



2019 台灣胸腔暨重症加護醫學會

2019 Taiwan Society of Pulmonary and Critical Care Medicine



# Cone beam CT-derived augmented fluoroscopy (CBCT-AF) combined with endobronchial ultrasonography-guide sheath (EBUS-GS) for biopsy of peripheral lung lesions

台大新竹分院 胸腔內科

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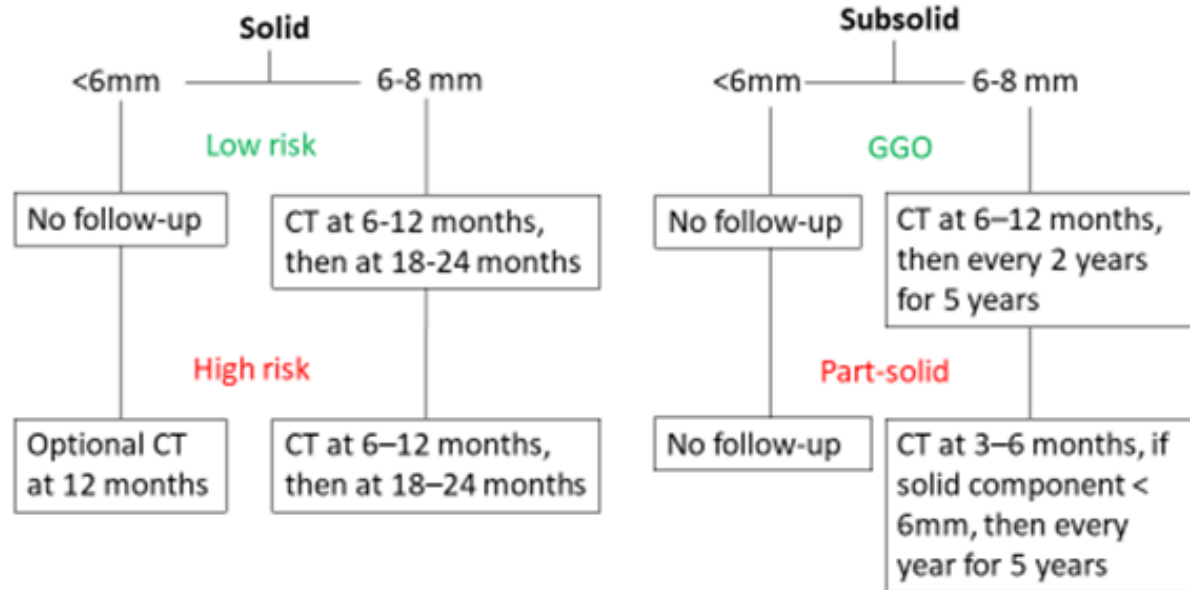
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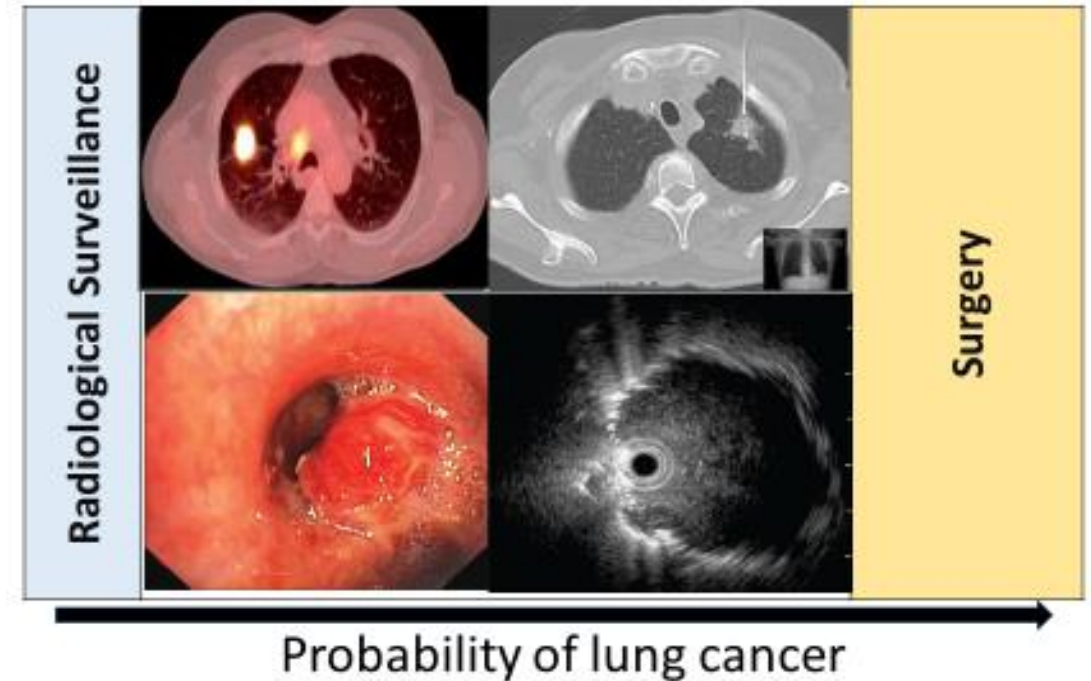


# Management of lung nodule

≤ 8mm



>8mm



# What is the CT-guided Biopsy Data?

Geraghty et al <sup>166</sup> /2003	846	C	CT scan	0.91	0.99	0	0.19	0.74
Yamagami et al <sup>167</sup> /2003	110	C	CT scan	0.95	1	0	0.15	0.78
Arslan et al <sup>168</sup> /2002	121	A	CT scan	0.89	1	0	0.27	0.78
Tan et al <sup>169</sup> /2002	100	A	Fluo, CT scan	0.93	0.96	0.01	0.18	0.76
Wallace et al <sup>170</sup> /2002	57	A, C	CT scan	0.82	1	0	0.28	0.68
Lopez Hanninen et al <sup>114</sup> /2001	79	C	CT scan	0.96	1.00	0	0.06	0.63
Laurent et al <sup>115</sup> /2000	202	C	CT scan	0.94	1.00	0	0.18	0.80
Hirose et al <sup>116</sup> /2000	50	C	CT scan	0.83	1.00	0	0.19	0.58
Chen et al <sup>117</sup> /2000	185	C	CT scan	0.93	1.00	0	0.18	0.93

Pooled sensitivity for peripheral bronchogenic cancer: **90%** (CI 88 - 91%)

Sensitivity of CT-guided **92%** vs Fluoroscopic guided **88%**

False negative rate **20-30%**

Cattelan et al <sup>106</sup> /1997	118	A	CT scan	0.93	1.00	0	0.13	0.81
Li et al <sup>107</sup> /1996	97	A	CT scan	0.89	1.00	0	0.43	0.88
Klein et al <sup>108</sup> /1996	129	A, C	CT scan	0.95	1.00	0	0.08	0.64
Milman et al <sup>109</sup> /1995	103	A	Fluo	0.69	1.00	0	0.49	0.76
Böcking et al <sup>125</sup> /1995	371	A, C	CT scan	0.99	0.94	0.02	0.04	0.79
Zakowski et al <sup>110</sup> /1992	176	A	Fluo, CT scan	0.84	1.00	0	0.47	0.84
Yang et al <sup>111</sup> /1992	120	A	US	0.62	1.00	0.00	0.63	0.82
Cristallini et al <sup>112</sup> /1992	390	A, B	Fluo, CT scan	0.94	0.99	0.00	0.16	0.77
Calhoun et al <sup>113</sup> /1986	197	A	Fluo	0.87	1.00	0.00	0.35	0.81
Knudsen et al <sup>127</sup> /1996	128	A	US	0.95	0.95	0.02	0.09	0.68
Gasparini et al <sup>73</sup> /1999	589	A, C	Fluo, CT scan	0.93	0.99	0.00	0.15	0.72
Garcia Rio et al <sup>128</sup> /1994	84	A	CT scan	0.84	1.00	0.00	0.39	0.80

# What is the Bronchoscopy Data?

First Author	Year	No. of Patients <sup>a</sup>	Sensitivity (%)				
			All Methods	TB Biopsy	Brush	BAL	TBNA
Kawaraya <sup>128</sup>	2003	1372	88	77	57	-	35
Rennard <sup>119</sup>	1990	730	-	-	-	47	-
Gasparini <sup>110</sup>	1999	480	76	50	-	-	70
Oswald <sup>77</sup>	1971	435	-	28	-	-	-
Buccheri <sup>96</sup>	1991	337	-	75	44	33	-
Hattori <sup>76</sup>	1971	208	-	-	83	-	-
Lam <sup>102</sup>	1983	155	86	61	52	52	-
Pirozovski <sup>118</sup>	1992	145	-	33	30	65	58

