光田醫療社團法人 光田綜合醫院 Kuang Tien General Hospital
since1913

109 年胸部影像判讀繼續教育課程(北區)

肺結節與腫瘤判讀
(Interpret Lung Nodules vs. Masses)

光田綜合醫院　胸腔內科暨肺癌主任
何明霖 Ming-Lin HO, M.D. ,Ph.D.

肺結節與腫瘤：定義 Definition

- 根據Fleischner Society提出的用於胸部成像的術語表
  - 肺結節 (Lung/Pulmonary nodule)：定義為直徑< 3 cm的大致圓形不透明(Opacity)或定義不清。
    - 單獨的肺結節 (Solitary Pulmonary Nodule, **SPN**)：肺單獨的，局限的，不透明的，無相關的肺、胸膜或縱隔異常，直徑小於3 cm
      - Completely **surrounded** by lung parenchyma
      - It occurs in 1 every 500 CXR
  - 肺部腫塊 (Lung mass)：直徑≥ 3 cm的圓形病變，除非經過組織學證實，否則不可以立刻考慮為肺癌。
      - 95% malignancy

Glossary of terms for thoracic imaging. Radiology. 2008;246:697–722.

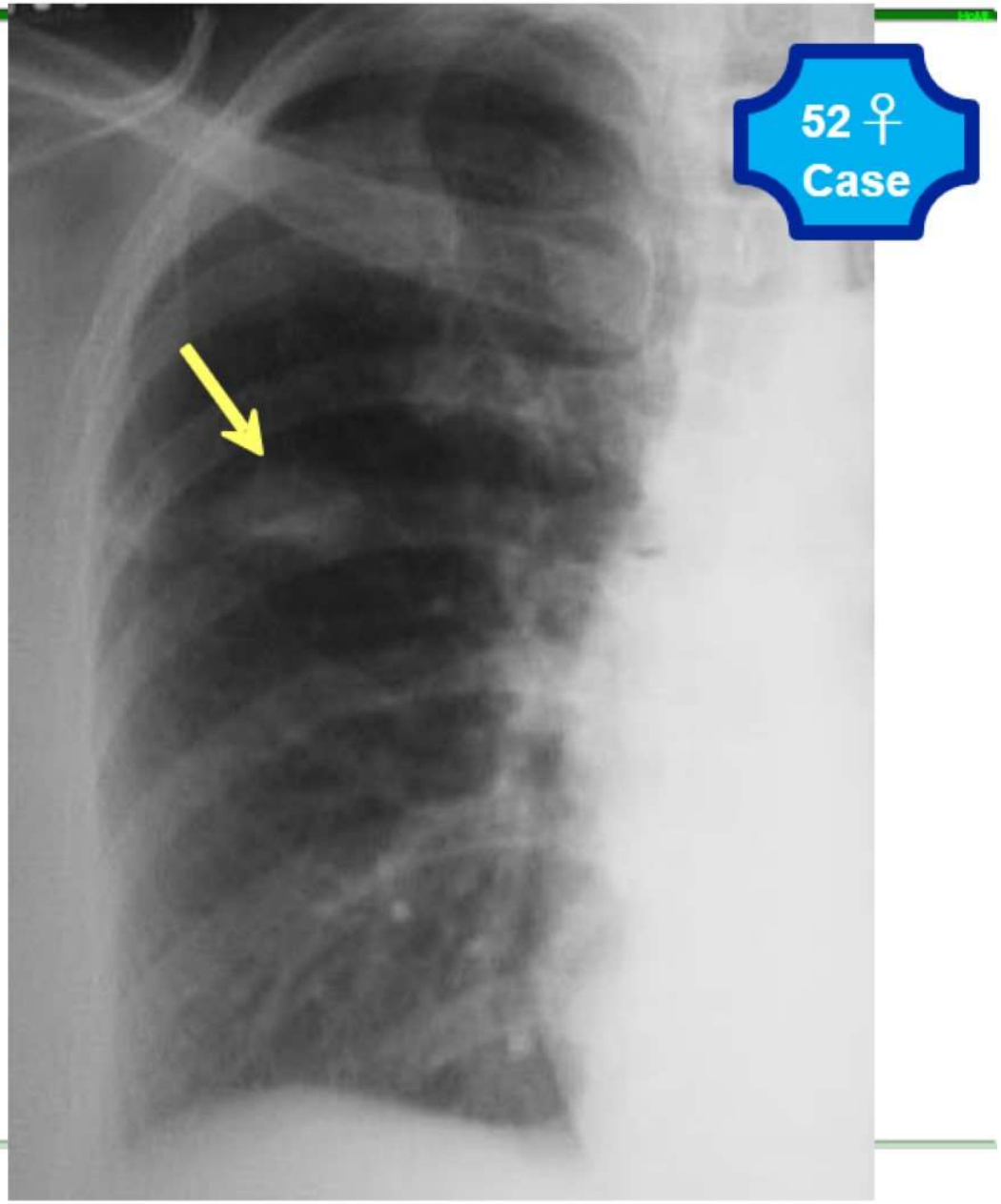
Size

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

Miliary nodule micronodule Nodule Mass

52-years old lady went for a health check-up

She has a 2.2 cm
sized nodule
in the right mid-zone

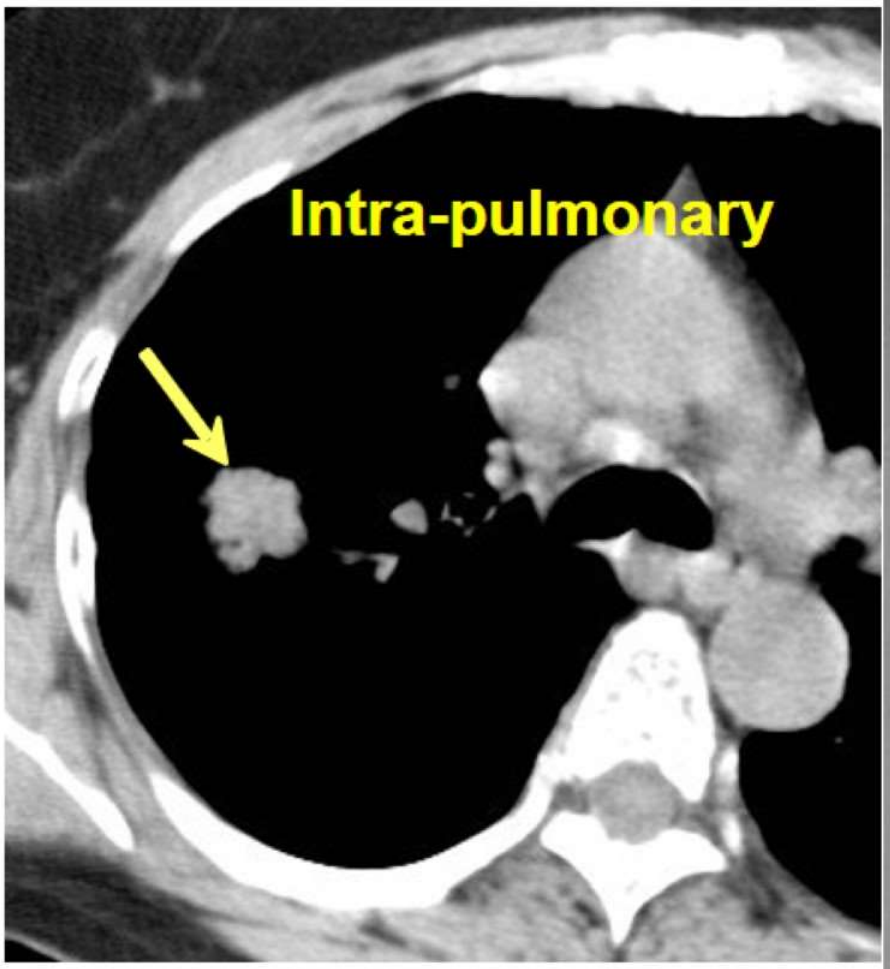


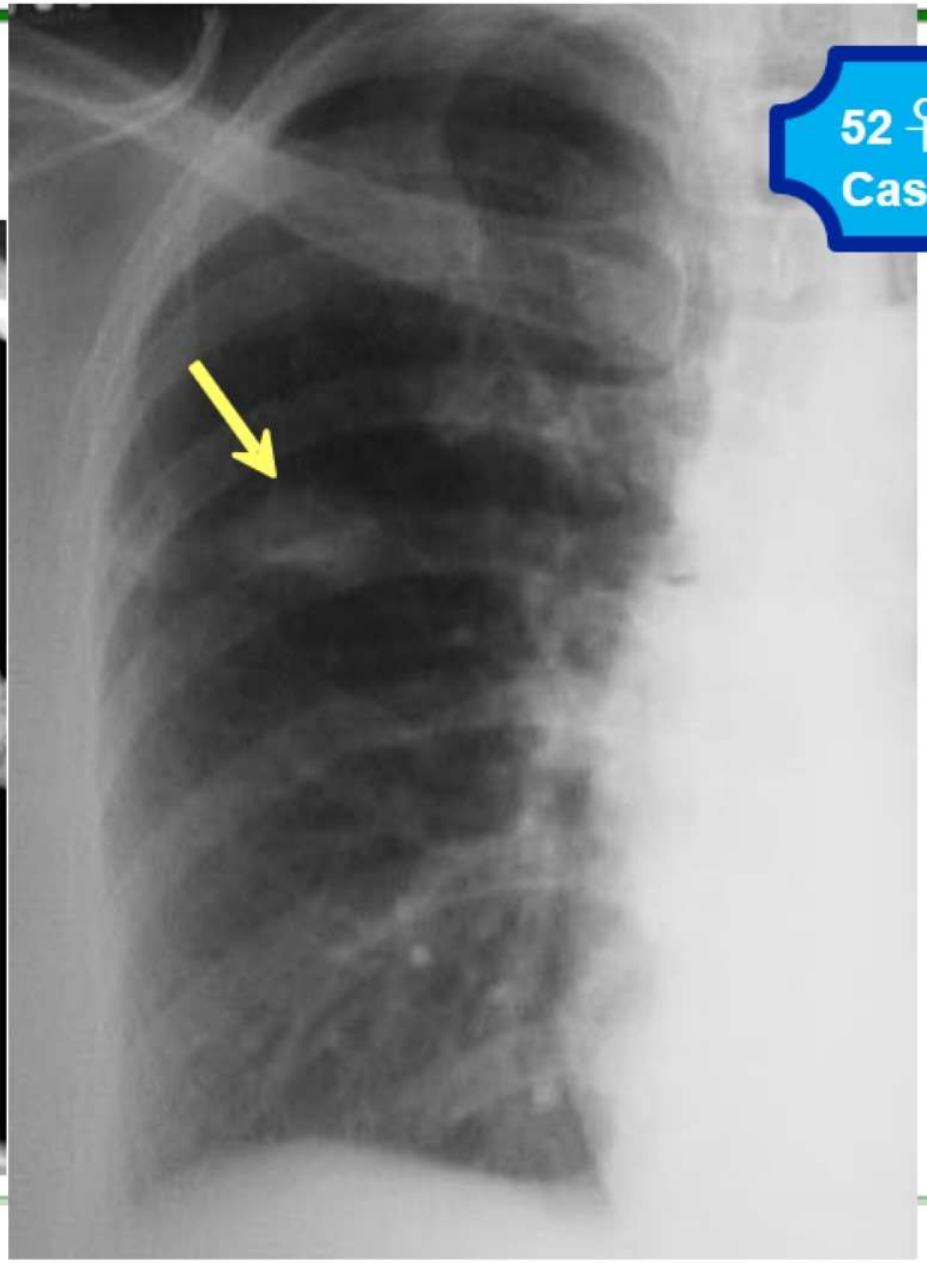
■ Next Steps

1. Do nothing
   - old granuloma
2. Aggressive
   - suspected malignancy
3. Give antibiotics ?
4. Investigate further

52-years old lady went for a health check-up

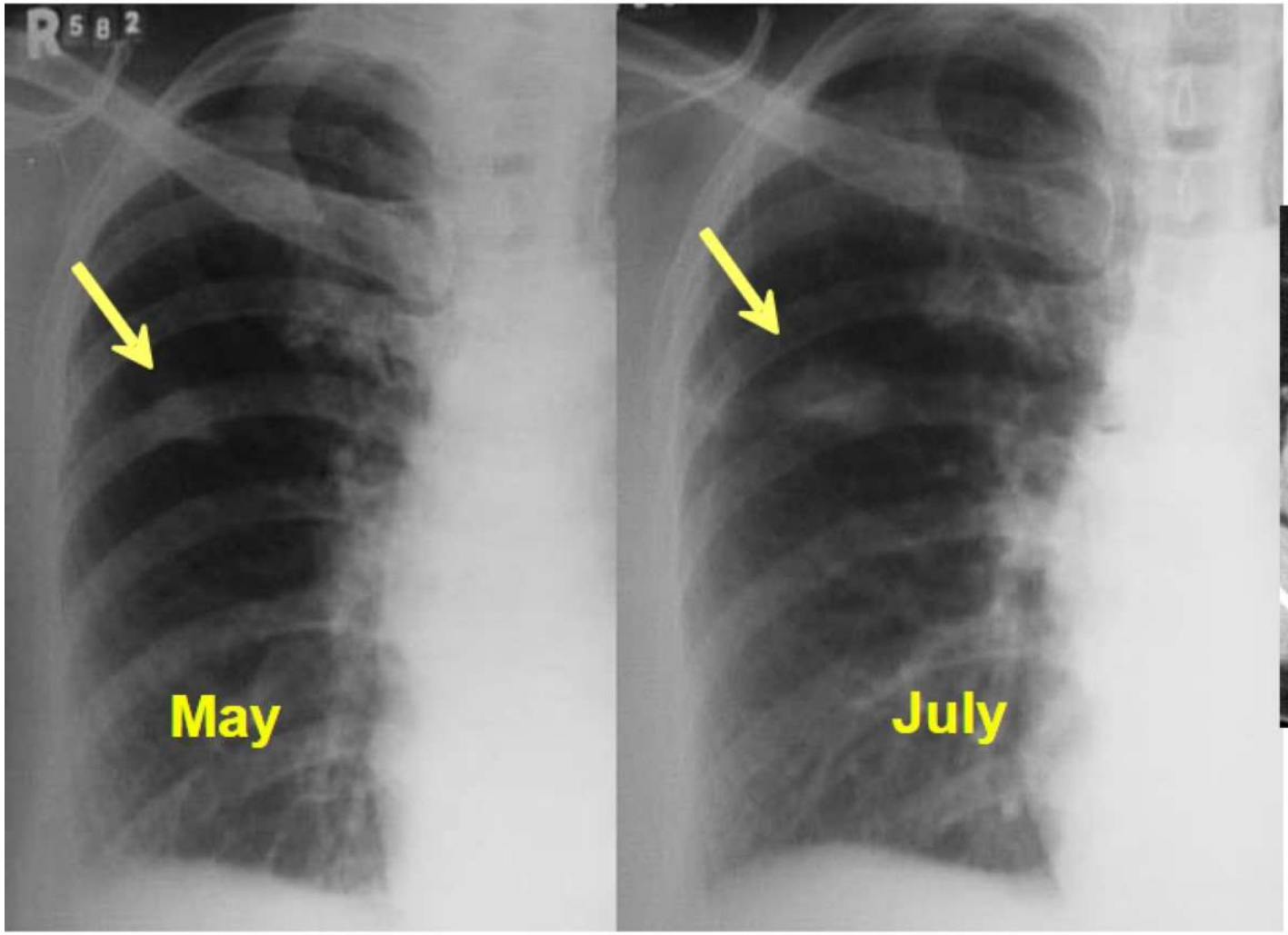
She has a 2.2 cm





52-years old lady went for a health check-up

CT scan show the lesion to be in the right upper lobe

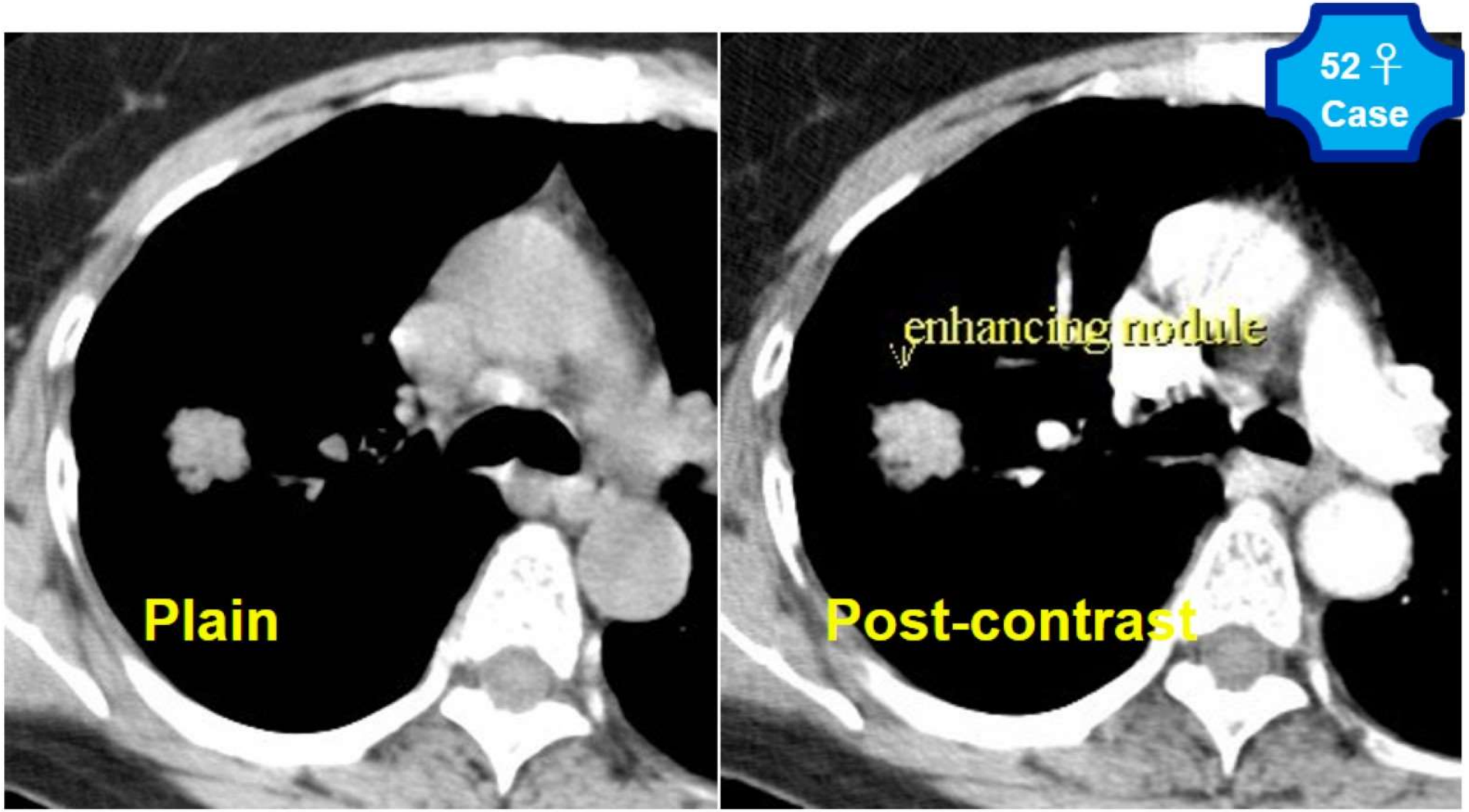


52 ♀
Case

She shows a significant increase in size over 2 ½ months

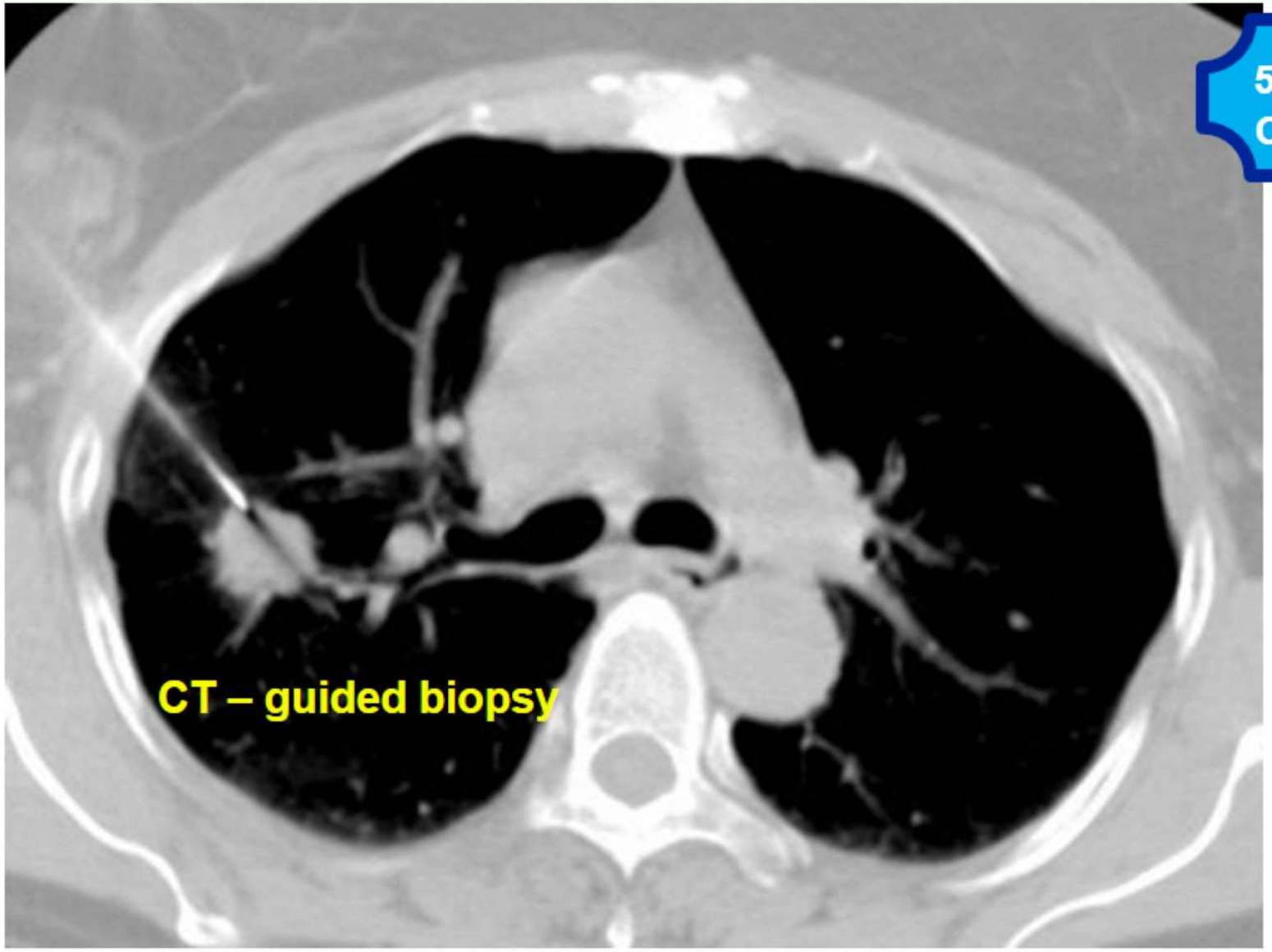
52-years old lady went for a health check-up

CT scan show the lesion to be in the right upper lobe



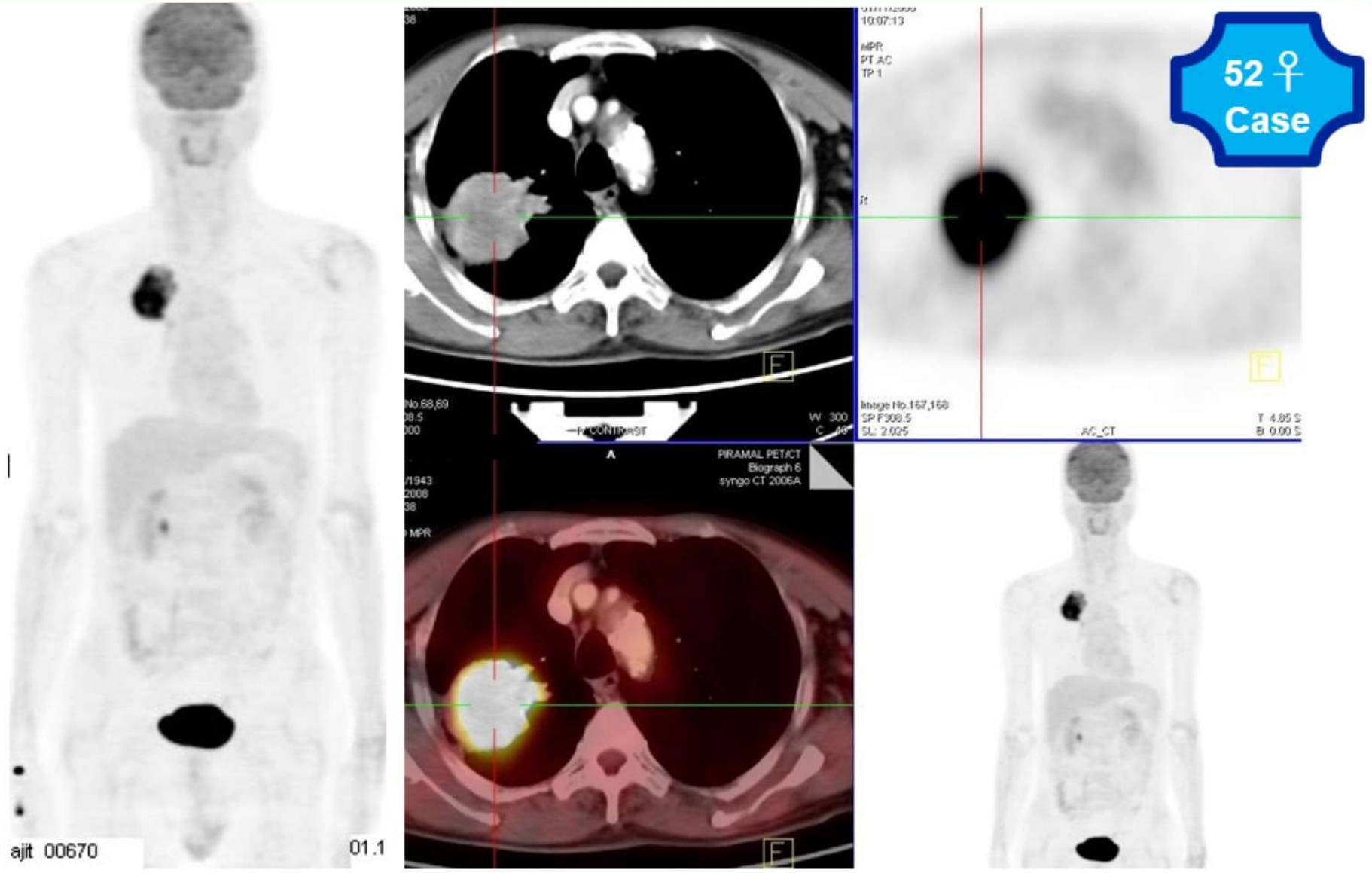
Contrast-enhanced study shows enhancement

52-years old lady went for a health check-up



52-years old lady went for a health check-up

Bronchogenic carcinoma – operable (T2N0M0)



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肺結節鑑別診斷
Lung nodules differential diagnosis

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- 腫瘤 Neoplasms
  - 惡性的 Malignant
    - 支氣管肺癌 Bronchogenic lung cancer
    - 淋巴瘤 Lymphoma
    - 類癌 Carcinoid
    - 肉瘤 Sarcoma
    - 肺轉移 Lung metastases
  - 良性 Benign
    - 錯構瘤 Hamartoma
    - 軟骨 Chondroma
    - 脂肪瘤 Lipoma
    - 呼吸性乳頭狀瘤病 Respiratory papillomatosis
    - 肺良性轉移性平滑肌瘤 Pulmonary benign metastasizing leiomyoma
- 傳染病 Infections
  - 分枝桿菌 Mycobacteria
  - 真菌 Fungi
  - 圓形肺炎 Round pneumonia
  - 肺膿瘍 Lung abscess
  - 化膿性栓子 Septic emboli
  - 諾卡氏菌 Nocardia spp.
  - 包蟲囊腫 Hydatid cyst
  - Q發燒 Q fever
- 免疫介導的疾病 Immune-mediated diseases
  - 類風濕關節炎 Rheumatoid arthritis
  - 韋格納肉芽腫 Granulomatosis with polyangiitis
  - 結節性結節病 Nodular sarcoidosis
  - 組織性肺炎（隱源性或繼發性） Organizing pneumonia (cryptogenic or secondary)
  - 淋巴肉芽腫 Lymphoid granulomatosis
  - 壞死性結節性肉芽腫 Necrotizing sarcoid granulomatosis
- 先天性異常 Congenital abnormalities
  - 動靜脈畸形 Arteriovenous malformation
  - 支氣管囊腫 Bronchogenic cyst
  - 肺隔離 Pulmonary sequestration
  - 肺靜脈曲張 Pulmonary venous varix
  - 支氣管擴張支氣管閉鎖 綜 Bronchial atresia with bronchocele
- 其他 Miscellaneous
  - 圓形肺不張 Round atelectasis
  - 腎上腺內淋巴結 Endoparenchymal lymph node
  - 進行性纖維化 Progressive mass fibrosis
  - 炎性假瘤 Inflammatory pseudotumor
  - 澱粉樣變性 Amyloidosis
  - 類脂性肺炎 Lipoid pneumonia

Ann Thorac Med. 2019 Oct-Dec; 14(4):226–238.

常見的肺結節鑑別診斷

Common Lung nodules differential diagnosis

Malignant (Neoplasm)	**Primary lung carcinoma** Primary pulmonary lymphoma Primary pulmonary carcinoid tumor Solitary metastasis
Benign	**Hamartoma** Chondroma
Infectious	**Granuloma** (tuberculous, fungal) Round pneumonia/atelactasis Abscess
Non-infectious	Rheumatoid nodules Wegener granulomatosis

Vascular	Arteriovenous malformation Pulmonary infarct Haematoma
Congenital	Bronchial atresia Sequestration Bronchogenic cyst
Simulants of a solitary pulmonary nodule	External object (eg, **Nipple**, mole) Pseudotumor (fluid in fissure) Pleural plaque or mass Mucoid impaction

比較可能是惡性腫瘤的影像表現

Factors Influencing Probability of Malignancy

- Size
- Growth rate
- Attenuation and Enhancement on CT
- Margin
- Location
- cavitation
- Patient age
- Gender
- Smoking history
- Occupational history
- Endemic granulomatous disease

比較舊片最重要!!!

Bankier et al. Radiology 2017; 285:584-600

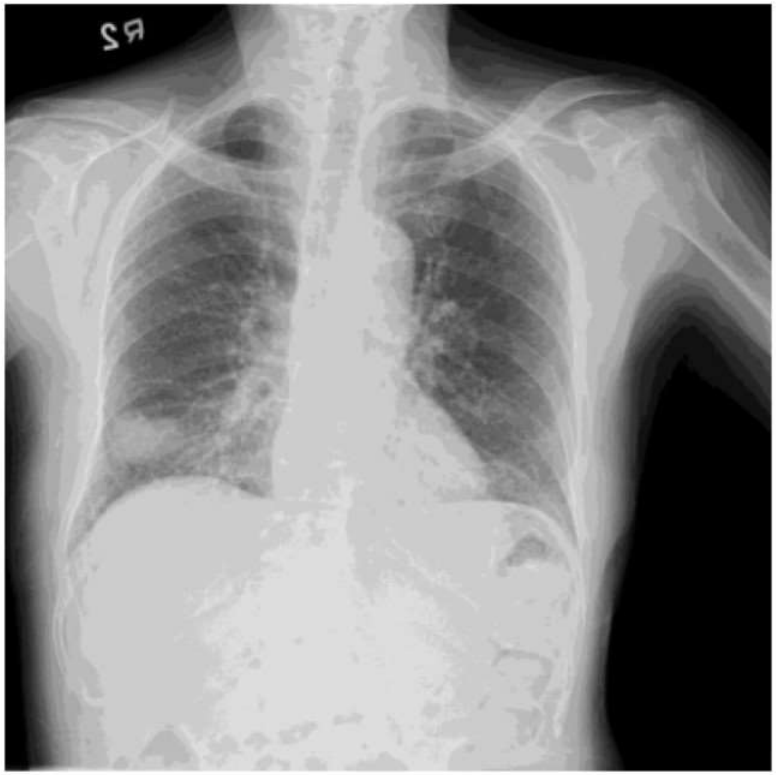
Past Cancer History

- In patients with **melanoma, sarcoma, or testicular carcinoma**, a malignant SPN is 2.5 times more likely to be a metastasis than a primary lung cancer
  - 在患有黑色素瘤，肉瘤或睾丸癌的患者中，**惡性SPN轉移**的可能性是原發性肺癌的2.5倍

- However, in patients with **head and neck squamous cell carcinoma**, a malignant SPN is 8 times more likely to be a primary lung cancer.
  - 但是，在患有頭頸部鱗狀細胞癌的患者中，惡性SPN患原發性肺癌的可能性是其的8倍。

Malignant history
Colon cancer with lung metastasis

Solitary pulmonary mass on RLL
History of colon cancer s/p op.

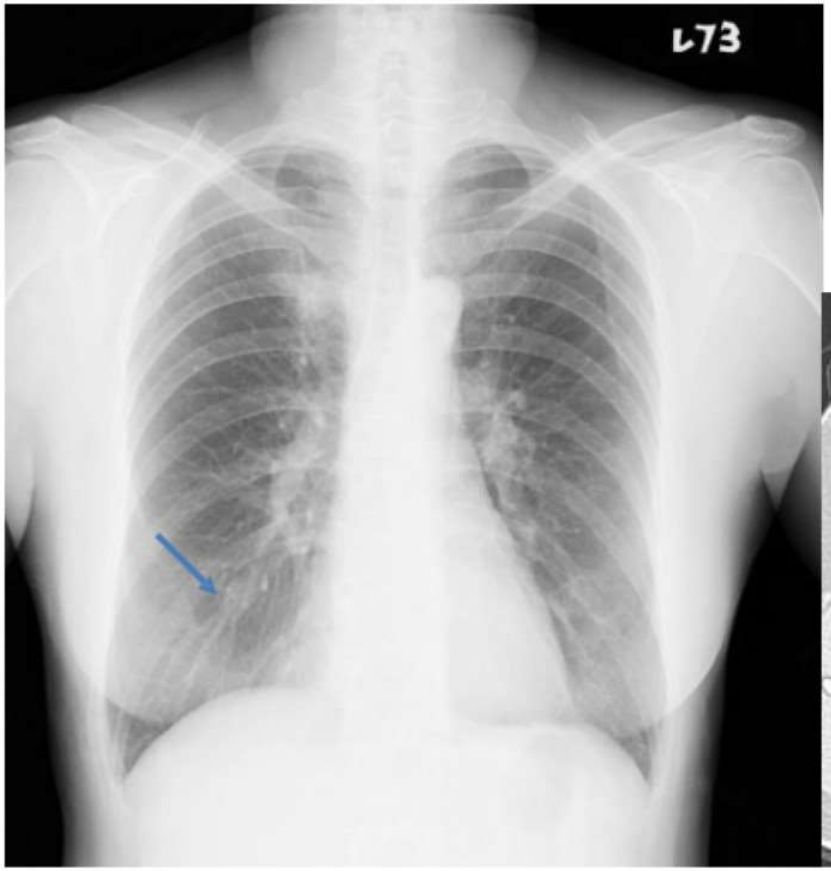


Dx: Colon cancer with lung metastasis

Malignant history
Adenocarcinoma of lung origin

GGO or part-solid nodule in extrapulmonary malignancy

Suggest primary lung cancer



Colon cancer s/p op.

Pulmonary nodule on RUL: adenocarcinoma of lung origin

肺結節/腫瘤的影像鑑別診斷

Image Analysis for Lung Nodules/Masses

1. Location: Intra-thoracic or extra-thoracic
2. Size/Diameter
3. Density: Solid/Sub-solid/Ground-glass
4. Margin/Shape
5. Growth rate/Doubling time
6. Calcification
7. Cavitation/Cavity wall thickness
8. Contrast enhancement
9. Multiple lung nodules
10. Satellite lesion

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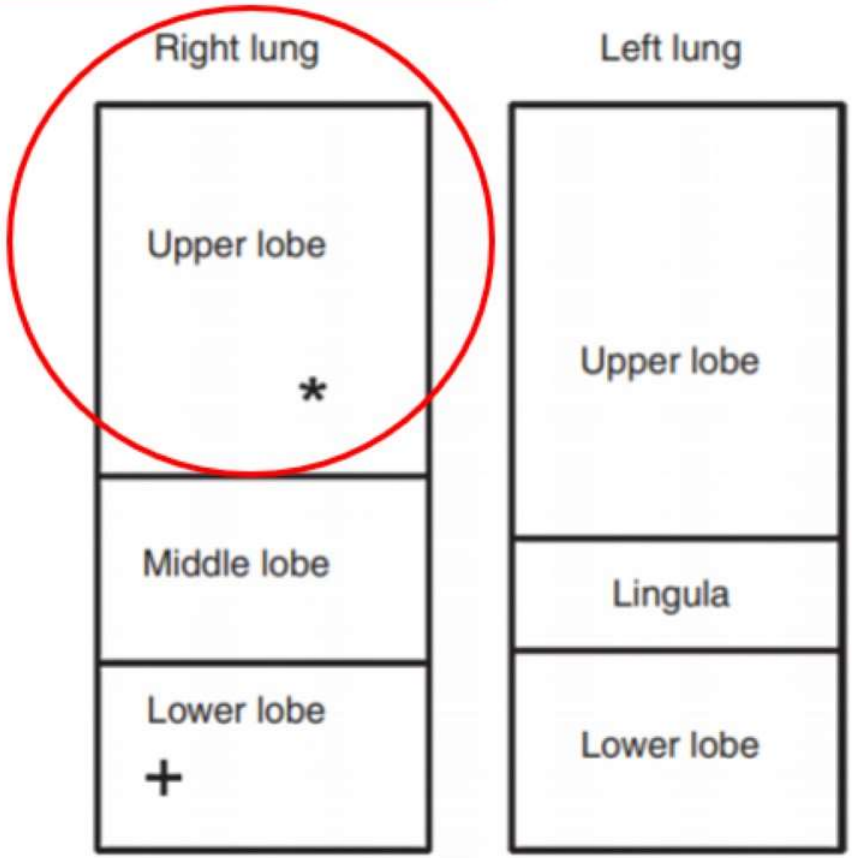
Research Article
See related article by Massion and Walker, p. 1173

Cancer Prevention Research

Short- and Long-term Lung Cancer Risk Associated with Noncalcified Nodules Observed on Low-Dose CT



*, NCN (noncalcified nodule)

+, Lung tumor

[Person level]

NCN pos/lung cancer pos

[Lung level]

Left lung: NCN neg/lung cancer neg

Right lung: NCN pos/lung cancer pos

[Lobe level]

