INTERVENTIONAL BRONCHOSCOPY

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INTRODUCTION

Interventional Bronchoscopy (IB)

- Evolving field within pulmonary medicine that focuses on providing consultative and procedural services to patients with malignant and non malignant airway & parenchymal disorders
- IB encompasses the following three main areas in pulmonary medicine: malignant ; nonmalignant airway disorders; and artificial airways

IDEAL INTERVENTIONAL BRONCHOSCOPY SUITE

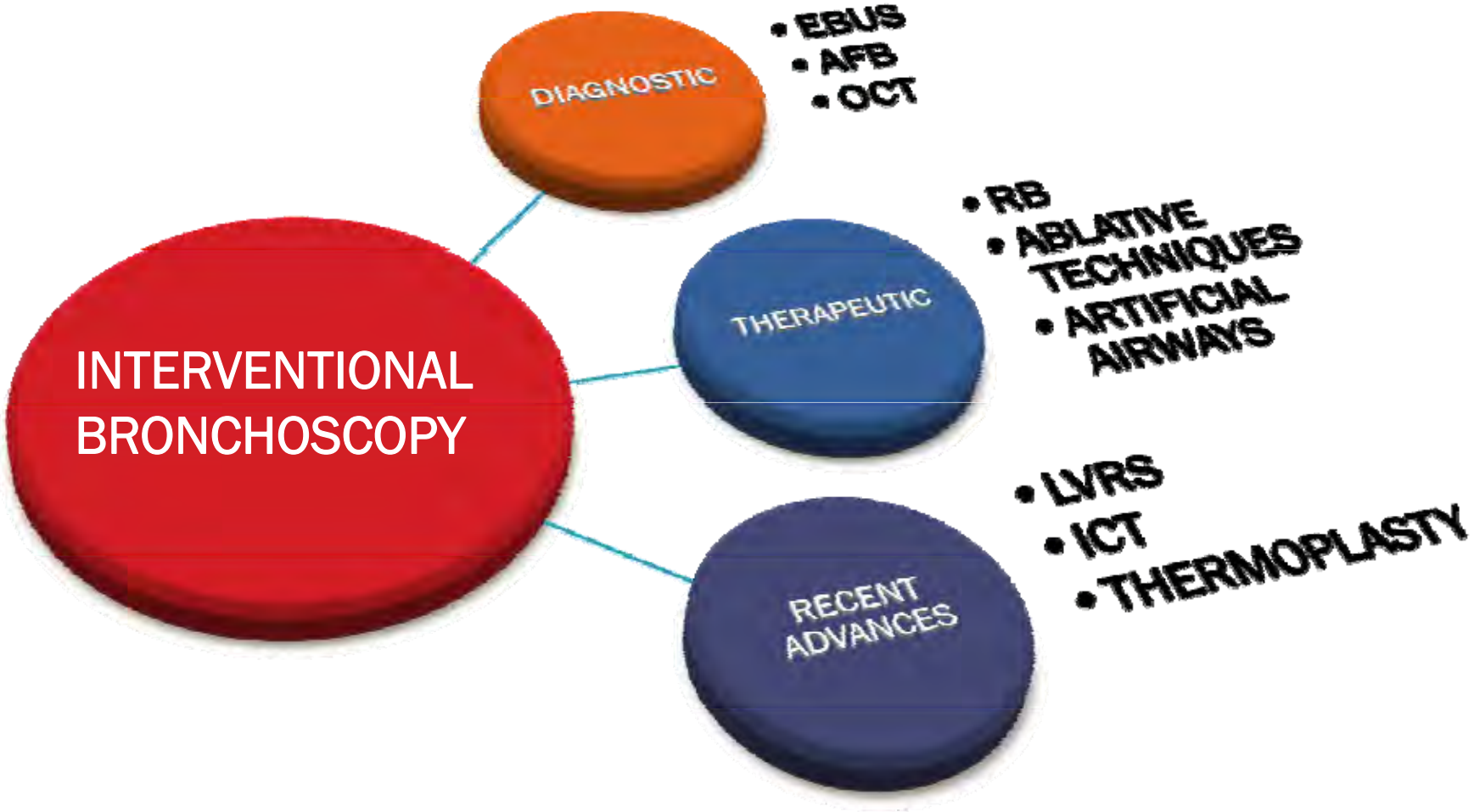
BASIC SUITE

- Airway examination
- BAL
- Cytologic brushing
- Endobronchial Biopsy
- Transbronchial biopsy
- TBNA

ADVANCED SUITE

- EBUS
- Autofluorescence
- External Navigation
- Electrocautery / APC
- Cryotherapy & PDT
- Laser & Stenting
- Thoracoscopy

SPECTRUM OF INTERVENTIONAL BRONCHOSCOPY



DIAGNOSTIC BRONCHOSCOPY

US FDA approved innovations in diagnostic bronchoscopy available to interventional Pulmonologist :

- Autofluorescence bronchoscopy (AFB)
- EBUS

  Future modalities
- Navigational bronchoscopy by electromagnetic guidance
- Narrow band imaging
- Optical coherence tomography

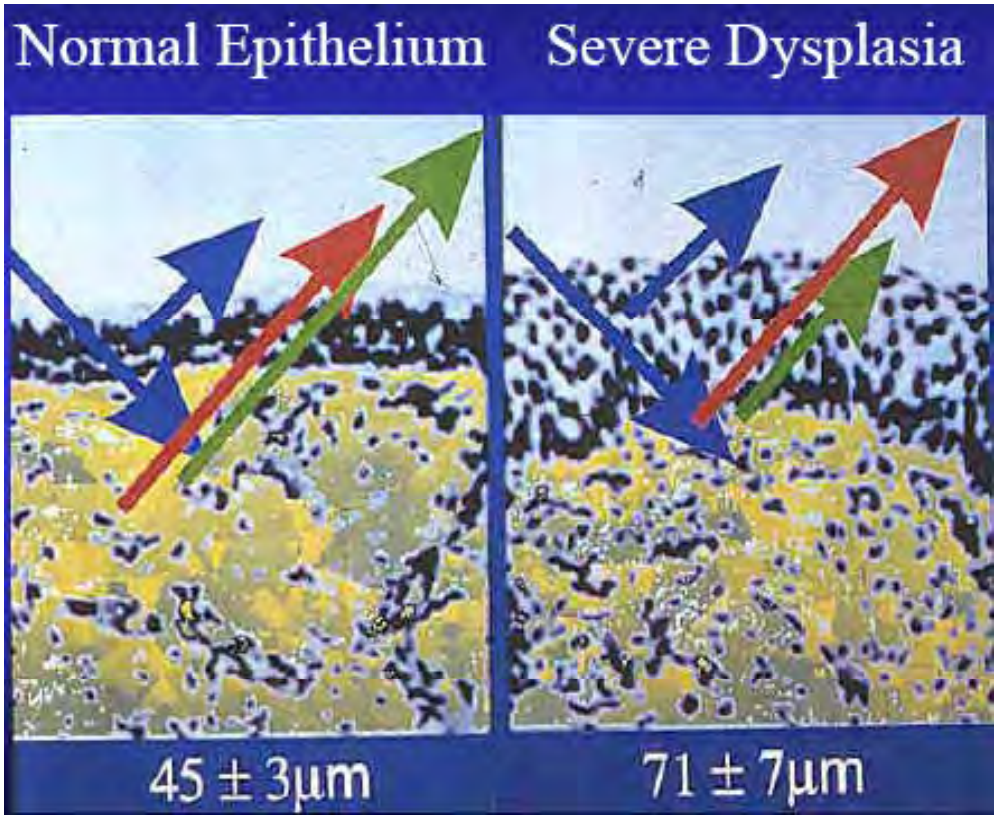
AUTOFLUORESCENCE BRONCHOSCOPY

- AFB endoscopic tool identify precancerous lesions predominantly preinvasive squamous cell carcinoma in respiratory tract based on tissue fluorescence
- S. Lam et al (1990s) applied Auto Fluorescence (AF) concept to development of diagnostic Bronchoscopy
- Even when the sputum shows atypia or carcinoma, 40% - 71% may not be detected during routine white light bronchoscopy

