The Floppy Airway- A Review of Tracheobronchomalacia in Adults

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Patient Presentation 1

- *52 y/o male with history of DM, GERD, chronic bronchitis, asthma, htn, hypercholesterolemia, psoriasis, dyspnea, recurring pneumonias that began in 1990's.*
- *Progression of dyspnea over last few years with nocturnal wheezing and periods of LOC with apnea.*
- *Sx history of endoscopic gastric plication, cervical neck fusion*
- *30 ppy smoking history*
- *Family History of CVA, CAD*

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Patient Presentation 1 Continued

- *Physical exam notable for obesity, audible wheezing and dyspnea invoked with mild activity.*
- *The patients "asthma" was not very responsive to inhaled bronchodilators and steroid treatment. Dynamic CT evaluation was ordered*

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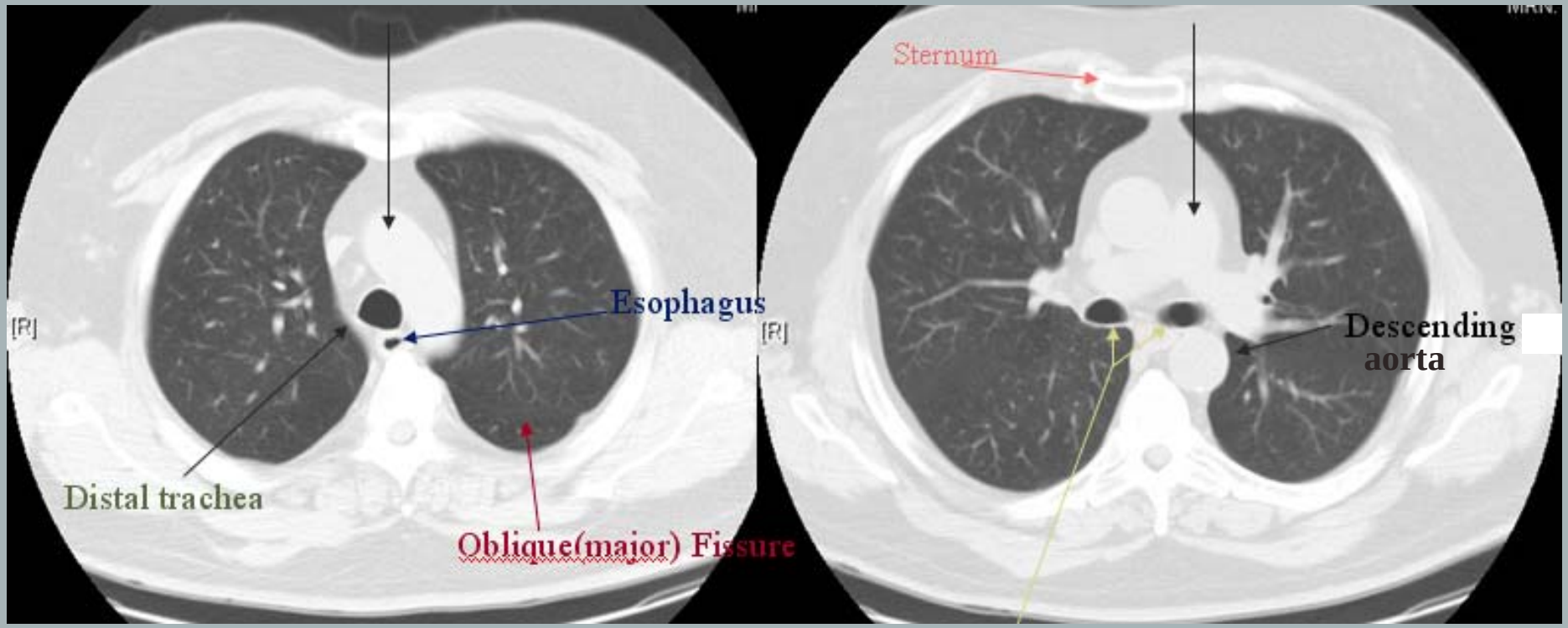
CT- End inspiration images

