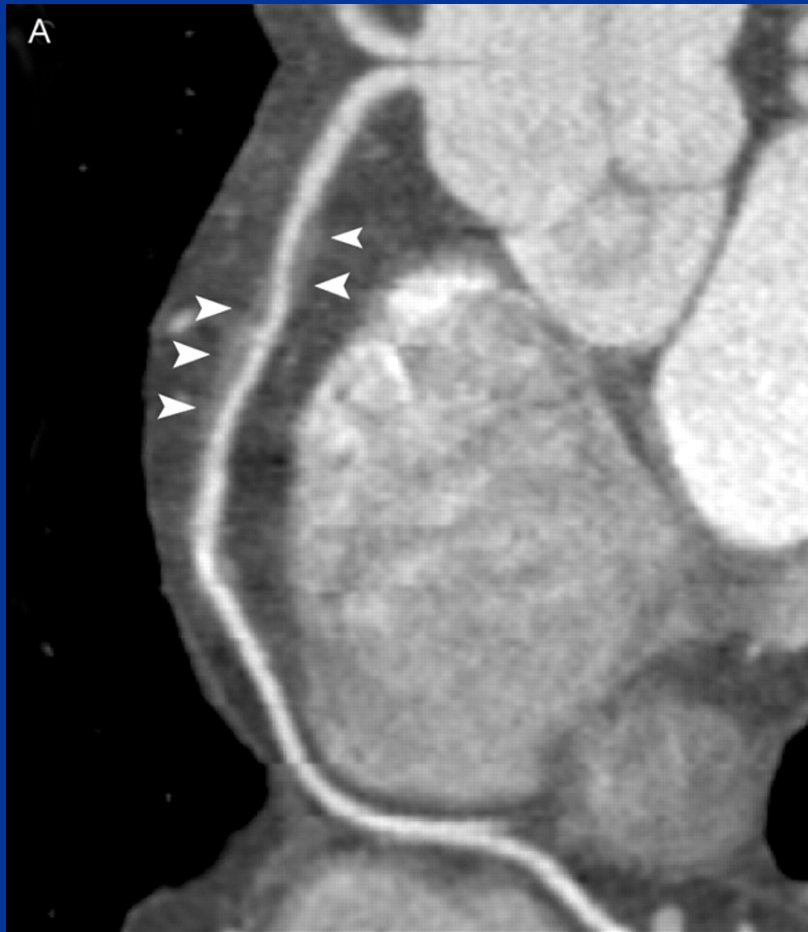
Courtesy of Erasmus Medical Center Rotterdam / Netherlands



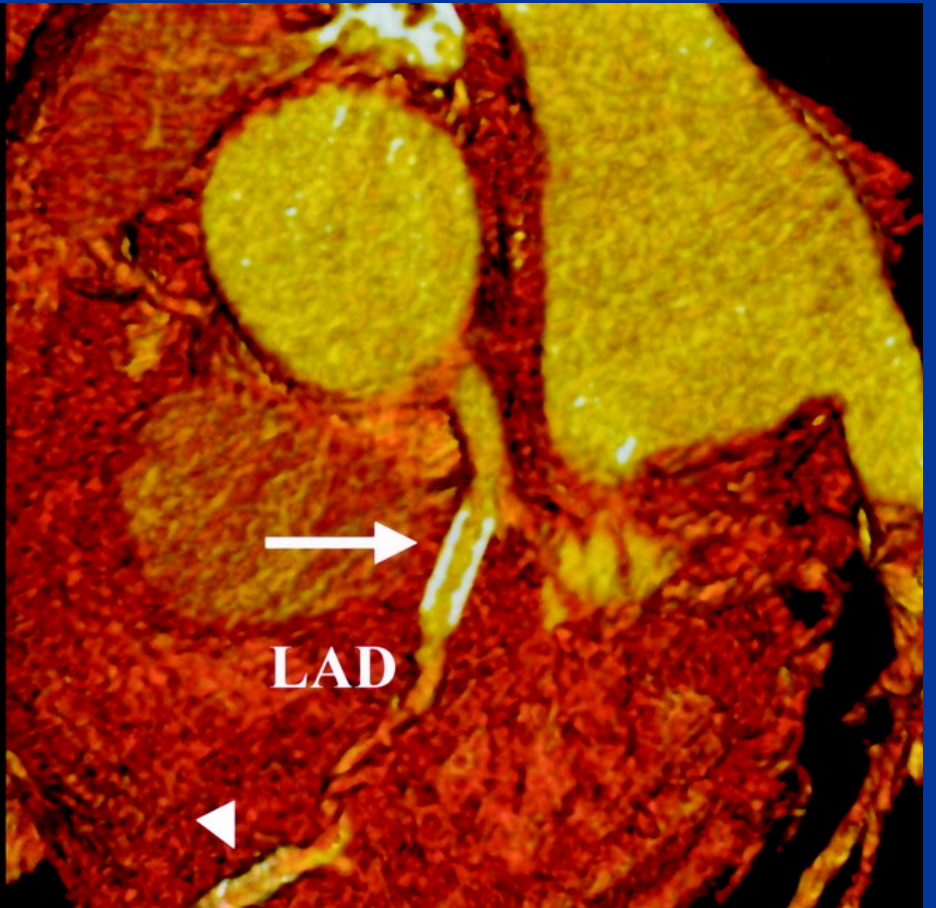
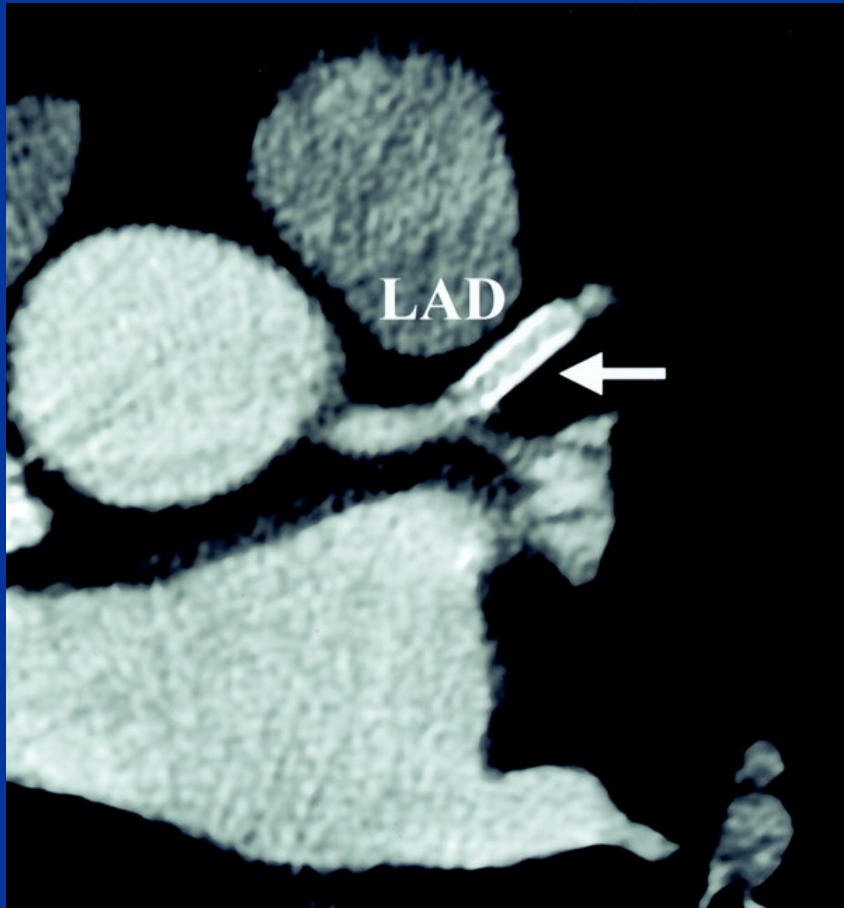
Courtesy of Toyohashi Heart Center, Japan



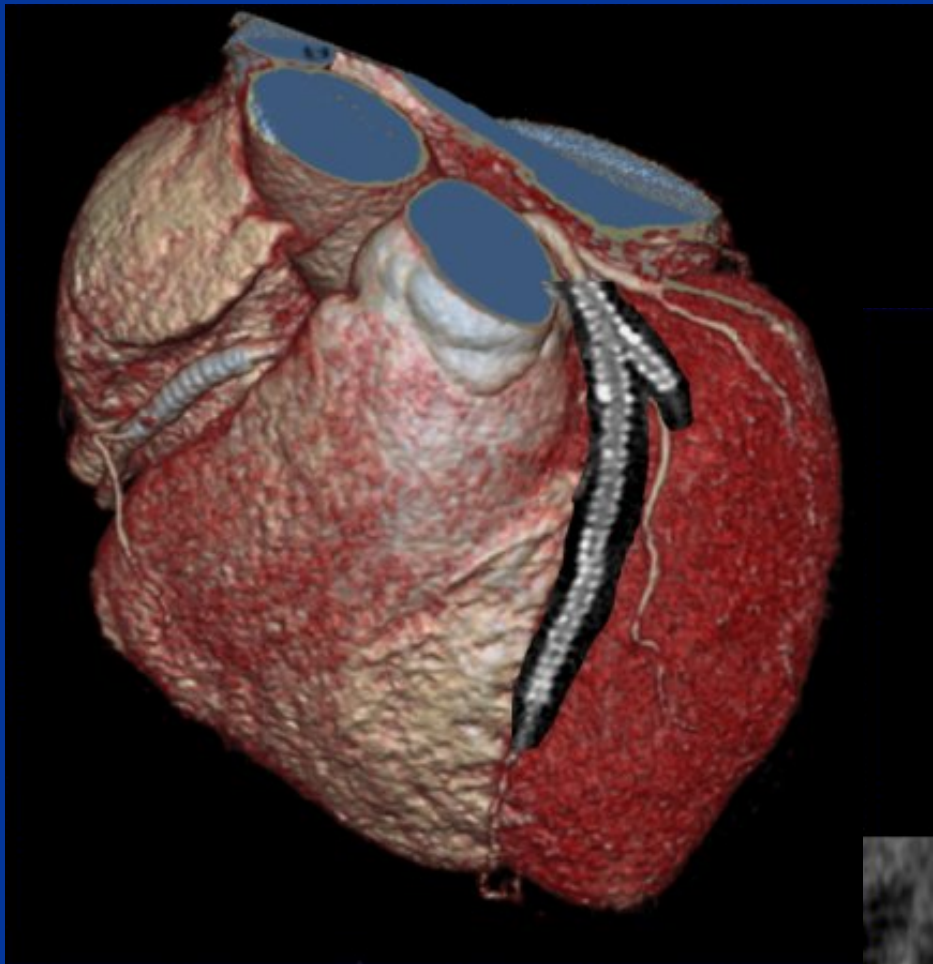
# Soft Plaque Visualization



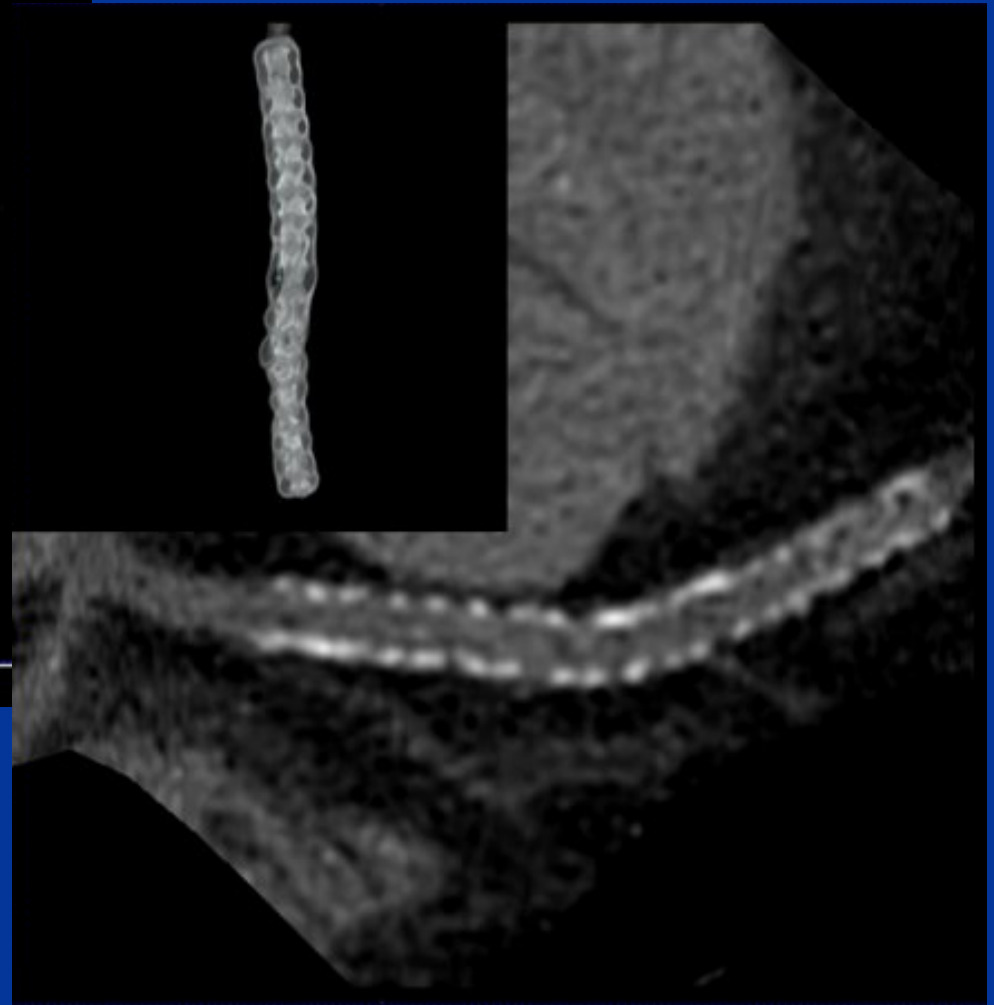




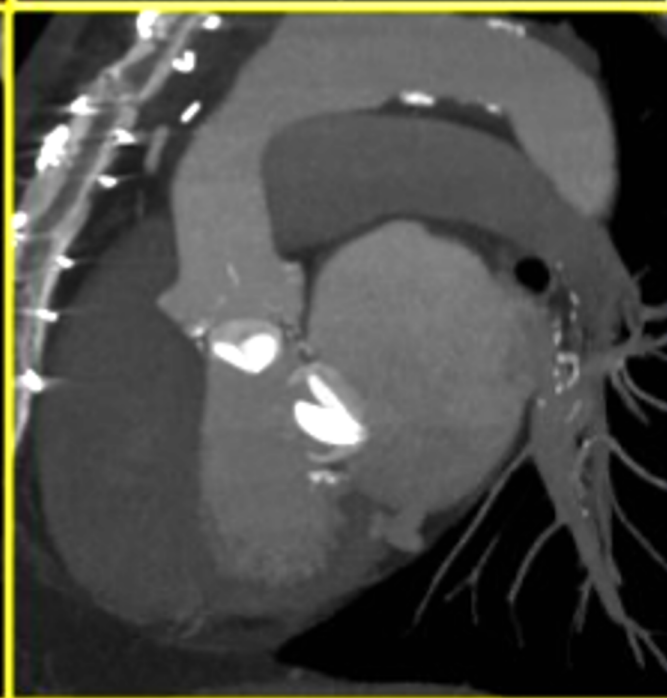
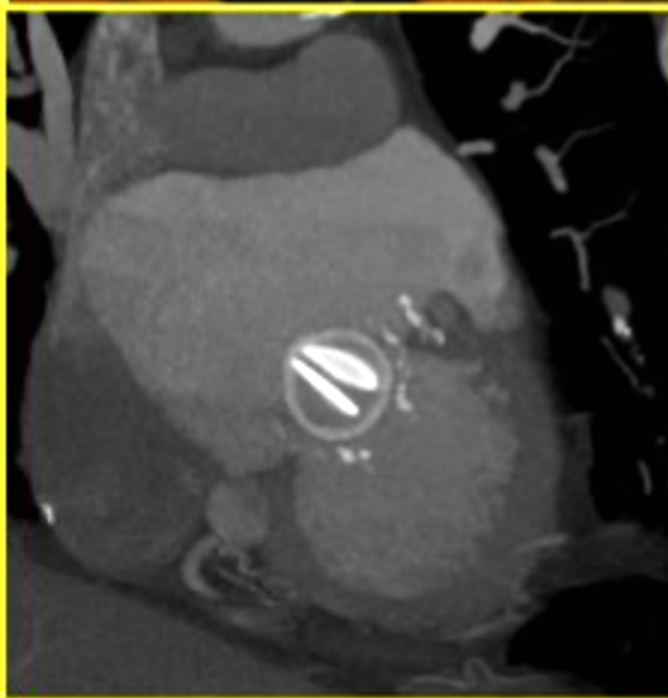
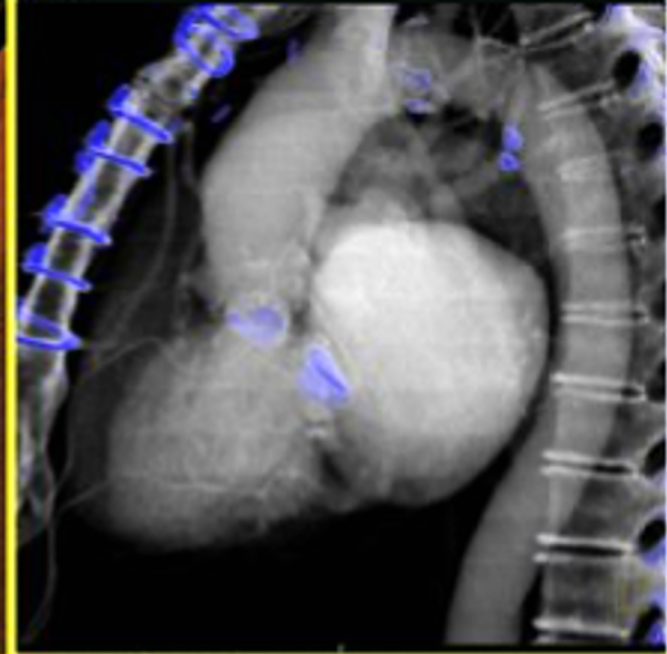
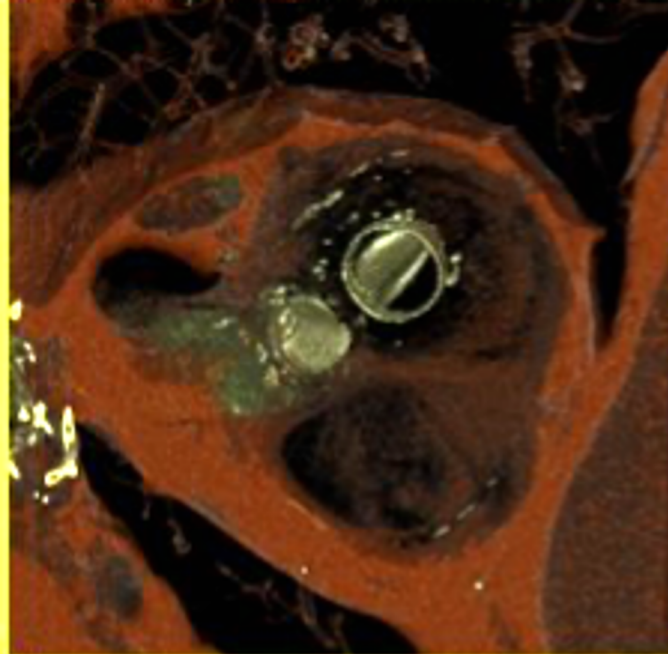




