空洞性病變與囊泡病變

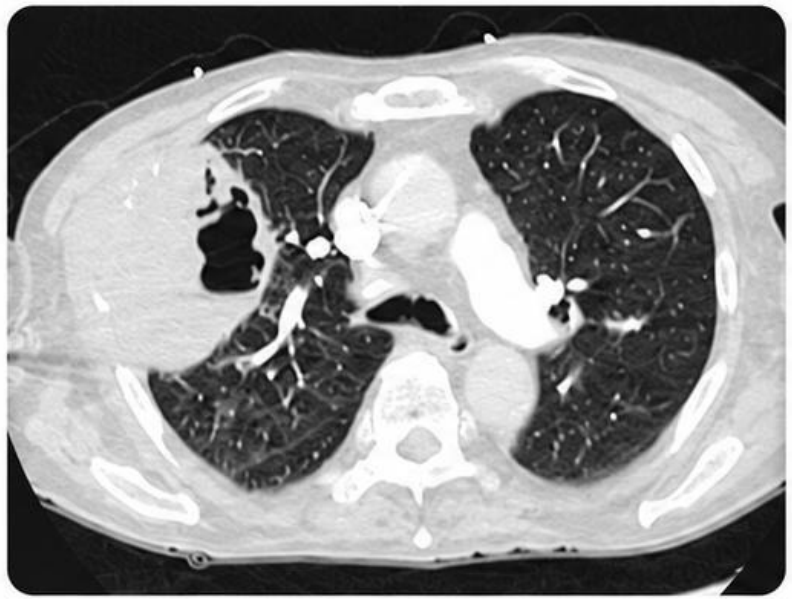
胡耕寧 醫師

Fleischner Society Definitions of Air-Filled Pulmonary Lesions

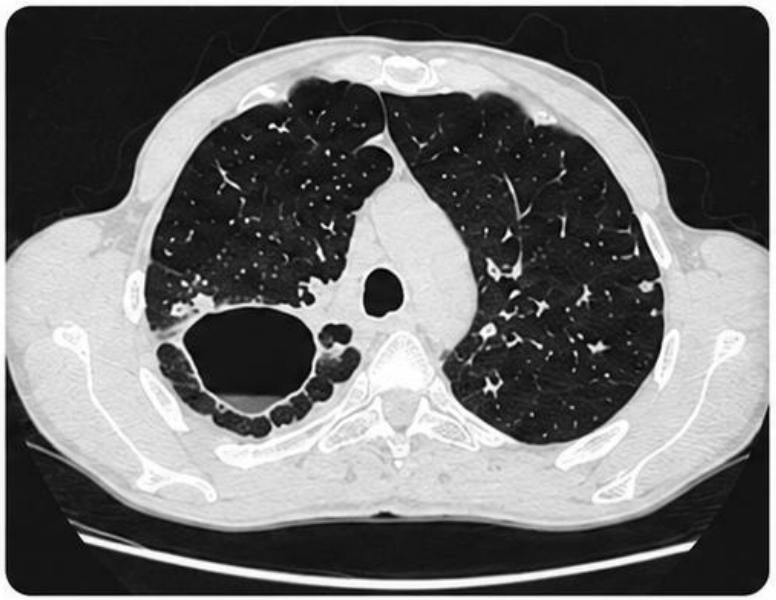
Term	Fleischner Society Definition	Wall Thickness	Typical Size	Key Features
Cavity	A gas-filled space, seen as a lucency or low-attenuation area, **within pulmonary consolidation, a mass, or a nodule**. The wall thickness may vary.	Variable (often thick)	Variable	Develops within a pre-existing lesion, usually due to necrosis.
Cyst	A round parenchymal lucency or low-attenuation area with a **well-defined epithelial or fibrous wall, usually <2 mm thick**. It is usually air-filled but may occasionally contain fluid or solid material.	Usually <2 mm	Variable	True thin-walled air-containing lesion.
Bulla	An airspace measuring **>1 cm** in diameter, usually accompanied by emphysema and possessing a **very thin wall (<1 mm)**.	Usually <1 mm	>1 cm	Results from destruction and confluence of alveoli in emphysema.
Bleb	A **small (<1–2 cm) subpleural collection of air**, usually located at the lung apex between the visceral pleura and lung parenchyma.	Imperceptible or <1 mm	<1–2 cm	Common cause of primary spontaneous pneumothorax.
Pneumatocele	A **transient, thin-walled, gas-filled lesion** developing within the lung, most commonly following infection, trauma, or positive-pressure ventilation.	Thin	Variable	Usually reversible.
Emphysema	Permanent enlargement of airspaces distal to the terminal bronchiole accompanied by **destruction of alveolar walls**, without obvious fibrosis.	No true wall	Variable	Represents destruction of lung parenchyma rather than a true cystic lesion.

Cavity

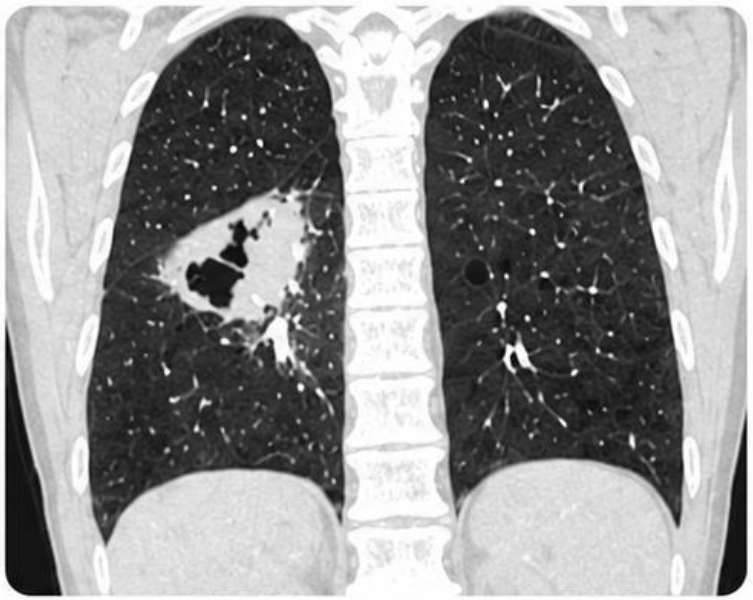
- Located **within a pulmonary nodule, mass, or consolidation**
- Usually caused by **necrosis**
- Wall thickness ranges from **thin** to **thick**
- May contain an **air-fluid level**



Thick-walled cavity
within consolidation



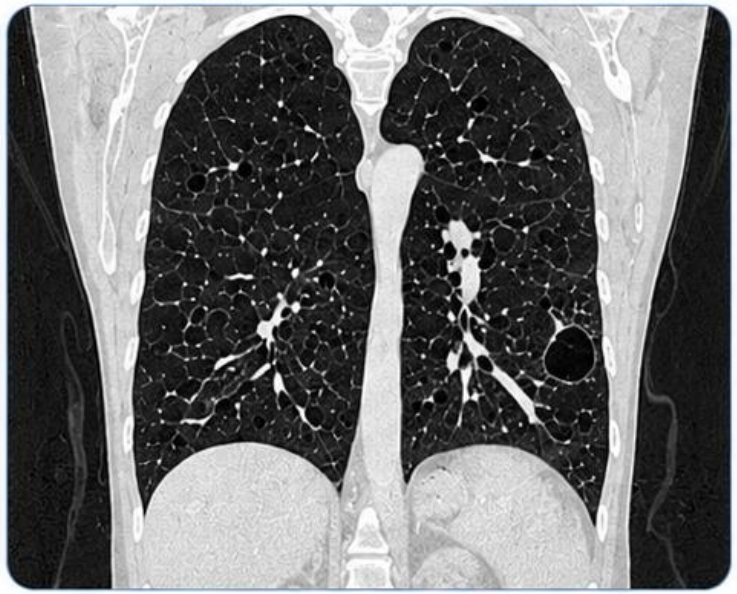
Cavity with air-fluid level
within mass



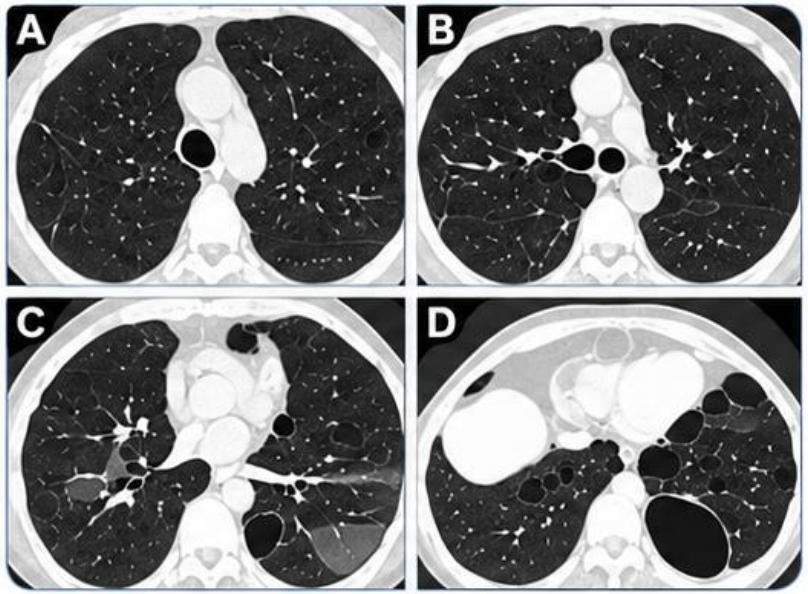
Cavity within nodule
in the right upper lobe

Cyst

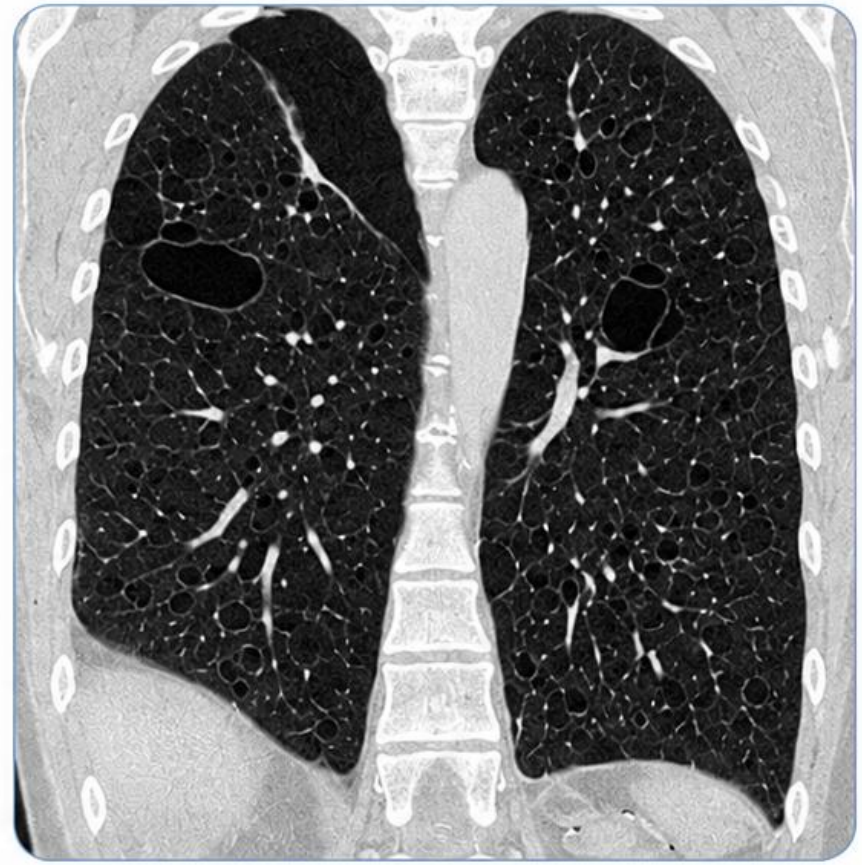
- Round, **well-circumscribed** lesion
- Thin wall (**<2 mm**)
- Surrounded by **relatively normal lung**
- May contain **air, fluid, or soft tissue**



Well-circumscribed thin-walled cyst
in the left lower lobe



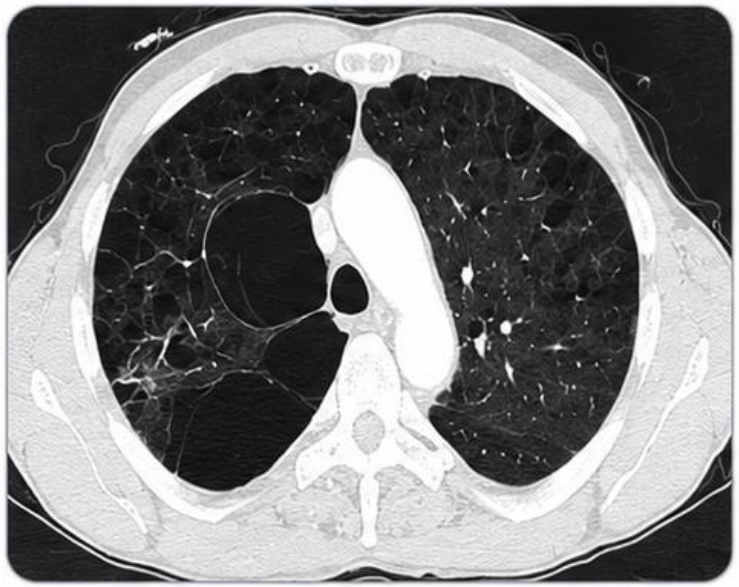
Cysts with different contents:
(A, B) air; (C) fluid;



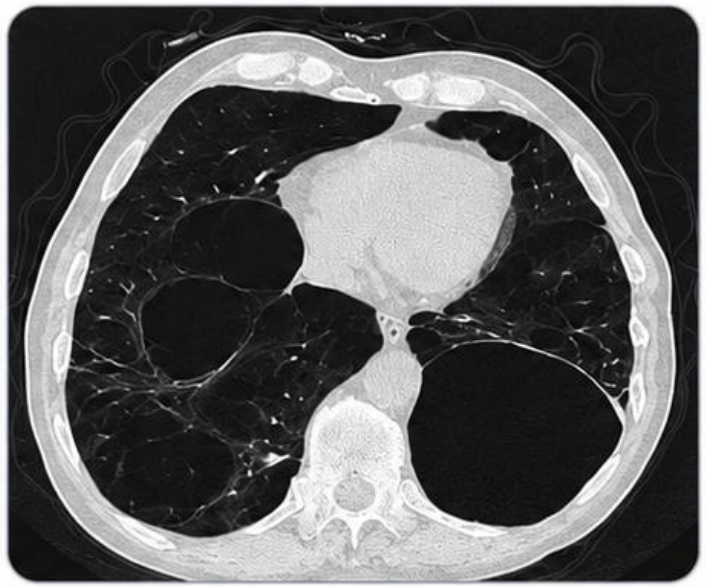
Multiple thin-walled cysts
in both lungs

Bulla

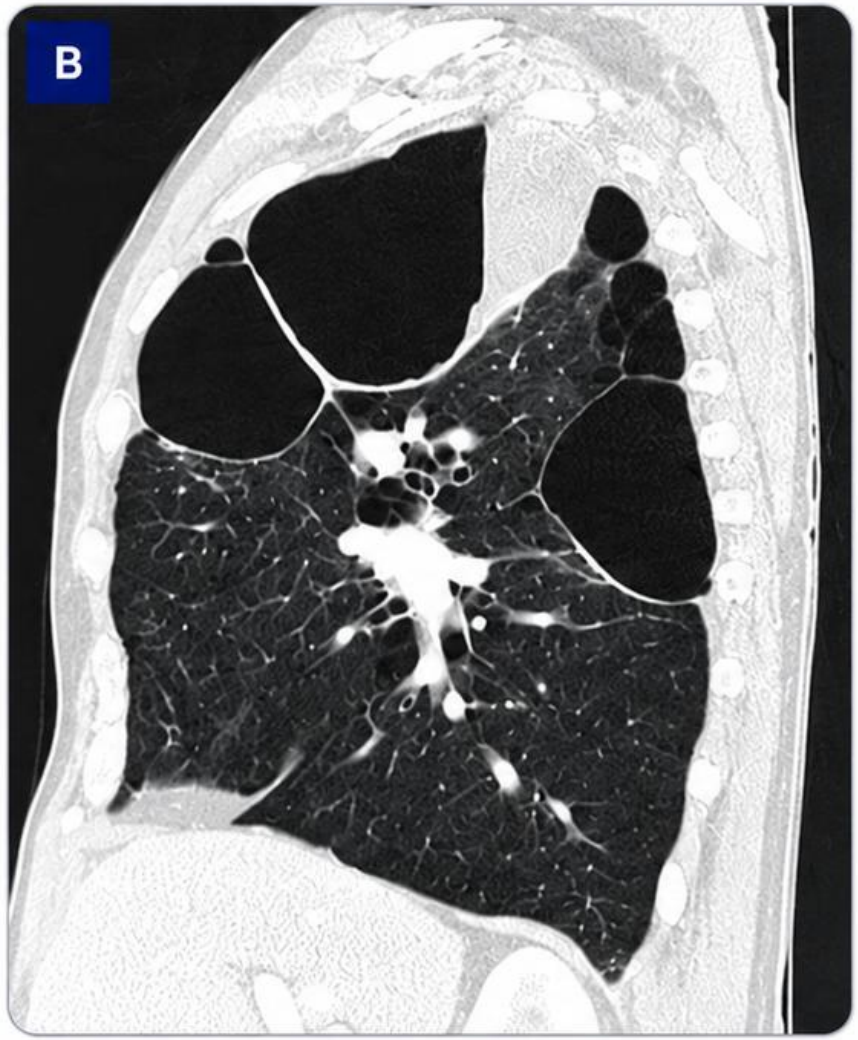
- Airspace **>1 cm**
- Wall usually **<1 mm**
- Associated with **emphysema**
- Often **subpleural**



Bilateral apical bullae with emphysema



Large bulla (>1 cm) with very thin wall

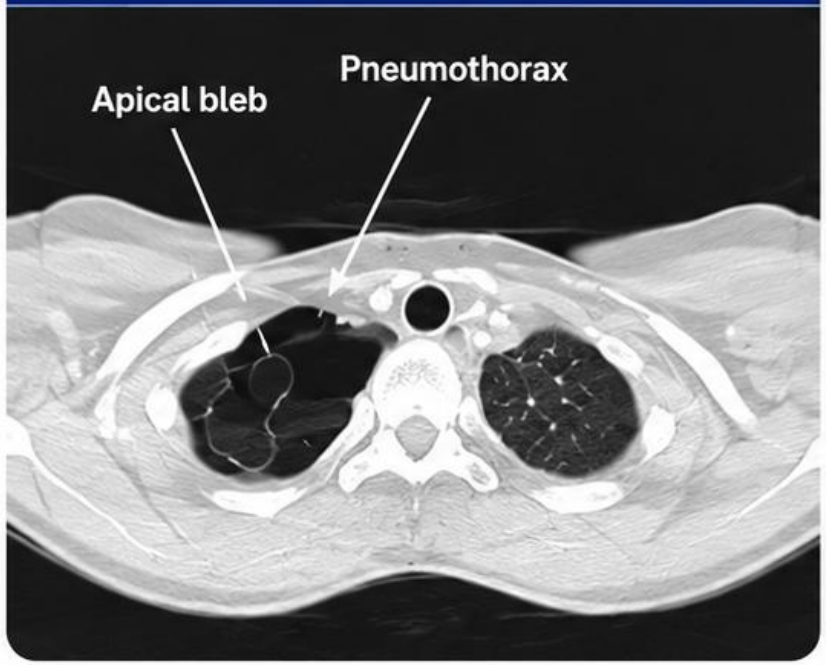


Multiple large subpleural bullae in the upper lobe

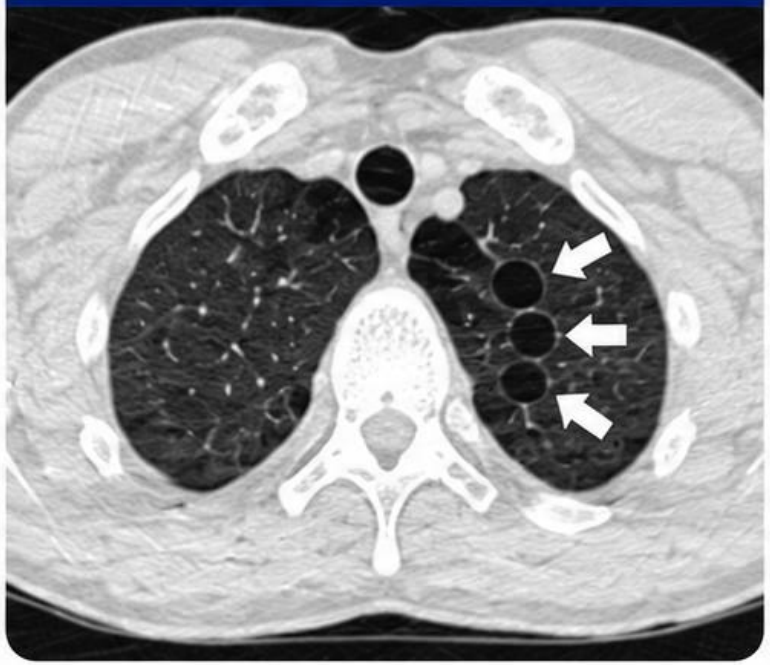
Bleb

- Small **subpleural air collection**
- Usually at the **lung apex**
- **Not** considered a **true cyst**

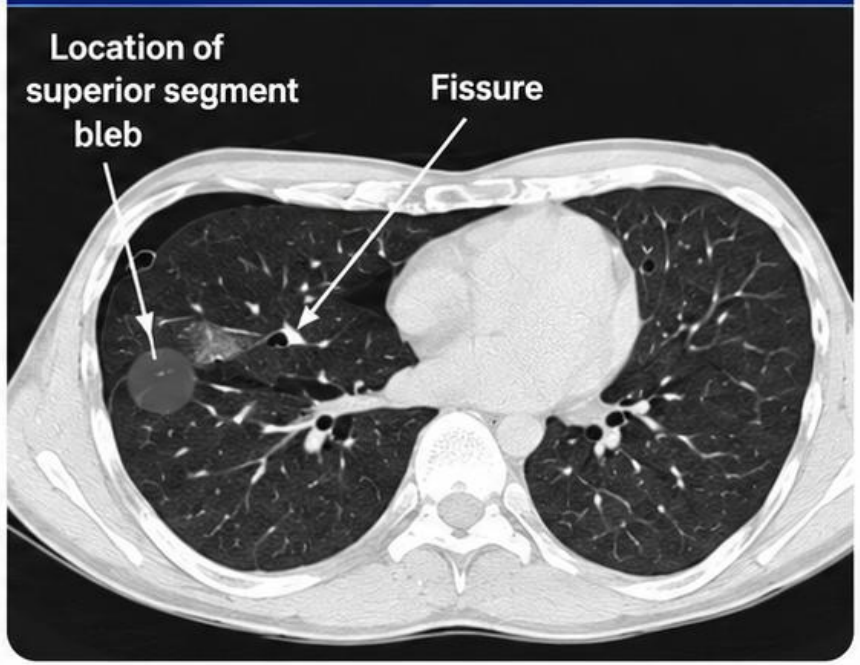
Apical bleb with pneumothorax



Multiple apical blebs

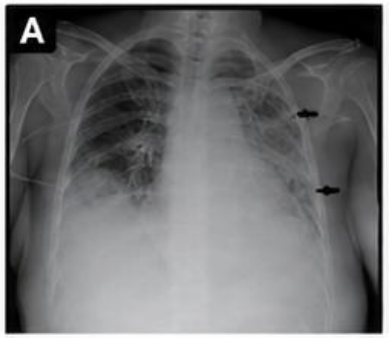


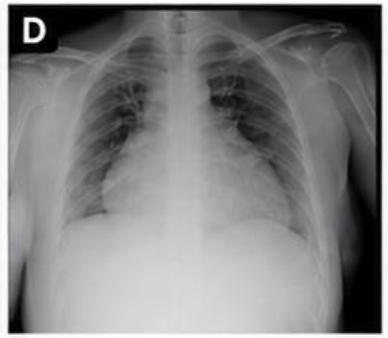
Subpleural bleb with fissure

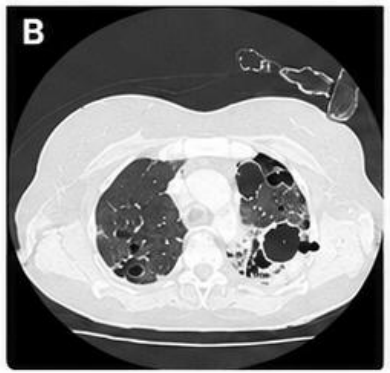


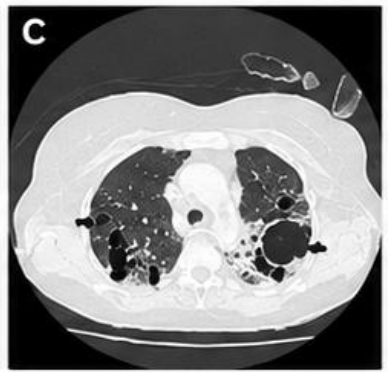
Pneumatocele

- **Thin-walled** air-filled cavity
- Usually **temporary**
- May **enlarge** or **completely resolve** over time

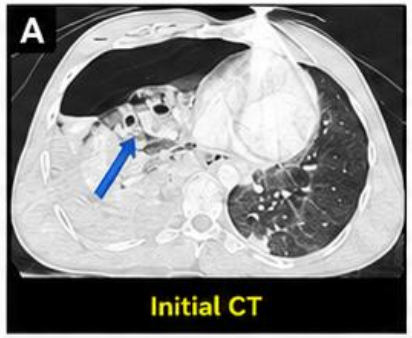


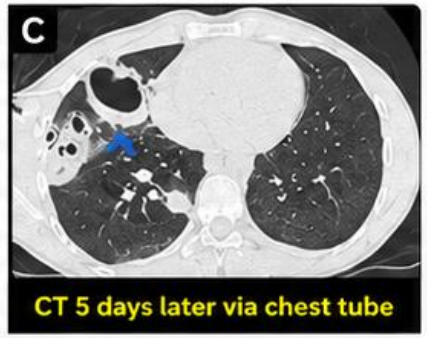


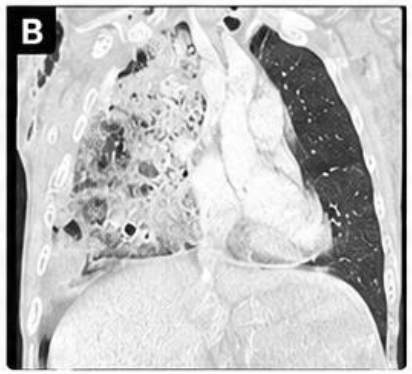




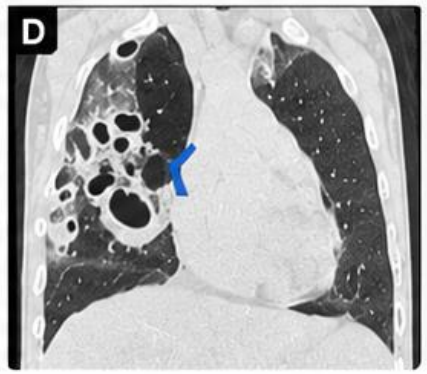
Chest radiograph:
initial (A) and follow-up (D)



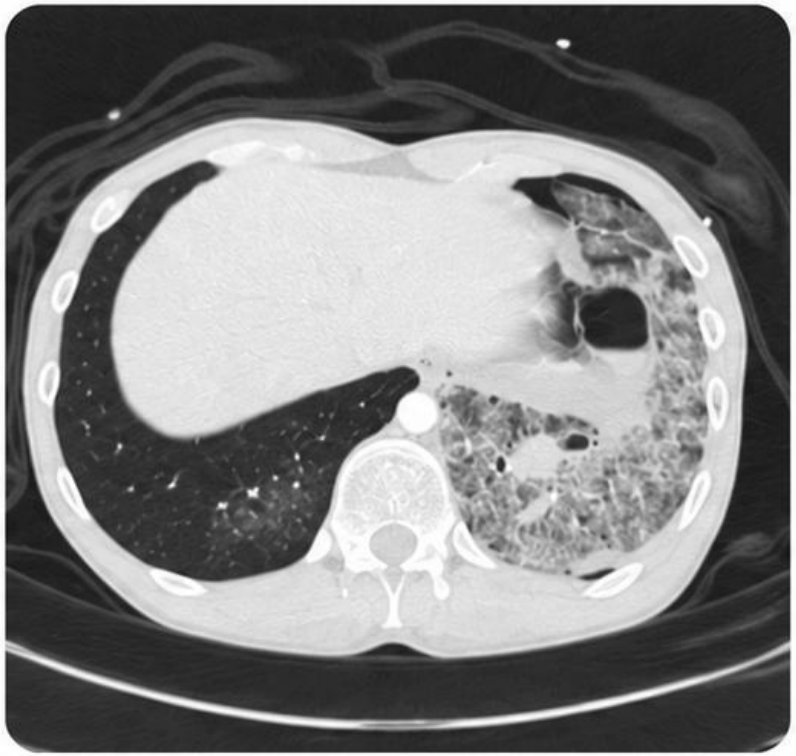




CT progression:
enlargement of pneumatocele



CT after drainage:
gradual resolution



Large pneumatocele
with surrounding consolidation

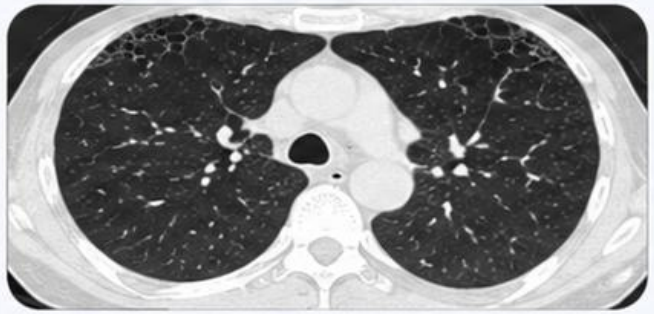
Emphysema

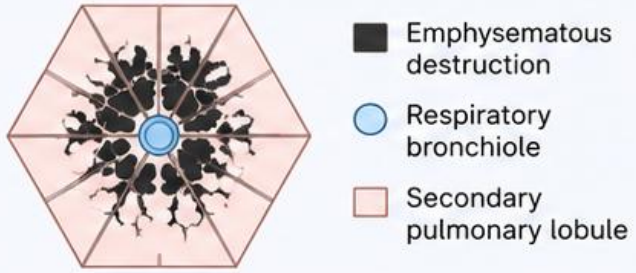
- Characterized by destruction of alveolar walls **without formation of a true epithelial-lined cyst.**

Subtypes

1. Centrilobular emphysema (CLE)

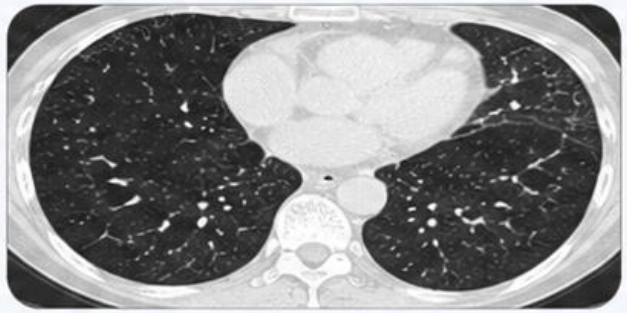
- Most common; strongly associated with smoking
- Affects the center of secondary pulmonary lobule (respiratory bronchiole)
- Predominantly in **upper lobes**

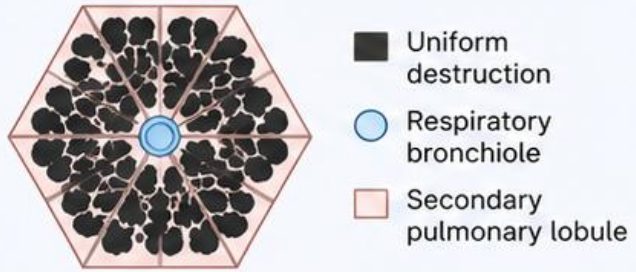




2. Panlobular emphysema (PLE)

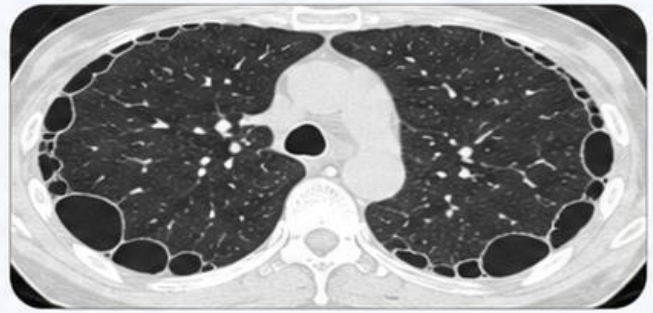
- Associated with α1-antitrypsin deficiency
- Uniform involvement of the entire secondary pulmonary lobule
- Predominantly in **lower lobes**

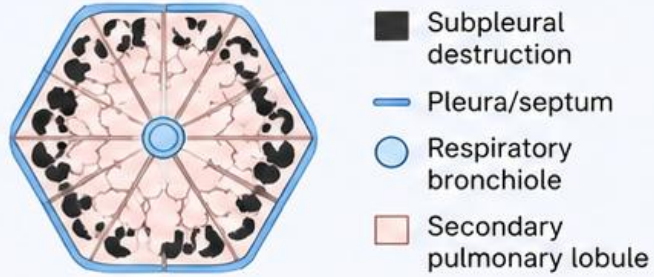




3. Paraseptal emphysema (PSE)

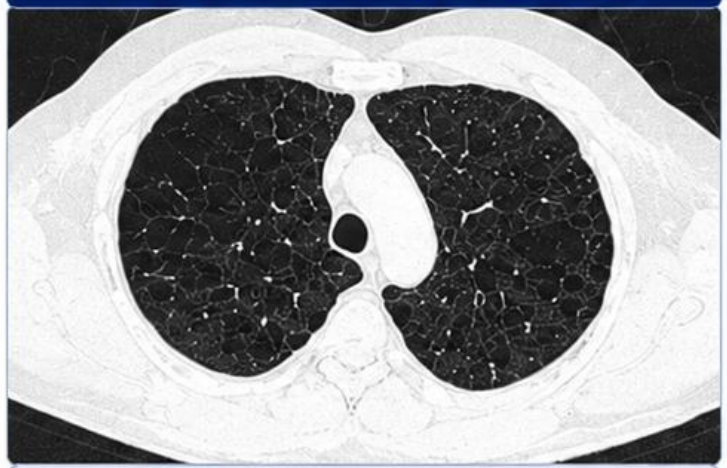
- Involves alveoli adjacent to pleura and interlobular septa
- Can lead to formation of bullae and pneumothorax
- Predominantly in upper lobes





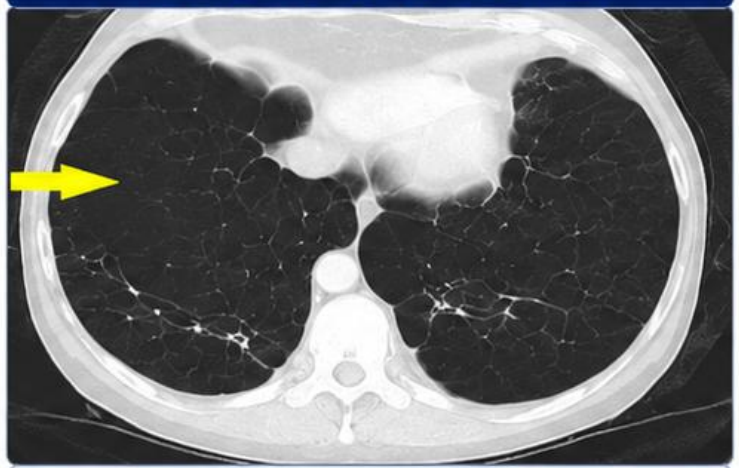
Type	Typical CT Appearance	Distribution	Typical Association
Centrilobular emphysema (CLE)	Multiple small, ill-defined low-attenuation areas without visible walls	**Upper lobes**, centered in the secondary pulmonary lobule	**Smoking** (most common)
Panlobular (Panacinar) emphysema (PLE)	Uniform diffuse low attenuation involving the entire acinus	**Lower lobes**	**α1-antitrypsin deficiency**
Paraseptal emphysema (PSE)	Subpleural elongated airspaces arranged in a single layer; may coalesce into bullae	**Peripheral lung adjacent to pleura or fissures**, often upper lobes	**Spontaneous pneumothorax**, bullae formation

Centrilobular emphysema (CLE)



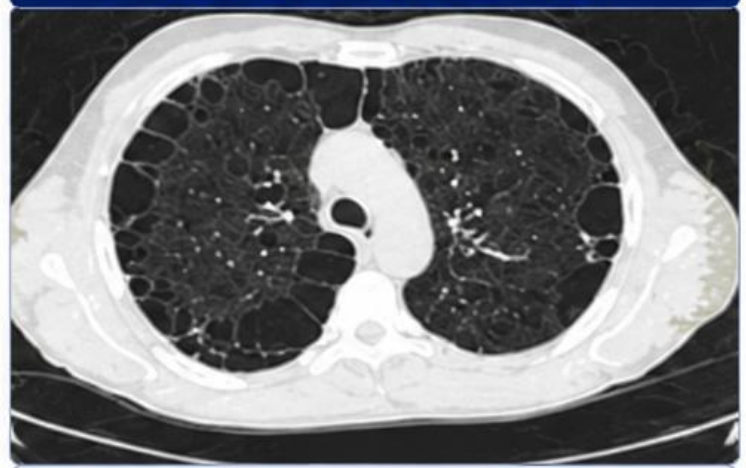
Multiple small, ill-defined low-attenuation areas without visible walls in the upper lobes.

