Current status of navigation bronchoscopy

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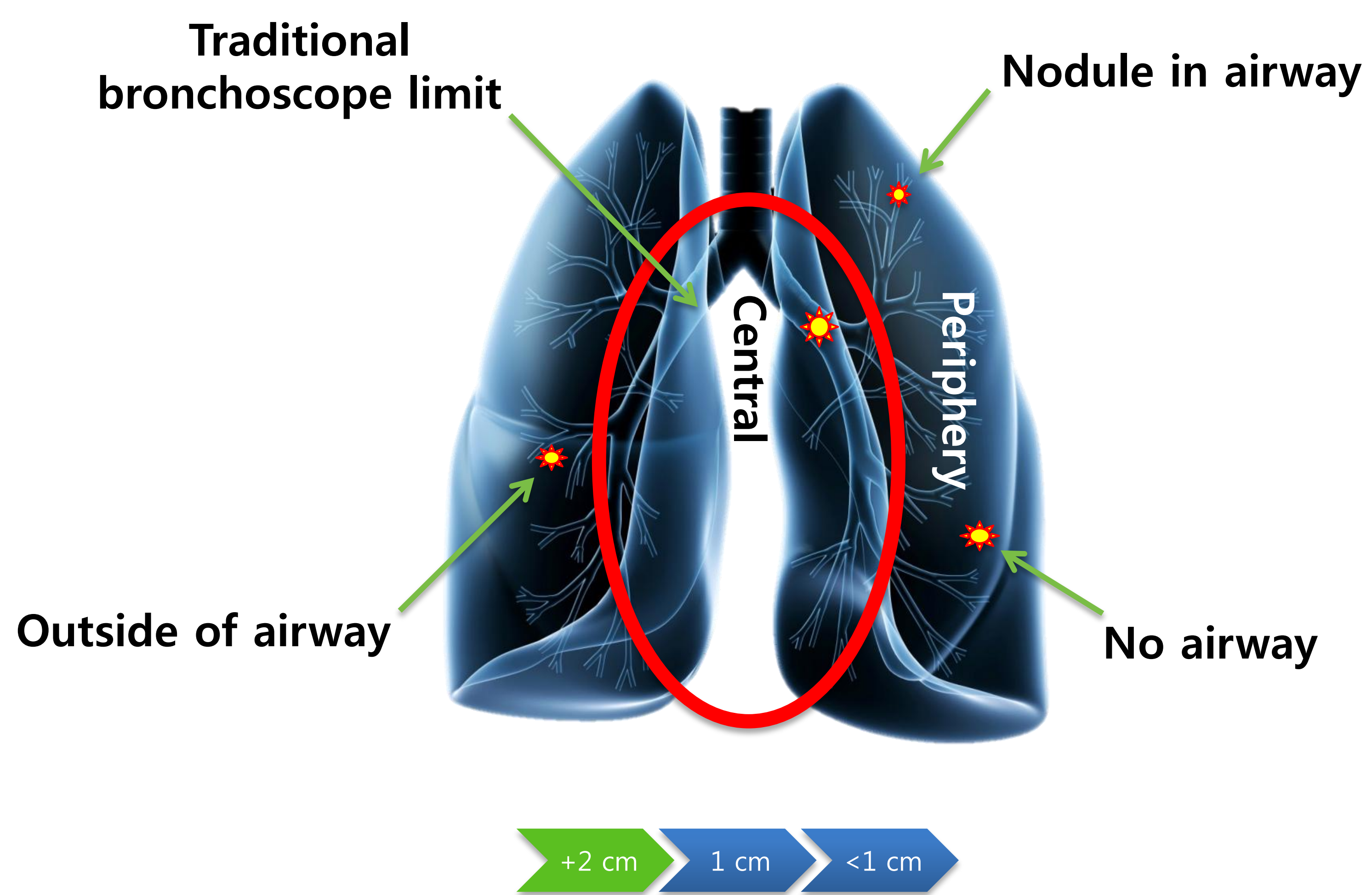
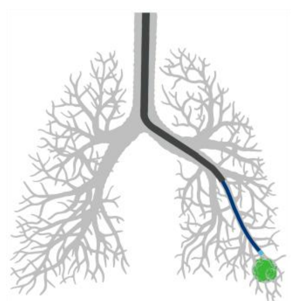
New challenge in lung biopsy



Current option with diagnostic dilemma of SPN

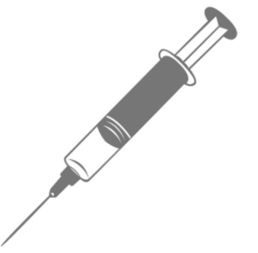
Watchful Waiting

ENB™ Procedure



Traditional Bronchoscopy

Transthoracic Needle Biopsy (TTNB)



Thoracotomy (Wedge Resection)

Diagnostic approach using bronchoscopy

- Conventional bronchoscopy

- Ultrathin/thin bronchoscopy
- EBUS-GS (guide sheath) using thin bronchoscope

→ Bf-NAVI; Cybernet Systems, Tokyo, Japan

→ LungPoint; Broncus Technologies, Inc., Mountain View, CA

- Electromagnetic navigation bronchoscopy

→ superDimension, Covidien

→ SPiN Drive, Veran

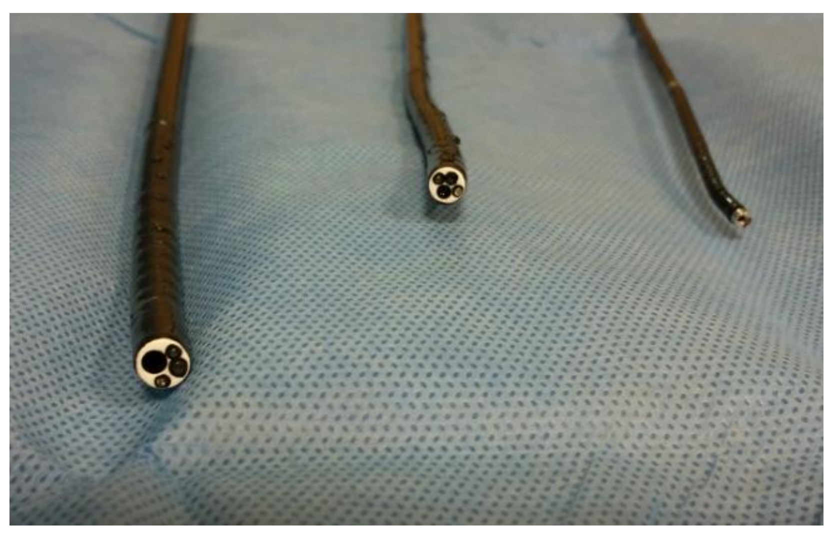
EBUS-GS using thin scope

Ultrathin/thin scope

	제품명	직경 (mm)	내경 (mm)	만곡	시야범위 (mm)	시야각	비고
Ultrathin	BF-XP260F	2.8	1.2	상 180° 하 130°	2-50	90°	
	Y-0025	3	1.7	상 180° 하 130°	2-50	90°	개발 중
	BF-XP290	3.1	1.2	상 210° 하 130°	2-50	110°	
Thin	BF-P260F	4.0	2.0	상 180° 하 130°	3-50	120°	Radial EBUS 가능
	BF-P290	4.2	2.0	상 210° 하 130°	2-50	110°	Radial EBUS 가능

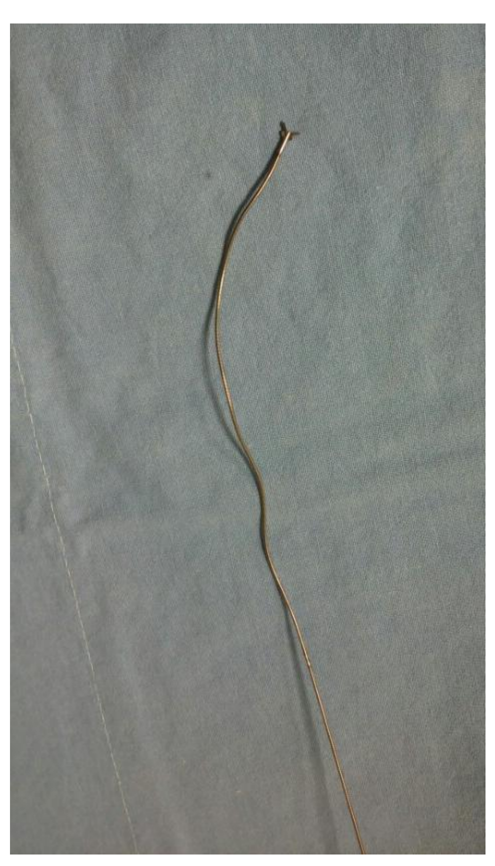
기관지내시경 굵기 비교

- 좌측: 일반기관지경, BF-1T260, distal end 5.9 mm, channel 2.8 mm
- 중간: 형광기관지경, BF-F260, distal end 5.5 mm, channel 2.0 mm
- 우측: Ultrathin, BF-XP260F, distal end 2.8 mm, channel 1.2 mm



