支氣管鏡及支氣管鏡超音波概論

臺大醫院 胸腔內科
Vs 林敬凱

June 29, 2024

Outline

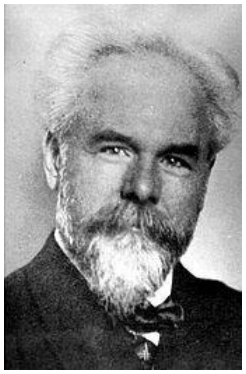
- Introduction of bronchoscopy

- Introduction of endobronchial ultrasound (EBUS)
  - Radial-probe endobronchial ultrasound (RP-EBUS)
  - Covex-probe endobronchial ultrasound (CP-EBUS)

History of Bronchoscopy

1876 Gustav Killian

Remove a pork bone and three other foreign bodies from the main bronchi by laryngoscope



1895 Alfred Kirstein

Visualization of the vocal cords and proximal large airways by esophagoscope.

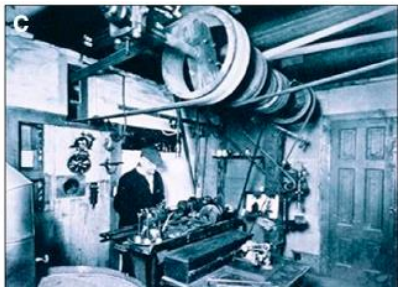
Anaesthesia, 1986, Volume 41, pages 4245

Becler HD et al. J Bronchol 2:77-83, 1995

History of Bronchoscopy

1904 Chevalier Jackson

First rigid Bronchoscopy (consisted of an illumination and suction tubing attached to a rigid esophagoscope.)



1966 Shigeto Ikeda

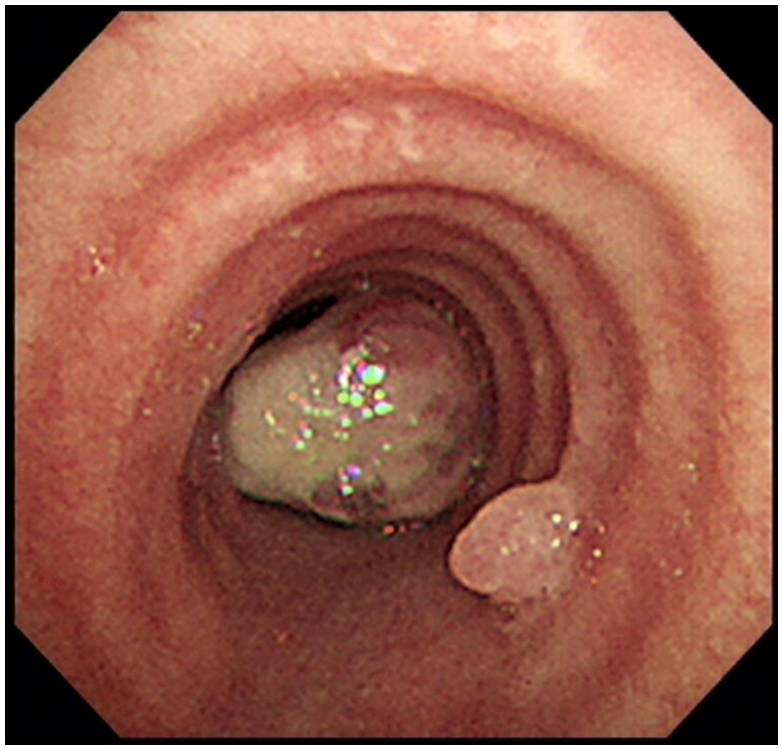
First flexible bronchoscopy (with Machida)

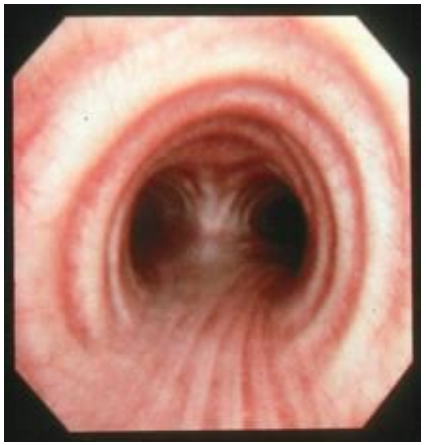

Jackson C. The Laryngoscope Company; 1907

Ikeda S et al. Keio J Med 17:1-16, 1968

Airway Morphology

- Many pathologies of the airway involve the bronchial wall and the parabronchial structures
- Limited to the lumen and the internal surface of the airway





Felix et al. Eur Radiol (2007) 17: 1806–1812

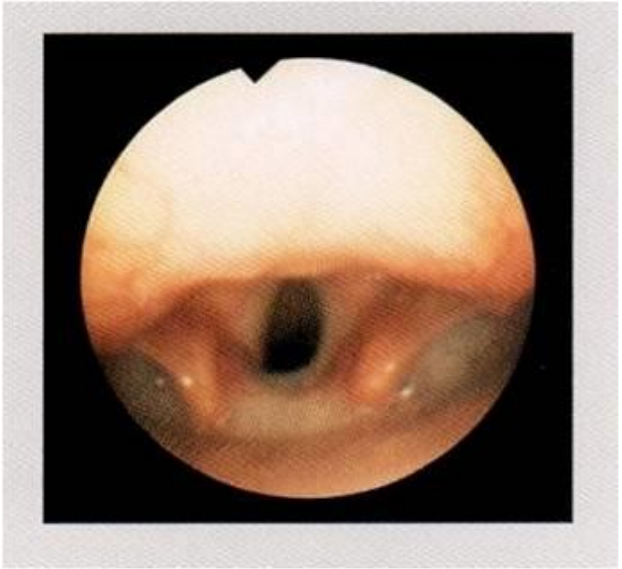
內視鏡影像成像

內視鏡先端內建CCD攝影鏡頭

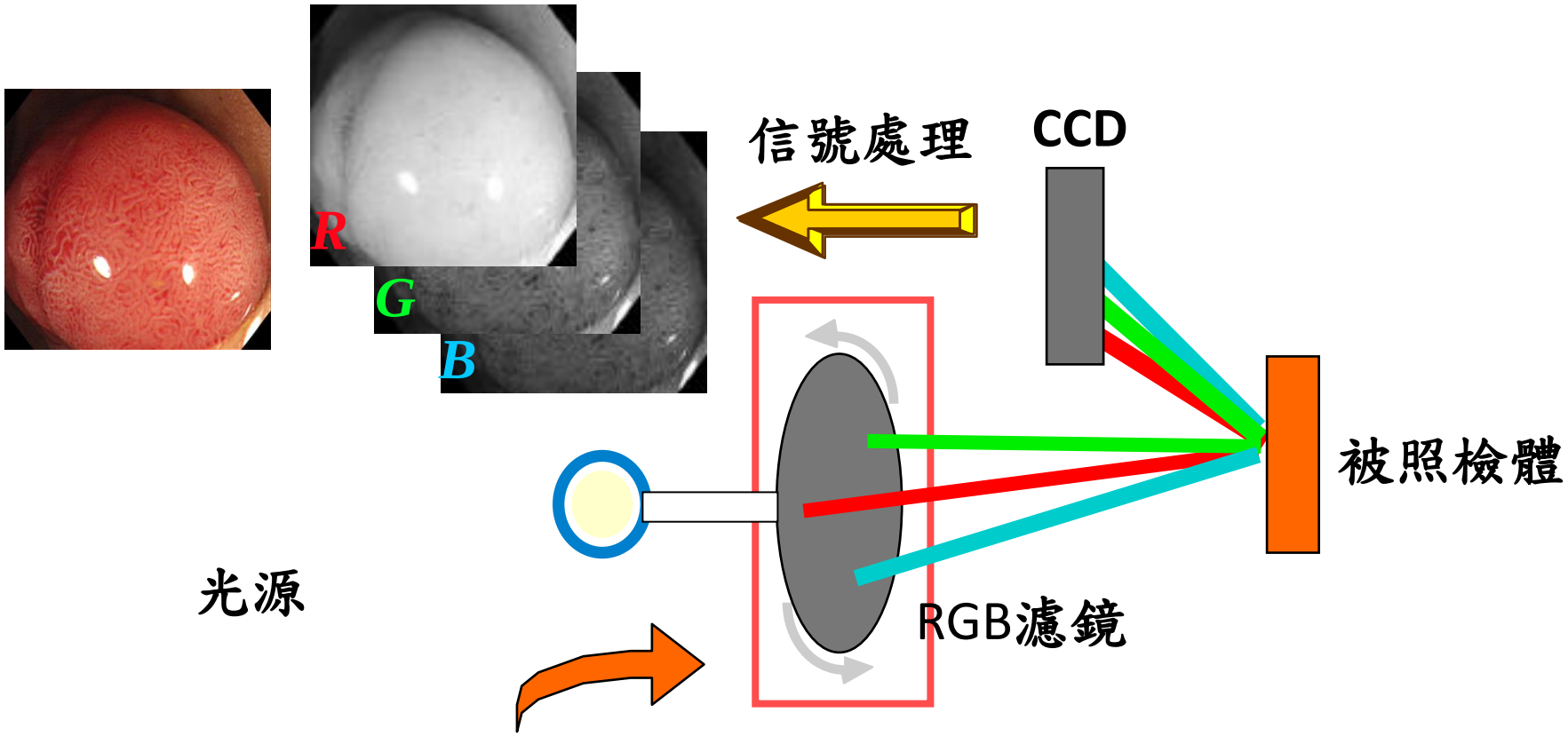
影像較光纖內視鏡更為漂亮與細膩

元佑實業提供

V.S



一般內視鏡--光波原理

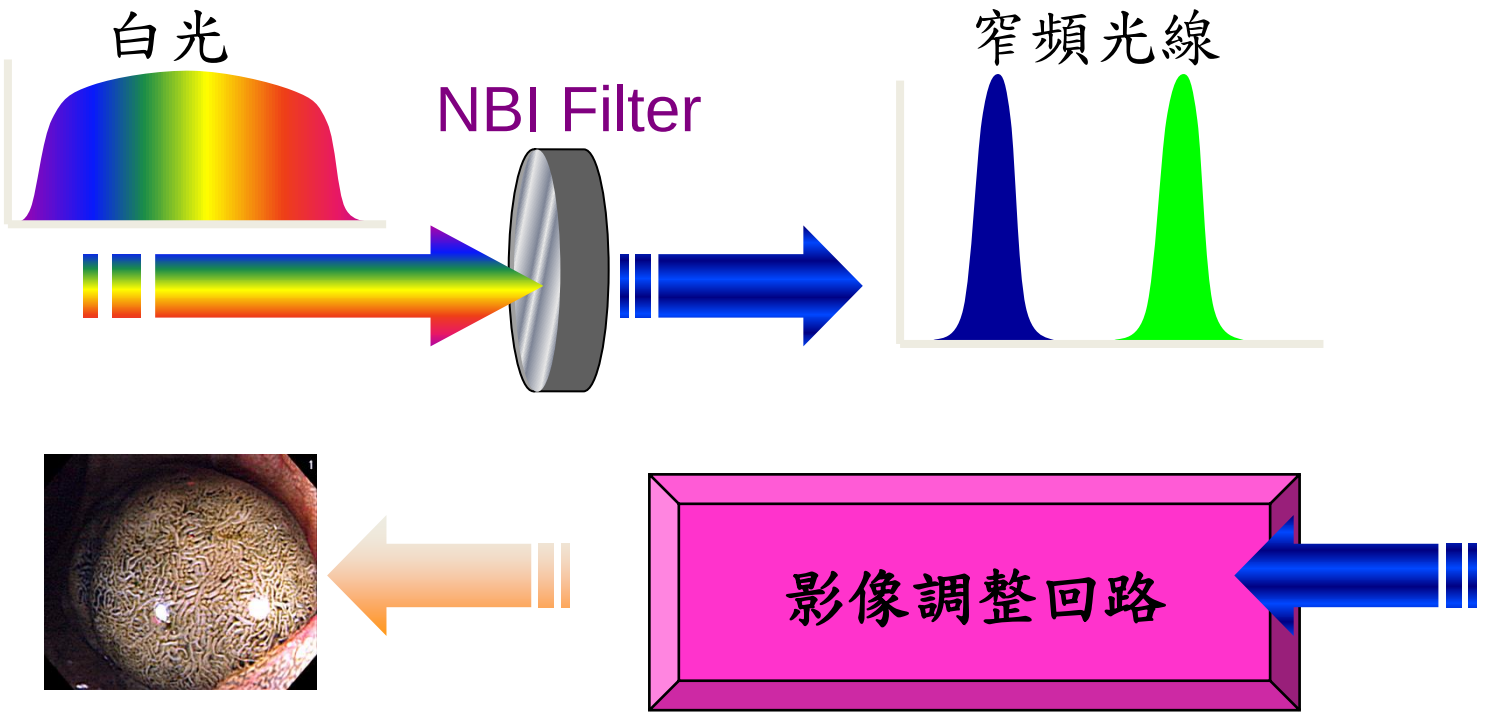


利用濾鏡的分光特性---分離出RGB光波

元佑實業提供

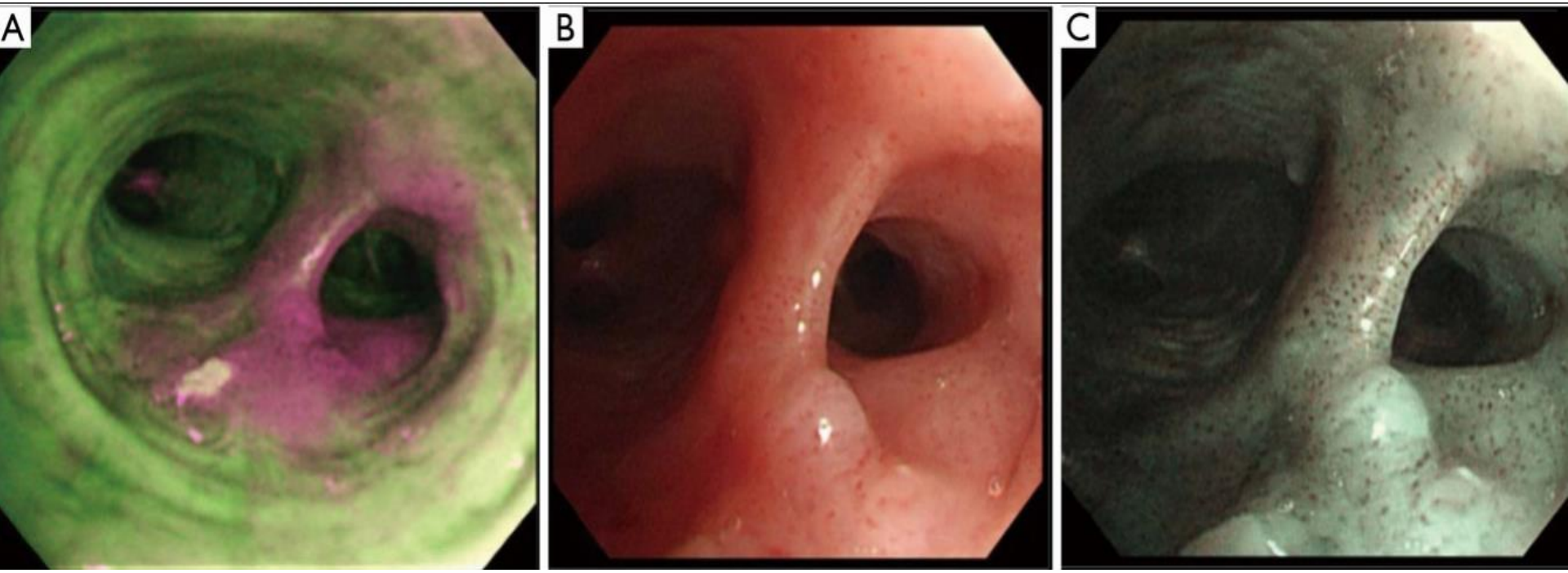
NBI (Narrow band imaging)
窄波光原理

- NBI＝窄波光學的影像強調



元佑實業提供

A F I
(Auto-Fluorescence Imaging)

