



Ada Amobi, HMS III
Gillian Lieberman, MD

Beth Israel Deaconess
Medical Center

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From Presentation Through Staging: *Primary Lung Carcinoma*

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Gillian Lieberman, MD

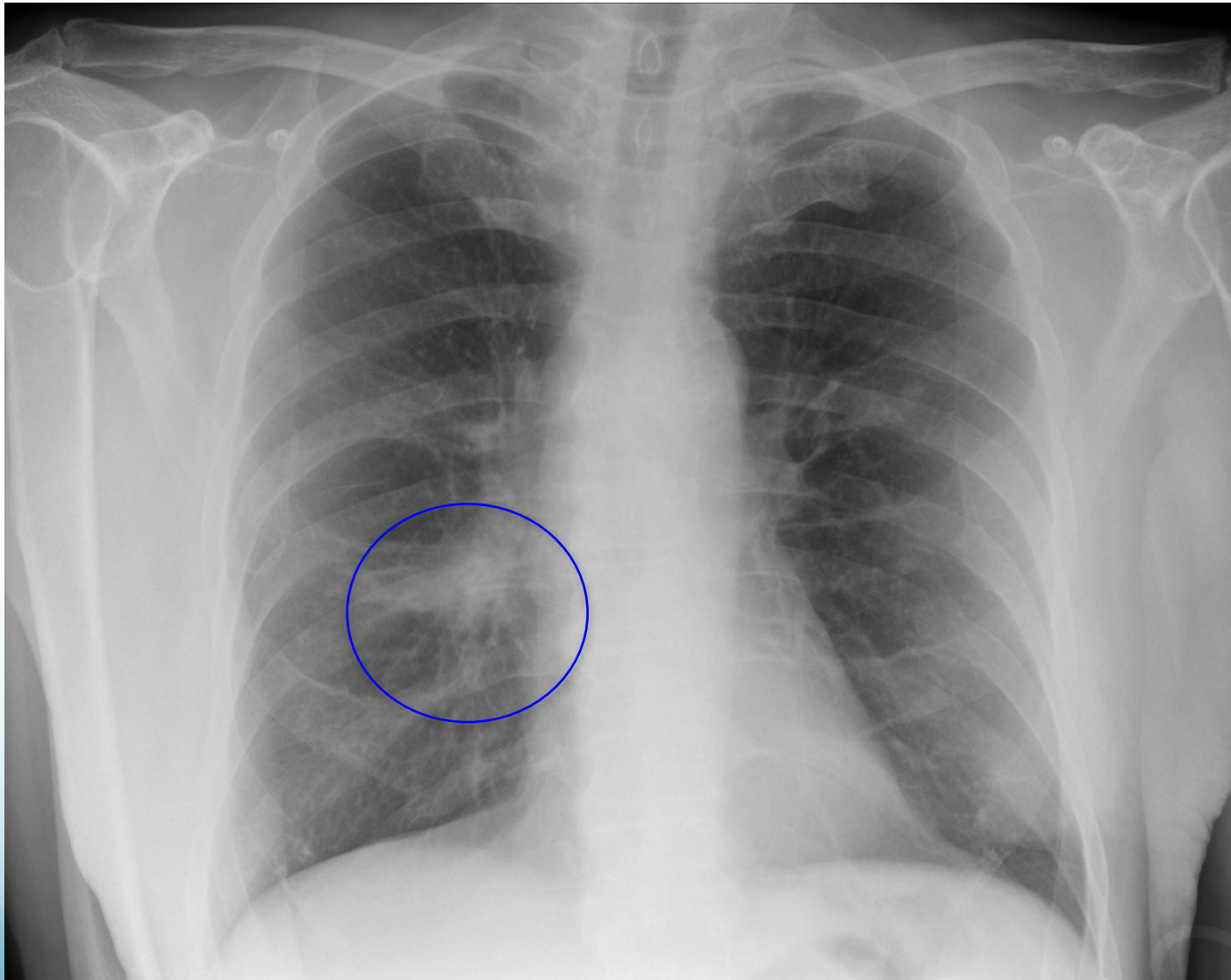
AGENDA

- Introduction to our patient
- Anatomy review: lung lobes
- Differential diagnosis of a solitary pulmonary nodule
- Menu of imaging tests of a solitary pulmonary nodule
- Differential diagnosis of a cavitating pulmonary nodule
- Key imaging features of lung cancer nodule
 - Shapes and margins
 - Cavitations
 - Calcifications
- Review of benign calcifications
- Definitive diagnosis and staging of lung cancer
- Imaging guided tissue sampling
- Whole body PET Scanning
- TNM Staging
- Post-treatment: Radiologic Follow Up
- Update on our patient

Our Patient

- Mr. AB is a 68 year old man with hypertension, hyperlipidemia and a 60 pack-year smoking history who presented with slurred speech and facial droop to the emergency room.
- On CT and MRI, he was found to have brain lesions concerning for metastases. As part of his subsequent work up, he had a chest x-ray which revealed the following...

Our Patient: Frontal Chest X-Ray



3.8cm
spiculated
mass like
density

Our Patient: Lateral Chest X-Ray

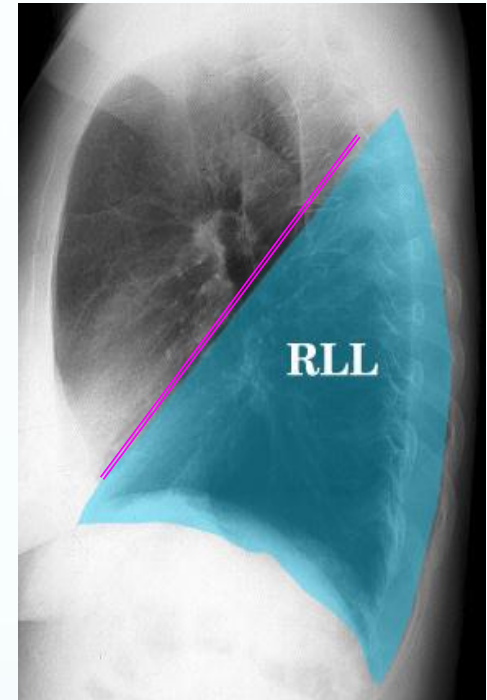
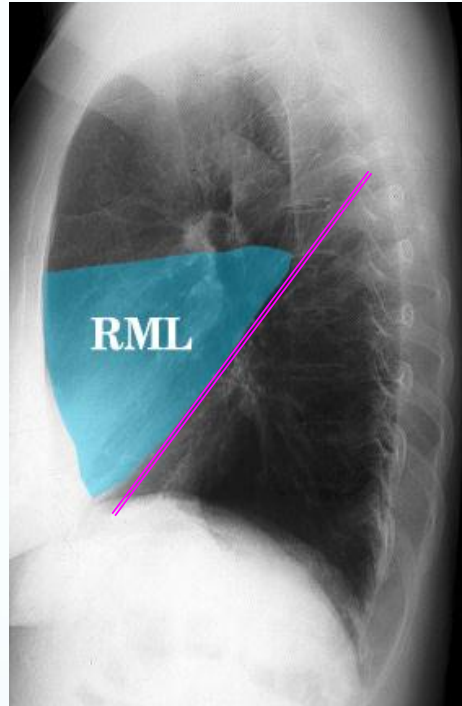
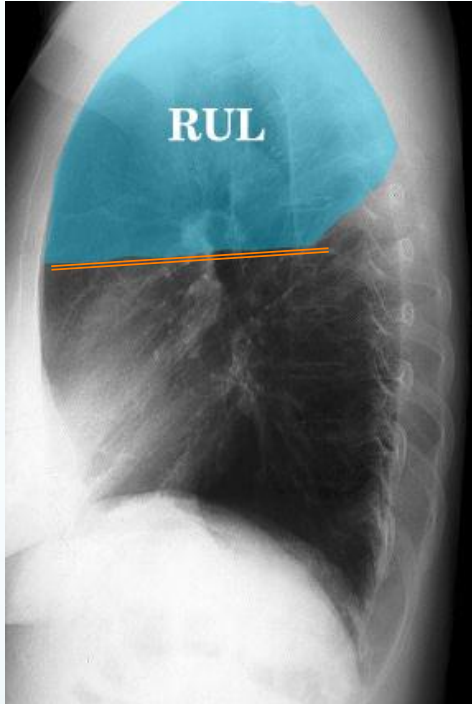


With the lateral view we now confirm that this is an intrathoracic lung mass

PACS, BIDMC

In what lobe is the mass situated?