Level of aortic arch

Pulmonary artery bifurcation



No major abnormalities seen

Images via PACS BIDMC

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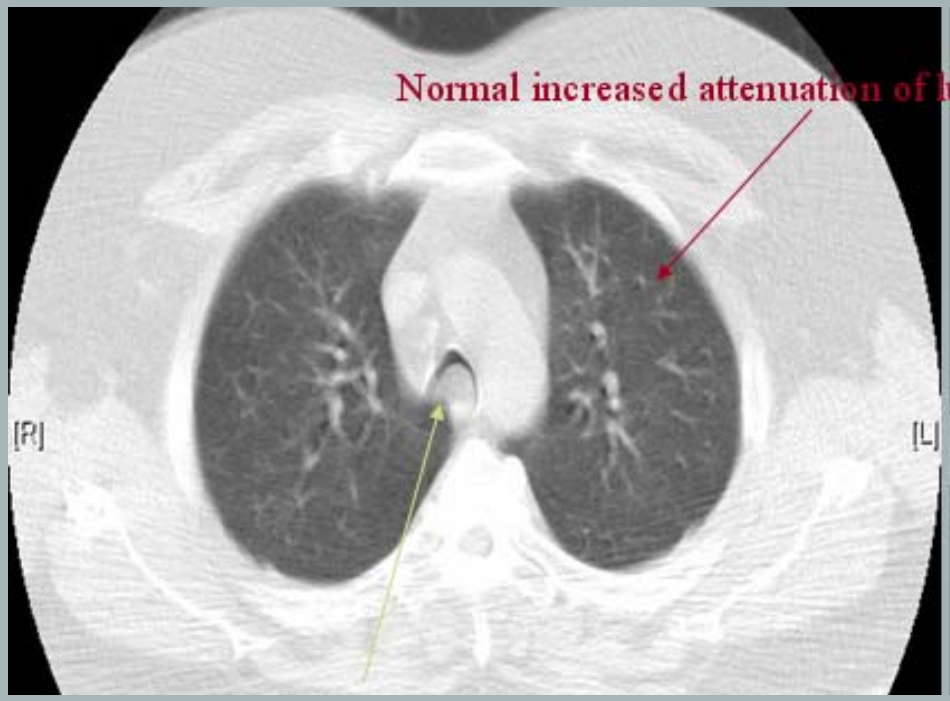
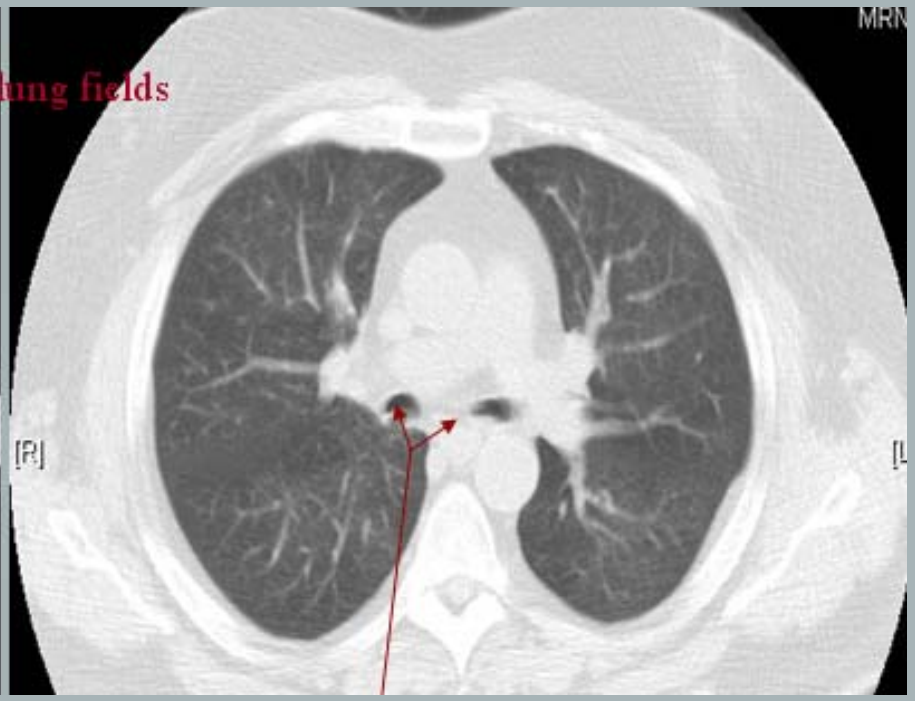
Selected Dynamic (expiratory) CT images

Level of aortic arch



Marked luminal obstruction with anterior bowing of posterior tracheal wall

Level of pulmonary artery bifurcation



Bilateral bronchi luminal narrowing

Images via PACS BIDMC

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CT images-End Inspiration(Lt) vs. Expiratory(Rt)

>70% tracheal luminal narrowing on expiration, highly suggestive of tracheomalacia