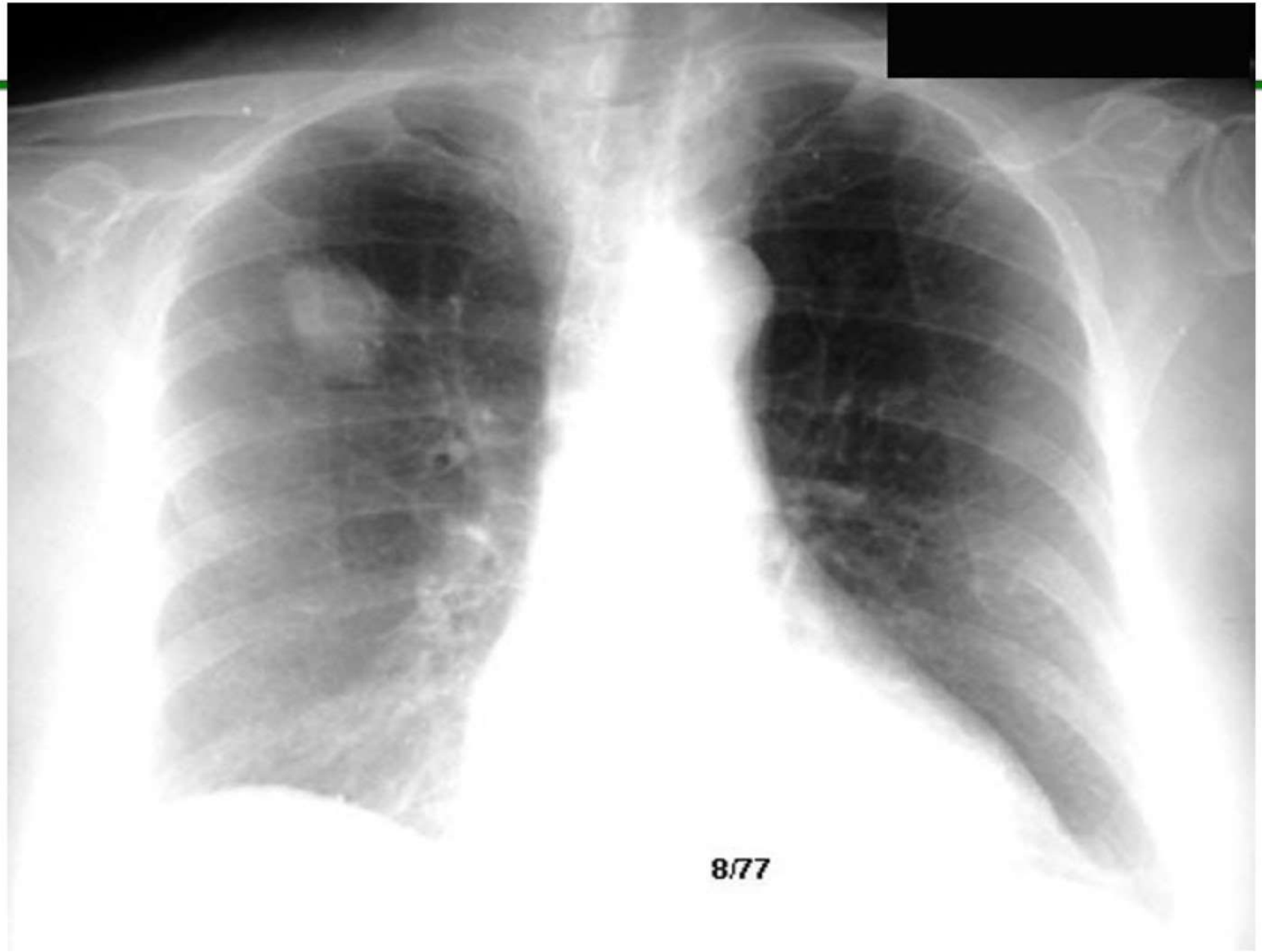
4 Lobes: NCN neg/lung cancer neg

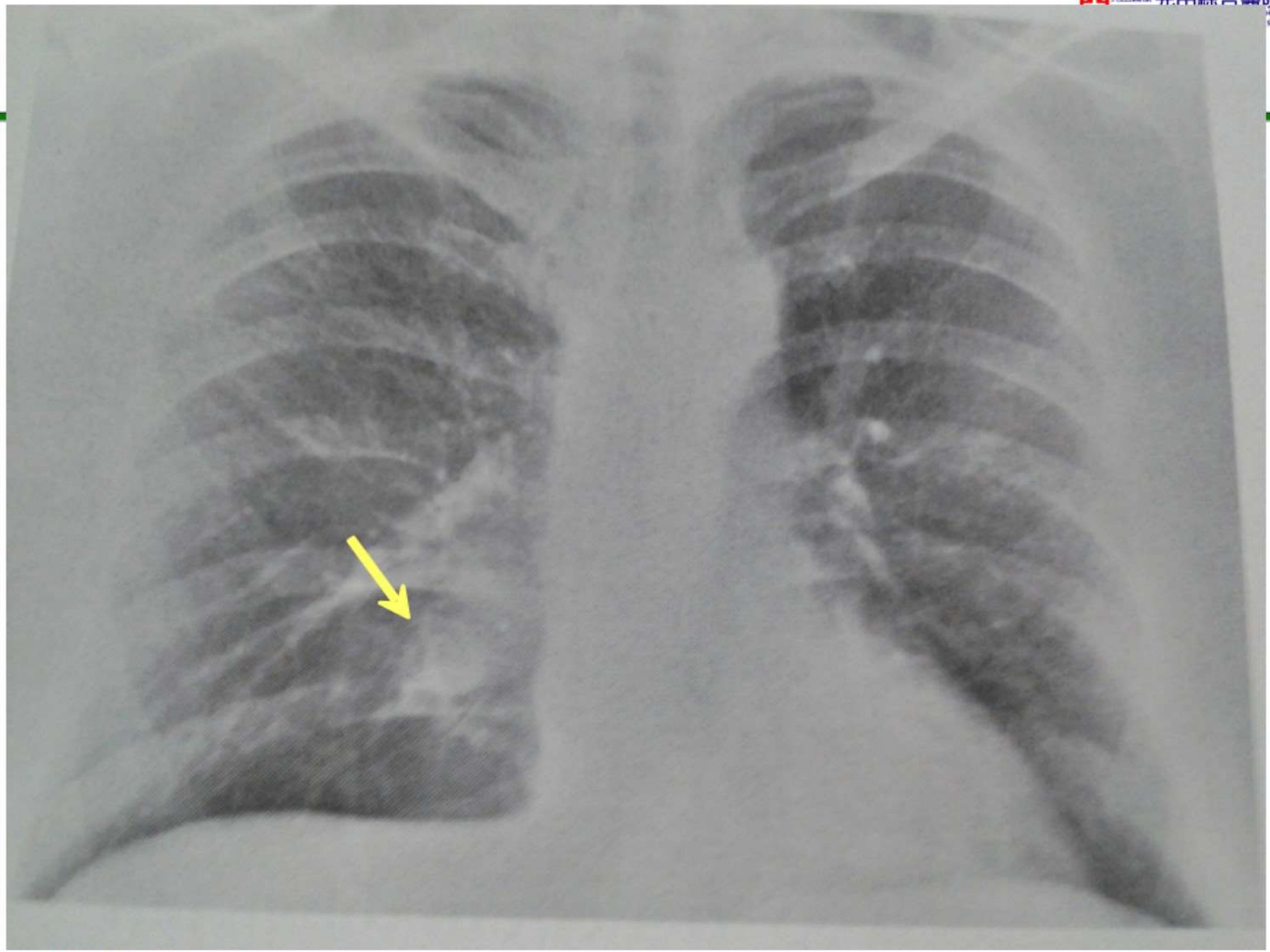
Right upper: NCN pos/lung cancer neg

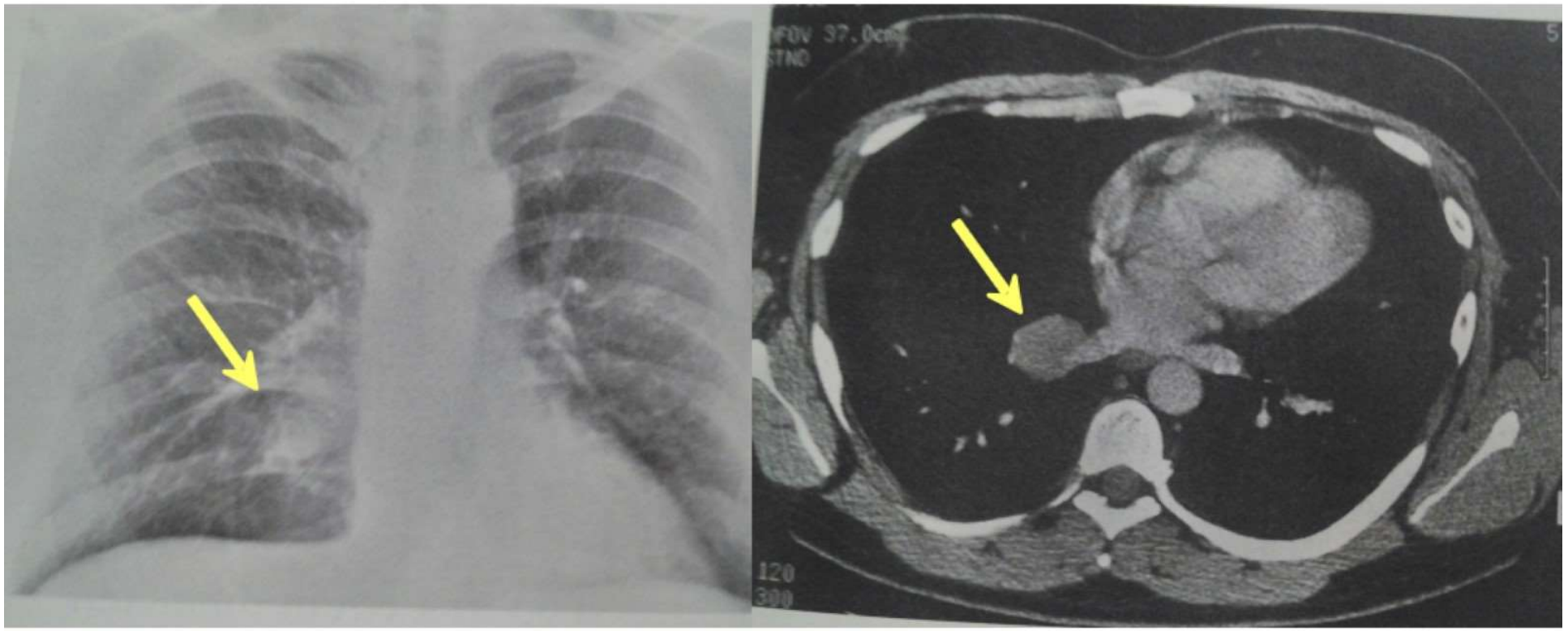
Right lower: NCN neg/lung cancer pos

先找到病兆(Lesion), …

Algorithm using a typical case

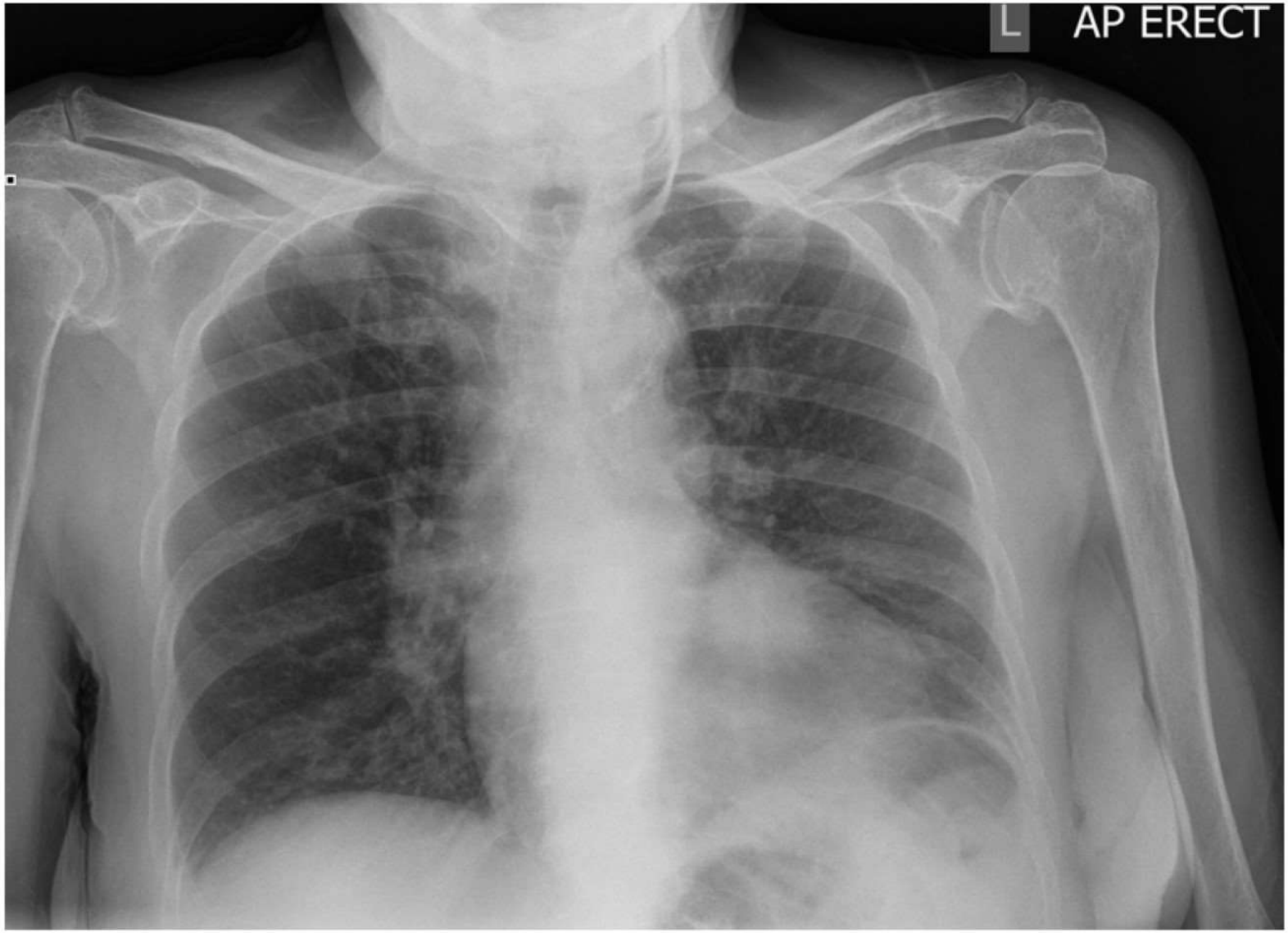

8/77



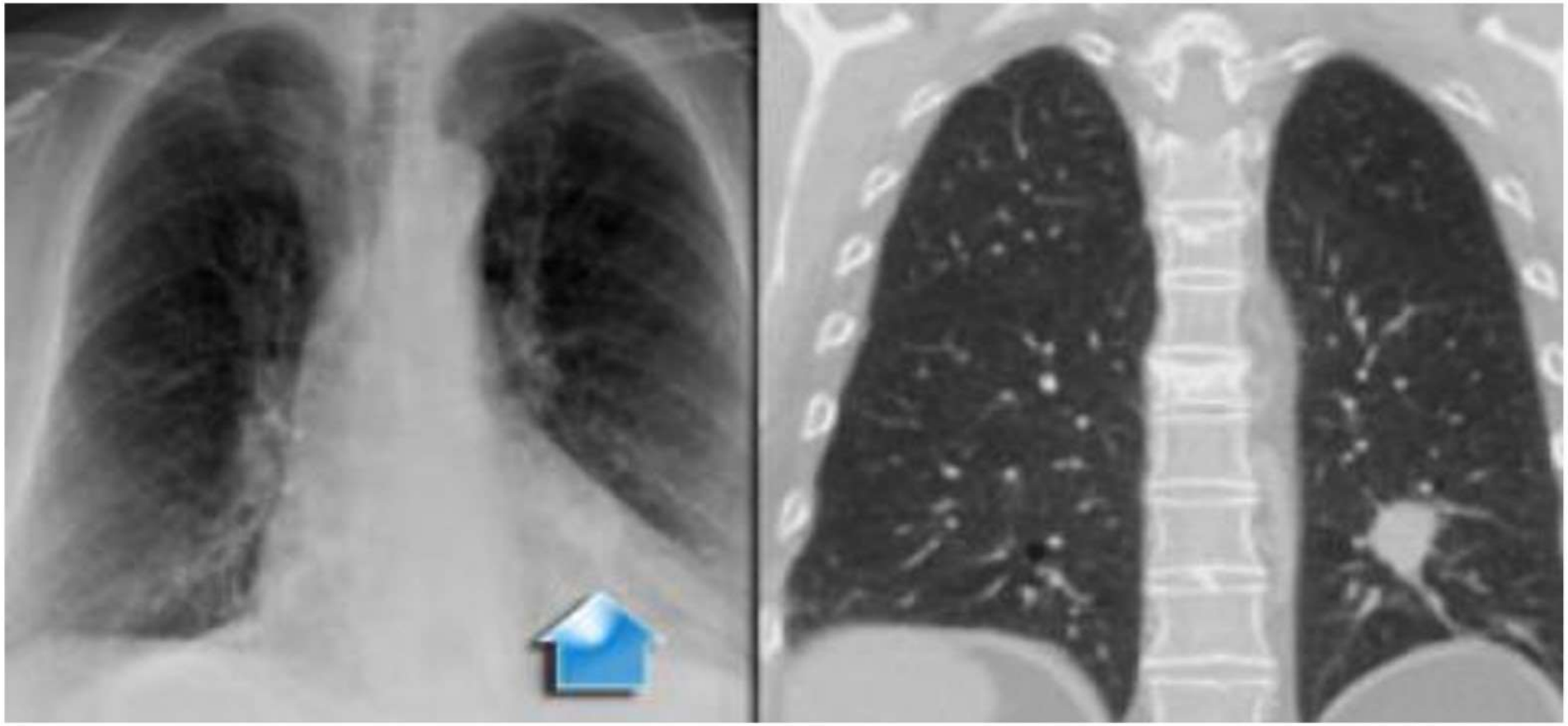


Left lower lobe (retrocardiac) lung cancer

Left lower lobe lung cancer



T1 tumor – A typical T1 tumor in the left lower lobe, completely surrounded by pulmonary parenchyma.



In patients with idiopathic fibrosis, lung cancers more commonly involve periphery of lower lobe

誤判

Miss reading on the CXR

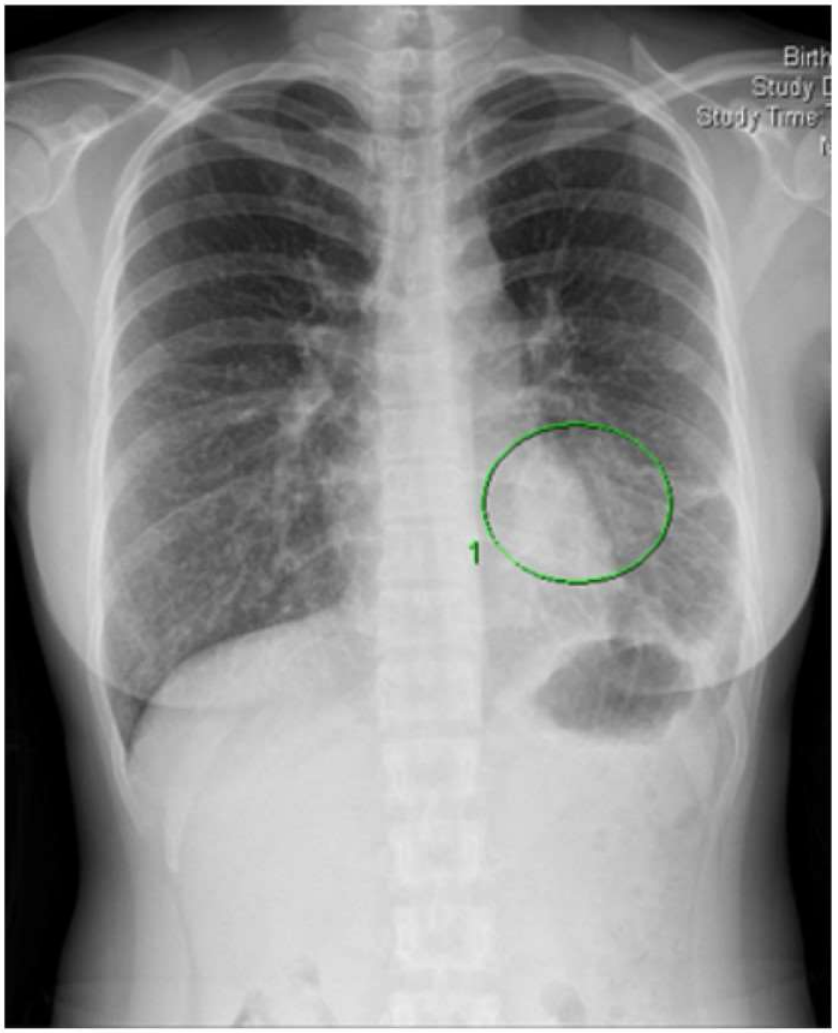
光田綜合醫院

Ming-Lin HO

Miss reading of lung cancer on the CXR

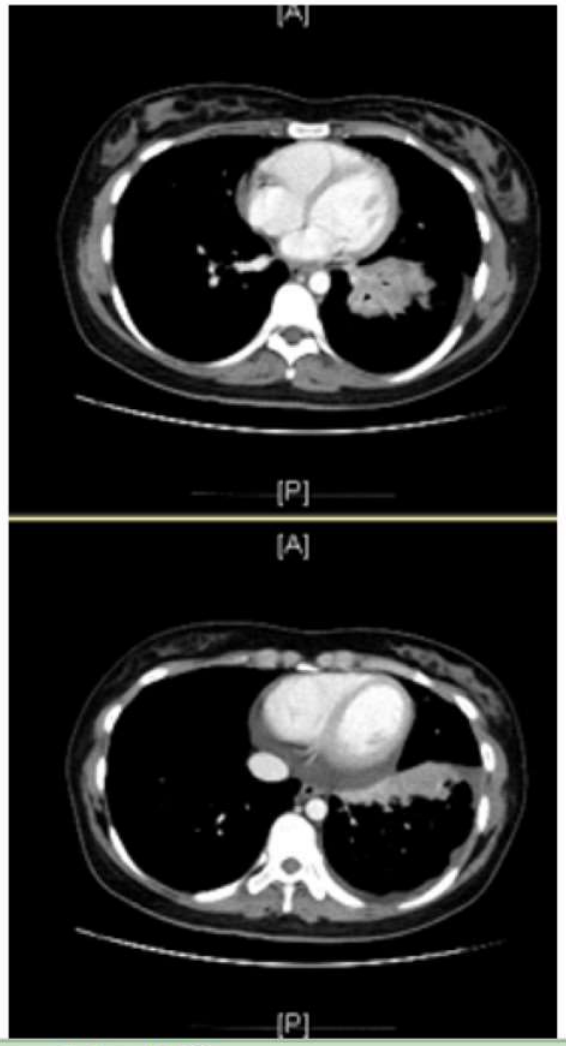
2018-08-13

2019-05-28

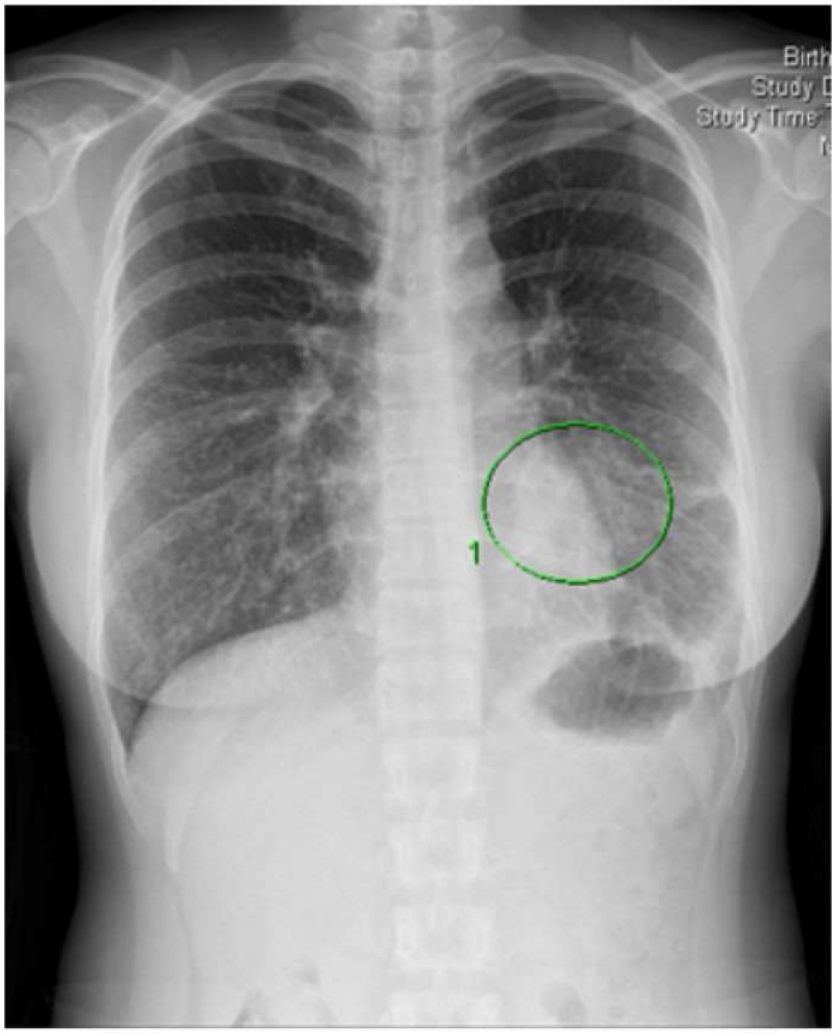


Miss reading of lung cancer on the CXR

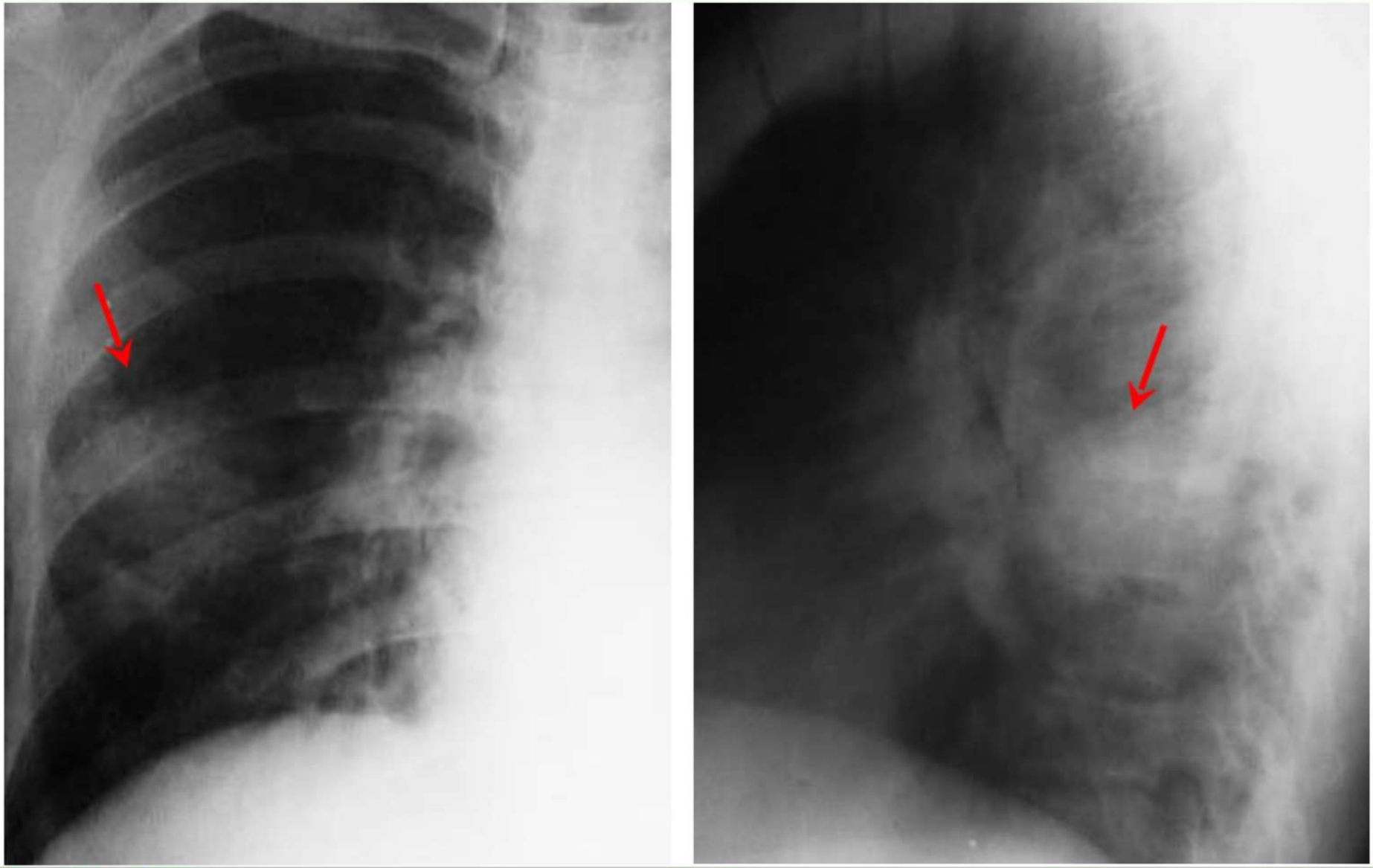
2019-05-30



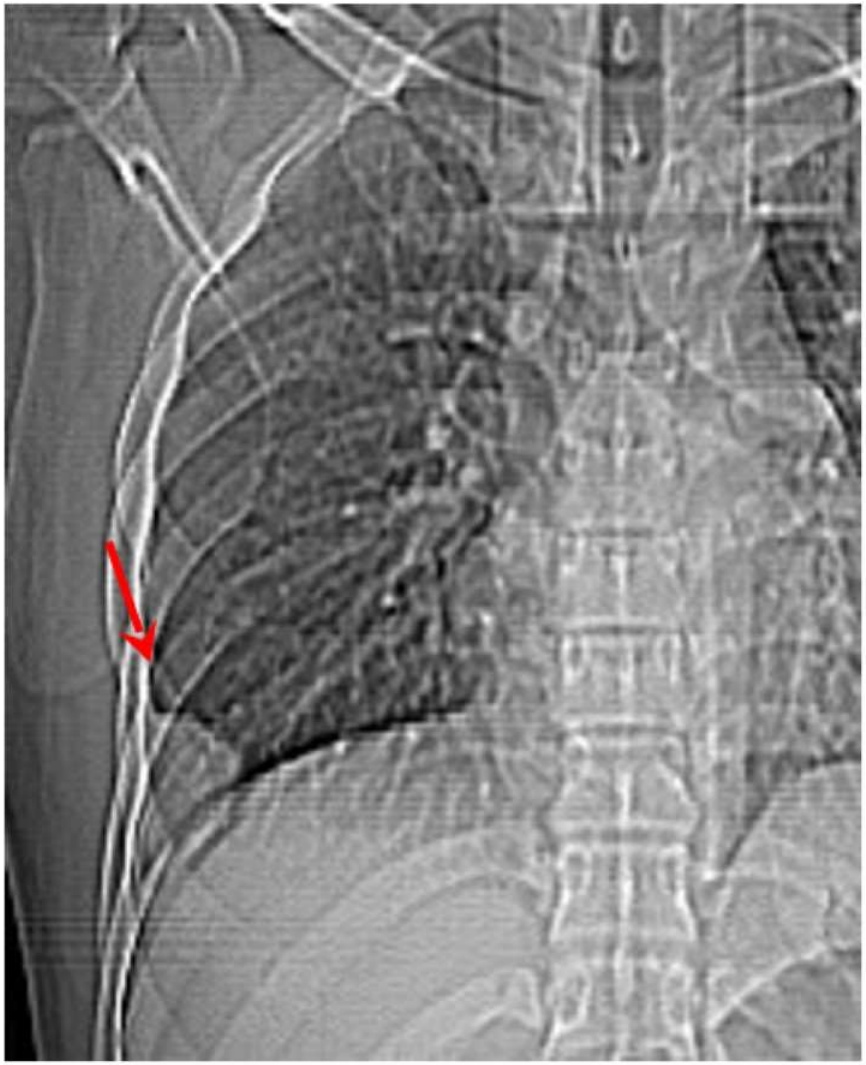
2019-05-28

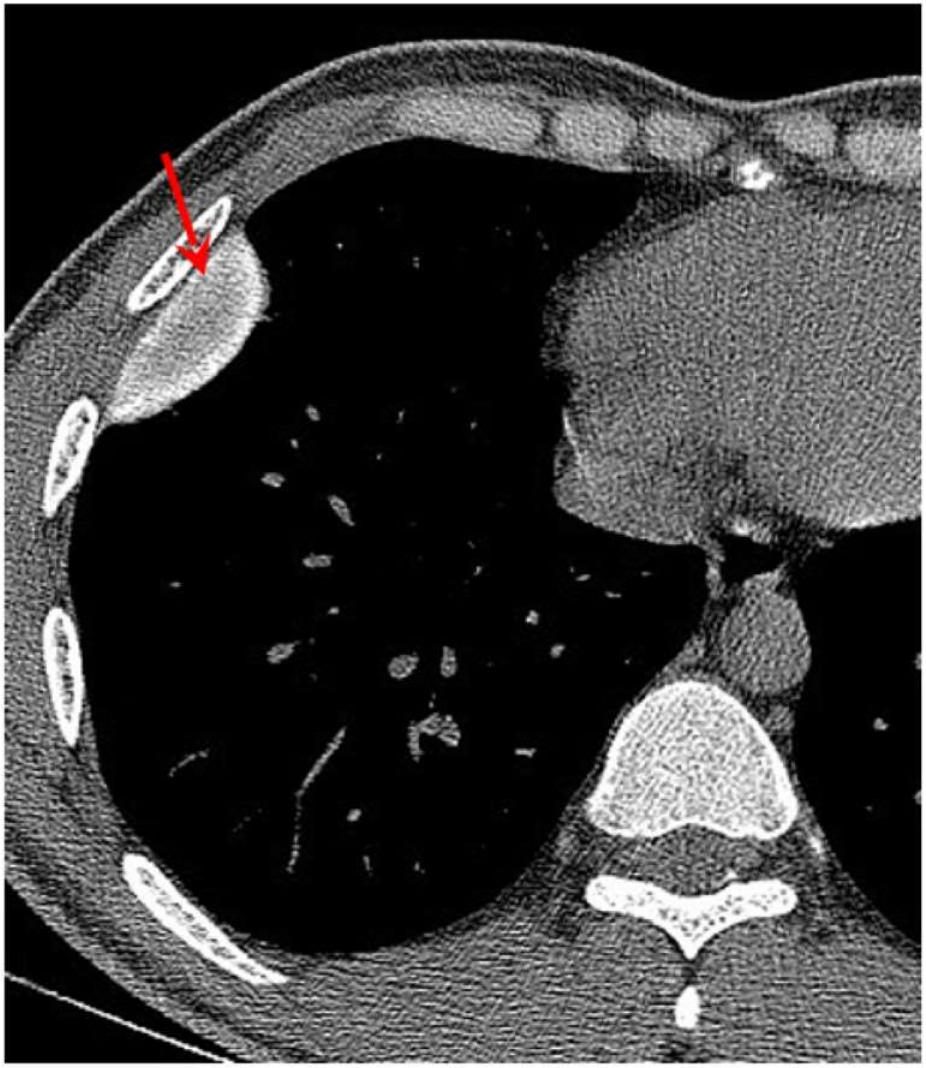


This lesion is intra-pulmonary – seen on both frontal and lateral radiographs in the lung

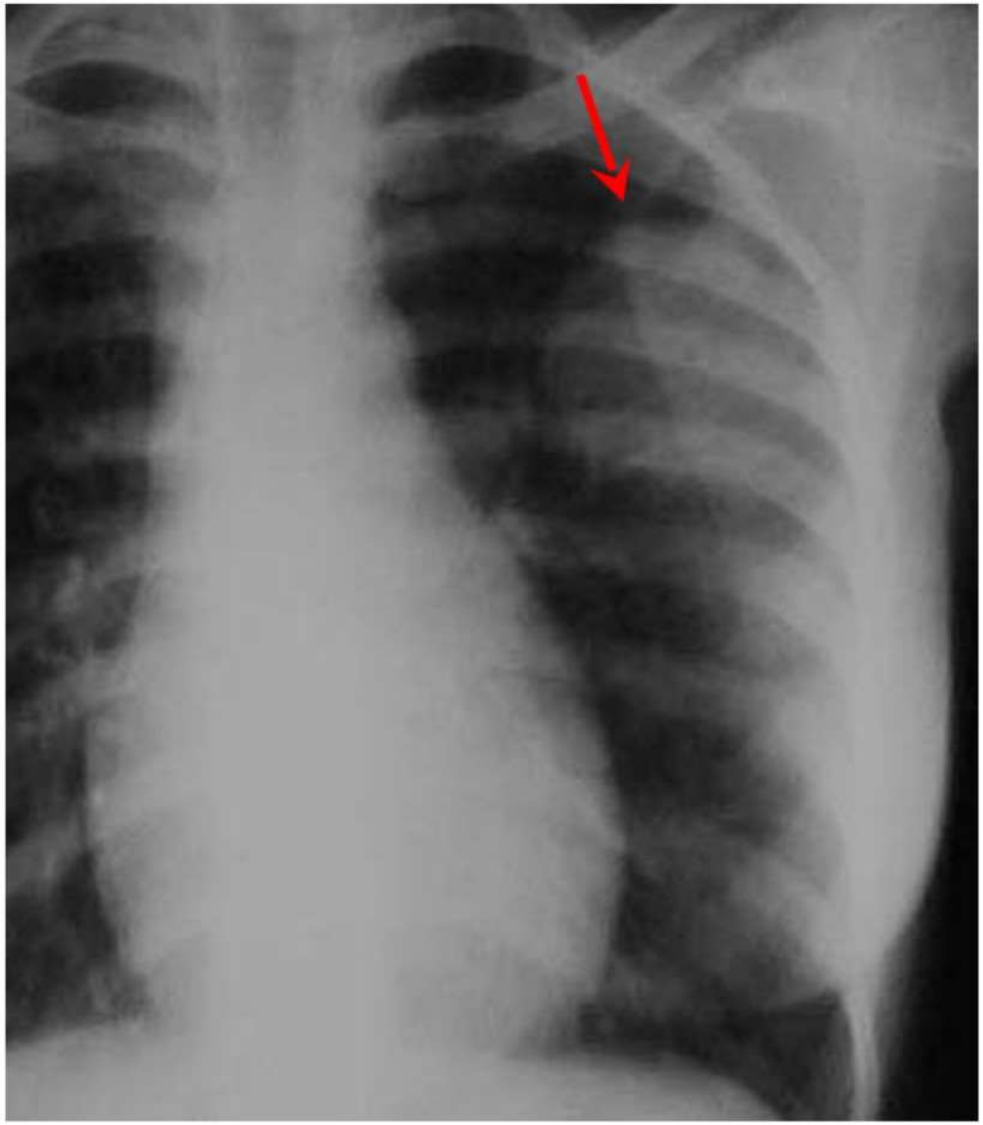


This lesion also pleural – probably an old calcified hematoma and hence not an SPN





This patient had neurofibromatosis 1 and came for a CT guided biopsy of a left upper lobe mass



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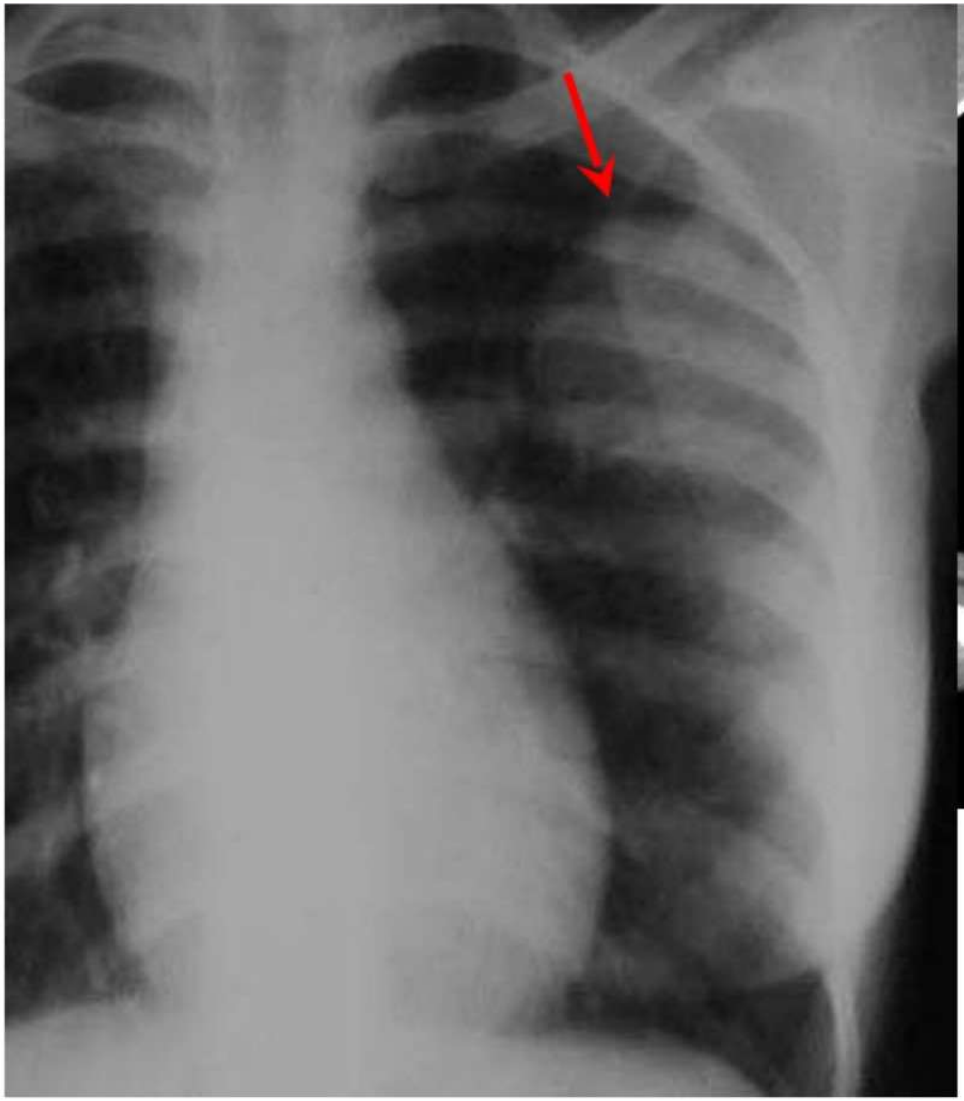
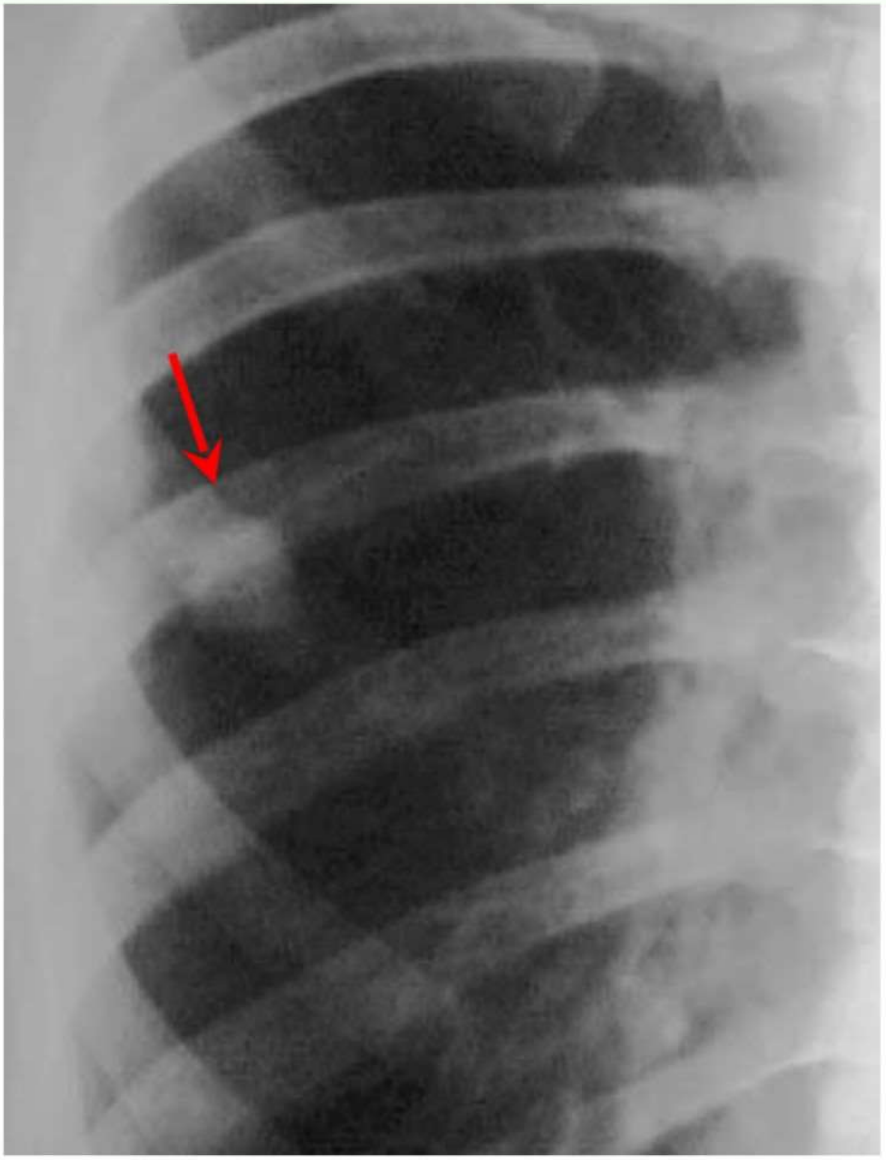
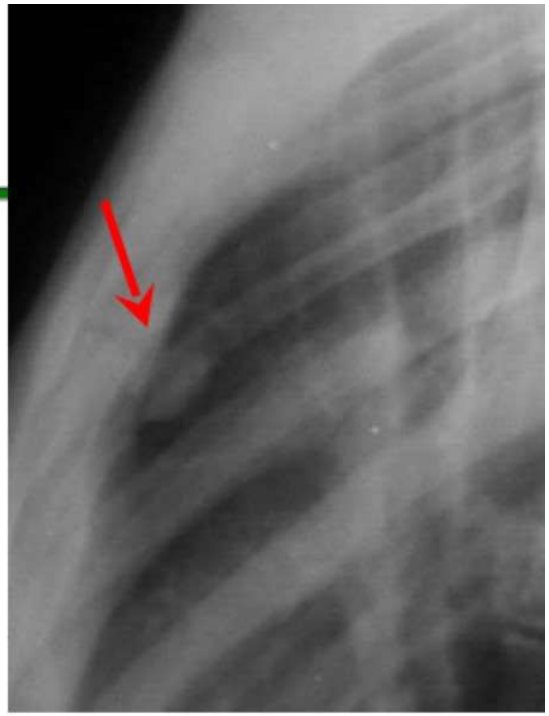
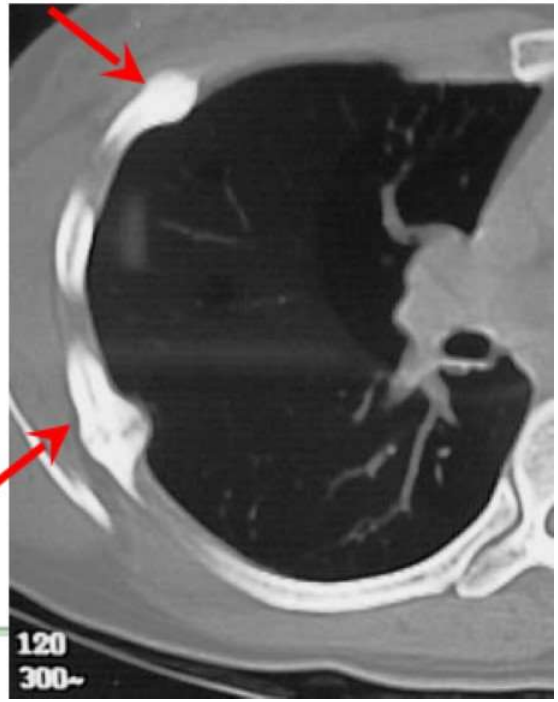