Anatomy Review: Right Lobes on Lateral Chest X-Ray



Photos from "Lung Anatomy" www.wikiradiography.com

The minor or horizontal fissure (orange) follows the fourth intercostal space from the sternum and then meets the oblique fissure as it crosses 5th anterior rib.

The major or oblique fissure (magenta) can be thought of as a curved line that begins at the spinous process of T4 crosses the 5th interspace and then follows the contour of the 6th rib anteriorly.

Anatomy Review: Right Upper Lobe

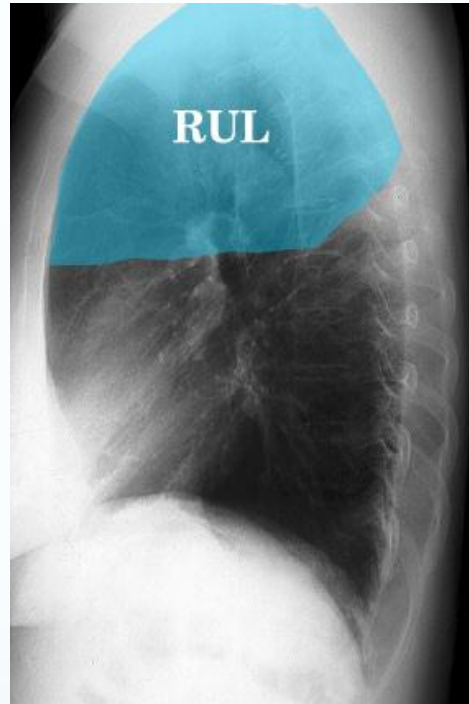


Photo from "Lung Anatomy" www.wikiradiography.com

- Occupies the upper 1/3 of the right lung.
- Anteriorly : extends inferiorly as far as the 4th right anterior rib
- Posteriorly : adjacent to the first three to five ribs

Anatomy Review: Right Middle Lobe

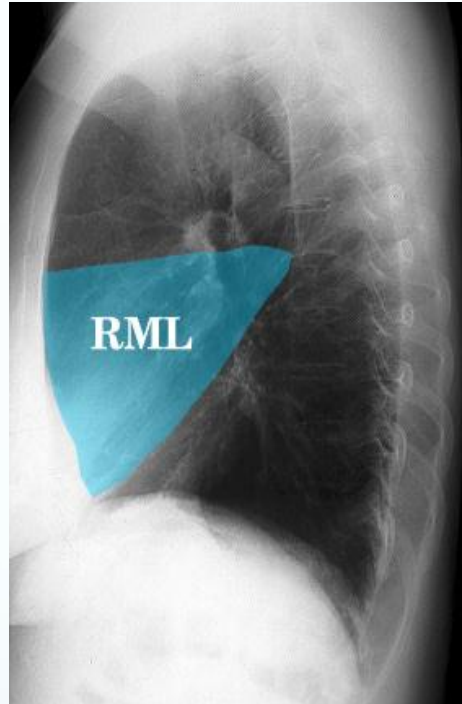


Photo from "Lung Anatomy" www.wikiradiography.com

- The right 4th rib separates the Right Middle Lobe from Right Upper Lobe
- The 6th rib is where the Right Middle Lobe is separated from the Right Lower Lobe by the oblique fissure.

Anatomy Review: Right Lower Lobe

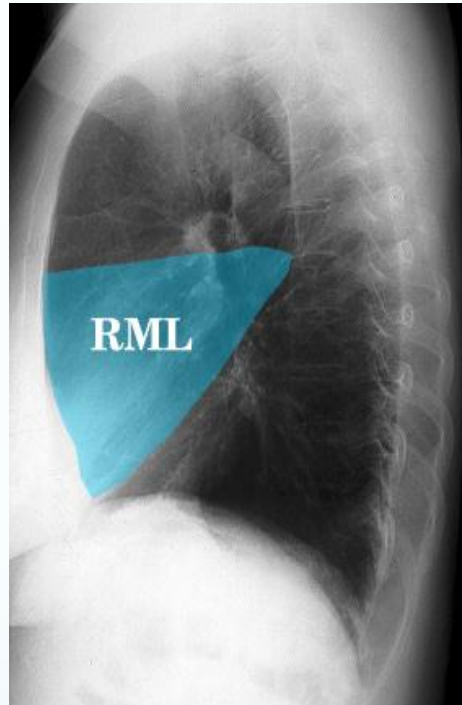


Photo from "Lung Anatomy" www.wikiradiography.com

- This is the largest lobe
- Posteriorly: extends as far superiorly as the 6th thoracic vertebral body, and extends inferiorly to the diaphragm.

Anatomy Review: Left Upper Lobe on Lateral Chest X-Ray



Photos from "Lung Anatomy" www.wikiradiography.com

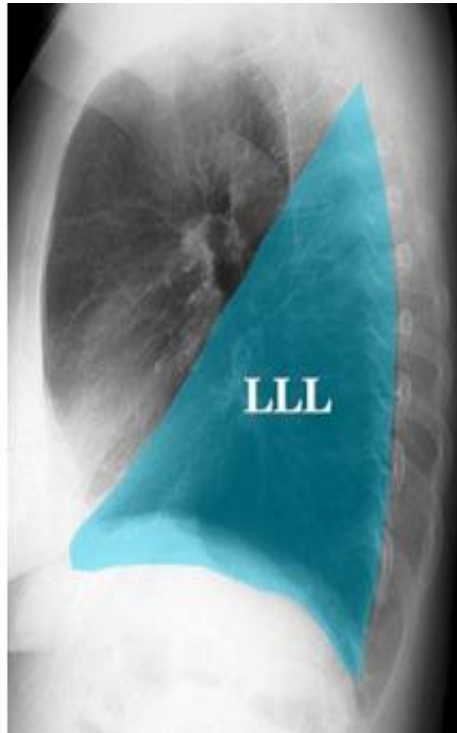
The Left Major Fissure (magenta) runs from between T3 and T4 spinous process, crosses the 5th interspace laterally and then follows the contour of the 6th rib.

The Left Upper Lobe extends up from the major fissure with its apex above the clavicles.

