Flexible Bronchoscopy:

More Than Just a Diagnostic Tool

Kimberly M Baker-El Abiad, MD
Division of Pulmonary, Critical Care, & Occupational Medicine

10/19/2018

Objectives

- Brief historical background on bronchoscopy
- Review variety of Indications for bronchoscopy
- Discuss role of bronchoscopy in central airway obstruction
  - Benign & malignant
- Discuss role of bronchoscopy in some chronic lung diseases

Brief Historical Background

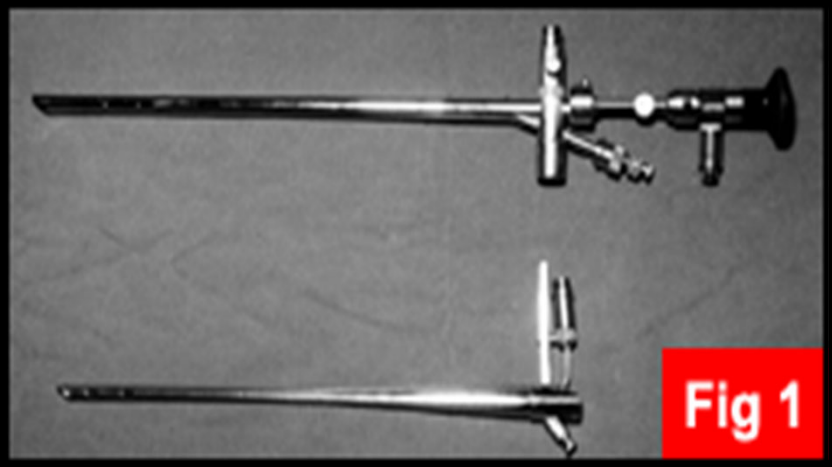
- Indications have expanded over the years and likely will continue to expand
- Rigid bronchoscopy 1897 *(Gustav Killian)*
    - Visual inspection of trachea and proximal mainstem bronchi
    - Initially for removal of foreign bodies

Courtesy of Dr. Heinrich Becker.

FIGURE 24-1. *Gustav Killian positioning a rigid bronchoscope on a cadaver.*

Gustav Killian – Rigid bronchoscopy

Rigid Bronchoscope

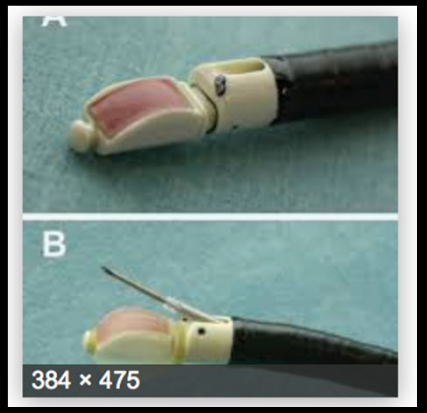


Brief Historical Background

- Flexible bronchoscope 1966 *(Shigeto Ikeda)*
  - Better visualization of upper lobes and inspection of distal segments of lower lobes
  - No need for general anesthetic
  - Better tolerated
  - Procedure could be performed as an outpatient
- Ongoing development of tools for use through the flexible scope

Fiberoptic Bronchoscope

Video Bronchoscope



EBUS Scope

Indications for Bronchoscopy

- Inspection
- Diagnostic
- Therapeutic
- Research

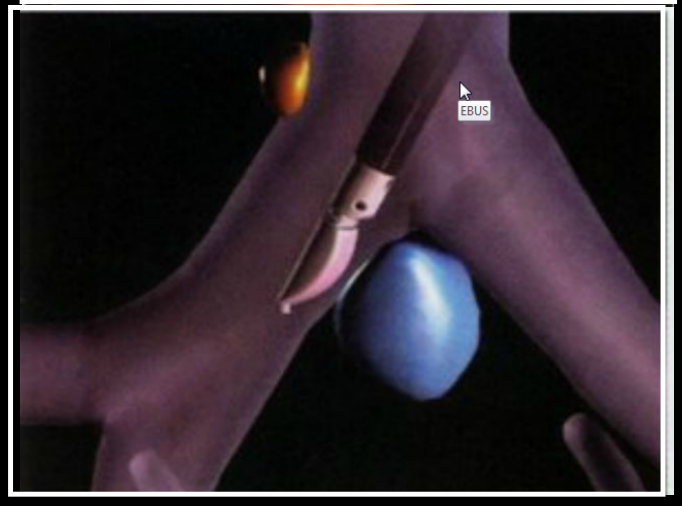
Indications for Bronchoscopy: Inspection

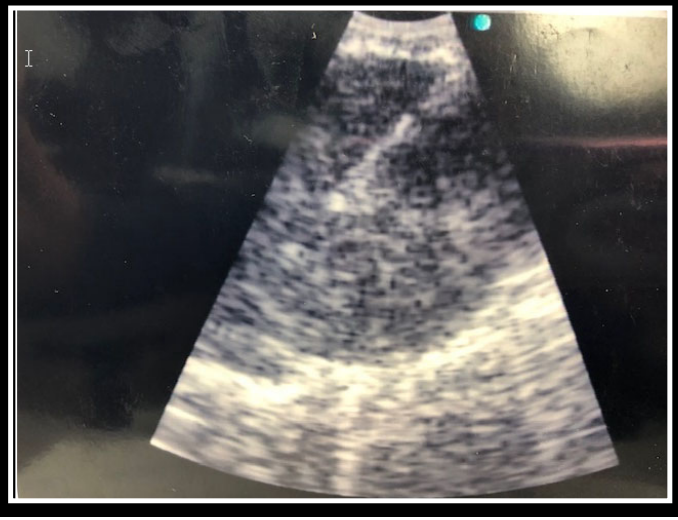
- Cough
  - After other extensive workup non-diagnostic
- Hemoptysis
  - To secure airway; insert endobronchial blocker; localize site of bleeding
  - Examine upper airway at same time
- Localized/fixed wheeze
  - Endobronchial tumor/foreign body
- Recurrent/Persistent PNA (in same location)

Indications for Bronchoscopy: Inspection

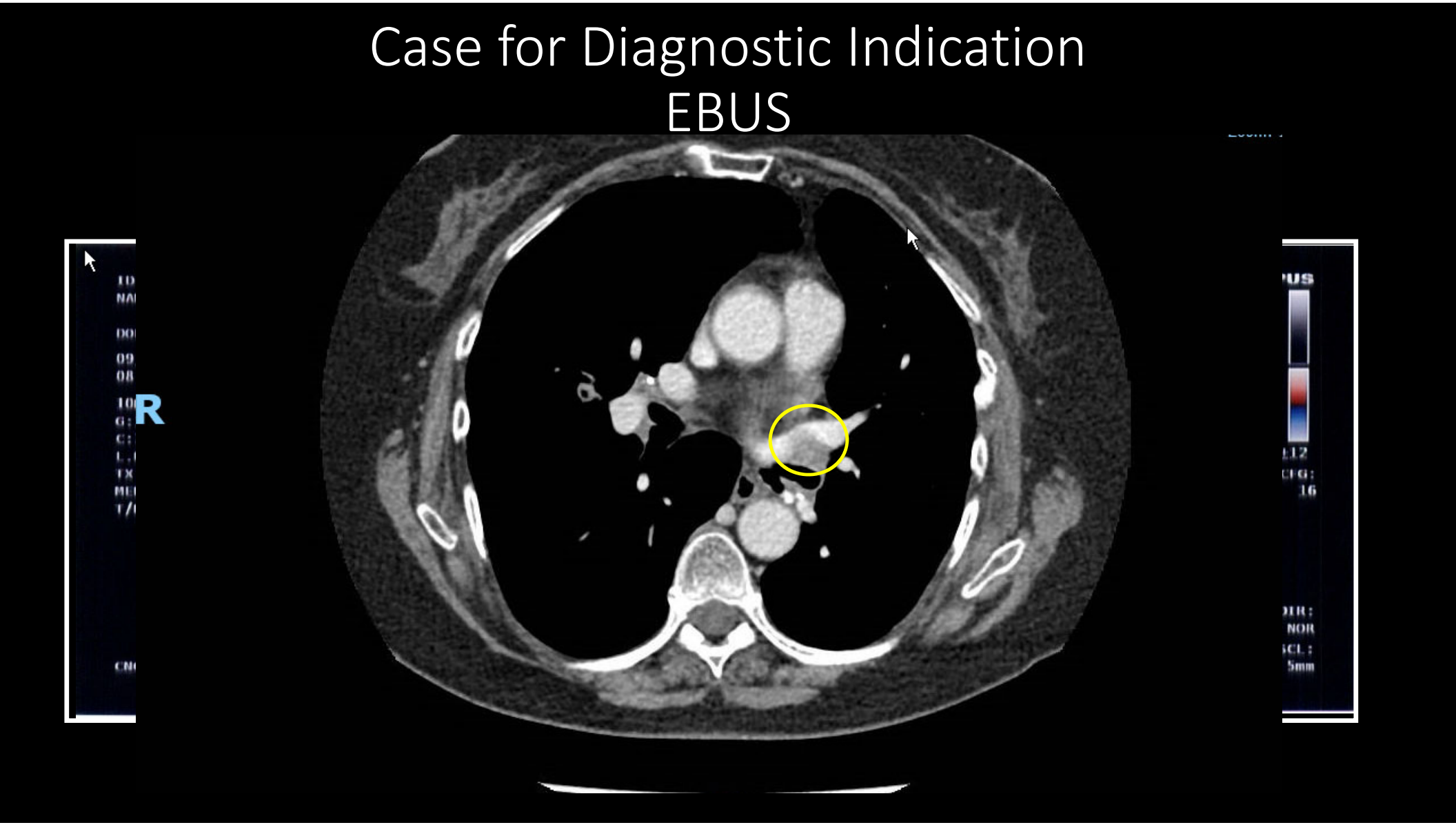
- Unexplained hoarseness/vocal cord paralysis
- Suspected TE fistula
  - Setting of esophageal cancer; XRT to chest
  - Pre-op evaluation in esophageal cancer (looking for invasion)
- Chest trauma
  - Disruption of tracheobronchial tree

Case for Diagnostic Indication
EBUS



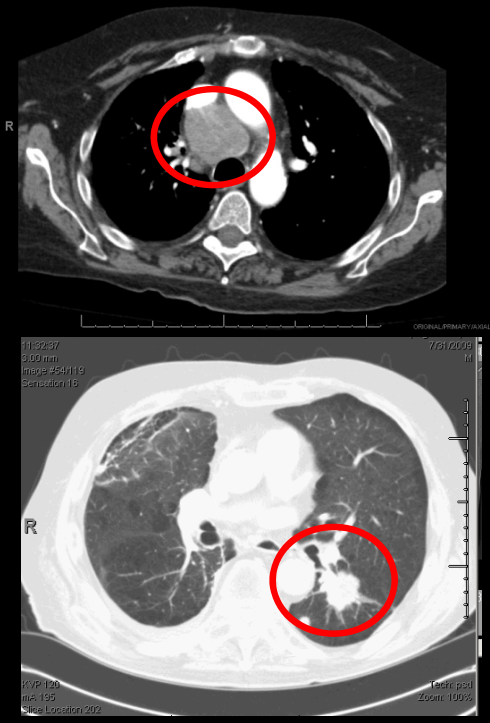


Case for Diagnostic Indication
EBUS



Indications for Bronchoscopy: Diagnostic

- Adenopathy
  - Diagnosis – malignant/nonmalignant
  - Staging info
- Mass
  - TBBX
  - TBNA
  - TB Brush
  - ?BAL