Classic example of “hyposkilia”
– the patient had never been examined

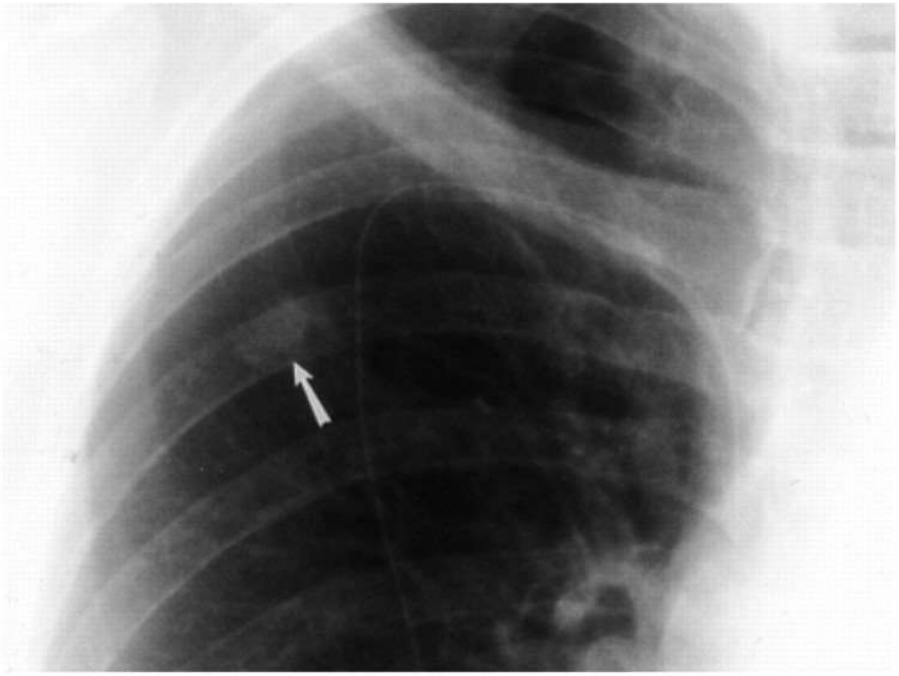
This lady also came for a CT guided biopsy of a left mid-zone lesion





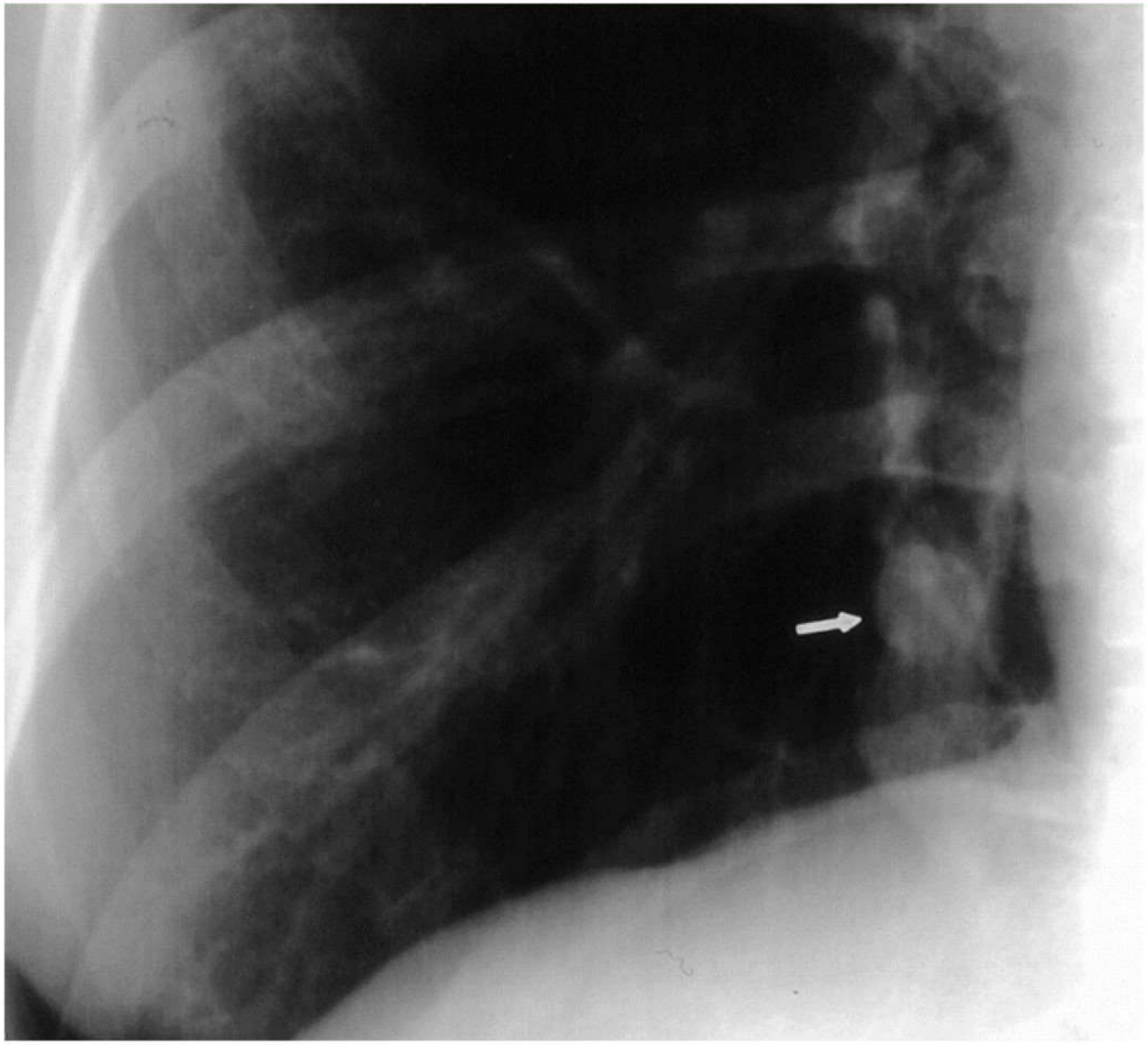


Rib fracture in a 50-year-old woman with multiple myeloma



CT scan shows a healed fracture of the right second rib (arrow).

Segmental bronchial atresia in a 17-year-old girl



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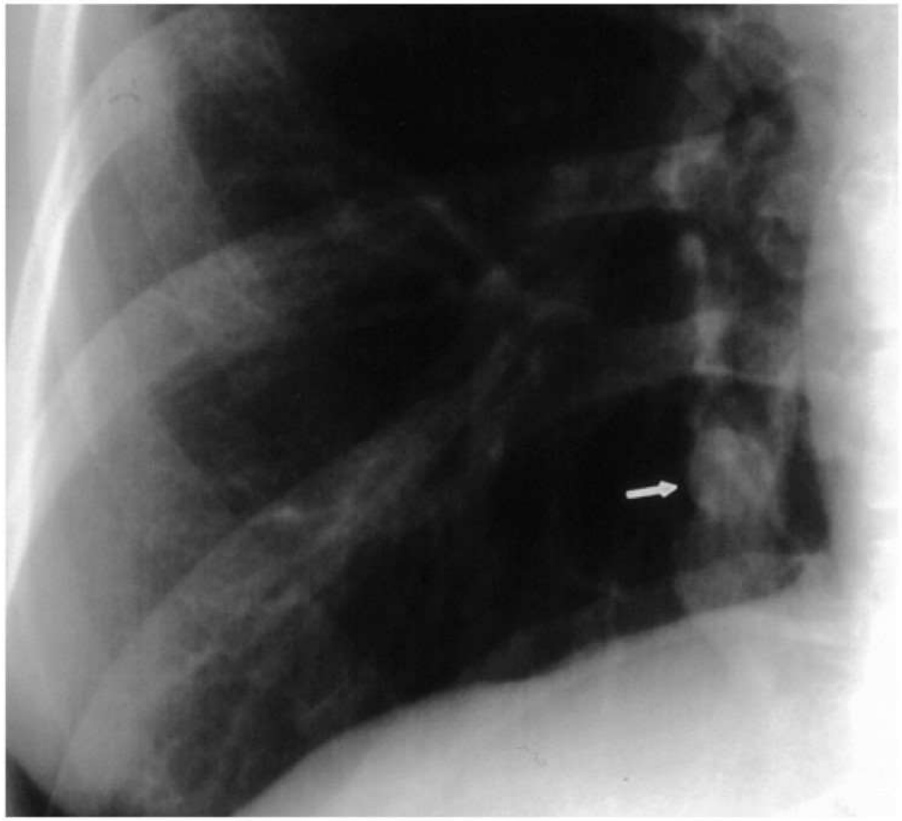
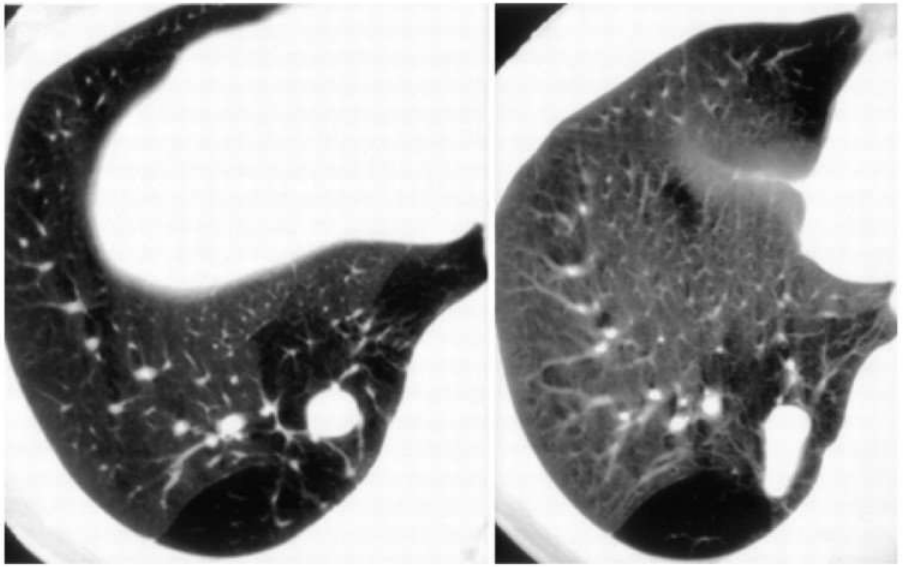
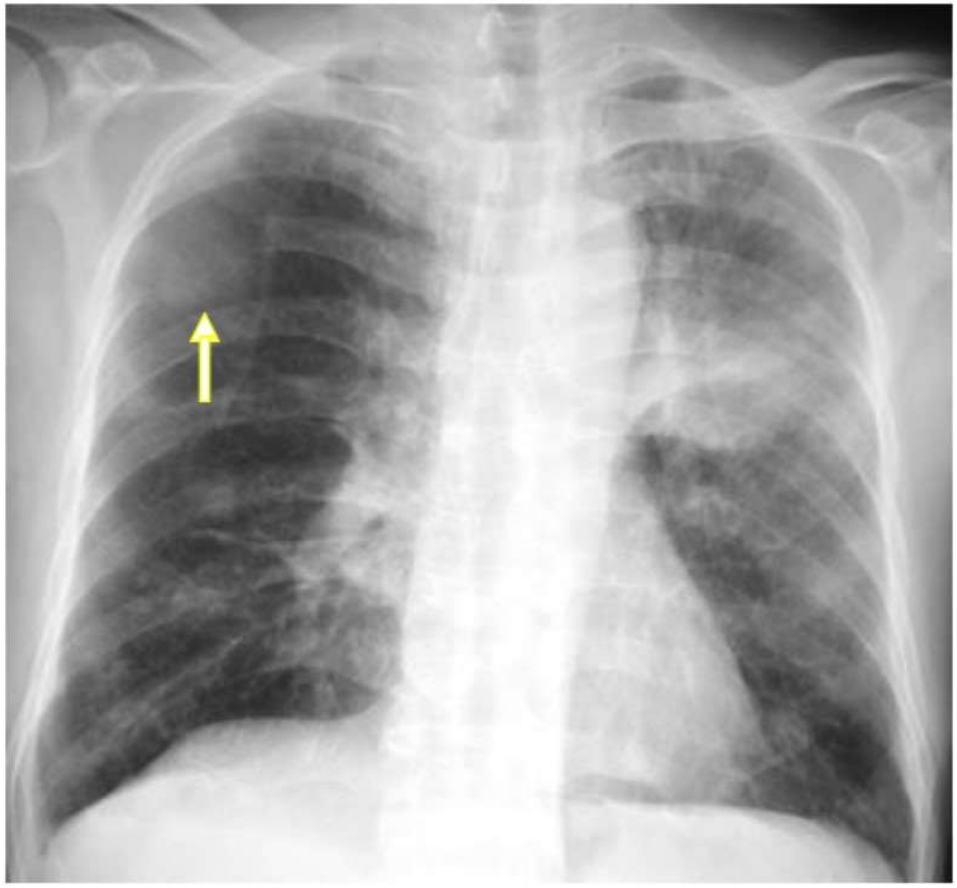
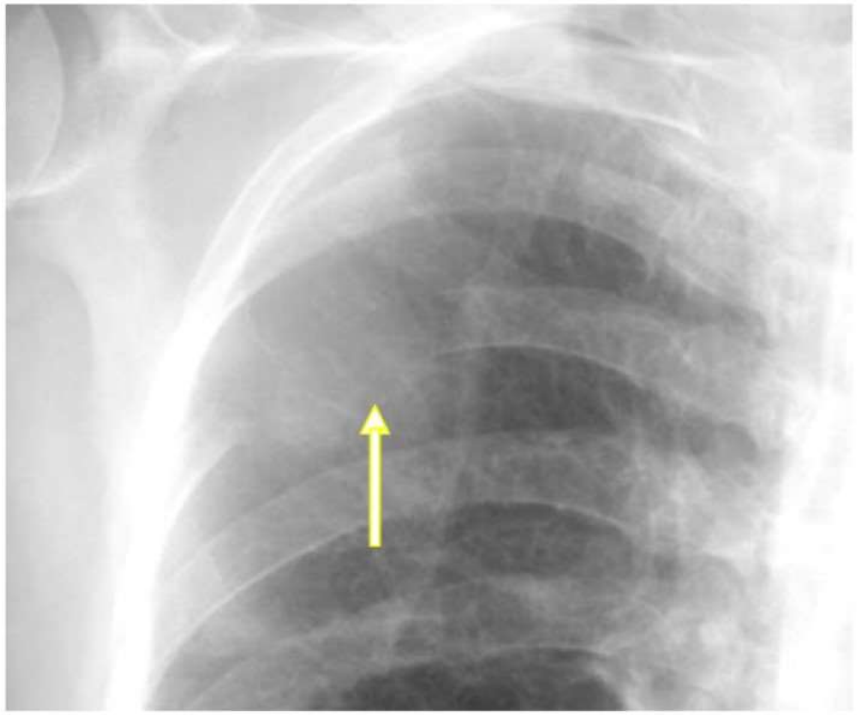




Lung cancer LUL with rib destruction





Size of SPN

- Most SPN are less than 2 cm in diameter

- Malignant nodules
  - 40% less than 2 cm
  - 15% less than 1 cm
  - 1% less than 7 mm
  - 0% less than 5 mm

RECIST 1.1

Response Evaluation Criteria In Solid Tumors

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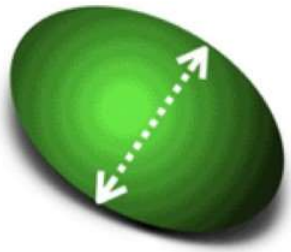
Criteria for target lesions

Tumours

CT scan: long axis ⩾ 10mm
Chest X-ray: long axis ⩾ 20mm

Malignant lymph nodes

Short axis diameter ⩾ 15mm



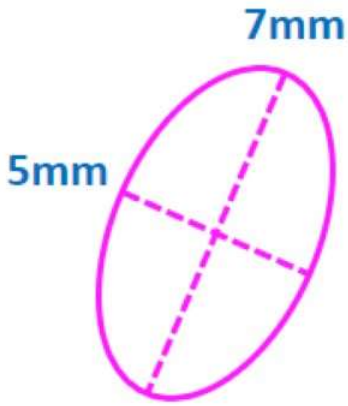
Selection of lesions

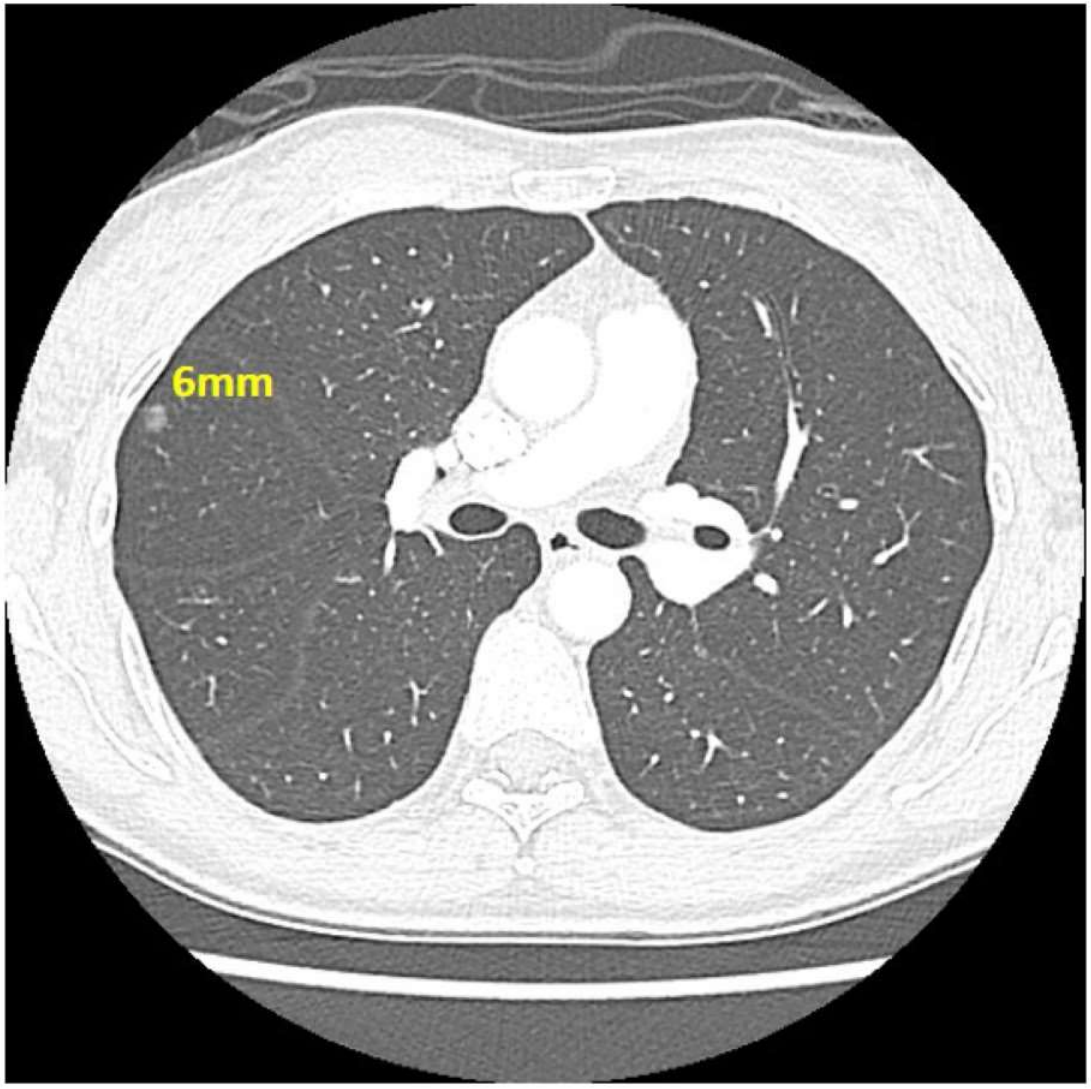
Choose 1 to 5 target lesions, equally distributed over affected organs (with a maximum of 2 per organ)

Preferably choose largest lesions

Preferably choose well-described lesions that are easy to measure

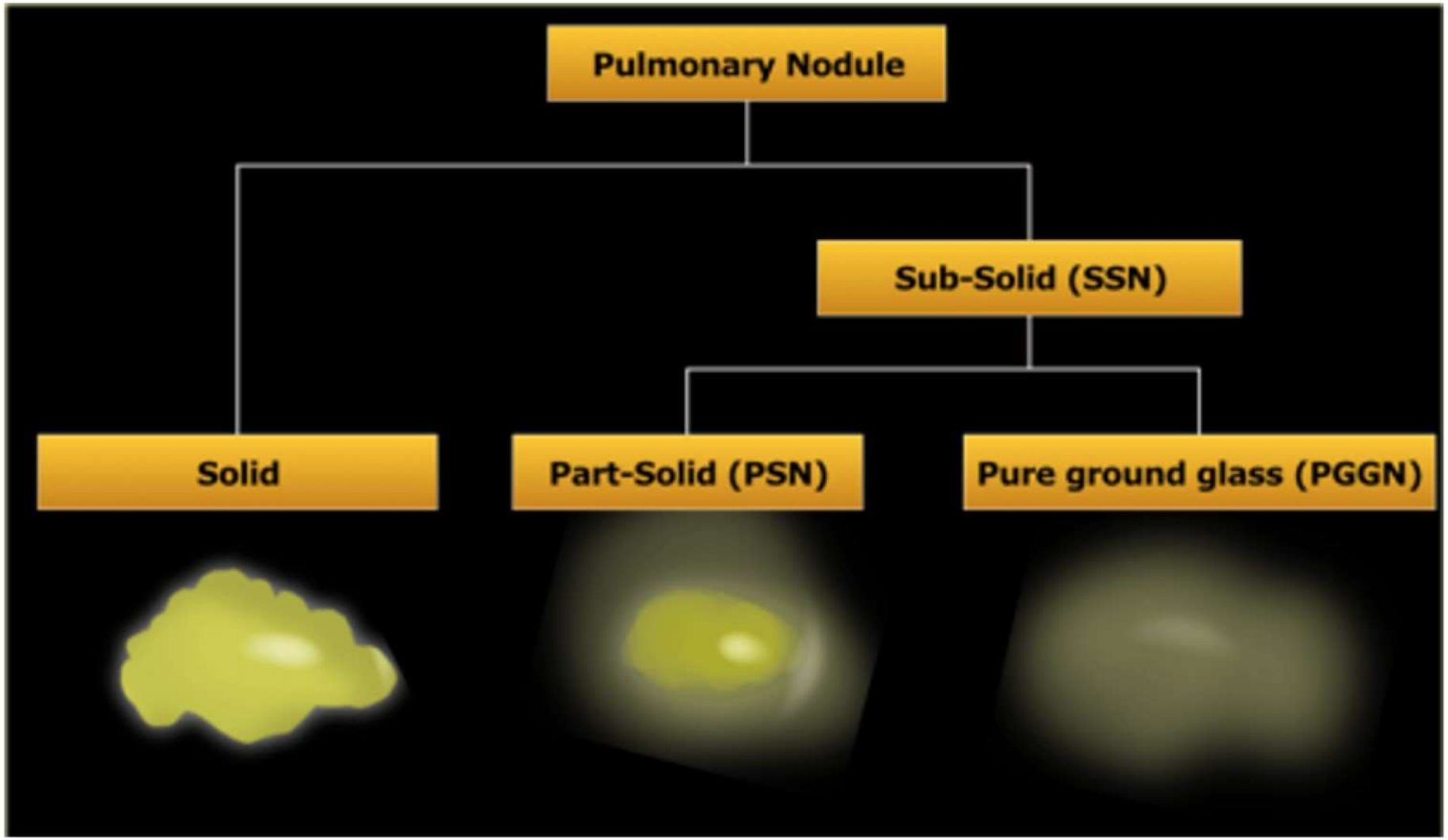
Lung Window





Bankier et al. Radiology 2017; 285:584-600

Fleischner 2017 guideline



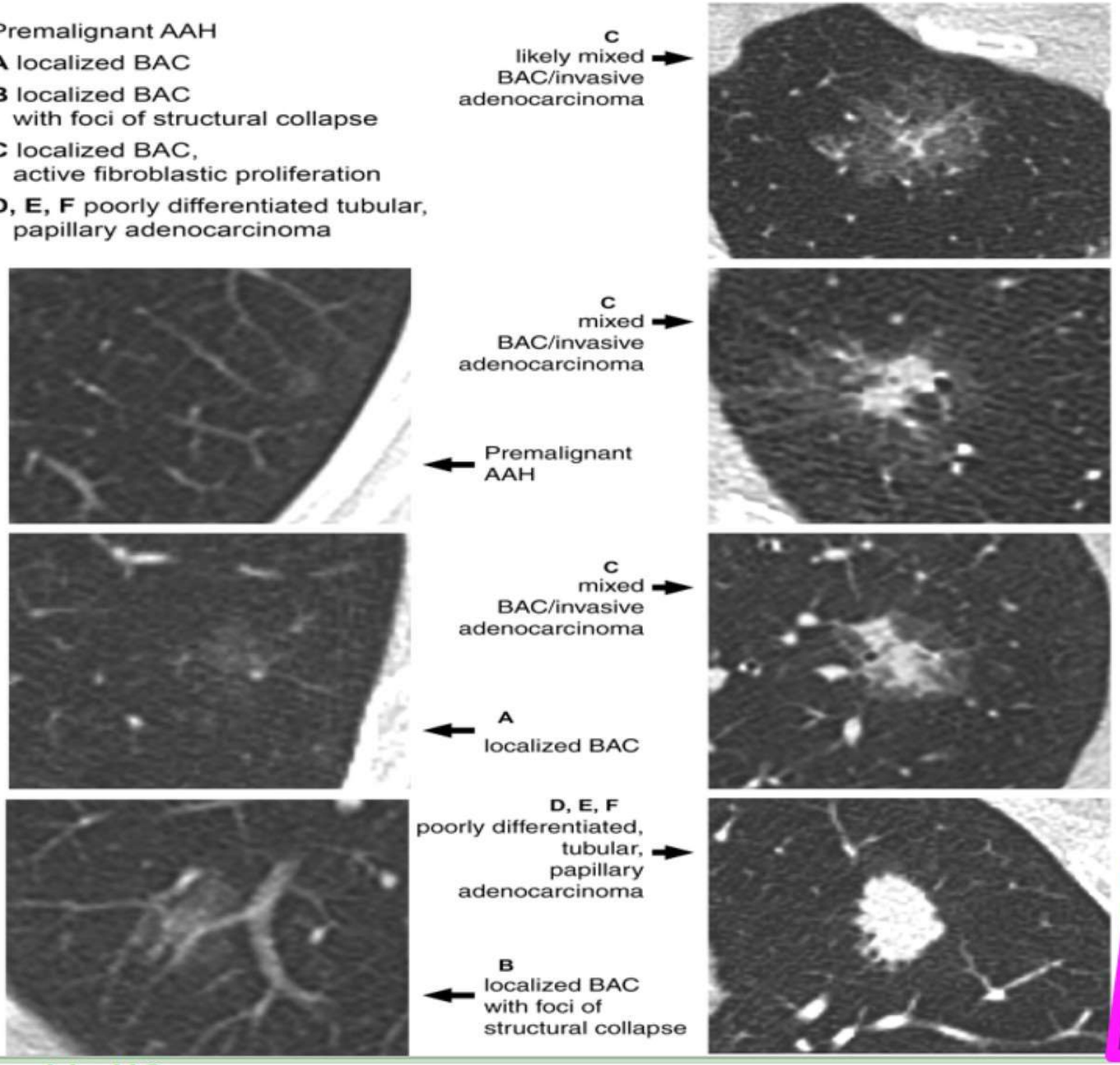
Premalignant AAH

A localized BAC

B localized BAC
with foci of structural collapse

C localized BAC,
active fibroblastic proliferation

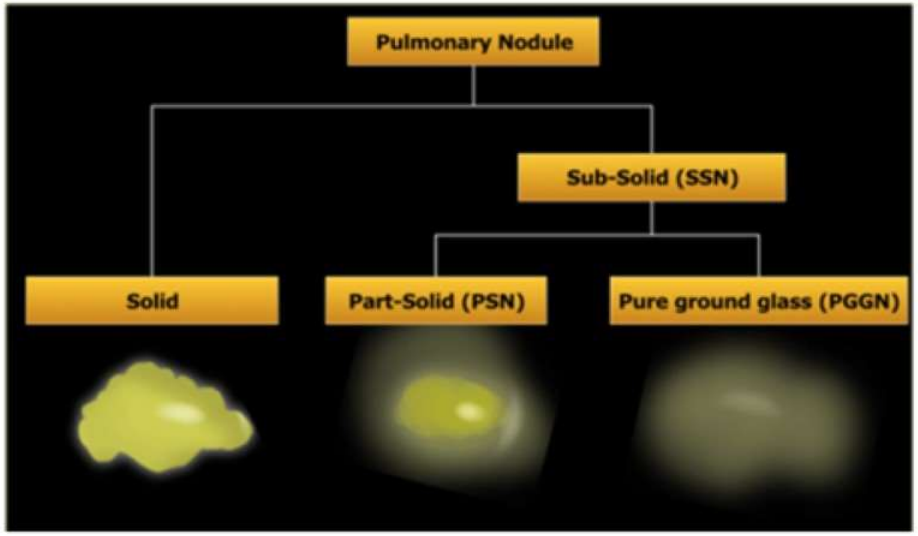
D, E, F poorly differentiated tubular,
papillary adenocarcinoma



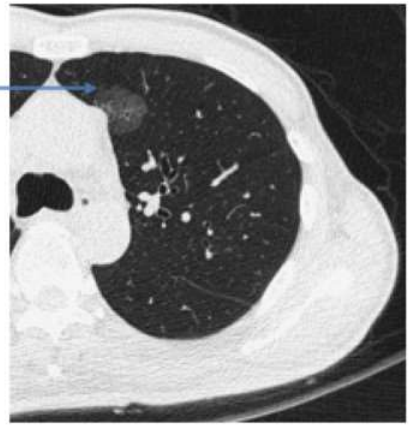
肺癌生長史約9~11年才能長大到1公分

Fleischner 2017 guideline

Density of pulmonary nodule



Pure GGN

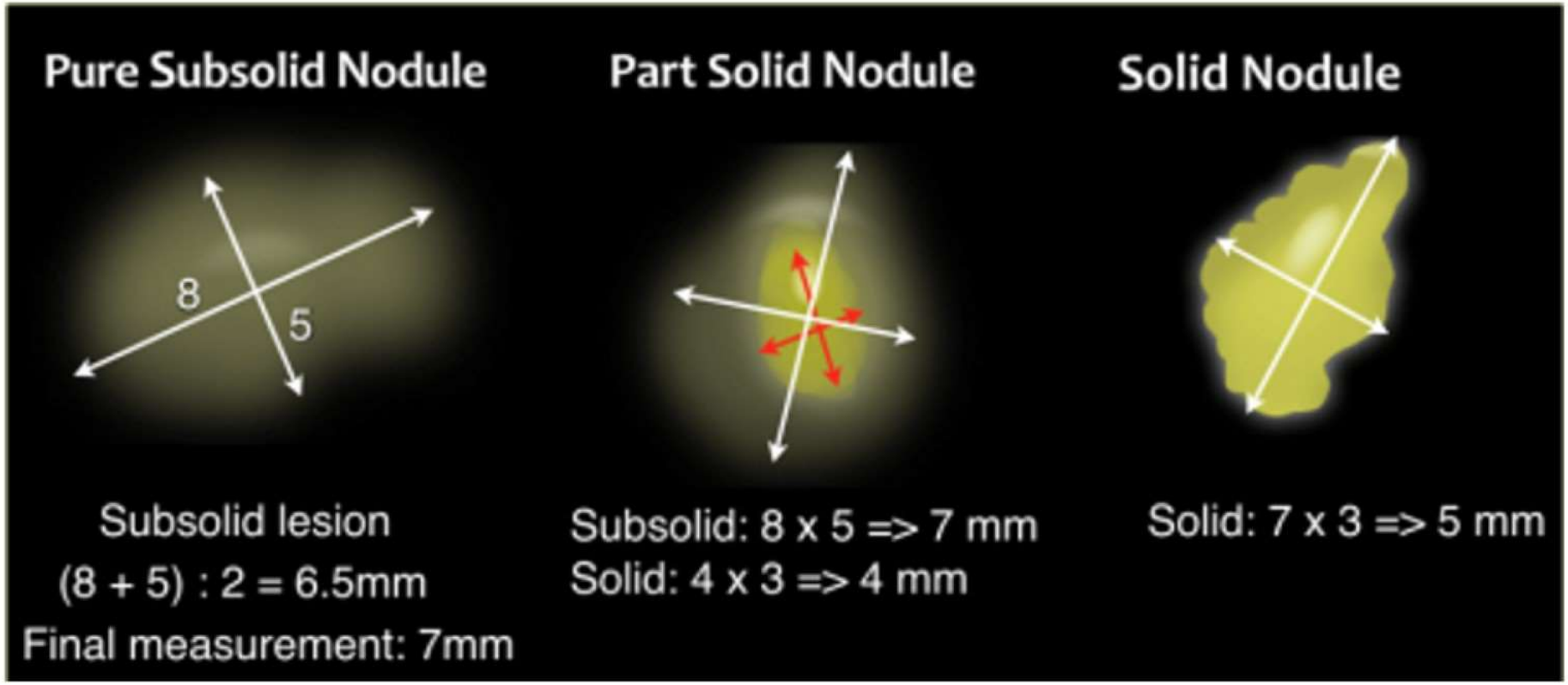


Ming-Lin HO

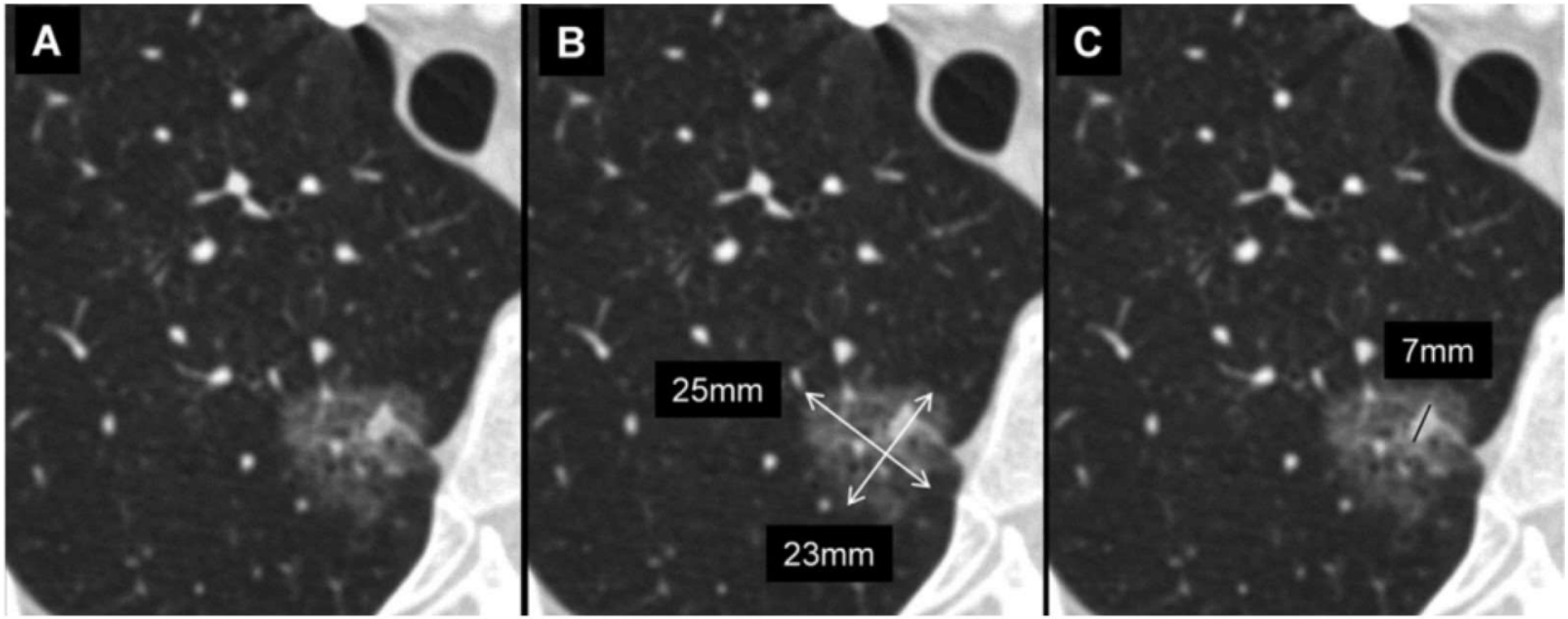
- 根據其在CT成像中的衰減，肺結節分為三種不同類型：
  - 1. **實體的結節(Solid nodules)**：最常見的類型，其特徵是均勻的軟組織減弱 (homogeneous soft-tissue attenuation)
  - 2. **毛玻璃狀結節 (Ground-glass nodules)**：外觀不均勻且有朦朧感肺實質的局部衰減增加，而不會遮蓋下面的支氣管和血管結構
  - 3. **部分實體結節(Part-solid nodules)**：包括固體和毛玻璃減弱成分。

Ann Thorac Med. 2019 Oct-Dec; 14(4):226–238.

