Chest and abdominal CT introduction

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Choice of imaging modality

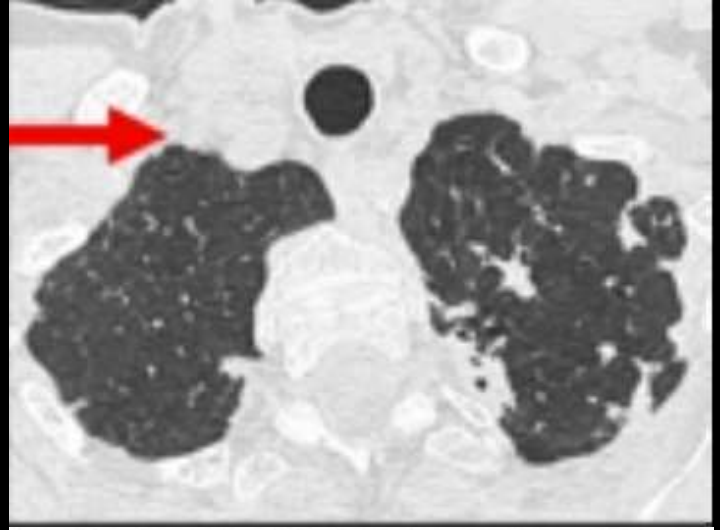
- Chest imaging generally
  - ❖CXR
  - ❖Lung ultrasound
  - ❖Chest CT
  - ❖MRI of the chest

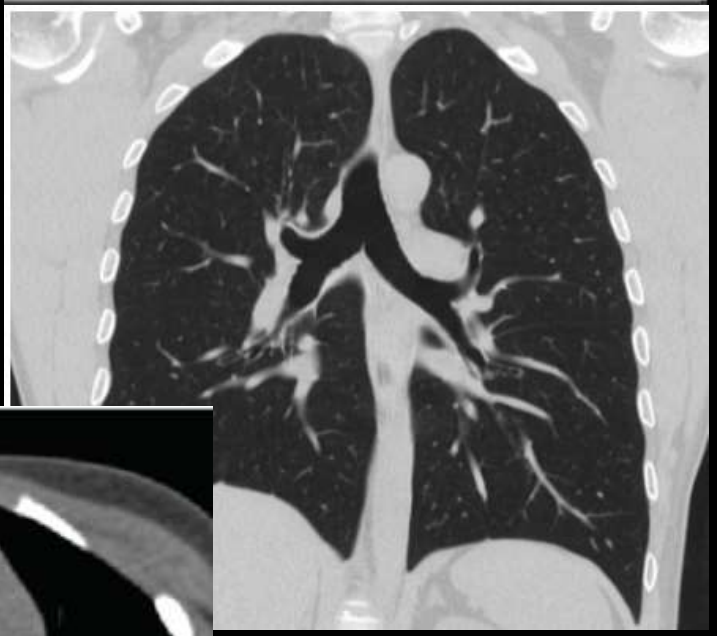
Remember on CT

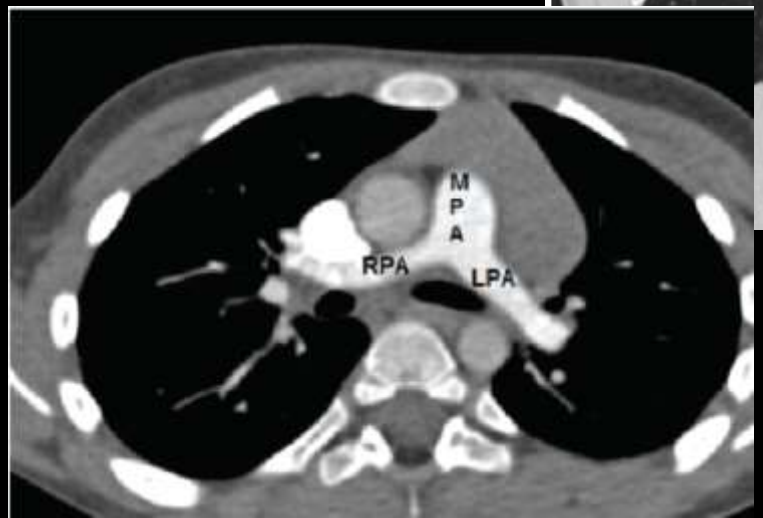
- Air is black
- Fat is black
- Soft tissues are grey
- Bone, calcium, iodine contrast, acute blood are white
- With contrast blood vessels are white
- Tissues which take up become more whiter

Chest CT types

- Standard Chest CT
  - With contrast
  - without contrast
- High resolution chest CT (HRCT)
- CT angiogram



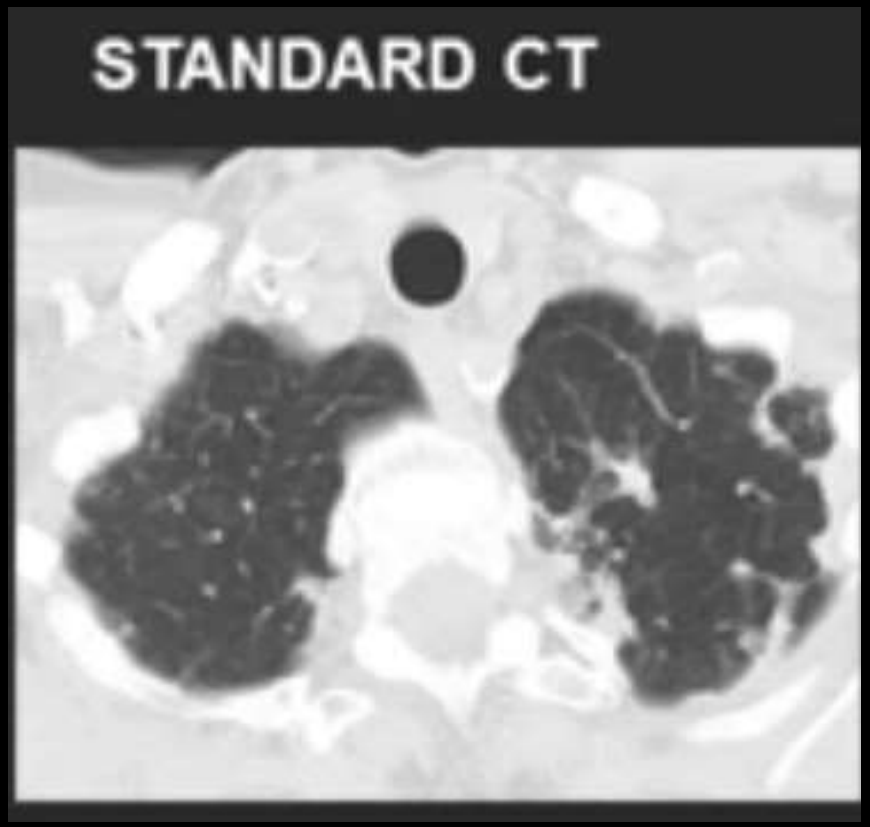




Standard chest CT

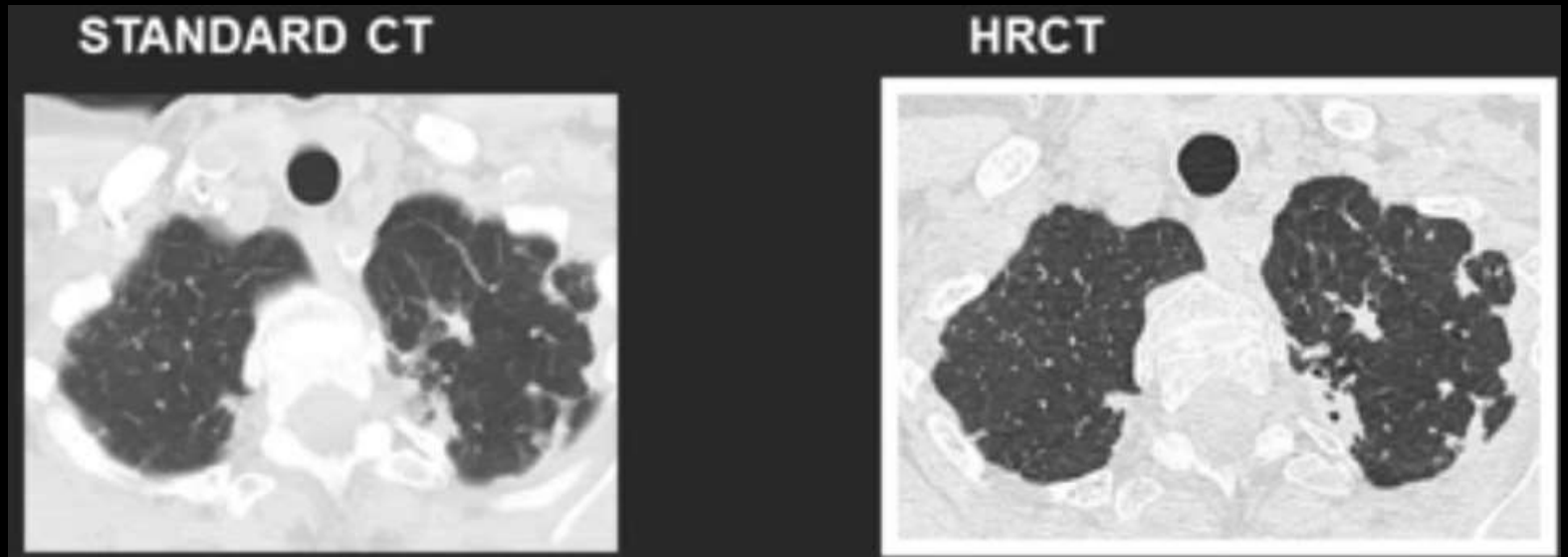
- Slice thickness 3-10mm
- Gross evaluation of lungs
- Scans a large volume very quickly
- Covers whole lung
- +_contrast
- **Indications**
- Pleural/mediastinal abnormalities
- Lung mass
- Empyema vs abscess
- Mets folowup
- Lung collapse in an adult
- Chest trauma

- CT in lung window



HRCT(high resolution CT)

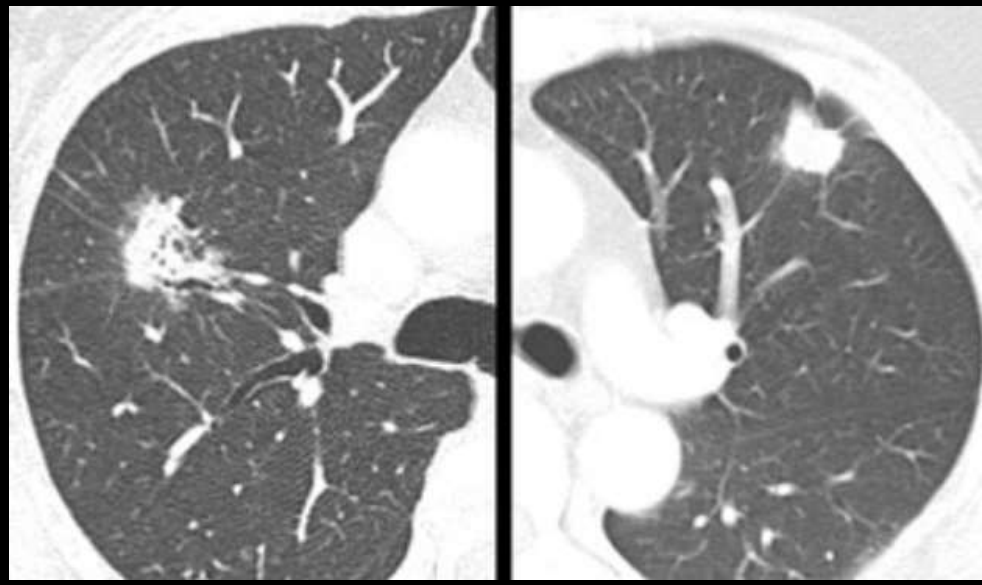
- Very thin slices (<2mm)
- High resolution of the lung parenchyma, airspaces, airways , and interstitium
- No contrast



HRCT indications

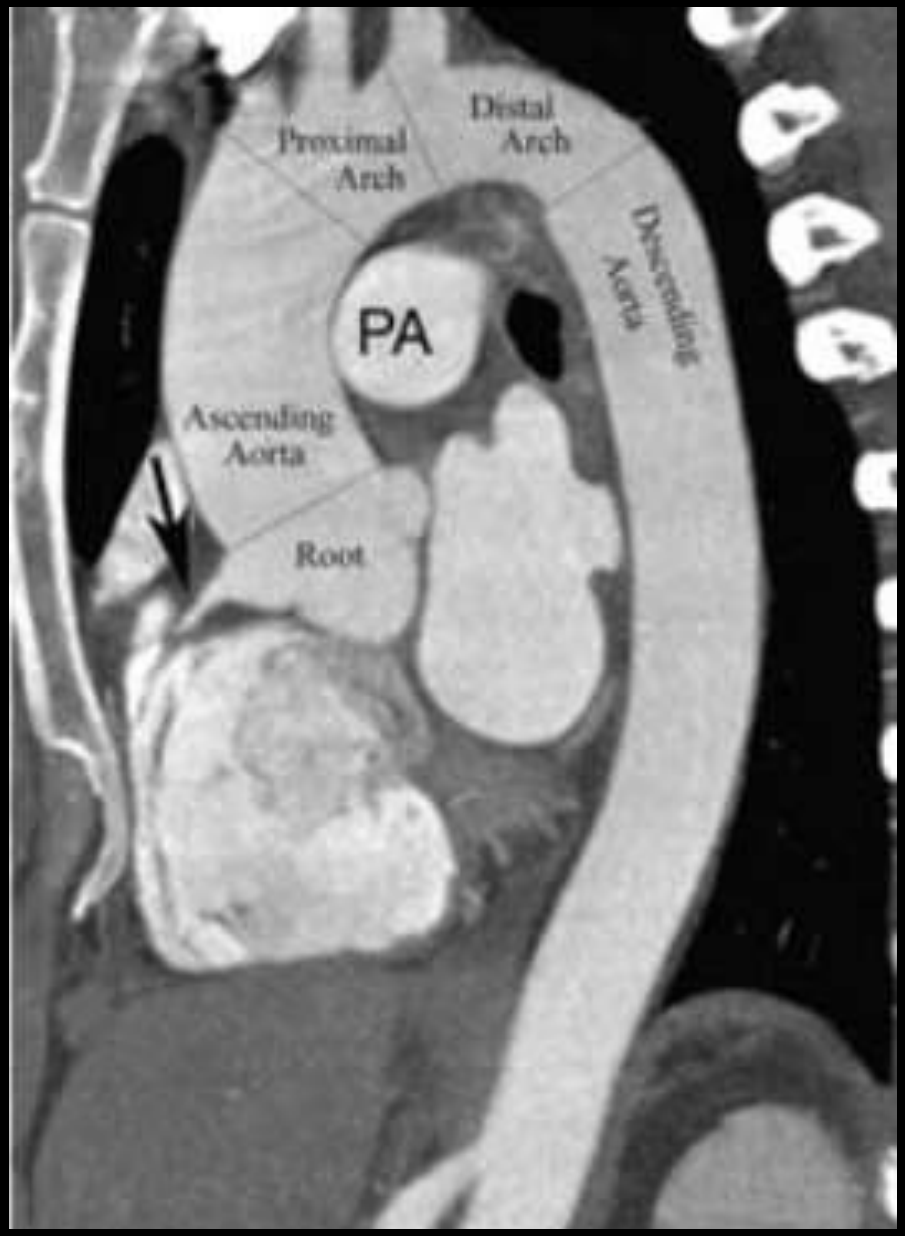
- Investigating Hemoptysis
- Diffuse CXR abnormality
- Normal CXR with abnormal PFTs
- Baseline for patients with diffuse lung disease
- Solitary pulmonary nodules
- Reversible vs non reversible(fibrotic lung disease)’
- FU of unknown lung disease
- Infections like COVID 19

- Two lung lesions



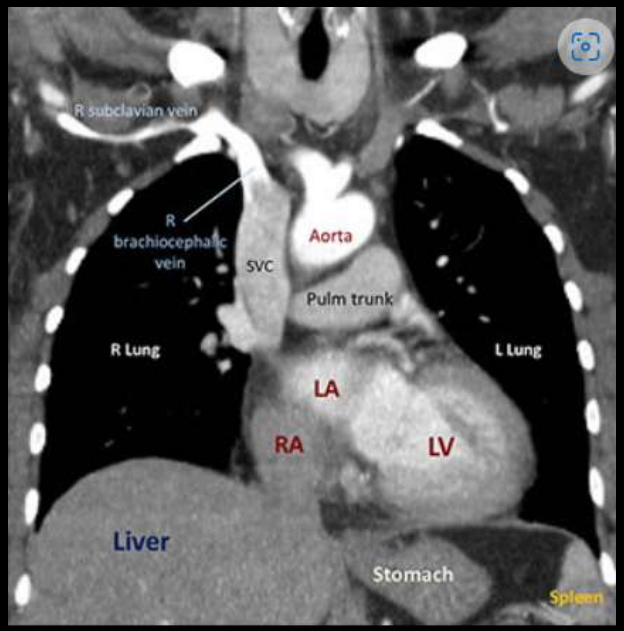
3. CT angiogram

- Contrast injected in peripheral vein
- Injection rate controlled automatically
- Dye is where you want it during scanning
- INDICATIONS
- Pulmonary embolism
- Aortic dissection
- Aortic aneurysm
- Cardiac studies
- Risks is contrast allergy



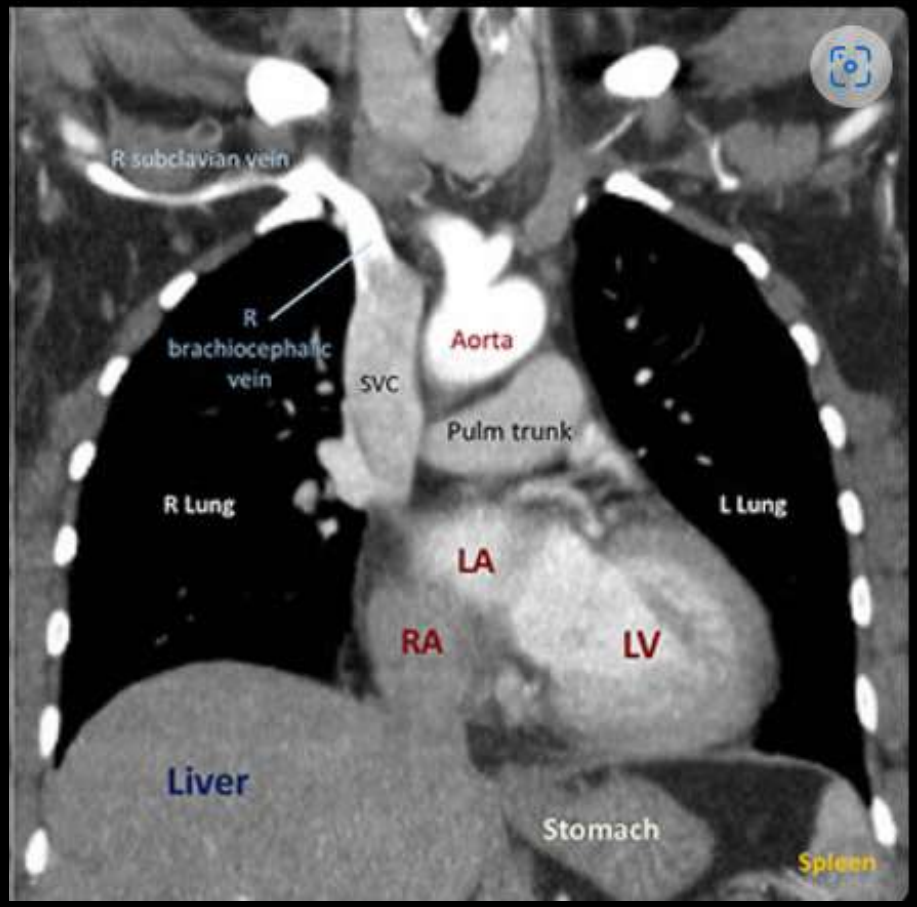
Approaching the CT anatomy

- Three windows
- Lung window
- Bone window
- Mediastinal window

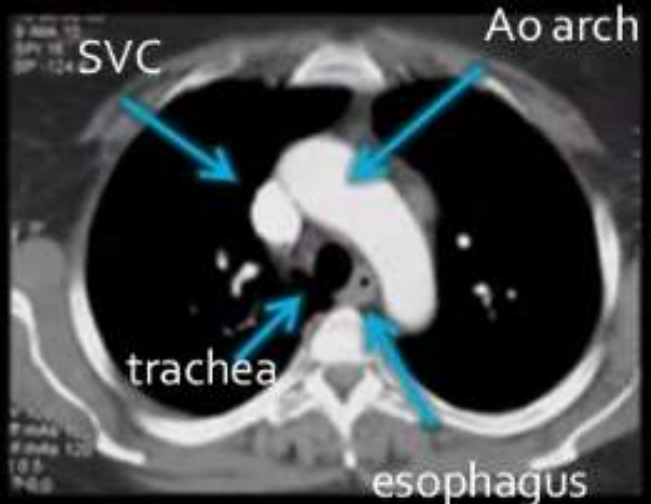


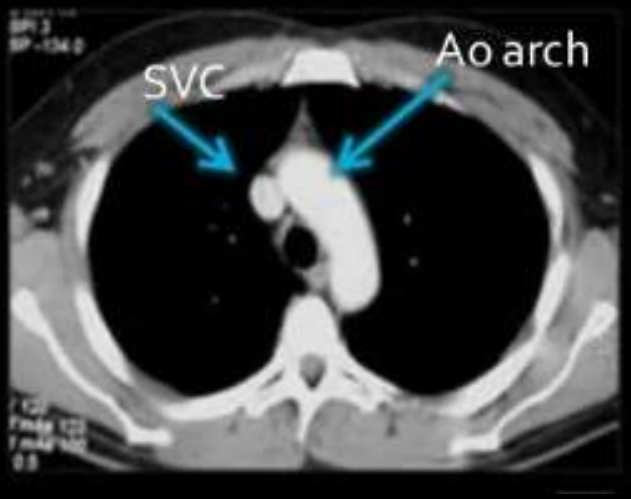
1 soft tissue window

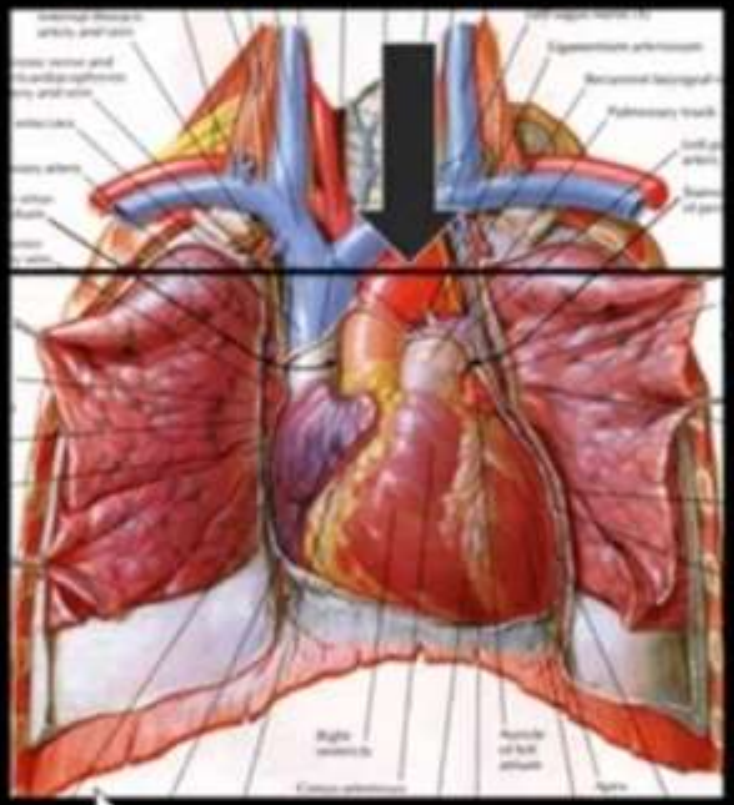
- Look at thyroid , pleura and chest wall
- Heart; chambers, calcification, pericardium
- Vessels; Aorta, PA, small vessels
- Nodes; mediastinal, axillary



