Chest CT

Lecture No. 5 (Dated 8th August 2020) for 8th & 9th Semester Students of MBBS

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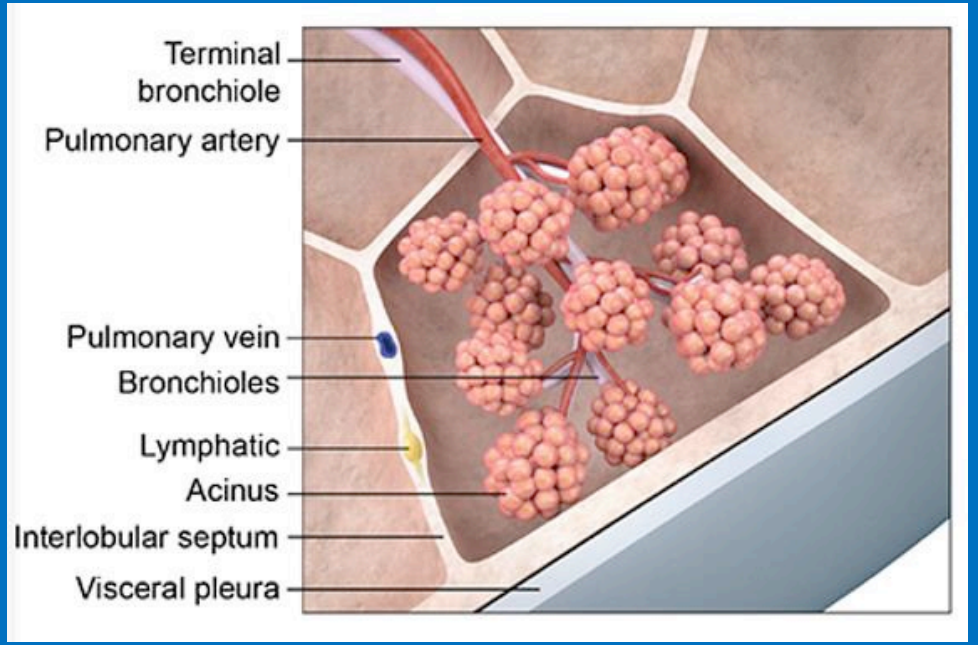
Lung field abnormalities -Interstitial disease

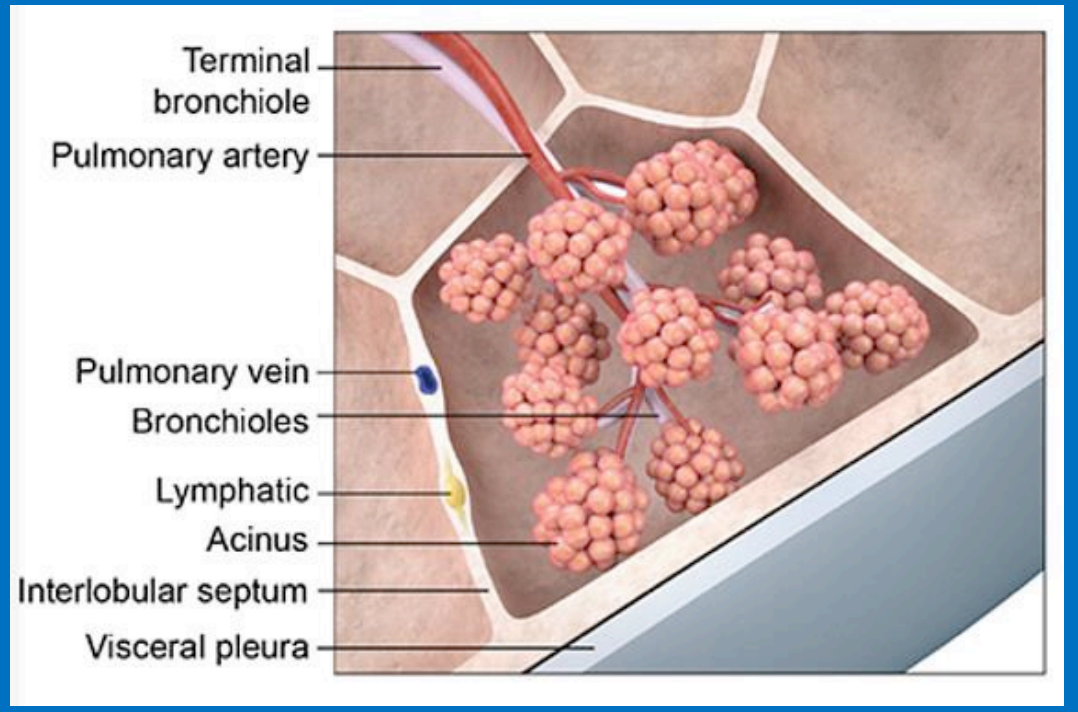
The secondary pulmonary lobule:

- The **smallest functional** unit of the lung.
- Each lobule is demarcated by **interlobular septae**, which contain **lymphatics** and **pulmonary veins**.
- The lobule is supplied centrally by a **terminal bronchiole** and accompanying **centrilobular pulmonary artery**, which are together known as the **bronchovascular bundle**.
- A second set of **lymphatics** also runs with the **bronchovascular bundle**.



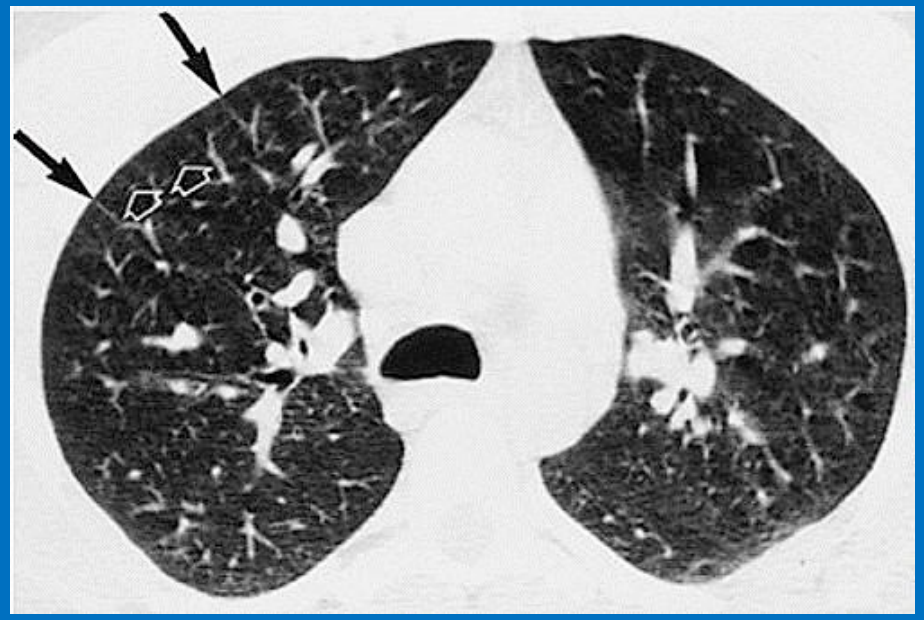
Interstitial disease-secondary pulmonary lobule

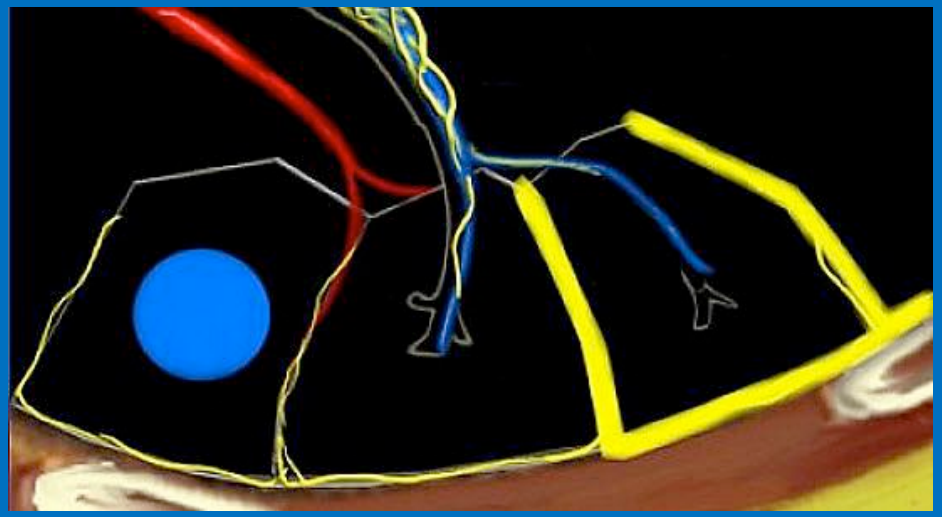
- **Centrilobular area** is the central part of **the secondary lobule**. It is usually the site of diseases, that enter the lung through the **airways**(i.e. **hypersensitivity pneumonitis, respiratory bronchiolitis, centrilobular emphysema**).
- **Perilymphatic area** is the peripheral part of **the secondary lobule**. It is usually the site of diseases, that are located in **the lymphatics** of **the interlobular septa** (i.e. **sarcoid, lymphangitic carcinomatosis, pulmonary edema**).These diseases are usually also located in the central network of **lymphatics** that surround the **broncho-vascular bundle**.



Interstitial disease-secondary pulmonary lobule

Normal **interlobular septa** (solid black arrows) and **centrilobular arteries** (open white arrows) are clearly visible. **Interlobular septa** are normally **0.1 mm** thick and can be seen in the lung periphery, particularly along the **anterior** and **mediastinal** pleural surfaces

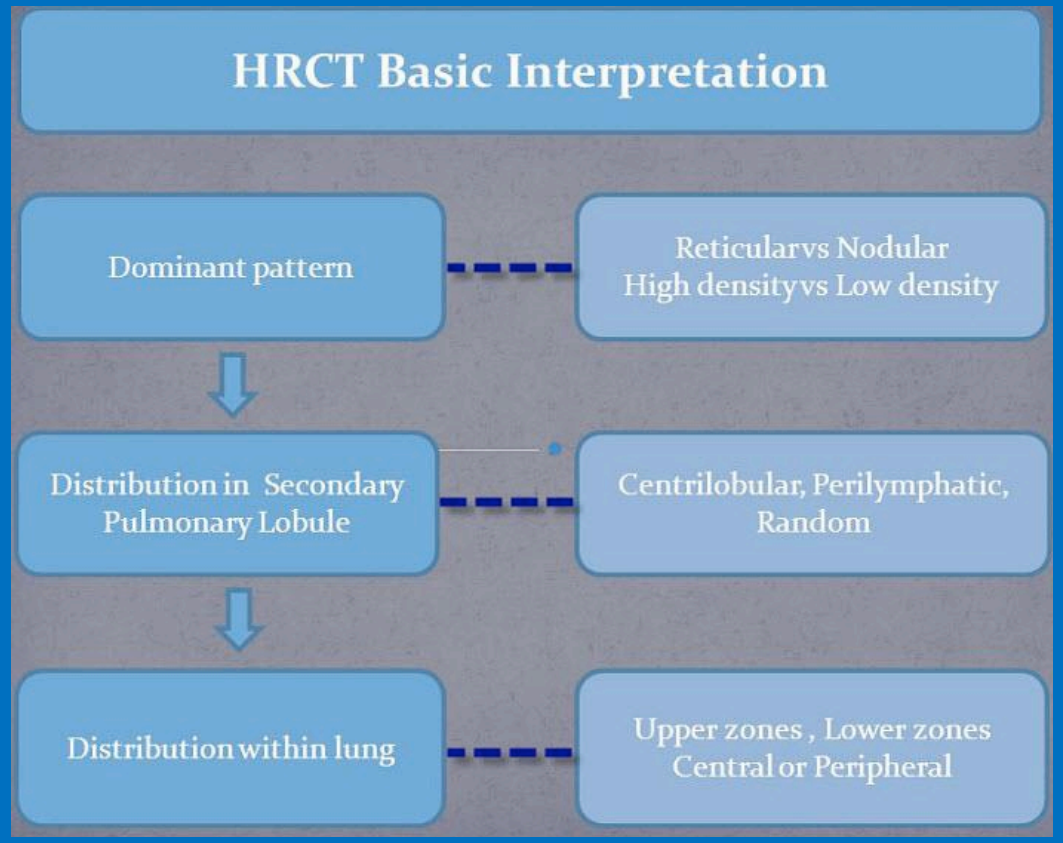




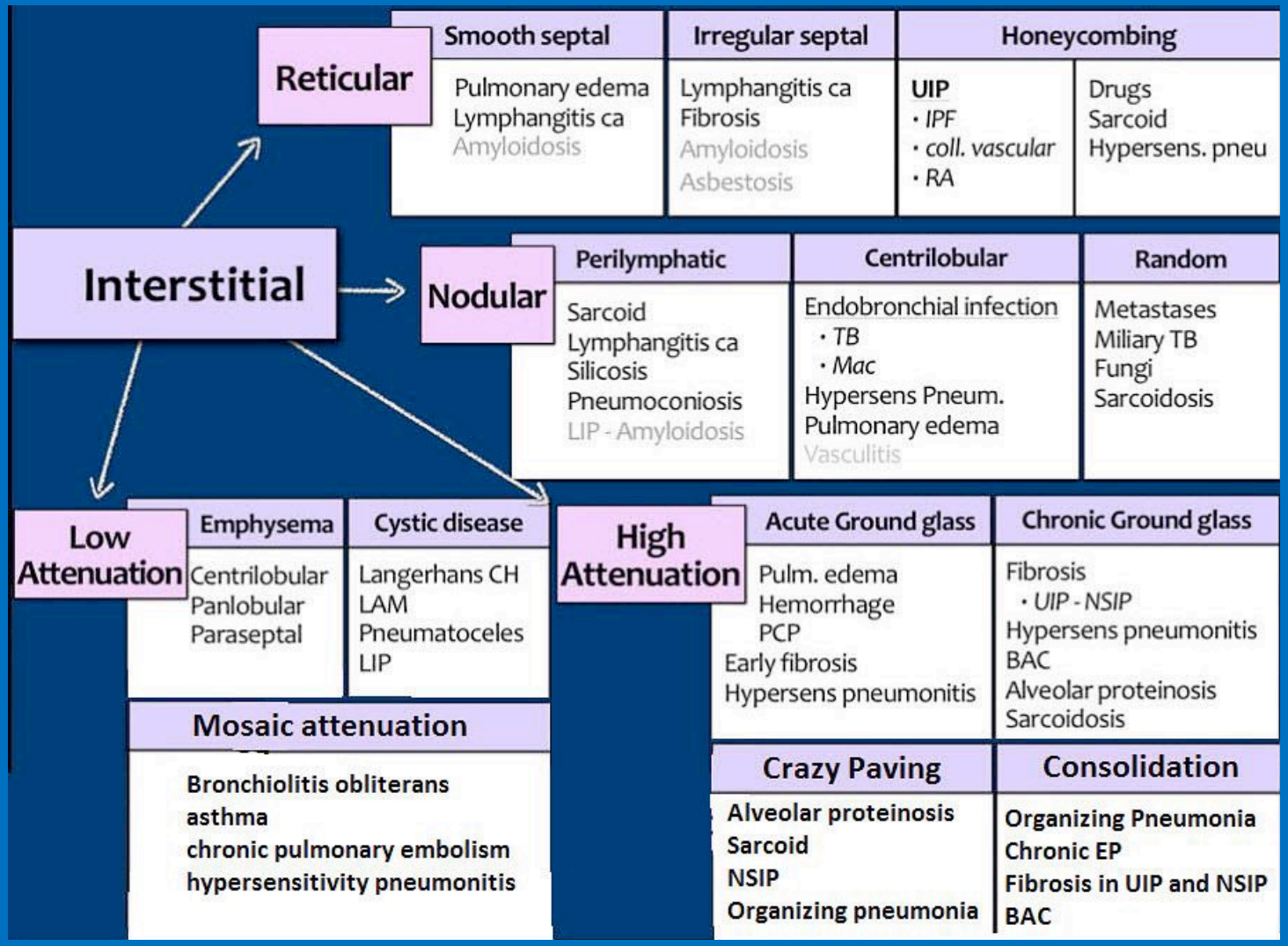
Centrilobular area in blue (left) and **perilymphatic area** in yellow (right)

Lung field abnormalities -Interstitial disease

- **High-resolution computed tomography (HRCT)** has the ability to better define diseases that have similar CXR patterns.



Lung field abnormalities -Interstitial disease



Lung field abnormalities -Interstitial disease

what is the dominant HR pattern?