Courtesy of Erasmus Medical Center Rotterdam / Netherlands



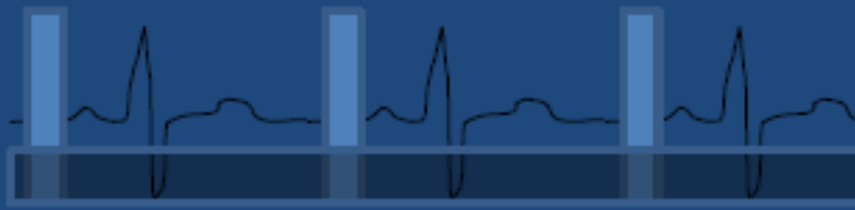
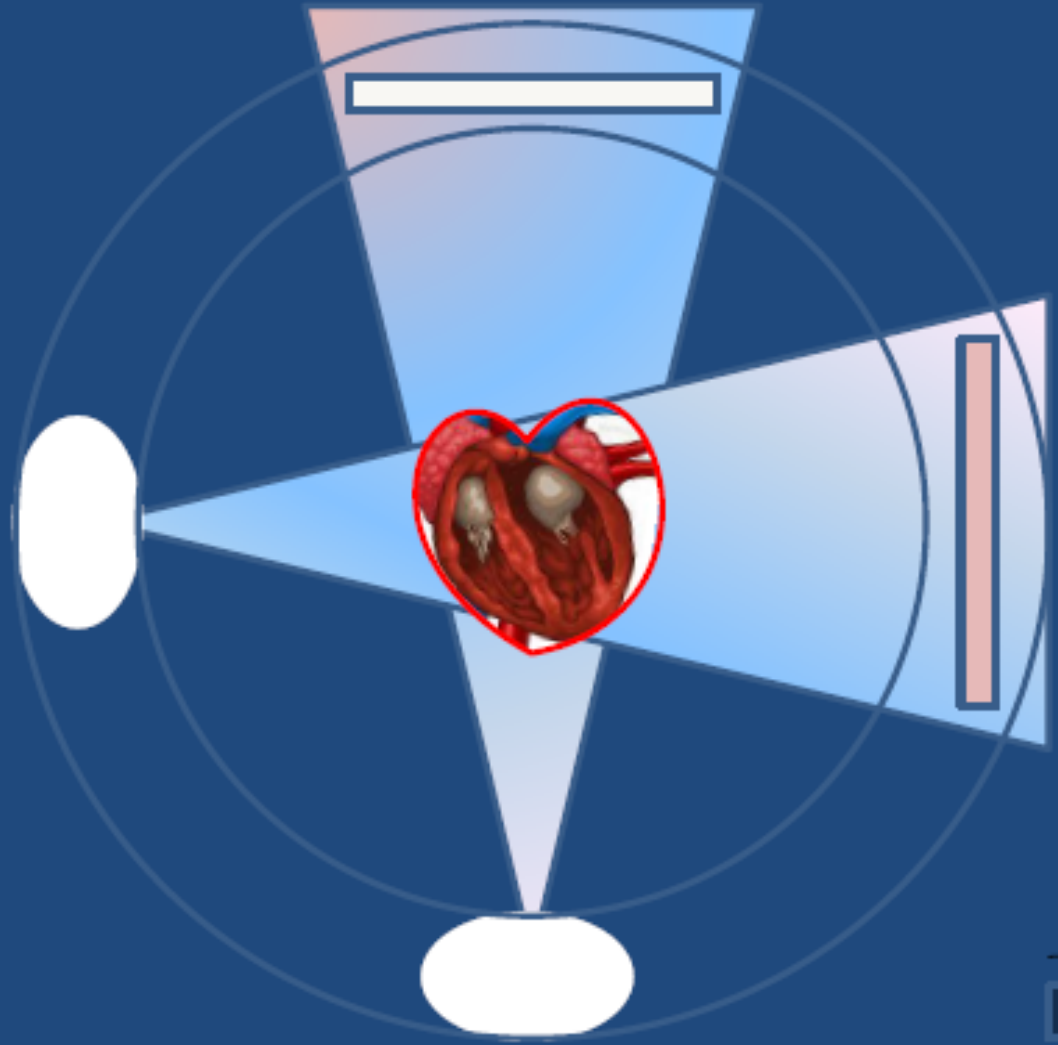
Courtesy of Toyohashi Heart Center, Japan



Courtesy of Jankharia Imaging / Mumbai, India

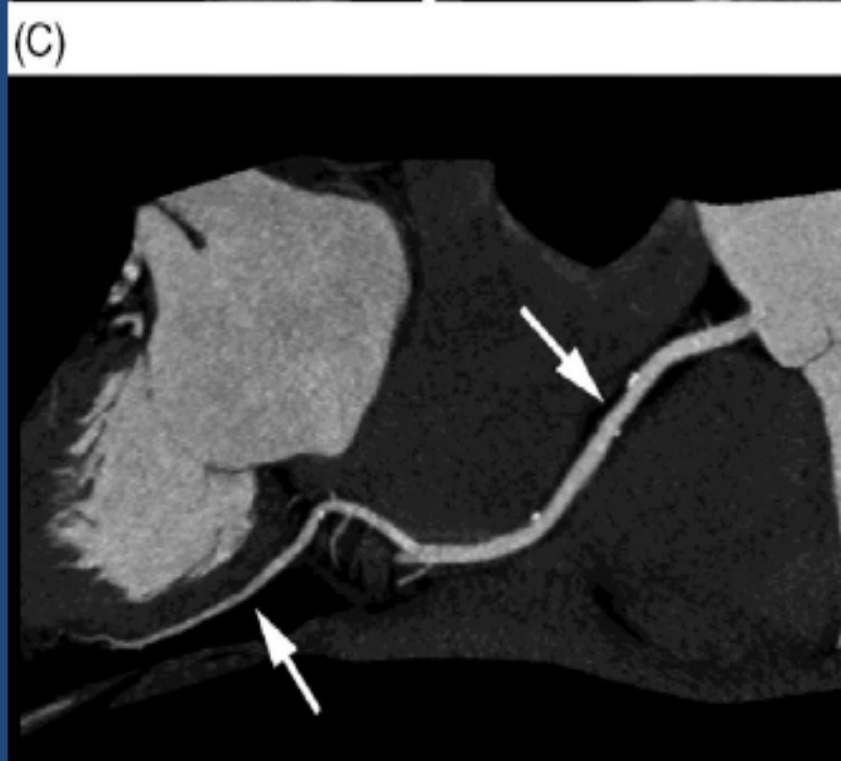
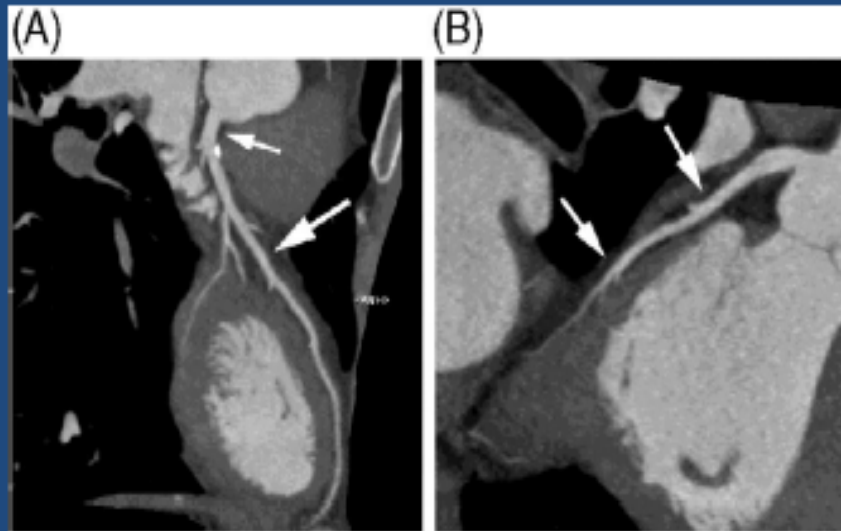


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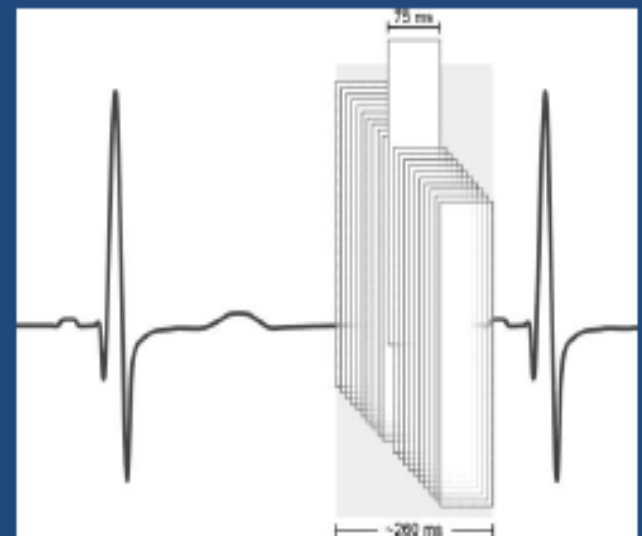
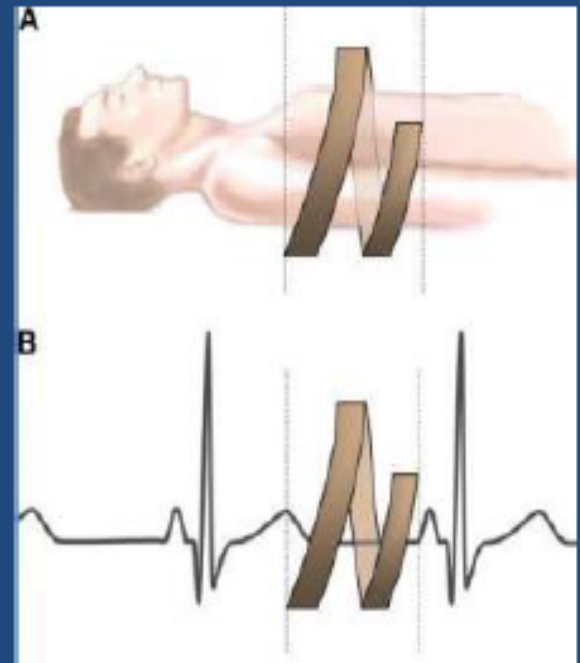


# High Pitch Coronary CT Scanning

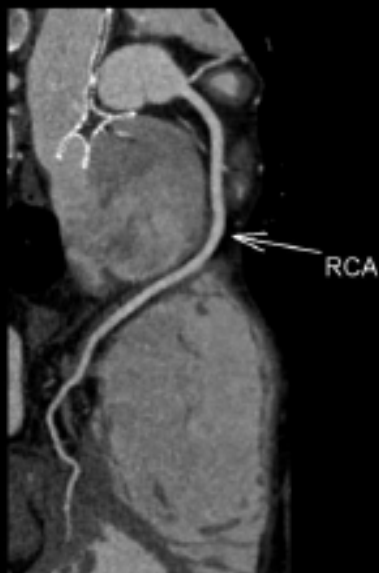
Male patient (183 cm, 78 kg, heart rate 54 b.p.m.)



