A RADIOLOGY MASTERCLASS

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Consultant Thoracic Radiologist

Manchester University NHS Foundation Trust (MFT)

20th June 2025

LOTS OF PICTURES, SOME INTERACTION AND HOPEFULLY SOME FUN!

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AGENDA

- Understand more about CT
- Anatomy on CT
- CT terms
- Scanning protocols and relevance
- Interactive quiz
- Understand more when in an MDT or in clinic

RULES

- No question is ‘too straightforward’ or ‘stupid’
- Please interrupt ask questions as we go along
- Safe space for learning

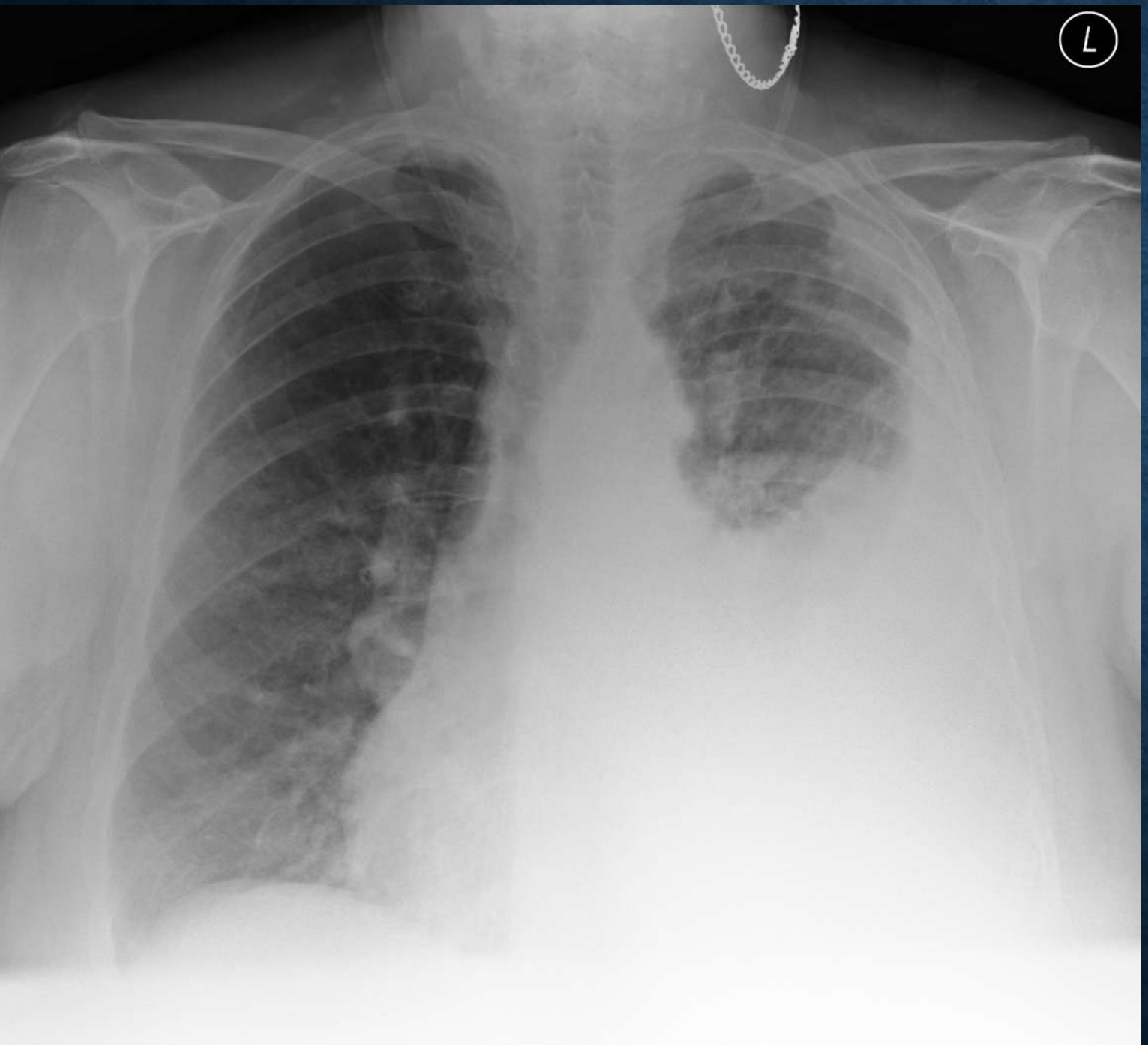
QUIZ - USING SLI.DO

- CXR
- Decide what kind of CT you would perform
- Choices:
  1. CTPA
  2. Volumetric HRCT
  3. Non volumetric HRCT
  4. Portal phase CT
  5. Low dose CT

Poll 1: What kind of CT you would perform?

Poll 2: What kind of CT you would perform?

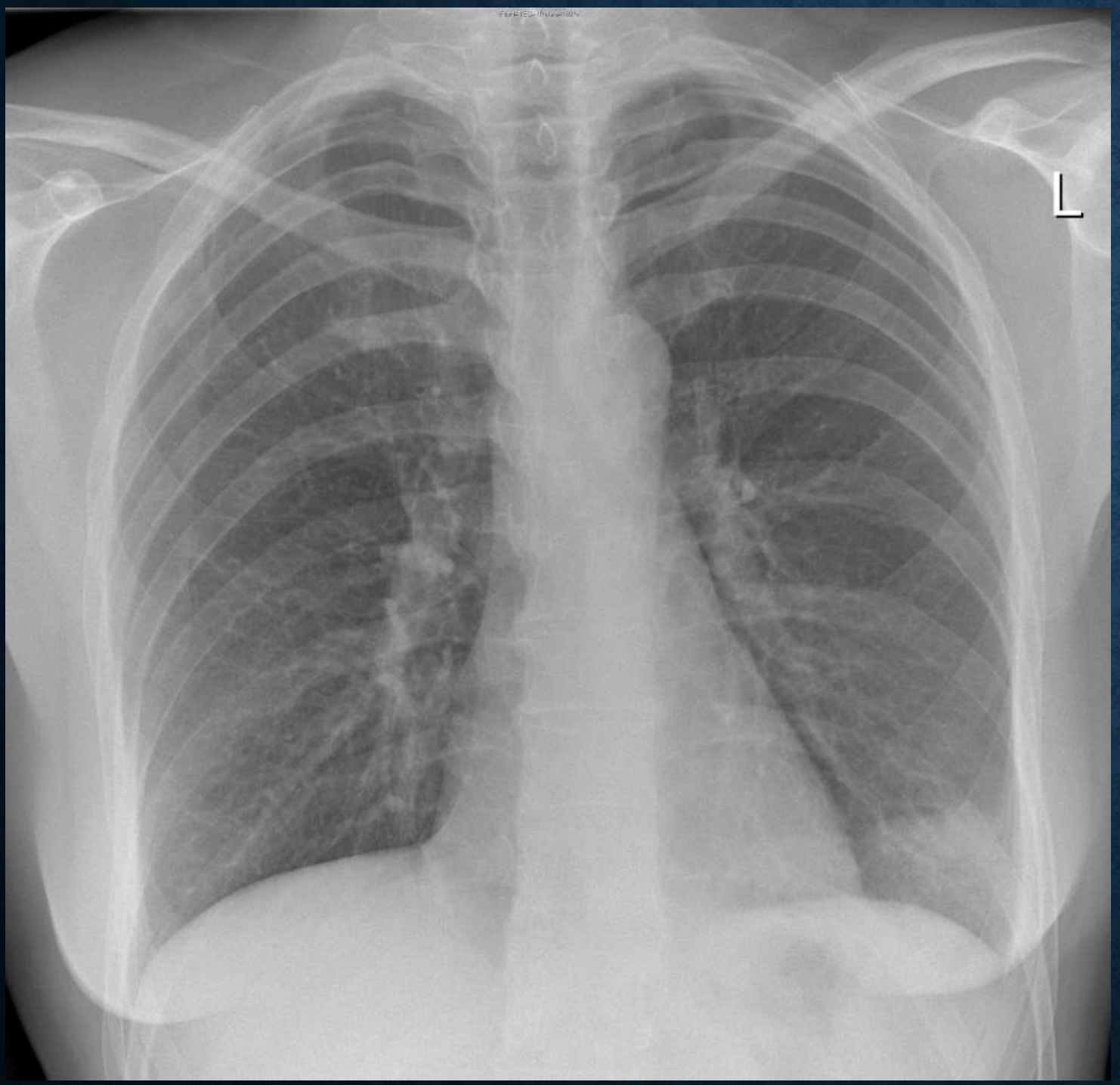
Poll 3: What kind of CT you would perform?



76 ♀

Clinical question: ? cause

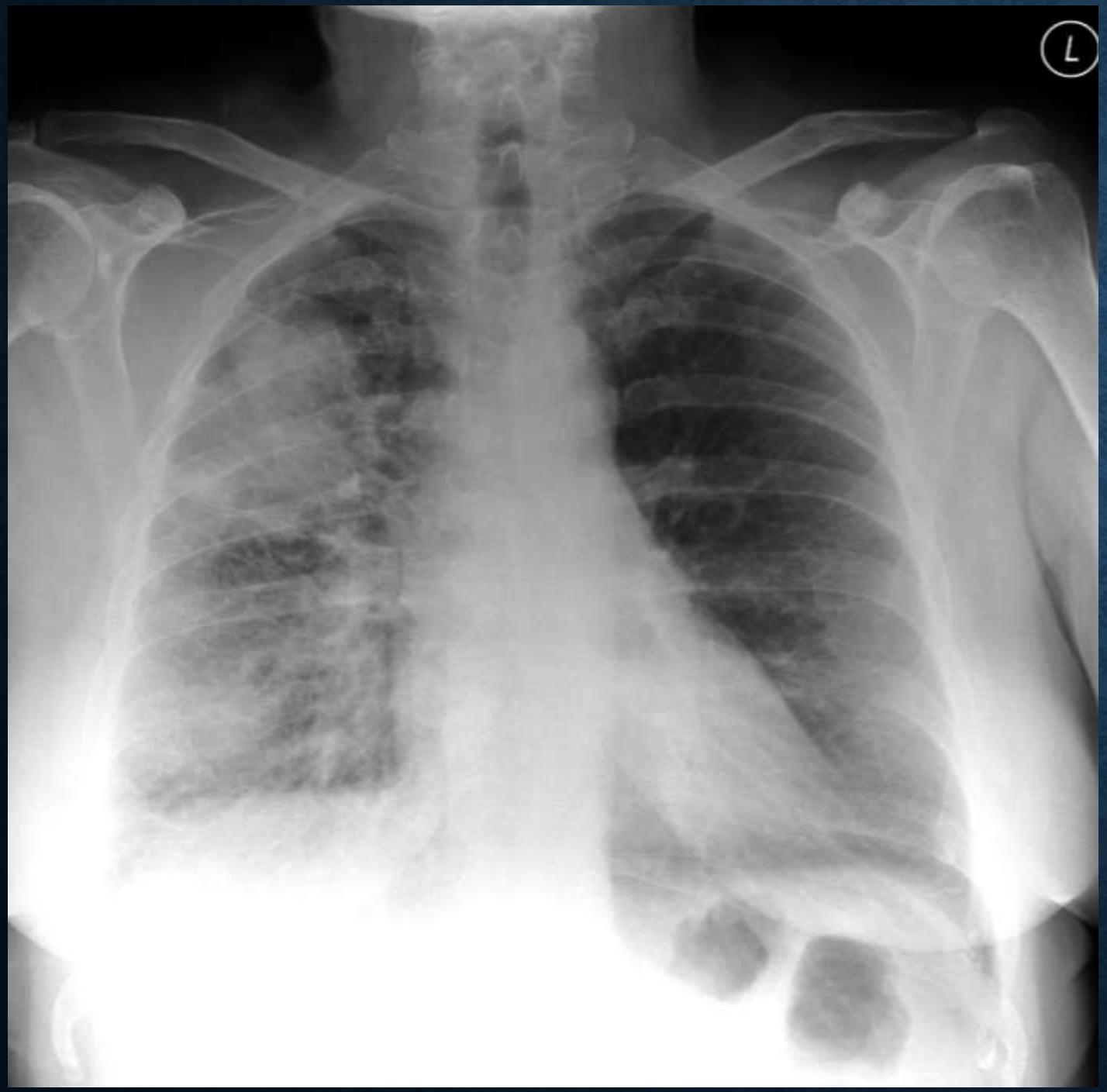
1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT



27 ♂

Clinical question: SOB ? Cause

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT



65 ♀

Clinical question: ?
Cancer

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

53 ♀

Clinical question: ? Nodule RUZ

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

WHAT IS A CT?

- CT – computed tomography
- Tomos = slice; graphein = to write
- Definition: imaging of an object by analysing its slices

HISTORY

- 1924 – mathematical theory of tomographic image reconstructions
- 1930 – conventional tomography
- 1963 – theoretical basis of CT
- 1971 – first commercial CT (Sir Godfrey Hounsfield[1])
- 1974 – first 3rd generation CT
- 1979 – Nobel prize (Cormack & Hounsfield)
- 1989 – single-row CT
- 1994 – double-row spiral CT
- 2001 – 16-row spiral CT
- 2007 – 320-row spiral CT

2000 – I qualified as a doctor!

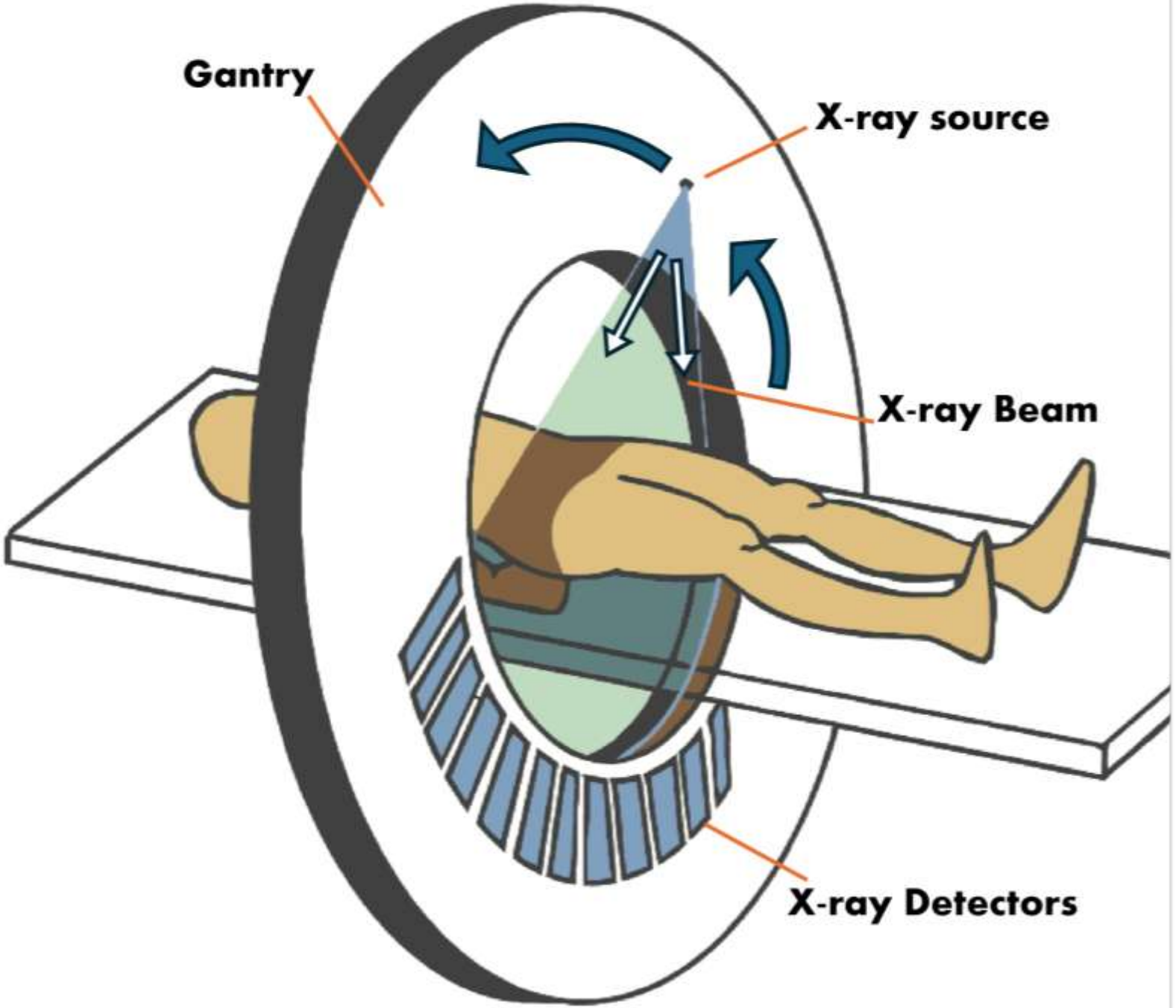
CT PROTOTYPE VS NOW

Prototype

- Scanning time : 9 days
- Reconstruction : 2.5 hours
- Resolution : 80 x 80

Multislice CT

- Scanning time : seconds
- Reconstruction : seconds
- Resolution : 512 x 512



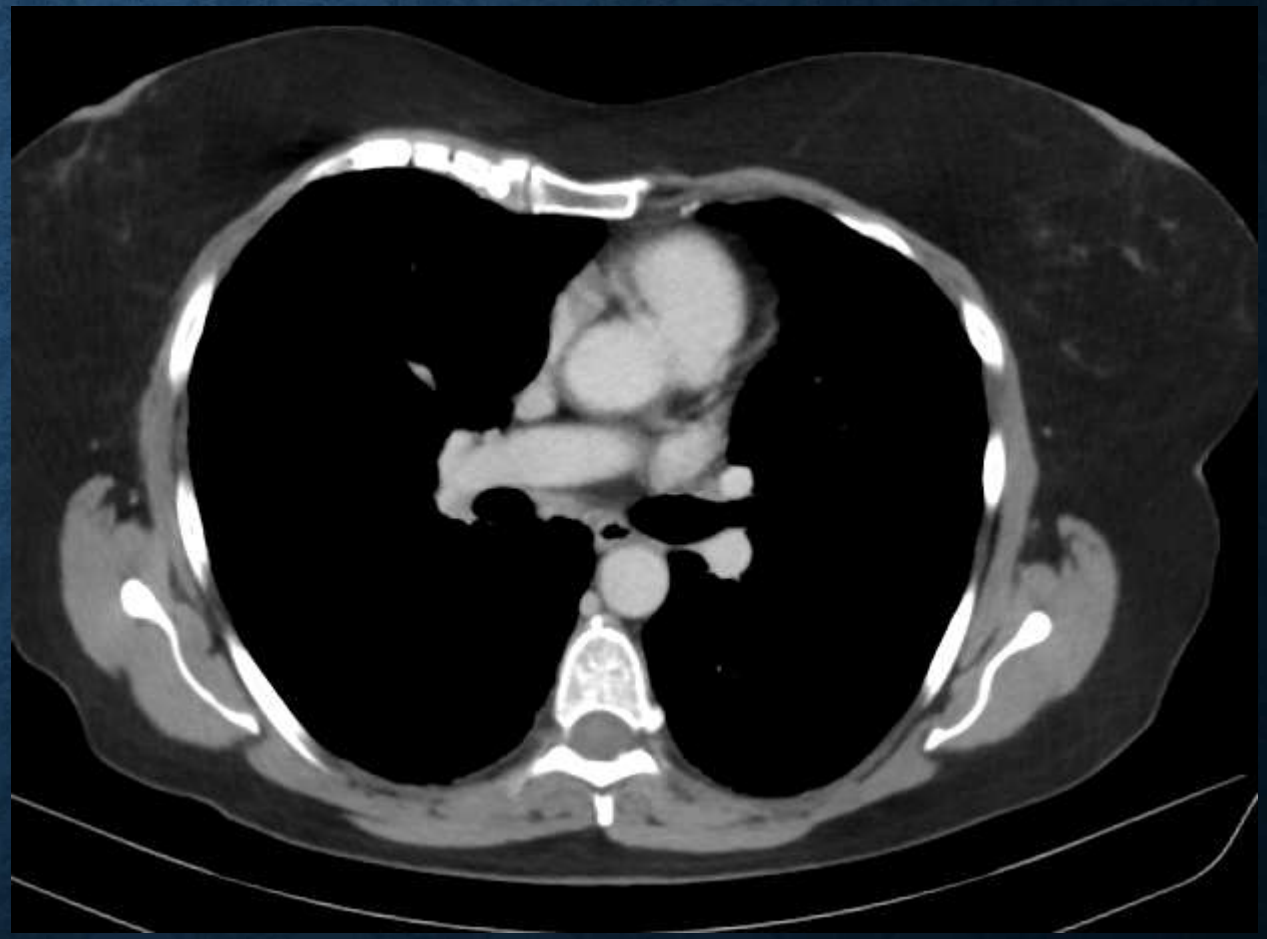
SPIRAL CT

Image courtesy of Dr Ben Layton, Consultant Radiologist

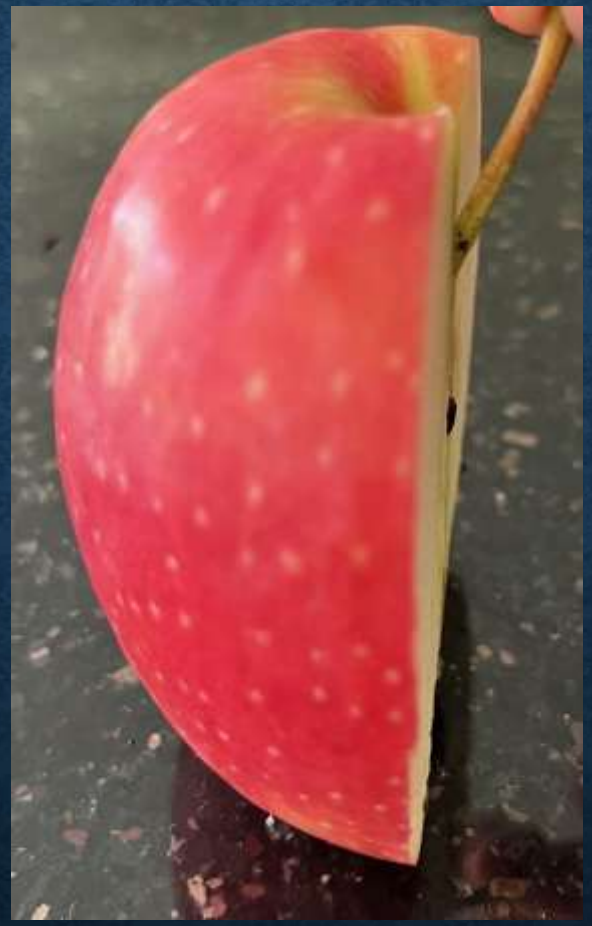
AXIAL, SAGITTAL OR CORONAL IMAGES

What do the terms mean?

AXIAL IMAGES



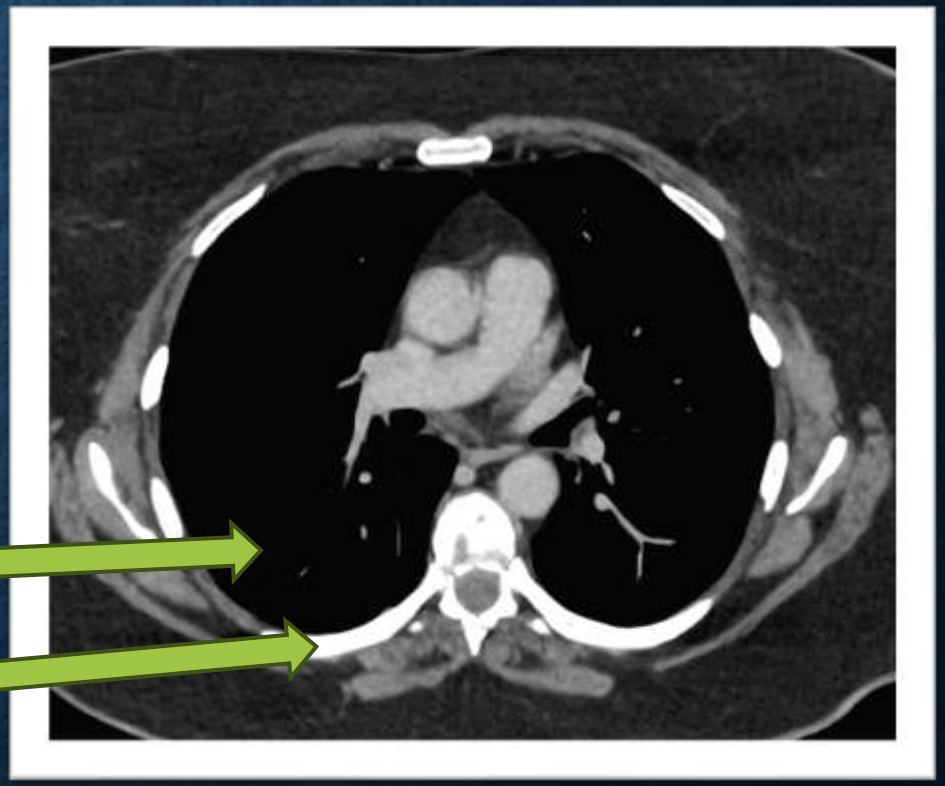
SAGITTAL IMAGES

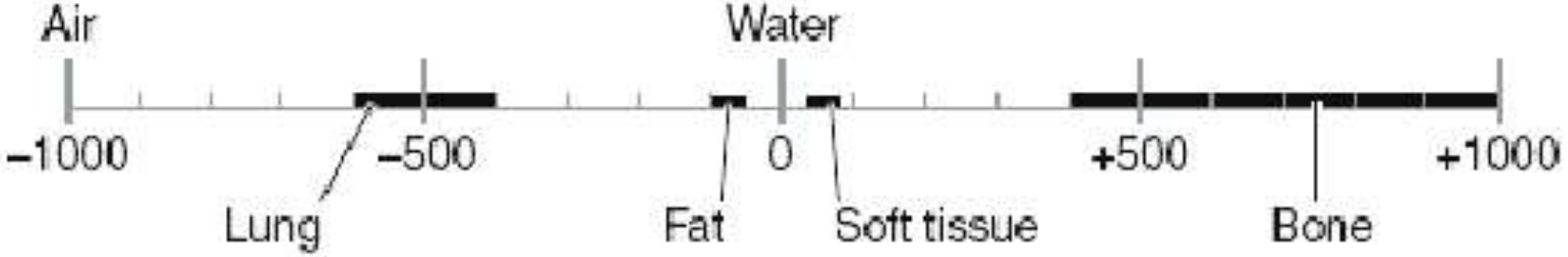


CORONAL IMAGES

IMAGE RECONSTRUCTION

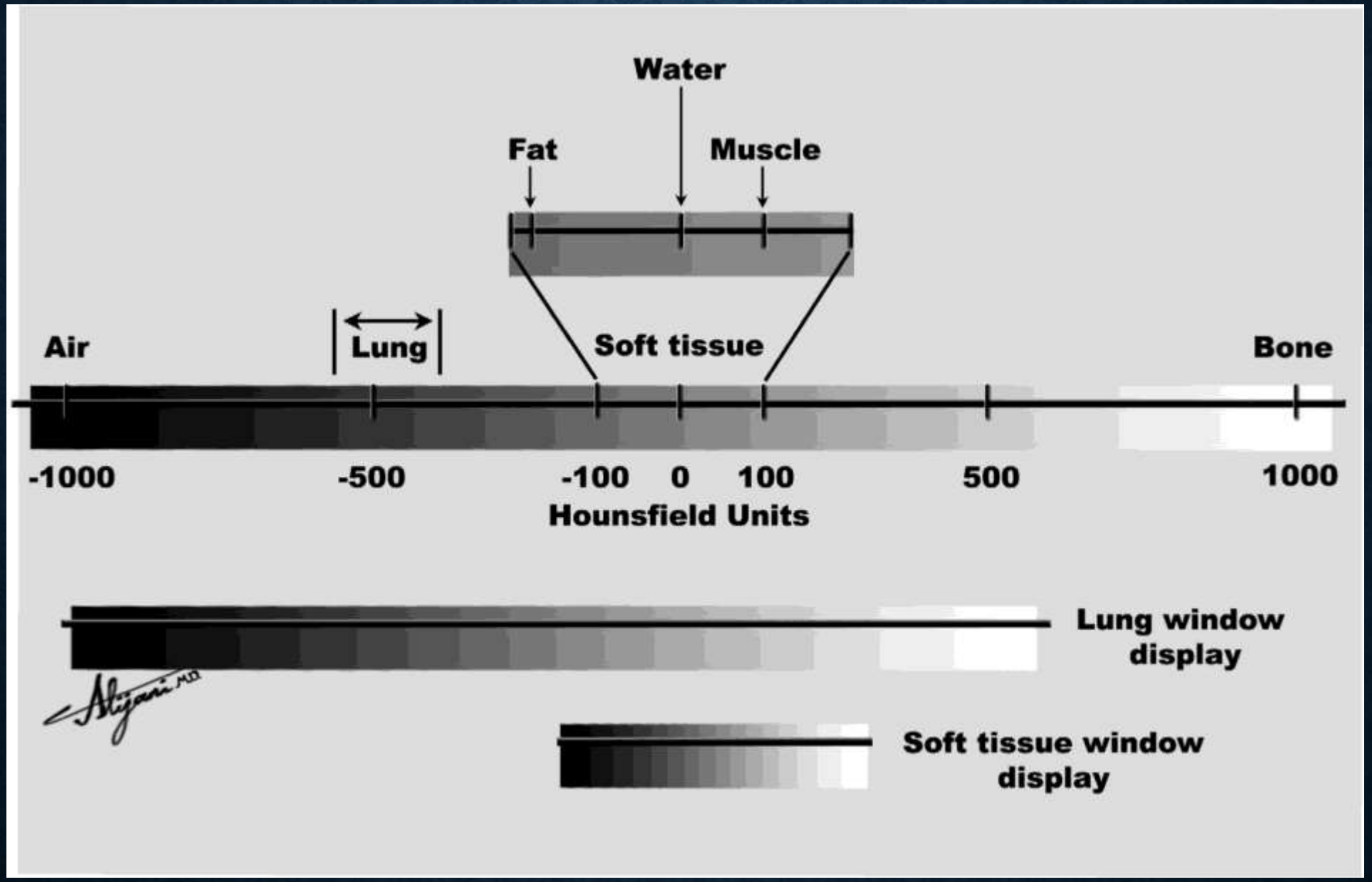
- Hounsfield scale : tissue density is expressed in different shades of grey
- This is related to the amount of xray absorption of that tissue
- The more it absorbs, the whiter it is
- Air is black
- Bone is white





