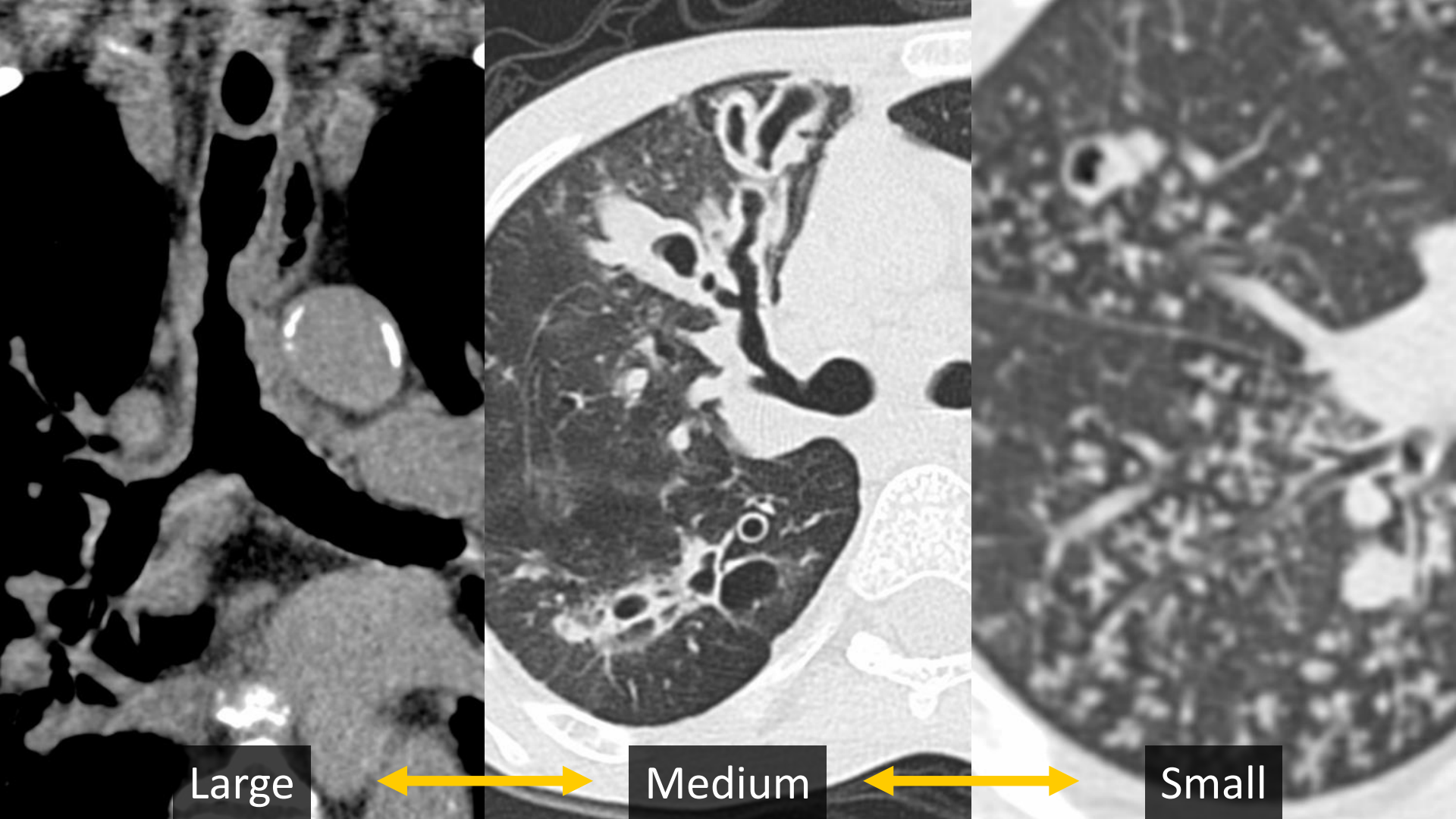
Large and Medium Airways Disease

American College of Radiology™

We Have No Relevant Disclosures

- Milliron, Bethany, Travis S. Henry, Srihari Veeraraghavan, and Brent P. Little. “Bronchiectasis: Mechanisms and Imaging Clues of Associated Common and Uncommon Diseases.” *RadioGraphics* 35, no. 4 (July 2015): 1011–30. https://doi.org/10.1148/rg.2015140214.
- Aslam, Anum, Jose De Luis Cardenas, Robert J. Morrison, Kiran H. Lagisetty, Diana Litmanovich, Edith Carolina Sella, Elizabeth Lee, and Prachi P. Agarwal. “Tracheobronchomalacia and Excessive Dynamic Airway Collapse: Current Concepts and Future Directions.” *RadioGraphics* 42, no. 4 (July 2022): 1012–27. https://doi.org/10.1148/rg.210155.
- Chung, Jonathan H, Jeffrey P Kanne, and Matthew D Gilman. “CT of Diffuse Tracheal Diseases,” 2011.


Large
Medium
Small

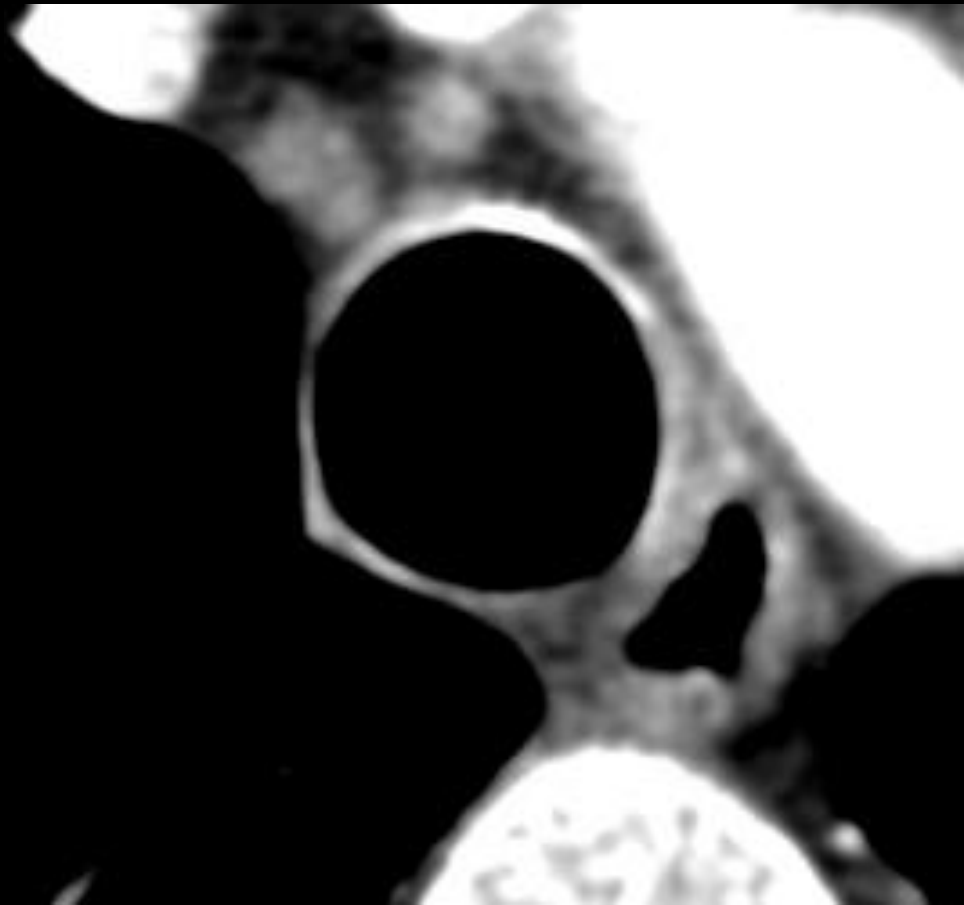
CT Imaging Techniques

- Helical suspended end inspiration
  - Standard thin section technique
  - No contrast except for tumor
- Helical forced dynamic expiration (when tracheobronchomalacia suspected)
  - Low dose (~20 mAs)
- 3-D postprocessing

Large Airways

Normal Trachea

- 16-22 incomplete cartilage rings
- Variable axial dimensions
  - 10-25 mm transverse
  - 10-27 mm AP



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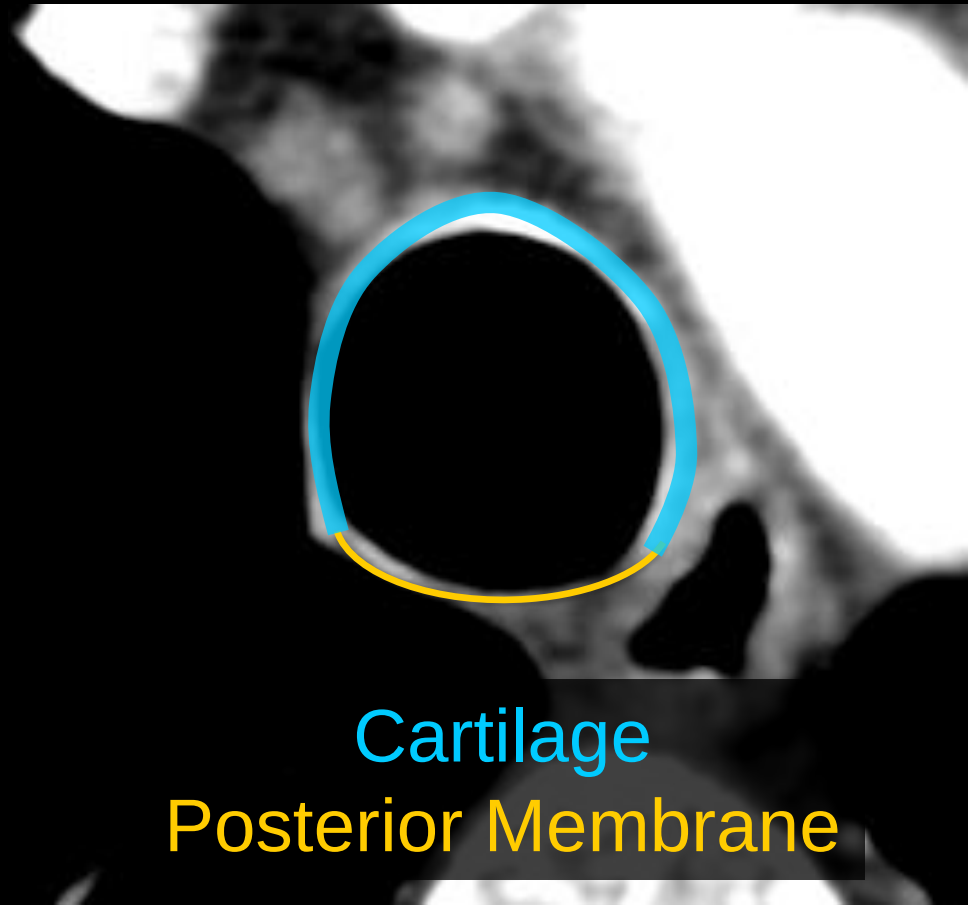
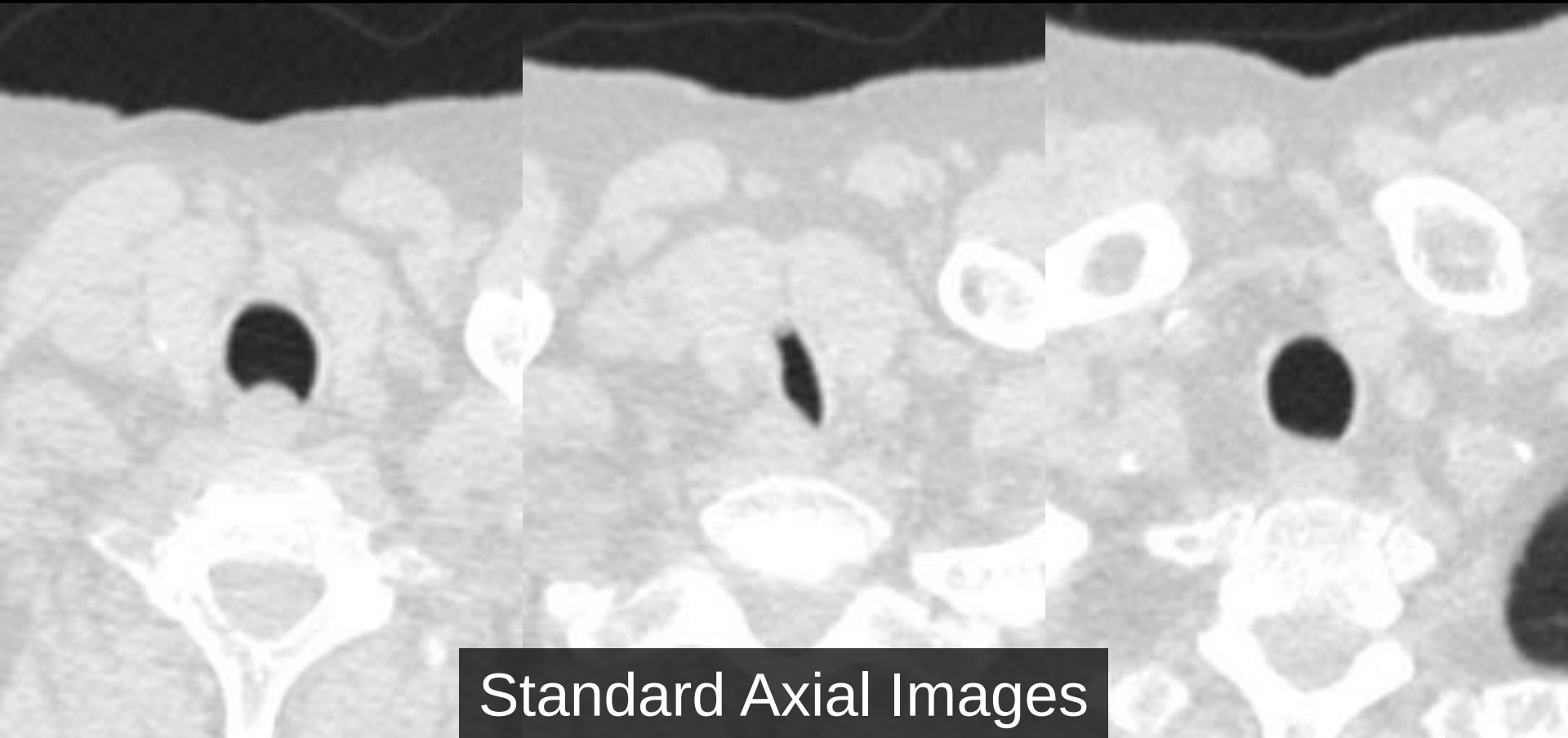
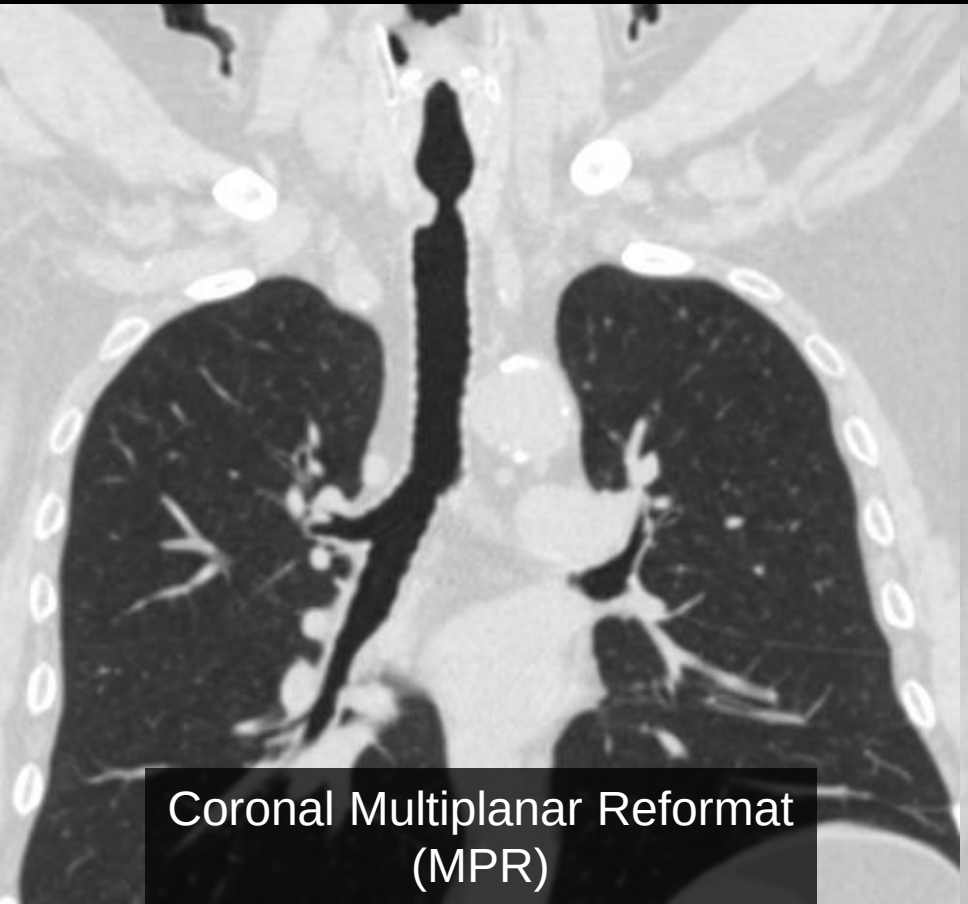


Multiplanar 2D/3D Analysis



Standard Axial Images

Multiplanar 2D/3D Analysis



Coronal Multiplanar Reformat (MPR)

Minimum Intensity Projection (MinIP)

Approach to the Abnormal Airway

Narrowing vs. Enlargement?

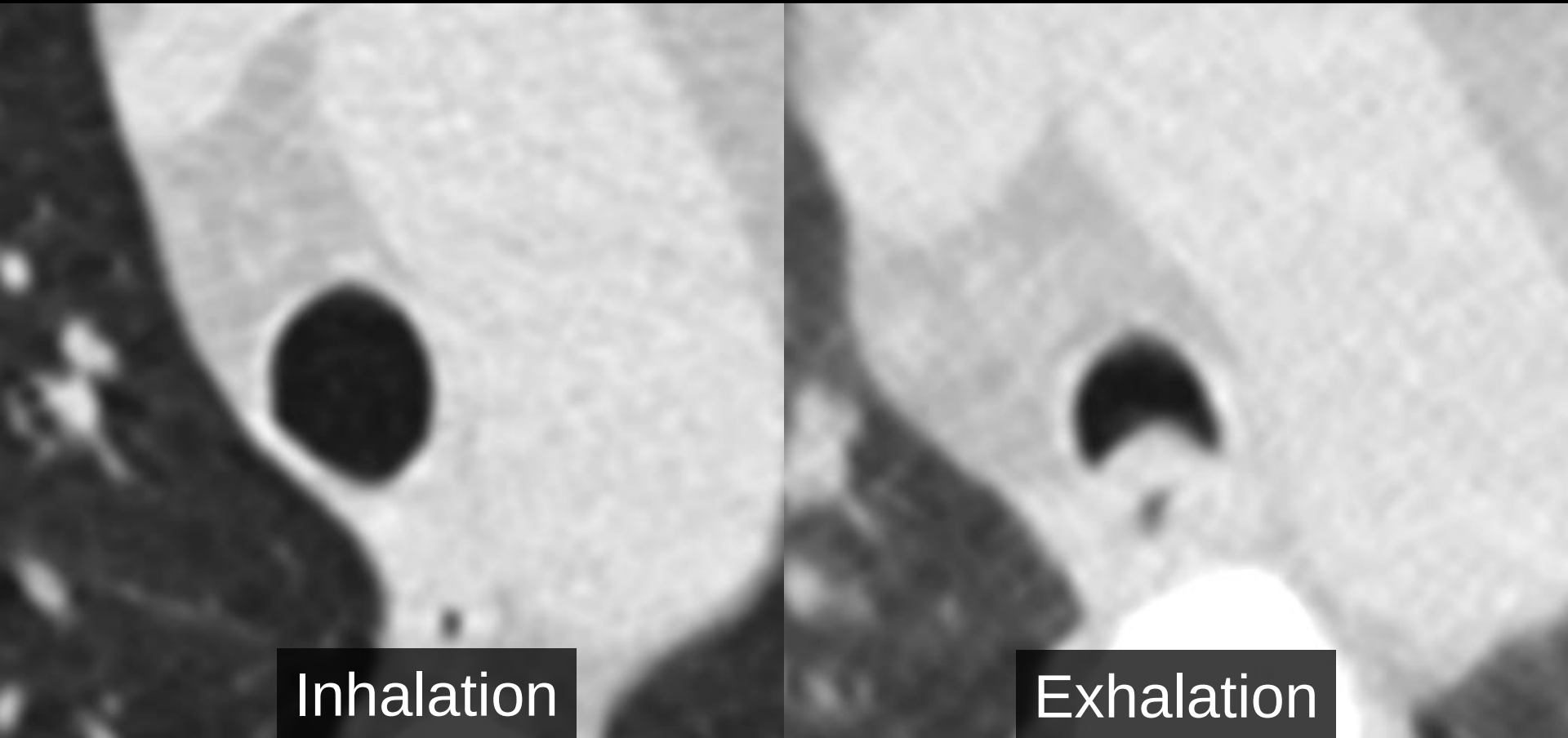
Focal vs. Diffuse?

Diffuse Tracheal Narrowing

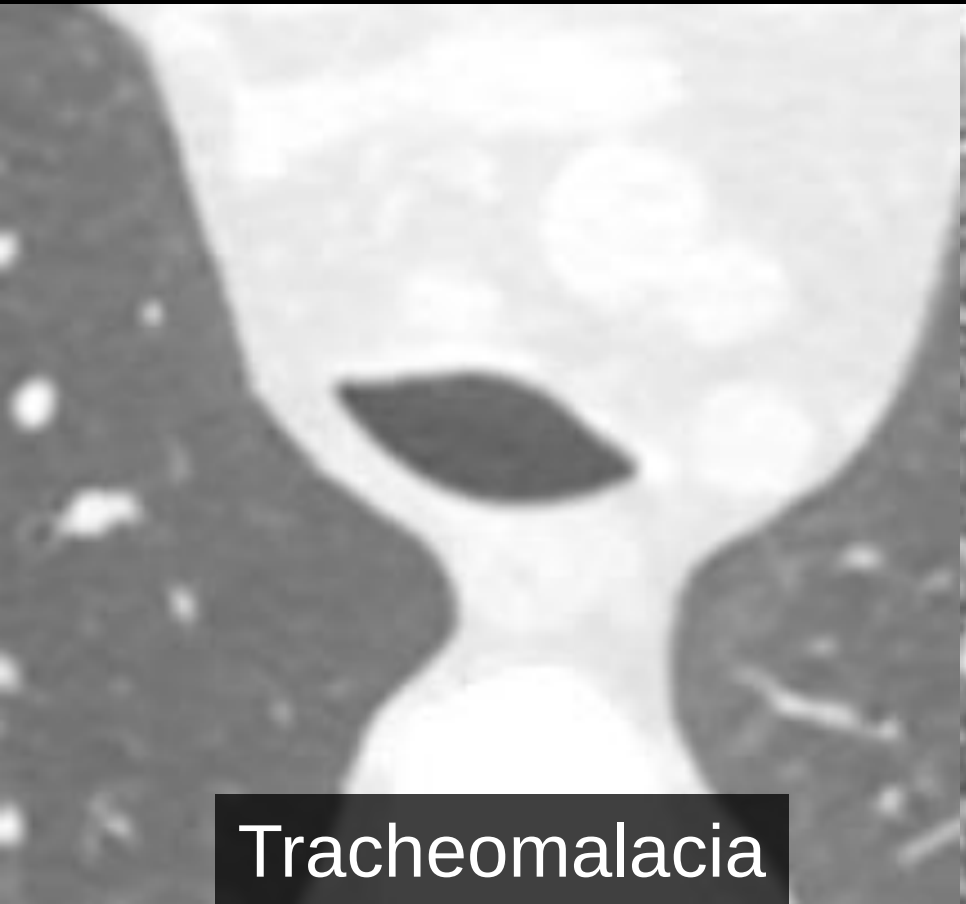
- Collapsibility
- Saber-sheath trachea

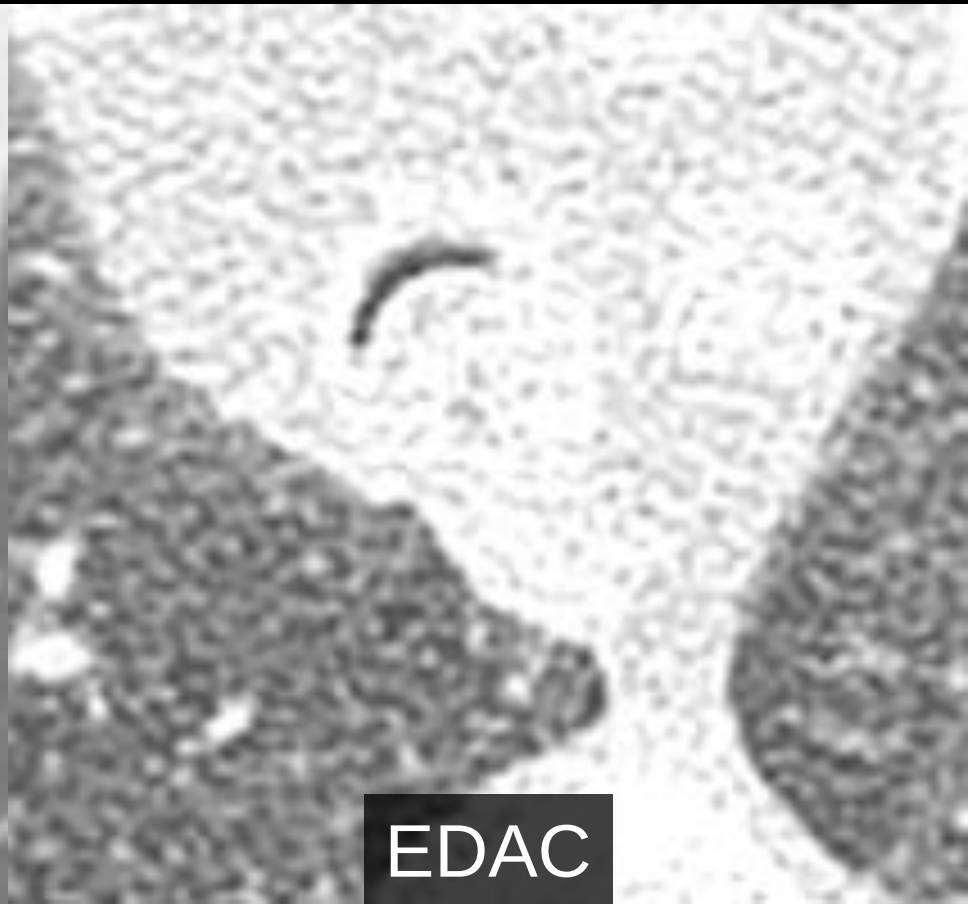
- Spares posterior membrane
- Involves posterior membrane

Collapsibility - Normal



Collapsibility - Abnormal

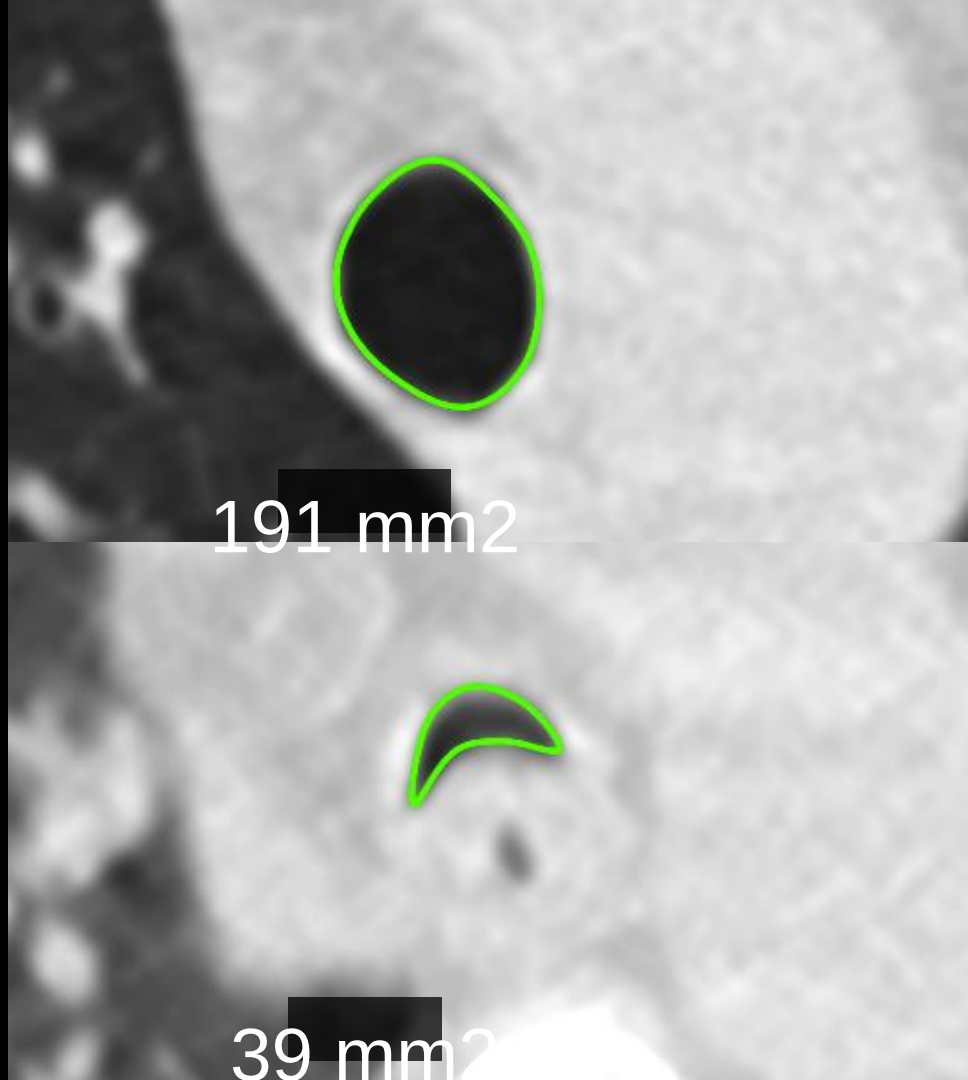




Excessive Dynamic Airway Collapse (EDAC)

- Excessive collapse of posterior membrane

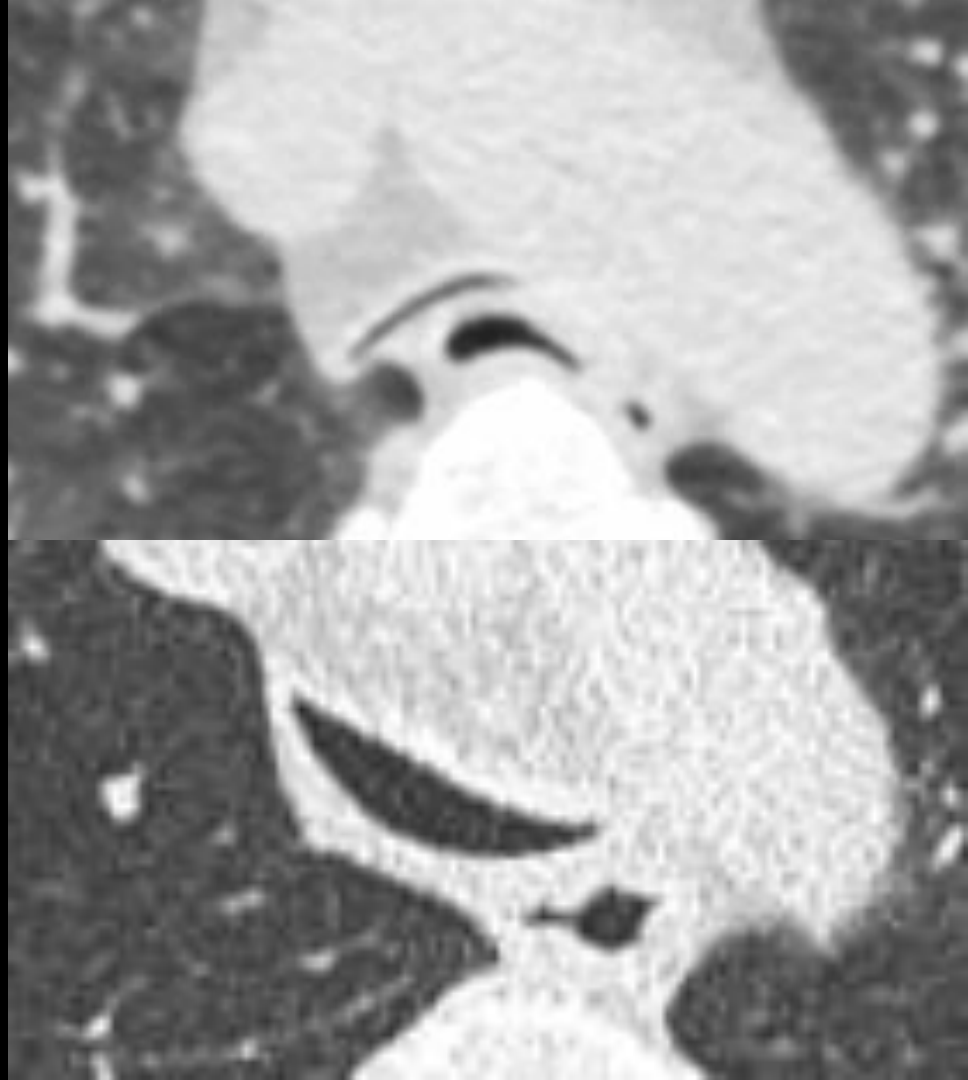
- Diagnosis:
  - 75-80% loss of cross-sectional area
  - 54 +/- 19% in normal volunteers



Boiselle PM et al. *Radiology*. 252(1):255–62.

