



ENB-guided lung surgery: More than 200 cases of targeting and biopsy for small pulmonary nodules



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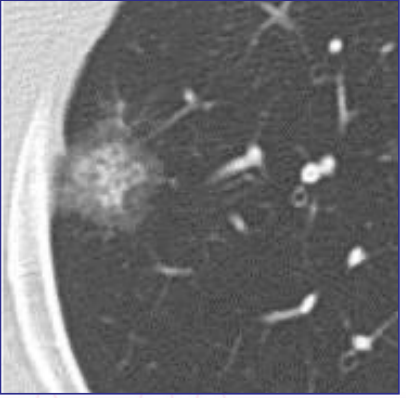
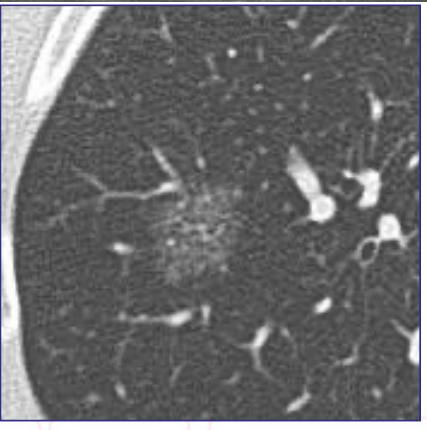
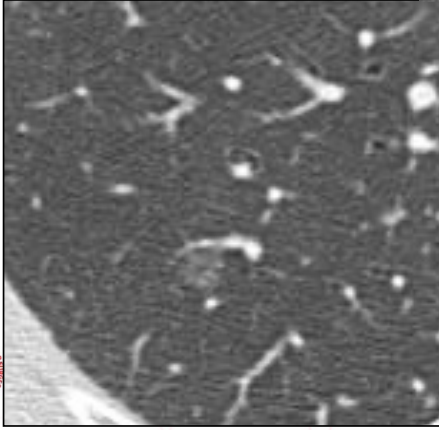
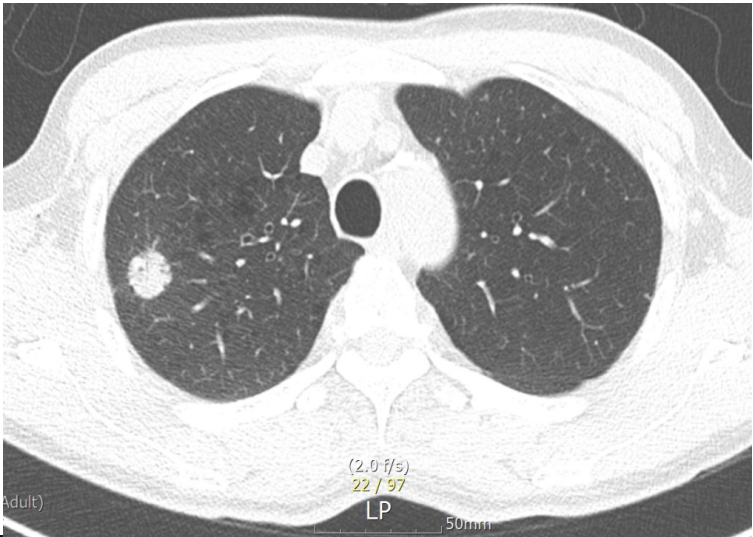


MASSACHUSETTS
GENERAL HOSPITAL



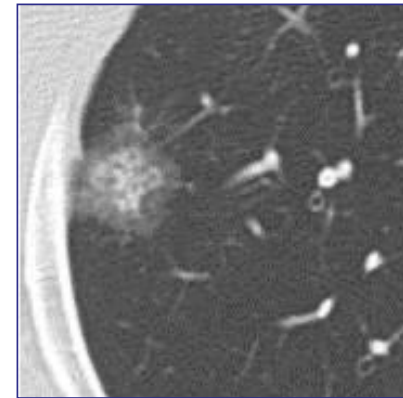
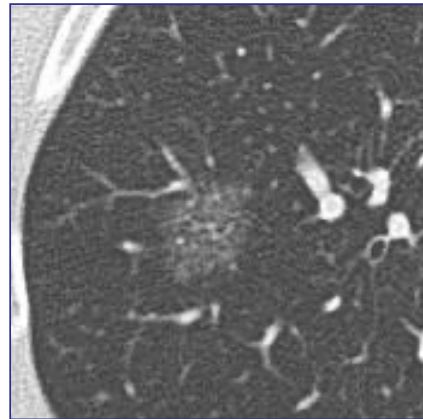
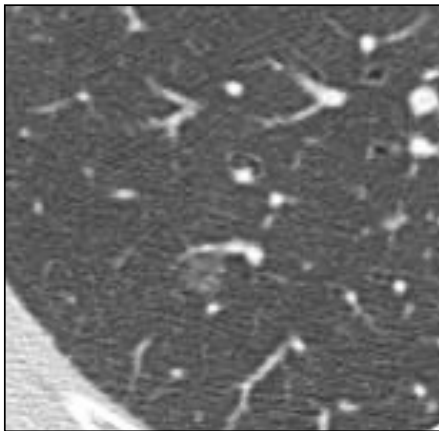
HARVARD
MEDICAL SCHOOL

Increase routine H/C with CT



What would you do?

- f/u, PCNA, PCNB, Surgical resection?



Prospective observation study for subsolid lesions

ORIGINAL ARTICLE



Natural History of Pulmonary Subsolid Nodules: A Prospective Multicenter Study



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Kazuto Ashizawa, MD, PhD,^e Keiko Kuriyama, MD, PhD,^f
Akiko Miyagi Maeshima, MD, PhD,^g Naoya Koizumi, MD, PhD,^h
Tetsuro Kondo, MD, PhD,ⁱ Haruhisa Matsuguma, MD, PhD,^j Norihisa Nitta, MD, PhD,^k
Hironobu Ohmatsu, MD, PhD,^l Jiro Okami, MD, PhD,^m Hiroshi Suehisa, MD, PhD,^{n,o}
Taiki Yamaji, MD, PhD,^{p,q} Ken Kodama, MD, PhD,^{m,r} Kiyoshi Mori, MD, PhD,^{s,t}
Kouzo Yamada, MD, PhD,ⁱ Yoshihiro Matsuno, MD, PhD,^u
Sadayuki Murayama, MD, PhD,^v Kiyoshi Murata, MD, PhD^k

- Observation of the natural course of subsolid nodules
- NCCH and other 7 institutions
- 795 patients with 1,229 subsolid nodules
- Mean follow-up period: 4.3 ± 2.5 years



Kakinuma R, et al. *JTO* 2016;11:1012-1028

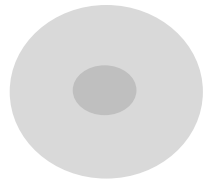
Results



Pure GGN



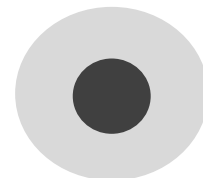
1.2%



Heterogeneous GGN



19.8%



Part-solid GGN



4.6%



Introduction

- According to other studies, more than **86%** of resected pure GGNs are diagnosed as AIS, MIA or IA.

Ann Thorac Cardiovasc Surg. 2014;20(5):347-52. Epub 2013 Oct 3.

Invasiveness and malignant potential of pulmonary lesions presenting as pure ground-glass opacities.

Ichinose J¹, Kohno T, Fujimori S, Harano T, Suzuki S, Fujii T.

Oncotarget. 2017 Mar 7;8(10):17229-17238. doi: 10.18632/oncotarget.11236.

Preoperative nomogram for identifying invasive pulmonary adenocarcinoma in patients with pure ground-glass nodule: A multi-institutional study.

She Y¹, Zhao L¹, Dai C¹, Ren Y¹, Zha J¹, Xie H², Jiang S³, Shi J³, Shi S⁴, Shi W⁵, Yu B⁶, Jiang G¹, Fei K¹, Chen Y⁷, Chen C¹.

Chest. 2013 Oct;144(4):1291-1299. doi: 10.1378/chest.12-2987.

Persistent pure ground-glass opacity lung nodules \geq 10 mm in diameter at CT scan: histopathologic comparisons and prognostic implications.

Lim HJ¹, Ahn S², Lee KS³, Han J², Shim YM⁴, Woo S⁵, Kim JH¹, Yie M¹, Lee HY¹, Yi CA¹.

