Large and Small Airways Disease
Part 1

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Trachea - Anatomy

- Hollow cylinder composed of series of C-shaped cartilaginous rings
- Completed posteriorly by flat band of muscle and connective tissue named posterior tracheal membrane
- From cricoid cartilage (C6) to carina (T5)
- Divides into right and left main bronchi
Trachea - Anatomy

- 12 cm long, coronal diameter 25-21 mm
- Oval or horseshoe-shaped
- Flat or convex posteriorly
  - convex anteriorly on expiratory CT
- Coronal/sagittal ratio 0.6:1.00
- Narrowing coronal diameter <0.6 is termed saber sheath trachea
Men
T: 13-25mm
AP: 13-27mm

Women
T: 10-21mm
AP: 10-23mm
Normal components of the tracheal wall
Trachea and central bronchi

- Many diseases may affect trachea and mainstem bronchi
- Asymptomatic or nonspecific symptoms
  - cough, dyspnea, wheezing, stridor
- Clinical course is often long-term and misdiagnosis of bronchial asthma is common
- May be divided: focal or diffuse
Trachea: focal diseases

- Narrowing
  - intrinsic
  - extrinsic

- Masses
  - neoplastic
    - benign
    - primary
    - secondary
  - nonneoplastic
    - mucus
    - ectopic thyroid

- Dilatation
  - tracheocele, malacia, UL fibrosis
Tracheal Stricture

- Usually caused by damage from cuffed ET or tracheostomy tube
- Cuff pressure exceed capillary pressure leading ischemic necrosis and fibrosis
- Typical hourglass deformity on X-rays
- Nowadays is rare because of use of low-pressure high-volume ET cuffs
Tracheal Stricture

- **Sx:** SOB exertion, dyspnea, brassy cough, stridor, wheezing
- **Causes:** most common traumatic
  - congenital posterior fusion tracheal rings
  - infections: Histo, Blasto, TB
  - inflammatory: sarcoidosis, RP, SM, WG
  - neo: chondroma, squamous papilloma, fibroma, granular cell tumor
Extrinsic Compression/Narrowing

- Most common causes are intrathoracic goiter and paratracheal lymph nodes
- Other causes: aberrant left pulmonary artery, aortic ring, bronchogenic or pericardial cyst
- Extrinsic masses tend to displace trachea with or without narrowing of its lumen
Tracheal Neoplasm

- Primary tracheal neoplasms are rare in contrast to larynx and bronchial tree
- Most common secondary tumors are infiltrating esophageal and thyroid neo or infiltrating lymph node metastasis
Tracheal Neoplasm

- First report was in 1767 (PM fibroma)
- Very rare accounting <1% all neoplasms and <0.1% cancer death each year
- Related to smoking
- 40% had prior, concurrent or later oro-pharinx, larynx or lung cancer
- M:F 3:1 peak incidence 5th – 6th decades
Tracheal Neoplasm

- Etiology:
  - benigns arise from any tracheal tissues
  - malignants arise from epithelium/mucous glands (90%) or mesenchymal (10%)
  - 90% of all primary tracheal tumors in adults are malignants
Malignant Tumors

- Symptoms are absent or nonspecific
- Early diagnosis is difficult
- Tracheal tumors are inconspicuous on x-ray
- CT is highly sensitive detecting tracheal tumors
- Squamous cell carcinoma and adenoid cystic carcinoma account for more than 85%
Malignant Tumors

- Adenoid cystic carcinoma originates from tracheal mucous glands
- On CT primary malignant tracheal tumor may appear as polypoid, focal sessile, eccentric or circumferential
- Attachment to tracheal wall may be broad-based or narrow and pedunculated
- Mets may occur direct or hematogenous
Non-Hodgkin Lymphoma

- Systemic non-Hodgkin lymphomas may also involve the upper airway
- Endobronchial lymphoma two types:
  - Type I diffuse submucosal infiltrates from hematogeneous/lymphatic spread
  - Type II central airway involvement by a solitary mass
Non-Hodgkin Lymphoma

Several possible mechanisms of endobronchial NHL include:

- direct invasion from lung mass
- direct invasion from mediastinal mass
- lymphatic spread to peribronchial tissue
- transbronchial aspiration of tumor emboli
- direct hematogeneous metastasis
Non-Hodgkin Lymphoma

- Clinical:
  - systemic sx related to lymphoma
  - dyspnea, cough, hoarseness, CP
  - rarely asymptomatic
- Diagnosis is difficult cause symptoms and chest x-ray are nonspecific
- CT is useful
- Bronchoscopy and Bx is mandatory
Benign Tumors

- Sq cell papillomas most common
- Solitary associated smoking, >adults
- Multiple associated HPV, >childhood
- Other tumors are exceedingly rare:
  - chondroma arises from cartilage, calcification
  - fibroma sessile or pedunculated, cervical trachea
  - hemangioma infant/young children, cervical trachea
  - granular cell myoblastoma from neural elements
Benign Tumors

