

Solitary Pulmonary Nodule (SPN)

By Ahmad el oudat

Chest X-ray (CXR) Interpretation:

1. Confirm Patient Details and Quality

Identify patient name, age, and date of the X-ray.

- **Check Quality (RIPE):**

- **Rotation:** Spinous processes should be centered between the clavicles.
- **Inspiration:** Count at least 9 to 10 posterior ribs (transverse ribs).
- **Penetration (AP or PA):** most CXR are PA, if you can see the scapula, it's an AP CXR.
- **Exposure:** Should see the thoracic vertebrae through the heart.

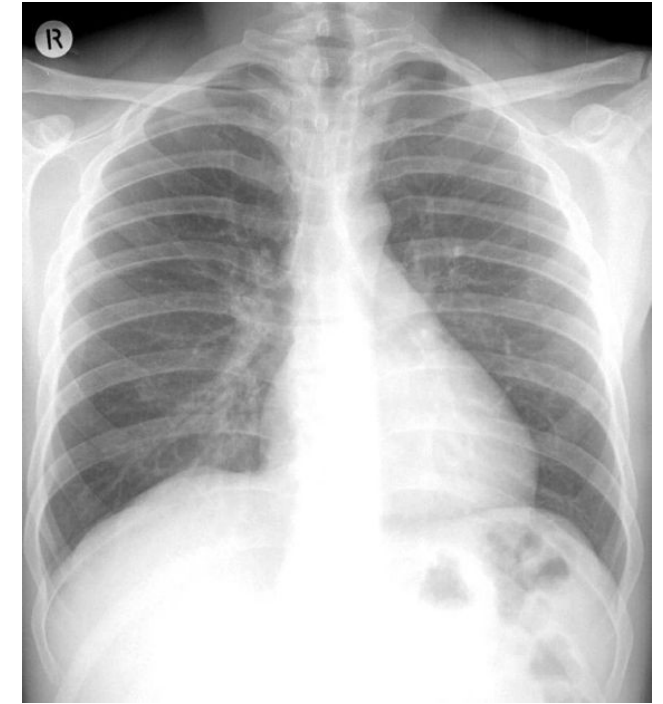
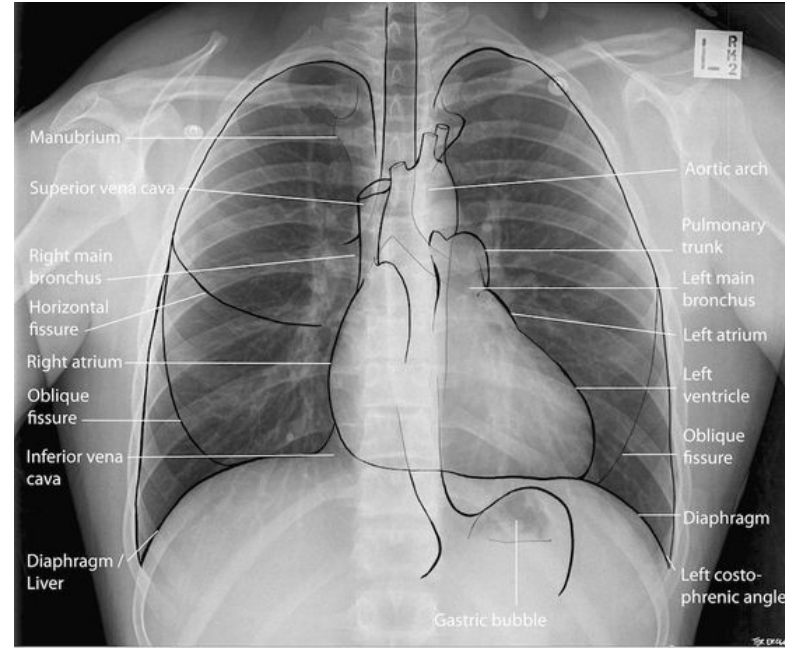
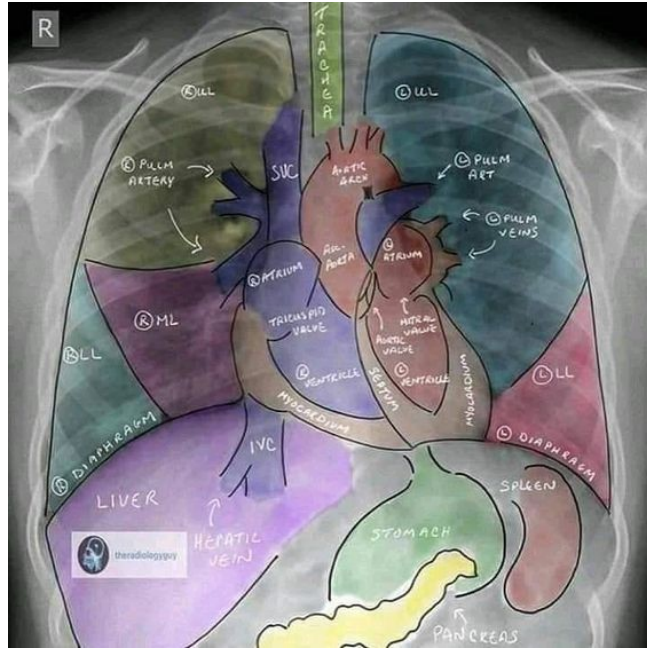
Chest X-ray (CXR) Interpretation: (cont.)

2. Systematic Review of Structures (ABCDEF)

- **A = airways** (trachea and costophrenic angle).
- **B = bones** (and soft tissue).
- **C = cardiac silhouette** (and mediastinum).
- **D = diaphragm** (and gastric bubble).
- **E = effusions** (assessment of the pleura, which includes findings beyond just pleural effusions).
- **F = fields** (i.e., lung fields).

lastly, assessment of **lines, tubes, devices**, and **prior surgeries**, such as sternotomies and valve replacements.

Normal chest x-ray AP



Chest CT Interpretation:

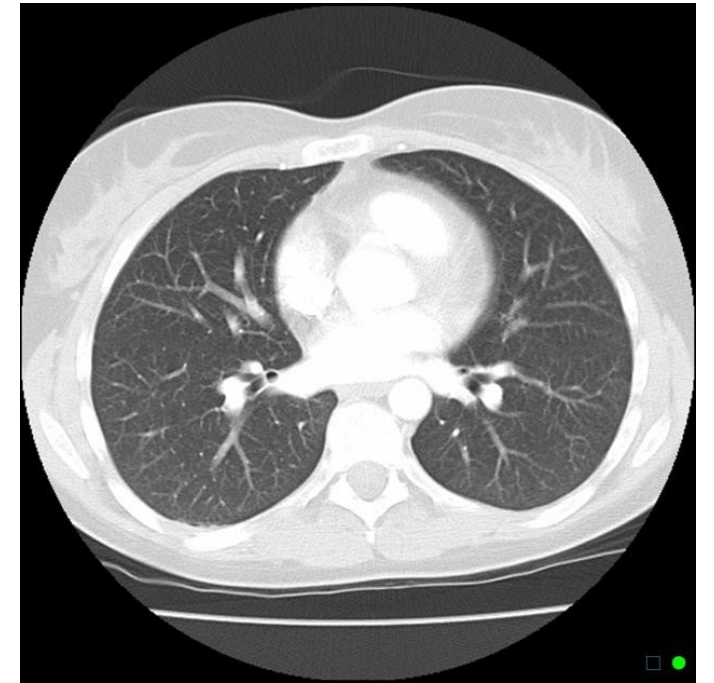
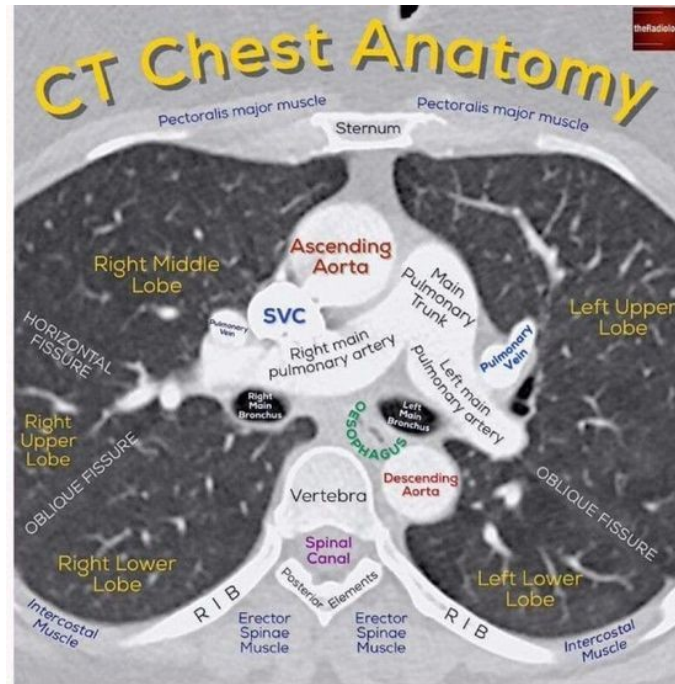
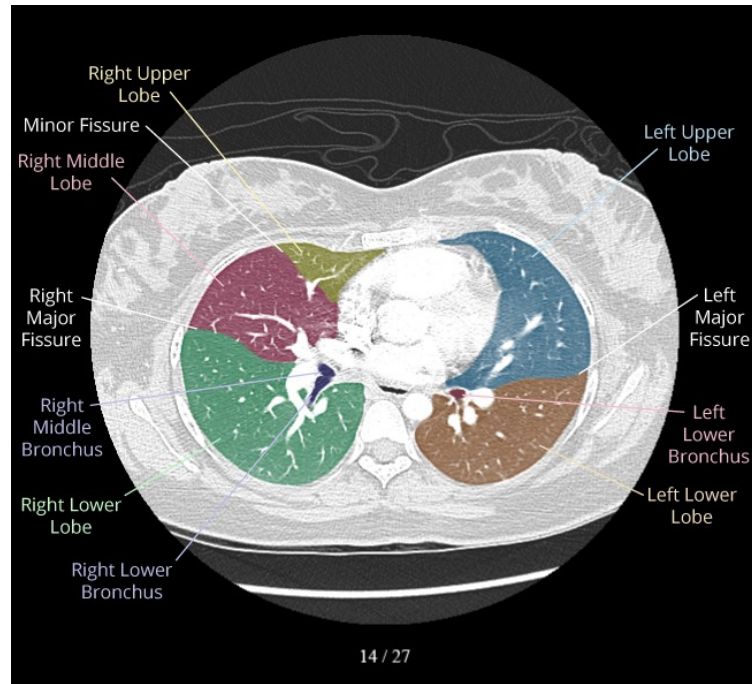
1. Confirm Patient and Scan Details:

- Check the patient's name, date, and time of the scan.
- Confirm the orientation and slice thickness.

2. ABCs of Chest CT Interpretation:

- **A = Airway:** Trachea and bronchi.
- **B = Bones and soft tissue:** Ribs, spine, and muscles.
- **C = Cardiac and great vessels:** Heart and aorta.
- **D = Diaphragm:** Right and left hemidiaphragms.
- **E = Effusions:** Pleura and pleural spaces.
- **F = Fields (Lung parenchyma):** Lung tissue for any abnormalities.
- **G = Gadgets:** Look for any medical devices (e.g., pacemakers, catheters, stents).

Normal chest CT



What is a Solitary Pulmonary Nodule (SPN)?

It is a **single, rounded** opacity within the lung parenchyma that is **<3 cm** in diameter and **surrounded by lung parenchyma without** associated lymphadenopathy, atelectasis, or pneumonia.

Found incidentally on **Chest x-ray**.

most cases are benign, it is essential to determine whether its **benign** or **malignant**.

clinicians globally have widely adopted the **Fleischner Society** guidelines to assess SPNs.

How to determine if its benign or malignant?

Differentiating between benign and malignant SPNs can be challenging without a biopsy.

Risk factors:

- Current or previous smoker.
- Diagnosis of chronic obstructive pulmonary disease.
- Advanced age.
- Sex (men > women).
- Size of nodule (direct relationship).

Evaluation: Imaging Techniques:

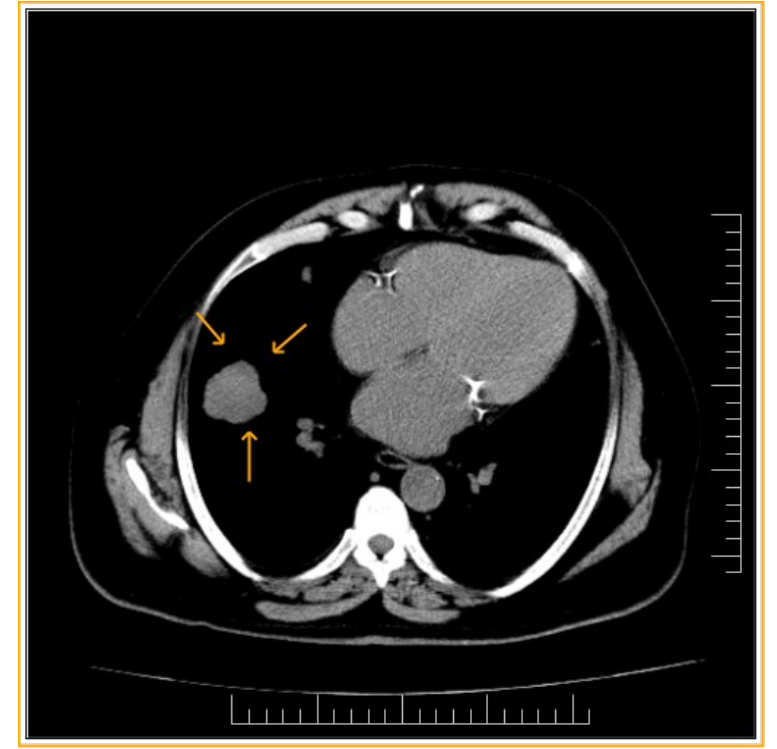
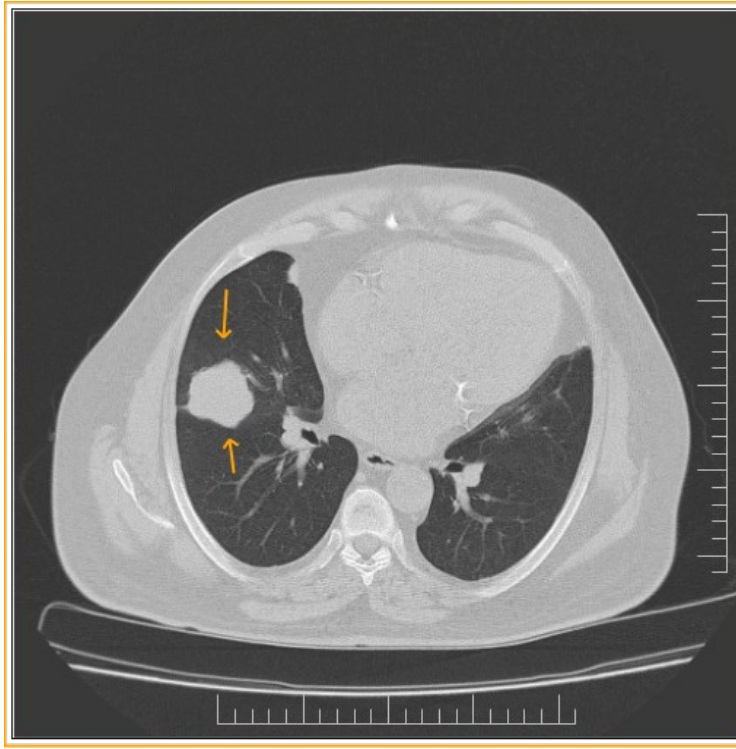
Primary Imaging Modality:

- **A chest CT scan** is the first-line modality to detect an SPN.
- **PET scan** may be used for nodules >8 mm or in patients with high malignancy risk.

Other Imaging Techniques:

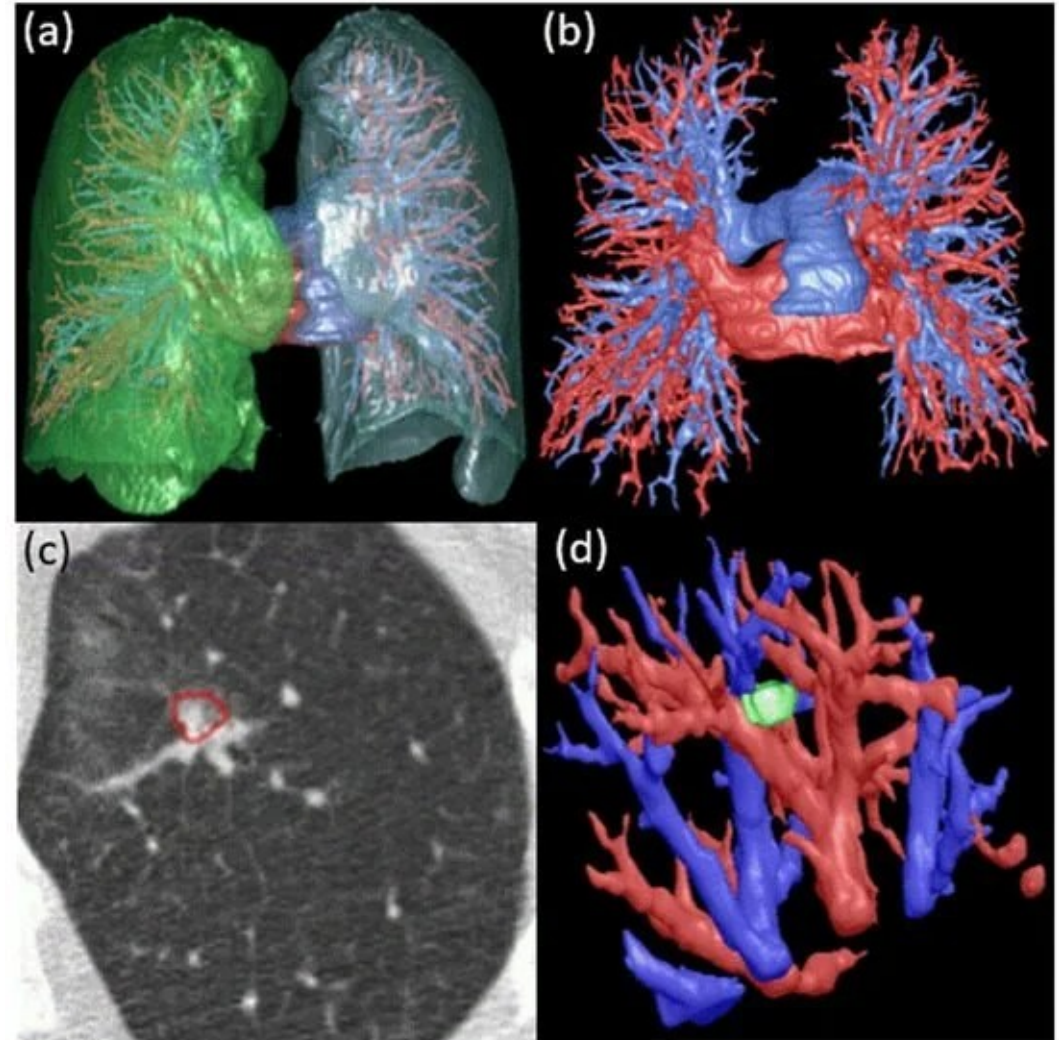
- **Chest X-ray (CXR)** is widely used but less sensitive; commonly reveals SPNs in asymptomatic patients.
- **MRI** is generally not useful for solid SPNs but may help with cystic or ground-glass nodules.

Evaluation: Imaging Techniques (cont).



The future is here old man!

Vascular Biomarkers for
Pulmonary Nodule
Malignancy: Arteries vs Vein.



Noninvasive Evaluation Tools:

- **Electromagnetic Navigation Bronchoscopy (ENB):** Used when other methods are infeasible; limited by cost.
- **Tumor Markers:**
 - Includes carcinoembryonic antigen.
 - folate receptor-positive circulating tumor cells.
 - galectin-3-binding protein.
 - C163A

Biopsy for Definitive Diagnosis:

The ultimate test to evaluate for the etiology of the nodule is a biopsy.

Types:

- Fine-needle aspiration.
- liquid biopsy.
- excisional biopsy.

