Metaphorical Signs in Computed Tomography of Chest

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Conflict of Interest

- None!

Medical Crime of the Century?

Murder of the Chest X-ray

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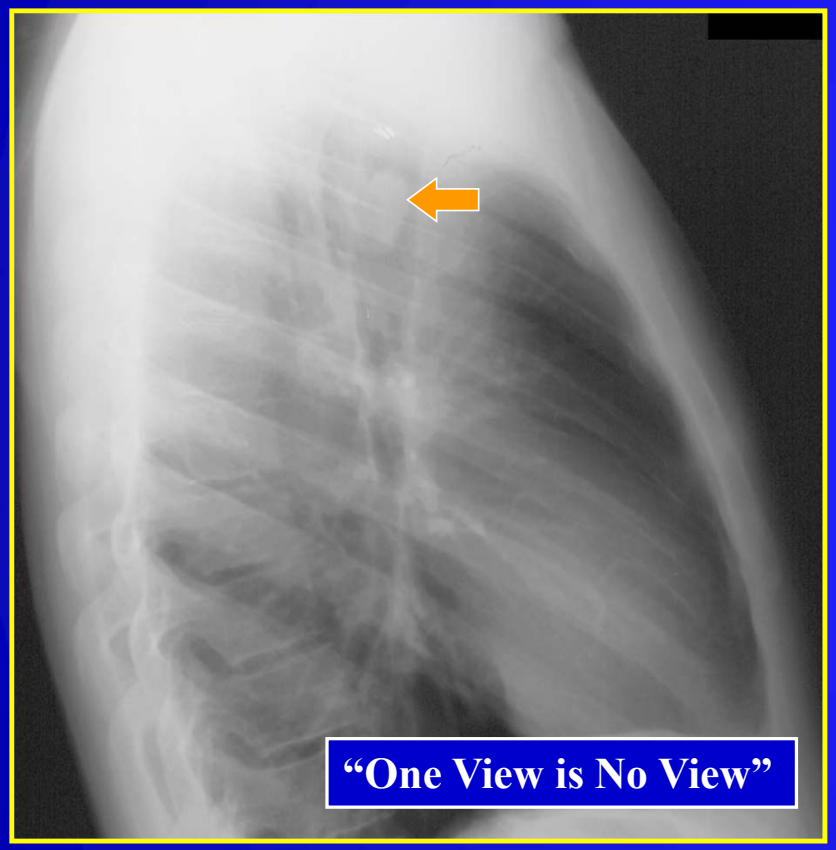
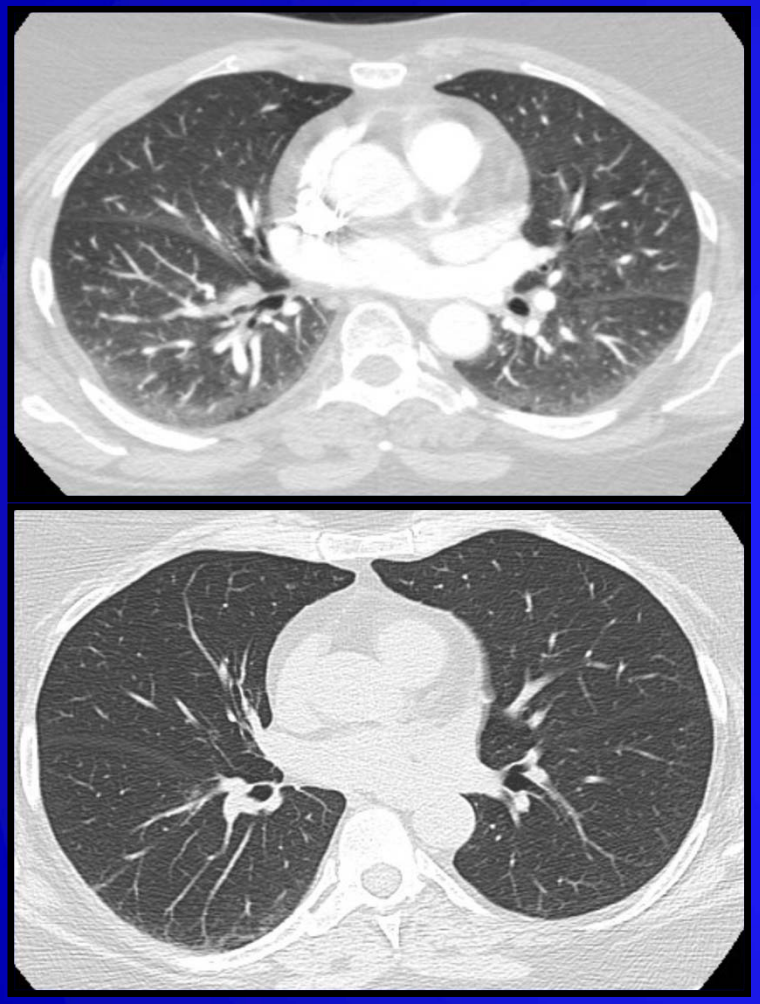
Me(h)taphoric CT Signs



- "Chest X-Ray has poor sensitivity."
  - *A Radiologist*

  "Whose sensitivity are we talking about?"
  - *A Pulmonologist*
- "One view is no view!"
- "Normal HRCT" is an oxymoron
- CT Chest:
  - Most Common Indication: "IMSS"
  - Three CT angios in 1 week!
  - 13 CTs in 3 months!
  - Chest CT Q Monday!
  - CT to confirm position of a chest tube!
- Loss of analytical approach!!
  - "Digital watch syndrome"



GGOs on CT Angio

CT Begets CT

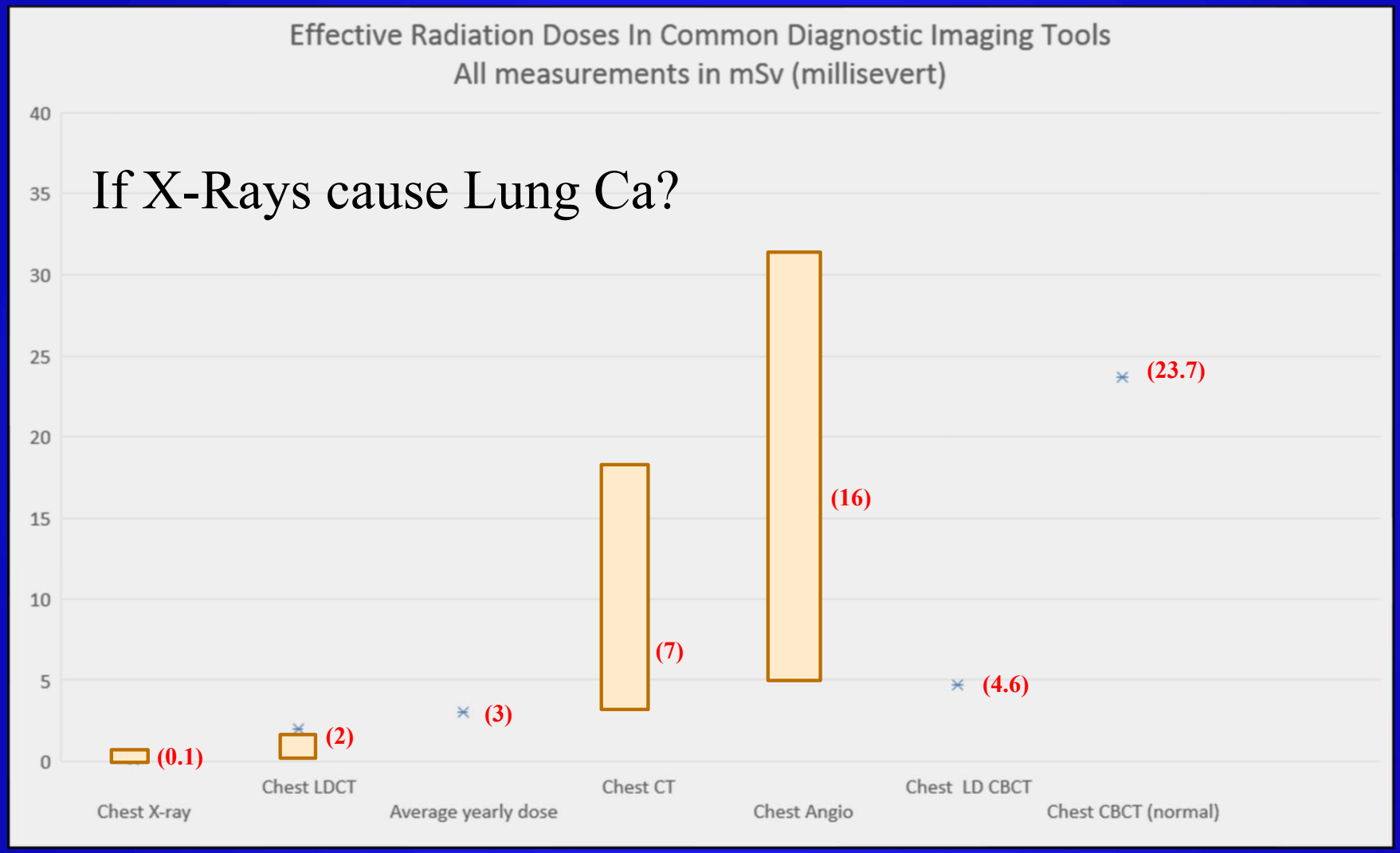
- CT Angio → GGO → CT to R/O ILD
- CT with ? Fluid → Prone CT
- CT with mosaicism → Expiratory CT
- Abdominal CT → Full chest CT
- Nodule on a CT → CT with EMN protocol
- TBM or EDAC: Dynamic CT
- Screening CT for Lung Ca → F/U CT

Oxqj#Fdqfhu#Vfuhhqlqj=#Surmhfwhg#p sdfw

- LDCT approved for lung ca screening in high risk US population
  - Ages 55–77
  - No signs or symptoms of lung ca
  - 30 pack-year smoking history
  - Current smoker
  - Former smoker who quit in the last 15 years
- By 2020, low-dose CT screening is projected to result in*:
  - 10.7 million more LDCT
  - 52,000 – 76,000 more lung ca detected

Decision Memo for Screening for Lung Ca with LDCT (CAG-00439N) Feb. 15 2015
Roth JA . Projected Clinical, Resource Use, and Fiscal Impacts of Implementing LDCT Lung Ca Screening in Medicare, J Oncol Practice2015 Jul;11(4):267-72. doi: 10.1200/JOP.2014.002600. Epub 2015 May 5 *

If X-Rays cause Lung Ca?

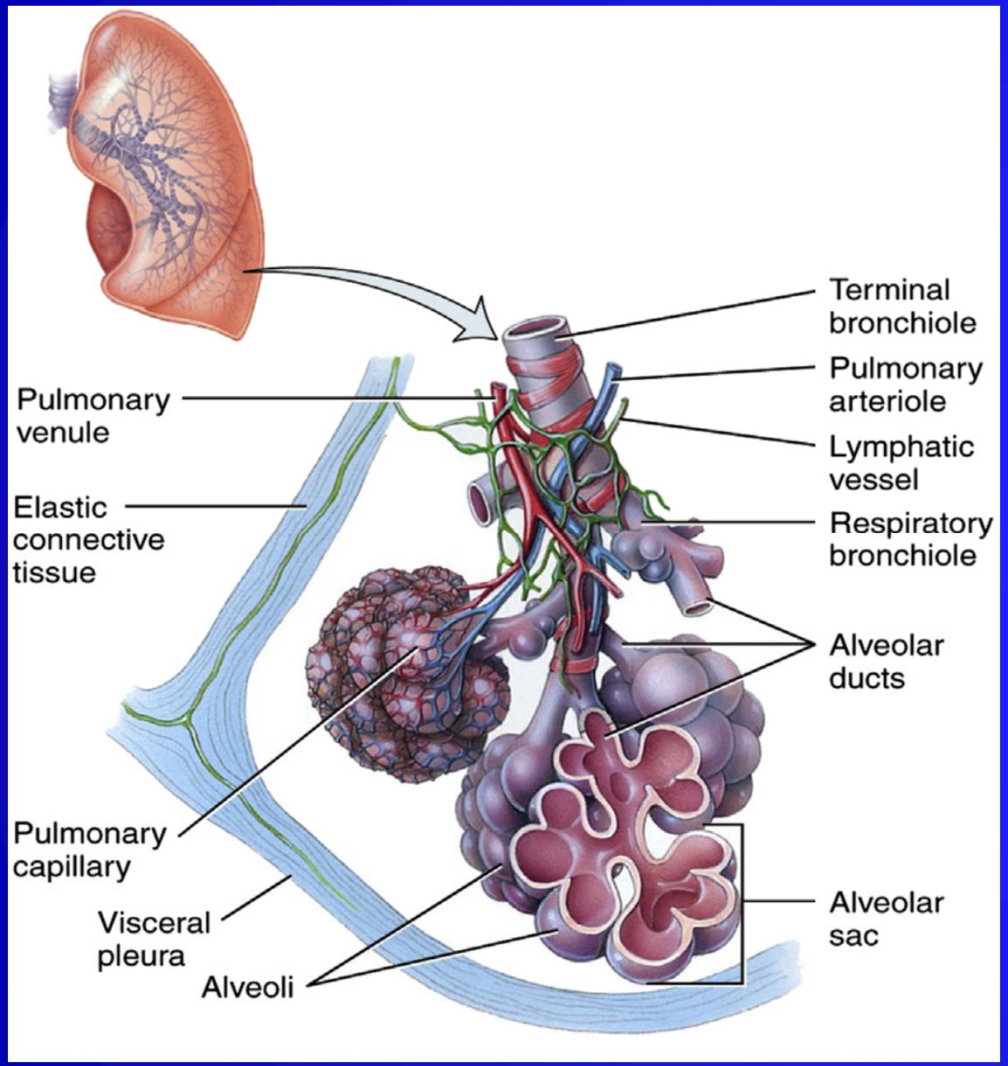


Metaphoric CT Signs in Chest Imaging

Crop formations?

Important to recognize:

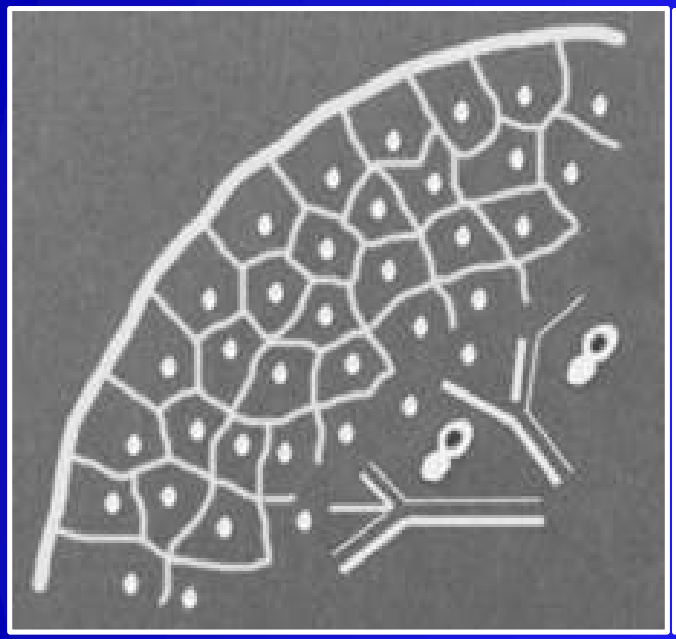
- Several are unique to CT
- Shortens list of differential
- With clinical data, further narrows in on the Dx
- Could be pathognomonic
- Uniformity of reporting
- Types:
  - Parenchymal
  - Airway
  - Vascular
  - Pleural-based

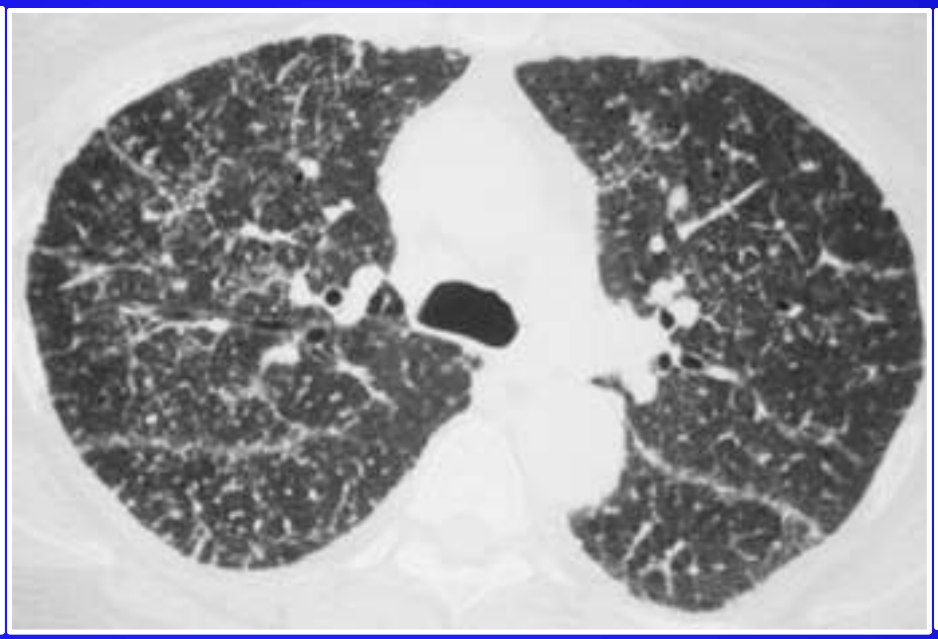


Lobule of the Lung

- Fundamental unit at the sub-segmental level
- ~ Polyhedral in shape
- Largest dimension: 1.0 -1.25 cm
- 12 Pulmonary acini
- Centrilobular structure:
  - Terminal bronchiole
  - Pulmonary arteriole
  - Central lymphatics
- Interlobular septum:
  - Pulmonary vein
  - Lymph channels

Components of Lung Lobule





- Lobular parenchyma,
- Centrilobular structure
- Interlobular septum

Air Crescent Sign

- Crescentic or circumferential rim of radiolucent airspace within a parenchymal consolidation or a nodular opacity
- Differential Dx:
  - Invasive aspergillosis
  - TB
  - Hydatid cyst
  - Abscess
  - Bronchogenic Ca
  - Pnemocystis Jirovecii Pneumonia

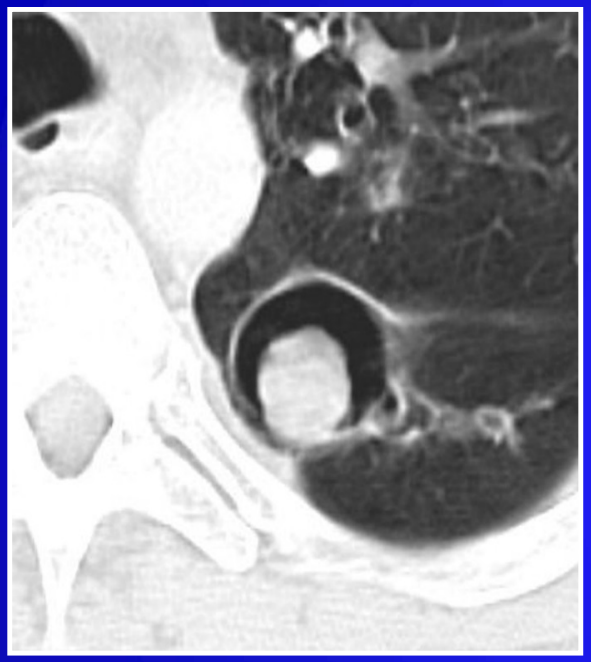
Air Crescent Sign

Invasive Aspergillosis:

- Fungal hyphae leading to vasculature invasion → Thrombosis → Infarction → Necrosis
- Crescent formation: Separation of devitalized necrotic center from the surrounding opaque rim of hemorrhagic tissue
- Recovery phase of the disease
- Favorable prognosis [67% vs 8% survival in leukemia]

Gefter W, et al. Invasive pulmonary aspergillosis and acute leukemia. Limitations in the diagnostic utility of the air crescent sign. Radiology. 1985;157(3):605-610

Monod Sign

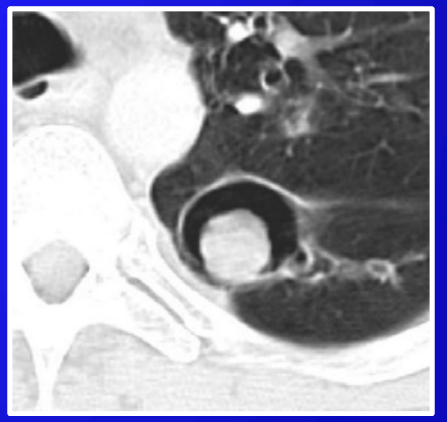


- Air surrounding a fungal ball in a preexisting pulmonary cavity which falls to a gravity dependent location
- Mass within a preexisting cavity
- Not a crescent sign!!
- Differential Dx:
  - Fungus ball [Aspergilloma]

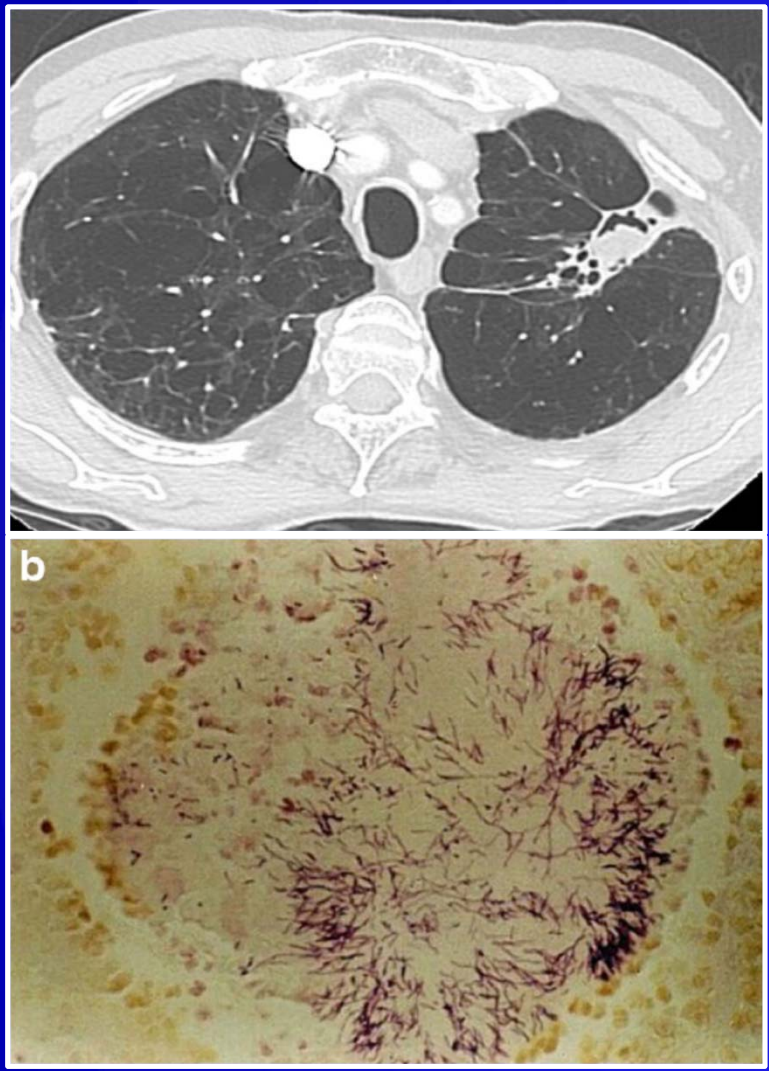
Pesle GD, Monod O. Bronchiectasis due to asperigilloma. Dis Chest. 1954;25(2):172-183

Air Crescent Sign vs Monod Sign

Variable	Air Crescent Sign	Monod Sign
Description	Crescentic or circumferential rim of radiolucent airspace within a parenchymal consolidation	Air surrounding a fungal ball in a preexisting pulmonary cavity
Differential diagnosis	Invasive aspergillosis, pulmonary mucormycosis, bronchogenic carcinoma	Aspergilloma
Mobility of mass	Nonmobile	Mobile mass within the cavity
Positional change	None	Mass gravitates to the dependent areas of the cavity
Patient profile	Usually immunocompromised	Immunocompetent



Raju S, Ghosh S, Mehta AC, Chest CT Signs in Pulmonary Disease A Pictorial Review, CHEST, 2017

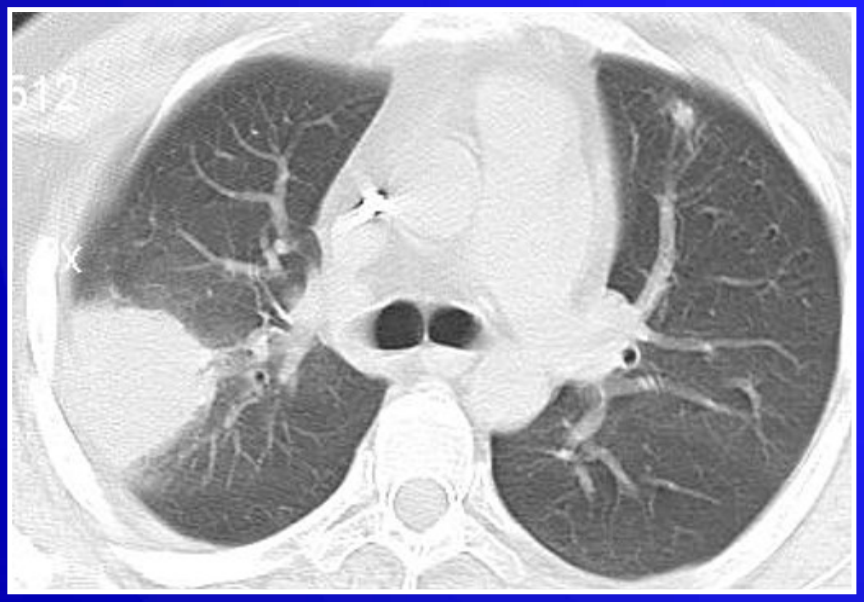


Actinomycosis

Fungus Ball

- Differential Dx:
  - Aspergilloma
  - Coccidioidomycosis: *C.Immitis, C. Posadasii*
  - Actinomycosis*
  - Nocardiosis
  - Candidiasis
  - Intracavitary Hematoma
  - M.TB
  - Adenocarcinoma
  - *Pseudallescheria Boydii, Scedosporium Apiospermum*
  - Hydatid Disease: Larval stage

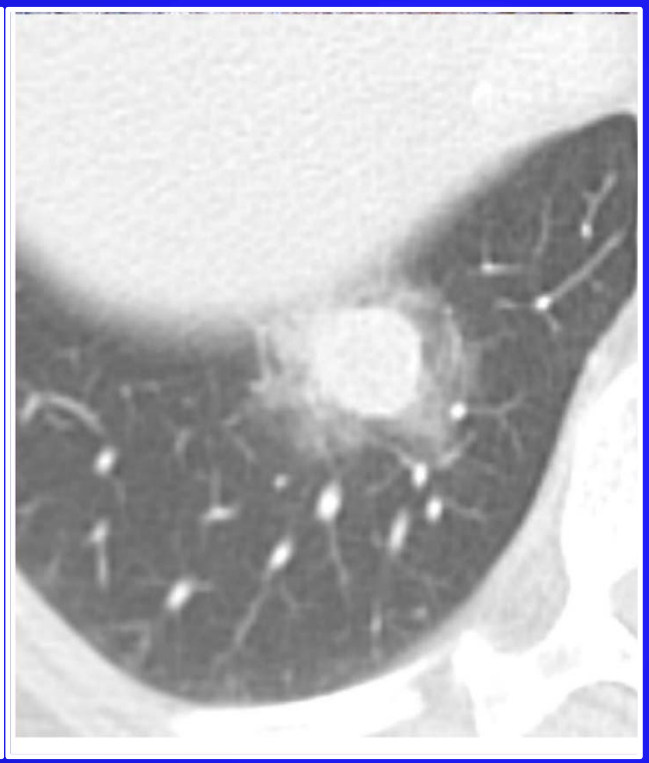
Gazzoni F, et al Pulmonary Diseases with Imaging Findings Mimicking Aspergilloma, Lung (2014) 192:347–357



Halo Sign

- Solid pulmonary nodule surrounded by a circumferential ground glass opacity
- Differential Dx:
  - Invasive pulmonary aspergillosis
  - Pulmonary mucormycosis
  - Adeno Ca in situ
  - Granulomatosis with Polyangiitis
  - Amyloidosis
  - Sarcoidosis
  - Metastatic cancer

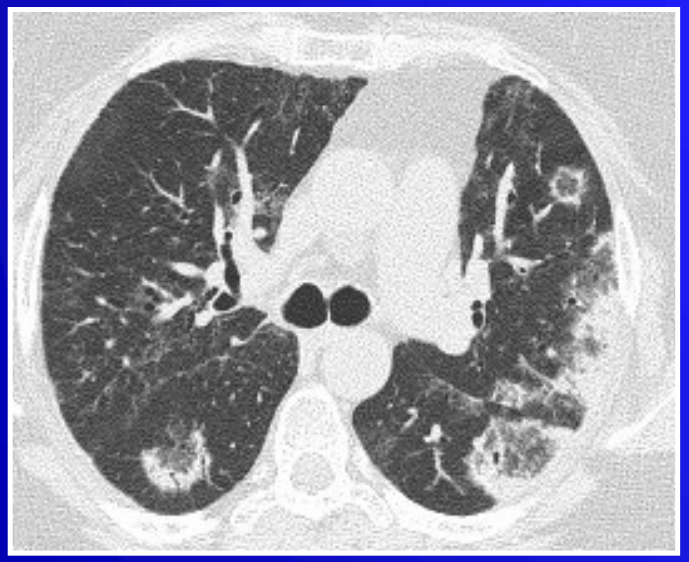
Halo Sign



- Histology:
  - Central nodule: Infarction
  - Surrounding GGO: Hemorrhage
- Incidence: High with Invasive Aspergillosis
- May disappear over time

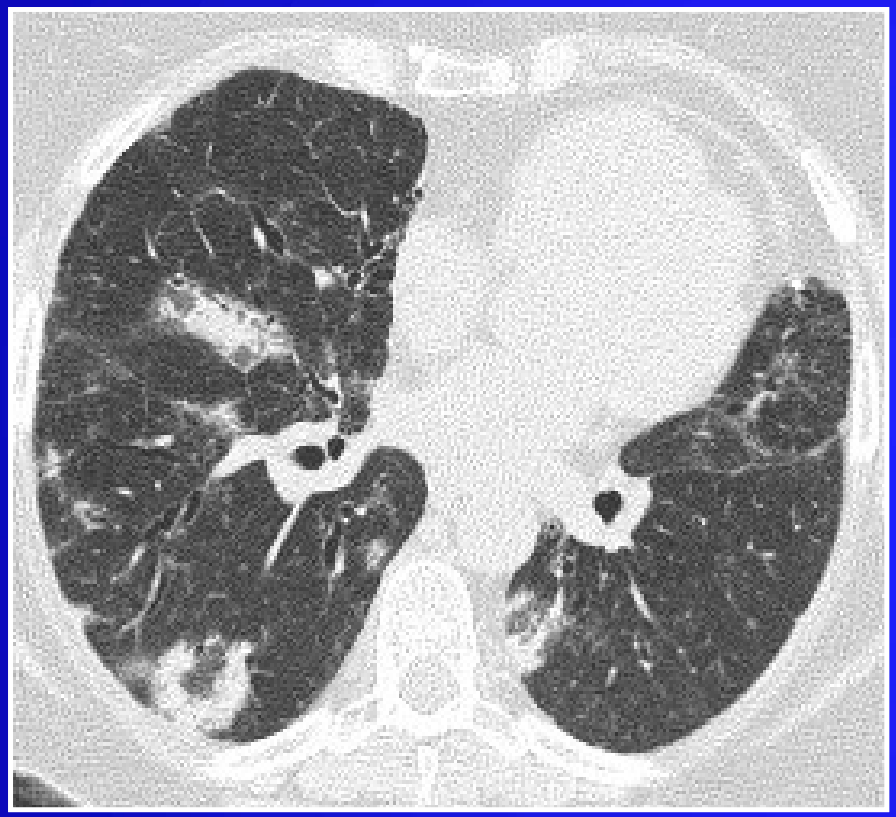
Shine Raju S, Ghosh S, Mehta AC, Chest CT Signs in Pulmonary Disease :A Pictorial Review, CHEST, 2017

Atoll Sign-Reverse Halo



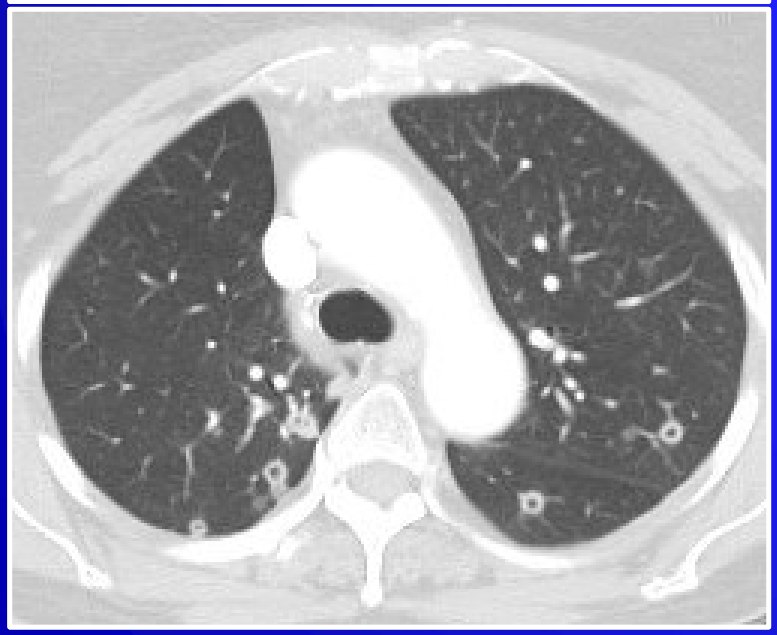
- Central GGO surrounded by a crescentic or circumferential denser air space consolidation
- Differential Dx:
  - Cryptogenic Organizing Pneumonia
  - M. TB, CAP, PJP
  - Lymphomatoid Granulomatosis, GPA
  - Lipoid pneumonia
  - Sarcoidosis
  - Neoplasms
  - Paracoccidioidomycosis

Atoll Sign



- Central GGO: Alveolar septal inflammation, cellular debris
- Peripheral consolidation: organizing pneumonia within alveolar ducts

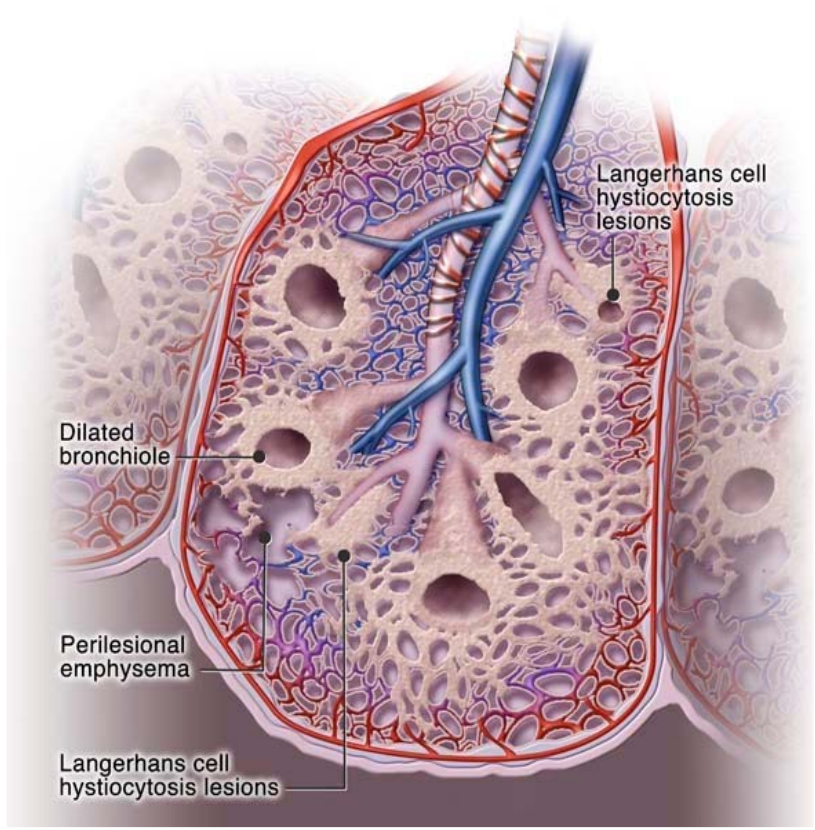
Marchiori E, et al. Reversed halo sign: high-resolution CT scan findings in 79 patients. Chest. 2012;141(5):1260-1266

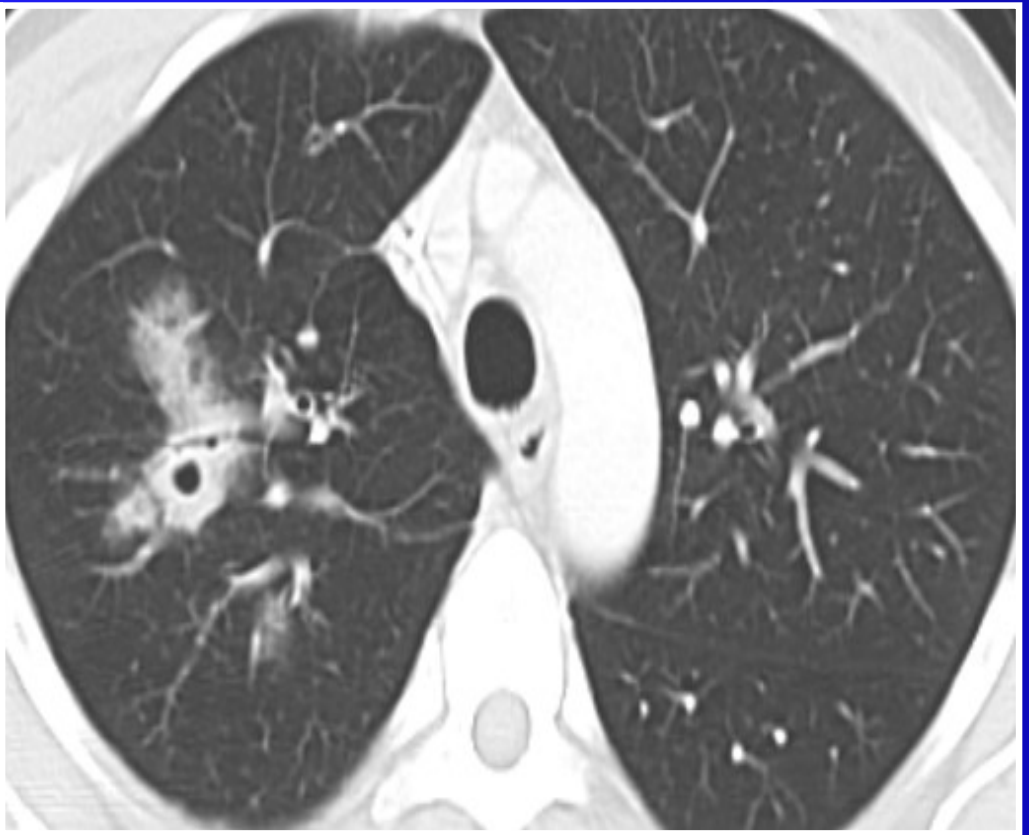


"Cheerios®" Sign

- Synonym: Open bronchus sign: Proliferation of neoplastic or non-neoplastic cells around a patent airway
- Pulmonary nodule with a lucency at its center resembling "Cheerios®" breakfast cereal (General Mills)
- Differential Dx:
  - Adenocarcinoma
  - Pulmonary Langerhans Cell Histiocytosis
  - Fungal infection
  - Lung metastasis
  - Rheumatoid nodules
  - Granulomatosis with Polyangiitis