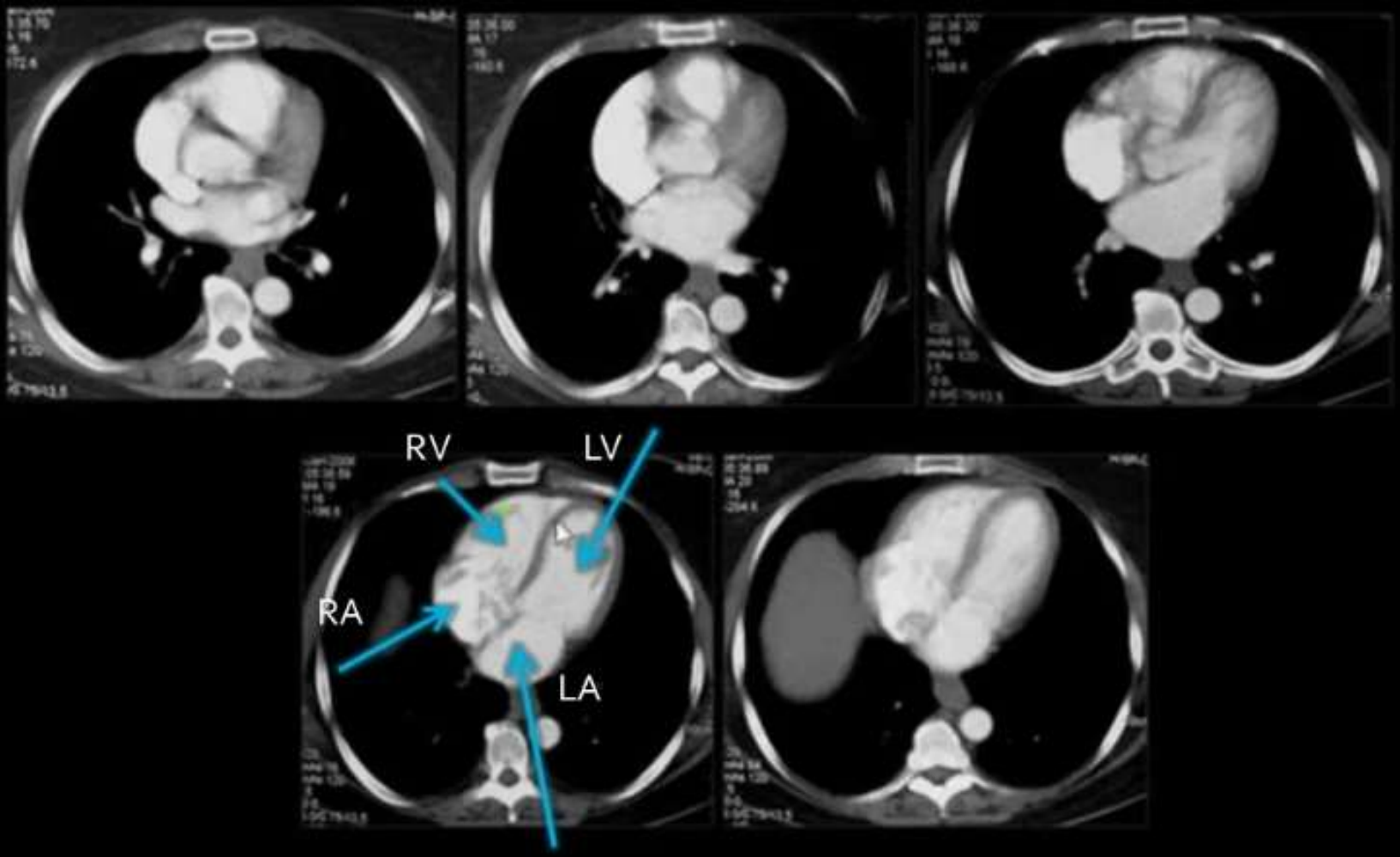
Mediastinal window





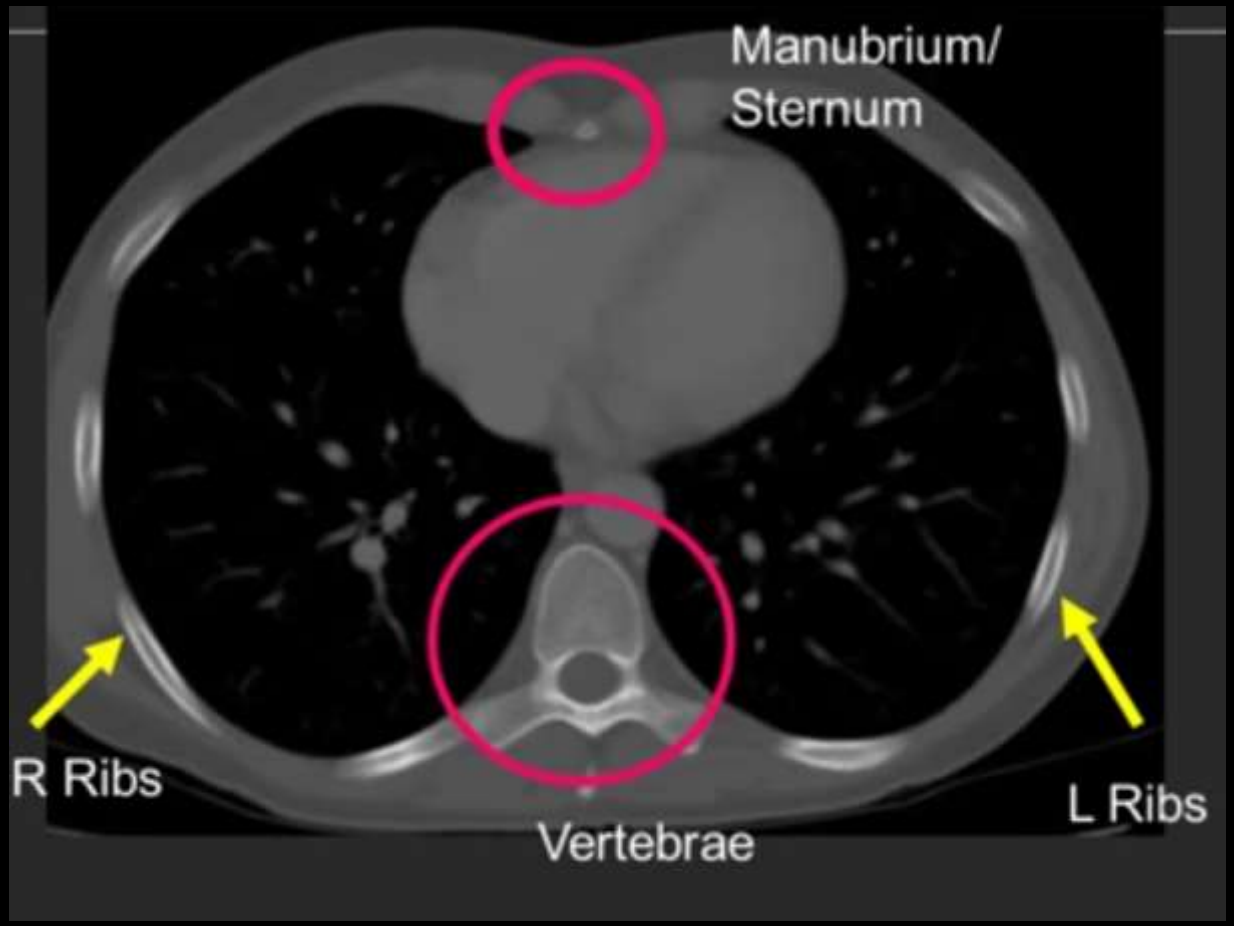


Mediastinal structures



Bone window

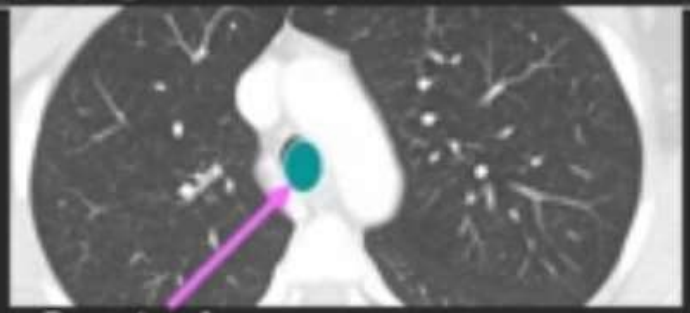
- Here we look for fractures, sclerosis and lytic bone lesions



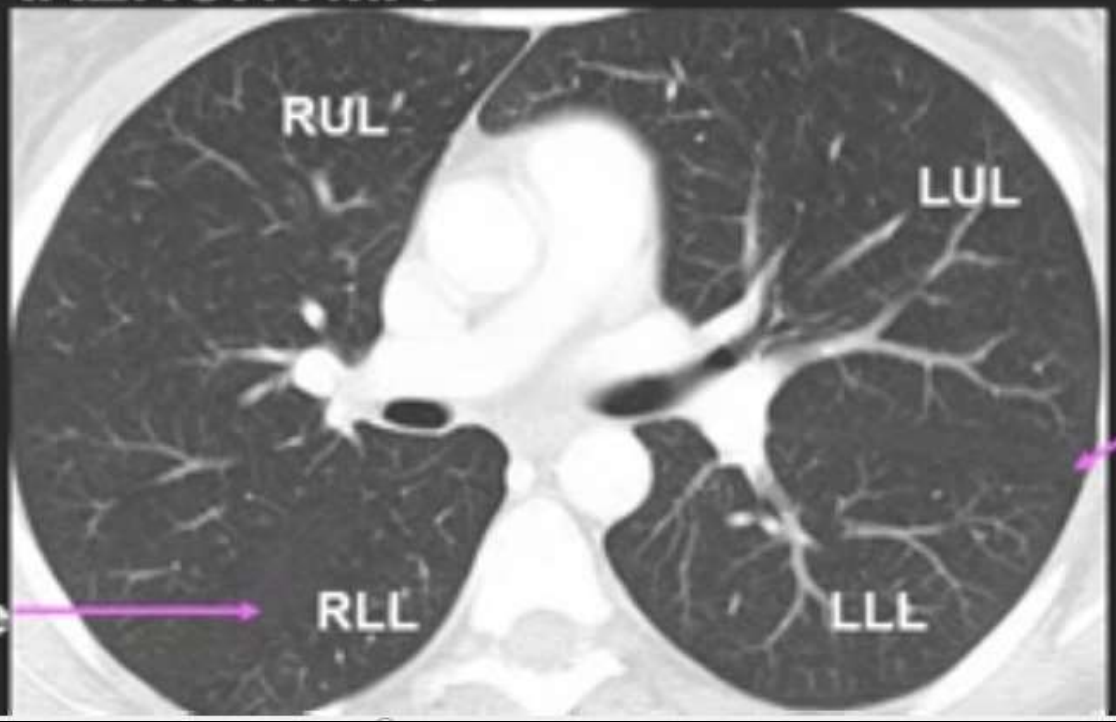
Lung window

- Air appears black
- Aerated lung dark grey
- Other structures white
- Blood vessels move with related airway airways

AIRWAYS

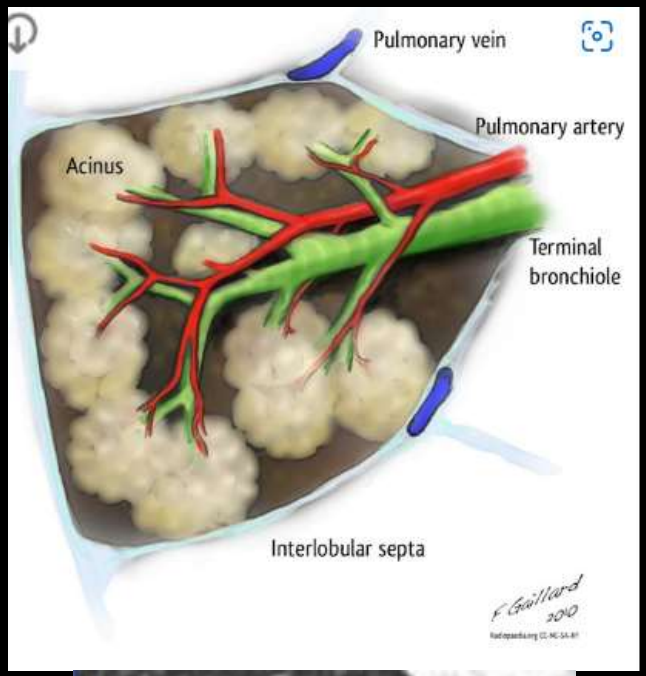


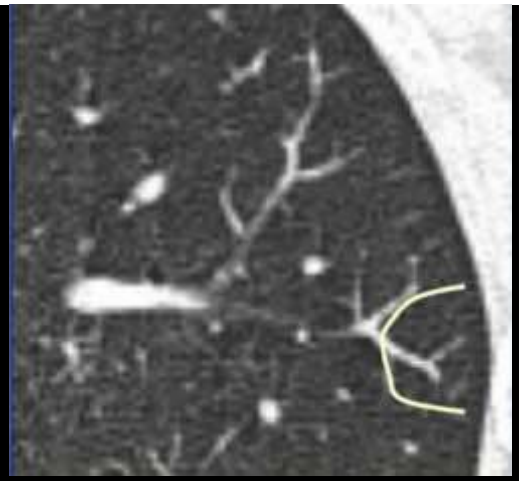
PARENCHYMA



Secondary pulmonary lobule

- Functional unit of the lung
- Key to chest CT terminology
- 30 acini 9 supplied by a common distal pulmonary artery and bronchiole



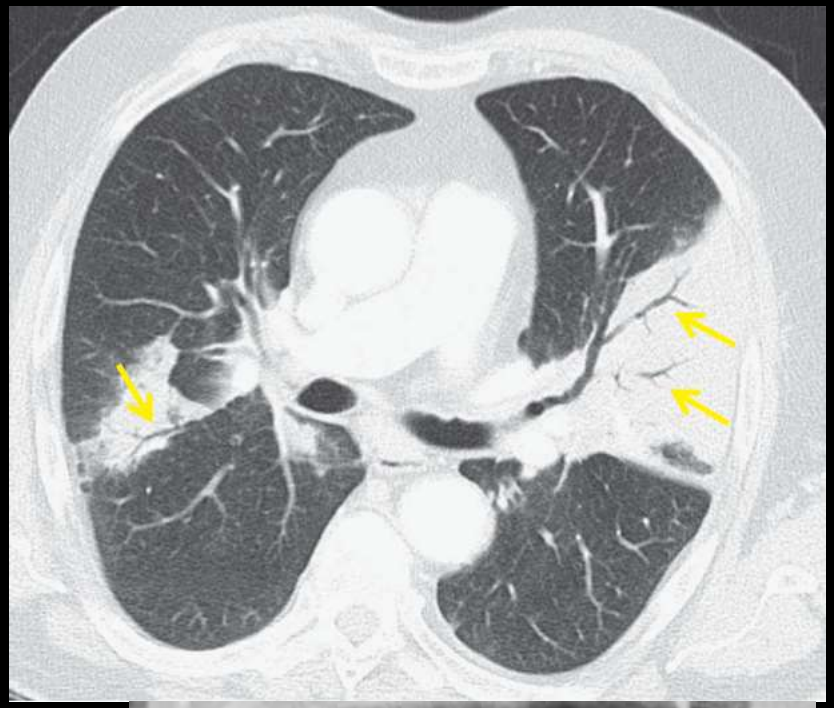


Common pathologic features

- Air bronchograms
- Bronchiectasis
- Septal thickening
- Ground glass opacity
- Emphysema
- Nodules and masses
- Cysts, cavities
- Filling defect
-

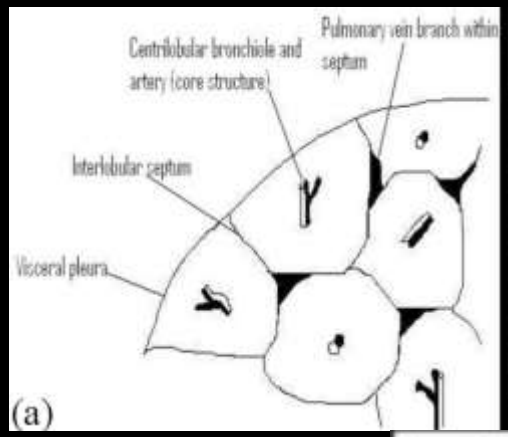
Air bronchograms

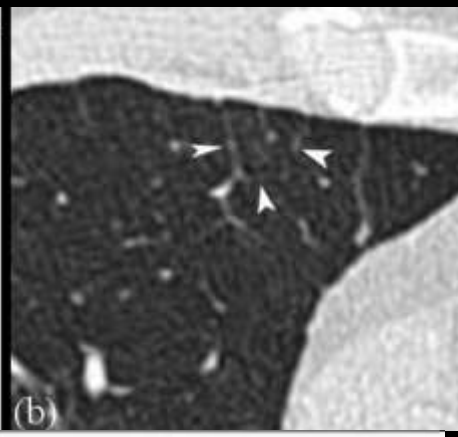
- Air in bronchi and bronchioles passing through airless parenchyma
- Appear as linear branching lucencies
- Implies proximal bronchi patency
- DDX
- Pneumonias
- Hemorrhage
- Bronchoalvelor carcinoma
- Pulmonary edema etc
- Organizing pneumonia

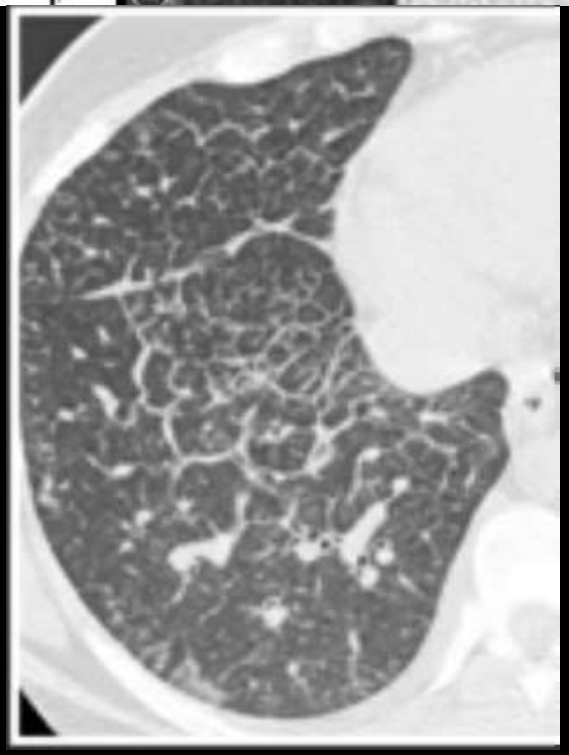


Septal thickening

- Secondary pulmonary lobule s basic unit of lung
- Thickening and outlining of septa is best seen on CT
- Reflects peri lobular pulmonary disease
- COMMON CAUSES
- Pulmonary edema
- Lymphatic cancer spread
- Infections eg PCP,COVID 19
- NSIP, Kaposi sarcoma







