Asthma

KEY FACTS

TERMINOLOGY

- Reversible airway obstruction, chronic airway inflammation, and nonspecific airway hyperreactivity

IMAGING

- **Radiography**
  - Bronchial wall thickening
  - Hyperinflation: Transient or fixed
  - Atelectasis, pneumothorax, pneumonia
- **CT**
  - Bronchiectasis: Cylindrical, mucoid impaction
  - Assessment of extent and severity of airway wall thickness/luminal narrowing
  - Bronchiolitis: Mosaic attenuation on inspiration, expiratory air-trapping, small centrilobular nodules
  - Identification of associated conditions
- Primary role of imaging is to identify complications (not to make diagnosis)

TOP DIFFERENTIAL DIAGNOSES

- Vocal cord paralysis
- Tracheobronchial obstruction
- Constrictive bronchiolitis

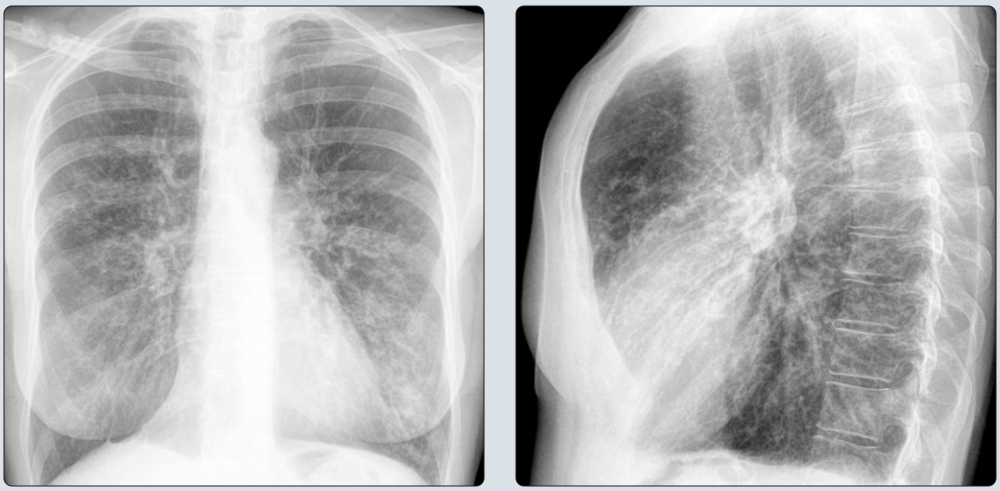
PATHOLOGY

- Chronic inflammation of mid and small-sized bronchi
- Bronchiolar findings: Constrictive bronchiolitis