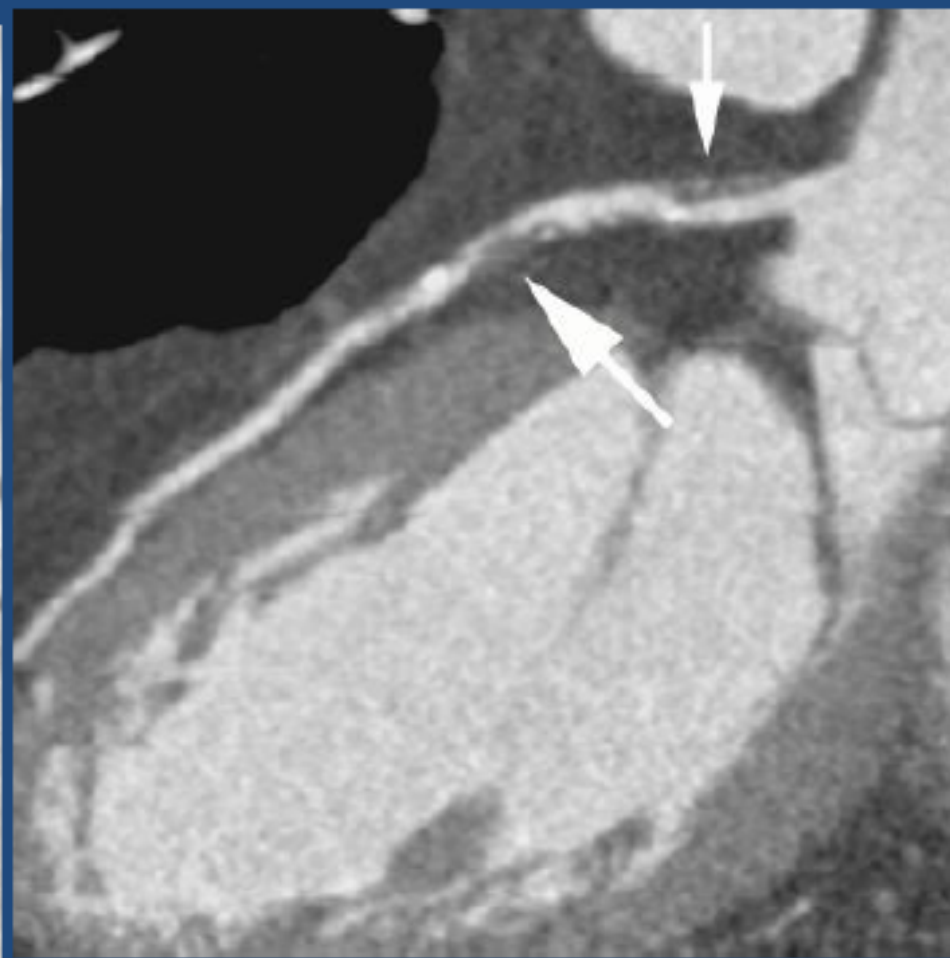
0.89 mSv



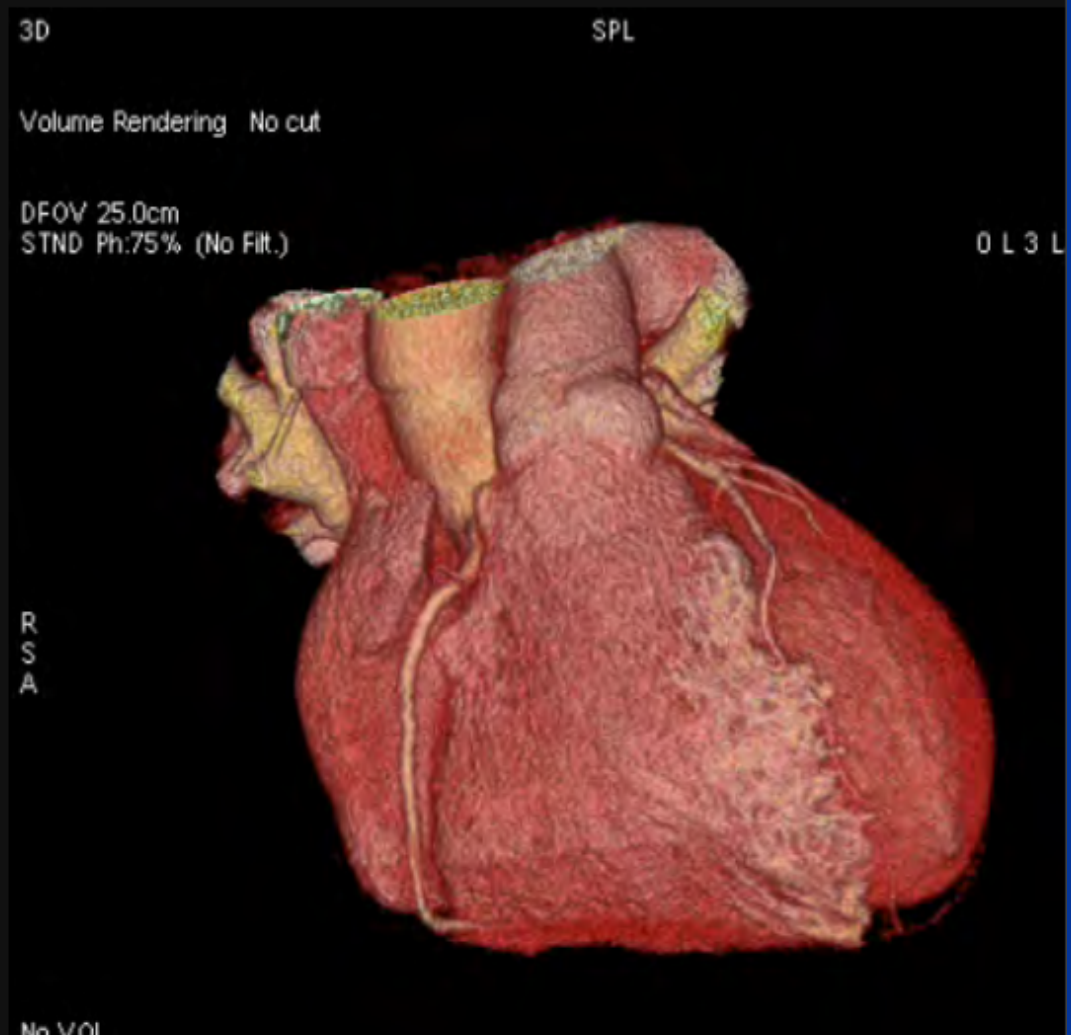
Gated with contrast



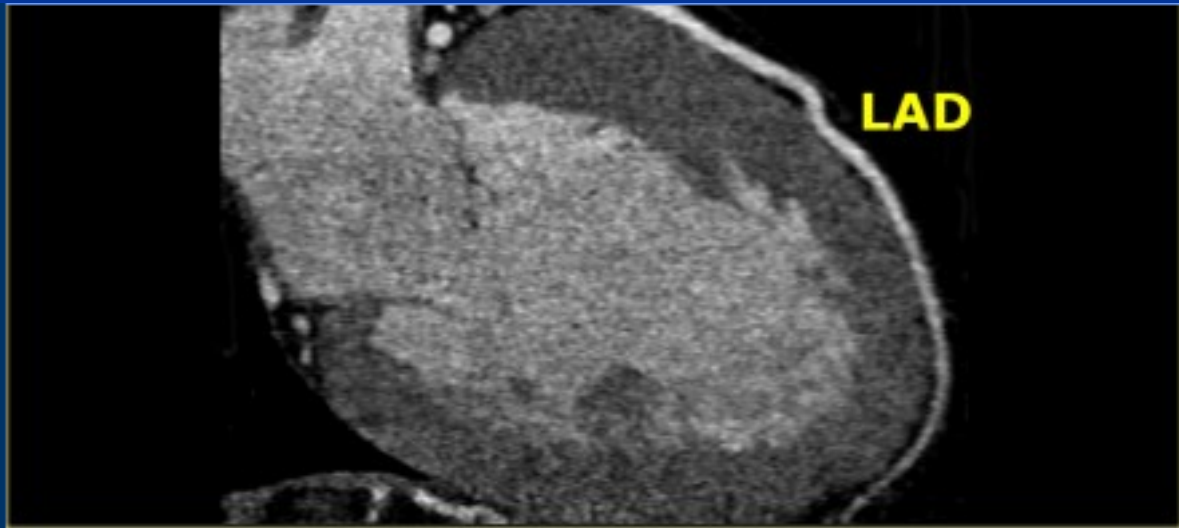
# Plaque visualization



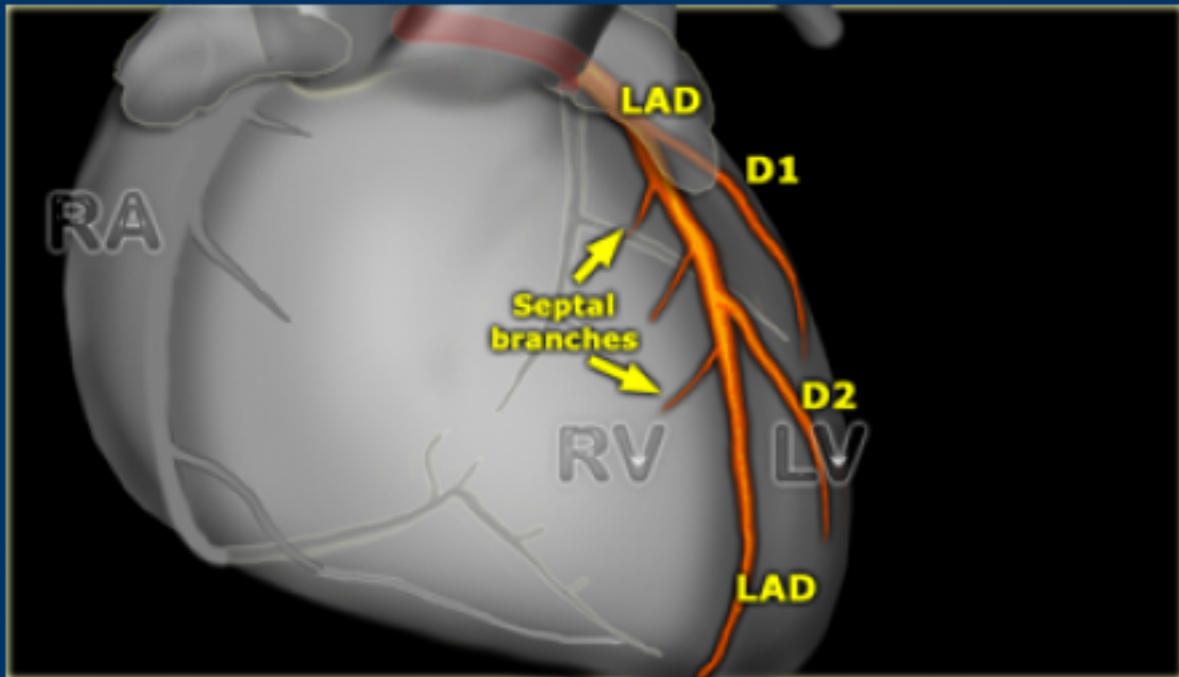
- **Knowledge of normal anatomy will allow for ideal imaging planes and sections.**
- **Knowledge of normal anatomy will allow for the identification of pathology and proper CT scan interpretation.**

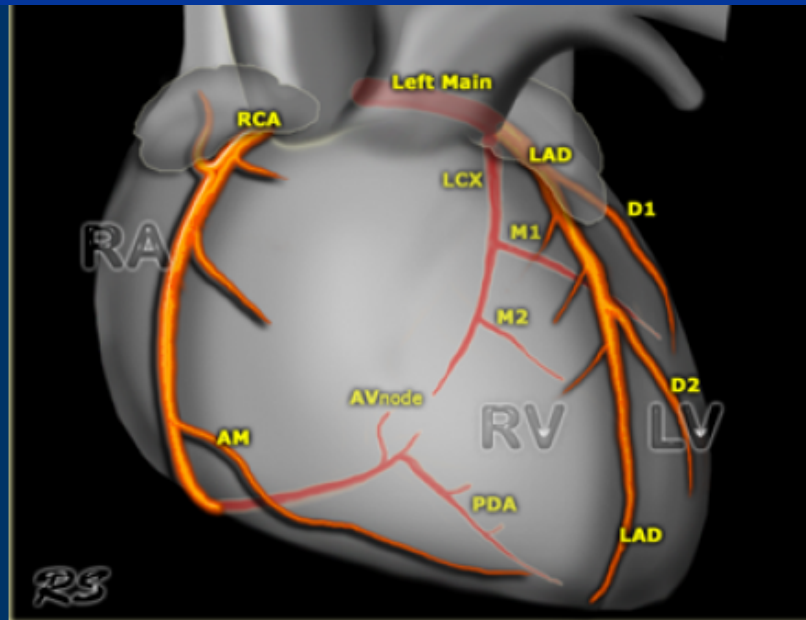




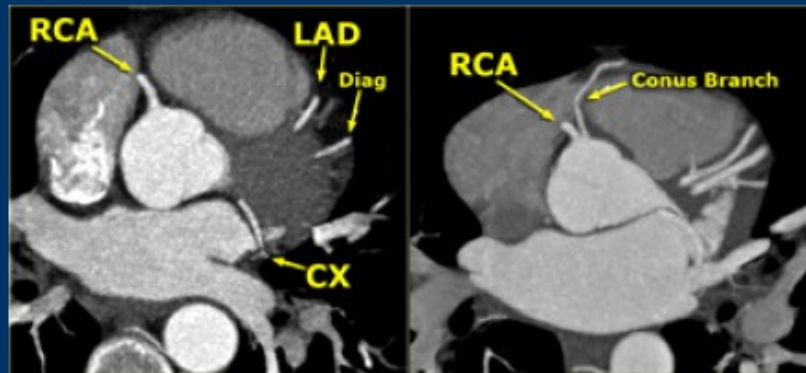
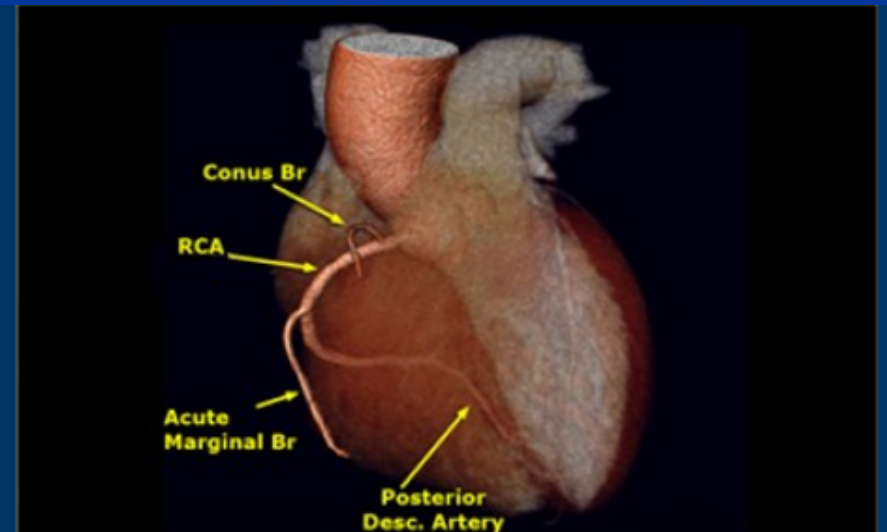


CT image of the LAD in RAO projection



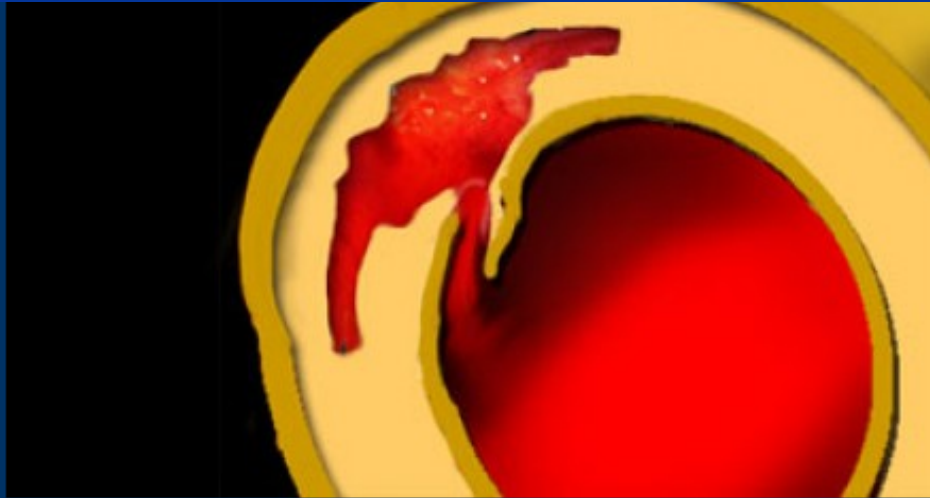


RCA, LAD and LCx in Anterior projection

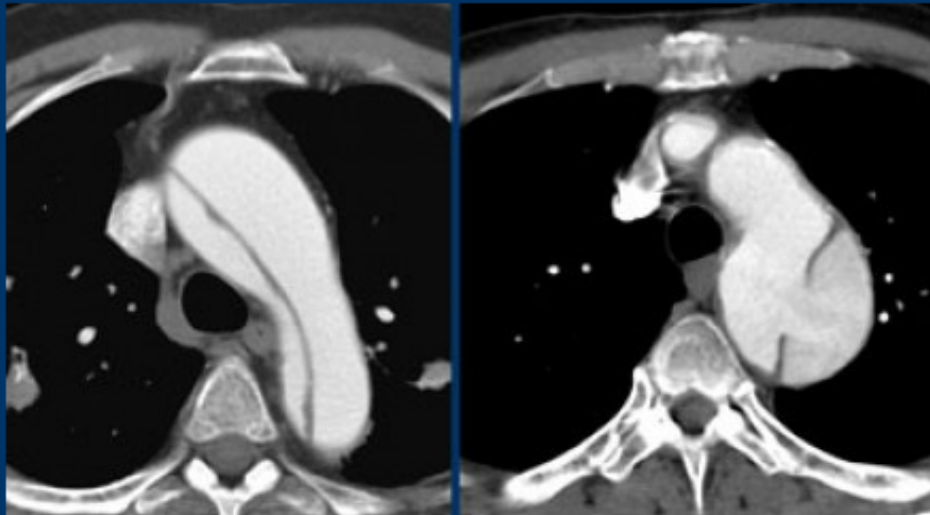


LEFT: RCA comes off the right sinus of Valsalva  
RIGHT: Conus artery comes off directly from the aorta

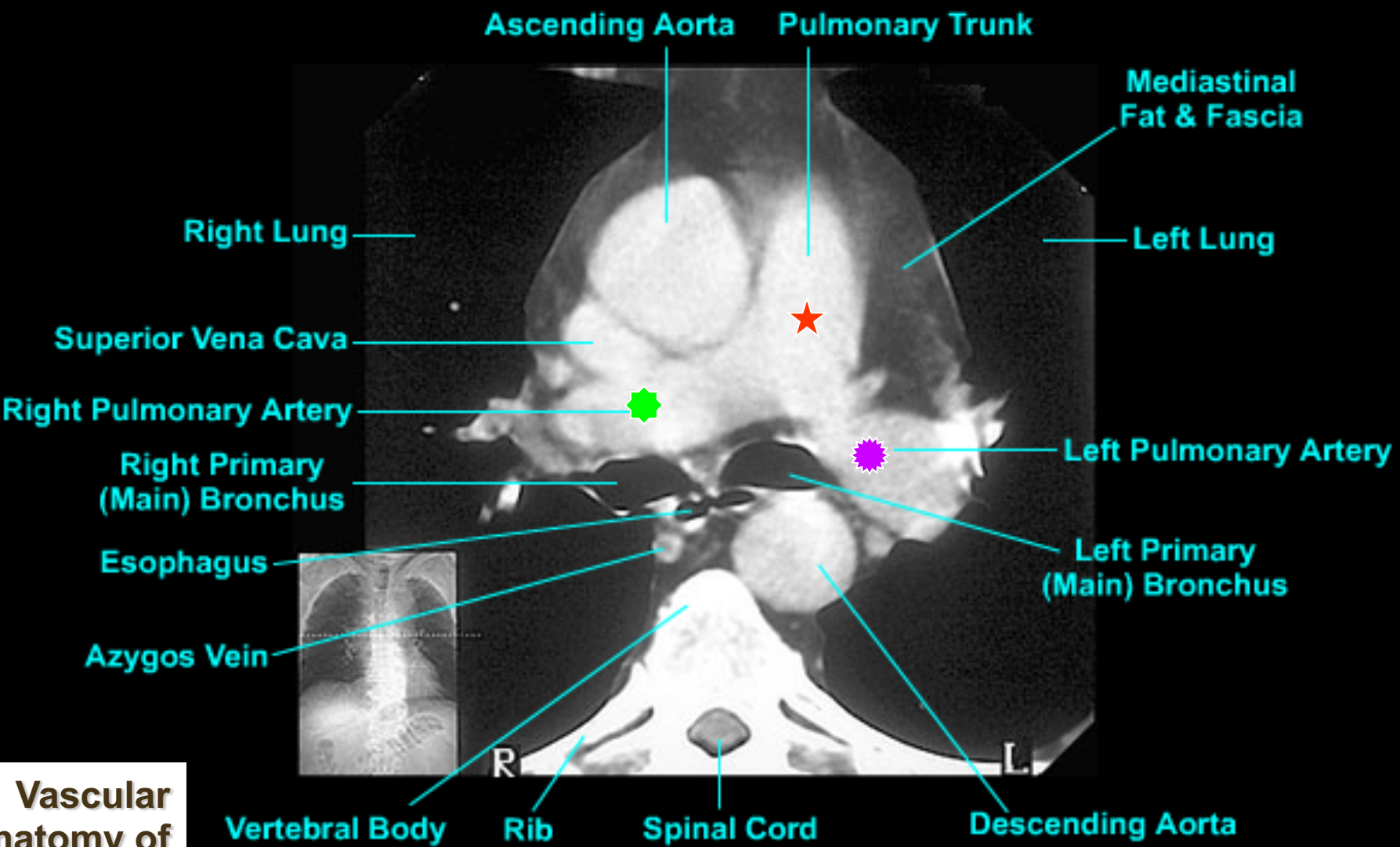
# AORTIC DISSECTION



Classic Aortic Dissection

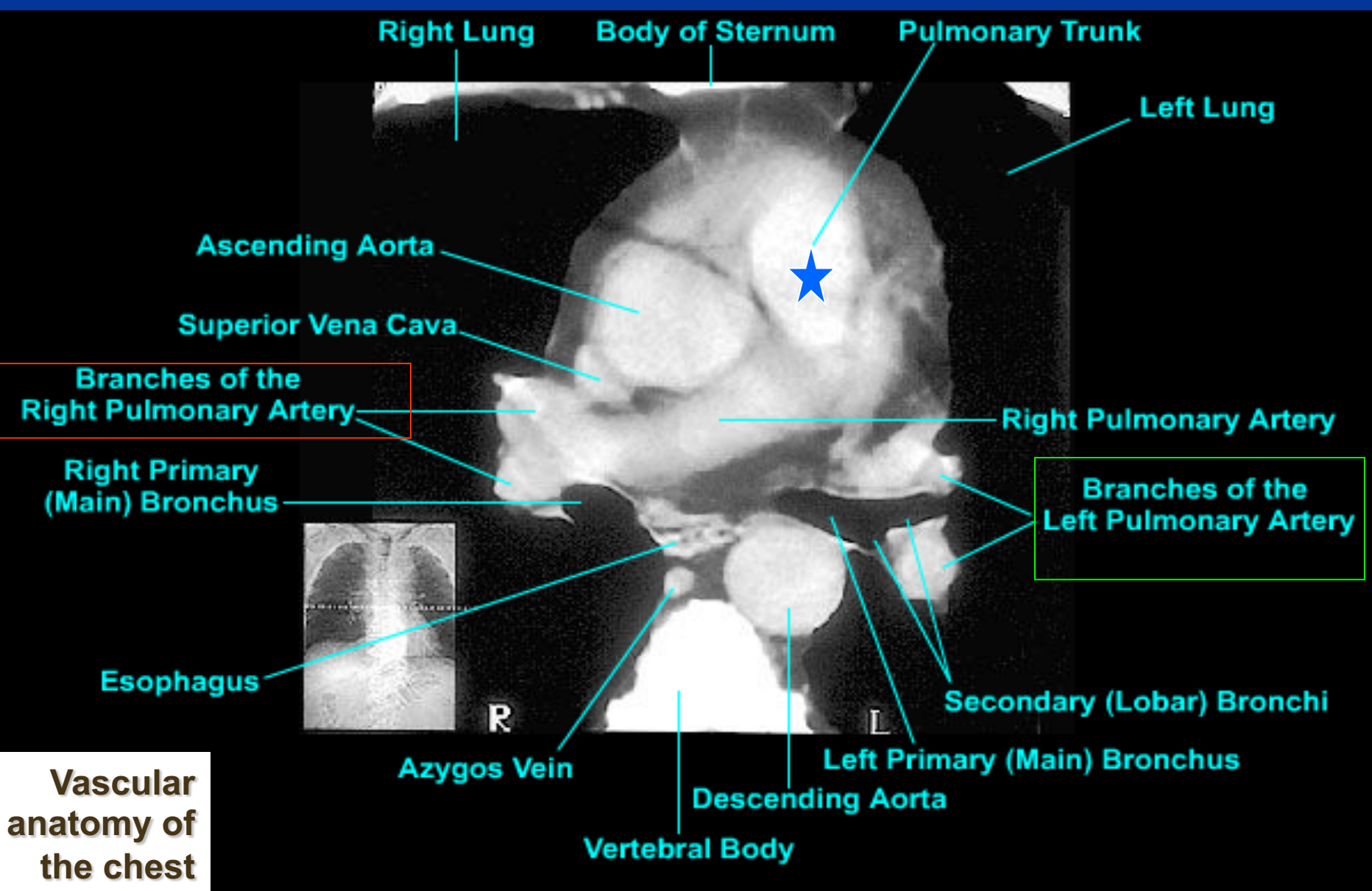


LEFT: Type A dissection with clear intimaflap seen within the aortic arch. RIGHT: Type B dissection. Entry point distal to left subclavian artery.