A-High attenuation (CT scan findings manifesting as increased opacity)

1-LINEAR ABNORMALITIES

2-NODULES

3 -GROUND GLASS OPACITY

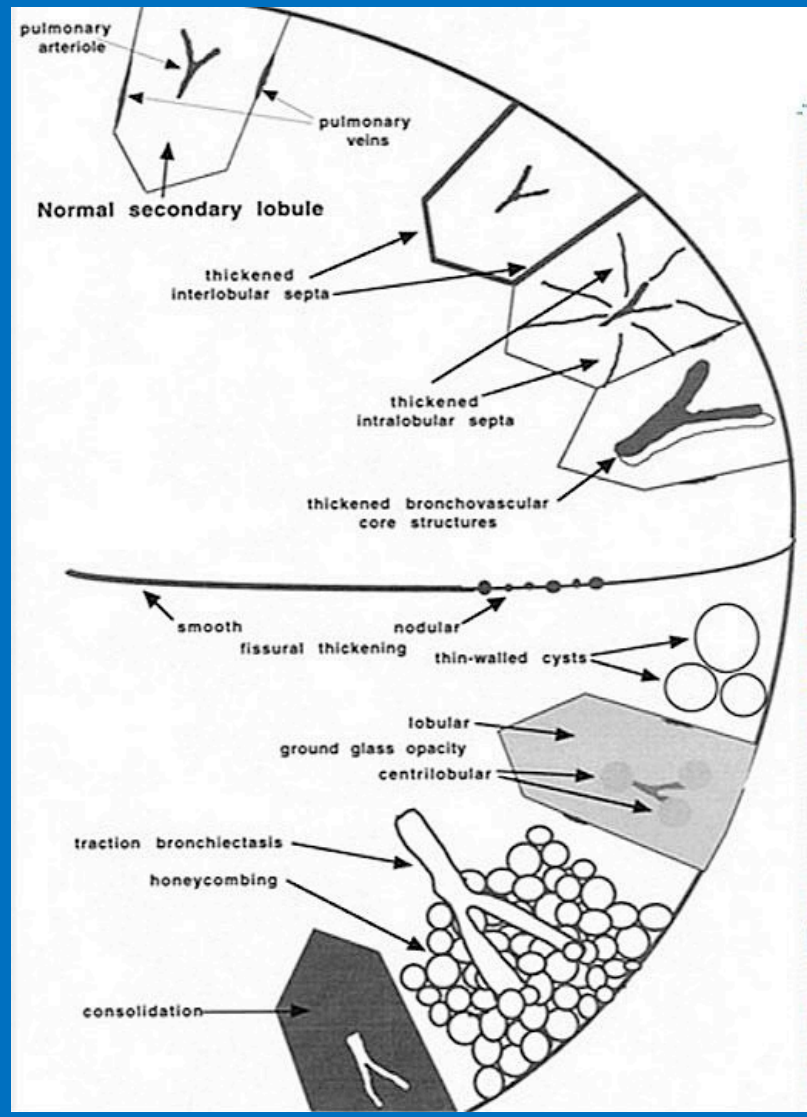
4 -CONSOLIDATION

B-Low attenuation (CT scan findings manifesting as decreased opacity)

1-AREAS OF DECREASED ATTENUATION WITH WALLS
(CYSTS ; HONEYCOMB ; BRONCHIECTASIS)

2-AREAS OF DECREASED ATTENUATION WITHOUT WALLS
(EMPHYSEMA, MOSAIC ATTENUATION)

lung field abnormalities -Interstitial disease



HRCT Findings in Interstitial Lung

1- Interlobular (Septal) Lines
2-Intralobular Lines
3-Thickened Fissures
4-Thickened bronchovascular structures
5-Centrilobular (Lobular Core) Abnormalities

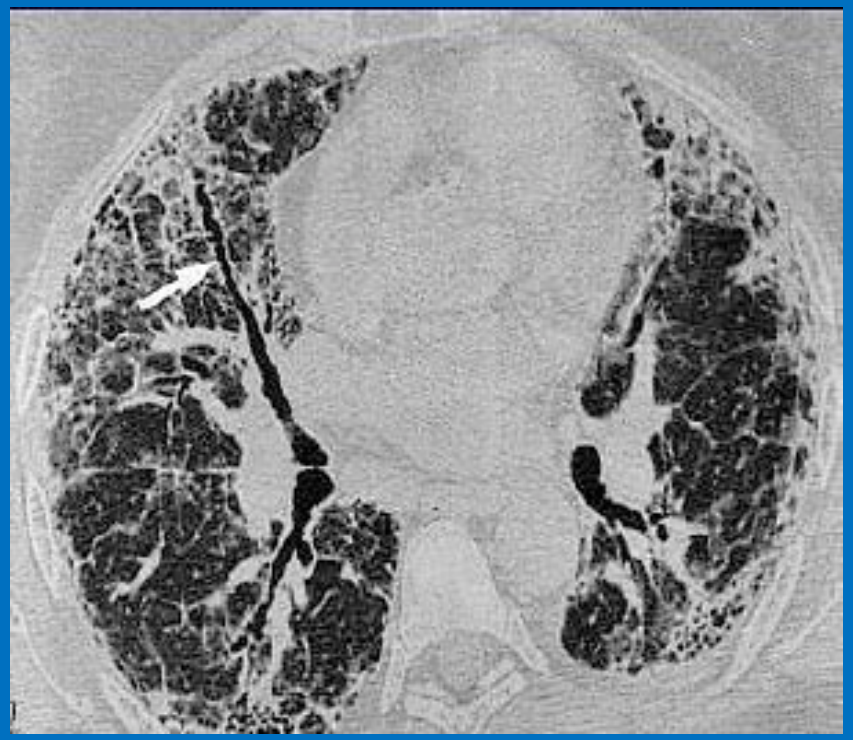
Dot lik
tree-in-bud
Ildefined

6- Subpleural lines
7-Parenchymal bands
8-Honeycombing
9-Thin-walled cysts
10-Irregularity of Lung Interfaces
11-Ground-Glass or Hazy Increased Density
12-Architectural Distortion and Traction Bronchiectasis
13-Conglomerate Masses
14-Consolidation

Lung field abnormalities -Interstitial disease

Reticular Pattern: results from the **summation** or **superimposition** of **irregular linear** opacities.

- **Fine "ground-glass" (1-2 mm)**: e.g. **interstitial pulmonary oedema**
- **Medium "honeycombing" (3-10 mm)**: commonly seen in **pulmonary fibrosis**
- **Coarse (> 10 mm)**:**cystic** Spaces caused by parenchymal destruction, e.g. **usual interstitial pneumonia (UIP), pulmonary sarcoidosis, Pulmonary Langerhans cell histiocytosis (PLCH)**



Lung field abnormalities -Interstitial disease

Causes of Reticular Pattern:

Pulmonary edema (heart failure, fluid overload, nephropathy)

Infection (viral, mycoplasma, Pneumocystis, malaria)

Post-infectious scarring (tuberculosis, histoplasmosis, coccidioidomycosis)

Mitral valve disease

Collagen vascular disorders

Granulomatous disease (pulmonary sarcoidosis, eosinophilic granuloma)

Drug reactions (e.g. amiodarone)

Pulmonary neoplasms (lymphangitis carcinomatosis, pulmonary lymphoma)

Inhalational lung disease (asbestosis, silicosis, coal workers pneumoconiosis, hypersensitivity pneumonitis, chronic aspiration pneumonia)

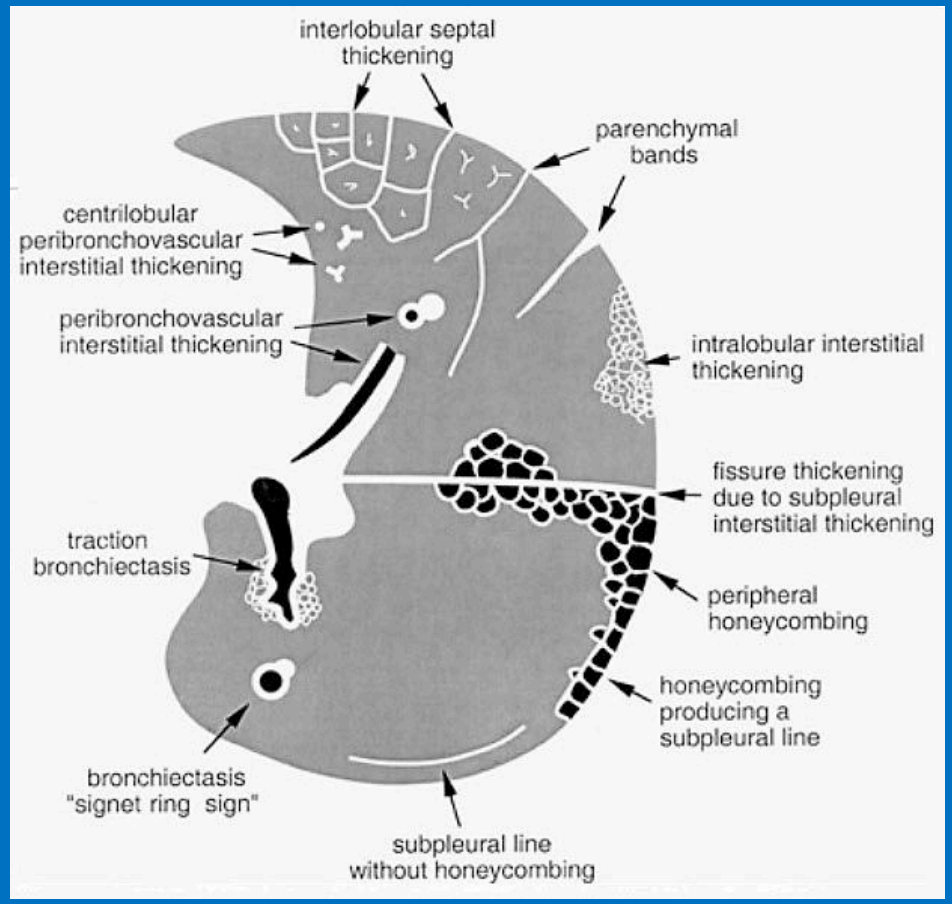
Idiopathic (usual interstitial pneumonia, lymphangioleiomyomatosis, tuberous sclerosis, neurofibromatosis, amyloidosis)

Interstitial disease-Reticular pattern

linear and reticular opacities:
Represents thickening of **interstitial fibers** of lung by
-fluid

or
-fibrous tissue

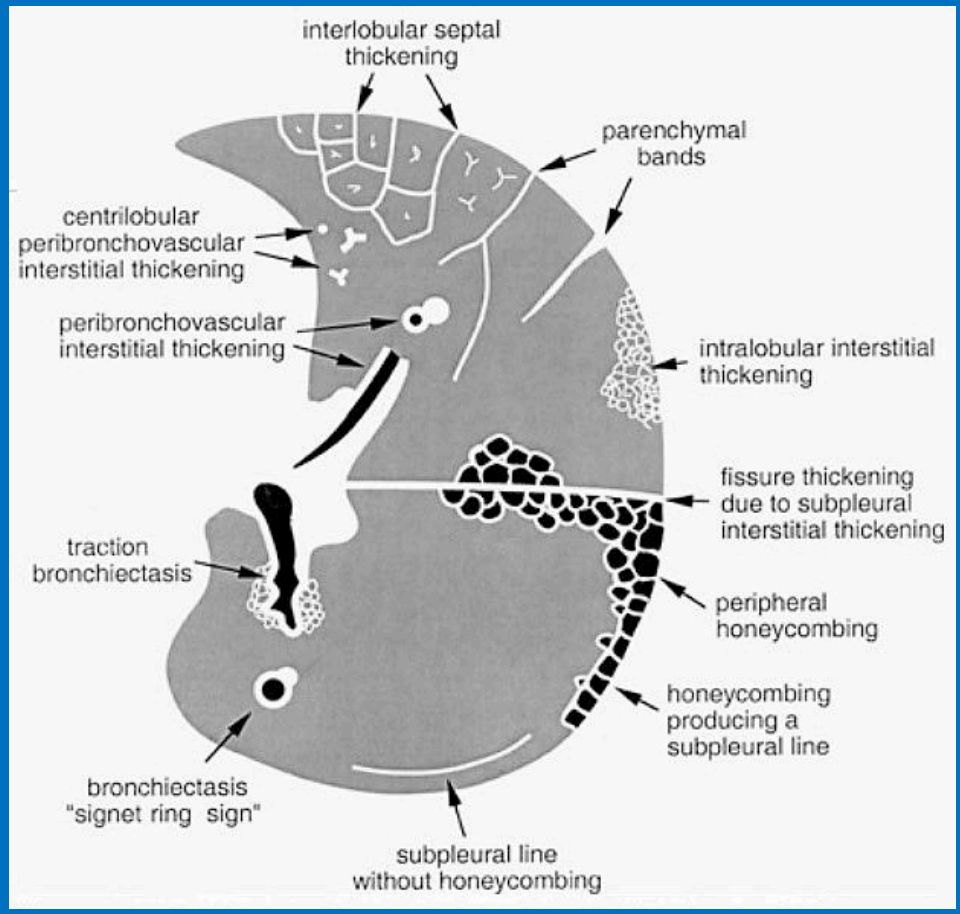
or
-infiltration by **cells**



Interstitial disease-Reticular pattern

Linear Pattern:

1. Thickened **interlobular septa**
2. **Peribronchovascular** interstitial thickening
3. **Intralobular** Lines
4. Thickened **Fissures**
5. **Subpleural** lines
6. **Parenchymal bands**

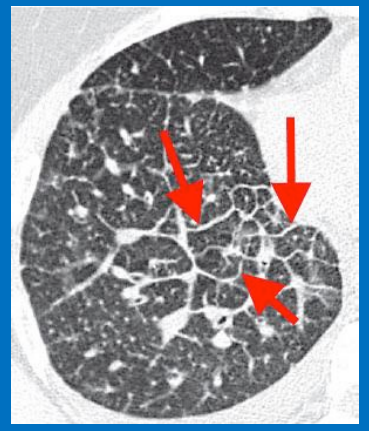


Interstitial disease-Reticular pattern-Linear Pattern

Interlobular Septal thickening:

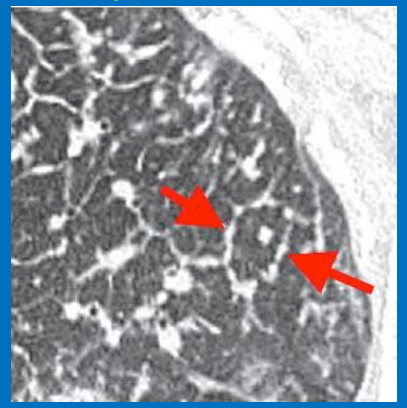
Smooth

- Pulmonary **oedema, haemorrhage**
- **Lymphoma, leukaemia**
- **lymphangitic carcinomatosis**
- **lymphocytic interstitial pneumonia** (LIP), **non specific interstitial pneumonia**(NSIP)



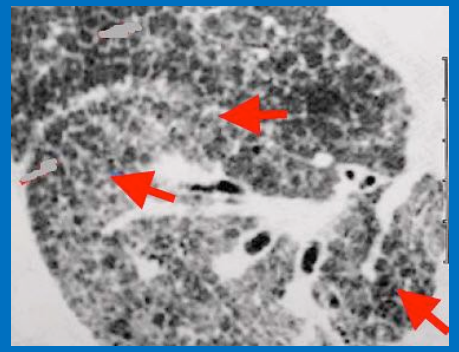
Nodular

- Sarcoidosis
- lymphangitic carcinomatosis
- lymphoproliferative disorders(LIP, lymphoma, leukaemia)
- Silicosis, coal worker's pneumoconiosis (CWP)
- Kaposi sarcoma



Irregular

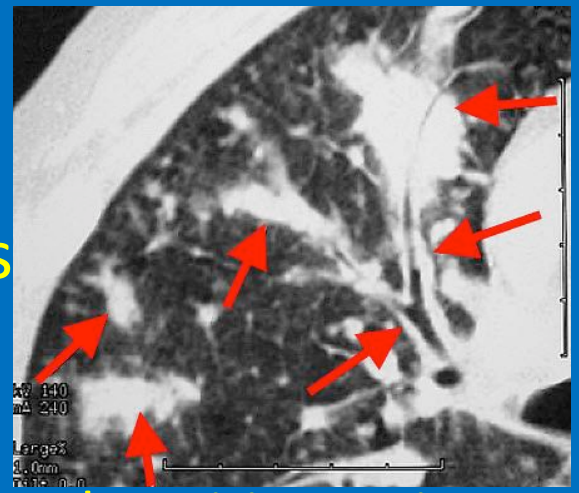
- UIP
- Sarcoidosis
- Asbestosis
- HP
- lymphangitic carcinomatosis



Interstitial disease-Reticular pattern

Peribronchovascular interstitial thickening : Causes:

- sarcoidosis
- pulmonary interstitial oedema
- certain types of pneumonias –pneumonitis
  mycoplasma pneumonia
  acute eosinophilic pneumonia
  Lymphoid interstitial pneumonia (LIP)
- microscopic polyangiitis
- lymphangitis carcinomatosis



Lymphangitic Carcinomatosis. A thin-section CT shows both smooth and nodular thickening of the bronchovascular structures (arrows) that represents lymphatic tumor surrounding the axial interstitium.

Interstitial disease-Reticular pattern

Honeycomb cysts:

- an irreversible finding in interstitial lung disease
- small(3 to 10 mm) cystic spaces with thick(1 to 3 mm) walls
- usually posterior subpleural and basal in distribution
- frequently seen in UIP and chronic HP and occasionally in sarcoidosis.
- additional signs:

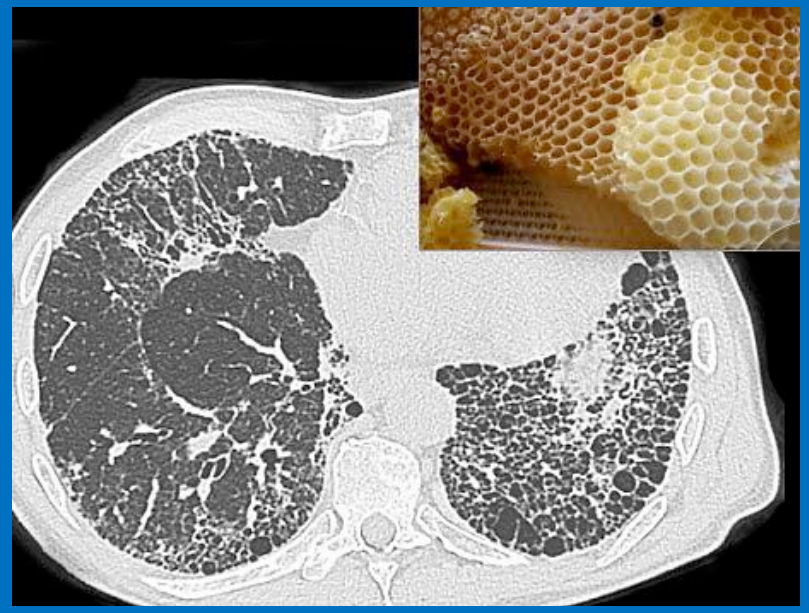
thickened interlobular and intralobular lines

parenchymal bands

areas of ground glass opacity

Idiopathic Pulmonary Fibrosis (IPF). The HRCT scan shows basal and peripheral reticular opacities with honeycombing and traction bronchiectasis.

irregularity of lung interfaces (between broncho-vascular bundles or fissures or pleural surfaces and lung)



Idiopathic Pulmonary Fibrosis (IPF). The HRCT scan shows basal and peripheral reticular opacities with honeycombing and traction bronchiectasis.