J Thorac Cardiovasc Surg 1993

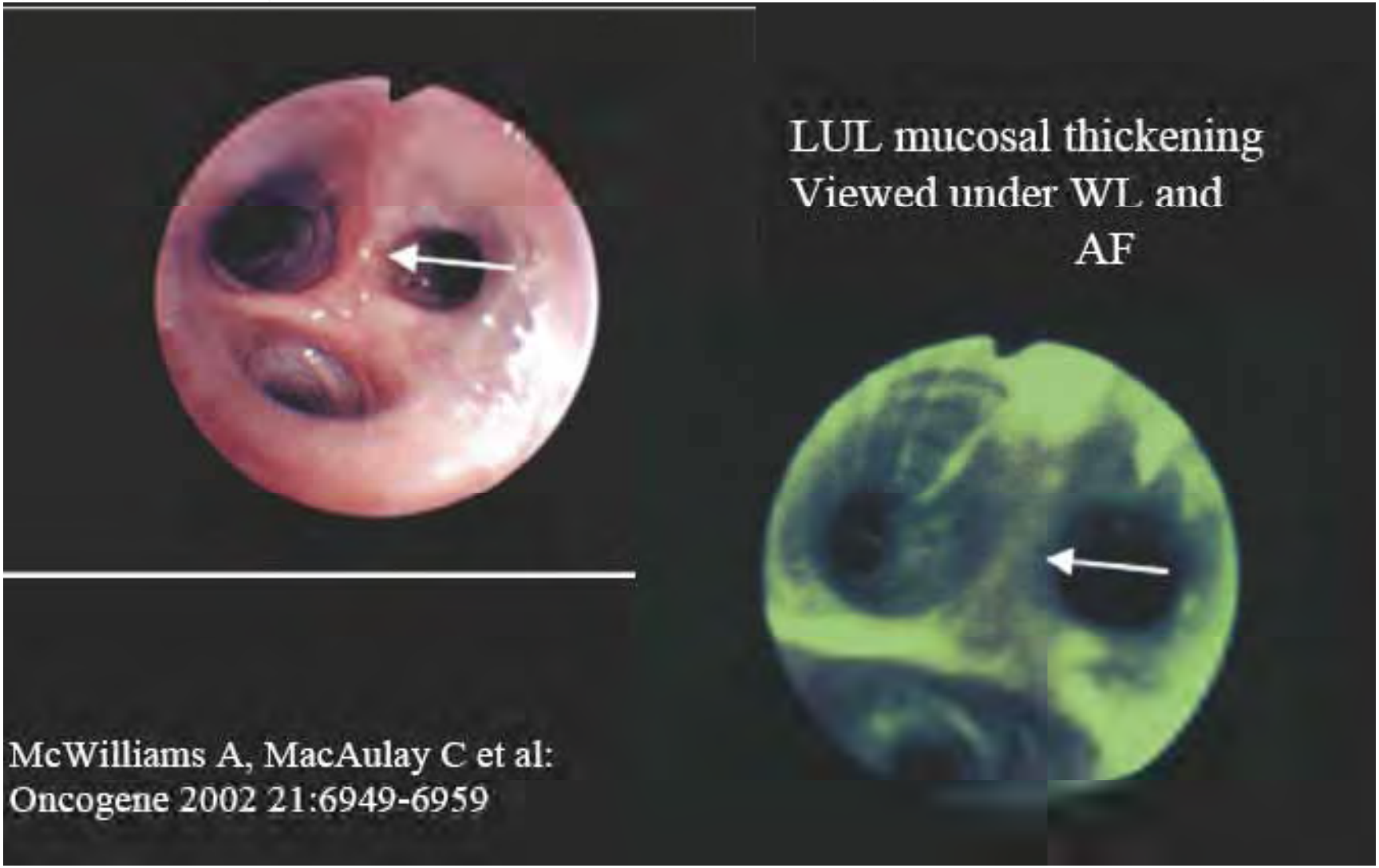
PRINCIPLES OF AUTOFLUORESCENCE

- Normal respiratory tissue fluoresces green when exposed to light in the violet–blue spectrum (400–450 nm).
- As mucosal and submucosal disease progresses from normal, to metaplasia, to dysplasia, to CIS : progressive loss of the green AF, causing a red-brown appearance of the tissue



CHEST 2007; 131:261–274

AUTOFLUORESCENCE BRONCHOSCOPY



CLINICAL APPLICATIONS

- Studies have shown superiority of AFB over white-light bronchoscopy in detection of cancerous lesions
- Impact on survival has not been elucidated
- AFB is not yet recommended as a screening tool for lung cancer
- Published data in more than 1,400 patients suggest that WLB alone detects on average only 40% of high-grade dysplasia and CIS, whereas AFB increases the detection rate up to 88%

Ann Thorac Surg 2005;80:2395– 401

LIFE STUDY

Of Moderate-dysplasia or worse biopsies (142):

detection by	WL only	WL + AF
	35/142	95 / 142
	25%	**67%**

TOTAL +VE BX 379

Of Moderate to Severe Dysplasia & CIS only (102)

	9 (8.8%)	**57 (56%)**

Of Invasive Carcinoma (40)

26 (65%)	38 (95%)

Chest 2000;118:1776 –82

Average additional time spent with AF imaging 9.4 mins

AFB: LIMITATIONS

- Cost of autofluorescence unit
- Lack of specificity(False +ve 34% vs 10% WL)

Ann Thorac Surg 2005

- Follow-up of any detected abnormality, as currently no standards exist
- No accepted standard on who should undergo procedure and no widely accepted algorithm on management of lesions exists
- Future studies may investigate utility of routine AF examinations prior to surgery in patients with resectable lung cancer

ENDOBRONCHIAL ULTRASOUND

- EBUS allows visualization of tracheobronchial tree with real-time ultrasound and permits visualization of internal structure of pulmonary lesions
- Hurter and Hanrath initially reported EBUS to diagnose pulmonary and mediastinal tumors

Dtsch Med Wochenschr 1990

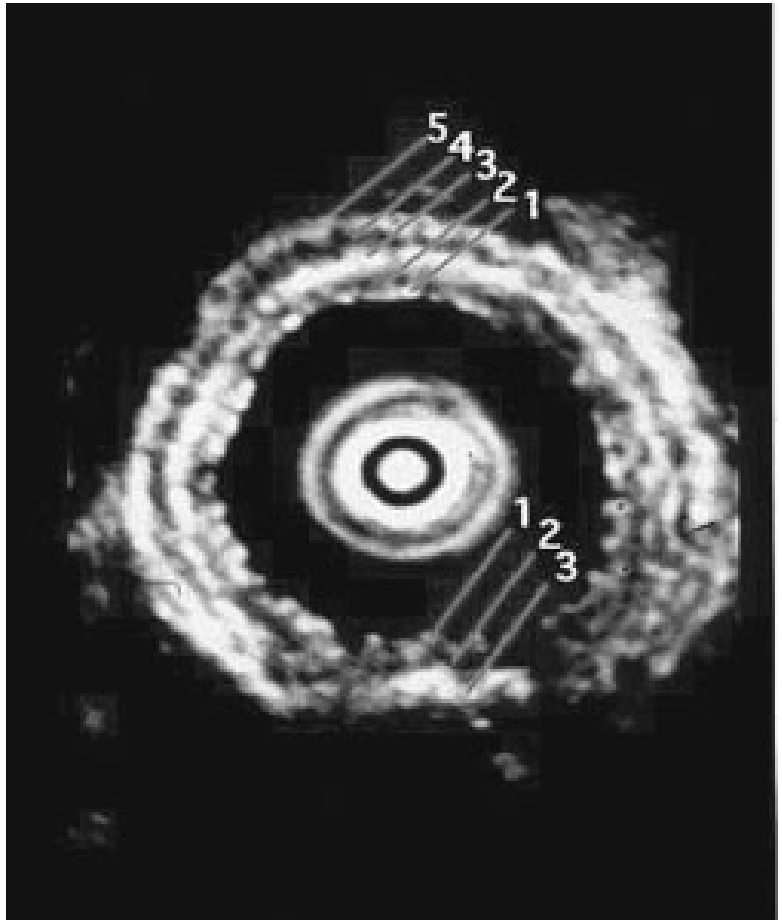
- EBUS term used for two distinct devices ,radial probe EBUS and recently introduced convex probe EBUS

RADIAL PROBE EBUS

- Radial probe EBUS catheter-based device currently available in frequencies ranging from 12 to 30 MHz
- Balloon sheath model (20 MHz, external diameter 2.5 mm,UM-BS20–26R, Olympus, Tokyo), used for evaluating central airways
- ultraminiature model (20-MHz, external diameter 1.4 mm, UM-S20–20R,OlympusTokyo) used for peripheral lung lesions

LAYERS OF THE AIRWAY WALL

- Mucosa - hyperechoic
- Submucosa - hypoechoic
- Cartilage has three layers
  a. Endochondrium - hyperechoic
  b. Internal layer - hypoechoic
  c. Perichondrium - hyperechoic
- Supporting connective tissue outside cartilage - hypoechoic
- Adventitia surrounding supporting connective tissue - hyperechoic



Semin Respir Crit Care Med 2004;25:425–431

INDICATIONS

(1) Determine depth of tumor invasion of tracheobronchial lesions

(2) Define positional relationships with pulmonary artery and veins and hilar structures

(3) Visualize paratracheal and peribronchial lymph nodes and metastases and allow EBUS-guided TBNA

(4) Localize and diagnose peripheral pulmonary lesions (benign or malignant)

Semin Respir Crit Care Med 2008;29:453–464

BIOPSY OF EARLY-STAGE LUNG CANCER

- Radial probe EBUS useful in assessing depth of tumor invasion and guiding treatment (endobronchial intervention vs resection)

