

Solitary Pulmonary Nodule

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Definition

肺內腫瘤 / 結節依其大小可分為

節結nodules ($\leq 3\text{cm}$)

腫瘤masses ($> 3\text{cm}$)

$> 3\text{ cm}$ 的lesion，**malignancy**的機會較高。

在平面X光像看到nodule時，**首先須排除一些肺外的異物**，例如**胸壁**上的構造、**皮膚**/皮下病灶、**肋膜**病灶或bone island。

肺內結節可分為

孤立性(solitary)

多發性(multiple)

Reasons for 3 cm as the cut point

■ 為何設標準在3 cm：

■ ~~> 3 cm的lesion，malignancy的機會較高。~~

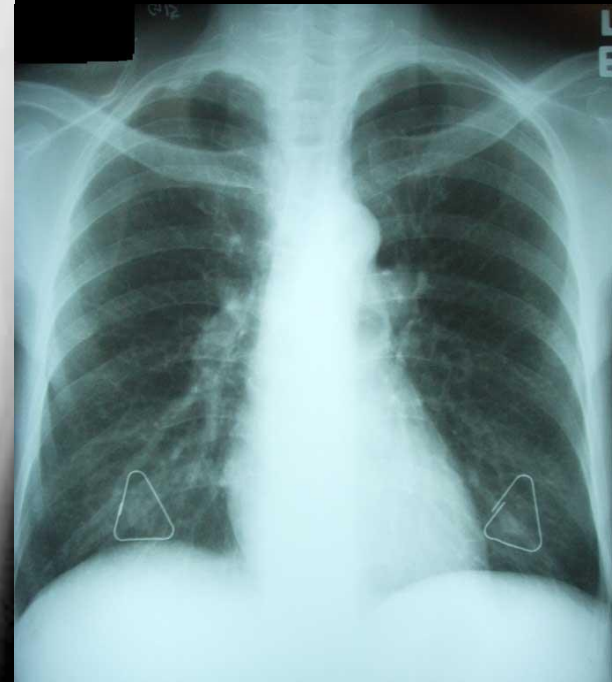
■ ~~小於3 cm的lung cancer較少有mediastinal LN metastasis。~~

■ 以鈣化的特徵來幫助鑑別診斷只限於< 3 cm的病灶



Nipple shadows

Bilateral small nodule
in the projection of
nipples



Nodule/ Mass 鑑別診斷的依據

Patient factor

- 臨床症狀
(Clinical information)
- 年齡(Age)
- 抽菸史
- 職業

Lesion factor (2S, 3C, DOA)

- 大小(Size)
- 形狀、邊緣(Shape/Margin)
- 有無開洞(Cavitation)
- 鈣化的有無與型態
(Calcification)
- CT下注射顯影劑的變化
(Contrast enhancement)
- Doubling time(比較舊片)、
Density (CT scan, HU)
- Other associated findings, ex:
satellite lesions
- 位置(Area)、Air-bronchogram

病人端資訊：Age

- < 35 y/o: favor benign
> 35 y/o: favor malignancy
- Exception is **hamartoma**, the peak age incidence is in the **50s**.
- Possibility of malignancy
 - 50 y/o: 50%
 - 60 y/o: 60%
 - 70 y/o: 70%

病人端資訊：Smoking

- The **most important** environmental carcinogen of lung cancer
- ↑ **20-fold** lung ca. risk compared with never smoker
 - ↑ risk in cigar & pipe smoking, but less than cigarette
- Stronger effect of **duration** than of amount

S1: 大小(Size)

- 大size要R/I malignancy，但是小size卻不能R/O malignancy
 - Benign lesion: rarely > 3 cm
 - Malignancy: any size
- No size criterion allows exclusion of malignancy
- Literature:
 - 10^9 cells = 1 cm
 - Benign tumor: 80% < 1cm; only 6% > 3cm
 - Malignant tumor: 57% > 3cm

S2: 形狀(Shape)/邊緣(Margin)

■ Favor Benign

- Well-defined margin

 - Benign (80%)

■ Favor malignant

- Lobulated

 - Malignant 60~80%

- Focal **spiculation**

 - Malignant 80%

- Diffuse spiculation
(corona radiata)

 - Malignant 95%

- **Tail sign (pleural tag)**

 - Malignant 60~80%

S2: 形狀(Shape)/邊緣(Margin)

Sharply margined

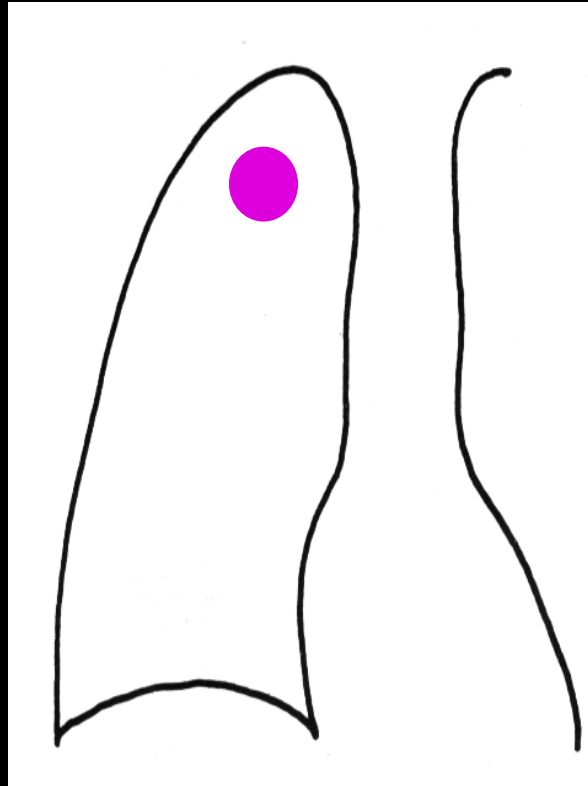
Round



Lobulated



Poorly-defined



Contour



Notch sign
(Rigler)



Corona radiata



Eccentric cavitation



Rat tail sign



Rabbit ears

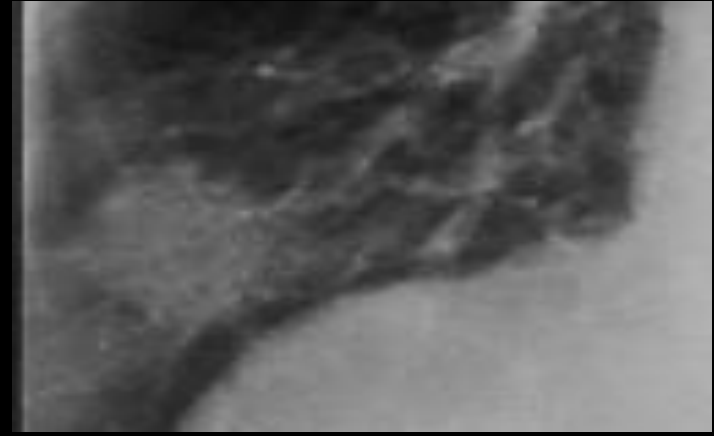


Pleural tag

S2: 形狀(Shape)/邊緣(Margin)



Lobulated (分葉的)



Spiculated (針狀的/長角)

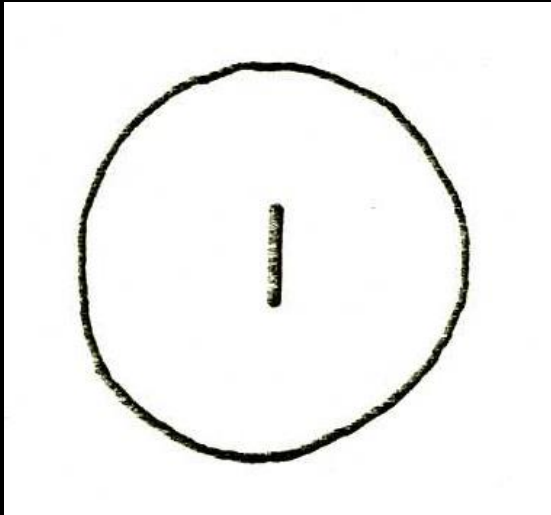


Smooth (外緣平滑)

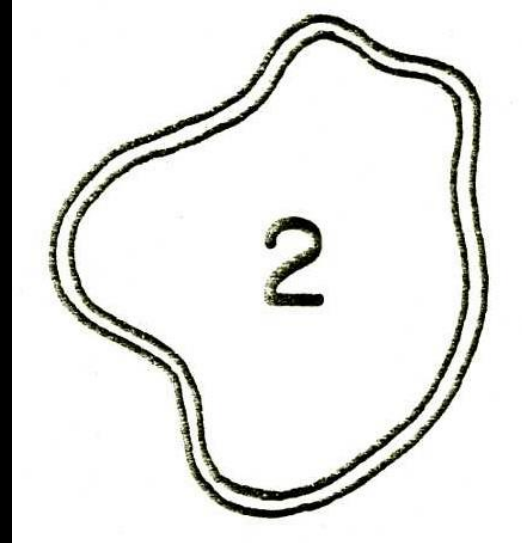


Ill-defined (不清楚/不規則的)

Typical Appearance of Lesions with Edges

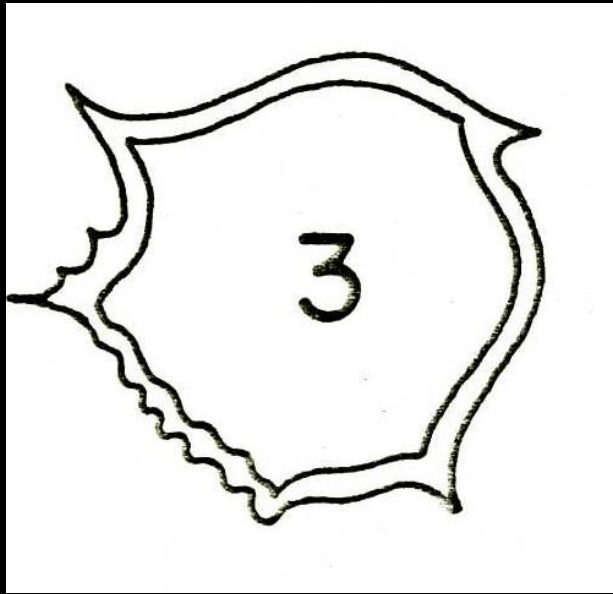


1. Sharp & smooth

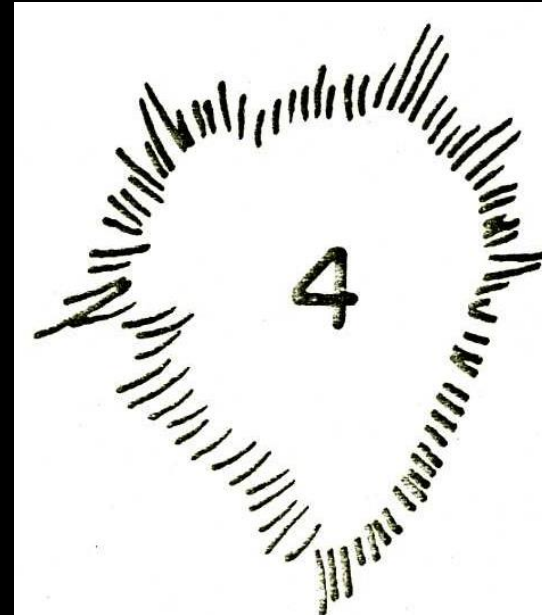


2. Scalloped
(lobulated)

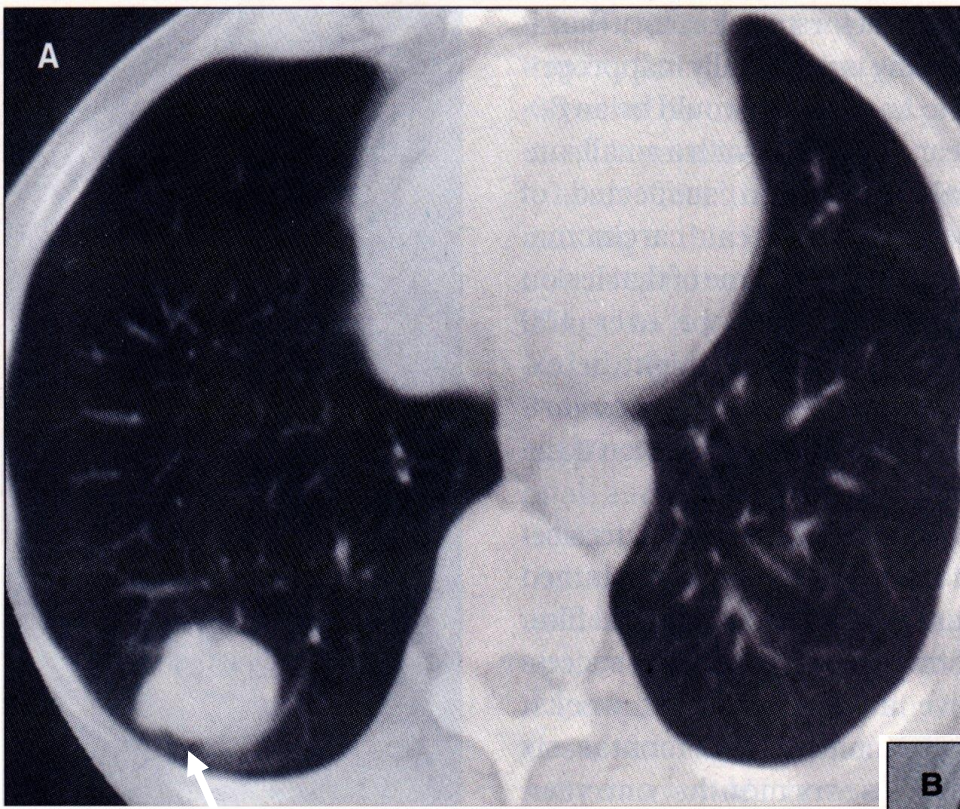
Typical Appearance of Lesions with Edges



3. Spiculated

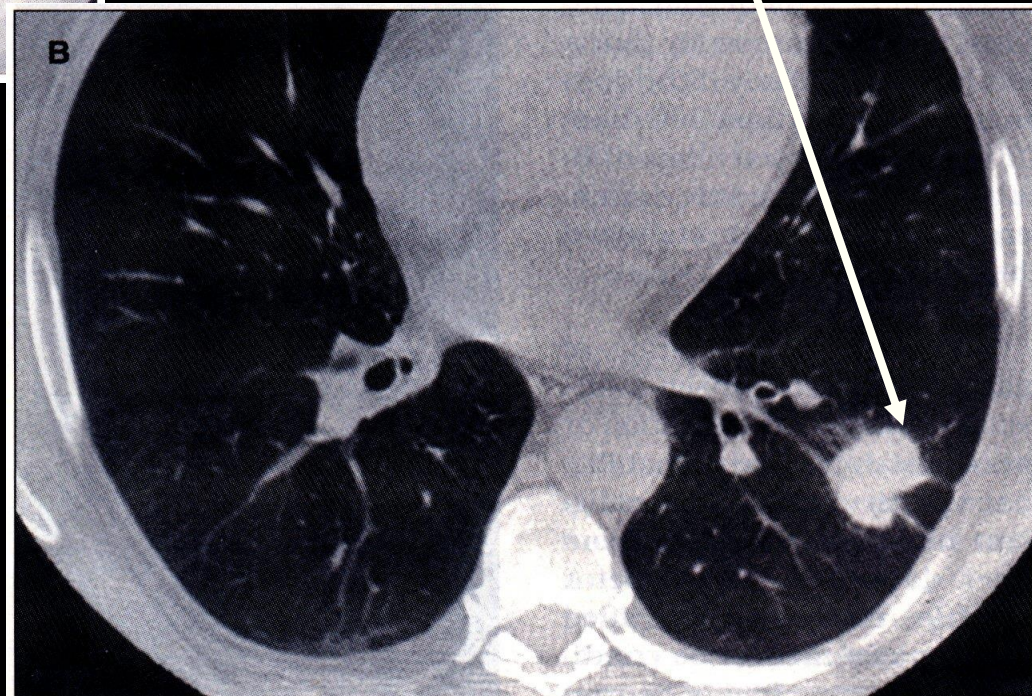


4. Corona radiata



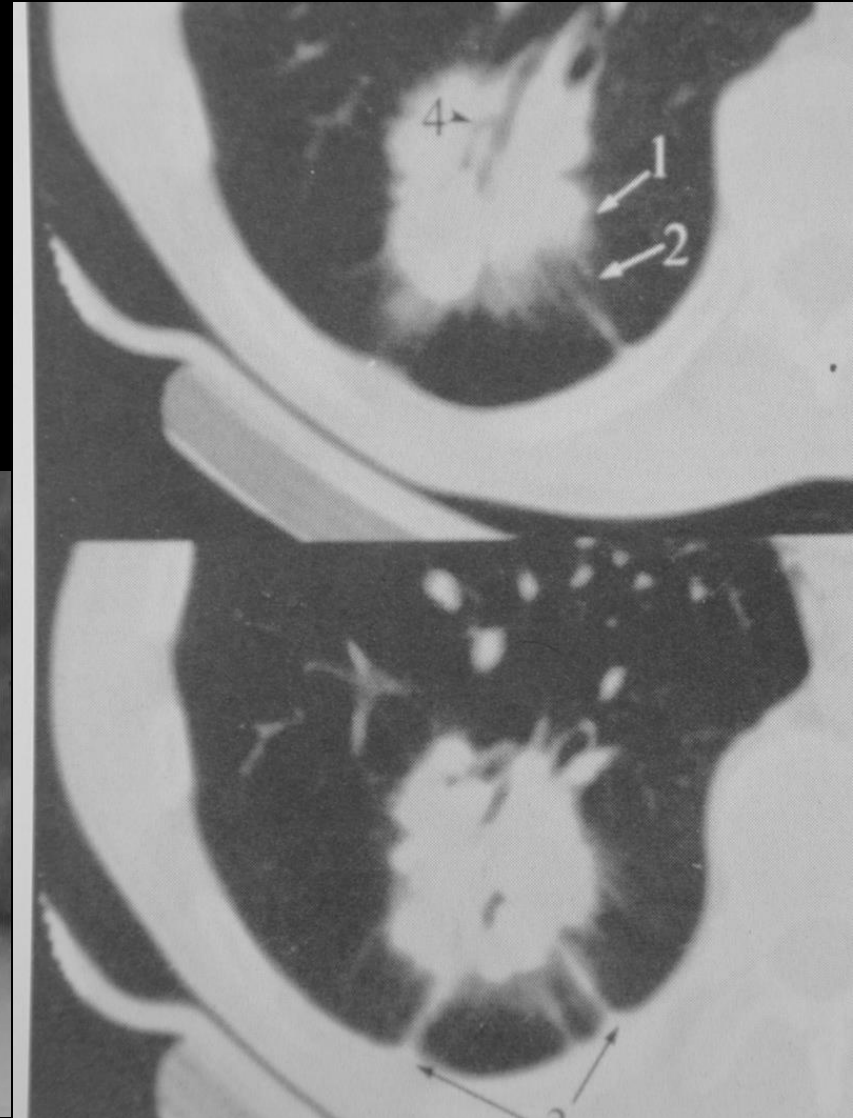
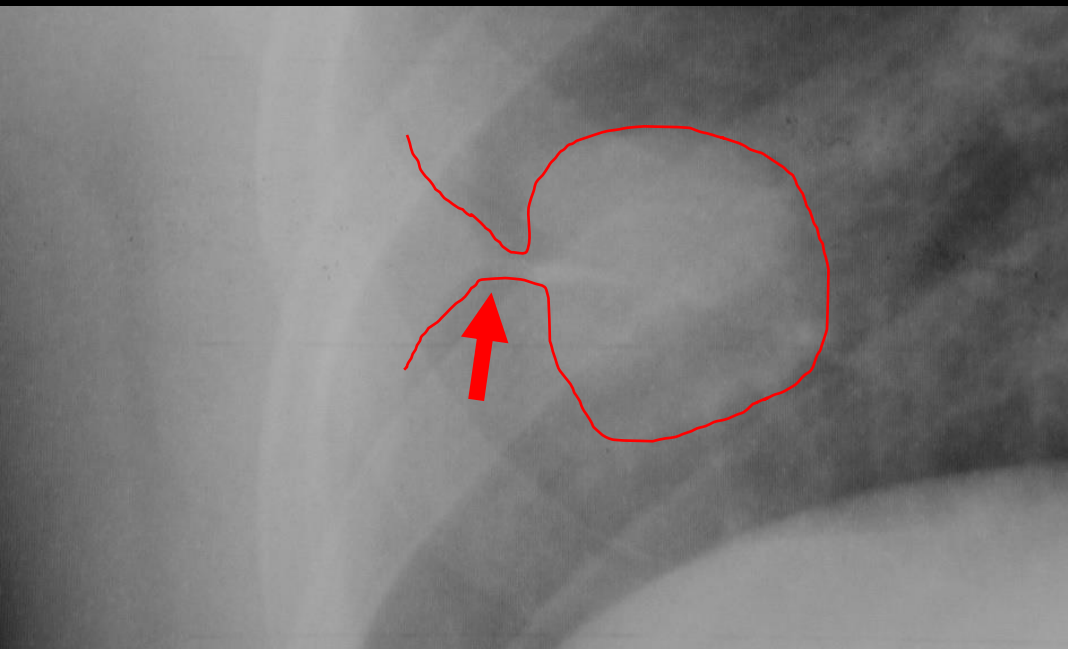
Lobulated

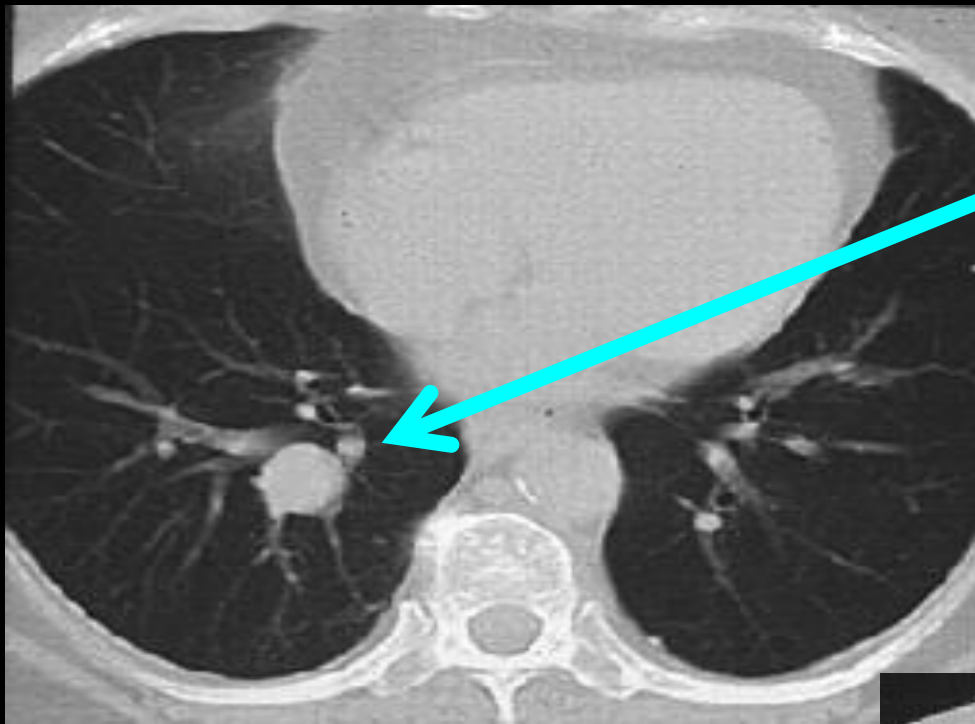
**Focal
spiculation**



Tail sign (Rat tail sign)

- Line extends to visceral pleura
- Favor **malignancy** (limited value)
- Most common **adenocarcinoma**, but also in other malignancy, metastasis, granuloma.





Smooth

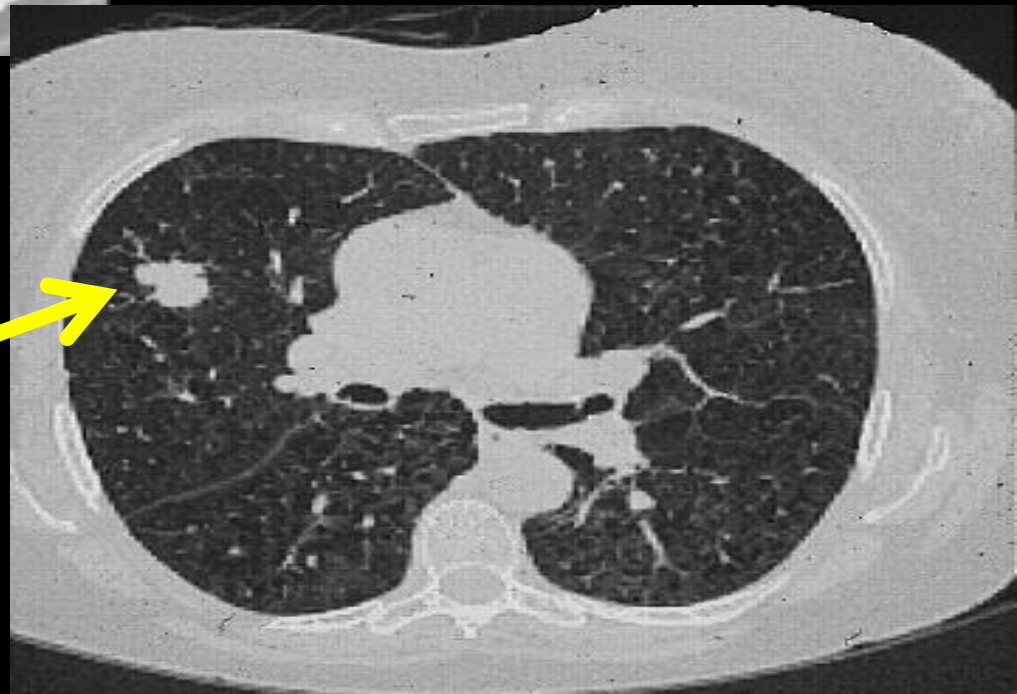
border of nodule

→ **20%** malignant

Scalloped

border of nodule

→ **60%** malignant



Spiculation/Corona Radiata

- Favor **malignancy**: 不能直接診斷

 - **94% diffuse corona** are malignant

 - **81% focal spiculation** are malignant

- Causes:

 - Tumor **infiltration**

 - **Lymphatic** spreading

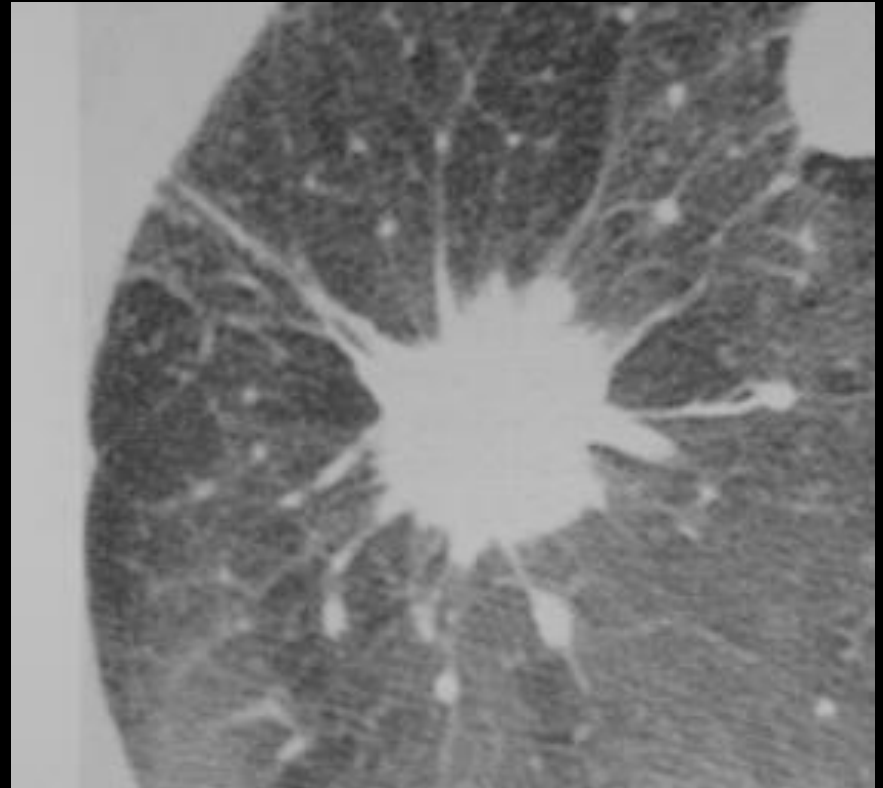
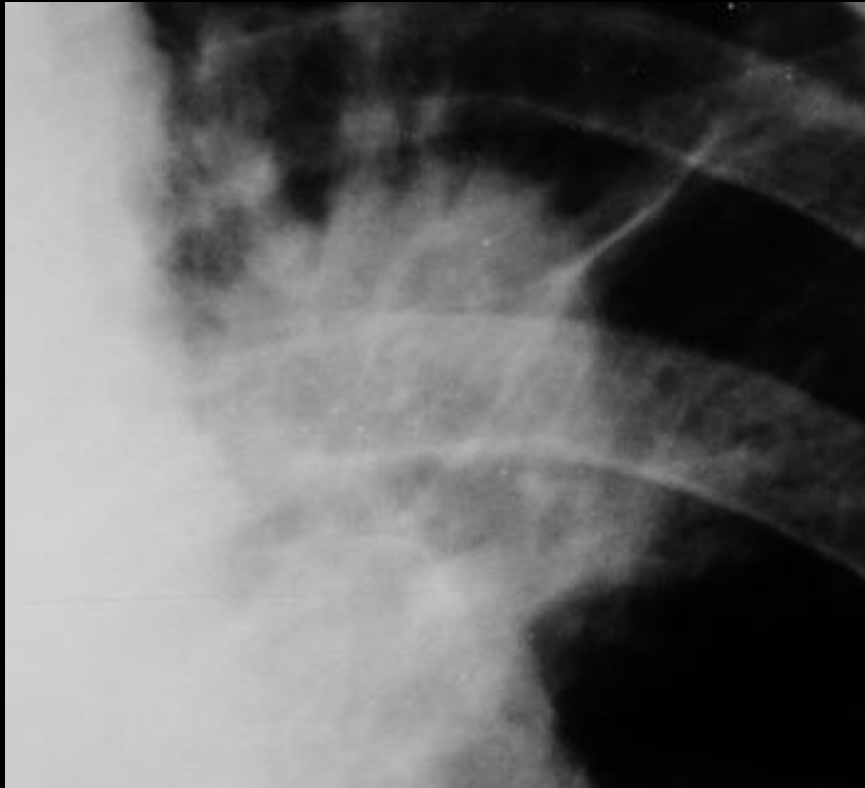
 - Also in organizing process of infection/inflammation/infarction

- Diagnostic value is enhanced by **serial CXR**

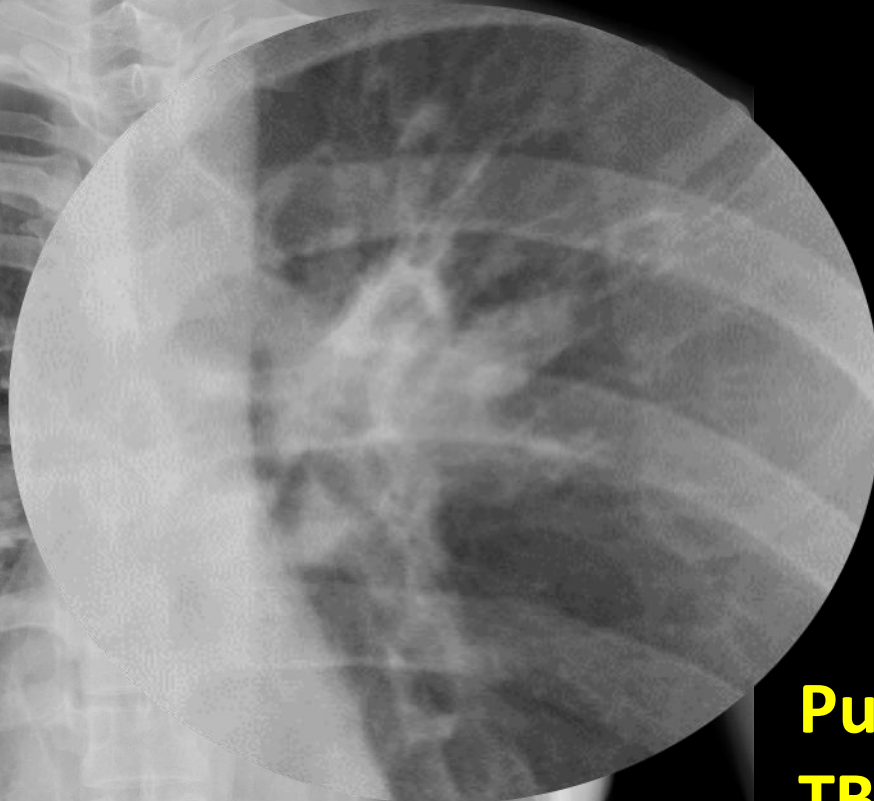
 - Malignant: enlarges, more spiculated and ill-defined

 - Benign: Becomes smaller and less spiculated as inflammation fades

Corona Radiata



R75



**Pulmonary
TB**

C1: Cavitation/開洞

- **6個**觀察重點：壁厚、內緣、內容物、位置、數目、周圍肺實質的變化
- **壁厚**: 越厚越懷疑惡性
 - 壁薄 <4mm: favor benign
 - 壁厚 >16mm: favor malignancy
- **內緣(Inner wall)**
 - 規則、一致、平滑(Smooth/uniform) : favor benign
 - 不規則、結節狀(Irregular/nodular): favor malignancy
- **Eccentric cavitation**: favor malignant

C1: Cavitation/開洞

■ 內容物：

- Fluid: malignancy is less likely, except bleeding or 2nd infection
- **Fungus ball**: aspergillosis

■ 位置：

- Central: more common fibrotic or neoplastic lesions
- Peripheral: more metastatic or embolic lesions
- Apical: TB, fungus ball

■ 數目：

- Solitary: primary lung cancer, lung abscess
- Multiple: metastasis, Wegener granulomatosis, **septic emboli**

■ 周圍肺實質的變化：

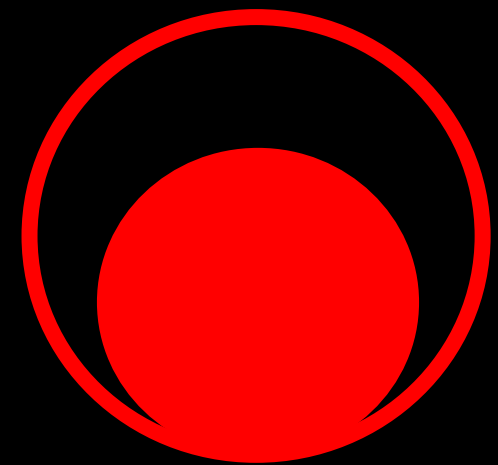
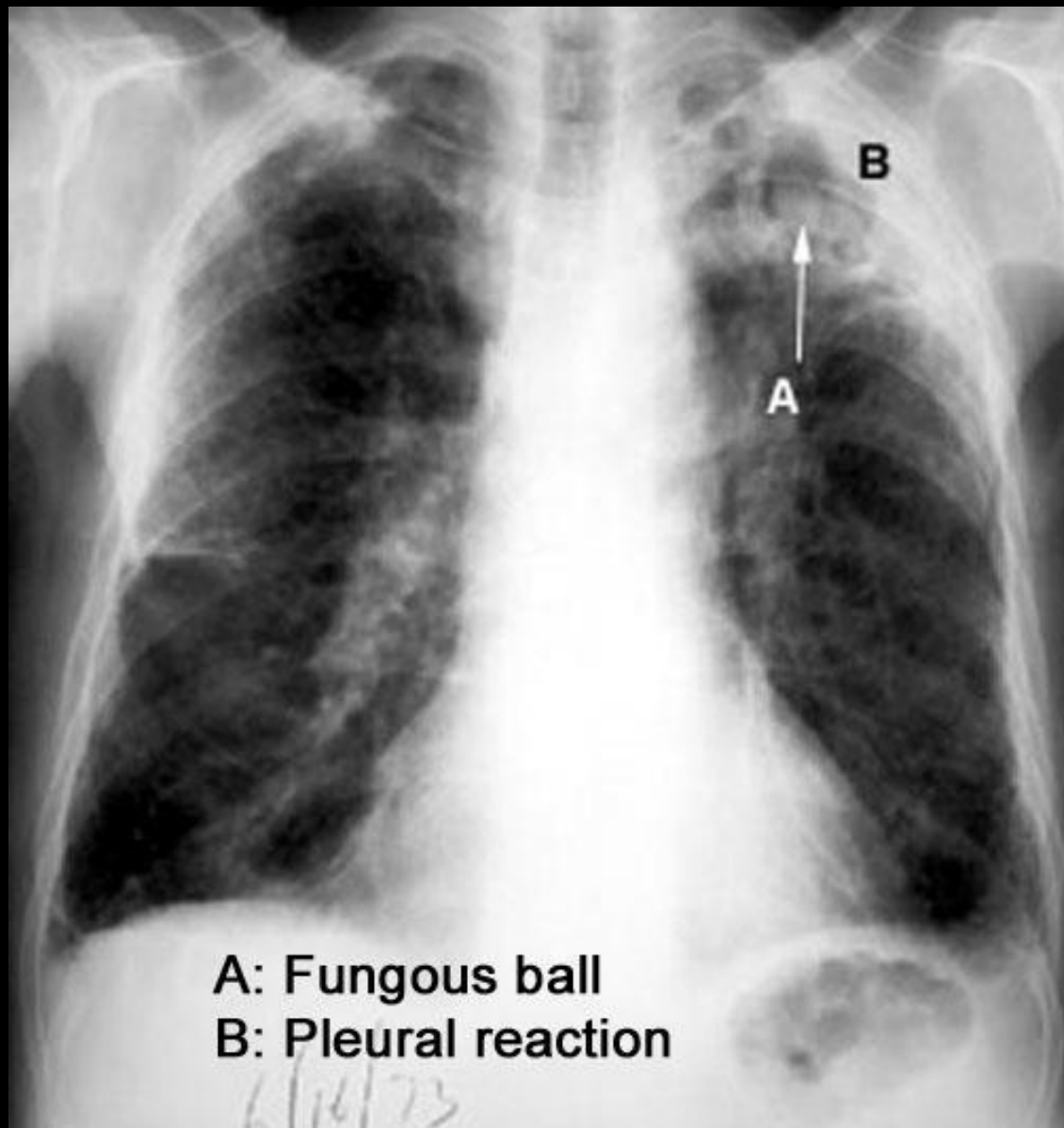
- Air-space consolidation: acute process
- Irregular reticular strands: chronic fibrotic change



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

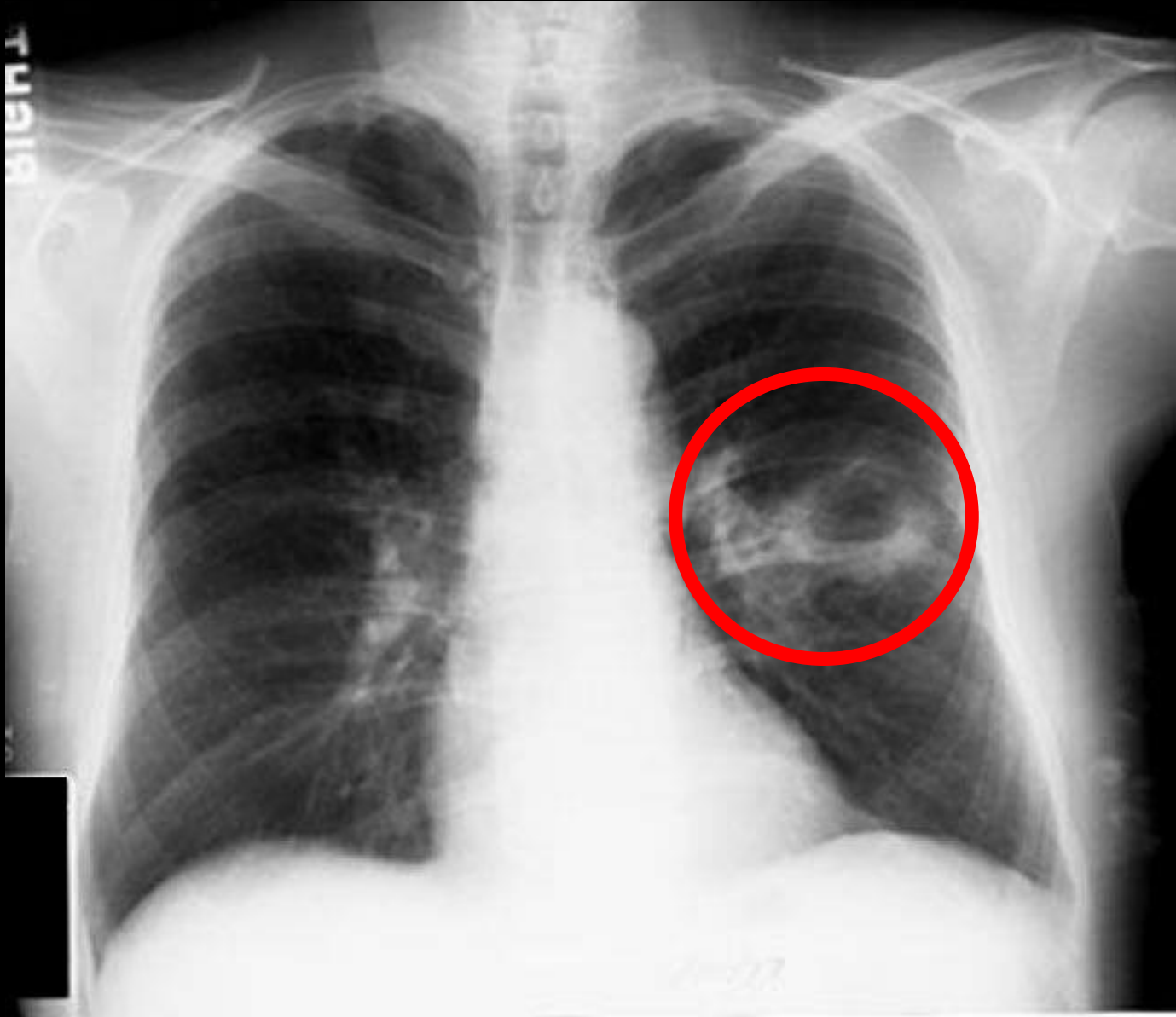
Squamous Cell Carcinoma

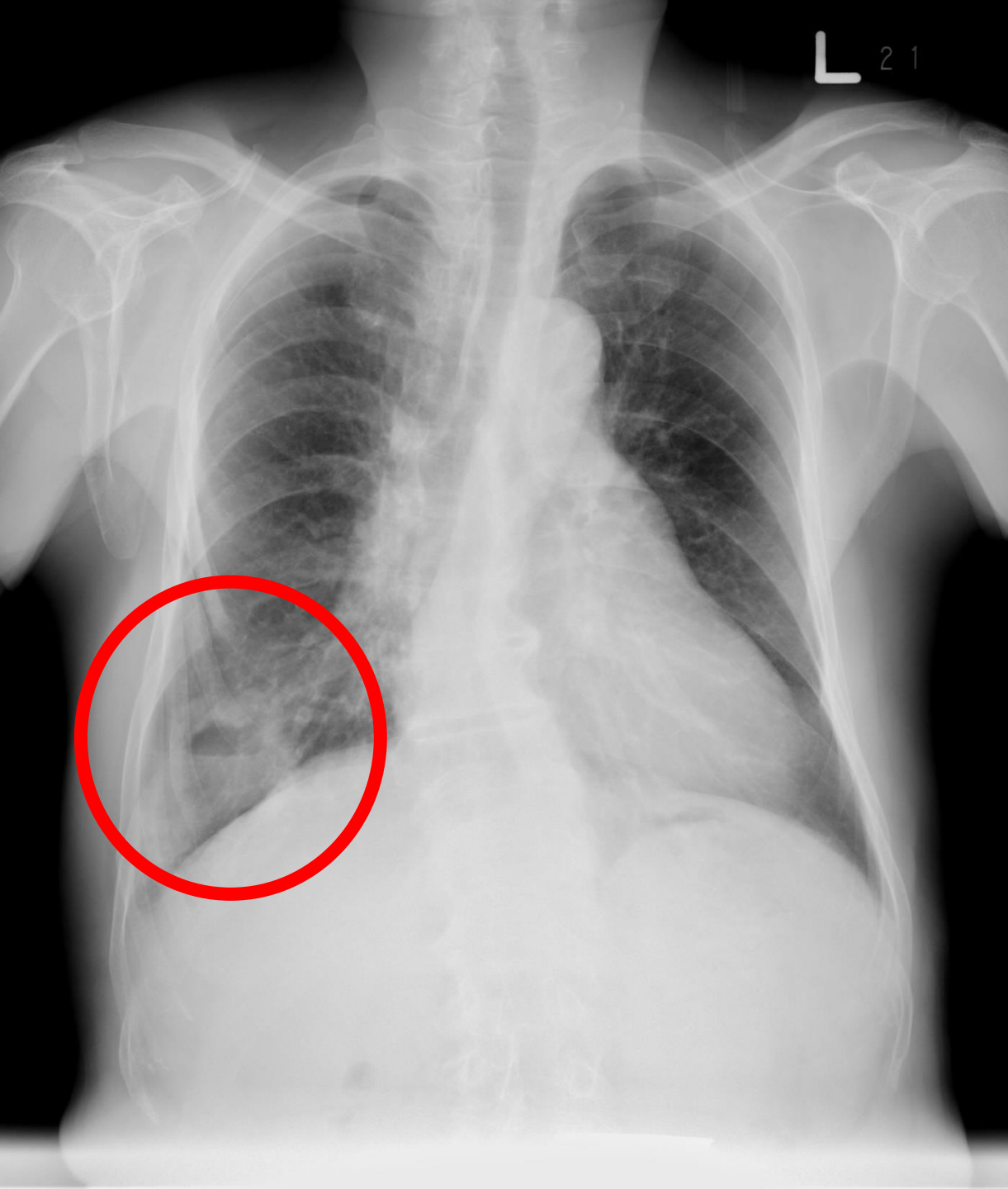
Aspergilloma



Ball in hole

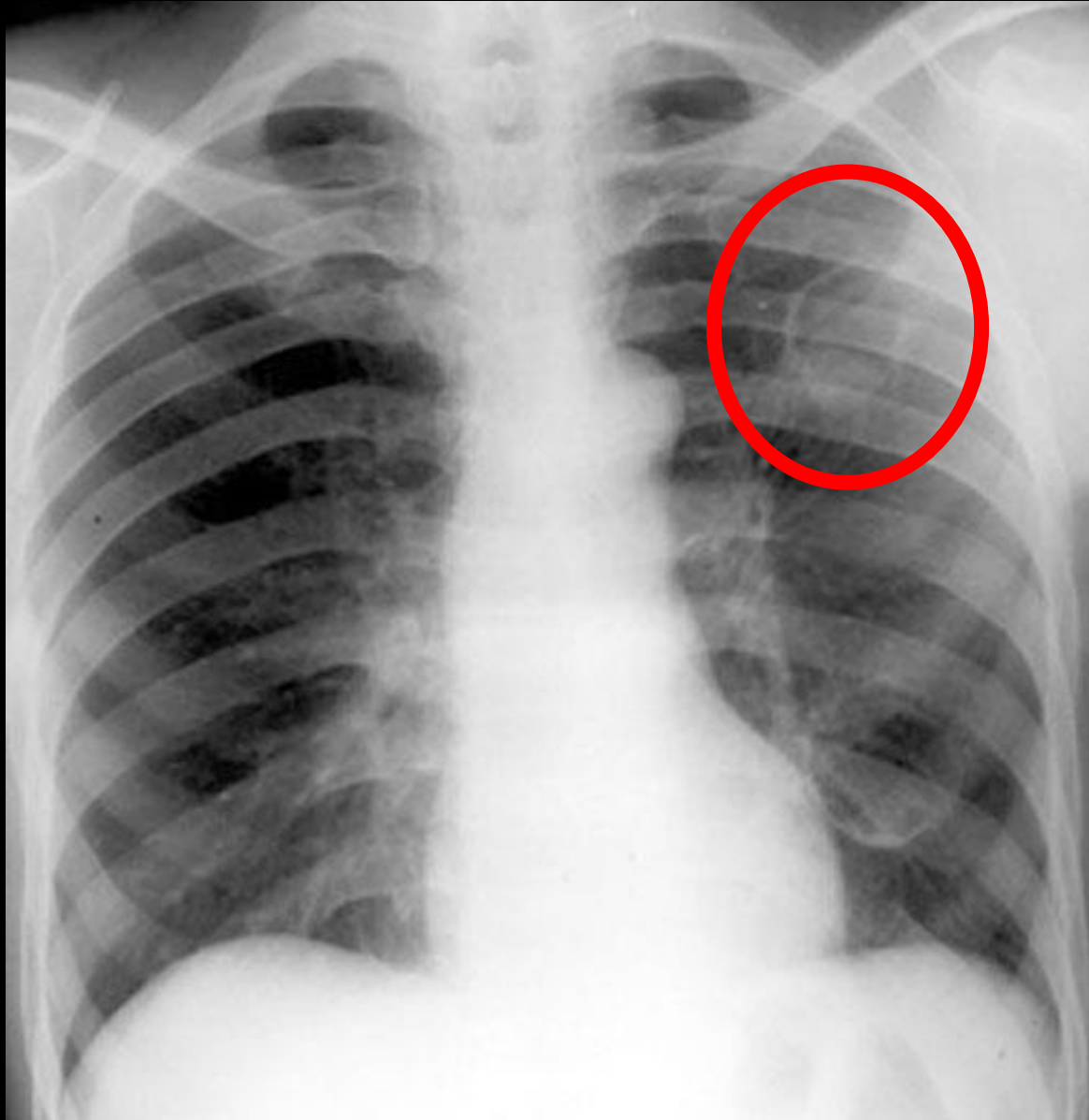
Squamous Cell Carcinoma of Lung





**Squamous
cell
carcinoma**

Coccidioidomycosis



C2: Calcification/鈣化

- 最重要可用來區分良性與惡性的特徵
- Helpful in D/D only when **lesion < 3 cm**
 - For R/I benign
 - 有鈣化不一定代表是良性
 - 幾乎可以代表良性病灶的鈣化(CD-LP)
 - Central, diffuse, laminated, popcorn-like
 - CT scan上視鈣化病灶為良性的criteria
 - 面積: **benign pattern** of calcification 且面積 **> 10%** nodule 橫切面積
 - 分布: 鈣化呈 **symmetrical** distribution
 - 外形: 有鈣化 nodule 外緣平滑
 - Nodule 大小 **< 3cm**