Methods of doing a biopsy

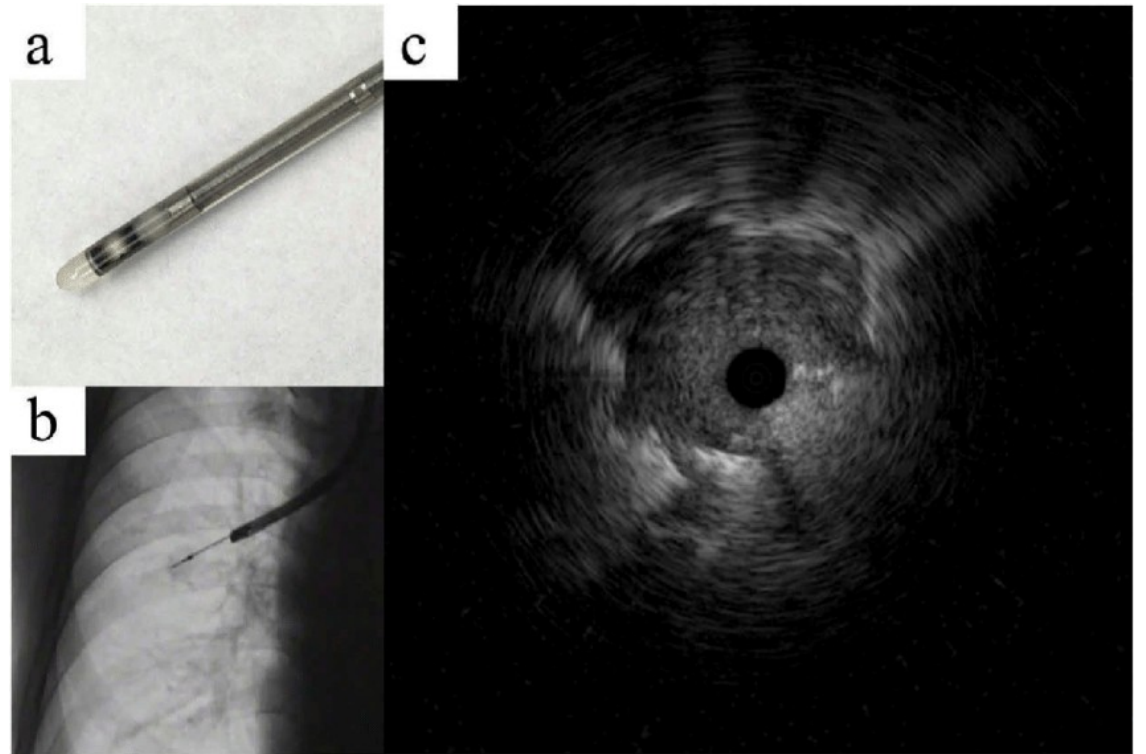
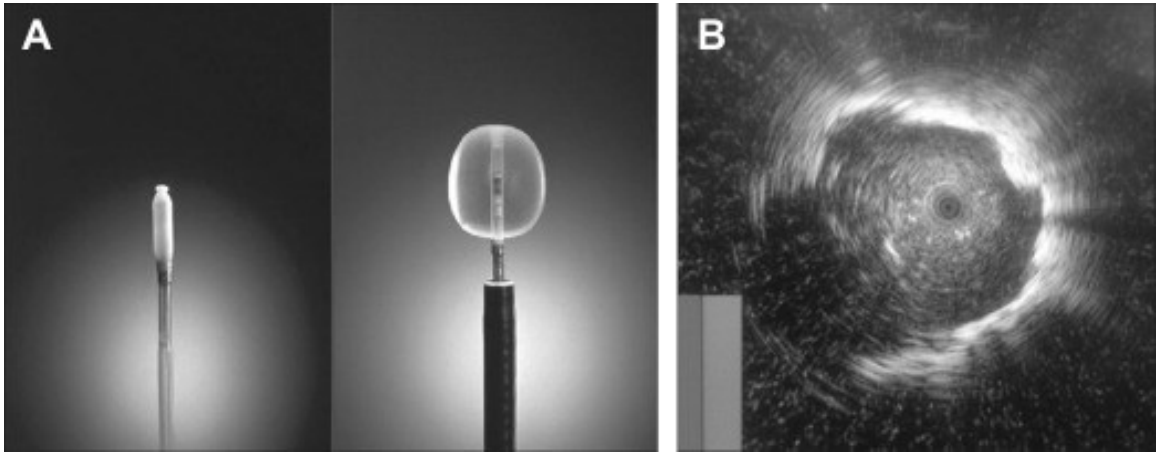
- CT-guided transthoracic needle aspiration.
- Bronchoscopy (which has multiple variations).
- transthoracic biopsy

Bronchoscopic biopsy carries a **lower risk** of adverse events than transthoracic biopsy but has an overall **lower diagnostic yield**.

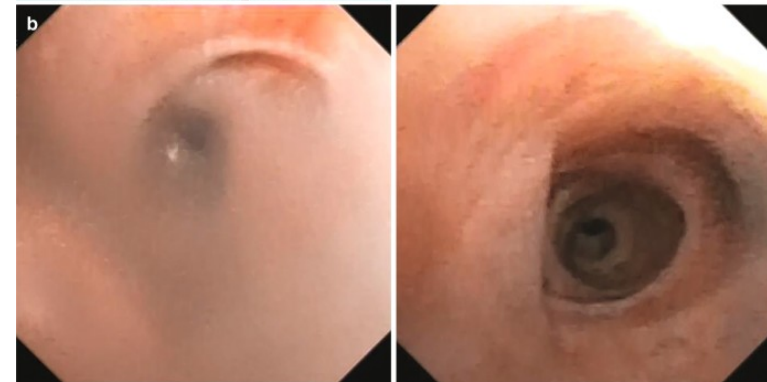
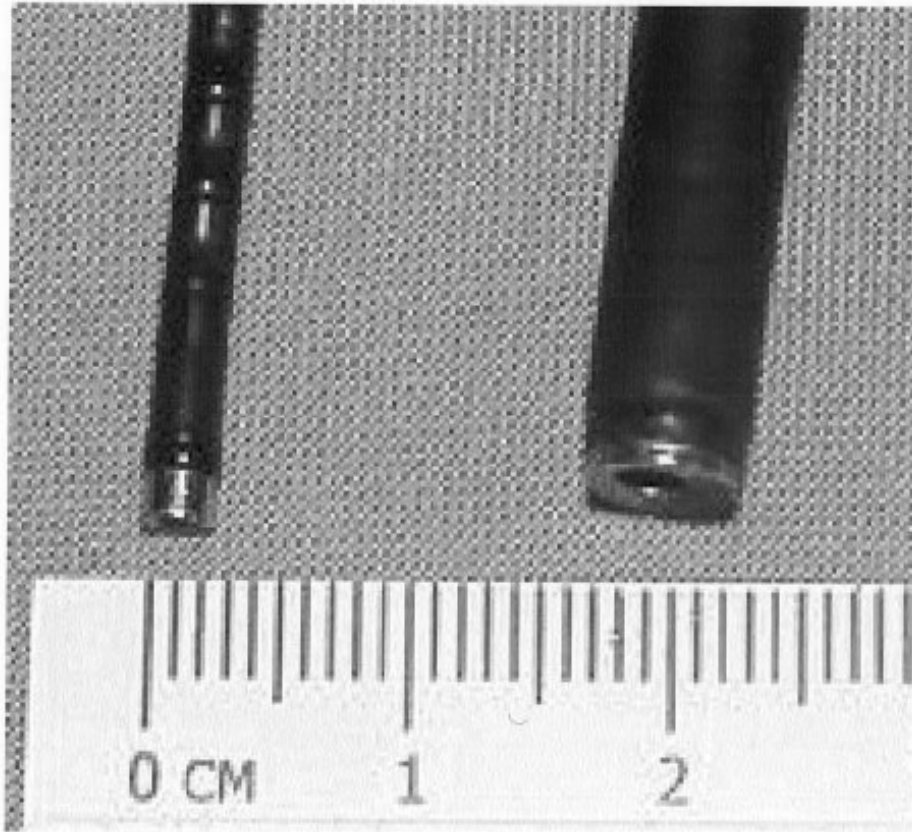
Variations of Bronchoscopy

- RP-EBUS (Radial probe endobronchial ultrasonography).
- thin/ultrathin bronchoscopes.
- VBN (Virtual bronchoscopic navigation).
- robotic bronchoscopy.
- ENB (electromagnetic navigational bronchoscopy).

