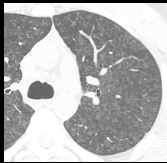


# Small Airways

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University of Wisconsin  
School of Medicine and Public Health

**CHESTRAD 2023**

A Case Review and Lecture Series  
Saturday 15<sup>th</sup> July - Sunday 16<sup>th</sup> July - Monday 17<sup>th</sup> July  
27 CPD Points

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## Introduction

- Numerous classification schemes
  - Histopathology
  - Clinical presentation
  - CT pattern
- Patients may present with acute respiratory illness or subacute or chronic disease

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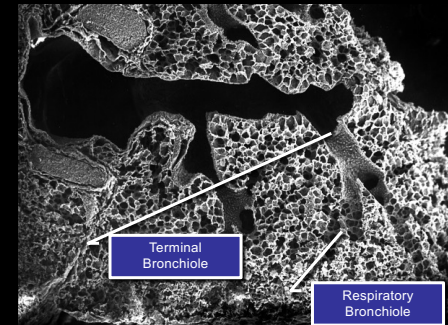
## Objectives

- Review anatomy of small airways
- Understand classification of small airways disease
- Illustrate HRCT findings of small airways disease

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## Small Airways

- Bronchioles
  - No cartilage
  - No glands
- Membranous
  - Lobular and terminal
  - Conducting
- Respiratory
  - Contain alveoli
  - Gas exchange



Lawrence Berkeley National Lab Image Library

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## Small Airways Disease

- Inflammatory
  - Cellular bronchiolitis
  - Follicular bronchiolitis
  - Respiratory bronchiolitis
  - Panbronchiolitis
- Fibrotic
  - Constrictive bronchiolitis
  - Neuroendocrine hyperplasia

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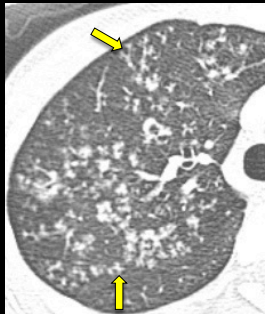
## Small Airways Disease

- CT pattern
  - Tree-in-bud opacities
  - Poorly-defined centrilobular nodules
  - Ground-glass opacity and consolidation
  - Mosaic attenuation
  - Lobular air trapping (expiratory CT)

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## Tree-in-Bud Opacities

- Branching centrilobular opacities
- V- and Y-shapes
- Reflect dilation and impaction of bronchioles
- Most commonly indicates infection



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## Ground-Glass Nodules

- “Smudgy”
- Centrilobular
- Can mimic diffuse ground-glass opacity



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## GGO and Consolidation

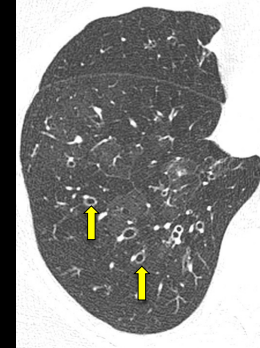
- Usual reflects component of bronchopneumonia
- Disease typically not limited to small airways



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## Mosaic Attenuation

- Patchwork of areas of increased and decreased attenuation
- Bronchial dilation clue to underlying small airways disease



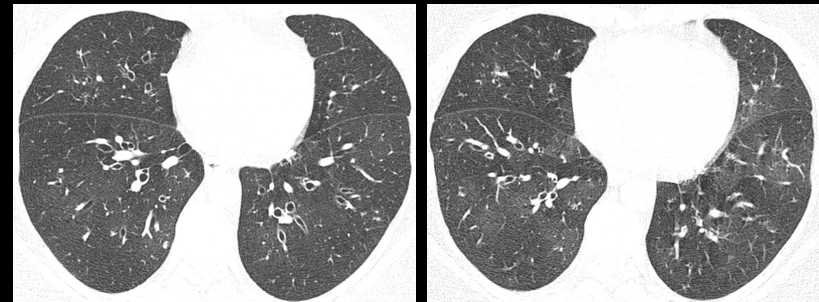
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## Air Trapping

- Normal lung *increases* in attenuation on expiration
- Areas of air trapping remain hypolucent