C2: Calcification/鈣化

■ Calcification in **malignancy**

- 13% in chest CT scan; 其中2% of lung cancer 是 < 3cm

- Typically **amorphous** (無定形)

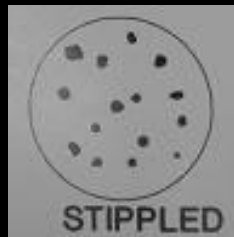
- **Punctate** (小點狀)/**stipple**/psammomatous (砂樣狀) :

 - Metastasis from **mucin-secreting tumor**, ex: **colon, ovarian tumor**; primary lung cancer很少發生

- 必須要注意的pitfalls :

 - 有些**carcinoids**和**metastasis of primary bone-forming malignancy**, such as **OGS, chondrosarcoma**時常會出現dense foci of calcification或整個鈣化, 不要誤判為benign lesion. History很重要

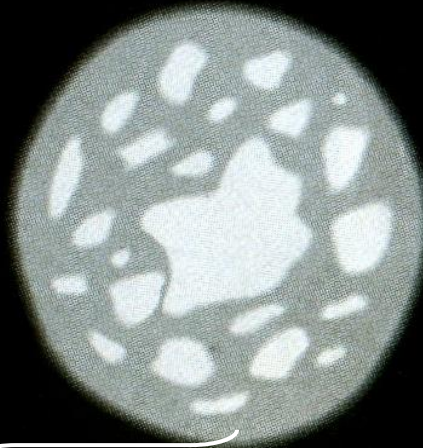
 - **Eccentric calcification**可以是benign or malignant



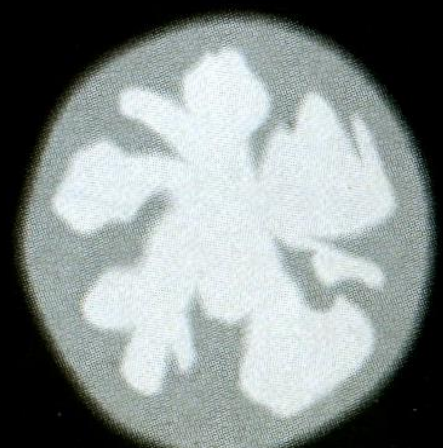
Eccentric



Stippled
(multiple punctate)



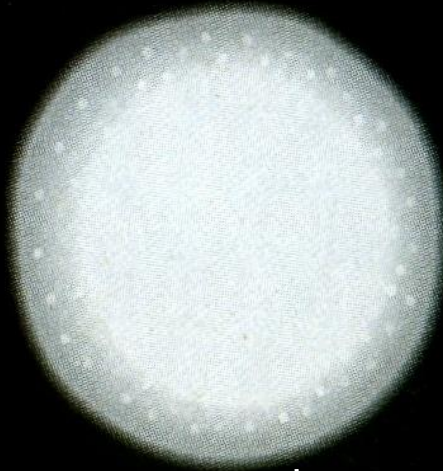
Popcorn 



Malignancy

Harmatoma

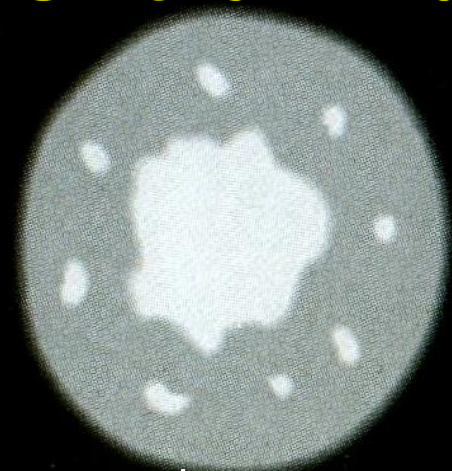
Diffuse



Laminated

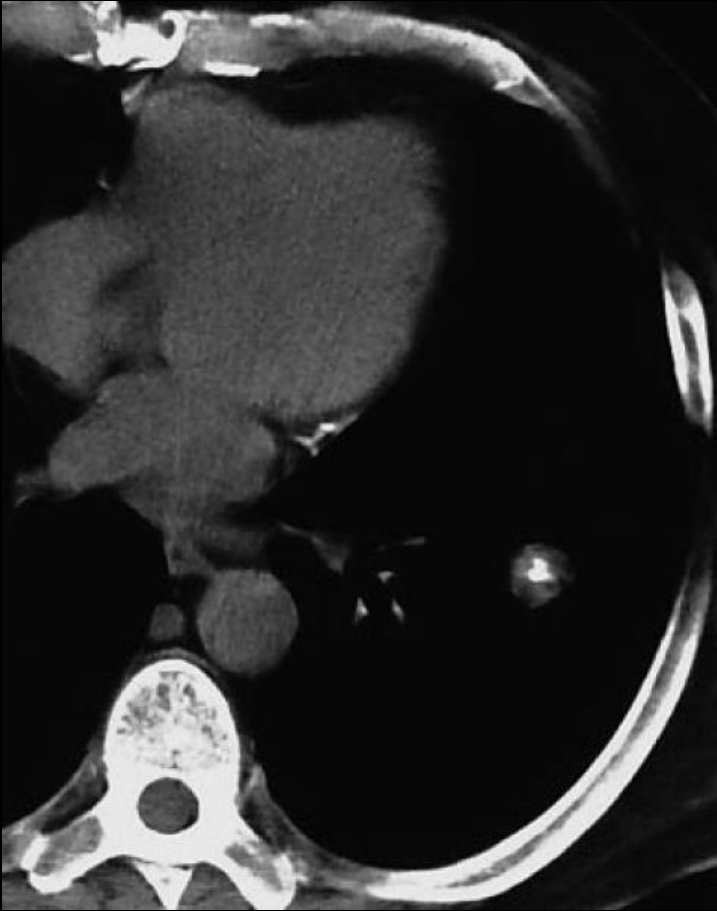


Central nidus

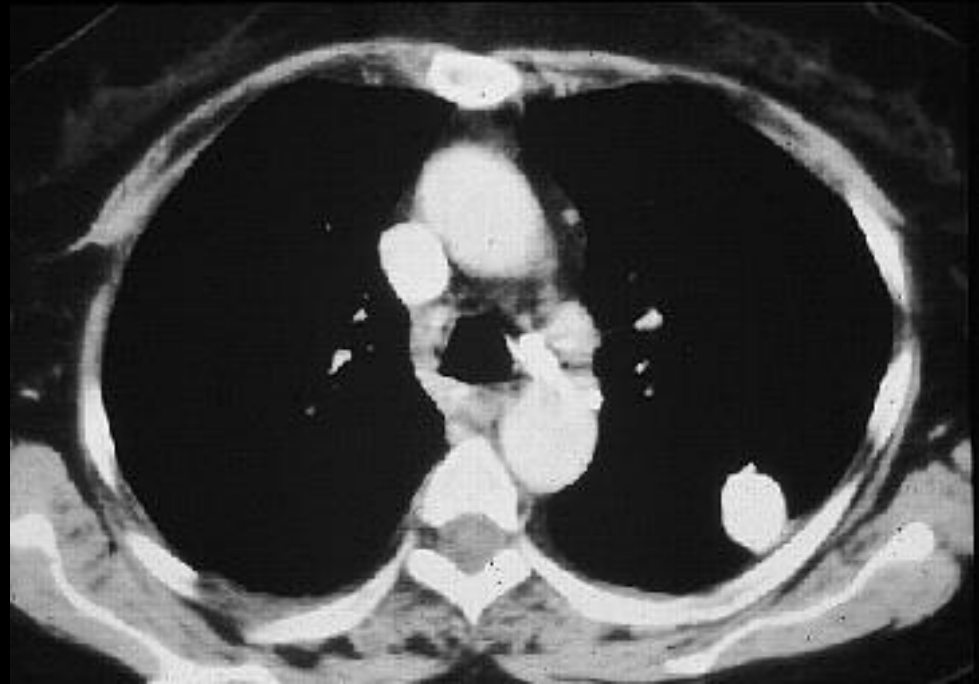


Benign, esp. granuloma

Benign calcification

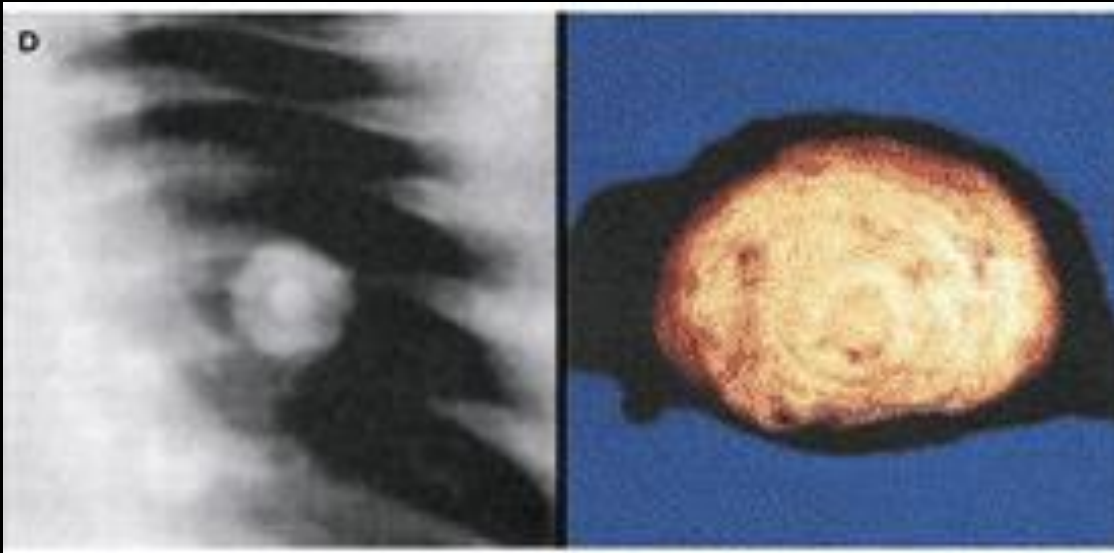


Central nidus calcification



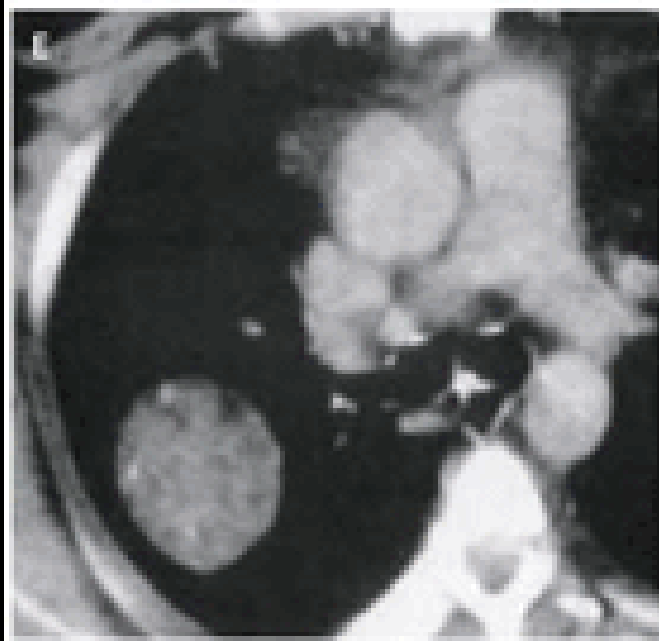
Diffuse calcification

Benign calcification



Histoplasmosis

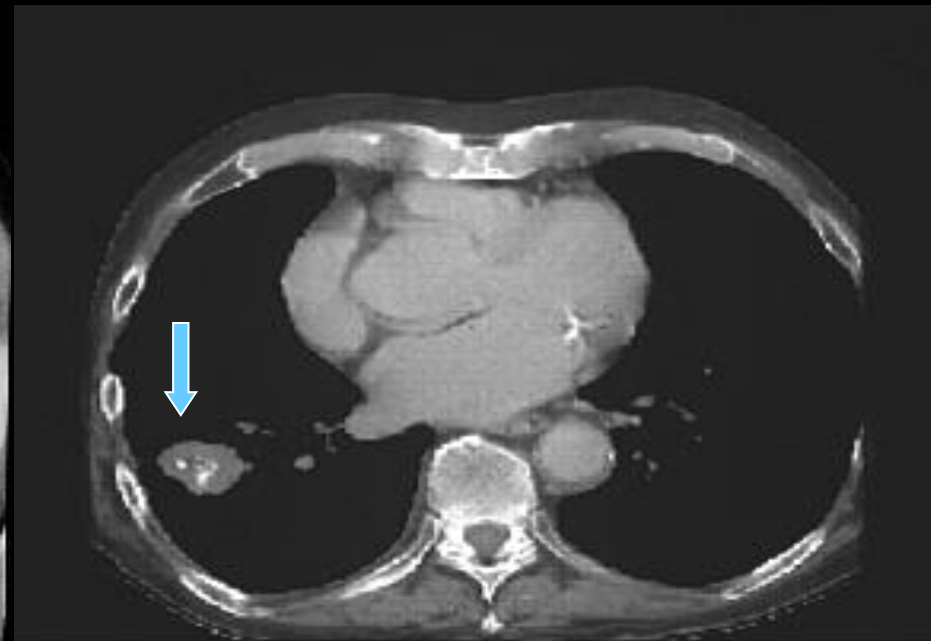
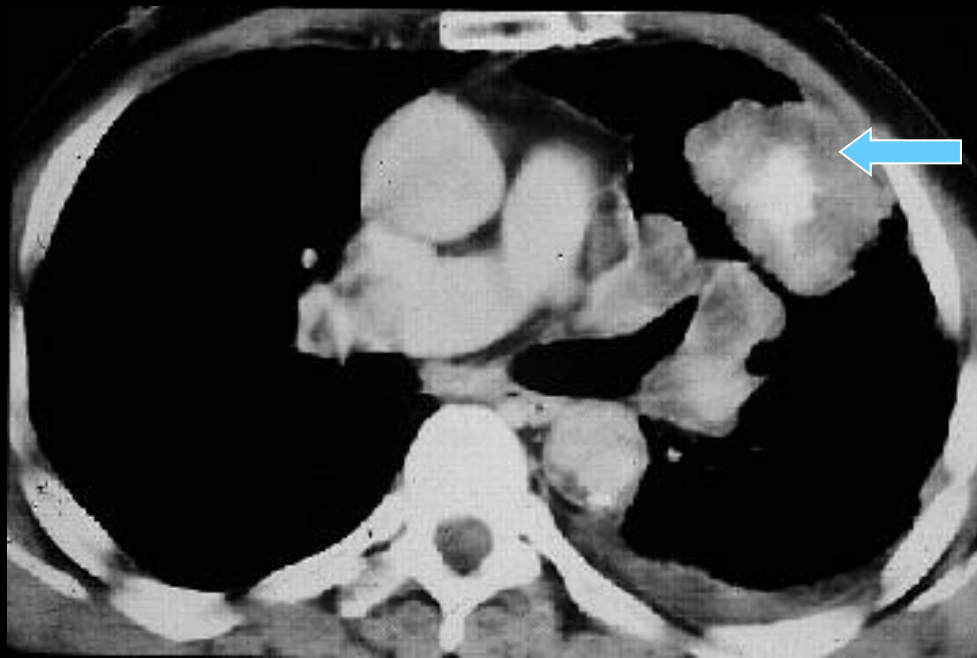
Laminated calcification



Harmatoma

Popcorn-like calcification

Malignant calcification



Amorphous calcification **Punctate** calcification

Malignant calcification



**Eccentric
Calcification**



C3: Contrast Enhancement

■ Cause:

- Tumor **neovascularity** seen on CT

■ 應用：

- Nodule **enhancement < 15 HU** after administration of contrast material is strongly indicative of **benignity**.

- PPV: 99%

- 少數的false negative:

- **Central noncavitating necrosis**

- **Adenocarcinomas (especially bronchioloalveolar cell carcinoma)**, which may be related to mucin production

- Enhancement > 15HU

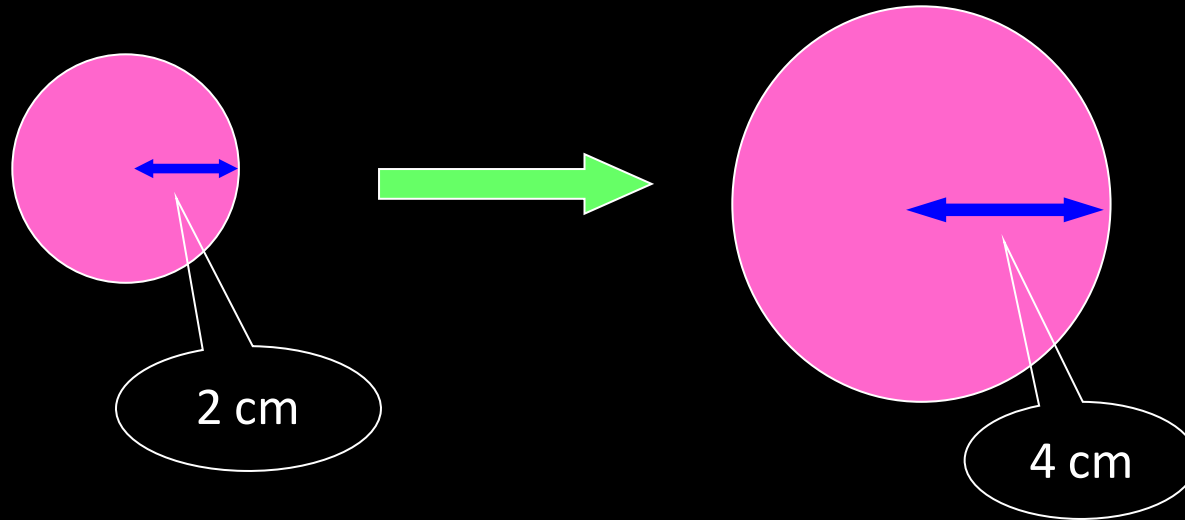
- 58%: malignancy

- 42%: due to active inflammatory disease that have increased blood flow, such as granulomas or organizing pneumonias

- 結論：

- Post-contrast enhancement > 15HU 對於診斷 malignancy 很 sensitive，但是 not specific

D1: Doubling Time



- Doubling time : 體積變成2倍所需的時間
- 球形體積= $\frac{4}{3}\pi R^3$
 - 若半徑變2倍，則體積變為8倍(2^3)
- 所以當半徑變2倍時，體積變成8倍(2^3)，即經過三個 doubling time。
 - 若相隔時間為6個月，則doubling time = $6/3 = 2$ 個月

D1: Doubling Time

- 在CXR上，tumor由single cell要長到 1 cm nodule 才容易看的到，期間需要經過 約 **30** doubling time。
- Malignancy的doubling time, range from **30-300 days** or **1.8-18 months**
- 一般而言, lung cancer的doubling time :
 - Small cell carcinoma = **30 days**
 - Squamous cell, Large cell carcinoma = **90 days**
 - Adenocarcinoma = **120 days (30~180 days)**
- Rule of “2”
 - **Doubling time < 2wk** or **> 2 yrs**: favor **benign** lesion

D2: Density

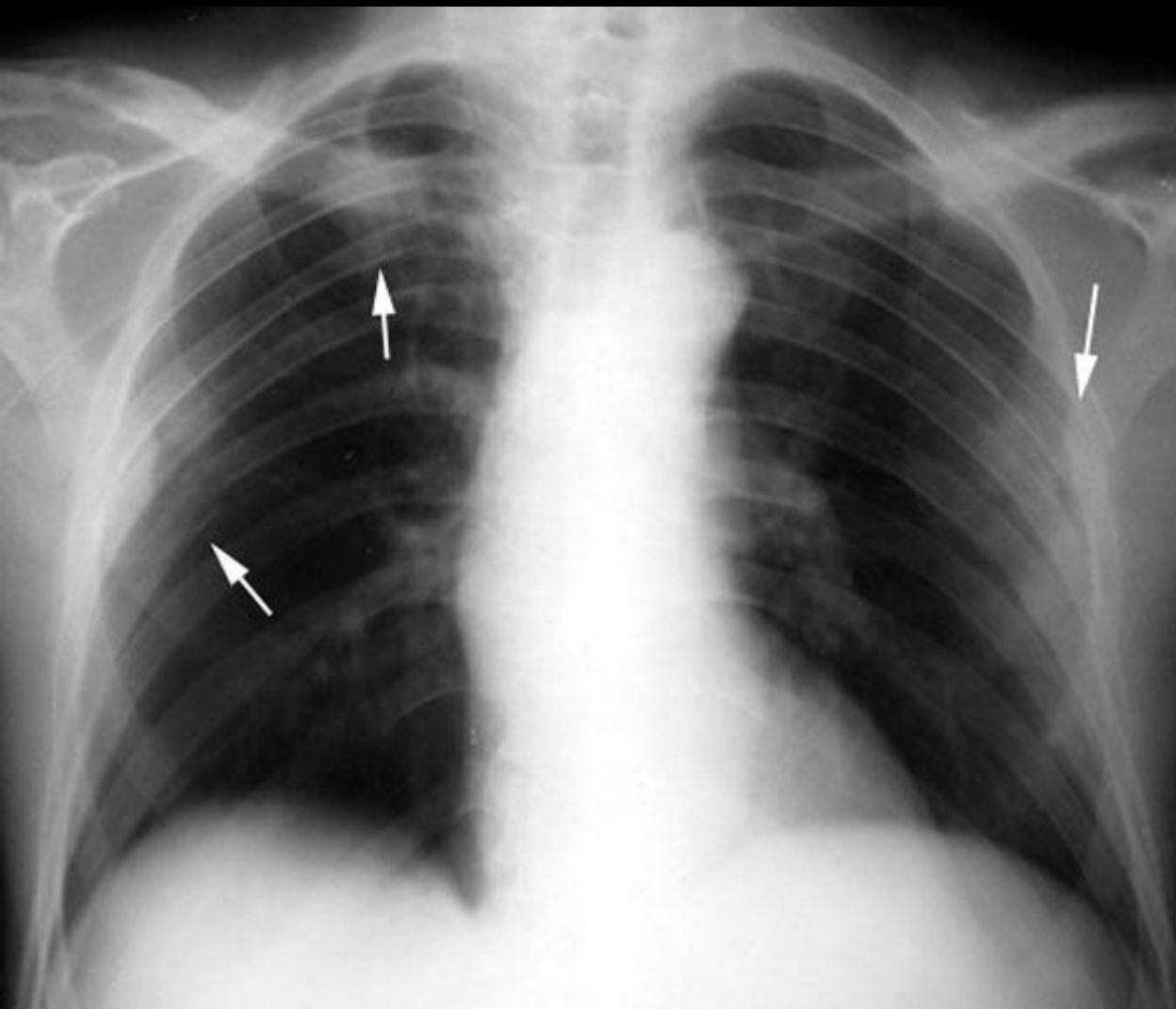
- 做CT檢查時，可測量結節之密度，單位以 Hounsfield unit (HU) 來表示。
- 結節內有脂肪組織 (-40~-120 HU)者，極可能是 **hamatoma**。

Relative Attenuation Coefficients of Nodule Components (Hounsfield units, HU)

Air	-1000	HU
Fat	-50 ~ -100	HU
Water	0	HU
Cyst	0 ~ 20	HU
Fresh blood clot	40 ~ 60	HU
Non-calcified nodule	40 ~ 160	HU
Calcified nodule	> 200	HU
Bone	1000	HU

O: Other Associated Findings

- Rib destruction
- Satellite lesion
- Hilar/mediastinal LN enlargement
- Parenchymal scar
- Pleural effusion



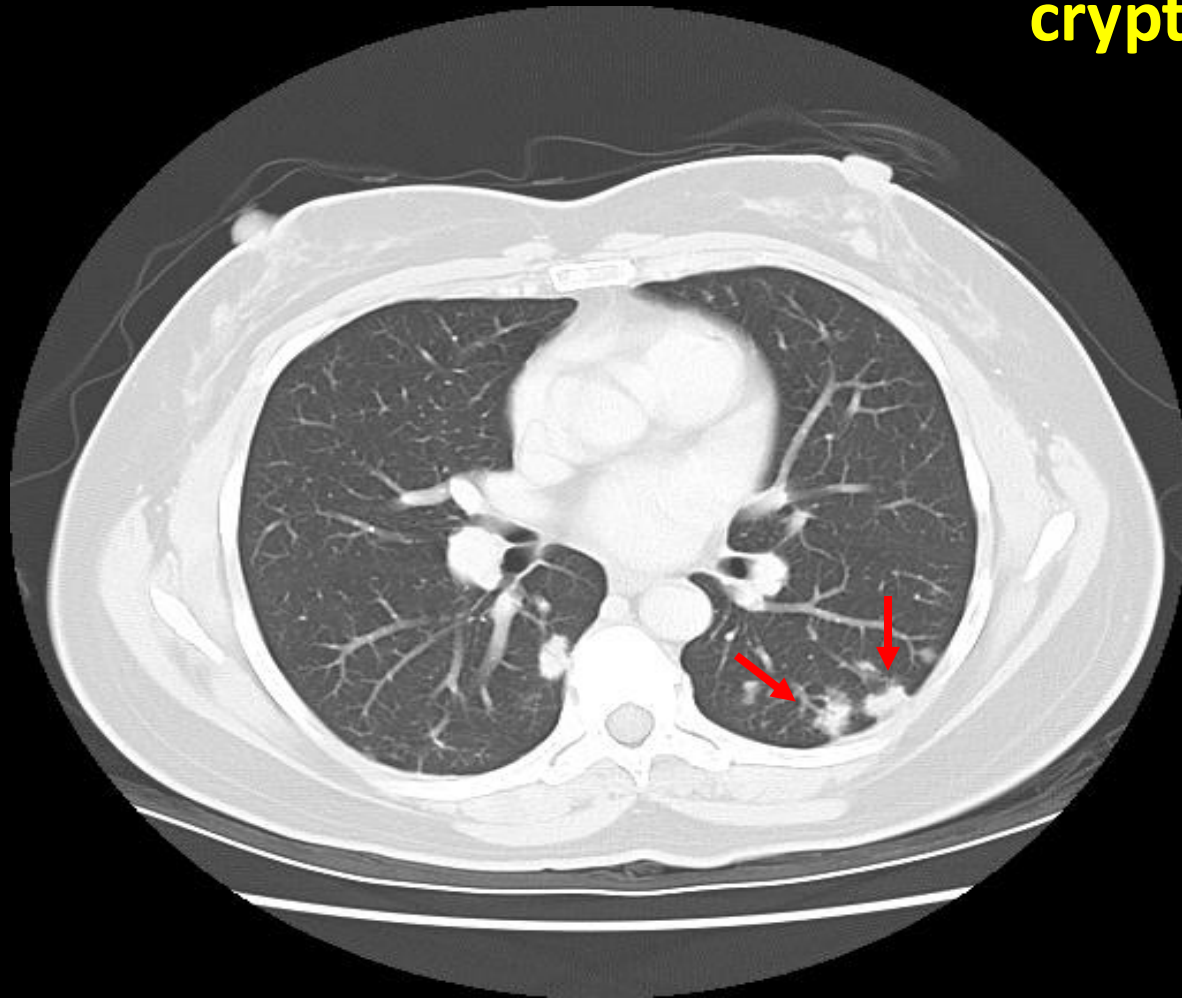
Lung cancer with rib metastasis

Solitary pulmonary
nodule
behind right
clavicle

Others: Satellite lesions

Benign: TB, fungus

cryptococcus



A1: Area/位置

■ Malignant:

- **Upper**(70%) > lower, **R't** (1.5 x) > L't
- One study showed most missed lung cancers are located in the **right upper lobe**
- **IPF** (idiopathic pulmonary fibrosis): 肺癌常發生在 **periphery of lower lobe** (fibrosis 最厲害處)
- Primary lung cancer
 - SCLC, SqCC: more **central**; high-tar, unfiltered cigarettes
 - Adenocarcinoma: more **peripheral**; low-tar, filtered cigarettes (可以吸得比較深)

A1: Area/位置(2)

■ Benign:

- Equally distributed over upper and lower lobes
- TB: upper lobe or superior segment of lower lobe

A2: Air-bronchogram

- 大多為**良性**，如pneumonia等感染性疾病
- 例外：但有時**adenocarcinoma (previous: BAC)** 或 **lymphoma**亦可見air-bronchogram (因為 parenchymal lesion為**consolidative type**)。

Hierarchy of Likelihood Ratios for Malignancy

Characteristic	Likelihood Ratio
Cavity wall thickness (mm)	
>16	37.97
>4–16	0.72
≤4	0.07
Size (cm)	
>3.0	5.23
2.1–3.0	3.67
1.1–2.0	0.74
≤1.0	0.52
PET standardized uptake value	
>2.5	4.30
≤2.5	0.04
Age (y)	
>70	4.16
50–70	1.90
30–39	0.24
20–29	0.05

Growth rate (d)	
>465	0.01
7–465	3.40
<7	0
Enhancement (HU)	
>15	2.32
≤15	0.04
<u>Irregular spiculated edge</u>	5.54
<u>History of malignancy</u>	4.95
<u>Current smoker</u>	2.27
Never smoked	0.19
<u>Indeterminate calcification at CT</u>	2.20
Upper and/or middle lobe location	1.22
Smooth nodule at CT	0.30
Benign calcification at CT	0.01

Etiology of solitary pulmonary nodules

H-I-I-N

- Hemodynamic-vascular
- Infection
- Inhalation
- Neoplasm
- Congenital (先天)
- 肺外

Type of Cause	Disease Entity
Neoplastic	
Malignant	Primary pulmonary carcinoma Adenocarcinoma, squamous cell carcinoma, bronchioloalveolar cell carcinoma, small cell carcinoma Primary pulmonary lymphoma Primary pulmonary carcinoid Solitary metastasis Melanoma, osteosarcoma, testicular cancer, breast, prostate, colon, renal cell carcinoma
Benign	Hamartoma, chondroma Arteriovenous malformation Fibroma Neural tumor (schwannoma, neurofibroma) Sclerosing hemangioma
Infectious	Granuloma <i>Mycobacterium tuberculosis</i> Fungal (<i>Histoplasmosis</i> , <i>Coccidioidomycosis</i> , <i>Blastomycosis</i> , <i>Cryptococcosis</i> , <i>Aspergillosis</i>) <i>Dirofilaria immitis</i> Bacterial (<i>Nocardia</i> , <i>Actinomycosis</i> , round pneumonia) Measles Abscess Septic embolus
Noninfectious	Sarcoidosis Lipoid pneumonia Amyloid Subpleural lymph nodule Rheumatoid arthritis Wegener granulomatosis Pulmonary scar Infarct
Congenital	Bronchogenic cyst Bronchial atresia with mucoid impaction Sequestration
Other	Skin nodule Rib fracture Pleural thickening, mass or fluid

Figure 5: Chart shows differential diagnosis of SPN.

H: Hemodynamic- Vascular

■ Cardiovascular

- AVM

- Pneumocytoma of the lung (Sclerosing hemangioma)

- Pulmonary artery aneurysm

- Pulmonary vein varix

■ Collagen-vascular

- GPA (Wegener's granulomatosis)

- Rheumatoid nodule

■ Thromboembolic

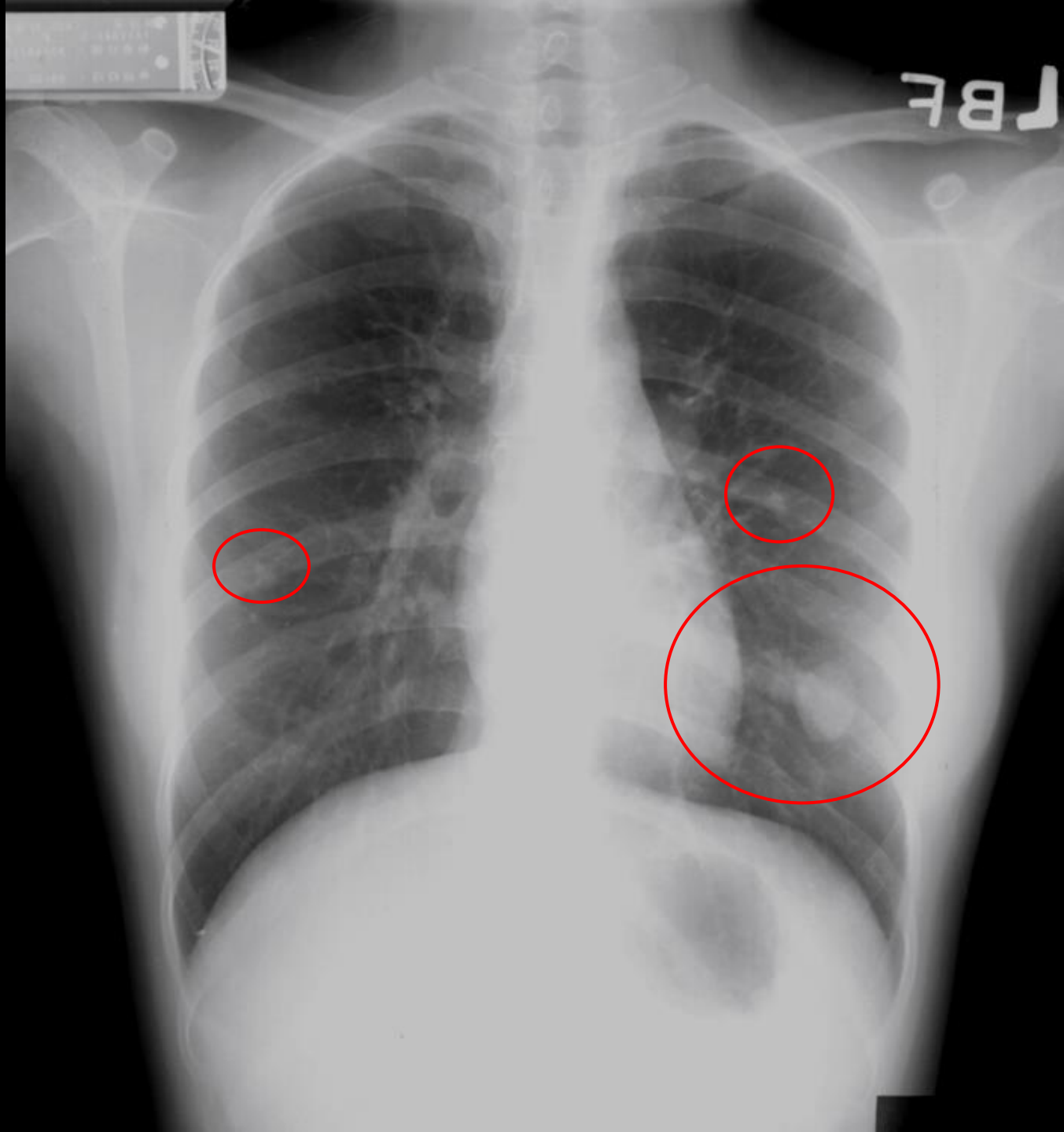
- Infarct (organizing)

AVM

- Hilum → **Feeding pulmonary artery** → AVM → **Drainage pulmonary vein** → LA
- 60% have AVM in the skin, mucous membrane or other organ. (Rendu-Osler-Weber disease)
- 通常不會大於**2-3cm**，否則臨床上會出現很厲害的shunt，病患會很喘。
- CXR:
 - Round or oval homogeneous mass of uniform density; somewhat **lobulated** in contour, but **sharply** defined.
 - Connected with **feeding a.** and **drainage v.**
 - **1/3** have **multiple** lesions
 - More common in **lower lobes** (65%)
 - Surrounding lung is usually normal



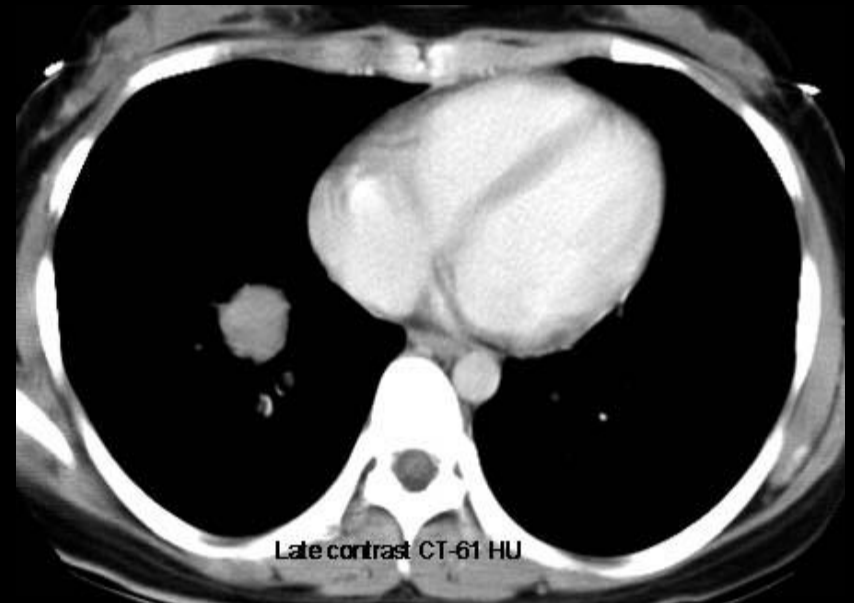
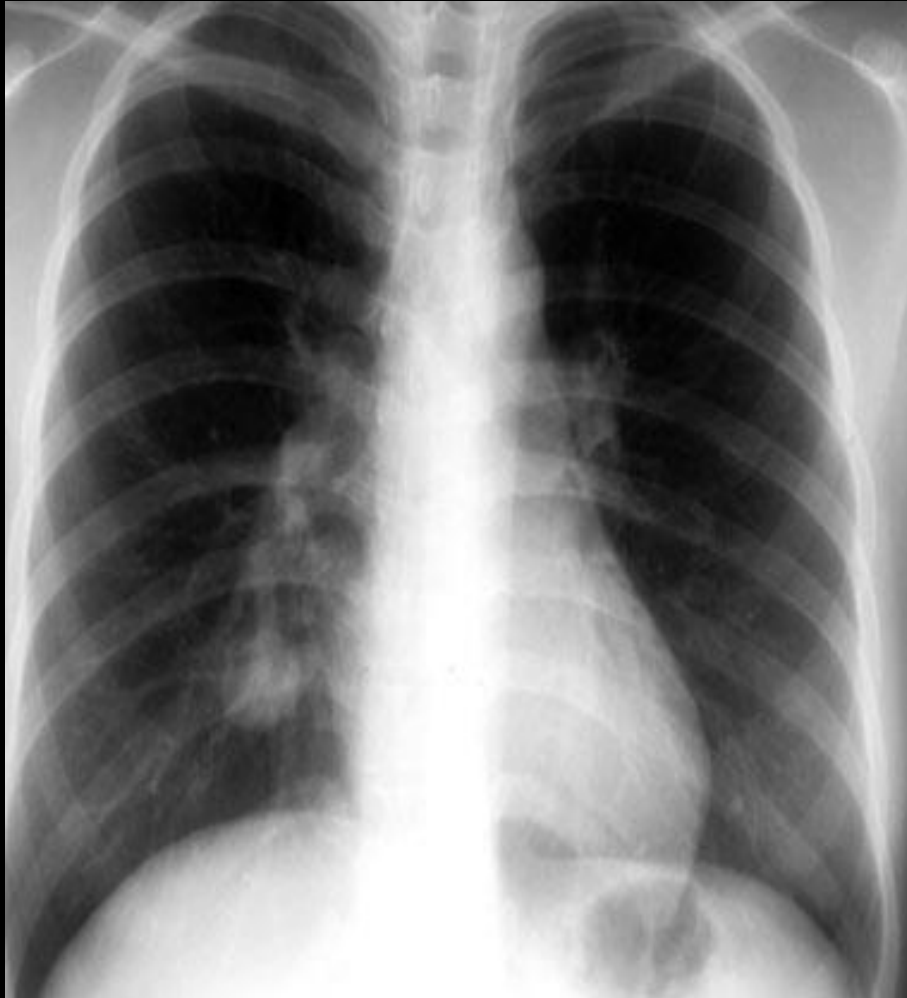
Pulmonary AVM



Pneumocytoma of the lung (Sclerosing Hemangioma)

- derived from a **primitive epithelial cell**; benign
- **Female** predominant; Average age at diagnosis: **42y/o**
- Imaging:
 - A solitary **well-defined, round** pulmonary nodule, usually enhances inhomogeneously after contrast.
 - Frequent **juxtapleural** in location
 - Average: **3cm** in size (range: very small to 8cm),可能會長很慢
 - 偶有**鈣化**
 - CT: a **halo of lucency**, which corresponds **enlarged alveoli** and **interstitial septal destruction** suggesting bleeding into the lung from this highly vascular tumor → 可能會**咳血**，少見。

Sclerosing hemangioma





**Sclerosing
Hemangioma**

Granulomatosis with polyangiitis (GPA)

Wegener Granulomatosis

- Classic Wegener's triad: **sinus**, **lung** and **renal** disease
- Lung parenchymal change
 - Single or multiple pulmonary nodules/masses: **multiple多(75%)**
 - 最常見的表現
 - **Ill-defined** or **irregular marginated**, no zonal predominance
 - 50%會開洞，通常是**irregular, thick walled**
 - 少**pleural effusion(<10%)**, **mediastinal or hilar LAP**
 - 經過治療之後，這些**nodules or cavities**會消失或是留下scar
 - CT scan : **nodules with irregular margin**，沿著**peribronchovascular**分布
 - Localized or diffuse consolidation
 - 通常代表**pulmonary hemorrhage**
 - A focal area of dense consolidation, patchy bilateral areas of consolidation, or diffuse air-space consolidation
- Airway narrowing:
 - **Subglottic stenosis**
 - Involvement of the tracheal or bronchial walls usually consists of mucosal or submucosal granulomatous thickening，在CT scan上可見到**smooth or nodular thickening of tracheal or bronchial wall thickening**.

