Imaging of Solid Solitary Nodules
Santiago E. Rossi, MD

Solitary Pulmonary Nodule Introduction
- Over 150,000 SPN/year
- 30-50% malignant
- 20-30% non-small cell lung carcinomas
- Multiple imaging techniques$strategies

Solitary Pulmonary Nodule Conventional Evaluation
- Morphology
  Size, margin, cavitation, nodule attenuation
- Clinical Evaluation
  Age, smoking history, symptoms
- Growth

CT Evaluation of SPN
- Calcifications
central, diffuse, laminated, popcorn
- Margin
  smooth vs. spiculated
- Cavity wall thickness
  <4mm vs. >16mm
- Nodule Attenuation

Calcification Patterns

- CT Evaluation of SPN
  • Calcifications
central, diffuse, laminated, popcorn
  • Margin
    smooth vs. spiculated
  • Cavity wall thickness
    <4mm vs. >16mm
  • Nodule Attenuation
Benign Calcification

- Central, Diffuse, Laminated

Calcification: Eccentric

CT Evaluation of SPN
- Calcifications: central, diffuse, laminated, popcorn
- Margin: smooth vs. spiculated
- Cavity wall thickness: <4mm vs. >16mm
- Nodule Attenuation

Margins
- Smooth, Lobular, Spiculated
CT Evaluation of SPN

- Calcifications
  central, diffuse, laminated, popcorn
- Margin
  smooth vs. spiculated
- Cavity wall thickness
  <4mm vs. >16mm
- Nodule Attenuation

Cavitation: Wall Thickness

- <4 mm: 93% benign
- >16 mm: 97% malignant
- 5 - 15 mm: 50% benign, 50% malignant

Arteriovenous Malformation

Image of a chest with a yellow arrow pointing to a vessel, indicating an arteriovenous malformation.
Solitary Pulmonary Nodule
Conventional Evaluation

- Morphology
  Size, margin, cavitation, nodule attenuation
- Clinical Evaluation
  Age, smoking history, symptoms
- Growth

Cavitary Pulmonary Infarction

SPN: Central Calcification

Metastatic Chondrosarcoma
Reverse Halo Sign

Lung Cancer: Radiofrequency Ablation

Pulmonary Infarction (PE)

Solitary Pulmonary Nodule

Conventional Evaluation

- Morphology
  Size, margin, cavitation, nodule attenuation
- Clinical Evaluation
  Age, smoking history, symptoms
- Growth
Solitary Pulmonary Nodules

• Compare to old films
Growth rate: doubling in volume equals an increase in nodule diameter of 25%

SPN: Growth

28 days later

67 yo man with emphysema

8 months later

Evaluation of SPN

• PET vs. Biopsy
• CT Nodule Enhancement
• Serial CT
  3, 6, 12, and 24 months

FDG-PET
PET negative: Adenocarcinoma (BAC)

PET negative: Carcinoid

PET negative: Carcinoid

SUV 9

77 yo man esophageal CA with chemo-XRT
Cryptococcal Infection

Solitary Pulmonary Nodule
Clinical Prediction Model & PET

Patient age
Smoking history
Time since quitting smoking
Nodule size (mean 15mm, <7mm unsuitable)

Gould, MK Chest 2007;131:383-388

77 yo man esophageal CA with chemo-XRT

Solitary Pulmonary Nodule
Clinical Prediction Model & PET

SPN PET negative
Pre-test probability of malignancy
- Post-test probability
  Decision in patient management

Gould, MK Chest 2007;131:383-388

Pre-test probability low (20%)
PET negative
Post-test probability < 2%
Follow-up

Gould, MK Chest 2007;131:383-388
**Solitary Pulmonary Nodule**

Clinical Prediction Model & PET

- Pre-test probability high (65%)
- PET negative
- Post-test probability >10%
- Needle biopsy or VATS

Gould, MK Chest 2007;131:383-388

---

**68 yo woman with left pneumonectomy for sarcoma**

---

**Evaluation of SPN**

- PET vs. Biopsy
- CT Nodule Enhancement
- Serial CT
  3, 6, 12, and 24 months

---

**Adenocarcinoma**

SUV 1.4

---

**Adenocarcinoma**

---

**CT Enhancement**

- Morphologic Limitations
  Nodule size > 5mm, Spherical, Homogeneous Attenuation (no fat, calc, cavitation, necrosis)
- Technique
  Thin collimation
  100 cc (300 mg I/cc) @ 2-3 cc/sec
  Serial scan q 30 sec x 5 min
CT Enhancement

- Interpretation
  - < 15 HU = benign
  - 16 - 24 HU = indeterminate
  - > 25 HU = probably malignant

- Accuracy (20 HU threshold)
  - 98% sensitivity for malignancy

Evaluation of SPN

- PET vs. Biopsy
- Contrast CT: Nodule Enhancement
- Serial CT
  - 3, 6, 12, and 24 months

Fleischner Society Recommendations

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>Low Risk Patient</th>
<th>High Risk Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 4 mm</td>
<td>No F/U</td>
<td>12 months *</td>
</tr>
<tr>
<td>5, 6 mm</td>
<td>12 months *</td>
<td>6 – 12 months</td>
</tr>
<tr>
<td>7, 8 mm</td>
<td>6 – 12 months</td>
<td>3 – 6 months</td>
</tr>
<tr>
<td>&gt; 8 mm</td>
<td>3, 9, 24 months</td>
<td>3, 9, 24 months</td>
</tr>
<tr>
<td></td>
<td>CT+, PET/CT, Bx</td>
<td>CT+, PET/CT, Bx</td>
</tr>
</tbody>
</table>

Fleischner Society Recommendations

Do Not Apply

- History of malignancy
- Young patients < 35 years old
- Febrile patients (infection)

Imaging of SPN: Summary

- Stratifying patients’ risk factors for malignancy is essential in the management of SPN
- Obtain prior films for comparison to assess growth
- Management strategies include PET, biopsy, CT enhancement and serial F/U
- Exception to guidelines for F/U is the subsolid lesion