Radiologic investigation of Chest and CVS diseases

By

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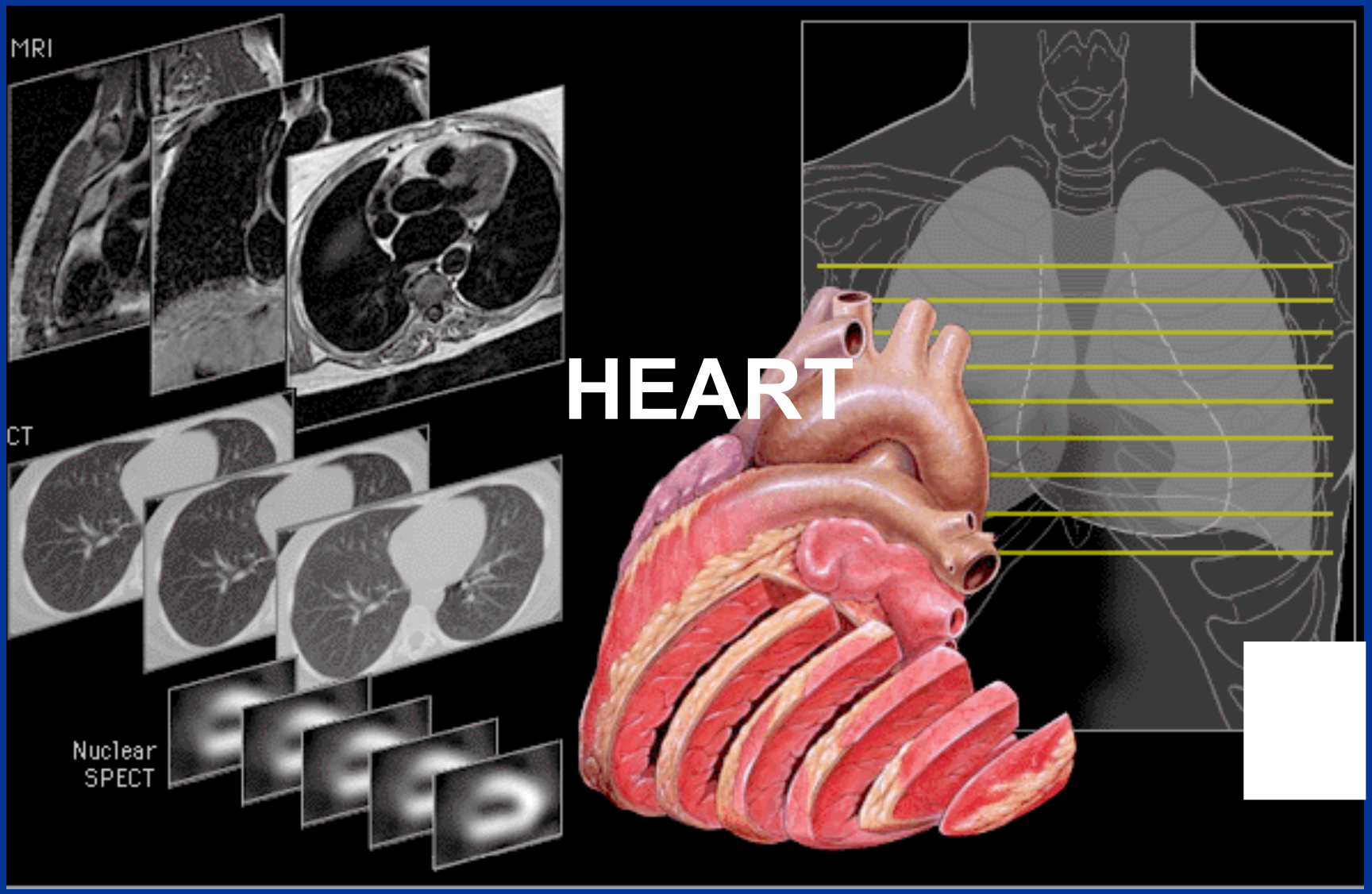
KKUH

KING SAUD UNIVERSITY

LAST UPDATE
SEPT 2021


MRI
CT
Nuclear
SPECT
HEART

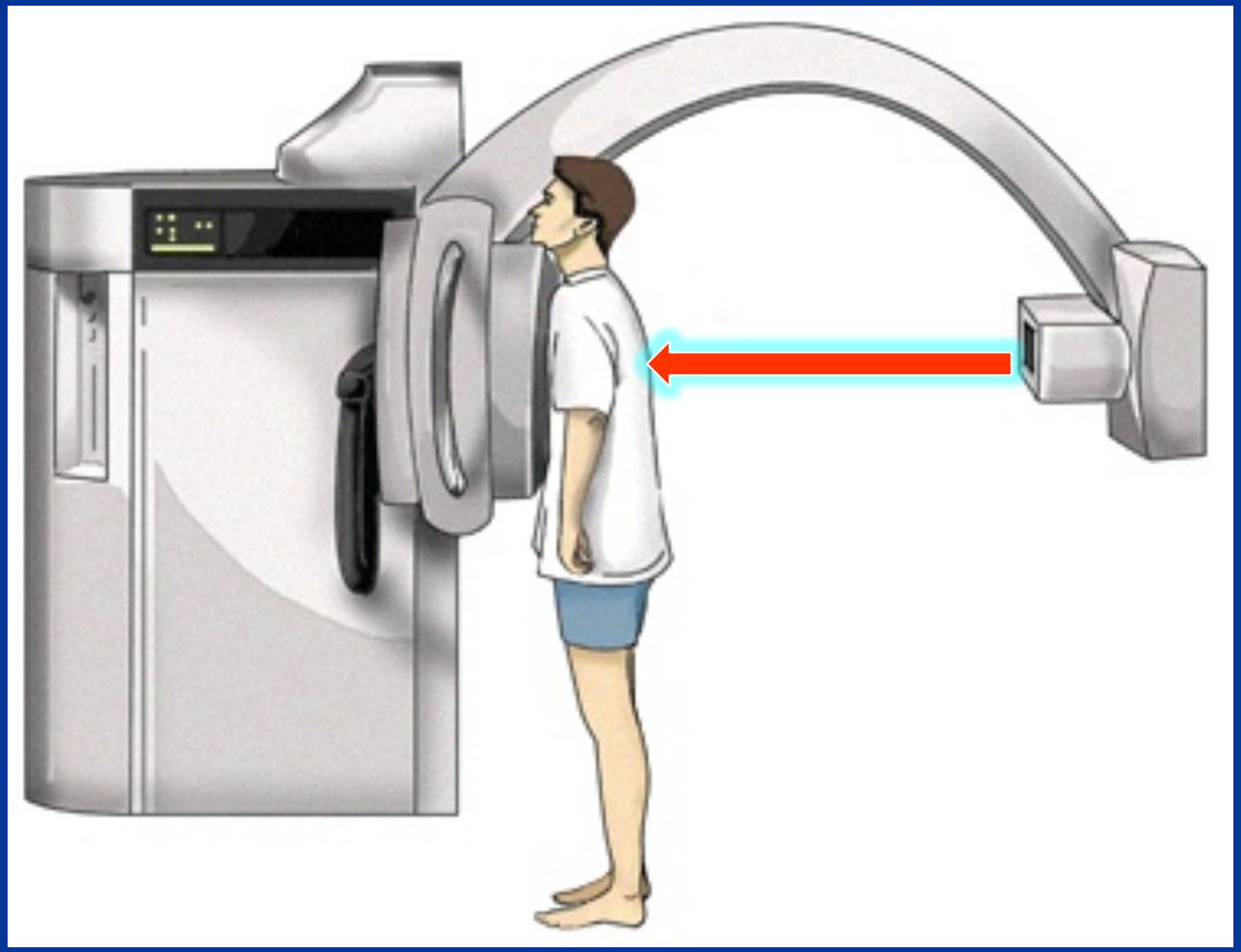
Objectives

- Understand available imaging modalities
- CXR Diagnostic approach

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



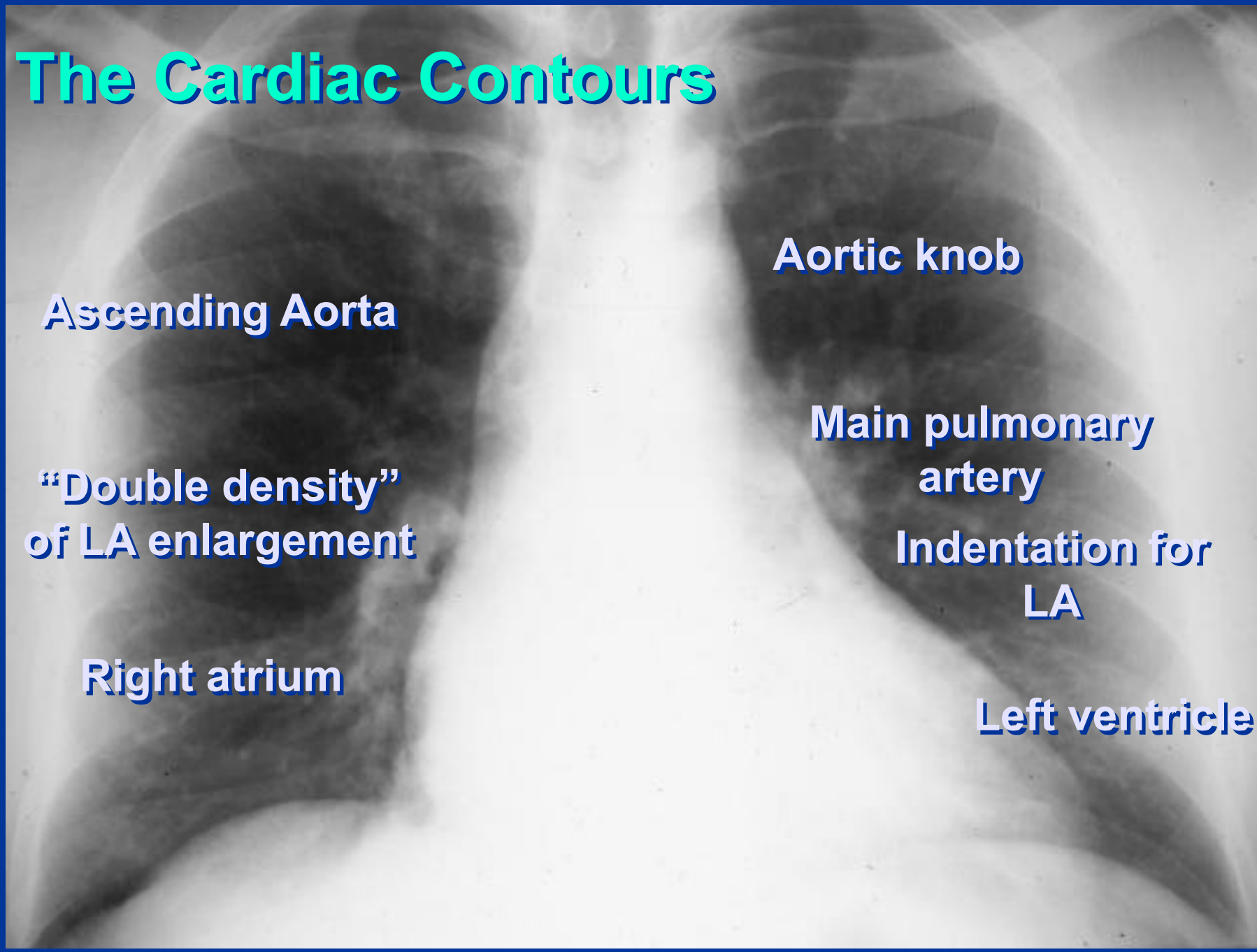
Diagnostic Approach

- Need to evaluate

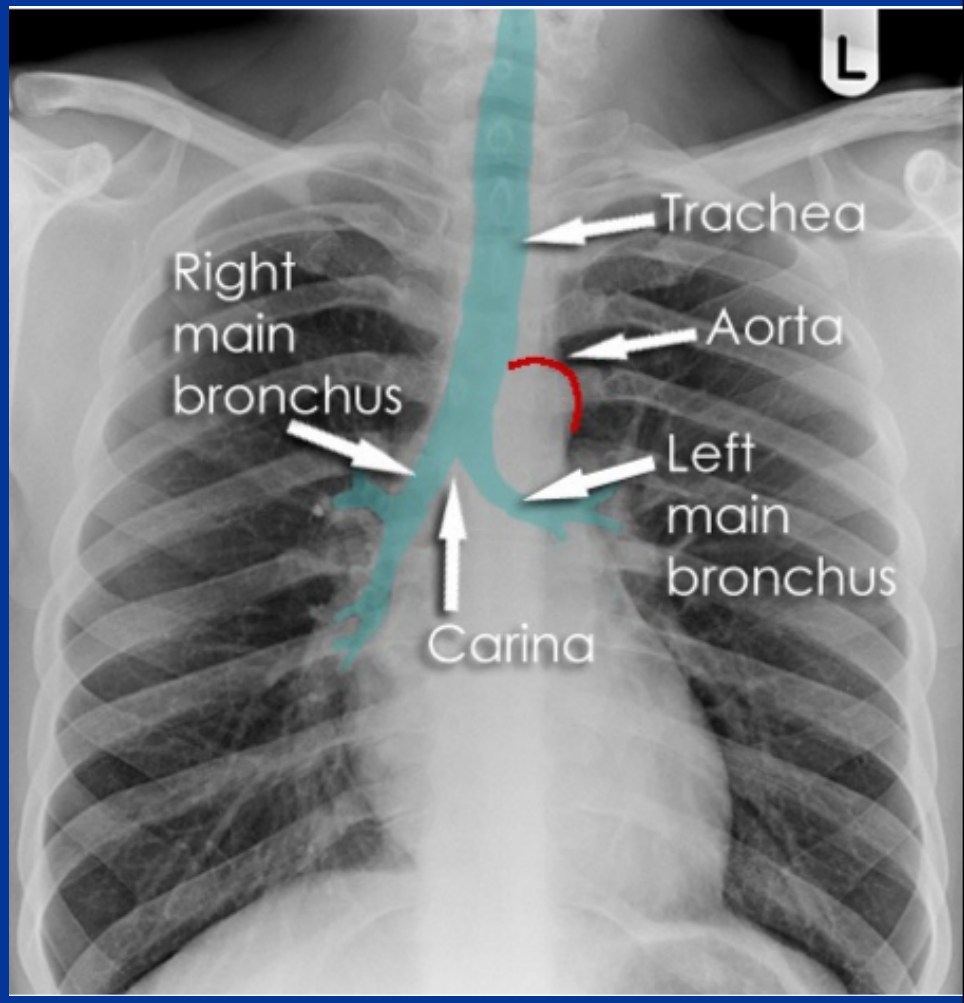
  1. morphology

  2. physiology

The Cardiac Contours

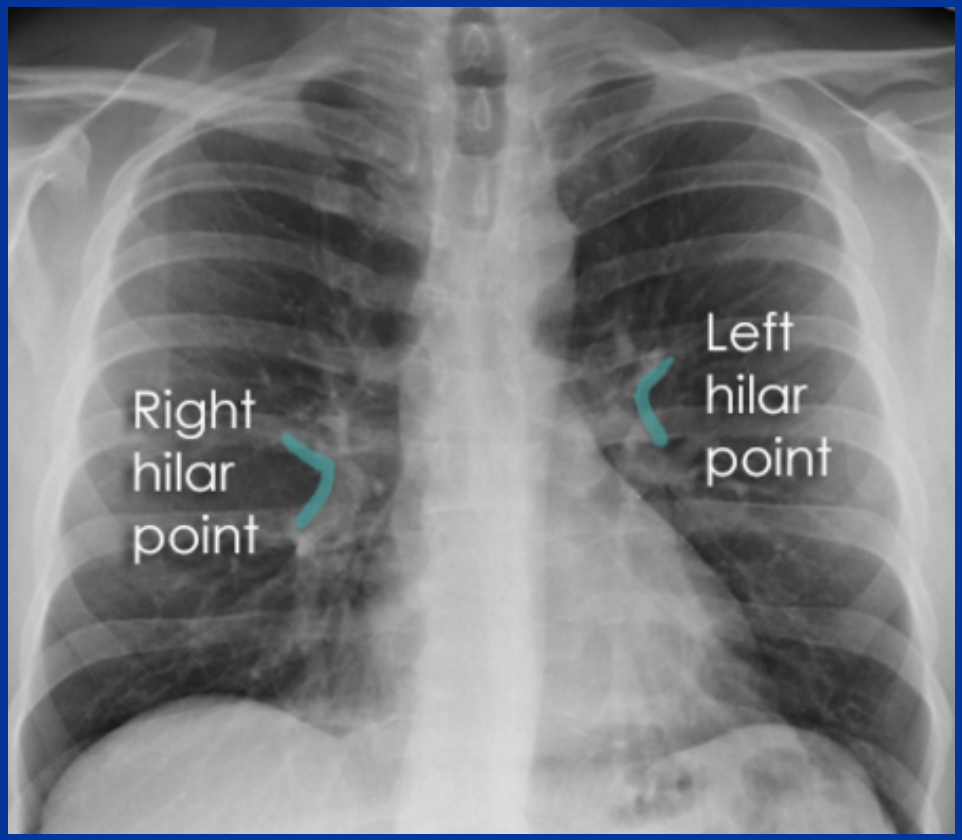


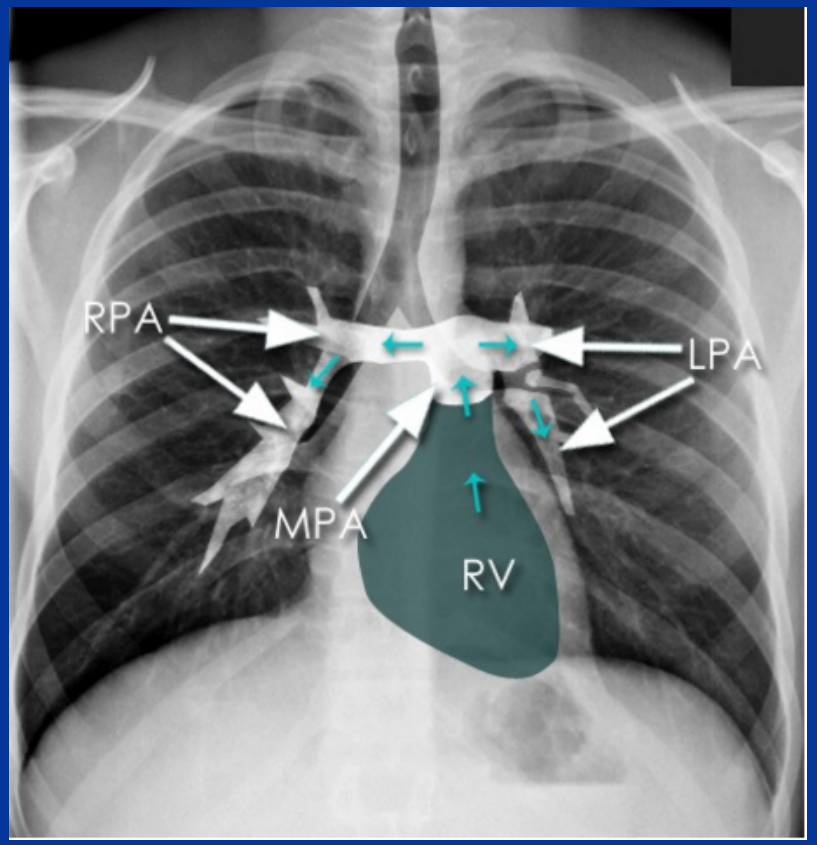

L


L
Trachea
Right
main
bronchus
Aorta
Left
main
bronchus
Carina

Hilar levels

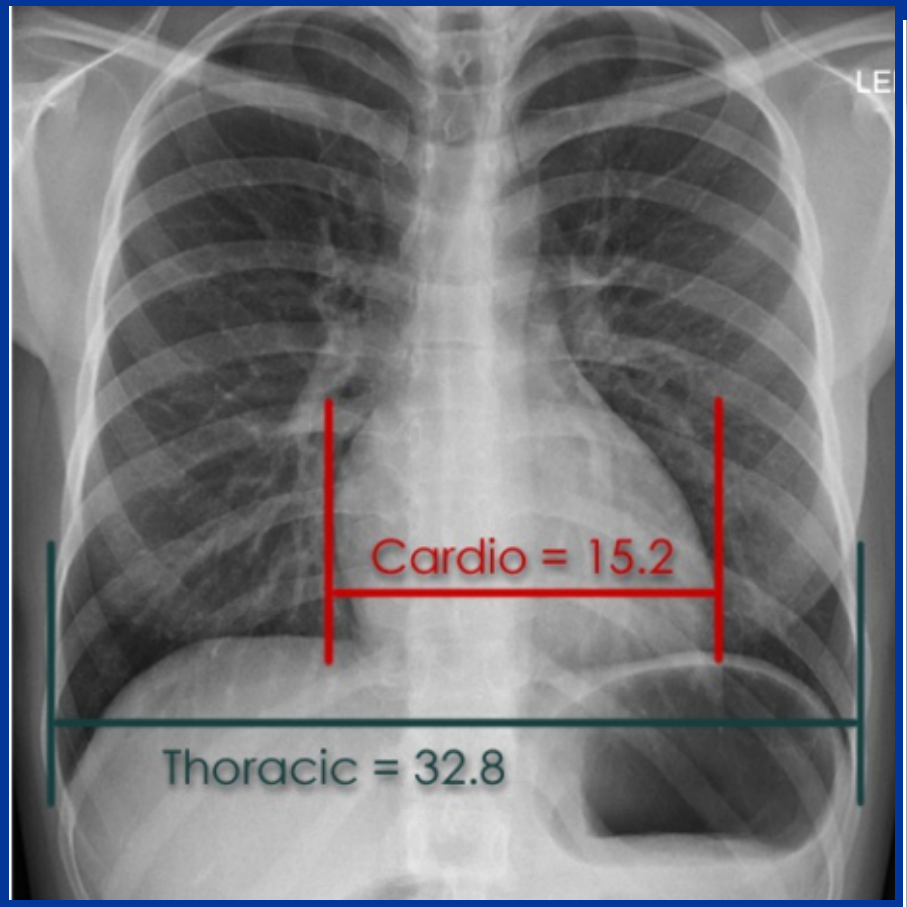
- look for increase in density as well as size. If the hila are out of position, ask yourself if they are pushed or pulled, just as you would when assessing the trachea.

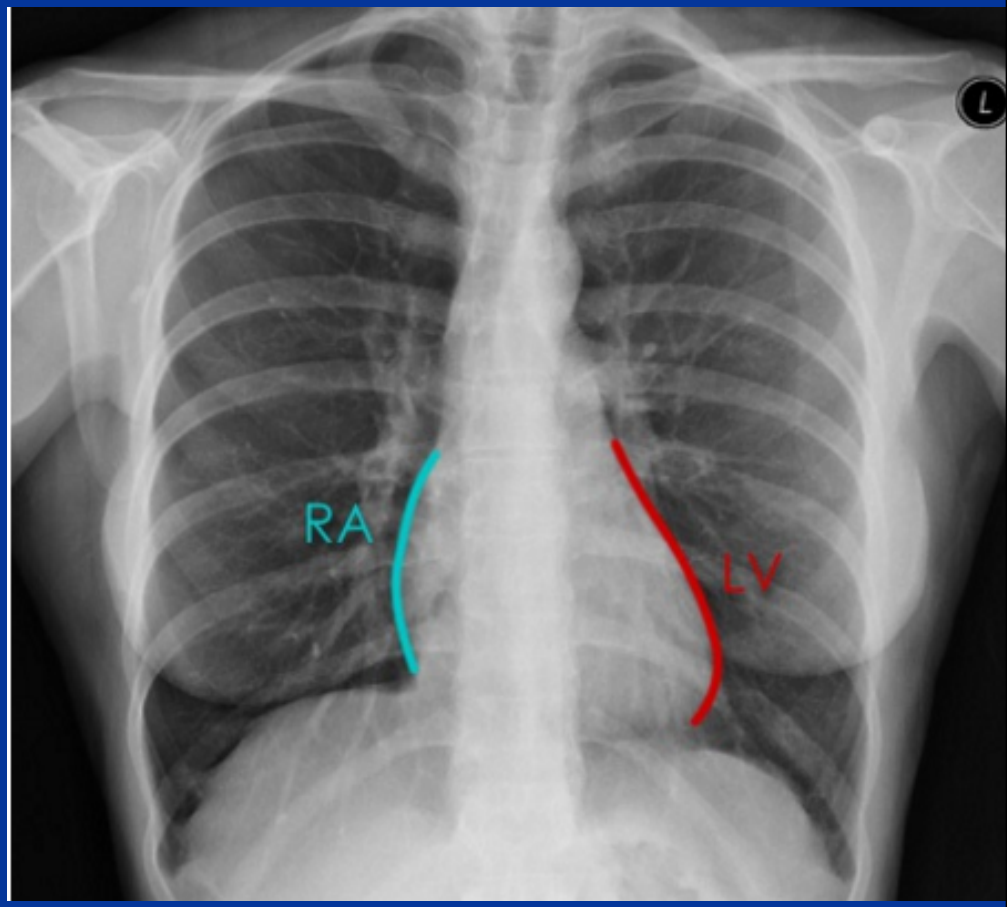




Normal Cardiac Contours

Cardiac contours





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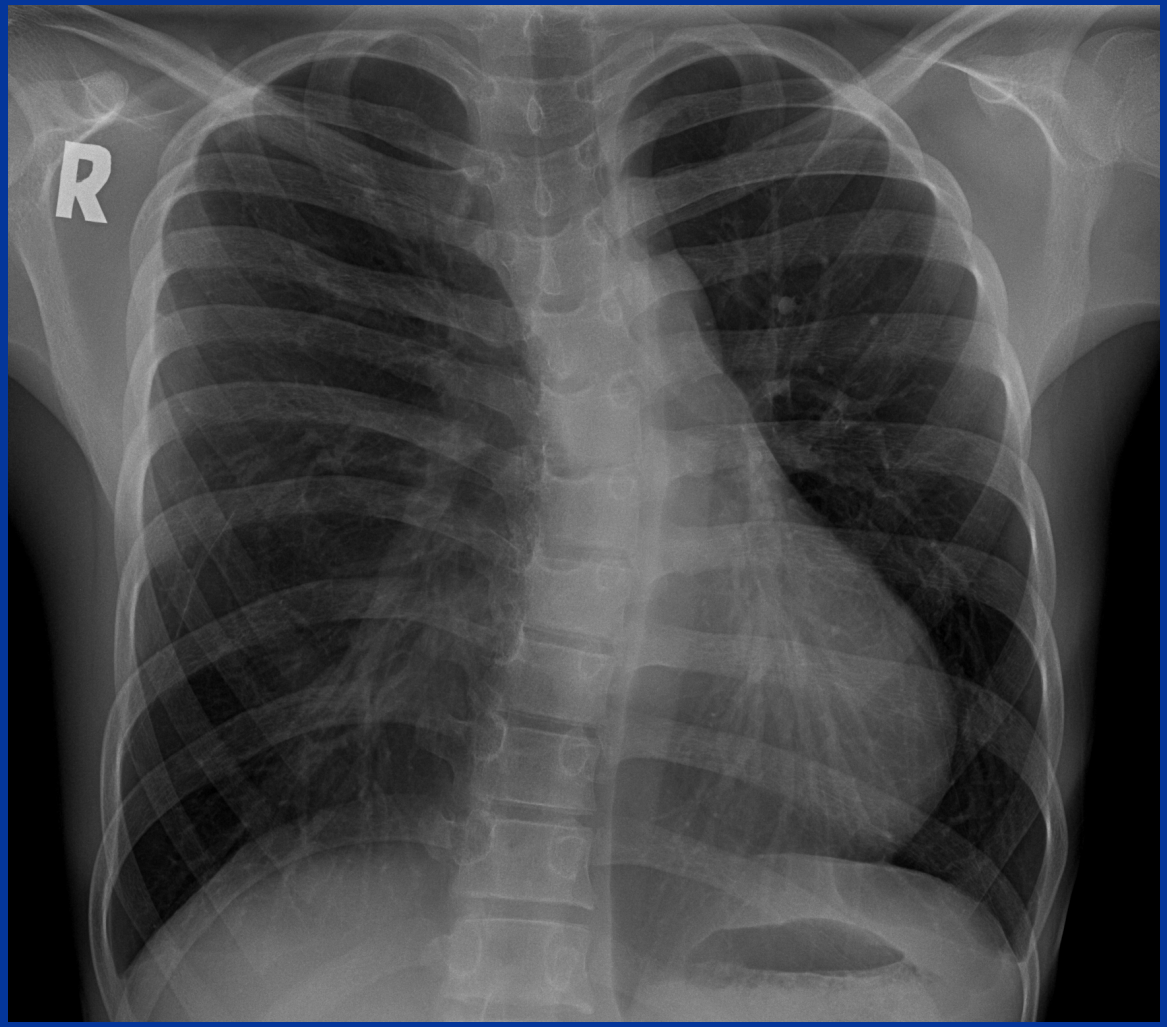
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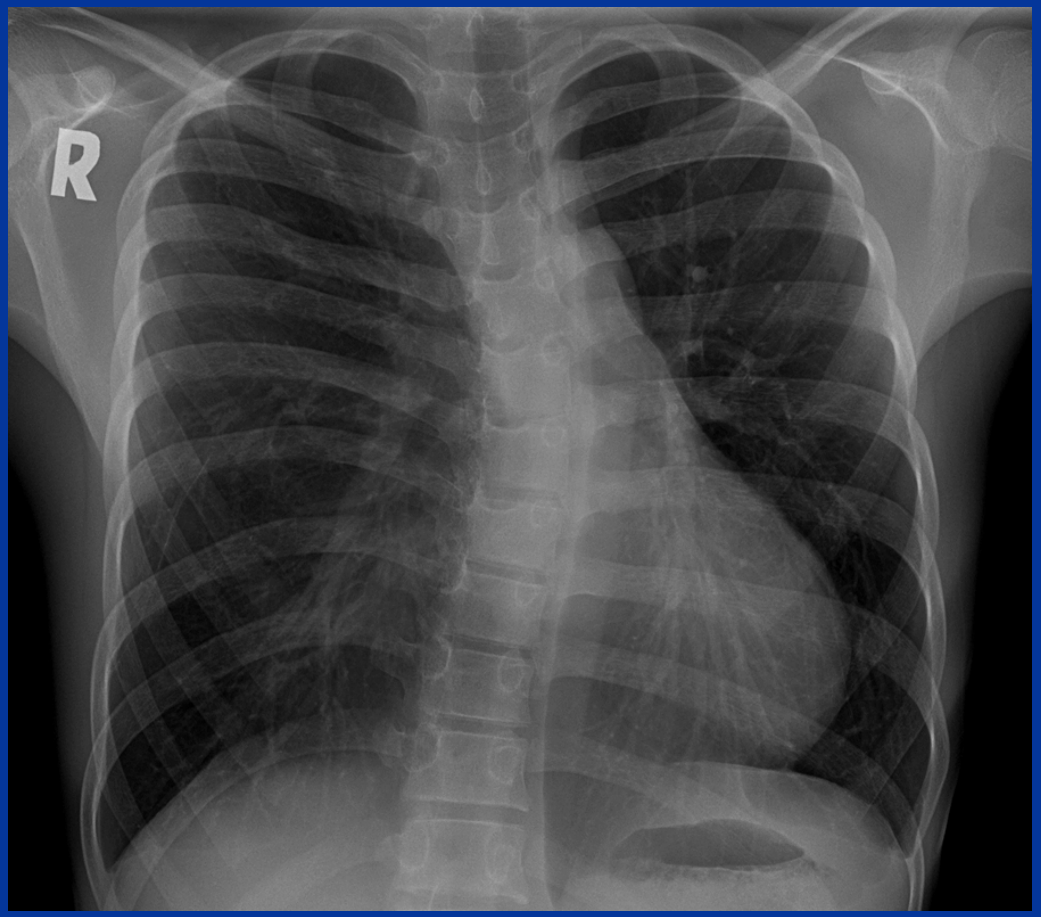
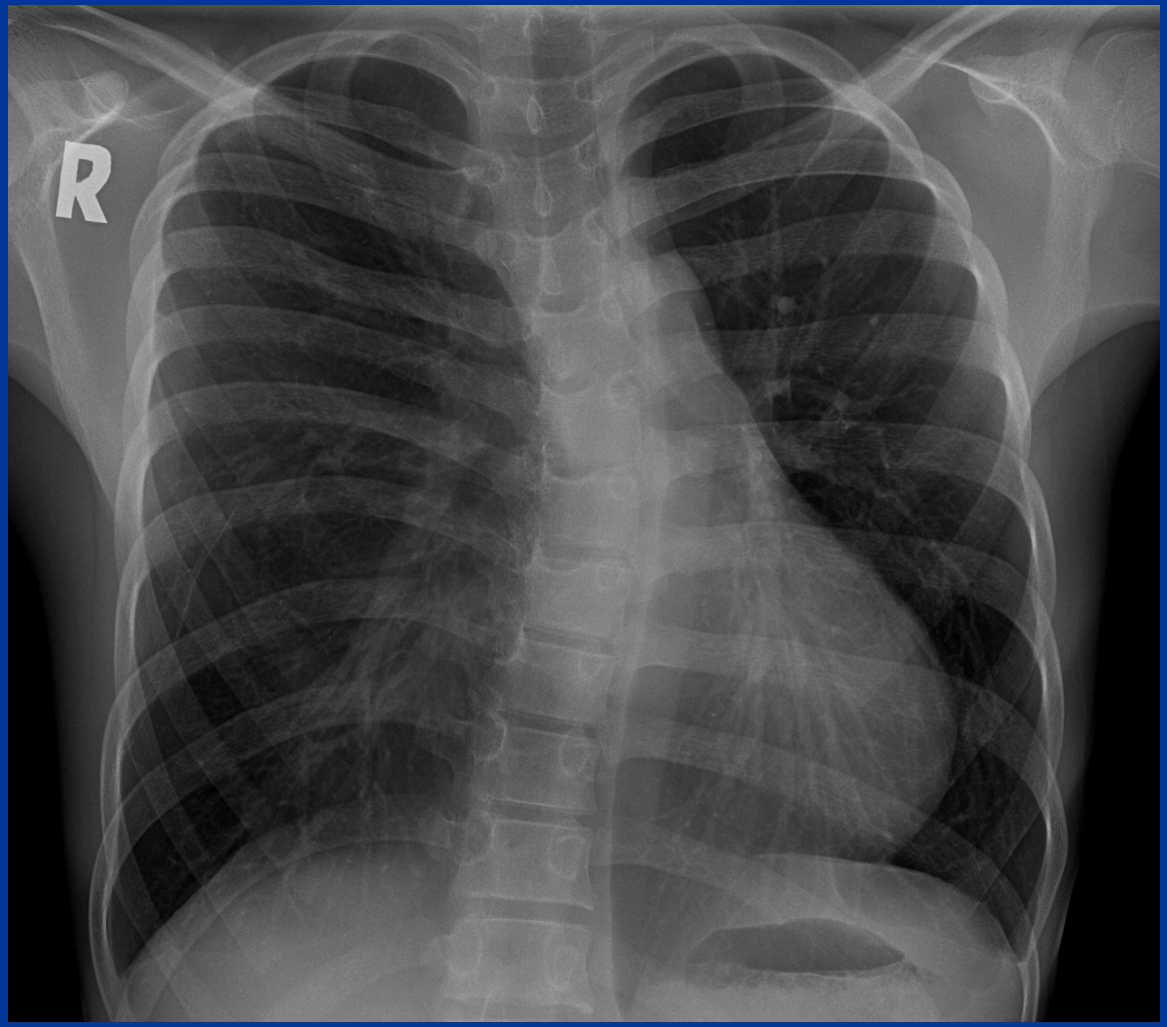
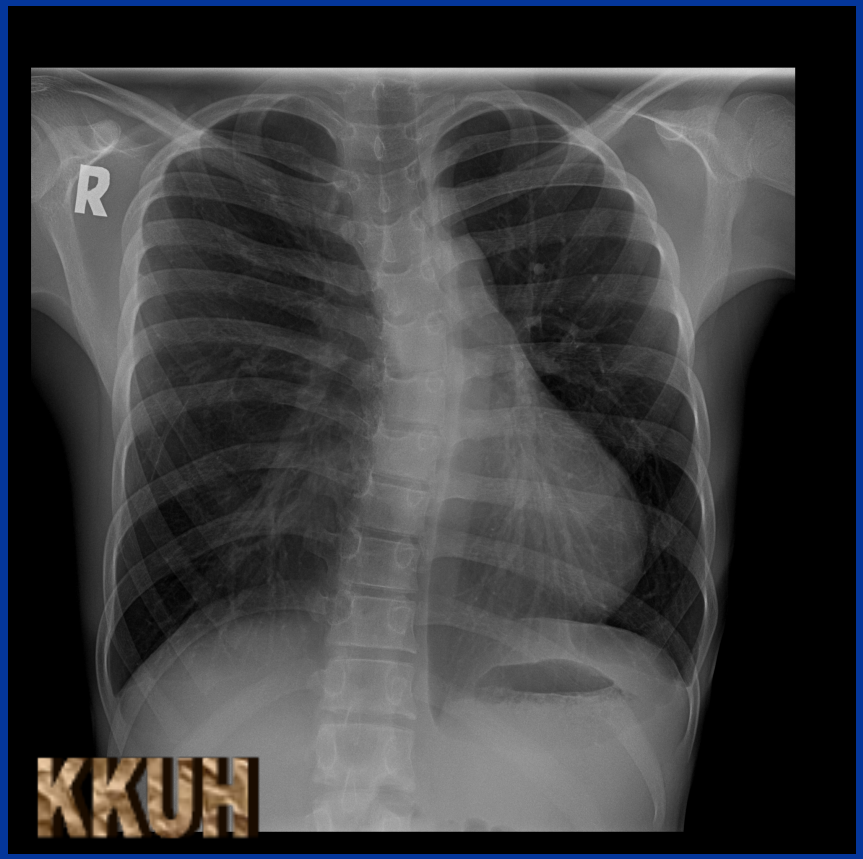