Narrowed Bronchi B/L

Images via PACS BIDMC

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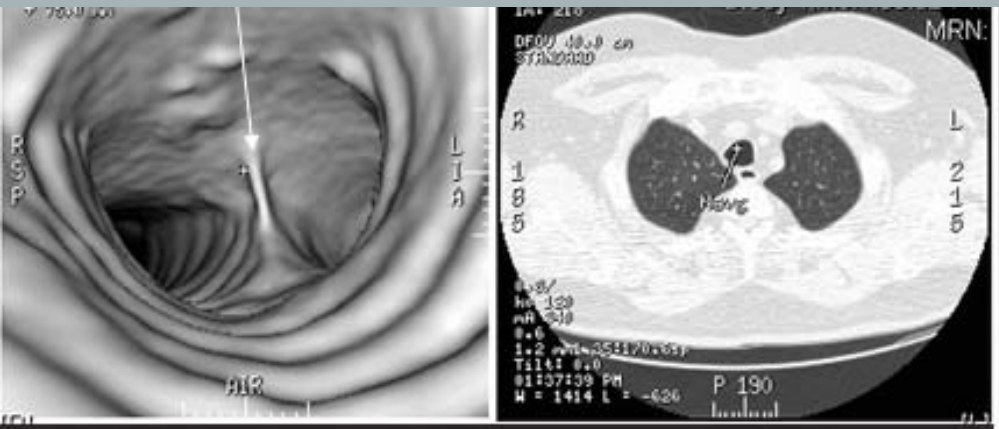
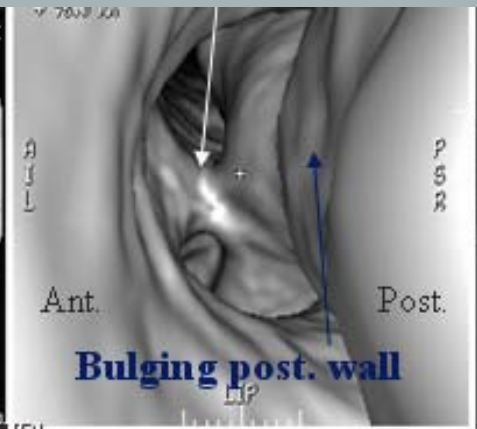
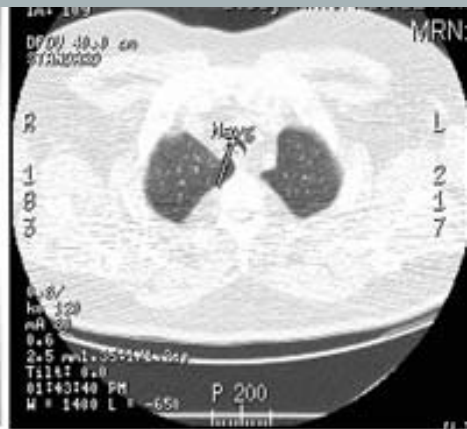
Axial, 2D sagittal/coronal, and 3D virtual bronchoscopy reconstruction CT images

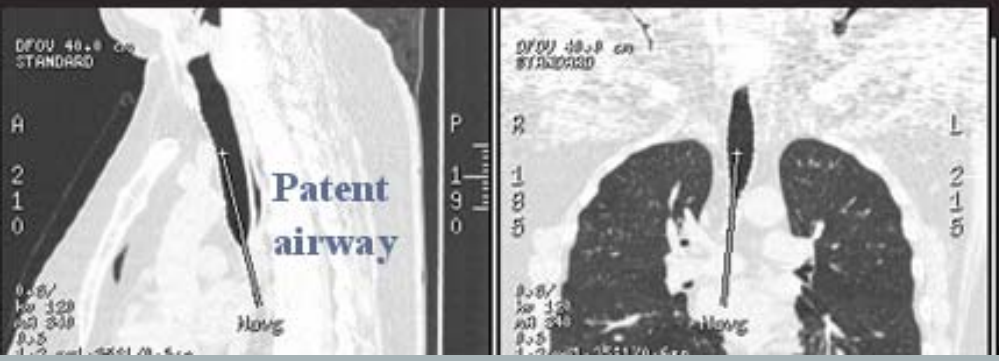
Carina

Carina









End inspiration

Expiratory

Images via PACS BIDMC

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Patient Presentation 1 Continued

- *Course after initial evaluation*
  - *Imaging findings suggestive of tracheobronchomalacia*
  - *Bronchoscopy to confirm diagnosis*
  - *Stenting of distal trachea and proximal left mainstem bronchus*
  - *Improvement of symptoms post-op with decline later. Repeat bronchoscopy displayed stent migration and subsequent removal performed.*
  - *Patient eventually referred for tracheoplasty*

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Patient Presentation 2

- *48 y/o women with resected left upper lobe for a carcinoid tumor.*
  - *S/P multiple thoracotomies for bleeding, adhesion lysis and attempted correction of bronchial torsion.*
  - *Eventual development of dyspnea and SOB on exertion, hemoptysis and frequent pneumonias.*
- *PMH of GERD and arthritis.*
- *30 ppy smoking hx*
- *Family history of COPD, CAD, lung cancer*
- *PE only positive for scattered wheezes, L>R*

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Patient Presentation 2 Continued

- *Pt was seen by pulmonology, had attempted stent placement for correction of bronchial torsion without success.*
  - *Repeat bronchoscopy revealed intact left upper bronchus stump, with 180 degrees torque of left mainstem bronchus.*
- *Dynamic airway imaging ordered to further assess bronchi and trachea*