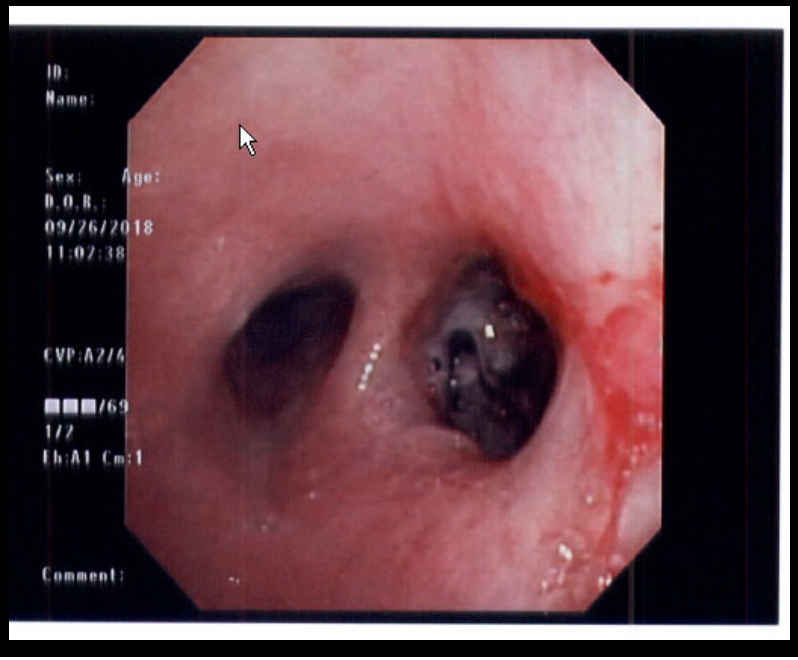


Indications for Bronchoscopy: Diagnostic

- Interstitial Lung Disease
  - BAL
  - TBBX
- Non-Resolving Pneumonia
- Evaluating for pulmonary infections in critically ill patients
- Infiltrate in an immunocompromised host?
- Lung transplant:
  - Evaluate for rejection/infection
    - Surveillance/change in pulmonary function
    - Symptoms concerning for infection
  - Evaluate anastomosis

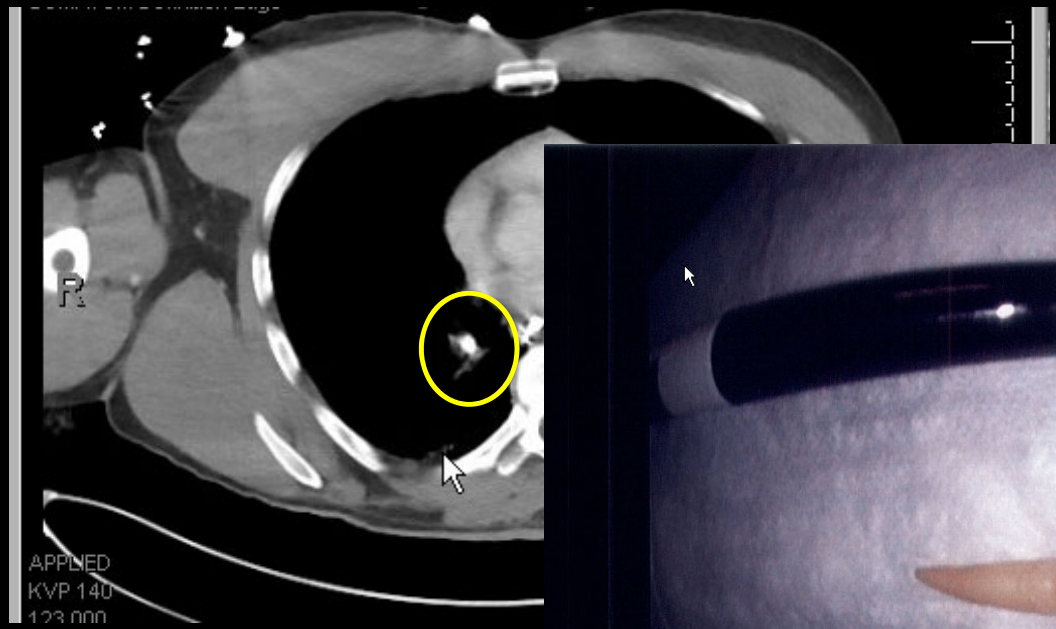
Indications for Bronchoscopy
Diagnostic

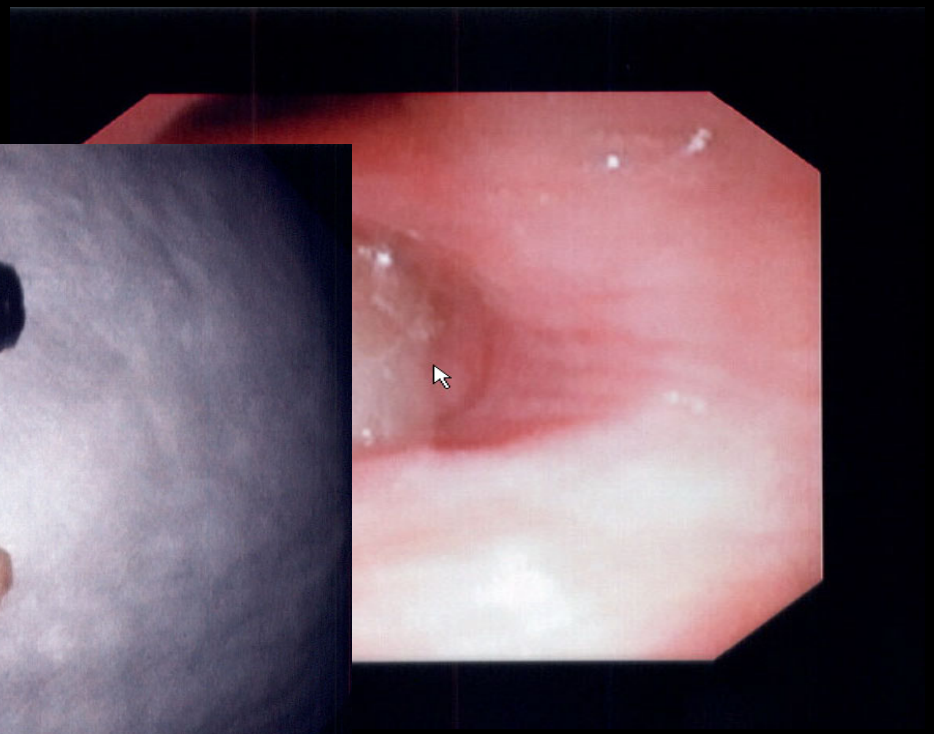
- Foreign body:
  - Known/suspected
- Persistent atelectasis/lobar collapse
- Localization of BP fistula



Indications for Bronchoscopy: Therapeutic

Brief history





Indications for Bronchoscopy: Therapeutic

- Remove secretions/mucous plugs (IF conventional noninvasive techniques have been unsuccessful)
  - ‘Snot’ bronch
- Removal of foreign bodies
  - Rigid/flexible scope
- Difficult intubations

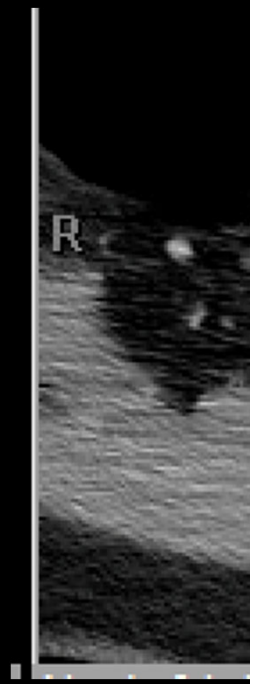
Indications for Bronchoscopy: Therapeutic

- Relief of Obstruction
  - Benign/Malignant
  - Debulking of tumor
  - Dilation of stenosis
- Therapy for Asthma
  - Bronchial Thermoplasty
- Closure of BP Fistula
- Bronchoscopic Lung Volume Reduction

Case #1: History/Physical

- 41 year old woman presenting with 1 year of dyspnea and cough that has gradually gotten worse
- Sometimes told she has ‘noisy’ breathing
- Sputum sometimes hard to expectorate
- No other significant medical history or family history
  - Remote intubation as a child
- No improvement with inhalers
- Exam unremarkable except insp/exp ‘wheeze’ over neck

Case #1: PFTs and Imaging

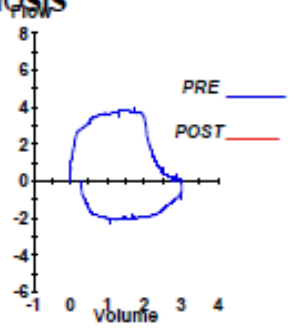


Diagnosis: SUBGLOTIC STENOSIS

Previous Study:

Current Study:
02/05/18

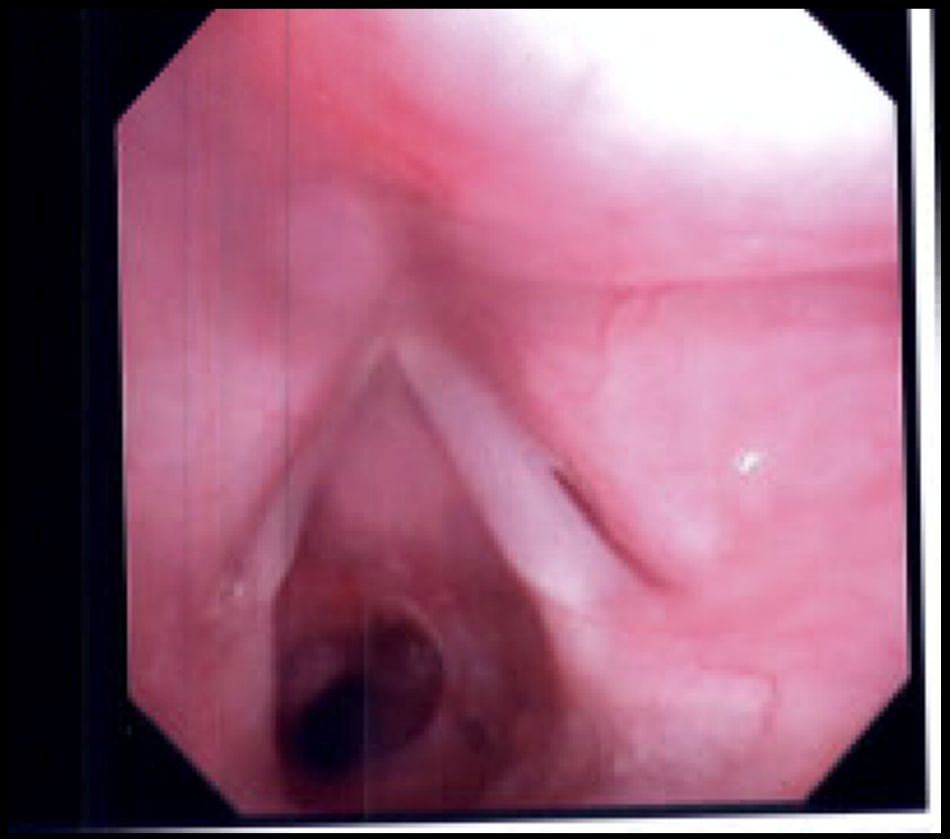
FVC	Liters	FVC	3.04 Liters	(86) %	impr by
FEV1	Liters	FEV1	2.52 Liters	(88) %	impr by
FEF25-75%	L/sec	FEF25-75%	3.15 L/sec	(104) %	impr by
PEF	L/sec	PEF	3.84 L/sec	(57) %	impr by
TLC	Liters	TLC	Liters	() %	impr by
RV	Liters	RV	Liters	() %	impr by
DLCO	mL/mmHg/min	DLCO	mL/mmHg/min	() %	impr by