Bone	+400 → +1000
Soft tissue	+40 → +80
Water	0
Fat	−60 → −100
Lung	−400 → −600
Air	−1000

https://www.researchgate.net/figure/The-Hounsfield-scale-of-CT-numbers_fig2_306033192

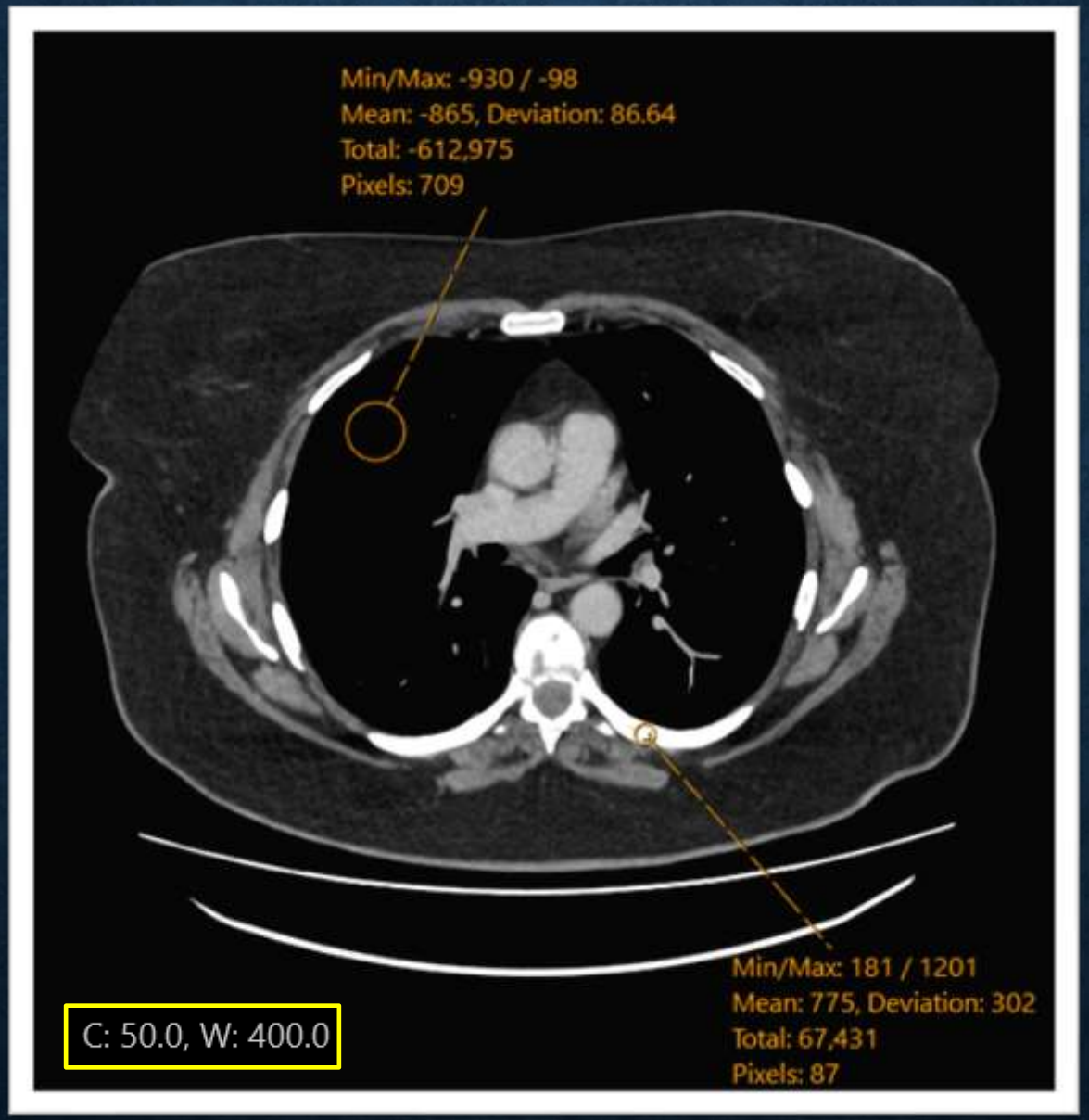


https://radiologykey.com/computed-tomography-12/

WINDOWING

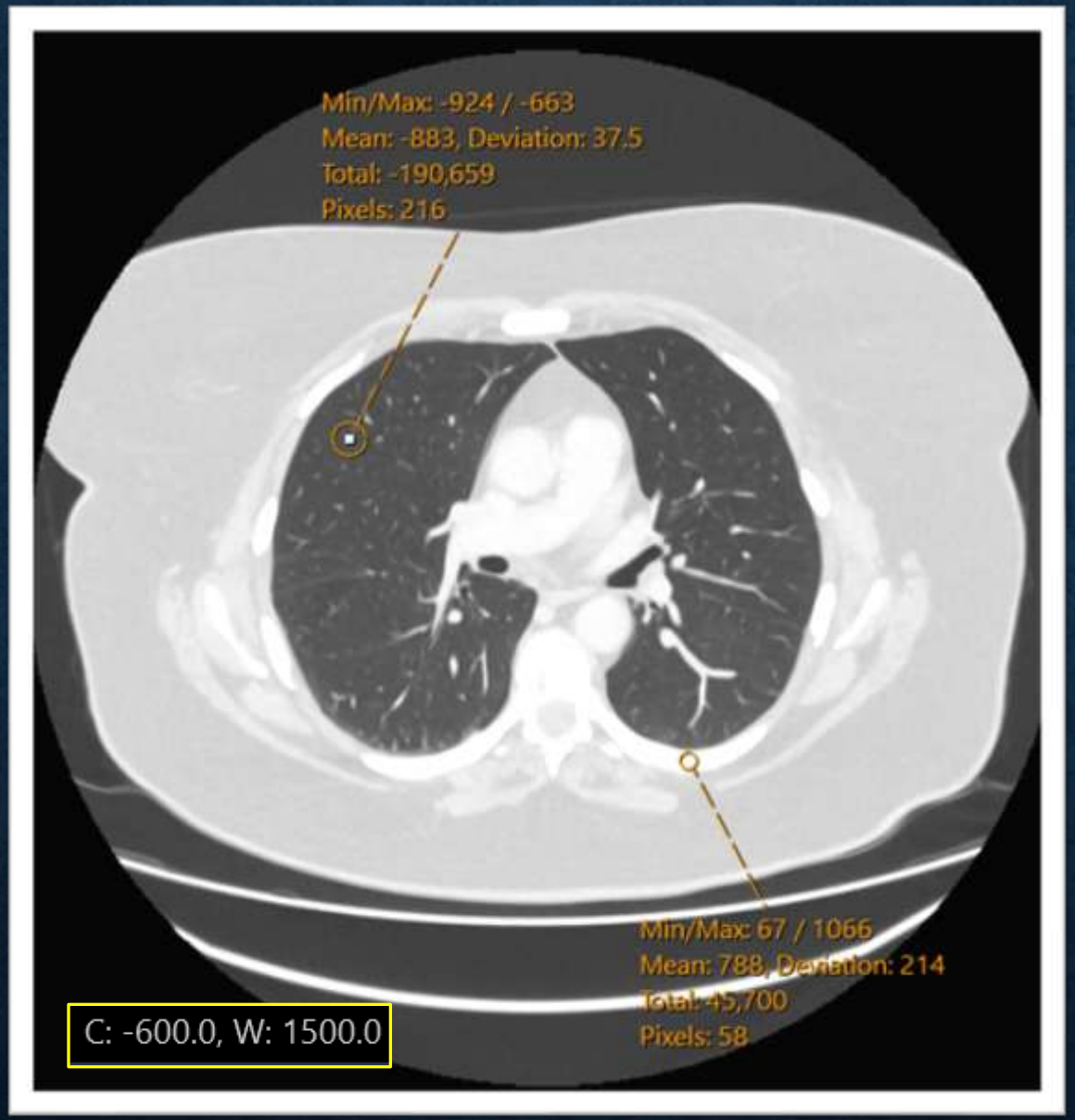
- Same data displayed in different ways
- Window width and window levels
- Depends on structure of interest

Air – black
Mean HU -865

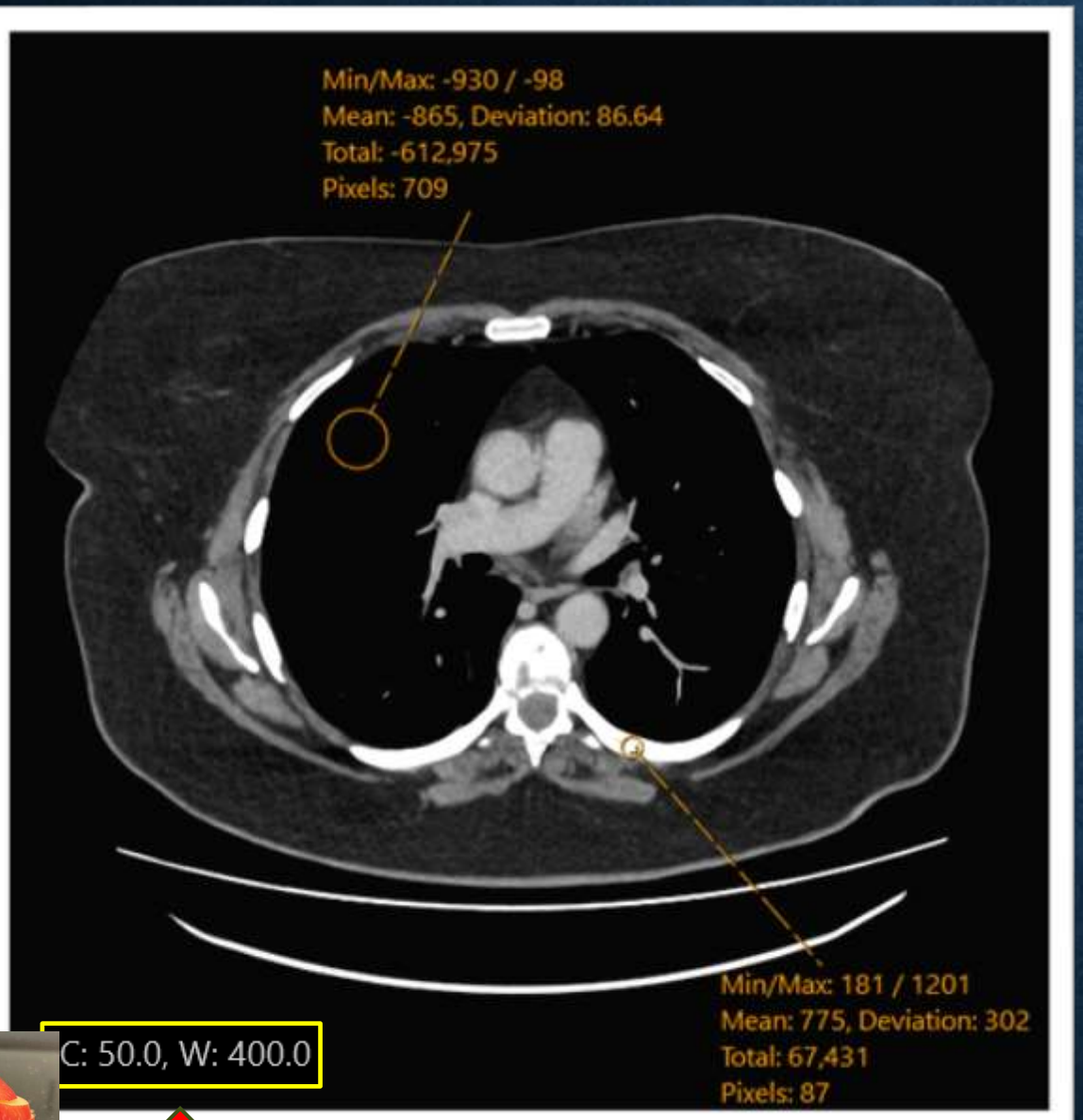


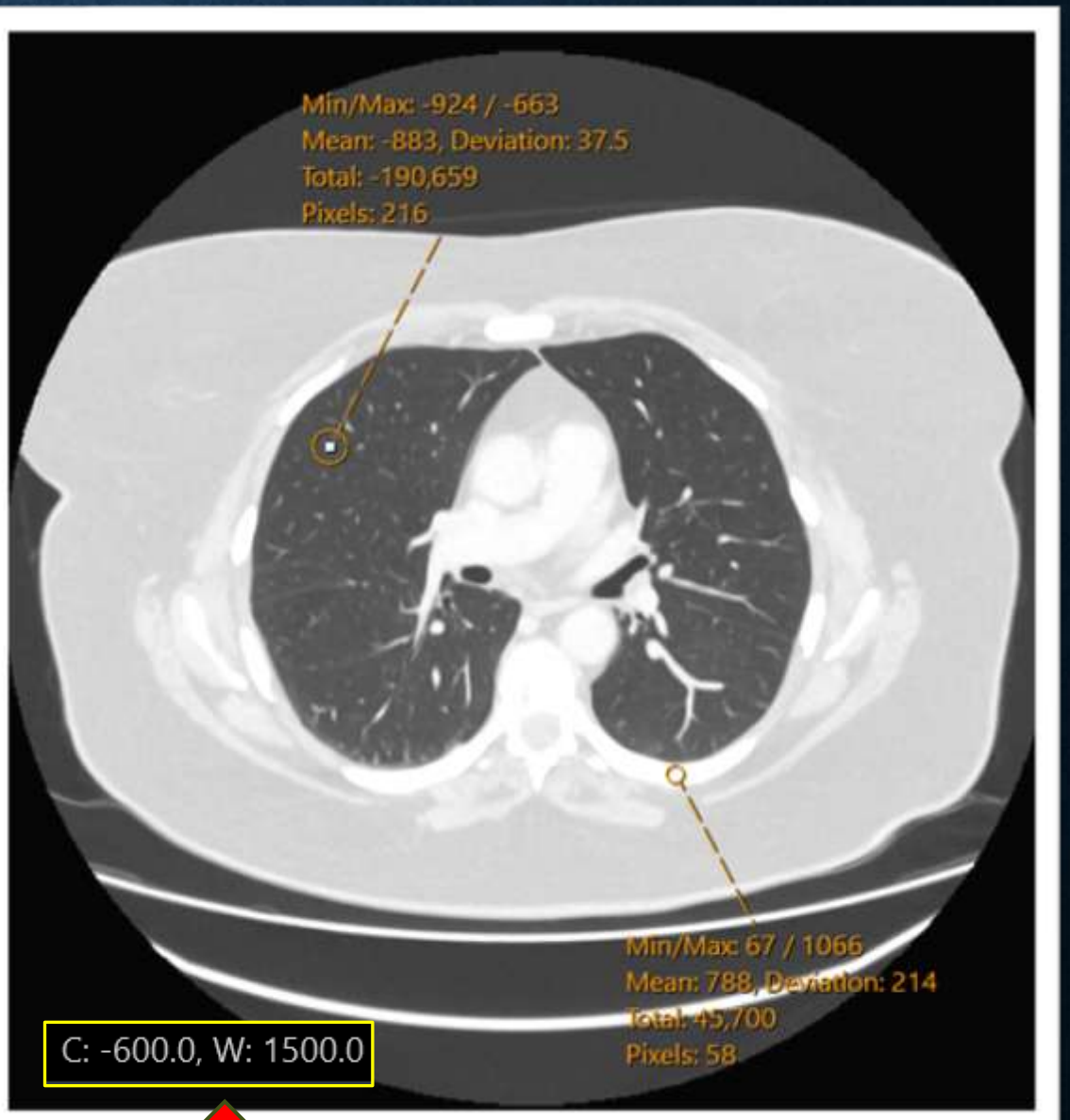
Bone – white
Mean HU +775

Air – black
Mean HU -883

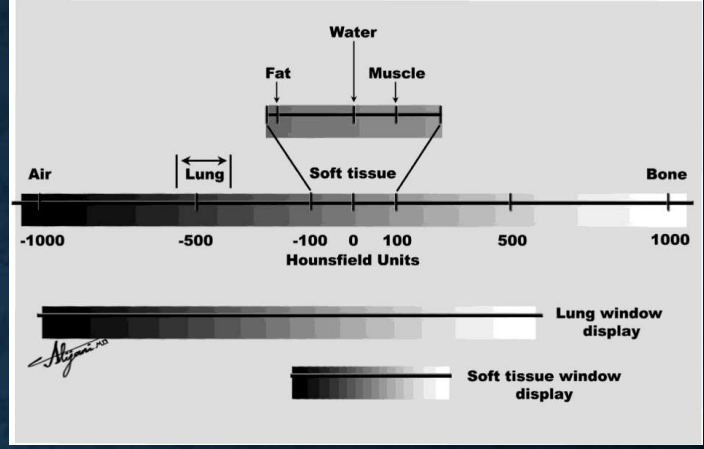


Bone – white
Mean HU +788


Min/Max: -930 / -98
Mean: -865, Deviation: 86.64
Total: -612,975
Pixels: 709
Min/Max: 181 / 1201
Mean: 775, Deviation: 302
Total: 67,431
Pixels: 87
C: 50.0, W: 400.0


Min/Max: -924 / -663
Mean: -883, Deviation: 37.5
Total: -190,659
Pixels: 216
Min/Max: 67 / 1066
Mean: 788, Deviation: 214
Total: 45,700
Pixels: 58
C: -600.0, W: 1500.0

WINDOW WIDTH



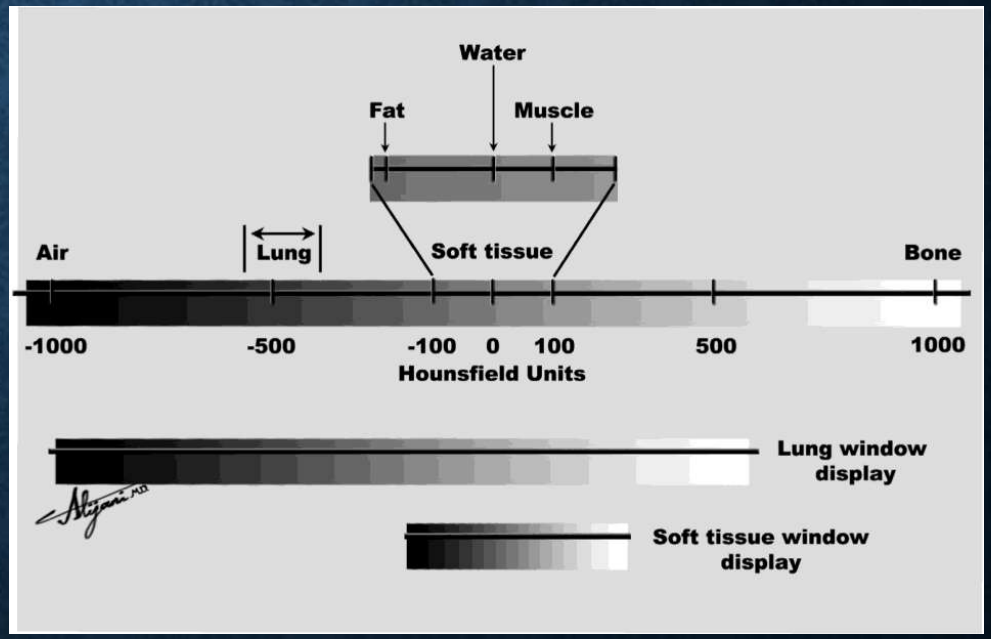
- Window width : measure of the RANGE of CT numbers that an image displays
  - If wide - lots of shade of grey
    - Transition of dark to light structures is over a larger range
    - V different attenuation structures side by side – LUNG (vessels and air)
  - If narrow – less shades of grey
    - Transition of dark to light structures is over a smaller range
    - To examine similar attenuation structures - SOFT TISSUE

WINDOW LEVEL / WINDOW CENTRE

- MIDPOINT of the range of the CT numbers displayed

- Upper grey level is WL + (WW ÷ 2)
- Lower grey level is WL - (WW ÷ 2)

- Looking at a brain W:80 L: 40
  - All values above +80 will be white
  - All values below 0 will be black