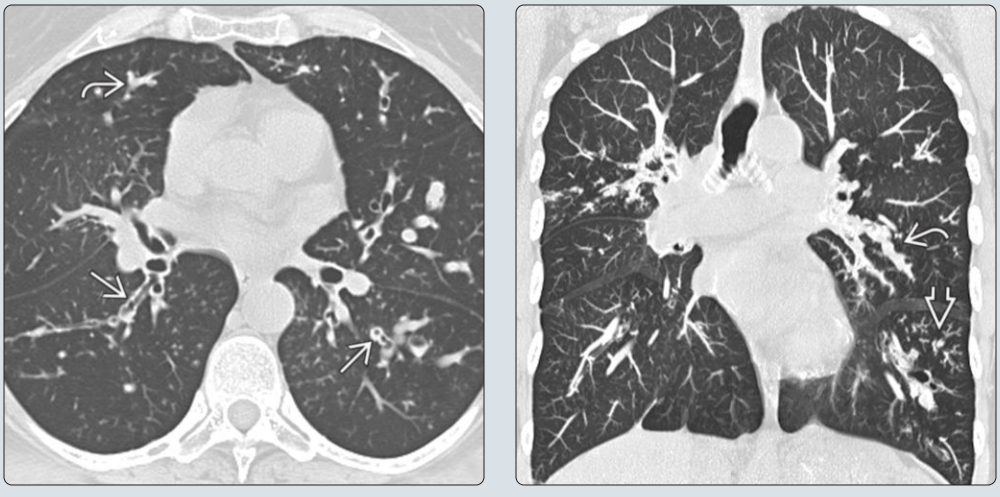
CLINICAL ISSUES

- "Not all that wheezes is asthma"
- Symptoms/signs
  - Cough, shortness of breath, wheezing, and chest discomfort
- Affects 7% of USA population
  - Children, adolescents, and adults
- Treatment: Combination of anti-inflammatory drugs and bronchodilators

(Left) *PA chest radiograph of a patient with longstanding asthma shows bilateral lung hyperinflation and nonspecific bilateral reticular opacities.* **(Right)** *Lateral chest radiograph of the same patient shows flattening of the diaphragm and enlargement of the retrosternal clear space, consistent with marked hyperinflation. Note diffuse peribronchial cuffing. While nonspecific, hyperinflation and peribronchial cuffing are common findings in patients with asthma.*



(Left) *Axial NECT of the same patient shows extensive bronchiectasis, bronchial wall thickening, and branching opacities that represent mucoid impactions.* **(Right)** *Coronal NECT MIP image of the same patient shows bronchiectasis, mucoid impactions, and tree-in-bud opacities from bronchiolar mucoid impactions. Cylindrical bronchiectasis is more common in asthma, and cystic or varicoid bronchiectasis is more common in allergic bronchopulmonary aspergillosis. (Courtesy S. Rossi, MD.)*



TERMINOLOGY

Definitions

- Reversible airway obstruction, chronic airway inflammation, and nonspecific airway hyperreactivity

IMAGING

General Features

- Best diagnostic clue
  - Imaging is for identification of complications (not for diagnosis)

Radiographic Findings

- **Bronchial wall thickening** or **peribronchial cuffing** (most common)
- **Hyperinflation**: Transient or fixed
- **Complications**
  - **Atelectasis**: Often from mucoid impaction, middle lobe commonly affected
  - Pneumonia
  - **Pneumothorax and pneumomediastinum**

CT Findings

- Assessment of extent and severity of airway wall thickness/luminal narrowing
  - ↑ thickness correlates with disease severity
- **Bronchiectasis**
  - Typically 1 or few dilated bronchi
  - Signet ring sign, absence of bronchial tapering
  - Mucoid impactions
  - Cylindrical bronchiectasis more likely in asthma without allergic bronchopulmonary aspergillosis (ABPA)
  - Central cystic or varicoid bronchiectasis, mucoid impaction, and centrilobular nodules suggest ABPA
- **Bronchiolitis**
  - Mosaic attenuation during inspiration
  - Expiratory air-trapping
  - Small centrilobular nodules
- Identification of associated conditions (e.g., ABPA) and mimics (e.g., hypersensitivity pneumonitis)

Imaging Recommendations

- Best imaging tool
  - Consider imaging only if complications suspected
- Protocol advice
  - Indications for chest radiography
    - Chronic obstructive pulmonary disease
    - Fever or temperature > 37.8° C
    - History of intravenous drug use
    - Seizures
    - Immunosuppression
    - Clinical suspicion of pneumothorax

DIFFERENTIAL DIAGNOSIS

Vocal Cord Paralysis

- Severe symptoms, inspiratory/expiratory stridor, episodic hoarseness
- No bronchial wall thickening
- Laryngoscopic diagnosis

Tracheal or Carinal Obstruction

- Tumor, post-intubation tracheal stenosis, vascular ring, foreign body, sarcoidosis, granulomatosis with polyangiitis, amyloidosis, relapsing polychondritis
- Imaging studies for identification and assessment of obstructing lesion