Sensitivity					
Patient No.	All Methods	Biopsy	Brush	BAL	TBNA
5742	78%	57%	54%	43%	65%

Mori <sup>120</sup>	1989	85	84	-	84	42	-
Pilotti <sup>73</sup>	1982	84	-	-	29	-	-

most studies used fluoroscopy routinely for peripheral lesions

Aristuazabal <sup>97</sup>	1998	64	-	34	-	-	-
Mak <sup>98</sup>	1990	63	56	37	29	38	-
de Gracia <sup>116</sup>	1993	55	-	-	-	33	-
Trkanjec <sup>129</sup>	2003	50	86	62	16	29	-
Castella <sup>95</sup>	1995	45	-	-	-	-	69
Debeljak <sup>115</sup>	1994	39	-	77	59	36	-
Wongsurakiatl <sup>114</sup>	1998	30	50	17	-	47	-
Stringfield <sup>107</sup>	1977	29	-	48	-	-	-
Kvale <sup>108</sup>	1976	29	-	27	21	12	-
Sing <sup>70</sup>	1997	22	-	-	22	-	-
Cox <sup>101</sup>	1984	22	36	29	22	36	-
Gay <sup>99</sup>	1989	20	-	-	-	-	65
Summary		5,742	78	57	54	43	65

# What is the Bronchoscopy Data?

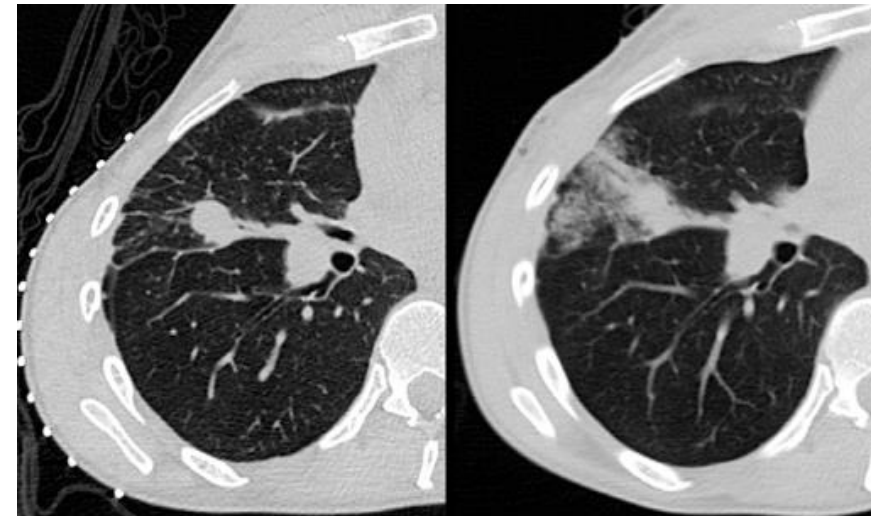
All Methods:		< 2 cm LESION				> 2 cm LESION			
First Author	Year	N	Pos	Neg	Sens	N	Pos	Neg	Sens
Gasparini <sup>110</sup>	1995	195	82	113	<b>42</b>	300	169	131	<b>56</b>
Hattori <sup>76</sup>	1971	17	13	4	<b>76</b>	182	150	32	<b>82</b>
Baaklini <sup>88</sup>	2000	16	4	12	<b>25</b>	135	93	42	<b>69</b>
Wallace <sup>122</sup>	1982	65	3	62	<b>5</b>	78	24	54	<b>31</b>
Bandoh <sup>130</sup>	2003	25	8	17	<b>32</b>	72	50	22	<b>69</b>
Radke <sup>106</sup>	1979	21	6	15	<b>29</b>	76	49	27	<b>64</b>
Naidich <sup>121</sup>	1988	15	4	11	<b>27</b>	46	26	20	<b>57</b>
Trkanjec <sup>129</sup>	2003	17	9	8	<b>53</b>	33	27	6	<b>82</b>
McDougall <sup>105</sup>	1981	9	1	8	<b>11</b>	36	21	15	<b>58</b>
Stringfield <sup>107</sup>	1977	3	1	2	<b>33</b>	26	13	13	<b>50</b>
<b>Summary</b>		<b>383</b>	<b>131</b>	<b>252</b>	<b>34</b>	<b>984</b>	<b>622</b>	<b>362</b>	<b>63</b>

Pooled sensitivity for peripheral lesions  
 <20mm **34%** vs > 20mm **63%**



# TTNA related Complications

- **Pneumothorax: 15-26.6%**
  - Chest tube insertion :1-14.2%
- **Pulmonary hemorrhage: 1-27%**
  - Hemoptysis <5%
- **Air embolism: 0.061%**
- **Tumor seeding: 0.012-0.061%**



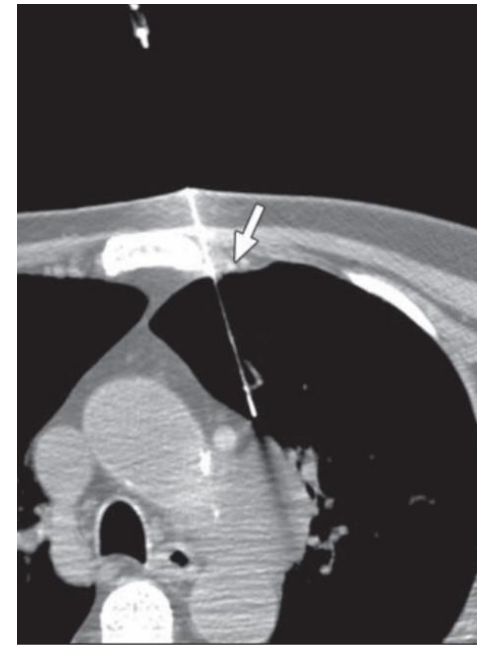
# Not All CT-guided Biopsy are Equal



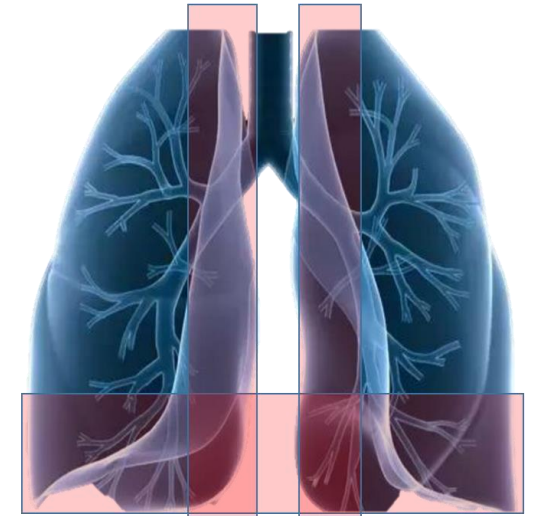
**Lesions on the diaphragm**



**Cavitary lesions**

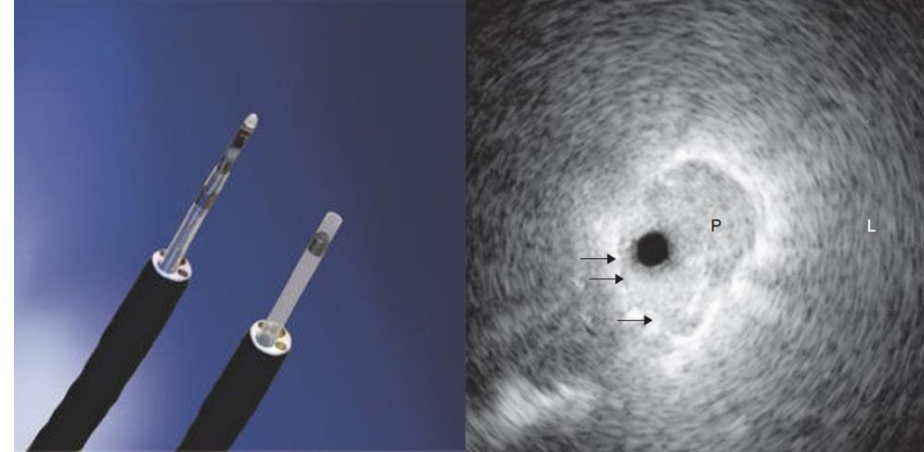


**Central lesions**



# EBUS Diagnostic Yield

## Meta-analysis Data



	Diagnostic Yield = <b>70.6%</b>	
Total number of lesions	N= 7258 (54 studies)	
Lesion size	≤ 20mm: 60.5%	>20mm:75.7%
Histology	Benign: 60.2%	Malignant 72.4%
Bronchus sign	Absent: 52.4%	Present: 72.6%
Complications	Pneumothorax/bleeds/pneumonia 2.8% Chest tube insertion(13/7258) 0.2%	