Tracheomalacia

- Weakening of the cartilage
- Loss of normal shape of the trachea



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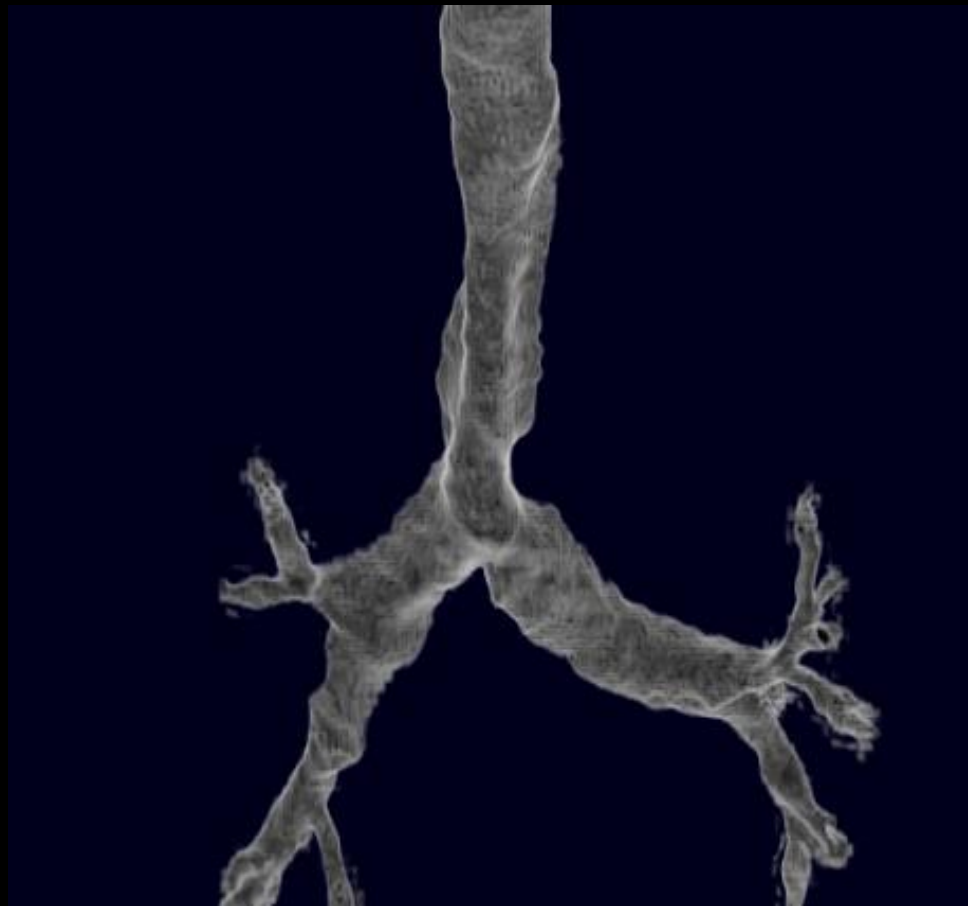
Saber-Sheath Trachea

Saber-Sheath Trachea

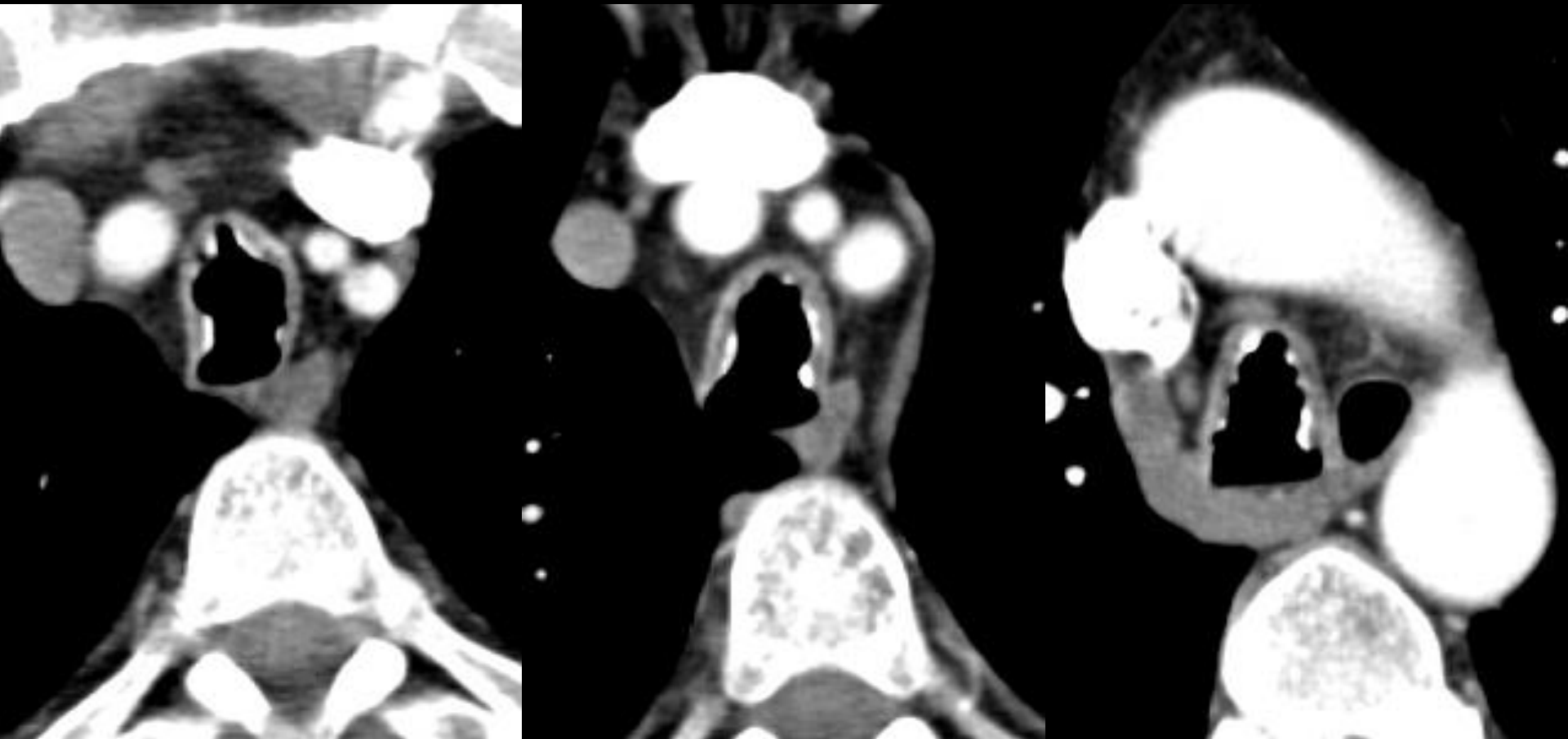
- Pathognomonic for COPD
- Coronal narrowing (>2:1)
- Spares extrathoracic trachea



Diffuse Tracheal Narrowing

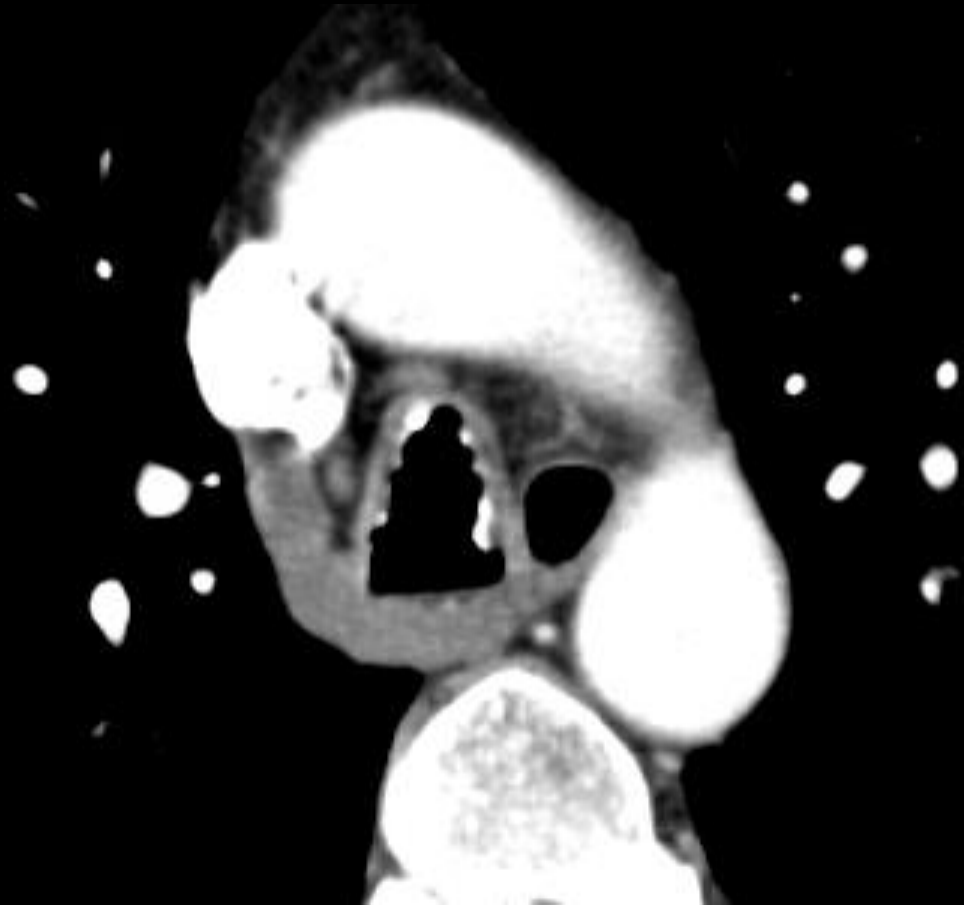
- Spares posterior membrane:
  - TPOP
  - RPC

Tracheobronchopathia Osteochondroplastica

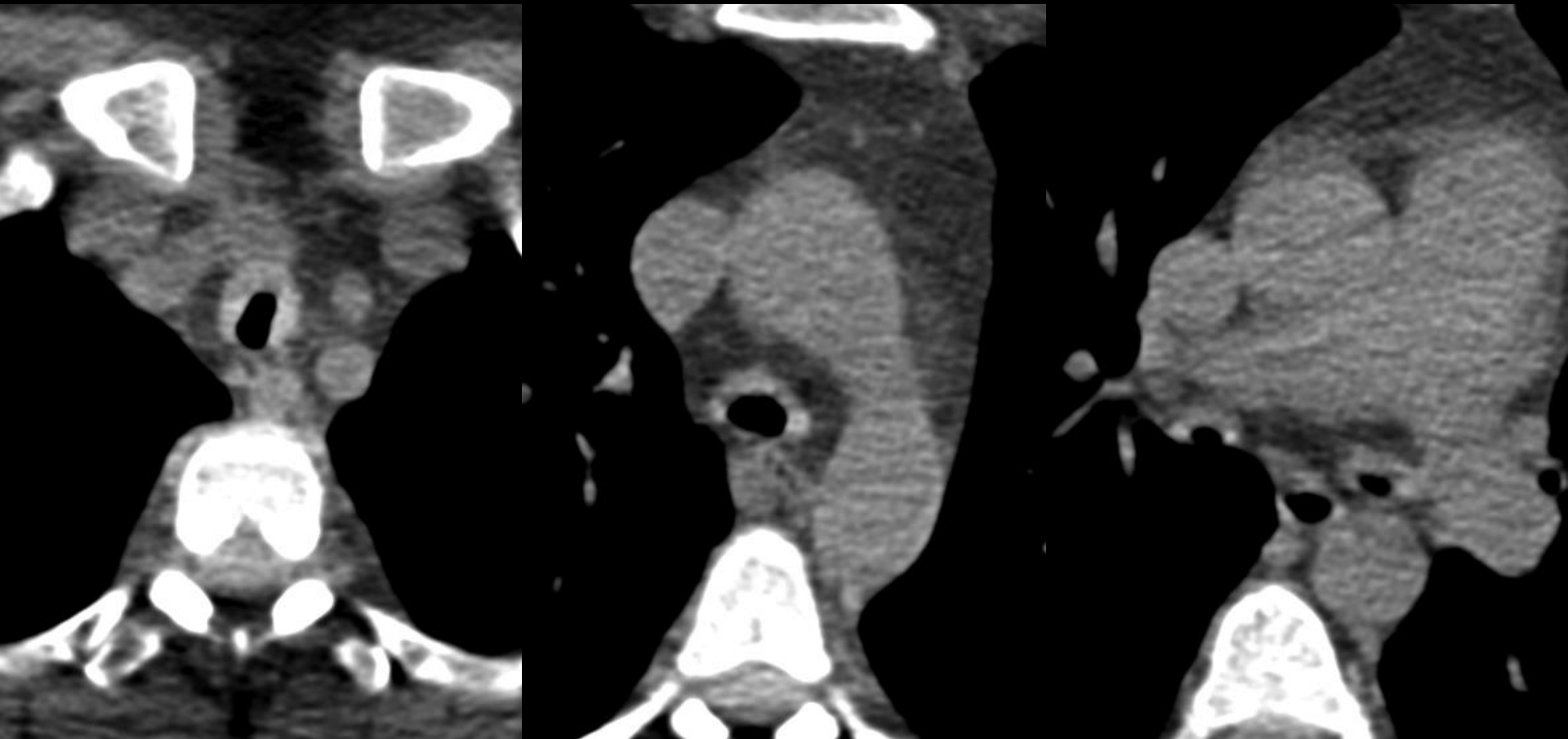


Tracheobronchopathia Osteochondroplastica

- CT findings
  - Soft tissue nodules localized to the cartilaginous rings of the trachea and bronchi
  - *Spares* posterior tracheal membrane
  - Calcification common
  - Significant airway stenosis uncommon



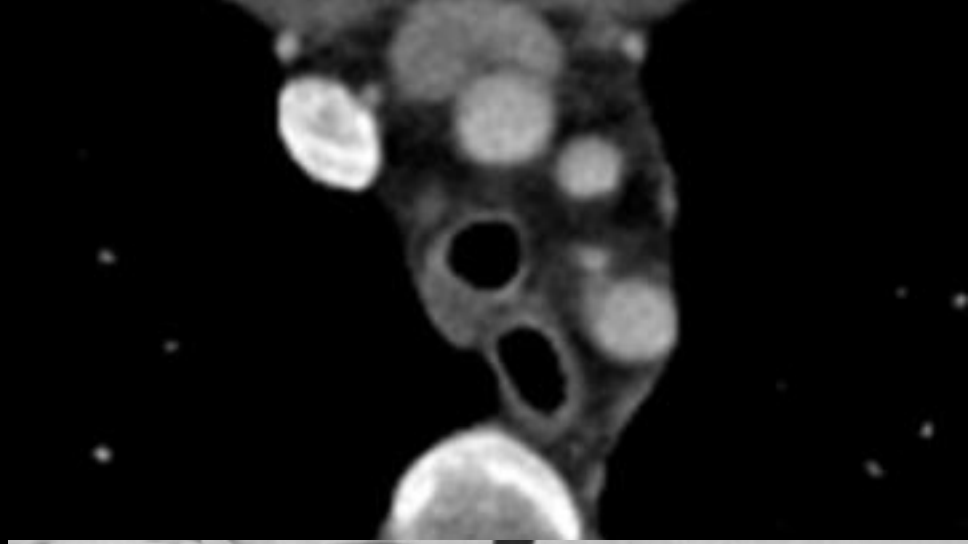
Relapsing Polychondritis



Relapsing Polychondritis (RPC)

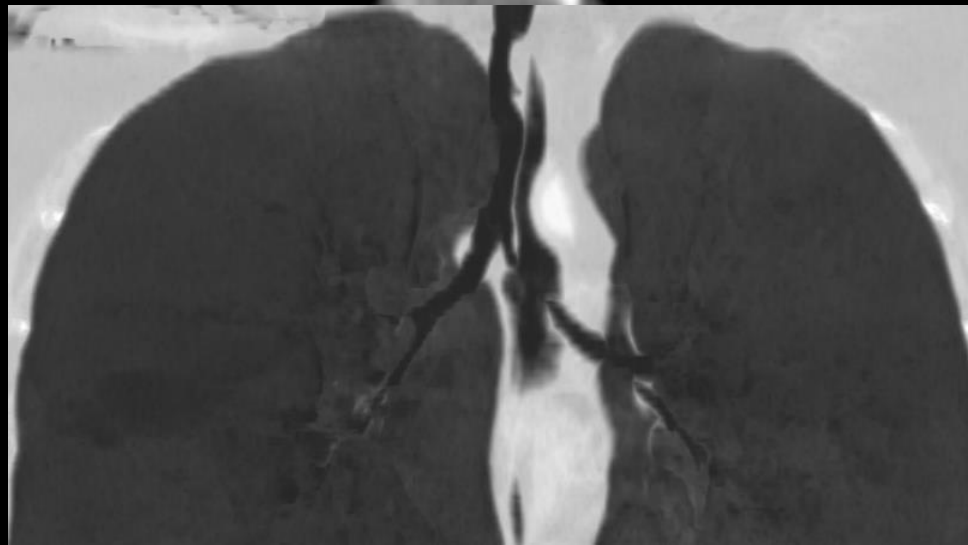
- Systemic, inflammatory disease of cartilage
  - Airways
  - Ears
  - Nose
  - Joints
  - Heart valves
- Recurrent respiratory infection major source of morbidity

Diffuse Tracheal Narrowing

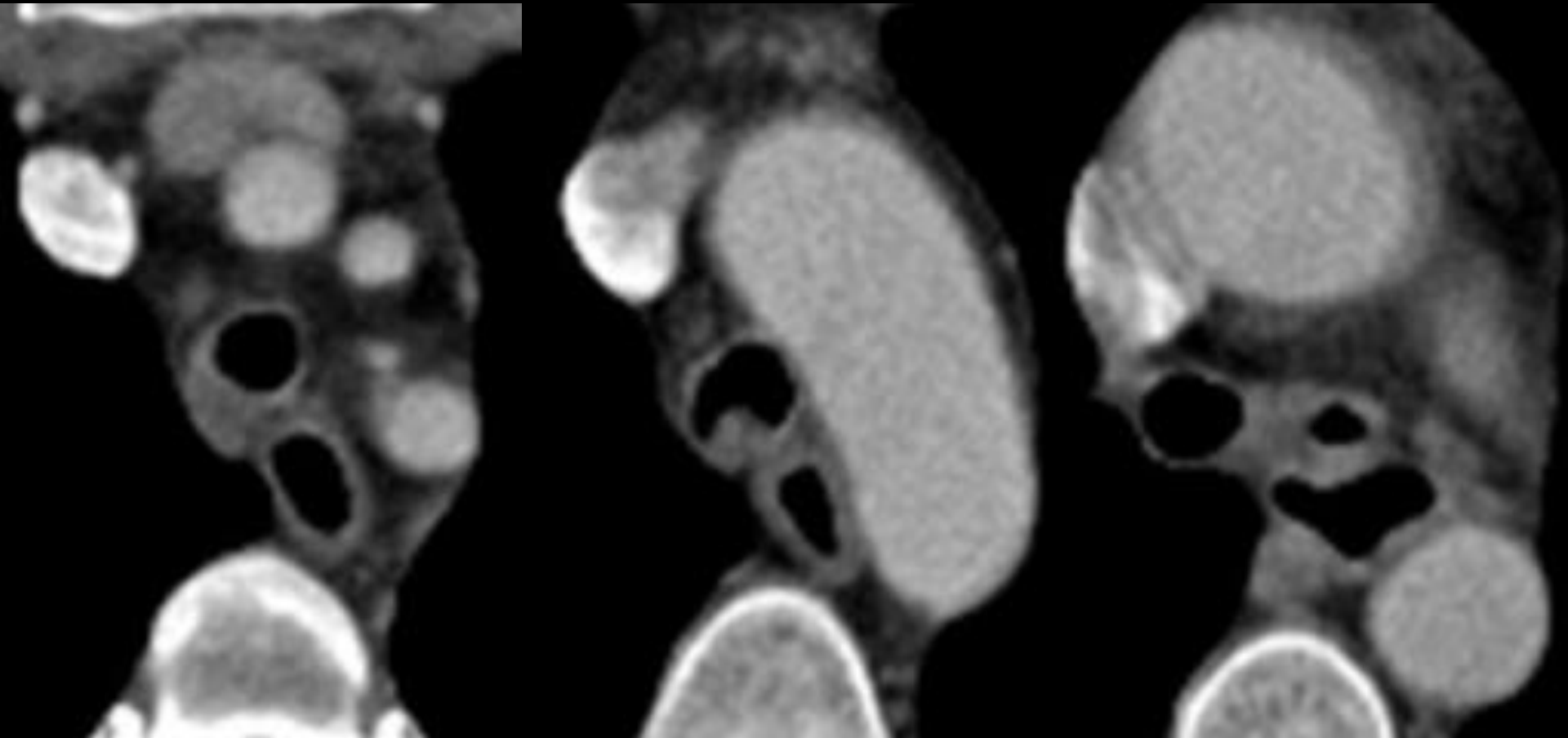


Involves posterior membrane:

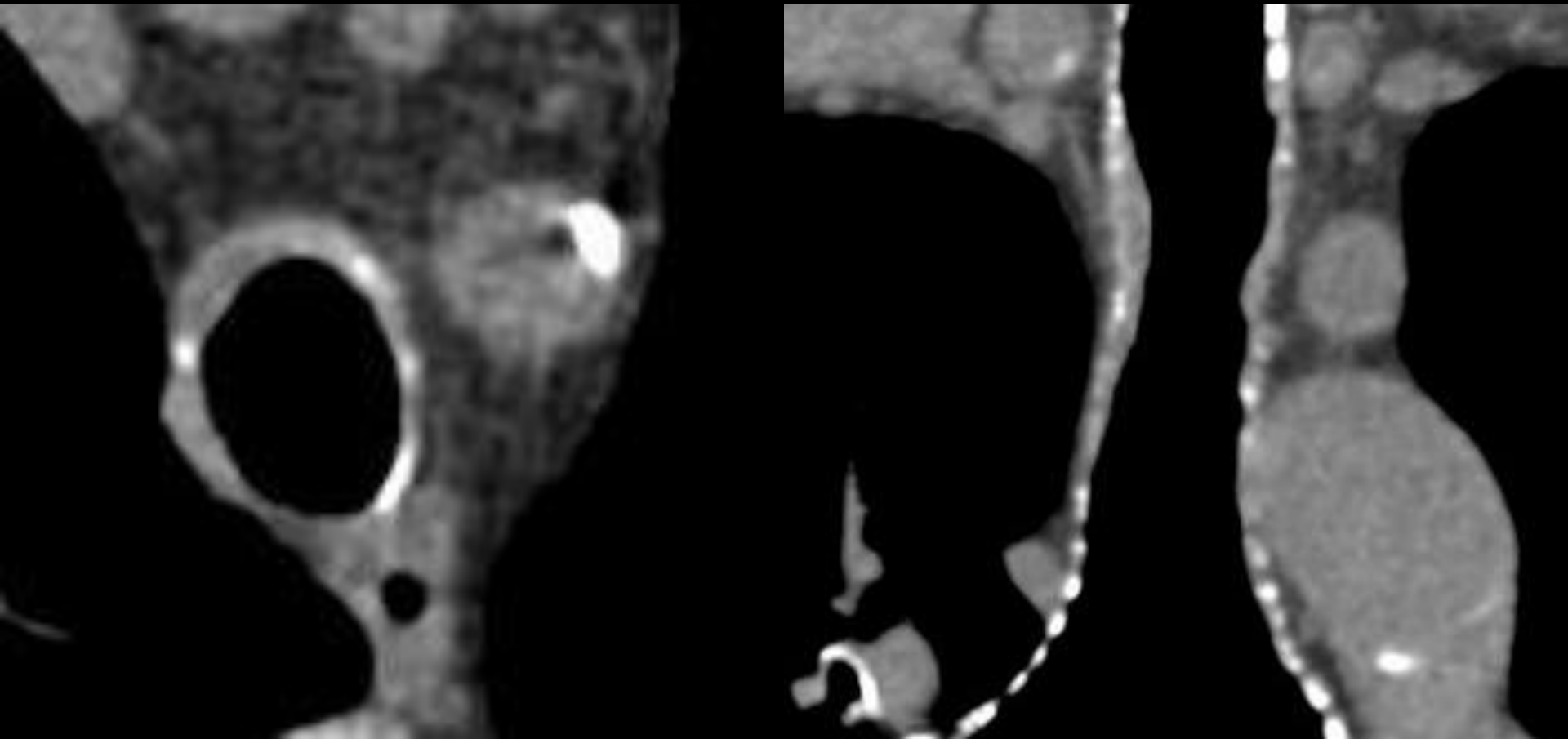
- Granulomatous disease
- Granulomatous infection
- Amyloid
- Inhalation/radiation
- Idiopathic



GPA – 28yo with renal failure

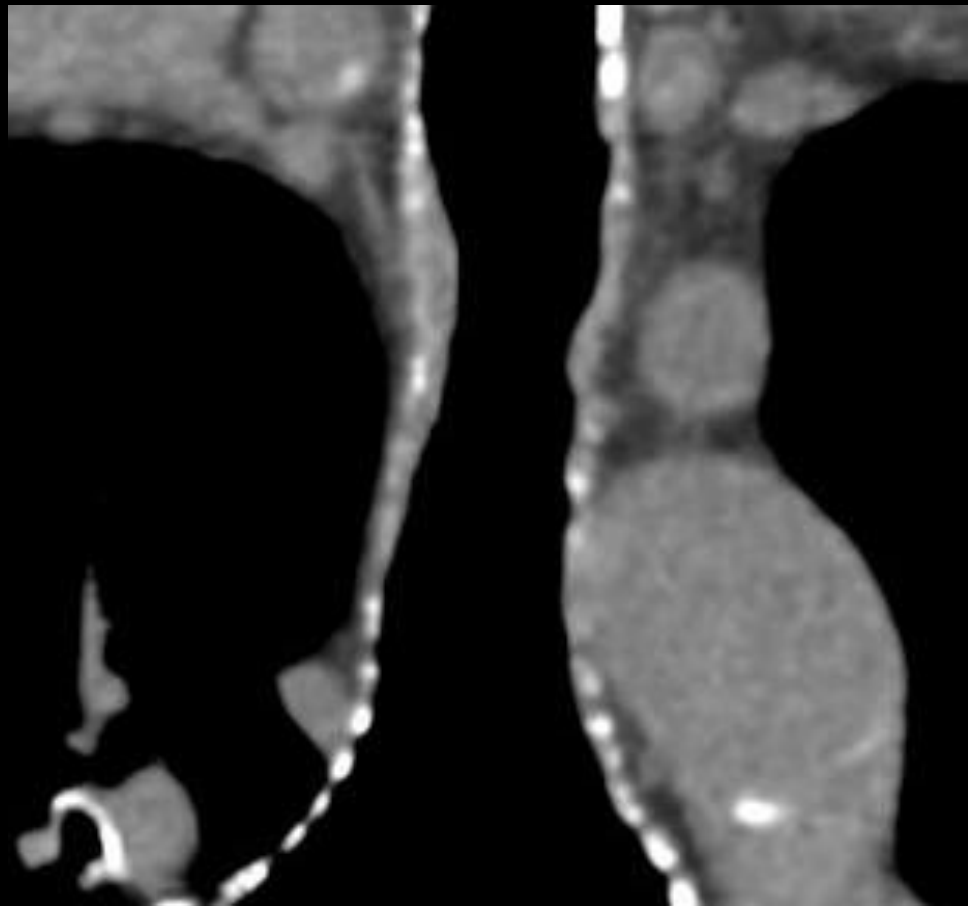


GPA



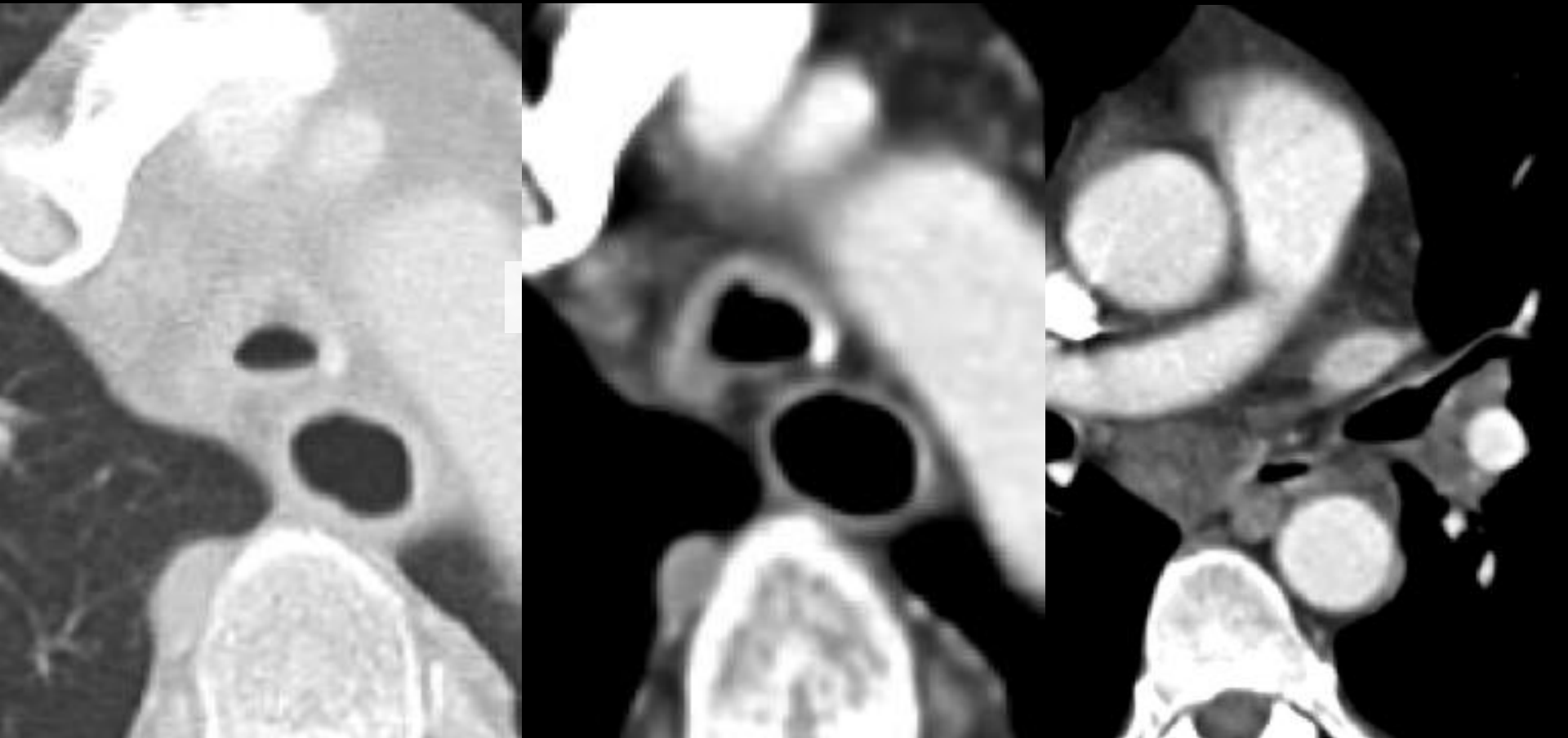
GPA

- Circumferential wall thickening
- Tracheal or bronchial stenosis (especially subglottic trachea)
- Tracheobronchomalacia
- Obstructive pneumonitis
- Nodules, masses, cavities
- Consolidation

