IN THE NAME OF GOD



Isfahan University of Medical Sciences

Dominant HRCT pattern

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HRCT



High-resolution CT scanning (HRCT)

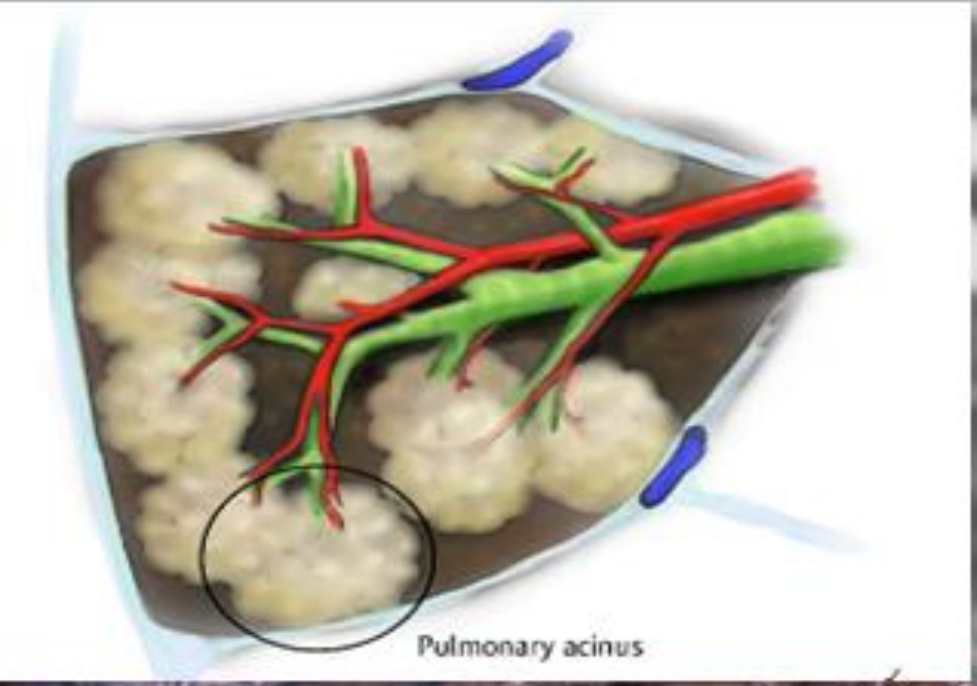
- This is traditionally a sampling test : Not all of the lung is examined.
- 1- to 2-mm slices are taken about 10 mm apart.
- Very good for detecting interstitial lung disease : A very detailed assessment of lung architecture
- Not a good technique for finding mass lesions :Because the lesion could occur in one of the spaces between the slices
- Intravenous contrast is not normally used with HRCT.

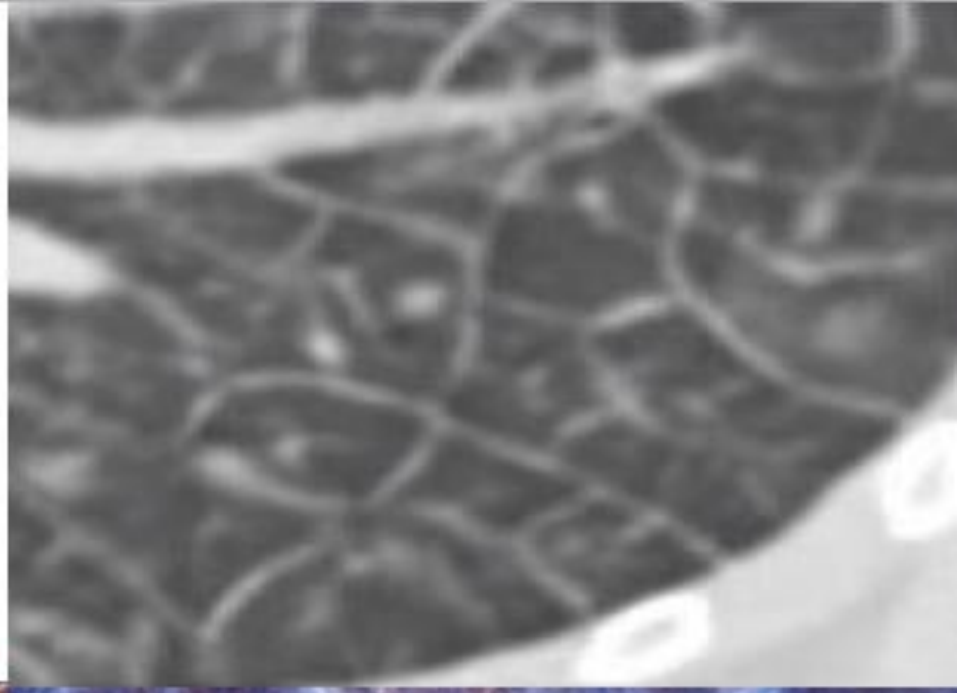
Combined imaging

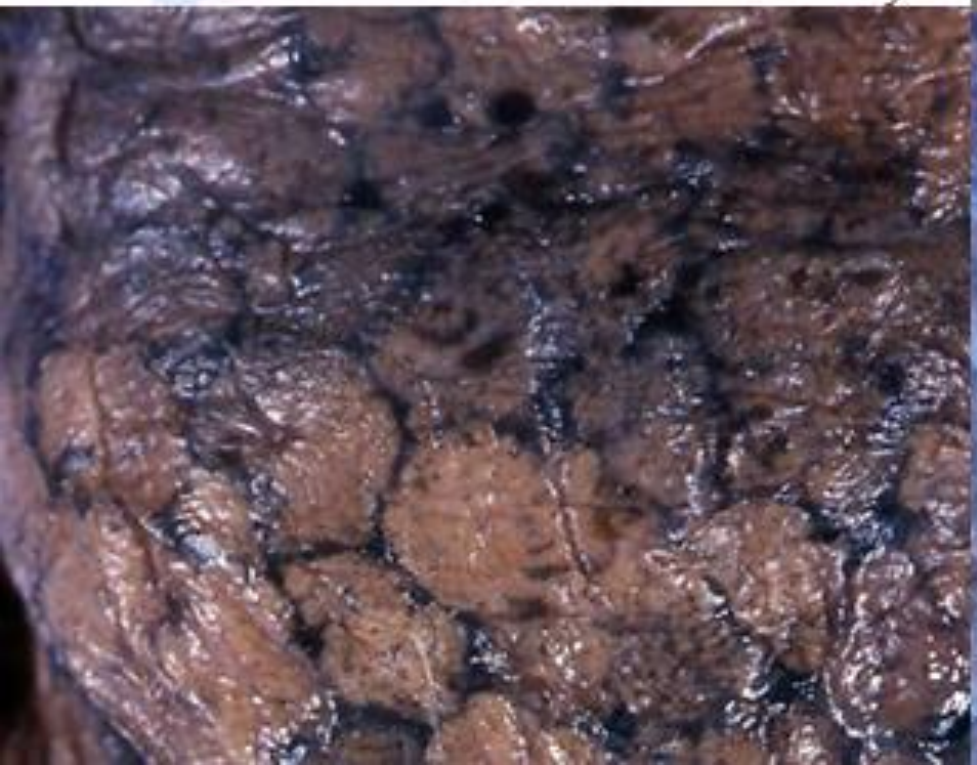
- Most CT scanners are able to acquire spiral images and with the same data set can process the image to produce a high-resolution study
- **Exposes the patient to a higher radiation dose**

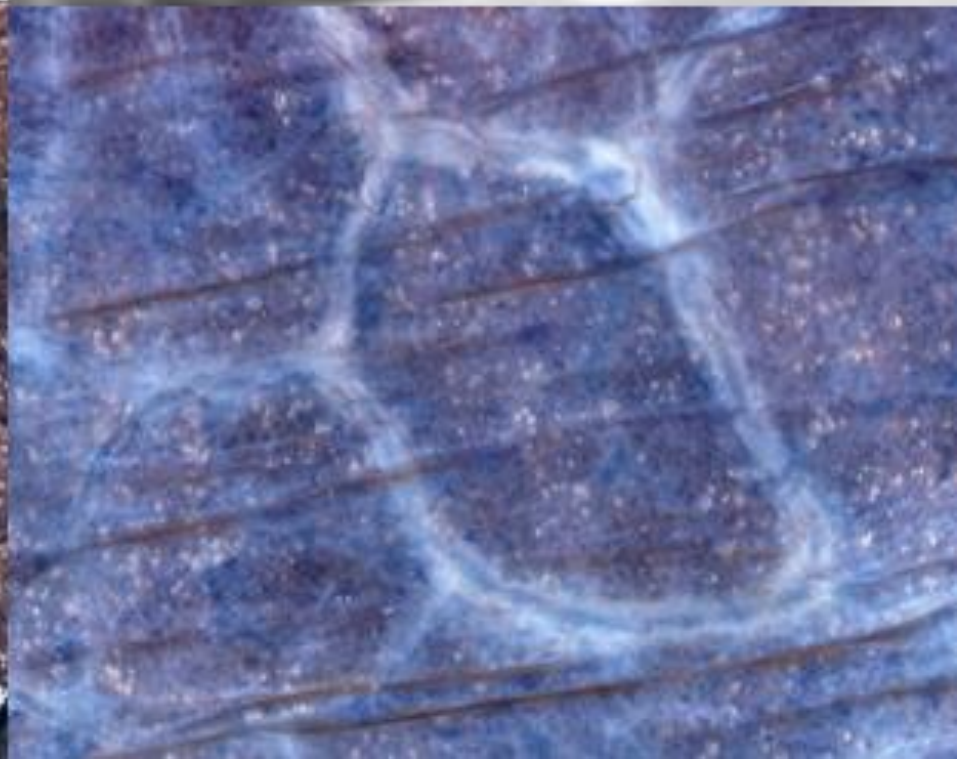
Anatomy of Secondary lobule

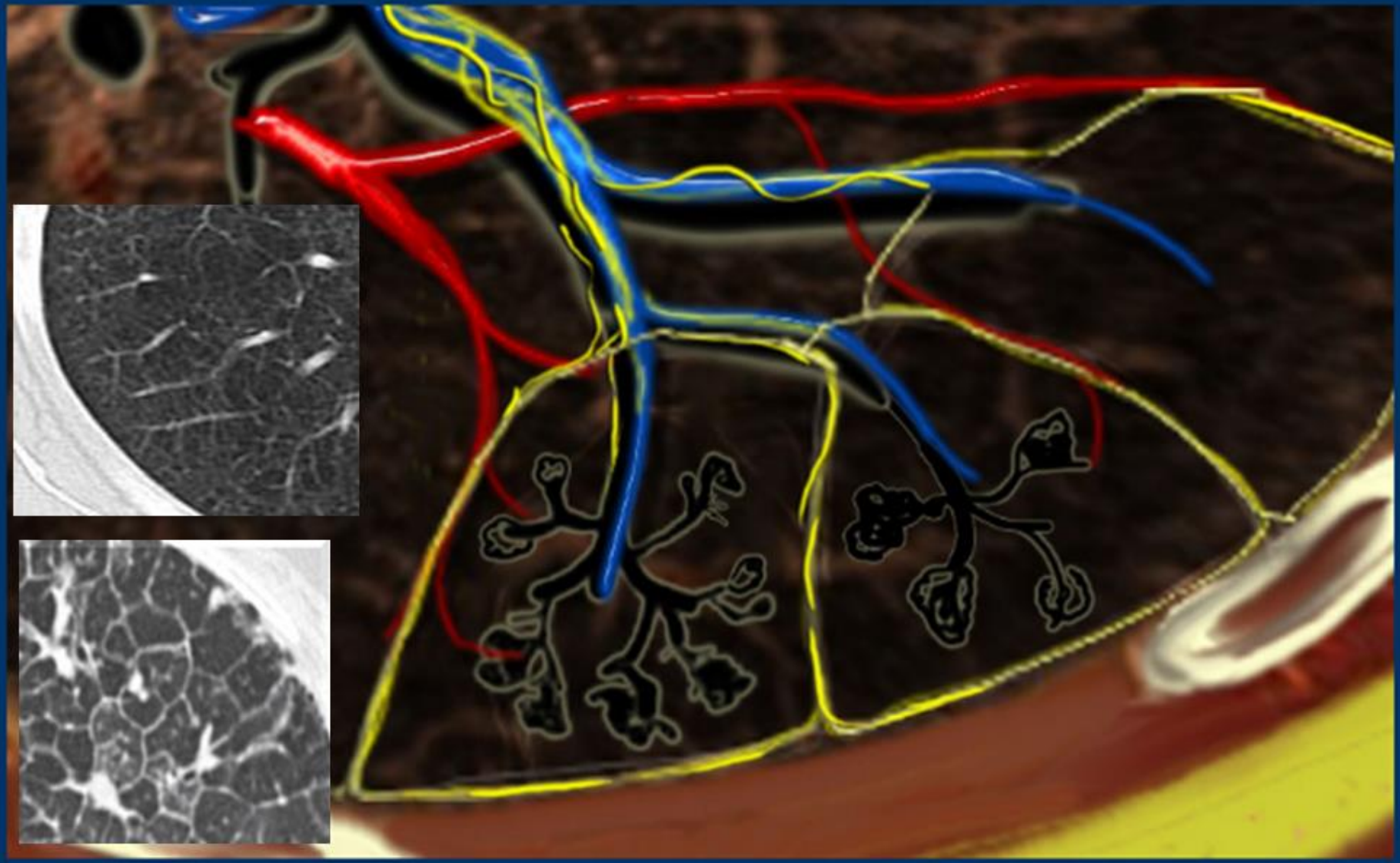
Knowledge of the lung anatomy is essential for understanding HRCT.
The interpretation of interstitial lung diseases is based on the type of involvement of the secondary lobule.
The secondary lobule is the basic anatomic unit of pulmonary structure and function.
It is the smallest lung unit that is surrounded by connective tissue septa.
It measures about 1-2 cm and is made up of 5-15 pulmonary acini, that contain the alveoli for gas exchange.
The secondary lobule is supplied by a small bronchiole or terminal bronchiole in the center, which is parallelled by the centrilobular artery.
The pulmonary veins and lymphatics run in the periphery of the lobule within the interlobular septa.
Under normal conditions only a few of these very thin septa can be seen.
There are two lymphatic systems: a central network, that runs along the bronchovascular bundle towards the centre of the lobule and a peripheral network, that is located within the interlobular septa and along the pleural linings.