GPA/Wegener's Granulomatosis

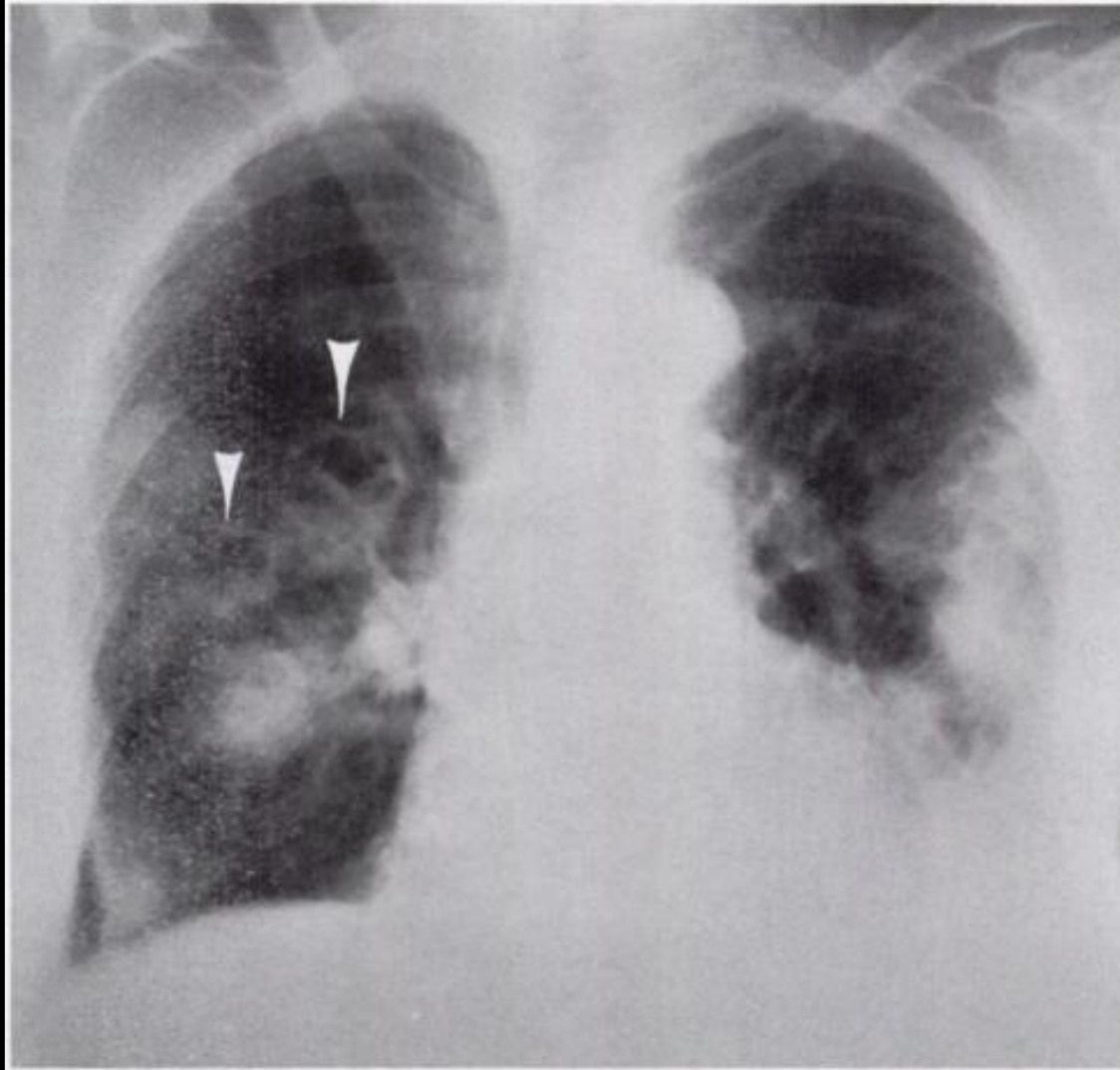


bilateral irregular nodules and a mass in the right lower lobe



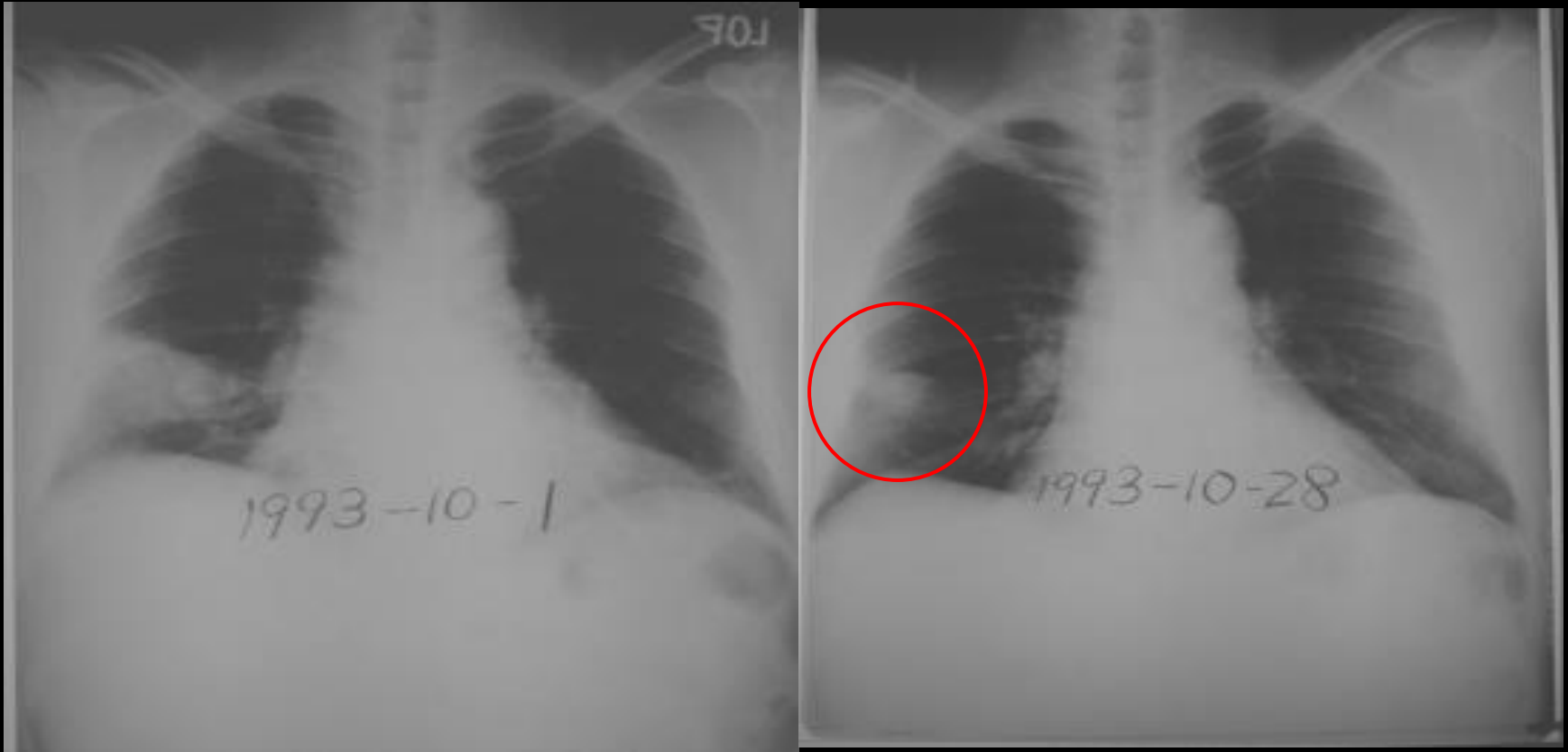
multiple irregular nodules in a peribronchovascular distribution

GPA/Wegener's Granulomatosis



- Multiple, bilateral irregular marginated cavitary pulmonary nodules. Variable thickness of wall is noted.
- Consolidation over LLL

Hampton's hump/Melting sign (Organization of Pulmonary Infarction)



dome-shaped, pleural-based opacification in the lung most commonly due to pulmonary embolism and lung infarction

Infection

■ Bacteria:

- Lung abscess
- Organizing pneumonia

■ TB: granuloma

■ Fungus:

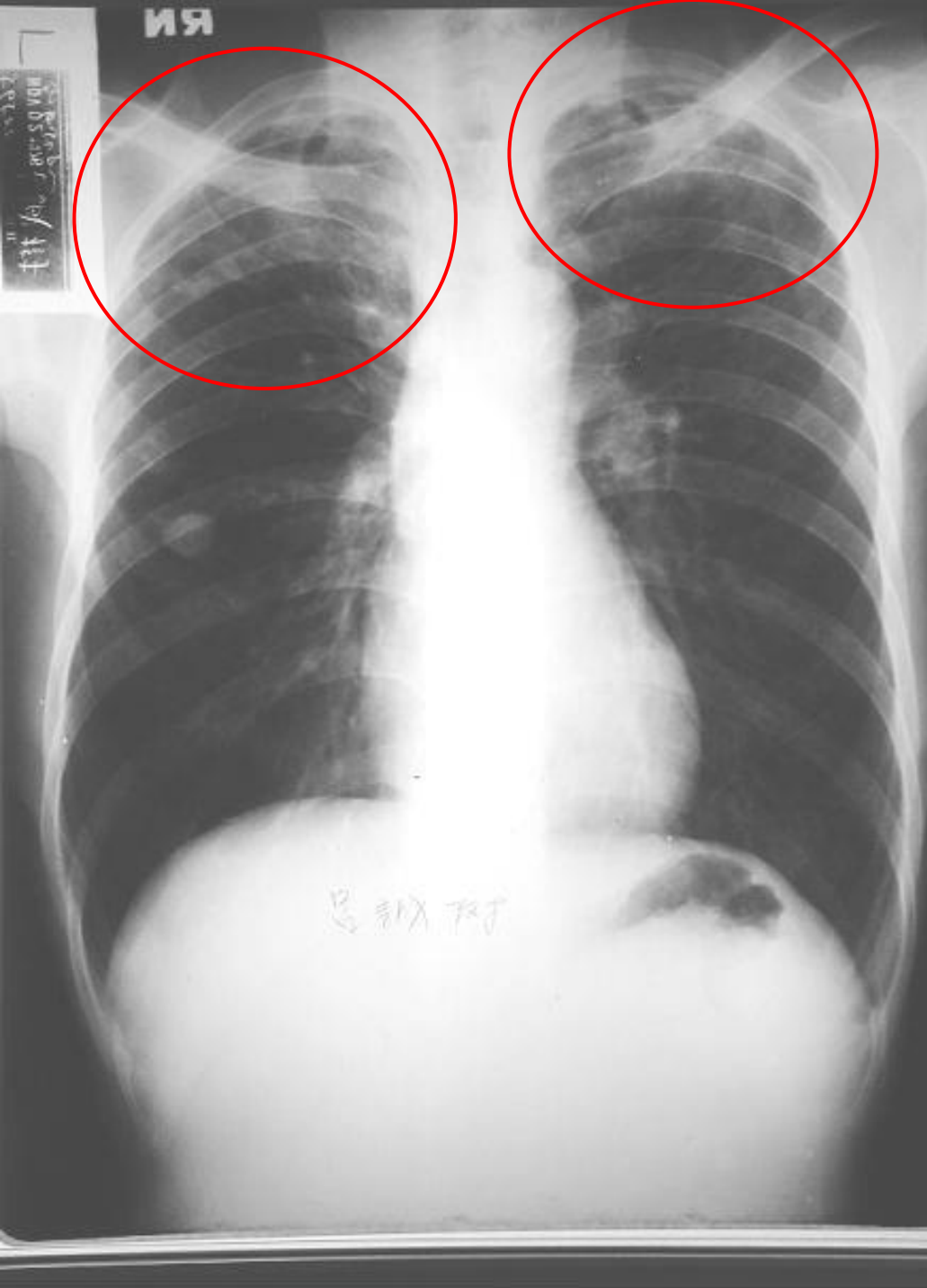
- Cryptococcus
- Aspergillosis: aspergilloma (fungus ball)
- Coccidioidosis
- Histoplasmosis

■ Parasite

- paragonimiasis

Tuberculoma

- Usually 1-4 cm in diameter
- Typically **smooth** and **sharply defined**; occasionally, lobulated or spiculated
- 多發生在**upper** lung field
- **Satellite lesions**: in 80% of cases
- **Calcification**: diffuse, central or punctate
- Cavitation: uncommon
- CT scan: **no or little or ring enhancement**



Tuberculoma



Tuberculoma



Densely
calcified
nodule

Cryptococcus

■ 分類：

- Pulmonary nodules or masses with well- or illdefined margins
- Segmental or lobar consolidation
- Small nodular or reticulonodular opacities

■ Immunocompetent patient

- Solitary or multiple pulmonary nodules or masses
 - 最常見
 - 0.5~5cm in size; more common in lower and peripheral lung
- Focal areas of consolidation: air-bronchogram (+)

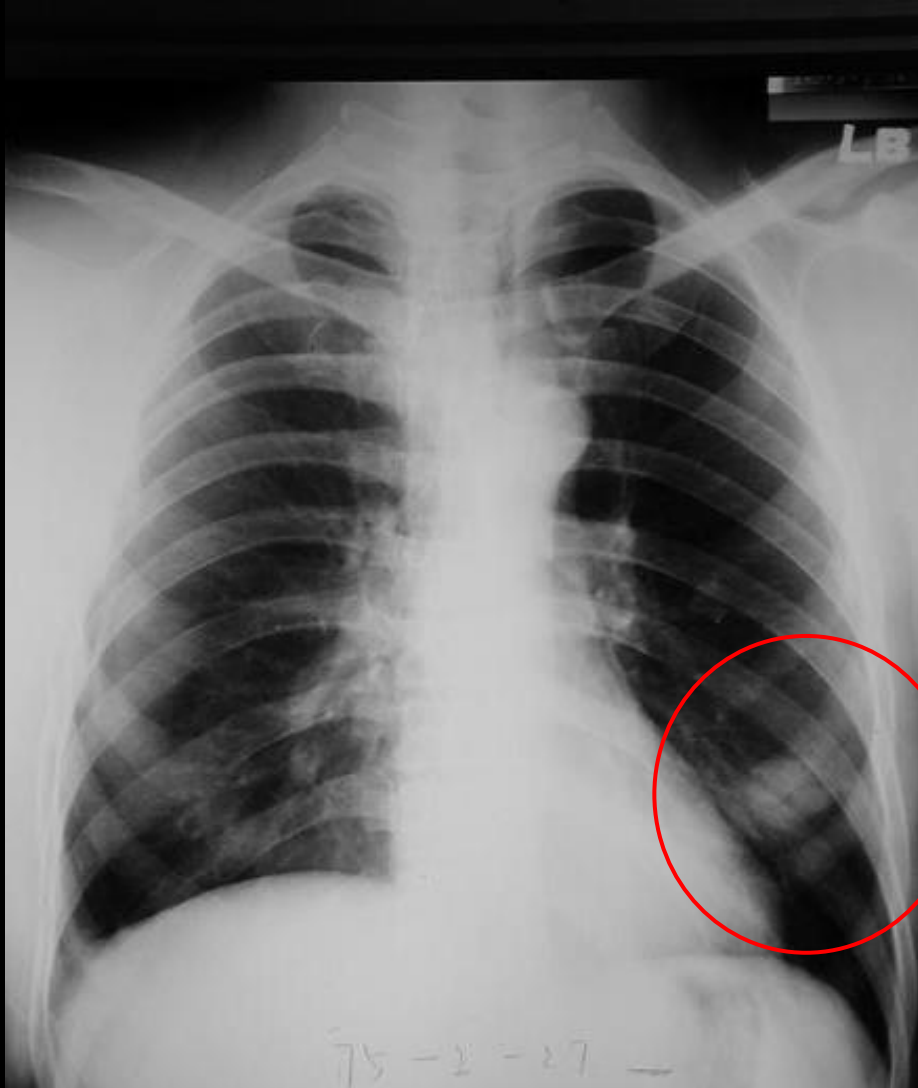
AJR 1984; 141:893-896

AJR 2005; 185:622-62

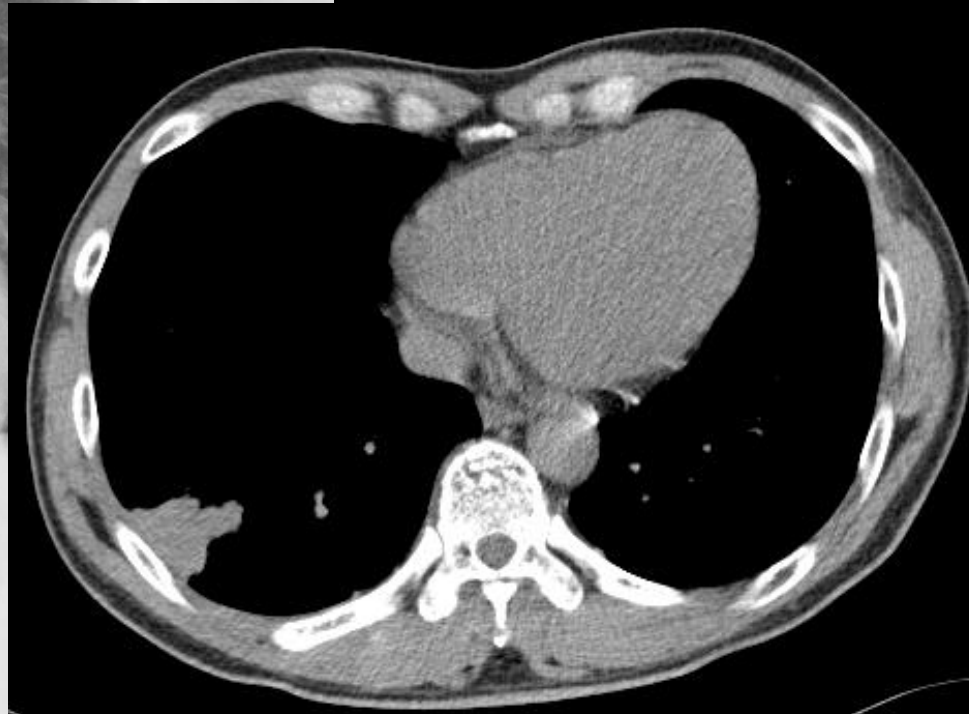
Cryptococcus (2)

- Immunocompromised patient
 - Wide varieties, including single nodules, multiple nodules that progressed to confluence and/or cavitation, segmental consolidation, bilateral bronchopneumonias, or mixed patterns.
 - Adenopathy, miliary pattern, cavitation and pleural effusions are limited in these patient

Cryptococcus



Cryptococcus



Aspergillosis

- 臨床上可以分為五種類型：
 - Saprophytic aspergillosis (**aspergilloma**)
 - Hypersensitivity reaction (allergic bronchopulmonary aspergillosis, **ABPA**)
 - **Semi-invasive** (chronic necrotizing) aspergillosis
 - **Airway-invasive** aspergillosis (acute tracheobronchitis, bronchiolitis, bronchopneumonia, obstructing bronchopulmonary aspergillosis)
 - **Angioinvasive** aspergillosis
- Clinical manifestation is correlated with underlying immunity.

Aspergillosis - Aspergilloma

- Aspergillus infection without tissue invasion
- Conglomeration of intertwined **fungal hyphae** admixed with **mucus** and **cellular debris** within a **preexistent pulmonary cavity or ectatic bronchus**.
- The most common underlying causes are **TB** and **sarcoidosis**.
- Clinical: usually asymptomatic; the most common symptoms is **hemoptysis**.
- Image:
 - Solid, round or oval **soft-tissue mass** within **a lung cavity**
 - **“Air-crescent” sign**: the mass is separated from the wall of the cavity by an airspace of variable size and shape
 - The aspergilloma usually **moves when the patient changes position**
 - Aspergillomas are often associated with **thickening of the cavity wall and adjacent pleura**. 約有10%的mycetoma會自行resolution, 而pleural thickening也會隨著消失. 所以thickening of pleural and cavity wall可能是由**hypersensitivity reaction**而造成.

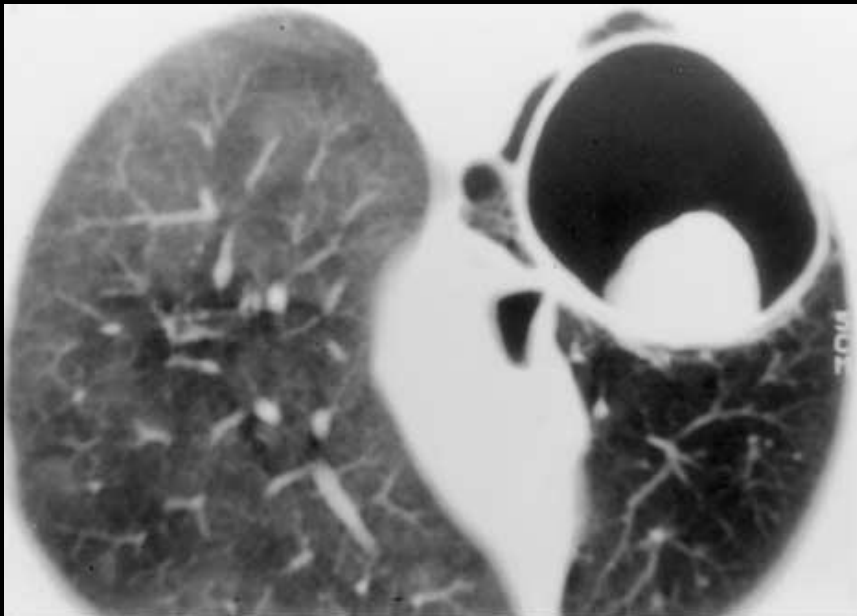
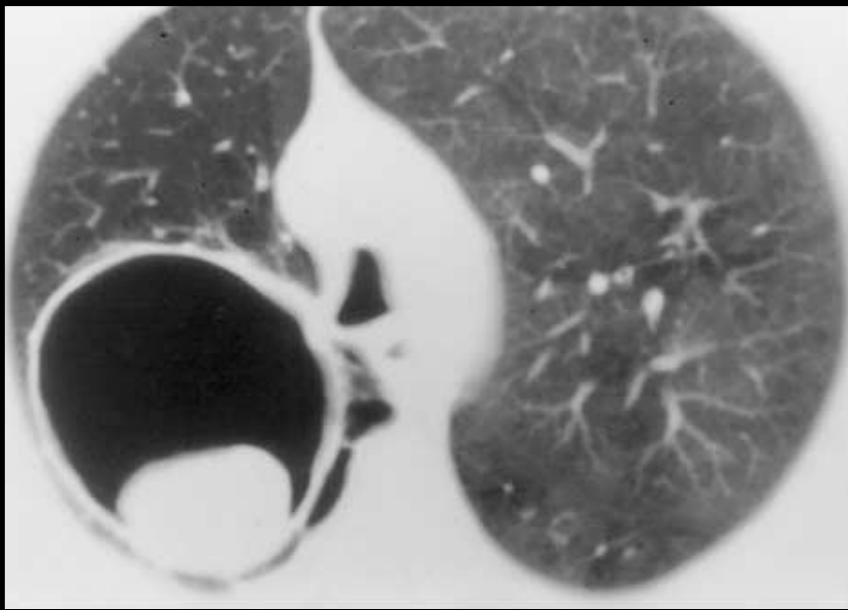
Aspergilloma



Multiple fungus ball within a cavity over RUL



Multiple irregular fungus balls virtually filling the pulmonary cavity



Air crescent sign

Pleural thickening

The **fungus ball** moves when position change of the patient

Neoplasm

■ Malignant:

- Primary lung cancer(含carcinoid tumor)
- Metastasis
- Lymphoma
- Primary sarcoma of lung

■ Benign:

- Hamartoma
- Hemangioma
- Chondroma
- Leiomyoma
- Amyloidosis
- endometrioma

Lung Cancer

- Can be of any size
- Often **irregular, spiculated margin**
- **Tail sign**: most commonly seen in **adenocarcinoma**
- Although **calcification** occurs in 5-10% of lung cancer, it usually affects **tumors > 3cm**
- **Cavitation**: most in **squamous cell carcinoma > 3 cm**
- Contrast-enhanced in CT
- Associated findings:
 - Hilar / mediastinal LN enlargement
 - Rib destruction / pleural effusion
 - Rarely with satellite lesions



Squamous cell carcinoma

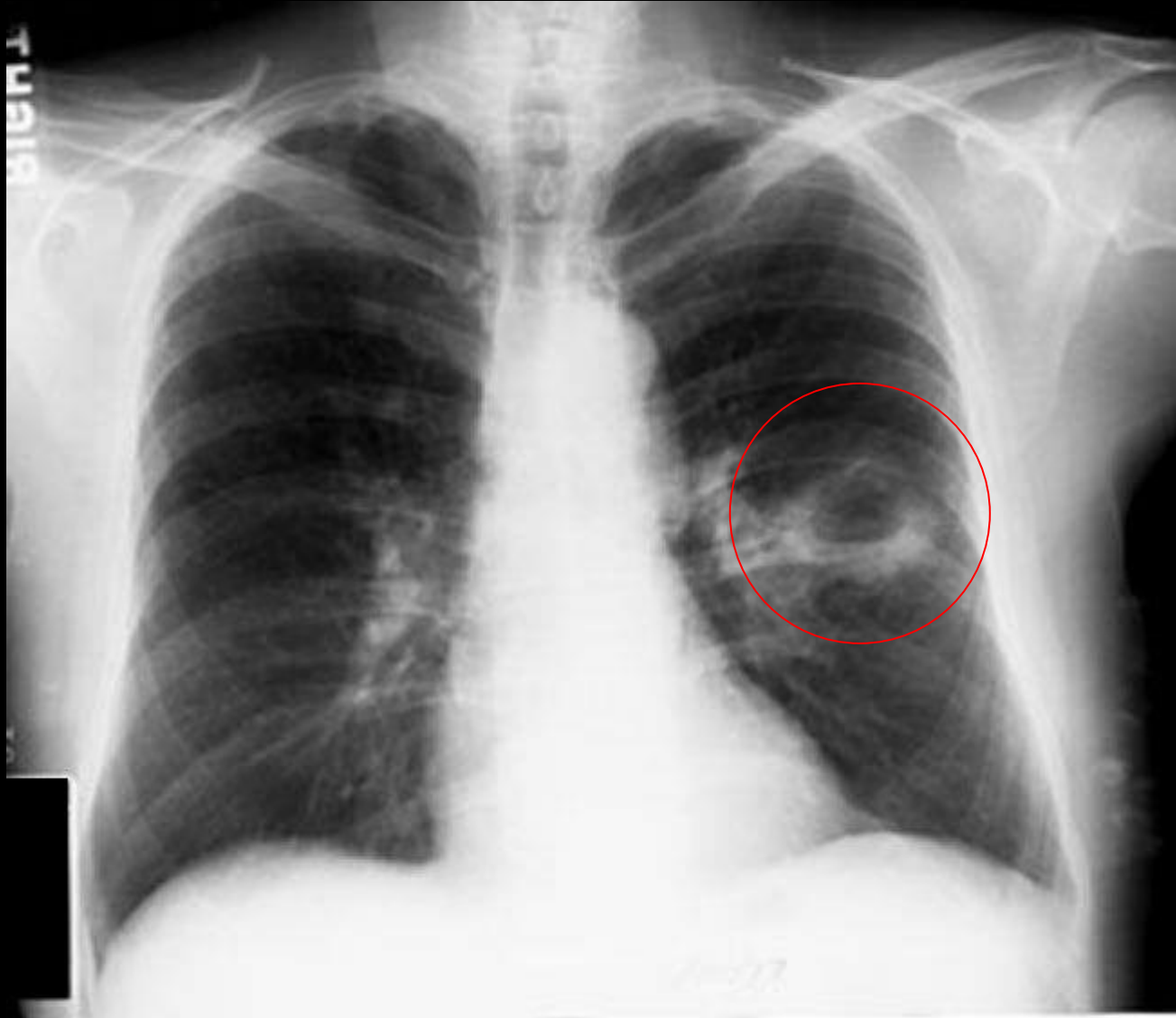
Lobulated border



Tail sign

Adenocarcinoma

Squamous Cell Carcinoma of Lung



Bronchoalveolar carcinoma - Consolidation type



Carcinoid

■ 性質：

- Low-grade malignancy with metastatic potential
- Derived from **neuroendocrine cells** normally scattered throughout tracheobronchial epithelium
- Lung is the second most common location (GI tract最常見)
- **the commonest primary pulmonary neoplasm of children**, mostly being seen in late adolescence

Carcinoid(2)

■ Imaging

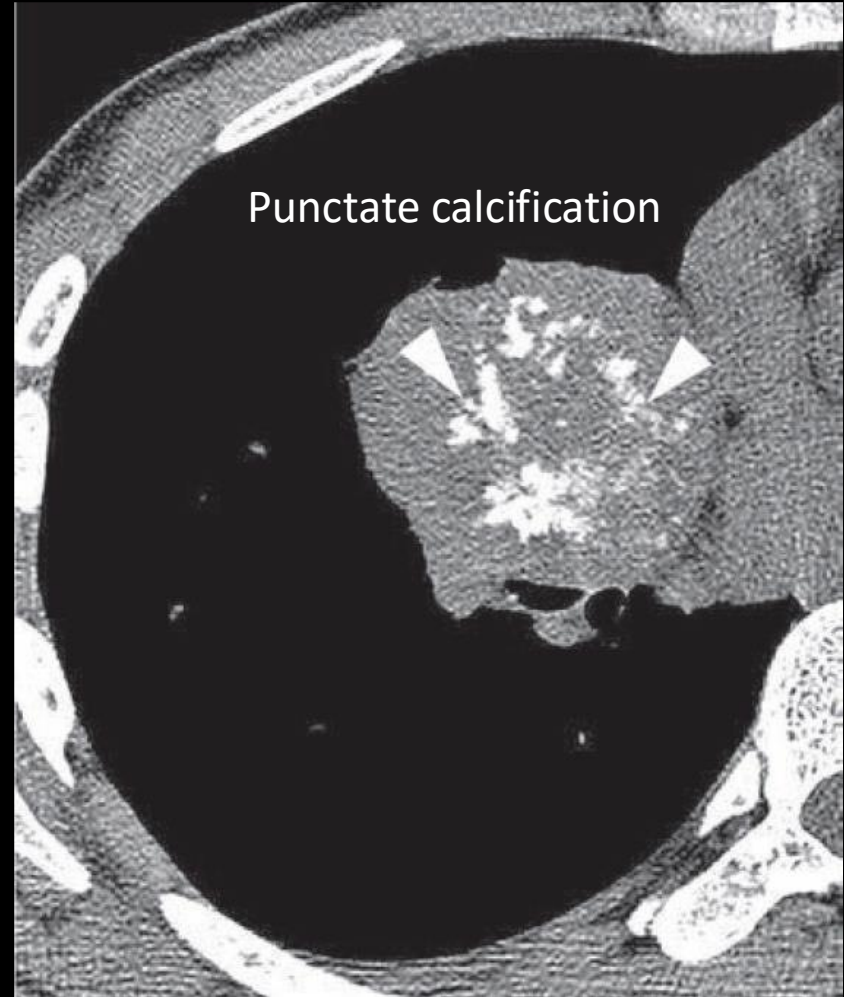
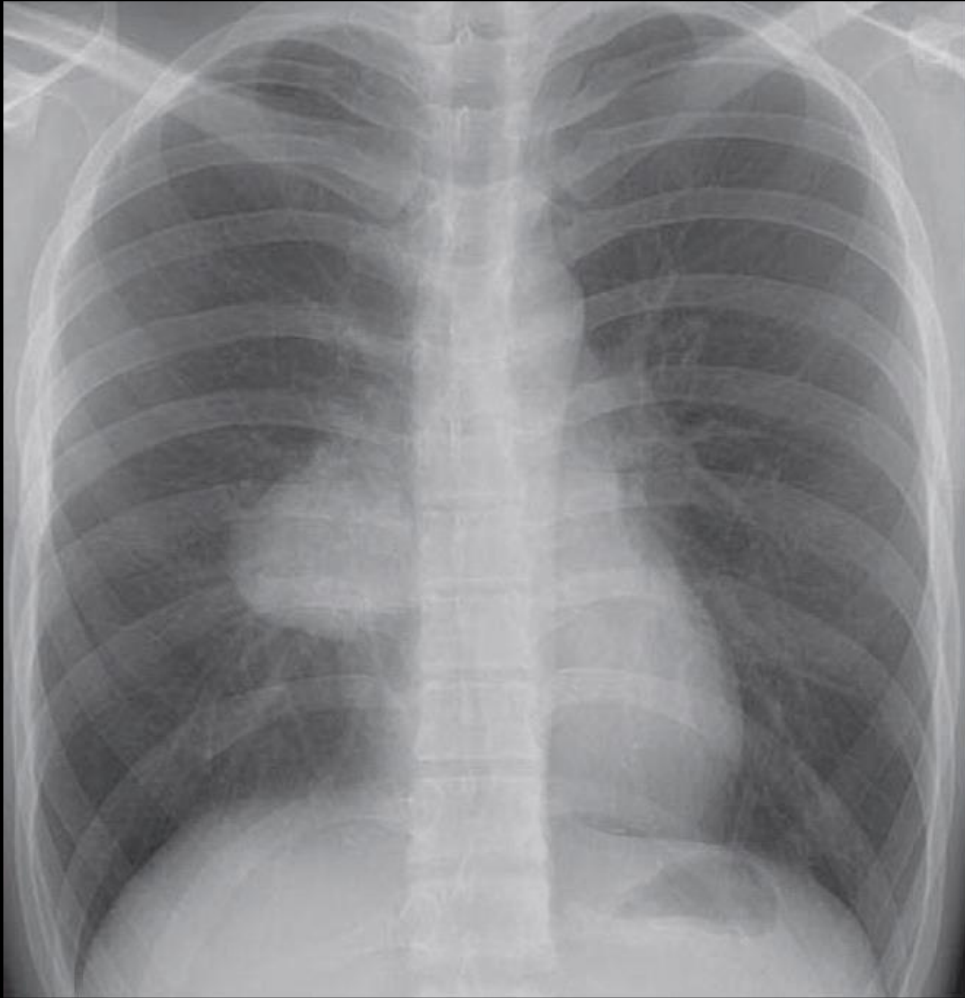
■ Typical carcinoid:

- 85%由main, lobar or segmental bronchus發生 (**central**), 2~5cm
- **Well-defined/oval/round**, hilar/perihilar mass +/- post-obstructive atelectasis or pneumonia
- CT: **calcification** (usually eccentric but not common), homogeneous contrast enhancement due to **high vascularity**

■ Atypical carcinoid:

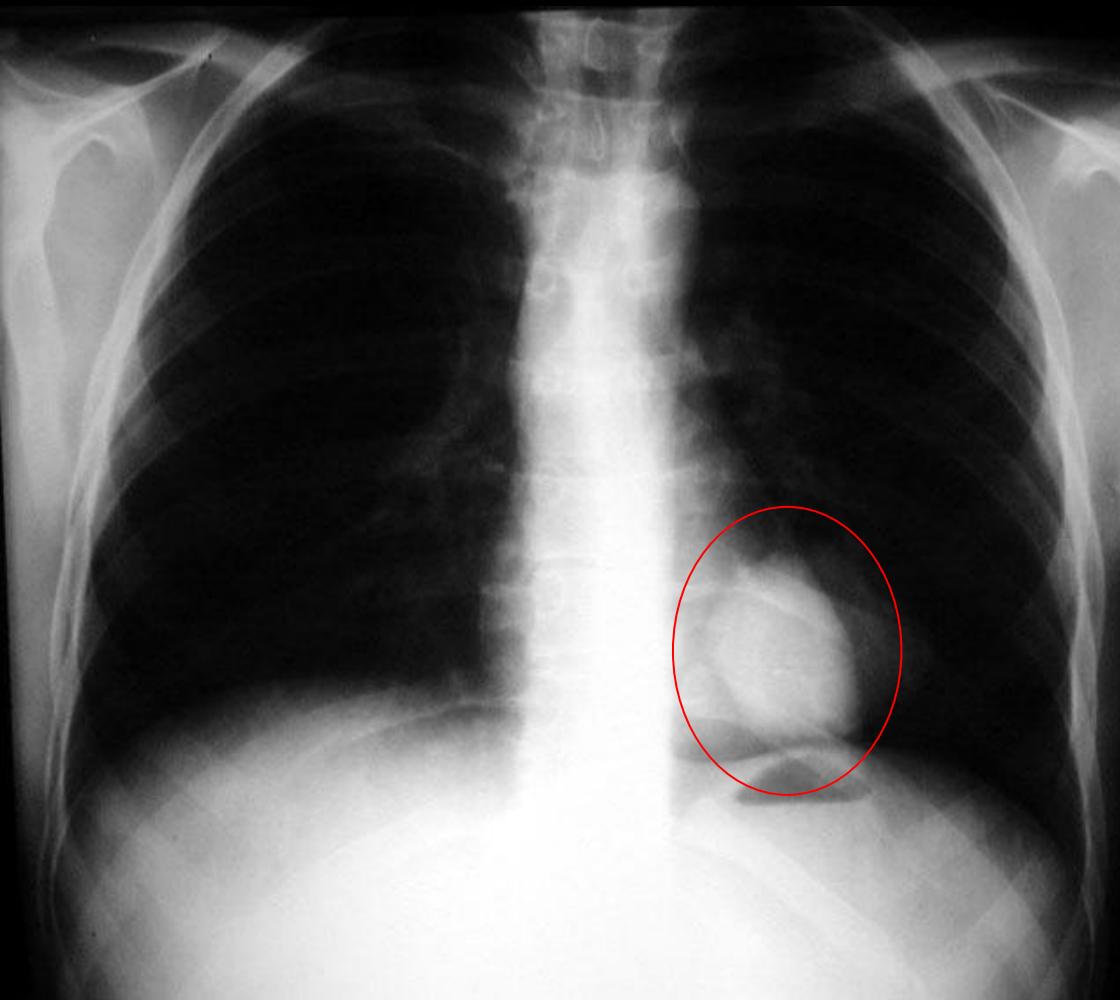
- 大部分發生在lung **periphery**
- 較容易合併**enlarged hilar LAP**
- CT : **larger size, necrosis(+), enlarged hilar LAP**, more variable enhancement

Typical Carcinoid



Metastasis

- Metastasis as a solitary tumor is relatively **uncommon**.
- Certain metastasis are more likely to produce solitary metastases: **colon** (esp. rectosigmoid ca), **kidney**, **testes**, **ovary** cancer; **sarcoma** (esp. bone); **malignant melanoma**.
- 50% have **smooth margins**; round, oval or lobulated contour.
- **History**

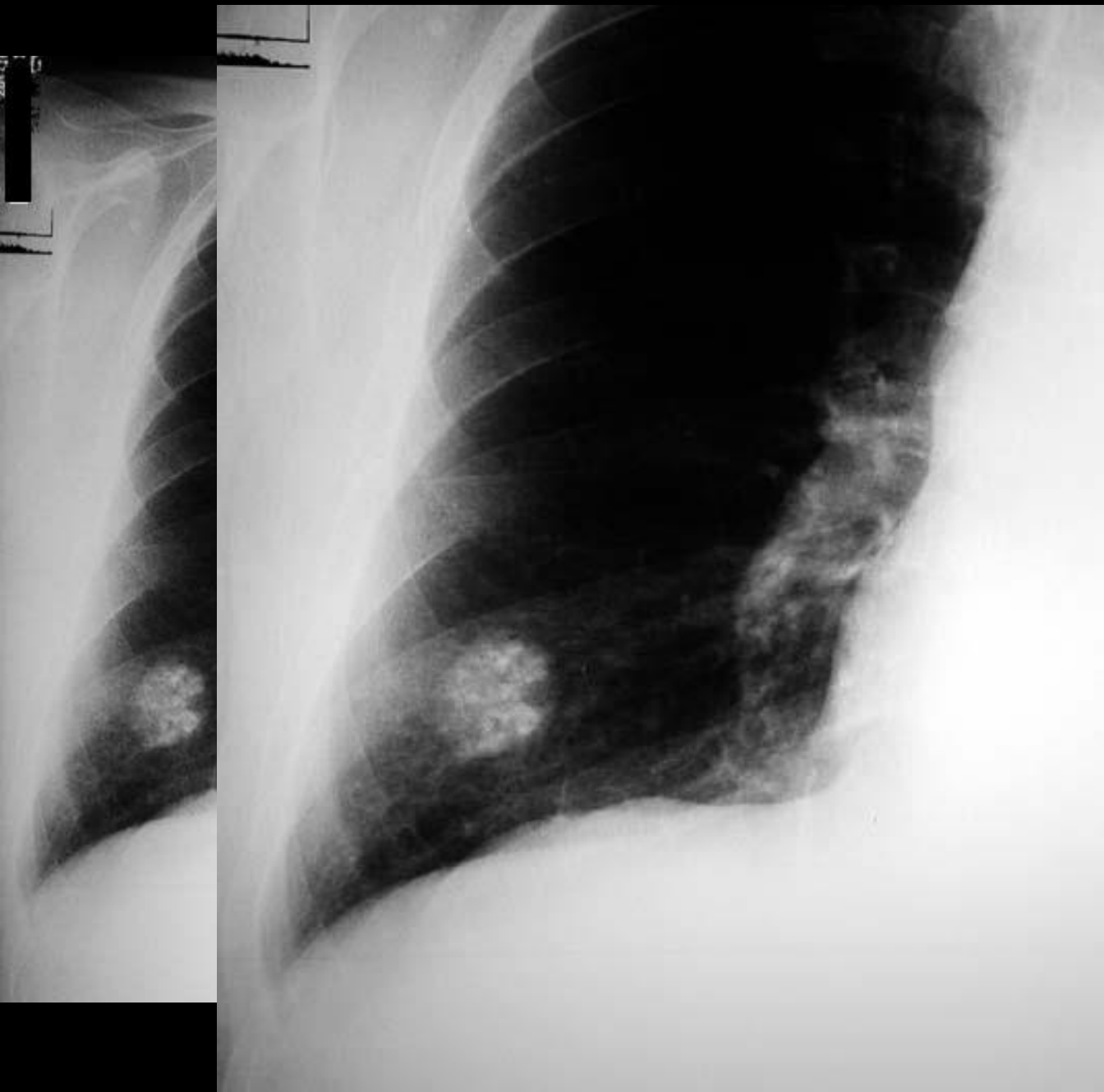


Malignant melanoma metastatic to lung

- Mass density LLL
- Retrocardiac soft tissue density

Hamartoma

- Derived from **bronchial wall mesenchymal cells**.
- Onset in adult life, peak age in the **50y/o**左右.
 - 30 y/o以前少見
- CXR:
 - A **well-defined** solitary nodule, slightly **lobulated** (sometimes slow growth)
 - **< 4 cm** in diameter
 - "**Popcorn Calcification**" is uncommon(<10%)
 - Cavitation is rare
- Thin section CT of the lesion usually reveals smooth edges, focal collections of **fat** (60%) or **calcification** (25%).



Hamatoma

Popcorn
Calcification

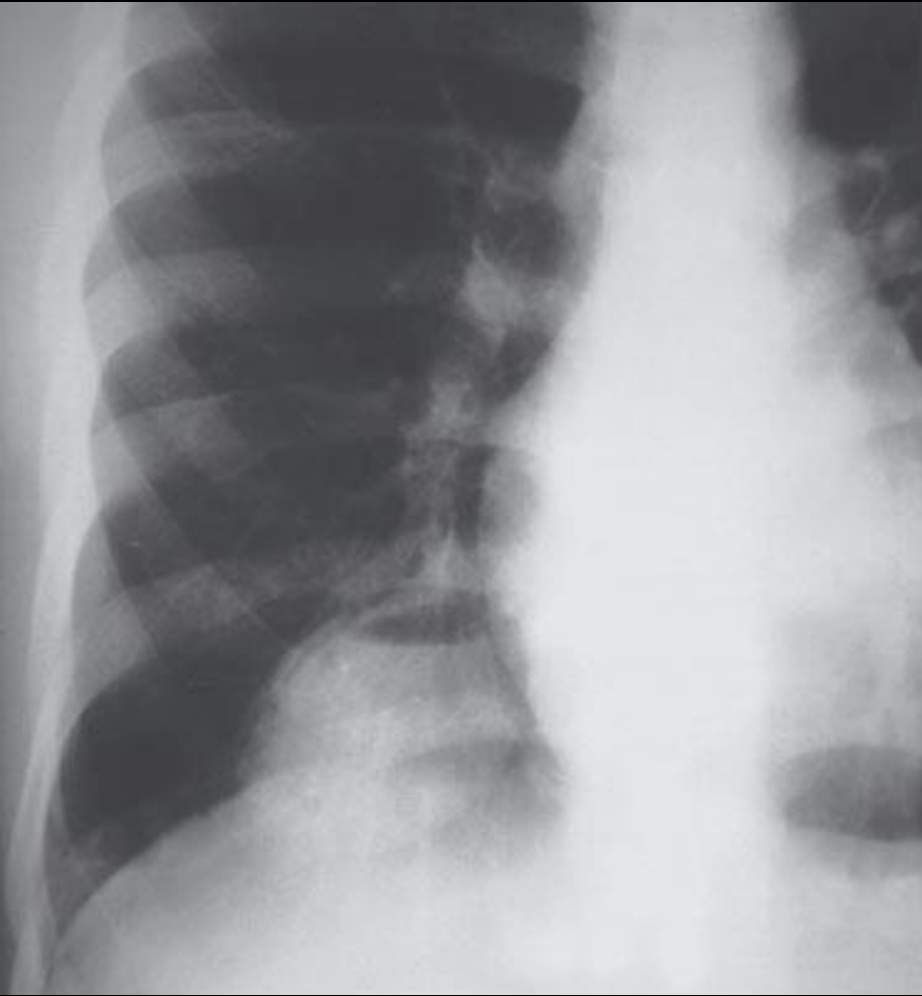
Congenital (先天)

- Bronchogenic cyst (fluid-filled)
- Pulmonary sequestration

Bronchogenic Cyst

- Result from abnormal budding of the developing tracheobronchial tree with separation of the buds from the normal airways.
- **65~90%** of bronchogenic cysts are **mediastinal**.
- Pulmonary:
 - Communicate with bronchial tree
 - S/S: **infection(75%)**, dyspnea, hemoptysis.
 - They are usually **solitary, well-defined, thin-walled, and unilocular**.
 - The common location is the **lower lobes**.