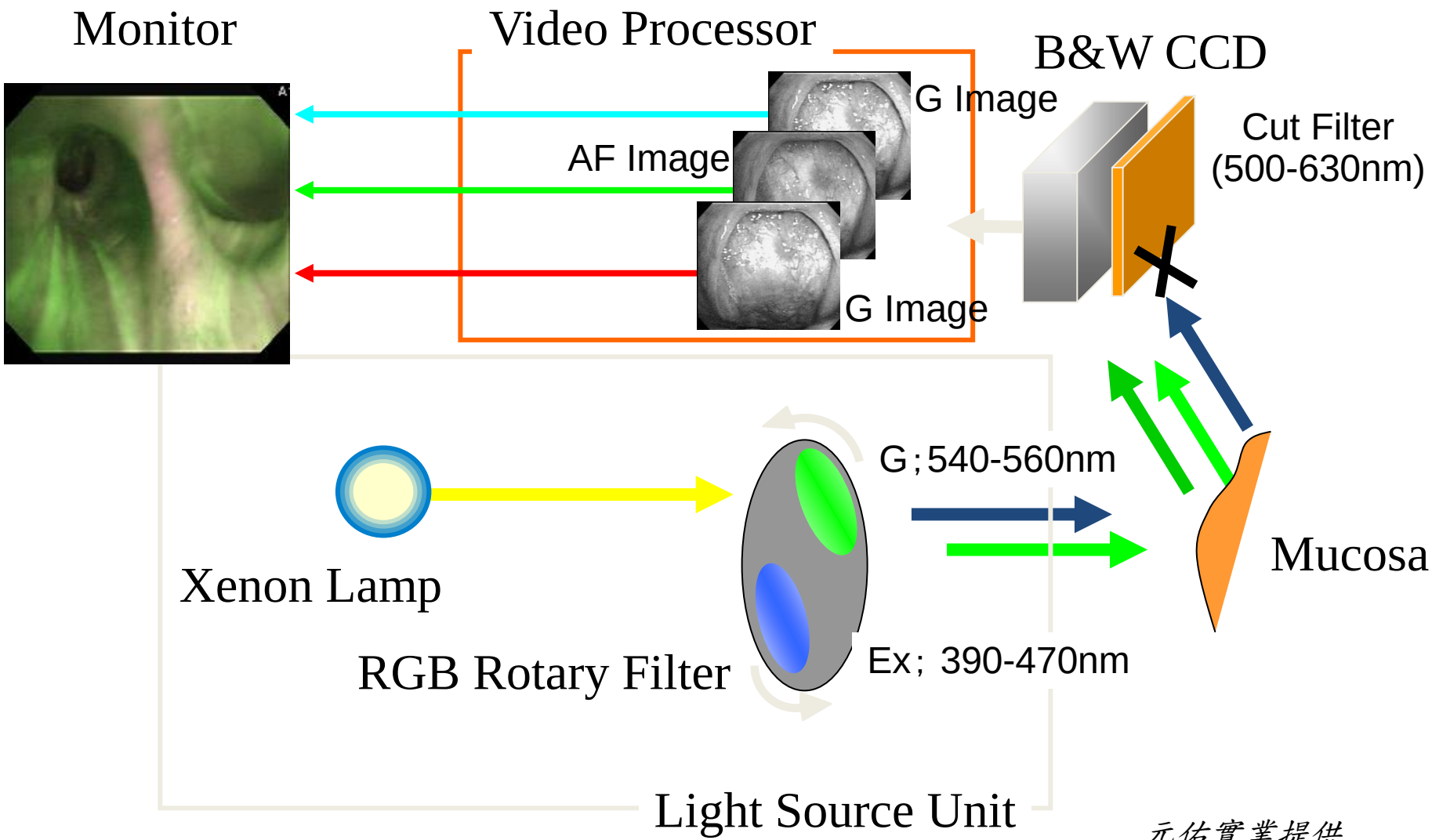


Autofluorescence Imaging

Narrow band imaging

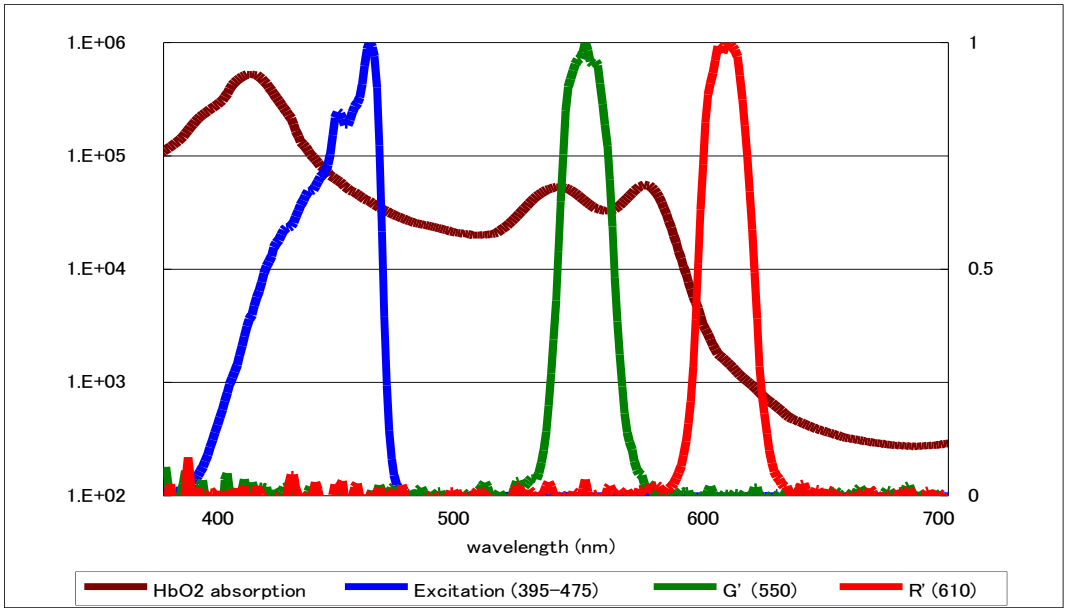
Marco Andolfi et al. J Thorac Dis. 2016 Nov;8(11):3329-3337.

System Configuration



元佑實業提供

AFI Color Tone

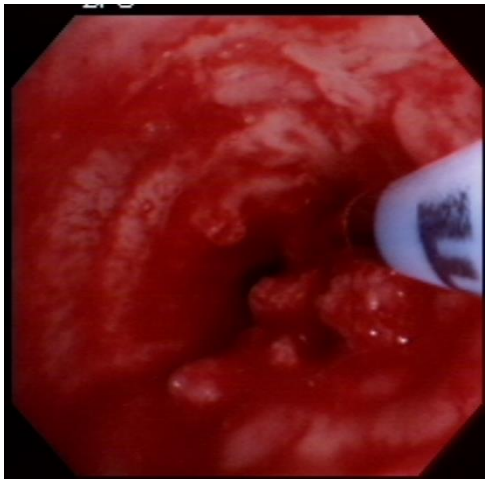


	AF	G'	R'		AFI
Normal				⇒	
Hyperplastic				⇒	
Adenoma/ Adenocarcinoma				⇒	
Inflammation/ (Adenoma・Adenoca.)				⇒	

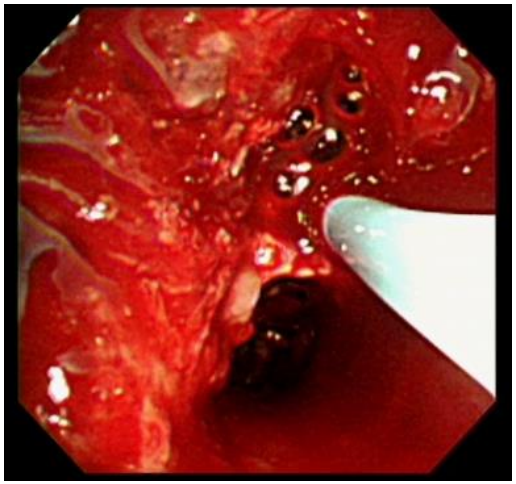
元佑實業提供

Therapeutic Respiratory Endoscopy

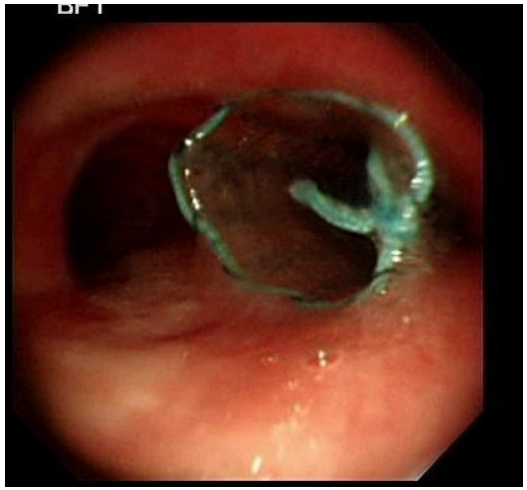
- Endobronchial management



Cryotherapy

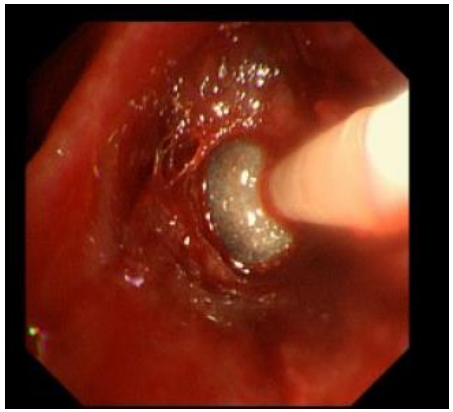


APC



Stent

Electrosurgery

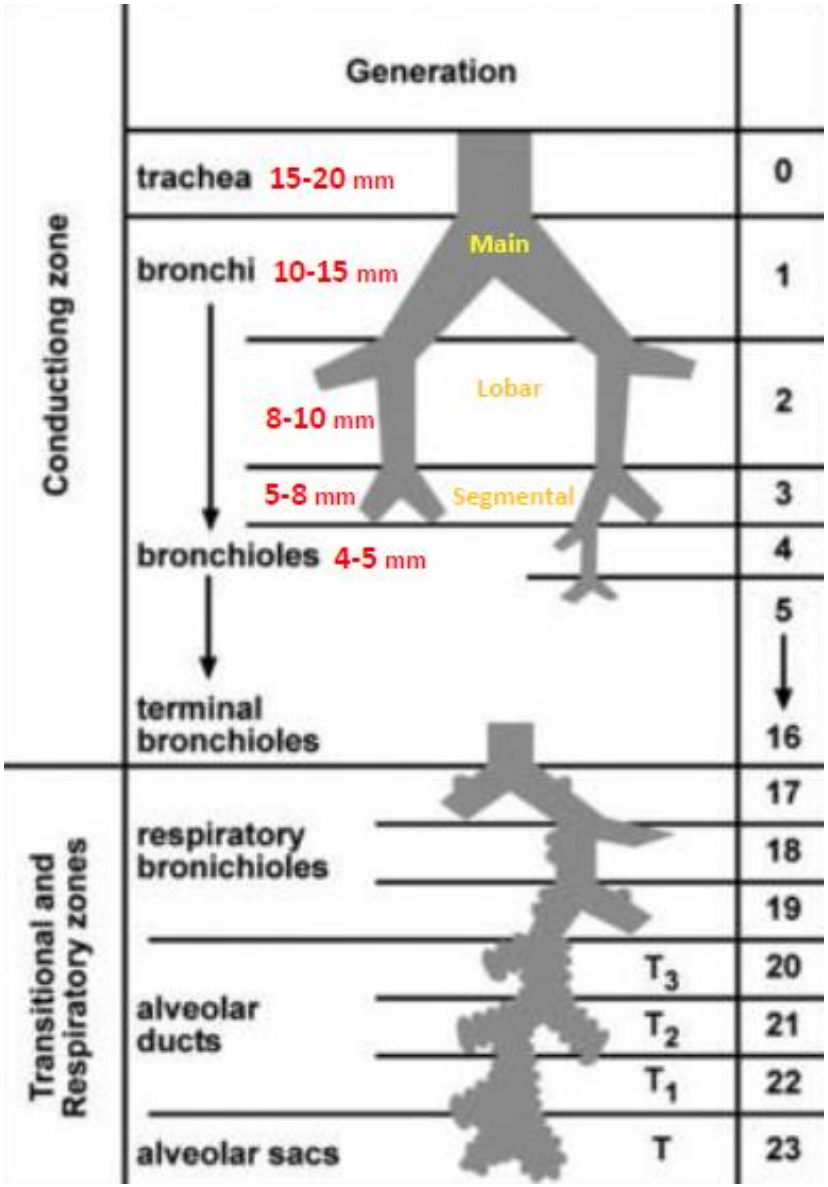


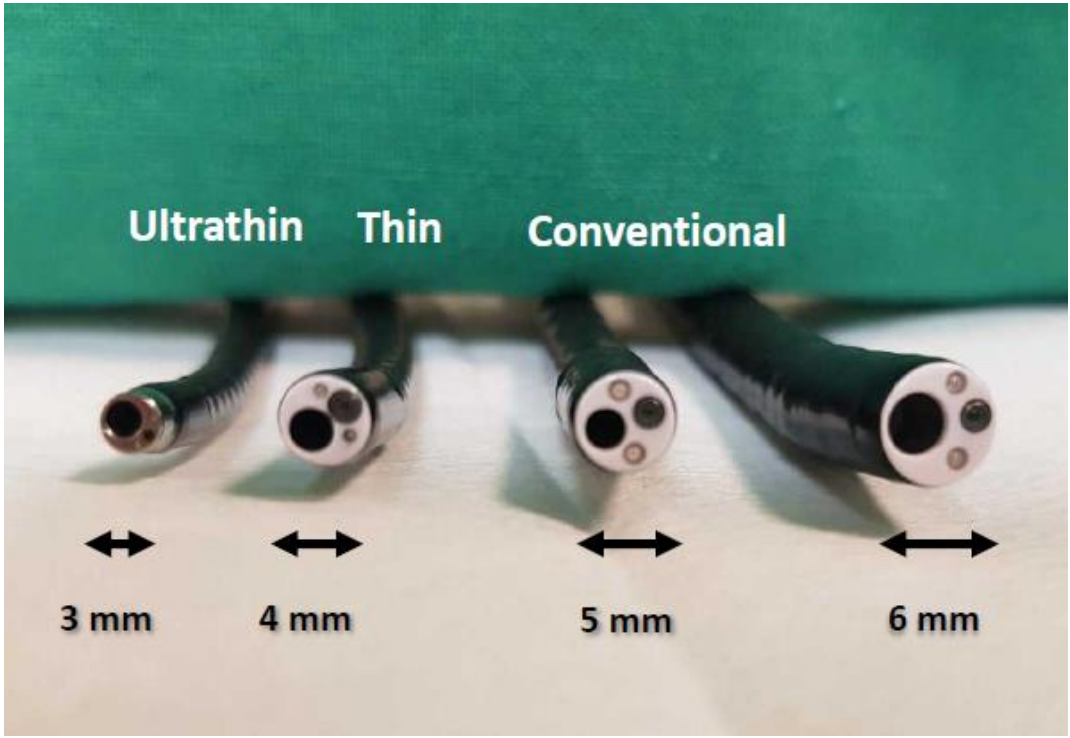
Balloon dilatation

Laser
Photodynamic therapy
Rigid bronchoscopy

From NTUCC

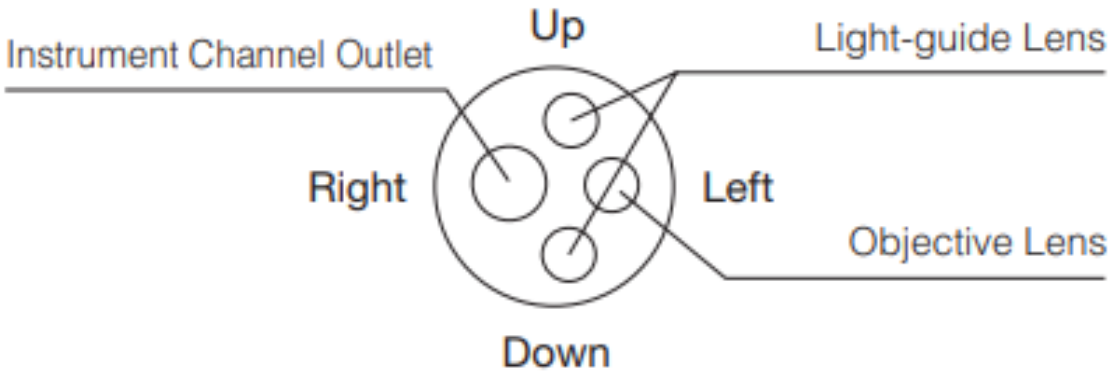
Types of Bronchoscopy





圖片：台大癌醫中心醫院提供

Distal End of Bronchoscopy



	前端部外徑(mm)	軟性部外徑(mm)	Working channel (mm)	
BF-Q290	4.8	4.9	2.0	標準型
BF-1TQ290	5.9	6.0	3.0	處置型
BF-H290	6.0	5.7	2.0	高畫質(HD)
BF-P290	4..2	4.1	2.0	小兒型
BF-MP290F	3.0	3.7	1.7	極細型
BF-XP290	3.1	3.0	1.2	極細型
BF-F260	5.5	5.4	2.0	字體螢光(AFI)

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  - Radial-probe endobronchial ultrasound (RP-EBUS)
  - Covex-probe endobronchial ultrasound (CP-EBUS)

Endobronchial Ultrasonography (EBUS)

EBUS

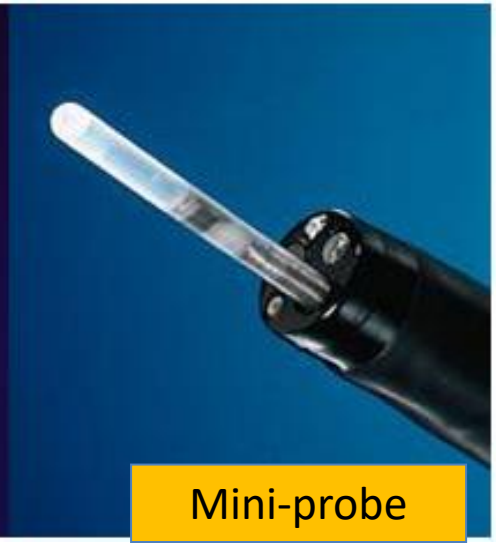
Balloon sheath

Radial probe

Convex probe

EUS

Radial probe



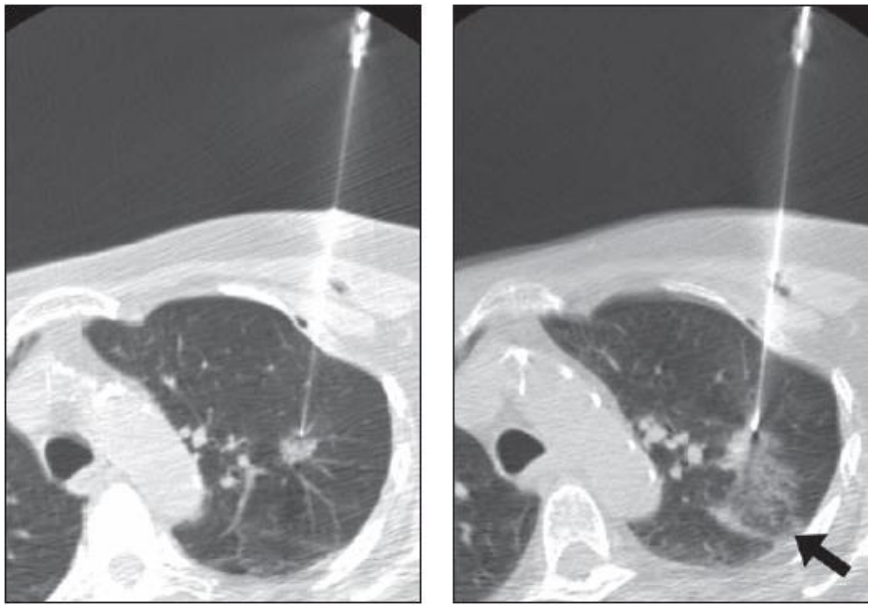
Mini-probe

Linear probe

From olympus company

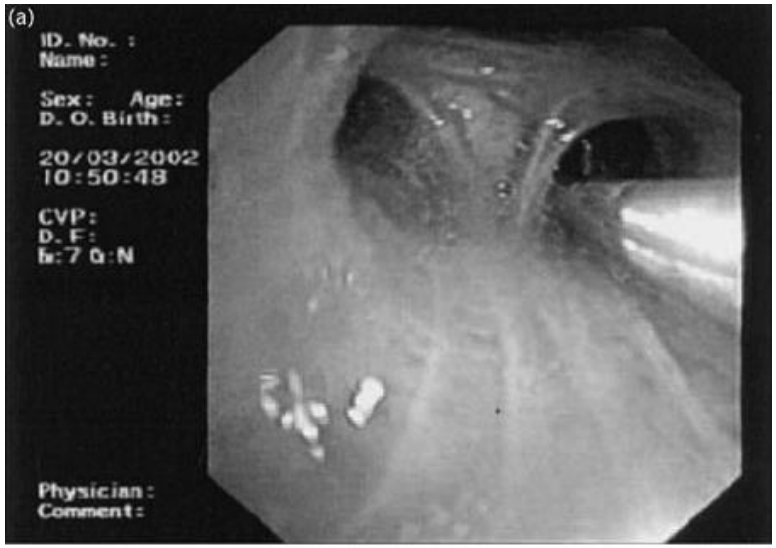
Peripheral intrapulmonary lesions

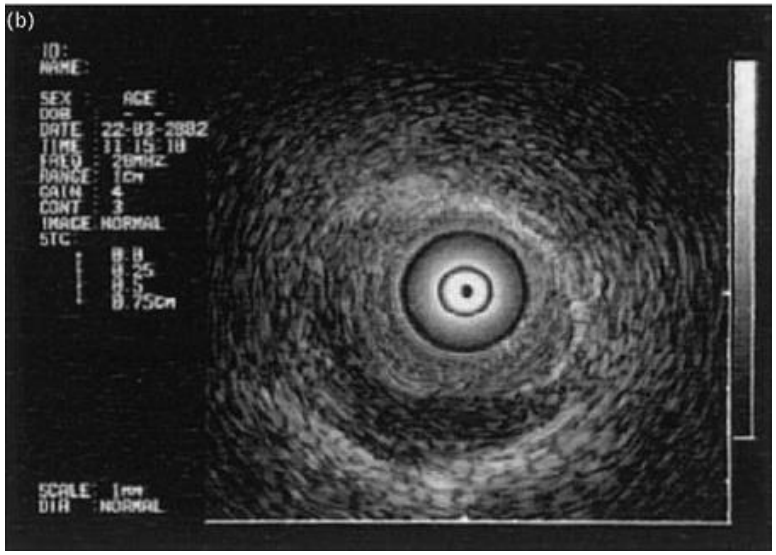
- Transbronchial biopsy (TBB) often performed for peripheral intrapulmonary lesions
- For small and distal lesion
  - CT guidance bronchoscopy
  - Percutaneous needle aspiration: pneumothorax, air embolism, tumor seeding