Fleischner 2017 guideline



Lung Window



Bankier et al. Radiology 2017; 285:584-600

ORIGINAL ARTICLE

Probability of Cancer in Pulmonary Nodules Detected on First Screening CT

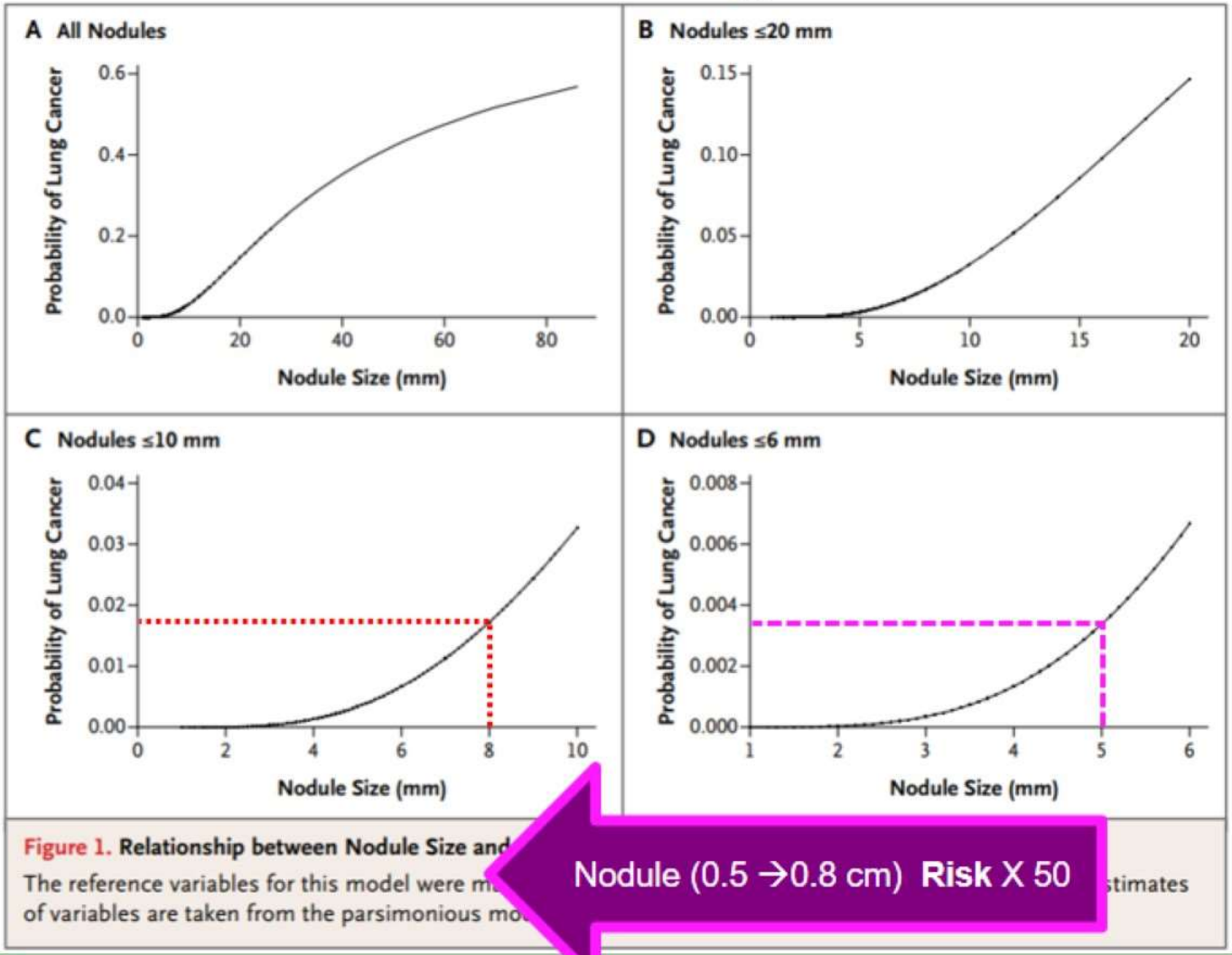


Figure 1. Relationship between Nodule Size and

The reference variables for this model were m… …stimates of variables are taken from the parsimonious mo…

Nodule (0.5 →0.8 cm) **Risk** X 50

Ming-Lin HO

N Engl J Med 2013;369:910-9

Fleischner Society 2017 指引，
電腦斷層檢查意外發現肺部結節之處置建議

光田綜合醫院 社團法人 Kuang Tien General Hospital since1913

■ 實質結節 (Solid nodule)

一：實質結節

		結節大小		
結節型態	<6mm	6-8mm	>8mm	建議
單一 **Single**				
低風險群	不須常規追蹤	6-12 個月後追蹤 CT，然後 18-24 個月後考慮追蹤 CT	考慮 3 個月後追蹤 CT，或正子攝影，或組織切片	結節小於 6mm 不須常規追蹤，但高風險群合併可疑的結節型態或結節位於上肺葉，可於 12 個月後追蹤 CT
高風險群	考慮 12 個月後追蹤 CT	6-12 個月後追蹤 CT，且於 18-24 個月後追蹤 CT	考慮 3 個月後追蹤 CT，或正子攝影，或組織切片	同上
多發 **Multiple**				
低風險群	不須常規追蹤	3-6 個月後追蹤 CT，然後 18-24 個月後考慮追蹤 CT	3-6 個月後追蹤 CT，然後 18-24 個月後考慮追蹤 CT	以最可疑的結節為標的，根據其大小與風險制定追蹤時間
高風險群	考慮 12 個月後追蹤 CT	3-6 個月後追蹤 CT，且於 18-24 個月後追蹤 CT	3-6 個月後追蹤 CT，且於 18-24 個月後追蹤 CT	同上

內科學誌 2018：29：137-142

Assessment of Probability of Malignancy

Criteria	Probability of Malignancy: Low Probability of Malignancy (<5%)	Intermediate Probability of Malignancy (5-65%)	High Probability of Malignancy (>65%)
Clinical Factors	*Young Patient *Less Smoking *No Prior Cancer *Smaller Nodule Size *Regular Nodule Margins *Non-Upper Lobe Nodule Location	*Mixture of Low and High Probability Features	*Older Patient Heavy Smoking *Prior Cancer *Larger Nodule Size *Irregular/Spiculated Nodule Margins *Upper Lobe Nodule Location
Surveillance CT Scan Result	*Resolution or Near-Complete Resolution *Progressive Decrease in Size *No Growth Over ≥2 yrs (Solid Nodule) or ≥3-5 yrs (Subsolid Nodule)		*Evidence of Growth
PET Scan Result	*Low PET Activity	*Weak-Moderate PET Activity	*Intensely Hypermetabolic Activity
Non-Surgical Biopsy (TTNA, Bronchoscopy) Result	*Specific Benign Diagnosis	*Non-Diagnostic	*Suspicious for Malignancy

Fleischner Society 2017 指引，
電腦斷層檢查意外發現肺部結節之處置建議

光田綜合醫院 社團法人 Kuang Tien General Hospital since1913

■ 亞實質結節 (Solid nodule)

二：亞實質結節

	結節大小		
結節型態	<6mm	≥ 6mm	建議
單一			
毛玻璃狀	不須常規追蹤	6-12 個月後追蹤 CT，若結節持續存在，每兩年追蹤 CT，追蹤時間為五年	<6mm 但可疑的結節型態，考慮於第二年及第四年追蹤 CT，若變大或產生實質部分，考慮手術切除
部分實質	不須常規追蹤	3-6 個月後追蹤 CT，若結節持續存在，大小不變且實質部分 <6mm，每年追蹤 CT，追蹤時間為五年	若結節持續存在，且實質部分 ≥ 6mm，須懷疑為惡性
多發	3-6 個月後追蹤 CT，若穩定，考慮於第二年及第四年追蹤 CT	3-6 個月後追蹤 CT，後續處置以最可疑的結節為標的	多發性毛玻璃結節 <6mm 常為良性，但高風險群，考慮於第二年及第四年追蹤 CT

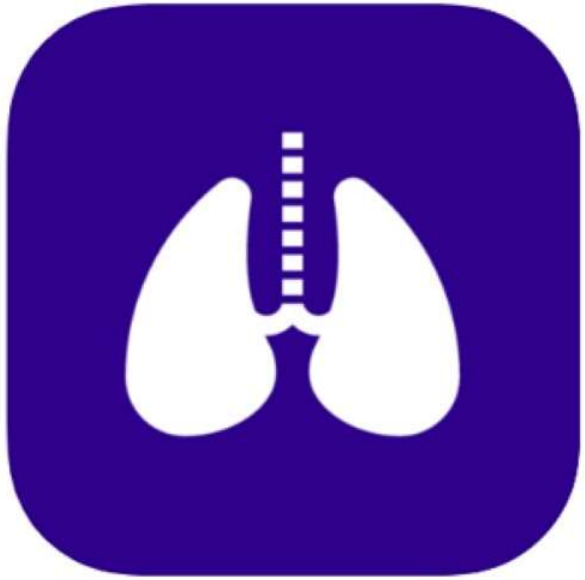
內科學誌 2018：29：137-142

Cancer Research UK

Mac iPad iPhone Watch TV Music

App Store Preview

This app is available only on the App Store for iPhone and iPad.



Pulmonary Nodule Risk 17+

Cancer Research UK

★★★★★ 5.0, 1 Rating

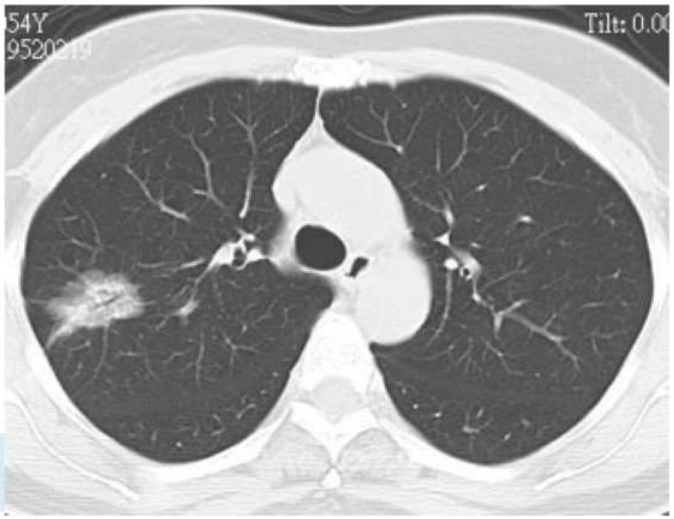
Free

Internal characteristics

Benign or malignant?

Malignant features:

1. Air-bronchogram
2. Vascular invasion



airbronchogrram

3. Bubble lucency: patent small bronchi or small cystic spaces within tumor

Favor: adenocarcinoma (30%). Adenocarcinoma in situ (60%)

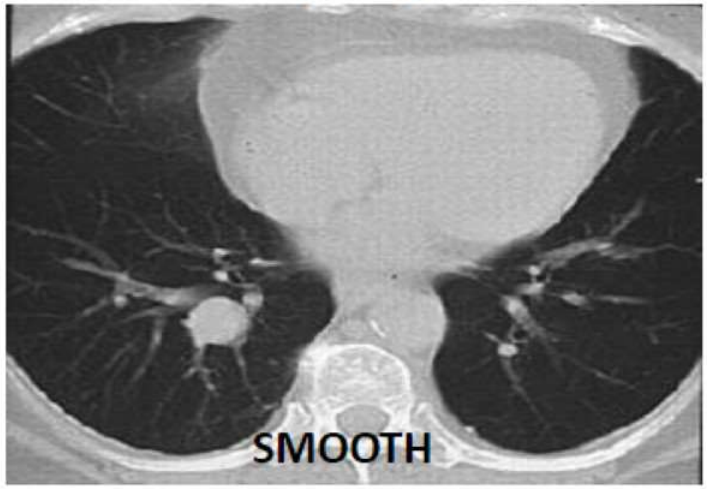
氣泡透明

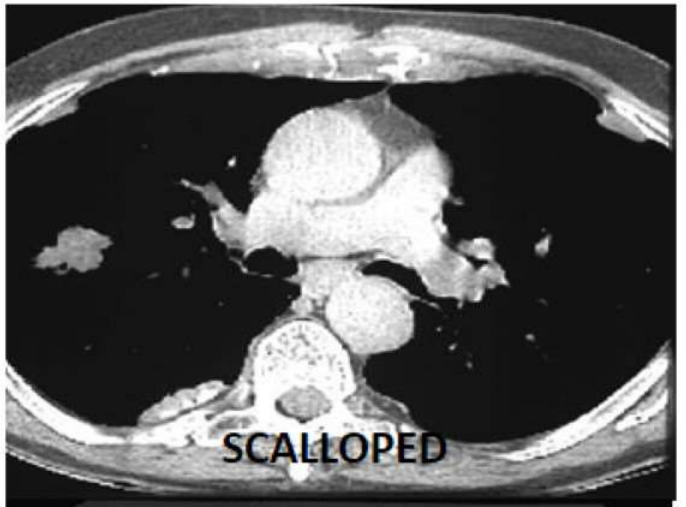
Bubble lucency

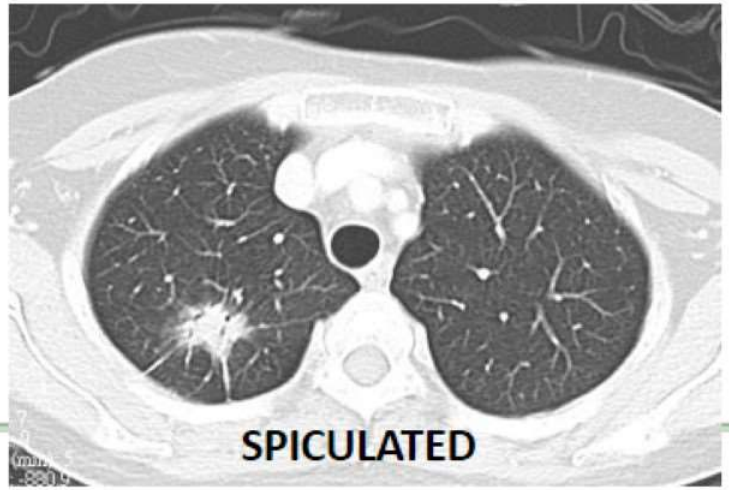
Shape and margin

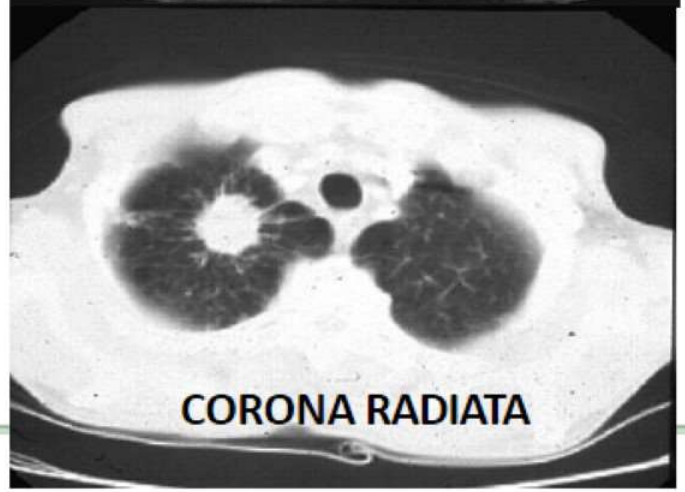
- Smooth border: 20% malignancy
- Scalloped border: 60% malignancy
- Spiculation border: 80% malignancy
- Corona radiata: 95% malignancy

1. 邊框光滑：20%惡性
2. 扇貝形邊緣：60%惡性
3. 星芒狀毛刺邊界：80%惡性
4. 放射冠：95%惡性





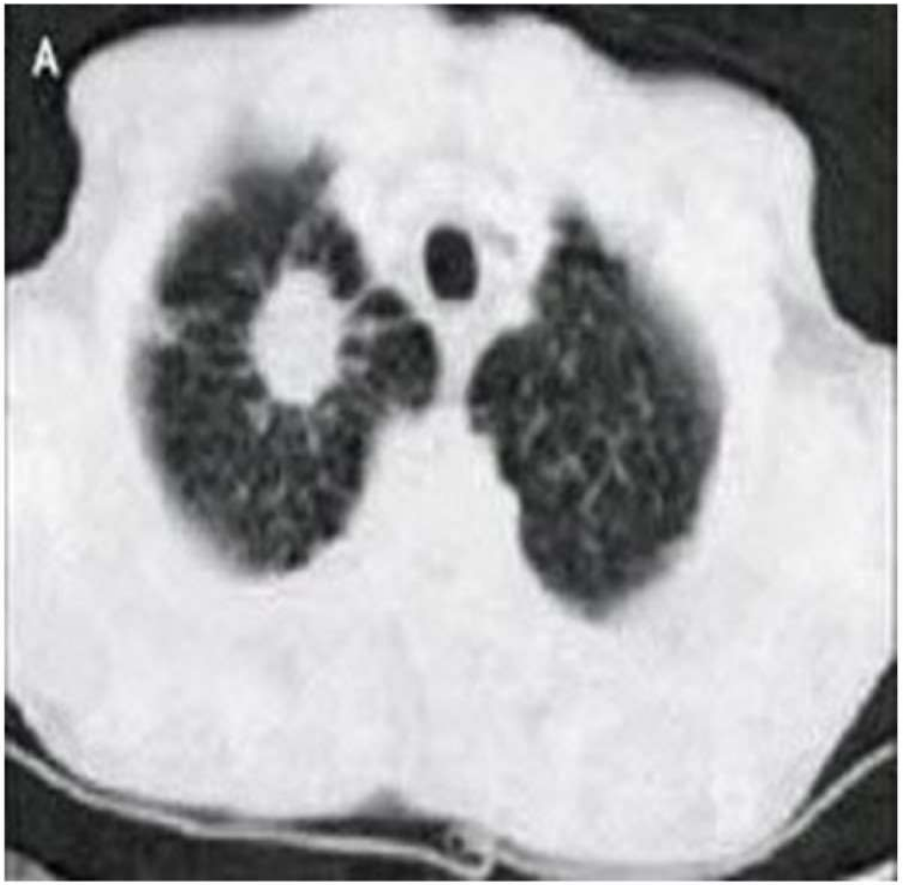


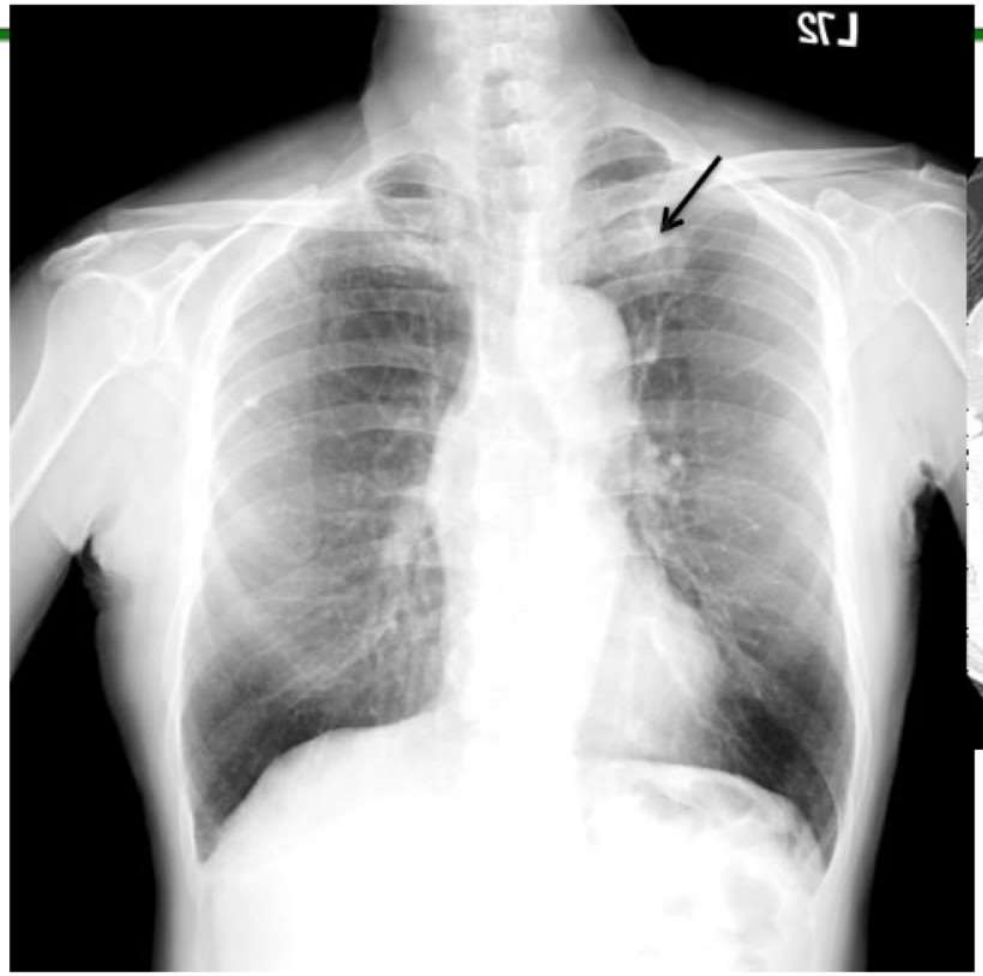


Patterns of Margins

- Corona radiata sign

- Fine linear strands extending 4-5 mm outward
- Spiculated on CXRs
- **84 – 90% are malignant**

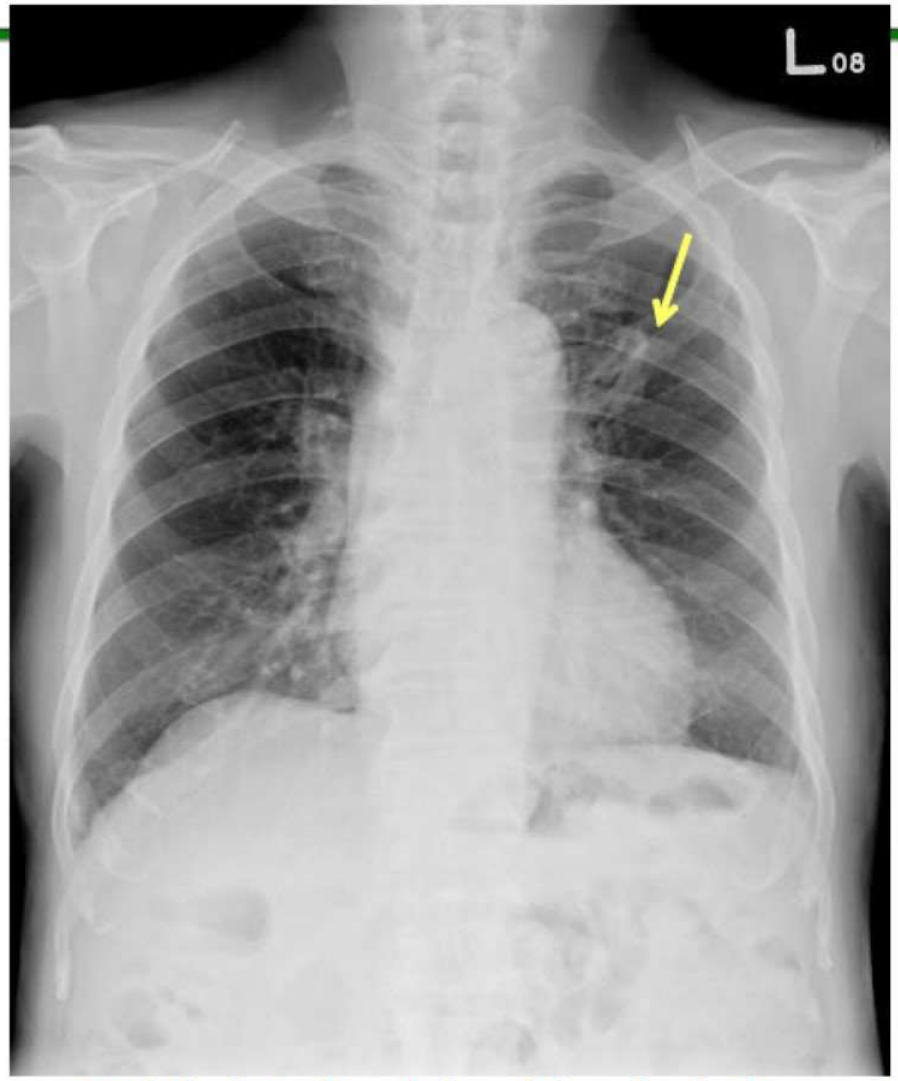




82/M smoker, progressive enlarged LUL nodule
CT: spiculation pattern in pul. nodule
Dx: adenocarcinoma of lung, LUL

Corona radiata pattern

Small nodule on LUL



CT: lobulated nodule with spiculation on LUL

Dx: adenocarcinoma of lung, LUL

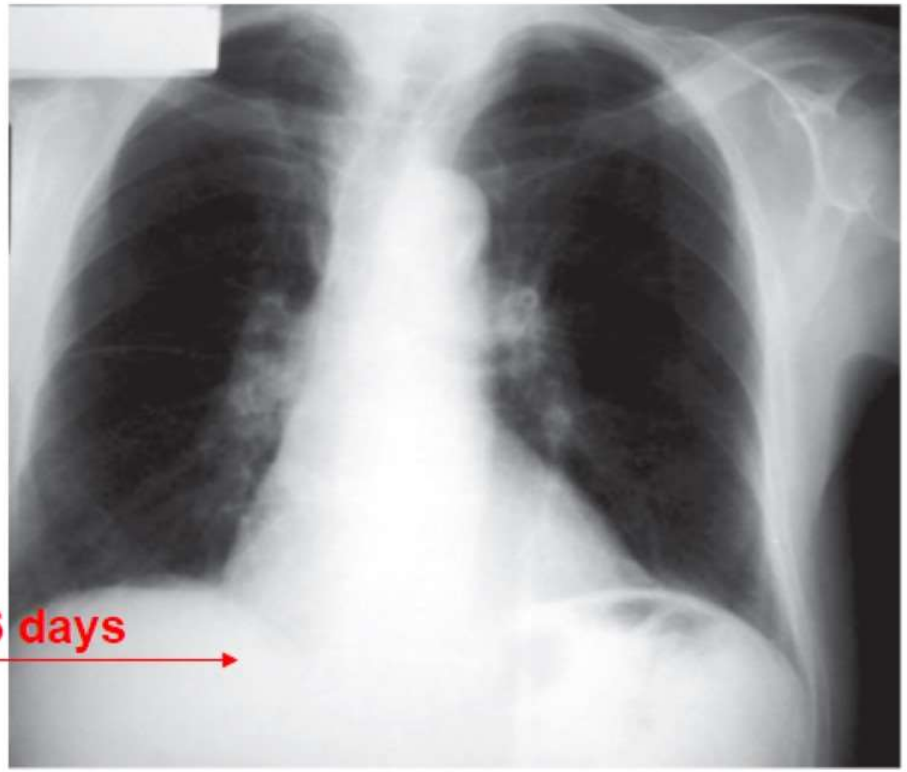
Growth of a nodule

- Benign lesions grow slowly with doubling time exceeding 500 days
  - 良性病變生長緩慢，倍增時間超過500天
- A doubling time of less than 20 days signifies inflammatory process
  - 少於20天的倍增時間表示發炎過程
- Always compare the current radiographs with prior ones (if available)
  - 始終將當前的射線照片與先前的射線照片進行比較（如果有）

Vanishing or Phantom Tumor of the Lung

- **假瘤 (False tumor; Phantom tumor)**：心臟衰竭併發急性肺水腫為一常見之胸腔科疾患。患者經適當處置後，症狀多能迅速緩解。故而正確之胸部X光診斷是極其重要的。此類病患之胸部X光表現各式各樣，不一而足。一例心臟衰竭併發急性肺水腫，肋膜積液潴留於小肺裂（minor fissure）而狀似肺腫瘤之病例。

a phantom tumor as a well delineated, drop-like density in the right middle lung field.

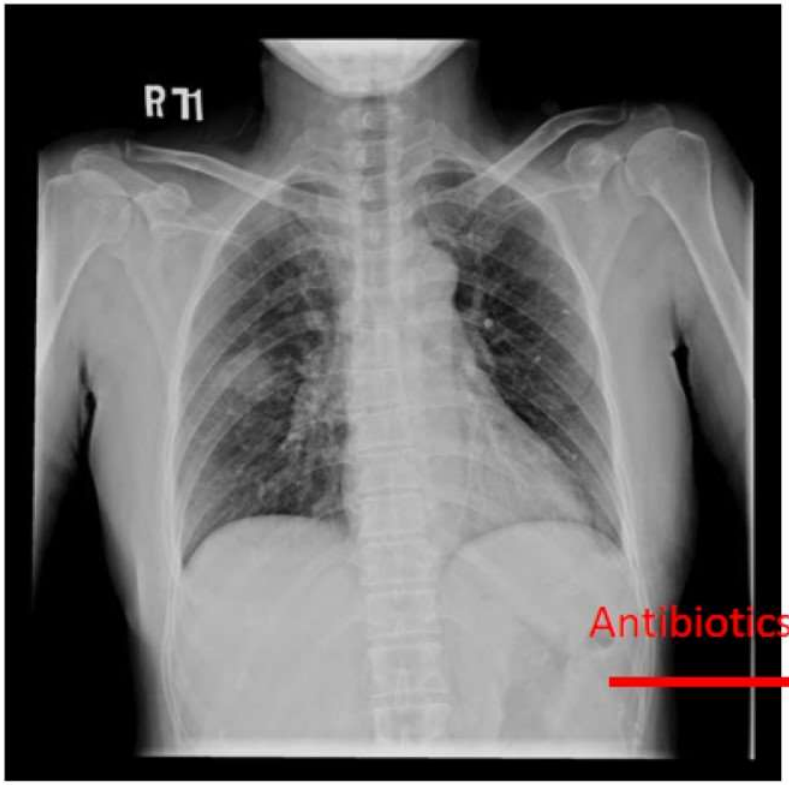


Complete resolution of the patient's phantom tumor **after 6 days of therapy for congestive heart failure**.

Texas Heart Institute Journal Volume 37, Number 6, 2010

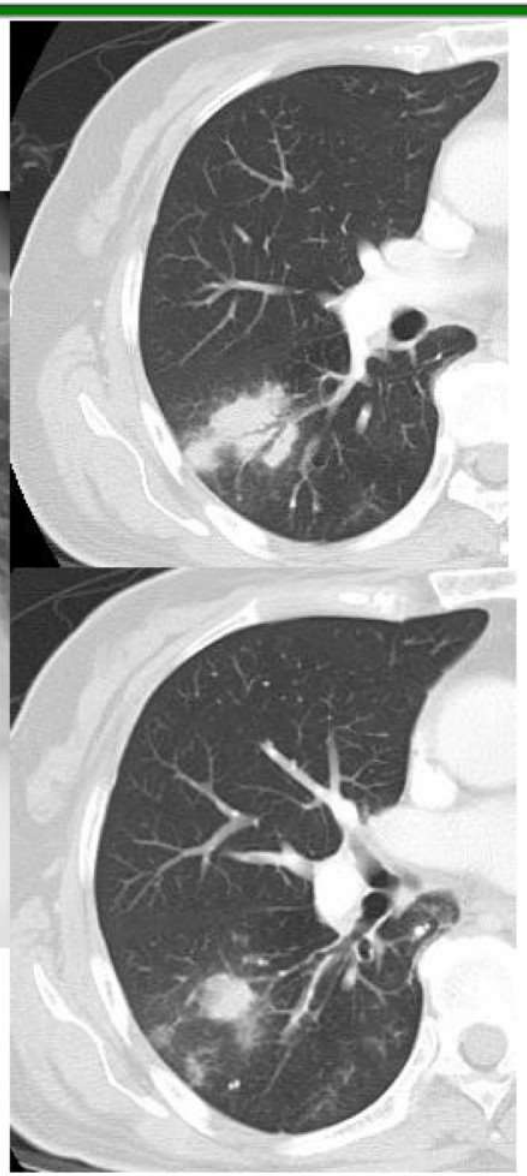
假瘤 (False tumor; Phantom tumor)

11/26/2007



01/07/2008

Antibiotics x14 days



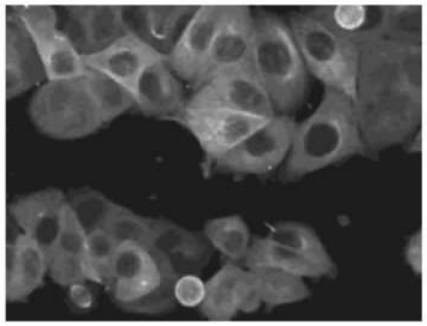
Vanishing tumor

Round pneumonia

腫瘤倍增時間
(Tumor doubling time, TDT)

$$\text{原體積} \times 2^{\frac{T}{TDT}} = \text{原體積} \times \left(\frac{D2}{D1}\right)^3$$

$$\text{Log } 2 = 3 \log \left(\frac{D2}{D1}\right)$$

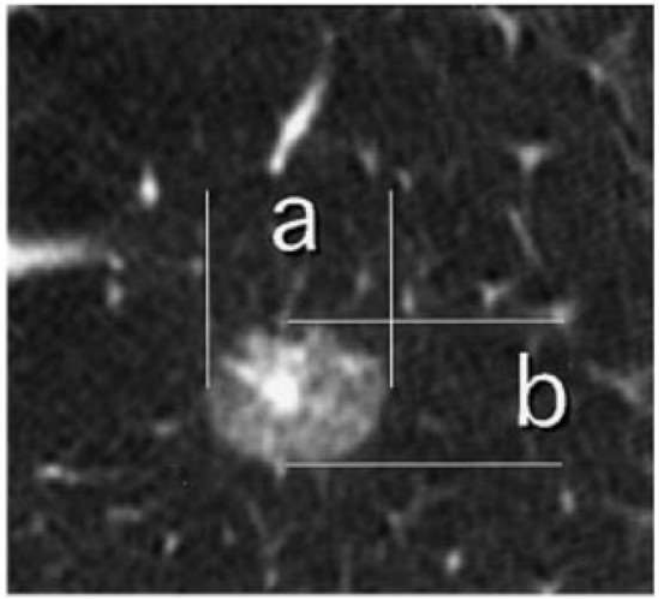


$$TDT = \frac{T \log 2}{3 \log \left(\frac{D2}{D1}\right)}$$

手動2D測量
Volume-Doubling Time (VDT)

$$V_t = V_o \times 2^{t/\mathrm{VDT}}$$

$$\mathrm{VDT} = \frac{t \times \log 2}{\log (V_t / V_0)}$$



$$V = \pi / 6 \times ab^2$$

The British journal of radiology, 2000, 73.876: 1252-1259

手動2D測量
Volume-Doubling Time (VDT)

光田綜合醫院 社團法人 Kuang Tien General Hospital since1913

Online calculator for lung nodule volume-doubling time (VDT)

	Date	Dimensions	Volume (prism)	Volume (ellipsoid)
Examination 1	2020-05-08 ×			
Examination 2				
Examination 3				

2day 3mo 6mo < Year > < Month > < Day >

Date 1 Reset Help About

Type in your data above.

for Android

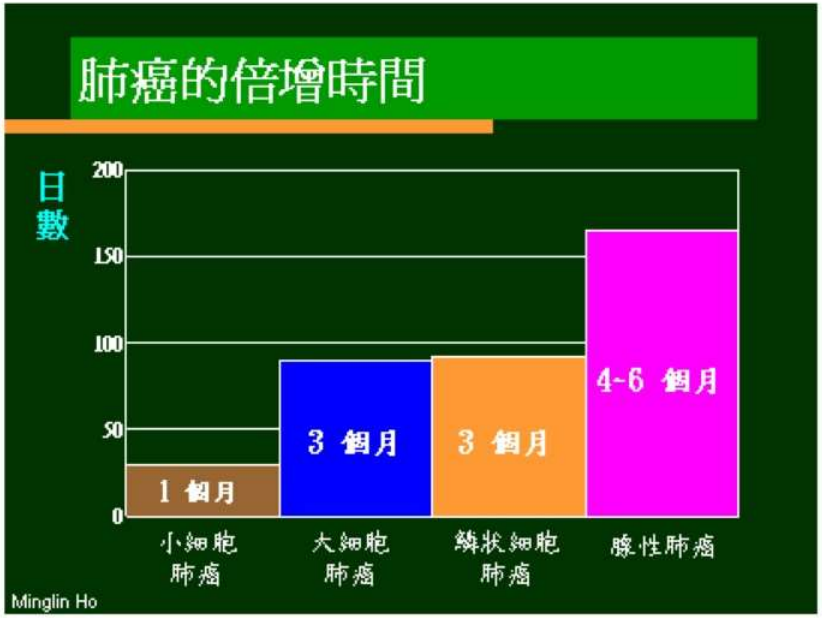
Android App VDT2

XiPhone

腫瘤倍增時間
(Tumor doubling time, TDT)

- Malignant nodules grow at a constant rate expressed as doubling time
  - **猜測:** 惡性結節以恆定速度增長，表示為倍增時間
  - 不同腫瘤的生長速度存在差異，其實即便是腫瘤本身的生長速度也不是完全均一的，而是一個動態變化的，也就是腫瘤自己會改變它們的生長速度。
  - 一個原本生長很慢的腫瘤，可能會突然加快了速度，變得長得很快了。改變它們生長速度的原因可能有藥物、免疫、腫瘤自身獲得性基因突變等等
- This usually falls between 25 and 450 days with a median of 120 days
  - 這通常介於**25**到**450**天之間，中位數為120天
- An increase of 28% in nodule diameter indicates doubling
  - 結節直徑增加28%表示增加一倍

肺癌的倍增時間
(Tumor doubling time, TDT)



Growth rate

Malignant cells

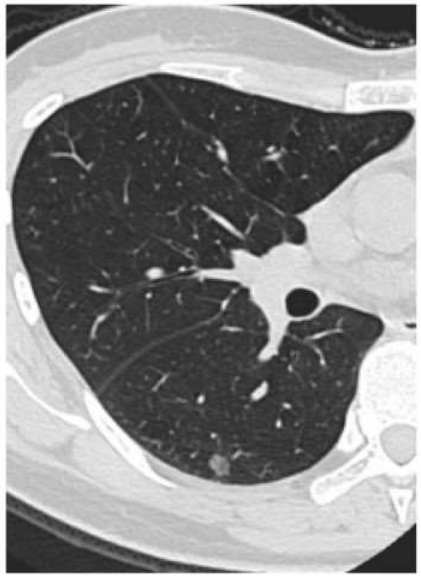
- **CT nodule doubling time:**
  - pure GGN 1556 days
  - part-solid nodule
    - solid component < 5mm 1199 days
    - solid component > 5mm 627 days

(Radiology 2014; 273: 276-284)

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small pure GGN rarely grow in size (1)



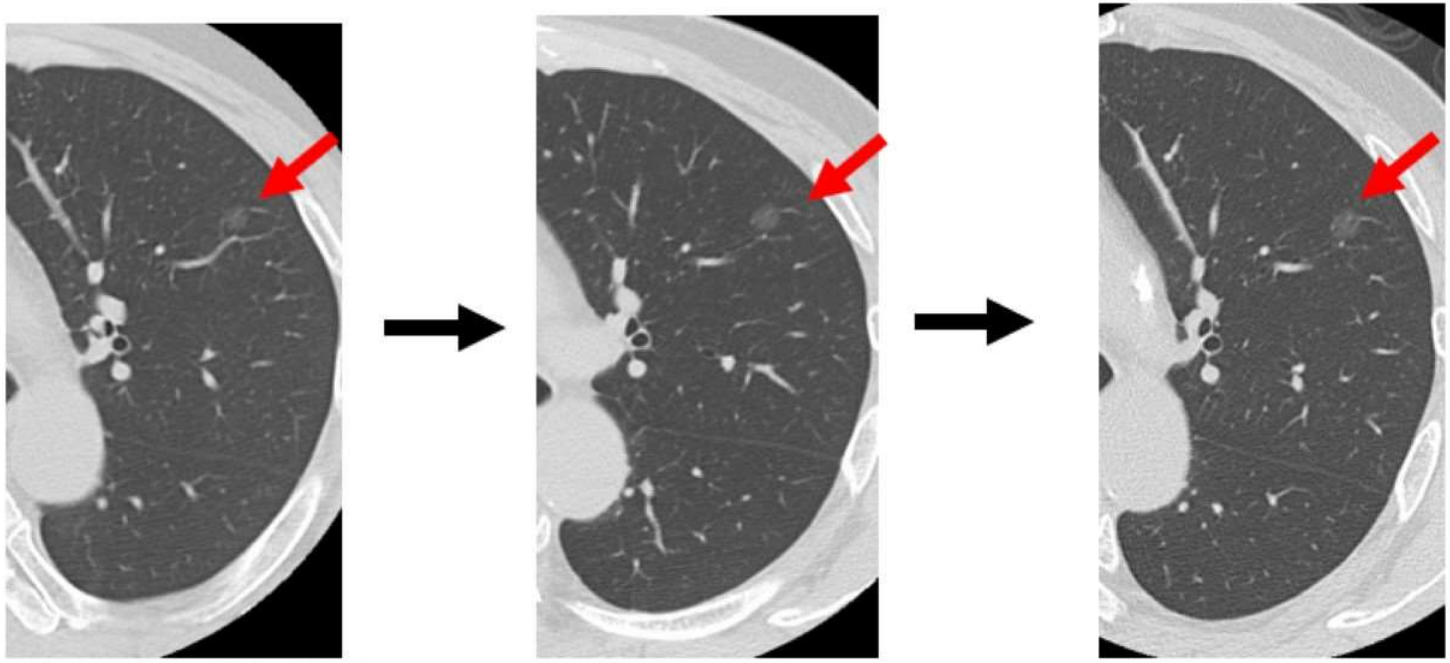
At detection (F, 40s)

9 years later

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small pure GGN rarely grow in size (2)



At detection (M, 60s)
(2mm thickness image)

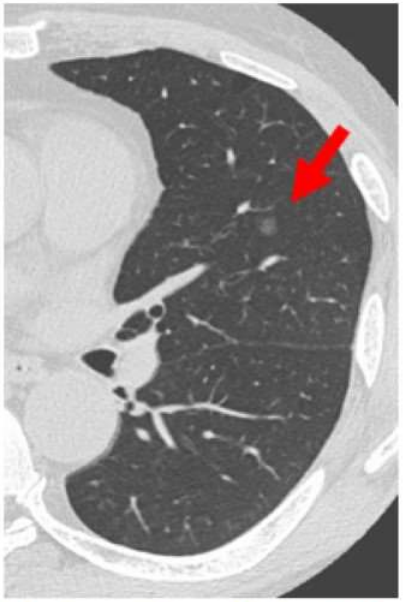
6 years later
(1mm thickness)

11 years later
(1mm thickness)

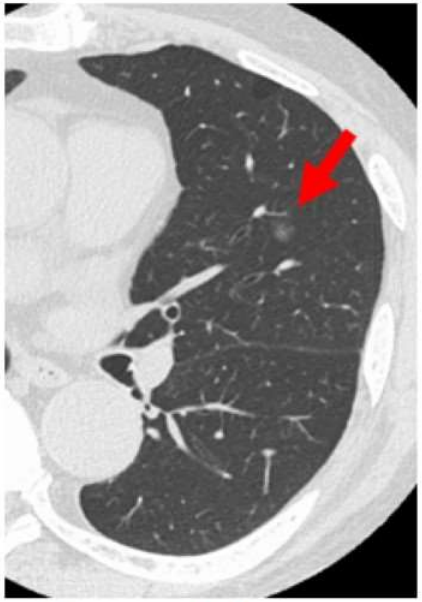
Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small pure GGN rarely grow in size (4)



At detection (M, 60s)
(2mm thickness image)



12 years later
(1mm thickness image)

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

GGN which slightly grew in size during 7 years

At detection (F 70s)
(2mm thickness image)

7 years later
(1mm thickness)

Partial resection
↓
AIS

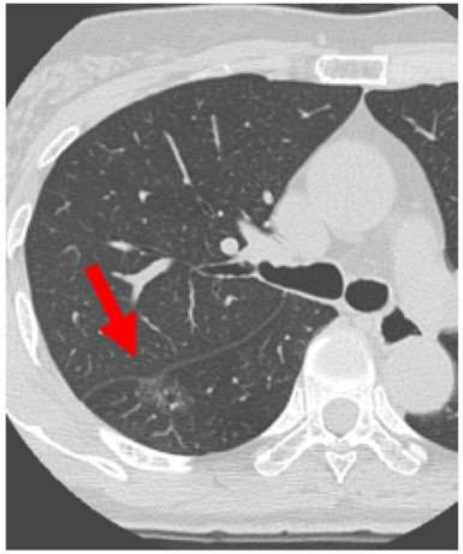
Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

GGN which slightly grew in size during 5 years

Ill-defined GGN

At detection (F, 50s)



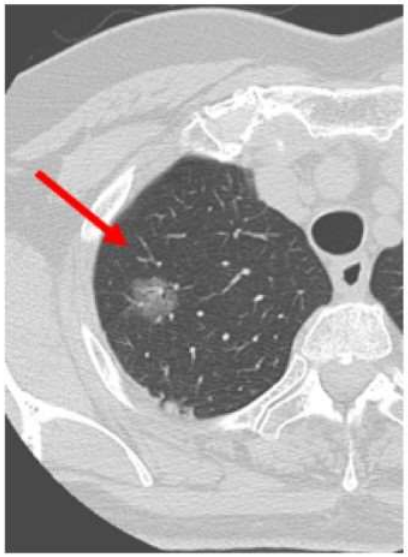
5 years later

(S6 segmentectomy → MIA)

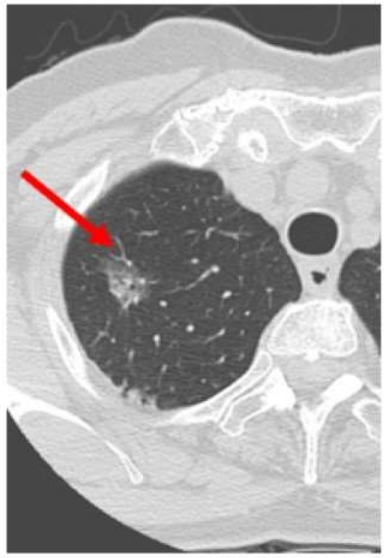
Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