Panlobular emphysema (PLE)



Uniform diffuse low attenuation involving the entire acinus, predominantly in the lower lobes.

Paraseptal emphysema (PSE)



Subpleural elongated airspaces in a single layer adjacent to the pleura, often in the upper lobes.

Comparison of Air-Filled Pulmonary Lesions

Feature	Cavity	Cyst	Bulla	Bleb	Pneumatocele	Emphysema
True wall	✓	✓	Very thin	Minimal	✓	✗
Wall thickness	Variable	< 2 mm	< 1 mm	Imperceptible	Thin	None
Develops within another lesion	✓	✗	✗	✗	✗	✗
Associated with emphysema	Occasionally	✗	✓	Sometimes	✗	✓
Usually reversible	Rarely	No	No	No	**Yes**	No
Typical mechanism	Necrosis	Cyst formation	Alveolar destruction	Subpleural air collection	Post-infectious/ traumatic	Alveolar wall destruction

A Structured Diagnostic Approach

Why is a systematic approach important?

- Cavitary and cystic lung diseases encompass a **broad spectrum** of infectious, inflammatory, congenital, smoking-related, and neoplastic disorders.

- Because many diseases share similar imaging appearances, diagnosis should rely on a **systematic evaluation** of lesion morphology, distribution, associated CT findings, and clinical context rather than on a single imaging feature.

HRCT INTERPRETATION CHECKLIST

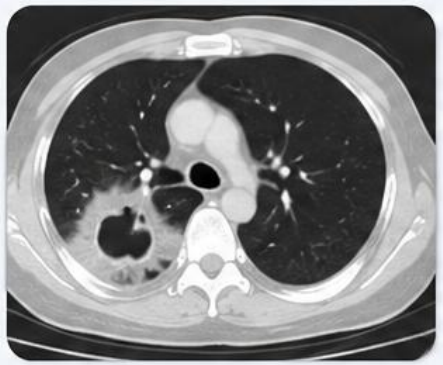
Step	Question	What to look for / Examples
1	How many lesions?	Single; Multiple • Solitary • Multiple / Diffuse
2	Where are the lesions distributed?	Subpleural; Peribronchovascular / Central; Random (Intraparenchymal); Diffuse • Upper / Middle / Lower lung zone • Peripheral vs Central • Focal / Multifocal / Diffuse
3	What are the wall characteristics?	Thin (≤ 2 mm); Thick (> 2 mm); Irregular; Nodular thickening • Wall thickness (thin / thick) • Inner margin (smooth / irregular) • Outer margin (smooth / lobulated) • Presence of wall nodules
4	What is inside the lesion?	Air (Air density); Fluid (Homogeneous); Soft tissue (Soft tissue density); Fungus ball (Intracavitary mass); Air-fluid level (Fluid + Air) • Air only • Fluid • Soft tissue / Solid component • Fungus ball • Air-fluid level
5	Are there associated CT findings?	Nodules; Ground-glass opacity; Bronchiectasis; Honeycombing; Fibrosis; Lymphadenopathy; ... • Nodules / Ground-glass opacities • Bronchiectasis • Consolidation • Emphysema / Honeycombing • Pleural effusion / Lymphadenopathy
6	Does the clinical context support the diagnosis?	Age; Sex; Smoking history; Immune status; Infection risk; Genetic / Family history; Past medical history • Age / Sex • Smoking history • Immune status / Infection risk • Congenital or genetic disease • Past medical history

Integrate all imaging features with clinical context → Reach the most likely diagnosis

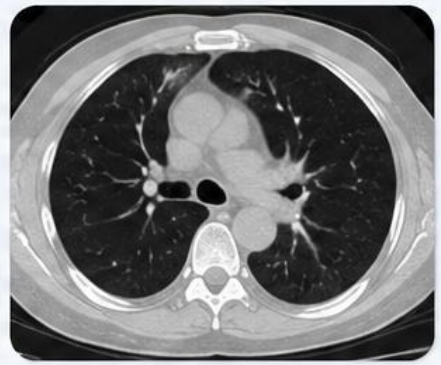
Step 1. Single or Multiple Lesions?

Solitary lesion

- Primary lung cancer
- Lung abscess
- Tuberculosis
- Fungal infection
- Congenital bronchogenic cyst (if fluid-filled)



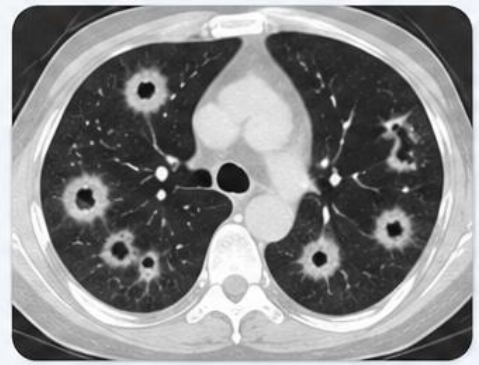
Lung abscess



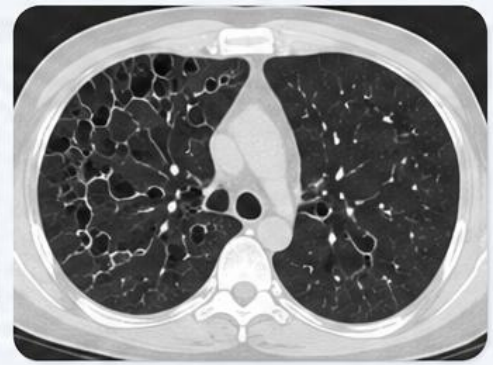
Primary lung cancer (cavitary)

Multiple lesions

- Septic pulmonary emboli
- Granulomatosis with polyangiitis
- Cavitating pulmonary metastases
- Pulmonary Langerhans cell histiocytosis (PLCH)
- Lymphangioleiomyomatosis (LAM)
- Lymphoid interstitial pneumonia (LIP)



Septic pulmonary emboli



Pulmonary Langerhans cell histiocytosis (PLCH)

Multiple lesions usually indicate a systemic disease rather than a localized process.

Step 1. Single or Multiple Lesions?

Solitary lesion

- Primary lung cancer
- Lung abscess
- Tuberculosis
- Fungal infection
- Congenital bronchogenic cyst (if fluid-filled)

Multiple lesions

- Septic pulmonary emboli
- Granulomatosis with polyangiitis
- Cavitating pulmonary metastases
- Pulmonary Langerhans cell histiocytosis (PLCH)
- Lymphangioleiomyomatosis (LAM)
- Lymphoid interstitial pneumonia (LIP)

Multiple lesions usually indicate a systemic disease rather than a localized process.

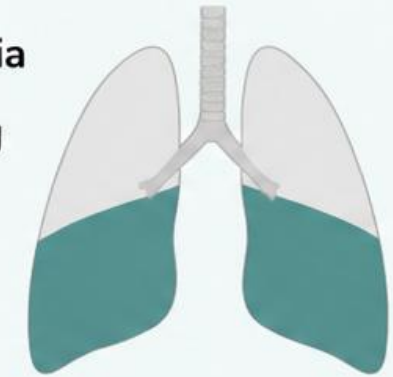
Step 2. Evaluate Distribution

Upper lung predominance

- Pulmonary tuberculosis
- PLCH
- Smoking-related emphysema
- Chronic cavitary aspergillosis

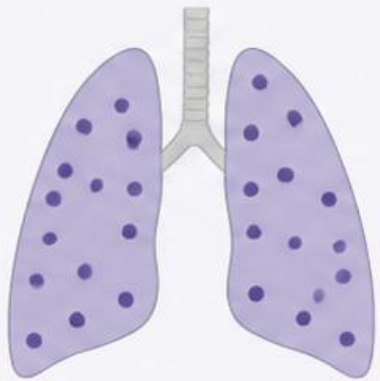
Lower lung predominance

- Lymphoid interstitial pneumonia
- Fibrosis-related honeycombing
- Amyloidosis



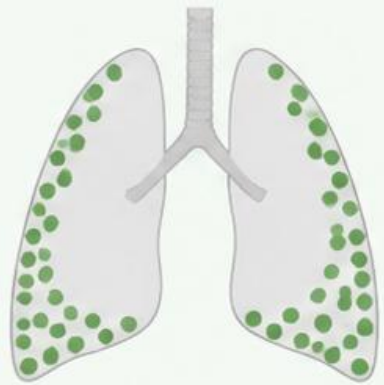
Diffuse distribution

- LAM
- Birt–Hogg–Dubé syndrome
- Pneumocystis jirovecii pneumonia
- Diffuse emphysema



Peripheral predominance

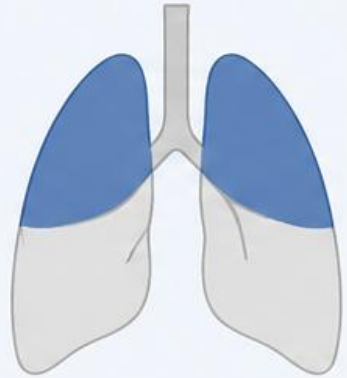
- Septic emboli
- Rheumatoid nodules
- Pulmonary infarction



Step 2. Evaluate Distribution

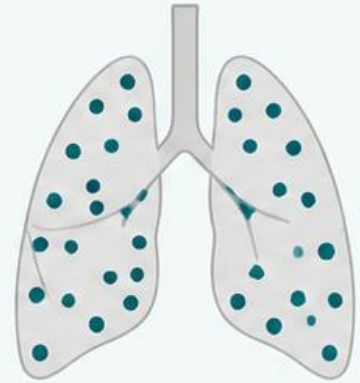
Upper Lung Disease

- Predominantly upper lobes
- Relative sparing of lung bases
- Frequently associated with smoking or tuberculosis



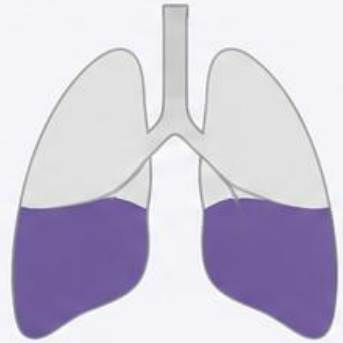
Diffuse Disease

- Uniform bilateral involvement
- Symmetric distribution
- Suggests diffuse cystic lung disease



Lower Lung Disease

- Basal predominance
- Frequently associated with autoimmune disease or pulmonary fibrosis



Teaching Pearl

- Always assess the entire lung before focusing on an individual lesion.

Step 3. Wall Characteristics

3.1 Assess Wall Thickness

3.2 Evaluate the Inner Margin

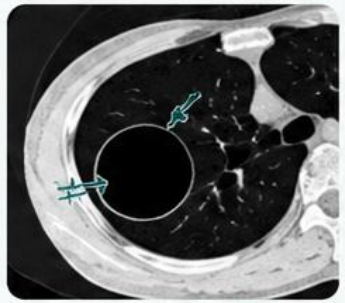
3.3 Wall Morphology

Step 3.1 Assess Wall Thickness

Wall thickness **reflects the underlying pathological process**.

Thin wall (<2 mm)

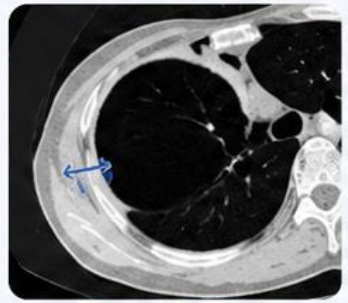
- Pulmonary cyst
- LAM
- BHD syndrome
- Pneumatocele



< 2 mm

Intermediate wall (2–4 mm)

- Resolving infection
- Chronic inflammatory lesions



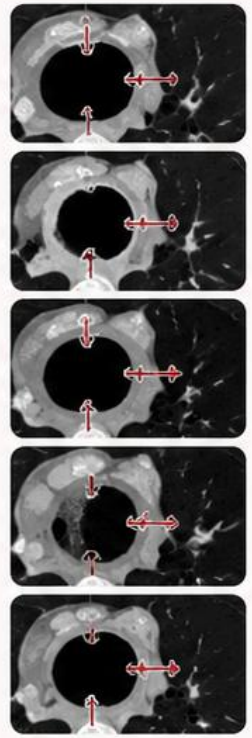
2–4 mm

Wall thickness helps narrow the differential diagnosis.

Thick wall (>4 mm):

Suggests active destructive disease.

- Squamous cell carcinoma
- Lung abscess
- Tuberculosis
- Necrotizing pneumonia
- Granulomatosis with polyangiitis



> 4 mm

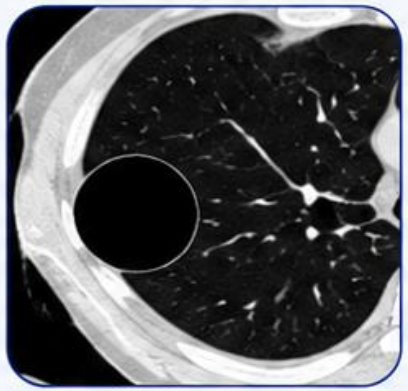
Key point: Thin walls suggest benign or cystic lesions; thick walls suggest active, destructive disease.

Thin Wall versus Thick Wall

Thin-walled lesions

Characteristics

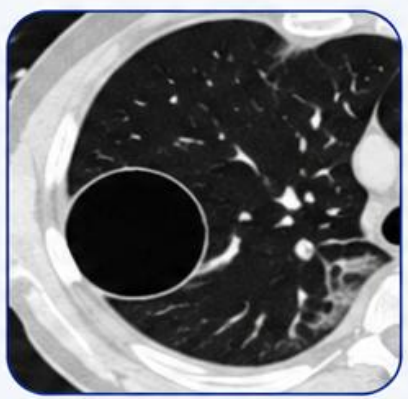
- Uniform wall
- Smooth contour
- Stable appearance
- Usually represent true cysts



Thin wall (<2 mm)

Examples

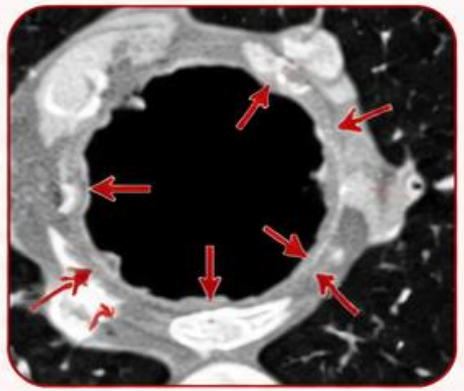
- LAM
- BHD syndrome
- Congenital pulmonary cyst



Thick-walled lesions

Characteristics

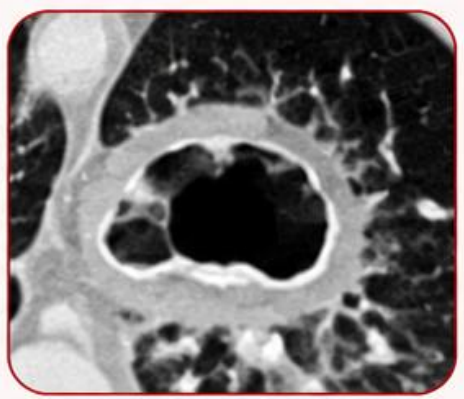
- Irregular wall
- Variable thickness
- Nodular components
- Progressive enlargement



Thick wall (>4 mm)

Examples

- Lung cancer
- Lung abscess
- Active tuberculosis

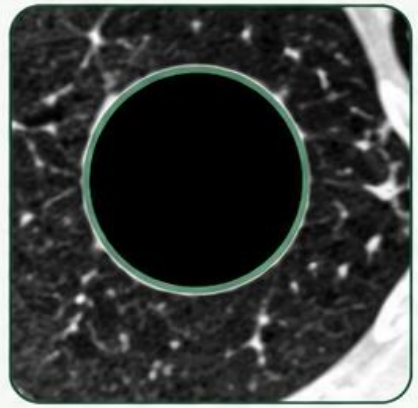


Step 3.2 Evaluate the Inner Margin

The inner wall provides important clues regarding disease activity.

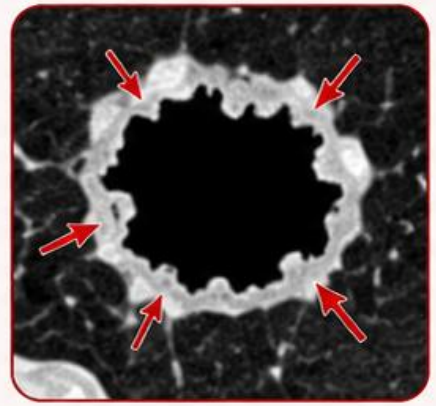
Smooth inner margin

- True pulmonary cyst
- Bulla
- Pneumatocele
- Congenital cyst



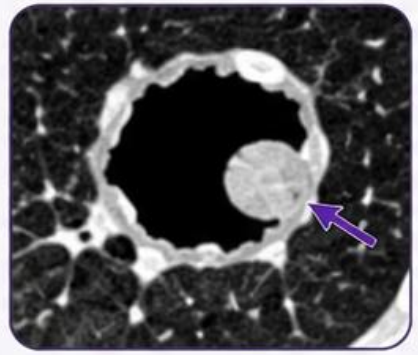
Irregular inner margin

- **Suggests**
- Cavitary malignancy
- Tuberculosis
- Lung abscess
- Chronic fungal infection



Nodular inner margin

- Cavitating carcinoma
- Intracavitary tumor
- Aspergilloma



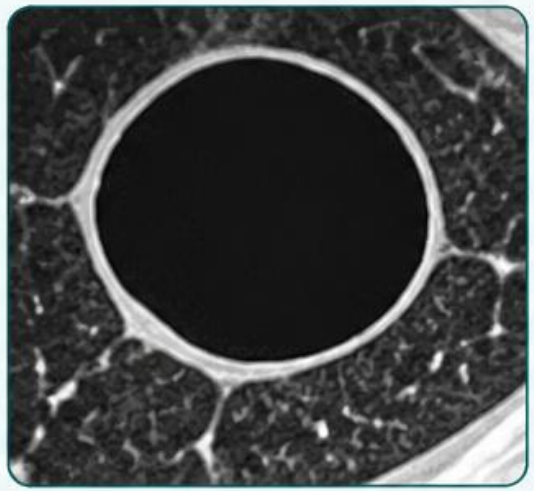
Teaching Pearl

- A nodular inner wall should always prompt exclusion of malignancy.

Step 3.3 Wall Morphology

Smooth

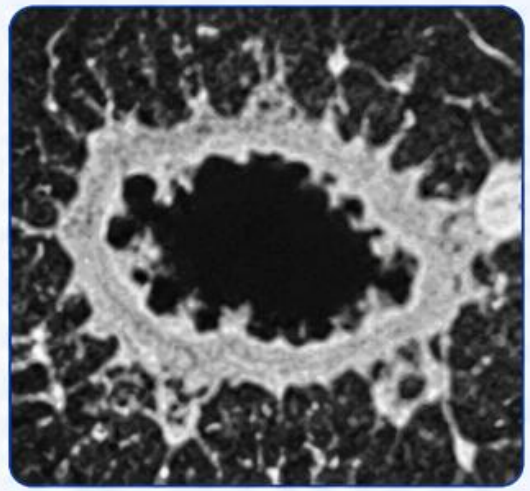
- Usually reflects non-destructive disease.



Smooth wall

Shaggy

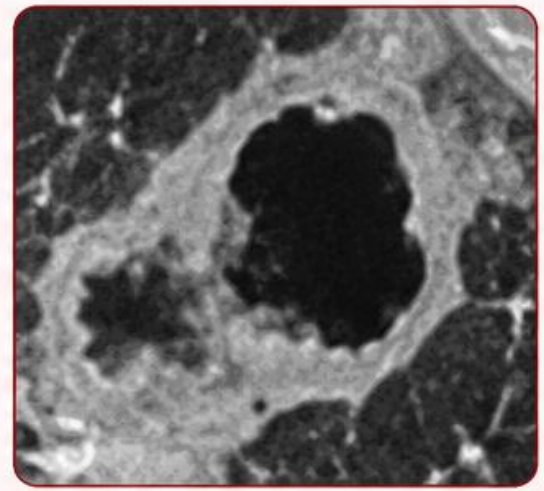
- Often indicates active infection.



Shaggy wall

Thick irregular

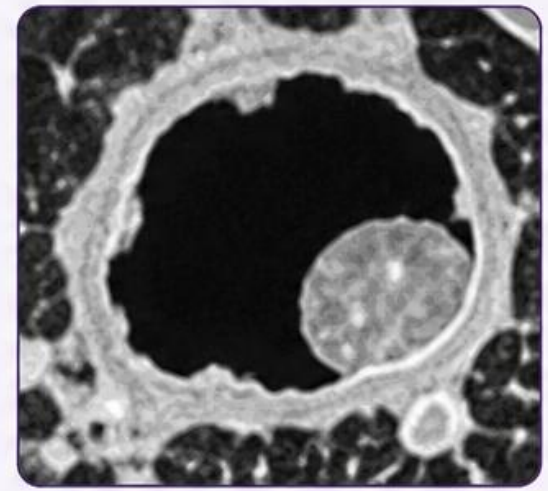
- Suggests necrosis or invasive tumor.



Thick irregular wall

Nodular

- Strongly suggests malignancy or fungal colonization.



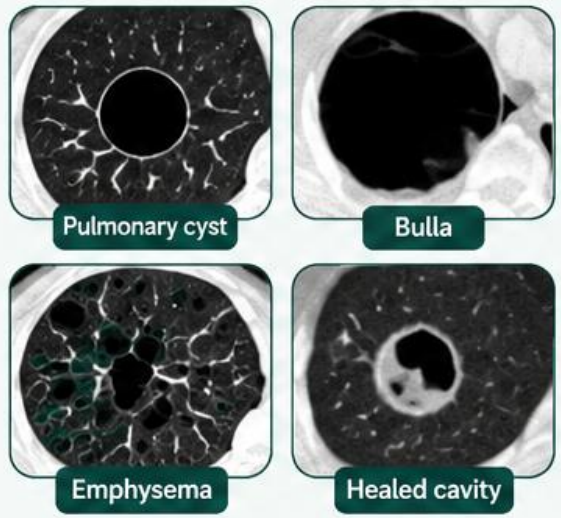
Nodular wall

Teaching Pearl: Wall morphology reflects the pathological mechanism rather than the disease name.

Step 4. Evaluate the Lesion Contents

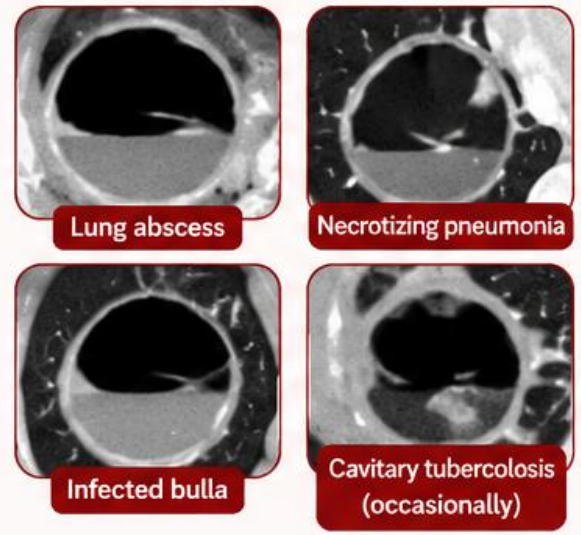
Air only

- Pulmonary cyst
- Bulla
- Emphysema
- Healed cavity



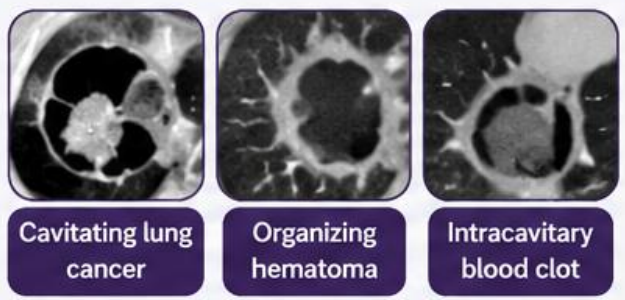
Air-fluid level

- Lung abscess
- Necrotizing pneumonia
- Infected bulla
- Cavitary tuberculosis (occasionally)



Soft tissue within cavity

- Cavitating lung cancer
- Organizing hematoma
- Intracavitary blood clot



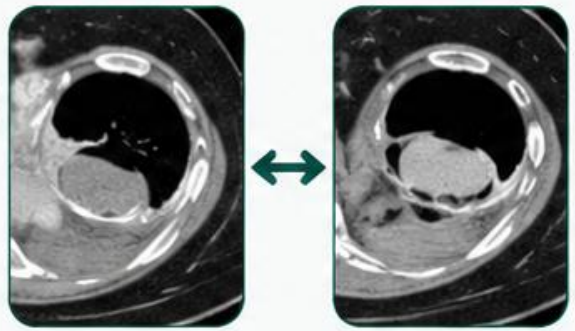
Fungal ball (aspergilloma)

- Fungal ball within pre-existing cavity
- Most commonly aspergilloma

Step 4. Evaluate the Lesion Contents

Mobile intracavitary mass

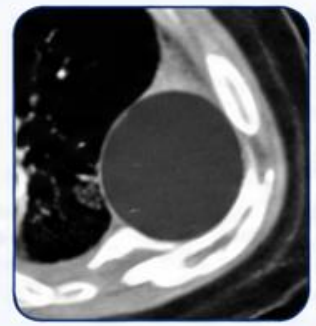
- **Aspergilloma (fungus ball)**
  - ✓ Air crescent sign
  - ✓ Changes with patient position

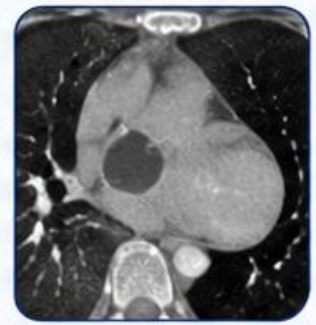


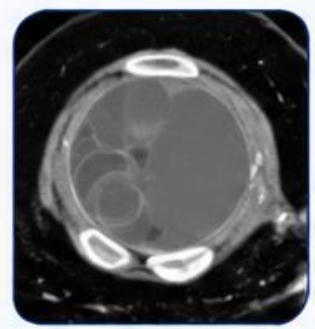
Supine position ↔ Prone position

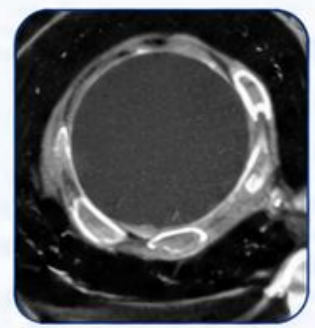
Completely fluid-filled lesion

- Bronchogenic cyst
- Infected pulmonary cyst
- Hydatid cyst
- Congenital cystic lesion


Bronchogenic cyst


Infected pulmonary cyst


Hydatid cyst

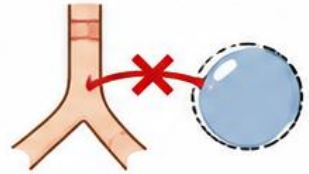
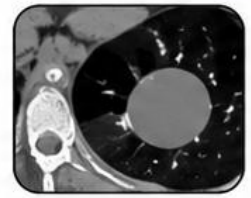
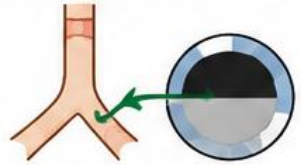
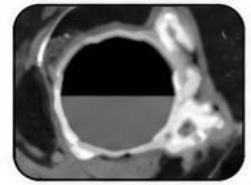
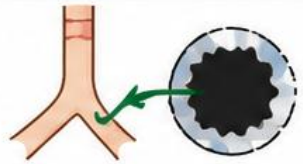
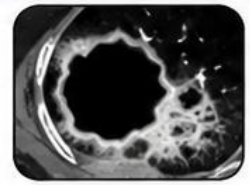
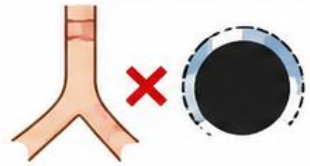
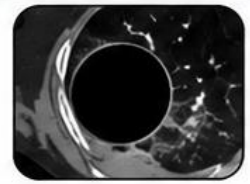

Congenital cystic lesion

CT Contents and Their Most Likely Diagnoses

CT Content	Most Likely Diagnosis
Air only	Pulmonary cyst, bulla
Air-fluid level	Lung abscess, necrotizing pneumonia
Fungus ball	Aspergilloma
Soft tissue nodule	Cavitary carcinoma
Blood	Hemorrhage, GPA
Completely fluid-filled	Bronchogenic cyst

Communication with the Airway

Airway communication affects lesion contents and the presence of an air–fluid level.

Lesion	Communication with Airway	Illustration	Typical Imaging Appearance
Bronchogenic cyst	Usually absent		 Fluid attenuation; may develop an air–fluid level only after infection or rupture
Lung abscess	Usually present		 Thick-walled cavity with a characteristic air–fluid level
Tuberculous cavity	Usually present		 Air-filled cavity that facilitates drainage of necrotic material and endobronchial spread
Pulmonary cyst	Usually absent		 Thin-walled air-filled lesion; internal fluid suggests infection, hemorrhage, or rarely malignancy

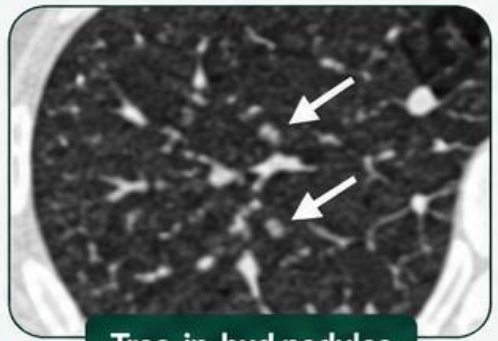
Teaching Pearl: Presence of airway communication strongly favors infectious or malignant etiologies.

Step 5. Look for Associated CT Findings

Always interpret the lesion within the context of the surrounding lung.