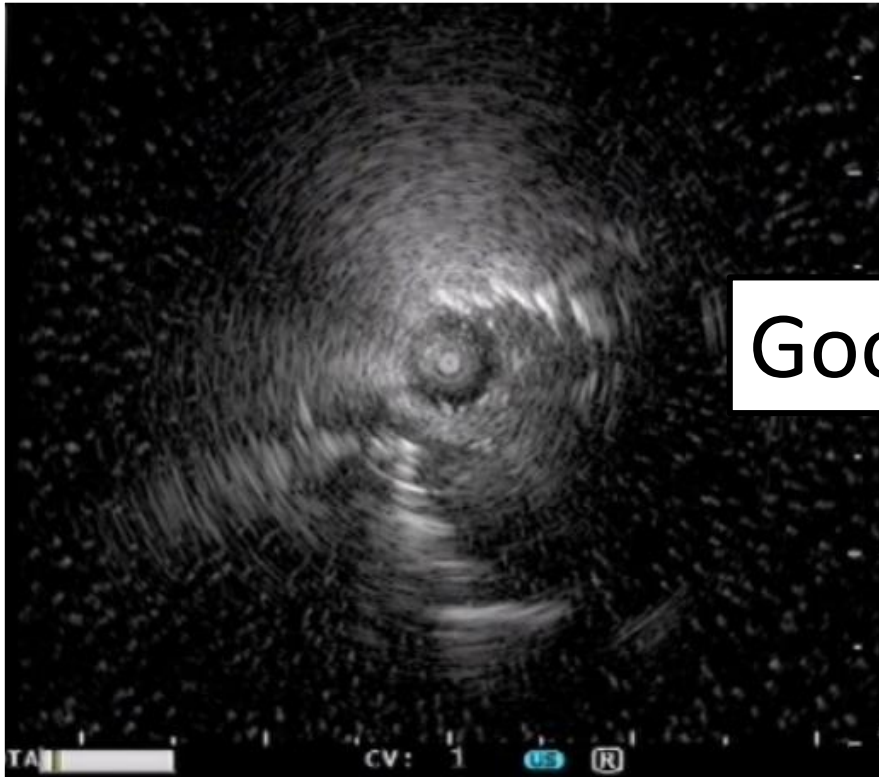
# Bronchoscopy Techniques Data

2002-2010; 3,052 lesions from 39 studies

Technology	Studies	Diagnostic Yield	Q P Value(異質性)
Virtual Bronchoscopy	10	72.0%	.01
Electromagnetic Navigation	11	67.0%	.21
Guide Sheath	10	73.2%	< .0001
Ultrathin Bronchoscopy	11	70.0%	.12
Radial EBUS	20	71.1%	< .0001
<b>All</b>	<b>39</b>	<b>70.0%</b>	<b>&lt; .0001</b>

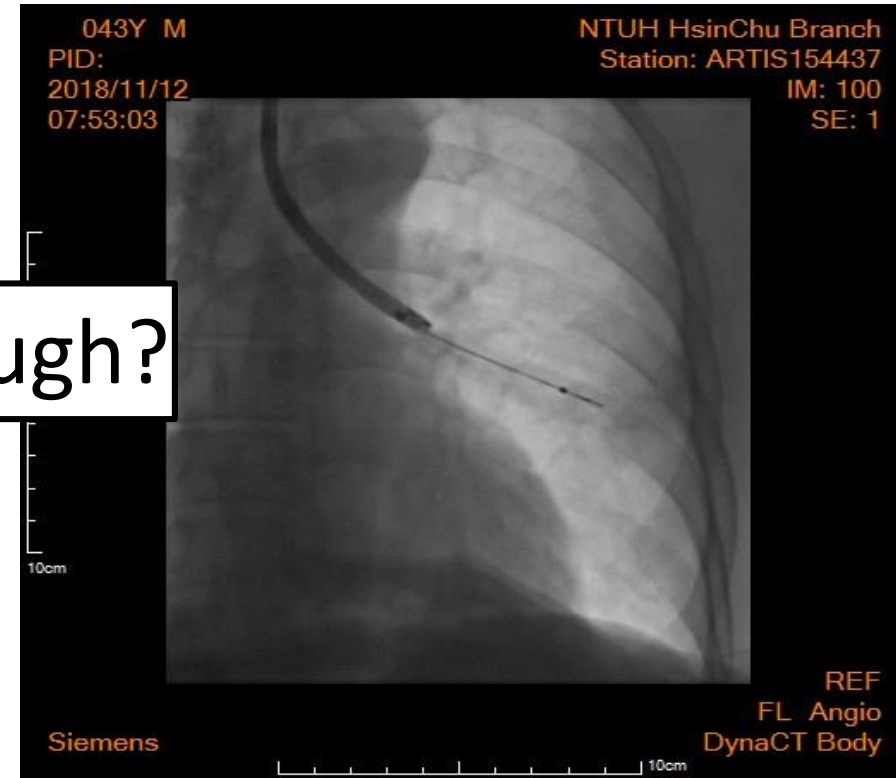
Other methods could increase Diagnostic yield?