*Furthermore, among these studies, the largest one included 898 pure GGNs and reported that **44%** were invasive.*



Indication for intervention

	Pure GGNs	Mixed GGNs
Japanese Society of CT Screening (16)	Size >15 mm. Increase in size, or newly developed solid component upon follow-up	Surgery when detected
American Association for Thoracic Surgery (15)	5-10 mm: suspicious change in size or appearance upon follow-up; >10 mm: stable upon follow-up	Same as pure GGNs
Fleischner Society (13,14)	Size >10 mm and persistent	Persistent and solid component \geq 5 mm
National Comprehensive Cancer Network (23)	5-10 mm: increase in size and/or become solid/part-solid upon follow-up; >10 mm: stable, or increase in size and/or become solid/part-solid upon follow-up	4-8 mm: increase in size upon follow-up; >8 mm: increase in size, or suspicious on PET

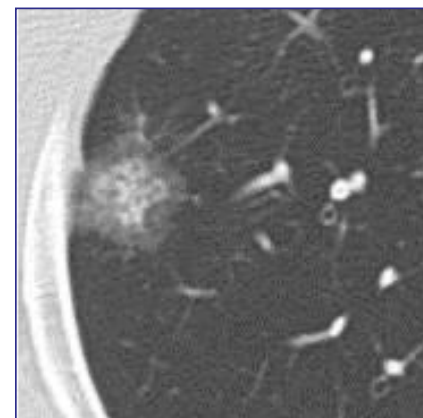
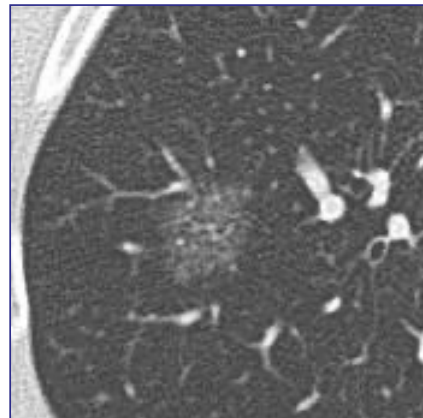
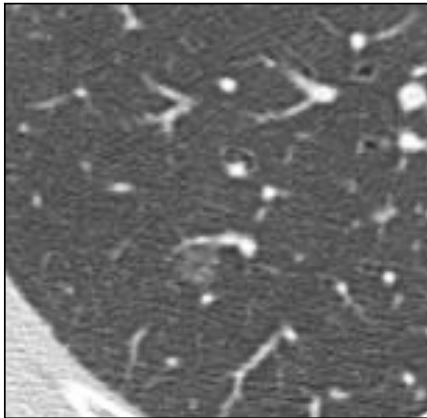
CT, computed tomography; GGNs, ground glass nodules.

- As these studies progressed and after accumulation knowledge of GGN, each of societies presented their respective indication for intervention for GGN.



What would you do?

- f/u, PCNA, PCNB, Surgical resection?



Unmet needs; Low accuracy of PCNB in adenocarcinoma that presented with GGN

AJR Am J Roentgenol, 2003 Jun;180(6):1665-9.

CT-guided transthoracic needle aspiration biopsy of small (< or = 20 mm) solitary pulmonary nodules.

Ohno Y¹, Hatabu H, Takenaka D, Higashino T, Watanabe H, Ohbayashi C, Sugimura K.

TABLE 2 Diagnostic Accuracy for Each Range of Influencing Factors

Factor	Accuracy (%)
Lesion size (mm)	
≤ 10	52
11-15	74.4 ^b
16-20	91.5 ^b

Lung Cancer, 2006 Feb;51(2):173-9. Epub 2005 Dec 27.

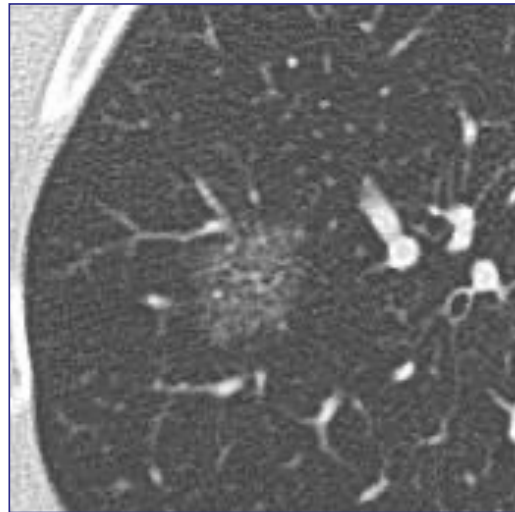
Percutaneous CT-guided fine needle aspiration for lung cancer smaller than 2 cm and revealed by ground-glass opacity at CT.

Shimizu K¹, Ikeda N, Tsuboi M, Hirano T, Kato H.

Lesion size (mm)	<10	11-15	16-20	Total
GGO lesions	17	16	10	43
Solid lesions	16	16	21	53
Diagnostic yield	48.5% (16/33)	62.5% (20/32)	83.9% (26/31)	64.6% (62/96)



What is most difficult thing to Surgical biopsy of this GGN?

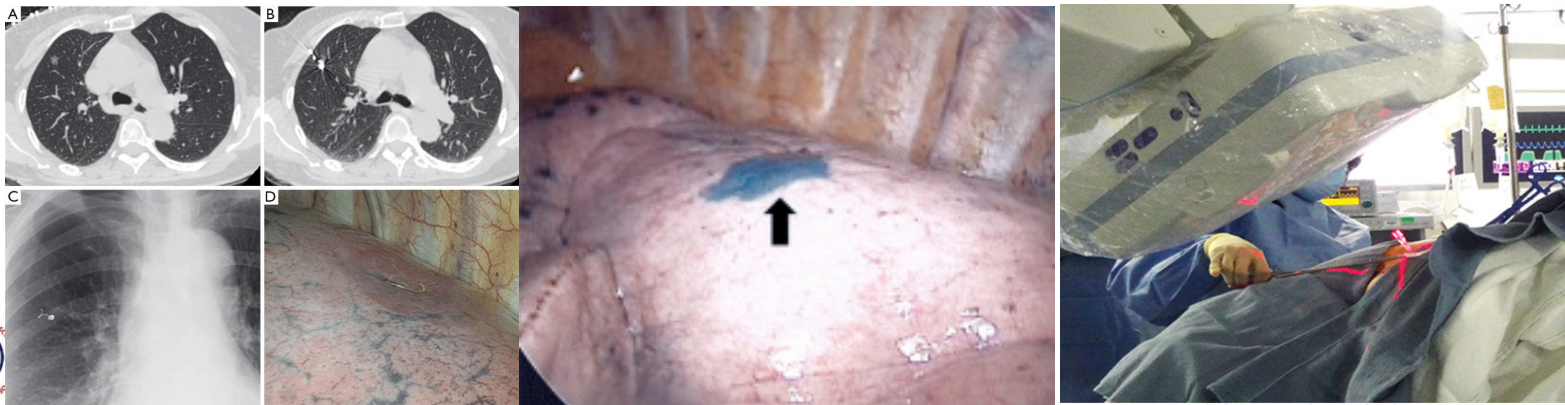


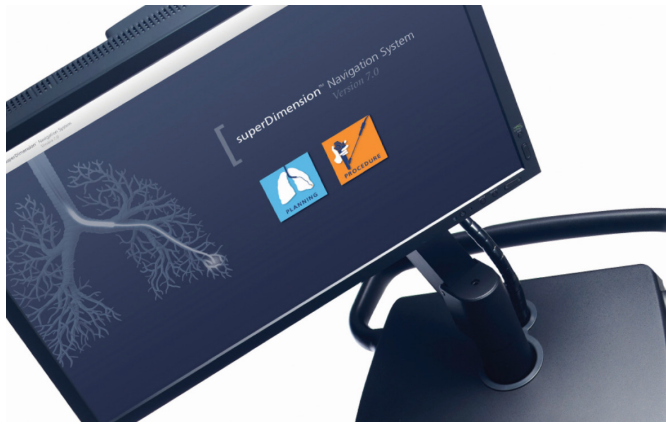
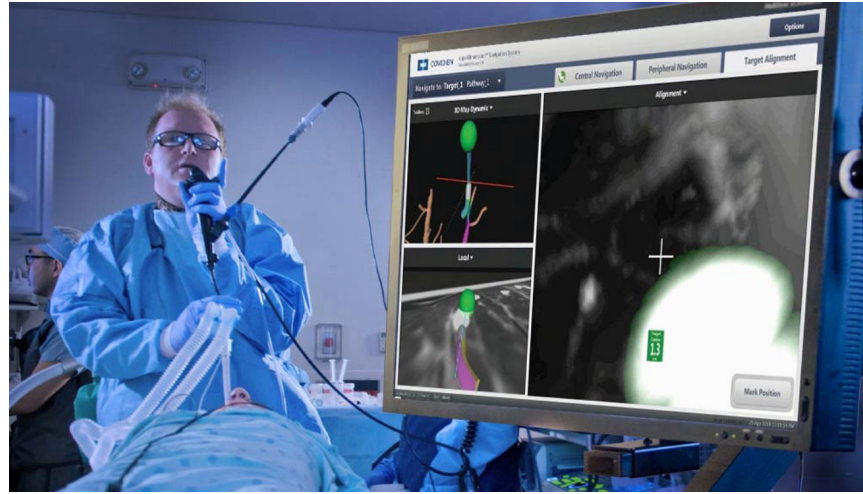
Maybe localization



Localization : Most important thing

During the lung surgery for small lung lesion, it is sometimes difficult to identify the exact location of small lung nodules not only MIS like a VATS or robot surgery but also open surgery.