- In a study of 18 patients with centrally located lung cancer, all nine patients who underwent PDT therapy after intracartilaginous tumor identified by radial probe EBUS remained without evidence of remission for a median follow-up of 32 months

Am J Respir Crit Care Med 2002

MEDIASTINAL LYMPH NODE EVALUATION AND BIOPSY

- Regions inaccessible to mediastinoscopy : posterior subcarinal and hilar nodes
- Overall success rate of 86%, regardless of lymph node size or location

Chest 2004;125:322–325

- Combining radial probe EBUS and EUS improved diagnostic yield (94%) over either modality alone

Am J Respir CritCareMed2005

EVALUATION AND BIOPSY OF PERIPHERAL LUNG NODULES

- Radial-probe EBUS enables ultrasonic visualization of peripheral lung nodules beyond the visual range of the bronchoscope
- Diagnostic yield of radial probe EBUS for biopsy of peripheral lung nodules is 58 to 80%

Am J RespirCrit Care Med 2007;176:36–41

- Ultraminiature probe with guide sheath left in place following localization of the target lesion allows for repeated coaxial biopsies at the same site

Chest2004;126:959–965

RADIAL PROBE: OTHER APPLICATIONS

- Well suited to distinguish between malignant central airway compression and infiltration

Chest 2003;123:458–462

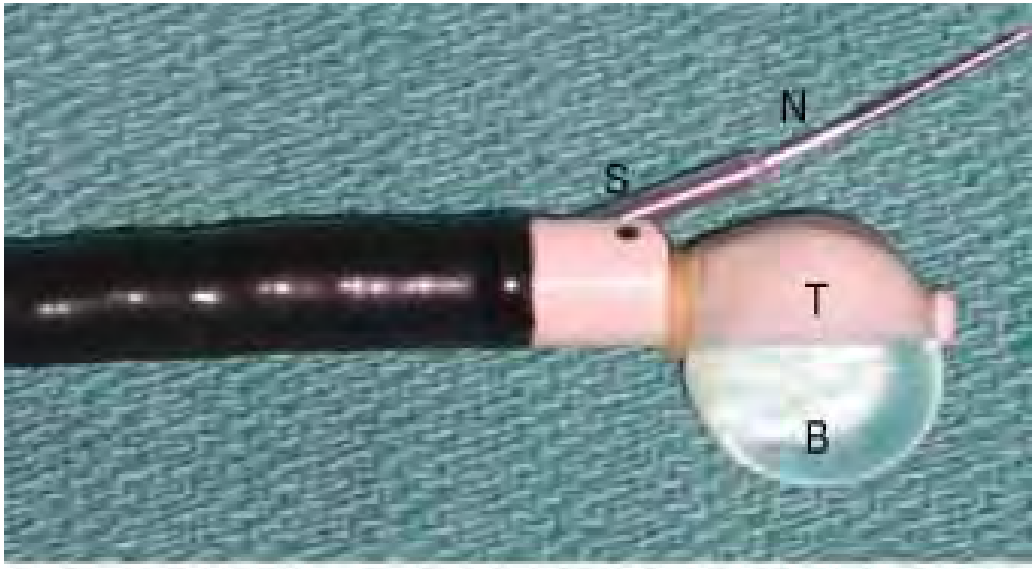
- Far superior to CT and MRI with sensitivity and specificity of 92 % and 83% in comparison with 59% and 56%(CT) and 75% and 73% (MRI) respectively

Respiration 2006;73:651–657

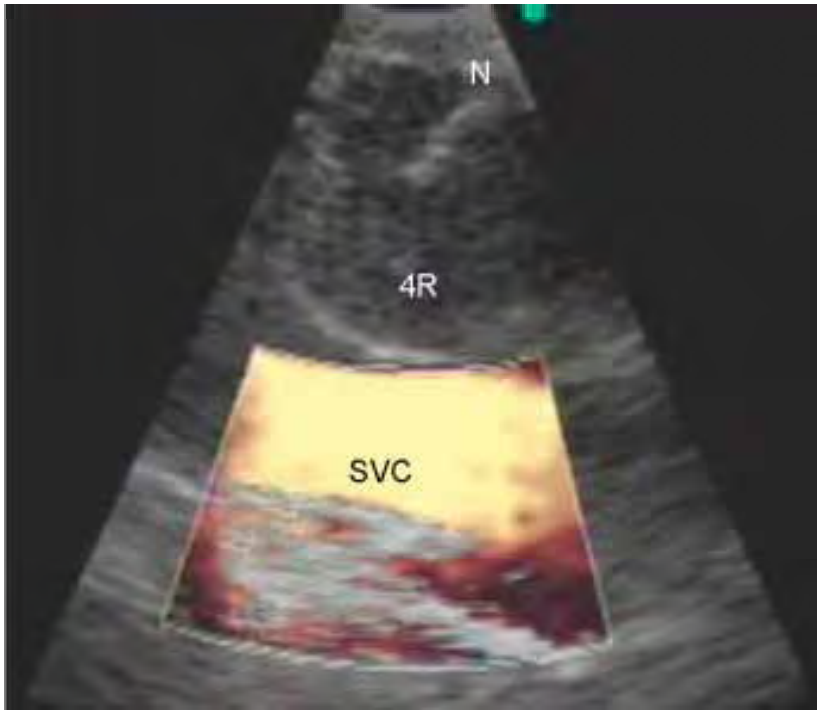
- In lung transplant recipients,used to evaluate anastomotic site and useful in differentiating acute lung rejection from graft infection

Chest 2006;129:349–355

CONVEX PROBE EBUS



Convex probe endobronchial ultrasound.
(XBF-UC 160F, Olympus, Tokyo)



Utrasound-guided real-time needle aspiration (N) of an enlarged (1.43 cm) right paratracheal lymph node (4R) with underlying SVC

Semin Respir Crit Care Med 2008;29:453–464

CONVEX PROBE : MAJOR APPLICATIONS

- Mediastinal Lymph Node Evaluation and Biopsy
  - Ability to accurately biopsy lymph nodes under real-time image guidance
  - CP EBUS-TBNA lymph node sampling compared with surgically resected specimens or clinical follow-up : EBUS-TBNA accurate (diagnostic accuracy 93 to 97%, sensitivity of 94 to 95.7%, and specificity of 100%) and safe technique

Thorax 2006 ;61:795–798

- Sensitivity and specificity of convex probe EBUS for malignancy 84.3% and 100% and for benign disease 75% and 100%, respectively

Chest 2007;132:S591

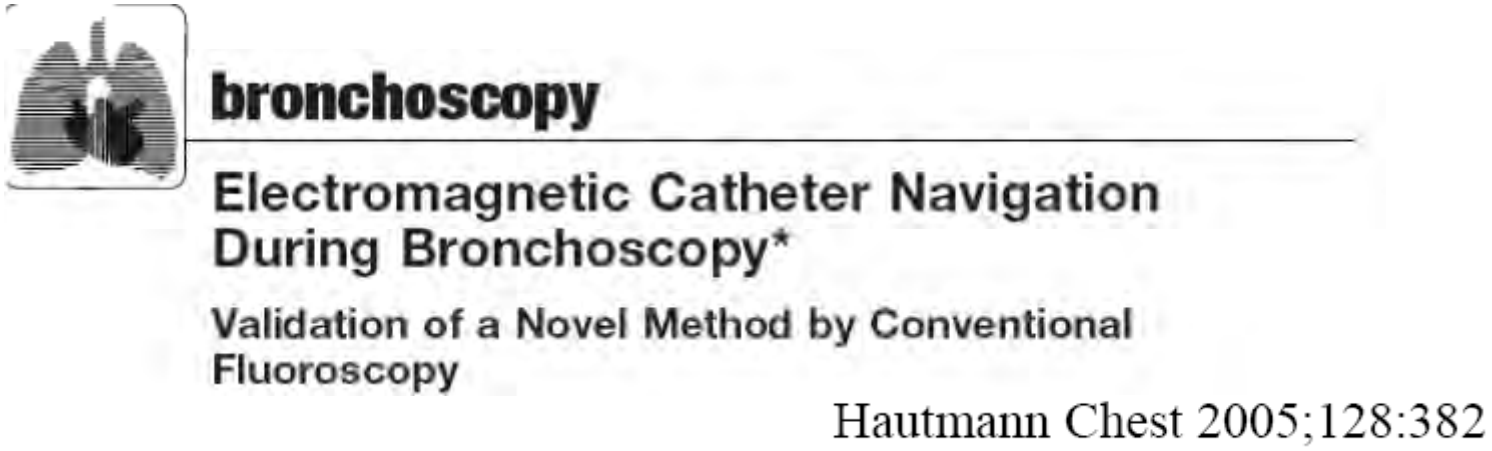
CONVEX PROBE MAJOR APPLICATIONS

- Lung Cancer Staging
- NSCLC undergoing initial staging because of adenopathy on CT scan, CP EBUS-TBNA had a sensitivity and specificity of 94.6% and 100% with no complications. As a result,eight thoracotomies, 29 mediastinoscopies, four thoracoscopies, and nine CT-guided biopsies avoided Lung Cancer 2005;50:347–354
- A statistically significant improvement in diagnostic accuracy when using convex probe EBUS-TBNA (sensitivity 92.3% and specificity 100%) in comparison with PET (80% and 70.1%) and CT (76.9% and 55.3%) was reported Chest2006;130:710-718