R


L

Cardiac displacement

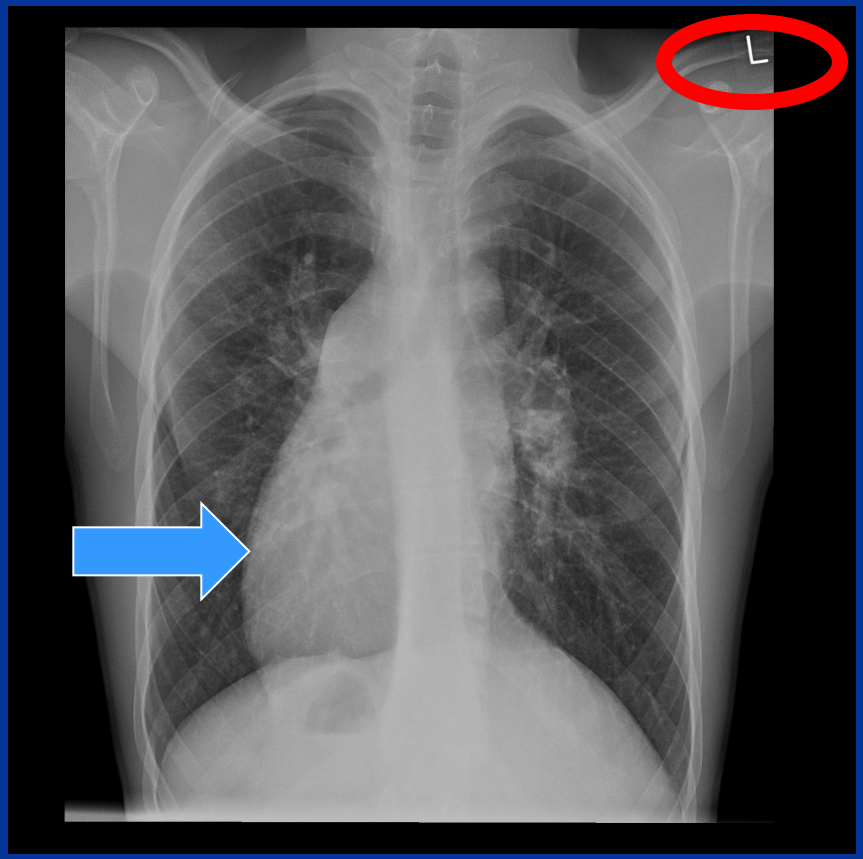


Cardiac displacement



Pectus excavatum

??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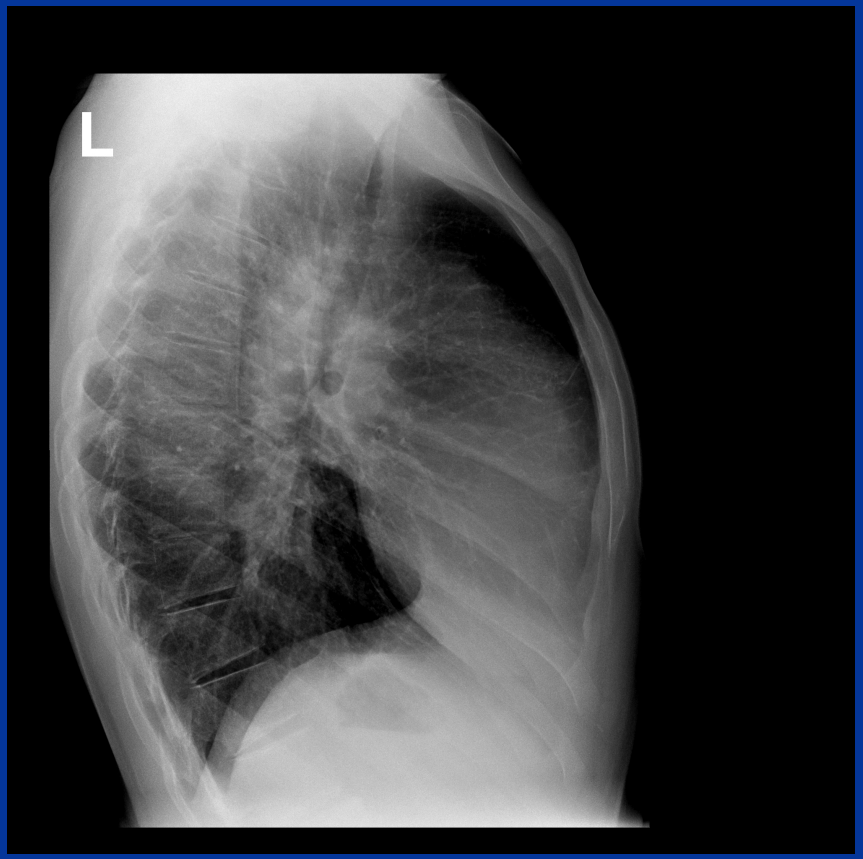
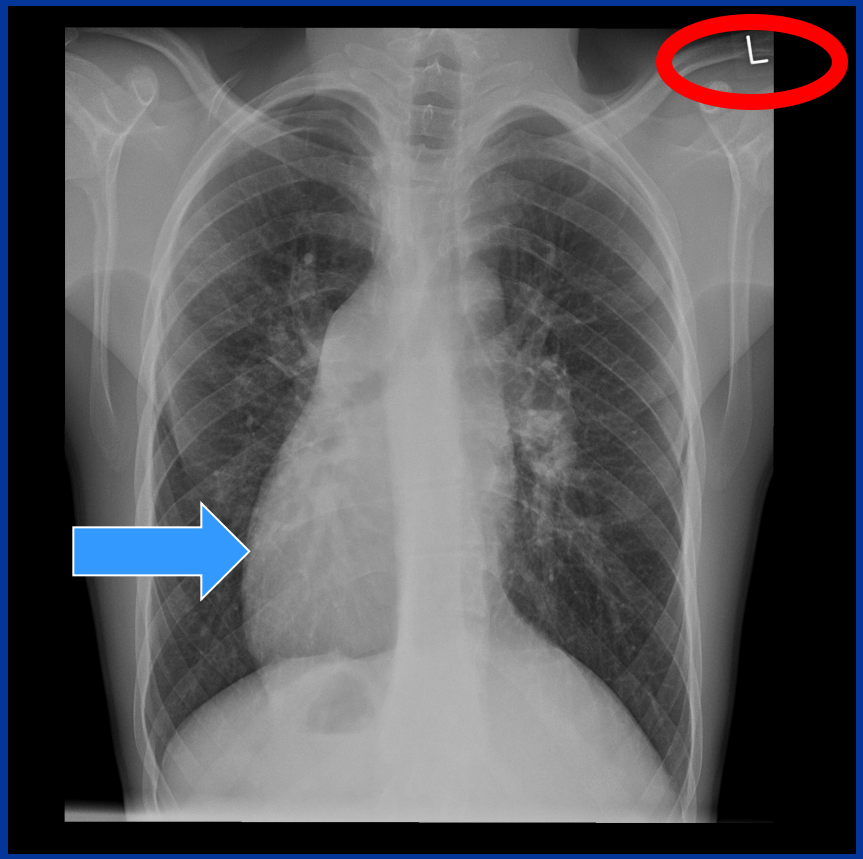
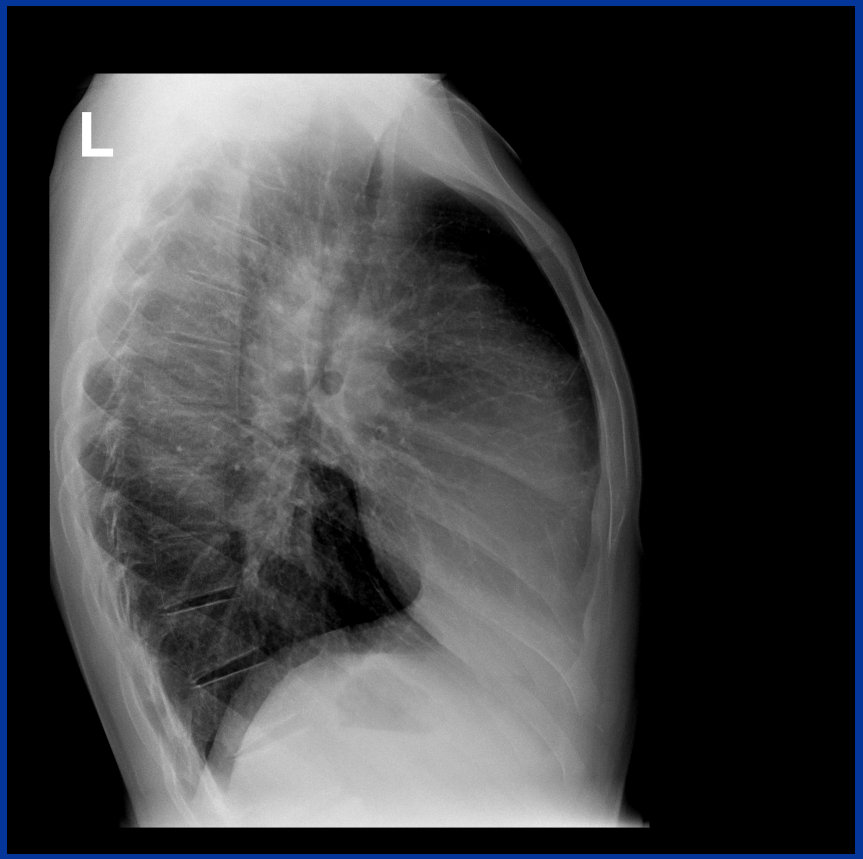
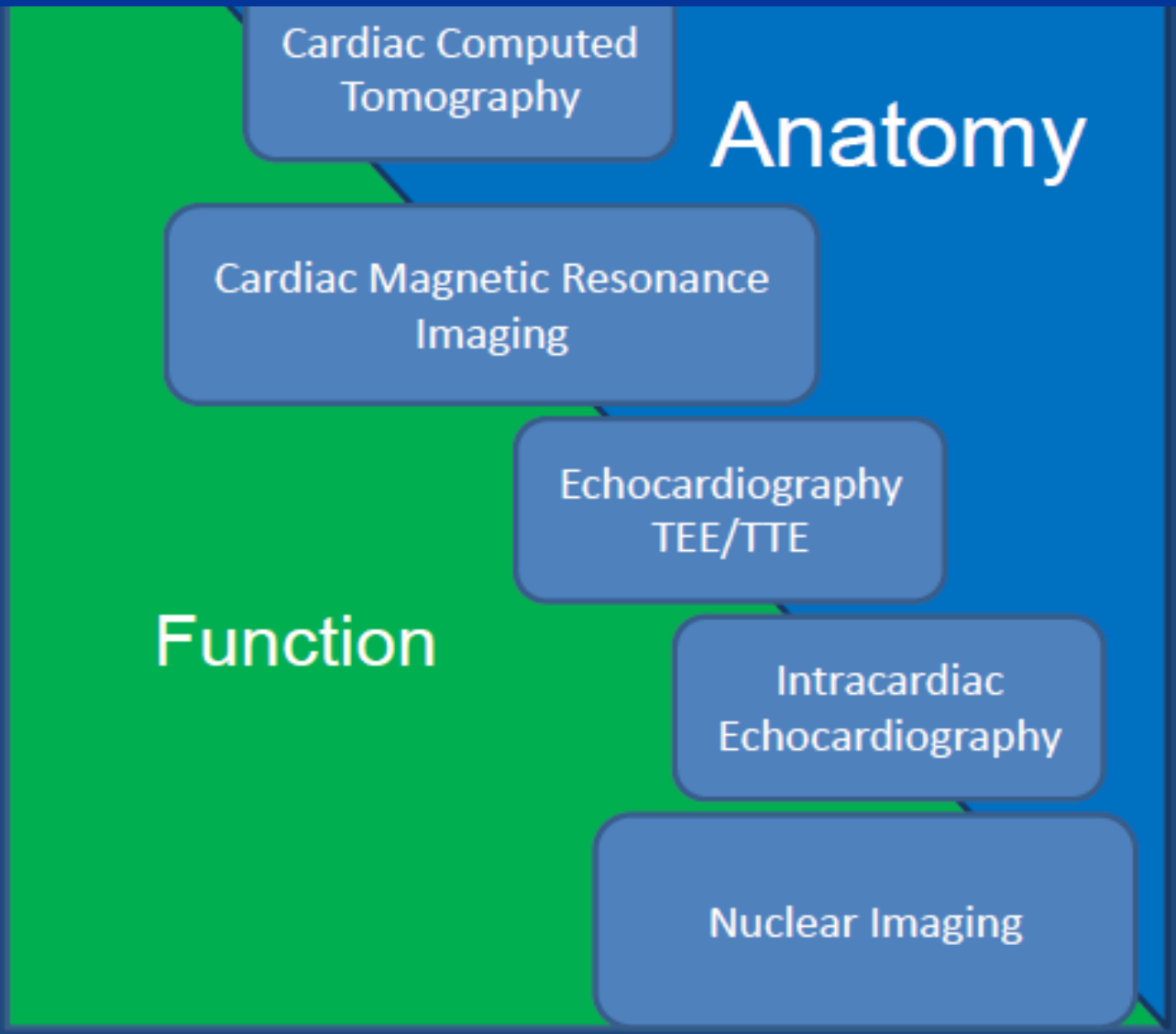

L

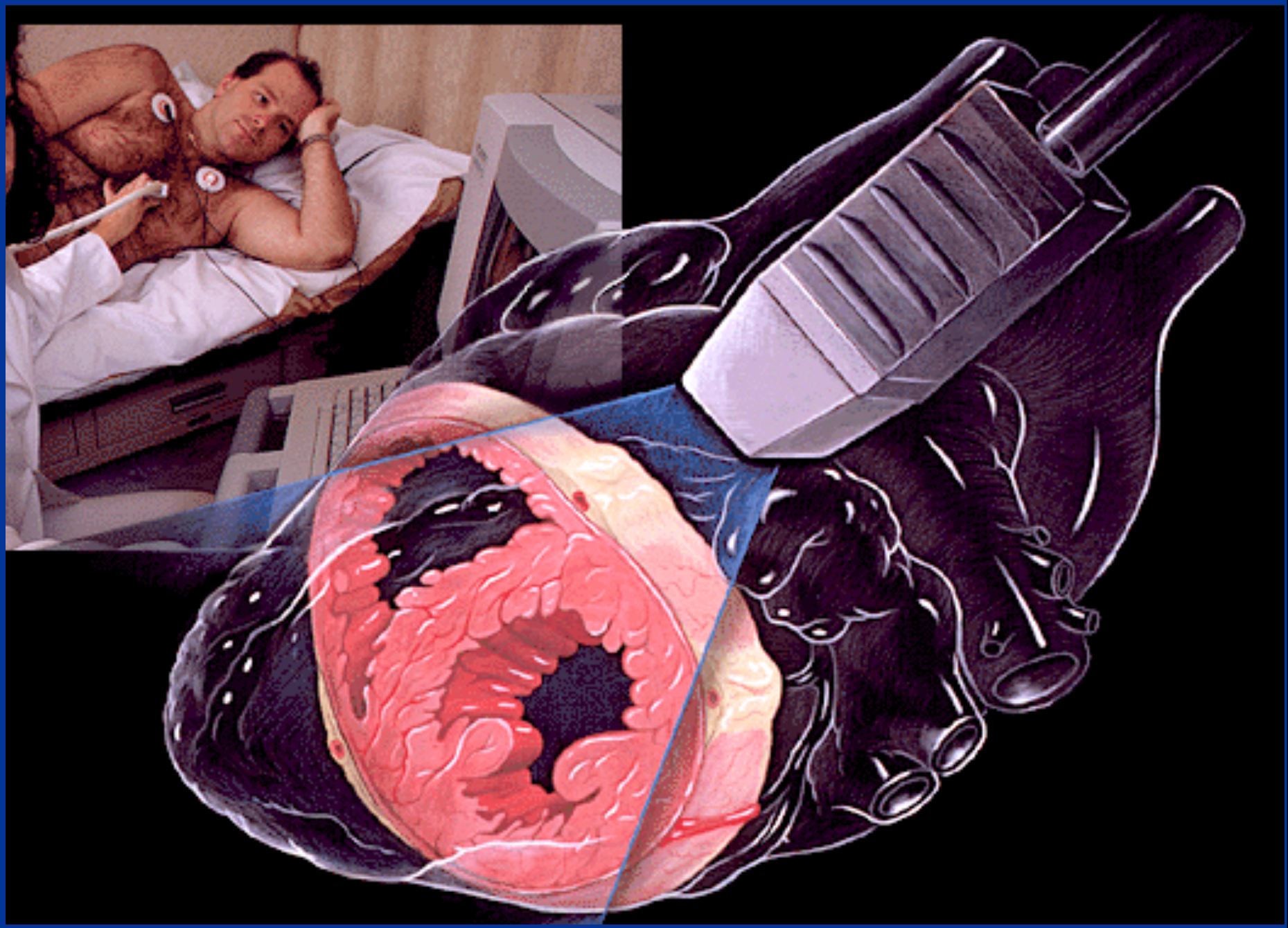
DEXTROCARDIA



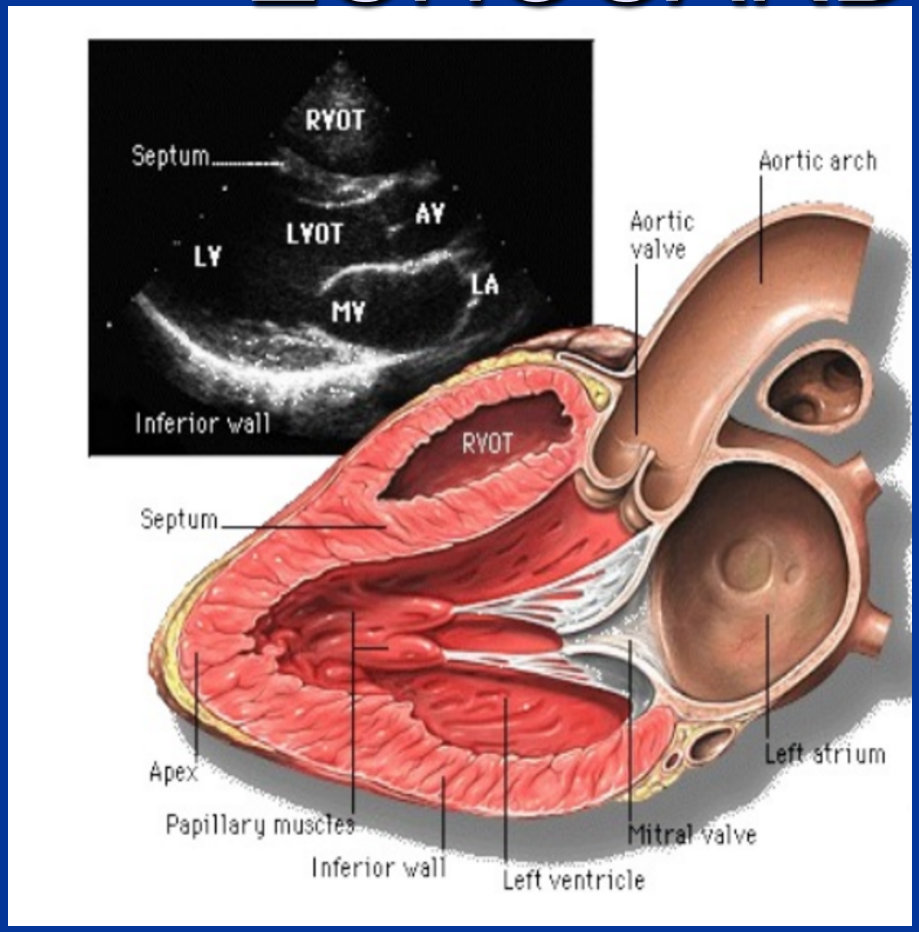


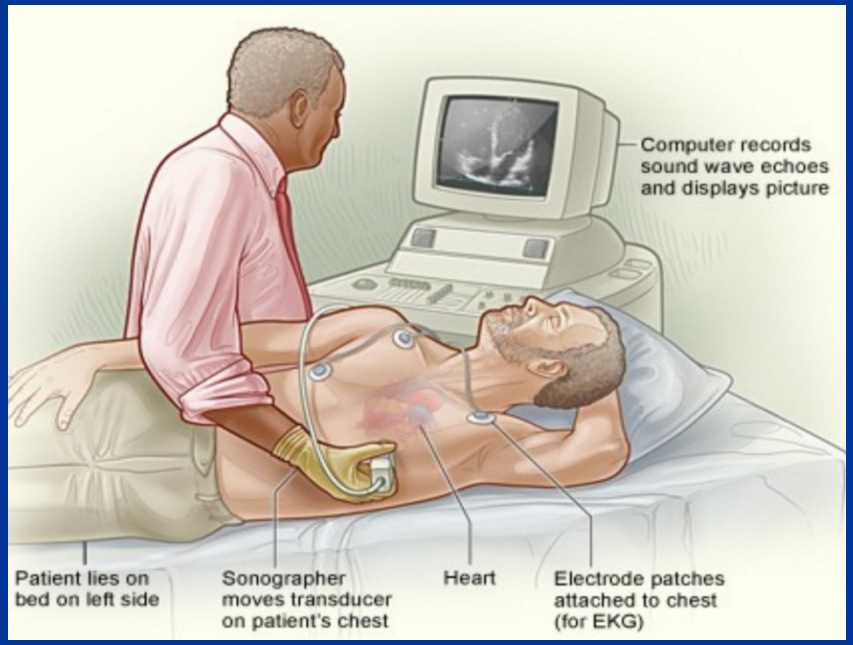
HEART


Cardiac Computed Tomography
Anatomy
Cardiac Magnetic Resonance Imaging
Echocardiography TEE/TTE
Function
Intracardiac Echocardiography
Nuclear Imaging



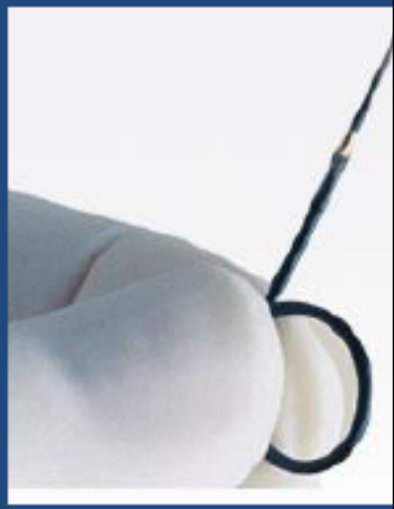
TRANS-THORACIC ECHOCARDIOGRAPHY

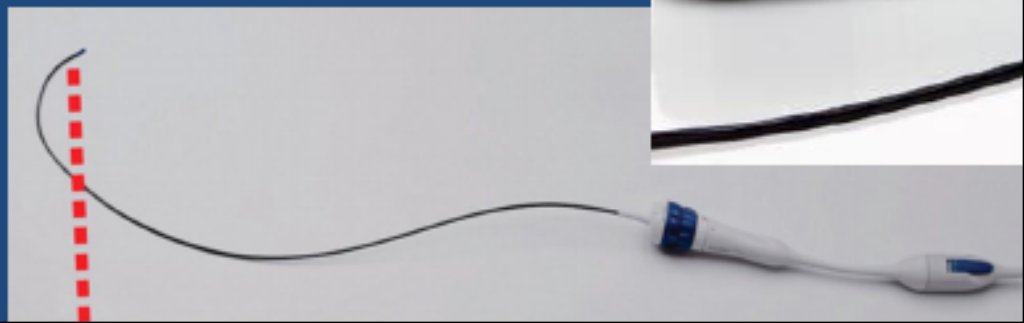




Echocardiography Methods

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

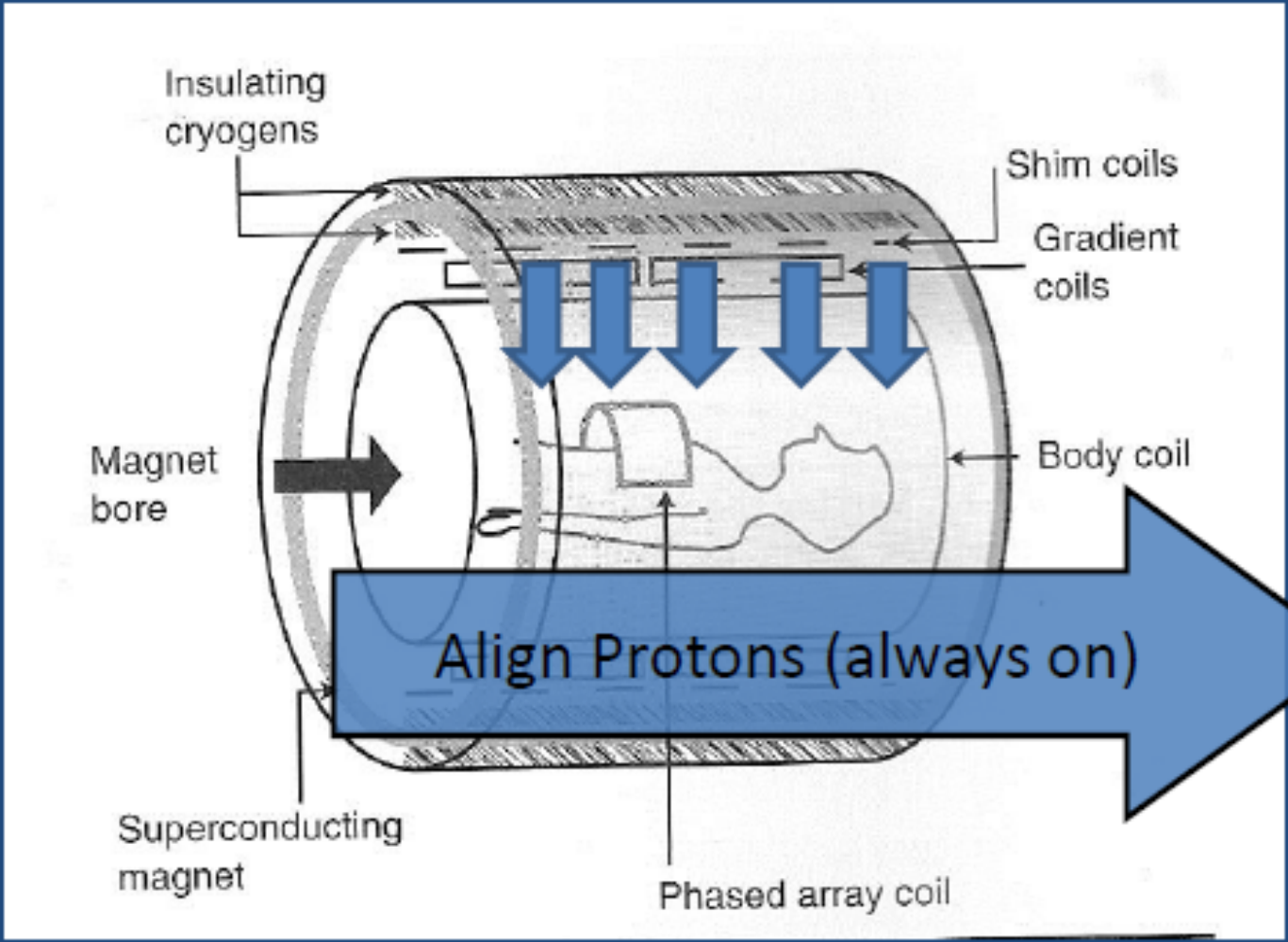


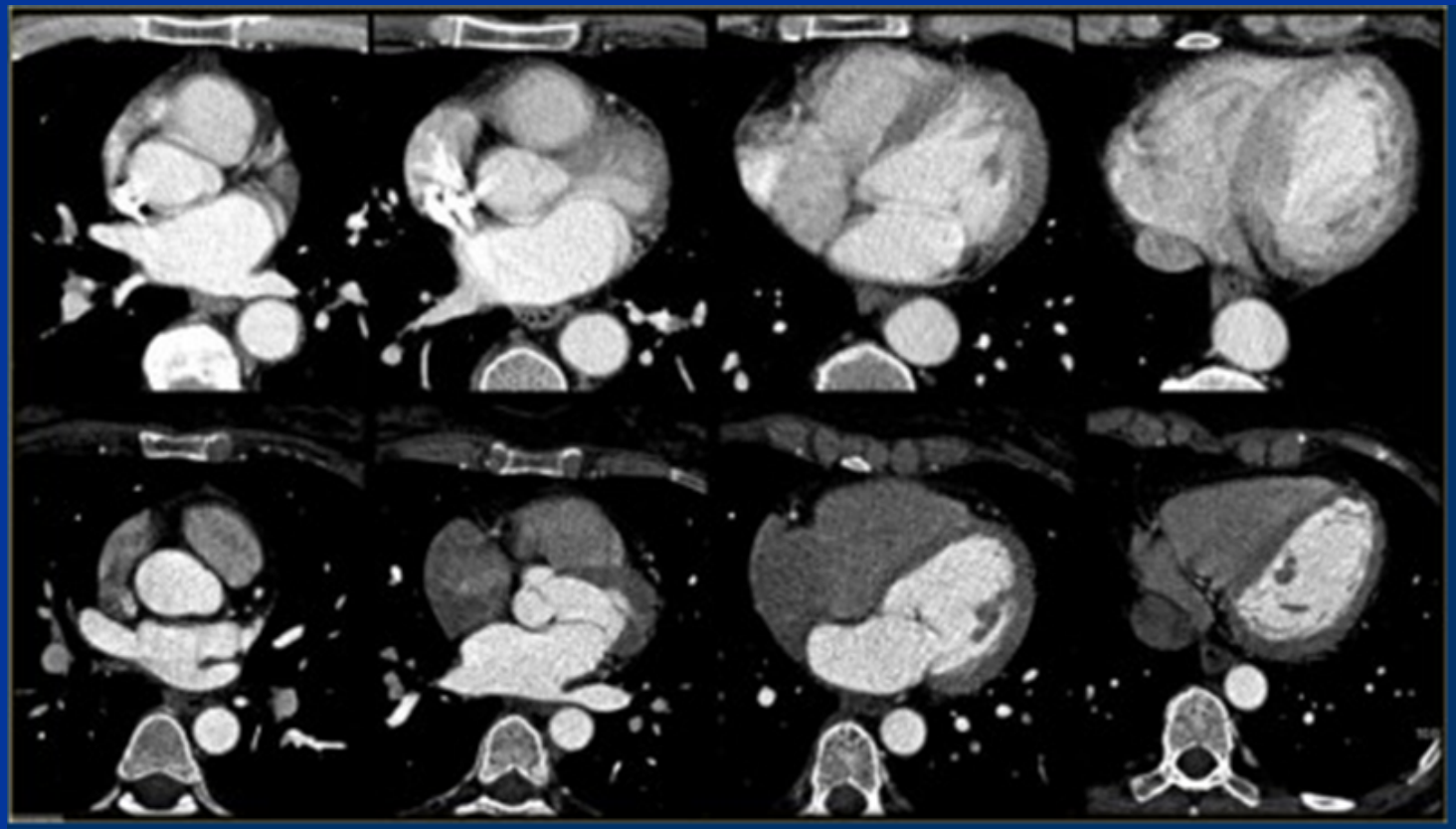


Transesophageal Echocardiography

- **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.

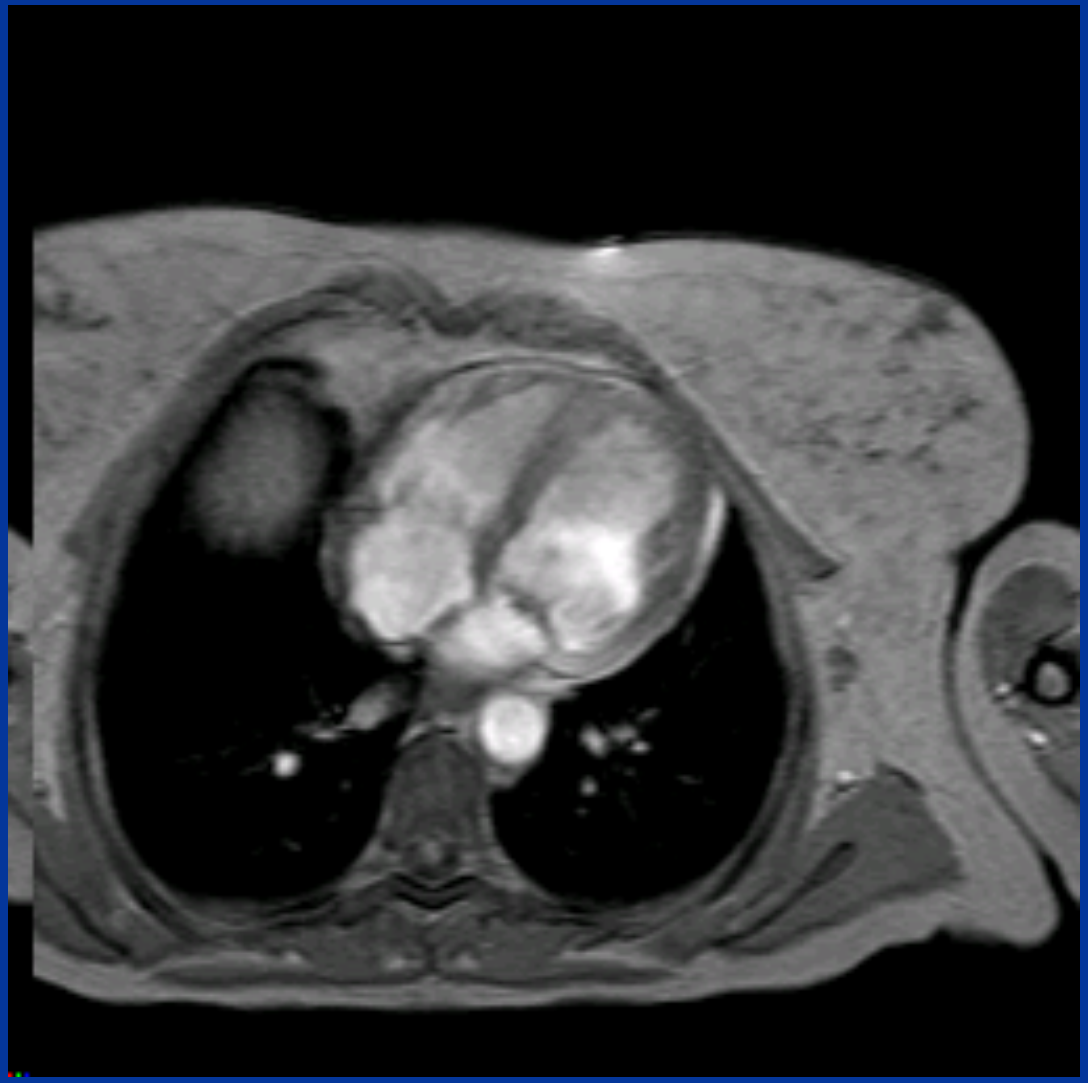
MRI


Insulating cryogens
Shim coils
Gradient coils
Magnet bore
Body coil
Align Protons (always on)
Superconducting magnet
Phased array coil



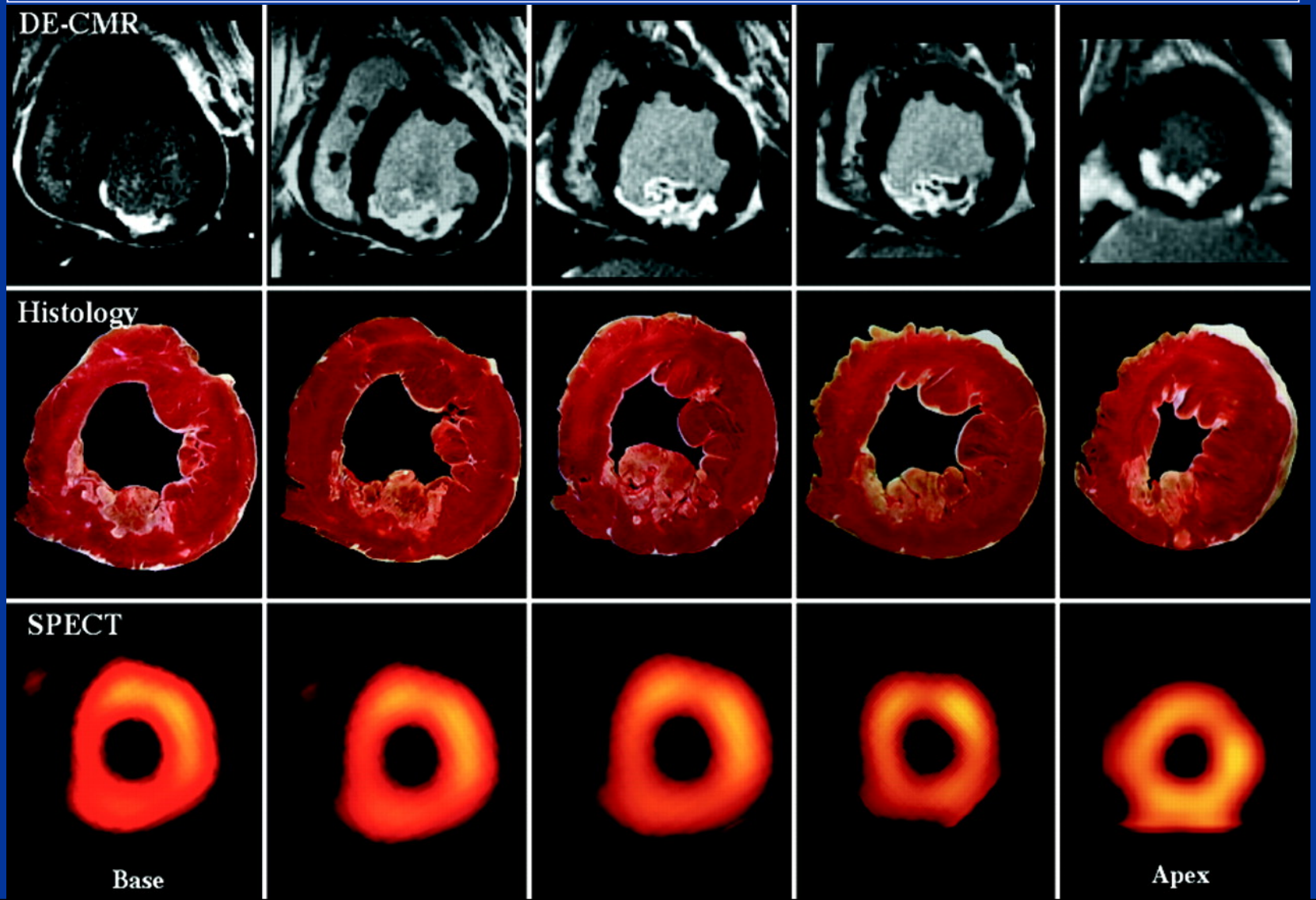
Axial slices through the heart

Cardiac Magnetic Resonance



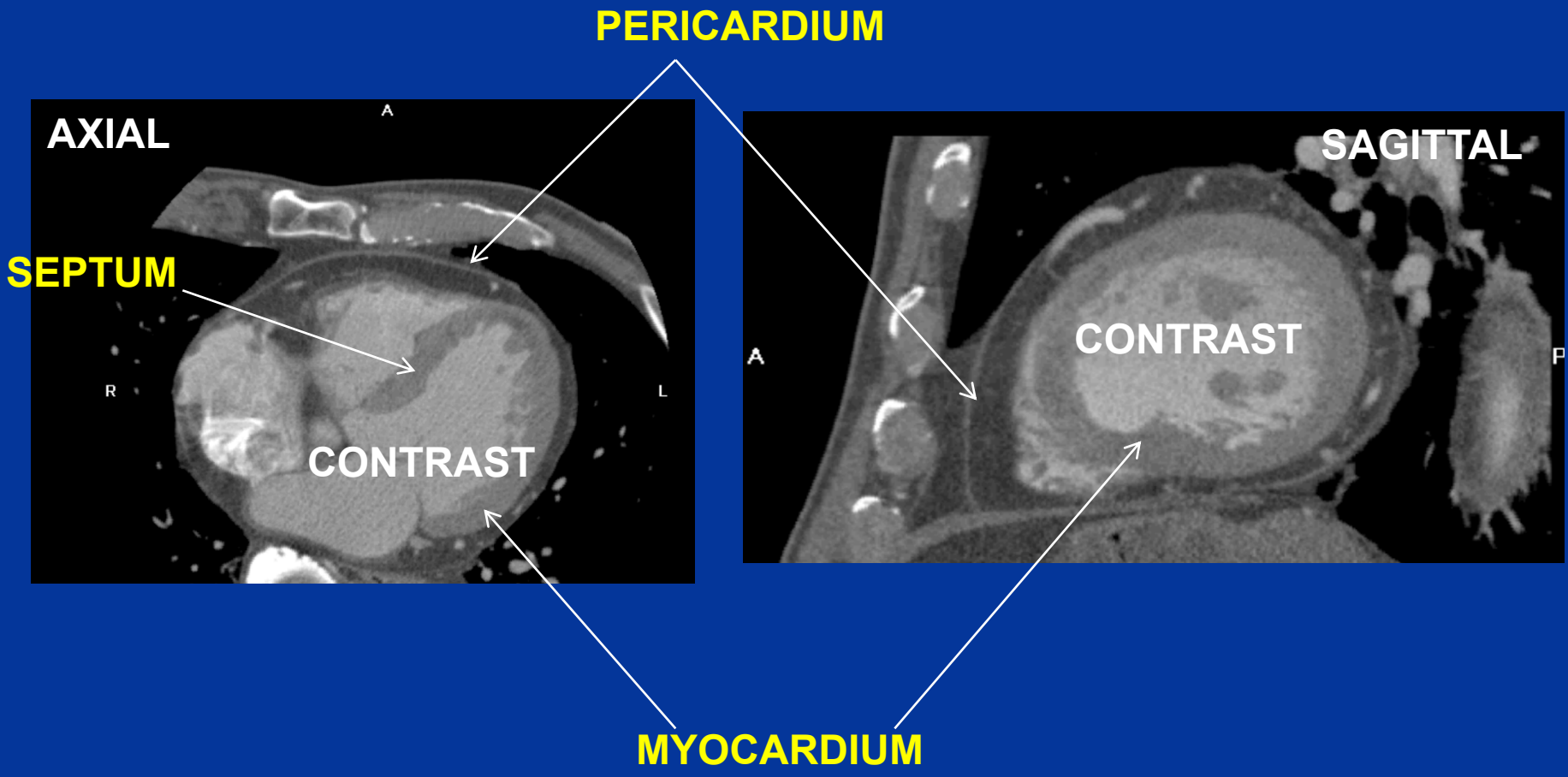
Viability Assessment

CMR Delayed Hyper-Enhancement



CARDIAC CT
FOR THE HEART AND CRONARY VESSLES

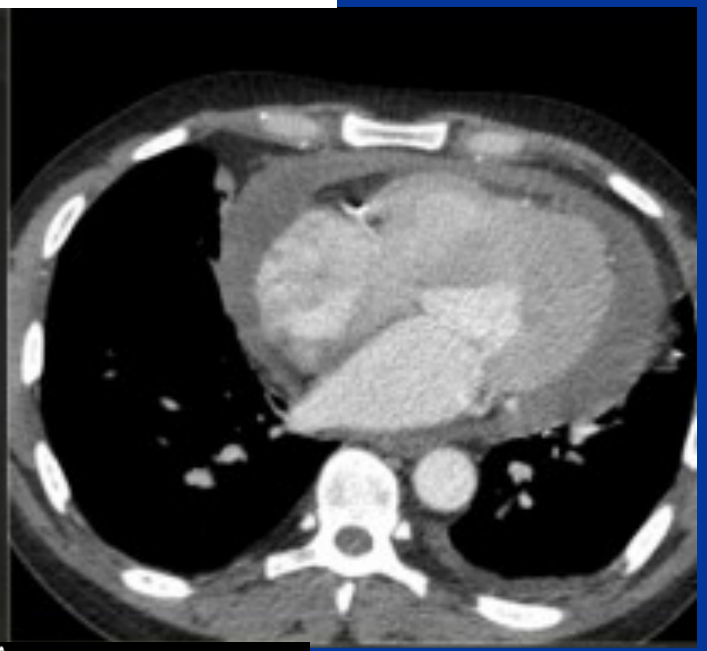
PERICARDIUM

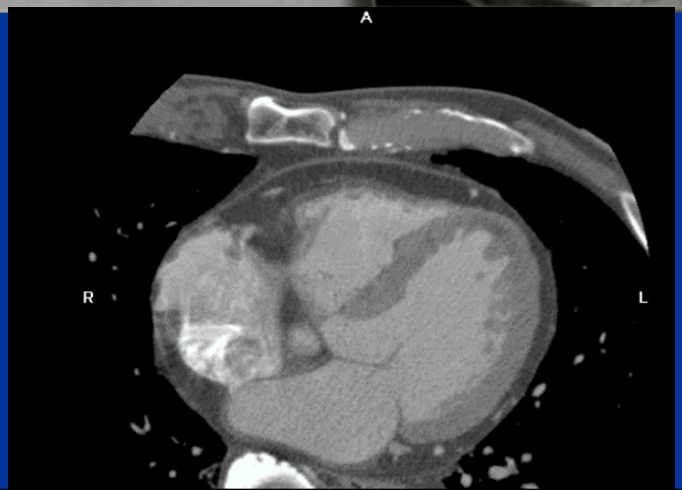


Pericardial effusion

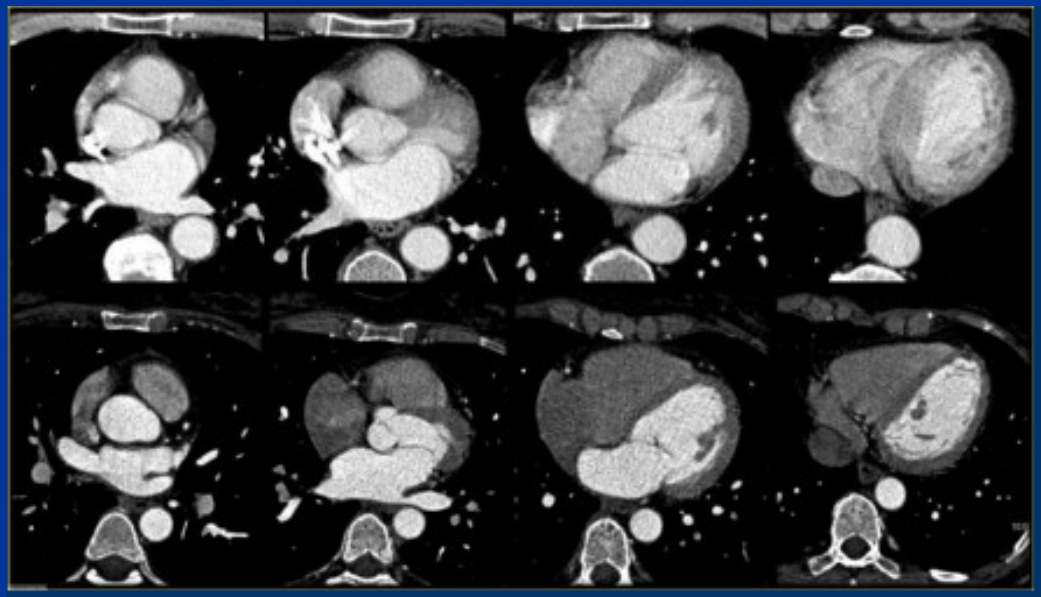
Whenever we encounter a large heart figure, we should always be aware of the possibility of pericardial effusion simulating a large heart.