Tree-in-bud nodules

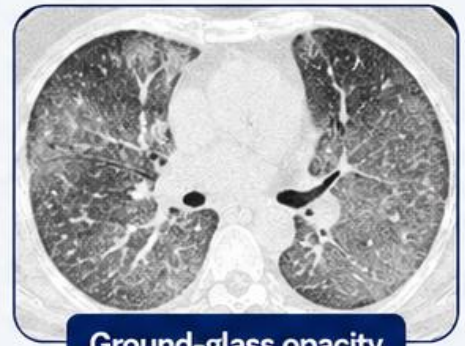
- Tuberculosis
- Nontuberculous mycobacterial infection
- Aspiration



Tree-in-bud nodules

Ground-glass opacity

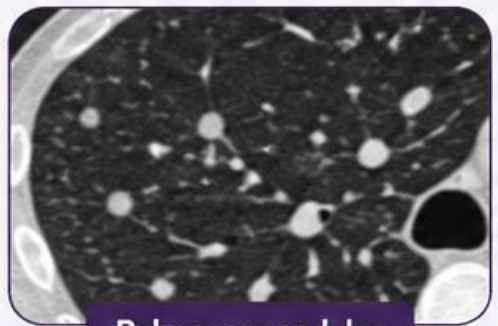
- Pneumocystis pneumonia
- Diffuse alveolar hemorrhage
- Viral pneumonia



Ground-glass opacity

Pulmonary nodules

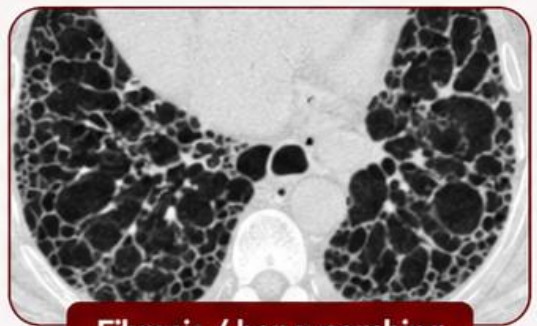
- Vasculitis
- Metastatic disease
- Septic emboli



Pulmonary nodules

Fibrosis or honeycombing

- UIP/IPF
- Connective tissue disease-associated ILD



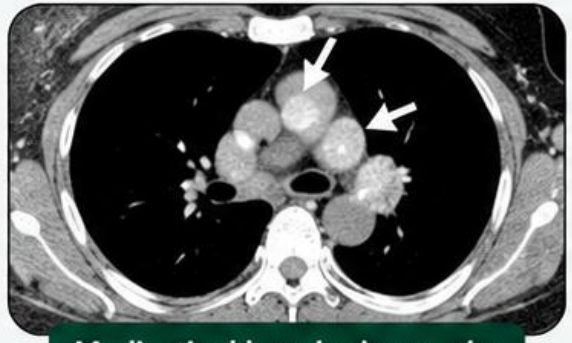
Fibrosis / honeycombing

Step 5. Look for Associated CT Findings

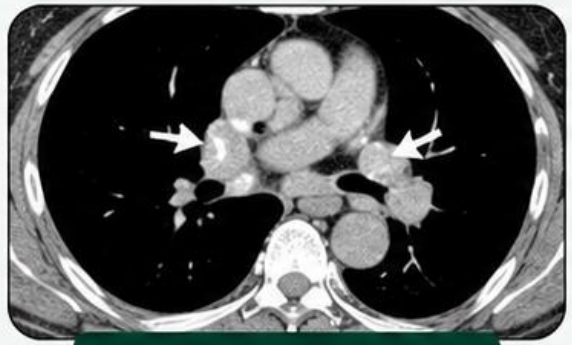
Always interpret the lesion within the context of the surrounding lung.

Lymphadenopathy

- Tuberculosis
- Sarcoidosis
- Malignancy



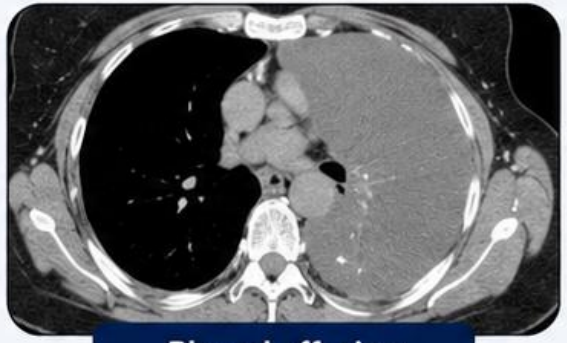
Mediastinal lymphadenopathy



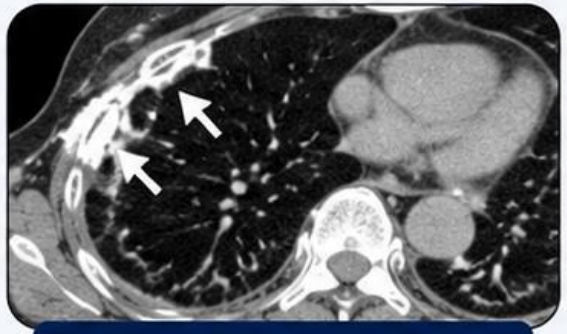
Hilar lymphadenopathy

Pleural abnormalities

- May indicate
- Empyema
- Rheumatoid disease
- Malignancy



Pleural effusion



Pleural thickening / nodularity

Integrating Associated Findings

CT Finding	Most Likely Diagnosis
Tree-in-bud	Tuberculosis, NTM
Feeding vessel sign	Septic emboli
Diffuse thin-walled cysts	LAM
Upper-lobe bizarre cysts	PLCH
Basal cysts with ground-glass opacity	LIP
Honeycombing	UIP/IPF

Step 6. Integrate the Clinical Context

Clinical context helps narrow the differential diagnosis.

Age

- **Young adults →** LAM, PLCH, congenital cystic diseases

LAM

Congenital cystic disease

- **Older patients →** Malignancy, chronic infections

Malignancy

Chronic infections

Smoking history

- Pulmonary Langerhans cell histiocytosis

- Centrilobular emphysema

- Squamous cell carcinoma

Immune status

- Aspergillosis

- Pneumocystis jirovecii pneumonia

- Nocardiosis

- Necrotizing bacterial pneumonia

Infection risk

- Tuberculosis exposure

- Endocarditis (septic emboli)

- Aspiration

- Recent hospitalization

Step 6. Integrate the Clinical Context

Autoimmune disease

- **Granulomatosis with polyangiitis (GPA)**
  May present with multiple cavities or nodules.

- **Rheumatoid arthritis**
  Can be associated with nodules, cavities, or interstitial lung disease.

- **Sjögren syndrome (LIP)**
  Lymphocytic interstitial pneumonia may cause cysts or nodules.

Malignancy history

- **Raises suspicion for**
  Upper lobe cavitary lesions may suggest malignancy.

- **Cavitary pulmonary metastases**
  Multiple, thick-walled or irregular cavities are common.

- **Recurrent primary lung cancer**
  Consider tumor recurrence with cavitation.

- **Treatment-related pulmonary changes**
  Radiation, chemotherapy, or targeted therapy can cause cavitation or necrosis.

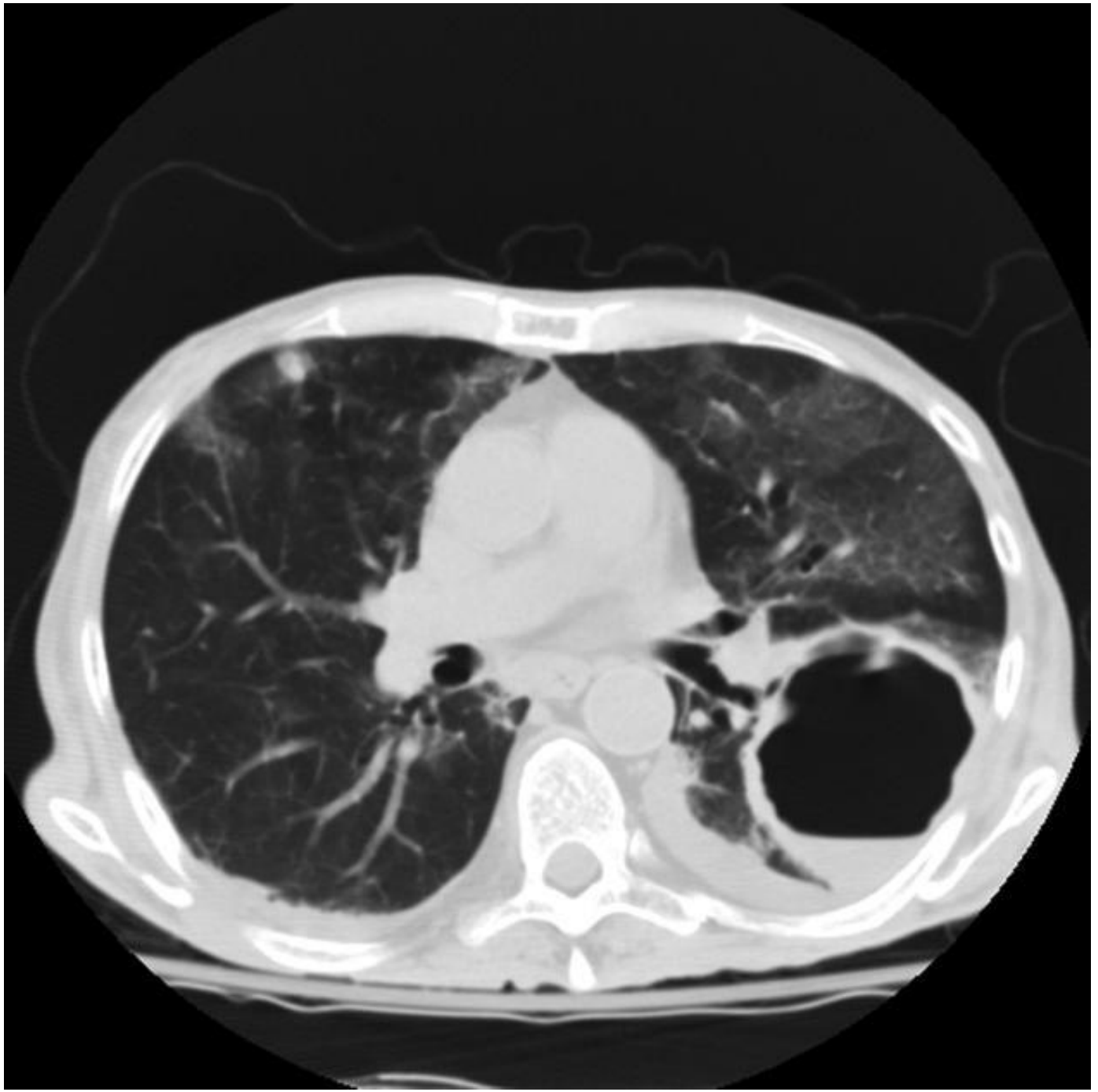
The **same HRCT pattern** may represent **different diseases** depending on the **clinical context**. Accurate diagnosis requires integration of imaging findings with patient history, risk factors, laboratory data, and microbiological results.

HRCT INTERPRETATION CHECKLIST

Step	Question	What to look for / Examples
1	How many lesions?	Single; Multiple • Solitary • Multiple / Diffuse
2	Where are the lesions distributed?	Subpleural; Peribronchovascular / Central; Random (Intraparenchymal); Diffuse • Upper / Middle / Lower lung zone • Peripheral vs Central • Focal / Multifocal / Diffuse
3	What are the wall characteristics?	Thin (≤ 2 mm); Thick (> 2 mm); Irregular; Nodular thickening • Wall thickness (thin / thick) • Inner margin (smooth / irregular) • Outer margin (smooth / lobulated) • Presence of wall nodules
4	What is inside the lesion?	Air (Air density); Fluid (Homogeneous); Soft tissue (Soft tissue density); Fungus ball (Intracavitary mass); Air-fluid level (Fluid + Air) • Air only • Fluid • Soft tissue / Solid component • Fungus ball • Air-fluid level
5	Are there associated CT findings?	Nodules; Ground-glass opacity; Bronchiectasis; Honeycombing; Fibrosis; Lymphadenopathy; ... • Nodules / Ground-glass opacities • Bronchiectasis • Consolidation • Emphysema / Honeycombing • Pleural effusion / Lymphadenopathy
6	Does the clinical context support the diagnosis?	Age; Sex; Smoking history; Immune status; Infection risk; Genetic / Family history; Past medical history • Age / Sex • Smoking history • Immune status / Infection risk • Congenital or genetic disease • Past medical history

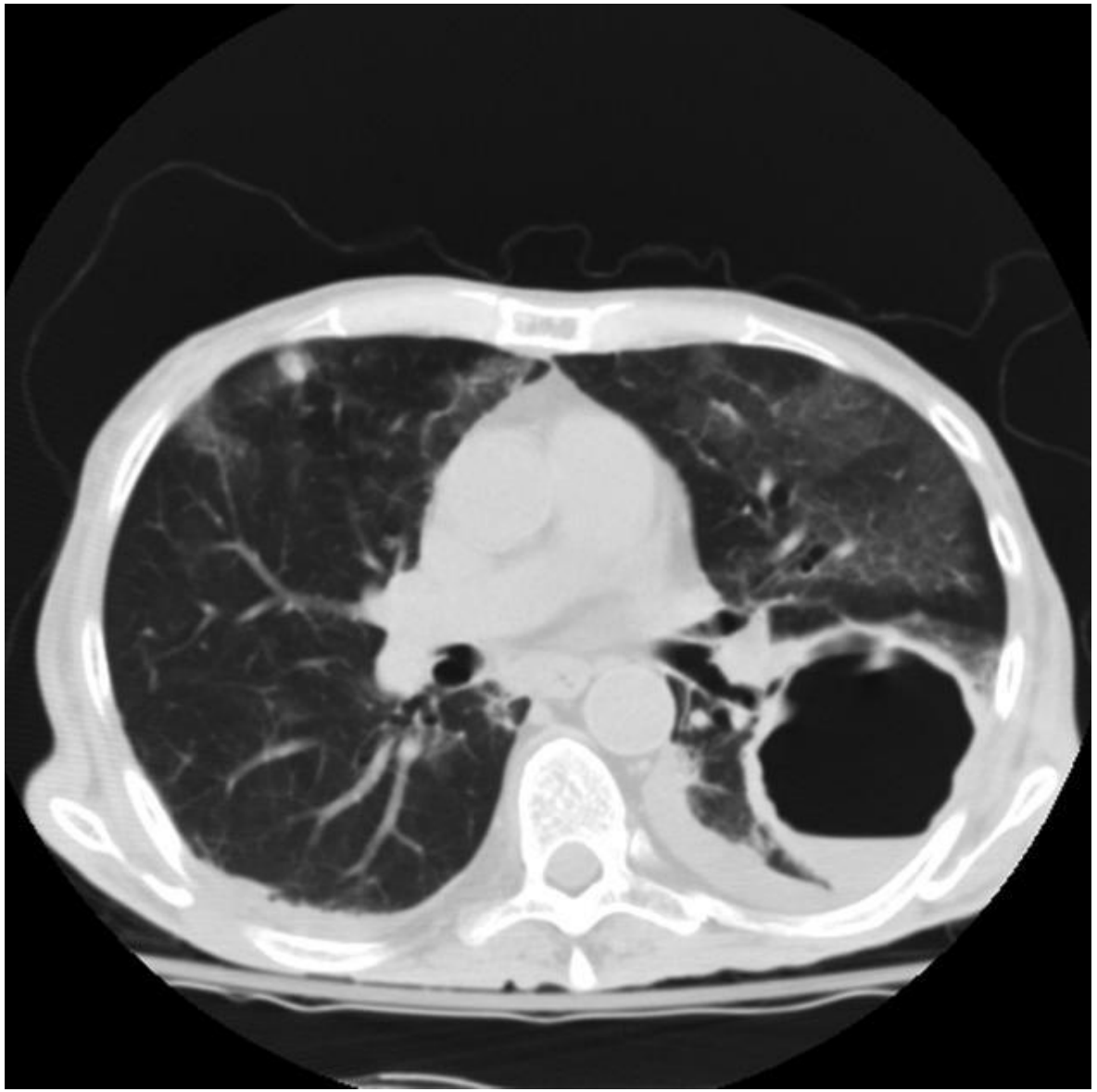
Integrate all imaging features with clinical context → Reach the most likely diagnosis

Case 1

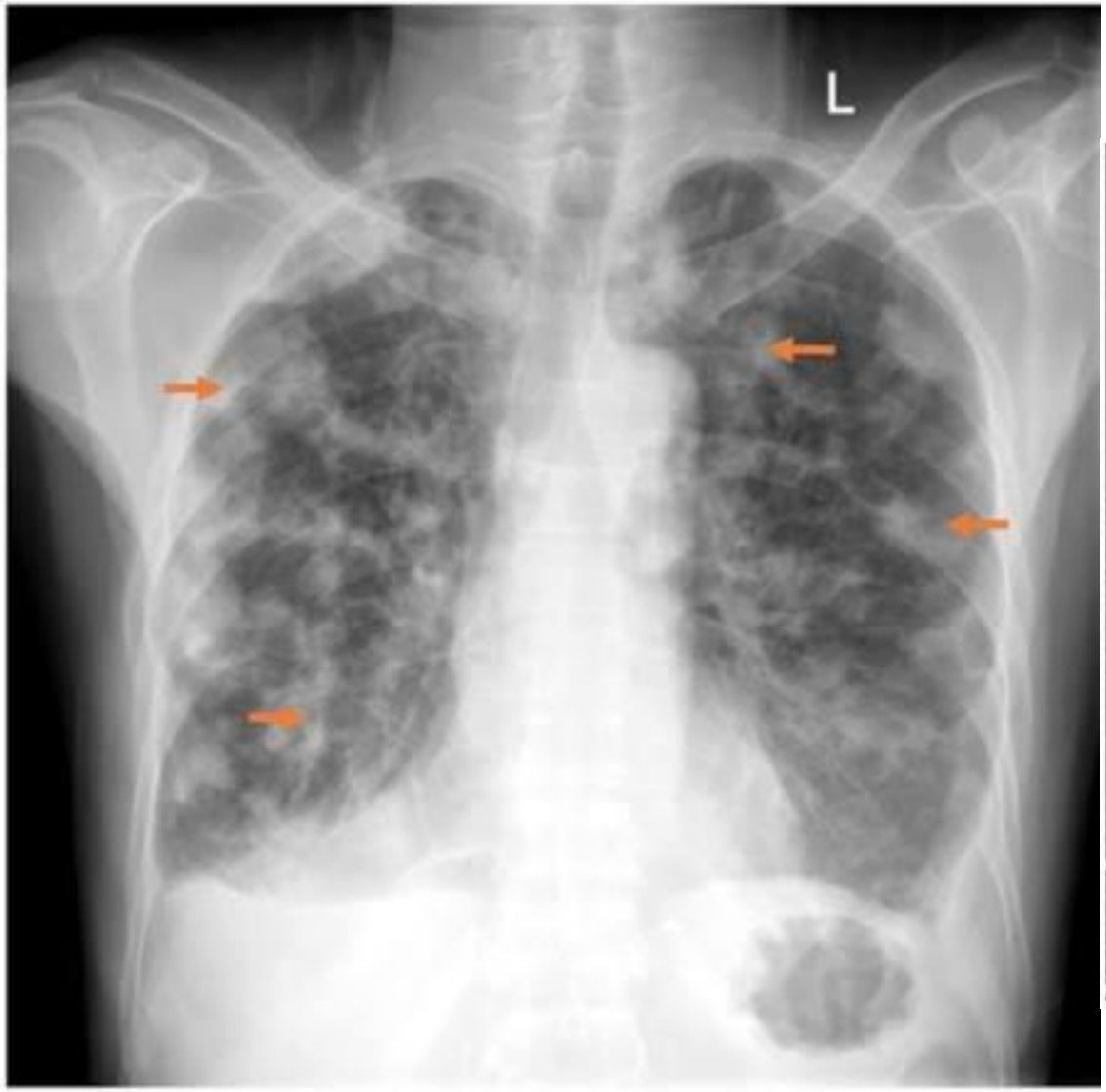


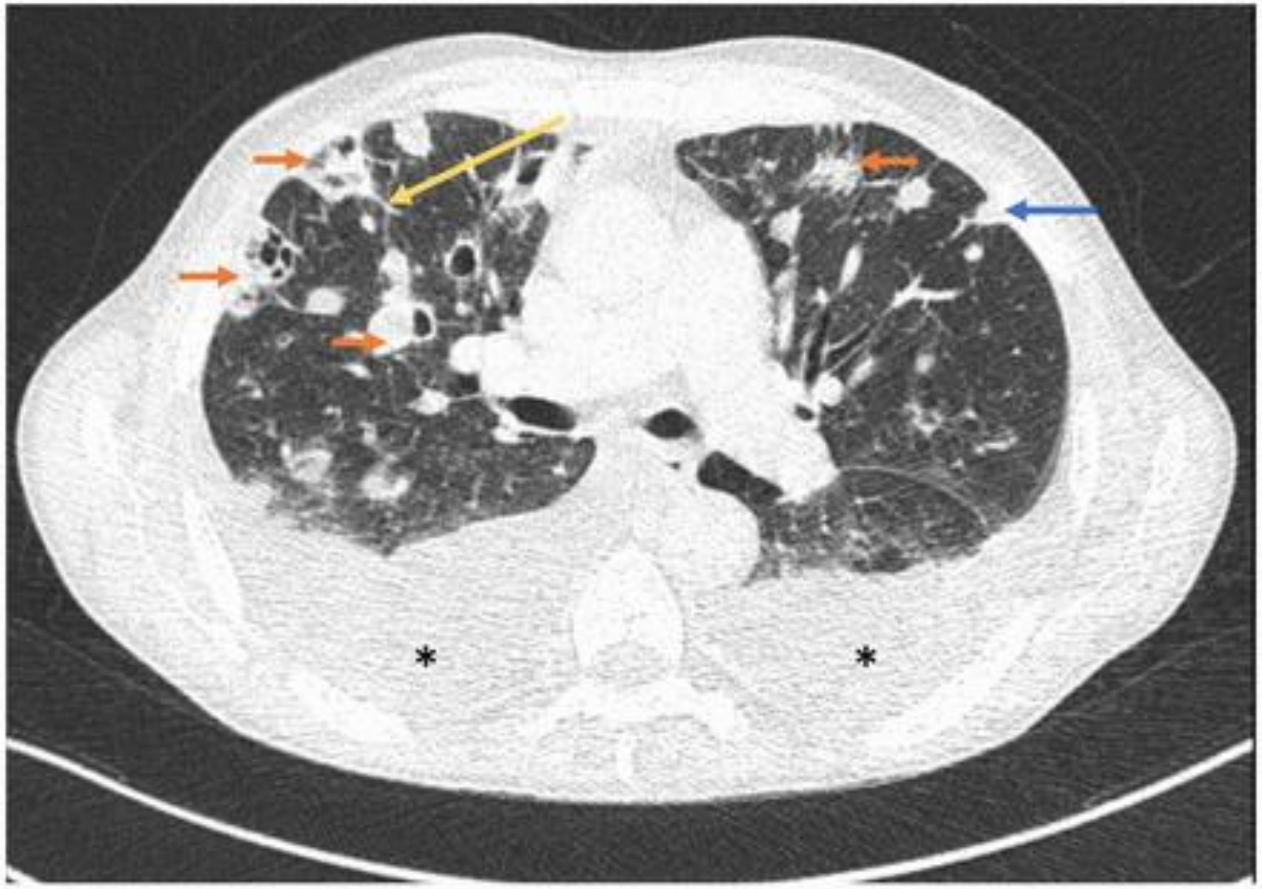
Lung Abscess

- Step 1: Single lesion
- Step 2: Lower lobe
- Step 3: Thick wall、Irregular wall
- Step 4: Air-fluid level
- Step 5: Adjacent consolidation
- Step 6: Aspiration risk、High fever、Leukocytosis



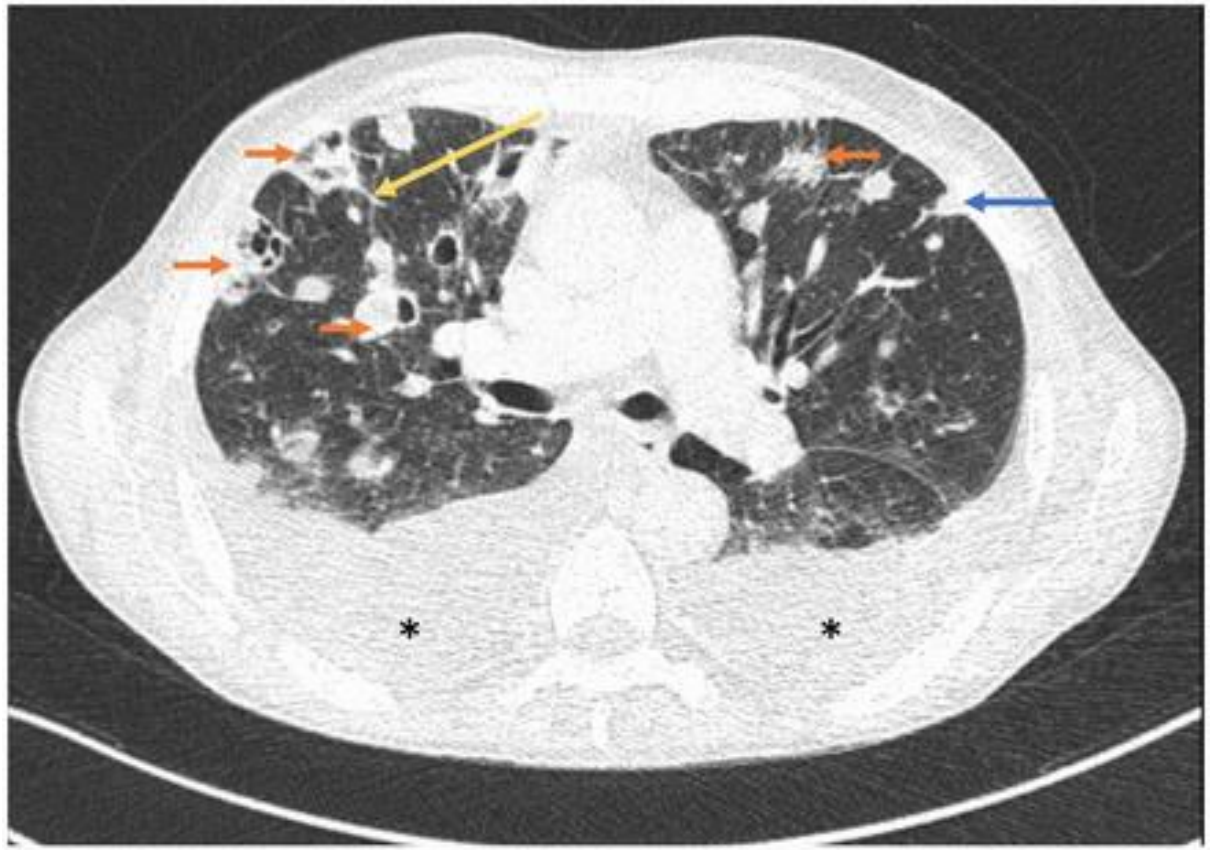
Case 2



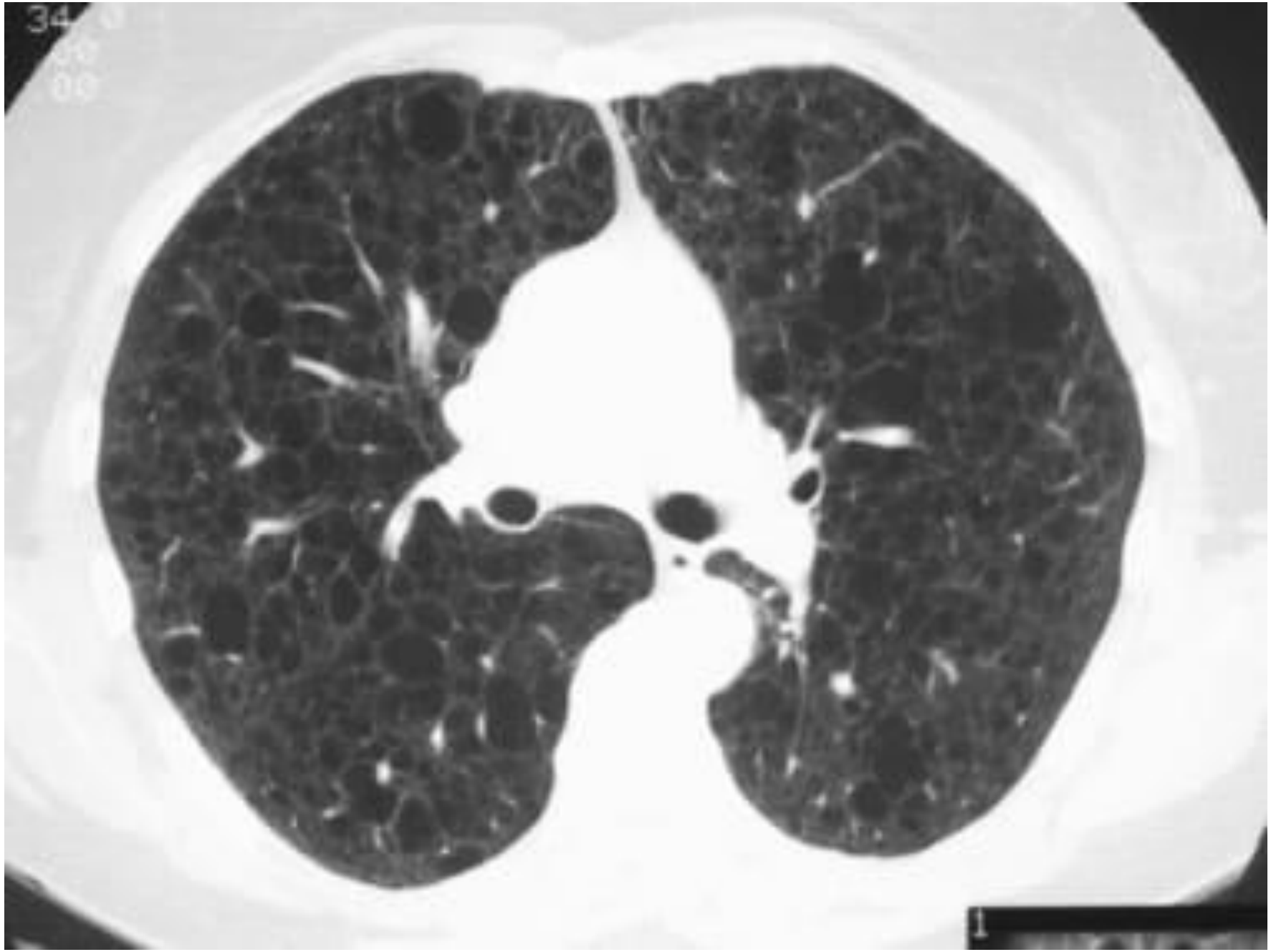


Septic Pulmonary Emboli

- Step 1：Multiple lesions
- Step 2：Peripheral、Random
- Step 3：Variable wall thickness
- Step 4：Small cavitating nodules
- Step 5：Feeding vessel sign、Pleural effusion
- Step 6：IV drug use、Endocarditis、Positive blood culture

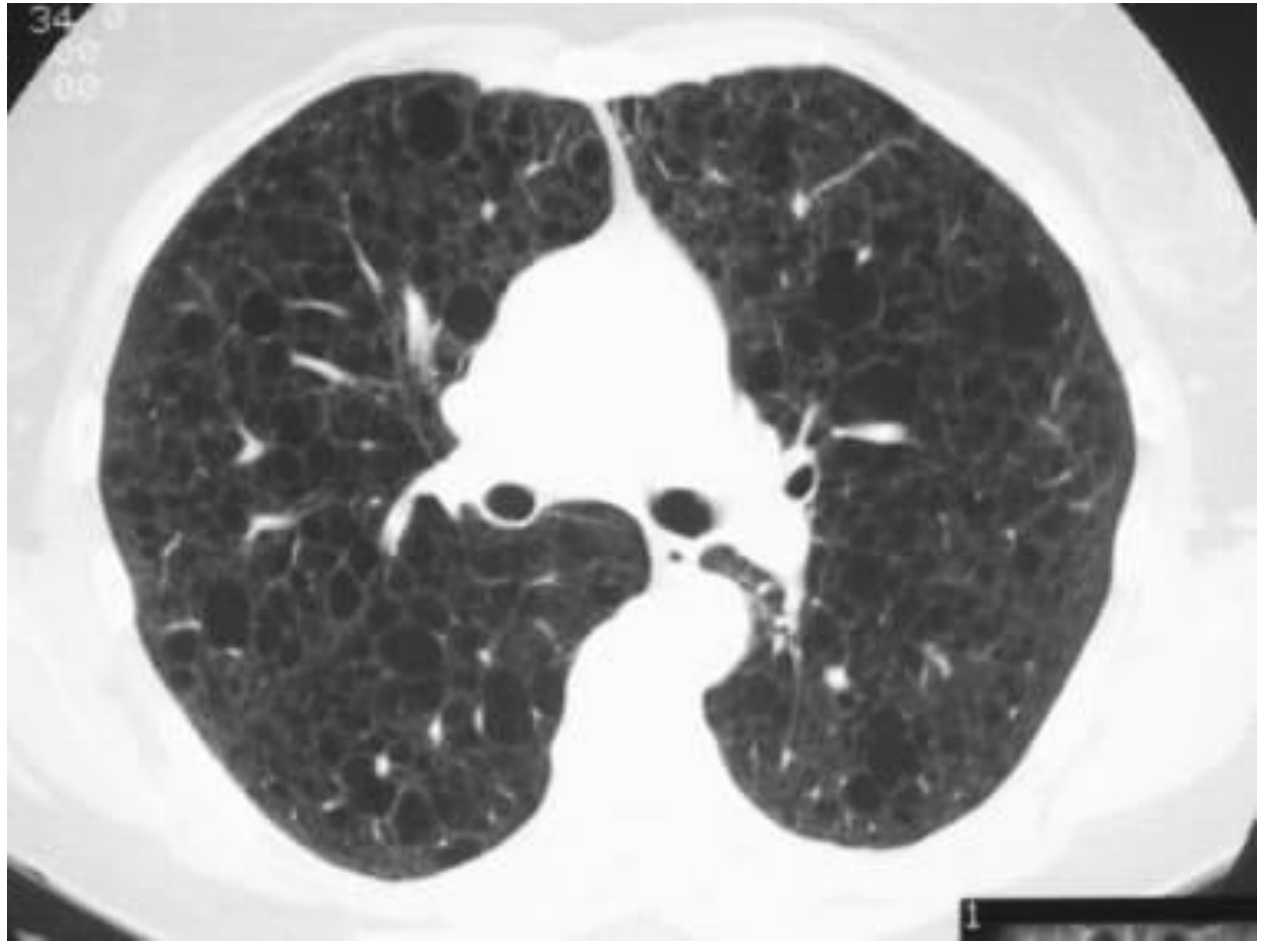


Case 3



Lymphangioleiomyomatosis(LAM)

- Step 1: Diffuse lesions
- Step 2: Diffuse
- Step 3: Uniform thin wall
- Step 4: Air only
- Step 5: No nodules、No fibrosis
- Step 6：Female、Tuberous sclerosis、Recurrent pneumothorax



C

CANCER

- **Primary bronchogenic carcinoma**: most frequently SCC
- **Pulmonary metastasis**: most frequently SCC, also adenocarcinoma, sarcoma

A

AUTOIMMUNE

Wegener Granulomatosis, rheumatoid arthritis (rheumatoid nodules) etc.