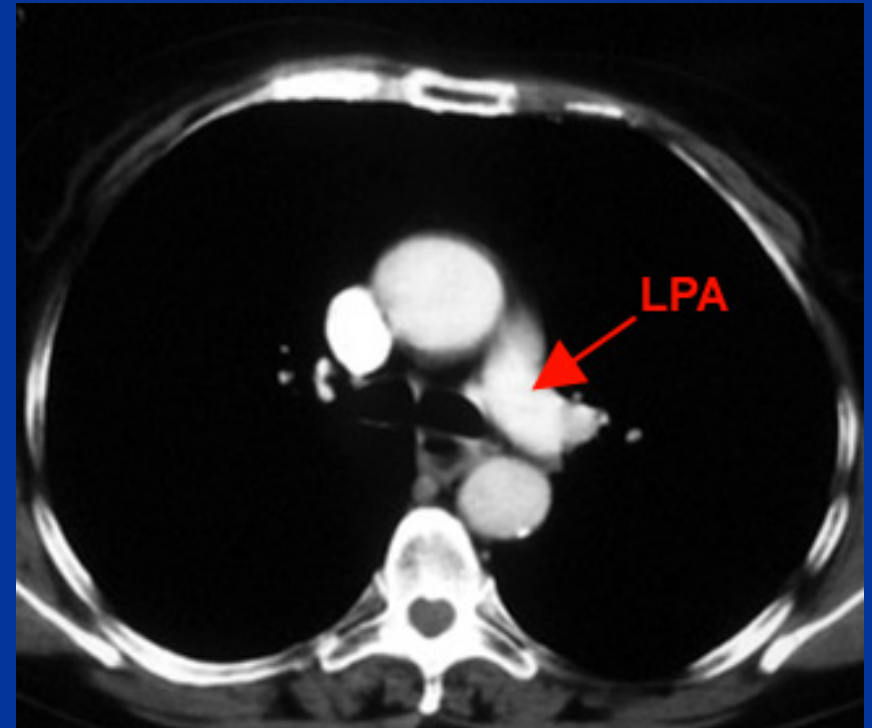
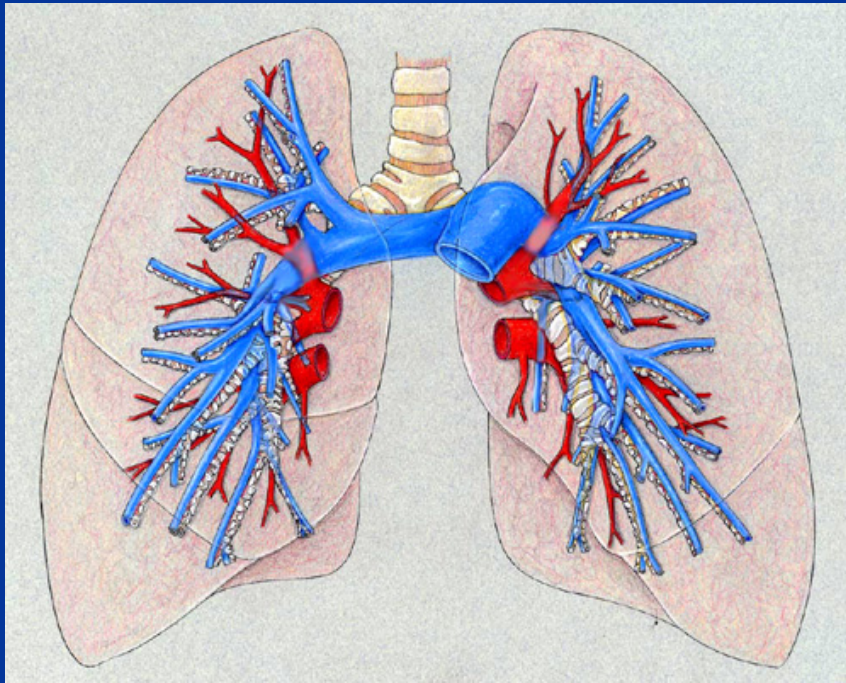


**Vascular anatomy of the chest**

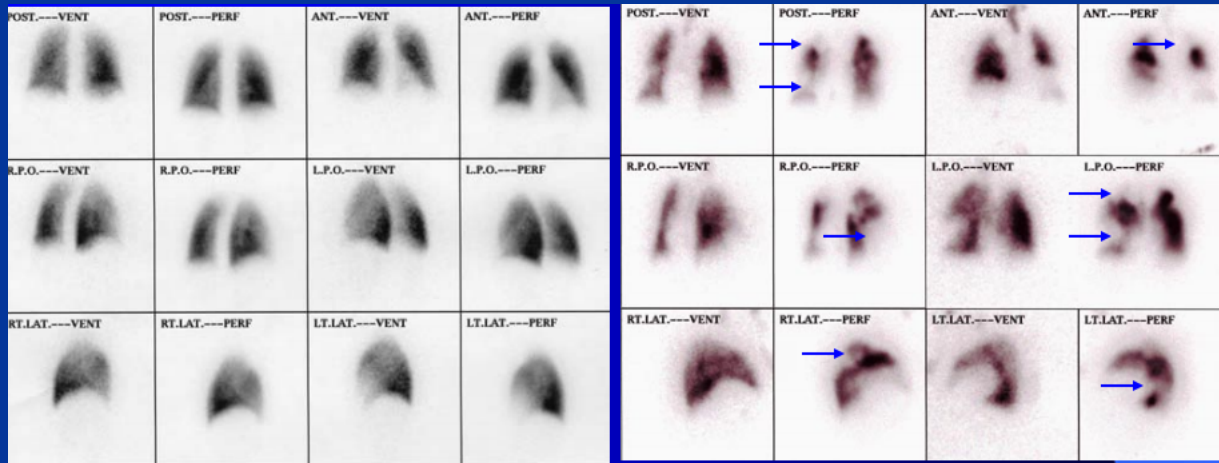




# Pulmonary artery

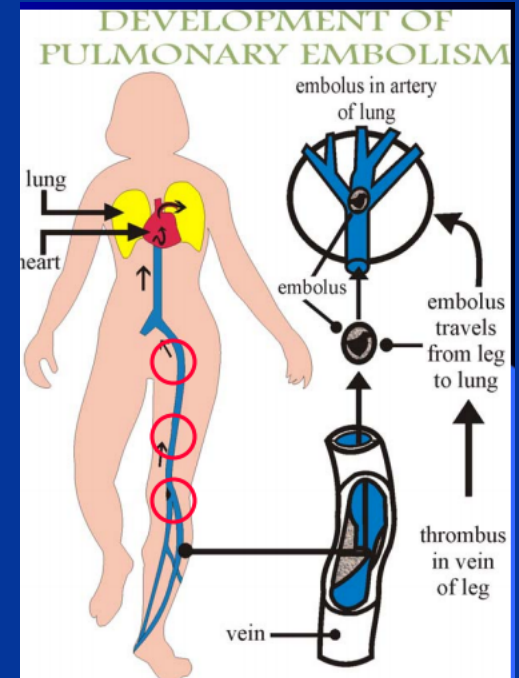


## V/Q SCAN

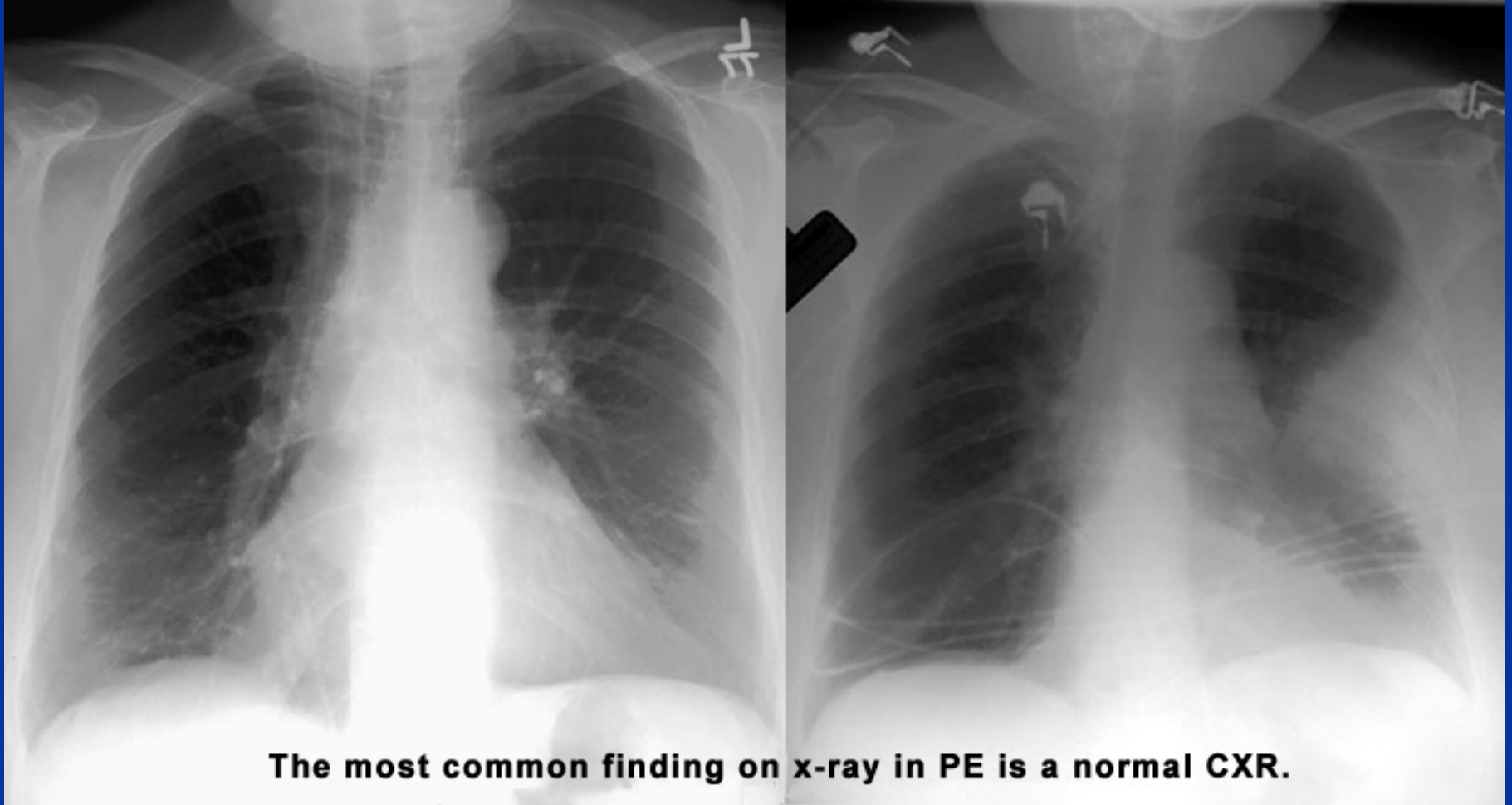


**NORMAL**

**HIGH PROBABILITY OF PE**



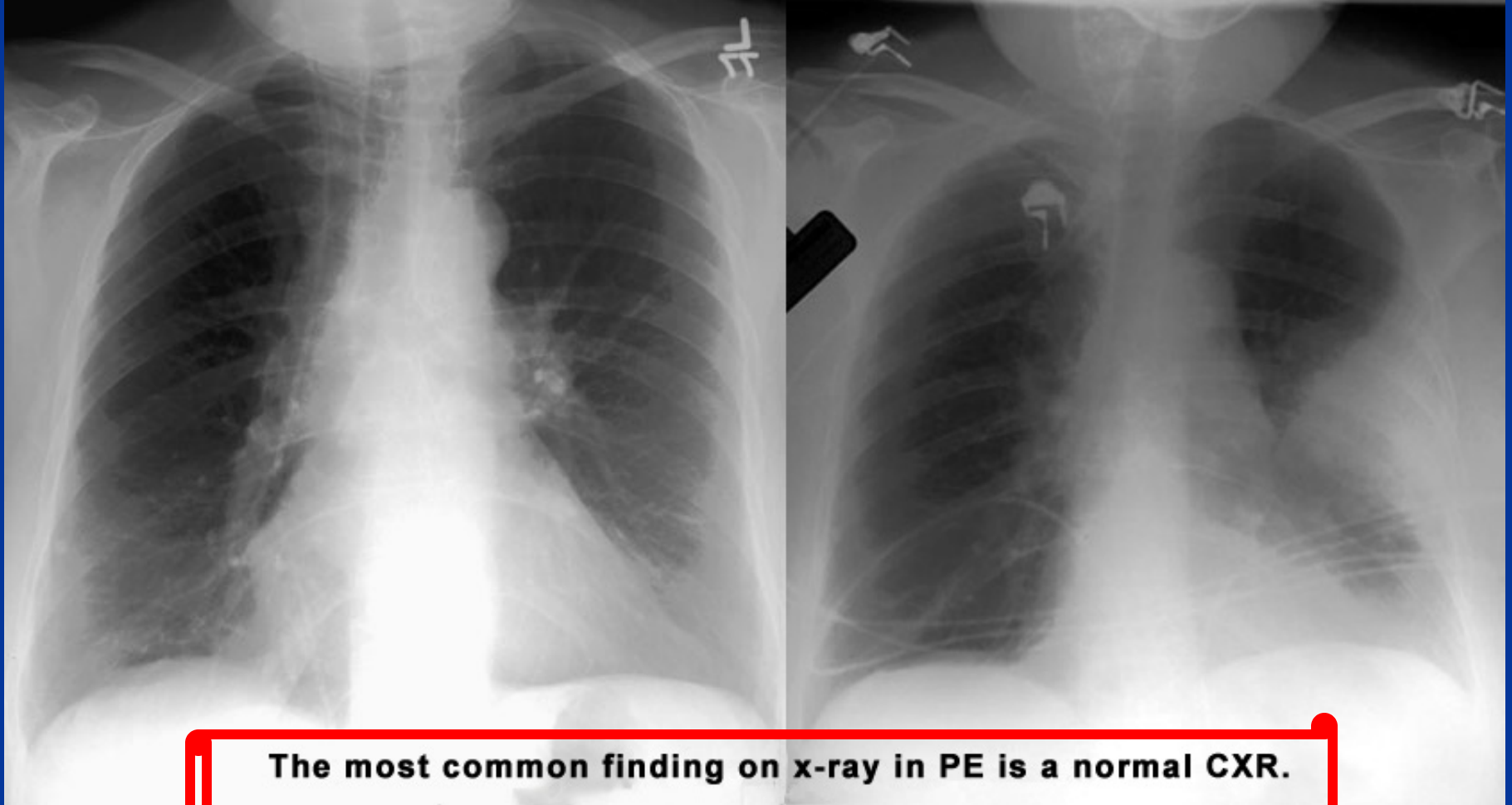
# Pulmonary embolism



**The most common finding on x-ray in PE is a normal CXR.**

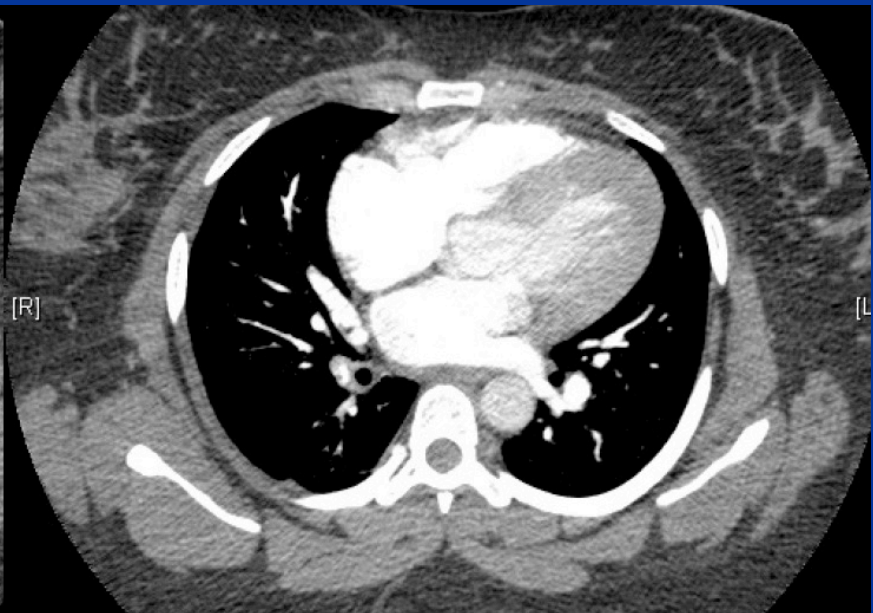
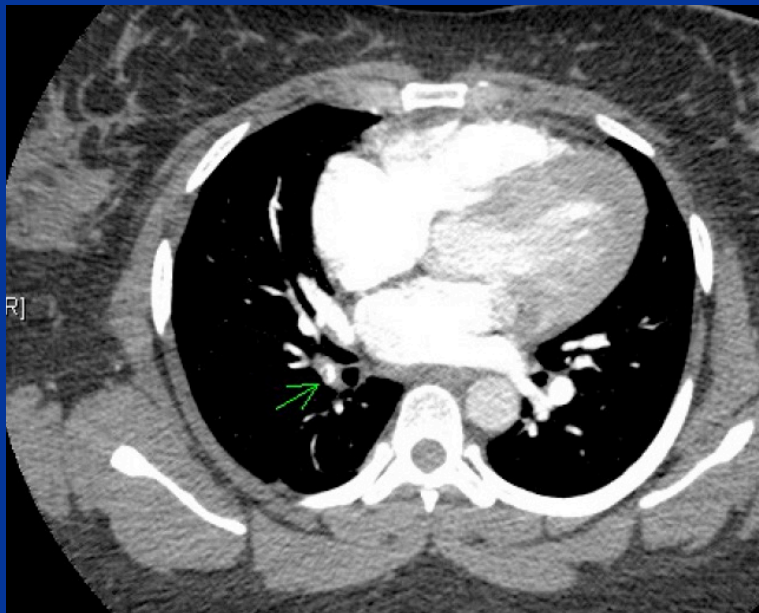
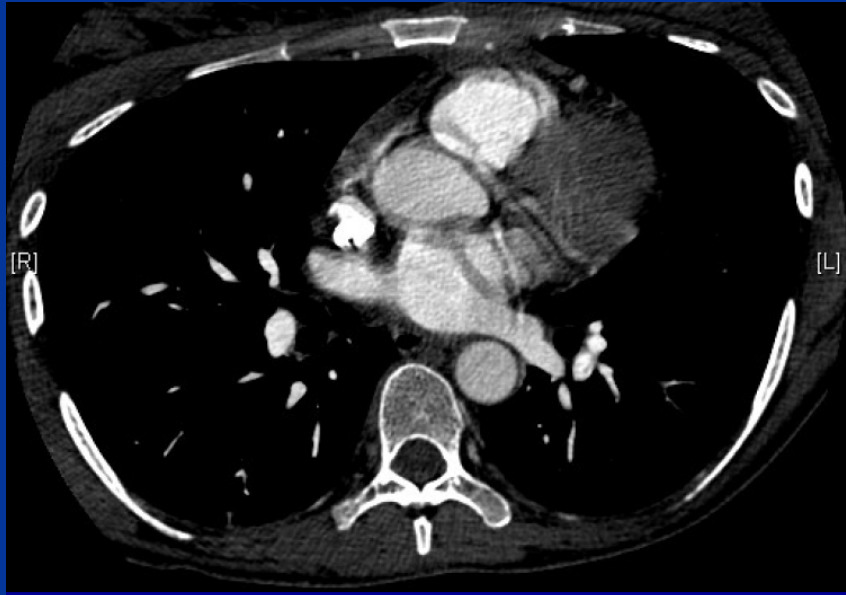