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.

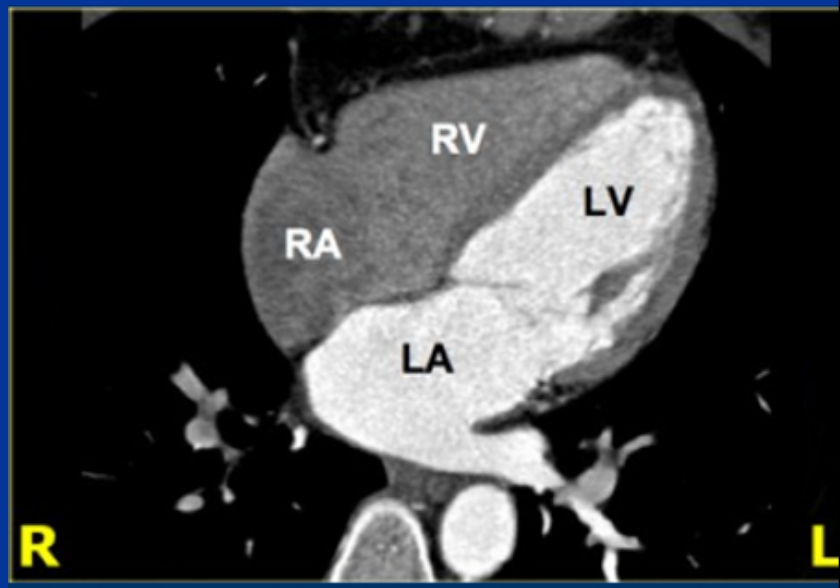




CARDIAC CHAMBERS



Axial slices through the heart



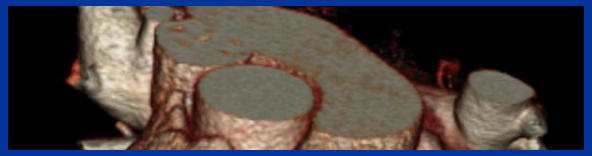
4-chamber view. RA=right atrium, RV=right ventricle, LA=left atrium, LV=left ventricle

4 to 64 Slice Scans

Five Heart Beats

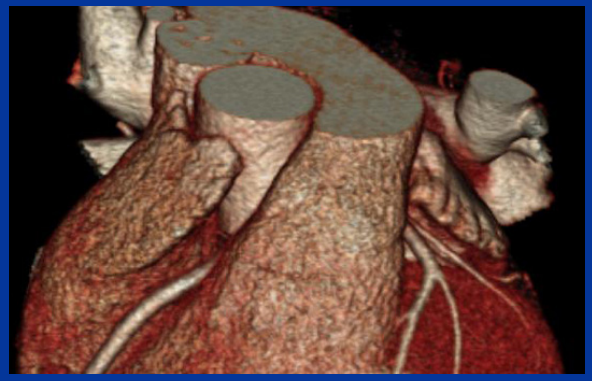
10 mm detector
Pitch ~0.25

3 cm in 5 sec



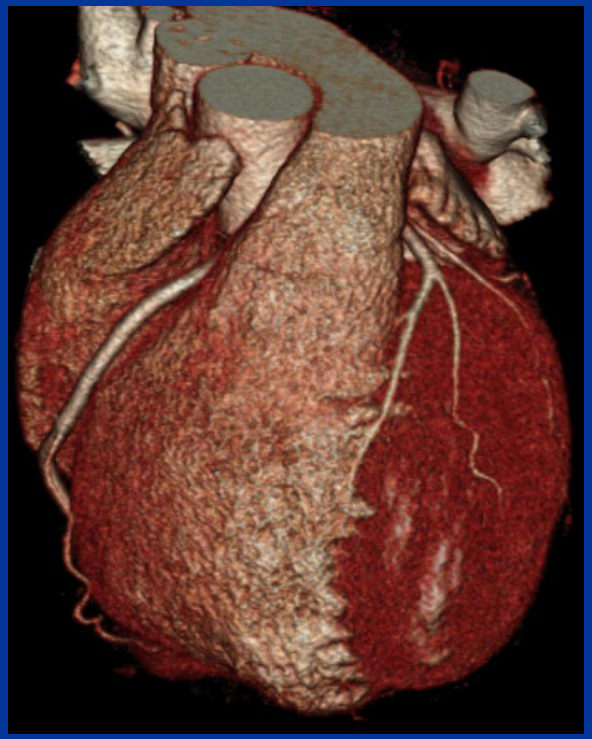
20 mm detector
Pitch ~0.25

6.2 cm in 5 sec

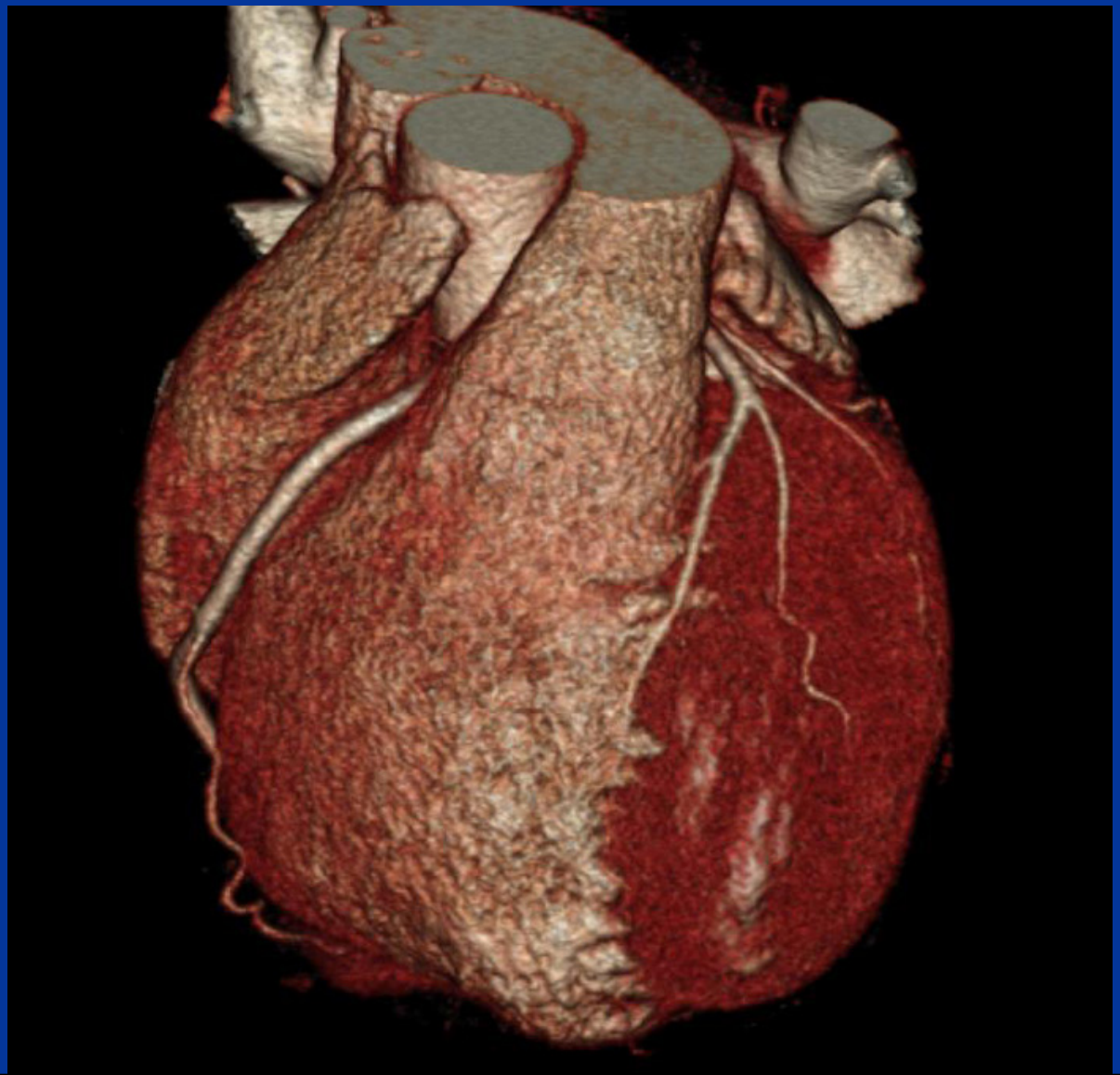


40 mm detector
Pitch ~0.25

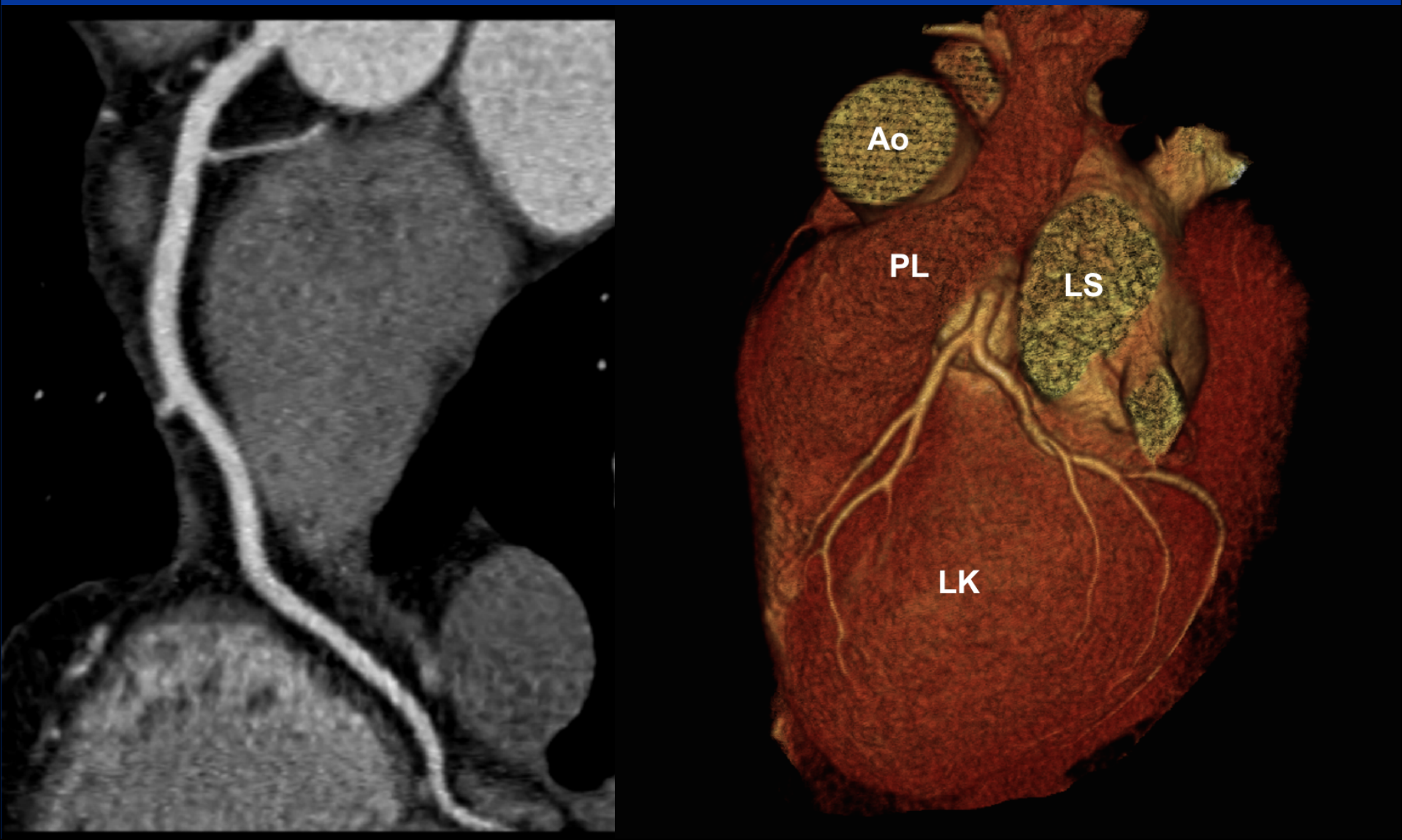
12.5 cm in 5 sec



3-D Volume Rendered Image

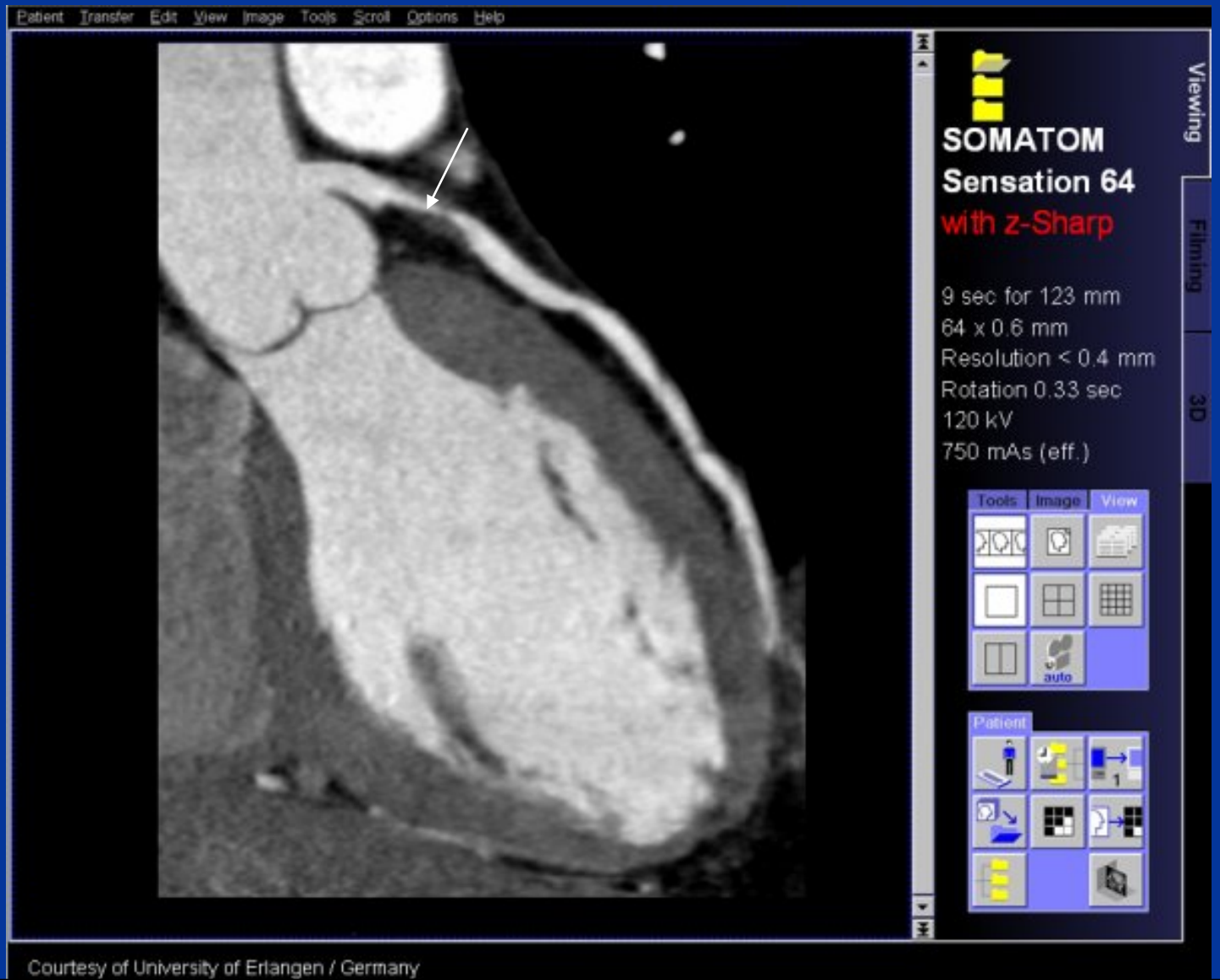


CTC

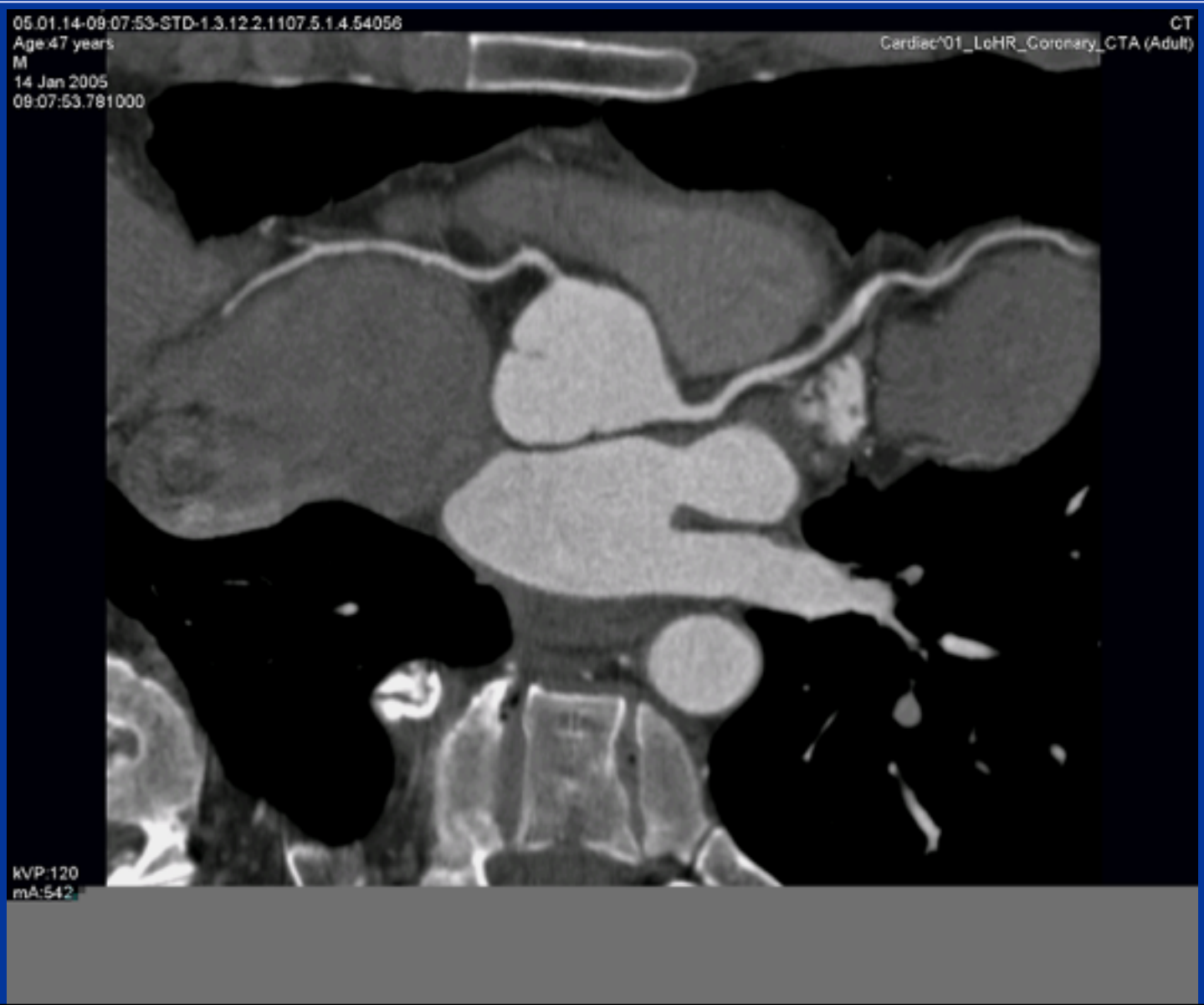


Maximum Intensity Projection

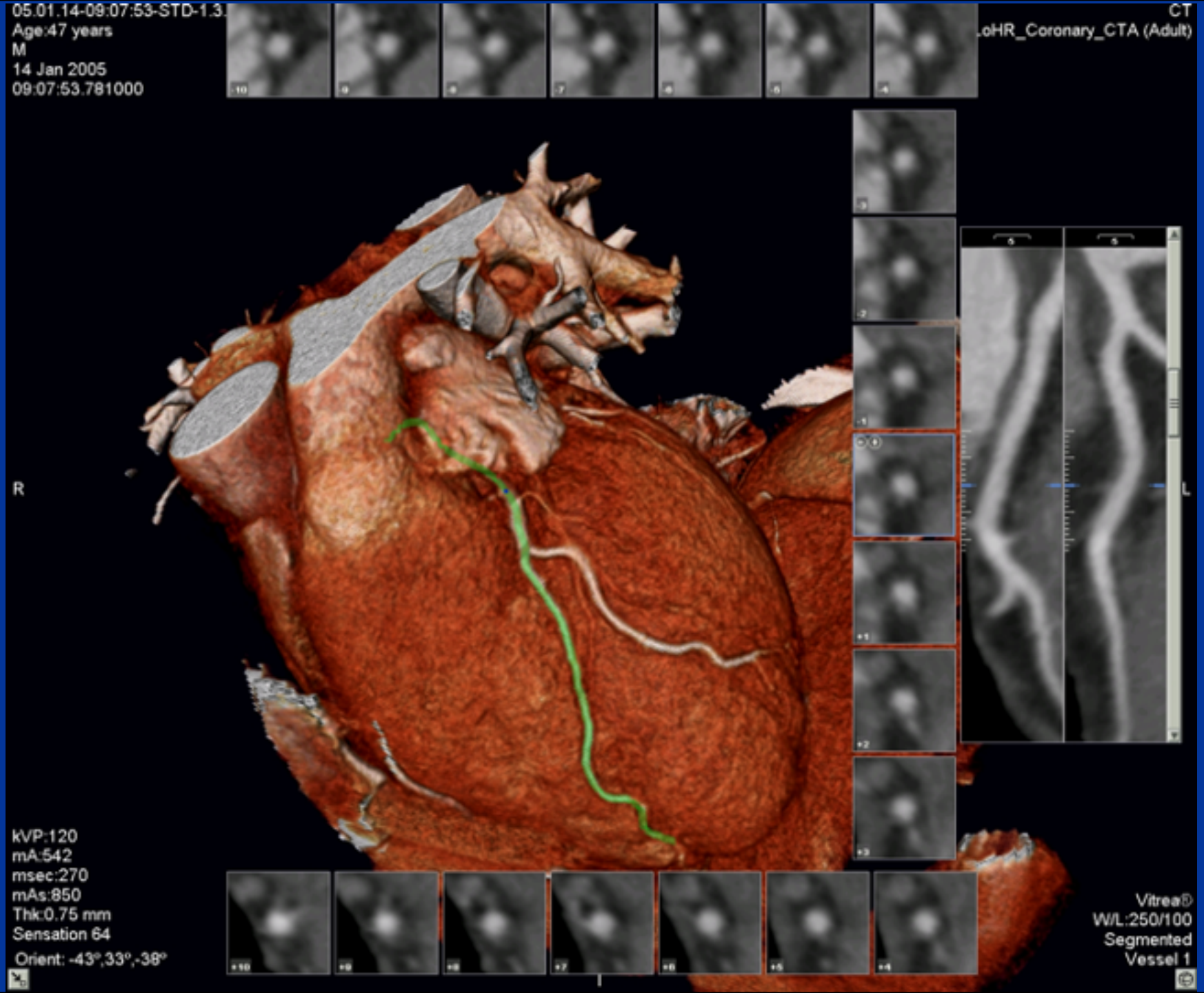
Soft Plaque in Proximal LAD



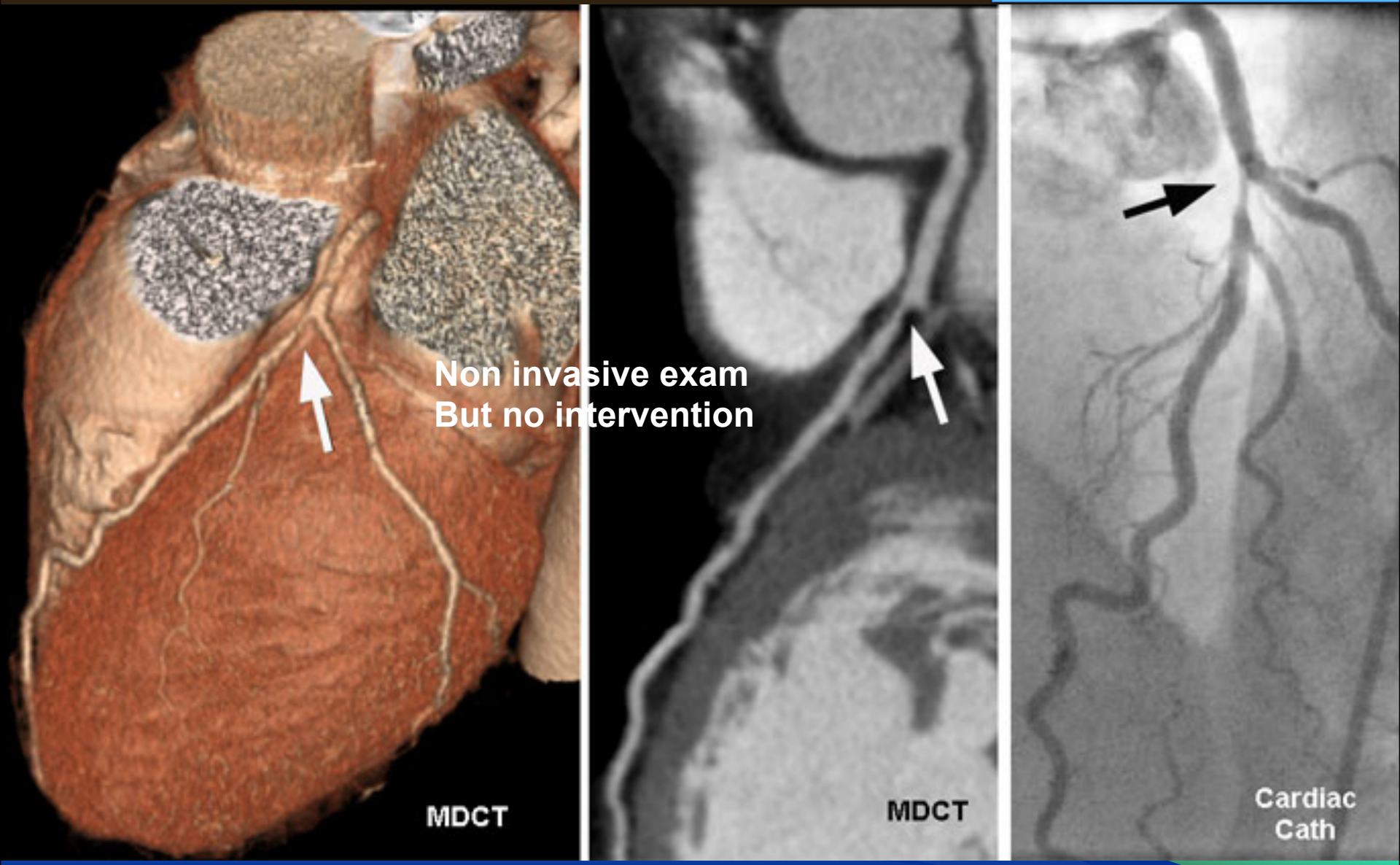
Curved Planar Image

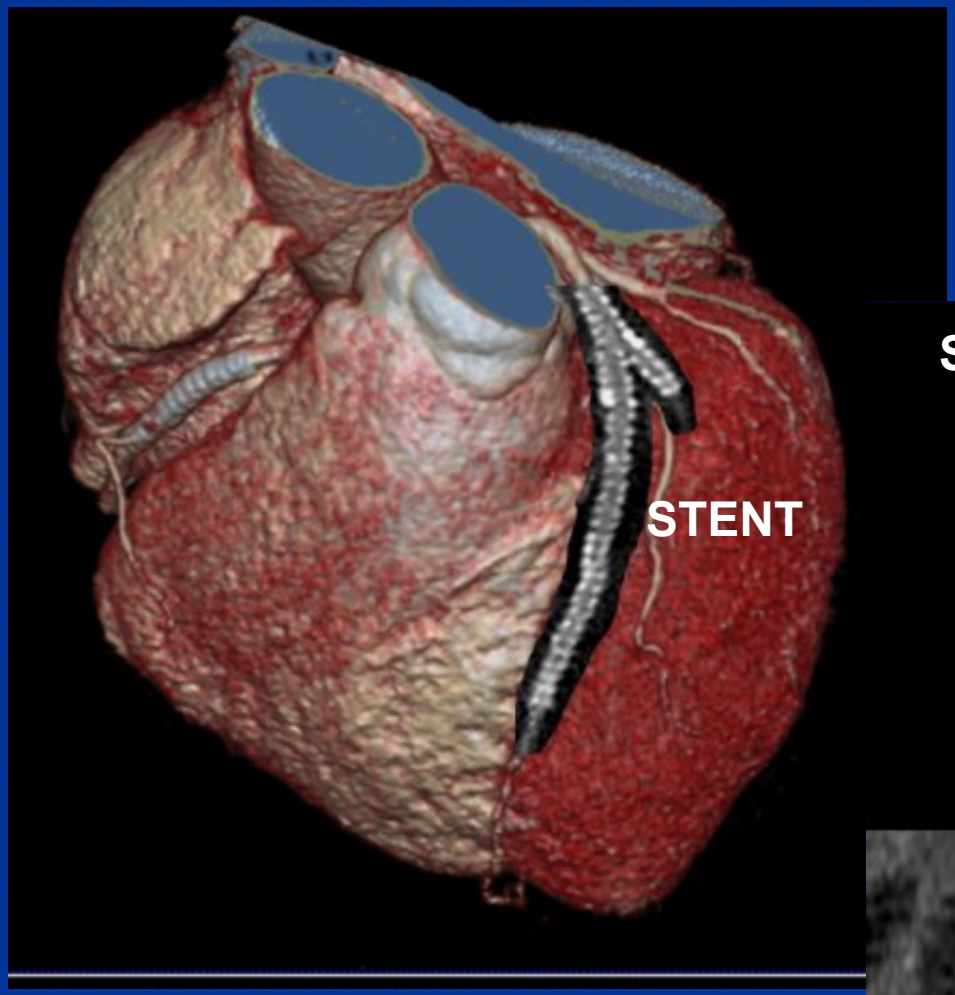


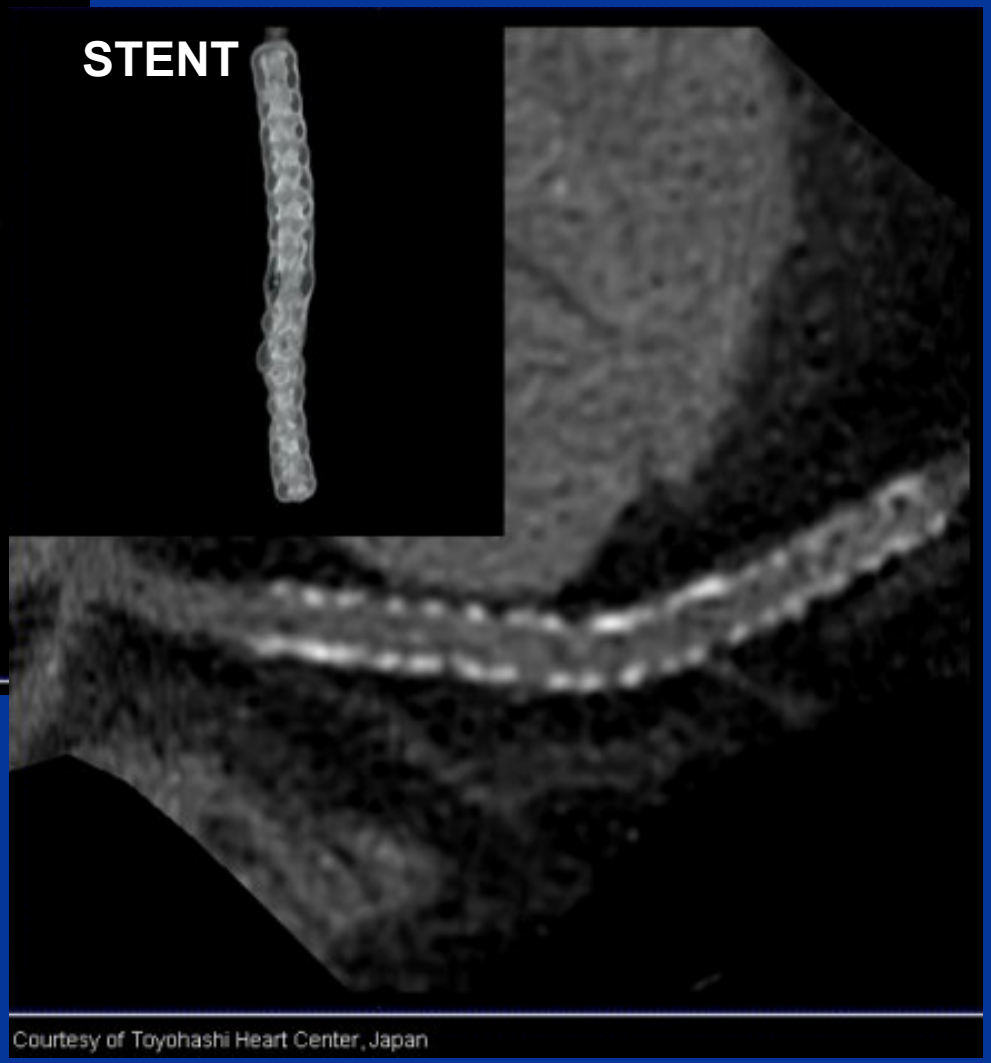

11/17/2004
10:52:57.69
7 IMA 0
VRT
Spin: -28
Tilt: 27
RAF
A
L


05.01.14-09:07:53-STD-1.3
Age:47 years
M
14 Jan 2005
09:07:53.781000
CT
LoHR_Coronary_CTA (Adult)
R
L
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

