Essential Diagnostic Tests and Staging in Lung Cancer

Lung Cancer School 2026

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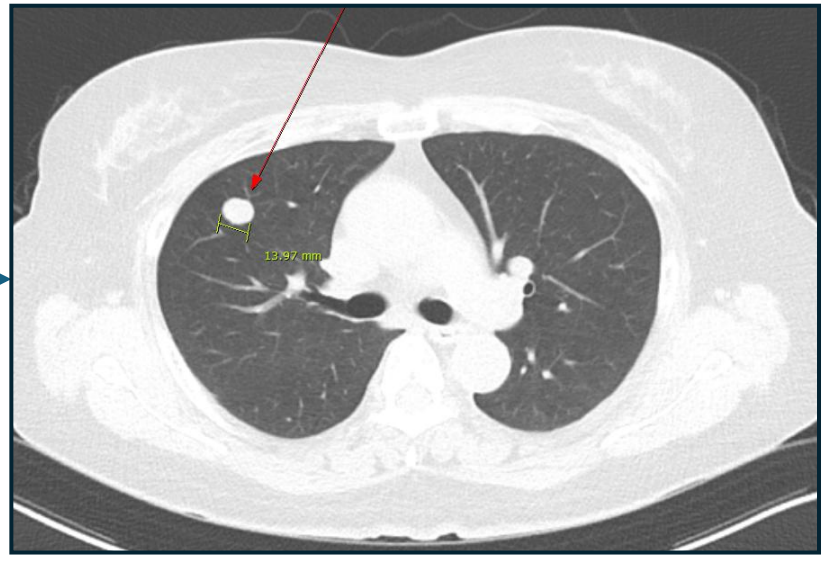
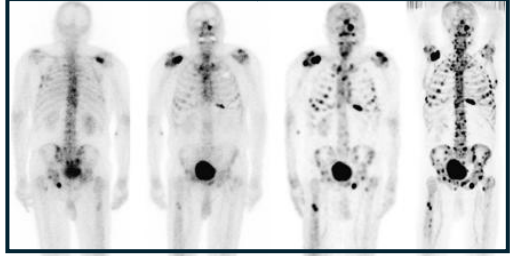
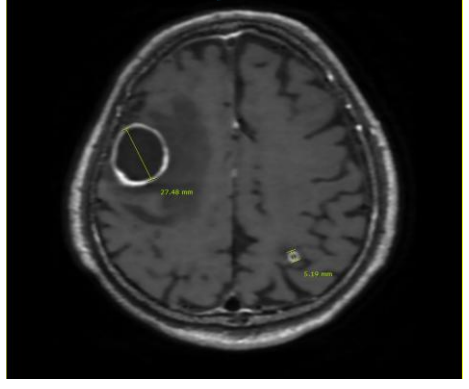
폐암 진단의 첫걸음 – 영상학적 검사 (Imaging Studies)

- Chest X-ray
- Chest CT
- FDG PET/CT
- Brain MRI
- Bone scan







검진 임상시험 (Landmark Trials)

National Lung Screening Trial (NLST) [1]

- Inclusion
  - ✓ 나이: 55–74
  - ✓ 30갑년 이상의 흡연력
  - ✓ 금연한지 15년이 경과하지 않은 자
- Intervention: LDCT vs. 흉부 X선의 폐암 조기검진 효과를 비교
- Conclusion: 폐암 특이사망률 20% 감소

Nederlands–Leuvens Longkanker Screenings Onderzoek (NELSON) [2]

- Inclusion
  - ✓ 나이: 50–74
  - ✓ 3/4 pack × 25 years or 1/2 pack × 30 years
  - ✓ current or quit within 10 years
- Intervention: LDCT vs. Usual care group
- Conclusion: 폐암 특이사망률 남성 26%, 여성 39% 감소

[1] *New England Journal of Medicine*. 2011;365(5):395-409. doi:10.1056/NEJMoa1102873.
[2] *New England Journal of Medicine*. 2020;382(6):503-513. doi:10.1056/NEJMoa1911793.

검진 임상시험 (RCT)

Table 1. Randomized Controlled Trials of Lung Cancer Screening with LDCT

	NLST	MILD	DANTE	ITALUNG	DLCST	NELSON	LUSI	UKLS
Country	USA	Italy	Italy	Italy	Denmark	Netherlands/Belgium	Germany	UK
Centers	Multicenter (33 sites)	Single (originally multicenter design)	Single	Multicenter (3 sites)	Single	Multicenter (4 sites)	Single	Multicenter (2 sites)
Entry period	2002–2004	2005–2011	2001–2006	2004–2006	2004–2006	2003–2006	2007–2011	2011–Present
Total enrolled	53454	4099	2450	3206	4104	15792	4502	4055
Gender (M/F)	59/41	66/34	100/0	65/35	55/45	84/16	65/35	75/25
Age (years)	55–74	≥ 49	60–74	55–69	50–70	50–74	50–69	50–75
Smoking	30 PY, current or quit within 15 years	20 PY, current or quit within 10 years	20 PY, current or quit within 10 years	20 PY, current or quit within 10 years	20 PY, current or quit within 10 years	3/4 pack × 25 years or 1/2 pack × 30 years, current or quit within 10 years	15 PY, current or quit within 10 years	5% risk of developing lung cancer in 5 years
Screen arm	LDCT (26722)	Annual LDCT (1190)/Biennial LDCT (1186)	LDCT (1264)	LDCT (1613)	LDCT (2052)	LDCT (7900)	LDCT (2029)	LDCT (2028)
MDCT no. of rows	At least 4	6–16	1, 16	1, 16	16	16, 64	16, 128	16
Section thickness (mm)	1–3.2	1	5	1 and 3	1 and 3	1	1	1 and 5
Control arm	CXR (26732)	Usual care (1723)	Usual care (1186)	Usual care (1593)	Usual care (2052)	Usual care (7892)	Usual care (2023)	Usual care (2027)
No. of screens (intervals)	3 (0, 1, 2 years)	Median (5, annual; 3, biennial)	5 (0, 1, 2, 3, 4 years)	4 (0, 1, 2, 3 years)	5 (0, 1, 2, 3, 4 years)	4 (0, 1, 3, 5.5 years)	5 (0, 1, 2, 3, 4 years)	1
HR for lung cancer mortality (95% CI)	0.80 (0.70–0.92), p = 0.004	1.52 (0.63–3.65), p = 0.21 at 5 year; 0.61 (0.39–0.95), p = 0.02 at 10 year	0.99 (0.69–1.43)	0.70 (0.47–1.03), p = 0.07	1.03 (0.66–1.6), p = 0.888	M: 0.74 (0.69–0.91), p = 0.003/F: 0.61 (0.35–1.04), p = 0.0543	NA	NA

CI = confidence interval, CXR = chest X-ray, DANTE = Detection and Screening of Early Lung Cancer by Novel Imaging Technology and Molecular Essays, DLCST = Danish Lung Cancer Screening Trial, F = female, HR = hazard ratio, LDCT = low-dose CT, LUSI = Lung Cancer Screening Intervention Trial, M = male, MDCT = multidetector-row CT, MILD = Multicentric Italian Lung Detection, NA = not applicable, NELSON = Nederlands-Leuvens Longkanker Screenings Onderzoek, NLST = National Lung Screening Trial, PY = pack-year, UKLS = UK Lung Cancer Screening Trial

요약 [1]: 고위험군 (고령 및 흡연력)에 대해 컴퓨터 단층촬영을 통한 폐암 검진은 폐암 사망률을 줄인다.

[1] *J Korean Soc Radiol. 2019 Sep;80(5):849-859. https://doi.org/10.3348/jksr.2019.80.5.849*

한국 폐암 검진 (Chest CT)

K-LUCAS (Korean Lung Cancer Screening Project)[1]

Table 4 Key screening performance of K-LUCAS compared with NLST

Indicators	K-LUCAS	NLST
True positive	40	270
False positive	825	6,921
False positive rate (%)	14.6	26.6
Non-cancer case of total positives (%)	95.4	96.2
Cancer detection rate (%)	0.7	1.0
TNM stage I detection rate (%)	57.1	49.1
TNM stage II detection rate (%)	9.5	6.9
Biopsy procedure rate (%)	6.8	2.4
Cancer detection per biopsy (%)	63.9	33.3
Bronchoscopy procedure rate (%)	7.2	4.8
Cancer detection per bronchoscopy (%)	45.0	25.1
Surgical procedure rate (%)	5.6	4.7
Cancer detection per surgical procedure (%)	87.1	75.6
Complication per total diagnostic follow-ups (%)	1.1	3.4

Positive screen 15.2% (865/ 5,692)
- ✓ Lung RADS 3= 529
- ✓ Lung RADS 4= 336

Cancer detection 0.7%
- ✓ Stage I 57.1%
- ✓ Stage II 9.5%

Biopsy procedure 6.8%
Surgical procedure 5.6%

[1] *Transl Lung Cancer Res. 2021 Feb;10(2):723-736. doi: 10.21037/tlcr-20-700.*

영상학적 평가 (실제 폐암[악성]일 위험도)

Lung RADS (ver 1.1) and FDG PET

Lung-RADS™ Version 1.1

Assessment Categories Release date: 2019

Category Descriptor	Lung-RADS Score	Findings	Management	Risk of Malignancy	Est. Population Prevalence
Incomplete	0	Prior chest CT examination(s) being located for comparison Part or all of lungs cannot be evaluated	Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed	n/a	1%
Negative No nodules and definitely benign nodules	1	No lung nodules Nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules	Continue annual screening with LDCT in 12 months	< 1%	90%
Benign Appearance or Behavior Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth	2	**Solid nodule(s):** < 6 mm new < 4 mm **Part solid nodule(s):** < 6 mm total diameter on baseline screening **Non solid nodule(s) (GGN):** <30 mm **OR** ≥ 30 mm and unchanged or slowly growing **Category 3 or 4 nodules unchanged for ≥ 3 months**			
Probably Benign Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	3	**Solid nodule(s):** ≥ 6 to < 8 mm at baseline **OR** new 4 mm to < 6 mm **Part solid nodule(s)** ≥ 6 mm total diameter with solid component < 6 mm **OR** new < 6 mm total diameter **Non solid nodule(s)** (GGN) ≥ 30 mm on baseline CT or new	6 month LDCT	1-2%	5%
Probably Suspicious Findings for which additional diagnostic testing is recommended	4A	**Solid nodule(s):** ≥ 8 to < 15 mm at baseline **OR** growing < 8 mm **OR** new 6 to < 8 mm **Part solid nodule(s:** ≥ 6 mm with solid component ≥ 6 mm to < 8 mm **OR** with a new or growing < 4 mm solid component **Endobronchial nodule**	3 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component	5-15%	2%
Suspicious Findings for which additional diagnostic testing and/or tissue sampling is recommended	4B	**Solid nodule(s)** ≥ 15 mm **OR** new or growing, and ≥ 8 mm **Part solid nodule(s) with:** a solid component ≥ 8 mm **OR** a new or growing ≥ 4 mm solid component	Chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm solid component. *For new large nodules that develop on an annual repeat screening CT, a 1 month LDCT may be recommended to address potentially infectious or inflammatory conditions*	> 15%	2%
	4X	Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy			
Other Clinically Significant or Potentially Clinically Significant Findings (non lung cancer)	S	**Modifier - may add on to category 0-4 coding**	As appropriate to the specific finding	n/a	10%
Volumetric measurements	1.5 mm = 1.8 mm³ 4 mm = 33.5 mm³ 6 mm = 113.1 mm³ 8 mm = 268.1 mm³		10 mm = 523.6 mm³ 15 mm = 1767.1 mm³ 20 mm = 4188.8 mm³ 30 mm = 14137.2 mm³		

Mayo Clinic Model [1] (CT)

- Age
- Smoking
- history
- Previous extrathoracic cancer
- Nodule diameter
- Upper lobe location
- Spiculation

Brock Model (PanCan) [2] (CT)

- Age
- Sex
- Family
- history
- Emphysema
- Nodule size
- Upper lobe
- Spiculation
- Part-solid 여부
- Number of nodules

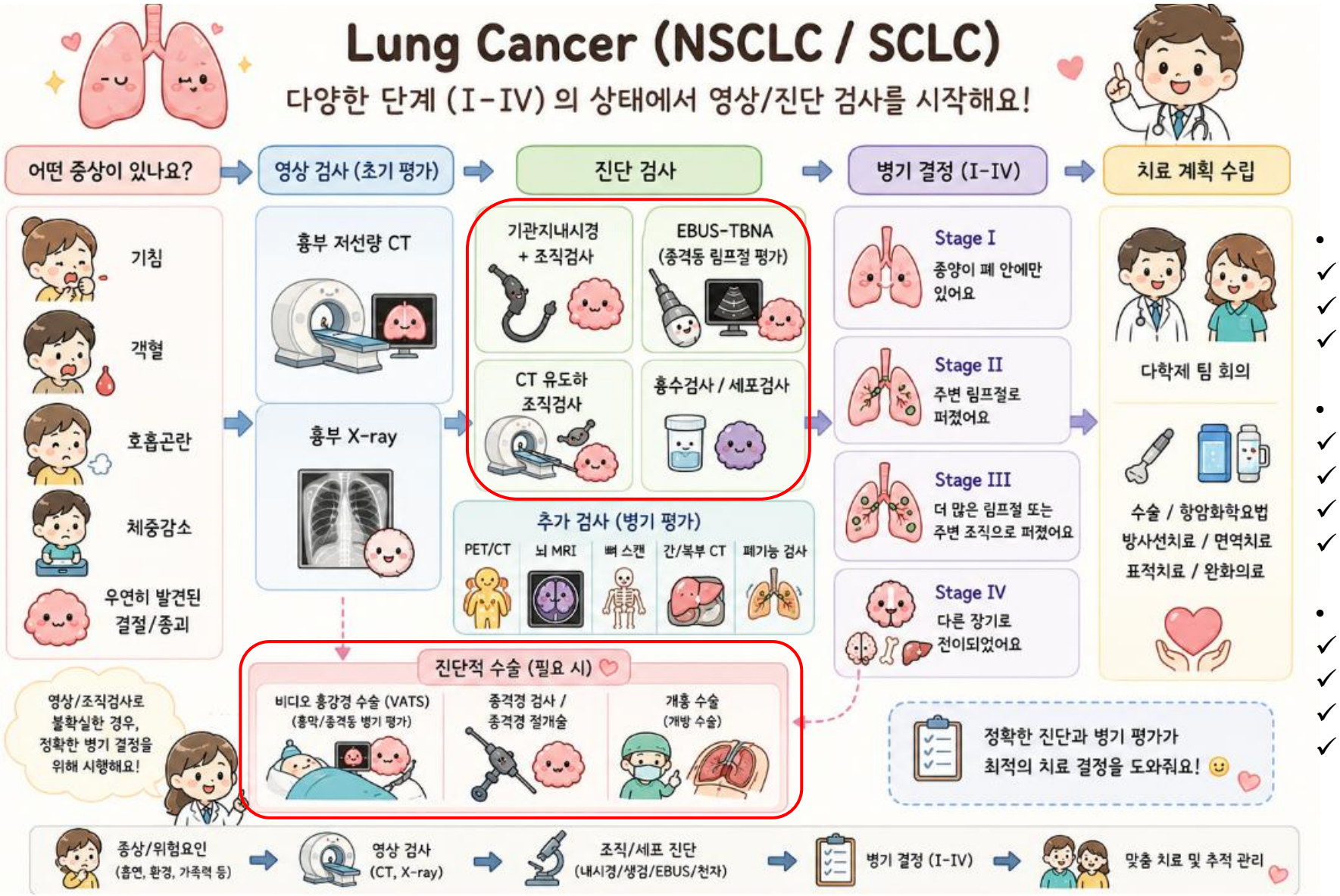
Herder Model (Mayo + FDG PET) [3-4]

FDG PET/CT

- Standardized Uptake Value (SUV)
  - ✓ SUV of 2.5 or higher is generally considered suggestive of malignancy
- Metabolic Tumor Volume (MTV)
  - ✓ The total volume of the tumor
- Total Lesion Glycolysis (TLG)

[1] J Thorac Oncol. 2014 Oct;9(10):1477–1484.
[2] N Engl J Med. 2013;369(10):910-9.
[3] Chest 128, 2490–2496 (2005)
[4] Thorax thoraxjnl–2015–207221 (2015).

환자와의 첫만남 (Variable Initial Manifestation)



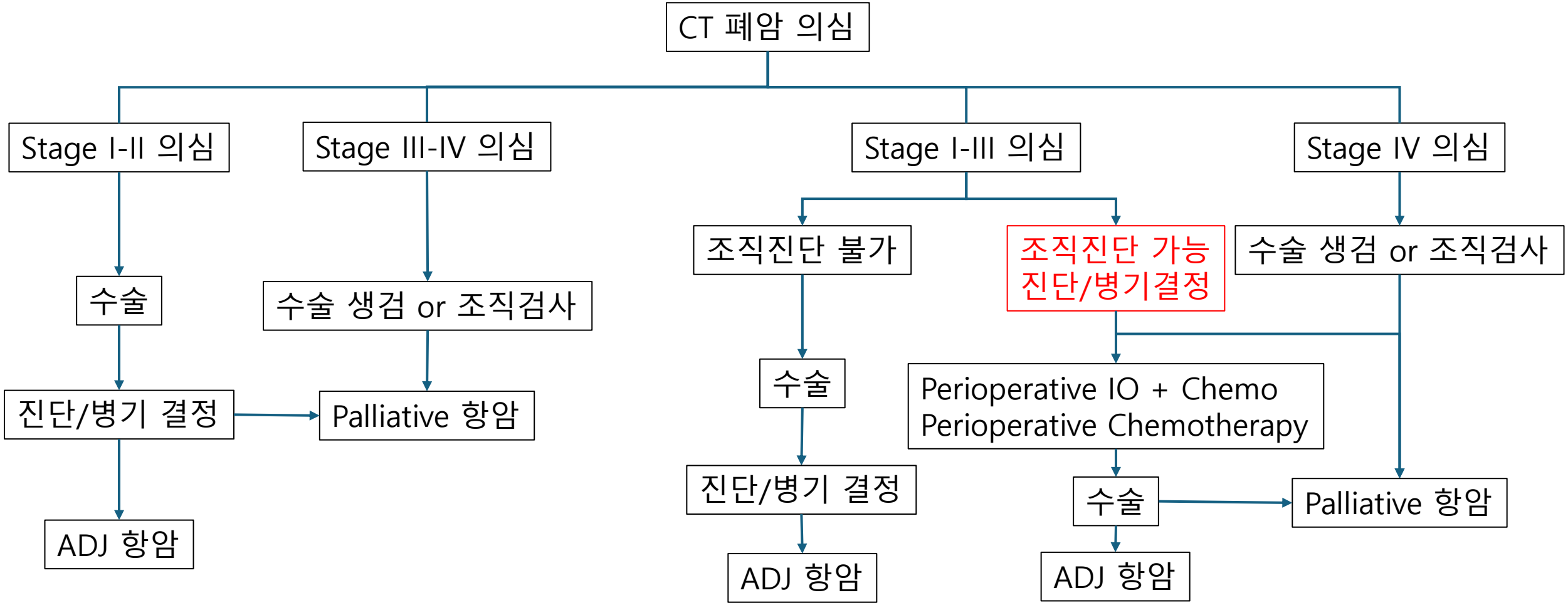
- **Initial manifestation**
  - ✓ Early-stage Disease (Stage I–II)
  - ✓ Locally Advanced Disease (Stage III)
  - ✓ Metastatic Disease (Stage IV)

- **Initial manifestation**
  - ✓ Lung disease (COPD/Asthma/ILD)
  - ✓ Lung function
  - ✓ 6MWT (6분 보행검사) (m / Nadir Sat)
  - ✓ Medical operability

- **Patient state**
  - ✓ Performance status
  - ✓ Emotional status
  - ✓ Economic status
  - ✓ Educational status

치료/검사 전략

- 과거 (Before Precision Medicine)
- 현재 (Precision & Perioperative Era)



Different Clinical Pathways in First diagnosed Lung Cancer

Scenario A; Potentially Curable Disease (Stage I-III)

CT; Localized lung lesion

외래 진료

Non-surgical Histologic Diagnosis (if feasible)
- Lung biopsy (Percutaneous, Bronchoscopic, Robot)
- Mediastinal LN biopsy

Pathologic diagnosis done (확진)
- NSCLC vs. SCLC

Surgical biopsy (확진)
- Curative intent vs. diagnosis

Complete molecular testing for NSCLC
Image Staging PET CT / Brain MR / Bone scan
- NSCLC cStage I-III vs. IV
- SCLC cStage LD vs. ED

다학제 치료 결정
- Surgical treatment (±Neoadjuvant Chemo)
- CCRT or Chomotherapy

- Adjuvant chemotherapy
- Palliative chemotherapy

Scenario B; Suspected Advanced Disease (Stage IV)

CT; Metastatic lesions suspected

Biopsy from the easiest & safest site
- Intrathoracic – lung biopsy / Mediastinal biopsy
- Extrathoracic – Biopsy
- Surgical biopsy if needed

Pathologic diagnosis done (확진)
- Complete molecular testing

Palliative chemotherapy

Scenario A; Potentially Curable Disease (Stage I-III)

Lung nodule; Chest CT image

CLINICAL PRESENTATION

RISK ASSESSMENT[b]