The Lingula (not shown) is a tongue shaped extension of the LUL

<http://www.anatomy.yalemedicine.org/VisibleHumanLessonPlans/Session3Lung.htm>

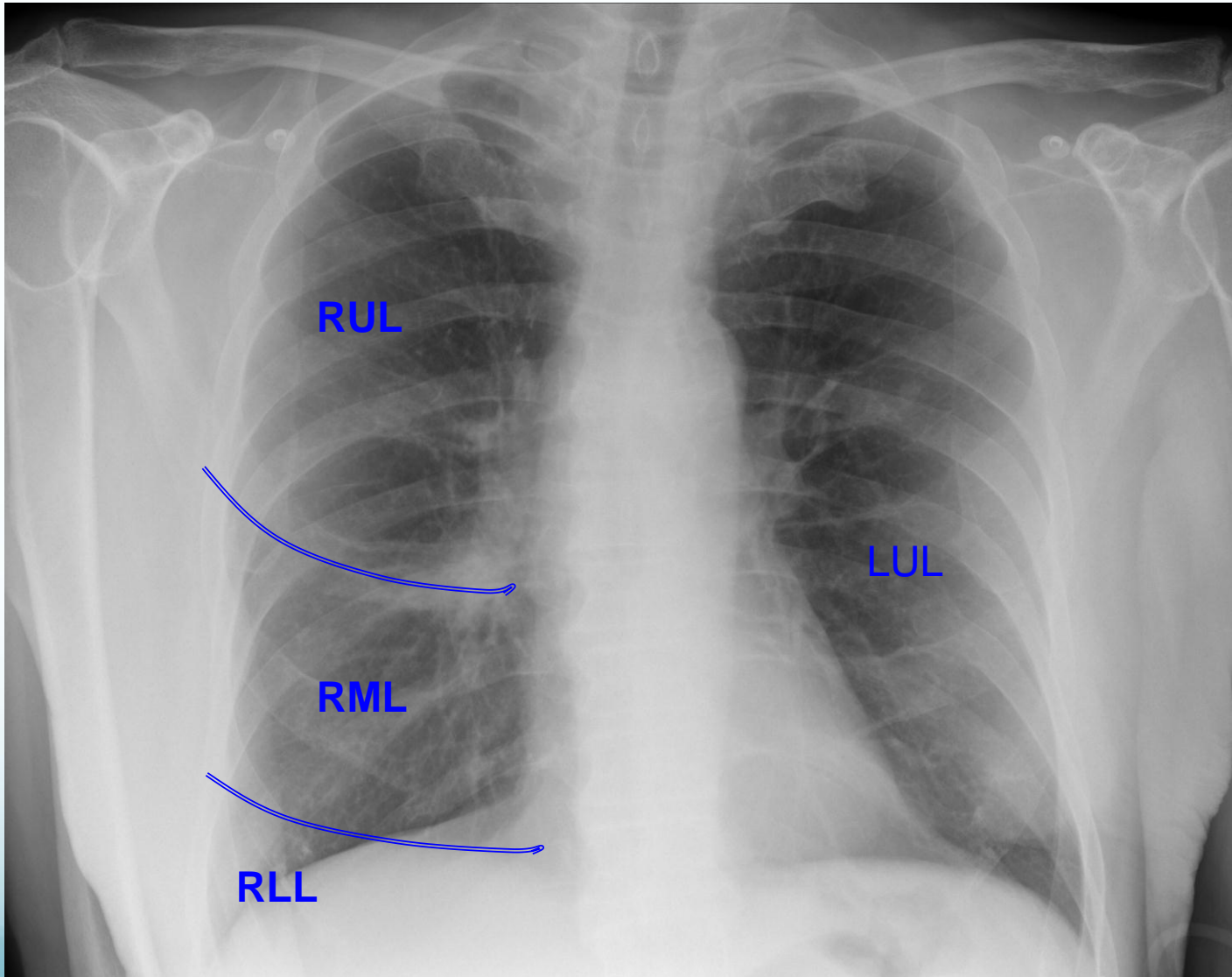
Anatomy Review: Left Lower Lobe on Lateral Chest X-Ray



Photos from "Lung Anatomy" www.wikiradiography.com

The Left Lower Lobe extends down from the major fissure to the level of the diaphragm

Our Patient: Anatomy Review of Right Lobes



What could be the cause of our patient's solitary lung nodule?

Differential Diagnosis of a Solitary Pulmonary Nodule*

- **Neoplasm**

Bronchogenic carcinoma, hamatoma

- **Trauma**

infected lung cyst

- **Infection**

TB, septic emboli, echinococcus, fungal infection

- **Infarction**

- **Collagen Vascular disease**

Granulomatosis with polyangitis, Rheumatoid lung

* This is a non-exhaustive list of common examples.

Menu of Imaging Tests

- **Chest radiograph:** nodule characteristics
- **Chest CT:** nodule characteristics including calcifications, lobulations, cavitations; assessment of intra and extrathoracic disease
- **MRI:** especially good for mediastinal or chest wall involvement
- **PET:** important in finding distal metastases as part of lung cancer staging

Grainger & Allison's diagnostic radiology : a textbook of medical imaging. Elsevier Churchill Livingstone 2008.

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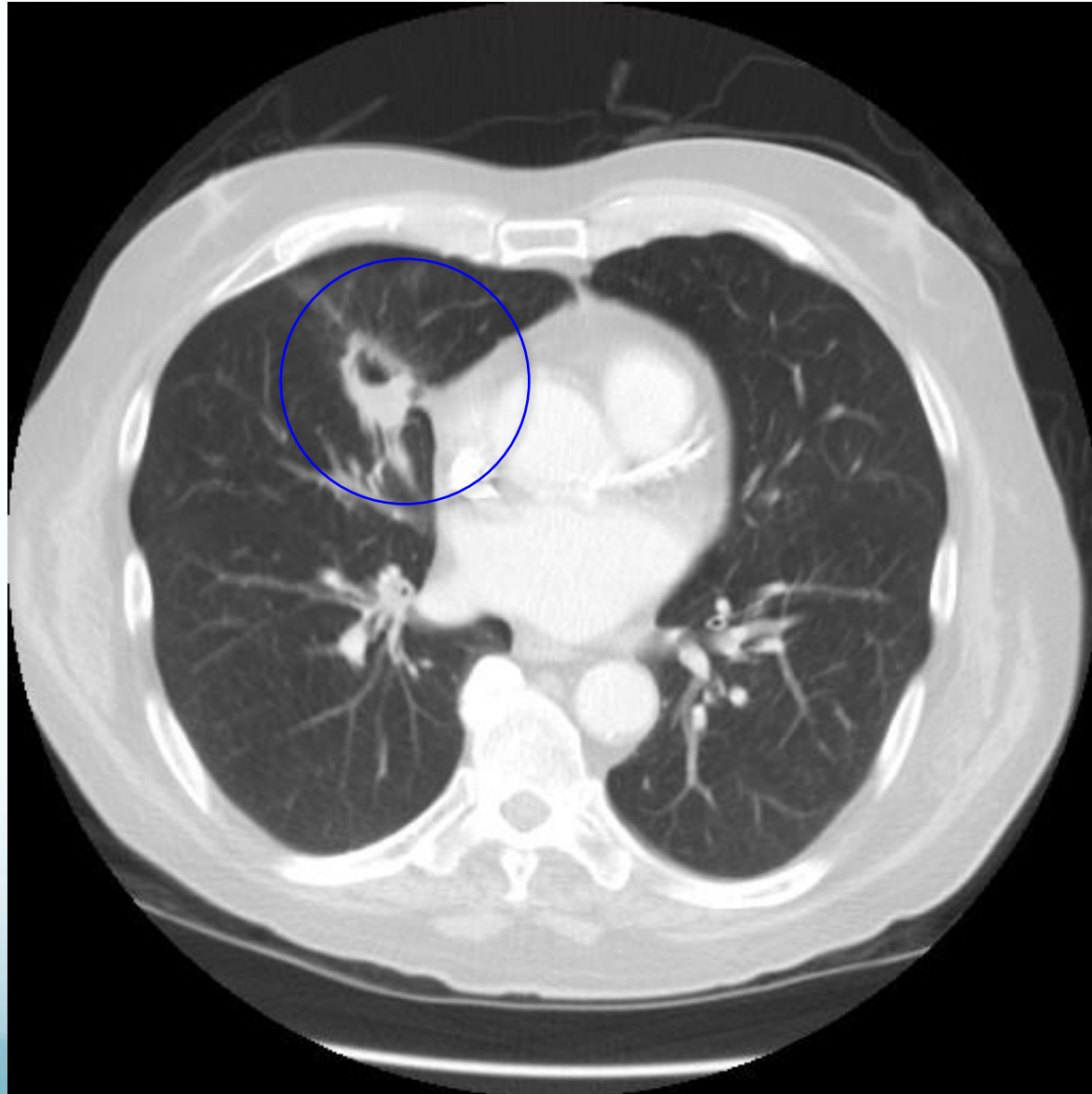
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Gilman MD,