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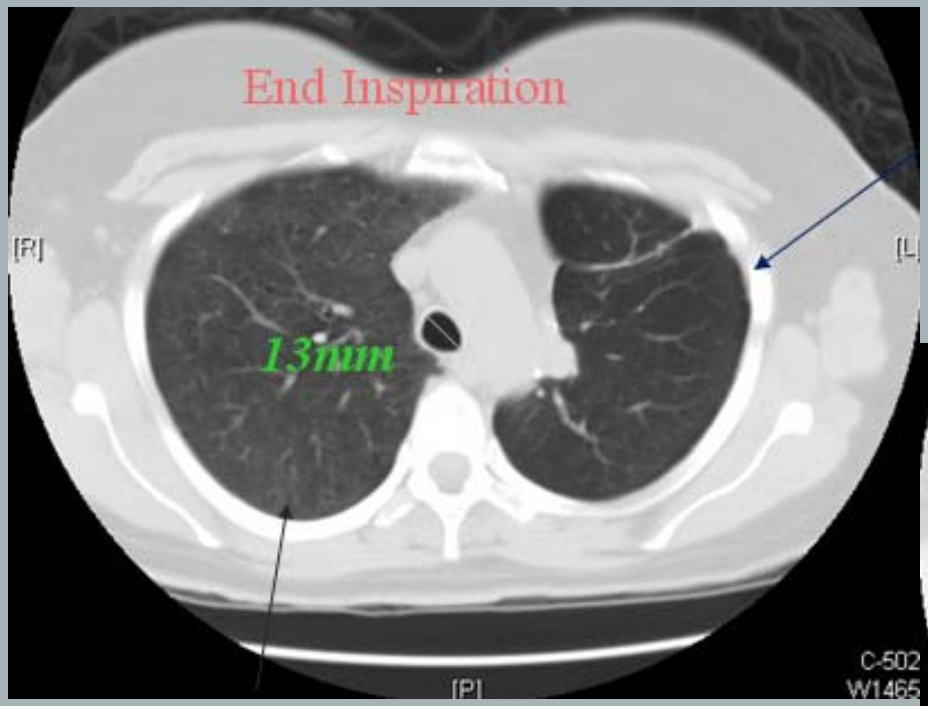
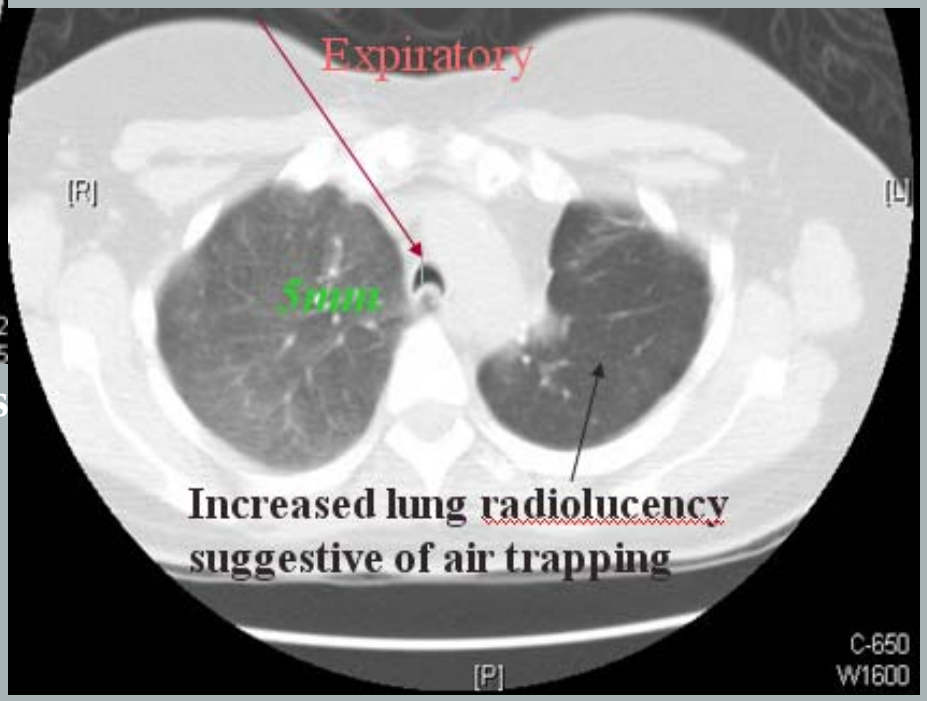
CT- End inspiration and dynamic (expiratory) axial images



Diffuse ground glass opacities (hazy opacities without obscuring vessels)

Smaller left lung s/p LUL resection

Cresentic anterior wall bowing suggestive of tracheomalacia, *60%* luminal diameter reduction



Can you see any other findings?