Incidental finding of nodule suspicious for lung cancer →

- **Multidisciplinary evaluation[a]**
- **Smoking cessation counseling**

→

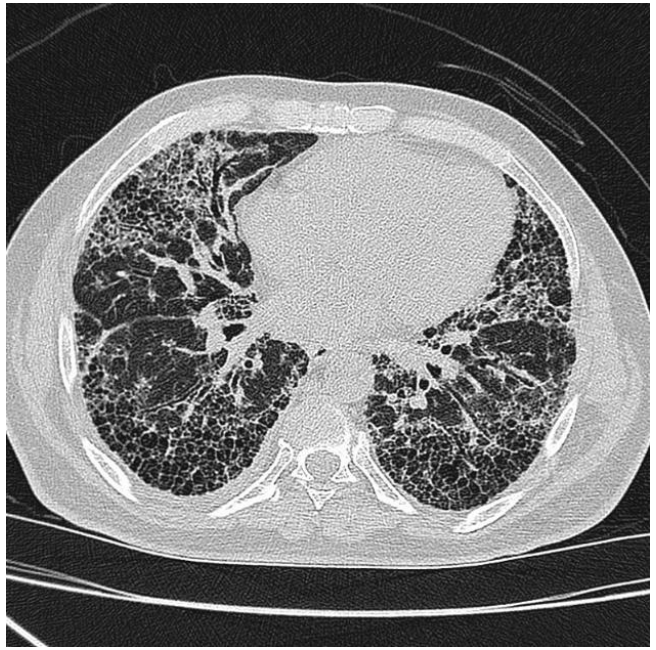
Patient factors
- **Age**
- **Smoking history**
- **Previous cancer history**
- **Family history**
- **Occupational exposures**
- **Other lung disease (chronic obstructive pulmonary disease [COPD], pulmonary fibrosis)**
- **Exposure to infectious agents (eg, endemic areas of fungal infections, tuberculosis) or risk factors or history suggestive of infection (eg, immune suppression, aspiration, infectious respiratory symptoms)**

Radiologic factors[c,d]
- **Size, shape, and density of the pulmonary nodule**
- **Associated parenchymal abnormalities (eg, scarring or suspicion of inflammatory changes)**
- **Fluorodeoxyglucose (FDG) avidity on FDG-PET/CT imaging**

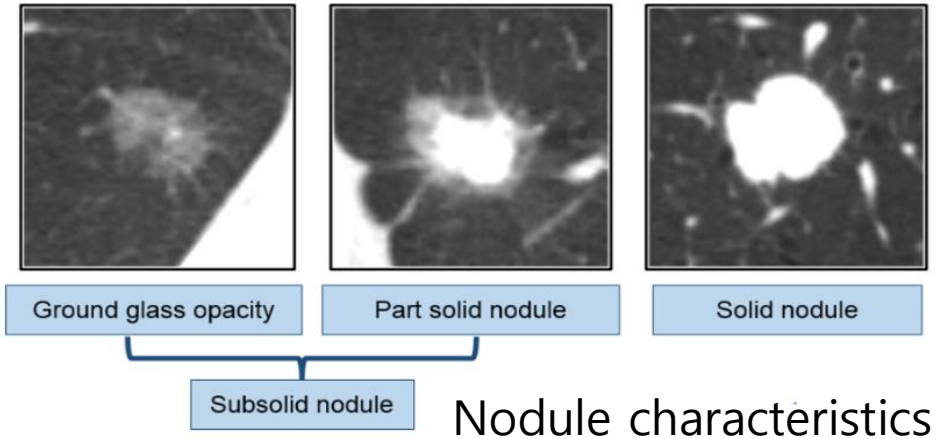
→ **Solid nodules** Follow-up (DIAG-2)

→ **Subsolid nodules** Follow-up (DIAG-3)

Lung nodules in asymptomatic patients at high risk detected during lung cancer screening with LDCT → NCCN Guidelines for Lung Cancer Screening



ILD (Y/N)
Emphysema (Y/N)
Bronchiectasis (Y/N)



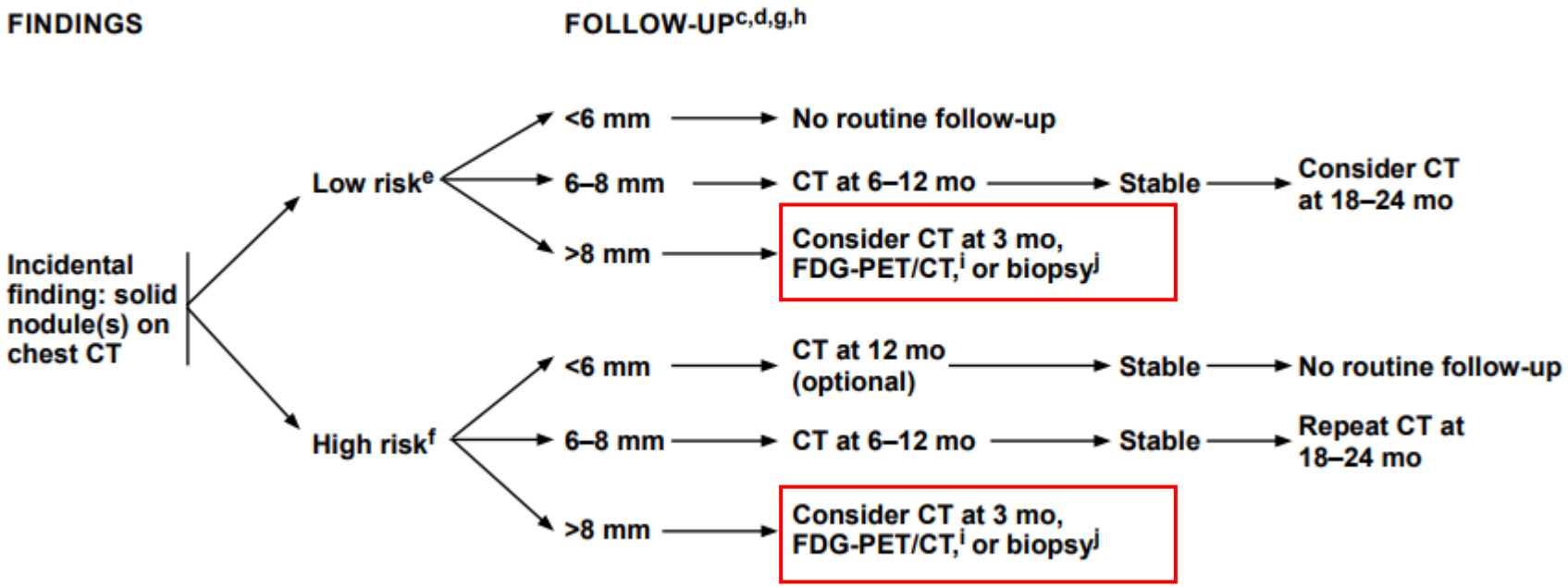
Nodule characteristics

https://dx.doi.org/10.1594/ecr2017/C-1099

NCCN Guidelines Version 6.2026

Scenario A; Potentially Curable Disease (Stage I-III)

Lung nodule; Chest CT image



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[e] low risk = minimal or absent history of smoking or other known risk factors

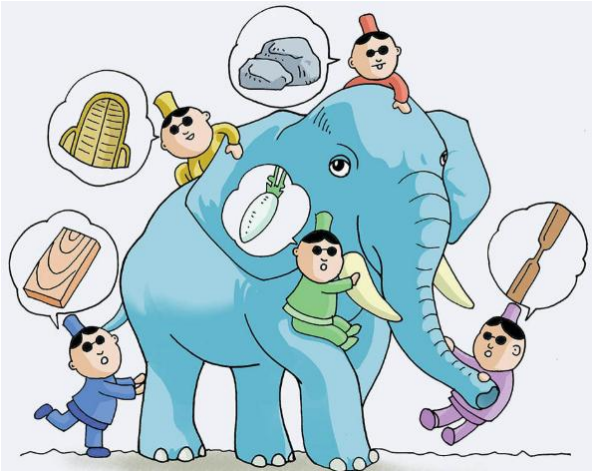
[f] High risk = history of smoking or other known risk factors. Known risk factors include history of lung cancer in a first-degree relative or exposure to asbestos, radon, or uranium

정확하게 + 충분히 (Complete molecular testing)

비수술적 확진 검사
(Non-surgical Pathologic Diagnosis)

- 영상 (컴퓨터 단층촬영, PET CT)은 **폐암의 위험도 (Lung RADS)**에 대한 평가이다.
- 암에 대한 확진과 치료결정은 병리학적 진단이 필수적 (Complete molecular testing)이다.
- **최근 Cell free 검체 (cell free DNA, NGS)**의 많은 발전이 있었으나, 조직 진단은 여전히 중요하다.
  - ✓ cfDNA NGS Sensitivity 70–80% Specificity 95–99% [1-3]
  - ✓ Tissue NGS Sensitivity 93–99% Specificity 97–99% [1-3]
- 조직검사 기법의 발전으로 다양한 방식(Needle/Forceps/CRYO)이 존재한다.
- 비수술적 조직검사는 위음성 (실제 암이나, 조직검사에서 양성질환으로 나오는 경우)을 조심해야 한다.

조직검사; 진단률이 100% 일 수 없음
일부만 가지고 전체를 이해할 수 있나?
"눈감고 코끼리 다리 만지기"



[1] DOI: 10.1016/j.critrevonc.2020.102962
[2] DOI: 10.1158/1078-0432.CCR-19-0006
[3] DOI: 10.1016/j.jtho.2021.12.015

확진을 위한 조직 검사 – 접근 방식의 결정
(Biopsy Routes)

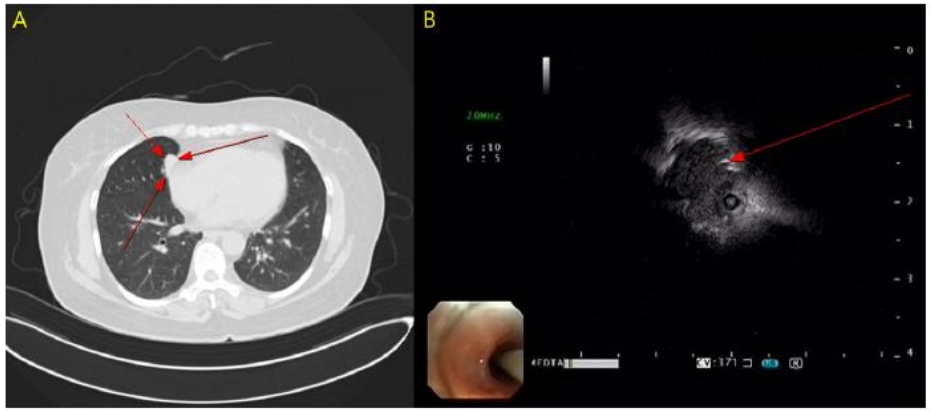
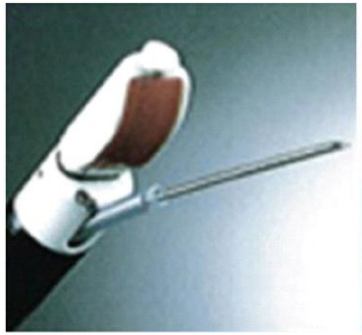


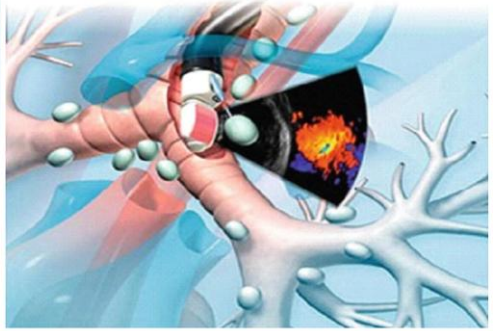
Figure 2. Representative case of successful RP-EBUS localization in a pulmonary nodule without CT-BS: (**A**) Chest CT demonstrating a pulmonary nodule (arrow) without an identifiable CT bronchus sign. (**B**) RP-EBUS image showing a dense sign with an adjacent orientation relative to the target lesion (arrow). RP-EBUS, radial probe endobronchial ultrasound-guided; CT-BS, computed tomography bronchus sign.

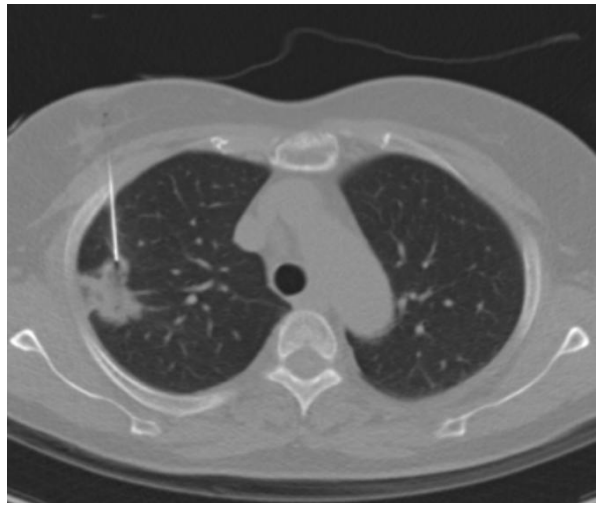
Lung biopsy

- Non-surgical biopsy
  - Bronchoscopic procedures
    - ✓ Navigation bronchoscopy
    - ✓ Radial probe Bronchoscopy[1]
    - ✓ Robot bronchoscopy
  - Percutaneous biopsy
- Surgical biopsy



Tip of linear EBUS bronchoscope (courtesy of Olympus)





Lymph node biopsy (N1-3)

- EBUS-TBNA
- Surgical (Mediastinoscopy, Mediastinotomy)

[1] Diagnostics 2026, 16(12), 1912;https://doi.org/10.3390/diagnostics16121912

EUROPEAN RESPIRATORY REVIEW
REVIEW
P. BALASUBRAMANIAN ET AL.

Diagnostic yield and safety of diagnostic techniques for pulmonary lesions: systematic review, meta-analysis and network meta-analysis

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- Lung biopsy techniques
- Systemic review
- Meta-analysis

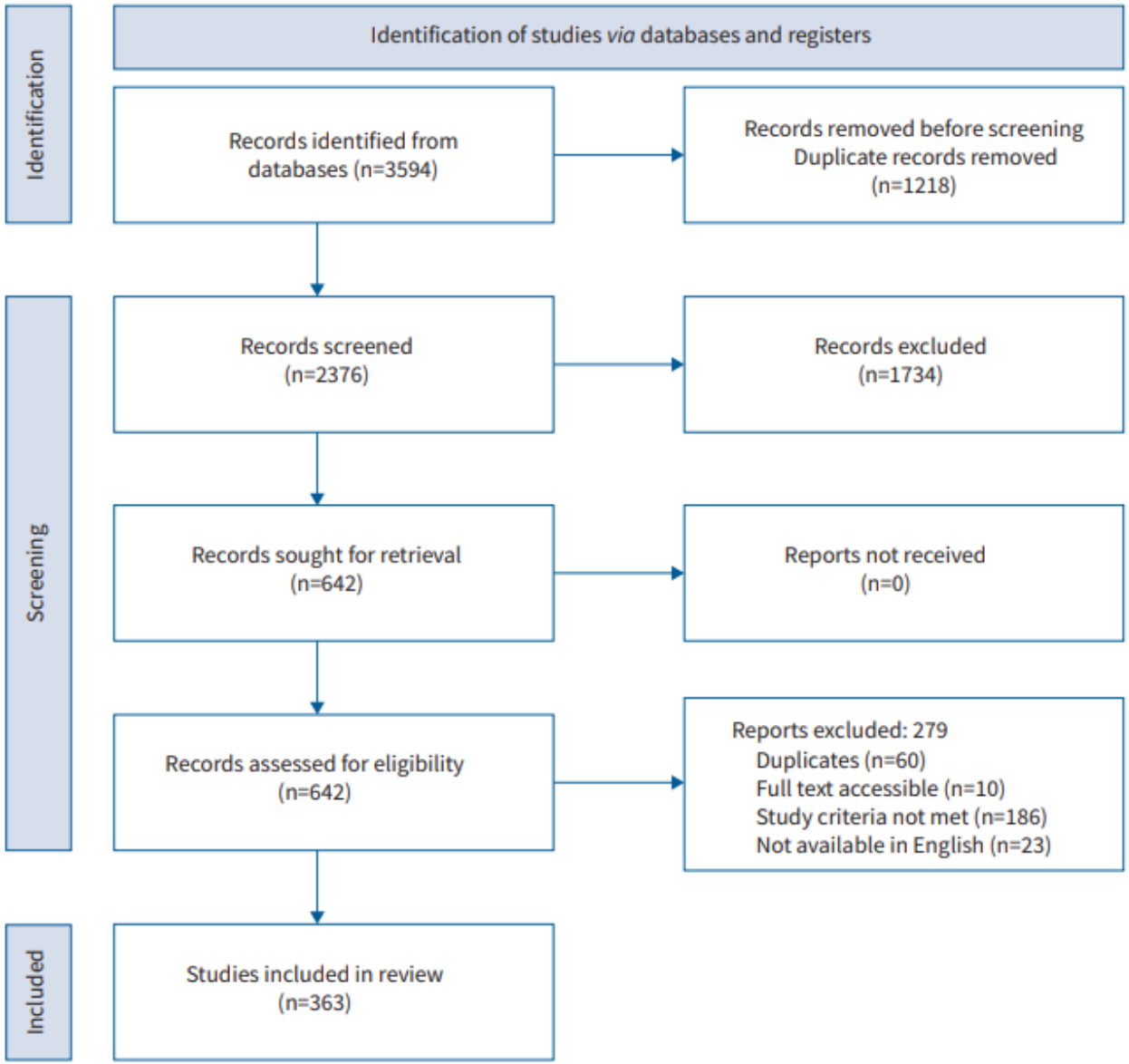

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.

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TABLE 1 Diagnostic yield overall and across subgroups

Technique	Number of studies	Number of nodules sampled	Size of nodules (mean±SE), cm	Diagnostic yield (95% CI), %	τ^2	I^2, %
CT-TBNA	80	31 964	2.02±0.19	88.9 (87–90.5)	0.42	93.2
Bronchoscopic procedures	320	47 555	2.38±0.07[¶]	73.9 (72.4–75.3)[+]	0.11	87.1
rEBUS	146	28 383	2.66±0.12	72 (70.1–73.8)	0.20	87.8
VB	44	6379	2.56±0.12	75.1 (72.2–77.8)	0.14	77.4
EMN	94	10 270	2.17±0.07	72.7 (69.4–75.6)	0.30	86.2
RAB	24	2523	1.78±0.14	84.8 (81.1–87.8)	0.22	74.8
Overall	363[#]	79 519	2.31±0.06[§]	78.1 (76.6–79.4)[f]	0.12	94

[#]: 37 studies had comparison with two different diagnostic modalities. Subgroup difference (random effects model) for computed tomography-guided transthoracic biopsy or needle aspiration (CT-TBNA) *versus* bronchoscopic procedures: [¶]: Q-value=2.32, p-value 0.13; [+]: Q-value=114, p<0.0001. Subgroup difference (random effects model) for each individual diagnostic procedure: [§]: Q-value=28.39, p-value <0.0001; [f]: Q-value=150.63, p<0.0001. EMN: electromagnetic navigation; RAB: robot-assisted bronchoscopy; rEBUS: radial endobronchial ultrasound; VB: virtual bronchoscopy.

TABLE 2 Pairwise meta-analysis of the studies comparing two diagnostic procedures

Procedures	Number of studies	Relative risk (95% CI)	p-value	I^2, %	Publication bias
CT-TBNA *versus* rEBUS	9	1.19 (1.04–1.37)	0.02	79	High
CT-TBNA *versus* EMN	2	1.15 (0.31–4.37)	0.40	87	High
CT-TBNA *versus* RAB	1	1.01 (0.92–1.11)	0.86	NA	NA
VB *versus* only-rEBUS	14	1.06 (0.97–1.16)	0.05	43	Low
EMN *versus* only-rEBUS	5	1.12 (0.95–1.33)	0.12	55	Low
EMN *versus* VB	4	0.78 (0.26–2.34)	0.53	86	High
EMN *versus* RAB	2	0.89 (0.23–3.47)	0.48	49	Low

CT-TBNA: computed tomography-guided transthoracic biopsy or needle aspiration; EMN: electromagnetic navigation; NA: not applicable; RAB: robot-assisted bronchoscopy; rEBUS: radial endobronchial ultrasound; VB: virtual bronchoscopy.

Diagnostic yields

Biopsy

- CT-TBNA>Bronchoscopic procedure

Bronchoscopic procedure

- RAB > VB > EMN~R-EBUS

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TABLE 6 Subgroup analysis

Diagnostic yield by subgroups	Diagnostic yield % (95% CI)				
	CT-TBNA	rEBUS	VB	EMN	RAB
Malignant	91.2 (88.1–94.3)	74.4 (72.0–76.9)	81.9 (78.0–85.8)	75.6 (68.0–83.1)	83.5 (76.9–90.1)
Benign	79.0 (69.9–88.0)	74.1 (61.9–86.3)	60.6 (47.6–73.6)	87.2 (68.6–100)	76.4 (46.5–100)
p-value	0.019	0.885	0.011	0.27	NA
Lesion >2 cm	89.1 (84.8–93.5)	76.6 (74.4–78.7)	83.3 (79.0–87.5)	72.7 (66.5–78.9)	88.9 (79.6–98.1)
Lesion <2 cm	85.5 (81.0–90.0)	56.2 (51.7–60.8)	65.4 (59.1–71.7)	62.1 (54.5–69.7)	81.9 (71.6–92.2)
p-value	0.02	<0.001	<0.001	0.0002	0.03
Solid	84.6 (68.3–1.00)	75.5 (72.1–78.9)	77.6 (68.4–86.8)	75.9 (62.3–89.6)	79.0 (67.1–90.9)
Subsolid	89.1 (80.6–97.7)	59.5 (52.3–66.7)	62.6 (43.7–81.5)	56.1 (48.0–64.1)	74.6 (55.2–93.9)
p-value	0.18	0.0003	0.11	0.02	0.47
Bronchus sign+	NA	80.1 (76.2–84.1)	83.1 (80.4–85.5)	70.1 (60.2–79.9)	92.3 (84.0–97.1)
Bronchus sign–	NA	53.1 (43.6–62.7)	28.2 (23.3–33.6)	38.4 (13.2–63.6)	81.7 (75.3–87.1)
p-value	NA	<0.001	0.066	0.58	0.539[#]
Cryoprobe+	NA	68.9 (64.5–72.5)	85.5 (73.7–97.1)	NA	86.6 (75.4–94.0)
Cryoprobe–	NA	57.8 (47.6–67.4)	78.8 (64.6–93.1)	NA	76.6 (63.9–86.6)
p-value	NA	0.748	0.54	NA	0.652[#]
CBCT+	NA	74.9 (65.2–84.6)	84.3 (82.1–86.4)	77.0 (40.2–100)	89 (83.9–92.8)
CBCT–	NA	70.4 (64.6–93.1)	76.5 (16–100)	41.8 (40.0–43.5)	NA
p-value	NA	0.54	0.47	0.54	NA
Low risk of bias	89.7 (87.8–91.4)	72.3 (69.3–75.1)	73.6 (69.7–77.2)	69.8 (64.8–74.4)	85.2 (81.7–88.1)
High risk of bias	87.6 (83.7–90.6)	71.9 (69.6–74.1)	77.2 (72.9–80.9)	75 (70.8–78.7)	84.4 (72.1–91.9)
p-value	0.260	0.84	0.20	0.10	0.88
rEBUS+	NA	NA	75.0 (72–77.7)	72.3 (68.8–75.5)	85.1 (81.4–88.2)
rEBUS–	NA	NA	85.7 (57.3–96.4)	73.7 (67–79.4)	76.9 (69.3–83.1)
p-value	NA	NA	0.36	0.70	0.02

[#]: Only one study available, chi-square test used. CBCT: cone beam computed tomography; CT-TBNA: computed tomography-guided transthoracic biopsy or needle aspiration; EMN: electromagnetic navigation; NA: insufficient sample size/not applicable; RAB: robot-assisted bronchoscopy; rEBUS: radial endobronchial ultrasound; VB: virtual bronchoscopy.