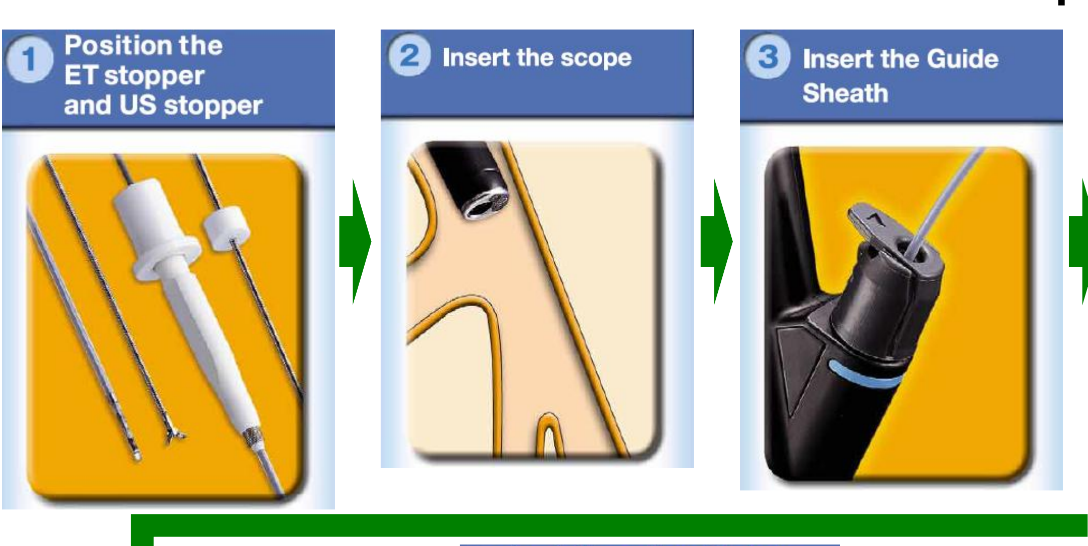
Biopsy forceps 크기 비교

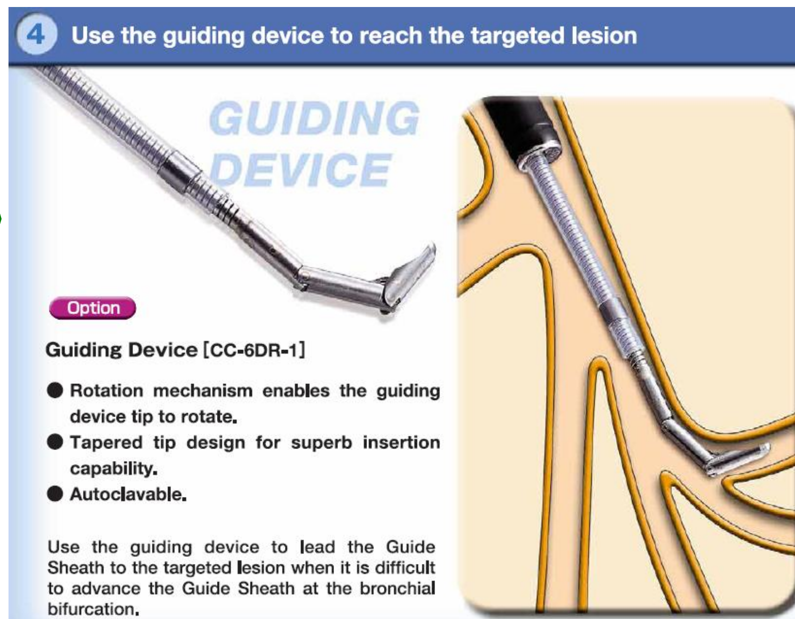
◆ 1.2 mm 용

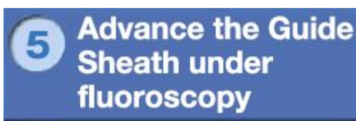


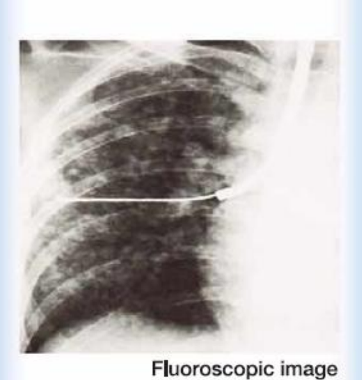
◆ 1.2 mm vs 2.0 mm 이상

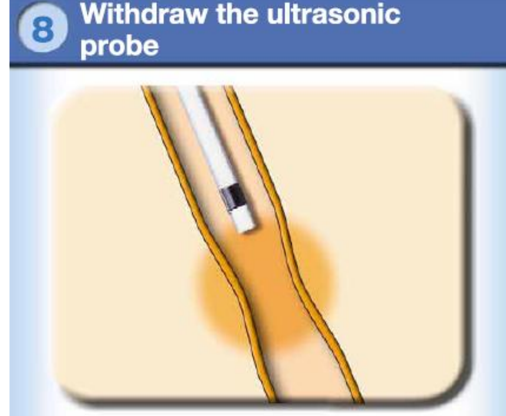
Guide sheath technique procedure-1



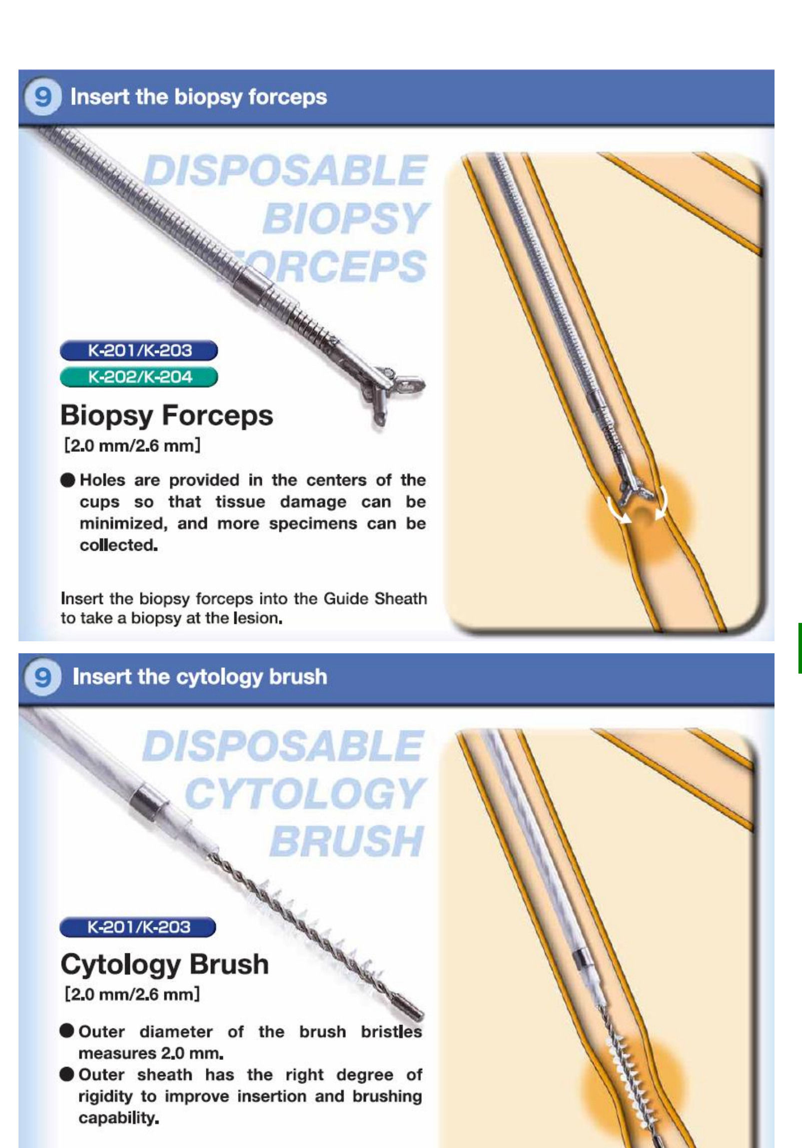




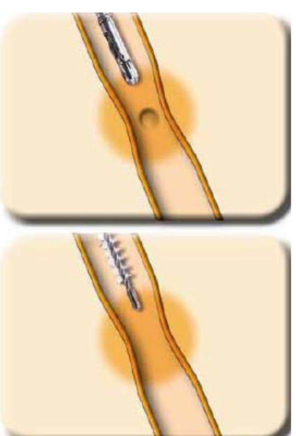




Guide sheath technique procedure-2

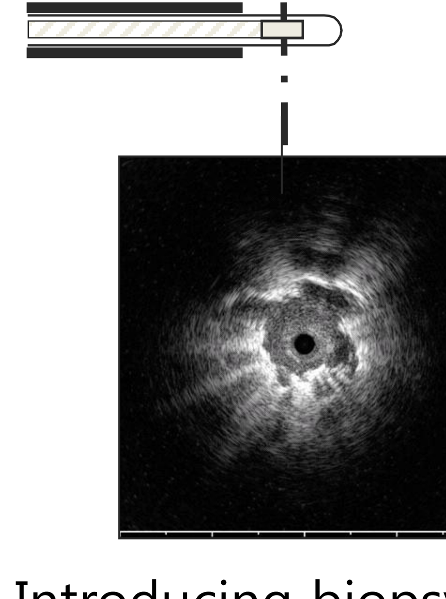


10 Repeat sampling



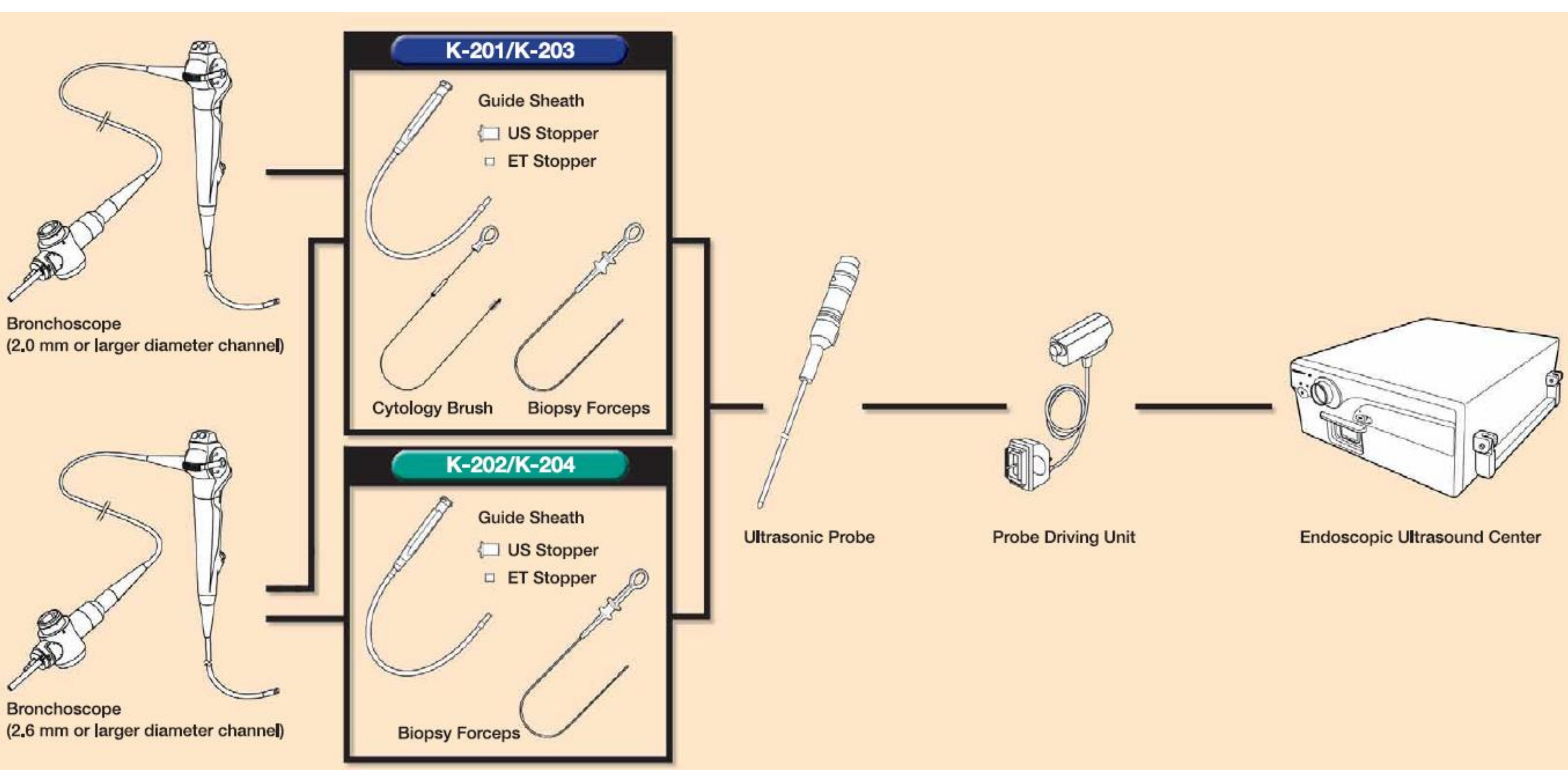
EBUS-GS

1. Advancing the guide-sheath-covered US probe to the peripheral pulmonary lesion to obtain an EBUS image

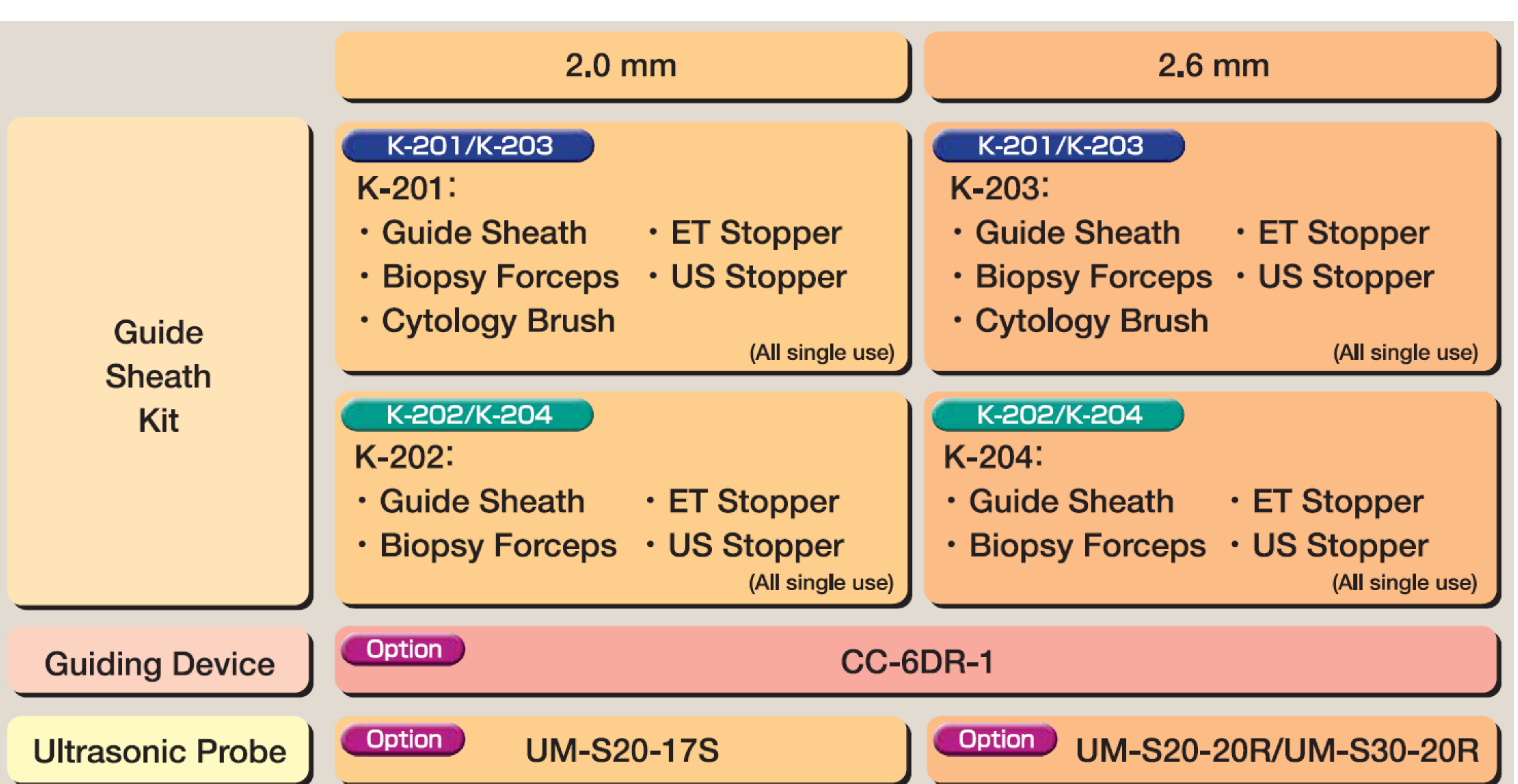


2. Introducing biopsy forceps and bronchial brush via the guide-sheath to obtain specimens

Guide sheath kit system chart



Guide sheath products



Ultrasonic probe

제품명	직경 (mm)	주파수
UM-S20-17S	1.7	20 MHz

Guide sheath kit

제품명	구성품	내용	직경 (mm)
K-201	SG-200C	Guide sheath	1.95
	FB-233D	Biopsy forceps	1.5
	BC-204D-2010	Cytology brush	1.4

Thin scope for Radial Probe EBUS

	제품명	직경 (mm)	내경 (mm)	만곡	시야범위 (mm)	시야각	비고
Thin	BF-P260F	4.0	2.0	상 180° 하 130°	3-50	120°	Radial EBUS 가능
	BF-P290	4.2	2.0	상 210° 하 130°	2-50	110°	Radial EBUS 가능

Virtual bronchoscopic navigation combined with ultrathin bronchoscopy. A randomized clinical trial

Am J Respir Crit Care Med 2013;188(3):327-33.

- A multi-center randomized clinical trial
- To evaluate the usefulness of **virtual bronchoscopic navigation (VBN)** in transbronchial biopsy using an **ultrathin bronchoscope (outer diameter, 2.8 mm)** for small pulmonary peripheral lesions
- 334 patients
- **Peripheral pulmonary lesions (diameter, ≤30 mm)**
- **VBN-assisted group (67.1%)** and **non-VBN-assisted group (59.9%**; $P = 0.173$)
- **Biopsy using X-ray fluoroscopy**

Virtual bronchoscopic navigation combined with endo bronchial ultrasound to diagnose small peripheral pulmonary lesions: a randomised trial

