Lung Nodules and Malignancy: Radiologic Assessment

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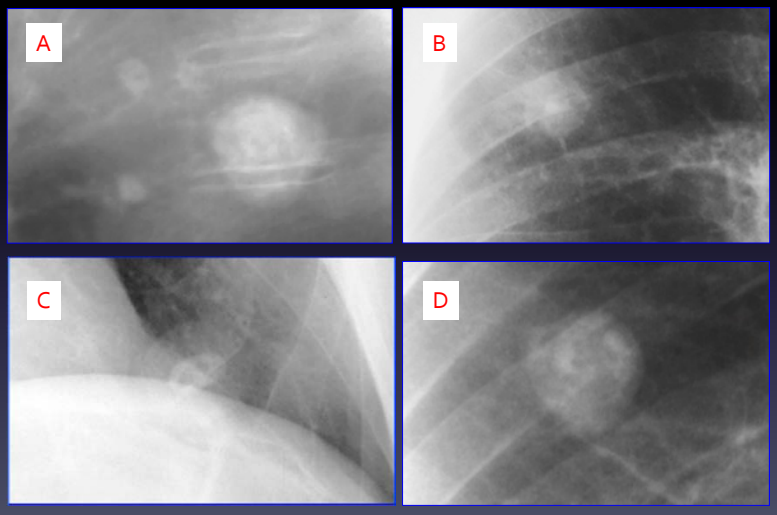
"Nodule/Mass on chest radiograph in smoker"

- Clinical Assessment
  - Clinical Risk of malignancy
  - Patient's suitability & preferences for surgical treatment
  - Suitability for nonsurgical treatment
  - Follow-up

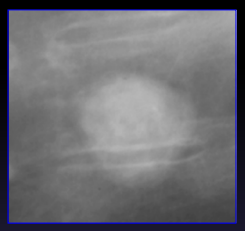
- Radiologic Assessment
  - Radiographic probability of malignancy
  - Suitability for tissue sampling when appropriate
  - Staging
  - Suitability for non-surgical treatment when appropriate
  - Response to treatment and monitoring for recurrence

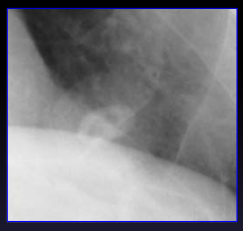
Case 1. Which calcified nodule cannot be considered benign?

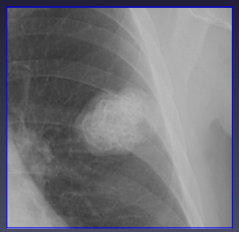


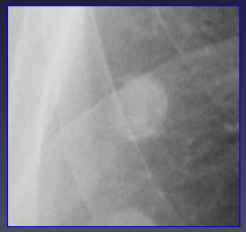
To be considered benign, a calcified nodule must show the following characteristics:

1. Solid nodule
2. Smooth margination
3. Benign pattern of calcification


Target calcification


Central calcification


Popcorn calcification


Diffuse calcification

To be considered benign, a calcified nodule must show the following characteristics:

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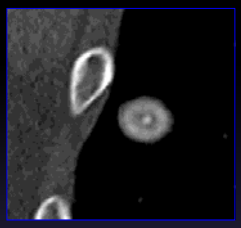
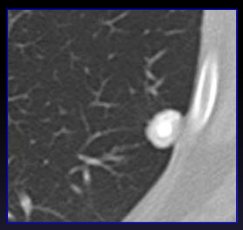
3. Benign pattern of calcification

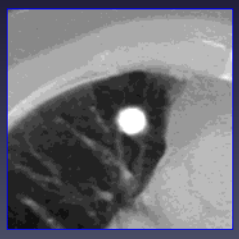


Target calcification



Central calcification

Popcorn calcification



Diffuse calcification

Fat in a nodule

- Hamartoma
- Unless patient has h/o
  - Liposarcoma
  - Renal cell ca

Courtesy of Jeffrey Kanne, MD
Dept. Radiology, University of Wisconsin

Fat in a nodule

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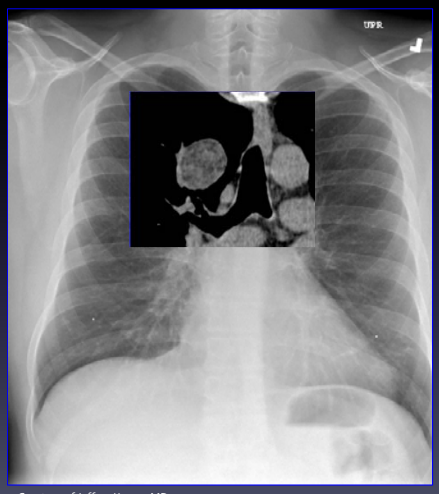
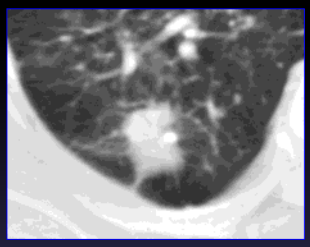
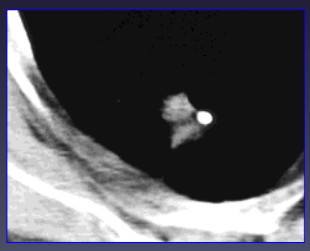


Courtesy of Jeffrey Kanne, MD
Dept. Radiology, University of Wisconsin

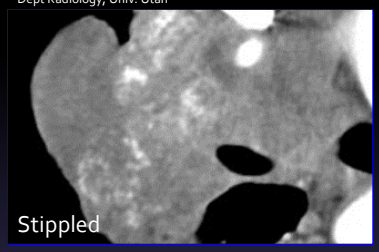
An irregularly margined nodule cannot be considered benign regardless of the type of calcification present.
Eccentric calcification cannot be considered a benign type of calcification.



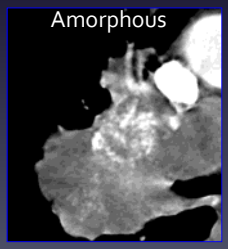


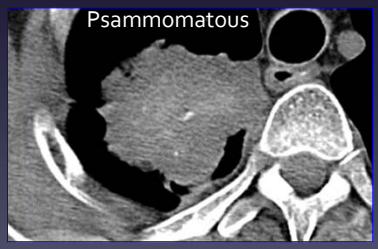
Examples of calcification not considered benign

Courtesy of Howard Mann, MD
Dept Radiology, Univ. Utah

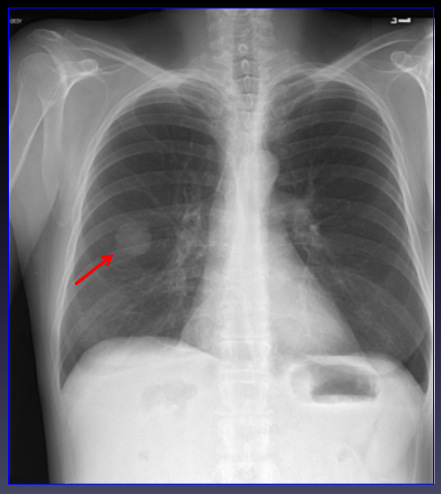


Courtesy of J.David Godwin, M.D
Dept. Radiology, Univ. Washington





Case 2. 59 yo M smoker with cough



Which radiographic feature makes this lesion worrisome for malignancy?

