Imaging Non-small Cell Lung Cancer and Emphysema

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Agenda

- Patient presentation
- Menu of tests for primary and metastatic lung cancer
- Radiologic characteristics of lung cancer
- Staging of NSCLC
- Menu of tests for emphysema
- Radiologic characteristics of emphysema
Patient 1: History

- 56 yo male with a 70 pack-year smoking history

- Starting 1 months ago:
  - Dyspnea and hoarseness on exertion
  - Dysphagia regarding liquids and solids, decreased appetite, 15 lb weight loss
  - Chest pain
  - Mild fatigue

- Denies night sweats, fevers, chills, and frank hemoptysis

- PMH: COPD, GERD
Patient 1: Physical Exam

- Family Hx: Father died of lung cancer
- Social Hx: Denies exposure to asbestos
- Physical Exam:
  - Temp 99.7/97.5  BP 111/77  Pulse 63  RR 20  O2Sat 96%RA
  - GEN: Thin, pleasant male NAD
  - HEENT: Dry mucous membranes, single firm <1cm lymph node on left post cervical chain
  - PULM: Inspiratory stridor, coarse expiratory rhonchi on the right
Differential Diagnoses

- Malignancy
- HEENT: benign vocal cord lesions
- Neuro: nerve dysfunction
- Cardiac: aortic aneurysm
- Pulm: exacerbation of COPD, pneumonia
- GI: achalasia, peptic stricture, complications of GERD, esophagitis
- Inflammatory: scleroderma, Sjogren's
Menu of Tests

- CXR
- CT with contrast
- PET
- PET/CT
- Bone Scan
- MRI
Normal Chest Anatomy

Lymph nodes live here:
1. Right paratracheal stripe (RPTS)
2. Hila
3. AP window
4. AE line
5. Fat Pads

PACS, BIDMC
PA Frontal Upright CXR
Patient 1: CXR Images

1. Aortic knob and trachea shifted leftwards
2. Narrowed trachea
3. Mass in the right paratracheal stripe

1. Anterior mediastinal mass
Menu of Tests: CT

- CT with contrast of the chest
  - IV contrast helps to distinguish vascular structures from mediastinal structures and lesions
  - Assess the primary tumor size, location
  - Assess for potential vascular involvement and potential lymph node involvement
  - Assess for mets in the thoracic cavity: nerves, lung parenchyma, pleura, ribs, diaphragm
  - Assess for atelectasis or obstructive pneumonia

- CT of abdomen (liver, adrenals) and pelvis to assess for metastatic disease
Patient 1: Findings on Coronal CT Image

- Large mass abutting right border of the trachea, with possible invasion at the blue diamond mark
- Smaller mass in the right hilar region
- Left-ward deviation of the trachea
Pt 1: Tracheal Infiltration on CT

- Large mass abutting right border of the trachea, with eccentric calcification
- Blue diamond indicates invasion into trachea
- Trachea and esophagus shifted leftwards, due to mass effect \( \rightarrow \) manifesting as dyspnea and dysphagia
DDx, revised

- Centrally located lung cancer: small cell lung cancer, squamous cell lung cancer
- Lymphoma

Biopsy reveals: Squamous Cell Carcinoma
Squamous Cell Lung Cancer

- Chronic insult (usually smoking)
- **Metaplasia** of the normal bronchial columnar epithelial cells to squamous cells
- **Centrally located**, in relatively large or proximal airways
- May cause airway obstruction, leading to distal atelectasis or pneumonia
- May cavitate
- Usually spread to neighboring pulmonary parenchyma, mediastinum or into lymphatics
Q: Now that we know the patient has squamous cell lung cancer, how do we decide what treatment options to offer?

A: Use the TNM system to stage the tumor!
TNM Staging of NSCLC: T

- **Primary Tumor (T)**
  - **T1** = tumor ≤ 3 cm AND no evidence of invasion
  - **T2** = 3 cm< tumor ≤ 7 cm OR invades a mainstem bronchus, visceral pleura OR associated with atelectasis/obstructive pneumonitis
  - **T3** = tumor > 7cm OR invasion of chest wall, diaphragm, phrenic nerve, parietal pericardium OR separate tumor nodule(s) in same lung lobe
  - **T4** = tumor of any size that invades mediastinum, heart, great vessels, trachea, recurrent laryngeal nerve, esophagus, vertebral body, or carina
TMN Staging of NSCLC: N

- **Regional Lymph Node Involvement (N)**
  - N0 = no involvement
  - N1 = ipsilateral intrapulmonary, peribronchial, hilar lymph nodes
  - N2 = ipsilateral mediastinal or subcarinal lymph nodes
  - N3 = contralateral mediastinal or hilar lymph nodes

- **Metastasis (M)**
  - M0 = no mets
  - M1a = malignant pleural effusion, pericardial effusion, pleural nodules, or mets in contralateral lung
  - M1b = distal mets
Staging of Patient’s NSCLC: T, N

**T**: Primary tumor size around 5.2 to 5.6 cm with invasion of trachea = T4

**N**: Ipsilateral hilar lymph node involvement = N1

1. Right-sided mass
2. Invasion and leftward shift of trachea
3. Right hilar lymph node involvement
Staging of Patient’s NSCLC: M

M: No metastases found in abdomen, pelvis or brain = M0
## Patient 1: Stage IIIA NSCLC