Interstitial disease-Reticular pattern-Honeycomb cysts

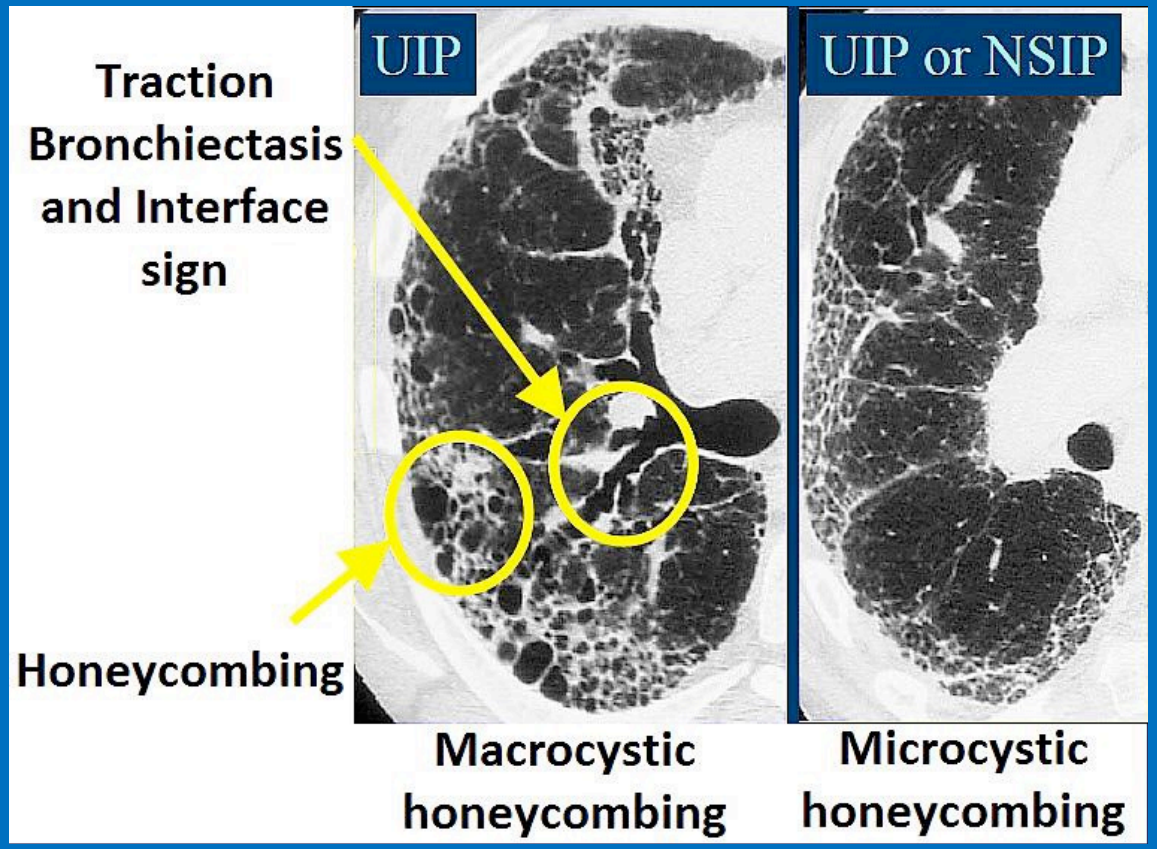
Microcystic e.g fibrotic nonspecific interstitial pneumonia (NSIP)

Macrocystic e.g UIP

Mixed macrocystic and Microcystic e.g UIP

Combined emphysema and honeycombing e.g desquamative interstitial pneumonia (DIP) and Pulmonary Langerhans cell histiocytosis(PLCH)

Combined emphysema and honeycombing e.g desquamative interstitial pneumonia (DIP) and Pulmonary Langerhans cell histiocytosis (PLCH)



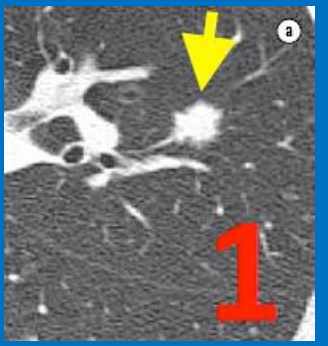
Lung field abnormalities -Interstitial disease

Nodular pattern:
Homogenous and contain no air bronchograms
Nodular opacities may be:

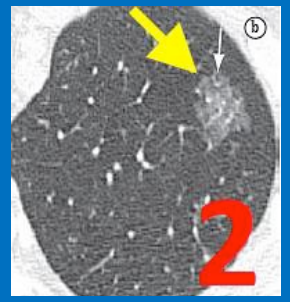
- Miliary nodules: <2 mm
  Pulmonary micronodule: 2-7 mm
  Pulmonary nodule: 7-30 mm
  Pulmonary mass: >30mm

Morphology:
Solid calcified pulmonary nodules
Ground glass pulmonary nodules (partly solid or non-solid): may represent:
Malignancy: primary or metastases
atypical adenomatous hyperplasia
focal interstitial fibrosis
Aspergillosis
focal pulmonary haemorrhages

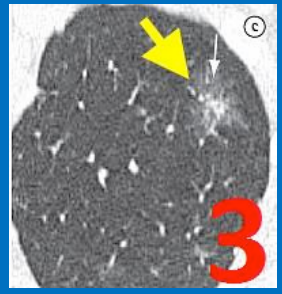
solid nodule



ground glass nodule



partly solid nodule



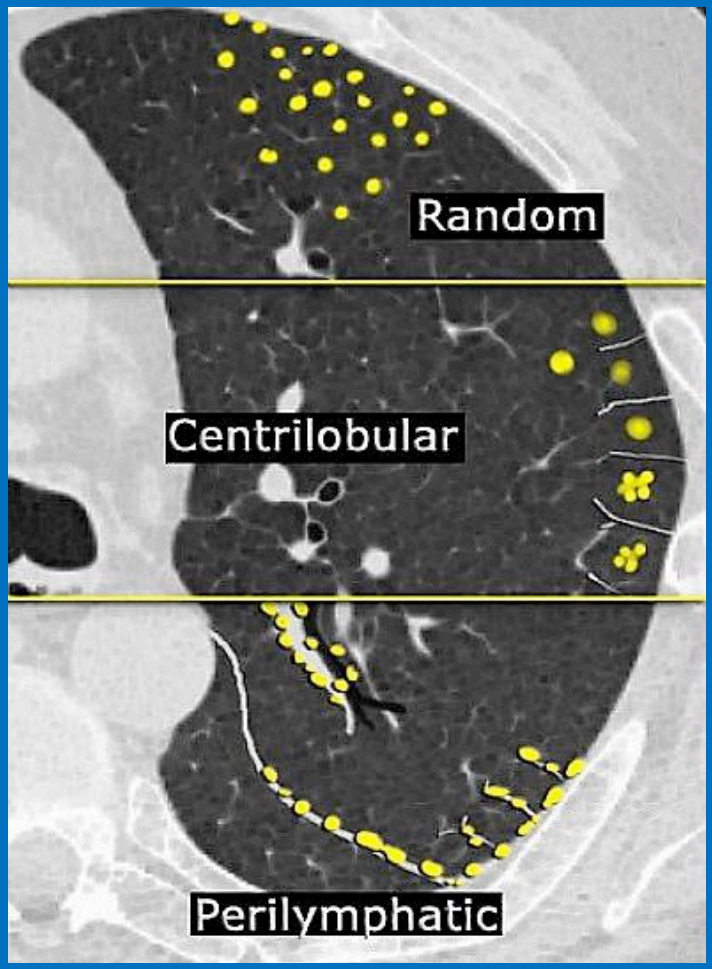
Interstitial disease-Nodular pattern

Nodular distribution:

Random distribution: Nodules involve the pleural surfaces and fissures.

Centrilobular distribution: Unlike perilymphatic and random nodules, centrilobular nodules spare the pleural surfaces. The most peripheral nodules are centered 5-10 mm from fissures or the pleural surface.

Perilymphatic distribution: nodules are seen in relation to pleural surfaces, interlobular septa and the peribroncho vascular interstitium.

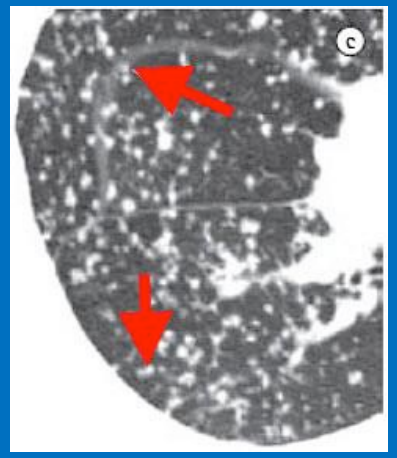


Interstitial disease-Nodular pattern

Nodular distribution:

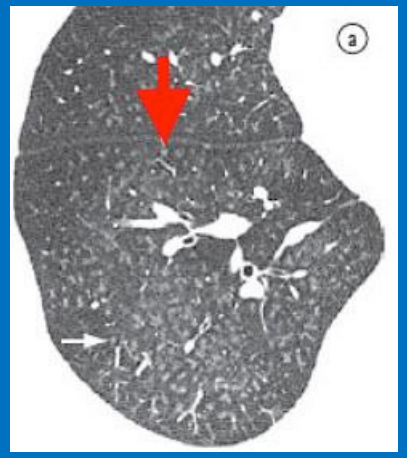
Random

Hematogenous metastases, Miliary tuberculosis, Miliary fungal infections, PLCH (early nodular stage), Sarcoidosis (when very extensive)



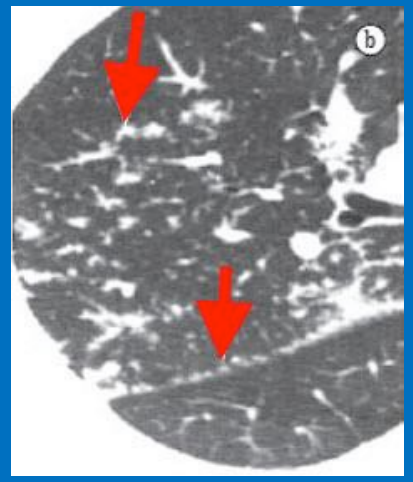
Centrilobular

Infectious bronchiolitis, diffuse panbronchiolitis, respiratory bronchiolitis, HP, LIP, pulmonary edema, vasculitis, plexogenic lesions of pulmonary hypertension, metastatic neoplasms



Perilymphatic

Sarcoidosis, silicosis, coal-worker's pneumoconiosis, lymphangitic spread of carcinoma, LIP, amyloidosis



Interstitial disease-Nodular pattern

Causes of Miliary opacities :

Infection

- tuberculosis
- fungal (often febrile)
- healed varicella pneumonia
- viral pneumonitis
- nocardosis
- Salmonella

Miliary metastases

- thyroid carcinoma
- renal cell carcinoma
- breast carcinoma
- malignant melanoma
- pancreatic neoplasms
- osteosarcoma
- trophoblastic disease

Sarcoidosis

Pneumoconioses

- silicosis
- Coal workers pneumoconiosis

Pulmonary haemosiderosis

Hypersensitivity pneumonitis

Langerhans cell histiocytosis(PLCH)

pulmonary alveolar proteinosis

Interstitial disease-Nodular pattern

Causes of Calcified pulmonary nodules:

Healed infection
- Calcified granulomata, e.g.
  - Thoracic histoplasmosis
  - Recovered military TB
- Healed varicella pneumonia

Pneumoconioseses
- silicosis
- coalworker's pneuomconiosis

Pulmonary hamartomas

Metastatic pulmonary calcification
- Chronic renal failure
- Multiple myeloma
- Secondary hyperparathyroidism
- Massive osteolytic metastases
- IV calcium therapy

Pulmonary haemosiderosis
- idiopathic pulmonary haemosiderosis
- Mitral stenosis
- Goodpasture syndrome

Pulmonary alveolar microlithiasis

Sarcoidosis

Calcified pulmonary metastases

Pulmonary amyloidosis

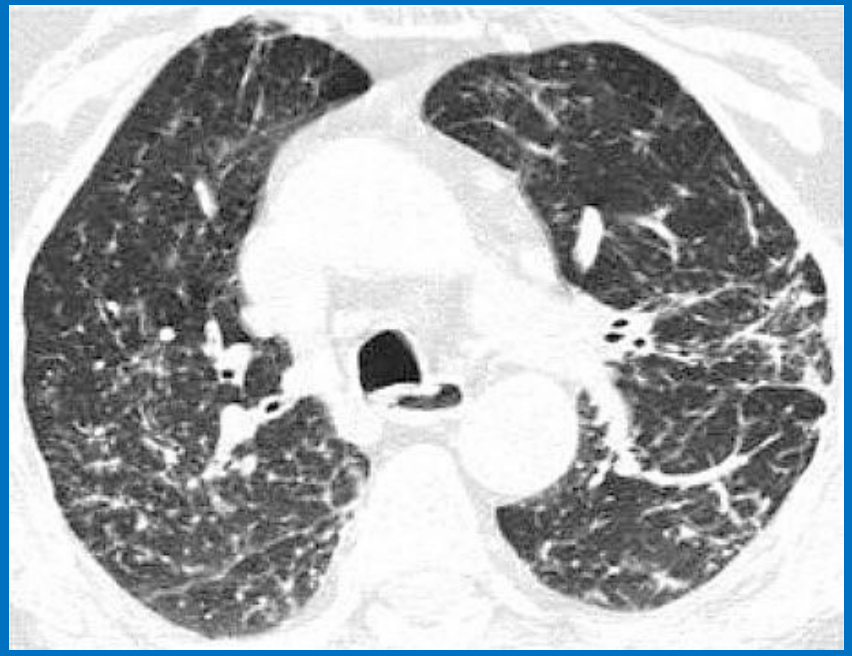
Pulmonary hyalinising granuloma

Calcifying fibrous Pseudotumour of lung

Interstitial disease-Nodular pattern

Reticulonodular pattern:

- A reticulonodular pattern results from a combination of reticular and nodular opacities.
- A differential diagnosis should be developed based on the predominant pattern.
- If there is no predominant pattern, causes of both nodular and reticular patterns should be considered.
- Causes: the same disorders as reticular patterns



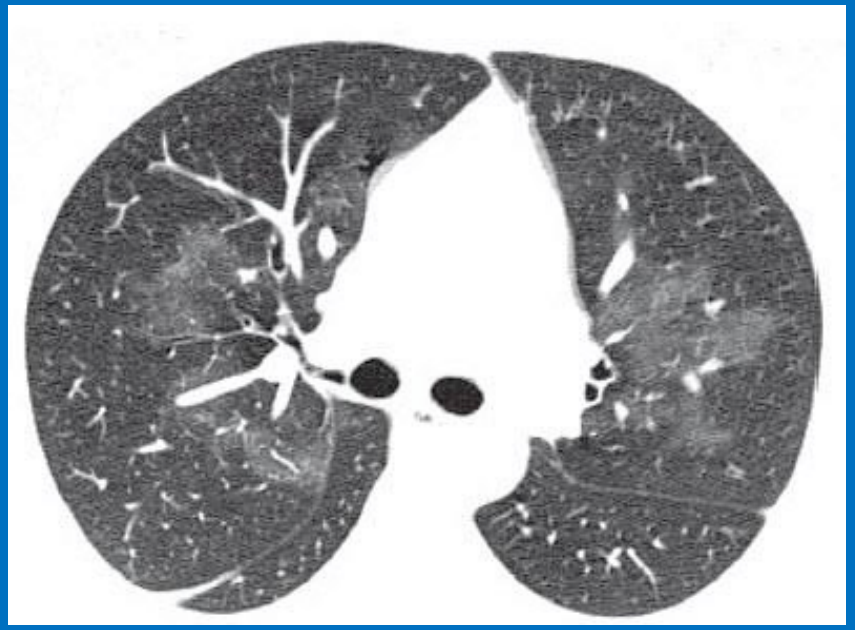
Sarcoidosis. a “reticulonodular pattern” characterised by the presence of thickening of the interlobular septae and bronchovascular bundles, perilymphatic and perifissural micronodules and architectural distortion

Interstitial disease-High attenuation

Ground-glass opacification /opacity (GGO): a hazy area of increased attenuation in the lung with preserved bronchial and vascular markings.

Aetiology:

- Normal expiration
- Partial filling of air spaces
- Partial collapse of alveoli
- Interstitial thickening
- Inflammation
- Oedema
- Fibrosis
- Neoplasm



Symmetric perihilar ground-glass opacity, representing pulmonary haemorrhage in a patient with Wegener's granulomatosis.

Interstitial disease-High attenuation

Ground-glass opacification /opacity (GGO) and consolidation: causes:

- Edema
- diffuse alveolar damage (DAD)/acute respiratory distress syndrome (ARDS)/acute interstitial pneumonia (AIP)
- Infections(bacterial, viral, Pneumocystis jiroveci, Mycoplasma pneumoniae)
- Hemorrhage
- Hypersensitivity pneumonitis
- Eosinophilic pneumonia(acute)
- Radiation pneumonitis (acute)
- Hypersensitivity pneumonitis
- Smoking related interstitial lung disease (respiratory bronchiolitis-associated interstitial lung disease (RB-ILD), DIP)
- Idiopathic interstitial pneumonias (Non-specific interstitial pneumonia (NSIP), rarely usual interstitial pneumonia)
- Bronchioloalveolar carcinoma
- Cryptogenic Organizing Pneumonia (COP)
- Lymphoid interstitial pneumonia (LIP)
- Eosinophilic pneumonia (chronic)
- Exogenous lipoid pneumonia
- Alveolar proteinosis
- Sarcoidosis

Interstitial disease-High attenuation
Ground-glasso pacity (GGO) and consolidation: distribution:

Focal

- Infection
- Aspiration
- Hemorrhage
- Bronchoalveolar cell carcinoma
- Infarct

Patchy

- Infection
- Sarcoid
- Hypersensitivity pneumonitis
- Organizing pneumonia
- Bronchoalveolar cell carcinoma
- Hemorrhage
- Eosinophilicpneumonia

Diffuse /Symmetric

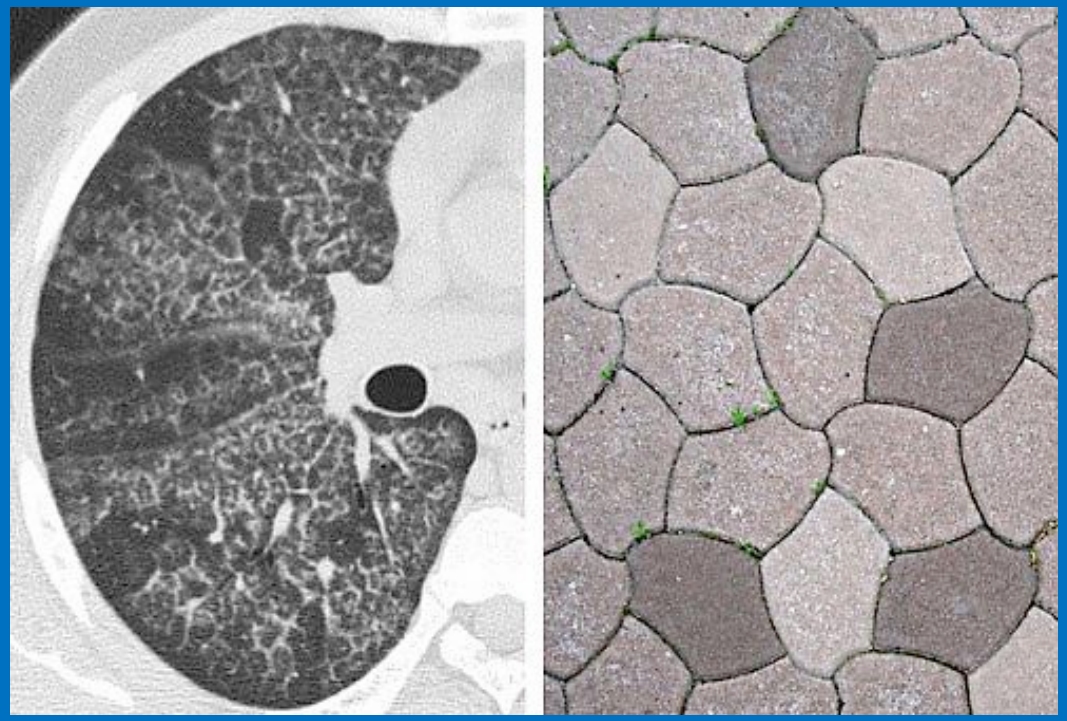
- Edema
- DAD/ARDS/AIP
- Infections(viral, atypical)
- Interstitial pneumonias
- Hemorrhage
- Bronchoalveolarcell carcinoma
- Alveolar proteinosis

Interstitial disease-High attenuation

Crazy paving: a combination of ground-glass opacity with superimposed interlobular septal thickening and intralobular reticular thickening