Bronchogenic Cyst

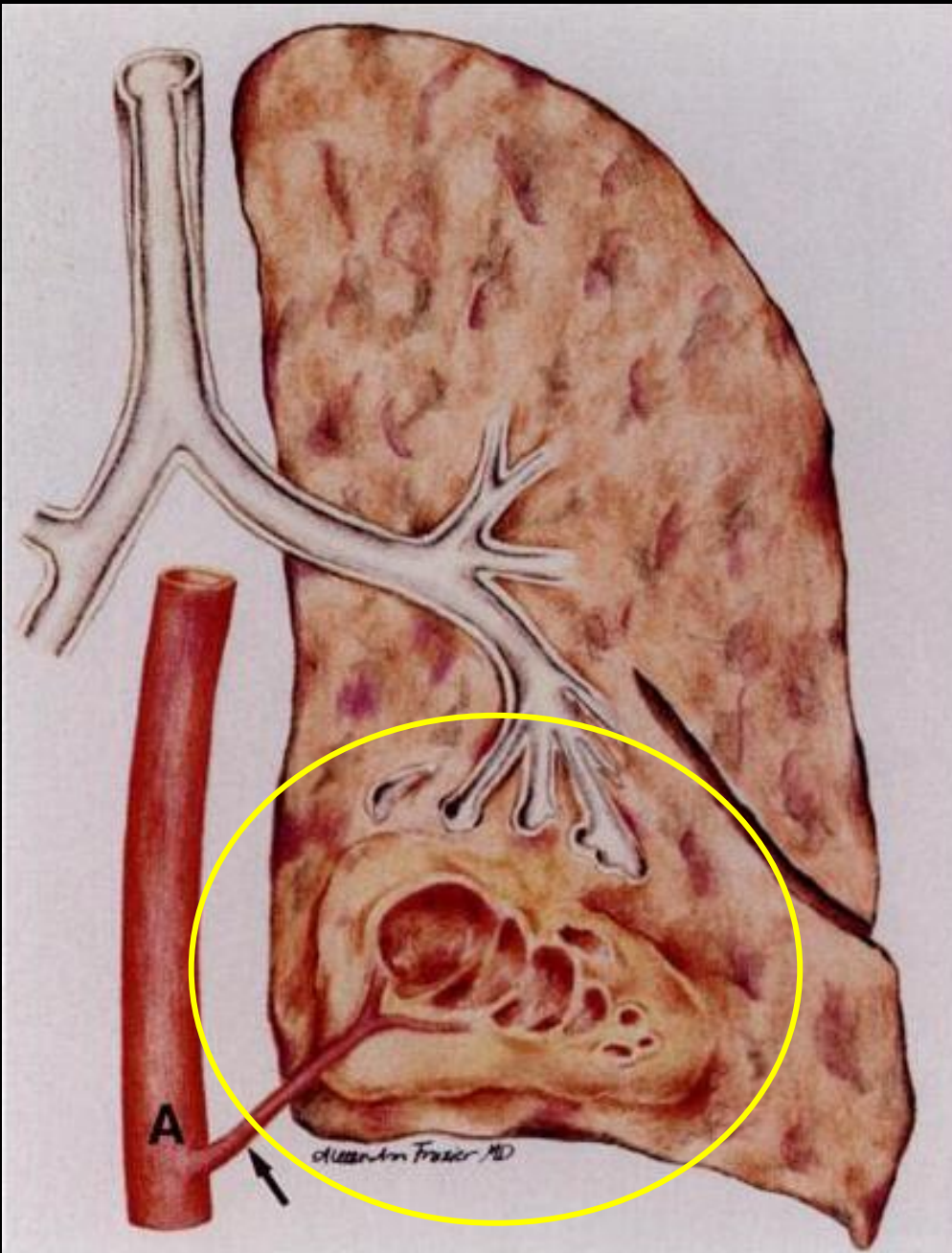


Pulmonary Sequestration

- Two form of pulmonary sequestration: intralobar(75%), extralobar(25%)
- Intralobar:
 - Almost always within **lower lobe**; **L>R**
 - **Shares** the visceral pleura of an normal lung
 - Lacks a normal communication to the tracheobronchial tree.
 - Pathologic features: chronic inflammation, cystic change, and fibrosis.
 - Supplying vessels:
 - **A - aortic branch**; V - pulmonary v. → LA
 - **acquired** origin, acquired a systemic blood supply subsequent to **chronic post-obstructive pneumonia**.

Intralobar Sequestration

- Does not have a normal connection to the tracheo-bronchial tree.
- A systemic artery typically arises from the distal thoracic aorta (A) to supply the lesion.



Intralobar Sequestration

■ Clinical S/S:

■ **Early adulthood**

■ 慢性咳嗽、濃稠(膿)痰，反覆發生的肺炎而且愈來愈嚴重

■ **不常合併** congenital anomalies.

■ CXR:

■ Uncomplicated:

■ A homogeneous consolidation with irregular margins or as a uniformly dense mass with smooth or lobulated contours, located in the **posterior basal portion of a lower lobe(B10)**

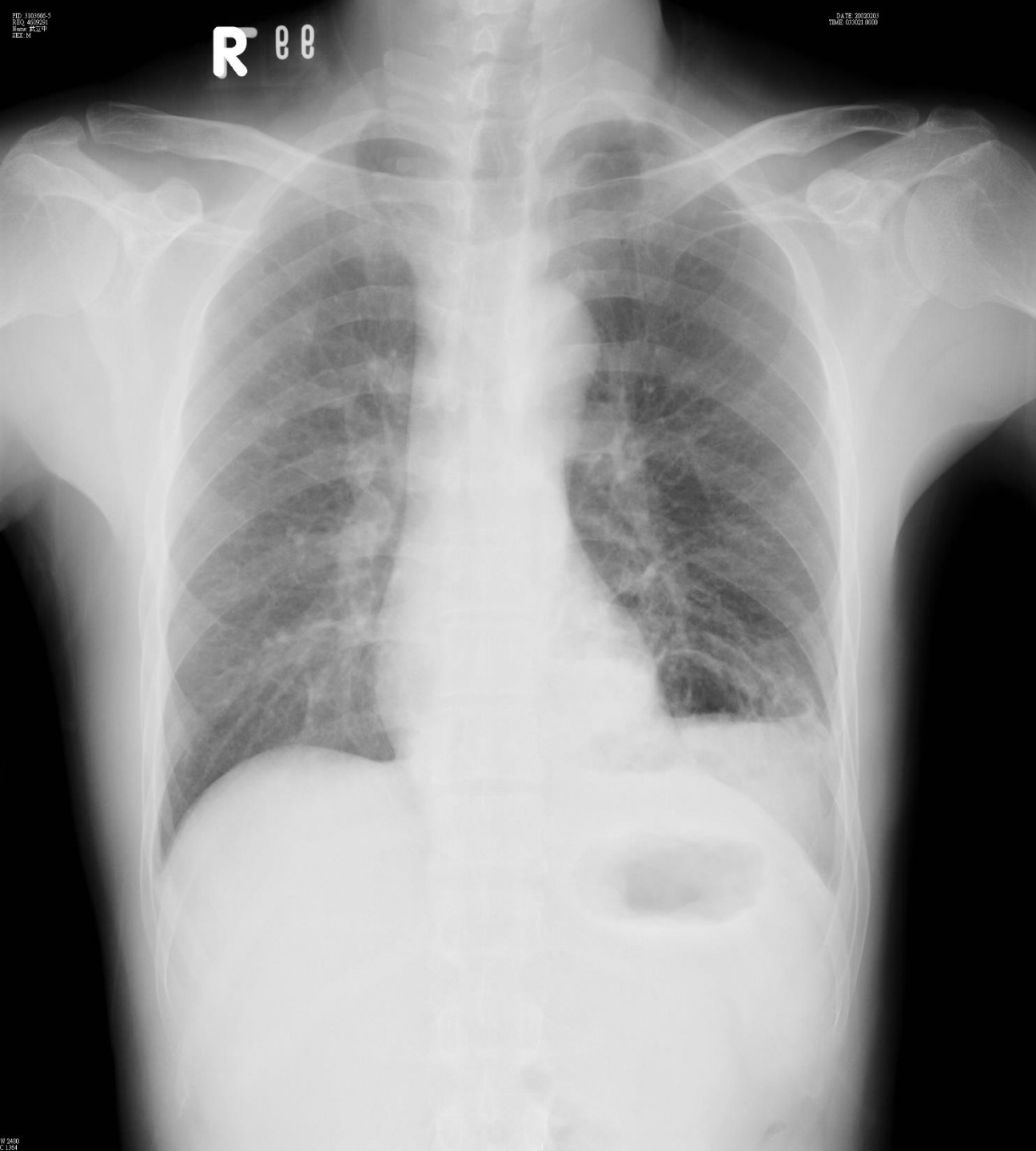
■ Intralobar sequestration should always be considered in **recurrent or persistent pneumonia localized to the lower lobe.**

■ Complicated with advanced chronic infection

■ Predominantly **cystic/cavitary lesion**, which manifests as closely related “ring” shadows, 從single large cyst到multiple cysts of variable size.

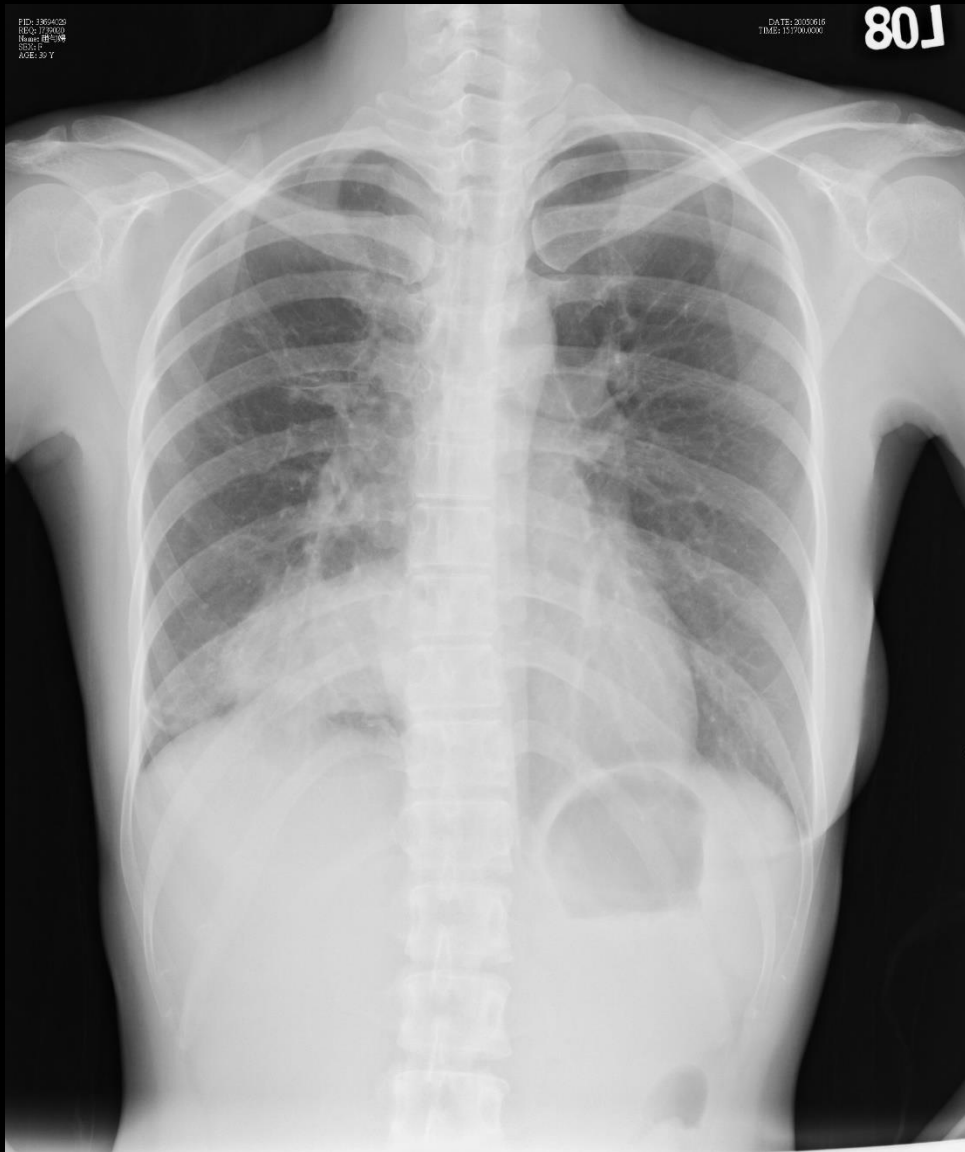
■ 有**1/3 cystic intralobar sequestration**會出現**air-fluid level**，表示lesion至少有部分與tracheobronchial tree相通。

R 00



**Intralobar
Sequestration**

Intralobar Sequestration

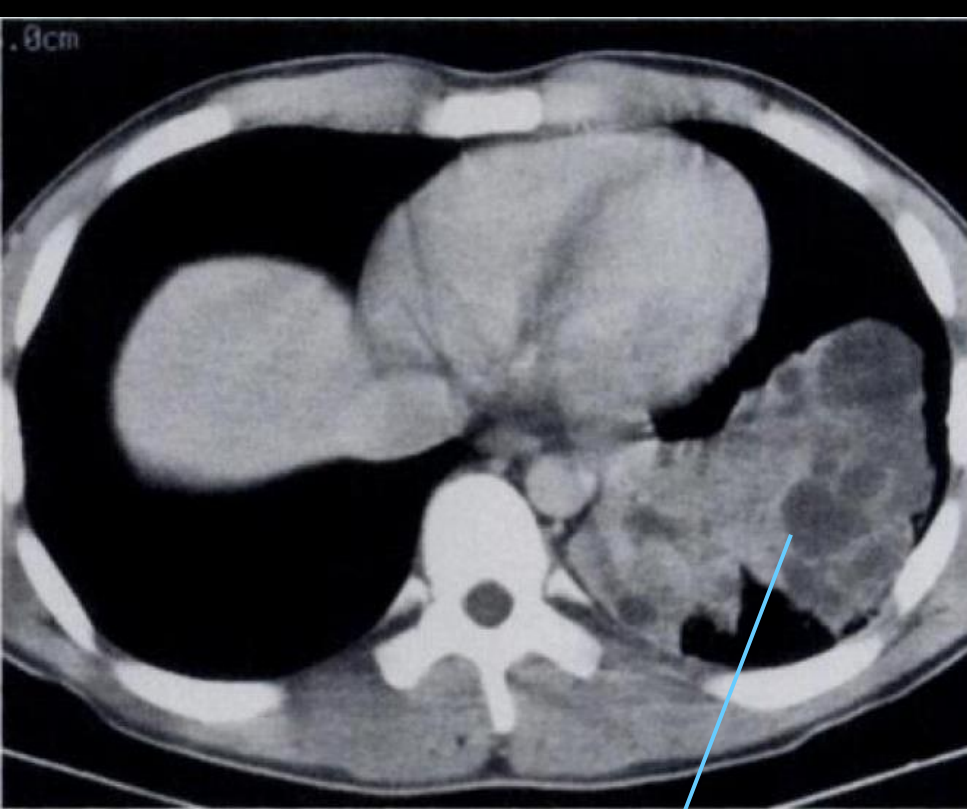


Intralobar Sequestration

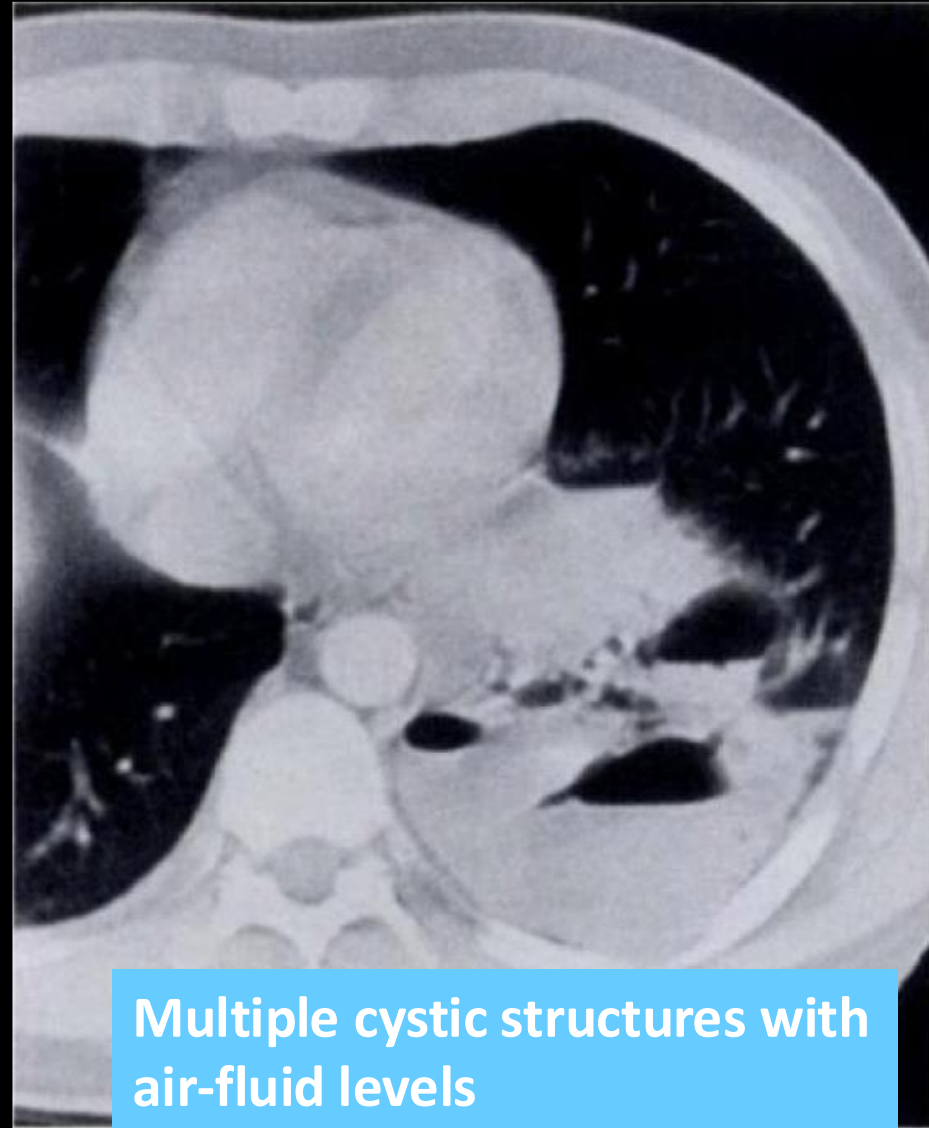
■ CT scan:

- 典型表現：**homogeneous or heterogeneous soft-tissue mass in the lower lobe** or a **heterogeneous consolidation with an irregular border**.
- Usually within **posteromedial portion of the lower lobe**.
- 可以開洞而出現air-fluid levels
- **Heterogeneous enhancement** by IV contrast
- Cystic form, 包括an almost purely cystic mass or as a confluence of multiple thin-walled cysts containing fluid, air-fluid levels, or air alone
- The **anomalous systemic artery** that supplies the lesion is visualized in up to **80%** of cases after contrast material administration and may be seen in cross section or as an enhancing linear structure adjacent to the aorta in the inferior pulmonary ligament. 但是沒有發現並不能排除診斷。

Intralobar Sequestration



Heterogeneous attenuation with
cystlike structures within
sequestration

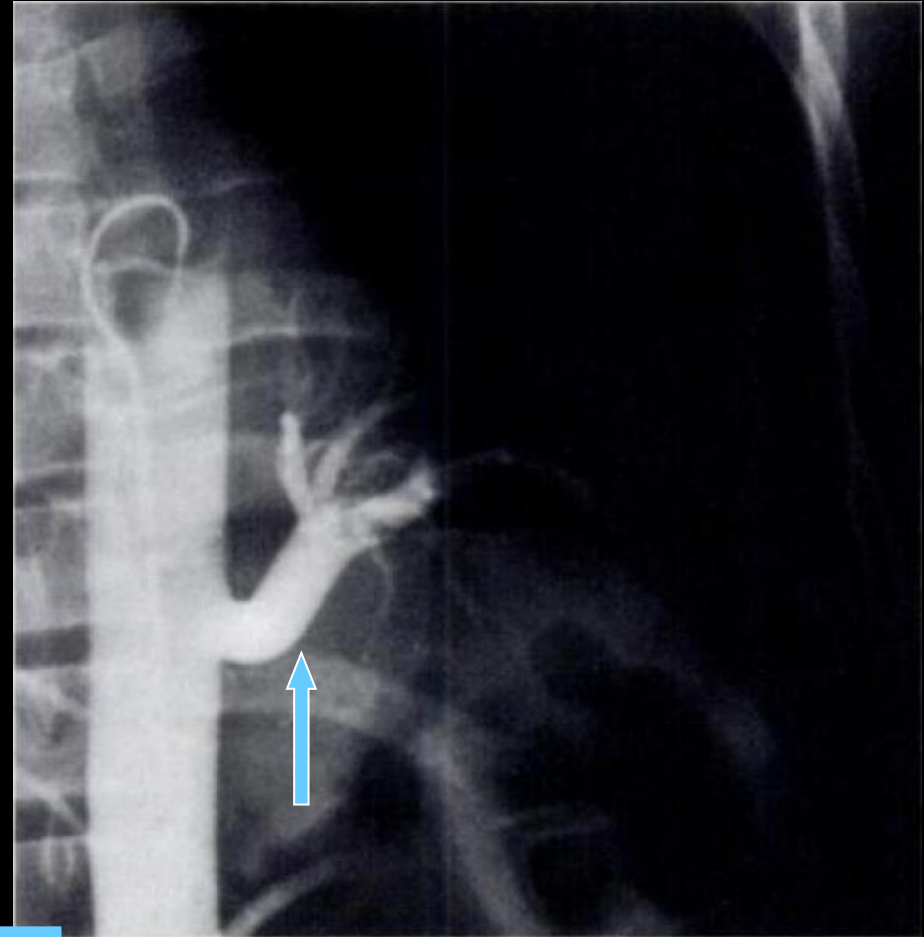


Multiple cystic structures with
air-fluid levels

Intralobar Sequestration



A large artery from D-aorta
supplying sequestration



RadloGraphics 1997; 17:725-745

Extralobar Sequestration

■ Extralobar:

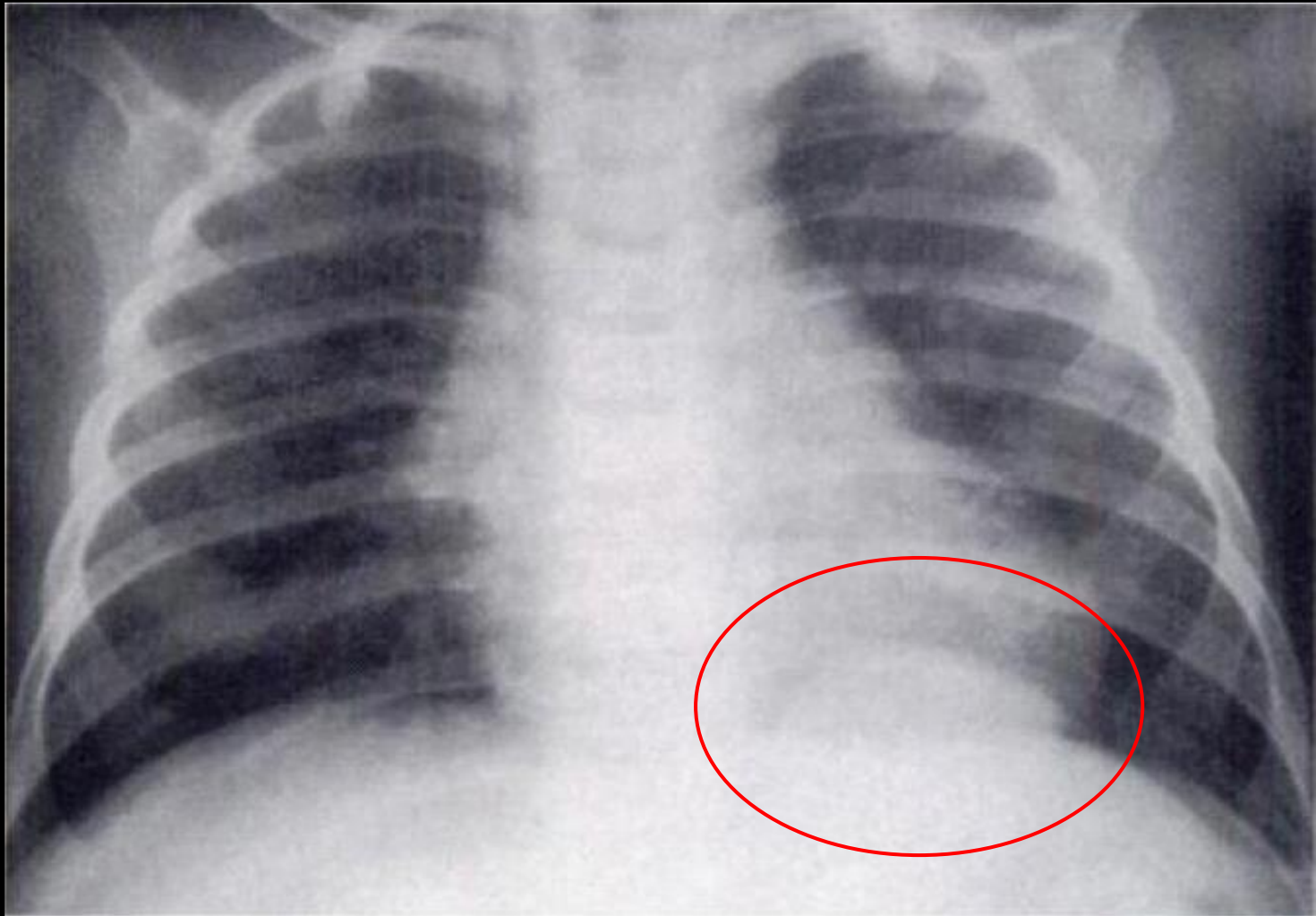
- 最常在**嬰兒時期**發現，其次是兒童時期。
- 有獨立的visceral pleura
- Typically found in the posterior costodiaphragmatic sulcus between the lower lobe and hemidiaphragm (63%-77%), 其他可發生在mediastinum, pericardium, within or below the hemidiaphragm.
- Supplying vessels:
 - A - aortic branch
 - V - **systemic v. (azygos/hemiazygos or SVC) → RA**
- Male : female = 4:1
- **常合併congenital anomalies** (50~65%)，最常見的是 congenital diaphragmatic hernia

Extralobar Sequestration

■ Image:

- **Single, well-defined, homogeneous, triangular opacity** typically located in the **lower thorax** in close association with the **posterior medial hemidiaphragm**
- A **small “bump”** on the **hemidiaphragm** or **inferior paravertebral region**
- **Air-bronchograms (-)** : 因為不與tracheobronchial tree相連
- Lesion的上緣和lung的交界處是清楚的interface，然而和diaphragm的交界可能會partially silhouette掉。

Extralobar Sequestration



A 6-month-old boy with respiratory distress at birth

	Intralobar (75%)	Extralobar (25%)
胚胎期	the bud remains within the pleura	forms after the pleura has formed. It is covered by its own pleura. 常合併 foregut 異常的先天疾病 (ex: CCAM)
與pleural和remain lung關係	share a common visceral pleural investment with the adjacent normal lung tissue	have their own pleural lining that separates them from the remaining lung tissue.
血流供應 Both types have an abnormal systemic blood supply, <u>most often from the thoracic aorta</u> , but in roughly 20% of cases the artery originates from the abdominal aorta; atypical origins of the feeding vessels, even from coronary arteries, are well described.		
venous drainage	pulmonary vein	often via the azygous vein, but variations are common

Extramedullary Hematopoiesis (1)

- Common causes of EMH:
 - Thalassemia intermedia or major
 - Congenital hemolytic anemia
 - Congenital spherocytosis
 - Sickle cell anemia
- The most common sites:
 - Liver, spleen, LN
 - Spinal cord: paravertebral areas of the thorax
 - Pleura, pulmonary parenchyma, and bronchial wall
- Most common site of intrathoracic sites:
 - **Paravertebral region in lower thorax**

Extramedullary Hematopoiesis (2)

■ CXR:

■ Posterior mediastinal mass

- 單側 or 雙側
- 位置：最常出現在 **paravertebral area** (along costo-vertebral junction), lower T-vertebrae (T6以下)，甚至可以 involve 整個 vertebrae
- 邊緣清楚、lobulated, 以 vertebral body 為中心
- 很少有鈣化 or bone erosion

■ Ribs:

- Marrow expansion 造成 rib 變寬，尤其在近 vertebra 端
- Trabecula 變得明顯



**Extramedullary
hematopoiesis**

Round Atelectasis

■ 定義：

- Occurs as a consequence of diseases with **chronic pleural scarring**, especially **asbestos**-related pleural disease and **TB**

■ Pathogenesis:

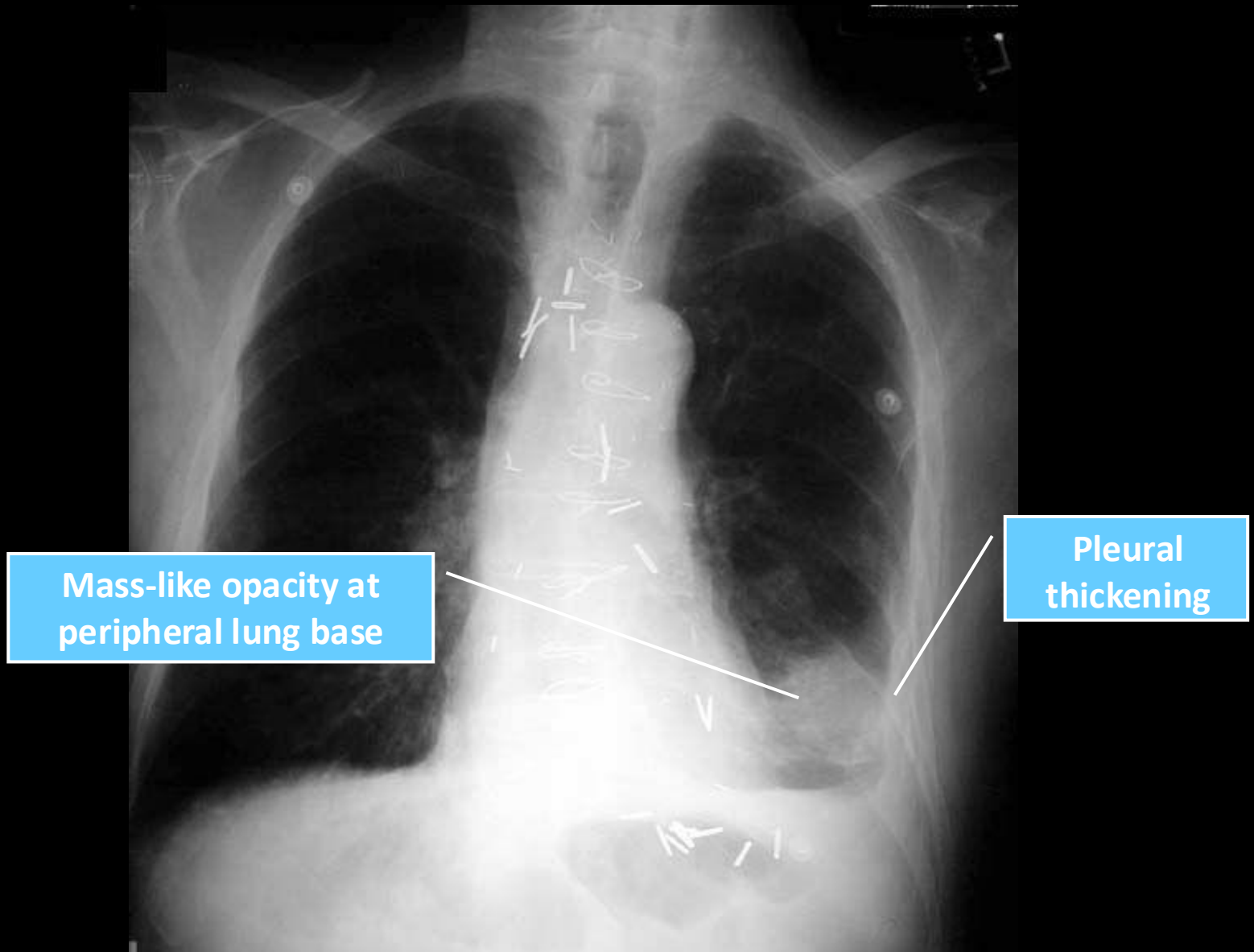
- 當pleural effusion快速形成時，會造成passive atelectasis of adjacent lung。而visceral pleura可能會被卷入塌陷的肺裡，如果pleural effusion產生了明顯的fibrinous adhesion (如TB pleurisy)或是之前有chronic pleural disease (如asbestosis or TB)，則atelectatic lung會被**enfolding visceral pleura trapping**在裡頭。

Round Atelectasis

■ Imaging:

- Typically appears as a rounded, peripheral, pleural-based mass that abuts an area of pleural thickening.
- 最常發生在lung base (esp. post-medial) , 一定在subpleural region
- **Comet tail sign** on CT: bronchovascular markings are seen to curve into the lesion, which represents rolled-up atelectatic lung.

Round Atelectasis



結論

- 處理單一肺結節患者最重要的角色在於察覺異常之存在。
- 欲判別單一肺結節應先小心分辨人為過誤(鈕扣、nipple、外物...)、皮膚病灶、肋骨病灶與鈣化之肉芽腫(由外而內去D.D)
- 系列x光之檢視有助於分別肺炎、梗塞與腫瘤(time interval)。
- 最終診斷常需切片。

Approach to solitary pulmonary nodule

Solitary nodule

(病灶特徴口訣: 2S, 3C, DOA)

(找病因口訣: H-I-I-N)

Previous films available

previous film unavailable

Size, growth rate
Margin, calcification

Check CEA, cryptococcal Ag
Sputum cytology, AFB
Rx: antibiotics x 7 days

No improvement

Improved

Benign nature

Check cryptococcal Ag
CEA, cytology, AFS
Rx: antibiotics x 7 days

Malignant nature

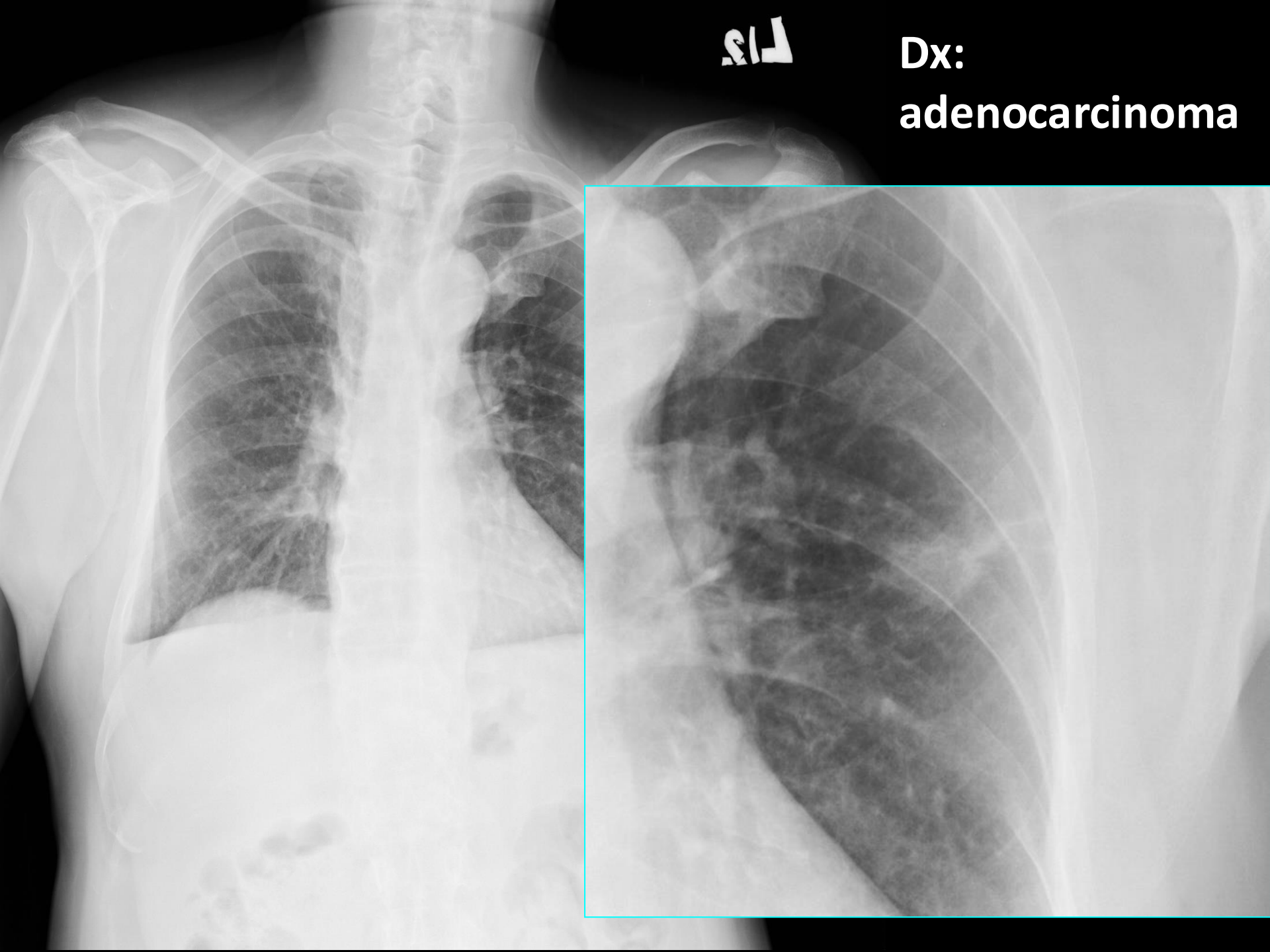
CEA, chest CT
Other tumor markers
Bronchoscopy
PET
VATS

Infectious origin

Quiz

13

Dx:
adenocarcinoma



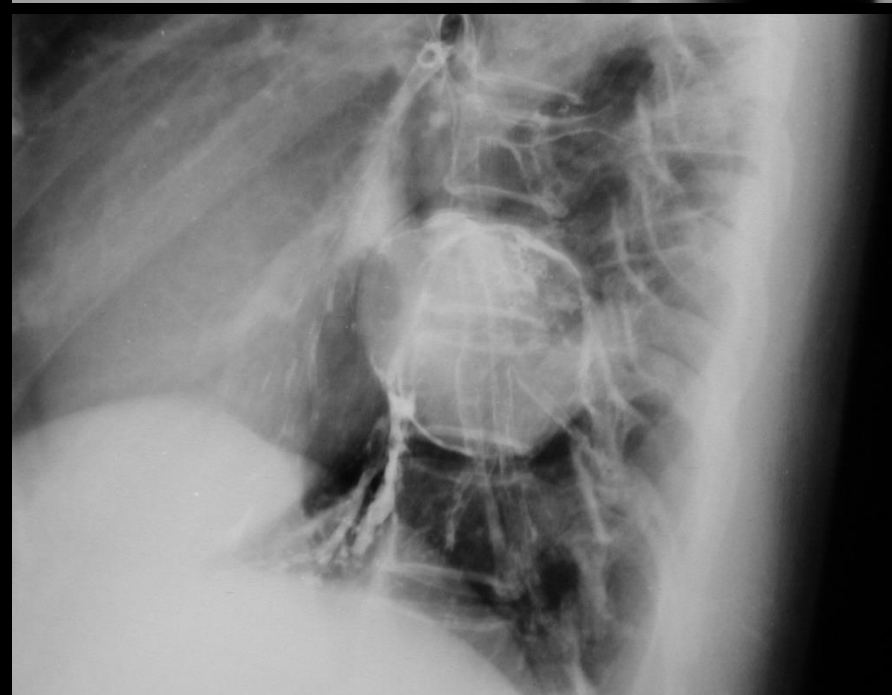
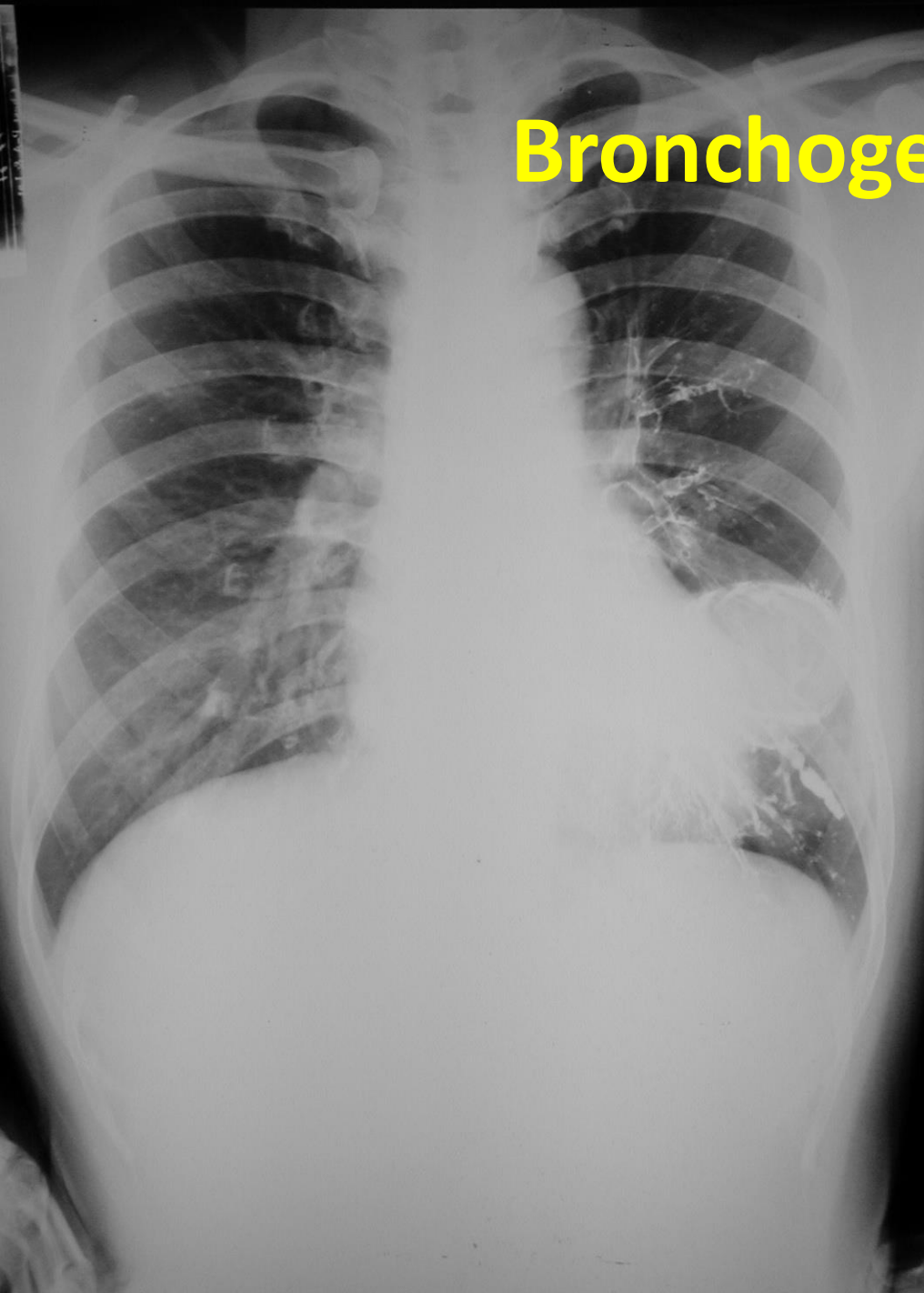
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AVM