# Pulmonary embolism

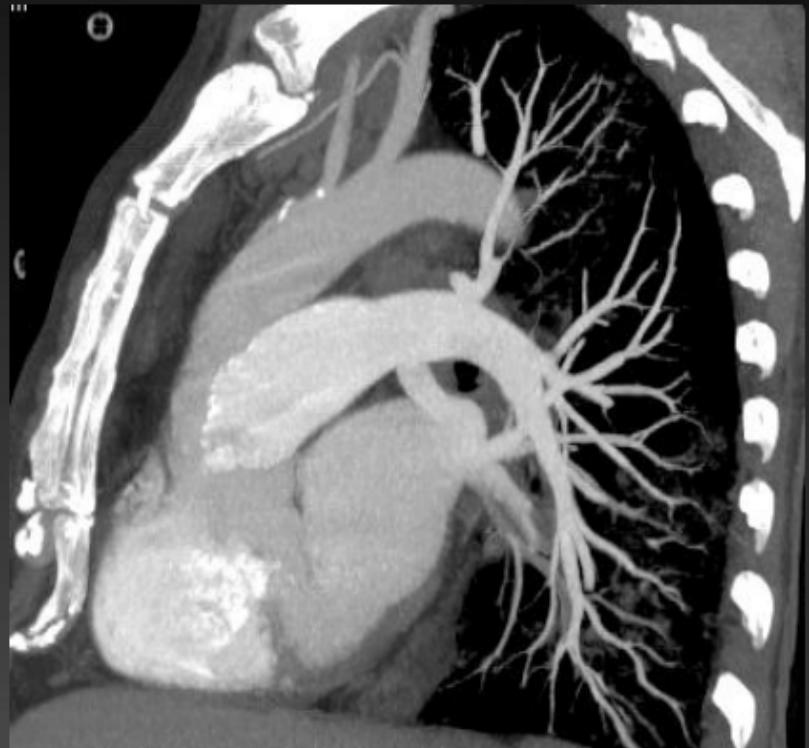
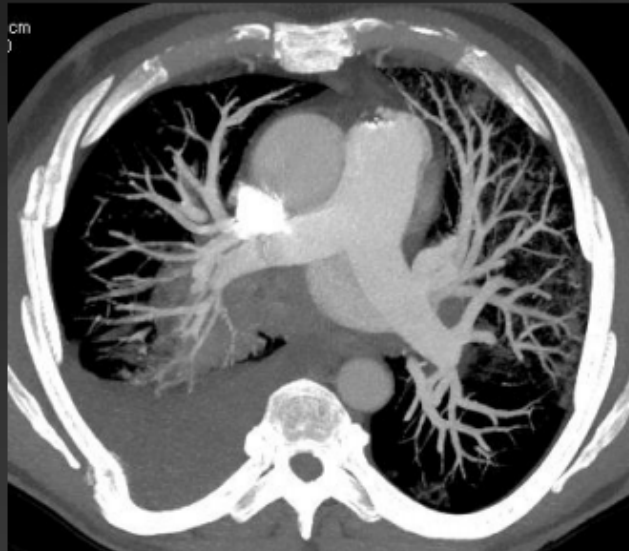


**The most common finding on x-ray in PE is a normal CXR.**

**THE GOLD STANDARD FOR  
DIAGNOSIS OF PE IS CTA**

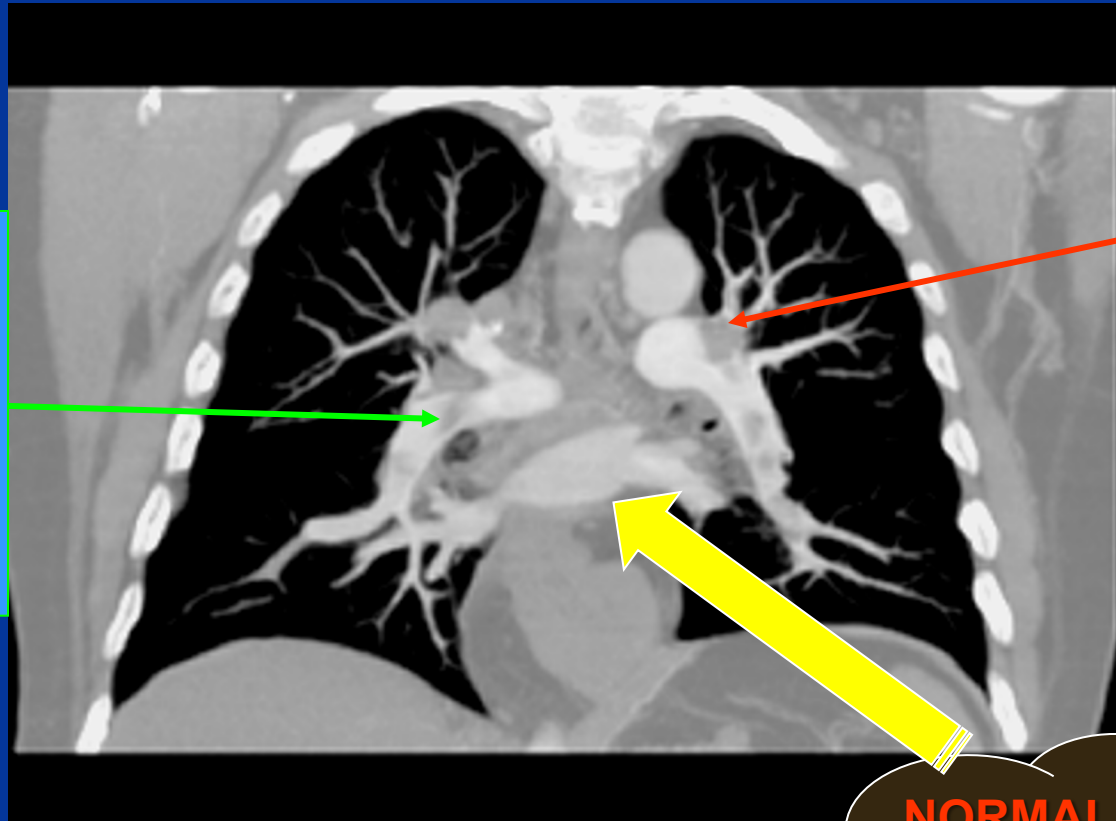


# CTA PULMONARY VASCULATURE





# CTA (Coronal Reconstruction)

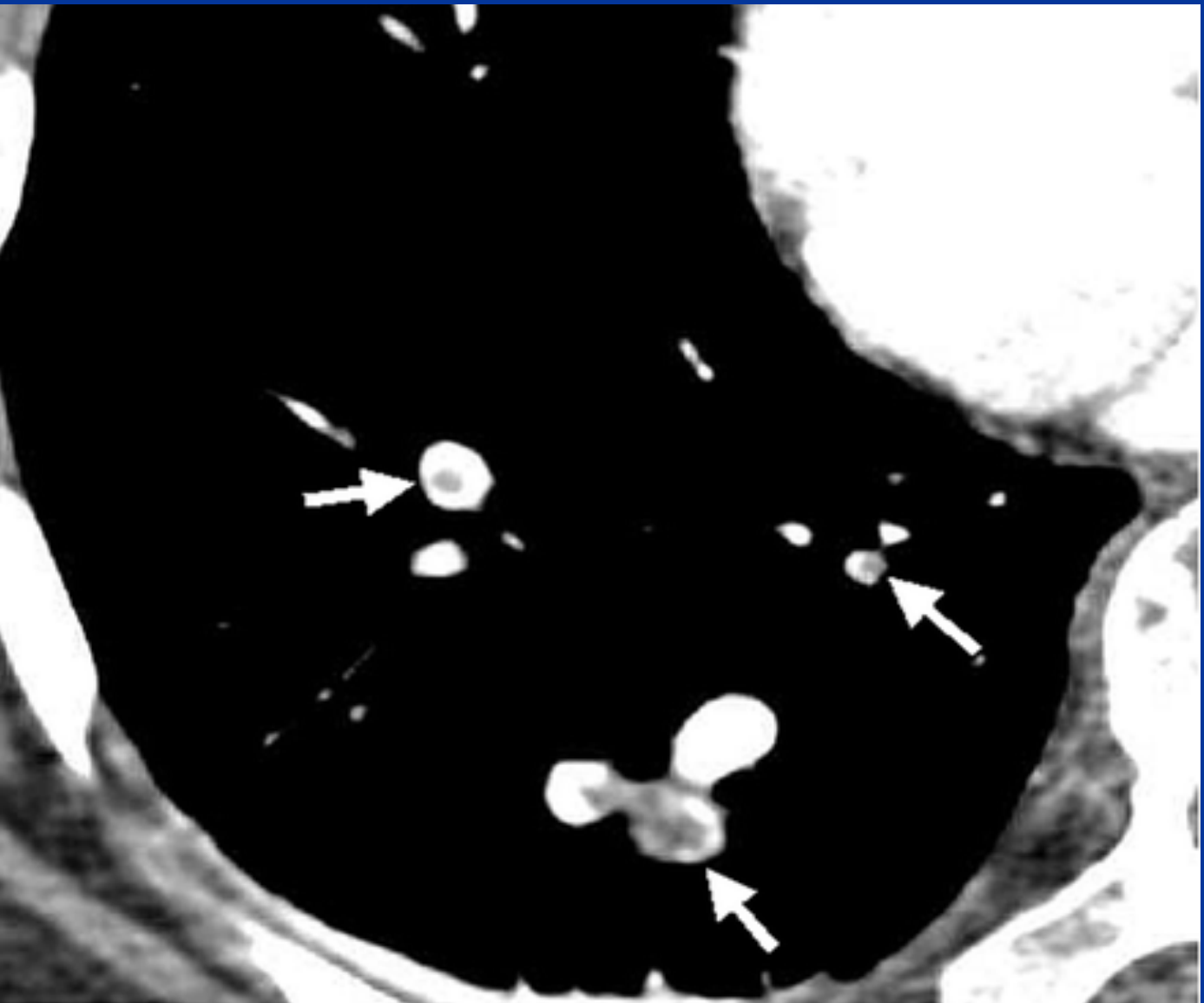


Embolus in  
descending  
right  
pulmonary  
artery

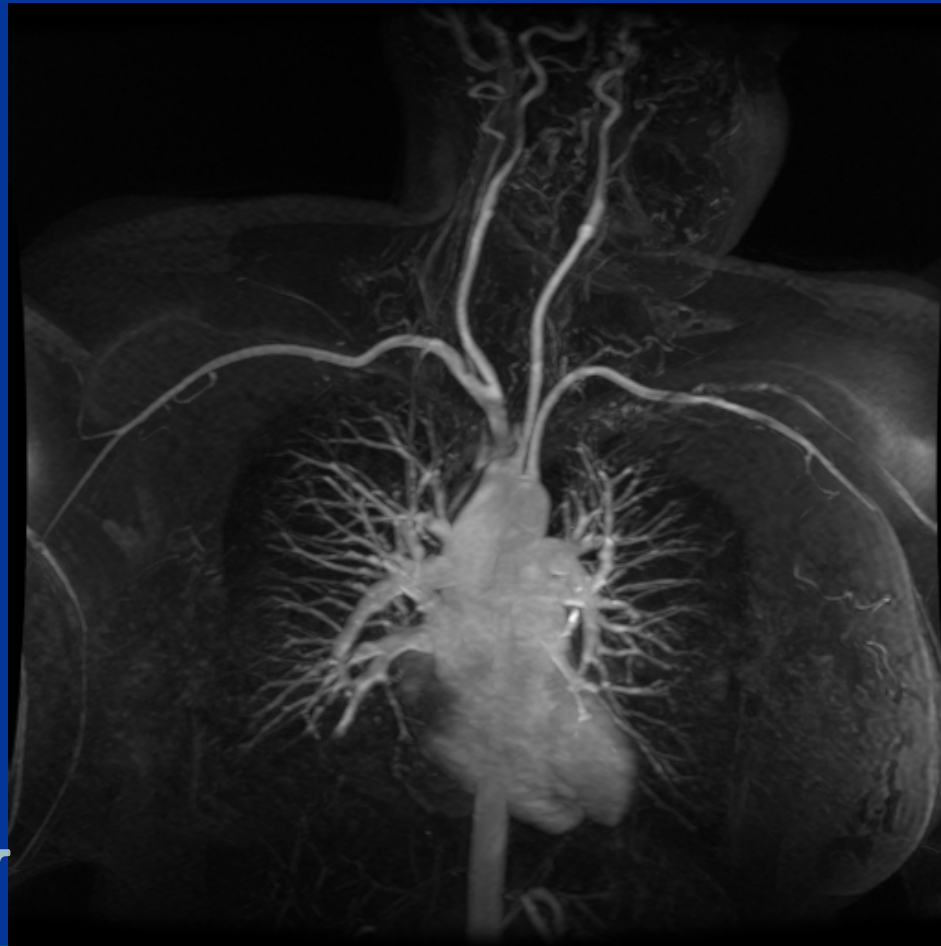
Embolus in  
left main  
pulmonary  
artery