GGN which decrease in size, and become denser



At detection (F 60s)

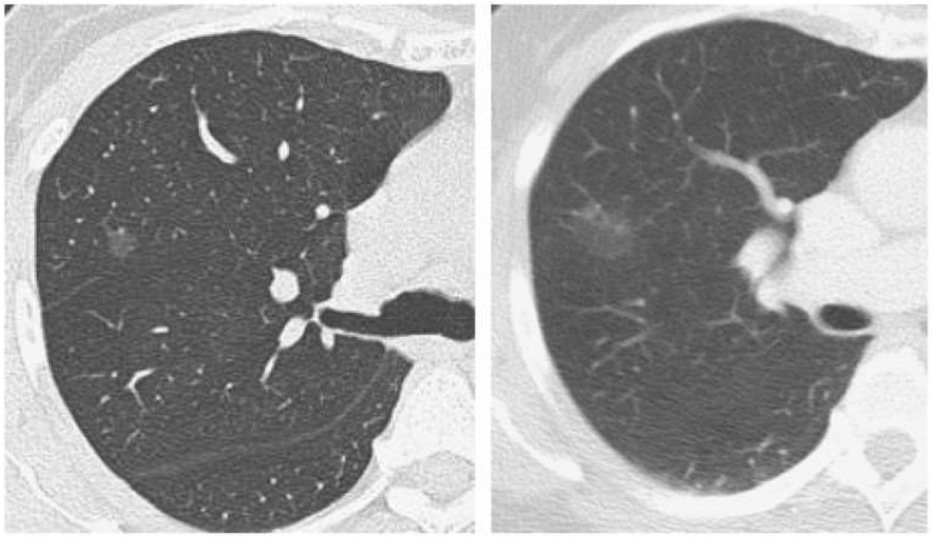


4 years later

Right upper lobectomy → MIA

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule



10/30/2006

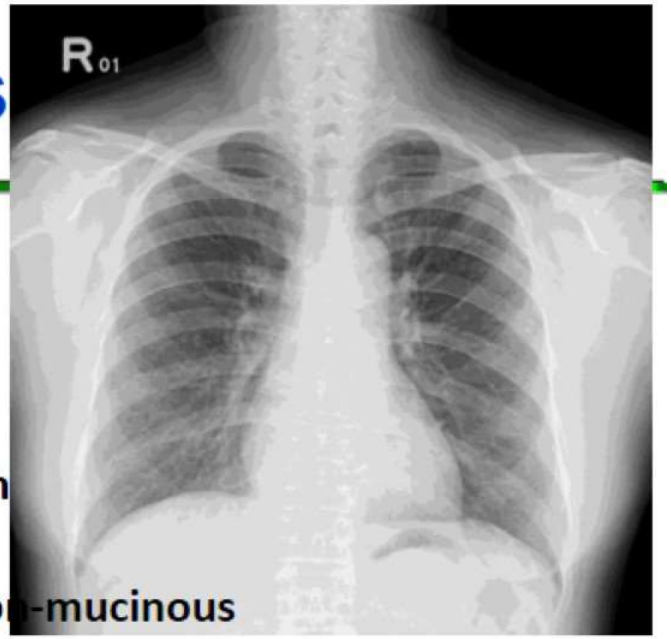
11/30/2012

Indolent tumor growth

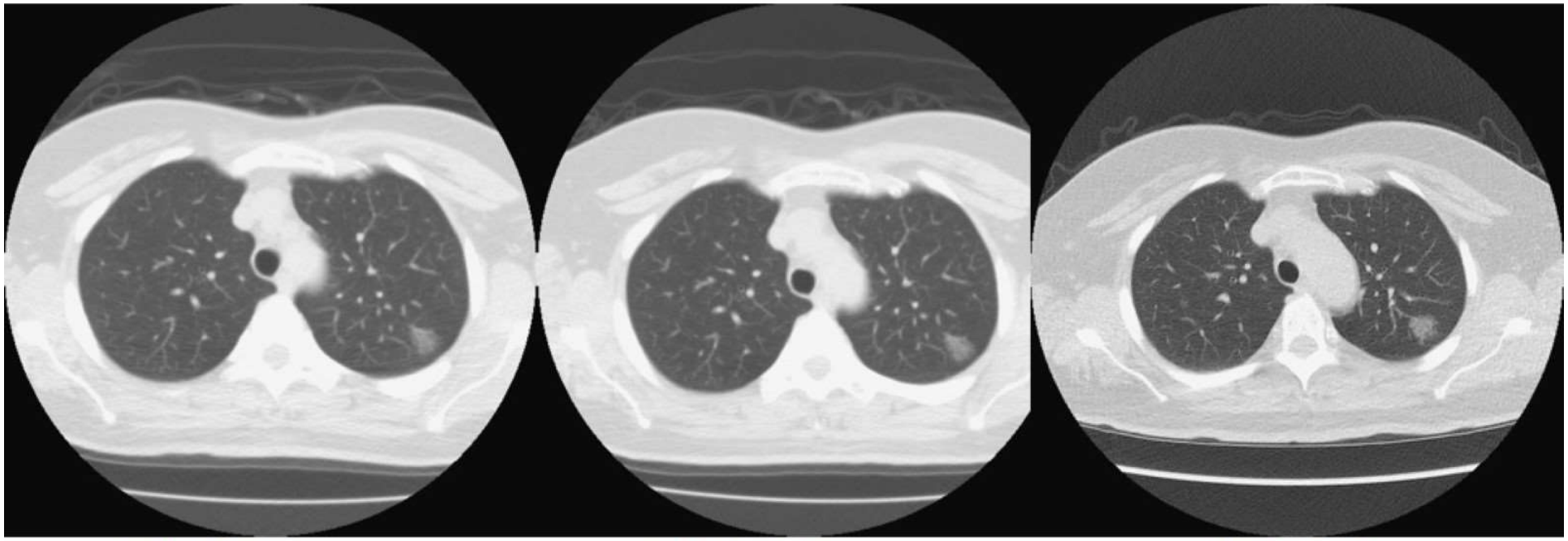
Adenocarcinoma RUL, T1aN0M0
Invasive, non-mucinous

Small pulmonary nodules

- Pure GGN
- Part solid nodule
- Solid nodule



Indolent tumor growth
Adenocarcinoma,
LUL, stage IA GGN , non-mucinous



07/06/2006 04/01/2008 01/05/2013

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Pure GGN is generally unchanged for years.

A few pure GGNs extremely slowly grow.

↓

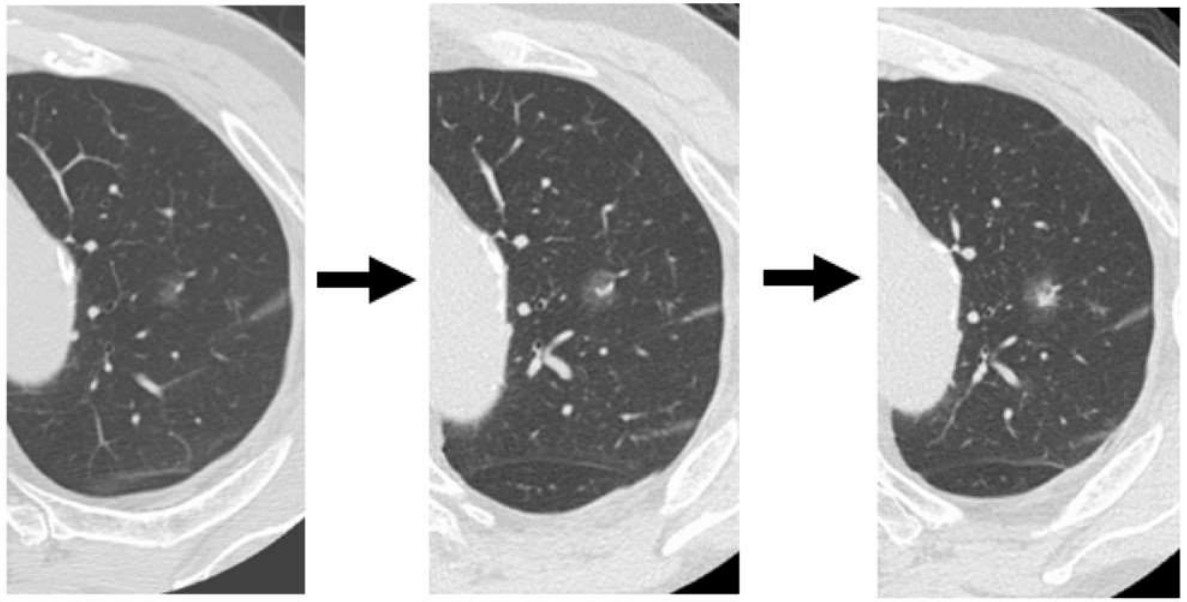
GGN is *not* considered an 'early' stage lung cancer.

Kakinuma R, et al. Radiology. 2015;276:873-82.

Small pulmonary nodules: follow-up

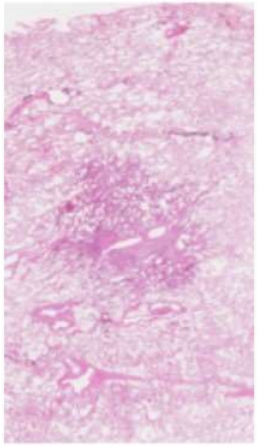
- Pure GGN
- Part solid nodule
- Solid nodule

GGN that appear solid portion for 5 years of follow-up



At detection　　3 years later　　5 years later

Rare case



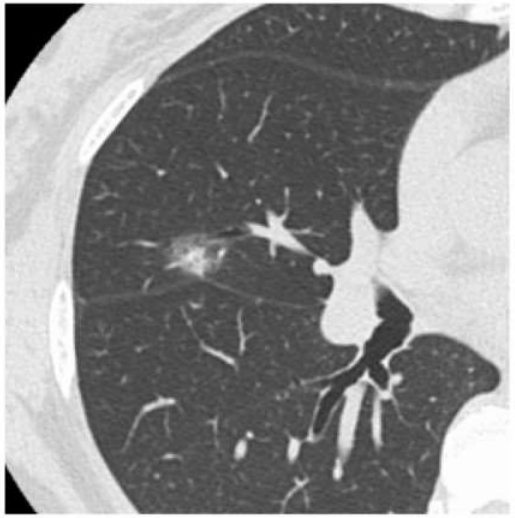
MIA

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Part Solid Nodule

Persistent and well-defined →



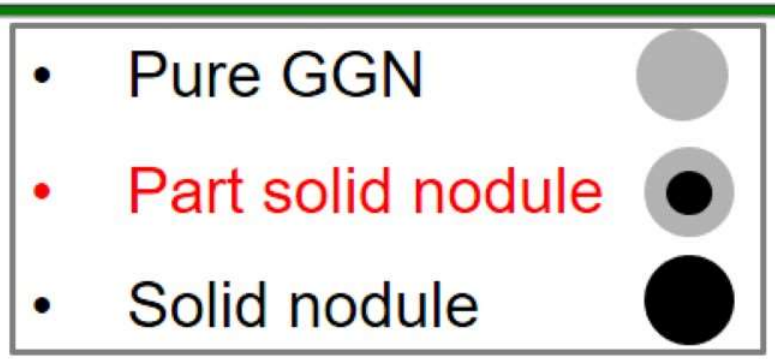
MIA

Lepidic Ad or MIA

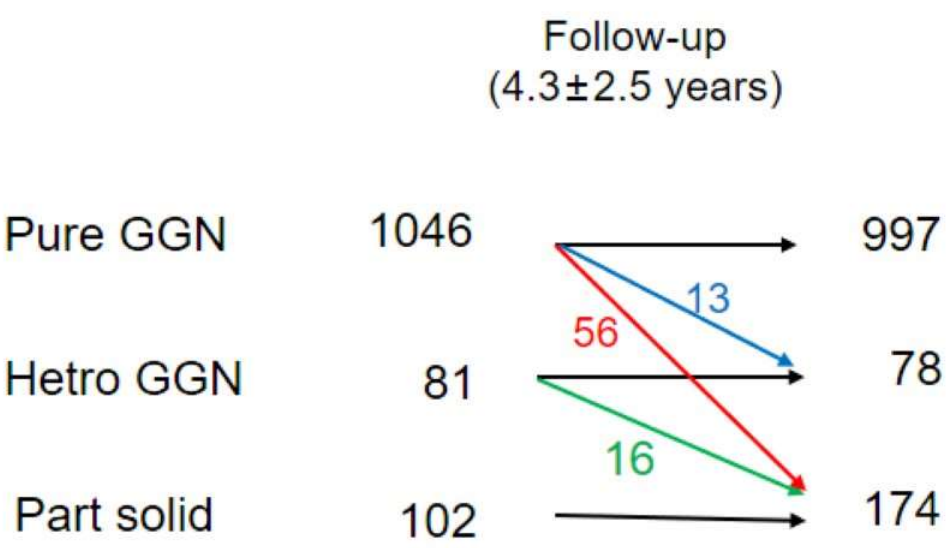
Lepidic Adeno ca.

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule



Subsolid (GGN + Part solid): Follow-up



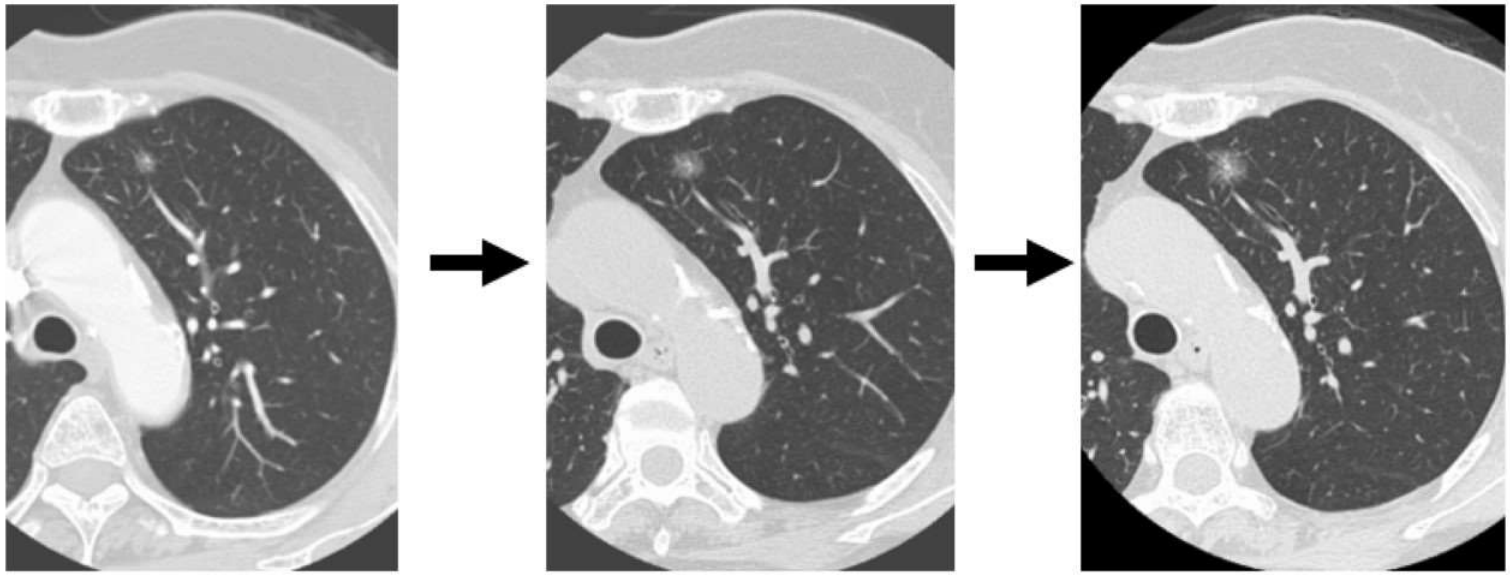
	Resected cases (n=79)			
	AAH	AIS	MIA	Inv Ad
Pure GGN	5	21	9	
Hetro GGN	2		5	
Part solid	1	10	26	12

Kakinuma R, et al. J Thorac Oncol. 2016;11:1012-28.

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Part Solid Nodule: Follow-up case (1)



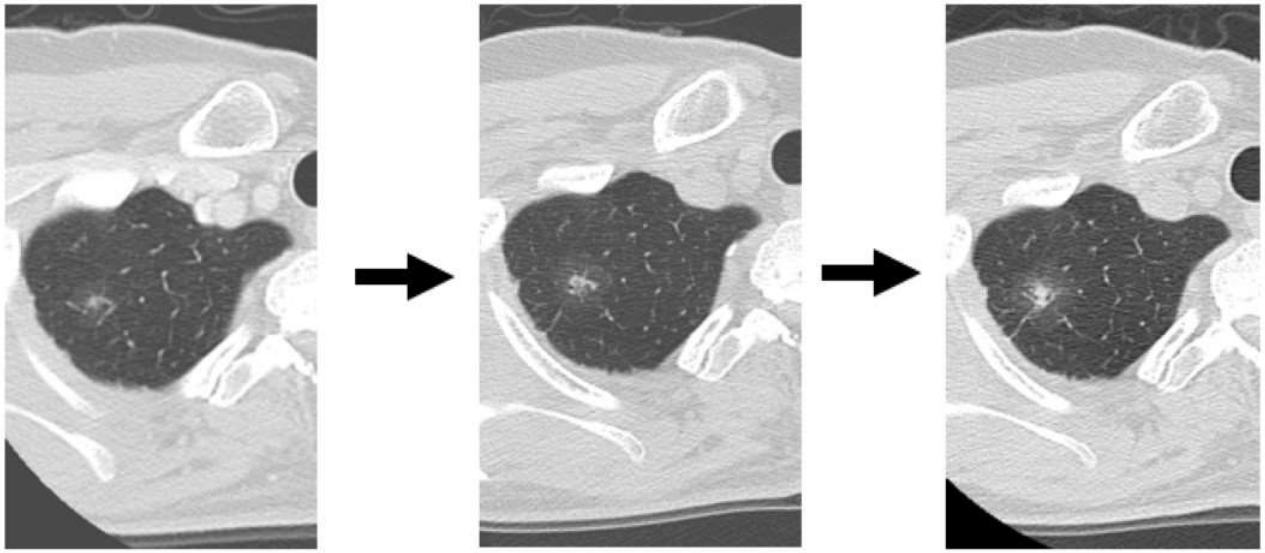
At detection (M 70s) → 4 years later → 8 years later (M 80s)

Under follow-up

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Part Solid Nodule: faint GGA (F, 60s)



At detection | 3 years later | 6 years later

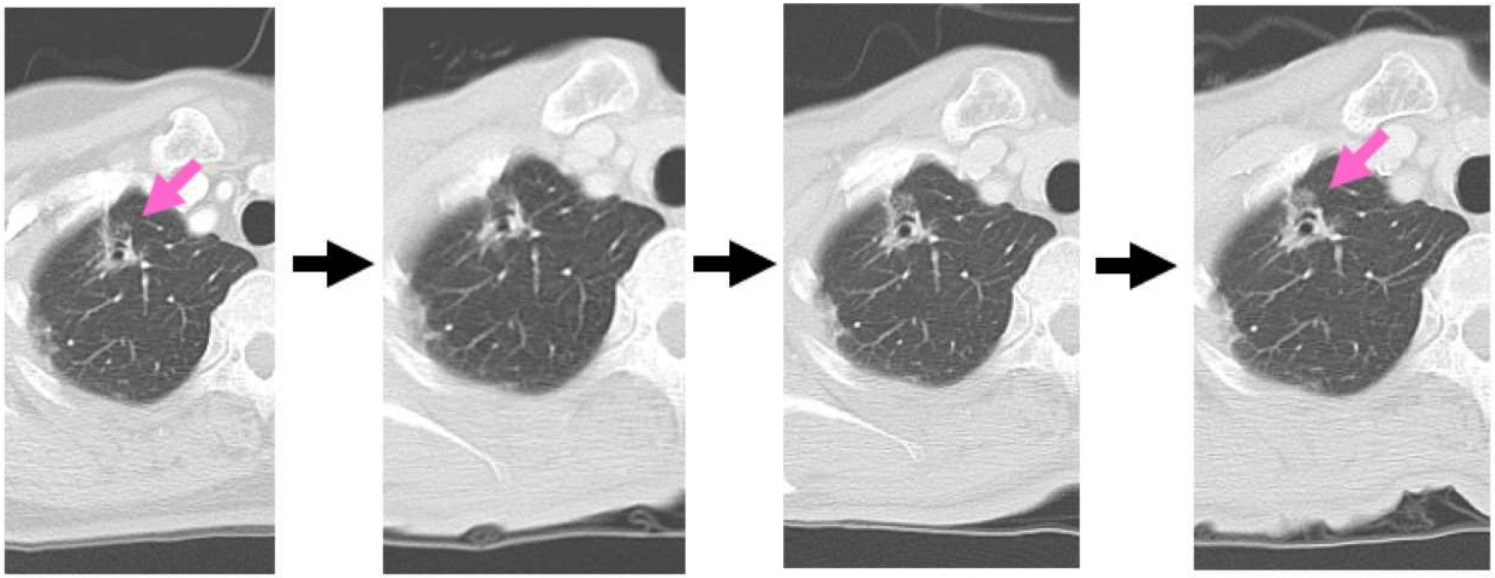
(Right upper lobectomy)

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Part Solid Nodule: a case after gastrectomy

lepidic predominant AdenoCa.

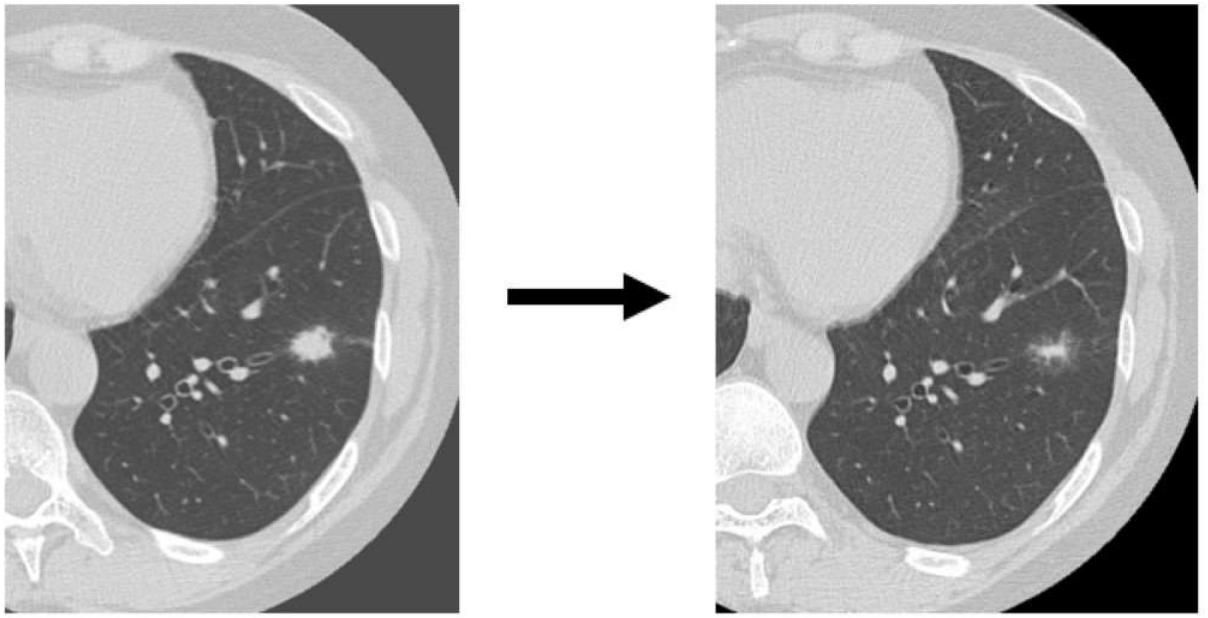


At detection | 1 year later | 2 years later | 3 years later (5mm reconstruction images)

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Part Solid Nodule



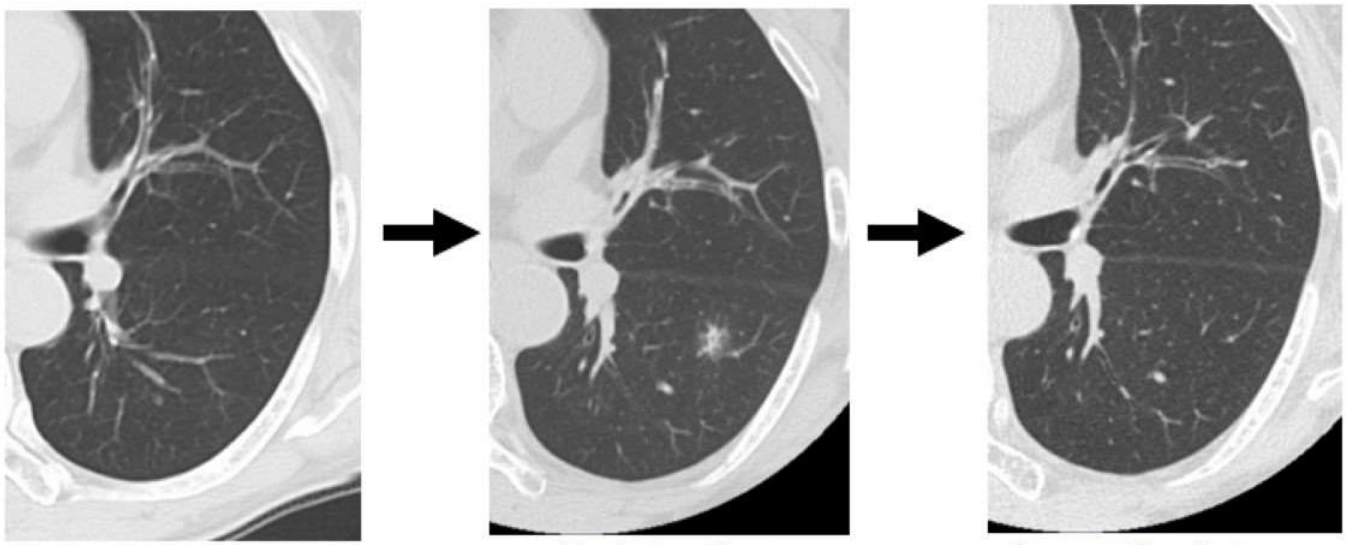
Before 3 months

Curing process of inflammatory nodule

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

During follow-up of GGN at right upper lobe,
Part solid nodule appears at left lower lobe



Before 1 year
(5mm thickness)

At detection
(1mm thickness)

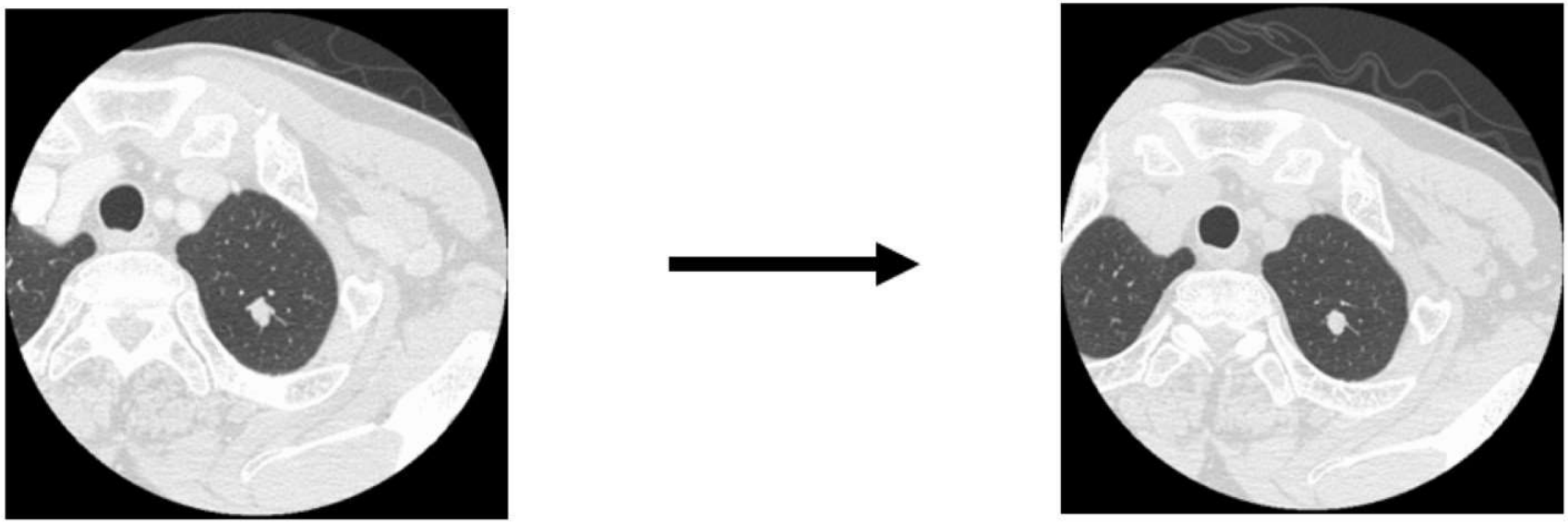
3 months later
(1mm thickness)

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Solid nodule: Cancer or Granuloma?

Granuloma



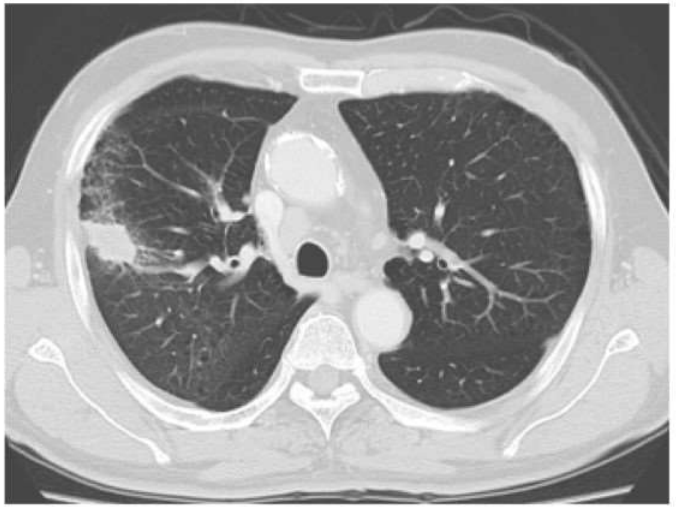
Detection 3M later → 6M later → 1 year later → 2 years later

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Male 50s, Smoker
Status after endoscopic therapy
for colon cancer

Before 1 year

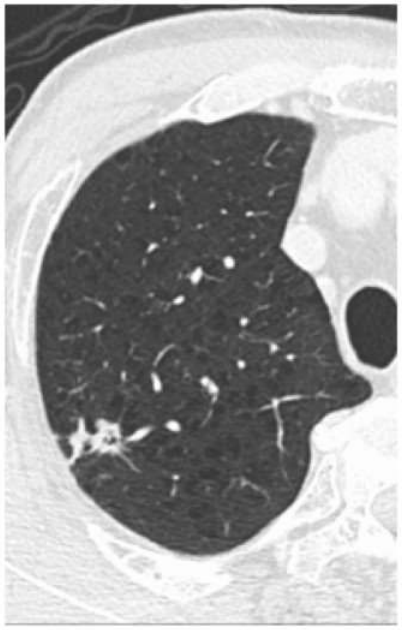


Poorly differentiated adenocarcinoma
with mediastinal lymphnode metastasis

Small pulmonary nodules: follow-up

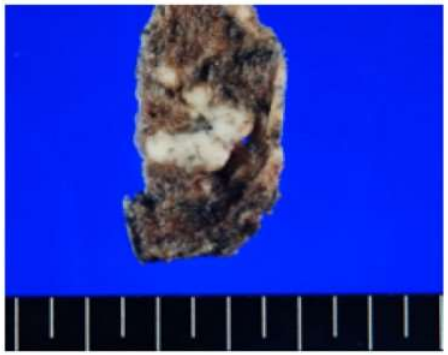
- Pure GGN
- Part solid nodule
- Solid nodule

Solid nodule?



Irregular margin nodule in pulmonary emphysema

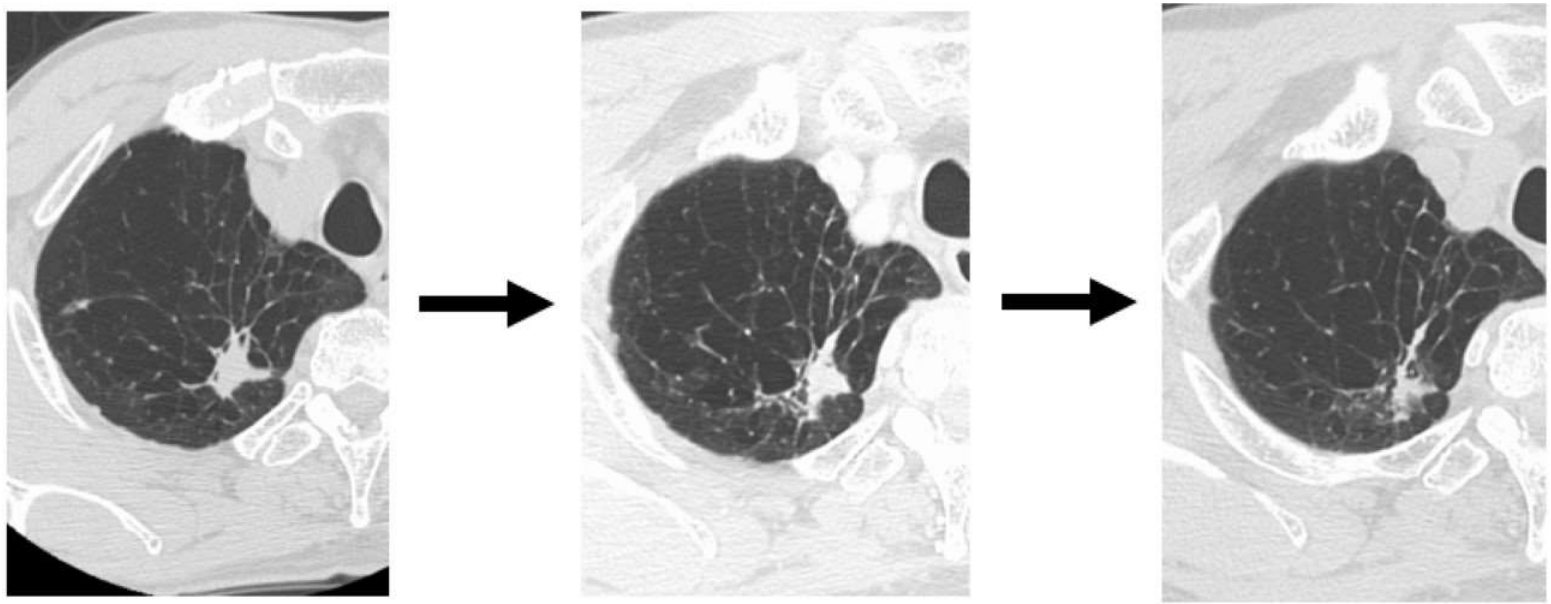
Squamous cell ca.



Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Solid nodule with irregular margin in the emphysema



At detection

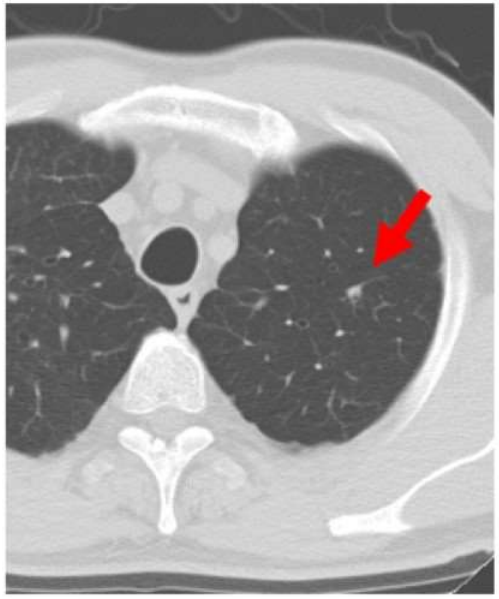
2 months later

4 months later

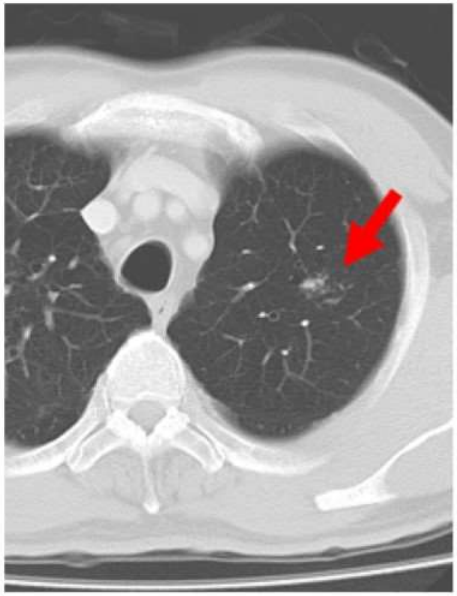
Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small solid nodule, Male 60s, Smoker



At detection

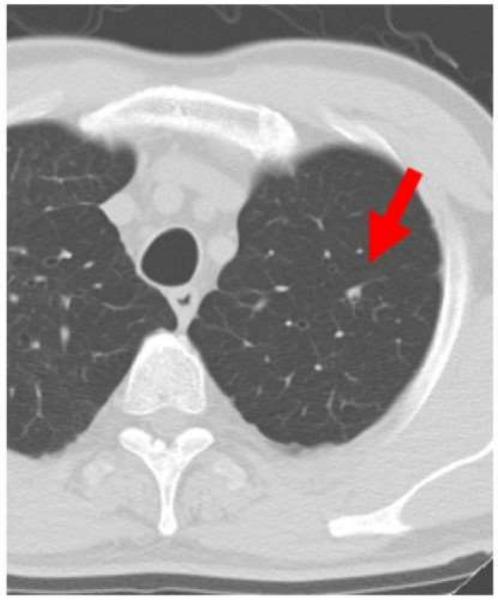


3 months later Left hilar lymphadenopathy!

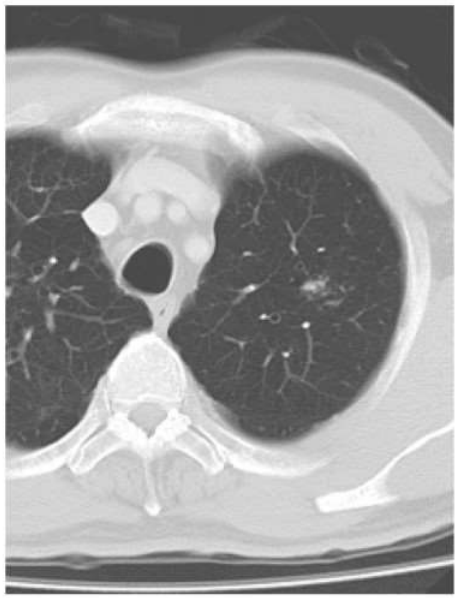
Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small solid nodule, Male 60s, Smoker



Primary lesion of SCLC
(No lymphadednopathy)



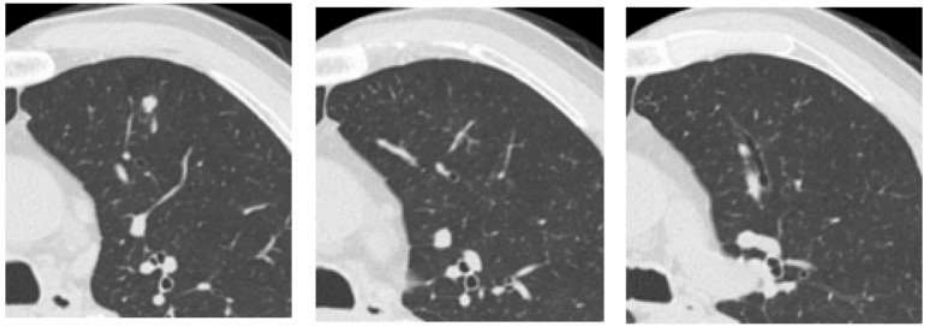
3 month later Left hilar lymphadenopathy!

Small pulmonary nodules: follow-up

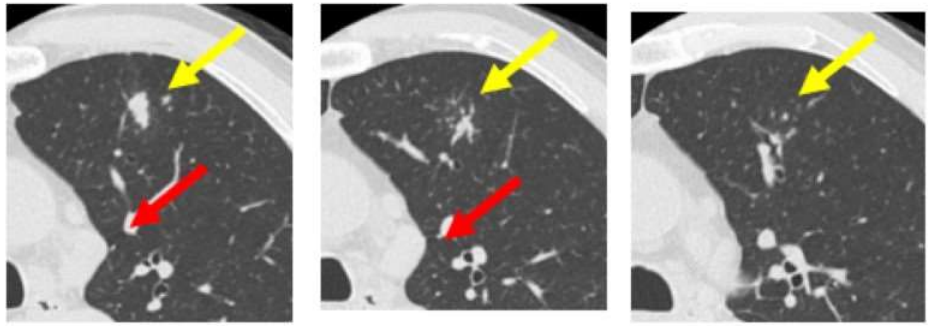
- Pure GGN
- Part solid nodule
- Solid nodule

Small solid nodule, Male 60s, Smoker

2 months later



4 months later



Mediastinal lymphadenopathy!

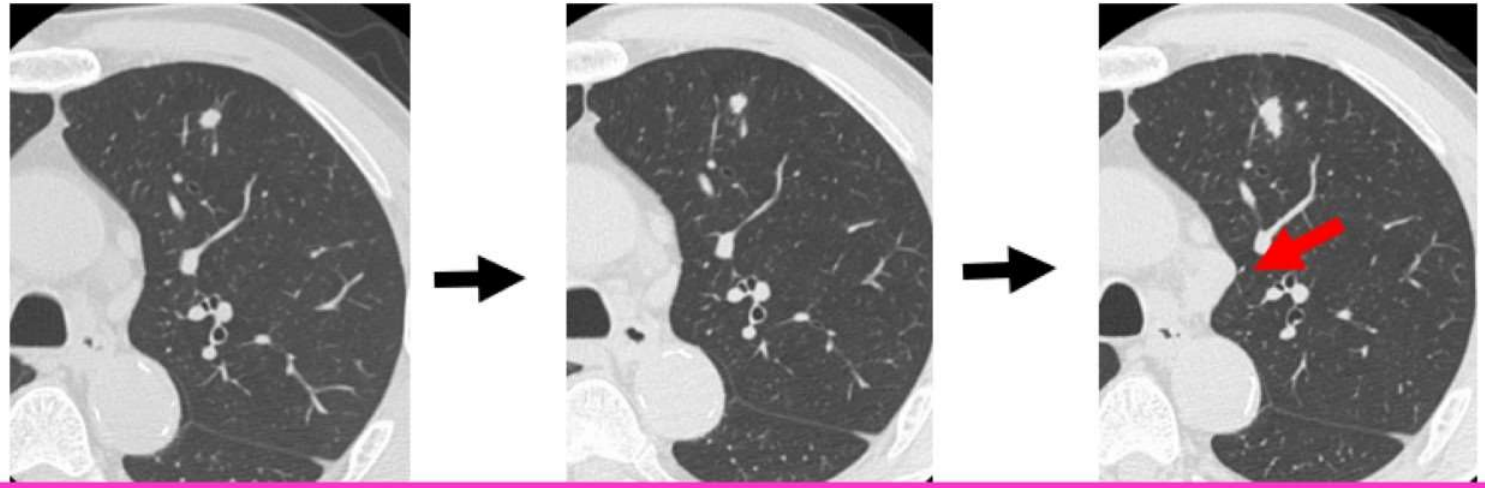
Small cell carcinoma!