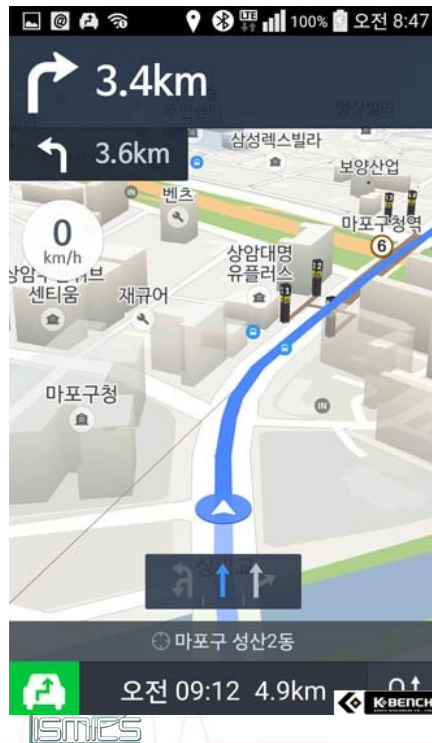


ENB guided lung surgery

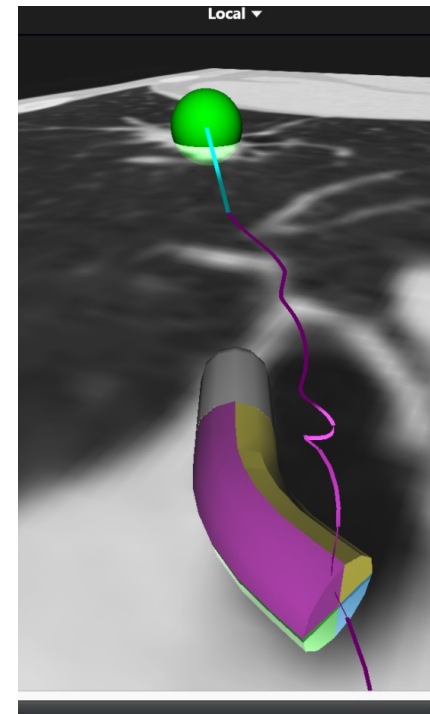


What is ENB

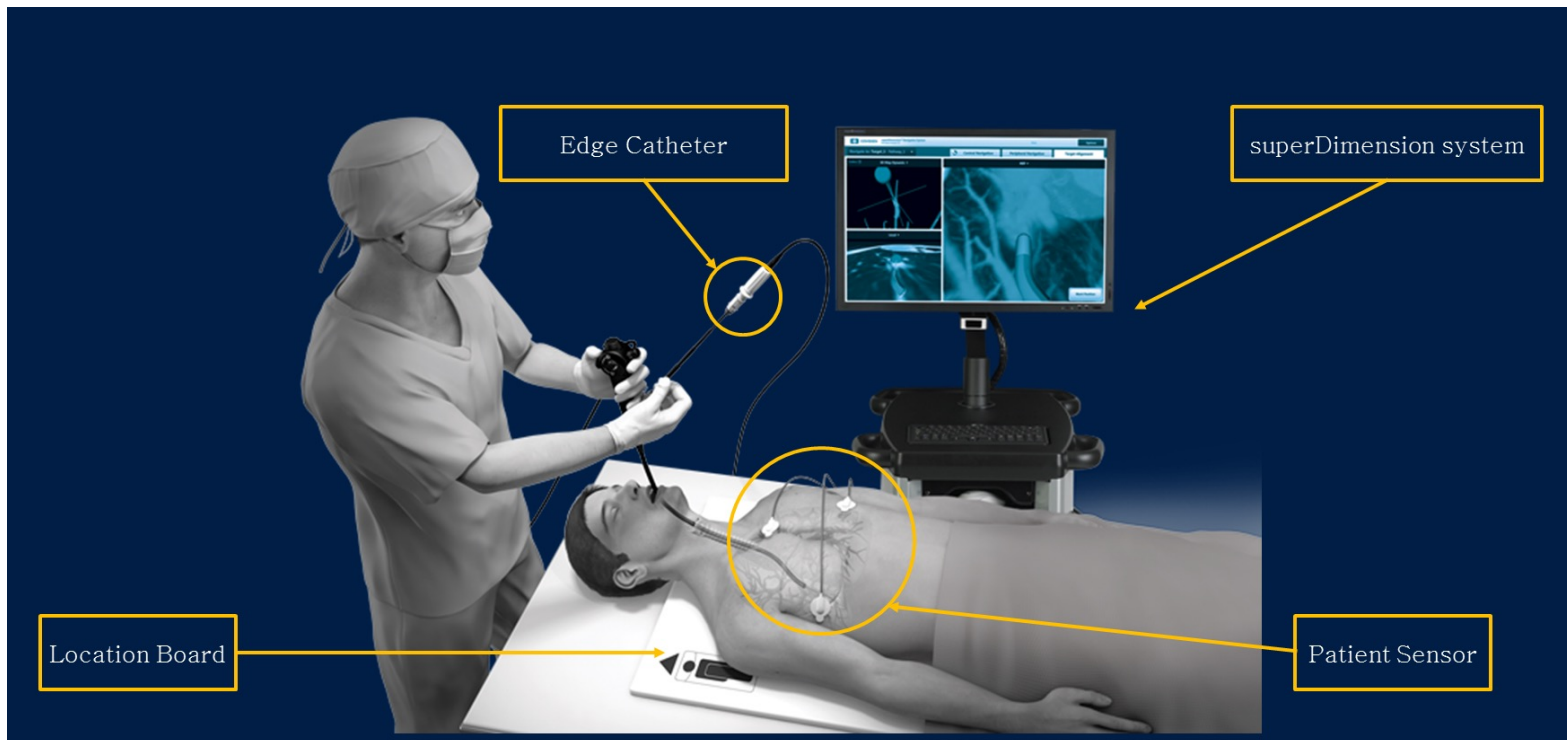
Use GPS navigation to destination



Use EM navigation to destination



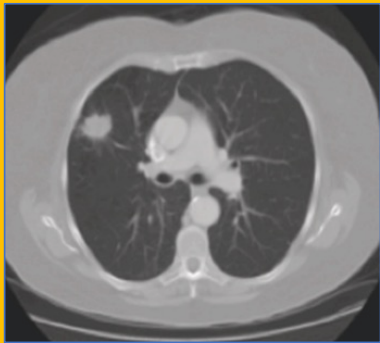
How to ENB work



superDimension™ Navigation System Workflow

CT Scan

- DICOM data



Plan

- Create a plan for the ENB™ Procedure



Navigate

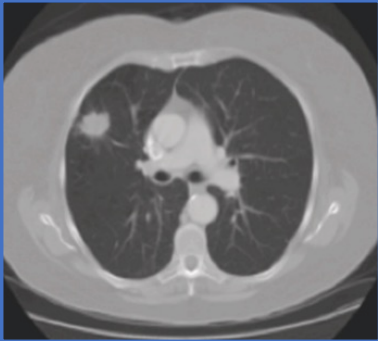
- Sample
- Localize



superDimension™ Navigation System Workflow

CT Scan

- DICOM data



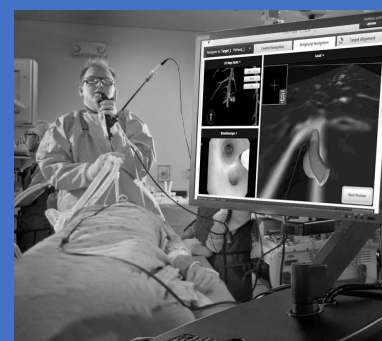
Plan

- Create a plan for the ENB™ Procedure

