From Presentation Through Staging:

*Primary Lung Carcinoma*

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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
  o Shapes and margins
  o Cavitations
  o 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

In what lobe is the mass situated?

With the lateral view we now confirm that this is an intrathoracic lung mass.
Anatomy Review: Right Lobes on Lateral Chest X-Ray

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 the 6th rib anteriorly.

http://www.anatomy.yalemedicine.org/VisibleHumanLessonPlans/Session3Lung.htm
Anatomy Review: Right Upper Lobe

- 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.

Photo from "Lung Anatomy" www.wikiradiography.com

http://www.anatomy.yalemedicine.org/VisibleHumanLessonPlans/Session3Lung.htm
Anatomy Review:
Right Middle Lobe

• 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

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

Photo from “Lung Anatomy” www.wikiradiography.com

http://www.anatomy.yalemedicine.org/VisibleHumanLessonPlans/Session3Lung.htm
Anatomy Review: Left Upper Lobe on Lateral Chest X-Ray

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

Photos from “Lung Anatomy” www.wikiradiography.com

http://www.anatomy.yalemedicine.org/VisibleHumanLessonPlans/Session3Lung.htm
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, harmatoma

- **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


Our patient had a CT scan which revealed that his lung nodule was a cavitary mass.
Our Patient: Cavitary Mass on Axial CT
Our Patient: Cavitary Mass on Coronal CT
Our Patient: Additional Peripheral Nodule on Axial CT
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

Bartlett et al. “Lung Abscess” www.uptodate.com
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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

Dumbell 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

Klein J. S and Braff S. Contemporary Chest Imaging 2008
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**

[Image of popcorn calcification in chest CT scan]

Brant and Helms  Fundamentals of Diagnostic Radiology Lippincott Williams and Wilkins 2012
Patterns of Benign Calcifications

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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.

Coleman, ER  PET in Lung Cancer J Nucl Med May 1, 1999 vol. 40 no. 5 814-820
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.
• 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

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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References

Ahn et al. Perifissural Nodules Seen at CT Screening for Lung Cancer Radiology 2010; 3: 949-956

American College of Radiology “Radiographically Detected Solitary Pulmonary Nodule” ACR Appropriateness Criteria 2012

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


References