Drainage vessel

Bronchogenic cyst





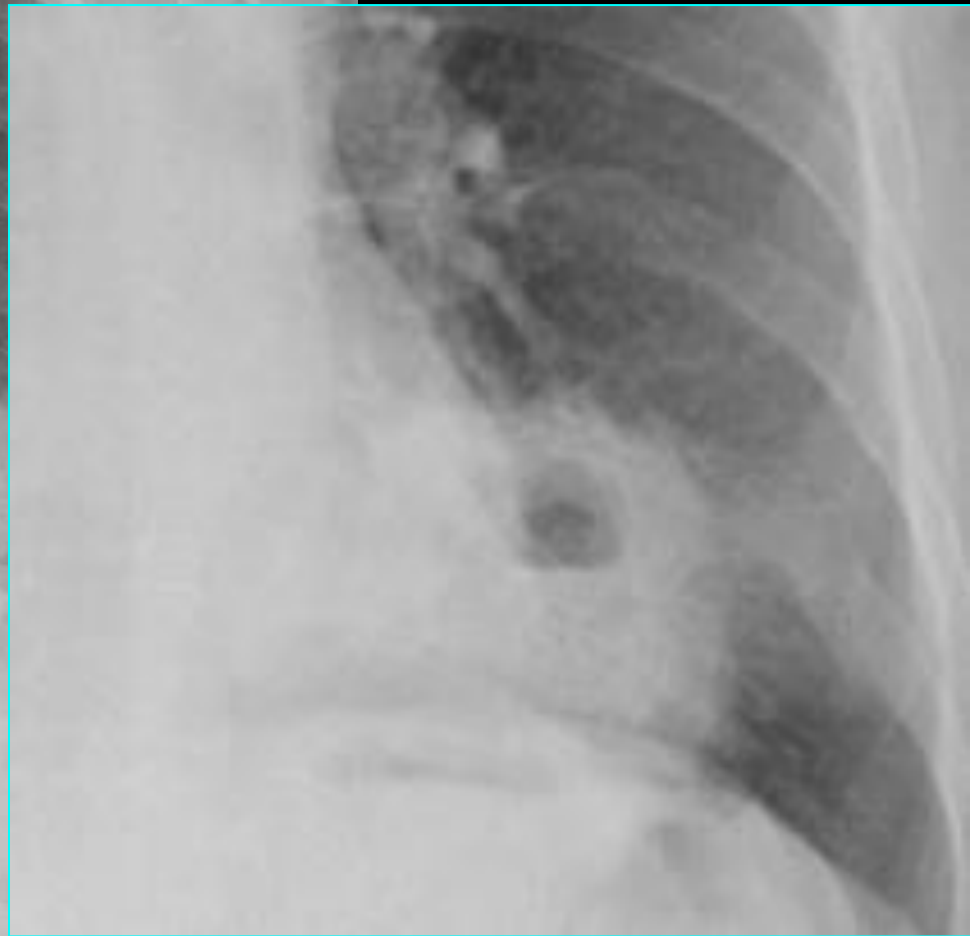
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L't nipple

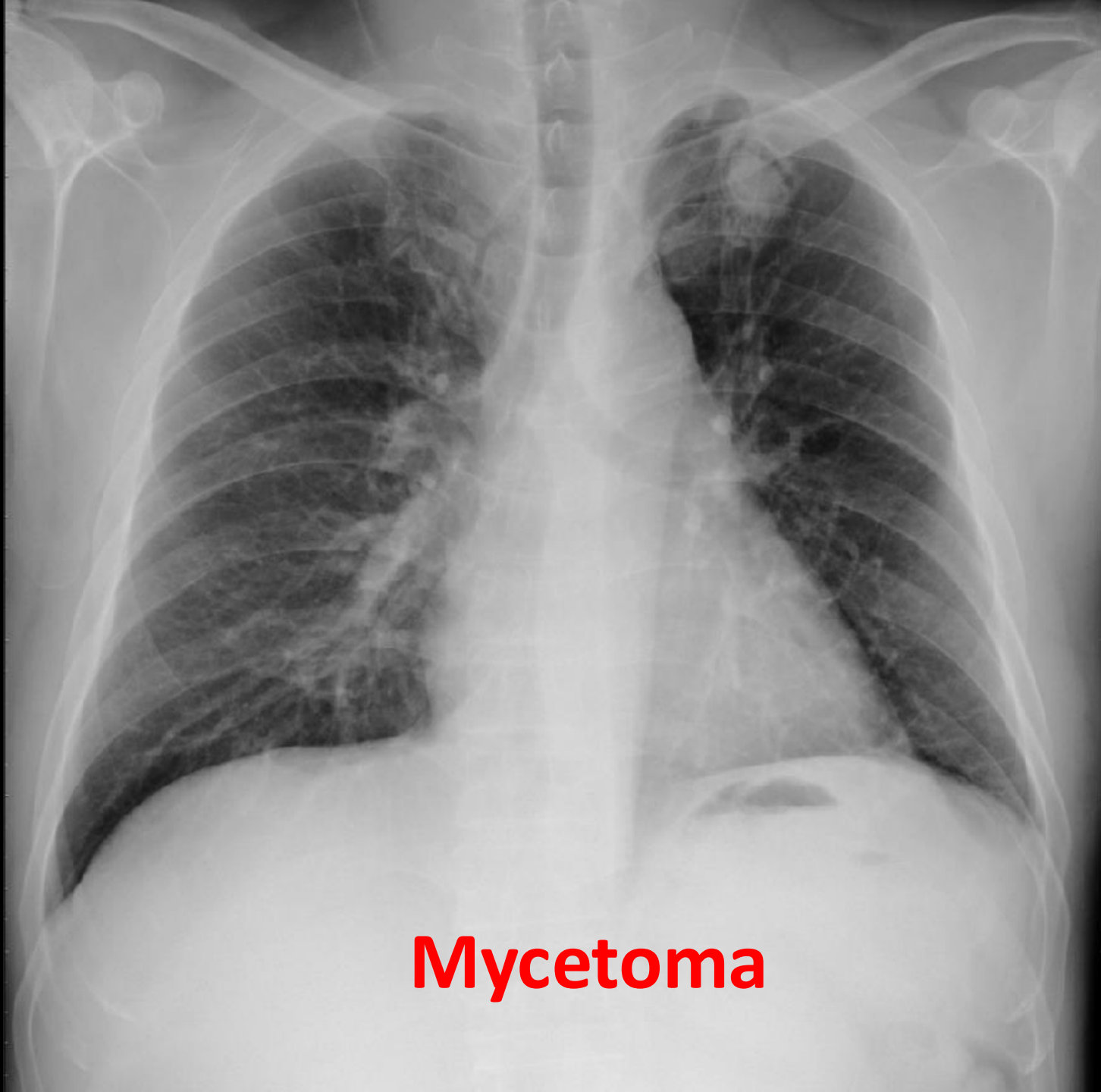


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**Thick-wall cavitary
lesion on LLL
Inner wall irregular:
malignant sign
Dx: squamous cell
carcinoma, LLL**

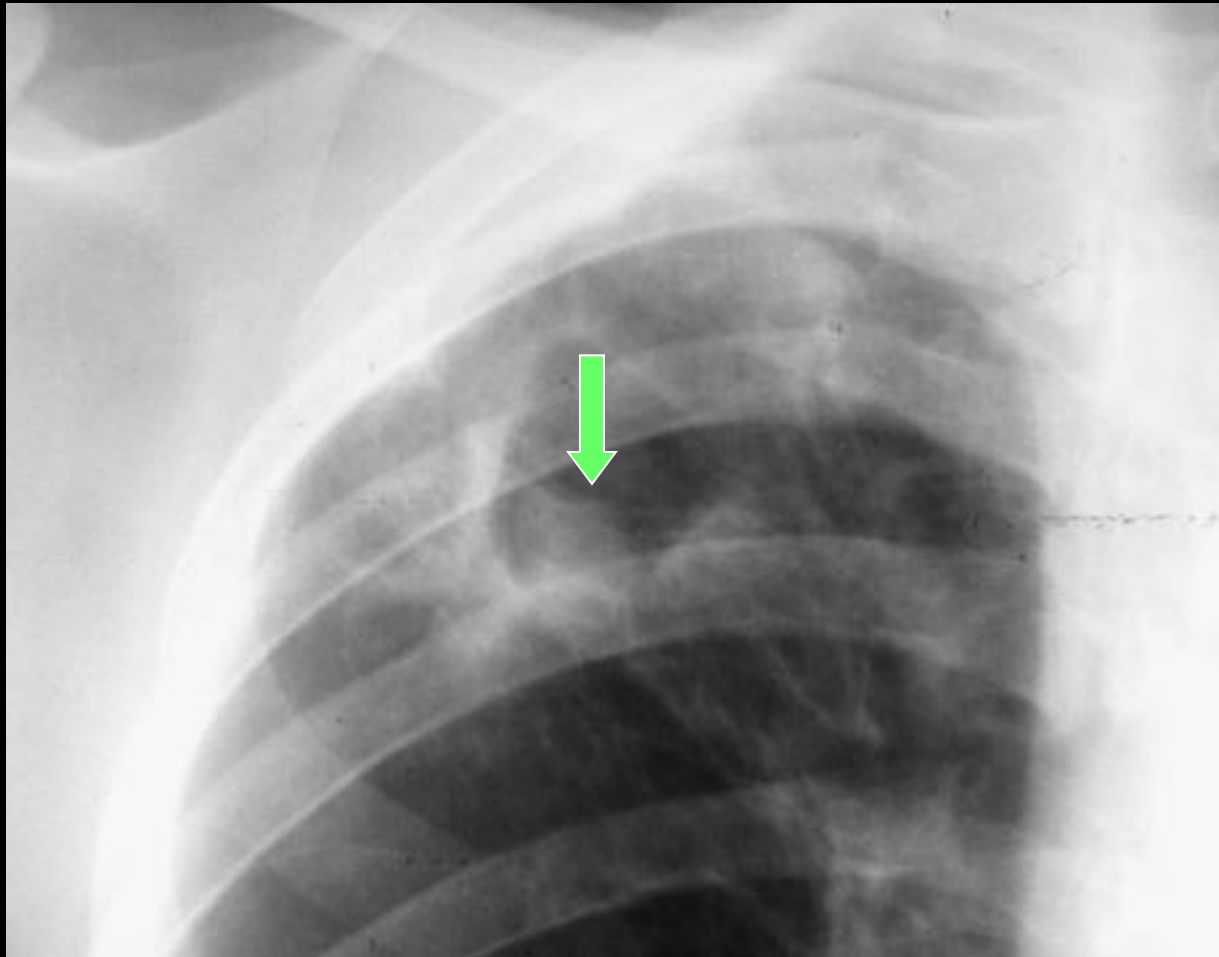


2895813-6



Mycetoma

Cavitary lesion with “ball in hole” lesion
Mycetoma(fungus ball)



Cavitary lesion with inflammatory process on RLL

Dx: **lung abscess**, RLL



3172975-6

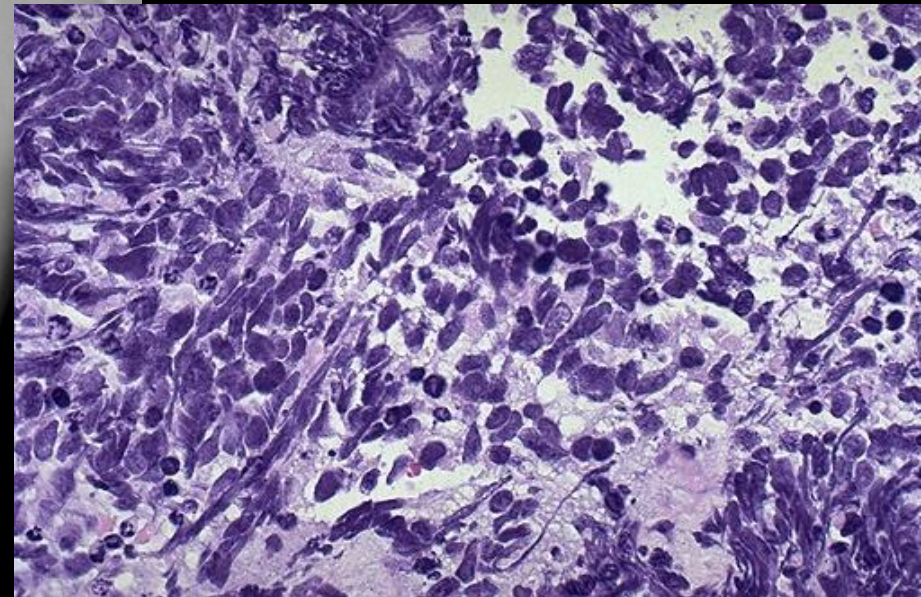
R₆₅

Thin-walled cavitory lesion on RUL
Satellite lesions (+)
Dx: pulmonary TB ,active



488622-0

Small cell lung cancer: CXR, histology, cytology



3245351-3

Multiple Pulmonary Nodules

Outline

- * Definition

- * Etiology: HIIN

- ✓ Hemodynamic: AVM, GPA, RA
- ✓ Infection: septic emboli, TB, cryptococcus, aspergillosis, Nocardiosis, virus
- ✓ Inflammation: sarcoidosis, pneumoconiosis
- ✓ Neoplasm: metastasis, lymphoma

■ Diffuse micronodular lesions

■ Quiz

Multiple Pulmonary Nodules

- * 肺內腫瘤:
Nodules($\leq 3\text{cm}$)
Masses($> 3\text{cm}$)
- * 在X光像看到Nodule→排除肺外的異物胸壁、皮膚、皮下或肋膜病灶
- * 只有**同時在正面照和側面照中都位於肺野**裡面，才能確定這個陰影是**肺內**的病灶。
- * 一定要**比較舊片**

評估多發性肺結節的注意事項

- Solitary pulmonary nodule約40~60%是良性
Multiple pulmonary nodules者惡性機率約80% → **metastatic disease** 最常見!
- D/D with multi-focal ill-defined densities
(**consolidation** lesions)

First impression: immunity status

- * In >95% of *immunocompetent* patients with multiple nodules, the etiology is
 - * Metastases
 - * Infection (typically tuberculous or fungal granulomas)
- * If the patient is *immunocompromised*, the differential diagnosis of multiple nodules can be broad.

Etiology: HIIN

■ H (hemodynamic)

- Cardiovascular
 - AVM
 - Organizing hematoma
- Collagen-vascular
 - Wegener's granulomatosis
 - Rheumatoid nodules
- Thromboembolic
 - Organizing infarct

■ I (infection)

- Bacteria:
 - Septic emboli
 - Leptospirosis

■ TB:

- Miliary TB
- TB granuloma

■ Fungus:

- Cryptococcus
- Histoplasmosis: USA

■ Virus: atypical measles

■ Nocardiosis

■ I (inflammation/inhalation)

- Sarcoidosis
- Pneumoconiosis

■ N (neoplasm)

- Metastasis
- Lymphoma

H: Hemodynamic

■ Cardiovascular

- AVM: 1/3 multiple
- Organizing hematoma

■ Collagen-vascular

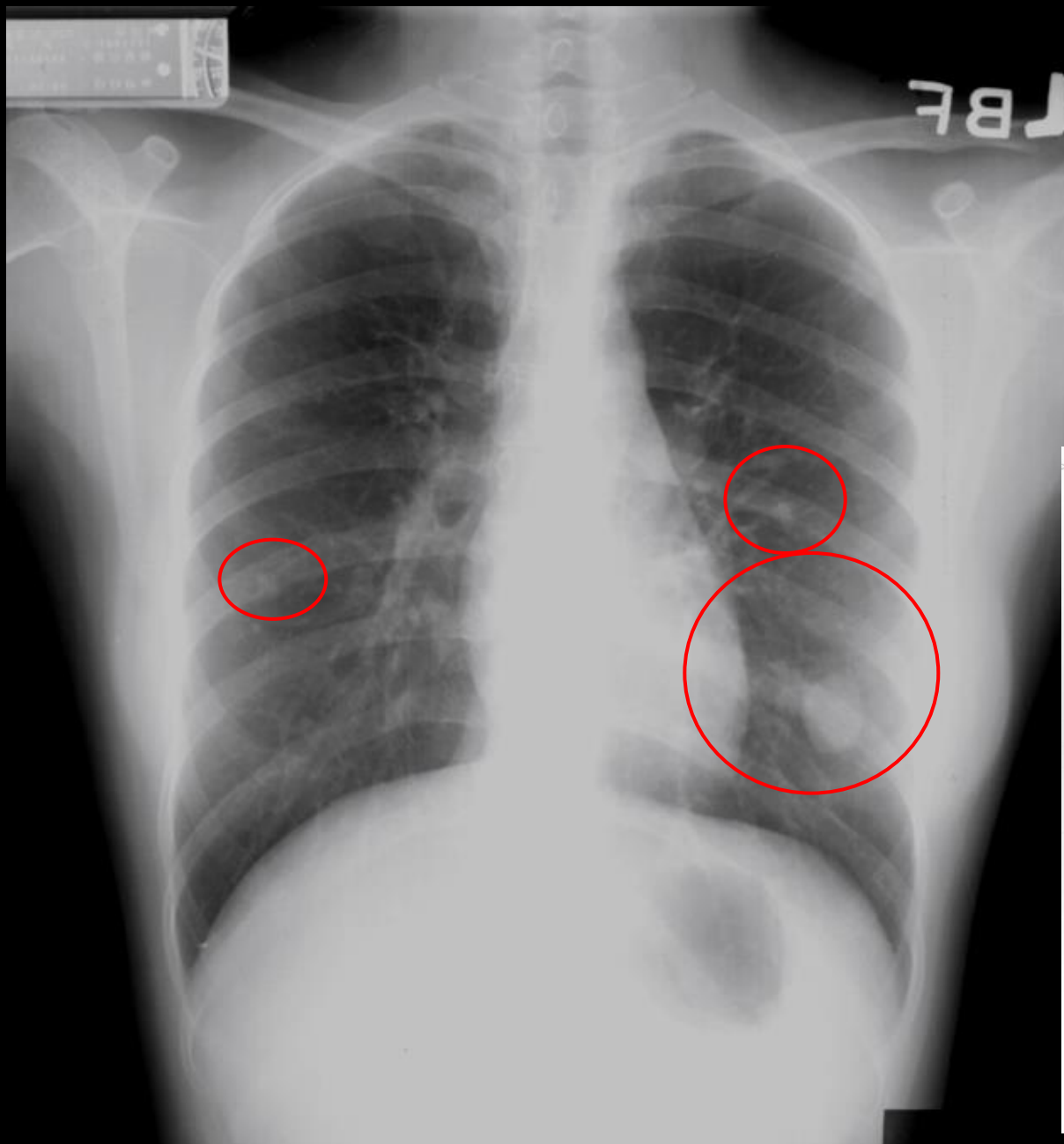
- **Wegener** granulomatosis
(Granulomatosis with polyangitis)
- **Rheumatoid nodules**

■ Thromboembolic

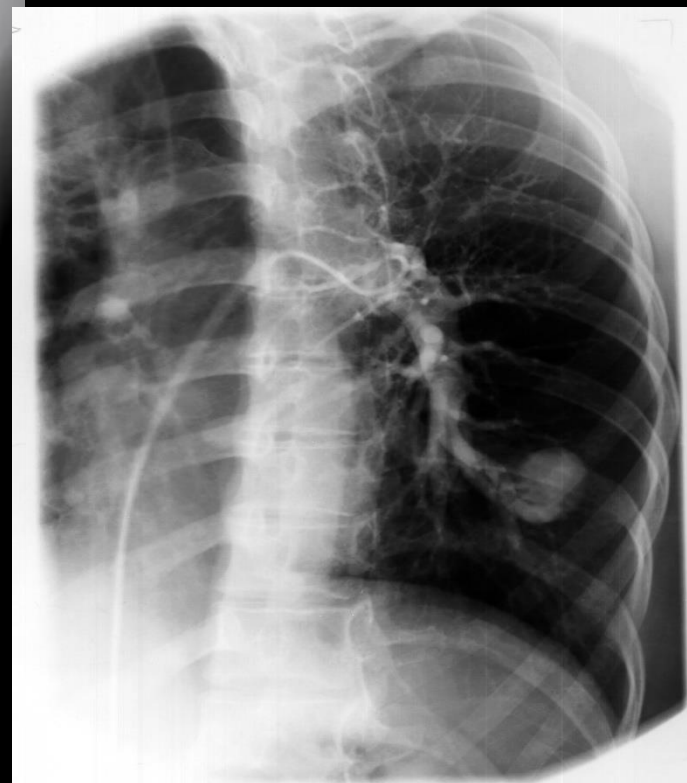
- Organizing infarct

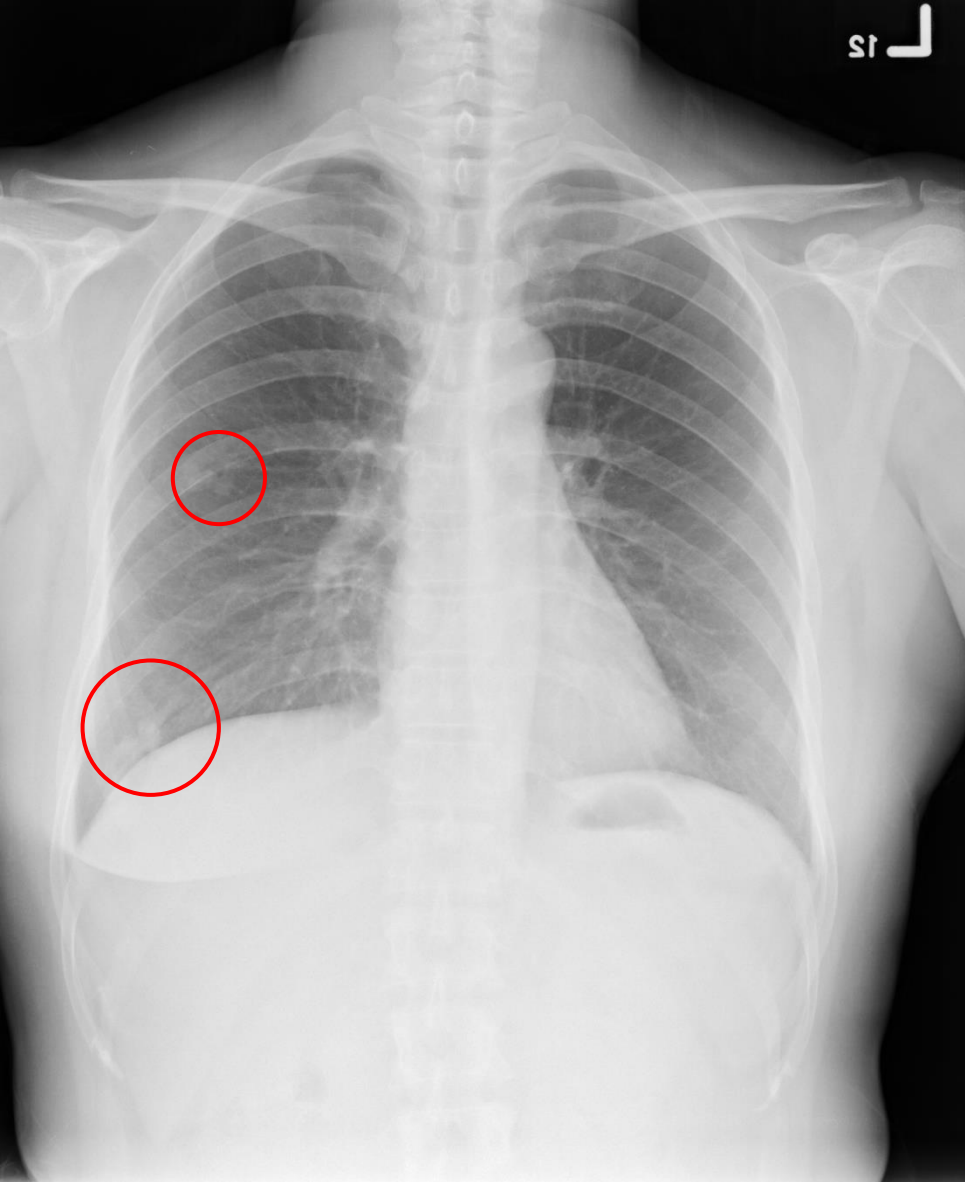
AVM

- Hilum → Feeding pulmonary artery → AVM → Drainage pulmonary vein → LA
- 60% have AVM in the skin, mucous membrane or other organ. (Rendu-Osler-Weber disease)
- 通常不會大於2-3cm，否則臨床上會出現很厲害的shunt，病患會很喘。
- CXR:
 - Round or oval homogeneous mass of uniform density; somewhat lobulated/tortuous in contour, but sharply defined.
 - Connected with feeding a. and drainage v.
 - 1/3 have multiple lesions
 - More common in lower lobes; most often in the medial third of lung.
 - Surrounding lung is usually normal



AVM





2003-09-09

Pre-embolization



2003-09-17

Post-embolization

Granulomatosis with polyangitis (GPA) (Wegener Granulomatosis)

- Classic Wegener's triad: **sinus, lung and renal** disease
- Lung parenchymal change
 - Single or **multiple pulmonary nodules/masses**: multiple多(75%)
 - **最常見**的表現
 - **Ill-defined** or irregular margined, no zonal predominance
 - **50%**會開洞，通常是**irregular, thick walled**
 - 少pleural effusion (<10%), mediastinal or hilar LAP
 - 經過治療之後，這些nodules or cavities會消失或是留下scar
 - CT scan : nodules with irregular margin，沿著**peribronchovascular**分布

Granulomatosis with polyangitis

(2)

- Localized or diffuse **consolidation**

- 通常代表 **pulmonary hemorrhage**

- A focal area of dense consolidation, patchy bilateral areas of consolidation, or diffuse air-space consolidation

- Airway narrowing:

- **Subglottic stenosis**

- Involvement of the tracheal or bronchial walls usually consists of mucosal or submucosal granulomatous thickening, 在CT scan上可見到 **smooth or nodular thickening of tracheal or bronchial wall thickening.**

Wegener Granulomatosis

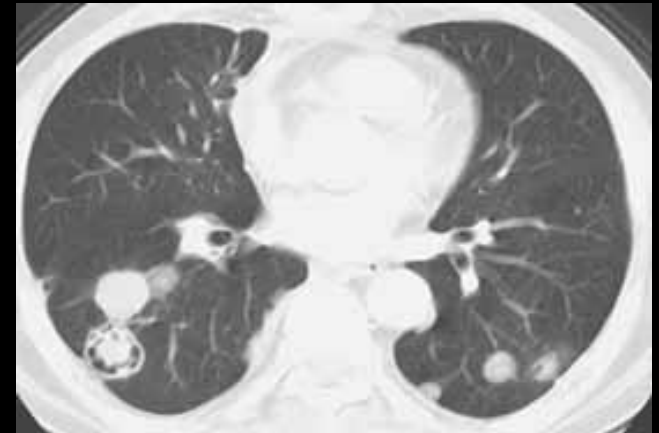


bilateral irregular nodules
and a mass in the right
lower lobe



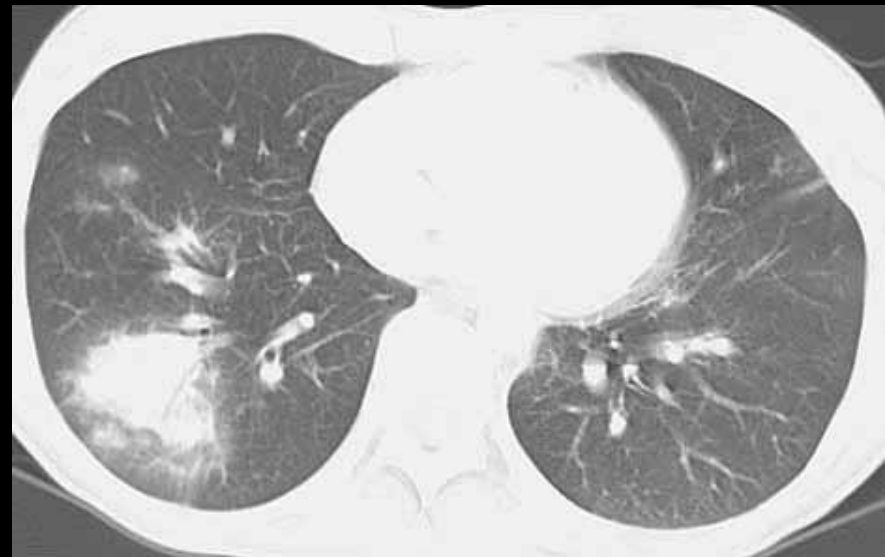
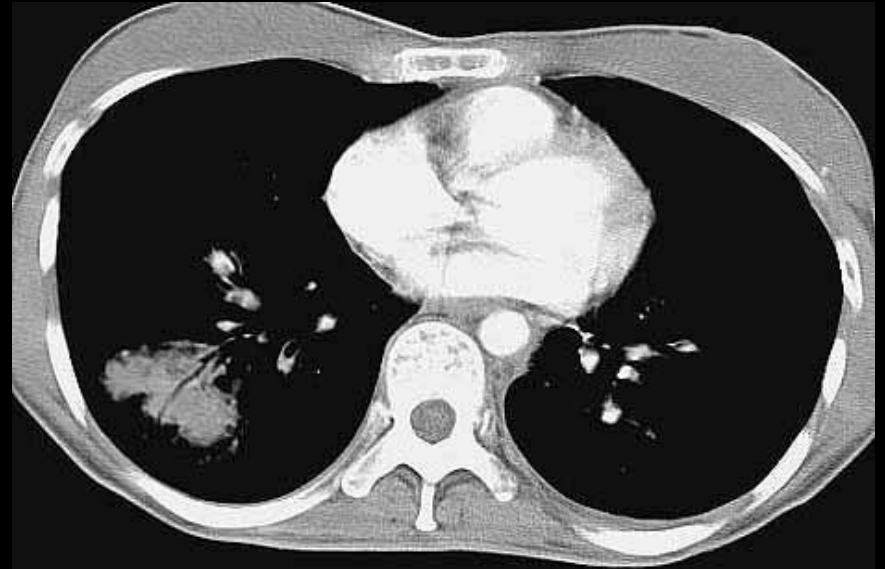
multiple irregular nodules in a
peribronchovascular
distribution

Wegener Granulomatosis



Wegener Granulomatosis

Consolidation type



Rheumatoid Arthritis

- Pleural Disease: 最常見的胸腔表現，男多。
 - Pleural thickening 比pleural effusion 常見。
 - Pleural effusions: 單側多，可能loculated，多好發在晚期常合併pericarditis和subcutaneous nodules。
- Pulmonary fibrosis
 - CXR: a reticular or reticulonodular pattern involving the lower lung zones
 - HRCT: a reticular pattern and irregular interlobular septal thickening predominantly in the lung periphery and lower lung zones
 - Patient with pulmonary fibrosis: increased risk of malignancy

Rheumatoid Arthritis

■ Pulmonary nodules

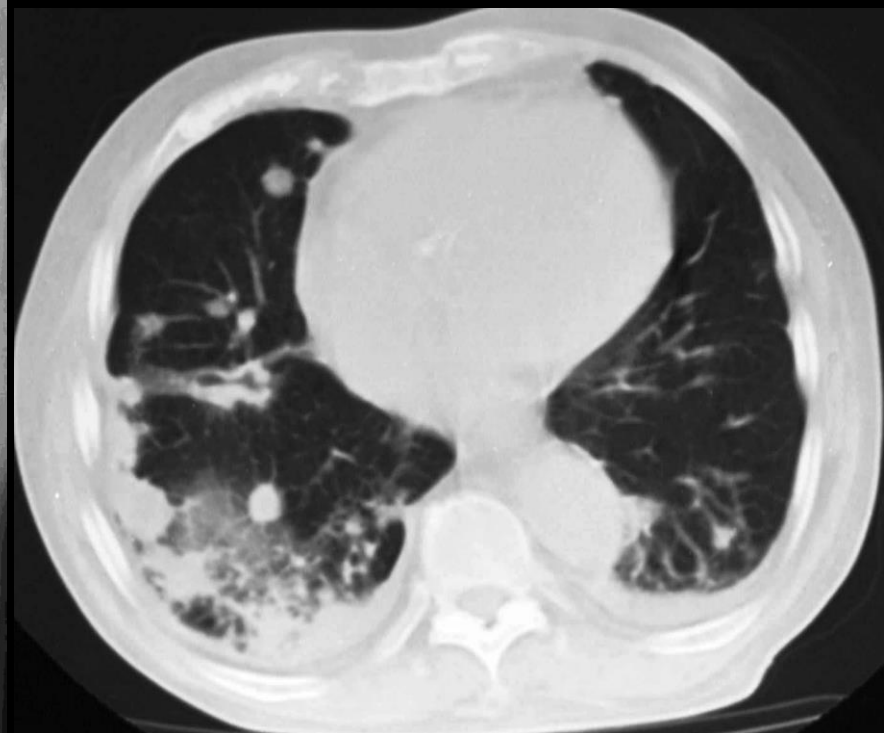
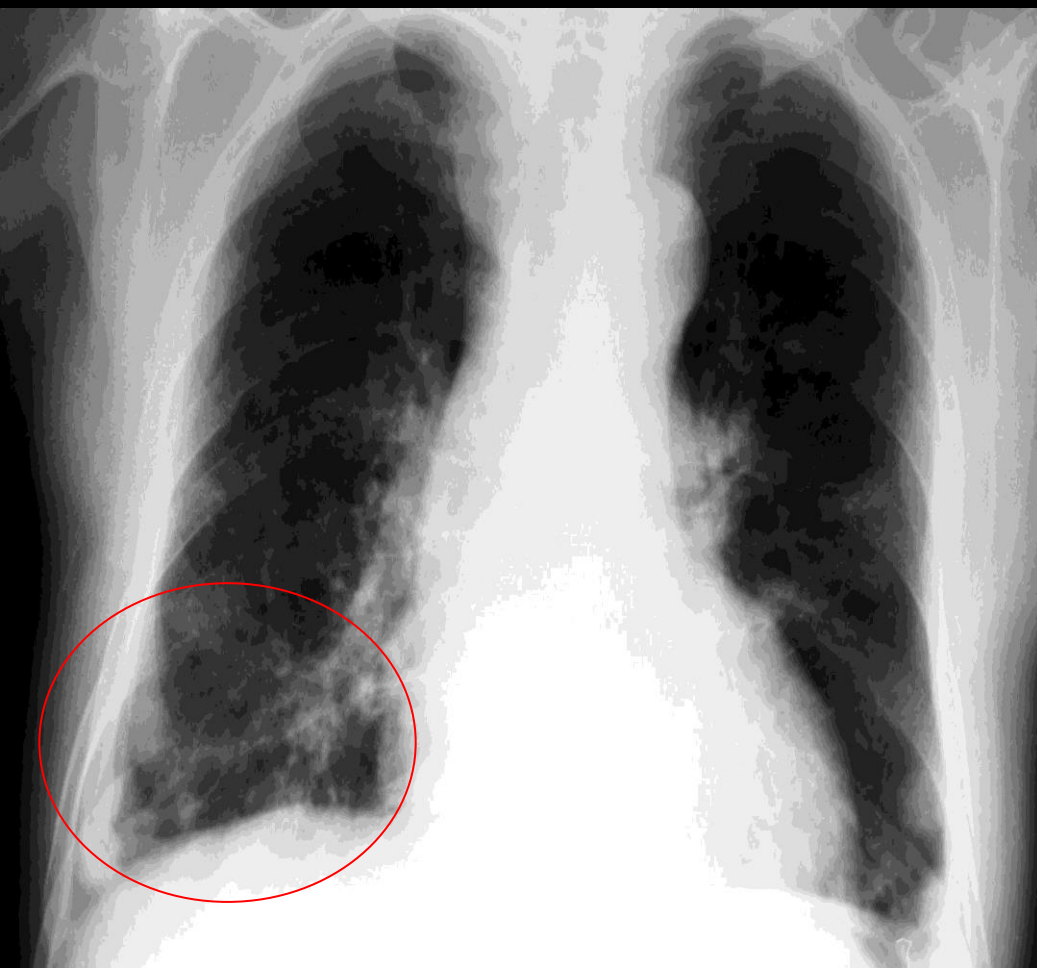
- 少見，多為advanced disease，常伴隨表皮結節，病理表現和表皮結節一樣。
- Usually multiple and well circumscribed → 常有 thick-walled cavities.

■ Airway diseases

- Bronchiolitis obliterans (BO)
- Bronchiolitis obliterans organizing pneumonia (BOOP)
 - Airspace consolidation, bilateral patchy peripheral or peribronchial distribution.
- Follicular bronchiolitis (FB)

■ Bone change

- Resorption of the distal part of the clavicles and erosive arthritis of the shoulders



I: Infection

■ Bacteria

- Septic emboli
- Leptospirosis

■ TB

■ Fungal

- Cryptococcosis
- Invasive aspergillosis:
in immunocompromised
patients
- Histoplasmosis:
calcification
- Coccidioidomycosis

■ Nocardiosis

immunocompromised

■ Virus

- Measles

■ Rickettsia

- Q fever

■ Parasites

- Paragonimiasis(肺吸蟲)
- Echinococcosis(絛蟲)

Septic Emboli

■ Risk factors:

- IV drug abuser, alcoholism, skin infection, peripheral septic thrombophlebitis, venous catheter
- Immunocompromised p't, esp. lymphoma and organ transplant

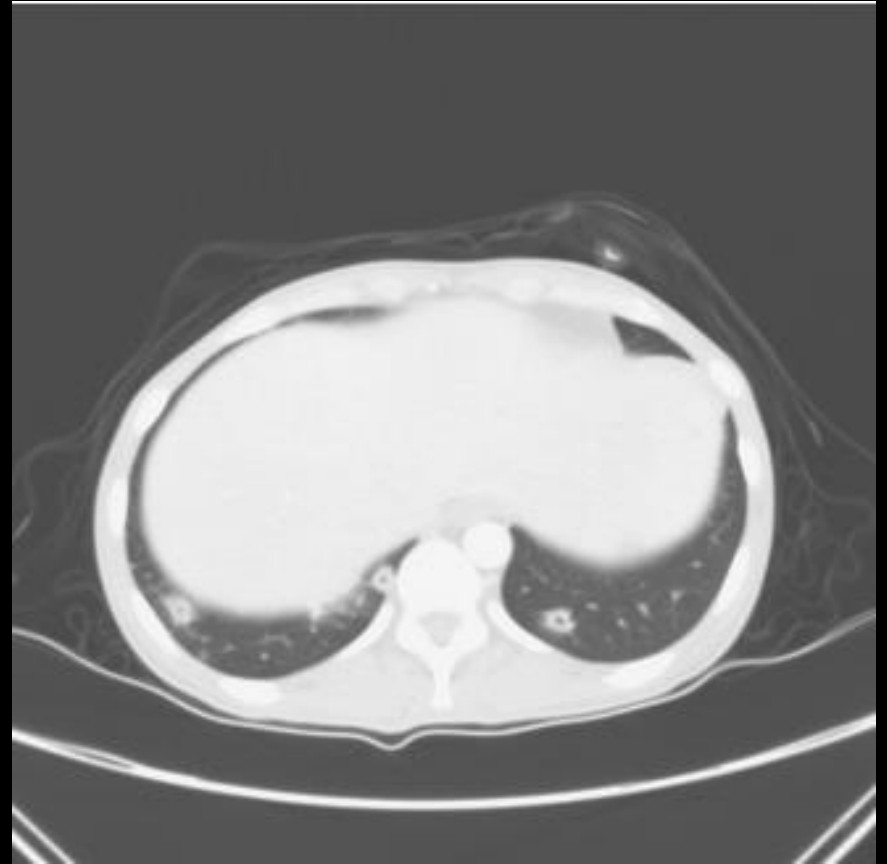
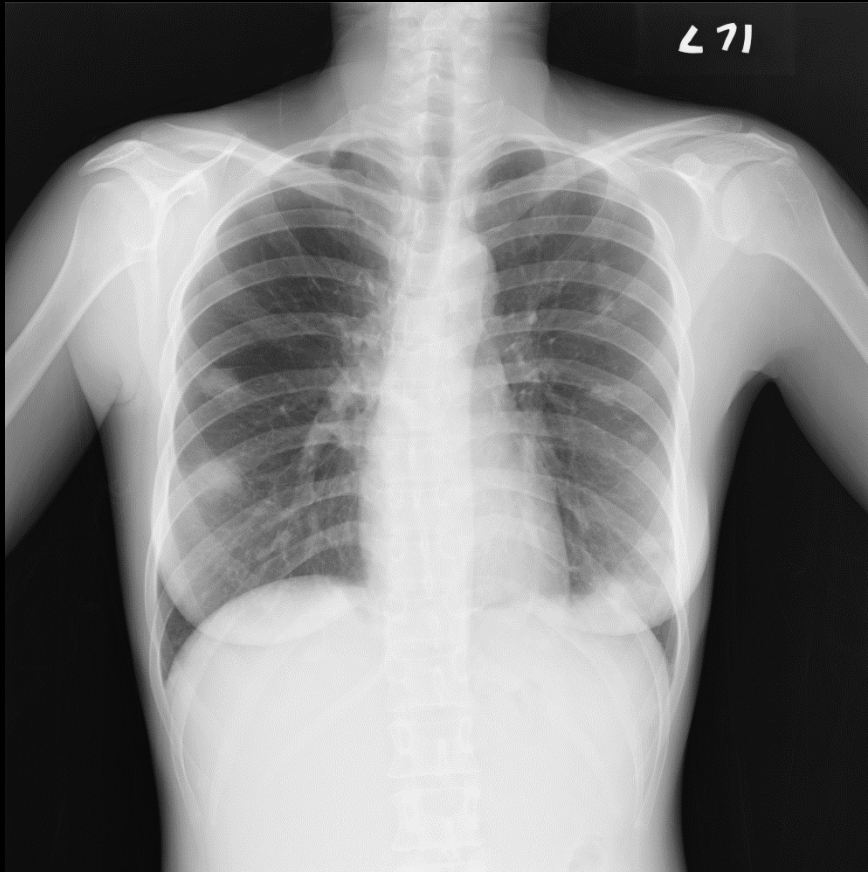
■ Most common pathogen:

- **Staphylococcus**

■ Best diagnostic clues: 邊邊wedge開洞。

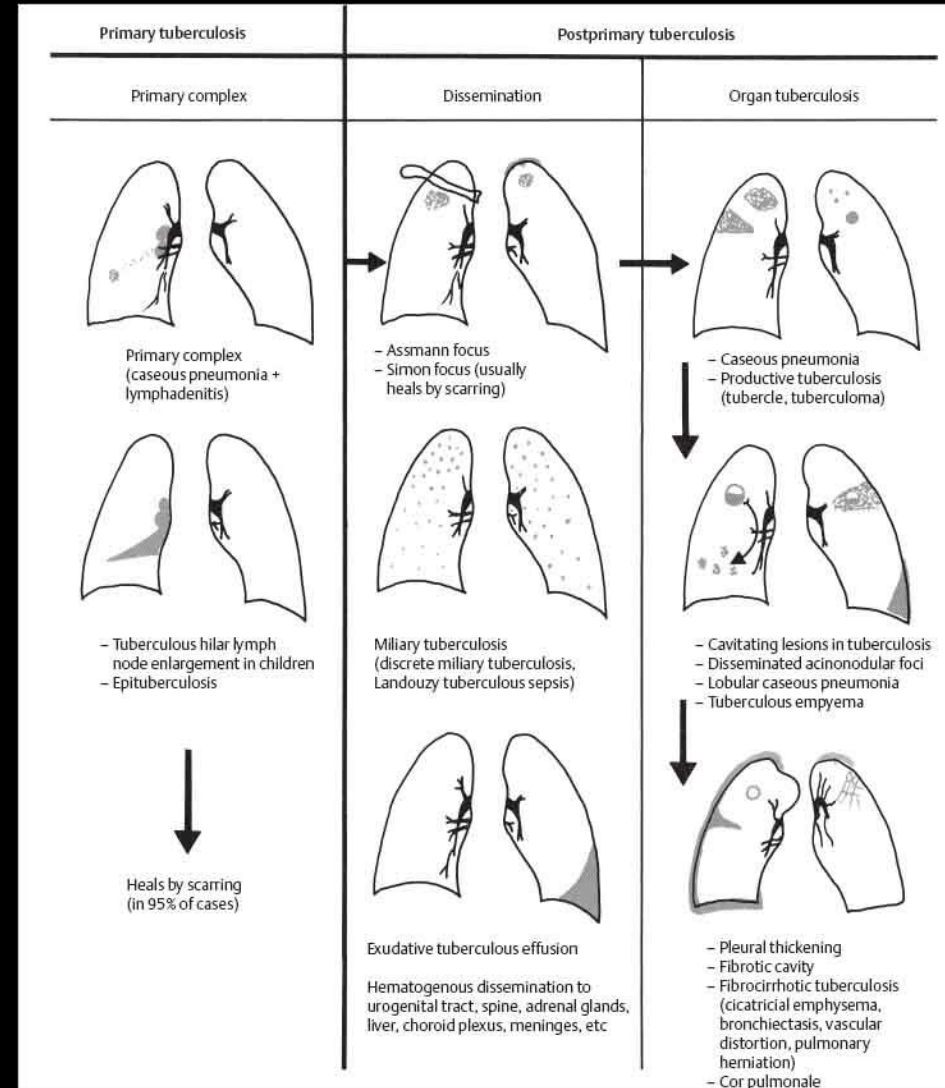
- Multiple, bilateral patchy areas of consolidation rapid evolving into ill-defined cavitory nodules
 - Air-bronchogram(25%)
 - Rapid cavitation
 - 有時會呈wedge-shapes
- Mainly over lung bases and subpleural location

Septic emboli

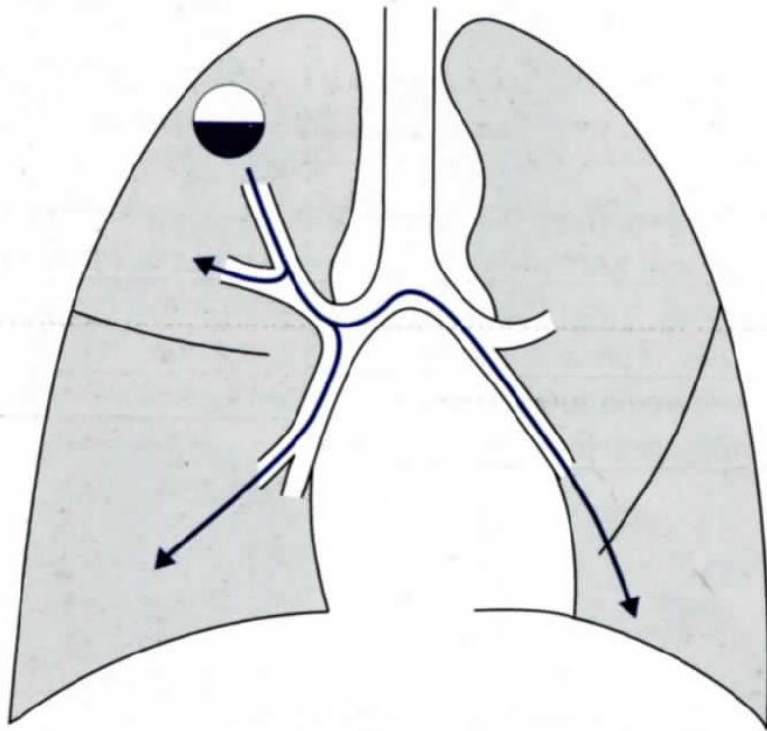


Pulmonary tuberculosis

- * Primary tuberculosis (=initial infection).
- * Progressive primary tuberculosis.
- * Postprimary tuberculosis (=reactivation).
 - * Bronchogenic spread.
 - * Hematogenous spread (miliary TB).
- * Scarring stage.