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## Air Trapping



Inspiratory

Expiratory

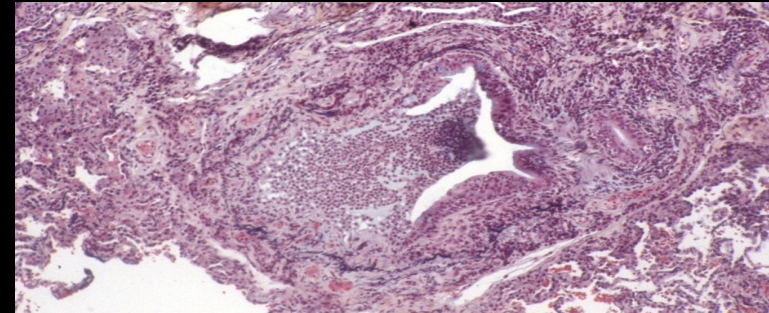
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## Cellular Bronchiolitis

- Inflammation in and around bronchioles
- Typically related to acute or chronic infection
- May result from aspiration

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## Cellular Bronchiolitis



Courtesy of David Lynch, MB (Denver, CO)

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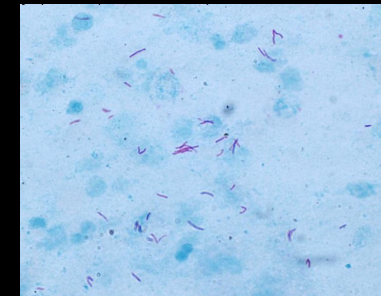
## Cellular Bronchiolitis

- CT
  - Centrilobular nodules
  - Tree-in-bud opacities
  - Diffuse or random distribution

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## Infectious Bronchiolitis

- Numerous organisms
  - Virus
  - Mycoplasma*
  - Chlamydia*
  - Mycobacteria*
  - Fungus (less common)



Handa U. et al. *J Infect Dev Ctries* 2012

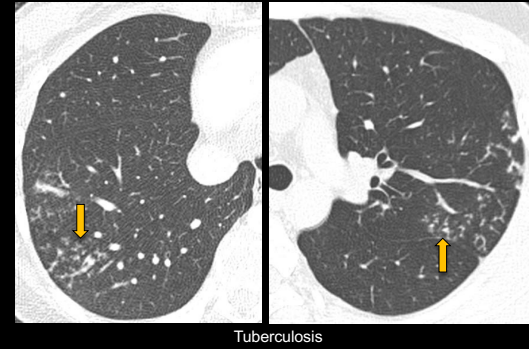
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## Infectious Bronchiolitis



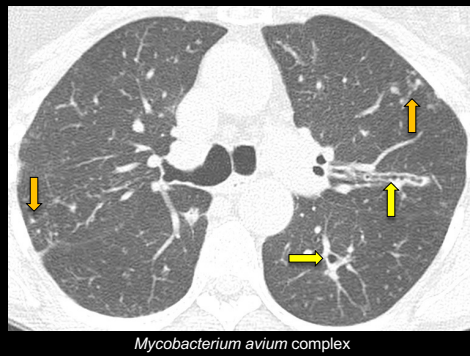
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## Infectious Bronchiolitis



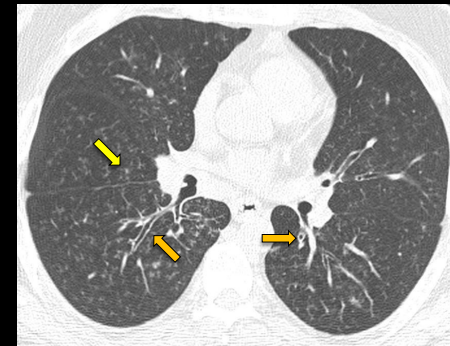
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## Infectious Bronchiolitis



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## Aspiration

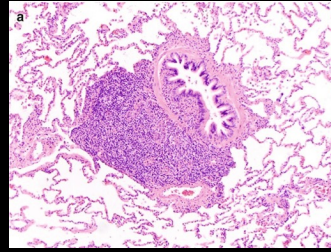


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## Follicular Bronchiolitis

- Pulmonary lymphoid hyperplasia
  - Discrete foci of hyperplastic lymphoid tissue
    - Bronchovascular bundles
    - Interlobular septa
    - Visceral pleura
  - Associations
    - Collagen vascular disease (esp. rheumatoid arthritis)
    - Immunodeficiency
    - Chronic inflammation



