Causes and Imaging Patterns Associated with Tree-in-Bud Opacities
Wallace T. Miller, Jr., MD

Causes and Imaging Patterns of Tree-in-Bud Opacities

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Conflicts of Interest

- Royalties
  - McGraw Hill
    - Diagnostic Thoracic Imaging
    - Diagnostic Abdominal Imaging
  - Wolters Kluwer
    - Field Guide to the Chest X-ray
  - DoRadiology
    - Thoracic Imaging: a Primer for Physicians
    - Thoracic Imaging: a Case Series

Objectives

- To learn the causes and relative frequencies of TIB
- To learn how patterns of TIB can narrow the differential diagnosis.

Causes and Imaging Patterns Associated with Tree-in-Bud Opacities

- All cases with TIB in 2010
  - 406 examinations
  - 3.0% (406/13,540) of all thoracic CTs
  - Causes established in 40.9% (166/406)

Jill Panosian MD

Causes of Tree-In-Bud Opacities

- Respiratory infections 72%
- Aspiration 25%
- DPAI 14%
- CF/PCD/ABPA
- Immune Def
- Other 7%
- Bronchiectasis a cause or contributor in 34%

Causes of Tree-In-Bud Opacities: Infections

<table>
<thead>
<tr>
<th>Mycobacteria</th>
<th>56%</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC</td>
<td>84%</td>
</tr>
<tr>
<td>M. Abscessus</td>
<td>9%</td>
</tr>
<tr>
<td>M. chelonae</td>
<td>4%</td>
</tr>
<tr>
<td>M. fortuitum</td>
<td>6%</td>
</tr>
<tr>
<td>M. kansasi</td>
<td>3%</td>
</tr>
<tr>
<td>M. massilense</td>
<td>1%</td>
</tr>
<tr>
<td>M. terrae</td>
<td>1%</td>
</tr>
<tr>
<td>M. Tuberculosis</td>
<td>1%</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Bacteria</th>
<th>40%</th>
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<tbody>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>53%</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>38%</td>
</tr>
<tr>
<td>Klebsiella pneumonia</td>
<td>6%</td>
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<td>Escherichia coli</td>
<td>4%</td>
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<tr>
<td>Monasella catarrhalis</td>
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<tr>
<td>Haemophilus influenza</td>
<td>4%</td>
</tr>
<tr>
<td>Enterobacter cloacae</td>
<td>2%</td>
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<tr>
<td>Acinetobacter baumannii</td>
<td>2%</td>
</tr>
<tr>
<td>Achromobacter pseudomallei</td>
<td>2%</td>
</tr>
<tr>
<td>Staphylococcus epidermis</td>
<td>2%</td>
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<tr>
<td>Stenotrophomonas maltophilia</td>
<td>2%</td>
</tr>
<tr>
<td>Burkholderia cepacia complex</td>
<td>2%</td>
</tr>
<tr>
<td>Bordetella bronchiseptica</td>
<td>2%</td>
</tr>
<tr>
<td>Staphylococcus epidermis</td>
<td>2%</td>
</tr>
<tr>
<td>Actinomyces israeli</td>
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* Some of the organisms exceed the total number of cases because some individuals had multiple organisms recovered.
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<td>RSV</td>
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</tr>
<tr>
<td>Parainfluenza</td>
<td>60%</td>
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<tr>
<td>Fungi</td>
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* Sums of the organisms exceed the total number of cases because some individuals had multiple organisms recovered.

# Causes of Tree-In-Bud Opacities: Aspiration

- 57% with a predisposing condition
  - Head and neck Ca / XRT
  - Esophagectomy
  - Achalasia
  - Altered MS
- 43% no predisposing condition
  - Detected by BA swallow

# Causes of Tree-In-Bud Opacities Bronchiectasis

- 39% NTMB
- 13% DPAI
  - CF/PCD/ABPA/Immune Def
- 8% Aspiration
- 41% Idiopathic
Causes of Tree-In-Bud Opacities

- BO/BOS
- Graft vs host disease
- BOOP
- Obstructing lesions
- Pulmonary lymphoma
- Folicular bronchiolitis

Patterns of Tree-In-Bud Opacities*

- Without bronchiectasis
  - Focal bronchiolitis: 25%
  - Widespread bronchiolitis: 14%
  - Bronchopneumonia: 23%
- With bronchiectasis
  - Random small airways disease: 21%
  - Widespread bronchiectasis: 6%
  - Apical bronchiectasis / cavitation: 2%

*All cases in 2010

Patterns: Focal Bronchiolitis

- Characteristics
  - Single small zone of TIB
  - Sometimes resolves / sometimes persists
  - Most common pattern seen (25%)
  - Least common with a proven diagnosis (9%) (p<.0001)
  - Frequently asymptomatic
  - In most cases

Patterns: Widespread Bronchiolitis

- Characteristics
  - Widespread TIB

- Non-specific pattern
  - All causes of TIB produce this pattern
    - Mycobacteria > bacteria > viruses
    - Aspiration > DPAI > miscellaneous

No respiratory symptoms. No diagnosis.