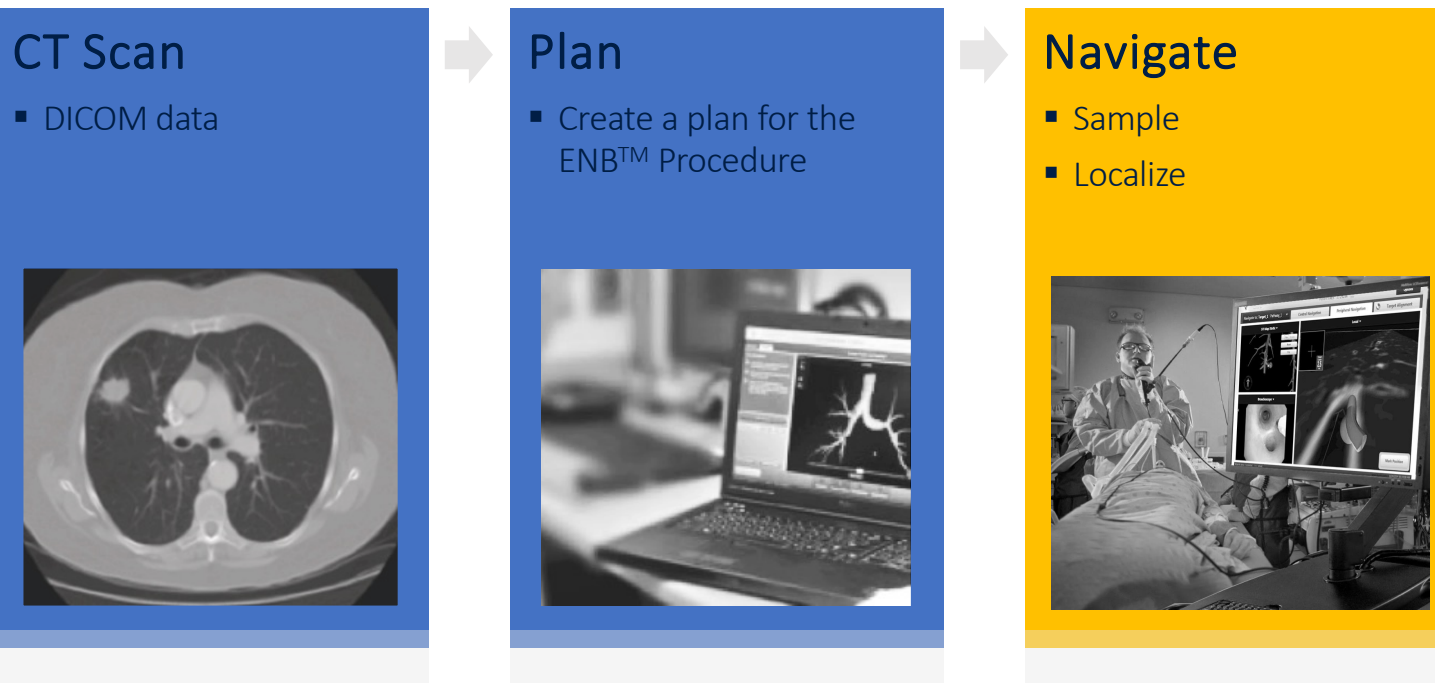


Navigate

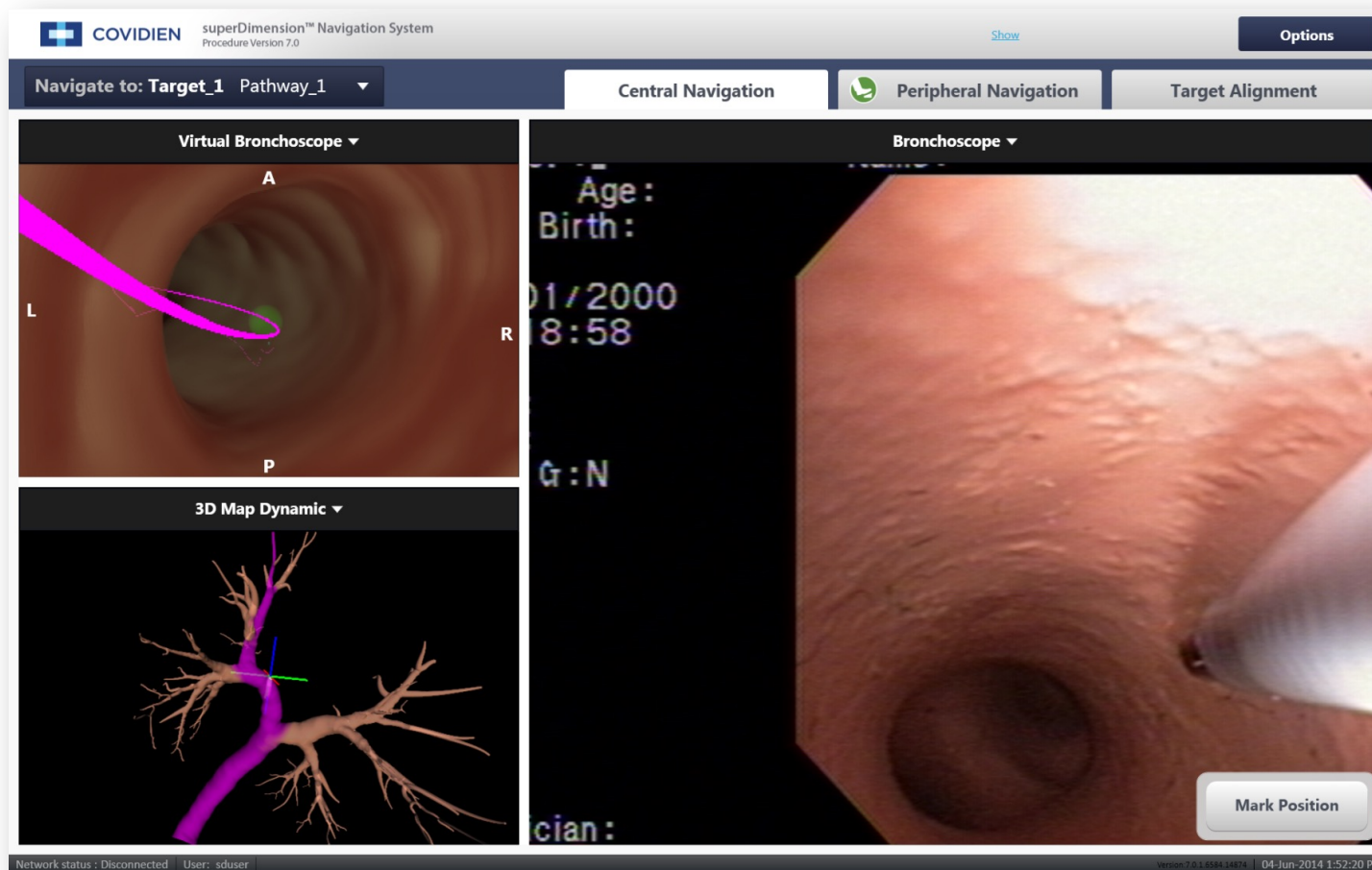
- Sample
- Localize



superDimension™ Navigation System Workflow

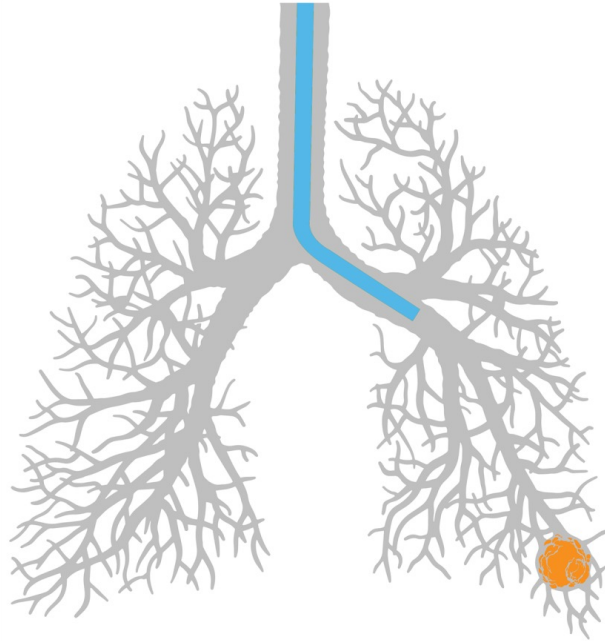


Central Navigation Tab

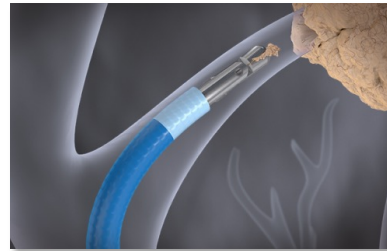


Complete Procedure

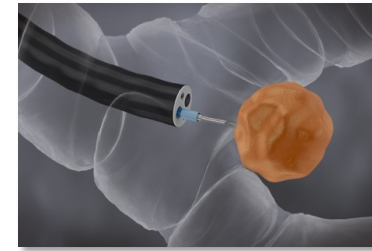
Navigate



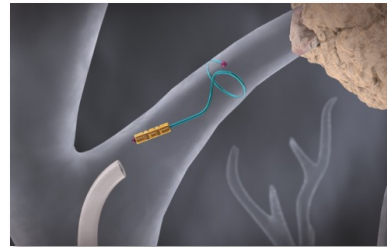
Acquire Tissue



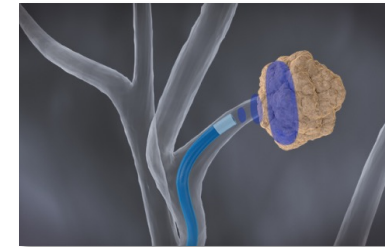
Stage



Place Fiducial Markers



Dye Localization

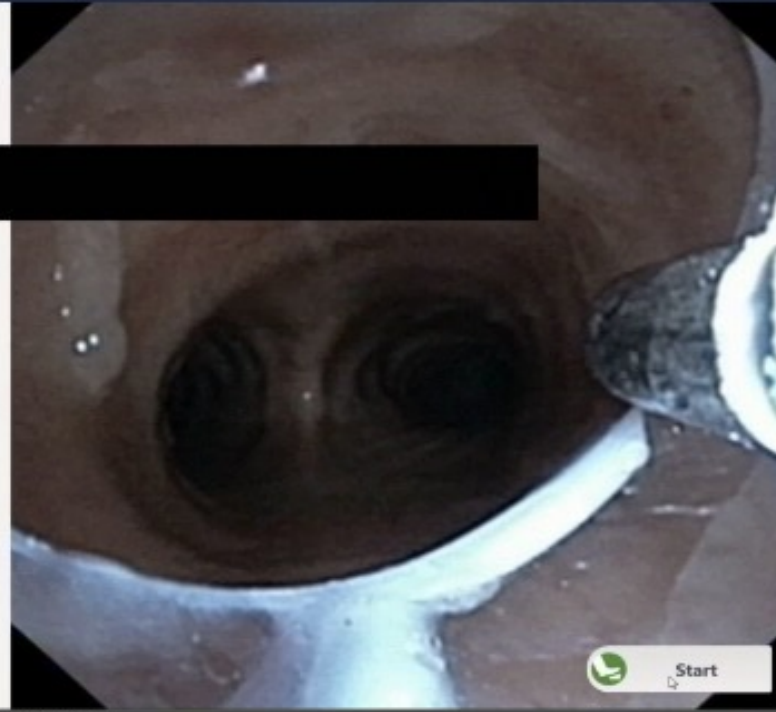


Automatic Registration

- 1
- 2
- 3

Move to the Starting Position

Place the bronchoscope mid-trachea.
Click **Start** to begin.