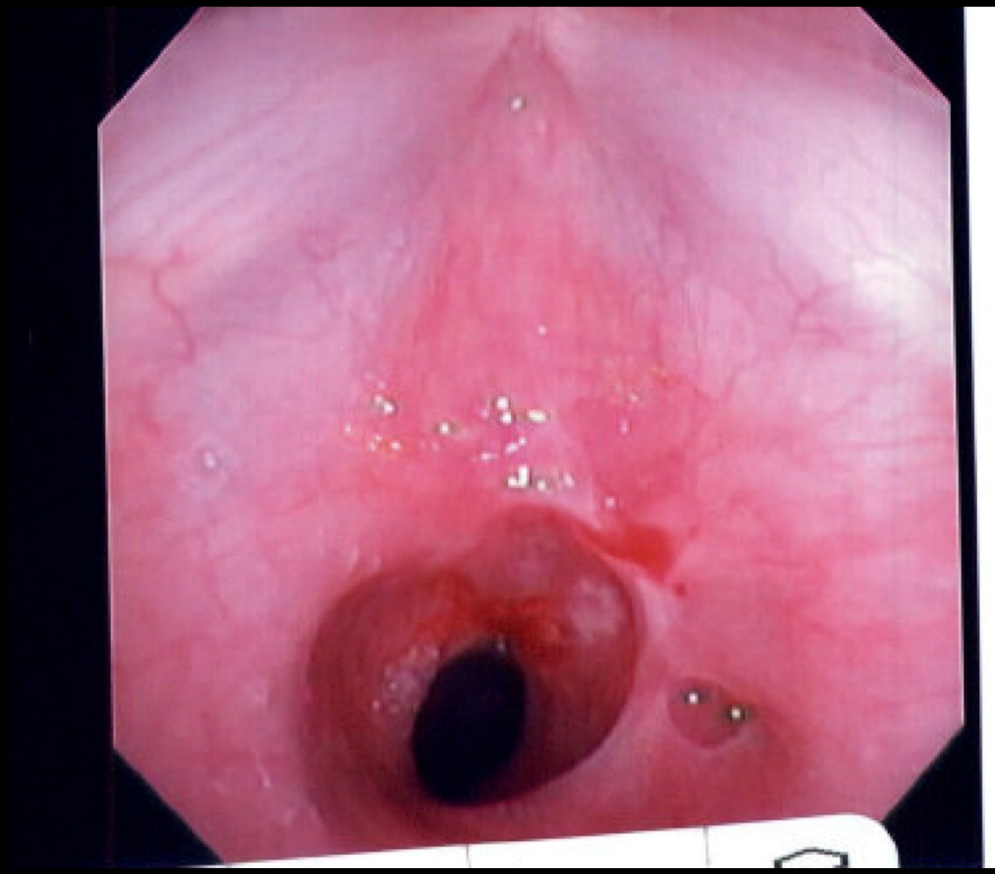


DATE	*FVC*	*FEV1*	*POST FEV1*	*25/75*	*PEF*	*PIF*	*TLC*	*FRC-PL*	*RV*	*DLCO*
CURRENT STUDY	3.04	2.52		3.15	3.84	2.08				

Spirometry		Pre	Ref	95% CI	% Ref	Post	% Ref	%Chg
FVC	Liters	3.04	3.51	(2.9 - 4.2)	86			
FEV1	Liters	2.52	2.87	(2.3 - 3.4)	88			
FEV1/FVC	%	83	82	(72.3 - 91.9)				
FEF25-75%	L/sec	3.15	3.02	(1.8 - 4.2)	104			
PEF	L/sec	3.84	6.74	(5.1 - 8.4)	57			
PIF	L/sec	2.08						

Case #1: Bronch images



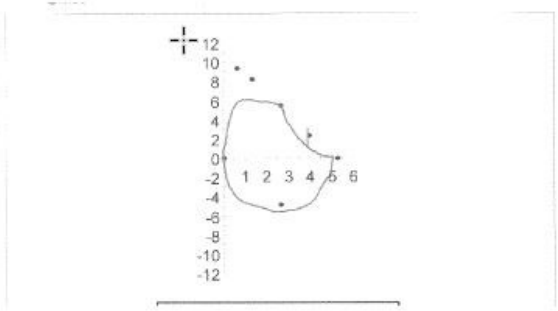


Case #2 – Presentation/History

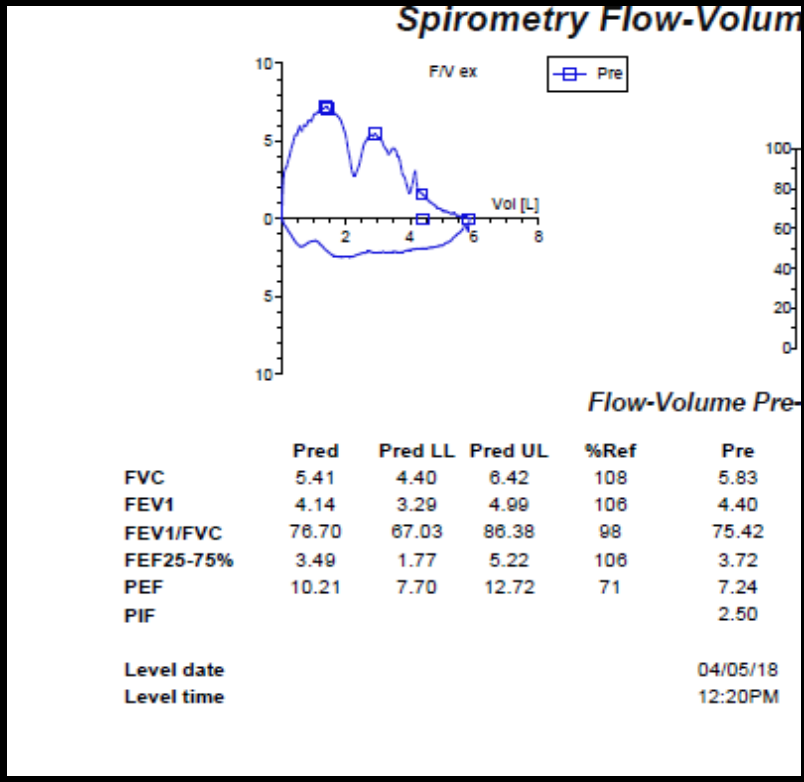
- 55 year old healthy man. Has had 1 year of dry cough and DOE, worse over last month.
  - Saw pulmonary and treated for asthma – no benefit
  - Saw ENT who scoped down to level of cords 3-4 months ago
  - EGD for GERD a few months ago – tolerated no problems
  - CT done few weeks prior to presentation because things 'just not getting better'
- Otherwise healthy
- Exam mainly remarkable for insp/exp stridor auscultating over trachea (forced maneuvers but not with normal tidal breathing)

Case #2 - Spirometry

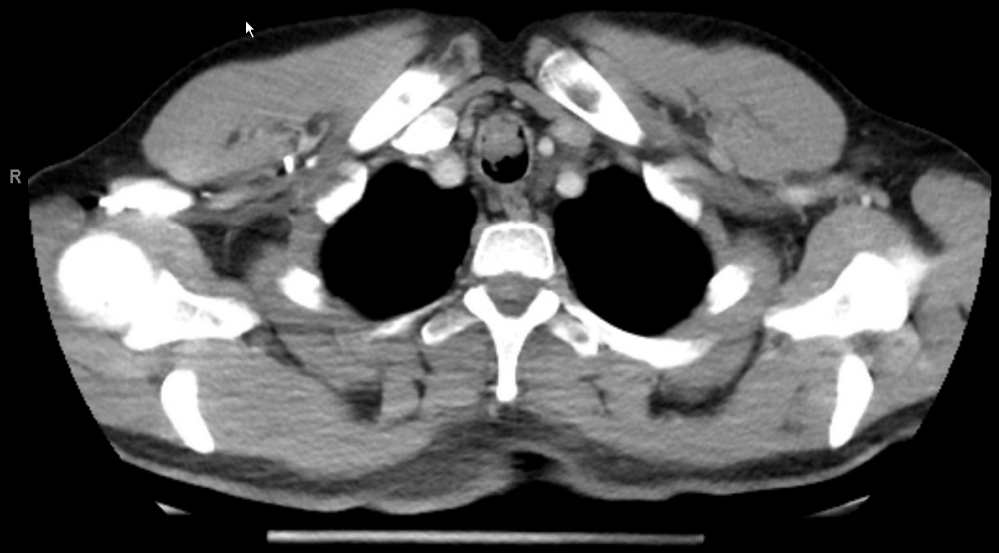
	Pre-Bronch				Post-Bronch		
	Actual	Pred	%Pred	LLN	Actual	%Pred	%Chng
---- SPIROMETRY ----							
FVC (L)	5.01	5.22	95	4.16			
FEV1 (L)	3.91	4.20	92	3.34			
FEV1/FVC (%)	78	77	101	67			
FEV6 (L)	5.01	5.22	95	4.23			
FEV1/FEV6 (%)	78	80	97				
FEF 25% (L/sec)	6.08	8.22	73				
FEF 75% (L/sec)	1.35	2.33	57				
FEF 25-75% (L/sec)	3.67	4.22	86	2.44			
FEF Max (L/sec)	6.08	9.40	64				
FEF50%/PIF50% (%)	100	90-100					
PIF 50% (L/sec)	5.59	4.86	114	2.75			
PIF Max (L/sec)	5.59						
MVV (L/min)	132	152	74	109			