Complications (Pneumothorax, Bleeding)

TABLE 5 Complications with different diagnostic procedures

Modality	Pneumothorax		Pneumothorax requiring chest tube		Clinically significant bleeding	
	Number of studies	% (95% CI)	Number of studies	% (95% CI)	Number of studies	% (95% CI)
CT-TBNA	70	16.8 (16.4–17.2)	47	1.6 (1.4–1.7)	53	5.2 (5.02–5.5)
rEBUS	107	0.9 (0.88–1.12)	65	0.2 (0.17–0.29)	90	1.4 (1.2–1.5)
VB	23	0.48 (0.33–0.69)	18	0.12 (0.05–0.25)	20	1.6 (1.34–1.98)
EMN	66	2.57 (2.28–2.90)	46	0.8 (0.67–1.03)	41	0.8 (0.66–1.02)
RAB	15	2.2 (2.7–2.9)	12	0.9 (0.64–1.48)	7	0.3 (0.18–0.72)

CT-TBNA: computed tomography-guided transthoracic biopsy or needle aspiration; EMN: electromagnetic navigation; RAB: robot-assisted bronchoscopy; rEBUS: radial endobronchial ultrasound; VB: virtual bronchoscopy.

Complications (PNX)
- CT-TBNA > Bronchoscopic procedure

Bronchoscopic procedure
- EMN > RAB > R-EBUS > VB

Complications (Bleeding)
- CT-TBNA>Bronchoscopic procedure

Bronchoscopic procedure
- VB > R-EBUS > EMN > RAB

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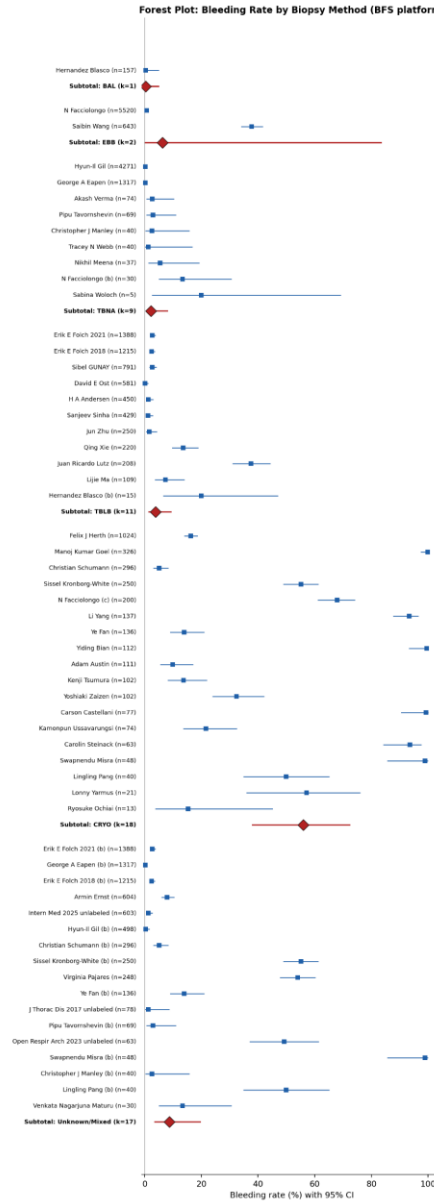
Bronchoscopic Approach Complications (Bleeding)

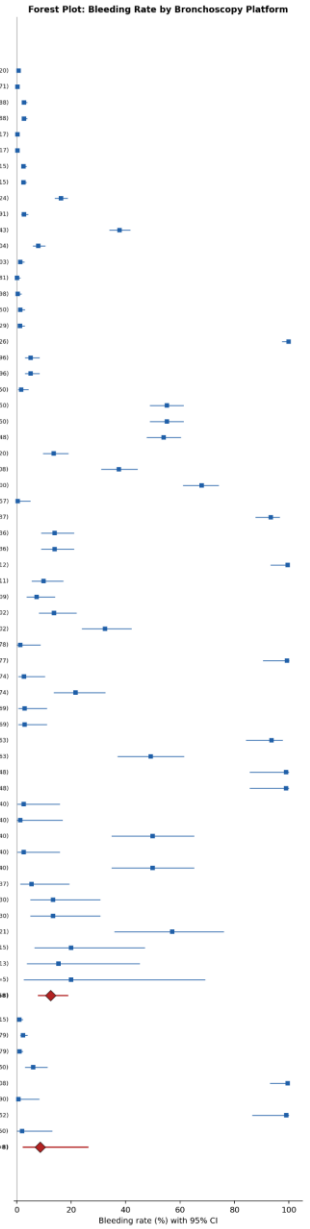
(D) Pooled any bleeding rate by bronchoscopy platform (random-effects model)

Platform	K	Total N	Events	Crude rate (%)	Pooled rate (%)	95% CI	τ^2	I^2 (%)
BFS	58	27,914	2,402	8.61	12.40	8.02-18.70	3.175	98.2
RAB	8	2,523	200	7.93	8.57	2.42-26.13	2.920	92.6
Subgroup difference test (QM): Q = 0.265, df = 1							P=0.607	

(E) Pooled any bleeding rate by biopsy method (BFS platform only)

Method	K	Total N	Events	Crude rate (%)	Pooled rate (%)	95% CI	τ^2	I^2 (%)
BAL	1	157	0	0.00	0.32	0.02-4.85	-	-
EBB	2	6,163	283	4.59	6.26	0.09-83.56	9.759	99.86
TBNA	9	5,883	23	0.39	2.21	0.58-8.05	3.622	89.2
TBLB	11	5,656	223	3.94	3.80	1.51-9.24	2.375	97.4
CRYO	18	3,132	1,332	42.53	55.97	38.13-72.39	2.086	97.3
Various	17	6,923	541	7.81	8.76	2.64-19.63	3.546	98.4
Subgroup difference test (QM): Q = 43.22, df = 5							p < 0.0001	

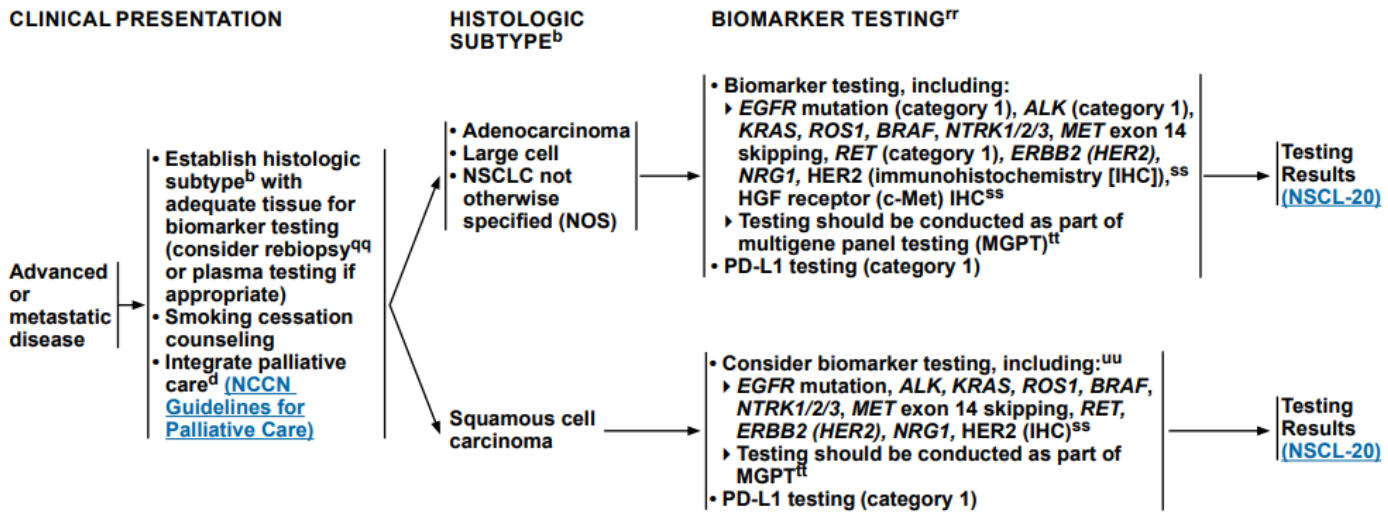




- 기관지내 출혈은 대량 기관지내 출혈 및 질식 등의 위험을 고려 시 통상 술 전 출혈 위험도 보다 보수적으로 판단이 필요하다.
- 출혈에 대한 합병증은 기관지 내시경 Platform차이 보다 조직검사 방식에 따라 차이가 있다
- CRYO biopsy>>TBLB~EBB>EBUS-TBNA>BAL
- 합병증에 대해 위험도 별로 결정이 필요하며, 고위험 시술은 입원하여 진행 할 수 있다.

Unpublished data

Tissue Adequacy for Next-Generation Sequencing



- Complete molecular testing
- 多多益善(다다익선); The more the better

✓ Surgical resection specimens achieve the highest rates of complete molecular profiling = 98%. [1]

✓ EBUS-TBNA specimens yield successful NGS results = 55% - 64% [2]

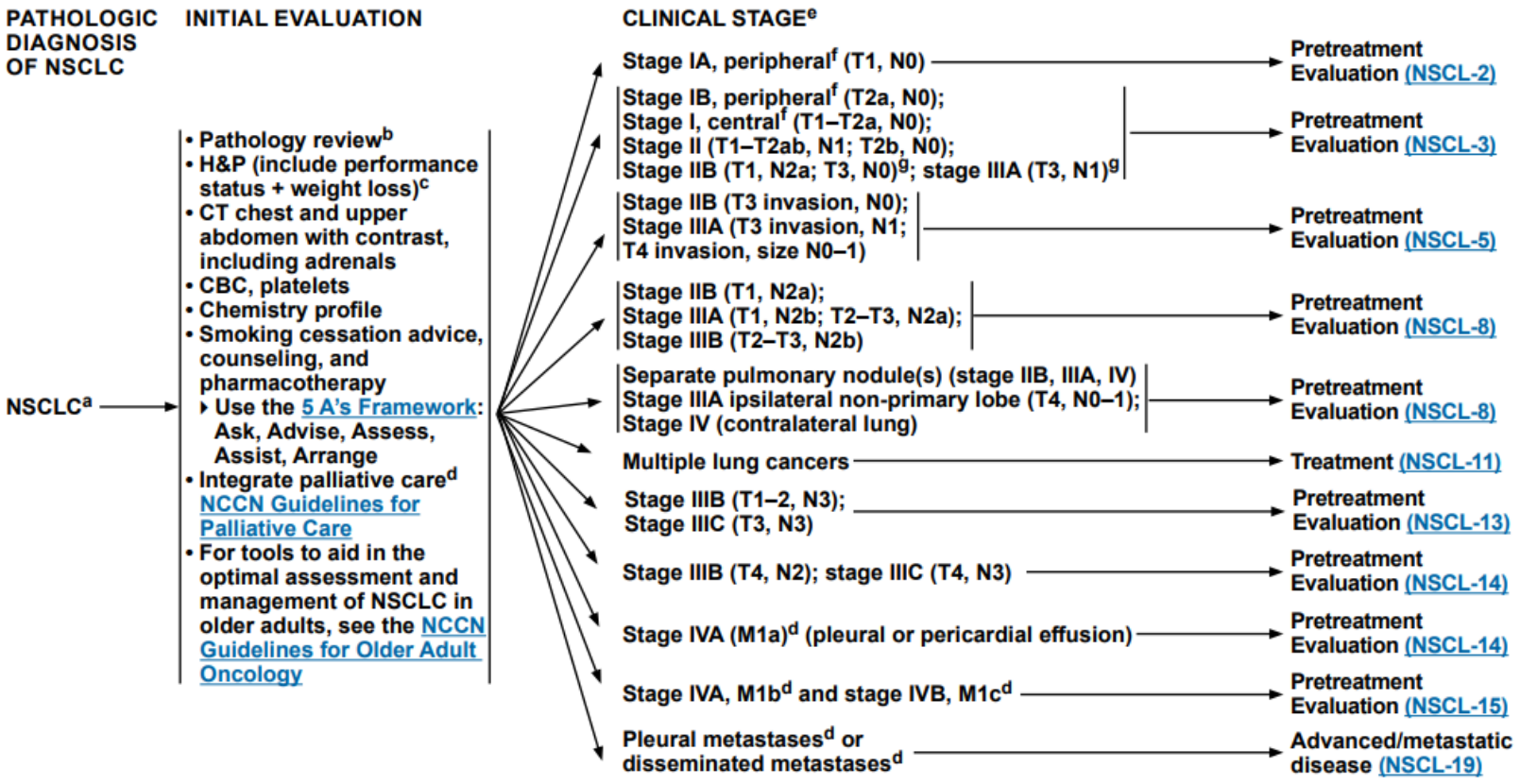
✓ CT-guided transthoracic core needle biopsies, larger bore needles have been associated with significantly higher NGS success rates = 18-gauge vs. 20-gauge needles; 90% vs. 33.3% [1]

✓ Recent data suggest that cryobiopsy yields larger, architecturally preserved tissue specimens [3]

작가	백남준
국가	대한민국
제작	1988년 10월 3일
종류	비디오 아트
크기	높이 18.5m
소장	대한민국 국립현대미술관 과천관 (1988년 -)

1. JTO Clin Res Rep 2023;4:100497.
2. Lung Cancer 2022;166:17-26.
3. BMC Pulm Med 2022;22:5.

Non-surgical Biopsy로 확진 후 Process



Pathology review
- NSCLC
- SCLC

Performance status
- CBC, chemistry
- Smoking cession
- Lung disease evaluation/treatment

Clinical staging
- EBUS-TBNA mediastinal staging
- PET CT/Brain MR

Early stage -> Curative intent operation

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Non-surgical Biopsy로 확진 후 Process

1. cStage IA (T1a-c N0; ≤ 3cm)

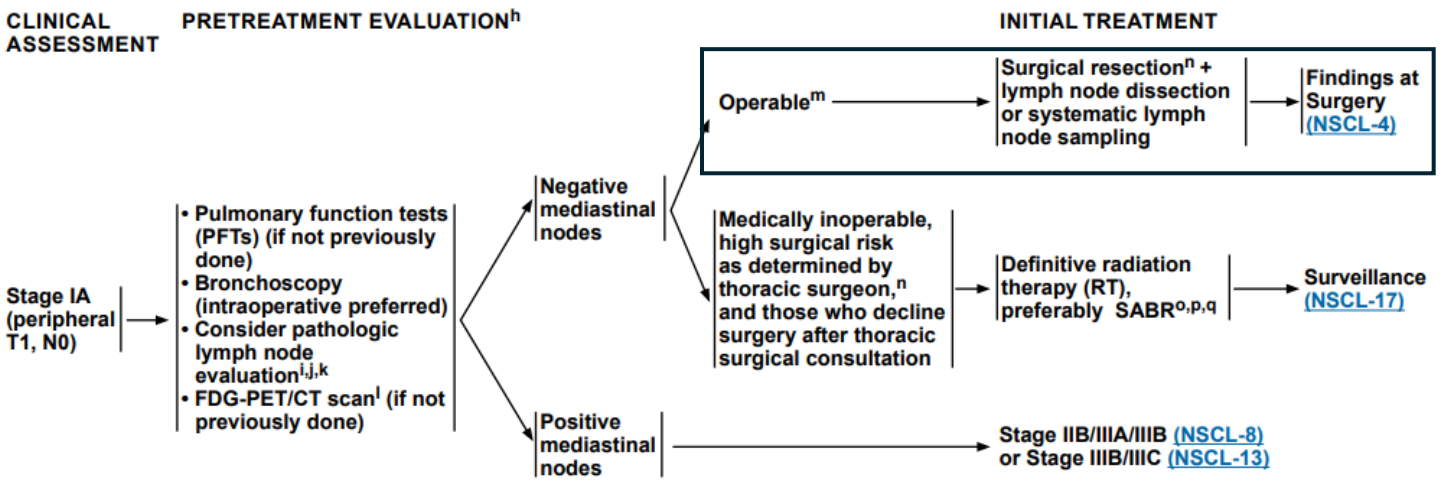

TABLE TNM stage grouping according to the proposed 9th edition of the TNM classification of lung cancers

T/M	Label	N0	N1	N2		N3
				N2a	N2b	
T1	T1a ≤ 1 cm	IA1	IIA	IIB	IIIA	IIIB
	T1b > 1 to ≤ 2 cm	IA2	IIA	IIB	IIIA	IIIB
	T1c > 2 to ≤ 3 cm	IA3	IIA	IIB	IIIA	IIIB
T2	T2a	IB	IIB	IIIA	IIIB	IIIB
	T2a > 3 to ≤ 4 cm	IB	IIB	IIIA	IIIB	IIIB
	T2b > 4 to ≤ 5 cm	IIA	IIB	IIIA	IIIB	IIIB
T3	T3 > 5 to ≤ 7 cm	IIB	IIIA	IIIA	IIIB	IIIC
	T3 Invasion	IIB	IIIA	IIIA	IIIB	IIIC
	T3 Satellite nodules	IIB	IIIA	IIIA	IIIB	IIIC
T4	T4 > 7 cm	IIIA	IIIA	IIIB	IIIB	IIIC
	T4 Invasion	IIIA	IIIA	IIIB	IIIB	IIIC
	T4 Ipsilateral nodules	IIIA	IIIA	IIIB	IIIB	IIIC
M1	M1a Contralateral nodules	IVA	IVA	IVA	IVA	IVA
	M1a Pleural, pericardial effusion	IVA	IVA	IVA	IVA	IVA
	M1b Single extra-thoracic lesion	IVA	IVA	IVA	IVA	IVA
	M1c1 Multiple extra-thoracic lesions in a single organ system	IVB	IVB	IVB	IVB	IVB
	M1c2 Multiple extra-thoracic lesions in multiple organ systems	IVB	IVB	IVB	IVB	IVB

Stage IA
- Resectability

Performance status (Operability)
- CBC, chemistry
- Smoking cession
- Lung disease evaluation/treatment
- **PFT / 6MWT (medical operability)**

Clinical staging
- EBUS-TBNA mediastinal staging (optional)[1]
- FDG PET/CT

[1] low likelihood of positive mediastinal lymph nodes are CT and FDG-PET CT negative in peripheral tumor (outer third) ≤ 3cm
Invasive mediastinal staging is recommended for central tumors

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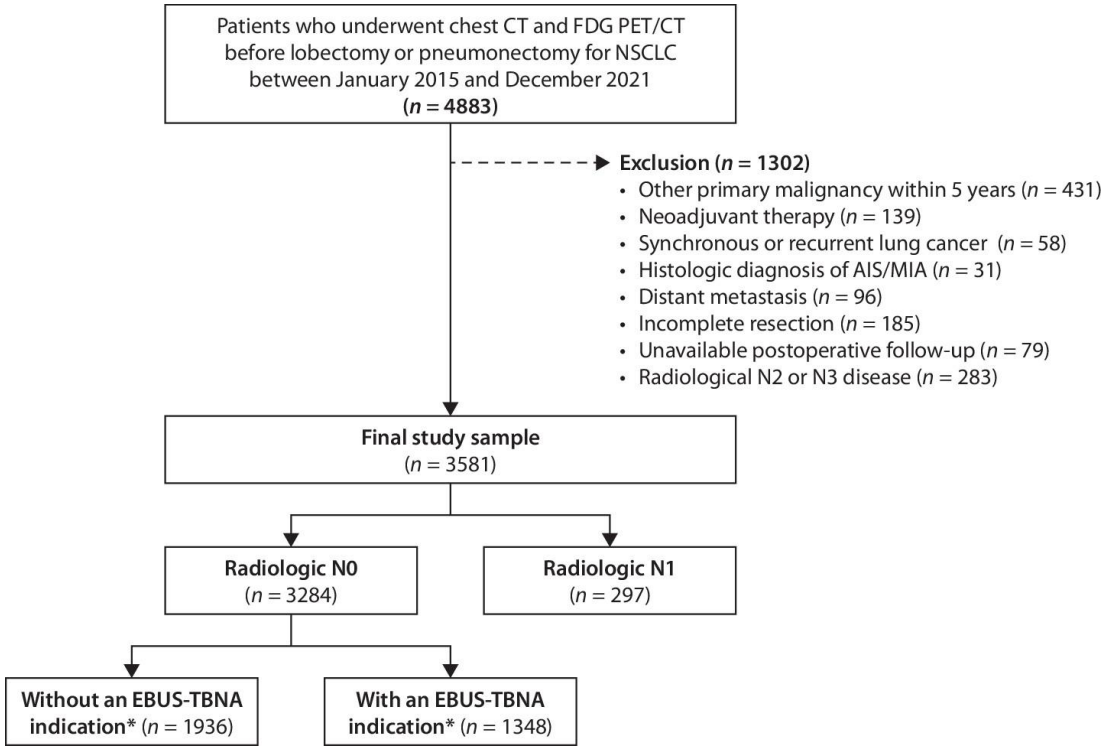
Radiologic N0 is Really Pathologic N0?