Pulmonary acinus

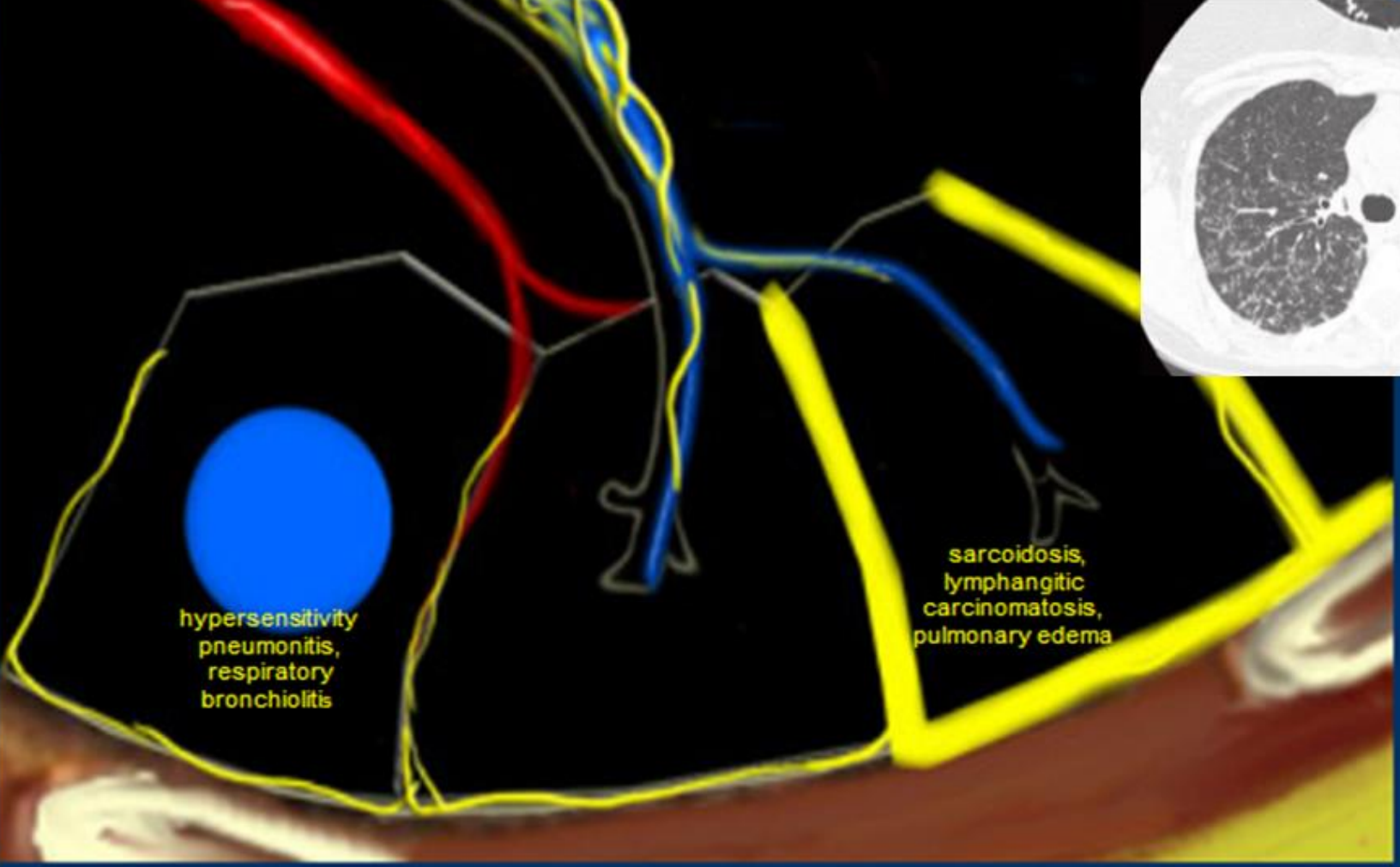




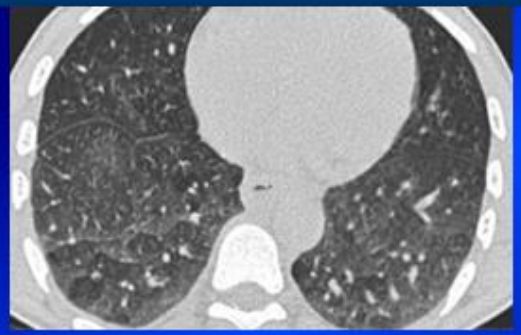




Secundary lobules. The centrilobular artery (in blue: oxygen-poor blood) and the terminal bronchiole run in the center. Lymphatics and veins (in red: oxygen-rich blood) run within the interlobular septa



Centrilobular area in blue and perilymphatic area in yellow.



Centrilobular area is the central part of the secundary 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 secundary lobule.
It is usually the site of diseases, that are located in the lymphatics of in 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 bronchovascular bundle.

Basic Interpretation

A structured approach to interpretation of HRCT involves the following questions:

- What is the dominant HR-pattern:
  - reticular
  - nodular
  - high attenuation (ground-glass, consolidation)
  - low attenuation (emphysema, cystic)
- Where is it located within the secondary lobule HR-pattern:
  - centrilobular
  - perilymphatic
  - random
- Is there an upper versus lower zone or a central versus peripheral predominance
- Are there additional findings:
  - pleural fluid
  - lymphadenopathy
  - traction bronchiectasis

HRCT	basic interpretation
Dominant pattern	Reticular Nodular High attenuation (GG - consolidation) Low attenuation (cystic)
Distribution in secundary lobule	Centrilobular Perilymphatic Random
Distribution within lung	Upper versus Lower zone Central versus Peripheral

Reticular pattern

In the reticular pattern there are too many lines, either as a result of thickening of the interlobular septa or as a result of fibrosis as in honeycombing.

Septal thickening

Smooth

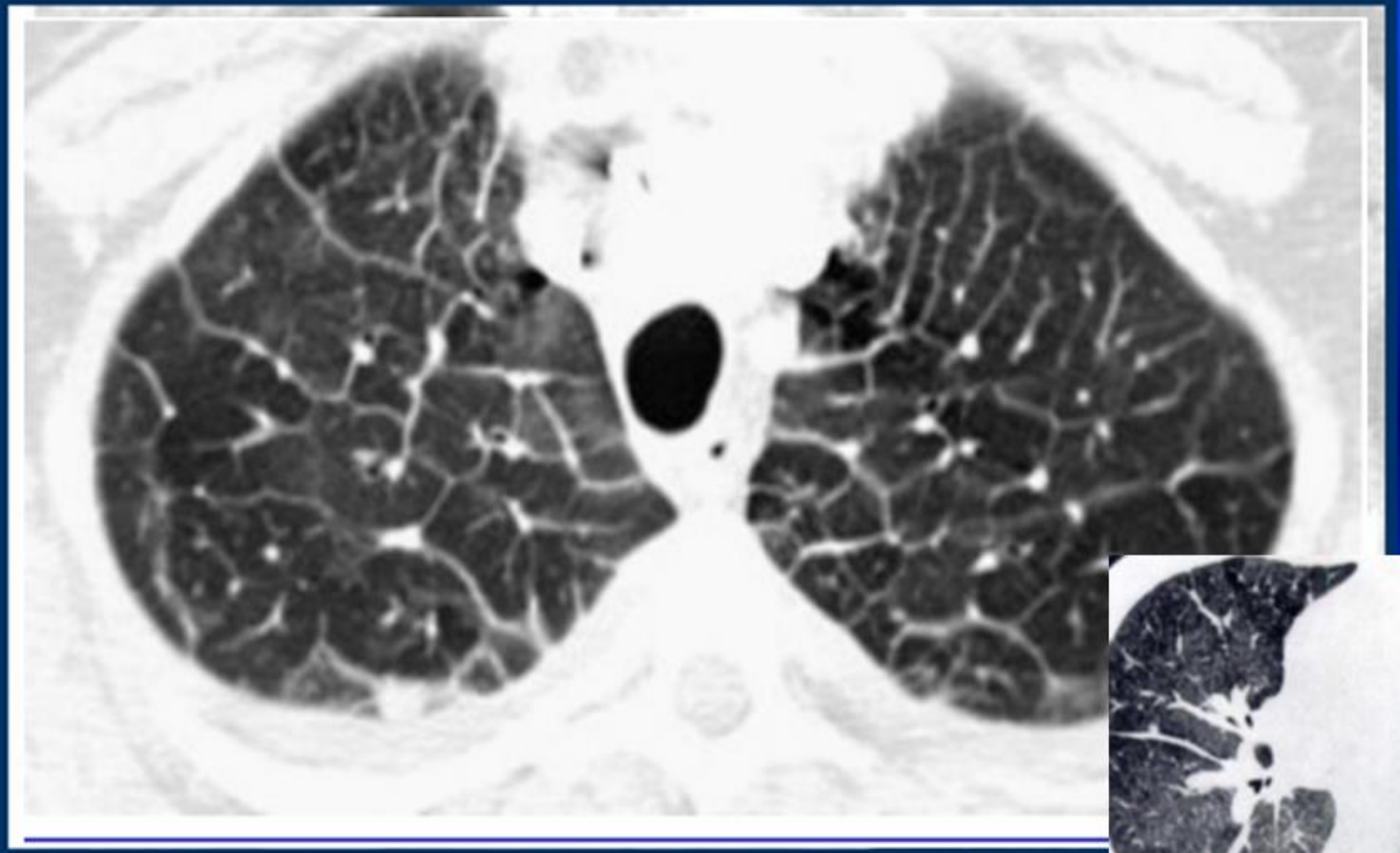
Lymphangitic spread of carcinoma
Interstitial pulmonary edema (heart failure)
Alveolar proteinosis