ELECTROMAGNETIC NAVIGATION BRONCHOSCOPY

- ENB utilizes a steerable sensor probe within an electromagnetic field map superimposed on a virtual bronchoscopy image to navigate to lesions beyond visual range of bronchoscope

Chest 2007; 131:261–274



Interventional Pulmonology

Respiration

Respiration 2003;70:516–522
DOI: 10.1159/000074210

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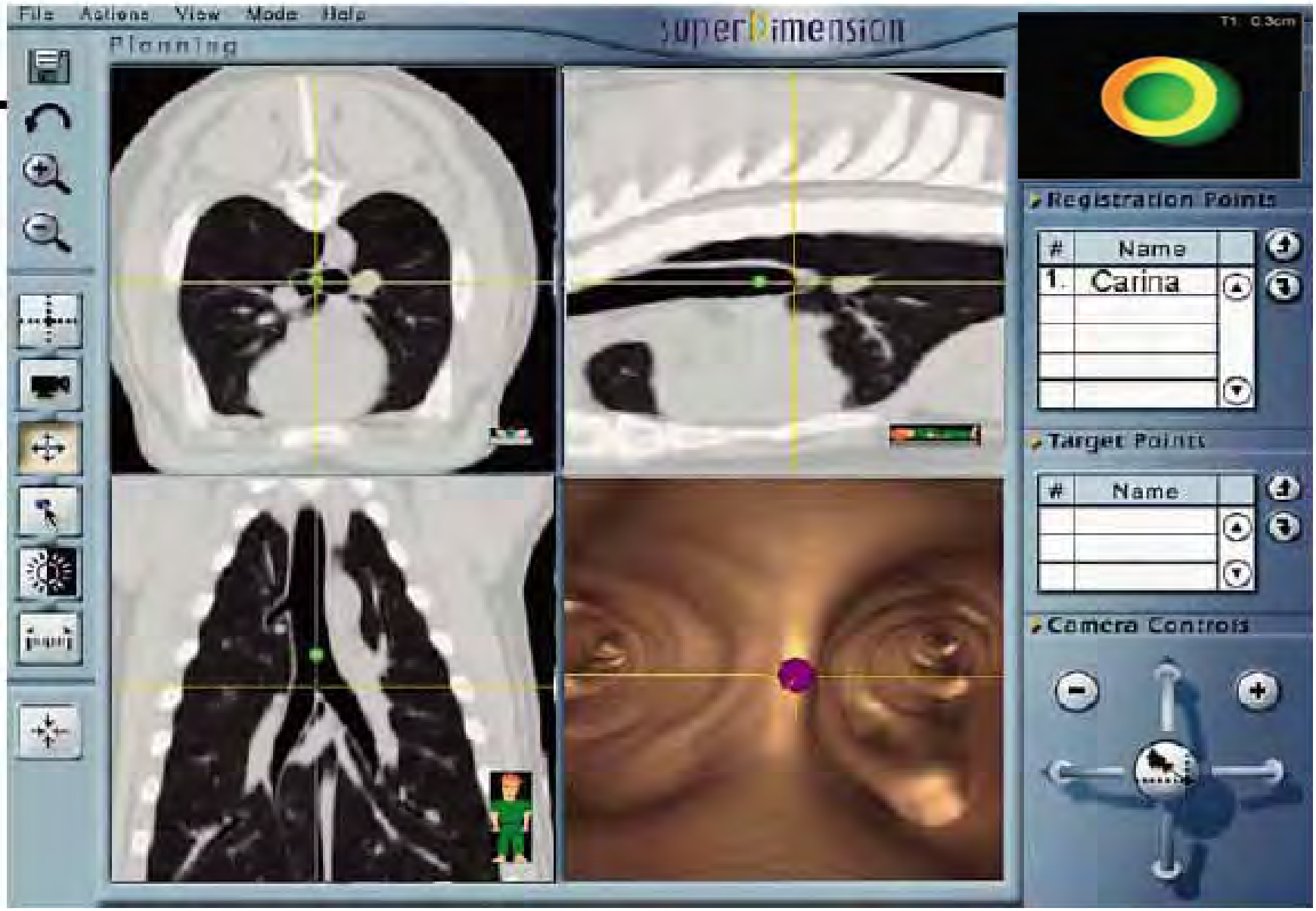


CHEST Original Research

INTERVENTIONAL PULMONOLOGY

Real-Time Electromagnetic Navigation Bronchoscopy to Peripheral Lung Lesions Using Overlaid CT Images*

(CHEST 2006; 129:988–994)

The First Human Study

Table 1—Size, Location, and Biopsy Results of the Peripheral Lung Lesions With Navigation Guidance of the SDBS

Case No.	Lesion Location	Lesion Size, cm	Lesion Biopsy Results
1	LUL	3.8	Normal tissue
2	RUL	5.0	NSCLC
3	RLL	1.5	Adenocarcinoma
4	LUL	4.2	Inflammation
5	RUL	2.7	Tuberculosis
6	RLL	3.5	Adenocarcinoma
7	LUL	3.2	Atypical epithelial cells

- 15 patients enrolled, 13 navigable
- 9 / 13 (69%) true positive cancer diagnosis
- 4/13 false negative

Electromagnetic Navigation Diagnostic Bronchoscopy in Peripheral Lung Lesions*

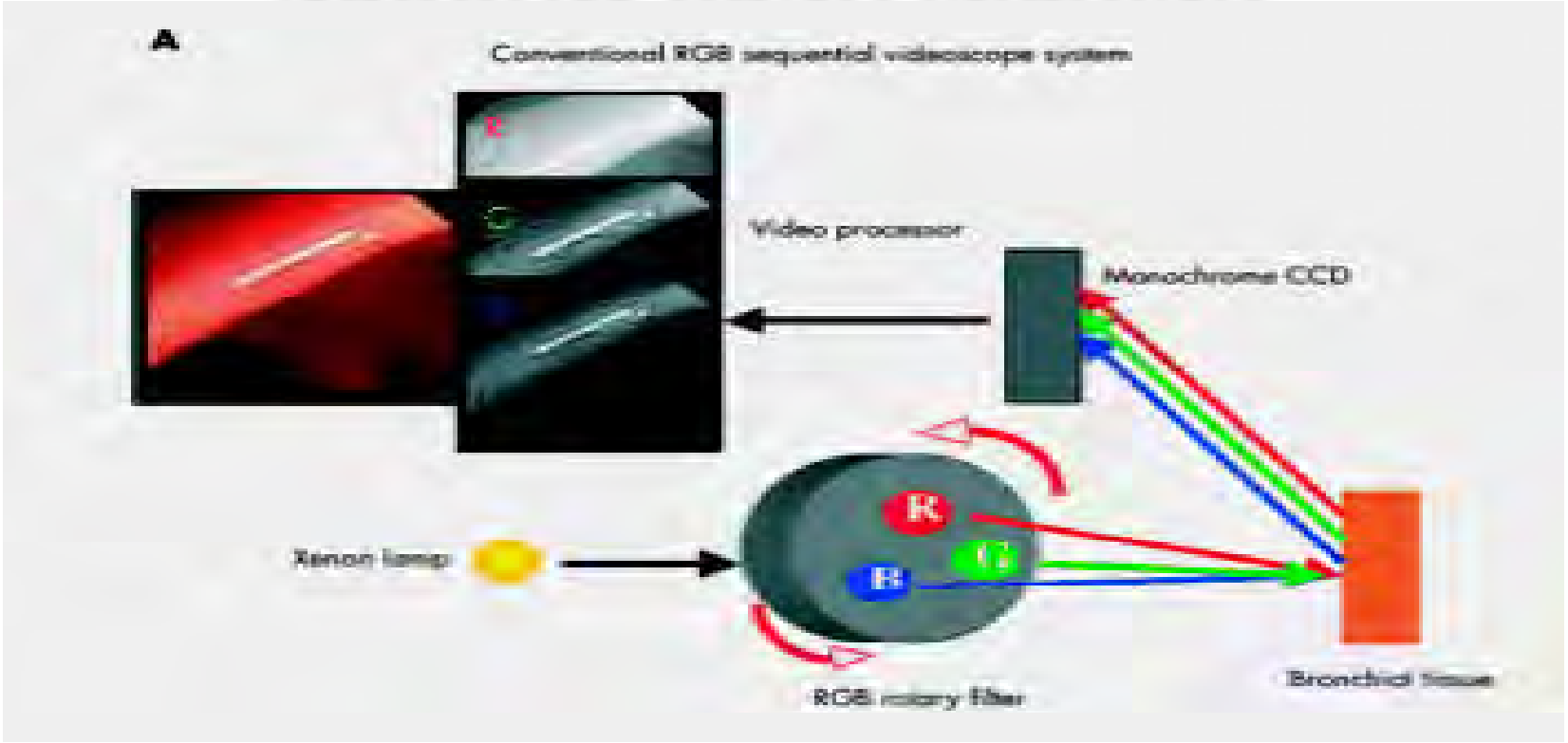
Ralf Eberhardt, MD; Devanand Anantham, MD; Felix Herth, MD; David Feller-Kopman, MD, FCCP; and Arvin Ernst, MD, FCCP