- **Without an Indication for EBUS-TBNA[a] (*n* = 1936)**
  - ✓ **pN0** = 1733 (89.5%)
  - ✓ **pN1** = 100 (5.2%)
  - ✓ **pN2** = 103 (5.3%) (N2a 79 [4.1%], N2b 24 [1.2%])
- **With an Indication for EBUS-TBNA[a] (*n* = 1348)**
  - ✓ **pN0** = 1060 (78.6%)
  - ✓ **pN1** = 167 (12.4%)
  - ✓ **pN2** = 121 (9.0%) (N2a 88 [6.5%], N2b 33 [2.4%])

- Among the 3,300 radiologic N0 cases, patients were stratified by the presence or absence of predefined EBUS-TBNA indications.
- Unforeseen **pN2 disease was detected in 5.0%** of cases **without an indication for EBUS-TBNA**, while the prevalence of occult pN2 metastasis rose significantly to 9.0% in those meeting EBUS-TBNA indications.

https://doi.org/10.2214/AJR.24.32486

Non-surgical Biopsy로 확진 후 Process

2. cStage IB (T2aN0; 3cm<tumor≤ 4cm)

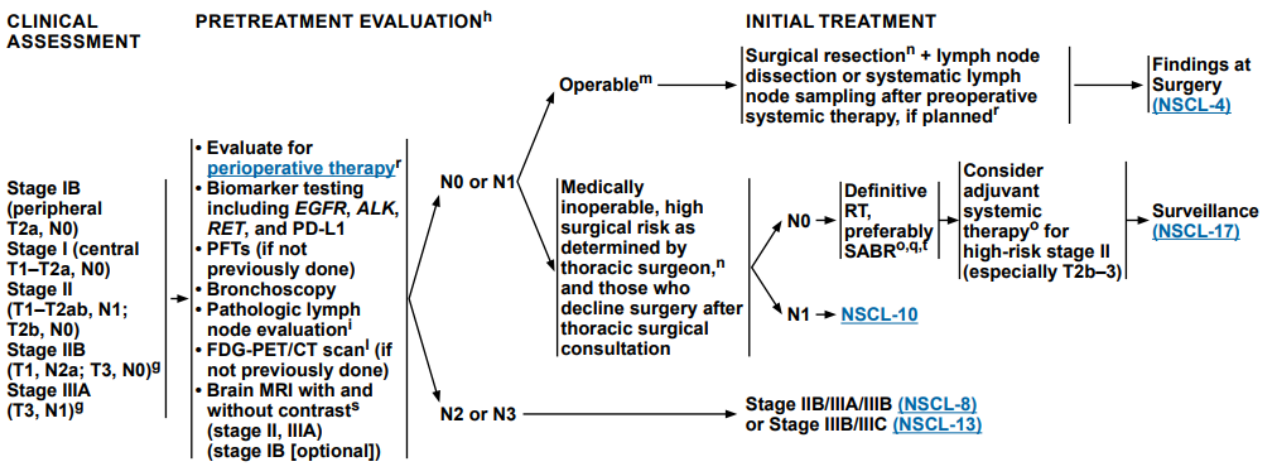


TABLE TNM stage grouping according to the proposed 9th edition of the TNM classification of lung cancers

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				N2a	N2b	
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	T1b > 1 to ≤ 2 cm	IA2	IIA	IIB	IIIA	IIIB
	T1c > 2 to ≤ 3 cm	IA3	IIA	IIB	IIIA	IIIB
T2	T2a	IB	IIB	IIIA	IIIB	IIIB
	T2a > 3 to ≤ 4 cm	IB	IIB	IIIA	IIIB	IIIB
	T2b > 4 to ≤ 5 cm	IIA	IIB	IIIA	IIIB	IIIB
T3	T3 > 5 to ≤ 7 cm	IIB	IIIA	IIIA	IIIB	IIIC
	T3 Invasion	IIB	IIIA	IIIA	IIIB	IIIC
	T3 Satellite nodules	IIB	IIIA	IIIA	IIIB	IIIC
T4	T4 > 7 cm	IIIA	IIIA	IIIB	IIIB	IIIC
	T4 Invasion	IIIA	IIIA	IIIB	IIIB	IIIC
	T4 Ipsilateral nodules	IIIA	IIIA	IIIB	IIIB	IIIC
M1	M1a Contralateral nodules	IVA	IVA	IVA	IVA	IVA
	M1a Pleural, pericardial effusion	IVA	IVA	IVA	IVA	IVA
	M1b Single extra-thoracic lesion	IVA	IVA	IVA	IVA	IVA
	M1c1 Multiple extra-thoracic lesions in a single organ system	IVB	IVB	IVB	IVB	IVB
	M1c2 Multiple extra-thoracic lesions in multiple organ systems	IVB	IVB	IVB	IVB	IVB

Stage IA
- Resectability
- Biomarker testing (Adjuvant chemotherapy)
- or 수술검체로 biomarker test도 가능

Performance status
- CBC, chemistry
- Smoking cession
- Lung disease evaluation/treatment
- **PFT / 6MWT (medical operability)**

Clinical staging
- EBUS-TBNA mediastinal staging (recommend)[1]
- **FDG-PET/CT**
- **Brain MRI**

[1]Include mediastinoscopy, mediastinotomy, EBUS, EUS, CT-guided biopsy
An EBUS-TBNA negative for malignancy in a clinically (CT and/or FDG-PET/CT) positive mediastinum should undergo subsequent mediastinoscopy prior to surgical resection

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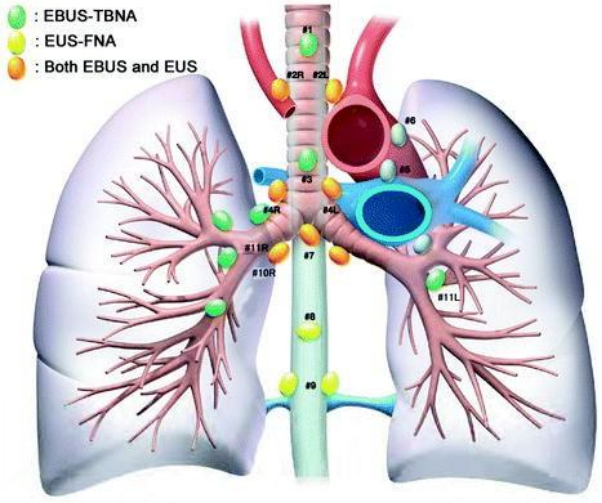
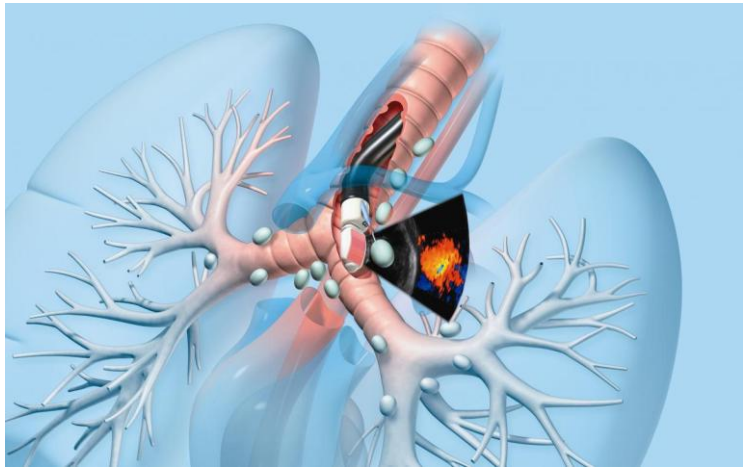
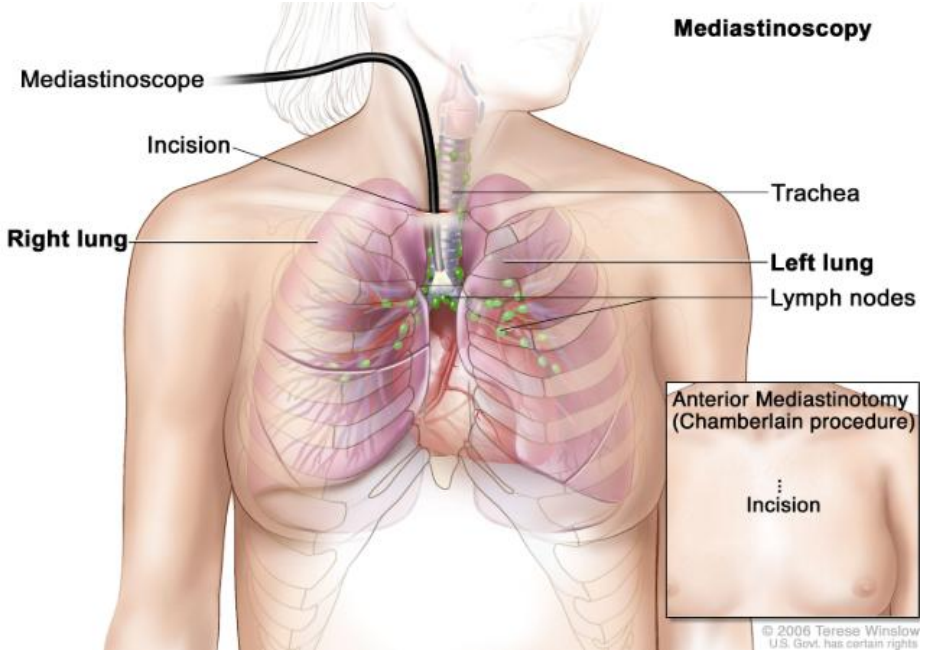
종격동 림프절 병기 설정 – 수술 가능 여부 (Resectability)
(Pathologic Mediastinal Staging)

- Mediastinoscopy [1]
- Mediastinotomy [1]
- EBUS TBNA (Sensitivity 88% · Specificity 100%) [2-3]

LN staging은 EBUS TBNA로 많이 표준화되었으나 [4]
Pathologic LN staging을 하지 않는 경우는
understaging 가능성이 있어 주의가 필요함 [5]







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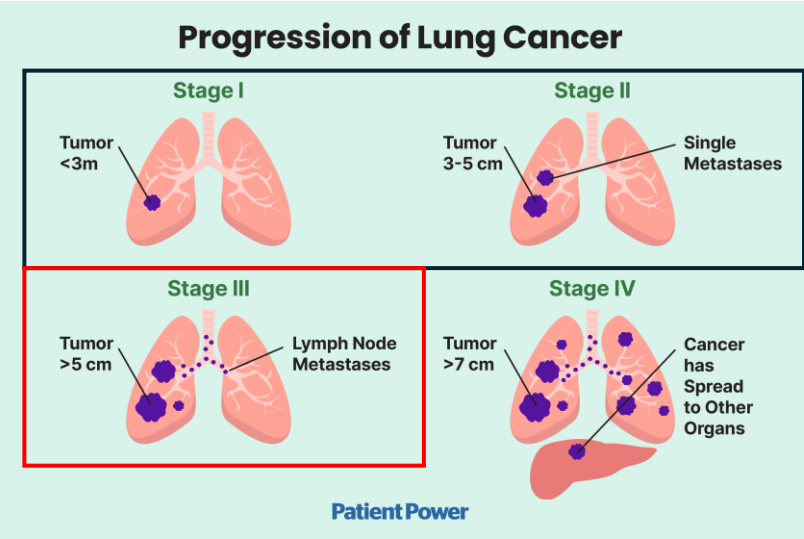
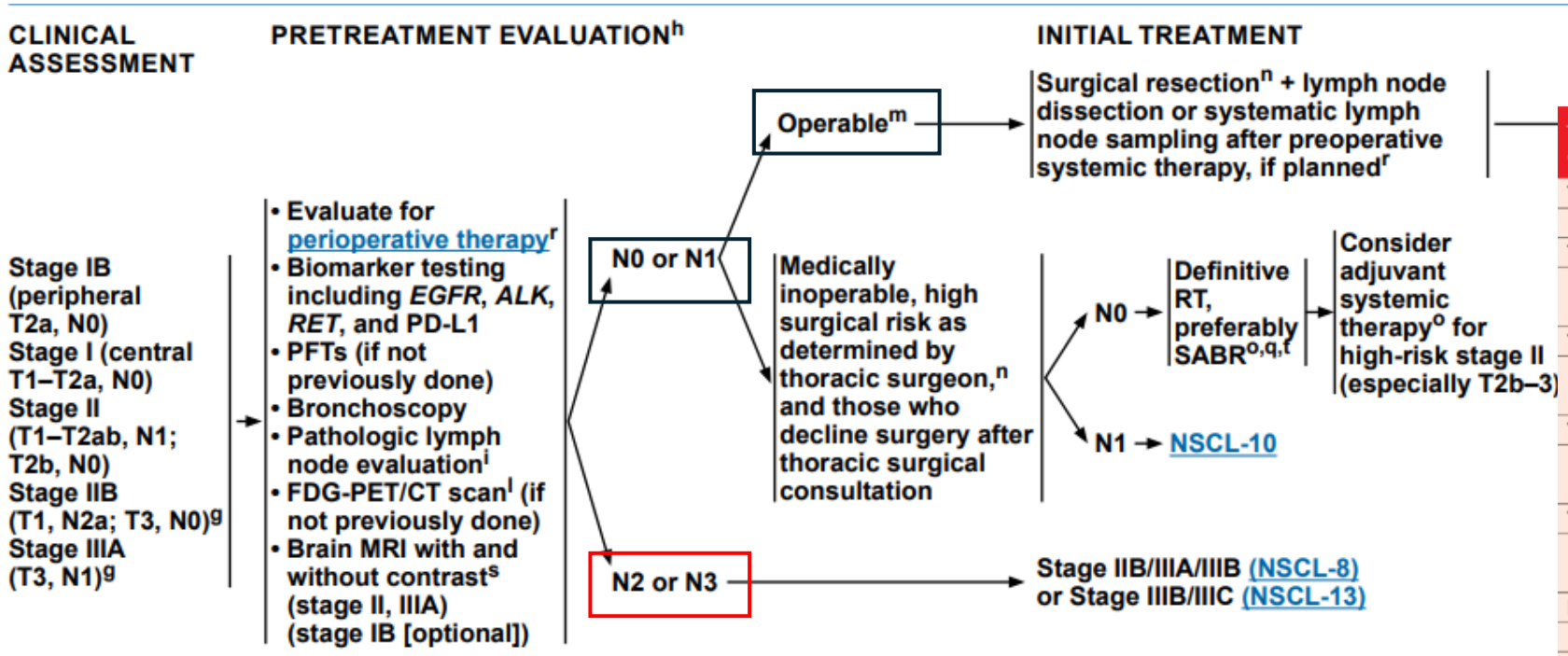
[2] Yasufuku, K. Springer, New York, NY. https://doi.org/10.1007/978-0-387-09437-3_8
[3] Adams K, et al. Thorax. 2009. DOI: 10.1136/thx.2008.109868
[4] DOI: 10.1016/j.chest.2023.03.041
[5] https://doi.org/10.2214/AJR.24.32486

종격동 림프절 병기 설정 – 수술 가능 여부
(Pathologic Mediastinal Staging; N0-1 vs. N2-3)





Findings at

TABLE TNM stage grouping according to the proposed 9th edition of the TNM classification of lung cancers

T/M	Label	N0	N1	N2		N3
				N2a	N2b	
T1	T1a ≤ 1 cm	IA1	IIA	IIB	IIIA	IIIB
	T1b > 1 to ≤ 2 cm	IA2	IIA	IIB	IIIA	IIIB
	T1c > 2 to ≤ 3 cm	IA3	IIA	IIB	IIIA	IIIB
T2	T2a	IB	IIB	IIIA	IIIB	IIIB
	T2a > 3 to ≤ 4 cm	IB	IIB	IIIA	IIIB	IIIB
	T2b > 4 to ≤ 5 cm	IIA	IIB	IIIA	IIIB	IIIB
T3	T3 > 5 to ≤ 7 cm	IIB	IIIA	IIIA	IIIB	IIIC
	T3 Invasion	IIB	IIIA	IIIA	IIIB	IIIC
	T3 Satellite nodules	IIB	IIIA	IIIA	IIIB	IIIC
T4	T4 > 7 cm	IIIA	IIIA	IIIB	IIIB	IIIC
	T4 Invasion	IIIA	IIIA	IIIB	IIIB	IIIC
	T4 Ipsilateral nodules	IIIA	IIIA	IIIB	IIIB	IIIC
M1	M1a Contralateral nodules	IVA	IVA	IVA	IVA	IVA
	M1a Pleural, pericardial effusion	IVA	IVA	IVA	IVA	IVA
	M1b Single extra-thoracic lesion	IVA	IVA	IVA	IVA	IVA
	M1c1 Multiple extra-thoracic lesions in a single organ system	IVB	IVB	IVB	IVB	IVB
	M1c2 Multiple extra-thoracic lesions in multiple organ systems	IVB	IVB	IVB	IVB	IVB

NCCN Guidelines Version 6.2026

Surgical Pathologic Diagnosis
(Lung biopsy and Pleural biopsy)

1. Lung surgery: Thoracoscopy

Types of lung cancer surgery

Lobectomy

A lobectomy involves removing one or more lobes of the lung that are affected by the cancer.

- Approximately one third to a half of your lung (30% to 50%) will be removed

It is the most-common operation for lung cancer. It may be suitable if your cancer is contained in a single lobe and you are reasonably fit. After surgery, your remaining lung will expand to fill the space left by the tissue that has been removed.

If more tissue needs to be removed, you may undergo a bi-lobectomy, which involves removing two lobes next to each other.

Segmentectomy

Each lobe of the lung is made up of several segments. A segmentectomy involves removal of one or more segments within a lobe.

- This can help to save unaffected tissue
- It is generally only suitable for removing tumours up to 2-cm wide

Wedge resection

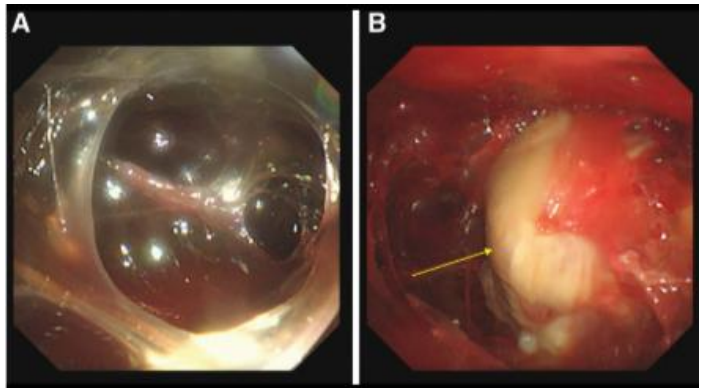
Involves removing a small, wedge-shaped part of the lung tissue surrounding the tumour.

- A wedge resection may be performed to remove a small or early-stage tumour or if you are too unwell for a segmentectomy or lobectomy
- A wedge resection may be needed if you have already had a lobectomy or segmentectomy in the past

Pneumonectomy

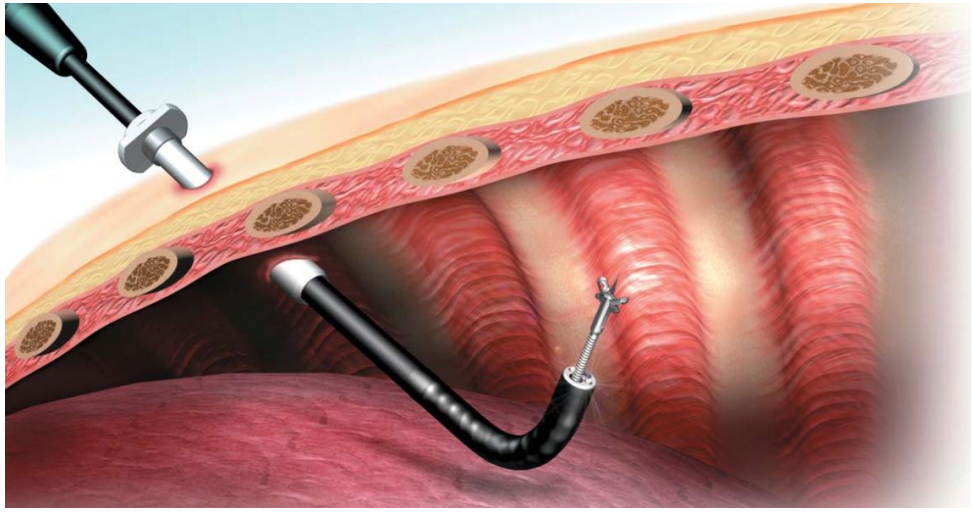
Removal of the entire affected lung on one side.