White et al. Chest 2000;118;1630-1638

Endobronchial Ultrasonography (EBUS)





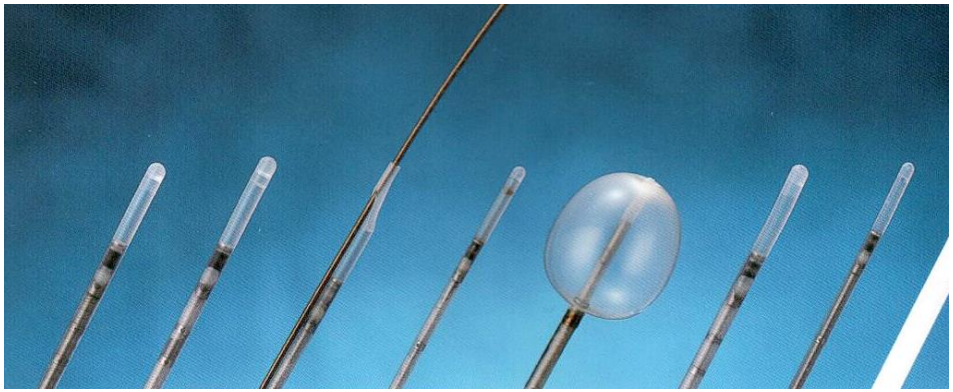


Table 4—Comparison Between Sensitivity, Specificity, Predictive Values, and Accuracy Observed in a Subset of Study and Control Groups: Patients With Lesions < 3 cm in Diameter*

Variables	EBUS-TBB (n • 47)	TBB (n • 58)	p Value
Sensitivity	75 (60–90)	30.7 (16.3–45.3)	0.0002
Specificity	100	100	NS
NPV	65.2 (46.2–84.3)	41.3 (1.4–69.2)	NS
PPV	100	100	NS
Accuracy	83 (72.2–93.7)	53 (40.6–66.3)	0.001

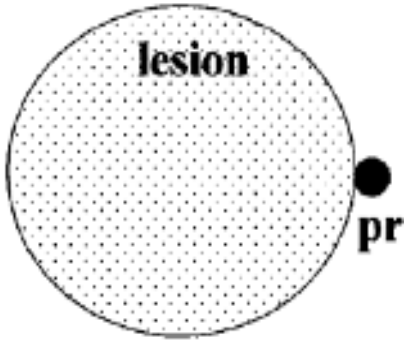
*Data are presented as % or % (95% CI). See Table 1 for expansion of abbreviation.

Paone et al. Chest 2005;128;3551-3557

The Location of the Probe

Within

Adjacent to

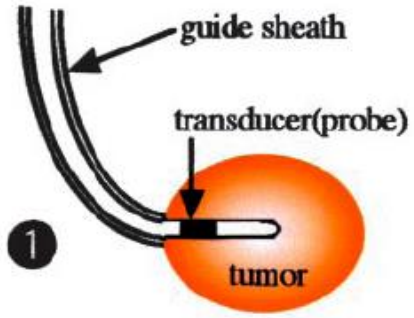


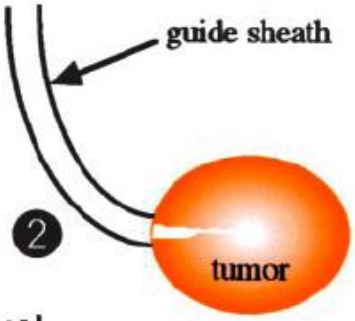
Noriaki et al. Chest 2004;126;959-965

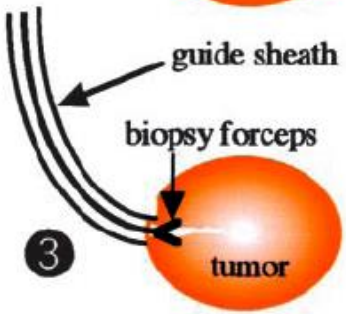
Problem of EBUS Radial Probe

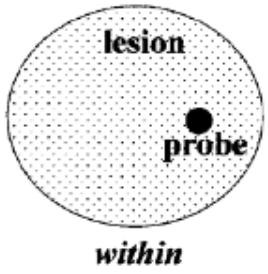
Not Real Time !!

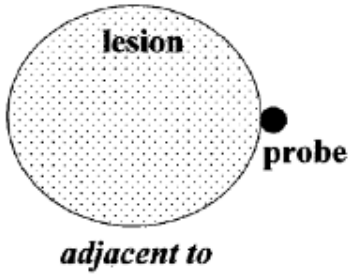
Ultra-miniature probe use guide sheath







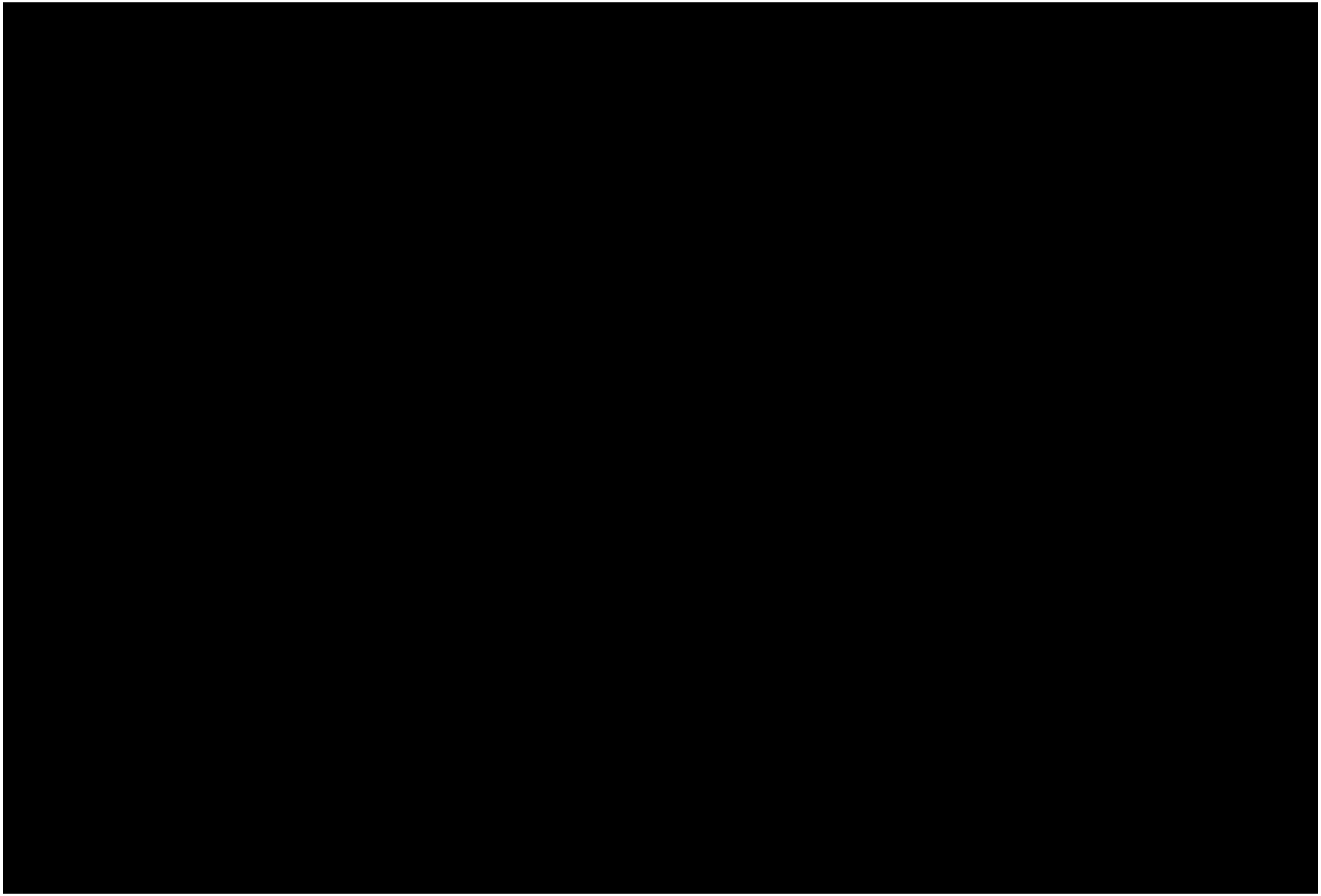




location of the probe	brushing (140)	TBB (110)	total (140)
within (121)	81/121 (67%)	79/96 (82%)	105/121 (87%)
adjacent to (19)	7/19 (37%)	1/14 (7%)	8/19 (42%)

Noriaki et al. Chest 2004;126;959-965

The Process of Transbronchial Biopsy



Advantage of EBUS-GS

- The position of lesions can be accurately determined
- Forceps can be introduced any number of times to the same bronchial segment
- The internal structure of lesions can be analysed
- There is very little post-transbronchial biopsy bleeding

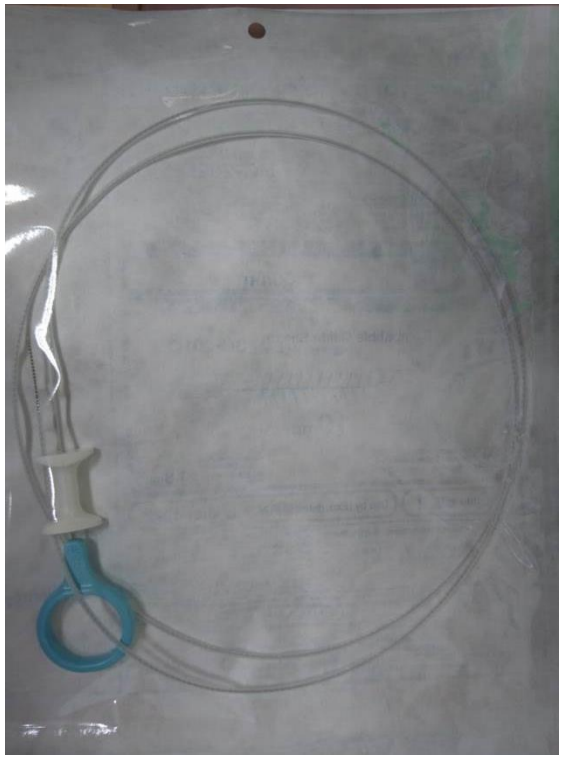
Noriaki et al. Endobronchial ultrasonography

EBUS-GS Kits

型號	外徑	內徑	搭配之RP-EBUS	搭配之支氣管鏡	備註
K201, K202	2.0 mm	1.7 mm	UM-S20-17S	BF-260, BF-Q290, BF-P260F, BF-P290	切片夾小，不易取得足夠檢體
K203, K204	2.6 mm	2.0 mm	UM-S20-20R	BF-1T260, BF-1TQ290	Guide sheath較硬，周邊或特殊位置(B1, B6)不易到達