Septal thickening

- Interlobular septal thickening from pulmonary edema

- Septal thickening from lymphatic cancer spread

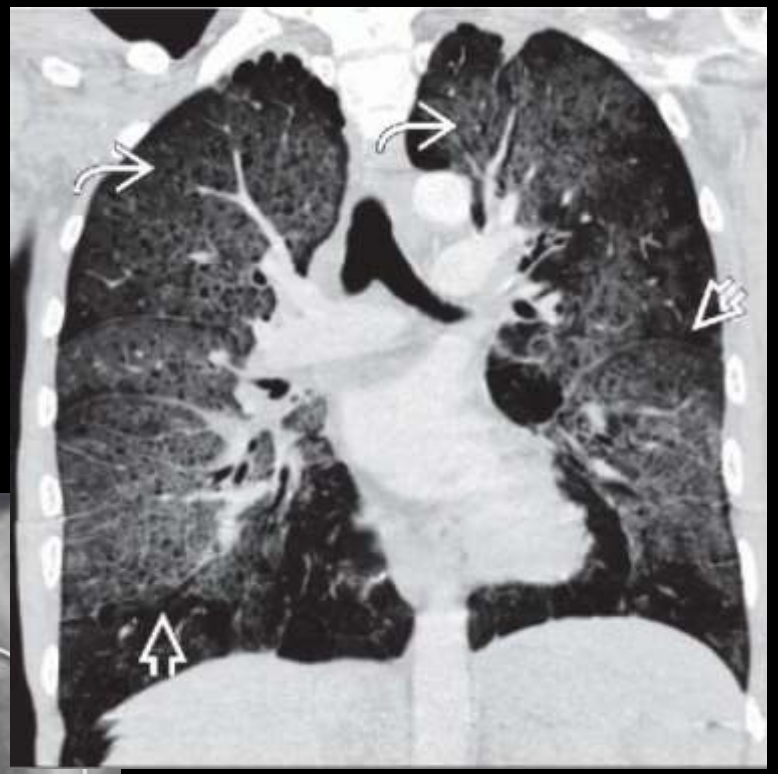
Ground glass opacity ,GGO

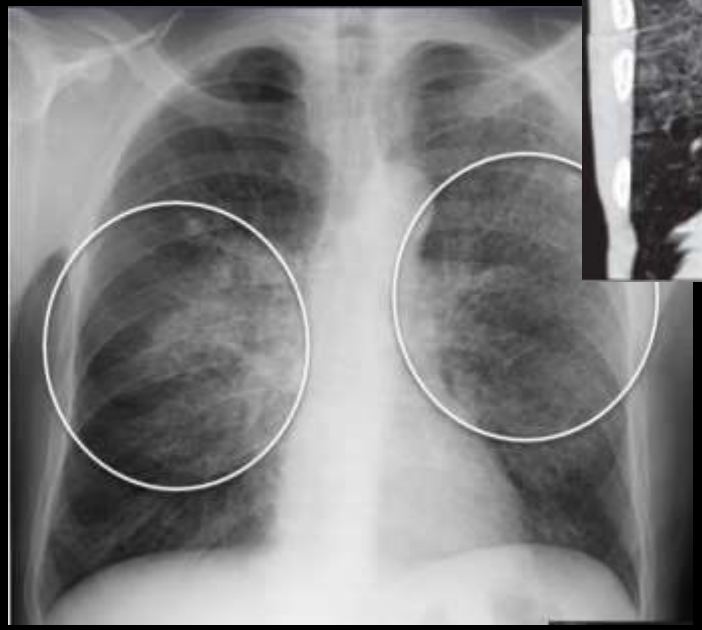
- Common non specific finding
- Hazy increase in density of the lung
- Partial filling of the alveoli
- Increased lung opacity not sufficient to obscure vessels
- Pattern of location is important
- DDX-
- COVID 19
- Resolving pneumonia
- PCP
- Alveolar proteinosis
- NSIP
-

- COVID 19 pneumonia

Examples of ground glass

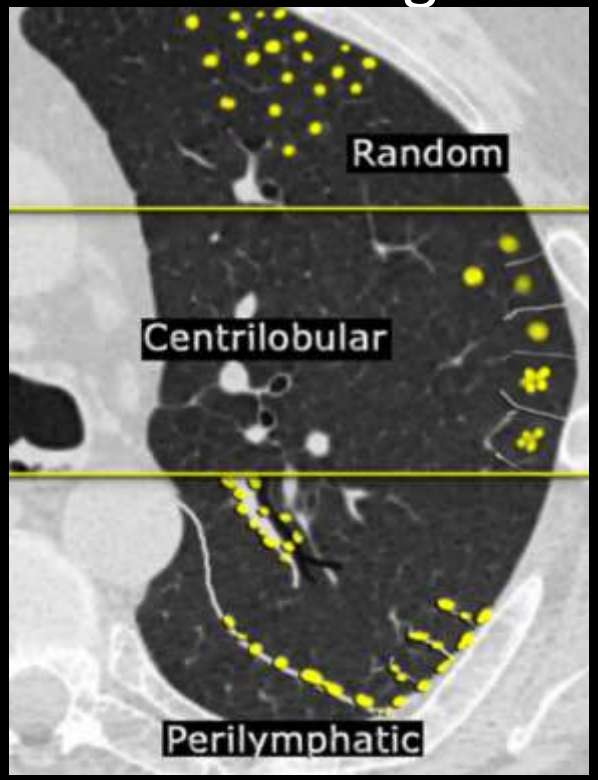
- Clinical context is important
- This was a case of PCP in HIV
- CDDX Heart failure



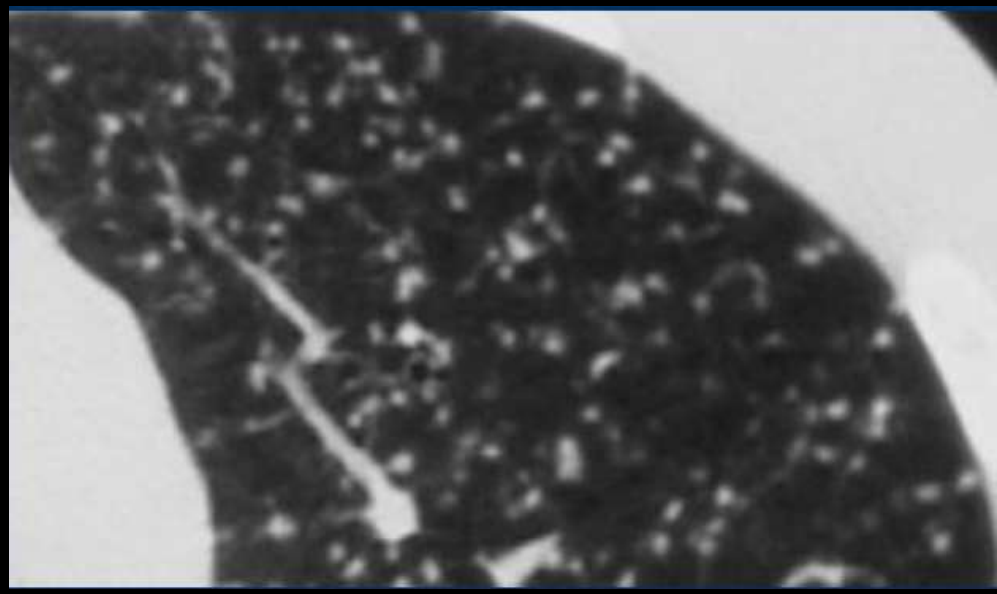


Nodular pattern of lung disease

- Distribution of nodules is important
- One of three categories



- Below nodules randomly distributed
- Could be MTB, hematogenous cancer spread etc

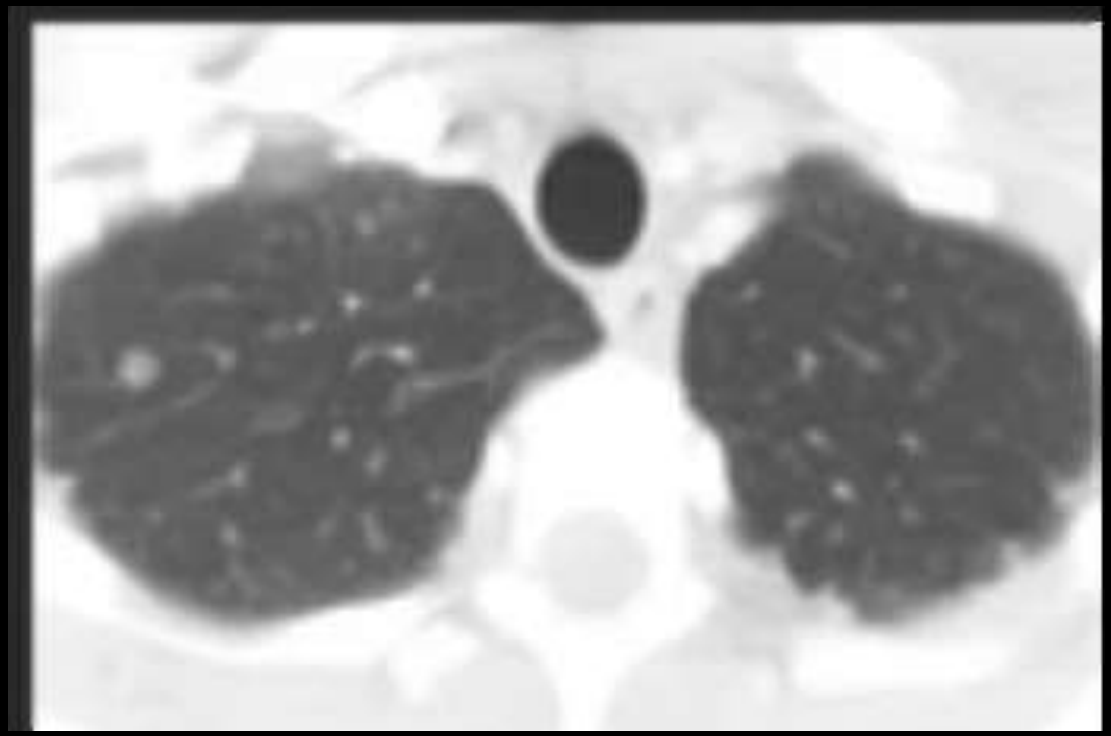


Solitary Pulmonary Nodules

- Spherical opacity less than 3cm
- BENIGN
- Unchanged in 2 yrs
- Less than 15-20HU
- Smooth margins
- Macroscopic calcification

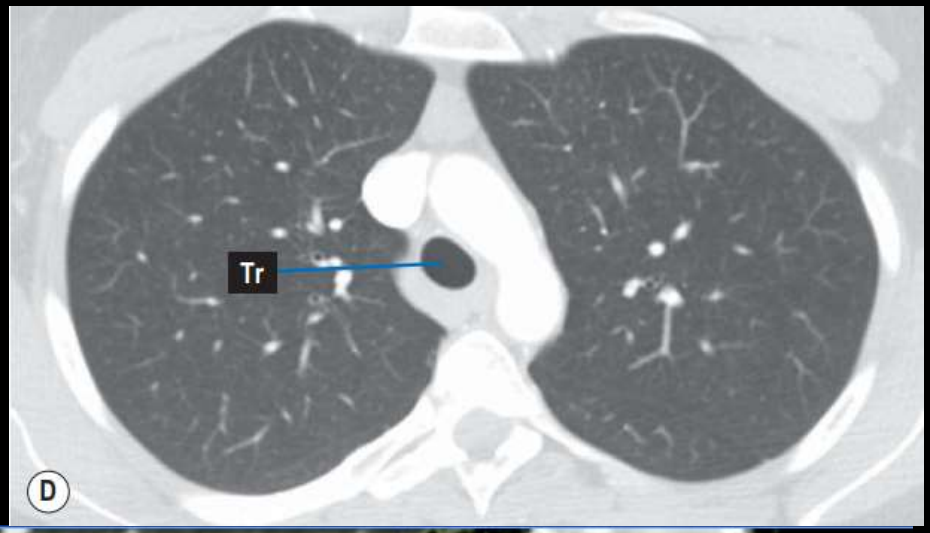
- MALIGNANT FEATURES
- Irregular margins
- Spiculated
- Multiple

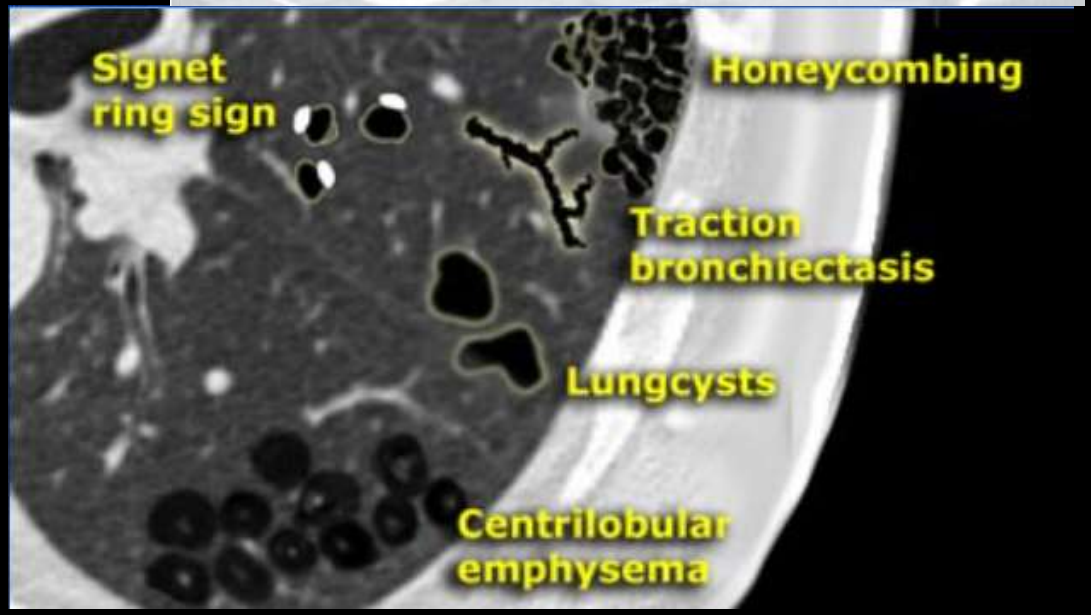
- Common causes of nodule include infections(abscess, granuloma), mets, tumors, lymphomas stc



Low attenuation areas

- These are airspace filling lesions
- Most of these diseases can be recognized on HRCT
- Emphysema
- Lung cysts (LAM, Langerhans cell histiocytosis)
- Bronchiectasis
- Honeycombing





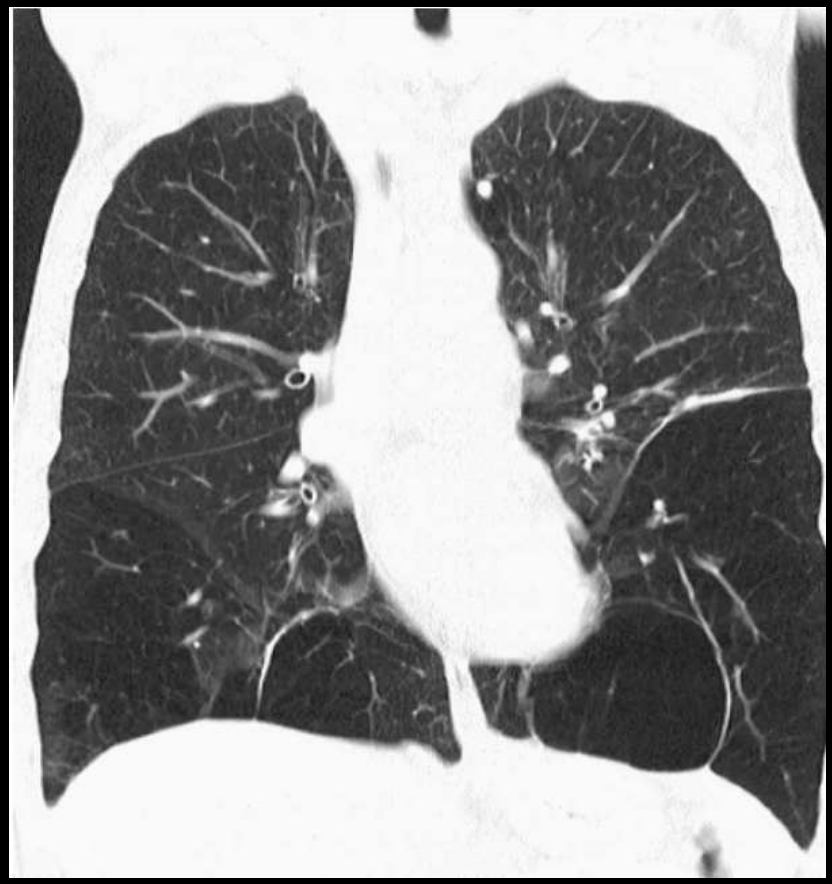
bronchiectasis

- Dilation of bronchi more than 2mm diameter
- Impaired clearance leads to recurrent infection which leads to bronchial damage
- Types
- Cystic, varicose, cylindrical
- HRCT is diagnostic tool of choice

- DDX-
- Post infections
- Pulmonary fibrosis
- Bronchial obstruction etc

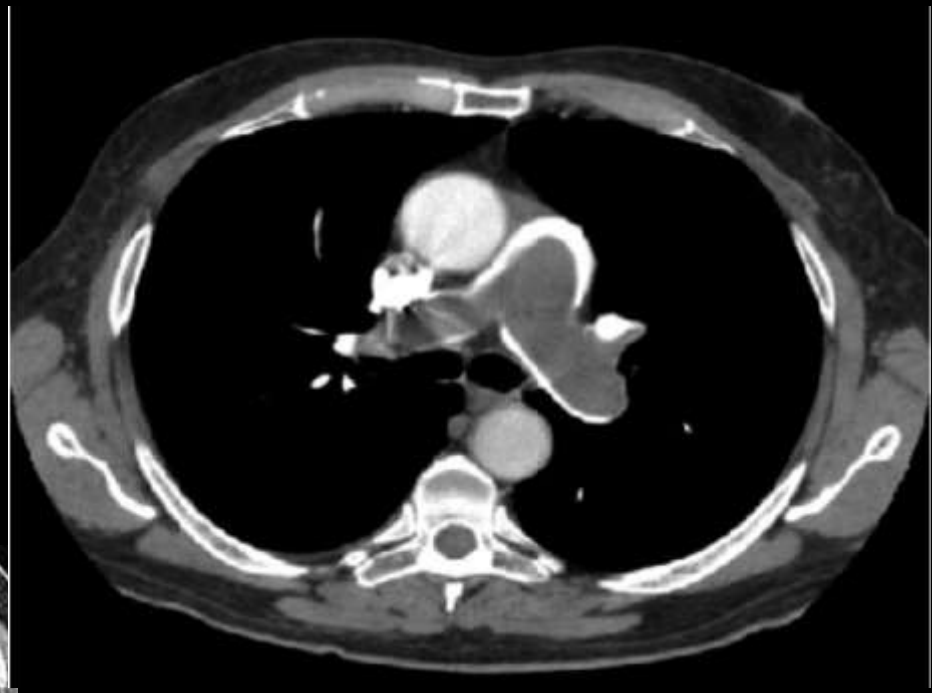
Pulmonary Emphysema

- Permanent dilation of the airways distal to the terminal bronchioles
- There isalveolar wall destruction without obvious fibrosis the appearances of emphysema on CT have been extensively reported
- Areas of low attenuation with ill defined margins, usually without visible walls,
-
- DDX
- Smoking related lung disease
- Vasculiitis
- Connective tissue disorders



Filling defects

- Well defined opacity in pulmonary artery
- Cant evaluate arteries below 4th segmental level



Other chest CT findings

- Pleural effusion
- CXR and ultrasound initial imaging modality
- Water density collection in pleural space
- This patient had pleural tumor deposits and a malignant effusion

Lung collapse

- There is always volume loss on affected side
- “unprovoked” collapse in adult needs CT evaluation to rule out cancer

Common pathologies

- COVID
- Pneumonia
- PCP
- PTB and post TB lung disease
- Pulmonary embolism
- Aortic syndromes
- Trauma
- Qand N

COVID 19

PCR for diagnosis

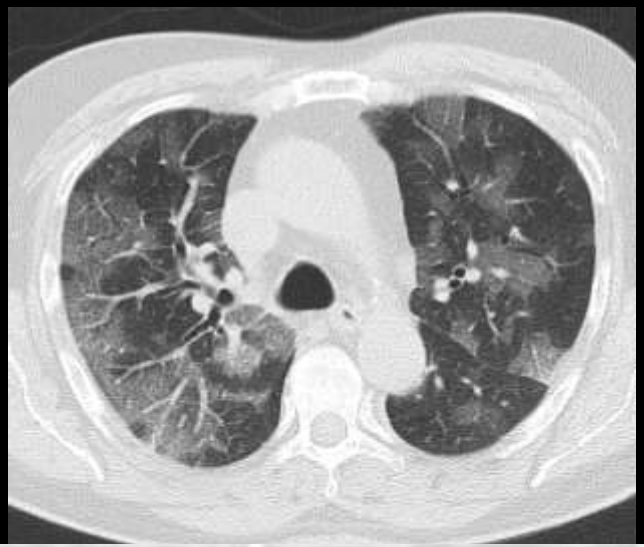
- CORADS Score
- Severity score
- Temporal staging
- High index of suspicion with normal CXR
- Look out for complications
- **Initially** ;