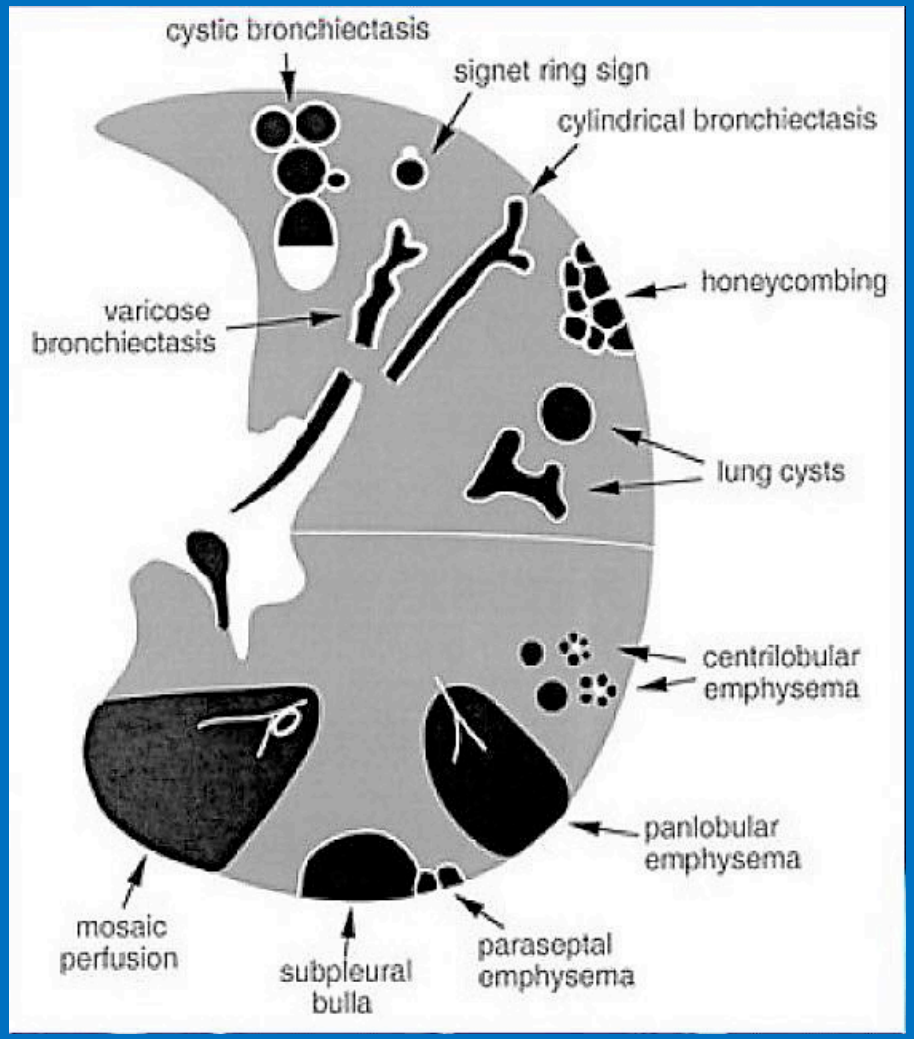
Causes:

- Pulmonary alveolar proteinosis (PAP)
- Edema (heart failure, ARDS, AIP)
- Infection(PCP, viral, Mycoplasma, bacterial)
- Pulmonary hemorrhage
- Cryptogenic organizing pneumonia (COP)
- Neoplasm (bronchoalveolar carcinoma (BAC))
- Sarcoidosis
- NSIP



Interstitial disease-Low attenuation

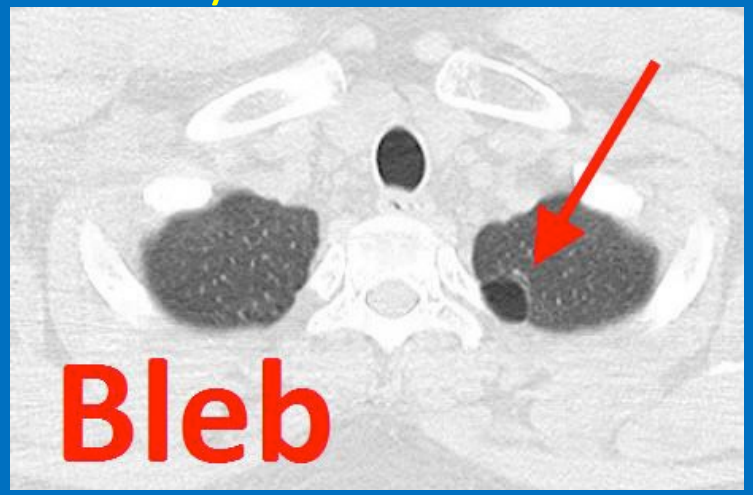
Low attenuation pattern

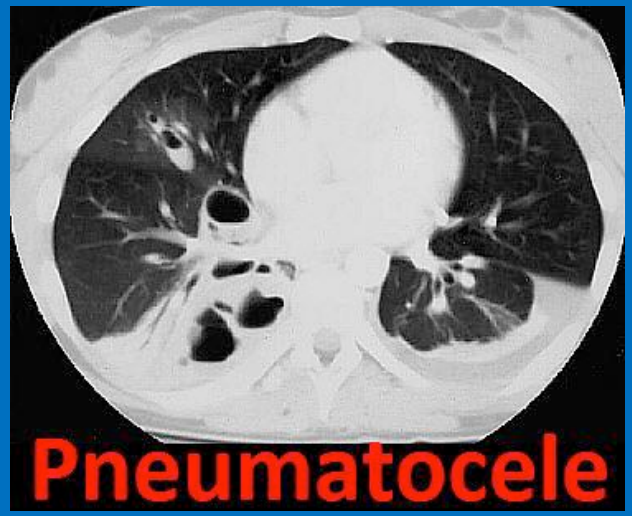


Interstitial disease-Low attenuation

Air containing spaces:

1. Blebsvappear as small air spaces (<1-2 cm) within the layers of the visceral pleura or subpleural, located most frequently at the lung apices. They have thin walls (less than 1 mm thick).
2. Bulla: thin wall (<1 mm), usually larger than blebs (>2 cm)
3. Pneumatoceleare rounded thin wall air space that represent distended airspaces distal to a check-valve obstruction of a bronchus or bronchiole, caused by acute pneumonia, trauma, or aspiration of hydrocarbon fluid and is usually transient
4. Cyst
5. Cavity





Interstitial disease-Low attenuation

A lung cyst:
An air filled structure and occurs without associated pulmonary emphysema with perceptible wall typically 1 mm in thickness but can be up to 4 mm. The diameter of a lung cyst is usually < 1 cm.
Aetiology:

- Interstitial disease:
- Pulmonary Langerhans cell histiocytosis (PLCH)
- lymphangioleiomyomatosis with or without tuberous sclerosis
- Interstitial pneumonia (DIP, LIP)
- Pneumatocele
- Sarcoidosis
- Neurofibromatosis
- Cystic bronchiectasis
- PCP
- Honeycombing in UIP
- Sjogren syndrome
- light chain deposition disease
- Amyloidosis

Others:

- Birt-Hogg-Dubé syndrome
- Pulmonary trauma
- Congenital cystic lung disease (congenital pulmonary airway malformation, pulmonary sequestration, bronchogenic cyst)
- Tracheobronchial papillomatosis
- Hydatid Cyst

Interstitial disease-Low attenuation-Cystic lung

Pulmonary Langerhans cell histiocytosis (PLCH):

Early stage:

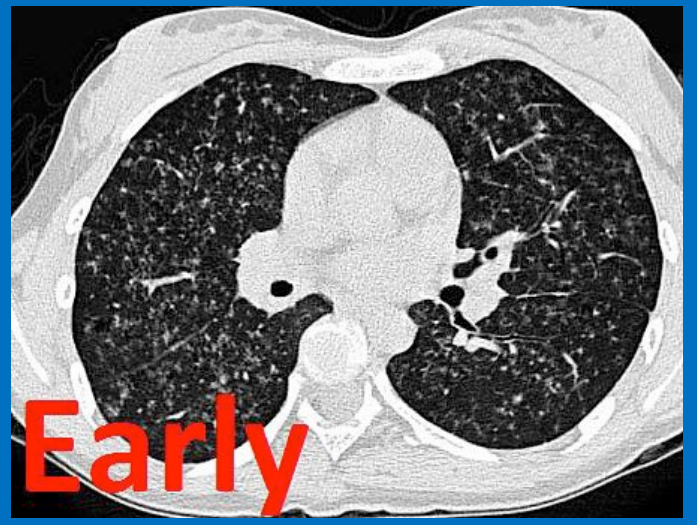
- Small irregular or stellate nodules in centrilobular location.

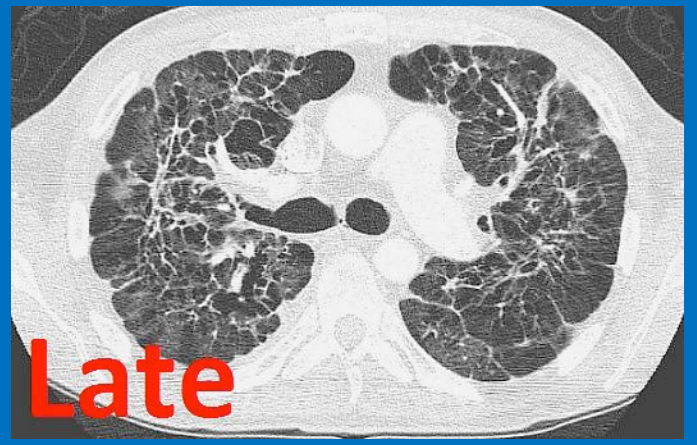
Late stage (more common):

- Bizarre shaped Cysts
- Upper and mid lobe predominance.
- Recurrent pneumothorax.

Other common findings:

- Ground-glass opacities
- Mosaic attenuation
- Emphysema
- Desquamative interstitial pneumonia (DIP)-like change
- Pulmonary Langerhans cell histiocytosis (PLCH

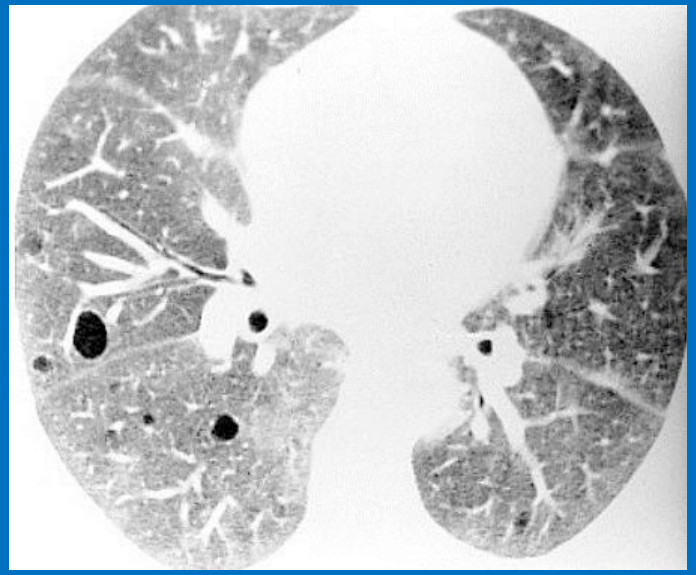




Interstitial disease-Low attenuation-Cystic lung

Lymphocytic interstitial pneumonitis (LIP): HRCT features:

- features tend to be diffuse with mid to lower lobe predominance
- thickening of bronchovascular bundles
- interstitial thickening along lymph channels
- small but variable sized pulmonary nodules(can be centrilobular or subpleural, and often ill-defined)
- ground-glass change
- scattered thin walled cysts:
  - usually deep within the lung parenchyma
  - size range from 1-30 mm
  - typically abuts vessels (i.e. is perivascular or subpleural)
  - differentiate LIP from malignant lymphoma
- mediastinal lymphadenopathy
- honeycombing



LIP. There is a background of ground-glass opacification and a few thin-walled cystic air spaces

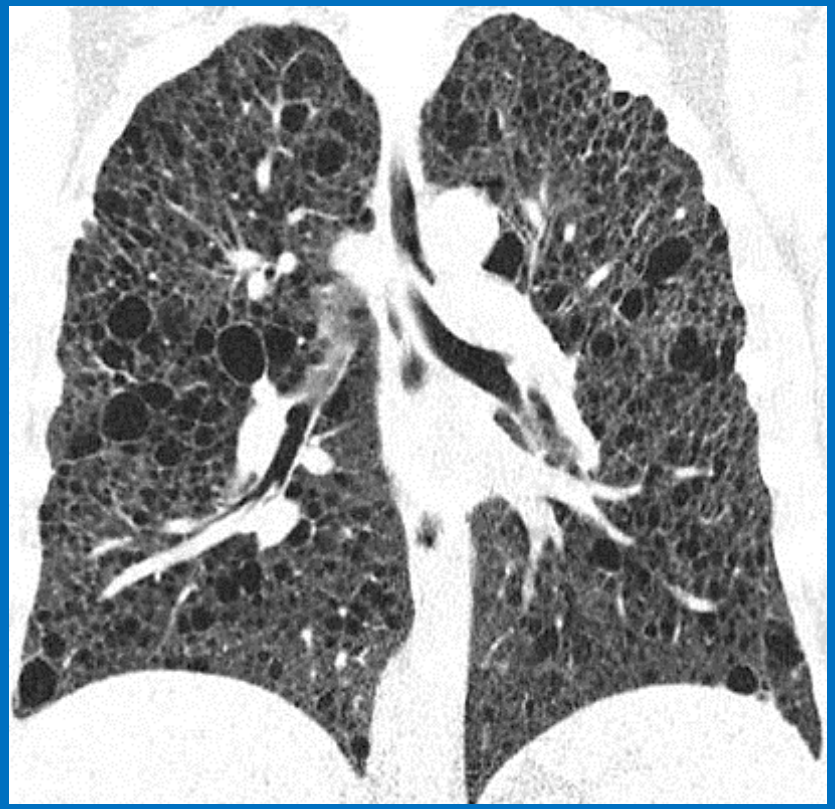
Interstitial disease-Low attenuation-Cystic lung

Lymphangioleiomyomatosis (LAM):is a rare multi-system disorder that can occur either sporadically or in association with the tuberous sclerosis complex (TSC), It affects women of child-bearing age

General/radiograph
- chylothorax: chylous pleural effusion
- evidence of hyperinflation
- diffuse bilateral reticulo nodular densities
- recurrent pneumothoraces

HRCT
- thin walled cysts of variable sizes surrounded by normal lung parenchyma, seen throughout the lung
- interlobular septal thickening
- may show a dilated thoracic duct

haemorrhages may be seen as areas of increased attenuation



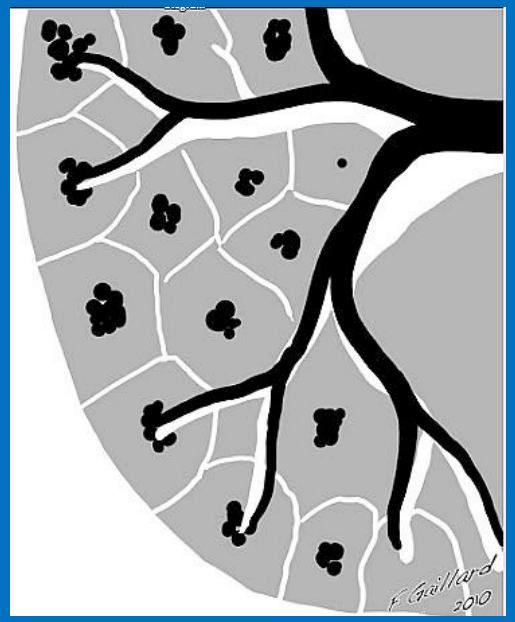
CT images demonstrate innumerable small regular lung cysts diffusely distributed throughout the lungs.

Interstitial disease-Low attenuation

Pulmonary emphysema: morphologic subtypes;

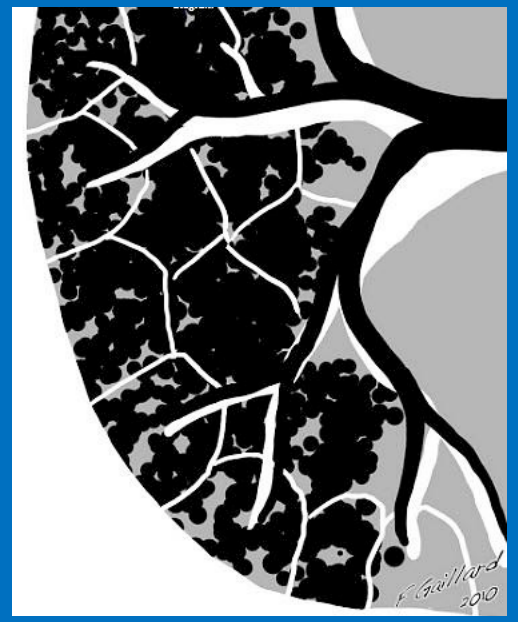
Centrilobular

- Most common type
- Affects the centrilobular portion of the lobule
- Upper lobe predominance
- Up to 1cmin diameter



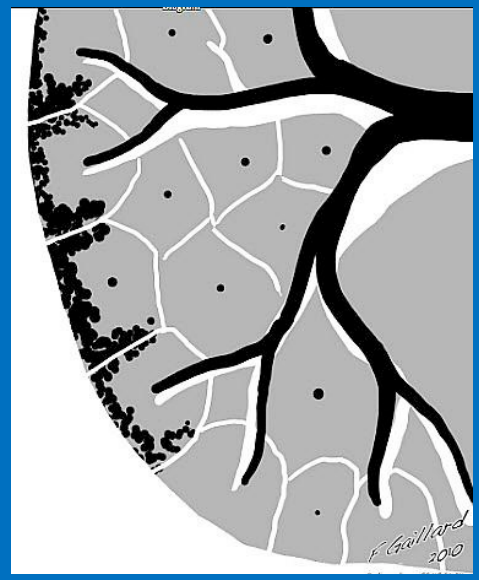
Panlobular

- In **alpha-1-antitrypsin** deficiency
- Affects the **whole secondary lobule**
- **Lower lobe** predominance



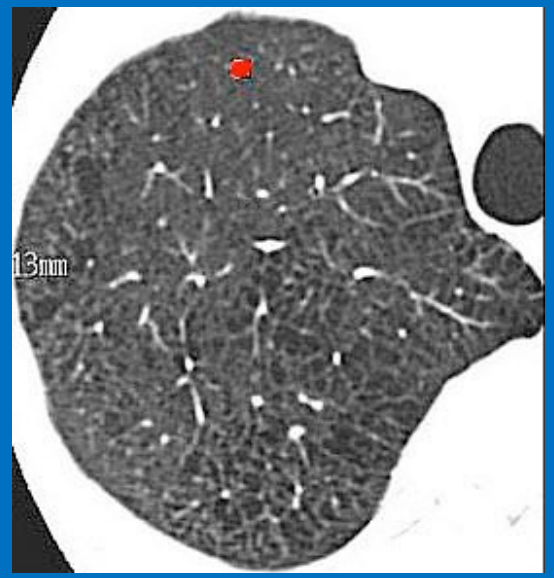
Paraseptal

- Adjacent to the pleura and interlobar fissures
- It can lead to the formation of subpleural bullae and spontaneous pneumothorax