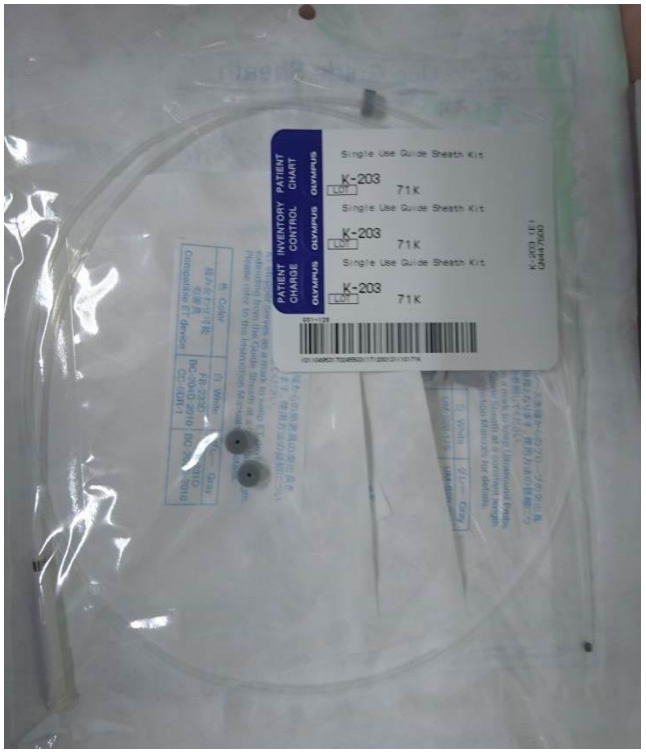
EBUS-GS Kits

- 3 components



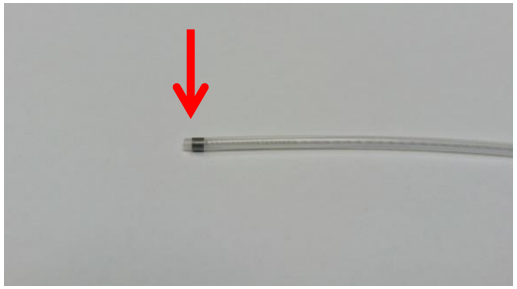
細胞刷

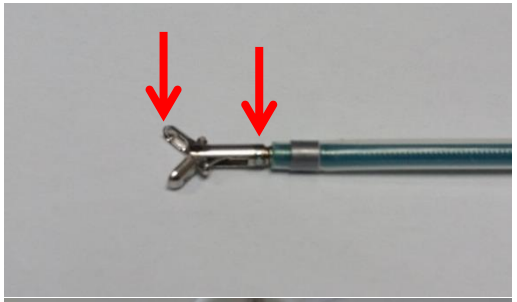
切片夾

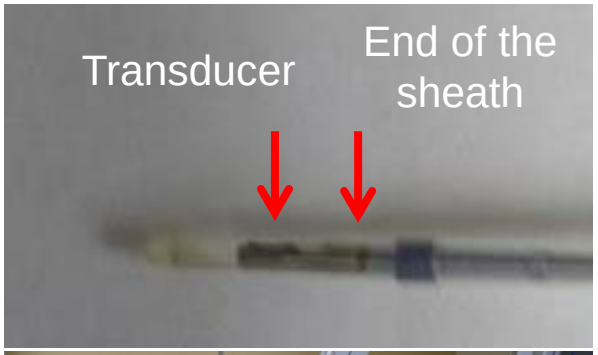


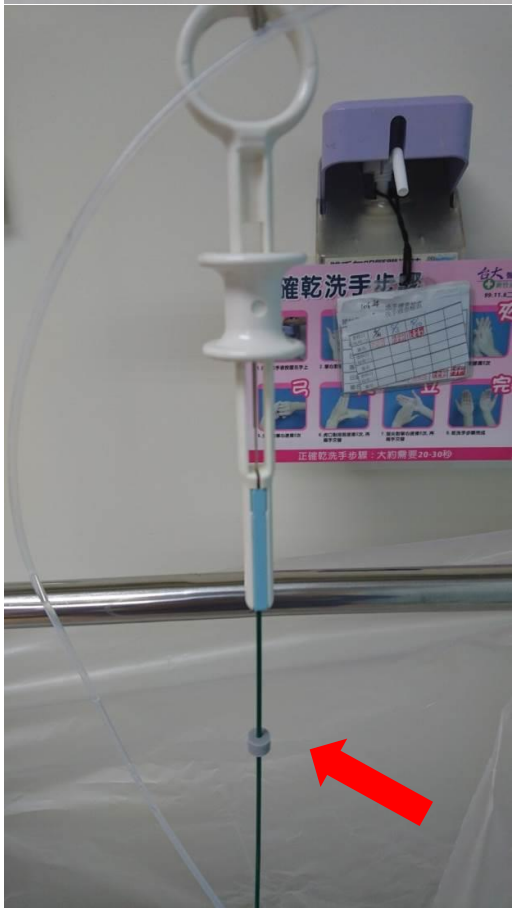
Guide sheath

EBUS-GS準備流程









Diagnostic Accuracy of EBUS-TBB

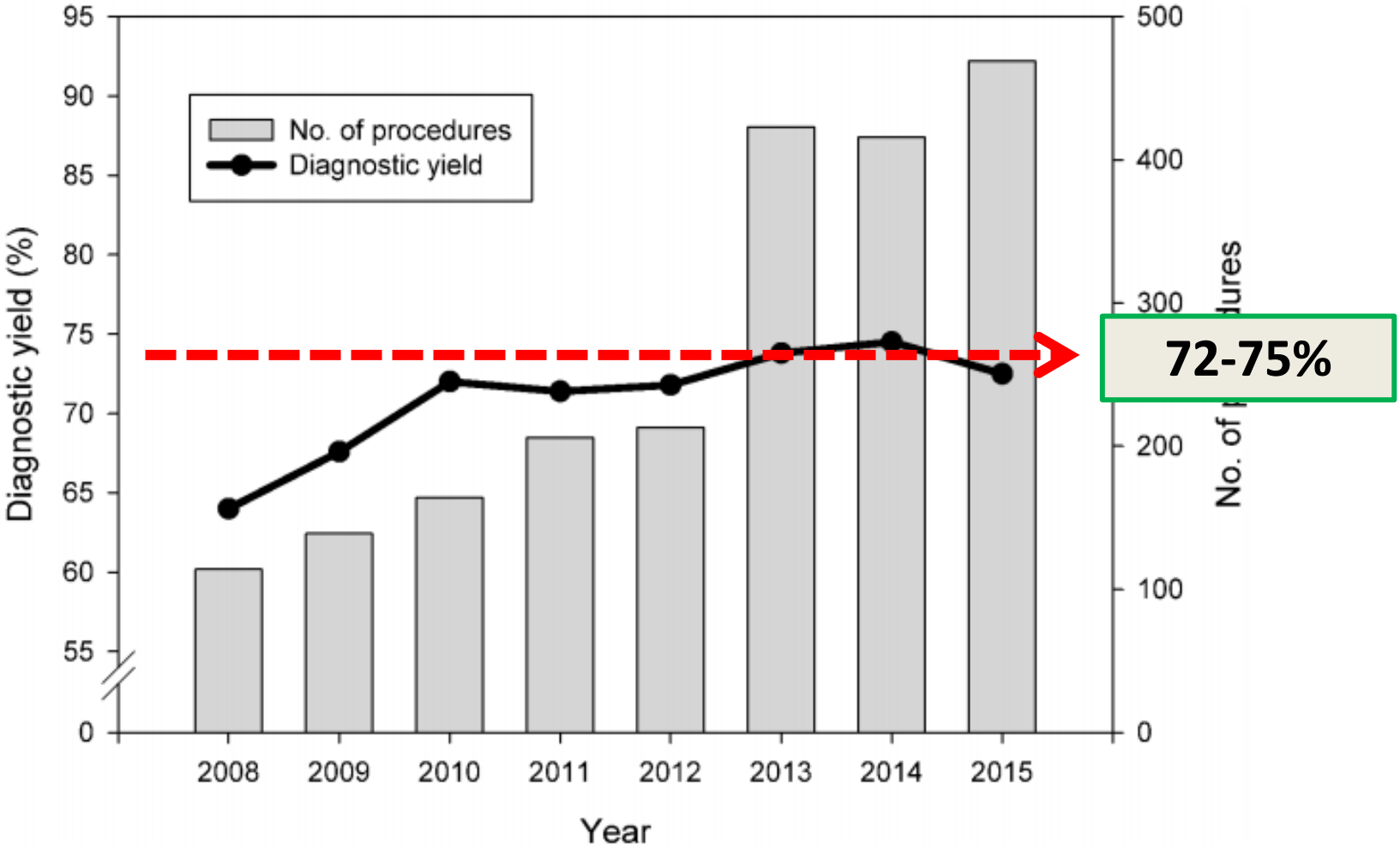
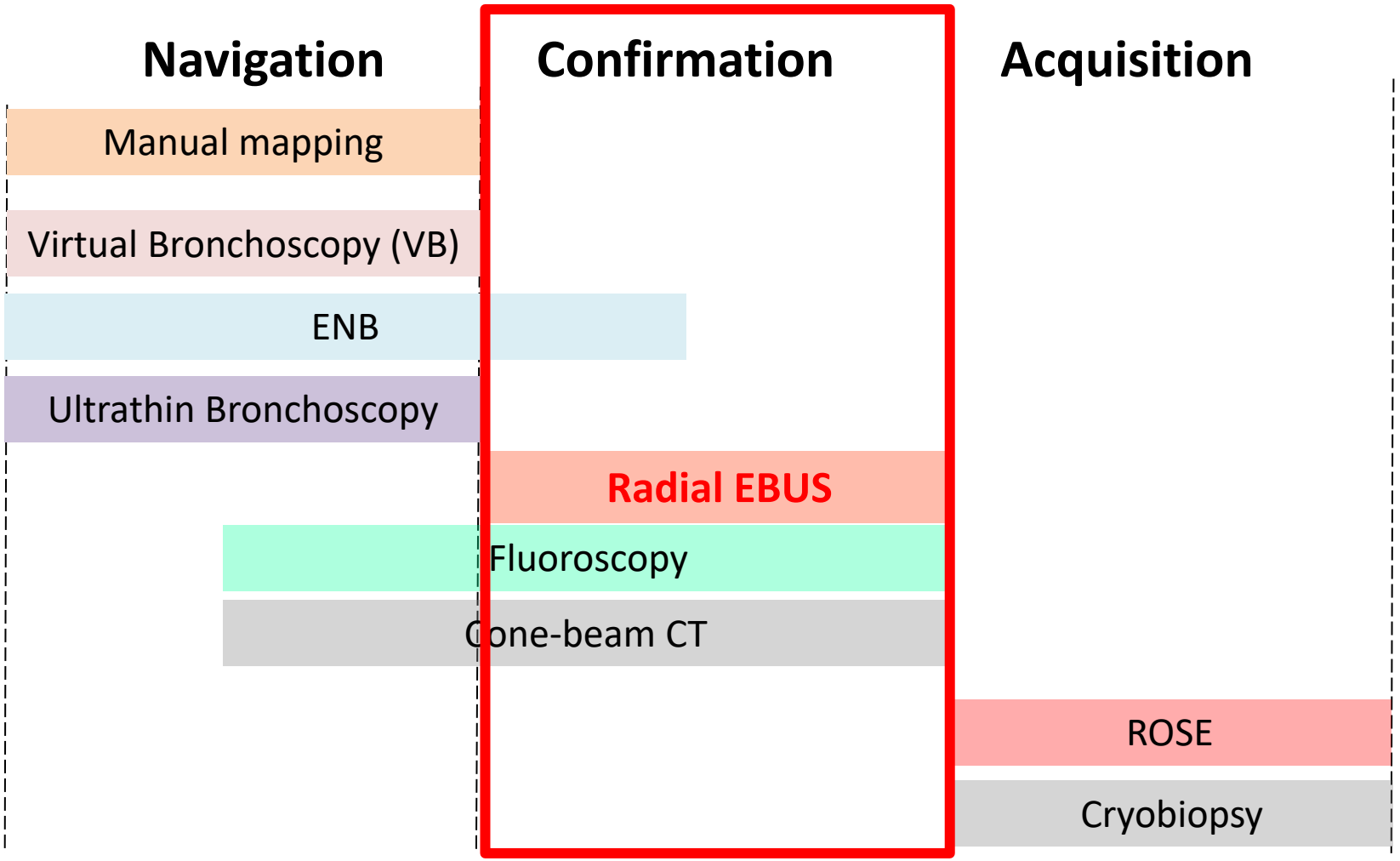


Fig 1. Diagnostic yield and case No. of endobronchial ultrasound-guided transbronchial biopsies over the study period.

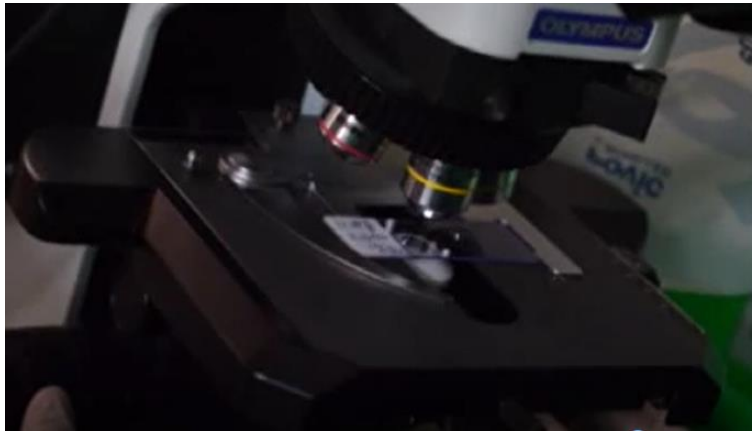
Chun-Ta Huang et al. Plos One. 2017 Jun 20;12(6):e0179719.

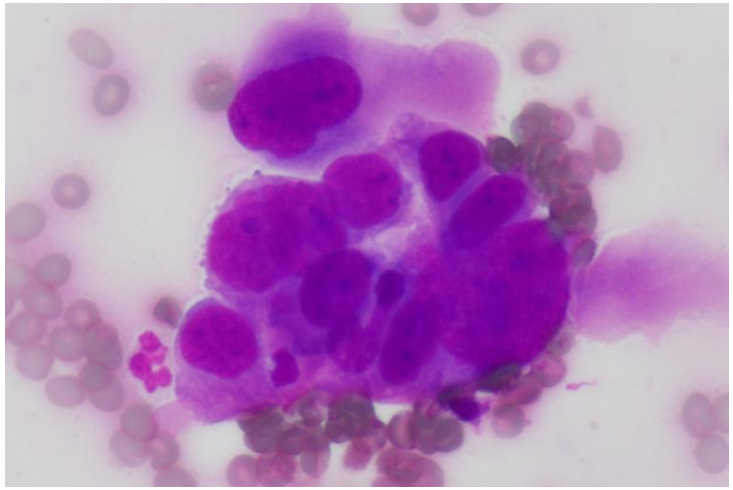
How interventional pulmonologist think?



Roberto F. Casal. J Bronchol Intervent Pulmonol Volume 25, Number 4, October 2018

Rapid on-site cytologic evaluation (ROSE)

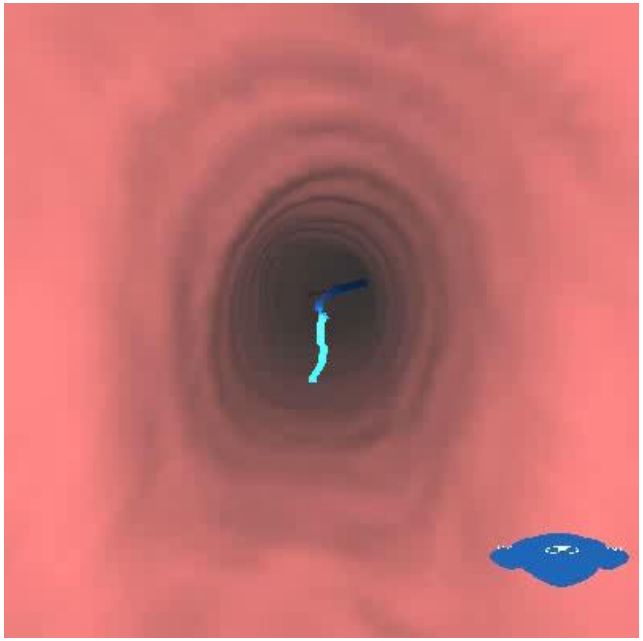




Variable	Diagnostic yield (%)		P
	ROSE group	Non-ROSE group	
Total	76/86 (88.4)	170/250 (68)	<0.001*
Biopsy times[a]			
≧ 4	74/81 (91.4)	147/194 (75.8)	0.003*
< 4	2/5 (40)	23/56 (41.1)	0.963
Indication[b]			
Initial diagnosis	57/65 (87.7)	162/227 (71.4)	0.007*
Re-biopsy	19/21 (90.5)	8/23 (34.8)	<0.001*
Tumor size[c]			
≥ 3 cm	49/53 (92.5)	113/154 (73.4)	0.004*
< 3 cm	27/33 (81.8)	57/96 (59.4)	0.020*
Lesion pattern[d]			
Solid	66/75 (88)	161/233 (69.1)	0.001*
Part-solid	10/11 (90.9)	9/17 (52.9)	0.036*
Bronchus sign[e]			
Presence	65/72 (90.3)	147/204 (72.1)	0.002*
Absence	11/14 (78.6)	23/46 (50)	0.059
Pleural effusion contact[f]			
Presence	2/3 (66.7)	10/15 (66.7)	1
Absence	74/83 (89.2)	160/235 (68.1)	<0.001*
Lobe[g]			
Upper lobe	37/42 (88.1)	79/119 (66.4)	0.007*
Non-upper	39/44 (88.6)	91/131 (69.5)	0.012*
Position of probe[h]			
Within	72/80 (90)	148/212 (69.8)	<0.001*
Adjacent to	4/6 (66.7)	22/38 (57.9)	0.685
Echogenicity[i]			
Heterogeneous	48/49 (98.0)	117/154 (76.0)	0.001*
Homogenous	28/37 (75.7)	53/96 (55.2)	0.030*

Lin CK et al. J Formos Med Assoc. 2020 Jan 18. pii: S0929-6646(20)30005-X.

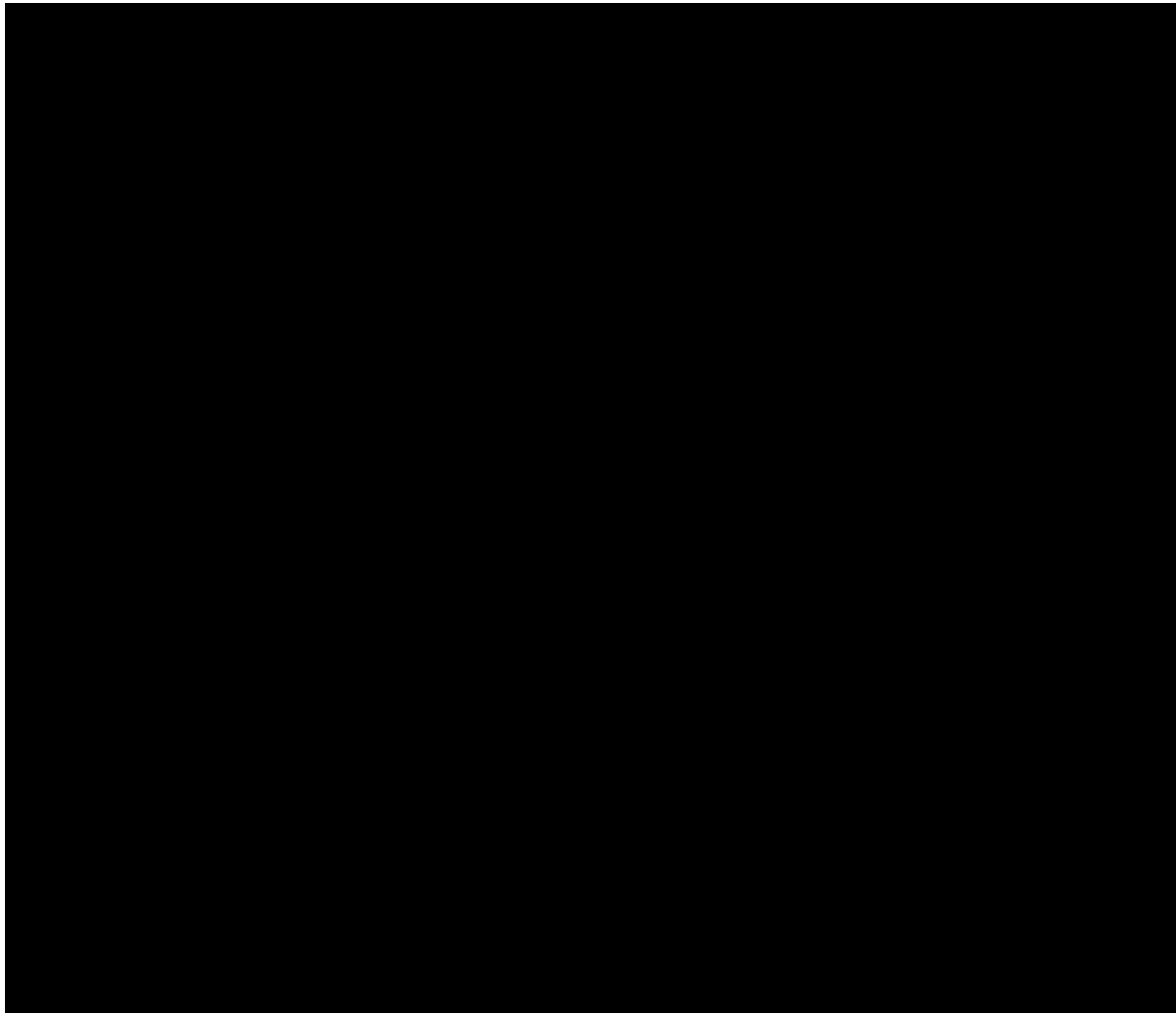
Virtual Bronchoscopic Navigation (VBN)



- EBUS-GS-TBB at RB6a: no malignancy
- Wedge resection:
  1. Chronic inflammation with fibrosis and microcalcifications.
  2. Granulomatous inflammation

Fluoroscopy guided bronchoscopy

- Real-time X-ray image
  - Localization of the forceps and brush
- Disadvantage:
  - Radiation
  - Difficult to visualize in some lesion
    - Behind the mediastinum or diaphragm
    - Ill-defined opacities
    - Small lesions

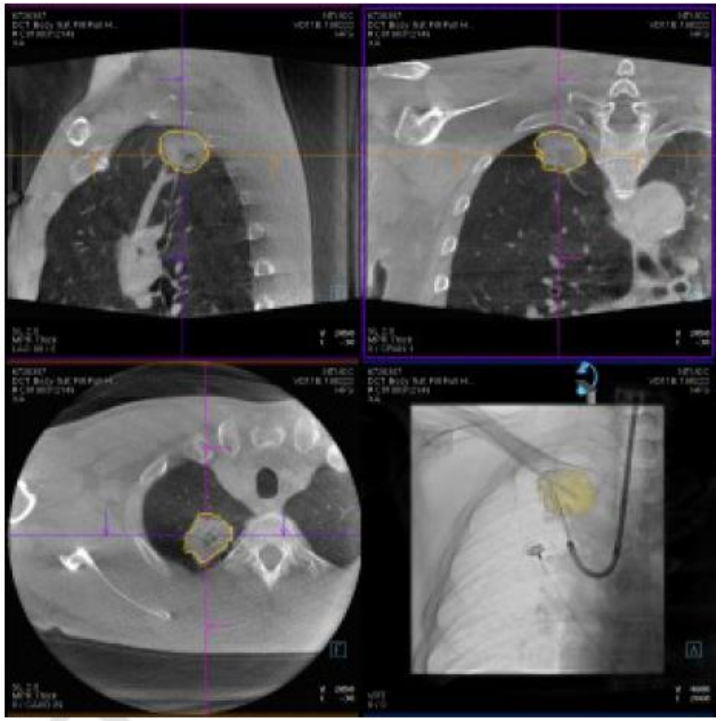


影片：From 台大癌醫中心醫院

Clinton L. Cummings, et al. J Natl Med Assoc. 1982 Mar;74(3):239-41.