LEAD Throat Disorder

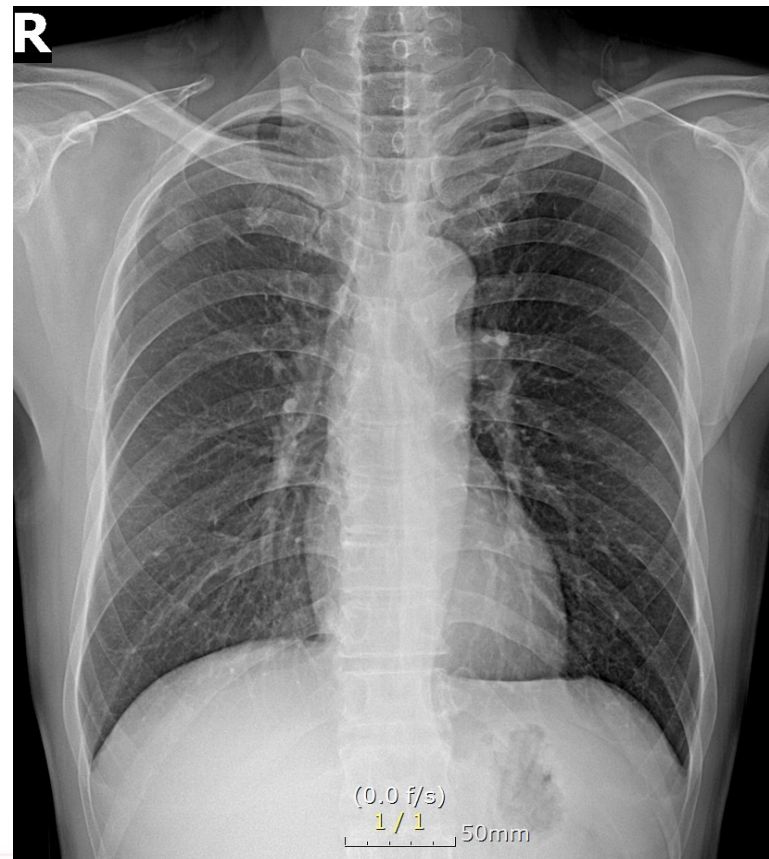
Case :Multiple GGN with known lung cancer

M/59

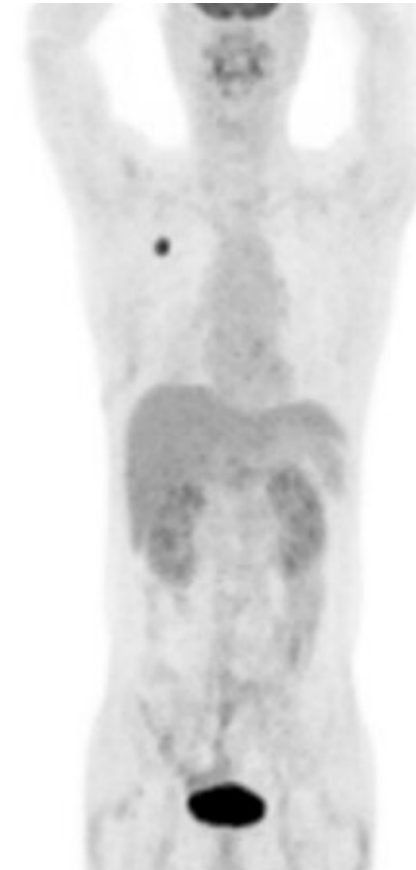
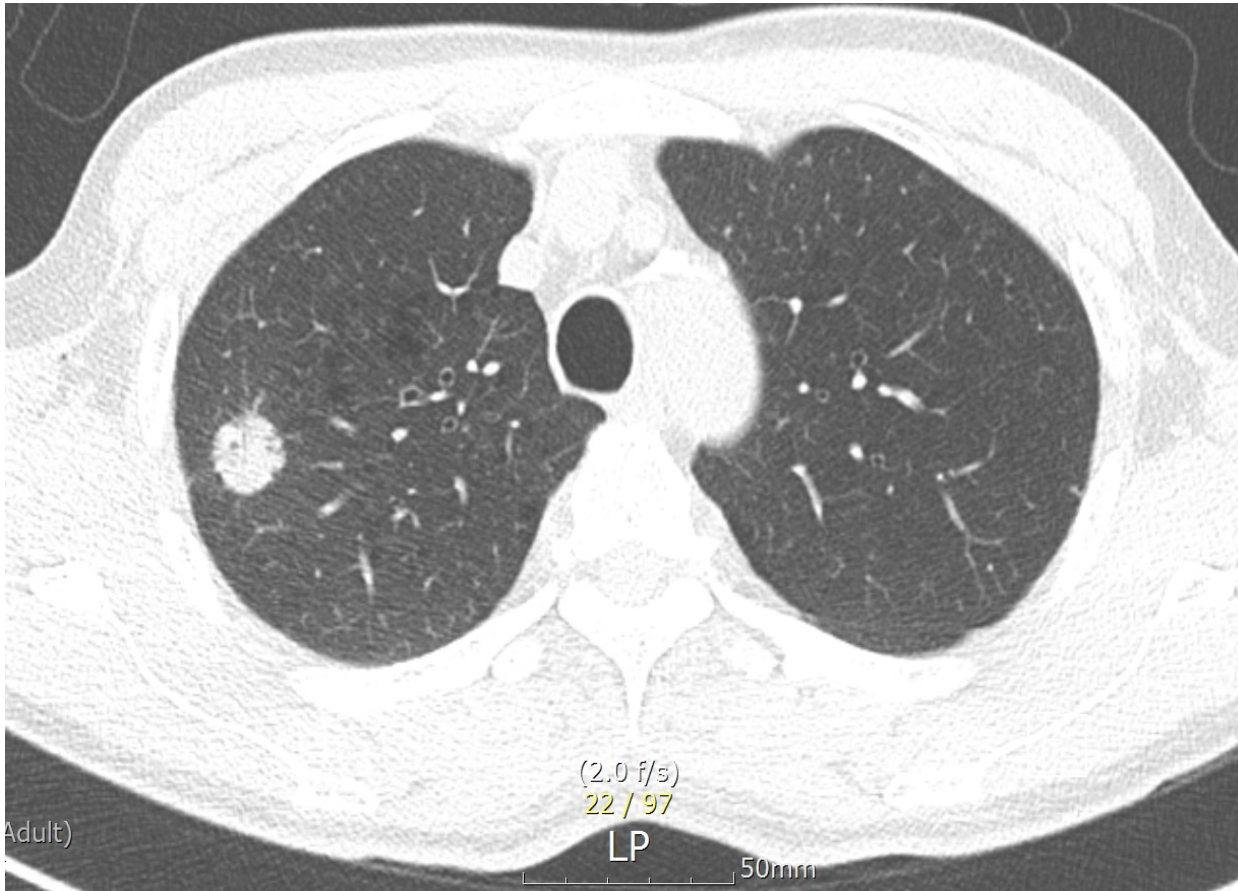
RUL nodule on chest X ray