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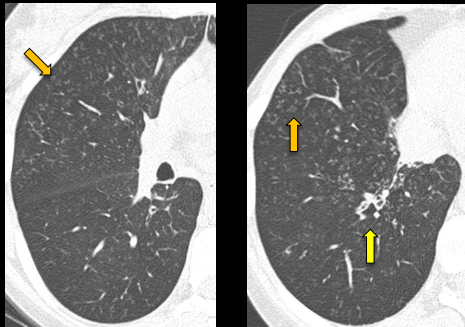
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## Follicular Bronchiolitis

- CT
  - Centrilobular nodules
  - Perilymphatic nodules
  - Peribronchovascular cysts
  - Occasional large nodules
  - Patchy ground-glass opacity

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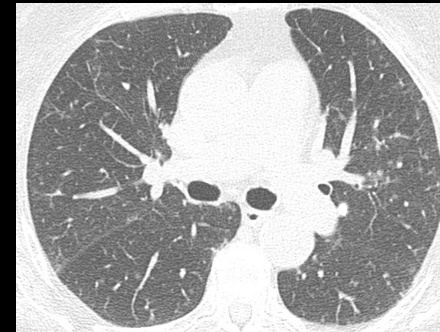
## Follicular Bronchiolitis



Rheumatoid Arthritis

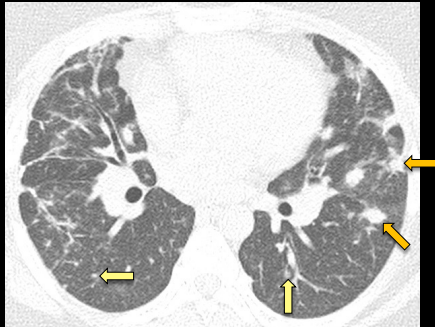
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## Follicular Bronchiolitis



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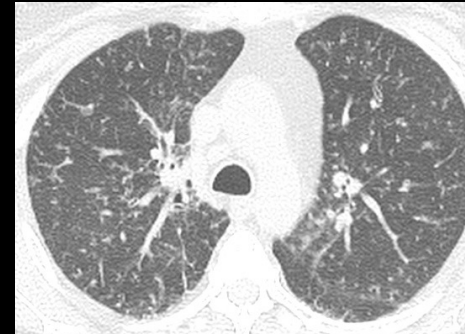
## Follicular Bronchiolitis



Rheumatoid Arthritis

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## Follicular Bronchiolitis

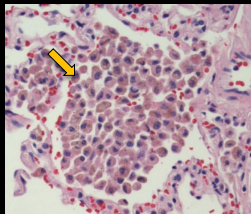


Rheumatoid Arthritis

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## Respiratory Bronchiolitis

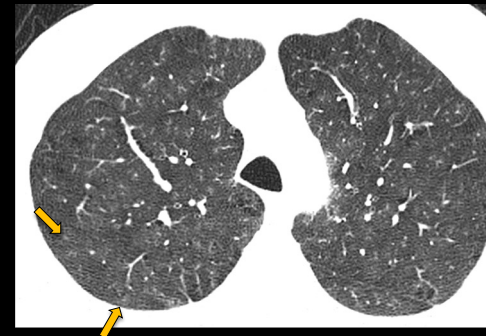
- Accumulation of pigmented macrophages in and around the respiratory bronchioles
- Almost exclusively in smokers



Courtesy of Jose Torrealba, M.D. (Dallas, TX)

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## Respiratory Bronchiolitis



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## Respiratory Bronchiolitis



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## Hypersensitivity Pneumonitis



Bird Fancier's Disease

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## Hypersensitivity Pneumonitis



Fiberglass Factory Worker

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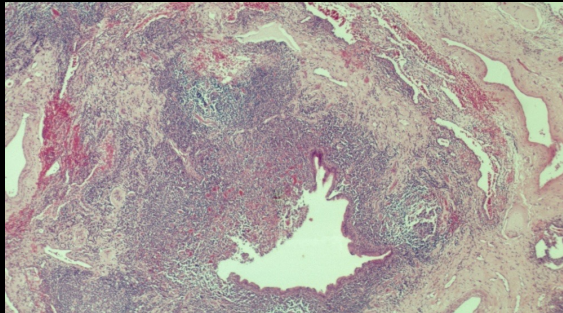
## Diffuse Panbronchiolitis

- Rare disease that almost exclusively affects only East Asian men (Japan, Korea)
- Etiology unknown but likely combination of environmental and genetics
- Rarely reported elsewhere – underdiagnosis?