Thorax 2011;66(12):1072-7.

- A multi-center randomized clinical trial
- To evaluate the usefulness of **virtual bronchoscopic navigation (VBN)** in transbronchial biopsy using **endobronchial ultrasonography with a guide-sheath (EBUS-GS)** for small pulmonary peripheral lesions
- 199 patients
- Small pulmonary peripheral lesions (≤ 3 cm)
- Randomized into VBN and non-VBN groups
- Advancement of a thin bronchoscope
- VBN group: VBN system
- Non-VBN group: Referring to the CT axial images
- Biopsy using EBUS-GS under fluoroscopy
- Increased diagnostic yield when VBN is combined with EBUS

Ultrathin bronchoscopy with multimodal devices for peripheral pulmonary lesions. a randomized trial

Am J Respir Crit Care Med 2015;192(4):468-76.

- A multi-center randomized clinical trial
- To compare the diagnostic yield under **EBUS, fluoroscopy, and virtual bronchoscopic navigation guidance using a 3.0-mm ultrathin bronchoscope (UTB group)** with **that using a 4.0-mm thin bronchoscope with a guide sheath (TB-GS group)** for peripheral pulmonary lesions
- 305 patients
- Small pulmonary peripheral lesions (≤ 30 mm)
- Diagnostic histologic specimens (P=0.044, Mantel-Haenszel test)
  - **UTB group: 74% (42% for benign and 81% for malignant lesions)**
  - **TB-GS group: 59% (36% for benign and 70% for malignant lesions)**
- Complications including pneumothorax, bleeding, chest pain, and pneumonia occurred in **3%** and **5%** in the respective groups.

Electromagnetic navigation bronchoscopy (Covidien)

Indication for use

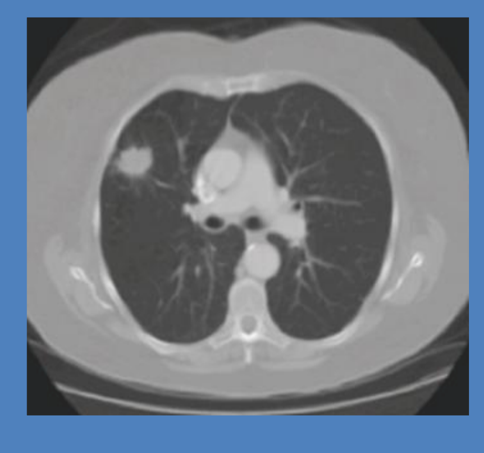
- Indicated for displaying images of the tracheobronchial tree to aid the physician in guiding endoscopic tools or catheters in the pulmonary tract and to enable marker placement within soft lung tissue.

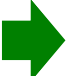
- The Electromagnetic Navigation Bronchoscopy™ procedure offers a minimally invasive approach to aid in the diagnosis and management of lung disease.