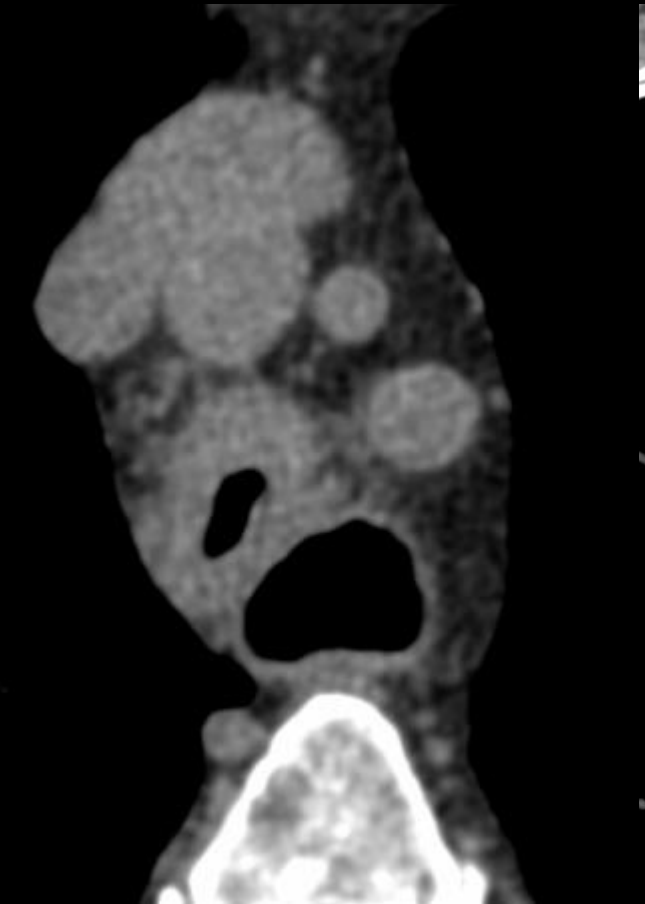


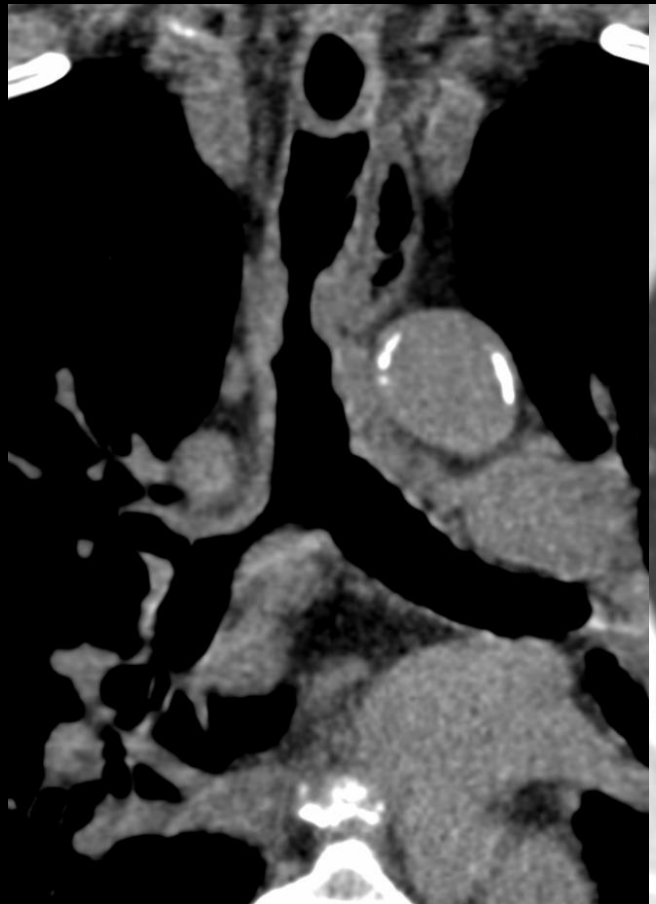
GPA

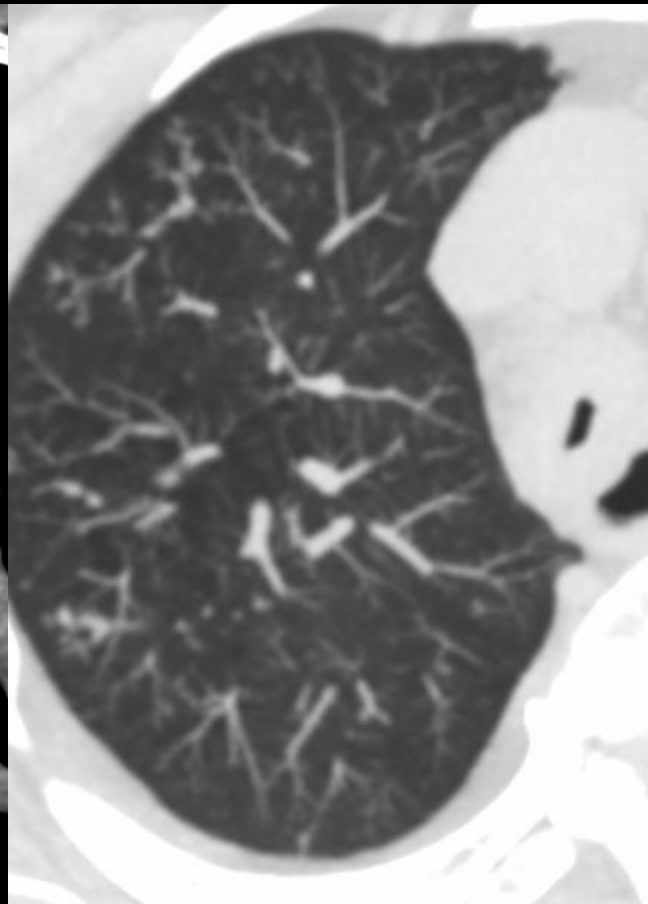
Granulomatous Infection (cryptococcus)



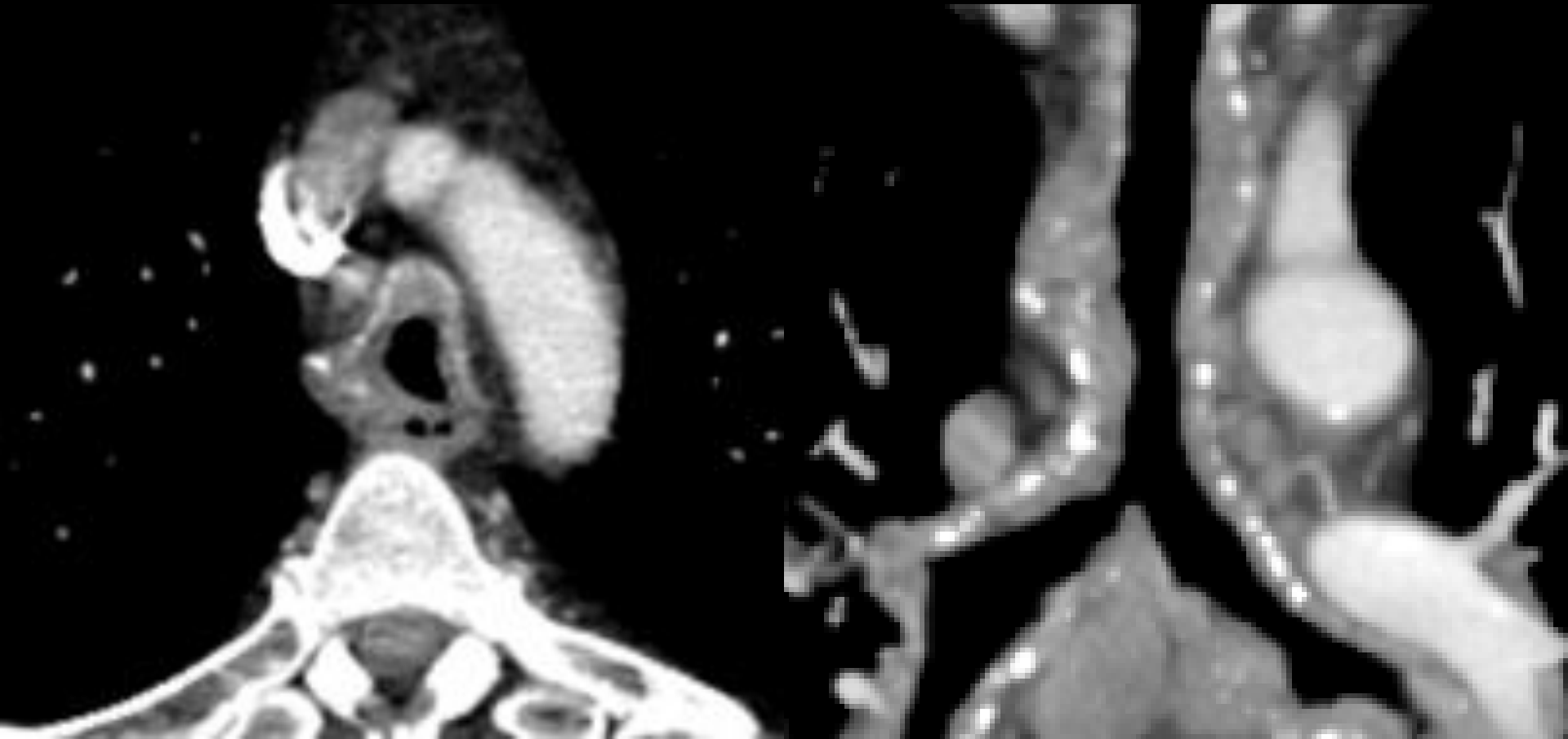
Granulomatous Infection (TB)





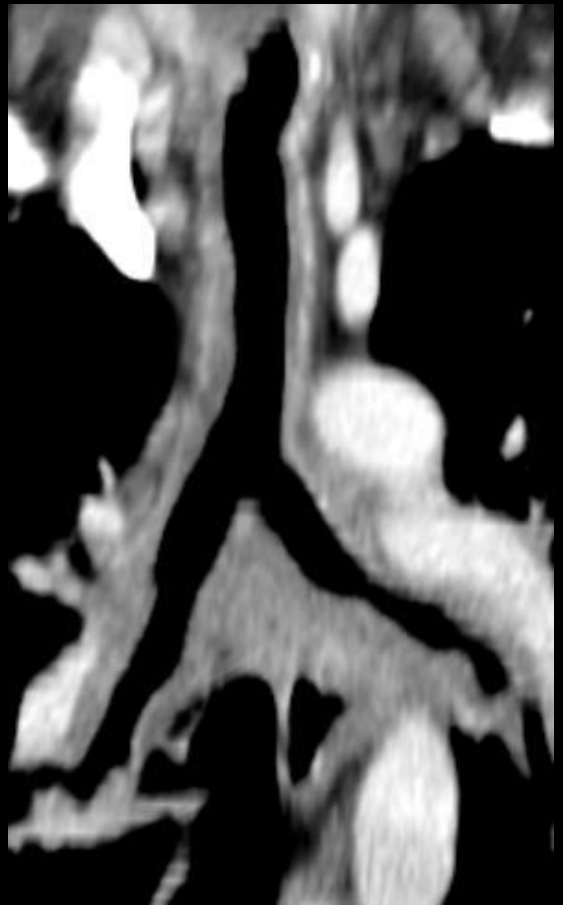


Amyloidosis

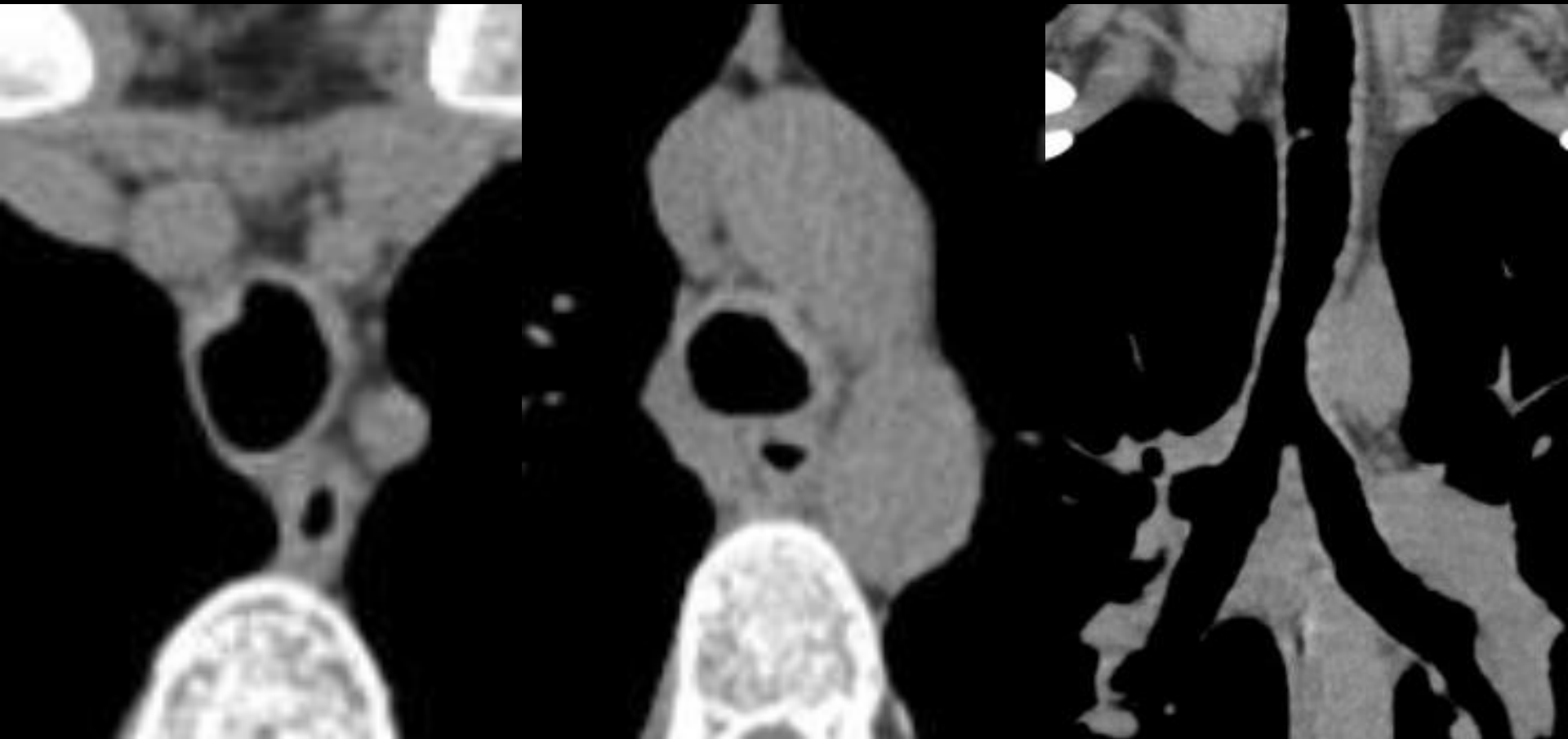


Tracheobronchial Amyloidosis

- Circumferential multifocal or diffuse tracheal wall thickening
- Luminal narrowing common
- Mural calcifications
- Focal endoluminal mass
- Usually limited to central airways

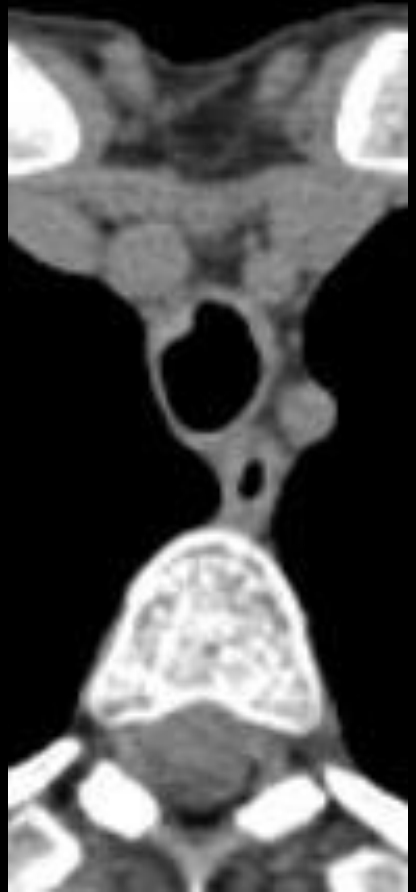


Inflammatory Bowel Disease

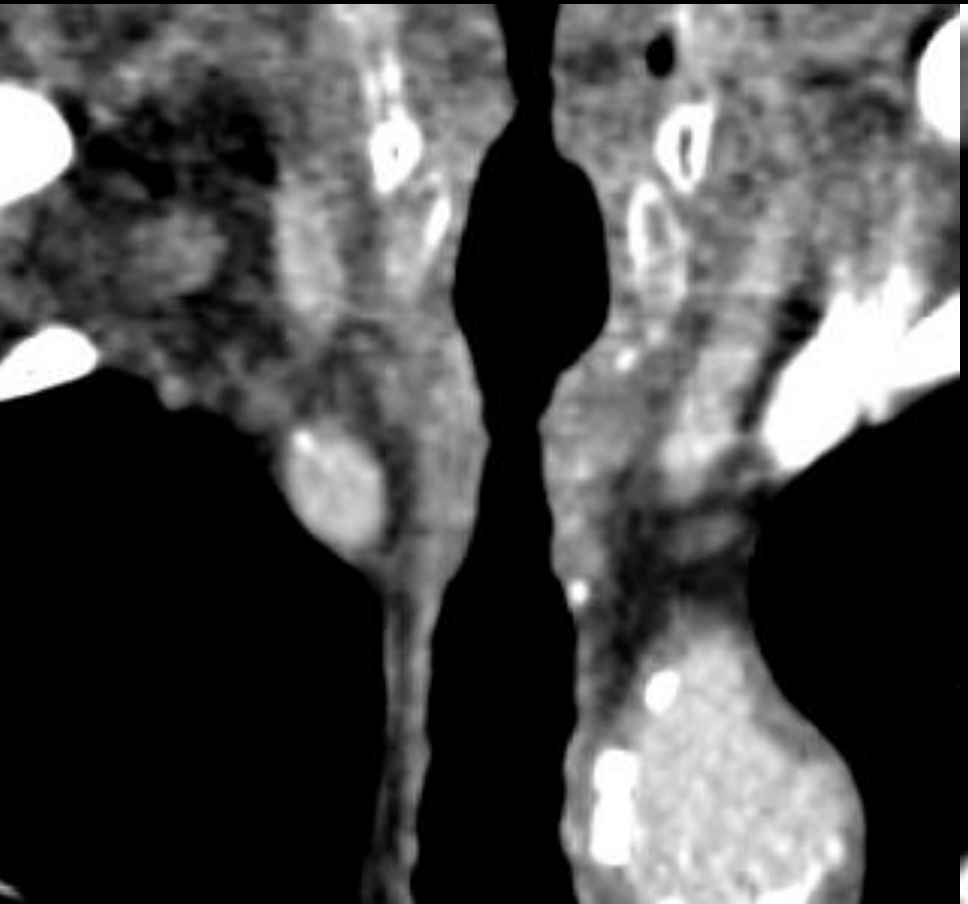


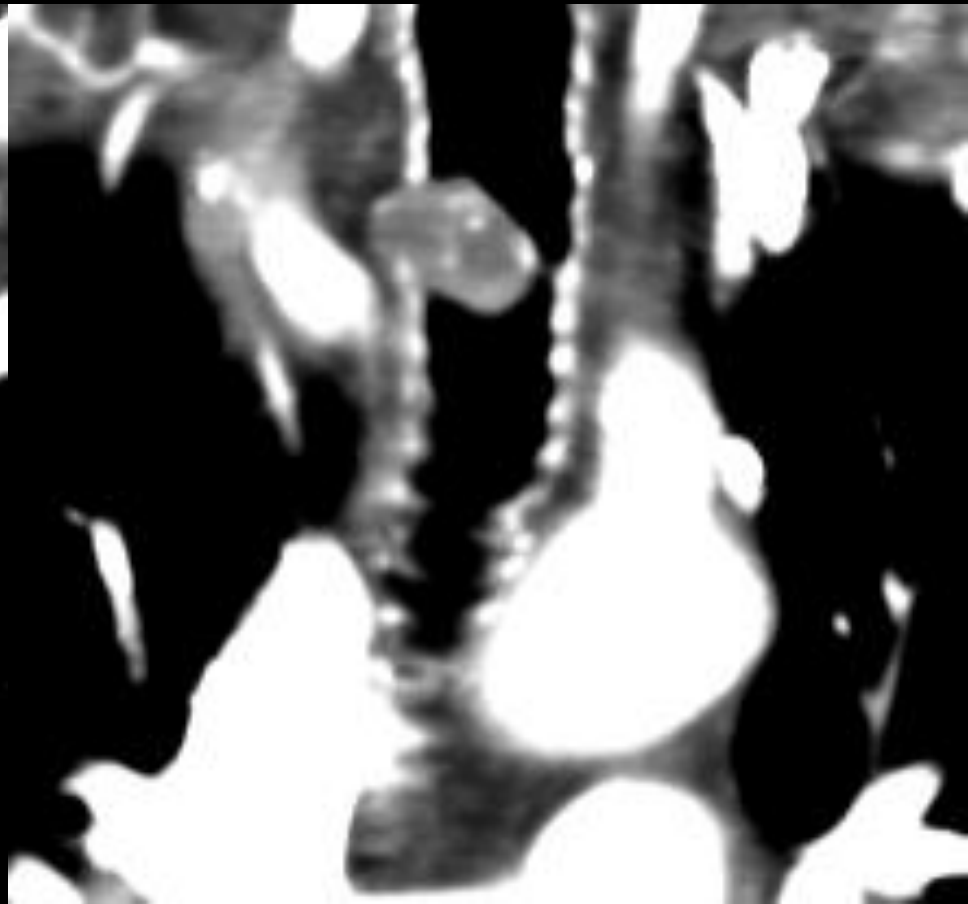
Inflammatory Bowel Disease

- Diffuse sclerosing tracheobronchitis
  - Very uncommon manifestation
  - Fibrosis or constrictive bronchiolitis more common
- More frequent with ulcerative colitis
- No clear relationship with disease activity in the gastrointestinal system
  - May develop after colectomy or with quiescent gastrointestinal disease

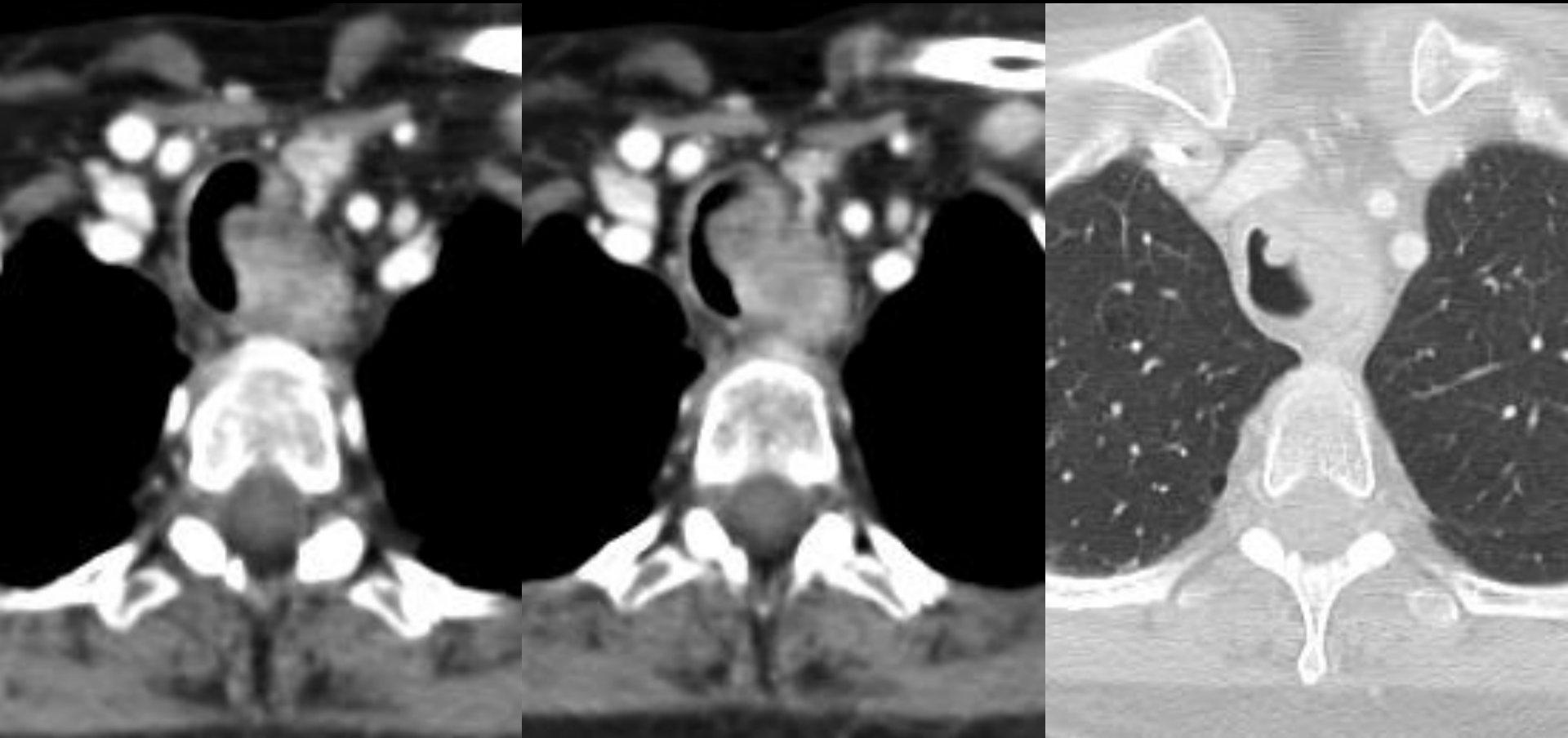


Focal Narrowing – Mass or No Mass?