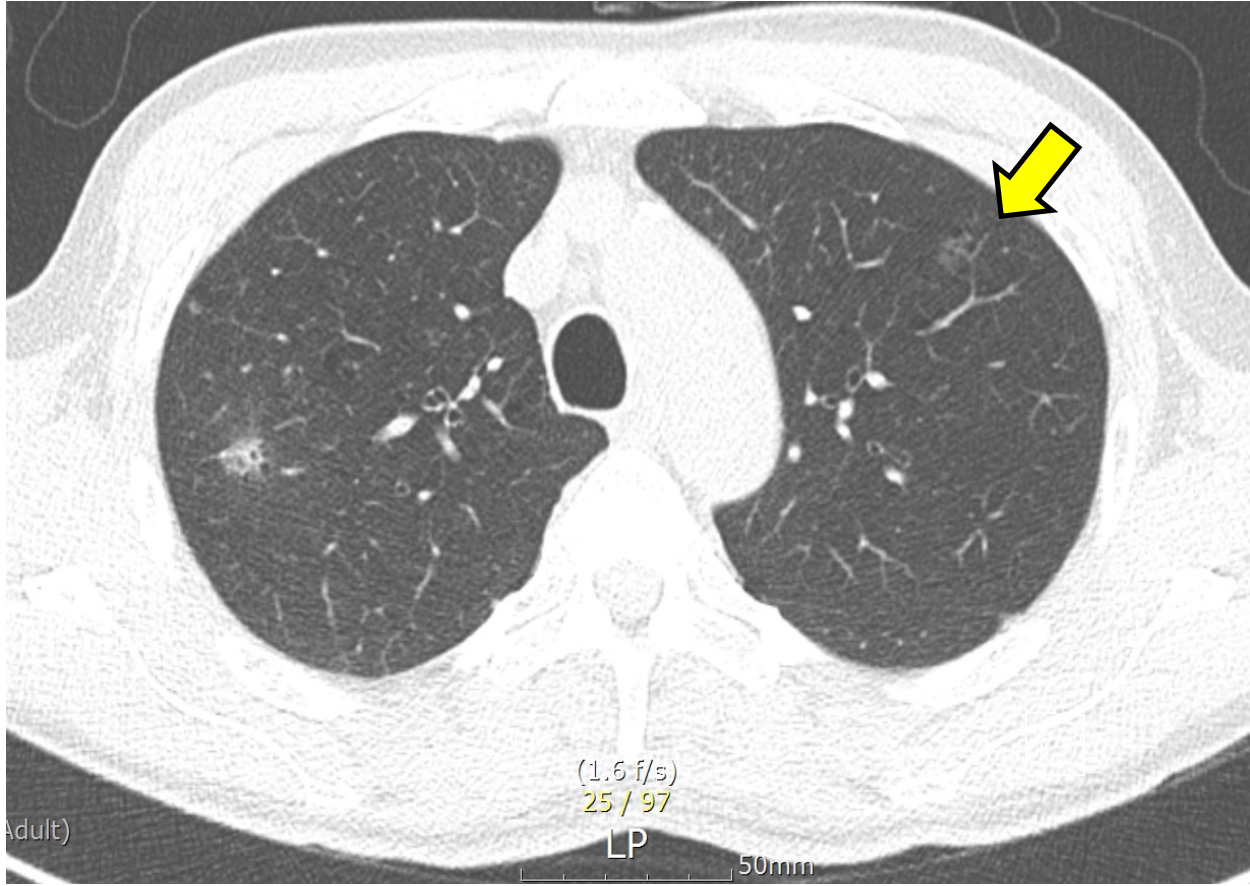
DM/HTN

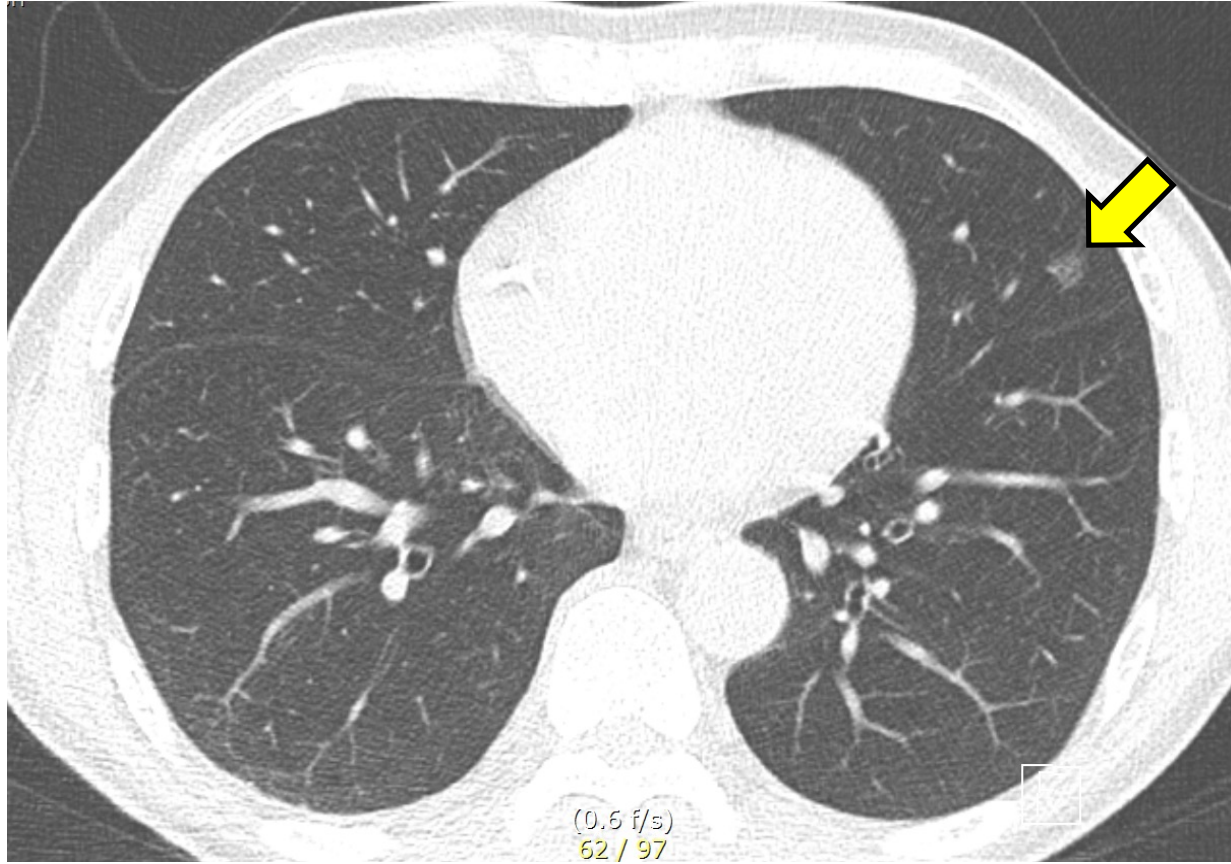
Smoking 100PY



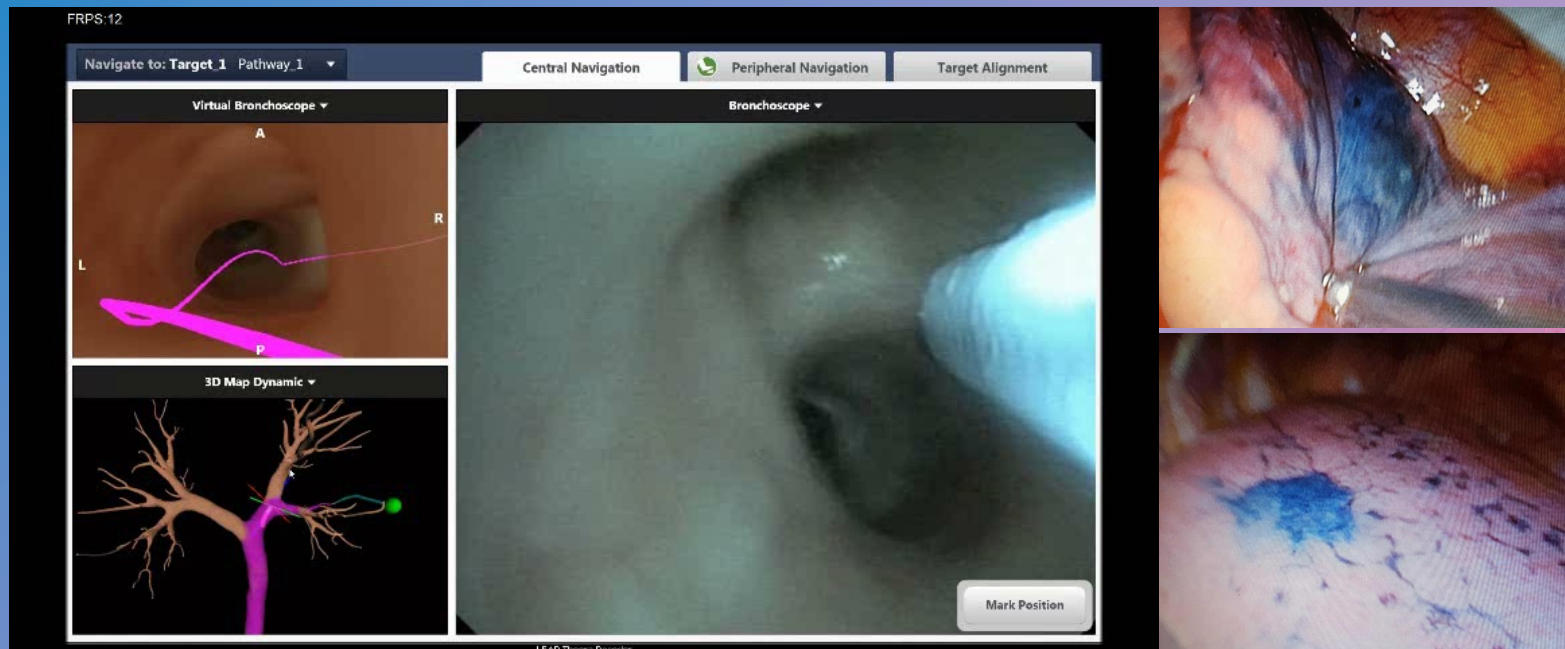
RUL PCNB: Adenocarcinoma







Super D localization





Pathology

RUL: adenocarcinoma, papillary (70%), acinar (30%)

size 2.5 x 1.7cm

lymph node metastasis (-)