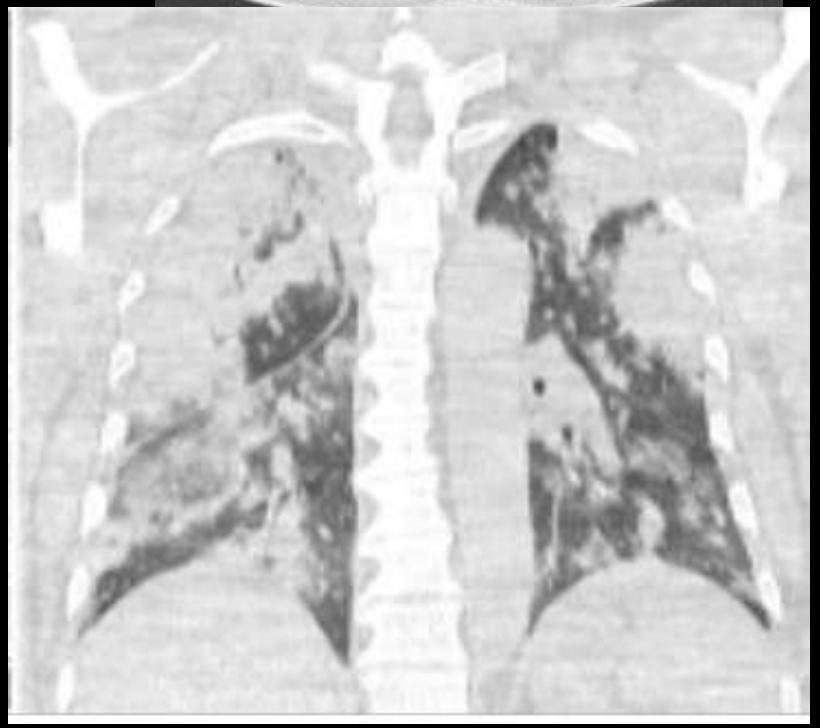
❖Ground glass opacities

❖Consolidations

❖Bilateral involvement

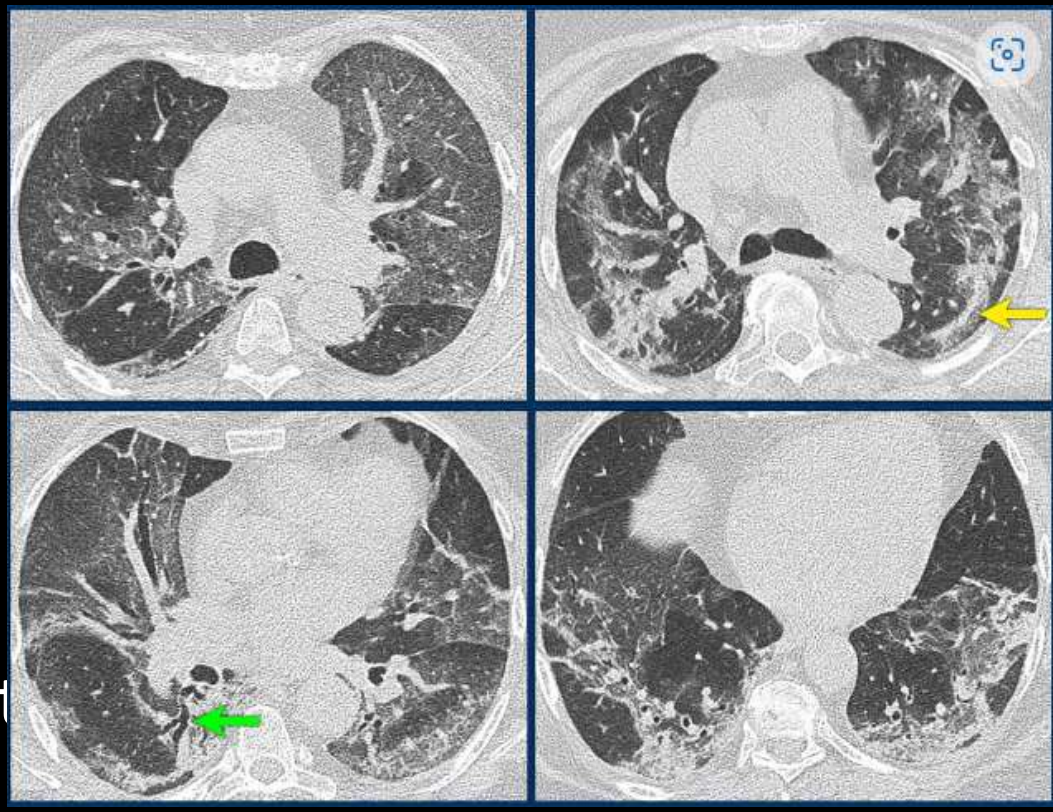
❖Multilobar involvement





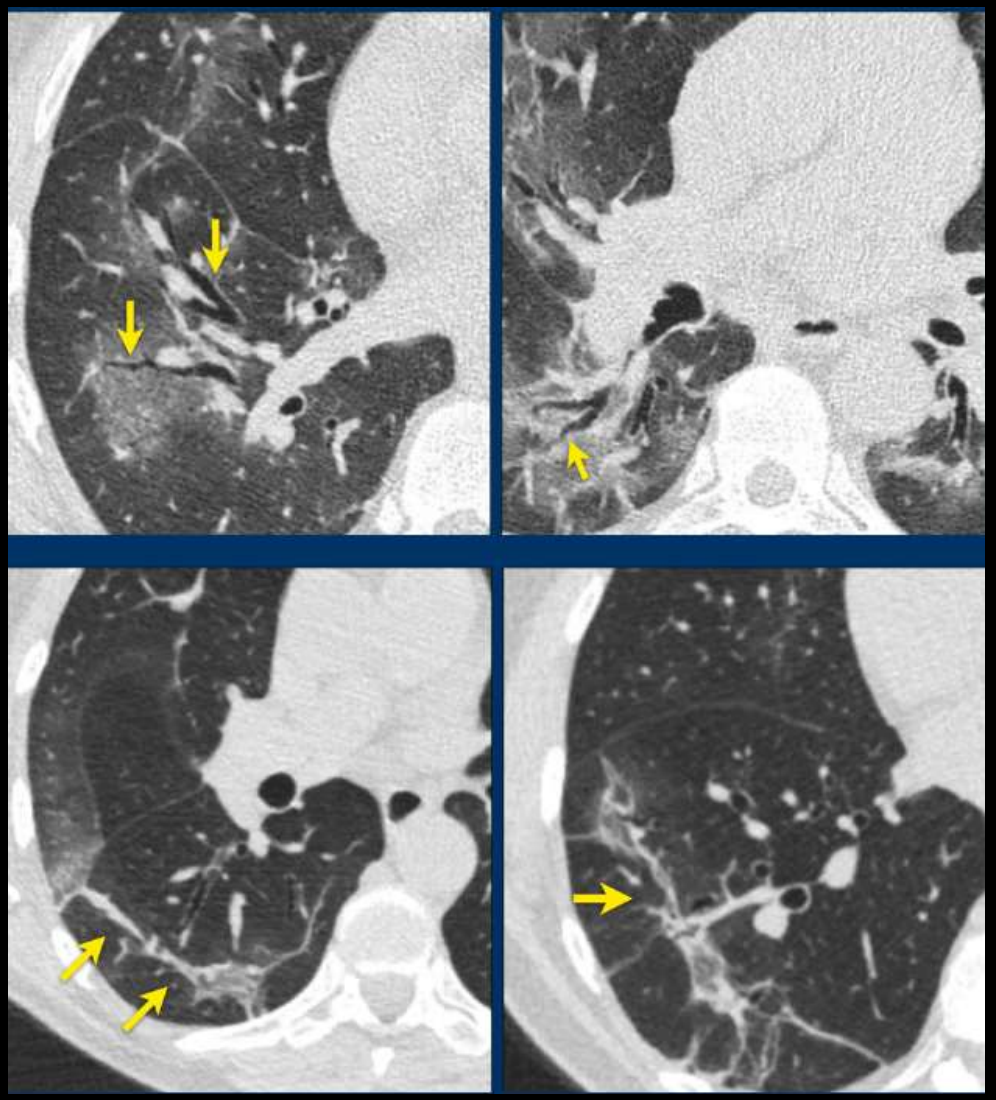
COVID late features

- GGO pattern
- Vessel enlargement
- Fibrotic streaks
- Consolidation more pronounced
- Subpleural line or a subpleural transparent line
- Pleural effusion



COVID 19

- Traction bronchiectasis
- Sub pleural bands
- Vessel dilation



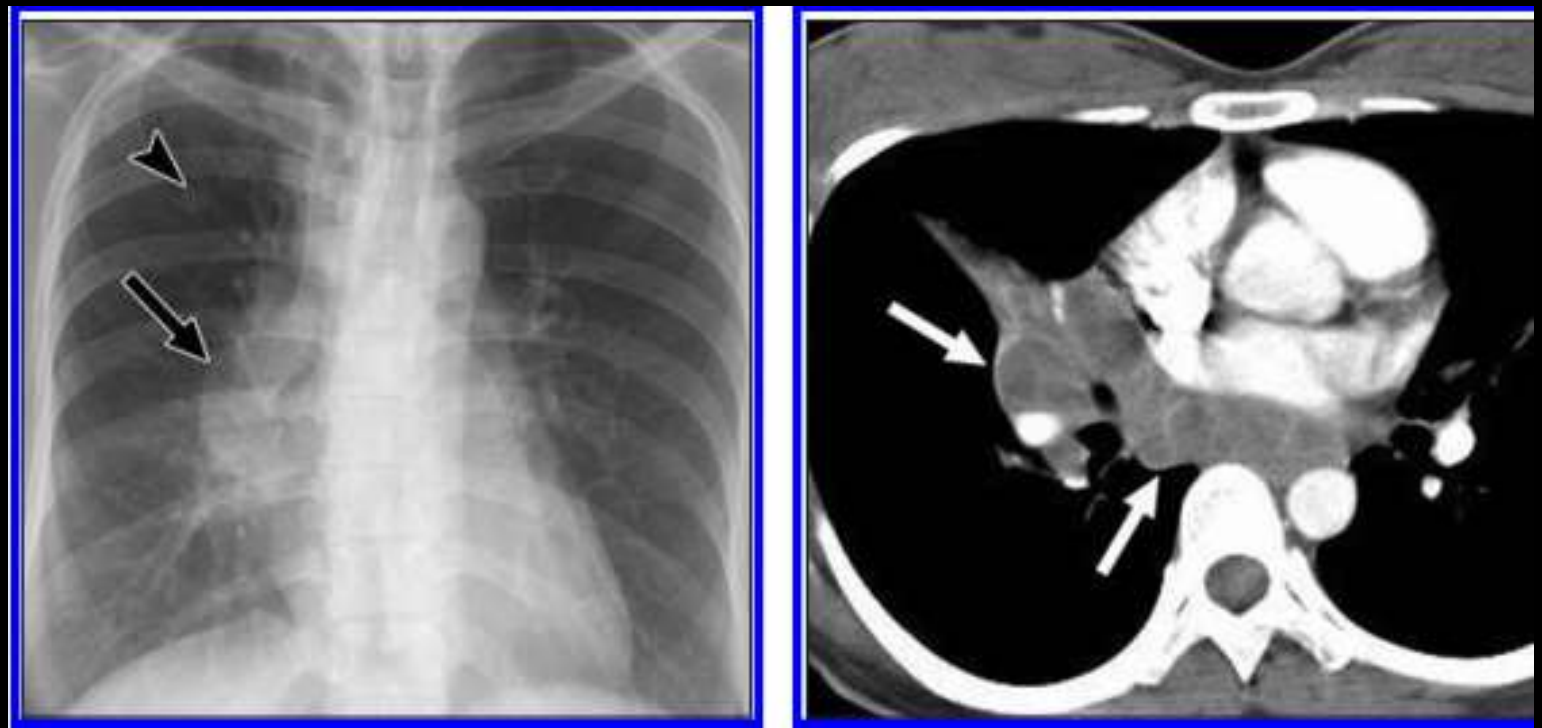
2. PTB and post TB lung disease

- A complete evaluation for TB includes clinical evaluation, microbiologic smears and culture, CXR
- CT not routinely used
- We look for radiological features of PTB in difficult cases
- complications of PTB
- Evaluate post TB lung disease

- Radiological findings include
- Consolidations
- Miliary nodules
- Lymphadenopathy
- Pleural effusions
- Upper lobe cavities
- Tree in bud pattern
- Post TB sequela features
- Pneumothorax
- Lung collapse

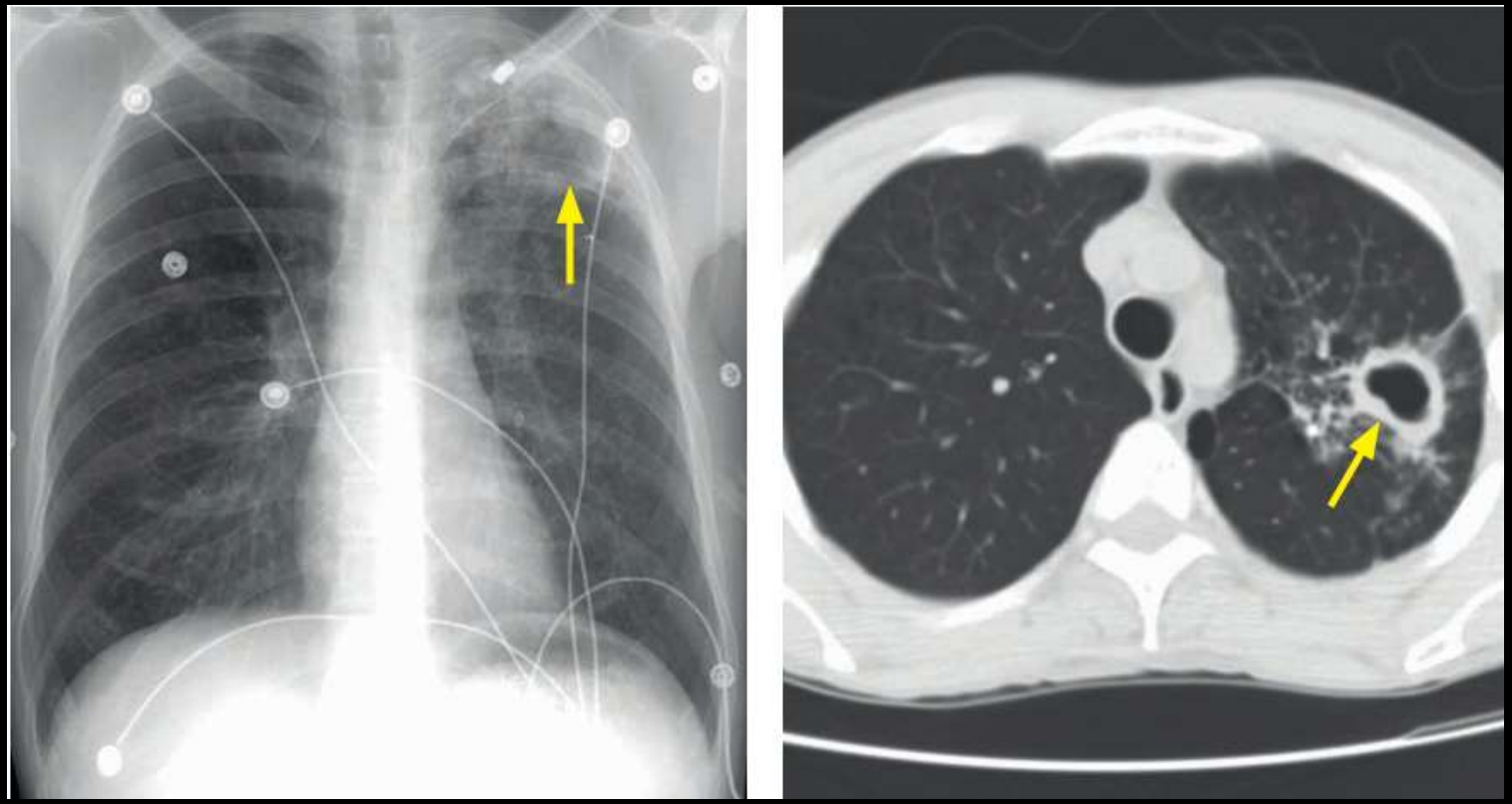
Primary Tuberculosis

- Primary TB manifesting primarily as lymphadenopathy
- CXR shows right hilar nodes, clearly seen on CT



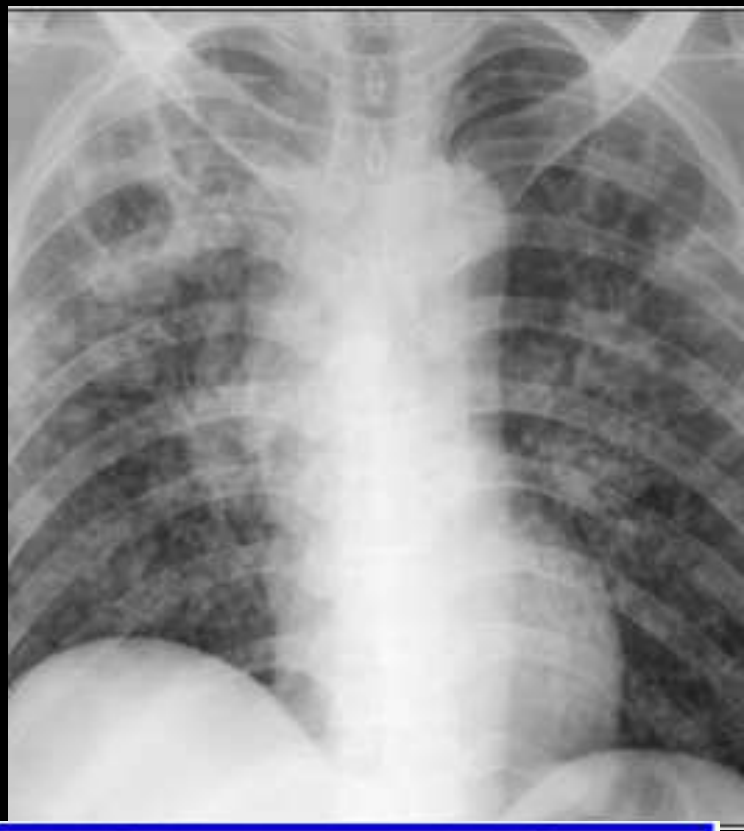
Post primary TB

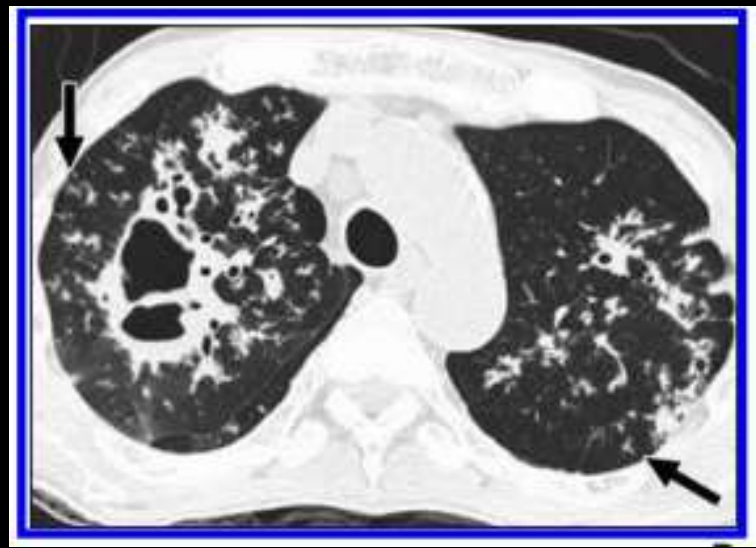
- Reactivation TB.
- The DDX could include cavitary lung cancer

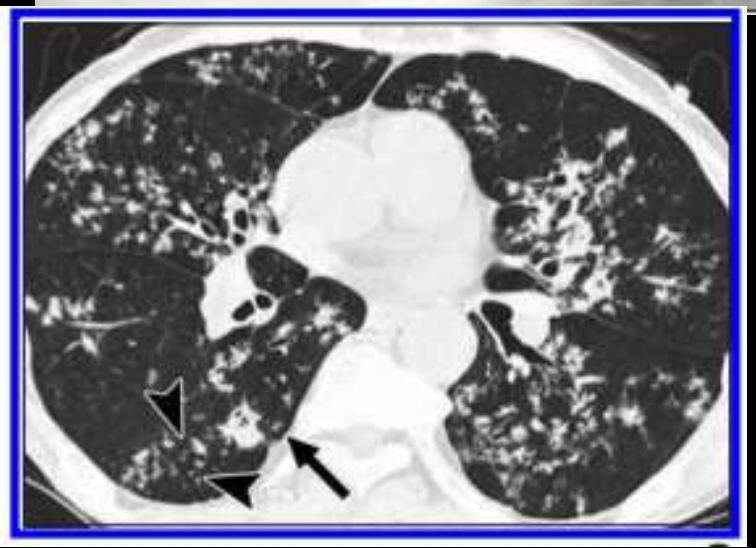


Reactivation TB

- Cavitary consolidation in the right upper zone
- HRCT show two cavities
- Tree in bud, consolidation