Images via PACS BIDMC

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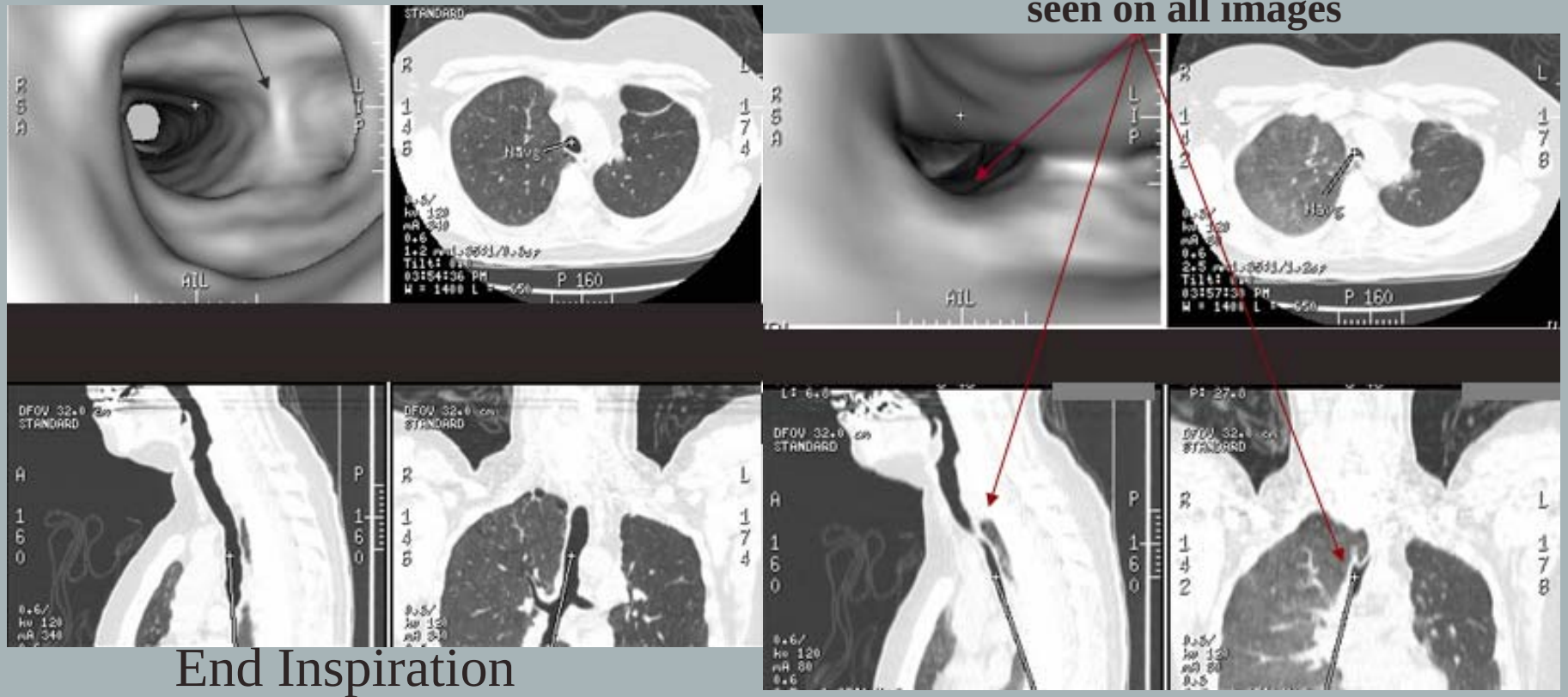
2D axial, sagittal/coronal, and 3D virtual bronchoscopy reconstruction CT Images

Carina

Luminal narrowing clearly seen on all images



End Inspiration

Expirator

Images via PACS BIDMC

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Patient Presentation 3

- *60 y/o male with Hx of steroid and O2 dependant COPD, DM, asthma, htn, GERD, penile cancer, repeated pulmonary infections, known tracheobronchomalacia treated well with stenting but requiring multiple stent replacements and bronchoscopies.*
- *Questionable diagnosis of Mounier-Kuhn syndrome*
  - *Syndrome of marked dilatation of the trachea and main bronchi, sometimes with tracheal diverticulosis, bronchiectasis, and recurrent lower respiratory tract infection*
- *45 ppy smoking hx*

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Patient Presentation 3 Continued

- *Patient evaluated by thoracic surgery and found to be candidate for tracheoplasty procedure*

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CT images- End inspiration(Lt.) and expiratory images (Rt.)

Small Bullae

Tracheomegaly (>3cm) consistent with Mounier-Kuhn syndrome

Marked tracheal luminal narrowing

Can you see the findings?

