Positron Emission Tomography in Lung Cancer

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Patient DD

- 53 y/o gentleman presented with worsening dyspnea on exertion for the past two months
- 30 pack-year smoking Hx and no significant past medical Hx
- Initially had flu like symptoms but never fully resolved
- + cough, fever, fatigue (2 months) and night sweats (1 year)
- - hemoptysis, chest pain, weight changes
- PA and Left lateral CXRs were obtained
Air/fluid level
Chest CT

RUL

air
fluid
mass

MGH PACS

? mass vs hernia
Clinical Course

- Chest tube-large empyema
- Bronchoscopy/biopsy-large soft tissue mass occluding right bronchus intermedius, preliminary path is SCLC.

- Cancer staging
  - CT- 7.5 X 10.5cm soft tissue mass in the right hilar region. Soft tissue mass in the left posterior mediastinum which may be contiguous with the stomach. 2.1 X 1.5 left adrenal nodule.
  - Head MRI-no mets
  - Bone scan- no bone mets
  - PET for staging as well as assessing left hilar mass and adrenal nodule. Results showed a large right lung mass and left retrocardiac mass, right hilar lymph node mets and 2 left adrenal increased uptake.
PET

MGH PACS

Heart

? Adrenal met

tumor

tumor
Our patient

- Final pathology: small cell lung cancer.
- Stage: extensive.
- Treatment:
  - Systemic chemotherapy
  - Radiation therapy to open occluded right bronchus intermedius
- PET imaging was unnecessary in this case
- Question: when is PET indicated in evaluating lung cancer and how is it used?
Positron Emission Tomography

- **Physics**
  - $\ e^+ + e^- \rightarrow \gamma + \gamma$
  - Photons (511 keV) leave the annihilation site in opposite direction
  - Simultaneous detection of the photons allow localization of annihilation location
  - Common positron emitters: $^{11}$C, $^{15}$O, $^{13}$N and $^{18}$F.

- **Type of detectors**
  - PET-several thousand ring detectors, more signal, better resolution
  - SPECT-retrofitter with coincidence detectors, cheaper
  - PET/CT-more accurate location of cancer
PET

- Physiology for imaging of cancers
  - Cancer cells have high metabolism, and rich in hexokinases.
  - Most commonly used molecule for cancer imaging is FDG (2-$^{18}$F-2-deoxy-D-glucose)
  - FDG is phosphorylated in the cell. It cannot be degraded nor can be excreted quickly after phosphorylation.
  - FDG labels cells with high metabolism-cancers
PET

- Patient preparation
  - Fasting for at least 4 hours
- Physiologic positives: brain, myocardium, urinary system, recently exercised muscle.
- False positives: Inflammation and benign neoplasms.
- False negatives: slow growing tumors-bronchoalveolar carcinoma, carcinoids, prostate cancer, etc.
- PET is approved for imaging of lung, thyroid, lymphoma, colon and melanoma cancers.
- PET is not indicated in SCLC (staging is only based on size) and slow growing tumors (low signal) such as bronchoalveolar carcinoma.
Indications for PET in lung cancer

- Diagnosis: malignant vs. benign. Especially in the evaluation of solitary pulmonary nodules (SPN)
- Cancer staging
- Post-therapy evaluation and recurrence assessment
130,000 new SPN/year.

- Majority of SPN are indeterminate by radiographic and CT criteria.
- Lowe et al reported PET has 92% sensitivity and 90% specificity for 0.7cm-4.0cm nodule. Radiology 202(2):435-439, 1997
- Gould et al reported PET has 96.8% sensitivity and 77.8% specificity. JAMA 285(7):914-924, 2001
- Standardized uptake value SUV>2.5 is considered malignant.
- Common false positives are granulomas.
Cancer Staging

- **NSCLC**
- Most accurate, noninvasive method for staging extracranial metastases.
- Marom et al compared PET vs CT, bone scan and MRI:
  - Overall staging: PET 83%, conventional 65%.
  - Mediastinal lymph nodes: PET 85%, conventional 58%.
  - Bone mets: PET-sensitivity 92%, specificity 99%, PPV 92%, NPV 99%; bone scan -50%, 92%, 50% and 92% respectively.

Radiology 212(3):803-809, 1999
Bury et al reported PET: 100% sensitivity, 92% specificity, 92% positive predictive value, 100% negative predictive value and 96% diagnostic accuracy; CT: 72%, 95%, 93%, 79%, and 84% respectively. Eur Respir J 14(6):1376-1380. 1999
PET is a powerful noninvasive diagnostic tool in lung cancer imaging. It is indicated in evaluation of SPN, staging of NSCLC, and in evaluating treatment effects. It is not indicated in SCLC, and bronchoalveolar cancer. Bone mets should be evaluated with PET, not bone scan in lung cancer.
References

Acknowledgements

- Kevin Donohoe, MD
- Daniel Cornfeld, MD
- Gillian Lieberman, MD
- Pamela Lepkowski
- Larry Barbaras and Cara Lyn D’amour