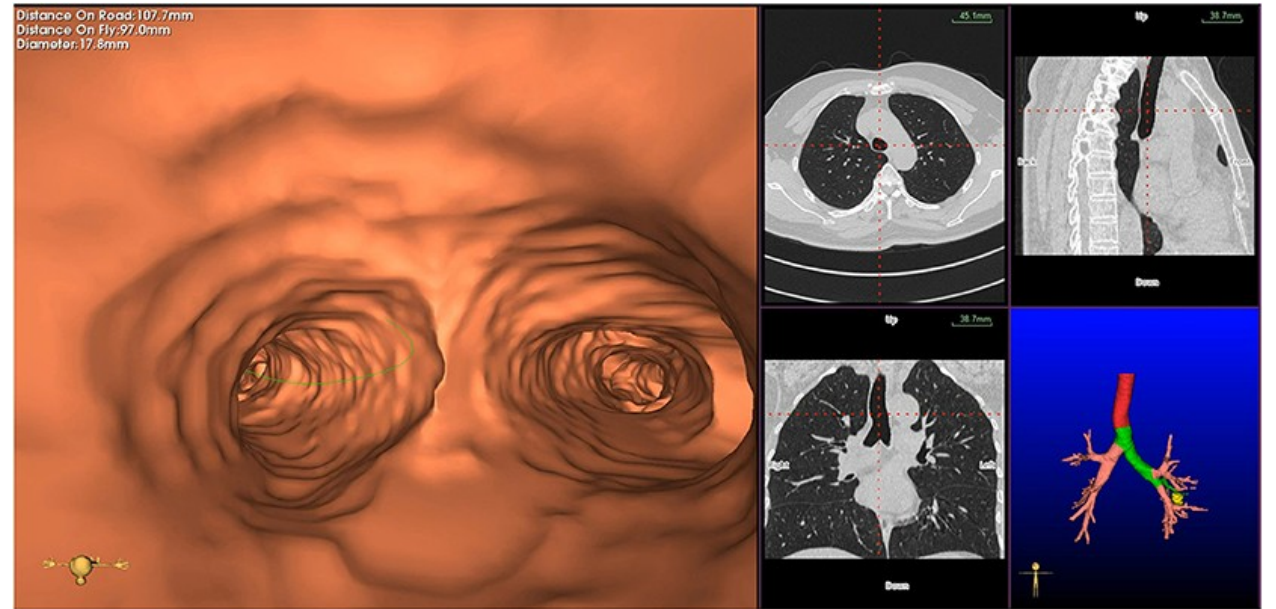
RP-EBUS (Radial probe endobronchial ultrasonography).



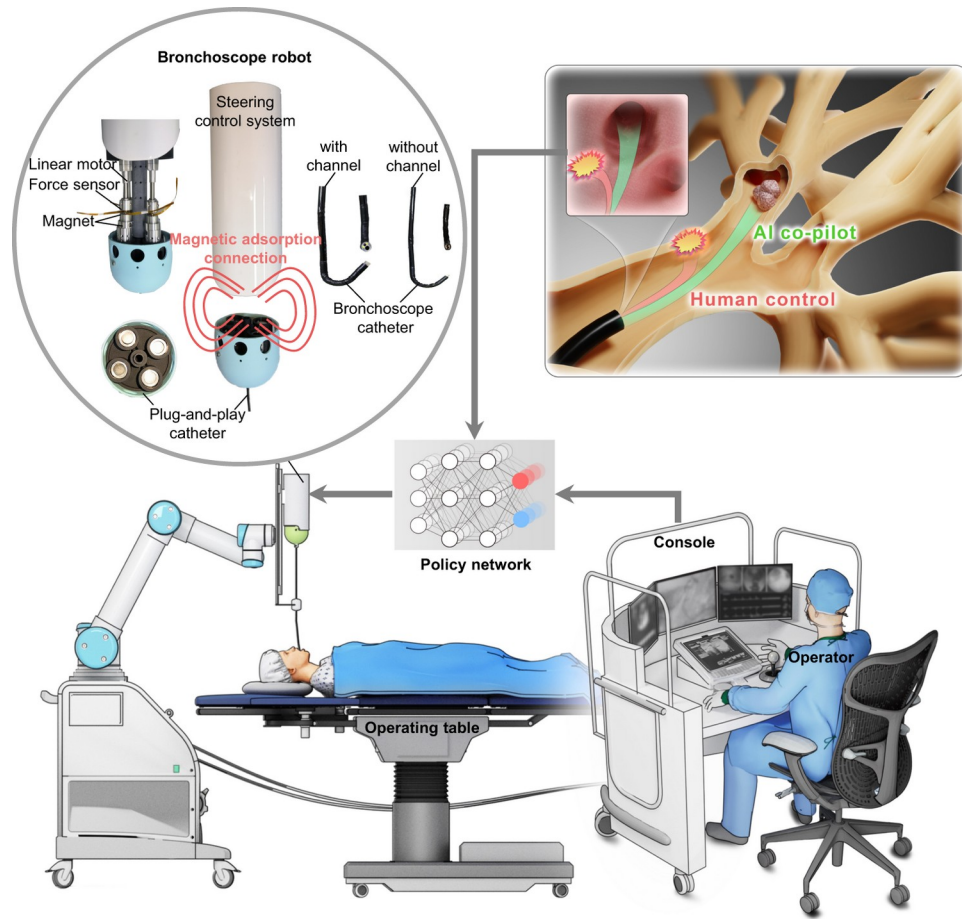
thin/ultrathin bronchoscopes.