# Current Localization methods



Radial EBUS

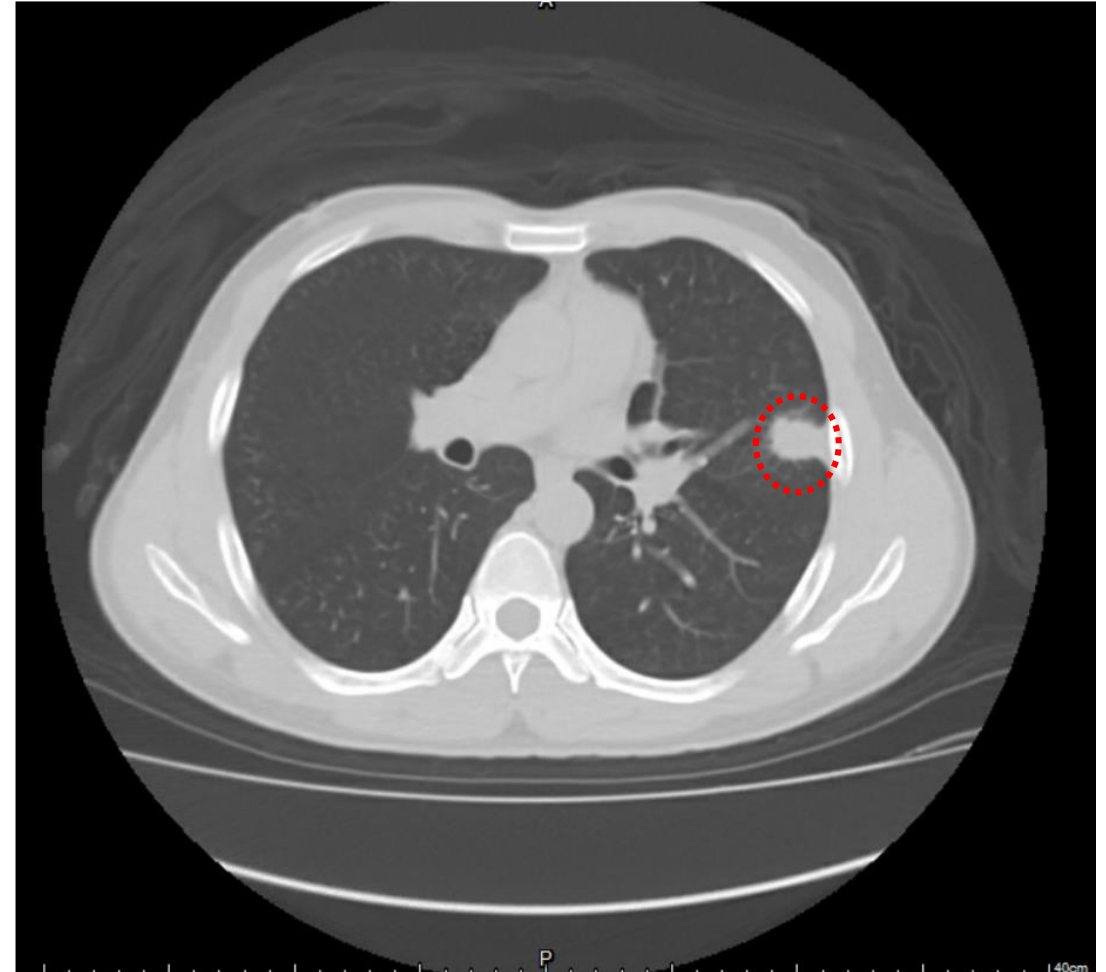
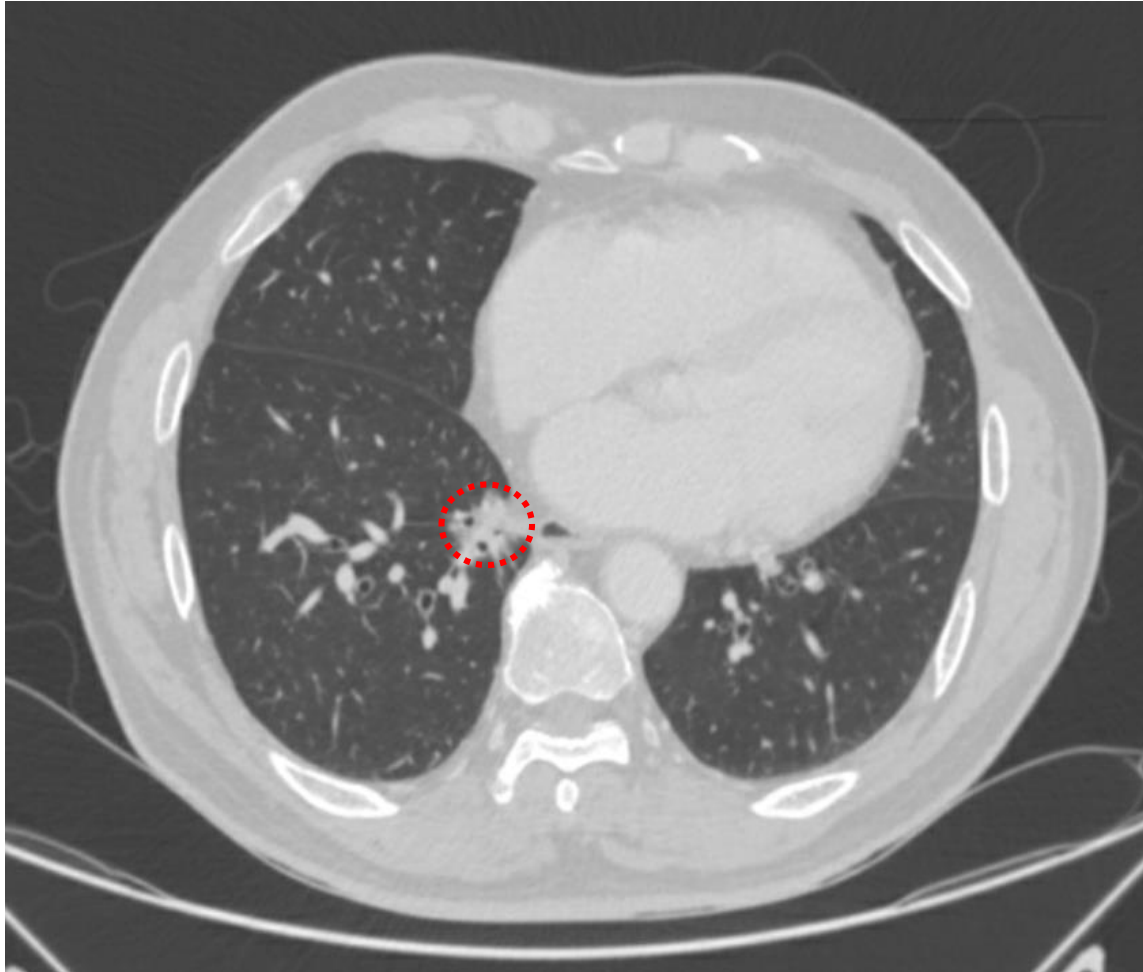
Good enough?



Fluoroscopy

(Almost not used in Taiwan)

# Which biopsy method would you choose?



# CBCT with Augmented Fluoroscopy for TBbX

## Biopsy workflow in NTUH Hsin-Chu

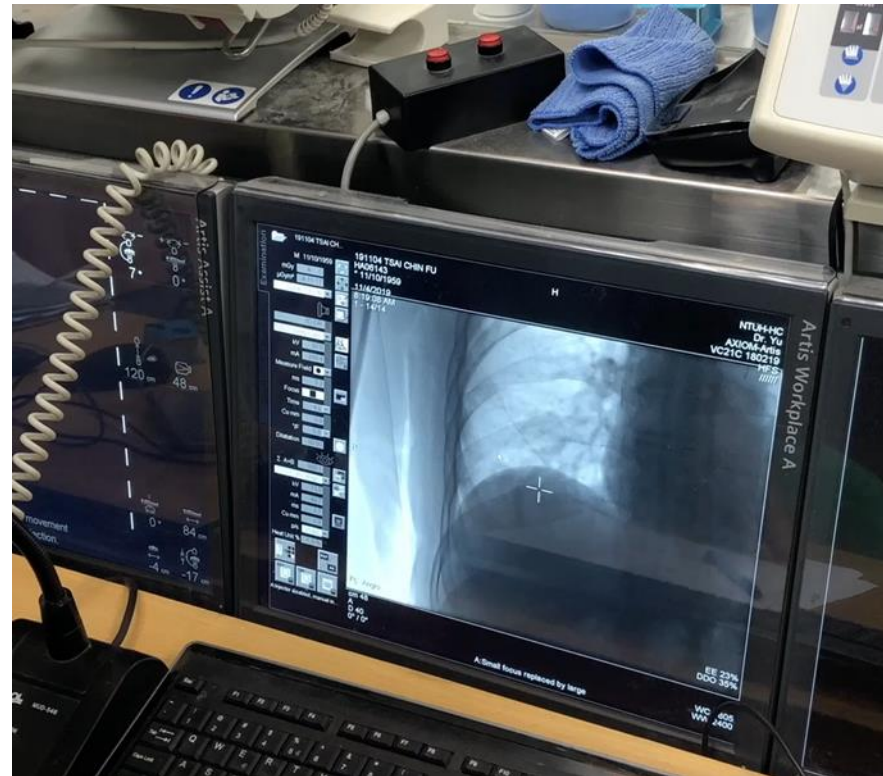
Step 1: Patient positioning



Step 2: CBCT scan and Mark lesion



Step 3: Bronchoscopy









# Step 3: Bronchoscopy



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Eh:A3 Ce:0

OLYMPUS

BestImage 工作清單(8) 診斷影像(1) 攝影 完成(/) 聯機模式 主畫面

1/3 2/3 3/3

病歷號 HA06143  
姓名 T4199857493  
年齡 59 性別 男  
檢查日期 2019/10/04 時間 08:14:28  
檢查者 醫師 醫師  
檢查室 呼吸科  
檢查時間 08:14:28