LUL, lingular: minimally invasive adenocarcinoma

size 0.6 x 0.3cm

clear resection margin

anterior: minimally invasive adenocarcinoma

size 0.6 x 0.2cm

clear resection margin



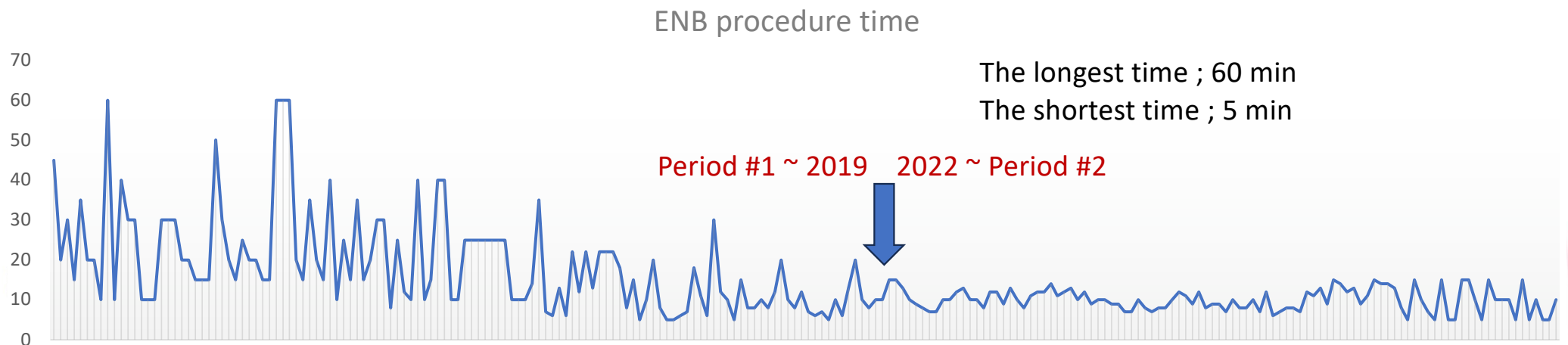
CNUH ENB data

- Single center, 2017 ~ September, 2023
- ENB cases 2017~2023 ; 228 times except 2020 ~ 2022 => 4 years
- ENB biopsy + tattooing ; 227 times on 183 patients
- ENB guided one-way check valve ; successful on one patient
- **There is no complication related with ENB procedure.**
- ENB biopsy success rate ; 22/26 ; 85%
 - Success was defined as frozen biopsy confirmed sufficient specimen on lung parenchyme
- ENB tattooing success rate ; 196/201 ; 97%
 - Success was defined as the ability to detect fluorescence dye (ICG + methylene blue) on VATS or thoracotomy

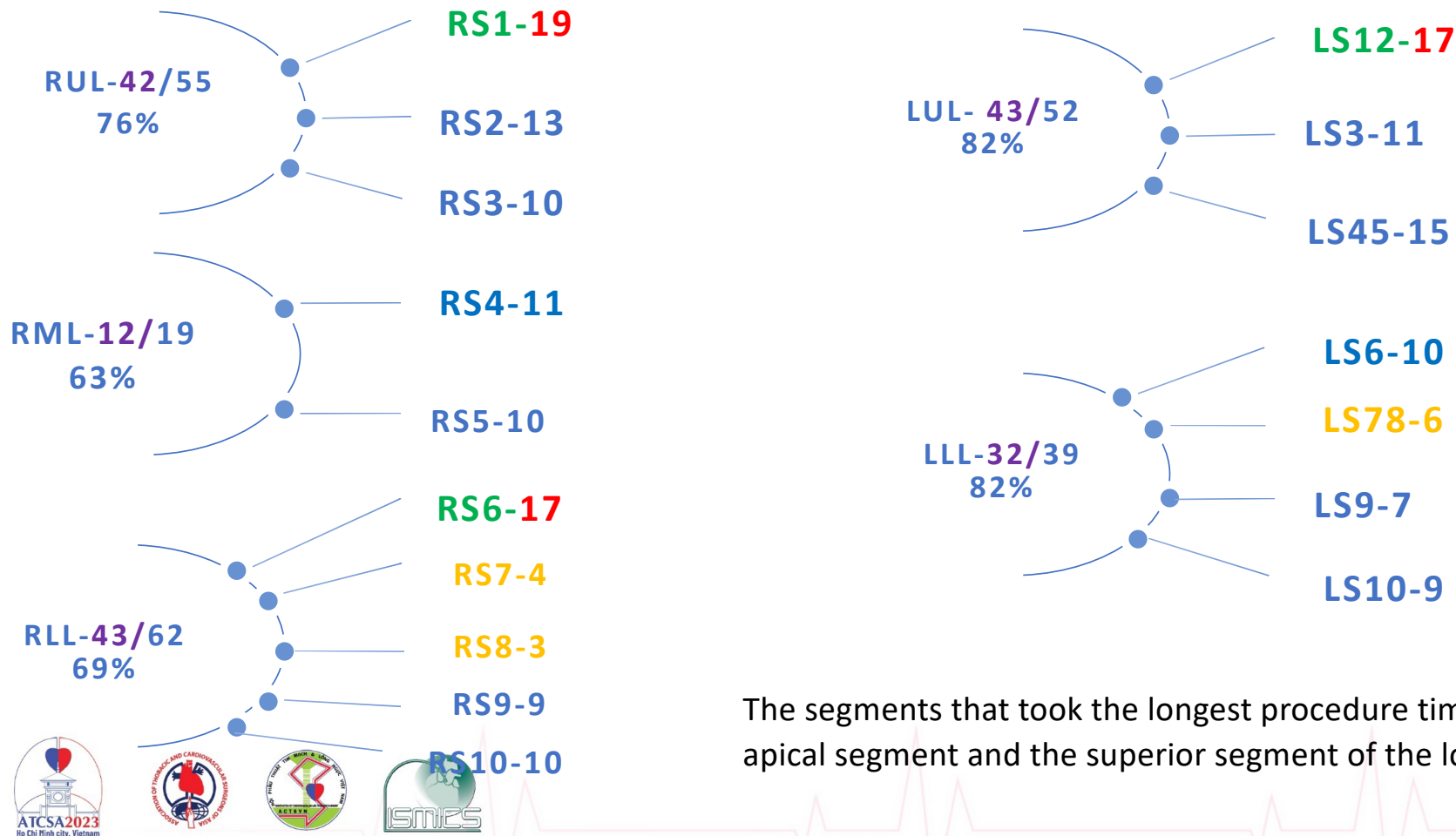


CNUH ENB data

- ENB procedure time ; total 3331 min on 228 times, average 15 min
 - Duration definition ; after single-lumen endotracheal intubation, start at registry to mark time (tatooing or biopsy)
 - Period #1 (2017~2019) ; 118 times, average 19 min
 - Period #2 ; (2022~2023) ; 106 times, average 10 min
 - Statistically differences ($p=0.001$) were seen between two group of period



ENB procedure time ≤ 15 min



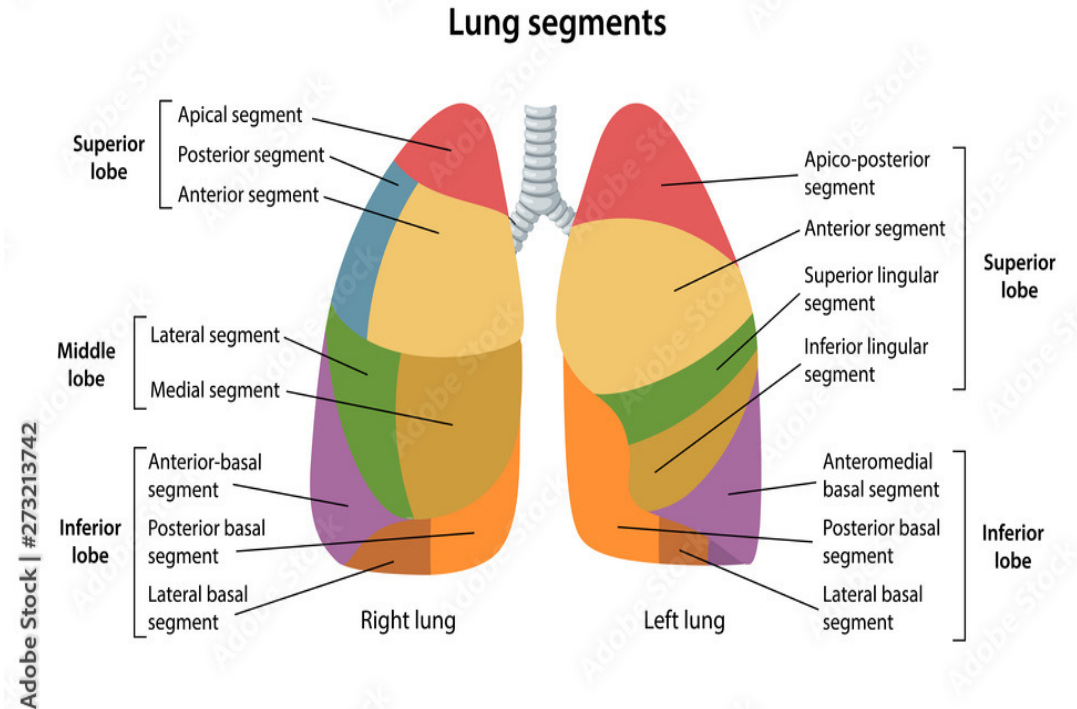
The segments that took the longest procedure time were the apical segment and the superior segment of the lower lobe.