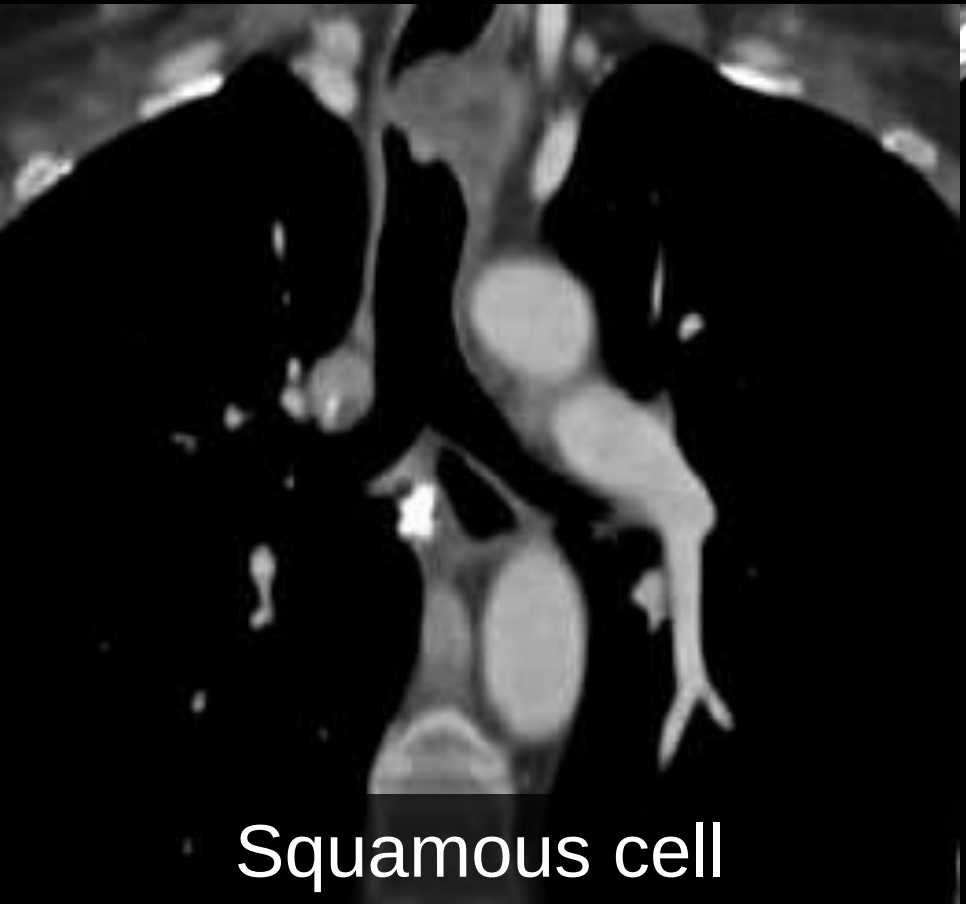




Focal Narrowing – Mass



Focal Narrowing - Mass

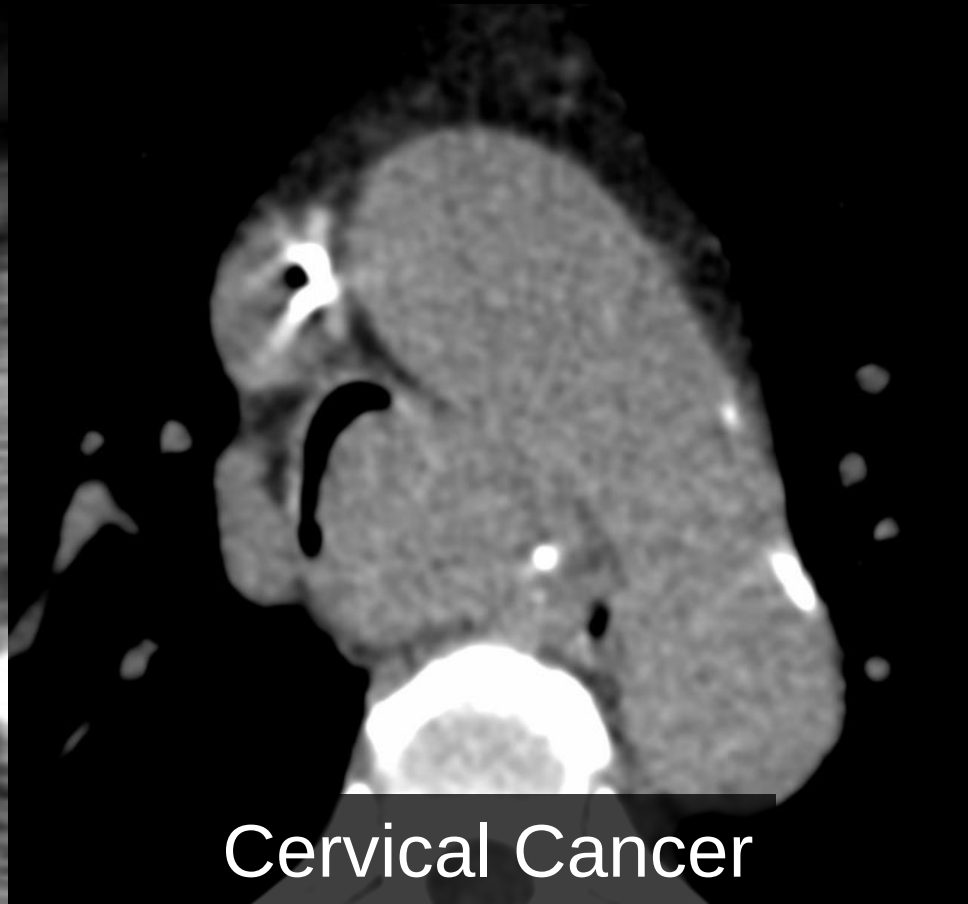


Squamous cell

Adenoid Cystic

Focal Narrowing - Mass

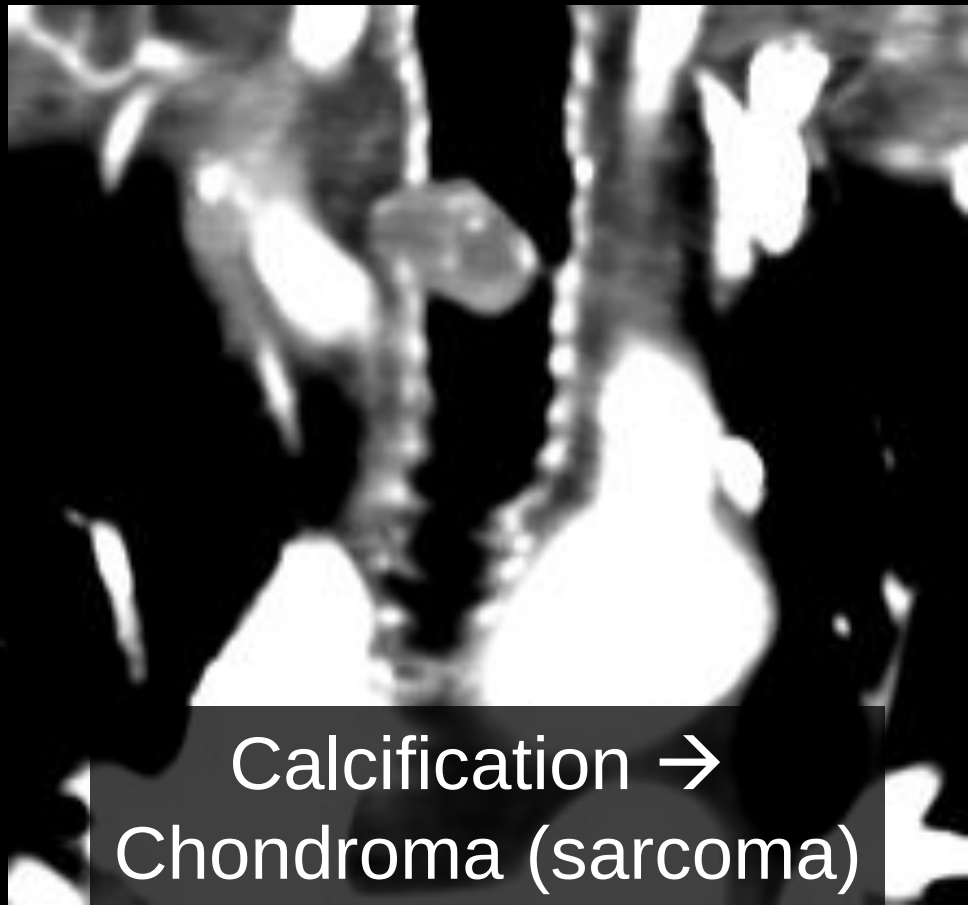
Lymphoma



Cervical Cancer

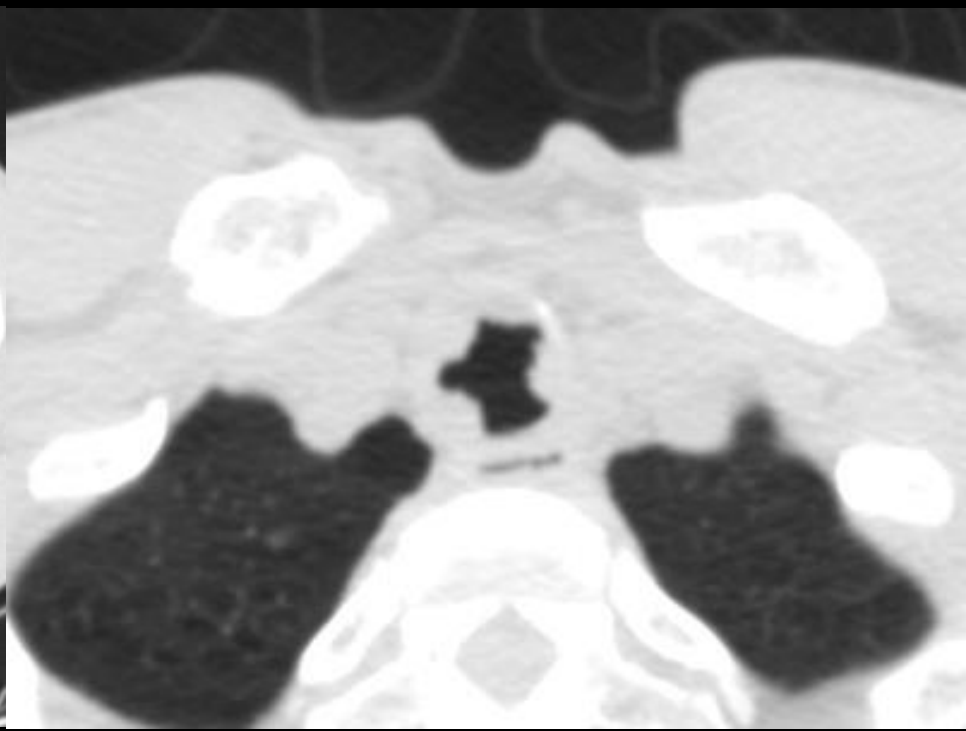
Attenuation Occasionally Helps…

Macroscopic Fat → Hamartoma



Calcification → Chondroma (sarcoma)

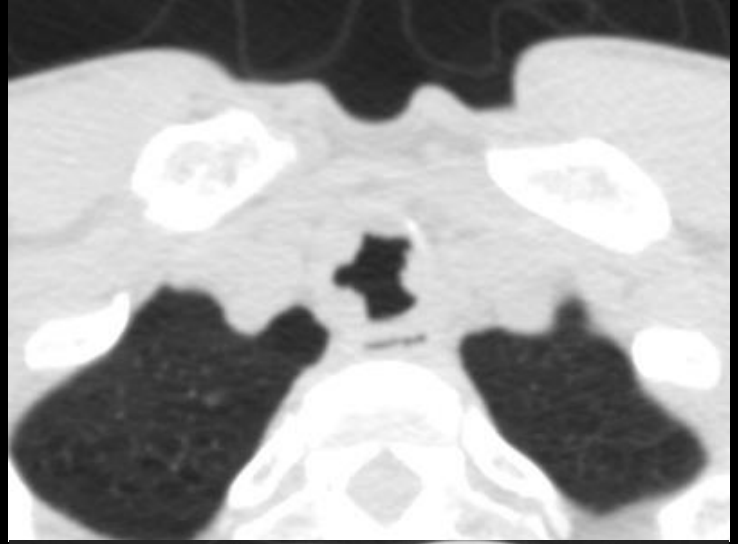
Papillomatosis

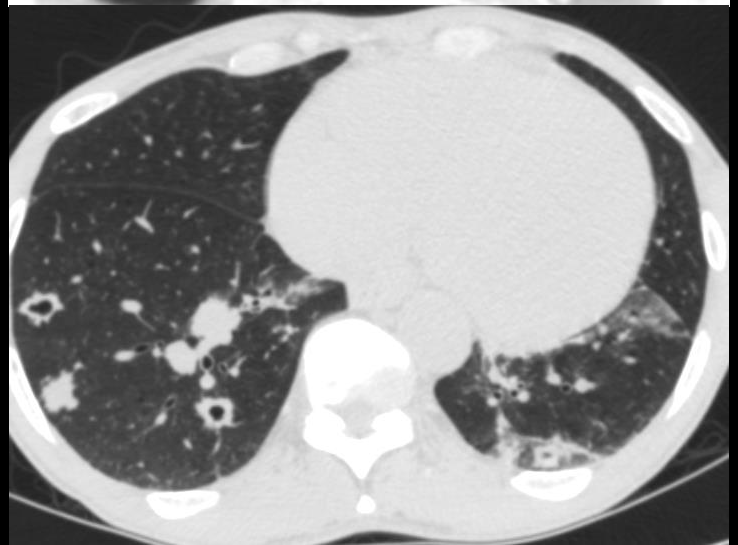


52-year-old man

Tracheobronchial Papillomatosis

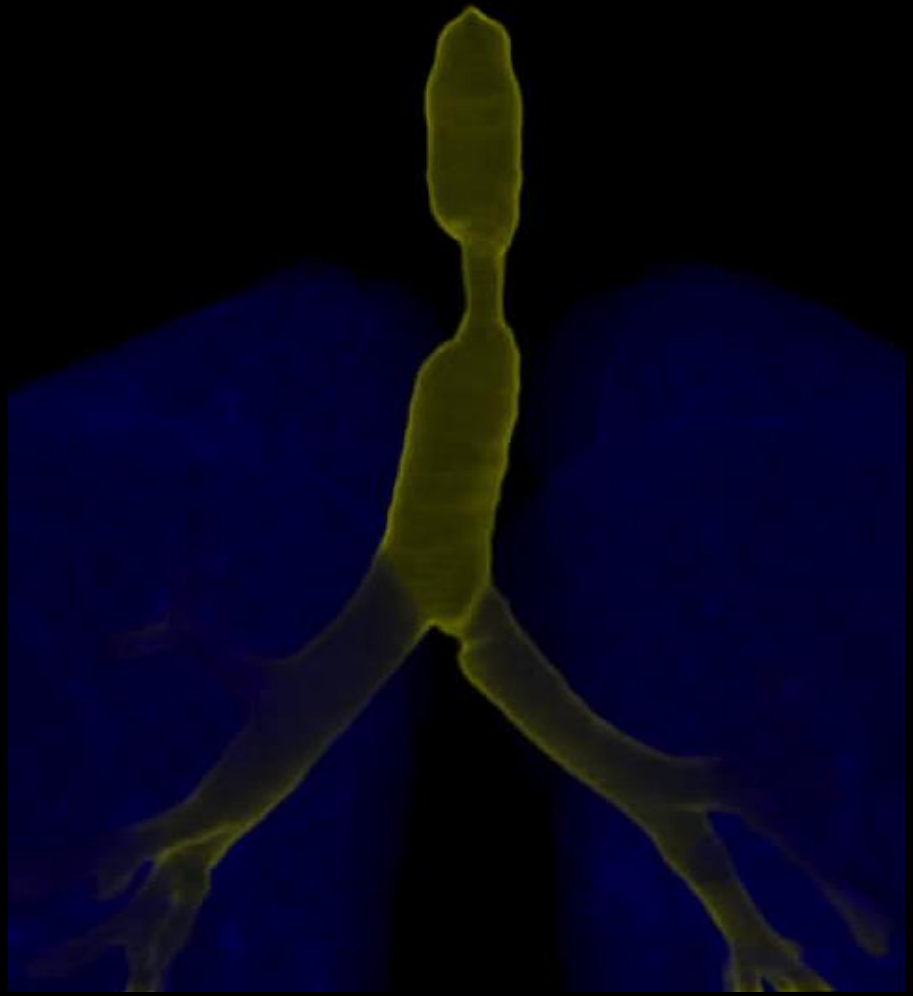
- HPV (6, 11)
- Bimodal distribution
- ~90% recurrence rate
- Squamous cell carcinoma transformation risk



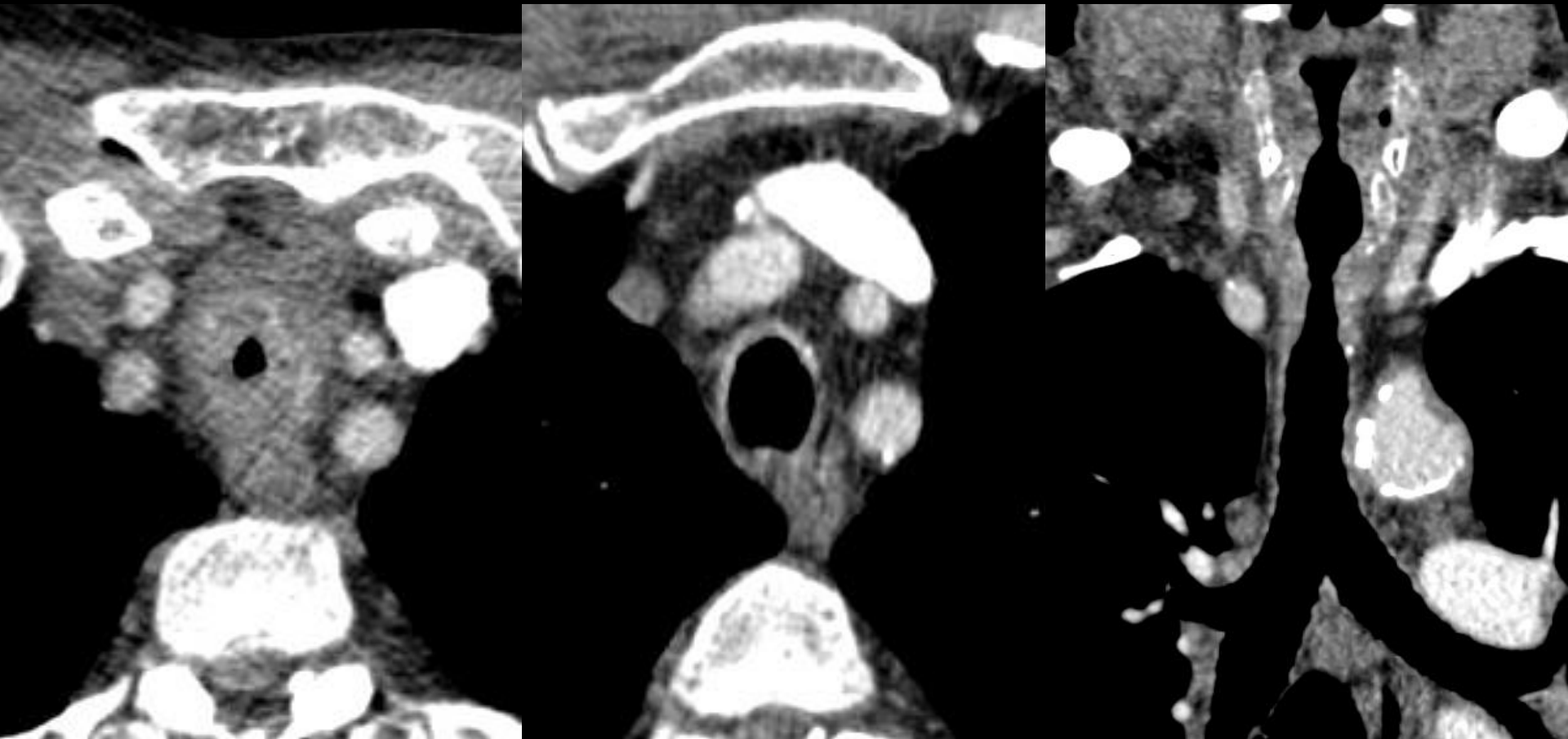


Focal Tracheal Narrowing

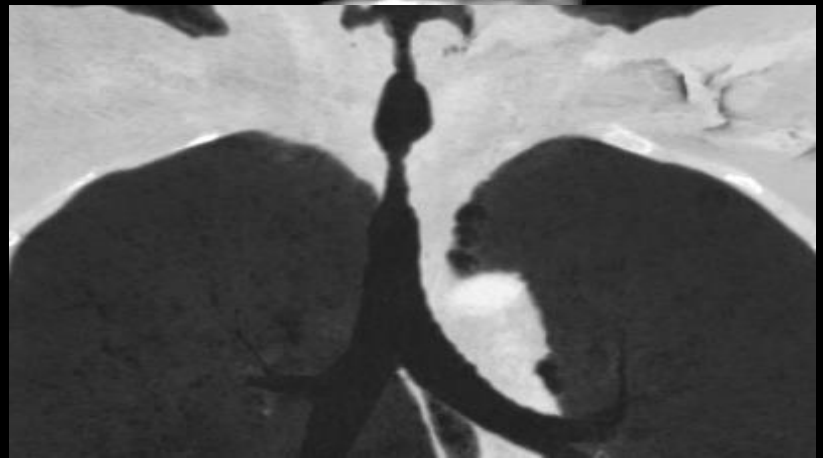
- Mass
  - Lumpy bumpy
  - Eccentric
- No mass (extrinsic vs intrinsic)
  - Smooth thickening
  - Clinical history



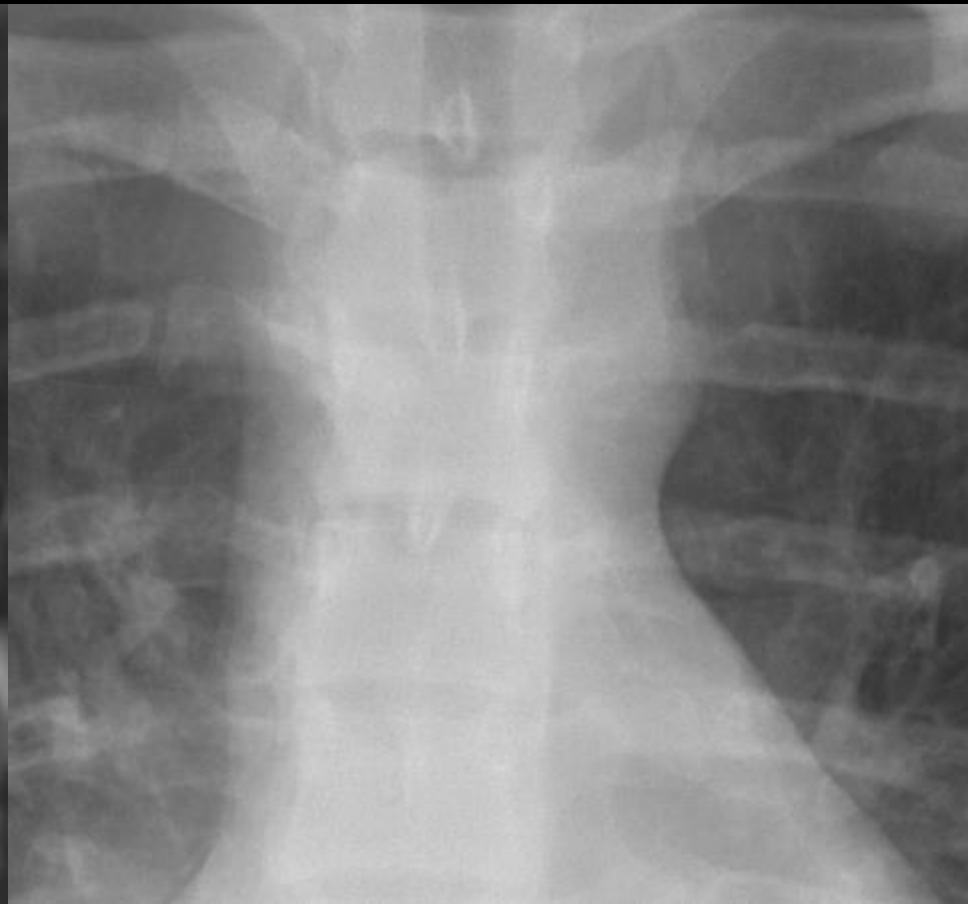
Post-Intubation Stenosis



Balloon Cuff vs. Tracheostomy



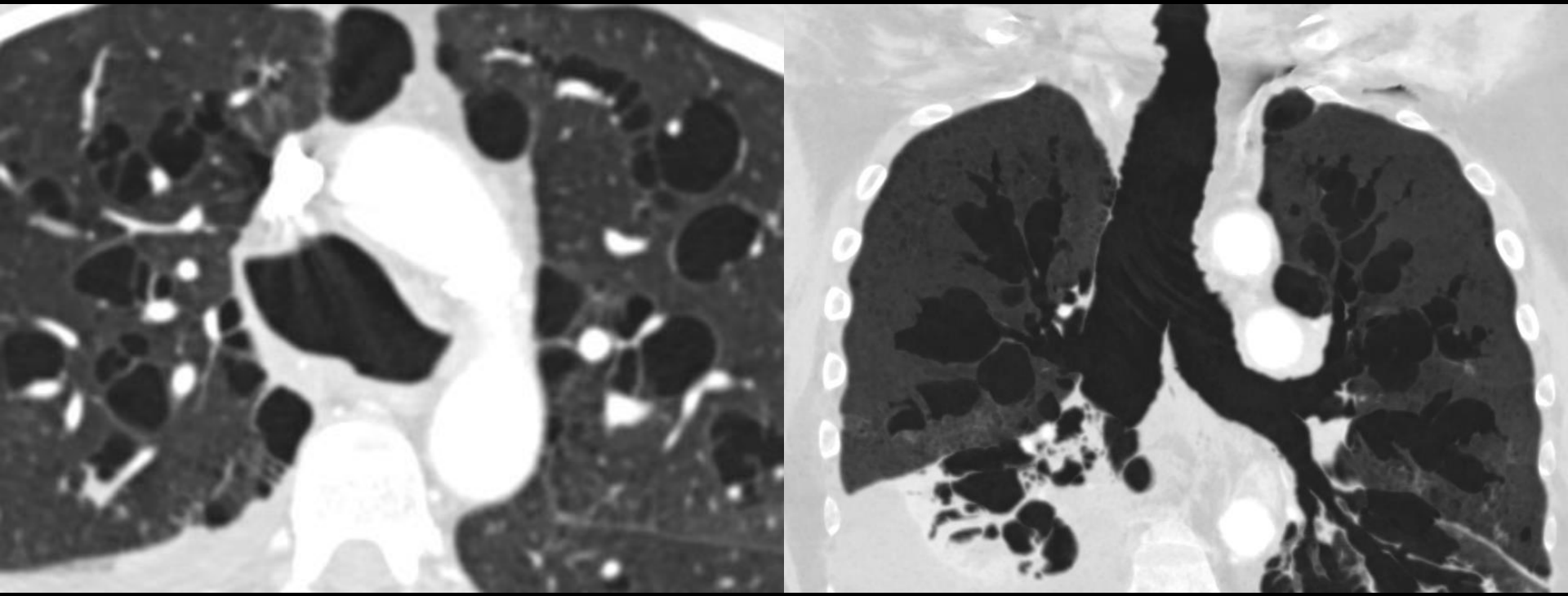
Extrinsic Compression – Double Arch



Airway Enlargement

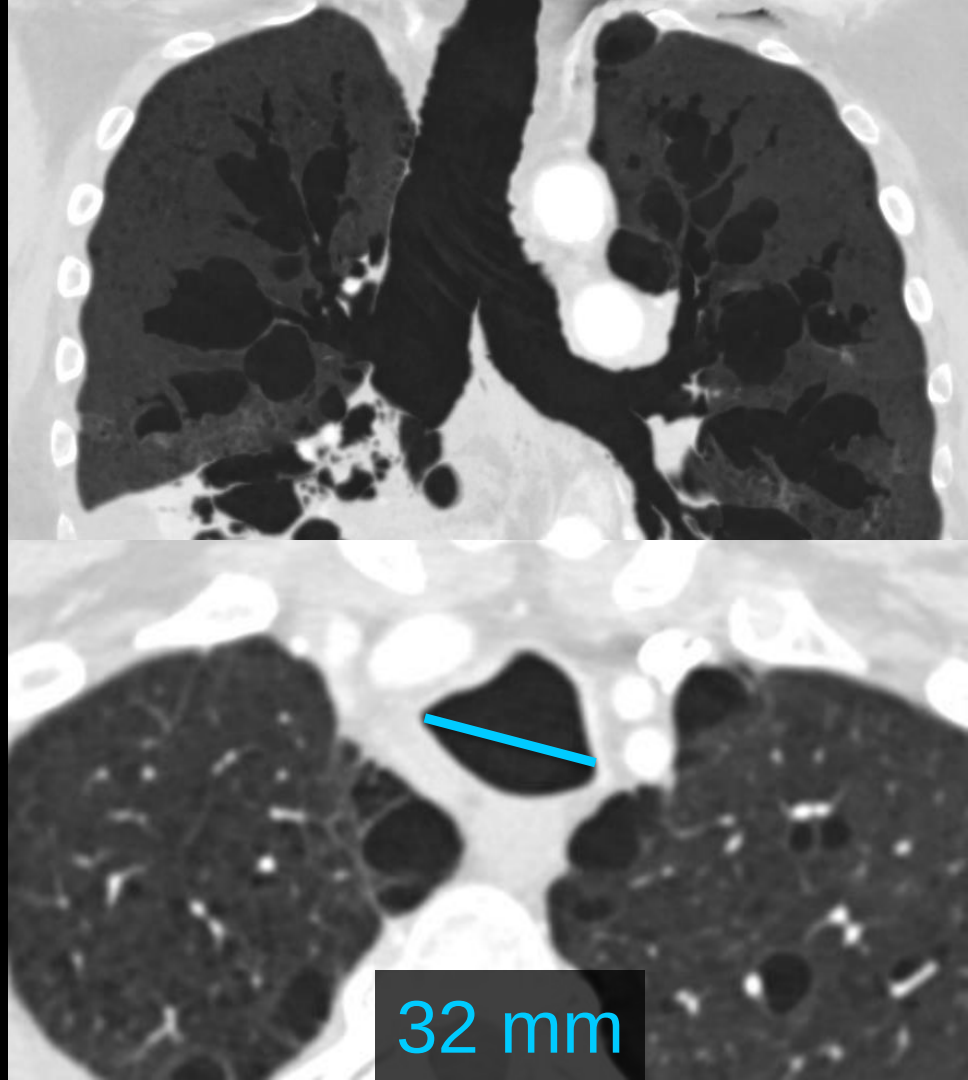
Acquired vs. congenital

Congenital Tracheobronchomegaly



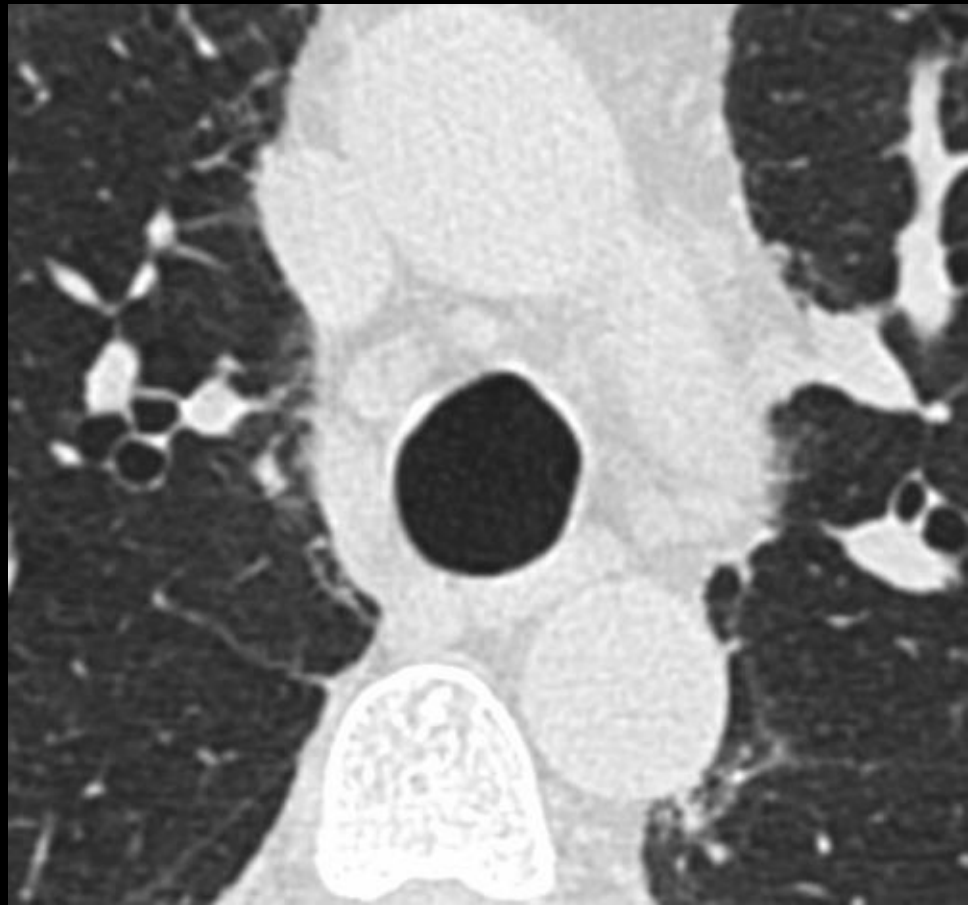
Congenital Tracheobronchomegaly

- Aka Mounier-Kuhn
- Absence/thinning of airway wall
- Uniform dilation of trachea and 1st-3rd order bronchi
- Chronic cough, repeated infection

