Imaging Small Airways Diseases: Not Just Air trapping

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What we are discussing

- SAD classification
- SAD imaging with MDCT emphasis
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
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

Worthy and Müller Classification: 5 histopathological entities:

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

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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
  - Lomustine

- **Other**
  - Inflammatory bowel diseases
  - Bronchiectasis, including cystic fibrosis
  - Hypersensitivity pneumonitis
  - Microcarcinoid tumourlets
  - Sauropus androgynus ingestion
    - Star gooseberry
  - Paraneoplastic pemphigus
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What do they all have in Common?

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Bronchiolitis

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

- Either we see bronchiolitis directly
  - two distinct patterns
- We see indirect manifestations of bronchiolitis and healing
- Both
- Accounts for the majority of presentations in clinical practice
SAD: 3 Basic CT Imaging Patterns

• Direct findings
  – Wall thickening, ectasia, impaction
    • Nodules
    • Tree in bud
  – Ill-defined, bronchocentric nodules

• Indirect findings
  – Mosaic pattern, air-trapping
Added value of MDCT

• Multiplanar reformats
  – Improve understanding of diseases

• MIPS add diagnostic value for distinguishing “tubular” abnormalities from true nodular disease
Direct HRCT findings:
Small airways directly visible

- Thickening of walls by inflammatory infiltrate
- +/- Surrounding exudate
- Tubular, nodular, or branching linear structures
Tree in Bud:
Very common observation

• Increased utilization of CT in all patient populations

• Clinical presentation important!
  – Atypical community acquired pneumonia
  – Immunocompromised, etc.
Common Diseases with Ill-Defined Centrilobular Opacities

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

- 3 different lung densities
- Normal lung, air-trapping, ground glass or consolidation
- Implies inflammatory small airways disease
- Typical with hypersensitivity pneumonitis
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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Mosaic Pattern: 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
Dynamic CT Caveats

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