Table 1—*Yield, Registration/Navigation Accuracy, Procedure Duration, and Pneumothorax Incidence in Studies of ENB Diagnosis of Peripheral Lung Lesions

Study	Technique	No.	Size, mm	Diagnostic Yield, %	Error, mm	Duration, min	Pneumothorax
Becker et al[5]	ENB and fluoroscopy-forceps biopsy and brush	29	All	69	Registration, 6.1 ± 1.7	Registration, 2 (1–9.3); navigation, 7.3 (1.3–14.1)	1 patient treated with chest tube
			< 30		Navigation, 5.8 ± 3.7		
			> 30		Navigation, 10.4 ± 7.8		
Schwartz et al[4]	ENB and fluoroscopy-forceps biopsy and brush	13	All	69	Navigation, 3.7		
Gildea et al[7]	ENB and fluoroscopy-forceps biopsy and brush	54	All	74	Registration, 6.6 ± 2.1; navigation, 9.0 ± 5.0	Registration, 3 ± 2; navigation, 7 ± 6; total, 51 ± 13	2 patients treated with chest tubes
		31	< 20	74			
		23	> 20	74			
		43	< 30	72			
		11	> 30	82			

*Values are given as the mean ± or No. (range), unless otherwise indicated.

NARROW BAND IMAGING



Narrow band imaging : New bronchoscopic system equipped with filters that illuminates target tissue at narrower red/green/blue bands of light spectrum with delineation of the details of microvascular network

Thorax 2003;58:989–995

A Pilot Study of Narrow-Band Imaging Compared to White Light Bronchoscopy for Evaluation of Normal Airways and Premalignant and Malignant Airways Disease*

Brad D. Vincent, MD; Mostafa Fraig, MD; and Gerard A. Silvestri, MD, FCCP

Background: **The objectives of this study were to characterize the appearance of normal, dysplastic, and frankly malignant airway lesion appearance under narrow-band imaging (NBI), and to determine if NBI, when used in conjunction with white light (WL) bronchoscopy, could improve detection of dysplasia and malignancy.**

Patients and methods: **This was a prospective, partially blinded study at a university teaching hospital. Bronchoscopy was performed on 22 patients with known or suspected bronchial dysplasia or malignancy. Full airway examination was performed first under WL bronchoscopy and then under NBI. Directed endobronchial biopsies of likely dysplastic, malignant, and normal (control) areas were then performed and sent for examination by a pathologist blinded to the gross description of the lesion. Pathology interpretations were then compared to the corresponding WL and NBI images.**

Results: **There were one malignant and four dysplastic lesions in 22 patients detected by NBI when findings by WL imaging were considered normal. In cases when the WL appearance was abnormal, NBI did not improve the diagnostic yield. The increased rate of detection of dysplasia and malignancy by NBI was statistically significant ($p = 0.005$).**

Conclusion: **NBI identified dysplasia or malignancy that was not detected by WL inspection in 23% of subjects. Further studies are needed to determine the efficacy of NBI in detection of premalignant airways lesions in an at-risk population.** ***(CHEST 2007; 131:1794–1799)***

Key words: bronchial dysplasia; carcinoma *in situ*; interventional bronchoscopy; lung cancer; malignancy; narrow-band imaging; white-light bronchoscopy

Abbreviations: AF = autofluorescence; CI = confidence interval; CIS = carcinoma *in situ*; NBI = narrow band imaging; WL = white light

NBI: PRACTICAL APPLICATIONS

- Characterization of vascular pattern of bronchial epithelial surface
- Understanding of angiogenesis in early phases of carcinogenesis of lung tissue and diagnosis of premalignant lesions
- Used to determine what areas to study with Optical Coherence Tomography and con-focal microendoscopes to achieve in-vivo biopsies
- High magnification bronchovideoscopy combined with NBI useful in detection of capillary blood vessels in ASD lesions at sites of abnormal fluorescence

Thorax. 2003 November; 58(11): 989–995

OPTICAL COHERENCE TOMOGRAPHY (OCT)

- OCT evolving technology that brings capability of a pathologist's microscope into flexible bronchoscope
- Analogous to ultrasound, but uses light waves instead of sound waves
- Light backscattered from within a sample processed to develop high-resolution, depth-resolved image suitable for analyzing internal microstructure, in vivo, without physical contact
- With appropriate lateral scanning, 2 D and 3 D images with resolution better than 10 micrometers acquired rapidly and non-invasively.

Chest 2007; 131:261–274

OCT : PRACTICAL APPLICATIONS

- When compared to HE stained histologic samples of animal and excised human tracheas, OCT images displayed with precision microstructures such as epithelium, lamina propria, glands, and cartilage
- Future clinical application of OCT would be detection and follow-up of submucosal *in situ histologic changes* without need to obtain a biopsy

Respiration 2005;72:537–541

INTERVENTIONAL THERAPEUTIC BRONCHOSCOPY

- Gustav Killian performed first documented bronchoscopic removal of foreign body

Munchener Medizinische Wochenschrift 1897;38:1038–1039

Indications for ITB:

- Life-threatening obstruction of central airways (i.e. trachea, mainstem bronchi and bronchus intermedius)
- Central airway obstruction (CAO) causing symptoms (dyspnea, atelectasis, postobstructive pneumonia, hemoptysis or airway lumen >50%)
- Inoperable early lung cancer amenable to bronchoscopic treatment

Semin Respir Crit Care Med 2008;29:441–452

TREATMENT PRINCIPLES

- Techniques enabling rapid removal of obstruction (Mechanical debulking/resection: laser resection, electrocautery) : life-threatening obstruction
- Techniques enabling delayed removal of obstruction (cryotherapy, endobronchial irradiation photodynamic therapy) : non-critical stenosis
- Techniques enabling maintenance of airway patency (stenting)
- Techniques enabling symptom control such as hemoptysis (electrocautery, argon plasma coagulation, laser therapy, ..

SPECTRUM OF ITB

Flexible Bronchoscopy	RB	Artificial Airways
Therapeutic	Balloon and rigid dilatation	Percutaneous tracheostomy
Balloon dilatation	Mechanical debulking	Minitracheostomy
Endobronchial heat treatment	Endobronchial heat treatment	Placement of transtracheal oxygen catheter
Laser	Laser	
Argon plasma coagulation	Argon plasma coagulation	
Electrocautery	Electrocautery	
Photodynamic therapy	Photodynamic therapy	
Endobronchial cryotherapy	Endobronchial cryotherapy	
Endobronchial brachytherapy	Endobronchial brachytherapy	
Placement of metallic stents	Placement of metallic and silicone stents	
	Placement of dynamic and Y-stents	
	Placement of Montgomery T-tubes	

Chest 2007; 131:261–274

RESURGENCE OF RIGID BRONCHOSCOPY (RB)

- Ability to ventilate patient while intervening in the airways,
- Capability of using large-suction catheters to aspirate
- Ideal for massive hemoptysis
- Tight airway stenosis: Dilatation
- Moderate-to-large tumor tissue burden in airway: Mechanical debridement

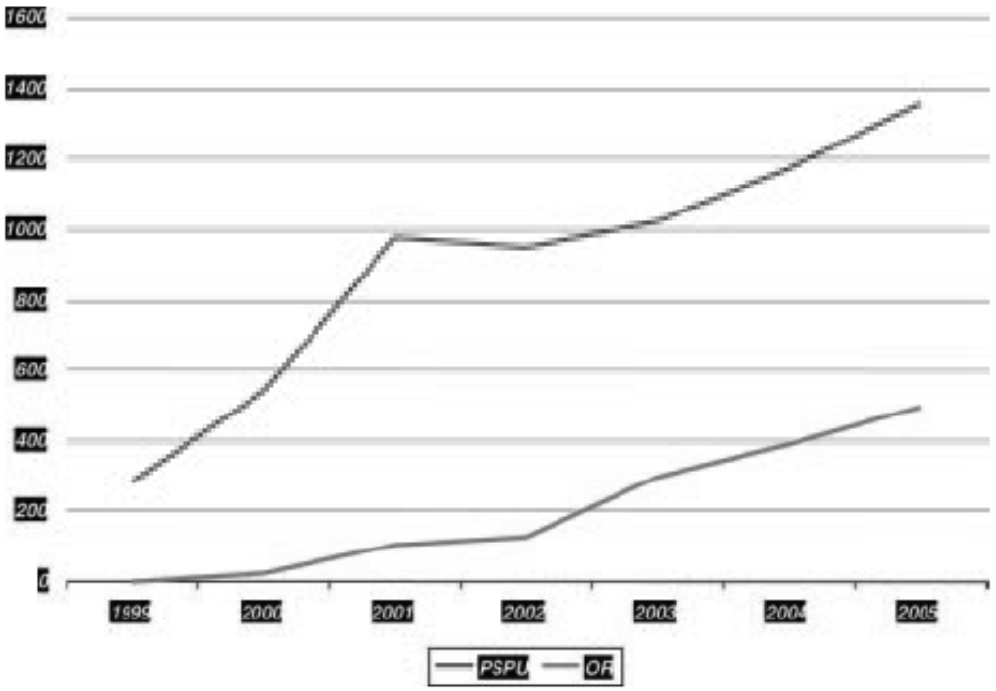


FIGURE 1. The curves depict the increasing number of rigid bronchoscopies (green) performed in an interventional pulmonary practice (Beth Israel Deaconess Medical Center) over several years. The increase in the number of bronchoscopies is mirrored by the general increase in flexible bronchoscopic