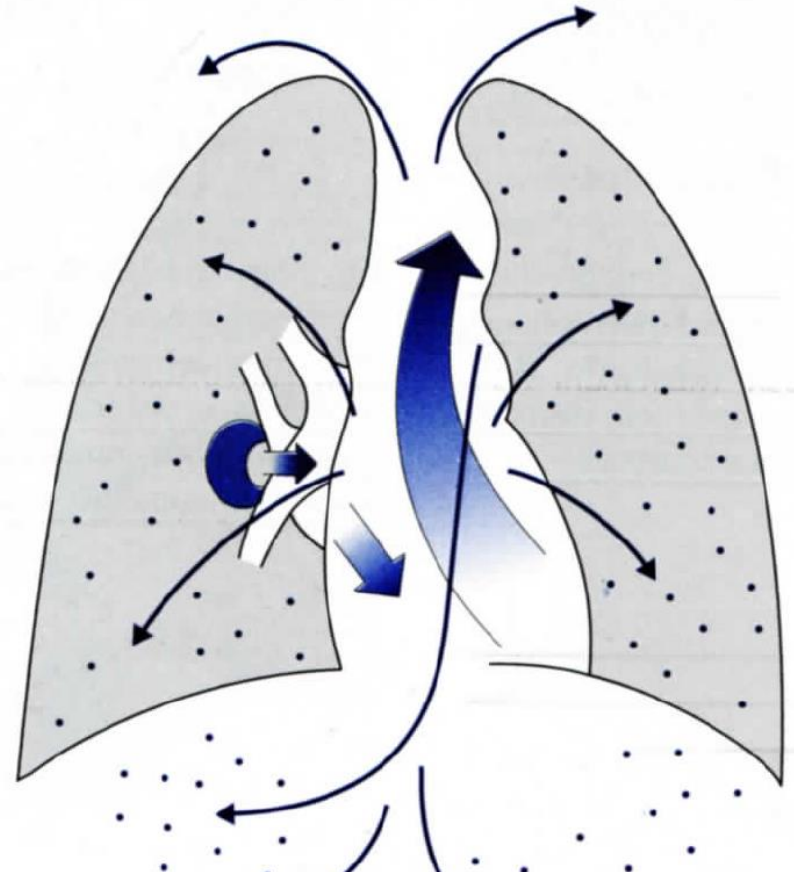


Spread of pulmonary tuberculosis



a

Endobronchial spread
(often diagonally to the
opposite lower lobe).

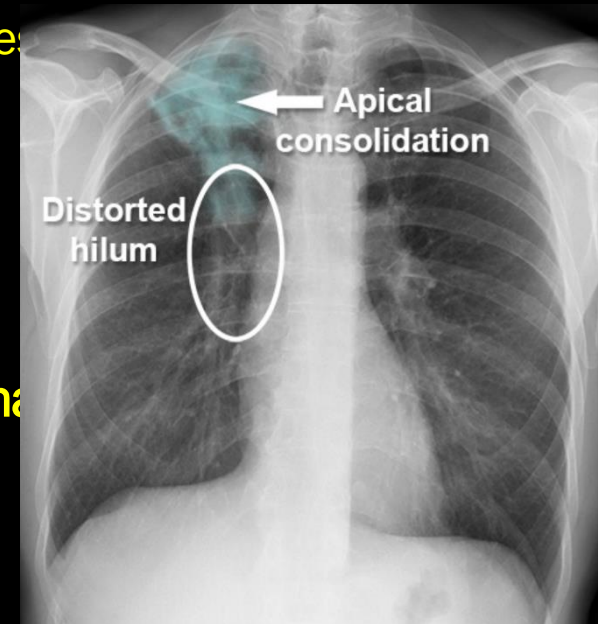


b

Diffuse hematogenous spread
(when an infected lymph node
erodes into blood vessels).

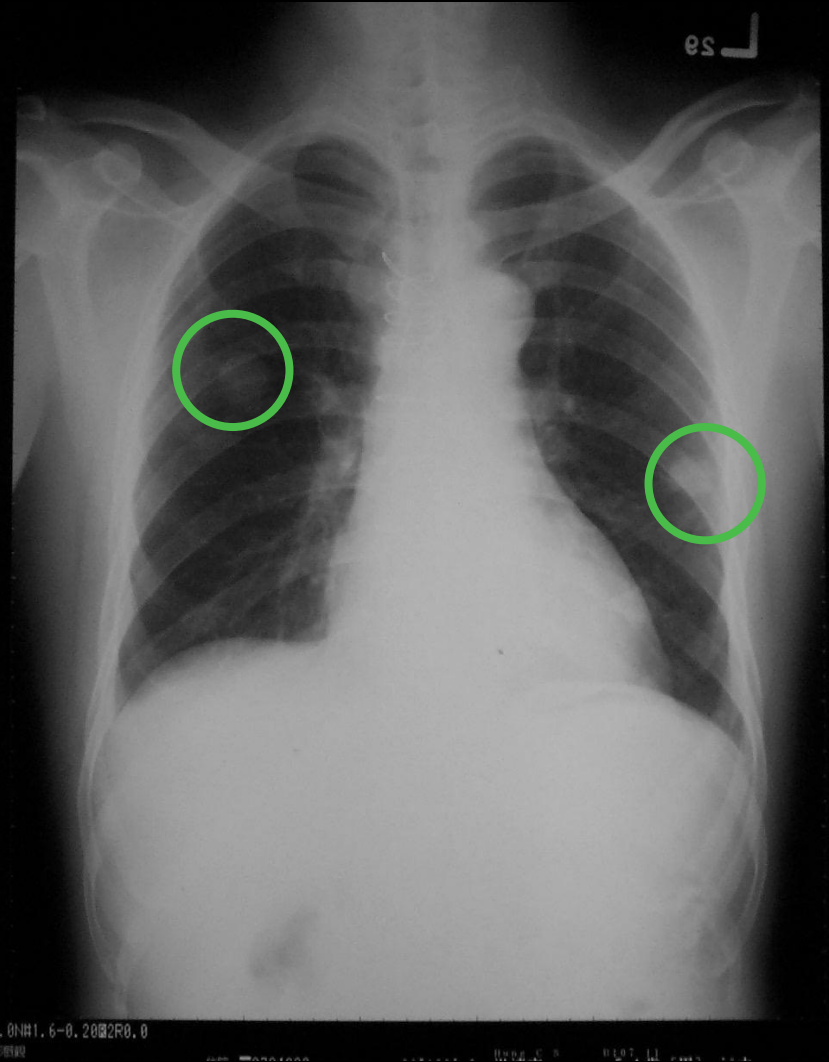
Post-primary tuberculosis: radiographic signs

- * Patchy, poorly defined, “soft” segmental **consolidation** with or without “hard” **fibronodular** opacities.
 - * **Apical and posterior segments (S1, S2) of upper lobes**
 - * **Superior segments (S6) of lower lobes.**
 - * **Involvement of multiple segments (common).**
- * Cavitation (20-45%).
 - * **Air-fluid levels (9-21%).**
- * Solitary or multiple nodules or masses (**tuberculoma 5%**).
 - * **0.5-4.0 cm in diameter.**
- * Volume reduction in the affected segments.
- * Polymorphism.
- * Increased shadowing.
- * Small volume **pleural effusion (6-18%).**
- * No lymph node involvement.



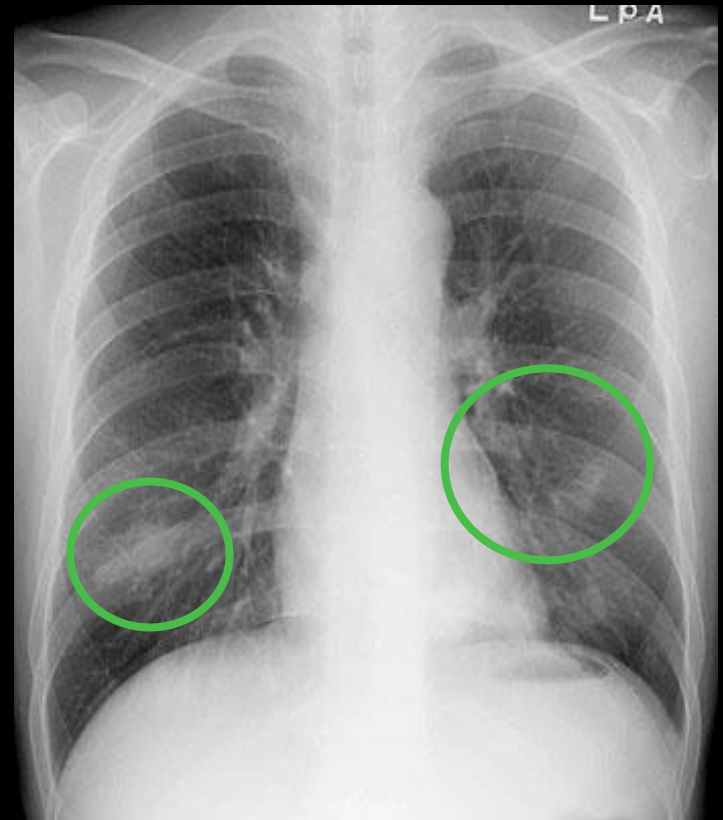
Tuberculoma

- * Two round nodules of uniform size at right and left middle zones.



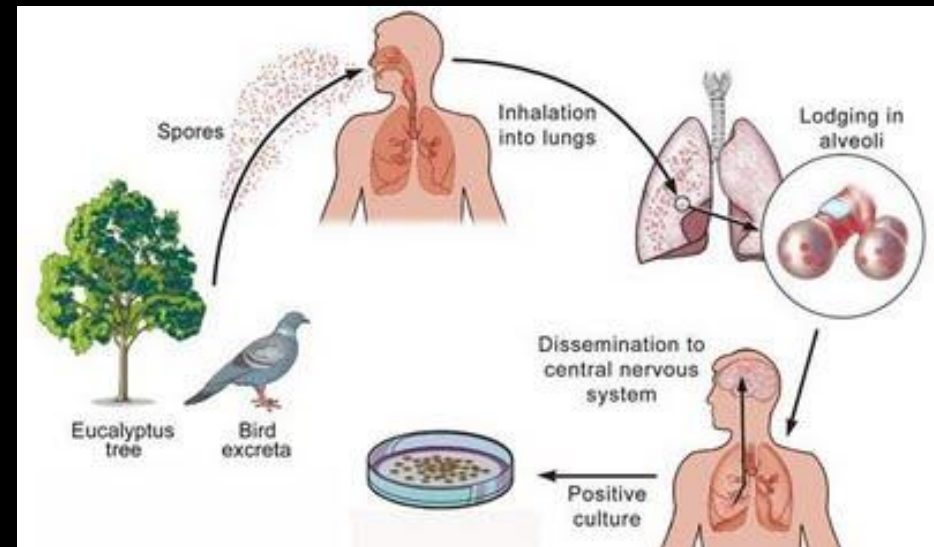
Post-primary tuberculosis

- * Several ill-defined, irregular **airspace opacities** in bilateral lower zones.
- * **Cavitation** is seen on the CT



Cryptococcosis

- * *Cryptococcus neoformans* and *gattii* are monomorphic fungus associated with dried bird feces
- * 70-80% of affected patients are immunocompromised
 - * HIV infection
 - * Lymphoma
 - * Chronic pulmonary diseases (e.g. sarcoidosis)



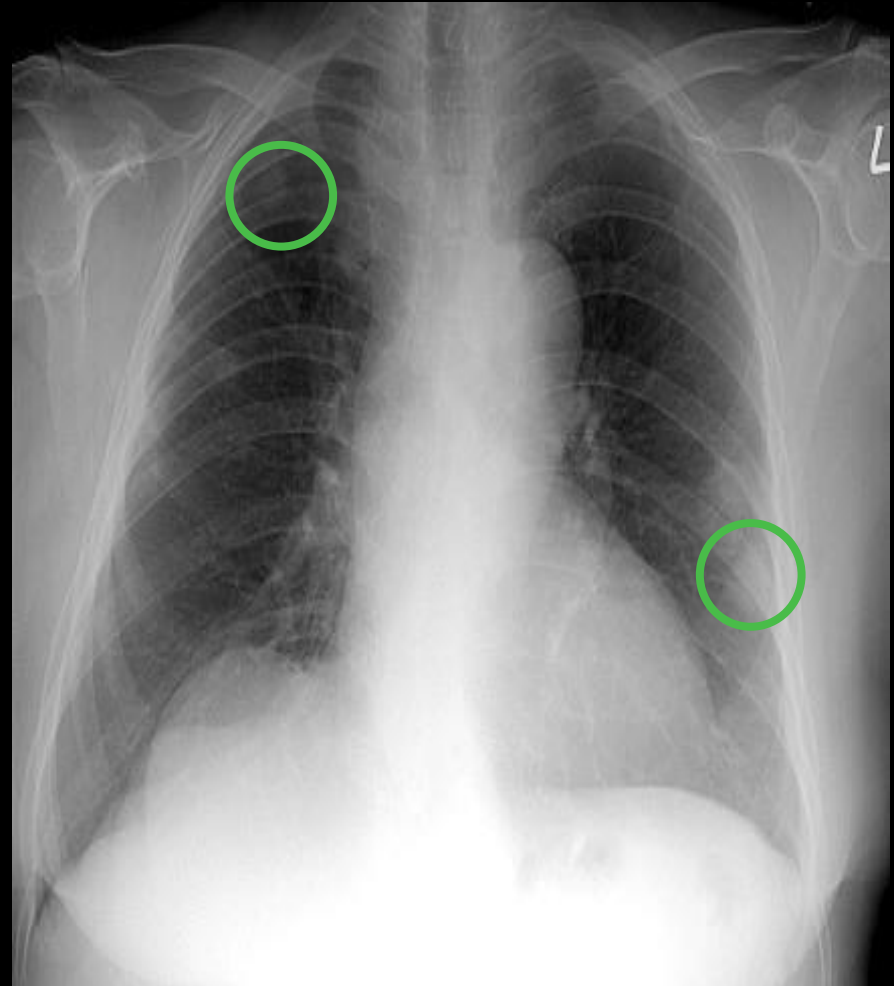
Masson-Fontana silver stain



India ink stain

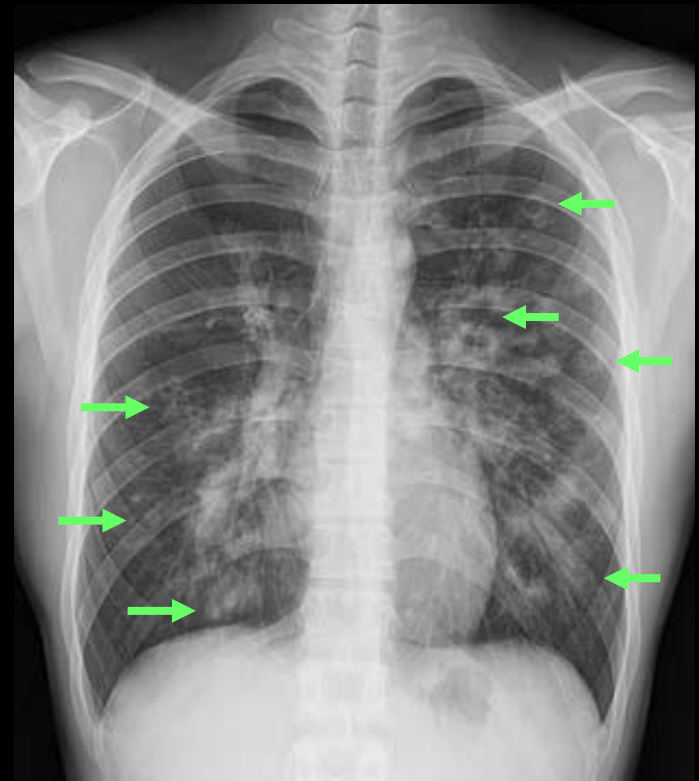
Cryptococcosis: radiographic signs

- * Solitary or multiple nodules (most common)
 - * **Cavitation** is more common seen in immunocompromised patients
- * Focal, irregularly margined opacities similar as those of bronchopneumonia
 - * **May be followed by development of nodules**
- * Hilar and mediastinal lymphadenopathy (rare)



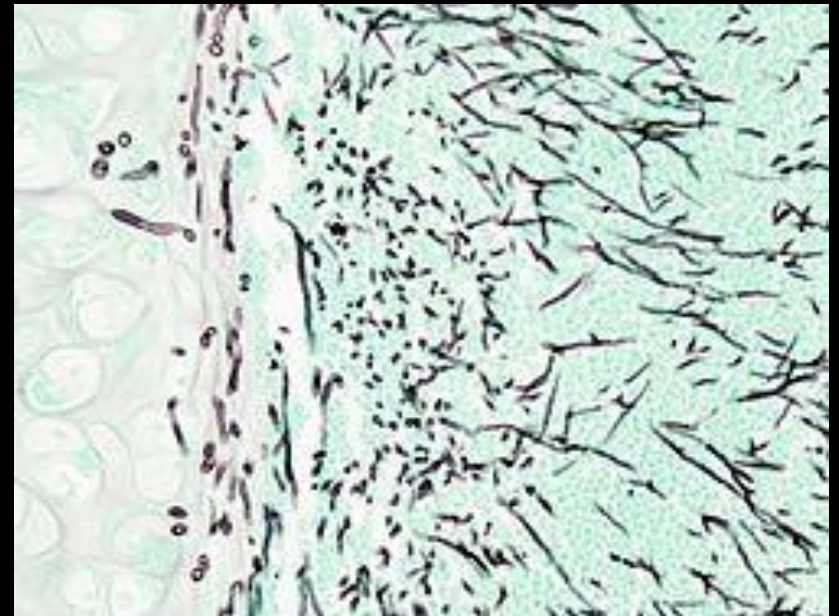
Cryptococcosis

- * Multiple nodules or masses with well- or ill-defined borders.
- * Many opacities with cavitation.



Aspergillosis

- * The most common fungal lung infection in **neutropenic** hosts.



Types of *Aspergillus* infection

Syndrome	Underlying problem	Radiographic signs
Invasive aspergillosis (IA)	Neutropenia , immunosuppression	Multiple large nodules , air crescent sign, halo sign (CT scan)
Semi-invasive aspergillosis	COPD, radiation fibrosis, post-primary tuberculosis	Slowly progressive upper lobe opacities
Aspergilloma	Cavitary lung disease	Mass within preexisting lung cavity
Allergic bronchopulmonary aspergillosis (ABPA)	Asthma (with eosinophilia, serum IgE >1000 IU/mL)	Central bronchiectasis, finger-in-glove pattern , transient consolidation

Invasive aspergillosis: radiographic signs

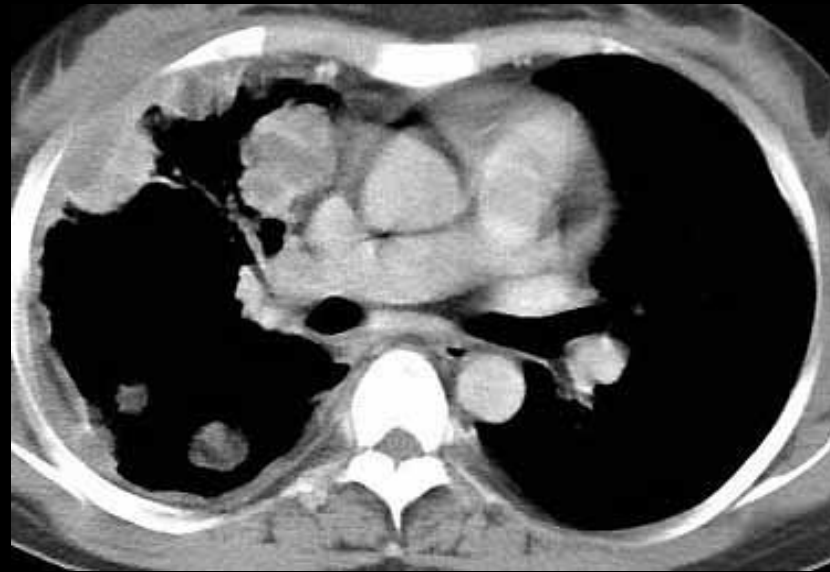
- * Usually begins as **multiple ill-defined nodules** that may later coalesce.
- * These masses may **cavitate** as the patient's immunity recovers.
- * An identical pattern can be seen in infections with ***Mucor*** species.

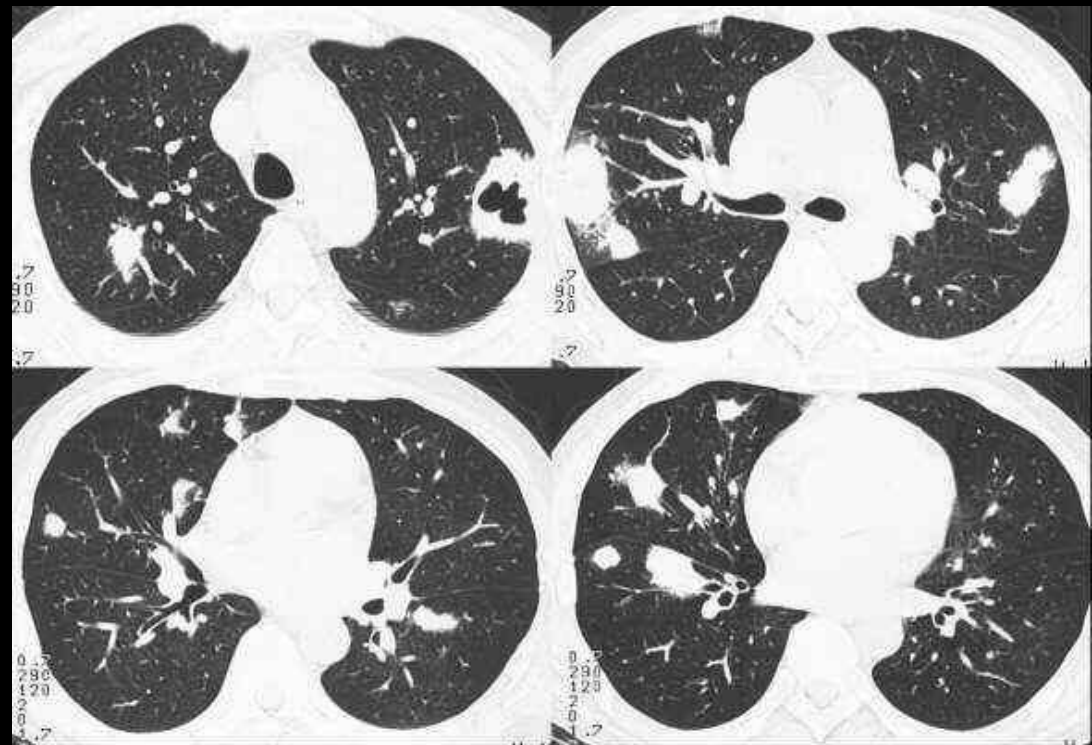
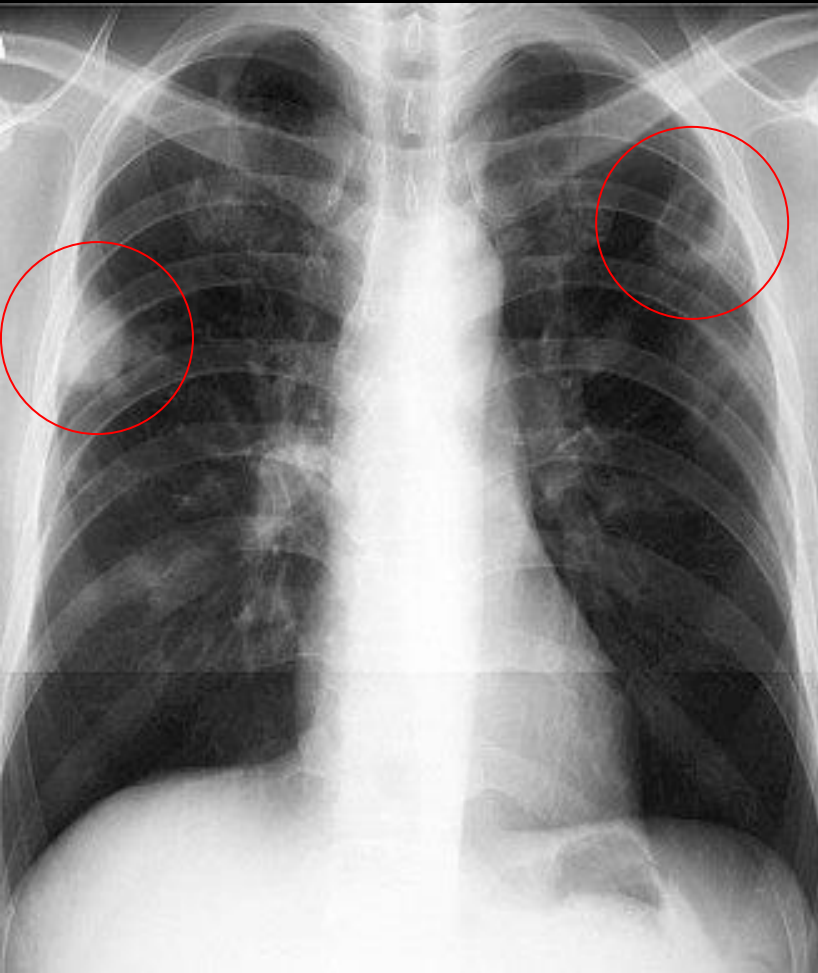


Nocardiosis

- **Immunocompromised** patient favored, but not necessarily
- The typical radiologic manifestations:
 - **Nodules and areas of consolidation**, with or without **cavitation**, that frequently involve the **pleural space**
- Frequent **CNS** involvement
- **Chest wall invasion** may occur but is uncommon
 - D/D of chest wall invasion lesion
 - Malignancy
 - Benign: TB, NTM, nocardiosis, actinomycosis

Nocardiosis





Nocardiosis

Virus Infection

■ Bronchiolitis

- Airway obstruction is usually partial and results in **hyperinflation** and **poorly defined nodular opacities**.

■ Lung parenchyma (Viral pneumonia)

- Usual pattern:
 - **Poorly defined nodules** (air-space nodules of 4–10 mm in diameter)
 - Patchy areas of **peribronchial GGO** and **air-space consolidation**.
 - **Hyperinflation**: because of the associated bronchiolitis.

Virus Infection (2)

- Progressive form :
 - **Rapid confluence** of consolidation leading to diffuse alveolar damage, consisting of homogeneous or patchy unilateral or bilateral air-space consolidation and ground-glass opacity or poorly defined centrilobular nodules

Varicella pneumonia

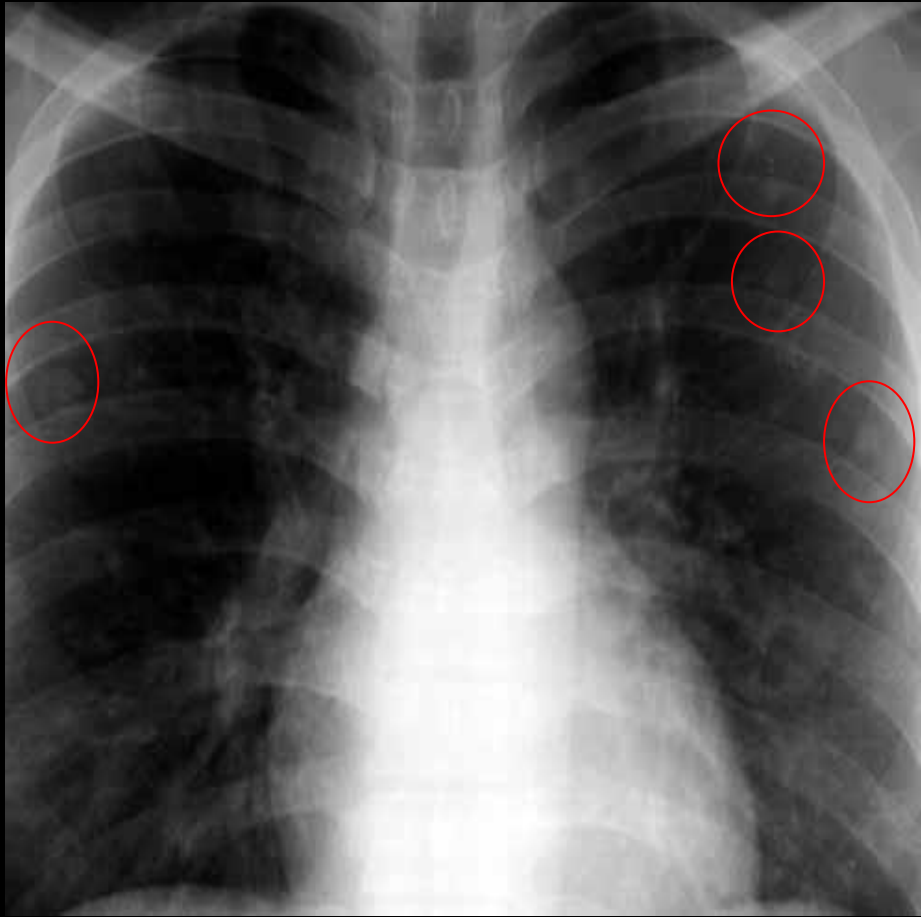
* CXR:

- * multiple 5-10 mm **ill-defined** nodules
- * small, round nodules usually resolve **within** a week after the disappearance of the skin lesions but may persist
- * 可以 scattered, **2-3 mm**

記得掀開病人的衣服看皮膚!!!

* CT

- * 兩側瀰漫性 well-defined and ill-defined nodules
- * nodules with a surrounding halo of ground-glass opacity, patchy ground-glass opacity, and coalescence of nodules are also seen

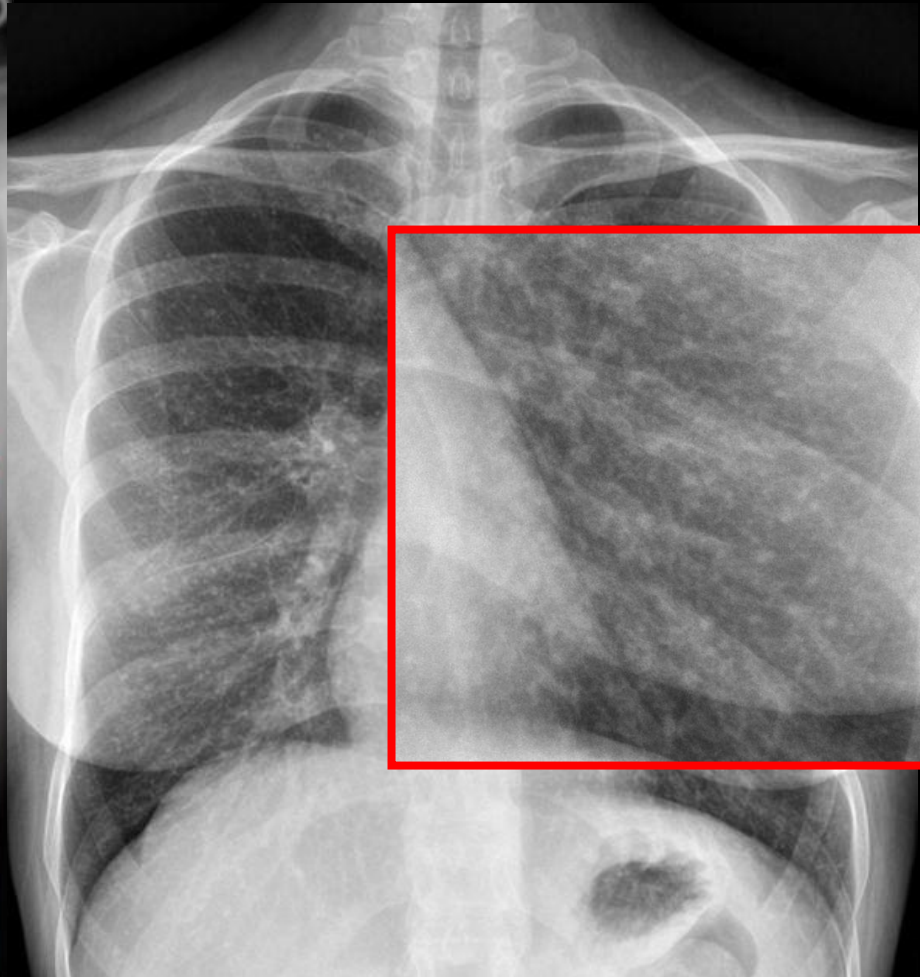
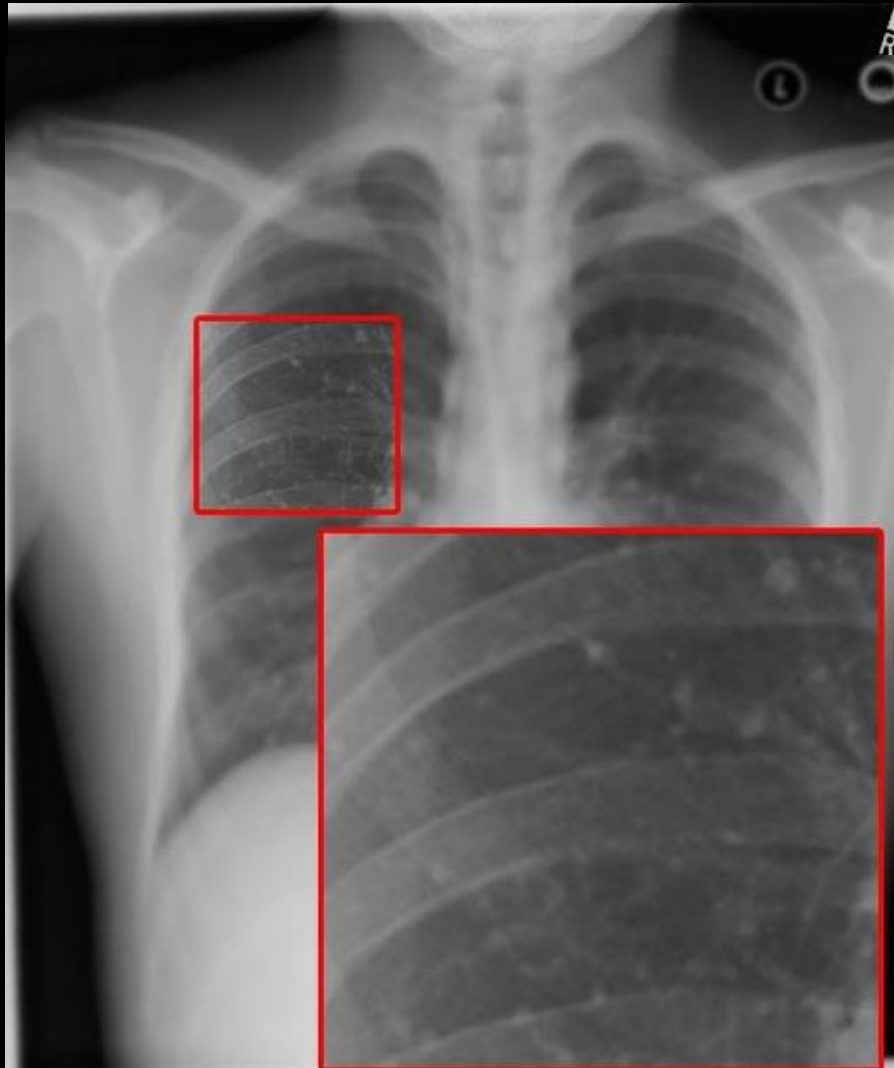


Varicella-Zoster pneumonia

Varicella Pneumonia



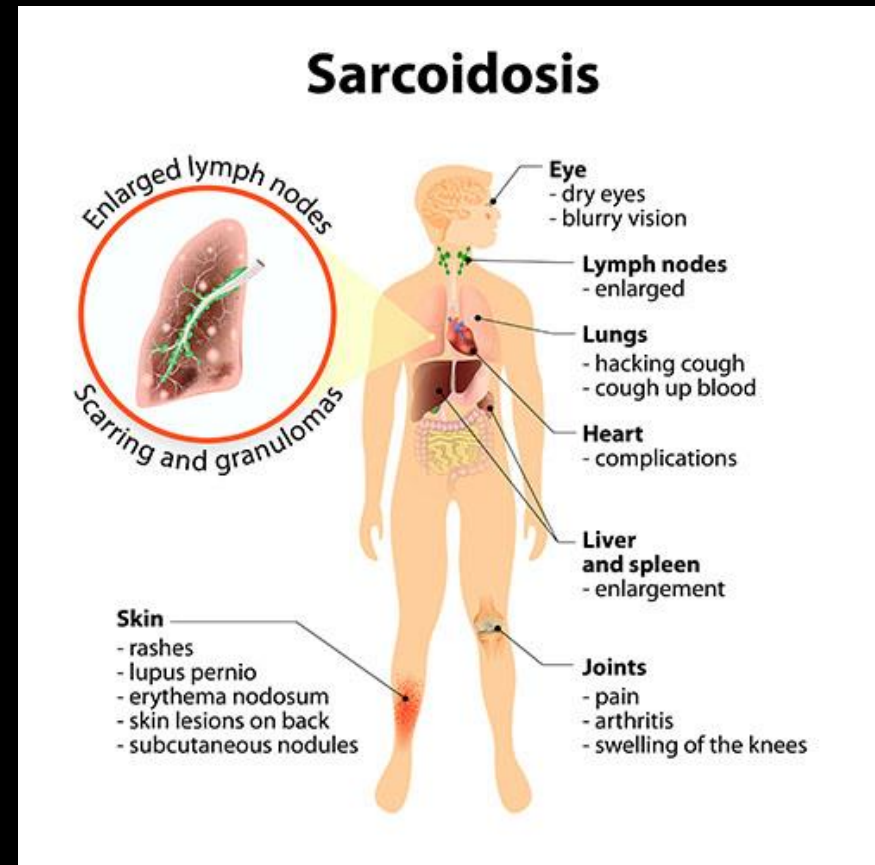
Varicella pneumonia



I: Inflammation

Sarcoidosis

- * A systemic disease of unknown cause that is characterized by the formation of granulomas in various organs.
 - * **Mainly the lung and lymphatic system.**
- * An exaggerated immune response to so far unidentified antigens.



Sarcoidosis

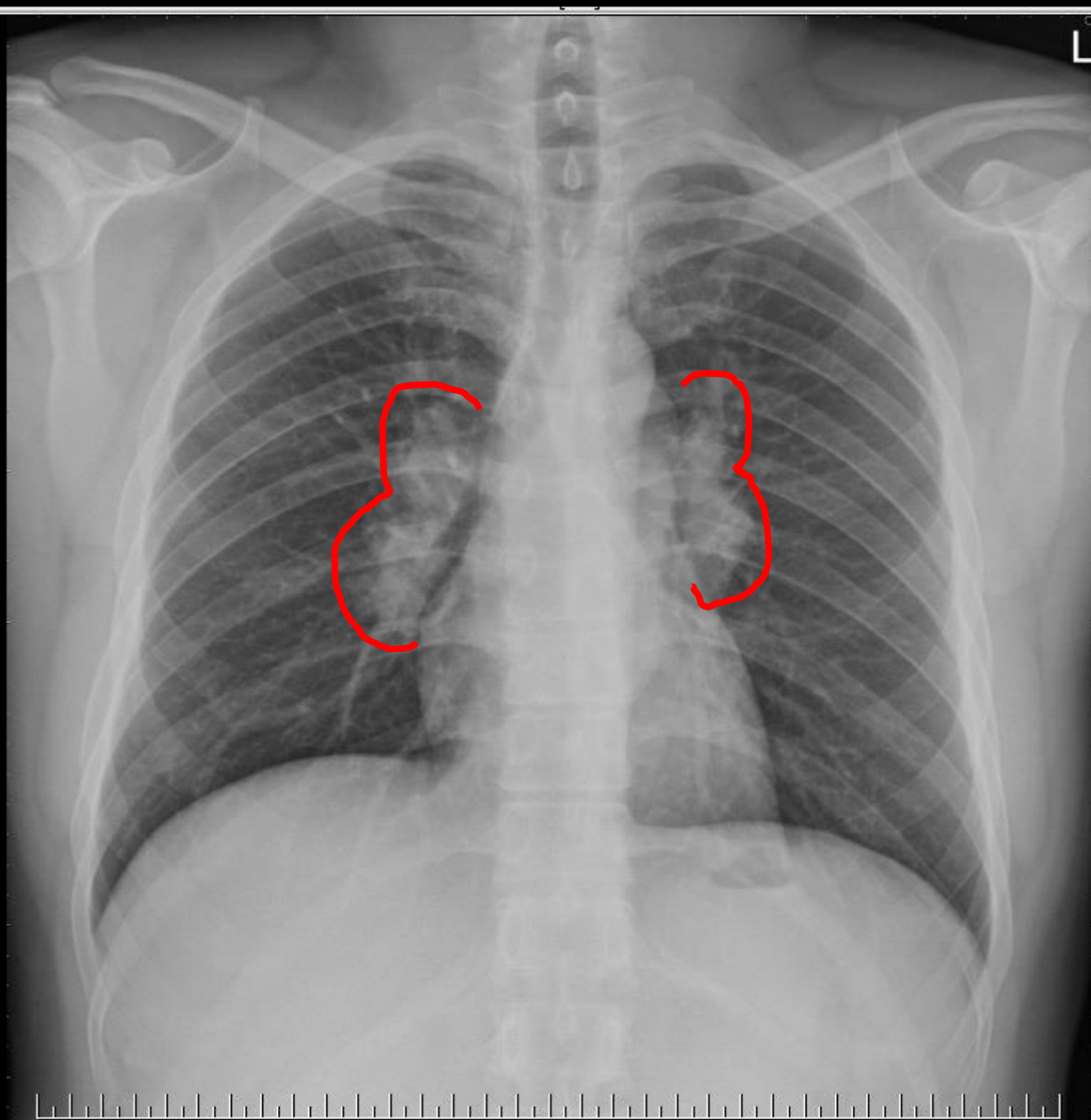
- Discrepancy of symptoms and CXR severity
- Middle age
- Best diagnostic clue:
 - Symmetric hilar and mediastinal (paratracheal, subcarinal) LNs without or with pulmonary opacities (upper lung predilection)
 - 1-2-3 nodes: right paratracheal, right and left hilar LNs

Sarcoidosis

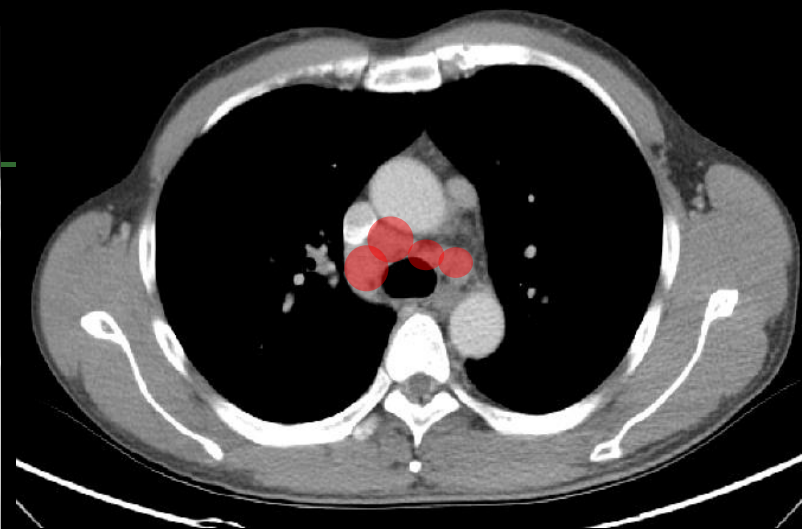
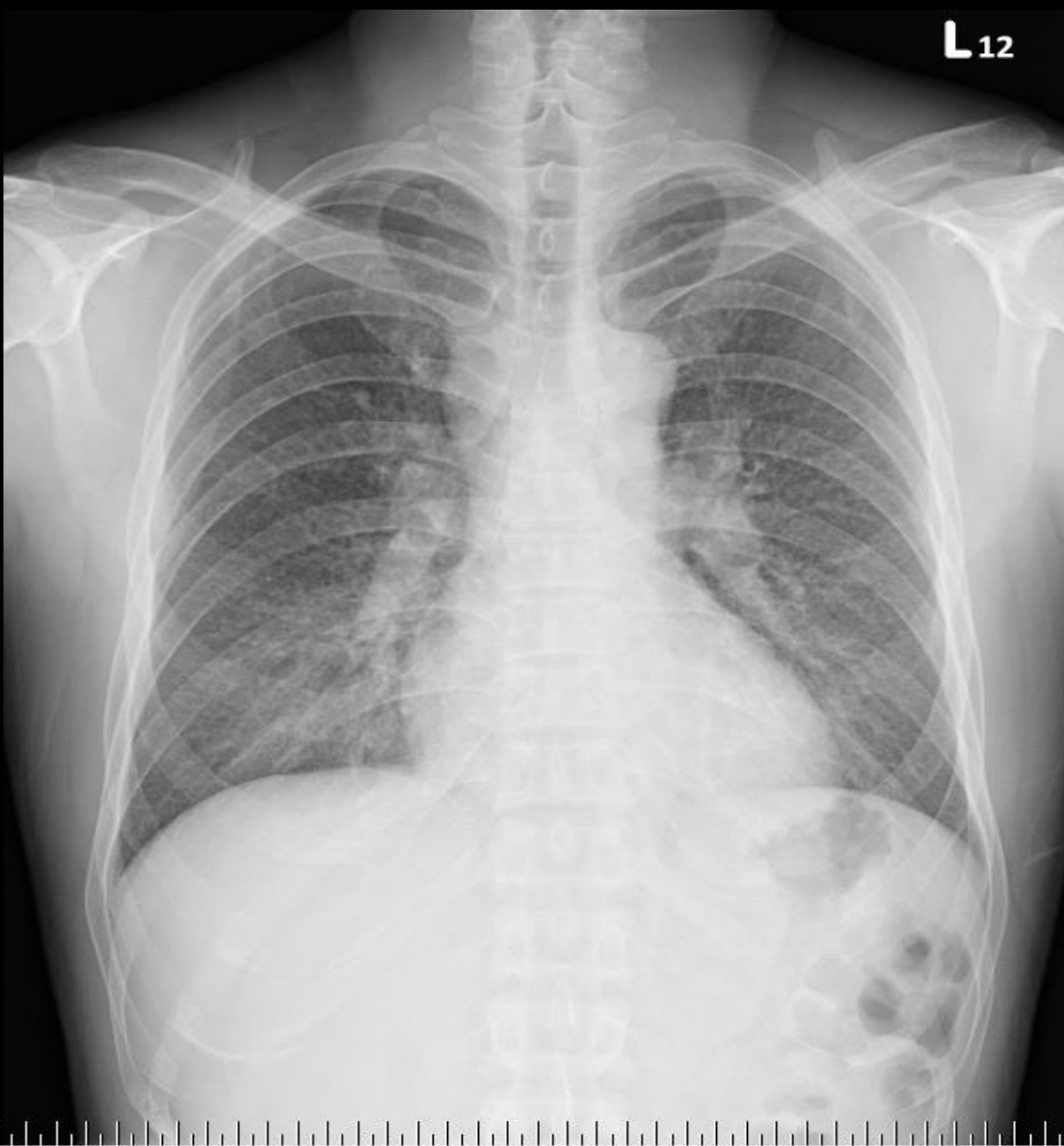
- CXR findings:
 - Lymphadenopathy:
 - most common
 - bilateral symmetric hilar/paratracheal
 - Lung parenchyma:
 - Fine nodular
 - **Reticulonodular**: predominant upper lung field
 - Large, poorly-marginated airspace nodules with air-bronchogram: alveolar sarcoid
 - Pulmonary fibrosis: upper lobe and superior segment of lower lobe