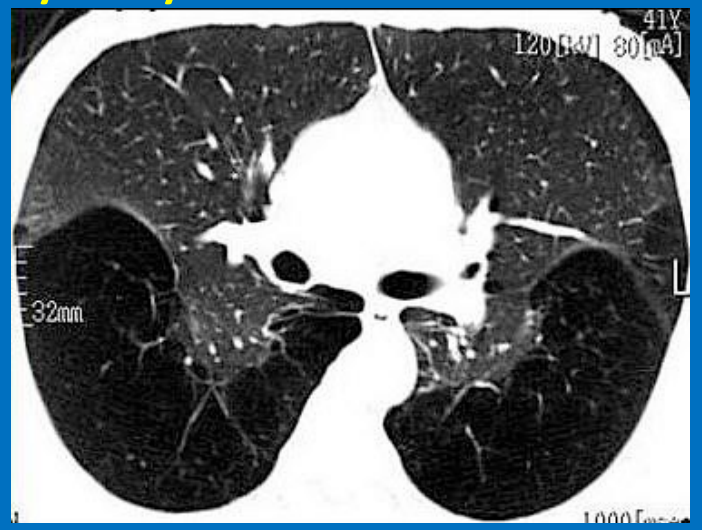


Interstitial disease-Low attenuation-emphysema

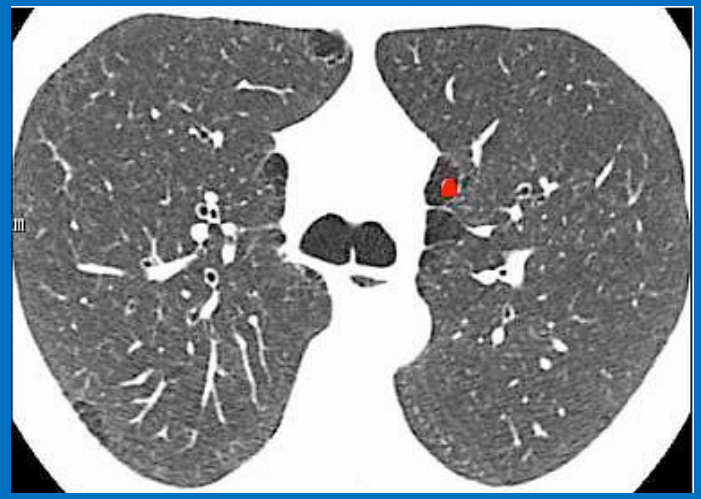
Pulmonary emphysema: In all three subtypes, the emphysematous spaces are not bounded by any visible wall



Centrilobular emphysema. low attenuation areas without walls located centrally in the acini. Red element shows the size of a normal acinus



Panlobular emphysema. large bullae in both inferior lobes due to uniform enlargement and destruction of the alveoli walls causing distortion of the pulmonary architecture

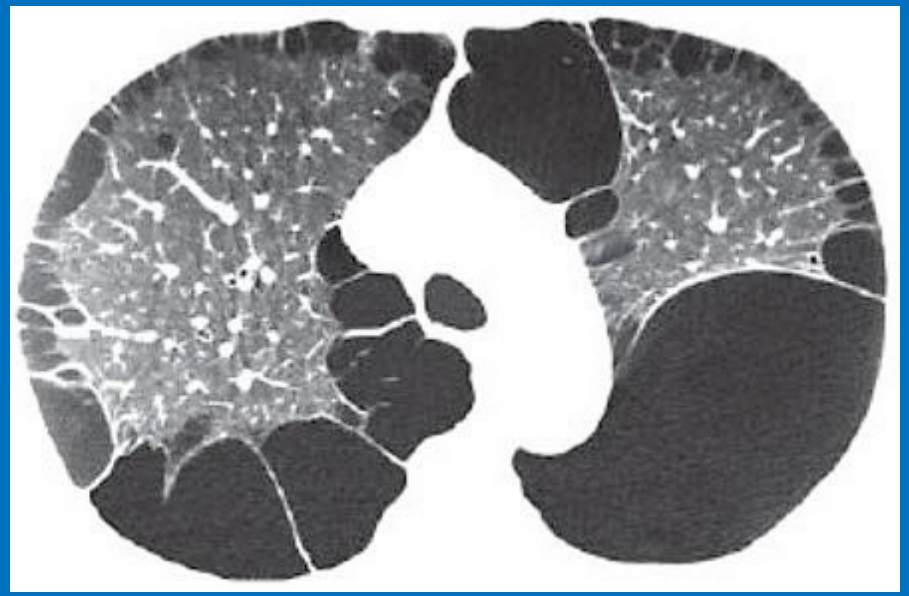


High-resolution CT (HRCT) shows subpleural bullae consistent with paraseptal emphysema. Red mark shows the size of a normal acinus

Interstitial disease-Low attenuation-emphysema

- An expansion of the alveolar spaces with a diameter over 1 cm and a wall thickness less than 1 mm.
- Giant bullae in 1 or both upper lobes occupying at least one-third of the hemithorax
- More in the paraseptal location.

Bilateral bullous emphysema

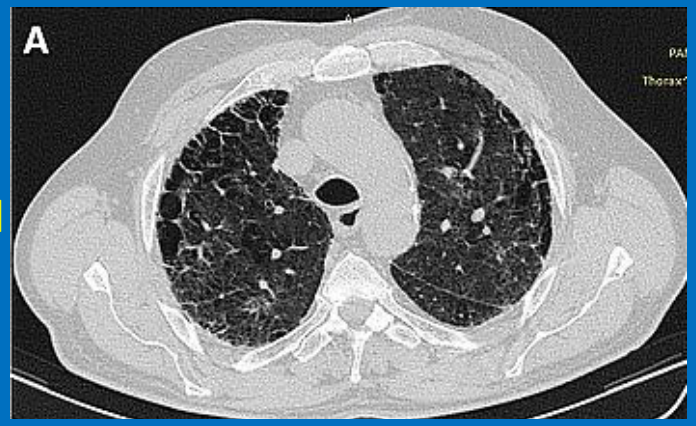


Interstitial disease-Low attenuation-emphysema

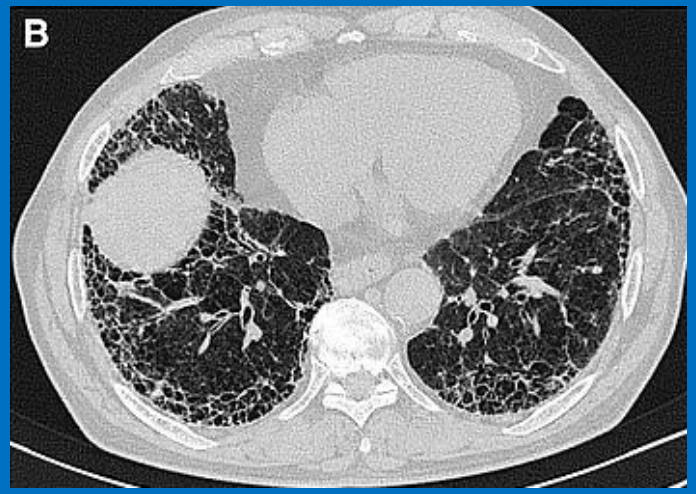
Combined pulmonary fibrosis and emphysema (CPFE): characterized by the coexistence of usual interstitial pneumonia (UIP) or nonspecific interstitial pneumonia (NSIP) with emphysema in smokers.

- HRCT would typically show:
- Centrilobular and/or paraseptal emphysema: often upper zone predominant
- Pulmonary fibrosis of the lower lobes: can be of UIP or NSIP pattern
- Complications:
- pulmonary hypertension
- lung cancer

A
HRCT scan at the level of the aortic arch. paraseptal emphysema



B
HRCT scan at the level of the dome of the right hemi-diaphragm. UIP pattern



Interstitial disease-Low attenuation-emphysema

Congenital Lobar Emphysema: progressive over inflation of one or more lobes of a neonate lung.

Rates of occurrence :

Left upper lobe -41%

Right middle lobe -34%

Right upper lobe -21%

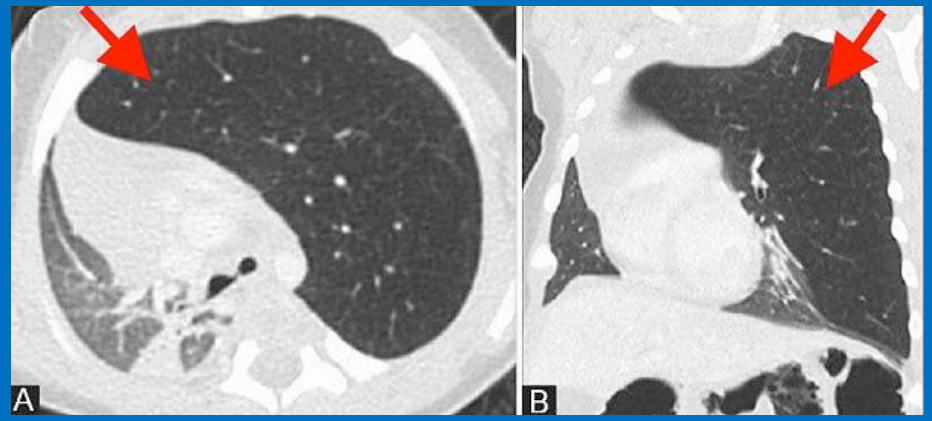
CT can provide details about the involved lobe and its vascularity, as well as information about the remaining lung.

A hyperlucent, hyperexpanded lobe with a paucity of vessels

Midline substernal lobar herniation and compression of the remaining lung.

Usually, the mediastinum is significantly shifted away from the side of the abnormal lobe.

Compressive atelectasis of neighbor in globes



Axial (A) andcoronal (B) CT show hyperinflated left upper lobe (arrows) with attenuated lung markings and herniation across the midline

Interstitial disease-Low attenuation-emphysema

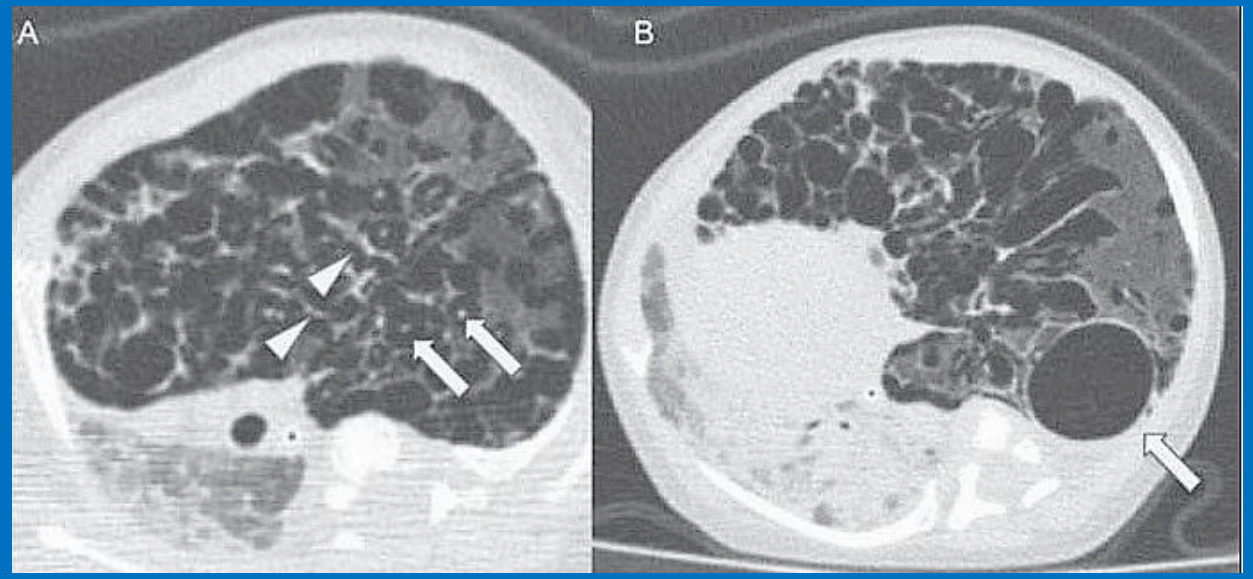
Pulmonary Interstitial emphysema (PIE): Much more common in neonates, rare in adults . PIE occurs almost in association with mechanical ventilation.

CT features :

lines and dots intermingled with large gaseous inclusions is typical, representing peribronchovascular bundles compressed by the air-filled interstitium

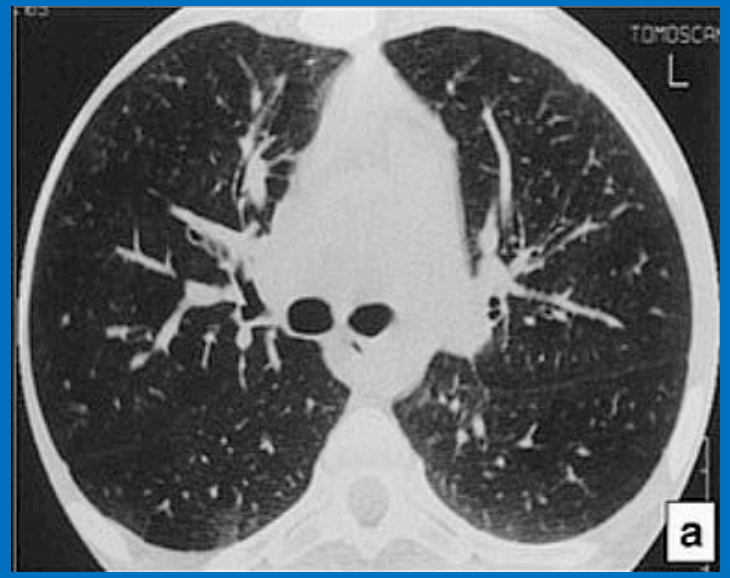
Shows cystic radiolucencies in affected segment

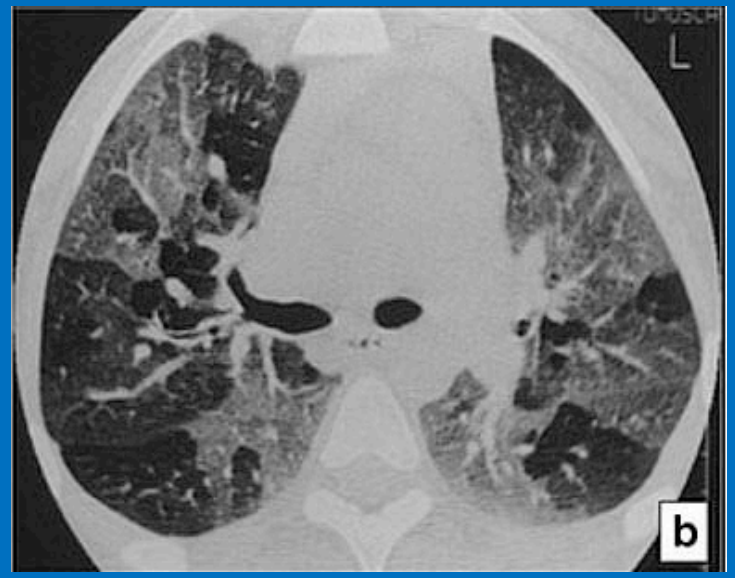
A: Multiple cystic, predominantly round images in association with linear (arrow heads) and punctate(arrows) images –lines and dots pattern.
B: Cystic mass with regular, well defined borders (pseudocyst).



Interstitial disease-Low attenuation

Mosaic attenuation: is used to describe density differences between affected and non-affected lung areas. There are patchy areas of black and white lung.





Obliterative bronchiolitis in a patient with cystic fibrosis. HRCT at the level of the carina at (a) inspiration and (b) expiration reveals at expiration a “mosaic attenuation pattern” secondary to air-trapping(b) which is not revealed on inspiration (a)

Interstitial disease-Low attenuation -Mosaic attenuation

Causes:

Obstructive small airways disease

- low attenuation regions are abnormal which become more evident in expiratory CT scans,
- e.g. Bronchiolitis obliterans, asthma, bronchiectasis, cystic fibrosis, hypersensitivity pneumonitis

Occlusive vascular disease

- Low attenuation regions are abnormal and reflect relative oligaemia,
- e.g. chronic pulmonary embolism, pulmonary hypertension

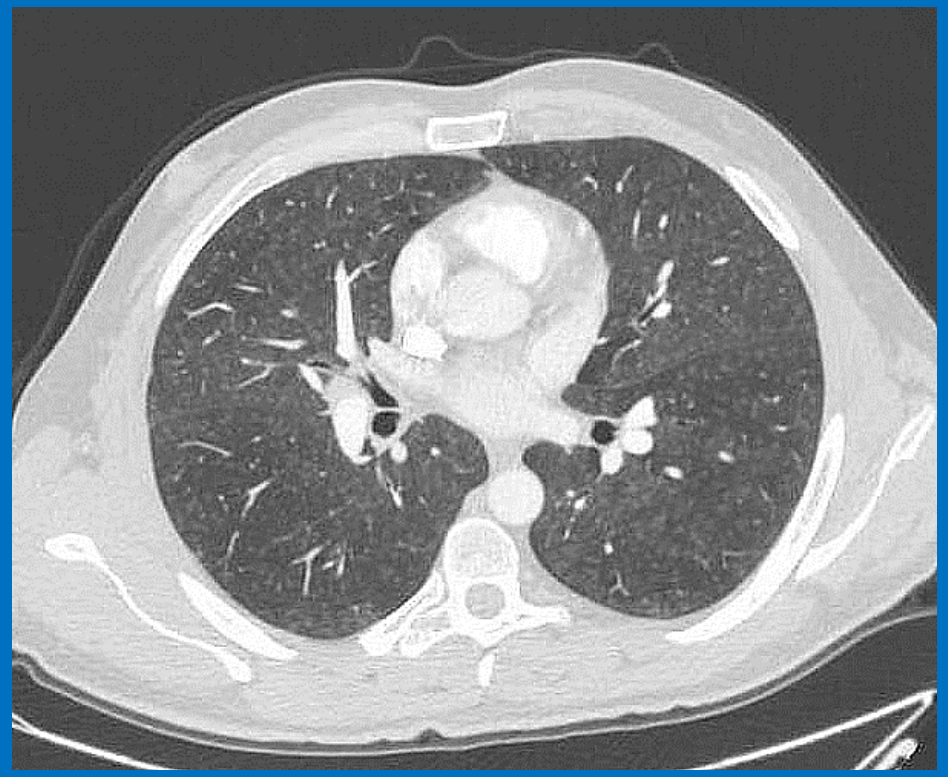
Parenchymal disease

- high attenuation regions are abnormal and represent ground-glass opacity
- e.g. hypersensitivity pneumonitis, pulmonary edema, Sarcoidosis, ARDS, Pneumocystis jiroveci, NSIP, Bronchoalveolar carcinoma

Lung field abnormalities -Interstitial disease

Hypersensitivity pneumonitis (HP) -(acute):

- Homogeneous ground-glass and alveolar opacities :
- usually bilateral and symmetric but sometimes patchy
- concentrated in the middle part and base of the lungs or in a bronchovascular distribution
- Airspace Consolidation
- Small (< 5 mm diameter) ill-defined centrilobular nodules

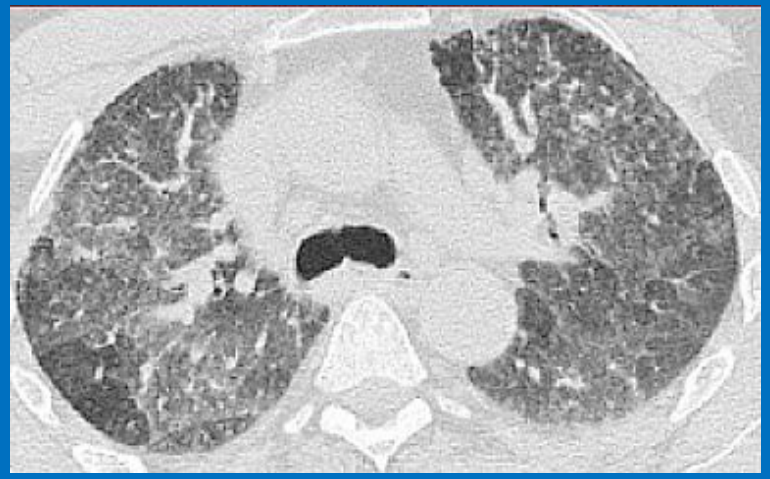


There is homogeneous bilateral and symmetric alveolar opacities and numerous centrilobular ground-glass alveolar nodules. No evidence of fibrosis.