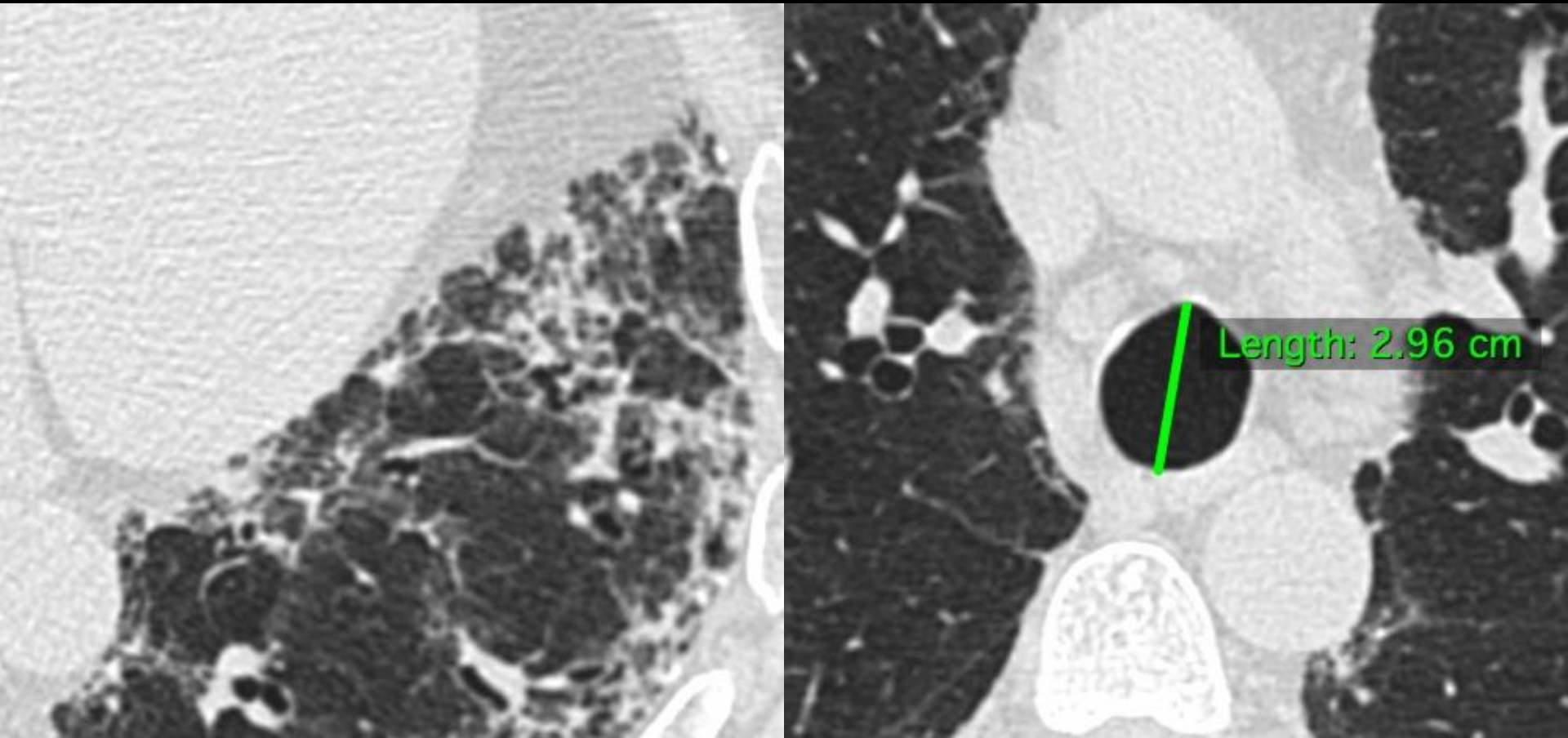


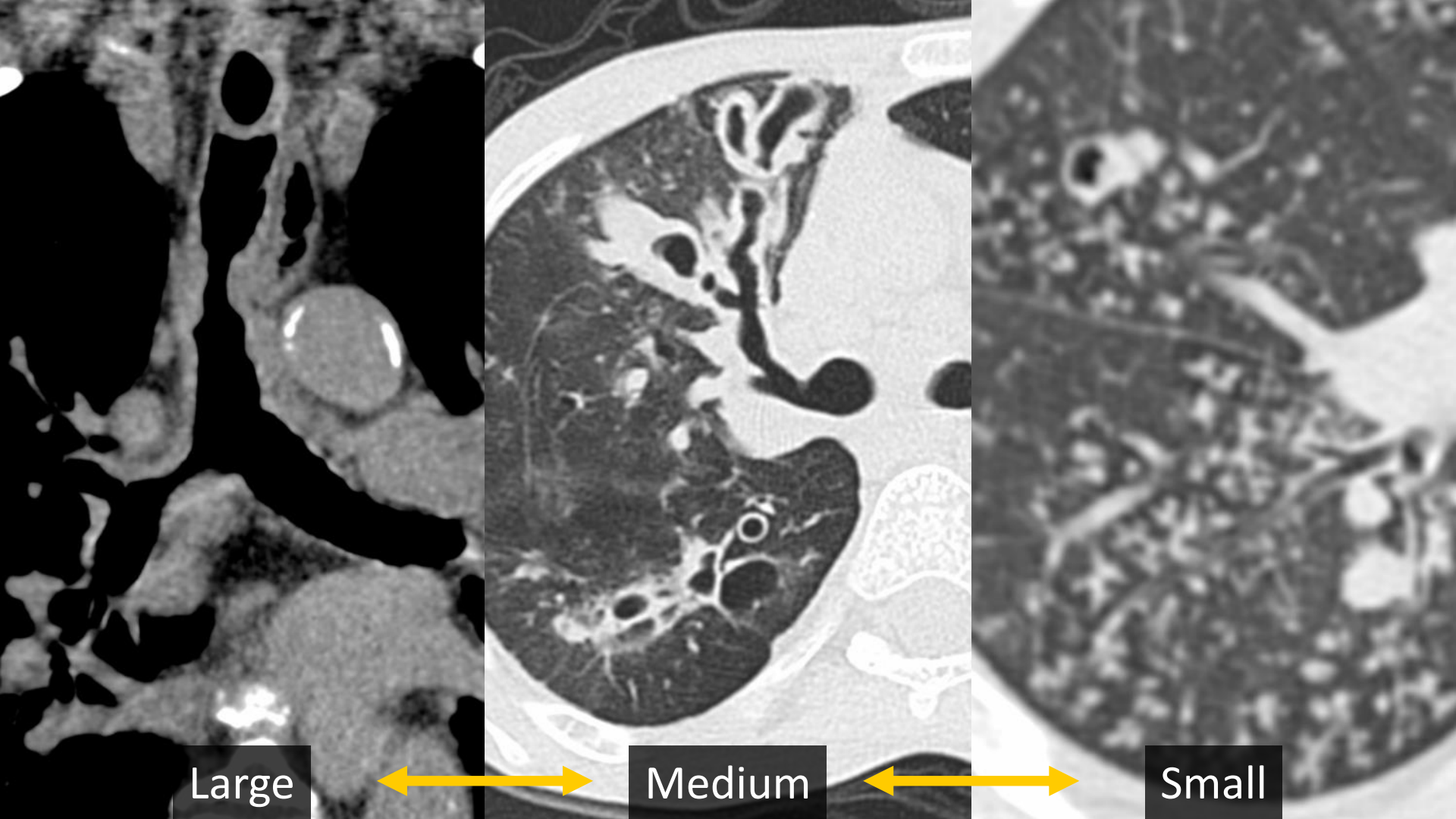
Acquired Tracheomegaly

- Seen in fibrosis or COPD
- More likely to maintain circular shape
- May exceed 26 mm cutoff



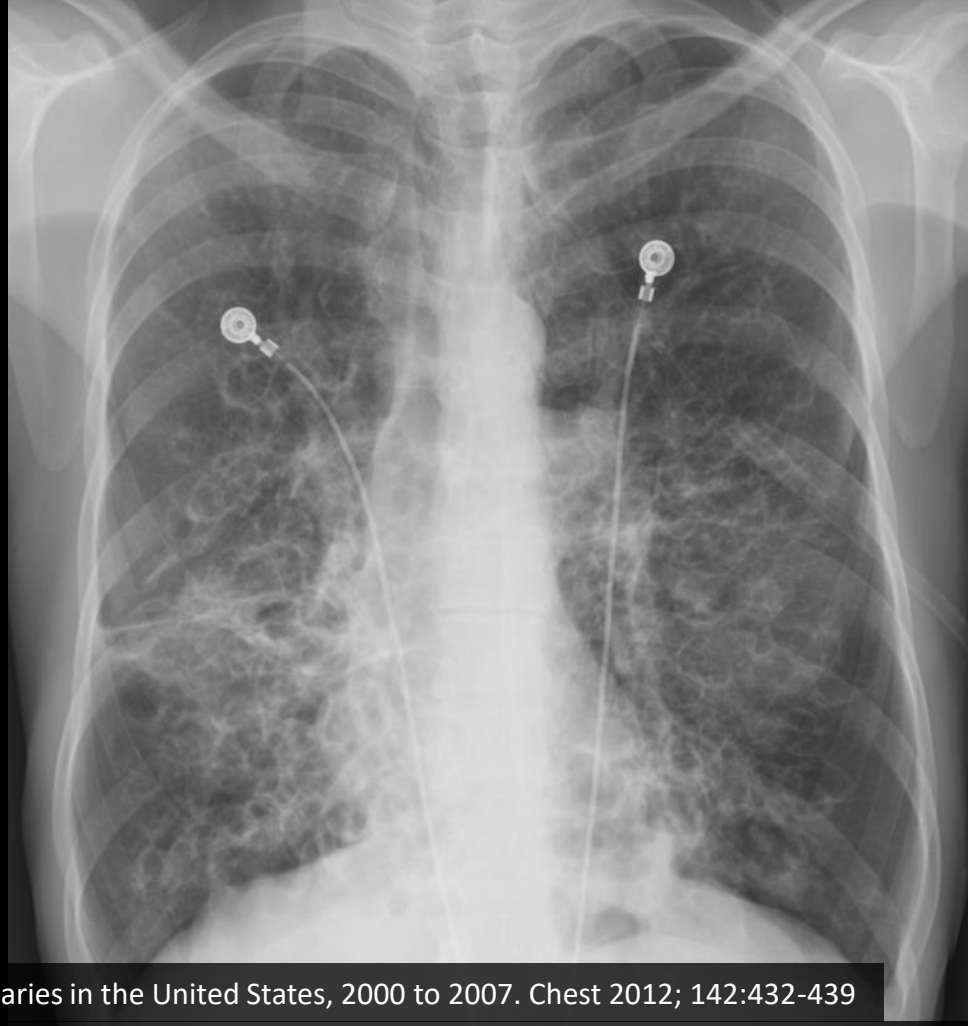
Acquired Tracheomegaly




Large
Medium
Small

Bronchiectasis

- Irreversible dilation of the bronchial tree



[1]Seitz AE et al. Trends in bronchiectasis among medicare beneficiaries in the United States, 2000 to 2007. Chest 2012; 142:432-439

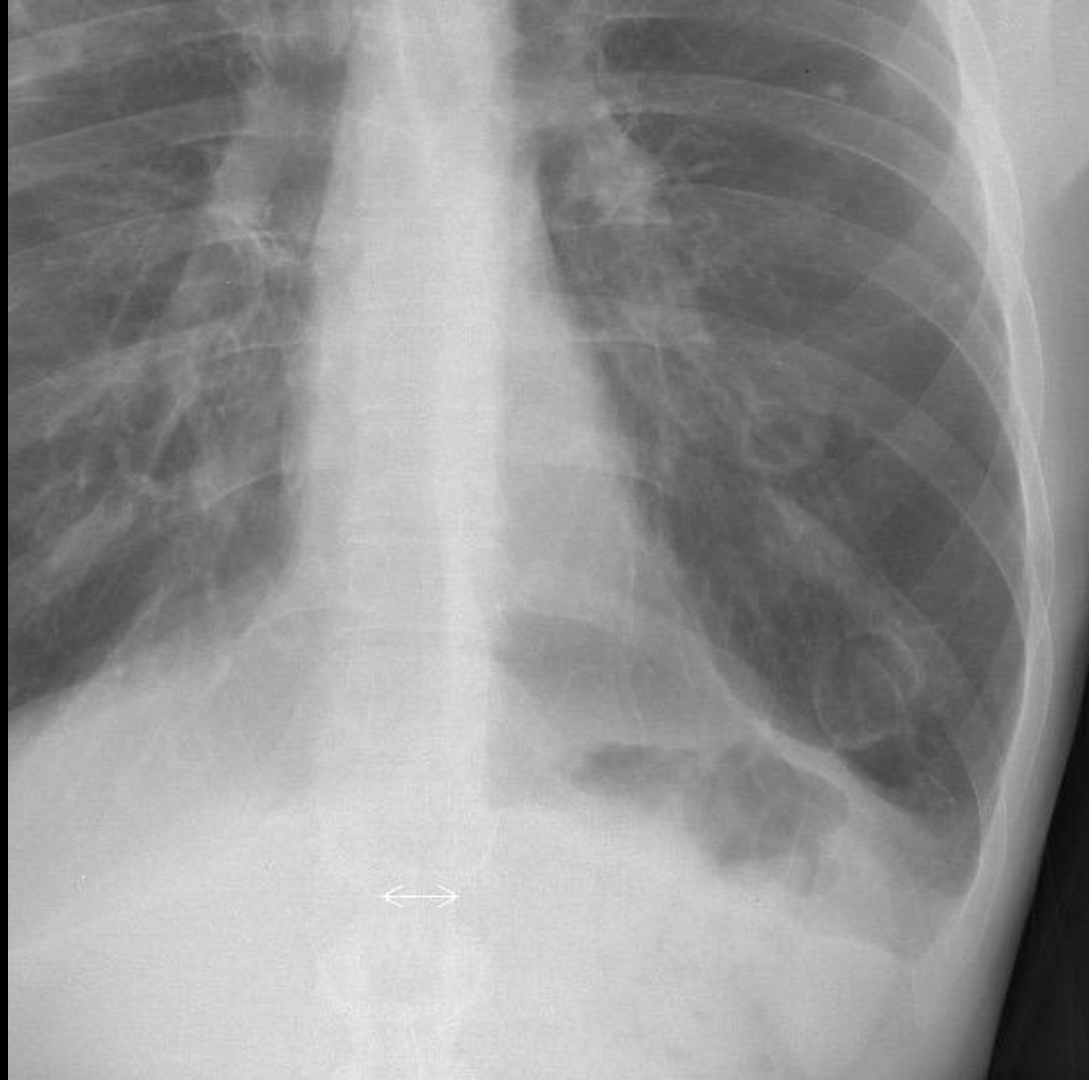
[2]Quint JK et al. Changes in the incidence, prevalence and mortality of bronchiectasis in the UK from 2004 to 2013. Eur Respir J 2016; 47:186-193

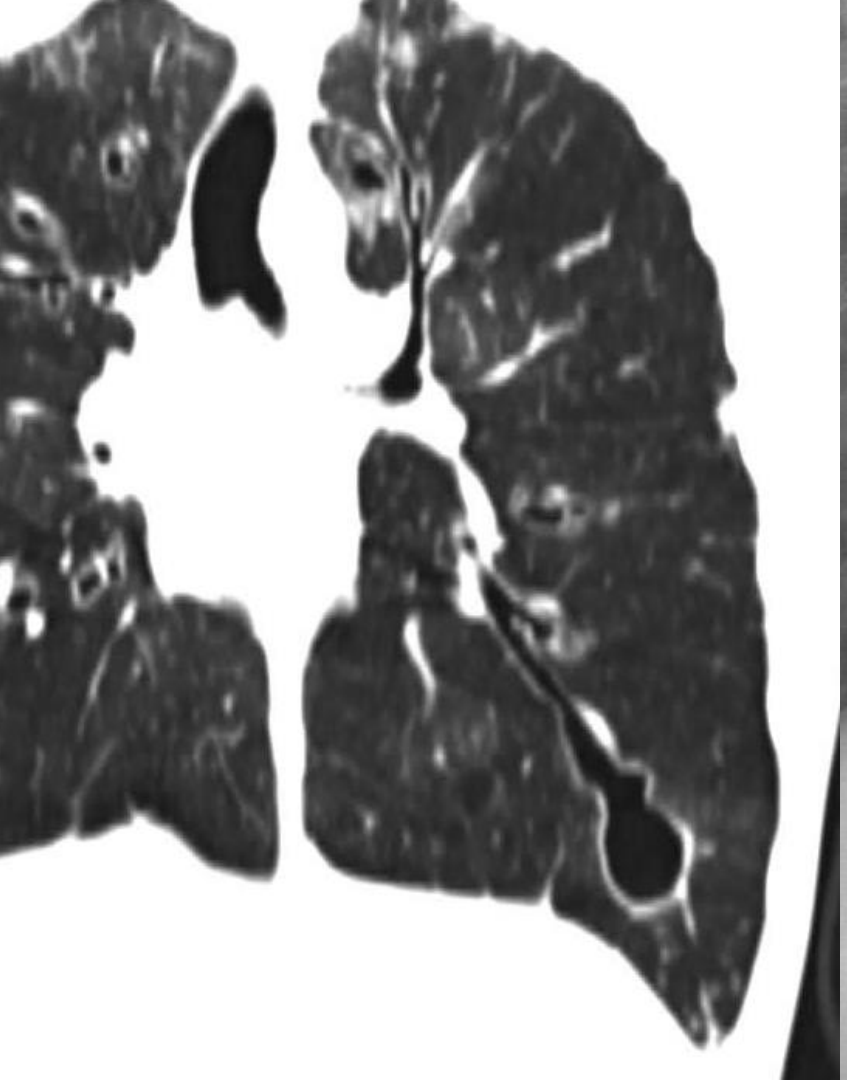
Bronchiectasis – Radiographic Findings

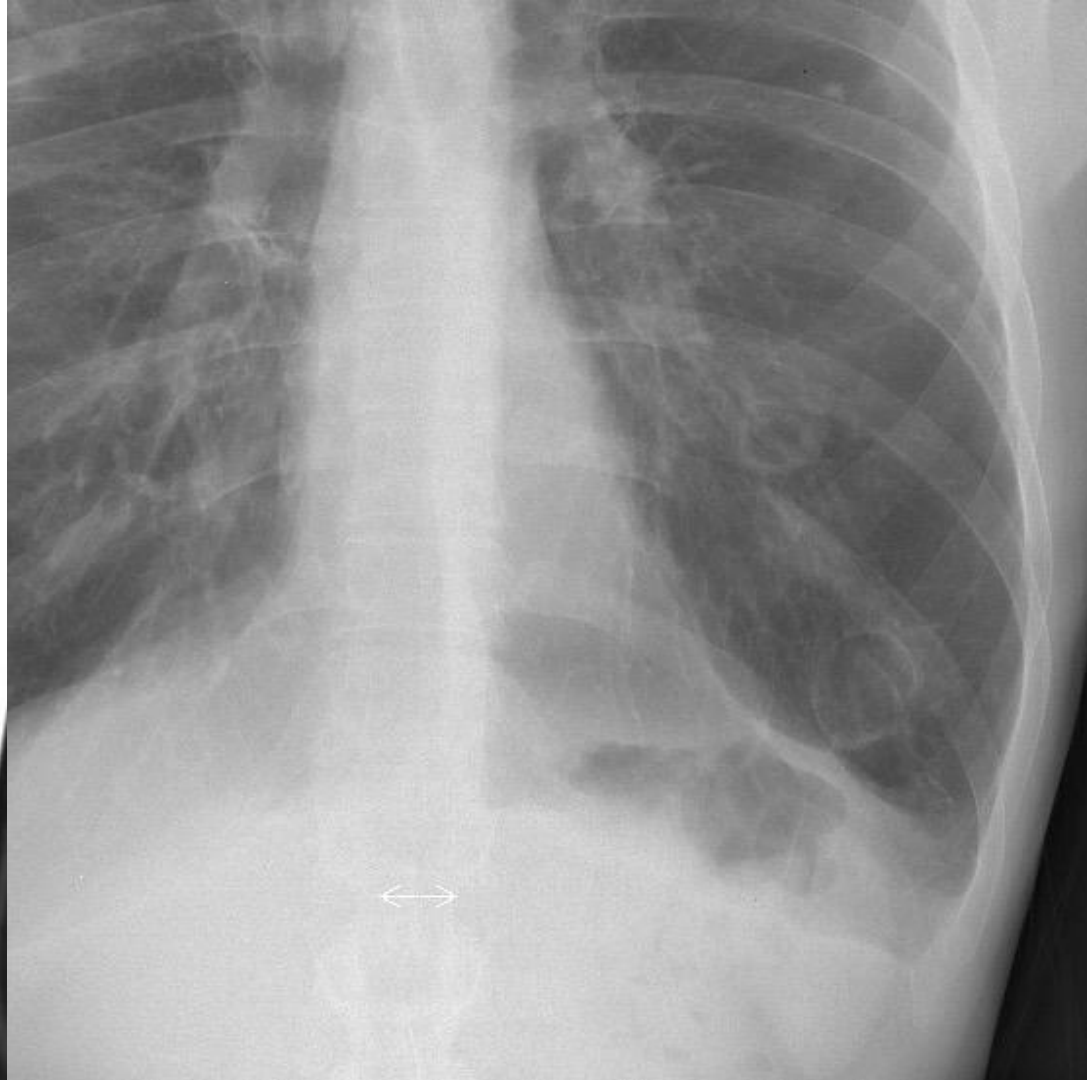
- Bronchial wall thickening
- ”Tram-track”
- ”Ring-like” opacities
- Plugged bronchi

Bronchiectasis – Radiographic Findings

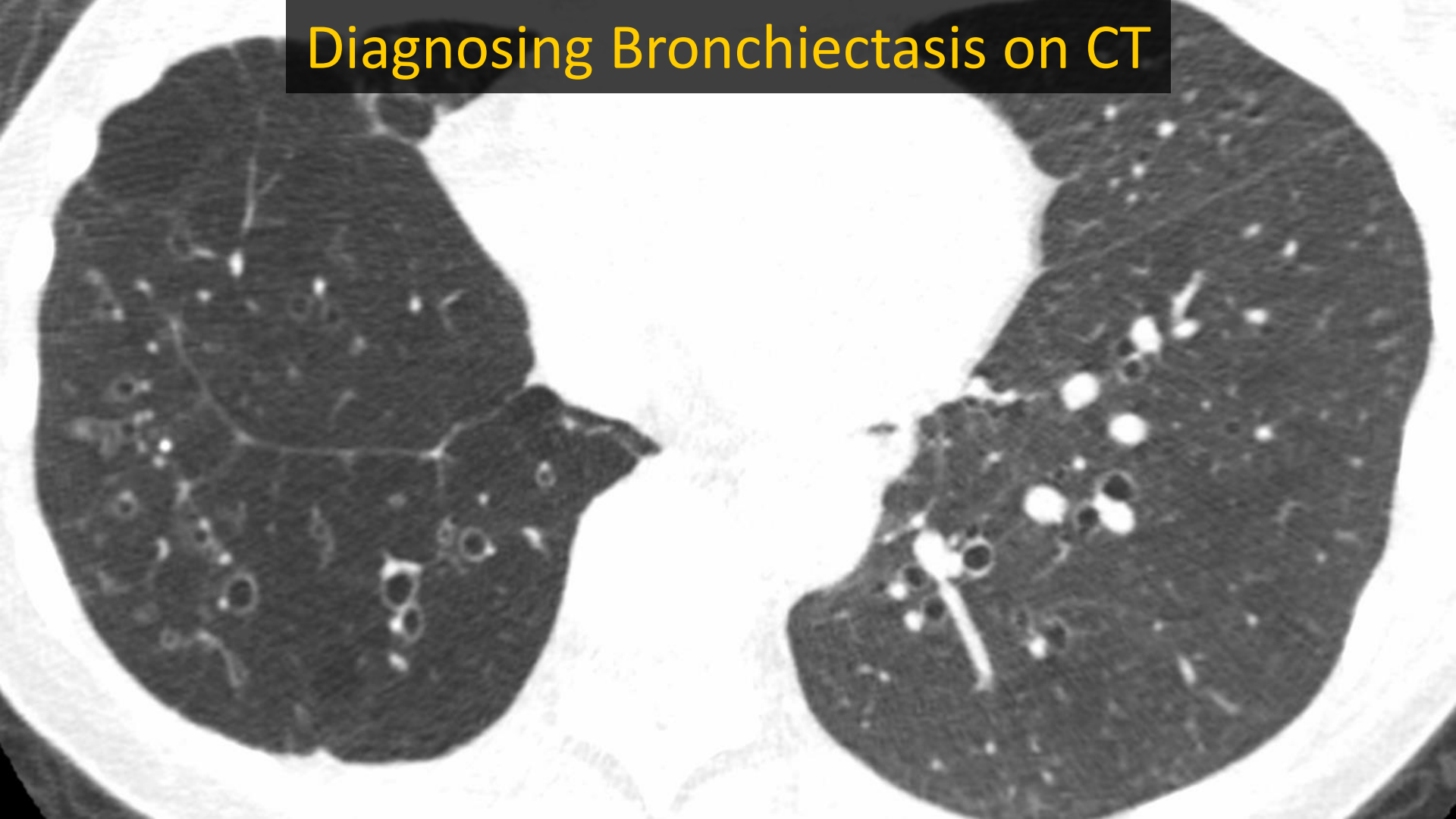
- Bronchial wall thickening
- ”Tram-track”
- ”Ring-like” opacities
- Plugged bronchi
- Paucity of vessels

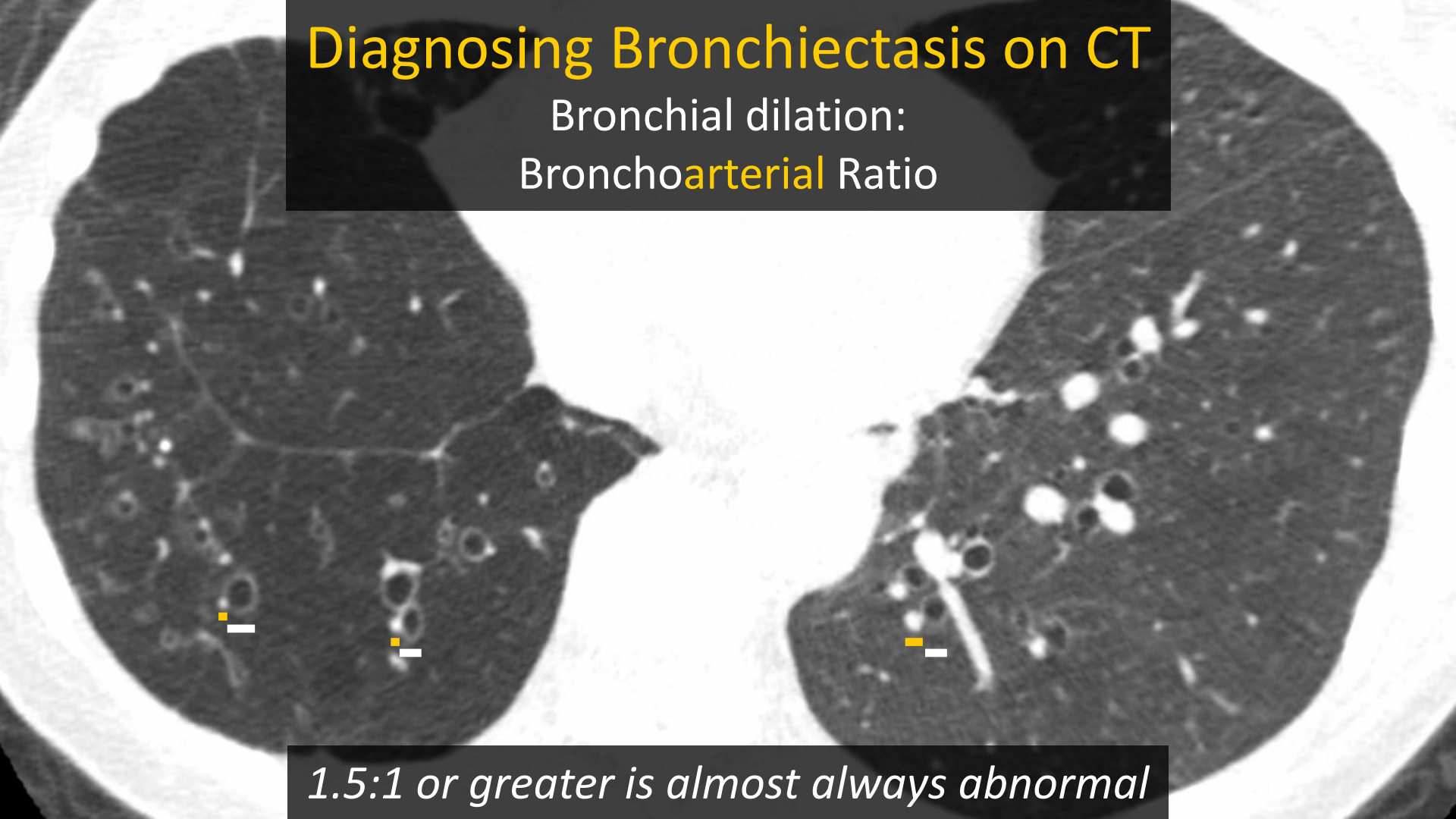


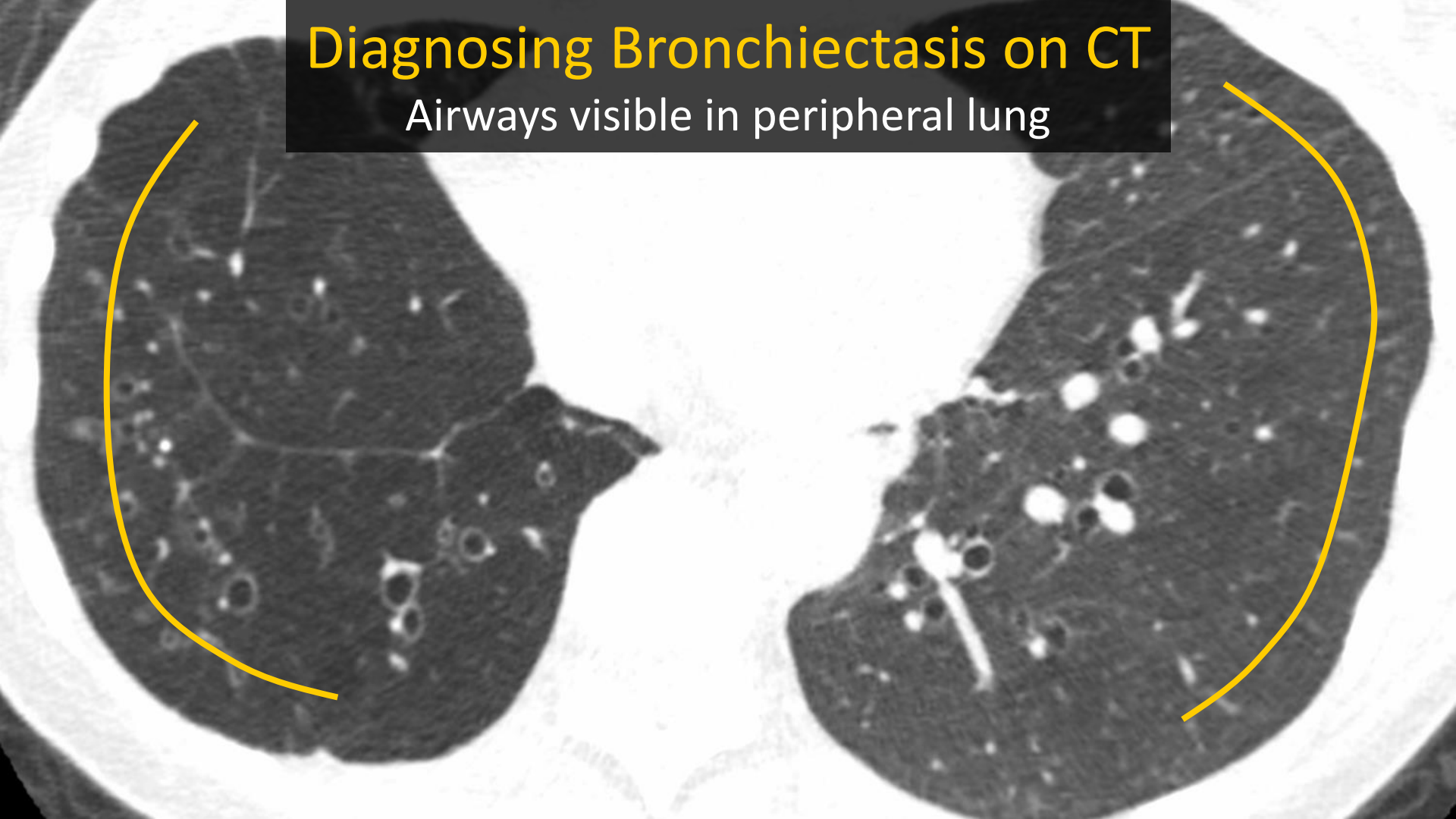




Diagnosing Bronchiectasis on CT

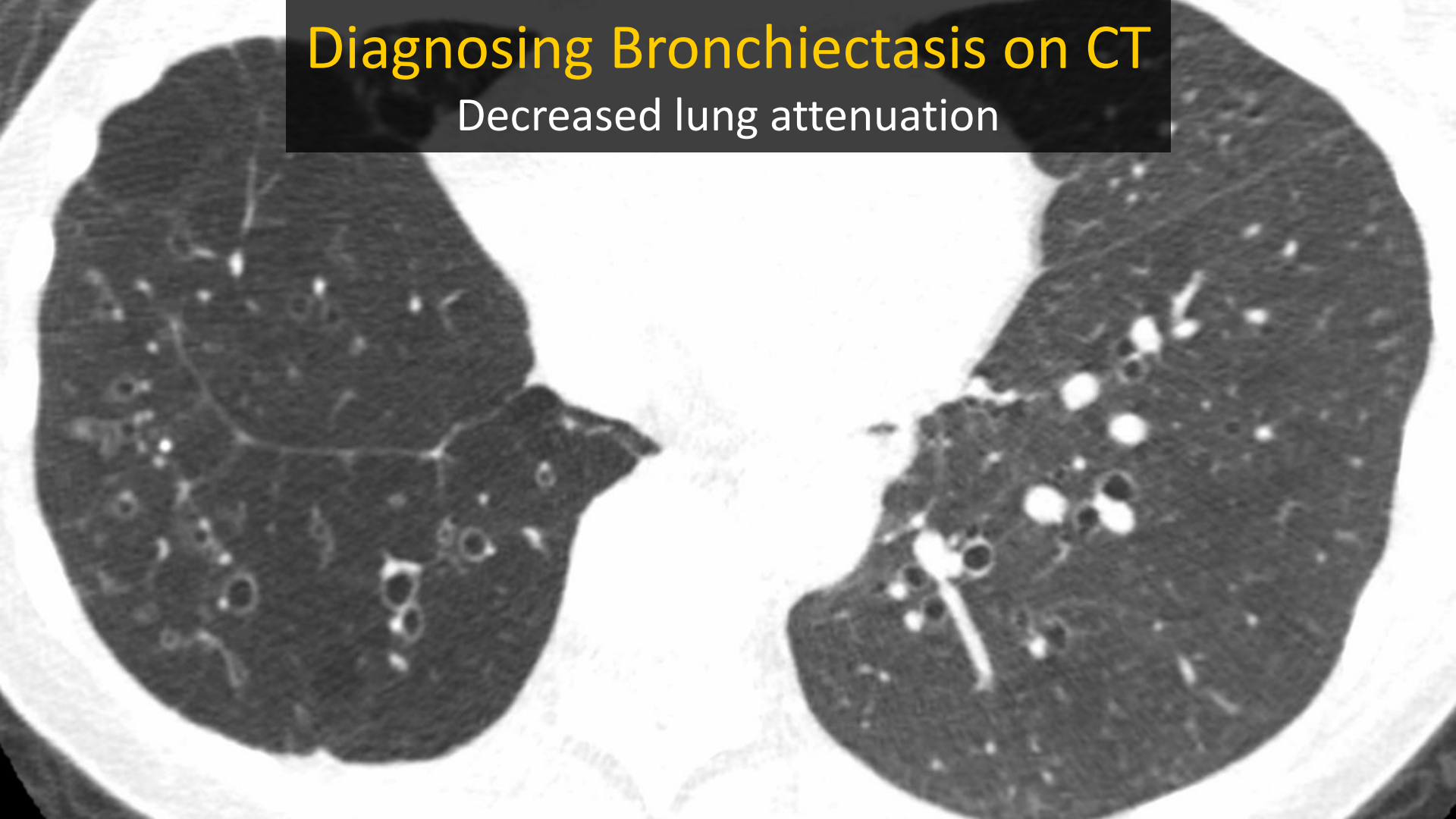


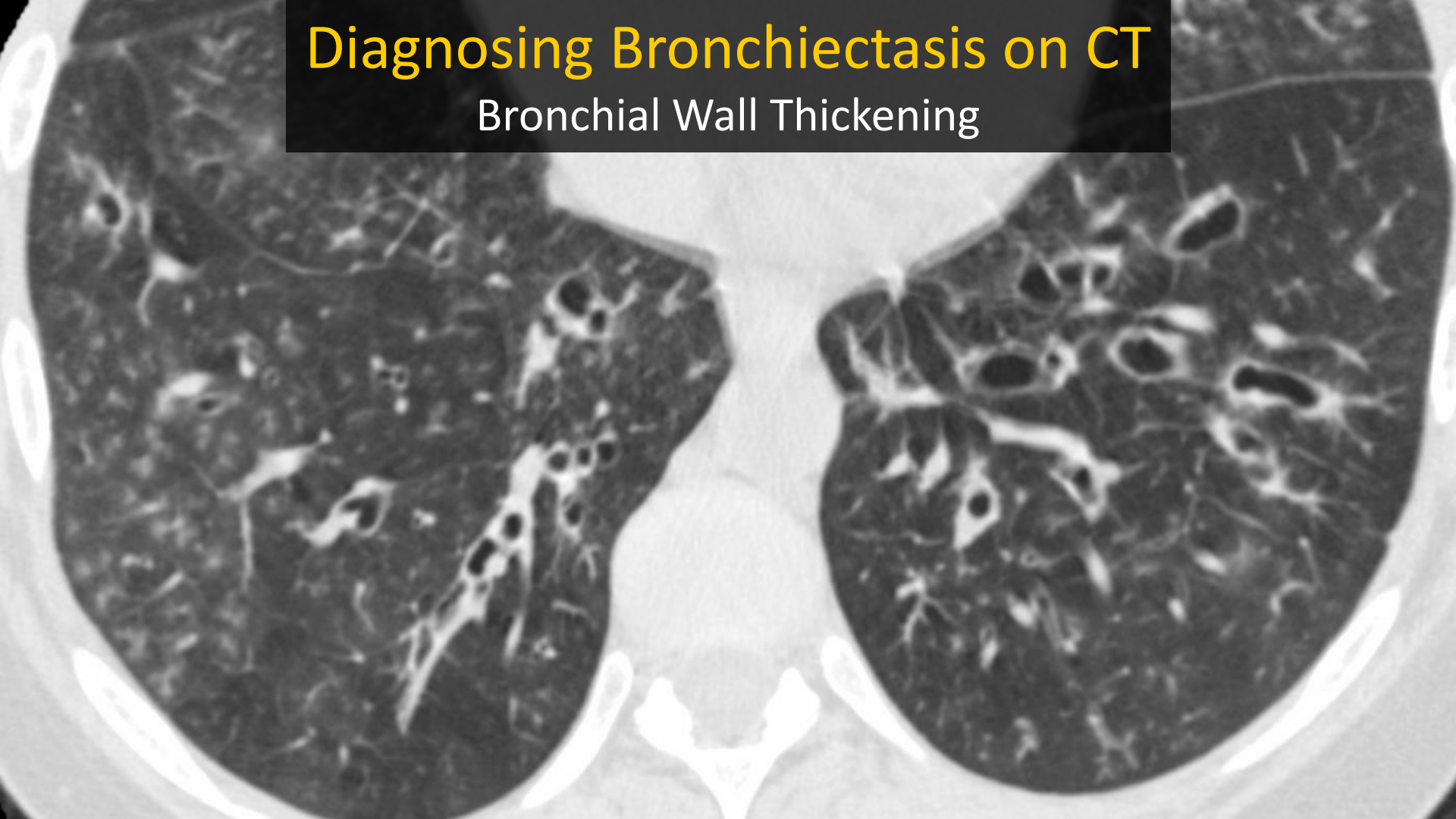

Diagnosing Bronchiectasis on CT
Bronchial dilation:
Bronchoarterial Ratio
1.5:1 or greater is almost always abnormal