Cone-beam CT

- Moving C-arm → submillimeter isotropic reconstruction in a large anatomic region
- ↑navigation and diagnostic yield
- finding of intra-procedural atelectasis



影片：From 台大癌醫中心醫院

Roberto F. Casal, et al. J Thorac Dis 2018;10:6950-6959.

Multiple guided technologies based on RP-EBUS

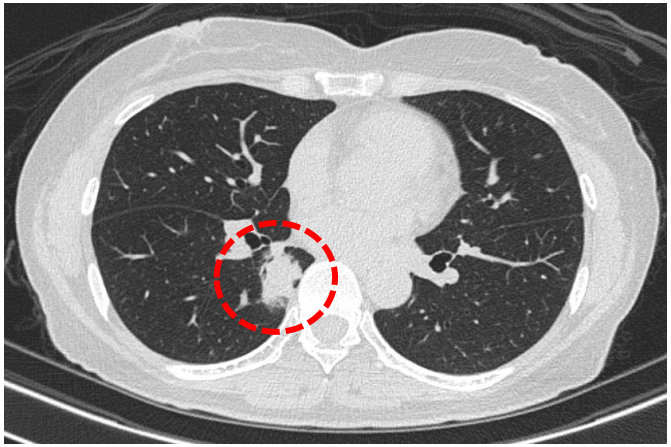
- Group A: R-EBUS
- Group B: EBUS-GS
- Group C: EBUS-GS+Fluoroscopy
- Group D: VBN+EBUS-GS+Fluoroscopy

Group	Number of patients enrolled	Number of patients with definitive diagnosis	Diagnostic yield (%)
Group A	26	16	62
Group B	45	34	76
Group C	11	9	82
Group D	12	11	92

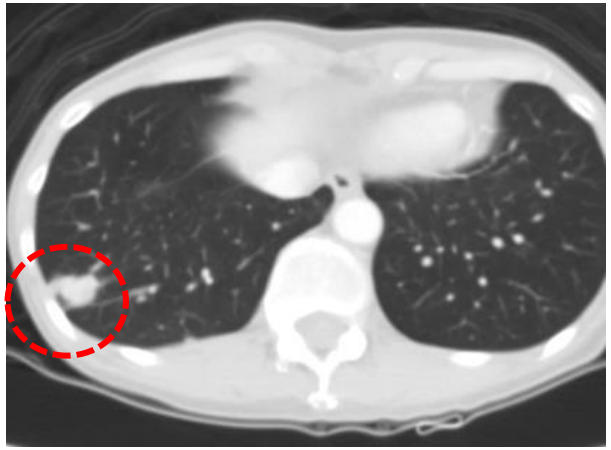
Huang Haidong et al. J Cancer. 2017;8:3514-3521.

Peripheral Pulmonary Lesions

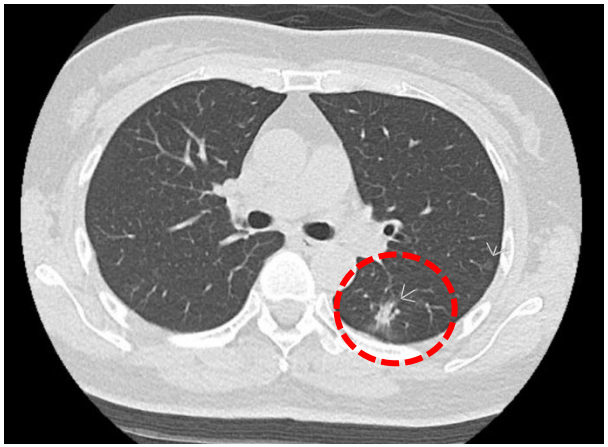
Case 1



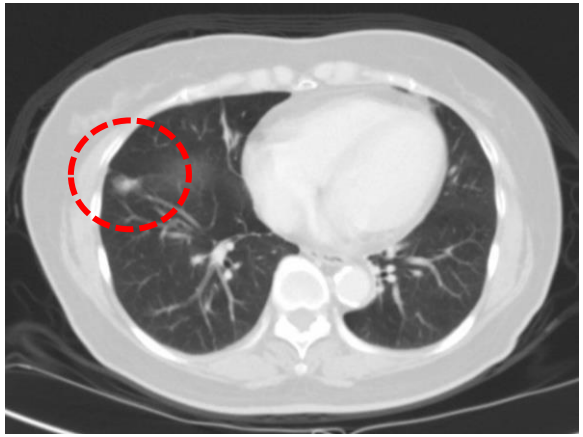
Case 2



Case 3



Case 4



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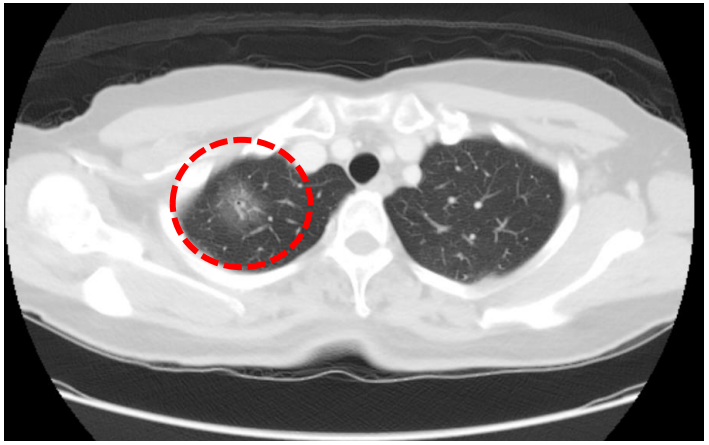
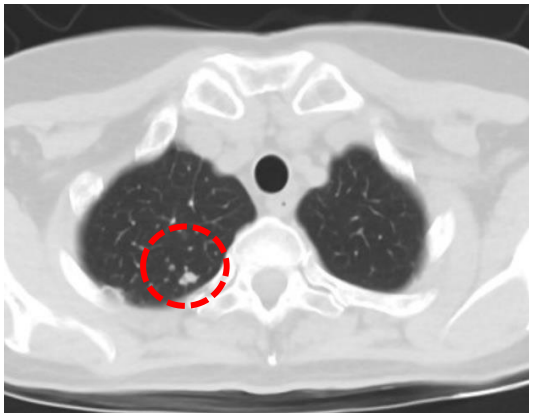


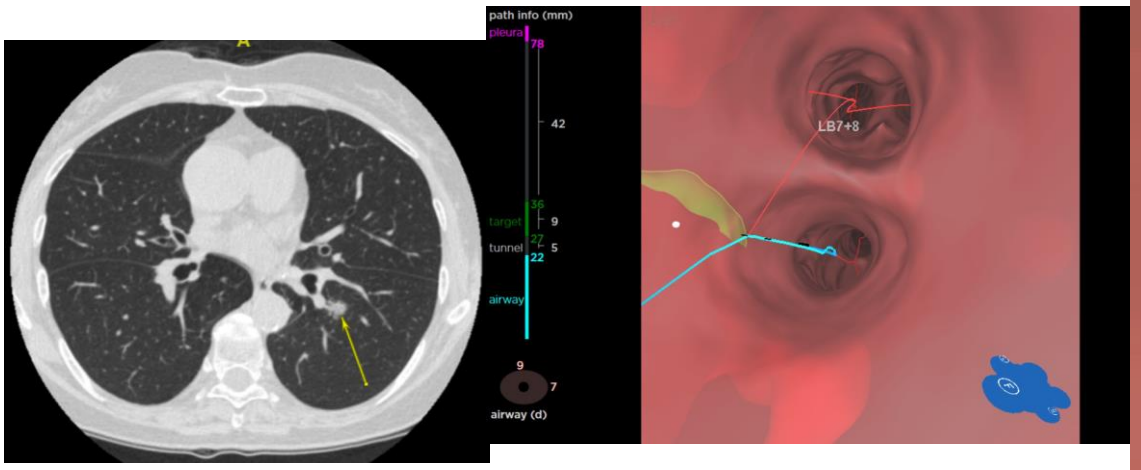
Case 6

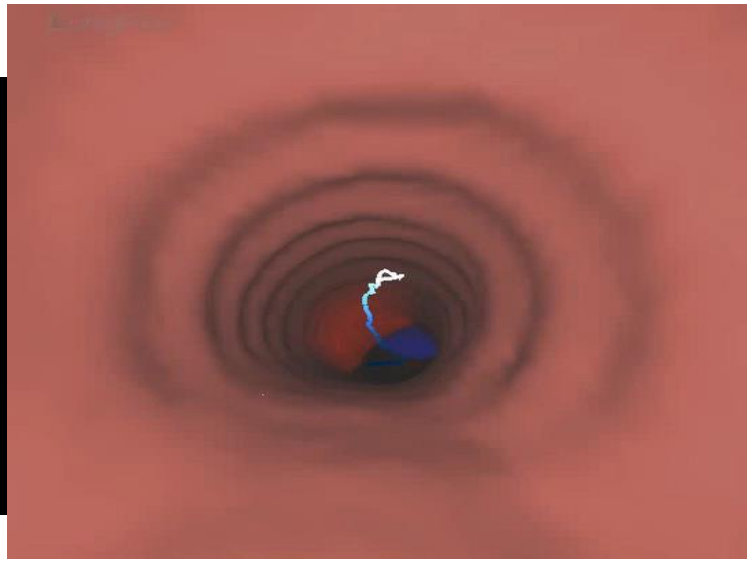


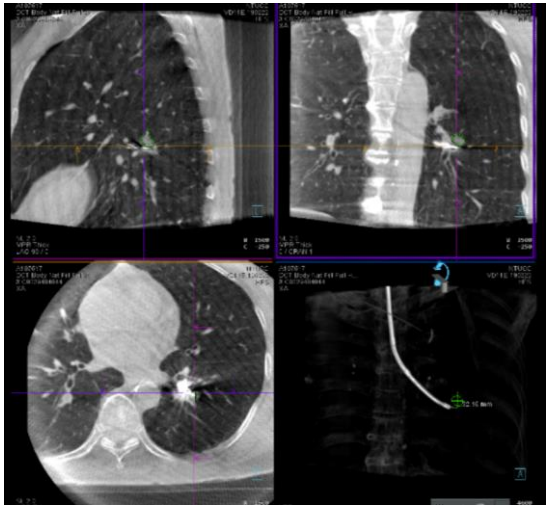
From NTUCC

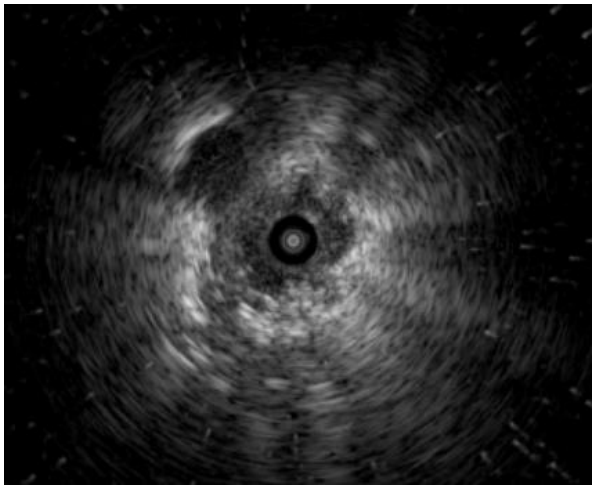
EBUS + BTPNA + CBCT + TBC + ROSE

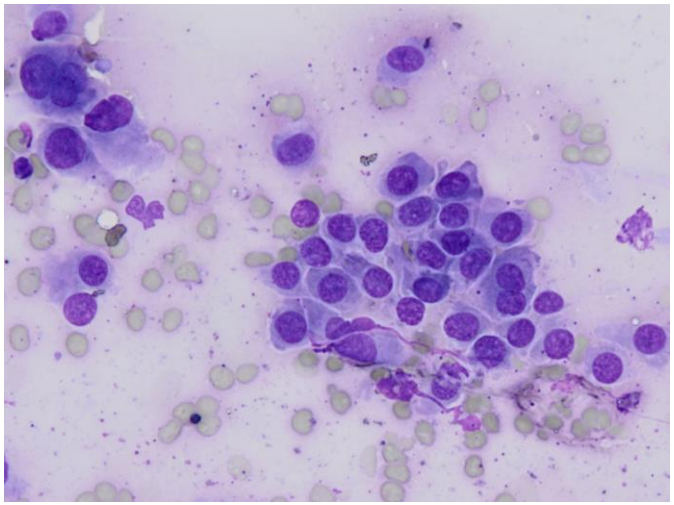
66F







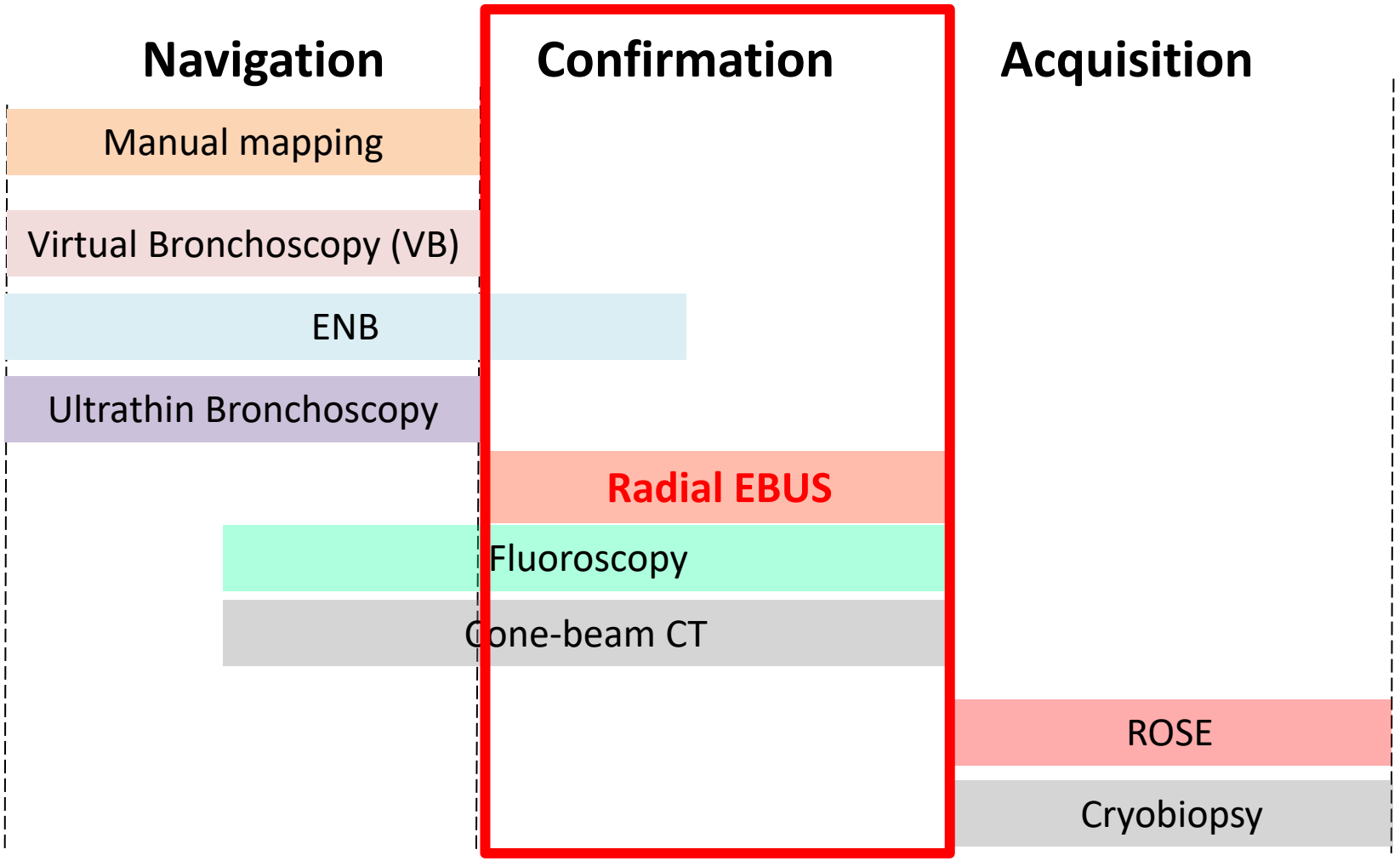




Lung adenocarcinoma

From NTUCC

How interventional pulmonologist think?