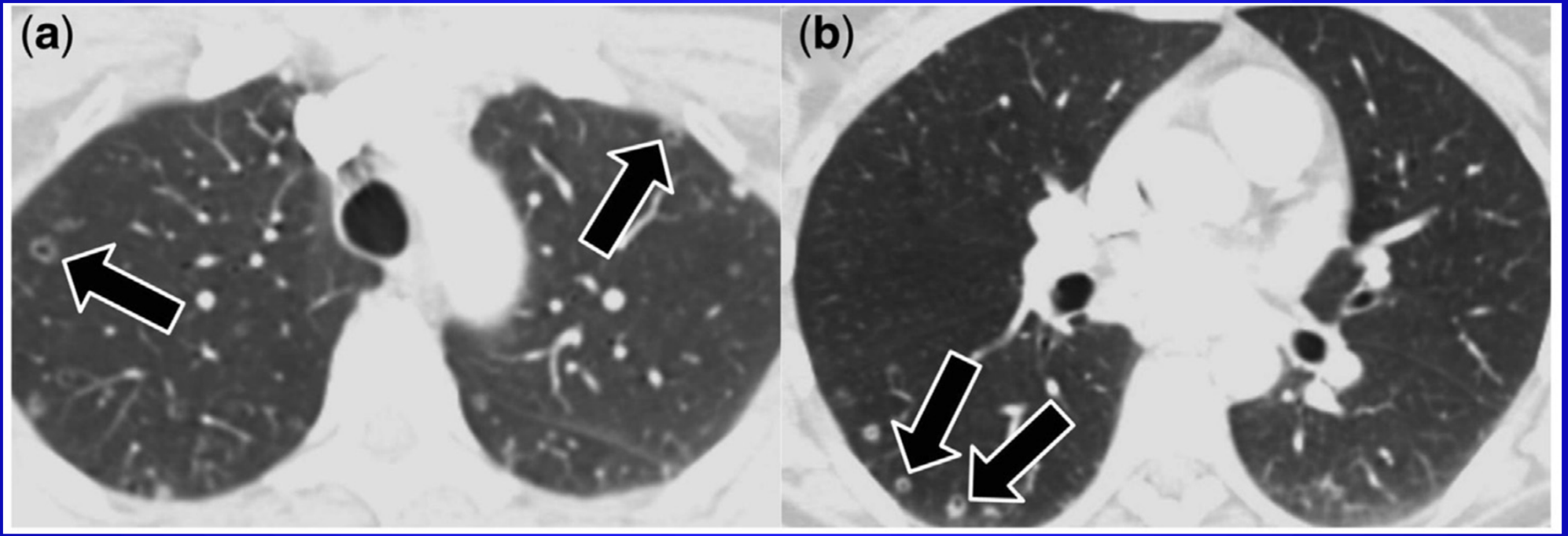
Open Bronchus Sign





Proliferation of neoplastic or nonneoplastic cells around a patent airway

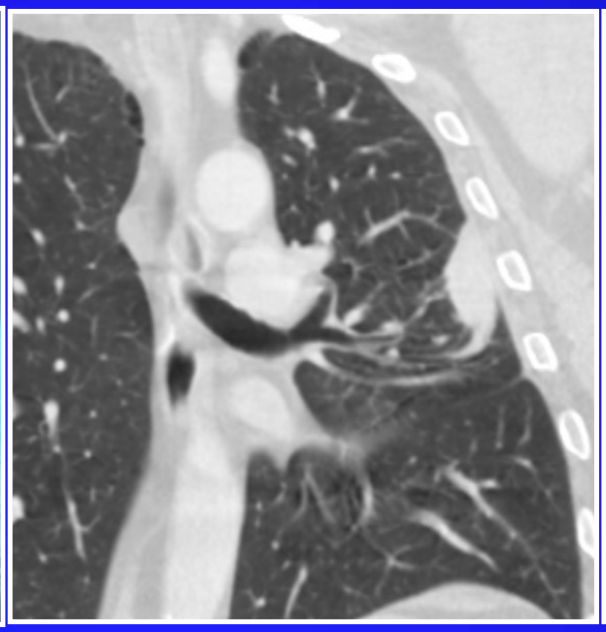
“Cheerios®” Sign



Pulmonary Langerhans Cell Histiocytosis [PLCH]

Shine Raju et al Chest CT Signs in Pulmonary Disease :A Pictorial Review, CHEST, 2017

Comet Tail Sign = Talon Sign


- Curvilinear opacity that originates from the pleural based opacity going towards the ipsilateral hilum
- Comet Tail: Blood vessels, Adjoining airways
- DDx: Round atelectasis of the lung, Bronchogenic Ca

Talon Sign = Comet Tail sign

- "Claw of a bird of prey"
- Comprise of vessels and adjoining airways that get pulled into a mass as lung collapses
- BV bundle entering the mass from all sides
- Pleural thickening present
- Benign:
  - Reduce in size
  - May disappear

Szydlowski GW, et al. Rounded atelectasis: a pulmonary pseudotumor. Ann Thorac Surg. 1992;53(5):817-821

Corona Radiata Sign

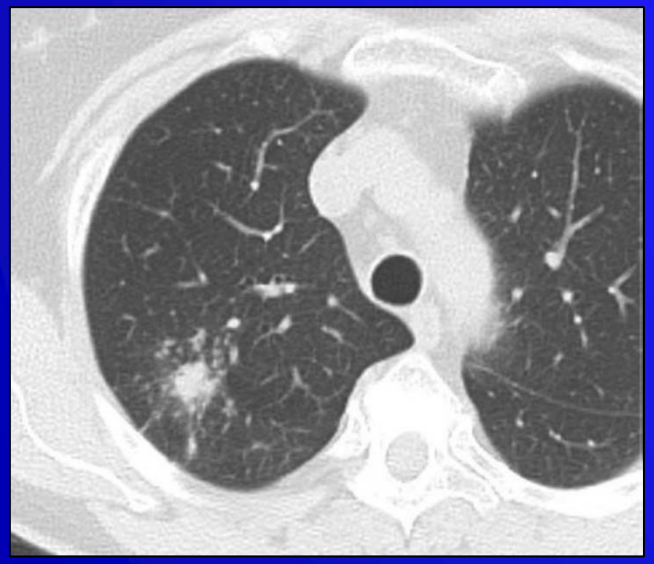
- Synonym: Sunburst Sign:
- Solitary pulmonary nodule or a mass with spiculated margins with distortion of surrounding blood vessels
- Differential Dx:
  - Bronchogenic Carcinoma
- Odds Ratio: 2.2-2.5

- Gurney JW. Determining the likelihood of malignancy in solitary pulmonary nodules with Bayesian analysis. Part I. Theory. Radiology. 1993;186(2):405-413
- McWilliams A, et al, Probability of cancer in pulmonary nodules detected on first screening CT. N Engl J Med 2013;369(10):910–919.

Sunburst Sign

Lung Malignancy

Shine Raju et al, Chest CT Signs in Pulmonary Disease :A Pictorial Review, CHEST , 2017

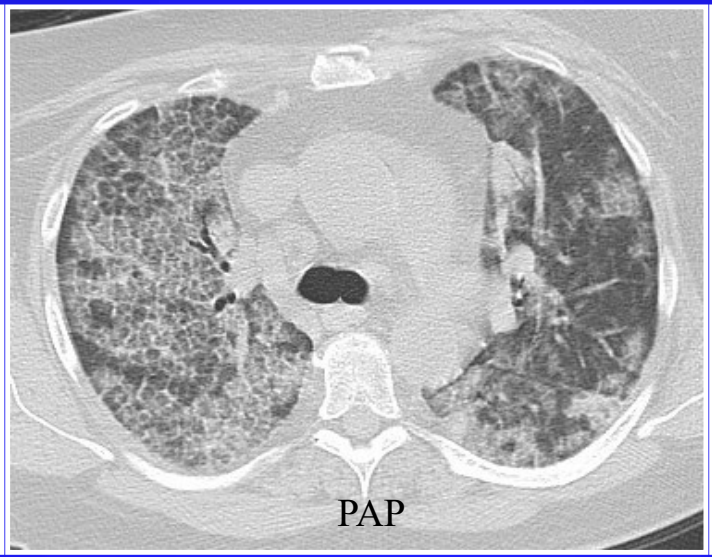


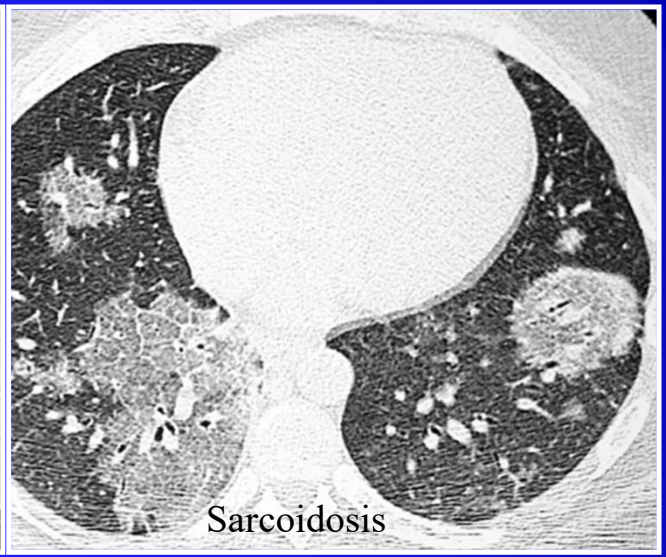
Galaxy Sign = Sarcoid Galaxy

- Coalescent granulomas appearing as a central dense mass with tiny peripheral satellite nodules, akin to a galaxy cluster
- Differential Diagnosis: [Benign]
  - Sarcoidosis
  - Progressive massive fibrosis
  - Active pulmonary tuberculosis
- Mediastinal Lymphadenopathy and calcification further adds to making the diagnosis

Nakatsu M, et al. Large coalescent parenchymal nodules inpulmonary sarcoidosis: "sarcoid galaxy" sign. AJR Am J Roentgenol, 2002;178(6):1389-1393

Crazy Paving

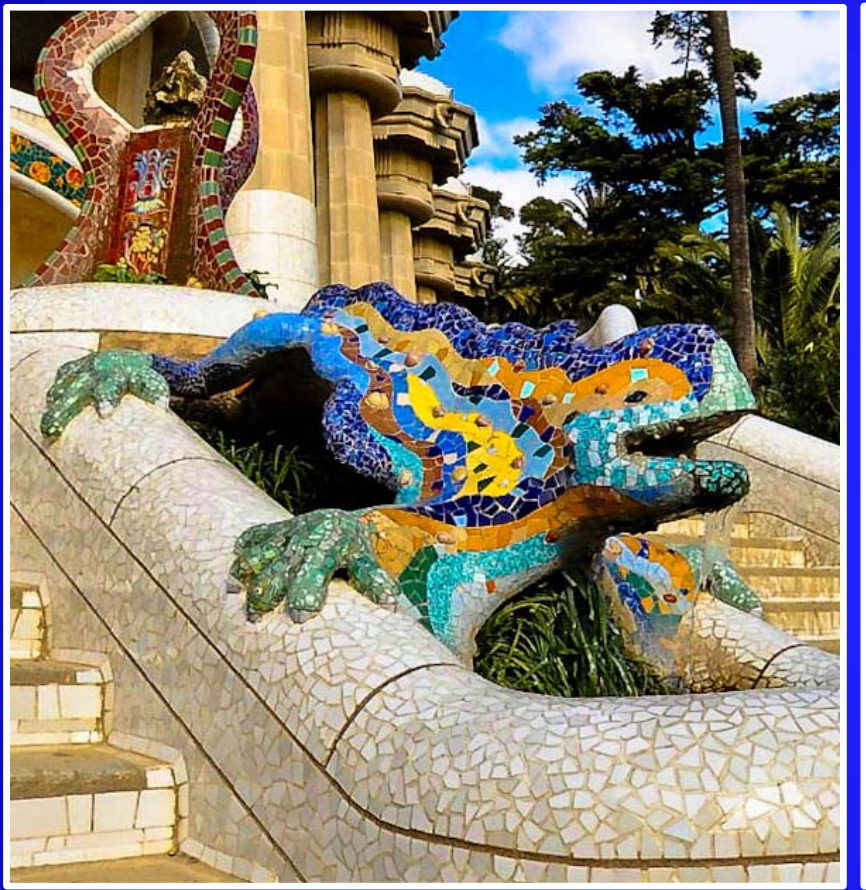




- Thickened interlobular septa on the background of diffuse ground glass opacities
- GGO represents concomitant alveolar process, i.e.: PAP, Sarcoidosis

Shine Raju et al, Chest CT Signs in Pulmonary Disease :A Pictorial Review, CHEST, 2017