Nodular or irregular

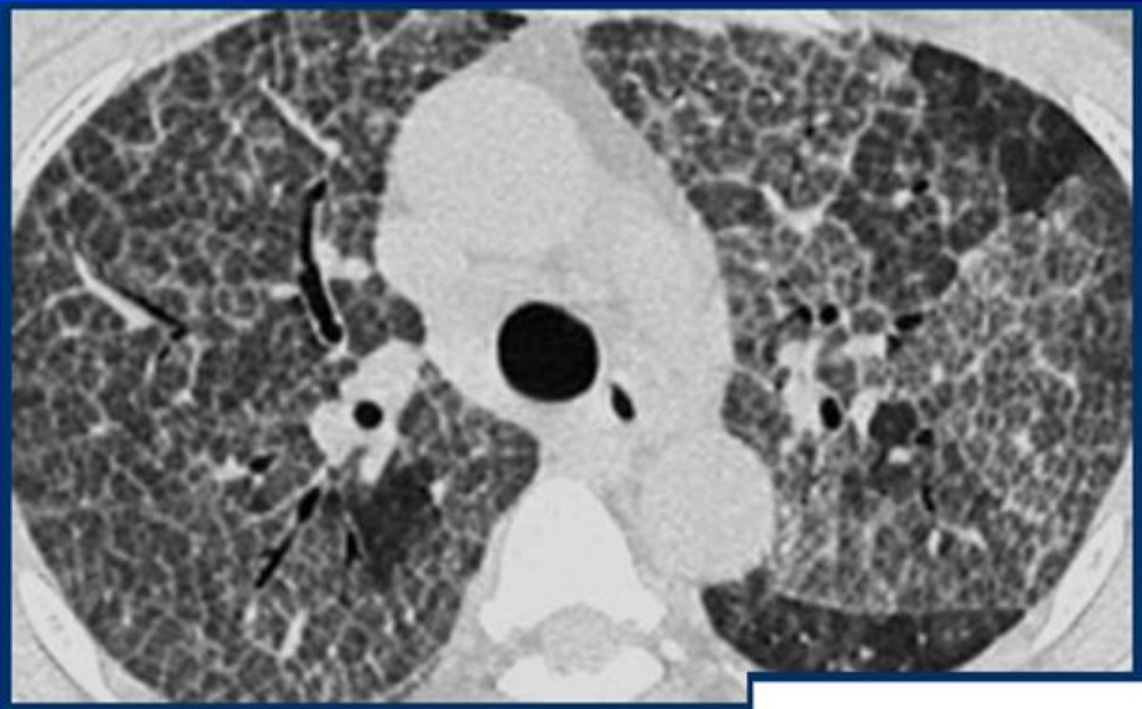
Lymphangitic spread of carcinoma
Lymphoma
Sarcoidosis
Silicosis

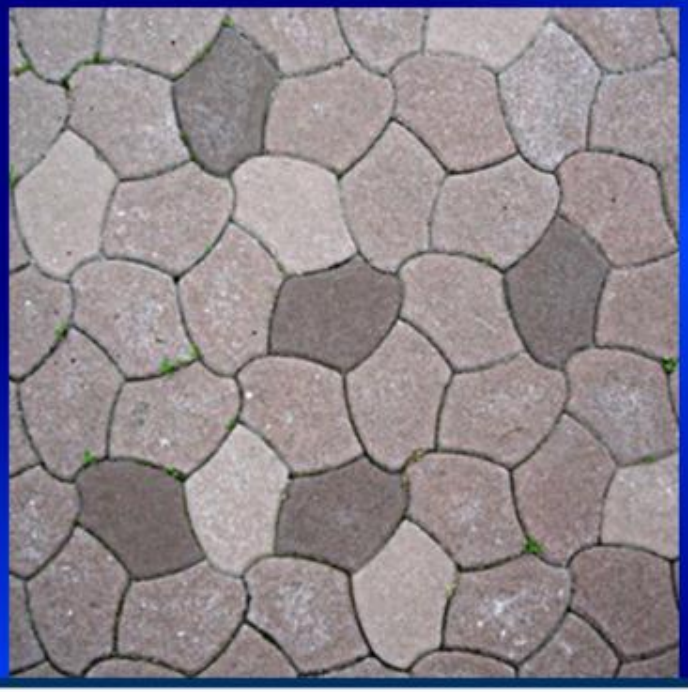
Cardiogenic pulmonary edema generally results in a combination of septal thickening and ground-glass opacity.

There is a tendency for hydrostatic edema to show a perihilar and gravitational distribution.



Septal thickening and ground-glass opacity with a gravitational distribution cardiogenic pulmonary edema.





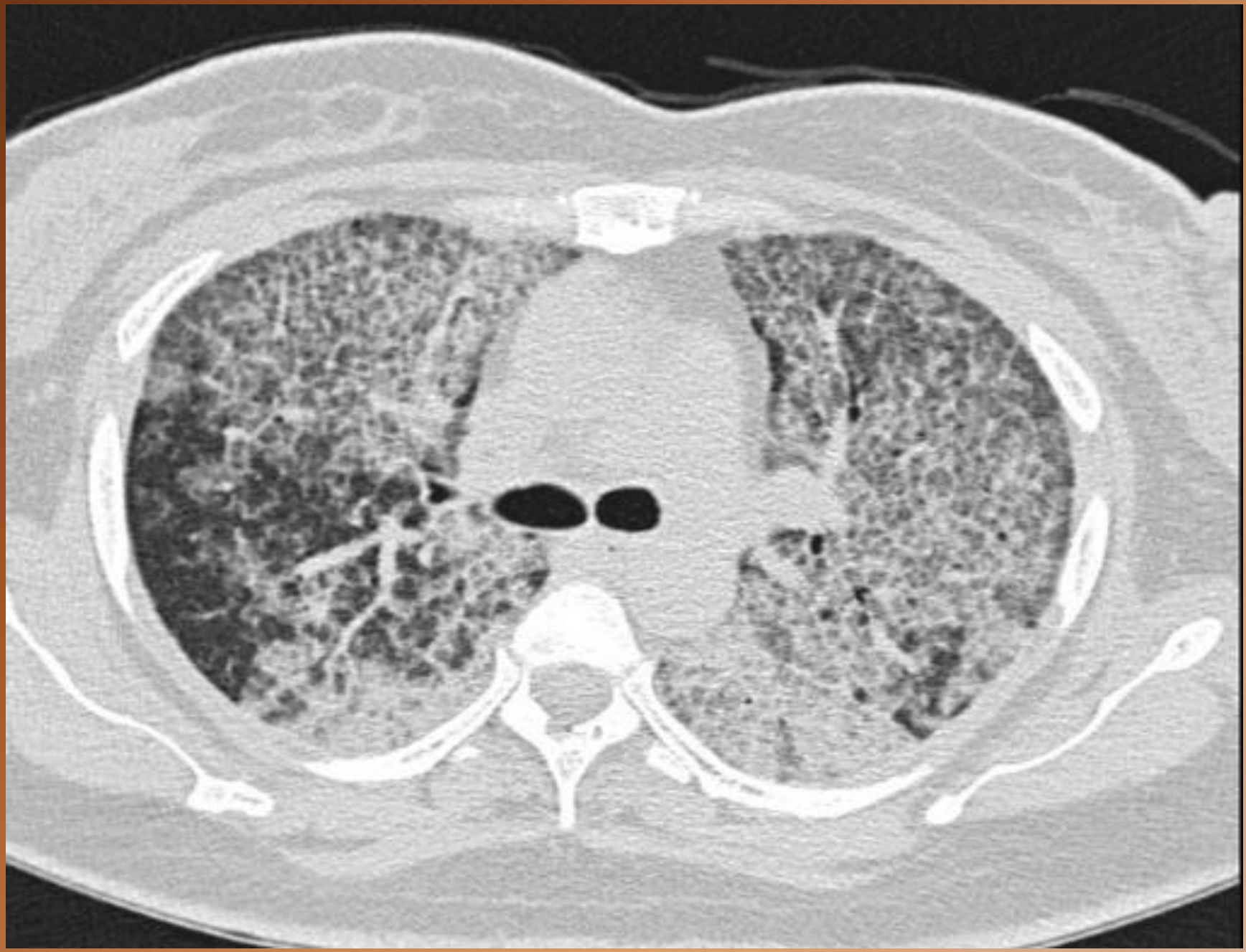


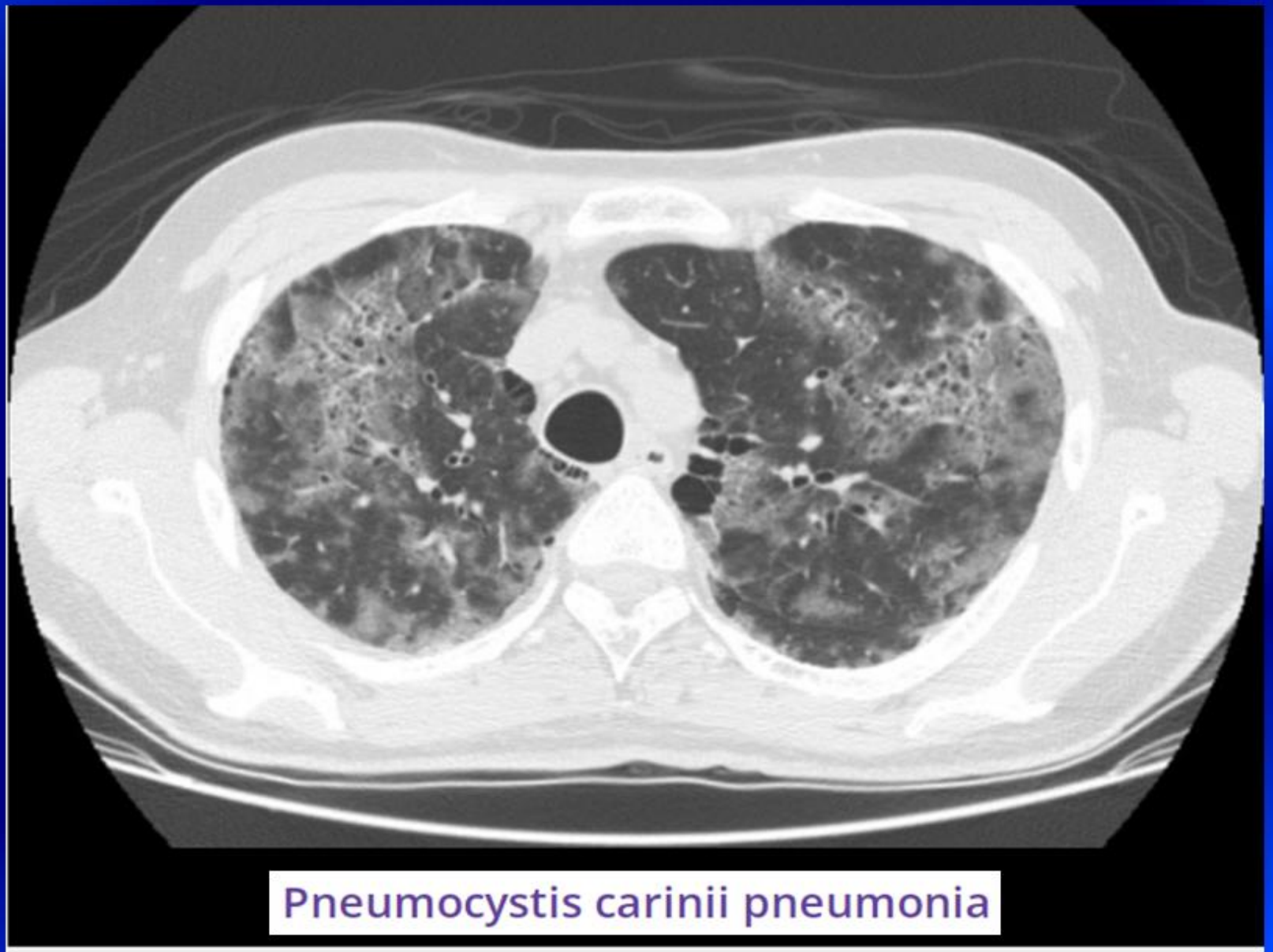
Crazy Paving

Crazy Paving is a combination of ground glass opacity with superimposed septal thickening (5).
It was first thought to be specific for alveolar proteinosis, but later was also seen in other diseases.