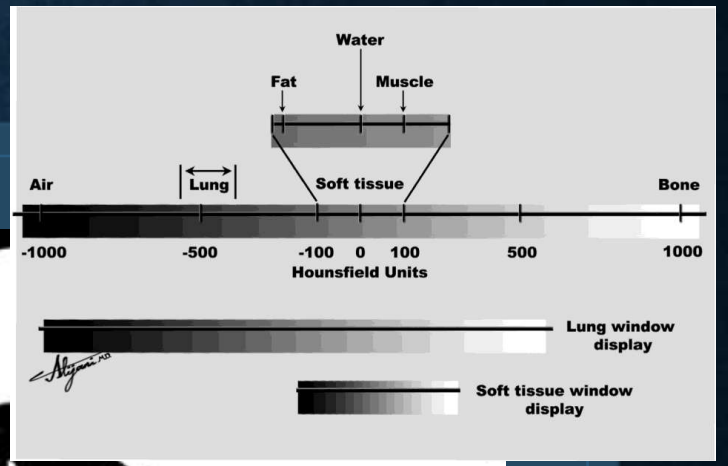


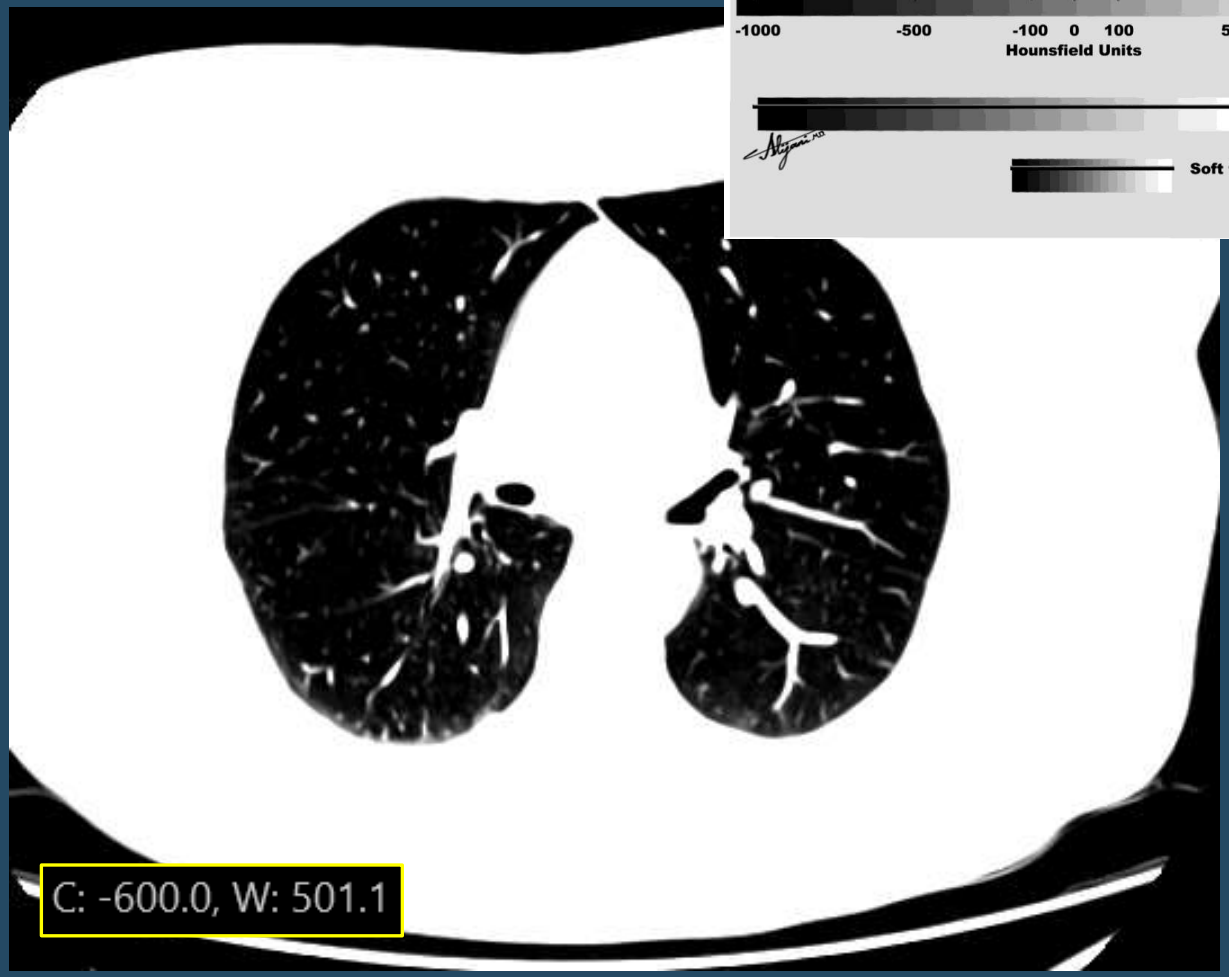
EFFECT OF CHANGING WW

- Centre is -600HU
- Width is 500

- All structures with HU > -350 will be white

- All structures with HU < -850 will be black



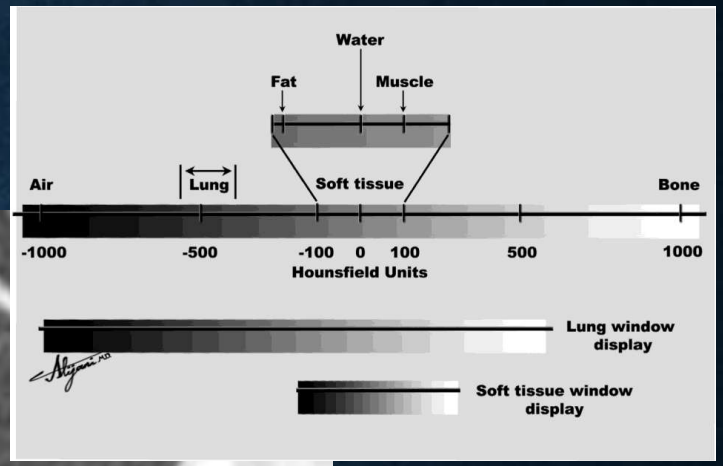


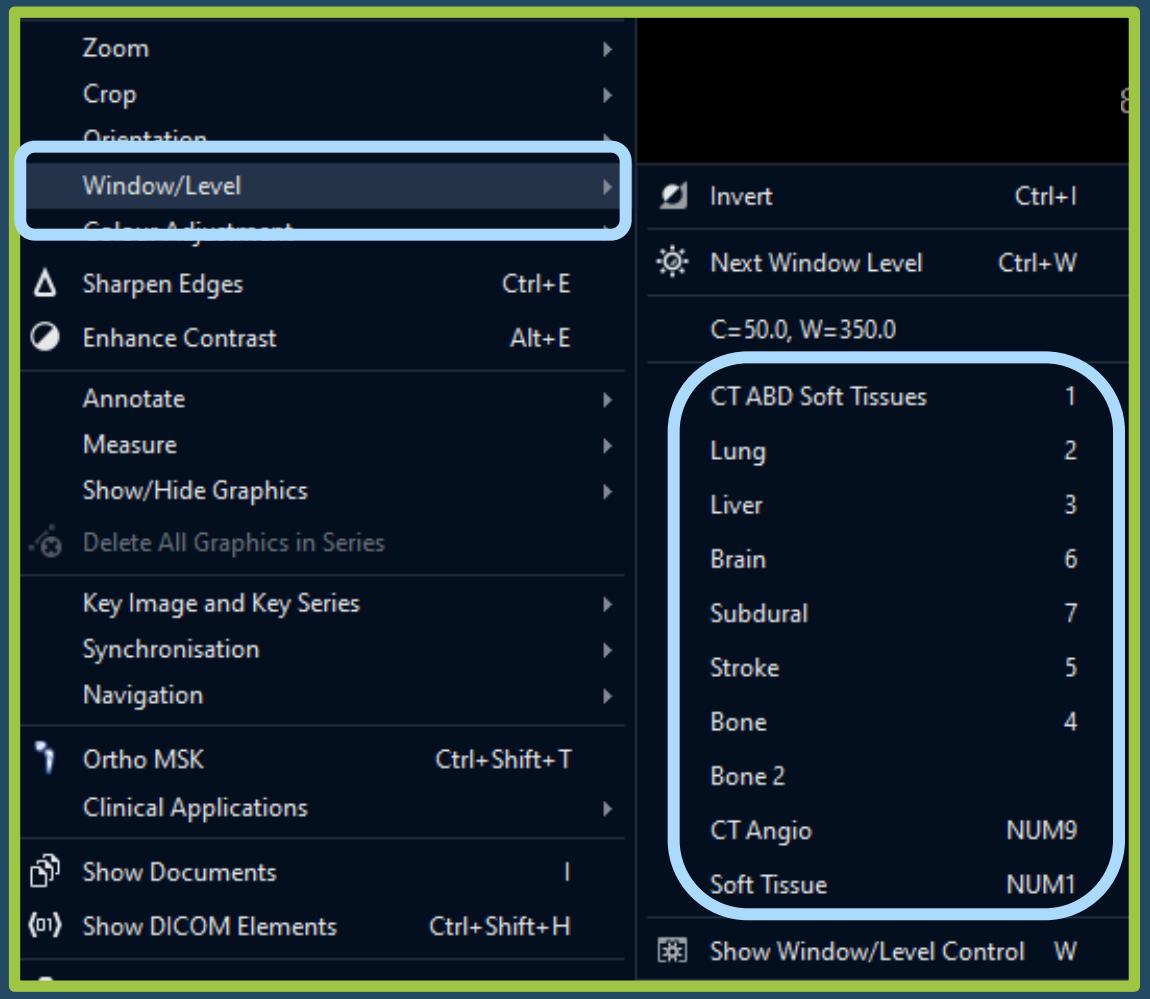
EFFECT OF CHANGING WW

- Centre is -600HU
- Width is 1500

- All structures with HU > +100 will be white

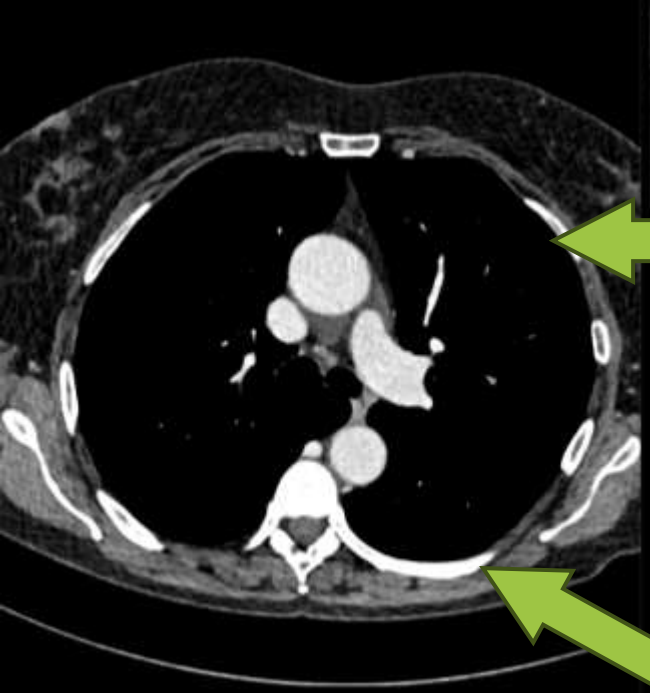
- All structures with HU < -1350 will be black

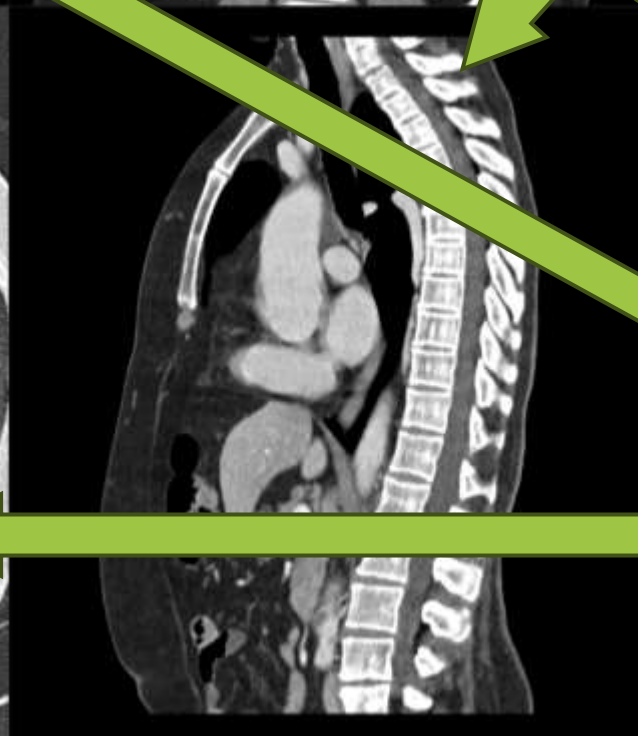




SECTRA PACS HAS STANDARD WW & WL SET UP

Screenshot from Sectra PACS





AXIAL

SAGITTAL

CORONAL

SOFT TISSUE WINDOWS

LUNG WINDOWS

RECAP

Gantry containing xray source and detectors

Spinning around patient

Patient is moved on CT table through the gantry

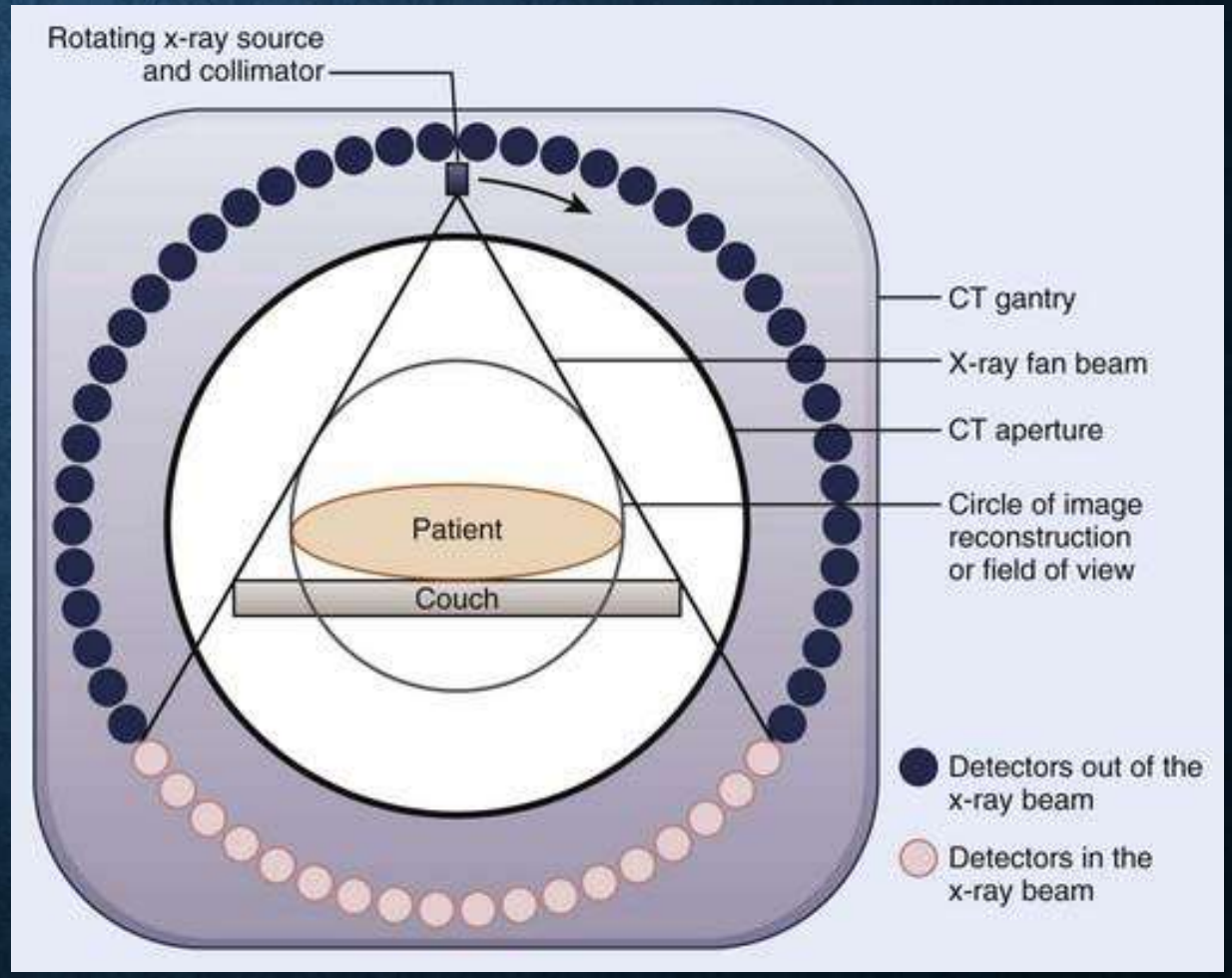
Spiral acquisition

Data produced that a computer then manipulates to provide a stack of images

Can be displayed in lots of ways depending on WW and WL settings

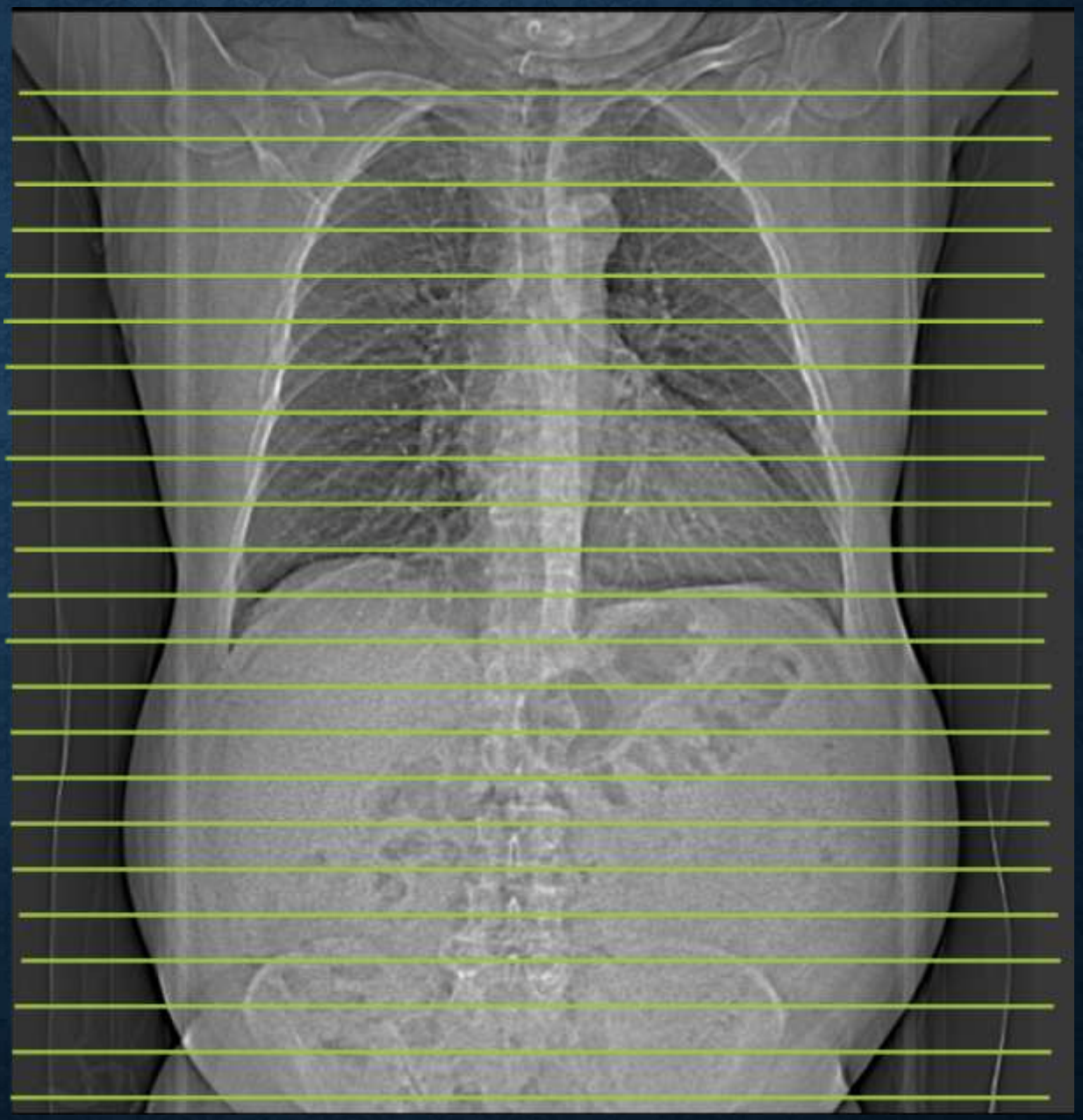
POSITIONING

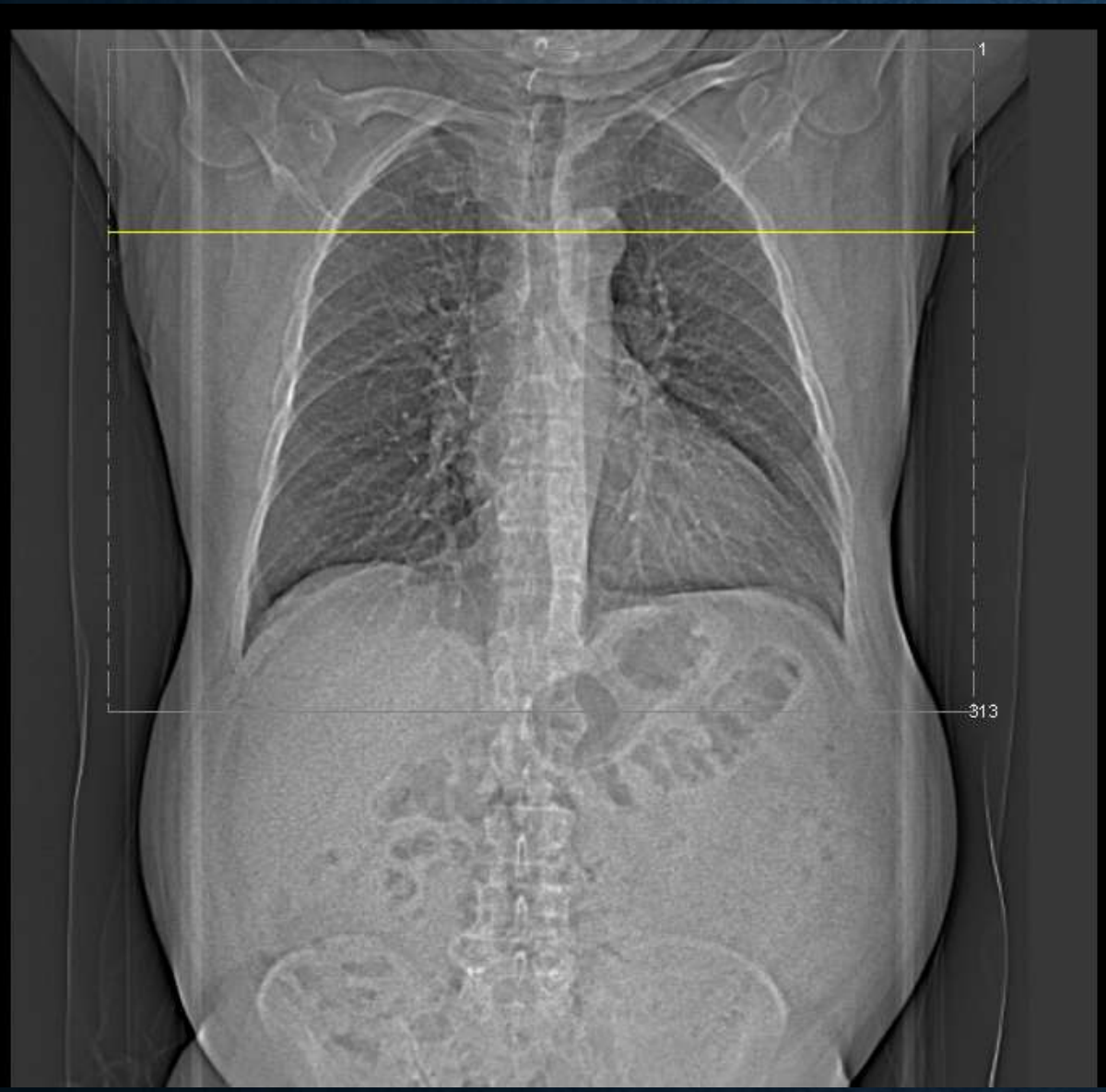
- Radiographers need to put patient in the ISOCENTRE
- If too low or too high – dose will be wrong and images poor quality

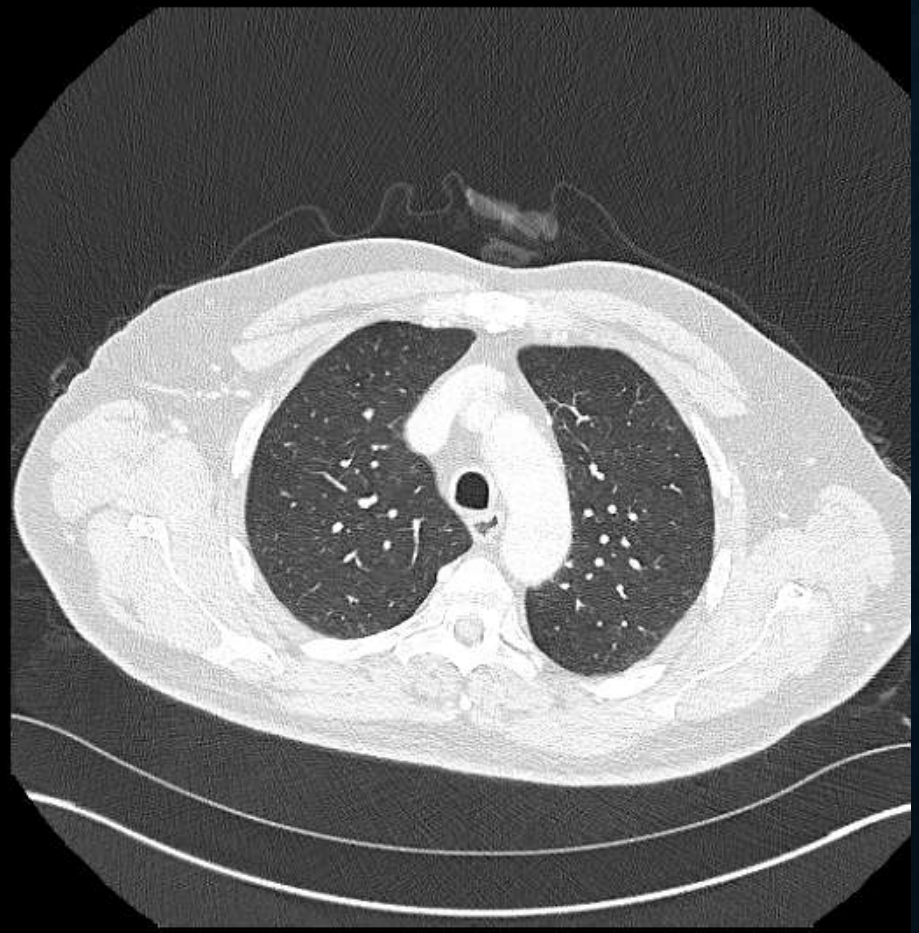


https://clinicalgate.com/immobilization-and-simulation/

GRID LINES




1
313

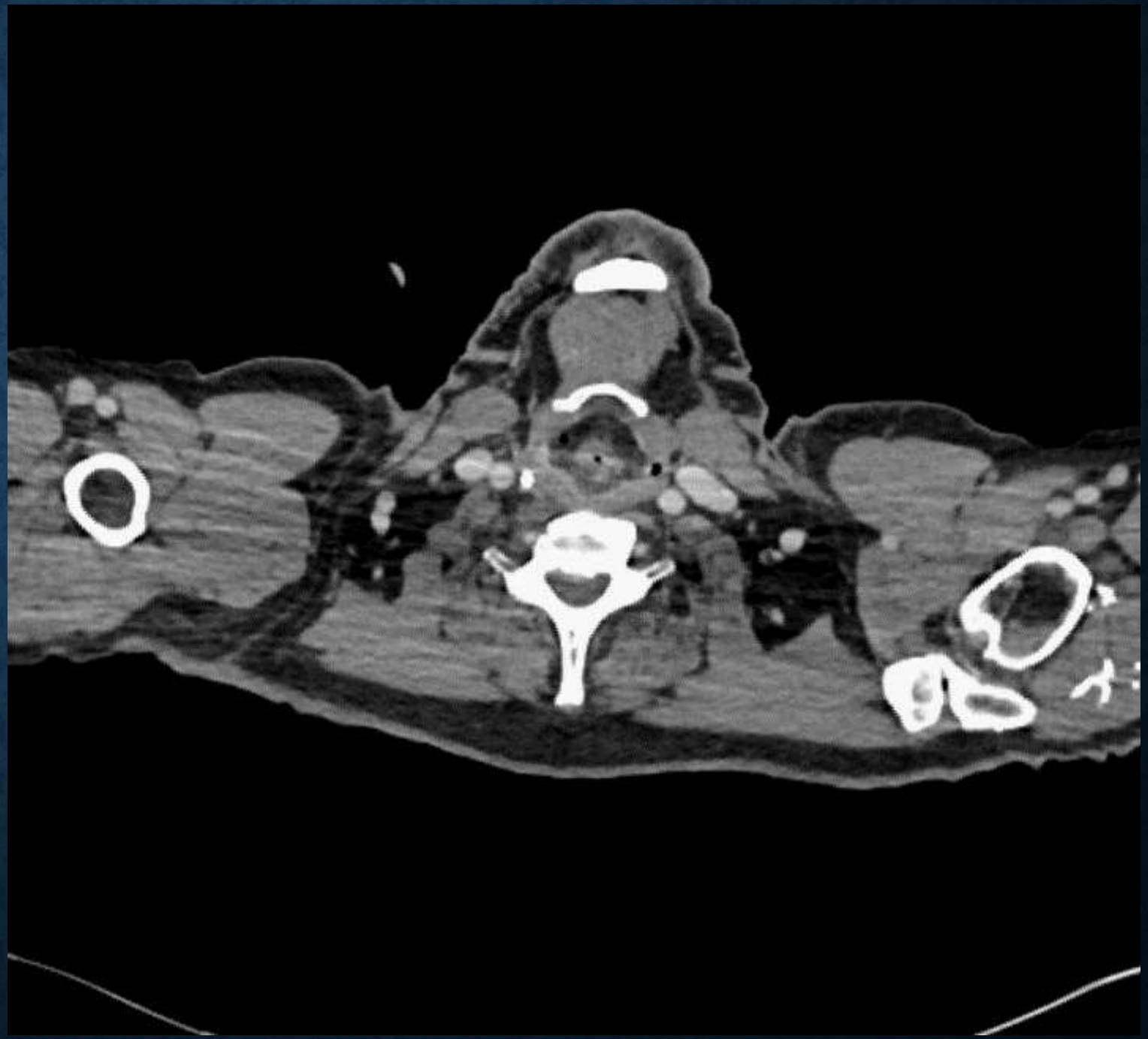


ANATOMY

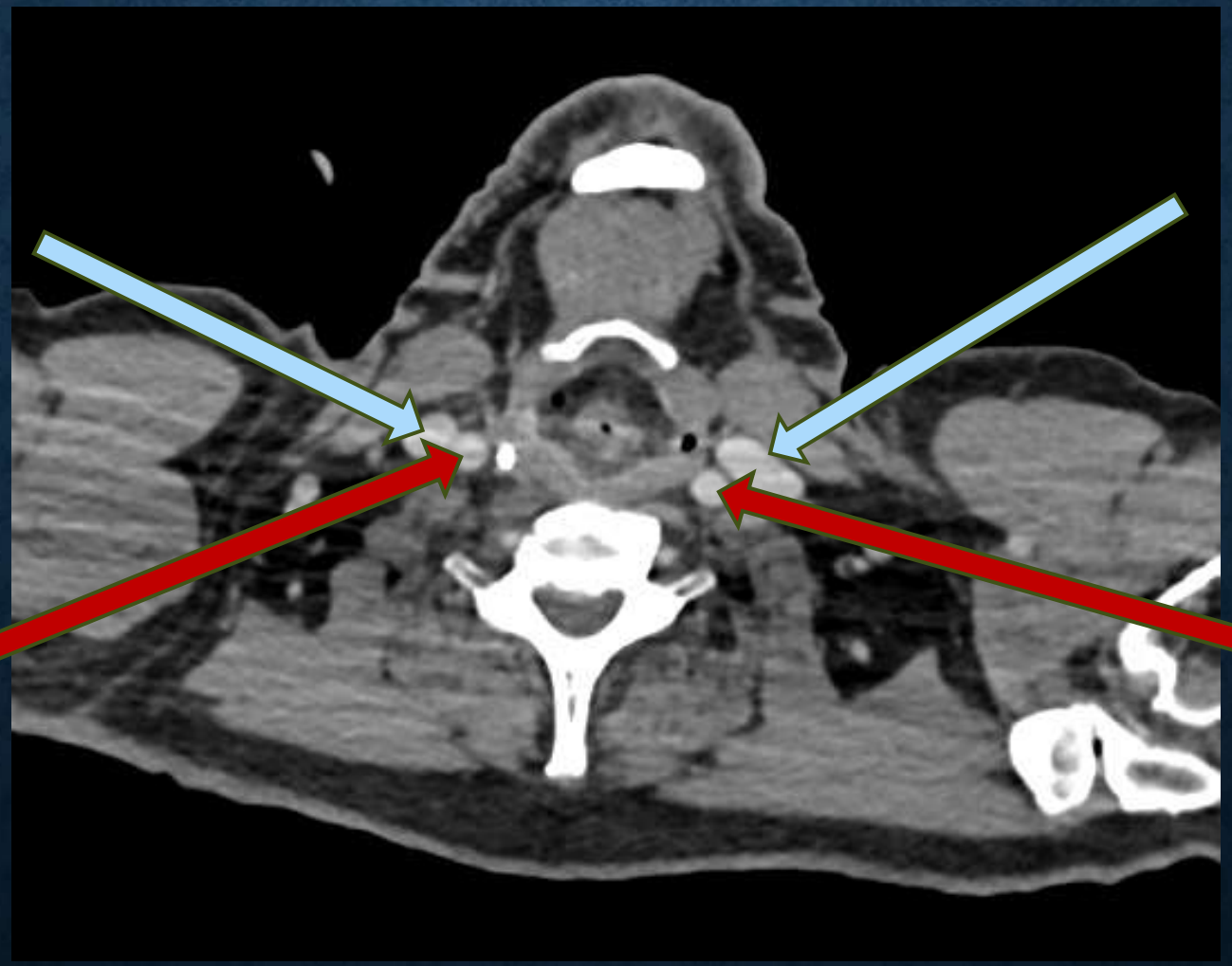
- Need to know normal before spotting abnormal
- Contrast makes it easier to identify vessels
- Different protocols of CT
  - Depends on what the question is
  - ? PE – need vessels in the pulmonary arteries
  - ? Mesothelioma – need soft tissue enhancement phase (pleural phase)