**NORMAL  
HOMOGENOUS  
FILLING OF THE  
VESSELS**

# CT Angiogram

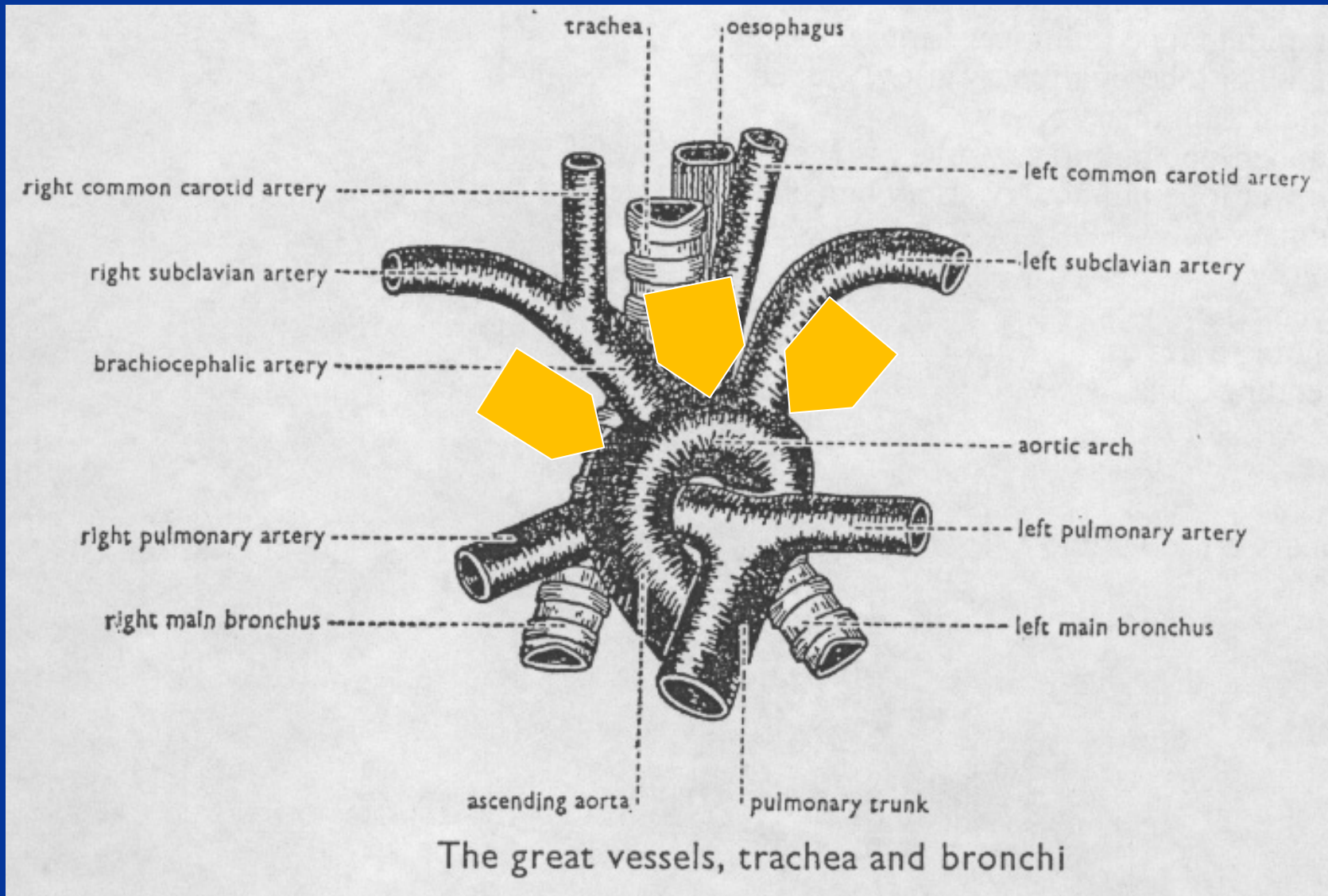


# AORTIC ARCH ANATOMY



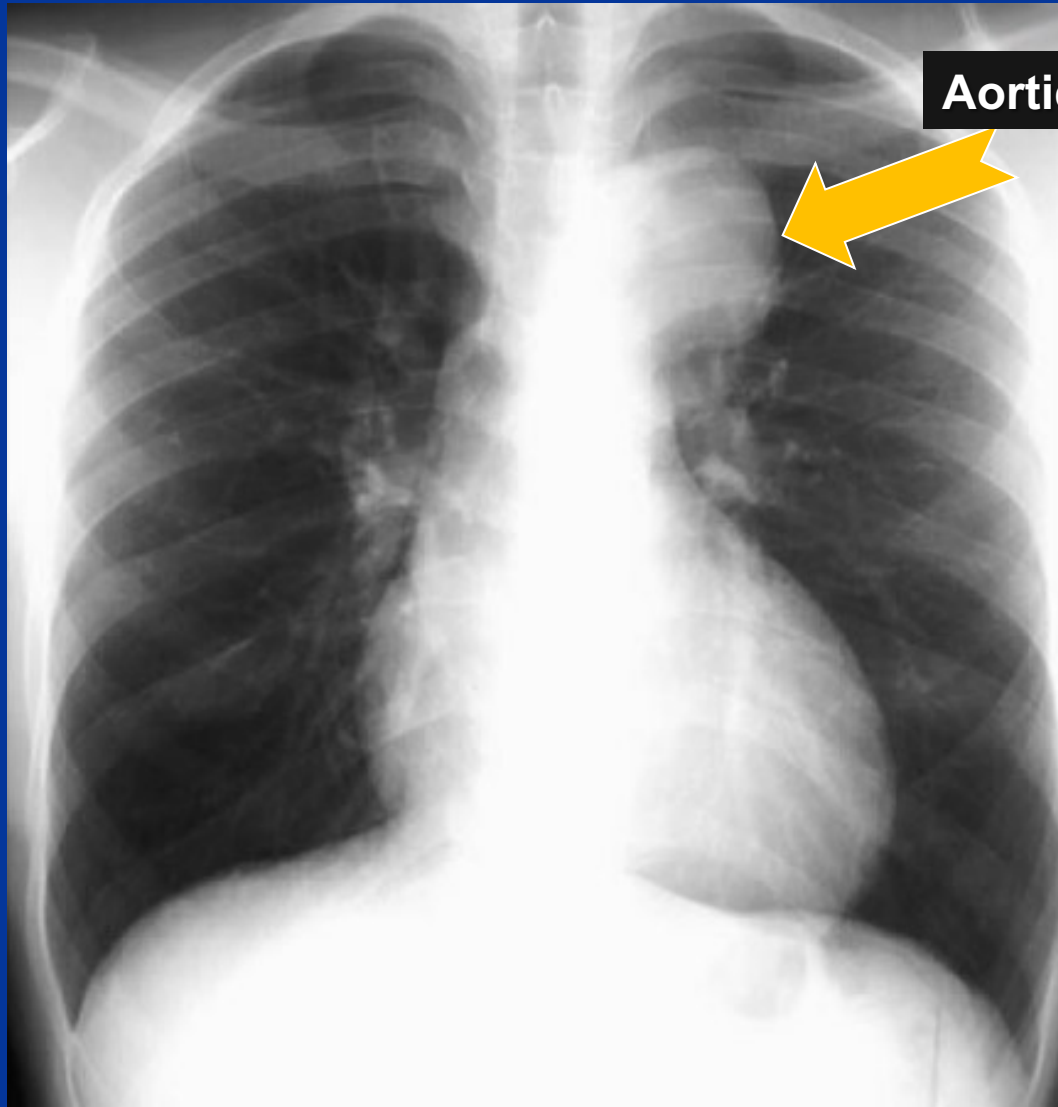
KKUH  
KKUH

# The Aortic arch/great vessels





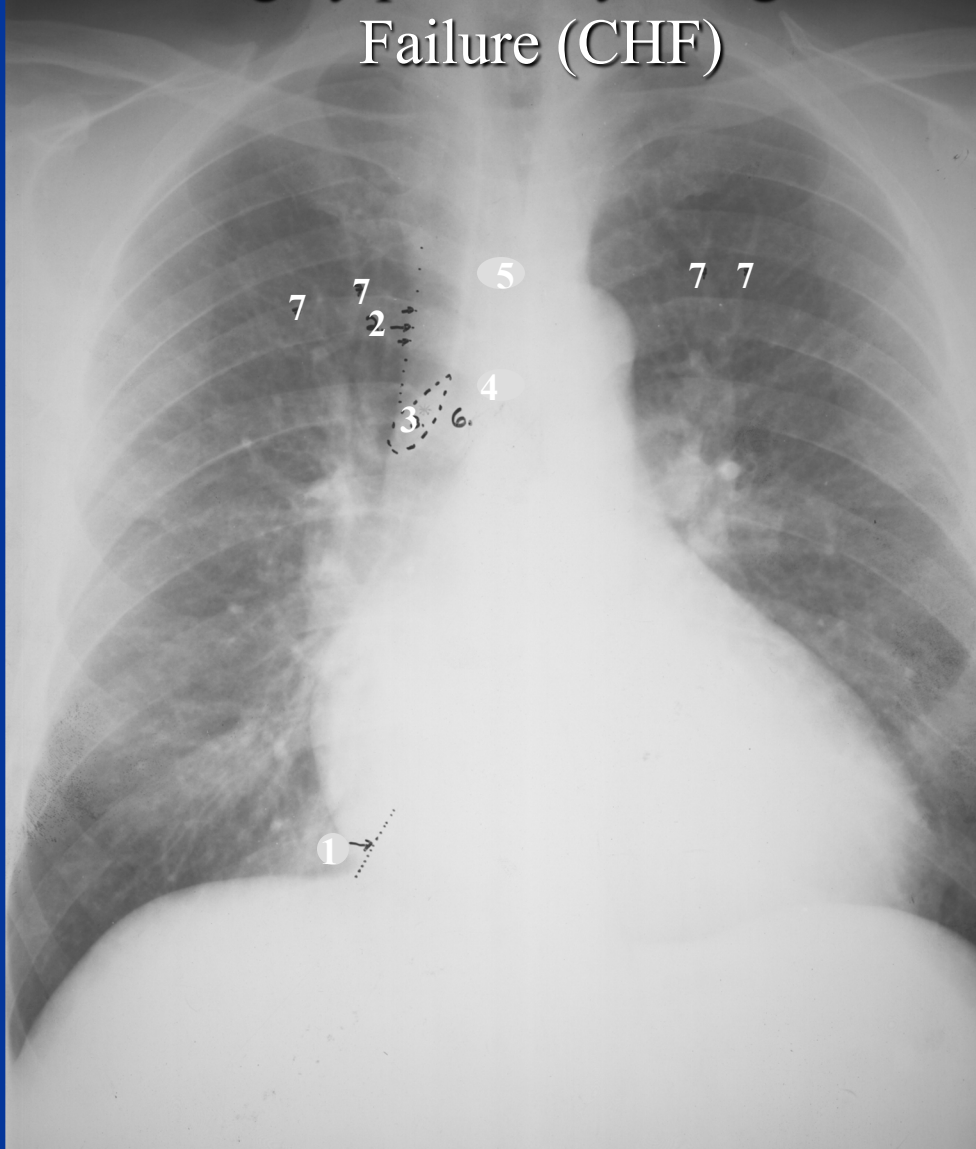
# Aortic aneurysm



Aortic knob/knuckle

# Heart and Vessels

## Cardiomegaly plus early Congestive Heart Failure (CHF)



Key:

1. Inferior vena cava (IVC)
2. Superior vena cava (SVC)
- \*3. Azygos vein
4. Carina
5. Trachea
6. Right main stem bronchus
7. Prominent pulmonary 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.

# Cardio-thoracic Ratio

One of the easiest observations to make is something you already know: the cardio-thoracic ratio which is the widest diameter of the heart compared to the widest internal diameter of the rib cage

**<50%**

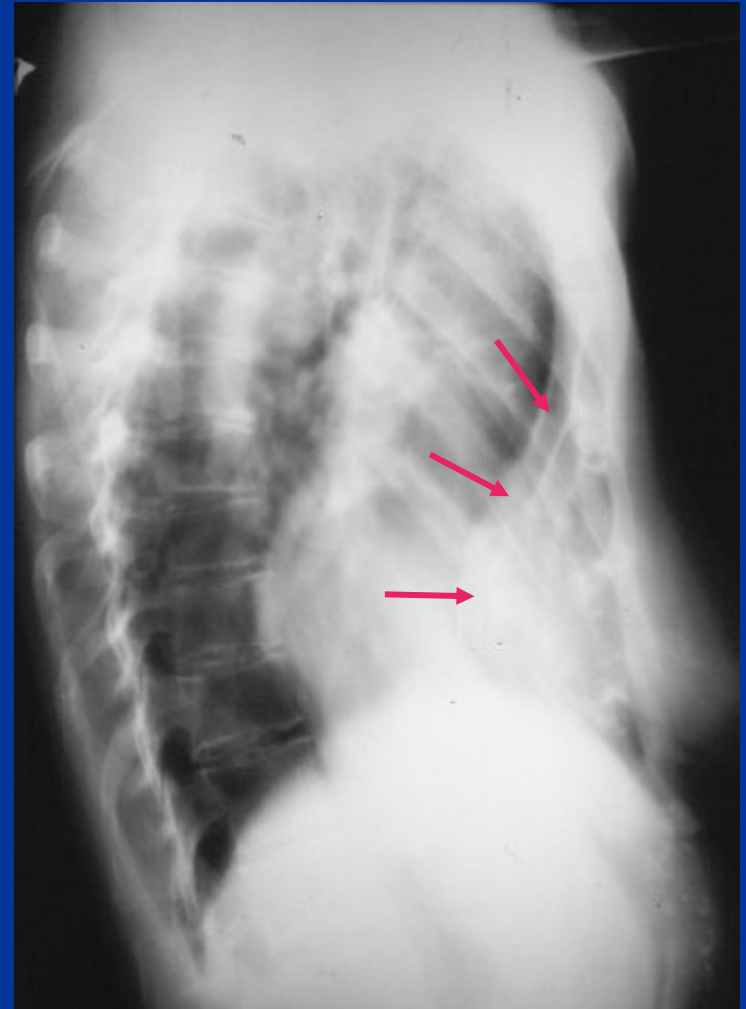
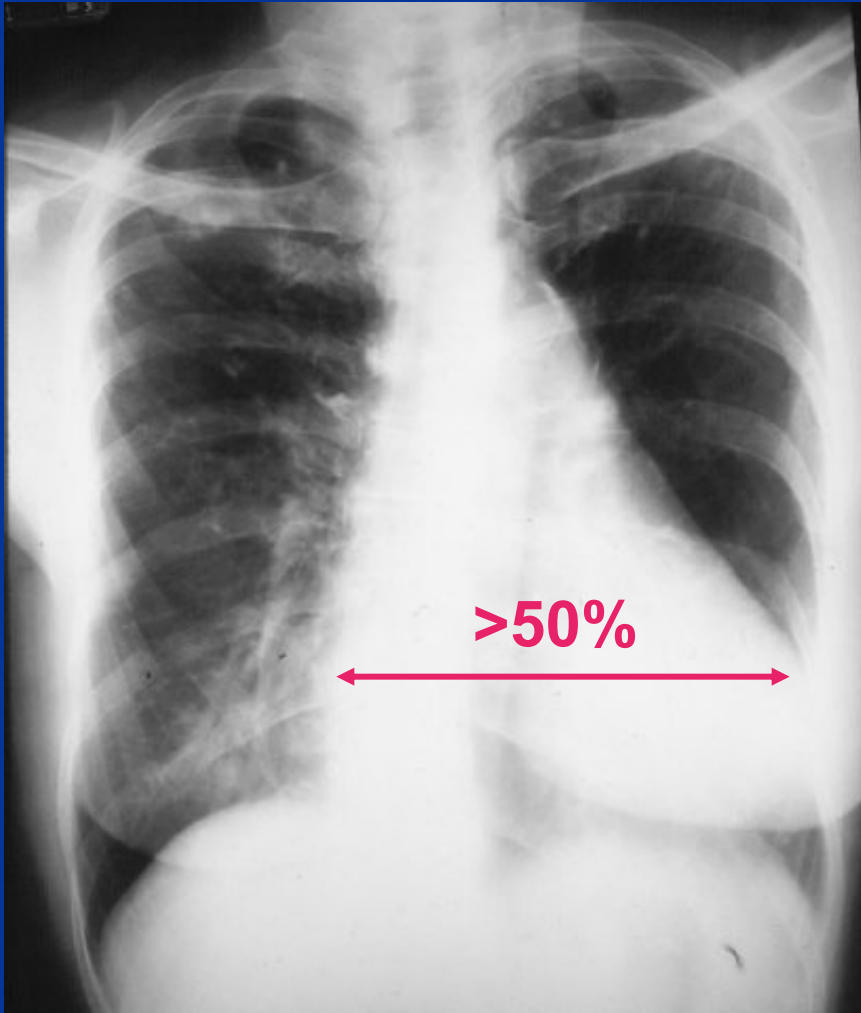


# Sometimes, CTR is more than 50%

## But Heart is Normal

- Extracardiac causes of cardiac enlargement
  - Portable AP films
  - Obesity
  - Pregnant
  - Ascites
  - Straight back syndrome
  - Pectus excavatum



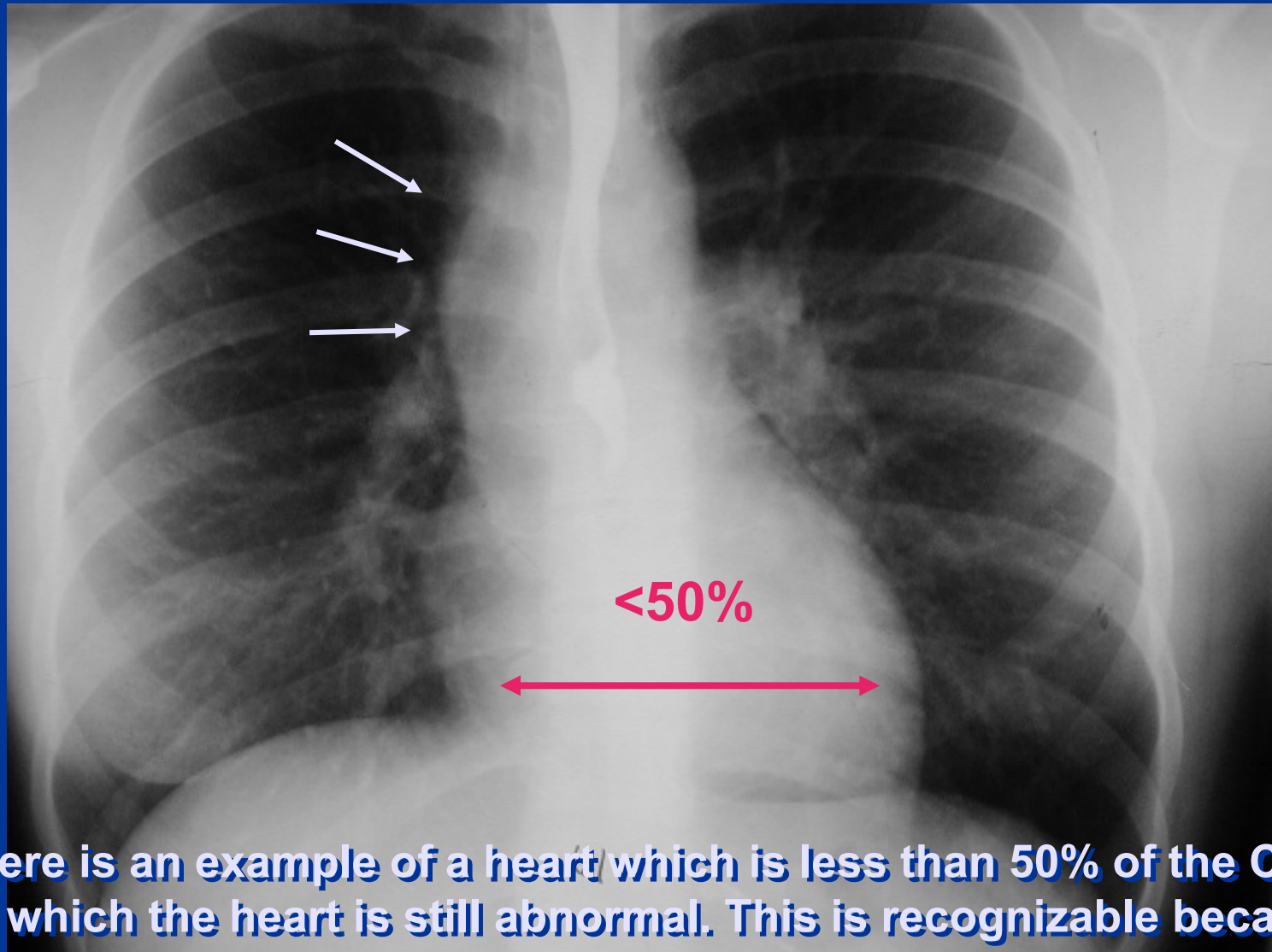


Here is a heart that is larger than 50% of the cardiothoracic ratio, but it is still a normal heart. This is because there is an extracardiac cause for the apparent cardiomegaly. On the lateral film, the arrows point to the inward displacement of the lower sternum in a pectus excavatum deformity.

# Sometimes, CTR is less than 50%

## But Heart is Abnormal

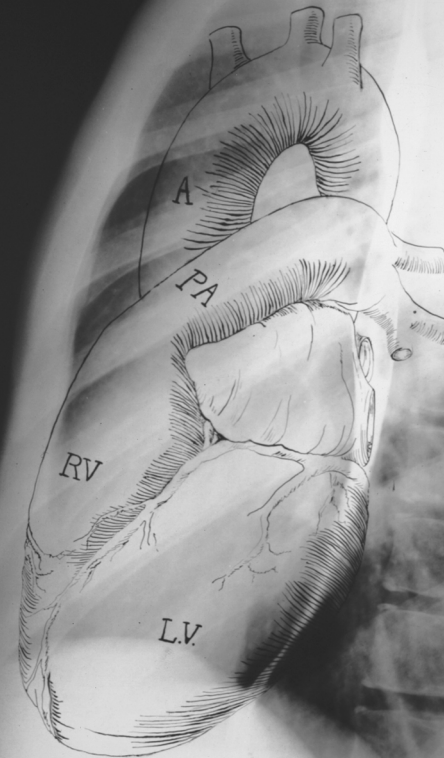
- Obstruction to outflow of the ventricles
  - Ventricular hypertrophy
- Must look at cardiac contours



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.





# The Cardiac Contours

Ascending Aorta

“Double density”  
of LA enlargement

Right atrium

Aortic knob

Main pulmonary  
artery

Indentation for  
LA

Left ventricle

There are 7 contours to the heart in the frontal projection in this system.

# The Cardiac Contours

Ascending Aorta

“Double density”  
of LA enlargement

Right atrium

Aortic knob

Main pulmonary  
artery

Indentation for  
LA

Left ventricle

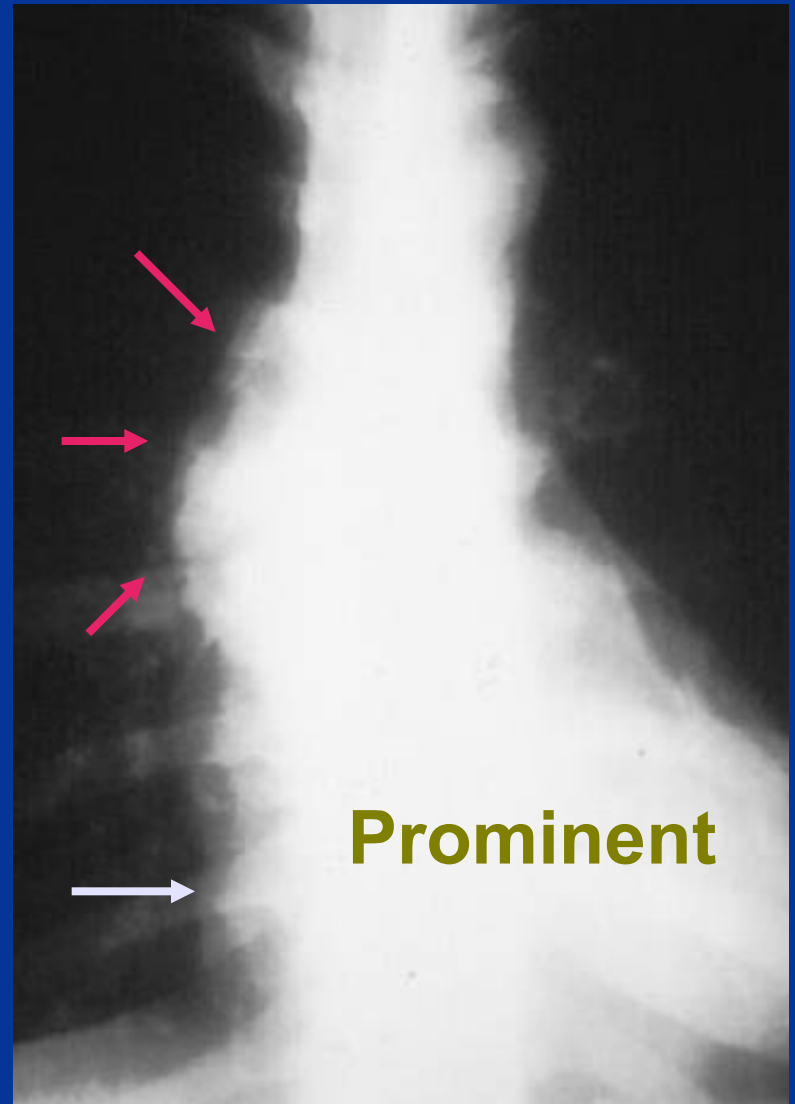
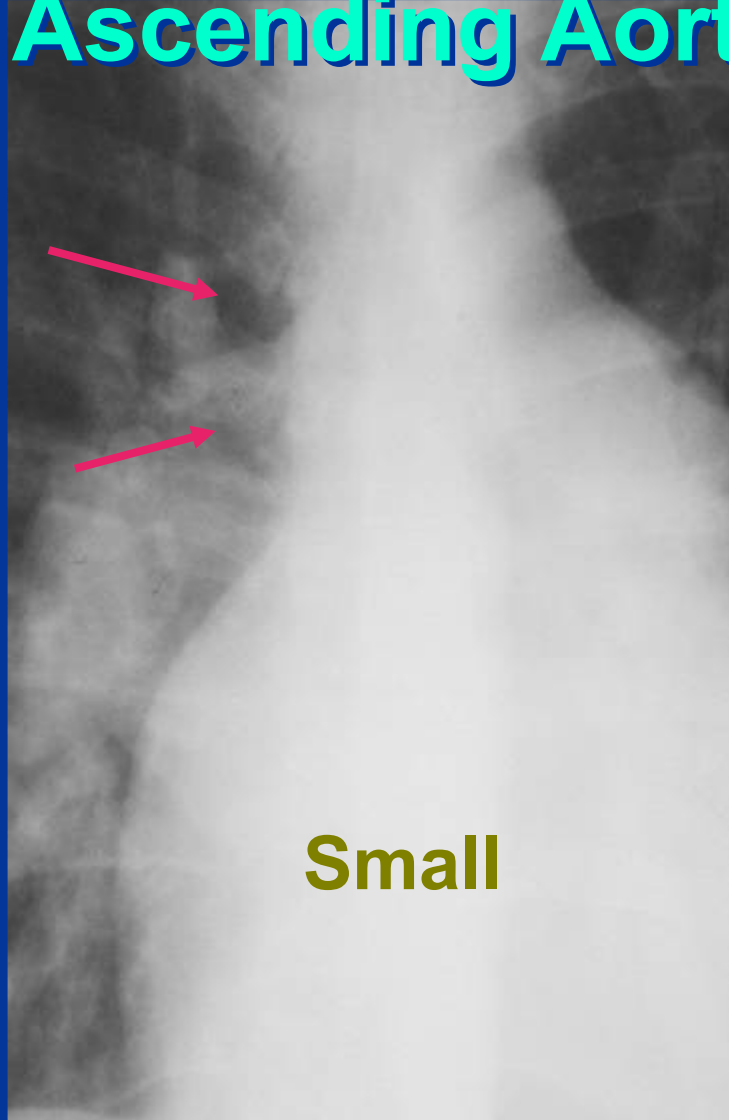
But only the top five are really important  
in making a diagnosis.