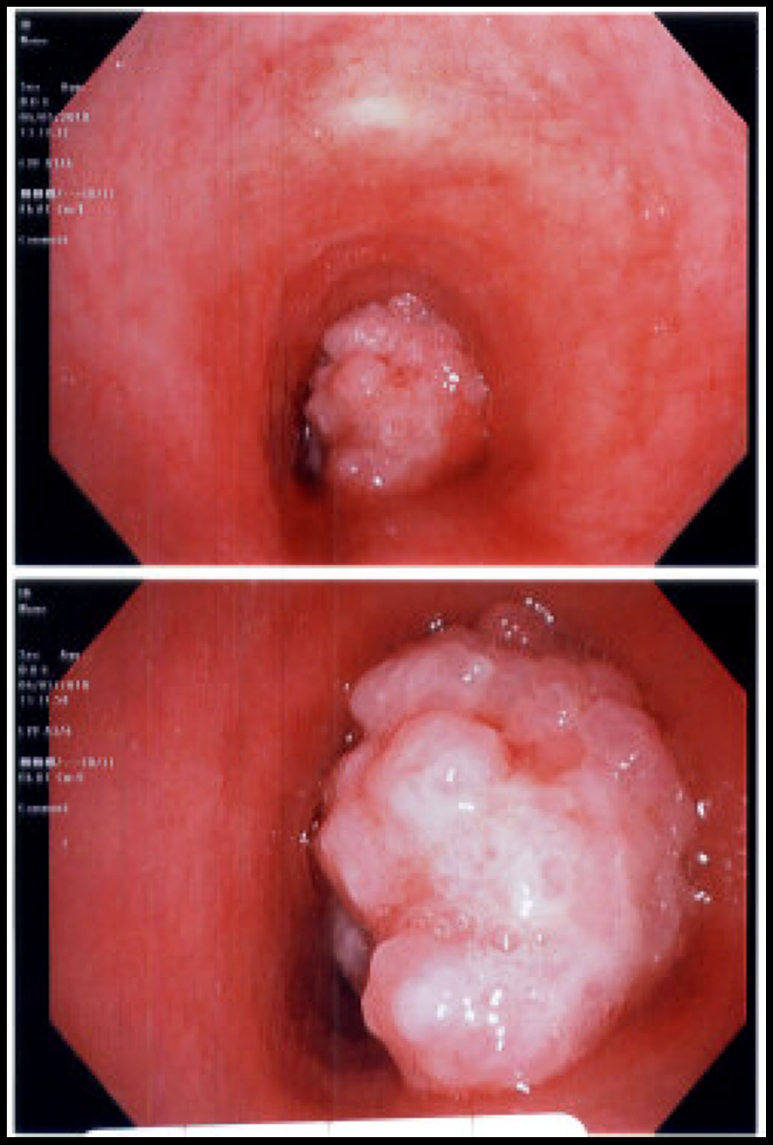
Flattening of expiratory limb suggesting variable intrathoracic defect



Case #2 - Images



Now what do we do?



What Next for Case 1 and 2?

- Send home to follow up in a few months?
- Send to ENT for emergent tracheostomy to secure airway/biopsy/debulk?
- Perform rigid bronchoscopy to secure airway/biopsy/debulk/dilate?
- Perform flexible bronchoscopy to secure airway/debulk/biopsy?

What Is Interventional Pulmonology (IP)?

- It is a subspecialty within pulmonary medicine that deals specifically with minimally invasive endoscopic and percutaneous procedures for diagnosis and treatment of neoplastic and non-neoplastic diseases of the airways, lungs, and pleura
- Performance of 'Advanced' diagnostic and therapeutic procedures

Flexible Bronchoscopy	Rigid Bronchoscopy	Artificial Airways	Pleural Procedures
Diagnostic	Balloon/rigid dilation	Percutaneous tracheostomy	Thoracic US
EBBX	Mechanical debulking	Transtracheal oxygen catheter placement	Chest tube
TBBX	Heat		Tunneled pleural catheters
TBNA	Laser		Medical pleuroscopy
EBUS	APC		Pleurodesis
Therapeutic	Electrocautery		Pleural biopsies
Balloon Dilation	PDT		
Heat	Cryotherapy		
Laser	Brachytherapy		
APC	Metallic & silicone stents		
Electrocautery	Y stent placement		
PDT	Montgomery T tube placement		
Cryotherapy			
Brachytherapy			
Metallic Stent			

Central Airway Obstruction

- Occlusion of >50% of trachea/mainstem bronchi, BI, or a lobar bronchus
- Qualitative Evaluation:
  - Benign/malignant
  - Mechanism of obstruction
  - What are the dynamic features?
- Quantitative Evaluation:
  - Vertical length
  - Location
  - Multifocal?
- Type of obstruction will often dictate therapeutic options
- Symptoms may not manifest until critical stenosis of 5-8 mm or new event exacerbates underlying stenosis

Nonmalignant Central Airway Obstruction/Stenosis

Benign Airway Tumors	**Granulation tissue**
Squamous papilloma	ETT
Hamartoma	Trach tubes
Lymphadenopathy	Airway stents
Sarcoidosis	Foreign bodies
Infectious (TB)	Surgical anastomosis
Vascular	Wegener's
Vascular Ring	**Webs**
Aneurysm	Idiopathic subglottic stenosis
Cartilage	TB
Relapsing Polychondritis	Sarcoid
Pseudotumor	**Other**
Endobronchial pseudotumor	Goiter
Hyperdynamic	Mucous plug
Tracheomalacia	Vocal cord paralysis
Bronchomalacia	Airway hematoma
	Burn/smoke injury
	Pill aspiration

Post Radiation

Post Transplant

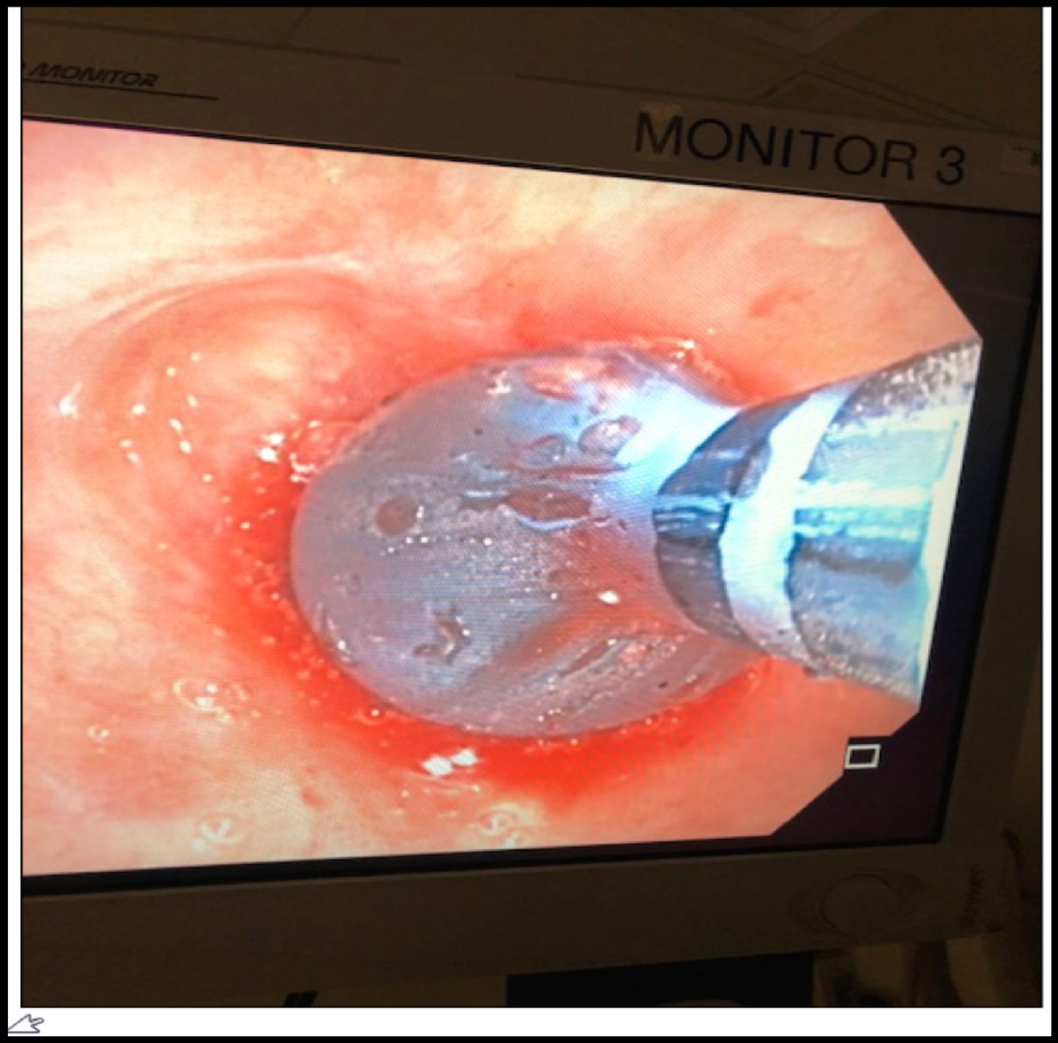
Bronchoscopic Ablative Techniques

Modality	Effects	Advantages	Disadvantages	Restoration of Airway Lumen, %
Nd:YAG laser	Coag and vaporization	Excellent debulking	$$$, often requires rigid	83-93%
Electrocautery	Superficial coagulation	Safety, multiple tools available, inexp	Frequent cleaning of probe	89%
APC	Superficial	Safety	Ineffective for in depth tissue debulking	91%
Cryotherapy	Delayed tissue destruction (1-2 weeks)	Safety; retrieval of foreign object, mucous plugs, clots	Not for acute debulking; multiple, procedures	78%
Brachytherapy	Delayed but in depth destruction	Long lasting effects	May predispose to hemorrhage	75-85%
PDT	Delayed	Rel long lasting effects	$$, multiple bronchoscopies, skin photosensitivity	46-67%

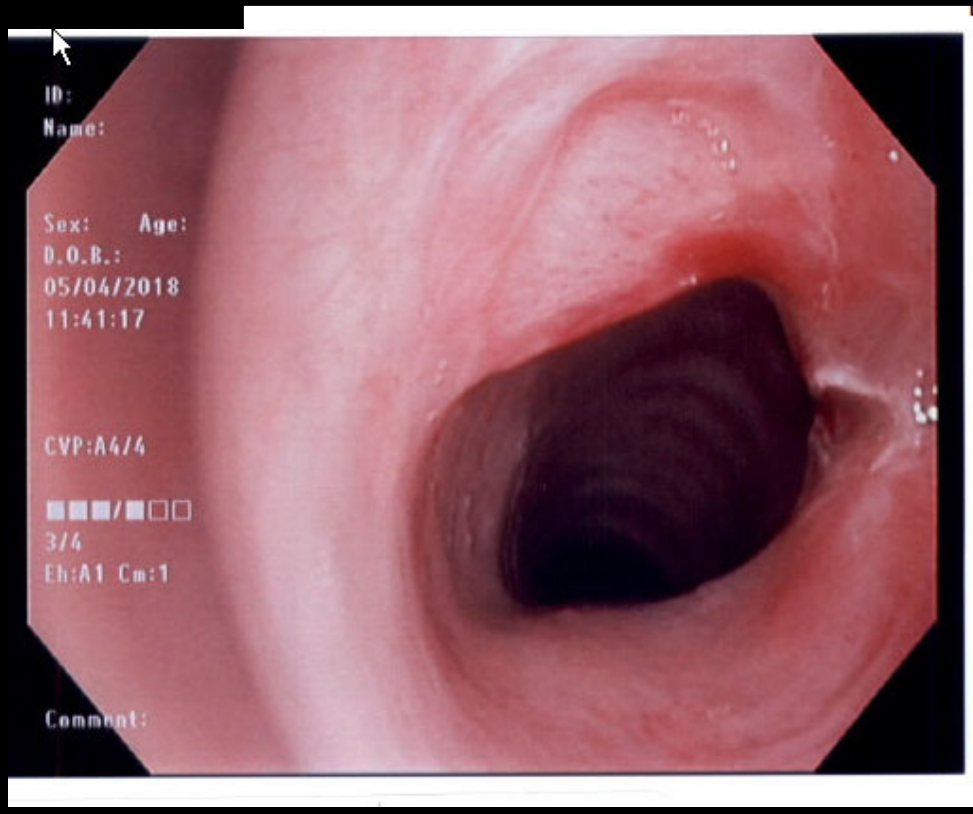
Adapted from Wahidi MM, Herth FJ, Ernst A. Chest 2007;131:261-274