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small solid nodule, Male 60s, Smoker

Small cell carcinoma!



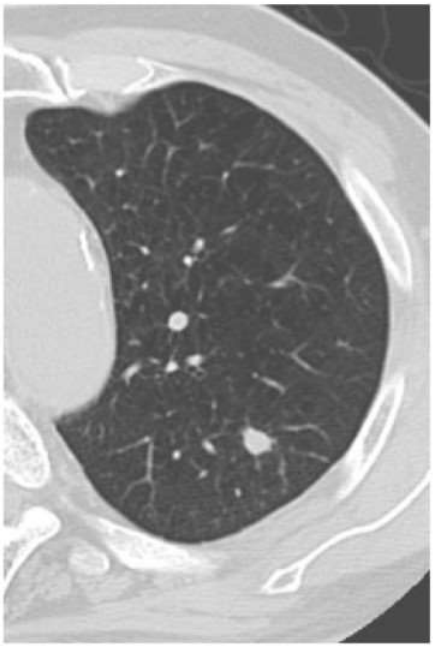
Can be diagnosed clinically and pathologically in stage III or IV!

At detection | 2 months later | 4 months later

Small pulmonary nodules: follow-up

- Pure GGN
- Part solid nodule
- Solid nodule

Small solid nodule, Male 70s, Smoker



Assume image 3 months later

· Disappeared → inflammation

· No change → Granuloma ?

· Increased → Squamous cell ca. ?
(poorly diff. Adeno ca.?)

· Lymphadonpathy → SCLC

Satellite lesion
Benign granuloms on LUL

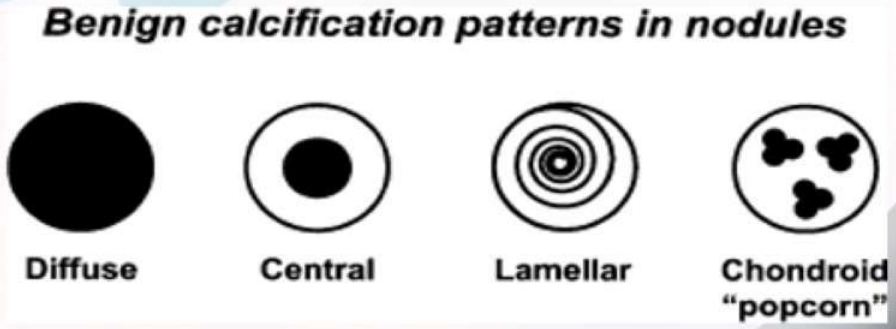
Benign granuloms on LUL

Satellite nodule
Favor TB granuloma

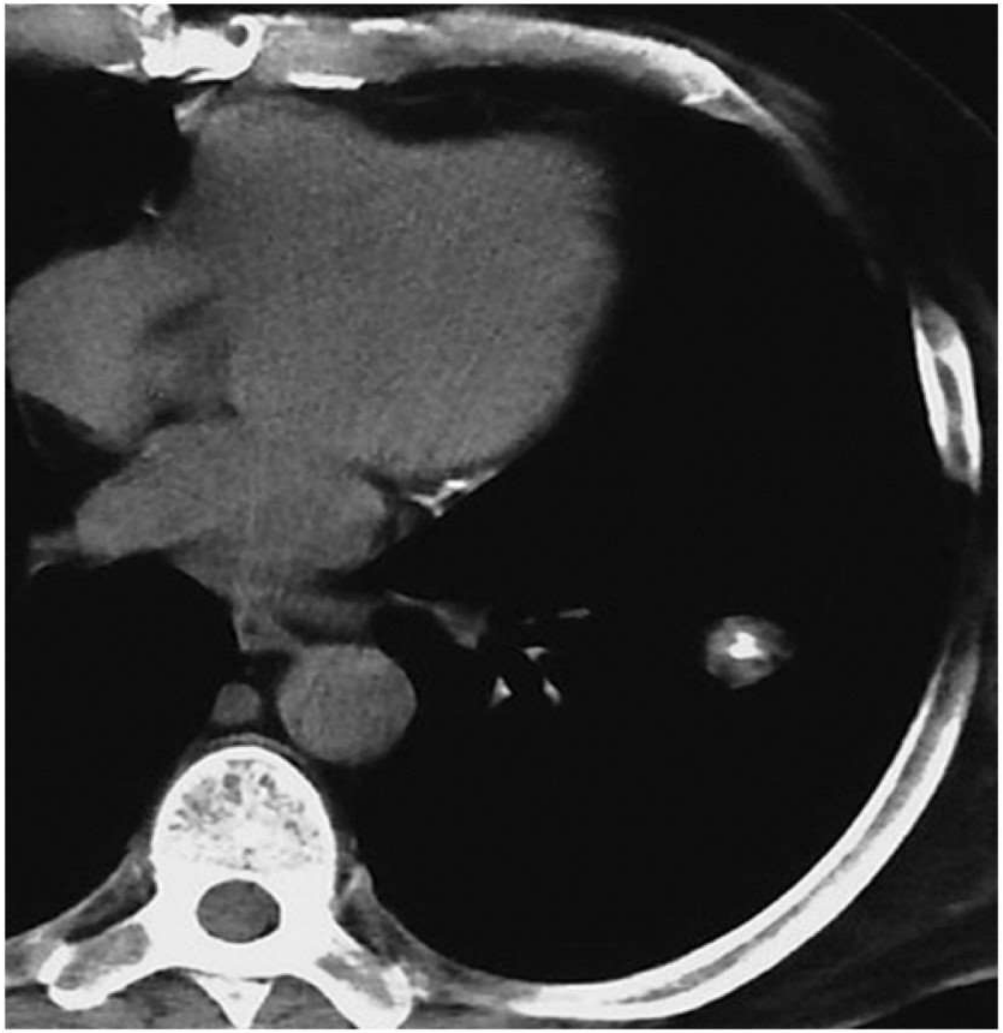
1. Radiographic pattern of calcium deposition is helpful
2. Benign lesions tend to have central, laminated (bull's eye), diffuse or popcorn pattern
   良性病變往往具有中央，層狀（牛眼），瀰漫性或爆米花狀

3. Malignant lesions have speckled or eccentric pattern
   惡性病變有斑點或偏心

Calcification

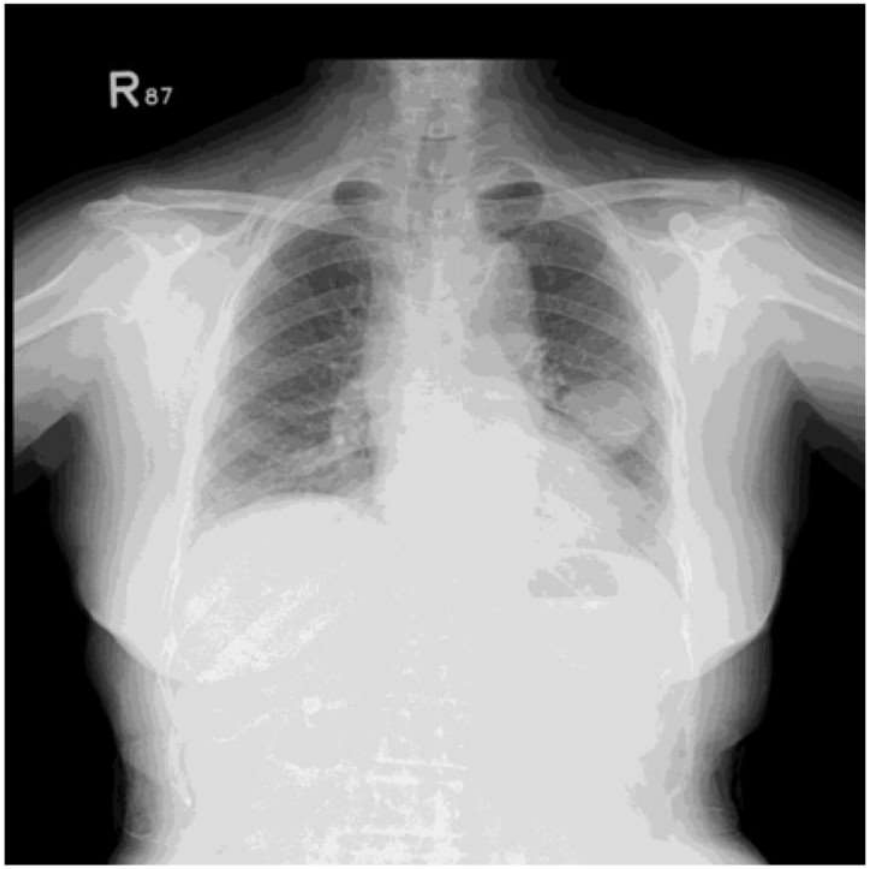


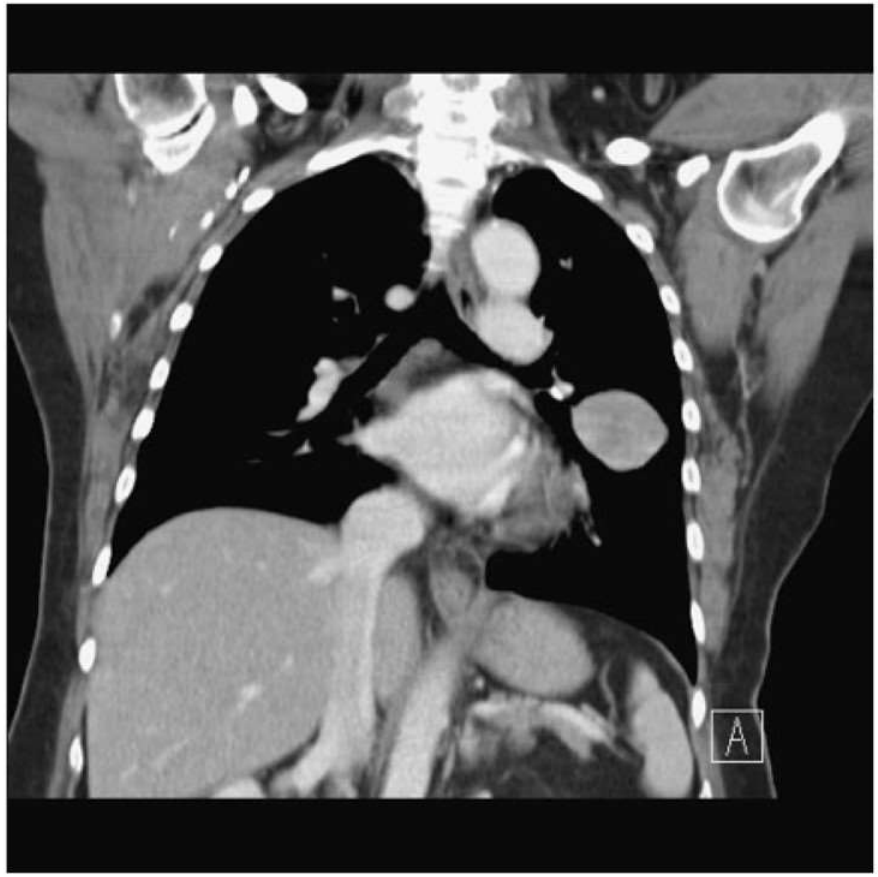
Calcification: Laminated or central pattern typical of granuloma



Benign :

Well-defined shape, Homogeneous density , Calcification, …

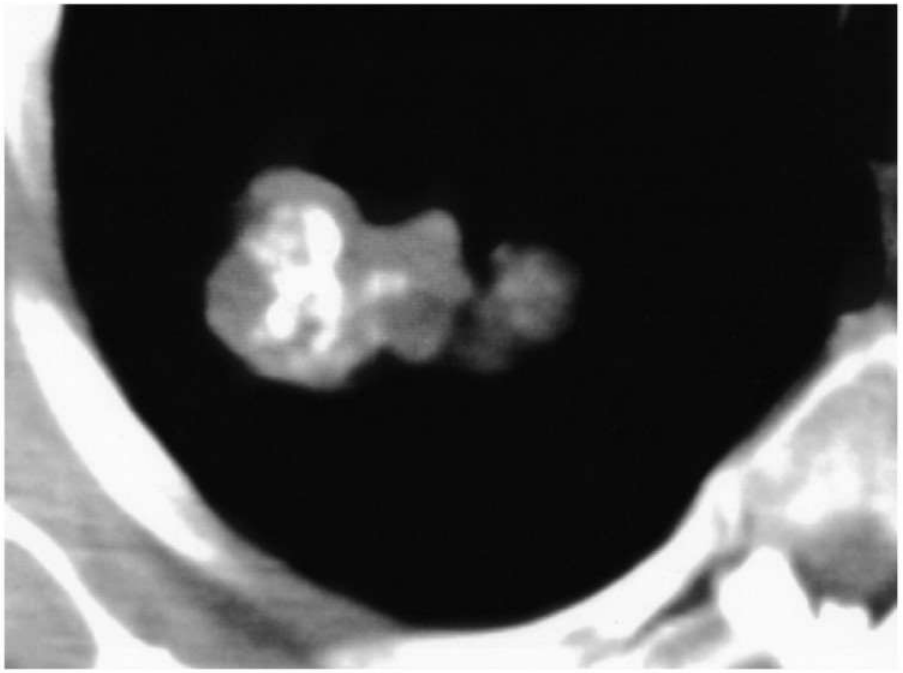




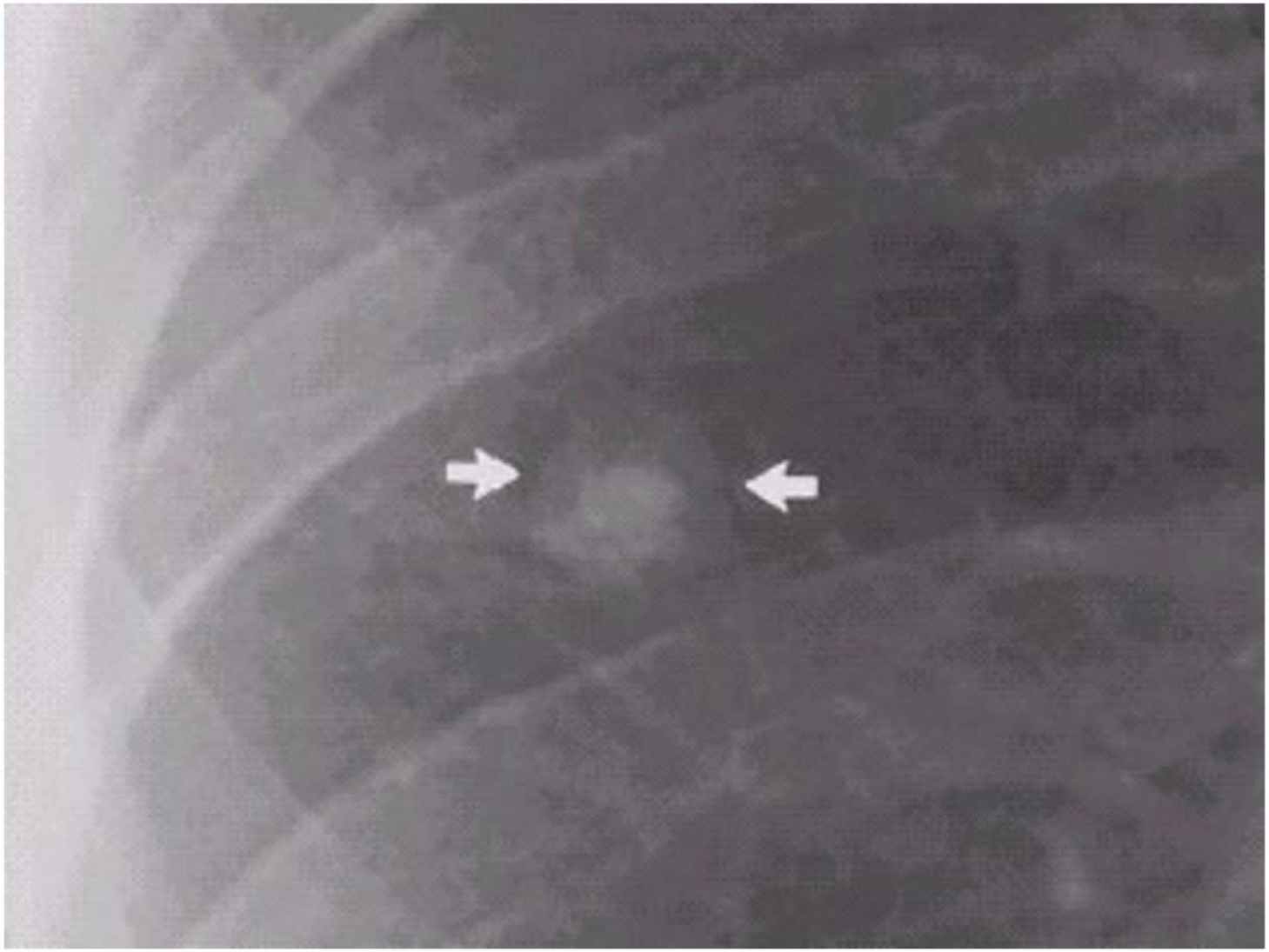
- 硬化性血管瘤（Sclerosing hemangioma）是肺部相對較少見的良性腫瘤，常見於40幾歲無症狀的中年女性，其典型呈現是位於肺部周邊單顆邊緣清楚的結節，而多發性結節表現的硬化性血管瘤是非常少見的，佔所有肺部硬化性血管瘤約4-5%的發生率。

Benign Calcification: Popcorn Calcification

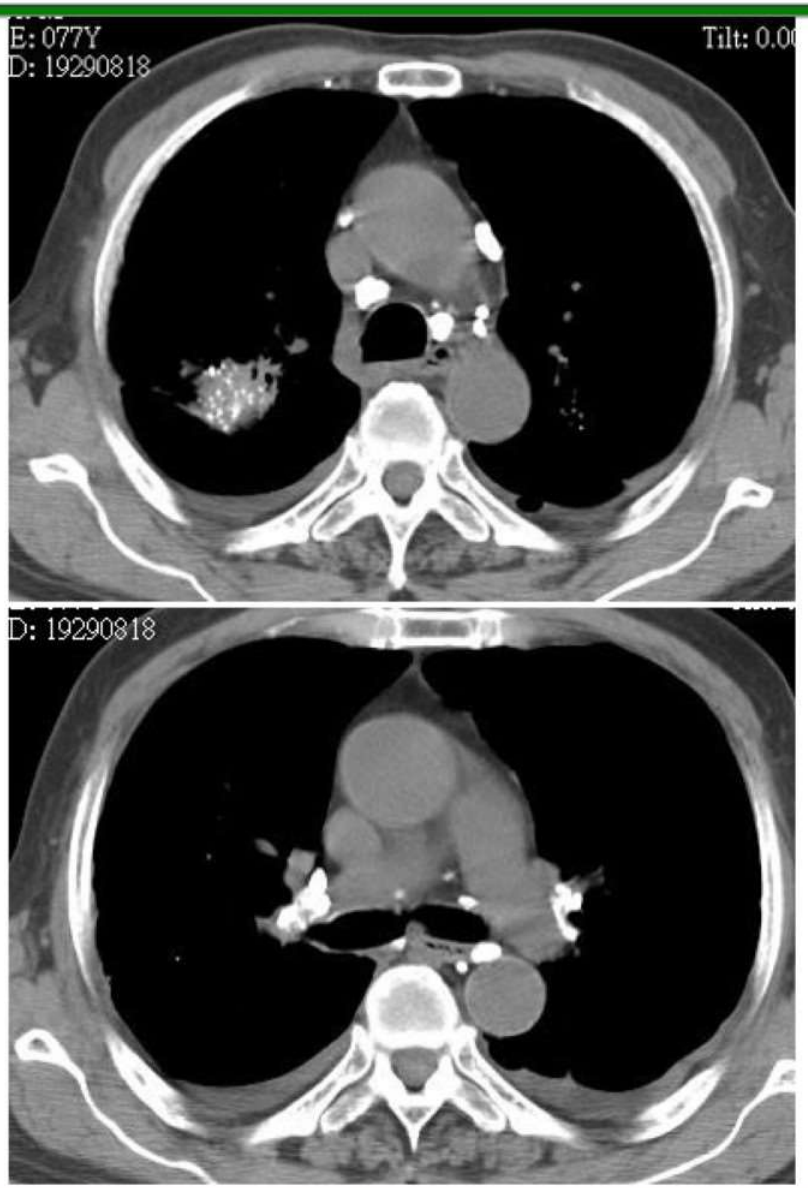
Benign Calcification: Popcorn Calcification



Benign Calcification: Central Calcification

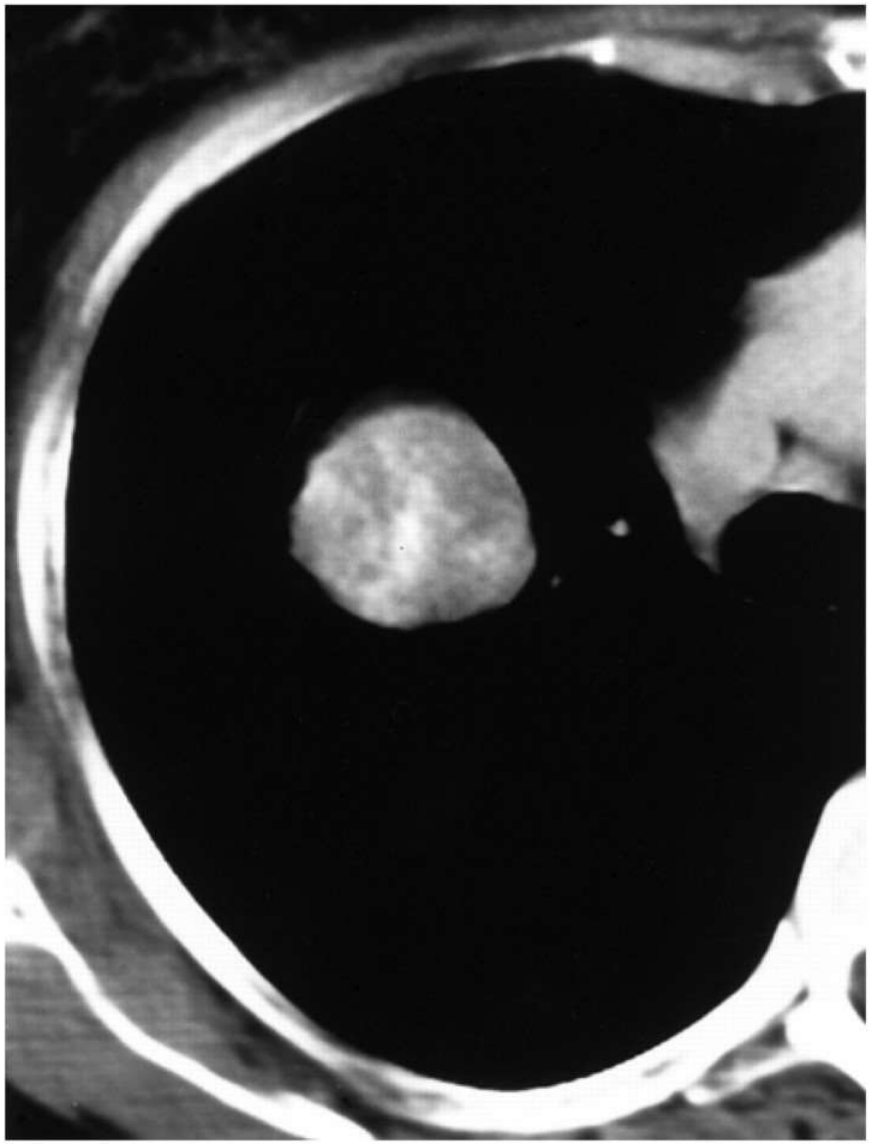


Pneumoconiosis and PMF in RUL

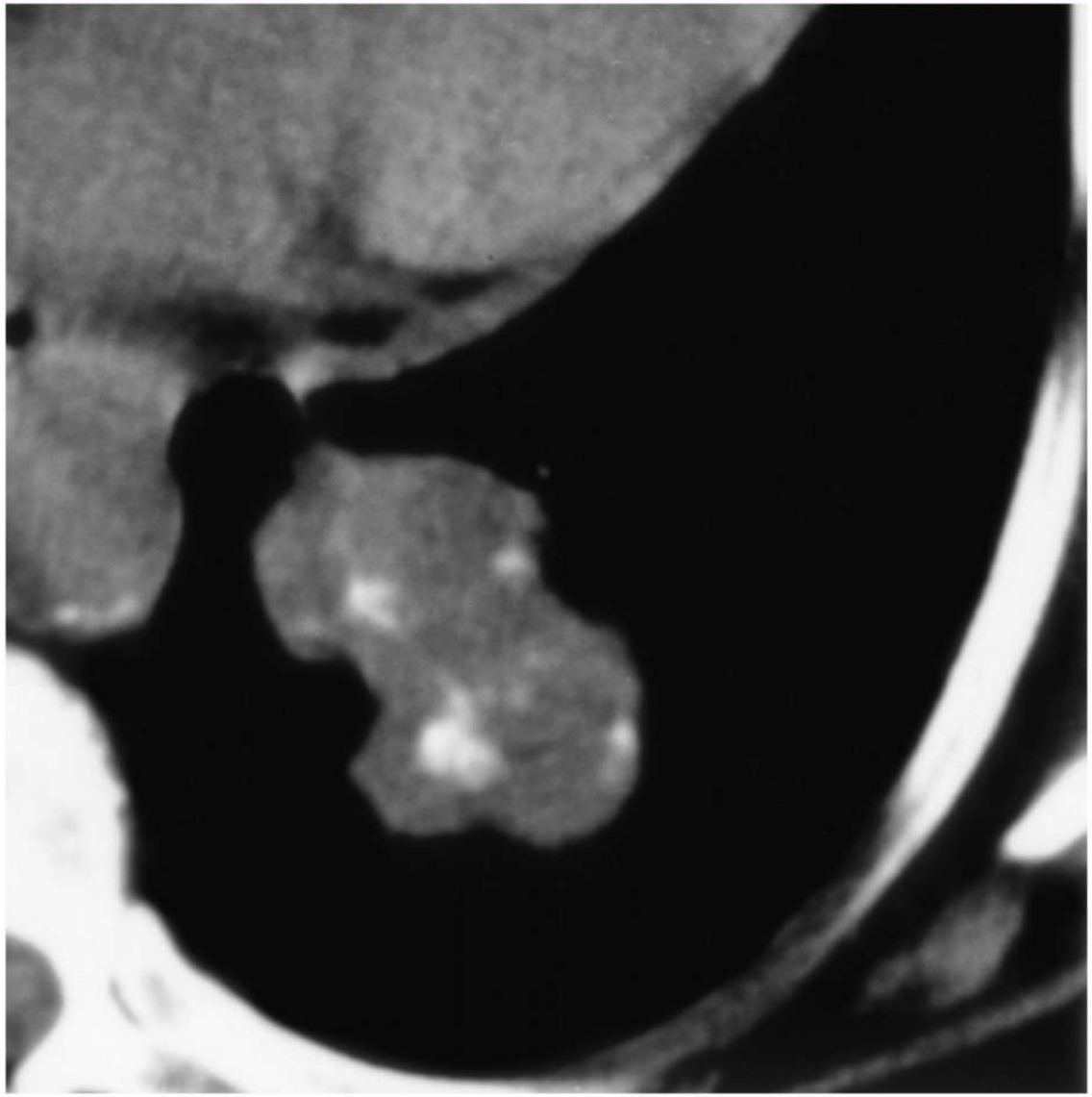


RUL tumor with calcification (diffused)
LN calcification (+)
Multiple small nodules bil. Lung fields
Dx: pneumoconiosis and PMF in RUL

NSCLC in a 45-year-old woman



Typical pulmonary carcinoid tumor in a 68-year-old woman

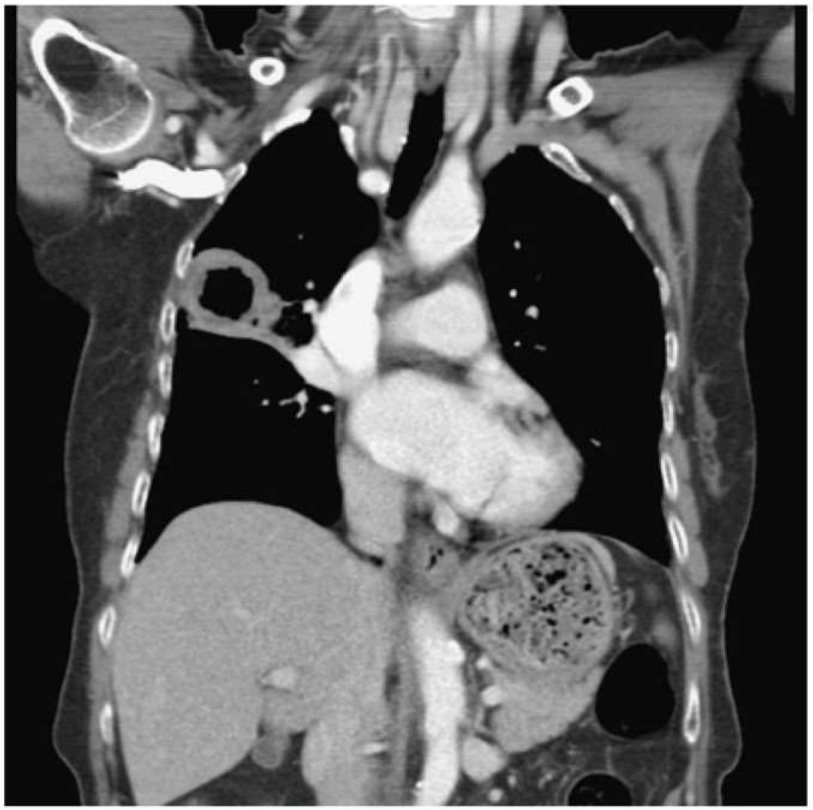


Cavity

- Thin-walled/ Thicked-walled
- Inner wall smooth/ Irregular
- Inflammatory processes?
- Acute/ Chronic
- Single/ Multiple cavity
- Air-crescent sign/ Ball-in-hole

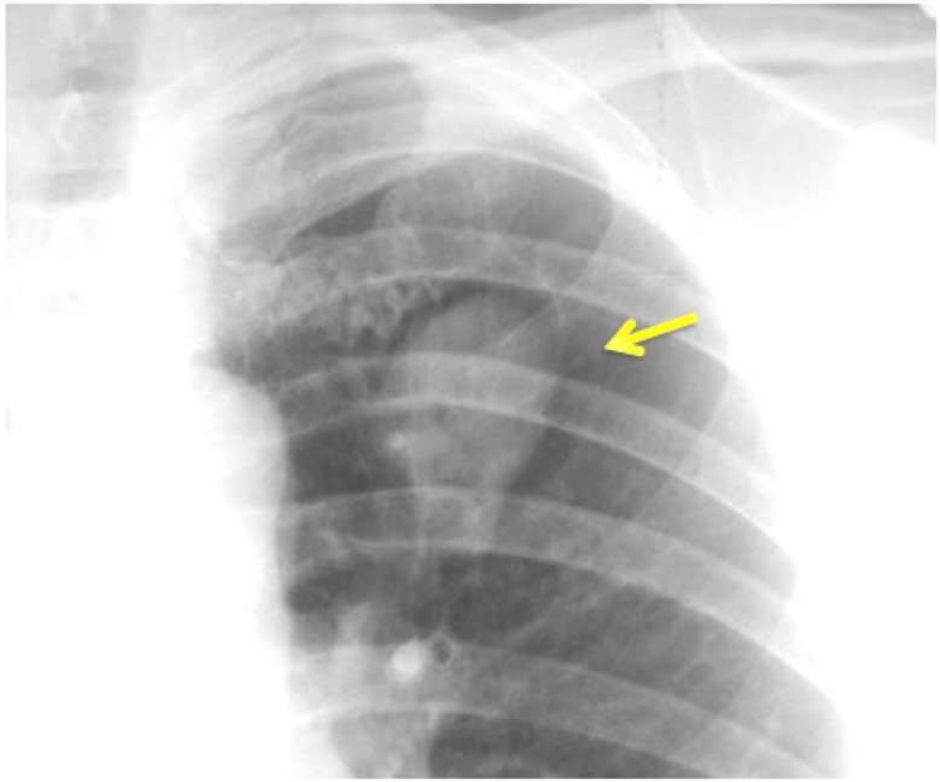
Cavitation

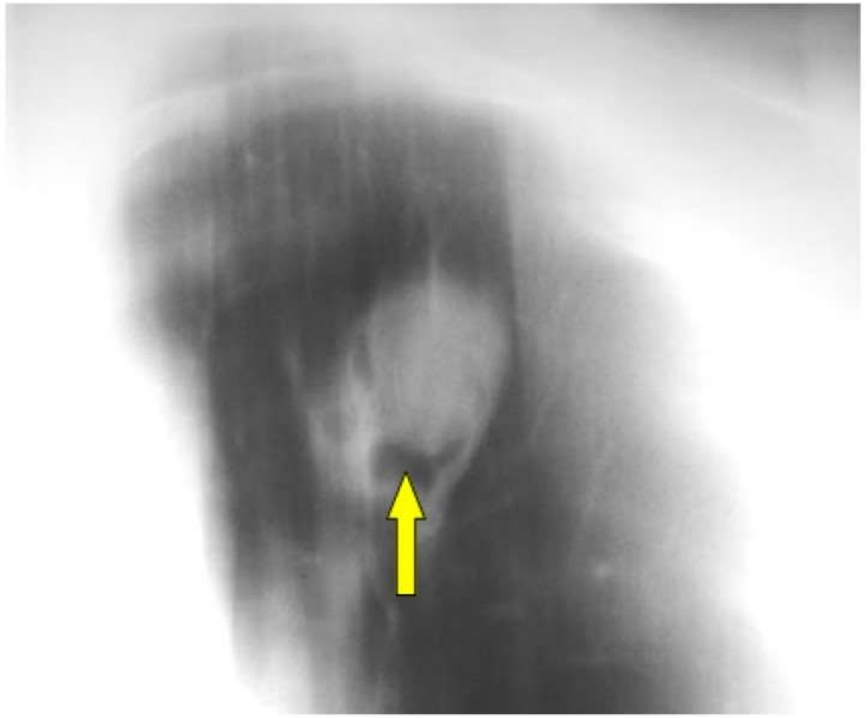
Thick-walled cavity in 80/F, dyspnea. Chest pain for three months.
Wall thickness > 15 mm
Favor malignancy or wegener's granulomatosis



Dx: Squamous cell carcinoma of lung, RUL

Air crescent on LUL Mass shadow



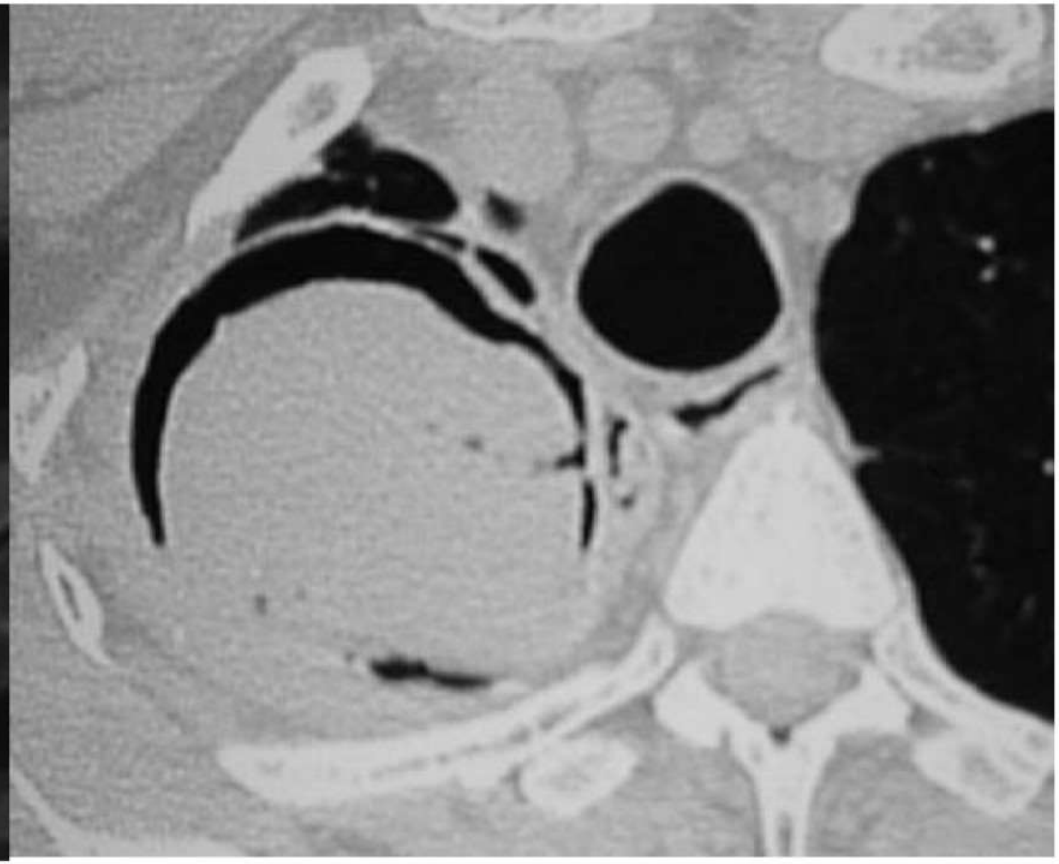


Ball-in-hole

Dx: mycetoma, LUL

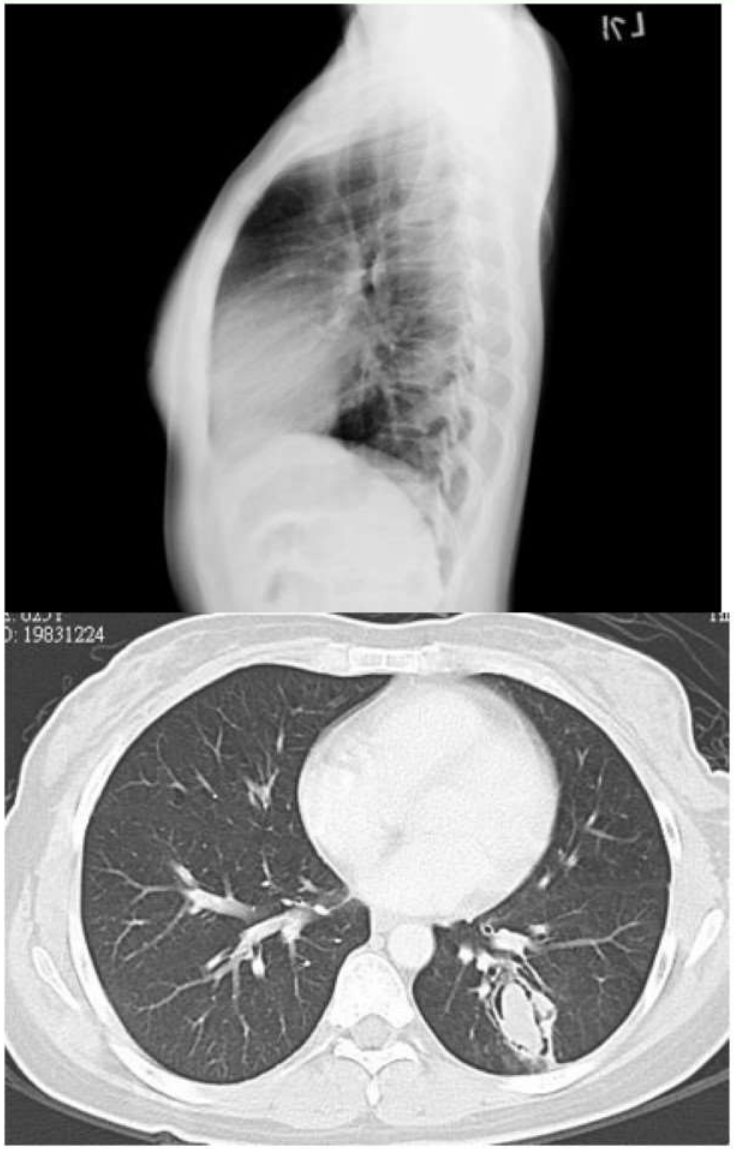
Fungal Ball

Crescent sign in relation to the right upper lobe SPN due to a fungal ball in a cavity



Aspergillosis on LLL (ball-in-hole)

26/F hemosputum off and on for three yrs.