Lung field abnormalities -Interstitial disease

Hypersensitivity pneumonitis (HP) -(Subacute): The CT demonstrates:

- Diffuse soft centrilobular ground-glass nodules (3-5 mm)
- Patchy ground-glass opacities predominantly involving the middle and lower lung zones
- Lobular areas of mosaic attenuation
- Air trapping may be seen on expiratory scans
- Headcheese sign



Subacute HP: Inspiratory axial CT image showing ground-glass opacities and lobular areas of mosaic lung attenuation

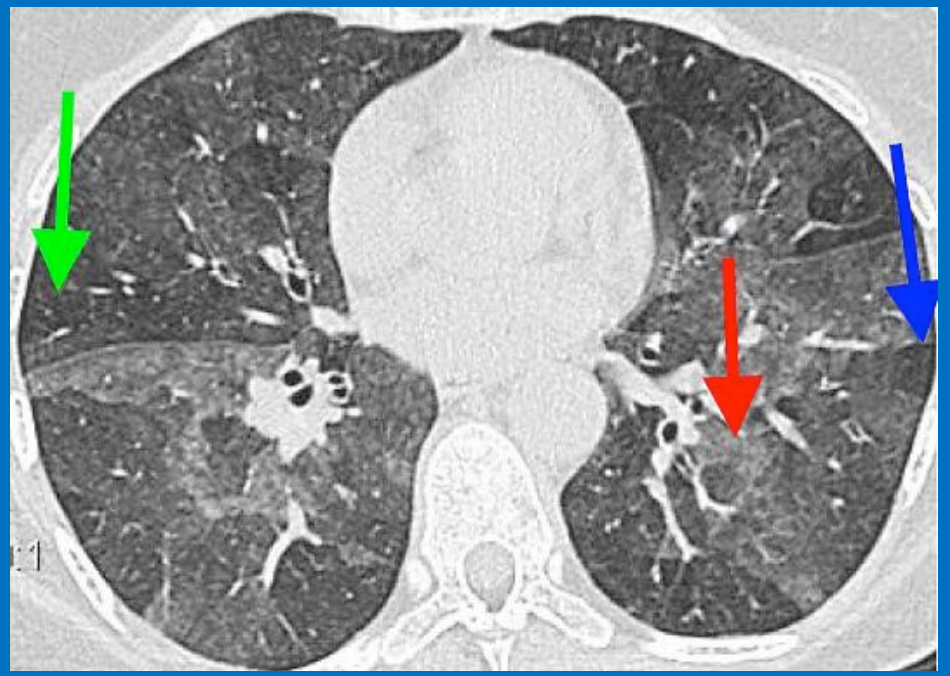
Interstitial disease -Hypersensitivity pneumonitis

Head cheese sign: a mixed infiltrative and obstructive process.

There is a combination of:

- lung consolidation
- ground glass opacities
- normal lung
- hyperinflated /air trapped lung (mosaic attenuation)

Relatively specific for HP, can occasionally be seen in other conditions including RB-ILD, DIP, LIP, follicular bronchiolitis, sarcoidosis, and atypical infections

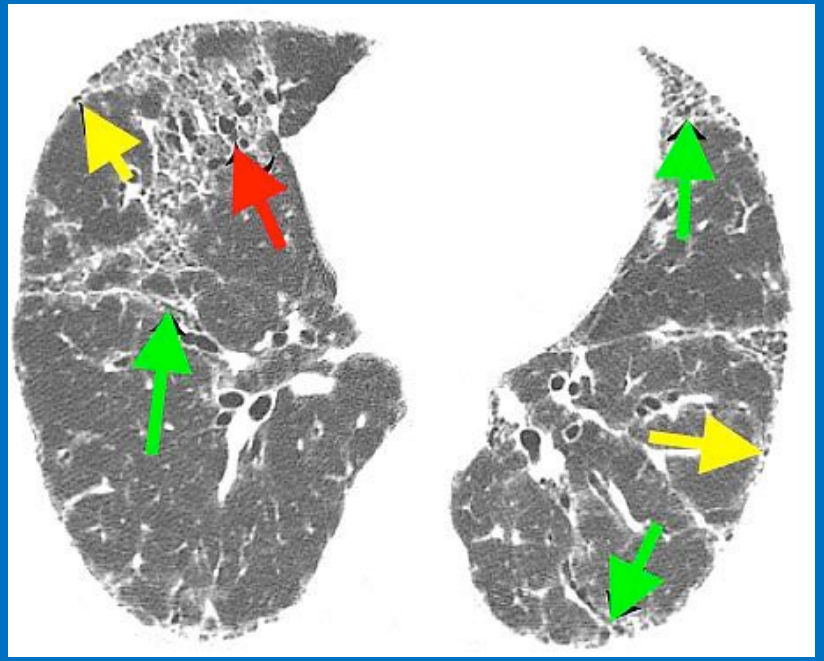


Headcheese sign in patient with subacute hypersensitivity pneumonitis showing combination of three lung attenuations -areas of mosaic lung attenuation (blue arrow), ground-glass opacities (red arrow) and normal lung attenuation (green arrow).

Lung field abnormalities -Interstitial disease

Hypersensitivity pneumonitis (HP) -(chronic):HRCT demonstrates:

- Findings of acute or subacute HP
- Reticulation and traction bronchiectasis, bronchiolectasis, and honeycombing due to fibrosis
- N.B. There is often a middle or upper zone predominance of CT findings with sparing of the lung bases, unlike NSIP or UIP which show a lower zone predominance.

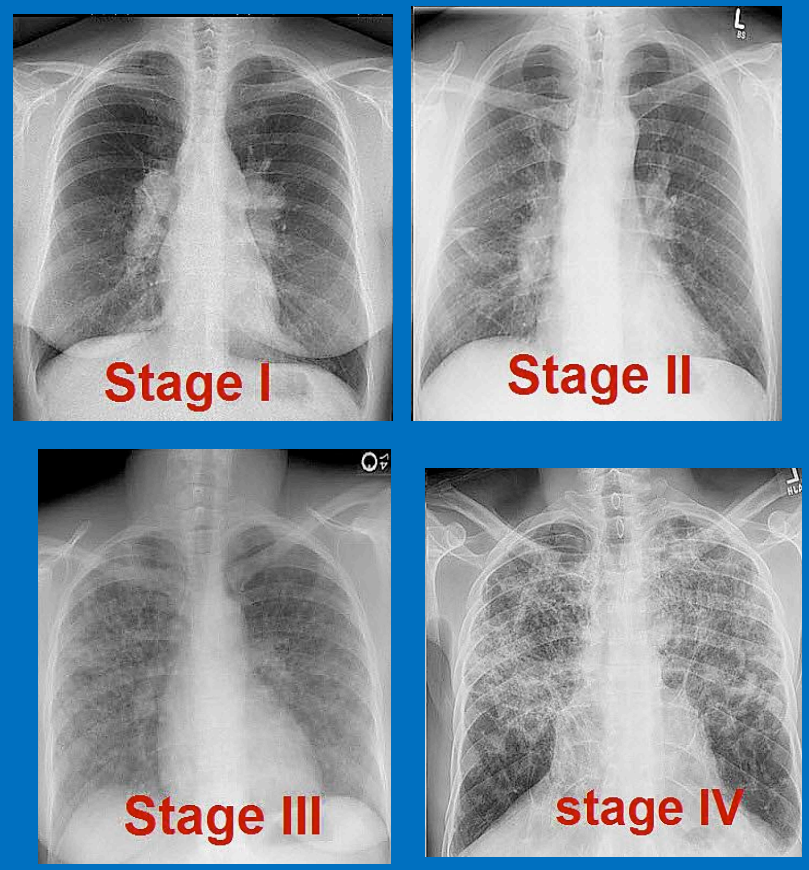


Chronic HP. bilateral reticulation, traction bronchiectasis(red arrow), and traction bronchiolectasis (green arrows). Also evident are subpleural cysts consistent with mild honeycombing (yellow arrows). Area of ground-glass opacity with superimposed reticulation is present in right middle lobe.

Lung field abnormalities -Interstitial disease

Sarcoidosis ;classified by chest x-ray into 5 stages :

stage 0: normal chest radiograph
stage I: hilar or mediastinal nodal enlargement only
stage II: nodal enlargement and parenchymal disease
stage III: parenchymal disease only
stage IV: end-stage lung (pulmonary fibrosis)



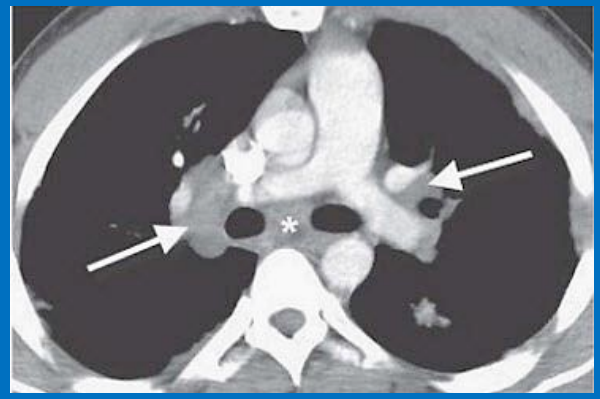
Interstitial disease-Sarcoidosis

HRCT demonstrates:

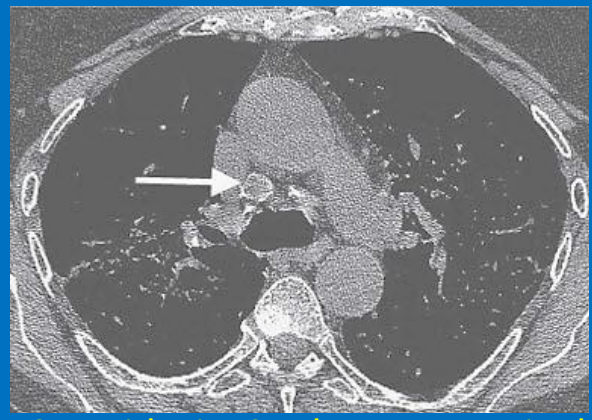
1.Nodal changes:

Bilateral hilar and mediastinal lymphadenopathy, usually symmetrical: Garland triad, also known as the 1-2-3 sign is bilateral hilar and right paratracheal lymphadenopathy.

Dystrophic calcification of involved lymph nodes: Calcification can be amorphous, punctate, popcorn like, or eggshell.



CT with mediastinal windowing shows bilateral hilar (arrows) and subcarinal (asterisk) lymphadenopathy.



Sarcoidosis. CT shows precarinal lymphadenopathy with egg shell calcification (arrow).

Interstitial disease-Sarcoidosis

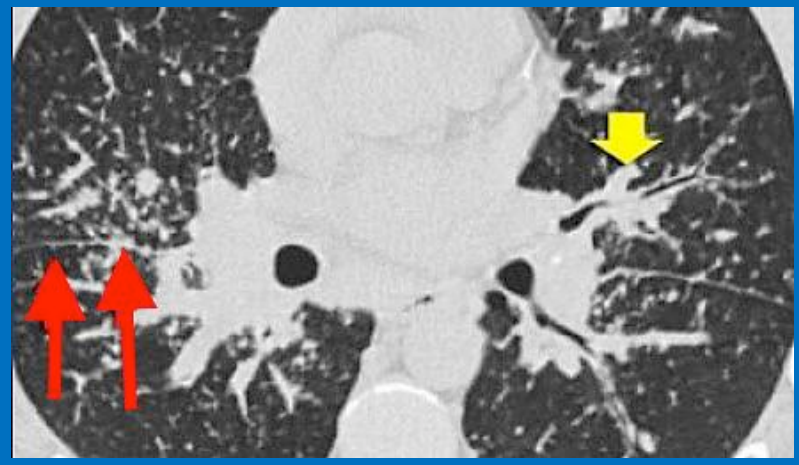
2.Parenchymal changes: Sarcoidosis and TB are often termed the “great mimicker” as their radiologic manifestations can simulate numerous diseases

A.Typical HRCT findings:

i. Irregular nodular thickening <10 mm, in a perilymphatic distribution with upper and middle zone predominance.

ii. Sarcoid cluster, galaxy signs, Fairy ring (previous)

iii. Mosaic attenuation and air-trapping

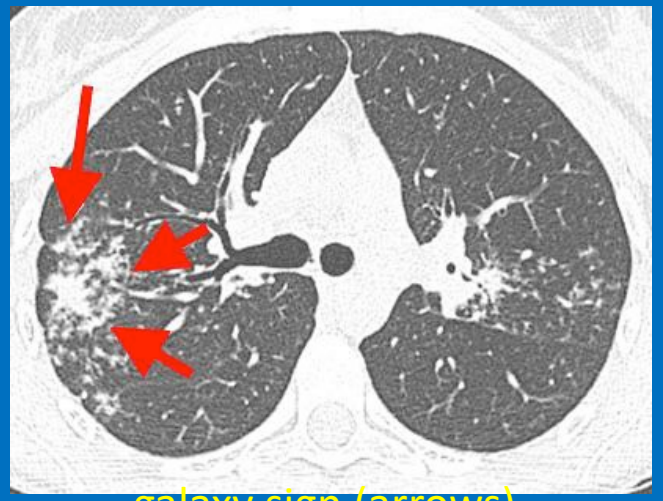


Sarcoidosis: hilar lymphadenopathy and small nodules along bronchovascular bundles(yellow arrow) and along fissures(red arrows)

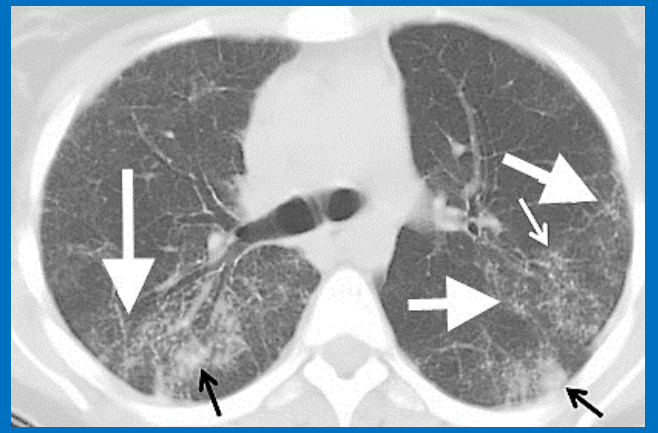
Interstitial disease-Sarcoidosis -Parenchymal changes

iv."galaxy sign": a large nodule (represents innumerable coalescent granulomas), usually with irregular boundaries, encircled by a rim of numerous tiny satellite nodules. Also seen in tuberculosis and lung carcinoma

v.“sarcoid cluster sign”: rounded or long clusters of many small nodules that are close to each other but, in contrast to those of the “sarcoid galaxy”, not confluent



galaxy sign (arrows)



sarcoid cluster (white arrows)

Interstitial disease-Sarcoidosis-Parenchymal changes

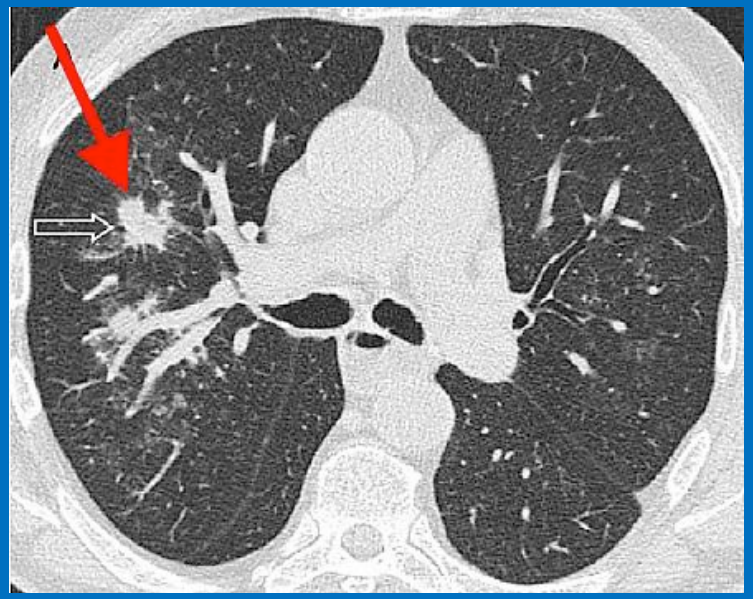
B. Atypical HRCT findings:

- large nodules, 1-3 cm in diameter, and masses >3 cm may cavitate and very seldom calcify
- pseudo alveolar sarcoidosis: Ground-glass opacity and lung consolidation

C. less common findings:

- paving pattern
- calcified micronodules
- halo sign and reversed halo sign
- Miliary Opacities: rare

Atypical pattern of sarcoidosis. Axial HRCT: large spiculated nodules in Right upper lobe (red arrow).