Radiographic staging of sarcoidosis

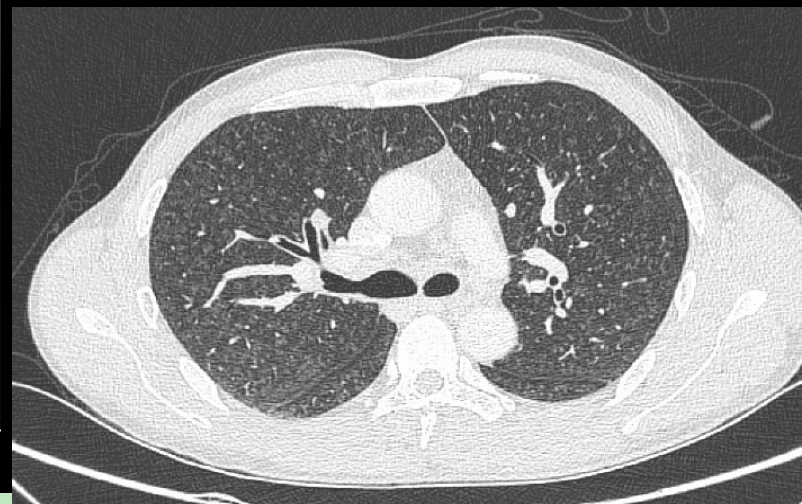
Stage	Findings
0	Normal chest X-ray (10%)
I	Lymphadenopathy alone (most common, 50%)
II	Lymphadenopathy and parenchymal involvement (30%)
III	Parenchymal involvement alone (least common)
IV	Fibrosis

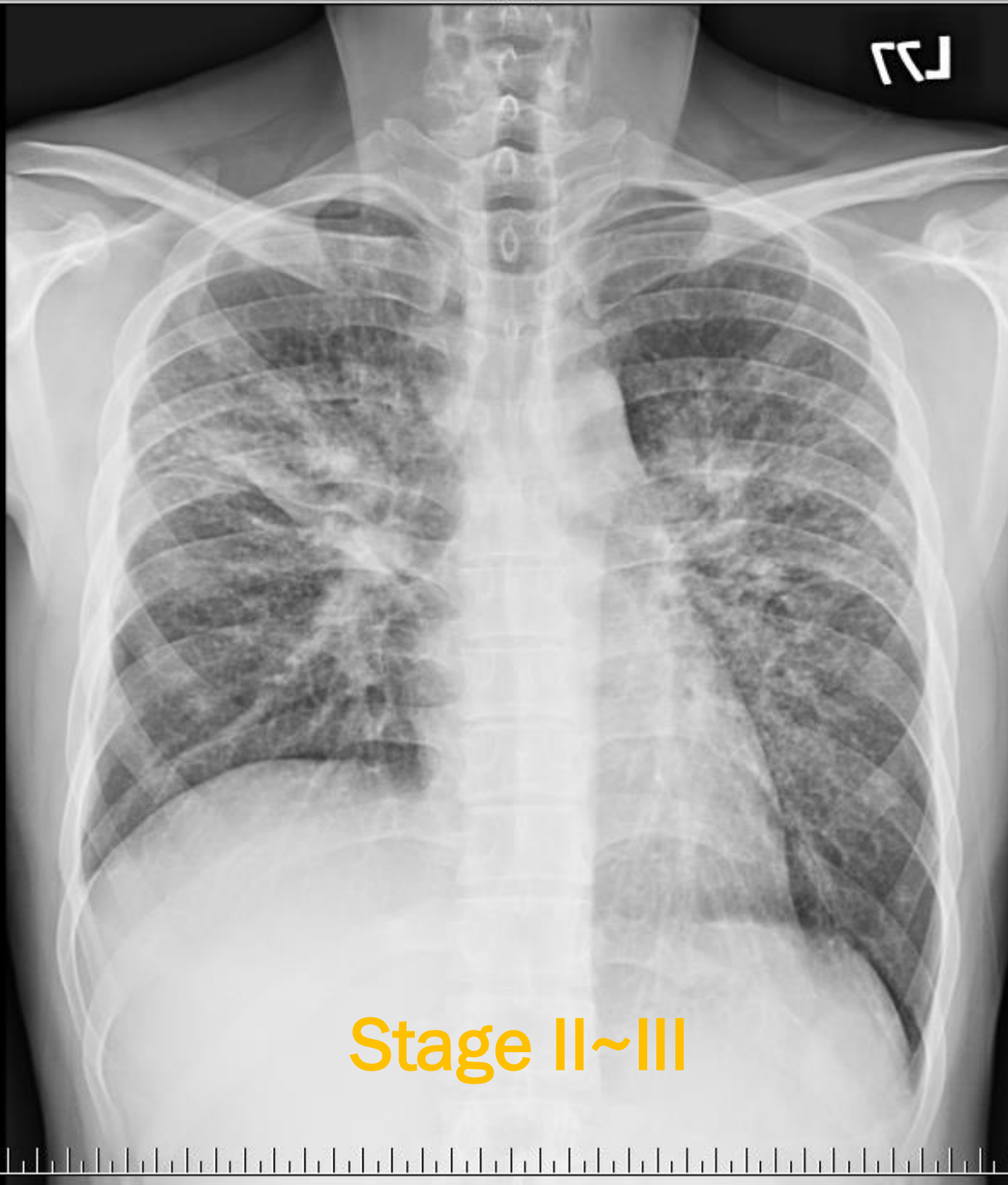


Stage
I

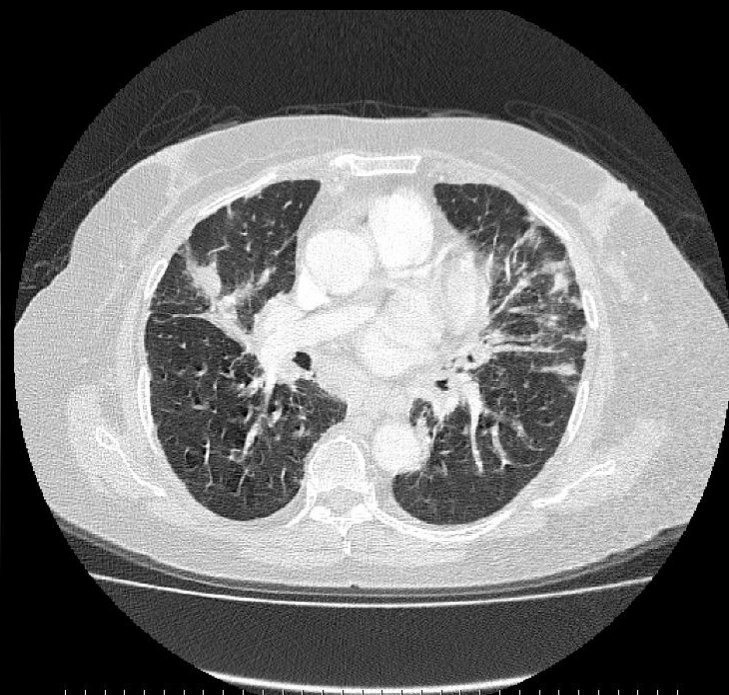


Stage II

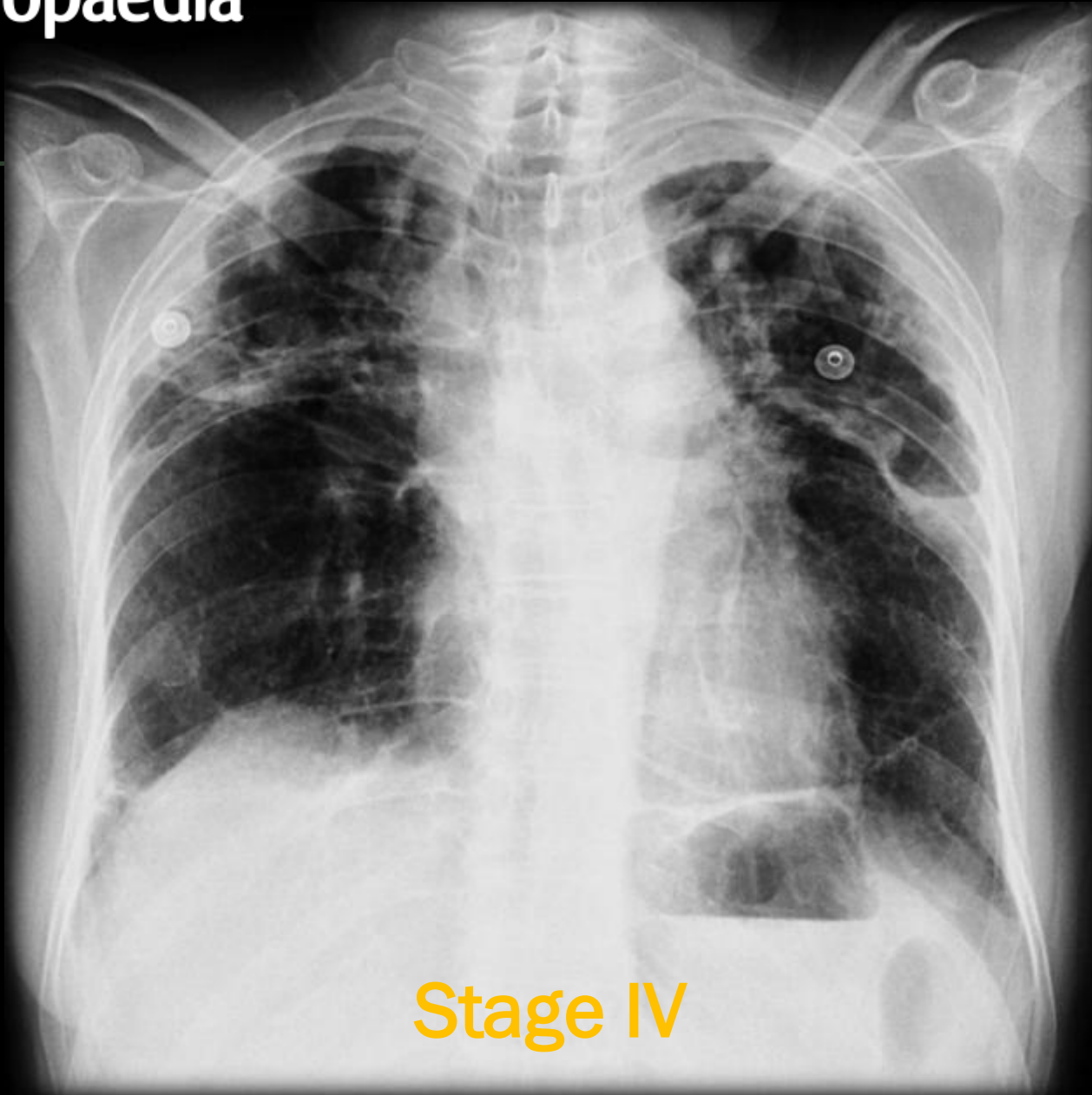




Stage II~III



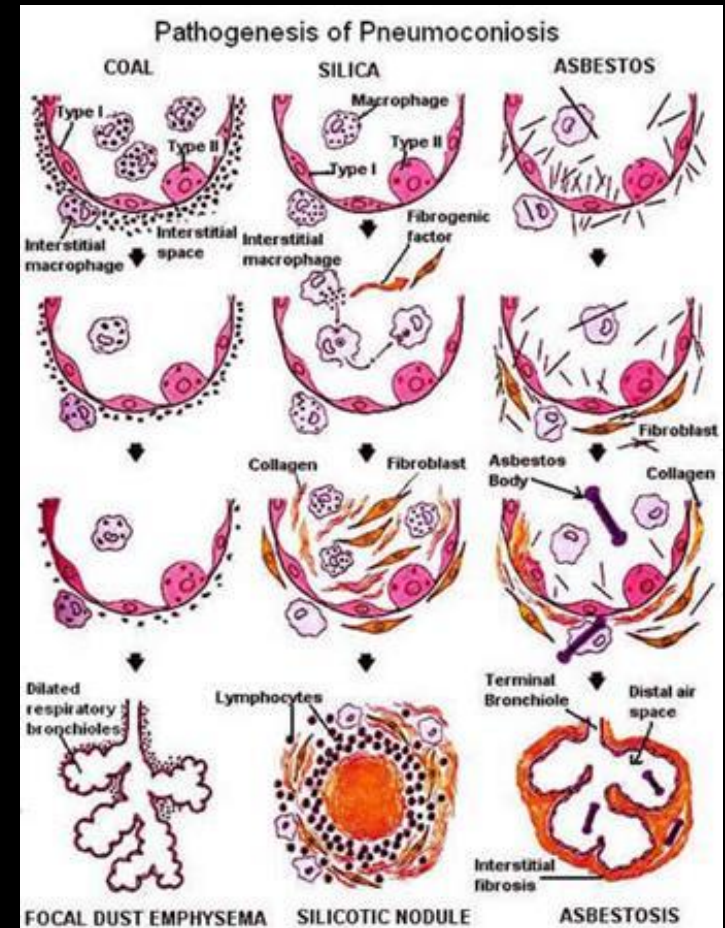
Stage III~IV



Stage IV

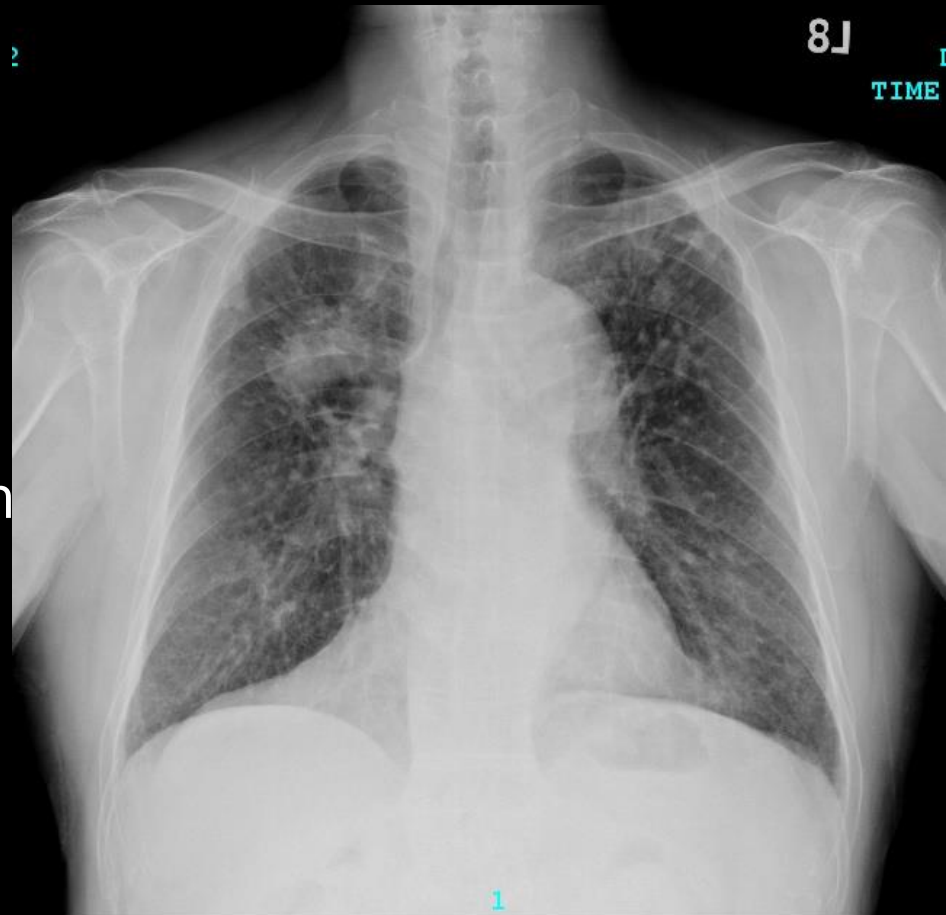
Pneumoconiosis

- * A collective term refer to abnormal pulmonary changes resulting from the inhalation and deposition of dusts
 - * **Silicosis**
 - * **Coal-worker's pneumoconiosis**
 - * **Asbestosis**
 - * **Berylliosis**
 - * **Hard metal pneumoconiosis**
- * An occupational history



Pneumoconiosis: radiographic signs

- * Numerous small (1-10 mm), sharply demarcated round opacities.
 - * With predilection for **perihilar or upper zones**.
 - * **Calcification** in 20-50% of cases.
- * Large, irregular masses with perifocal emphysema.
 - * **Progressive massive fibrosis (PMF)**.
 - * With predilection for perihilar or upper zones.
 - * (Occasional) cavitation.



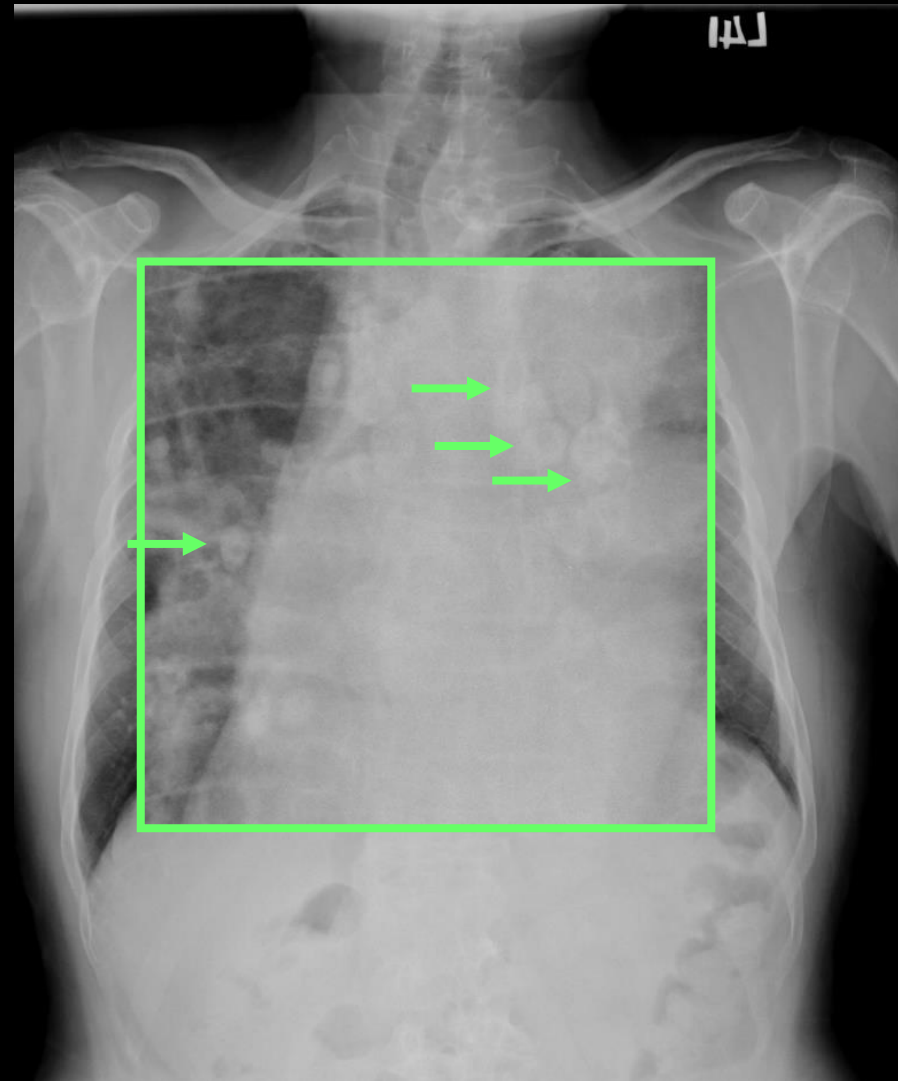
Progressive massive fibrosis (PMF)

- * Two large, dense, irregular masses with perifocal lucency at bilateral upper zones.
 - * Symmetric or asymmetric.
- * Several satellite large nodules around the masses.
- * Numerous tiny nodules in both lung fields.
- * Volume loss in upper lobes.
 - * Upward displacement of hila.



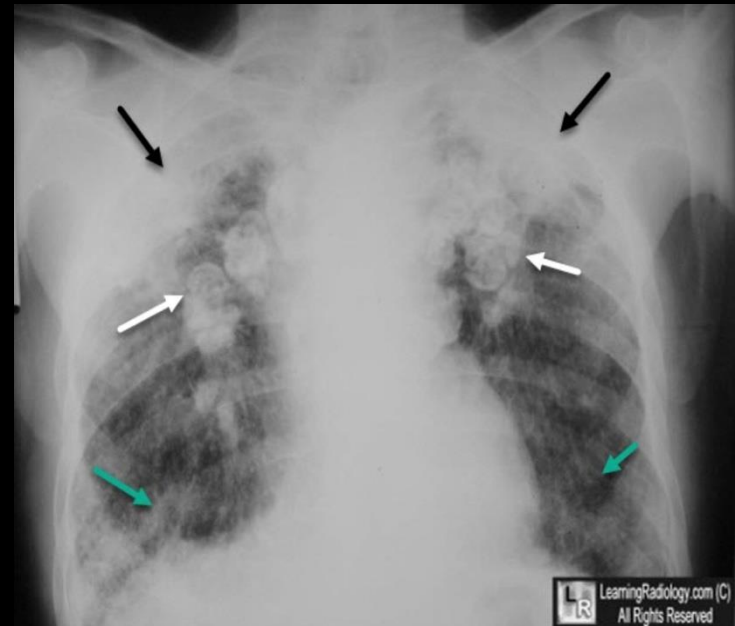
Silicosis

- * Numerous small nodules with sparing of basal lungs.
- * A irregular mass at right upper zone with perifocal emphysema.
- * “Eggshell” calcification in the hilar and mediastinal lymph nodes.



Silicosis with PMF

- Patchy, dense opacities with spiculated margins at bilateral apices.
- Multiple enlarged lymph nodes in bilateral hilar with “eggshell” calcification.
- Extensive ill-defined, confluent nodular shadowing.
- Silicotuberculosis
- 25% of patients with acute or classic silicosis
- Asymmetric nodules or consolidation, cavitation, and rapid disease progression – 在原来的病灶中有任何變化都要懷疑
- Cavitation is the strongest indicator of probable silicotuberculosis



*

*

*

* **Mesothelioma (asbestosis)**

Special considerations in patients with HIV

- * Numerous small nodules <1 cm are most likely the result of infections.
 - * Bacterial bronchopneumonia.
 - * Tuberculosis.
 - * Fungal pneumonia.
- * Multiple nodules >1 cm are more likely neoplastic.
 - * Kaposi's sarcoma.
 - * Lymphoma.

N: Neoplasm

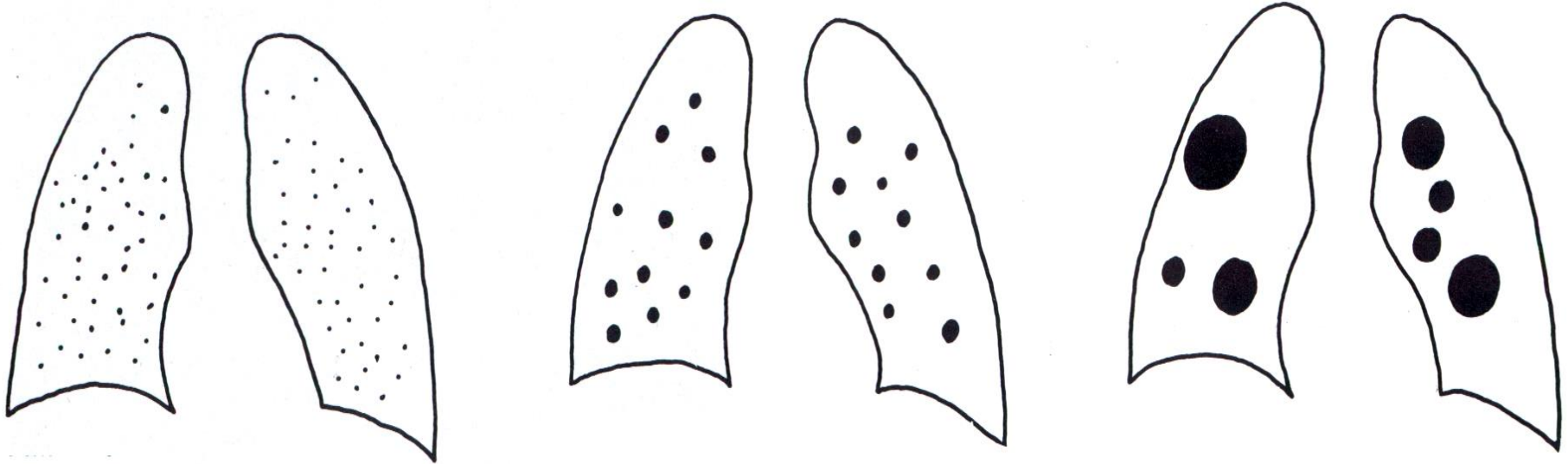
- Lung metastasis
- Lymphoma

N: Lung Metastasis

- Fine nodular pattern in a patient with a **known cancer** strongly suggests metastasis
- Size 大小不一，在 **lower** lung 的 nodule 較大
- **Dependent area predominant:**
 - 數目 較多、size 較大
- Most common **origin**
 - **Lung** to lung metastasis
 - **Thyroid** cancer
 - **Breast** cancer
 - GI tumor (e.g. pancreatic carcinoma)
 - Melanoma

Type of Pulmonary Metastases

Round metastases (1-10 cm) – *hematogenous* spreading



Miliary form:

Thyroid
Lung
Breast
Bone

Coarse nodular form:

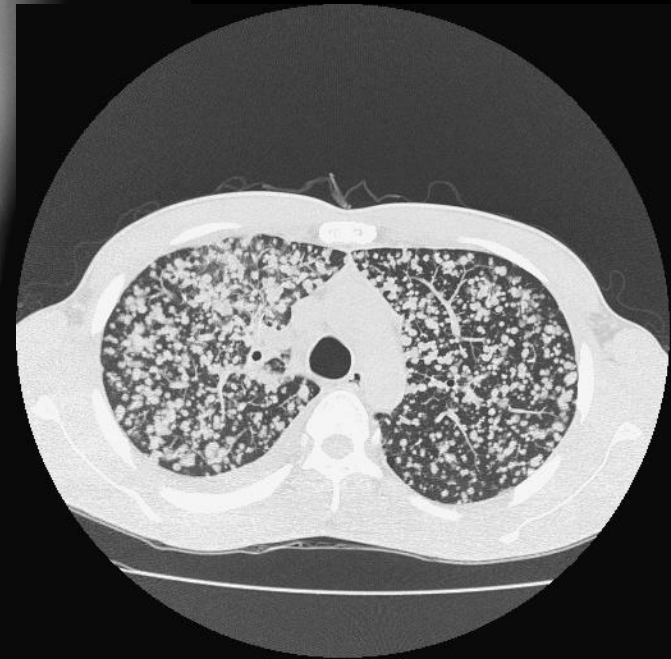
Oropharynx,
stomach, thyroid,
GYN, lymphoma,
choriocarcinoma

Cannonball type:

Renal cell carcinoma
choriocarcinoma
prostate cancer
synovial sarcoma

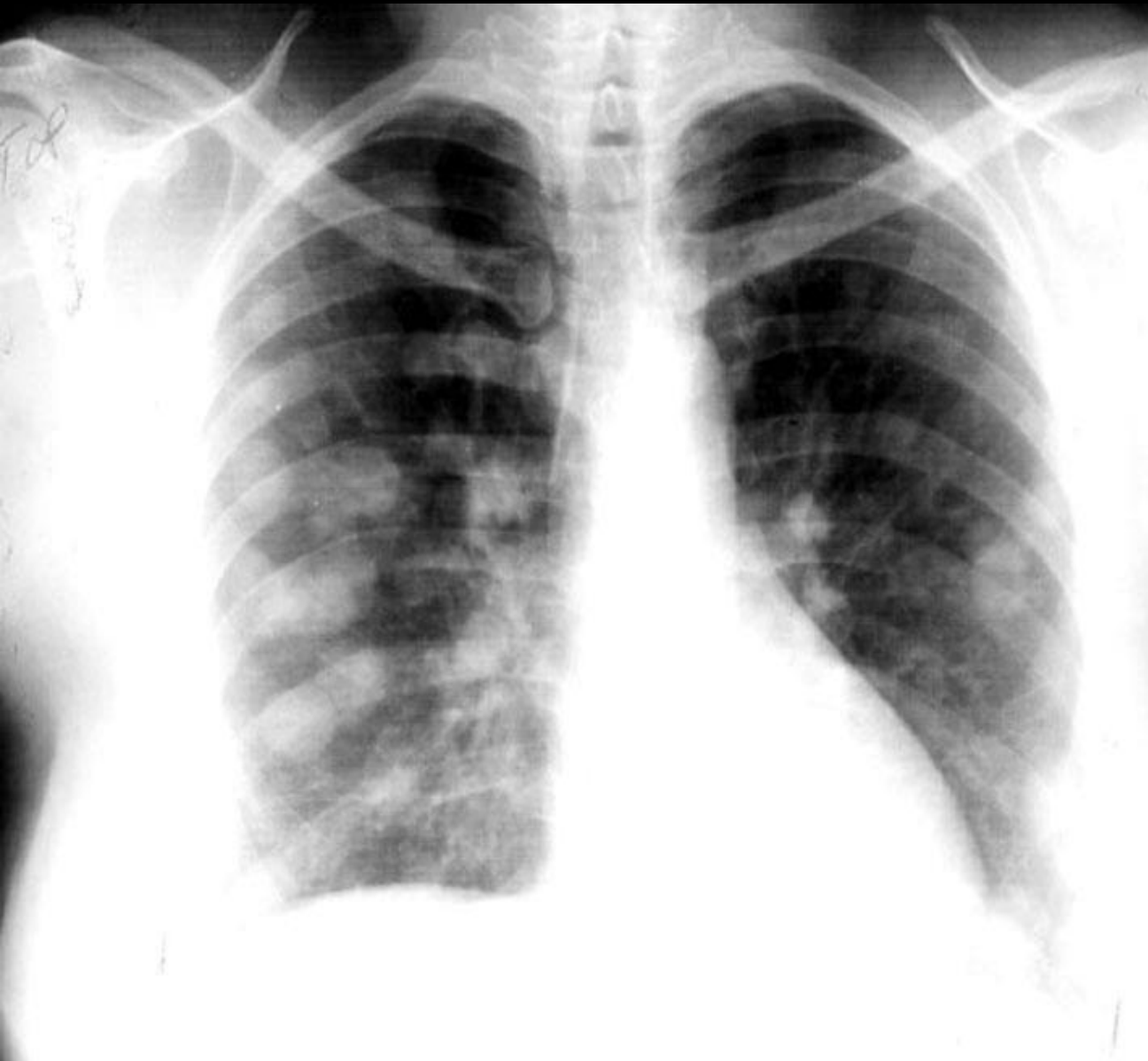
R 71

Lung adenocarcinoma with lung to lung mets



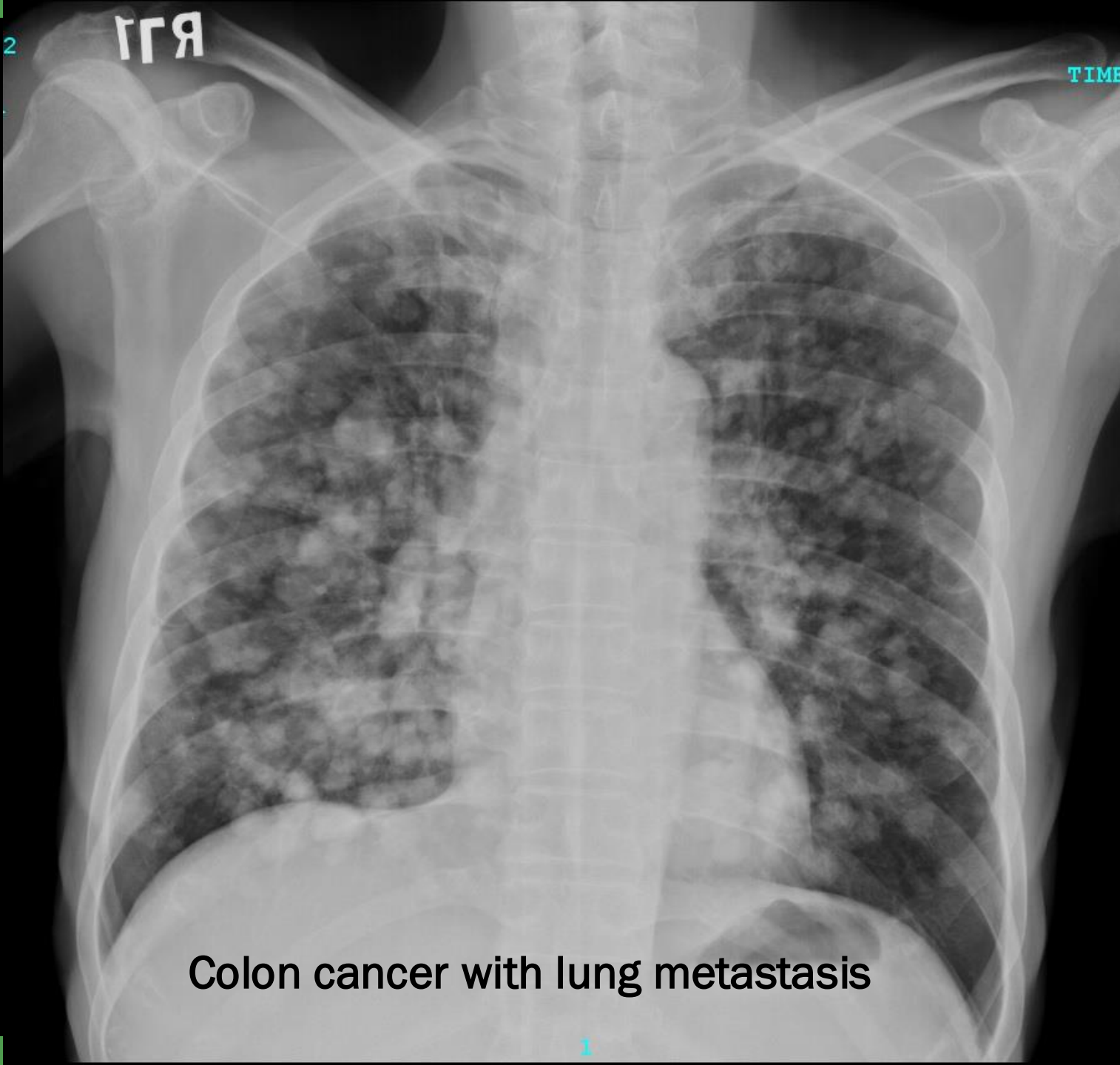
Cannonball metastases

- * Cannonball: 砲彈。
- * 法文(*envolée de ballons*): 氣球飛行。
- * 常見於:
 - * renal cell carcinoma
 - * Choriocarcinoma
- * 偶爾在:
 - * prostate cancer
 - * synovial sarcoma
 - * endometrial carcinoma

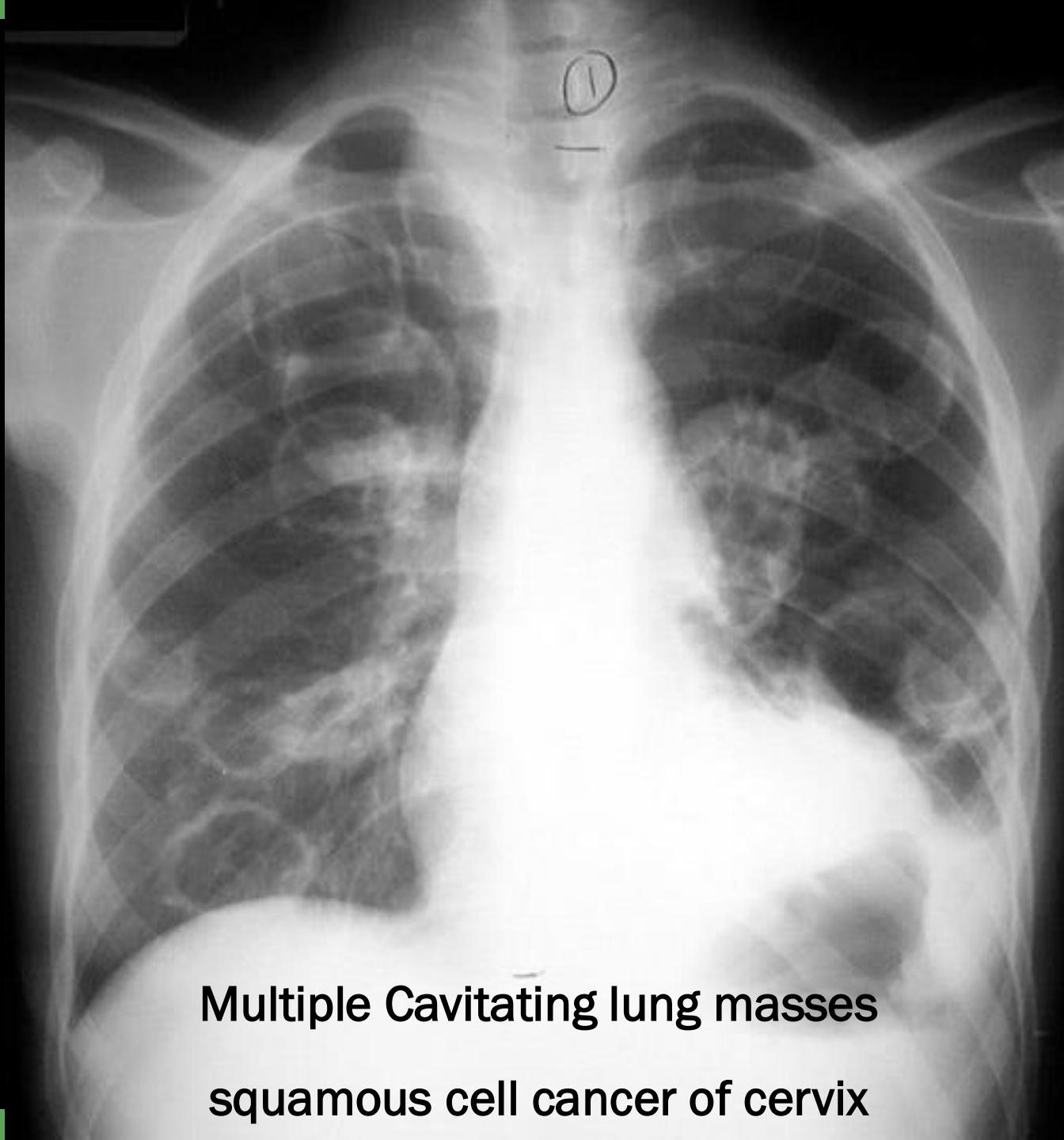


Cannon Balls – Lung Metastasis - Rectosigmoid Cancer

- Bilateral
- Multiple
- Round mass densities
- Sharp margins



Colon cancer with lung metastasis



**Multiple Cavitating lung masses
squamous cell cancer of cervix**

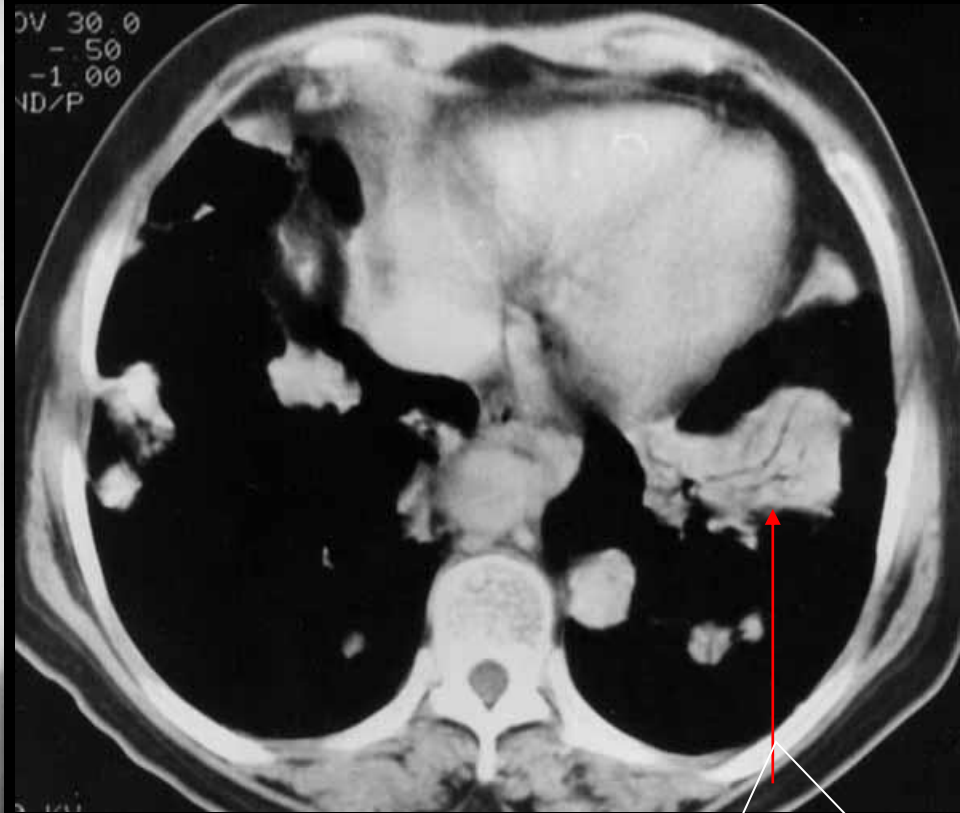
N: Lymphoma

- **Mediastinal lymphadenopathy** is the main findings on CXR
 - Non-Hodgkin lymphoma
 - Bulky **mediastinal** (esp. **superior**, such as prevascular & para-tracheal) and bil. **asymmetric hilar LAP**
 - Hodgkin lymphoma
 - **Anterior** (esp. thymus) and **superior** (most common: prevascular & para-tracheal) **mediastinal LAP**
- Lung parenchymal involvement: central or peripheral
 - Consolidation with air-bronchogram
 - Diffuse reticulonodular opacities
 - Single or multiple ill-defined nodules

Hodgkin Lymphoma



Non-Hodgkin's lymphoma



Air bronchogram

Multiple lung masses to ill defined consolidation, Widening of mediastinum

Diffuse Micronodular Pattern

Diffuse Micronodular lesion

- Definition: < 1cm in diameter
- More easily appreciated at CP angle in PA view and retrosternal space in Lat view
- Sharpness of border is important for D/D
 - Ill-defined – alveolar nodule – find clues of airspace dx
 - Discrete – Interstitial nodule – diffuse micronodules dx

Diffuse Micronodular Lesion

Differential Diagnosis

- **Malignancy:** diffuse metastasis and BAC
 - **Lower** lung predominant, C-P angle (+)
 - Variable size
- **Inhalation Dx:**
 - Pneumoconiosis: upper lung predominant
- **Infection:**
 - Miliary TB : from apex to C-P angle
 - Miliary fungal infection
 - Virus: eg, chickenpox
 - Nocardiosis

Diffuse Micronodular Lesion

Differential Diagnosis

- Others: **DASH**
 - **Diffuse panbronchiolitis (DPB)**: lower lung predominant
 - Pulmonary **alveolar microlithiasis (PAM)**
 - **Sarcoidosis**
 - **Hypersensitivity pneumonitis**: HP
 - Pulmonary Langerhans cell **histiocytosis (PLCH)**: upper lung predominant

Diffuse Panbronchiolitis

- Etiology unknown
- 主要發生在亞洲人，日本人最常見。
- 流行病學：
 - M/F : 1.4-2/1
 - 2/3 patients is non-smoker
 - Usually in 20~50 y/o, 平均在40y/o左右發生
- Chronic inflammation in
 - Paranasal sinuses: 造成chronic sinusitis
 - Respiratory bronchioles (obliteration and accumulation of foamy macrophages)
 - Alveolar ducts