ANATOMY

- Use the body's symmetry to help
- Particularly in the neck



VESSELS HAVE LENGTH



Internal jugular vein

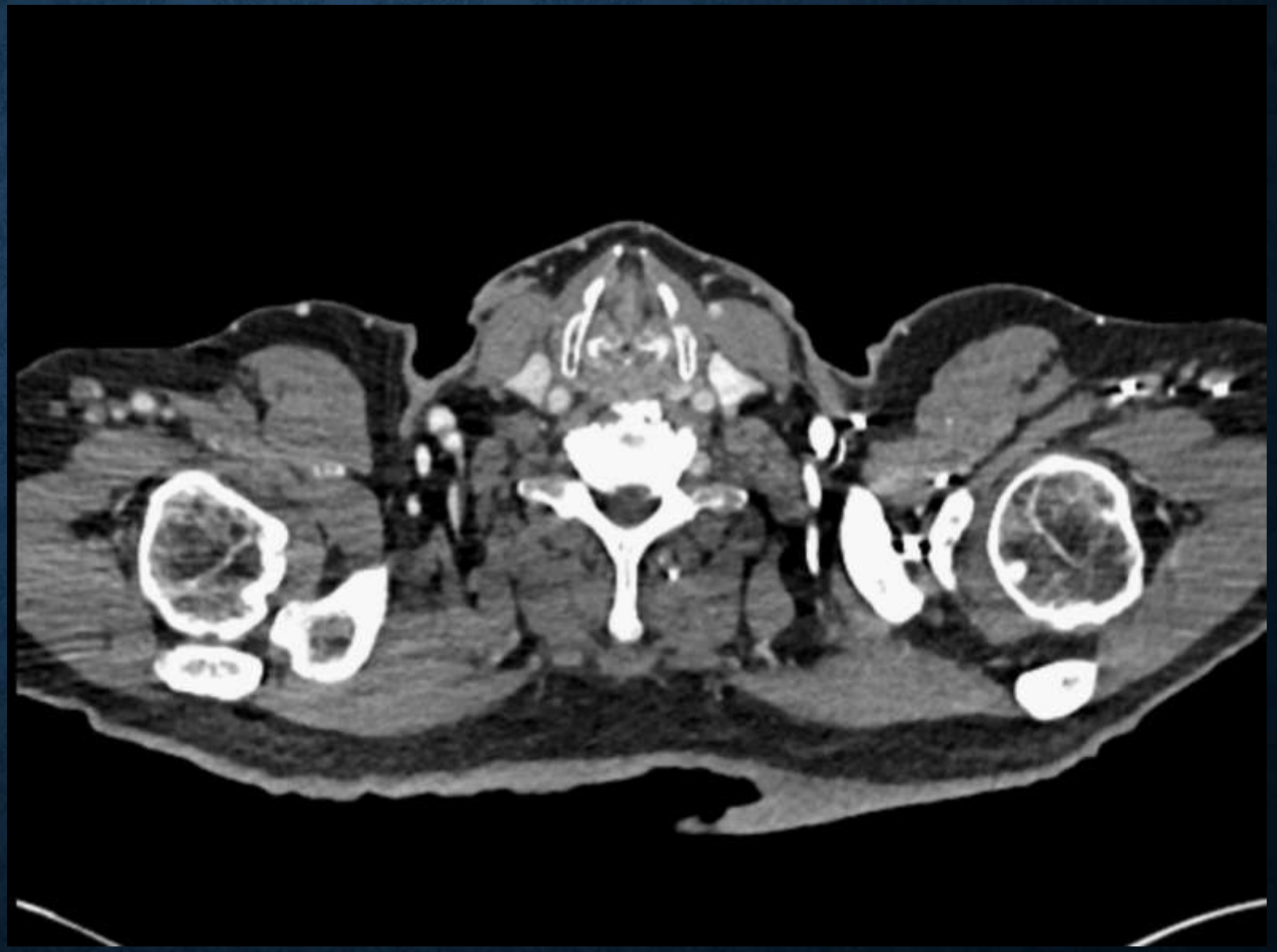
Internal jugular vein

Internal jugular artery

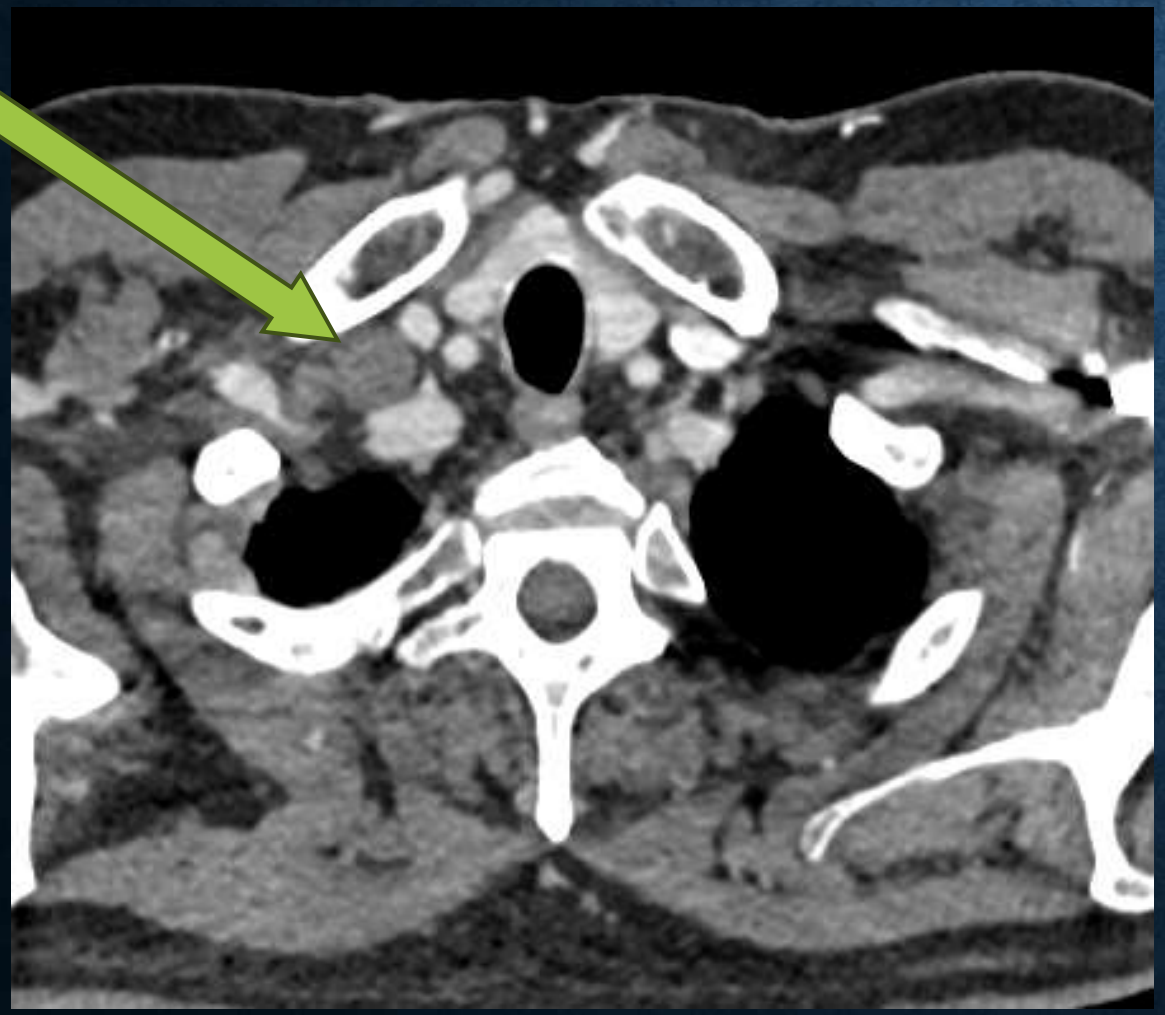
Internal jugular artery

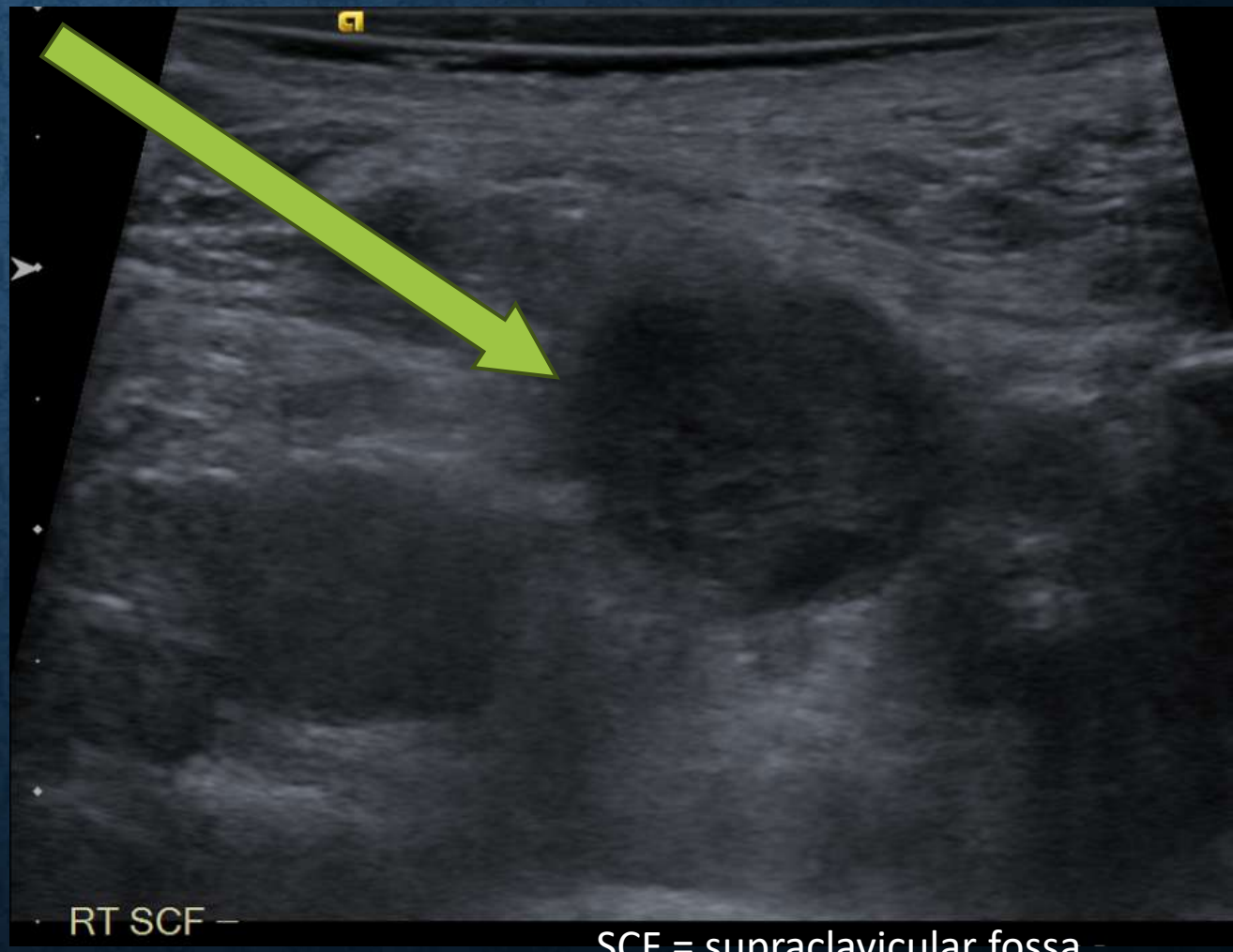
NECK NORMAL?