A. Lack of calcification
B. Location (right lower lobe)
C. Margins
D. Size

Lung Nodule/Mass: Definitions

Solitary Pulmonary Nodule

- Single, round, radiographic opacity (well- or poorly-defined) measuring up to 3 cm in diameter

Fleischner Society: Glossary of terms for thoracic imaging. Radiology 2008:246(3):710.

Dominant Pulmonary Nodule

- Single, dominant/larger nodule accompanied by </= 10 smaller nodules
- (10 = arbitrary number)

ACCP: Chest 2013;143(5)(Suppl):e93S

Mass

- Rounded radiographic opacity measuring more than 3 cm in diameter

More than 10 nodules

- Management
  - Metastatic disease
  - Infection
  - Inflammation

Nodule vs Mass: Goal of Further Evaluation

Nodule

- Benign
  - No further evaluation
- Indeterminate
- Malignant

Mass

- Staging
- Treatment

Risk Factors

- Clinical
- Radiologic

Observe

Staging/Treatment

This calculator should be used for high risk population only, not for nonsmokers. http://www.brocku.ca/lung-cancer-risk-calculator

Nodule : The likelihood of malignancy

- Nodule
- Benign
  - No further evaluation
- Indeterminate
  - ?
- Malignant
  - Staging
  - Treat if a candidate and patient desires therapy
  - Palliation

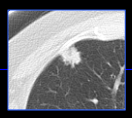
- Radiologic
  - Size
  - Margins
  - Location
  - Growth
  - Attenuation

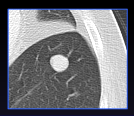
- Clinical
  - Smoking
  - Age/Gender
  - Exposures
  - Family history
  - Other malignancies
  - Lung disease

Radiologic

- Margins
- Location
- Growth
- Attenuation
- Size

- Spiculation
- Lobulated
- Smooth



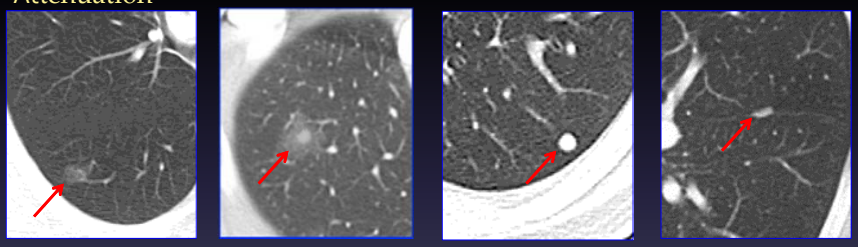


- Upper lobe, R/L

- Solid – stability x 2 years
- Subsolid – stability x 3+ years

Case 3. Noncalcified nodules < 8mm in diameter found during lung cancer screening. Radiographically, which is the most likely to be malignant and which is least likely to be malignant?

Attenuation

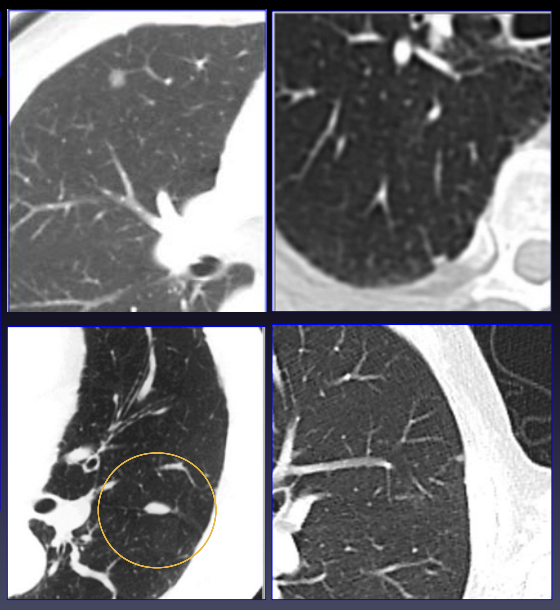


1. Pure ground glass 2. Mixed solid/GGO 3. Solid 4. Solid, perifissural

A. 2 and 3 B. 3 and 4
C. 2 and 4 D. 3 and 1

Pulmonary lymph nodes

Subpleural
- Shape:
  - Triangular
  - Oval, round
  - Rectangular
  - Dumbbell
- Connections:
  - Interlobular septum
  - Pulmonary vein
- Lower > Upper lungs
- Often associated with fissures

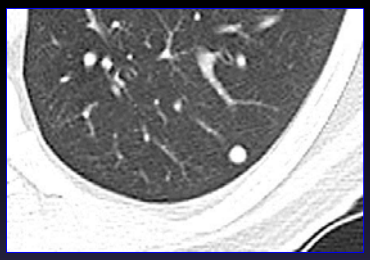


Solid SPN

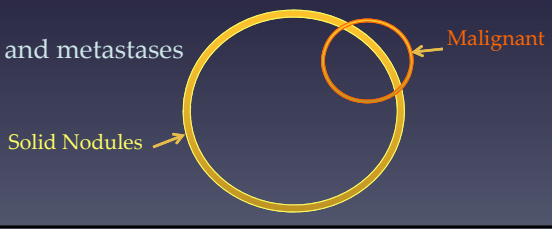
Solid nodules – the most common type of nodule, 2nd least likely to be malignant.

Most benign lesions – granulomas, fungi, TB, inflammatory lung disease, etc, are solid.

Risk of malignancy in solid nodules 5-8 mm diameter: 2-6%



Most lung cancers and metastases are solid nodules.



Pure ground glass or nonsolid nodules:

Causes:

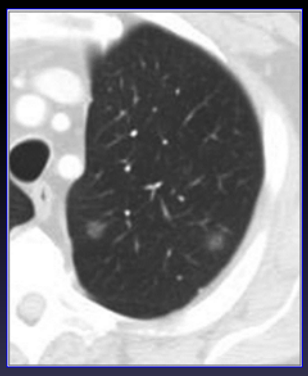
Malignant: Minimally invasive adenocarcinoma
Benign: Infection, blood, inflammation
Premalignant: Atypical adenomatous hyperplasia, Adenocarcinoma in situ

Recommendations:

< 5 mm do not necessarily need follow-up CT

Between 5-10 mm, follow-up with CT 3 months, if if unchanged, continue follow-up annually x 3+ yrs

> 10 mm, persists for 3 months, presume cancer. (20-25% will still prove to be benign on resection). Consider surgery if enlarging or solid component develops



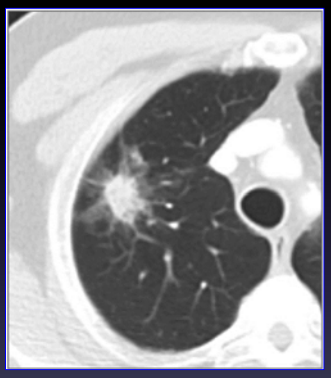
Godoy et al. Radiology;2009:253(3):606-22.
Gould et al. Chest 2013;143(5)(5):e93S-e120S.