superDimension navigation system workflow

CT Scan

- DICOM data





Plan

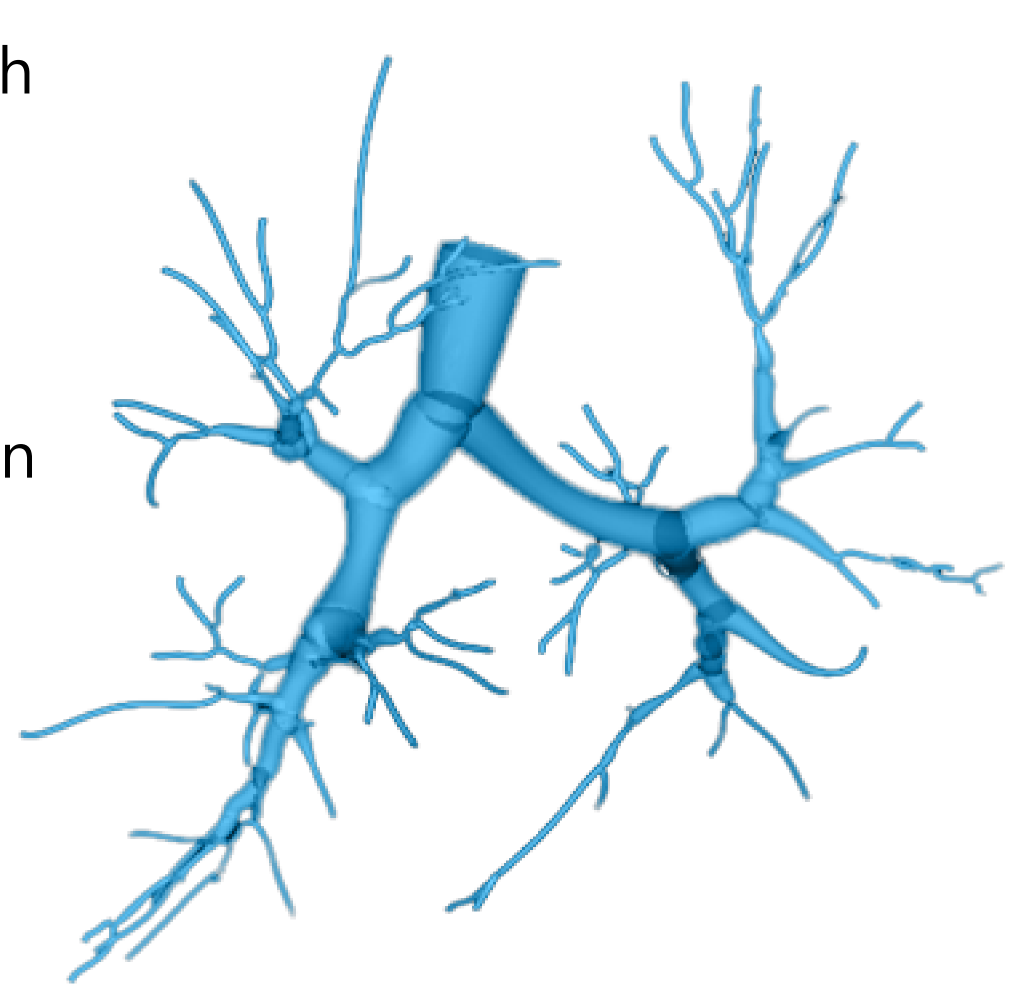
- Create a plan for the ENB™ procedure

Navigate

- Sample
- Localize

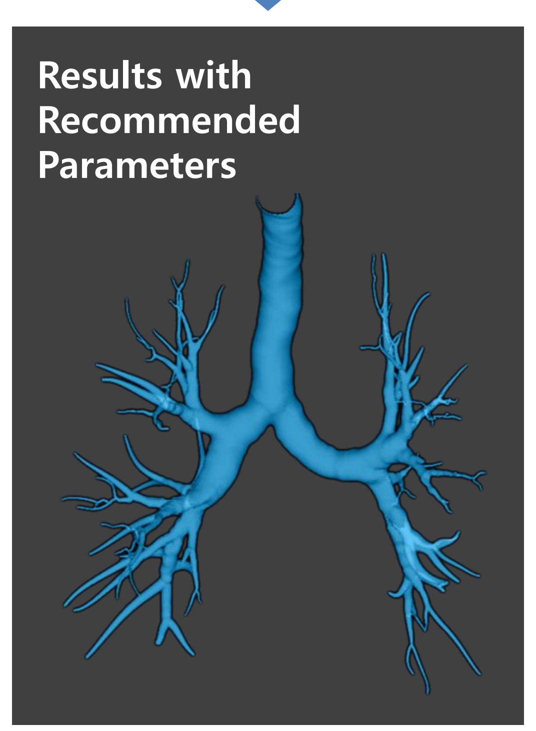
CT scan reconstruction

- Uses thin-slice DICOM with 20-50% overlap
- DVD/CD, USB, or PACS
- Allows for 3D map creation
  - Automatic registration
  - Pathway planning

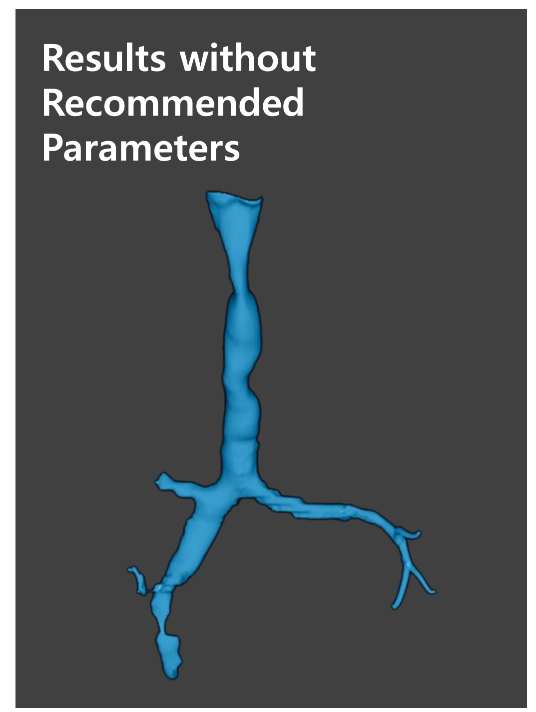


CT scan parameters

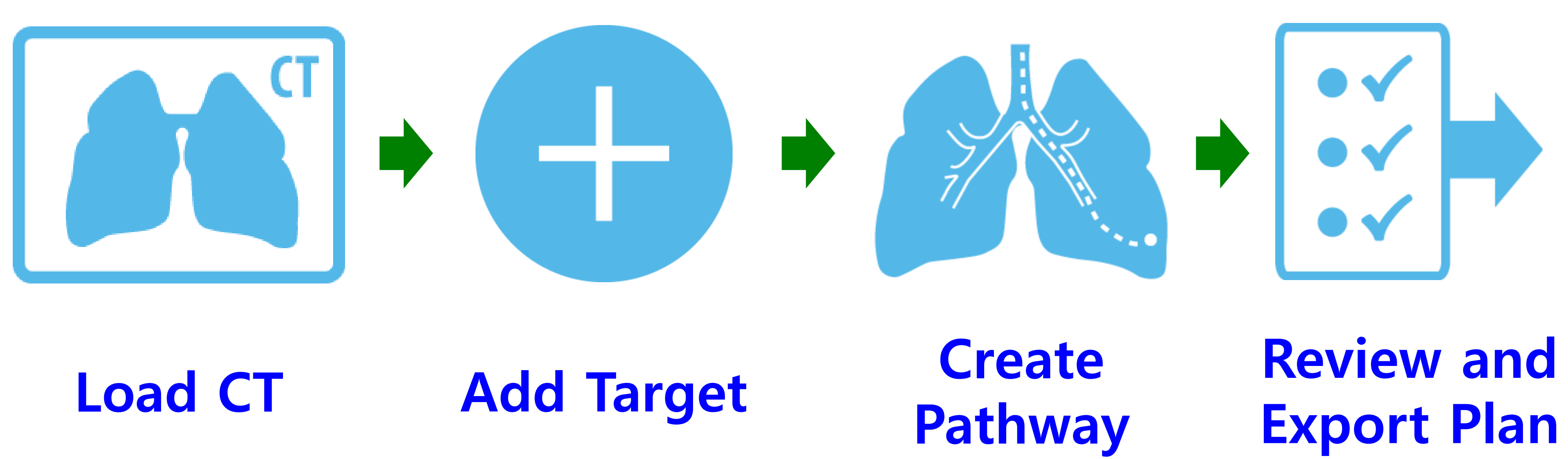
Parameters:	This CT	Recommended
Thickness:	1.25 mm	1.0 - 1.25 mm
Interval:	1	0.8 - 1.0 mm
Image Gaps:	No	No
Overlap:	20 %	20 - 50 %
Kernel:	STANDARD	STANDARD
Images:	312	50 - 690



Parameters:	This CT	Recommended
Thickness:	3.75 mm	1.0 - 1.25 mm
Interval:	3.27	0.8 - 1.0 mm
Image Gaps:	No	No
Overlap:	13 %	20 - 50 %
Kernel:	SOFT	STANDARD
Images:	267	50 - 690