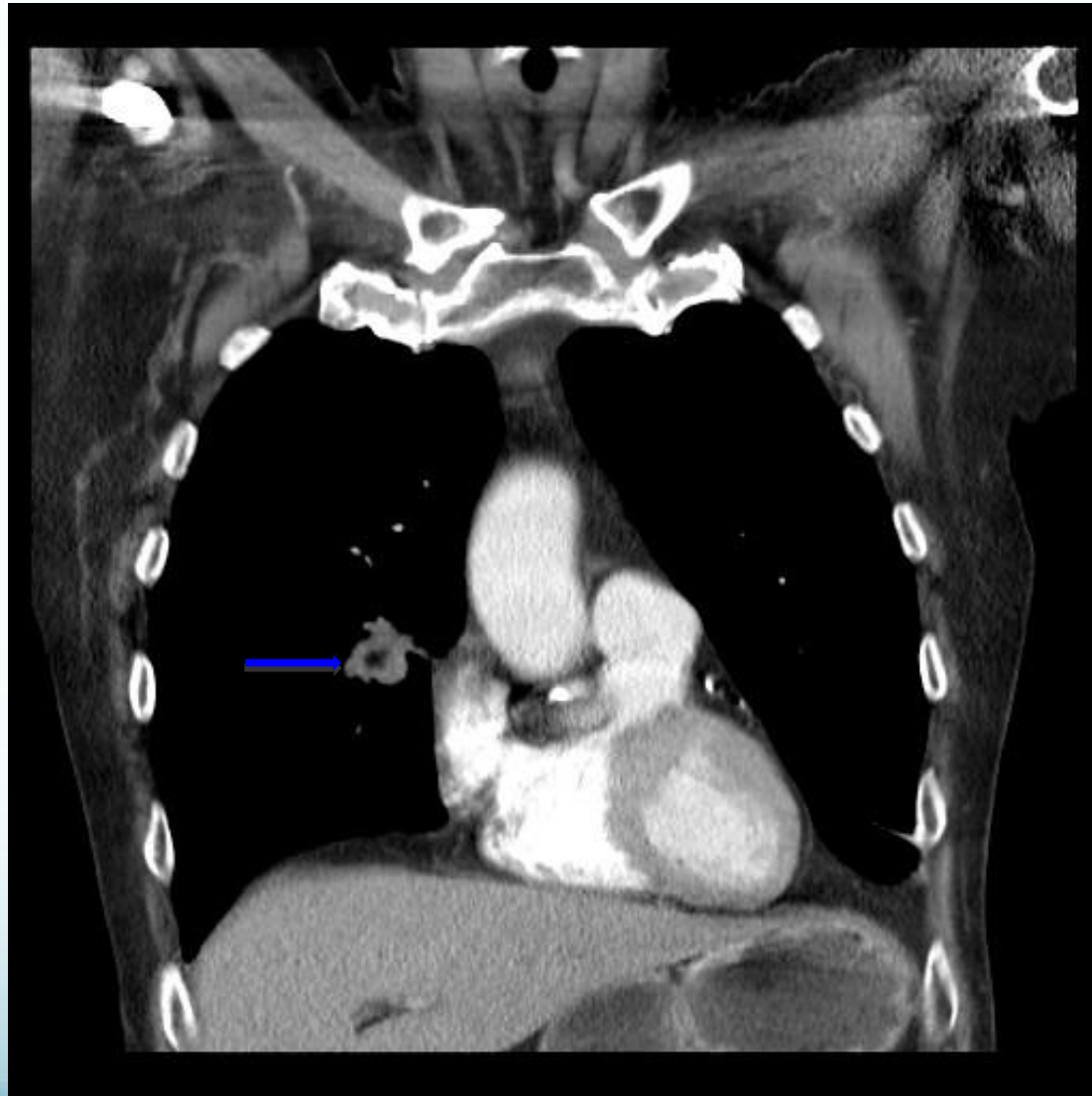
Webb WR, Gatsonis C,

Our patient had a CT scan which revealed that his lung nodule was a cavitory mass.