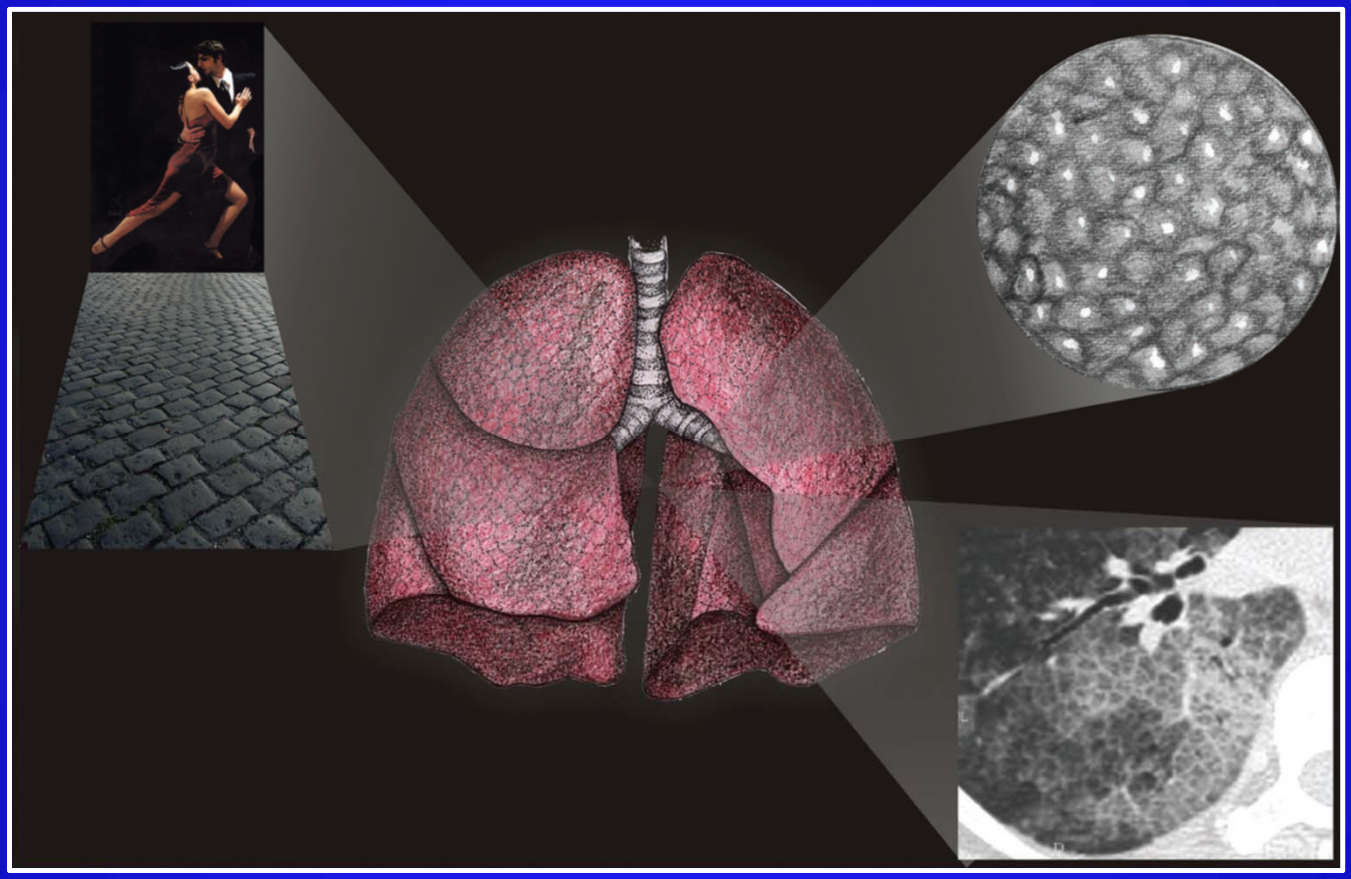
Crazy Paving



Gaudi's Park, Barcelona, Spain

Antonio Gaudi

Crazy Paving



Rossi SE et al, RadioGraphics 2003; 23:1509–1519 ● DOI: 10.1148/rg.236035101

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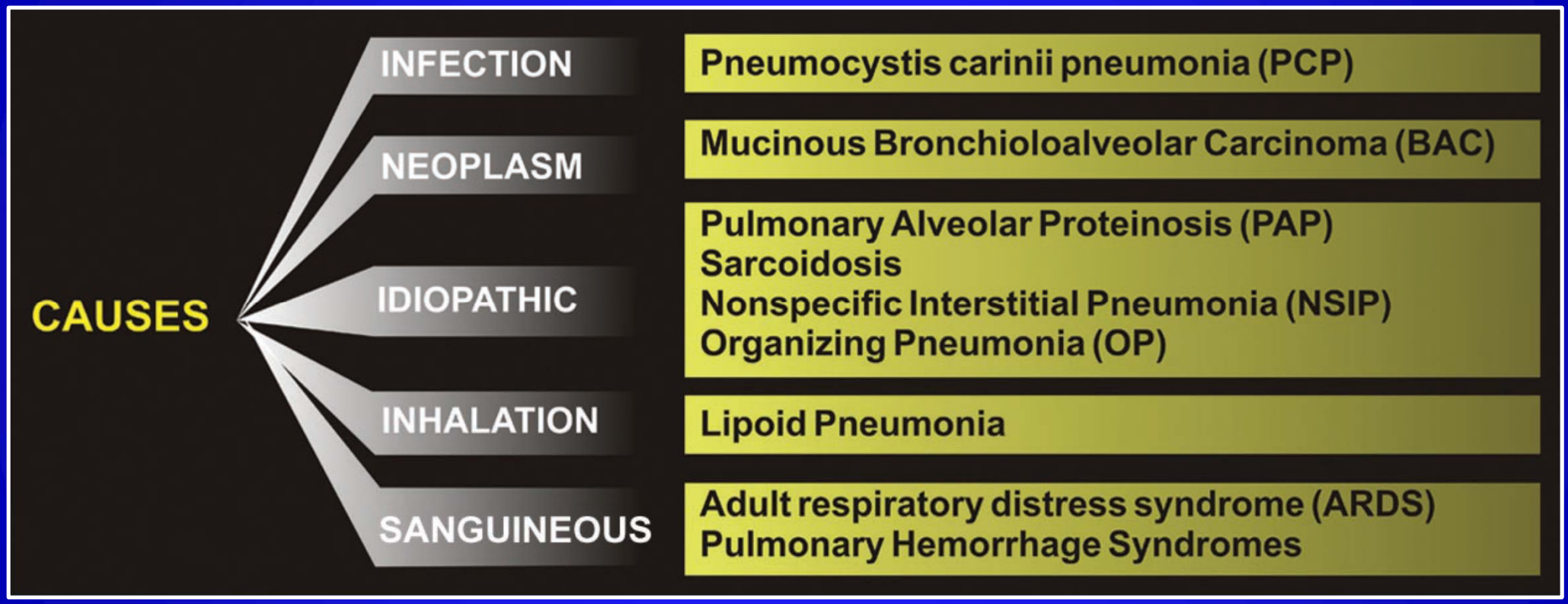
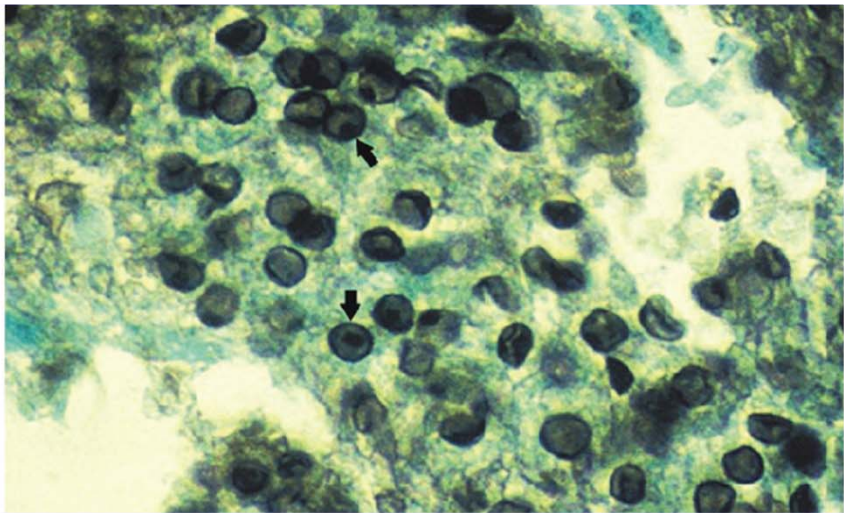
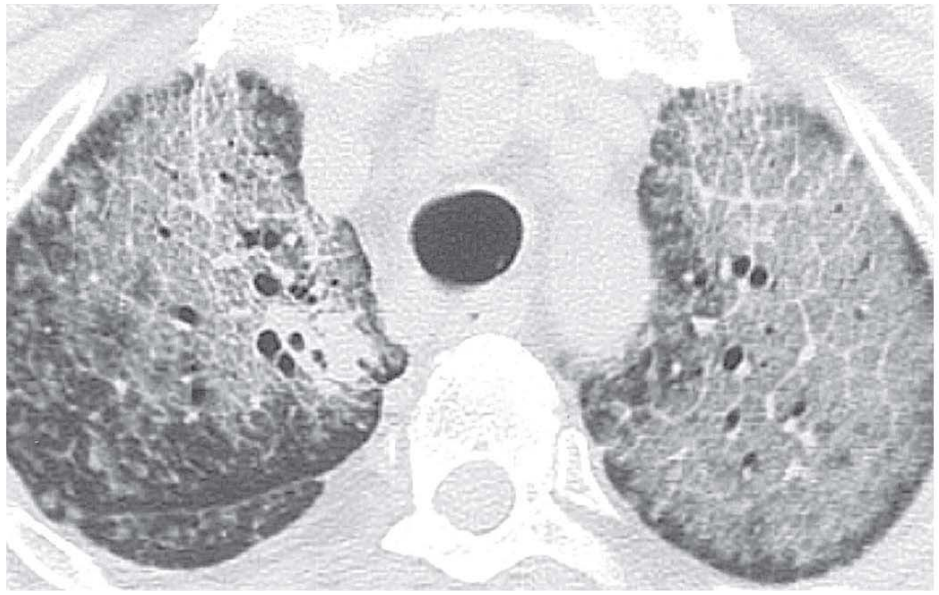


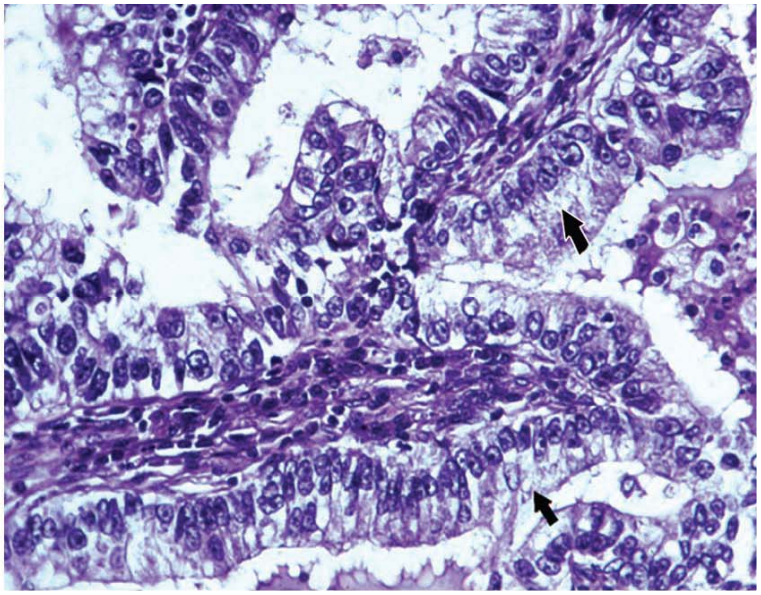
Rossi SE et al, RadioGraphics 2003; 23:1509–1519 ● DOI: 10.1148/rg.236035101
Godwin JD, Pulmonary alveolar proteinosis: CT findings. Radiology. 1988;169(3):609-613

Crazy Paving



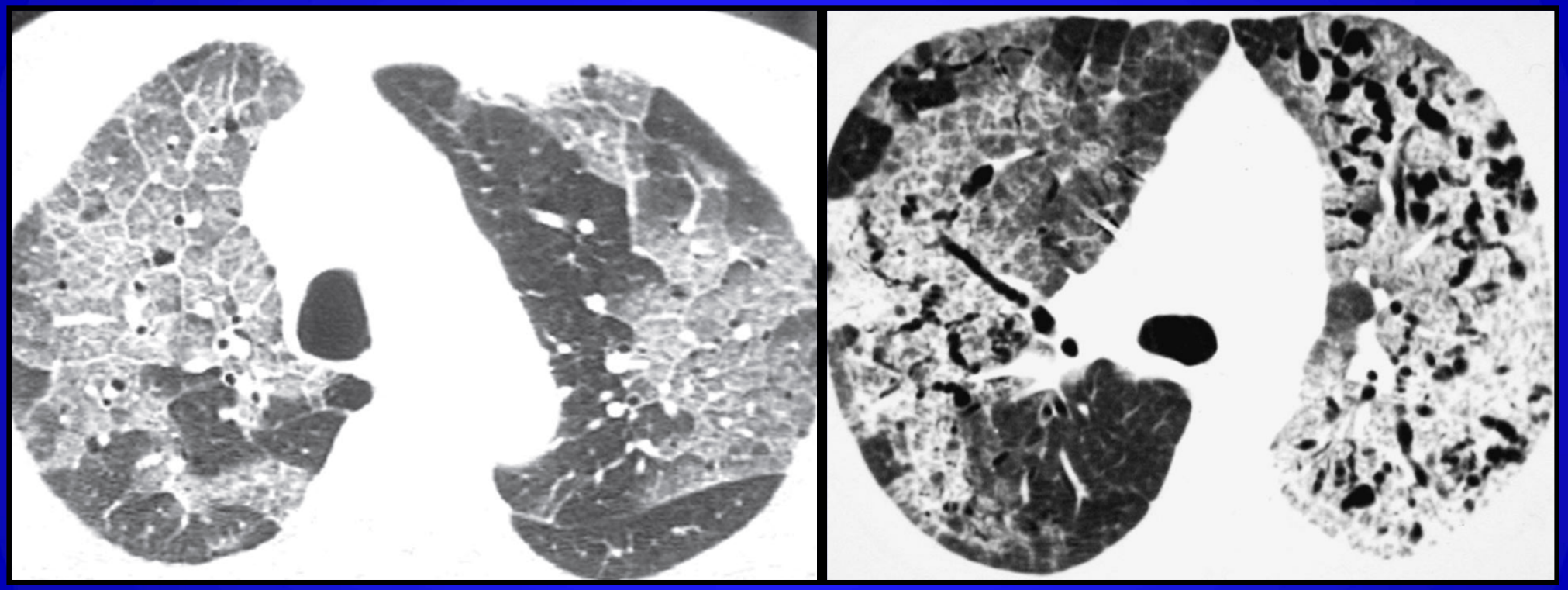
PJP





BAC

Crazy Paving



Alveolar Hemorrhage

ARDS

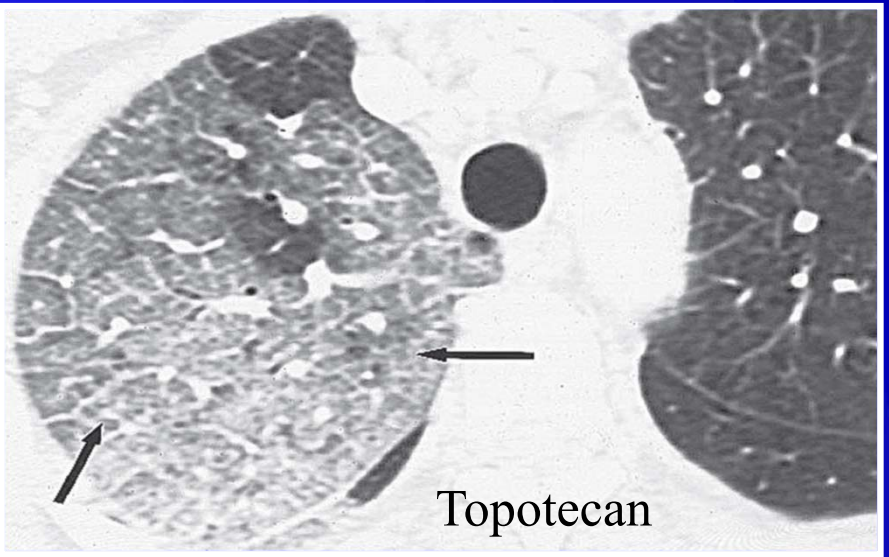
Rossi SE et al, RadioGraphics 2003; 23:1509–1519 ● DOI: 10.1148/rg.236035101

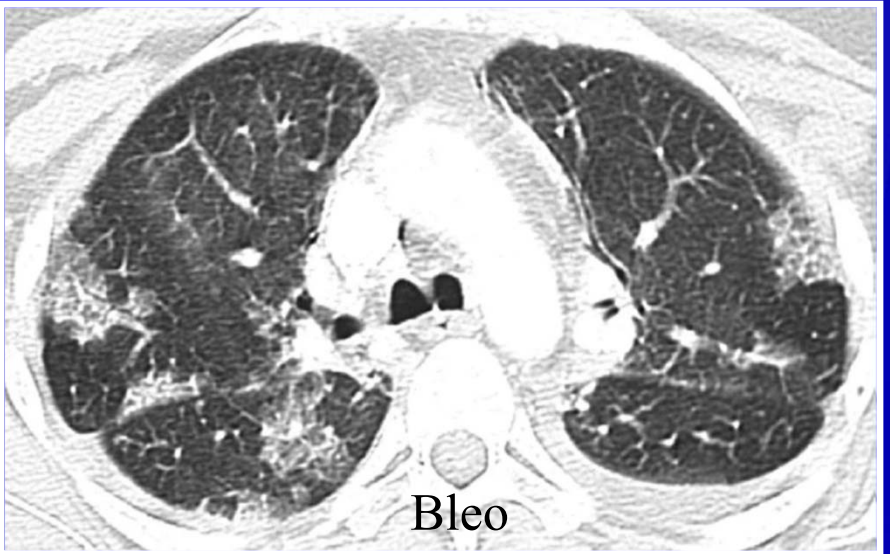
Crazy Paving

Drugs

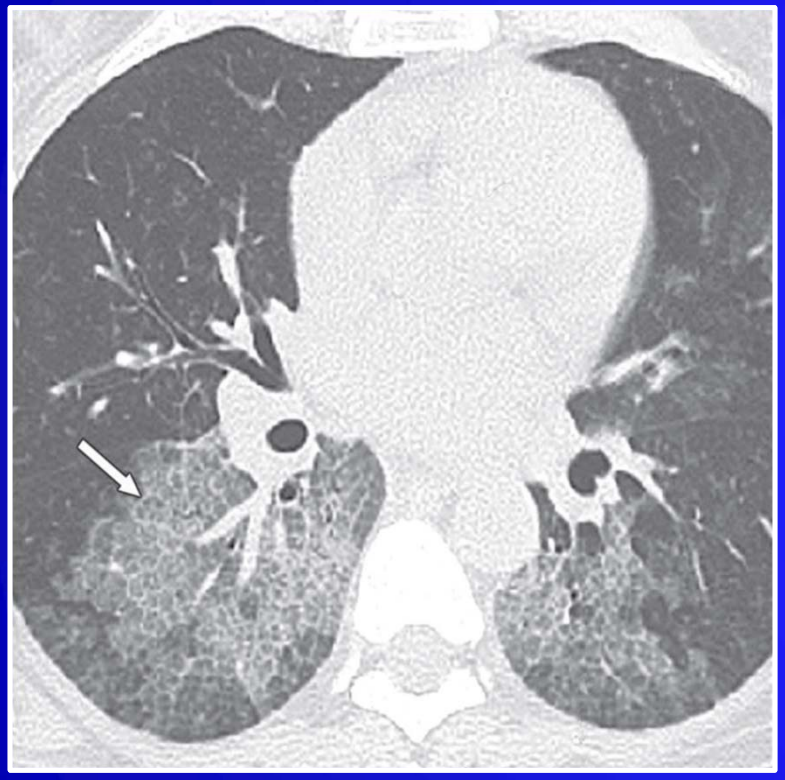
MTX

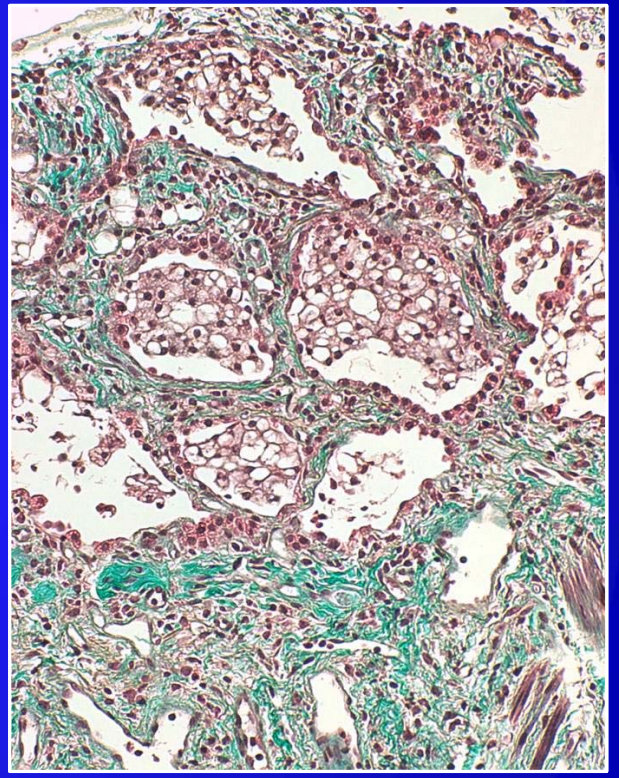
Amio



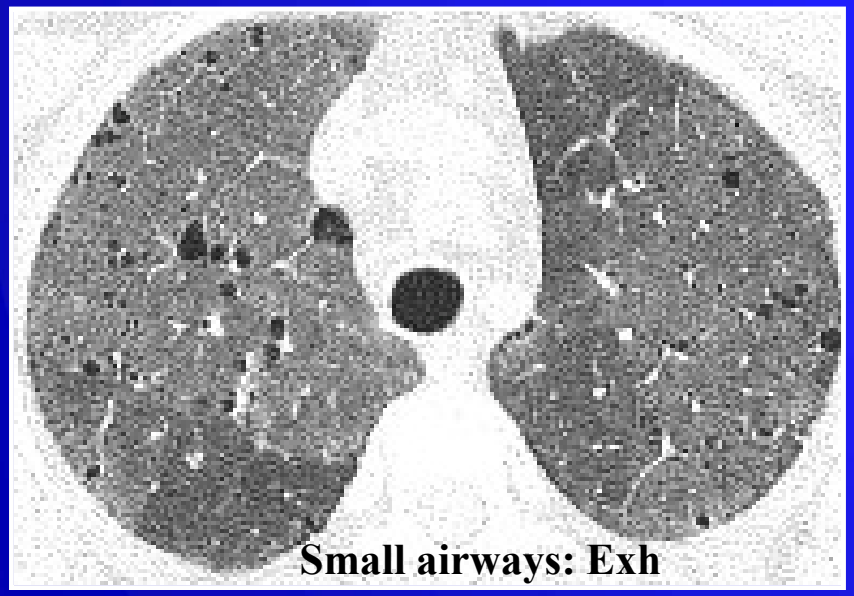


Lipoid Pneumonia





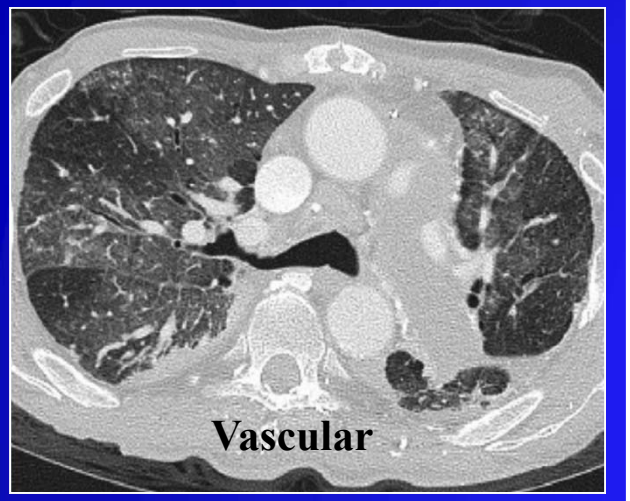
Kupeli E, Khemasuan D, Tunsupon P , Mehta AC. Special Feature: “Pills” and the Air Passages: A Continuum CHEST, 2015;147(1):242-250

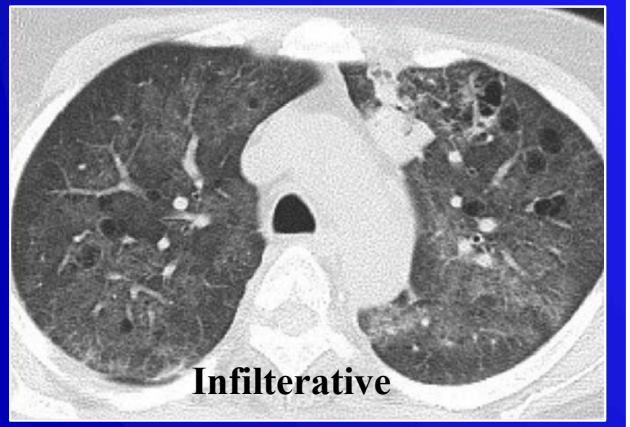


Mosaic Attenuation

- Variable attenuation seen on a chest CT in a lobular or multilobular distribution.
- Differential Dx:
  - Small airway disease:
    - Bronchiolitis obliterans [Air trapping]
  - Infiltrative lung disease:
    - PJP, HSP, COP, Eosinophilic pneumonia
  - Vascular lung disease
    - CTEPH [Mosaic oligemia or perfusion]