Interstitial disease-Sarcoidosis-Parenchymal changes

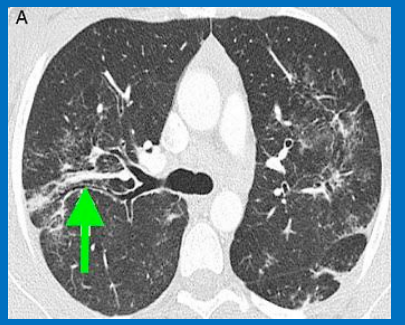
D. Pulmonary fibrosis (stage IV):

- linear bands of fibrosis
- traction bronchiectasis
- Honeycombing
- pulmonary cysts

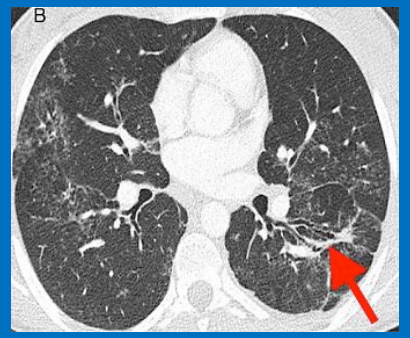
E. Complications:

- Mycetomas: in apical bullous disease
- Pulmonary hypertension

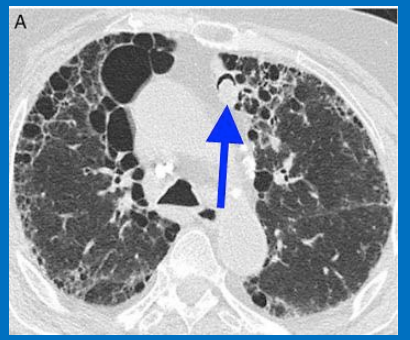
Traction bronchiectasis (open arrow)



Irregular dense **bands** (solid arrow)



honeycomb cysts, Mycetomas (blue arrows) and hilarand mediastinal calcified adenopathy.



lung field abnormalities -Interstitial disease

UIP pattern
(All four features present)

- **Subpleural**, **basal** predominance
- **Reticular** abnormality
- Absence of features listed as "**inconsistent with UIP pattern**" (see third column)
- **Honeycombing +/- traction bronchiectasis**

Possible UIP pattern
(All three features present)

- **Subpleural**, **basal** predominance
- **Reticular** abnormality
- Absence of features listed as "**inconsistent with UIP pattern**" (see third column)

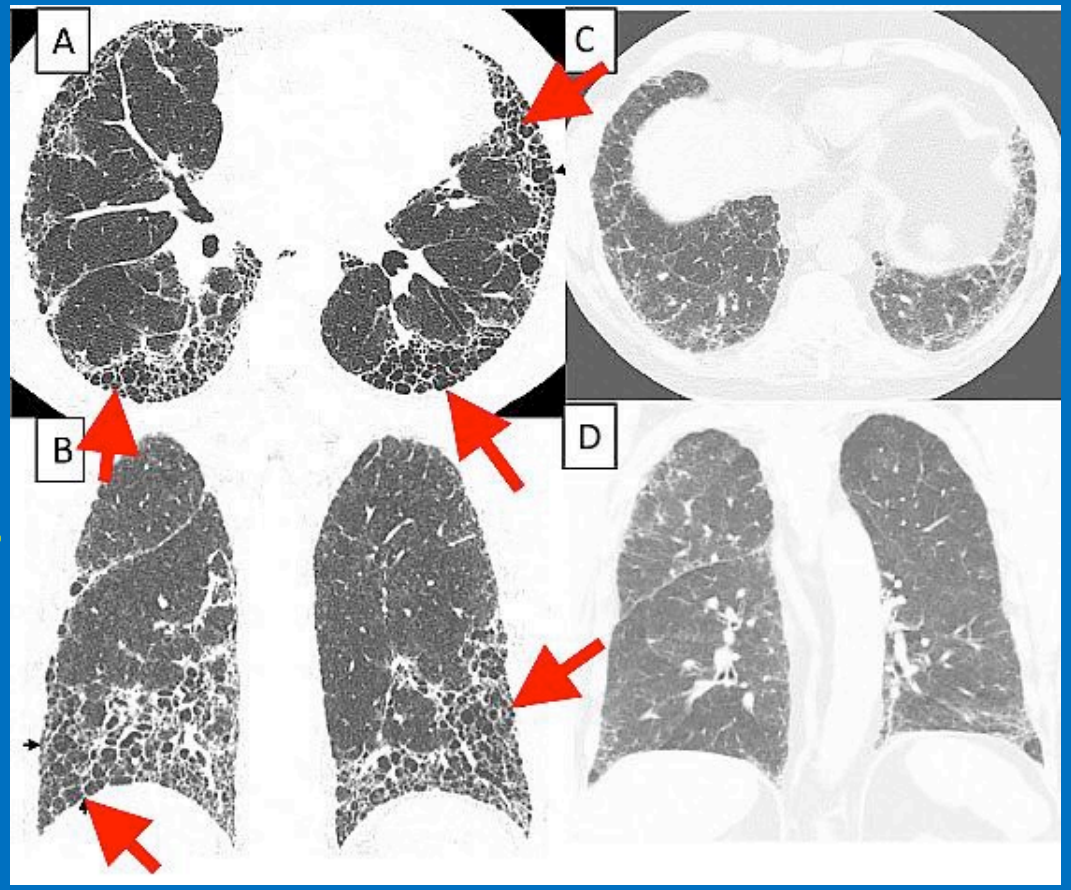
Inconsistent with UIP pattern
(Any one of the following seven features present)

- Upper or mid-lung predominance
- Peribronchovascular predominance
- Extensive ground glass abnormality (i.e. more than reticular abnormality)
- Diffuse mosaic attenuation / air-trapping (bilateral in ≥3 lobes)
- Profuse micronodules (bilateral, predominantly upper lobes)
- Discrete cysts (multiple, bilateral, away from honeycombing)
- Consolidation in bronchopulmonary segment(s) or lobe(s)

lung field abnormalities -Interstitial disease

Usual interstitial pneumonia (UIP):

(A and B) UIP pattern, with extensive honeycombing: axial and **coronal** HRCT images show **basal** predominant, **peripheral** predominant **reticular** abnormality with multiple layers of **honeycombing**(arrows).
(C and D) Possible UP pattern: axial and **coronal images** show **peripheral** predominant, **basal** predominant **reticular** abnormality with a moderate amount of **ground glass** abnormality, but **without honeycombing**.



Lung field abnormalities -Interstitial disease

Non-specific interstitial pneumonia (NSIP): HRCT findings

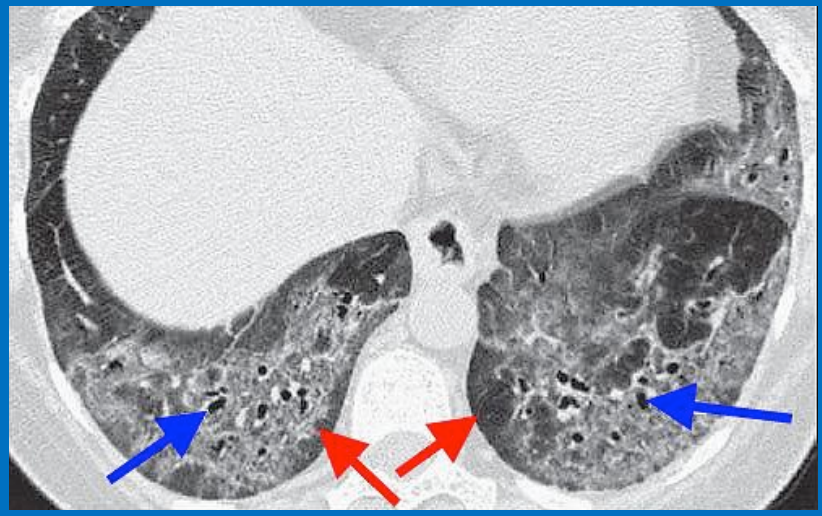
- Ground-glass opacities:
- dominant feature
- mostly bilateral
- basal or diffuse distribution
- mostly subpleural
- Immediate subpleural sparing -a relatively specific sign

Bilateral irregular reticulation

lung volume loss: particularly lower lobes

In advanced disease:

- traction bronchiectasis
- consolidation
- microcystic honeycombing: relatively less common



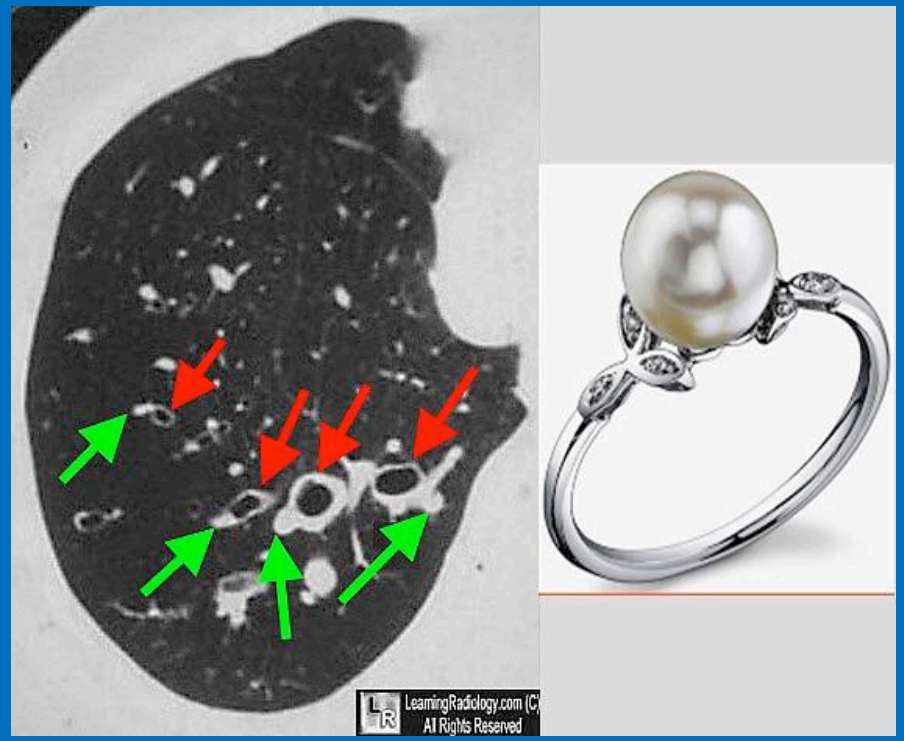
NSIP: peribronchovascular and **basilar** predominant distribution of **ground-glass** opacity with associated **traction bronchiectasis** (blue arrows). The areas of **immediate subpleural sparing** (red arrows) are **specific** to NSIP.

lung field abnormalities -Interstitial disease

Bronchiectasis: HRCT findings:

1.Bronchial dilatation and increased **bronchoarterial ratio** producing the so-called **signet-ring sign**: diameter of a bronchus greater than **1.5** times that of the adjacent pulmonary artery branch

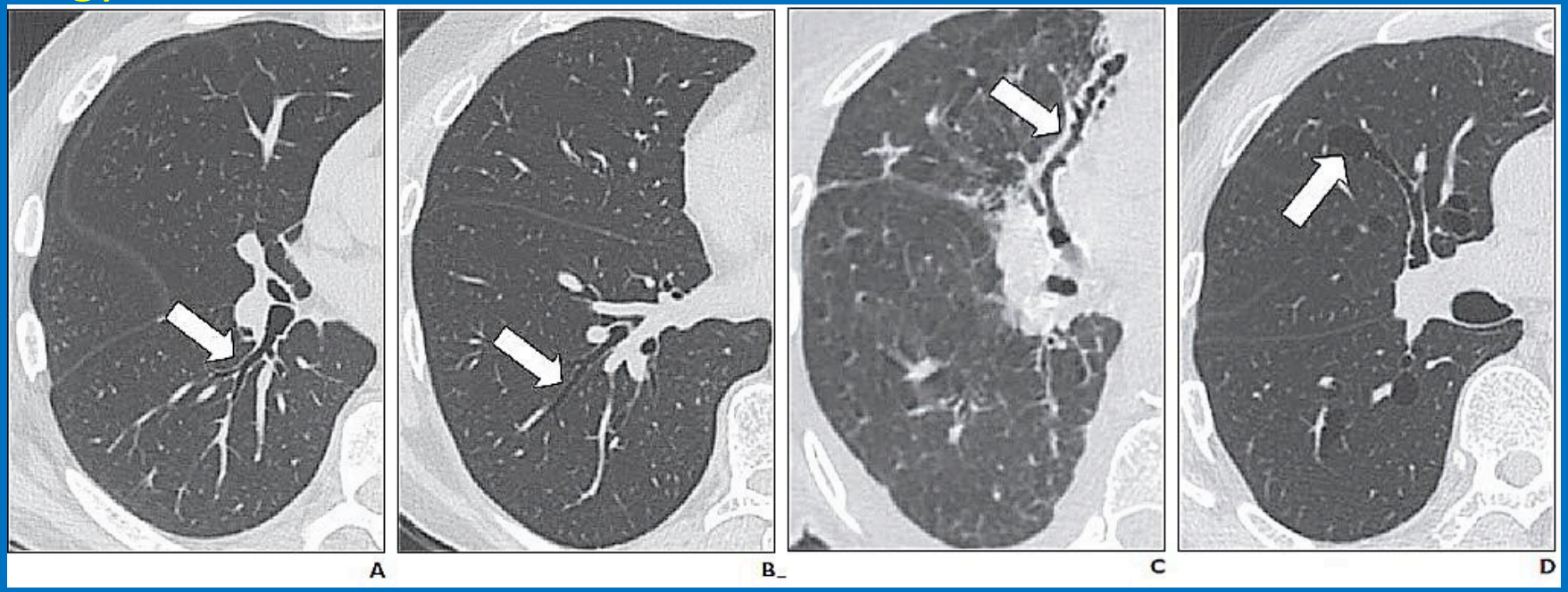
Signet-Ring Sign, Bronchiectasis. The bronchi (red arrows) are larger than their corresponding arteries(green arrows).



Interstitial disease-Bronchiectasis

2.Tram-track sign: the thickened **non-tapering (parallel)** walls of **cylindrical** bronchiectasis

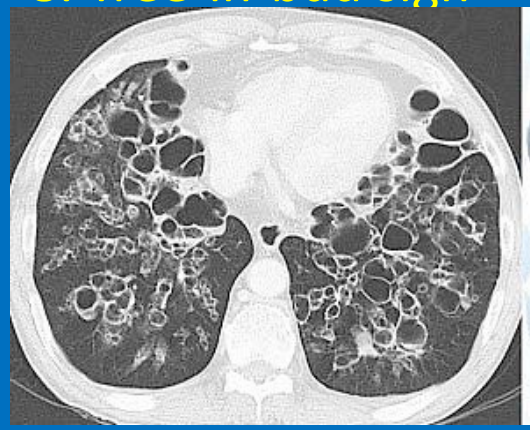
3. Distortions of normal bronchial shape, such as **varicoid (string of pearls)** or **cystic** morphology



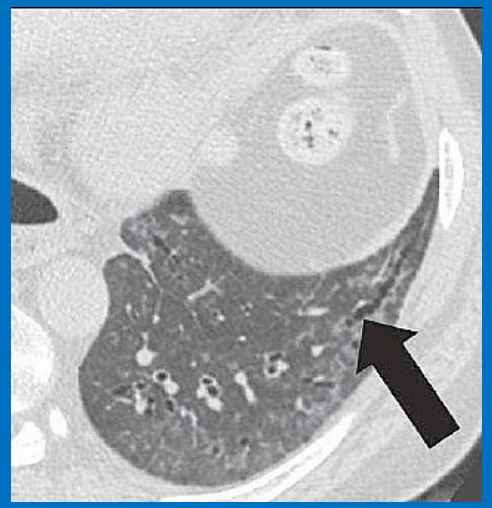
Normal bronchus (arrow) (A), cylindric bronchiectasis with lack of bronchial tapering (arrow) (B), varicose bronchiectasis with string-of-pearls appearance (arrow) (C), and cystic bronchiectasis (arrow) (D)

Interstitial disease-Bronchiectasis

4. Visualization of bronchi within 1 cm of the costal pleura.
5. Cystic bronchiectasis: severe form with cyst-like bronchi that extend to the pleural surface, which end in large clusters of grape-like cysts, (cluster of grapes sign). Air-fluid levels are commonly present
6. Mucus impaction (finger-in-glove sign)
7. Air-trappingand mosaic perfusion
8. Tree-in-bud sign



Bilateral severe **bronchiectasis**, resembling **grapes**



Black arrow points to bronchus visible in **peripheral 1 cm** of lung

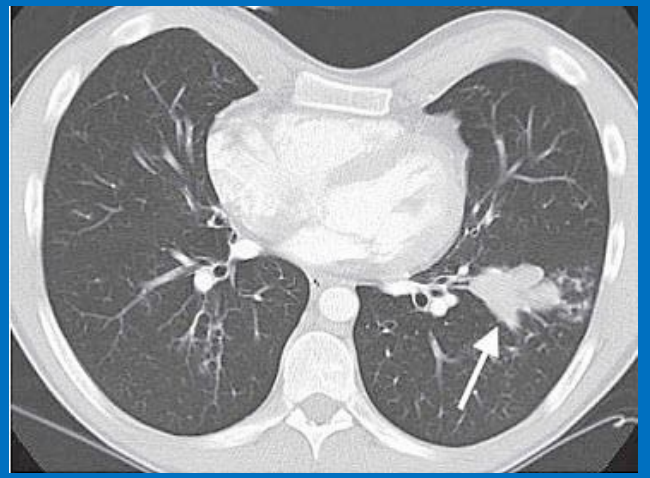
Interstitial disease-Bronchiectasis

Finger in glove sign: Indicates **mucoid impaction** within an obstructed bronchus or dilated bronchi with secretions,
Bronchiectasisis a common cause.

- ❑ Characterized by **branching tubular** or **finger like opacities**
- ❑ Originate **from the hilum** and are **directed peripherally**
- ❑ **Aetiology**

✓**Non-obstructive: allergic bronchopulmonary aspergillosis (ABPA), asthma, cystic fibrosis**

✓**Obstructive: neoplasms(bronchial hamartomas, lipomas, bronchogenic carcinoma, carcinoid), congenital (bronchial atresia, intralobar sequestration, bronchogenic cysts**)



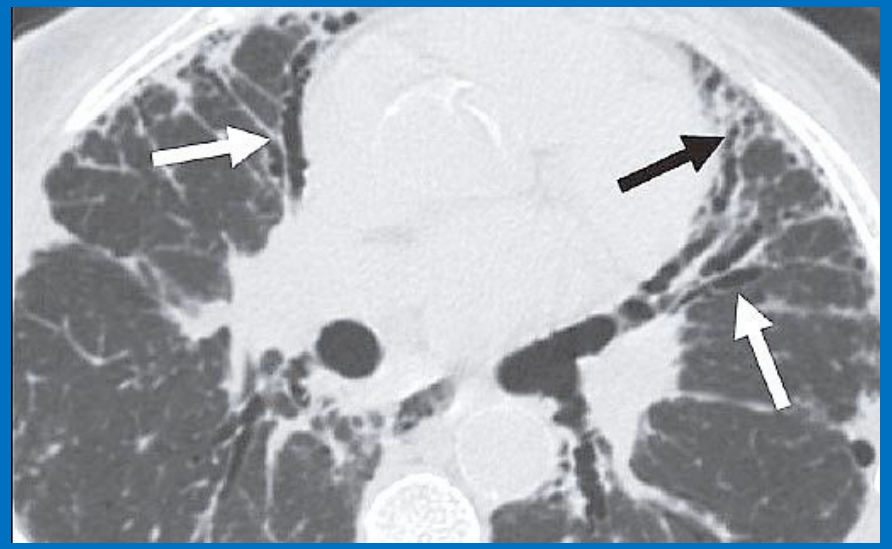
CT shows **dilated** and **impacted** central bronchi in the **left lower lobe**(arrow).