- Your surgeon may perform this procedure if there is no other way of completely removing the tumour
- This is only an option if you are considered fit enough, with enough spare lung capacity



2. Pleural biopsy: Thoracoscopy

- Surgical thoracoscopy (VATS)
- Medical thoracoscopy (Pleuroscopy) [1]



항목	**Medical thoracoscopy (Pleuroscopy)**	**Surgical thoracoscopy (VATS)**
시행자	호흡기내과	흉부외과
마취	국소마취 + 진정	전신마취 + 단일폐환기
기구	Rigid 또는 semi-rigid thoracoscope	Thoracoscope + 수술 기구
Pleurodesis	가능	가능
폐절제	불가능	가능
유착 박리	제한적	가능

[1] Medicine 101(47):p e31377, November 25, 2022. DOI: 10.1097/MD.0000000000031377

Surgical Diagnosis (Lobectomy)

항목	Open Thoracotomy	Video-assisted thoracoscopic surgery (VATS) 1	Robot-assisted Thoracic Surgery (RATS) [2-3]
접근법	개흉술	최소침습 흉강경	로봇 보조 최소침습
절개	15–25 cm	**2–5 cm (3–4 ports)**	**8–12 mm ports + utility incision**
늑골 벌림	O	X	X
시야	Direct vision	2D/3D thoracoscopy	3D HD
기구 자유도	손	제한적	7 degrees of freedom
촉각(촉진)	◎	△	△ (시각 보완)
림프절 절제	표준	**우수**	**우수 또는 VATS와 동등 이상**
출혈	많음	적음	가장 적은 경향
통증	가장 심함	적음	적음
입원기간	가장 김	**짧음**	**짧음**
회복	느림	빠름	빠름
비용	가장 저렴	**중간 (수술비 200만원~300만원)**	**가장 높음 (수술비 1500만 이상)**
장기 생존	기준	Open과 동등	Open/VATS와 동등

[1] The Lancet Oncology Volume 17, Issue 6, June 2016, Pages 836-844
[2] Lung Cancer. 2016 Nov:101:28-34. doi: 10.1016/j.lungcan.2016.09.004.
[3] Interact Cardiovasc Thorac Surg. 2020 Mar 1;30(3):359-365. doi: 10.1093/icvts/ivz273.

완치 목적 수술을 위한 수술 전 기능 평가 (Pre-op Physiology; Operability)

- Medical operability
- Pulmonary function tests[1] (PPO; Predicted Post Operative)
- Exercise/stress test
- ARISCAT Score

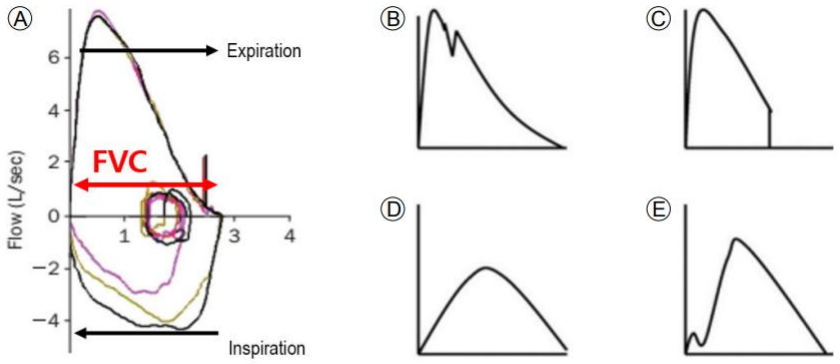
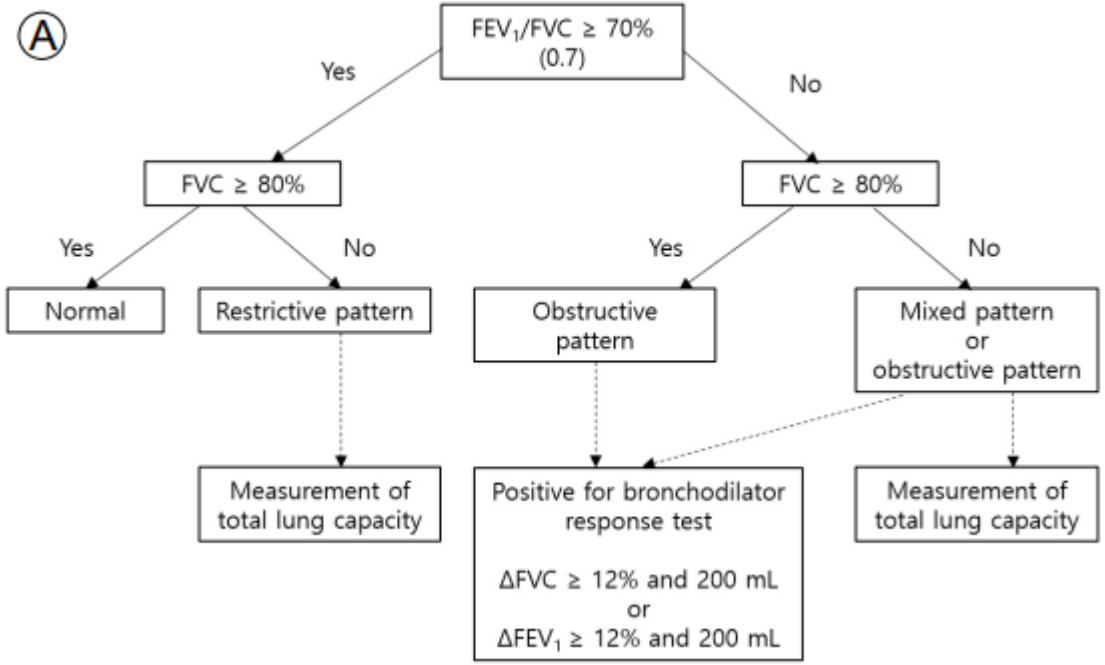


Figure 1. Acceptable and unacceptable flow-volume loops. (A) Normal, (B) cough, (C) early termination, (D) suboptimal effort, (E) hesitation to start. Reused from reference [6] with permission.



[1] The Korean Journal of Medicine: Vol. 96, No. 3, 2021

수술 가능성 (Medical Operability)

BREATHE
LUNG FUNCTION CORNER
R. ORLANDI ET AL.

Pulmonary function prediction in lung cancer resection candidates: the latest insights

Riccardo Orlandi[1], Sara Degiovanni[1], Clarissa Uslenghi[1], Asia Anghinelli[1], Paola Besana[1] and Alessandro Palleschi[1,2]

[1]Department of Thoracic Surgery, University of Milan, Milan, Italy. [2]Thoracic Surgery and Lung Transplantation Unit, Fondazione IRCCS Ca' Granda - Ospedale Maggiore Policlinico of Milan, Milan, Italy.

Corresponding author: Riccardo Orlandi (riccardo.orlandi@unimi.it)

Routine PFTs	CT scan	Ultrasound
• Forced volumes • Static volumes • D_{LCO}	• Conventional CT • Quantitative CT • Perfusion CT • Dual-energy CT	• Atelectasis • Pneumothorax • Pleural effusion • Diaphragm
Exercise testing	**Scintigraphy**	**MRI**
• 6MWT • SCT/SWT • CPET	• Planar $\dot{V}/\dot{Q}$ • SPECT/CT	• Functional • Contrast-enhanced

- **Pulmonary function tests (PFTs)** are central to this evaluation, offering quantitative measures of respiratory mechanics and gas exchange efficiency
- **Imaging modalities, such as computed tomography (CT), ventilation–perfusion ($\dot{V}/\dot{Q}$) scintigraphy and ultrasound, complement PFTs** by providing anatomical and regional **functional insights**

- No additional comments to ILD, IPF

Breathe 2025; 21: 250041 https://doi.org/10.1183/20734735.0041-2025

Pulmonary Function Tests

- **Spirometry (post BD FEV1)**
  - ✓ Spirometry is the most commonly used PFT and forms the foundation of preoperative evaluation
  - ✓ Patients with an FEV1 >80% of the predicted values are typically considered low risk for surgery
  - ✓ while those with FEV1 between 40% and 80% predicted may require additional testing

- **Diffusing capacity of the lung for carbon monoxide**
  - ✓ A low preoperative DL_{CO} is strongly associated with higher postoperative mortality following major pulmonary surgery

- Current guidelines do not recommend routinely measuring static lung volumes, and no established cut-off values exist.

- **Predicting postoperative pulmonary function**
  - ✓ ppoFEV1 = Preoperative FEV1 x (Total lung segments - Number of resected lung segments) / Total lung segments
  - ✓ Postoperative predicted DL_{CO} (ppo DL_{CO})
  - ✓ RUL=3, RML=2, RLL=5, LUL=5, LLL=4 (Total 19) e.g. RUL=3/19 = 15.8%
- A threshold of 40% is commonly used to distinguish between high-risk and standard-risk candidates for lung surgery.
- The ERS/ESTS guidelines suggest lowering this threshold to 30% due to advances in perioperative care

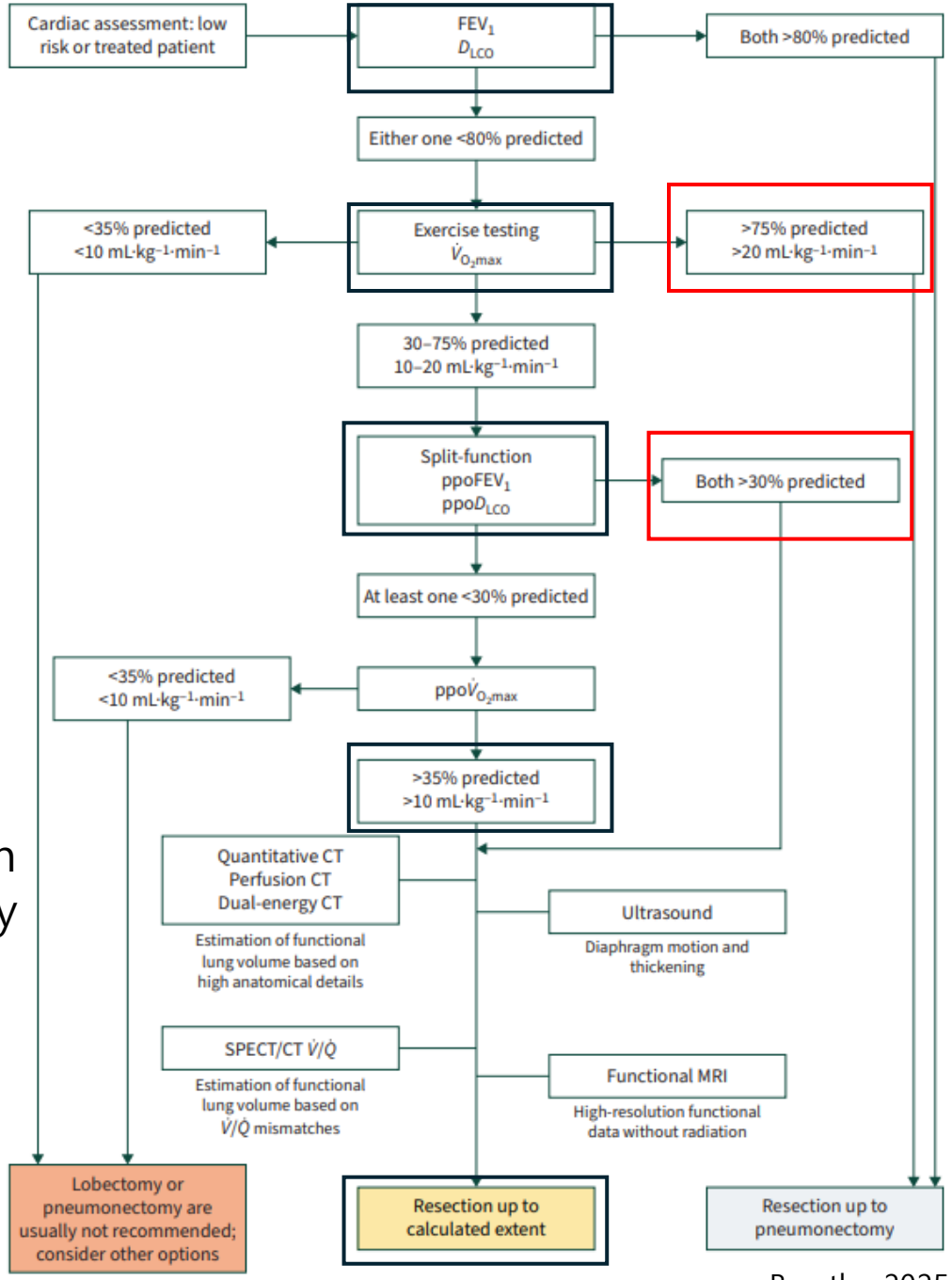
Breathe 2025; 21: 250041 https://doi.org/10.1183/20734735.0041-2025

Quantitative CT

- Emphysema quantification
- Lung volumes and density

V/Q scintigraphy

- Ventilation phase
- Perfusion phase
- Functional imaging



Breathe 2025; 21: 250041 https://doi.org/10.1183/20734735.0041-2025

Exercise/Stress testing

- The 6-min walk test in IPF [1]
  - ✓The GAP6 model adding **Nadir SpO2 during 6WMT** for an indicator of functional capacity improves prediction ability
  - ✓AUC the GAP vs. the GAP6, 0.646 vs. 0.671, $p < 0.0019$

- The 6-min walk test [2]
  - ✓6MWT distance (6MWD) ≥ 400 m (OR 0.53)
  - ✓DSP (6분 보행거리[m] × **검사 중 최저 SpO_2[%]**) ≥ 350 m% OR 0.47

- Cardiopulmonary exercise testing (CPET)
  - ✓CPET provides a comprehensive assessment of cardiopulmonary reserve and is especially useful for high-risk patients undergoing lung resection

[1] Front. Med. 10:1052129. doi: 10.3389/fmed.2023.1052129
[2] Interact Cardiovasc Thorac Surg. 2020 Apr 1;30(4):559-564. doi: 10.1093/icvts/ivz313.

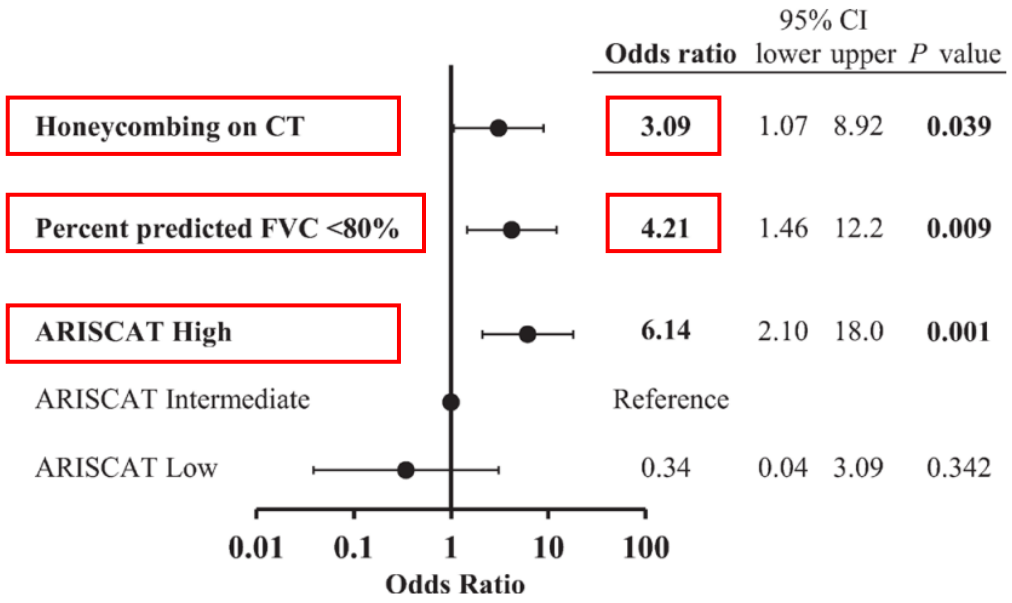
Post operative risk (ILD[1] and ARISCAT[2])

Interstitial lung disease

BMJ Open Respiratory Research

Predictors of postoperative acute exacerbation of interstitial lung disease: a case–control study

Keisuke Hosoki,[1] Yu Mikami,[1] Hirokazu Urushiyama,[1] Kunihiko Souma,[1] Gaku Kawamura,[2] Kanji Uchida,[2] Takahide Nagase,[1] Taisuke Jo[1,3]



ARISCAT score >45

Table 6. Independent Predictors of Risk for PPCs Identified in the Logistic Regression Model

	Multivariate Analysis OR (95% CI) n = 1,624*	β Coefficient	Risk Score†
Age, yr			
≤50	1		
51–80	1.4 (0.6–3.3)	0.331	3
>80	5.1 (1.9–13.3)	1.619	16
Preoperative SpO_2, %			
≥96	1		
91–95	2.2 (1.2–4.2)	0.802	8
≤90	10.7 (4.1–28.1)	2.375	24
Respiratory infection in the last month	5.5 (2.6–11.5)	1.698	17
Preoperative anemia (≤10 g/dl)	3.0 (1.4–6.5)	1.105	11
Surgical incision			
Peripheral	1		
Upper abdominal	4.4 (2.3–8.5)	1.480	15
Intrathoracic	11.4 (4.9–26.0)	2.431	24
Duration of surgery, h			
≤2	1		
>2 to 3	4.9 (2.4–10.1)	1.593	16
>3	9.7 (4.7–19.9)	2.268	23
Emergency procedure	2.2 (1.0–4.5)	0.768	8

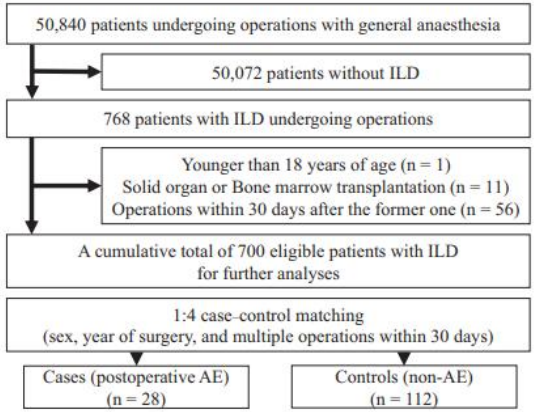


Figure 1 Flow diagram of patient recruitment. AE, acute exacerbation; ILD, interstitial lung disease.

예시환자
- ✓ 60세 (3)
- ✓ Preoperative SpO2 95% (8)
- ✓ Intrathoracic (24)
- ✓ Duration of surgery 2-3hrs (16)

Lobectomy = 40+11 = High

[1] BMJ Open Resp Res 2020;7:e000634. doi:10.1136/bmjresp-2020-000634
[2] Anesthesiology 113(6):1338-1350, December 1, 2010.

Cases

- Case 1 (Stage IV Pathologic Diagnosis)
- Case 2 (Stage IV; Surgical biopsy? Treatment?)
- Case 3 (cN Stage vs pN stage)
- Case 4 (cStage vs pStage) (Metastasis is the same Metastasis?)

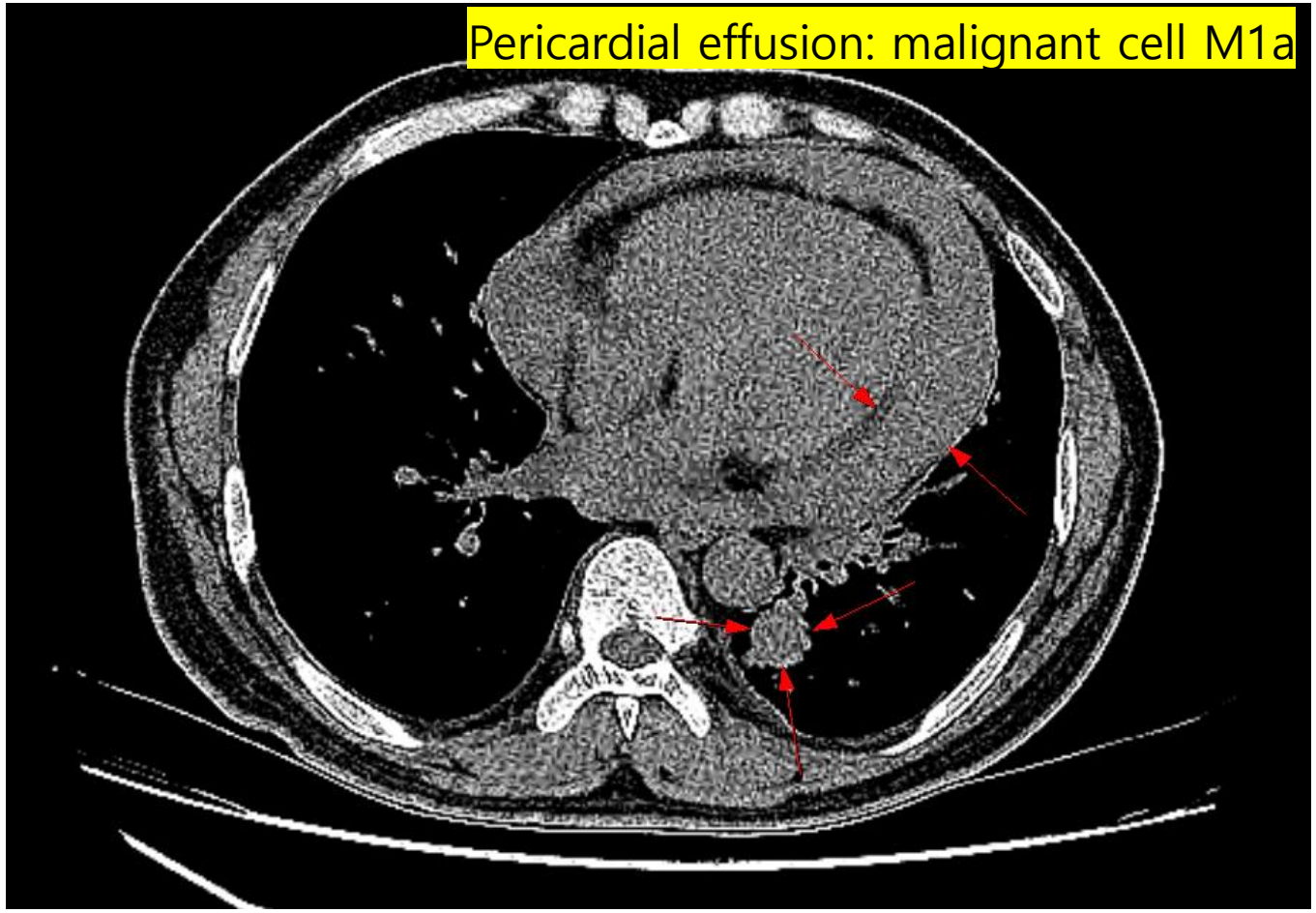
Case 1 (Stage IV Pathologic Diagnosis)
[Lung nodule with Malignant pericardial effusion]