Crazy Pavin can also be seen in:

- Alveolar proteinosis
- Sarcoid
- NSIP
- Organizing pneumonia (COP/BOOP)
- Infection (PCP, viral, Mycoplasma, bacterial)
- Neoplasm (Bronchoalveolarca (BAC)
- Pulmonary hemorrhage
- Edema (heart failure, ARDS, AIP)





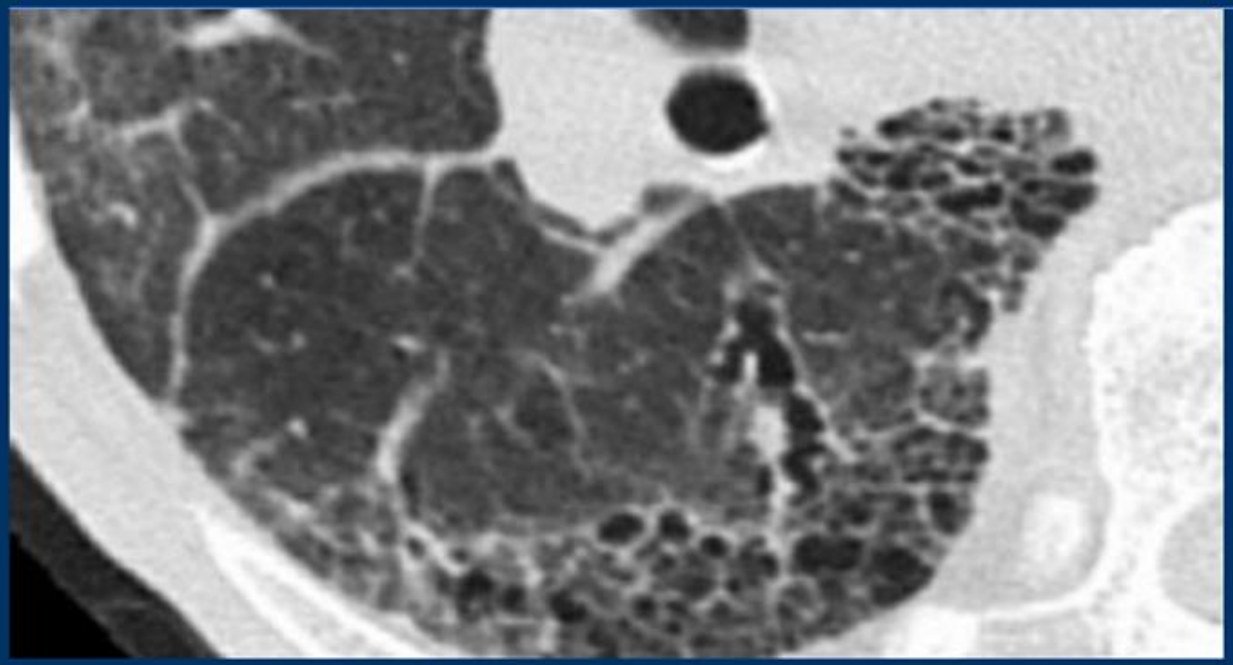
Pneumocystis carinii pneumonia

There are patches of ground-glass opacities with cystic lesions, reticulation, and septal thickening.

Honeycombing

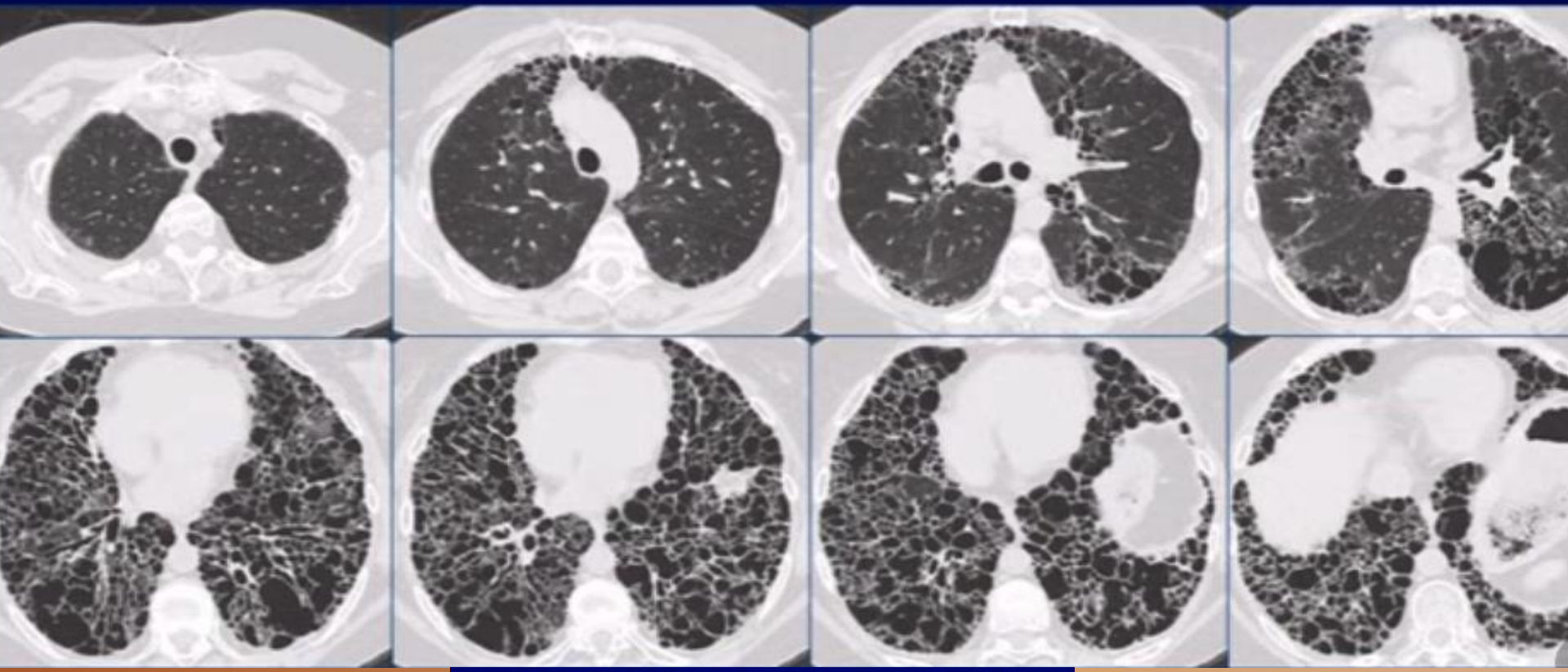
Honeycombing constitutes the second recognizable reticular pattern on HRCT.
Due to its cystic appearance, honeycombing is also addressed in the context of low-attenuation patterns.

Pathologically, honeycombing is characterized by the presence of small cystic spaces lined by bronchiolar epithelium, with walls composed of dense fibrous tissue.
It is the hallmark feature of usual interstitial pneumonia (UIP).



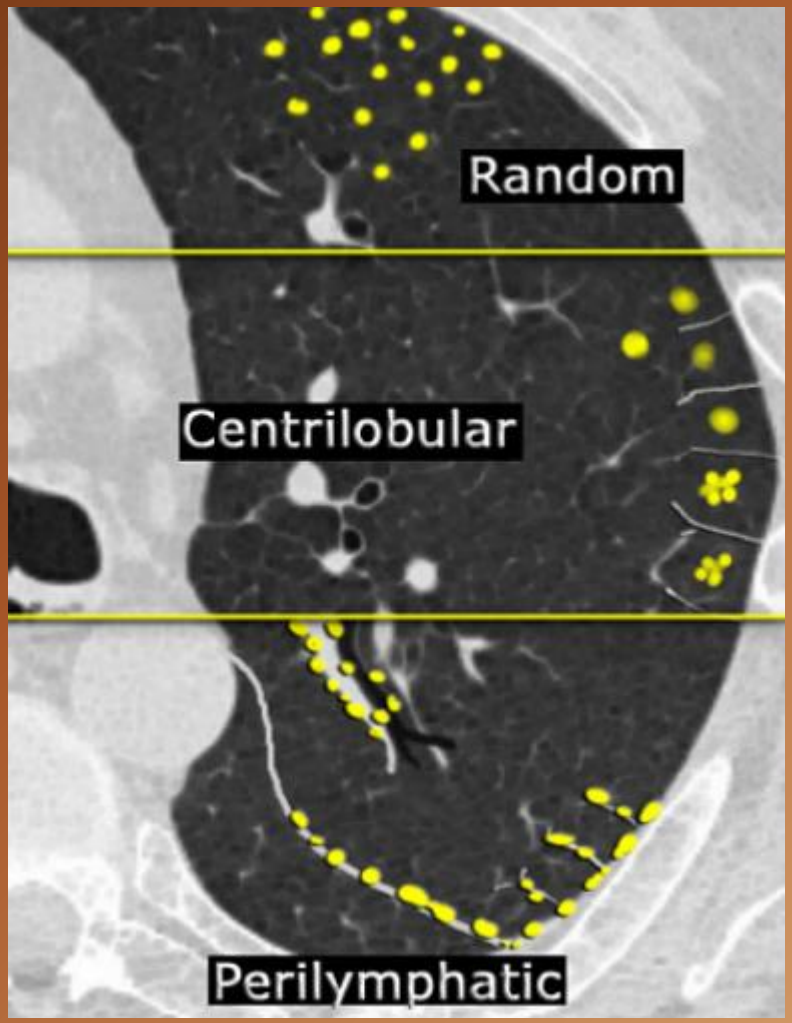
Honeycombing in a patient with UIP

Idiopathic Pulmonary Fibrosis (IPF)



- CT Features
  - Peripheral reticulation (+++)
  - Honeycombing (+++)
  - Ground glass (+)
  - Consolidation (+)
  - Lower lobe predominance (+++)

Nodular pattern

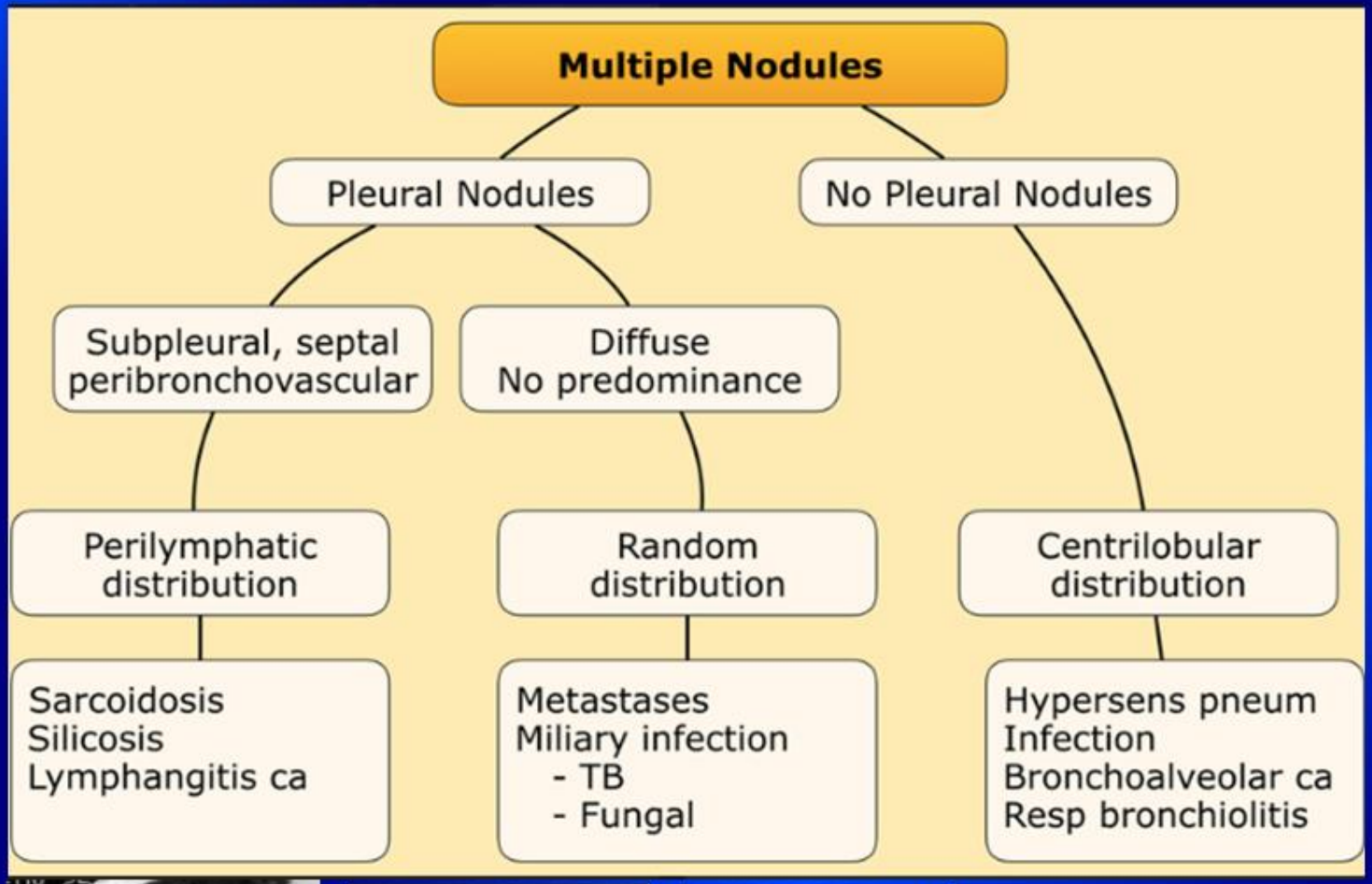


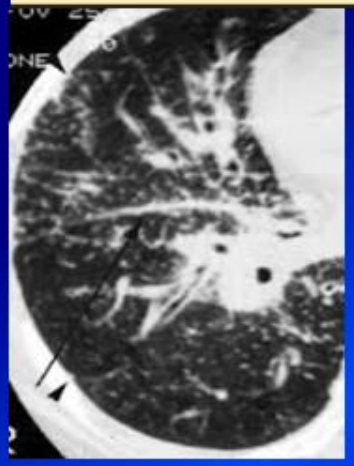
The distribution of nodules shown on HRCT is the most important factor in making an accurate diagnosis in the nodular pattern.
In most cases small nodules can be placed into one of three categories: perilymphatic, centrilobular or random distribution.
Random refers to no preference for a specific location in the secondary lobule.