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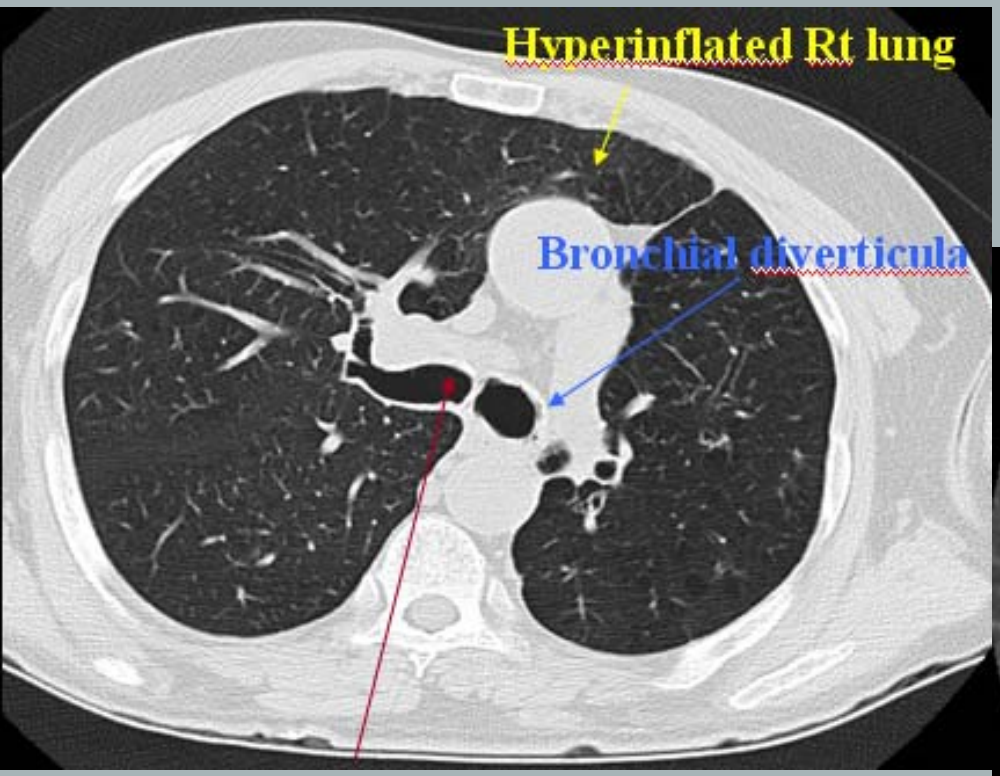
CT images- End inspiration(Lt) and expiratory(Rt) images



Marked luminal narrowing of proximal main stem bronchi

Enlarged bronchi with nodular, thickened walls

Can you see the other findings?

Findings help confirm

Mounier-Kuhn syndrome

Images via PACS BIDMC

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Gamut's Differential- Subglottic tracheal narrowing

- *Acquired Stenosis-*
  - *Trauma, hematoma, posttracheostomy fibrosis*
- *Carcinoma, Enlarged LN's*
- *Laryngotracheobronchitis*
- *Subglottic hemangioma (kids)*
- *Extrinsic mass-*
  - *paratracheal cyst, lymphoma, retropharyngeal abscess*
- *Vascular compression-*
  - *Rt aortic arch, double arch, aberrant left subclavian, aneurysm*
- *Tracheomalacia*

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Tracheobronchomalacia

- *Overview*
  - *Commonly under diagnosed condition in adults (secondary form)*
    - *Higher rates associated in patients with history of intubation, cuffed AND uncuffed tracheostomies, COPD/smoking, asthma, frequent respiratory infections, smoking, radiation, hx of TE fistula, chronic compression by extrinsic mass/vessel.*
    - *Primary form associated with congenital wall weakness in infants*
- *Incidence-*
  - *In general population estimated to be around 10%*
  - *Recent data suggests it may be 3rd most common cause of chronic cough*
- *PFT's*
  - *Flattening of expiratory limb of flow volume curve is highly suggestive but not seen in all patients.*
  - *No accurate correlation shown between FEV1 values.*