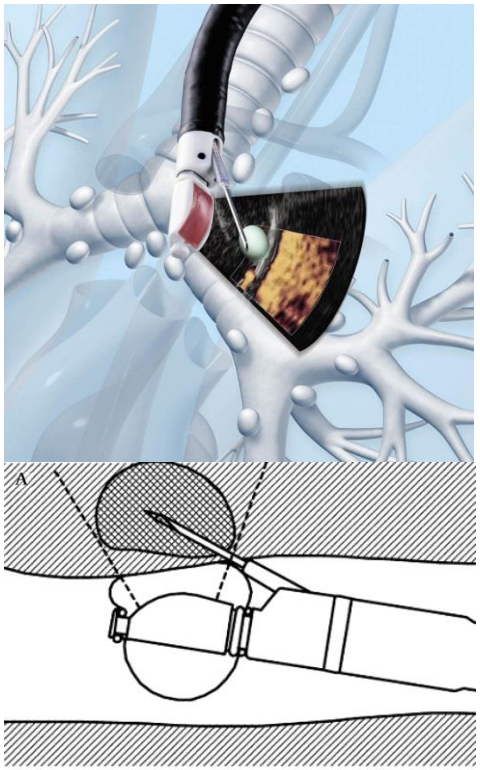
Roberto F. Casal. J Bronchol Intervent Pulmonol Volume 25, Number 4, October 2018

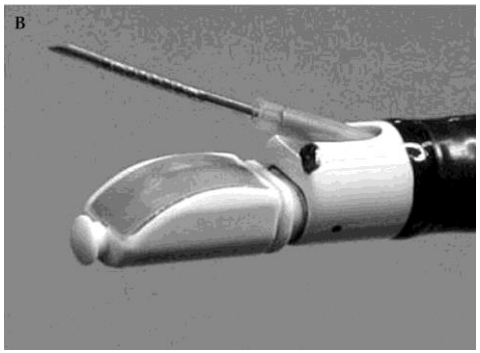
Outline

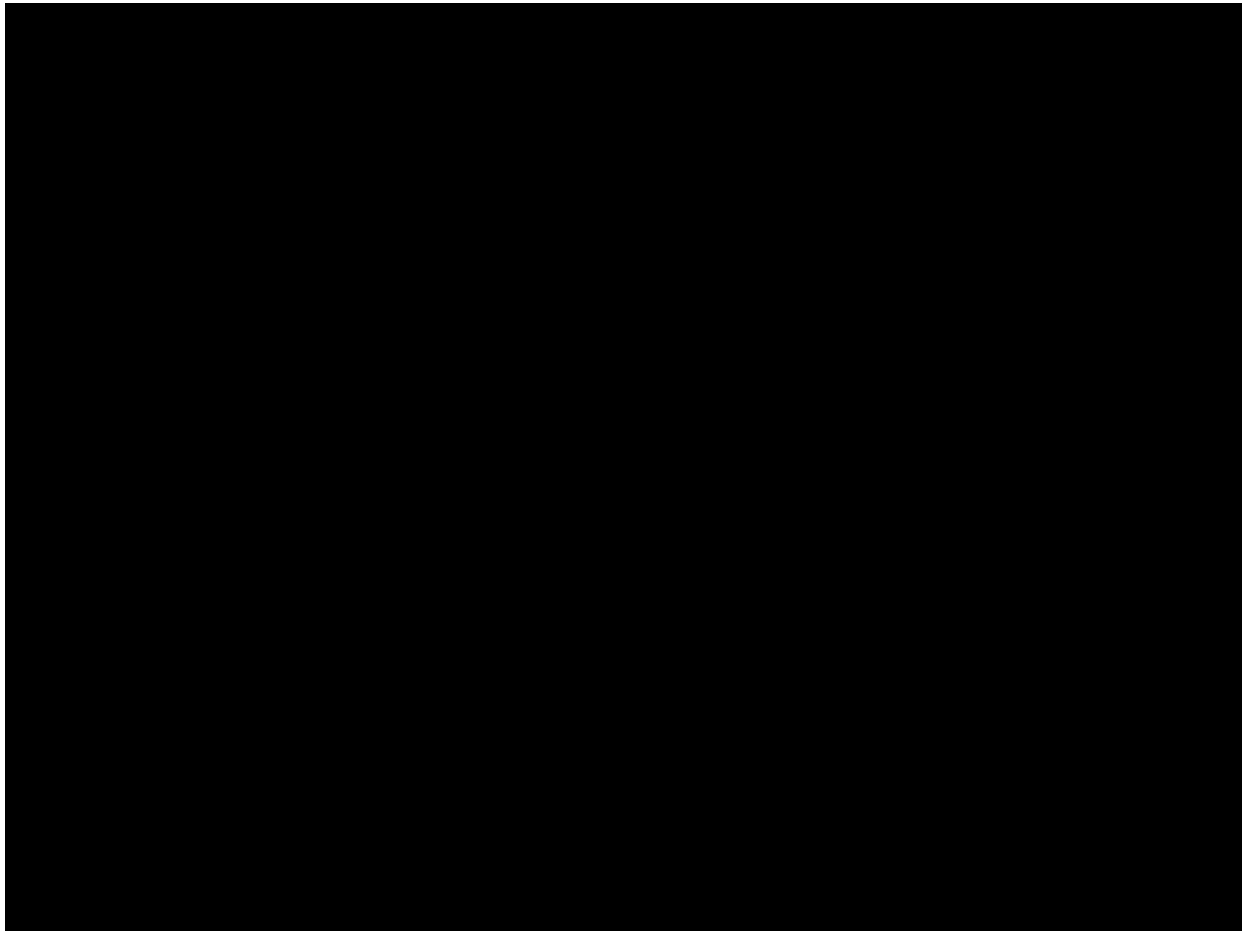
- Introduction of bronchoscopy

- Introduction of endobronchial ultrasound (EBUS)
  - Radial-probe endobronchial ultrasound (RP-EBUS)
  - Covex-probe endobronchial ultrasound (CP-EBUS)

Endobronchial Ultrasound-Guided Transbronchial Needle Aspiration (EBUS-TBNA)







From 台大新竹分院

EBUS elastography

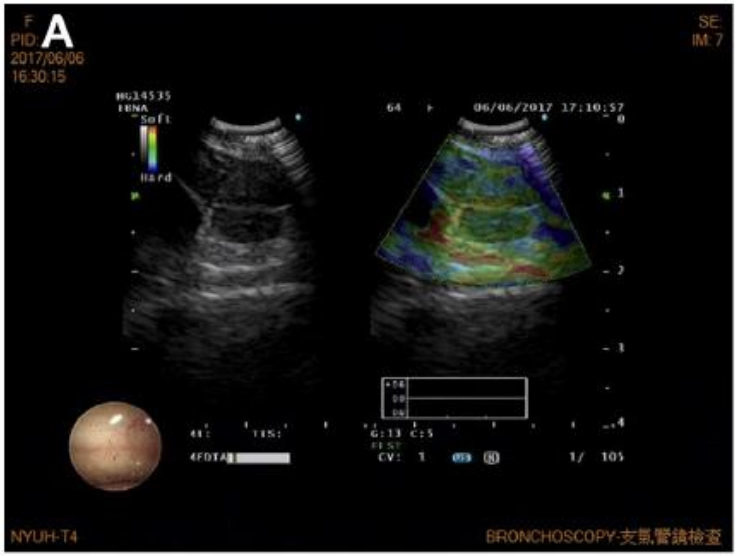
- **Backgrounds:**
- The imaging equivalent of the "palpation"
- An objective determination of hardness between normal and diseased tissues

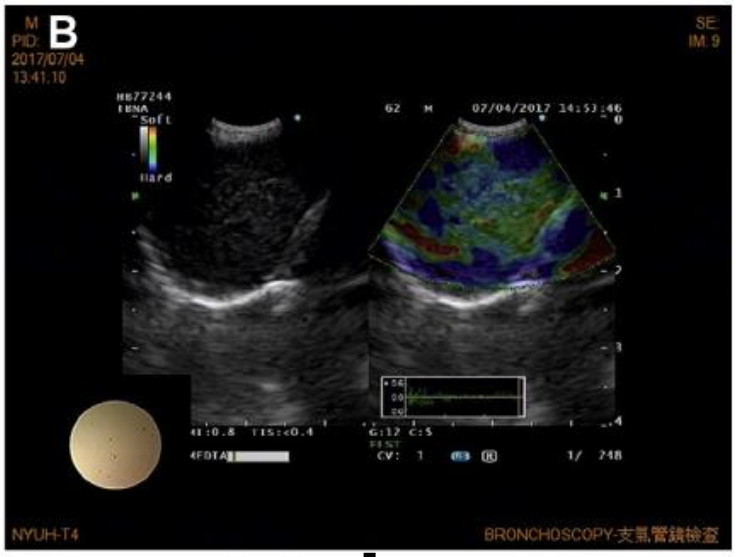
Christoph F. et al. Endosc Ultrasound 2015;4:176-90.

From 台大新竹分院

Differentiating malignant and benign LNs using EBUS elastography

Methods:





Type I: non-blue

Benign process

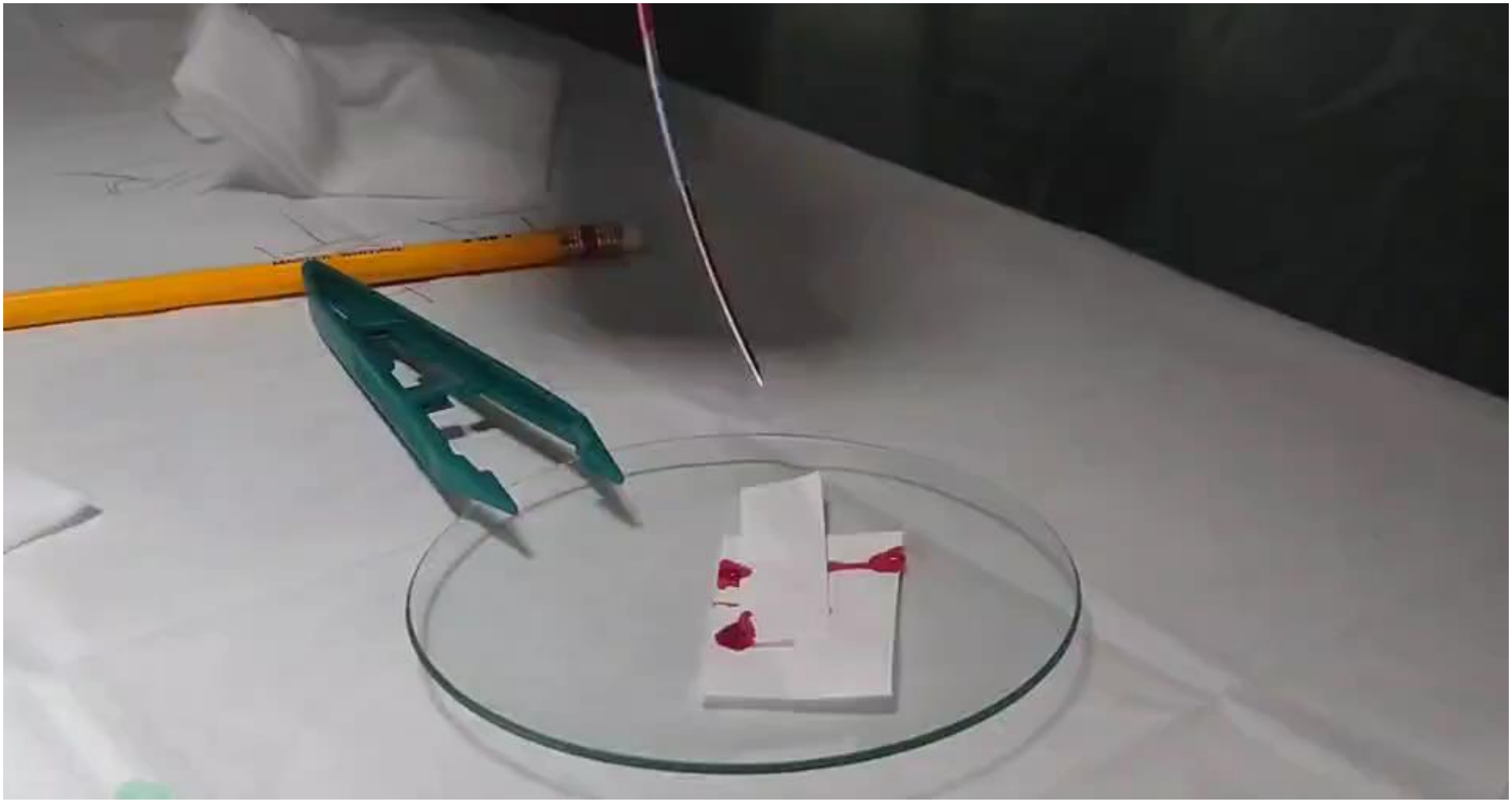
Type II: Part blue, part non-blue

Type III: blue

Malignancy

Lin et al. J Formos Assoc. 2019 Jan;118(1 Pt 3):436-443.

19G TBNA Needle



From 台大癌醫

Lymph Node Staging in Lung Cancer

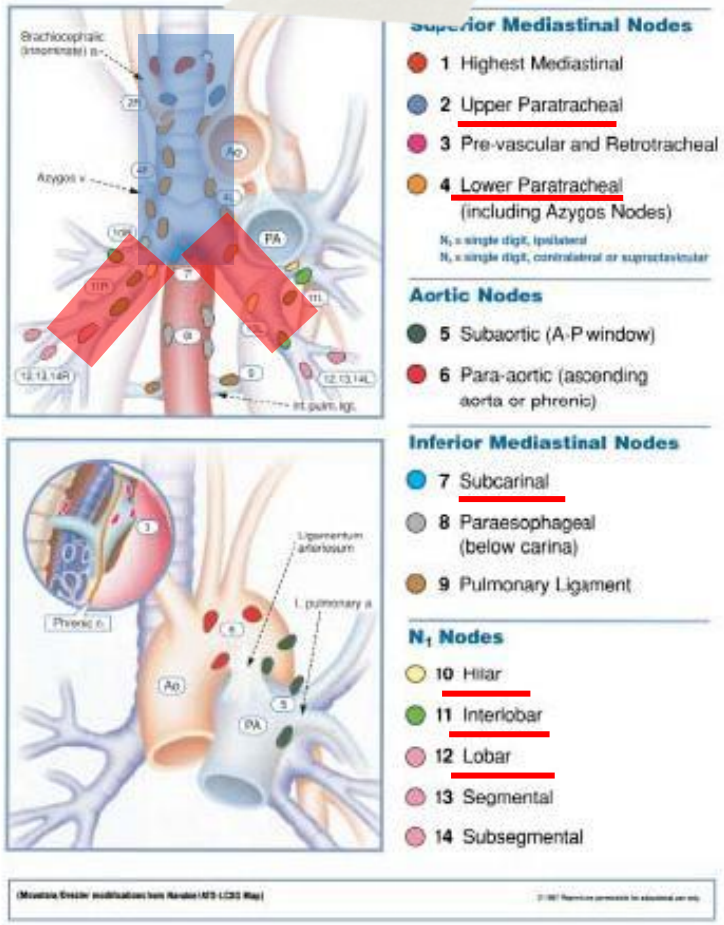


TABLE 1. Comparison of Invasive Staging Modalities of the Mediastinum

Method	Accessible Nodal Stations
Standard mediastinoscopy	Superior mediastinal, subcarinal
VATS	Superior mediastinal (right), subcarinal, aortic nodes
TBNA	Superior mediastinal, subcarinal, N1 nodes
Conventional	
Radial EBUS guided	
CT guided	
EBUS-TBNA	
EUS-FNA	Subaortic, inferior mediastinal, subcarinal

EBUS, endobronchial ultrasonography; EUS-FNA, endoscopic ultrasonography–guided fine-needle aspiration; EBUS-TBNA, endobronchial ultrasonography–guided transbronchial needle aspiration; TBNA, transbronchial needle aspiration; VATS, video-assisted thoracoscopic surgery.

Yasufuku et al. J Thorac Oncol 2007;2

Diagnosis and Management of Lung Cancer, 3rd ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines

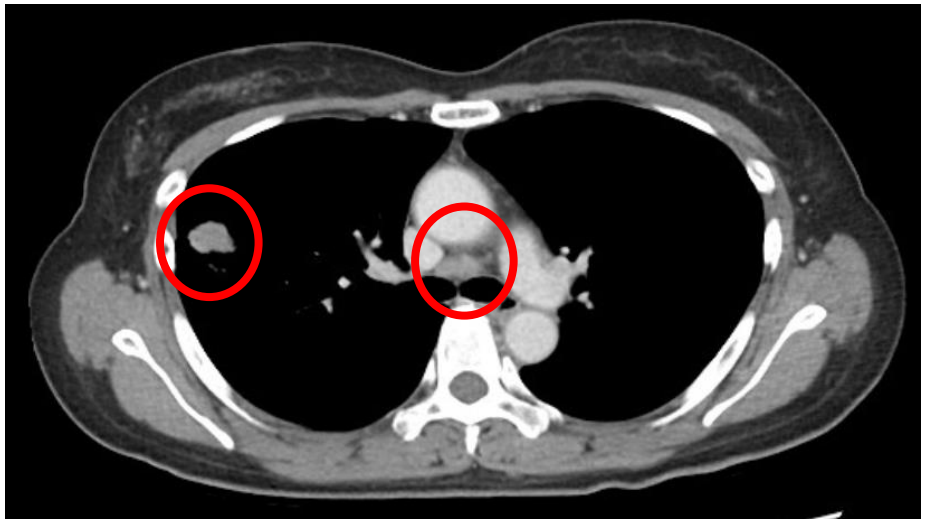
	Sensitivity	Specificity
CT	55%	81%
PET	77%	86%
EBUS	**89%**	**~100%**
EUS	89%	~100%
EBUS/EUS	91%	~100%

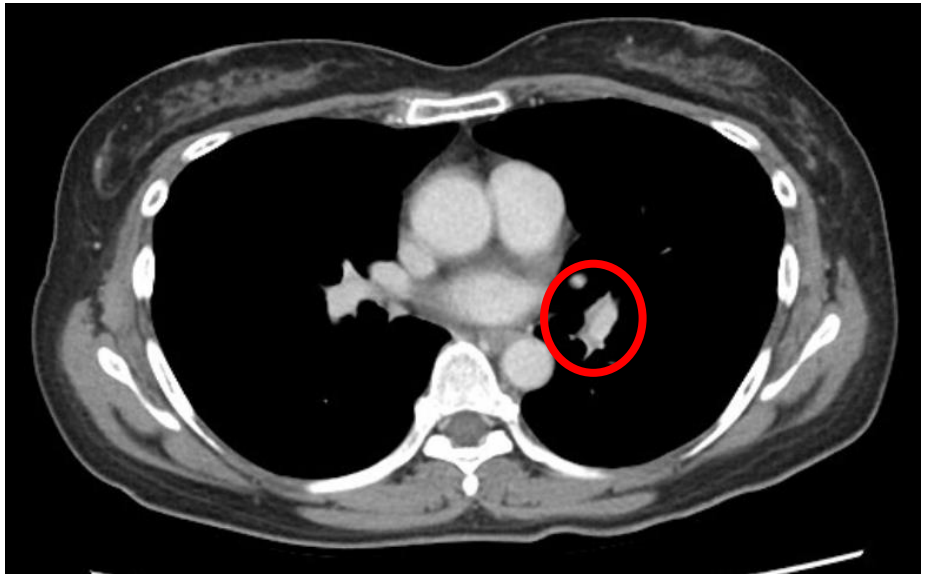
CT scanning has limited ability either to rule in or exclude mediastinal metastasis. PET scanning is more accurate than CT scanning, but tissue biopsy is still required to confirm PET scan findings. In direct comparison with surgical staging, **needle techniques have emerged as the best first diagnostic tools to obtain tissue**. Based on randomized controlled trials, PET or PET-CT scanning is recommended for staging and to detect unsuspected metastatic disease and avoid noncurative resections

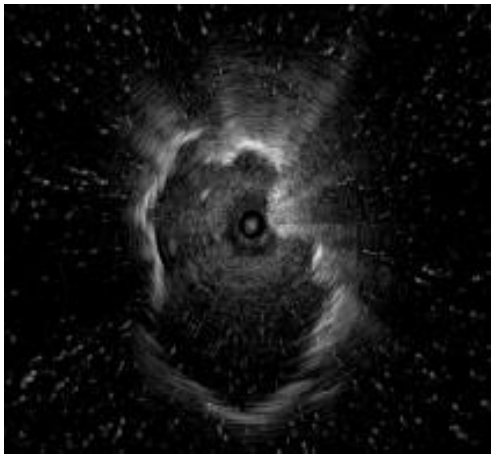
Silvestri GA, et al. CHEST 2013;143:e211S–e250S