- 70 woman with RCC. R/O metastasis

Parainfluenza Bronchiolitis

- 54 man in methadone clinic complained of cough and fever
- 49 man with leukemia sp alloBMT with GVHD of liver. Now with fever and cough.
- 56 man with asthma and chronic cough.
- 30 woman with acute promyelocytic leukemia sp ATRA with neutropenia. Now with fever, cough and dyspnea.
- 79 woman with mantle cell lymphoma and fevers.
- 52 man with multiple myeloma now with fever & cough.

**Patterns: Bronchopneumonia**

- Characteristics
  - TIB with consolidation or GGO
  - Associated with
    - Bacterial infection – specificity 0.84
    - Aspiration – specificity 0.80

**Haemophilus Influenzae Bronchiolitis**

**MAC Bronchiolitis**

**Silent Aspiration proven by BA swallow**

**Pulmonary Lymphoma**

**Stenotrophomonas maltophilia Bronchopneumonia**
**Pseudomonas & E coli Bronchopneumonia**
Aspiration by BA Swallow

- 46 man sp lung transplant with cough dyspnea

**RSV Bronchopneumonia**

- 53 man with relapsed AML and neutropenic fever.

**Aspiration Pneumonia**

- 31 man with history of polysubstance abuse now with fever and cough after crack cocaine use

**Patterns: Random Small Airways**

- Characteristics
  - Multifocal zones of bronchiectasis / TiB
  - RML / lingula / post segment RUL
  - Superimposed on regions of normal lung

- Highly associated with
  - Atypical mycobacteria – specificity 0.94
  - MAC – specificity 0.92
  - Older (>50) women

**Moderate Primary MAC Infection**

- 60 woman with a chronic cough

**Mild Primary MAC Infection**

- 57 woman with cough, dyspnea and fever
Patterns: Widespread Bronchiectasis

- Characteristics
  - Nearly uniform distribution bronchiectasis across lungs with scattered TIB

- Associated with
  - DPAI – specificity 0.92
  - CF – upper lobe predominance
  - ABPA / dysmotile cilia / immunodef – lower lobe

Patterns: Apical Predominant Disease

- Characteristics
  - Apical Bronchiectasis
  - Cavitation
  - Dependent spread of TIB

- Associated with
  - TB
  - NTMB (MAC, M kansasii, M xenopi, etc)
  - Bacteria
50 man with involuntary weight loss and chronic sinusitis

64 woman with chronic productive cough and intermittent fever

63 man with COPD and recurrent fevers and dyspnea unresponsive to antibiotic therapy.

68 man with head and neck CA sp XRT with brain metastasis. No pulmonary symptoms

65 man with head and neck cancer and fever

Apical Predominant Disease: Tuberculosis

Apical Predominant Disease: M. Abscessus

Apical Predominant Disease: Bacterial Pneumonia

Patterns: Dependent Predominant Disease

Characteristics
- TIB / Bronchiectasis LL > RML-lingula > UL

Associated with
- Aspiration specificity 0.79
Aspiration with Dependent Predominant Bronchiectasis and TIB

- 73 man with achalasia cough and dyspnea

Causes of Tree-In-Bud Opacities

- Respiratory infections 72%
  - Mycobacteria = Bacteria > Viruses
- Aspiration 25%
  - Idiopathic
  - Mycobacteria
  - DPAI (CF, ABPA, PCD, Im def)
- Other 7%
  - BO / GVHD / BOOP / lymphoma

Trees-in-bud opacity

- No Bronchiectasis
- Bronchiectasis
  - Alternating diseased regions with normal lung
  - Diffuse bronchiectasis

- Consolidation or GGO

- Focal TIB
  - Widespread TIB
  - Random Small Airways Pattern
  - Broncho-pneumonia Pattern
  - Basilar distribution Eosinophils abnormal

- Clinically insignificant

- Everything

- Aspiration

- Bacteria

- Less often aspiration

- Less often mycobacteria

Mycobacteria = Bacteria > Viruses

Consolidation or GGO Pattern

- Alternating diseased regions with normal lung

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- Less often aspiration

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Other Clues

- Clinical presentation
- Sex
  - Primary MAC – elderly women
- Esophagus
  - Esophageal abnormality and TIB
    - 0.86 specificity for Aspiration
- Age

Age and Bronchiectasis

Under 40
- Cystic Fibrosis
- ABPA
- Dysmotile cilia
- Immunodeficiency
  - Common variable
  - Hyper IgE (Job’s)
  - X-linked Hypogamma

Over 50
- Mycobacteria
- TB
- MAC
- Aspiration
- Idiopathic
  - Young Children
  - Williams Campbell
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