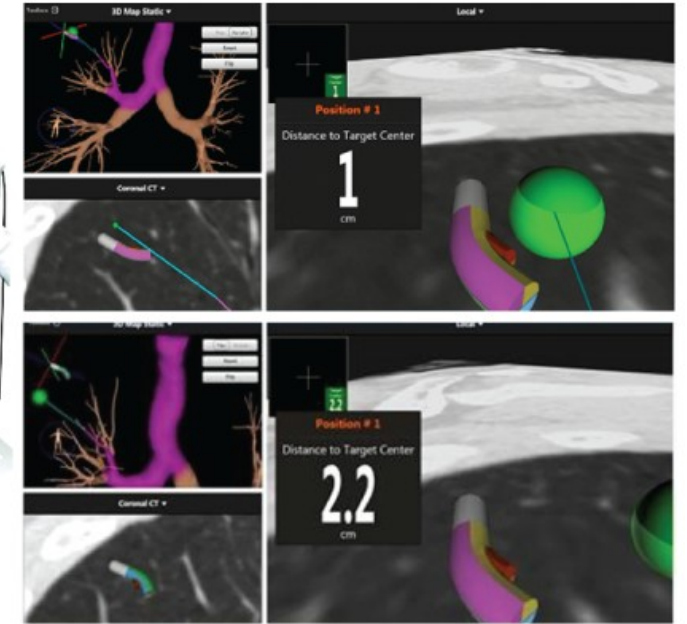
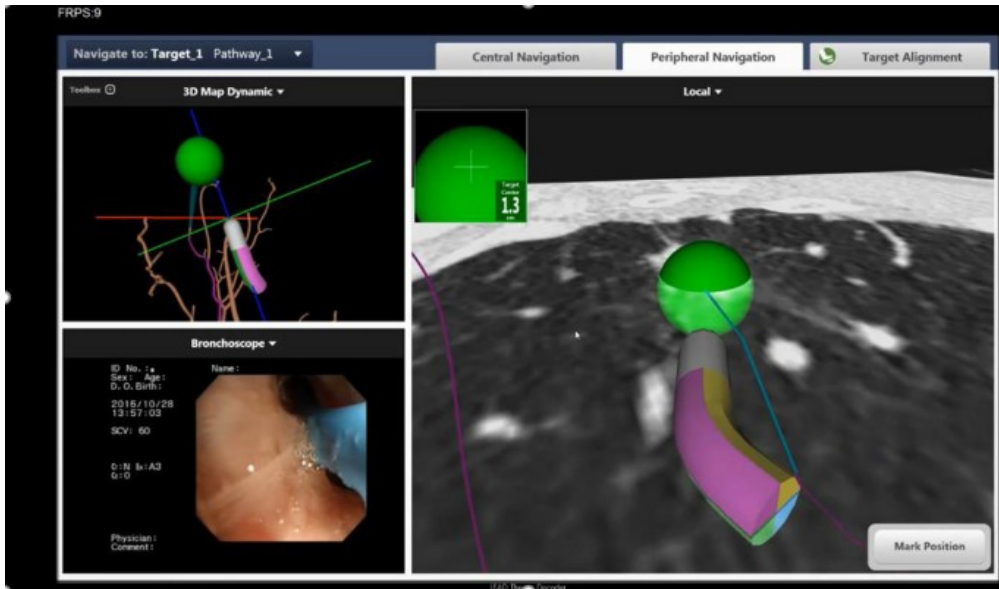
Virtual bronchoscopic navigation.



robotic bronchoscopy.



electromagnetic navigational bronchoscopy.



Malignancy Risk Assessment:

- **The lung imaging reporting and data system (Lung-RADS) Classification:** Categorizes findings from CT scans into risk levels (0 to 4) based on nodule characteristics.
- **Mayo Clinic Calculator:** Factors include age, upper lobe location, nodule size, spiculation, smoking status, recent extra-thoracic malignancy.
- **Brock University Calculator:** Considers age, upper lobe location, nodule size, spiculation, emphysema, ground-glass opacity, female sex, number of nodules, and family history of lung cancer (excludes smoking status).

Lung-RADS Categorizes:

Category 0: (incomplete) is used if prior CT imaging is not available for comparison or if the lungs are not completely imaged.

Category 1: (negative).

Category 2: (benign appearance)

Category 3: (probably benign). carries a 1% to 2% chance of malignancy.

Category 4A: (probably suspicious) carries a 5% to 15% chance of malignancy.

Category 4B: (suspicious) carries a >15% chance of malignancy.

Category 4X: (suspicious) is either category 3 or 4 with other features suspicious for malignancy, including spiculation, ground-glass nodules that double within 1 year, and enlarged regional lymph nodes.

Treatment / Management of Solitary Pulmonary Nodules (SPNs):

An interprofessional approach is best for managing an SPN. Assessing nodule **size**, **appearance**, patient **risk factors**, and **patient preference** is integral in treating SPNs.

Following guidelines are followed in such SPN:

- 2017 Fleischner Society.
- 2013 ACCP guidelines.
- Lung-RADS Follow-Up Recommendations.

2017 Fleischner Society Guidelines:

Solid Nodules:

- <6 mm in **low-risk** patients: No follow-up needed; for **high-risk**, optional CT at 12 months.
- 6-8 mm: CT follow-up at 6-12 months, and again at 18-24 months.
- 8 mm: Consider repeat CT at 3 months, PET/CT, or biopsy (especially for high-risk).

Ground-Glass Nodules:

- <6 mm: No routine follow-up.
- 6 mm: Repeat CT every 6-12 months, then every 2 years for 5 years; consider resection if solid components develop.

Partly Solid Nodules:

- <6 mm: No follow-up.
- 6 mm: CT at 3-6 months; if growth or solid component >6 mm, consider resection and follow-up CT for 5 years.

American College of Chest Physicians (ACCP) Guidelines (2013):

If SPN detected on CXR, use CT for comparison with prior images

No further testing if nodule stable for 2 years.

Solid Nodules:

- **<8 mm:** Divided by risk level; for low-risk, <4 mm requires no follow-up, 4-6 mm follow-up CT at 12 months, and 6-8 mm at 6-12 and 18-24 months.
- **High Risk Factors with Nodules 6-8 mm:** CT follow-up at 3-6 months, then 9-12 and 24 months.
- **8-30 mm:** Stratified by low, moderate, high pretest probability; PET or biopsy may be warranted for high probability.

Non-Solid and Ground-Glass Nodules:

- <5 mm: No further evaluation.
- 5 mm: Annual CT for 3 years.
- For nodules >1 cm, repeat CT at 3 months or consider biopsy.