- Clinical: cough, dyspnea, hemoptysis, wheezing
- Radiology:
  - Plain: N, narrowing, atelectasis, Ca^{++}
  - CT modality of choice
    - >2cm malignant, <2cm benign
    - lobulated soft tissue mass, eccentric narrow
  - MRI: evaluate extension planes/vascular
Tracheobronchial Papillomatosis

- Papilloma most common laryngeal tumor of childhood
- Surgical excision or regress at puberty
- In 2%-5% lesions may spread distally involving tracheobronchial tree
- Also called Recurrent Respiratory Papillomatosis
- Caused by human papilloma virus (HPV)
Tracheobronchial Papillomatosis

- Two peaks: children and 20-40 y/o
- Children: M:F ratio 1:1
- Adults: M:F ratio 4:1
- Clinical: cough, wheezing, hemoptysis, stridor, dysphagia, pneumonia, aphonia, hoarseness (adults)
- Adult disease less severe than juvenile
Tracheobronchial Papillomatosis

- Imaging findings:
  - CXR usually normal
  - CT of the neck and chest show extension
  - nodular lesions in airway/lung
  - often cavitate
  - cavitary progress to thick/thin cysts
  - nodules may be seen within cysts
Central Bronchi Tumors

- Primary tumors include Ca, carcinoid and bronchial gland tumor (adenoid cystic Ca and mucoepidermoid Ca)
- Account for 1% all tracheobronchial Tu
- 90% arise bronchus, 10% arise trachea
- Carcinoid account for nearly 90%
  Adenoid cystic Ca 8%
  Mucoepidermoid Ca 2%
Carcinoid Tumors

- Carcinoids arise from neuroendocrine or Kulchitsky cells
- Three types: typical, atypical, small cell
- Typical are low-grade malignant type, grows slowly, mets are infrequent
- Atypical are aggressive, mets more frequent
- SCC are high-grade malignant type
Carcinoid Tumors

- Carcinoids produce active peptides or hormones (serotonin, ACTH, ADH)
- Carcinoid syndrome: tachycardia, bronchoconstriction, flushing, diarrhea
- Clinical: -40% asymptomatic
- cough, dyspnea, wheezing, CP, hemoptysis, atelectasis
- 45-50 y/o
Carcinoid Tumors

- **Radiology:**
  - 80% arise centrally, 20% mimics SPN
  - hilar/perihilar mass 2-5 cm in size
  - round or ovoid, smoothly/lobulated mass
  - eccentric calcifications up to 30%
  - highly vascular with marked enhancement
  - primarily endobronchial extend into adjacent lung (iceberg lesion)
Carcinoid Tumors

- Plain: nodular hilar image, atelectasis
- MRI: hyperintense in T2 and STIR
- PET: no increased metabolic activity can be considered as benign lesion
- NM: because somatostatin receptors may show ↑ uptake In\textsuperscript{111} octreotide
Focal Tracheal Dilation

- Diverticulum is a focal herniation of mucosa through tracheal wall
- May be seen in normal patients
- Associated with COPD
- Usually asymptomatic and incidentally
- Near thoracic inlet along posterolateral right trachea
- Easily seen in CT, rarely seen on plain
Diffuse Tracheal Narrowing
Saber-sheath Trachea

- Reduced transverse and increased AP
- Coronal/sagittal ratio <0.5
- Involve entire intrathoracic trachea
- Affects exclusively men and calcification of rings is very frequent
- Almost always associated with COPD
Saber-sheath Trachea

- Radiology:
  - marked decrease coronal diameter
  - CT shows inward bowing or displacement lateral walls (cartilage weakness)
  - during forced expiration CT shows further inward bowing
Amyloidosis

- Characterized by deposition fibrillar protein-polysaccharide complex
- Deposits are found within submucosa
- Main bronchi commonly involved
- Rare condition and may involve airways as part of localized or systemic disease
Amyloidosis

- Calcifications in 10%
- Hoarseness, cough, stridor, dyspnea, hemoptysis, recurrent infections
- Recurrent atelectasis and pneumonia
- Masslike circumferential deposits that irregularly narrow the trachea
- Nodular thickening infrequent
Relapsing Polychondritis

- Systemic autoimmune disorder
- Cartilage inflammation affecting ear, nose, joints, larynx, tracheobronchial
- Early: wall swelling w cartilage destruction leads to dilated trachea
- Later fibrosis leads to narrowing trachea
- Limited to cartilage, not affect mucosa or submucosa
Relapsing Polychondritis

- Upper airways are affected >50%
- Wall thickening in anterior and lateral walls, sparing of posterior membrane
- Luminal narrowing may be fixed or may increase with forced expiration
- Cauliflower ears and saddle nose deformity
Tracheobronchopathia Osteochondroplastica