1. RIGHT
2. LEFT
3. NO IDEA



RIGHT SCF NODE – METASTATIC SQUAMOUS CELL CARCINOMA

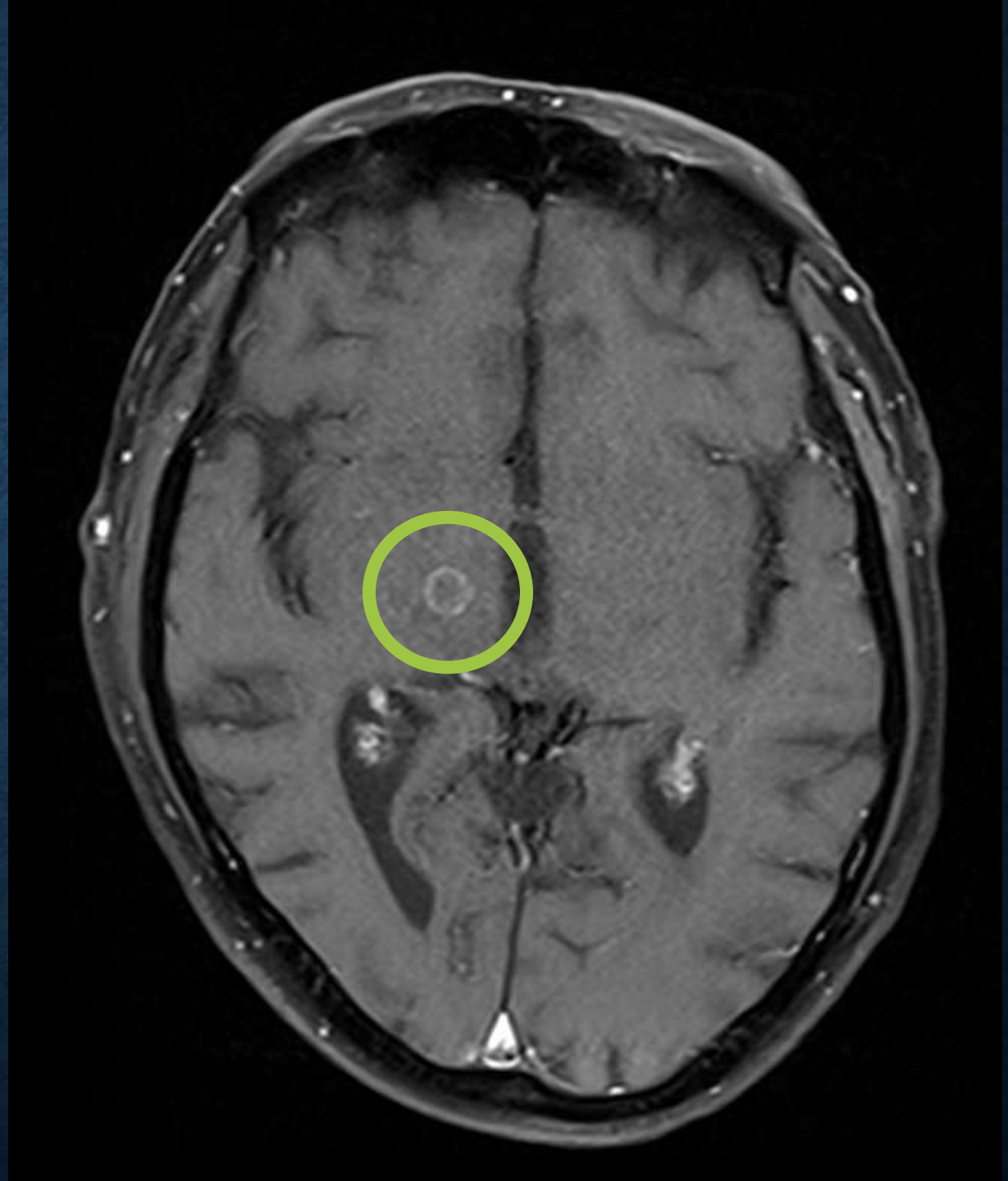


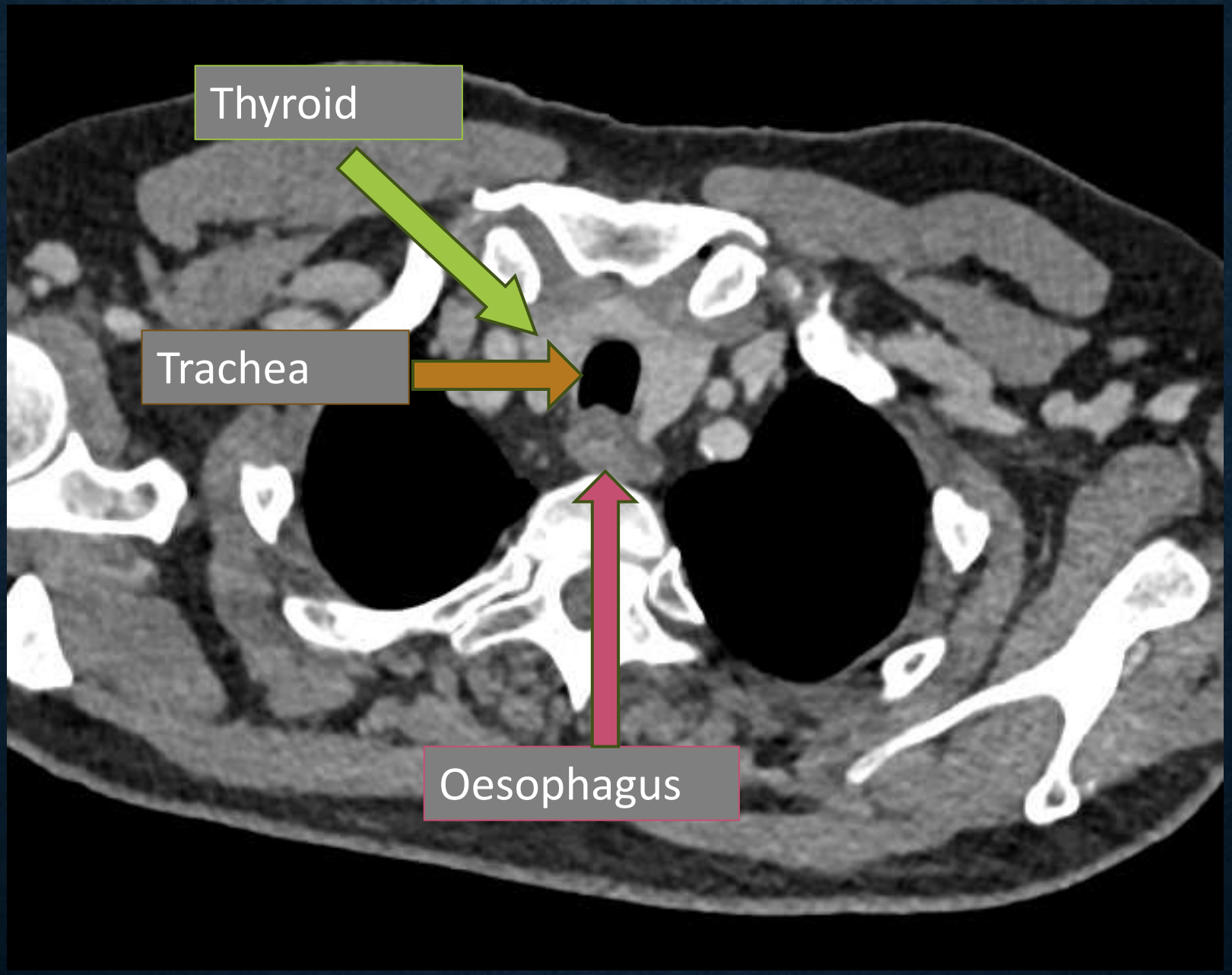


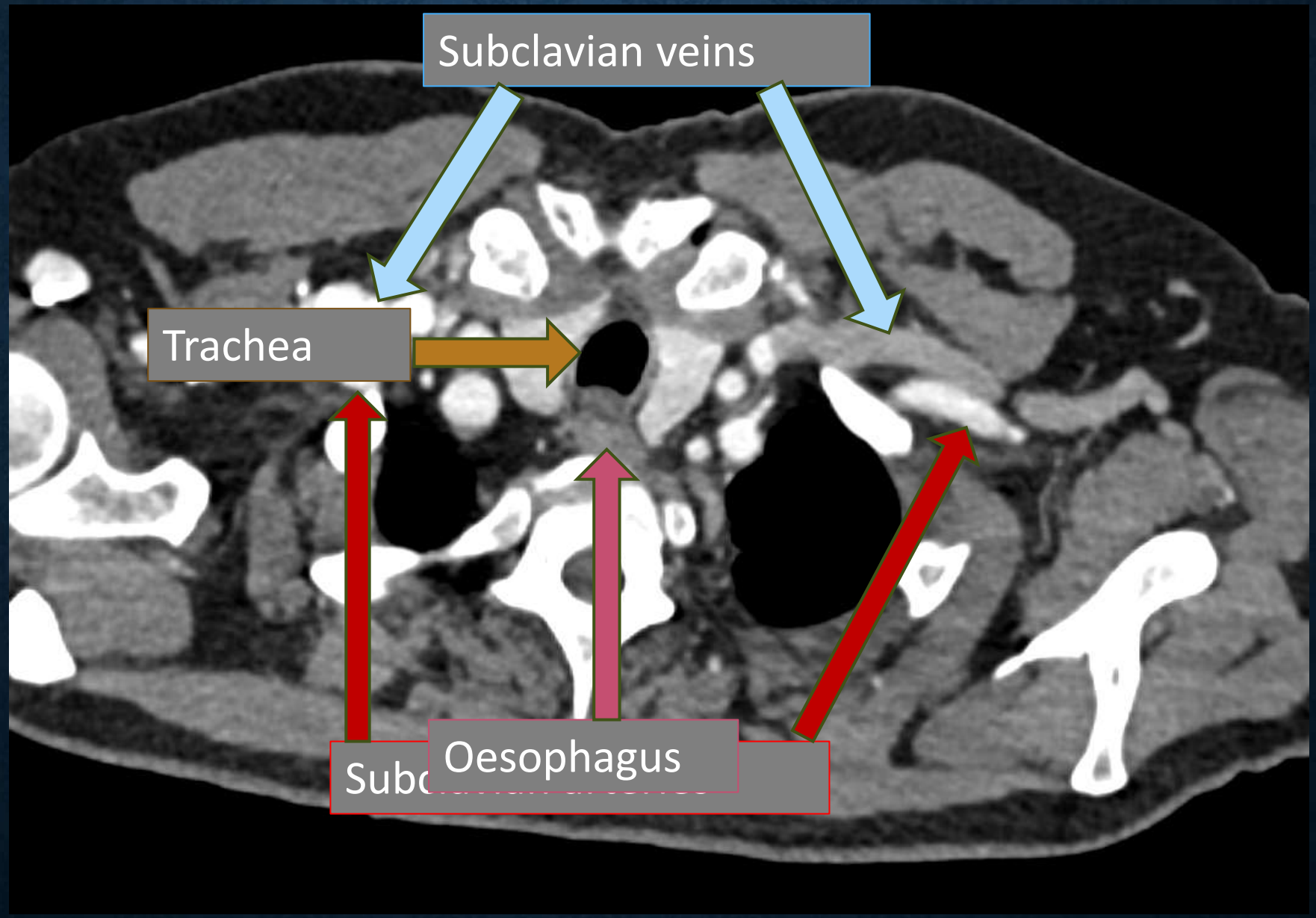
SCF = supraclavicular fossa

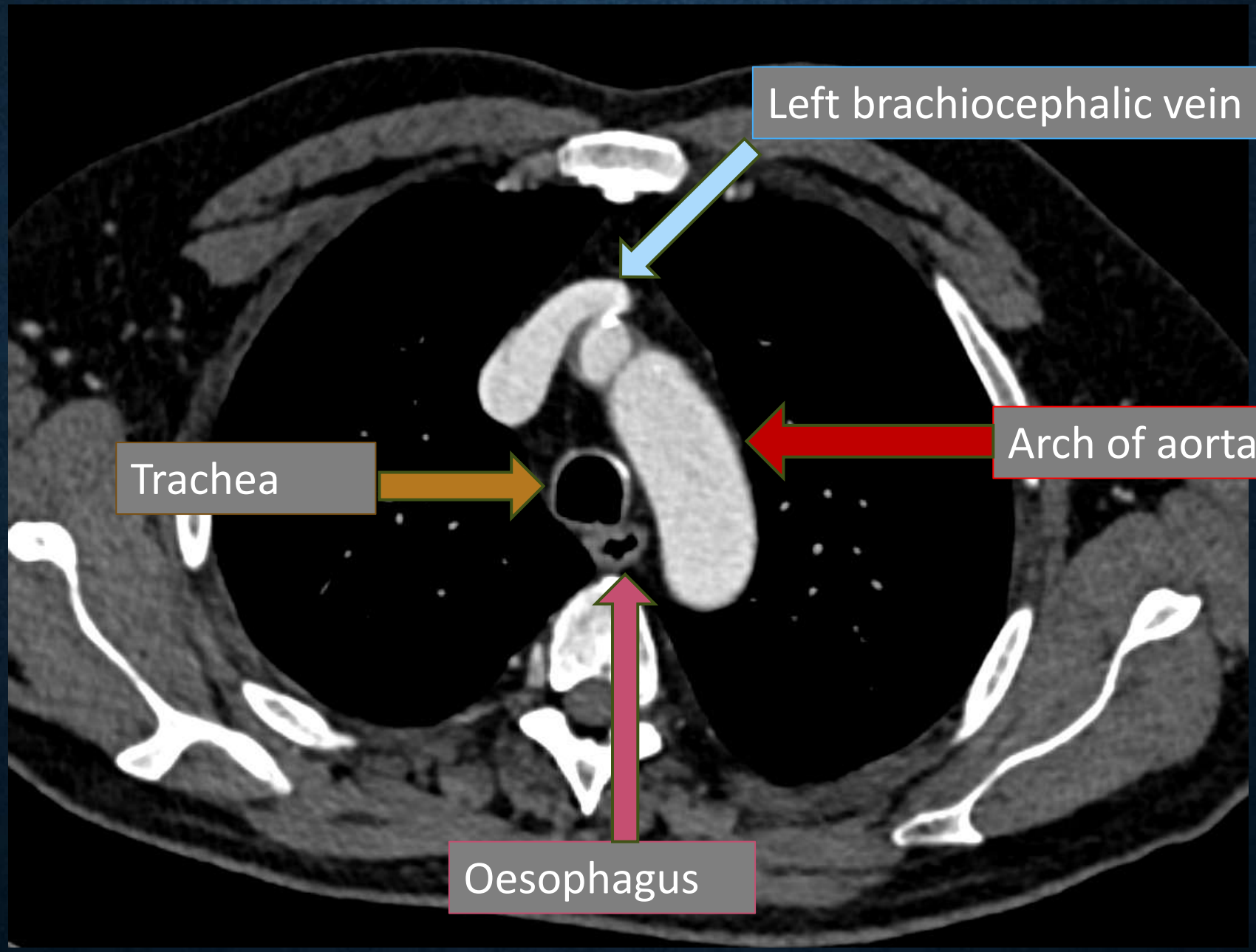
STAGE IV DISEASE

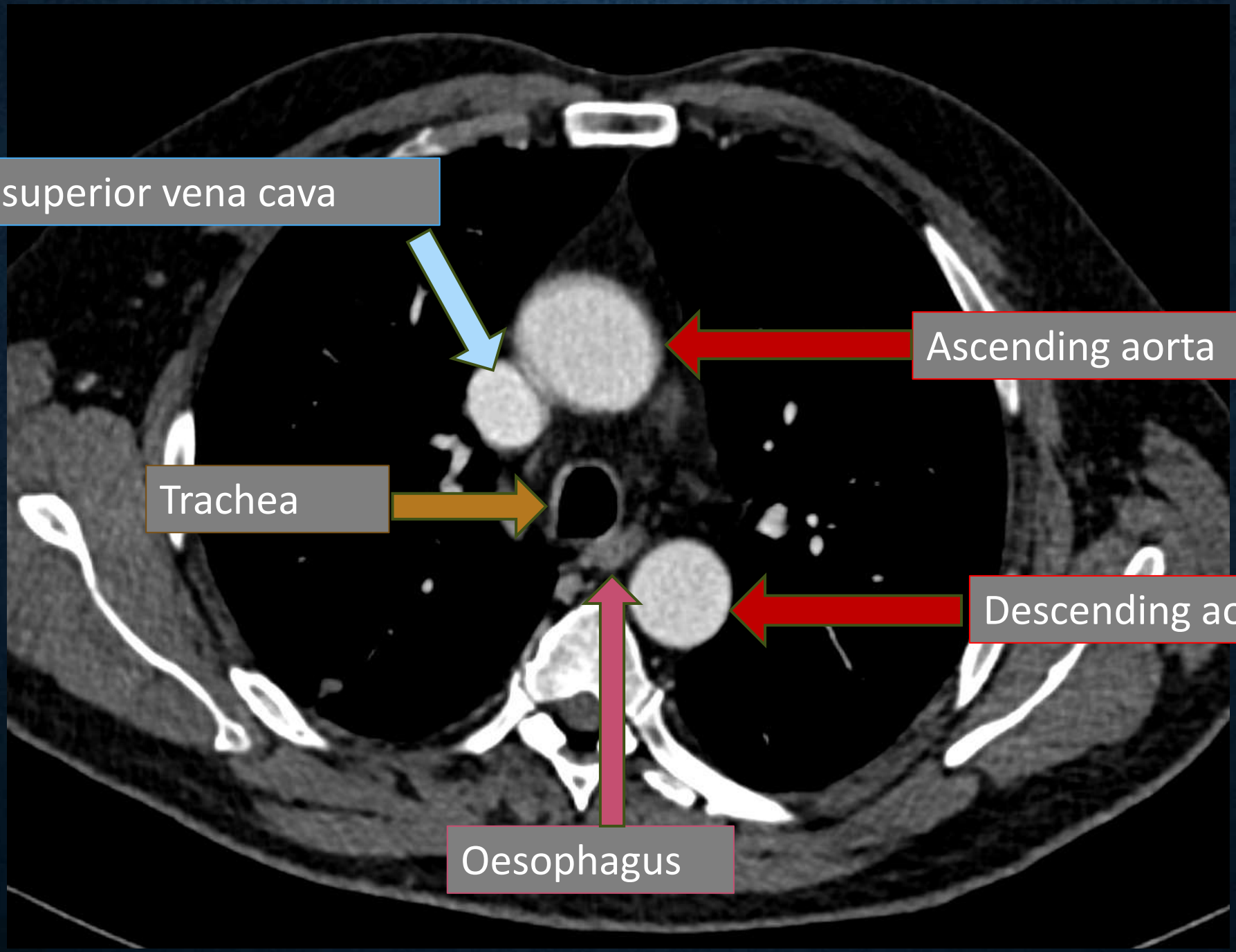
BRAIN METASTASIS

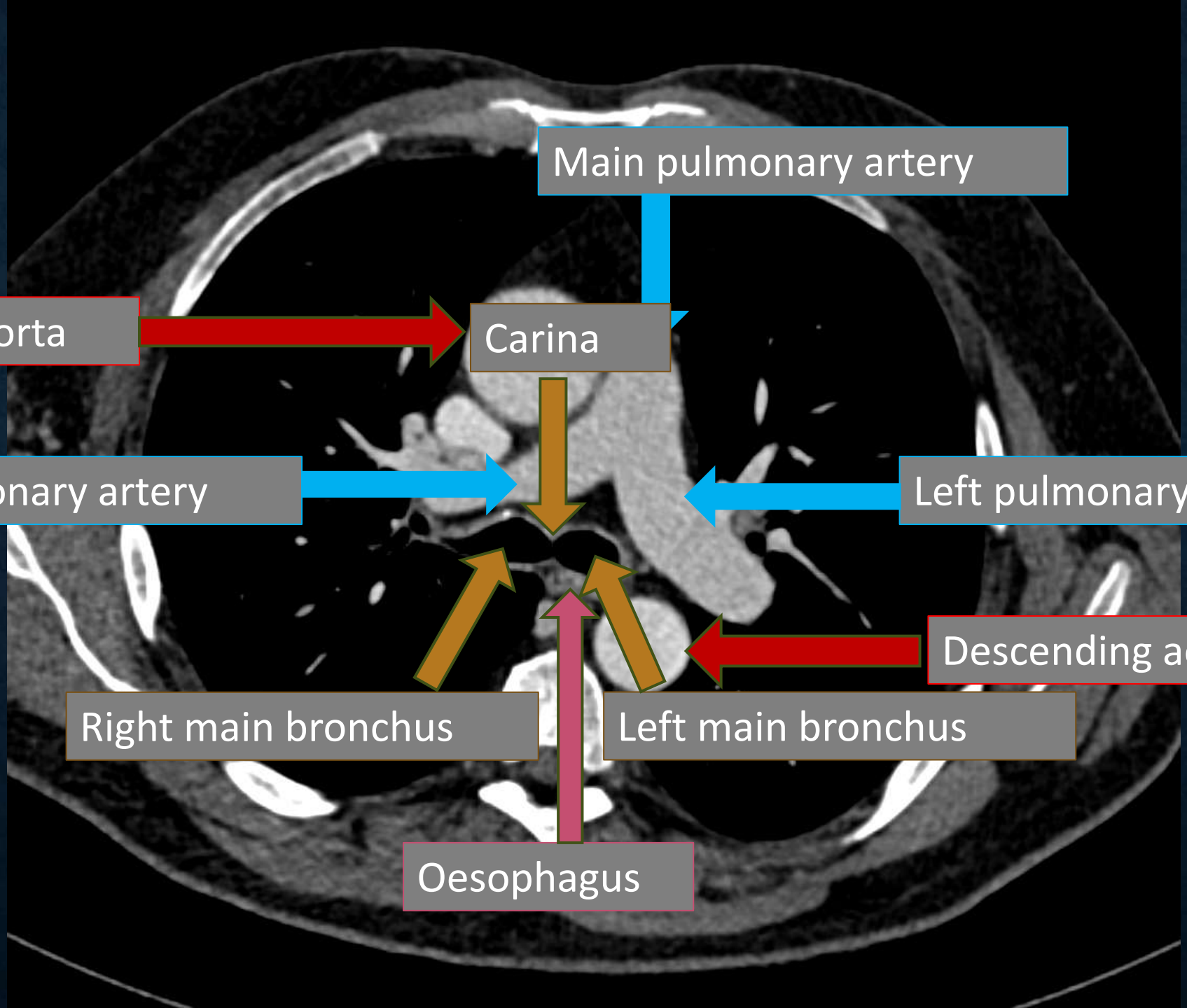



Thyroid
Trachea
Oesophagus


Subclavian veins
Trachea
Oesophagus


Left brachiocephalic vein
Arch of aorta
Trachea
Oesophagus


SVC – superior vena cava
Ascending aorta
Trachea
Descending aorta
Oesophagus


Main pulmonary artery
Ascending aorta
Carina
Right pulmonary artery
Left pulmonary artery
Descending aorta
Right main bronchus
Left main bronchus
Oesophagus

CT TERMS

Chest CT terms

- Acinus
- Acute interstitial pneumonia
- Air bronchogram
- Air crescent
- Air trapping
- Airspace
- AP window
- Apical cap
- Architectural distortion
- Atelectasis
- Azygoesophageal recess
- Aygous fissure
- Beaded septum sign
- Bleb
- Bronchiectasis
- Bronchiole
- Bronchiolectasis
- Bronchiolitis
- Bronchocele
- Bronchocentric
- Broncholith
- Bulla
- Bullous emphysema
- Cavity
- Centrilobular
- Centrilobular emphysema
- Collapse
- Consolidation
- Crazy-paving pattern
- Cryptogenic organizing pneumonia
- Cyst
- Desquamative interstital pneumonia
- Folded lung
- Fungus ball
- Gas trapping
- Ground-glass nodule
- Ground-glass opacity
- Halo sign
- Hilum
- Honeycombing
- Idiopathic fibrosis
- Infarction
- Infiltrate
- Interlobular septal thickening
- Interlobular septum
- Interstitial emphysema
- Interstitium
- Intralobular lines
- Juxtaphrenic peak
- Linear atelectasis
- Lobe
- Lobular core structures
- Lobule
- Lymphadenopathy
- Lymphoid interstitial pneumonia
- Mass
- Mediastinal compartments
- Micronodule
- Miliary pattern
- Mosaic attenuation pattern
- Mosaic perfusion
- Mycetoma
- Nodular pattern
- Nodule
- Non specific interstitial pneumonia
- Oligaemia
- Opacity
- Organizing pneumonia
- Panacinar emphysema
- Paraseptal emphysema
- Parenchyma
- Parenchymal band
- Parenchymal opacification
- Peribronchovascular interstitium
- Perilobular distribution
- Perilymphatic distribution
- Platelike atelectasis
- Pleural plaque
- Pneumatocele
- Pneumomediastinum
- Pneumonia
- Pneumocardium
- Pneumothorax
- Progressive massive fibrosis
- Pseudocavity
- Pseudoplaque
- Respiratory bronchiolitis-interstitial lung disease
- Reticular pattern
- Reticulonodular pattern
- Reversed halo sign
- Right paratracheal stripe
- Rounded atelectasis
- Secondary pulmonary nodule
- Segment

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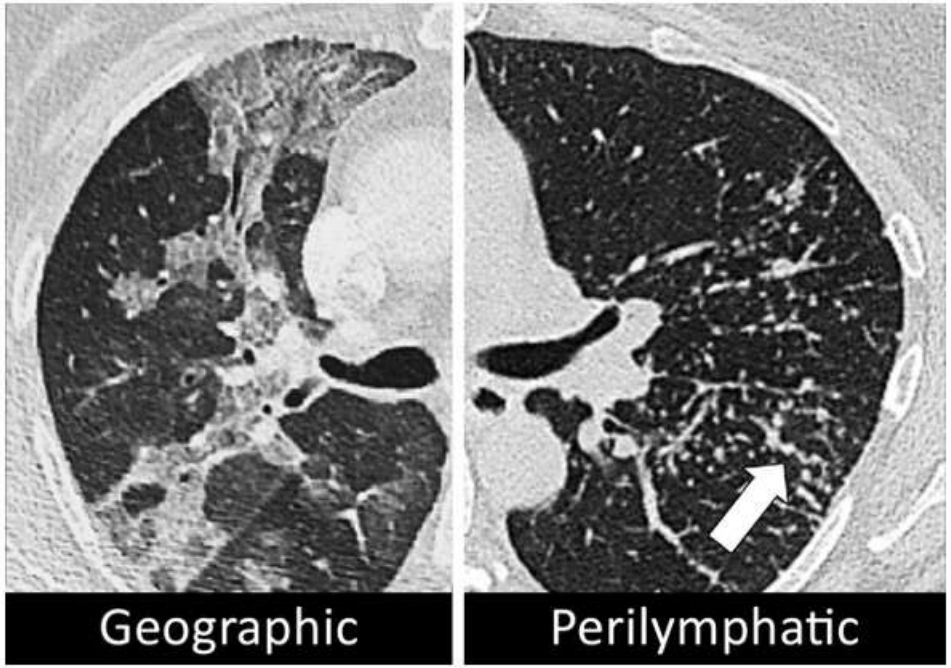
- Reticulonodular pattern
- Reversed halo sign
- Right paratracheal stripe
- Rounded atelectasis
- Secondary pulmonary nodule
- Segment

- Septal line
- Septal thickening
- Signet ring sign
- Silhouette sign
- Small-airways disease
- Subpleural curvilinear line
- Traction bronchiectasis
- Tree-in-bud pattern
- Usual interstitial pneumonia

Fleischner Society: Glossary of Terms for Thoracic Imaging



- Members of the Fleischner Society have compiled a glossary of terms for thoracic imaging that replaces previous glossaries published in 1984, 1996, and 2008. As with previous versions, the aim of the present glossary is to establish standardization of terminology for thoracic radiology and, thereby, to facilitate communications between radiologists and clinicians. Moreover, the present glossary aims to contribute to a more stringent use of terminology, increasingly required for structured reporting and accurate searches in large databases.

Bankier AA et al. Published Online: February 27, 2024
https://doi.org/10.1148/radiol.232558

Radiology

Bankier AA. Published Online: February 27, 2024
https://doi.org/10.1148/radiol.232558

Radiology

EXAMPLES OF FLEISCHNER GLOSSARY

55 pages

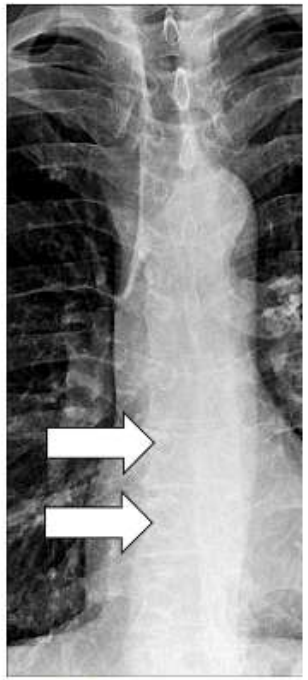


Figure 43: Azygo-esophageal recess: Frontal chest radiograph of the mediastinum shows the azygo-esophageal recess (arrows). *click to return to page 4*

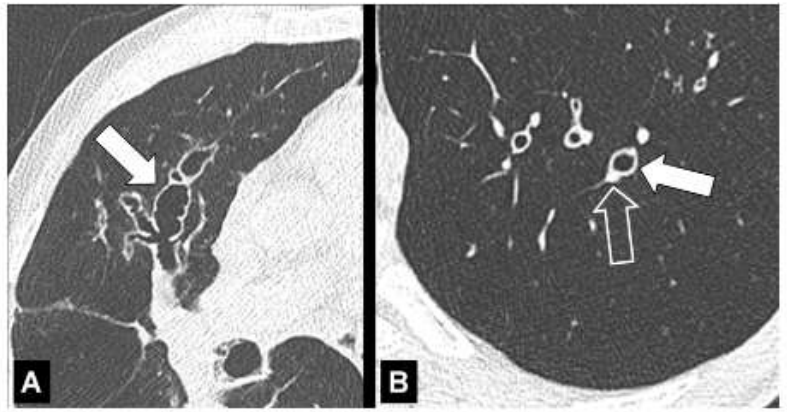


Figure 45: Bronchiectasis: Transverse CT images of the lungs in two different patients show severe bronchiectasis (solid arrow) in **(A)** right upper lobe and milder bronchiectasis (solid arrow) in **(B)** left lower lobe. Note the smaller diameter of the accompanying pulmonary artery (signet ring sign) (open arrow).

click to return to page 4

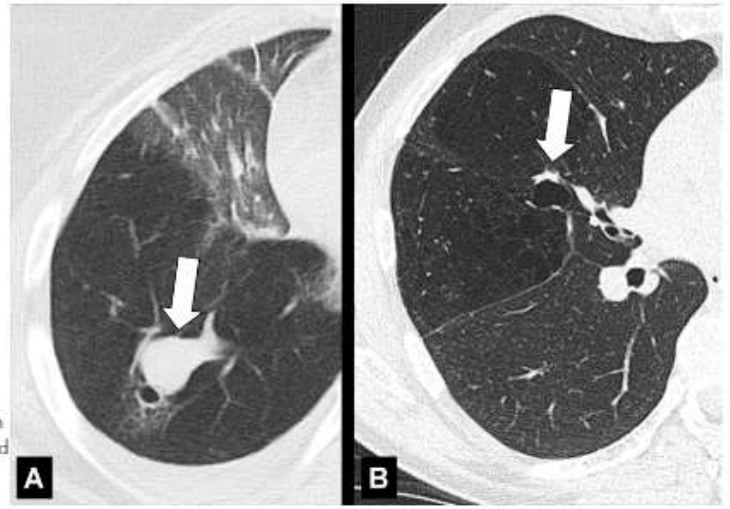


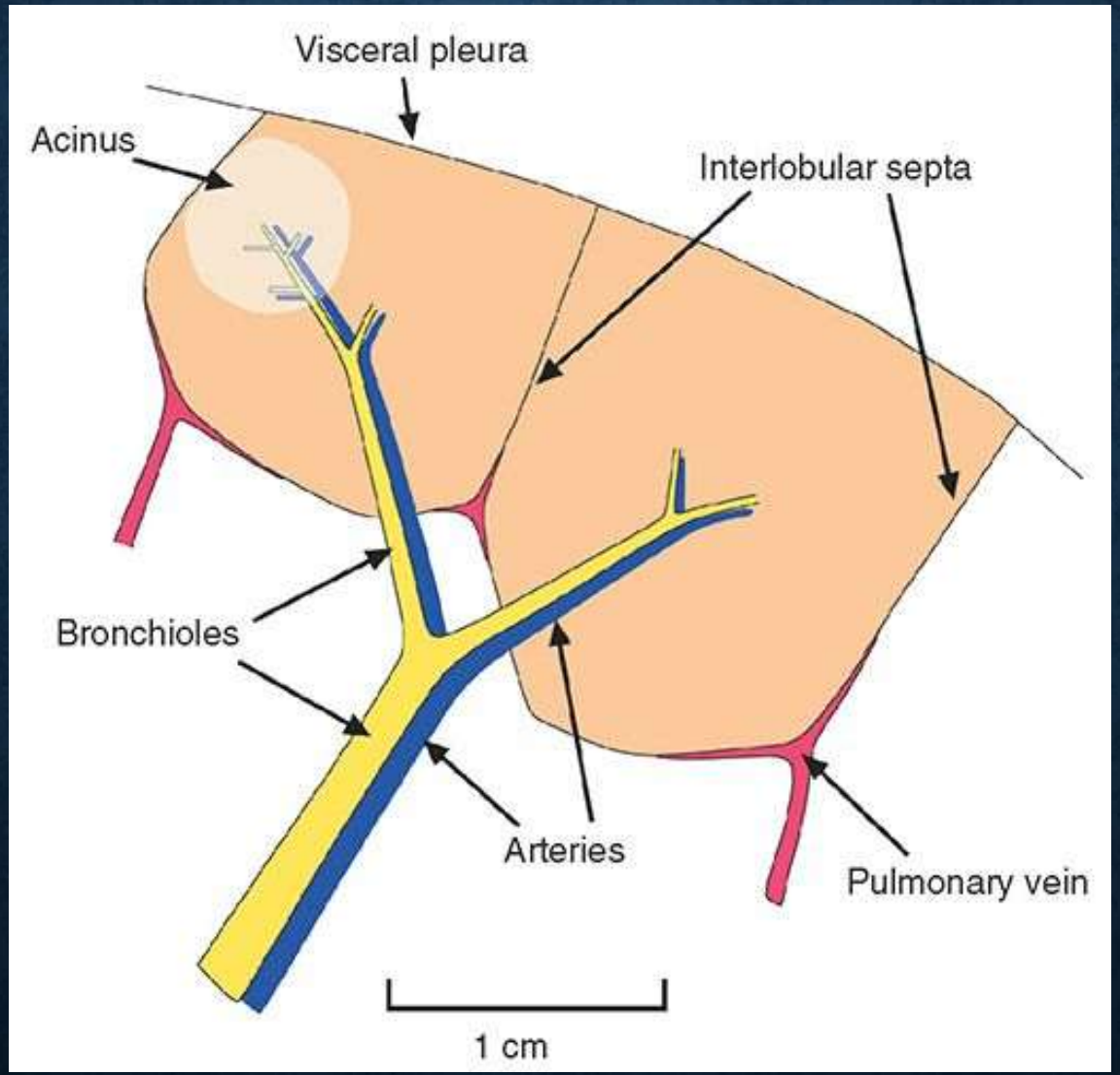
Figure 46: Bronchocele: Transverse CT images of the right lung in two different patients show localized bronchial dilatation **(A)** with and **(B)** without mucoid impaction within a hyperlucent lobe, due to congenital bronchial atresia (arrow). *click to return to page 4*

https://pubs.rsna.org/doi/epdf/10.1148/radiol.232558

A FEW TERMS

- Secondary pulmonary lobule
- Reticulation
- Nodule
- Mass
- Ground glass
- Consolidation

SECONDARY PULMONARY LOBULE



https://x.com/samrad77/status/1410483973302767617/photo/2

LOBULE

- The lobule (secondary pulmonary lobule) is the smallest unit of lung surrounded by connective-tissue septa
- Centrilobular structures
  - bronchioles
  - pulmonary arterioles
  - lymphatic vessels
- The connective-tissue septa surrounding the pulmonary lobule—the interlobular septa
  - Veins
  - Lymphatic vessels

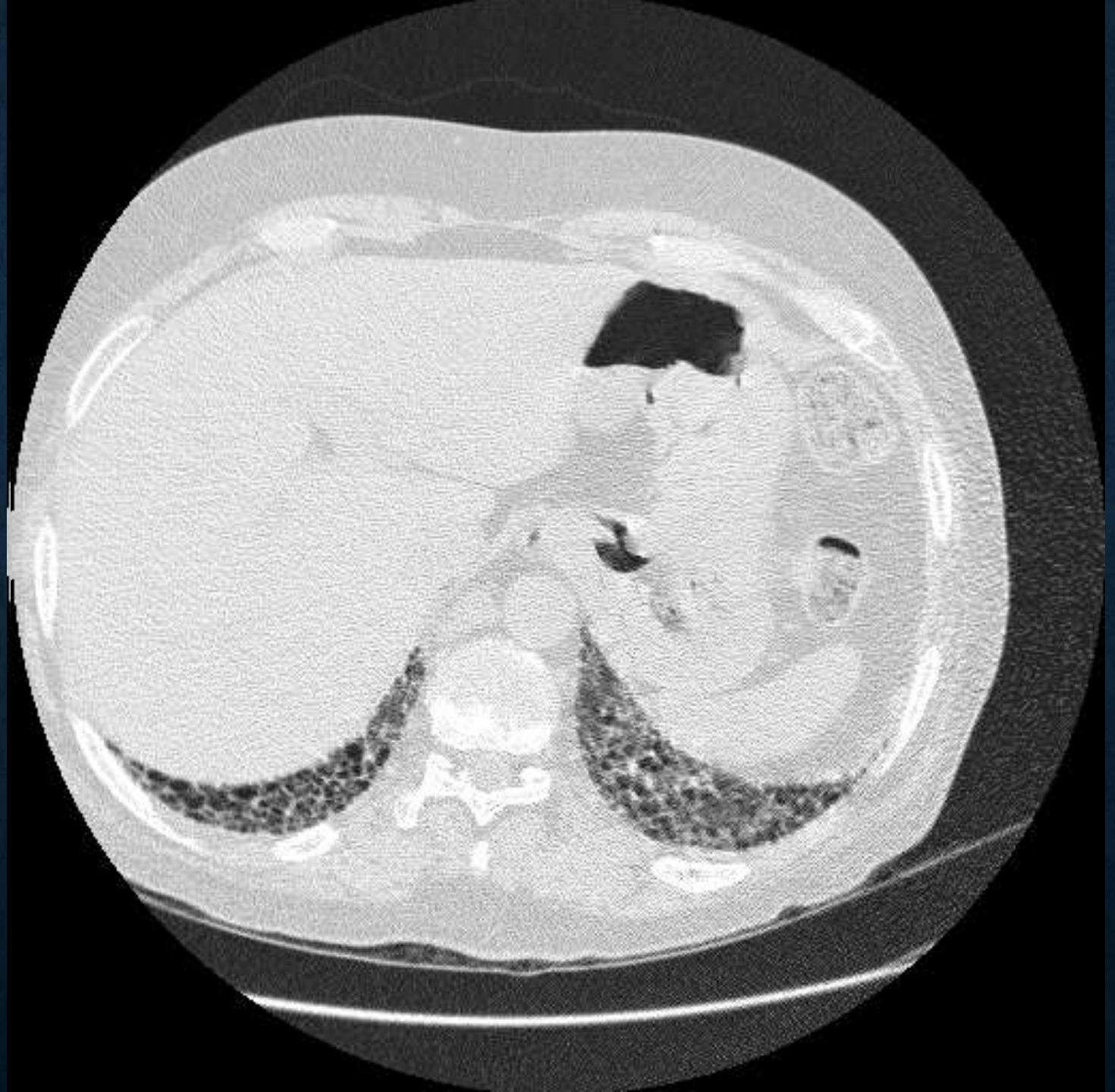
A FEW TERMS

- Secondary pulmonary lobule
- Reticulation
- Nodule
- Mass
- Ground glass
- Consolidation

RETICULATION

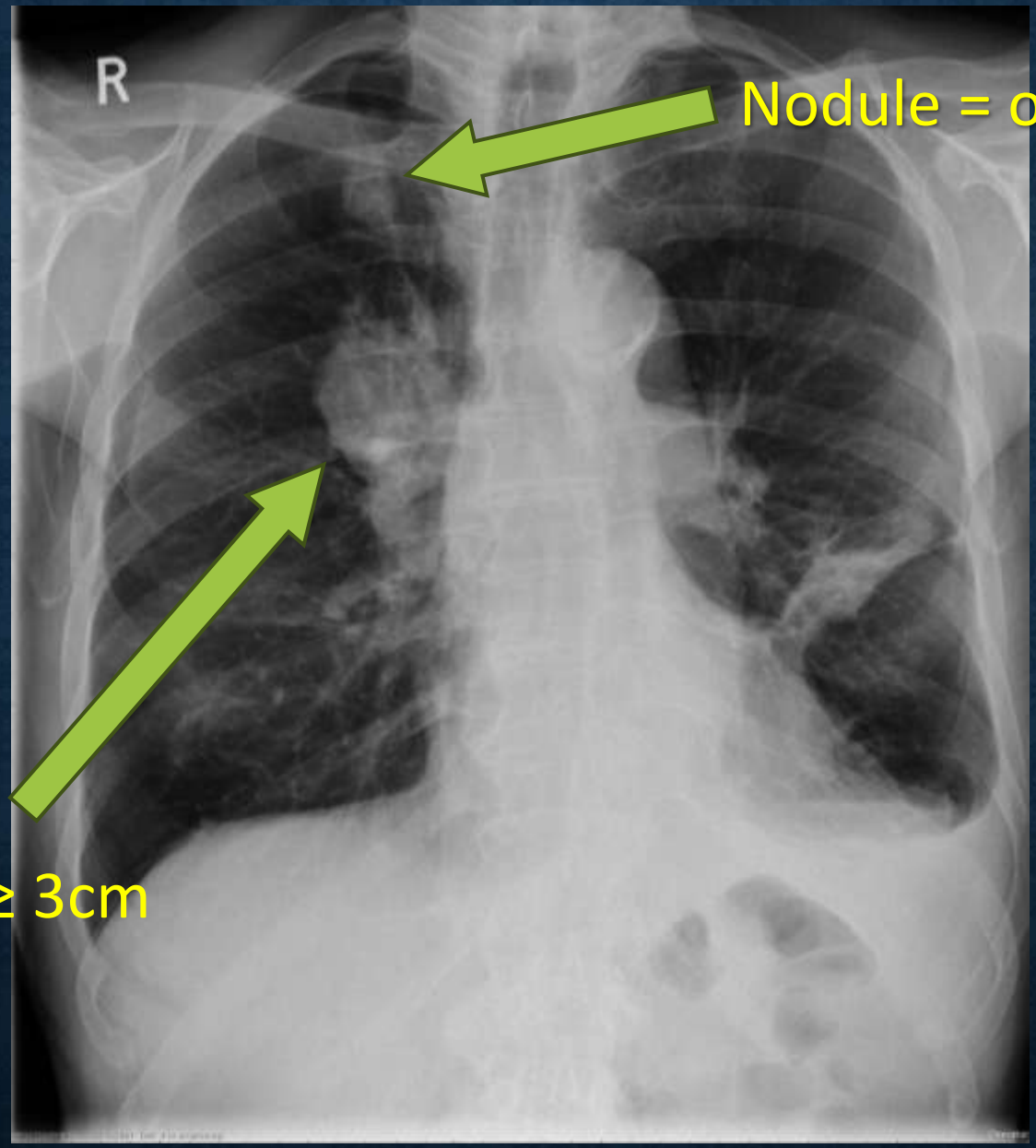
- On CXR – collection of innumerable small linear opacities that, by summation, produce an appearance resembling a net

