Lobectomy and Mediastinal LN dissection

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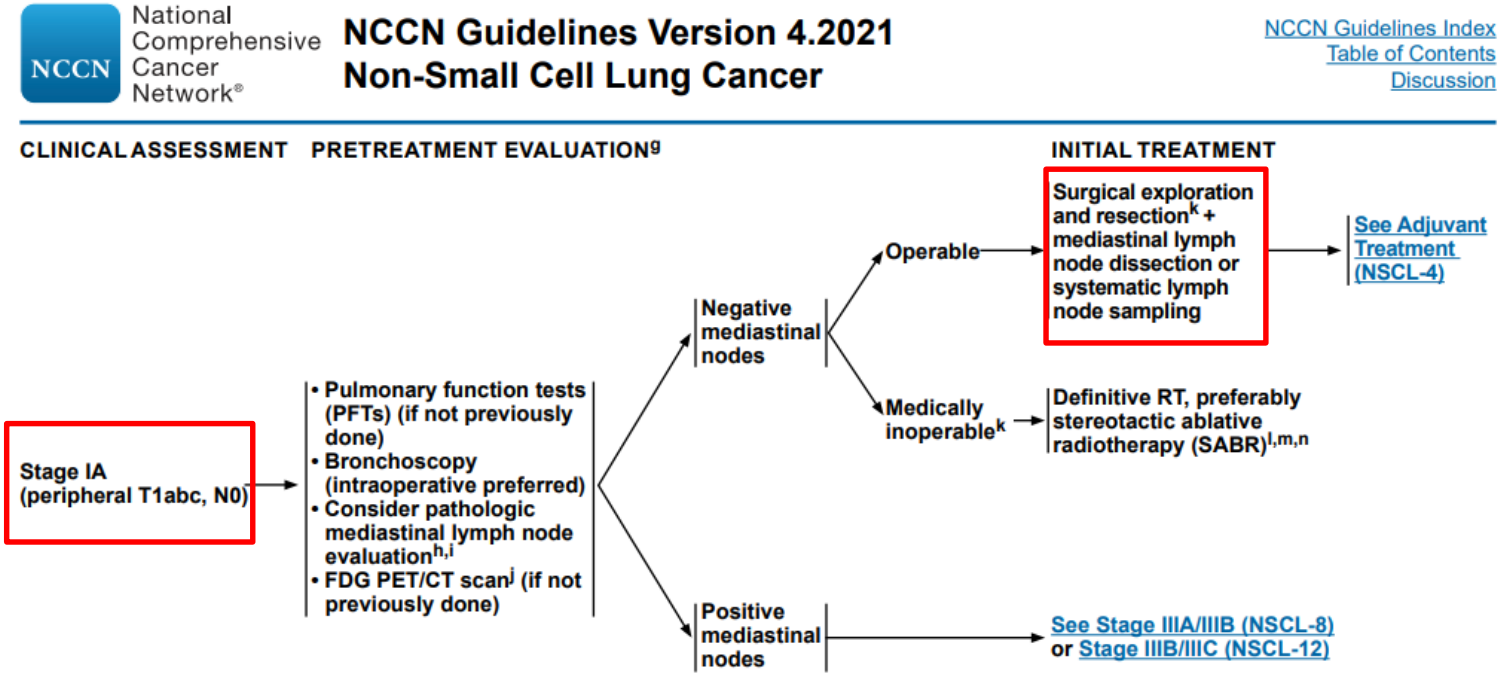
Principle of surgical therapy

