

ВИЗУАЛИЗАЦИЯ ЗАБОЛЕВАНИЙ МЕЛКИХ ДЫХАТЕЛЬНЫХ ПУТЕЙ

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IMAGING SMALL AIRWAYS DISEASES

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Learning Objectives: What we are discussing

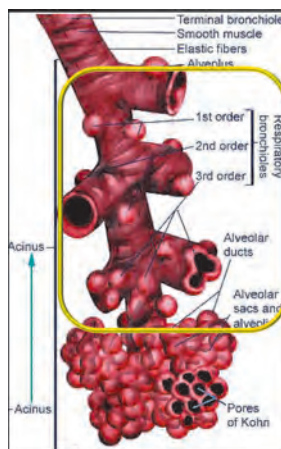
- SAD classification
- SAD imaging
 - emphasis on CT

Not discussing smoking-related *interstitial* lung diseases

- Spectrum of interstitial patterns of lung injury to cigarette smoke
 - Langerhans cell histiocytosis
 - Respiratory bronchiolitis-ILD
 - Desquamative interstitial pneumonia

What is a small airway?

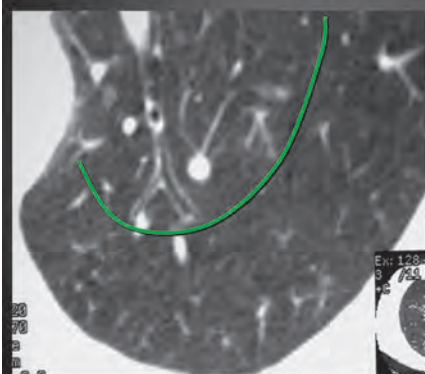
- Airway with diameter $< 1-2$ mm
- No cartilage in walls
 - Membranous
 - Conducting only
 - Respiratory
 - Conducting and gas exchange
- Practical perspective: include all airways beyond the resolution of HRCT in **normal** lungs



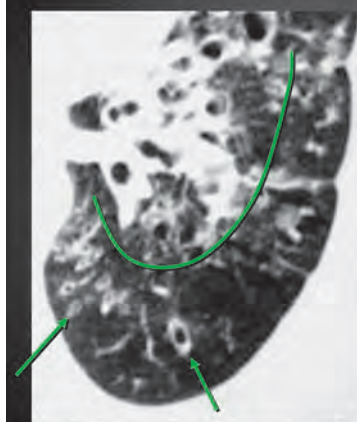
HRCT-normal limits

- Image out to 8th generation of normal airway branching

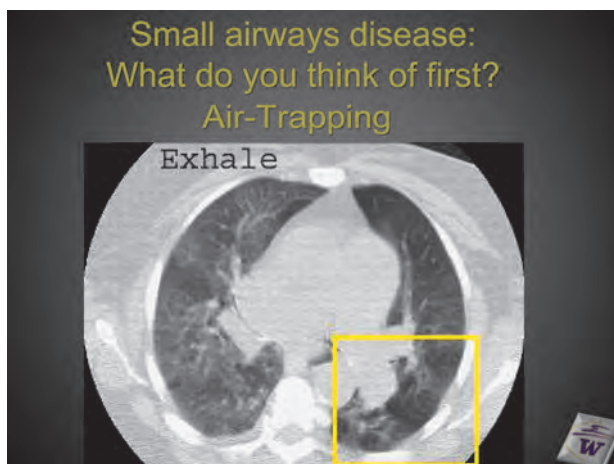
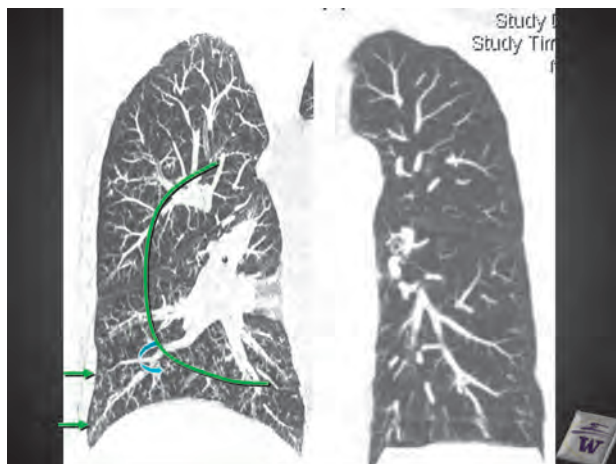
HRCT Anatomy



normal
airway
size-limit of
resolution



normal
airway
size-limit
of
resolution



Topic of SAD can be Complicated:

Myers and Colby SAD Classification by pathological features

- Constrictive bronchiolitis
- Obliterative bronchiolitis
- Bronchiolitis obliterans
- Cryptogenic organizing pneumonia
- Bronchiolitis obliterans organizing pneumonia
- Proliferative bronchiolitis
- Acute bronchiolitis
- Infectious bronchiolitis
- Adult bronchiolitis
- Respiratory bronchiolitis
- Smoker's bronchiolitis
- Respiratory bronchiolitis-associated interstitial lung disease
- Mineral dust airways disease
- Early pneumoconiosis
- Follicular bronchiolitis
- Diffuse panbronchiolitis

Myers JA, Colby PC. Pathologic manifestations of constrictive, obliterative, and proliferative bronchiolitis. Clin Chest Med 1993;13:401-422.

Worthy and Müller Classification:

5 histopathological entities:

- 1) cellular bronchiolitis
- 2) panbronchiolitis
- 3) respiratory bronchiolitis
- 4) constrictive bronchiolitis
- 5) bronchiolitis obliterans with intraluminal polyps

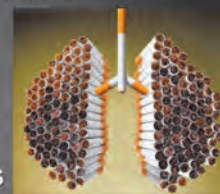
Further Complicated by sub-classifications: eg. Constrictive Bronchiolitis

- Postinfectious
 - Adenovirus
 - Respiratory syncytial virus
 - Influenza
 - Mycoplasma pneumoniae
- Inhalational injury
 - Nitrogen dioxide (silo-filler's disease)
 - Sulfur dioxide
 - Ammonia
 - Phosgene
 - Hot gases
- Connective tissue disorders
 - Rheumatoid arthritis
 - Sjögren's syndrome
- Transplant recipients
 - Bone marrow transplant
- Drugs
 - Penicillamine
 - L-mustine
- Other
 - Inflammatory bowel diseases
 - Bronchiectasis, including cystic fibrosis
 - Hypersensitivity pneumonitis
 - Microcarcinoid tumourlets
 - Sauropus androgynus ingestion
 - Star gooseberry
 - Paraneoplastic pemphigus

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Worthy SA, Müller NL. Small airway diseases. Radiol Clin North Am 1998;36:163-173.

Bronchiolitis

- Generic term
- Small airway is insulted
 - Inflammation in and around airways (not necessarily infection)
- or
- Residua of insult

Imaging Bronchiolitis

- Either we see bronchiolitis directly
 - two distinct patterns
- We see indirect manifestations of bronchiolitis and healing...or
- Both
- Accounts for the majority of presentations in clinical practice

SAD: 3 Basic CT Imaging Patterns

Direct findings

- 1) Wall thickening, ectasia, impaction

Nodules

Tree in bud

- 2) Ill-defined, bronchocentric nodules

Indirect findings

- 3) Mosaic pattern, air-trapping

Added value of MDCT

- Multiplanar reformats
 - Improve understanding of diseases
- MIPS add diagnostic value and *confidence* in distinguishing “tubular” abnormalities from true nodular disease

Clinical Physics

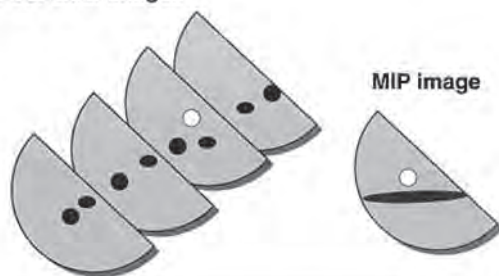
- MIP is an acronym for what?