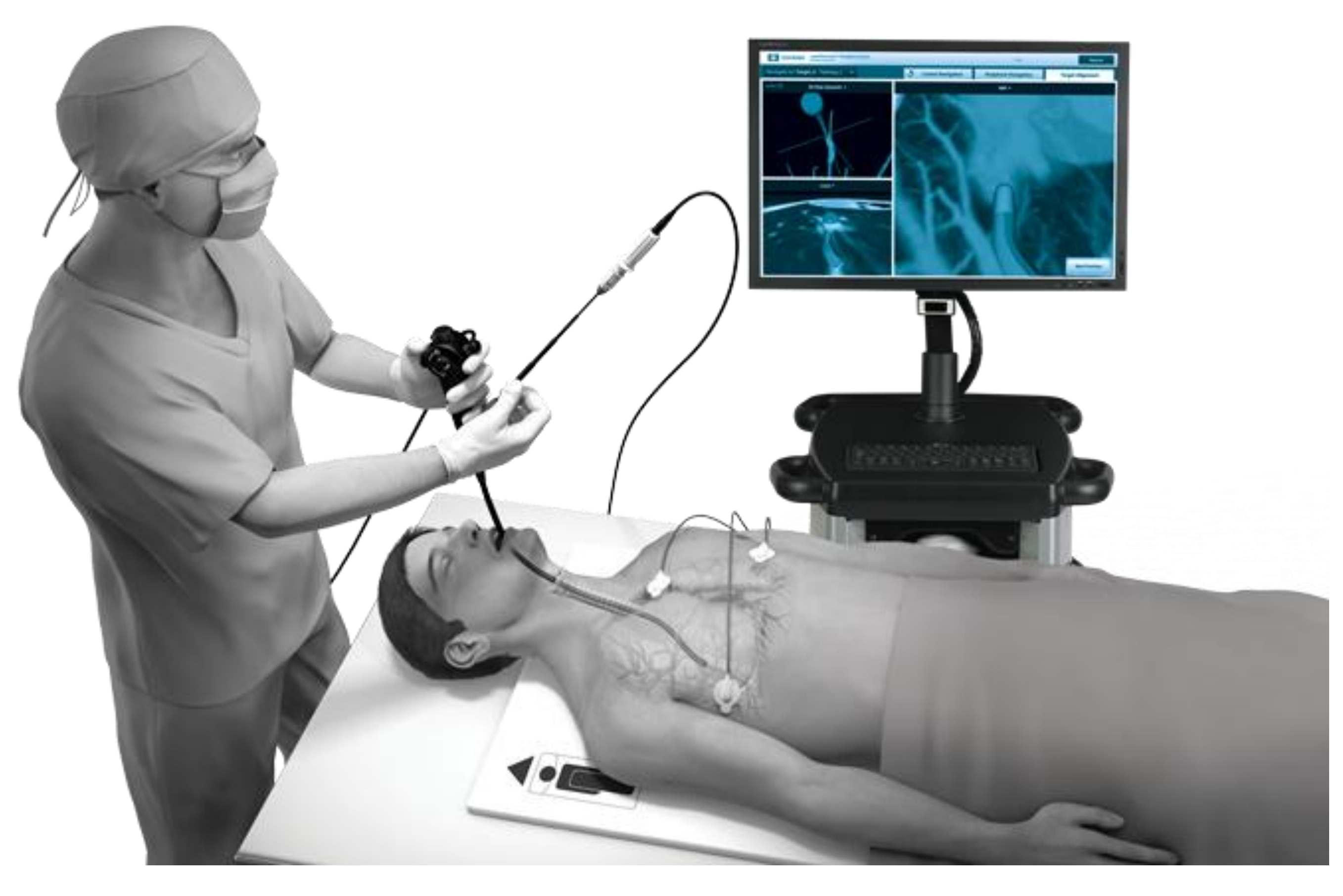


Planning workflow



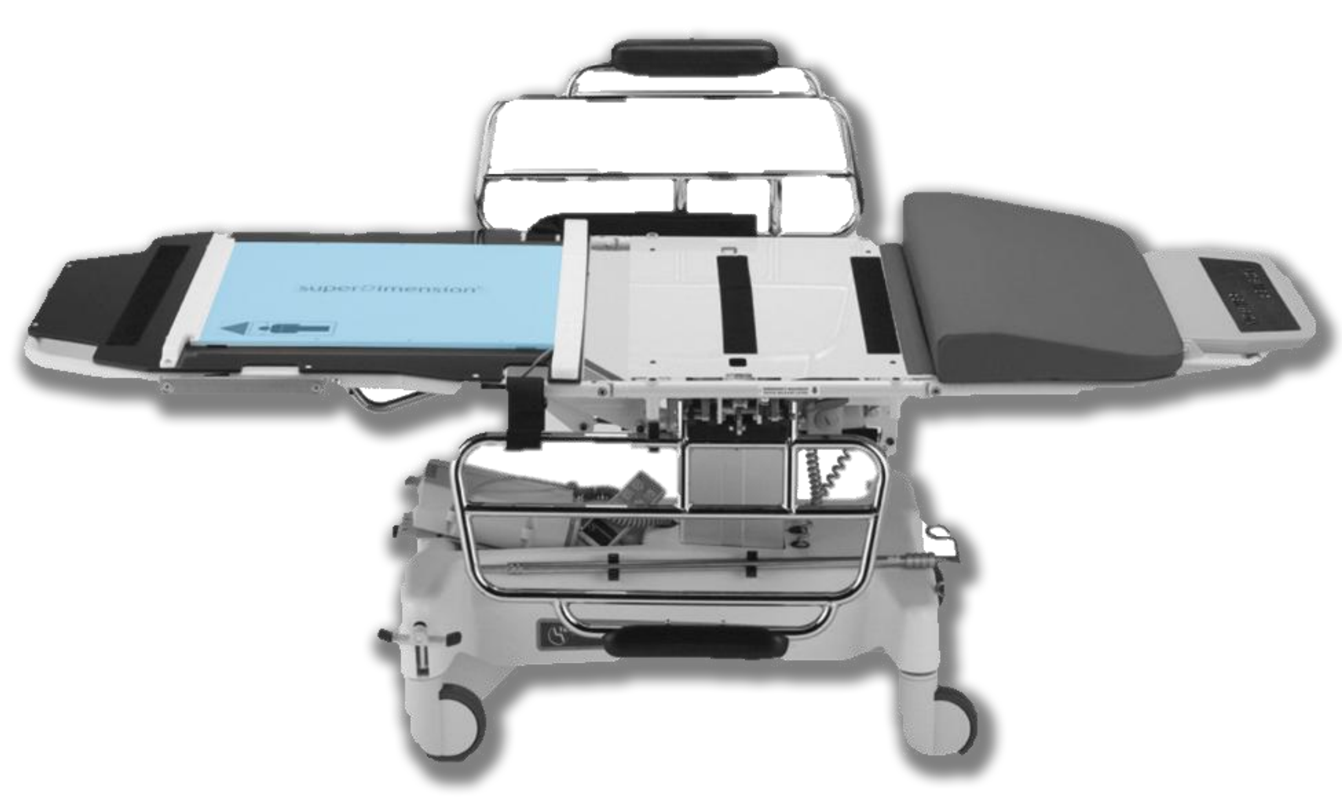
Localization

Location board + Patient sensors + Edge^{TM} navigation catheter



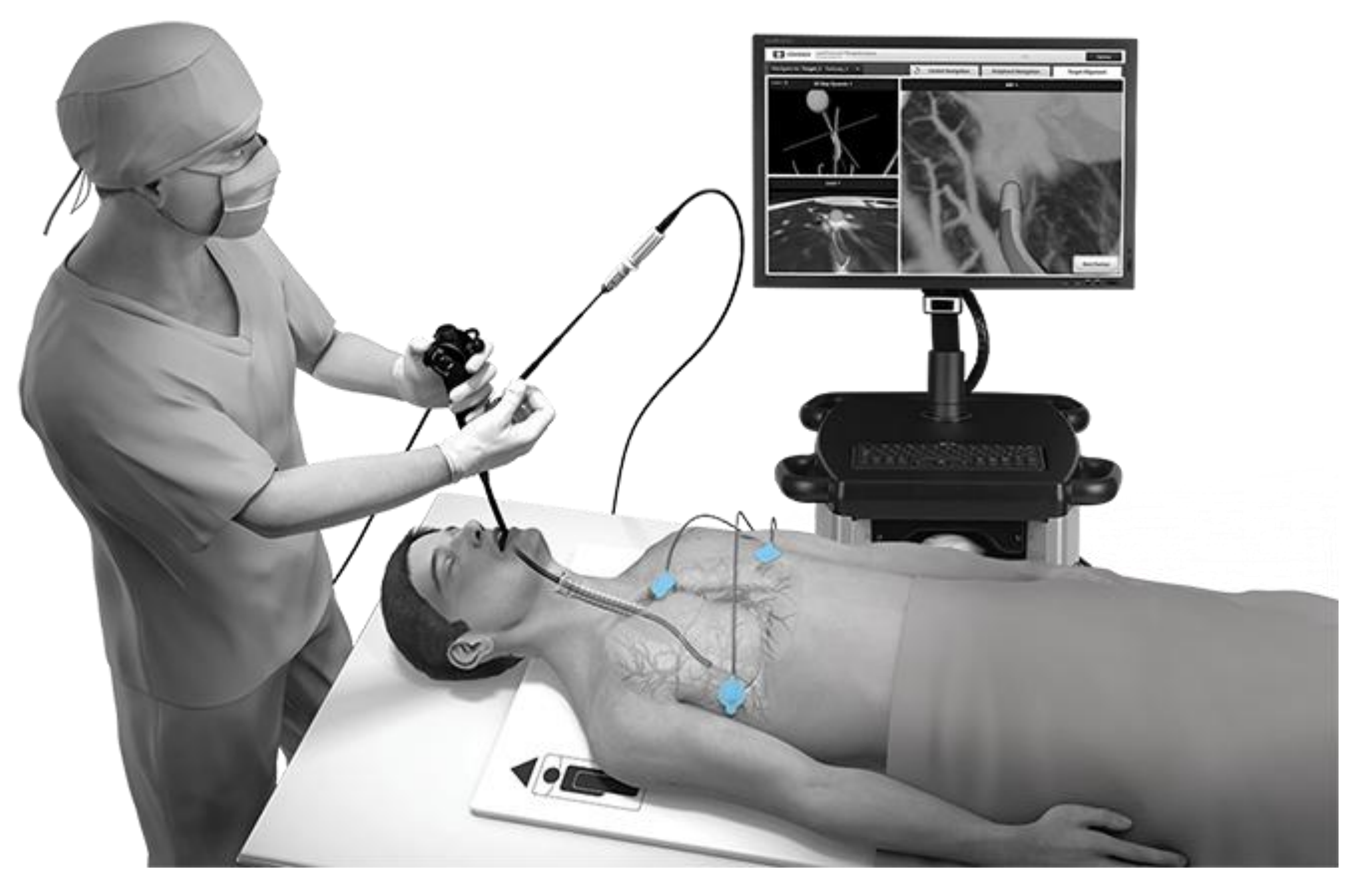
Location board

The location board is placed on a qualified procedure bed.

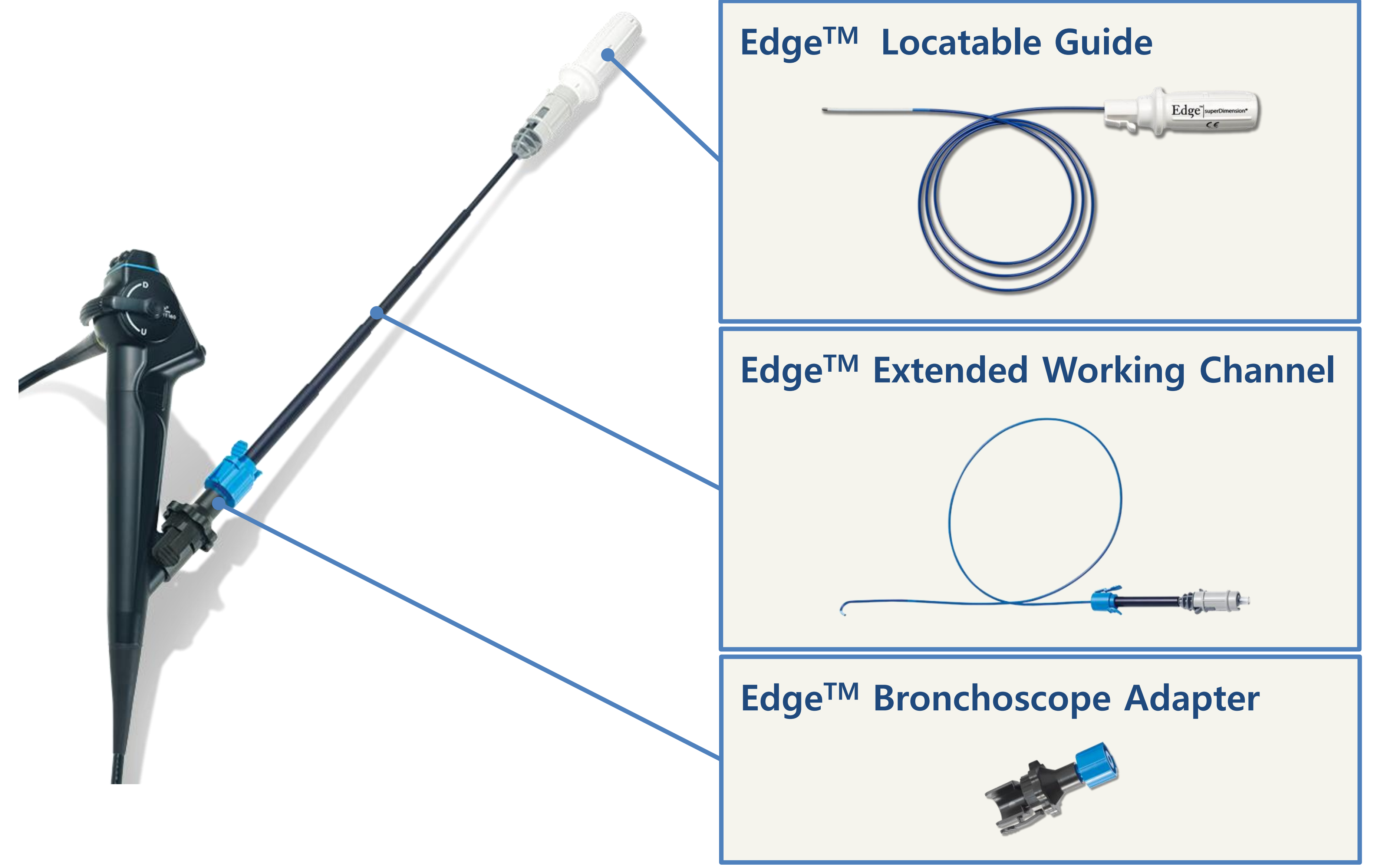


Patient sensors

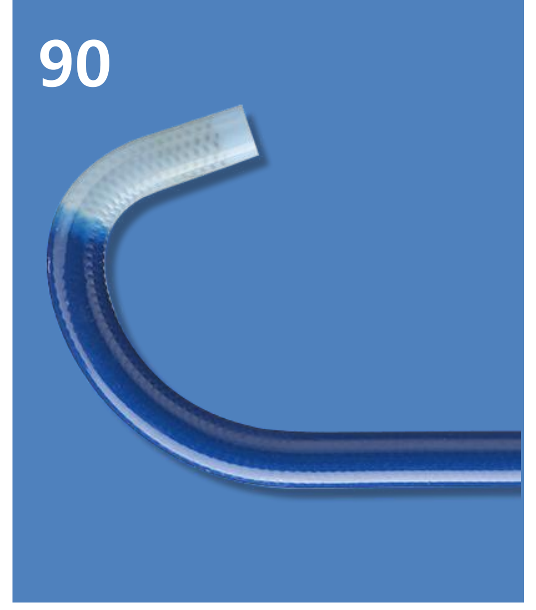
Track normal patient movement within the sensing volume.