: NCCN Guideline version 4. 2021 NSCLC



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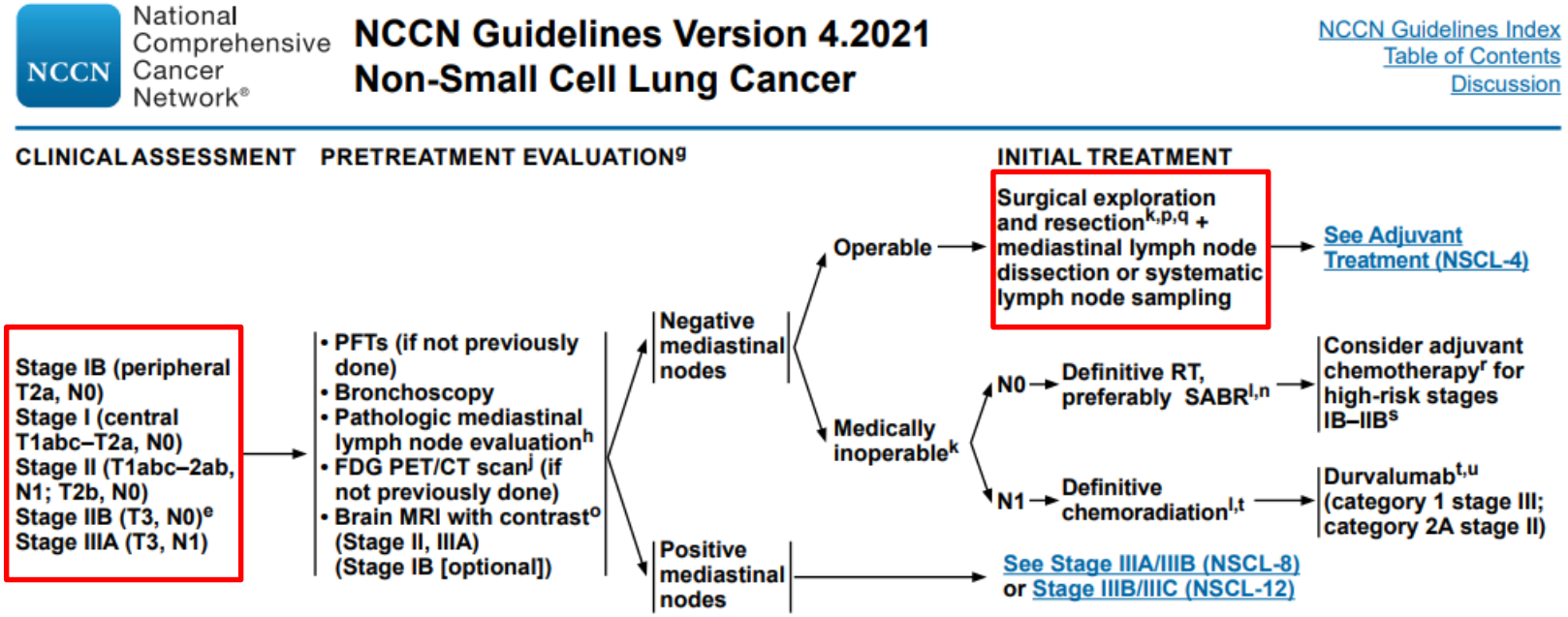