Case Sharing

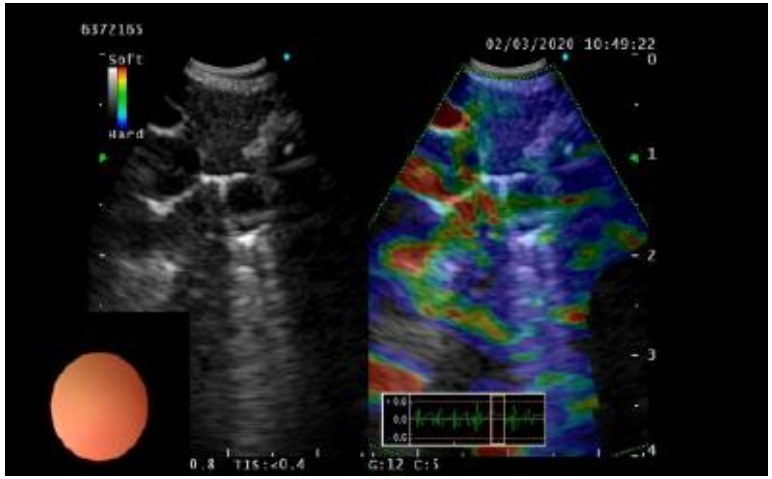
- 50F







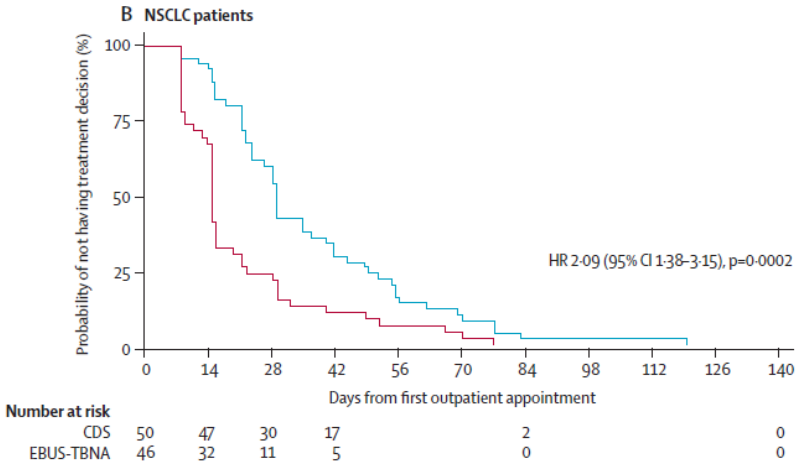
RB3a: adenocarcinoma with sarcomatoid change
Gr4R LN: adenocarcinoma, metastatic

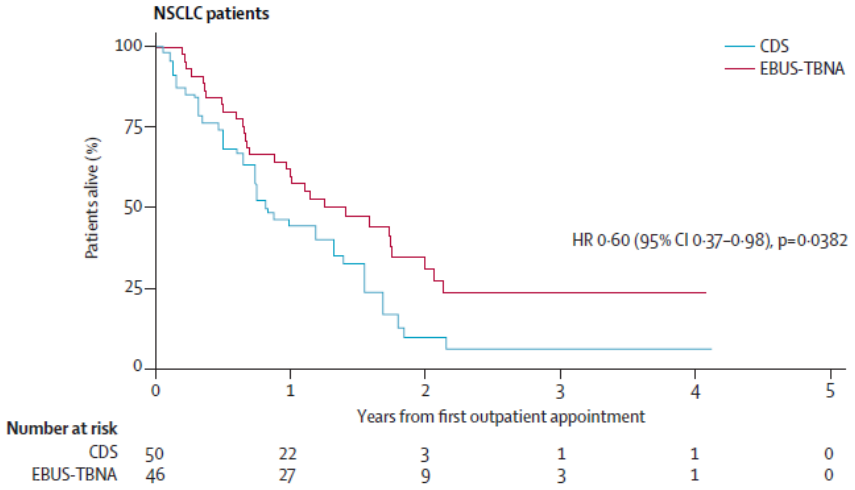


Gr11Li LN: adenocarcinoma, metastatic (**N3 (+)**)

From 台大癌醫中心醫院

EBUS-TBNA as an initial investigation technique for suspected lung cancer patients





	Conventional diagnosis and staging (n=66)	Endobronchial ultrasound-guided transbronchial needle aspiration (n=66)	p value
Investigations per patient	2·39 (0·78)	1·70 (0·72)	<0·0001
Patients diagnosed and staged with one investigation	8 (12%)	30 (45%)	<0·0001
Avoidable thoracotomies at 1 year	13 (76%)	5 (29%)	0·035

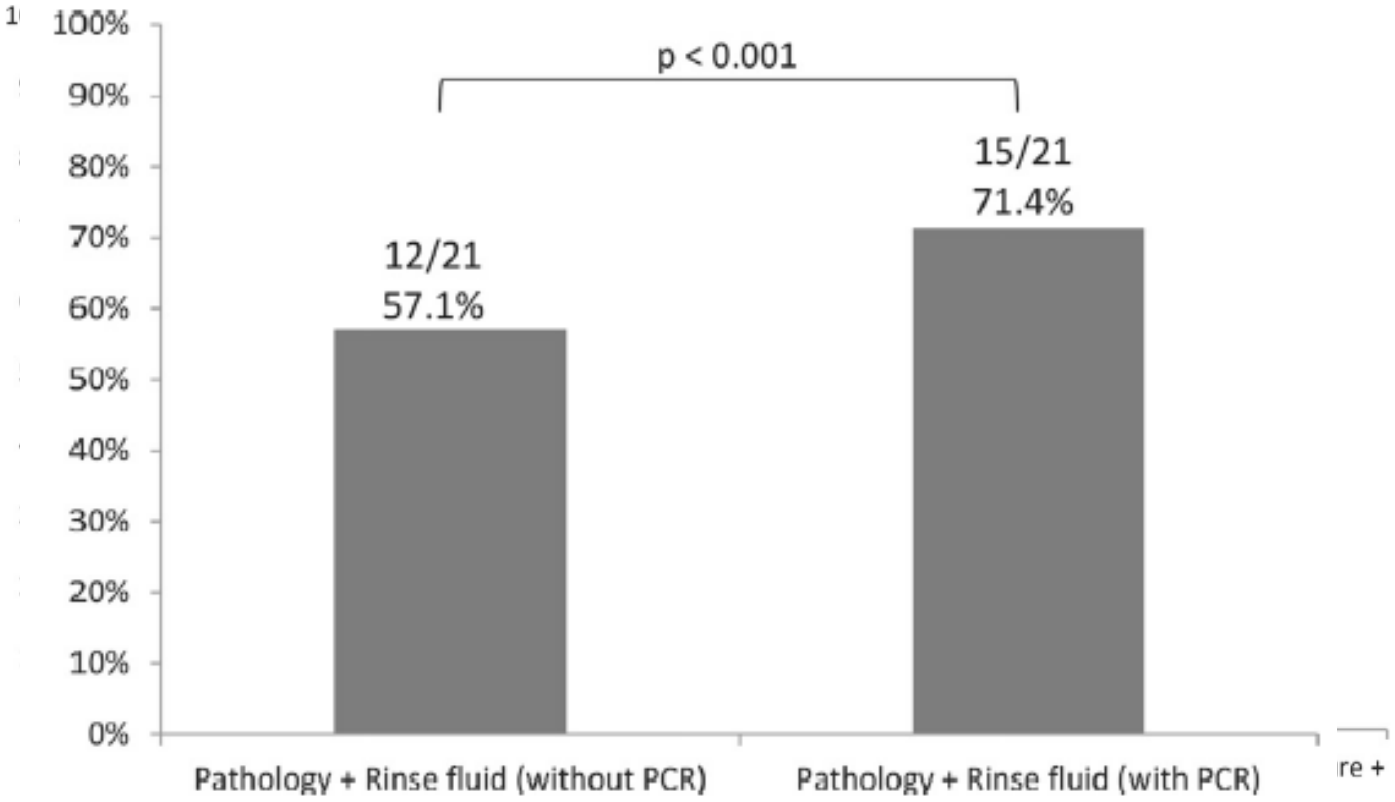
Data are mean (SD) or n (%).

Table 3: **Secondary outcomes**

Neal Navani, et al. Lancet Respir Med 2015; 3: 282–89

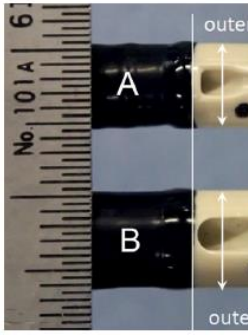
Diagnosis of mediastinal TB lymphadenitis using EBUS-TBNA with rinse fluid PCR

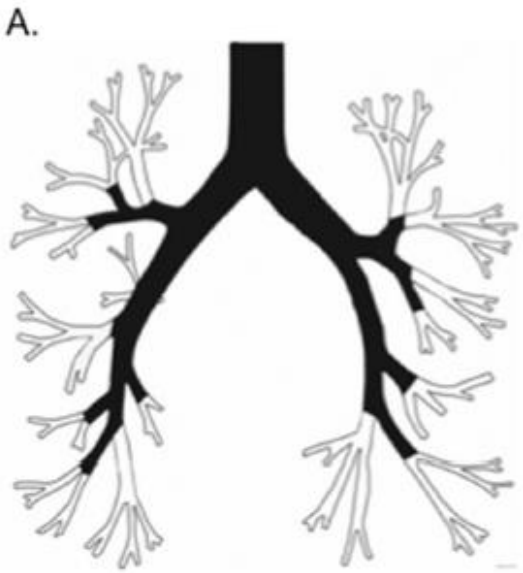
- **Methods:** 2010.04 ~ 2017.07, 21 patients with final diagnosis of TB lymphadenitis (excluding 219 patients)
- **Results:**

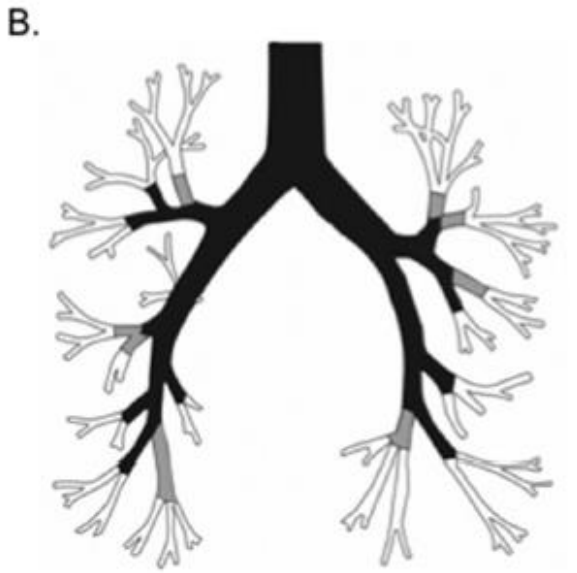


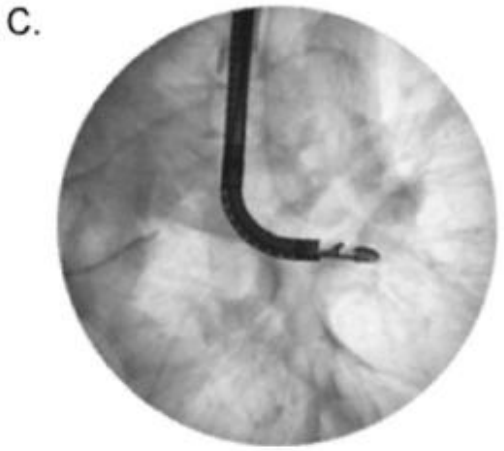
Lin et al. J Formos Assoc. 2019 Jul 31. pii: S0929-6646(18)30856-8.

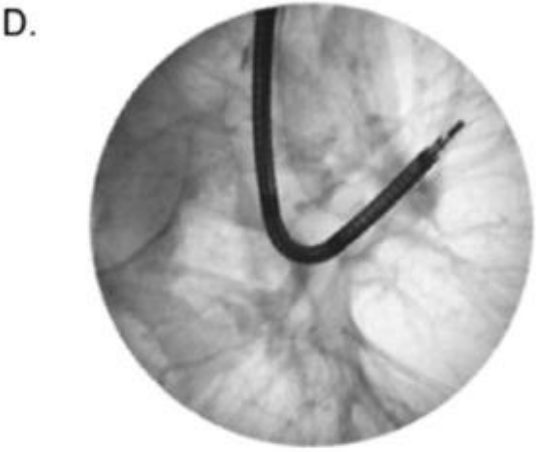
Thin Convex Probe Endobronchial Ultrasound Scope (TCP-EBUS)











rection of view
20°
35°

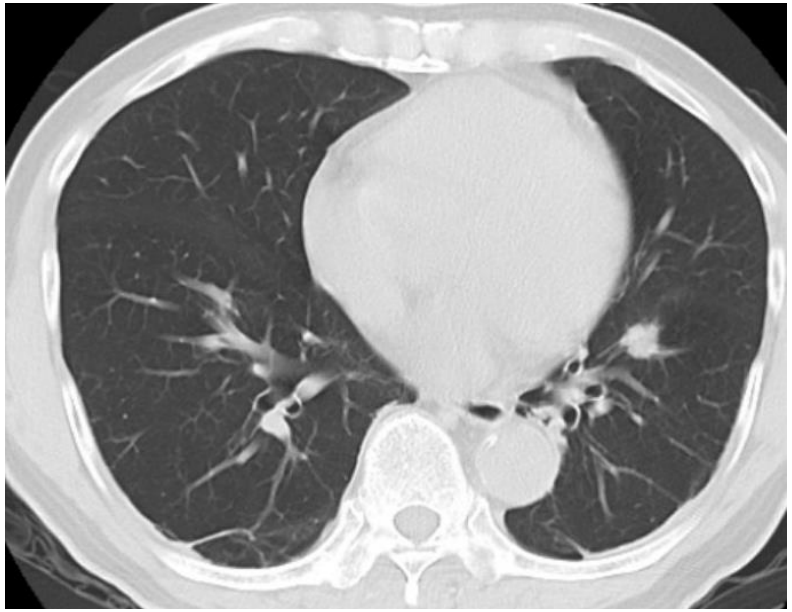
Number Assessed	
-EBUS	CP-EBUS
2	0
4	1
3	0
4	1
4	2
4	4
4	3
4	4
± 0.74	1.87 ± 1.64
	<0.05

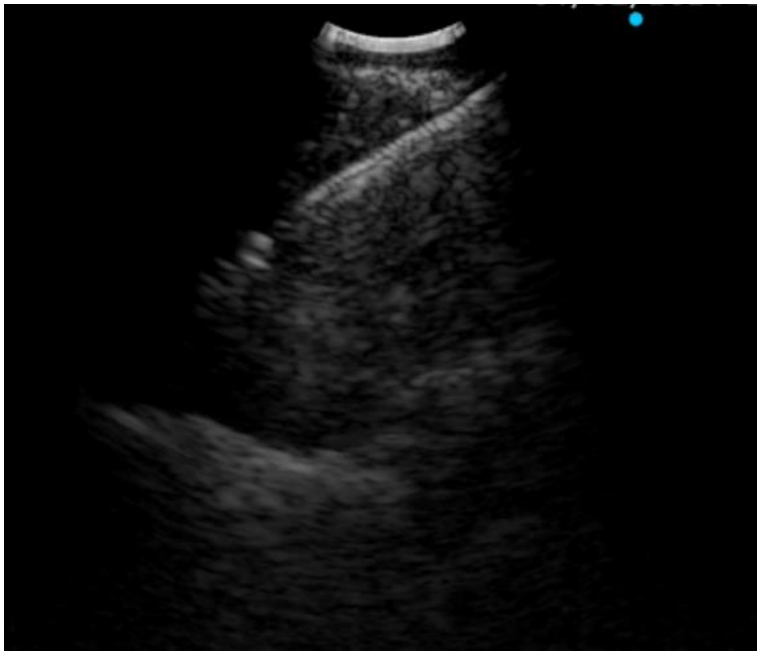
';103:1158–64

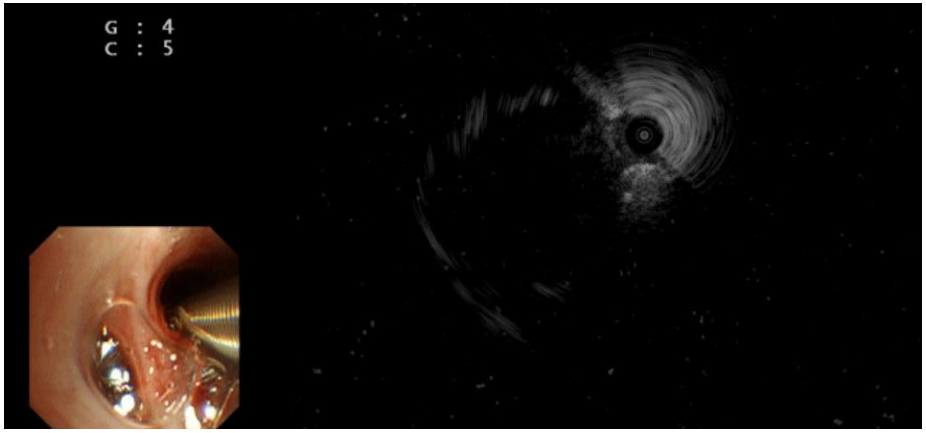
l 2015;22:20–27

Case Sharing (peripheral pulmonary lesion)

- 69M







Pathology: (LB8a lesion)

c-TBNA: no evidence of malignancy

EBUS-TBNA: adenocarcinoma, TTF1(+)