MIPS

Maximum Intensity Projection

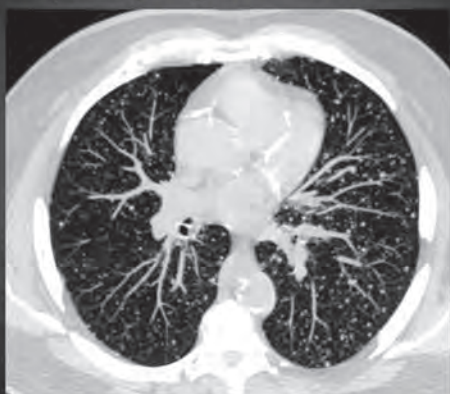
- Better detection of lung nodules and distinction of normal and abnormal tubular structures

Four axial images

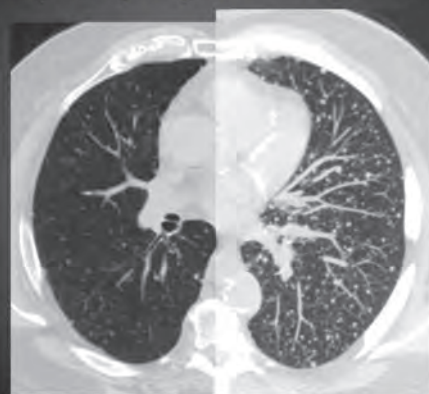


Incremental Benefit of Maximum-Intensity-Projection Images on Observer Detection of Small Pulmonary Nodules Revealed by Multidetector CT : <http://www.ajronline.org/content/179/1/149.long>

Papillary thyroid mets: MIP



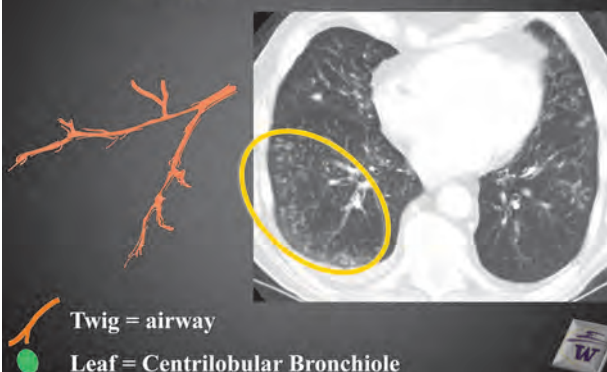
Papillary thyroid mets: MIP



Clinical Physics

- Why is MR not effective as CT for evaluating the airways?
- Low proton density in lung
- Fast signal decay due to susceptibility artifacts at air-tissue interfaces

Pattern 1: Tree-in-Bud



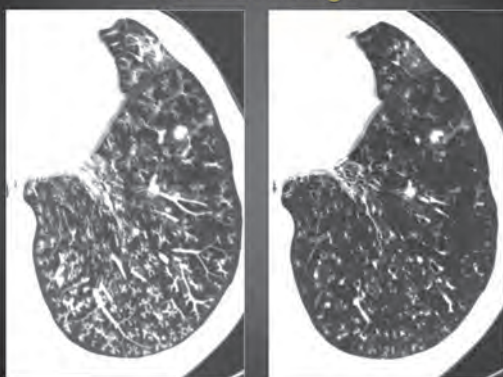
Tree in Bud: Very common observation

- Increased utilization of CT in all patient populations
- Clinical presentation important!
 - Atypical community acquired pneumonia
 - Immunocompromised, etc.

r/o PE: acute bronchiolitis



Infectious bronchiolitis MIP advantage



Heart txp recipient: Infectious bronchiolitis Strep p.



Value of MIPs

- MIP with a slab thickness of 8 mm is superior in detection of pulmonary nodules to all other tested techniques
- Although, volume rendering considered superior by some (*Prokopf*)

doi: 10.2214/AJR.08.1689 AJR May 2009 vol. 192 no. 5 1324-1329

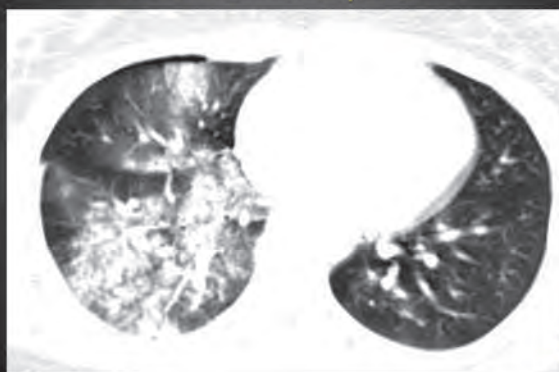
Lets remember that...