Part-solid SPN:

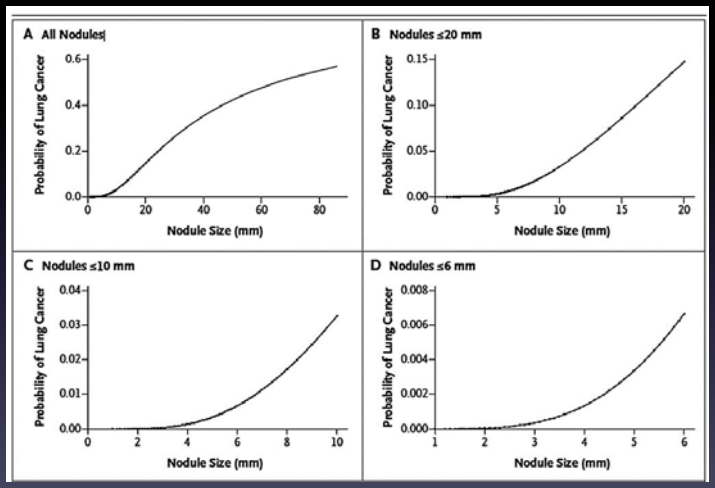
Likelihood of malignancy – highest in part-solid nodules.

40-50% of part-solid < 1.5 cm are malignant.

Greater risk of malignancy with increasing nodule size, especially if solid component represents > 50% of the nodule or is enlarging. Solid component often contains invasive adenoca, GGO = AAH or adenoca in situ.



Nodule Size (Lung Ca Screening, Pan-CAN)



McWilliams et al. NEJM 2013;369:910-9

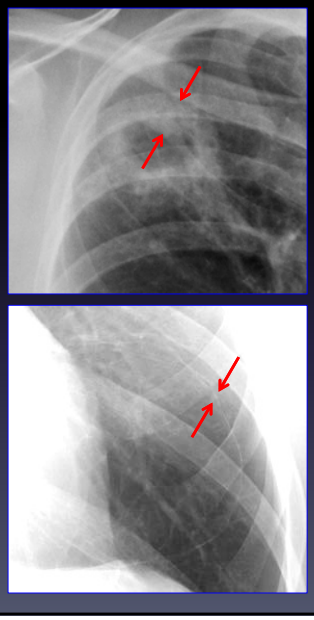
Case 4A. Which radiographic characteristic helps most in differentiating benign from malignant cavitary disease

1. Air-fluid level
2. Wall thickness
3. Size
4. Internal debris

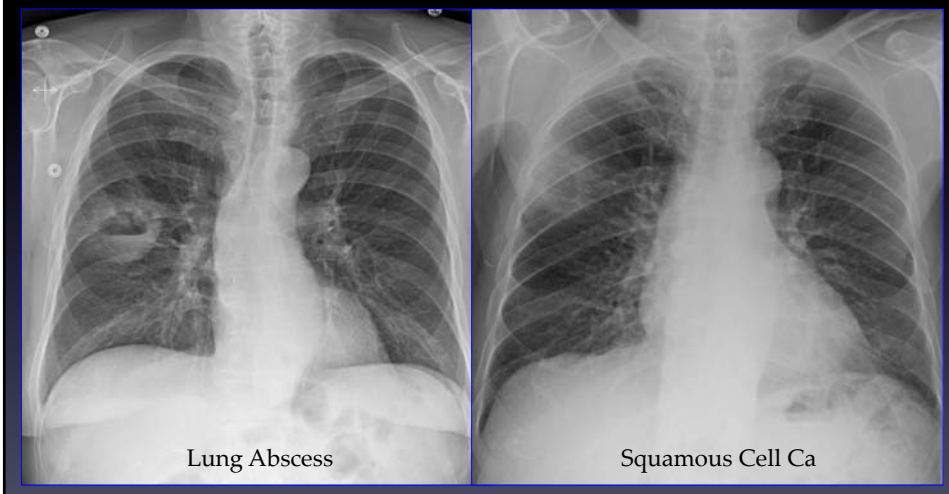
Cavity wall thickness

- Maximal wall thickness
  - < 4 mm, 19/20 (95%) benign
  - 5-15 mm, 16/22 (73%) benign
  - >16 mm, 16/19 (84%) malignant

Woodring et al. AJR 1983:140:473-4
Woodring et al. AJR 1980: 135:1269-71



Wall thickness alone should not be used to distinguish benign from malignant disease



Lung Abscess

Squamous Cell Ca

Causes of cavitary processes

Thin wall	Thick wall
• Metastatic disease • Vasculitides: GPA • Infections: Cocci, PJP, Echinococcus, Papillomatosis, post-infectious lung cyst, TB • Trauma: Pulmonary laceration • Bland/septic embolism • LCH • LAM • Congenital cysts • Emphysema/Bulla	• Primary lung cancer • Metastatic disease • Lymphoma • Vasculitides: GPA, RA • Infections: Lung abscess, TB • Bland/septic embolism • LCH • Sarcoidosis • PMF/Conglomerate masses • Trauma: Hematoma, laceration

4B. Which of the following primary tumors is most likely to cause cavitary metastases in the lung?

1. Melanoma
2. Cervical carcinoma
3. Renal cell carcinoma
4. Breast adenocarcinoma
5. Prostate adenocarcinoma

Cavitary Lung Metastases

- NSCCA Lung
- Cervical carcinoma
- Colon carcinoma
- Squamous cell ca of head and neck
- Sarcoma

- May have thin or thick walls
- Often coexist with solid nodules
- Often smoothly marginated
- Variable size in same individual
- Peripherally located

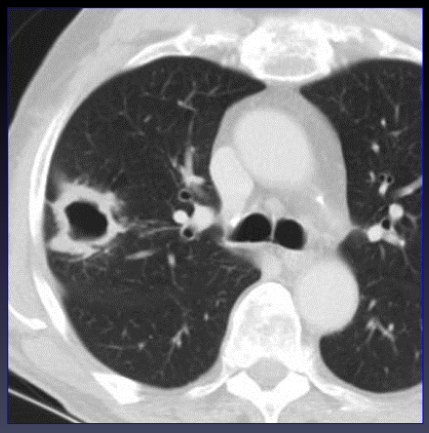
4C. Man with hemoptysis – Lucency is noted around the mass in the upper lobe. What is this sign?

1. Monad's Sign
2. Air-crescent sign
3. Luftsichel sign
4. Walking Man sign

Case 5A. CT guided transthoracic needle biopsy requested for a suspicious lesion.

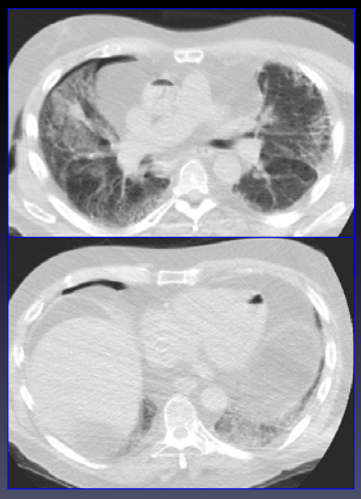
Which of the following is an <u>absolute</u> contraindication for biopsy?

1. Non-suppressible coughing
2. Uncorrectable coagulopathy
3. Uncooperative patient
4. Contralateral pneumonectomy
5. None of the above



Case 5B. The patient indicates that he feels "dizzy" during the procedure. His blood pressure and pulse are normal. Post biopsy images are shown below. What should you do?