V

VASCULAR (both bland and septic pulmonary emboli)

I

INFECTION (bacterial / fungal) / INHALATION

- Lung abscess
- Fungal / parasite infection
- Pulmonary tuberculosis
- Pneumoconiosis

T

TRAUMA – pneumatocele

Y

YOUTH

- CPAM (congenital pulmonary airway malformation)
- Pulmonary sequestration
- Bronchogenic cyst

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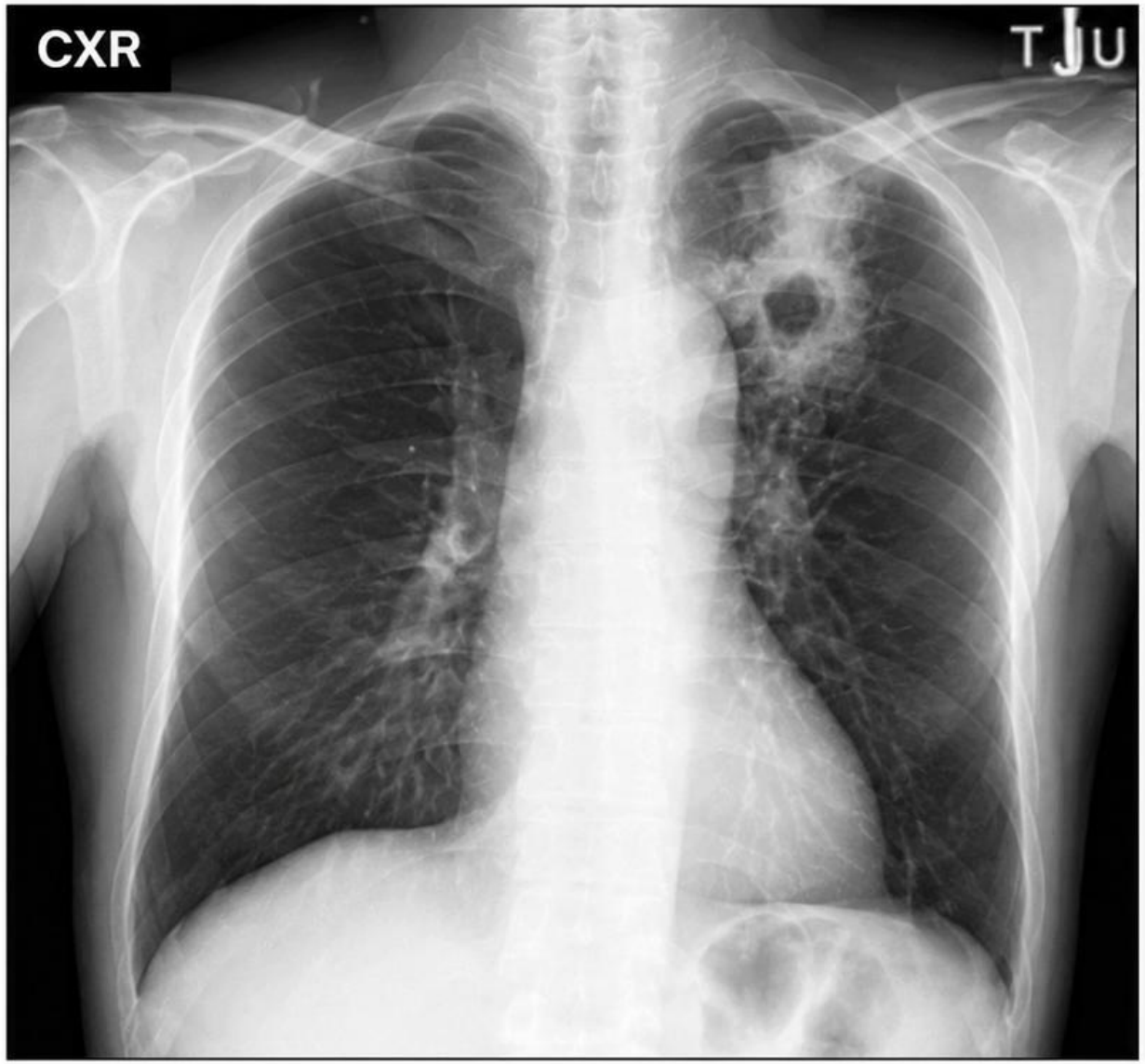
Primary lung cancer: Squamous cell carcinoma



Key features

- LUL mass
- Thick-walled cavity
- Eccentric location of cavity

Teaching point

Squamous cell carcinoma commonly cavitates due to central necrosis.

Primary lung cancer: Squamous cell carcinoma

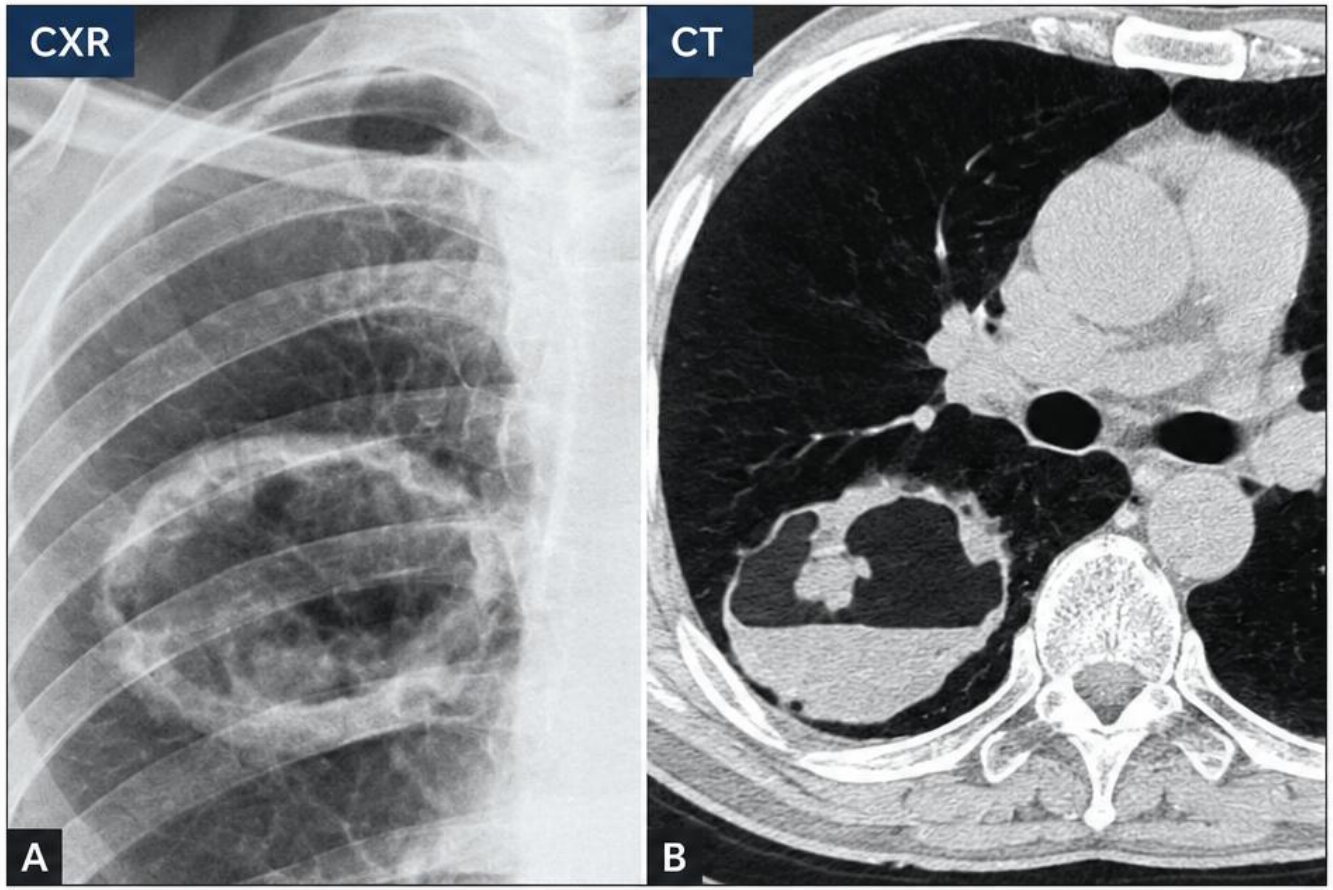


Fig. 13.9 Squamous cell carcinoma of bronchus showing cavitation. The cavity wall is of variable thickness and shows a mural nodule as well as an air–fluid level. **A,** Posteroanterior radiograph. **B,** CT.

Source: Hansell Imaging of Diseases of the Chest, 5th Ed.

Imaging features

- Cavitating mass
- Thick-walled cavity
- Variable wall thickness
- Mural nodule
- Air–fluid level may be present
- Eccentric location of cavity (often central, related to bronchus)

Key point

Squamous cell carcinoma commonly cavitates due to central necrosis.

Primary lung cancer with lymphadenopathy

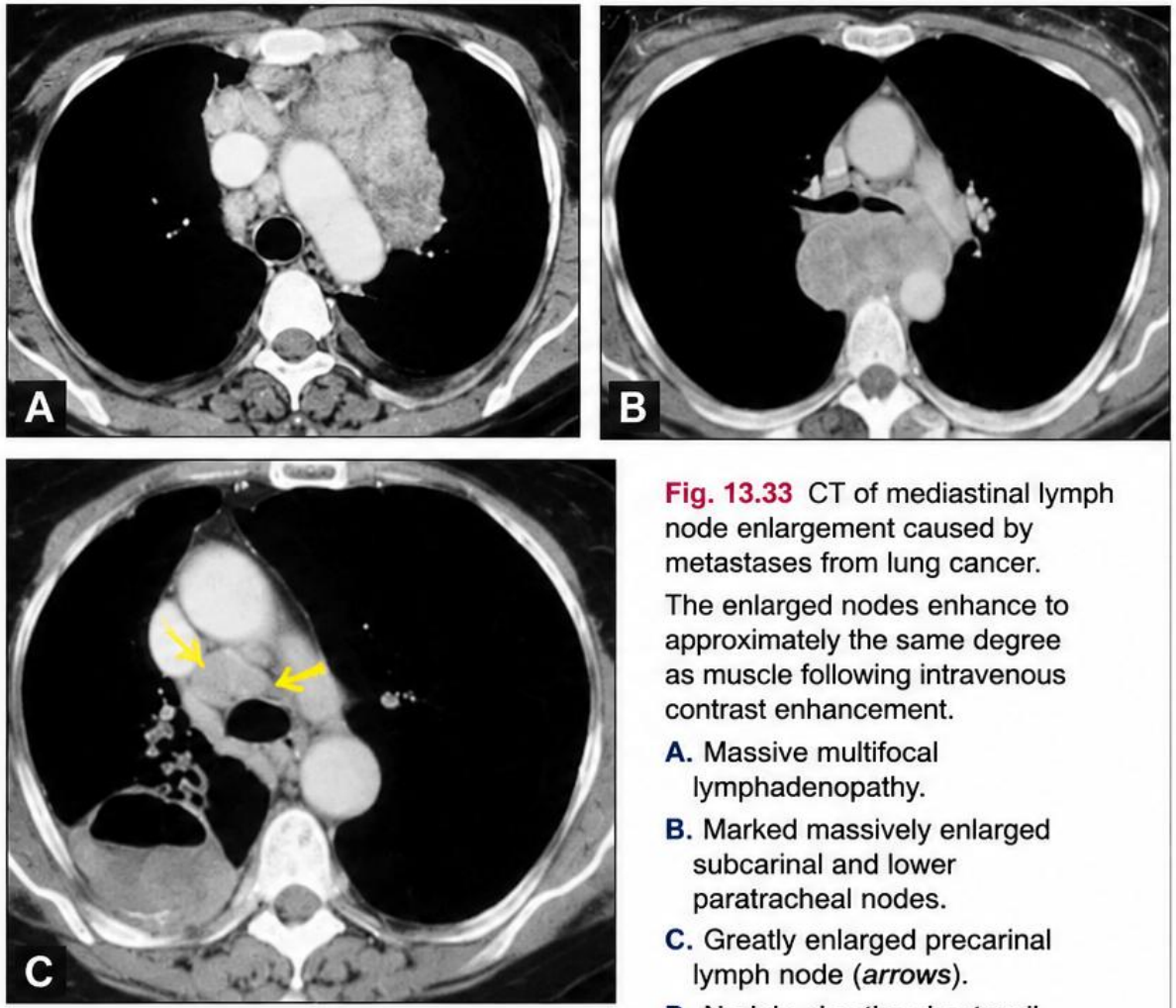


Fig. 13.33 CT of mediastinal lymph node enlargement caused by metastases from lung cancer.

The enlarged nodes enhance to approximately the same degree as muscle following intravenous contrast enhancement.

A. Massive multifocal lymphadenopathy.

B. Marked massively enlarged subcarinal and lower paratracheal nodes.

C. Greatly enlarged precarinal lymph node (*arrows*).

D. Nodule also the chest wall involvement by the primary tumor – a thin-walled cavitating carcinoma.

Source: Hansell Imaging of Diseases of the Chest, 5th Ed.

Key imaging features

- Mediastinal lymph node enlargement metastatic from primary lung cancer
- Nodes enhance to a similar degree as adjacent muscle after contrast
- Common stations: subcarinal, lower paratracheal, and precarinal
- May be associated with primary tumor findings (e.g., cavitating mass, chest wall involvement)

Clinical significance

Mediastinal lymphadenopathy in a patient with a lung mass strongly suggests nodal metastasis, which impacts staging and management.

Squamous cell carcinoma with thin-walled cavity/cyst

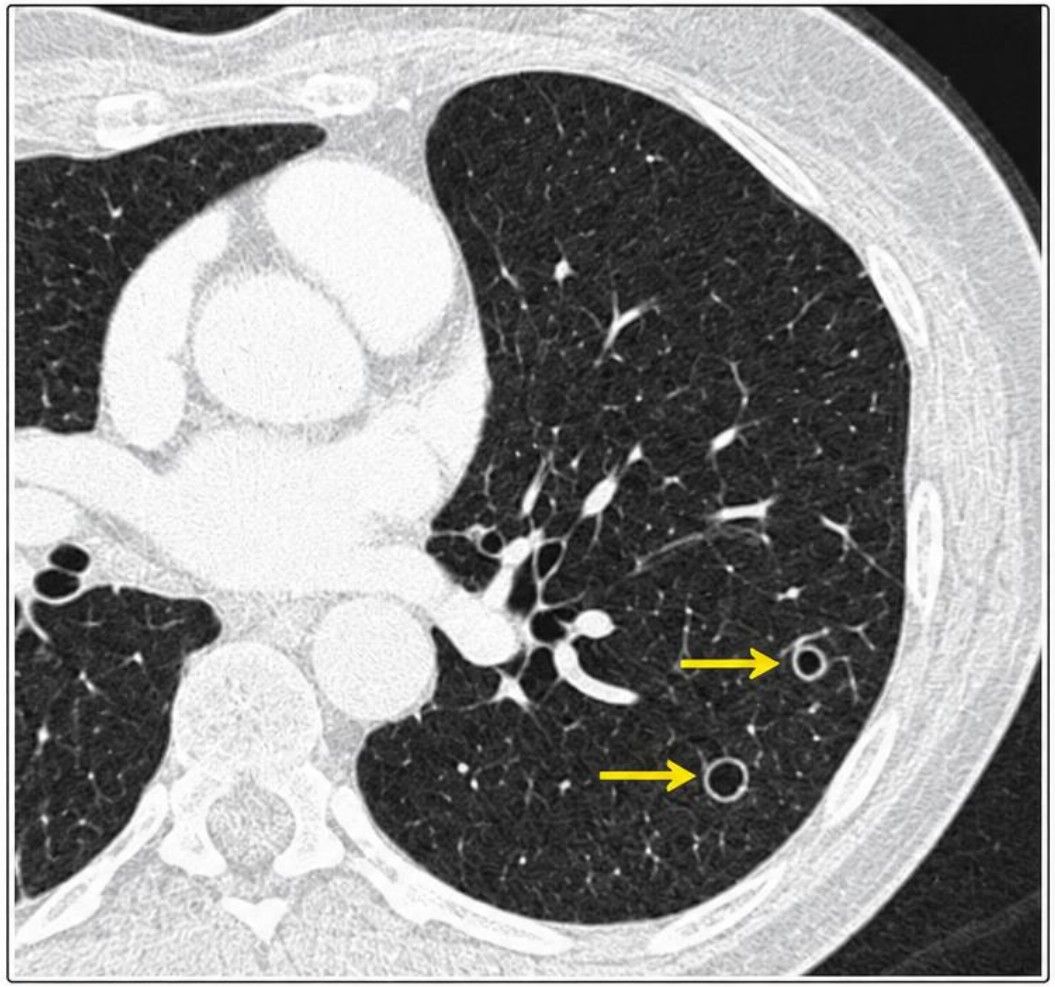


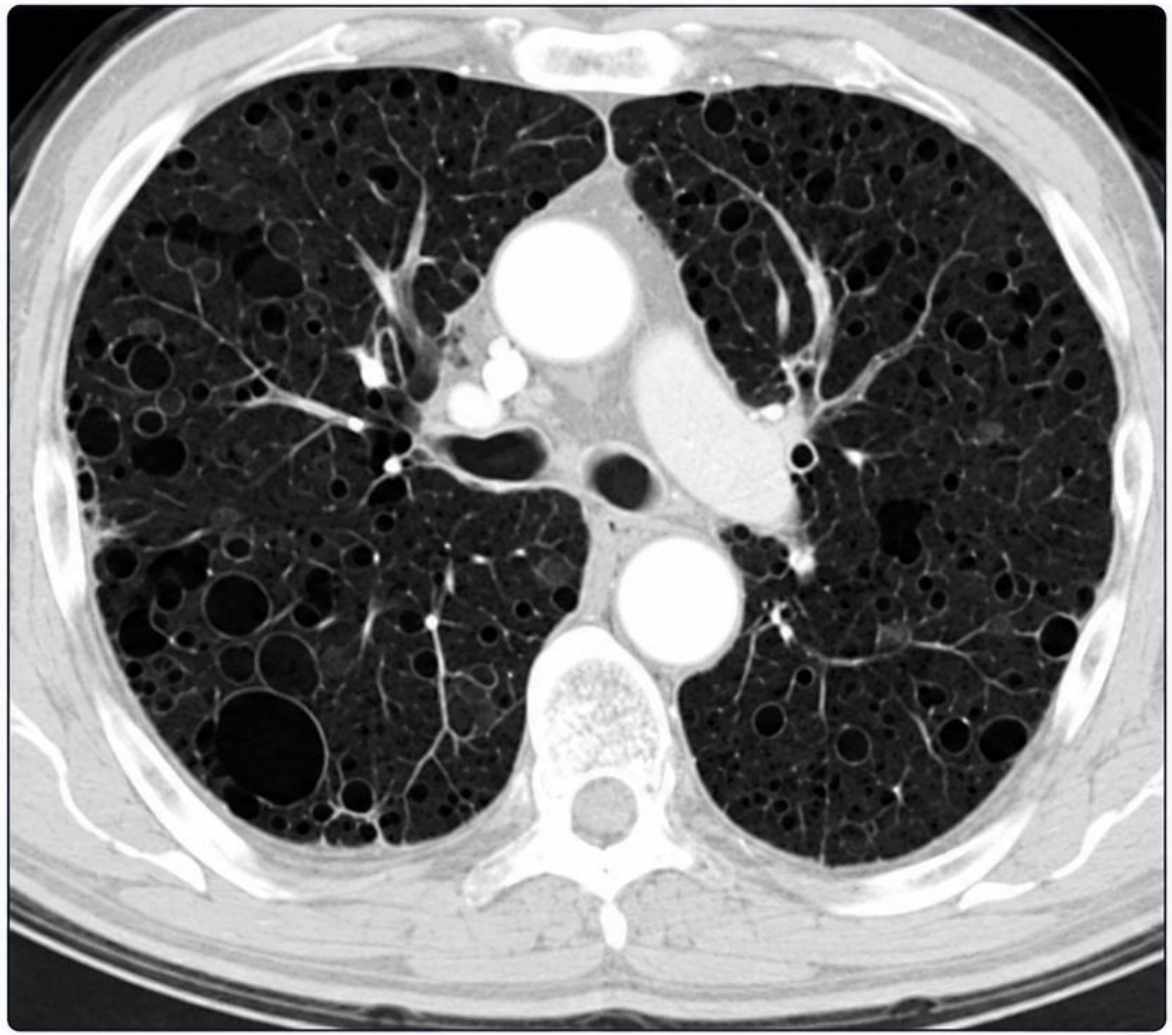
Fig. 13.107 CT of cavitating metastasis from squamous cell carcinoma (*arrows*).

Key points

- Squamous cell carcinoma can present with thin-walled cavitary lesions or cysts.
- May represent cavitating metastases or primary tumor.
- Cavities are usually small (<2 cm) with smooth, thin walls.
- Evaluate for other features of malignancy (e.g., spiculated nodule, consolidation, lymphadenopathy).
- Correlate with clinical history and assess for extrathoracic disease.

Hansell Imaging of Diseases of the Chest. 5th Ed

Metastatic colon cancer with thin-walled cysts



CHEST 2016; 150(4):945-965.

Imaging features

- Multiple, bilateral thin-walled cysts of variable size
- Cysts are usually round or oval with smooth, thin walls (< 2 mm)
- Lung parenchyma between cysts is usually normal
- Common metastatic tumors: colon (mucinous adenocarcinoma), ovarian, and others
- No associated nodules or consolidation (unless concomitant metastases)

Key point

Multiple thin-walled cysts in both lungs in a patient with a history of colon cancer strongly suggest pulmonary metastases.

C

CANCER

- **Primary bronchogenic carcinoma**: most frequently SCC
- **Pulmonary metastasis**: most frequently SCC, also adenocarcinoma, sarcoma

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AUTOIMMUNE

Wegener Granulomatosis, rheumatoid arthritis (rheumatoid nodules) etc.

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- Pulmonary sequestration
- Bronchogenic cyst

Granulomatosis with Polyangiitis (GPA)

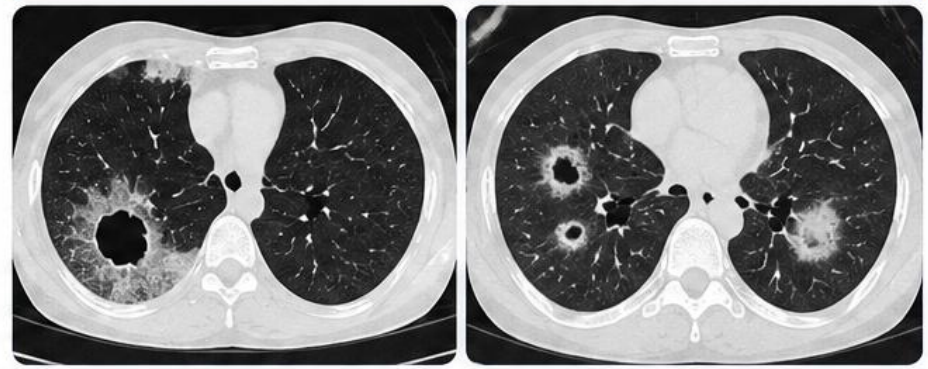
- formerly **Wegener granulomatosis**
- **c-ANCA (PR3-ANCA)-associated** necrotizing small-vessel vasculitis
- **Classic triad**

Lungs (95%) → cavitary pulmonary nodules, diffuse alveolar hemorrhage, hemoptysis

Upper airway (75–90%) → chronic sinusitis, nasal ulceration

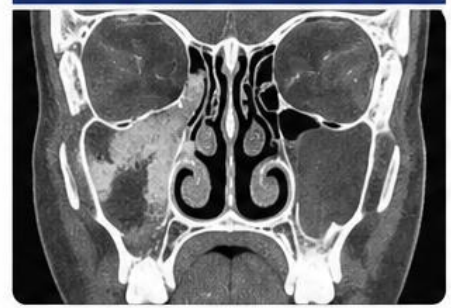
Kidneys (80%) → rapidly progressive glomerulonephritis, **acute kidney injury**

Pulmonary CT findings



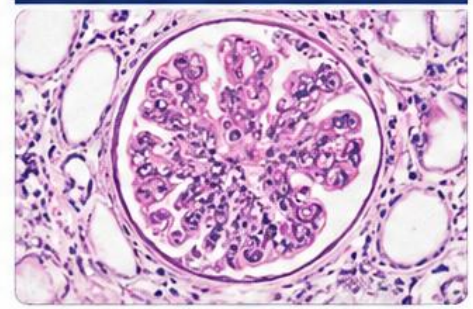
Multiple cavitary pulmonary nodules

Paranasal sinus CT



Chronic sinusitis

Renal involvement



Necrotizing crescentic glomerulonephritis

A patient with multiple cavitary pulmonary nodules, chronic sinusitis, and renal impairment should strongly raise suspicion for GPA.

Pulmonary Imaging Findings in GPA

Pulmonary Nodules and Masses (Most Common Manifestation)

- **Most common** pulmonary manifestation
- **Multiple nodules** are more common than solitary lesions **(~75%)**
- **Size:** 1–10 cm
- **Number:** usually **<10** lesions
- **Margins:** ill-defined or irregular, **without zonal predominance**
- **Cavitation** develops in approximately **50%**
  - Typically **thick-walled**
  - **Irregular** inner margins
- **Pleural effusion** (<10%) and **mediastinal/hilar lymphadenopathy** are uncommon
- Following immunosuppressive therapy, nodules and cavities may **completely resolve** or **heal with residual fibrotic scars**
- **CT:** irregular pulmonary nodules with a **peribronchovascular distribution**

Key Imaging Clues

- **Multiple** pulmonary nodules
- **Cavitation** in **~50%** (thick wall, irregular inner margin)
- **Peribronchovascular** distribution
- **No zonal** predominance
- **Minimal pleural effusion** and lymphadenopathy

Multiple cavitary pulmonary nodules with little or no lymphadenopathy are highly suggestive of GPA.

Pulmonary Imaging Findings in GPA

Pulmonary Hemorrhage

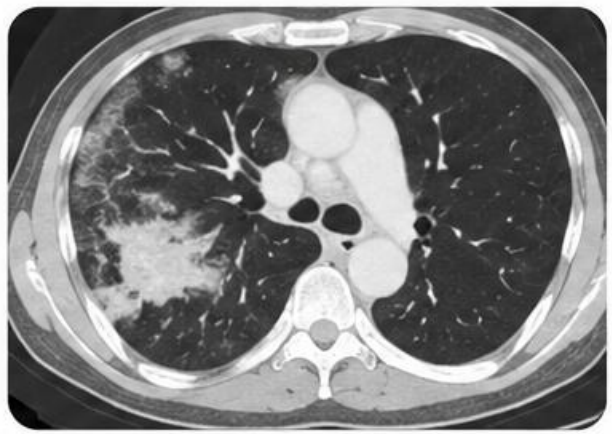
- Presents as **localized or diffuse ground-glass opacity (GGO)** or **air-space consolidation**

Reflects:

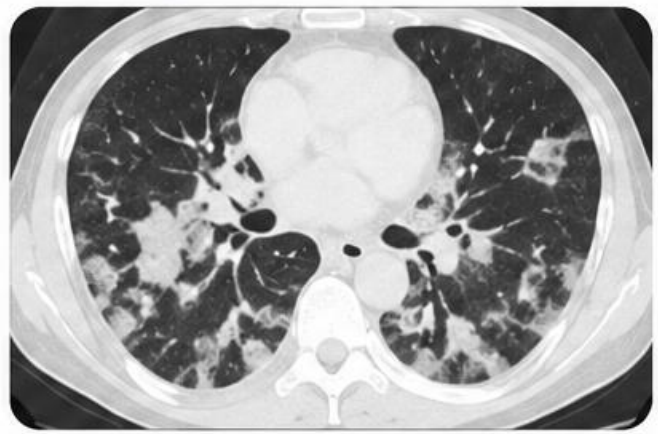
- **Diffuse alveolar hemorrhage** (most common)
- **Secondary infection**
- **Active alveolitis**

CT patterns include:

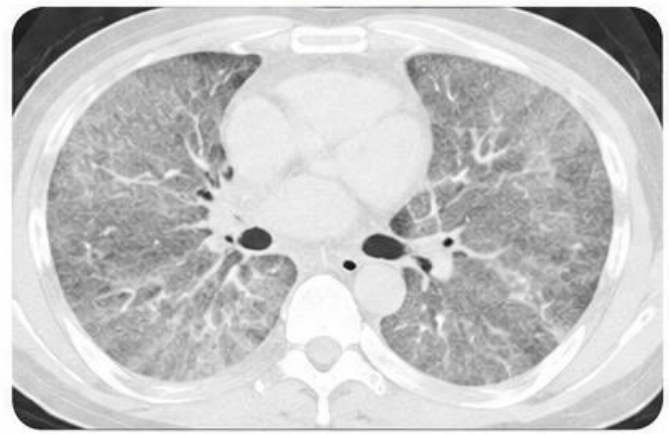
- **Focal dense consolidation**



- **Patchy bilateral consolidations**



- **Diffuse air-space opacification**



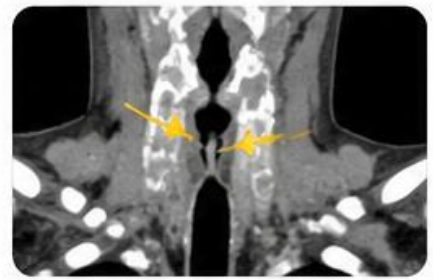
Pulmonary Imaging Findings in GPA

Airway Involvement

- **Subglottic tracheal stenosis** is the **most common** airway manifestation

- **May also involve the bronchi,** resulting in:
  - Airway narrowing
  - Bronchial wall thickening
  - Post-obstructive atelectasis

CT Findings of Airway Involvement in GPA

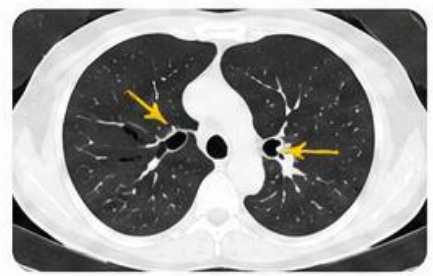


Subglottic tracheal stenosis

Focal circumferential narrowing of the subglottic trachea.

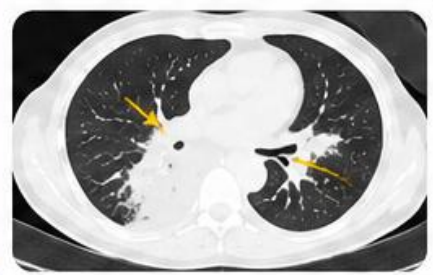
Bronchial airway narrowing

Airway lumen narrowing in segmental or lobar bronchi.



Bronchial wall thickening

Circumferential or eccentric thickening of the bronchial wall.



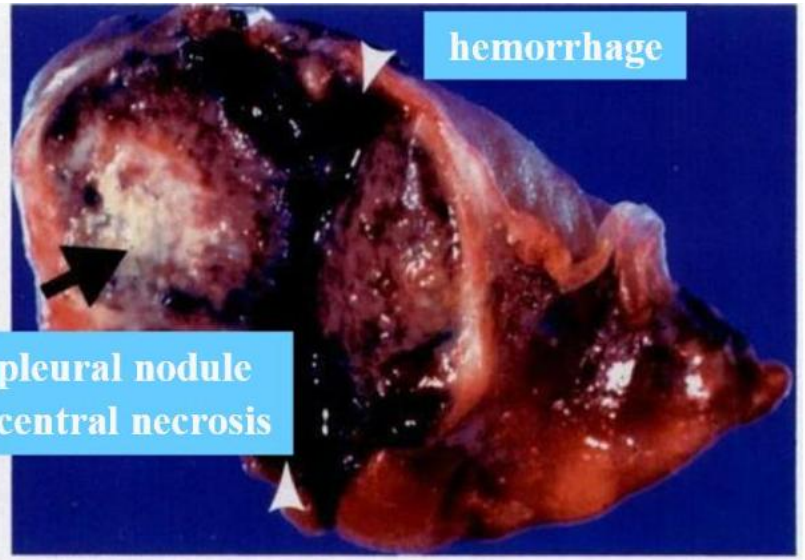
Post-obstructive atelectasis

Atelectasis distal to airway narrowing or obstruction.