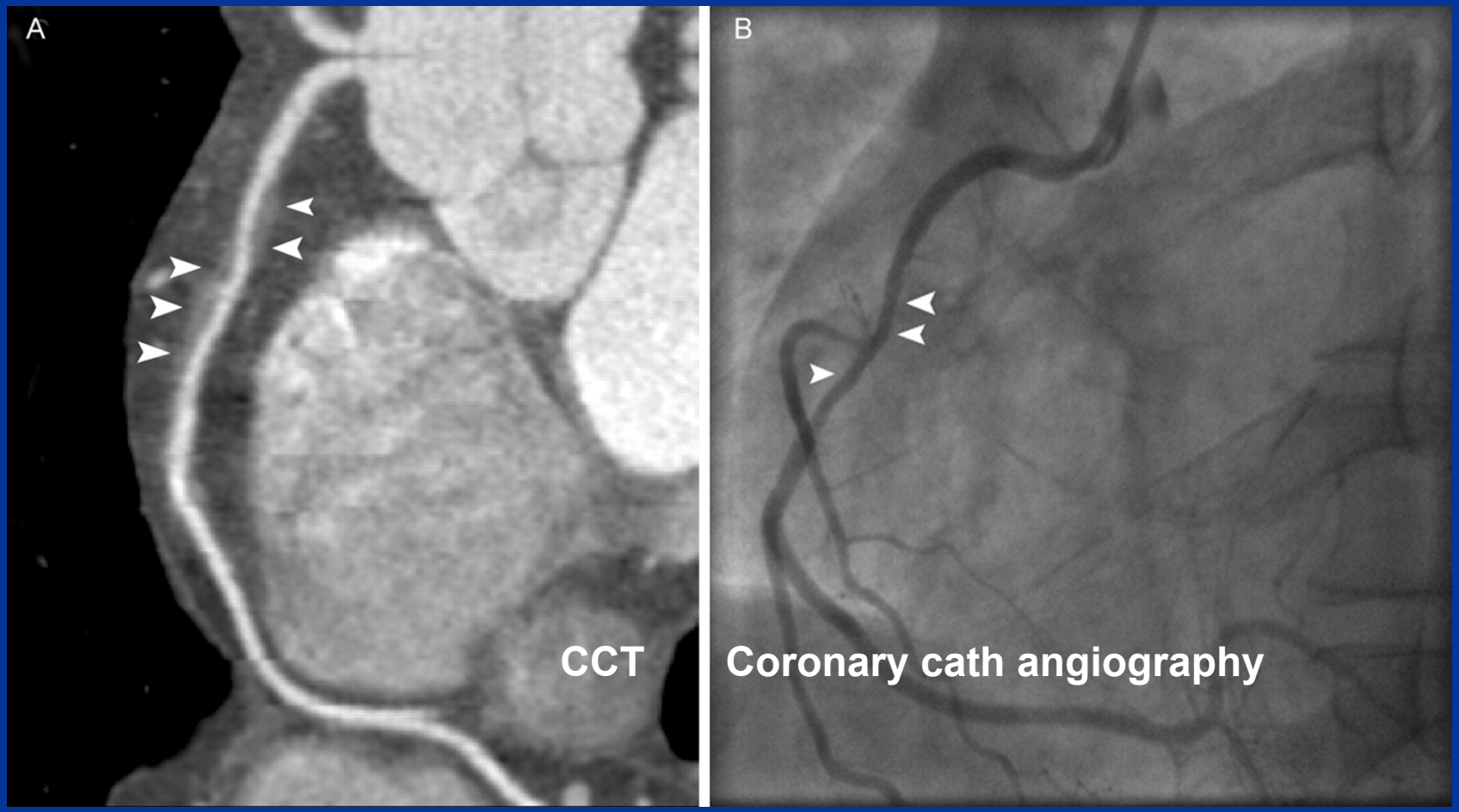
Invasive but
You can do
angioplasty and insert
stent

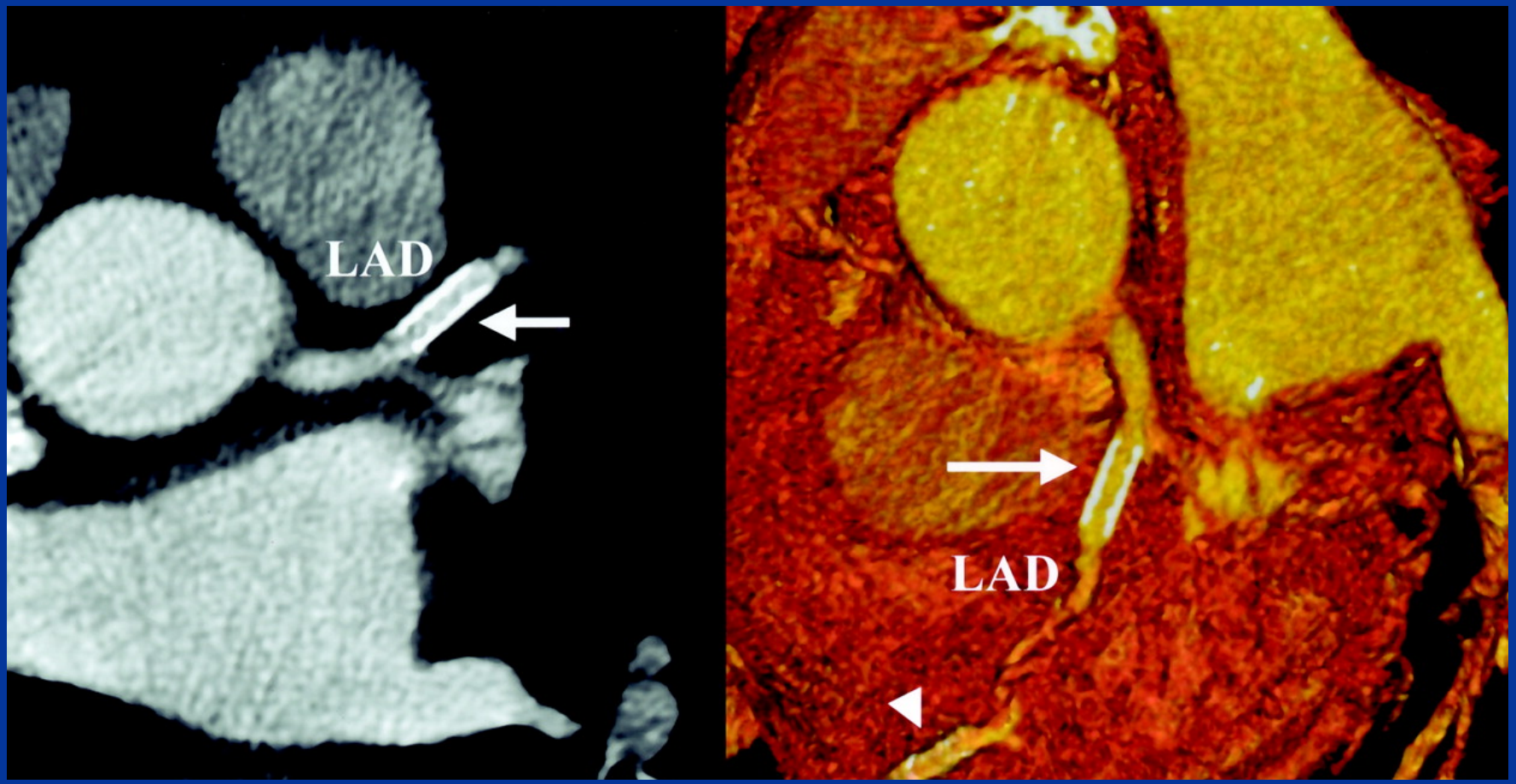


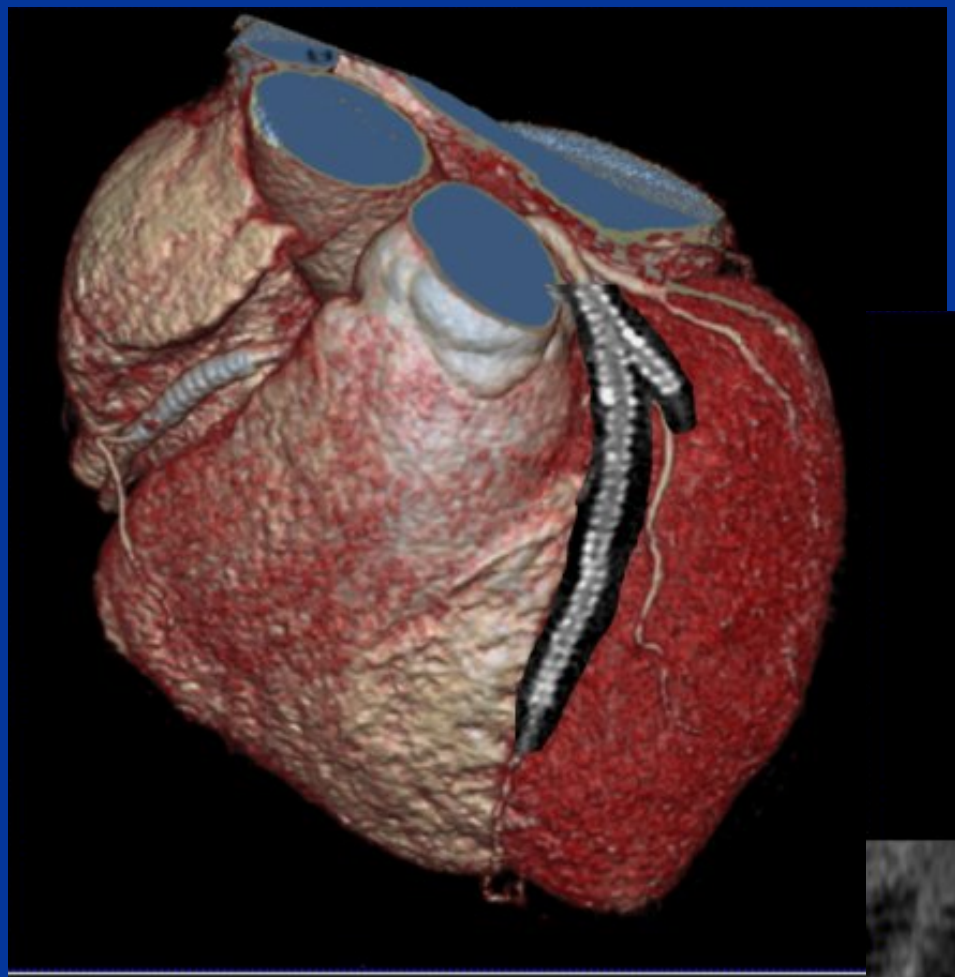

STENT


STENT
Courtesy of Toyohashi Heart Center, Japan

Soft Plaque Visualization

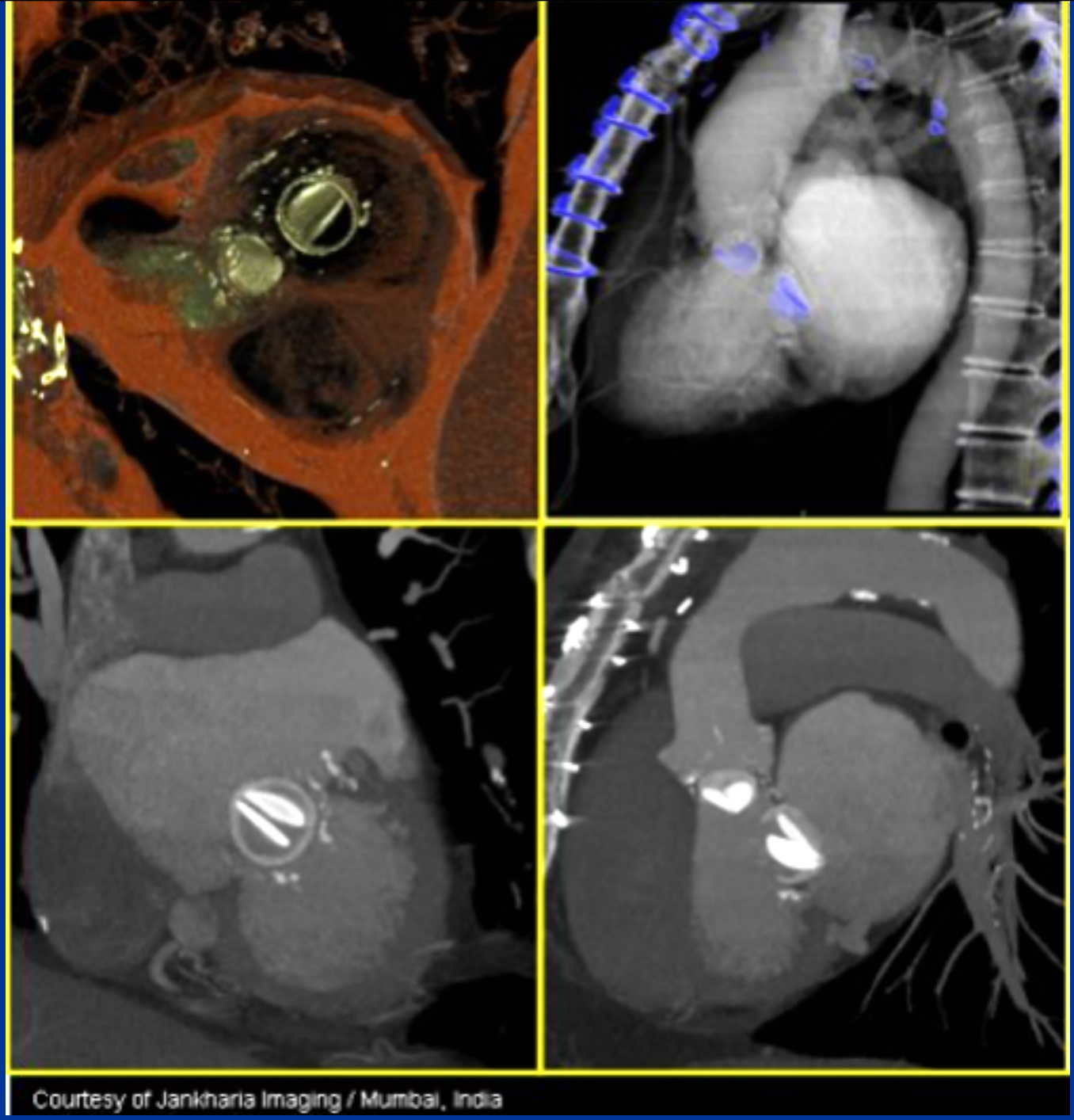



LAD
LAD



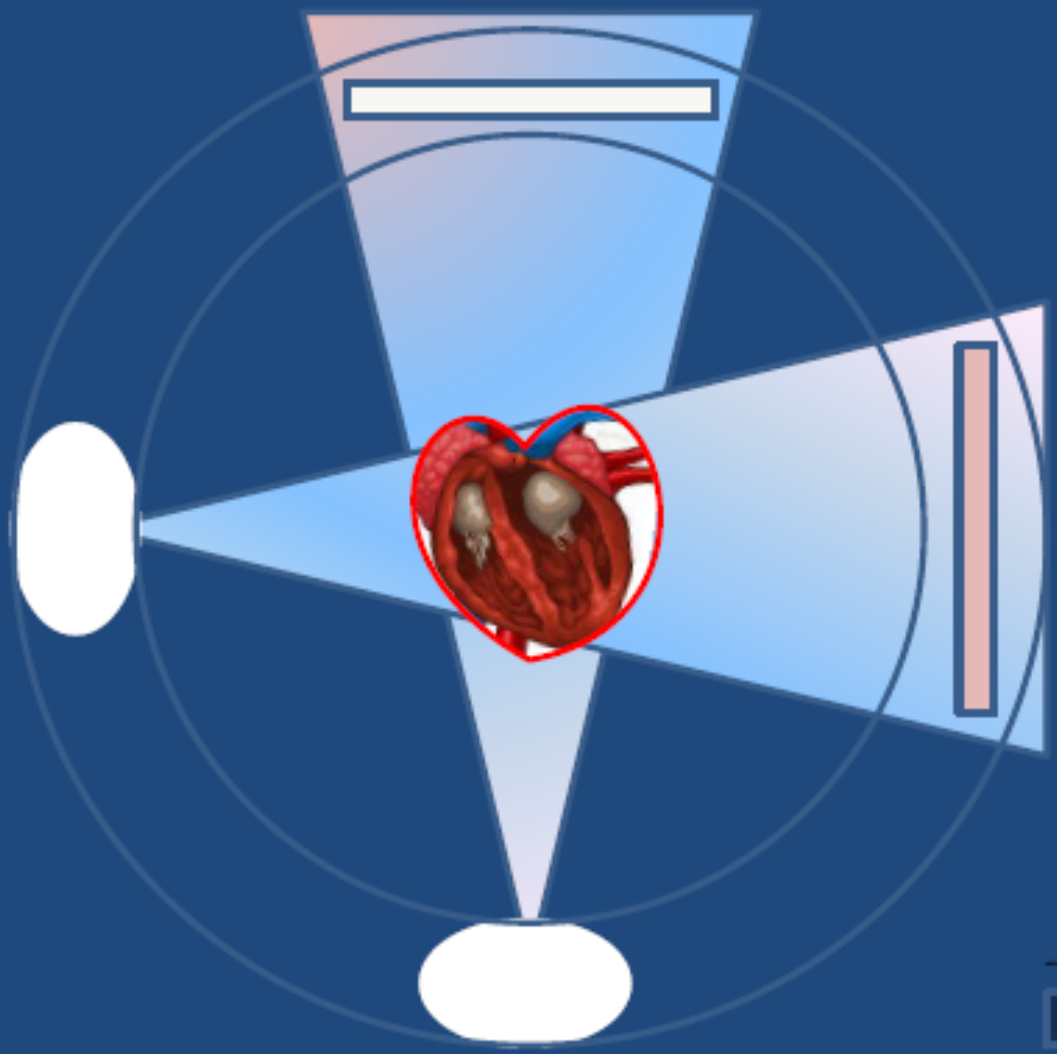
Courtesy of Erasmus Medical Center Rotterdam / Netherlands

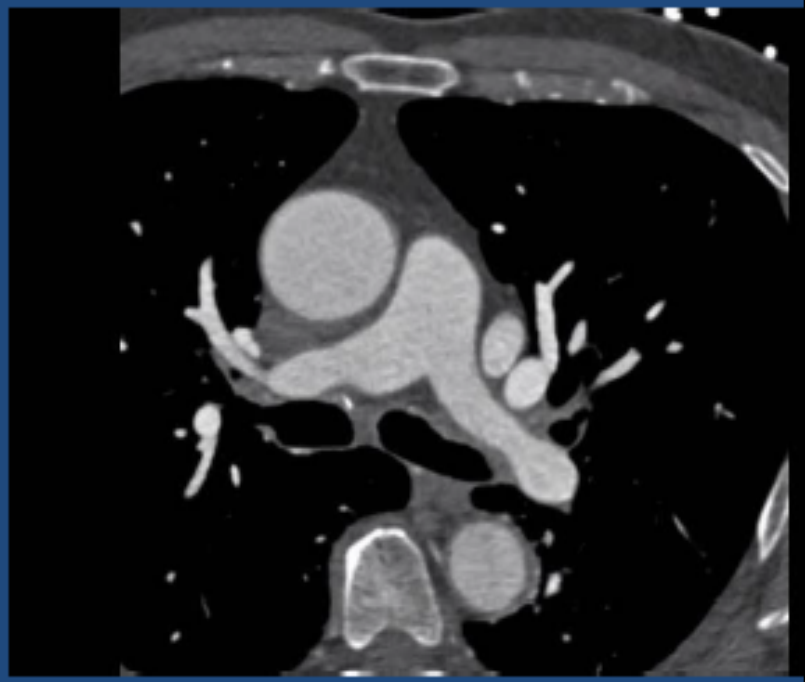
Courtesy of Toyohashi Heart Center, Japan



Courtesy of Jankharia Imaging / Mumbai, India

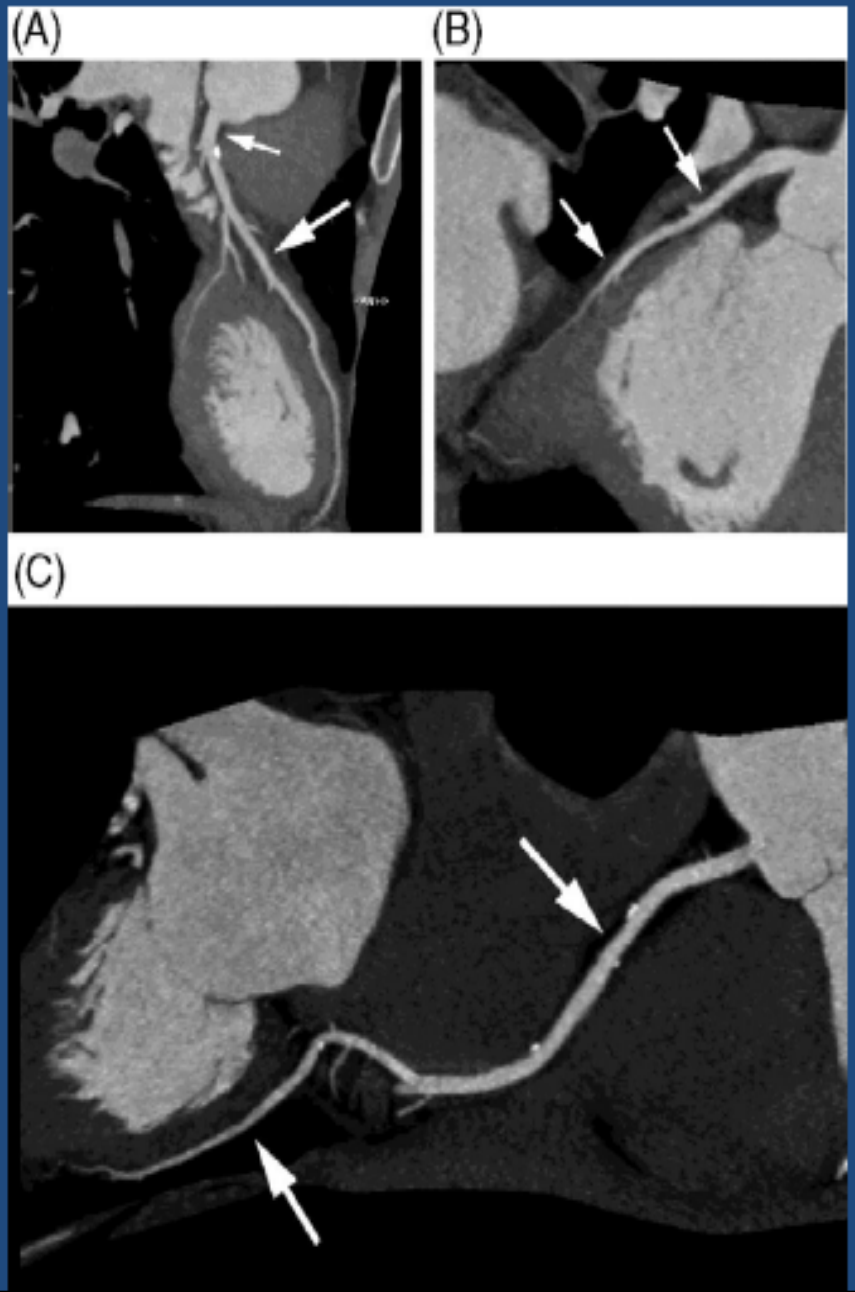
DUAL CCT OF THE HEART



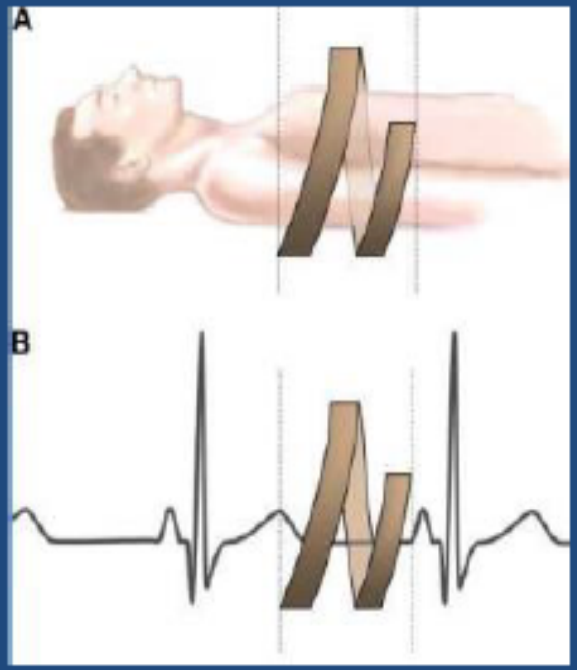


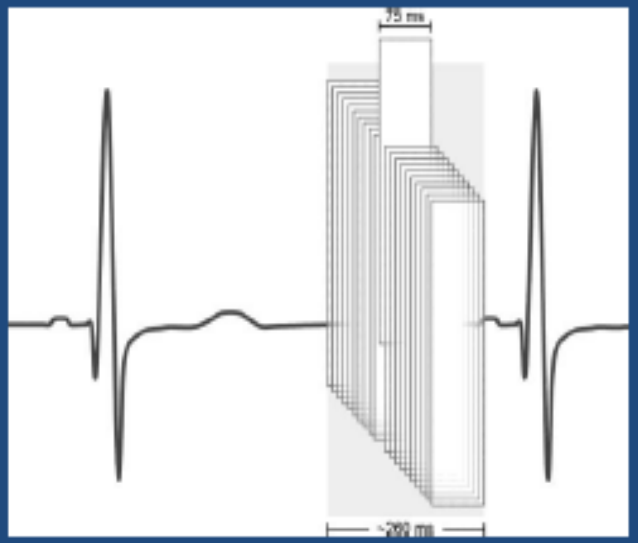
High Pitch Coronary CT Scanning

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

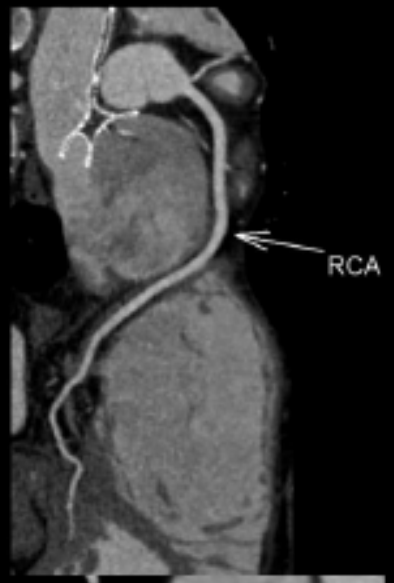


0.89 mSv

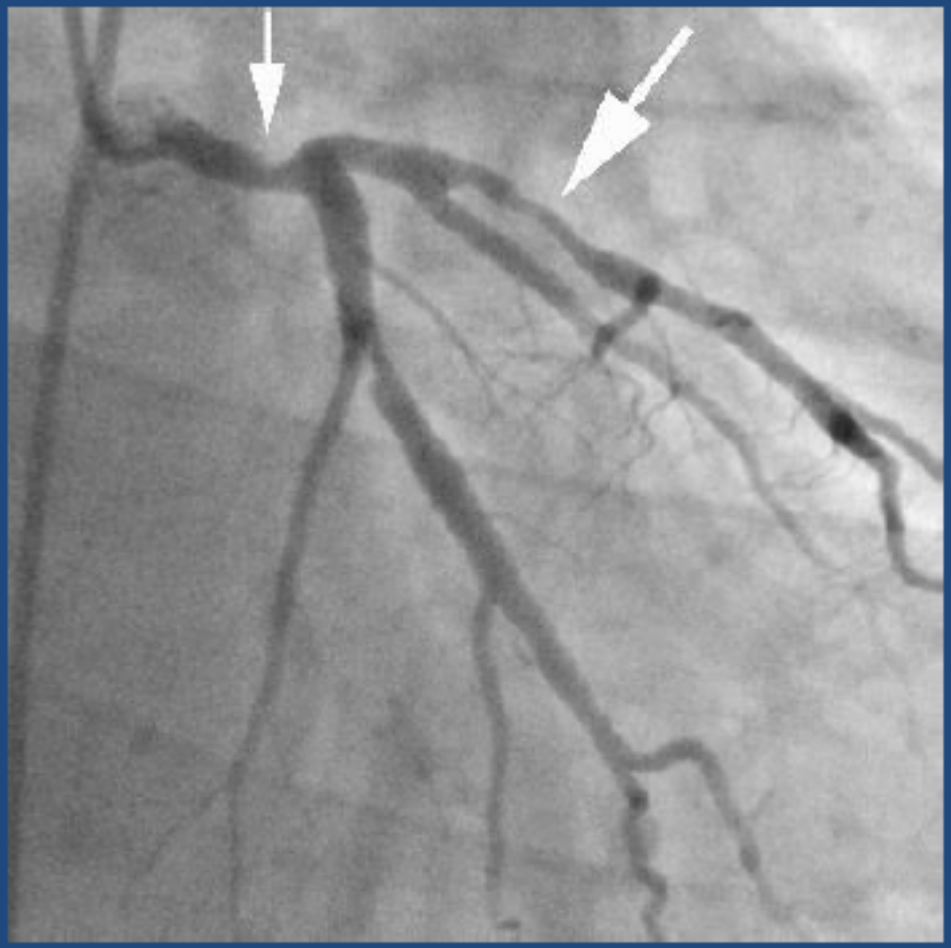


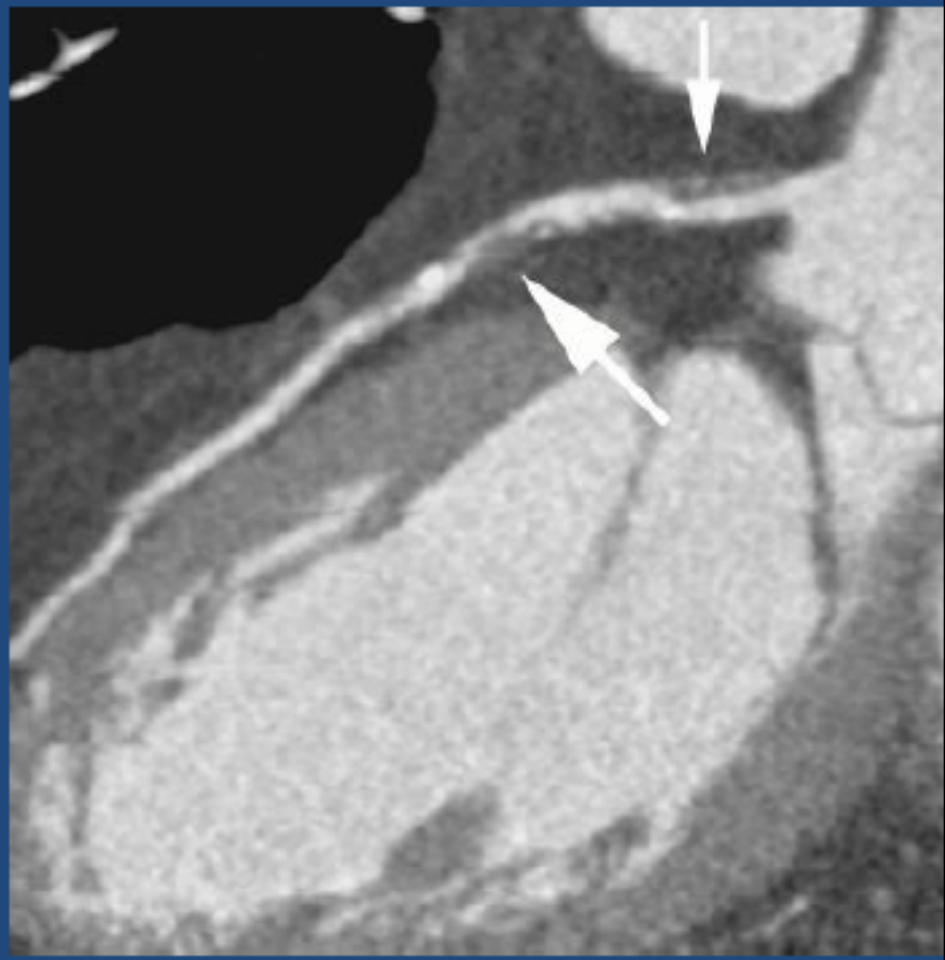


Gated with contrast

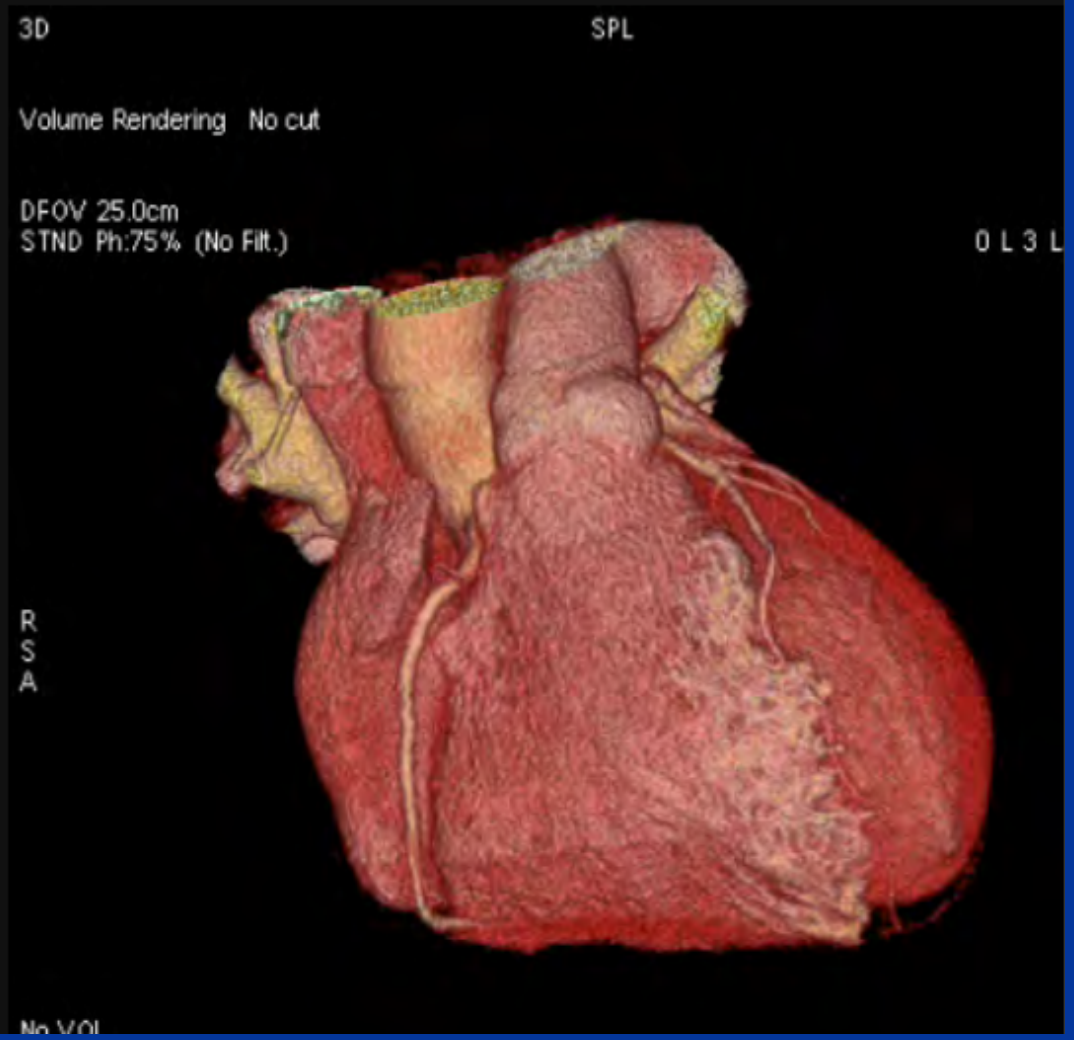


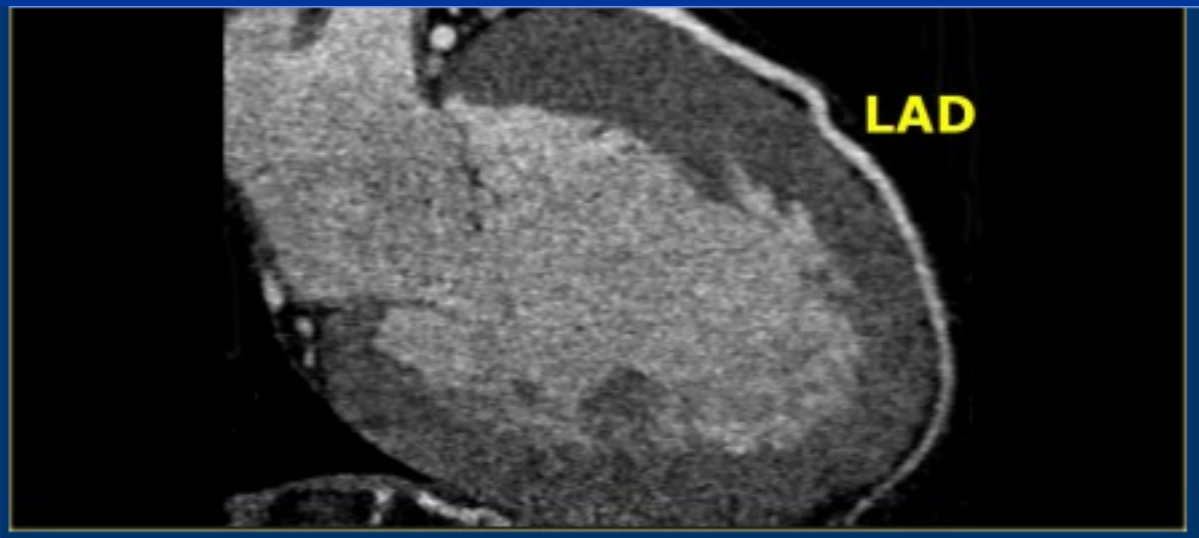
Plaque visualization



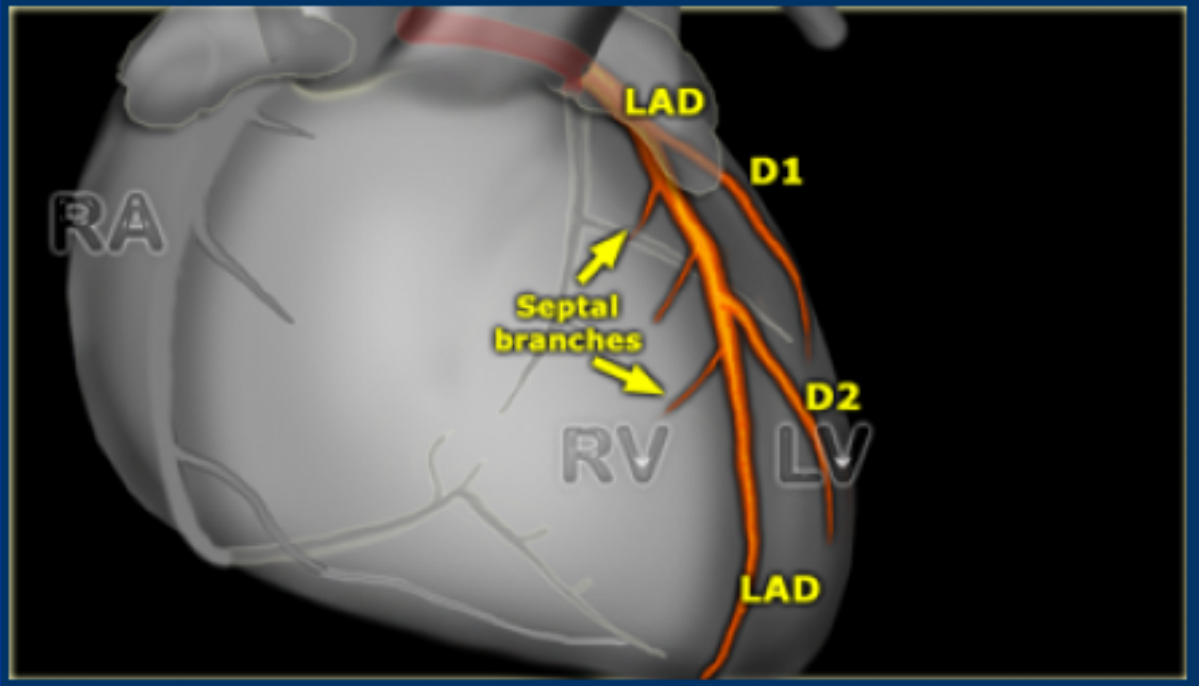


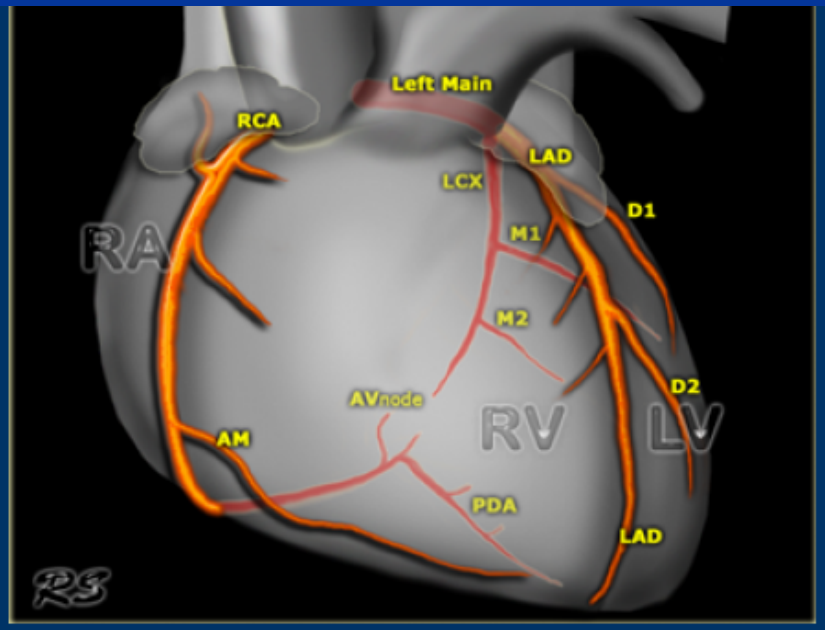
- Knowledge of normal anatomy will allow for ideal imaging planes and sections.
- Knowledge of normal anatomy will allow for the identification of pathology and proper CT scan interpretation.