Constrictive Bronchiolitis

- Idiopathic, post-infectious, autoimmune disease, asthma
- Often refractory to bronchodilators
- May be radiologically indistinguishable from asthma

PATHOLOGY

General Features

- Etiology
  - Common asthma triggers: Animals (pet hair or dander), dust, weather changes, air or food chemicals, exercise, mold, pollen, respiratory infections (e.g., common cold), emotional stress, tobacco smoke, medications (e.g., aspirin)
- Associated abnormalities
  - ABPA
  - Bronchocentric granulomatosis
  - Chronic eosinophilic pneumonia
  - Churg-Strauss syndrome

Microscopic Features

- Chronic inflammation of mid and small-sized bronchi
- Bronchiolar findings
  - Constrictive bronchiolitis

CLINICAL ISSUES

Presentation

- Most common signs/symptoms
  - Cough, shortness of breath, wheezing, and chest discomfort

Demographics

- Age
  - Children, adolescents, and adults
- Epidemiology
  - Affects 7% of USA population

Treatment

- Complex; combination of anti-inflammatory drugs (e.g., corticosteroids, cromolyn), bronchodilators

DIAGNOSTIC CHECKLIST

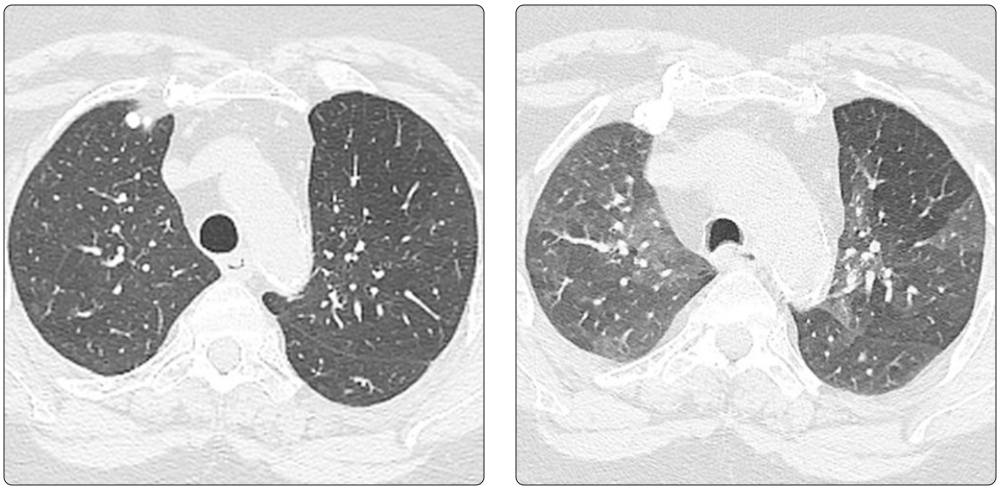
Consider

- "Not all that wheezes is asthma" when interpreting imaging studies of affected patients