- On HRCT – more clearly seen
  - Interlobular septal thickening
  - Intralobular septal lines
  - Cyst walls of honeycombing



A FEW TERMS

- Secondary pulmonary lobule
- Reticulation
- Nodule
- Mass
- Ground glass
- Consolidation



Nodule = opacity < 3cm

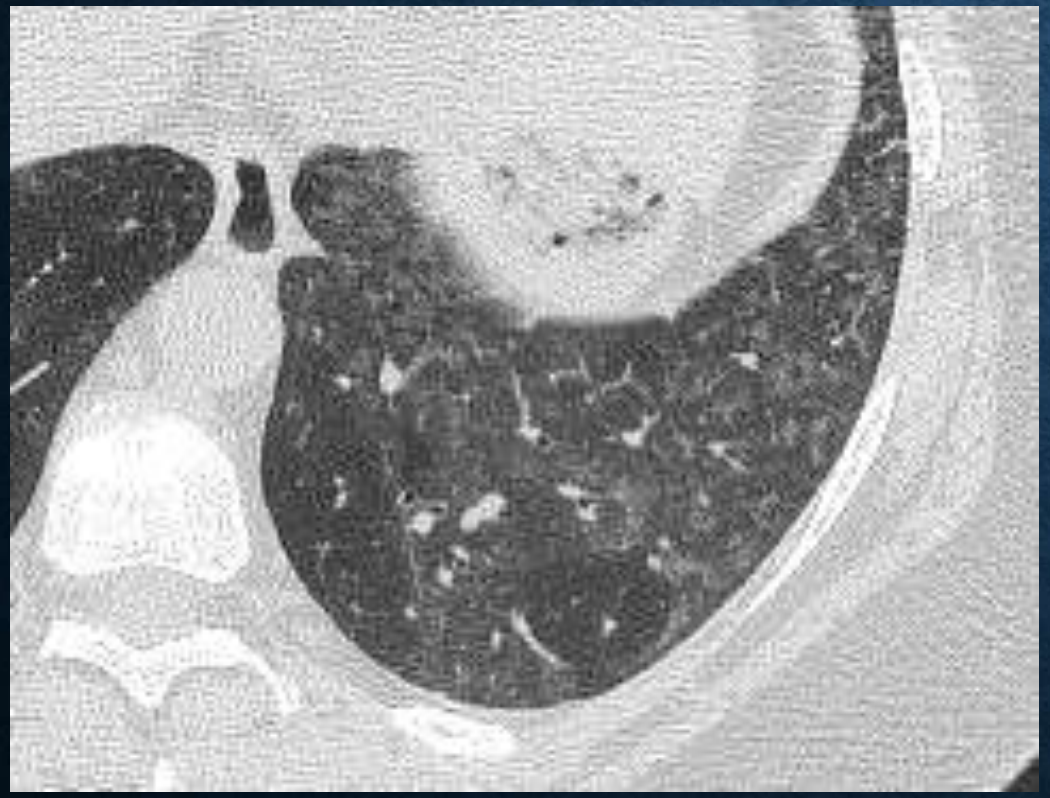
Mass = opacity ≥ 3cm

A FEW TERMS

- Secondary pulmonary lobule
- Reticulation
- Nodule
- Mass
- Ground glass
- Consolidation

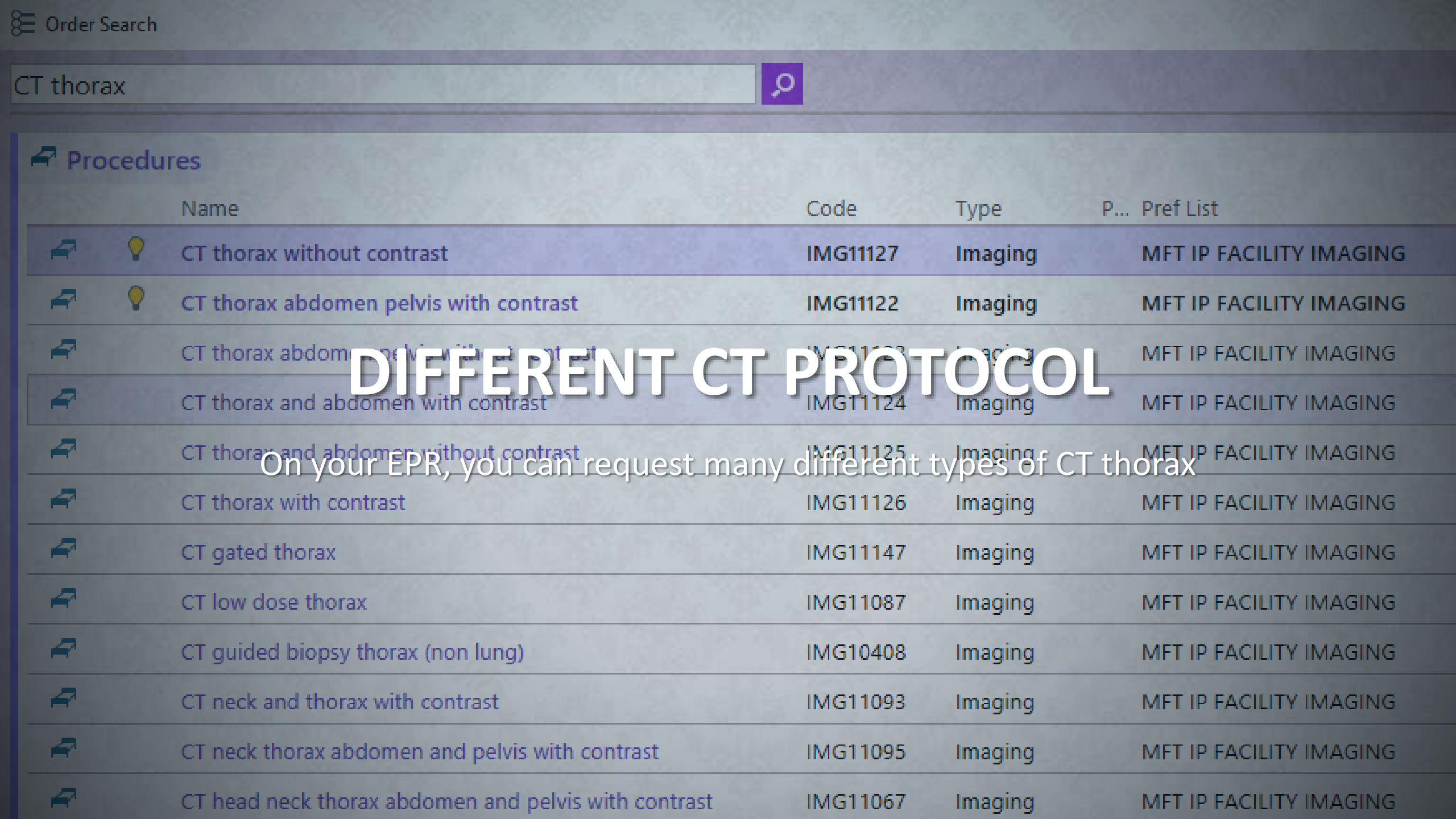
GGO VS CONSOLIDATION

GGO = opacity when vessels not obscured



Consolidation = opacity when vessels ARE obscured

Air bronchogram


Order Search
CT thorax
Procedures
Name
Code
Type
P...
Pref List
CT thorax without contrast
IMG11127
Imaging
MFT IP FACILITY IMAGING
CT thorax abdomen pelvis with contrast
IMG11122
Imaging
MFT IP FACILITY IMAGING
CT thorax and abdomen with contrast
IMG11124
Imaging
MFT IP FACILITY IMAGING
CT thorax with contrast
IMG11126
Imaging
MFT IP FACILITY IMAGING
CT gated thorax
IMG11147
Imaging
MFT IP FACILITY IMAGING
CT low dose thorax
IMG11087
Imaging
MFT IP FACILITY IMAGING
CT guided biopsy thorax (non lung)
IMG10408
Imaging
MFT IP FACILITY IMAGING
CT neck and thorax with contrast
IMG11093
Imaging
MFT IP FACILITY IMAGING
CT neck thorax abdomen and pelvis with contrast
IMG11095
Imaging
MFT IP FACILITY IMAGING
CT head neck thorax abdomen and pelvis with contrast
IMG11067
Imaging
MFT IP FACILITY IMAGING
DIFFERENT CT PROTOCOL
On your EPR, you can request many different types of CT thorax

WHICH ONE TO REQUEST?

- CT thorax without contrast
- CT thorax with contrast
- CT thorax and abdomen with contrast
- CT thorax and abdomen without contrast
- CT thorax, abdomen and pelvis with contrast
- CT thorax, abdomen and pelvis without contrast
- CT pulmonary angiogram

THE CHOICES

- CTPA
- Volumetric HRCT
- Non-volumetric HRCT
- Portal phase CT ie. Staging CT
- Low dose CT

HRCT : high resolution computed tomography

CTPA

- Looking for PEs
- Wells score

… or in MFT

- seems to be an entry criteria to get a bed on AMU!!

- Smart prep or bolus tracking

HRCT

- Limited number of diagnoses
  - IPF
  - Sarcoidosis
  - Bronchiectasis
  - Hypersensitivity pneumonitis
  - COP
  - Eosinophilic pneumonia
  - LCH /cystic lung diseases
  - Lymphangitis carcinomatosis
  - Asbestosis
  - TB
  - LVF

NON VOLUMETRIC HRCT

- Previously axial non contiguous
- 1mm every 10mm
- Good if young (<40 yo)
- Misses 90% lung
- IPF - higher risk of lung cancer

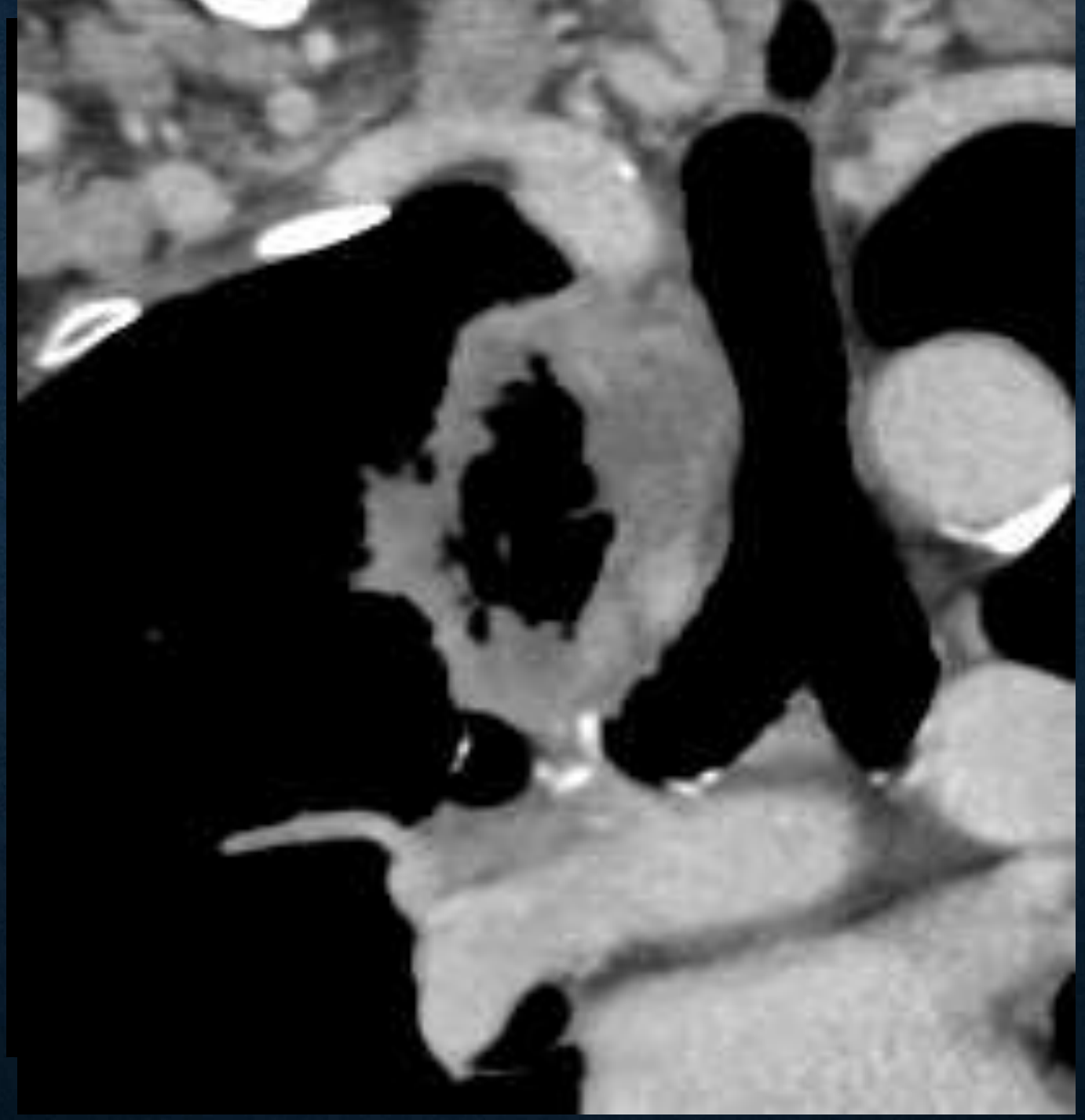
VOLUMETRIC HRCT

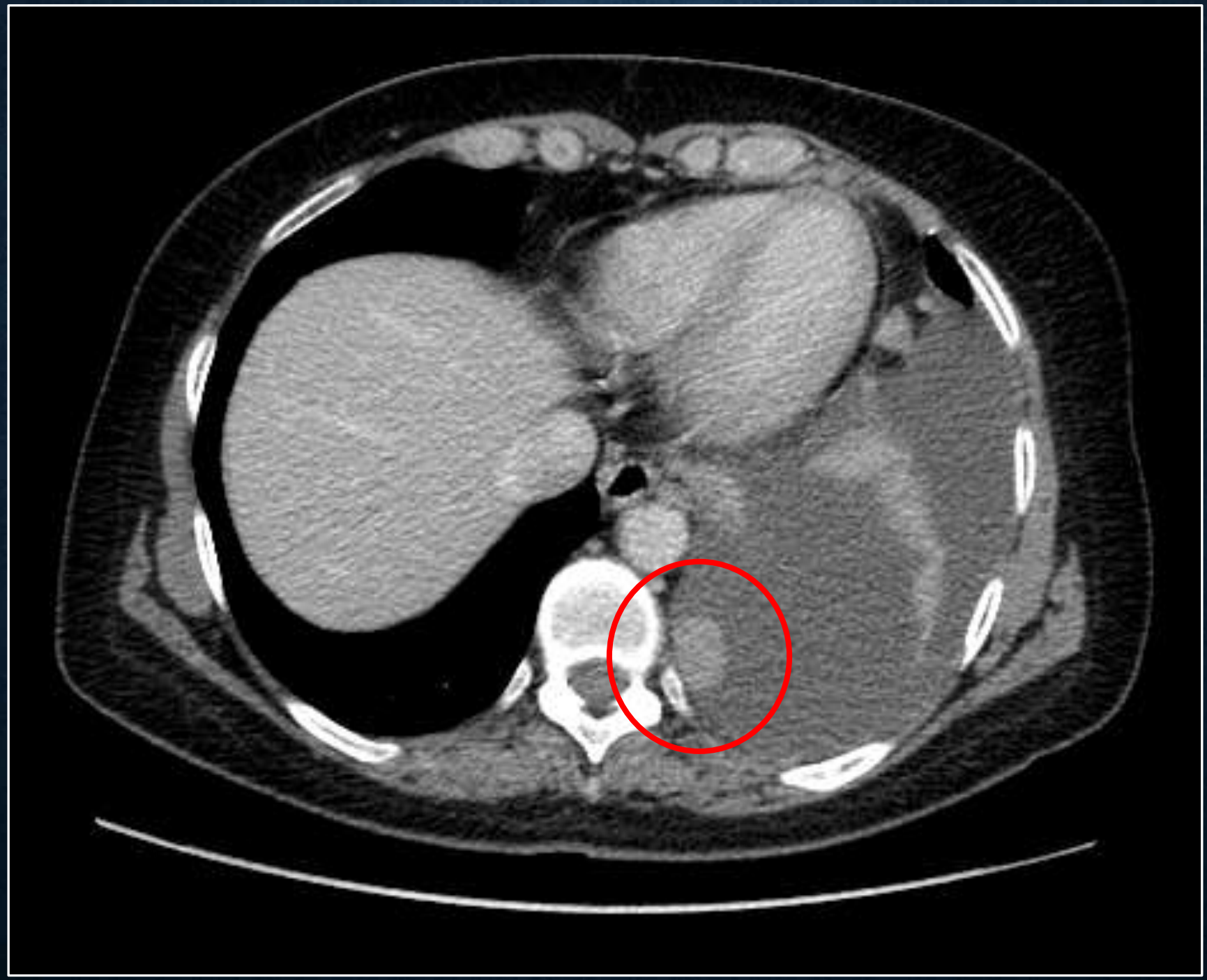
- Does what it says on the tin
- Scan WHOLE chest
- Good for distribution
- Pick up early lung cancers
- Reformats

PORTAL PHASE CT

- The workhorse
- Oncology imaging
- Lung cancer staging
  - Chest and upper abdomen
  - Lymph nodes
  - Mediastinal involvement

- Pleural imaging
  - Pleural enhances at 60-70 seconds ie. TISSUE PHASE
  - Enhancement, nodularity, mediastinal involvement





LOW DOSE CT

- Nodule follow up
- Neutopenic sepsis
- Problem solving the ‘slightly abnormal’ CXR

WHICH ONE TO CHOOSE

1. CTPA - ? PE
2. Volumetric HRCT - ? ILD in ≥ 40 yo
3. Non volumetric HRCT - ? ILD in < 40 yo
4. Portal phase CT - pleural disease/Ca
5. Low dose CT – problem solving/neutropenic sepsis/nodule FU

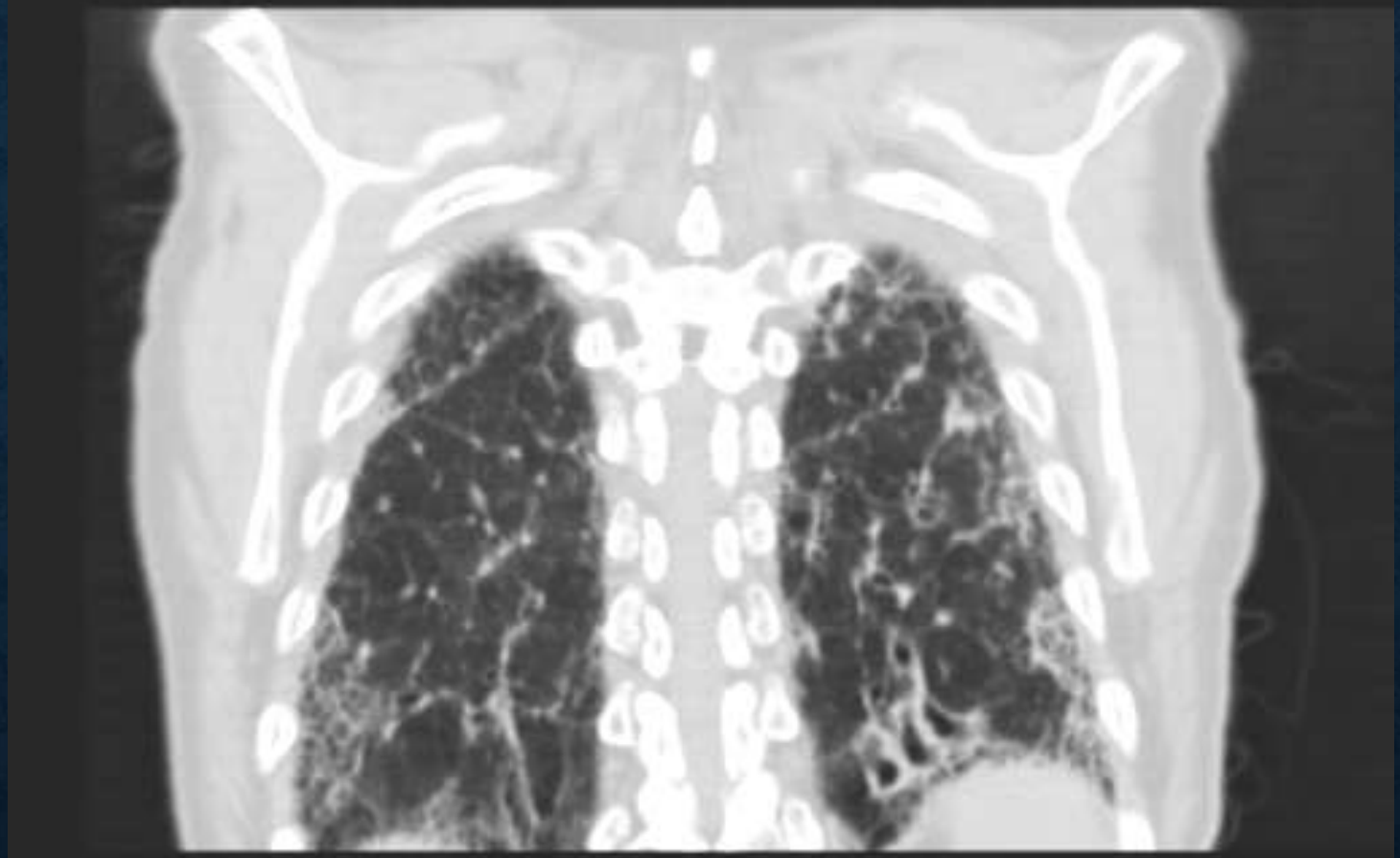
RE - TEST

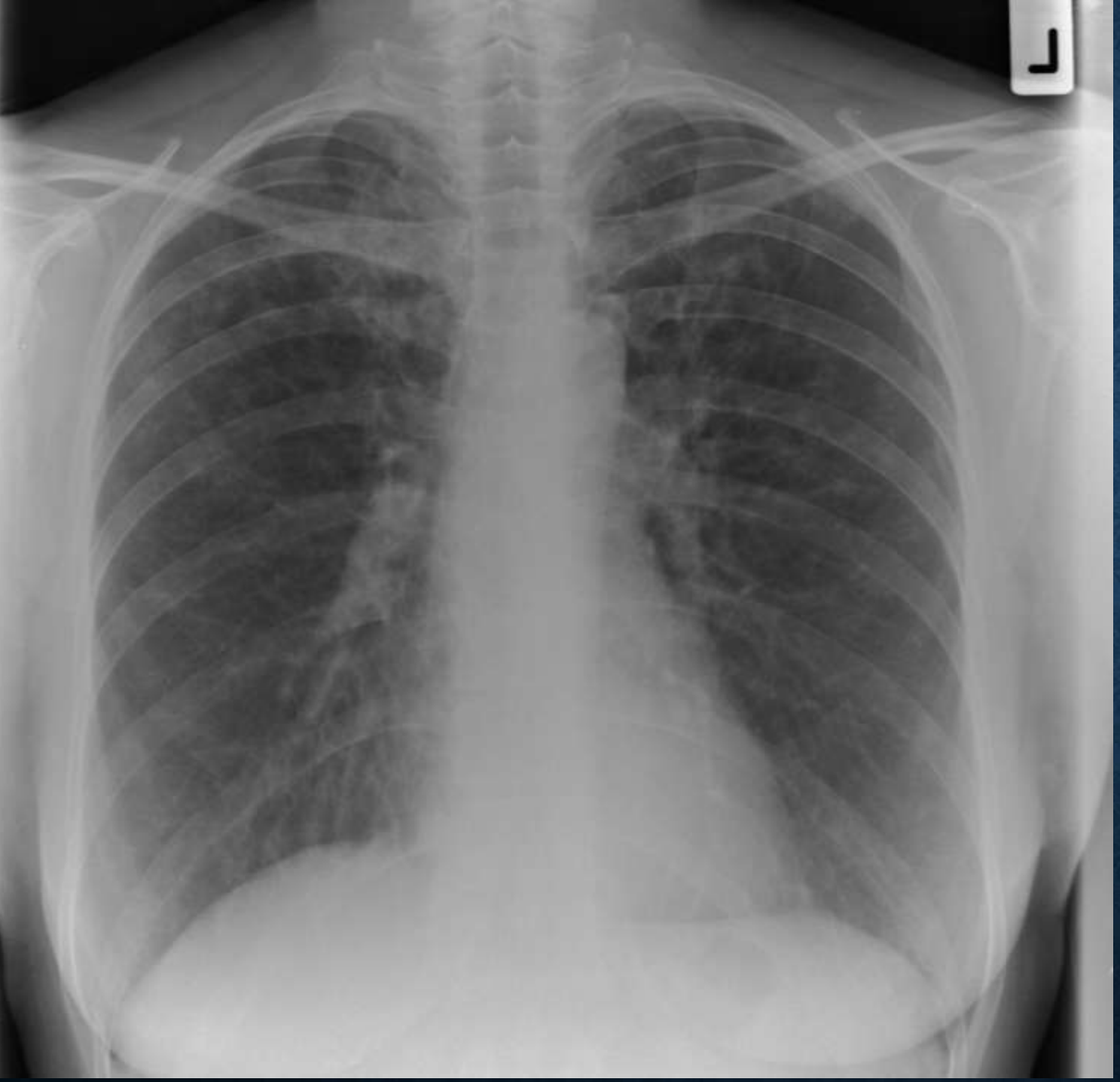
- CXR
- Decide what kind of CT you would NOW perform
- Choices:
    1. CTPA
    2. Volumetric HRCT
    3. Non volumetric HRCT
    4. Portal phase CT
    5. Low dose CT