Our Patient: Cavitory Mass on Axial CT

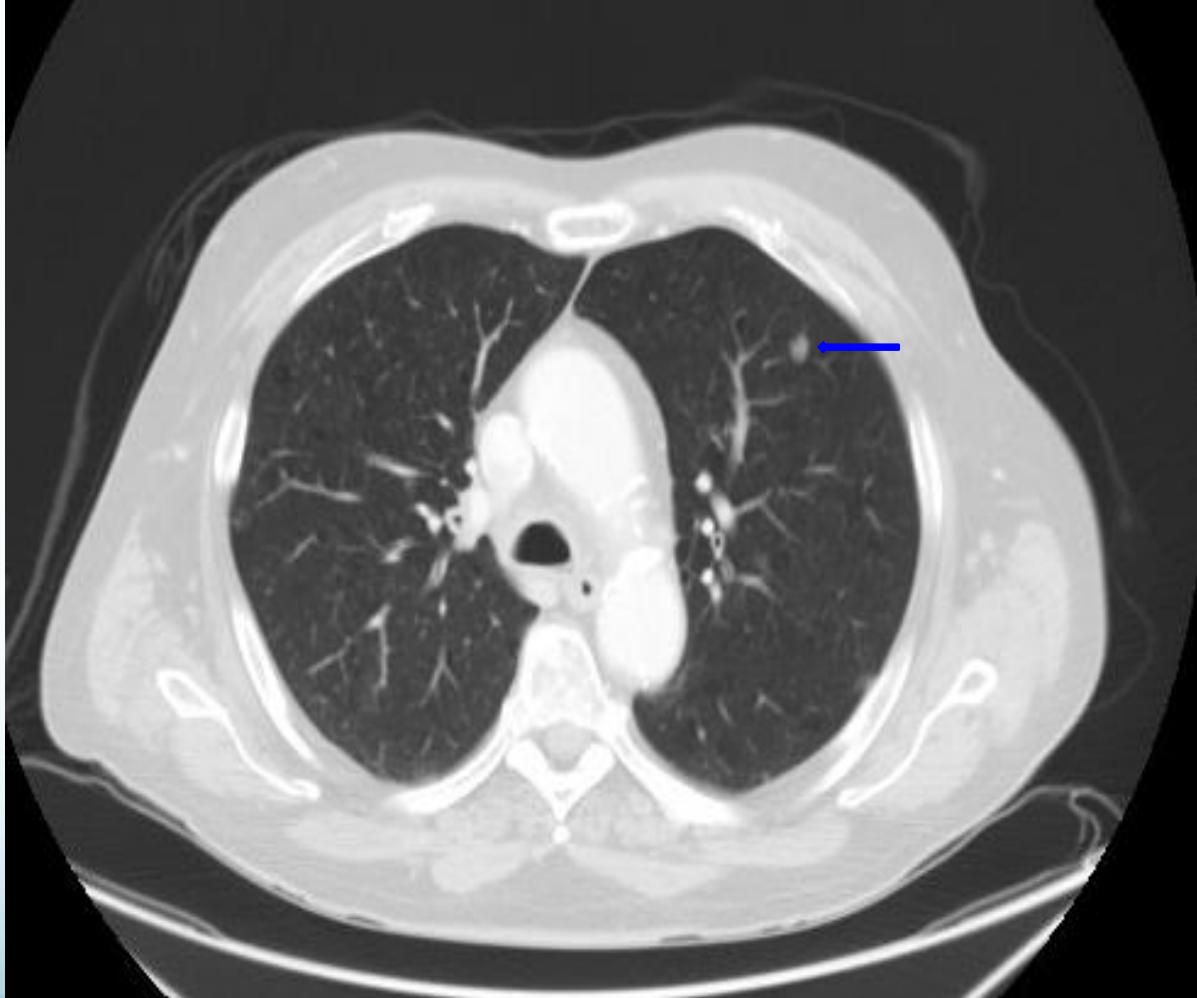


Our Patient: Cavitory Mass on Coronal CT



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Our Patient: Additional Peripheral Nodule on Axial CT



Peripheral
nodule

Now we know our patient's mass is cavitating, how does that affect our differential?

Differential Diagnosis of a Cavitating Pulmonary Nodule*

- Primary bronchogenic carcinoma
- Pulmonary metastases
- Pulmonary tuberculosis
- Bacterial abscess
- Fungal infection: aspergillus, histoplasma
- Infarct
- Congenital: pulmonary sequestration, cyst

*This is a non-exhaustive list of common examples

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Key Imaging Features of Lung Cancer Nodules.

SHAPES AND MARGINS

CALCIFICATIONS

CAVITATIONS

Some Typical Shapes and Margins of Malignant Nodules

- Spherical or oval
- Lobulated
- Dumb bell shape
- Corona radiata
- Tail (not shown here)

Some Typical Shapes and Margins of Malignant Nodules

Spherical or Oval



Grainger & Allison's diagnostic radiology 2008

Some Typical Shapes and Margins of Malignant Nodules

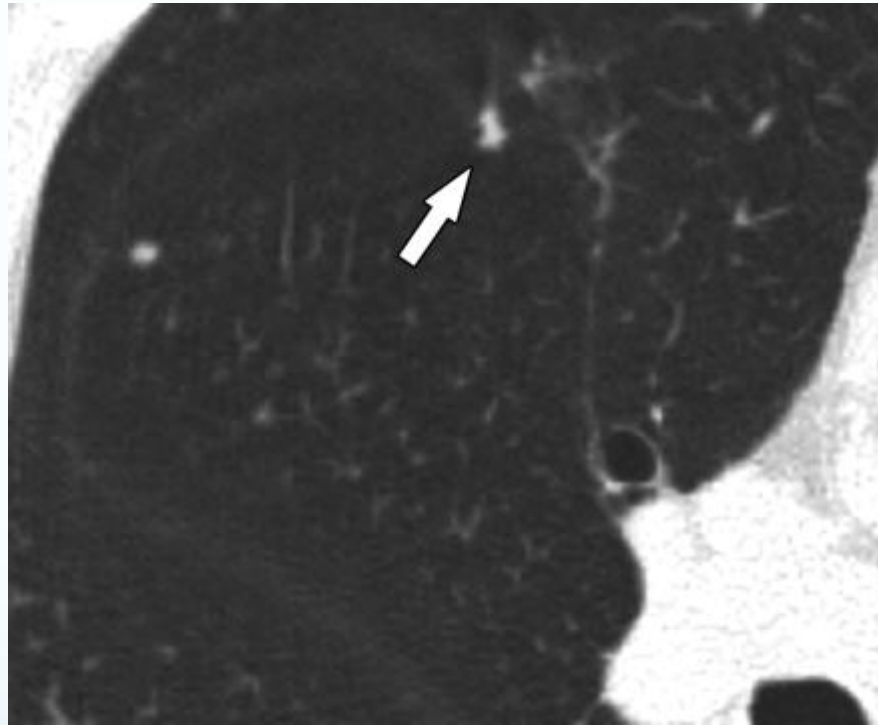
Lobulated



Erasmus J J et al. Radiographics 2000;20:43-58

Some Typical Shapes and Margins of Malignant Nodules

Dumbbell Shape



Ahn M I et al. Radiology 2010;254:949-956

Some Typical Shapes and Margins of Malignant Nodules

Corona Radiata



Grainger & Allison's diagnostic radiology 2008

Key Imaging Features of Lung Cancer Nodules.

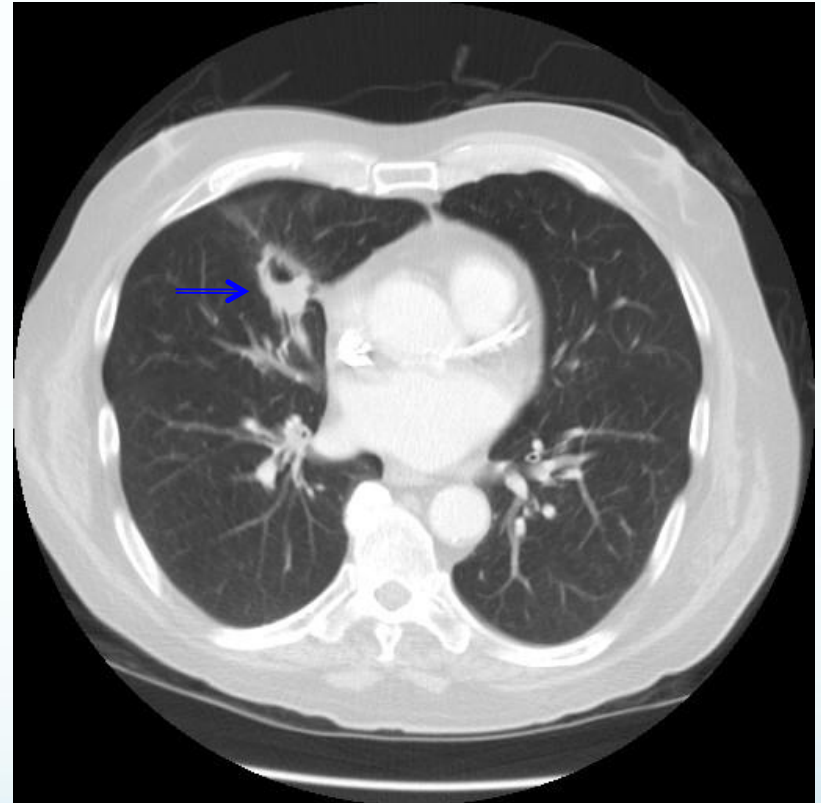
SHAPES AND MARGINS

CAVITATIONS

CALCIFICATIONS

Cavitations

- Best demonstrated by CT
- May be seen in tumors of any size
- Cavity wall is usually at least 8mm thick
- Fluid levels are common



Our Patient, PACS, BIDMC

Key Imaging Features of Lung Cancer Nodules.