Chest 2007; 131:261–274

TRACHEOBRONCHIAL FOREIGN BODIES

Flexible Bronchoscope	Rigid Bronchoscope
Moderate sedation (conscious sedation)	Need for general anesthesia
More accessible to all pulmonologists	Requires specialized training
Access to peripheral airways	Limited to large airways
Better suction	Better control of airway
Can be used in most patients	Contraindicated in craniofacial trauma or cervical spine lesions
Difficulty removing large objects without removing the bronchoscope	Can remove objects of any size through the lumen of the rigid bronchoscope
Difficult removal of sharp objects	Easier removal of sharp objects

Semin Respir Crit Care Med 2008;29:441–452

Table 1-Comparison of Currently Available Bronchoscopic Ablative Therapies

Chest. 2007;131:261–74.

Modality	Mechanism	Effect	Advantages	Disadvantages
Nd:YAG laser	Thermal energy produced by laser light	Coagulation and vaporization of tissue	Excellent debulking	Expensive; cumbersome setup
Electrocautery	Thermal energy produced by an electrical current	Coagulation of tissue but more superficial effect than laser	Excellent safety profile; multiple instrument designs; inexpensive	Contact mode requiring frequent cleaning of probe
Argon plasma coagulation	Thermal energy produced by the interaction between argon gas and an electrical current	Superficial coagulation of tissue	No undesired deep tissue effects	Ineffective for in-depth tissue coagulation or debulking
Photodynamic therapy	Injection of a photosensitizer followed by the destruction of presensitized tumor cells through illumination with nonthermal laser	Delayed destruction of tissue (24–48 h)	Relatively long-lasting effects	Expensive; need for multiple bronchoscopies; skin photosensitivity lasting up to 6 wk
Brachytherapy	Direct delivery of radiation therapy into the airway	Delayed and in-depth destruction of tissue	Long-lasting effect; synergistic with external beam radiation	Higher incidence of complications, particularly hemorrhage
Cryotherapy	Destruction of tissue by alternating cycles of freezing to extreme cold temperatures and thawing	Delayed destruction of tissue (1–2 wk)	Good tool for retrieval of foreign objects and removal of large mucus plugs or clots	Not suitable for debulking in acute airway obstruction; need for multiple bronchoscopies

LASER PHOTORESECTION

- Monochromatic, coherent light induce tissue vaporization, coagulation, hemostasis,and necrosis
- Destruction of granulation tissue, fibrous bands, and exophytic lesions associated with WG ,C.diphtheriae, tuberculosis, and postradiation fibrosis
- Nd:YAG laser 1% complication rate: hemorrhage, perforation of major blood vessel, endobronchial ignition, arrythmias, myocardial infarction, and stroke
- Absolute contraindication : isolated extrinsic compression of airways
- Largest study of 1838 patients reported achieving 93% airway patency and associated improvement in quality of life

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ENDOBRONCHIAL ELECTROSURGERY

- Application of heat produced by electrical current to cut, coagulate, or vaporize tissue in airways
- Palliation of unresectable malignant airway tumors
- Management of benign airway obstruction, and recently in curative intent for carcinoma in situ
- Contraindicated in extrinsic compression of airway and in patients with pacemakers
- Risk of significant bleeding (2 to 5%),endobronchial ignition while using high FiO2, and electrical shock

Semin Respir Crit Care Med 2008;29:441–452

TABLE 2 Indications for laser resection and electrocautery[#]

Malignant disorders	Primary lung cancer
	Endobronchial metastasis (from breast, colon, kidney, thyroid gland, oesophagus)
	In situ carcinoma[¶]
	Typical carcinoid[¶]
Benign tumours[¶]	Papilloma, fibroma, lipoma, hamartochondroma, leiomyoma
Stenoses	Due to the following:
	Anastomosis (lung transplantation, surgical resection)
	Intubation
	Tracheotomy, tracheostomy
	Tuberculosis
	Sarcoidosis
	Wegener's granulomatosis
	Trauma
	Inhalation injury
	Radiation therapy
	Granulation tissue
Miscellaneous	Reduction of bleeding
	Amyloidosis
	Endometriosis
	Closure of oesophago-bronchial fistulas
	Foreign body removal (lithotripsy)

Eur Respir J 2006; 27: 1258–1271

[#]: Endobronchial obstruction in the central airways; [¶]: intended to be curative.

ARGON-PLASMA COAGULATION

- Ionized argon gas to conduct electrical current between delivery probe and tissue
- Noncontact method more desirable over electrosurgery
- Drawback is shallow depth of penetration, thus limiting its use in large bulky tumors obstructing central airway
- Palliation of malignant obstruction as part of multimodality treatment, and also in benign conditions, like excess granulation tissue, papillomatosis,postinfectious airway stenosis

Semin Respir Crit Care Med 2004;25:367–374

PHOTODYNAMIC THERAPY

- Delayed tumor destruction method based on light-activated chemical compounds that cause cell death
- Early lung cancer not extending beyond the airway wall in patients not candidates for surgery or external beam radiation therapy
- Palliative treatment for endobronchial obstruction with no acute dyspnea

Eur Respir J 2002;19:356–373

- Most common complications of PDT using photosensitizer DHE include skin photosensitivity up to 4 to 6 weeks after procedure
- Local airway edema, strictures, hemorrhage, and fistula formation. Overall operative mortality 0%

CRYOTHERAPY

- Joule-Thompson principle to cause thermal tissue destruction by direct contact : N2,N2O,CO2
- Little immediate effect, and most of its effect occurs hours later
- Excellent results in removing foreign objects, blood clots, and polypoid lesions

Chest 1996;110:718–723

- Safe to use, even in a high oxygen environment. limited bronchial wall damage, under local anesthesia , lack of pain
- Most common side-effects : airway sloughing requiring a repeat bronchoscopy , and post procedure fever
- Combination of cryotherapy and chemotherapy to enhance apoptosis and necrosis in mouse model

Lung Cancer 2006;54:79–86

BALLOON BRONCHOPLASTY

- Use of balloons for symptomatic airway stenosis resulting from intubation, infection, radiation, malignancy, sarcoidosis ,WG, or inhalational injury
- Final desired diameter usually diameter immediately proximal or distal to stenosis
- Recurrence of stenosis , pain, and, albeit rarely, airway tear or rupture
- Published results of balloon dilation in non malignant stenosis : 70 -100% immediate results

Semin Respir Crit Care Med 2008;29:441–452

BRACHYTHERAPY

- Direct placement of radioactive seeds (iridium-192) into airway tumor or in close proximity by use of flexible bronchoscope: Delayed response
- Palliation of symptoms related to malignant airway obstruction and curative intent after surgical resection with microscopically positive resection margins
- Overall improvement and palliation of symptoms in 65 to 95% of cases
- Benign lesions of stent related granulomatosis
- Complications: hemorrhage, fistula formation, arrythmias, hypotension, bronchospasm, bronchial stenosis, and chronic bronchitis

Int J Radiat Oncol Biol Phys 2008;70:701–706

BRONCHIAL THERMOPLASTY

- Controlled application of radiotherapy to generate local heat and decrease smooth muscle mass in distal airways (≥3 mm) of asthmatics
- Decreased airway hyperresponsiveness, and persistence of benefit for at least 2 years

