Overview of Subsolid Nodules

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CT Morphologic Classification

- **Solid nodule:**
  - Nodular 1 lung attenuation that obscures the pulmonary vessels
- **Subsolid nodule (SSN):**
  - **Ground-glass nodule (GGN)**
    - Nodular 1 lung attenuation that does not obscure the pulmonary vessels
  - **Part-solid nodule (PSN)**
    - Mixed solid/ground-glass nodule
- **Evaluation of SSNs requires thin section images (<2.5 mm) to assess presence and % of solid vs. GG components**

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Lung Cancer Screening

- **Early Lung Cancer Action Project (ELCAP):**
  - CT scans + for nodules → 19% SSNs
  - 34% of SSNs were malignant vs. 7% of SNs
  - PSN: 63% malignant
  - GGN: 18% malignant

Adenocarcinoma: CT-Path Correlations

<table>
<thead>
<tr>
<th>Noguchi</th>
<th>WHO 2004</th>
<th>AASLC/ATS/ERS 2011</th>
<th>CT Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Localized BAC</td>
<td>AAH</td>
<td>AAH</td>
<td>GGN</td>
</tr>
<tr>
<td>B: Localized BAC with alveolar collapse</td>
<td>BAC</td>
<td>AIS</td>
<td>GGN (possible solid component)</td>
</tr>
<tr>
<td>C: Localized BAC with intrafibroal fraction</td>
<td>Adenocarcinoma mixed subtype (with BAC pattern)</td>
<td>MIA</td>
<td>GGN/PSN</td>
</tr>
<tr>
<td>D: Poorly differentiated ( \text{E} ): Tubular / ( \text{F} ): Papillary tumor</td>
<td>Adenocarcinoma mixed subtype</td>
<td>Invasive adenocarcinoma, classified by the predominant subtype</td>
<td>SN or PSN with solid component</td>
</tr>
</tbody>
</table>

Atypical Adenomatous Hyperplasia

- **Considered precursor to adenocarcinoma**
- **Proliferation type II pneumocyte or Clara cell-like cells w/ mild to moderate cellular atypia**
- **GGN usually ≤ 5 mm**

Spectrum of pulmonary adenocarcinoma

Henschke CI et al. AJR 2002;178:1053-7

Adenocarcinoma: CT-Path Correlations

Noguchi et al, Cancer 1996

Aoki et al, AJR 2000

Atypical Adenomatous Hyperplasia

Adenocarcinoma in situ (AIS) → Formerly bronchioloalveolar cell carcinoma (BAC)

- Preinvasive lesion ≤ 3 cm
- Pure lepidic growth
- No stromal, vascular, lymphatic or pleural invasion
- Noguchi type A and B
- Need complete histologic sampling for diagnosis
- Nonmucinous (most often), mucinous or mixed

Travis WD et al. J Thorac Oncol. 2011;6:244-85

Adenocarcinoma in situ (AIS) → Formerly bronchioloalveolar cell carcinoma (BAC)

- Nonmucinous: → GGN
  → Possible solid component due to alveolar collapse

Travis WD et al. J Thorac Oncol. 2011;6:244-85

Minimally invasive adenoca (MIA)

- Lepidic predominant tumor (≤ 3 cm)
- ≤ 5 mm stromal invasion
- No lymphatic, vascular or pleural invasion
- Near 100% disease-specific survival
- Need complete histologic sampling for diagnosis


Lepidic Predominant Adenoca (LPA)
→ Formerly adenoca-mixed subtype w/ nonmucinous BAC

- Lepidic predominant tumor
- > 5 mm stromal invasion
- Lymphatic, vascular or pleural invasion
- PSN or Solid (rarely GGO)

Travis WD et al. J Thorac Oncol. 2011;6:244-85

Invasive Mucinous Adenoca
→ Formerly adenoca-mixed subtype w/ mucinous BAC

- Solid or PSN (predominantly solid)
- Consolidation

Travis WD et al. J Thorac Oncol. 2011;6:244-85
Subsolid Nodules: Differential Diagnosis