From 台大癌醫中心醫院

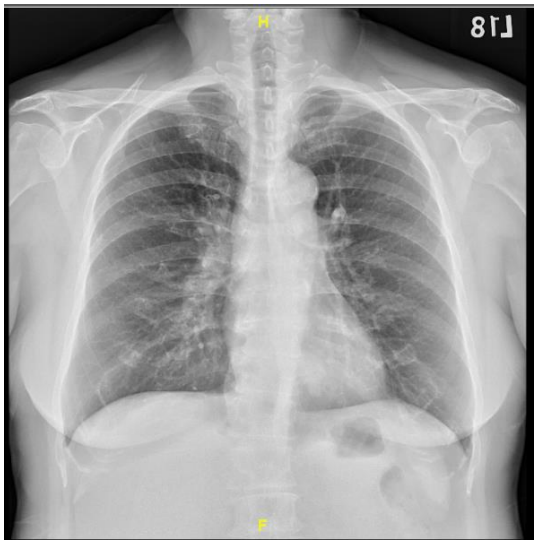
The clinical application of EBUS-TBNA

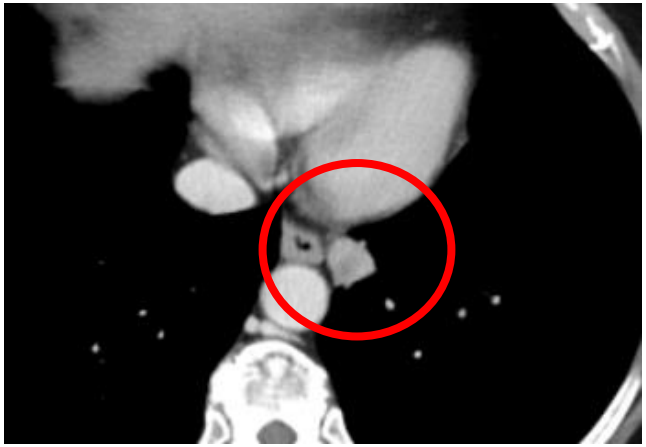
- Evaluation of hilar/mediastinal lymph node in patients with primary lung cancer
  - Preoperative LN staging
  - Postoperative LN staging
  - Restaging of the mediastinum post chemotherapy
- Evaluation of hilar/mediastinal LN in metastatic lung tumor
- Diagnosis of hilar/mediastinal lymphadenopathy of unknown etiology
- Diagnosis of mediastinal tumors
- Diagnosis of intrapulmonary tumors

Yasufiuku, Nakajima. Endobronchial Ultrasound guided Transbronchial Needle Aspiration Manual

Endoscopic ultrasound bronchoscope-guided fine needle aspiration (EUS-B-FNA)

- 64F





EUS-B-FNA: adenocarcinoma

From 台大癌醫

How to get more tissue? (EBUS-TBNA)

22G ViziShot
21G ViziShot

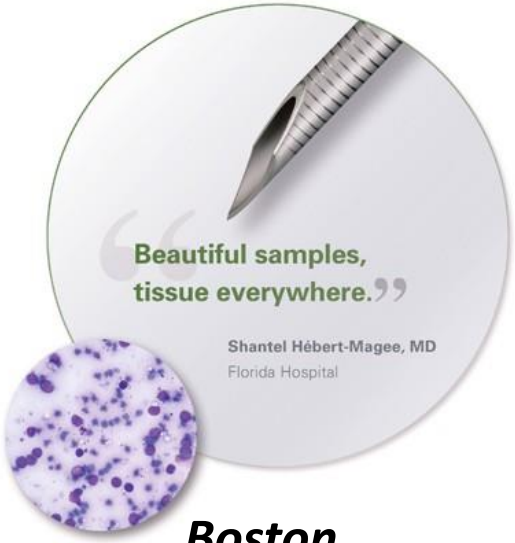
From 台大新竹分院

Different TBNA Needle

Medi-Globe

SonoTip® EBUS Pro Flex

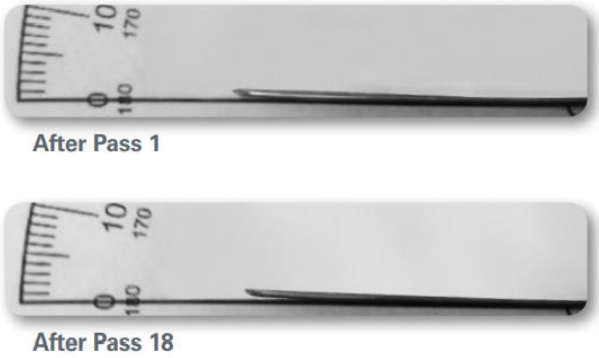
22G



Boston

Expect Pulmonary 22Ga

Expect Pulmonary 25Ga



Olympus

ViziShot 2

COOK

ECHO-HD-22-EBUS-O

ECHO-HD-25-EBUS-O

Different Biopsy Needle

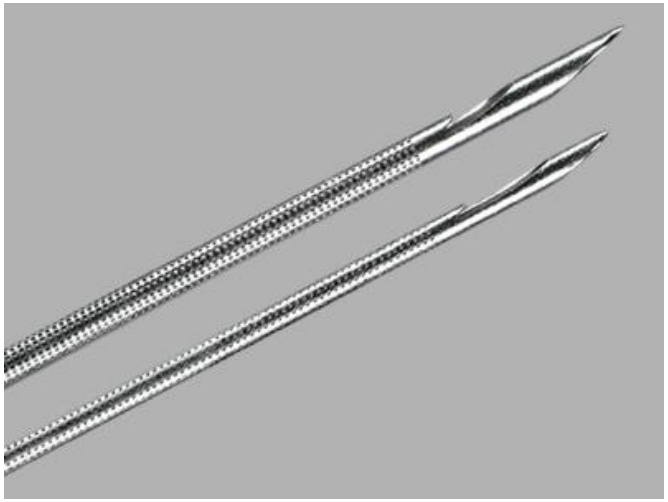
Medi-Globe

GUB-45-18-022

GUB-46-18-022

Boston

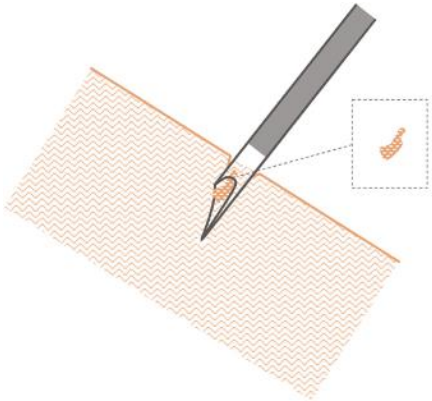
Franseen fine needle biopsy tool

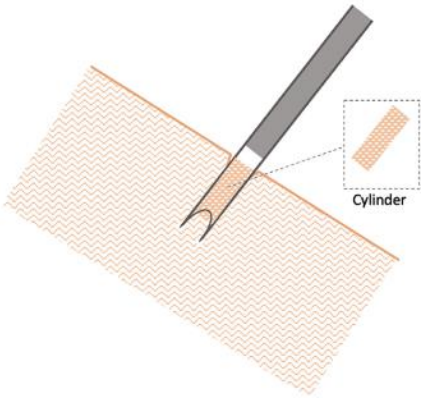


COOK

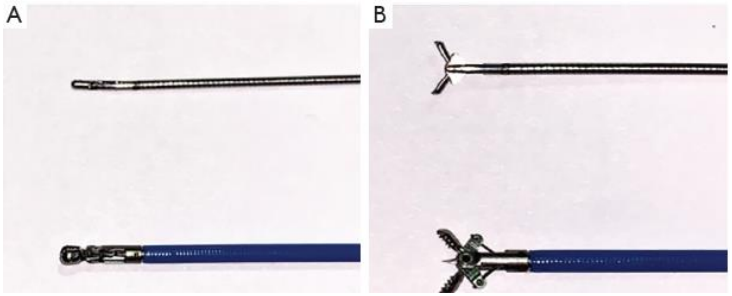
ECHO-HD-22-EBUS-O-C

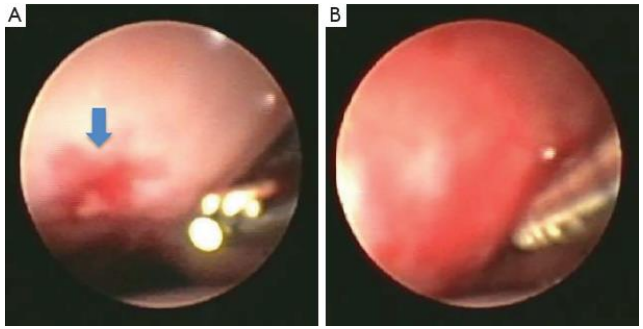
ECHO-HD-25-EBUS-O-C





EBUS-Miniforceps Biopsy (EBUS-MFB)

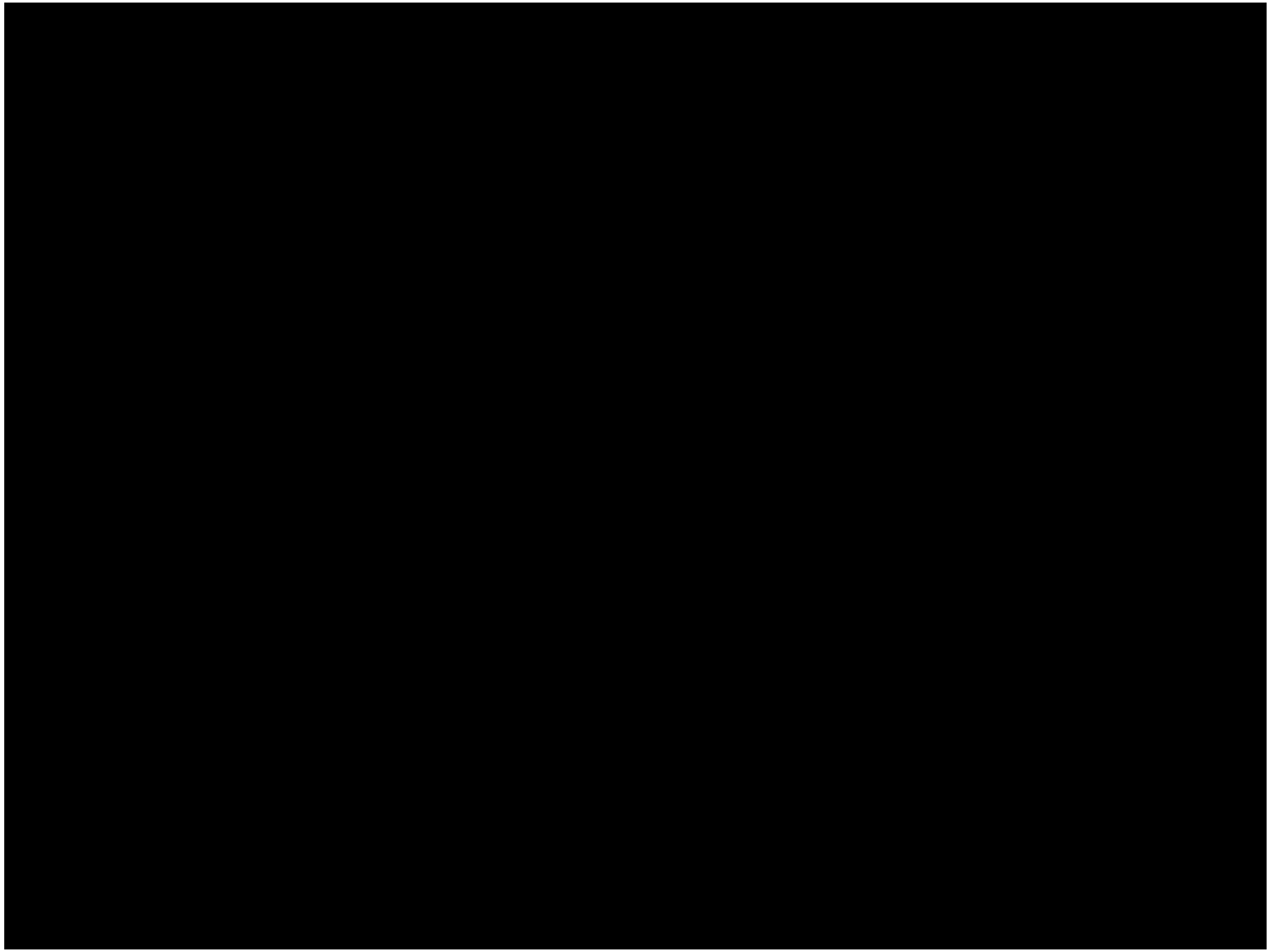




	EBUS-TBNA (%)	EBUS-MFB (%)	*p* Value MFB vs TBNA	Combined (%)	*p* Value Combined vs TBNA
Overall Yield	60/74 (81)	67/74 (91)	0.09	72/74 (97)	<0.001
Nonmalignant disease	43/49 (88)	43/49 (88)	ND[a]	48/49 (98)	0.025
Granulomatous disease	29/33 (88)	29/33 (88)		33/33 (100)	
Other nonmalignant	14/16 (88)	14/16 (88)		15/16 (94)	
Malignant disease	17/25 (68)	24/25 (96)	0.008	24/25 (96)	NP[b]
Non-small cell lung carcinoma	4/5 (80)	5/5 (100)		5/5 (100)	
Small cell lung carcinoma	6/8 (75)	8/8 (100)		8/8 (100)	
Breast carcinoma	4/4 (100)	4/4 (100)		4/4 (100)	
Renal cell carcinoma	1/1 (100)	1/1 (100)		1/1 (100)	
Sarcoma	0/1 (0)	0/1 (0)		0/1 (0)	
Lymphoma	0/4 (0)	4/4 (100)		4/4 (100)	
Other malignant	2/2 (100)	2/2 (100)		2/2 (100)	

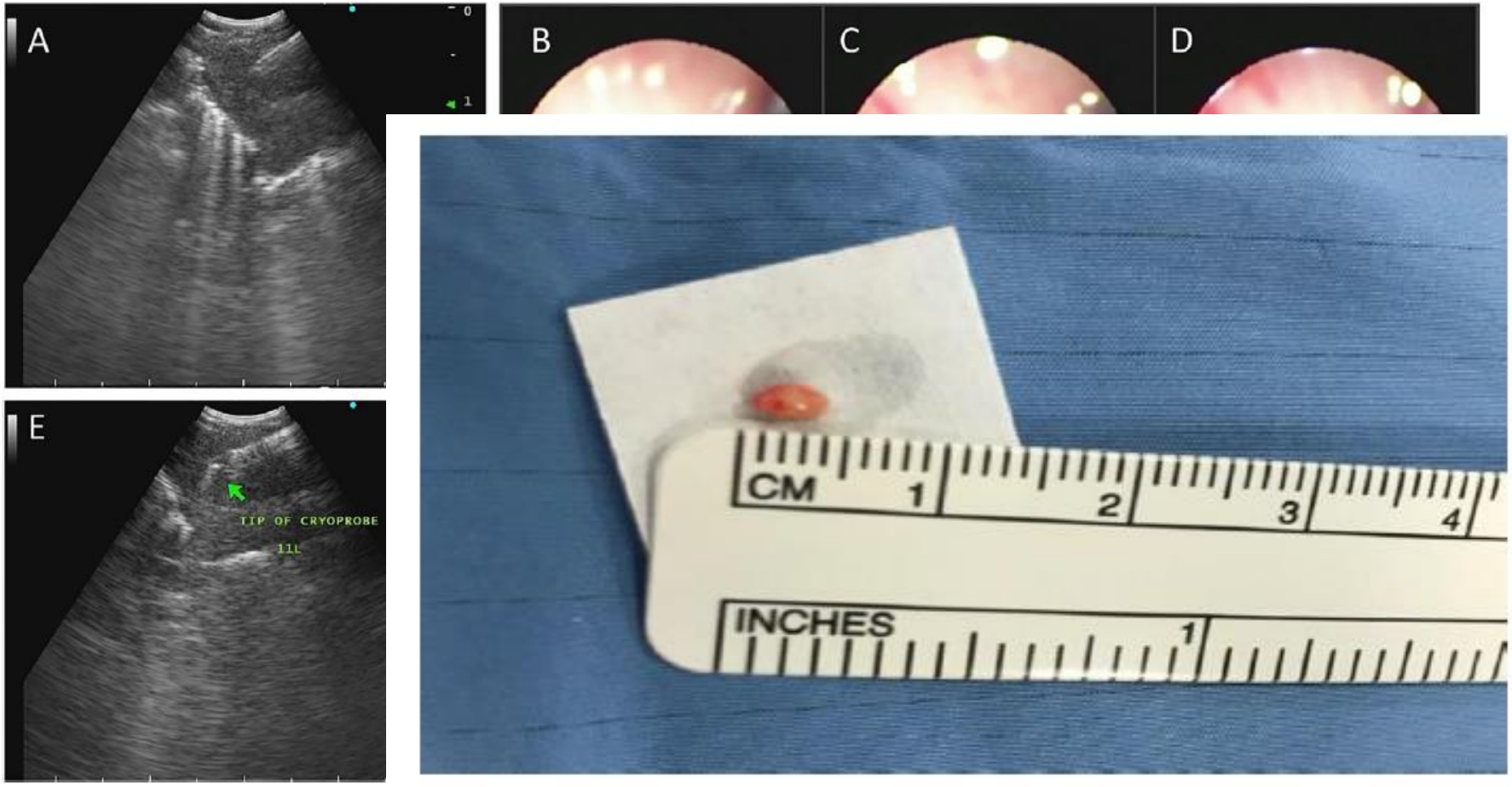
Ara Chrissian et al. Ann Thorac Surg 2011;92:284–9

EBUS - Intranodal Forceps Biopsy (IFB)



From 台大癌醫中心醫院

Transbronchial mediastinal cryobiopsy



Carlo Genova et al. BMC Pulmonary Medicine (2022) 22:5

Hari Kishan Gonuguntla et al. Respirology Case Reports, 9 (8), 2021, e00808

Summary

- Bronchoscopy is an important diagnostic and therapeutic tool for lung lesions

- EBUS can guide and confirm the location of lung lesion
  - RP-EBUS for peripheral pulmonary lesions
  - CP-EBUS for mediastinal and hilar lesions


Thanks for your attention !!

Diagnostic Yield of EBUS-TBNA vs. Mediastinoscopy

	Lymph node size in mm mean ± SD (range)	EBUS yield (%)	Mediastinoscopy yield (%)	P
All lymph nodes	15 ± 2.6 (10–21)	109/120 (91)	94/120 (78)	.007
Lymph node station				
2 all	16 ± 3.1 (10–21)	24/25 (96)	22/25 (88)	.30
2 right	18 ± 1.6 (14–20)	12/13 (92)	11/13 (85)	.99
2 left	14 ± 3.6 (10–21)	12/12 (100)	11/12 (92)	.99
4 all	15 ± 2.6 (10–19)	45/54 (83)	40/54 (74)	.24
4 right	15 ± 2.6 (10–19)	29/34 (85)	24/34 (71)	.14
4 left	15 ± 2.6 (10–19)	29/34 (85)	16/20 (80)	.99
7	15 ± 2.4 (10–19)	40/41 (98)	32/41 (78)	.007

Ernst A, et al. J Thorac Oncol 2008; 3:577–582