- Not all bronchiolitis is infectious



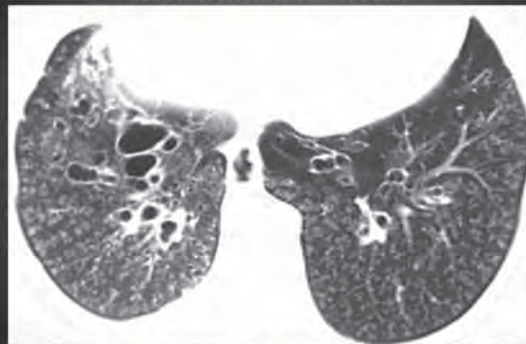
Aspiration: Esophageal Cancer

TIB/Trauma/aspiration



Lets remember that...

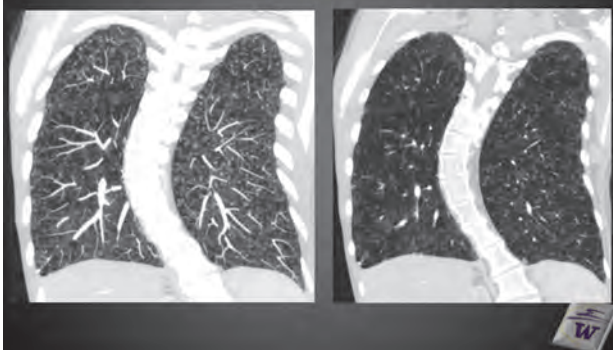
- Not all bronchiolitis is acute



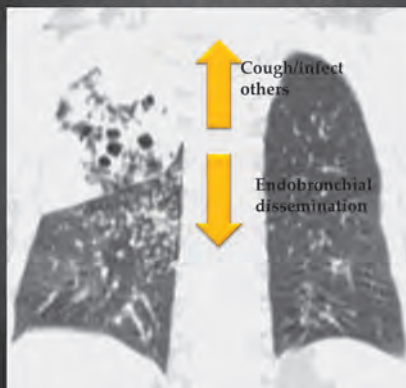
Kartagener's Syndrome

Panbronchiolitis

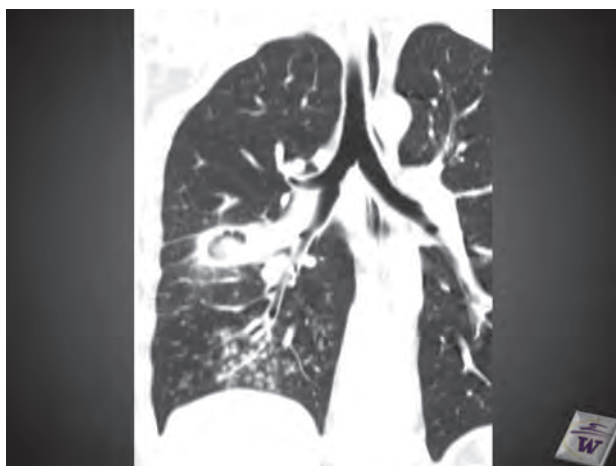
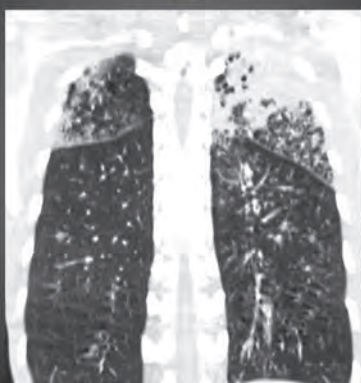
33 yo with BO synd after lung txp



Lets also remember TB...

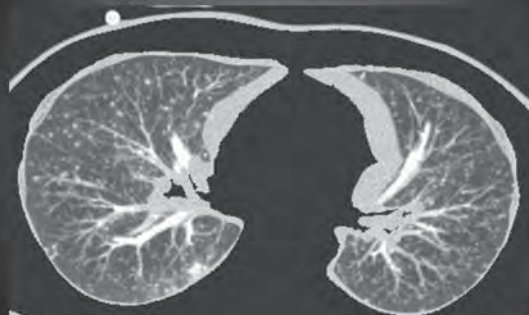


TB



Lets remember that...