Principle of surgical therapy

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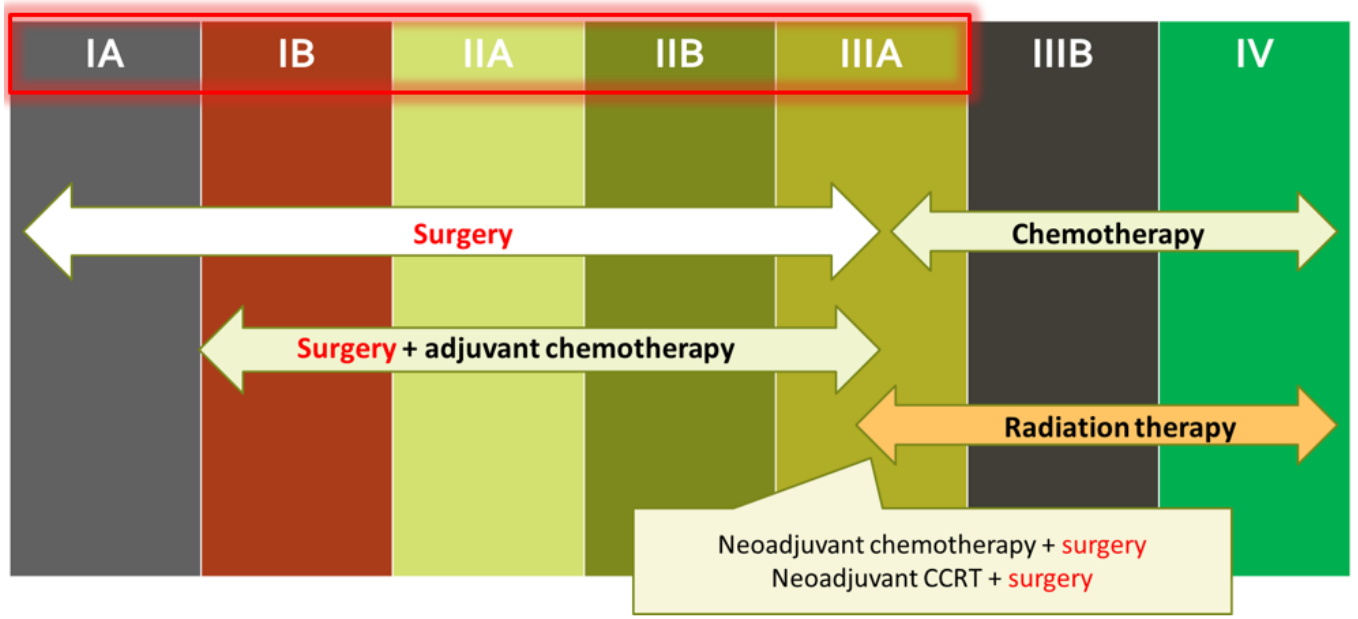
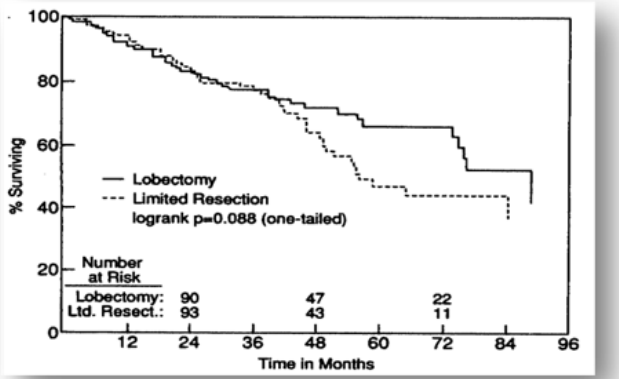


Surgery for lung cancer

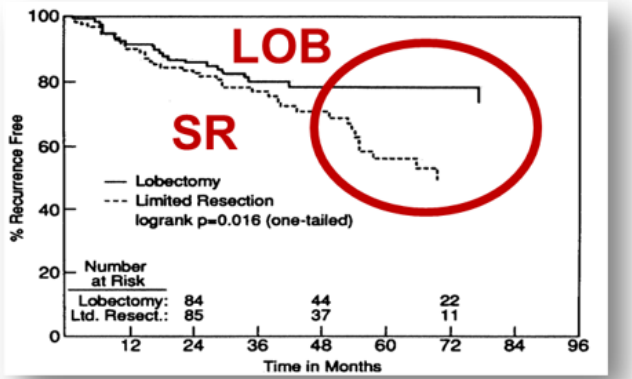
Standard surgical treatment for lung cancer is lobectomy.

The only RCT: LOB vs. SR for T1N0M0 NSCLC

OS (p=0.088)



Recurrence-free survival (p=0.016)