Aspergillosis on LLL (ball-in-hole)

Minimally invasive adenocarcinoma (MIA) in a 68-year-old woman

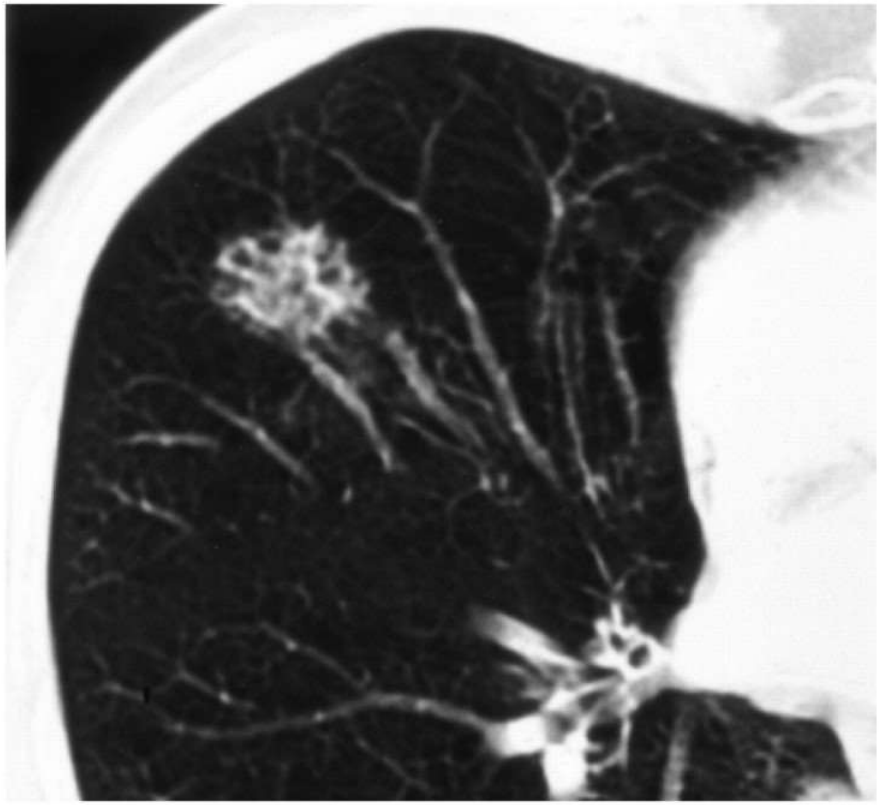


Table 2. Minimally Invasive Adenocarcinoma

Pathologic criteria

- A small tumor ≤3 cm
- A solitary adenocarcinoma[a]
- Predominantly lepidic growth
- Invasive component ≤0.5 cm in greatest dimension in any one focus
- Invasive component to be measured includes
  1. Any histologic subtype other than a lepidic pattern (such as acinar, papillary, micropapillary, solid, colloid, fetal, or invasive mucinous adenocarcinoma)
  2. Tumor cells infiltrating myofibroblastic stroma
- The diagnosis of minimally invasive adenocarcinoma is excluded if the tumor
  1. Invades lymphatics. blood vessels, air spaces, or pleura
  2. Contains tumor necrosis,
  3. Spread through air spaces
- The cell type in most cases consists of nonmucinous (type II pneumocytes or Clara cells), but rarely may be mucinous (tall columnar cells with basal nuclei and abundant cytoplasmic mucin, sometimes resembling goblet cells)

[a]When multiple adenocarcinomas in situ are found, they should be regarded as separate primaries rather than intrapulmonary metastases.

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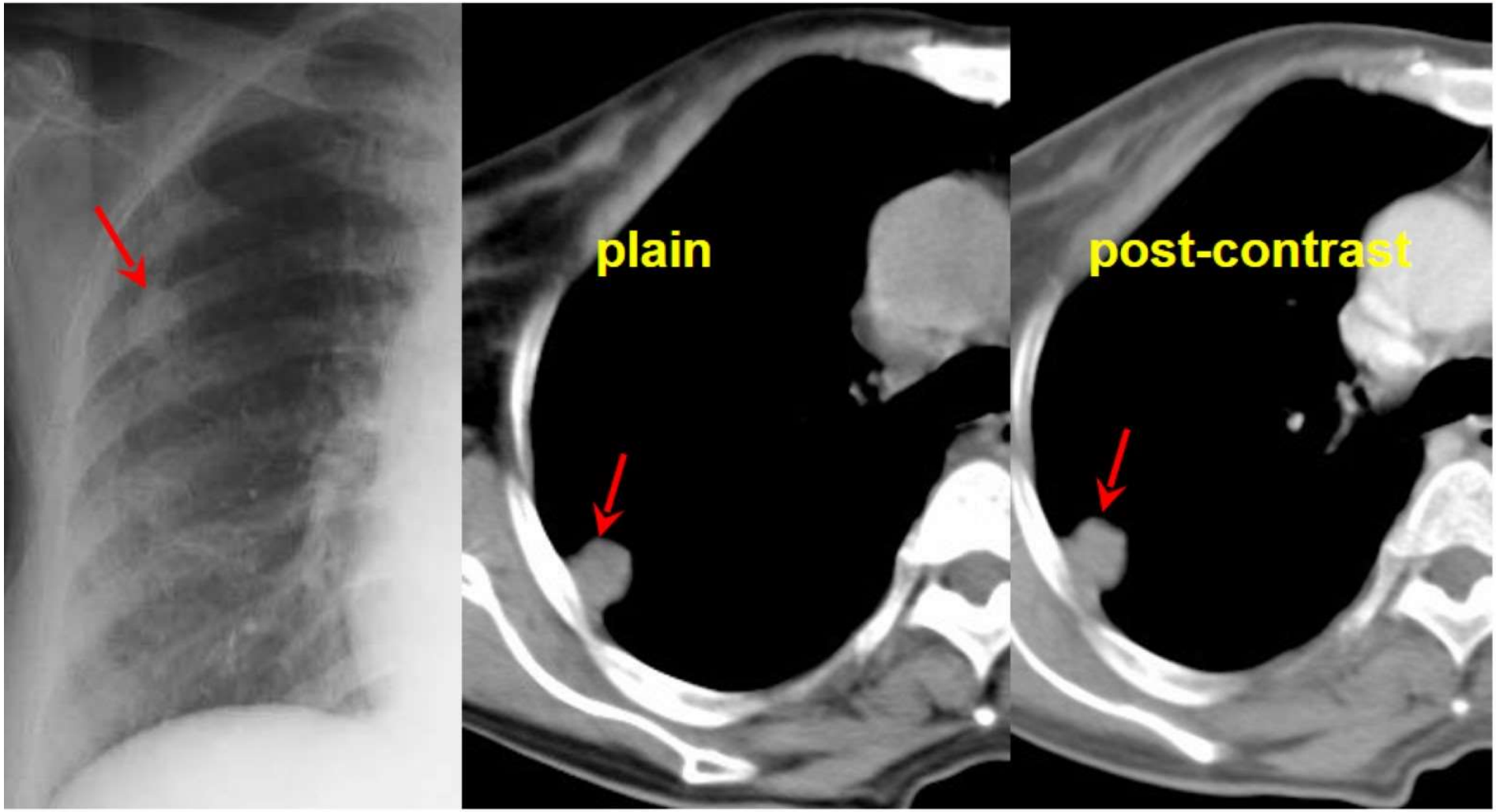
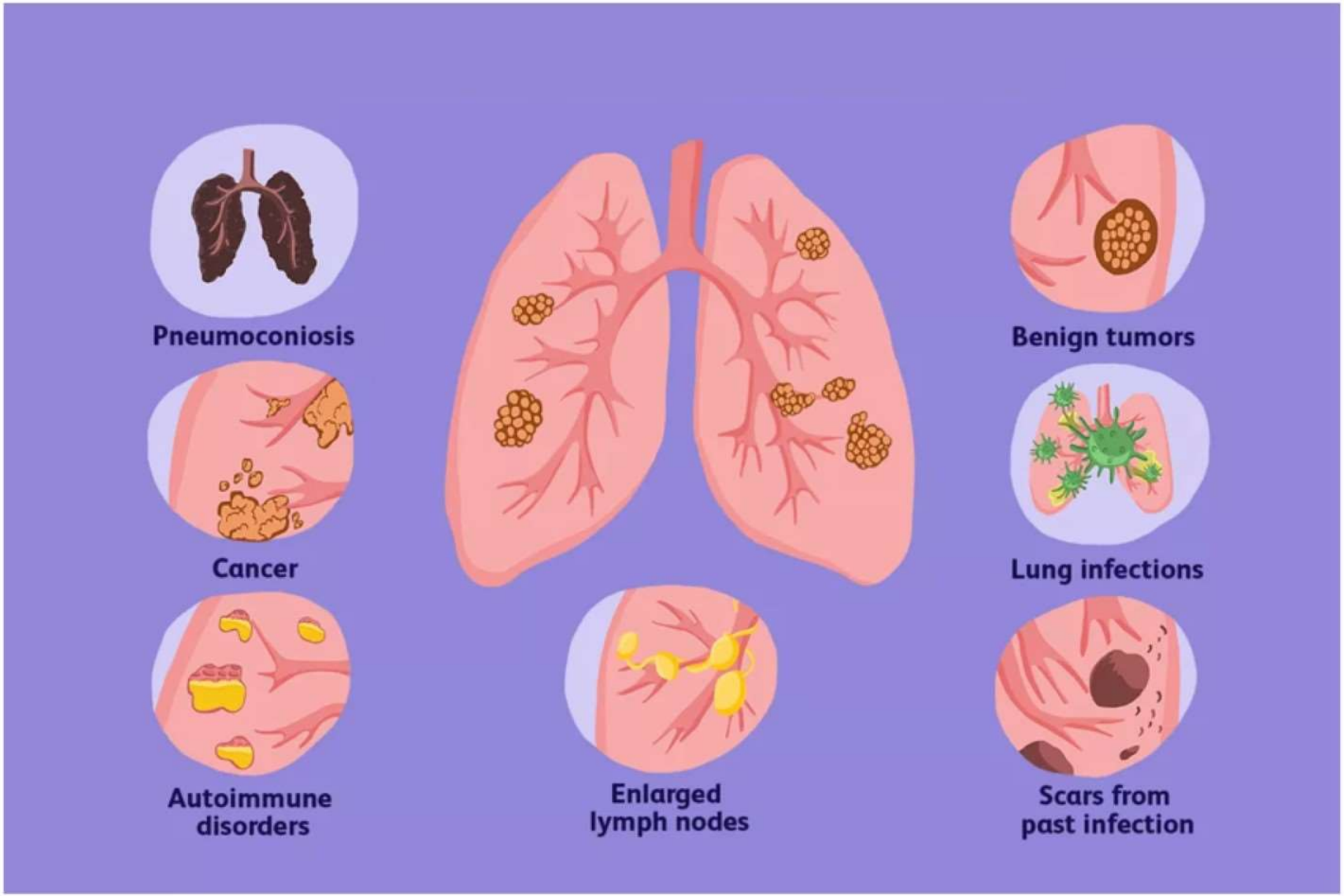
No enhancement whatsoever - benign



1. **Inflammatory processes**: TB. Granuloma, septic embolism, pneumoconiosis with PMF, fungal infection, wegener's granulomatosis
2. **Primary lung tumor**: lymphoma, lung cancer,
3. **Metastatic carcinoma**: pancreas, cervix, NPC, colon, renal cell ca.

Multiple lung nodules

Causes of Multiple Lung Nodules



Multiple Lung Nodules

Cryptococcal pneumonia

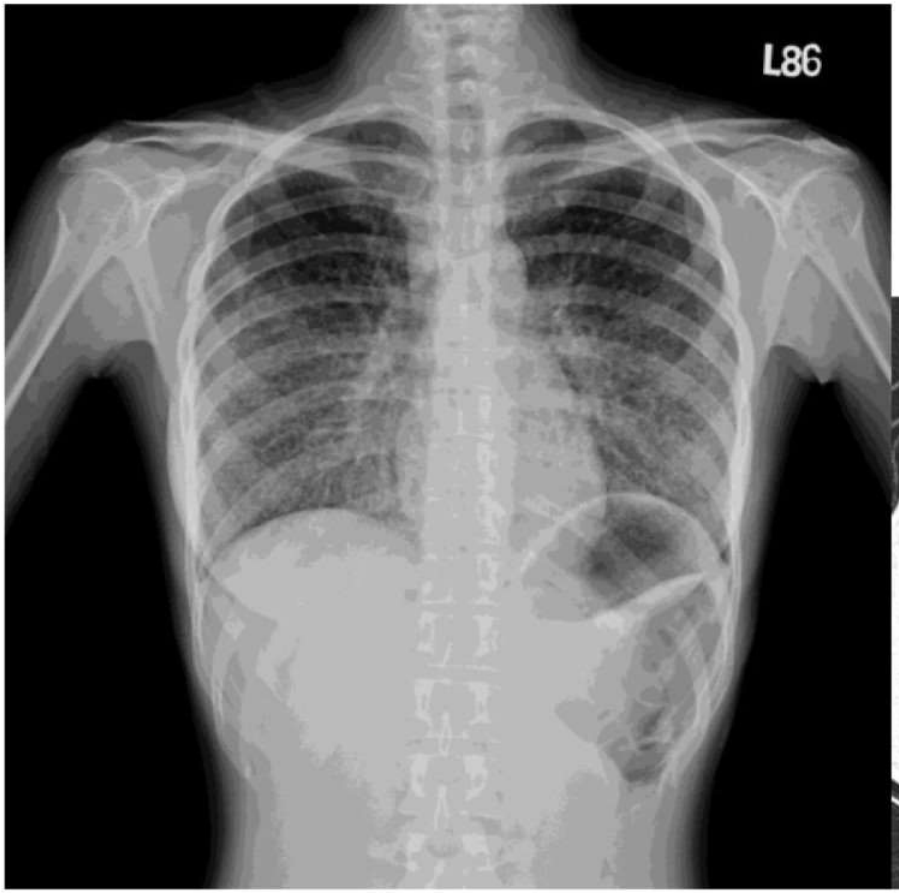
Cryptococcal pneumonia

Multiple pulmonary nodule
Miliary TB

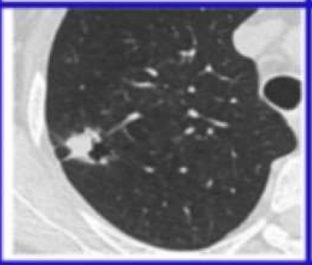
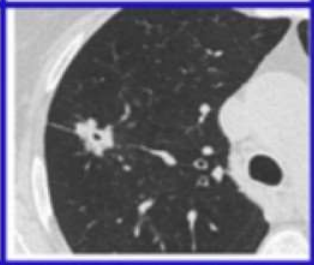
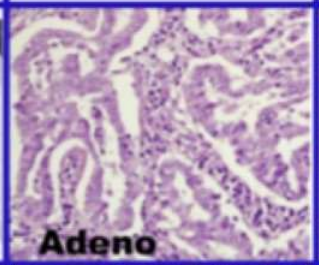
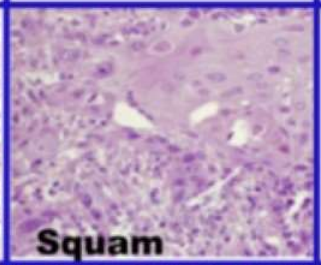
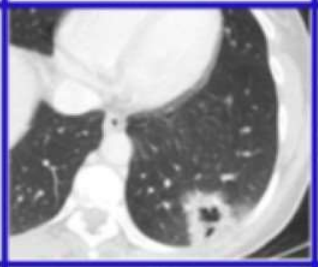
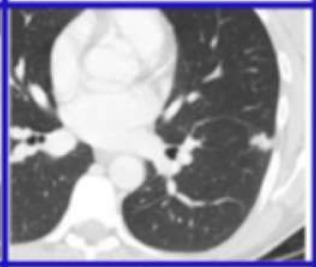
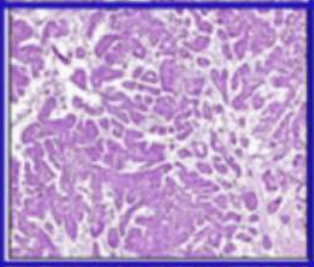
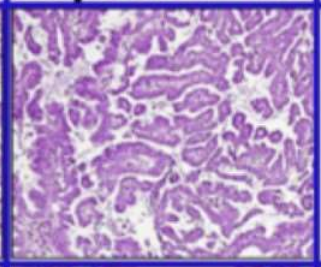
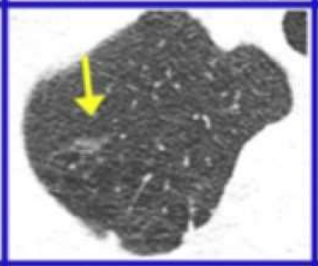
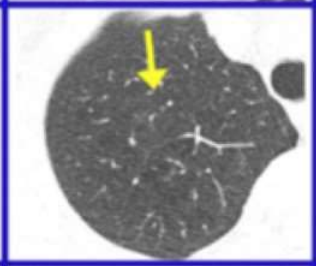
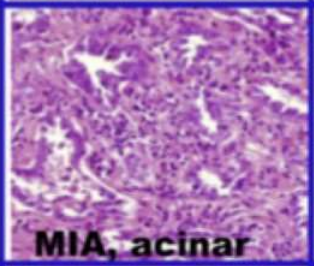
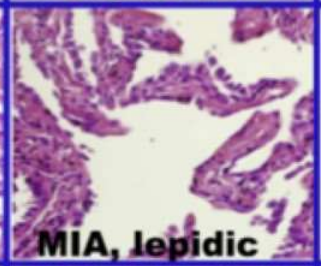
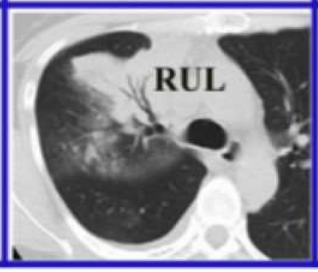
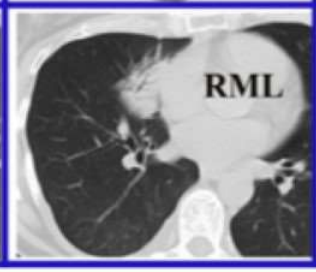
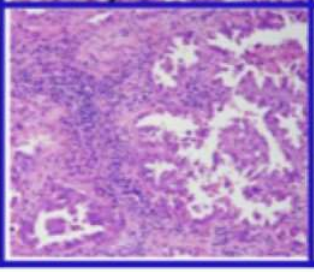
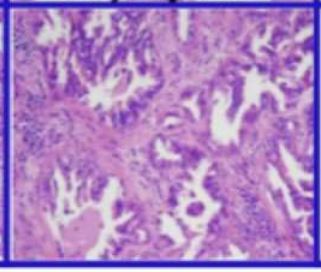
光田綜合醫院 Kuang Tien General Hospital since1913

Benign Multiple pulmonary nodules :

fungal infection, sarcoidosis, granulomatous infection,
lipomatosis, rheumatoid nodules, AV malformation



Multiple pulmonary sites of lung cancer

		Tumor Site 1	Tumor Site 2	Tumor Site 1	Tumor Site 2	TNM Classification
A	Second Primary Cancer					Separate T, N and M for each tumor
B	Separate Tumor Nodules					T3 if in same lobe T4 if same side (other lobe) M1a if different lobe, Single N and M for all
C	Multifocal GG/L Nodules					T according to highest T lesion, single N and M for all lesions collectively, (#/m) indicates multiplicity
D	Diffuse Pneumonic-Type					T3 if in same lobe T4 if same side (other lobe) M1a if different lobe, Single N and M for all

Journal of Thoracic Oncology 2016 Vol. 11 No. 5: 639-650

Radiographic Characteristics

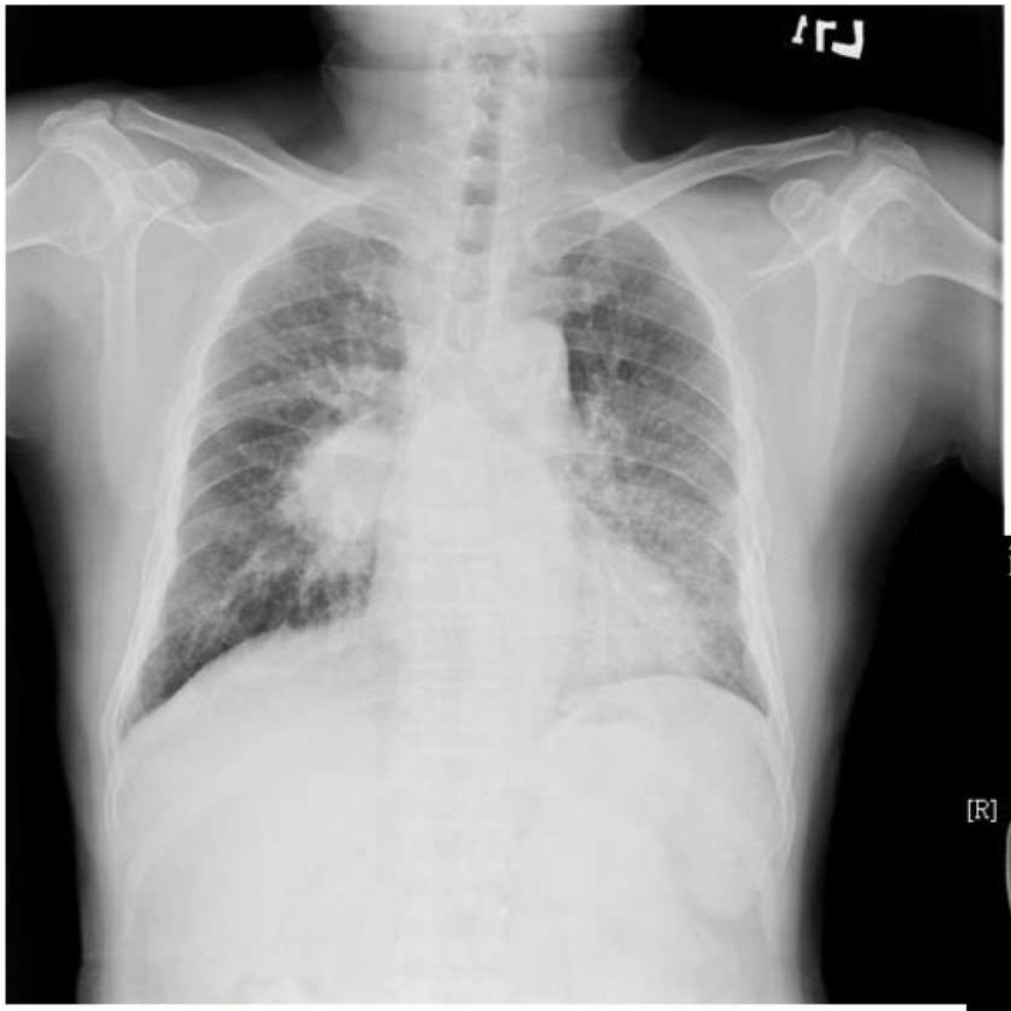
Malignant disease

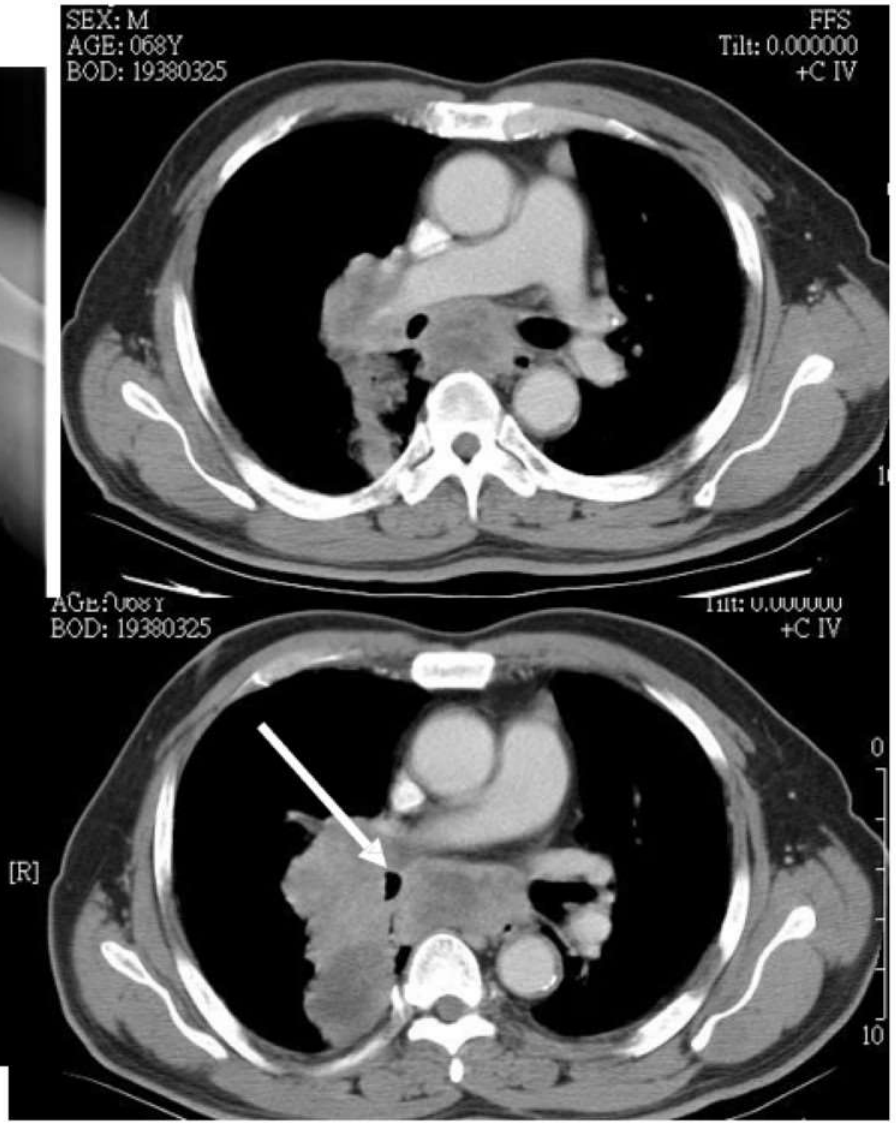
- Spiculated (primary)
  - 90% malignant
- Round, smooth, and peripheral (metastatic)
  - 20% malignant
- Thick walled cavity
- Eccentric calcification

Benign disease

- Characteristic calcifications
- Smaller than 5 mm
- Non-solid lesion 5-9 mm
- Thin walled cavity
- Satellite nodules
- Contrast enhancement less than 15 HU has a very high predictive value for benignity (99%).

CC: Airway narrowing





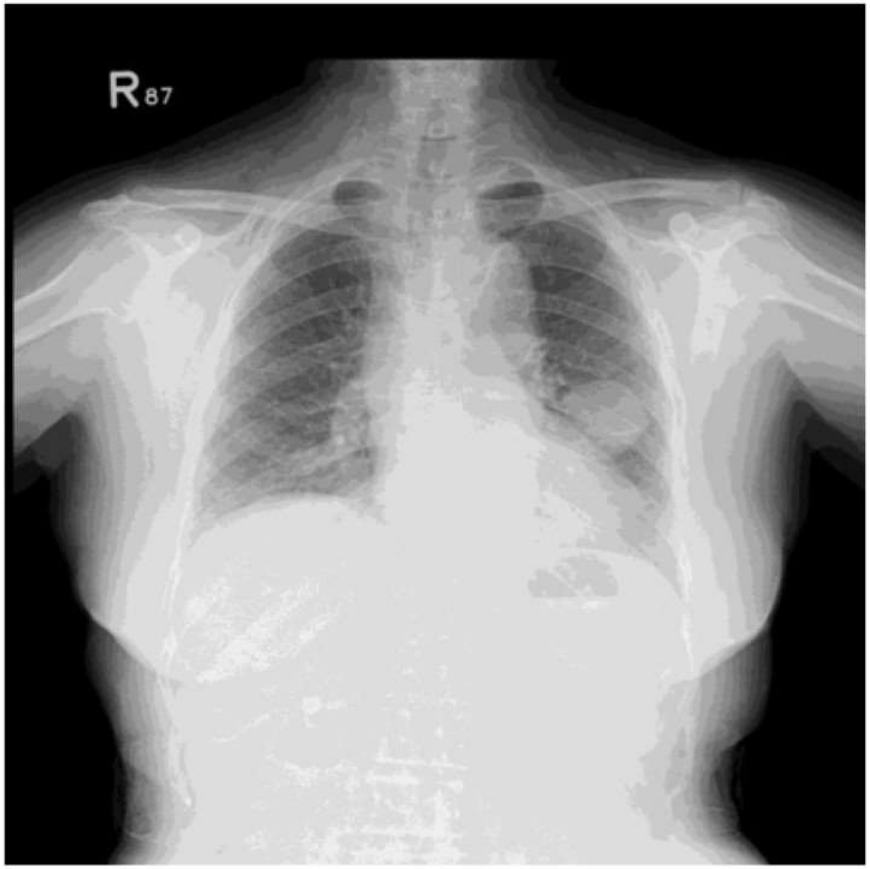
Dx: Carcinoma poorly differentiated,RUL

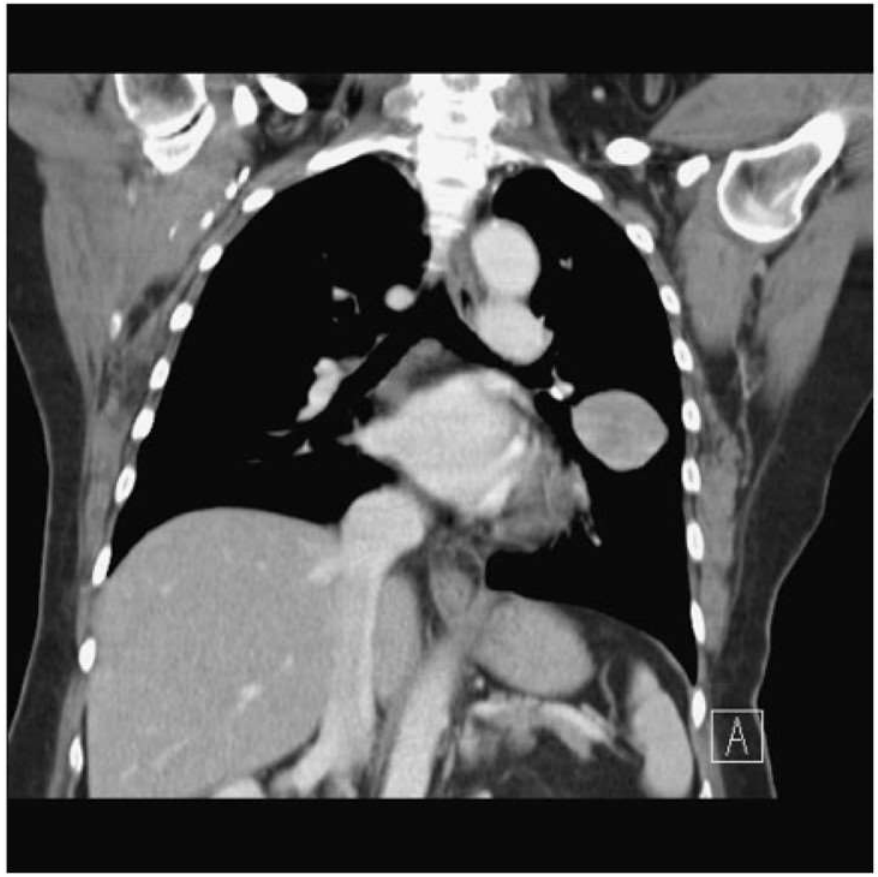
1. Calcification
2. Absence of enhancement
3. No growth in 2 years

Favored to Benign

Benign :

Well-defined shape, Homogeneous density , Calcification, …

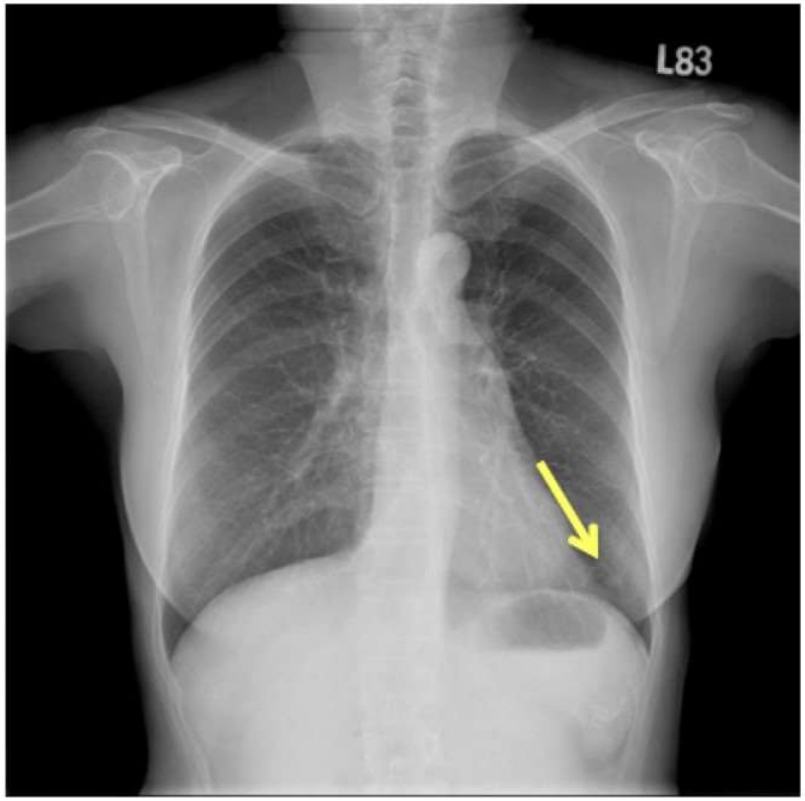




- 硬化性血管瘤（Sclerosing hemangioma）是肺部相對較少見的良性腫瘤，常見於40幾歲無症狀的中年女性，其典型呈現是位於肺部周邊單顆邊緣清楚的結節，而多發性結節表現的硬化性血管瘤是非常少見的，佔所有肺部硬化性血管瘤約4-5%的發生率。

Benign :

Well-defined shape, Homogeneous density , Calcification, …

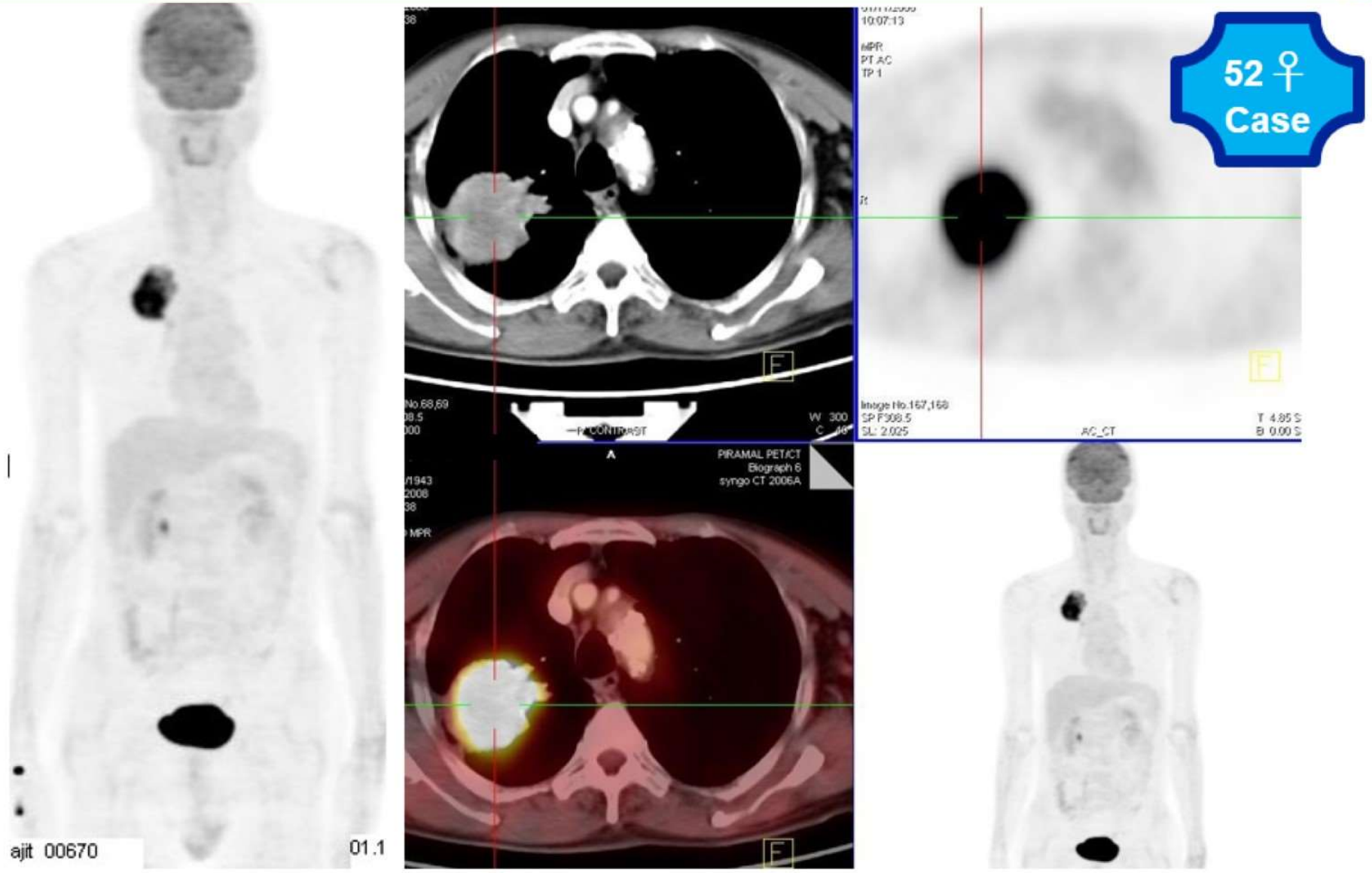


- **肺錯構瘤(pulmonary hamartoma)**多為偶然發現，為盛行率最高之肺部良性腫瘤。常於中年約40至60歲之間發現，多以男性為主，以肺週邊型較為多數，少數為氣管內生型。大部分肺錯構瘤不擴大或成長緩慢，少有惡性轉變。診斷可以影像學特徵及切片檢查確診。無症狀之肺錯構瘤，若診斷確定可以採用保守觀察策略；若腫瘤診斷不明確、腫瘤過大、腫瘤成長過快之年輕患者、或是有症狀之患者可採用胸腔外科手術治療。

臨床醫學 2018; 82: 558-61

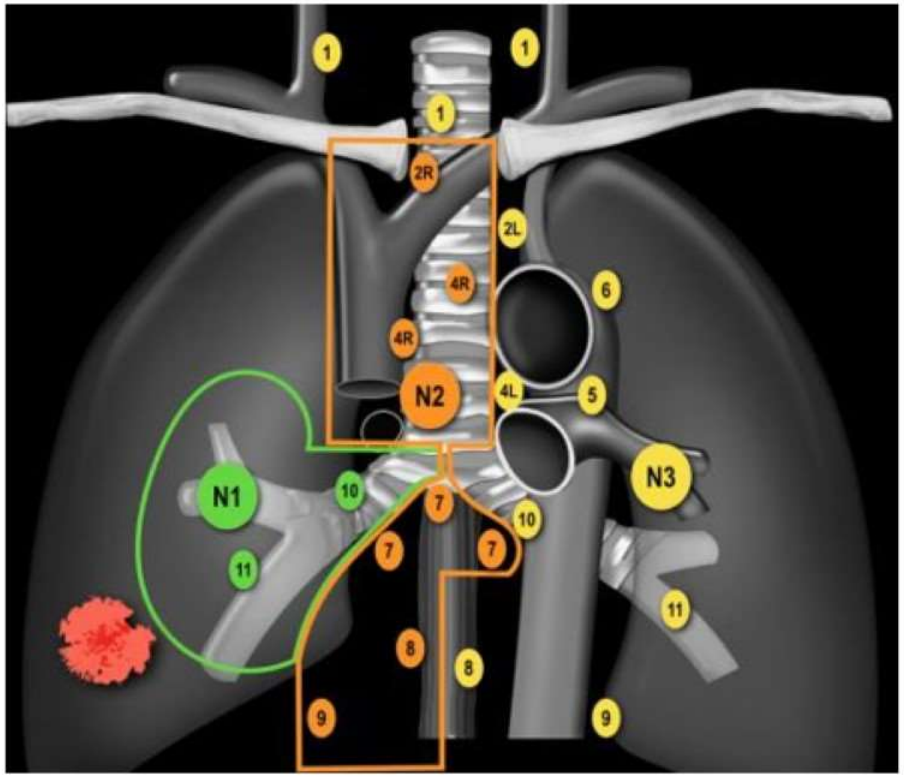
52-years old lady went for a health check-up

Bronchogenic carcinoma – operable (T2N0M0)



Ming-Lin HO

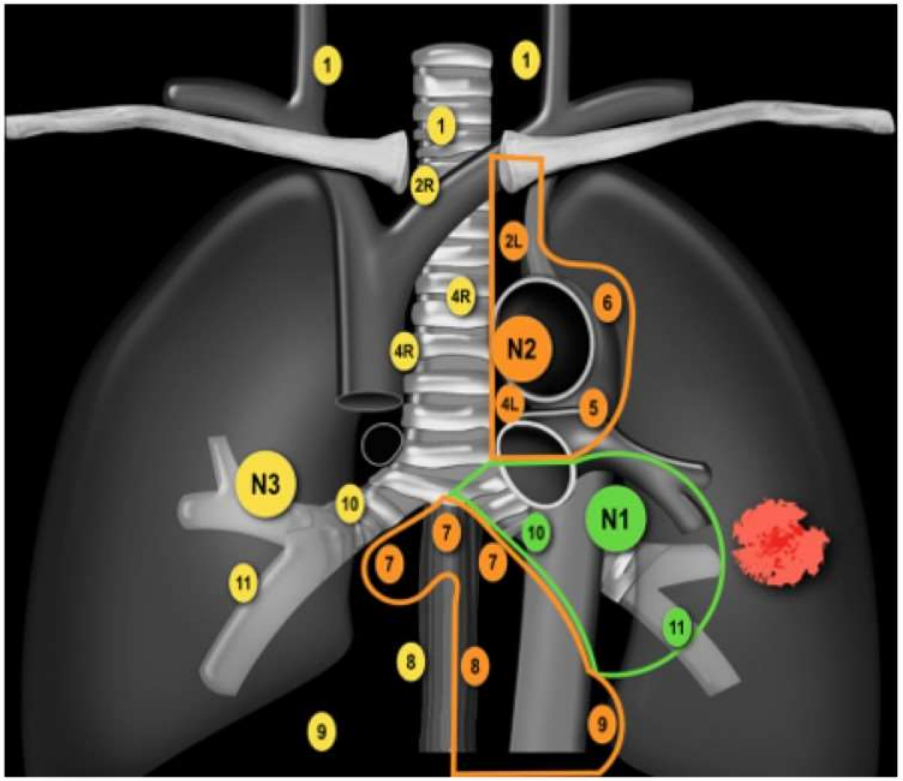
For a tumor in the Right lung the N-stages are:



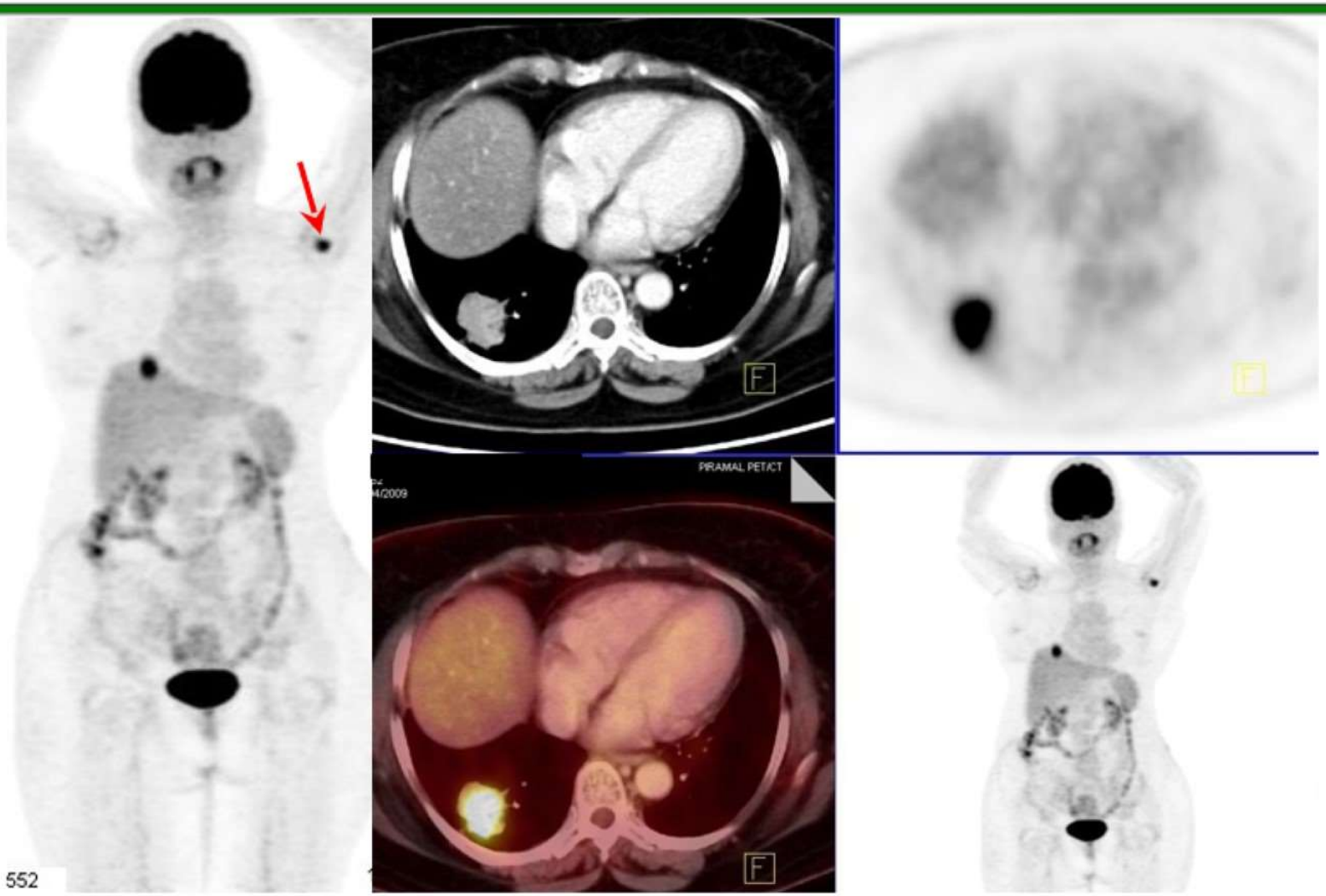
- N1
  - Ipsilateral peribronchial and/or hilar lymph nodes
  - 10R-14R
- N2
  - Ipsilateral mediastinal and/or subcarinal lymph nodes
  - 2R, 3aR, 3p, 4R, 7, 8R, 9R
- N3
  - Contralateral mediastinal and/or hilar, as well as any supraclavicular lymph nodes
  - 1, 2L, 3aL, 4L, 5, 6, 8L, 9L, 10L-14L

For a tumor in the Left lung the N-stages are:

- N1
  - Ipsilateral peribronchial and/or hilar lymph nodes
  - 10L-14L
- N2
  - Ipsilateral mediastinal and/or subcarinal lymph nodes
  - 2L, 3aL, 4L, 5, 6, 7, 8L, 9L
- N3
  - Contralateral mediastinal and/or hilar, as well as any supraclavicular lymph nodes
  - 1, 2R, 3aR, 3pR, 4R, 8R, 9R, 10-14R



A 52-year old doctor with bronchogenic carcinoma and solitary focus of uptake in the left humeral head – nonoperable (N0M1)



The fundamental idea when dealing with a solitary pulmonary nodule > 8mm is to not miss malignancy.