Am J Respir Crit Care Med 2006;173:965–969

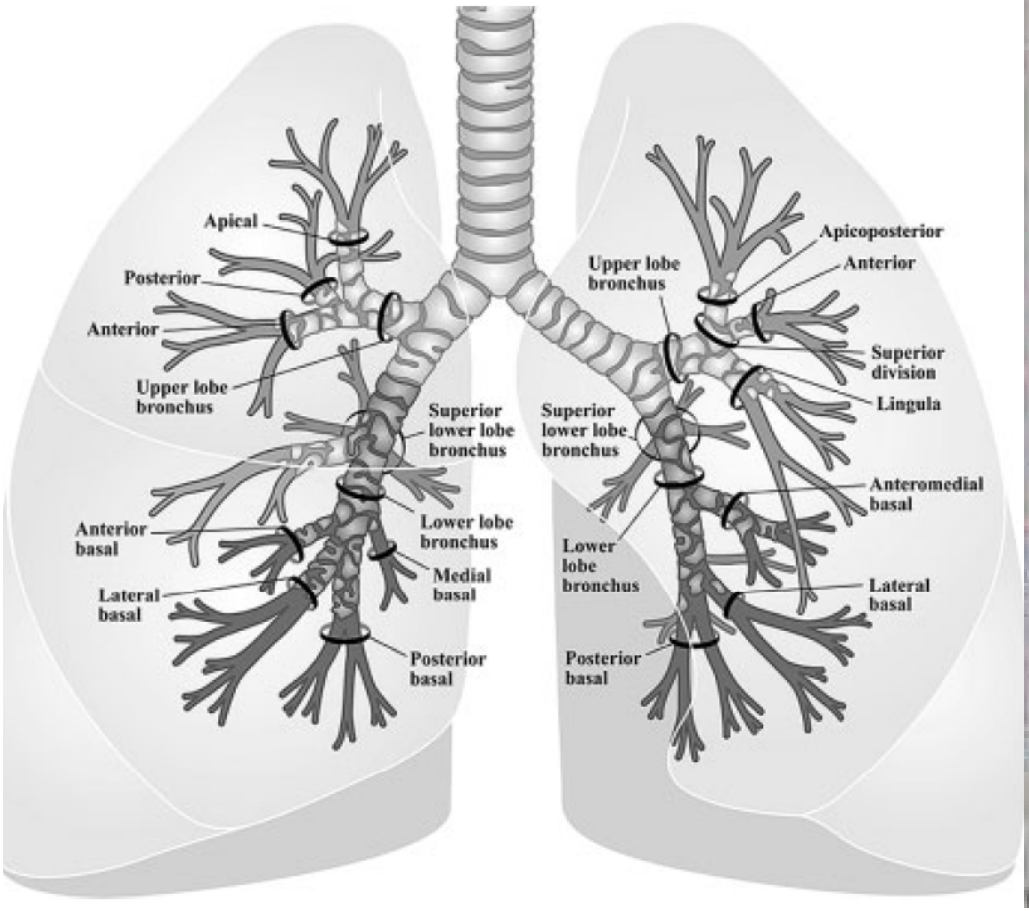
- AIR Trial: moderate or severe-persistent asthma : decrease in frequency of mild exacerbations and an increase in symptom-free days, subjective symptom improvement persisted for 12 months

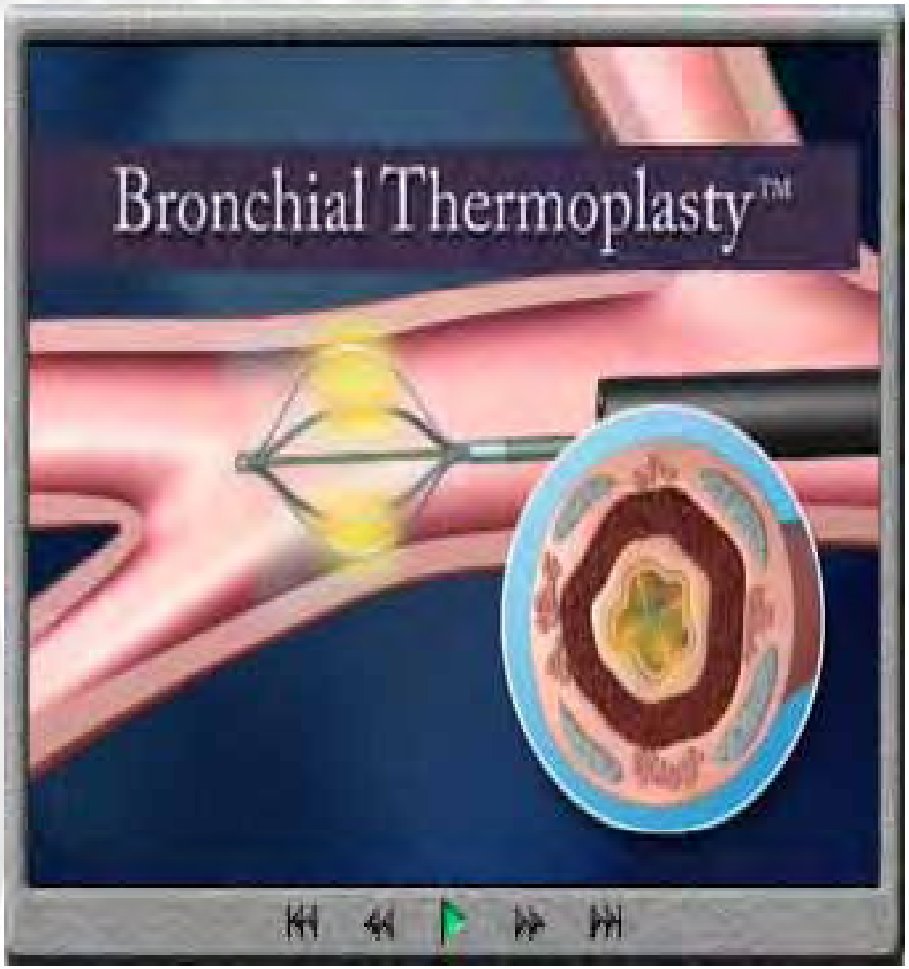
N Engl J Med2007;356:1327–1337

- Symptomatic, severe asthma : significant decrease in use of rescue medications ,improvement in FEV1, and ACQ scores

Am J Respir Crit Care Med 2007;176:1185–1191

BRONCHIAL THERMOPLASTY





Bronchial thermoplasty : stages
Semin Respir Crit Care Med 2008;29:441–452.

AIRWAY STENTING

- Airway stents are hollow tubular devices designed to maintain the patency of tracheobronchial tree
- An ideal stent :

1. Easy to insert and remove
2. Be available in different sizes to match obstruction
3. Once placed, should maintain its position without migration
4. Be firm enough to resist compressive forces, sufficient elasticity to conform to airway contours
5. Be made of inert material, not to irritate airway, precipitate infection, or promote granulation tissue
6. Should exhibit same characteristics of normal airway so that mobilization of secretions is not impaired

Semin Respir Crit Care Med 2004;25:375–380

INDICATIONS FOR AIRWAY STENTING

- Malignant tracheobronchial obstruction
  - With extrinsic compression of large airways
  - Despite laser resection and dilatation
  - Patients undergoing external beam radiation
- Postintubation subglottic stenosis after failure of laser resection or dilatation
- Benign, complex tracheobronchial stenosis
  - nonsurgical candidates
  - after failure of laser resection or dilatation
- Inflamatory or infectious processes while waiting for response to systemic therapy
- Anastomotic strictures after lung and heart–lung transplantation
- Tracheo- or bronchoesophageal fistula

Semin Respir Crit Care Med 2008;29:441–452

SILICONE STENTS

- Montgomery T tube ;

  Relief of subglottic stenosis
- Dumon stent :

  Molded silicone with external studs to prevent dislodgment
- Dynamic stent :

  Silicone Y stent with anterolateral walls reinforced with metal hoops and non reinforced collapsible silicone posterior wall

METALLIC STENTS

First generation : simple stents

- Gianturco stent & Palmaz stent

Second generation :metallic expandable stents

- Wallstent : cobalt-based super alloy tubular mesh inserted through flexible fiberoptic bronchoscope under fluoroscopic guidance

Third generation ; ‘‘shape memory’’

- Ultraflex stent:nitinol (nickel-titanium alloy) stent

Fourth generation : bioabsorable stents

- PLLA (poly-l-lactic acid) : extraction of device unnecessary, and normal airway preserved after stent resorption

Semin Respir Crit Care Med 2004;25:375–380

AIRWAY STENTING : CURRENT STATUS

- Complications :migration, obstruction with secretions or granulation tissue, airway wall erosion, halitosis, infection,hemoptysis, pain, cough, and stent rupture
- No clear advantage of one stent over the other
- Palliative nature of the procedure is not amenable to randomized, controlled trials frequently
- Performed in conjunction with ablative techniques in case of endobronchial tumors and with dilatational techniques