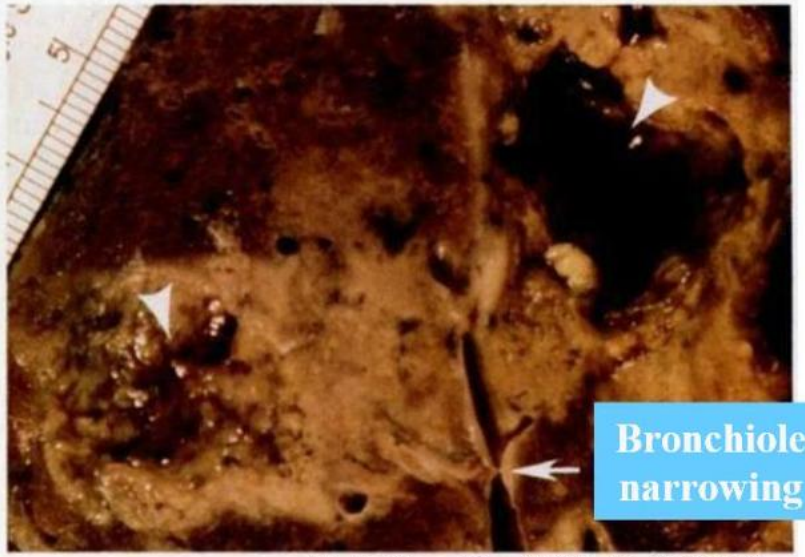
Granulomatosis with Polyangiitis (GPA)

1a.

Multiple cavitary and necrotic nodules

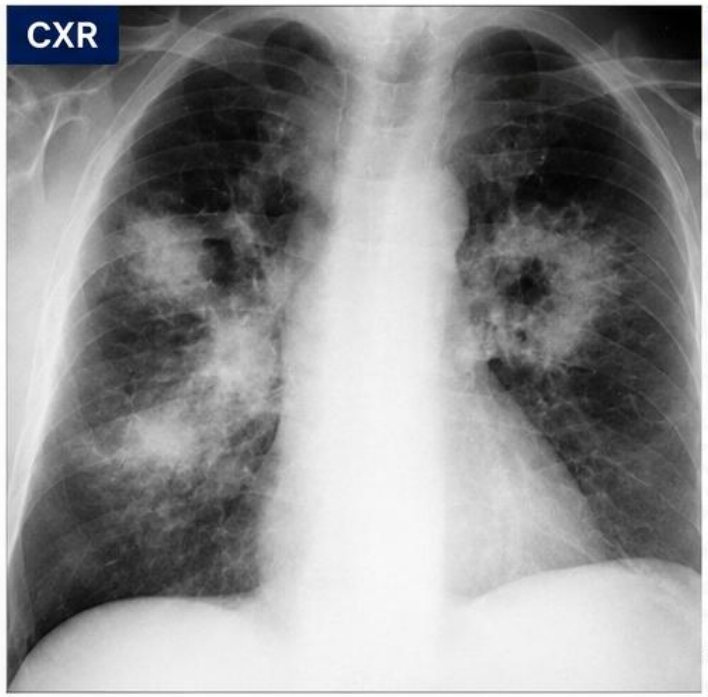


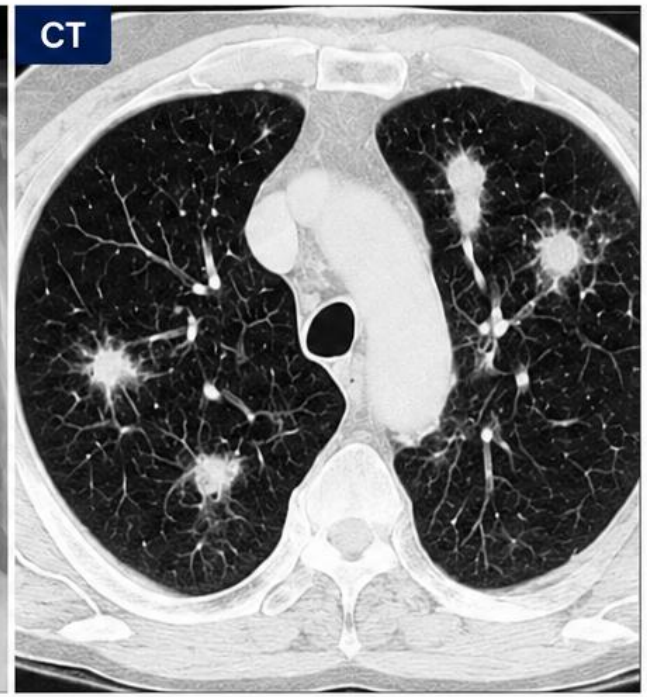
1b.



RadloGraphics 1998; 18:687-710

Granulomatosis with Polyangiitis (GPA)





Left: CXR shows bilateral, patchy air-space opacities and nodular lesions, some with cavitation.

Right: Axial CT (lung window) demonstrates multiple bilateral pulmonary nodules, several with cavitations, some showing central nodules with surrounding ground-glass attenuation (halo sign).

Imaging findings are consistent with granulomatosis with polyangiitis (GPA). Clinical correlation and serologic testing (e.g., c-ANCA/PR3) are recommended.

Imaging features

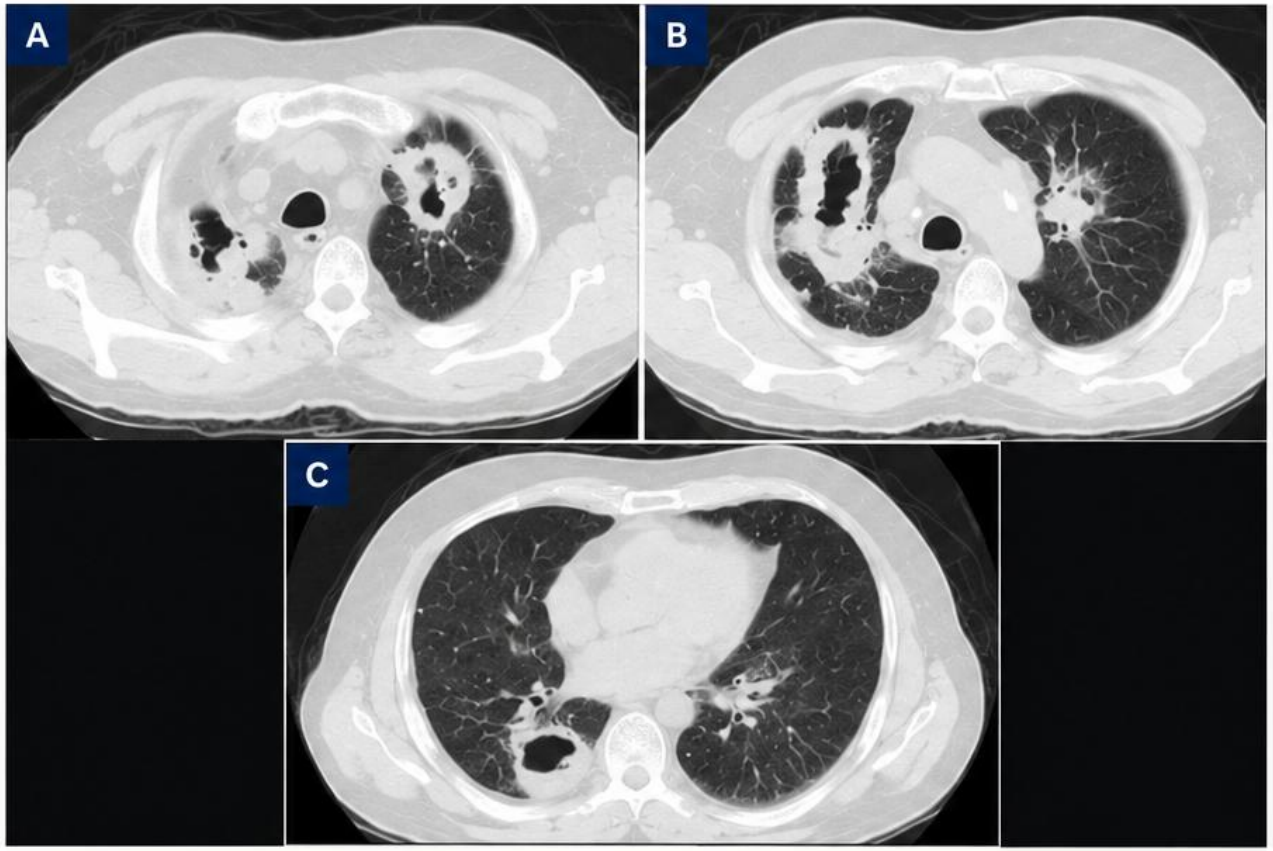
- Multiple pulmonary nodules, often bilateral and peripheral
- Nodules may cavitate (thick- or thin-walled cavities)
- Patchy or nodular consolidations
- Ground-glass opacities and septal thickening may be present
- May show a “halo sign” around nodules (hemorrhage)
- Airway involvement (tracheal or bronchial stenosis) may occur

Key point

GPA typically presents with multiple pulmonary nodules that may cavitate. Early recognition is important for prompt diagnosis and treatment.

RadioGraphics 2000; 20:1623–1635

Granulomatosis with Polyangiitis (GPA)



A. Axial CT (upper level): Multiple cavitary nodules in both lungs.

B. Axial CT (upper–mid level): Bilateral cavitary nodules with surrounding consolidation and ground-glass opacity.

C. Axial CT (lower level): Cavitary nodule in the right lower lobe with surrounding ground-glass opacity.

Imaging findings are consistent with granulomatosis with polyangiitis (GPA).
Clinical correlation and serologic testing (e.g., c-ANCA/PR3) are recommended.

Case courtesy of Radiopaedia.org

Imaging features

- Multiple cavitary nodules, often bilateral and peripheral
- Cavities may vary in size and wall thickness
- Nodules may show surrounding ground-glass opacity or consolidation
- Airway involvement and septal thickening may be present
- Findings can change over time with intervals between flares

Key point

GPA typically presents with multiple cavitating pulmonary nodules that can change over time. Early recognition is important for prompt diagnosis and treatment.

Thoracic Manifestations of Rheumatoid Arthritis (RA)

- **Pleural disease** (pleural effusion, pleural thickening)

- **Interstitial lung disease (RA-ILD)** / pulmonary fibrosis

- **Pulmonary nodules**
  - Uncommon
  - Usually **multiple, well-circumscribed**
  - May **cavitate**, forming **thick-walled cavities**
  - Often associated with **advanced RA** and **subcutaneous rheumatoid nodules**

- **Airway disease**
  - Bronchiectasis
  - Bronchiolitis

- **Osseous abnormalities**
  - Costochondral and cervical spine involvement

Thoracic Manifestations of Rheumatoid Arthritis (RA)

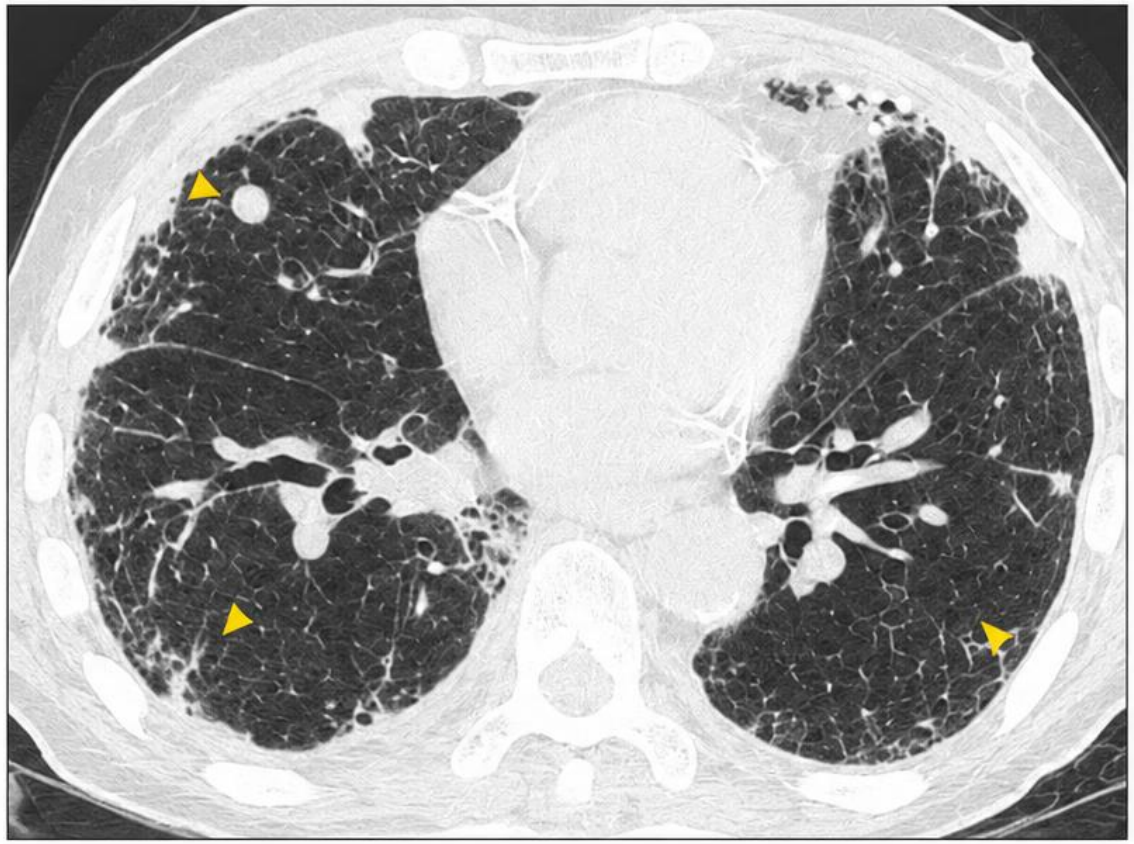


Fig. 10.33 Lung nodules in rheumatoid arthritis. CT shows a well-defined nodule in the right middle lobe, likely a rheumatoid nodule, and several triangular subpleural nodules which may represent lymphoid hyperplasia. All were stable on follow-up. There is a background UIP pattern.

Pulmonary manifestations in RA

- **Pleural disease**
  - Pleural effusion, pleural thickening
- **Interstitial lung disease (RA-ILD)**
  - Most common parenchymal manifestation
  - Usual interstitial pneumonia (UIP) pattern most frequent
- **Pulmonary nodules**
  - Uncommon
  - Usually multiple, well-circumscribed
  - May cavitate, forming thick-walled cavities
  - Often associated with advanced RA and subcutaneous rheumatoid nodules
- **Airway disease**
  - Bronchiectasis
  - Bronchiolitis
- **Osseous abnormalities**
  - Costochondral and cervical spine involvement

Hansell Imaging of Diseases of the Chest. 5th Ed

Thoracic Manifestations of Rheumatoid Arthritis (RA)

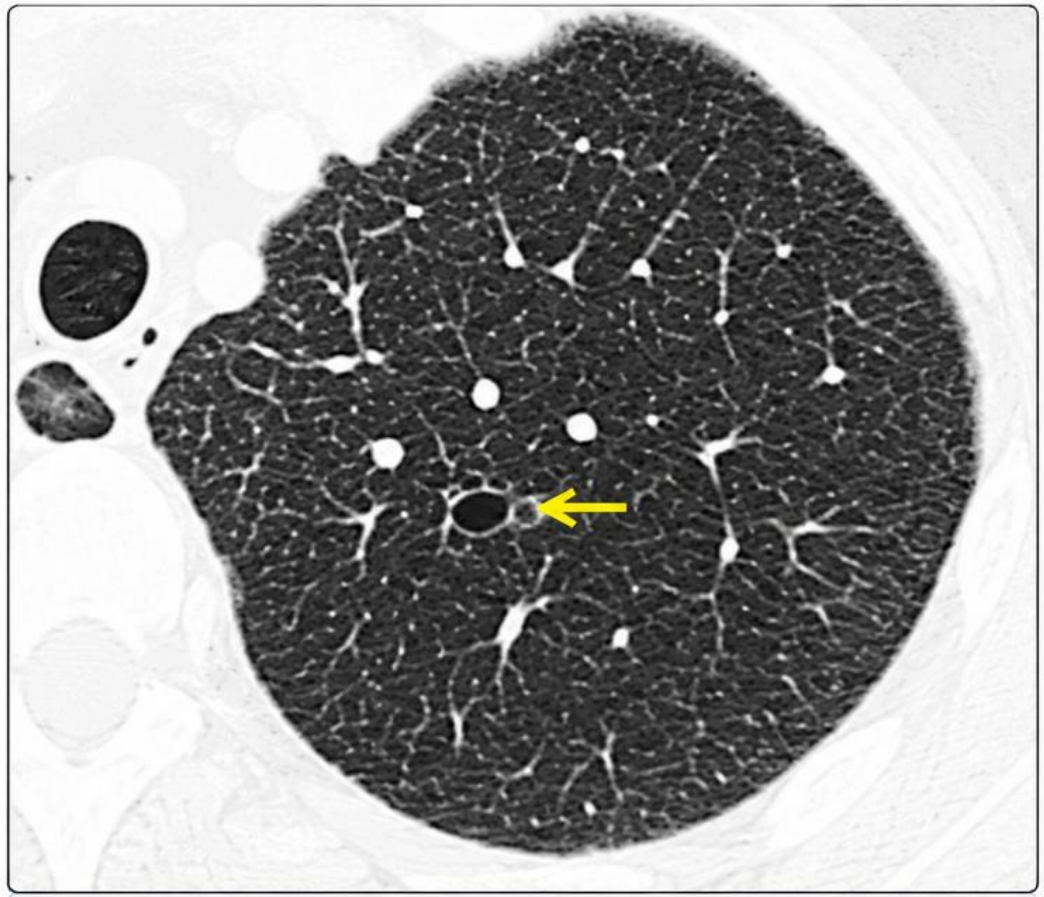


Fig. 10.34 Cavitary rheumatoid nodule. CT through the left upper lobe shows a small thin-walled cavitary nodule (arrow), which resolved on follow-up.

Cavitary rheumatoid nodule

- Pulmonary nodules occur in up to 0.4–32% of patients with RA.
- Nodules are usually multiple, peripheral, and well-circumscribed.
- Cavitation occurs in a subset (5–25%) and typically has **thin walls (< 4 mm)**.
- Cavitary nodules are more common in patients with:
  - Seropositive RA
  - Subcutaneous rheumatoid nodules
  - Long-standing disease
  - Smoking history
- May resolve spontaneously or with control of underlying disease.

Key point

A thin-walled cavitary nodule in a patient with rheumatoid arthritis strongly suggests a rheumatoid nodule rather than infection or malignancy, especially when multiple and peripheral.

Hansell Imaging of Diseases of the Chest. 5th Ed

C

CANCER

- **Primary bronchogenic carcinoma**: most frequently SCC
- **Pulmonary metastasis**: most frequently SCC, also adenocarcinoma, sarcoma

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T

TRAUMA – pneumatocele

Y

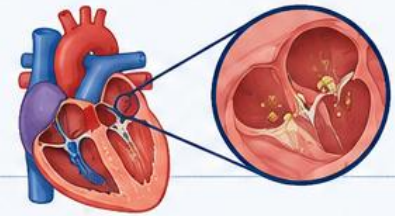
YOUTH

- CPAM (congenital pulmonary airway malformation)
- Pulmonary sequestration
- Bronchogenic cyst

Septic Pulmonary Emboli (SPE)

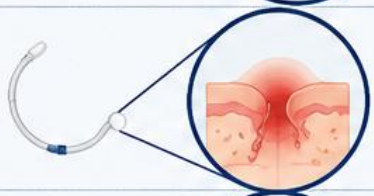
Risk factors

- Right-sided infective endocarditis

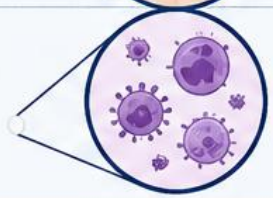


- IV drug use
- Infected venous catheter

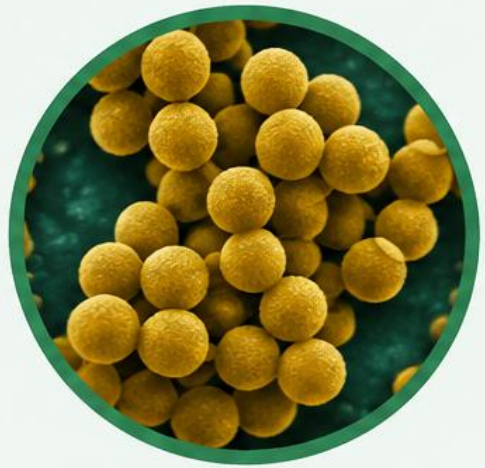
- Skin/soft tissue infection



- Immunocompromised state



Most common pathogen

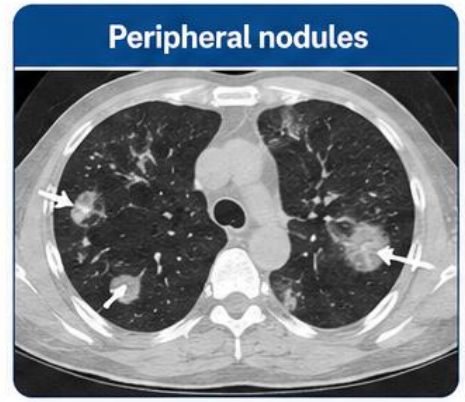


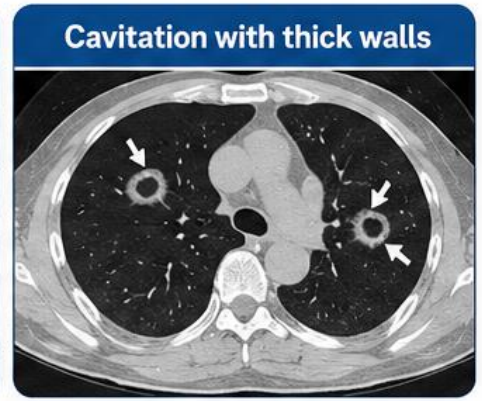
Staphylococcus aureus

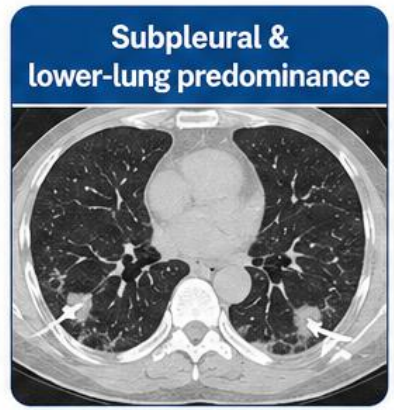
Septic Pulmonary Emboli (SPE)

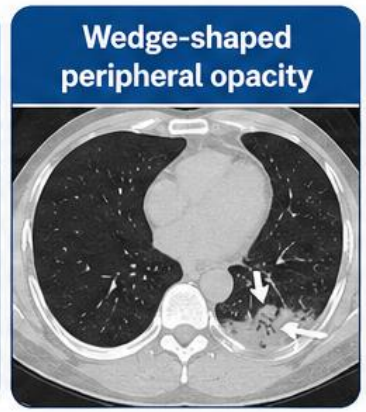
CT findings

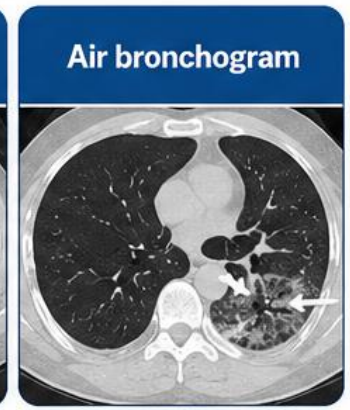
- Multiple bilateral **peripheral nodules**
- Rapid cavitation with **thick walls**
- **Subpleural** and **lower-lung** predominance
- **Wedge-shaped** peripheral opacities may be present
- **Air bronchogram** (~25%)





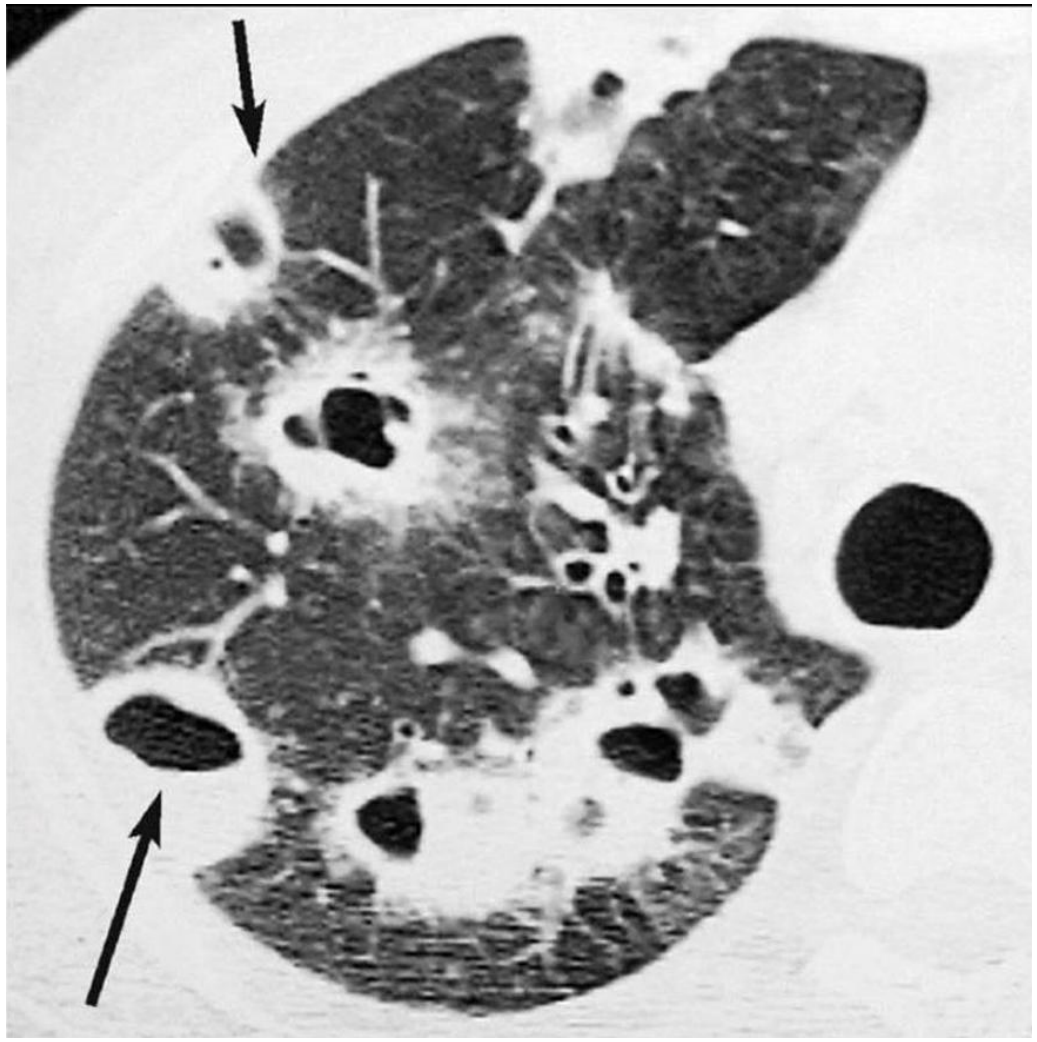






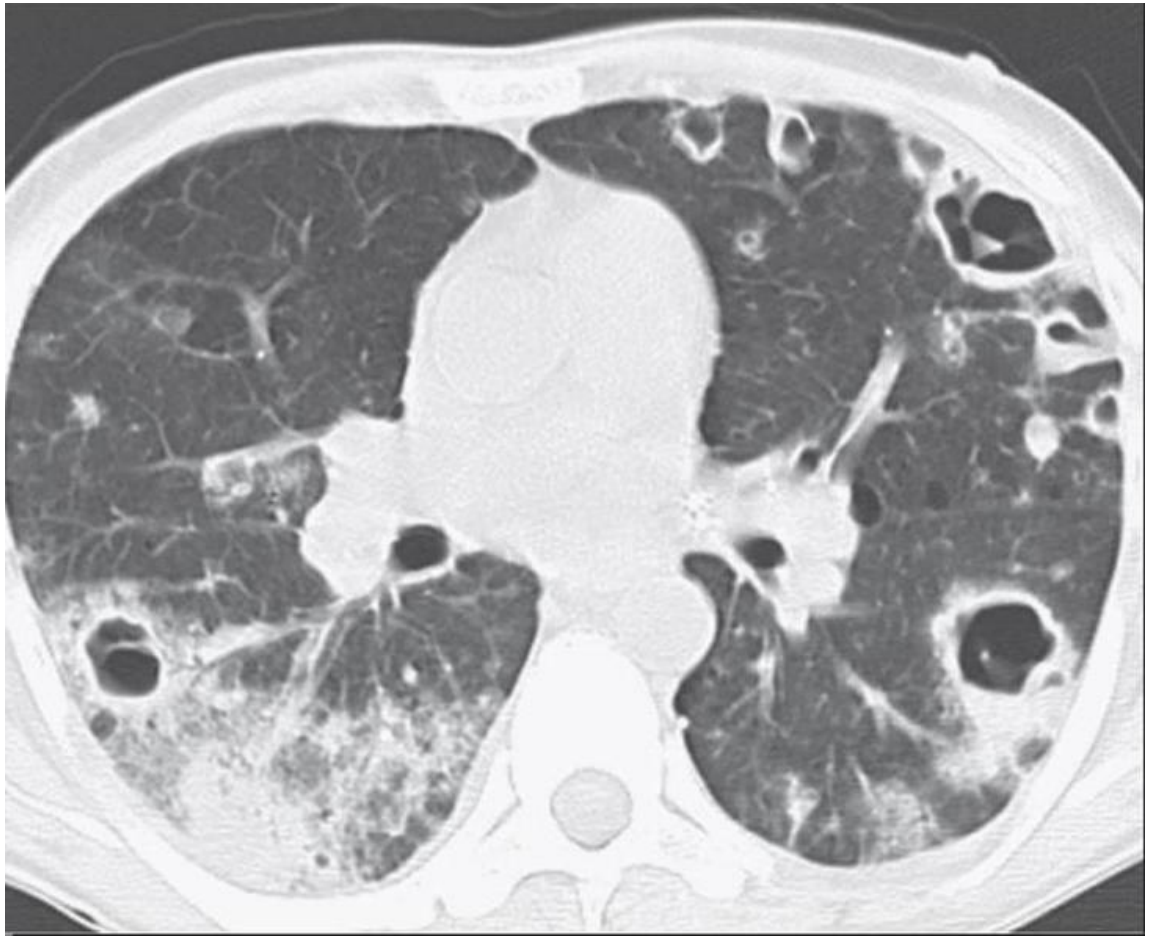
Multiple rapidly cavitating peripheral nodules in a patient with **bacteremia** or **right-sided endocarditis** are highly suggestive of **septic pulmonary emboli**.

CT Findings of Septic Pulmonary Emboli (SPE)



- **Multiple discrete pulmonary nodules** with **variable cavitation**
- **Peripheral, subpleural**, and **lower-lobe predominance**
- **Wedge-shaped peripheral consolidations**
- **Rim-enhancing nodules or consolidations** (reflecting pulmonary infarction/abscess)
- **Feeding vessel sign**: a vessel seen directly leading to a nodule (characteristic CT finding)

CT Findings of Septic Pulmonary Emboli (SPE)



- **Multiple discrete pulmonary nodules** with **variable cavitation**
- **Peripheral, subpleural**, and **lower-lobe predominance**
- **Wedge-shaped peripheral consolidations**
- **Rim-enhancing nodules or consolidations** (reflecting pulmonary infarction/abscess)
- **Feeding vessel sign**: a vessel seen directly leading to a nodule (characteristic CT finding)

C

CANCER

- **Primary bronchogenic carcinoma**: most frequently SCC
- **Pulmonary metastasis**: most frequently SCC, also adenocarcinoma, sarcoma

A

AUTOIMMUNE

Wegener Granulomatosis, rheumatoid arthritis (rheumatoid nodules) etc.

V

VASCULAR (both bland and septic pulmonary emboli)

I

INFECTION (bacterial / fungal) / INHALATION

- Lung abscess
- Fungal / parasite infection
- Pulmonary tuberculosis
- Pneumoconiosis

T

TRAUMA – pneumatocele

Y

YOUTH

- CPAM (congenital pulmonary airway malformation)
- Pulmonary sequestration
- Bronchogenic cyst

Infection

Bacterial

- **Septic pulmonary emboli**
- **Lung abscess**
- **Necrotizing pneumonia**
  - *Staphylococcus aureus*
  - Gram-negative bacilli (GNB)
  - Aspiration pneumonia
  - *Nocardia* spp.