- 46/M

- C/C dyspnea
- Cardiac tamponade CV ADM with pericardiocentesis

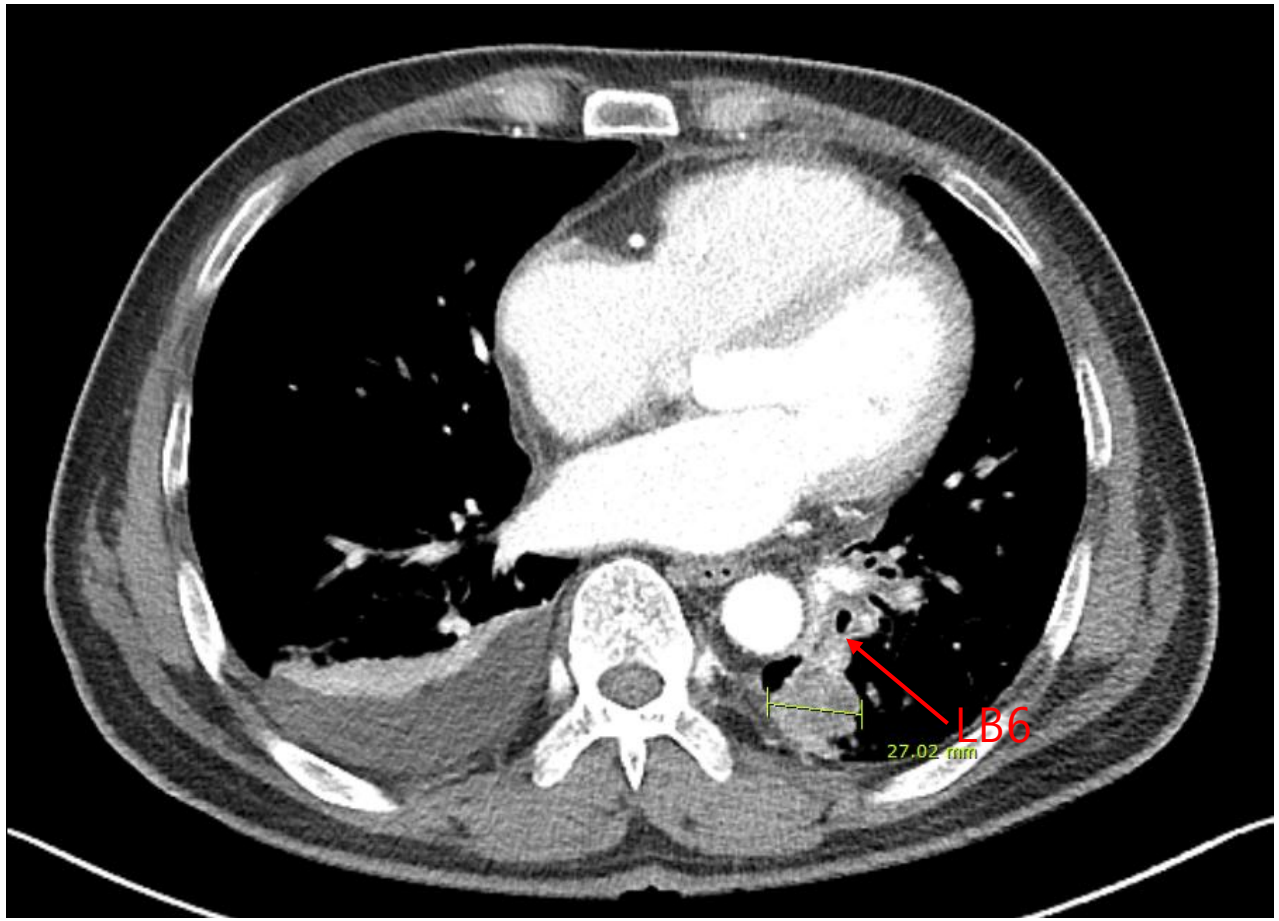
- CST for lung cancer

- 흡연력 Never smoker
- 음주력 Social
- 직업력 자영업
- Tb hx none



LLL 27mm nodule
Bronchus sign (+) Descending aorta adj (+)

Chest CT (Stage IV Pathologic Diagnosis)



Pericardiocentesis done
Right diagnostic thoracentesis done
Exudate and Tuberculosis less likely
Cytology pending

타과회신 *영상의학과* *(2025-01-06)*

회신내용

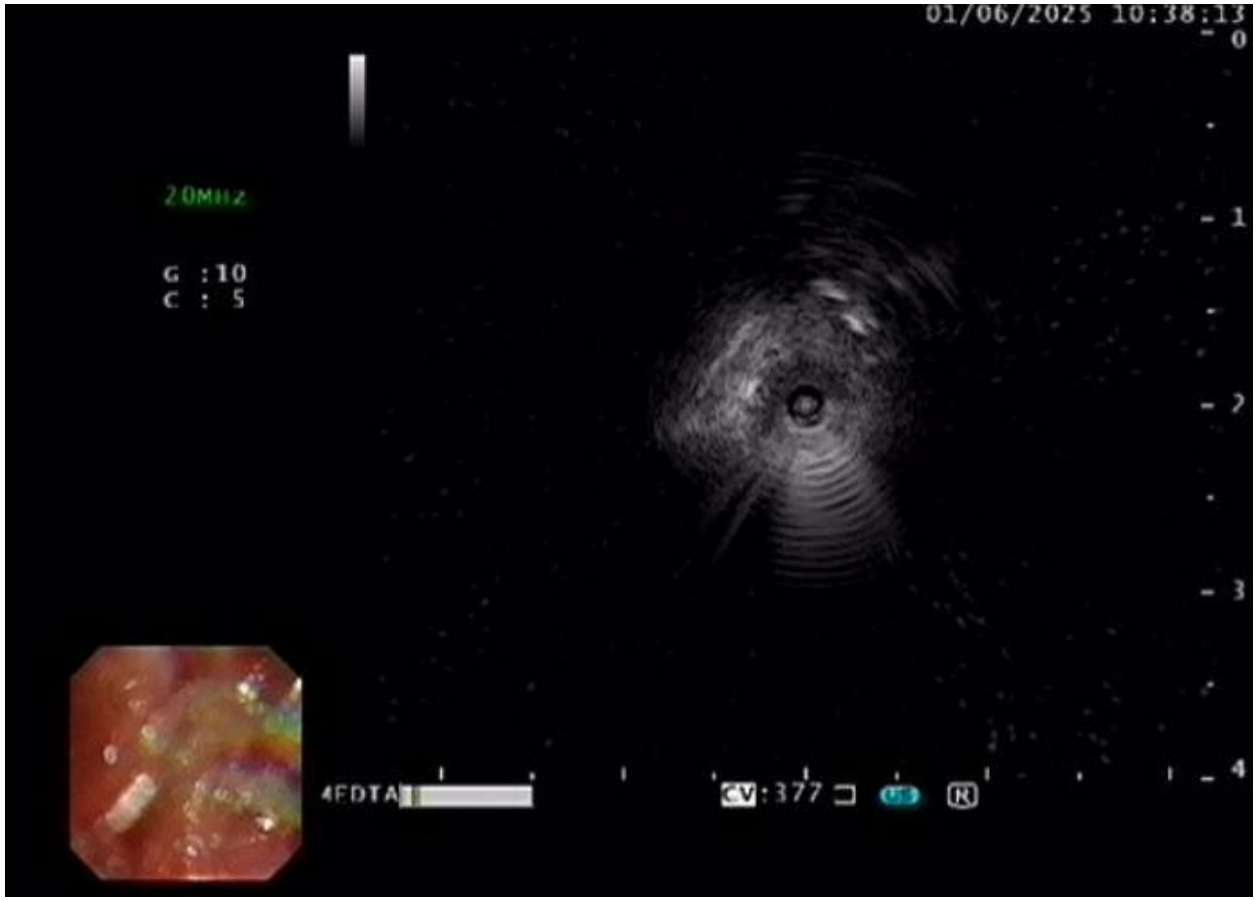
의뢰 감사드립니다.

바로 인접하여 LLL posterior basal segmental artery 가 위치하여 시술하기 굉장히 위험한 병변으로 판단됩니다.
필요하시면 시도하겠습니다. 그러나 시술 진행 중 위험도가 많이 높아 보인다면 검체 얻지 못하고 종료할 수 있겠습니다.

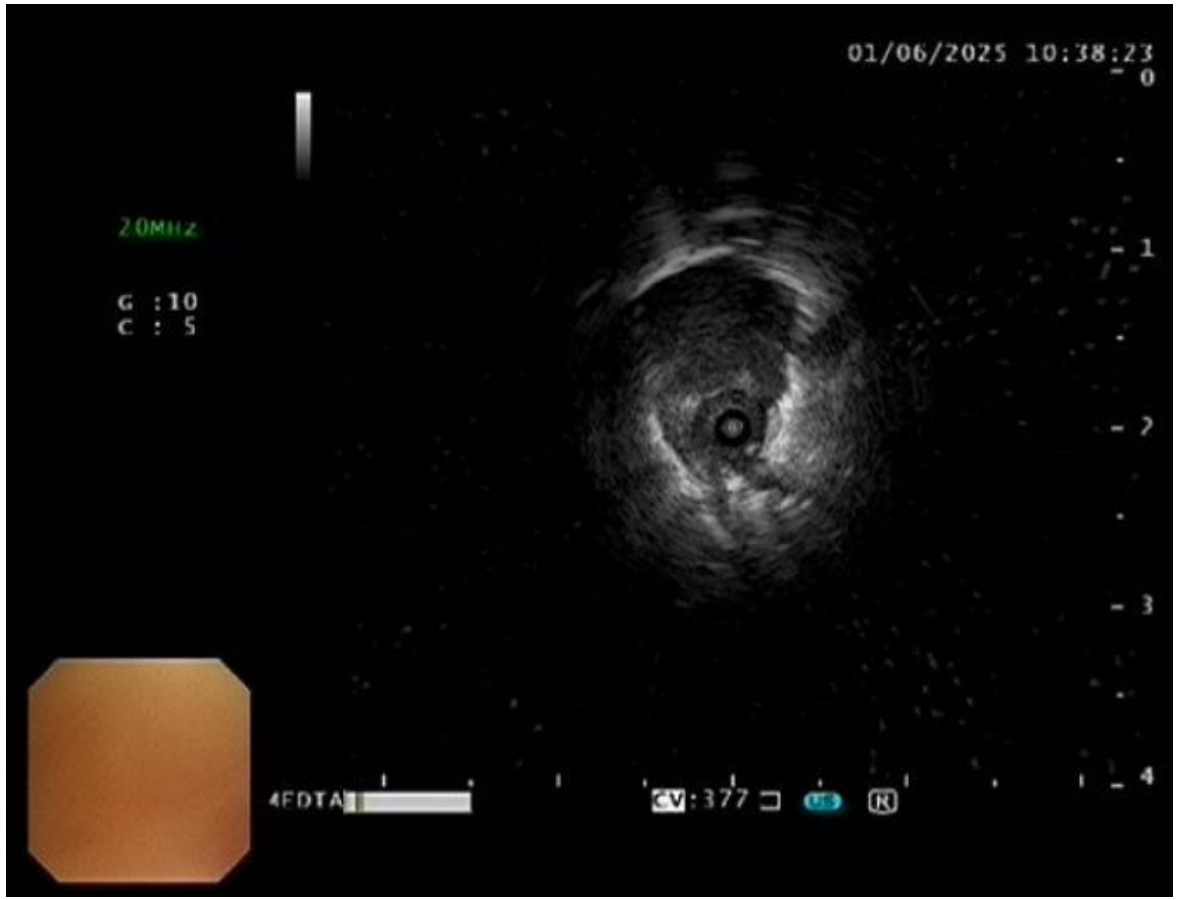
감사합니다.

"Malignant pericardial effusion으로 M1a, 4기인데 진단을 어떻게 하지?" "Surgical wedge?"

Bronchoscopy R-EBUS guided TBLC with GS



처음 R-EBUS Image; LB6 sub-division으로 진입



TBLC #1 후 진입 R-EBUS Image LB6 subdivision
R-EBUS within dense sign -> TBLC 추가 #5 진행

Diagnosis; ALK mNSCLC What's more?

NSCLC AD cT1cN0M1b cStage IVA (AJCC 9th)

(M1a: Malignant pericardial effusion, M1b: brain single mets)

EGFR wild **ALK (+++) PDL1 SP263 10%** KRAS neg BRAF neg ROS1 neg MET neg

Plan -> Palliative Target therapy for ALK mNSCLC

```
ADDITIONAL DIAGNOSIS:
Lung, bronchus, left lower, radial EBUS guided transbronchial lung biopsy:
    Non-small cell carcinoma,
      consistent with adenocarcinoma with squamoid differentiation

IMMUNOHISTOCHEMISTRY:
TTF-1 (+), P63 (+, partial)
```

```
DIAGNOSIS:
Body fluid, cell block:
  Malignant cells present

SPECIMEN ADEQUACY:
Satisfactory for evaluation
```

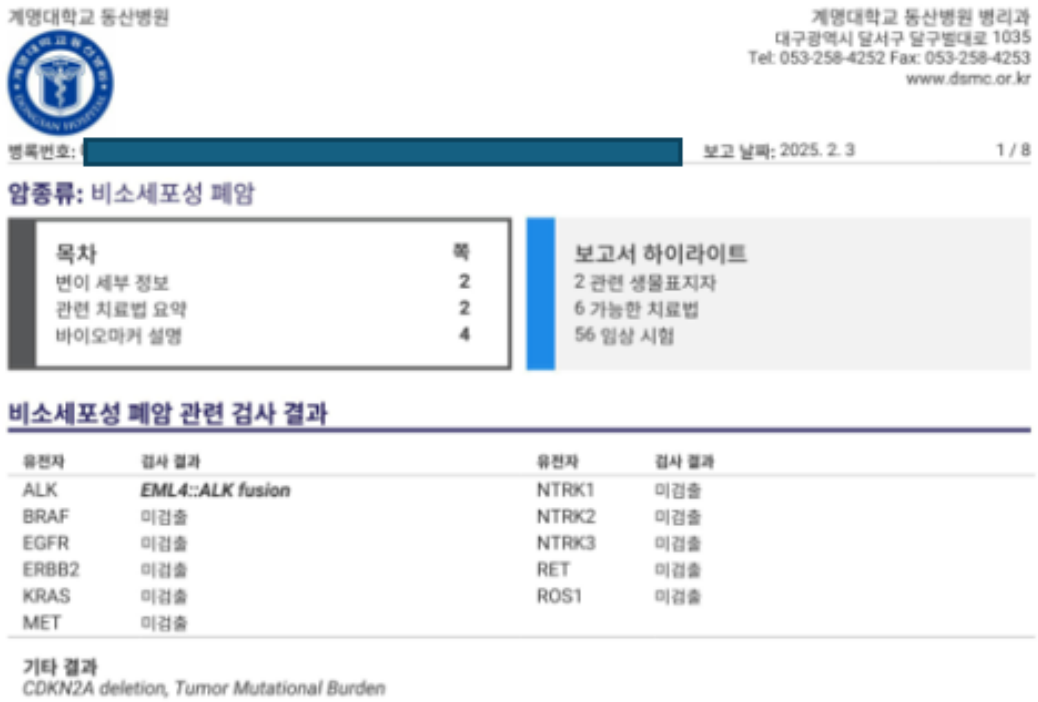
```
DIAGNOSIS:
Pleural fluid, cell block:
  Inflammation

SPECIMEN ADEQUACY:
Satisfactory for evaluation
```

FDG PET/CT
1) Lung cancer in LLL lung, suggestive.
2) Several hypermetabolic LNs at the mediastinal 1L, 2R, 4R/L and 12L. Reactive LN vs. metastatic LN
3) A few small hypermetabolic nodular lesions at the pericardium. R/O metastasis Rec) radiologic correlation

NGS results

- EML4 ALK fusion detected
- Variant type 1
- TP53 not detected
- Fusion read 수 = 약 28,631 reads



계명대학교 동산병원

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병록번호: [redacted] 보고 날짜: 2025. 2. 3 1 / 8

암종류: 비소세포성 폐암

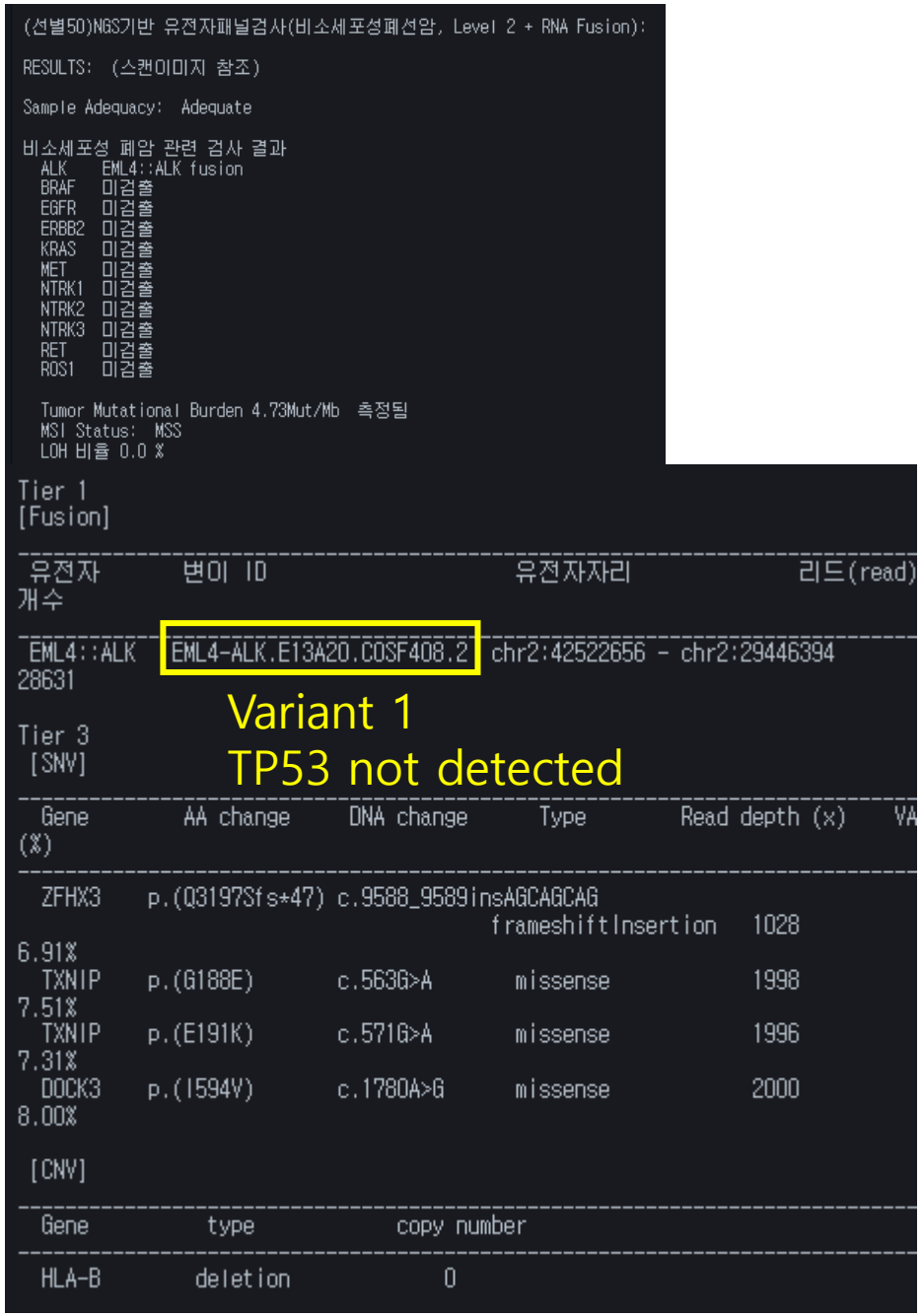
목차	쪽
변이 세부 정보	2
관련 치료법 요약	2
바이오마커 설명	4

보고서 하이라이트
2 관련 생물표지자
6 가능한 치료법
56 임상 시험

비소세포성 폐암 관련 검사 결과

유전자	검사 결과	유전자	검사 결과
ALK	*EML4::ALK fusion*	NTRK1	미검출
BRAF	미검출	NTRK2	미검출
EGFR	미검출	NTRK3	미검출
ERBB2	미검출	RET	미검출
KRAS	미검출	ROS1	미검출
MET	미검출		

기타 결과
CDKN2A deletion, Tumor Mutational Burden



(선별50)NGS기반 유전자패널검사(비소세포성폐선암, Level 2 + RNA Fusion):

RESULTS: (스캔이미지 참조)

Sample Adequacy: Adequate

비소세포성 폐암 관련 검사 결과

ALK	EML4::ALK fusion
BRAF	미검출
EGFR	미검출
ERBB2	미검출
KRAS	미검출
MET	미검출
NTRK1	미검출
NTRK2	미검출
NTRK3	미검출
RET	미검출
ROS1	미검출

Tumor Mutational Burden 4.73Mut/Mb 측정됨
MSI Status: MSS
LOH 비율 0.0 %

Tier 1
[Fusion]

유전자	변이 ID	유전자자리	리드(read) 개수
EML4::ALK	EML4-ALK.E13A20.COSF408.2	chr2:42522656 - chr2:29446394	28631

Variant 1
TP53 not detected

Tier 3
[SNV]