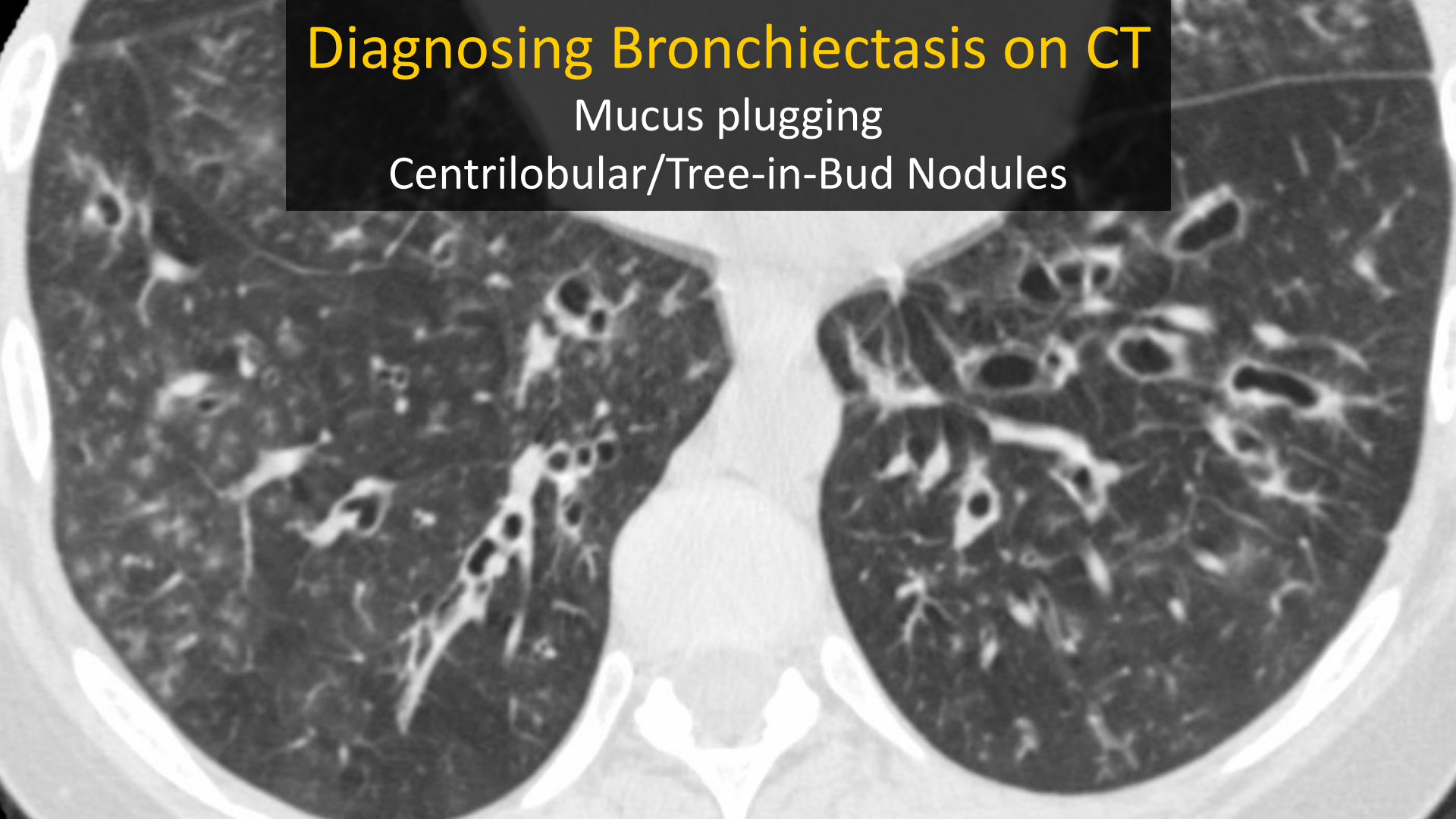

Diagnosing Bronchiectasis on CT
Airways visible in peripheral lung

Diagnosing Bronchiectasis on CT

Decreased lung attenuation




Diagnosing Bronchiectasis on CT
Bronchial Wall Thickening

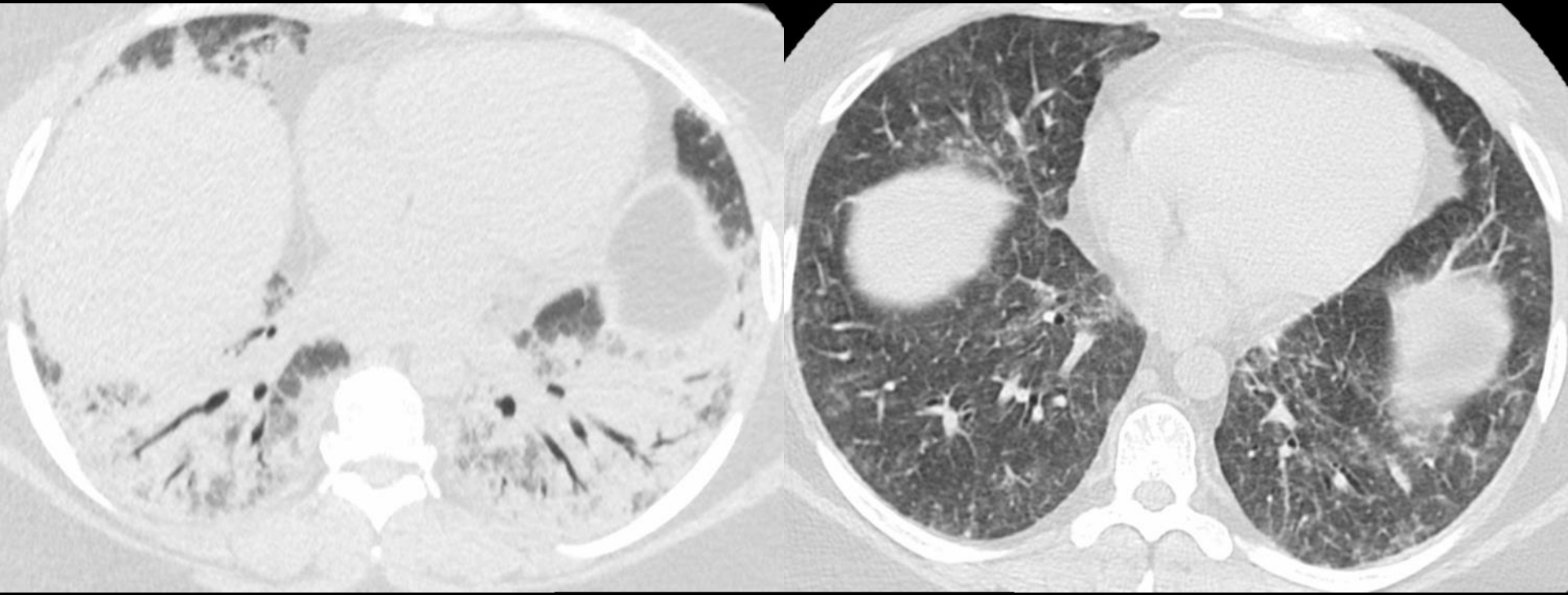

Diagnosing Bronchiectasis on CT
Mucus plugging
Centrilobular/Tree-in-Bud Nodules

Two Points of Clarification:

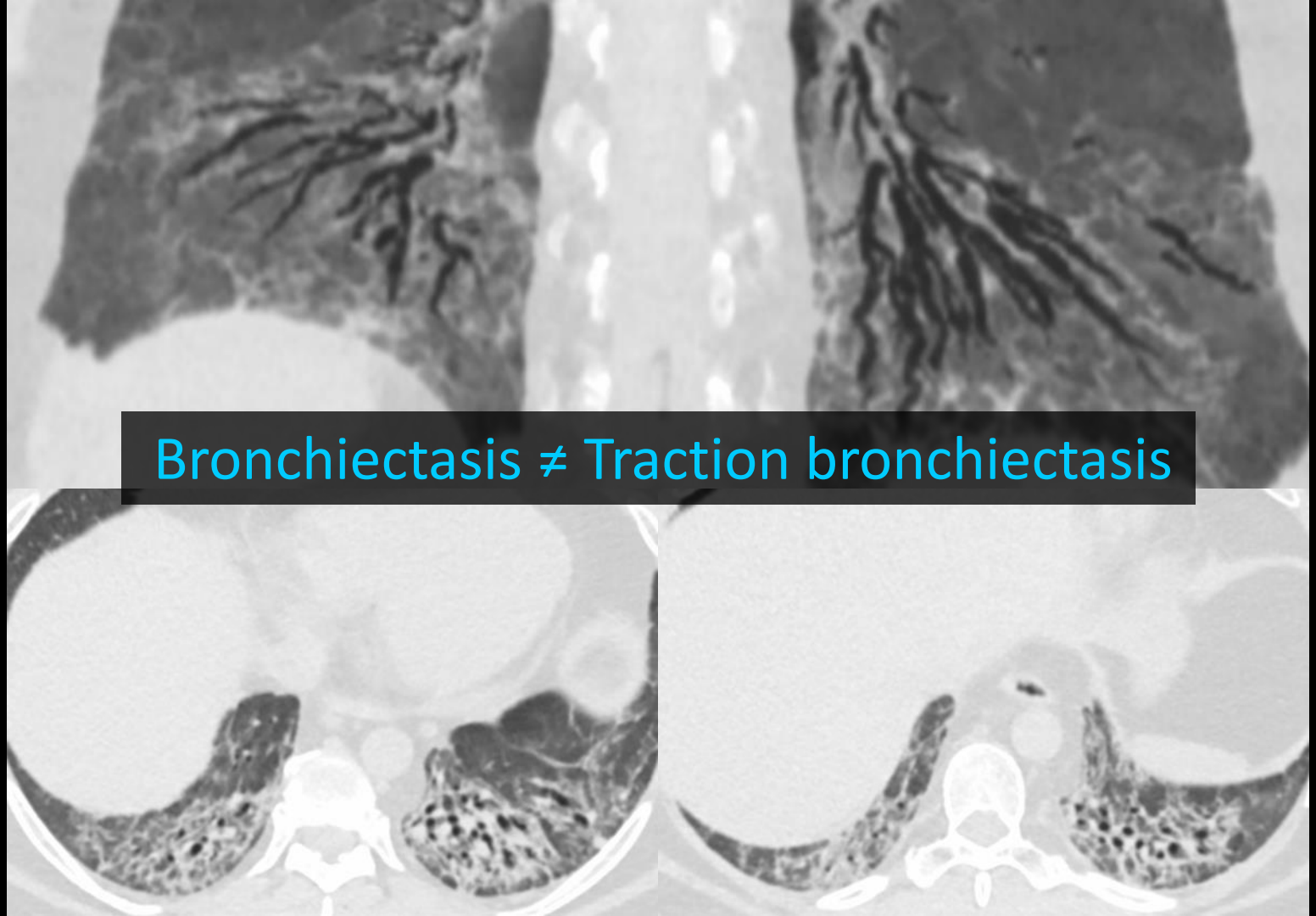
Bronchial dilation ≠ bronchiectasis

Bronchiectasis ≠ Traction bronchiectasis

Bronchiectasis is Irreversible

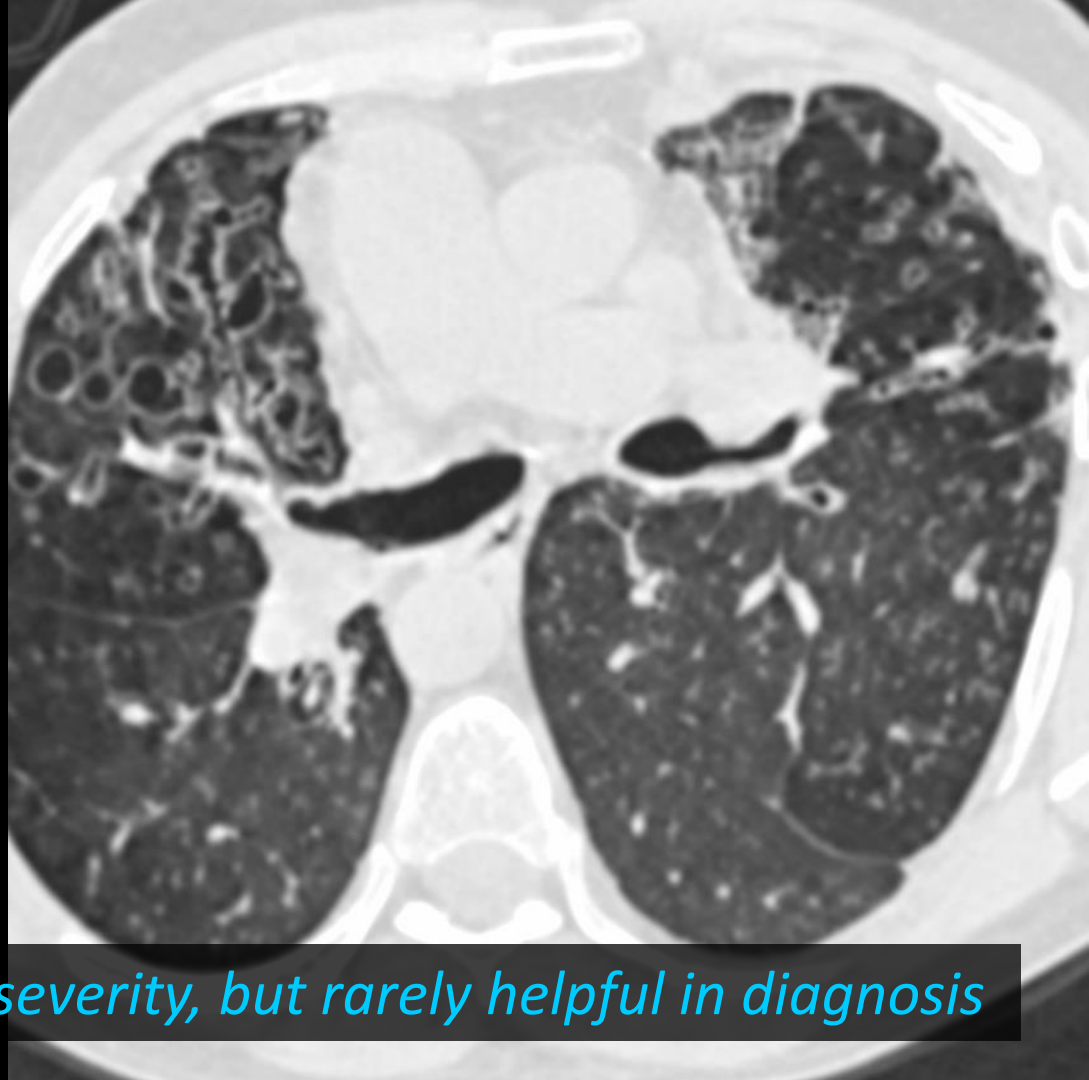


Not bronchiectasis!
(bronchial dilation)


Bronchiectasis ≠ Traction bronchiectasis

Morphology:

- Tubular
- Varicoid
- Cystic



Morphology is indicative of severity, but rarely helpful in diagnosis

Bronchiectasis - Distribution

- Distribution of abnormalities can help narrow differential diagnosis

- Based on CT, confident diagnosis >50% of the time[1]

- HRCT + Clinical Information – Diagnosis >90%[2]

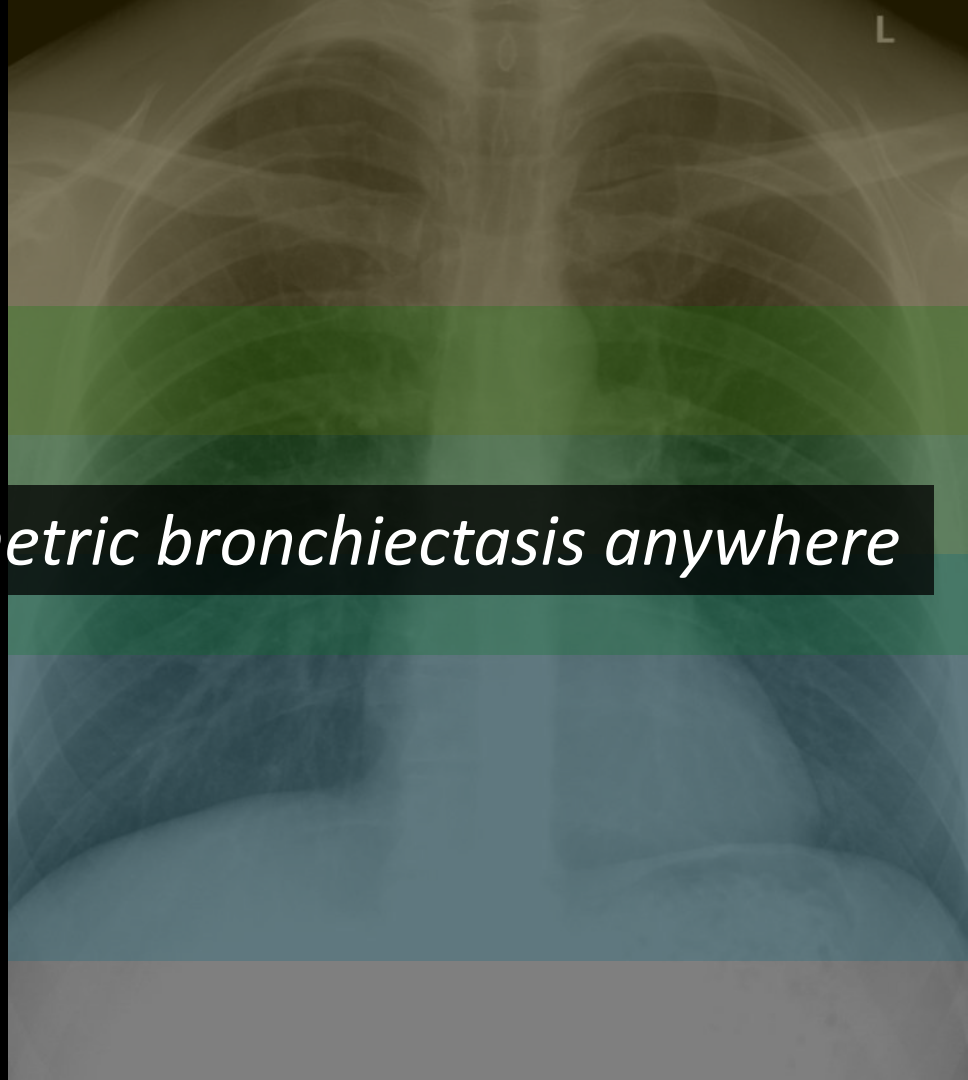
[1]Cartier Y et al. Bronchiectasis: accuracy of high-resolution CT in the differentiation of specific diseases. *AJR Am J Roentgenol* 1999; 173:47-52

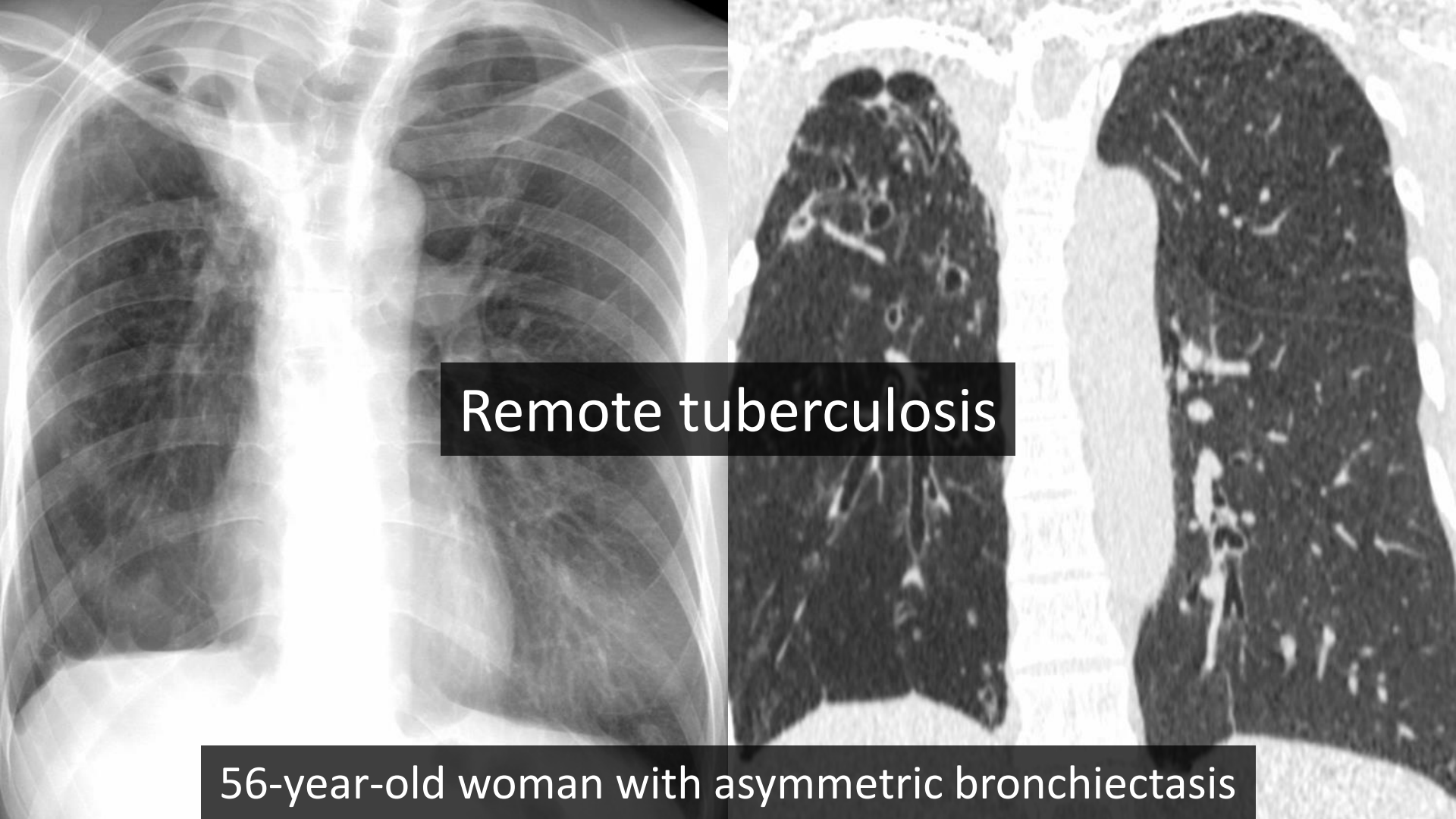
[2]McShane PJ et al. Bronchiectasis in a diverse US population: effects of ethnicity on etiology and sputum culture. Chest 2012; 142:159-167

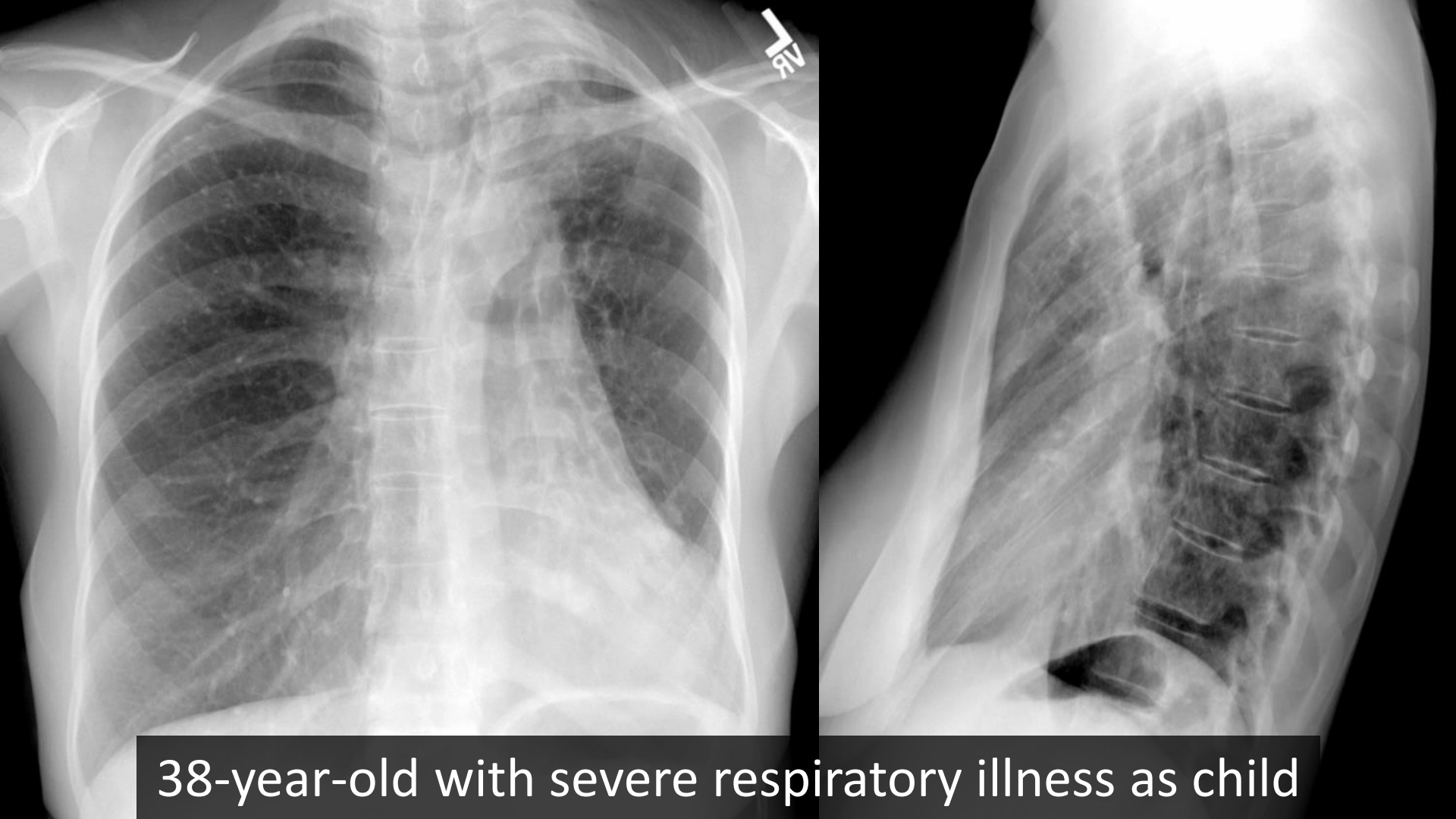
– Upper
  - CF (may be diffuse)
  - Sarcoid
– Mid/central
  - ABPA
  - MAC
– Lower
  - Chronic infection
  - Conditions predisposing to chronic infection
– Asymmetric - Infection

- Upper
  - CF (may be diffuse)
  - Sarcoid
- Mid/central
  - ABPA
  - MAC
- Lower
  - Chronic infection
  - Conditions predisposing to chronic infection
- Asymmetric - Infection