<table>
<thead>
<tr>
<th>Stage IA</th>
<th>T1a – T1b</th>
<th>N0</th>
<th>M0</th>
<th>Resectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage IB</td>
<td>T2a</td>
<td>N0</td>
<td>M0</td>
<td>Resectable</td>
</tr>
<tr>
<td>Stage IIA</td>
<td>T1a, T1b, T2a, T2b</td>
<td>N1, N0</td>
<td>M0, M0</td>
<td>Resectable</td>
</tr>
<tr>
<td>Stage IIB</td>
<td>T2b, T3</td>
<td>N1, N0</td>
<td>M0, M0</td>
<td>Resectable</td>
</tr>
<tr>
<td>Stage IIIA</td>
<td>T1a, T1b, T2a, T2b, T3, T4</td>
<td>N2, N1, N2, N0, N1</td>
<td>M0, M0</td>
<td>Complicated, but generally if no mediastinal LN = clinical stage I/II and resectable</td>
</tr>
<tr>
<td>Stage IIIB</td>
<td>T4, Any T</td>
<td>N2, N3</td>
<td>M0, M0</td>
<td>*same as above</td>
</tr>
<tr>
<td>Stage IV</td>
<td>Any T</td>
<td>Any N</td>
<td>M1a or M1b</td>
<td>Chemotherapy Resection of met Palliative care</td>
</tr>
</tbody>
</table>
Menu of Tests

✓ CXR
✓ CT with contrast

PET
PET/CT
Bone Scan
MRI
Menu of Tests: PET

- **PET** – injection of radio-isotope bound to FDG, 18-fluoro-2-deoxyglucose

  **Pros:**
  - Malignant lesions vs. benign lesions
  - Better at detecting lymph node involvement
  - Picks up adrenal or liver mets missed on CT

  **Cons:**
  - Insufficient details of images (however, can be overlaid on CT for better visualization)
  - Not suitable for brain imaging
  - False positives are common
Patient 2: SCC on PET

- Black arrow: Lymph node
- Magenta: Primary tumor

* 3 liver mets seen on PET and not on CT


A: Axial view, CT-
B & C: PET

A: Axial view, CT-
B: PET
Patient 3: Adrenal met on PET/CT

Axial view, PET/CT

Menu of Tests: Bone Scan

- **Bone scan** – image if there is clinical suspicion of bone metastases
  - **Pros**
    - Faster than PET
    - Less likely to have false negative results from osteoblastic lesions as compared to PET
  - **Cons**
    - PET can identify mets in bones and visceral organs
    - Sometimes, bone mets can also be seen on CXR – so no bone scan would be needed
Patient 4: Superior Sulcus Tumor on MRI

- MRI with and without contrast
  - Better visualization of soft tissue mets
  - #1 for imaging of brain lesions
  - No allergic reactions to gadolinium


T = trachea, V = vertebral body
Arrowheads = neurovertebral foramen
Arrow = left subclavian artery
SST = superior sulcus tumor
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Q: Recall Patient 1 has a past medical history of COPD. Did you notice the classic findings of emphysema on his CXR?
COPD

- COPD – airway disease
  - Emphysema – dilation and destruction of air spaces distal to the terminal bronchiole
    - Smoking – inflammation of airways and alveolar walls usually caused by increased mucus production and decreased ciliary clearance
  - Genetics (α₁-antitrypsin deficiency), air pollution, infection
  - Chronic bronchitis – productive cough for 3 consecutive months for not less than 2 successive years
Smoking: Centrilobular Emphysema

- Centrilobular areas of non-uniform, decreased attenuation
- Located in upper lung zones

Gross specimen and schematic

Hansell D M et al. Radiology 2008;246:697-722
Axial view, CT-
\( \alpha_1 \)-antitrypsin deficiency:
Panacinar Emphysema

- Generalized, usually uniform decrease of the lung parenchyma
- Decreased caliber of blood vessels
- Located in lower lung zones
Paraseptal Emphysema

- Involves distal alveoli and their ducts and sacs
- Bounded by pleura and interlobular septa
- Sometimes associated with bullae

Hansell D M et al. Radiology 2008;246:697-722
Axial view, CT-
Emphysema: Menu of Tests

- CXR
- CT without contrast
Patient 1: Emphysema on CXR

- Prominent lung markings, probably related to coexistent centrilobular emphysema
- Hyperinflated lungs
- Low and flat diaphragm
Patient 1: Emphysema on CT

- Non-uniform loss of attenuation in upper lung lobes, correlating with centrolobular emphysema

- Loss of attenuation in lung parenchyma, bordered by pleura and interlobular septa → paraseptal emphysema
Summary

- Menu of tests for lung cancer
  - Primarily: CXR, CT with contrast
    - Check the areas that lymph nodes live in
    - Check for shift/compression of mediastinal structures
  - Also: PET (mets), PET/CT (mets), MRI (soft tissue mets and brain)
  - Imaging is very helpful for staging of cancer
Summary

▶ Menu of tests for emphysema

▶ CXR
  ▶ Low and flat diaphragms
  ▶ Increased or decreased lung vascular markings

▶ CT
  ▶ Centrilobular: non-uniform low attenuation in upper lobes
  ▶ Panacinar: uniform, low attenuation in lower lobes
  ▶ Parasepta: low attenuation areas bounded by pleura and interlobular septa
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References