1. Place a chest tube
2. Position patient in left decubital position
3. Position patient in right decubital position
4. Leave patient flat, supine



Arterial Air Embolism

Requirement for air embolism	How does it happen
1. Direct communication between air source and vessel 2. Pressure gradient favors passage of air into the vessel rather than blood out of the vessel (negative venous pressure relative to atmospheric pressure)	1. Needle tip is located within a vein and the hub is open to air and patient breathes – inhalation creates negative venous pressure and air is pulled into vessel 2. Bronchovenous fistula caused by needle or needle tract 3. Biopsy of cavitary lesion, needle course through a vessel

Air Embolism

Pulmonary/Venous	Systemic/Arterial
• Air introduced into right heart and pulmonary circulation • Small amounts of venous air usually causes no or minor symptoms • Large amounts of air may cause blockage of blood flow into pulmonary artery, decreased cardiac output	• Air introduced into left heart and systemic circulation • Occasionally asymptomatic • May be catastrophic – stroke, MI, death

Venous or Pulmonary Air Embolism

Air introduced into right heart and pulmonary circulation

- 100% supplemental oxygen
- Position in left lateral decub position, trendelenburg or combo
- RVOFT positioned inferior to RV causes air to migrate superiorly within RV, less likely to embolize

- LLD/Trendelenburg may displace large bubbles in RVOFT – relieving air-block
- If not successful, chest compressions should be performed to force air out of RVOFT and into smaller pulmonary vessels, improving forward flow
- Remove embolized air – aspirate from RV via central venous catheter (if present)

Systemic or Arterial Air Embolism

Air introduced into left heart and systemic circulation

- Position flat, supine. Arterial flow more forceful and air bubbles are propelled forward by arterial flow even in Trendelenburg. Trendelenburg can exacerbate cerebral edema caused by cerebral air embolism
- Supportive care: mechanical ventilation, vasopressors, volume resuscitation

- High flow supplemental O2, increases resorption rate of embolized air by reducing partial pressure of nitrogen in blood which produces gradient for diffusion of nitrogen from air bubbles back into blood
- If cardiopulmonary/neurologic deficits develop: hyperbaric oxygen therapy (HBO) ASAP – preferably within 6 hr, but up to 30 h. Benefits of HBO weighed against potential risk of transport to HBO facility

Clinical features of air embolism

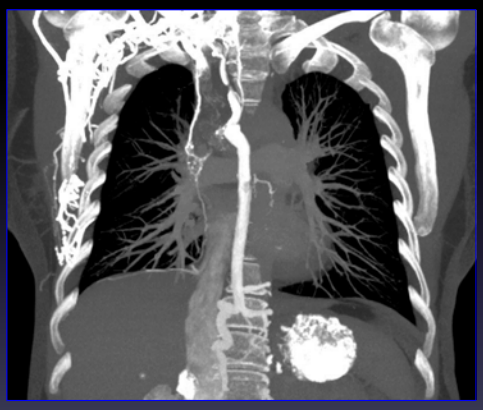
- None
- Hemodynamic collapse
- Acute insufficiency of lungs, brain, spinal cord, heart
- Dyspnea
- Substernal CP
- Sense of impending doom
- Light-headedness

- Dizziness
- Tachypnea
- Tachycardia
- Hypotension
- Wheezing
- Crackles
- Respiratory failure
- Altered mental status
- Focal neurologic deficits
- Seizure

Case 6. Which thoracic malignancy is least likely to cause this syndrome?

1. Hodgkins Disease
2. Non-Hodgkins Lymphoma
3. Squamous cell carcinoma
4. Small cell carcinoma

Case 6. Which thoracic malignancy is least likely to cause this syndrome?



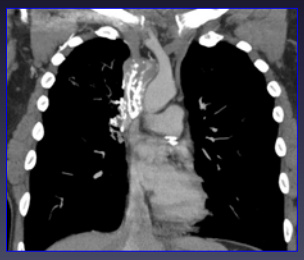
MIP

1. Hodgkins Disease
2. Non-Hodgkins Lymphoma
3. Squamous cell carcinoma
4. Small cell carcinoma

Superior vena cava syndrome

- Etiology:
  - Malignancy 60-85% cases
    - NSCLC – 50%
    - SCLC – 25%
    - NHL – 10%
  - Nonmalignant
    - Thrombosis - indwelling vascular devices
    - Fibrosing mediastinitis
    - Radiation fibrosis

- Malignant SVC syndrome may be caused by
  - SVC extrinsic compression by tumor or lymph nodes
  - Direct tumor invasion into vessel

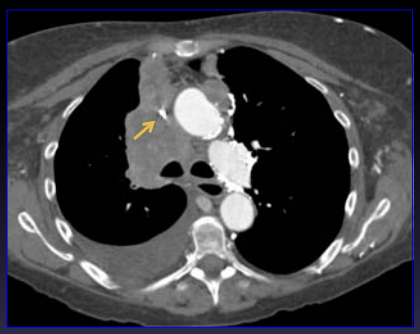


SVC syndrome due to Histoplasmosis
Case courtesy of J. Kanne MD, Univ Wisc

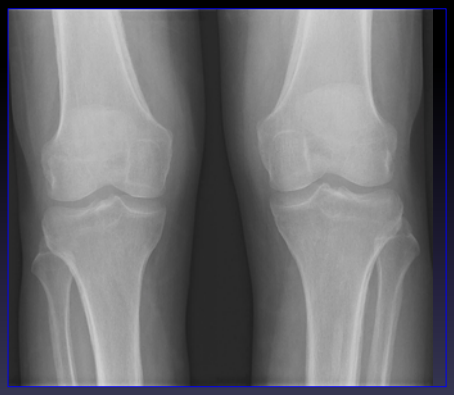
Superior vena cava syndrome

- Imaging
  - Chest Radiograph
  - Chest CT or MRI

- Histologic Diagnosis
- Treatment
  - Chemotherapy
  - Radiation
  - Stenting
  - Medical support



Case 7. 60 yo M with recent onset of bilateral knee pain



Case courtesy of Dr. H. Mann, Univ Utah

Further evaluation should include which of the following:

1. MRI both knees
2. Nuclear medicine bone scanning
3. Chest radiograph
4. Joint aspiration
5. PET-CT scan

Case 7. Hypertrophic osteoarthropathy

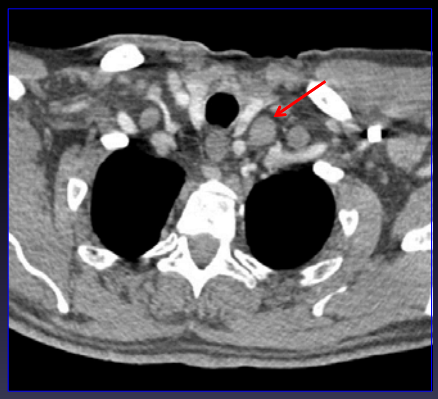
- Abnormal proliferation of skin and osseous tissue at distal parts of extremities include clubbing, periostosis of tubular bones, synovial effusion
- Primary – not associated with other medical disorders
- Secondary – associated with lung cancer, pulmonary infections, CF, R to L cardiac shunts, Hodgkins, cirrhosis.