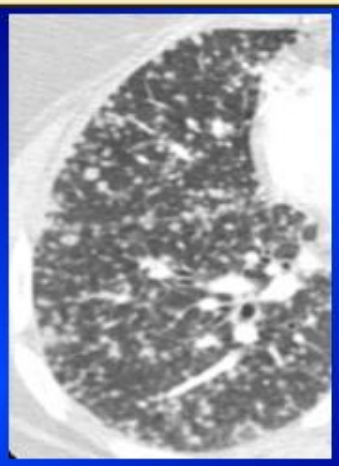
Perilymphatic distribution
In patients with a perilymphatic distribution, nodules are seen in relation to pleural surfaces, interlobular septa and the peribronchovascular interstitium.
Nodules are almost always visible in a subpleural location, particularly in relation to the fissures.

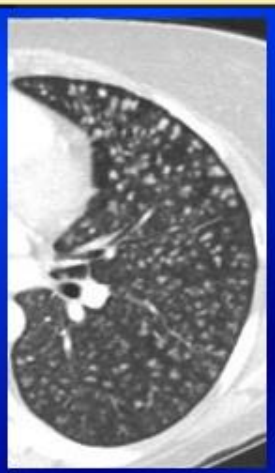
Centrilobular distribution
In certain diseases, nodules are limited to the centrilobular region.
Unlike perilymphatic and random nodules, centrilobular nodules spare the pleural surfaces.
The most peripheral nodules are centered 5-10mm from fissures or the pleural surface.

Random distribution
Nodules are randomly distributed relative to structures of the lung and secondary lobule.
Nodules can usually be seen to involve the pleural surfaces and fissures, but lack the subpleural predominance often seen in patients with a perilymphatic distribution.







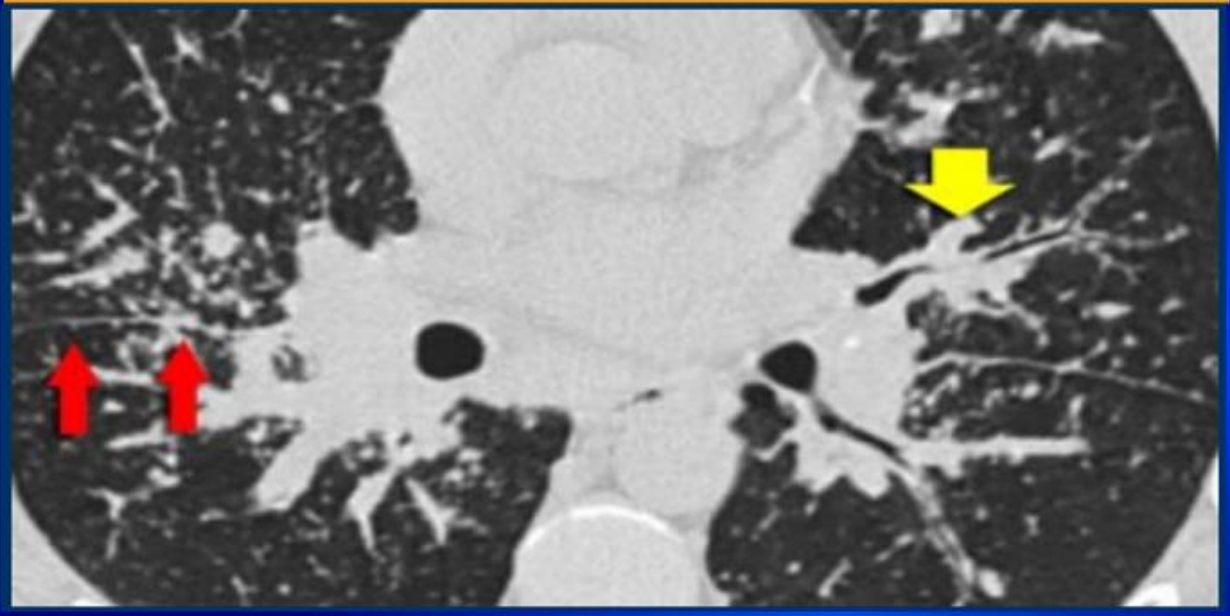


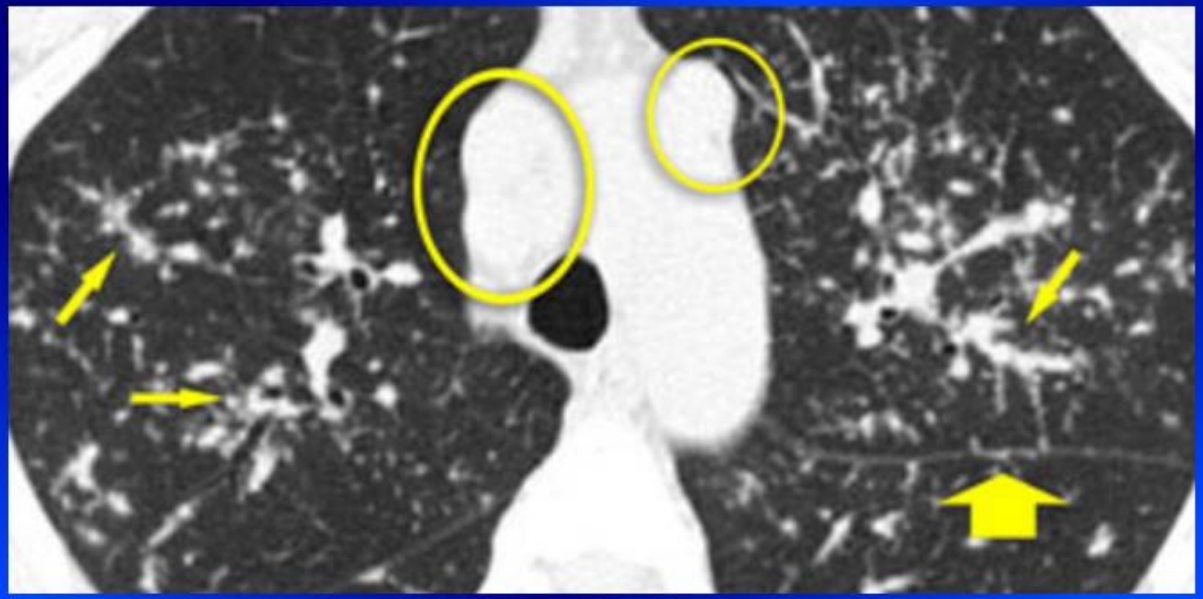
Algorithm for nodular pattern

The algorithm to distinguish perilymphatic, random and centrilobular nodules is the following:

- Look for the presence of pleural nodules.
  These are often easiest to see along the fissures.
  If pleural nodules are absent or few in number, the distribution is likely centrilobular.
- If pleural nodules are visible, the pattern is either random (miliary) or perilymphatic.
- If there are pleural nodules and also nodules along the central bronchovascular interstitium and along interlobular septa, you are dealing with a periplymphatic distribution.
- If the nodules are diffuse and uniformly distributed, it is likely a random distribution.

Perilymphatic nodules



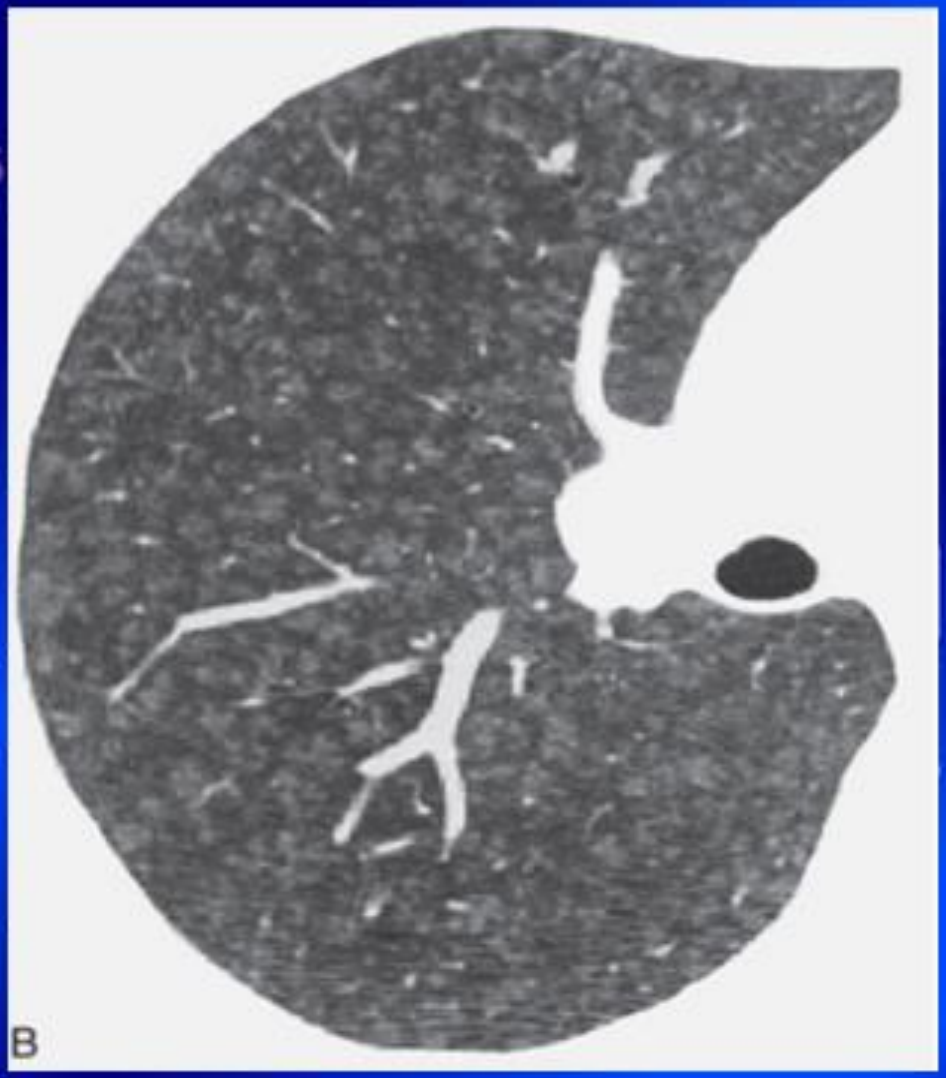


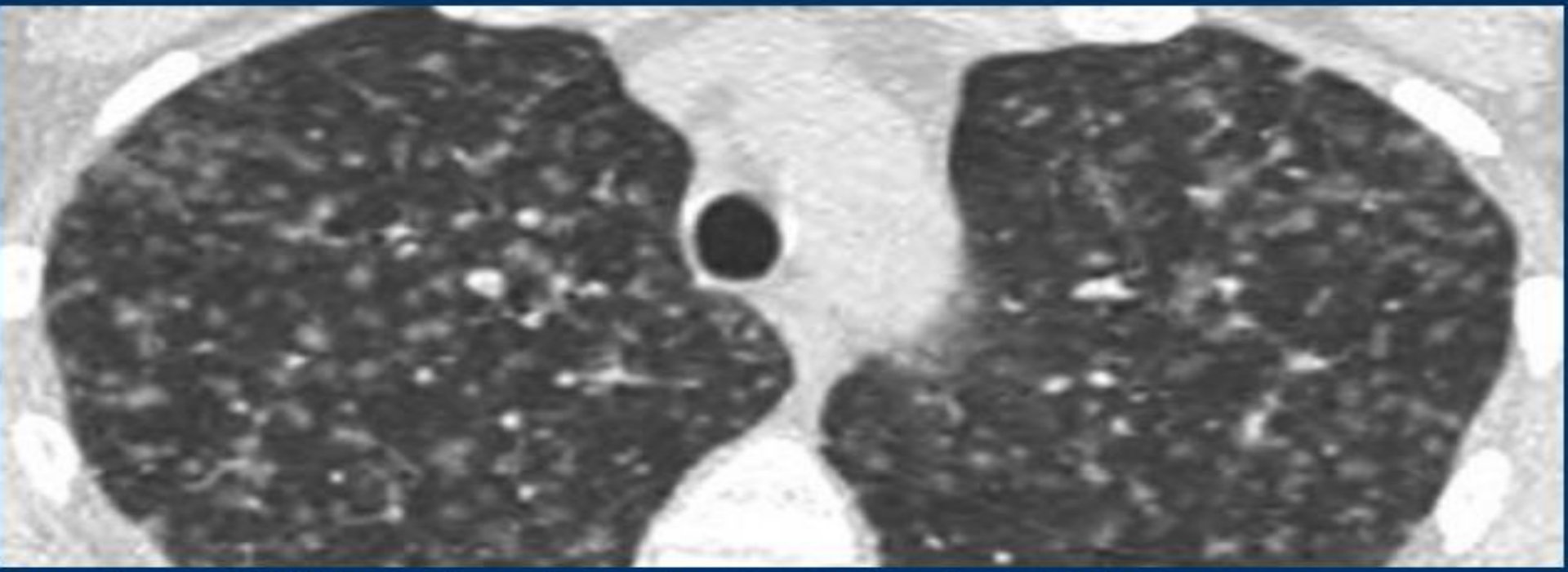
Centrilobular distribution



Findings include:

- centrilobular ground glass nodules with an upper and mid zone predominance

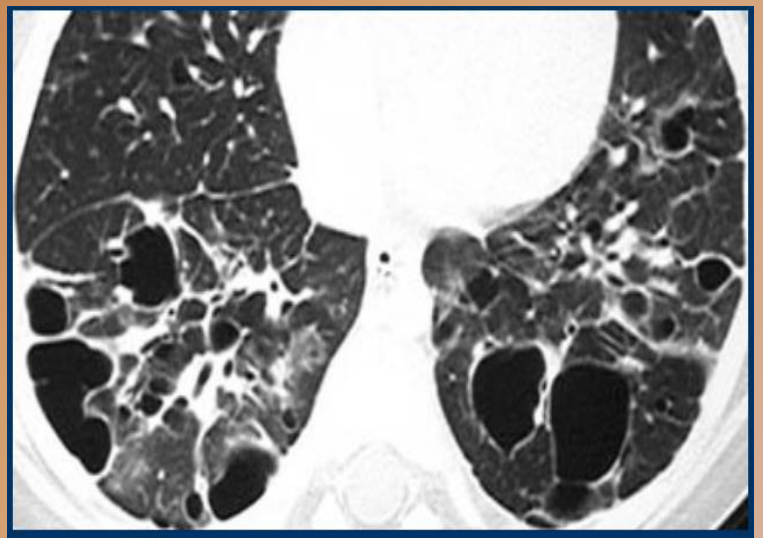




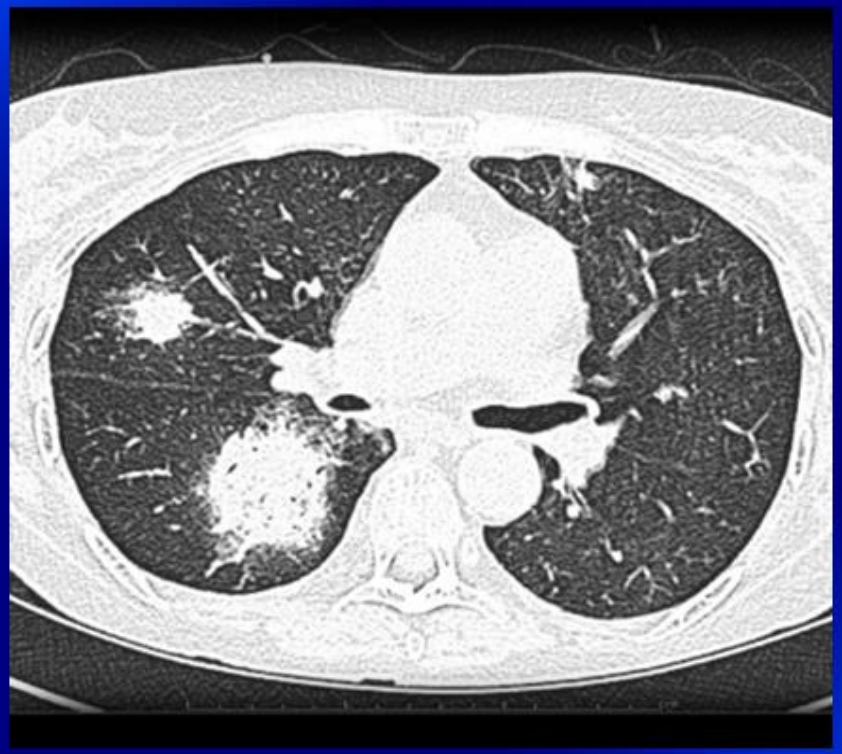
Langerhans cell histiocytosis: early nodular stage before the typical cysts appear.

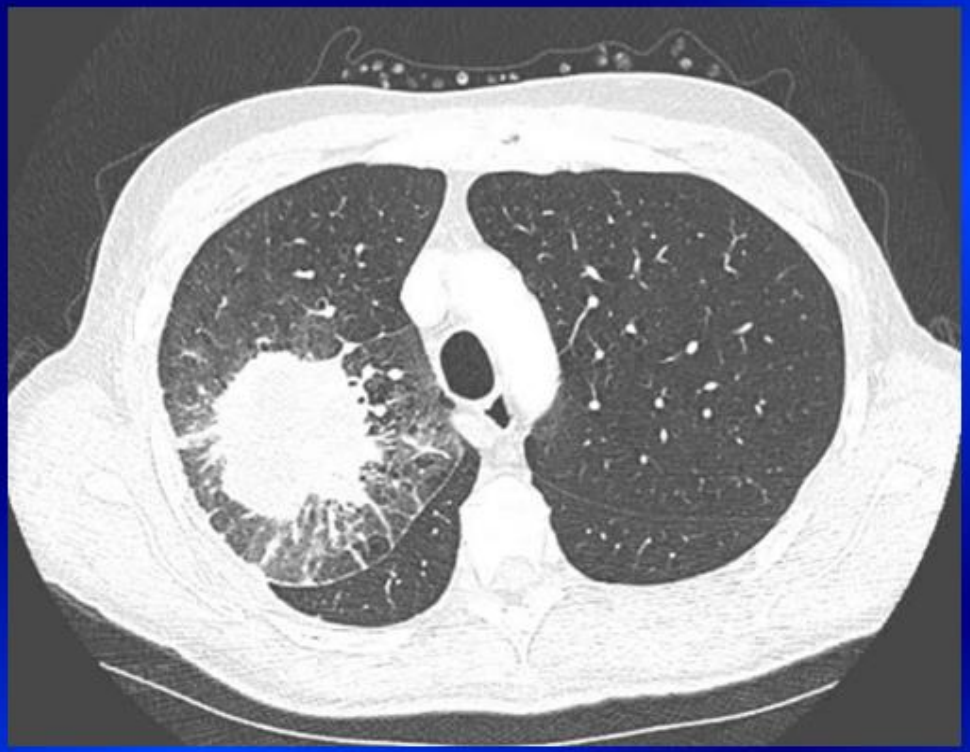
Here a typical random nodular pattern in a patient with Langerhans cell histiocytosis (LCH).
LCH is an uncommon disease characterised by multiple irregular cysts in patients with nicotine abuse.

LCH in the early phase is a nodular disease (figure).
These nodules eventually cavitate and become cysts.
As in all smoking related diseases, there is an upper lobe predominance.



Langerhans cell histiocytosis



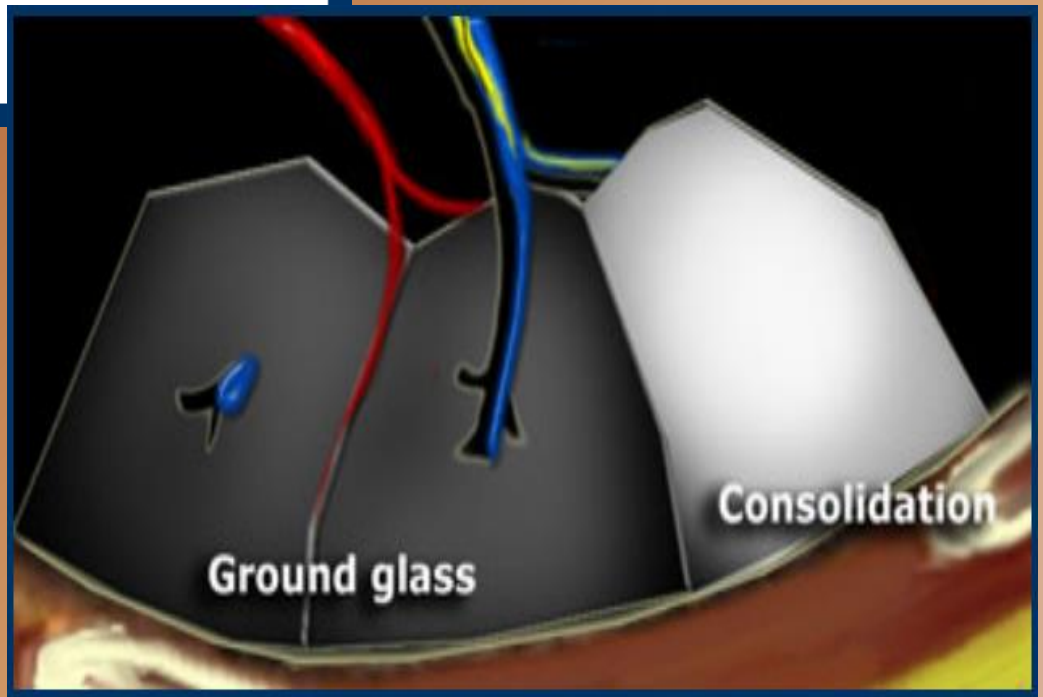


Halo sign consisting of ground glass – opacity surrounding a pulmonary nodule, mass, or consolidation. It is typically seen in invasive aspergillosis.

High Attenuation pattern

Increased lung attenuation is called ground-glass-opacity (GGO) if there is a hazy increase in lung opacity without obscuration of underlying vessels and is called consolidation if the increase in lung opacity obscures the vessels.

In both ground glass and consolidation the increase in lung density is the result of replacement of air in the alveoli by fluid, cells or fibrosis.
In GGO the density of the intrabronchial air appears darker as the air in the surrounding alveoli.
This is called the *dark bronchussign*
In consolidation, there is exclusively air left in the bronchi.
This is called the *air bronchogram*.



Dark bronchus sign in ground glass opacity. Complete obscuration of vessels in consolidation.

Ground Glass Opacity

Acute

Pulmonary edema
- Heart failure
- ARDS

Pulmonary hemorrhage

Pneumonia
- PCP
- Mycoplasma
- Viral

Acute Eosinoph pneumonia
Acute Hypersensitivity

Chronic

Hypersensitivity pneumonitis
Organizing pneumonia
Chron Eosinoph. pneumonia
Alveolar proteinosis