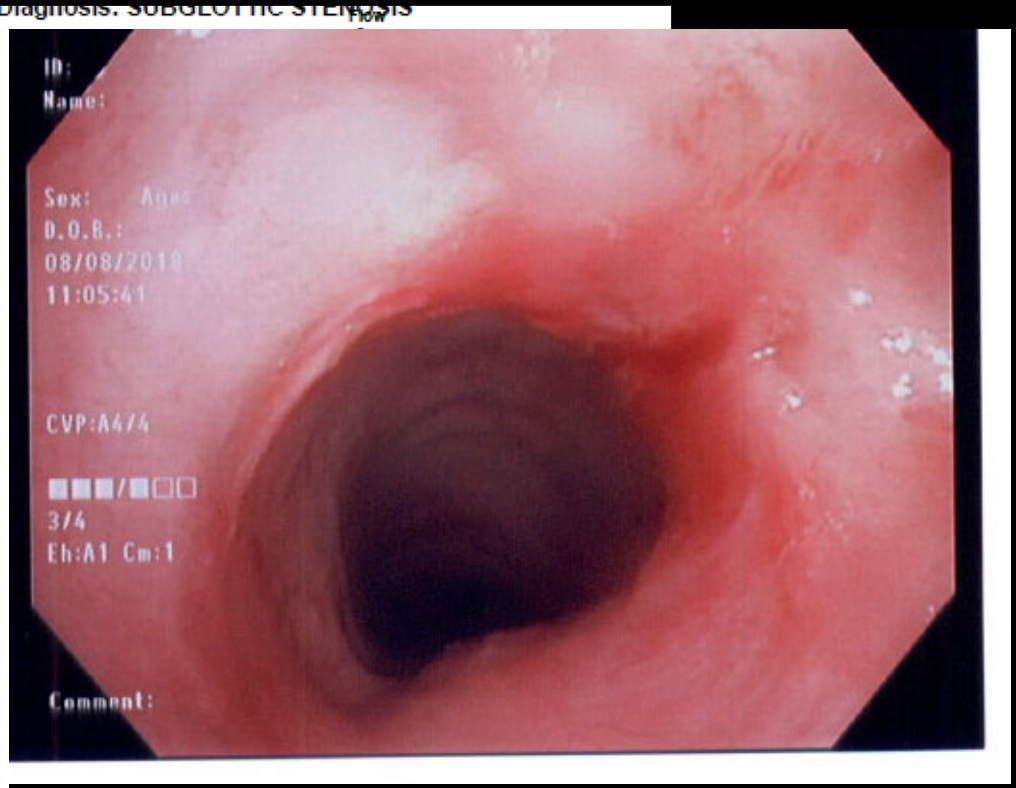
Benign Obstruction Stenosis
Balloon Dilation

- In most patients rates of immediate success and short term success (2-6 weeks) are high
  - Improved airway patency – radiologic and direct visualization
  - Improved symptoms
  - Improved lung function
- Longer term success is unpredictable
  - Multiple procedures
  - Combination of electrocautery and balloon dilation often needed together
- Less success
  - Localized malacia

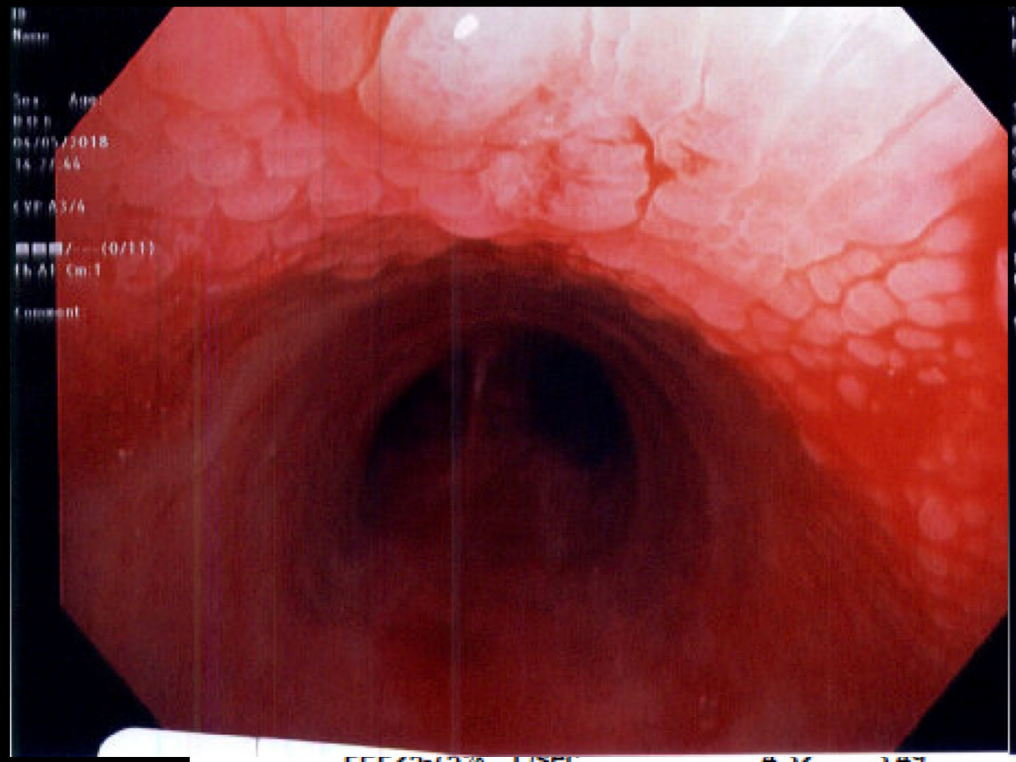

MONITOR
MONITOR 3

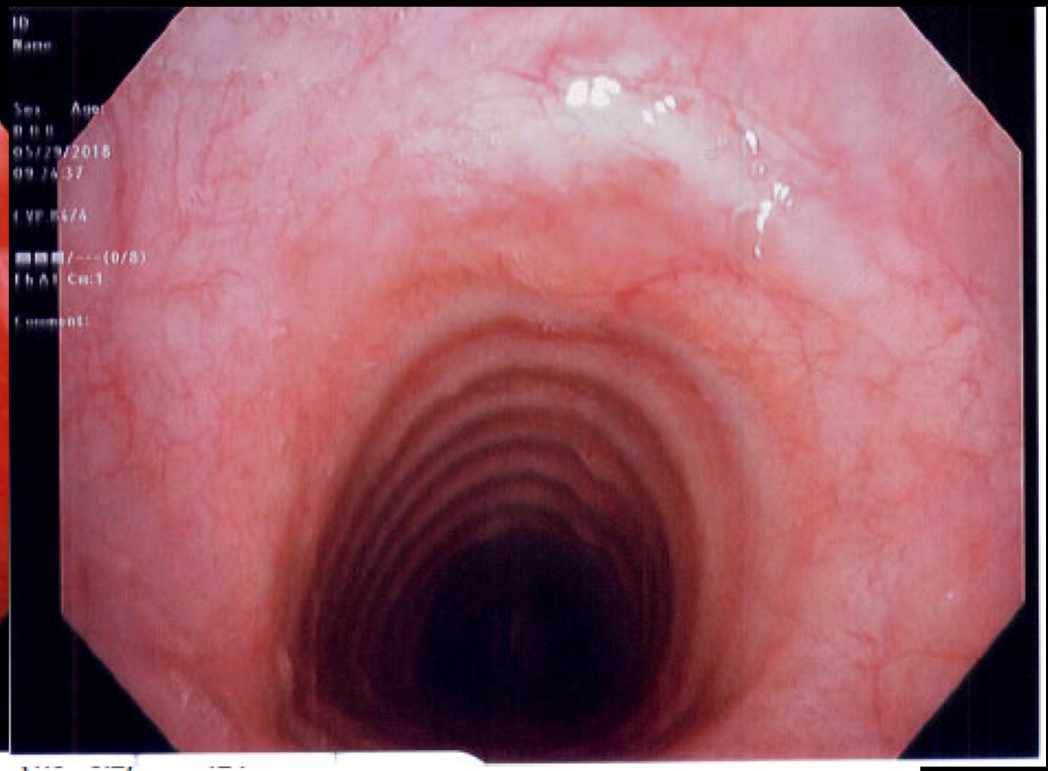
Case #1 : Post Intervention





Case #2: Post Intervention





PEF25-75%	L/sec	4.32	3.49		
PEF	L/sec	9.93	10.21	(7.7 - 12.7)	97
PIF	L/sec	9.76			

Malignant Airway Obstruction

- What can we do?
  - External beam XRT
  - Systemic therapy
  - Local therapy via bronchoscopy – debulking, stent placement
  - Discuss palliation of symptoms without invasive interventions

Malignant Central Airway Obstruction

Primary Endoluminal Malignancy	Metastatic Carcinoma to airway
Bronchogenic	Bronchogenic
Adenoid Cystic	Renal cell
Mucoepidermoid	Breast
Carcinoid	Thyroid
Plasmacytoma	Colon
Laryngeal and nasopharyngeal carcinoma	Sarcoma
Esophageal carcinoma	Melanoma
Lymphadenopathy	Mediastinal Tumors
Associated with above malignancies	Thymic and thyroid carcinomas
Lymphoma	Germ cell tumors