How about success rate?

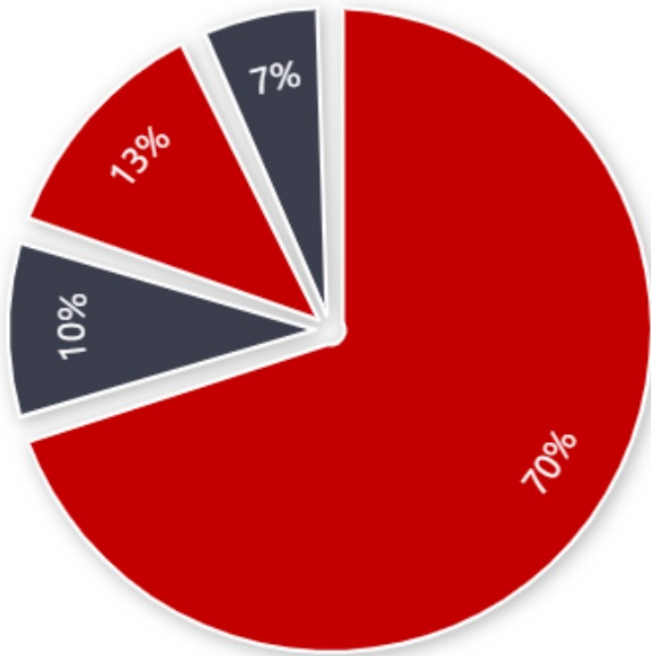
The anterior segment of both upper lobes was the most difficult segment with a success rate of 93%.

! Segments.success rate

LS12 n=20	95%	RS1 n=24	100%
LS3 n=15	93%	RS2 n=17	100%
LS45 n=16	94%	RS3 n=14	93%
LS6 n=11	100%	RS4 n=16	100%
LS78 n=7	100%	RS5 n=3	67%
LS9 n=10	90%	RS6 n=22	95%
LS10 n=11	100%	RS7 n=4	100%
		RS8 n=6	100%
		RS9 n=14	93%
		RS10 n=17	94%

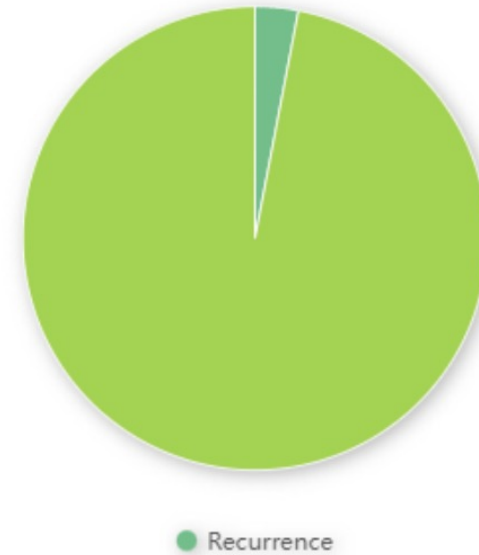


Surgical approach



● Wedge ● Segmentectomy ● Lobectomy ● No surgery, Biopsy only

Recurrence rate



Recurrence Location: 3%

Lung-3 (ipsilateral)

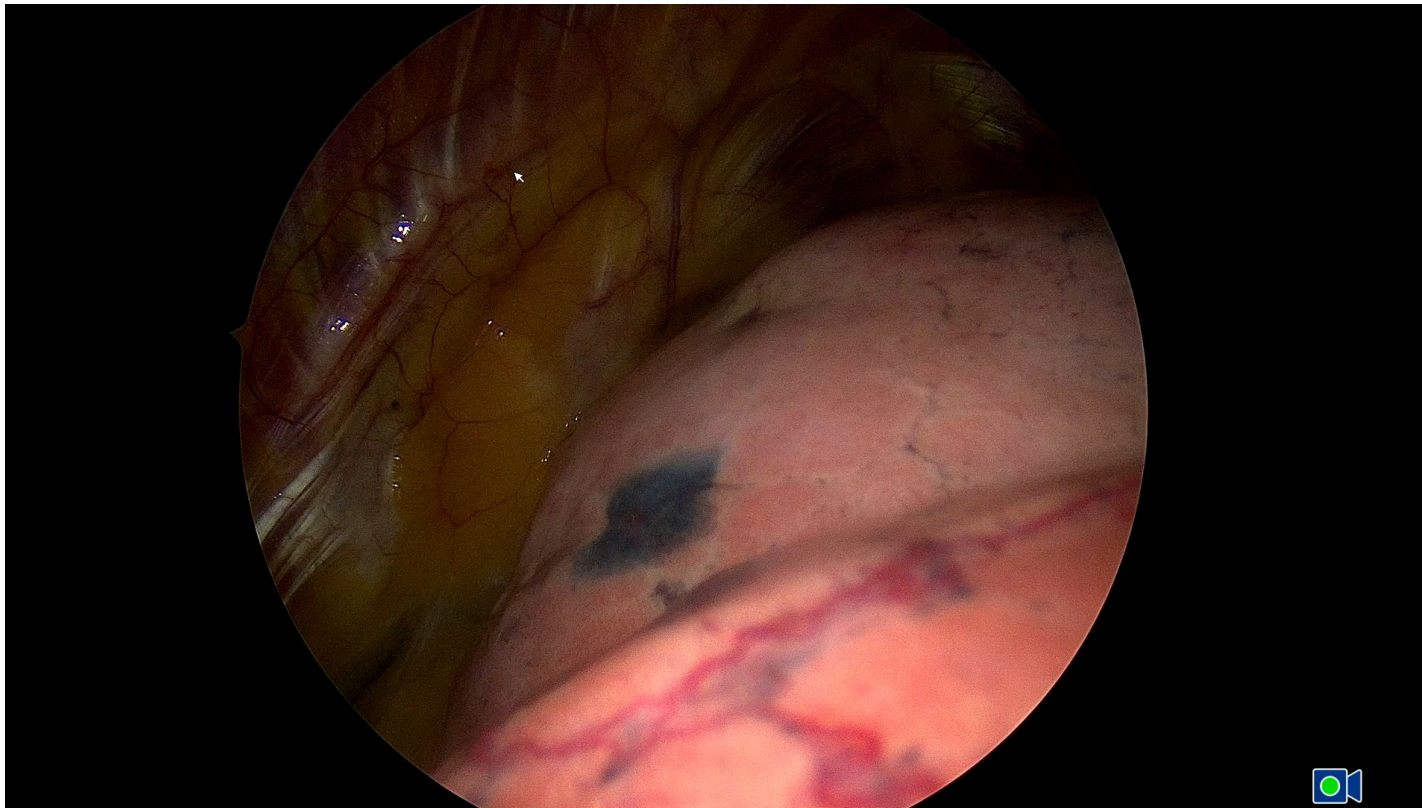
Lung-1 (contralateral)

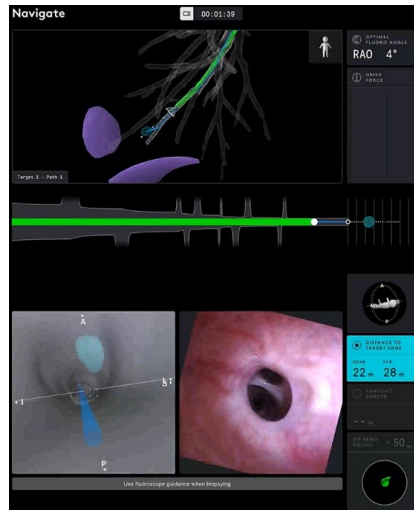
Brain-1

NIR thoracoscopy ICG

יהי אור

Fiat lux





Robotic ENB system introduce to Asian area by Intuitive and Ethicon near future. It will help us to do the ENB procedure easier and overcome running curve.