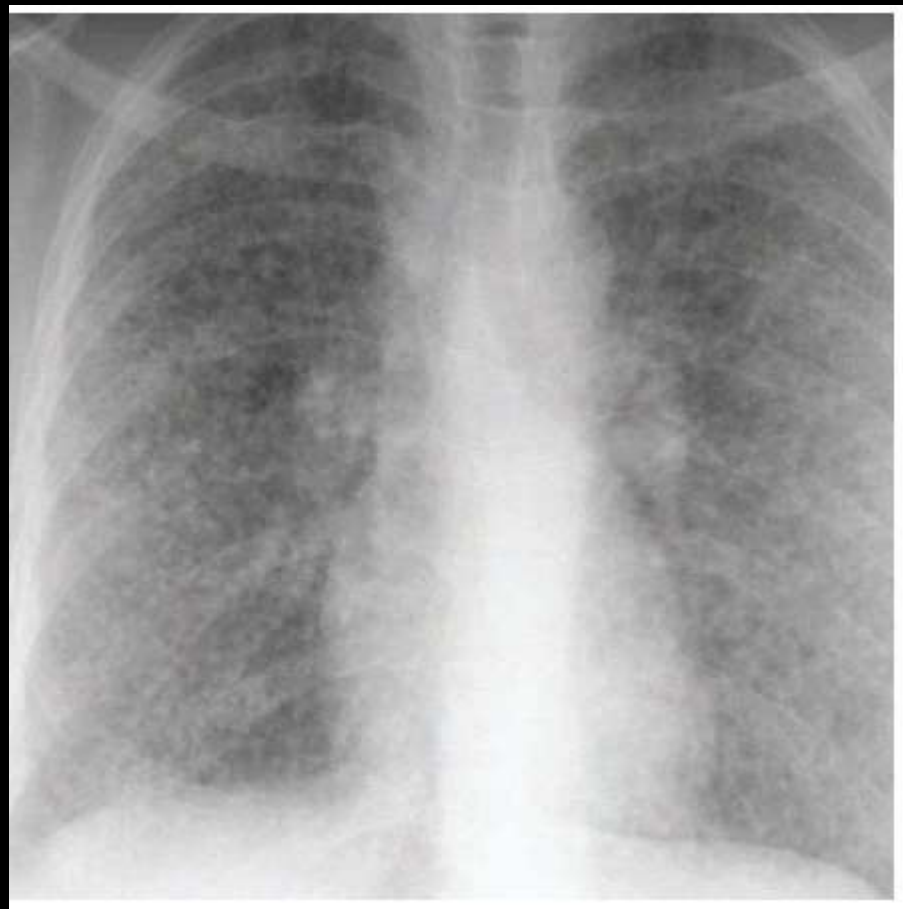






Miliary pattern of MTB

- Miliary TB



Post TB sequela

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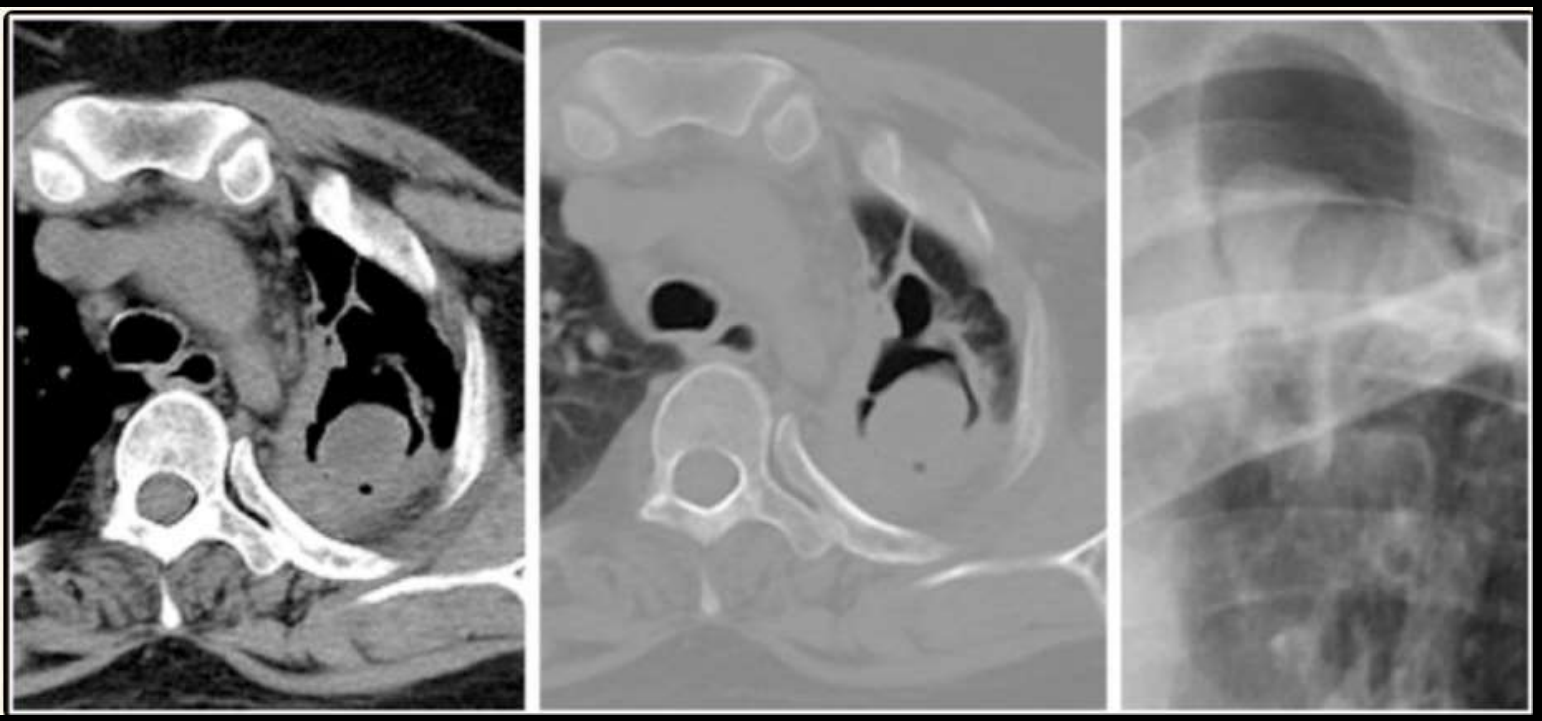
Parenchymal	Airways	Pleura/chest wall	Arteries	Mediastinal
Tuberculoma	Bronchiectasis	empyema	Rasmussens aneurysm	Calcified mediastinal nodes
Thin walled cavity	Broncholithiasis	fibrothorax		Fibrosing mediastnitis
Cicatrization collapse		Pneumothorax		Pericardial TB
Aspergilloma		Bronchopleural fistula		
Bronchogenic carcinoma				

Cicatrization collapse

- Part of lung is destroyed and the debilitating fibrosis and cavities lead to collapse
- Radiologically there is volume loss, mediastinal shift and ipsilateral mediastinal shift

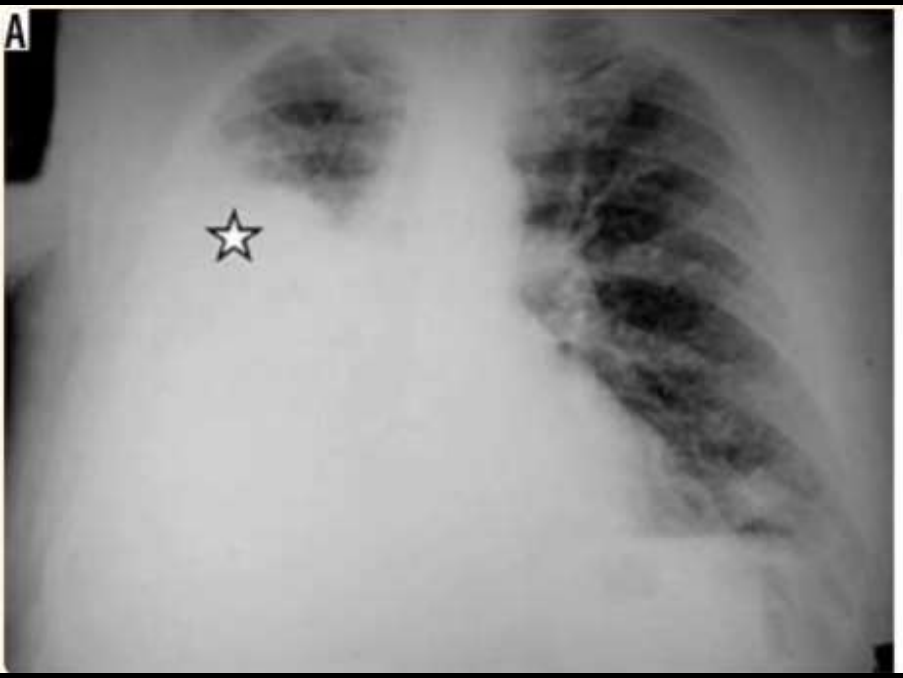
Aspergilloma

- Chest X ray shows a cystic lesion with internal soft tissue opacity and air crescent sign. Corresponding CT chest sections in mediastinal and lung window settings shows a thin walled cavity with a fungal ball



Pneumonia

- Mostly a clinical diagnosis
- CXR first imaging modality
- Chest CT to identify complications, alternative DX

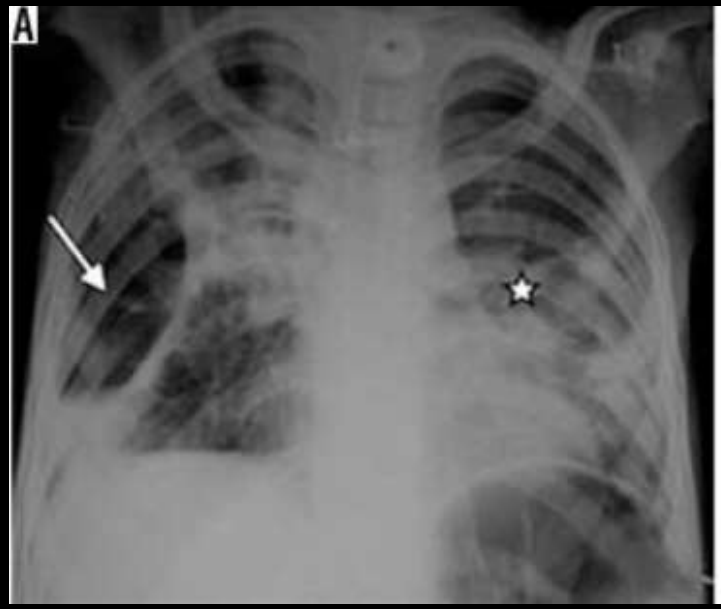


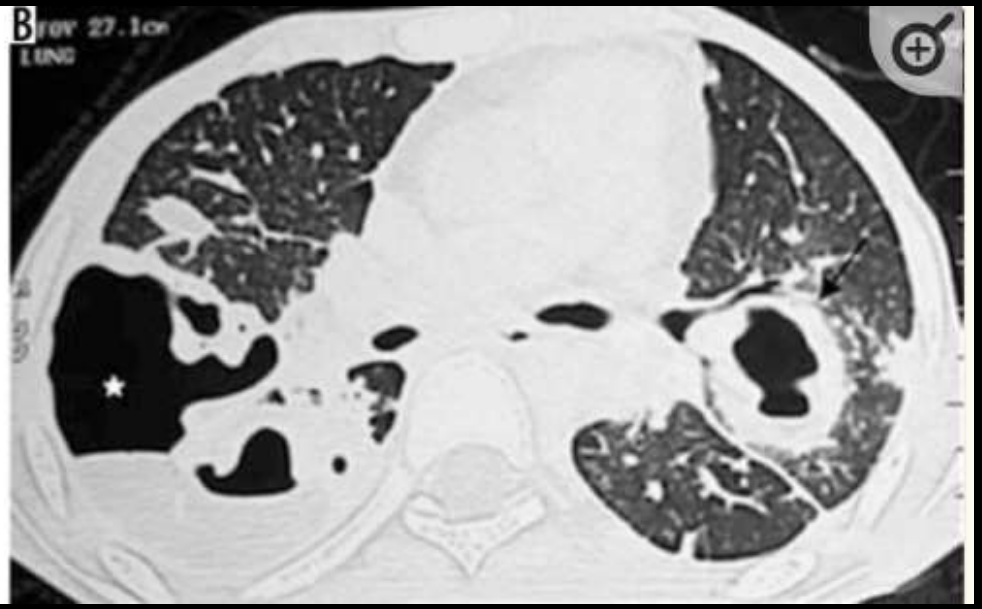
Radiological features

- Reticular pattern
- Consolidation
- Cavitation
- Pneumatocele
- Nodules
- Pleural effusions

Pneumonia examples

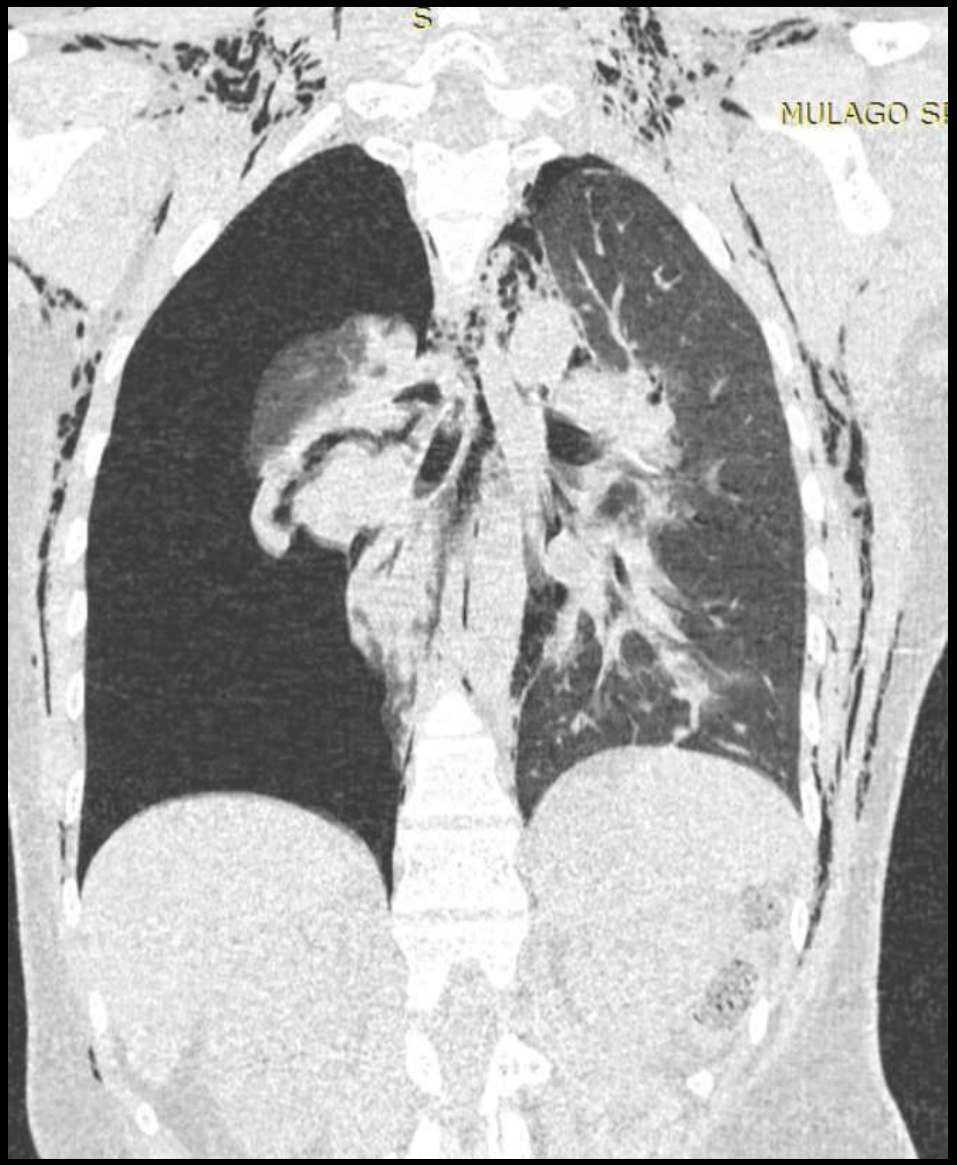
-
- B) Chest computed tomography (CT) image shows presence of thick-walled cavity with rupture into right pleural cavity (asterisk) and thick-walled cavity, with adjacent centrilobular nodules, in left upper lobe (black arrow)





Trauma

- Multi causality trauma
- Look for
- Pneumothorax
- Consolidations
- Pneumomediastinum
- Rib fractures
- Fracture of 1st/ 2nd rib indicate severe trauma
- Lung collapse
- Hemothorax

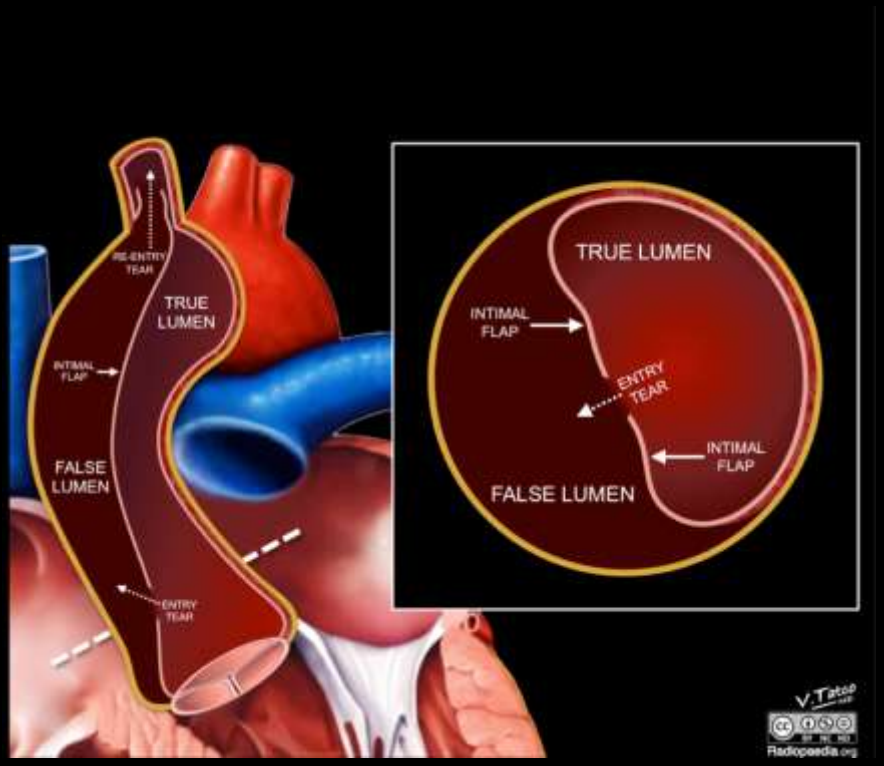


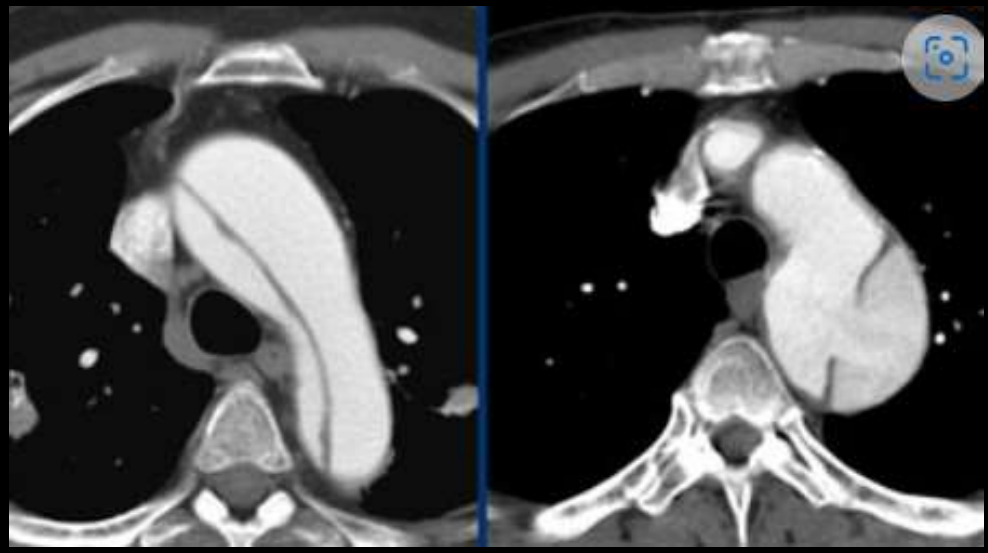
Thoracic Aortic aneurysm/dissection

- Diffuse/focal dilation involving all layers of aortic wall
- Rare than abdominal aortic aneurysm
- Ask for CT aortogram or CT angiogram of the aorta
- Timing of contrast in the aorta

Aortic dissection

- Intimal flap
- Increased aortic diameters
- Double lumen
- Other signs





Dissection

- Dissection of descending aorta

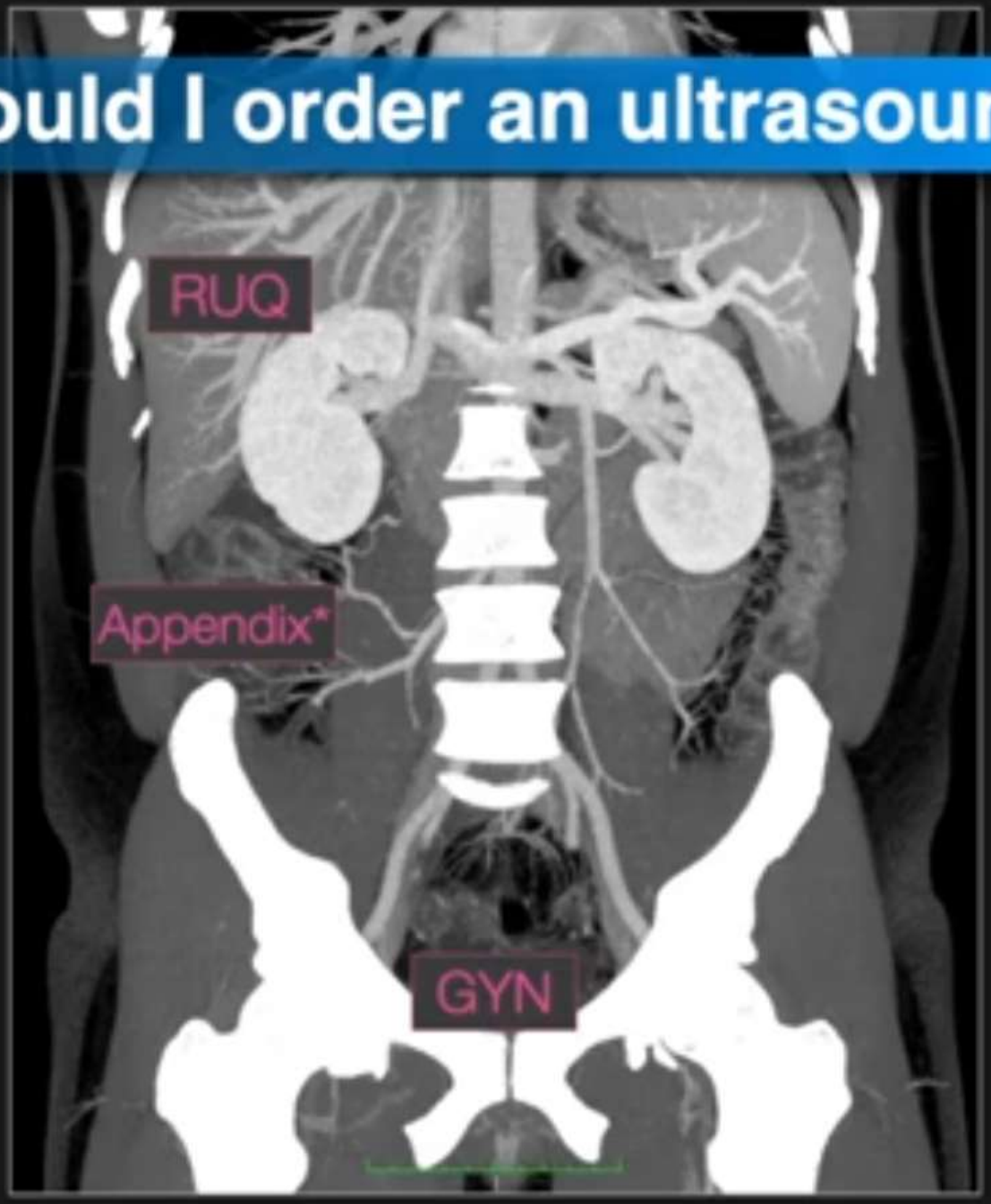
Summary and questions

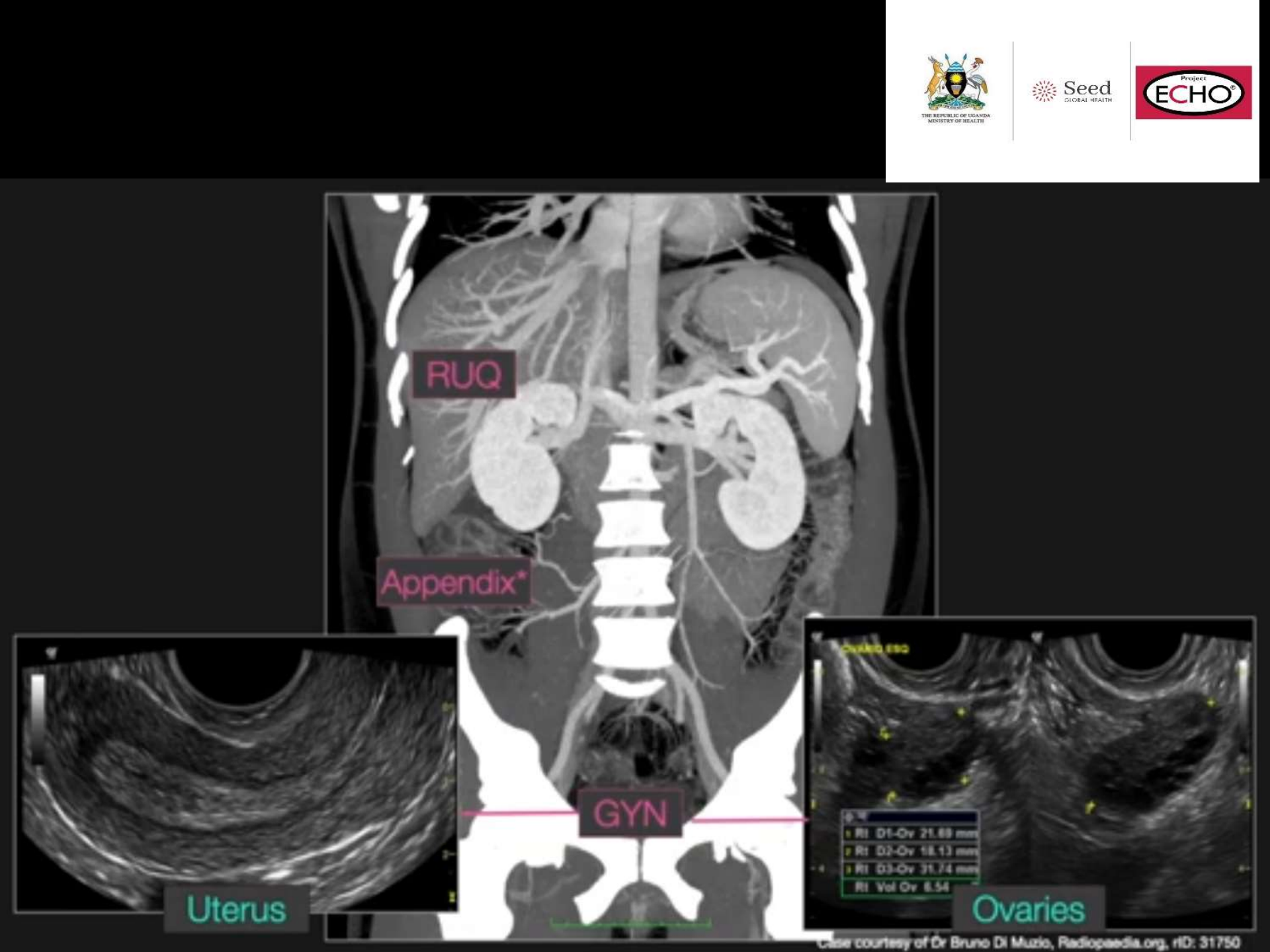
- Be systematic
- Assess the quality of image
- Specific protocol will depend on history or physician request
- More specialized tests are more expensive

Introduction to Abdominal CT imaging

- Workhorse for acute abdominal pain and cancer imaging
- CT plays complementary role to AXR, Ultrasound and MRI
- Always consider if imaging will be of additional value to patient management

Should I order an ultrasound?