Case courtesy of Dr. H. Mann, Univ Utah

Case 8. 67 yo with 4 cm LUL mass and FDG-PET avid left supraclavicular node

Assuming that the node is metastatic, what nodal category would this be?

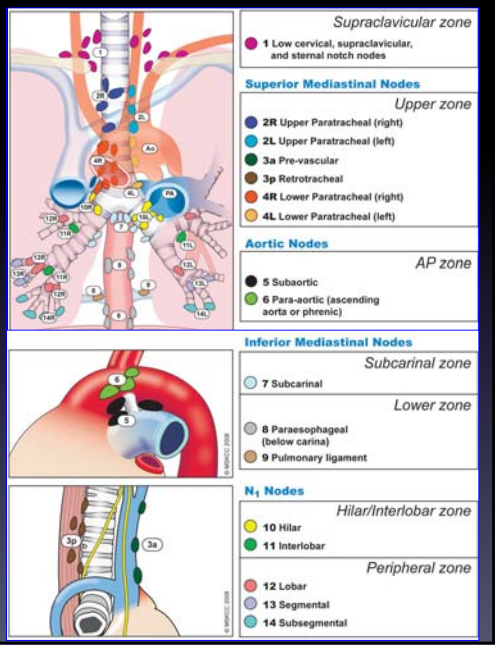
- 1. NX
- 2. N1
- 3. N2
- 4. N3
- 5. M1



Lymph Nodes

- N0 – No regional nodal metastases
- N1 – Metastases to ipsilateral peribronchial and or ipsilateral hilar and intrapulmonary nodes
- N2 – Metastases to ipsilateral mediastinal and/ subcarinal nodes
- N3 – Metastases in contralateral mediastinal, contralateral hilar, ipsilateral or contralateral scalene or supraclavicular nodes
- Nx – Regional nodes not assessable

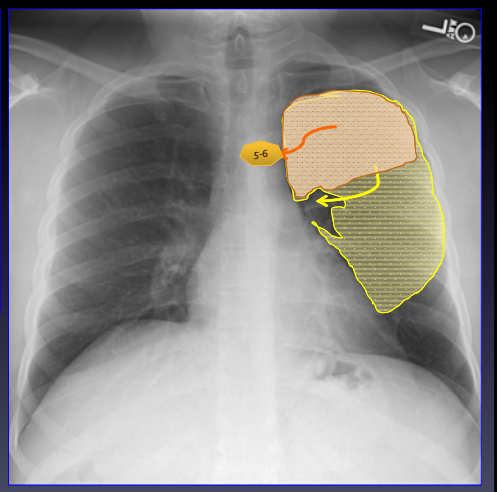
American Joint Committee on Cancer, 7th Edition



Lymph drainage pattern

Left upper lobe

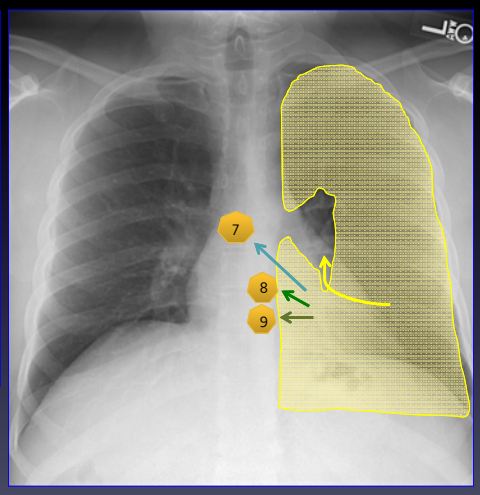
- Drains to left upper hilar nodes
- Upper segmental lesions may drain directly to left upper mediastinal nodes (station 5, 6)



Lymphatic Drainage

Left lower lobe

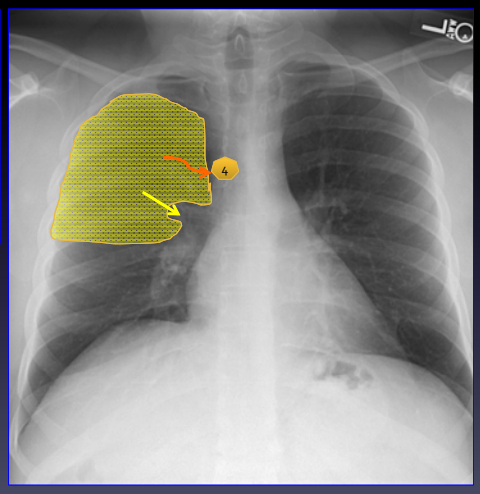
- Drains to lower left hilar nodes
- May drain directly to subcarinal mediastinal nodes (7)
- May drain to inferior pulmonary ligament (9) or periesophageal (8) mediastinal nodes



Lymphatic Drainage

Right Upper Lobe

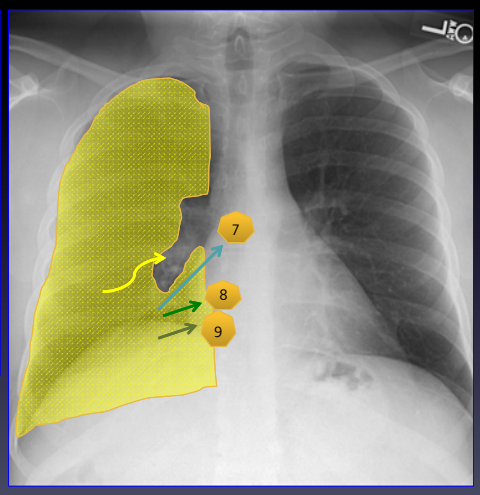
- Drains to upper hilar nodes
- May drain directly to upper right mediastinal nodes (4)



Lymphatic Drainage

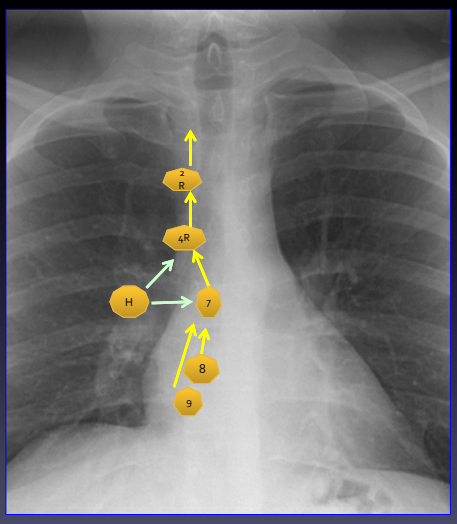
Right Middle/Lower Lobe

- Drain to inferior hilar nodes
- May drain directly to subcarinal mediastinal nodes (7)
- RLL may drain directly to periesophageal (8) or inferior pulmonary ligament (9) mediastinal nodes