Mosaic Attenuation Types





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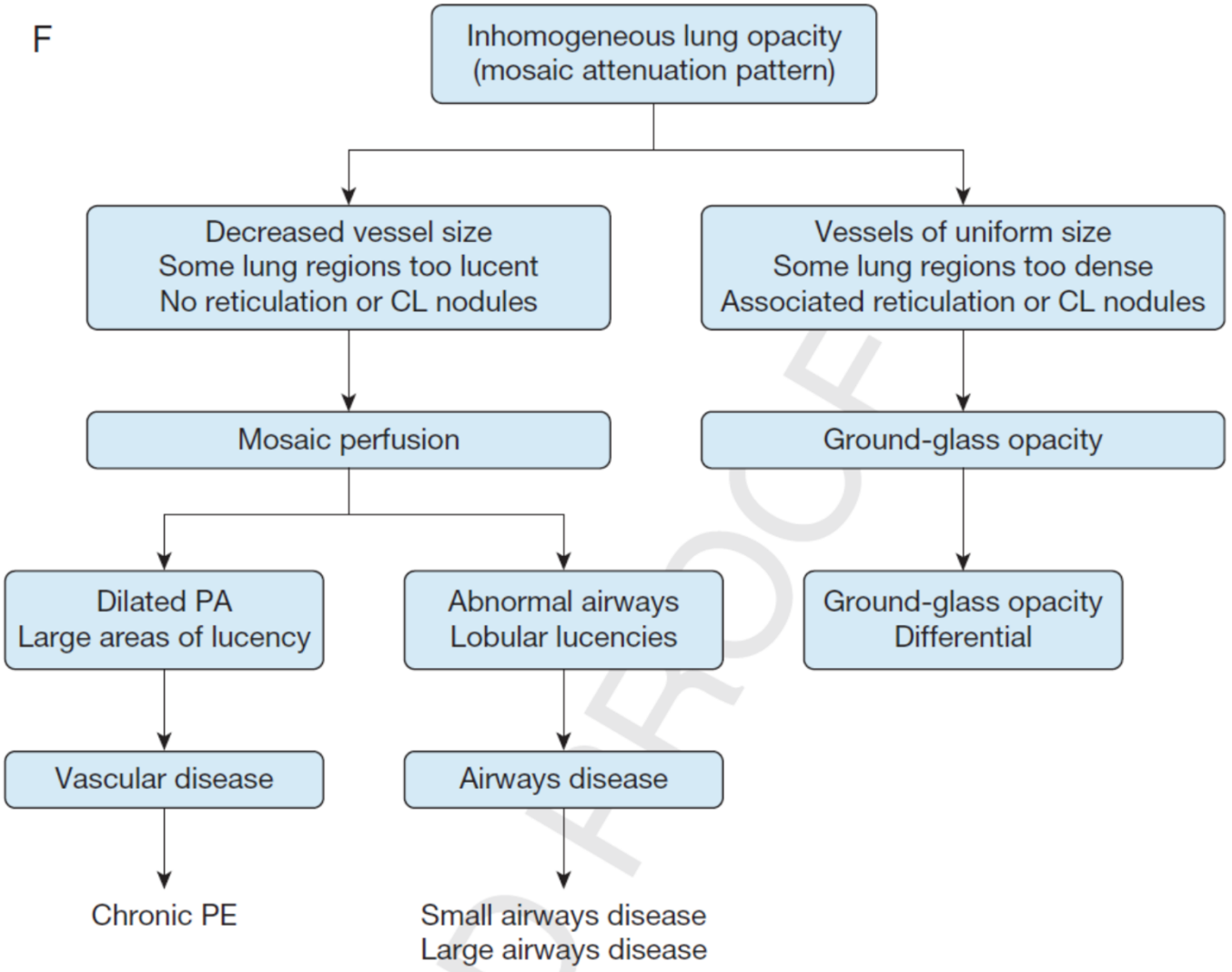
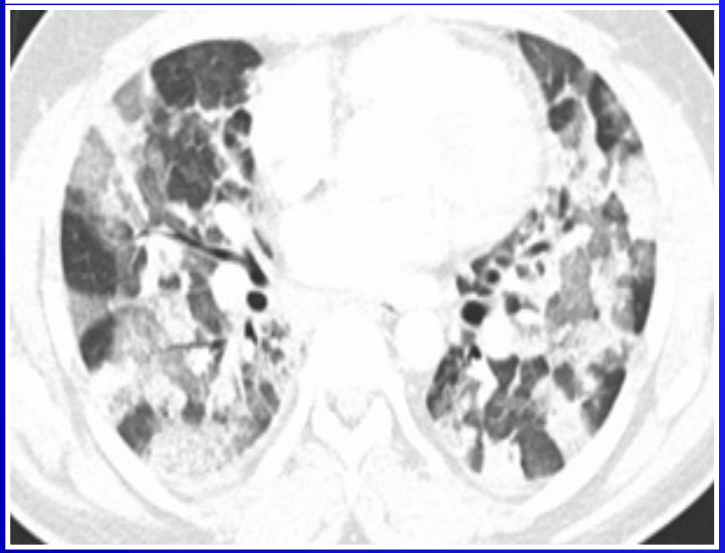
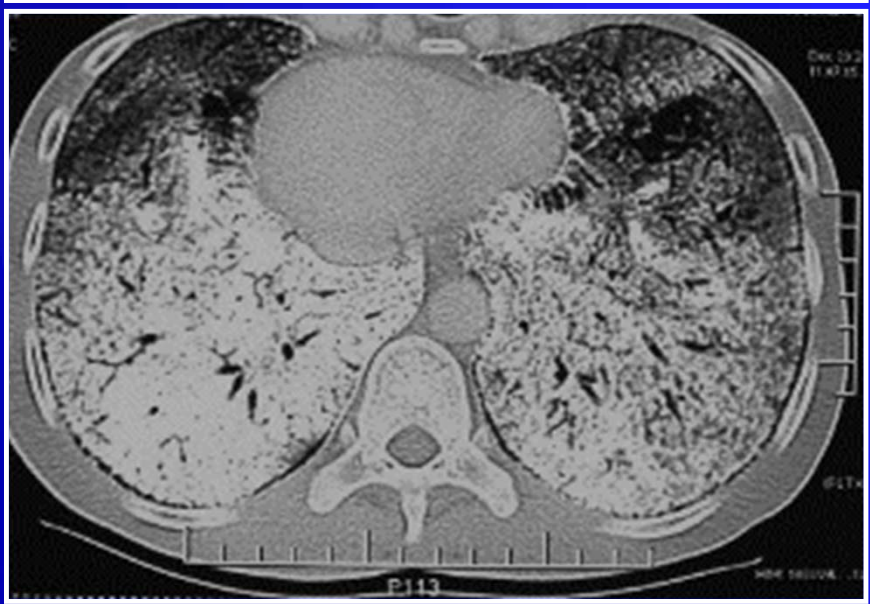




Headcheese Sign

- Head cheese: Type of terrine [French food] made from pieces of meat obtained from various parts of different animals (calf, pig)
- Sign: Juxtaposition of distinct radiographic areas of low, normal and high attenuation
- Differential Dx:
  - Sub-acute hypersensitivity pneumonitis
  - Mycoplasmal infection
  - Sarcoidosis
  - Respiratory bronchiolitis

Shine Raju et al, Chest CT Signs in Pulmonary Disease :A Pictorial Review, CHEST, 2017

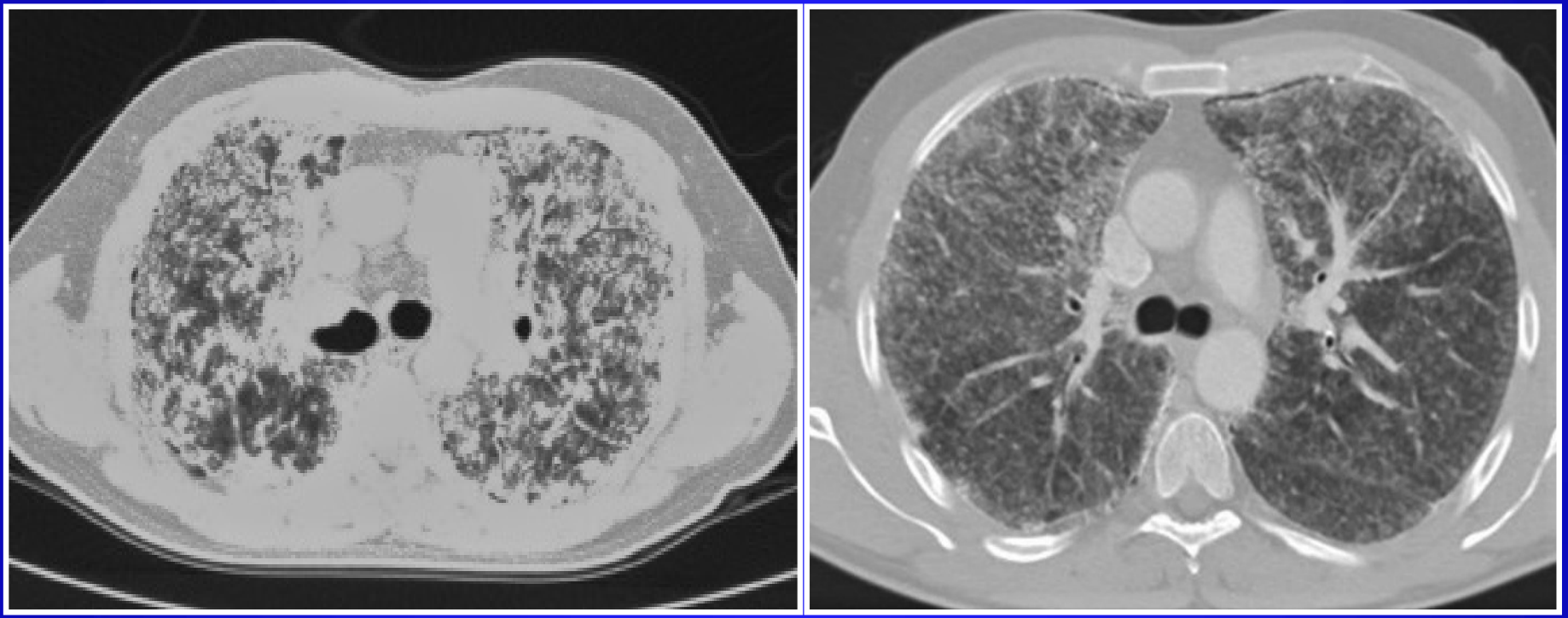


Black Pleural Line - Sandstorm Sign

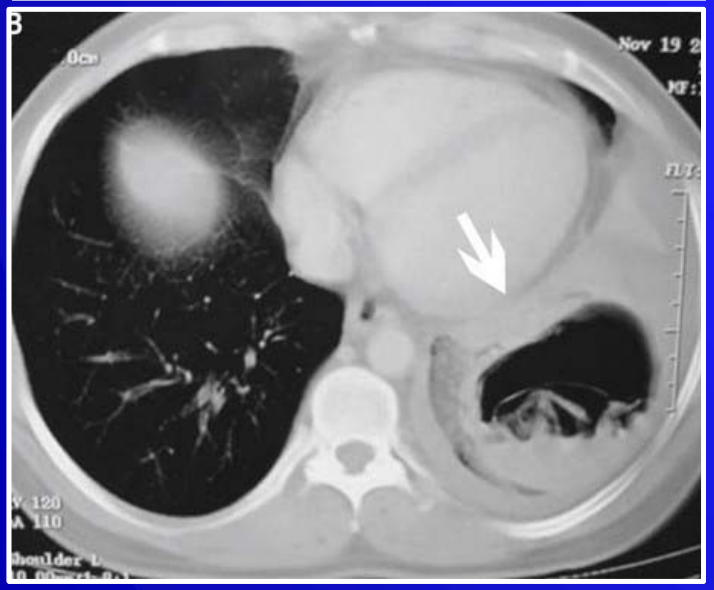
- Black lucent line between the ribs and the surrounding calcified parenchyma
- Diffusely dense pulmonary micronodular calcifications
- Differential Dx:
  - Pulmonary Alveolar Microlithiasis
  - Metastatic Thyroid Ca

Marchiori E, et al. Pulmonary alveolar microlithiasis: high-resolution computed tomography findings in 10 patients. J Bras Pneumol. 2007;33(5):552-557

Black Pleural Line-Sand-Storm Sign



Gasparetto EL, et al. Pulmonary alveolar microlithiasis presenting with crazy-paving pattern on high resolution CT. Br J Radiol. 2004;77(923):974-976

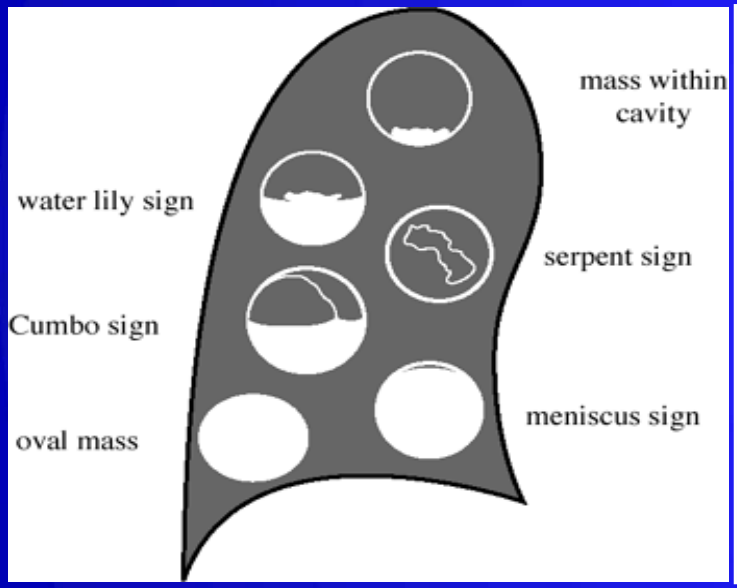


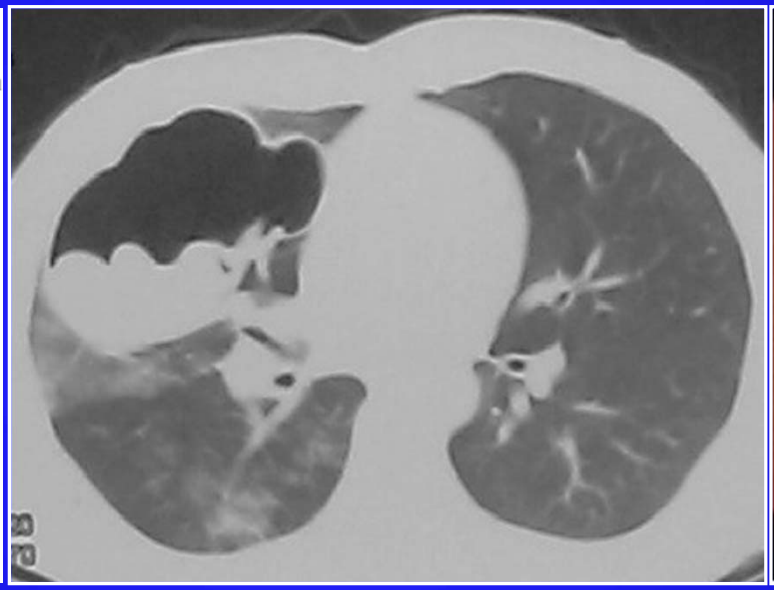
Water Lily Sign - Camalote Sign

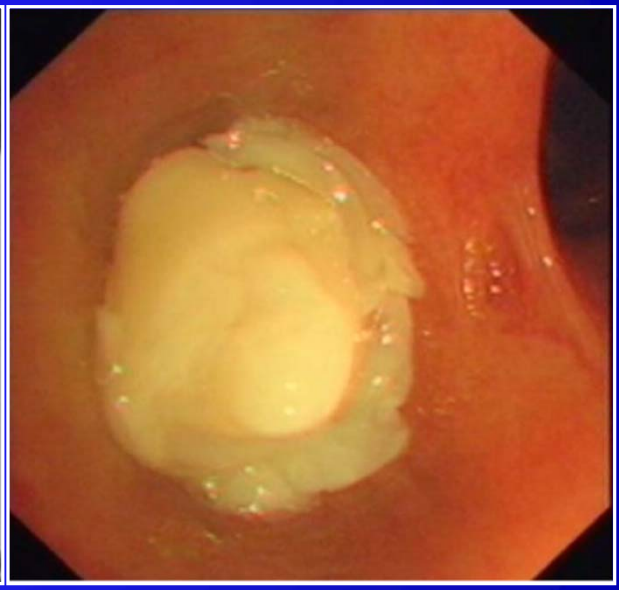
- Hydatid cyst in the lung with a free-floating endocyst, which collapses and floats in the cystic fluid like a water-lily or a camalote
- Synonym: Sunrise or Sunset sign
- Pathognomonic for cystic echinococcosis or hydatid disease of the lung
- Pleural effusion, +ve serology

Fainsinger MH. Pulmonary hydatid disease; the sign of the camalote. S Afr Med J. 1949;23(35):723

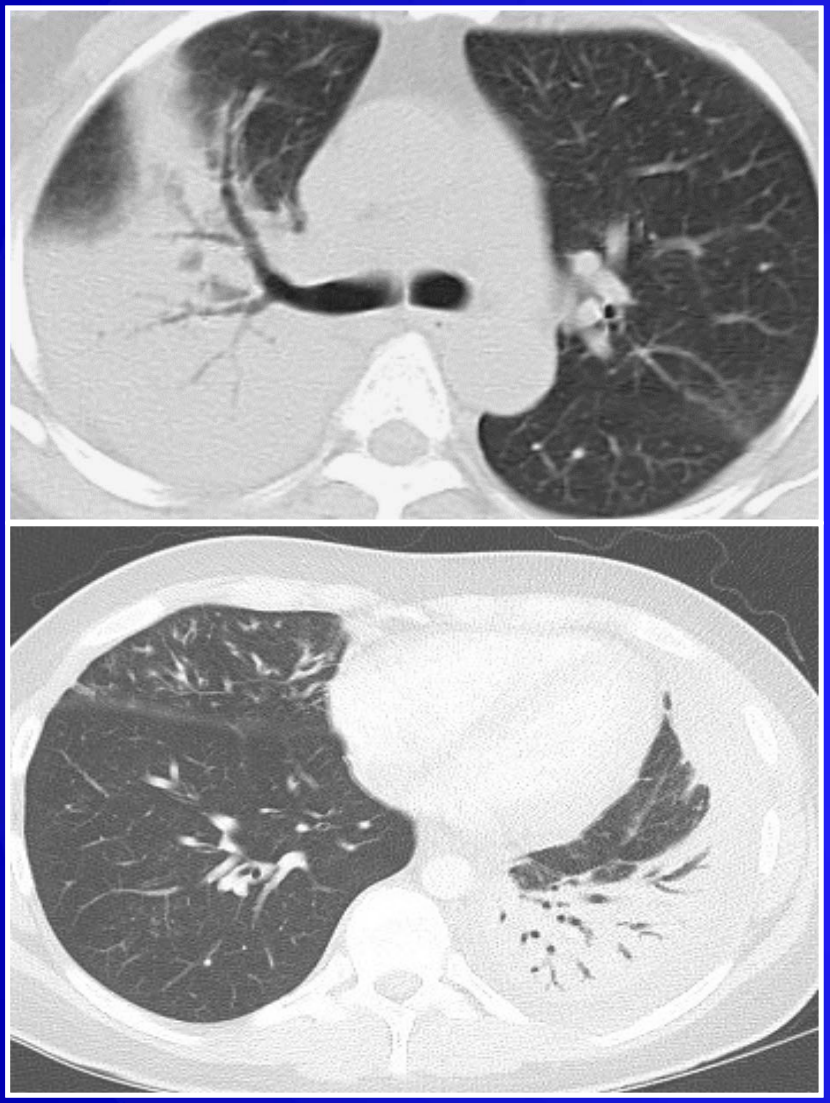
Echinococcosis





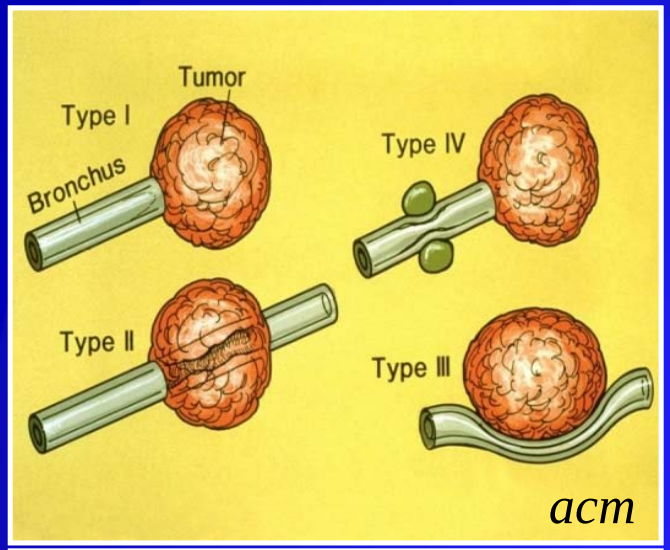


Khemasuwan D, Farver C, Mehta AC, Parasite and the Air Passages, Chest, 2014; 145(4):883–895