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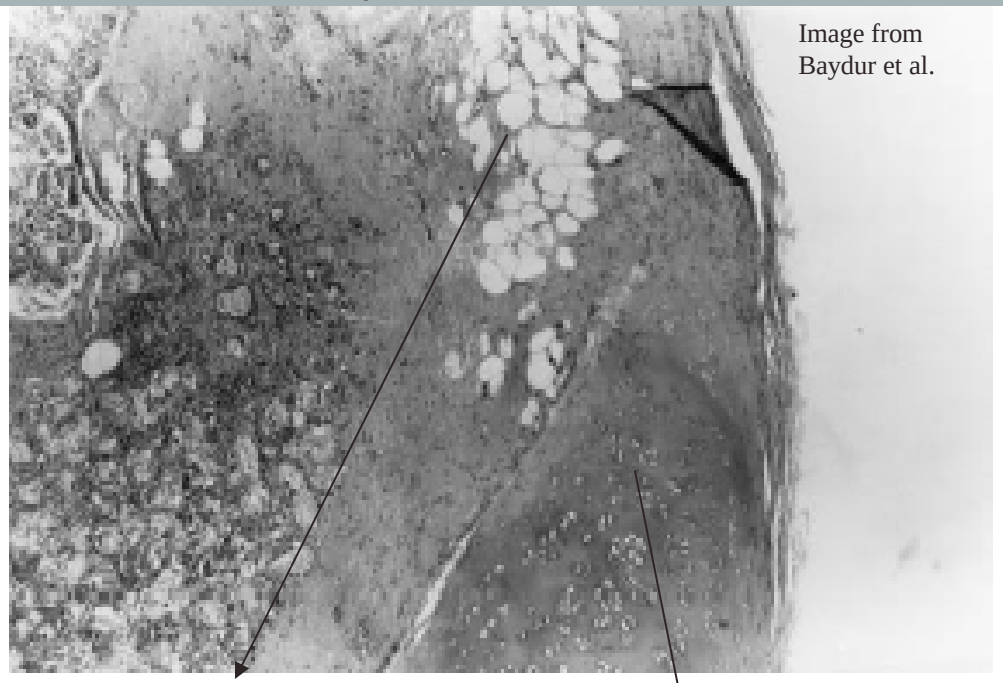
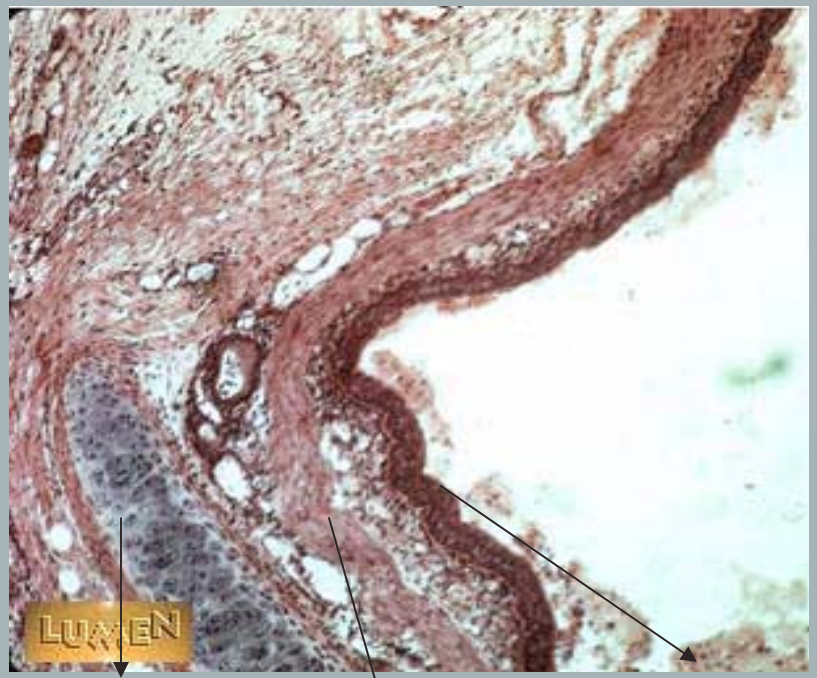
Pathology/Histology

- *Increased compliance/collapsibility of posterior membranous tracheal/bronchial wall with cartilaginous degeneration, loss of elastic fibers and fibrofatty replacement.*
- *Wall weakness thought to lead to poor cough, retained secretions, air trapping, and recurrent infections*

Image from http://www.meddean.luc.edu/lumen/MedEd/Histo/frames/h_fram15.html





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Tracheobronchomalacia-Imaging

- *Bronchoscopy remains gold standard.*
- *Often defined as 50% decrease in airway cross sectional area on dynamic expiratory scan.*
  - *Prior studies have advocated definition to be from >70% cross-sectional reduction, to values of 18% and 28% reduction for the upper and middle trachea respectively (Aquino et al.).*
  - *Control subjects have shown an average decline of 2-35% in various studies .*
- *Dynamic cine fluoroscopic imaging displaying tracheal collapse with induction of cough is likely most sensitive test for diagnosis.*

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Tracheobronchomalacia-Imaging

- *Dynamic Multidetector CT (MDCT) imaging*
  - *Along with Electron Beam CT, recognized as non-invasive means of diagnosis.*
  - *Low dose CT images for expiratory views have been shown to be accurate, quicker to acquire and provide decrease radiation to patient.*
  - *Reconstructed 2D and 3D virtual bronchoscopy views (as seen in our patients) often provide a preferred and quicker means to diagnosis. 3D virtual bronchoscopy allows images beyond sites of stenosis not accessible by conventional bronchoscopy and has been proven accurate with fixed lesions.*
    - *Gilkeson et al. confirmed strong correlation between dynamic CT imaging and bronchoscopic results.*

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Tracheobronchomalacia- Imaging

- *MR imaging-*
  - *Has shown preliminary use with dynamic imaging during coughing maneuver. Coughing thought to be better provoking factor then expiration alone.*
  - *Consider with young patients to avoid radiation and patients with contrast contraindications*
- *Other imaging findings-*
  - *Anterior crescentic bowing of posterior wall on expiration*
    - *Helps distinguish malacia from more common tracheal stenosis.*
  - *Increased prevalence of air trapping-*
    - *Results in decreased homogeneous attenuation (more radiolucent) then seen with expiration in normal lung.*
    - *Some define as less then 100 Hounsfield unit increase of lung density on expiratory images (Arakawa et al.)*

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Tracheobronchomalacia- Treatment

- *Stenting-*
  - *Used with improvement of symptoms in diverse bronchial pathology, however long term data not available. Some patients experience further irritation of airway and stent migration.*
  - *Long term metallic stent placement should be avoided in malacia due to increased risk of stent fracture from active luminal changes.*
- *Symptomatic- via use of steroids, bronchodilators, and supplemental oxygen*