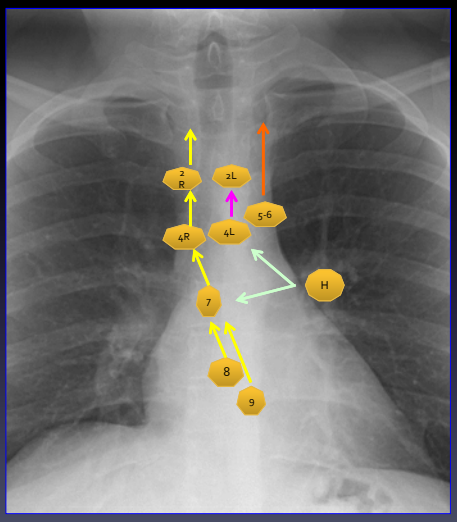
Lymphatic Drainage

The most common mediastinal nodal drainage pattern from right-sided lung cancers

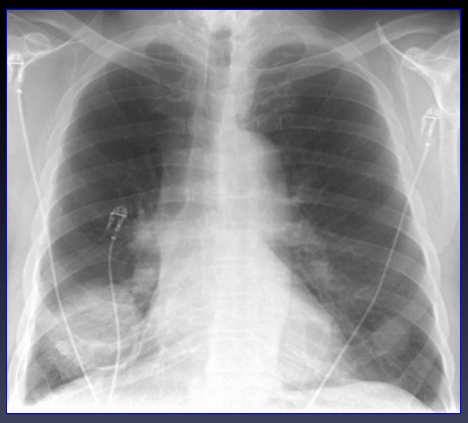


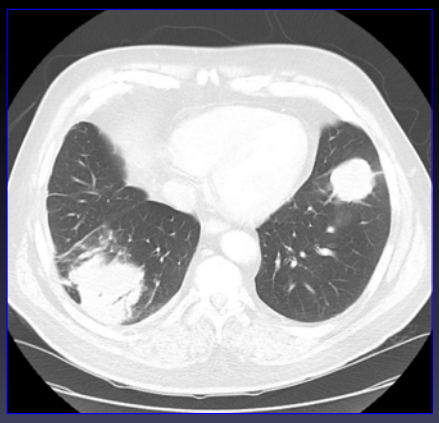
Lymphatic Drainage

The most common mediastinal nodal drainage patterns from left-sided lung cancers

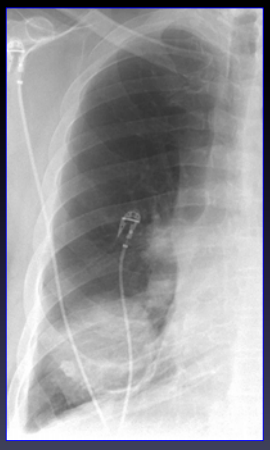


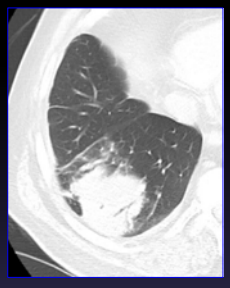
Case 9. 40 yo M with cough, weight-loss, fatigue





Case 9. 40 yo M with cough, weight-loss, fatigue





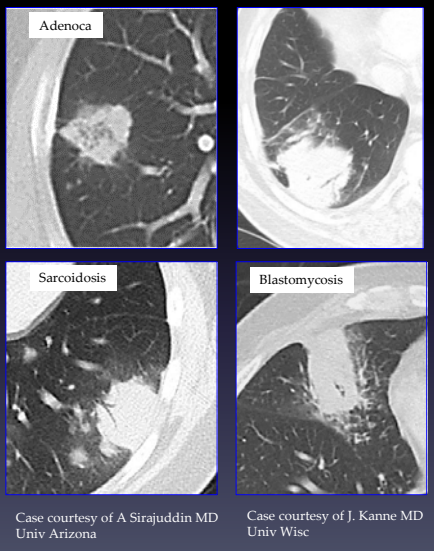
Which of the following diseases is most likely?

1. Invasive adenoca of the lung
2. Pulmonary lymphoma
3. Pulmonary amyloidosis
4. Metastatic colon carcinoma

Pulmonary nodule/masses with air-bronchograms

Differential Diagnosis

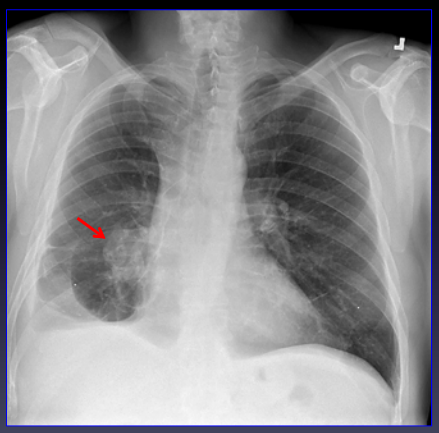
- Adenocarcinoma with lepidic growth pattern
- Primary pulmonary lymphoma
- Pulmonary amyloidosis
- Sarcoidosis
- Infection



Case courtesy of A Sirajuddin MD
Univ Arizona

Case courtesy of J. Kanne MD
Univ Wisc

Case 10A. Ex-navy submariner with cough - Given the chest radiograph on the left, which of the following radiologic procedures/exams should be recommended?

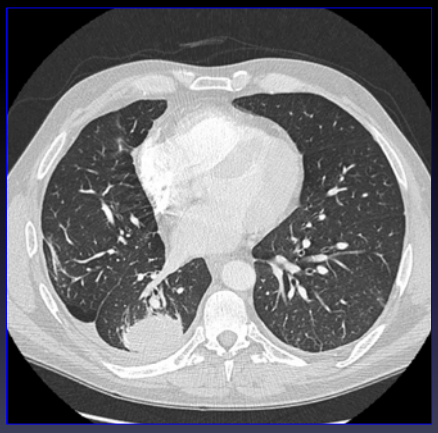


1. CT guided biopsy
2. CT chest without IV contrast
3. CT chest with IV contrast
4. PET-CT
5. Comparison with old chest radiograph

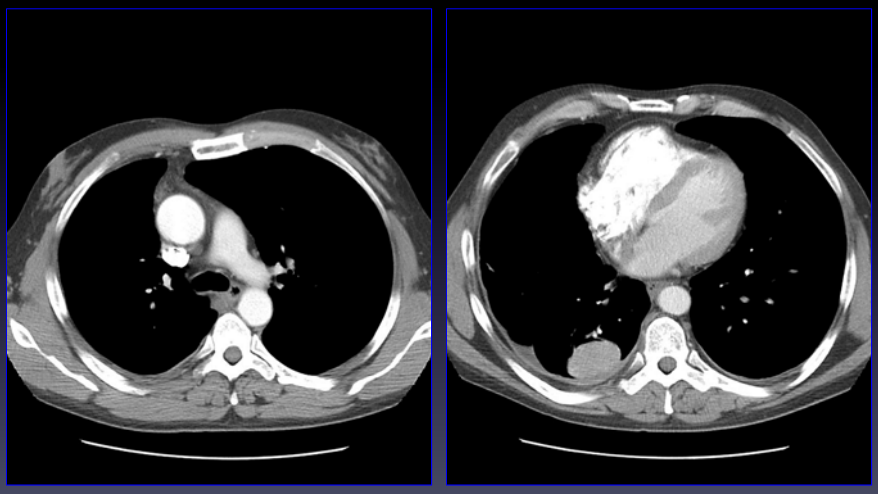
Case 10A. Ex-navy submariner with cough - Given the chest radiograph on the left, which of the following radiologic procedures/exams should be recommended?