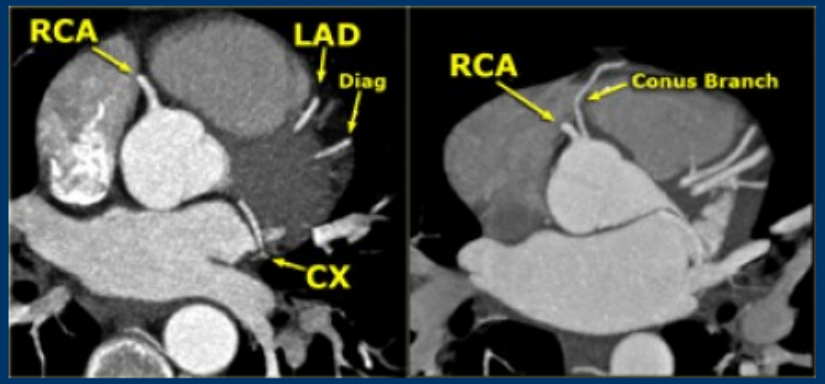


CT image of the LAD in RAO projection

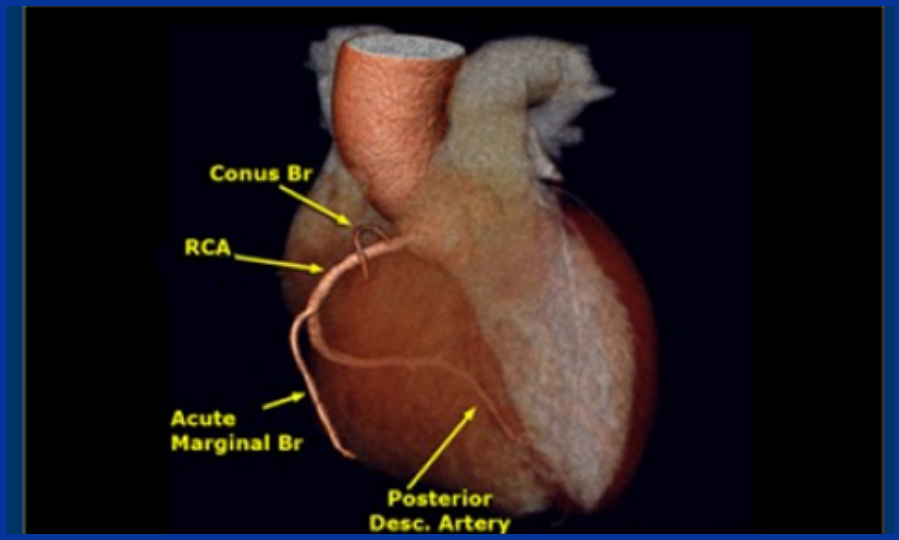




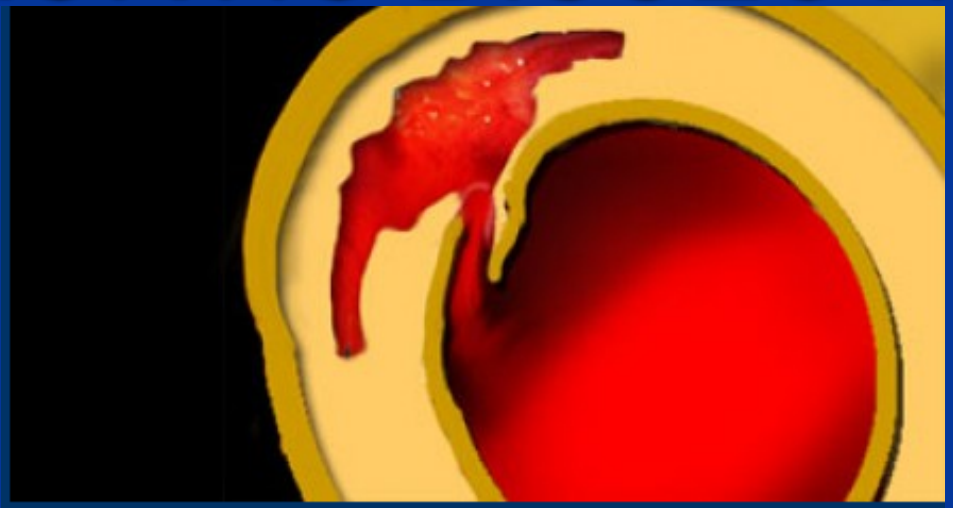
RCA, LAD and LCx in Anterior projection



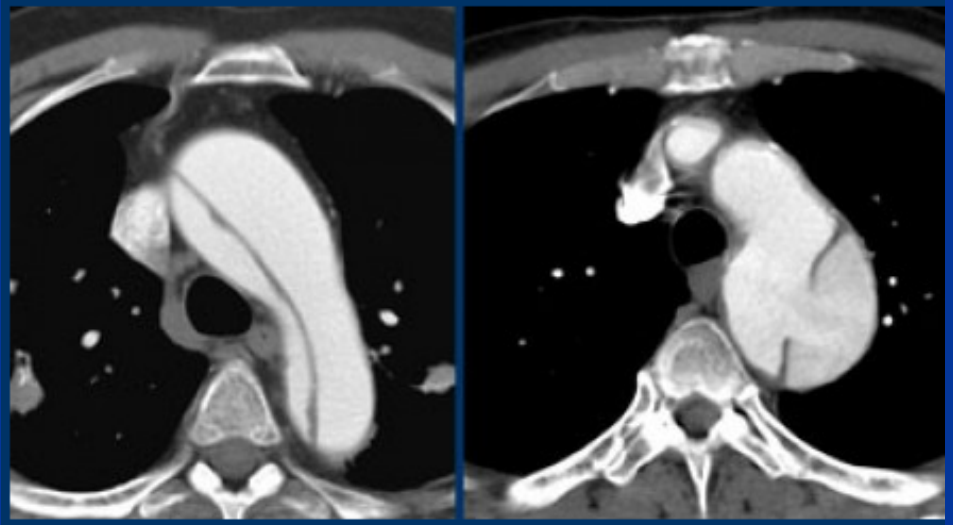
LEFT: RCA comes off the right sinus of ValsalvaRIGHT: Conus artery comes off directly from the aorta



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.

Cardiac MRI

- i.v. Gadolinium contrast agent, prospective imaging planes
- **Pros:** best for myocardial diseases, LV and RV volumes, masses, function and viability testing and for congenital heart diseases
- **Cons:** Expansive, time consuming, expet reader, perfusion and stress wall motion MRI are rarely available, does not show coronary arteries

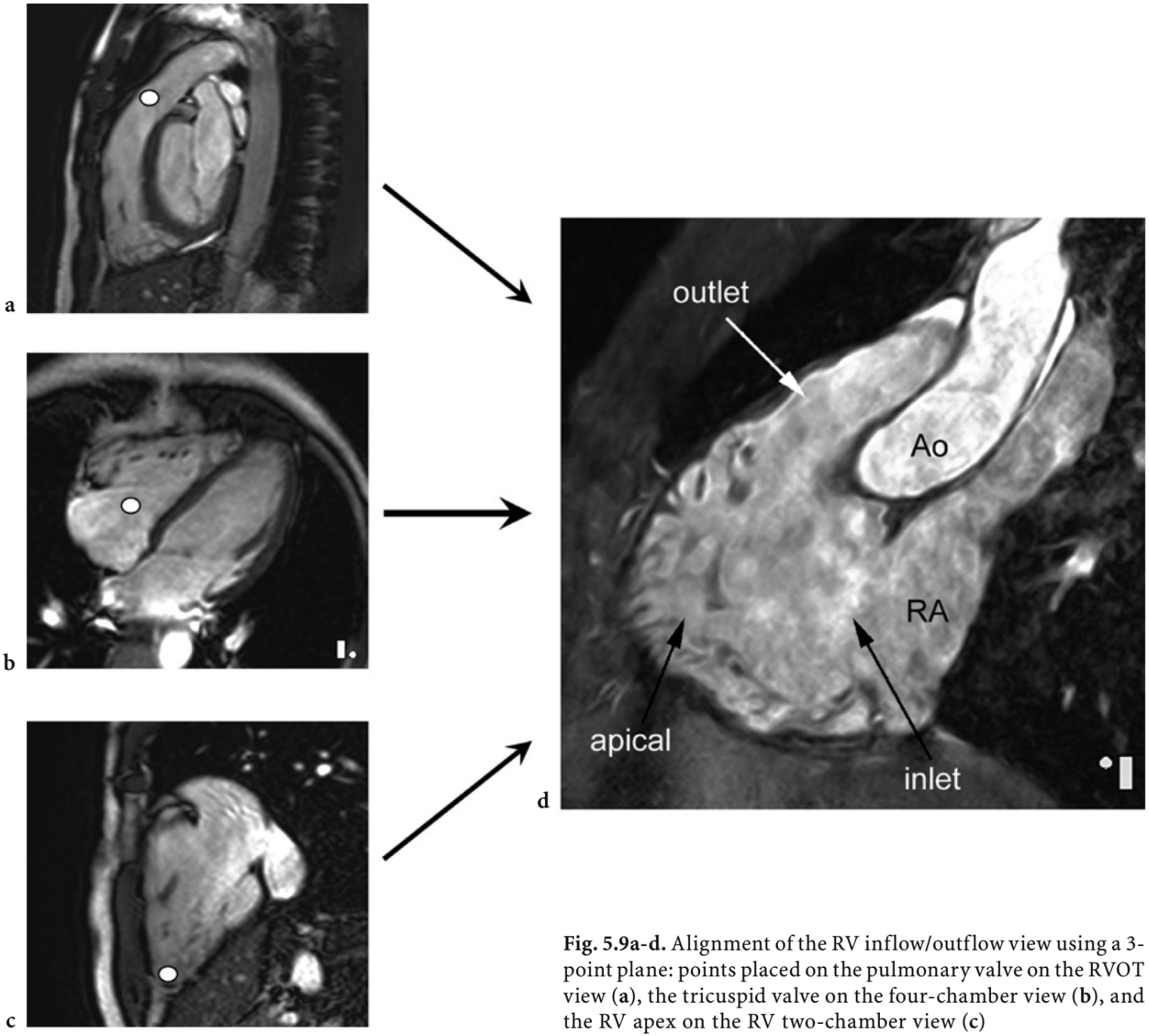


Fig. 5.9a-d. Alignment of the RV inflow/outflow view using a 3-point plane: points placed on the pulmonary valve on the RVOT view (**a**), the tricuspid valve on the four-chamber view (**b**), and the RV apex on the RV two-chamber view (**c**)

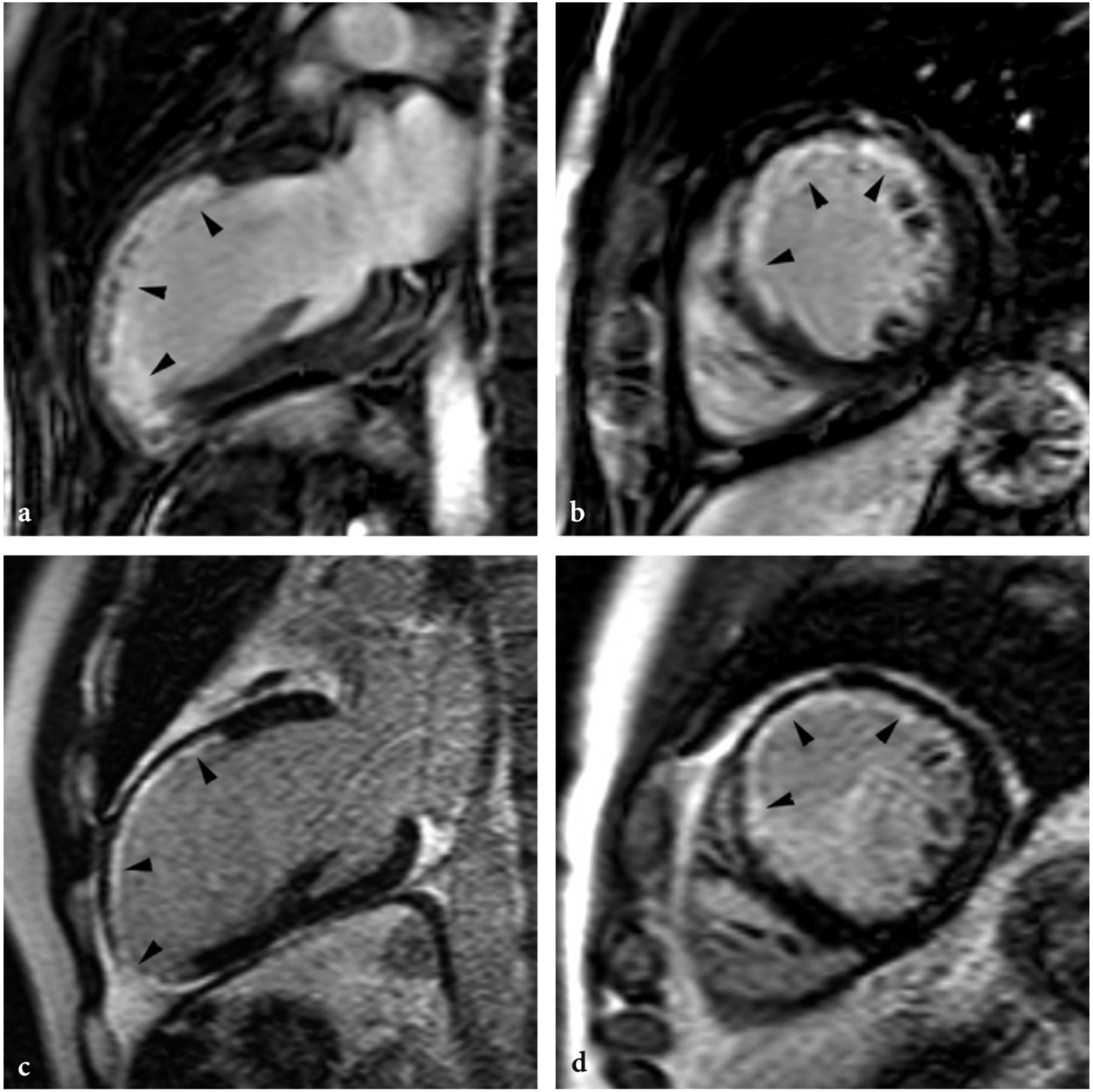
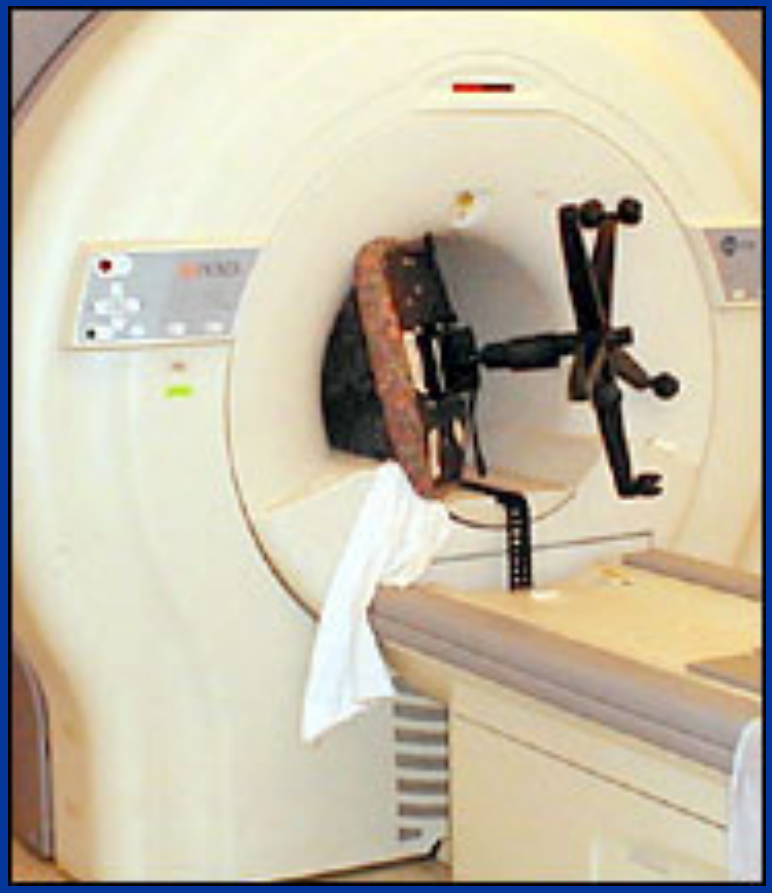


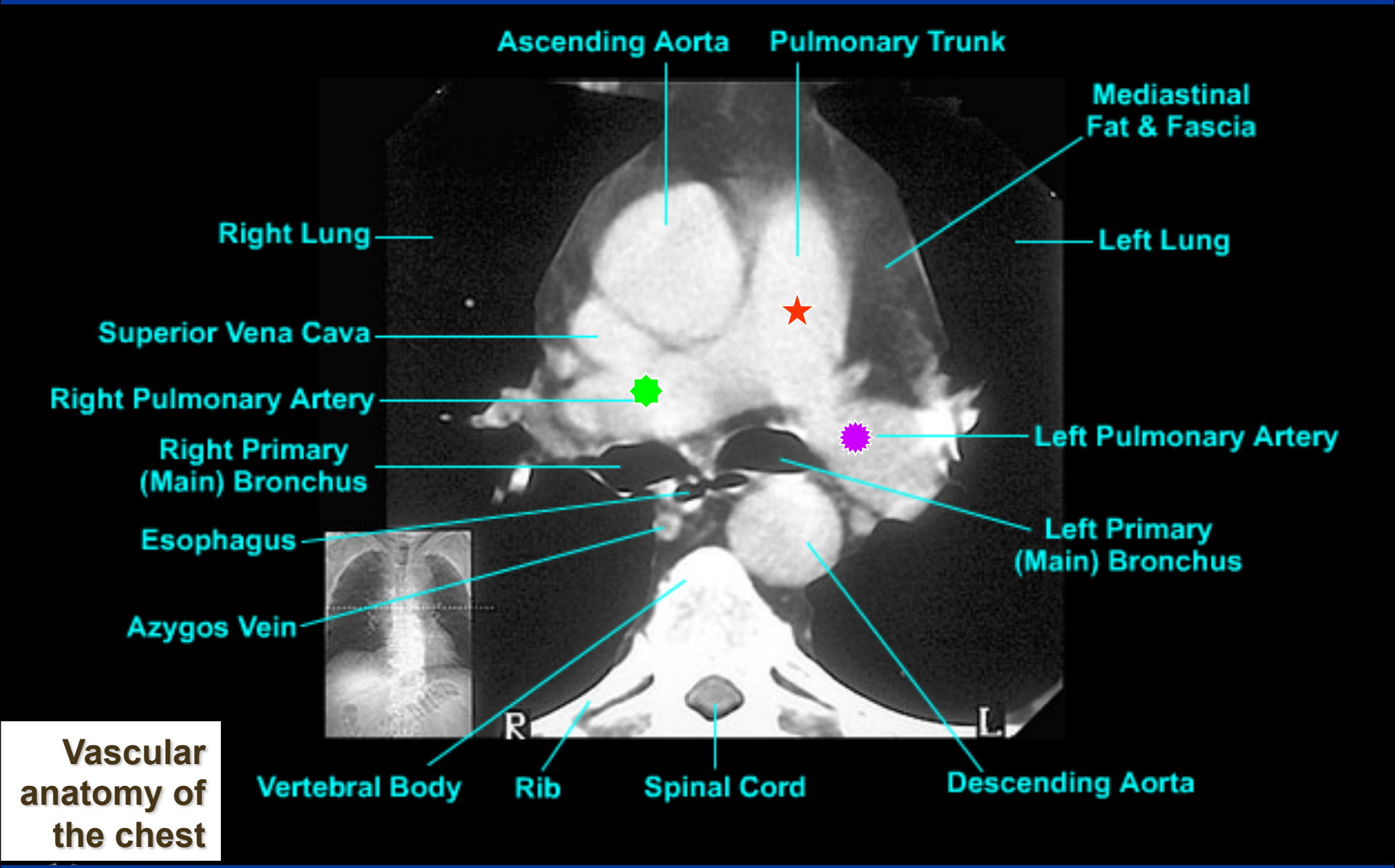
Fig. 8.16a-d Infarct shrinkage demonstrated in 54-year-old patient after LAD occlusion. *Top row*: CE-IR MRI study during the subacute phase (day 5) shows almost complete transmural enhancement in a large area located in the anteroapical wall (*arrowheads*) with several small no-reflow areas at the endocardial border. *Bottom row*: corresponding vertical long-axis (**c**) and short-axis (**d**) images taken 4 months later show significant decrease in the infarct size