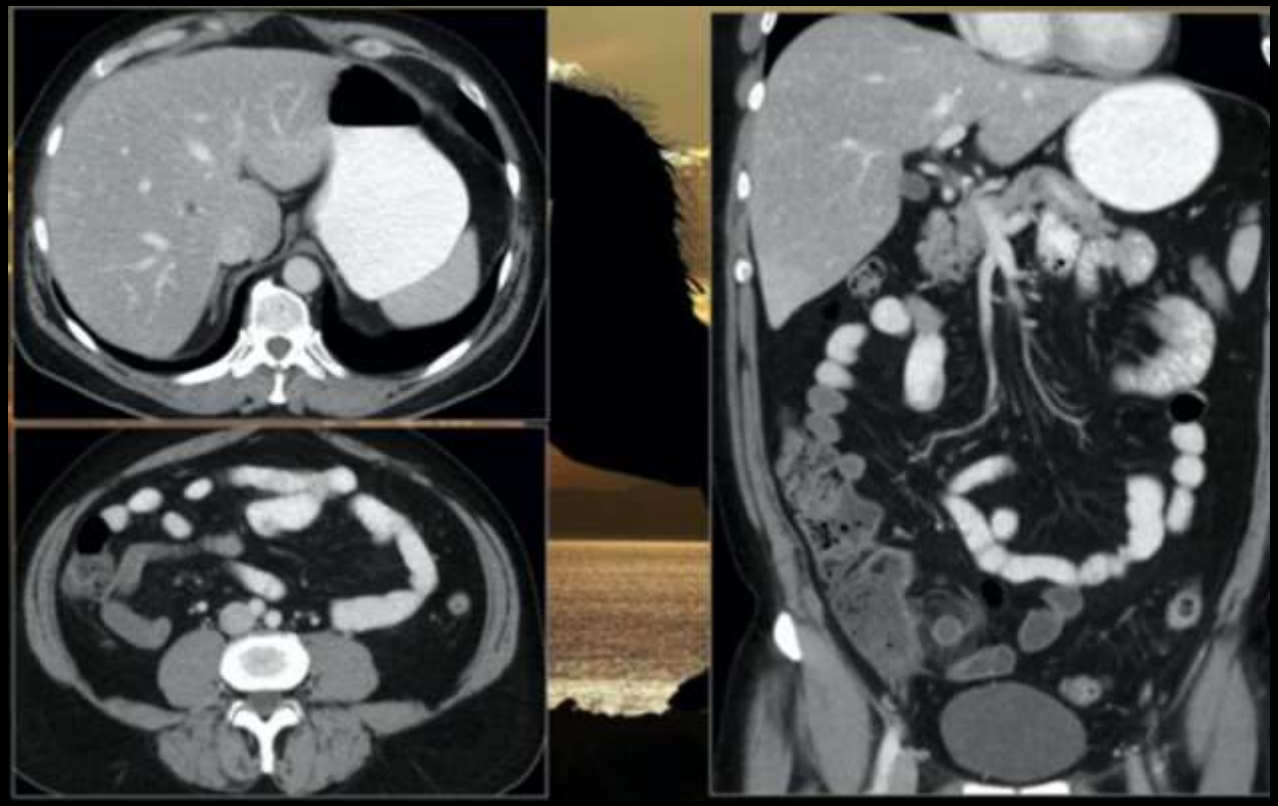



RUQ
Appendix*
GYN
Uterus
Ovaries
Case courtesy of Dr Bruno Di Muzio, Radiopaedia.org, rID: 31750

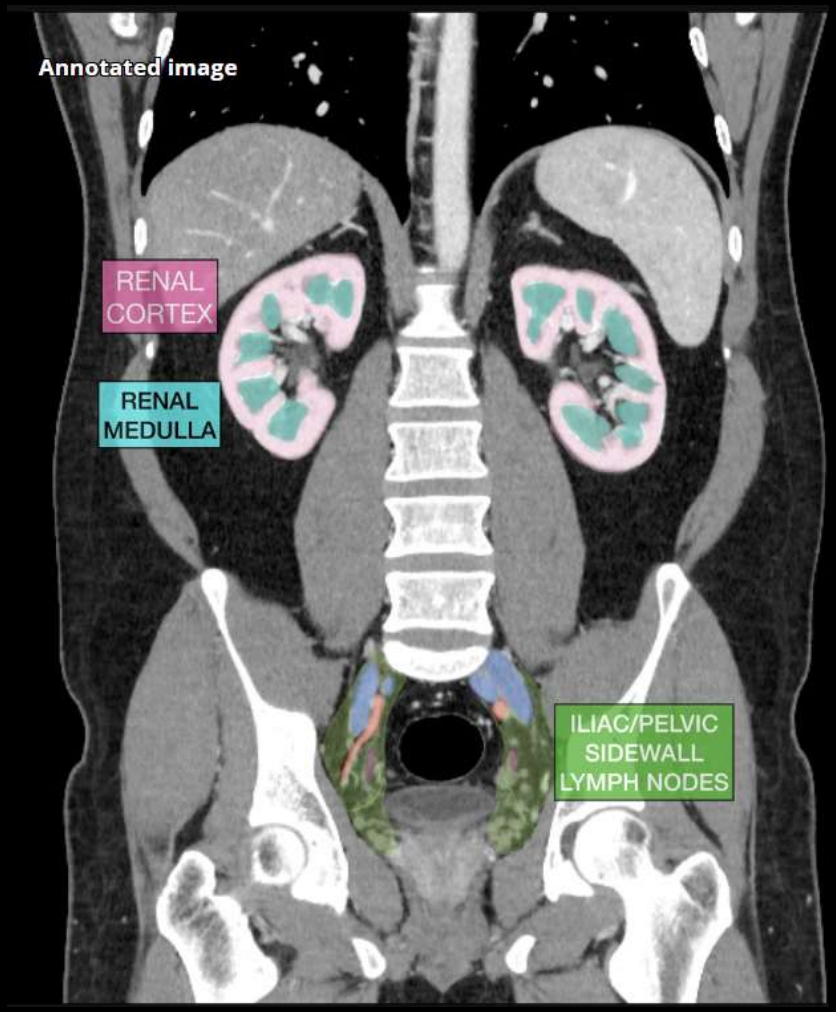
Indications

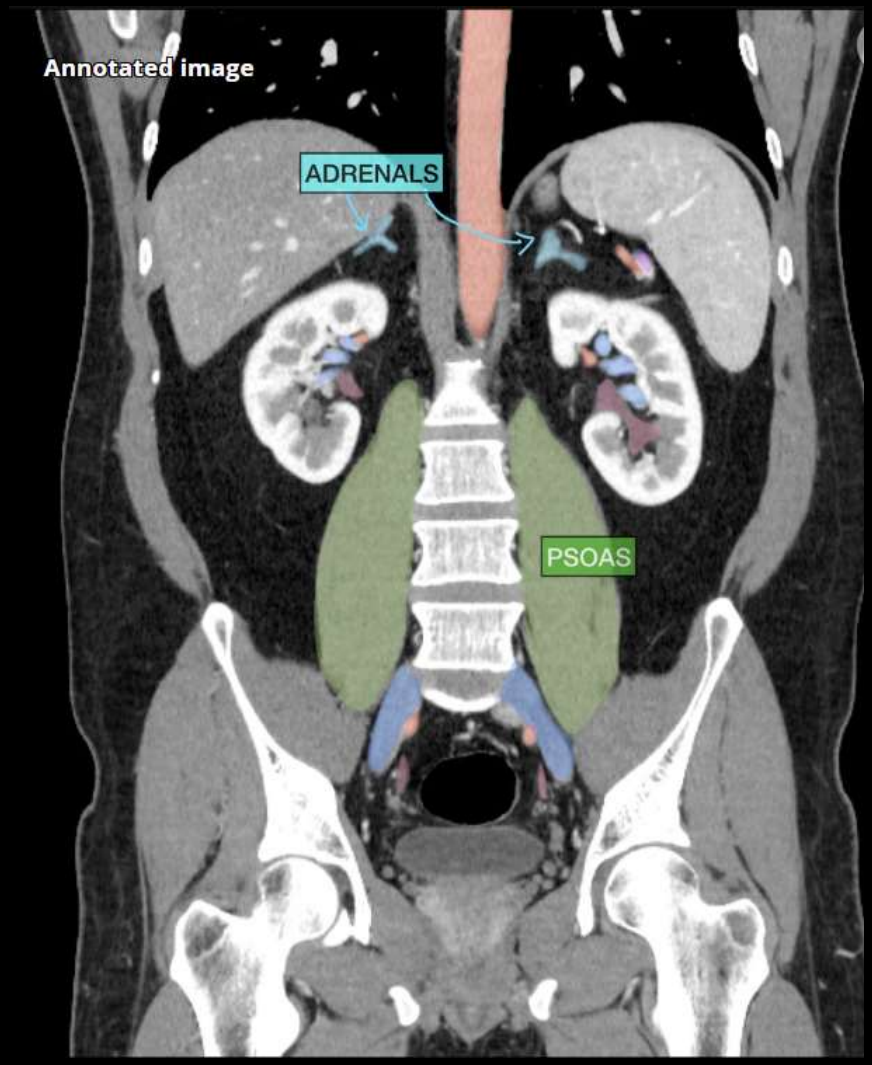
- Acute abdomen
- Renal stones
- Acute appendicitis
- Perforation
- Bleeding
- Cancer imaging
- General screening
- Staging
- Restaging
- Post operative evaluation
- complications