1. CT guided biopsy
2. CT chest without IV contrast
3. CT chest with IV contrast
4. PET-CT
5. Comparison with old chest radiograph

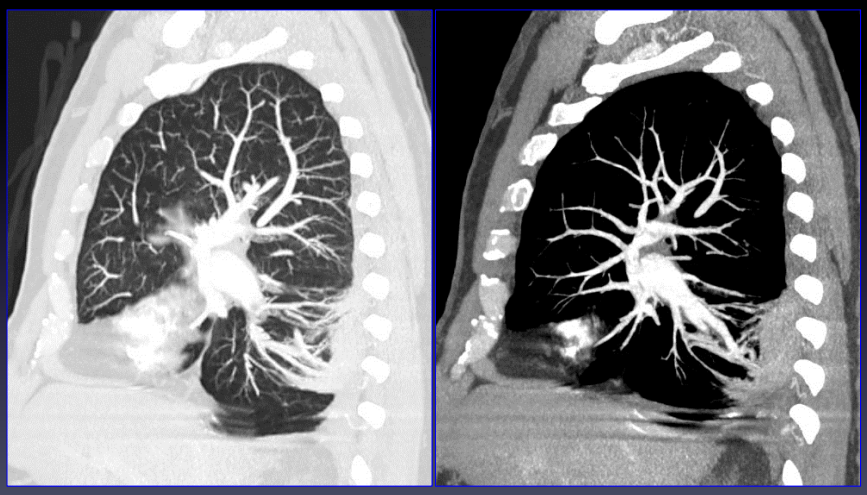
Ex-navy submariner with cough. No comparison radiographs



Ex-navy submariner with cough. CT with IV.



Ex-navy submariner with cough. CT with IV.



MIP Images

Case 10B. Ex-navy submariner with cough. CT with IV. Which of the following are CT criteria for this entity's diagnosis?

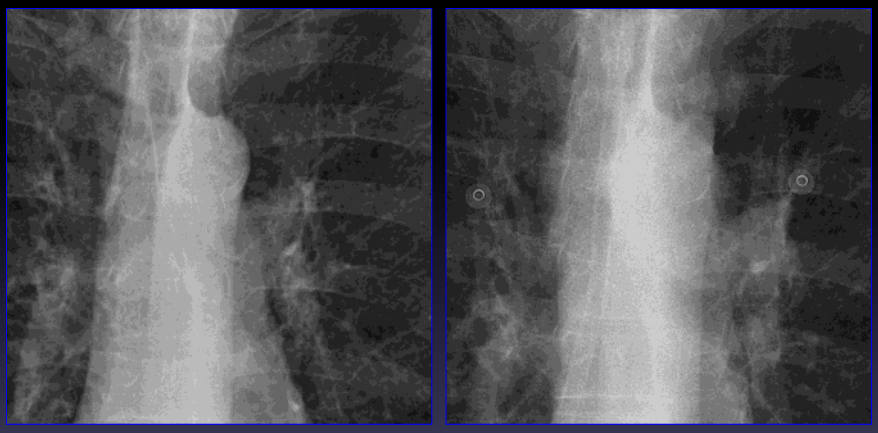
1. Pleural disease
2. Comet-tail sign
3. Ipsilateral volume loss
4. Homogenous enhancement

A. 1, 2, 3
B. 1,3
C. 2,4
D. All of the above

Round atelectasis – CT criteria

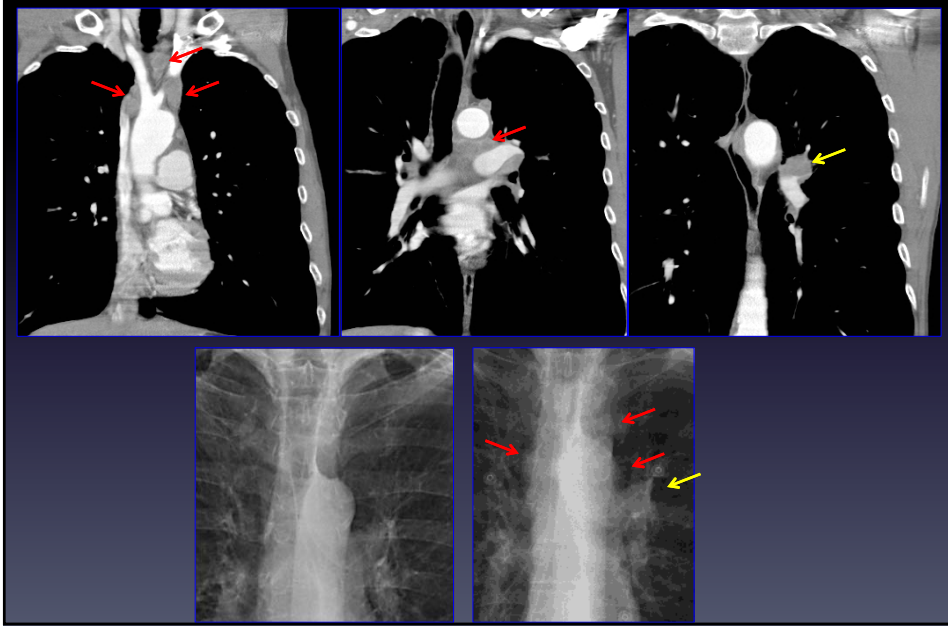
- Lung which is folded upon itself, mass abuts pleura
- Pleural disease must exist
- Ipsilateral volume loss
  - Change in position of fissures, diaphragm, mediastinum, hila
- Homogenous enhancement
  - During pulmonary venous phase
- Comet-tail sign

Case 11A. 63 yo M, smoker with hoarseness. Where is there tumor?

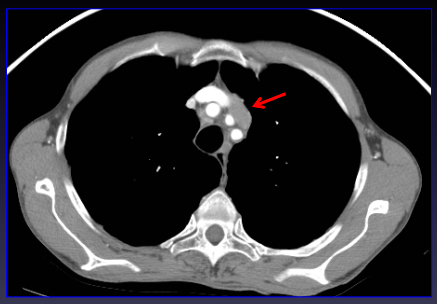


1. **Left hilum only**
2. **Left hilum, AP window**
3. **Left hilum, bilateral upper mediastinum**
4. **Bilateral upper mediastinum**

Bilateral upper mediastinal and left hilar node involvement



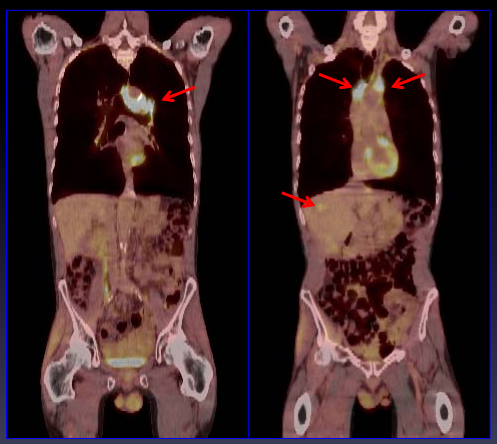
Case 11B. 63 yo M, smoker with hoarseness.



True or False:

The station 6 lymph nodes indicated by the red arrow are accessible for tissue sampling via cervical mediastinoscopy.

Case 11C. 63 yo M, smoker with hoarseness. Biopsy shows small cell lung cancer – PET CT done to stage



True or False:

There is no difference between small cell and non-small cell lung cancer staging in present-day clinical setting.