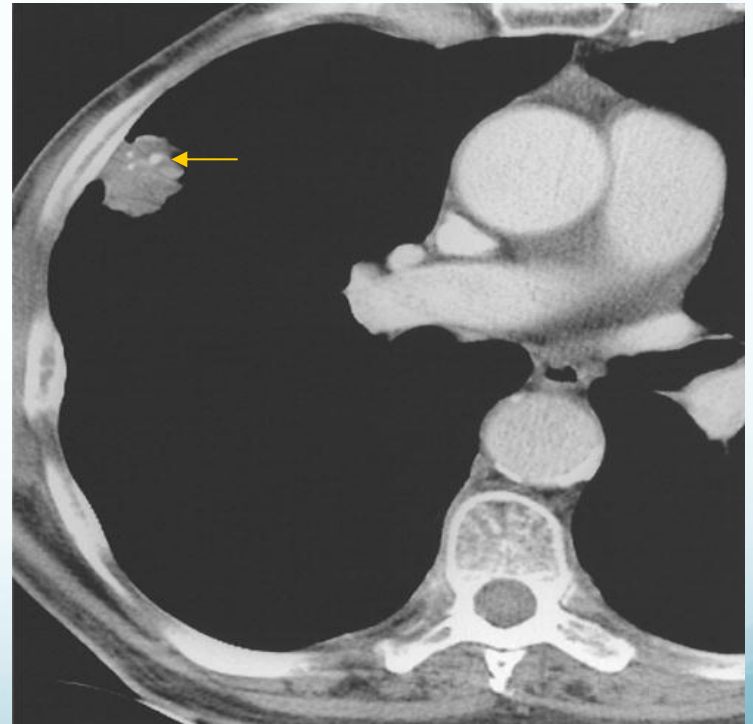
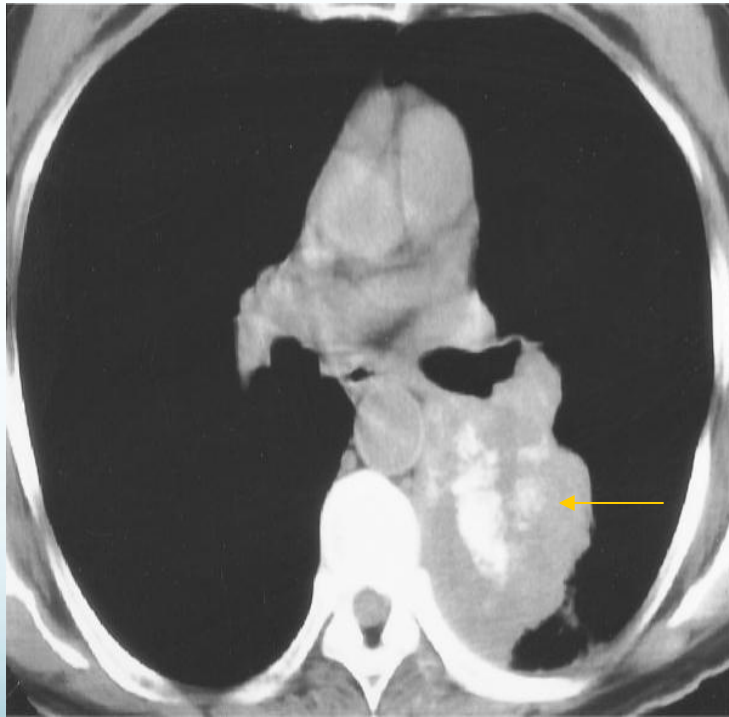
SHAPES AND MARGINS

CAVITATIONS

CALCIFICATIONS

Calcifications

- Better seen on chest CT
- **“amorphous”** quality
- Usually seen in larger tumors (5cm or more)



Review: Patterns of Benign Calcifications

- Complete
- Central
- Peripheral
- Laminated
- Popcorn

Patterns of **Benign** Calcifications

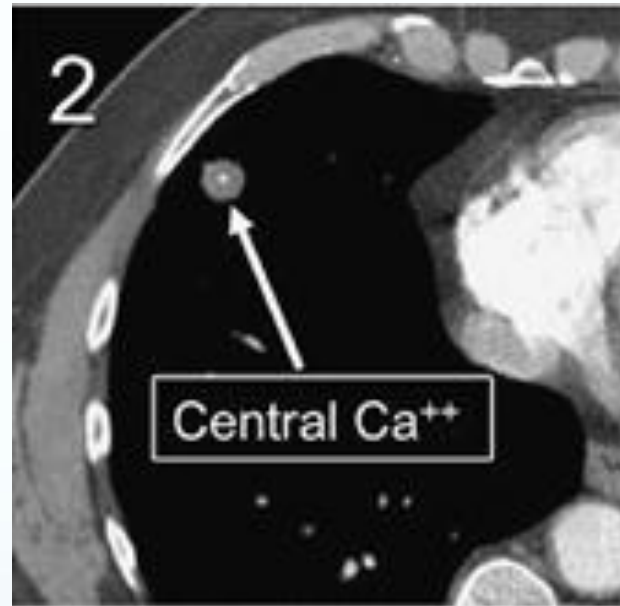
Complete Calcification



Brant and Helms Fundamentals of Diagnostic Radiology Lippincott Williams and Wilkins 2012

Patterns of **Benign** Calcifications

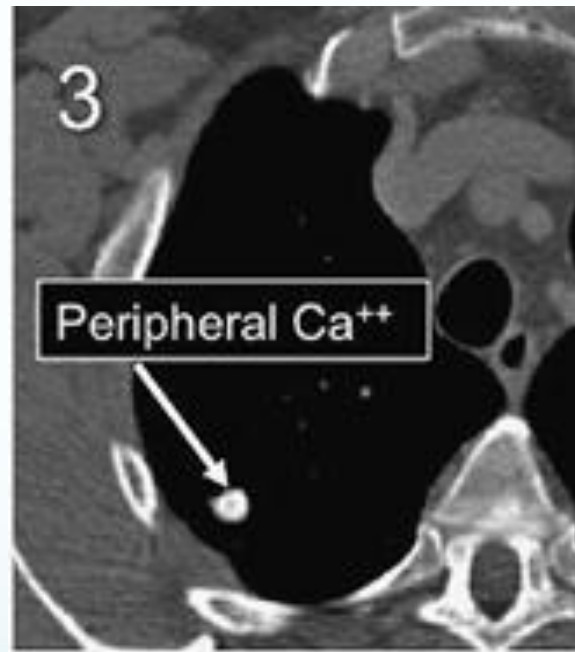
Central Calcification



Brant and Helms Fundamentals of Diagnostic Radiology Lippincott Williams and Wilkins 2012

Patterns of **Benign** Calcifications

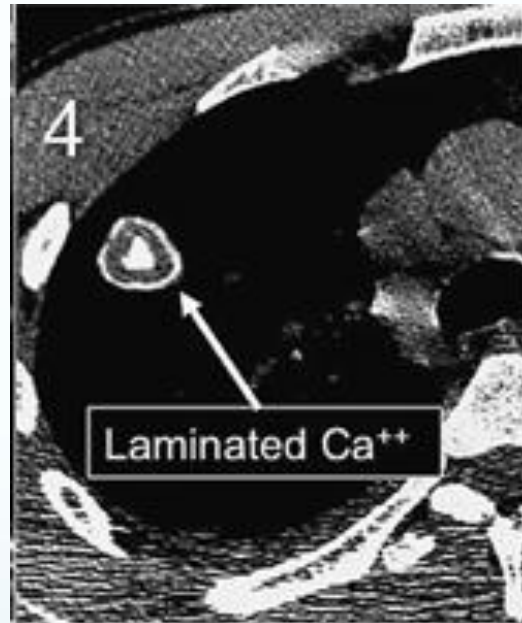
Peripheral Calcification



Brant and Helms Fundamentals of Diagnostic Radiology Lippincott Williams and Wilkins 2012