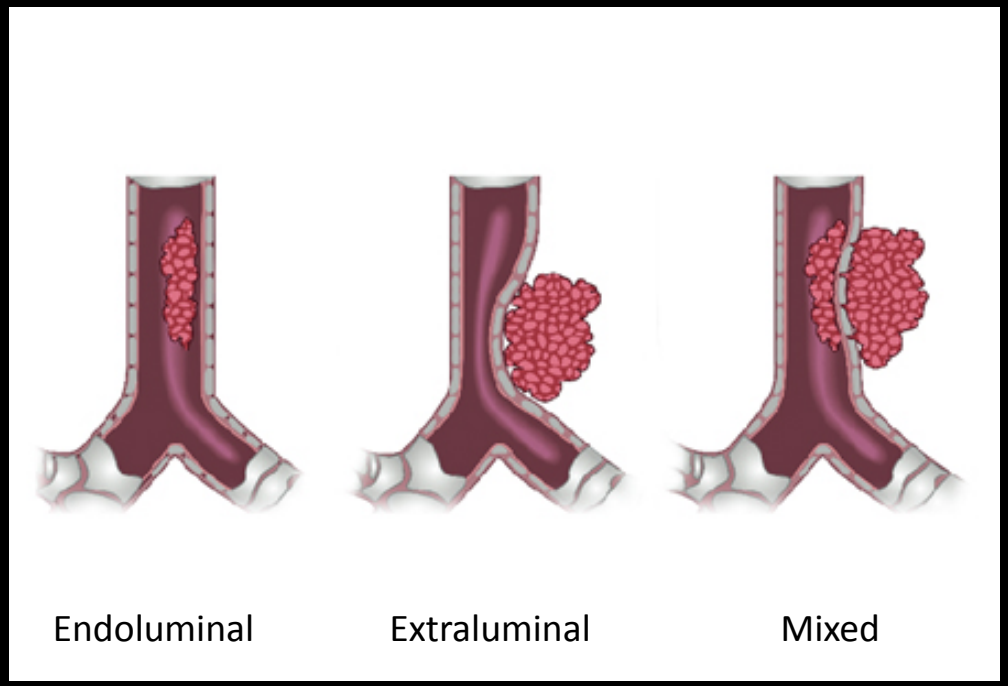
Malignant Airway Obstruction

- Estimated that up to 30% of patients diagnosed with primary lung cancers can present with central airway disease
  - Progressive obstruction contributes to morbidity
  - Tracheal/carinal obstruction
    - Progressive dyspnea and slow asphyxiation
  - Bronchial obstruction
    - Cough/breathlessness
    - Retained secretions
    - Recurrent infections
- Treatment often palliative and rarely curative

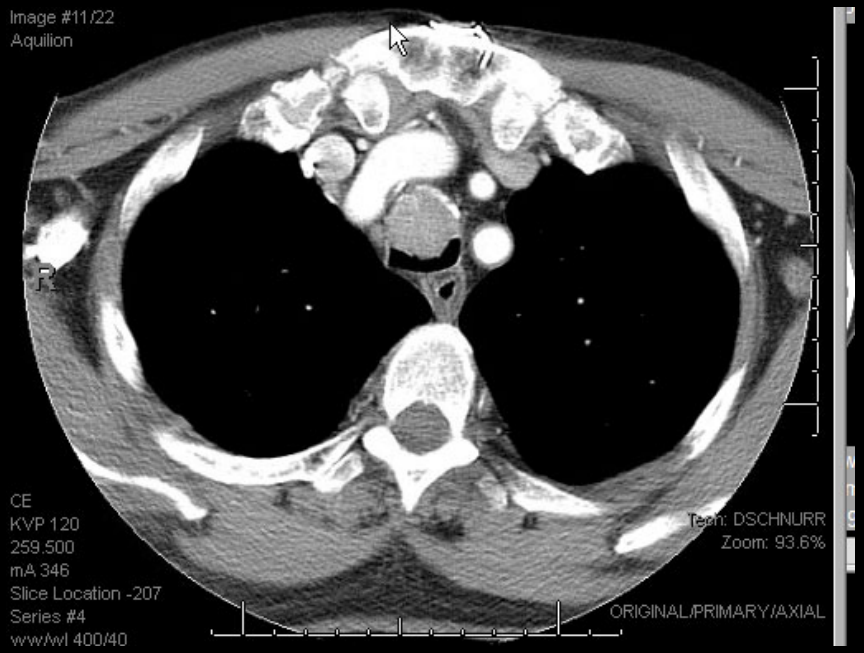
Malignant Central Airway Obstruction

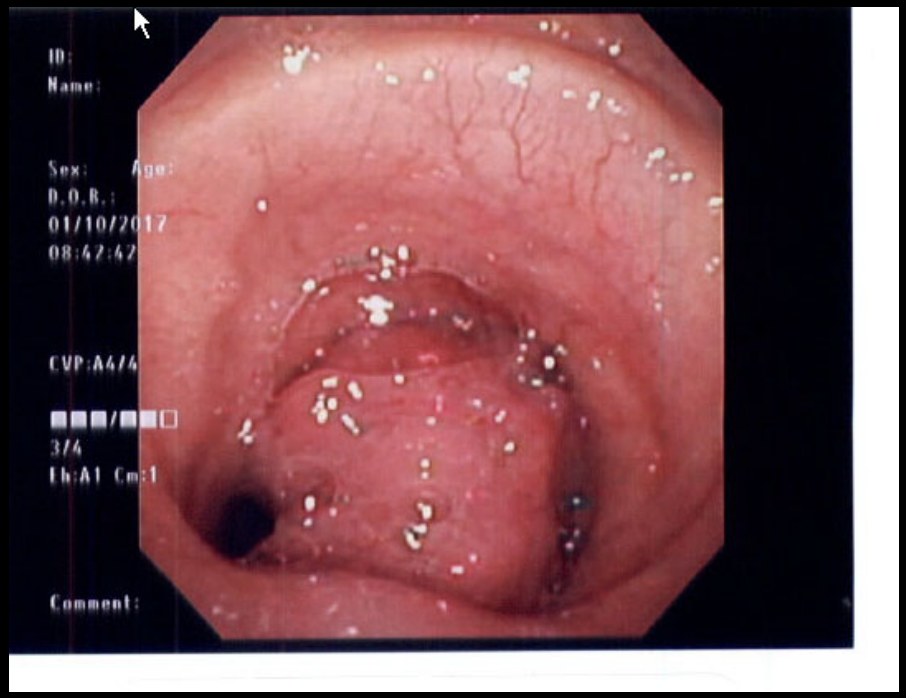
- Goals of therapeutic bronchoscopy
  - Palliate symptoms
  - Improve functional status