# Ascending Aorta

Low density,  
almost straight  
edge  
represents size  
of ascending  
aorta



# Ascending Aorta

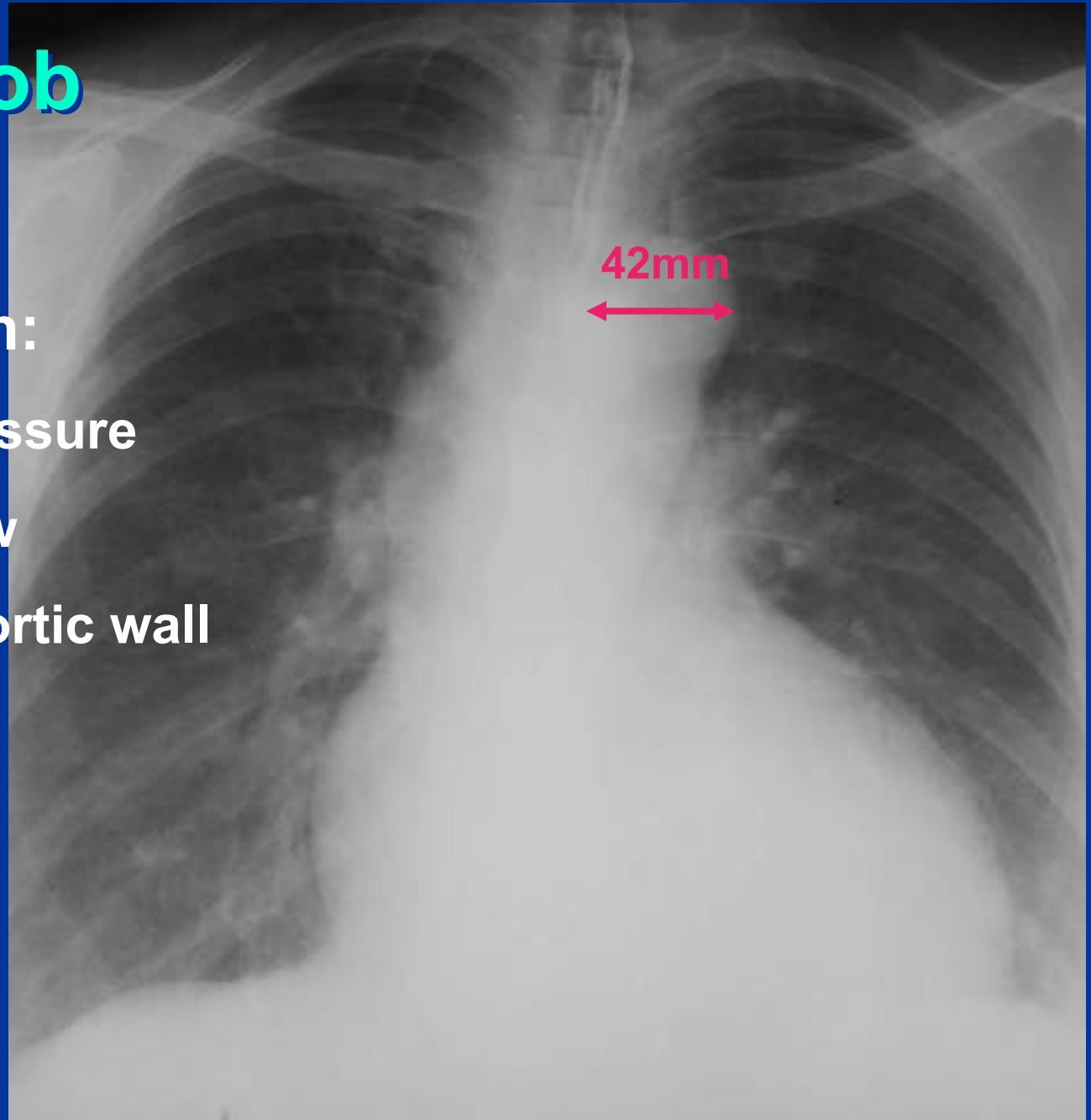


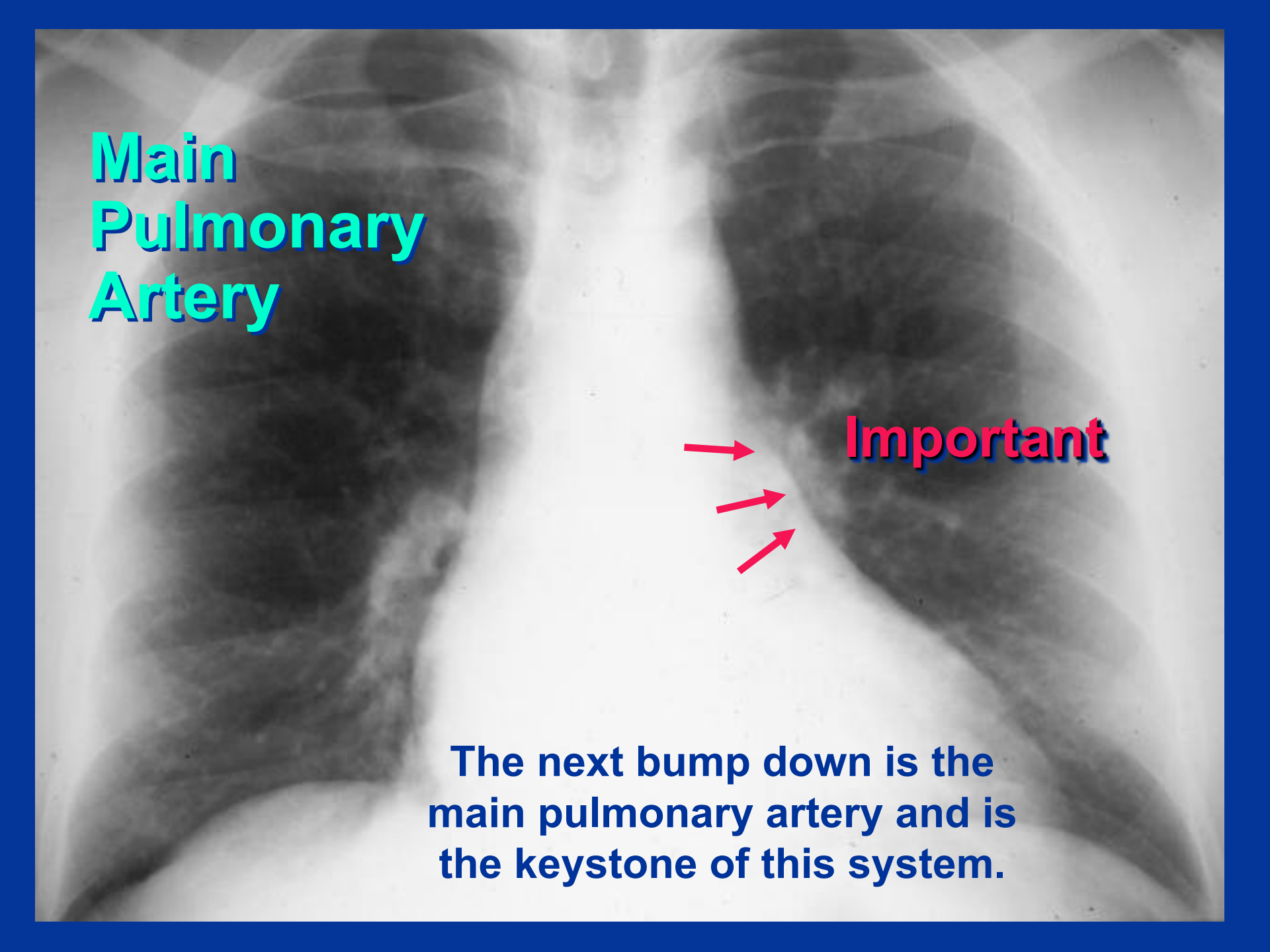


# Aortic Knob

Enlarged with:

- Increased pressure
- Increased flow
- Changes in aortic wall





**Main  
Pulmonary  
Artery**

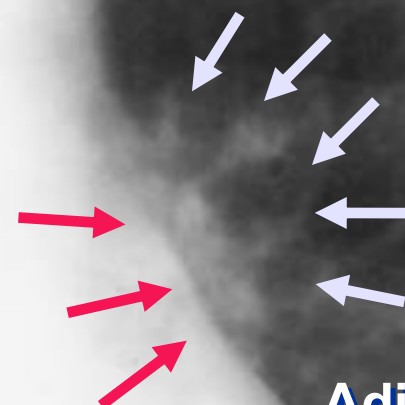
**Important**

**The next bump down is the  
main pulmonary artery and is  
the keystone of this system.**

# Finding the Main Pulmonary Artery



# Finding the Main Pulmonary Artery



Adjacent to left  
pulmonary artery

We can measure the main pulmonary artery . . .



# Left atrial enlargement

Concavity where L atrium will appear on left side when enlarged

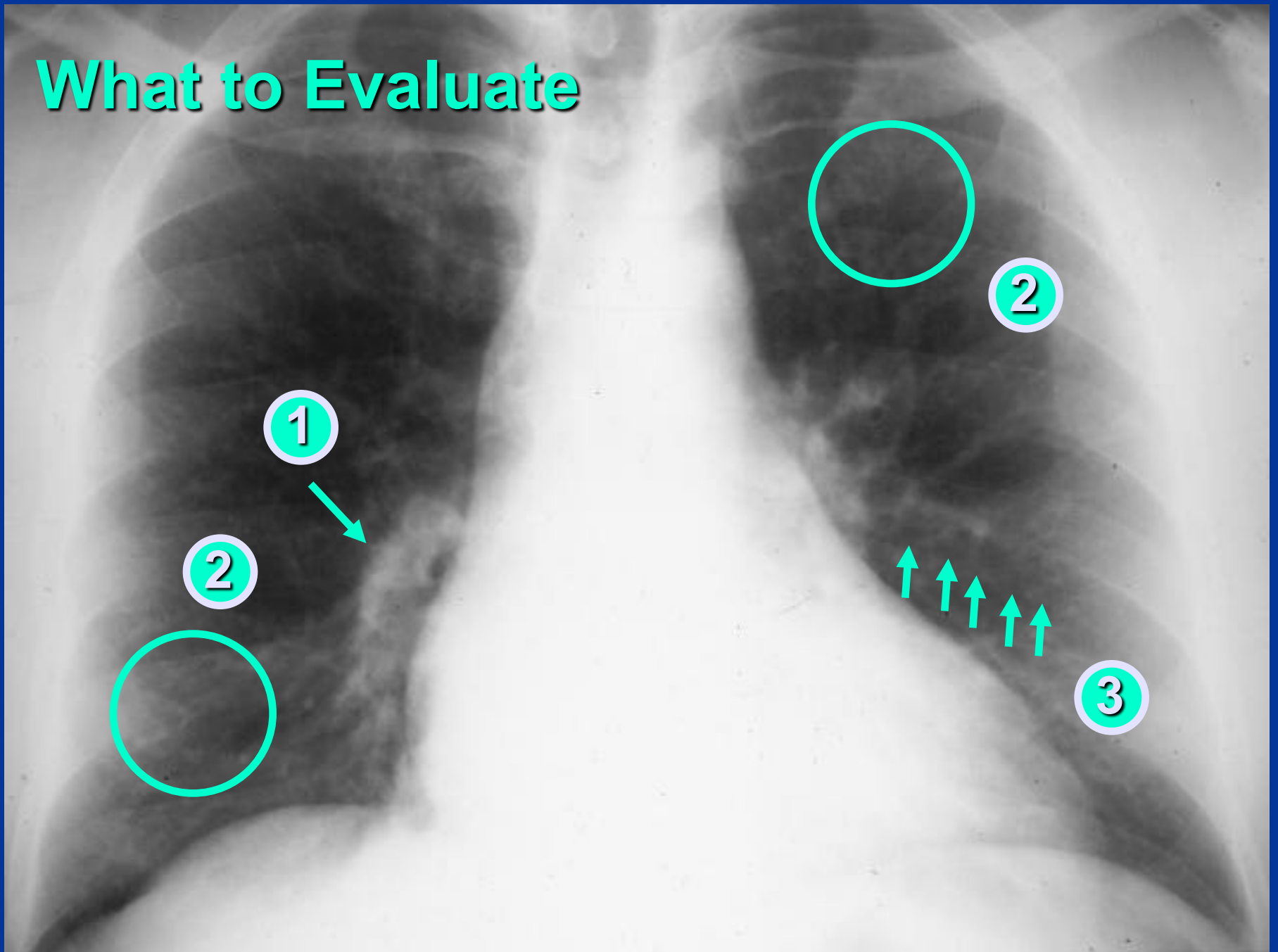


# **The Pulmonary Vasculature**

# Five States of the Pulmonary Vasculature

- Normal
- Pulmonary venous hypertension
- Pulmonary arterial hypertension
- Increased flow
- Decreased flow

# What to Evaluate

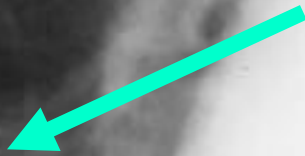


## 2. Normal Distribution of Flow Upper Versus Lower Lobes

In erect position,  
blood flow to  
bases  $>$  than flow  
to apices

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





### 3. Normal Distribution of Flow Central versus peripheral

Central vessels  
give rise to  
progressively  
smaller peripheral  
branches

Normal  
tapering of  
vessels  
from  
central to  
peripheral



# Normal Vasculature - review

RDPA  
< 17 mm in  
diameter

1



2

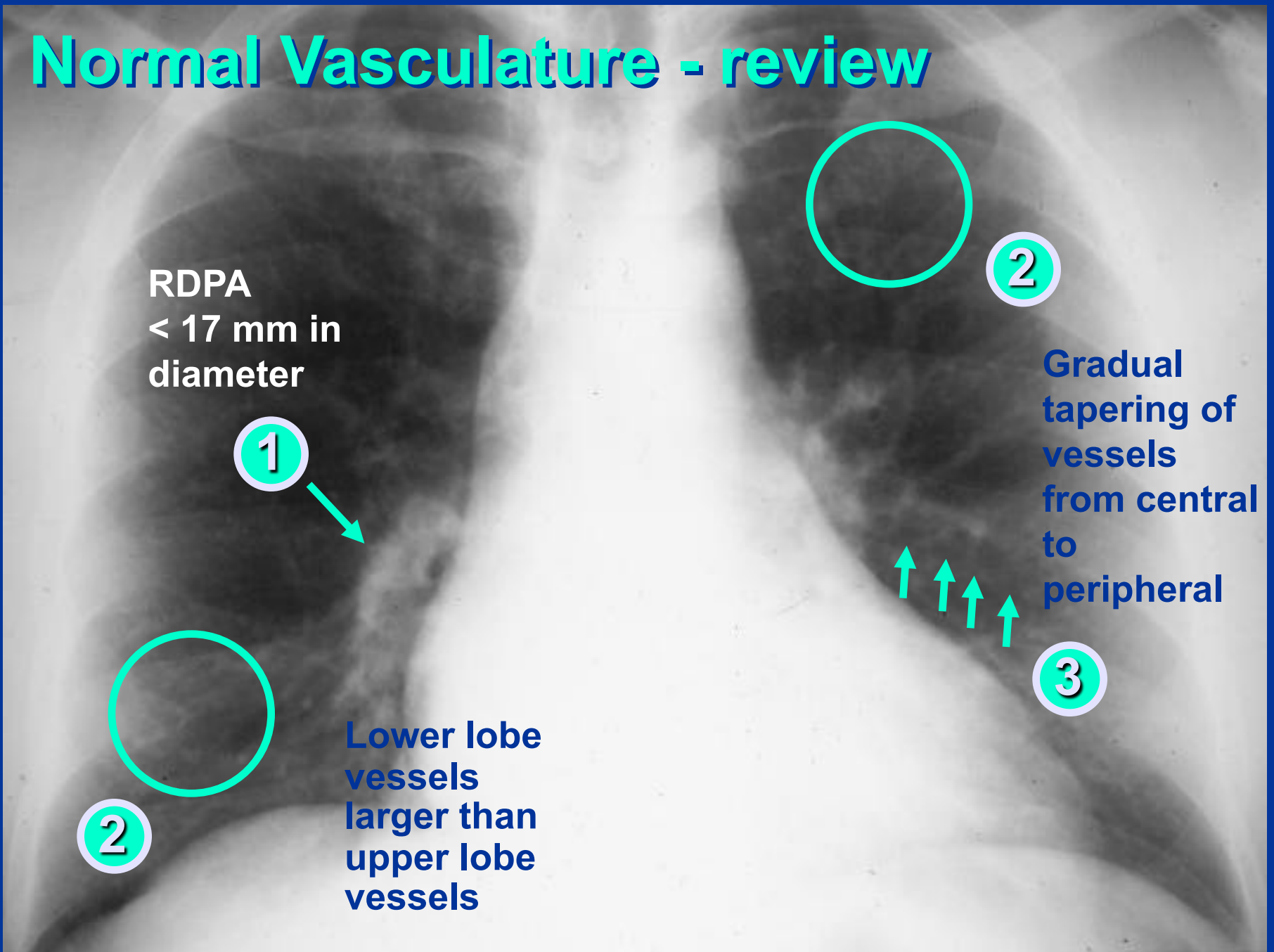
Gradual  
tapering of  
vessels  
from central  
to  
peripheral