Imaging planes

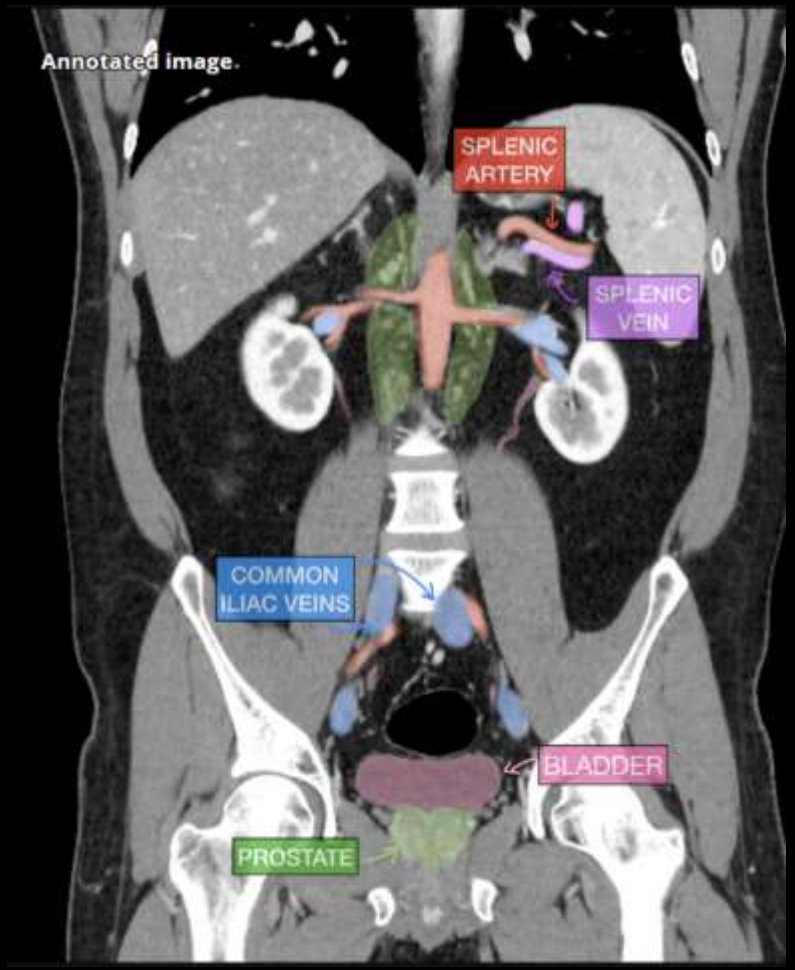


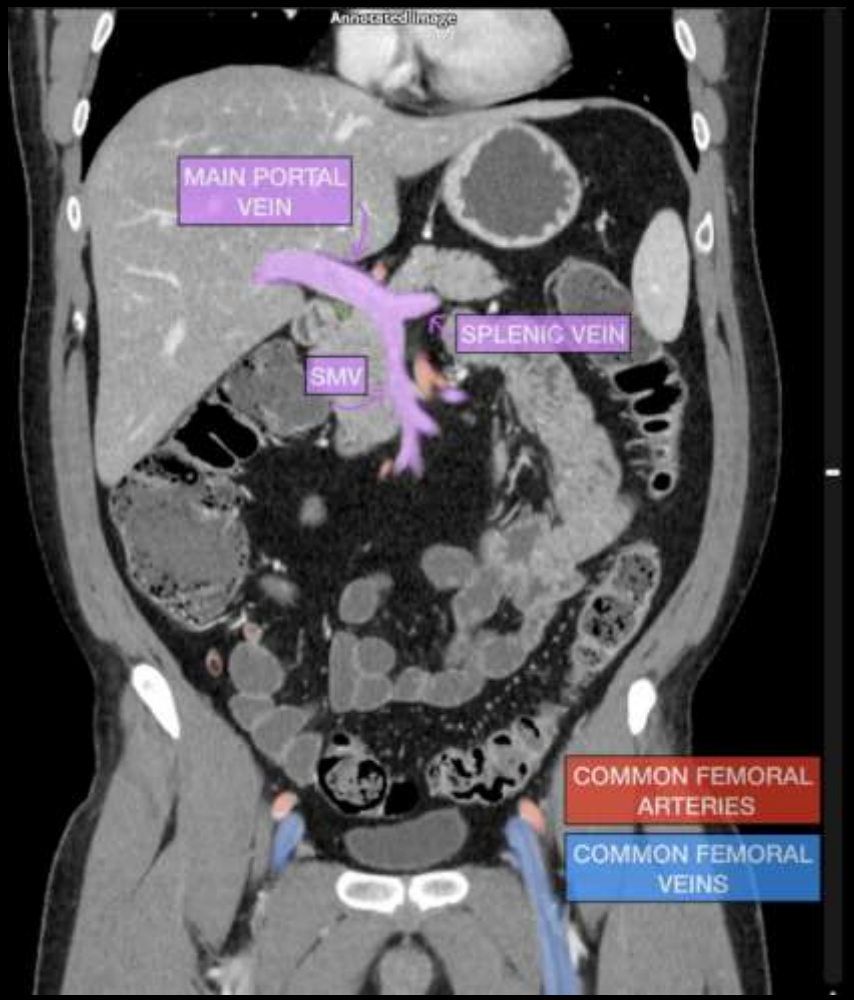
Basic anatomy



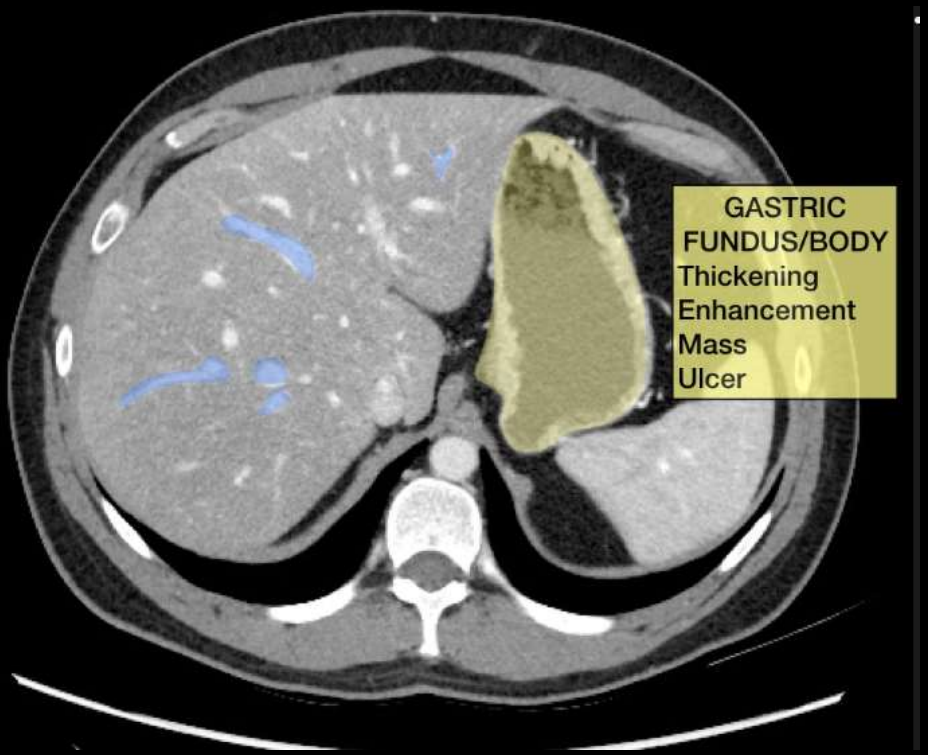


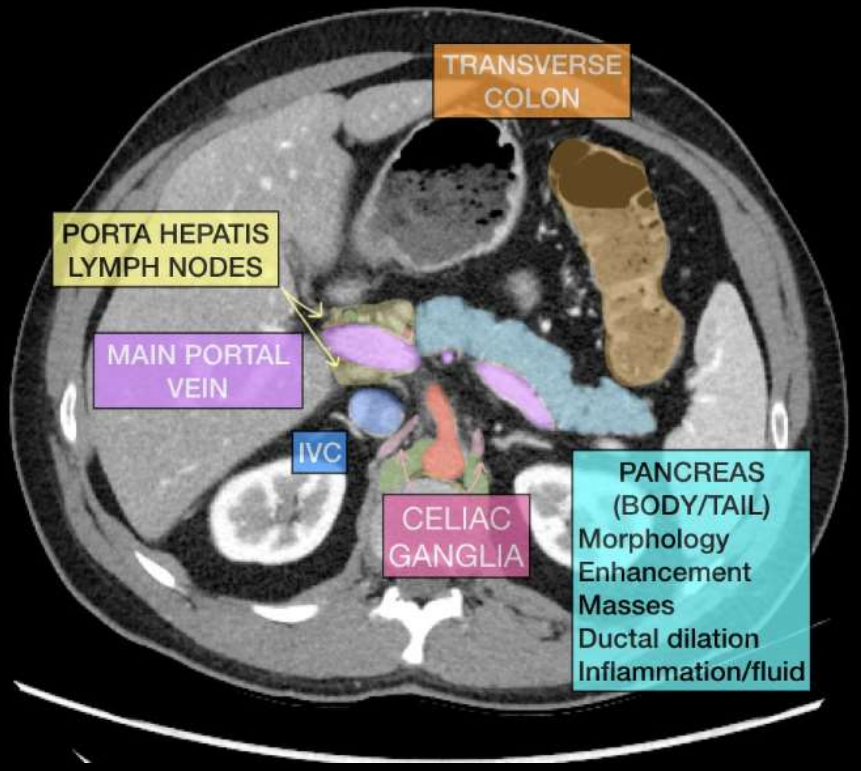
Basic anatomy





Axial anatomy





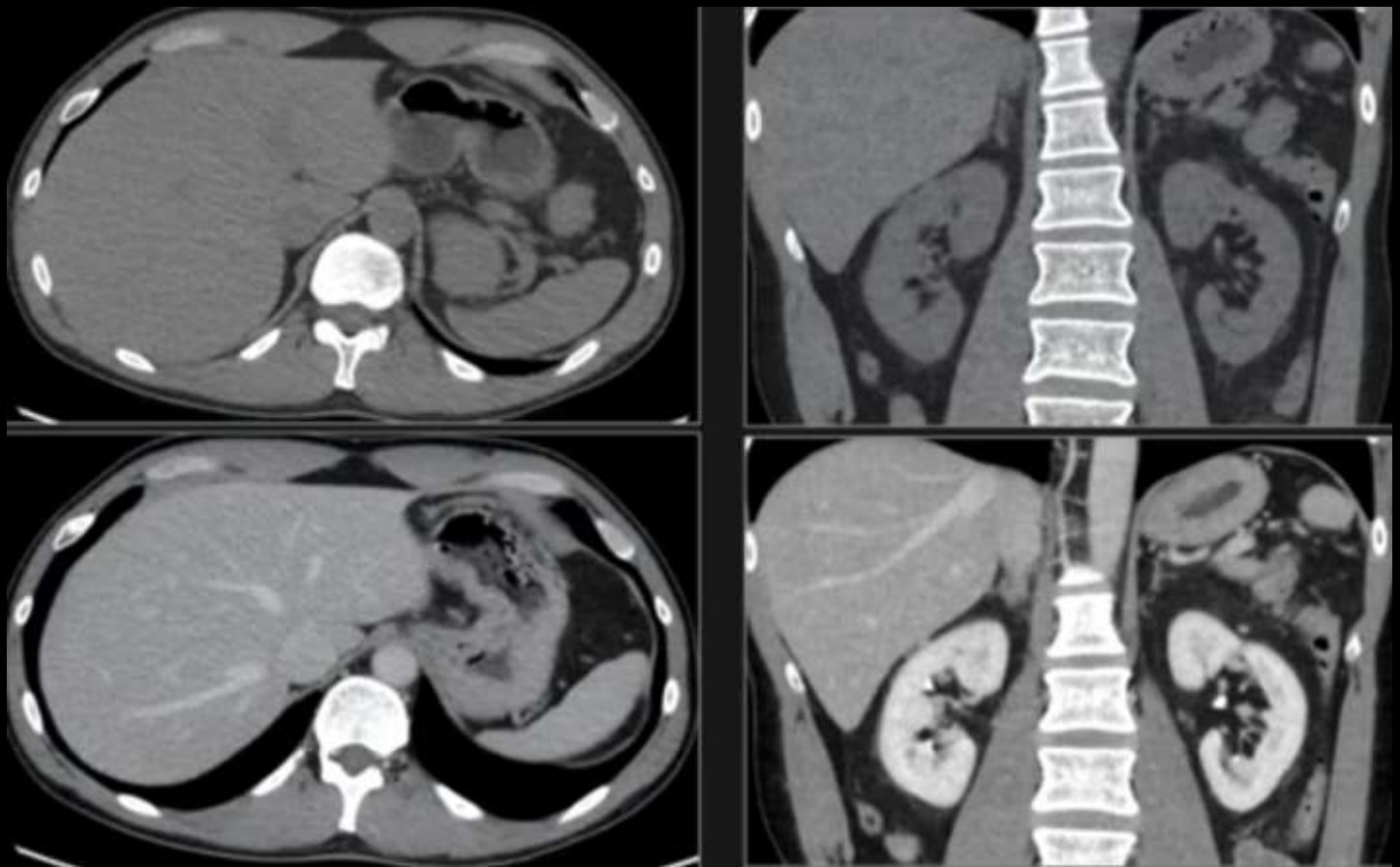
Use of contrast media

- Helps view vessels and solid organs better
- Some tumors have unique contrast uptake or washout
- Some abdominal will have to be imaged at different times of contrast uptake to get pathology

- We use iodinated contrast
- Specific timings
- Examples
- Contrasted abdominal CT
- Triphasic liver CT scan
- CT Urogram
- Pancreatic protocol
-

Use of contrast

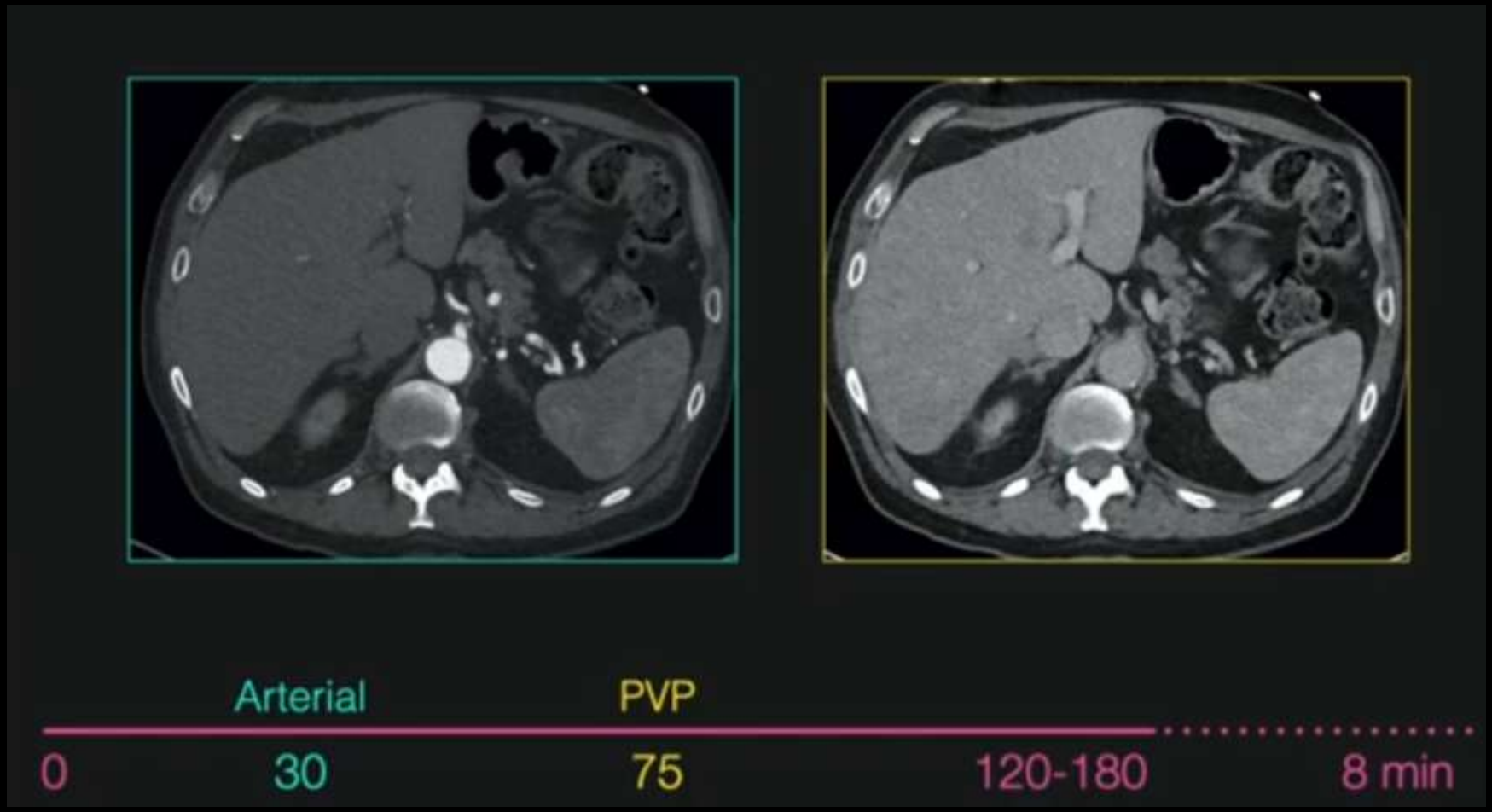
- To assess pathology and view function of major organs



Non contrast

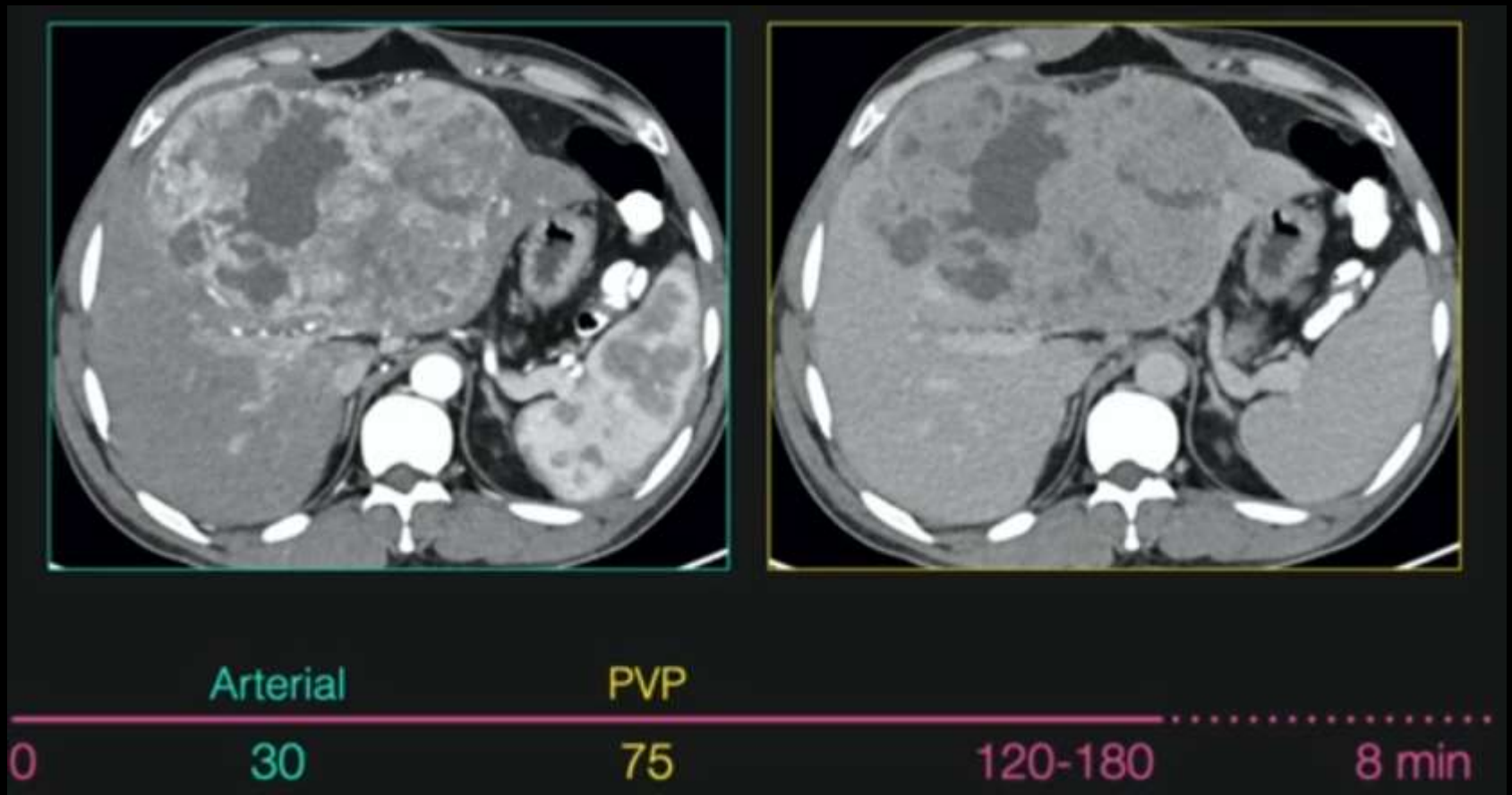
- Renal failure
- Severe allergy
- Flank pain
- Calcifications

Contrast timing

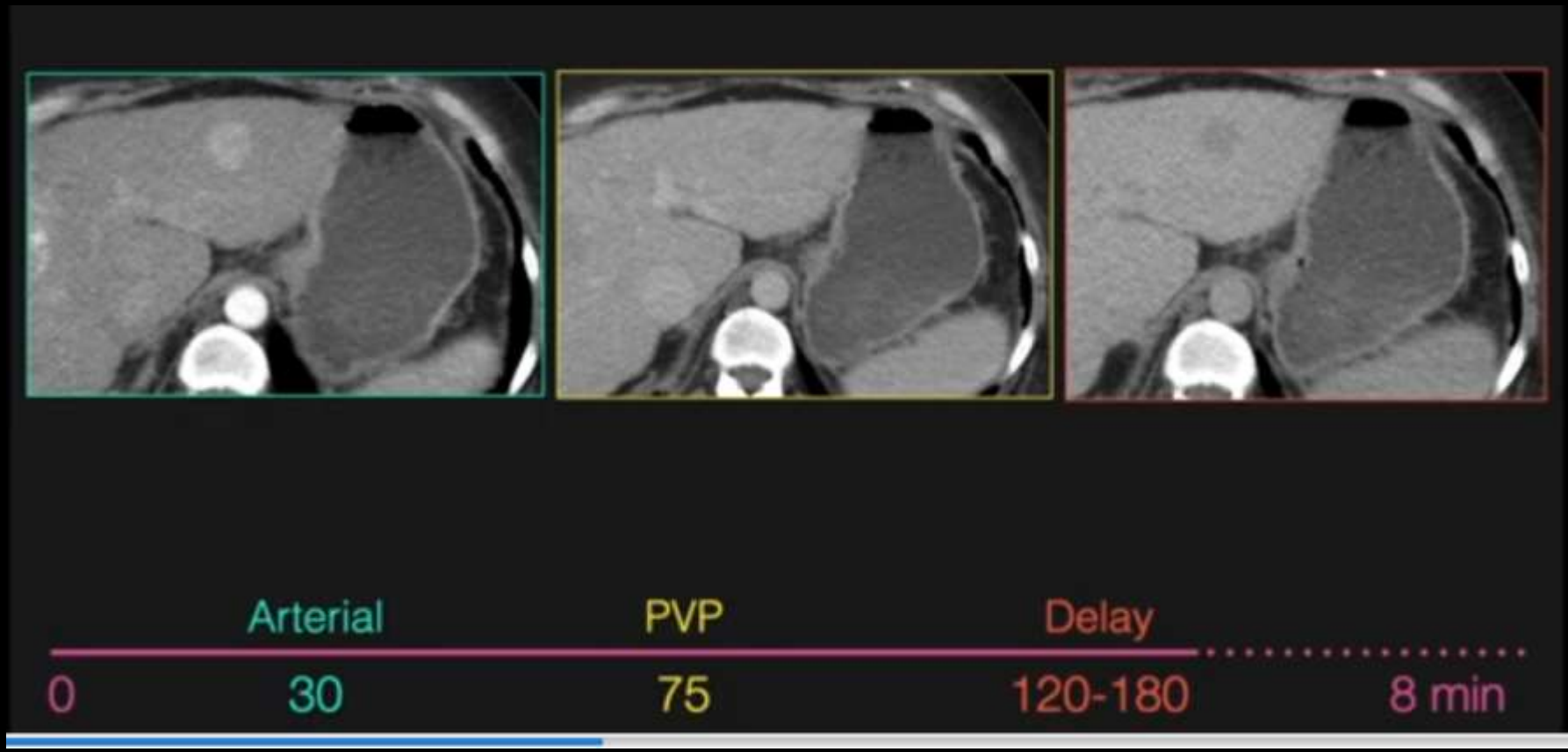


ARTERIAL PHASE

- Arterial phase necessary for liver tumors and neuroendocrine tumors of pancreases

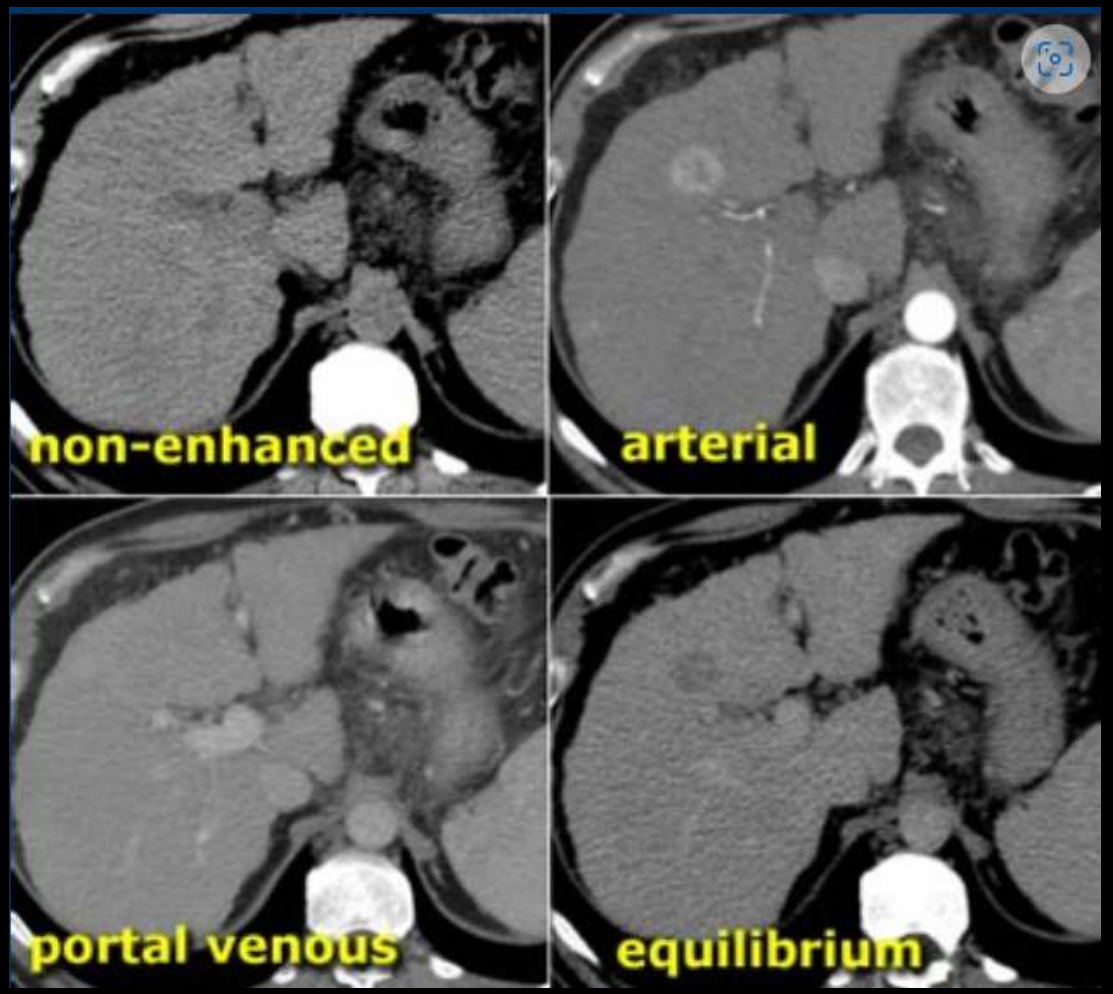


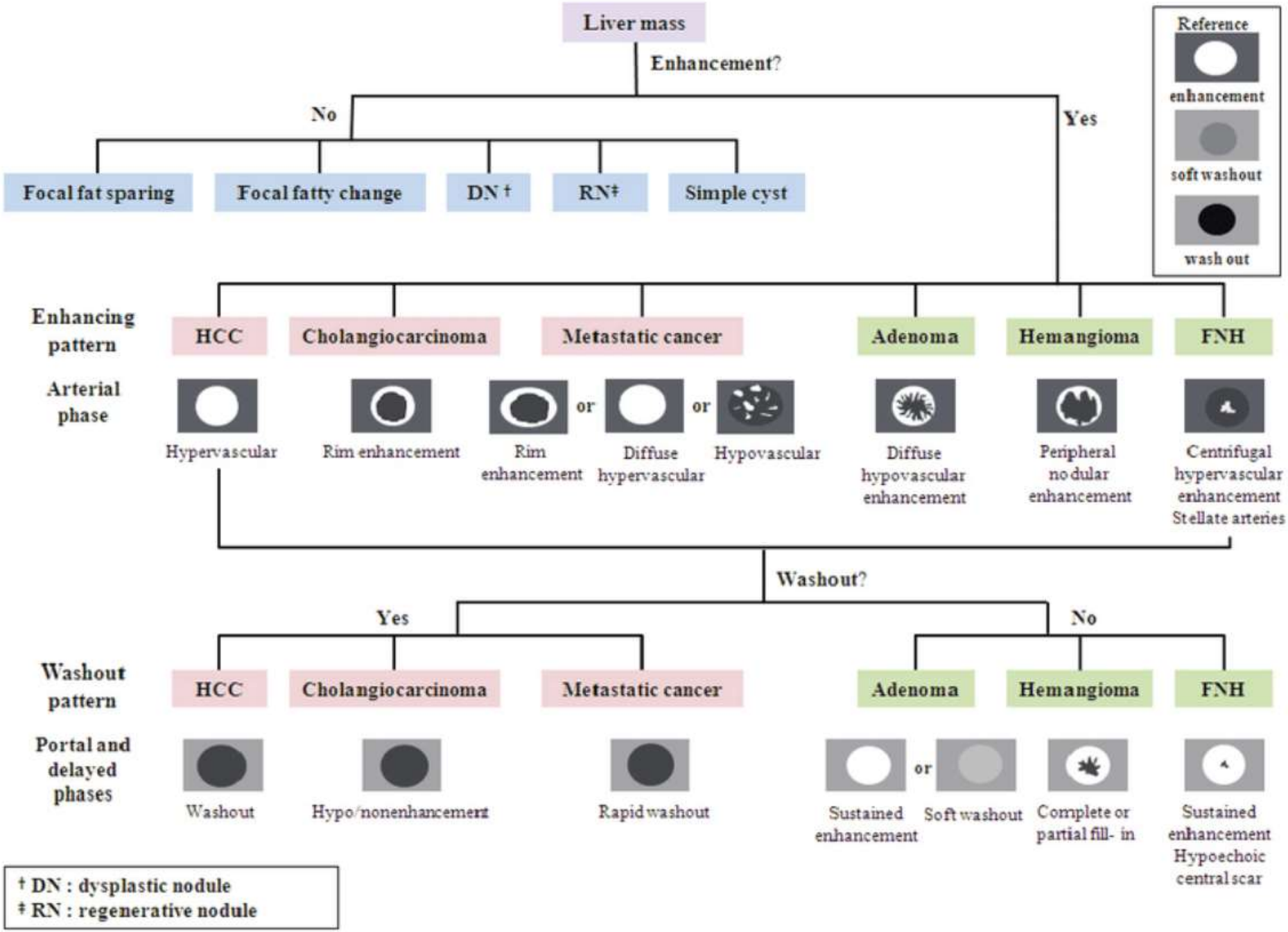
TRIPHASIC CT , used in liver masses



Triphasic liver CT

- For focal liver mass characterization
- Different liver masses have different enhancement patterns
- Example is HCC
- Arterial enhancement with early washout