Patterns of **Benign** Calcifications

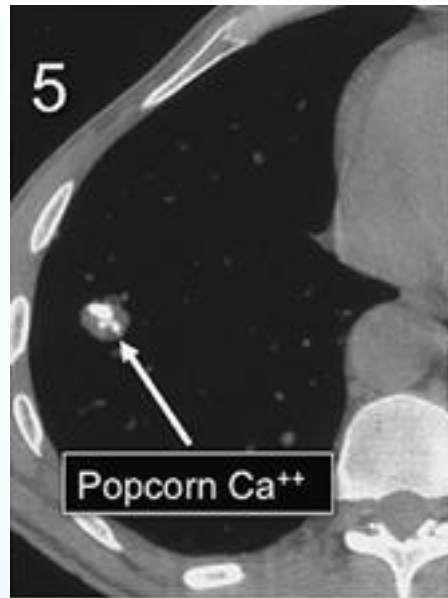
Laminated Calcification



Brant and Helms Fundamentals of Diagnostic Radiology Lippincott Williams and Wilkins 2012

Patterns of **Benign** Calcifications

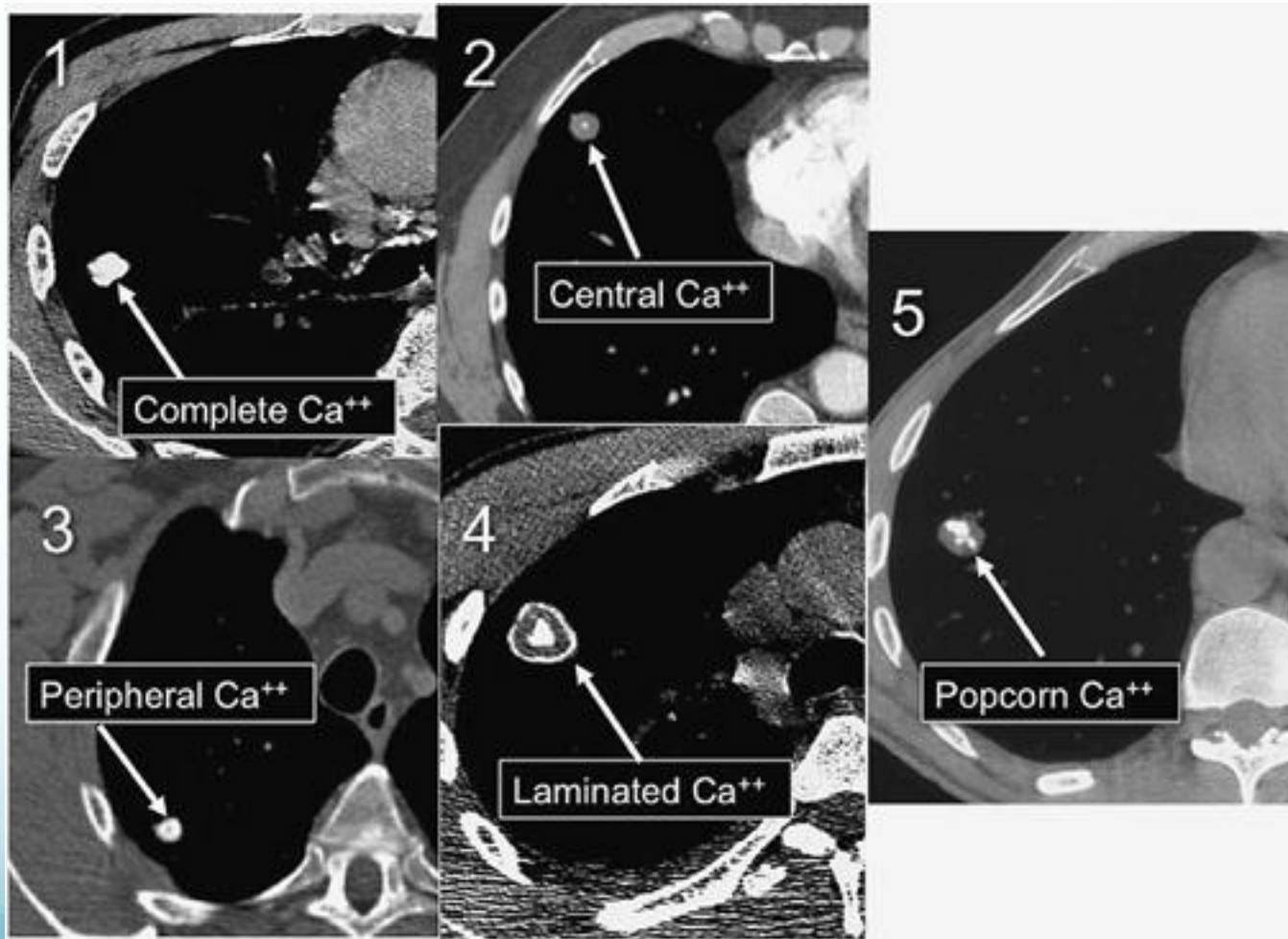
Popcorn Calcification



Brant and Helms Fundamentals of Diagnostic Radiology Lippincott Williams and Wilkins 2012

Patterns of Benign Calcifications

Summary

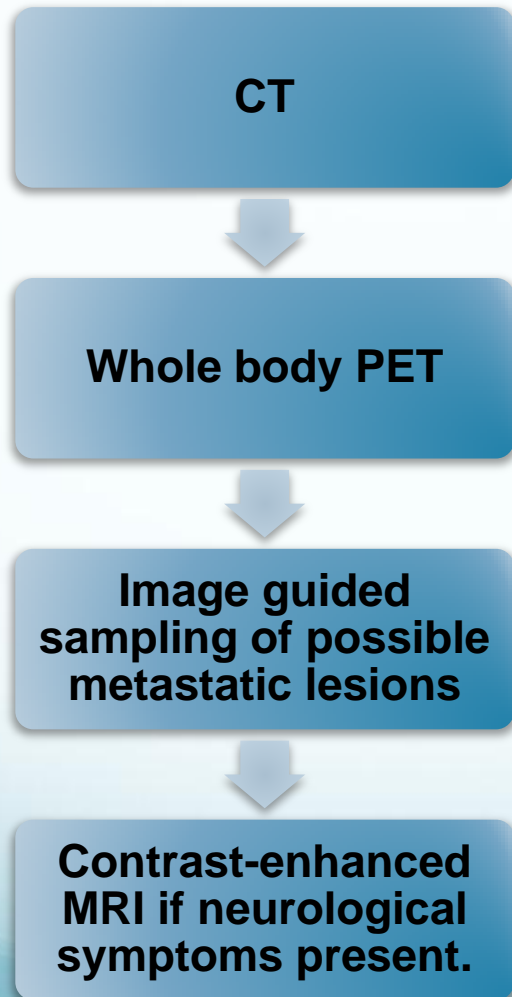


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Definitive Diagnosis and Staging of Lung Cancer

Definitive Diagnosis and Staging of Lung Cancer



- This schematic shows the general progression of imaging tests during the diagnosis and staging of lung cancer.