- Not all TIB is the respiratory tree



Miliary TB

Pattern 2 III-Defined Centrilobular Opacities

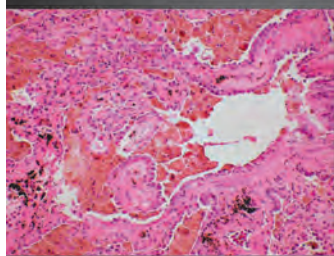
Common Diseases with III-Defined Centrilobular Opacities

- Respiratory Bronchiolitis (Smoking-Related Dz)
- Hypersensitivity Pneumonitis
- Acute toxic inhalation
 - Ammonia, chlorine, NOx, etc.

Less Common Diseases with III-Defined Centrilobular Opacities

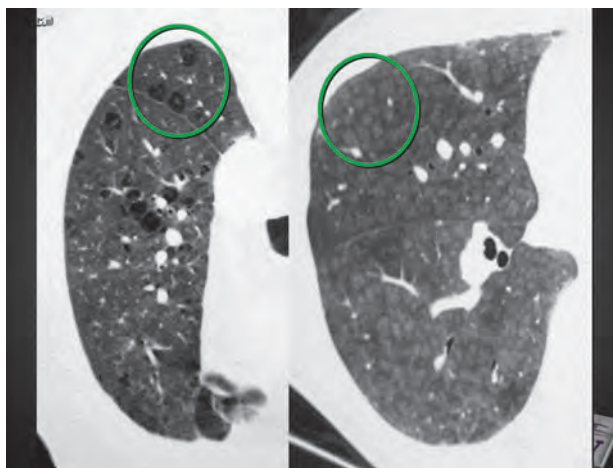
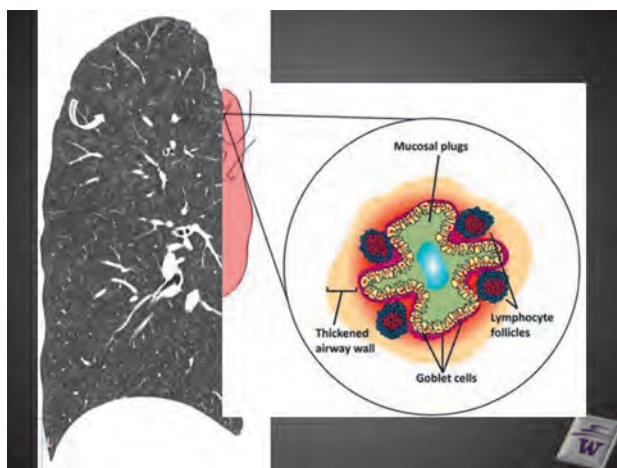
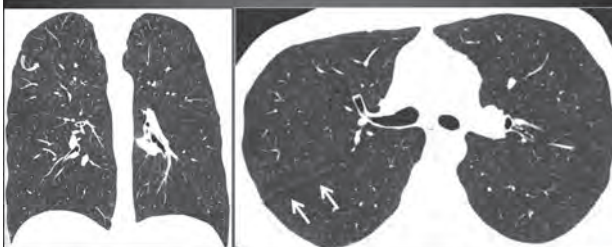
- drug reaction
- systemic autoimmune disease
- low-grade lymphoproliferative disease

Respiratory Bronchiolitis



- Lumen and peribronchiolar alveoli filled with macrophages
- Many macrophages contain finely granular, golden brown tobacco pigment

Respiratory Bronchiolitis: smoker



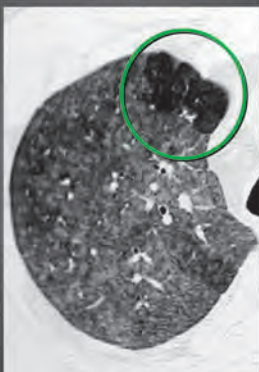
Chlorine gas inhalation



Hypersensitivity Pneumonitis



Hypersensitivity Pneumonitis



Head Cheese Sign

- 3 different lung densities
- Normal lung, air-trapping, ground glass or consolidation
- Implies inflammatory small airways disease
- Typical with hypersensitivity pneumonitis