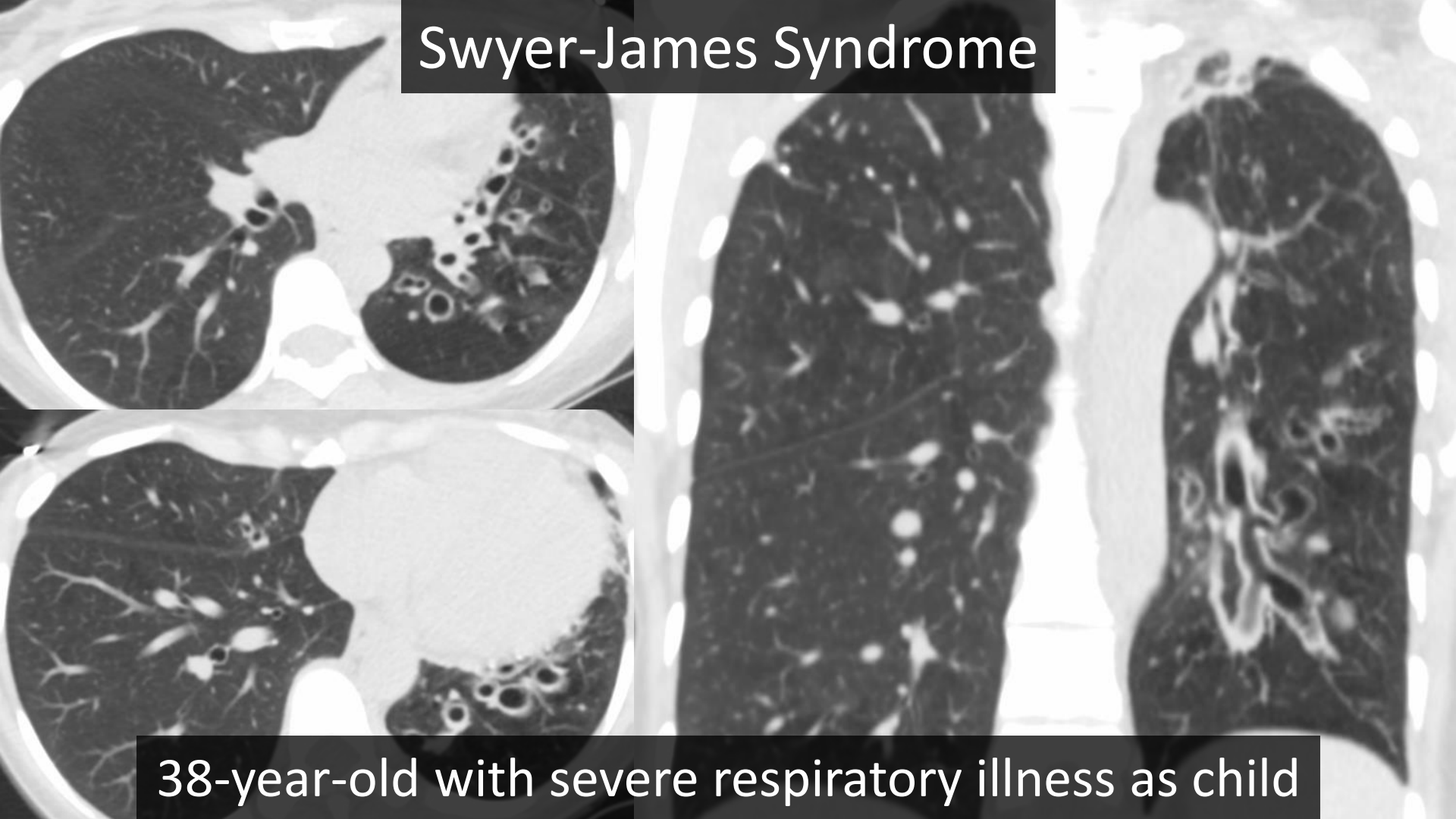
Pneumonia can cause asymmetric bronchiectasis anywhere




Remote tuberculosis
56-year-old woman with asymmetric bronchiectasis


38-year-old with severe respiratory illness as child

Swyer-James Syndrome



38-year-old with severe respiratory illness as child

– Upper
  - CF (may be diffuse)
  - Sarcoid
– Mid/central
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– Lower
  - Chronic infection
  - Conditions predisposing to chronic infection
– Asymmetric - Infection

– Upper
  - CF (may be diffuse)
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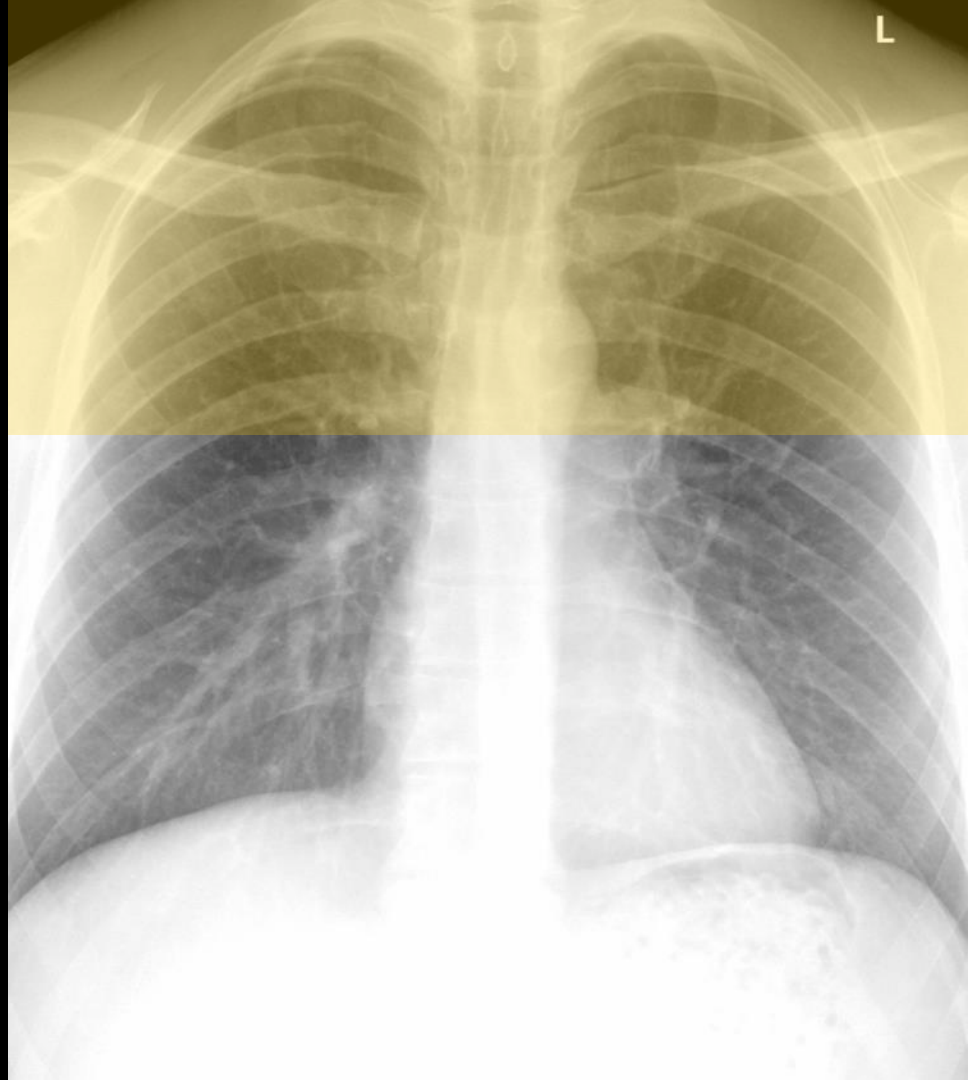
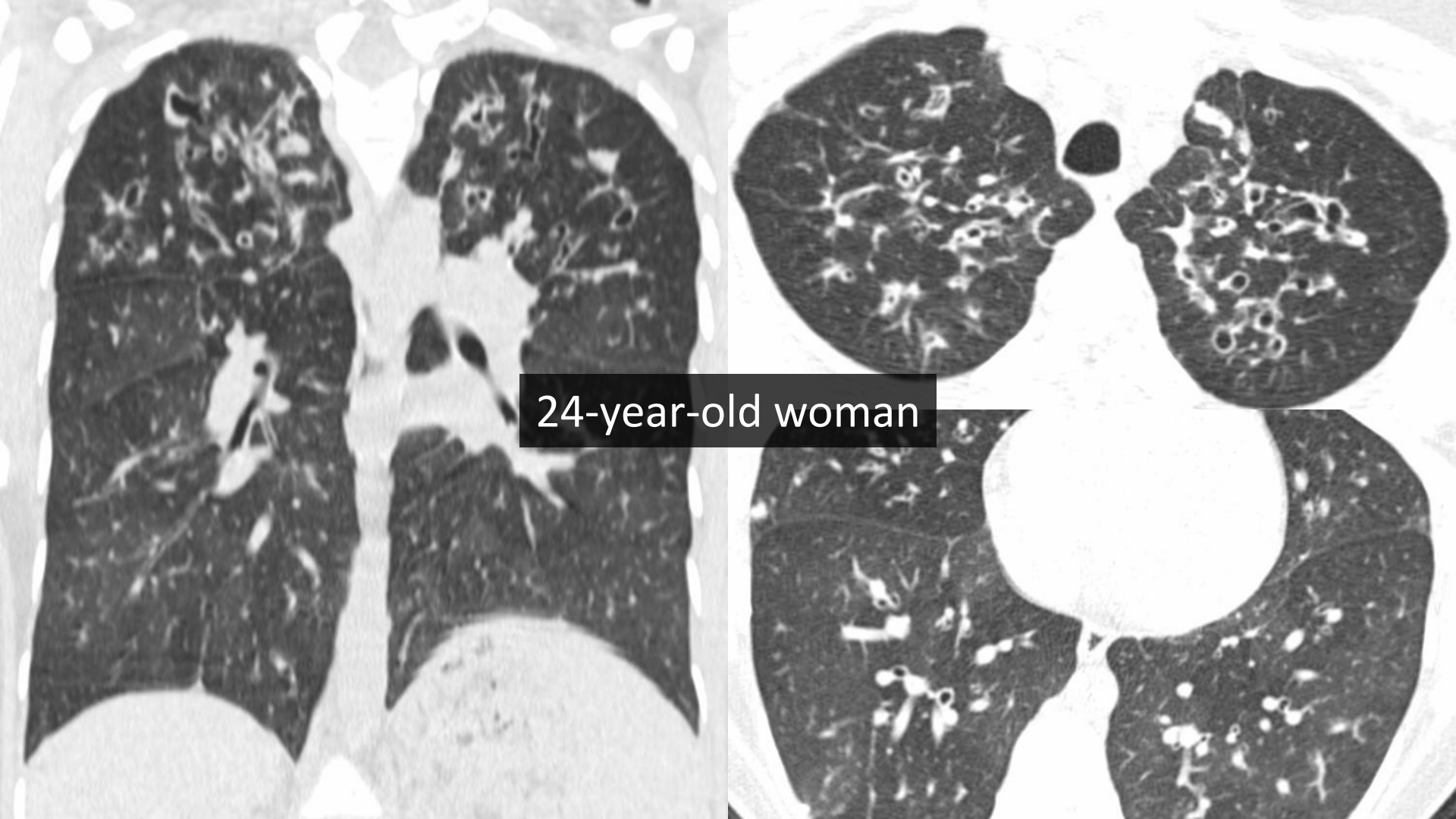
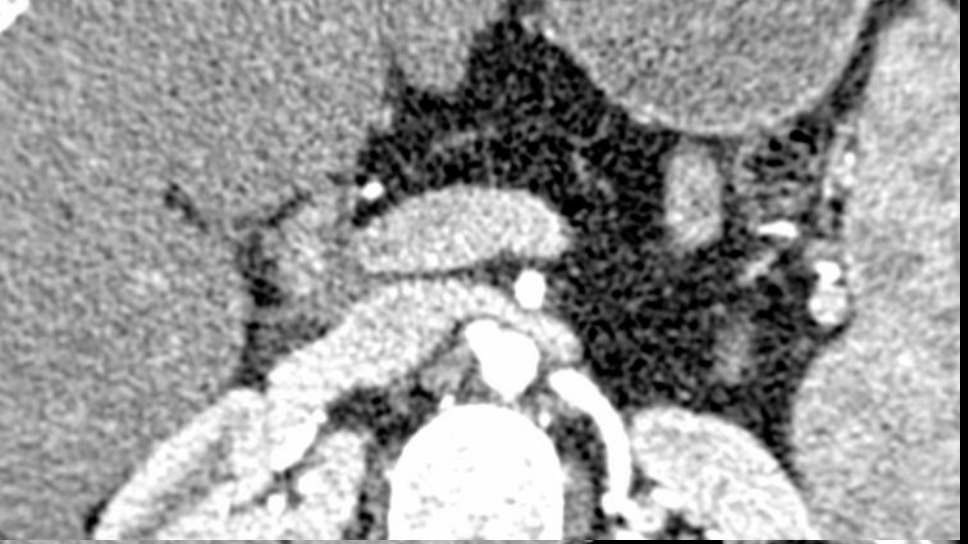
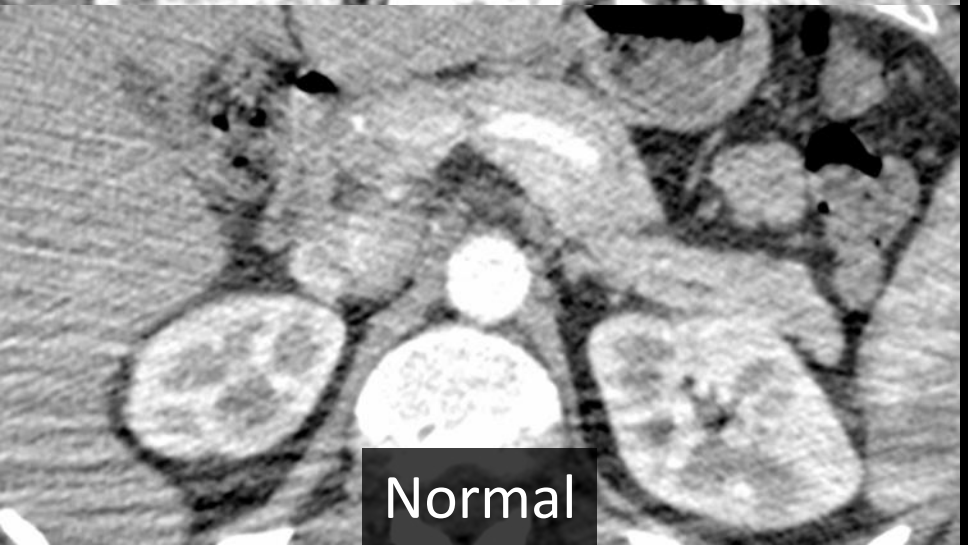



24-year-old woman

Cystic Fibrosis

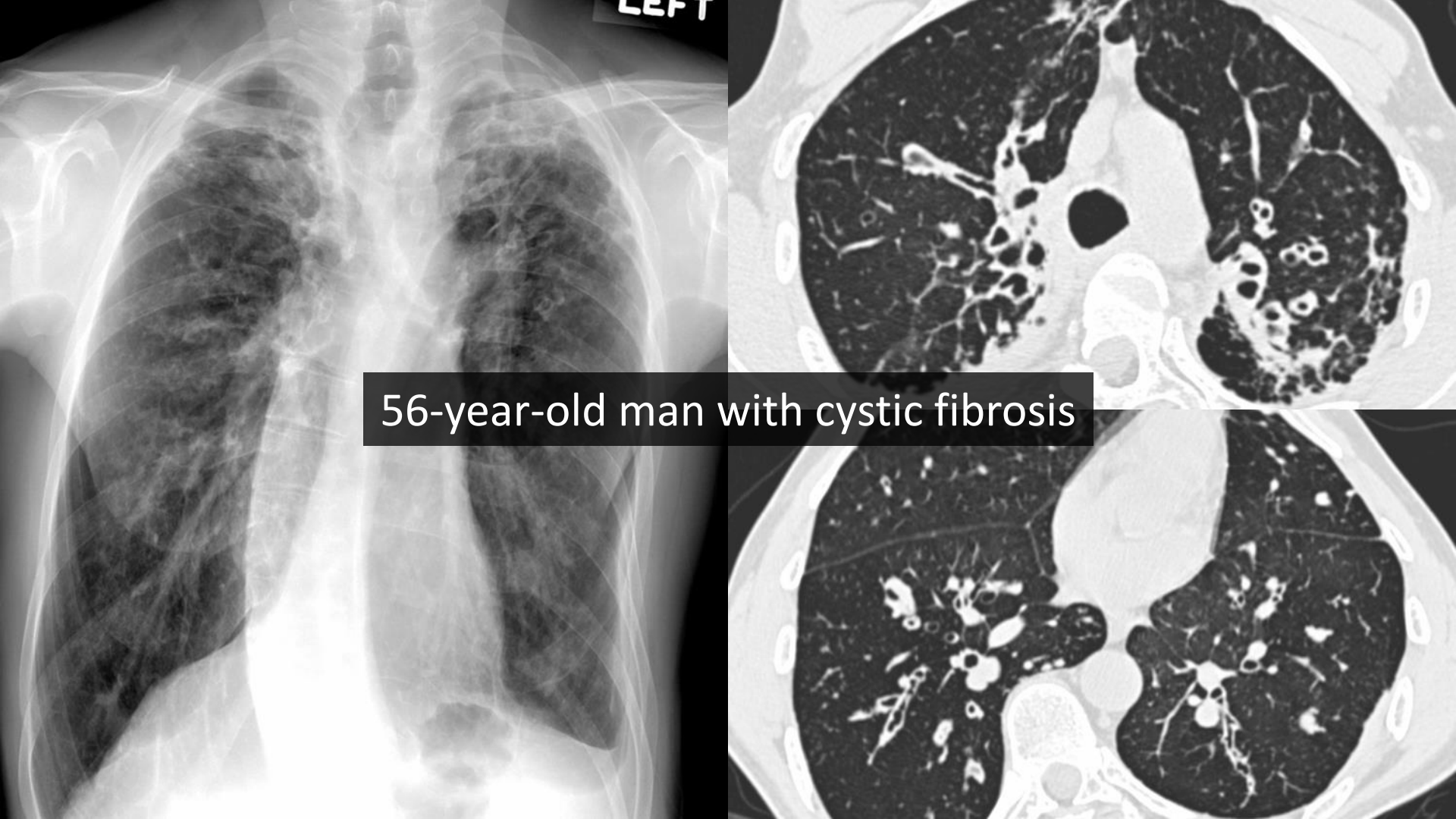
- Upper lobe predominant or diffuse
- bronchial wall thickening
- Nodular opacities → mucoid impaction
- Mosaic attenuation → air trapping



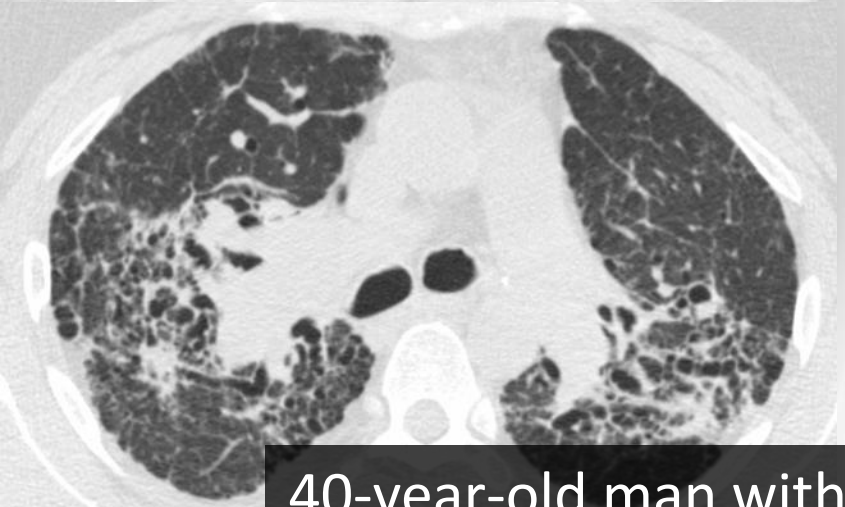


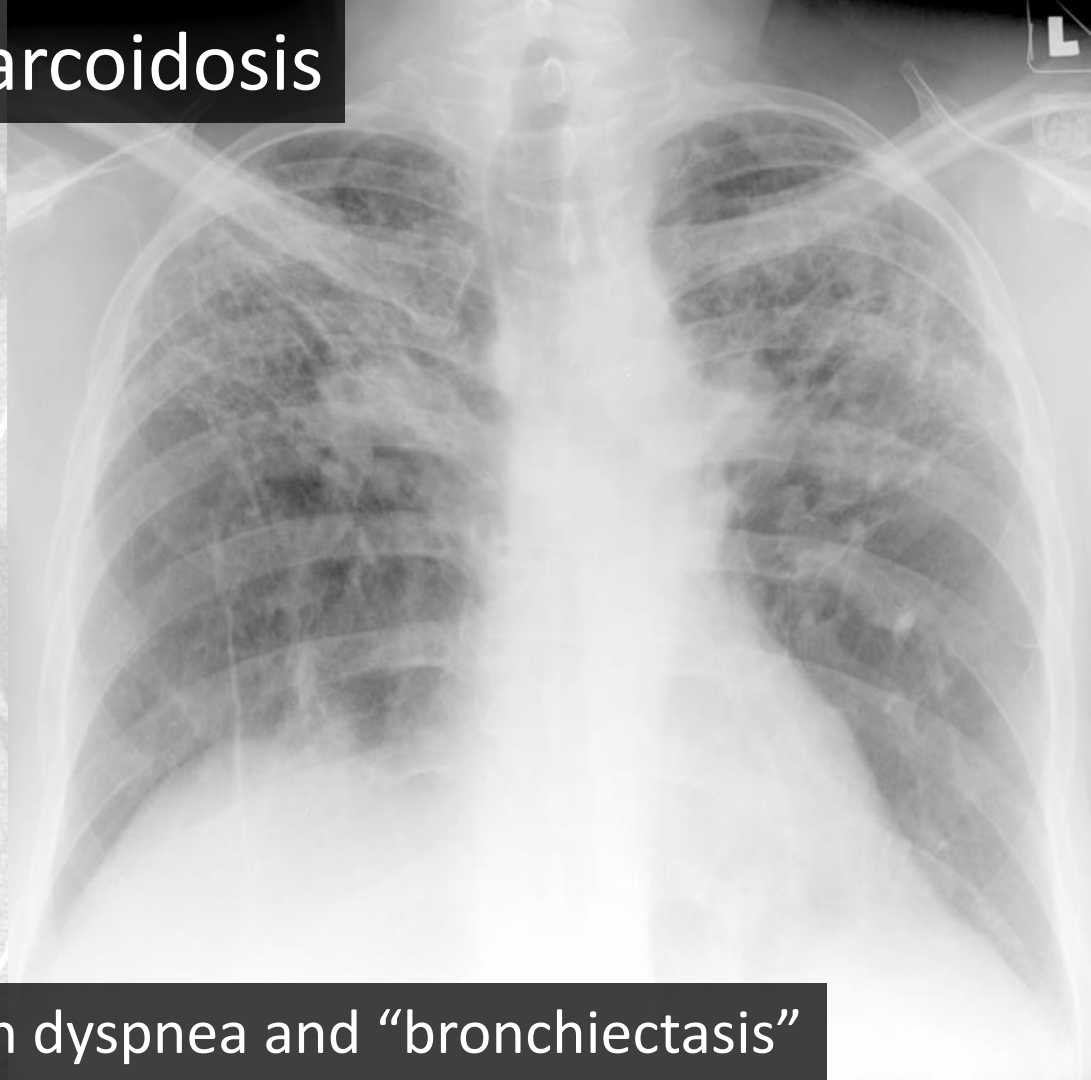
Cystic Fibrosis

- Abnormal sweat chloride
- Lung infection
- Pancreatic insufficiency


LEFT
56-year-old man with cystic fibrosis

Sarcoidosis

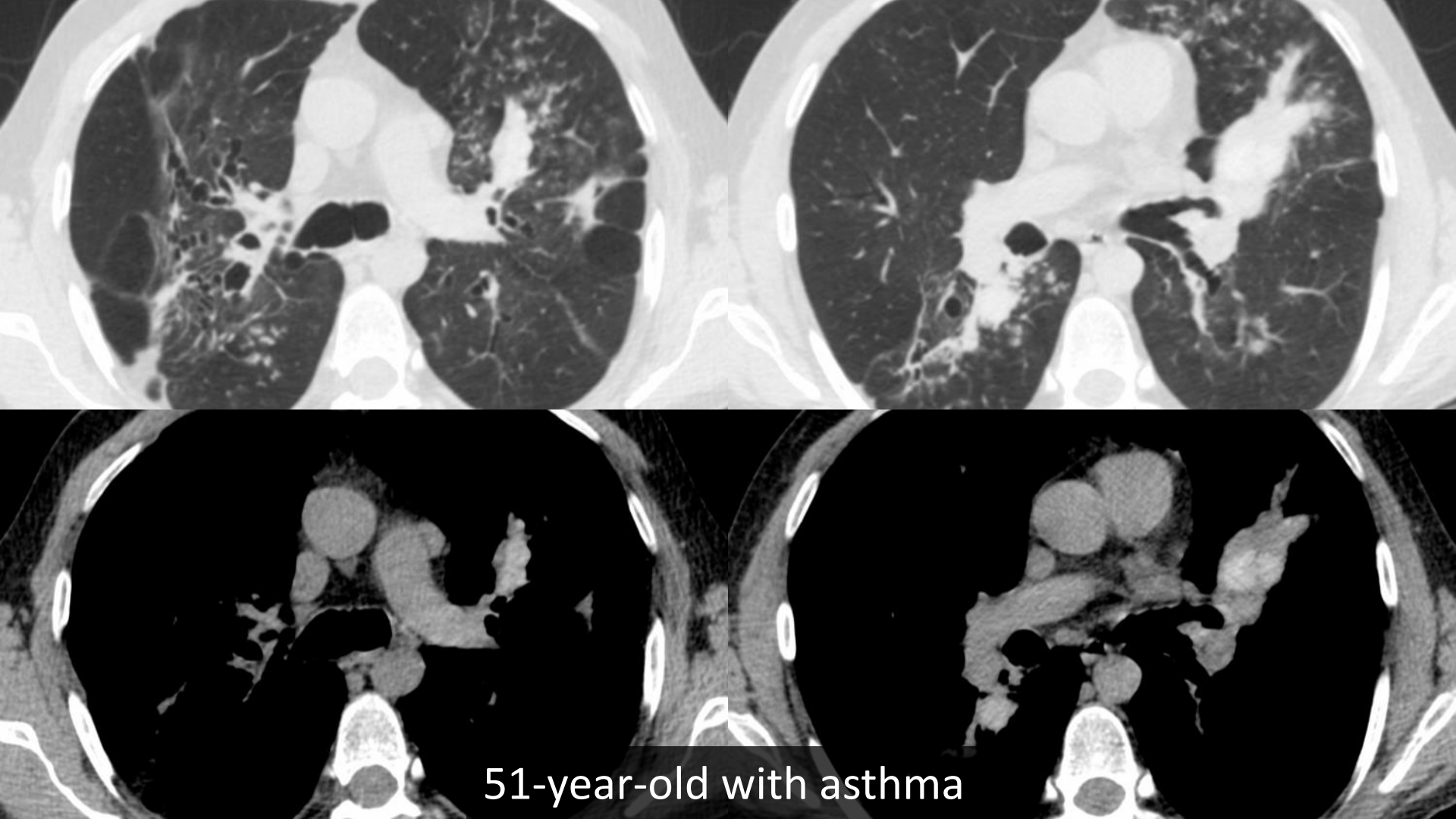




40-year-old man with dyspnea and “bronchiectasis”

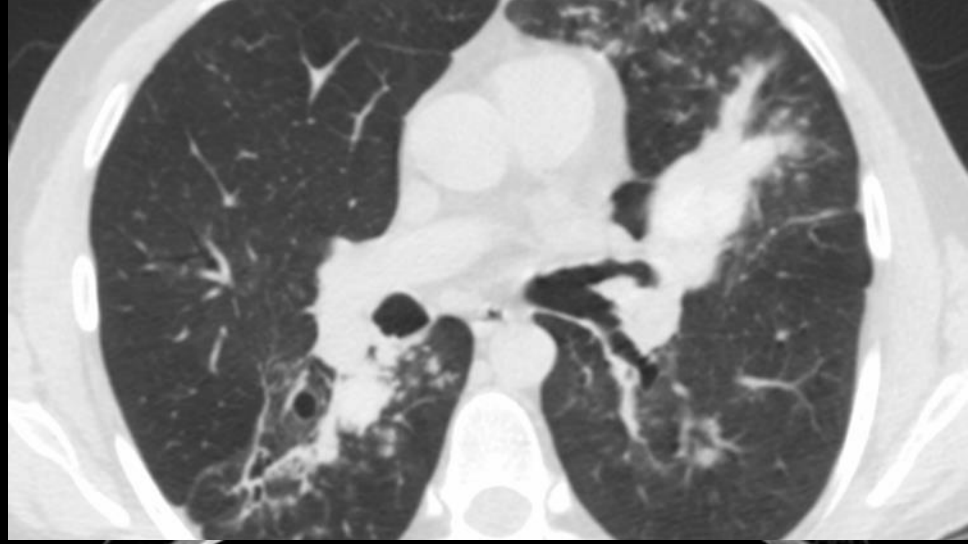
– Upper
  - CF (may be diffuse)
  - Sarcoid
– Mid/central
  - ABPA
  - MAC


51-year-old with asthma


51-year-old with asthma

Allergic Bronchopulmonary Aspergillosis

- Central bronchiectasis (close to hilum)
- Mucus impaction
- HAM (high attenuation mucus)
  - 1/3 of patients → but specific