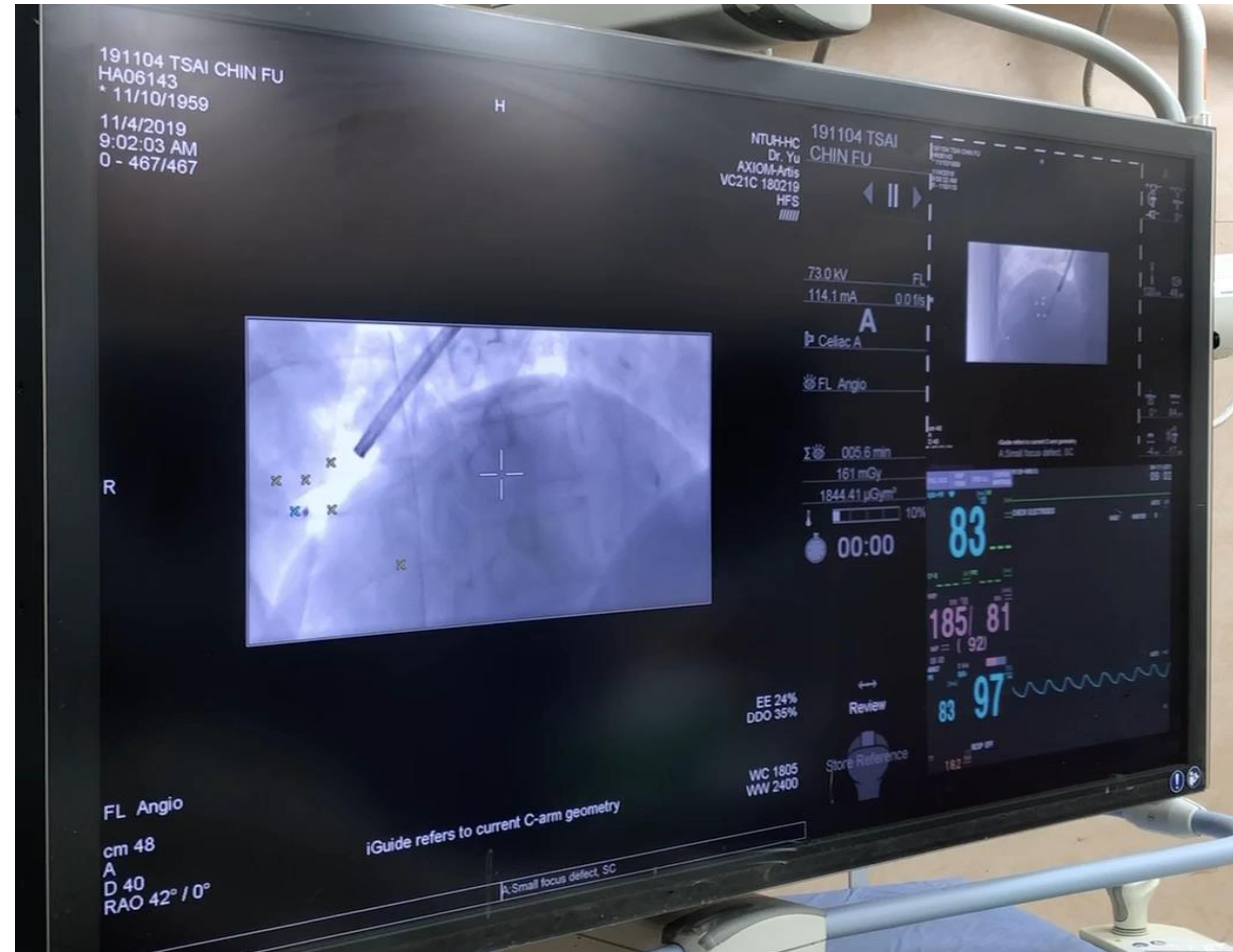
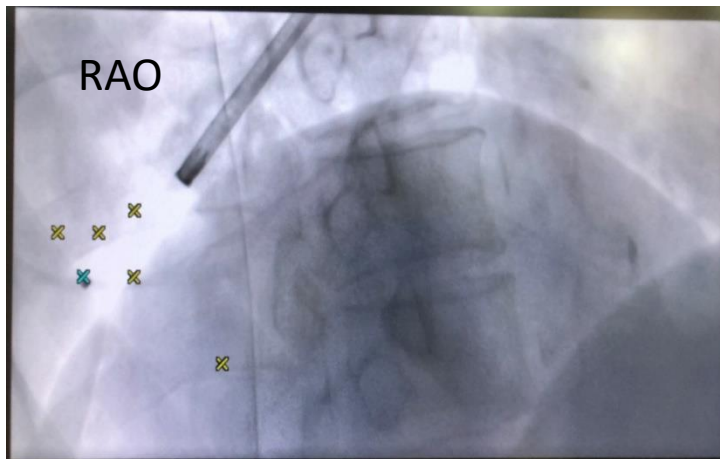
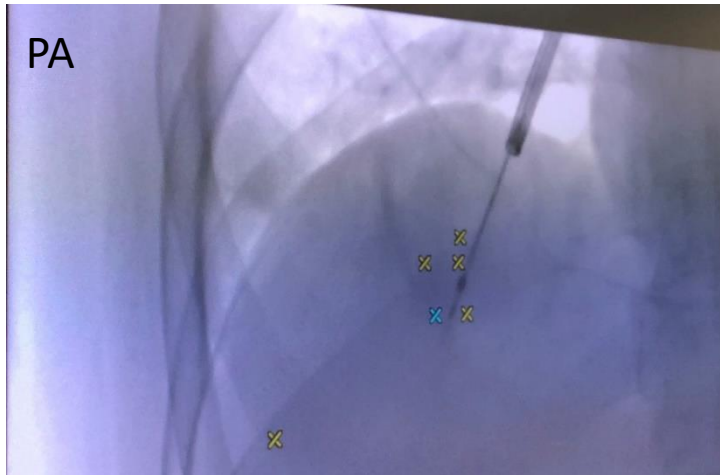
患者姓名 醫師  
患者ID 醫師  
患者性別 男  
患者年齡 59

11/04/2019 08:14:28

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紙類回收

# Multiple difference angles fluoro images



# CBCT with Augmented Fluoroscopy for TBBx

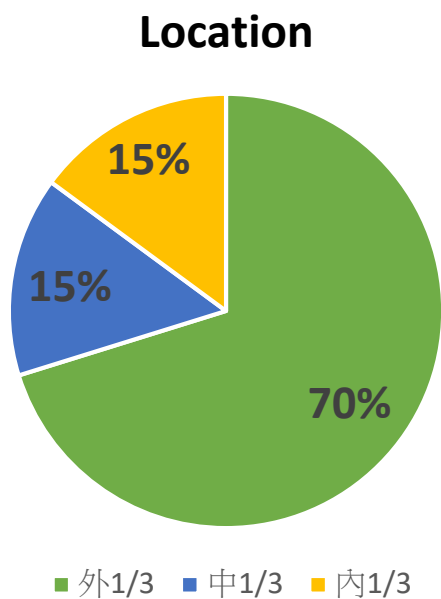
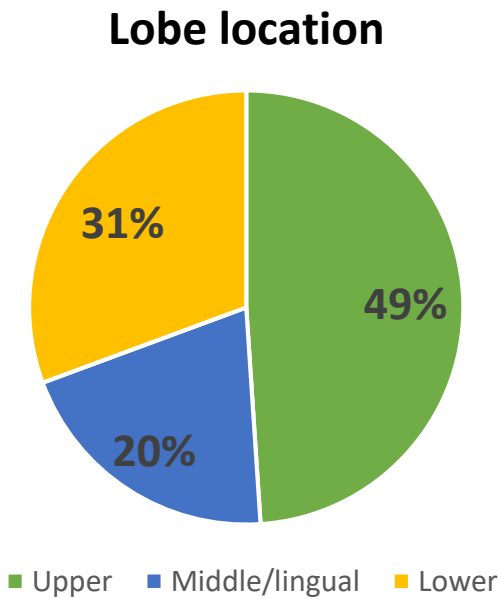
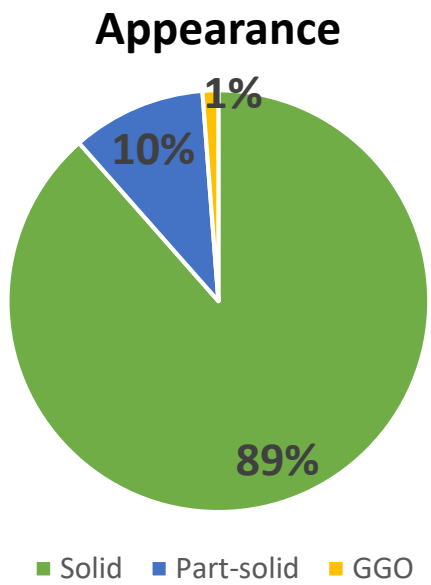
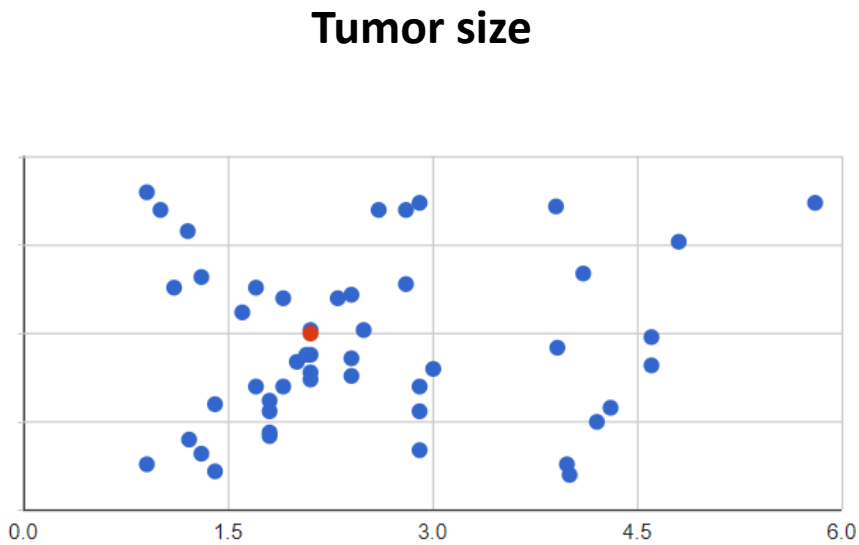
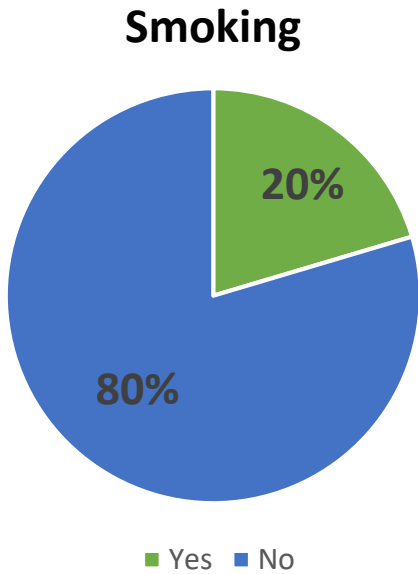
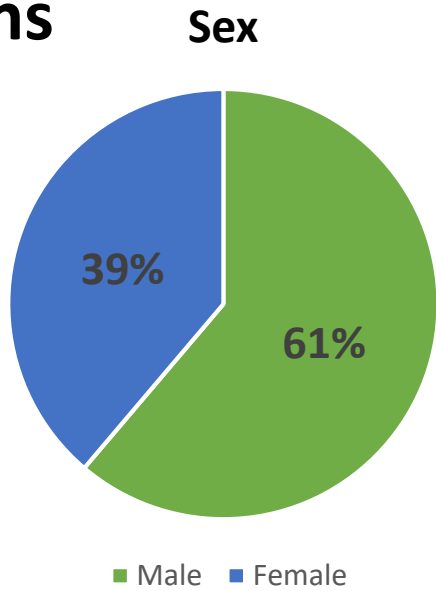
## Procedure method and equipment