LCSG. *Ann Thorac Surg* 1995;60:615-623

Principle of surgical therapy

: NCCN Guideline version 4. 2021 NSCLC

Resection

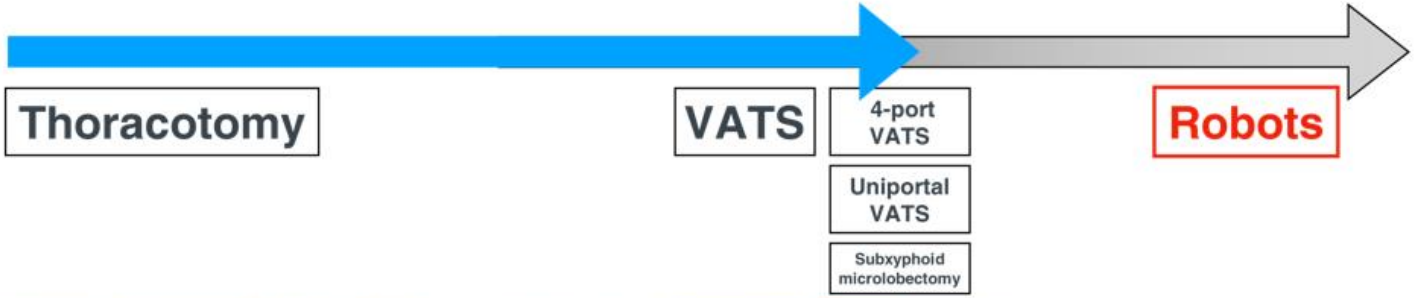
- Anatomic pulmonary resection is preferred for the majority of patients with NSCLC.
- Sublobar resection - Segmentectomy and wedge resection should achieve parenchymal resection margins ≥2 cm or ≥ the size of the nodule.
- Sublobar resection should also sample appropriate N1 and N2 lymph node stations unless not technically feasible without substantially increasing the surgical risk.
- Segmentectomy (preferred) or wedge resection is appropriate in selected patients for the following reasons:
  - Poor pulmonary reserve or other major comorbidity that contraindicates lobectomy
  - Peripheral nodule[1] ≤2 cm with at least one of the following:
    - Pure AIS histology
    - Nodule has ≥50% ground-glass appearance on CT
    - Radiologic surveillance confirms a long doubling time (≥400 days)
- VATS or minimally invasive surgery (including robotic-assisted approaches) should be strongly considered for patients with no anatomic or surgical contraindications, as long as there is no compromise of standard oncologic and dissection principles of thoracic surgery.
- In high-volume centers with significant VATS experience, VATS lobectomy in selected patients results in improved early outcomes (ie, decreased pain, reduced hospital length of stay, more rapid return to function, fewer complications) without compromise of cancer outcomes.
- Lung-sparing anatomic resection (sleeve lobectomy) is preferred over pneumonectomy, if anatomically appropriate and margin-negative resection is achieved.
- T3 (invasion) and T4 local extension tumors require en-bloc resection of the involved structure with negative margins. If a surgeon or center is uncertain about potential complete resection, consider obtaining an additional surgical opinion from a high-volume specialized center.

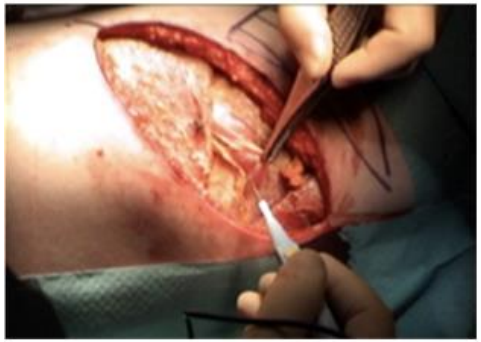
Margins and Nodal Assessment (see NSCL-B 2 of 4)

The Role of Surgery in Patients with Stage IIIA (N2) NSCLC (see NSCL-B 2 of 4 through NSCL-B 4 of 4)

[1]Peripheral is defined as the outer one third of the lung parenchyma.

Surgical approach for lung cancer





Principle of surgical therapy

: NCCN Guideline version 4. 2021 NSCLC

- **VATS or minimally invasive surgery** (ex.Robot) should be strongly considered for patients with no anatomic or surgical contraindications, as long as there is no compromise of standard oncologic and dissection principle of thoracic surgery.

➔ VATS lobectomy : strongly recommendation for lung cancer

➔ Pain↓, Hospital stay ↓, complication ↓, rapid return to function

Principle of surgical therapy

：NCCN Guideline version 4. 2021 NSCLC

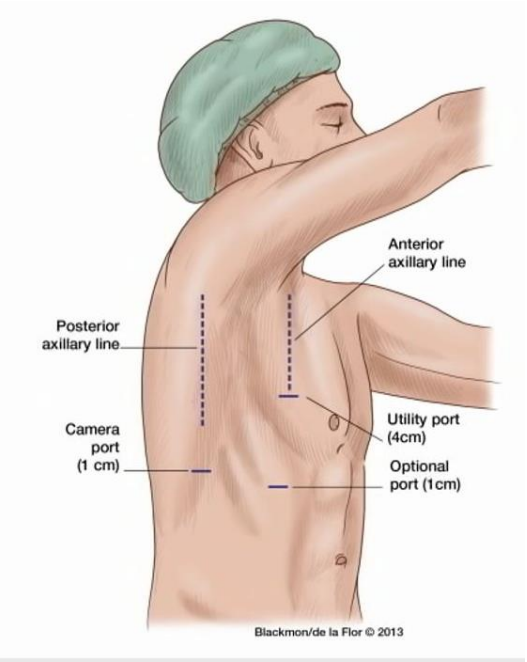
- Anatomical pulmonary resection is preferred for the majority of patients with NSCLC.
- **Sublobar resection** : segmentectomy and wedge resection should achieve parenchymal resection margins >2cm or >the size of the nodules