Diffuse Panbronchiolitis

■ CXR: **triad**

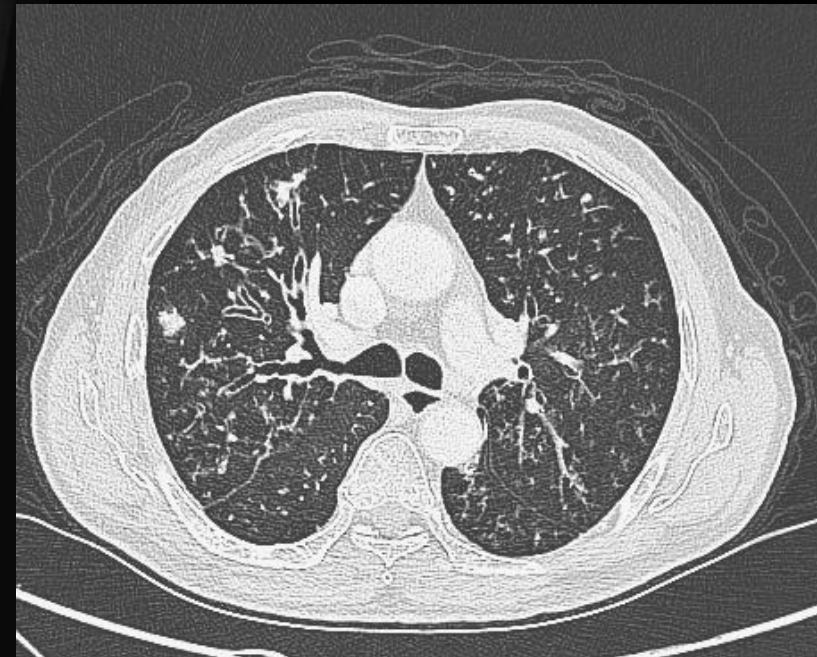
- **Diffuse nodules** <5 mm in diameter, mainly in lower lung fields
- **Hyperinflation**, bilateral
- **Bronchiectasis**

■ HRCT

- **Centrilobular nodular** opacities
- **Branching linear opacities** connecting to nodules (tree-in-bud)
- **Bronchiolectasis / bronchiectasis**

L44

Diffuse panbronchiolitis (DPB)



Miliary TB

■ Risk groups:

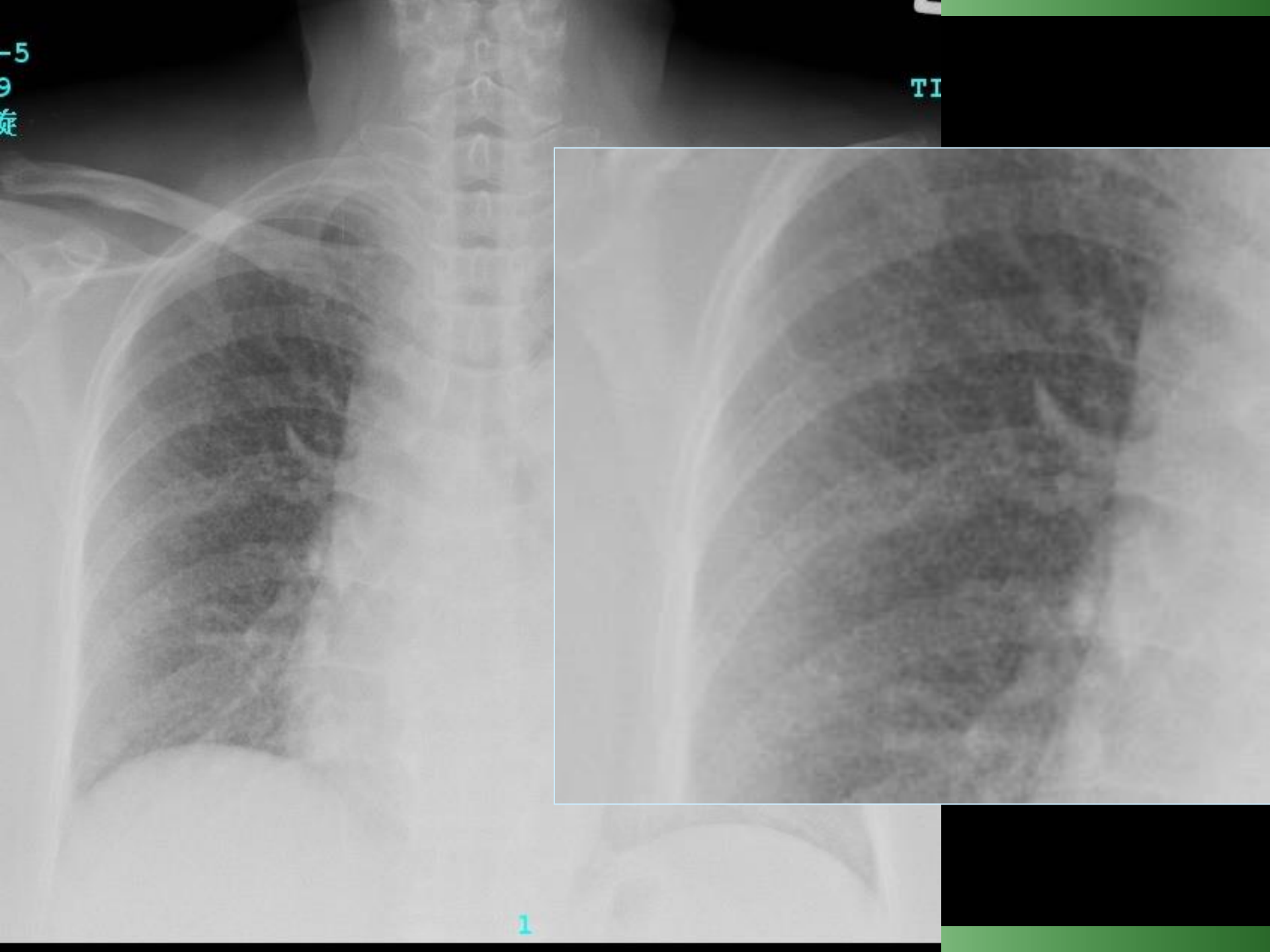
- elderly, infants, and immunocompromised persons

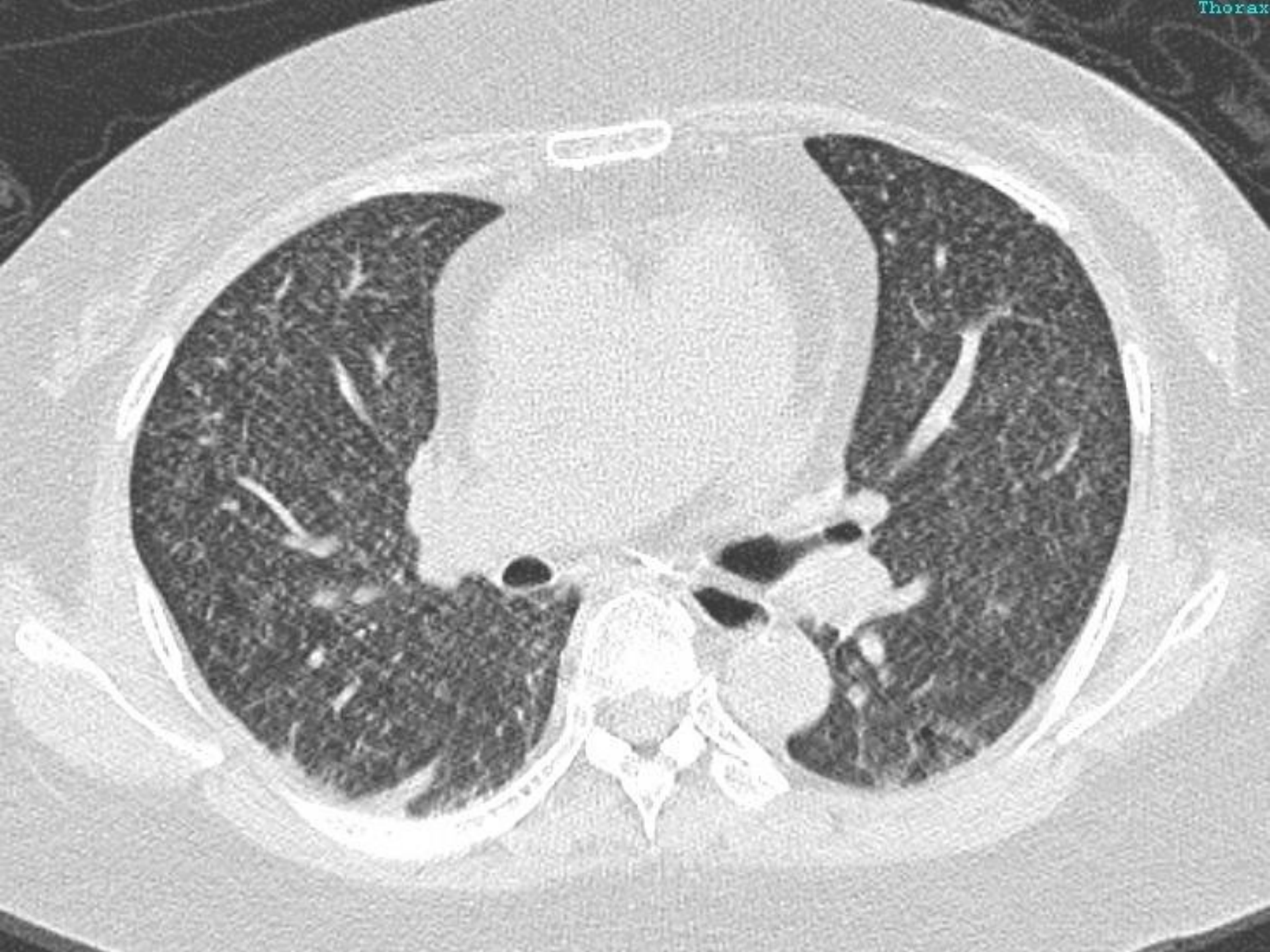
■ CXR:

- Evenly distributed (**from apex to CP angle**), diffuse small **2~3 mm nodules**, with a slight lower lobe predominance
- **細到不能再細, 密到不能再密**
- May increase in size to 3-5 mm, when
 - in immunocompromised host or without treatment
- 通常在治療後2~6個月內會消失，不會留下scar或鈣化

■ CT scan

- Nodules seen in a **random** distribution

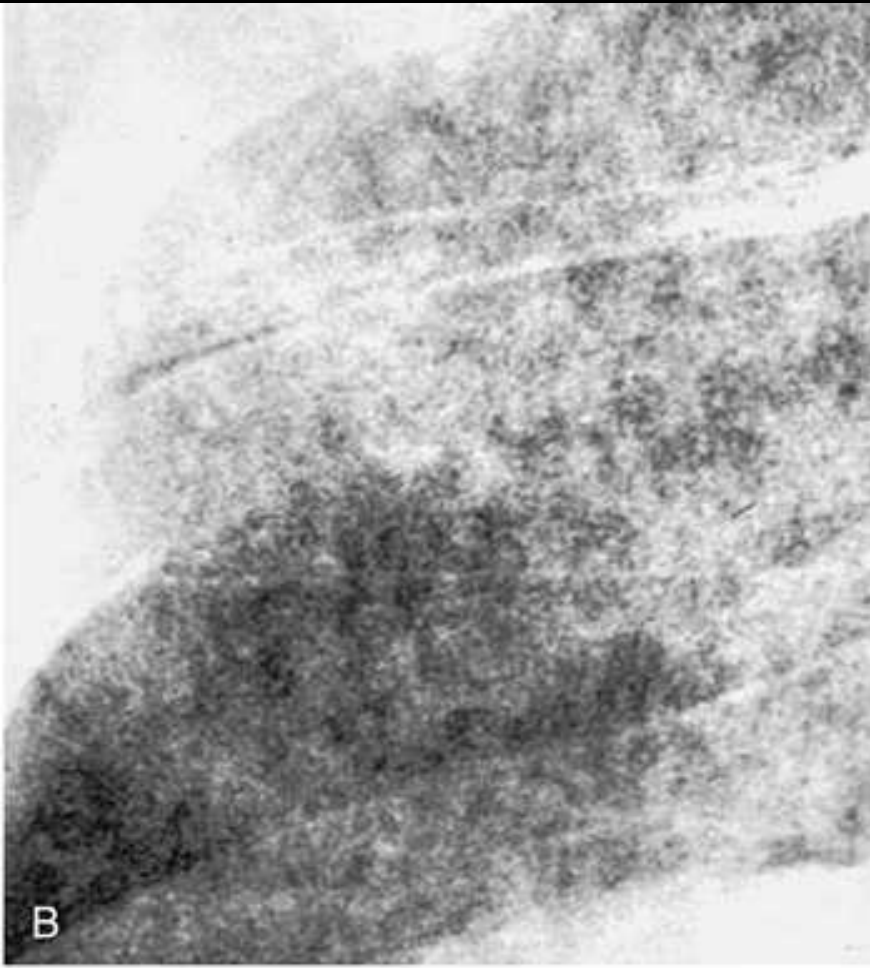




Alveolar Microlithiasis

- A rare disease characterized by the presence of innumerable **tiny calculi within alveolar air spaces**
- Usually **asymptomatic**
- Etiology and pathogenesis unknown
 - Inborn error? Unusual response to an insult?
 - Immune dx? Abnormal Ca or P metabolism?
- Sandstorm appearance
 - **Very fine micronodules** diffusely in both lungs
 - Sharply defined nodules, **< 1 mm in diameter**.
 - May appear **confluent** where numerous

Alveolar Microlithiasis



Hypersensitivity pneumonitis (HP)

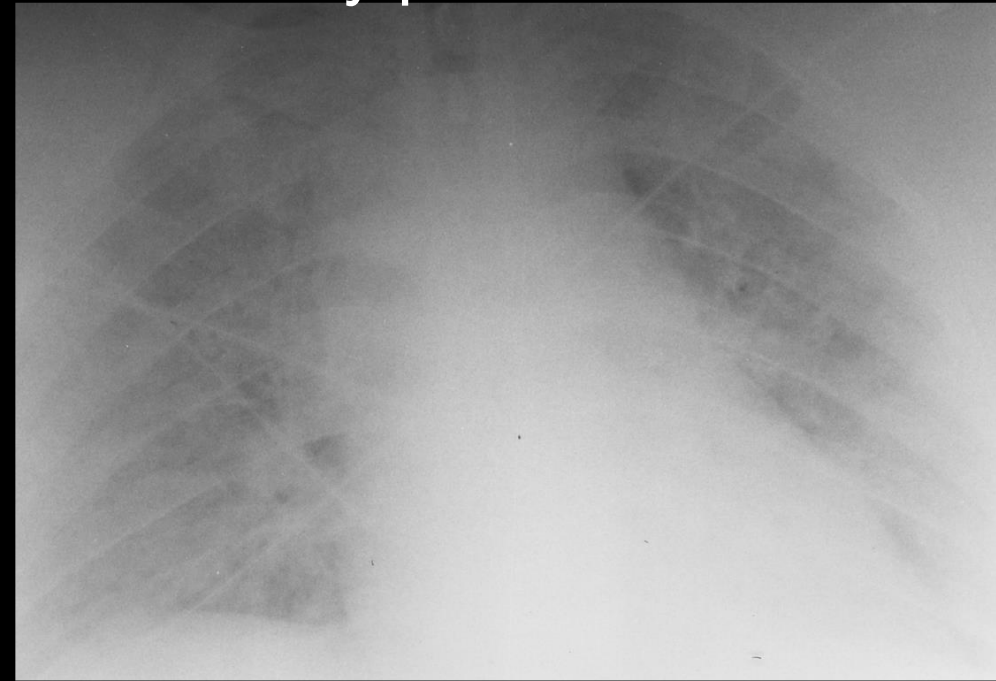
- Exposure to **organic or chemical** antigen
 - Farmer's lung, bird-fancier's lung, "hot tub" lung
- Best diagnostic clue:
 - **Mid/lower lung** miliary or interstitial or alveolar pattern, **C-P angle sparing** (因為是**inhalation-related**)
 - HRCT: **ill-defined nodules, GGO, mosaic attenuation**
- CXR/CT findings:
 - **Acute stage:** 10% with abnormal CXR
 - bilateral areas of increased opacities-heterogeneous or homogeneous → **simulate pulmonary oedema**
 - 容易誤認為pneumonia
 - HRCT: bilateral homogeneous ground-glass and alveolar opacities, lower-zonal predilection

Hypersensitivity pneumonitis (HP)

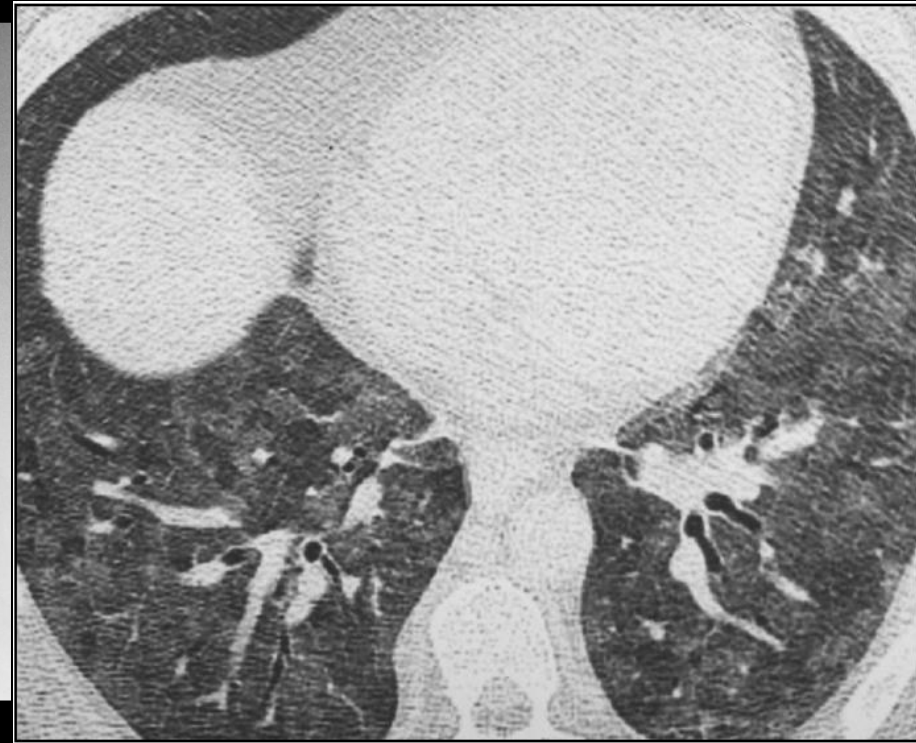
- Subacute stage: 90% with abnormal CXR
 - Poorly-defined small nodules
 - Diffuse or mid-lower increased lung density with blurred lung marking
 - HRCT: Ill-defined centrilobular nodules, GGO, mosaic perfusion (head-cheese sign); middle and lower lung fields
- Chronic stage:
 - Fibrotic change over midlung
 - C-P angle sparing
 - no pleural effusion and LAP
 - HRCT: fibrosis, reticular opacities; middle and upper lung fields

Hypersensitivity Pneumonitis – Acute Stage

Acute hypersensitivity pneumonitis (bird fancier's lung) in 34-year-old man with severe dyspnea



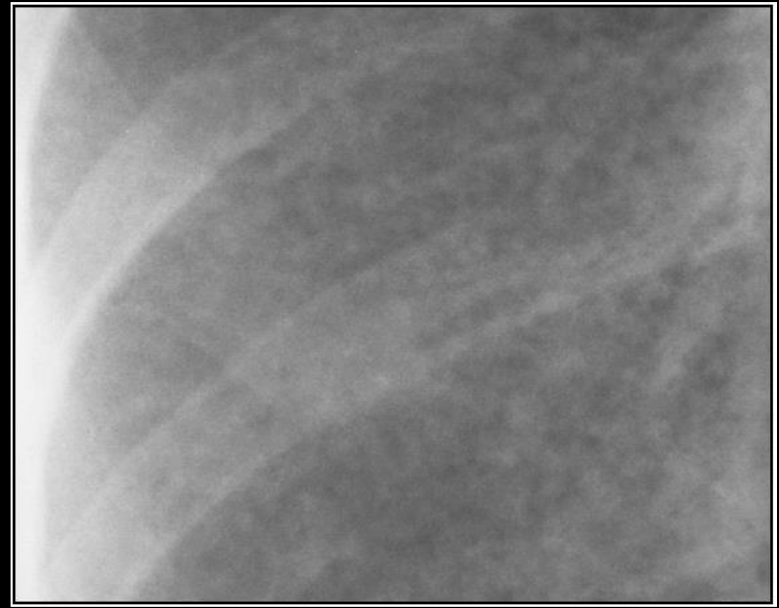
Bilateral homogeneous pulmonary opacities



HRCT: scattered ground-glass opacities

Hypersensitivity Pneumonitis

– Subacute Stage



bilateral, diffusely distributed, well-defined small lung nodules and GGO.

Scattered ground-glass opacities
Centrilobular distribution peripherally

Hypersensitivity Pneumonitis – Chronic Stage



1. Bil. reticulonodular opacities in mid lung zones and mild loss of lung volume
2. Irregular linear opacities, architectural distortion, and traction bronchiectasis.
3. Centrilobular nodules in right mid lung



Pulmonary Langerhans Cell Histiocytosis (PLCH)

- Diffuse destructive disorder of distal airways from granuloma that contain Langerhans cells
- Young adult, **M**>F, **smoker**
- Best diagnostic clue:
 - Reticulonodular opacities in upper and middle lung zones in a smoker
 - Bilateral symmetric
 - Upper and middle lung zones, **sparing C-P** angle
 - Preserved or increased lung volume

Pulmonary Langerhans Cell Histiocytosis (PLCH)

■ CXR findings:

- Diffuse symmetric **nodular** and **reticulonodular** opacities
 - Multiple ill-defined nodules, 1-10mm
 - Cyst, 1-3cm
- **Upper** and **middle** lung zones, **sparing C-P angle**
- **Lung volume: preserved or increased**
- Recurrent **pneumothorax**
- Early stage: nodular, advanced: reticulonodular, Late stage: coarse reticular (honeycombing)

Pulmonary Langerhans Cell Histiocytosis (PLCH)

- HRCT findings:

- **Nodules: 60~80%**

- Centrilobular, peribronchial, peribronchiolar

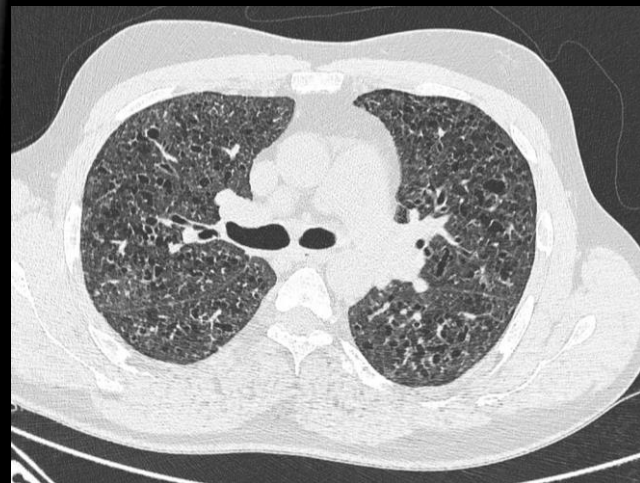
- **Cysts:** more common than nodules, **80%**

- 奇形怪狀 (septated, lobulated, spherical, confluent, bizarre)

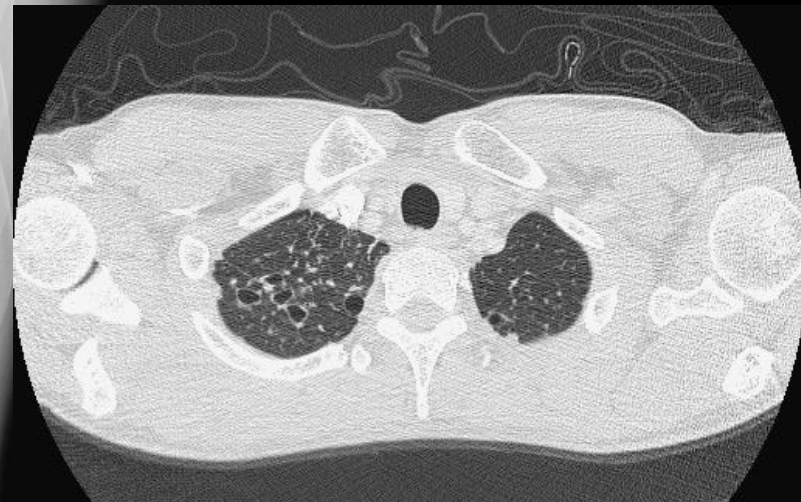
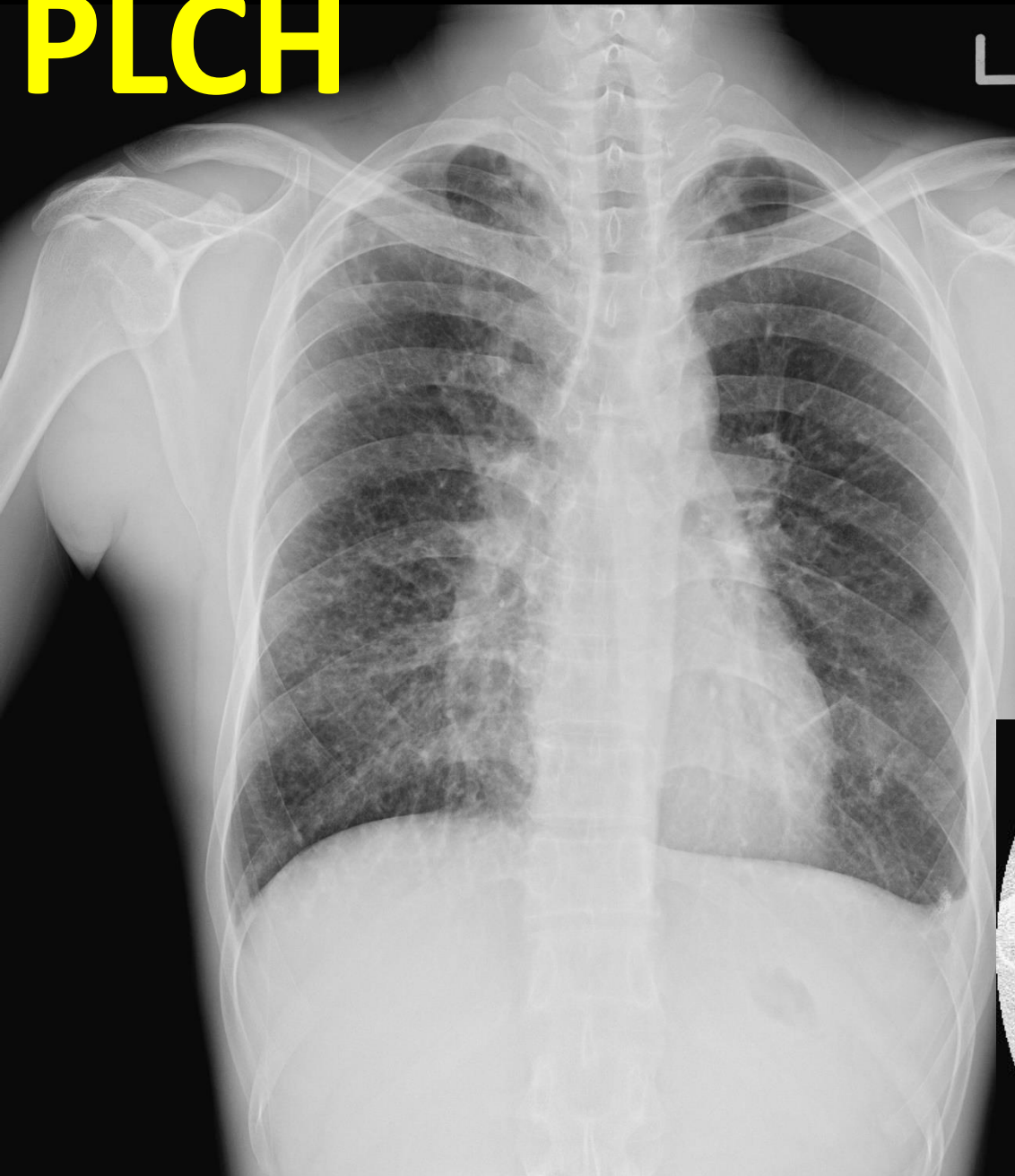
- 大小、壁厚不一致

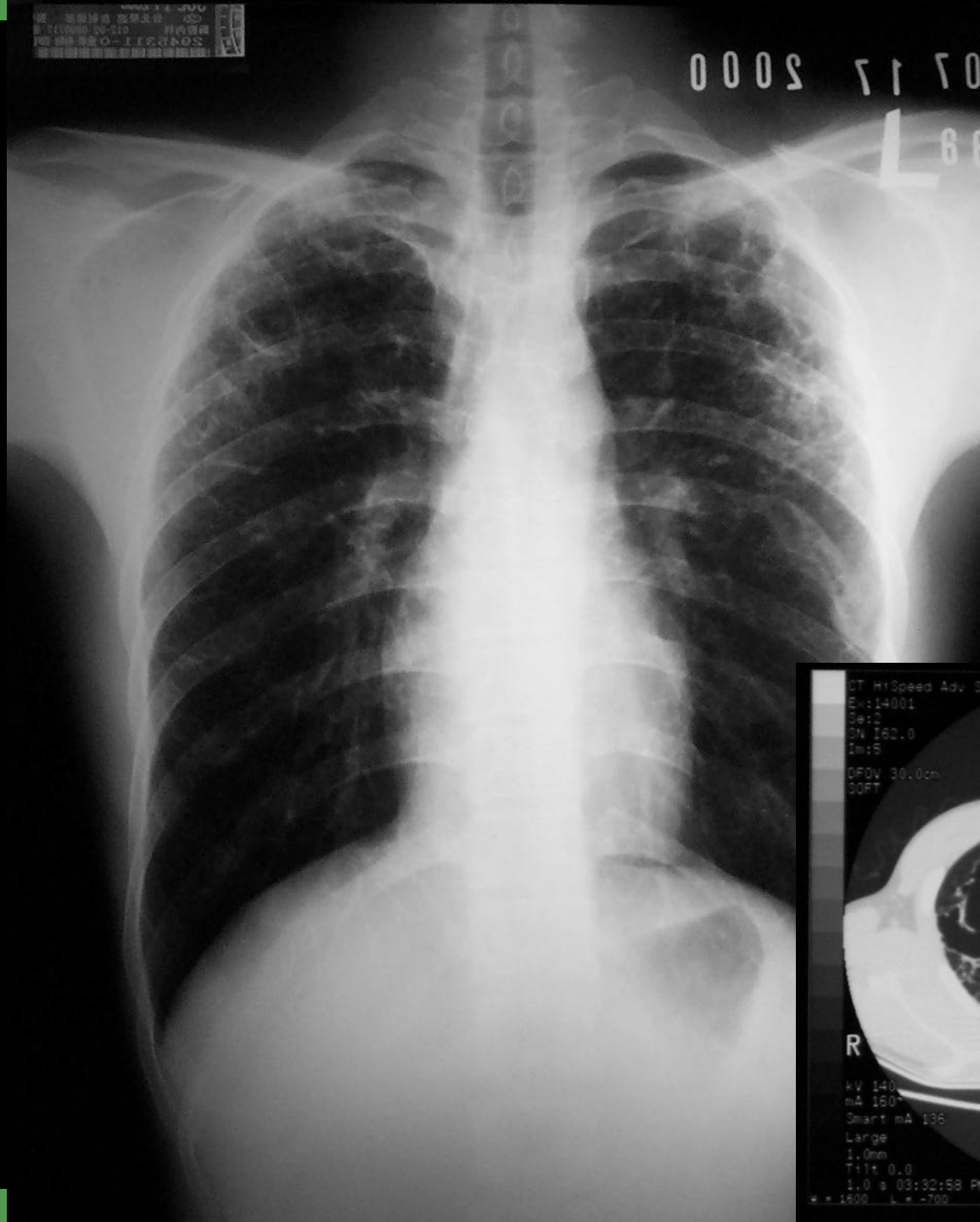
R

PLCH



PLCH





PLCH



Diffuse Micronodular Lesion 判讀攻略

■ 位置(main location)

■ Upper lung

1. Pneumoconiosis
2. Sarcoidosis
3. PLCH

■ Lower lung

1. Metastasis
2. Miliary TB: diffuse, 但lower lung比較大顆一點
3. DPB: diffuse, 但lower lung比較大顆一點
4. Hypersensitivity pneumonitis (acute, subacute stage)

■ C-P angle

■ C-P angle(+)

1. Favor hematogenous spread
2. Ex: metastasis, miliary TB

■ C-P angle(-)

1. Favor inhalation-related
2. Ex: Pneumoconiosis, HP

■ 會鈣化的diffuse micronodular lesions

1. Varicella-zoster virus pneumonia
2. Histoplasmosis: 台灣沒有
(註) Miliary TB不會鈣化

Diffuse Micronodular Lesions 的判讀攻略

各etiology的相關findings很重要

■ Metastasis

1. Enlarged neck/mediastinal/hilar LAP
2. Primary: lung, thyroid (neck), breast (s/p mastectomy), HCC (s/p TAE, abnormal R't diaphragm shadow)

■ Pneumoconiosis

1. Egg-shell hilar LAP
2. PMF, fibrotic change
3. Pneumothorax

■ Miliary TB

1. Enlarged LAP
2. Associated TB change over typical region

■ DPB

1. Triad: micronodule, bronchiectasis, bilateral hyperinflation

■ Sarcoidosis

1. Typical LAP (1-2-3 sign) in stage 2

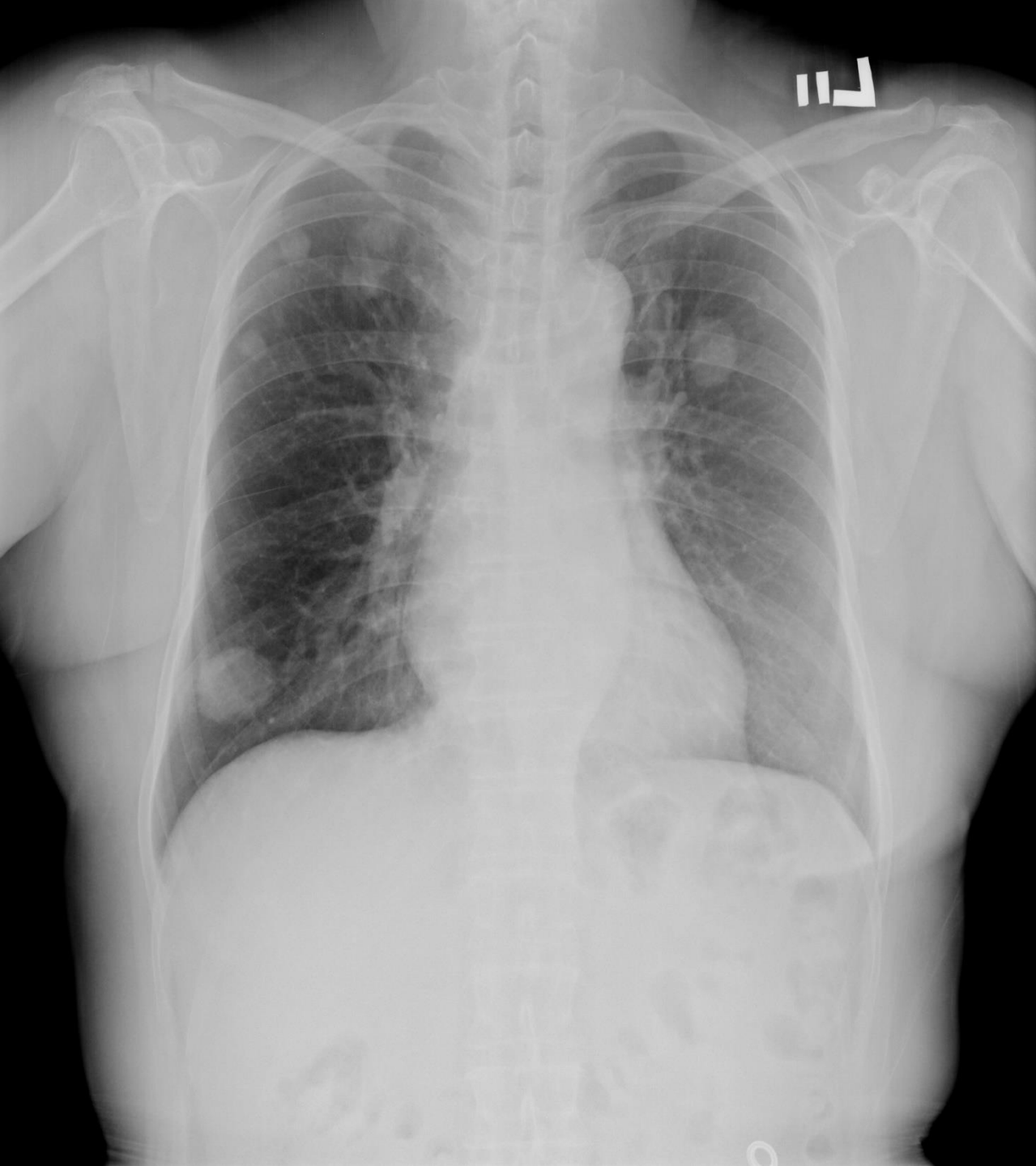
■ Hypersensitivity pneumonitis

1. Poorly-defined nodule and consolidation
2. Air-trapping when expiratory film

■ PLCH

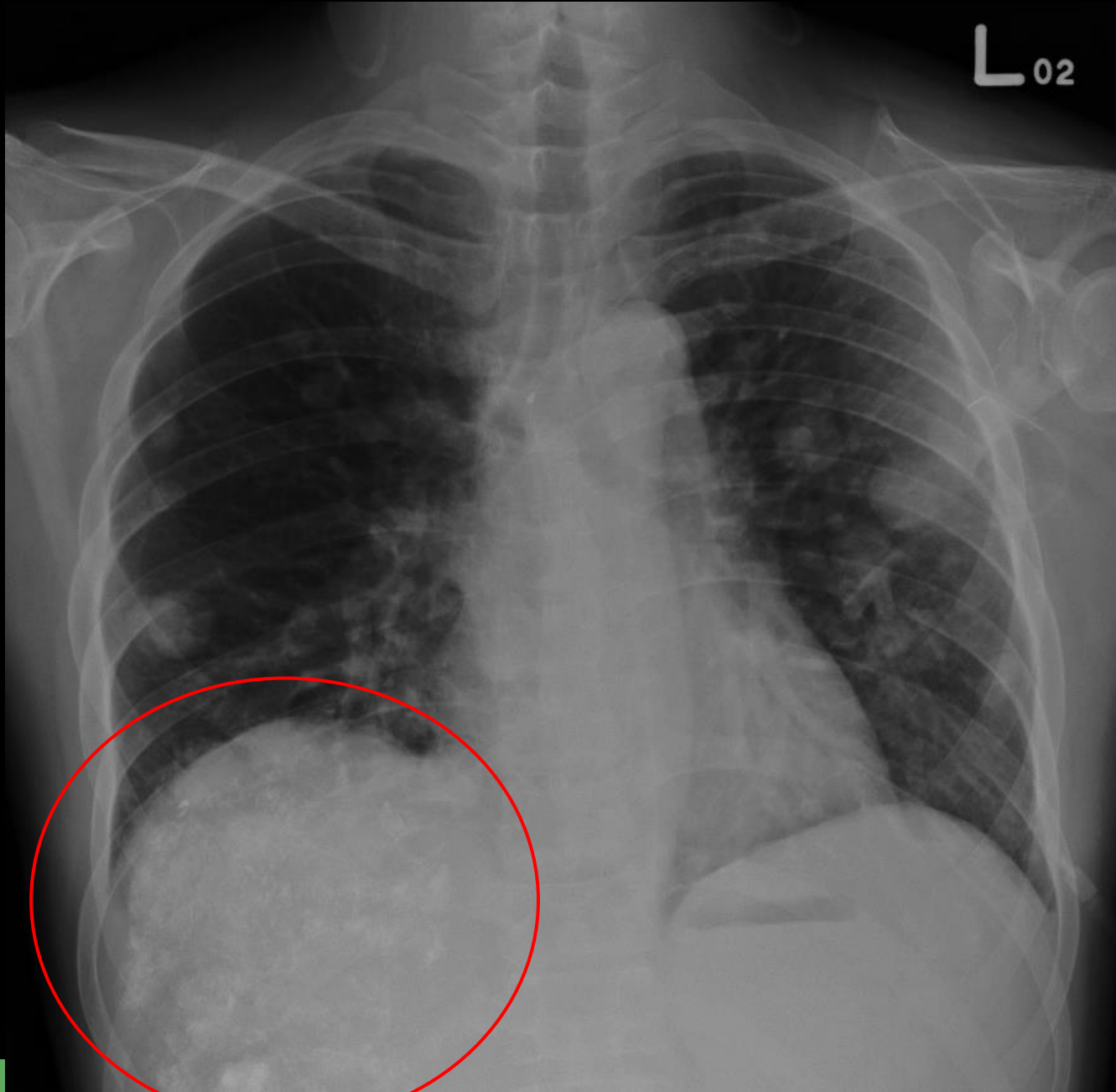
1. Young patient
2. Associated reticular or cystic change

Quiz



Breast cancer with
lung metastasis
- s/p R't mastectomy

Hepatoma with lung metastasis





Leukocytosis
Fever
Chillness

Multiple nodules with ill-defined margin
Dx: Septic embolism
(S. aureus)

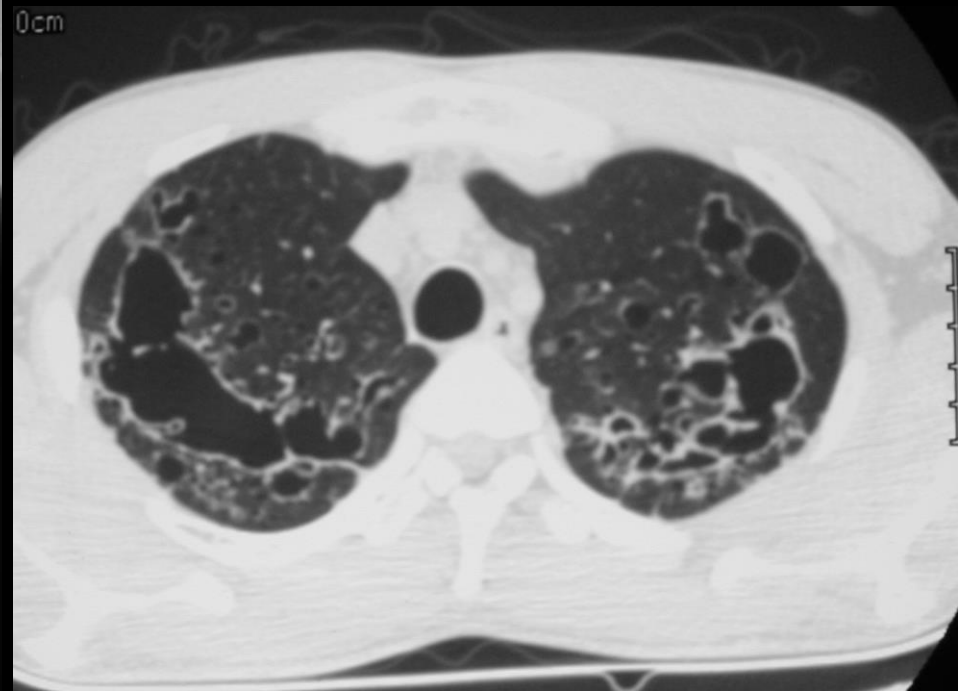
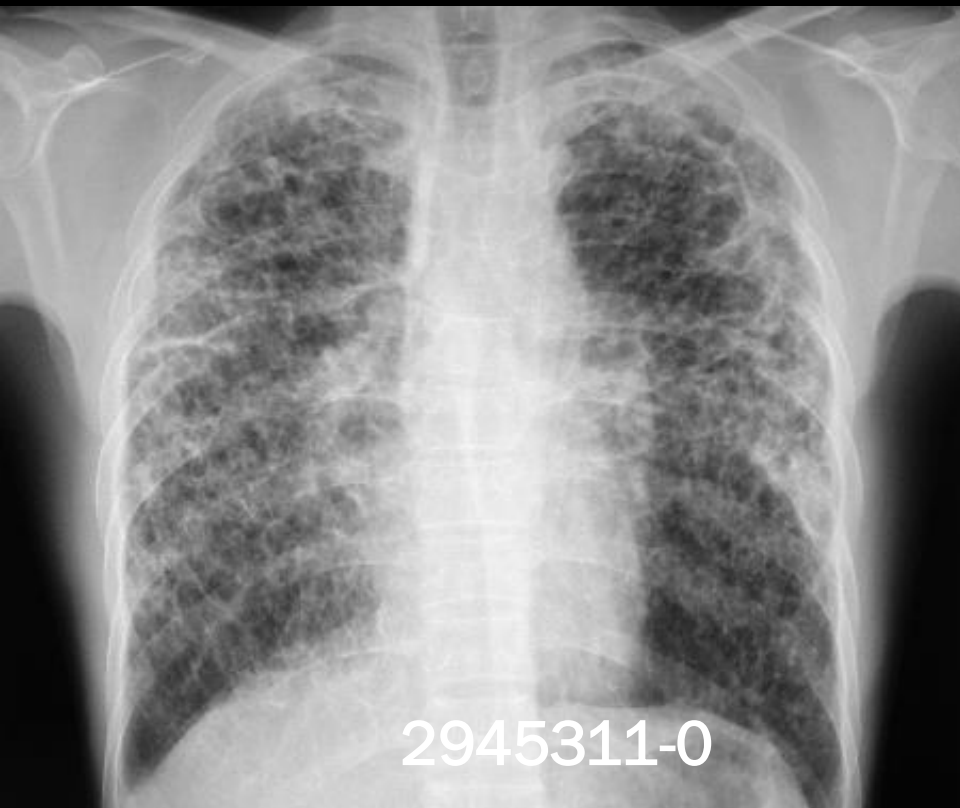
Diffuse micronodular lesions, bilateral Miliary TB



Pneumoconiosis with Progressive massive fibrosis



Pulmonary Langerhans cell histiocytosis





Neurofibromatosis with lung involvement