Image Guided Tissue Sampling

- Image-guided percutaneous needle aspiration or biopsy
- Endobronchial ultrasound (EBUS)-guided forceps biopsy
- Conventional flexible bronchoscopy with forceps biopsy, blind transbronchial fine needle aspiration (TBNA), or both
- Electromagnetic navigational bronchoscopy (ENB)-guided forceps biopsy

Our Patient: Diagnosis

Our patient had a trans-bronchial biopsy which revealed a Non-small cell Adenocarcinoma

Whole Body PET Scan

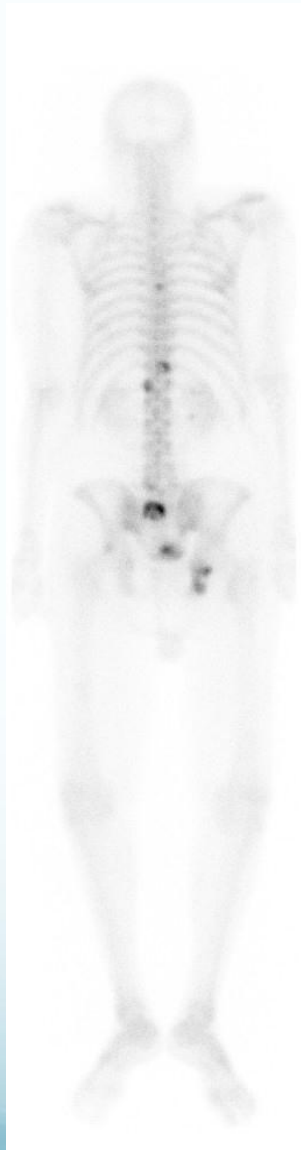
- A Fluorodeoxyglucose (FDG) tracer which binds to blood glucose is typically used.
- Qualitative and semi-quantitative interpretations may be used.
- Standardized Uptake Ratio (SUR), is used for a semi-qualitative interpretation

$$\text{SUR} = \frac{\text{mean ROI activity (MBq/mL)}}{\text{injected dose (MBq)/body weight (g)}}$$

benign lesions: mean SUR of 2.0; malignant regions: mean SUR of 5.9

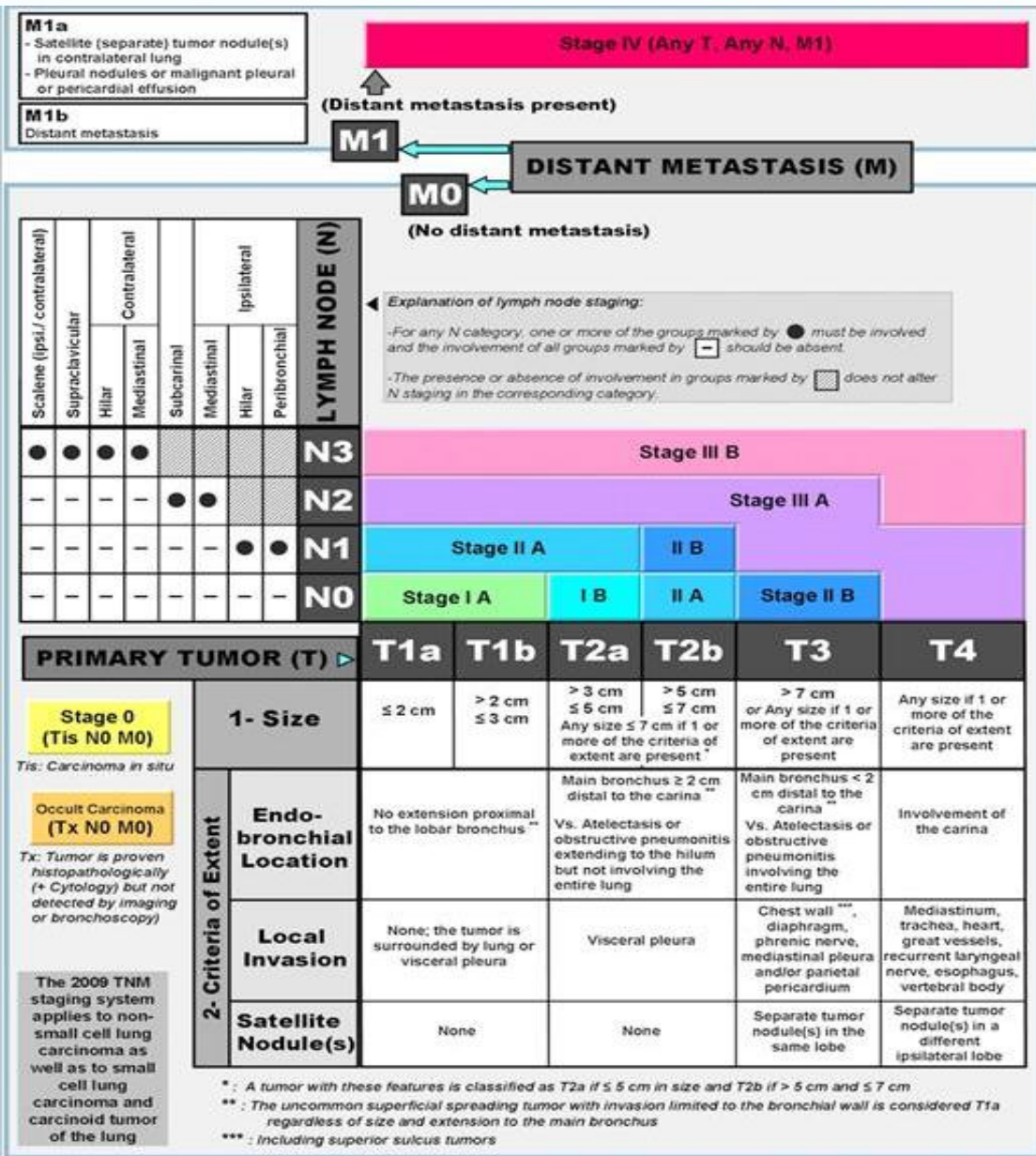
- Sensitivity of 92% and specificity of 90% for detection using a SUR cutoff of 2.5
- Sensitivity of with 98% and a specificity of 69% for detection using visual analysis (qualitative analysis).
- The whole body PET Scan is excellent for detecting adrenal, bone, liver metastases.

Our Patient: Whole Body PET Scan



- To the right is our patient's whole body PET Scan which revealed metastatic lesions in his thoracic spine, pubic symphysis and femoral head.

TNM Staging System



•To the left is a chart showing the general classification criteria for Lung Cancer staging.

•Given our patient's distant metastases he was diagnosed with Stage IV disease.

Post-Treatment Radiologic Follow Up

- No absolute guidelines on the frequency of surveillance post intervention
- Lack of demonstrated survival benefit with detecting asymptomatic recurrence
- Imaging needs depend on the ordering specialty: radiation oncologists vs. medical oncologists vs. thoracic surgeons
- **CT every four to six months for the first two years and then annually thereafter.**
- **PET may be useful in identifying if new lesions are in fact metastatic**

Our Patient: Follow Up

Mr. AB received whole brain chemotherapy for the metastases to his brain. He was well for several months after treatment but started to decline.

Mr. AB and his family opted for hospice care rather than further palliative chemotherapy

Summary of Topics Covered

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Acknowledgements

Claire Odom

Dr. Agarwal

Dr. Lieberman

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