Interstitial disease-Bronchiectasis

Traction bronchiectasis:

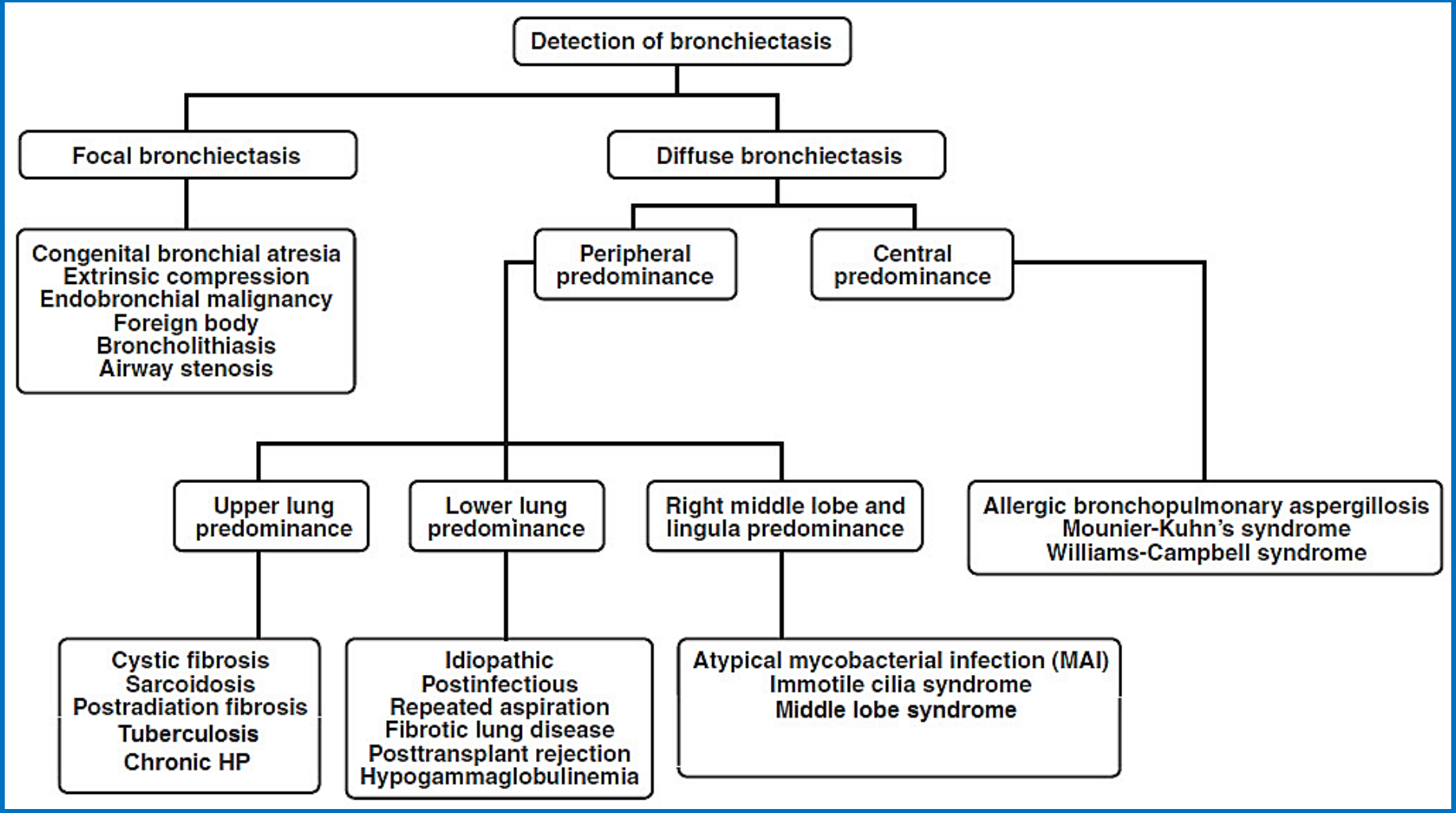
- An **aetiological** sub type of bronchiectasis
- There is irreversible **dilatation** of bronchi and bronchioles due to **traction** of surrounding parenchymal fibrosis
- Distribution: There may be a predilection for the **upper lobes** where there is less supporting cartilage.

Usual interstitial pneumonia. **Bibasilar** and **subpleural reticulation** and **traction bronchiectasis** are seen in areas of fibrosis (arrows).



Interstitial disease-Bronchiectasis

Location:



Pneumocystis pneumonia (PCP): HRCT findings

Ground-glass pattern:

- a principal finding
- predominantly involving perihilar or mid zones

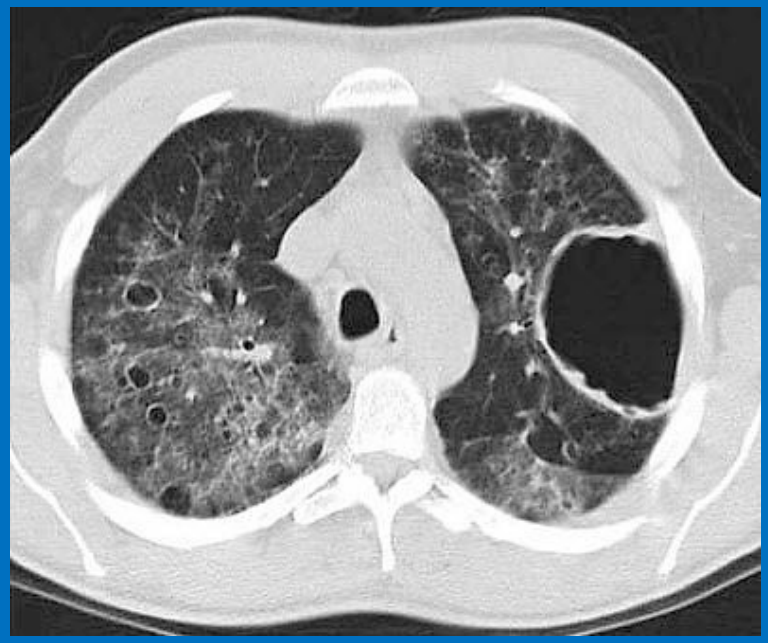
Reticular opacities or septal thickening

Crazy paving

Cysts (or pneumatoceles):

- typically involving upper lobes
- have bizarre shapes and thick walls
- increased risk of pneumothorax

Uncommon: lymphadenopathy, pleural effusion, consolidation and nodules (granulomas)

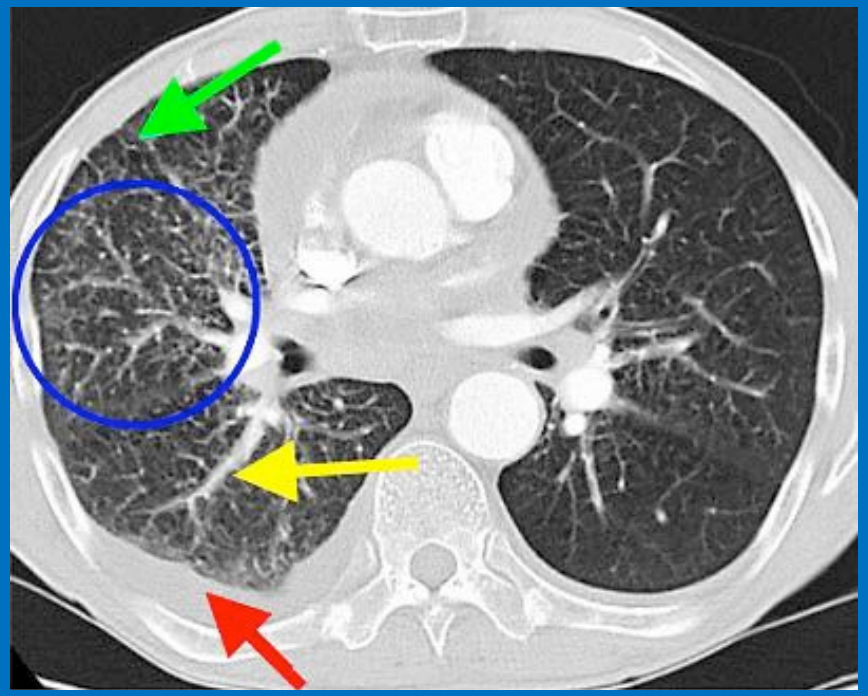


Pneumocystis carinii pneumonia (PCP): CT shows a combination of ground glass opacities and pneumatoceles

lung field abnormalities -Interstitial disease

Lymphangitic carcinomatosis: HRCT findings:

- **Irregular**, **nodular**, and/or **smooth interlobular septal** thickening
- Thickening of the **peribronchovascular interstitium** and **fissures**
- **Mediastinal** and / or **hilar lymphadenopathy**
- **Pleural effusions (pleural carcinomatosis),** especially **laminar** effusion
- **Nodular** opacities
- A helpful sign is that the **overall lung** and **lobular architecture** is preserved



Lymphangitic carcinomatosis: unilateral interstitial edema (blue circles) with a pleural effusion (red arrow), thickening and irregularity of the bronchovascular bundles (yellow arrow) and thickening of the interlobular septa (green arrow).

lung field abnormalities -Interstitial disease

Silicosis:

1.Acute silicosis (silicoproteinosis):

Bilateral nodular/ground-glass opacities with a centrilobular distribution.

Multi focal patchy ground glass opacities

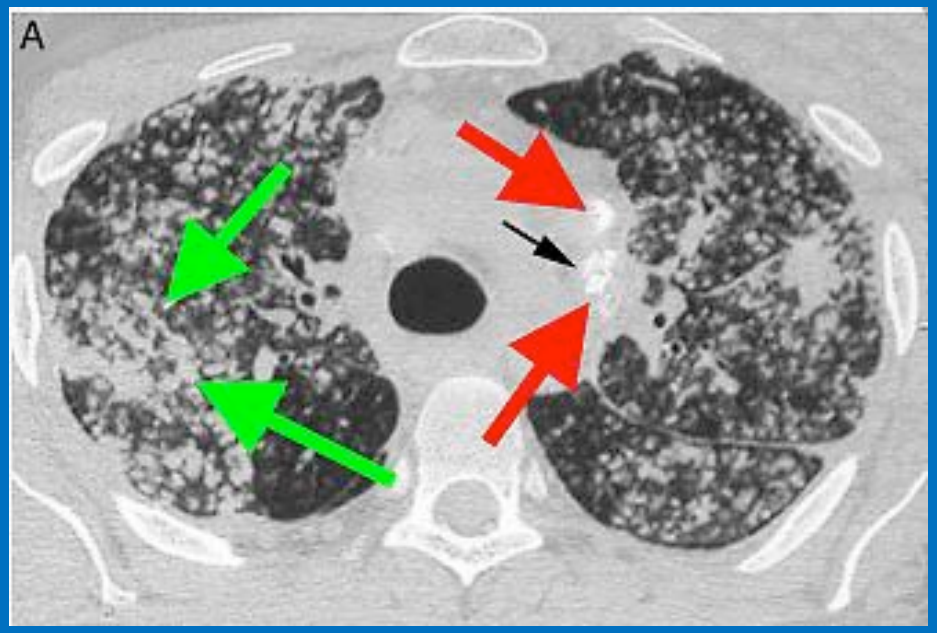
Consolidation

Crazy-paving appearance:

DD-Alveolar proteinosis

Punctate calcifications superimposed in areas of consolidation

Calcified lymph nodes



Silicoproteinosis. Numerous bilateral airspace nodules, some of them confluent(green arrows) with areas of consolidation. Calcified mediastinal and hilar lymph nodes (red arrows) are also evident.

Interstitial disease -Silicosis

2.Classic or chronic simple silicosis (common type):

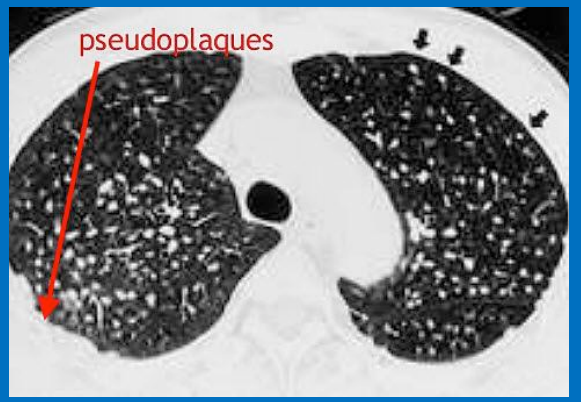
Multiple small nodules:

- 2-5 mm in diameter
- Well-defined and uniform in shape and attenuation with perilymphatic distribution
- Predominantly located in the upper lobe and posterior portion of the lung
- Subpleural nodules, if they are confluent may resemble pleural plaques
- Nodules may Calcify

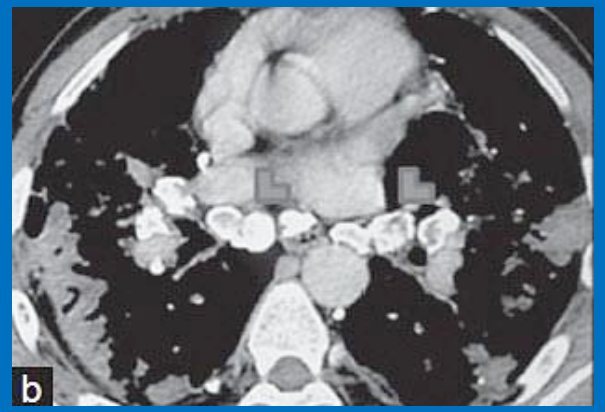
Lymph node enlargement:

Egg shell calcification is common, DD:

Sarcoidosis



HRCT shows numerous **small nodules** and **pseudo plaque** formation



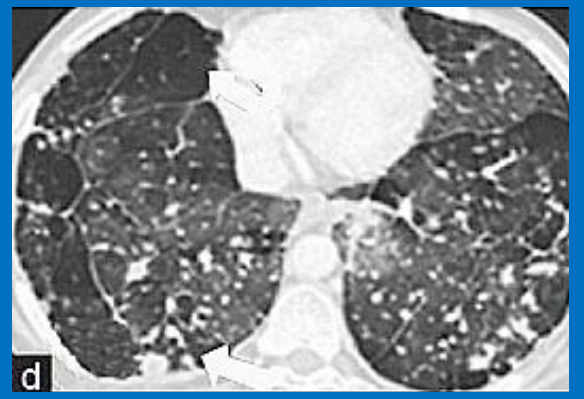
Eggshell calcification

Interstitial disease -Silicosis

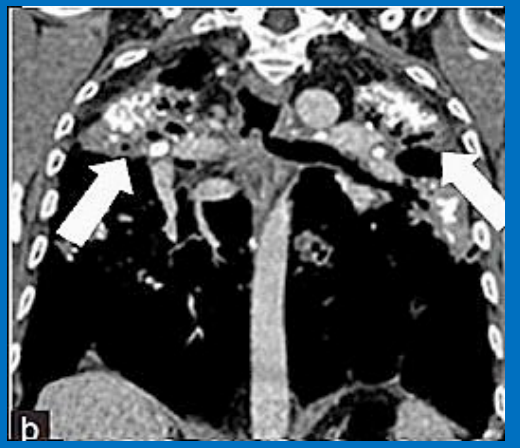
3.Classic or chronic complicated silicosis (progressive massive fibrosis (PMF), or conglomerate silicosis): HRCT findings:

- Focal soft-tissue masses:
- diameter >1 cm
- irregularmargins
- may calcify+ cavitate(ischemic necrosis/TB)
- commonly involving apicaland posterior segmentsof the upper lobes
- surrounded by areas of emphysematous change
- with progressive fibrosis, these large opacities migrate towards hila

PMF. Axial HRCT images in lung window, show presence of round opacities with paraseptal emphysema.



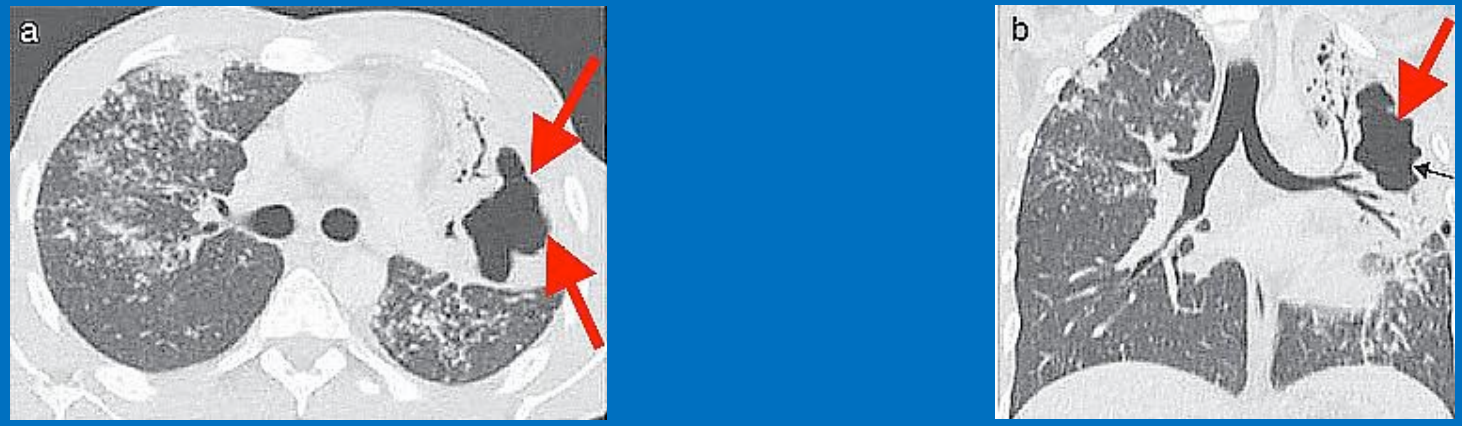
PMF. Coronal CT scan obtained with mediastinal window shows bilateral conglomerate masses with calcifications (arrows).



Interstitial disease -Silicosis

4.Complicated silicosis by tuberculous (Silicotuberculosis):

- Asymmetric nodules or consolidation, cavitation
- cavitation in a silicotic conglomerate may be due to tuberculosis, anaerobic infection or ischemia



CT a) axial and b) coronal. Micronodular pattern with conglomerate formation and an extensive cavitation is shown in a patient with silicotuberculosis (arrows).

lung field abnormalities -Interstitial disease

Upper zone

- Pneumoconiosis(silica or coal)
- Paraseptaland centrilobularemphysema
- RB-ILD
- PLCH
- Chronic HP
- Berylliosis
- Cystic fibrosis
- ABPA
- Eosinophilicpneumonia
- Sarcoidosis
- Silicosis
- Tuberculosis
- Ankylosingspondylitis
- Neurofibromatosis

lower zone

- Asbestosis
- Rheumatologic diseases
- DIP
- COP
- UIPZ
- NSIP
- Aspiration
- Pulmonary edema
- lipoid pneumonia
- lymphangiticcarcinomatosis
- Alveolar hemorrhage
- Panlobaremphysema

Peripheral

- Asbestosis
- Rheumatologic diseases
- Eosinophilicpneumonia
- COP
- UIP

Central

- Sarcoidosis
- Cardiogenicpulmonary edema

Diffuse

- Hypersensitivity pneumonitis (HP)
- LAM
- Diffuse pneumonia
- Sarcoidosis
- lymphangiticcarcinomatosis

Rest of the topic will be covered in next Lecture on 22nd August 2020

Thank You