Fungal

- **Aspergillosis**
- **Mucormycosis**
- **Coccidioidomycosis**
- **Cryptococcosis**

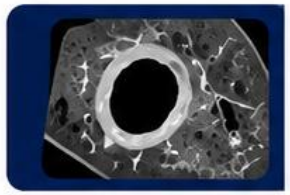
Mycobacterial

- **Tuberculosis (TB)**
- **Nontuberculous mycobacteria (NTM)**

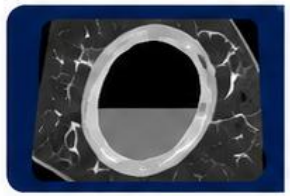
Parasitic

- **Echinococcosis (Hydatid disease)**

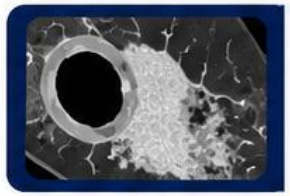
Pyogenic Lung Abscess – Imaging Findings



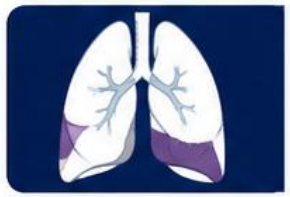
- **Thick-walled cavity** with a **shaggy, irregular inner margin**
  - Wall thickness typically > 4 mm



- **Air–fluid level** is common
  - May be horizontal or slightly oblique



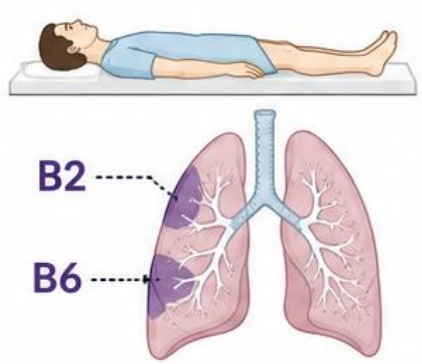
- **Usually evolves from necrotizing pneumonia**
  - Surrounding **consolidation** favors **lung abscess** over cavitary malignancy

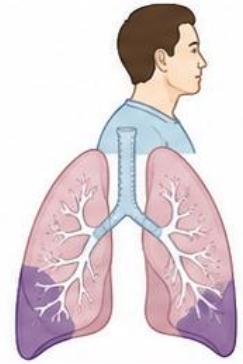


- **Aspiration-related abscesses** occur in **dependent lung segments**

Supine position

- Posterior segment of the upper lobe (**B2**)
- Superior segment of the lower lobe (**B6**)





Upright position

- **Basal** segments of the lower lobes (most dependent)

Pyogenic Lung Abscess – Pathogenesis

Pathogenesis

1. 

Virulent pathogen
Aspiration of oropharyngeal secretions containing pathogenic organisms

2. 

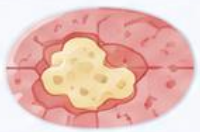
Suppurative inflammation
Neutrophil infiltration and pus formation

3. 

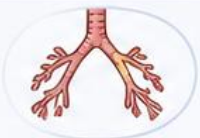
Vascular injury and thrombosis
Vascular damage leads to thrombosis

4. 

Ischemia + parenchymal necrosis
Reduced blood flow causes ischemia and parenchymal necrosis

5. 

Liquefaction of necrotic tissue
Enzymatic digestion leads to liquefaction of necrotic tissue and pus collection

6. 

Drainage through the bronchial tree
The liquefied material drains into the airways via a bronchus

7. 

Cavity formation
An air–fluid cavity remains after drainage and ongoing infection

Common Pathogens

- **Gram-positive cocci (GPC)**
  - *Staphylococcus aureus*
  - β-hemolytic *Streptococcus*

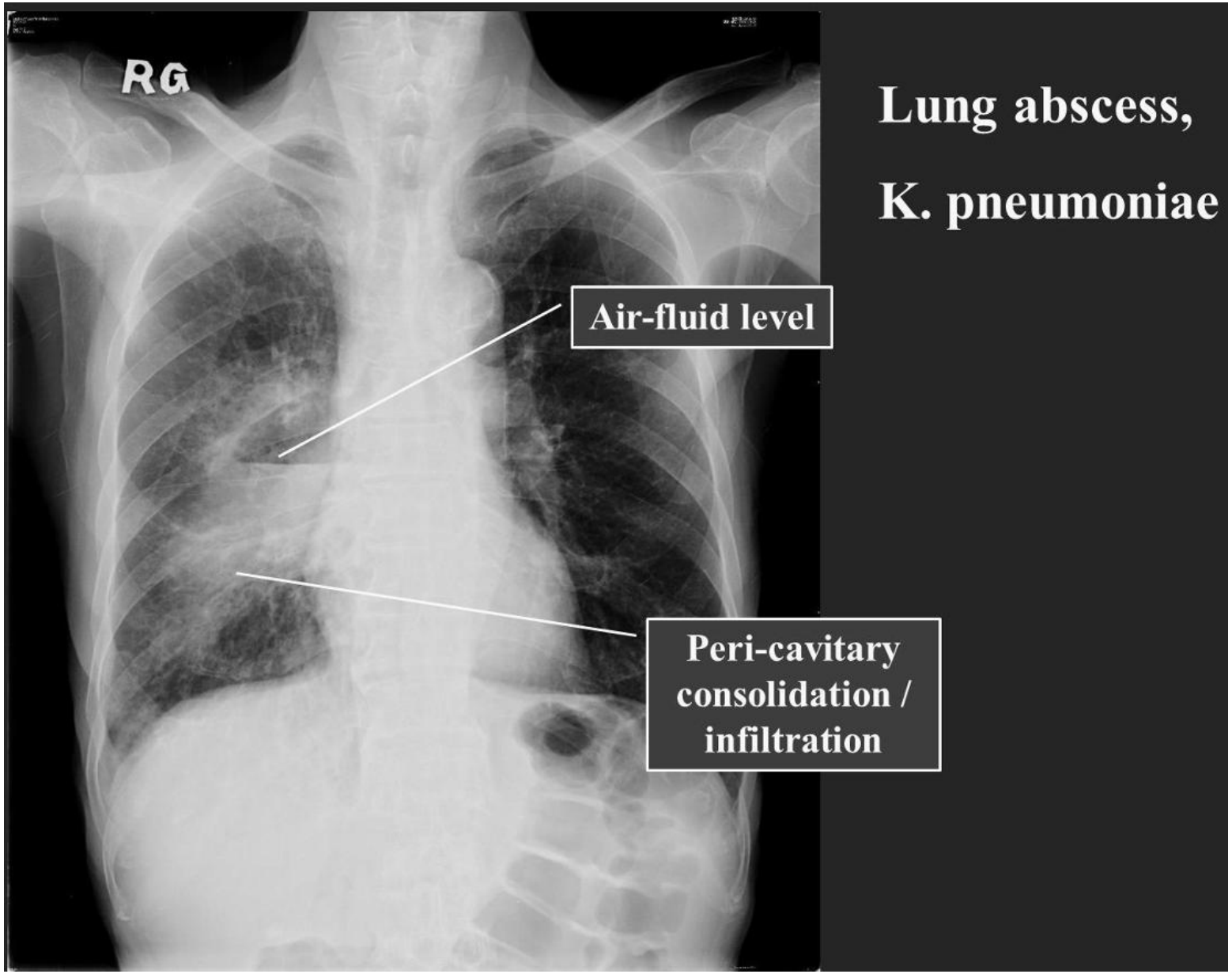
- **Gram-negative bacilli (GNB)**
  - *Klebsiella pneumoniae*
  - *Pseudomonas aeruginosa*
  - *Escherichia coli*

- **Anaerobes**
  (especially aspiration-related)

Key Point

Pyogenic lung abscess results from a sequence of infection → inflammation → ischemia/necrosis → liquefaction → drainage → cavity formation. Aspiration of infected material is the most common precipitating event.

Pyogenic Lung Abscess



C

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- **Primary bronchogenic carcinoma**: most frequently SCC
- **Pulmonary metastasis**: most frequently SCC, also adenocarcinoma, sarcoma

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TRAUMA – pneumatocele

Y

YOUTH

- CPAM (congenital pulmonary airway malformation)
- Pulmonary sequestration
- Bronchogenic cyst

Pneumatoceles

Thin-walled, transient air-filled cysts

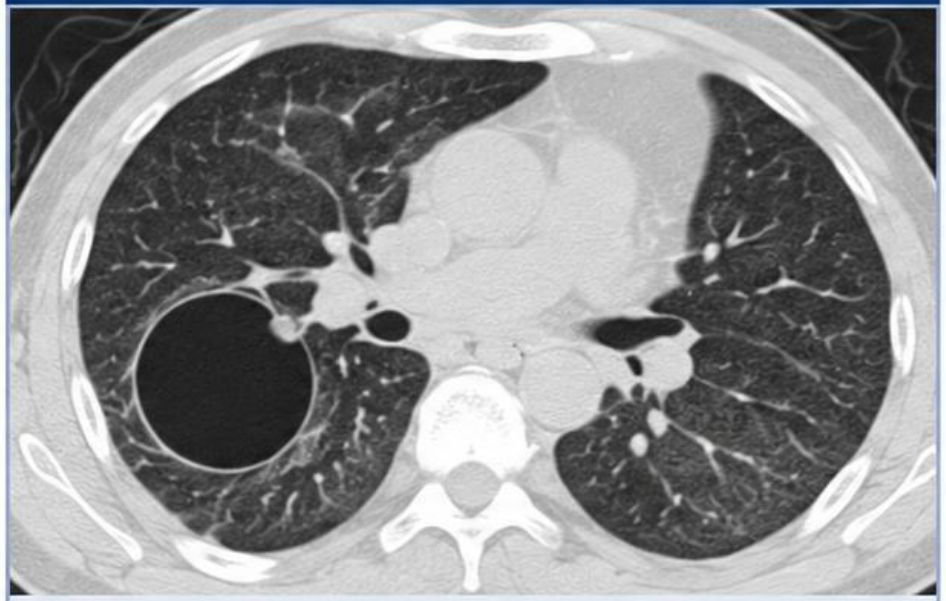
CAUSES

- **Infection**
  - *Staphylococcus aureus* (especially in infants and children)
  - *Pneumocystis jirovecii* pneumonia (PCP) in patients with AIDS
- **Blunt chest trauma**

NATURAL HISTORY

- Usually **resolves spontaneously** over weeks to months

Chest CT Example



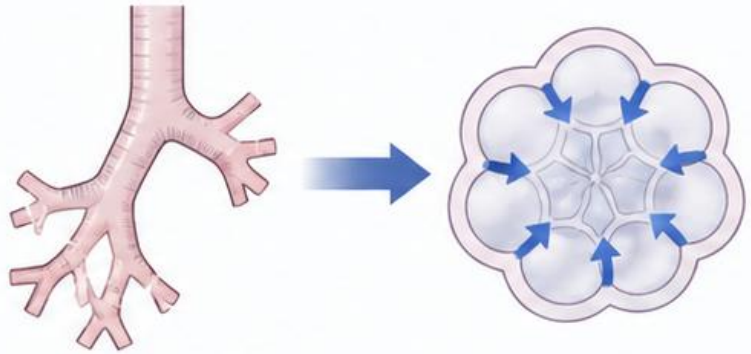
Thin-walled air-filled cyst in the right lower lobe after pneumonia

A thin-walled cyst that **develops during or after pneumonia** and subsequently **resolves** strongly suggests a **pneumatoceles.**

Pneumatocele – Pathogenesis

1 單向活瓣（check-valve）效應 → 空氣滯留（air trapping）

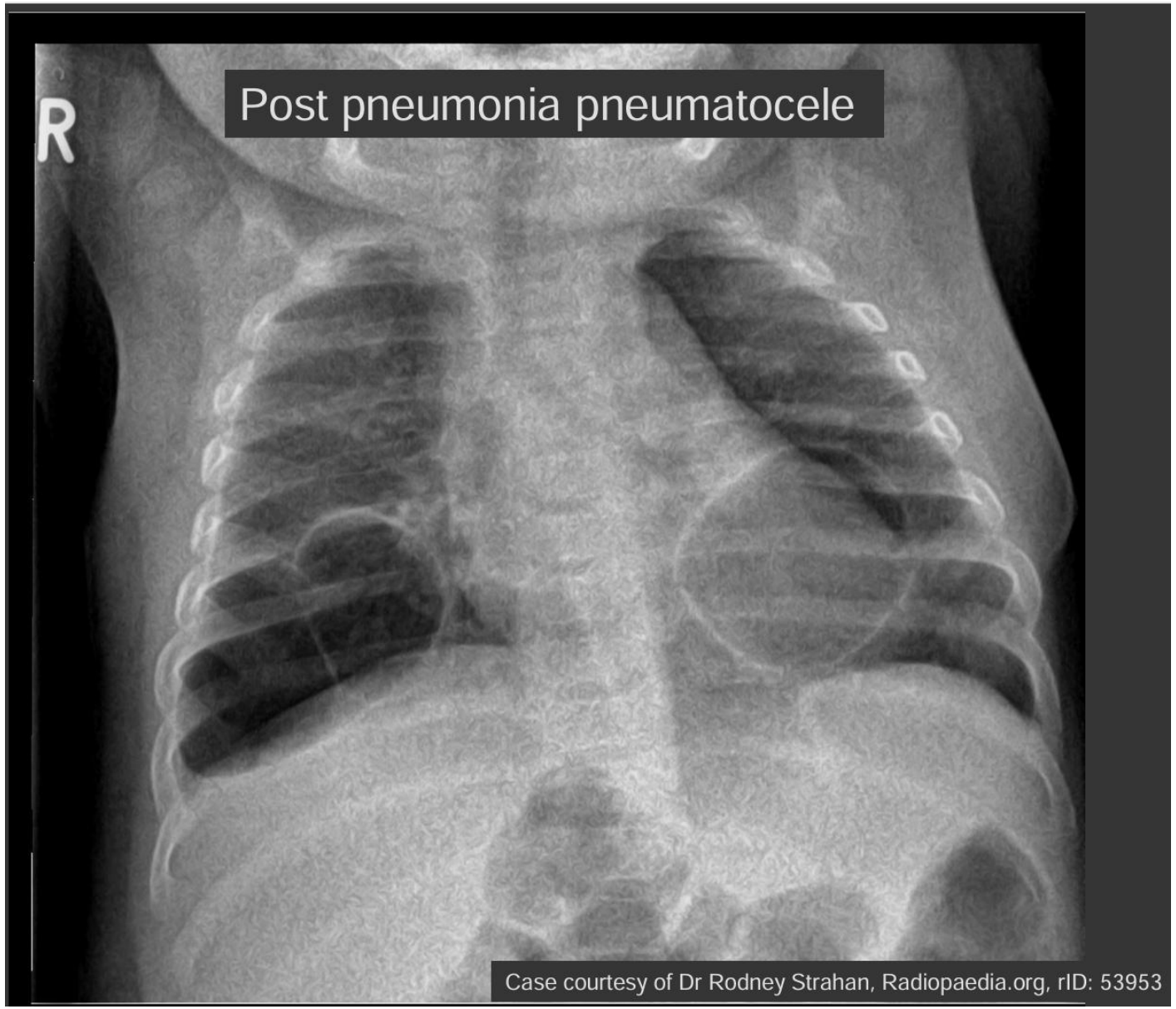
- 肺部感染（最典型是 **Staphylococcus aureus pneumonia**）、外傷或發炎，造成小支氣管部分阻塞。
- 阻塞不是完全堵住，而是形成 **單向活瓣**：
  - **吸氣時**：氣道張開，空氣可以進入肺泡。
  - **呼氣時**：氣道塌陷或被分泌物堵住，空氣無法順利排出。



2 Interstitial air dissection with formation of a subpleural air-filled cavity

- 當肺泡壓力過高時，部分肺泡壁破裂（**alveolar rupture**）
- 空氣不是直接進入胸膜腔，而是先漏到肺間質（**interstitium**）
- 空氣沿著：血管周圍（**perivascular**）、支氣管周圍（**peribronchovascular**）、結締組織間隙擴散（**air dissection**）
- 最後聚集於胸膜下（**subpleural**），形成 **subpleural air-filled cavity**（胸膜下充氣囊腔）

Pneumatocele



Pneumatocele

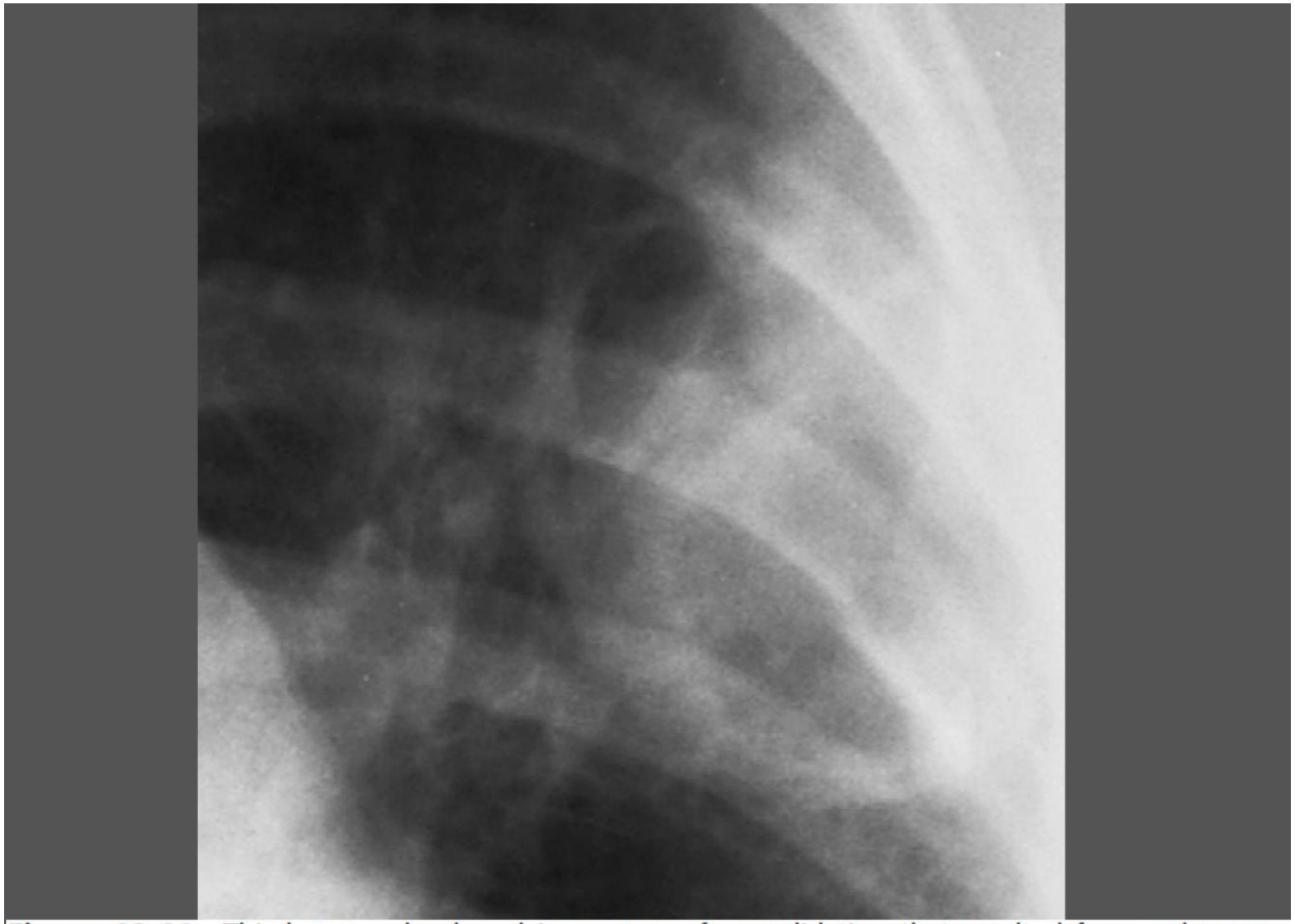


Figure 23-12 This lucency developed in an area of consolidation that resulted from pulmonary contusion following a crush injury to the left chest. This is a so-called *traumatic lung cyst* or *pneumatocele.*

James C. Reed, Chest Radiology, 6th

C 

CANCER

- **Primary bronchogenic carcinoma**: most frequently SCC
- **Pulmonary metastasis**: most frequently SCC, also adenocarcinoma, sarcoma

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AUTOIMMUNE

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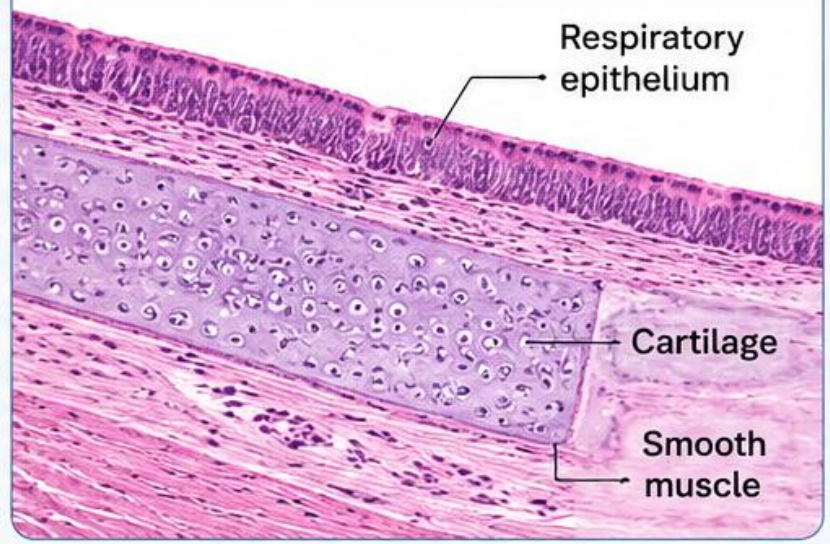
- Pulmonary sequestration
- Bronchogenic cyst

Bronchogenic Cyst

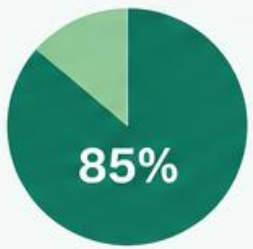
PATHOGENESIS

- Congenital **bronchopulmonary foregut** malformation
- Single, **thin-walled cyst** lined by respiratory epithelium
- Contains **mucoid or serous fluid**
- **No airway communication** unless infected
- Cyst wall contains **cartilage and smooth muscle** (pathologic hallmark)

PATHOLOGIC HALLMARK



LOCATION



Mediastinal (85%)

- **Carinal** (~50%)
  Most common
- **Paratracheal** (~20%)

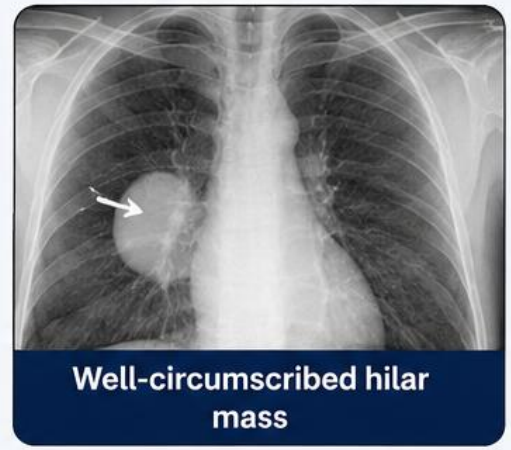
Intrapulmonary (15%)

- Usually **perihilar** and **lower lobes**

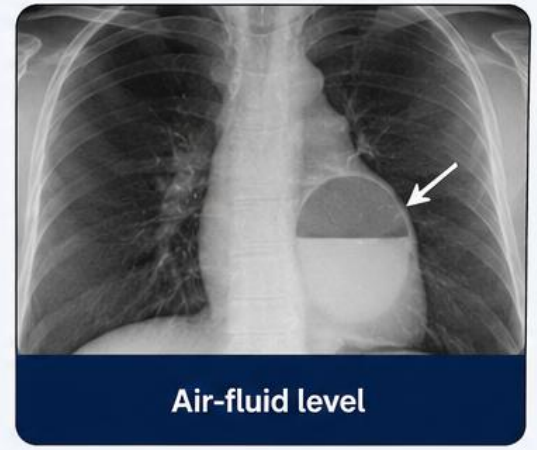
Bronchogenic Cyst – Imaging Features

CHEST RADIOGRAPH

- Well-circumscribed **hilar or mediastinal mass**
- **Air–fluid level** if infected or communicating with the airway



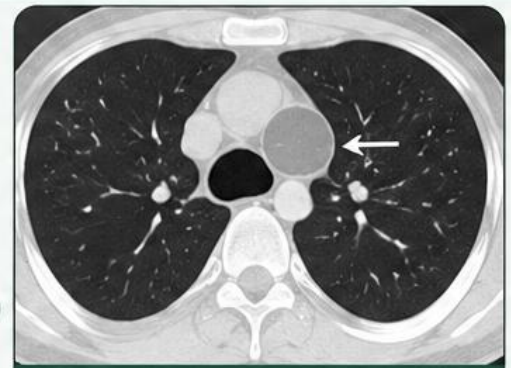
Well-circumscribed hilar mass



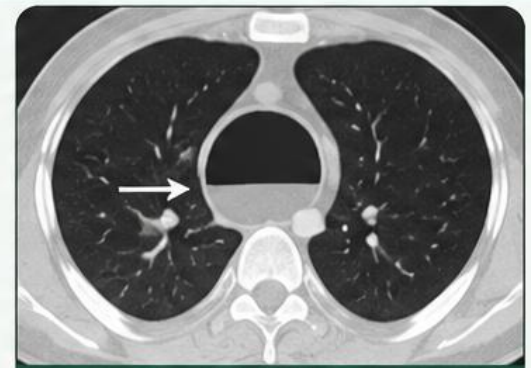
Air-fluid level

CT

- Well-defined **thin-walled cyst**
- Adjacent to the **trachea or major bronchi**
- Variable attenuation (**water** to **soft tissue density**)
- Air or gas indicates **infection** or **airway communication**



Well-defined thin-walled cyst adjacent to the trachea



Air within the cyst (airway communication or infection)

Key Point: Bronchogenic cysts typically appear as well-defined, thin-walled lesions near the central airways. Air or air-fluid levels suggest infection or communication with the airway.

Bronchogenic Cyst

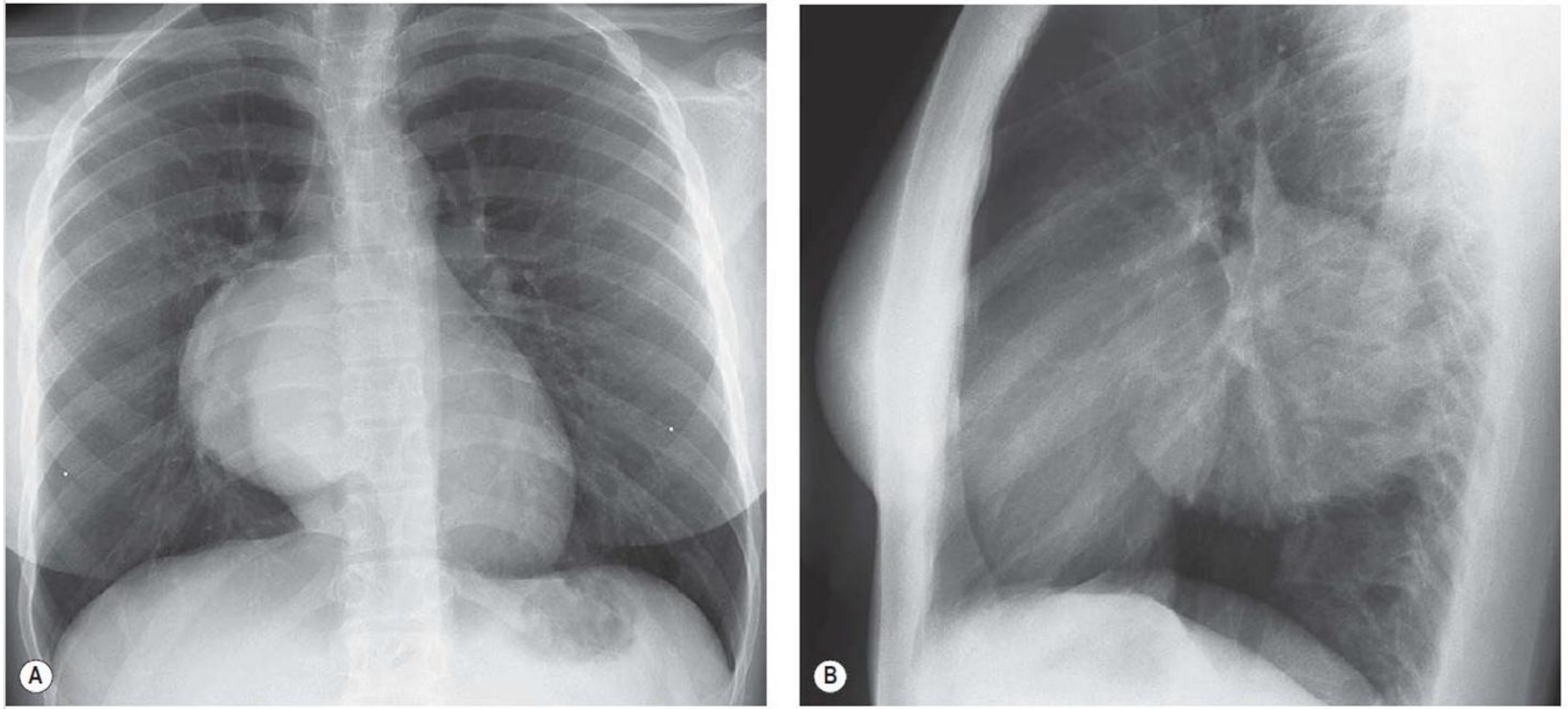


Fig. 16.32 Bronchogenic cyst in a young woman with cough. **A**, Frontal and **B**, lateral chest radiographs show a large, smooth, well-marginated mass in the middle mediastinum – the most common location for a bronchogenic cyst.

Bronchogenic Cyst

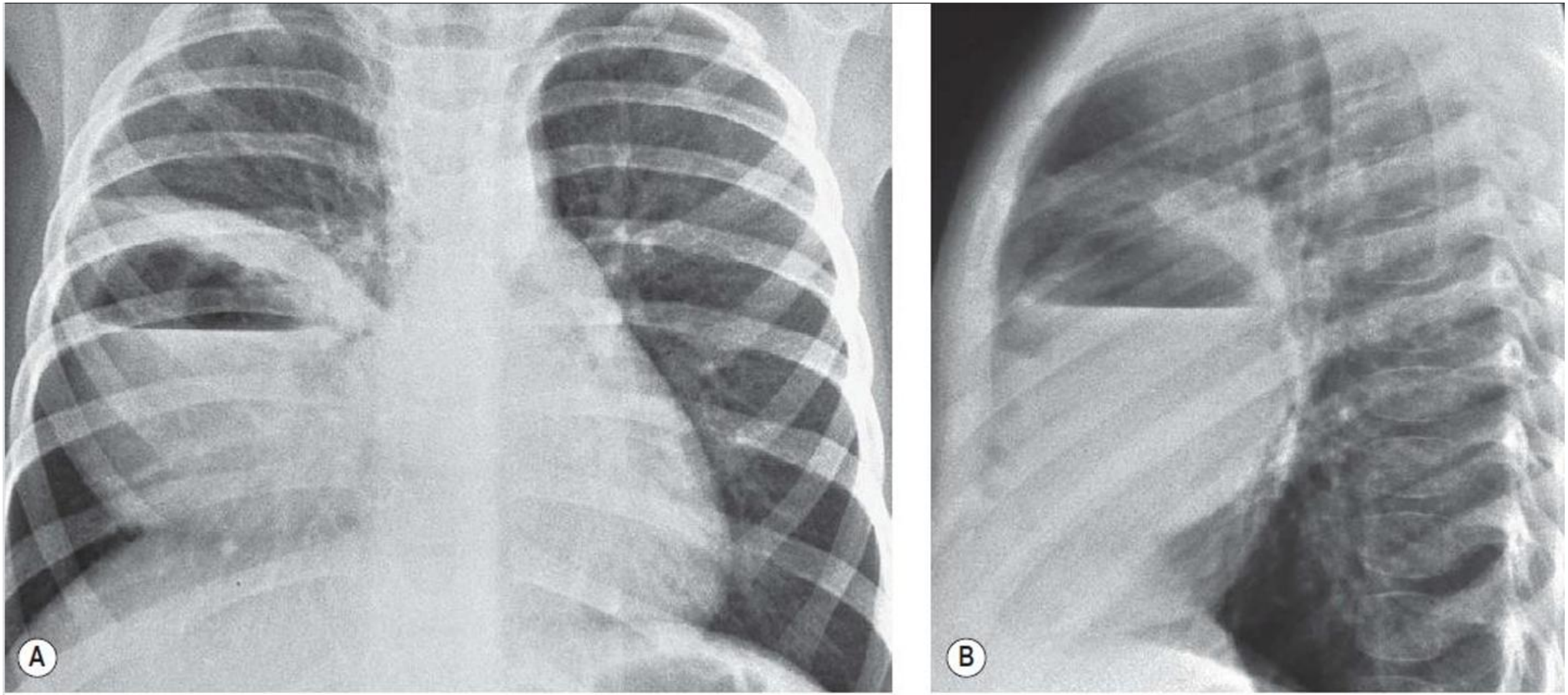
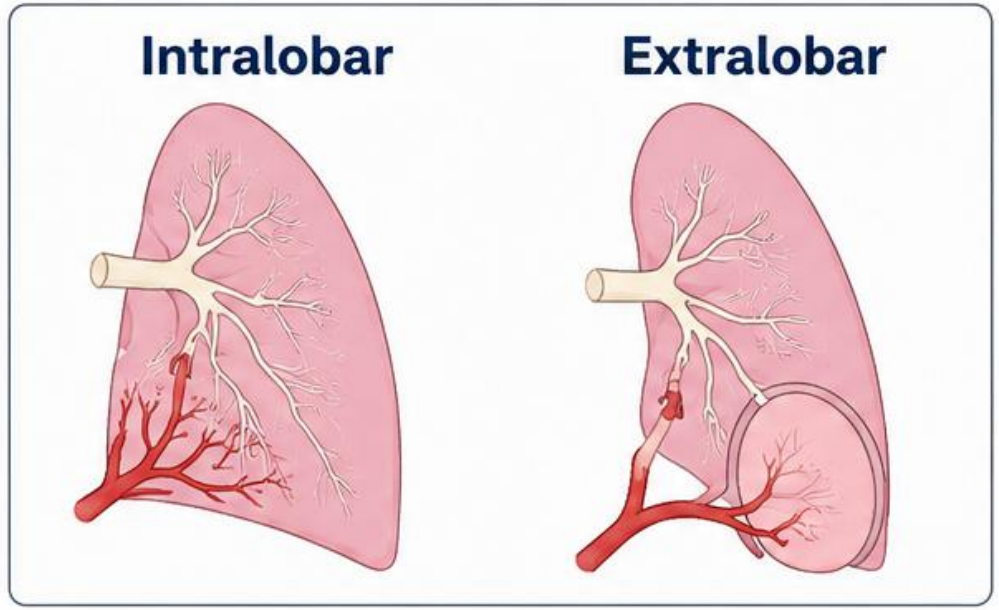


Fig. 16.33 Infected intrapulmonary bronchogenic cyst in a child. **A**, Frontal and **B**, lateral chest radiographs show a large right-sided intrapulmonary mass with an air–fluid level. The cyst wall is thickened by inflammation.