Hazards of MRI

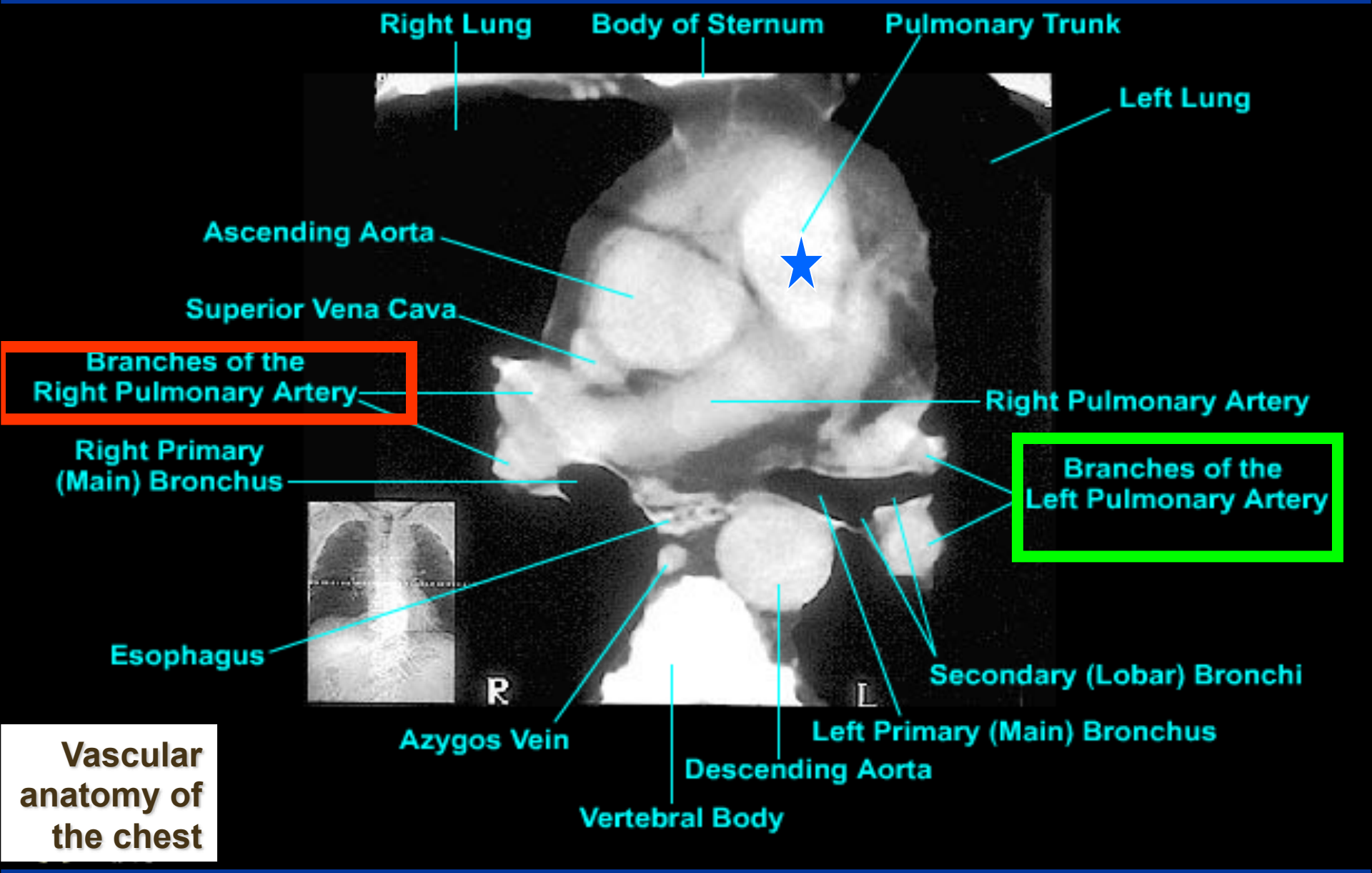
Magnet-Seeking Projectiles



Anatomy in CT angiography of the chest (pulmonary) CTA

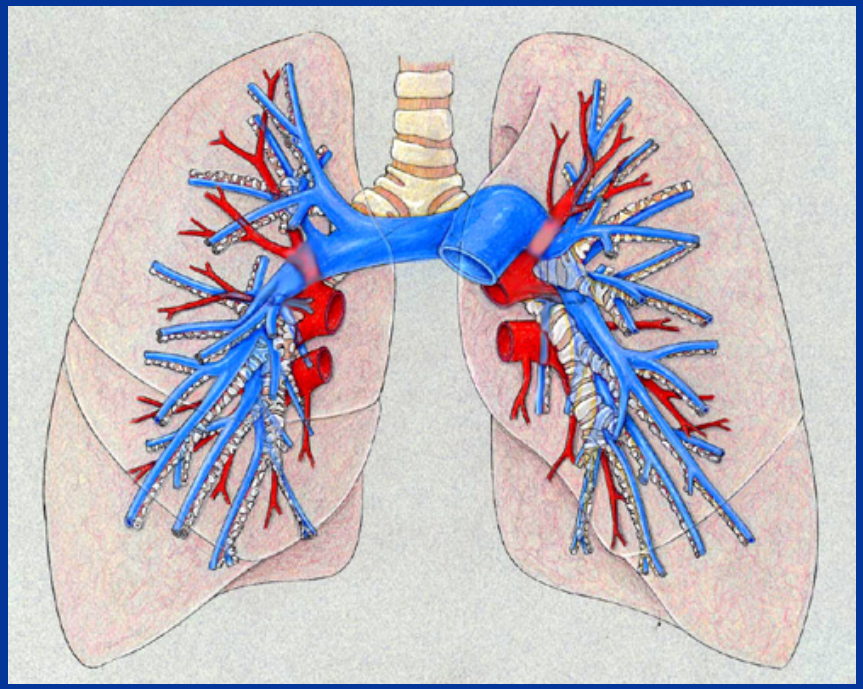


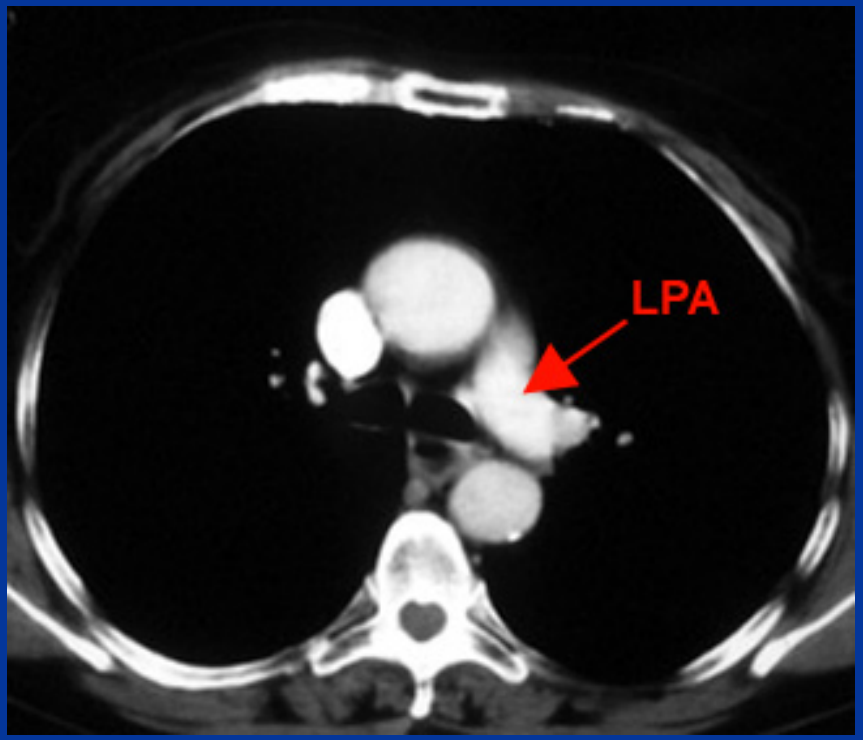
Vascular anatomy of the chest



Vascular anatomy of the chest

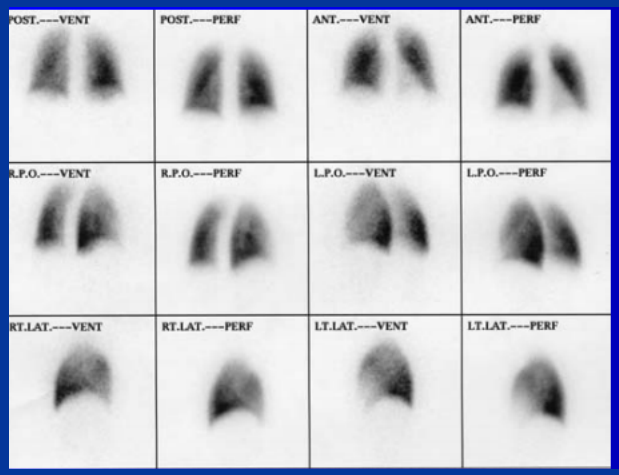
Pulmonary artery



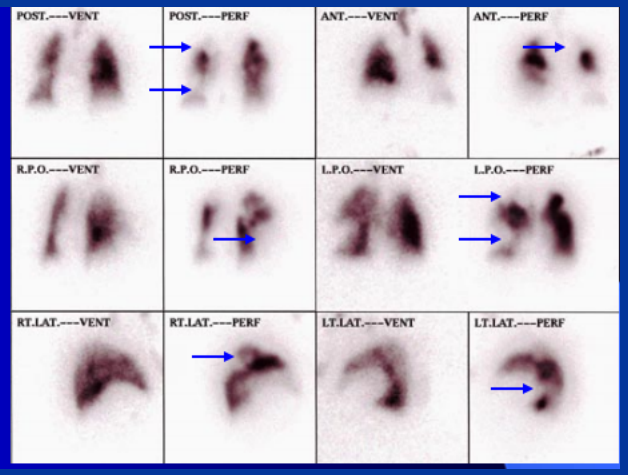


Pulmonary embolism

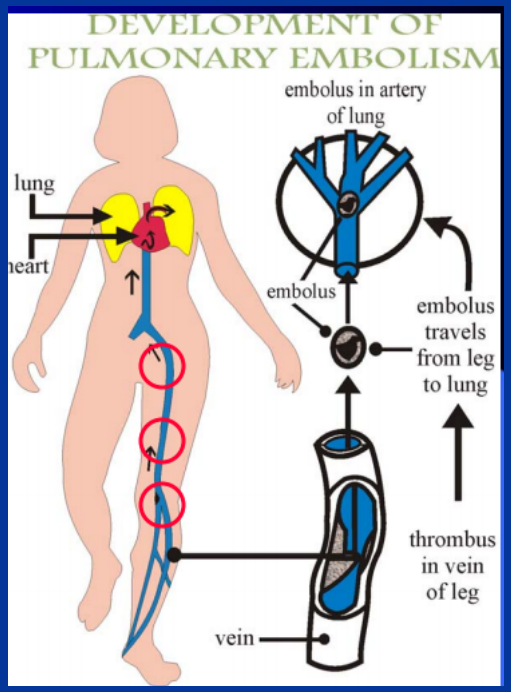
V/Q SCAN



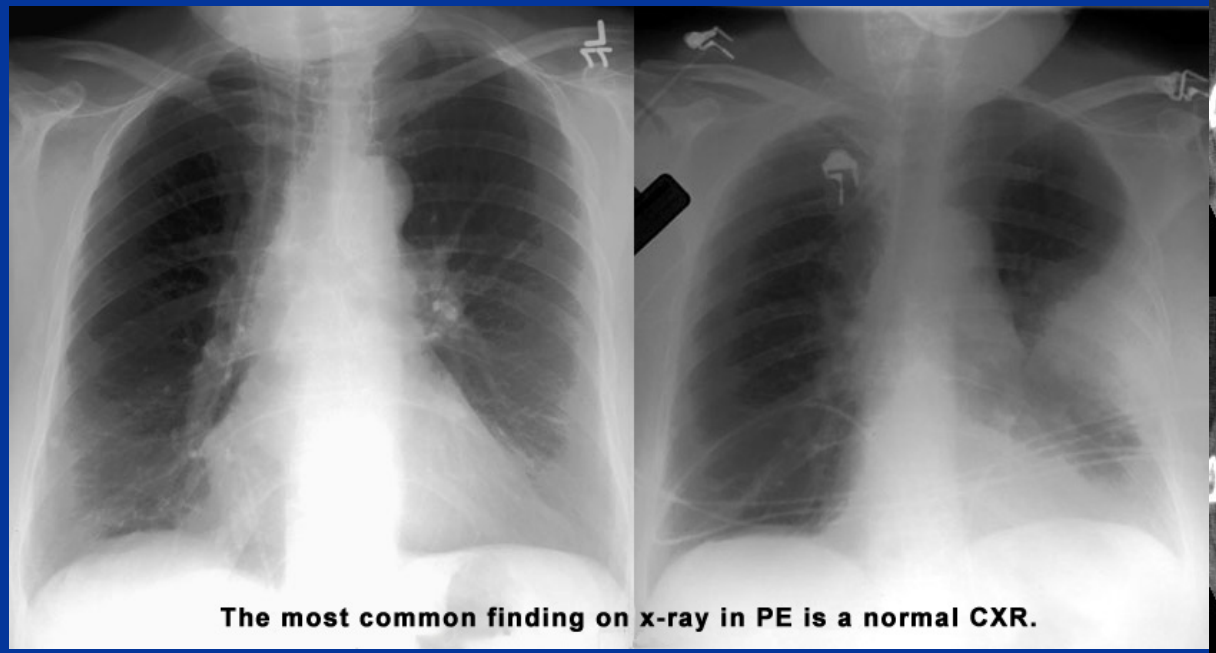
NORMAL

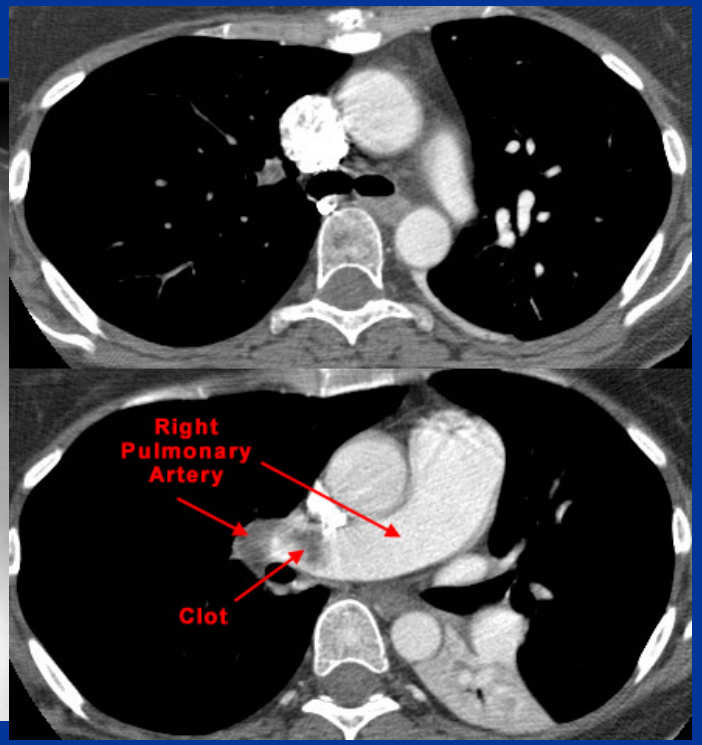


HIGH PROBABILITY OF PE

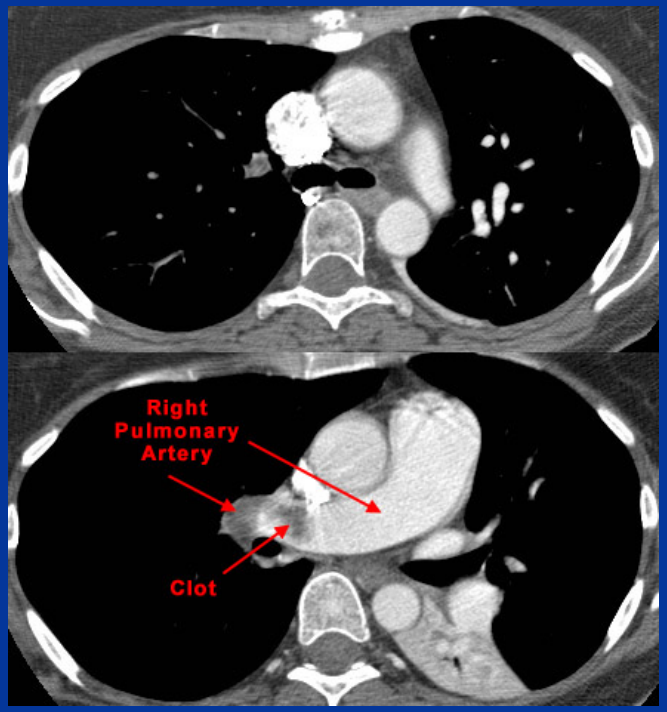


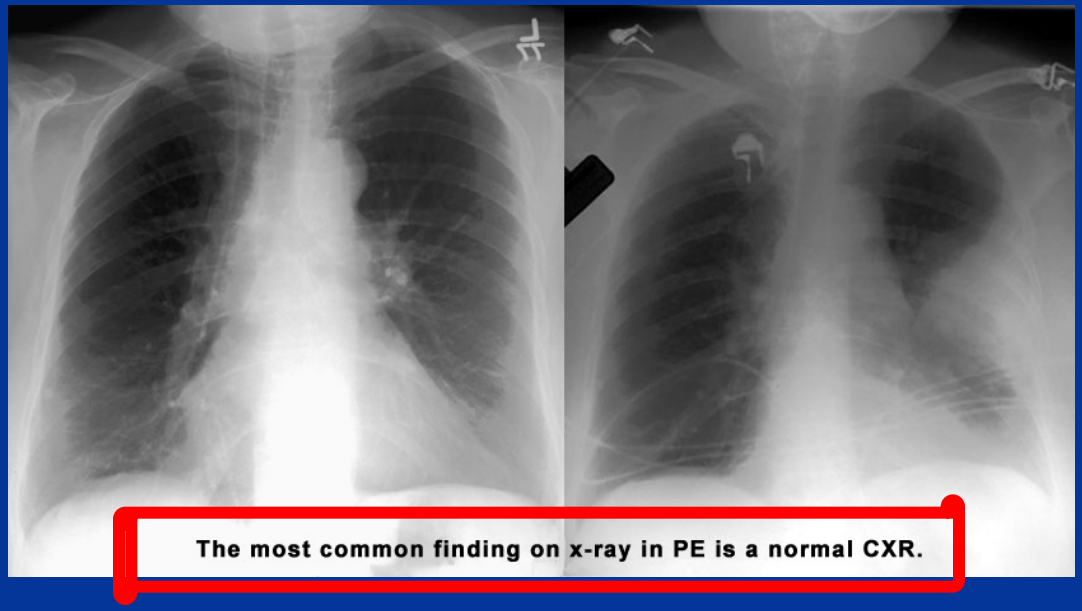
Pulmonary embolism





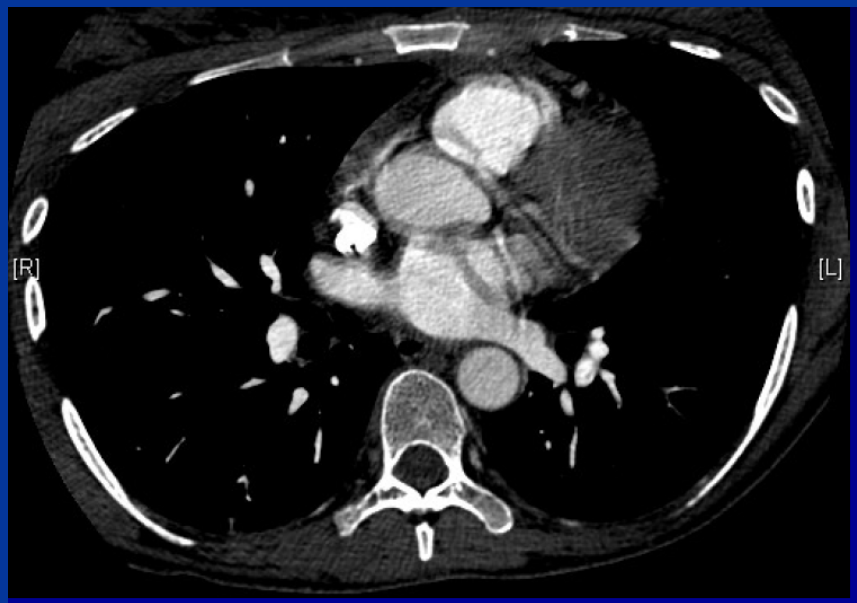
Pulmonary embolism





You have many imaging choices to diagnose PE in proper clinical scenario

THE GOLD STANDARD FOR DIAGNOSIS OF PE IS CTA


[R]
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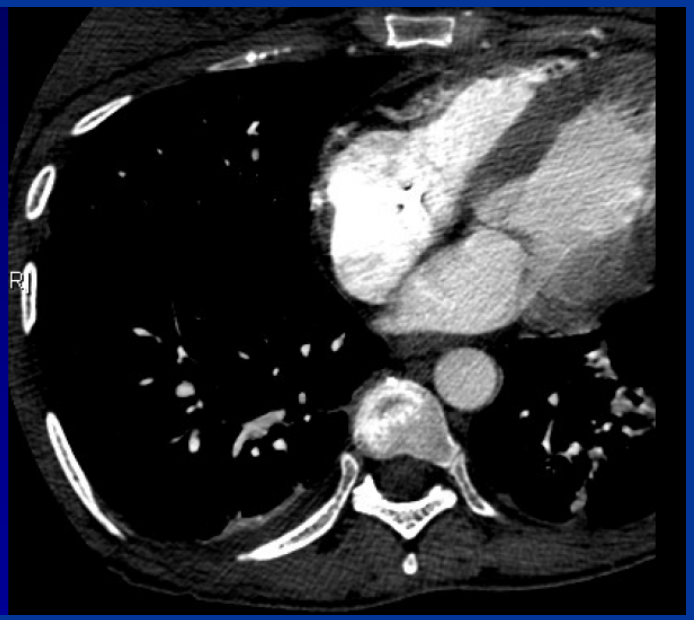
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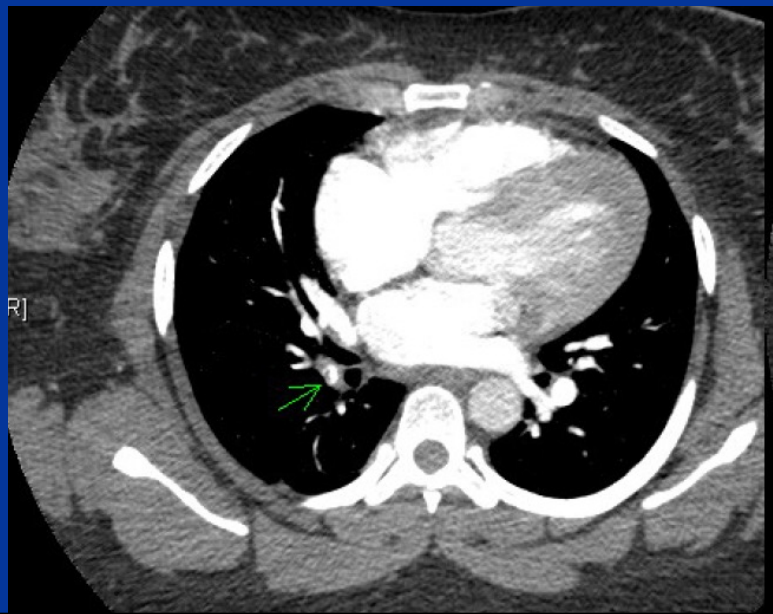
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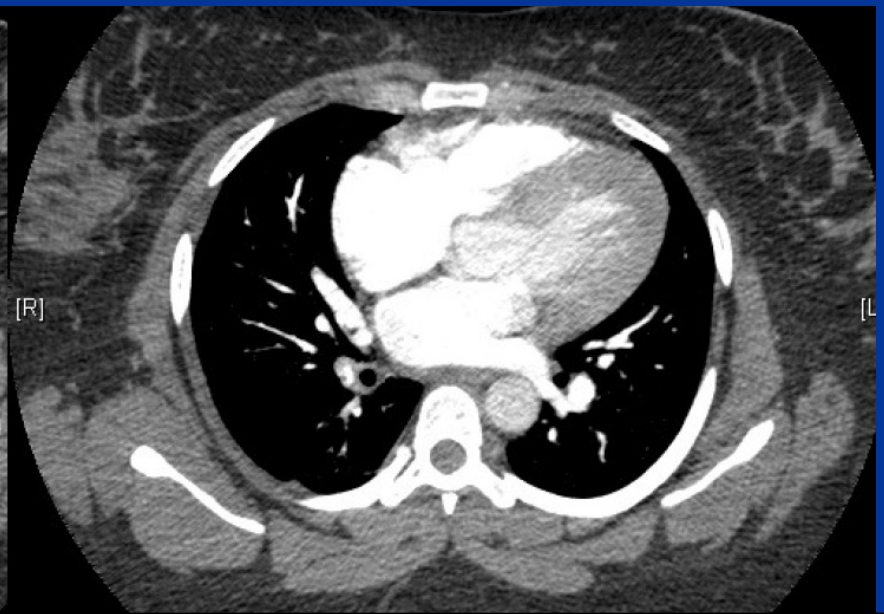
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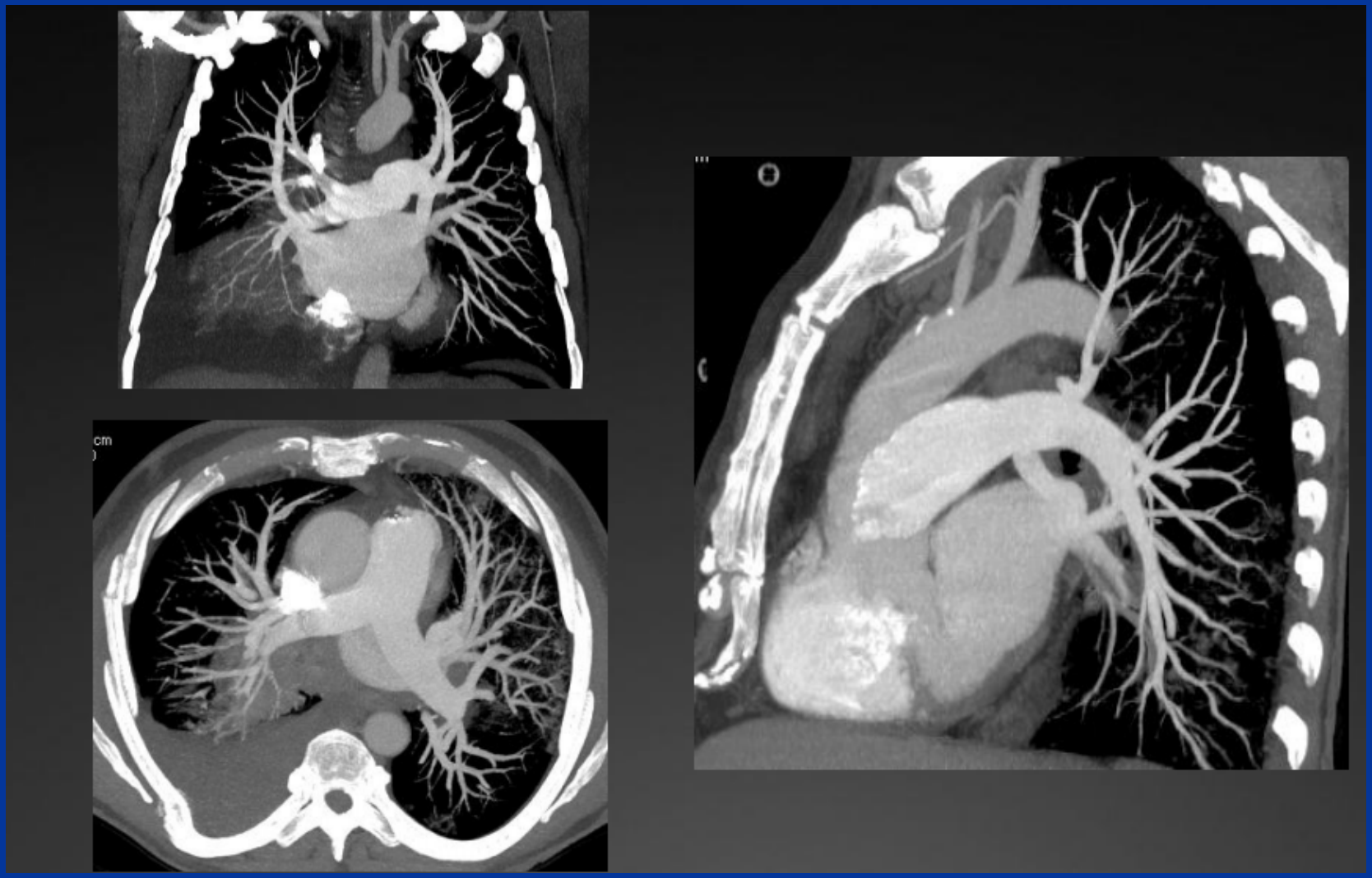
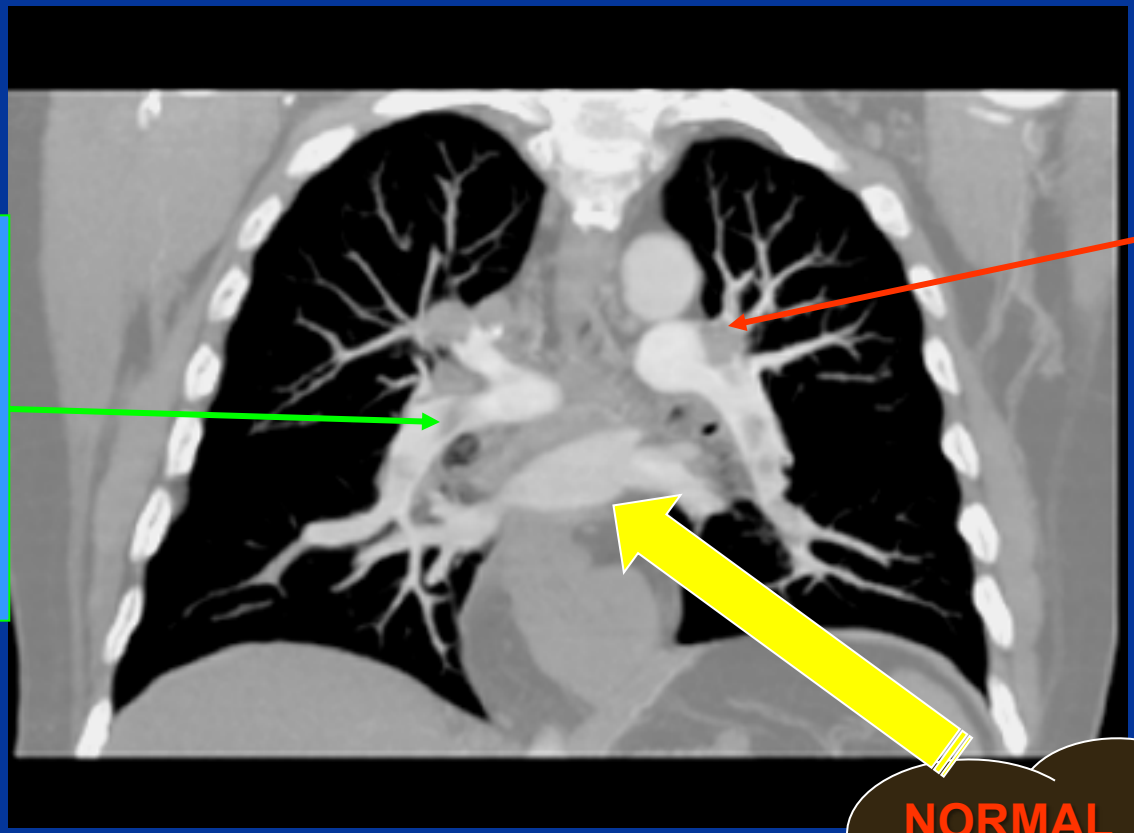
CTA PULMONARY VASCULATURE



CTA
(Coronal Reconstruction)

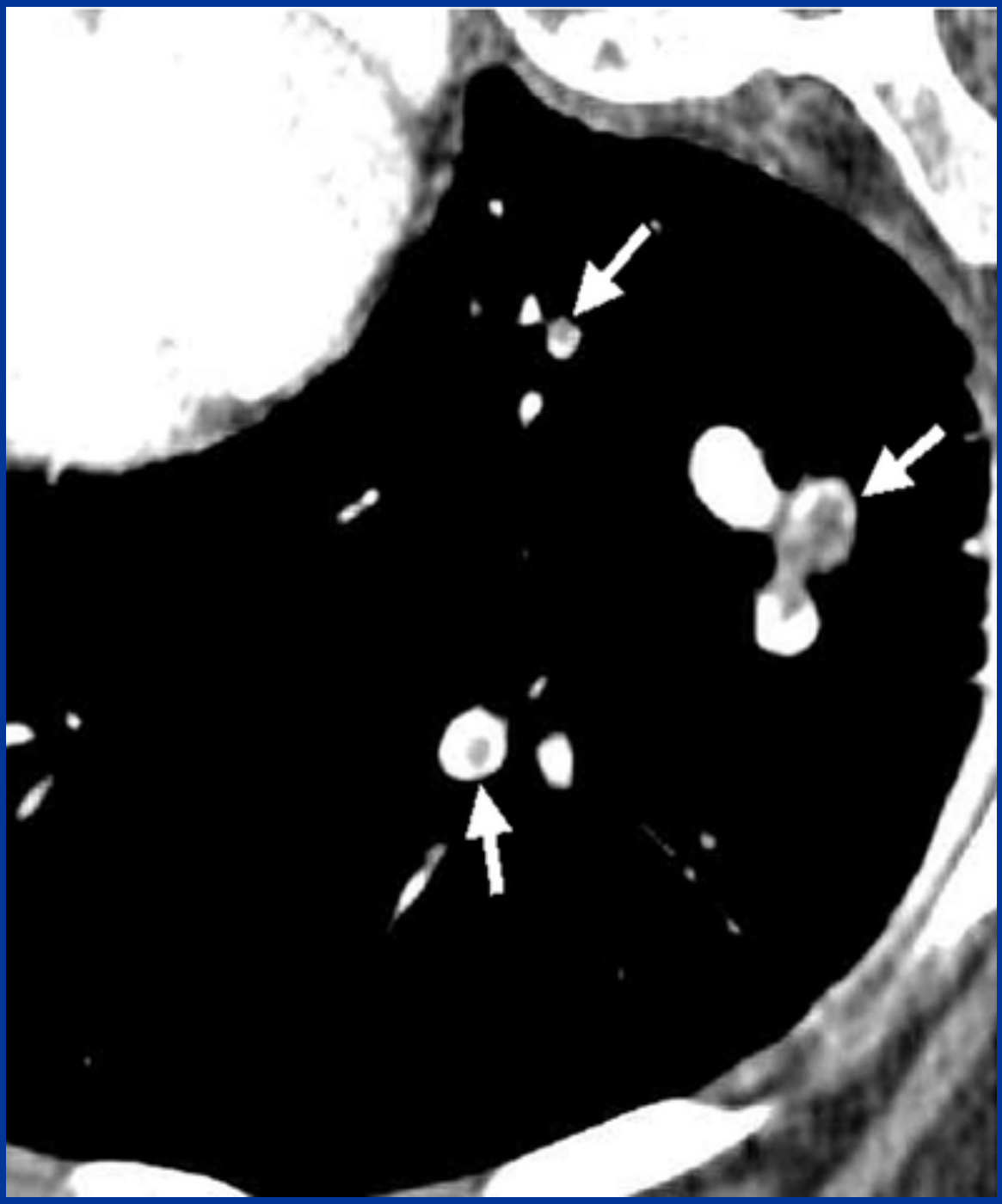


Embolus in descending right pulmonary artery

Embolus in left main pulmonary artery

NORMAL HOMOGENOUS FILLING OF THE VESSLES

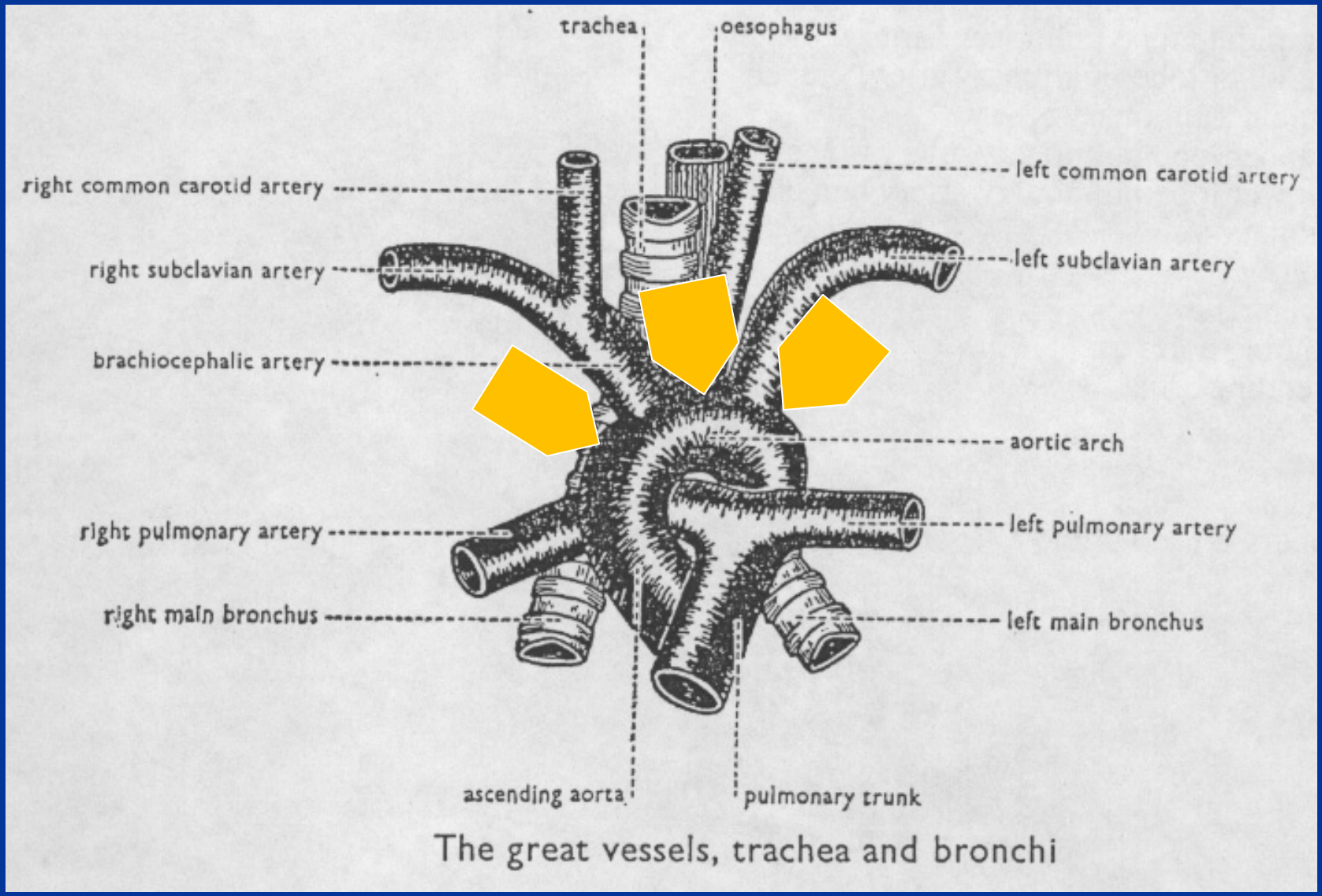
CT Agiogram



AORTIC ARCH ANATOMY

KKUH

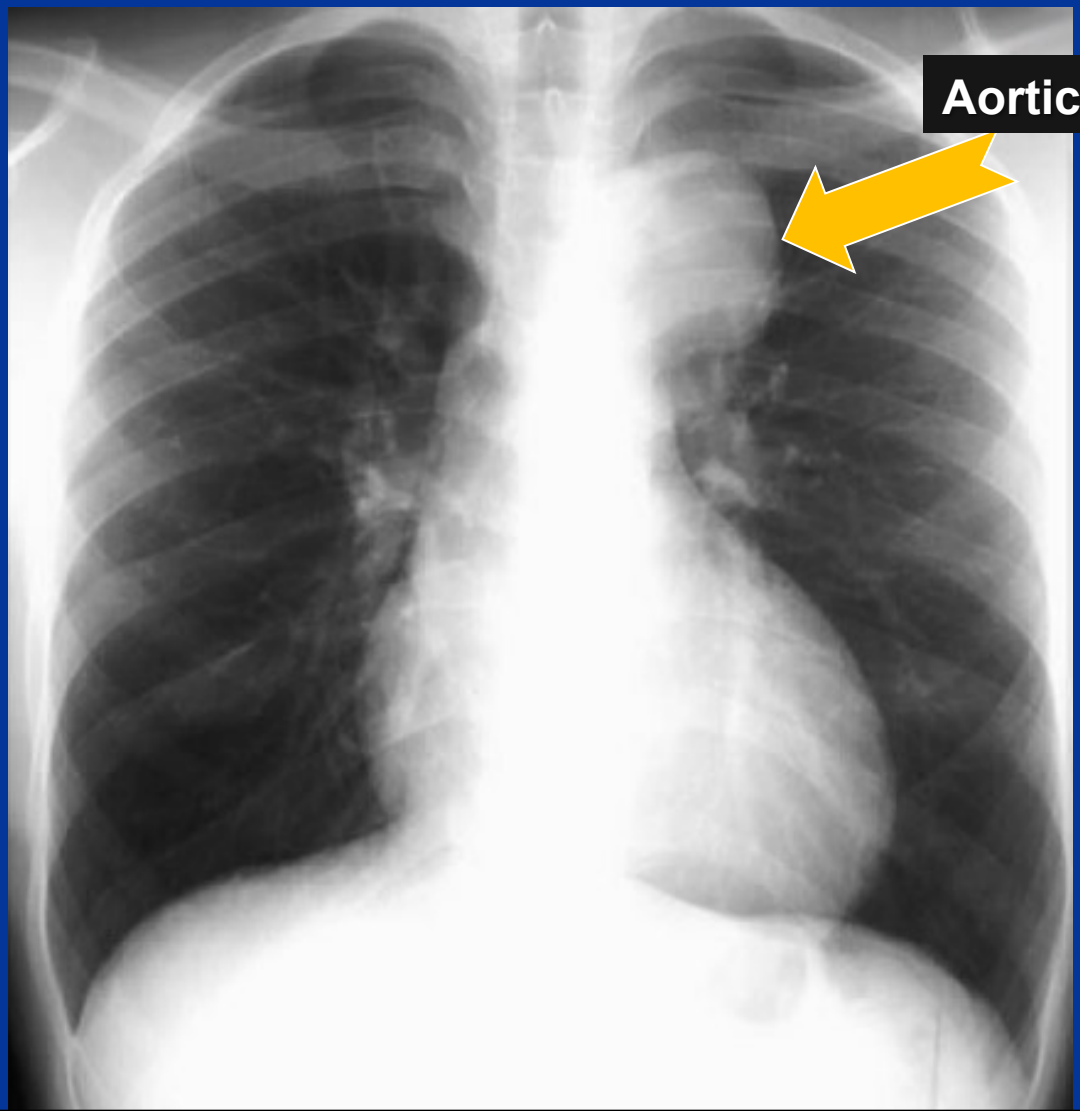
The Aortic arch/great vessels



The great vessels, trachea and bronchi

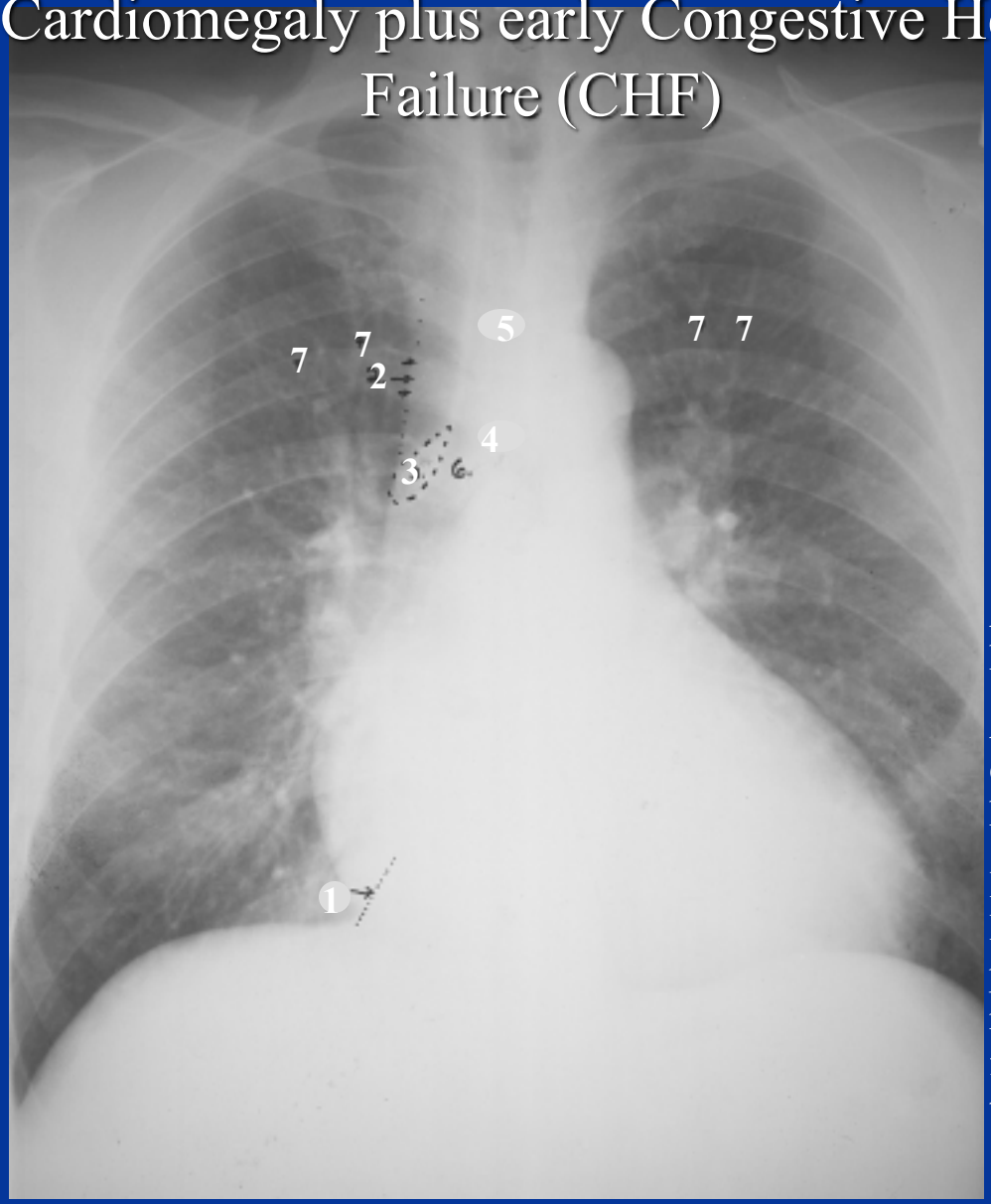
"Man's Anatomy by Tobias & Arnold

Aortic aneurysm



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

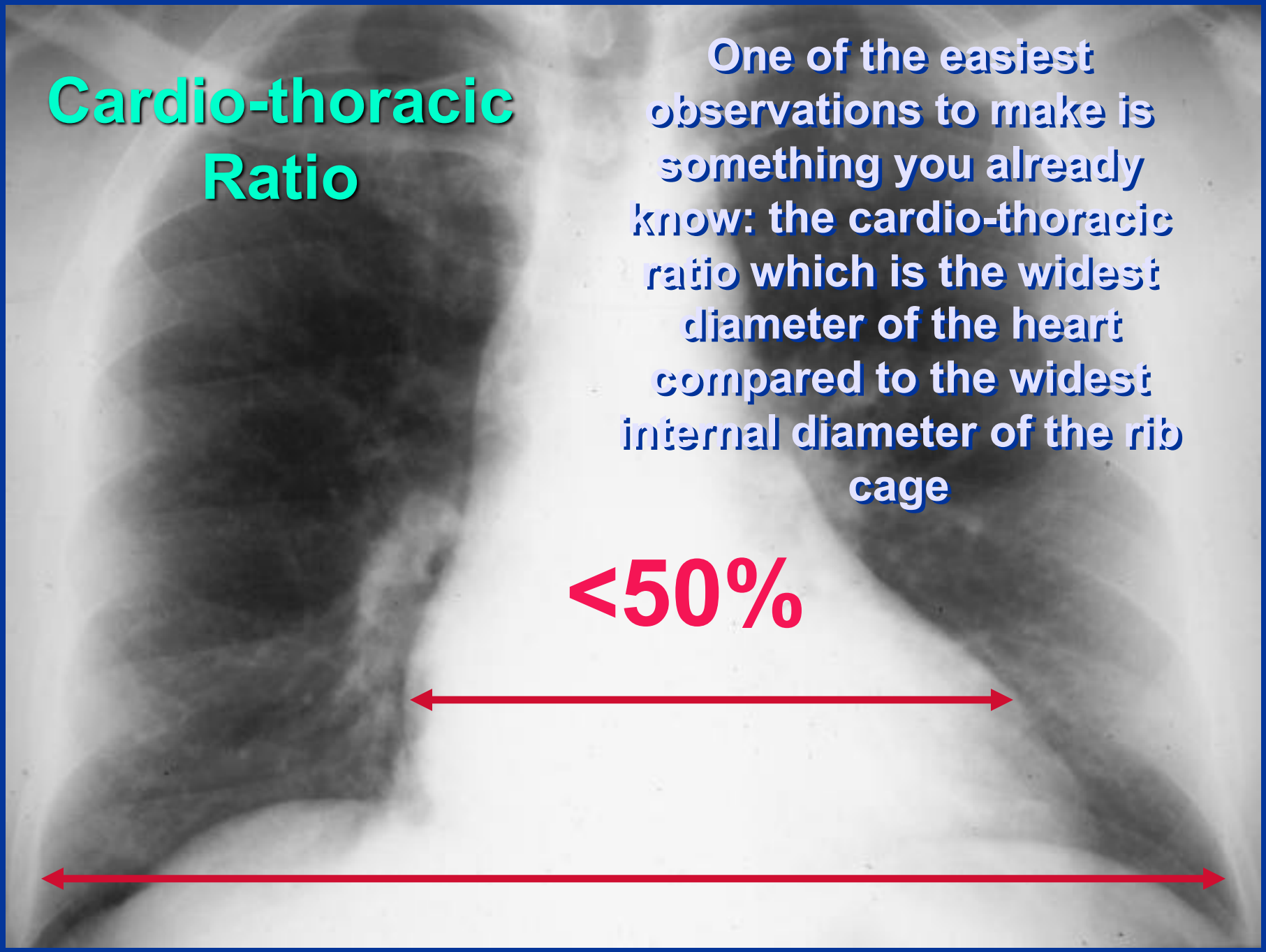
Any and or all heart chambers may enlarge when the heart becomes diseased. Cardiomegaly = a big heart.

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.

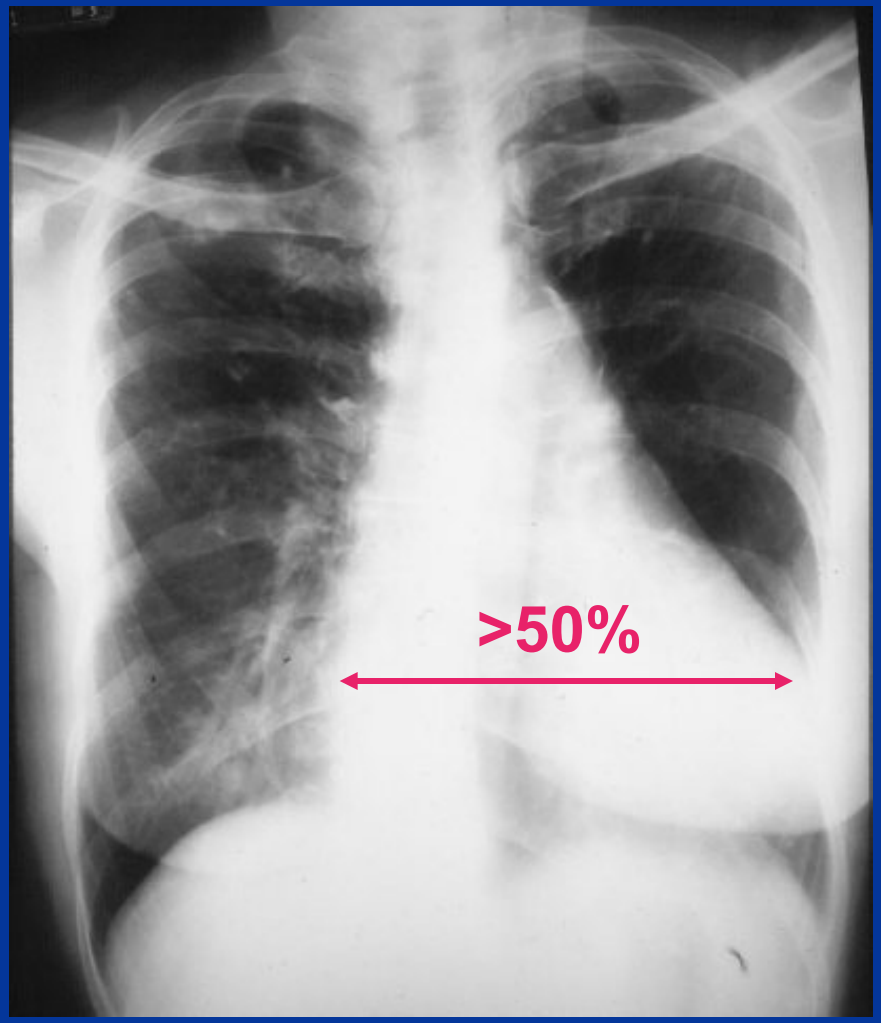
Cardio-thoracic Ratio

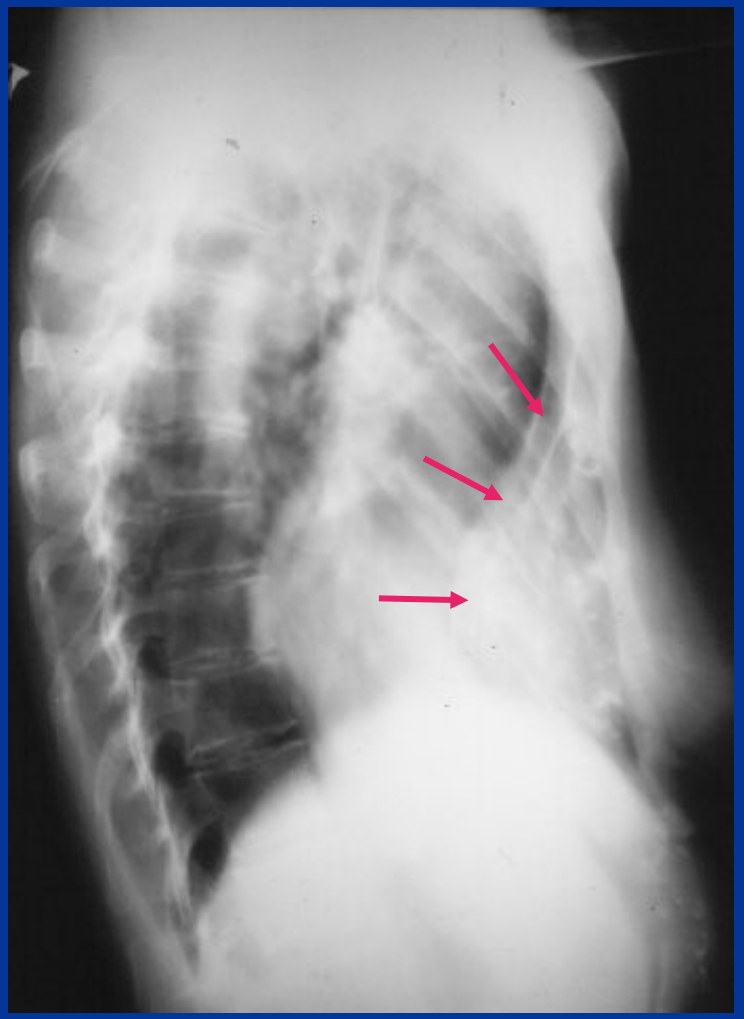
One of the easiest observations to make is something you already know: the cardio-thoracic ratio which is the widest diameter of the heart compared to the widest internal diameter of the rib cage



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

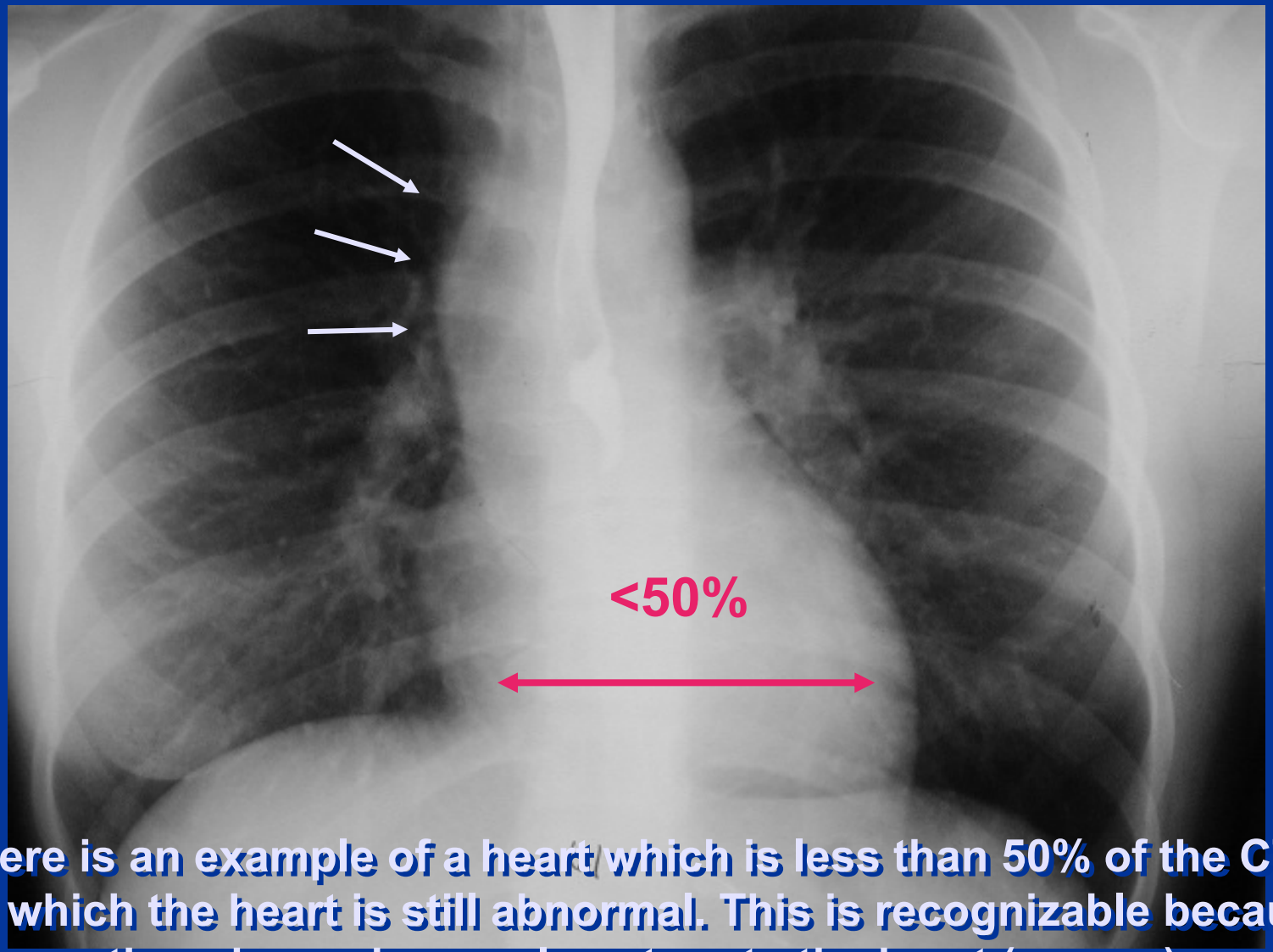




Here is a heart that is larger than 50% of the cardiothoracic ratio, but it is still a normal heart. This is because there is an extracardiac cause for the apparent cardiomegaly. On the lateral film, the arrows point to the inward displacement of the lower sternum in a pectus excavatum deformity.