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## Diffuse Panbronchiolitis



Courtesy of David Lynch, MB (Denver, CO)

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## Diffuse Panbronchiolitis

- Mean age of diagnosis 40
- Productive cough
- Progressive dyspnea
- Chronic sinusitis

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## Diffuse Panbronchiolitis

- CT
  - Centrilobular nodules
  - Tree-in-bud opacities
  - Bronchiolectasis
  - Bronchiectasis
  - Airway wall thickening

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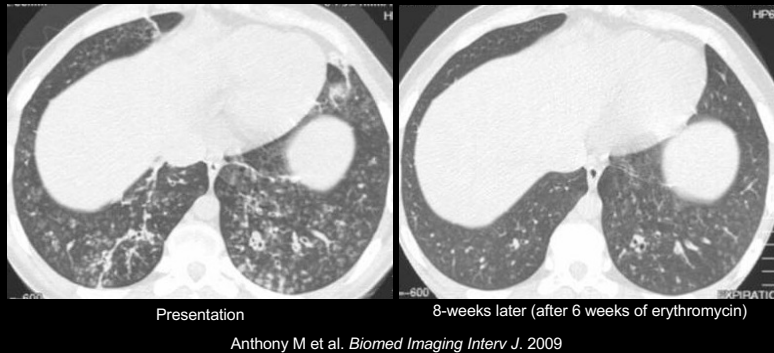
## Diffuse Panbronchiolitis



Courtesy of Travis S. Henry, M.D. (Durham, NC)

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## Diffuse Panbronchiolitis



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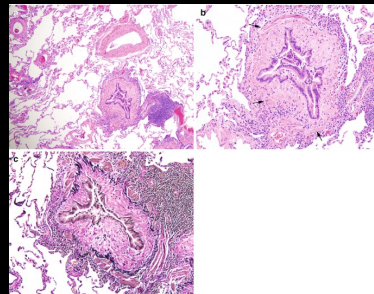
## Cellular Bronchiolitis

Diagnosis	CT Clue(s)	Clinical Clue(s)
Infection	Peribronchial consolidation	Acute respiratory illness
Aspiration	Gravitationally dependent Debris in larger airways	Inpatient Instrumentation Altered swallowing
Follicular bronchiolitis	Cysts Patchy ground-glass opacity	Connective tissue disease (esp. RA) Immunodeficiency
Respiratory bronchiolitis	Upper lobe predominance "Smudgy" ground-glass nodules	Smoker
Hypersensitivity pneumonitis	Diffuse centrilobular ground-glass nodules Lobular air trapping	Nonsmoker Dry cough Exposure
Diffuse panbronchiolitis	Bronchiectasis	Chronic sinusitis East Asian male

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## Fibrotic Bronchiolitis

- Constrictive bronchiolitis
- Neuroendocrine cell hyperplasia



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## Constrictive Bronchiolitis

- Fibrosis of bronchiolar wall with luminal narrowing or occlusion
- Formerly referred to as obliterative bronchiolitis
- Results in airflow obstruction

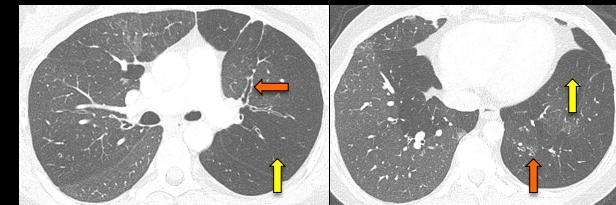
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## Constrictive Bronchiolitis

- Idiopathic
- Post-infectious
- Connective tissue disease
- Chronic graft-versus-host disease
- Chronic lung allograft rejection
- Inhalational injury