Webb's Headcheese Sign



Indirect CT Finding of SAD

- Scarring and obliteration of airway lumen result in *air trapping*
- Patchy density differences of lung parenchyma distal to diseased airway
- Lucent areas represent areas of under-ventilated and under-perfused lung
- Mosaic attenuation pattern

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- 2) panbronchiolitis
- 3) respiratory bronchiolitis
- 4) **constrictive bronchiolitis**
- 5) bronchiolitis obliterans with intraluminal polyps

Supplemental Exhalation CT

- Increase confidence in identifying *Air-trapping*

Normal



Air Trapping



Mosaic Pattern:

- In general, is nonspecific

3 very different causes

- primary small airways disease (e.g. asthma, o.b.)
- primary vascular disease (e.g. chronic pulmonary emboli)
- proliferative parenchymal dz (e.g. EAA, infection)



Clinical Correlation

- Differentiation readily made when clinical and physiological information is taken into account

Mosaic Pattern: 3 Distinct Clinical Histories

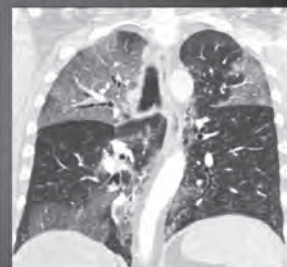
- Chronic dyspnea, wheezing, low DLCO, obstructive PFT, no cough, no fever
- Chronic dyspnea, normal PFT, no cough, no response to bronchodilators, no wheezing, no fever
- Acute dyspnea, fever, cough, constitutional symptom, no response to bronchodilators, no wheezing



Lucent or Dense?