Mechanisms of Malignant Obstruction

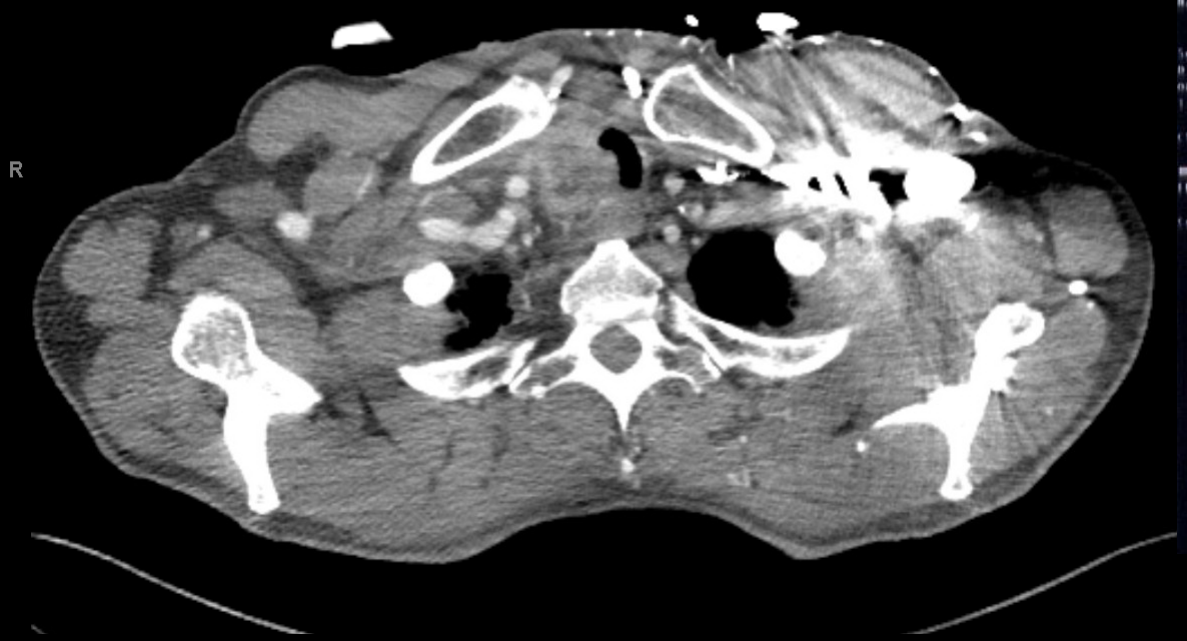


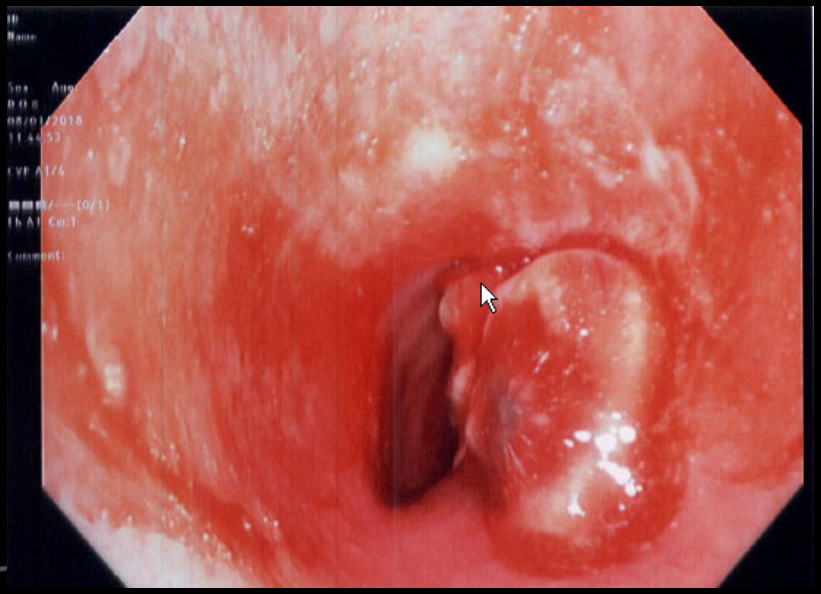
Malignant Obstruction - Endobronchial



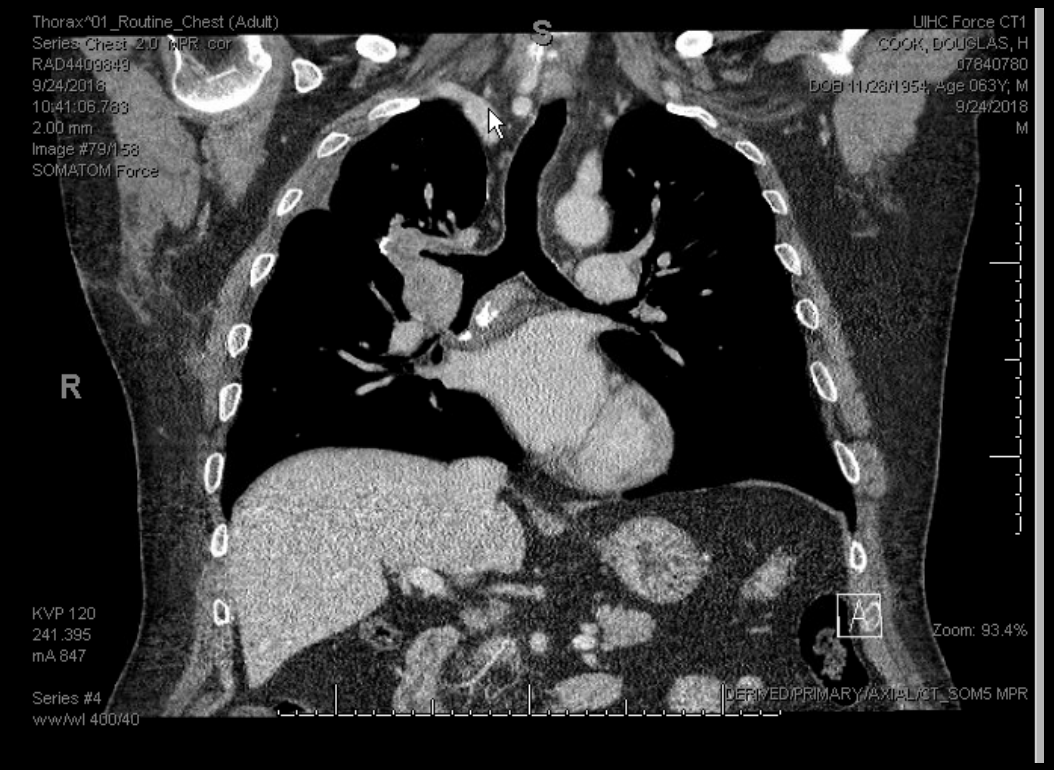


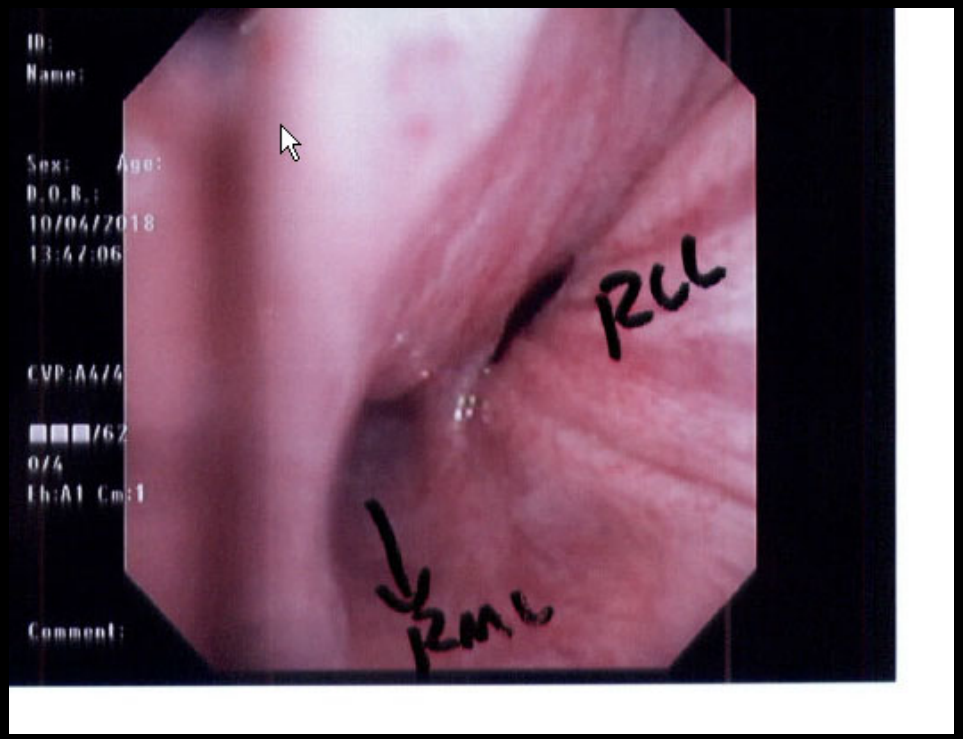
Malignant Obstruction -Combination





Malignant Obstruction –External Compression





Malignant Airway Obstruction

- What ‘can’ we do bronchoscopically?
  - What is technically feasible?
  - Can the patient tolerate a procedure?
  - Debulk alone? Stent alone? Debulk and stent?
- Can doesn’t always mean ‘should’
  - How symptomatic is the patient?
  - Is there ‘salvageable’ lung beyond the obstruction?
  - Are there comorbidities?
  - What is the prognosis?
  - Will the intervention ‘make a difference?’
- Variable approaches
  - Unlikely that one ‘debulking’ mechanism superior to another
  - Combination of debulking +/- stenting

Debulking:
Tools Available to Us

- Thermal Therapy
  - Heat:
    - Nd:YAG Laser; APC; Electrocautery
  - Cold
    - Cryotherapy
- Other : PDT, Brachytherapy
- Baskets/nets/snares/probes
- Variety of forceps
- Balloons

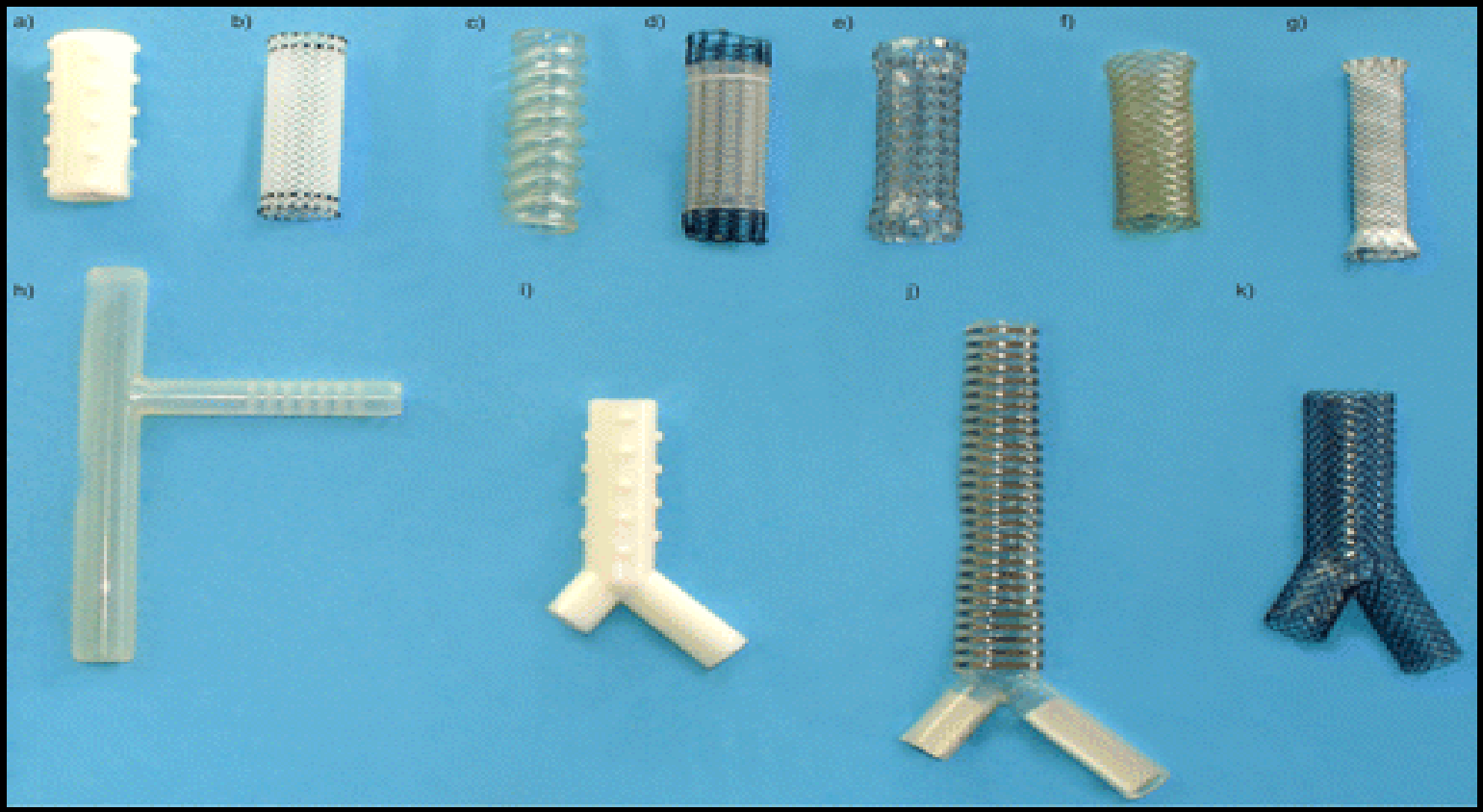
Tracheobronchial Stents

- Re-establish patency of compressed/ strictured airways from benign or malignant proces
- Sealing of fistulas
- Rarely for benign conditions like tracheomalacia or granulation tissue
- Often combined with other modalities
  - Debulking
  - Balloon dilation

Airway Stenting

- Reasoning
  - Will it prevent airway reocclusion?
  - Does it provide additional benefit to mechanical debulking?
  - Consider long term complications
  - Palliation of symptoms
- Bridging while therapy is initiated
- Silicone and metal
- Placement via rigid or flexible scope
  - Largely institution dependent