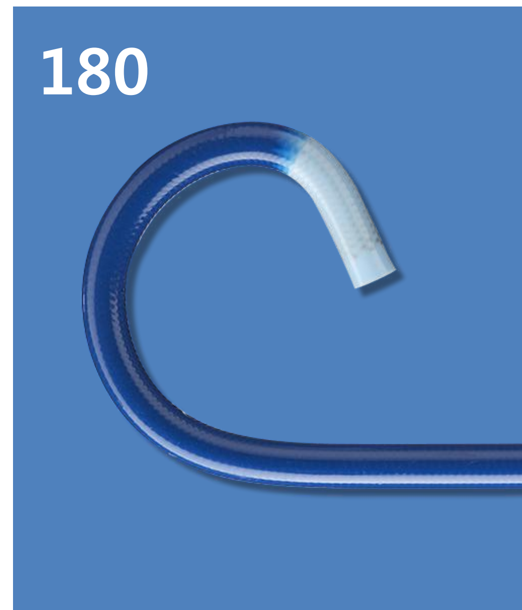


Edge™ navigation catheter

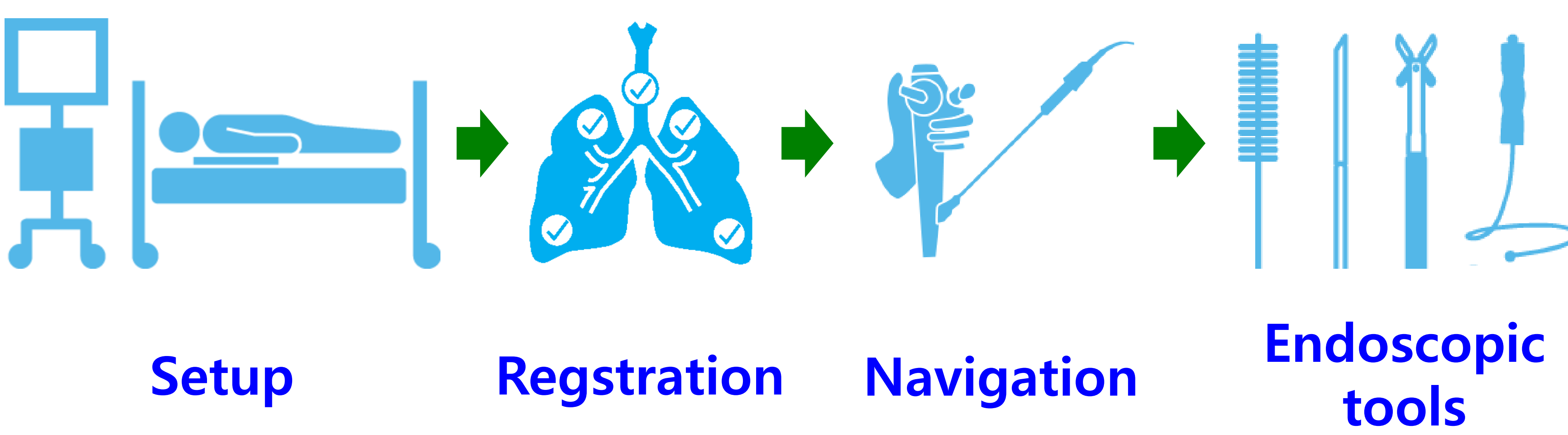


Edge™ extended working channel

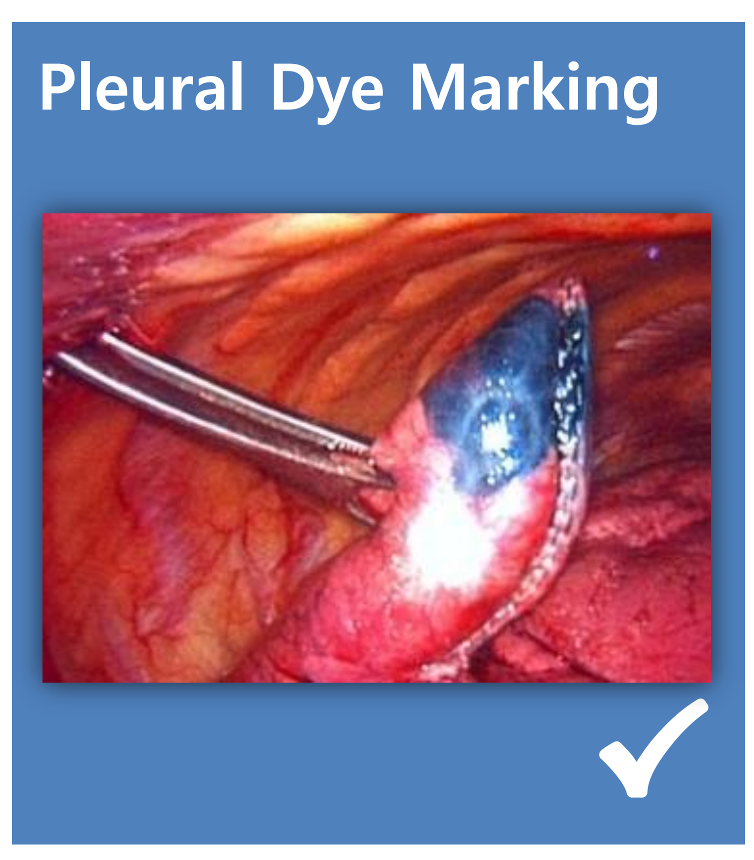


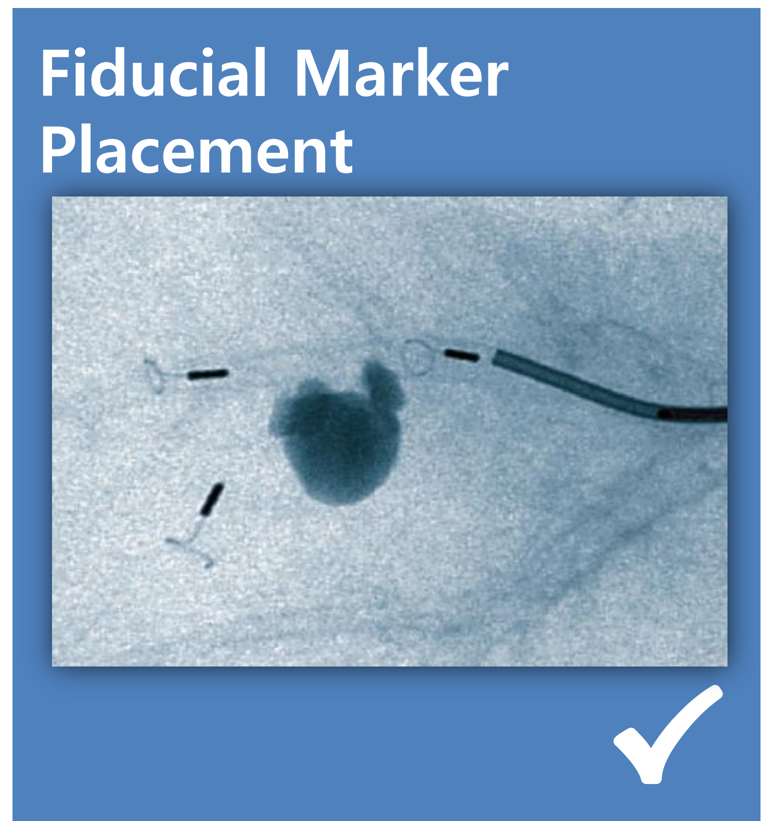


Navigation workflow



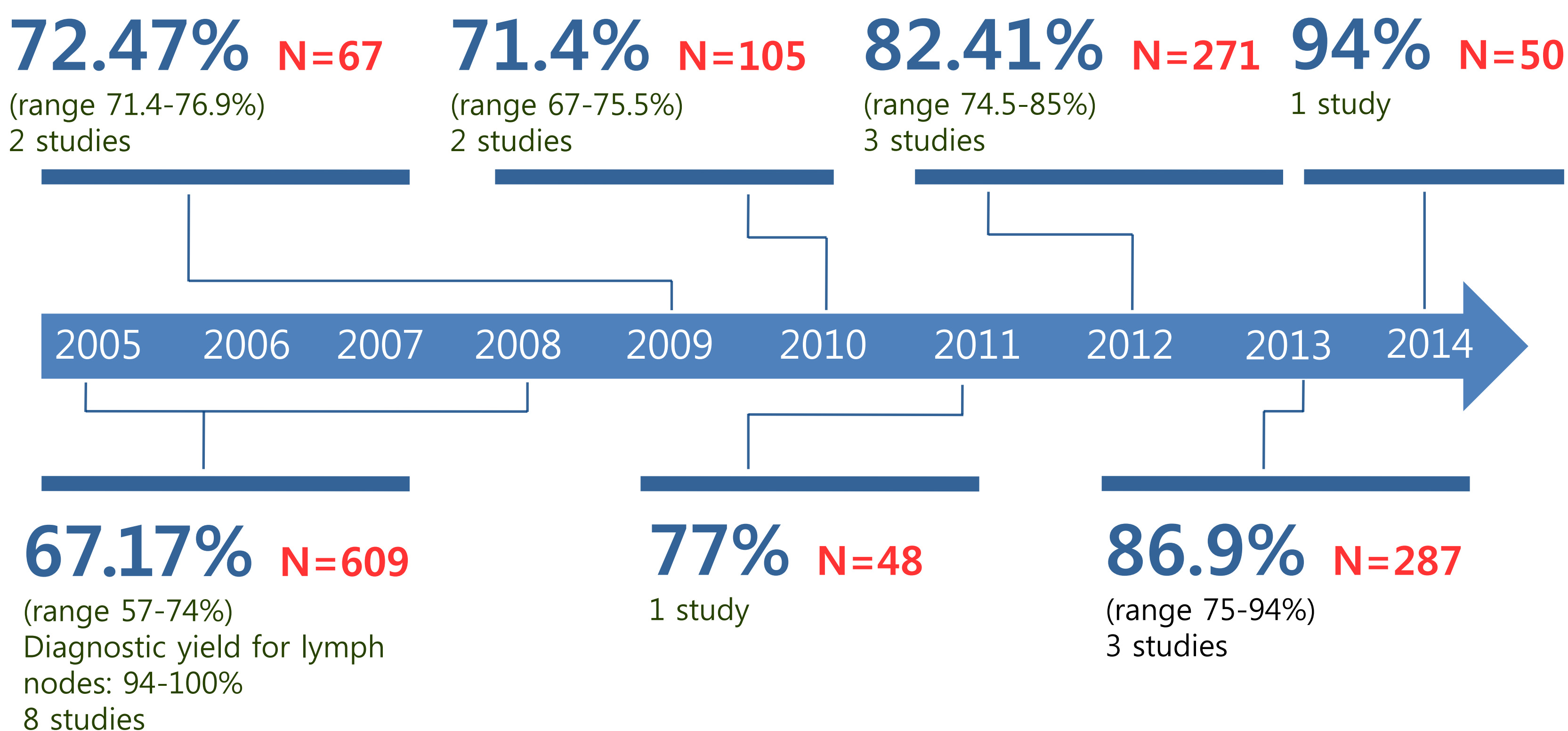
Localization techniques





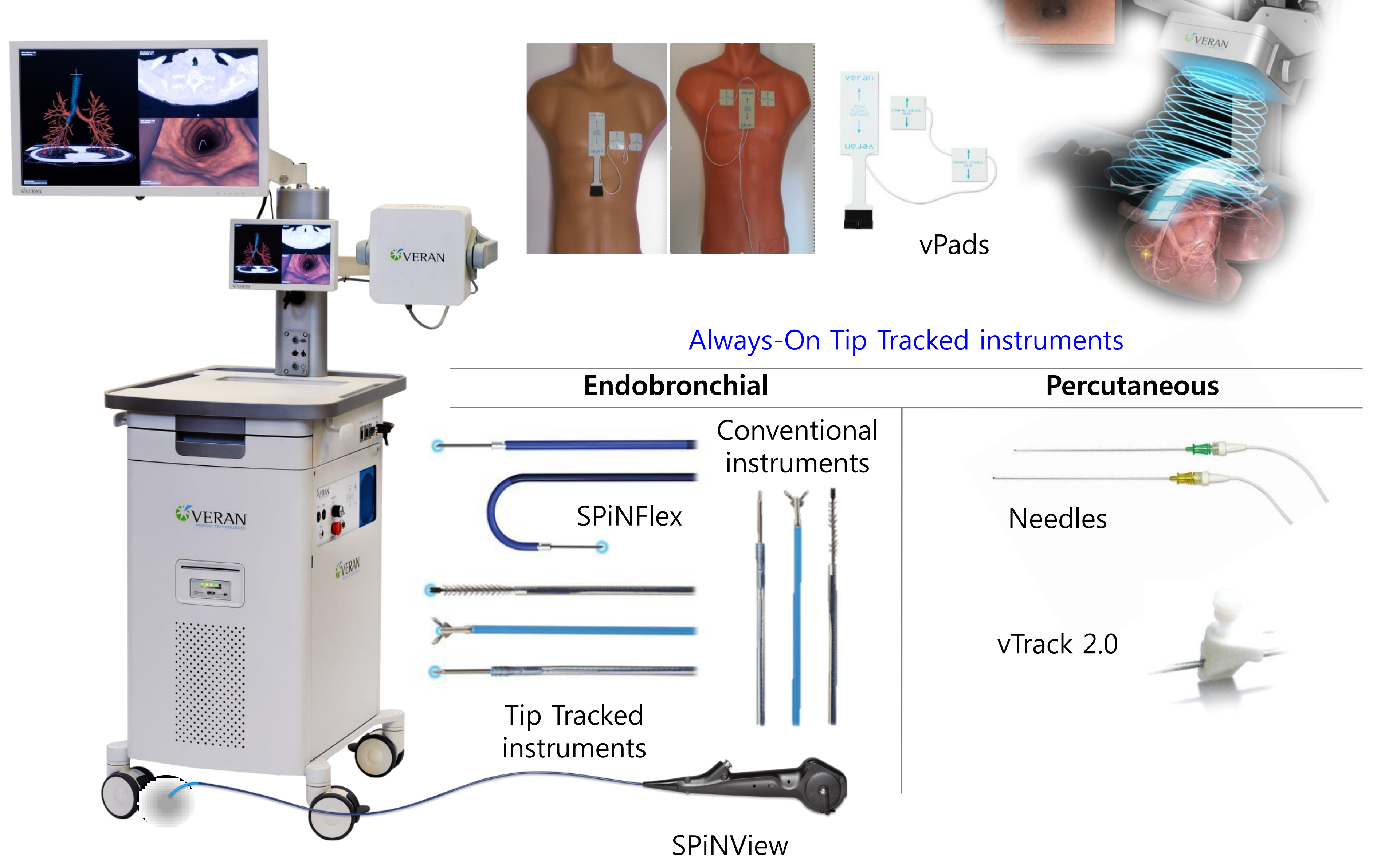
Aid with diagnostic yields by year

Increase from 67.17 – 94%



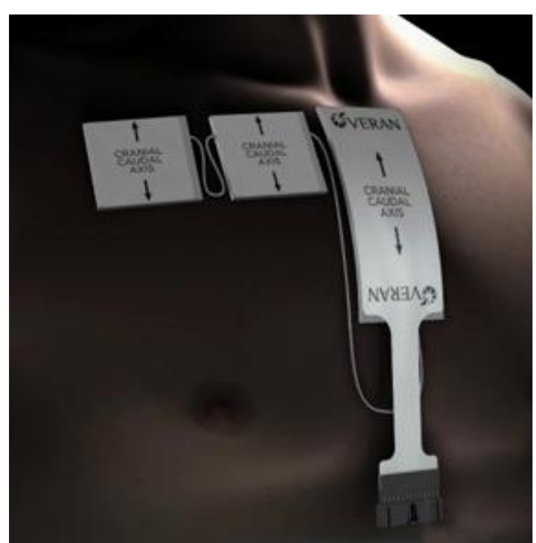
Electromagnetic navigation bronchoscopy (Veran)

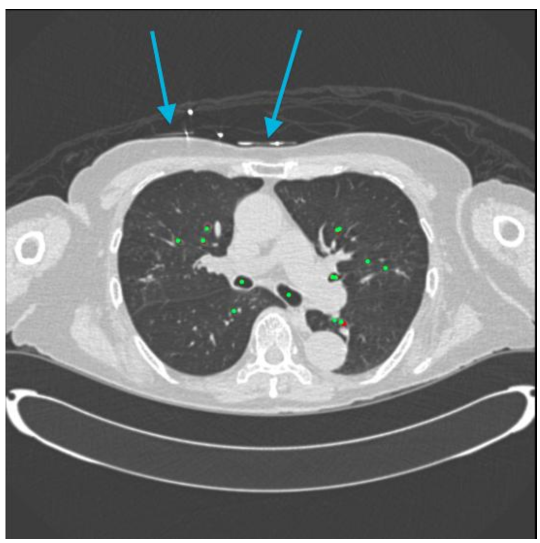
SPiN Drive navigation system



Automatic registration

- The sensors in the vPads not only track patient movement but they allow us to align the CT images to the patients actual anatomy by a process called automatic registration.