- Mild-to-moderate conscious sedation
  - Midazolam and Fentanyl
  - No ETT intubation
- Oral or nasal route
- Supine position
- CBCT (Artis Zee; Siemens Healthcare GmbH)
  - 5-seconds low-dose scan protocol
  - Annotation software (syngo iGuide Toolbox)
- Bronchoscope (Olympus)
  - BF-260 or 290(4.9/2.0), BF-P190(4.2/2.0)
- EBUS-GS
  - UM-S20-17S with K-201 kit
  - Biopsy forceps and brushes



# 47 consecutive patients

## 49 lesions



# Results

## procedure related data

- Median lesion size: **21 mm** (IQR 12.0 mm)
- Bronchus sign: **63.3%**
- **rEBUS: Concentric: 57.1%**, eccentric: 32.6 %, invisible: 4.1%, blizzard: 6.1%
- Median bronchoscopy duration: **21.0 min** (IQR 13.0 min)
- **47.9%** invisible by traditional fluoroscopy
- Median fluoroscopy duration: **2.2 min** (IQR 1.9 min)
- Median radiation exposure (dose area product): **1630.2  $\mu\text{Gym}^2$**  (IQR 737.6  $\mu\text{Gym}^2$ )



Diagnosis	Number
<b>Malignancy</b>	
Adenocarcinoma	18
Squamous	7
NSCLC, NOS	2
LELC	1
Lymphoma	1
Total of malignancy	<b>29</b>
<b>Benign</b>	
Pneumoconiosis	2
Radiation fibrosis	1
Cryptococcosis	4
Organizing pneumonia	1
Pneumonia	4
Other benign lesions	8
Total of benign	<b>20</b>

# Results

## Diagnostic yield and complication

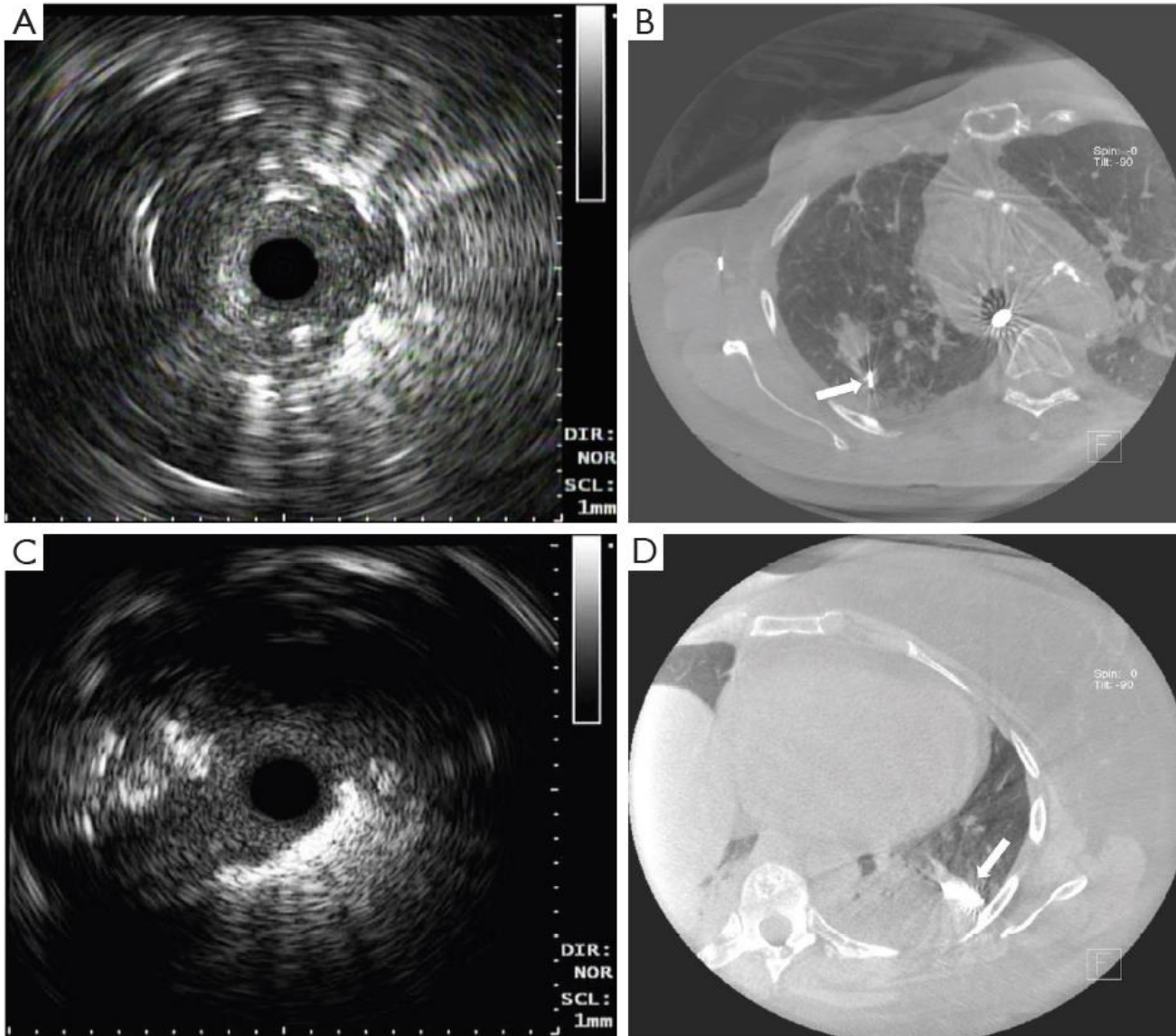
- **Diagnostic yield\*: 71.4%**
  - $\leq 10\text{mm}$  (n=3): 33.0%
  - $10\text{mm} \sim 20\text{mm}$  (n=17): 70.6%
  - $20\text{mm} \sim 30\text{mm}$  (n=18): 83.3%
  - $>30\text{mm}$  (n=7) : 63.6%
- Prevalence of malignancy (n=29): 59.2%
- **Sensitivity of malignancy (n=26): 89.7%**
- **Complication: Pneumothorax occurred in 1 patient (2.1%)**

\*only included definite malignancy or benign lesions and excluded all indeterminate results

\*If only inflammatory tissue or lymphocytes -> considered nondiagnostic.