Lung fibrosis
- UIP
- NSIP

Bronchoalveolar carcinoma

Ground-glass opacity

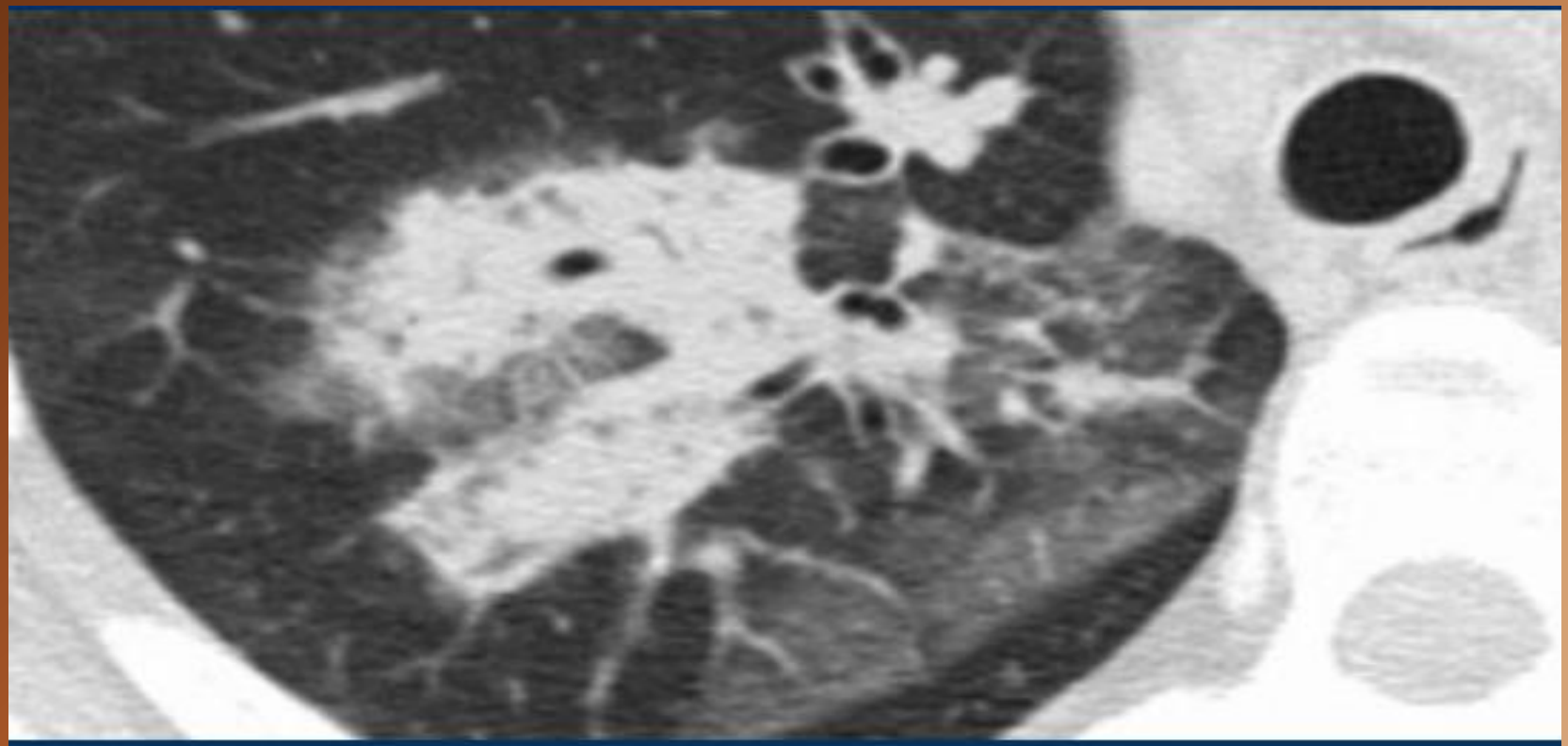
Ground-glass opacity (GGO) represents:

- Filling of the alveolar spaces with pus, edema, hemorrhage, inflammation or tumor cells.
- Thickening of the interstitium or alveolar walls below the spatial resolution of the HRCT as seen in fibrosis.

So ground-glass opacification may either be the result of air space disease (filling of the alveoli) or interstitial lung disease (i.e. fibrosis).

The location of the abnormalities in ground glass pattern can be helpfull:

- Upper zone predominance: Respiratory bronchiolitis, Pneumocystis pneumonia.
- Lower zone predominance: UIP, NSIP, DIP.
- Centrilobular distribution: Hypersensitivity pneumonitis, Respiratory bronchiolitis



Broncho-alveolar cell carcinoma with ground-glass opacity and consolidation

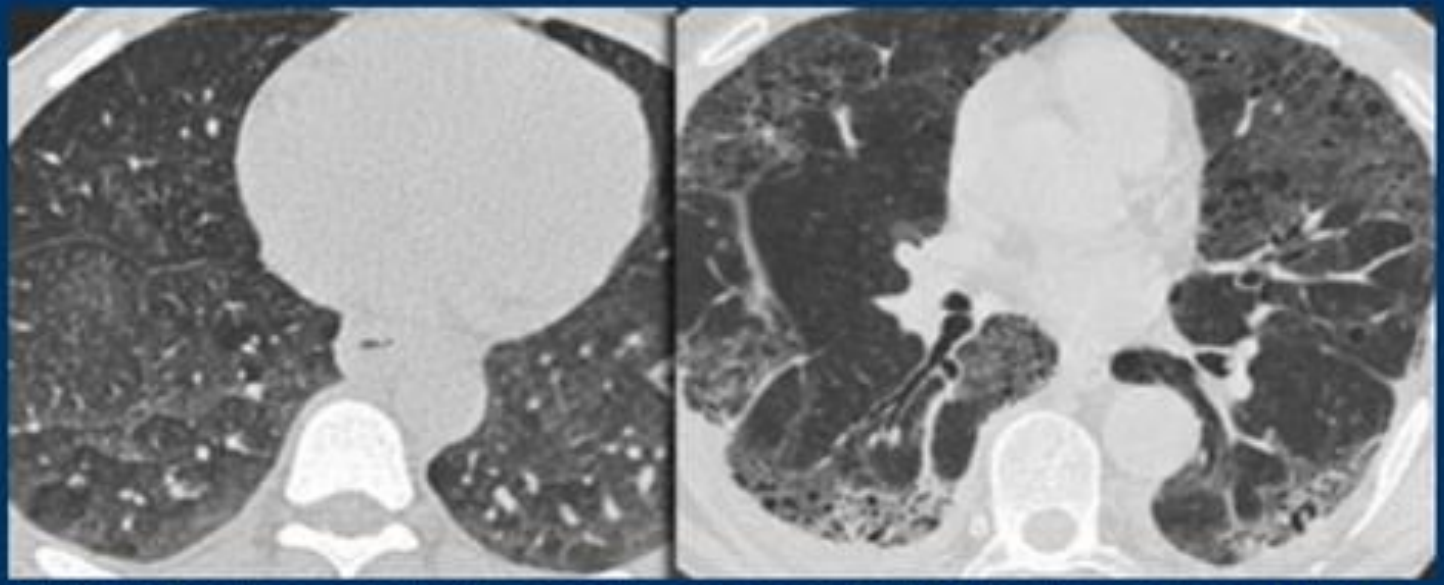
In the image on the left, **consolidation and GGO** are observed in a patient with persistent chest abnormalities and weight loss, without signs of infection. This presentation suggested a chronic disease.
The absence of honeycombing or traction bronchiectasis ruled out fibrosis, while the weight loss raised suspicion for malignancy.
Histology confirmed bronchioloalveolar cell carcinoma (BAC).

Treatable or not treatable?

While GGO is nonspecific, it is a highly significant finding: 60–80% of patients with GGO on HRCT have an active and potentially treatable lung disease.
In the remaining 20–40% of cases, the GGO reflects fibrosis, and the disease is not treatable.
In these cases, associated HRCT findings of fibrosis, such as **t**raction bronchiectasis and honeycombing, are typically present.

Example

The images show two cases with GGO: one without fibrosis (potentially treatable) and another with traction bronchiectasis (indicating fibrosis).



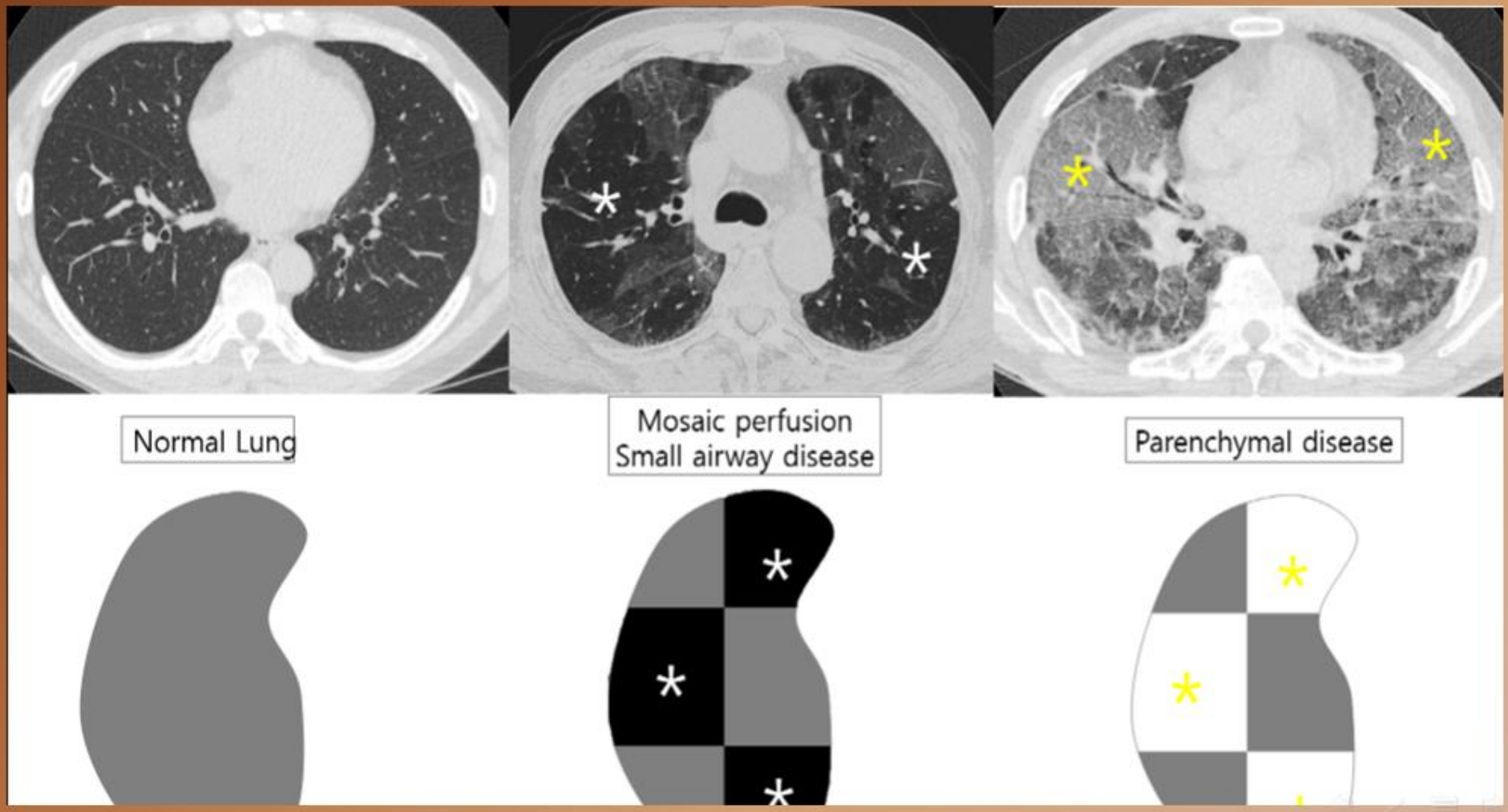
LEFT: No fibrosis, so potentially treatable lung disease. RIGHT: Fibrosis, so no treatable lung disease.