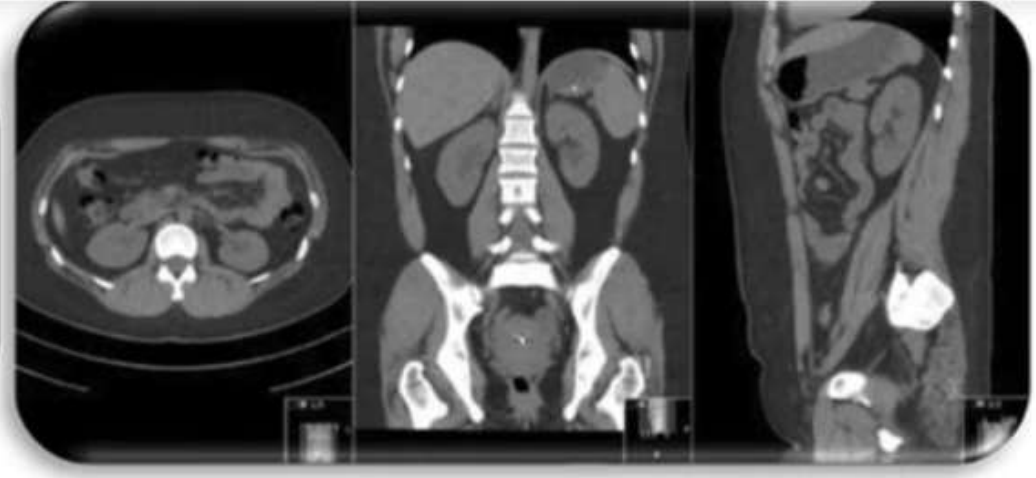



Liver mass
Enhancement?
No
Yes
Focal fat sparing
Focal fatty change
DN †
RN‡
Simple cyst
Reference
enhancement
soft washout
wash out
Enhancing pattern
HCC
Cholangiocarcinoma
Metastatic cancer
Adenoma
Hemangioma
FNH
Arterial phase
Hypervascular
Rim enhancement
Rim enhancement
or
Diffuse hypervascular
or
Hypovascular
Diffuse hypovascular enhancement
Peripheral nodular enhancement
Centrifugal hypervascular enhancement Stellate arteries
Washout?
Yes
No
Washout pattern
HCC
Cholangiocarcinoma
Metastatic cancer
Adenoma
Hemangioma
FNH
Portal and delayed phases
Washout
Hypo/nonenhancement
Rapid washout
Sustained enhancement
or
Soft washout
Complete or partial fill- in
Sustained enhancement Hypoechoic central scar
† DN : dysplastic nodule
‡ RN : regenerative nodule

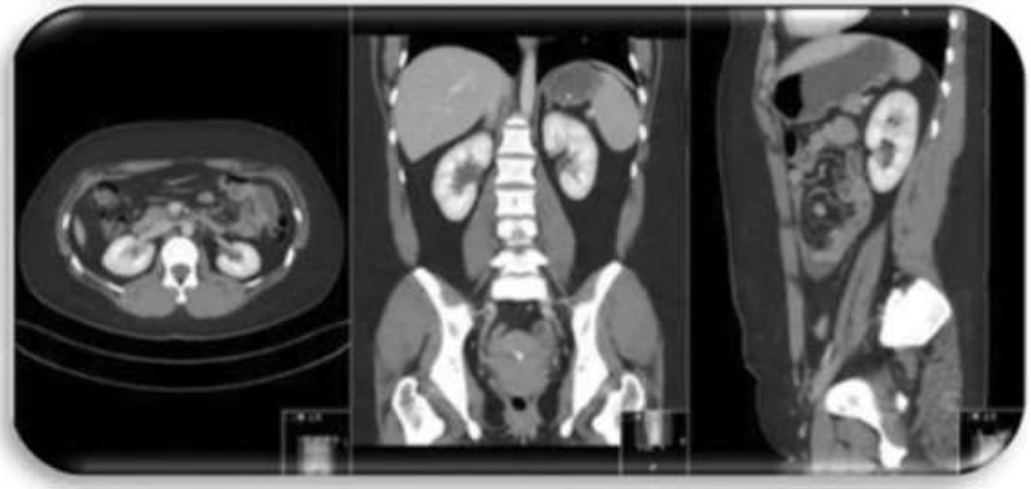
CT Urogram for kidneys

- Has now replaced IVP/IVU as the imaging modality of choice in GUT
- Higher radiation dose
- INDICATIONS
- Part of workup for Hematuria
- Urothelial mass
- Obstructive uropathy(hydronephrosis, hydroureter)
- Congenital collecting system abnormality

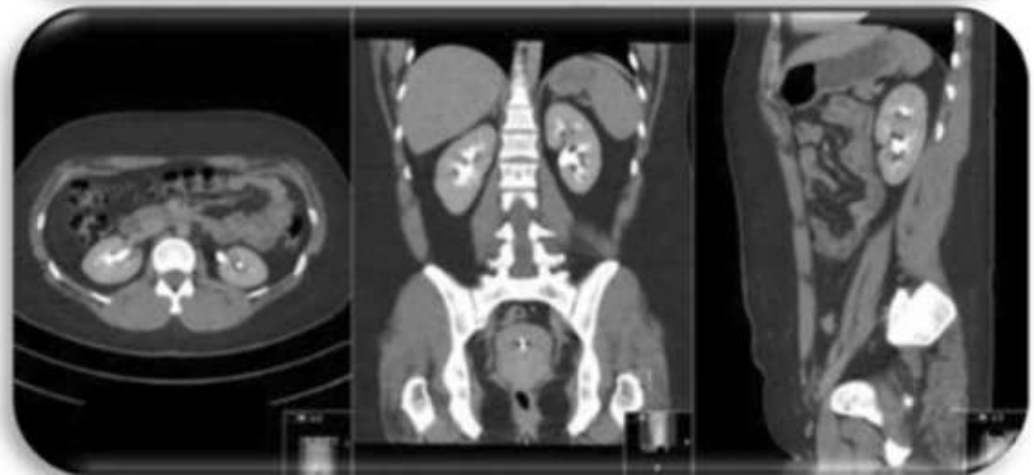
Native Phase



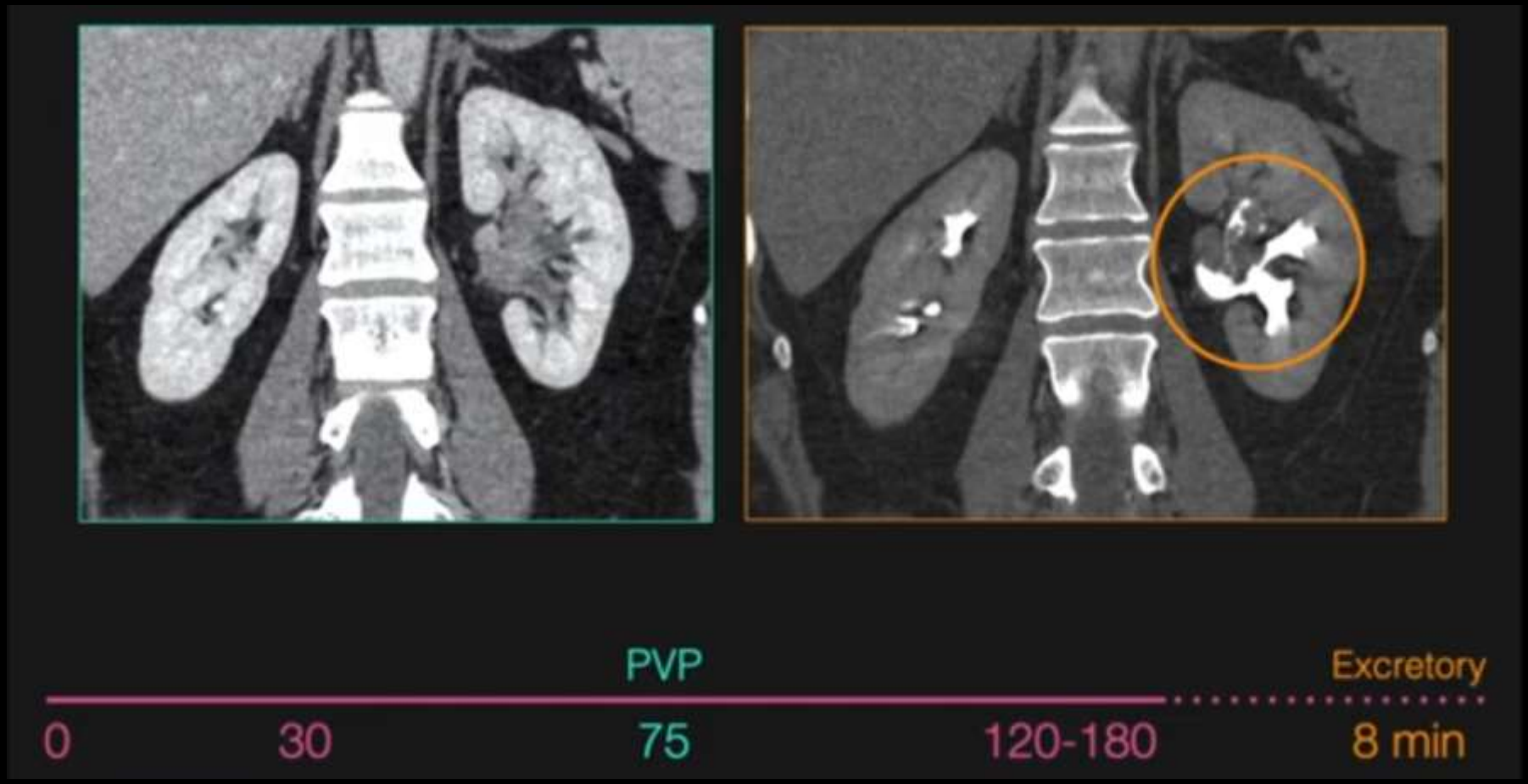
Nephrogram Phase



Excretory Phase



Excretory phase defines the CT urogram



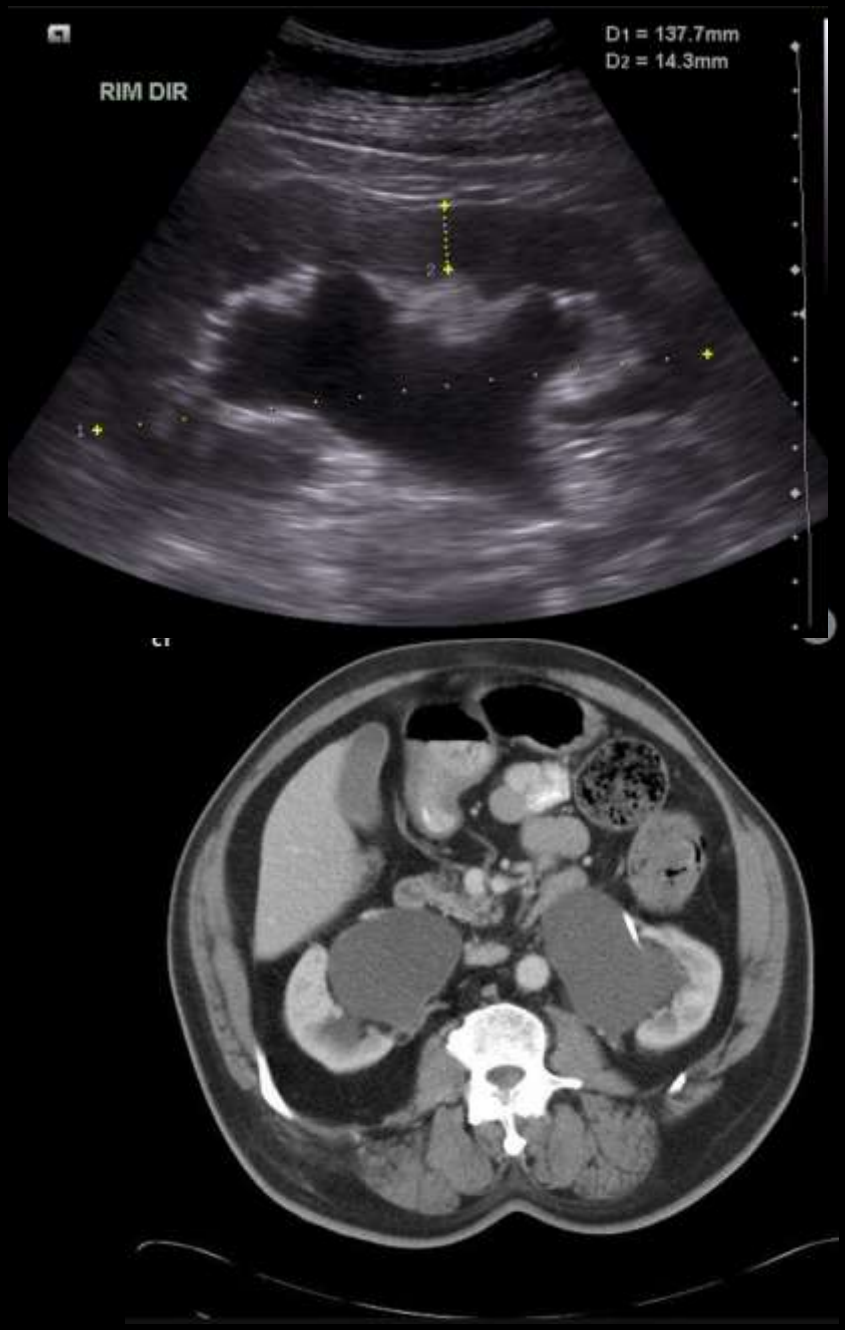
Renal pathology

- Renal cell carcinoma in the right kidney

- Right renal mass
- Poorly takes up contrast
- Capsule not breached
- Renal parenchyma opacifying well

Hydronephrosis

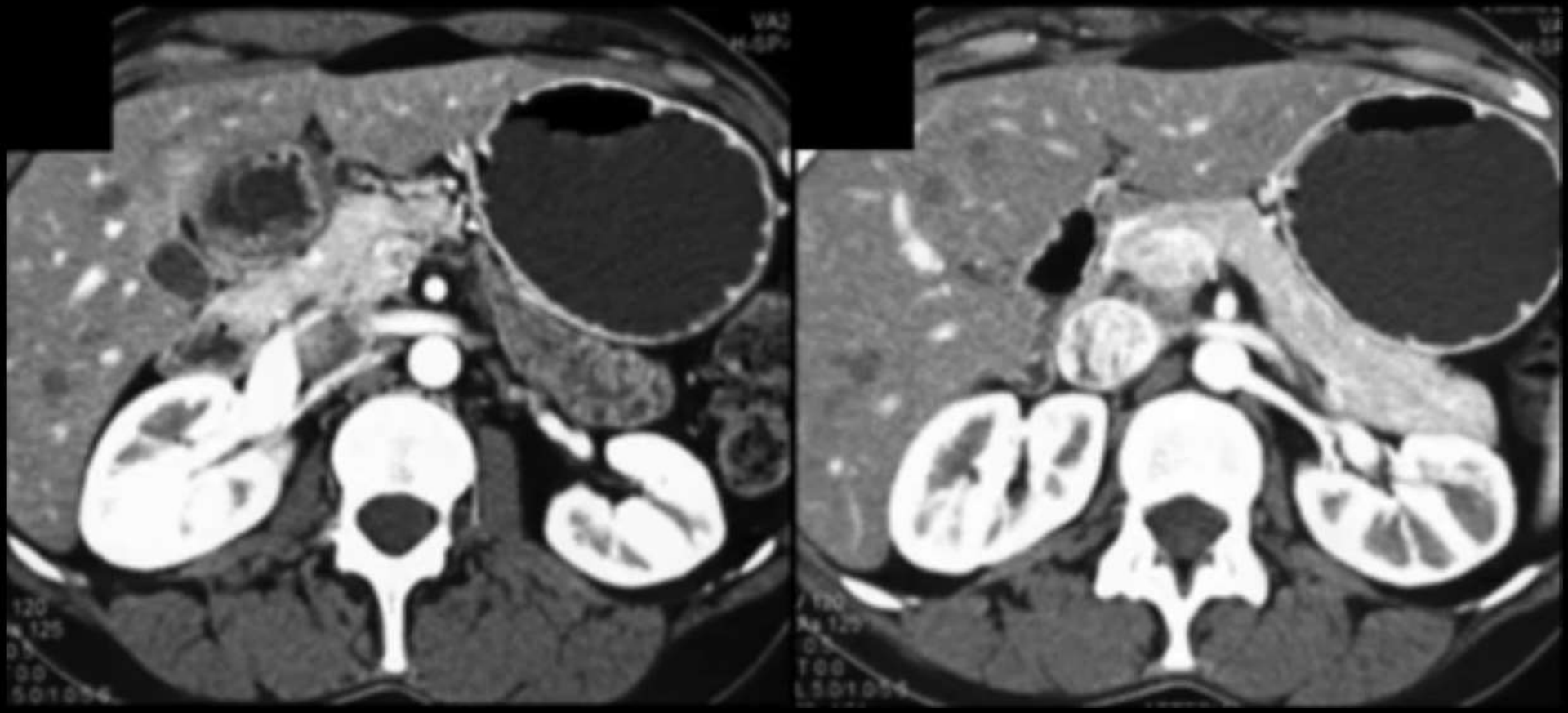
- Dilatation of the urinary collecting system of the kidney (the calyces, the infundibula, and the pelvis
- Usually first identified on ultrasound
- CT shows hydronephrosis and may identify the cause
- Unenhanced will look for stones
- Obstructive masses on cortico medullary
- Stricture on delayed



Look at the pancreas

- Mostly retroperitoneal
- Multi modality imaging
- Ultrasound, CT, MRI/MRCP
- CT remains modality of choice for evaluating for pancreatic mass, complications of pancreatitis
- CT guided interventions

Normal pancreatic enhancement

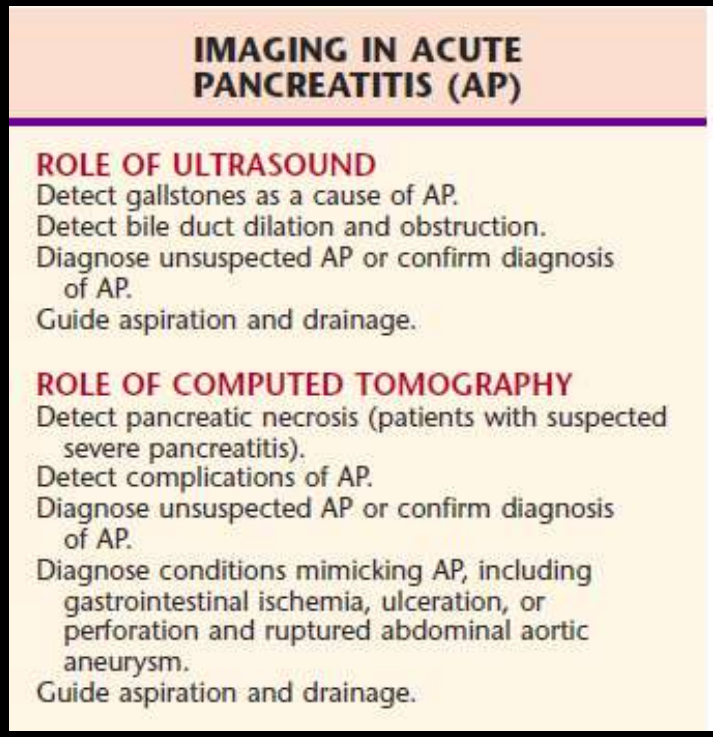


Acute Pancreatitis- Diagnosis

The diagnosis of acute pancreatitis is made by fulfilling 2 of the following three criteria:

Revised Atlanta Classification

1) Abdominal pain:
   - Acute onset of persistent, severe, epigastric pain
   - Often radiating to the back.
2) Serum lipase or amylase activity:
   - > 3 times greater than the upper limit of normal.
3) Characteristic imaging findings of acute pancreatitis



IMAGING IN ACUTE PANCREATITIS (AP)

ROLE OF ULTRASOUND
Detect gallstones as a cause of AP.
Detect bile duct dilation and obstruction.
Diagnose unsuspected AP or confirm diagnosis of AP.
Guide aspiration and drainage.

ROLE OF COMPUTED TOMOGRAPHY
Detect pancreatic necrosis (patients with suspected severe pancreatitis).
Detect complications of AP.
Diagnose unsuspected AP or confirm diagnosis of AP.
Diagnose conditions mimicking AP, including gastrointestinal ischemia, ulceration, or perforation and ruptured abdominal aortic aneurysm.
Guide aspiration and drainage.

- *Imaging is only required to establish the diagnosis if the first two criteria are not met.*
- *Imaging is crucial for the detection of complications and to help guide treatment*

CT features of acute pancreatitis

- **Abnormalities that may be seen in the pancreas include:**
- **typical findings**
  - focal or diffuse parenchymal enlargement
  - changes in density because of edema
  - indistinct pancreatic margins owing to inflammation
  - surrounding retroperitoneal fat stranding
- **liquefactive necrosis of pancreatic parenchyma**
- **infected necrosis**
  - FNA helpful
- **abscess formation**
- **hemorrhage**
  - high-attenuation fluid in the retroperitoneum or peripancreatic tissues
- **calcification**
  - evidence of background chronic pancreatitis

Acute interstitial edematous pancreatitis

- CT show diffuse enlargement with irregular pancreatic outline,
- obliterated peripancreatic fat, mesenteric edema,.
- No signs of necrosis is observe

Summary

- Know the indications
- Provide adequate history
- Look for gross
- Get an expert opinion