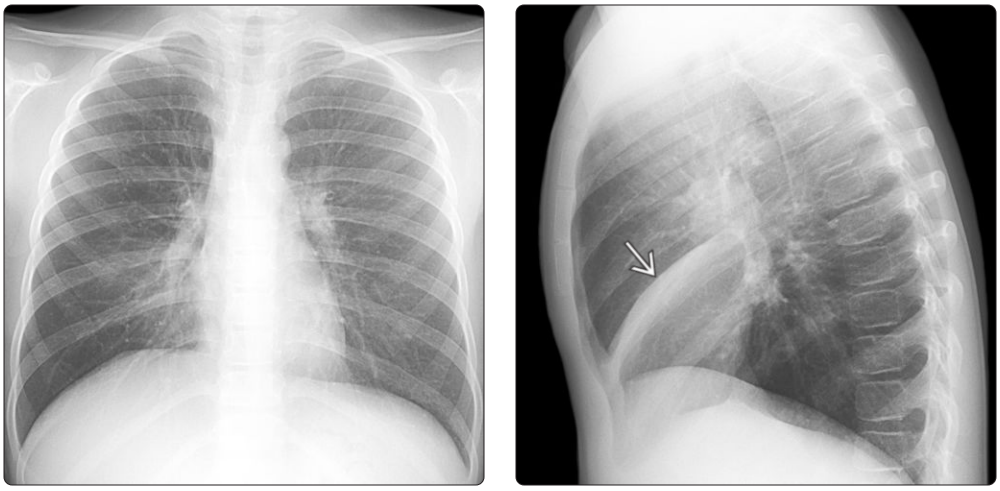
SELECTED REFERENCES

1. Eddy RL et al: Is Computed tomography airway count related to asthma severity and airway structure and function? Am J Respir Crit Care Med. 201(8):923-33, 2020
2. Ash SY et al: The role of imaging in the assessment of severe asthma. Curr Opin Pulm Med. 23(1):97-102, 2017
3. Richards JC et al: Imaging of asthma. Immunol Allergy Clin North Am. 36(3):529-45, 2016

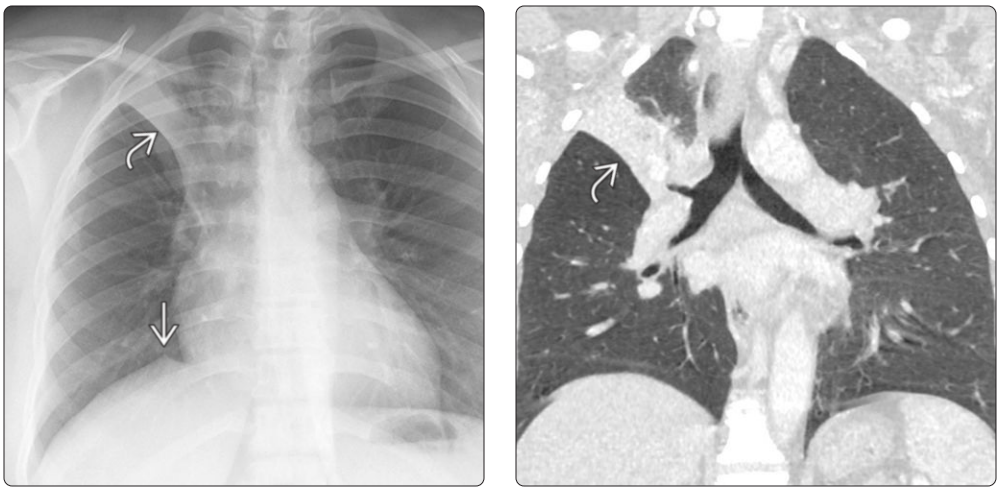
(Left) *Axial inspiratory HRCT of a patient with asthma shows a very subtle pattern of bilateral mosaic attenuation.* **(Right)** *Axial expiratory HRCT of the same patient shows scattered bilateral subsegmental air-trapping, consistent with small airways disease. This finding often correlates with severity of asthma and is associated with a history of asthma-related hospitalization, intensive care unit admissions, &/or mechanical ventilation.*

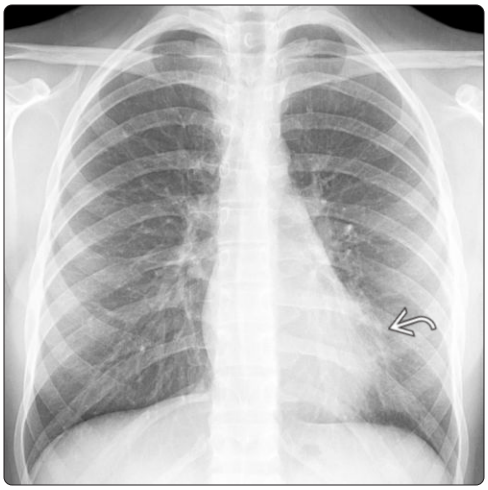


(Left) *PA chest radiograph of a young patient with asthma shows mild elevation of the right hemidiaphragm and obscuration of the right cardiac border secondary to atelectasis of the middle lobe.* **(Right)** *Lateral chest radiograph of the same patient shows a band-like opacity ➔ caudal to the inferiorly displaced horizontal fissure that confirms middle lobe atelectasis. Atelectasis is one of the most common abnormalities found on chest radiographs of patients with asthma.*