## Augmented fluoro images derived from CBCT

# rEBUS = ultimate localization?



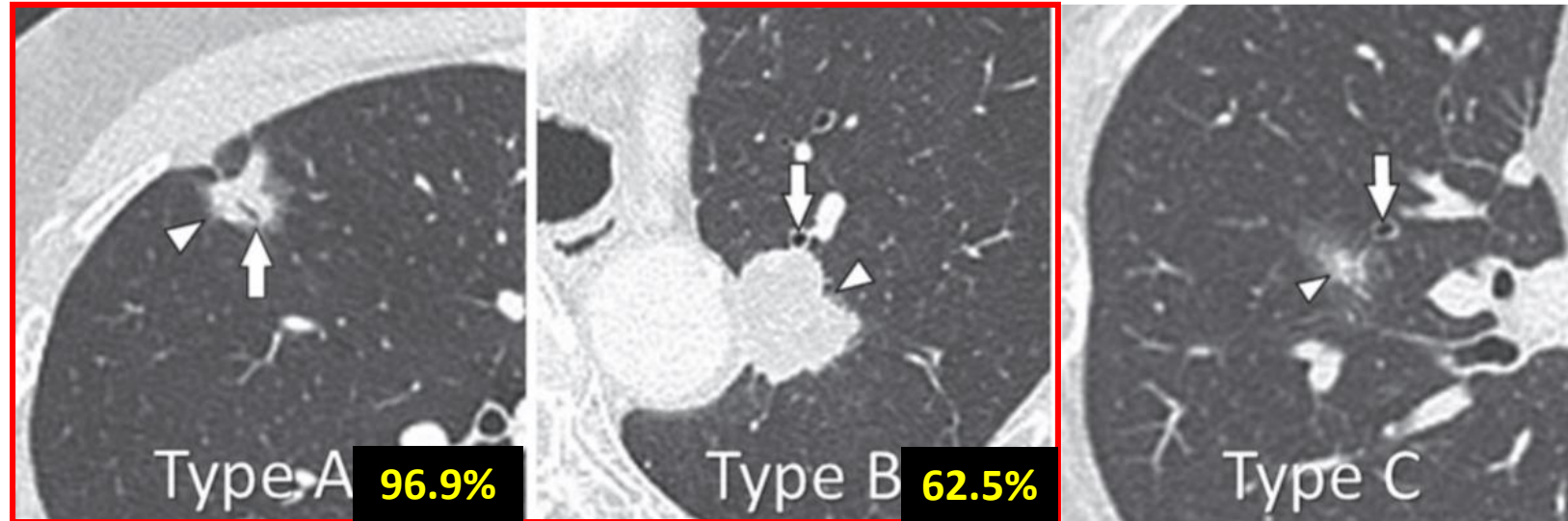
CBCT demonstrating **unsuccessful navigation** and **atelectasis** obscuring target.



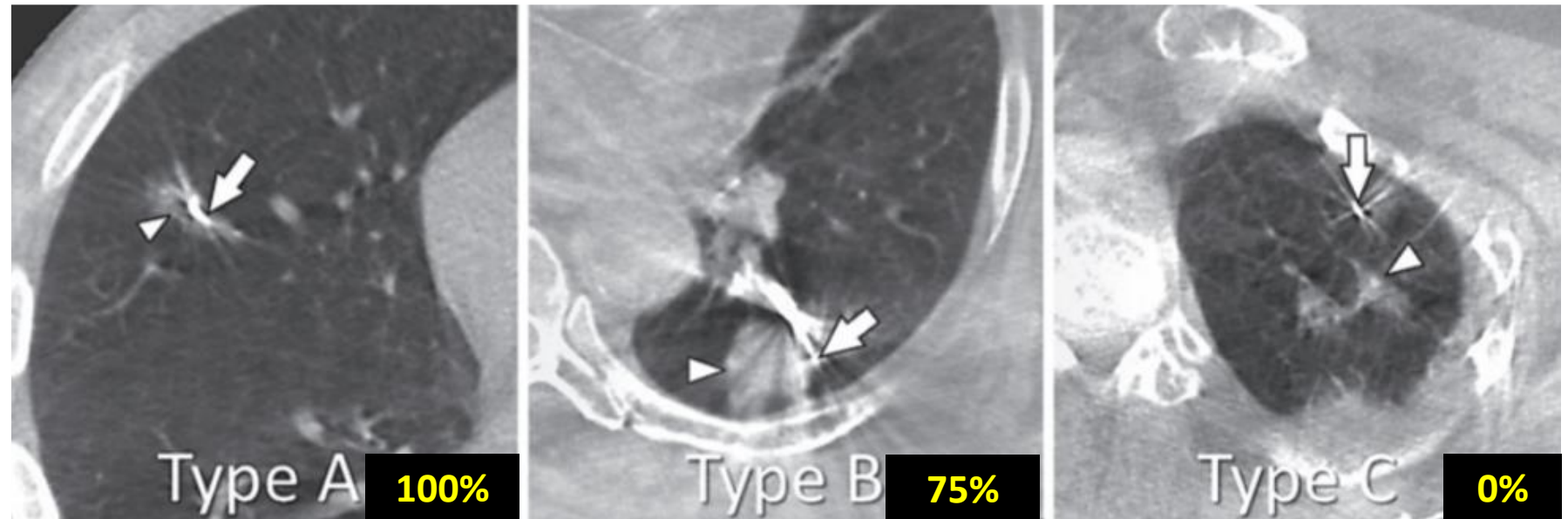
Additional benefit of CBCT other than AF image formation