- Rare disorder seen in elderly men
- Characterized by presence of multiple osseous or cartilaginous nodules or both
- Submucosa tracheobronchial walls
- Sparing of posterior membrane
- Lesions arise as enchondromas from cartilage then project into lumen
- Bronchoscopy or CT. No malacia
Wegener’s Granulomatosis

- Mucosal and submucosal inflammation and ulceration, destruction cartilage
- Trachea in 15%-25%, no malacia
- Subglottic involvement is most typical
- Variable involvement distal trachea and mainstem bronchi
- CT shows circumferential wall thickening and narrowing lumen
Diffuse Tracheal Dilatation
Tracheobronchomegaly

- Also known as Mounier-Kuhn syndrome
- Congenital abnormality of trachea and main bronchi
- Characterized by cystic dilatation of tracheobronchial tree
- More common in AA males
- Only 5% are females
Tracheobronchomegaly

- Atrophy or absence elastic fibers and thinning muscle trachea and bronchi
- Associated with Ehlers-Danlos synd
- Most often occur in 3rd and 4th decades
- Trachea and bronchi become markedly dilated on inspiration and collapse on expiration
Tracheobronchomegaly

- Predispose to: fibrosis, bronchiectasis, emphysema, chronic suppuration
- Sx: recurrent pneumonia, hoarseness, dyspnea, cough, purulent sputum
- Imaging:
  - tracheobronchomegaly
  - saclike outpouchings
  - pulmonary fibrosis, bullae
  - bronchiectasis
Tracheobronchomalacia (TBM)

- Characterized by flaccidity of supporting tracheal cartilage, widening posterior membranous wall and ↓ A-P caliber
- Pathologically results from weakening of cartilage and hypotonia PM trachea
- Two types: -congenital presents at birth -acquired associated with COPD, intubation, RT, Tu, CF, RP
Tracheobronchomalacia (TBM)

- Sx are nonspecific, cough, wheezing and dyspnea, often misinterpreted as asthma
- Incidence estimated to be 10%
- Imaging:
  - bronchoscopy gold standard
  - anterior crescentic bowing posterior wall on expiration
  - near complete obliteration
Inspiration

Expiration

Gilkeson RC et al. AJR 2001;176:205-210
Tracheal and Bronchial Injury
Tracheal and Bronchial Injury

- Most often seen with blunt chest trauma from deceleration-type injury
- Mechanism is forceful compression of central tracheobronchial tree against thoracic spine
- Fracture involve:
  - proximal bronchi 80%
  - trachea (2cm carina) 15%
  - peripheral bronchi 5%
Tracheal and Bronchial Injury

- Horizontal laceration or transection parallel to cartilage most common form
- Concomitant Ao laceration, great vessel injury and bone fractures
- One third injuries have delayed dx
- Penetrating tracheal injuries involve cervical trachea
Tracheal and Bronchial Injury

- Pneumothorax and pneumomediastinum
- Collapsed lung or pneumonia due to bronchial stenosis
- Aberrant endotracheal tube
- MDCT with 3D reconstruction
- Definitive diagnosis is by bronchoscopy
Tracheostomy Malposition

- Asclepiades of Bithynia performed first tracheostomy in 100 BC
- Indications: upper airway obstruction, pulmonary toilet, long-term ventilation
- Procedure can be performed:
  - emergency: trauma, edema, obstruction
  - elective: long-term ventilation
Tracheostomy Malposition

- Improper position of tracheostomy tubes appear to be a common complication
- In a series of 403 patients 10% had tube malposition
- Tracheostomy performed by non-thoracic surgeon increased risk

Schmidt U et al Chest 2008;134:288-294
Tracheostomy Malposition

- Complications are classified into intraoperative, early and late postoperative.
- False passage is an early postoperative event.
- May occur with initial placement tube or retraction distal end of tube with patient movement or tube manipulation.
- Consequences include subcutaneous emphysema, PTX, pneumomediastinum.
Acquired Esophagorespiratory Fistula

- In adults usually acquired lesions
- Occur as a complication of:
  - intrathoracic malignancies (60%)
  - prolonged tracheal intubation
  - esophageal instrumentation
  - infection
  - trauma
Acquired Esophagorespiratory Fistula

- Occur in 5%-10% pts with advanced esophageal cancer
- Risk increase in cases have prior irradiation
- Prognosis extremely poor
- Strongly suspected recurrent pneumonia

Dx:
- fluoroscopy with oral contrast material
- CT useful detecting fistulous tract
Esophagopleural Fistula

- Fistulas may develop because of close anatomic relationship
- Early diagnosis is important due to life-threatening consequences
- Clinical findings include: chest pain, fever, dysphagia, dyspnea
Esophagopleural Fistula

- Associated with advanced esophageal Ca, TB, surgical procedures, endoscopic examinations, chemical injury, RT
- Radiographic findings include air in pleural space, hydropneumothorax, empyema, oral contrast in pleura
- CT modality of choice
Thank you!