處理> 8mm的孤立性肺結節時，基本想法就是不要延遲診斷肺癌。

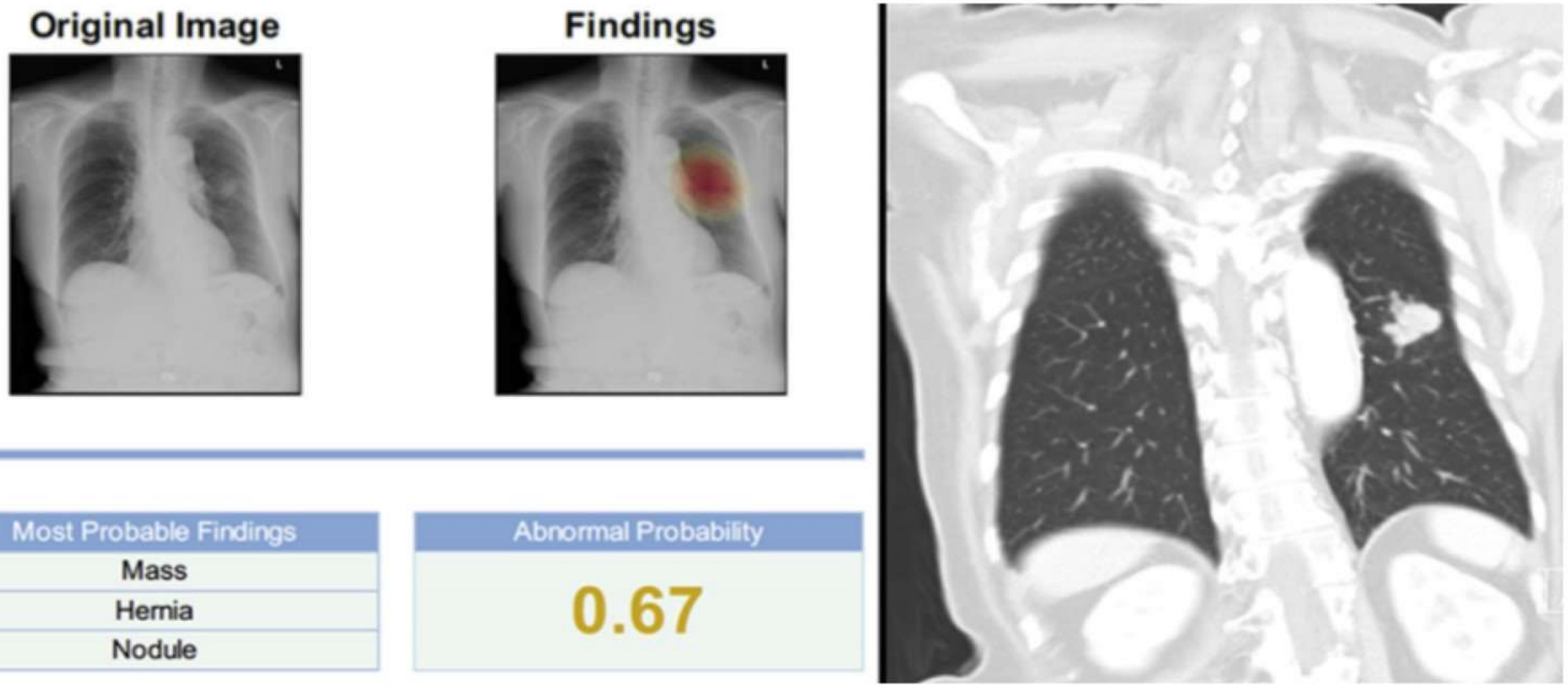
the deep-learning based computer-aided diagnosis system will likely play a vital role in the early detection and diagnosis of pulmonary nodules/masses on chest radiographs.

基於深度學習的電腦輔助診斷系統可能會在胸部X片上早期發現和診斷肺結節/腫塊中扮演重要作用。

C.-H. Liang et al. / Clinical Radiology 75 (2020) 38e45

通過熱圖算法正確檢測到左中肺野中2.3厘米的實性結節，被診斷為肺癌，異常評分為0.67。

光田綜合醫院 Kuang Tien General Hospital since1913

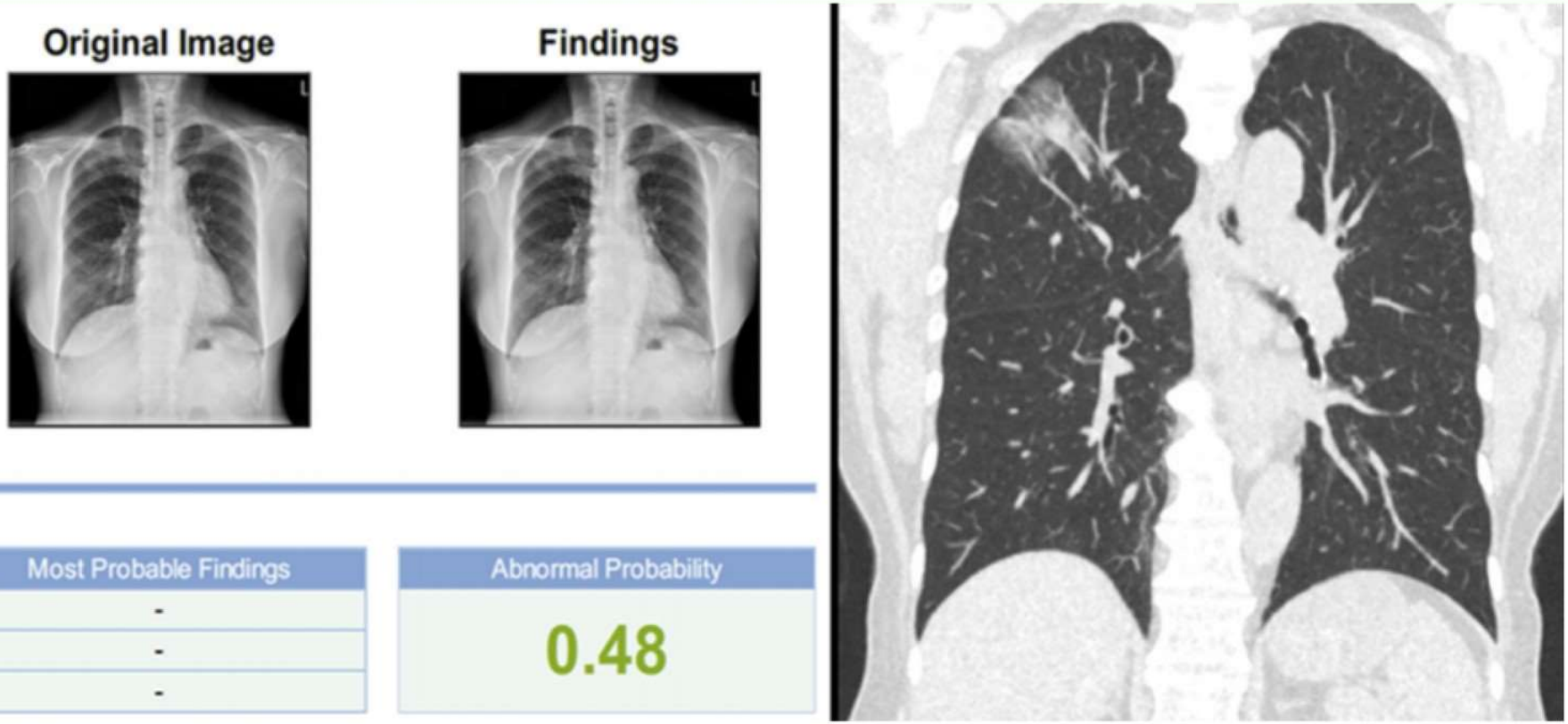


- A solid nodule 2.3 cm, diagnosed as lung cancer, in the left middle lung field properly detected by the heat map algorithm, with an abnormality score of 0.67.

C.-H. Liang et al. / Clinical Radiology 75 (2020) 38e45

熱圖算法遺漏了一個假陰性結果的微弱結節，該結節被診斷為肺腺癌，表現為2.9 cm的部分實心右上葉結節，如CT所示。 但是，可以正確檢測到它的異常分數為0.48。

光田綜合醫院 Kuang Tien General Hospital since1913

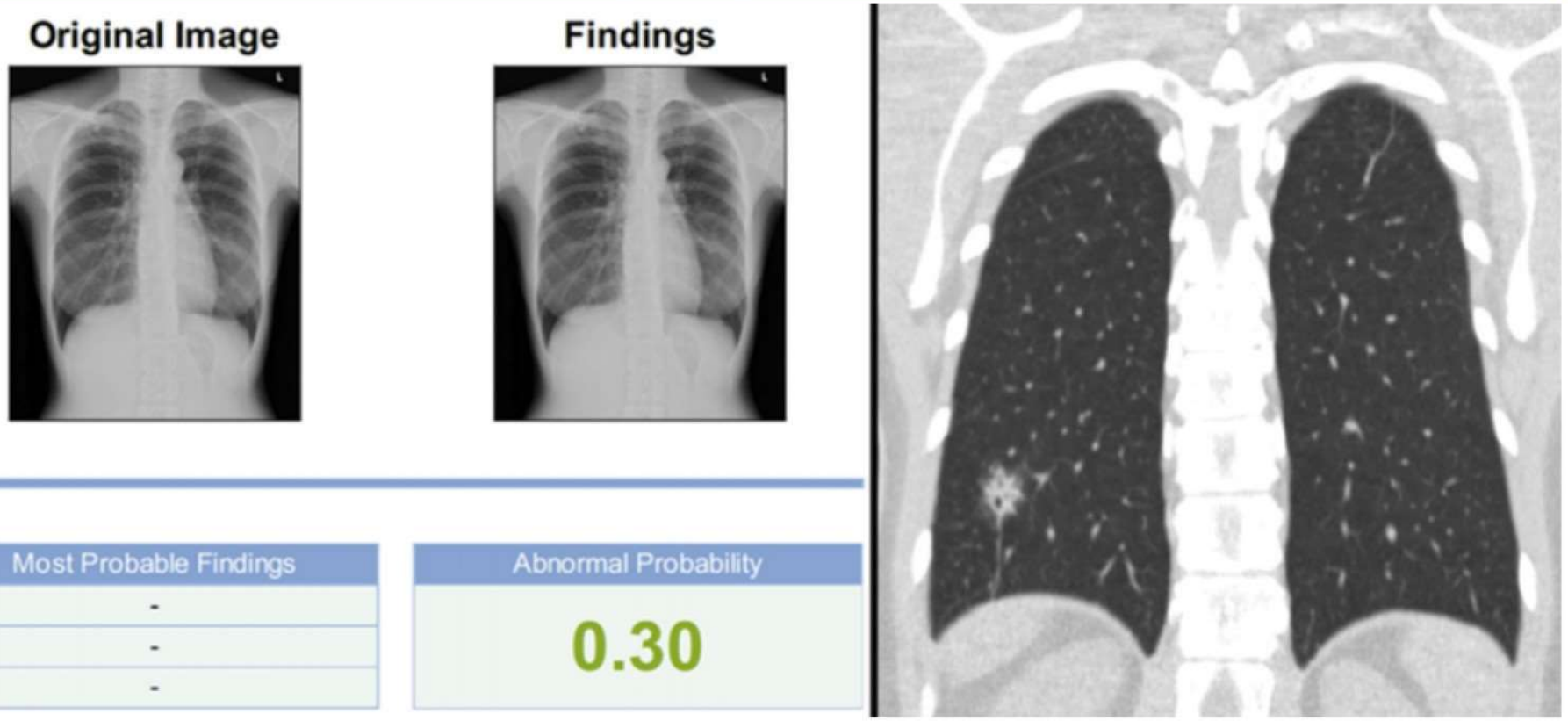


- A faint nodule with false-negative findings missed by the heat map algorithm, which was diagnosed as pulmonary adenocarcinoma manifesting as a part-solid right upper lobe nodule of 2.9 cm as demonstrated at CT; however, it was properly detected with an abnormality score of 0.48.

C.-H. Liang et al. / Clinical Radiology 75 (2020) 38e45

兩個分類器（熱圖和異常概率評分）都漏掉了一個假陰性結果的淡淡結節，被診斷為肺腺癌，表現為右下葉部分實性結節，長1.6 cm，如CT所示。

光田綜合醫院 Kuang Tien General Hospital since1913

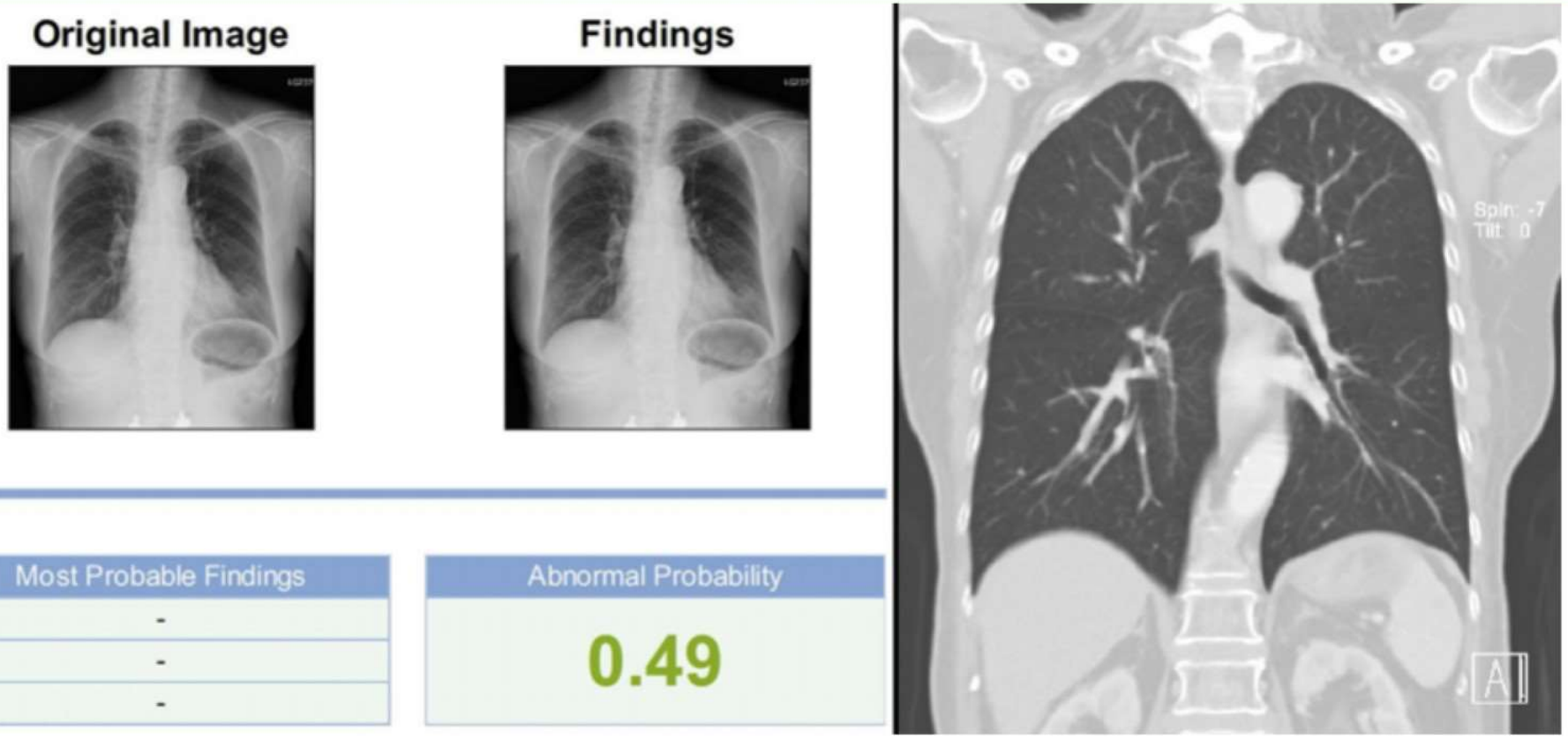


- A faint nodule with false-negative findings missed by both classifiers (heat map and abnormal probability score), which was diagnosed as pulmonary adenocarcinoma manifesting as a right lower lobe part-solid nodule of 1.6 cm as demonstrated at CT.

C.-H. Liang et al. / Clinical Radiology 75 (2020) 38e45

兩個AI算法分類器均會產生假陽性結節（結節和異常評分）。胸部X光片顯示，這名73歲的女性在下兩個肺野中的肺部標記均增加，在CT上被診斷為正常的胸部發現。

光田綜合醫院 Kuang Tien General Hospital since1913



- False positive nodule by both AI algorithm classifiers (nodule and abnormality score). The chest radiography showed that this 73-yearold woman with increasing lung marking in both lower lung fields, which was diagnosed as a normal chest finding at CT.

C.-H. Liang et al. / Clinical Radiology 75 (2020) 38e45

低輻射劑量肺部電腦斷層掃描 早期杜絕肺癌的威脅

◎文 何明霖/胸腔內科主治醫師

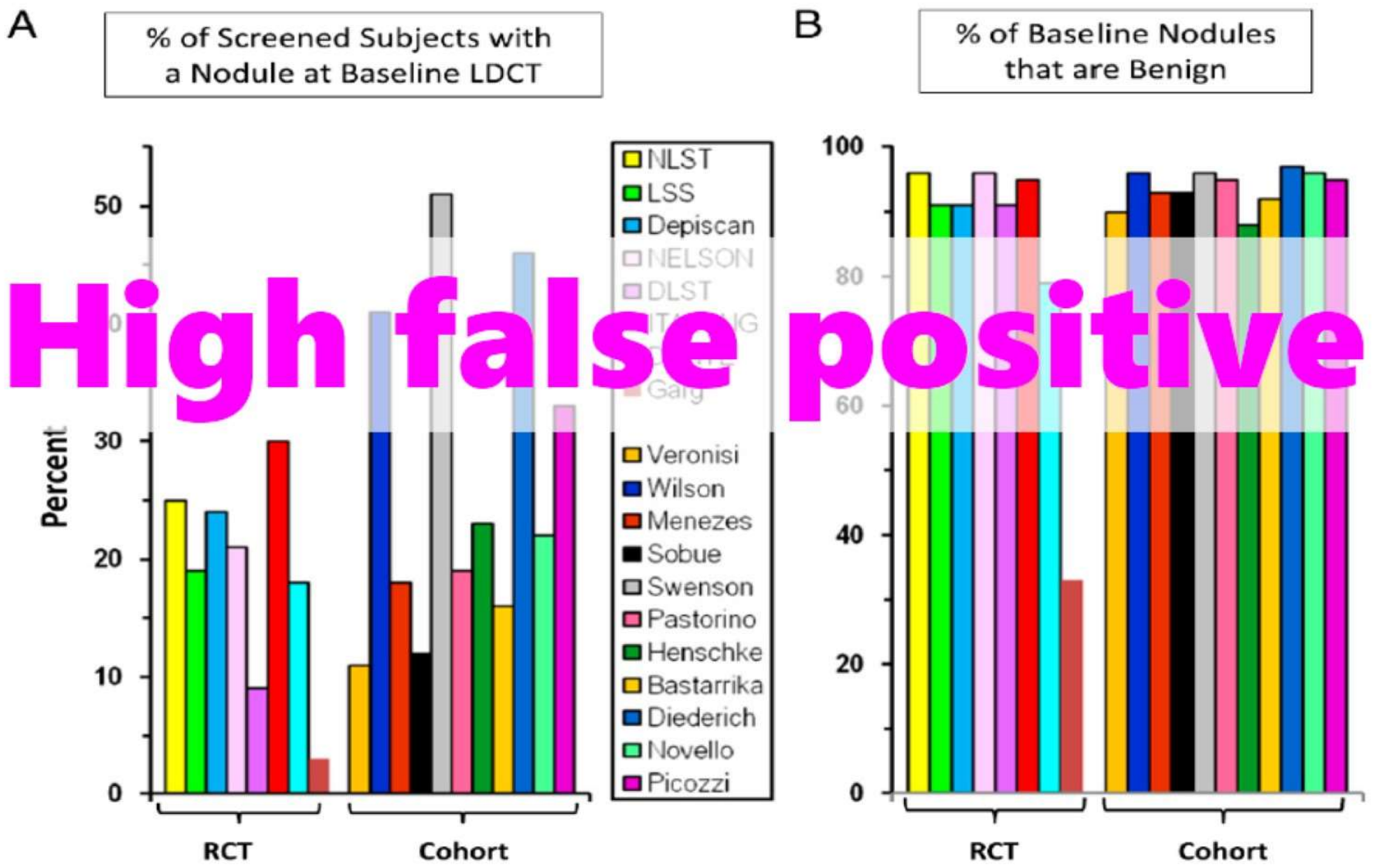
健檢項目

根據台灣衛生福利部的先前統計資料，肺癌的發生率是第四名，死亡率卻是高居癌症死因首位，五年存活率僅15～20%，其最大原因在於肺部是個血流充沛的器官，肺癌早期沒有症狀，一旦出現症狀或胸部Ｘ光發現異常時腫瘤都已過大，所以腫瘤細胞很早就會轉移到其他器官如肝臟、骨頭及腦部器官遠處轉移。若能早期篩檢發現，治療較單純有效。除了能節省肺癌相關治療的醫療費用，更可避免肺癌晚期繁雜治療的痛苦。

臨床上也發現有許多不抽菸的肺癌患者，例如從不抽菸的女性，肺腺癌的發生率反而增加。香菸以外致癌的因素，例如：空氣污染、廚房油煙、氡、裝潢的甲醛、放射線或遺傳基因等，都可能影響肺癌的形成。近年來，許多名人不抽菸竟罹患肺腺癌，造成了“名人效應”，更讓不少民眾心生警惕，讓民眾更重視檢查肺癌篩檢項目。

為能早期偵測肺癌，其中最便捷的方法，就是照一張胸部的Ｘ光片。但是一般的X片敏感性不佳，很難發現小於1公分的腫瘤。此外，對於隱藏在胸椎、心臟前後、肋骨及長在橫膈膜的下方、及肝臟前後方的腫瘤更是一般X光片判讀病灶的盲點。

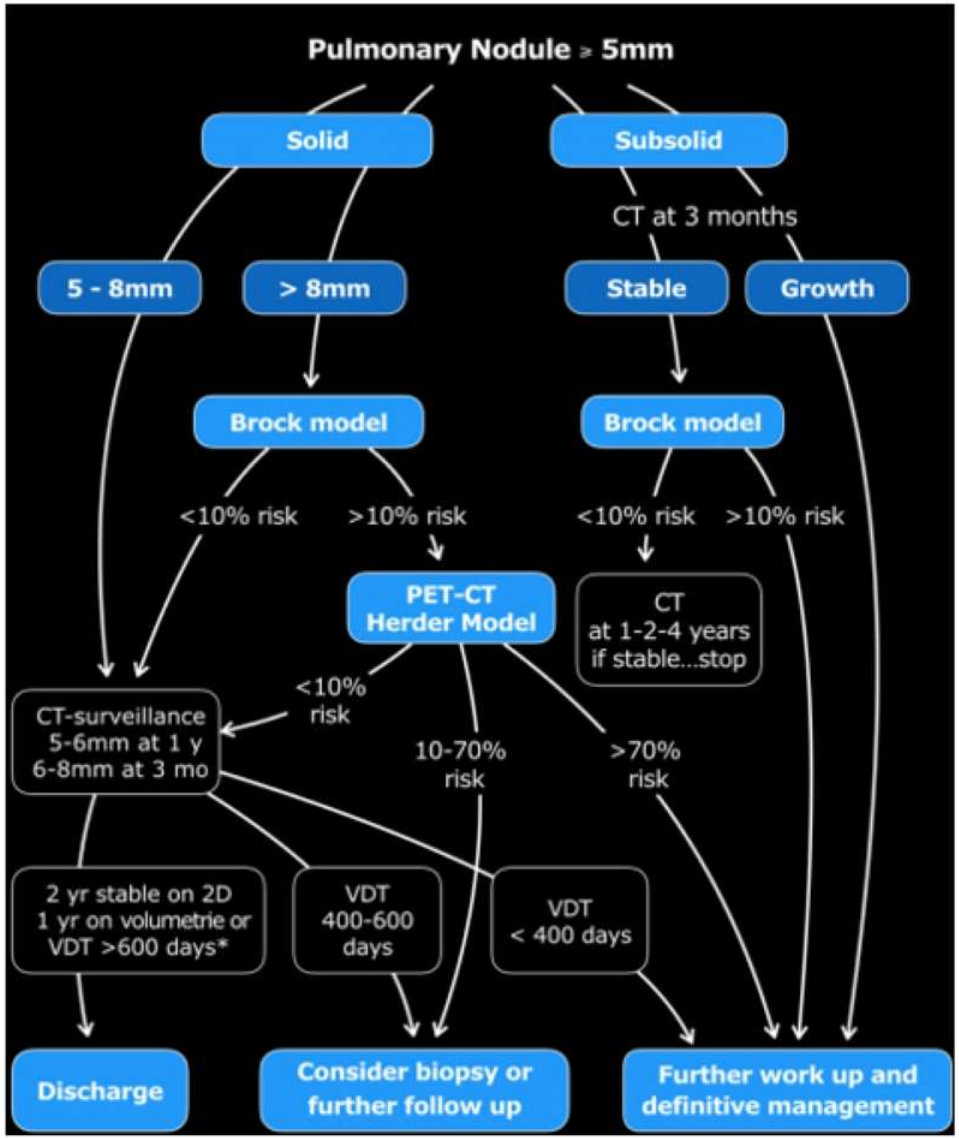
Potential Harms of LDCT Screening



High false positive

CHEST 2013; 143(5)(Suppl):e78S–e92S

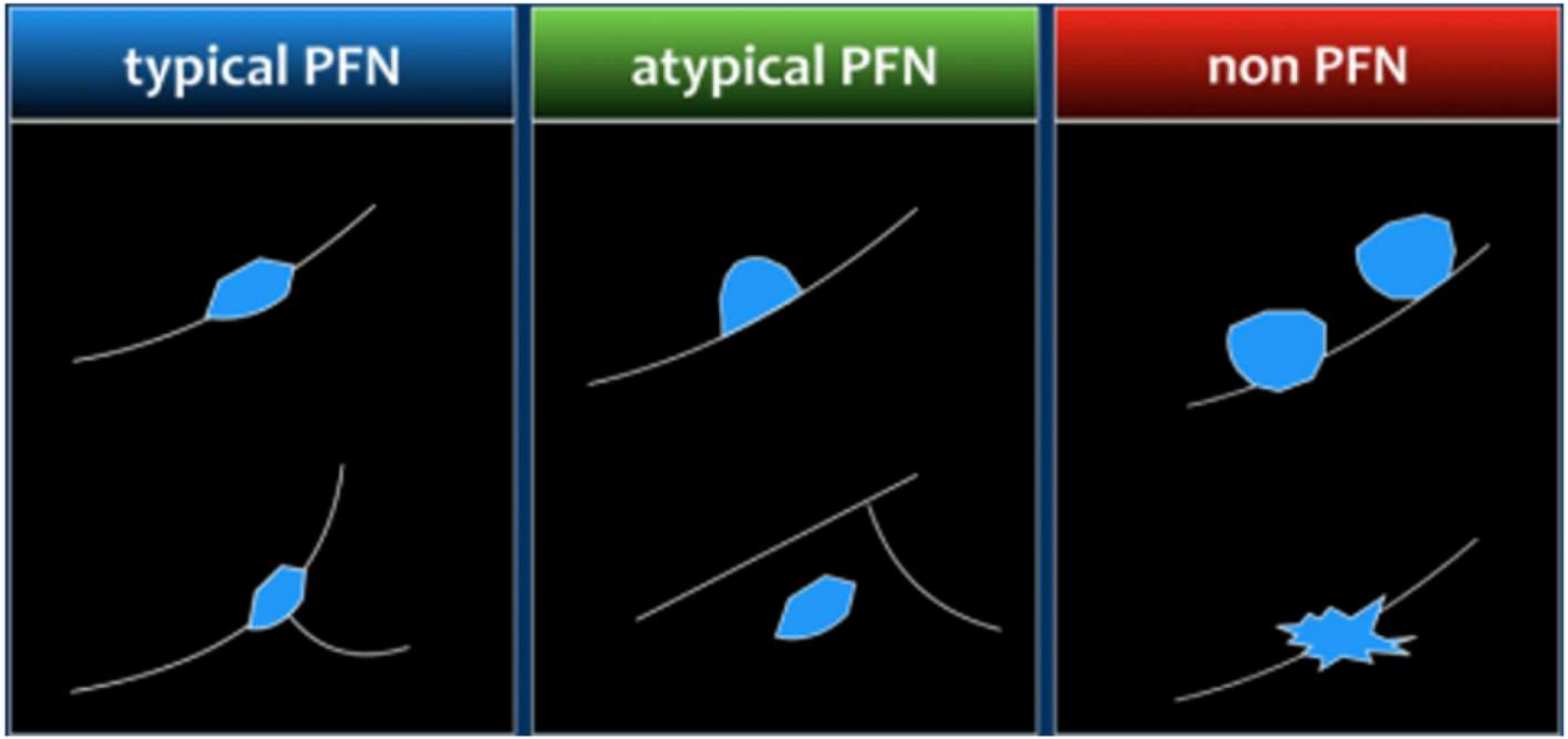
Guideline of the British Thoracic Society



- 第1步
  - 對於小於5mm的結節，典型的有良性鈣化的良性病變，如hamartomas和perifissural nodules，通常不用追蹤
- 第2步
  - 僅≥5mm 的病灶需要追蹤。 將病變分為solid和subsolid （groundglass 或part solid）
- 第三步
  - 使用Brock Model應用程序評估3個月以內穩定的 solid lesions >8mm 和subsolid lesions 的惡性風險。
- 第4步
  - 執行PET-CT時，請使用Herder模型。
  - 如果使用體積測量 (volumetry)，則需要追蹤1年，而手動2D測量則需要2年的追蹤期。

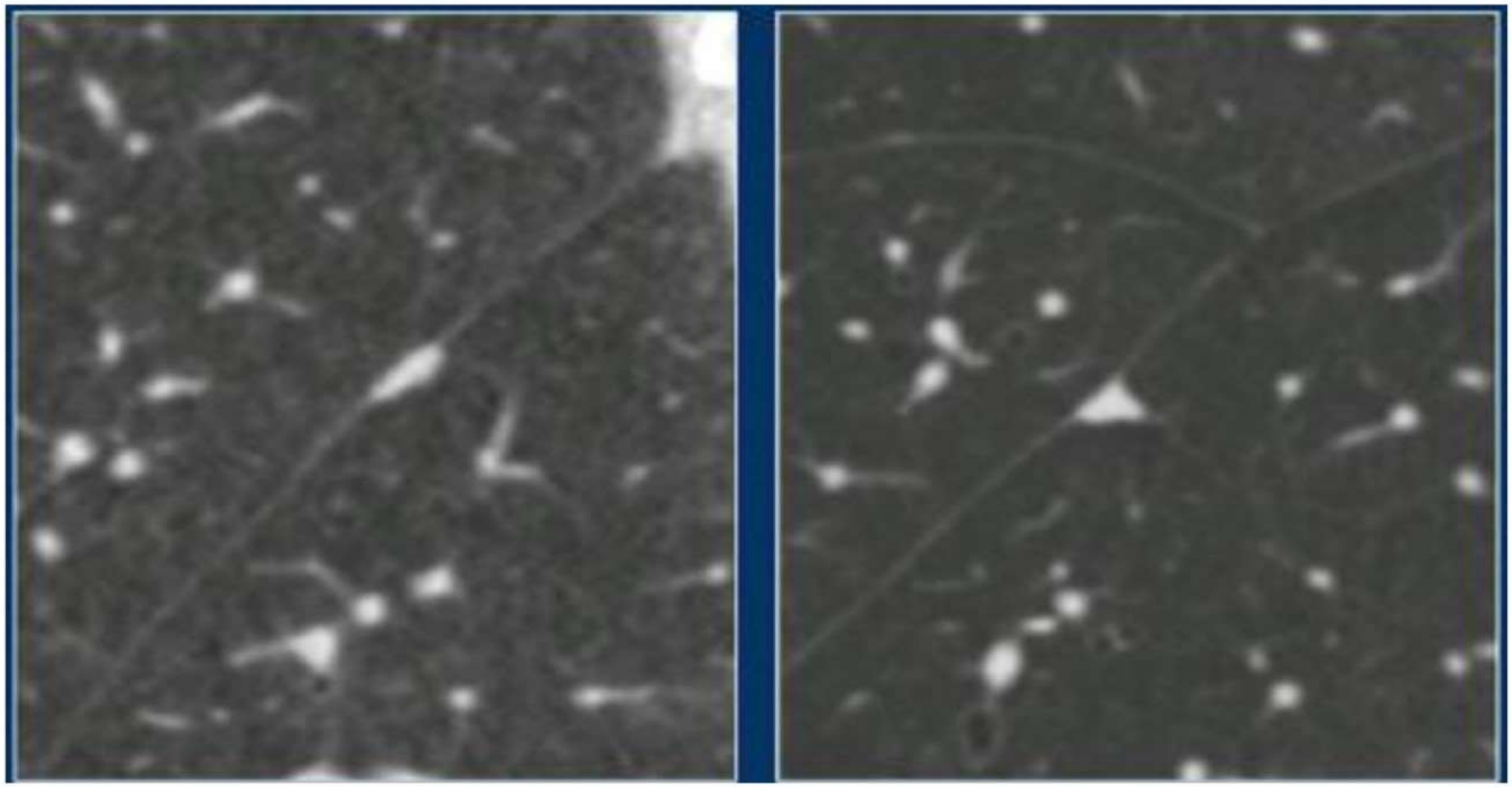
- 結節顯示體積變化小於25%的結節應視為穩定並在指定的追蹤間隔後排除。
- 僅當VDT> 600天以體積法計算時，才考慮排除。
- 如果有先前的影像學檢查，請根據體積加倍時間(volume doubling time)確定患肺癌的風險。

Perifissural nodules



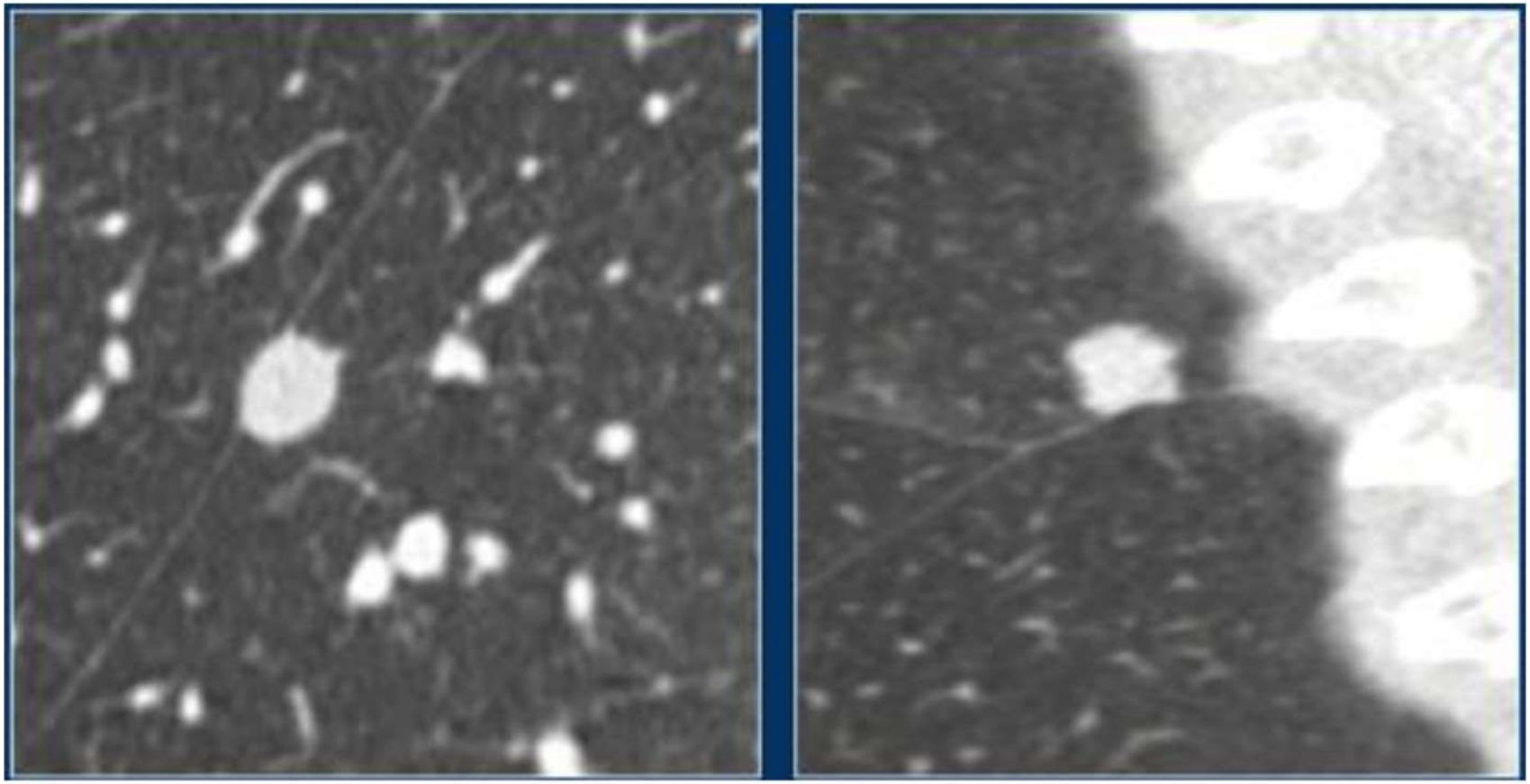
週壁結節是一個獨立的實體，可能代表肺內淋巴結。
從形態上講，它們是實心，均質的結節，邊緣光滑，呈橢圓形或圓形，扁形或三角形。
它們的位置在裂隙或胸膜的15毫米之內。 他們可能接觸或可能不接觸中葉間隔。
後者區分典型PFN和非典型PFN（見圖）。
PFN在連續影像學檢查中可顯示出顯著的增長率，有時可與惡性結節相當。
這不是惡性腫瘤的典型徵兆，而僅僅是其推測的淋巴起源的結果。

Typical Perifissural nodules



- 在篩查背景中，在5.5年的追蹤中，發現919例典型和非典型PFN均未發現惡性。這證實了Ahn等人的先前結果。
- 假定這種良性病因可以推斷到臨床受試者，最近這已得到一項使用常規護理臨床CT成像的研究的支持。
- 當前可用的指南建議，當小結節位於裂旁或其他並發胸膜的位置，並且形態與肺內淋巴結一致時，即使平均尺寸超過6 mm，也不建議進行CT追蹤。

Non- Perifissural nodules



- 與形態特徵不符的固定結節應視為非PFN結節（圖），並且需要進行追蹤。