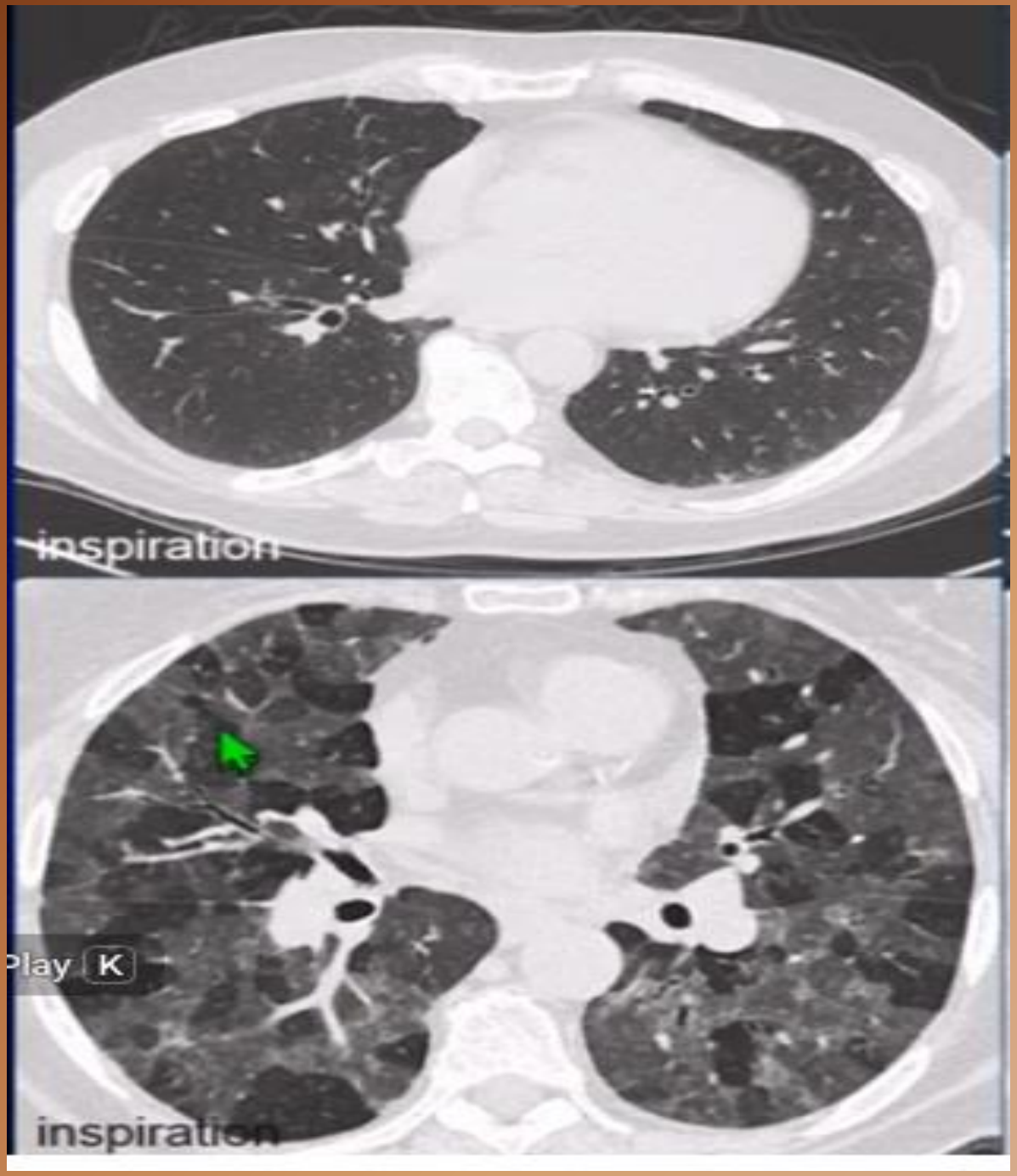
Mosaic attenuation

The term **mosaic attenuation** describes density differences between affected and unaffected lung regions, resulting in a patchy appearance of black and white lung areas. The radiologist's role is to determine which component—the black or the white lung—is abnormal.

Mosaic Attenuation

Asthma
Bronchiolitis Obliterans
Hypersensitivity Pneumonitis
Pulmonary Embolism

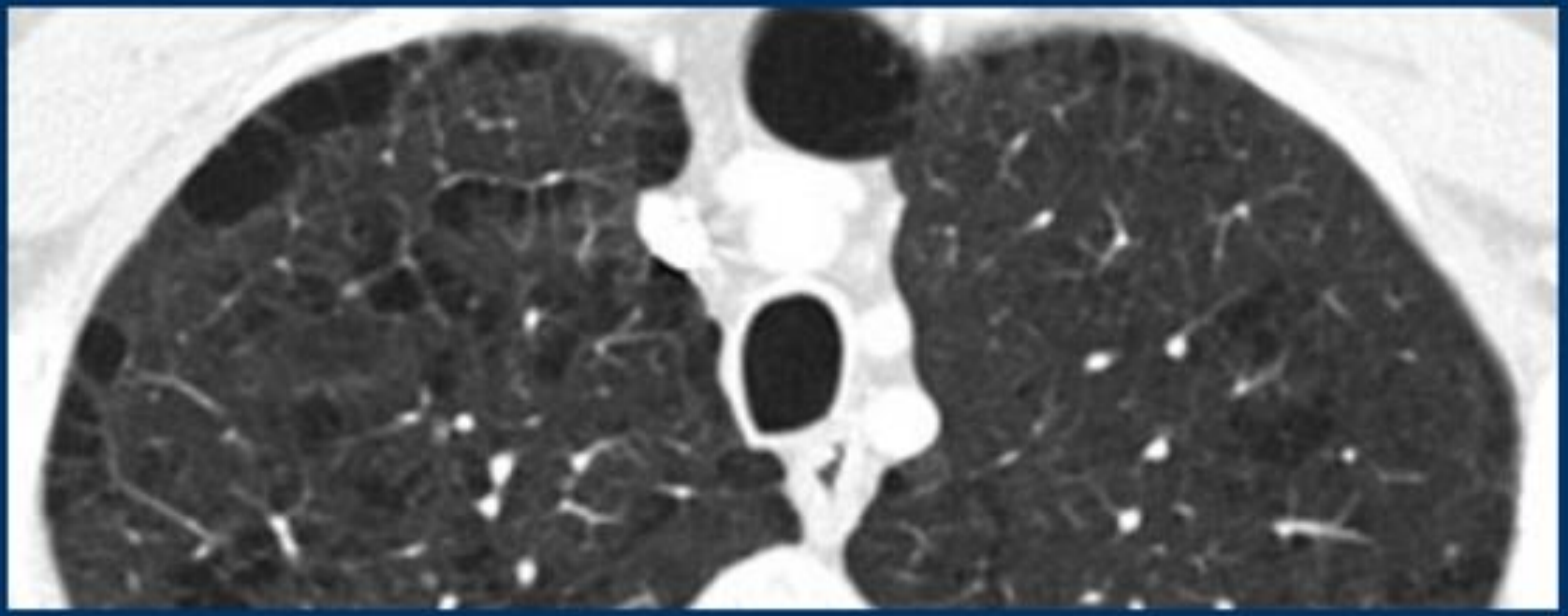



inspiration
Play K
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Low Attenuation pattern

The fourth pattern includes abnormalities that result in decreased lung attenuation or air-filled lesions.
These include:

- Emphysema
- Lung cysts (LAM, LIP, Langerhans cell histiocytosis)
- Bronchiectasis
- Honeycombing



Paraseptal emphysema with small bullae

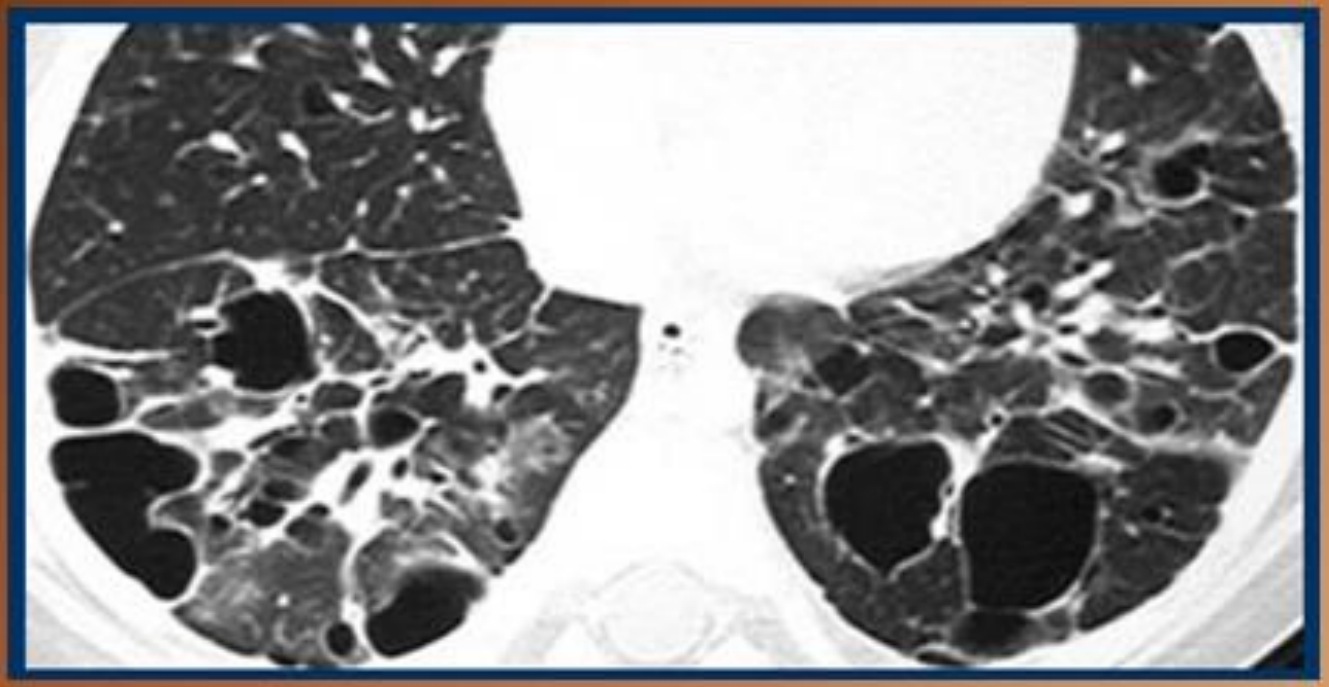
Cystic lung disease

Lung cysts are defined as radiolucent areas with a wall thickness of less than 4mm.
Cystic lung diseases as listed in the table on the left.

Cavities are defined as radiolucent areas with a wall thickness of more than 4mm and are seen in infection (TB, Staph, fungal, hydatid), septic emboli, squamous cell carcinoma and Wegener's disease.

Cystic lung disease

Langerhans cell Histiocytosis
Lymphangioleiomyomatosis
Pneumatoceles (PCP)
Lymphocytic interstitial pneumonia
Honeycombing



Langerhans cell histiocytosis (LCH) is an idiopathic disease characterized in its early stages by granulomatous nodules containing Langerhans histiocytes and eosinophils.

In its later stages, the granulomas are replaced by fibrosis and the formation of cysts.

It is an uncommon condition.

The majority of patients are young or middle-aged adults presenting with non-specific symptoms of cough and dyspnea. Up to 20% of patients present with pneumothorax and over 90% of patients are smokers.

Most cysts appear round, but can also have bizarre shapes (bilobed or clover-leaf shaped).

An upper lobe predominance in the size and number of cysts is common.

Bronchiectasis

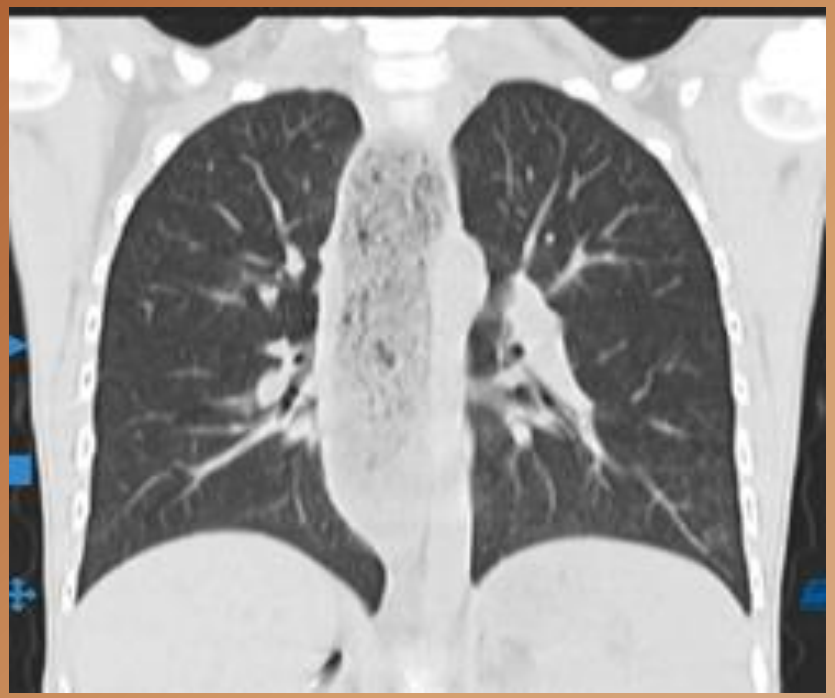













THANKS A LOT

#دکترپورمیرزایی
https://www.aparat.com/v/frpalxa

آپارات

Impulse Oscillometry (IOS)

t.me/pediatricmedicine
Link

The precise measurements of the flow signal generated by the impulse (V'_j) and the resulting pressure response of the lung-thorax system (P_j) directly at the patient's mouth represent the **respiratory impedance Z_{rs}**. It can be considered as primary parameter.

$$Z_{rs} = \frac{P_j}{V'_j} = R_{rs} + j \cdot X_{rs}$$

The clinical interpretation of the measurements is usually based on the two components of respiratory impedance Z_{rs}, **respiratory resistance R_{rs}** and **lung reactance X_{rs}**. In a normal lung, R_{rs} represents the equivalent of the flow resistance in the (large) central airways, whereas X_{rs} represents the small, peripheral airways in addition to the retraction capacity of the lungs. See Fig. 2.



Fig. 1
Performing an oscillometric measurement. To avoid loss of pressure, the palms of the hands should stabilize the cheeks.

ایمپالس اوسیلومتری (IOS) و نقش آن در ارزیابی عملکرد ریه

#دکتربورمیرزایی

عملیات ذخیره دیدگاه‌ها اشتراک