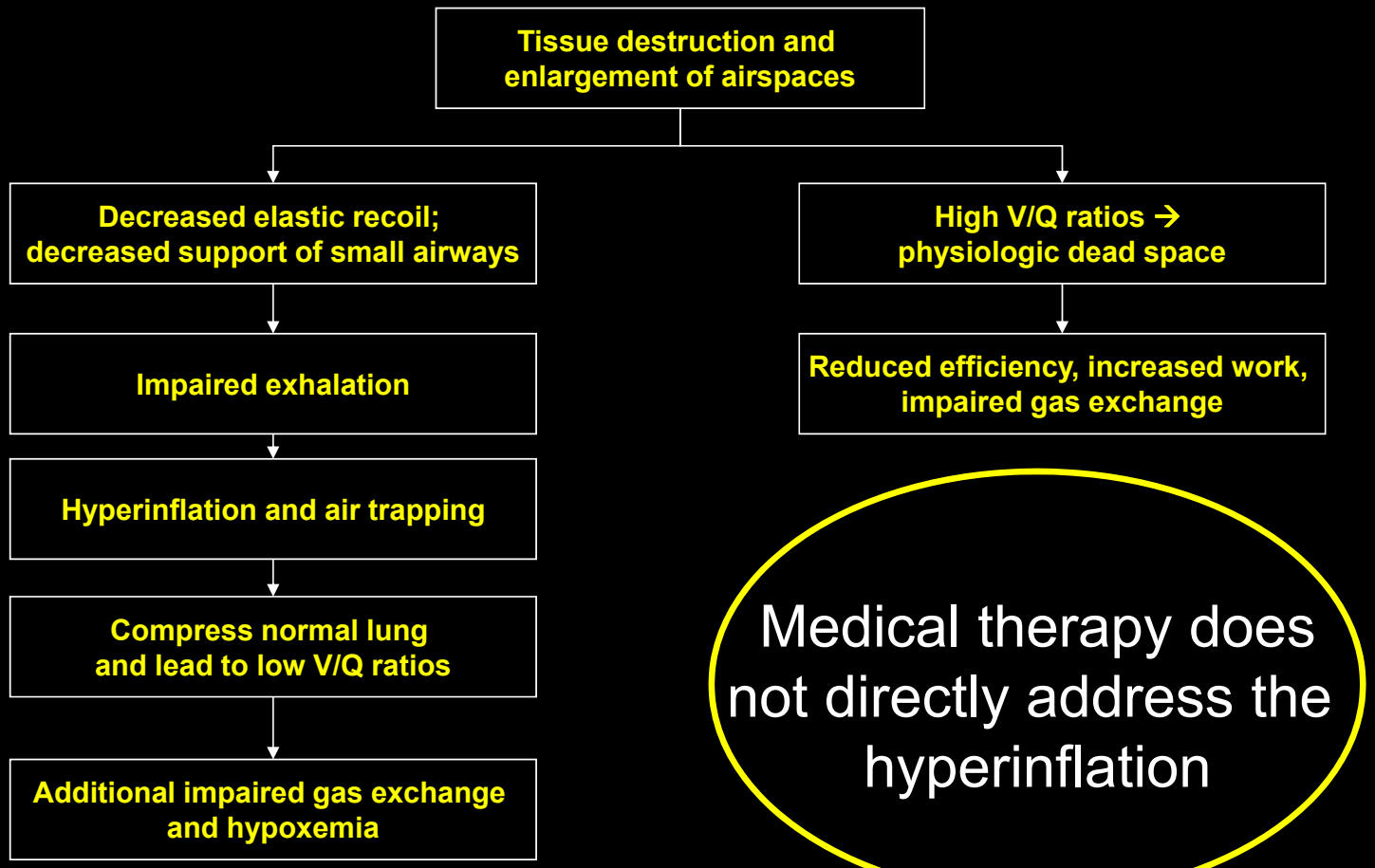
Tracheobronchial Stents



Bronchoscopy in Chronic Obstructive Lung Diseases

- COPD/Emphysema
- Chronic Asthma

Emphysema - Background



Treatment of Emphysema

- LVRS an option to select group of patients
  - High morbidity and mortality
- Investigations into bronchoscopic lung volume reduction

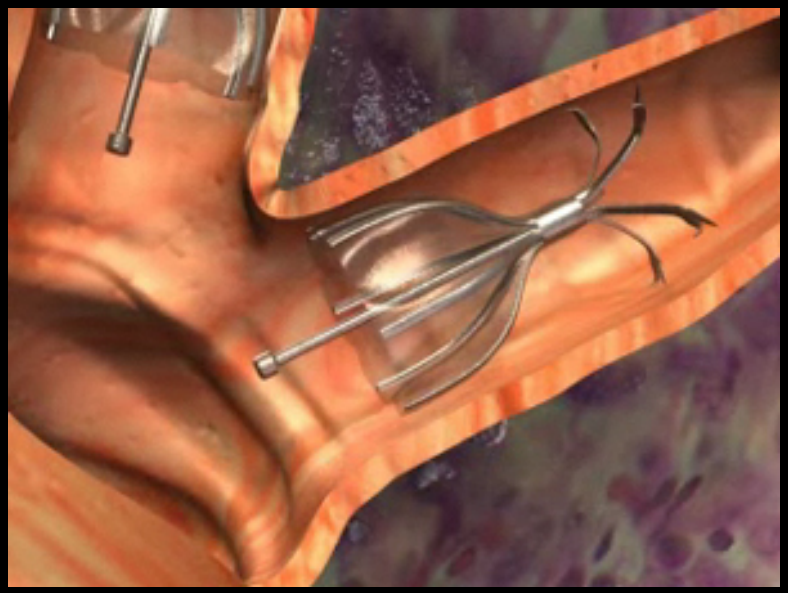
Bronchoscopic Lung Volume Reduction

- Endobronchial valve
  - VENT – Zephyr Valve
- Airway bypass
  - EASE
- Aeris Medical
  - Clotting Liquid (BLVR)
- Uptake Medical
  - Steam
- Spiration
  - One way valve

Endobronchial Valves

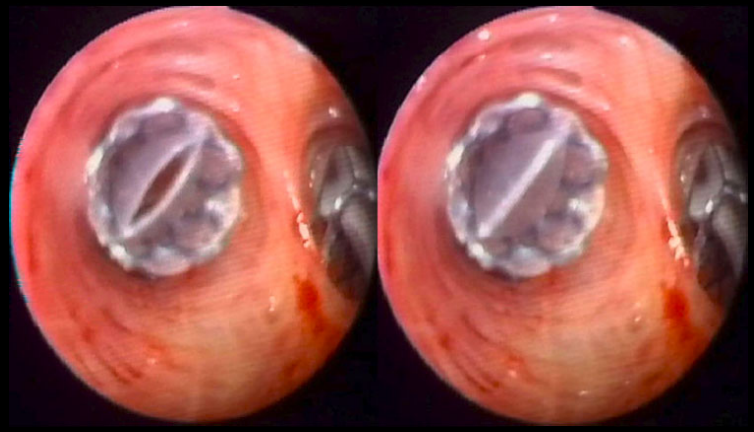
- Bronchoscopic lung volume reduction for severe emphysema
- Induce lobar atelectasis but dependent on absence of collateral ventilation
- Air escapes during expiration but cannot enter during inspiration
- Complications
  - Anesthesia related
  - Expectoration of valve
  - Bleeding
  - Pneumothorax

Spiration Intrabronchial Valve



- Not approved for treatment of emphysema but can be used in select case for closure of post op persistent air leaks

Zephyr Valve Design



- One way valve allowing air out with exhalation but not allowing inspired air into targeted region
- Allows drainage of secretions
- Silicone valve supported by nitinol self-expanding retainer
- Valve loaded onto deployment device and passed through working channel of bronchoscope
- Designed to be removable if necessary

Bronchoscopic Lung Volume Reduction

- LIBERATE Trial
  - 190 subject; severe heterogeneous emphysema and no collateral ventilation
  - Random assignment
    - ZEPHYR valve or standard of care
  - AT 12 months :
    - 48% with EBV and 17% with SOC had improvement in FEV1 >= 15%
    - Between group dif all significant for FEV1, 6MWD, dyspnea, QOL
    - 26% pneumothoraces in EBV group
    - 4 deaths in first three months in EBV group

The ‘Mechanical’ Side of Asthma

- Airway hyperresponsiveness
- Intermittent obstruction
  - Mucous plugging
  - Airway smooth muscle contraction
    - Variety of triggers
    - Increased mass of airway smooth muscle

Bronchial Thermoplasty

- Delivery of radiofrequency energy to the airway wall
- Objective
  - To reduce the contractile ability of airway smooth muscle
  - Utility based on supposition that blockade of ASM will cause amelioration of symptoms and reduce exacerbations (by means of reducing bronchoconstriction)
- Heat tissue to 65º C
  - Reduce smooth muscle mass
  - Avoid tissue destruction and scarring

Bronchial Thermoplasty in Humans

- Airways reached with bronchoscope
- Expandable basket with four electrode arms opened to make circumferential contact with airway
- Targets airways distal to mainstem bronchi down to 3 mm diameter

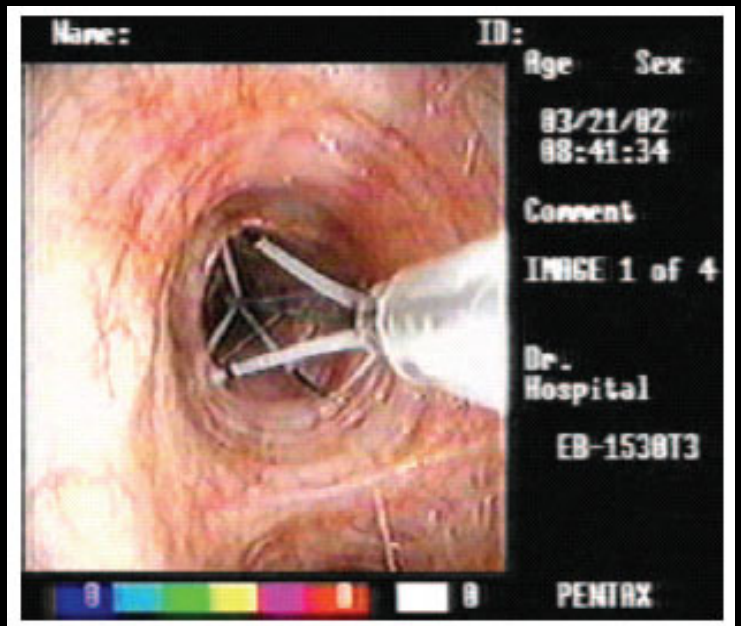
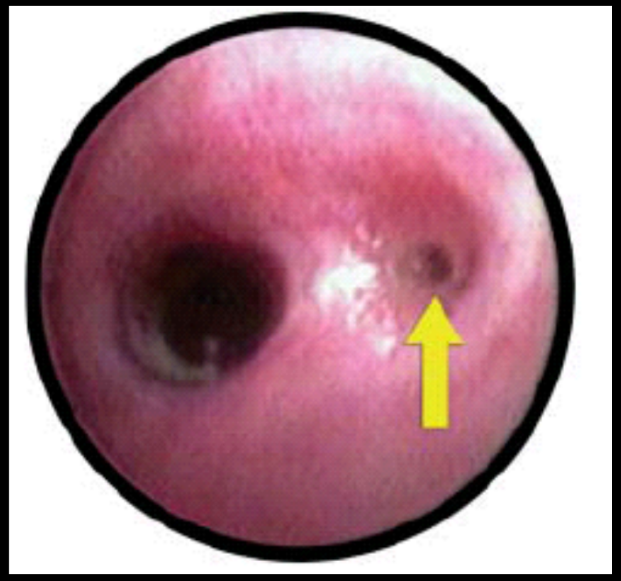


FIGURE 1. Bronchoscopic visualization of the Alair System device placed in the airway immediately prior to bronchial thermoplasty.

Miller, Cox, et al. CHEST, June 2005.

Bronchial Thermoplasty



- Local application of methacholine
  - Left: received RFA
  - Right: untreated airway

Cox, et al. AJRCCM. 2004

Bronchial Thermoplasty

- FDA approved for severe persistent asthma despite high dose inhaled steroid and LABA, nonsmoker, no life threatening exac, < 3 hosp in last 12 months, FEV1 ≥ 60
- 3 procedures 3 weeks apart
- Overall when looking at several trials and systematic reviews , BT compared with sham may reduce severe exacerbations
- More trials needed to better delineate its role

Conclusions

- Flexible bronchoscopy is a valuable tool with many indications
- There are a variety of interventions available via flexible bronchoscopy to restore airway patency/relieve symptoms in central airway obstruction
  - Choice of intervention is largely institution/physician dependent
- Bronchoscopy has found a role in select patients with chronic obstructive lung disease

Questions?

Thank You!