Gene	AA change	DNA change	Type	Read depth (x)	VA (%)
ZFHX3	p.(Q3197Sfs*47)	c.9588_9589insAGCAGCAG	frameshiftInsertion	1028	6.91%
TXNIP	p.(G188E)	c.563G>A	missense	1998	7.51%
TXNIP	p.(E191K)	c.571G>A	missense	1996	7.31%
DOCK3	p.(I594V)	c.1780A>G	missense	2000	8.00%

[CNV]

Gene	type	copy number
HLA-B	deletion	0

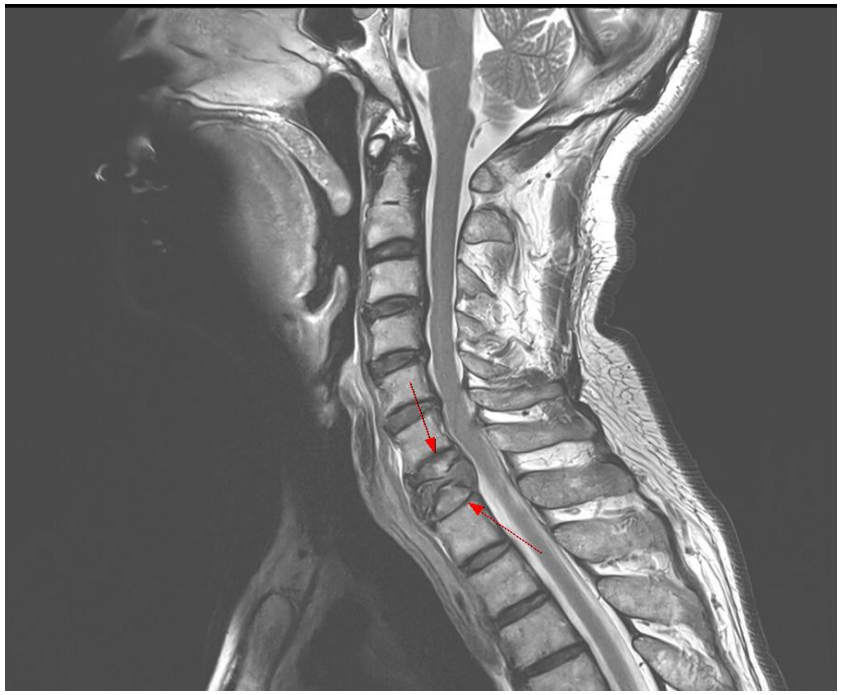
Case 2 (Stage IV; Surgical biopsy)
[Lung nodule with Bone metastasis]

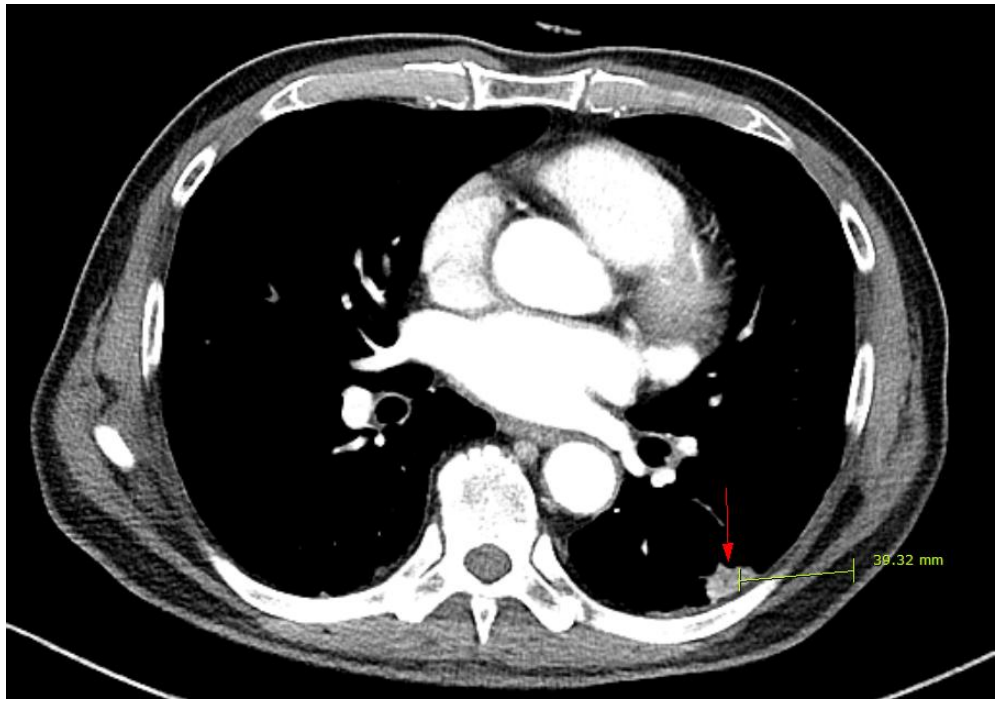
- 74/M

- C/C Neck pain -> OS ADM

- 흡연력 current smoker 0.5P * 50Yr
- 음주력 heavy
- 직업력 지게차 운전
- Tb hx non

LUL 20mm
Solid nodule
Bronchus sign (-)

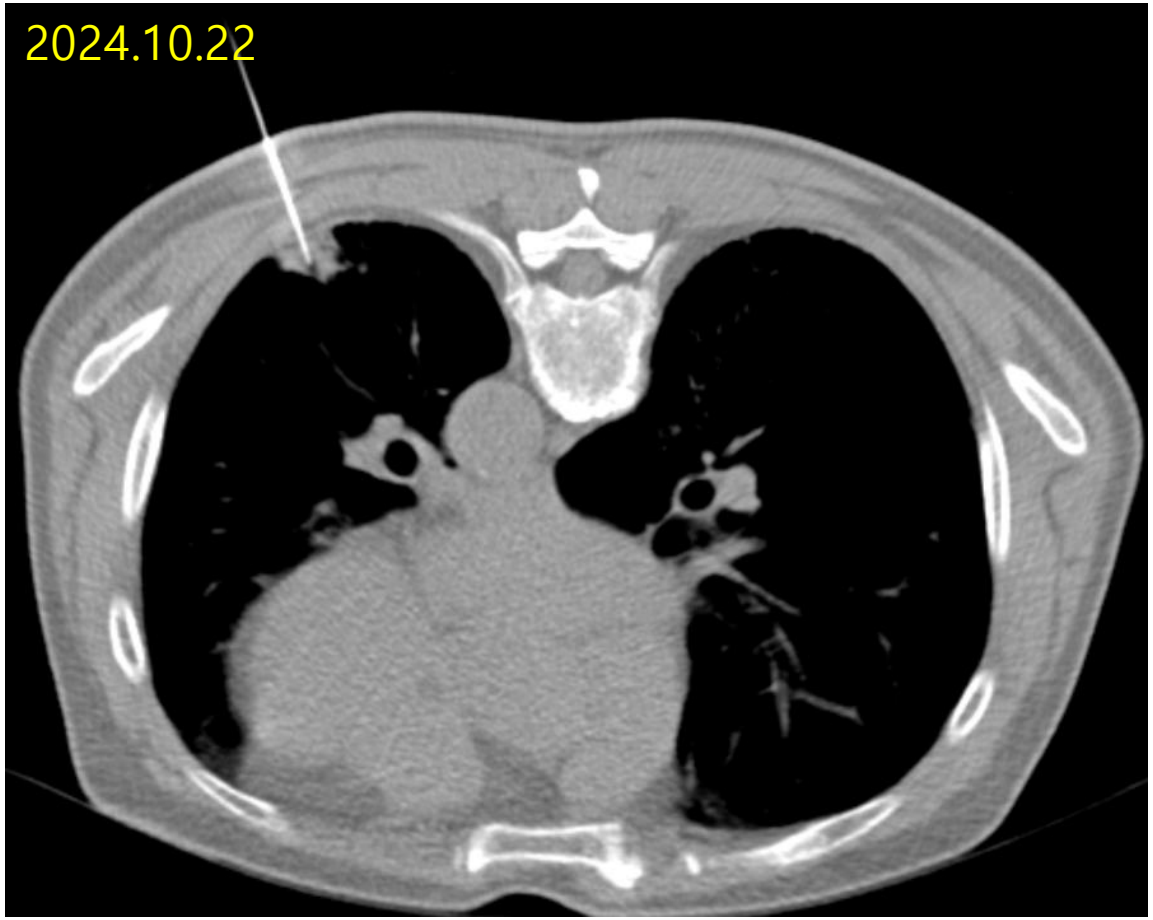




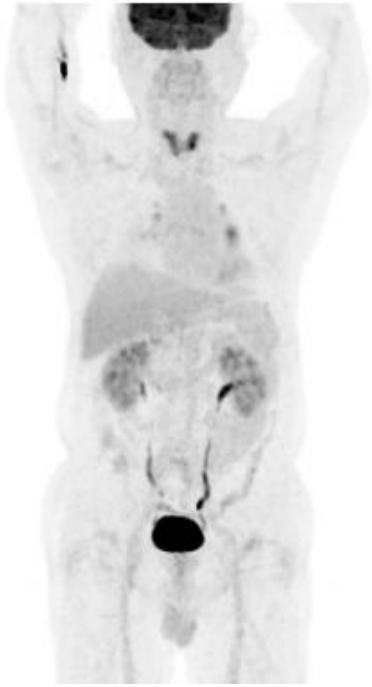
Percutaneous Biopsy

ADDITIONAL DIAGNOSIS:
Lung, left lower, CT guided lung biopsy:
Non-small cell carcinoma, consistetn with adenocarcinoma

IMMUNOHISTOCHEMISTRY:
CK7 (+), TTF-1 (+), Napsin A (+), P63 (-)



Lung cancer, adenoca, LLL, cT2aN0M1b
EGFRw ALK negative PD-L1(SP263): Positive (30 %)
추가 검사 불가합니다.

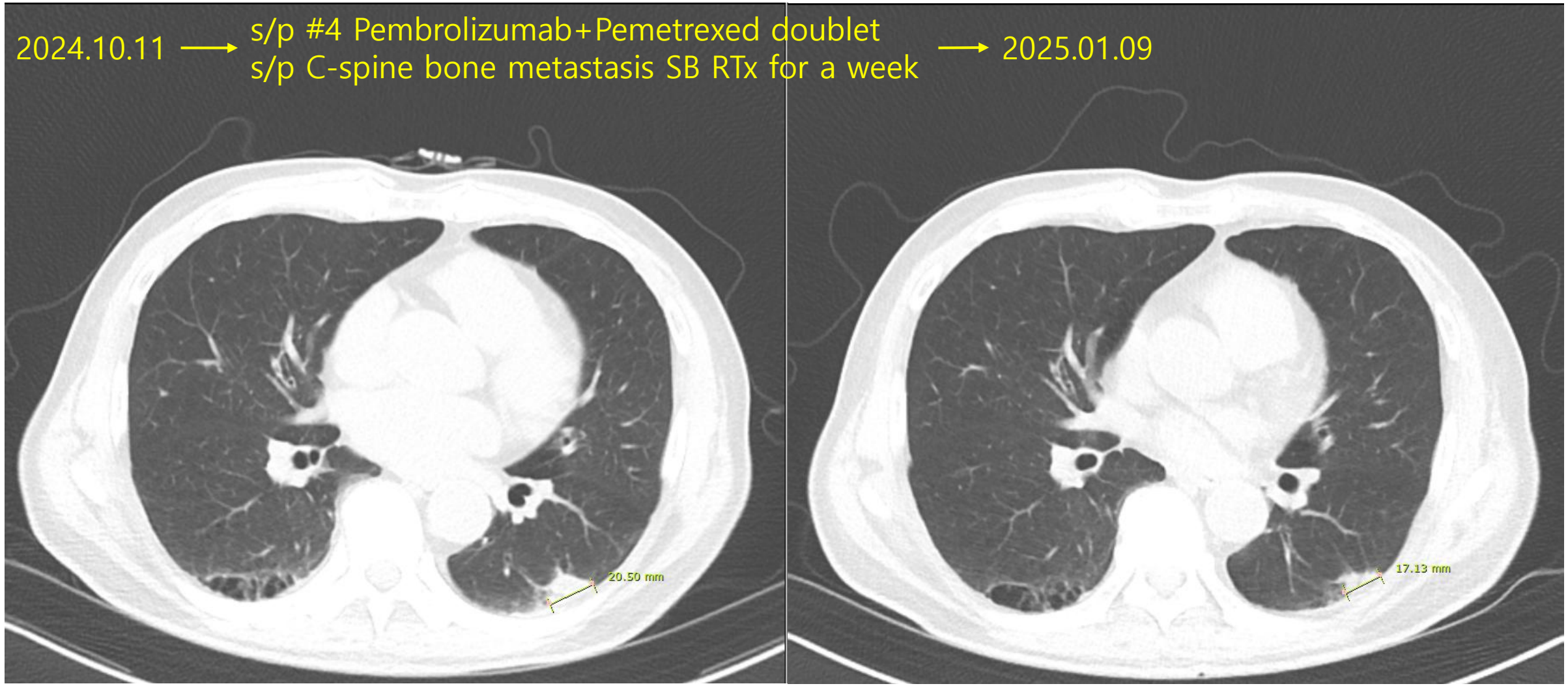


FDG PET/CT

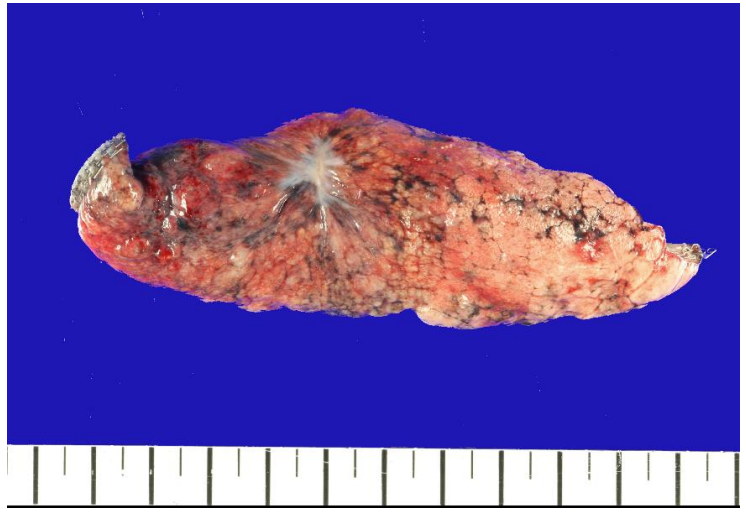
1) **R/O Lung cancer in LLL lung.**
2) A few hypermetabolic LNs at the mediastinal 10R/L. Reactive LN
3) **A hypermetabolic bone lesion at the C7 body.**

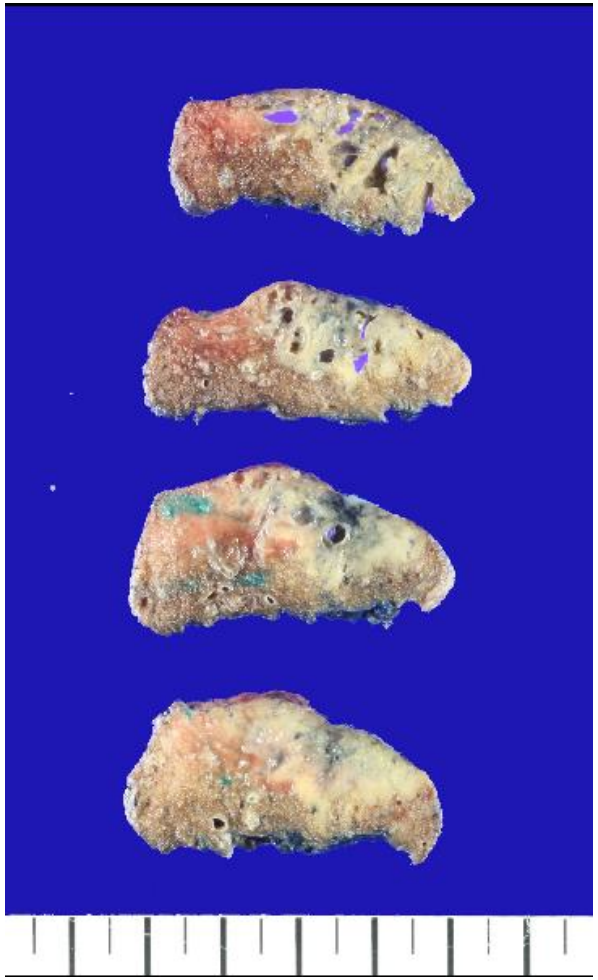
R/O metastasis Rec) Pathologic correlation

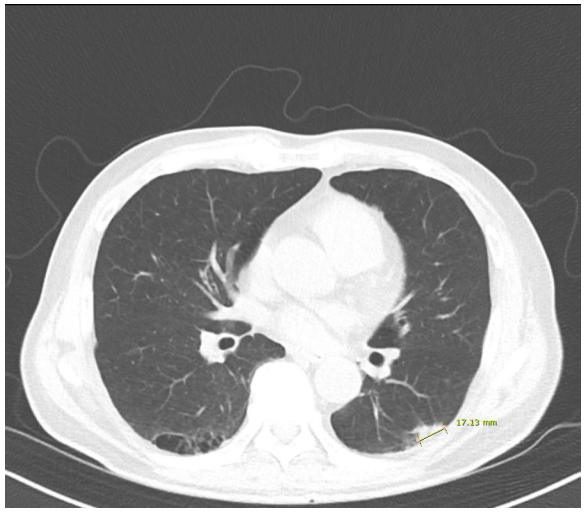
Treatment 1L IO with Chemotherapy



수술적 폐생검? vs. 치료?







Lung, left lower lobe, wedge resection:
Adenocarcinoma, grade 3

MICROSCOPIC:
Histologic type: Adenocarcinoma, predominantly solid
Histologic patterns:
Solid: 60 %
Lepidic: 10 %
Papillary: 10 %
Acinar: 10 %
Micropapillary: 10 %
Tumor size: 3.6 x 2.7 x 1.3 cm
Main bronchus: Not applicable
Resection margin: Clear but very closed (less than 0.1 cm)
Pleural invasion: Involved by tumor (PL1)
Lymphovascular invasion: Absent
Spread through air spaces: Present
Perineural invasion: Absent
Necrosis: Absent

Pathologic stage: pT2a Nx (AJCC 8th edition)
pT2a: Tumor > 3 cm but ≤ 4 cm in the greatest dimension
Invades visceral pleura (PL1)

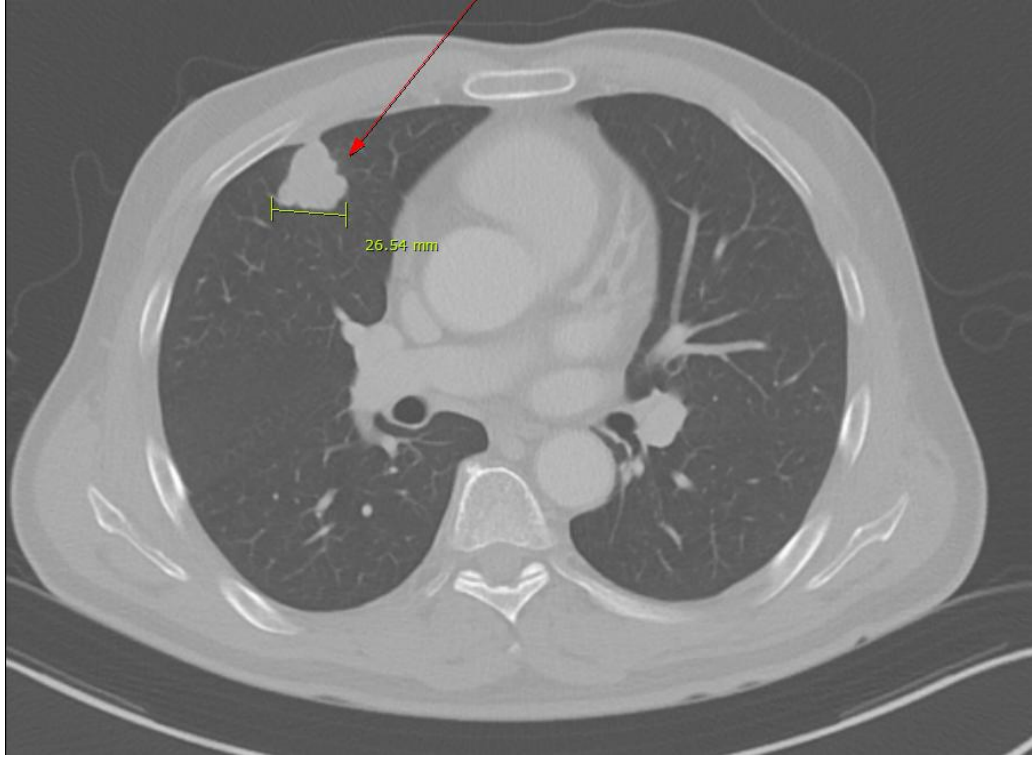
Case 3 (cN Stage vs pN stage)

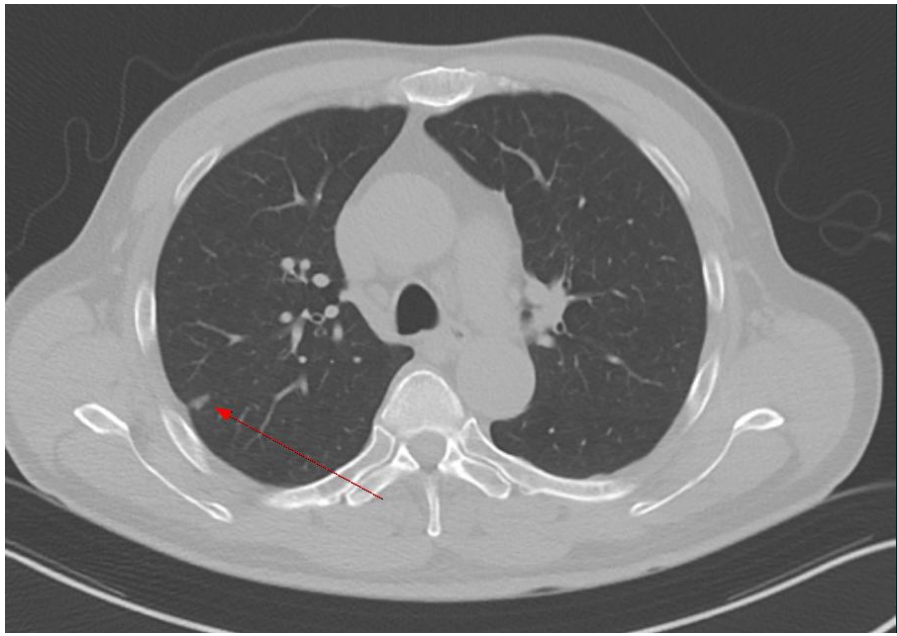
- 69/M

RUL Peripheral 26mm lobulating nodule
RUL Peripheral 9mm linear nodule

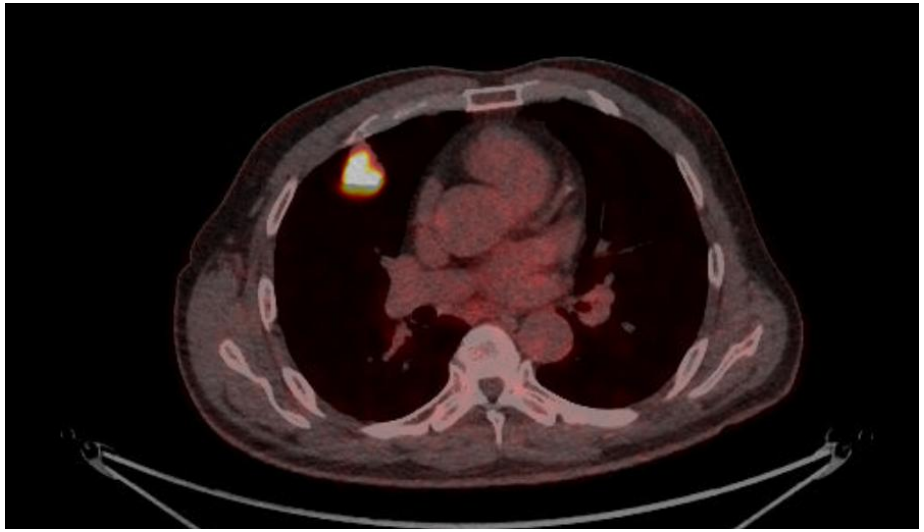
- C/C CT abnormality

- 흡연력 ex-smoker 1PPD*30yrs / 금연한지 6년째
- 음주력 Social
- 직업력 무직 / 과거: 식품관련업, 회사 납품
- Tb hx none





PET CT



Clinical Stage: cT1cN0M0 cStage IA

PET CT reading

- R/O Lung cancer in RUL without LN metastasis. Rec)Pathologic correlation.
- A part solid nodule without FDG uptake in the RUL of the lung.
- Rec) Follow-up study.Diffuse FDG uptake in the fundus of stomach. Rec) Endoscopic correlation to rule out malignancy.
- Otherwise, no evidence of abnormal hypermetabolic lesion suggesting distant metastasis.