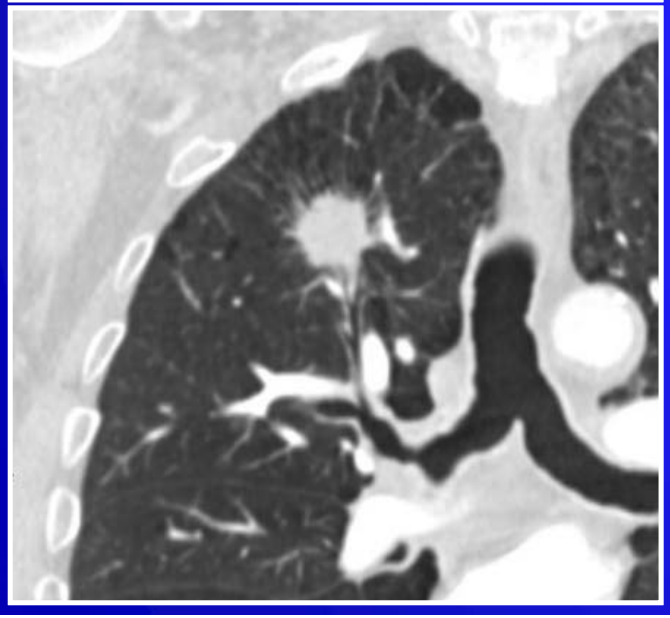
Air Bronchogram Sign

- Patent airways surrounded by opacified lung
- Air behaves as a contrast material
- Major airway obstruction unlikely
- Differential Dx:
  - Pneumonia
  - Pulmonary Edema
  - Severe ILD
  - Pulmonary infarction
  - Adenocarcinoma (BAC)
  - Non-obstructive atelectasis

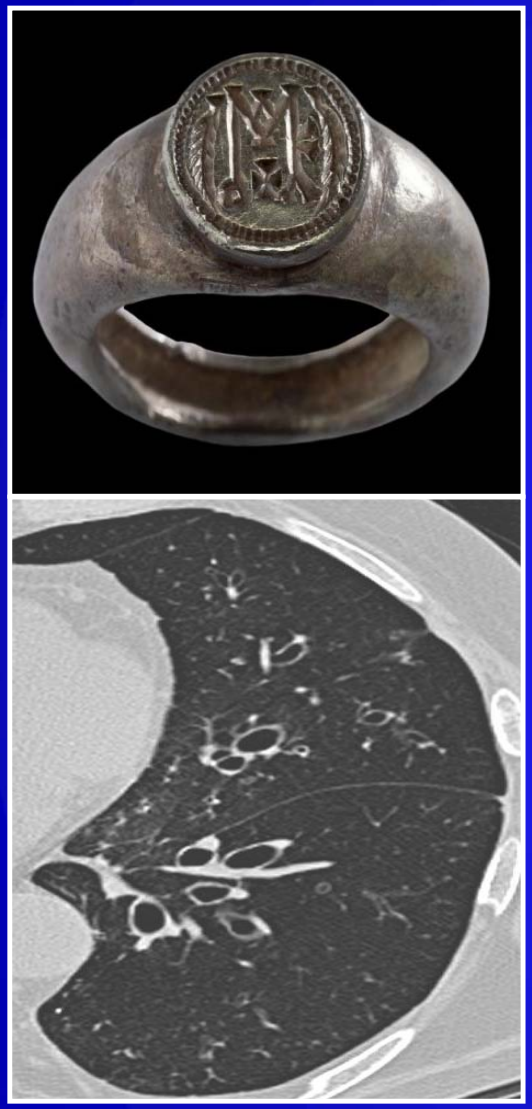


Positive Bronchus Sign

- Airway leading directly to a peripheral lung nodule or a mass.
- Positive predictive marker for a successful TBBx or brushing (90%)



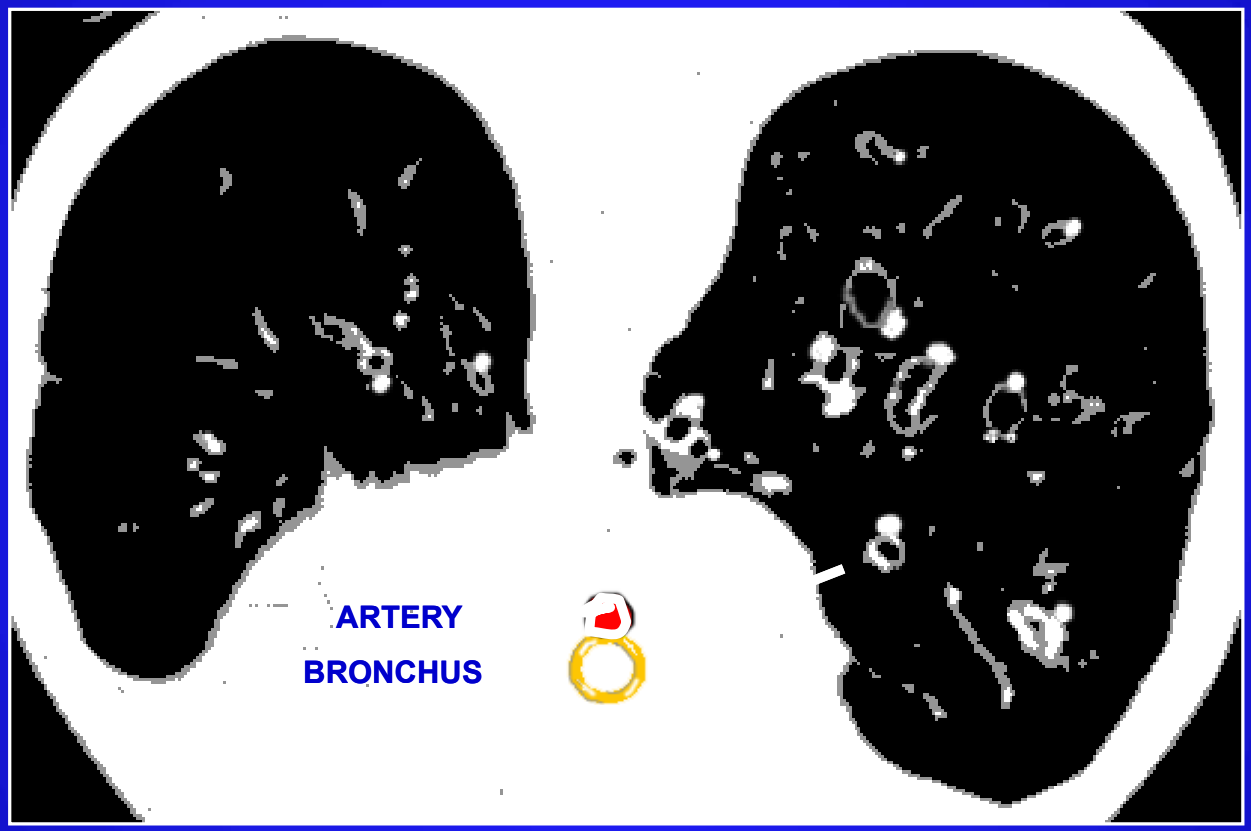
Gaeta M, et al. Bronchus sign on CT in peripheral carcinoma of thelung: value in predicting results of transbronchial biopsy. AJR Am JRoentgenol. 1991;157(6):1181-1185



Signet Ring Sign

- Dilated airway is prominently larger than its accompanying pulmonary artery in the cross sectional view
- Bronchoarterial ratio: > 1
- Parallel, non-tapering airways, seen extending to the lung periphery
- Associated findings:
  - Bronchial wall thickening
  - Cylindrical or traction bronchiectasis

Signet Ring Sign



Bronchiectasis

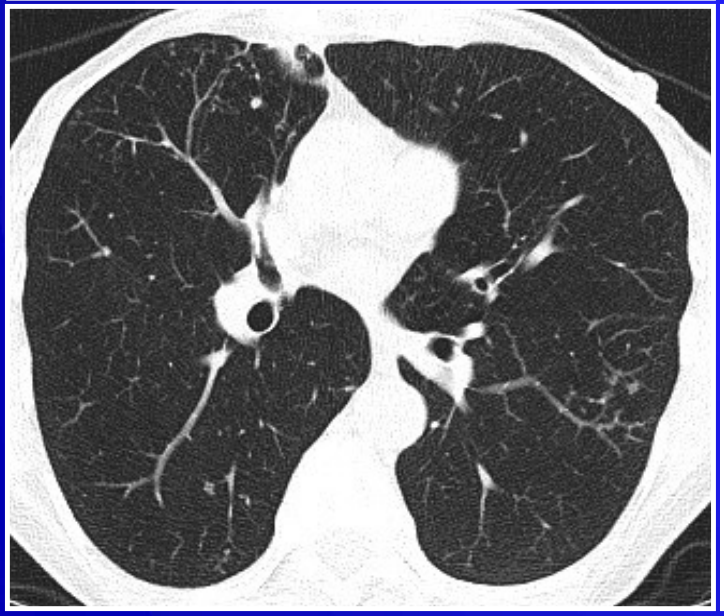
Tram Tracking

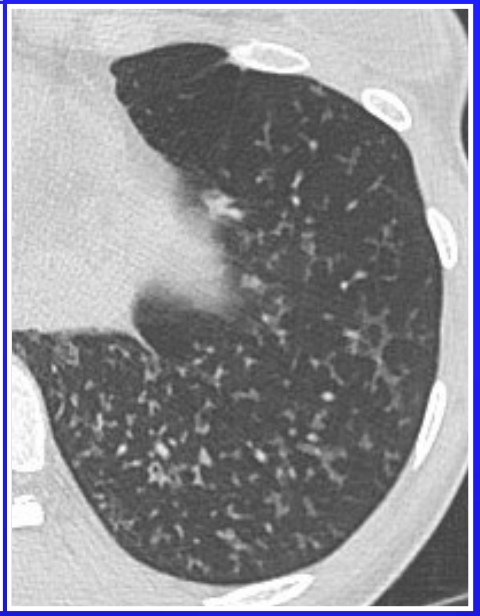
- Parallel, non-tapering airways extending to the lung periphery
- Peribronchial cuffing [Inflammation]
- Differential Dx:
  - CF: Proximal
  - ILD: Traction bronchiectasis, Bronchiectasis sicca (Dry)
  - ABPA: Proximal
  - Kartagener's syndrome

Shine Raju et al, Chest CT Signs in Pulmonary Disease
A Pictorial Review, CHEST 2017

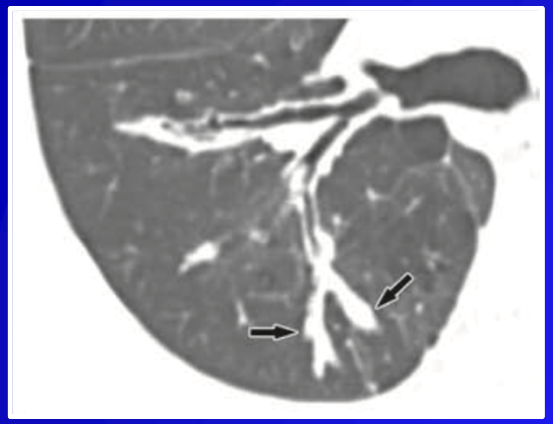
Tree-in-Bud

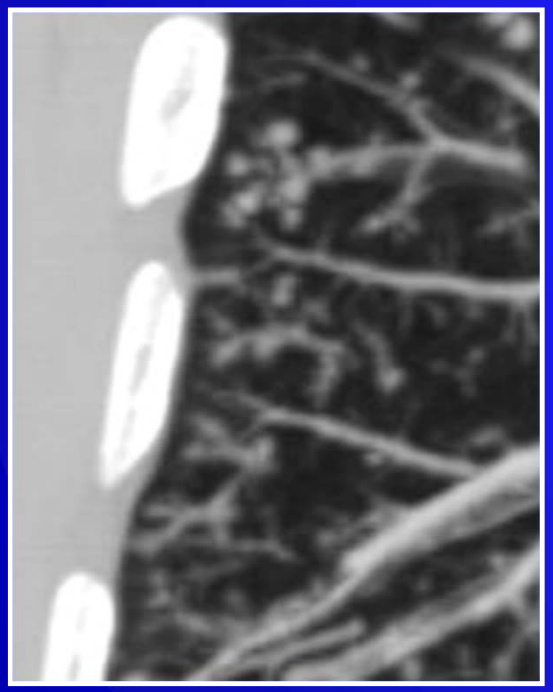
- Multiple centrilobular nodules arranged in a linear branching pattern as a budding tree [spring]
  - Within 1 cm of pleura, 2-4 mm
  - Endobronchial inflammation
  - Bronchiolar infection





- Differential Dx:
  - MTB*
  - MAI
  - Atypical pneumonia
  - Viral bronchiolitis
  - Aspiration pneumonitis
  - [Focal bronchiolitis]



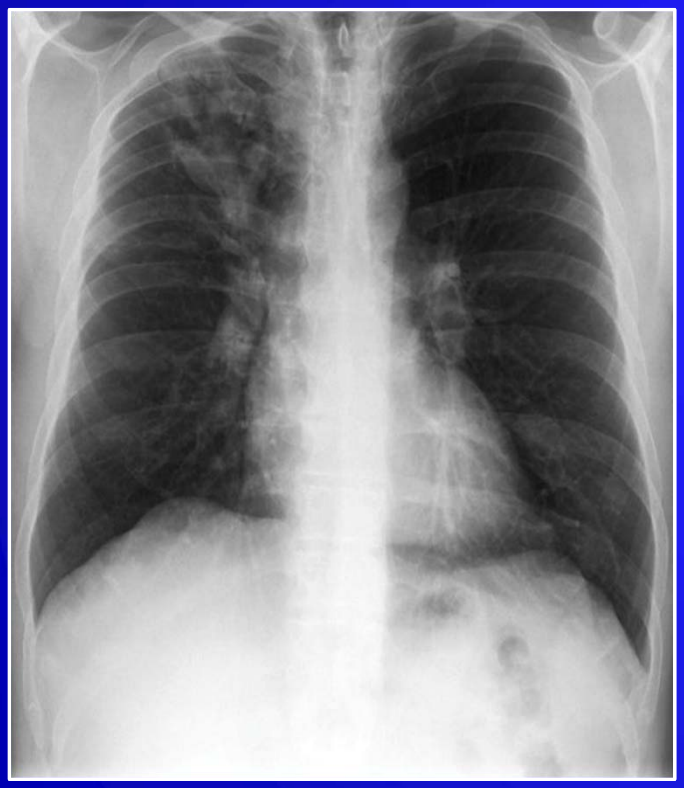


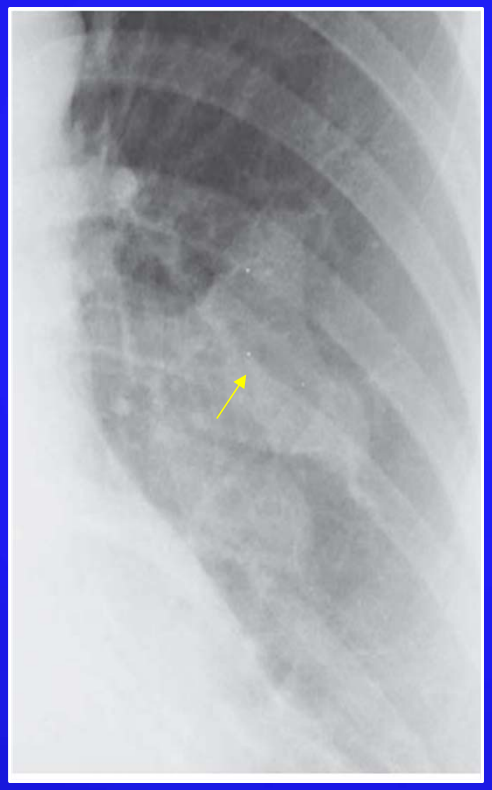
Finger-in-Glove Sign

- Tubular or branching opacities involving the large airways that resemble fingers
- Sign of large, dilated airways: Mucoid impaction = bronchocele, mucocele
- Radiate from the hilum toward the periphery
- Low attenuation (< 20 HU); never enhances with contrast
- Atypical appearances, such as ovoid opacities, also are common
- Tree-in-Bud: Impacted small (bronchioles) and non-dilated airways