Semin Respir Crit Care Med 2008;29:441–452

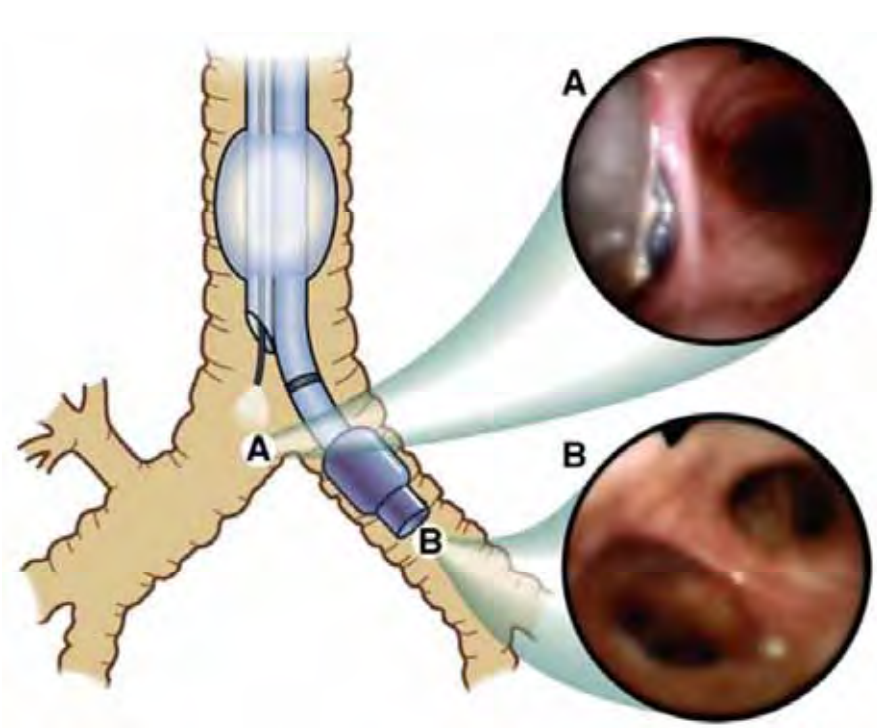
LUNG ISOLATION

- Isolation: avoid spillage / contamination
  - massive hemorrhage
  - infection
- Control the distribution of ventilation
  - unilateral bronchopulmonary lavage
- Unilateral lung disease requiring differential lung ventilation / PEEP strategies
- Surgical exposure:
  - Pneumonectomy / lobectomy / segmentectomy / sleeve resections / BPF repair
  - Thoracoscopy
  - Transplantation
  - LVRS
  - Pulmonary embolectomy

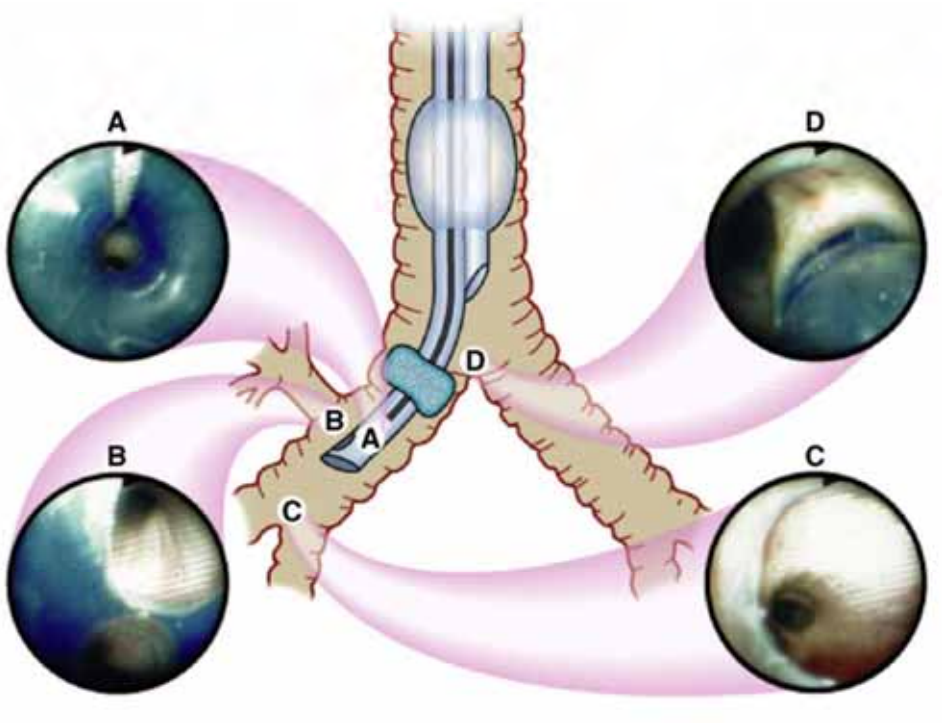
DOUBLE-LUMEN TUBES

- Have high-volume, low-pressure cuffs
- Available in right or left-sided varieties
- Distal bronchial cuff and a proximal tracheal cuff
  - bronchial cuff separates the lungs from each other
  - tracheal cuff separates the lungs from atmosphere

TYPES OF DLT



LEFT DLT



RIGHT DLT

Campos, Thorac Surg Clin 2005; 15: 71

UNIVENT TUBES

- Silicone tube with similar shape as conventional ETT
- Advanced into the mainstem bronchi under bronchoscopic visualization
- Includes a movable endobronchial blocker

ENDOBRONCHIAL LUNG VOLUME REDUCTION

- Poorly functioning lung, usually at apices surgically reduced with aim of improving respiratory mechanics by better fitting of lungs to rib cage
- LVRS associated with significant morbidity, mortality, and cost, nonsurgical alternatives for achieving volume reduction have been developed

Proc Am Thorac Soc. 2008 May 1;5(4):454-60

- Sabaratnam Sabanathan: first person to perform an endoscopic treatment for emphysema

Cardiovasc Surg (Torino) 2003;44:101–108

RATIONALE : ELVR

Concept I: Closing Anatomical Airways

- silicone plugs
- Emphasys valve
- Umbrella valve
- fibrin-based alveolar glue
- Biomodulators: ECMs and PCPs

Am J Respir Crit Care Med 2003;167:771–778

Concept II: Opening Extra-anatomical Passages

- Broncus Technologies : Exhale Emphysema Treatment System designed to create bronchial holes using a radiofrequency probe

Proc Am Thorac Soc. 2008 May 1;5(4):454-60

BLVRS : CURRENT STATUS

- All current clinical evidence is at best from case series and late stages of clinical trials
- Efficacy signals have been substantially smaller and less durable than those observed after LVRS
- Biological lung volume reduction (BLVR) using biological reagents to remodel and shrink damaged regions of lung : 3-month follow-up in humans

Chest. 2007 Apr;131(4):1108-13

BRONCHOSCOPIC INTRATUMORAL CHEMOTHERAPY

- Intratumoral injection of one or several conventional cytotoxic drugs directly into tumor tissue through a flexible bronchoscope
- Precise delivery of cancer drugs to and within tumor
- Dramatically higher intratumor drug concentrations than possible by systemic drug delivery,
- Virtually none of toxic side effects which normally occur with conventional systemic chemotherapy
- Reported to achieve broader tumor-specific systemic immune response in addition to local action

Lung Cancer (2008) 61, 1–12

BRONCHOSCOPIC INTRATUMORAL CHEMOTHERAPY

- Nonsystemic loco-regional chemotherapy
- Life threatening obstruction of the central airways
- Symptomatic obstruction of central airways (dyspnea, atelectasis, pneumonia)
- Asymptomatic obstruction with luminal diameter reduced to less than 50% of normal;
- Inoperable or operable early lung cancer amenable to potentially curative endoscopic treatment.

Eur Respir J 2002;19:356–73.

MULTIMODALITY TREATMENT FOR CAO

(A) Pretreatment

(B) Laser photoresection

(C) Argon-plasma coagulation debulking

(D) Postmechanical debulking

(E) Balloon dilatation

(F) Stent placement.

Semin Respir Crit Care Med 2008;29:453–464

MULTIMODALITY TREATMENT : OUTCOMES

Results in lung cancers

Results	Laser-assisted resection	High-frequency electrocautery	PDT	Cryotherapy	Silicone stents	Brachytherapy
Haemoptysis control	60	90	50–60[#]	65–86	Possible	80
Symptom improvement	80–90	50–60	70	66	90	85
PFT improvement	85	73	18–25[¶]	50	71	80
Airway clearance	90; immediate	84; immediate	50–60; delayed	75; delayed	90; immediate	80; delayed
Benefit duration months	2–3	ND	6–8	3–4	4	6.5
Ability to repeat	Yes	Yes	Yes	Yes	Yes	Yes[+]
Curative effects	Yes (selected cases)	Yes (80)	Yes (77–85)	Yes (81)	No	Yes (84)

Data are presented as %, unless otherwise indicated. PDT: photodynamic therapy; PFT: pulmonary functional tests; ND: not done. [#]: only when caused by submucosal vessels; [¶]: in bronchial obstructive cases; [+]: in selected cases.

Eur Respir J 2006; 28: 200–218

CONCLUSIONS

- Evolving field focusing on application of advanced bronchoscopic techniques for treatment of various malignant and nonmalignant airway disorders
- First-line endoscopic interventions should now be strongly considered due to more immediate results and a favorable safety profile
- Territorial battles with other disciplines, financial concerns, training, verification of competency and lack of rigorous scientific research in this field are main challenges and future directions facing IB
- Broader clinical application in near future to manage patients in a better way