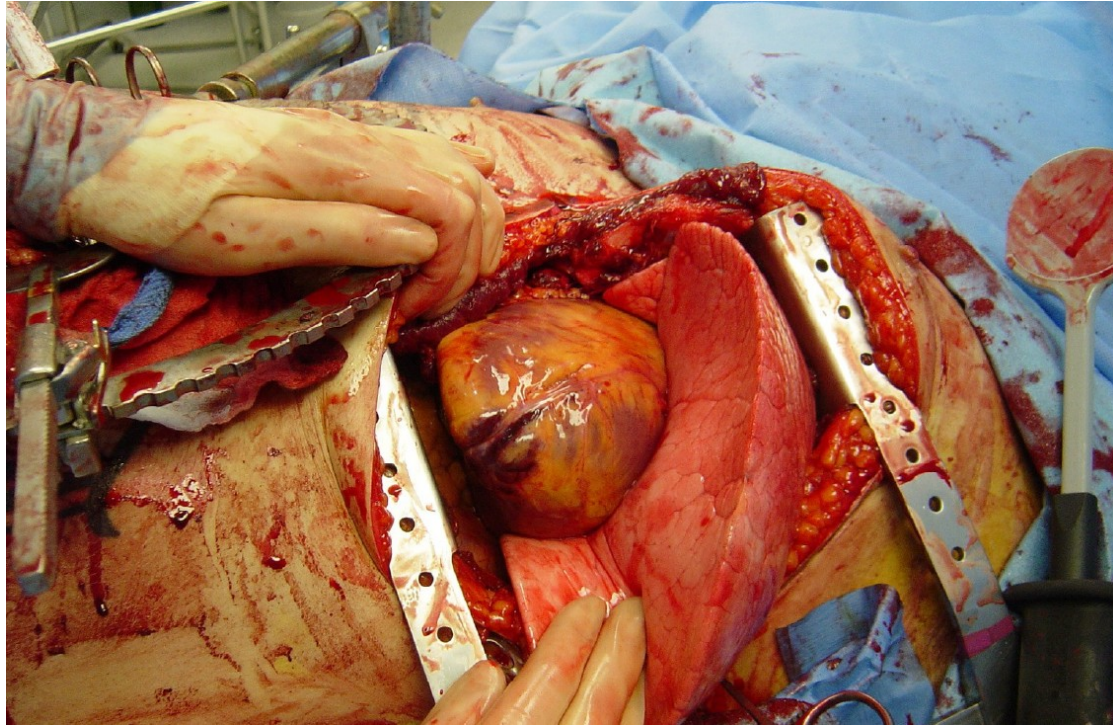
Lung-RADS Follow-Up Recommendations:

- Category 0: Requires comparison with previous imaging.
- Categories 1 & 2: Continue with annual low-dose CT.
- Category 3: Follow-up low-dose CT at 6 months.
- Category 4A: CT at 3 months or PET/CT for solid components >8 mm.
- Categories 4B & 4X: Full-dose CT with/without contrast, PET/CT, or biopsy.

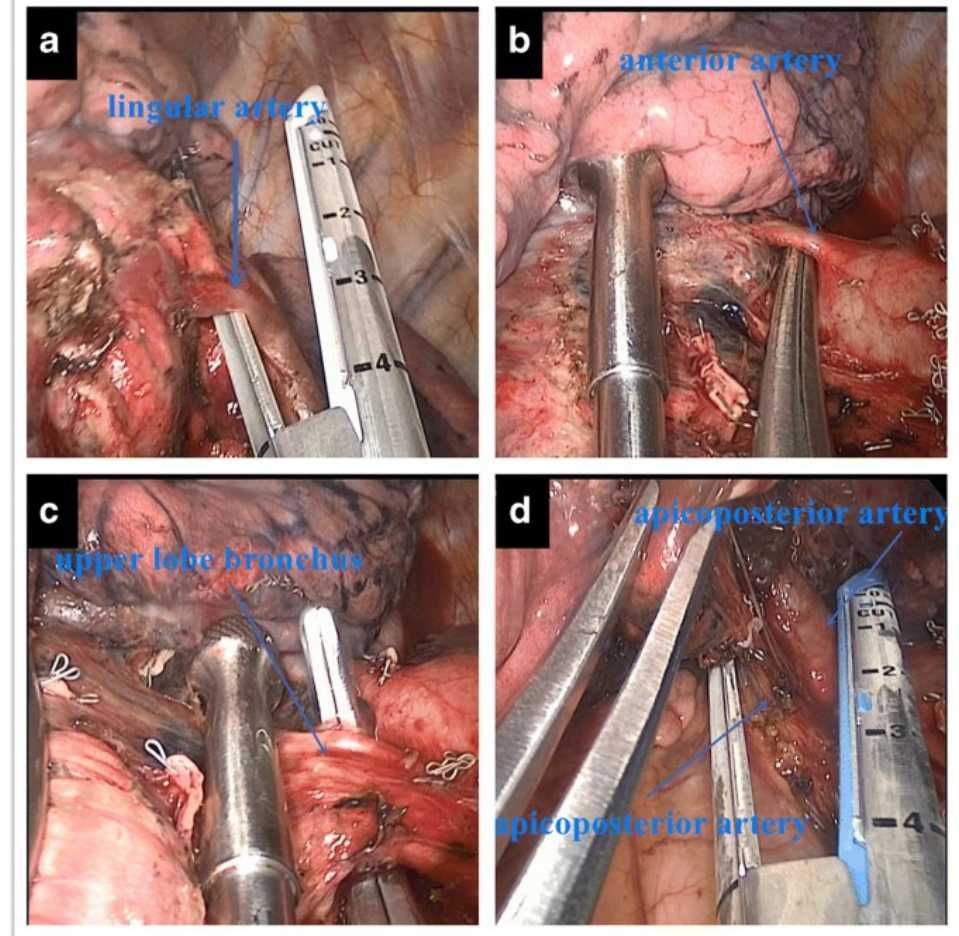
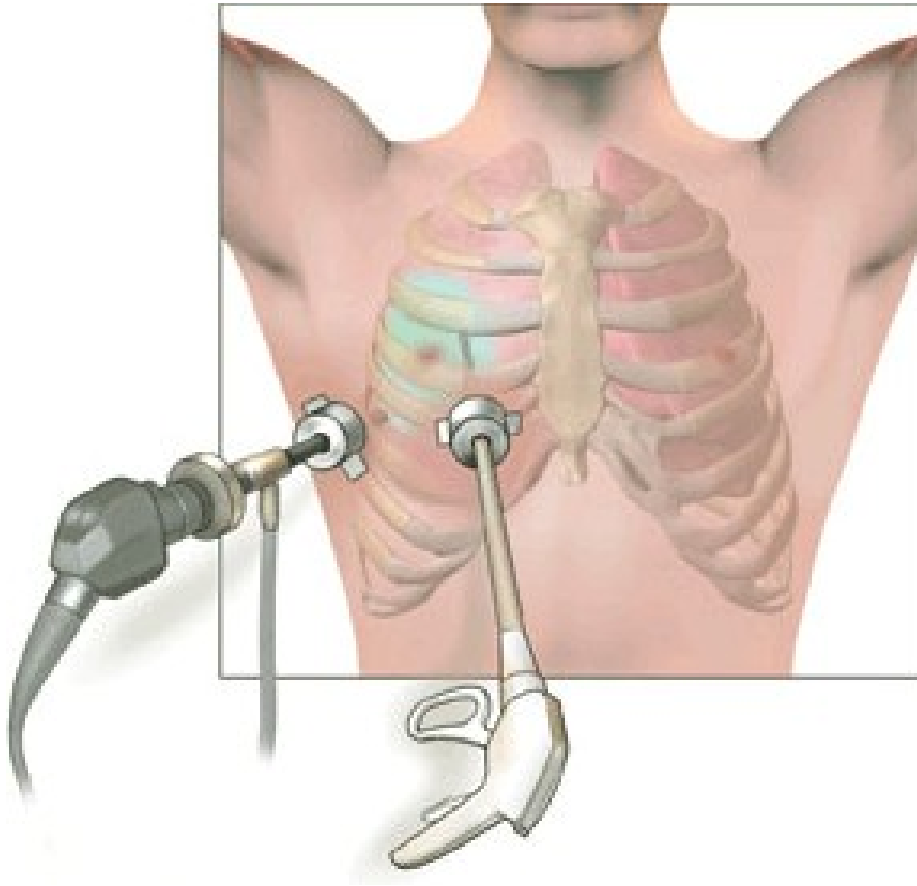
Surgical Options for High-Risk Cases:

- **Resection Techniques: Open thoracotomy, VATS** (video-assisted thoracic surgery), and **RATS** (robotic-assisted thoracoscopic surgery) offer similar 3-year survival, with VATS/RATS showing lower morbidity.
- **Stereotactic Body Radiotherapy (SBRT):** Alternative for non-surgical candidates with stage I NSCLC (non-small cell lung cancer); 5-year survival of 37% for SBRT versus 68% for VATS lobectomy.