*

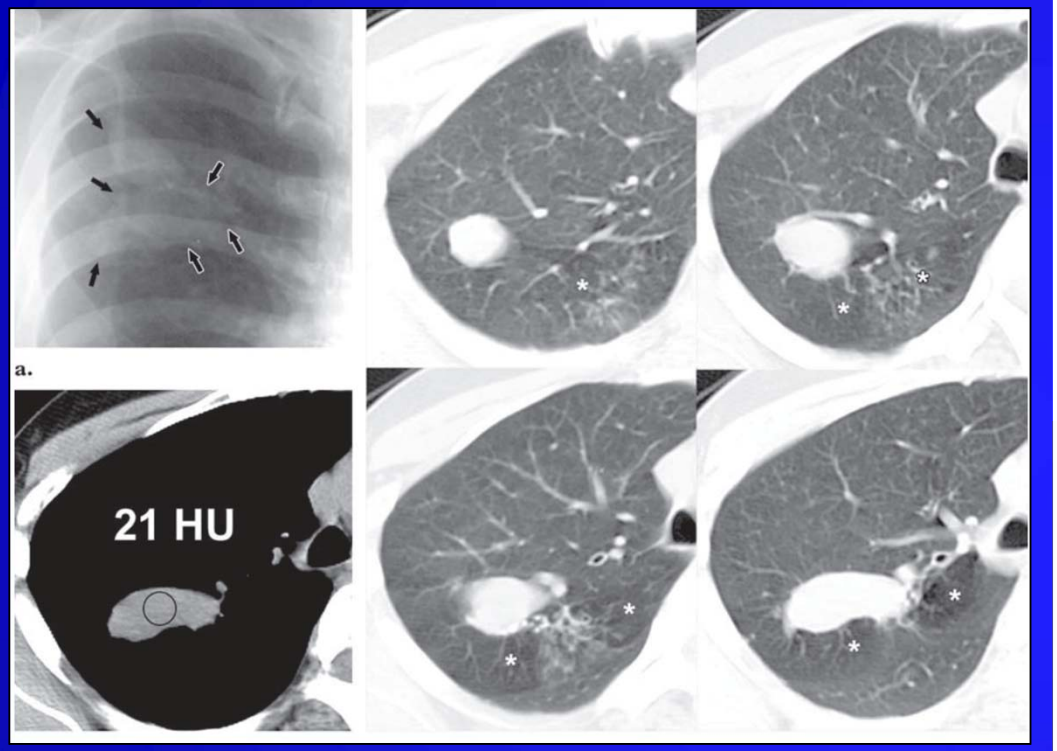
Finger-in-Glove sign





- CXR: May be difficult to differentiate mucoid impactions from other causes of tubular opacities: i.e. AVMs
- CT Characteristic features:
  - Bronchiectasis
  - Low-attenuation mucus inspissated in the bronchi
  - Clear connection with the central airways

Differential Diagnosis



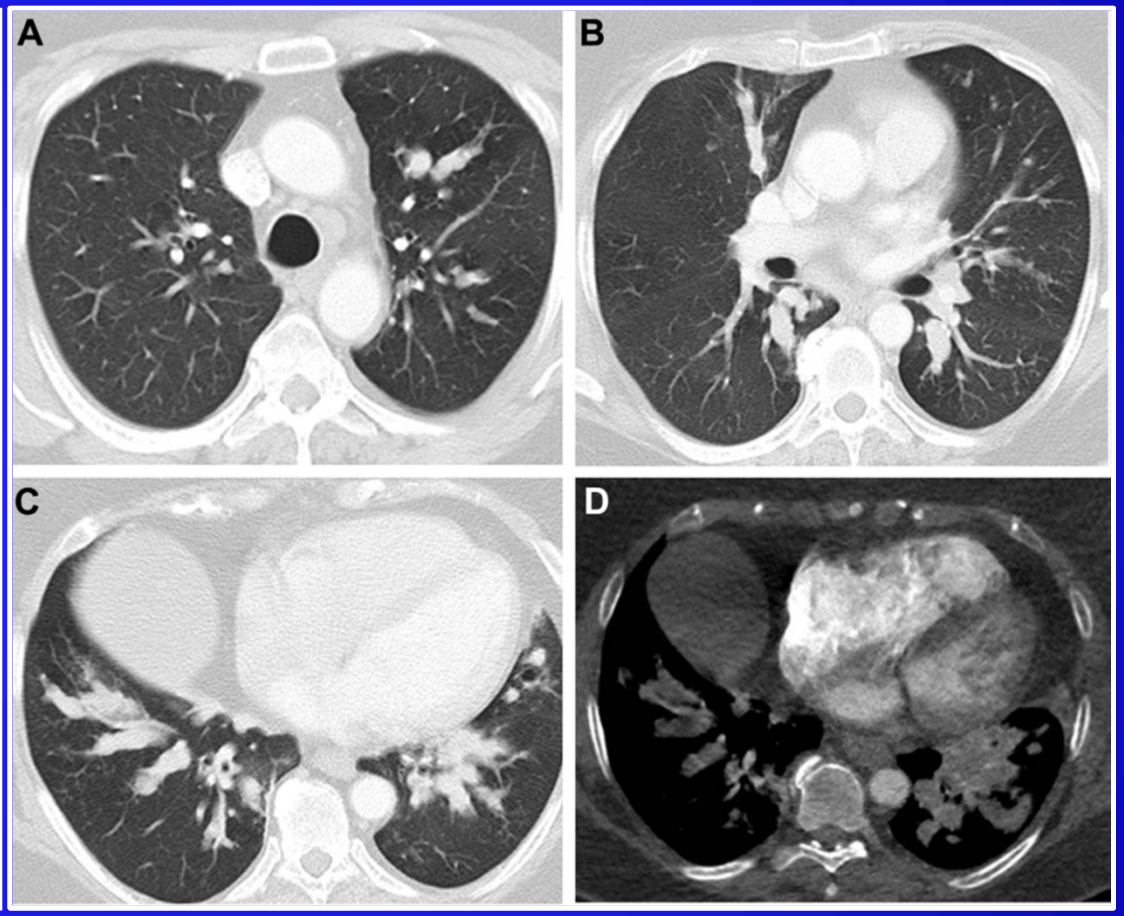
Segmental Bronchial Atresia

Martinez S, Mucoid Impactions: Finger-in-Glove Sign & Other CT & Radiographic Features. RadioGraphics 2008,28:5, 1369-1382

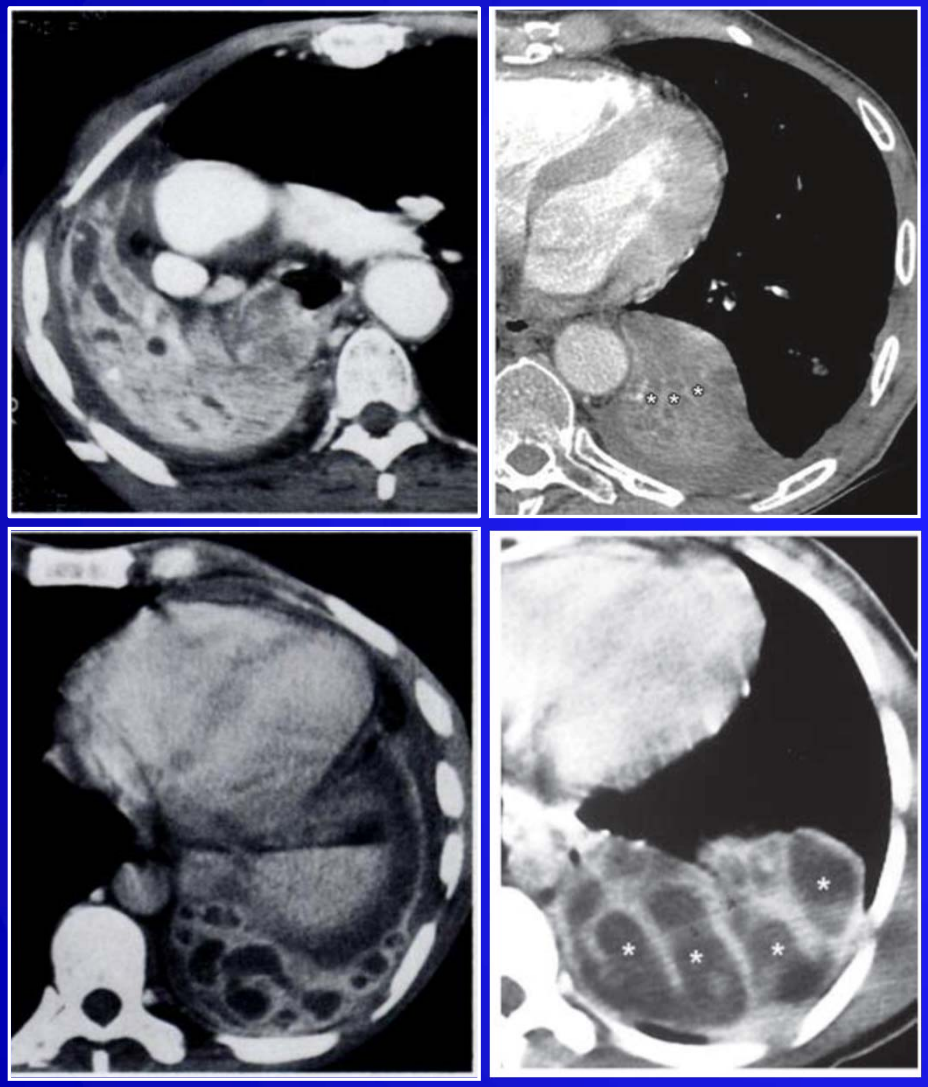
Table 1
Causes of Obstructive and Nonobstructive Mucoid Impactions

- Congenital
  - Segmental bronchial atresia
  - Cystic fibrosis
- Inflammatory-infectious
  - ABPA in asthma or cystic fibrosis*
  - Broncholithiasis
  - Foreign body aspiration
- Neoplastic
  - Benign
    - Bronchial hamartoma
    - Lipoma
    - Papillomatosis
  - Malignant
    - Bronchogenic carcinoma
    - Carcinoid tumor
    - Metastases

Finger in Glove Sign: Hyper IgE Syndrome



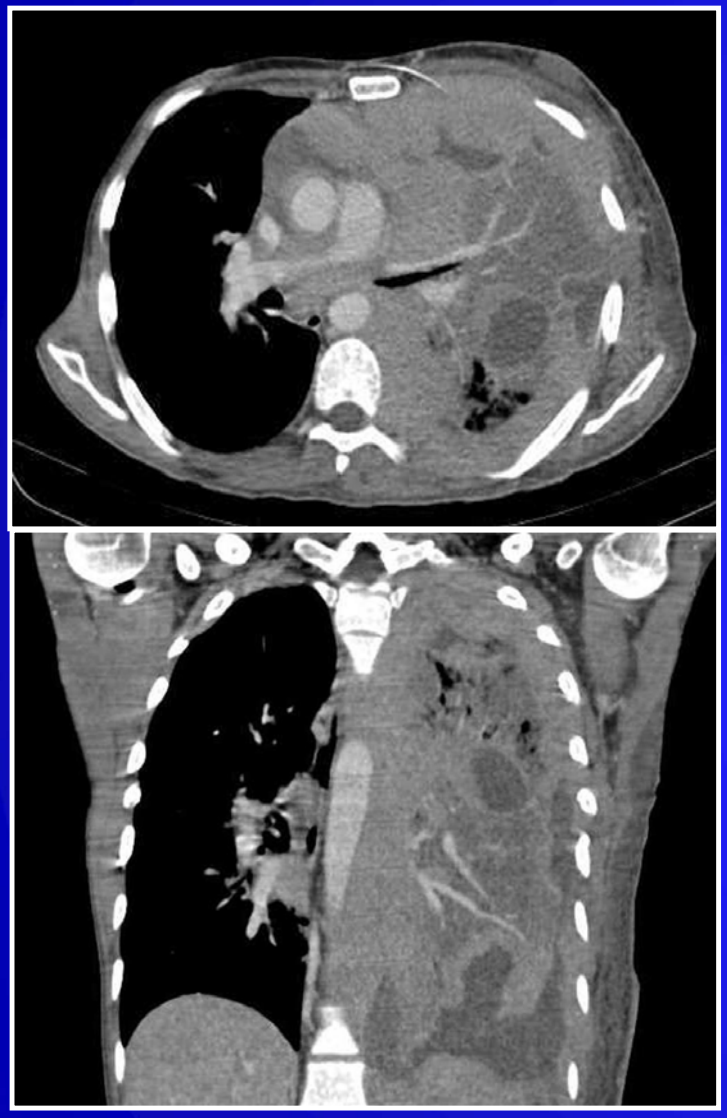
Moin M et al, Clinical & laboratory survey of Iranian pts with hyper-IgE syndrome. Scand J Infect Dis. 2006;38 (10):898-903



Mucoid or Fluid Bronchogram

- Associated sign
- Only seen on CT
- Low-density, treelike branching structures within consolidated or collapsed lung similar to air bronchograms – mucoid impaction

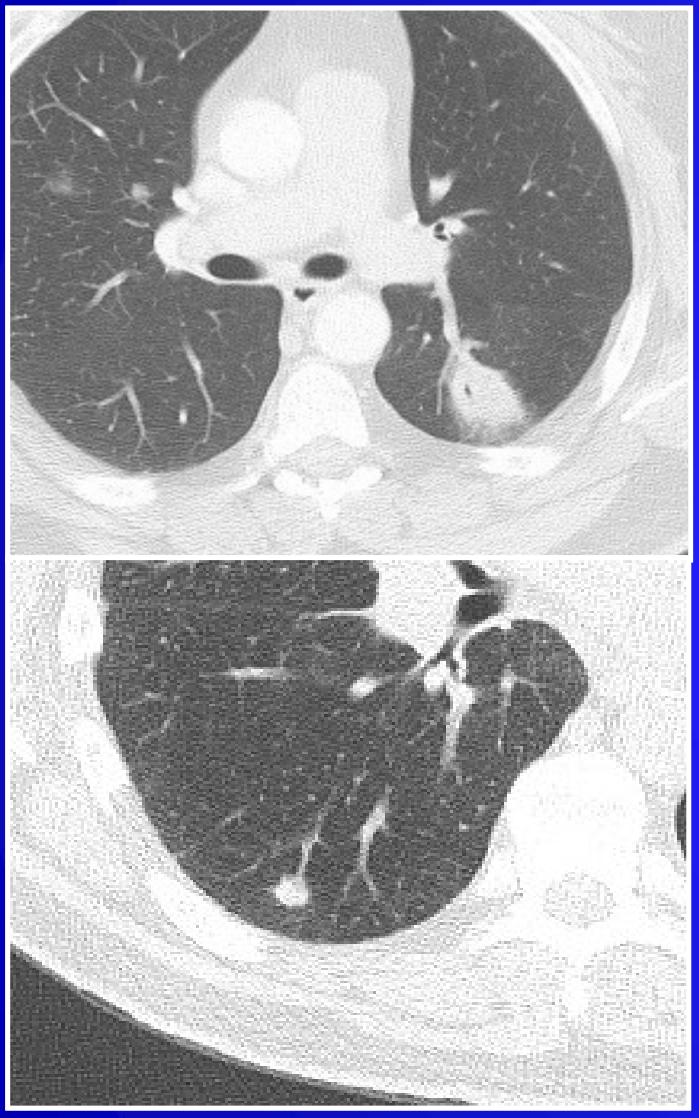
Shin M, Fluid Bronchogram: A Common Finding in Opacified Lung Requiring Contrast Medium Administration for Demonstration, Chest,1993,104 (3), 960-962, ISSN 0012-3692, https://doi.org/10.1378/chest.104.3.960



CT Angiogram Sign

- Prominent branching of pulmonary vessels traversing through a homogenous low attenuation area of lung consolidation [contrast CT]
- Differential Dx:
  - Mucinous Adenocarcinoma
  - Pulmonary Lymphoma
  - Post-obstructive Pneumonia
  - Pulmonary edema

Im JG, et al. Lobar bronchioloalveolar carcinoma: “angiogram sign” on CT scans. Radiology. 1990;176(3):749-753



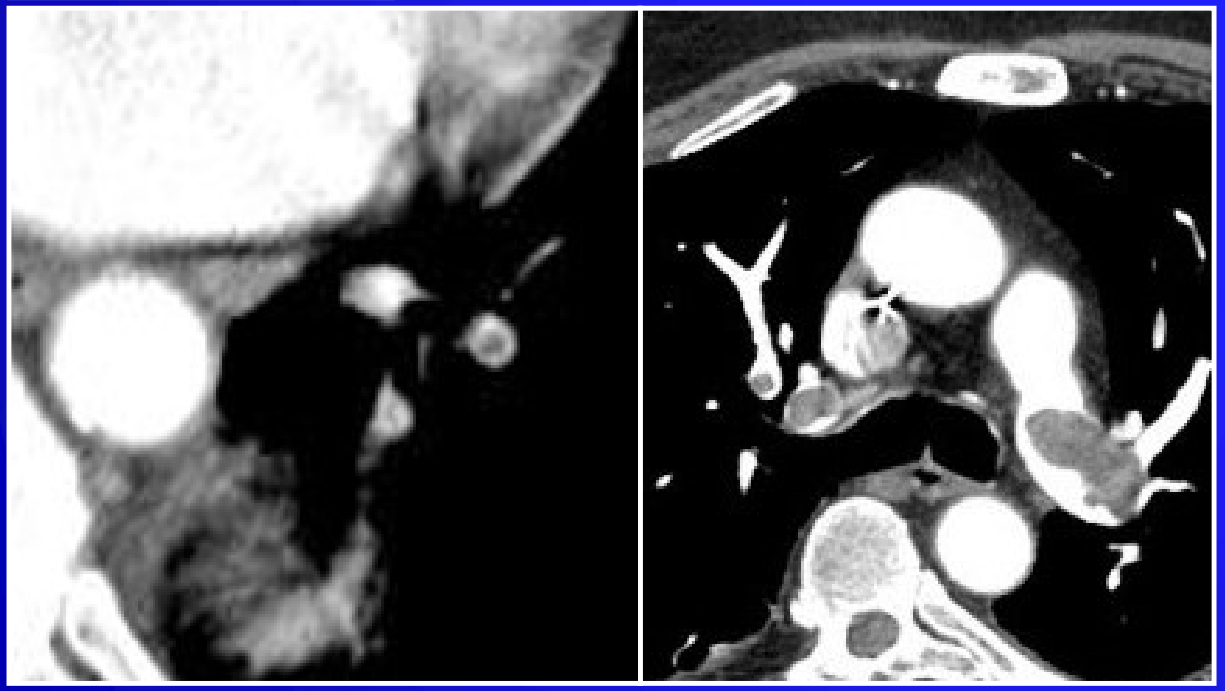
Feeding Vessel Sign

- Distinct pulmonary vessel leading into a lung nodule or mass
- Differential Dx:
  - Septic emboli
  - Pulmonary infarctions
  - Metastasis
  - Pulmonary AVMs

Iwasaki Y, et al. Spiral CT findings in septic pulmonary emboli. Eur J Radiol. 2001;37(3):190-194

Polo® Mint Sign (Nastle, UK)

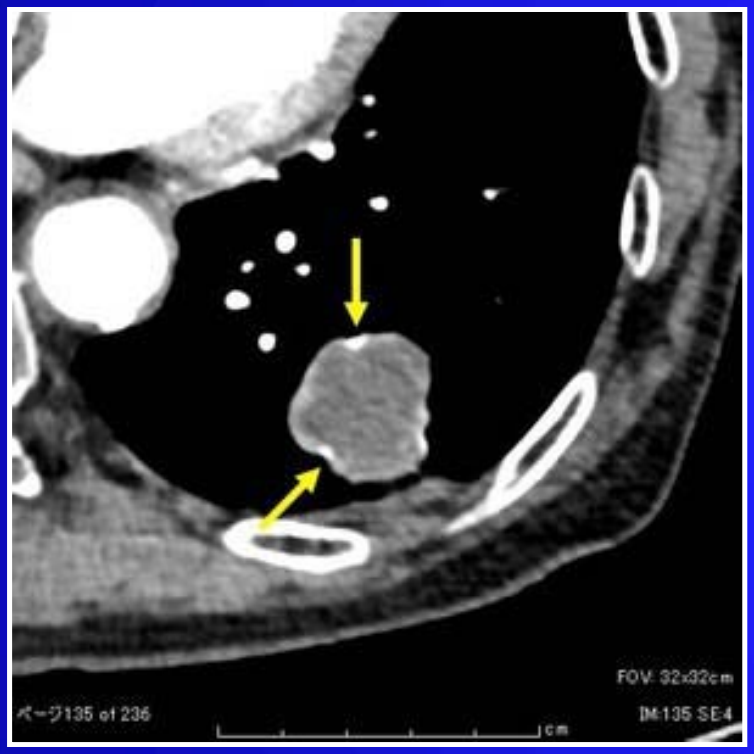
- Partial filling defect in a blood vessel surrounded by a rim contrast material on a CT angiogram images acquired perpendicular to long axis of the vessel