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Tracheobronchomalacia- Treatment

- *Tracheoplasty-*
  - *First described in 1954 with use of bone grafts*
  - *Currently many use Marlex mesh placed over posterior wall via thoractomy and pleural dissection and sutured in place at cartilaginous membranous junction.*
  - *Recreates D shape of trachea and reinforces posterior wall.*

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Tracheoplasty-Imaging

- *Expect increase posterior wall thickness (>3mm).*
  - *Boiselle et al. (currently in press) examined 5 pts s/p procedure and found an average thickness of posterior wall to be 5.4mm.*
  - *Best to wait a 1 month post-op for follow-up as edema and soft tissue hemorrhage can occur early after procedure*
- *As seen in cases, most patients have return of normal tracheal caliber and shape*

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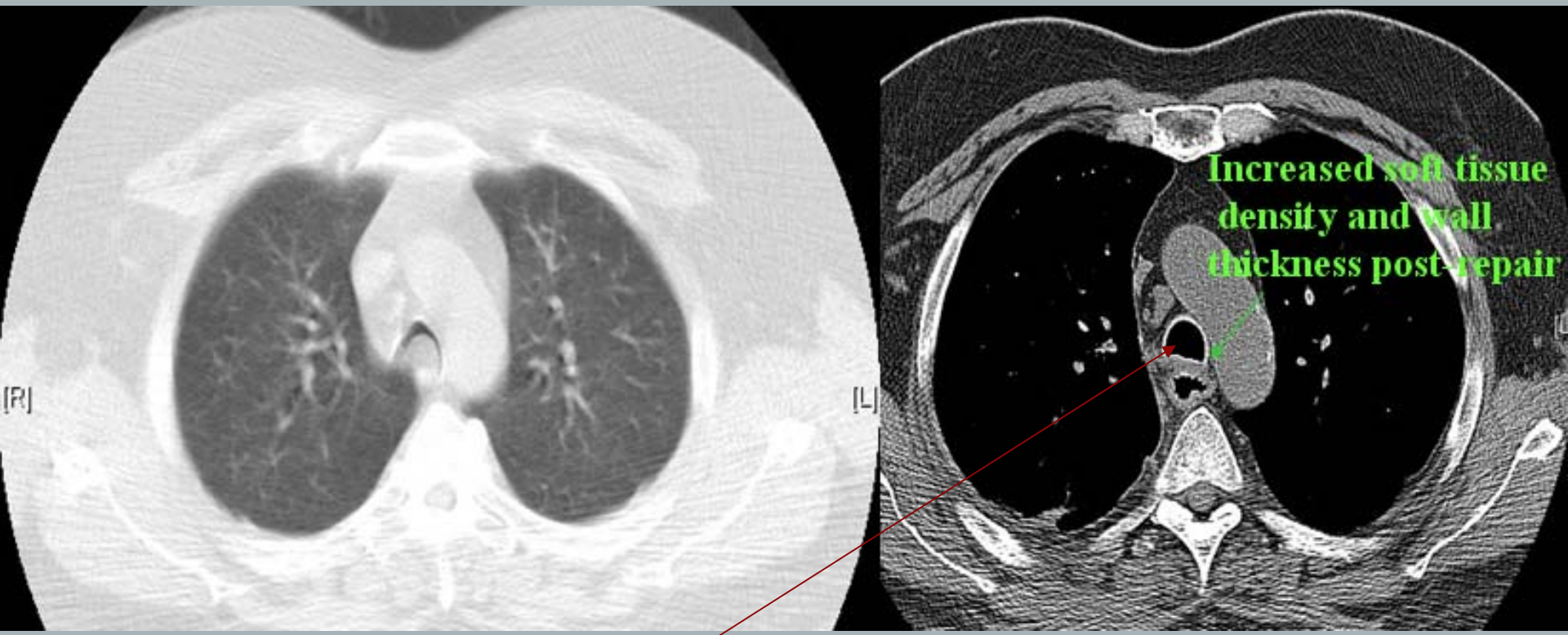
Patient 1 – Dynamic(expiratory) CT images pre and post tracheoplasty

Lung window

Soft tissue window



Can you see the post-op changes?

Images via PACS BIDMC

Return of normal "D" shaped tracheal lumen

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Patient 3- Dynamic (expiratory) CT images pre and post tracheoplasty

Images via PACS
BIDMC

Reconstitution of normal tracheal "D" configuration with expiration

Wall thickening

Continued bilateral air trapping

Continued proximal bronchomalacia (mesh not placed here)

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Take Home Points

- *Tracheobronchomalacia is more common then we think, and should be considered in patients with un-resolving respiratory symptoms and risk factors.*
- *Dynamic MDCT imaging allows expiratory images that demonstrate malacia and subsequent obstructive pathology and may soon become gold standard. MRI shows promise*
- *Tracheoplasty is an exciting technique for surgical candidates and offers relief of the obstruction with easily recognized post-op CT changes*

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