Lobectomy

NSCLC ADC cStage IA (9th AJCC) -> IIIA

PD-L1(SP142)
Tumor cell(TC) staining assessment: 0 %
Tumor infiltrating immune cell(IC) staining assessment: 1 %
PD-L1(SP263) (+, 1 %)
EGFR MUTANT DETECTE: Exon 21, L858R- MUTANT DETECTED
Exon 21, p.L858R (c.2573T>G, Cosmic No. 6224)
Exon 21, p.L858R (c.2573_2574TG>GT, Cosmic No. 12429)
KRAS/ALK/BRAF (-/-/-)

Clinical stage와 Pathologic stage의 괴리

- **Pathologic stage: pT3 N2a (AJCC 9th edition) pStage IIIA**

  - pT3: Separate tumor nodule(s) in the same lobe

  - pN2a: Metastasis to single ipsilateral mediastinal or subcarinal node station

- Lung, right upper lobe, (frozen wedge resection) and lobectomy:

  Adenocarcinoma, grade 3

  Adenocarcinoma, grade 2

- Lymph node, peribronchial, lobectomy:

  Metastatic carcinoma, primary in lung (1/2) with perinodal extension

- Lymph node, excision:

  '2': No tumor present (0/4)

  '4': Metastatic carcinoma, primary in lung (3/3) with no perinodal extension

  '7': No tumor present (0/4)

  '10': Metastatic carcinoma, primary in lung (1/5) with perinodal extension

  '11': Metastatic carcinoma, primary in lung (3/4) with no perinodal extension

  '11i': No tumor present (0/6)

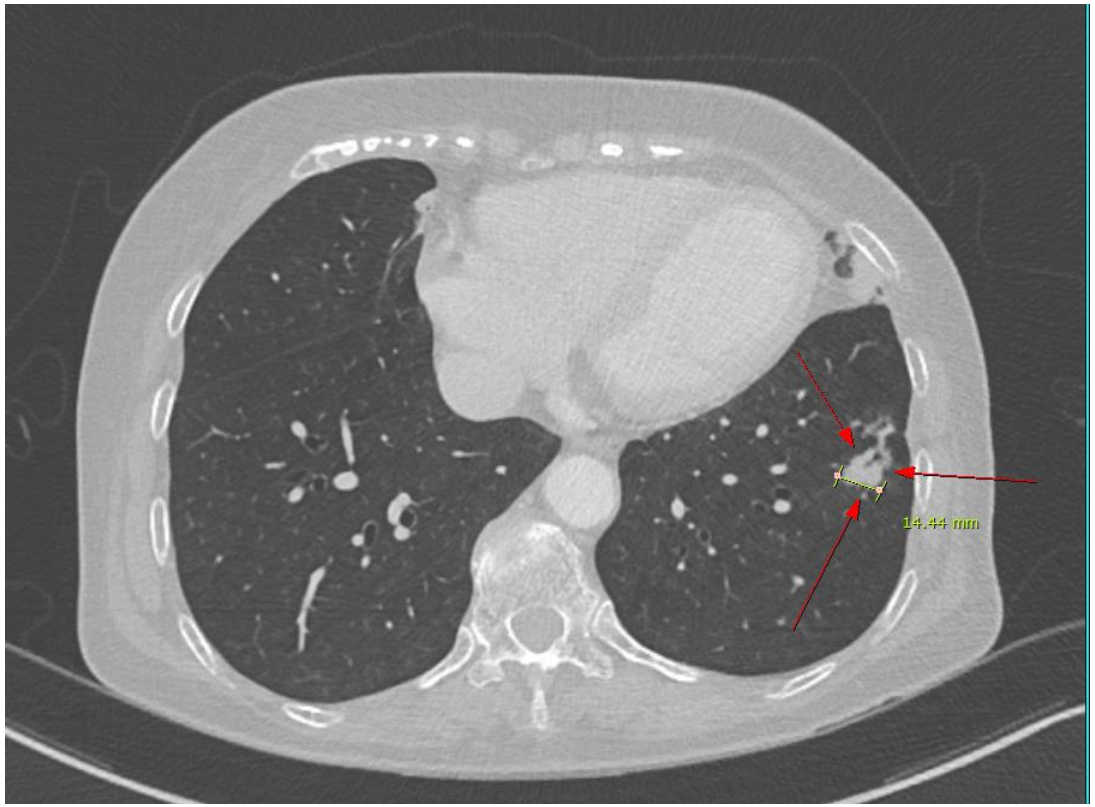
Case (cStage vs pStage)

(Metastasis is the same Metastasis?)

- 77/F
- C/C CT abnormality

LLL peripheral 14mm nodule
RML medial 8mm nodule

- 흡연력 never
- 음주력 none
- 직업력 주부
- Tb hx none



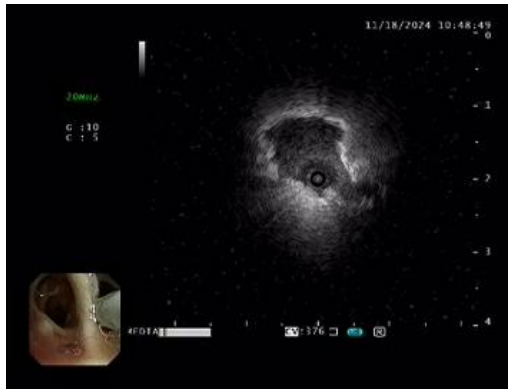
DIAGNOSIS:
Lung, bronchus, left lower, radial EBUS guided transbronchial lung biopsy:
Atypical glands, consistent with adenocarcinoma

GROSS:
Specimen status: Formalin fixed
Specimen: Pale tan tissue, 3 pieces, 0.5 x 0.4 x 0.2 cm in aggregates

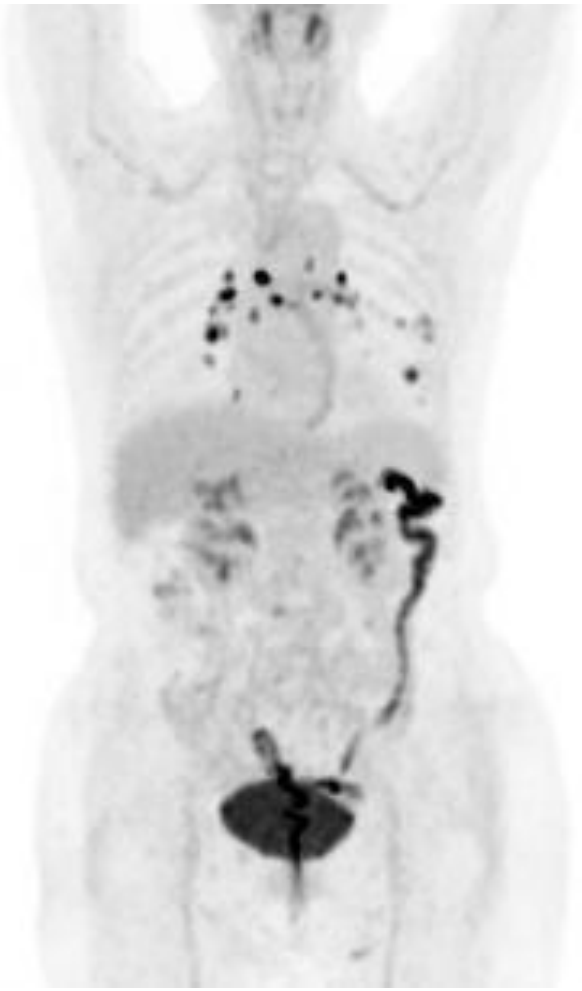
Entirely submitted

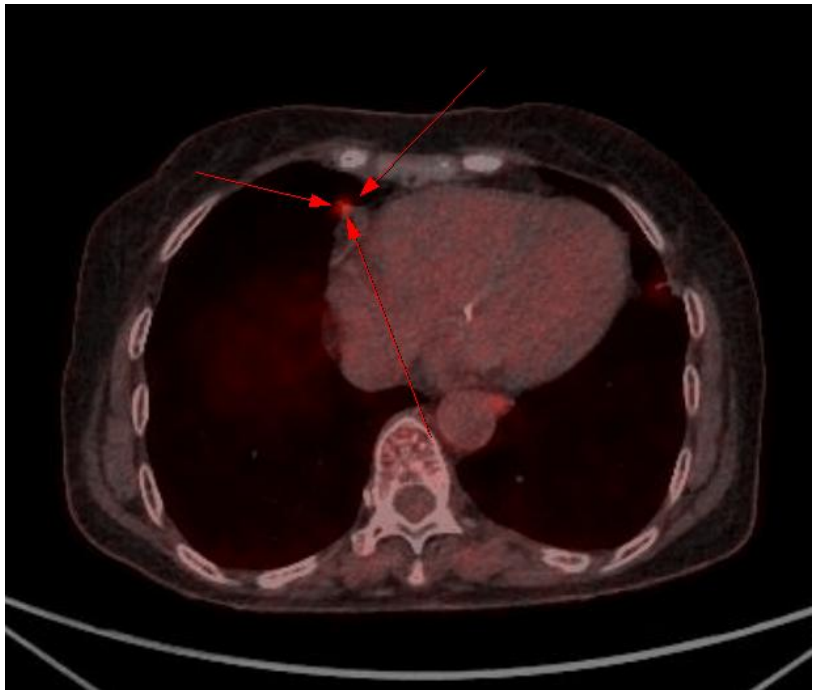
Blocks x 2

Representative tumor block: A2



PET Stage





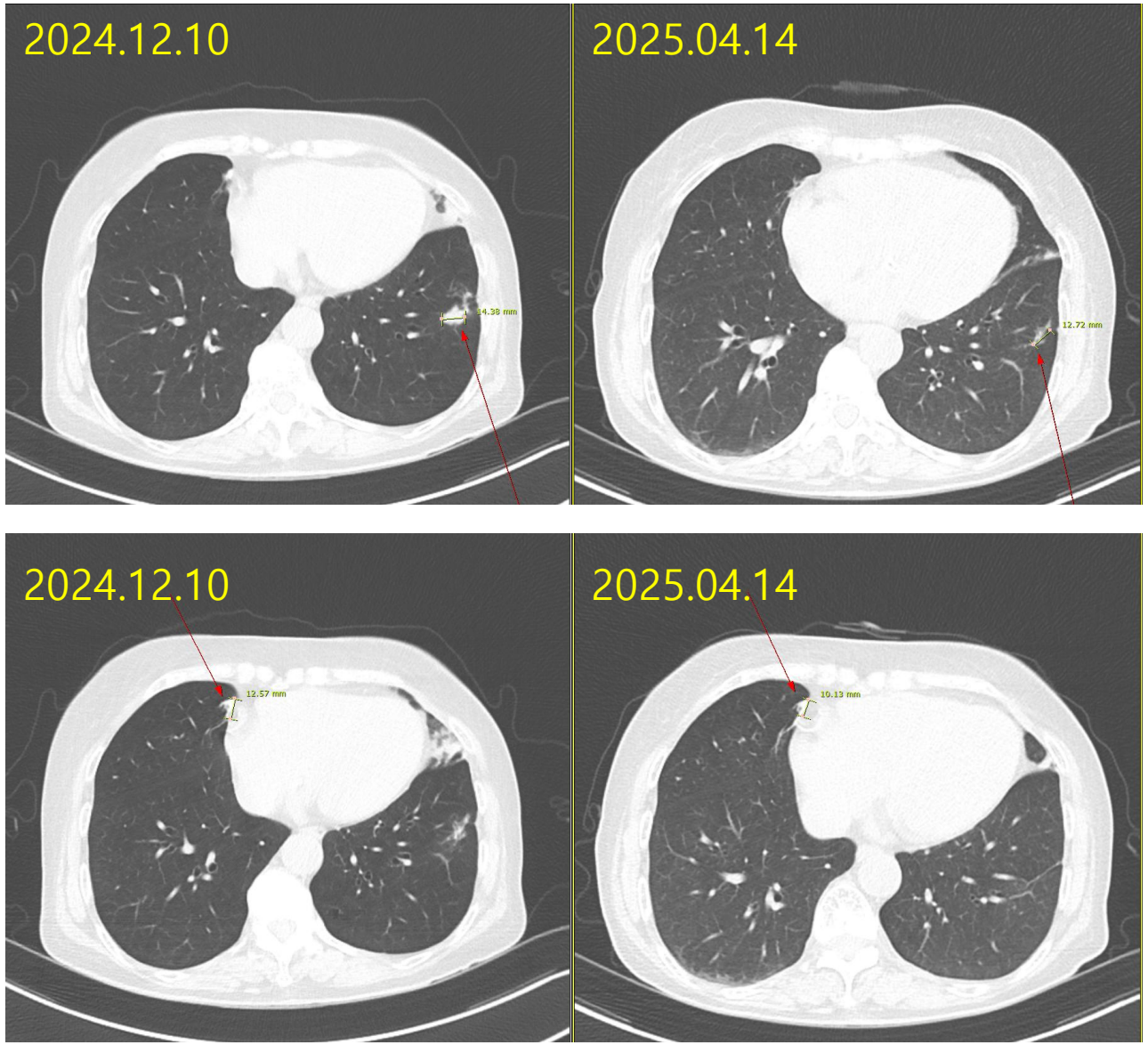
Mutation profile
- EGFRm L858R
- ALK neg
- PDL1 SP263 2%
- KRAS not detected
- MET absent

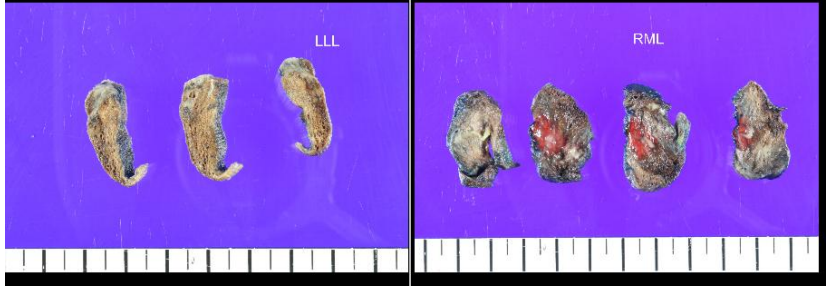
cT1bN3M1a c Stage IVa
- 치료 결정
- ✓ TKI mono
- ✓ Combination

"STAGING EBUS TBNA"
11L/7/4L/4R/11R

PET CT 일 자: 2024-12-04
1) Lung cancer in LLL lung, suggestive.
2) A small hypermetabolic nodular lesion in RML lung. Metastasis vs. inflammation (다학제: 전이 암종이 의심된다)
3) Several small clustered nodules in LUL lung. Inflammation, suggestive.
4) Multiple hypermetabolic LNs at the mediastinal 4R/L, 7, 10R/L and 11R/L. Reactive LN vs. metastatic LN

Clinical Course





2024-12-04 -> 5개월 정도 경과
2025.04.22
DIAGNOSIS:
Lung, left lower lobe, (frozen) wedge resection:
Adenocarcinoma, grade 2 (see NOTE)

Lung, right milddle lobe, wedge resection:
Adenocarcinoma, grade 2

Lung, left upper lobe, wedge resection:
Chronic granulomatous inflammation

MICROSCOPIC:
[For left lower lobe]
Histologic type: Adenocarcinoma, predominantly papillary
Histologic patterns:
Papillary: 60 %
Acinar: 40 %
Tumor size: 0.7 x 0.5 x 0.4 cm (left lower lobe)
Main bronchus: Not involved
Bronchial margin: Not involved
Pleural invasion: Involved by tumor
Lymphovascular invasion: Absent
Spread through air spaces: Present
Perineural invasion: Absent
Necrosis: Absent
Lymphoid reaction adjacent tumor lesion: Mild
Non-neoplastic features: Granulomatous inflammation
Lymph node metastasis: Not applicable
Pathologic stage: pT2a Nx (AJCC 8th edition)
- pT2a: Invades visceral pleura (PL1)
- pNx: Regional lymph nodes cannot be assessed

Clinical Course= ongoing TKI since 2024.12.17

Lung, left lower lobe, (frozen) wedge resection:
Adenocarcinoma, grade 2 (see NOTE)

- EGFR L858R **TP53 wild**

- Gene/AA change/DNA change /Type/VAF(%)
- EGFR p.(L858R) c.2573T>G missense 3.21%
- EGFR p.(E709K) c.2125G>A missense 4.31%

Lung, right milddle lobe, wedge resection:
Adenocarcinoma, grade 2

- EGFR wild

최종 진단은?

- Stage IV (M1a) EGFRm L858R Stage IV ADC

vs

- Stage I EGFRm ADC + Stage I EGFRw ADC

(선별50)NGS기반 유전자패널검사(비소세포성폐선암, Level 2 + RNA Fusion):

RESULTS: (스캔이미지 참조)

Sample Adequacy: Adequate

비소세포성 폐암 관련 검사 결과

ALK	미검출
BRAF	미검출
EGFR	p.(L858R) c.2573T>G, p.(E709K) c.2125G>A
ERBB2	미검출
KRAS	미검출
MET	미검출
NTRK1	미검출
NTRK2	미검출
NTRK3	미검출
RET	미검출
ROS1	미검출

Tumor Mutational Burden 3.79 Mut/Mb 측정됨
MSI Status: MSS
LOH 비율 0.0 %

[redacted]

채취부위 : RML, LLL, LUL
수 술 명 : Wedge resection of lung
임상진단 : Adenocarcinoma, grade 2
오더비고 : 수술병리 중 RML Adeno ca에 나가주세요

EGFR 유전자돌연변이검사(PNA기반의 실시간 PCR PANAMutyper):

RESULTS: Wild

EGFR 유전자의 주요 돌연변이 부위를 분석한 결과 돌연변이가 검출되지 않았습니다

Key Take-home Messages

- 폐암의 진단에 조직학적 진단의 중요성은 아주 크다.
- 비수술적 조직검사는 "정확하게"와 "충분하게"가 중요하다.
- 조직학적 진단은 Complete molecular tests를 포함한다 (Not SCLC but NSCLC until now).
- Stage I-II에서 clinical N0 + peripheral <3cm lesion은 EBUS-TBNA는 optional 하다.
  - ✓ Clinical N0에서도 pathologic N2가 5%내외 보고하기도 하므로, 주의해야한다.
  - ✓ FDG PET, Chest CT image를 기반으로 Clinical TNM stage는 Under-stage에 유의하여 판단이 필요하다.
- 비수술적 조직진단이 가능할 경우, 정확한 진단 및 환자별 개별화된 최선의치료 (optimal treatment)와 근거 기반의 정밀의료(precision medicine)를 할 수 있다.
- 비수술적 조직검사로 진단이 어려운 경우에는 수술적 생검이 효과적인 진단 방법이 될 수 있다.