Allergic Bronchopulmonary Aspergillosis

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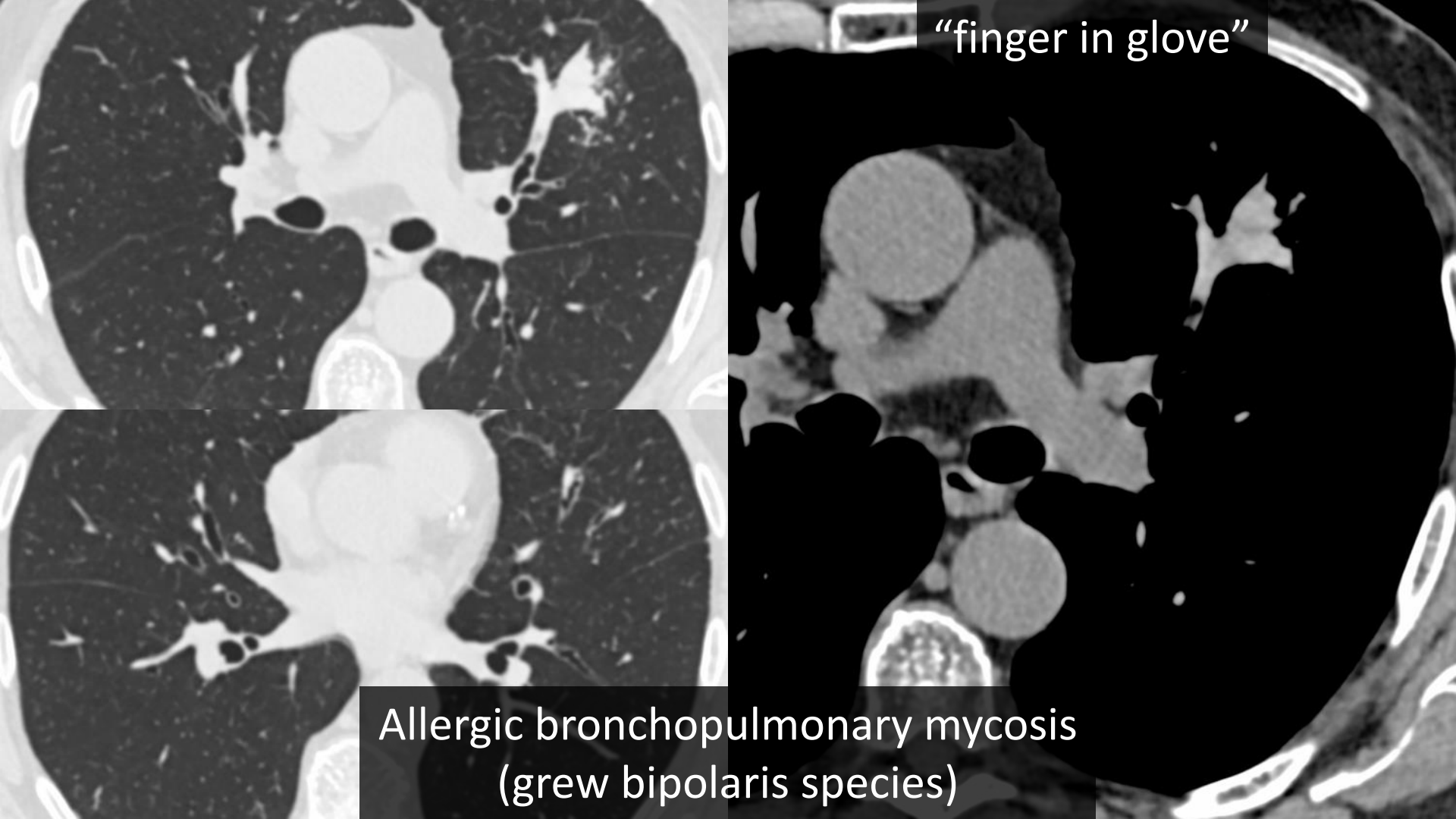
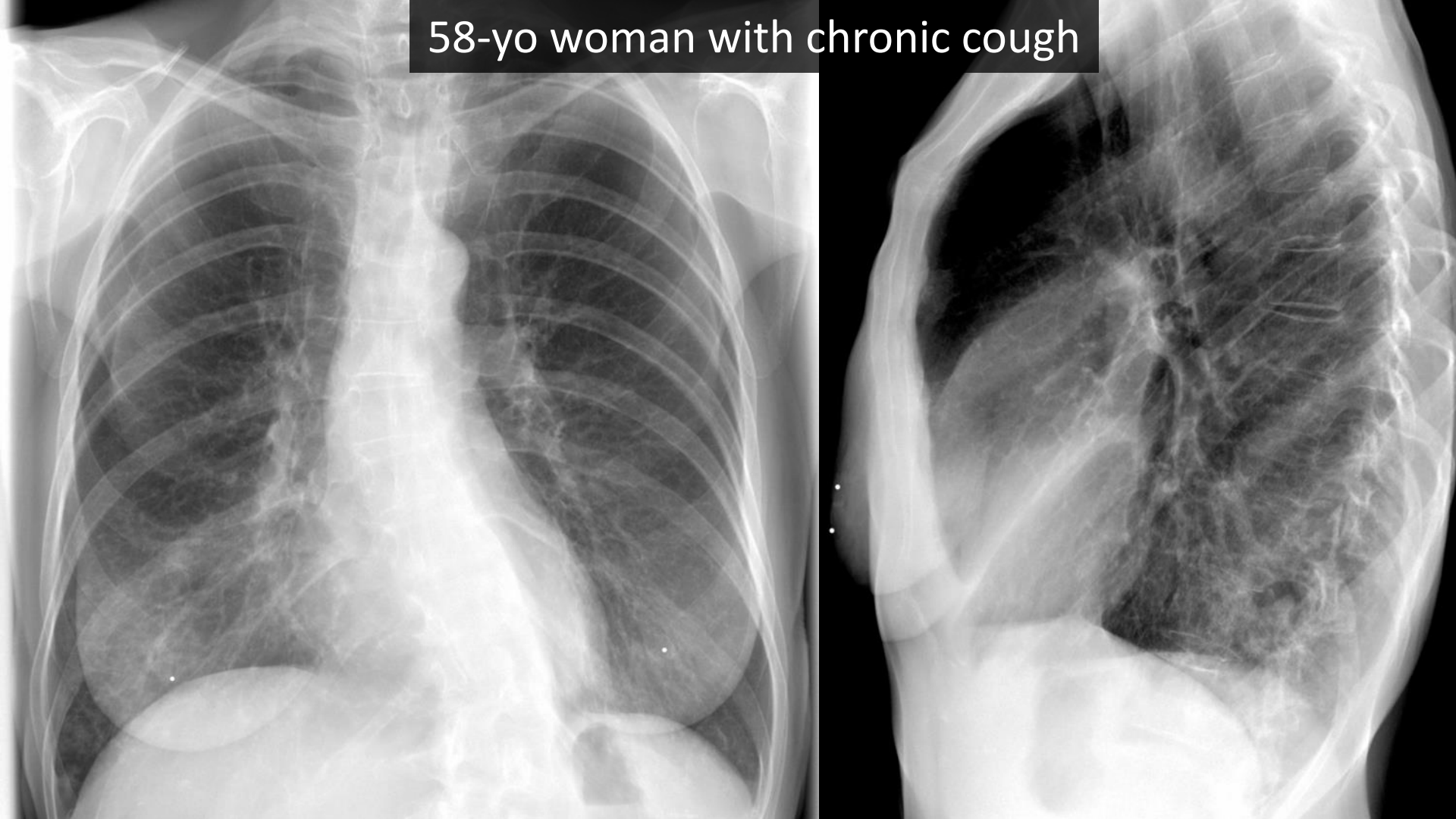
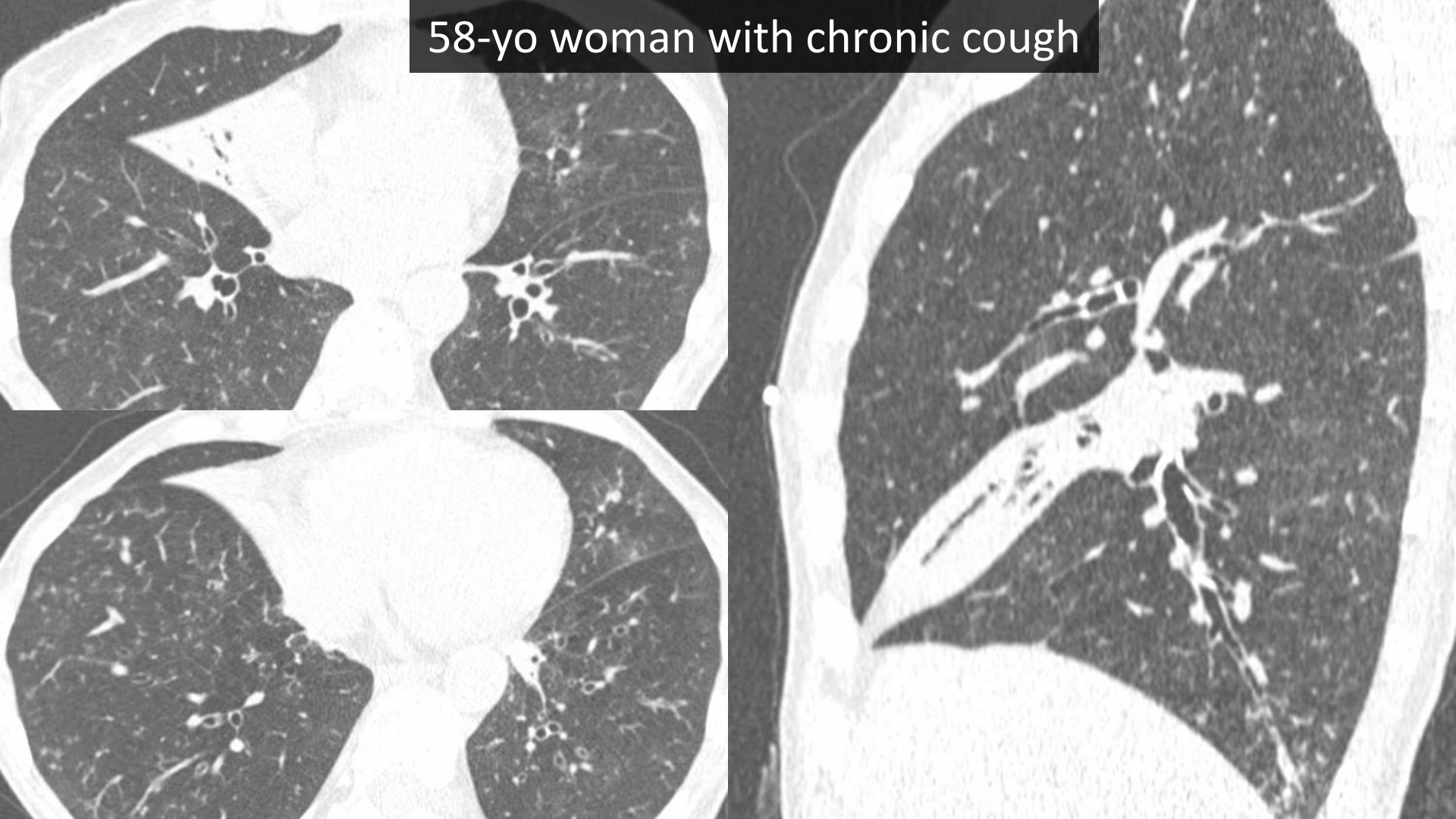
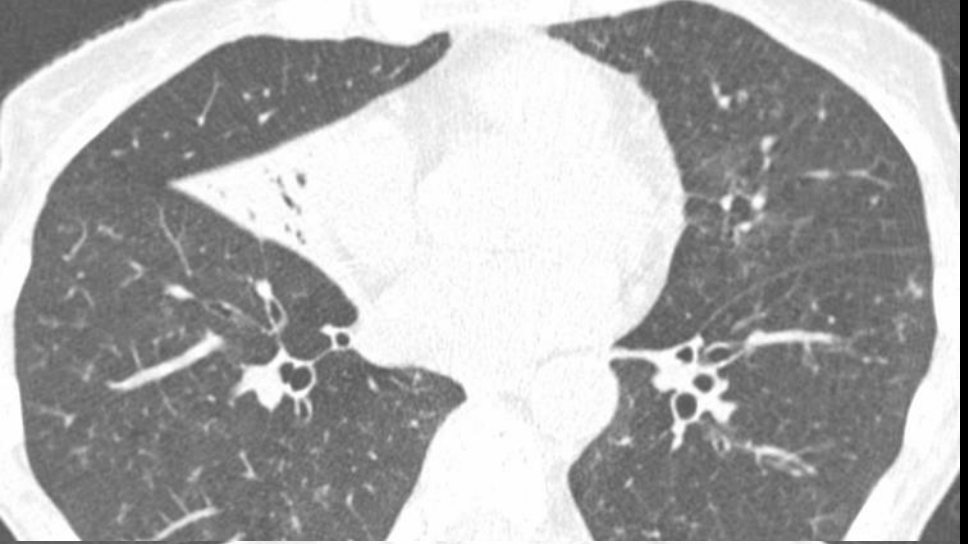
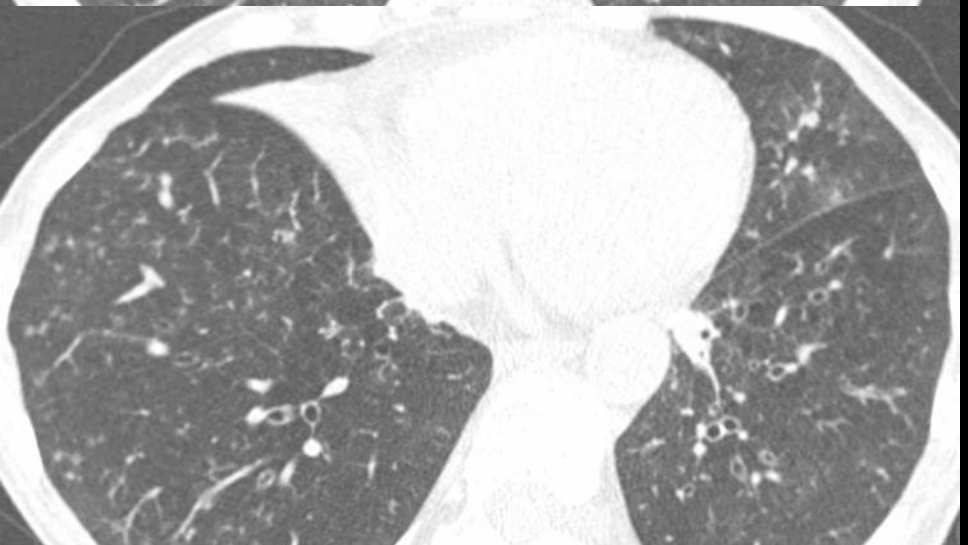

“finger in glove”
Allergic bronchopulmonary mycosis
(grew bipolaris species)


58-yo woman with chronic cough


58-yo woman with chronic cough





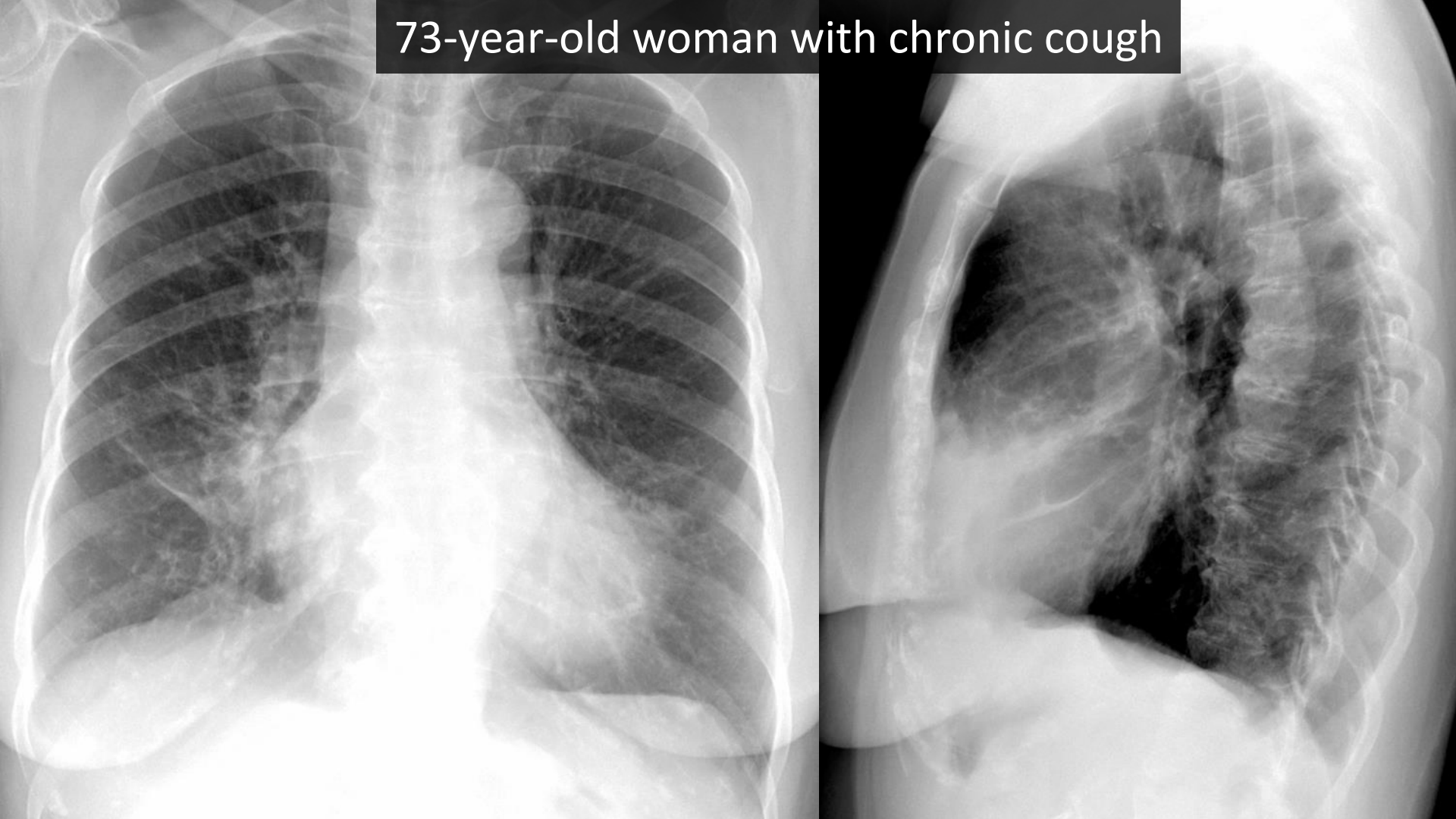
Atypical mycobacterial infection

(M. Avium Complex)

- (non-classic form)
- Middle lobe/lingula
- Bronchiectasis
- Mucus plugging
- Tree-in-bud

Atypical mycobacterial infection (M. Avium Complex)

- Phenotype:
  - Thin
  - Older females
  - Scoliosis
  - Pectus excavatum


73-year-old woman with chronic cough

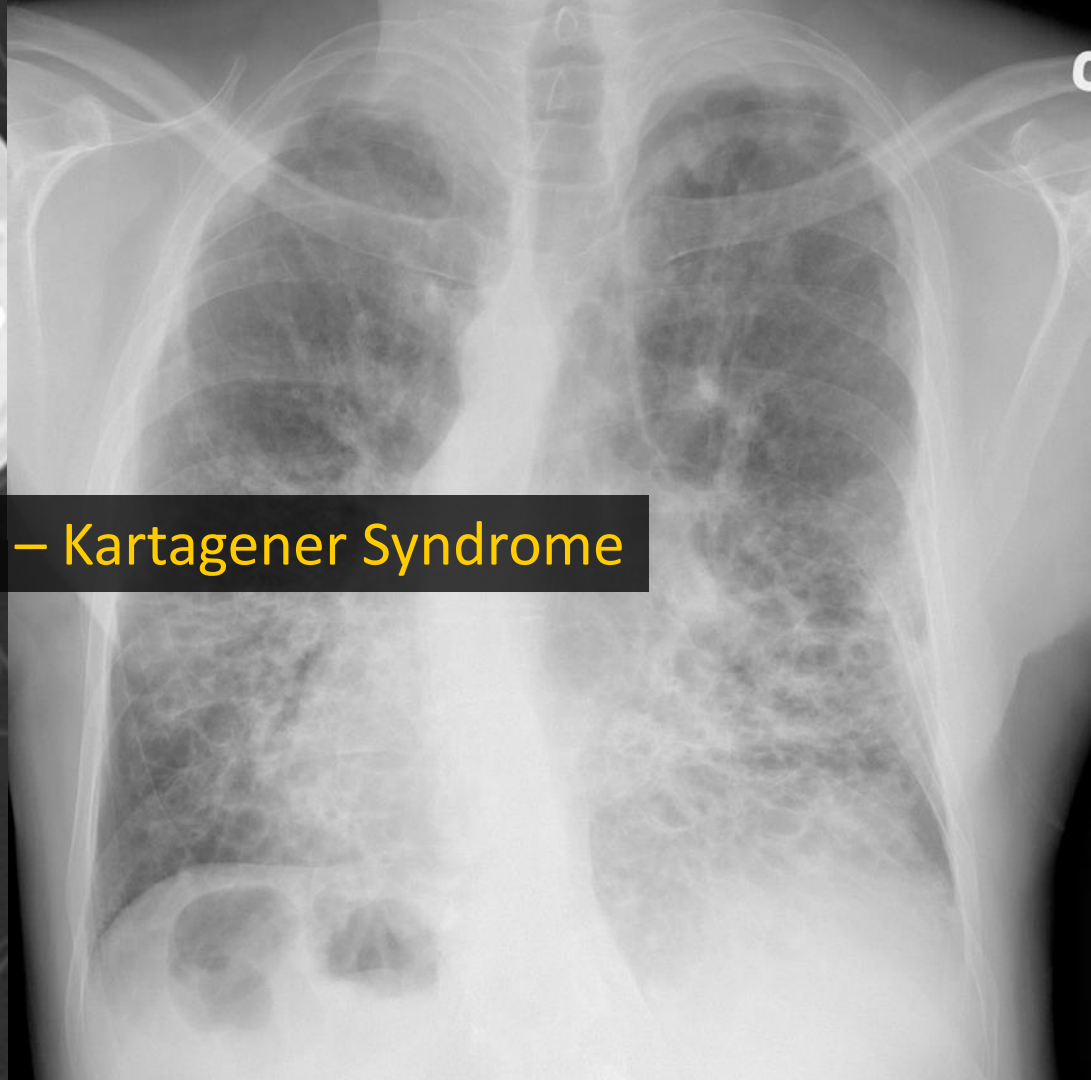
Mycobacterium Avium Complex

- Upper
  - CF (may be diffuse)
  - Sarcoid
- Mid/central
  - ABPA
  - MAC
- Lower
  - Chronic infection
  - Conditions predisposing to chronic infection

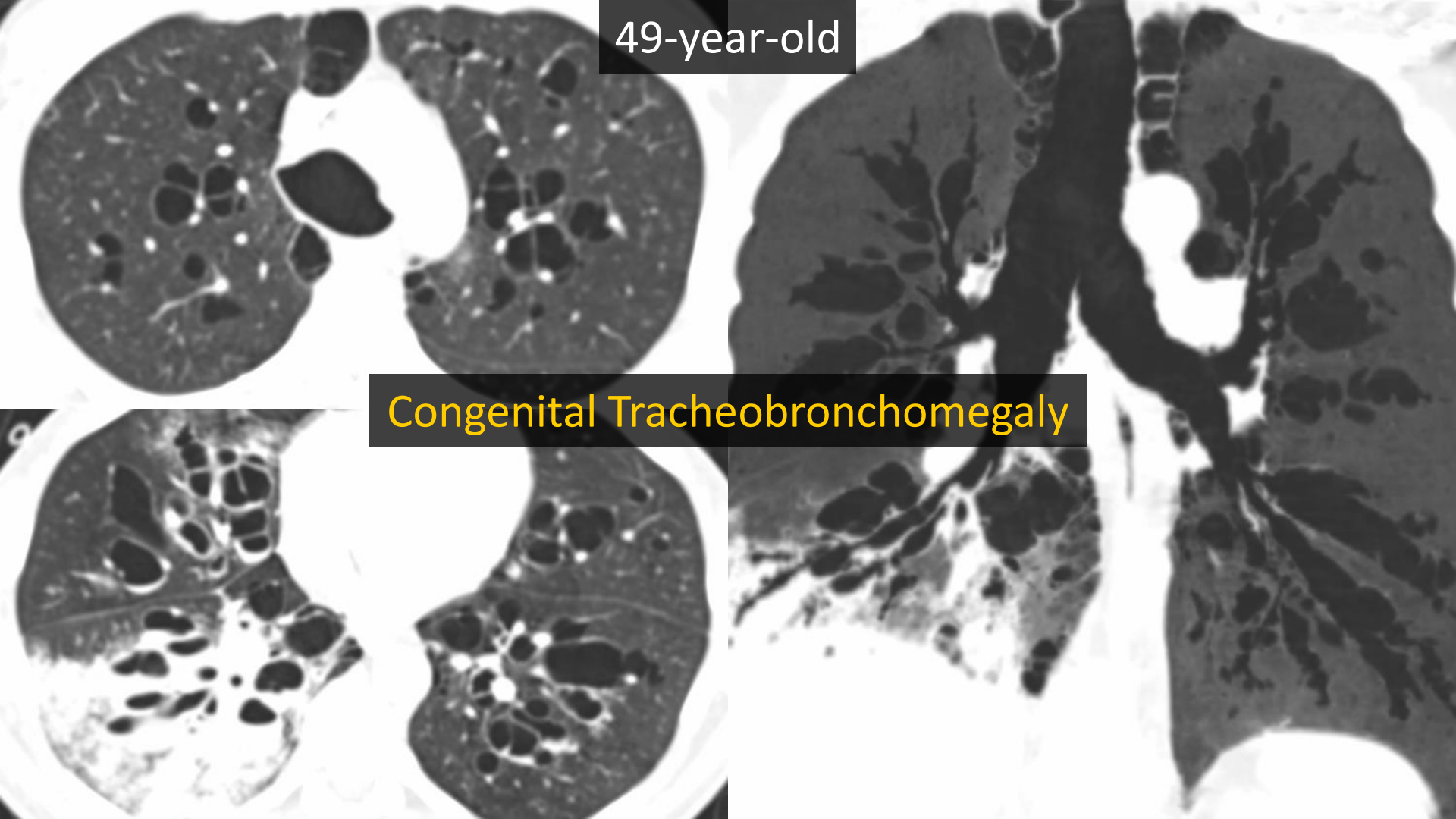
Lower-Lobe Predominant Bronchiectasis

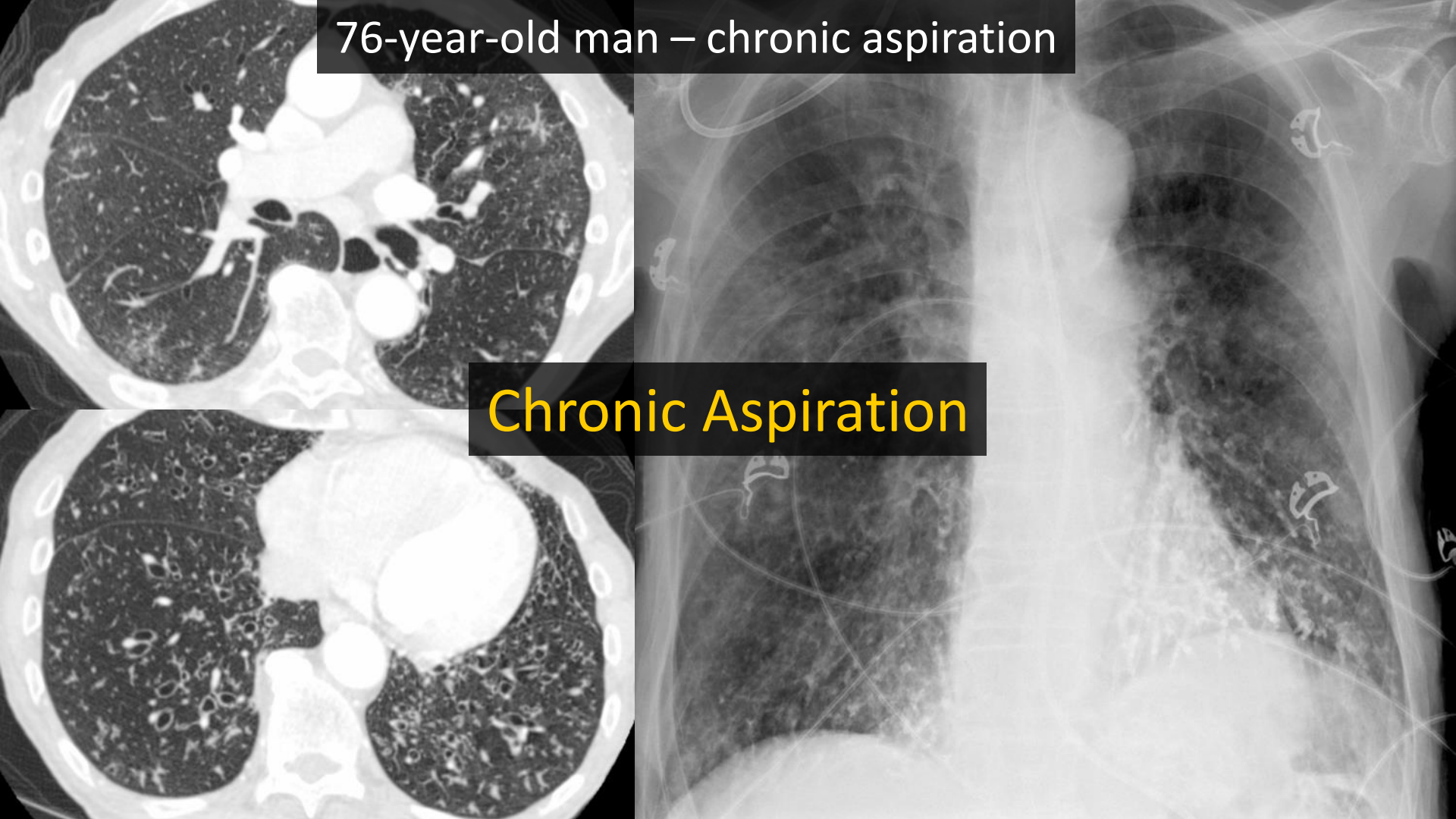
- Immotile cilia
- Congenital tracheobronchomegaly
- Williams-Campbell Syndrome
- Immunodeficiency
  - CVID
  - Hypogammaglobulinemia
  - IgA deficiency
  - HIV
- Recurrent Aspiration
- Alpha-1 Antitrypsin
- Inflammatory bowel disease
- Constrictive bronchiolitis
- Idiopathic bronchiectasis

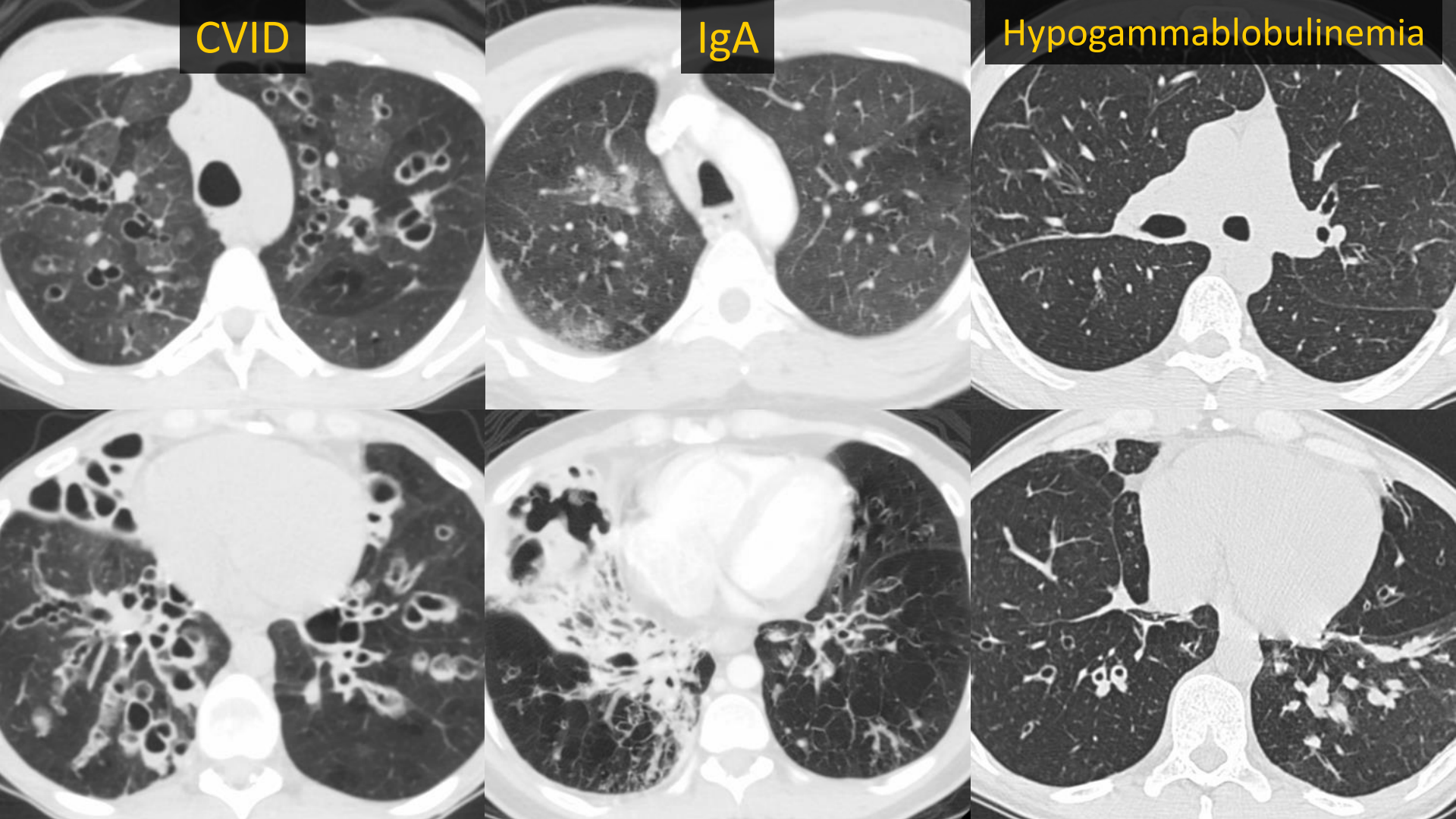
Chronic infection or conditions that predispose to chronic infection



Immotile Cilia – Kartagener Syndrome


49-year-old
Congenital Tracheobronchomegaly


76-year-old man – chronic aspiration
Chronic Aspiration


CVID
IgA
Hypogammablobulinemia

– Upper
  - CF (may be diffuse)
  - Sarcoid
– Mid/central
  - ABPA
  - MAC
– Lower
  - Chronic infection
  - Conditions predisposing to chronic infection
– Asymmetric - Infection

Questions?

- Large airways:
  - Narrowed or dilated?
  - Mass or no mass?
- Bronchiectasis (medium airways):
  - Upper vs mid vs lower