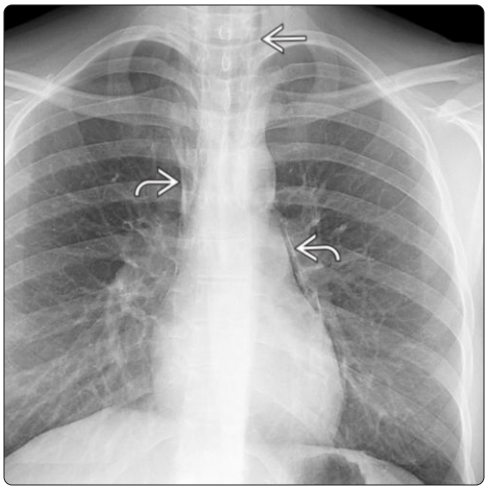


(Left) *PA chest radiograph of a patient with asthma shows a right upper lobe opacity with elevation of the minor fissure ➔ and a juxtaphrenic peak ➔, consistent with right upper lobe atelectasis.* **(Right)** *Coronal CECT of the same patient shows sublobar right upper lobe atelectasis ➔. Atelectasis in patients with asthma is typically associated with mucous plugs and does not necessarily imply acute illness, infection, or worsening asthma.*

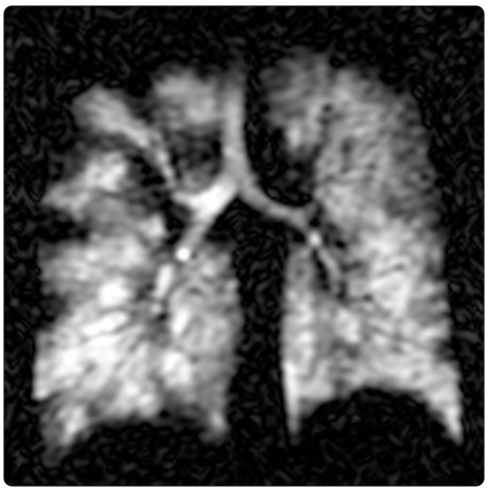




(Left) *PA chest radiograph of a patient with asthma who presented with dyspnea, fever, and leukocytosis shows obscuration of the left heart border, consistent with lingular pneumonia given the history.* **(Right)** *PA chest radiograph of the same patient shows post-treatment resolution of the lingular consolidation. Pneumonia is a common complication of asthma and an indication for imaging asthmatic patients. Since asthma is so prevalent, an effort should be made to image affected patients as little as possible.*



(Left) *PA chest radiograph of a patient with asthma who presented with acute dyspnea and chest pain shows extensive pneumomediastinum and subcutaneous air in the neck.* **(Right)** *Coronal CECT of the same patient shows pneumomediastinum and subcutaneous air in the neck. Pneumomediastinum as a complication of asthma is more common in children and more frequent than pneumothorax. Rarely, pneumomediastinum may be associated with air within the spinal canal.*



(Left) *PA chest radiograph of a patient with asthma shows a pneumothorax manifesting with a visible visceral pleural line at the right lung apex.* **(Right)** *Coronal MR with hyperpolarized ^{129}Xe of an asthmatic patient shows heterogeneous distribution of ^{129}Xe due to extensive ventilation defects. ^{3}He and ^{129}Xe have been used successfully in research studies designed to assess ventilatory abnormalities and are promising techniques for future clinical practice. (Courtesy H. P. McAdams, MD.)*