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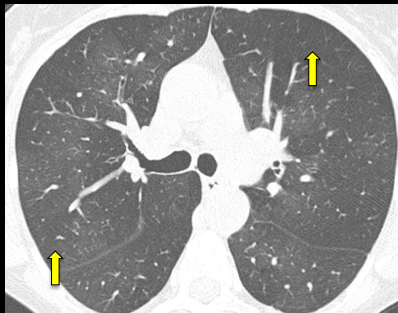
## Constrictive Bronchiolitis



Idiopathic

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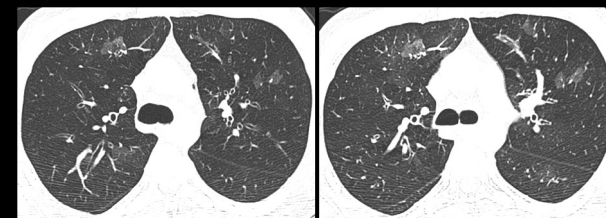
## Constrictive Bronchiolitis



Rheumatoid Arthritis

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## Constrictive Bronchiolitis



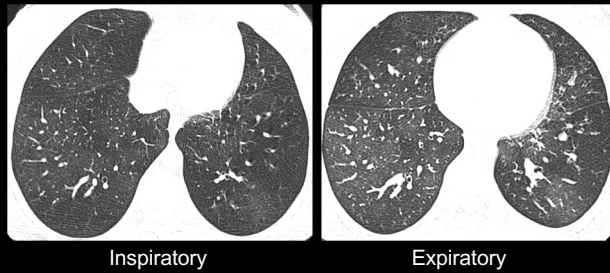
Inspiratory

Expiratory

Bronchiolitis Obliterans Syndrome (BOS)

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## Constrictive Bronchiolitis

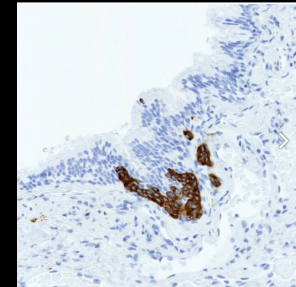


Bronchiolitis Obliterans Syndrome (BOS)

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## DIPNECH

- Diffuse idiopathic pulmonary neuroendocrine cell hyperplasia
- Preinvasive precursor to carcinoid tumors and tumorlets
- Secreted peptides can lead to bronchoconstriction and bronchiolar fibrosis.



PathologyOutlines.com

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## DIPNECH

- Women > 50 years old
- Chronic cough
- Progressive airflow obstruction
- May have history of pulmonary carcinoid

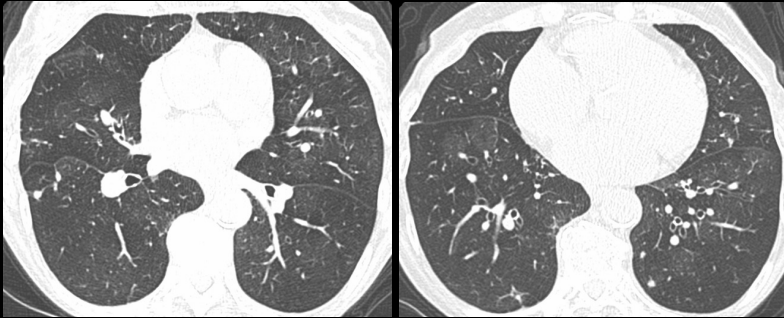
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## DIPNECH

- CT
  - Mosaic attenuation
  - Air trapping (expiration)
  - Scattered solid nodules

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## DIPNECH



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## Fibrotic Bronchiolitis

Diagnosis	CT Clue(s)	Clinical Clue(s)
Constrictive bronchiolitis	Mosaic attenuation Expiratory air trapping Bronchiectasis (usually mild)	Inhalational injury Rheumatoid arthritis Childhood infection Lung transplant Graft-versus-host disease
DIPNECH	Scattered small nodules on background of mosaic attenuation	Middle age female "Asthma" diagnosis Progressive airflow obstruction

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## Summary

- Small airways disease can present as an acute respiratory illness or insidious onset chronic lung disease
- CT shows both direct and indirect findings of small airways disease
- Expiratory imaging is particularly helpful in demonstrating air trapping

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Comments or Questions?

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