- The sensors act as reference points that can be seen within the CT. The software looks at where those same sensors are on the patients skin and aligns the CT with the patient.



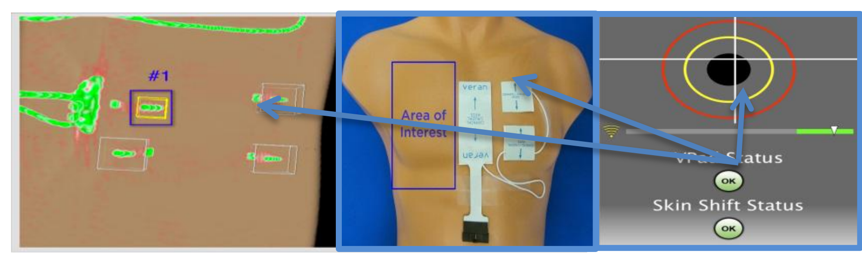


Dynamic referencing

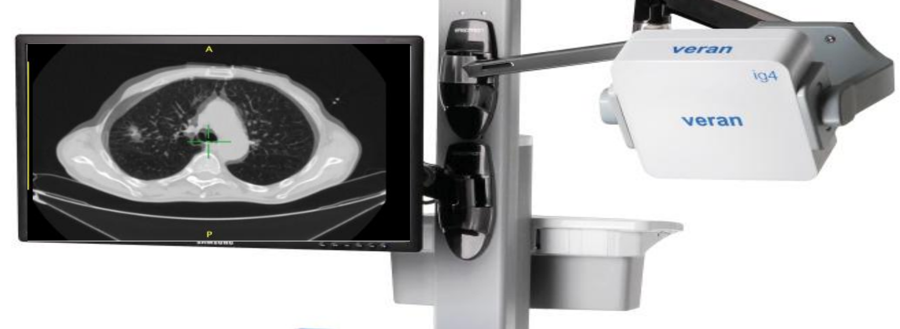
- Once the CT data has been registered to the patients anatomy a defined relationship between the two is created. Movement is detected when this relationship is different or broken.
- Once there is a difference in this relationship, it can reestablished. This is dynamic referencing.
- Dynamic referencing enables the patient to move after the field generator is placed over the vPads. If the patient does move, our software will let you know that we detect movement.

→ Patient Motion Detected. ⚠

- Once the patient stops moving the data is re-registered to the patients' anatomy automatically.

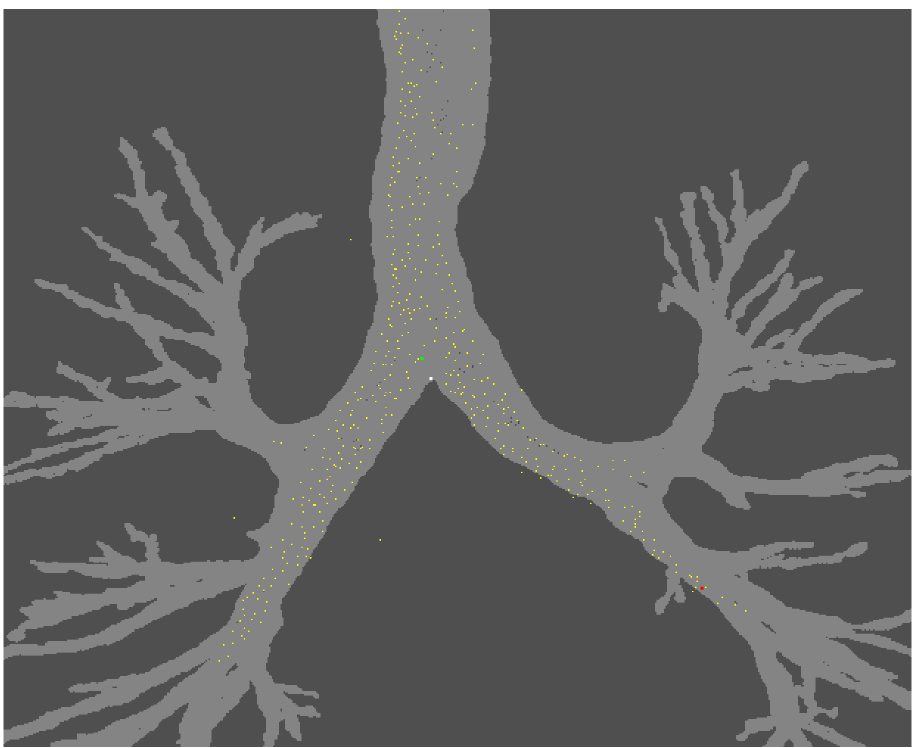


Veran software recognizes vPad sensors.



