Thoracic CT pattern in lung cancer: correlation of CT and pathologic diagnosis

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High-resolution CT findings of various lung cancers by histology

• Adenocarcinoma
  – Preinvasive lesions
  – Minimally invasive adenocarcinoma
  – Invasive adenocarcinoma
  – Variants of invasive adenocarcinoma

• Squamous cell carcinoma
  – Central type
  – Peripheral type

• Small cell carcinoma
IASLC/ATS/ERS classification of Lung Adenocarcinoma in Resected Specimens

• Preinvasive lesions
  – Atypical adenomatous hypereplasia: AAH
  – Adenocarcinoma in situ: AIS (≤3 cm formerly BAC)
    • Nonmucinous, and/or Mucinious

• Minimally invasive adenocarcinoma: MIA (≤3 cm lepidic predominant tumor with ≤5 mm invasion)

• Invasive adenocarcinoma
  – Lepidic predominant (formerly nonmucinious BAC pattern, with >5 mm invasion)
  – Acinar predominant,
  – papillary predominant,
  – Micropapillary predominant,
  – solid predominant with mucin production

• Variants of invasive adenocarcinoma
  – Invasive mucinous adenocarcinoma (formerly mucinous BAC)

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Atypical Adenomatous Hyperplasia (AAH)

A localized, small (usually 5 mm or less) proliferation of mildly to moderately atypical type II pneumocytes and/or Clara cells lining alveolar walls

Adenocarcinoma in situ (AIS)

A localized small (≤ 3cm) adenocarcinoma with growth restricted to neoplastic cells along preexisting alveolar structures (lepidic growth), lacking stromal, vascular, or pleural invasion. Septal widening with sclerosis is common.

Minimally Invasive Adenocarcinoma (MIA)

A small, solitary adenocarcinoma (≤ 3cm), with a predominantly lepidic pattern and ≤ 5mm invasion in the greatest dimension in any one focus.

Focal Ground Glass Nodules (GGNs)
Ground Glass Nodule (GGN): on HRCT scans

- Defined as a hazy increased opacity within a lung that does not obscure the underlying vessels.
- It shows preserved bronchial and vascular margins

Fleischner Society Glossary: Radiology 2008; 246:697-722
Ground Glass Nodules: on HRCT scans

- Caused by partial filling of the airspaces
- Interstitial thickening
- Partial collapse of the alveoli
- Increased capillary blood flow
- Or any combination of the above
- Common factor is partial displacement of air

Fleischner Society Glossary: Radiology 2008; 246:697-722
Pulmonary nodules

Nodules

Solid nodules

Subsolid nodules

Pure GGNs

Part-solid GGNs

GGNs = ground glass nodules
Subsolid Nodules ($\leq 3$ cm)

- Pure GGN
- Part-solid GGN
Preinvasive Lesions

AAH

AIS
Minimally Invasive Adenocarcinoma (MIA) (≤3 cm lepidic predominant tumor with ≤5mm invasion)
Minimally Invasive Adenocarcinoma
Survival for patients with ADC \( \leq 3 \) cm

![Graph showing cumulative survival over time for different categories of ADC size.](image)

- CF \( \leq 5 \) mm: N=21
- CF 5<\&\leq15 \text{ mm}: N=55
- CF >15 \text{ mm}: N=24

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Invasive adenocarcinoma

Lepidic predominant ADC

Papillary ADC

Micropapillary ADC

Acinar ADC

Solid ADC with mucin

Invasive adenocarcinoma

1. Spiculation
2. Convergence of bronchovascular bundles
3. Positive bronchus sign
4. Pulmonary vein involvement
5. Air bronchograms
6. Pleural indentations
7. Peripheral well-defined and lobulated ground-glass opacity
Lepidic predominant invasive adenocarcinoma
Histologic differences among normal lung, AIS, MIA, and invasive ADC

Normal lung

AIS

MIA

Invasive ADC

Slow evolution of pure GGN over 9 years

June 2004
4.3 mm
pure GGN

April 2008
8.3 mm
pure GGN

August 2011
12.5 mm
pure GGN

August 2013
18.0 mm
Part-solid GGN

New classification and HRCT findings

AAH  →  AIS  →  MIA  →  invasive adenocarcinoma

Pure GGN  →  Pure GGN  →  part-solid GGN
Part-solid GGN  →  Solid GGN
Which is lung cancer?
# Malignant vs Benign GGNs on HRCT

<table>
<thead>
<tr>
<th></th>
<th>Malignant GGNs</th>
<th>Benign GGNs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HRCT findings</strong></td>
<td>Rounded, lobulated</td>
<td>Polygonal, ill-defined margins</td>
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<tr>
<td></td>
<td>Well-defined margins</td>
<td></td>
</tr>
<tr>
<td><strong>Follow-up HRCT</strong></td>
<td>No regression</td>
<td>Regression</td>
</tr>
<tr>
<td><strong>FDG-PET</strong></td>
<td>Low sensitivity</td>
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Multiple pure GGNs: Multiple AAH/AIS

March 26, 1999

March 28, 2008

Variants of invasive adenocarcinoma
Invasive mucinous adenocarcinoma
Old inflammatory lesion?
Serial Chest Radiographs

97/1/27  01/5/1  05/4/28  08/5/16
Mildly increased FDG uptake in the right apical mass. Follow-up study is recommended.
HRCT

- Irregular shape with peripheral ground-glass opacity
- Many ectatic air bronchograms resembling **bubbles**
- Enhanced pleural tags

Adenocarcinoma, mixed subtype of papillary and bronchioloalveolar pattern pT1N2M0, stage 3A
Bubble like appearance on HRCT

Mean tumor volume doubling time was $1,363 \pm 1141$ days (range 382-2980 days)

Differential diagnosis for adenocarcinoma
Pulmonary cryptococcosis mimicking lung cancer

Squamous cell carcinoma (central type)
Obstructive pneumonia due to Squamous cell carcinoma
Squamous cell carcinoma (peripheral type)
Squamous cell carcinoma with cavity
Association of cavitation and survival

Squamous cell carcinoma resembling adenocarcinoma
Small cell carcinoma
Small cell carcinoma
Part-solid GGN (PET negative)
Serial HRCT

2009/2/12

2009/9/4

2011/2/3
Pit-fall sign

Survival of stage I NSCLC by pit-fall sign

Summary

• Persistent, well-defined and rounded GGNs strongly indicate lepidic growth adenocarcinoma

• HRCT findings of lung cancer reflect its histologic characteristics