3

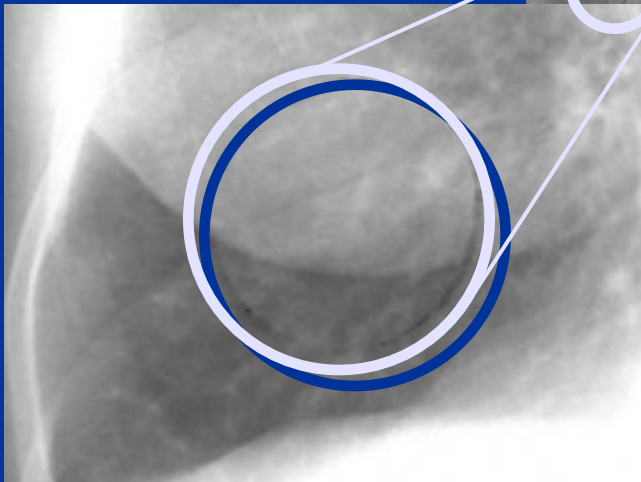
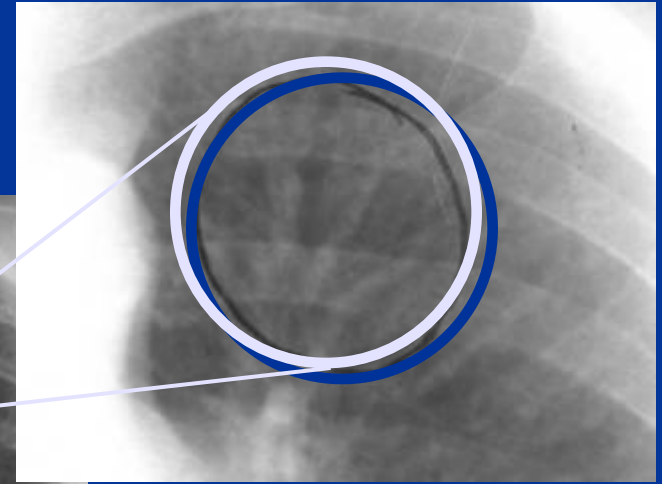
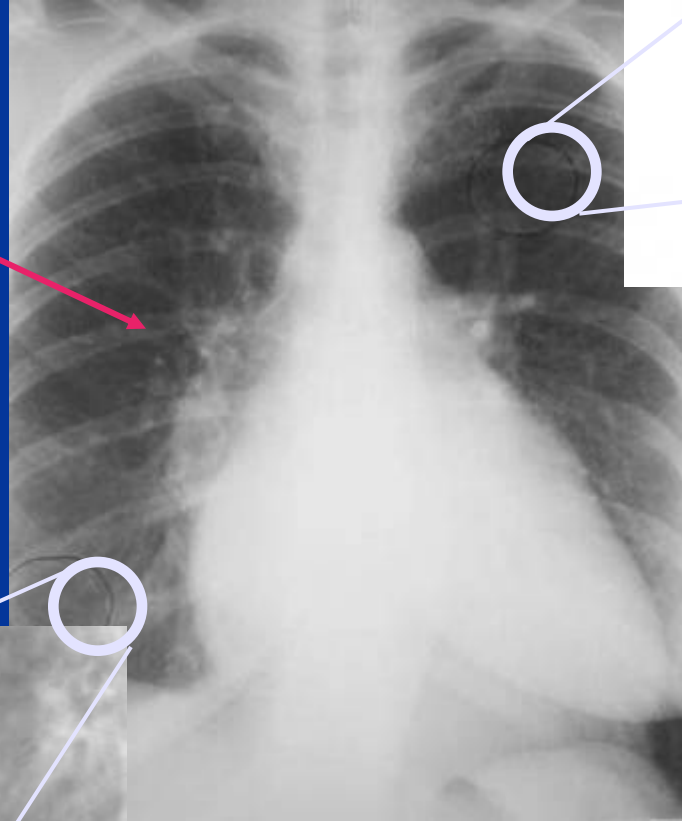
Lower lobe  
vessels  
larger than  
upper lobe  
vessels

2



# Venous Hypertension

RDPA usually  
> 17 mm

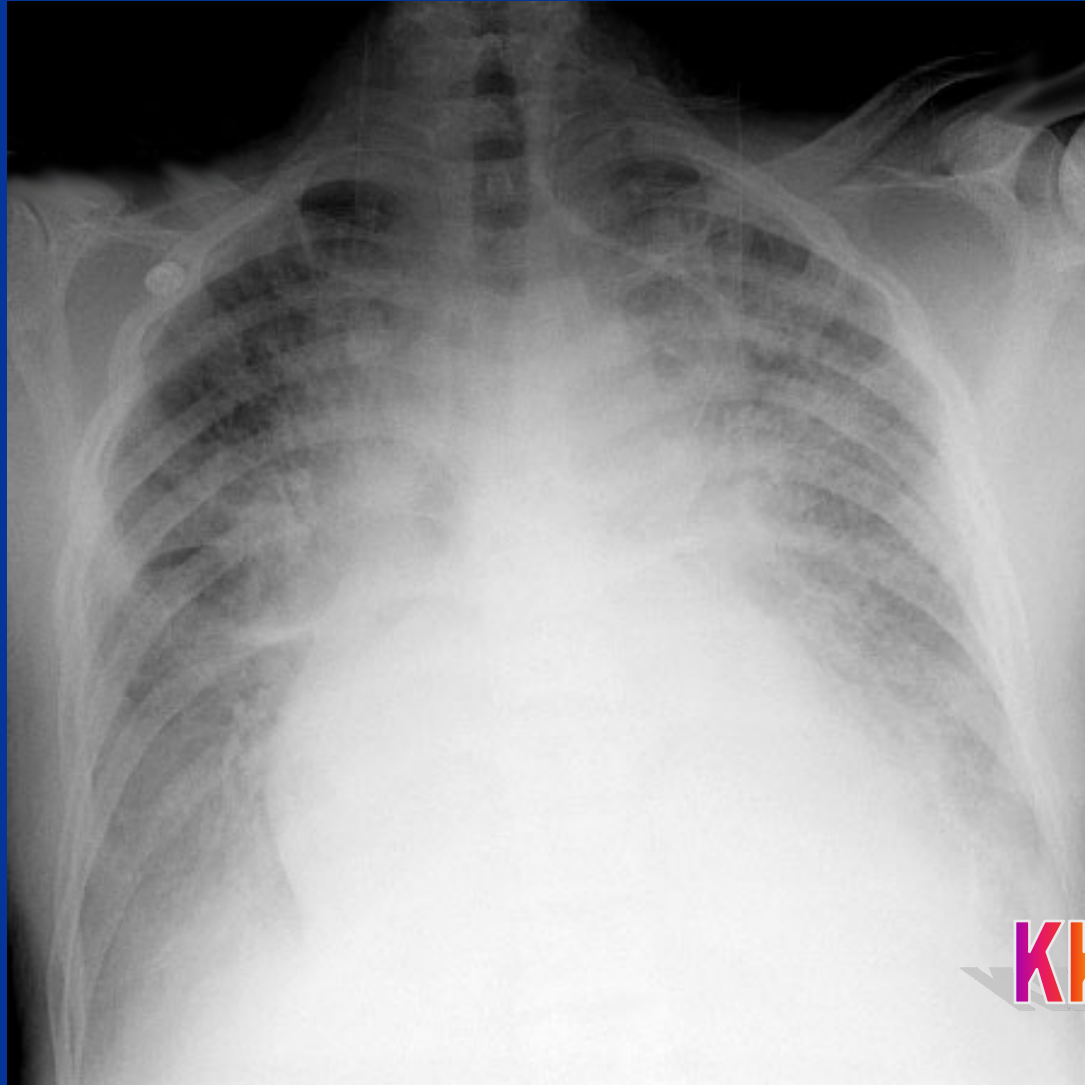


Upper lobe  
vessels equal  
to or larger  
than size of  
lower lobe  
vessels =  
Cephalization

# The Pulmonary Vasculature

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

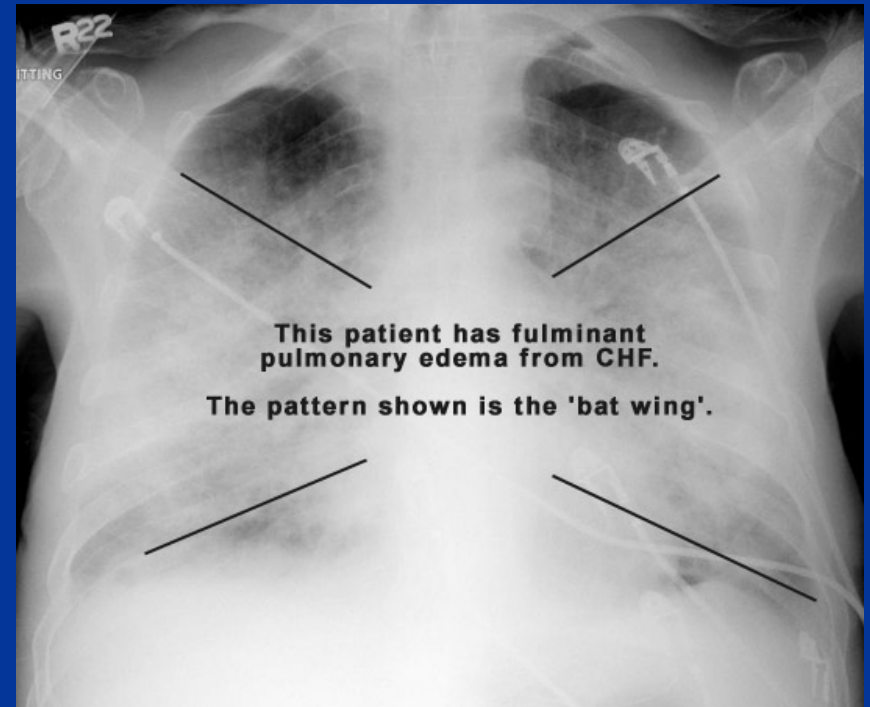
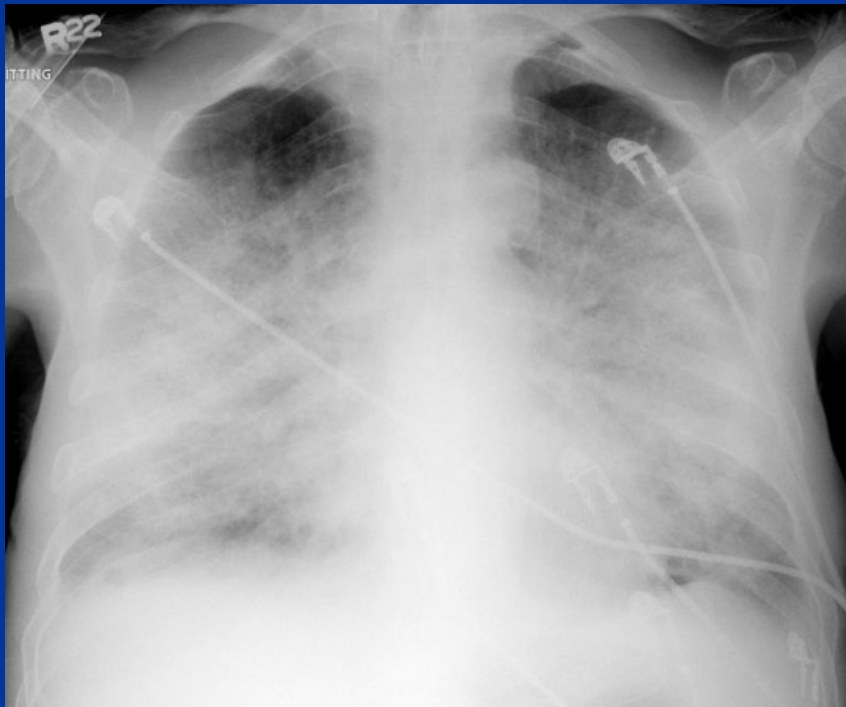
# CHF



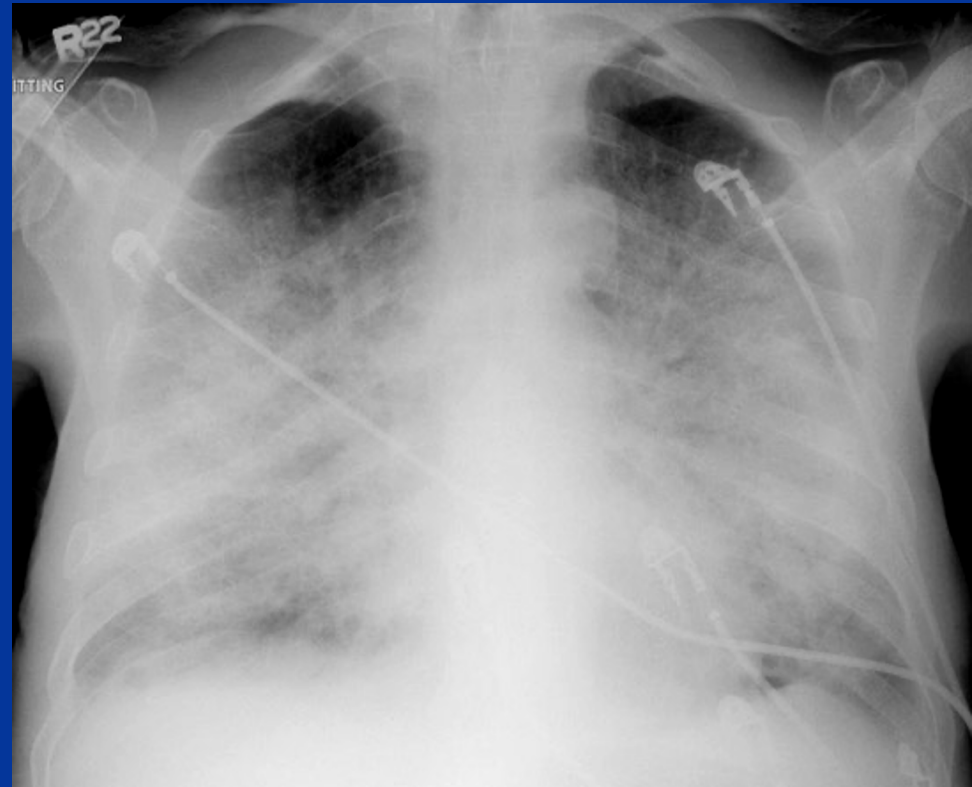
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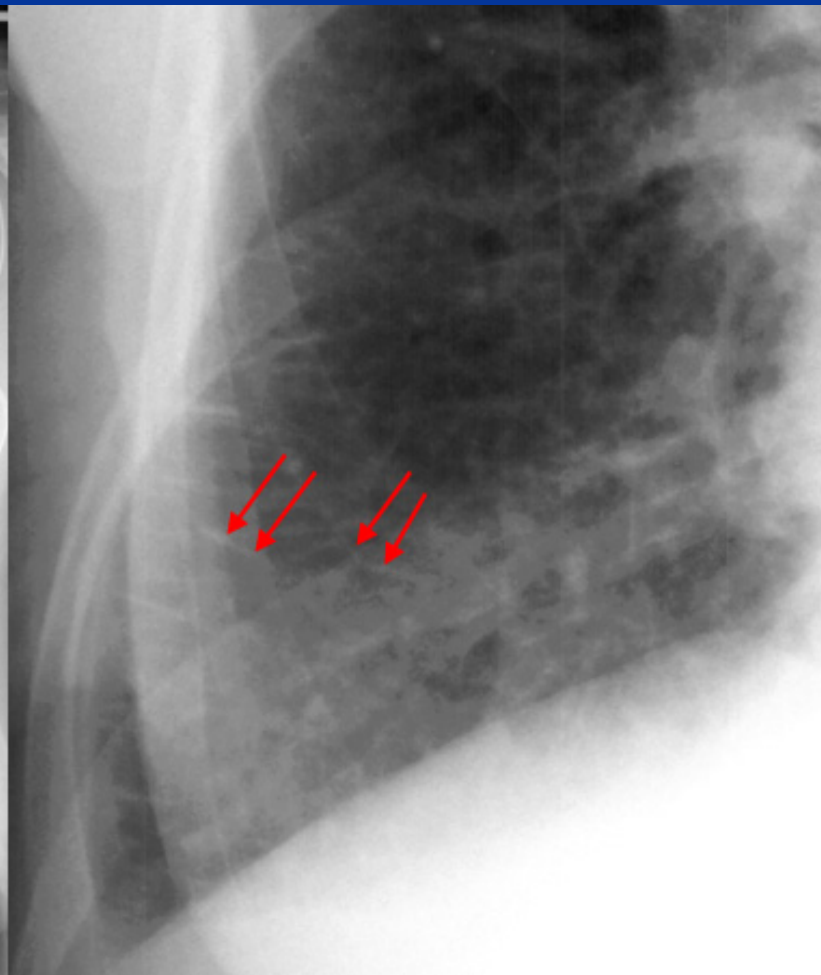
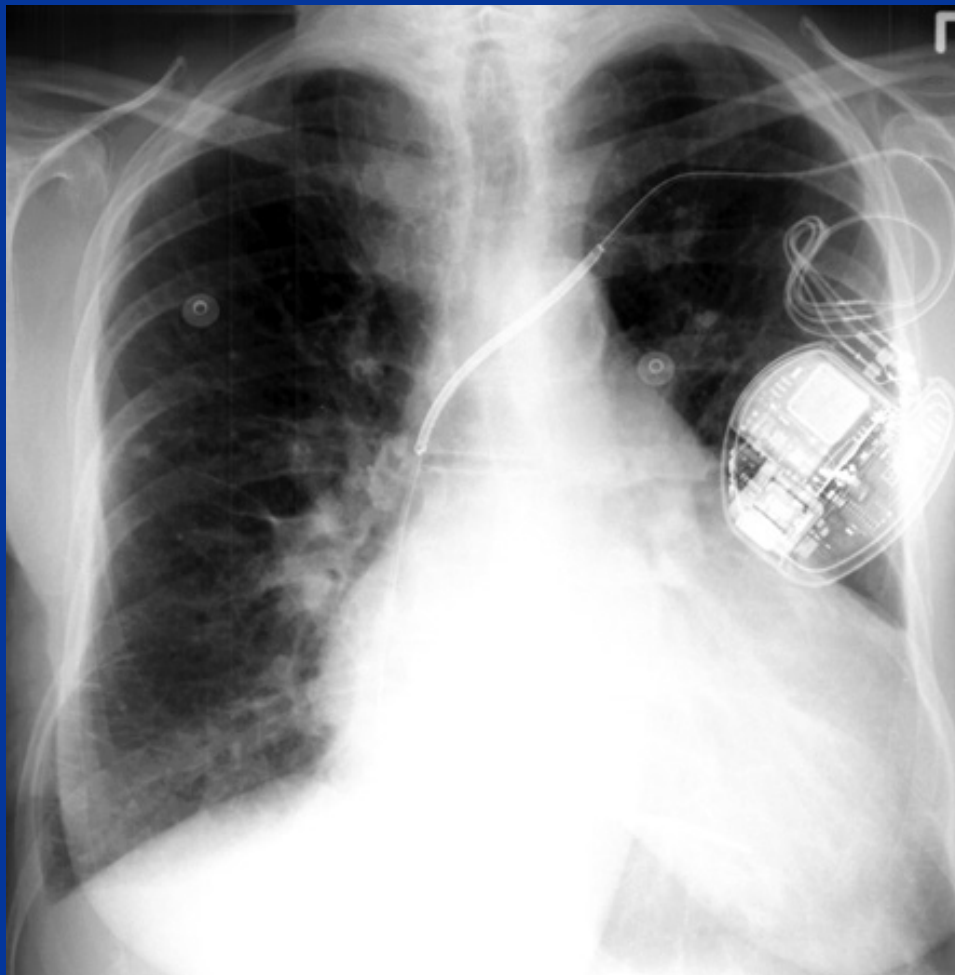
# ACUTE PULMONARY EDEMA



# CLEARED APE



# KERELY'S B-LINES



**THANK YOU**

***DR SHARKAWY***