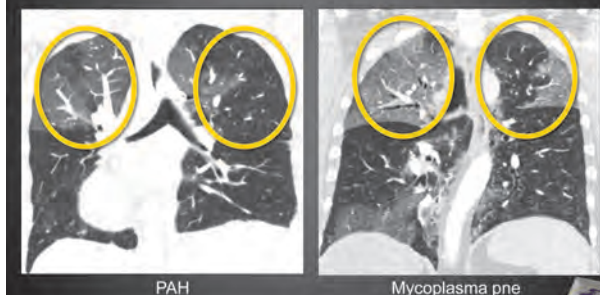


PAH

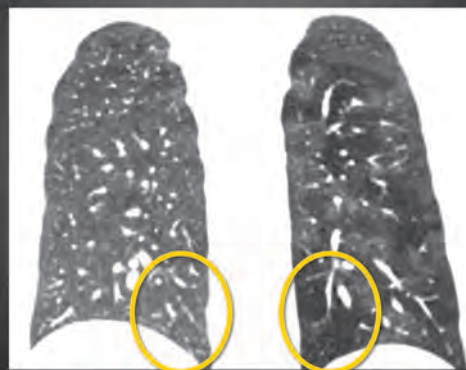


Mycoplasma pne

Check Vessel Caliber



Swyer James Syndrome



Constrictive bronchiolitis/gvhd



Constrictive bronchiolitis/CF

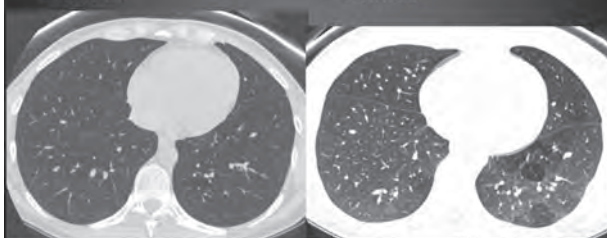


Associated Findings



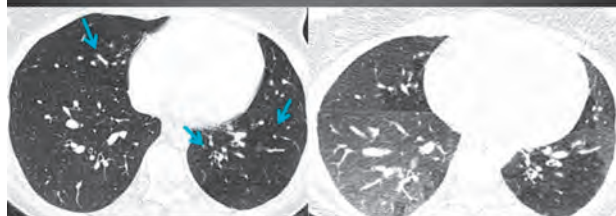
Asthma and airtrapping

- Inhale
- Exhale



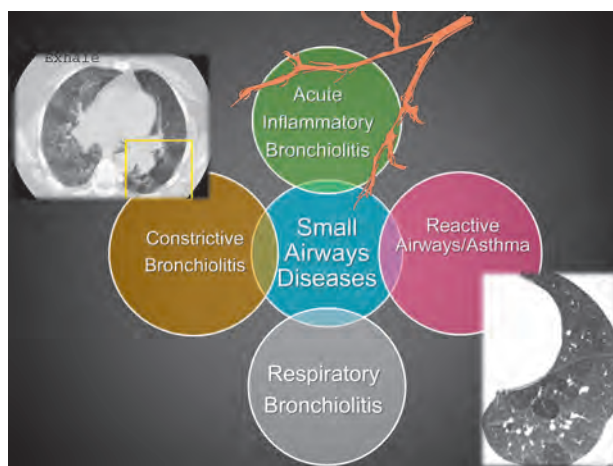
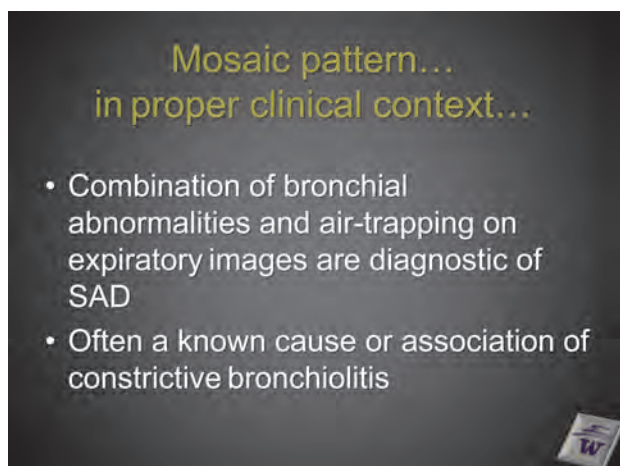
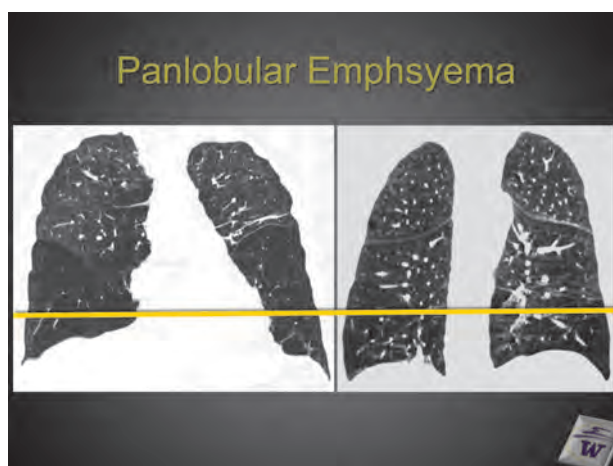
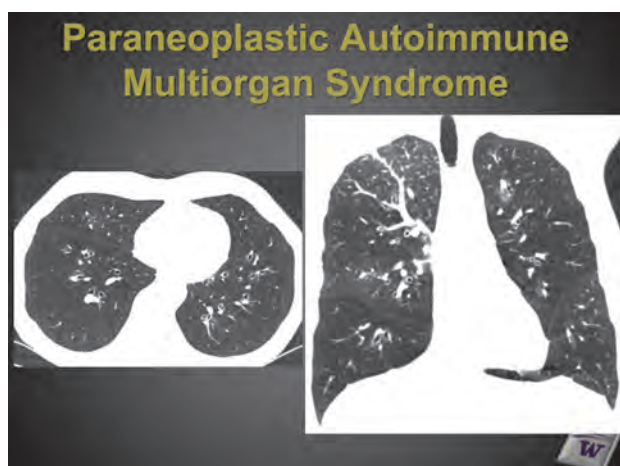
Constrictive bronchiolitis: HIV

- Inhal
- Exhal



Dynamic CT Caveats

- If air trapping is diffuse, may be difficult to recognize
- Dependent on level and severity of airway obstruction



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