Sometimes, CTR is less than 50%
But Heart is Abnormal

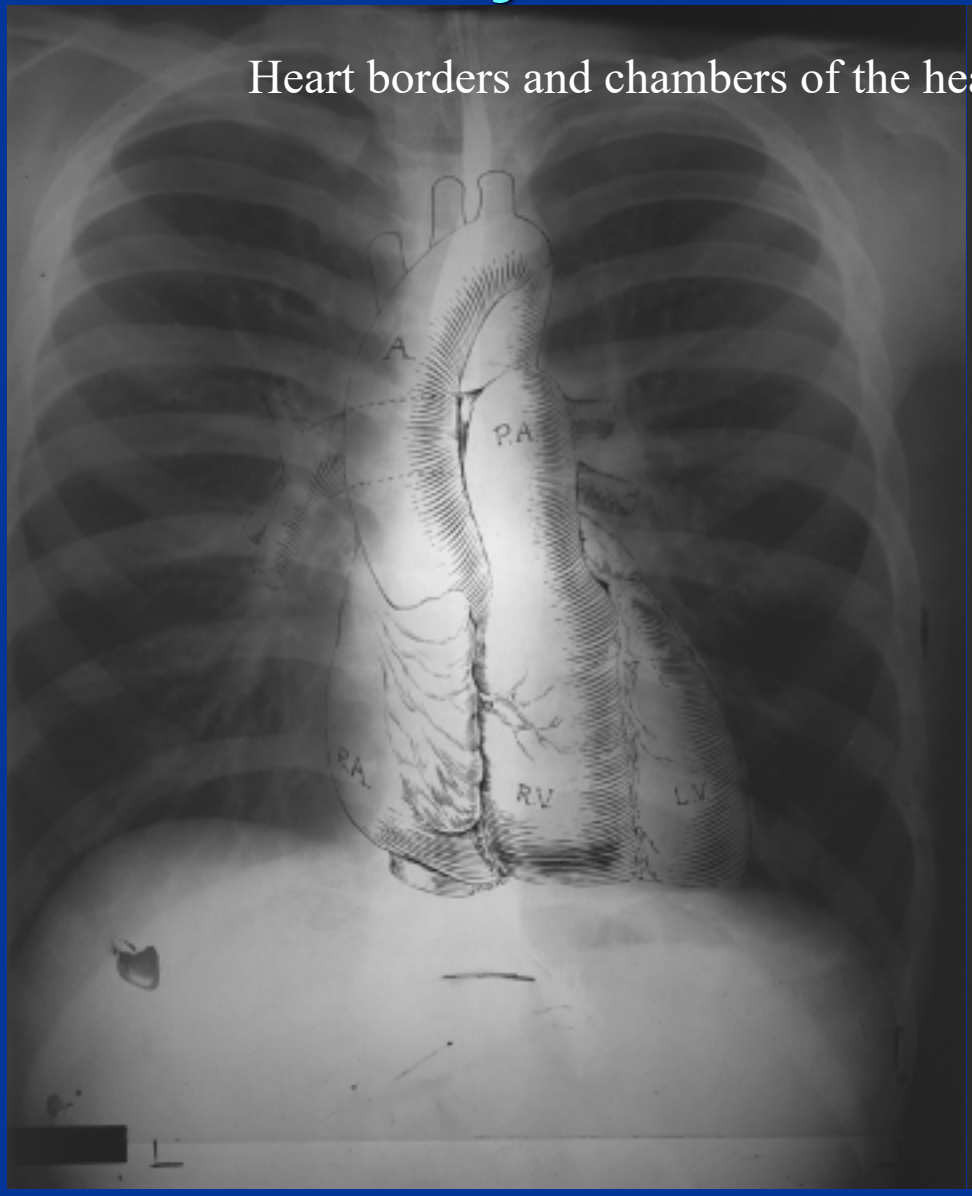
- Obstruction to outflow of the ventricles
  - Ventricular hypertrophy
- Must look at cardiac contours



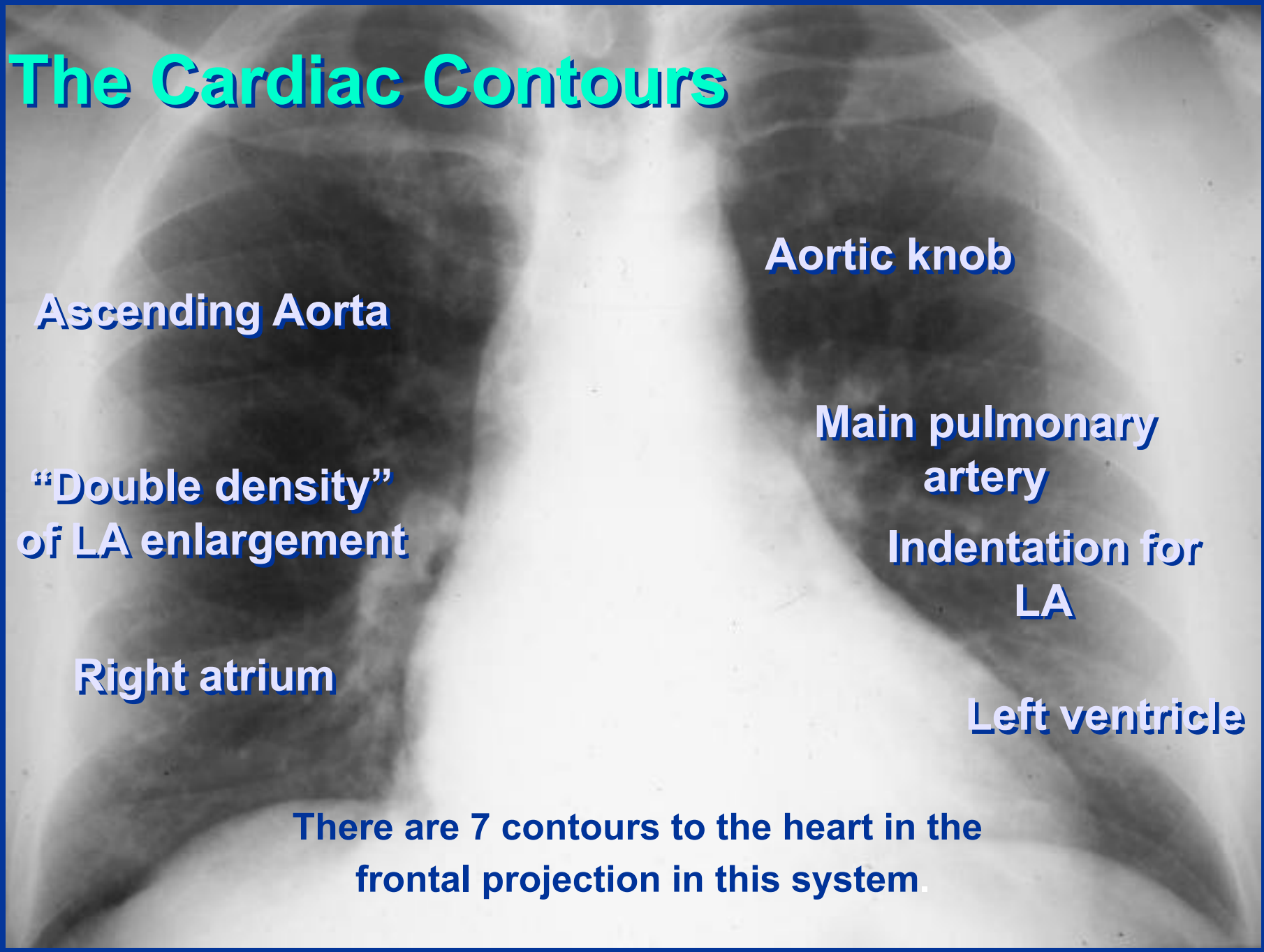
Here is an example of a heart which is less than 50% of the CTR in which the heart is still abnormal. This is recognizable because there is an abnormal contour to the heart (arrows).

Anatomy on Normal Chest X-Ray

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

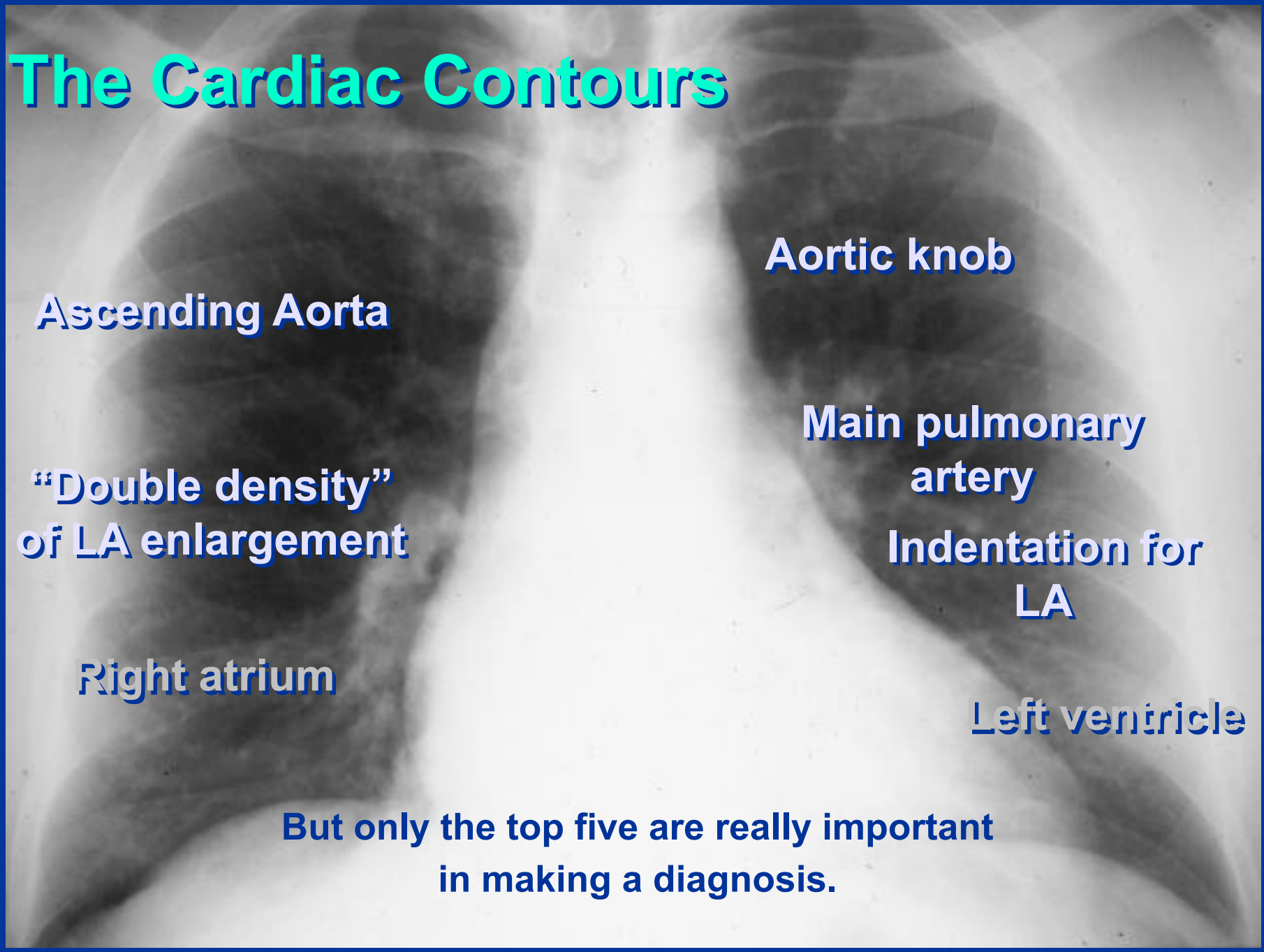


The Cardiac Contours



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

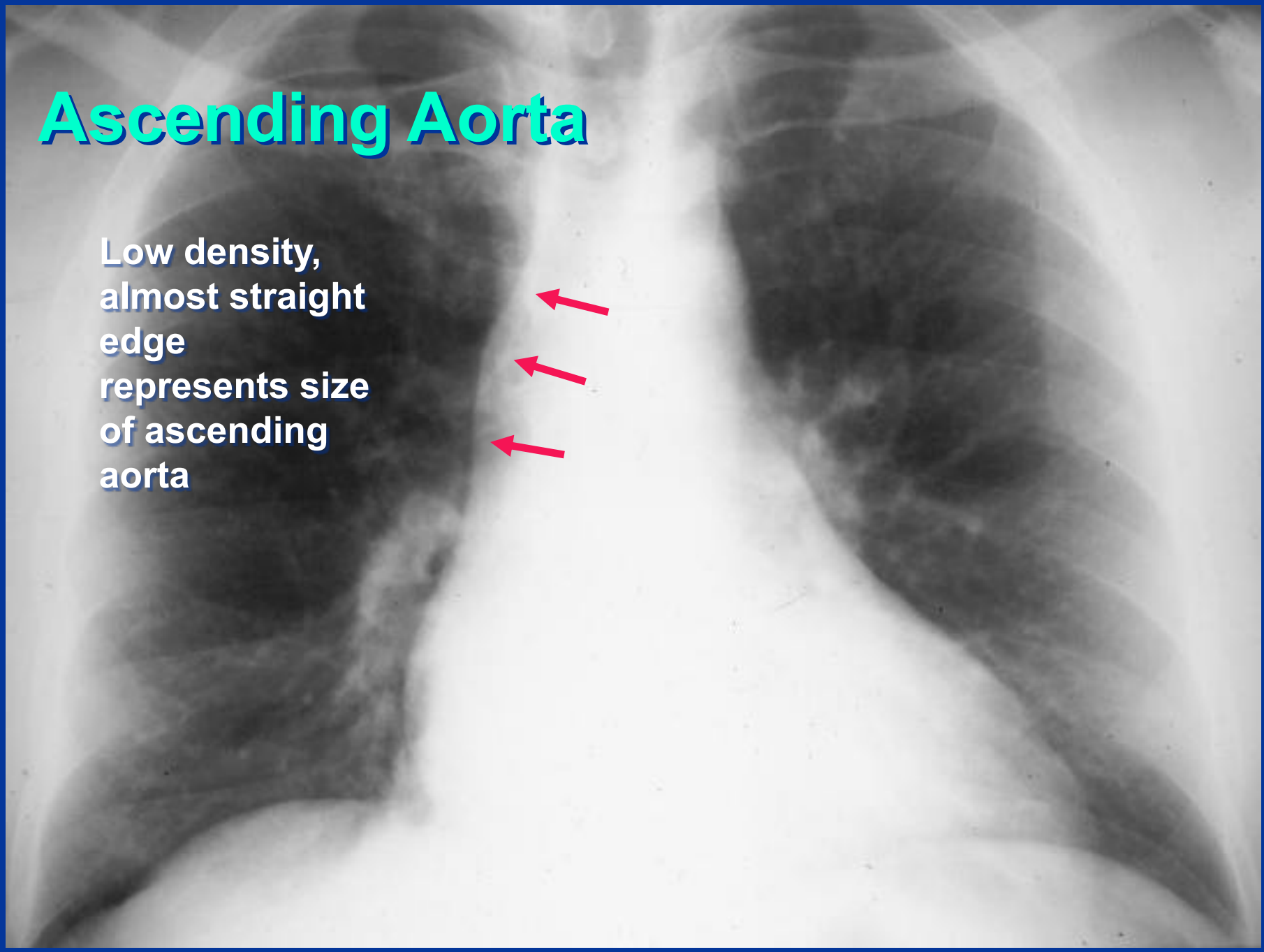
The Cardiac Contours



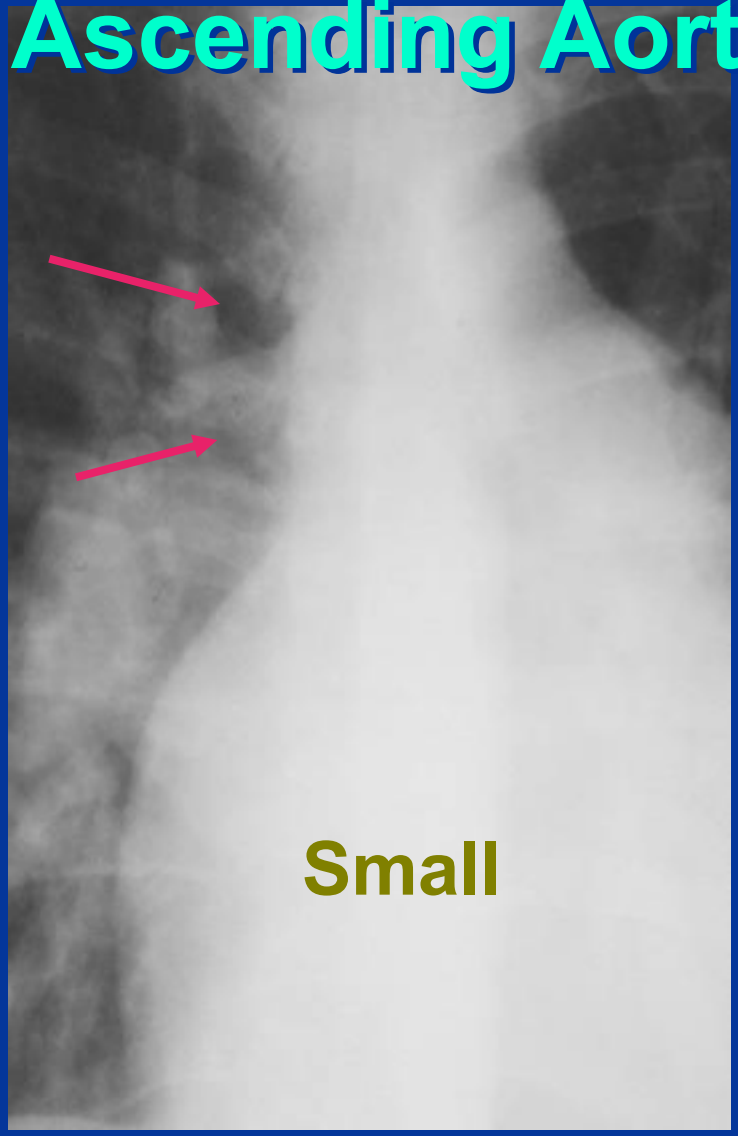
But only the top five are really important in making a diagnosis.

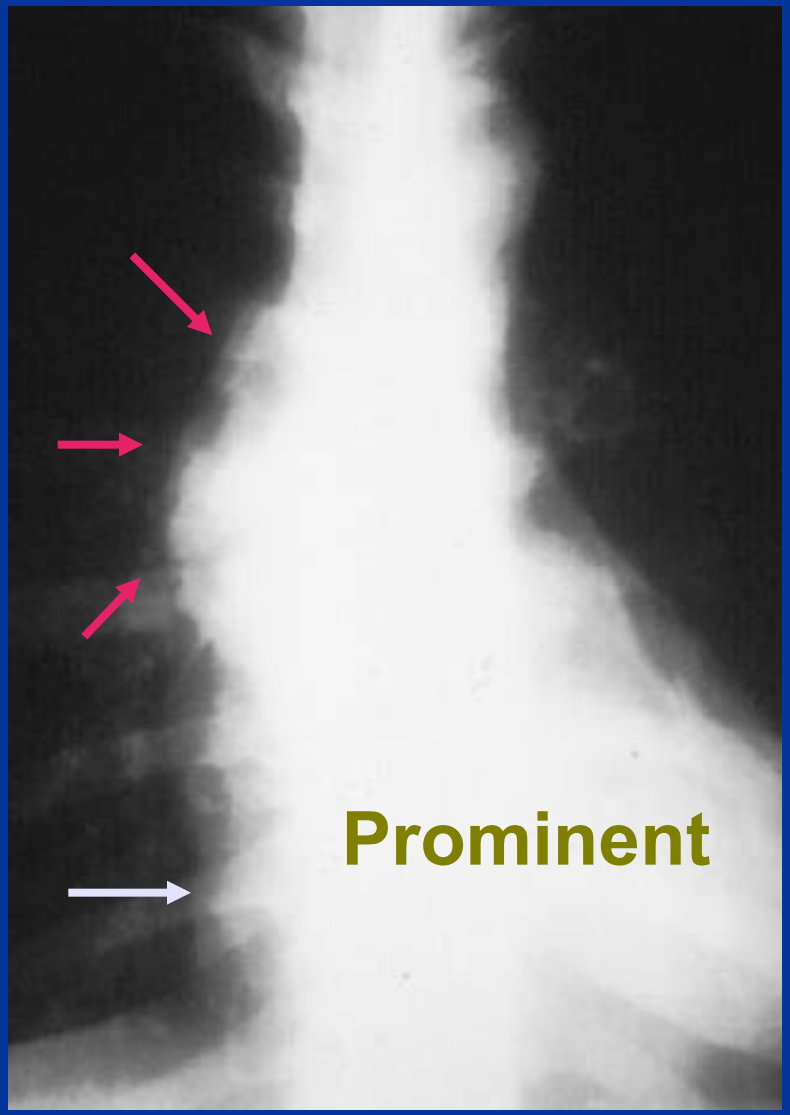
Ascending Aorta

Low density, almost straight edge represents size of ascending aorta



Ascending Aorta

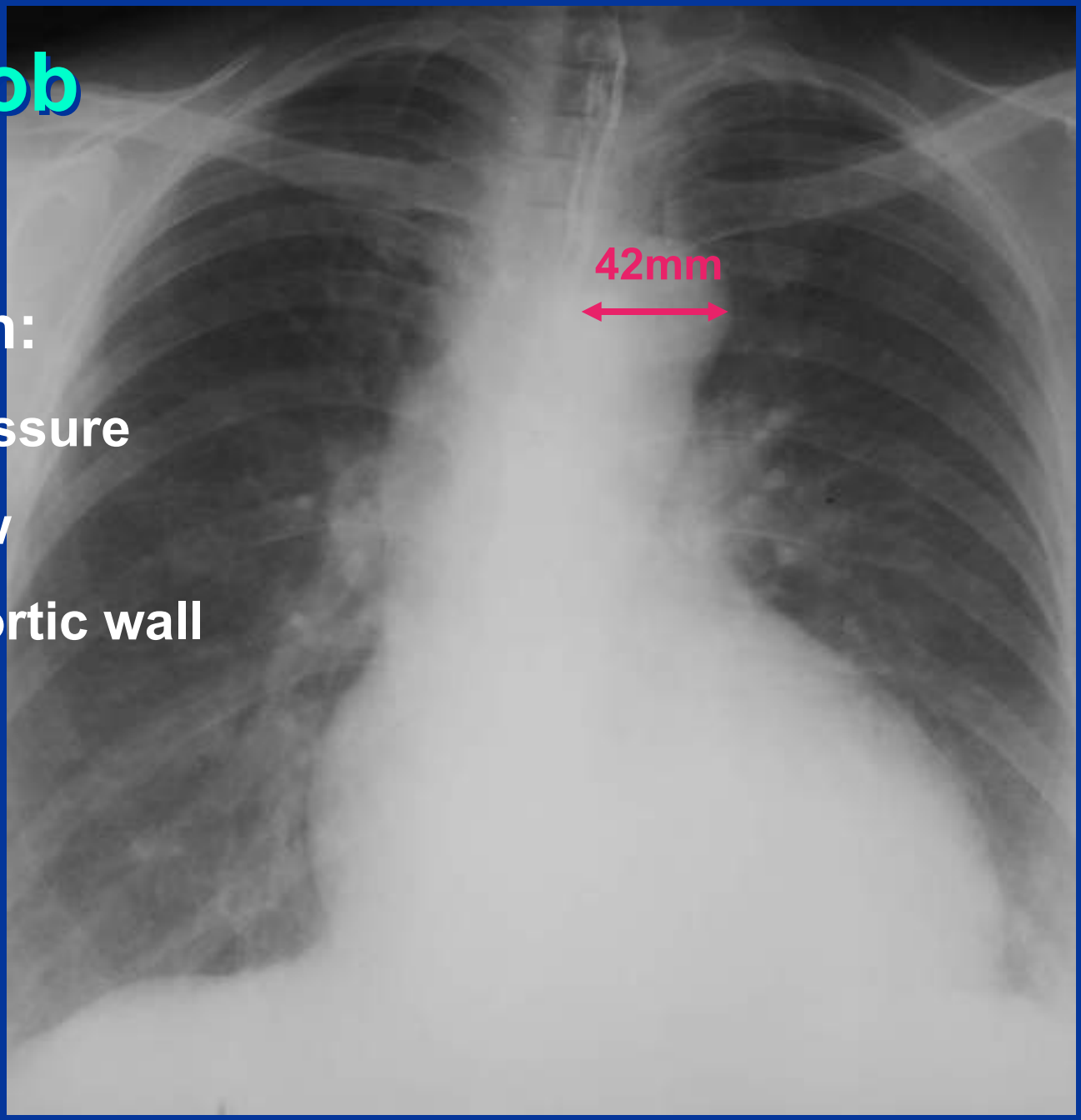


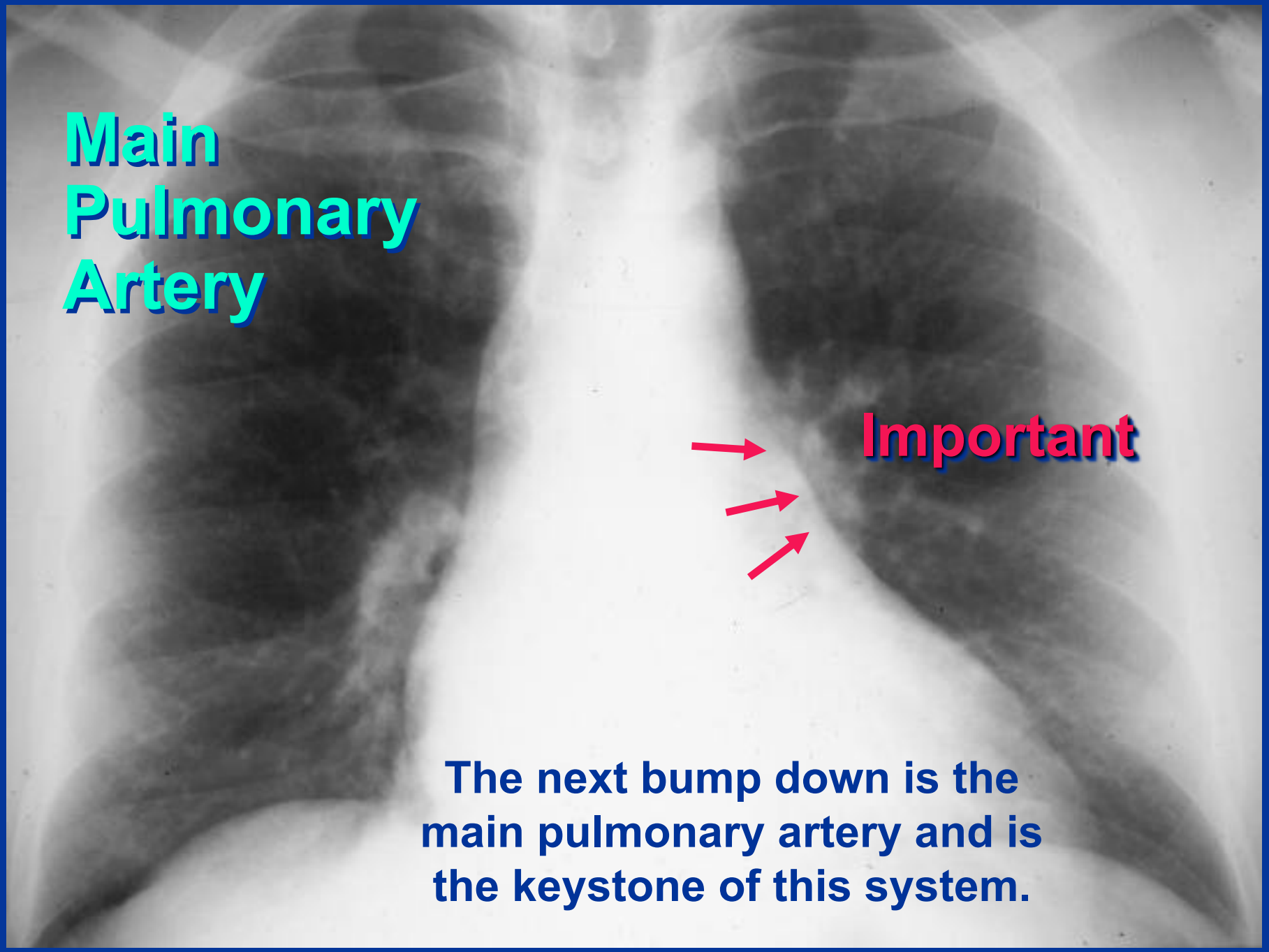


Aortic Knob

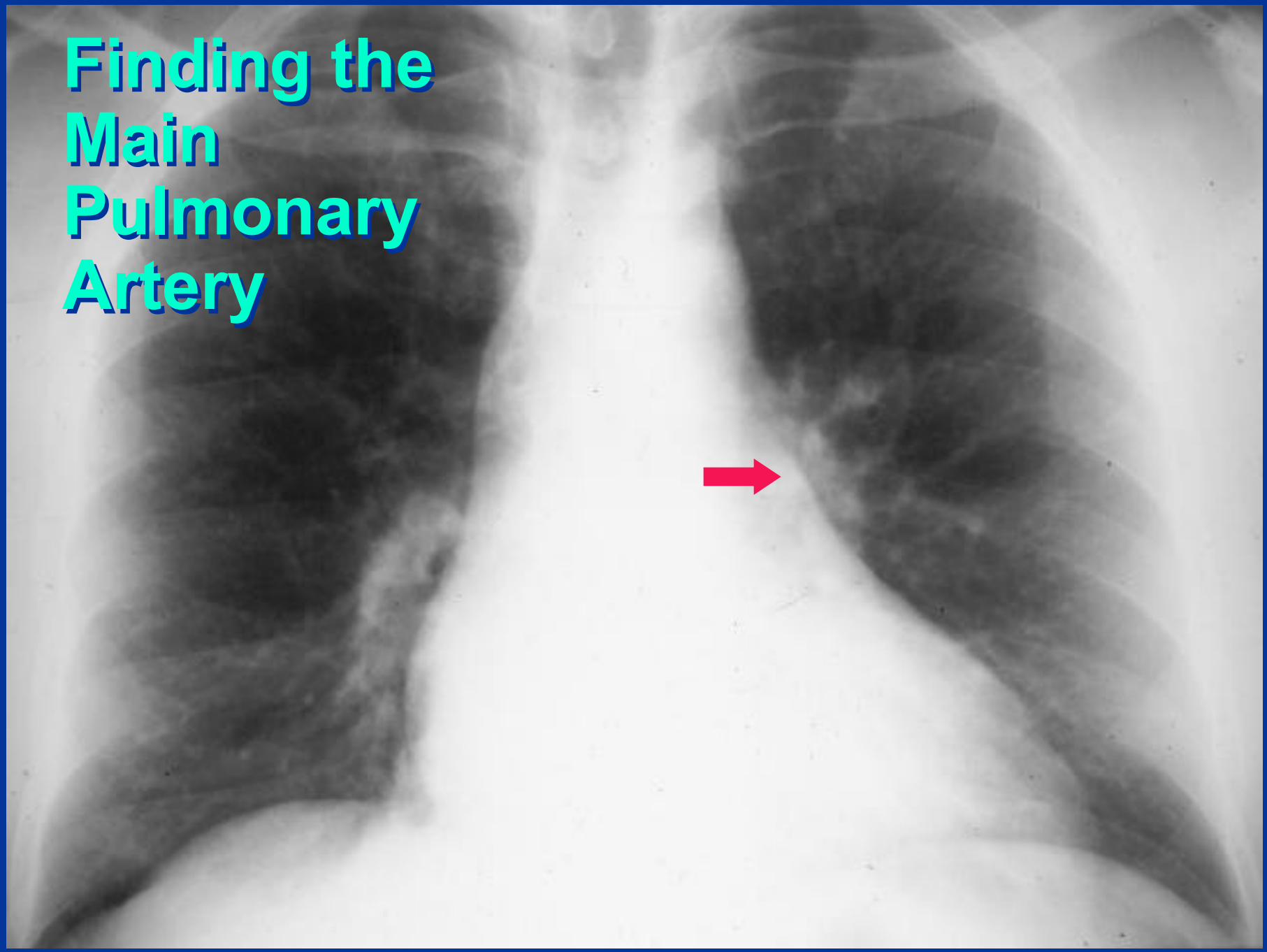
Enlarged with:

- **Increased pressure**
- **Increased flow**
- **Changes in aortic wall**

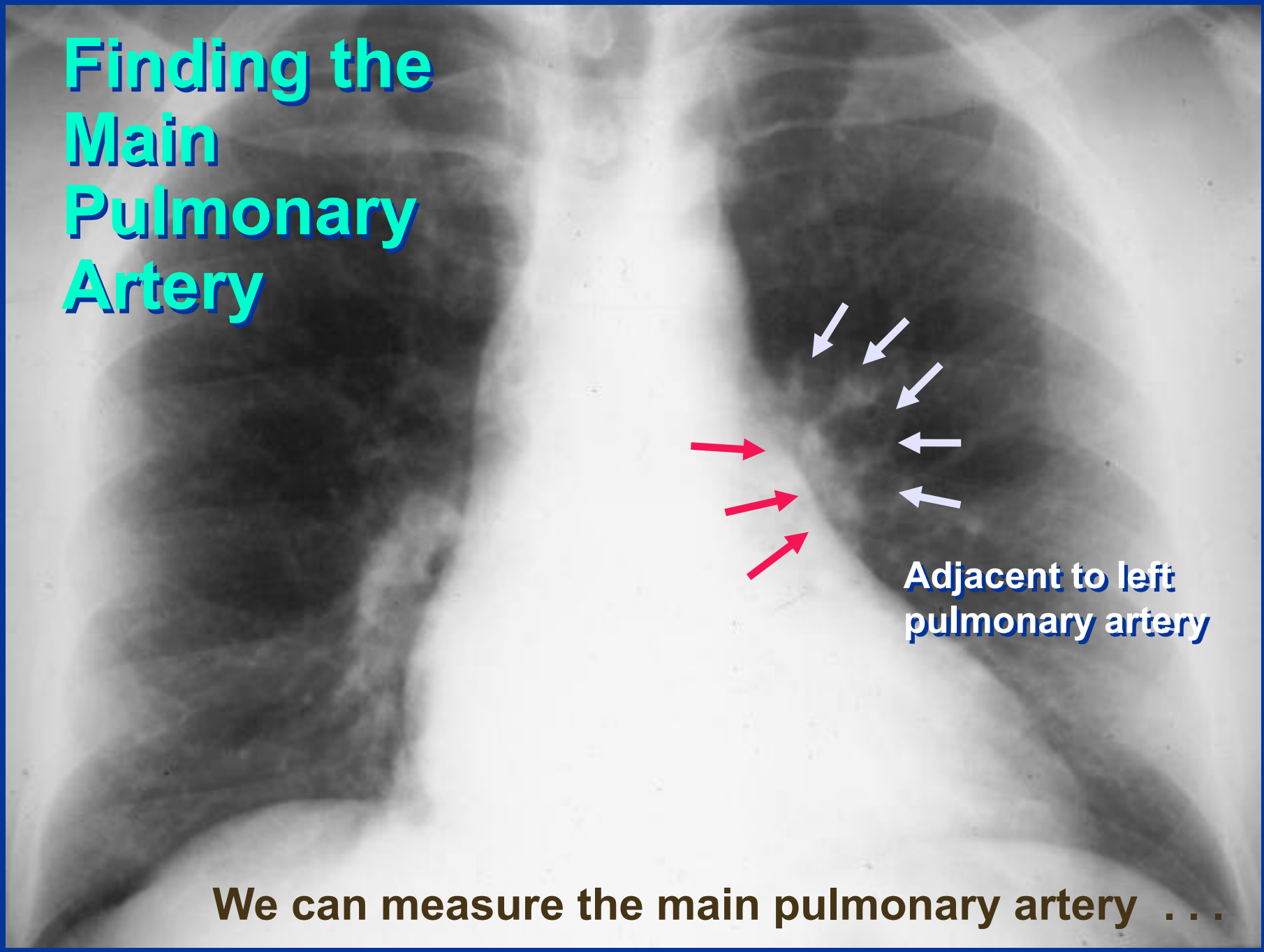



Main Pulmonary Artery
Important
The next bump down is the main pulmonary artery and is the keystone of this system.