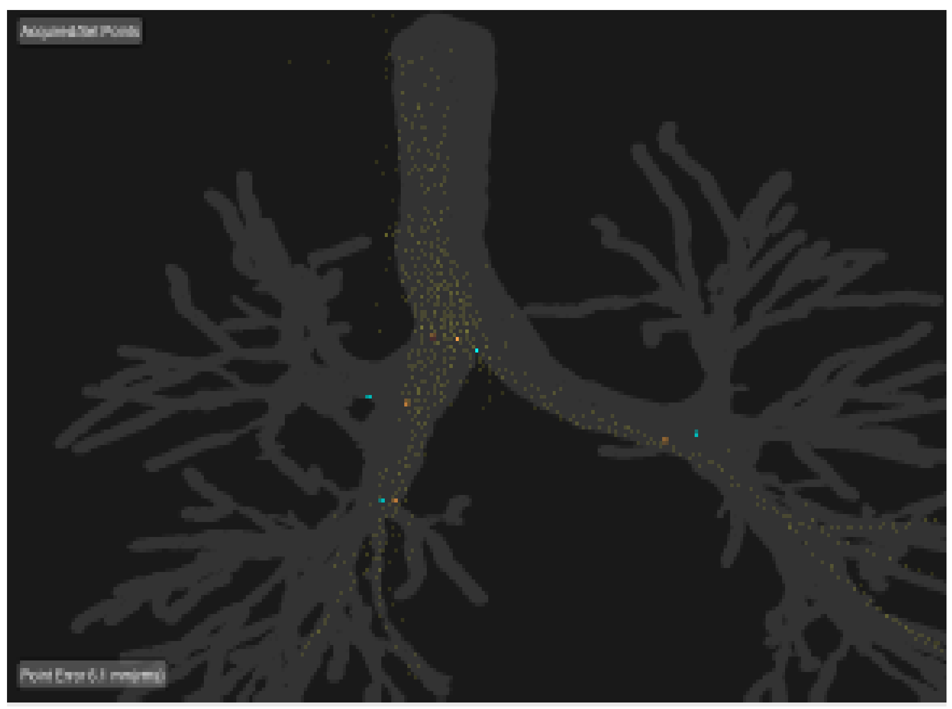
Lumen registration

- Lumen registration: The CT data is aligned to the patients anatomy by a process of acquiring multiple data points using a navigated instrument within the patients airways.
- A cloud of points is formulated representing the lumens.



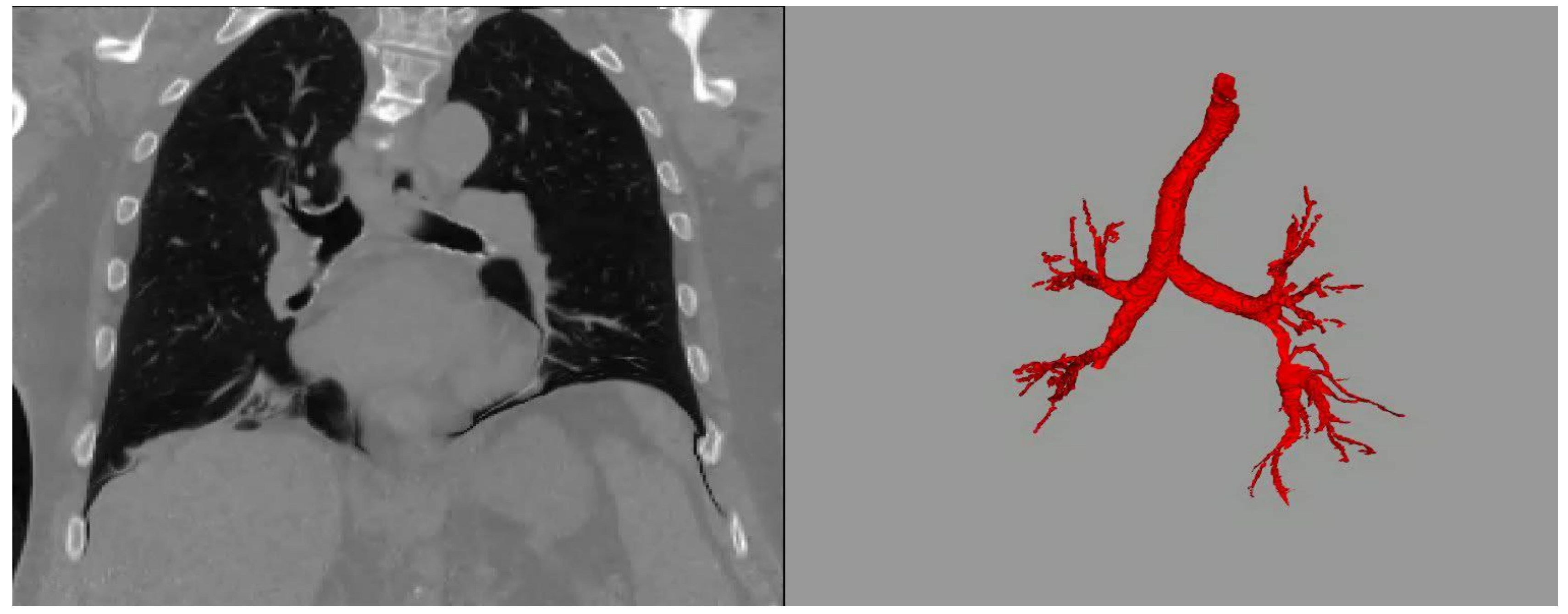
Point registration

- Point registration: The CT data is aligned to the patients' anatomy by a process of picking four points (carinas) on the CT scan and touching the same four points exactly within the patient using a navigated instrument.



Why is respiratory tracking important?

Monitor lung movement

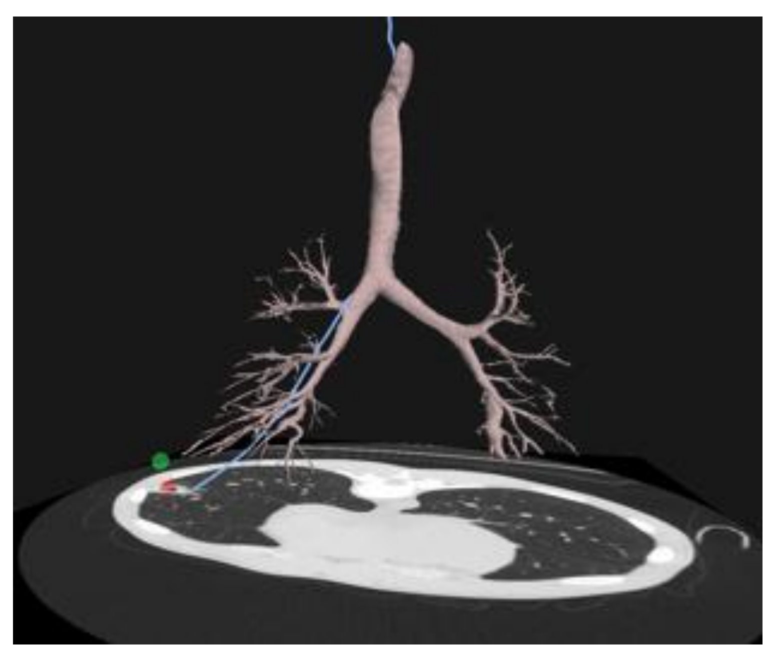


- 30-40% of lower lobe lesions move greater than 4 cm's
- 30-40% of upper lobe lesions move greater than 2 cm's

The RIGHT map – How much does in move?

Challenge

- Referral scans are at total lung capacity only
- TLC great for planning, often inaccurate for navigation
- Lungs move significantly from TLC to exhalation
- Navigation maps are static, lungs are not
- Navigation maps are not accurate throughout the procedure



Solution

- Gated respiratory CT scan (TLC & Exp)
- Plan on TLC CT data
- Navigate on exhalation CT Scan
- Notification of when map is not accurate

ENB™ procedure on diagnostic yield

- **Gex G et al: Diagnostic yield and safety of electromagnetic navigation bronchoscopy for lung nodules: a systematic review and meta-analysis, Respiration 2014;87(2): 165-76. Geneva, Switzerland**

→ Meta-analysis, 15 studies (1,033 lung nodules in 971 patients)

→ **Definitive diagnostic yield, 64.9% (range 55.7% to 87.5%)**

→ **Pneumothoraces, 32 patients (3.1%) & 17 (1.6%) chest tube drainage**

- **Pearlstein DP et al: Electromagnetic navigation bronchoscopy performed by thoracic surgeons: one center's early success, Ann Thorac Surg 2012;93(3):944-50. Wisconsin, USA**

→ **Diagnostic yield, 85%** utilizing rapid on-site examination (ROSE)

→ **6 pneumothoraces (5.8%)**

ENB™ procedure on localization for surgery

- **Bolton et al: The utility of electromagnetic navigational bronchoscopy as a localization tool for robotic resection of small pulmonary nodules, Ann Thorac Surg 2014;98(2):471-5. South Carolina, USA**

→ **ENB localization of non-palpable lesions with blue dye**

→ Successful in all attempted patients (19 patients)

- **Krimsky WS et al: Thoracoscopic detection of occult indeterminate pulmonary nodules using bronchoscopic pleural dye marking, J Community Hosp Intern Med Perspect 2014 17;4. Maryland, USA**

→ Dye marker was visible in 81% of patients

ENB™ procedure on fiducial marker placement for radiosurgery

- **Nabavizadeh N et al: ENB-guided fiducial markers for lung stereotactic body radiation therapy: analysis of safety, feasibility, and interaction stability, J Bronchology Interv Pulmonol 2014;21(2):123-30. Portland, OR, USA**

→ Of **105** fiducially placed, **103** were identified on simulation CT

→ Mean number placed per patient, **3.09**

→ **2 (6%)** patients, asymptomatic pneumothoraces

- **Schroeder C et al: Coil spring fiducial markers placed safely using navigation bronchoscopy in inoperable patients allows accurate delivery of CyberKnife stereotactic radiosurgery, J Thorac Cardiovasc Surg 2010;140(5):1137-42. Cleveland, OH, USA**

→ **234 fiducial markers** placed successfully in total 52 patients (60 tumors)

→ **3 Pnemothoraces (5.8%), 2 pig-tail chest tube**

Take home message

Approach to small peripheral pulmonary lesion

1) Traditional bronchoscopy
2) Thin bronchoscopy
3) Ultrathin bronchoscopy

→ EBUS-GS & virtual bronchoscopy

4) Electromagnetic navigation bronchoscopy - Covidien
5) Electromagnetic navigation bronchoscopy - Veran

\+ X-ray fluoroscopy