60 ♂

Clinical question: ?
Fibrosis

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

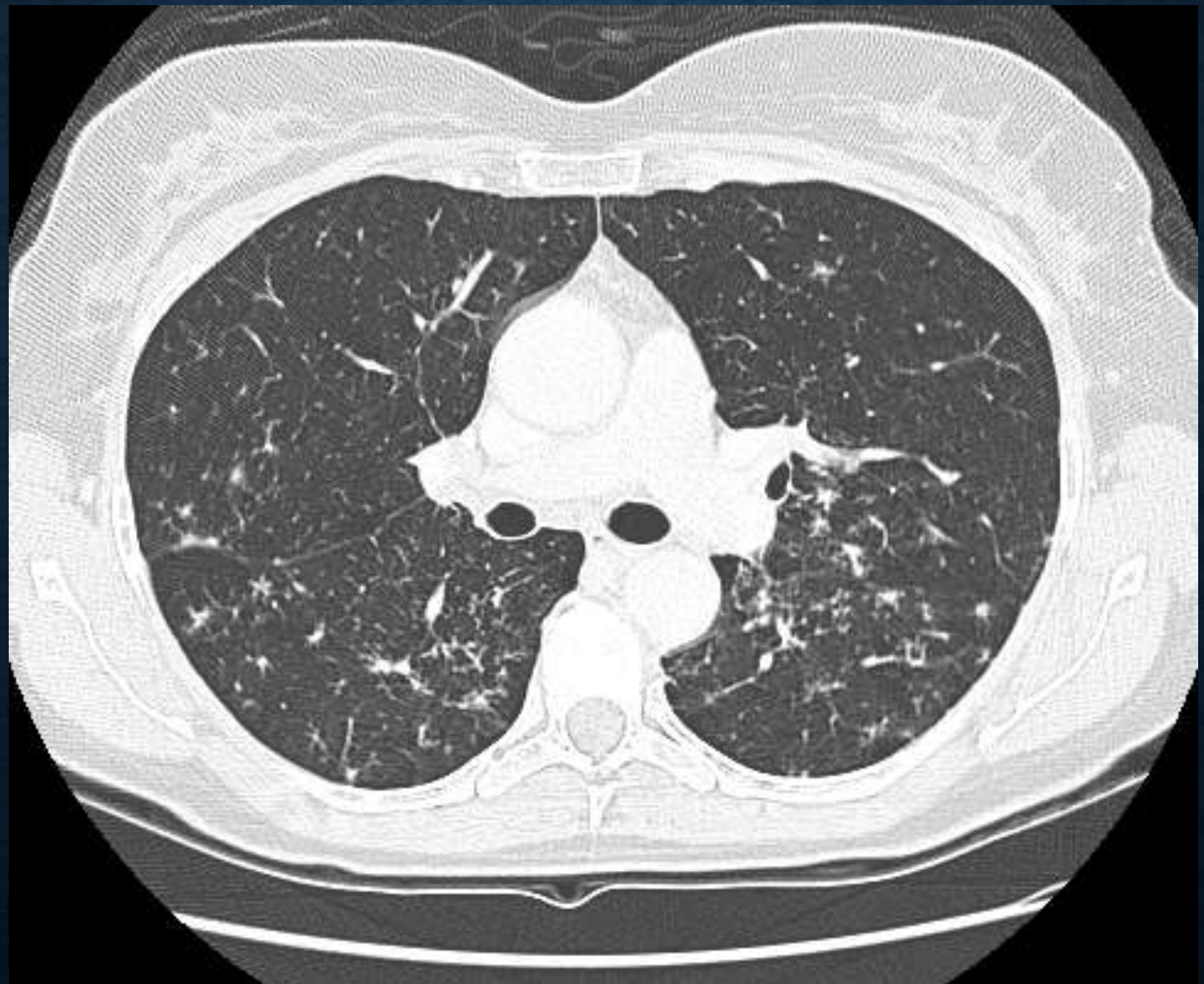




32 ♀

Clinical question: ? Sarcoidosis

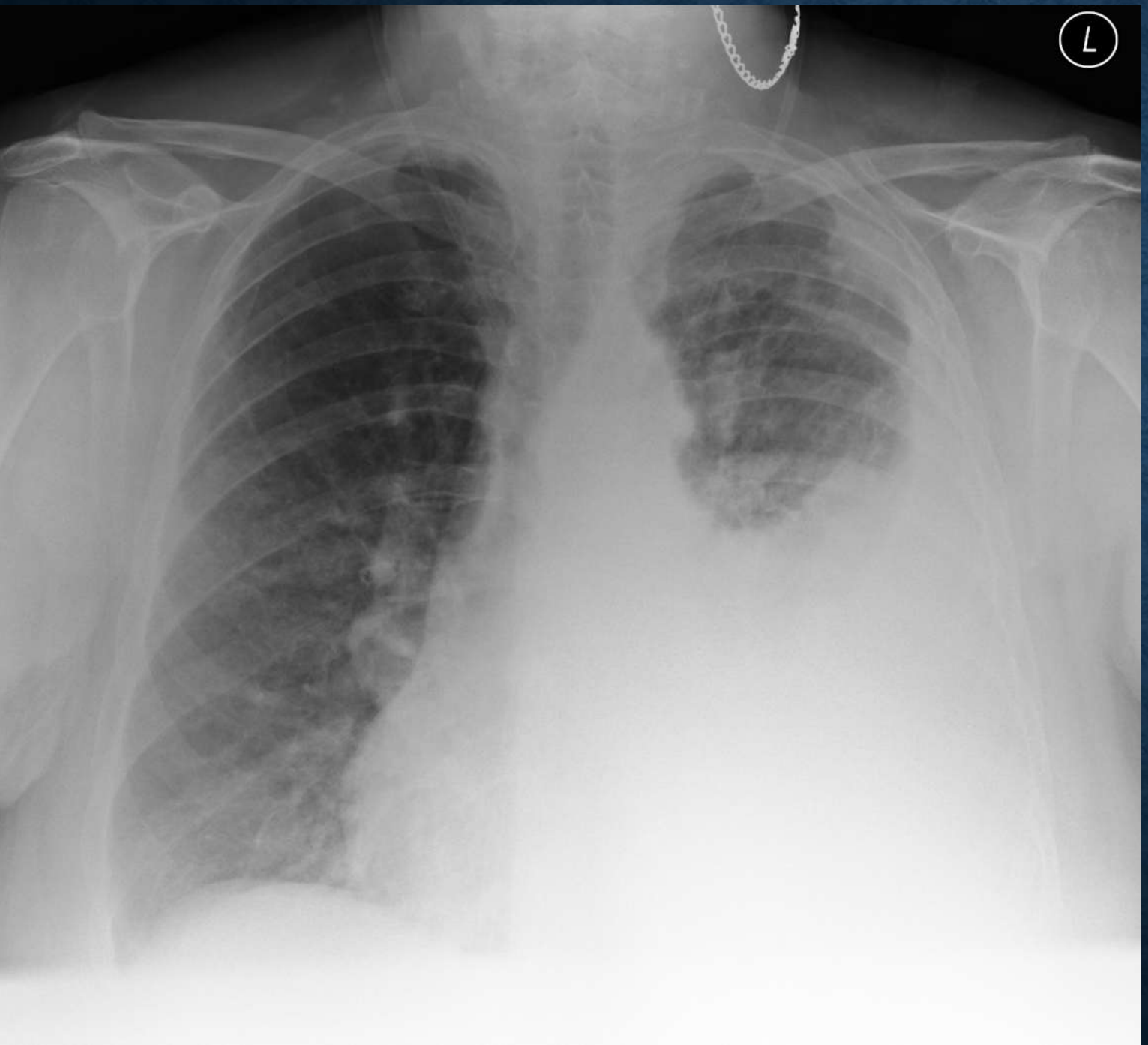
1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT



50 ♂

Clinical question: sepsis ? Source: neutropenic

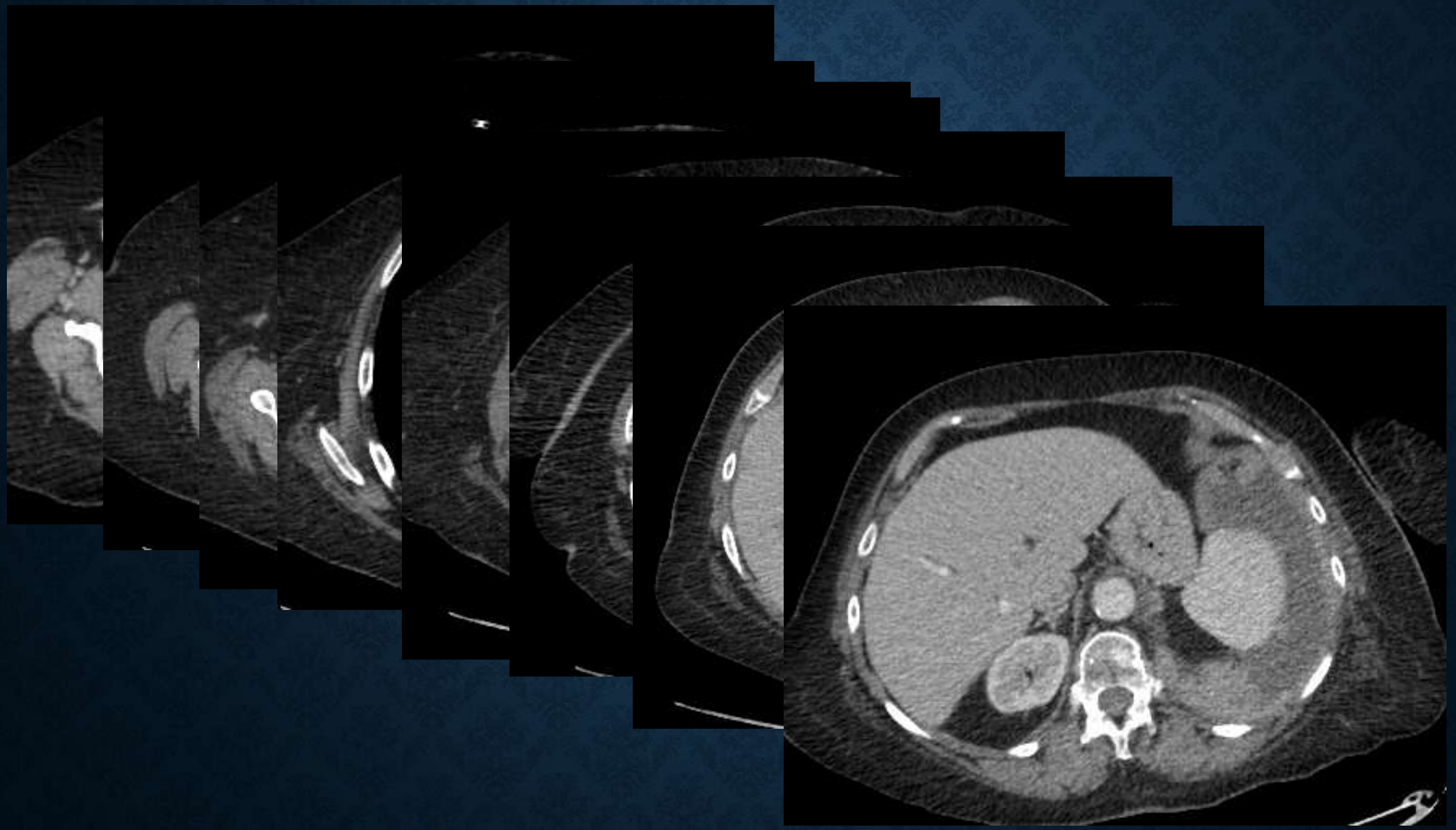
1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

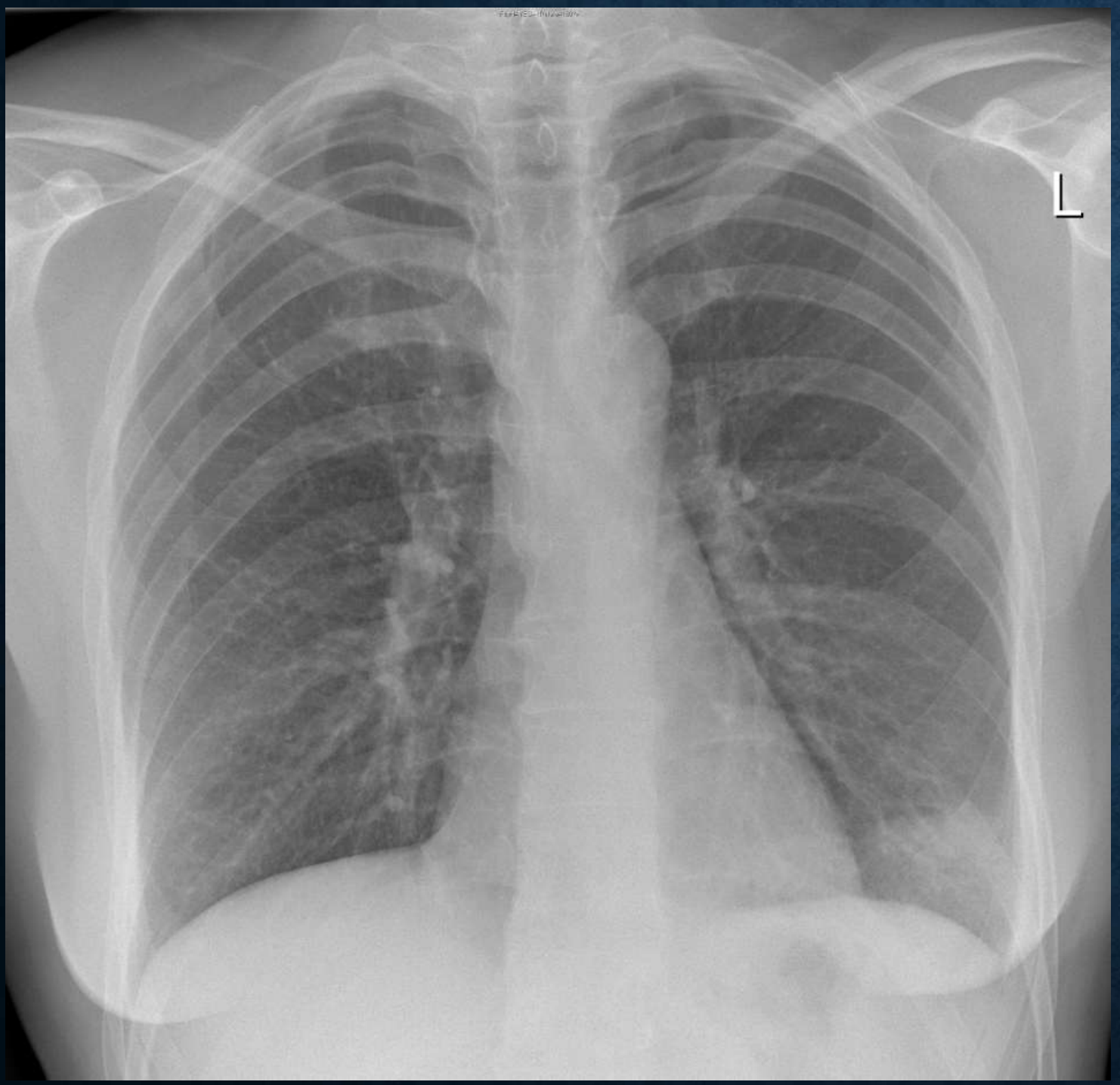


76 ♀

Clinical question: ? cause

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

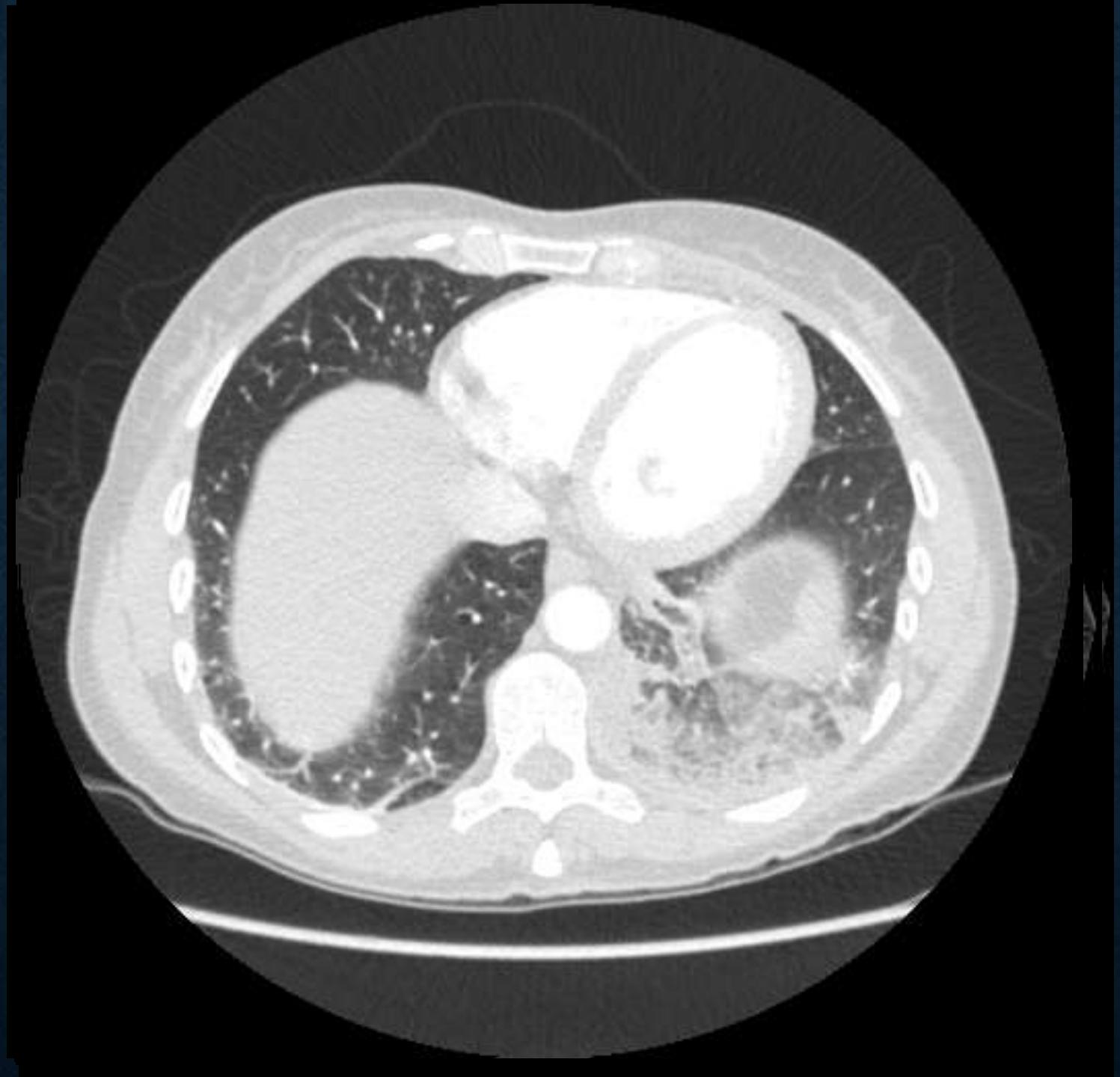


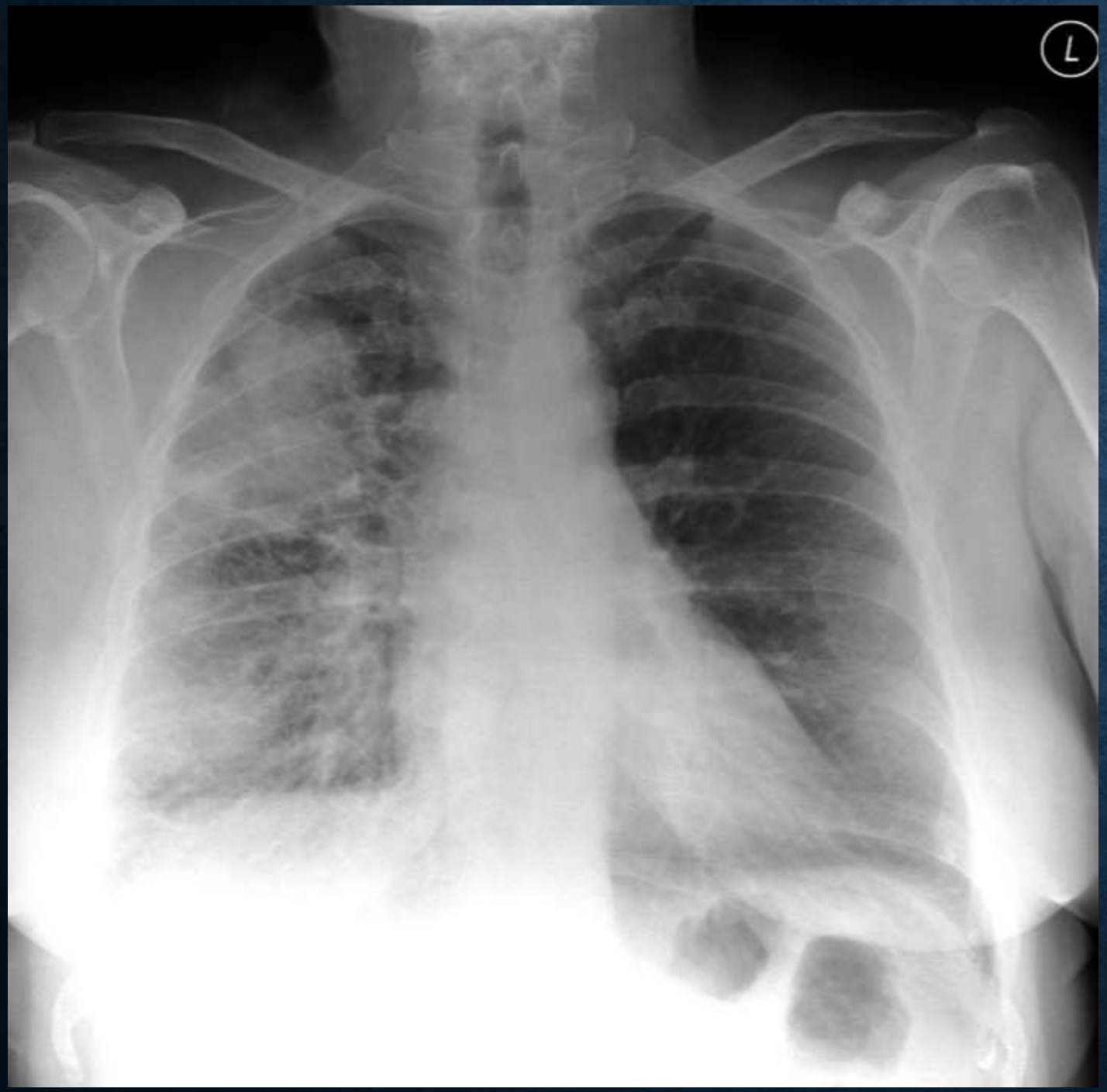


27 ♂

Clinical question: SOB ? Cause

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

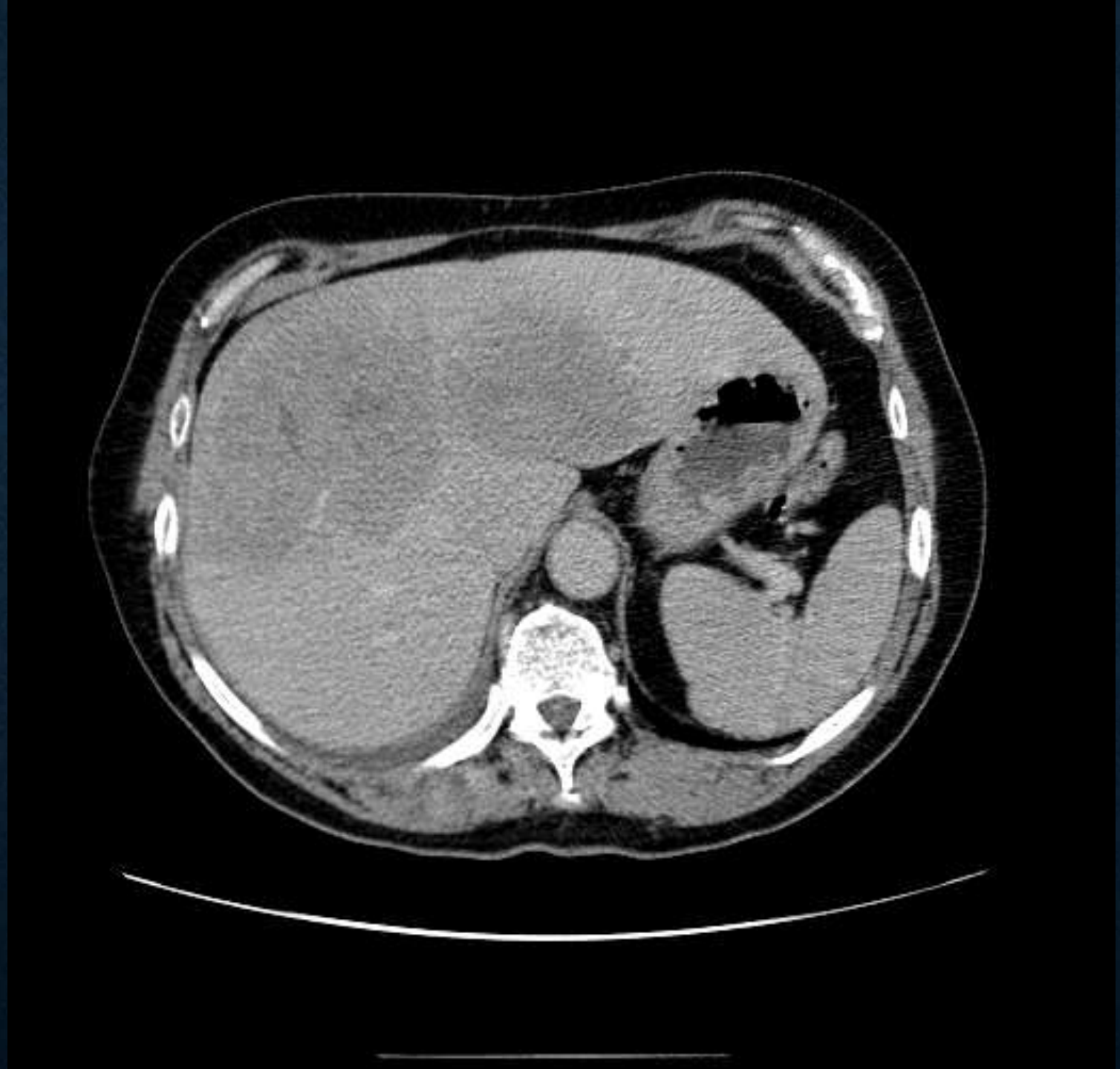




65 ♀

Clinical question: ?
Cancer

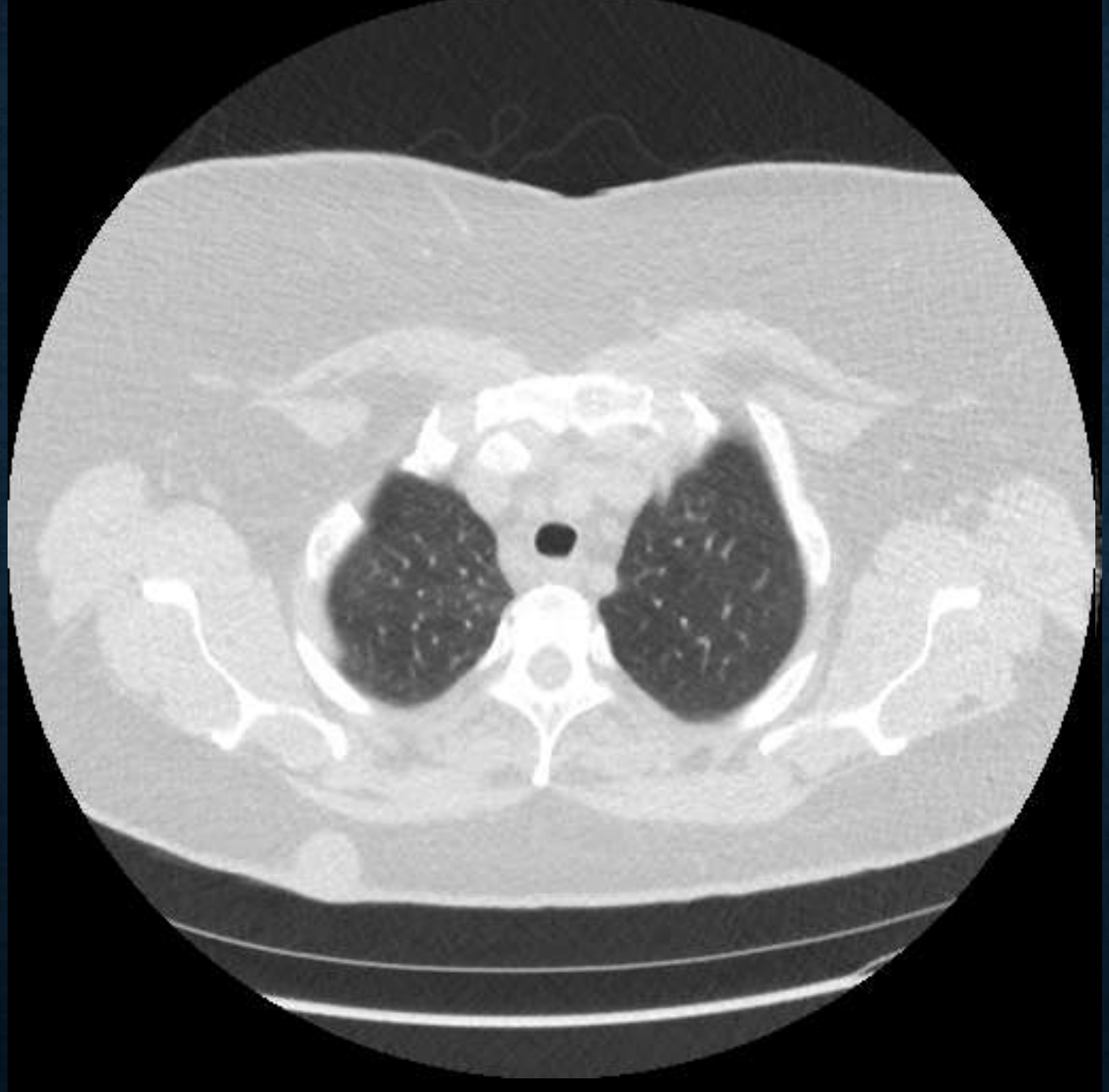
1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT



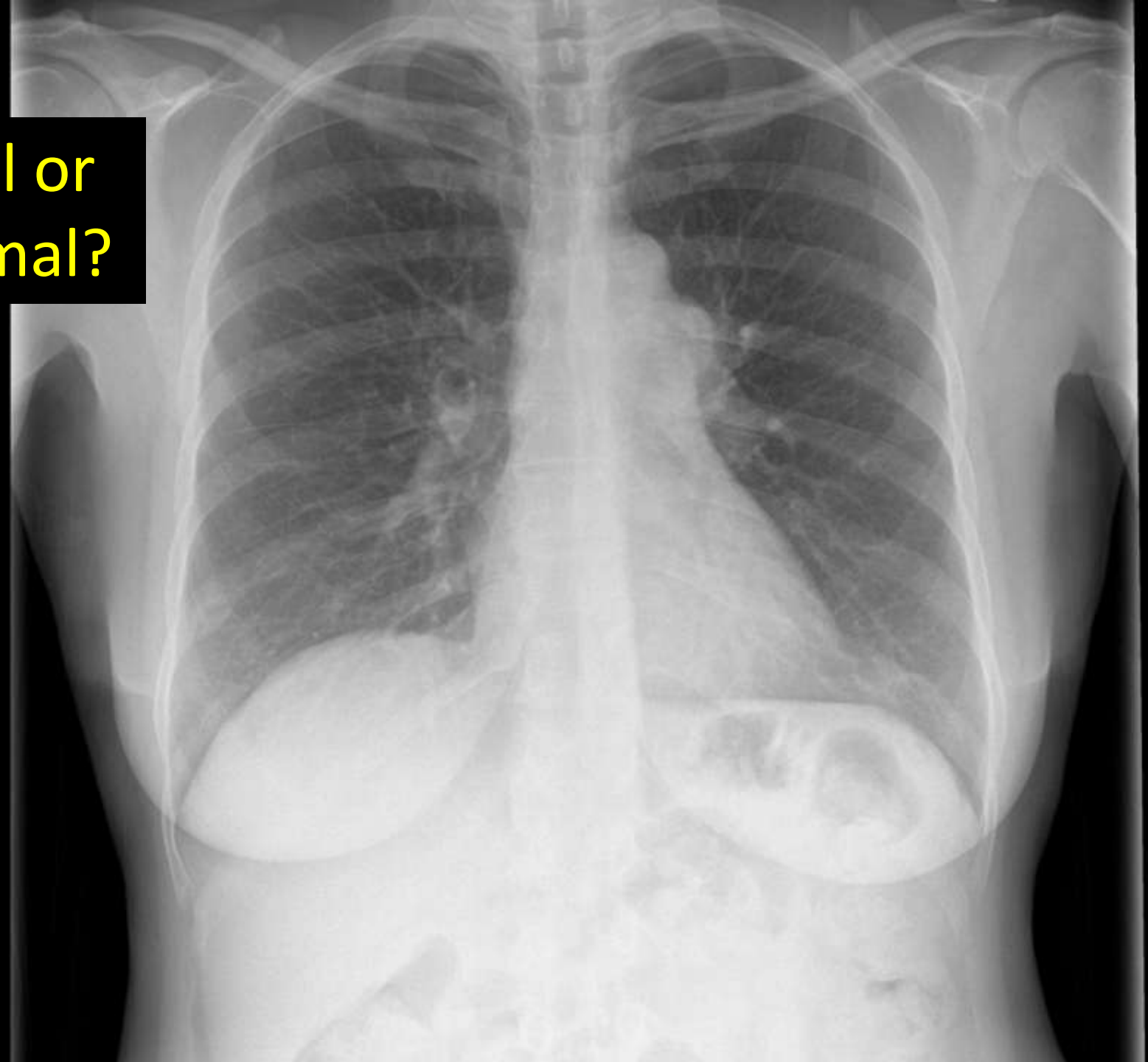
53 ♀

Clinical question: ? Nodule RUZ

1. CTPA
2. Volumetric HRCT
3. Non volumetric HRCT
4. Portal phase CT
5. Low dose CT

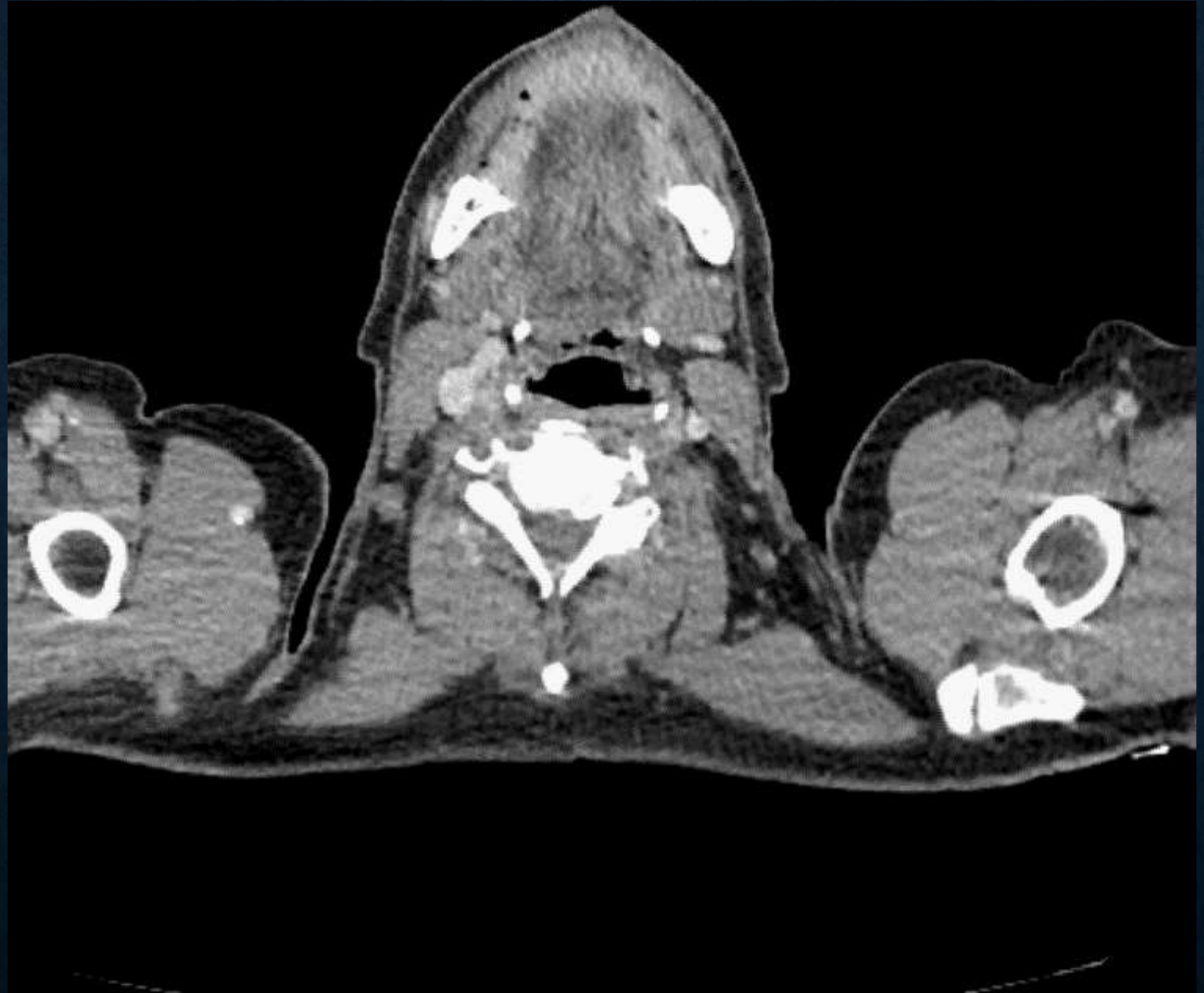


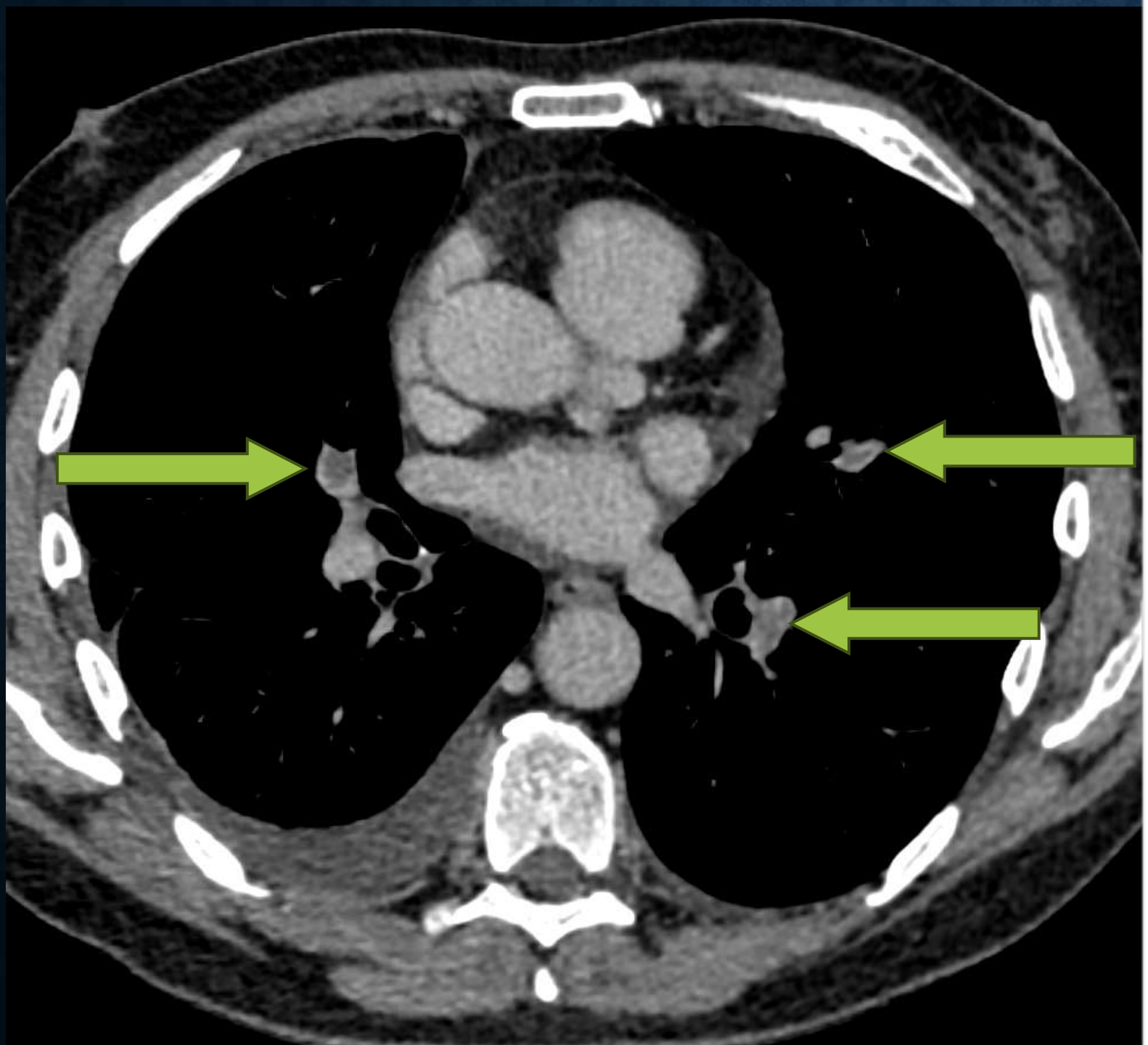
Normal or abnormal?



GOOD CASE

- 59♂
- 8 week h/o SOB
- Smoker
- Weight loss
- Cough

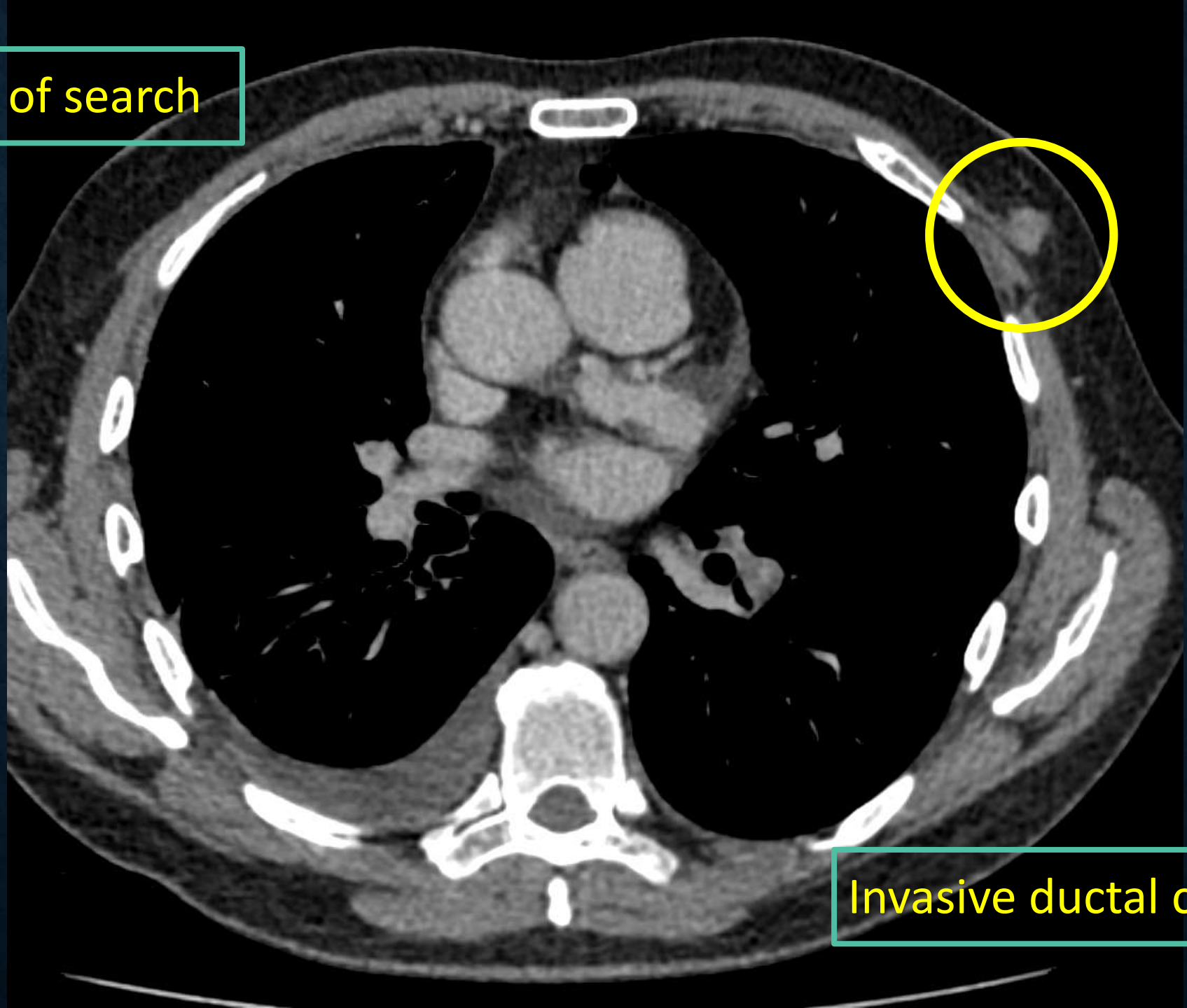




PORTAL PHASE CT

- Still can identify PE
- What else ?

Satisfaction of search

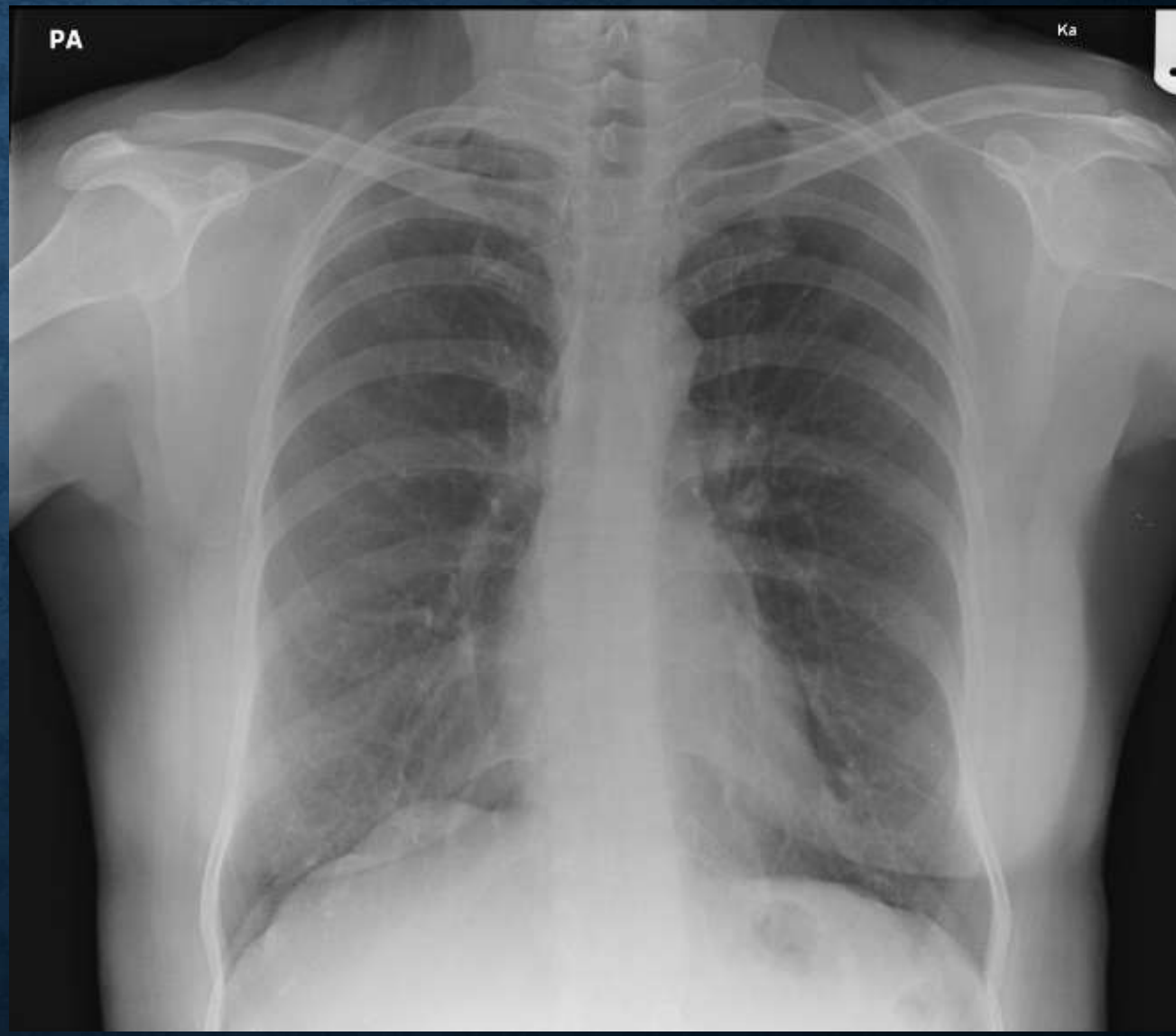


Invasive ductal carcinoma

- 64♂
- **Screening participant**

Current

15 years ago



Overview

Annalise Container
Clinical Decision Support

For trained clinicians only. Not for patient interpretation.

What to expect:

Localised findings:
Key regions of interest indicated.

Laterality findings:
Relevant body sides indicated.

Non-Localised findings:
Findings may not have any region of interest.

Images analysed in this study:

Scroll to begin viewing this series

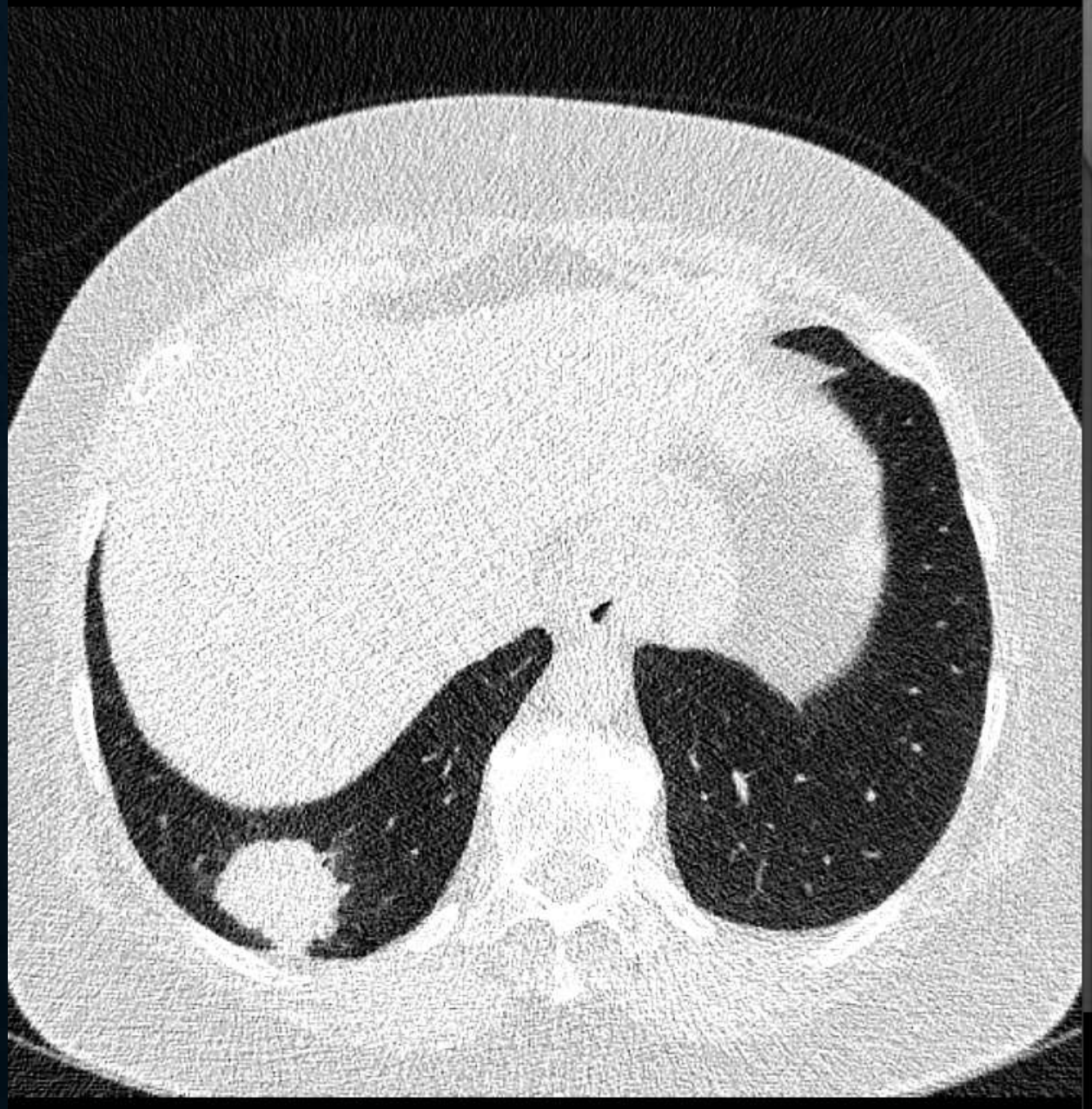
⚠ Not intended to provide direct diagnosis

Read User Guide before use: annalise.ai/guides

annalise.ai MD UK CA

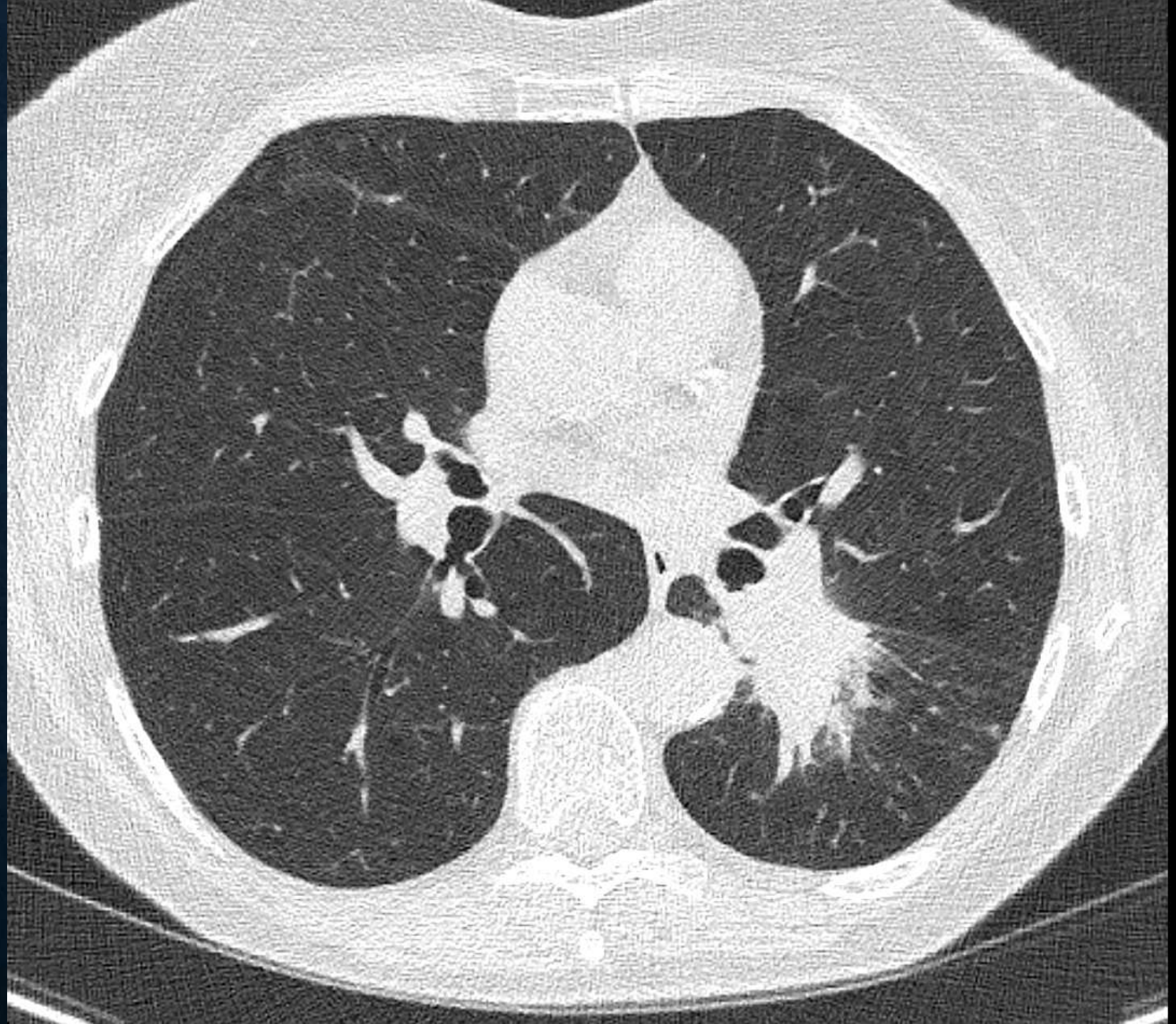
OTHER 3

Aortic arch calcification
Hyperinflation
Diaphragmatic eventration




1
339


PA L



CONCLUSION

- Understand more about CT
- Anatomy on CT
- CT terms
- Scanning protocols and relevance
- Interactive quiz
- Understand more when in an MDT or in clinic - Put it into practice

THANK YOU!