- Adenocarcinoma spectrum:
  - AAH
  - AIS
  - MIA
  - LPA

- Benign etiology
  - Infection
  - Focal fibrosis/scarring
  - Focal inflammation: OP, EP or NSIP

Retrospective study with 53 GGNs in 49 patients:
- 75% BAC or adenocarc with predominant BAC
- 6% AAH
- 19% Nonspecific OP/fibrosis

No significant morphologic Δ between benign and malignant GGNs
Kim HY et al. Radiology 2007;245:267-75

GGOs in patients with known extrapulmonary cancer:
- High malignancy rate (68%)
- Often primary lung cancers and not metastases
Park CM et al. Chest 2008;133:1402-9

CT Progression of Peripheral Adenocarcinoma

- 48 adenoc (Noguchi A-C) followed for a mean interval of 450 days (range: 85 – 951 days)
- Results: Lesions recognized 1st as GGO’s (50%) subsequently ↑ in size (75%), with solid components appearing (17%) and then subsequently increasing in extent (23%).
- Conclusion: Step wise progression Noguchi A-C can be identified on CT
Takashima S. AJR 2003
CT Progression of Peripheral Adenoca

Prognostic Value of the Extent Lepidic Growth in Peripheral Adenoca

- % GGO correlates well with extent of lepidic growth
- 104 adenocarcinomas < 2 cm
- Adenoca - pure GGN and PSN w/ > 50% GGO component → no nodal metastases or postoperative recurrences


Growth Rates: Small Lung Cancers

- Low-dose CT screening – 3 years
- 61 of 82 cancers AVG VDT: 52-1733 days
  - GGN = 813 days
  - PSN = 457 days
  - Solid =149 days

→ For subsolid nodules stability over 2 years does NOT indicate benign etiology

Hasegawa M. Br J Radiology 2000;73:1252-59

Management of Subsolid Nodules

Consensus regarding optimal time and duration of FU

- No differentiation between high risk and low risk patients as in Fleischner Society Guidelines for SNs → Higher risk of adenoca in younger and nonsmoking individuals
- Guidelines need to be interpreted in the light of individual clinical history

Godoy MC and Naidich DP. Radiology 2009;253:606--22

Management of Subsolid Nodules

- For solitary GGN < 5mm: No follow-up needed
- For isolated GGN > 5 mm: long term follow-up is required
  - Initial FU in 3 - 6 months
  - At least 3 - 5 yearly surveillance CT studies
  - TTNBx – potentially inaccurate and misleading (especially in GGNs < 10 mm)
  - PET/CT – unlikely to be of value

→ PET/CT – unlikely to be of value

Godoy MC and Naidich DP. Radiology 2009;253:606--22

Management of Subsolid Nodules

- For persistent isolated GGN > 5 mm:
  - Surgical resection should be considered if:
    - Increase in size or density
    - Development of solid component
Management of Subsolid Nodules

- For isolated PSN:
  - Initial FU in 3 - 6 months
  (up to 69.8% are transient → benign)
- Assume that isolated persistent PSNs are malignant:
  - Surgical resection should be considered
  - PET/CT may be helpful in staging

Lee et al. Radiology 2010;255:242
Godoy MC and Naidich DP. Radiology 2009;253:606-22

Management of Subsolid Nodules

- Multiple subsolid nodules
  - Initial FU in 3 - 6 months
  - Long-term FU
  - Surgical resection should be considered if dominant lesion:
    - GGN > 8 - 10 mm
    - Increase in size or development of solid component
    - PSN

Godoy MC and Naidich DP. Radiology 2009;253:606-22

Subsolid Nodules: Controversies

- Methods of nodule measurement
- Relationship between AAH, AIS, MIA and LPA: Is there invariably progression?
- Is there overdiagnosis?
- Role of limited resections vs lobectomy → GGO (< 2cm)
- Staging system

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Thank you!