Open thoracotomy.



video-assisted thoracic surgery.

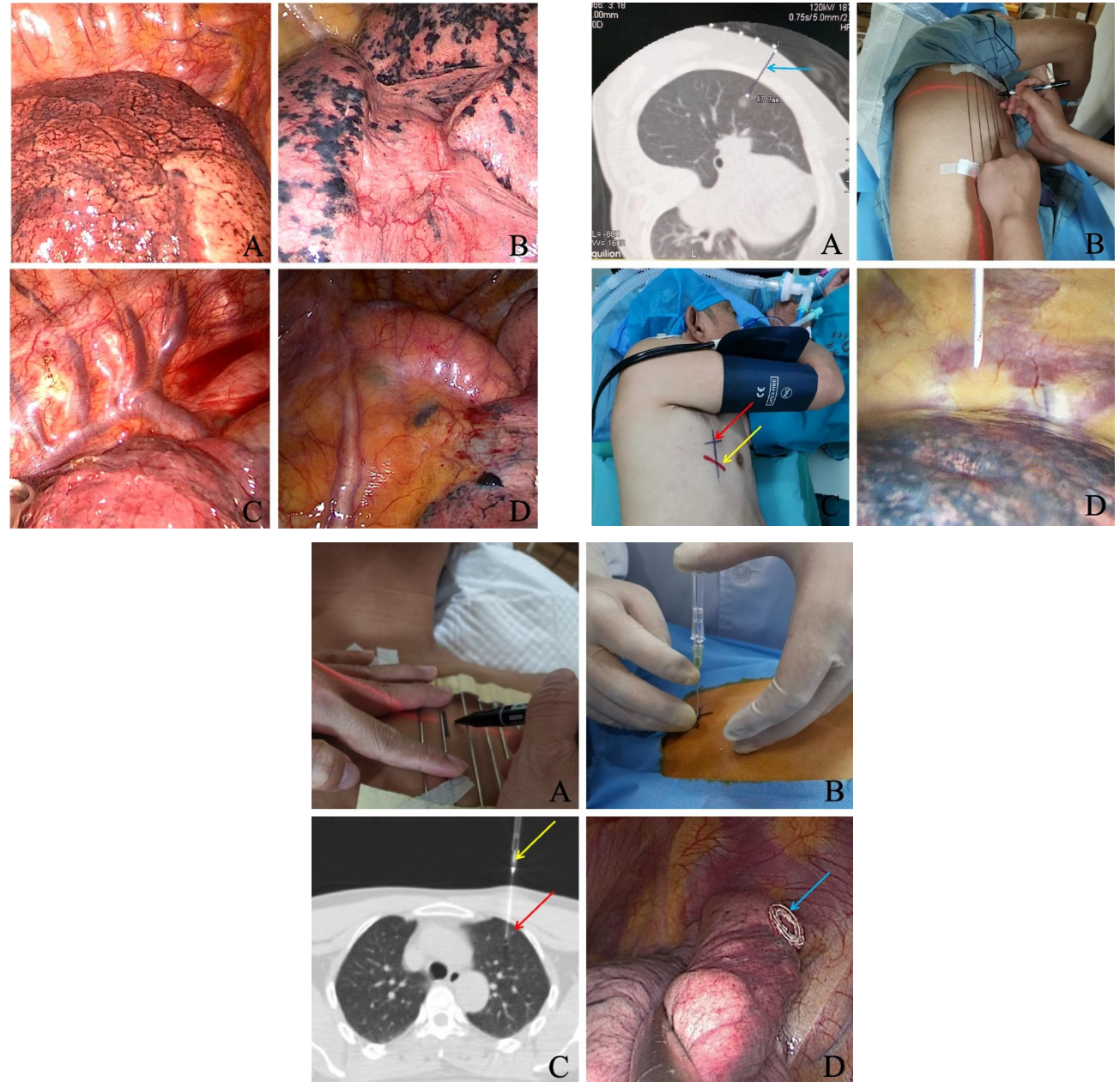


Robotic-assisted thoracoscopic surgery.



Clinical application of CT-assisted body surface localization combined with intraoperative stereotactic anatomical localization in thoracoscopic lung nodule resection: a single-centre retrospective study.

<https://pubmed.ncbi.nlm.nih.gov/38842205/>



Additional Management Options:

- **Preoperative Testing:** Pulmonary function and standard presurgical testing required for assessing risks.
- **Chemotherapy:** Based on specific SPN diagnosis.
- **Obstructive Nodules:** May need bronchoscopy or surgery for airway management.

Differential Diagnosis of Solitary Pulmonary Nodules (SPNs):

Malignant Characteristics:

- Typically located in upper lobes.
- Features: larger size, spiculated margins (corona radiata sign), enhancement after contrast injection, rapid growth.

Benign Characteristics:

- Often smaller, slow-growing (stable over 2 years).
- Commonly found in lower lobes or near pleural fissures.
- Features: low-density attenuation, cavitation with thin walls, central or diffuse calcifications.

Benign Differential Diagnoses and Imaging Characteristics:

- Tuberculosis (TB):
- Organizing Pneumonia
- Sarcoidosis:
- Aspergillosis:
- fungal infection:
- Granulomatosis with Polyangiitis:
- Pulmonary Sequestration:
- Schwannoma:
- Hamartoma:
- Inflammatory Myofibroblastic Tumor:
- Solitary Fibrous Tumor:
- Perivascular Epithelial Cell Tumor:
- Pleomorphic Adenoma:
- Carcinoid Tumor:
- Castleman Disease:

Benign SPN Causes:

- Amyloidosis
- Arteriovenous
- Malformation
Intrapulmonary Lymph
Nodes
- Rheumatoid Arthritis
- Round Atelectasis

Prognosis of Solitary Pulmonary Nodules (SPNs):

- Malignancy rates in SPNs range from 2% to 23%.
- Generally, SPNs are benign and may not require intervention.
- Prognosis worsens with multiple risk factors and malignant features on imaging.

Complications of Solitary Pulmonary Nodules (SPNs) Prognosis:

Surgical Complications:

- Hemorrhage
- Pulmonary embolism
- Infections: empyema, pneumonia, surgical site infections
- Pleural effusions
- Pneumothorax
- Myocardial infarction
- Central neurological events

FIN