Finding the Main Pulmonary Artery

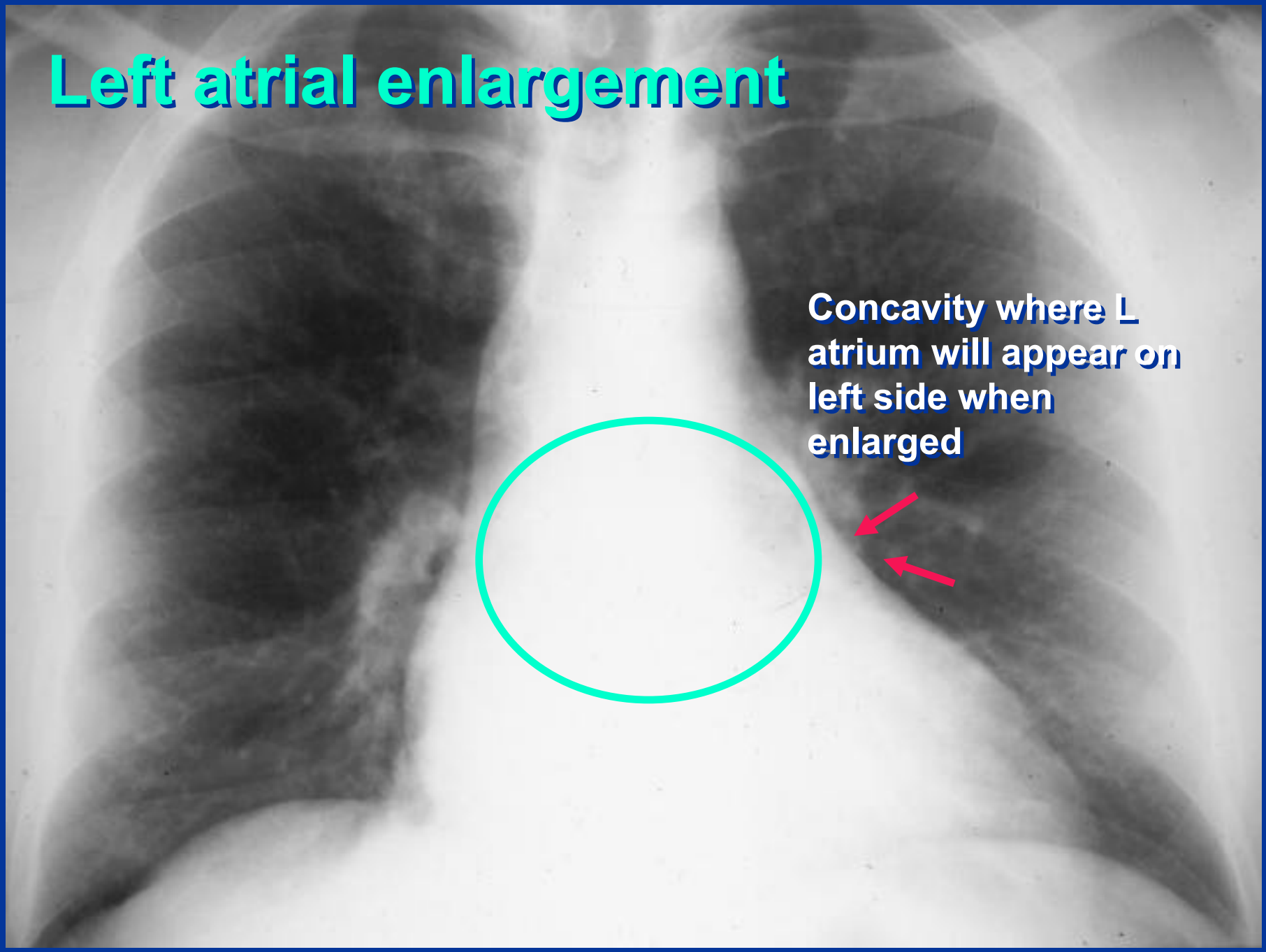


Finding the Main Pulmonary Artery



We can measure the main pulmonary artery . . .

Left atrial enlargement

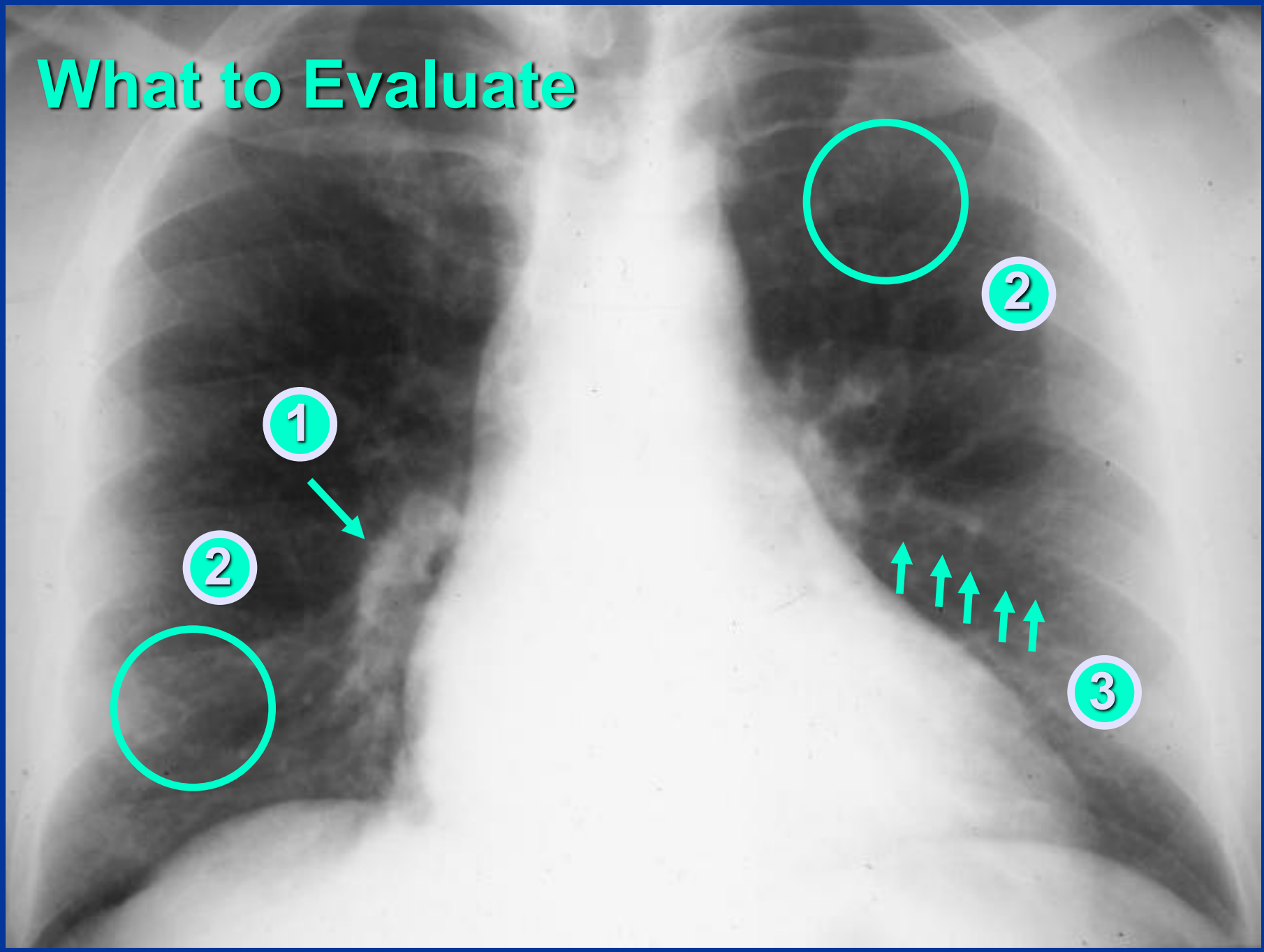


The Pulmonary Vasculature

Five States of the Pulmonary Vasculature

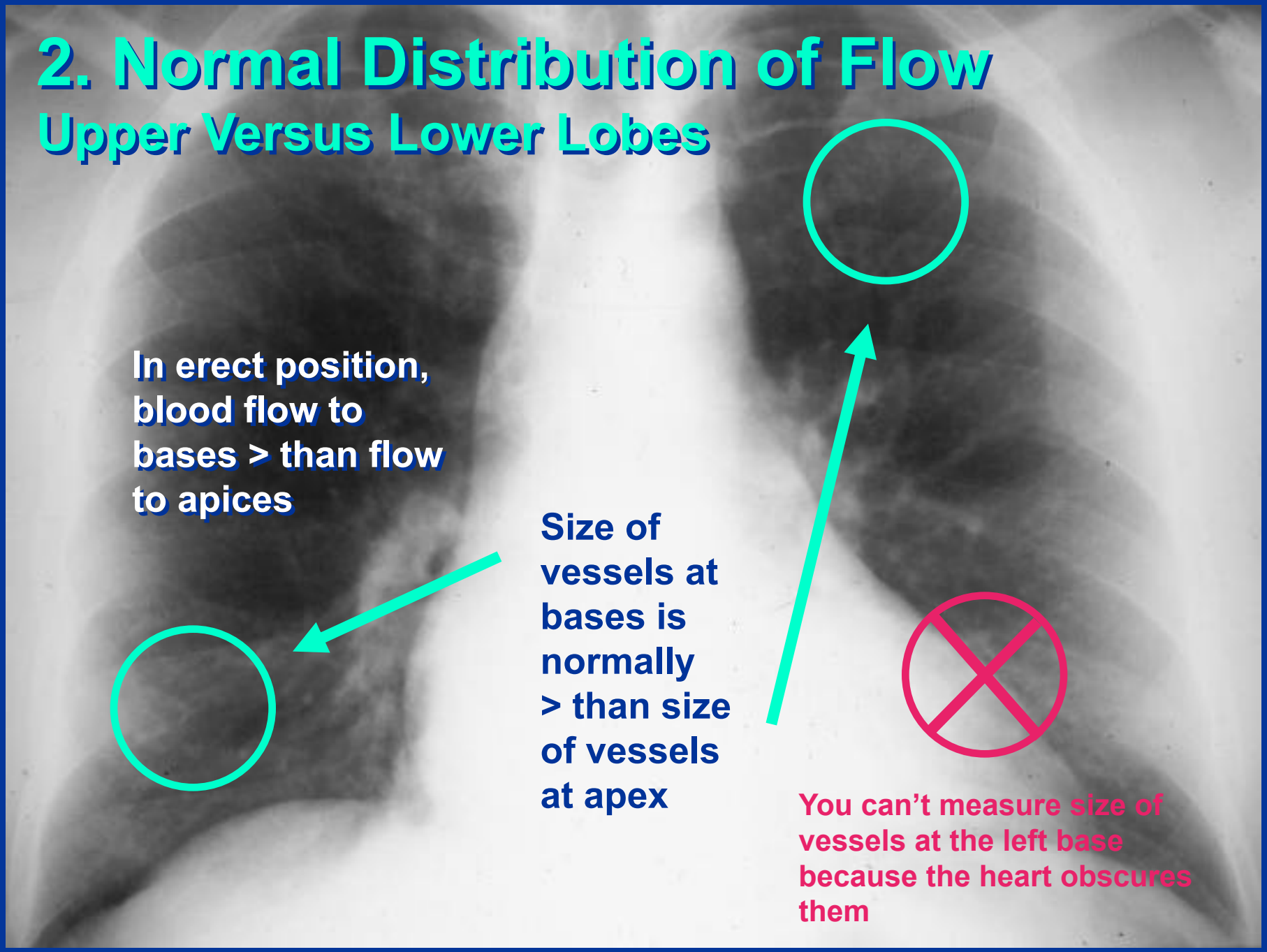
- Normal
- Pulmonary venous hypertension
- Pulmonary arterial hypertension
- Increased flow
- Decreased flow

What to Evaluate



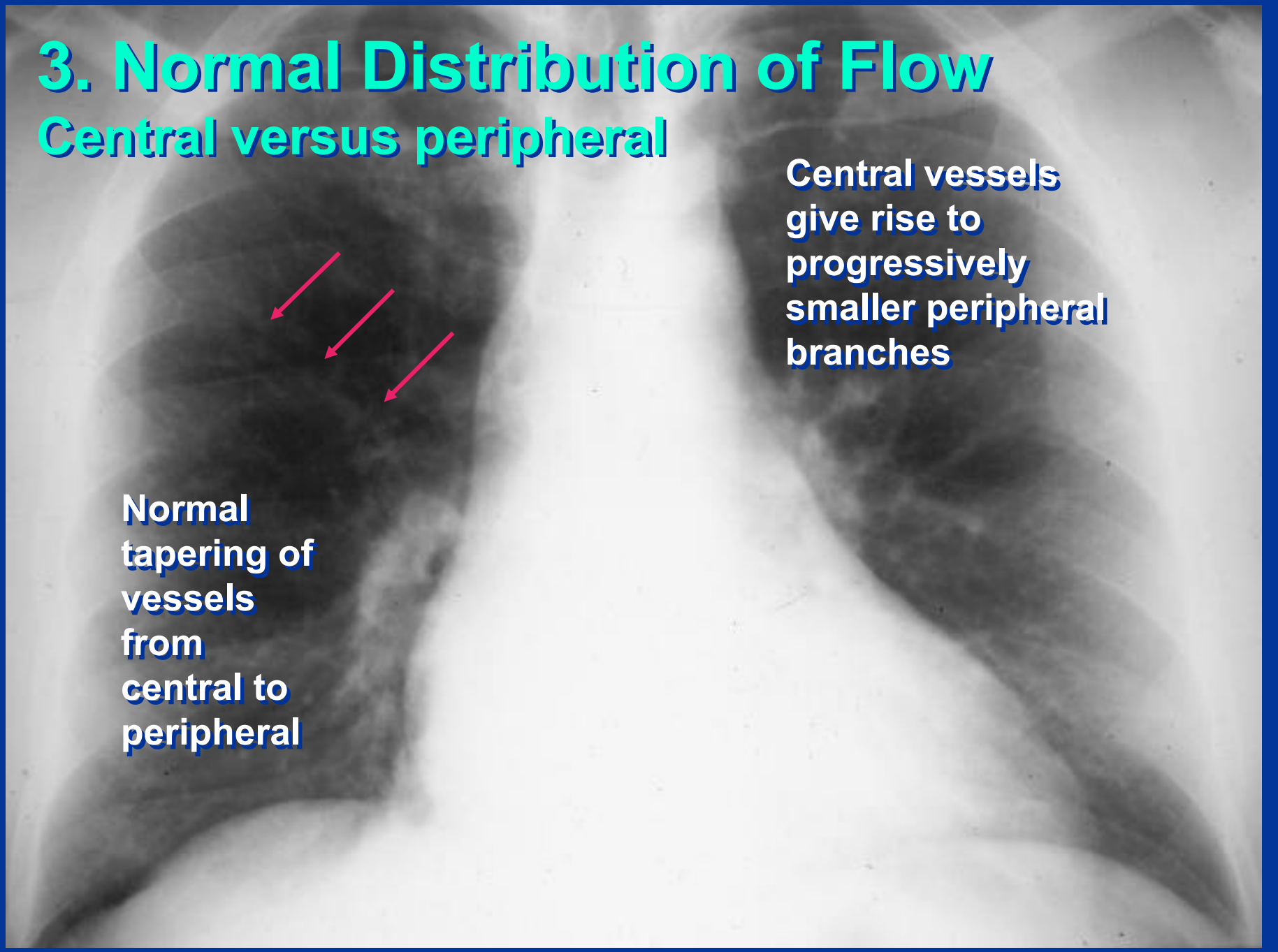
2. Normal Distribution of Flow

Upper Versus Lower Lobes



3. Normal Distribution of Flow

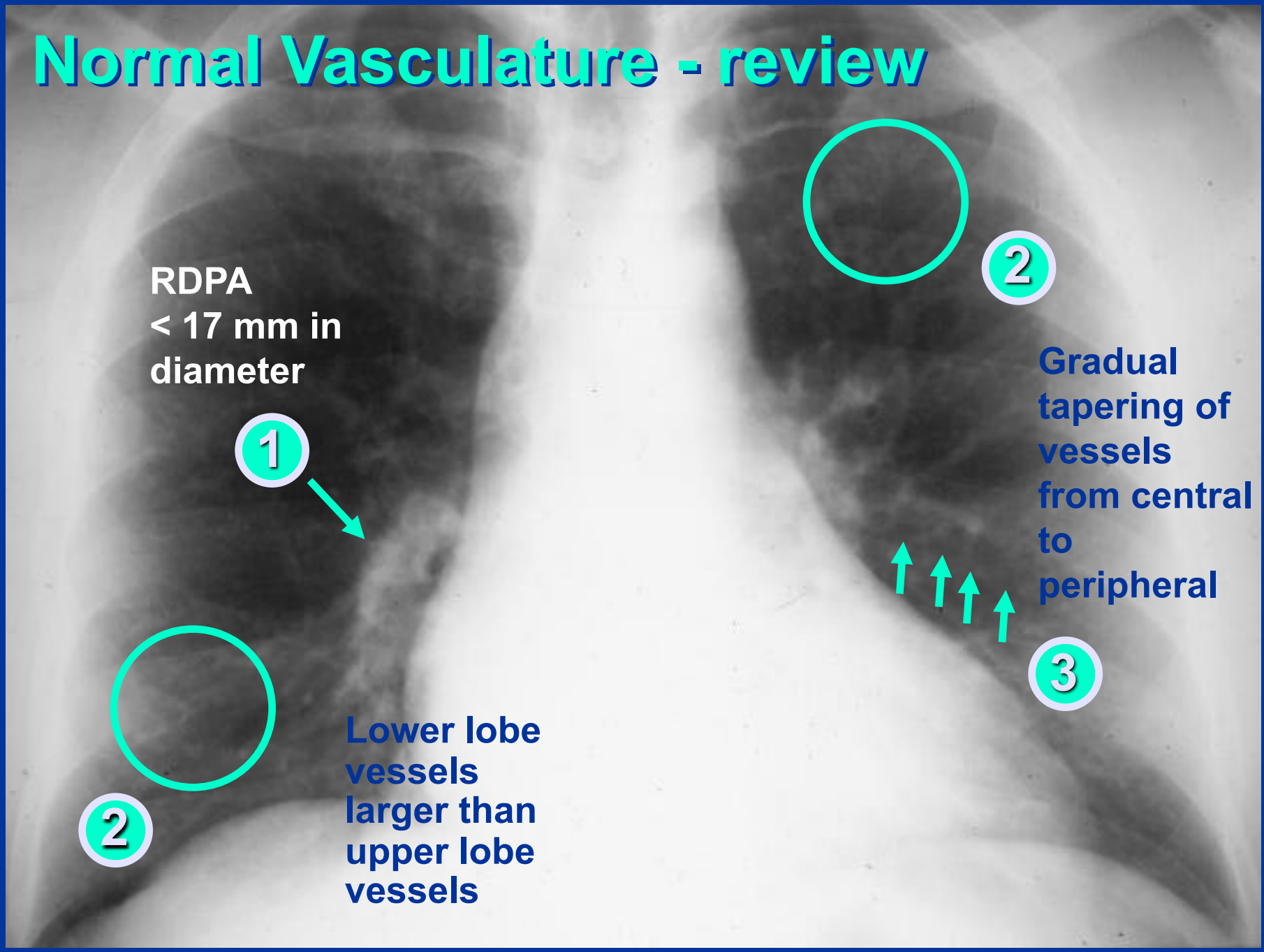
Central versus peripheral



Central vessels give rise to progressively smaller peripheral branches

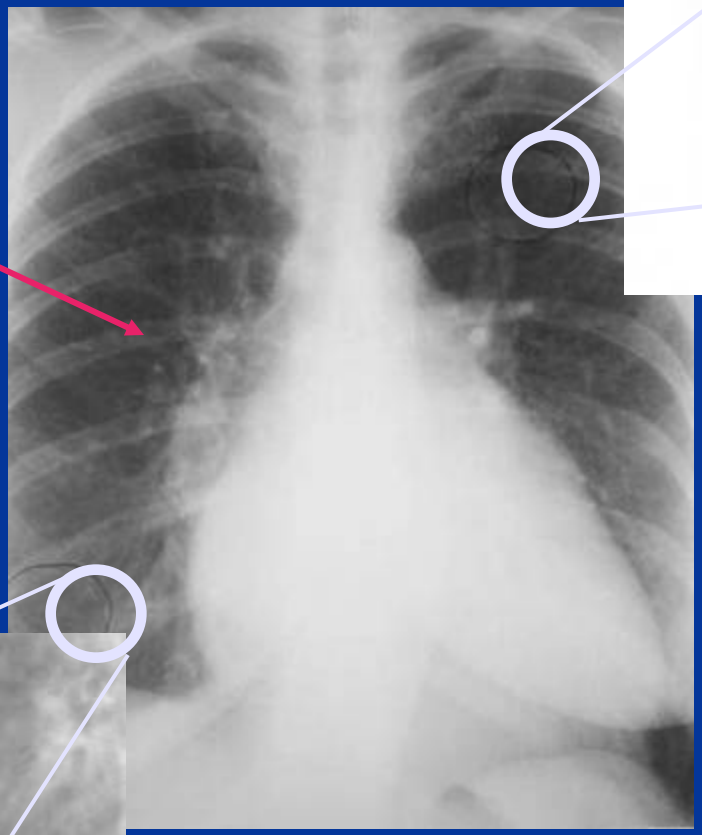
Normal tapering of vessels from central to peripheral

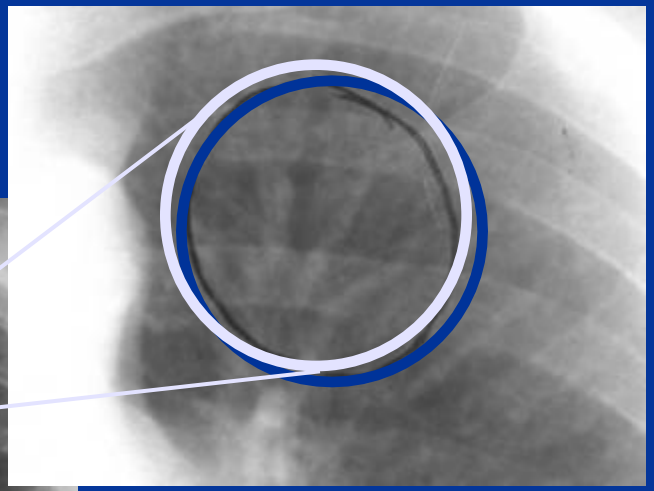
Normal Vasculature - review

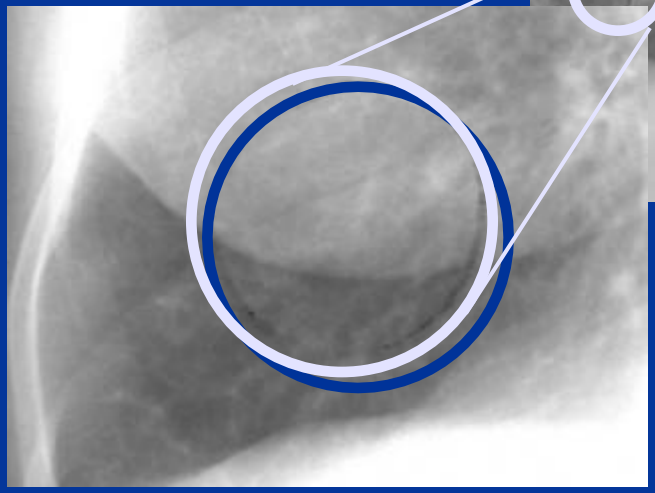


Venous Hypertension

RDPA usually
> 17 mm





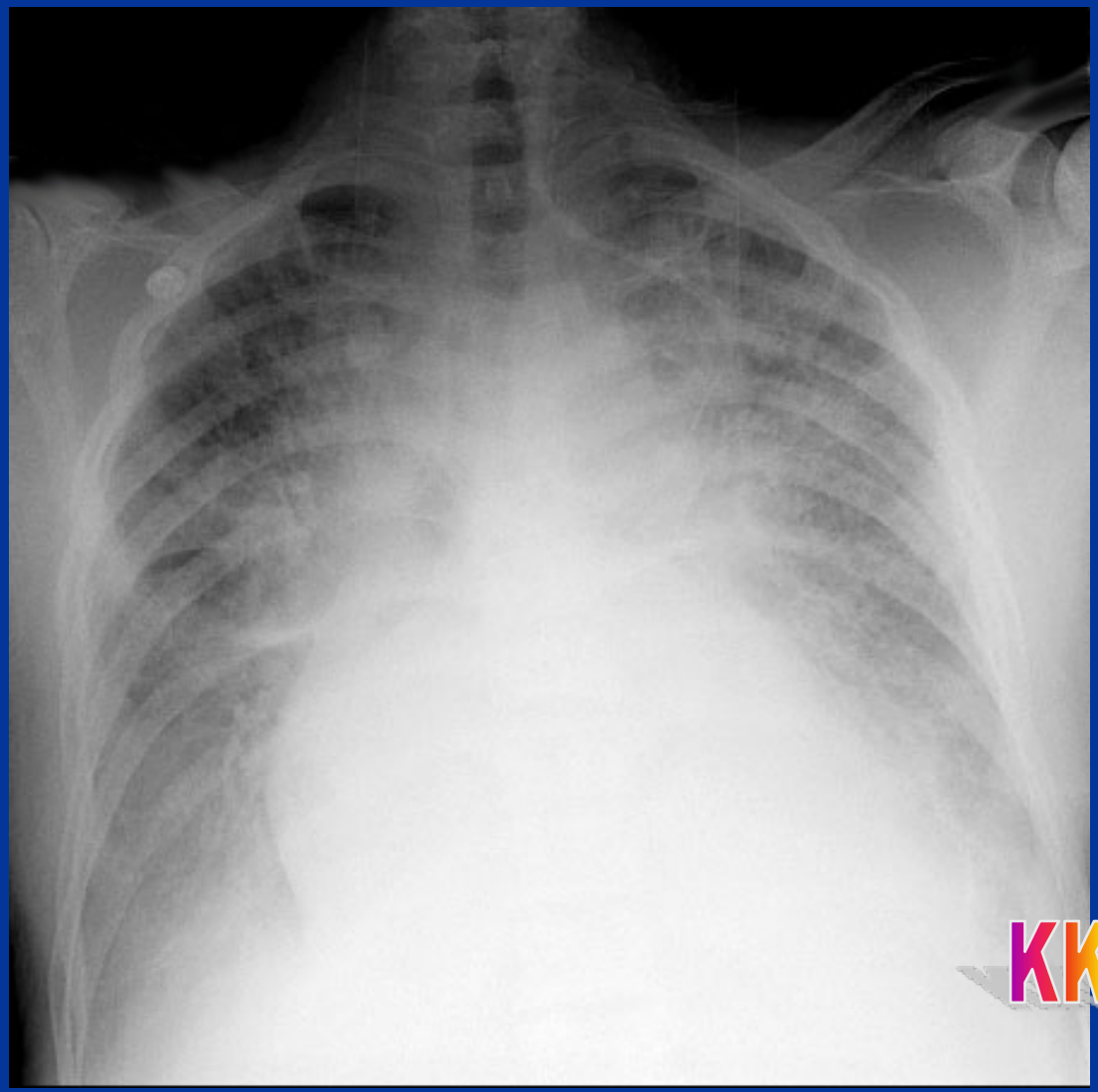


Upper lobe vessels equal to or larger than size of lower lobe vessels = Cephalization

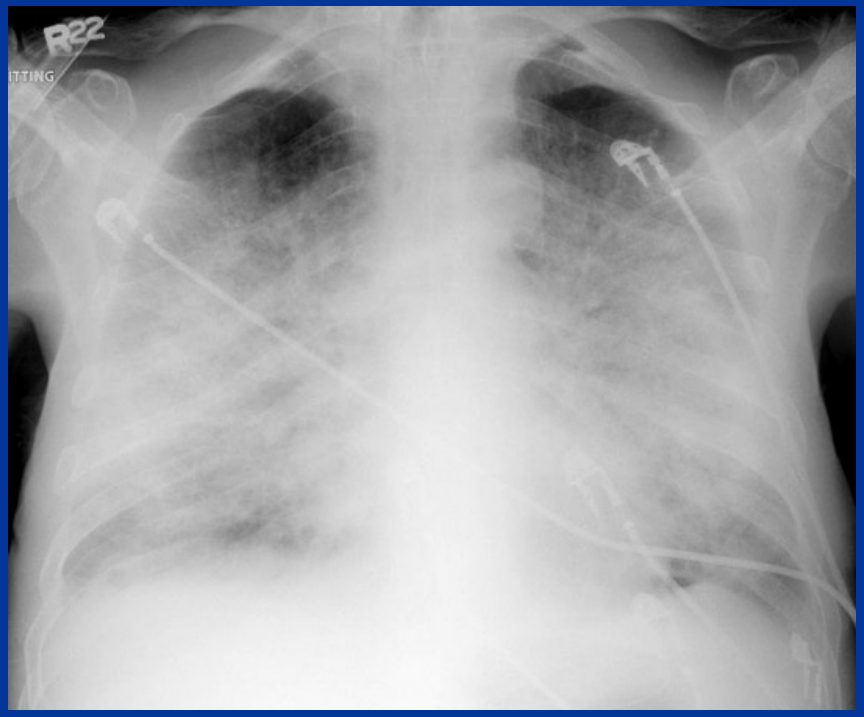
The Pulmonary Vasculature

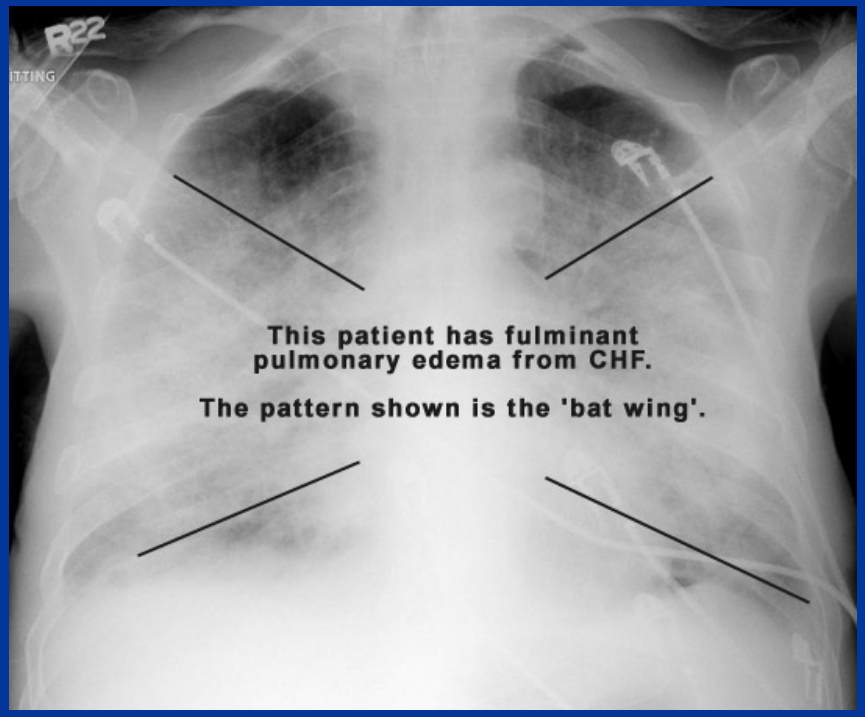
- Normal
- Pulmonary venous hypertension
- Pulmonary arterial hypertension
- Increased flow
- Decreased flow - mostly unrecognizable even when it is present

CHF

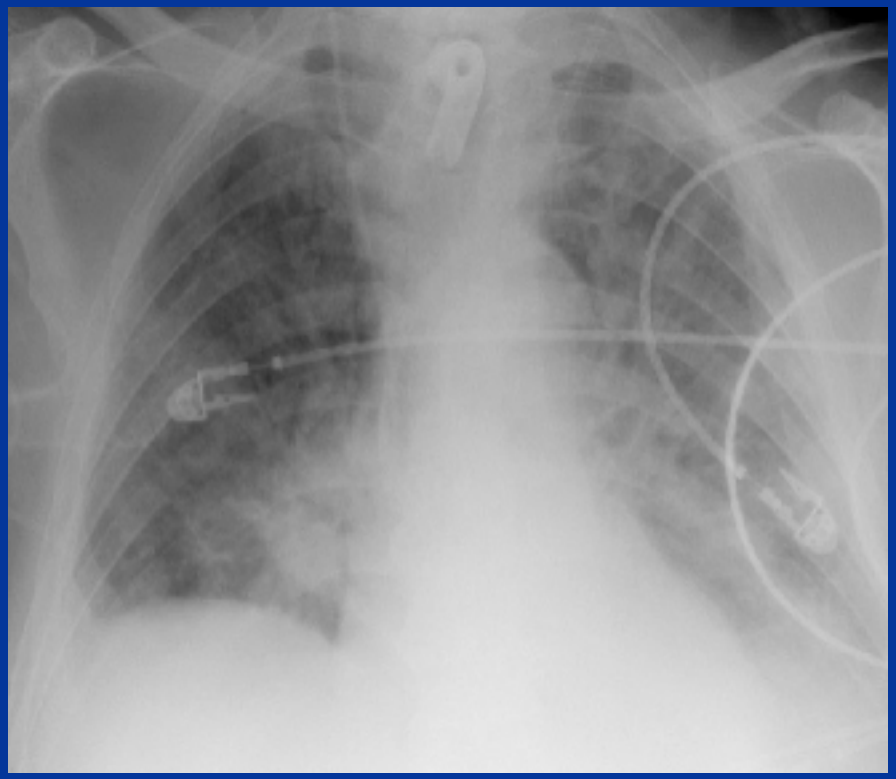


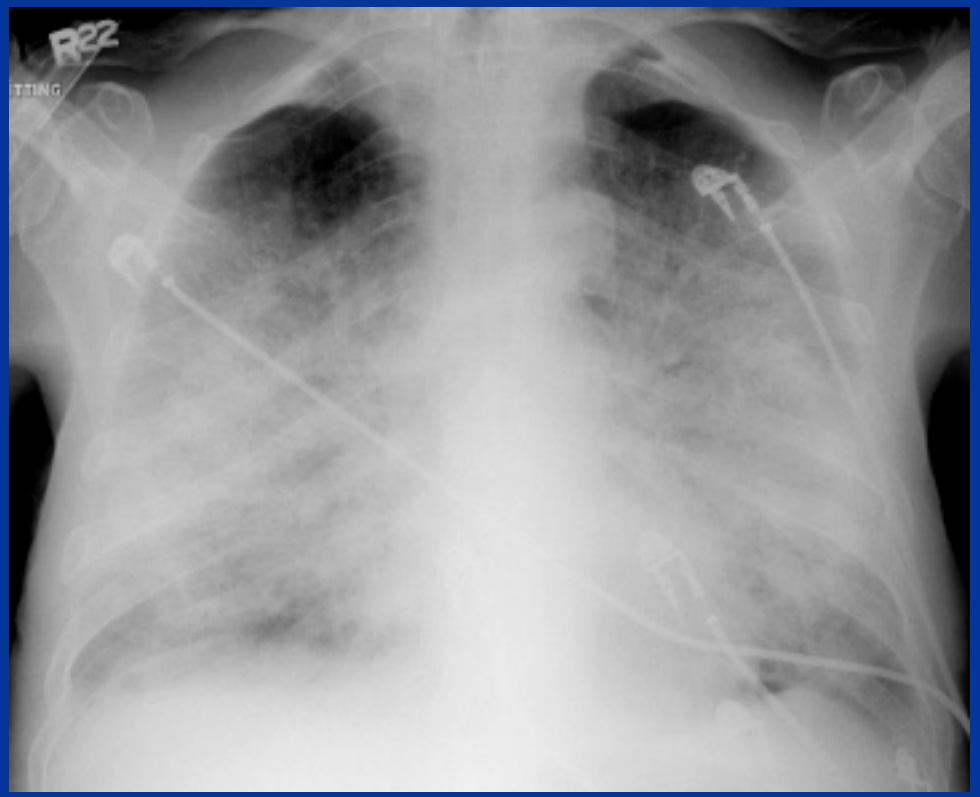
ACUTE PULMONARY EDEMA



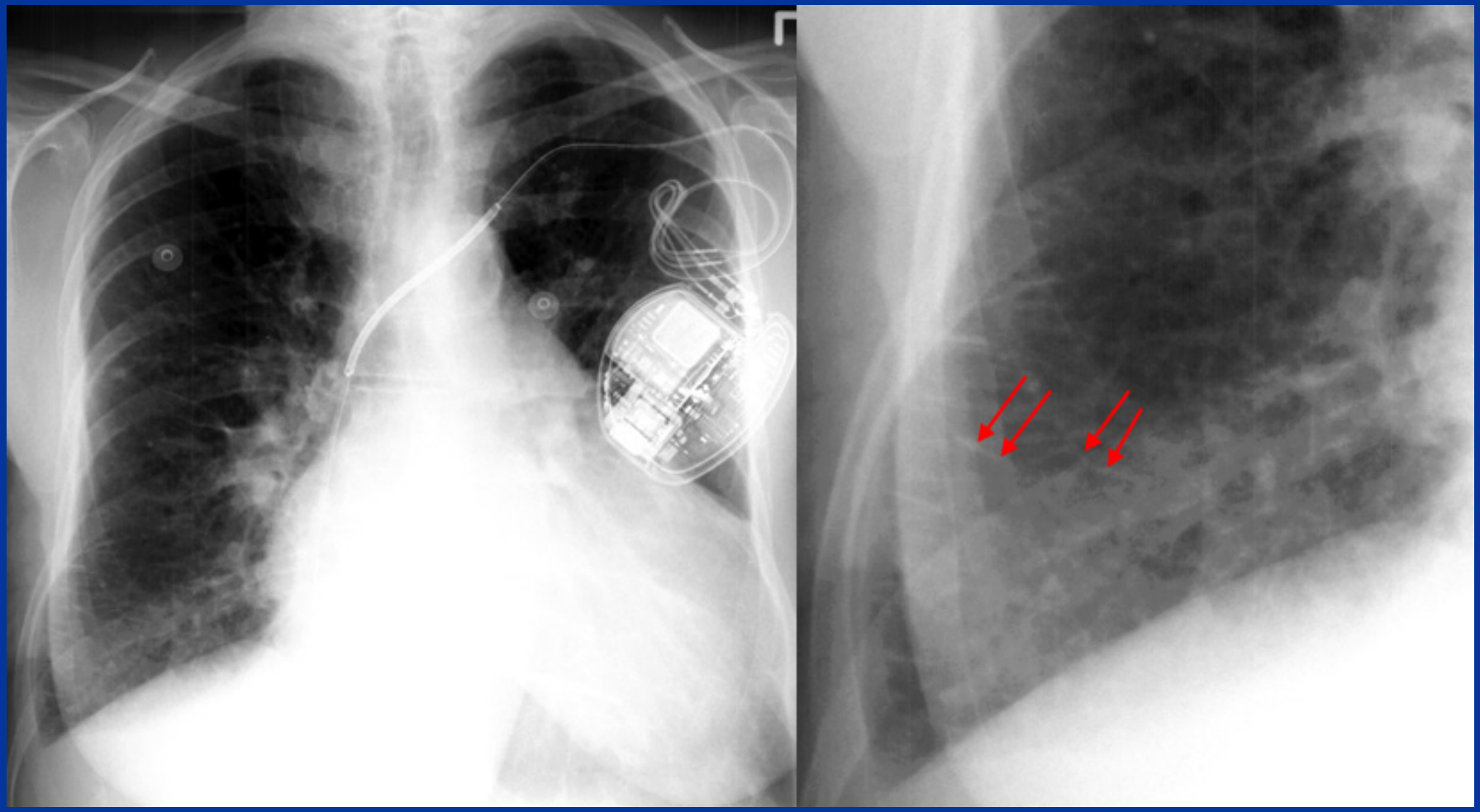


CLEARED APE





KERELY'S B-LINES



THANK YOU

DR SHARKAWY