Pulmonary Sequestration – Definition

- **Congenital lung malformation**
- **No communication** with the tracheobronchial tree
- **Systemic arterial supply** (usually from the thoracic or abdominal aorta)



Intralobar (75%)	Extralobar (25%)
Within normal lung, **shares visceral pleura**	Separate lung tissue with **its own pleura**
Left lower lobe (B10)	Left hemithorax, often infancy
Recurrent infection common	Infection uncommon
Usually diagnosed in adolescents/adults	Usually diagnosed in infancy
Congenital anomalies uncommon	Congenital anomalies common

Pulmonary Sequestration–Imaging Findings

Uncomplicated Sequestration

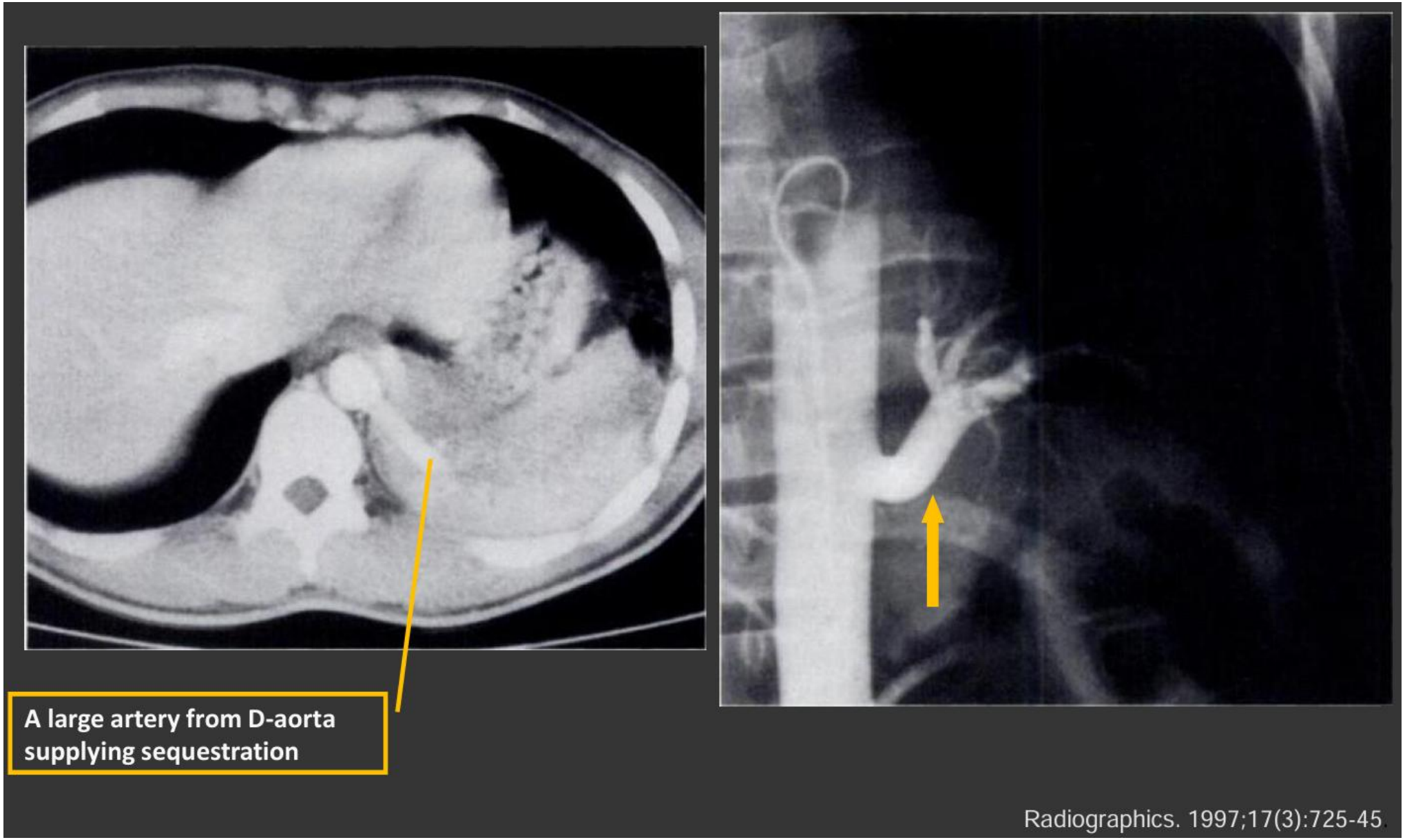
- Posterior basal **left lower lobe (B10)**
- Well-defined **homogeneous mass or consolidation**
- **Systemic feeding artery** from the aorta **(diagnostic hallmark)**
- No communication with the bronchial tree

Complicated Sequestration

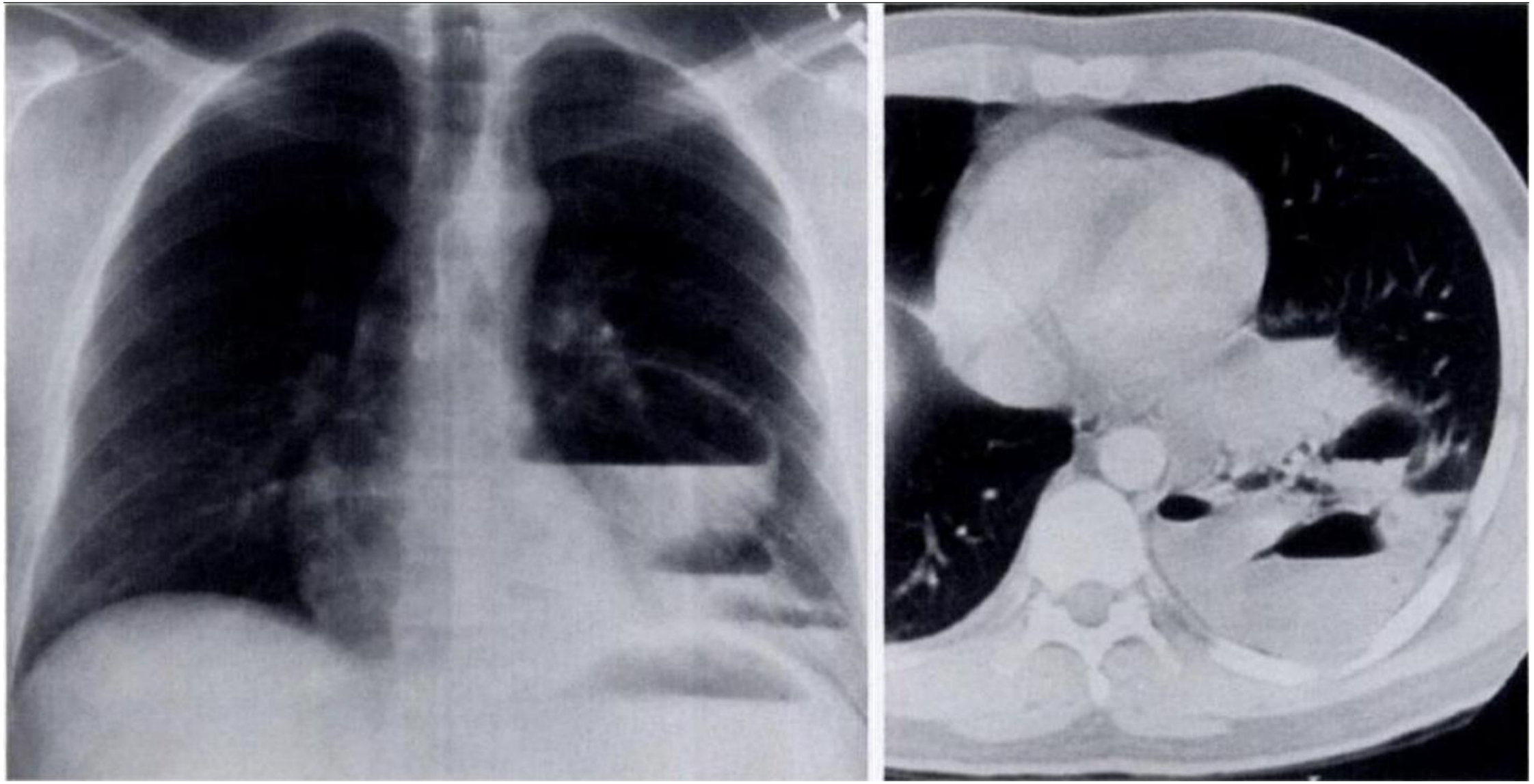
- Recurrent **infection**
- **Multiple cysts** or **cavitary lesions**
- **Air–fluid level** in approximately **one-third** of cystic lesions
- Air within the lesion suggests **secondary communication** with the **airway**

Key Point: Identification of a **systemic arterial supply** from the aorta is the hallmark imaging feature for pulmonary sequestration.

Intralobar Pulmonary Sequestration



Intralobar Pulmonary Sequestration



Radiographics. 1997;17(3):725-45

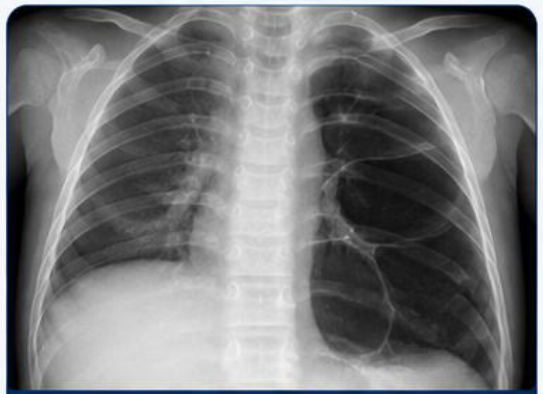
Congenital Pulmonary Airway Malformation (CPAM)

- *formerly Congenital Cystic Adenomatoid Malformation, CCAM*
- **Congenital hamartomatous malformation** of the terminal bronchioles
- **Abnormal bronchiolar proliferation** forms cysts instead of normal alveoli
- Usually diagnosed in **infants (<2 years)**

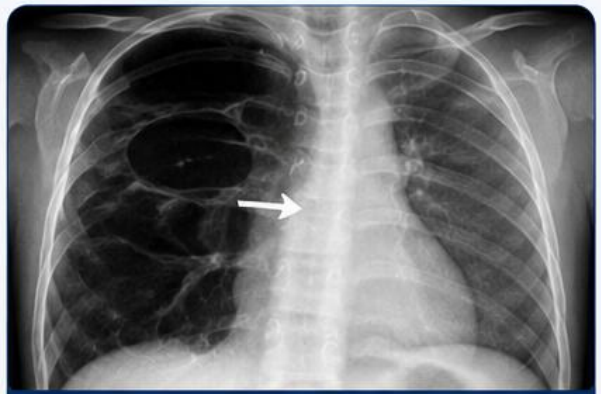
Congenital Pulmonary Airway Malformation (CPAM) – Imaging Findings

CHEST RADIOGRAPH

- Usually **unilateral, lower-lobe predominant**
- **Single or multiple** cysts
- **Expansion** of the affected hemithorax
- **Contralateral mediastinal shift** (large lesions)



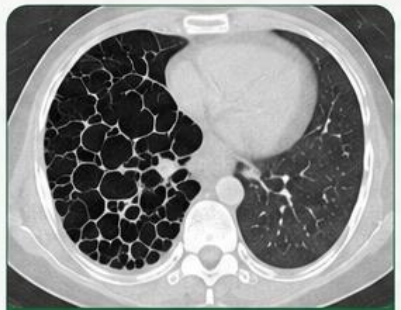
Unilateral, lower-lobe predominant cystic lesion



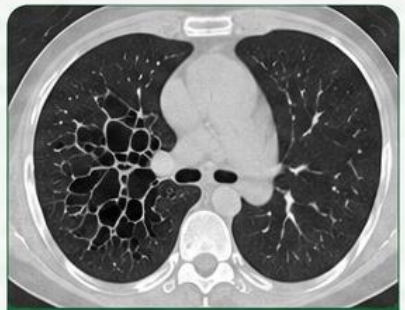
Expansion of hemithorax with contralateral mediastinal shift

CT

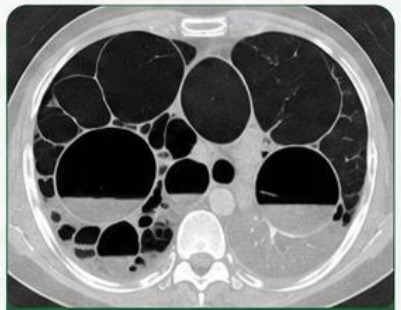
- Cluster of **multiple thin-walled cysts**
- Usually confined to **one lower lobe**
- **Variable cyst size** (microcystic or macrocystic)
- May show **air–fluid levels** if infected



Cluster of multiple thin-walled cysts



Confined to one lower lobe



Variable cyst size with air–fluid levels

Key Point: CPAM typically presents as a cluster of thin-walled cysts in one lower lobe, causing expansion of the hemithorax and possible mediastinal shift when large.

Congenital Pulmonary Airway Malformation (CPAM)

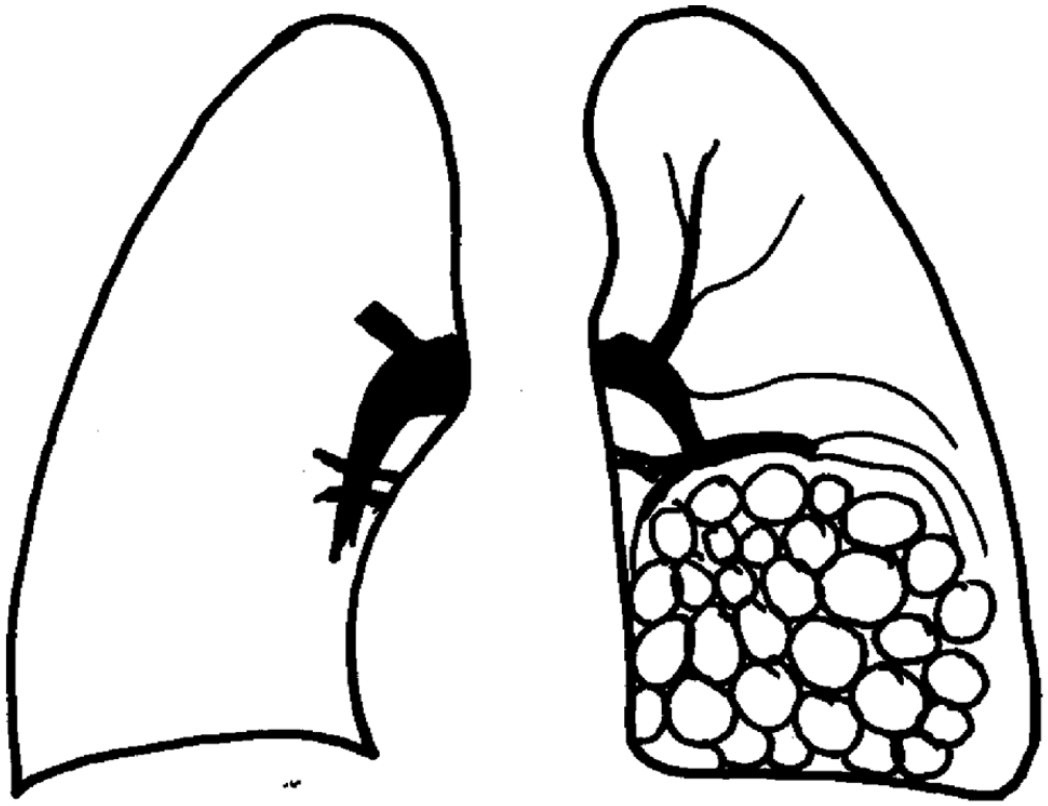


Fig. **68** Congenital cystic adenomatoid malformation. Overexpanded cystic area with vascular displacement

Sebastian Lange, Radiology of chest diseases, 1990

Congenital Pulmonary Airway Malformation (CPAM)

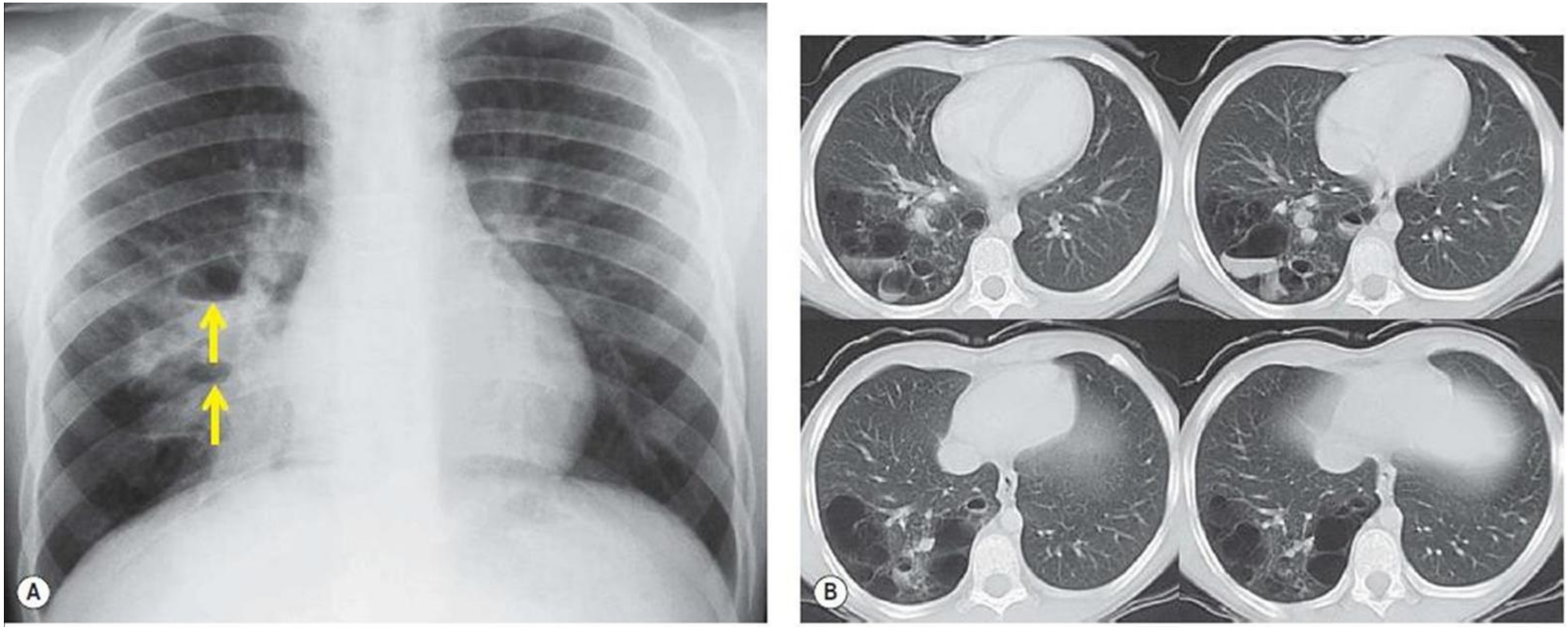
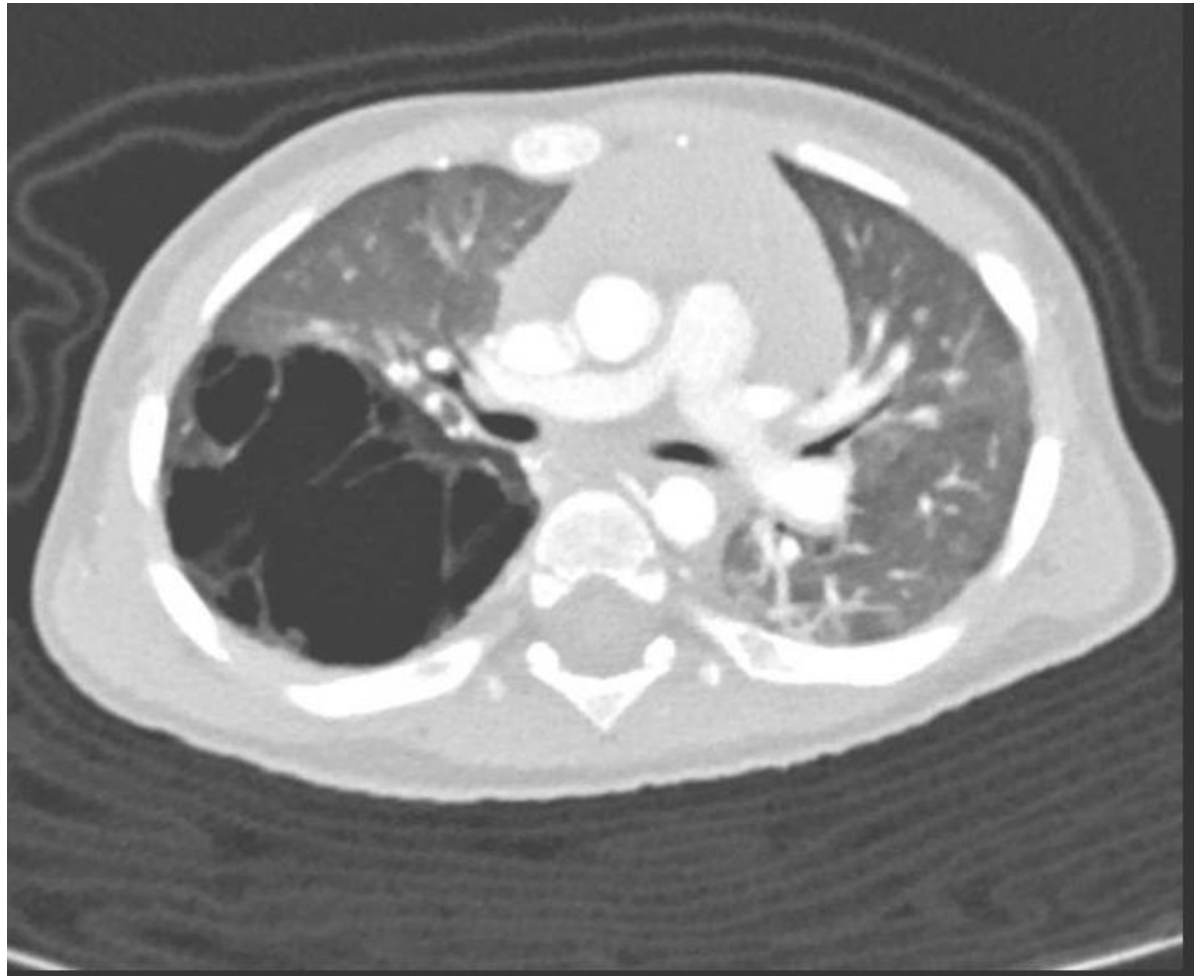
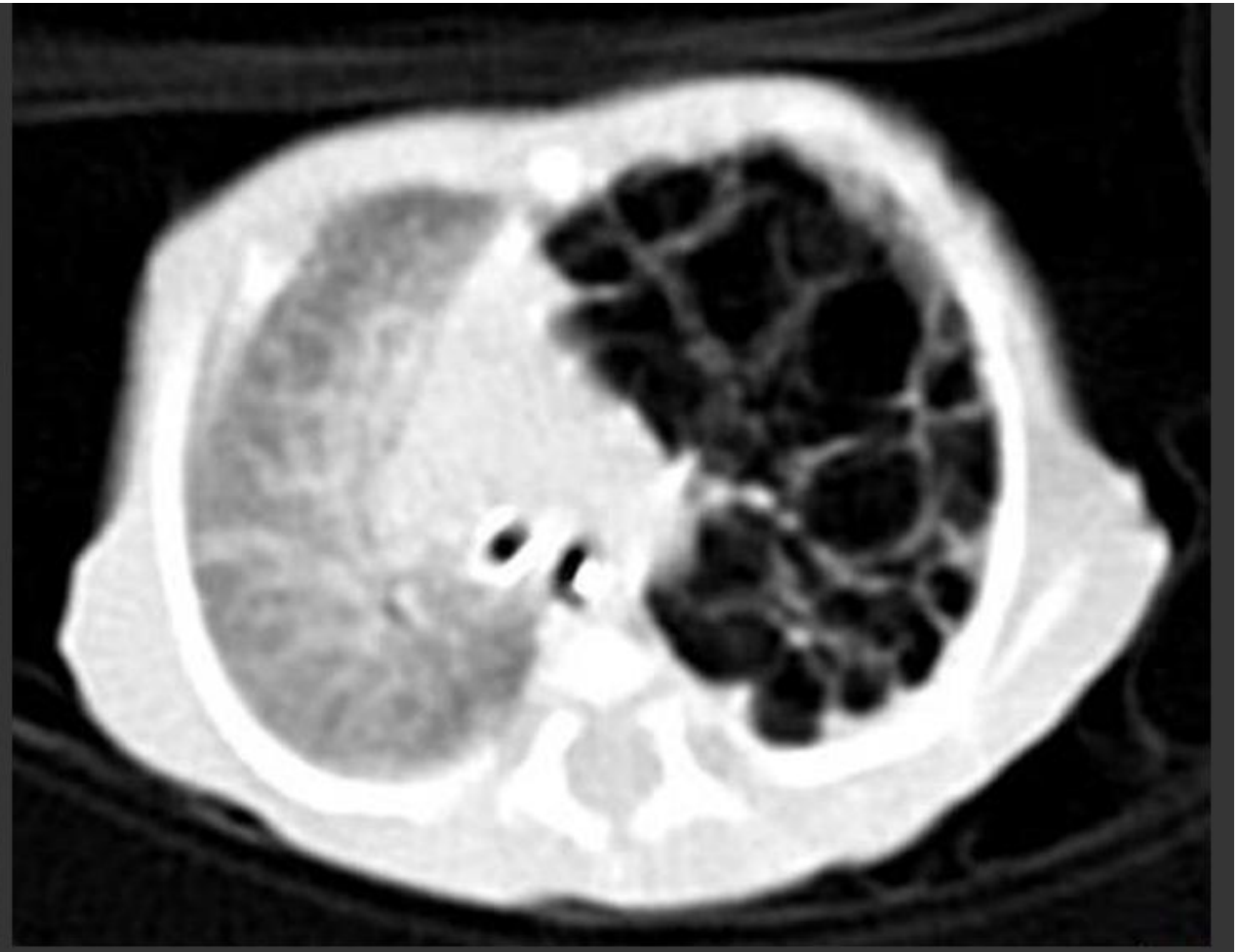


Fig. 16.50 Congenital cystic adenomatoid malformation of the right lung in a 7-year-old boy with a history of recurrent pneumonia. **A**, Frontal chest radiograph shows a heterogeneous right lung mass with multiple air–fluid levels (arrows). **B**, CT (lung window) shows a multicystic mass in the right lower lobe. (Courtesy of J R Galvin, MD, Armed Forces Institute of Pathology, Washington, DC, USA.)

Congenital Pulmonary Airway Malformation (CPAM)



Case courtesy of Dr Yair Glick, Radiopaedia.org, rID: 73514



Case courtesy of Dr Ahmed Abdrabou, Radiopaedia.org, rID: 25491

Multiple Cystic Lung Diseases – “4 L’s”

Disease	Key Imaging Features
Lymphangioleiomyomatosis (LAM)	• Numerous **uniform, thin-walled round cysts** • **Diffuse** distribution • **Normal** intervening lung
Pulmonary Langerhans Cell Histiocytosis (PLCH)	• **Upper-lung** predominant • **Irregular/bizarre-shaped** cysts with nodules • Costophrenic angles **spared**
Lymphocytic Interstitial Pneumonia (LIP)	• Thin-walled cysts with **ground-glass opacities** • **Septal thickening**, and small nodules • **Lower-lung** predominance
Laryngeal Respiratory Papillomatosis (LRP)	• Multiple **cavitary nodules** and **thin-walled cysts** • From **distal airway spread** • Recurrent **papillomas**

Multiple Cystic Lung Diseases – “4 L’s”

LAM
(Lymphangioleiomyomatosis)

- **Diffuse uniform round cysts** (women of childbearing age, TSC).

TSC

PLCH
(Pulmonary Langerhans Cell Histiocytosis)

- **Bizarre-shaped upper-lobe cysts + nodules** (smokers).

LIP
(Lymphocytic Interstitial Pneumonia)

- **Cysts + GGO + autoimmune disease** (especially Sjögren syndrome).

LRP
(Laryngeal Respiratory Papillomatosis)

- **Multiple cystic/cavitary nodules** due to **HPV** infection.

HPV

Lymphangioleiomyomatosis (LAM)

Key Clinical Features and Pathology

CLINICAL FEATURES

- Women of **childbearing age**
- Progressive **dyspnea**
- Recurrent spontaneous **pneumothorax**
- **Chylous pleural effusion** (chylothorax)

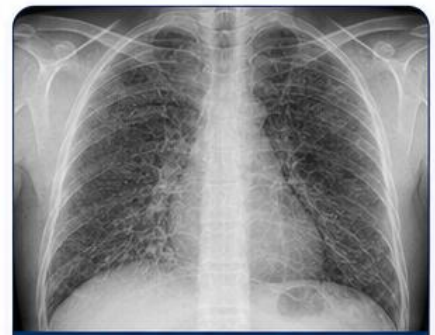
PATHOLOGY

- Abnormal proliferation of **smooth muscle–like (LAM) cells**
- Involves **airways, lymphatics,** and **blood vessels**

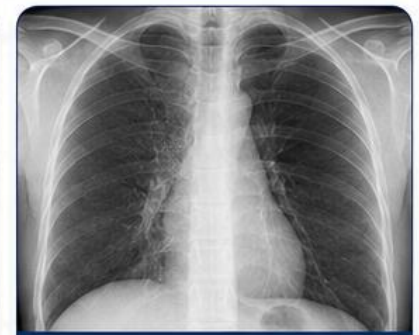
Lymphangioleiomyomatosis (LAM)–Imaging Findings

CHEST RADIOGRAPH

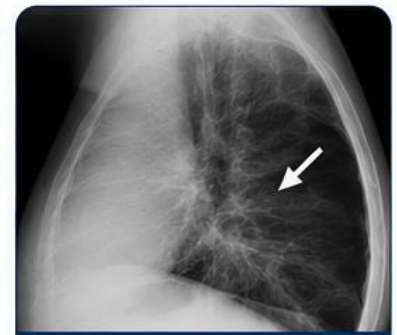
- Diffuse **reticular interstitial opacities**
- **Hyperinflation** or normal lung volume
- Recurrent **pneumothorax** or **pleural effusion**



Diffuse reticular interstitial opacities



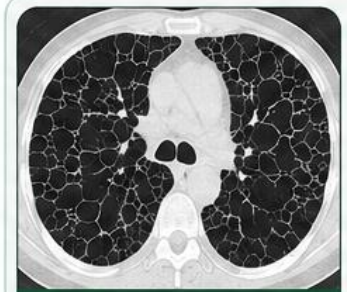
Hyperinflation



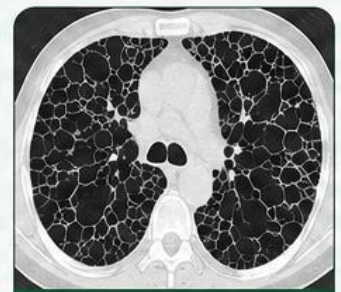
Pneumothorax

HRCT

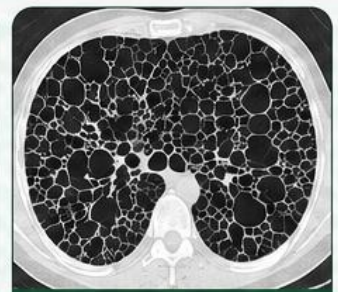
- Numerous, **thin-walled, round cysts**
- **Uniform size**
- **Diffuse distribution** without zonal predominance
- Normal intervening lung parenchyma
- **Pneumothorax** and/or **chylous pleural effusion**



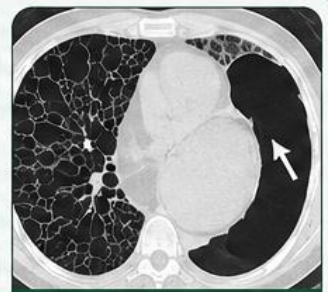
Numerous, thin-walled, round cysts



Uniform size



Diffuse distribution (no zonal predominance)



Pneumothorax / chylous pleural effusion

ASSOCIATED FINDINGS

Renal angiomyolipoma
Commonly associated (occurs in ~30–80% of patients)

Mediastinal or retroperitoneal lymphatic involvement
Lymphadenopathy or lymphatic cysts may be present

Lymphangioleiomyomatosis (LAM)

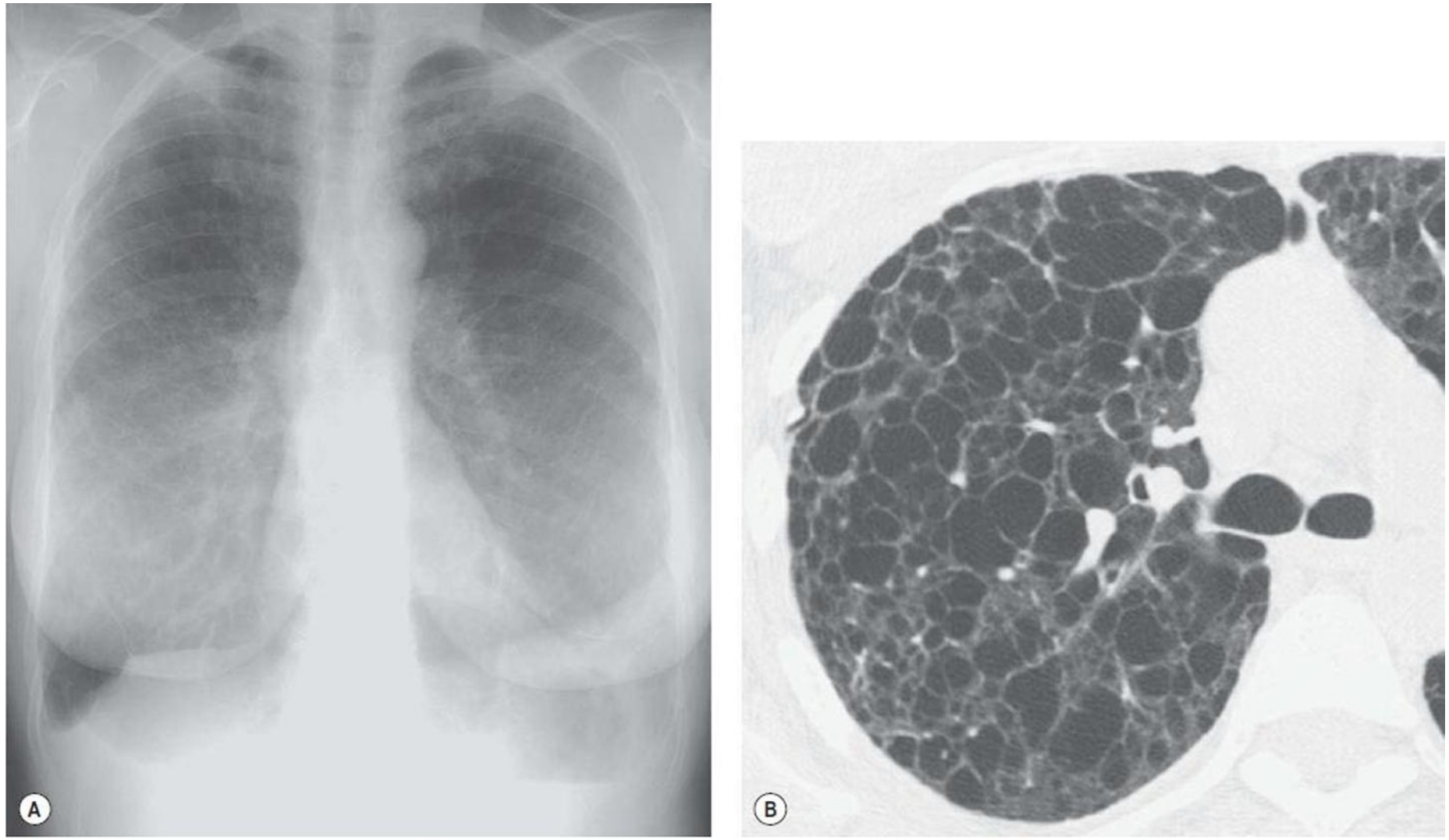


Fig. 11.65 A 54-year-old woman with LAM. **A**, Chest radiograph shows marked hyperinflation with a diffuse coarse reticular pattern. There is a small left effusion. **B**, CT shows profuse round cysts, each with a well-defined thin wall. The cysts are so numerous that they appear clustered.