Differential Dx:

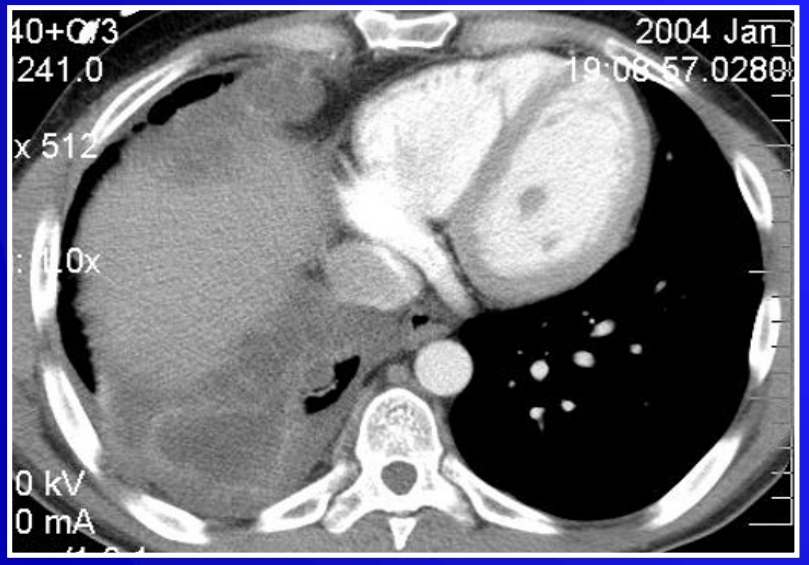
- Pulmonary embolism,
- Portal vein thrombosis

Rigler Notch Sign



- An indentation in the border of a solid lung mass, which is thought to represents a feeding vessel, thus suggesting the presence of a bronchial carcinoma
- Also observed in granulomatous infections,
- Should not be confused with the “Rigler Sign” on abdominal x-rays, which is indicative of pneumoperitoneum

Rigler L, et al, Planigraphy in the differential diagnosis of the pulmonary nodule, with particular reference to the notch sign of malignancy, Radiology,1955 Nov; 65(5):692-702



Split Pleura Sign

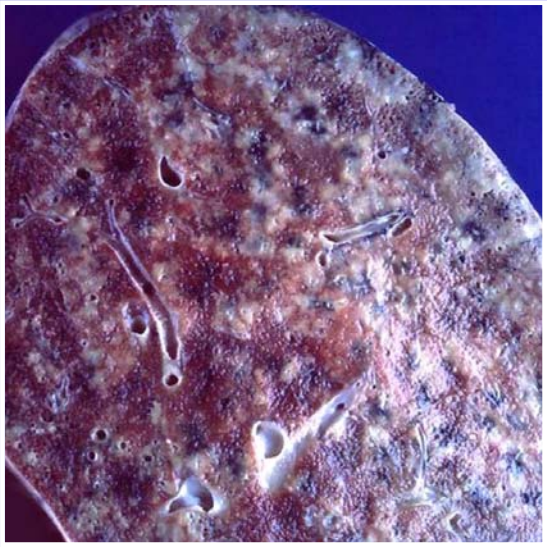
- Contrast enhancement of the parietal and visceral pleura - separated by the exudative effusion
- From fibrin deposition along the opposing pleural surfaces and ingrowth of blood vessels
- Differential Dx:
  - Empyema
  - Malignant effusions
  - Post talc pleurodesis
  - Mesothelioma
  - Hemothorax

Patterns: Not Signs

- Cannon Balls
- Miliary Pattern
- Honeycomb lung
- Swiss Cheese lung
- Saber Sheath Trachea
- Phantom Infiltrates

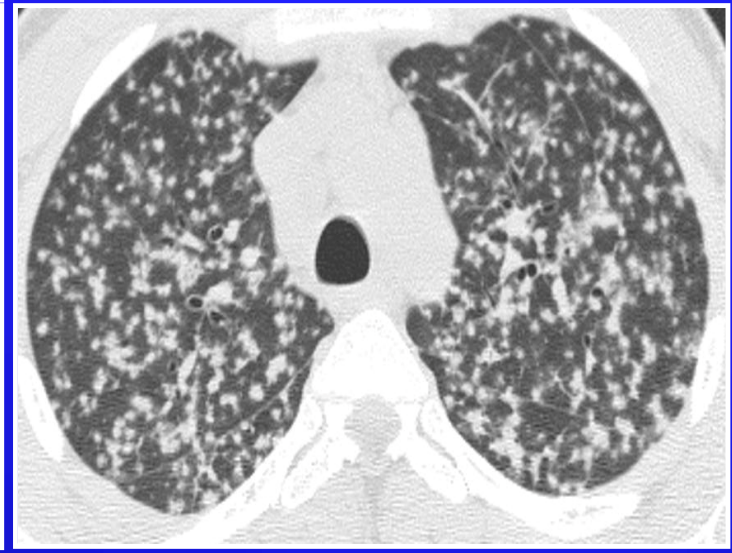
Cannon Balls

- Large, round, well circumscribed pulmonary nodules
- Differential Dx:
  - Renal Cell Carcinoma
  - Choriocarcinoma
  - Endometrial Carcinoma
  - Prostate Carcinoma



Miliary Pattern

- Diffusely distributed subcentimeter pulmonary nodules of varying sizes between 1-4 millimeters

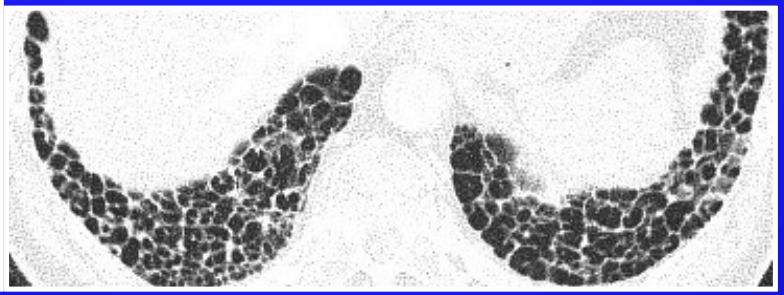


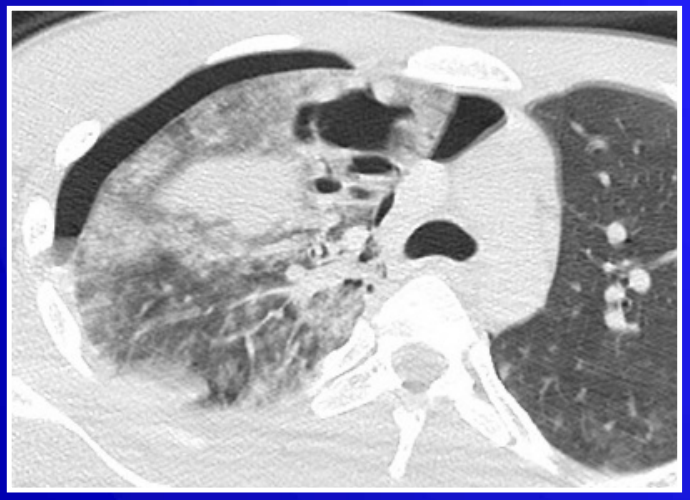
Differential Dx:

- Miliary TB
- Histoplasmosis
- Sarcoidosis
- Pneumoconiosis
- Adenocarcinoma
- Pulmonary Hemosiderosis
- Hematogenous mets: Thyroid, Renal, Trophoblast Ca

Honeycomb Lung

- Clustered cystic air spaces, typically of comparable diameters on the order of 3–10 mm but occasionally as large as 2.5 cm, usually sub-pleural and characterized by well-defined walls
- Differential Dx:
  - Usual interstitial pneumonia
  - NSIP
  - DIP
  - Acute interstitial pneumonia (AIP)





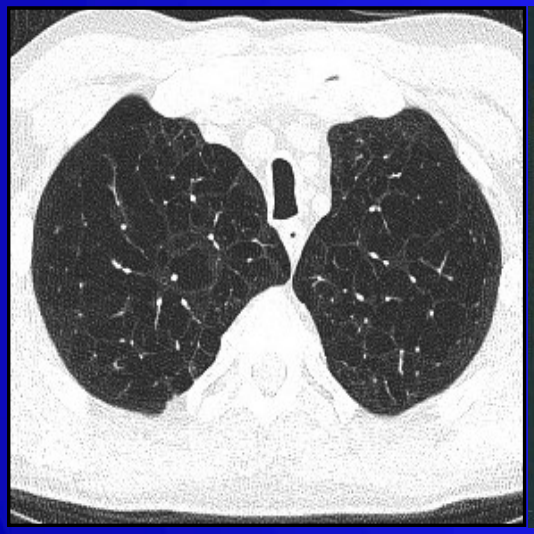
Swiss Cheese Lung

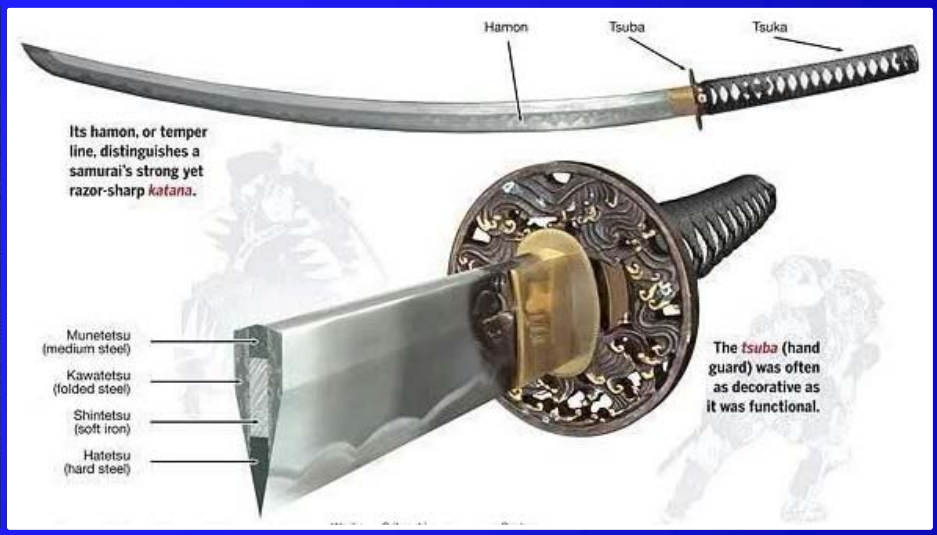
- Multiple pneumatoceles with air-fluid levels, called hematopneumatoceles
- Differential Dx:
  - Blunt trauma induced pulmonary lacerations

Shine Raju S, Ghosh S, Mehta AC, Chest CT Signs in Pulmonary Disease :A Pictorial Review, CHEST [In press]

Saber Sheath Trachea

- Lengthening of the trachea in its antero-posterior dimension in the coronal plane, in absence of mediastinal pathology
  - Limited to the intrathoracic portion
  - COPD and chronic bronchitis (30%)





Ismail S, Mehta AC, J Bronchology & Interventional Bronchology, 2003, 10 (4): 296-297

Phantom Infiltrates

Bayer AS, CHEST, 79: (5), 1981, 575

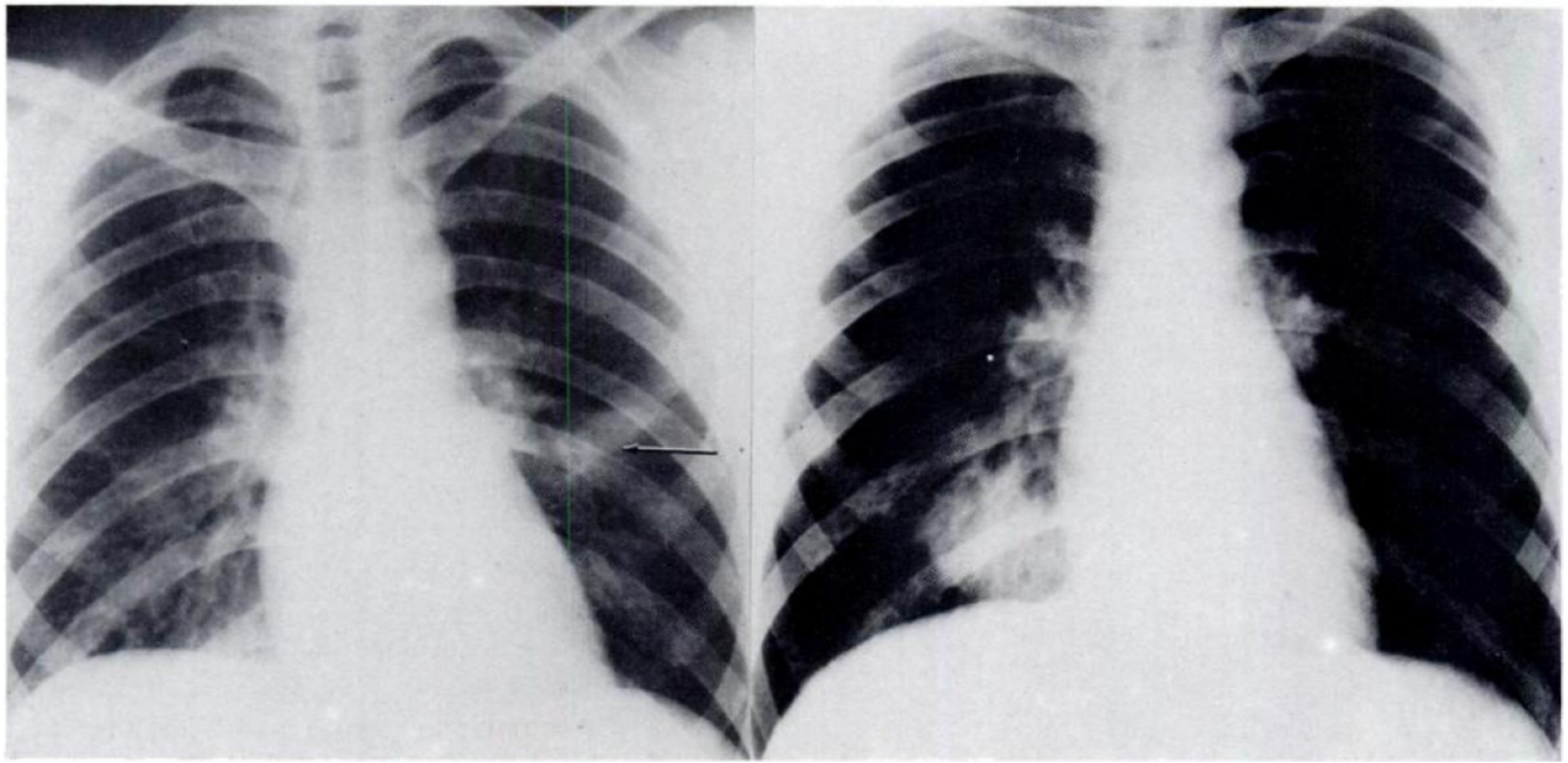
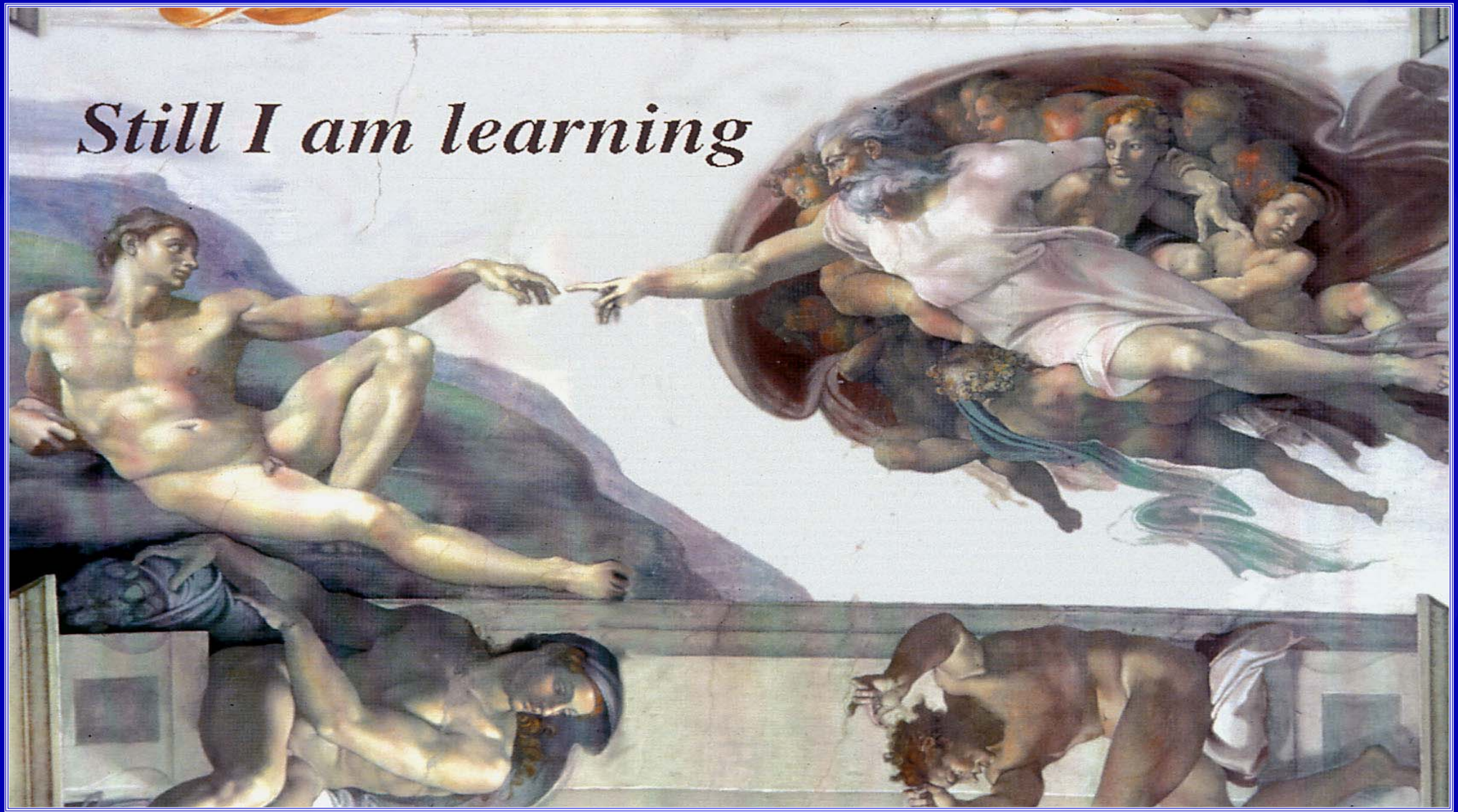


FIGURE 2A *(left)*. Acute (1°) pulmonary coccidioidomycosis. Left lingular infiltrate *(arrow)*. FIGURE 2B *(right)*. Same patient as in 2A, seven days later. Note disappearance of left lung infiltrate and appearance of new lesion in right lower lobe ("phantom infiltrate").

Summary

- Reading CXR is lost art!
- Physicians' reliance on CT Scan of the chest has increased exponentially
- Screening for Lung Ca will further increase number of CT performed
- 7.5% of screening CT show abnormalities other than Lung Ca*
- Metaphorical CT signs are of vital importance not only to diagnose but also to exclude other diseases
- With appropriate clinical and laboratory correlation, many of these signs can be pathognomonic for a particular disease entity
- Pattern recognition approach can definitely help in narrowing the differential diagnosis
- Add to the uniformity in reporting

*Reduced Lung-Cancer Mortality with LDCT Screening, N Engl J Med, 2011, 365;5, 395


Still I am learning