Clinical staging of small cell lung cancer

Limited Disease

- Tumor confined to the ipsilateral hemithorax and regional nodes able to be included in a single tolerable radiotherapy port

Extensive Disease

- Tumor beyond the boundaries of limited disease including distant metastases, malignant pericardial or pleural effusions, contralateral supraclav/hilar nodal involvement

Fleischner Recommendations for small, solid nodules incidentally detected at nonscreening CT

Nodule size*	Low Risk Patient	High Risk Patient
</= 4mm	No f/u needed	F/u @ 12m, if unchanged no additional f/u
>4-6mm	F/u 12m, if no change no further f/u	F/u 6-12m, then 18-24m if if no change
>6-8mm	F/u at 6-12m, then 18-24m if no change	F/u @ 3-6m, then 9-12m and 24m if no change
>8mm	F/u 3, 9, 24m, dynamic CECT, PET &/or Bx	Same as for low risk pt

- = average width & length
- Not applicable to pt c known malignancy, young patients, pt c sx

Fleischner recommendations for management of subsolid pulmonary nodules detected at CT

Recommendations for the Management of Subsolid Pulmonary Nodules Detected at CT: A Statement from the Fleischner Society

Nodule Type	Management Recommendations	Additional Remarks
Solitary pure GGNs		
≤5 mm	No CT follow-up required	Obtain contiguous 1-mm-thick sections to confirm that nodule is truly a pure GGN
>5 mm	Initial follow-up CT at 3 months to confirm persistence then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Solitary part-solid nodules	Initial follow-up CT at 3 months to confirm persistence. If persistent and solid component <5 mm, then yearly surveillance CT for a minimum of 3 years. If persistent and solid component ≥5 mm, then biopsy or surgical resection	Consider PET/CT for part-solid nodules >10 mm
Multiple subsolid nodules		
Pure GGNs ≤5 mm	Obtain follow-up CT at 2 and 4 years	Consider alternate causes for multiple GGNs ≤5 mm
Pure GGNs >5 mm without a dominant lesion(s)	Initial follow-up CT at 3 months to confirm persistence and then annual surveillance CT for a minimum of 3 years	FDG PET is of limited value, potentially misleading, and therefore not recommended
Dominant nodule(s) with part-solid or solid component	Initial follow-up CT at 3 months to confirm persistence. If persistent, biopsy or surgical resection is recommended, especially for lesions with >5 mm solid component	Consider lung-sparing surgery for patients with dominant lesion(s) suspicious for lung cancer

Note.—These guidelines assume meticulous evaluation, optimally with contiguous thin sections (1 mm) reconstructed with narrow and/or mediastinal windows to evaluate the solid component and wide and/or lung windows to evaluate the nonsolid component of nodules, if indicated. When electronic calipers are used, bidimensional measurements of both the solid and ground-glass components of lesions should be obtained as necessary. The use of a consistent low-dose technique is recommended, especially in cases for which prolonged follow-up is recommended, particularly in younger patients. With serial scans, always compare with the original baseline study to detect subtle indolent growth.

Recommendations for the management of subsolid pulmonary nodules detected at CT: A statement from Fleischner Society. Radiology 2012;266(1):304

Nonsmall Cell Lung Cancer Staging

Primary Tumor (T)

- **TX** Primary tumor cannot be assessed, or tumor proven by the presence of malignant cells in sputum or bronchial washings but not visualized by imaging or bronchoscopy
- **T0** No evidence of primary tumor
- **Tis** Carcinoma in situ
- **T1** Tumor 3 cm or less in greatest dimension, surrounded by lung or visceral pleura, without bronchoscopic evidence of invasion more proximal than the lobar bronchus (for example, not in the main bronchus)[1]
- **T1a** Tumor 2 cm or less in greatest dimension
- **T1b** Tumor more than 2 cm but 3 cm or less in greatest dimension
- **T2** Tumor more than 3 cm but 7 cm or less or tumor with any of the following features (T2 tumors with these features are classified T2a if 5 cm or less): involves main bronchus, 2 cm or more distal to the carina; invades visceral pleura (PL1 or PL2); associated with atelectasis or obstructive pneumonitis that extends to the hilar region but does not involve the entire lung
- **T2a** Tumor more than 3 cm but 5 cm or less in greatest dimension
- **T2b** Tumor more than 5 cm but 7 cm or less in greatest dimension
- **T3** Tumor more than 7 cm or one that directly invades any of the following: parietal pleural (PL3), chest wall (including superior sulcus tumors), diaphragm, phrenic nerve, mediastinal pleura, parietal pericardium; or tumor in the main bronchus less than 2 cm distal to the carina[1] but without involvement of the carina; or associated atelectasis or obstructive pneumonitis of the entire lung or separate tumor nodule(s) in the same lobe
- **T4** Tumor of any size that invades any of the following: mediastinum, heart, great vessels, trachea, recurrent laryngeal nerve, esophagus, vertebral body, carina, separate tumor nodule(s) in a different ipsilateral lobe

Distant Metastasis (M)

- **M0** No distant metastasis
- **M1** Distant metastasis
- **M1a** Separate tumor nodule(s) in a contralateral lobe, tumor with pleural nodules or malignant pleural (or pericardial) effusion[2]
- **M1b** Distant metastasis (in extrathoracic organs)

Notes

[1] The uncommon superficial spreading tumor of any size with its invasive component limited to the bronchial wall, which may extend proximally to the main bronchus, is also classified as T1a.

[2] Most pleural (and pericardial) effusions with lung cancer are due to tumor. In a few patients, however, multiple cytopathologic examinations of pleural (pericardial) fluid are negative for tumor, and the fluid is nonbloody and is not an exudate. Where these elements and clinical judgment dictate that the effusion is not related to the tumor, the effusion should be excluded as a staging element and the patient should be classified as M0.

ANATOMIC STAGE/PROGNOSTIC GROUPS

Occult Carcinoma	TX	N0	M0
Stage 0	Tis	N0	M0
Stage IA	T1a	N0	M0
	T1b	N0	M0
Stage IB	T2a	N0	M0
Stage IIA	T2b	N0	M0
	T1a	N1	M0
	T1b	N1	M0
	T2a	N1	M0
Stage IIB	T2b	N1	M0
	T3	N0	M0
Stage IIIA	T1a	N2	M0
	T1b	N2	M0
	T2a	N2	M0
	T2b	N2	M0
	T3	N1	M0
	T3	N2	M0
	T4	N0	M0
	T4	N1	M0
Stage IIIB	T1a	N3	M0
	T1b	N3	M0
	T2a	N3	M0
	T2b	N3	M0
	T3	N3	M0
	T4	N2	M0
	T4	N3	M0
Stage IV	Any T	Any N	M1a
	Any T	Any N	M1b

Growth Rates

- (Hasegawa et al. Br J Rad 2000;73:1252) 3y mass screening analysis of small lung cancers
  - Mean Volume Doubling Time (VDT) in smokers
    - GGO, 813d
    - Part solid, 457d
    - Solid, 149d
  - Mean Volume Doubling time in nonsmokers is even longer than in smokers

- 5mm nodule c 60d VDT reaches diameter of 20 mm in 12 m
- 5mm nodule c 240d VDT reaches 7.1 mm diameter in same period