## Bronchus sign



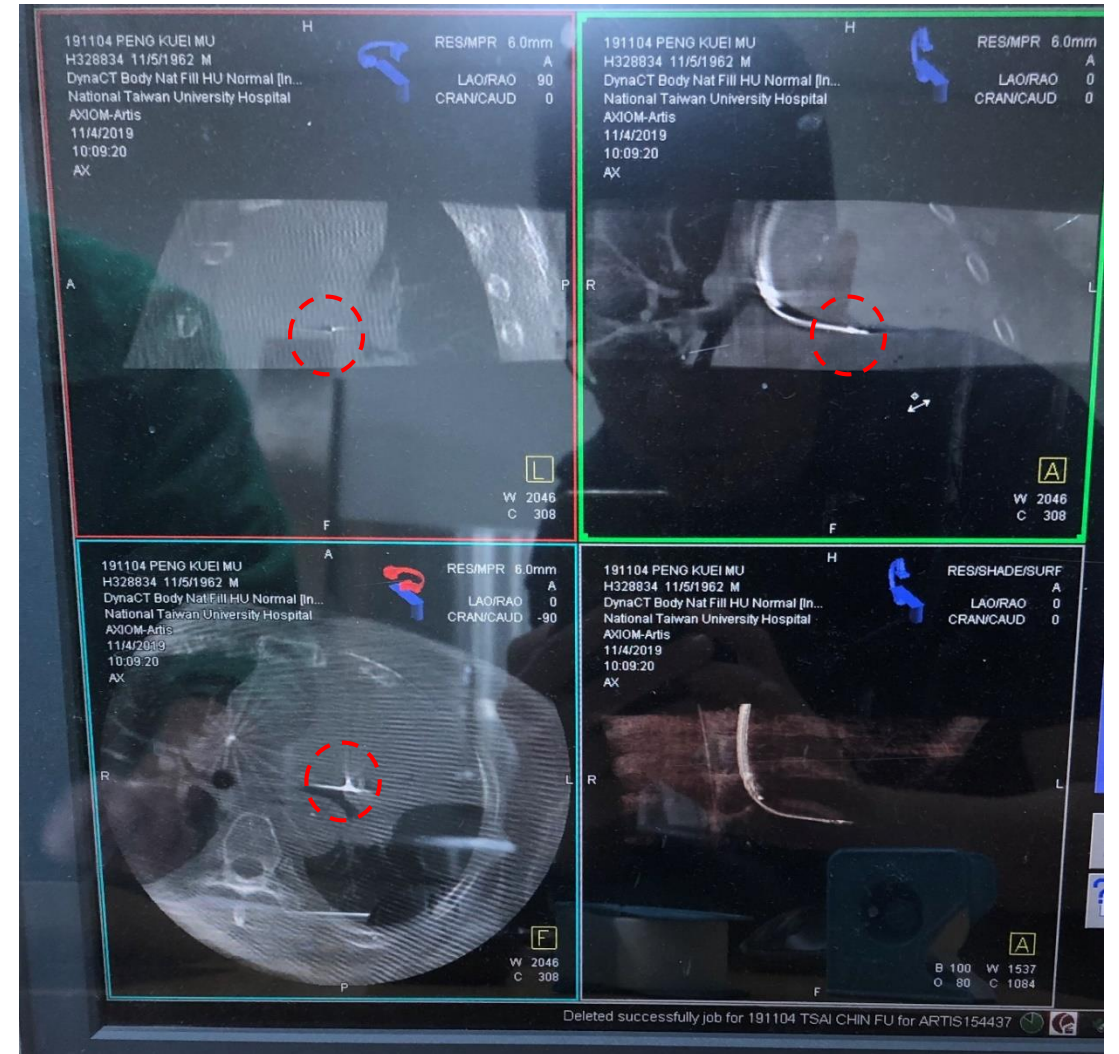
## CBCT target-forceps sign





# Real-time CBCT confirmation

NTUH Hsin-Chu branch experience



# Radiation dose

## CBCT-AF for pulmonary lesions biopsies

	Casal et al.	Van der Heijden et al.	Lau et.al	Pritchett et al.	NTUH Hsin-Chu
Patient No.	20	37	116	19	47
Effective dose Per CBCT scan (mSV)	5.4	2.1	1.0	2.0	7.5
No. of CBCT scan	1.5	2.4	3.7	1.5	1
<b>Total dose (mSV)</b>	<b>10.8</b>	<b>7.3</b>	<b>5.1</b>	<b>3.8</b>	<b>7.5</b>
CBCT dose (mSV)	8.1	4.8	3.8	3.0	7.3
Fluoro dose (mSV)	2.2	2.9	1.2	1.5	1.7

# Effective radiation dose of procedures

Procedure	Radiation dose
Chest CT	5-7 mSv
Brain Scan	3-5 mSv
PET	7 mSv
CT-guided lung biopsy	6-14 mSv
Coronary angiography(Diagnostic)	5-15 mSv
Coronary angiography(Therapeutic)	15-25 mSv
EP study	15-39 mSv
<b>CBCT-AF</b>	<b>4-11 mSv</b>

# Guided Bronchoscopy

## From Diagnosis to Treatment

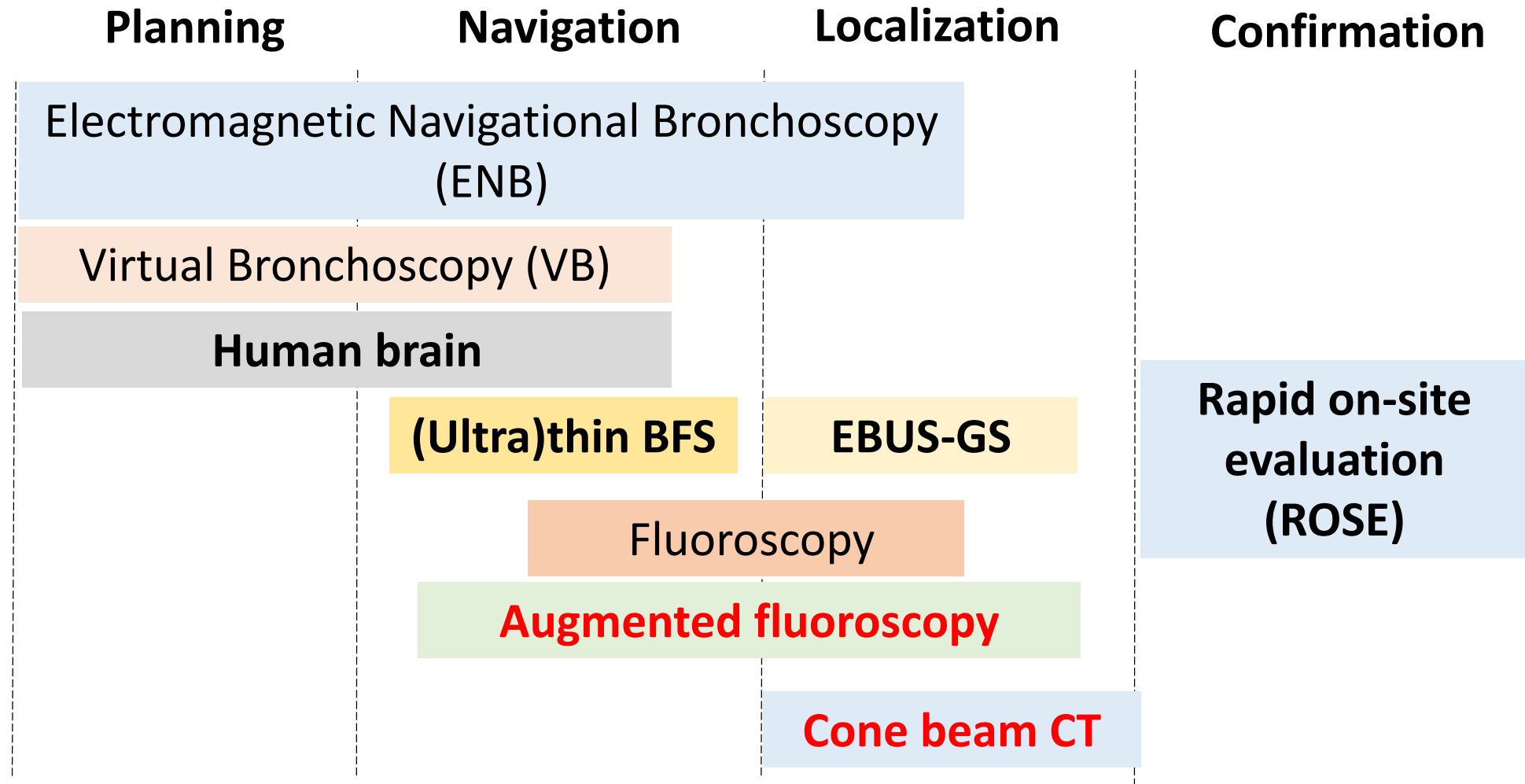
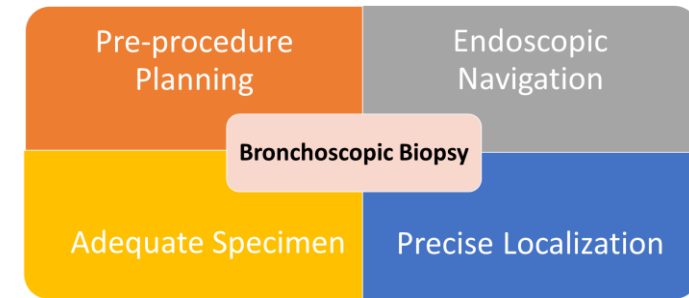
- Placement of Markers to Assist Resection or Radiotherapy
- Direct Tumor Injection of Chemotherapy or Gene Therapies
- Cryotherapy
- Photodynamic Therapy
- Transbronchial Brachytherapy
- Bronchoscopy-Guided Tumor Ablation

# Some issues to be discussed

- Sedation depth and ETT intubation
  - Positioning (supine, decubitus)
  - Guide-sheath
  - ENB
  - Radiation dose optimization
- 
- Retrospective study in single institution
  - Limited case number



# Transbronchial intervention: how to succeed?



# Conclusions

- CT guided biopsy has a higher diagnostic yield than for peripheral lung lesions, but accompany with higher complication rate.
- New bronchoscopic technology has closed the gap.
- Transbronchial biopsy with combined CBCT-AF and EBUS-GS was safely conducted with satisfactory diagnostic yield in our initial experience.
- Further randomized clinical trial is necessary to verify the applicability.



# Thank You

台大新竹 胸腔內科

于鎧綸

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