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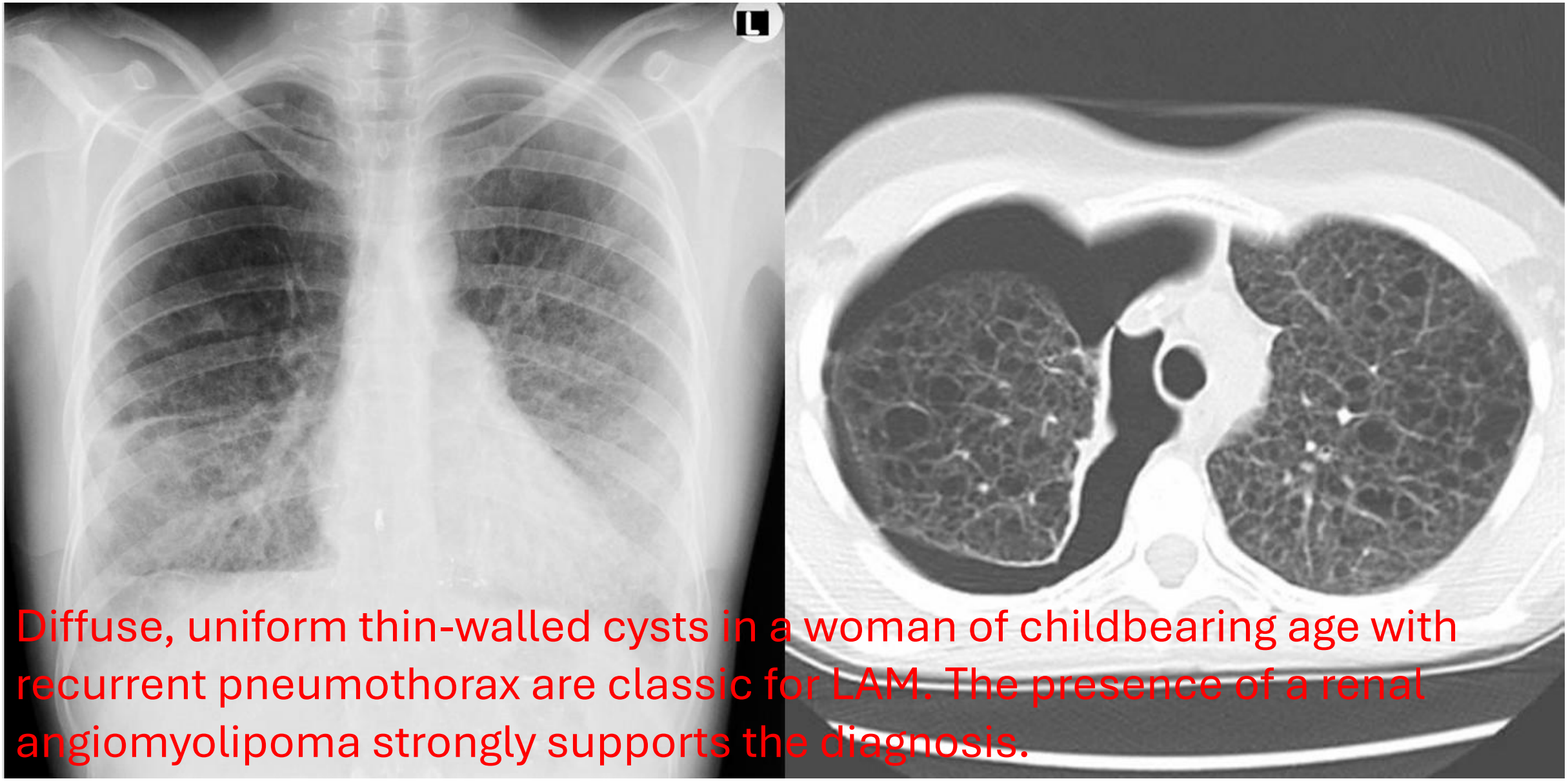
Lymphangioleiomyomatosis (LAM)



Diffuse, uniform thin-walled cysts in a woman of childbearing age with recurrent pneumothorax are classic for LAM. The presence of a renal angiomyolipoma strongly supports the diagnosis.

Pulmonary Langerhans Cell Histiocytosis (PLCH)

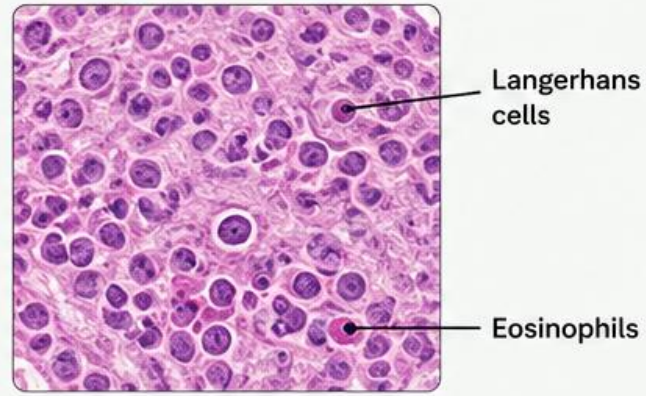
CLINICAL FEATURES

- **20–40 years**, no significant sex predilection
- Strongly associated with **cigarette smoking**
- Recurrent **spontaneous pneumothorax**

PATHOLOGY

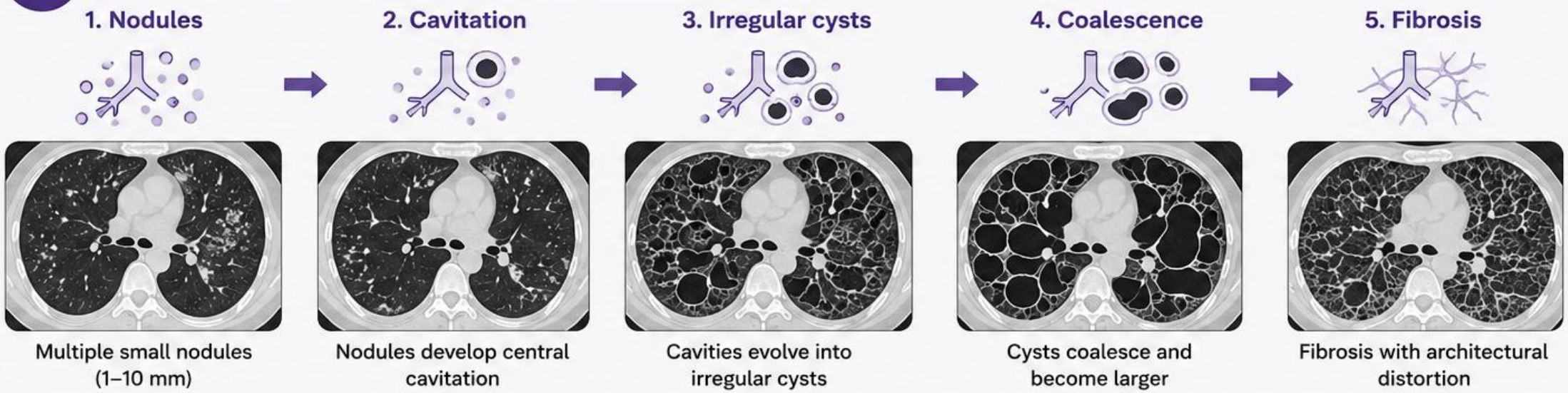
- **Proliferation of Langerhans cells** around **small airways** (bronchioles) and **bronchovascular bundles**
- Progression:

  Nodules → cavitation → irregular cysts → fibrosis



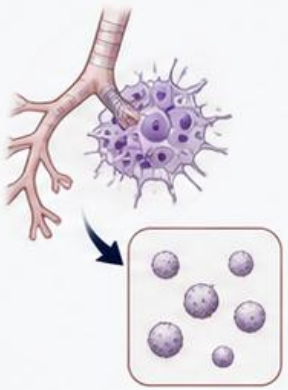
Langerhans cells with grooved nuclei and abundant eosinophils (H&E stain)

PATHOLOGIC PROGRESSION (IMAGING CORRELATION)



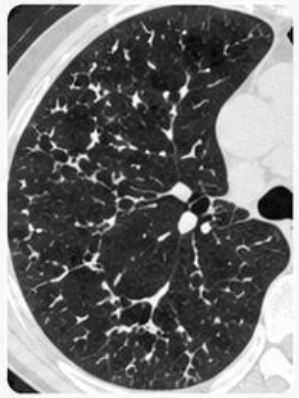
Pulmonary Langerhans Cell Histiocytosis (PLCH)

Step 1. Nodules

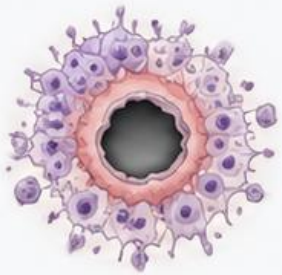


最早期，Langerhans cells 聚集形成：
小結節（**1–10 mm**）

此時 CT 可見：
nodules，病人甚至沒有 **cyst**。



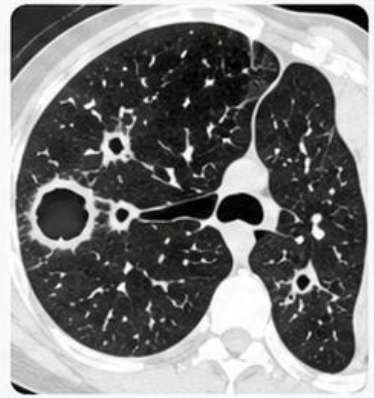
Step 2. Cavitation



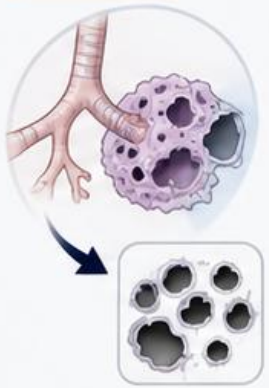
隨著發炎持續：
炎症會破壞細支氣管壁及周圍肺泡。

中央開始壞死：
Nodule develops a central cavity.

因此： **Solid nodule → Cavitary nodule**
HRCT： **Thick-walled cavitary nodules**

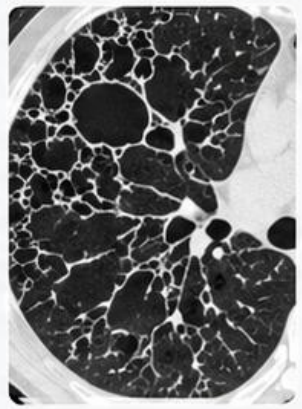


Step 3. Irregular cysts

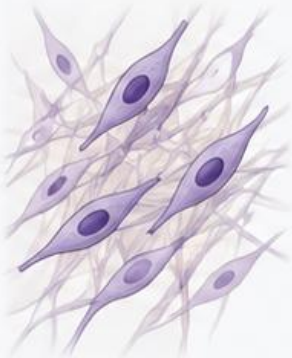


病灶纖續被破壞：
Bronchiolar wall destruction、Alveolar destruction，
空洞逐漸擴張。

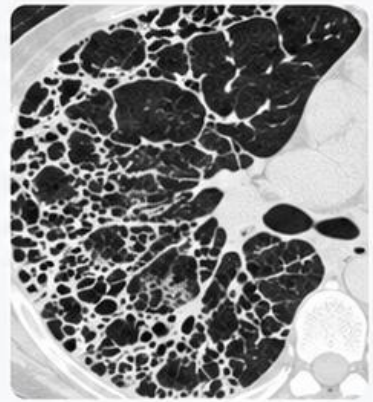
最後變成： **Thin-walled cysts**
但因為病變沿著 bronchiole 生長，所以 cyst 並不像肺大泡那麼圓。



Step 4. Fibrosis



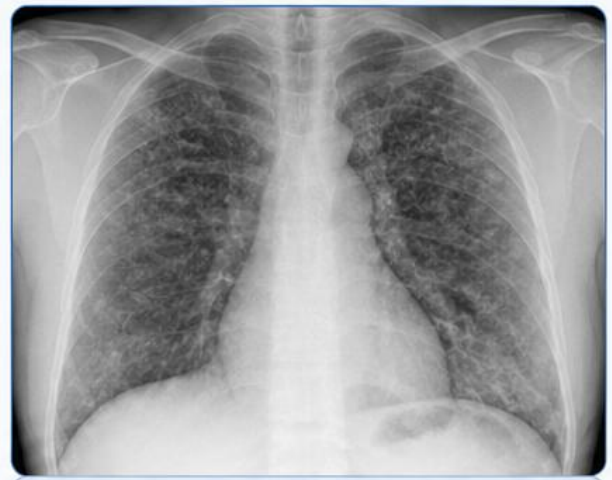
疾病晚期，反覆發炎後：
Fibroblasts 活化
↓
Collagen deposition
↓
Fibrosis



Pulmonary Langerhans Cell Histiocytosis (PLCH) – Imaging Findings

Chest Radiograph

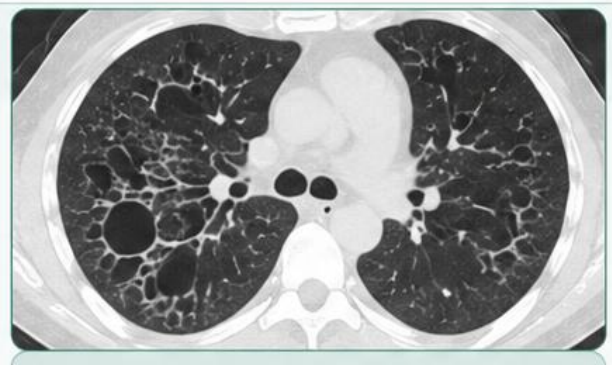
- **Early: multiple small nodules** (1–10 mm)
- Progressive: **reticulonodular opacities**
- Advanced: **coarse reticular pattern** with cysts
- **Bilateral, symmetric upper- and mid-lung predominance**
- **Costophrenic angles spared**
- Lung volume **normal or increased**
- **Pneumothorax** is **common**
- Pleural effusion and hilar/mediastinal lymphadenopathy are **uncommon**



Bilateral, symmetric upper- and mid-lung predominant reticulonodular opacities

HRCT

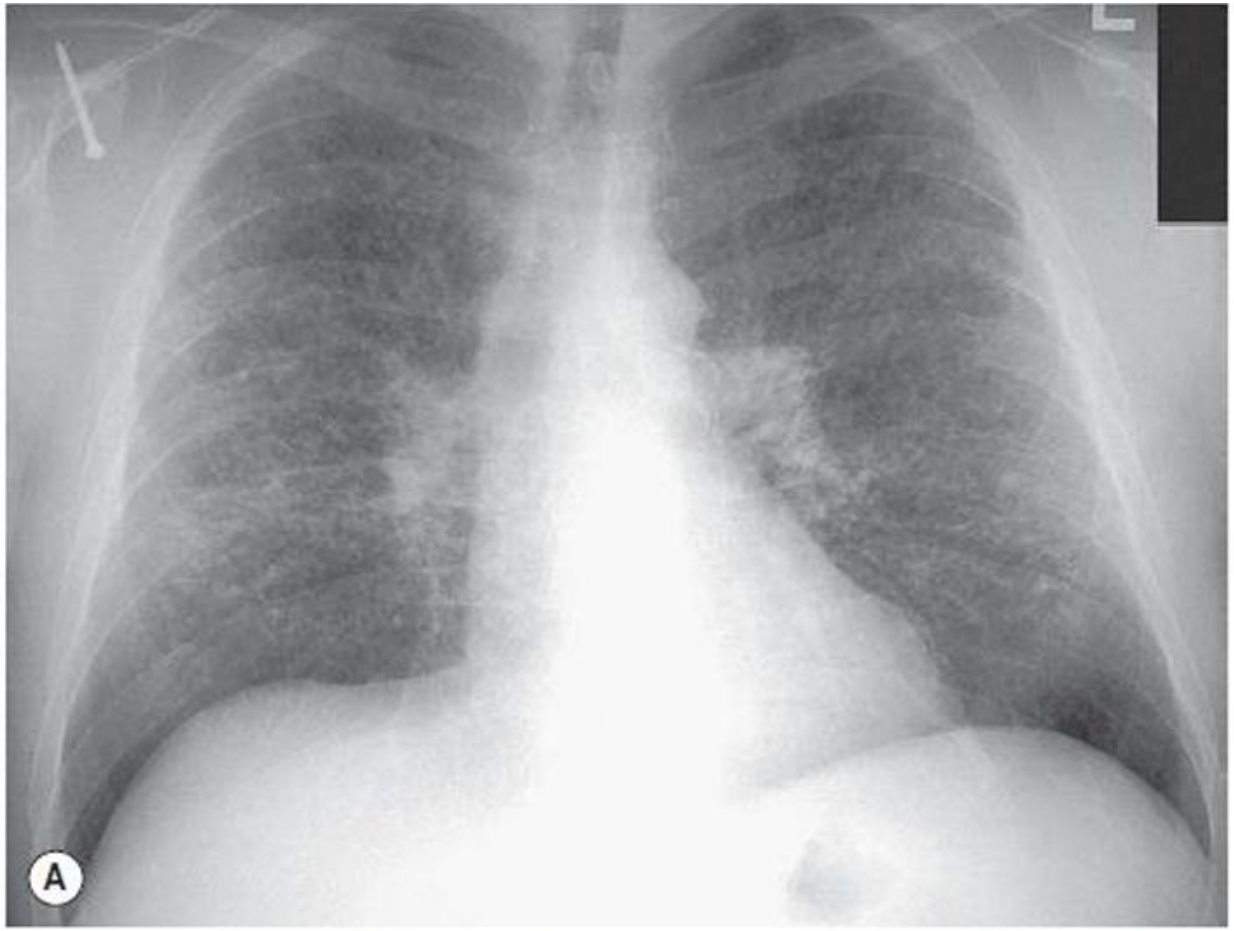
- **Centrilobular nodules** (early)
- **Thick- then thin-walled cavitary nodules**
- **Irregular/bizarre-shaped cysts** of variable size
- **Upper- and mid-lung predominance** with **costophrenic angle sparing**



Irregular/bizarre cysts and nodules with upper- and mid-lung predominance

Key Point: PLCH typically affects young adult smokers and shows upper- and mid-lung predominance with costophrenic angle sparing, cysts, and a high rate of pneumothorax.

Pulmonary Langerhans Cell Histiocytosis (PLCH)



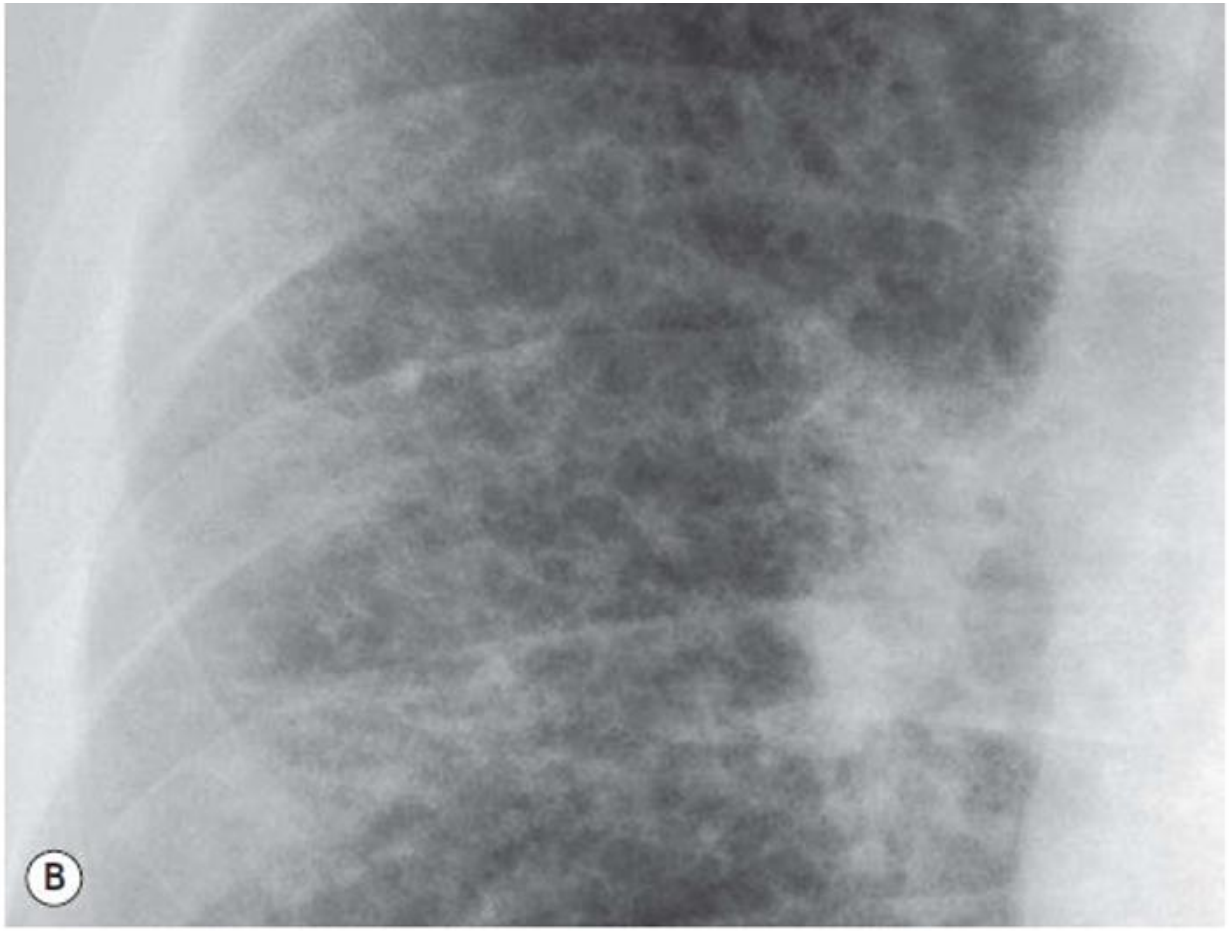


Fig. 8.6 **A**, Chest radiograph with **B**, magnified view shows characteristic features of pulmonary Langerhans cell histiocytosis. There is a diffuse parenchymal abnormality due to cysts and nodules, with upper and mid-lung predominance, and sparing of costophrenic sulci. Lung volumes are preserved. Enlargement of central pulmonary arteries suggests pulmonary arterial hypertension.

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Pulmonary Langerhans Cell Histiocytosis (PLCH)

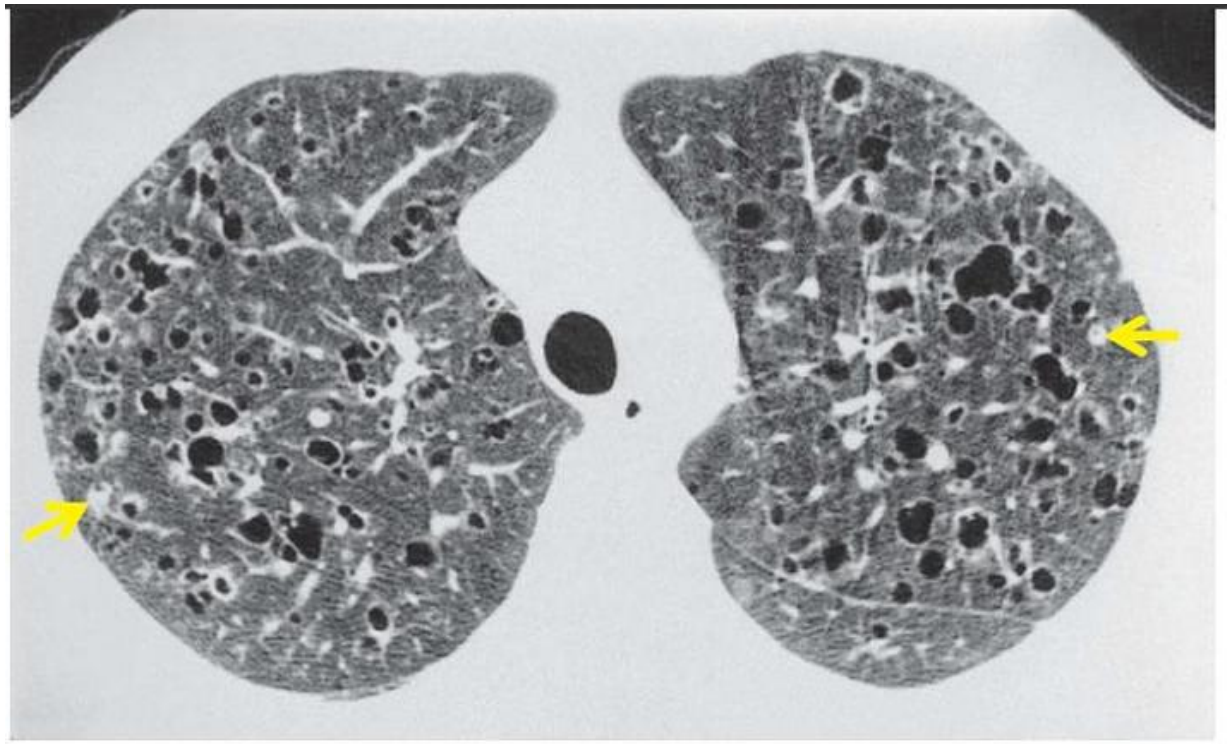

Fig. 8.7 Pulmonary Langerhans cell histiocytosis. CT through the upper lungs shows a characteristic combination of thin-walled cysts and poorly defined nodules. Two of the nodules are just beginning to cavitate (arrows); cavitation is thought to be the earliest stage of cyst formation.

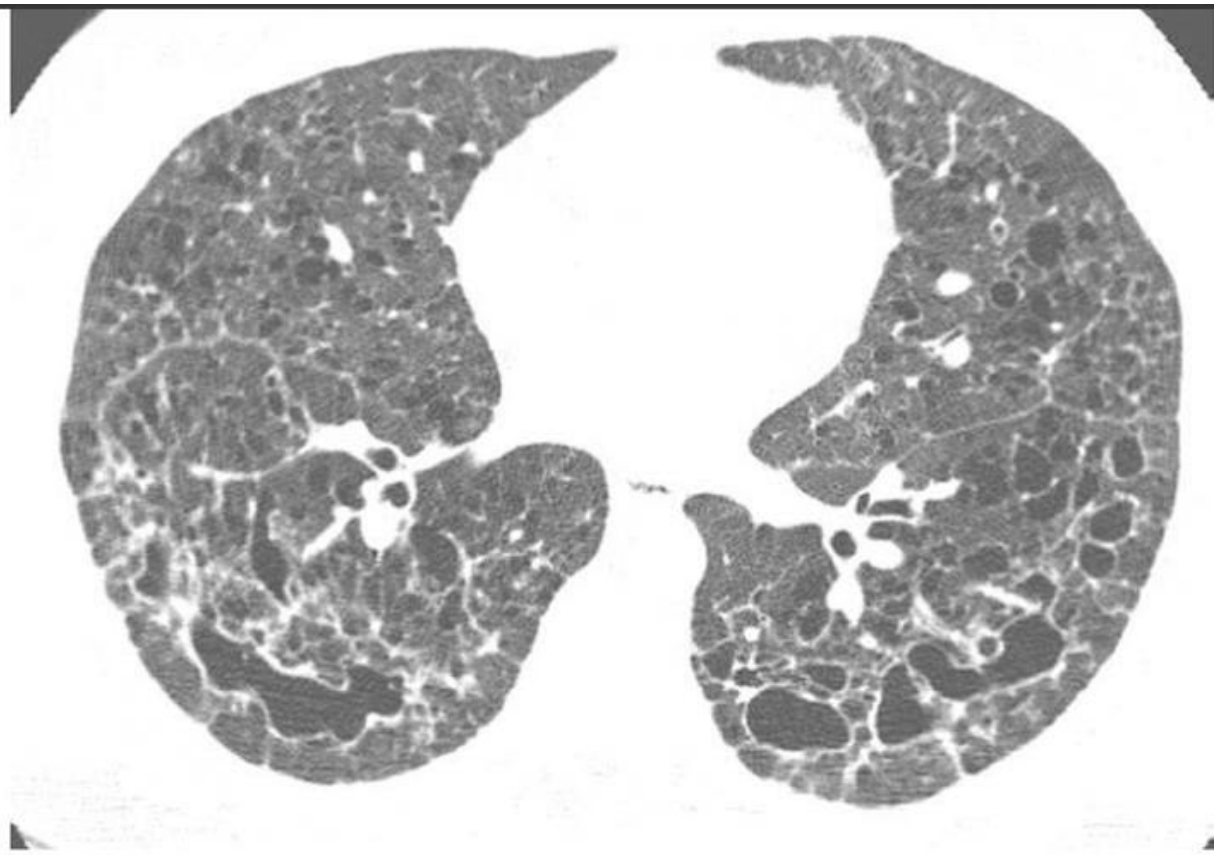

Fig. 8.9 Pulmonary Langerhans cell histiocytosis. CT shows numerous irregularly shaped cysts. A few small nodules are visible.

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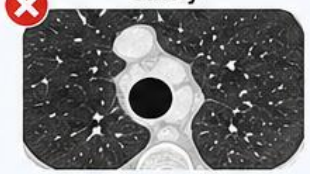
HRCT Evaluation of Pulmonary Cystic Lesions

Stepwise Approach to Differential Diagnosis

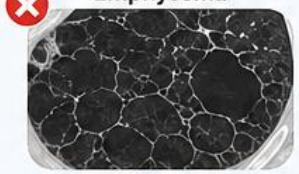
STEP 1
Is it a true cyst?

Exclude:

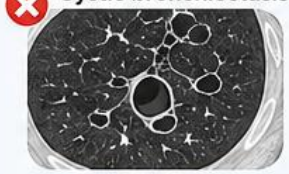
- Cavity



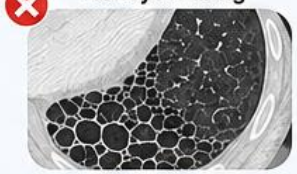
- Emphysema



- Cystic bronchiectasis



- Honeycombing



STEP 2
Location

Subpleural

- Bulla
- Paraseptal emphysema
- Honeycombing

Intraparenchymal

STEP 3
Solitary or Multiple?

Solitary

- Bronchogenic cyst
- Pneumatocele
- Pulmonary sequestration
- CPAM

Multiple / Diffuse

Proceed to Step 4

STEP 4
Associated HRCT Findings

Nodules

- PLCH
- LIP
- Amyloidosis
- LCDD

Ground-glass opacity

- LIP
- PJP
- DIP

No associated findings

- LAM
- Birt-Hogg-Dubé syndrome
- Laryngeal respiratory papillomatosis

STEP 5
Clinical Context

- Age
- Sex
- Smoking history
- Immune status
- Congenital lesion
- Recurrent infection
- Family history

FINAL

Final Differential Diagnosis

Integrate imaging features with clinical context to reach the most likely diagnosis.

Thank you