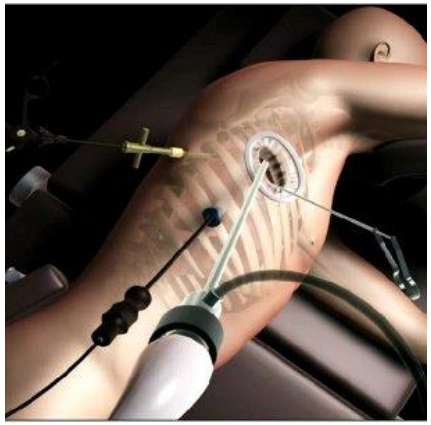
Principle of surgical therapy

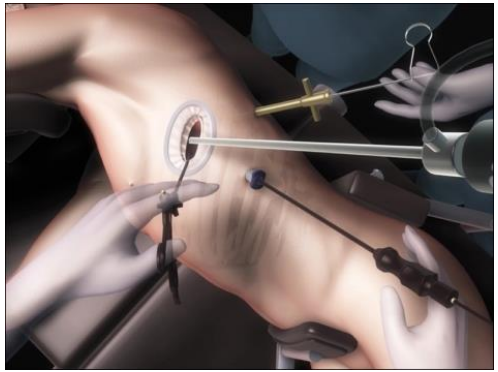
: NCCN Guideline version 4. 2021 NSCLC

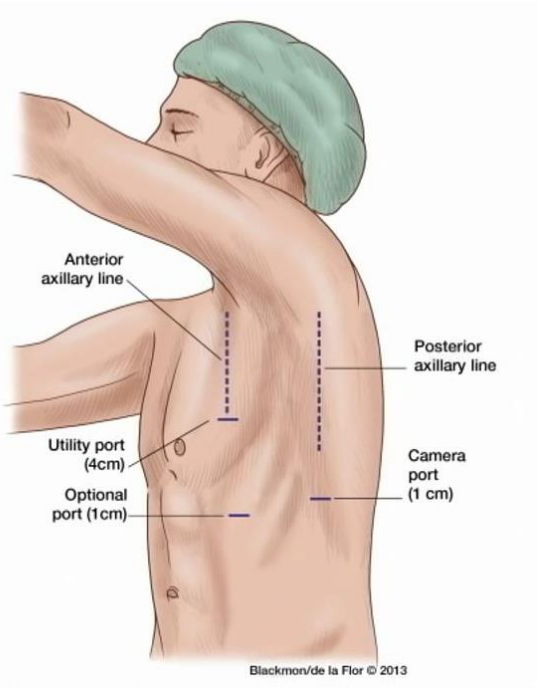
- **Segmentectomy**
  - Poor pulmonary reserve or other major comorbidity that contraindicates lobectomy
  - Peripheral nodule <2cm with at least one of the following:
    - Pure AIS histology
    - Nodules has >50% ground-glass appearance on CT
    - Radiologic surveillance confirmes a long doubling time(>400days)

VATS Lobectomy : position and approach

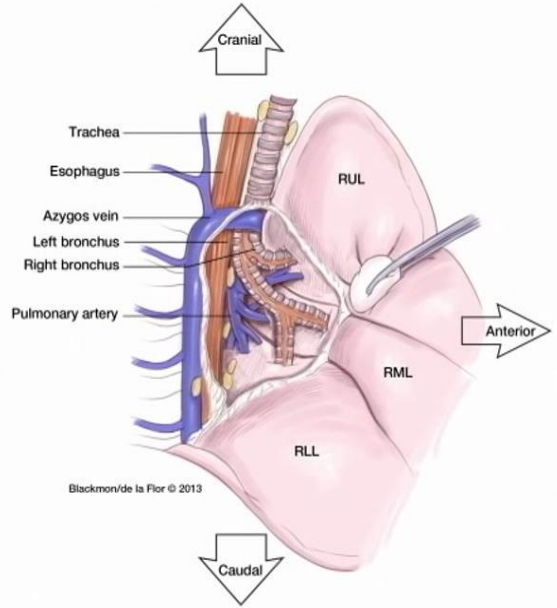


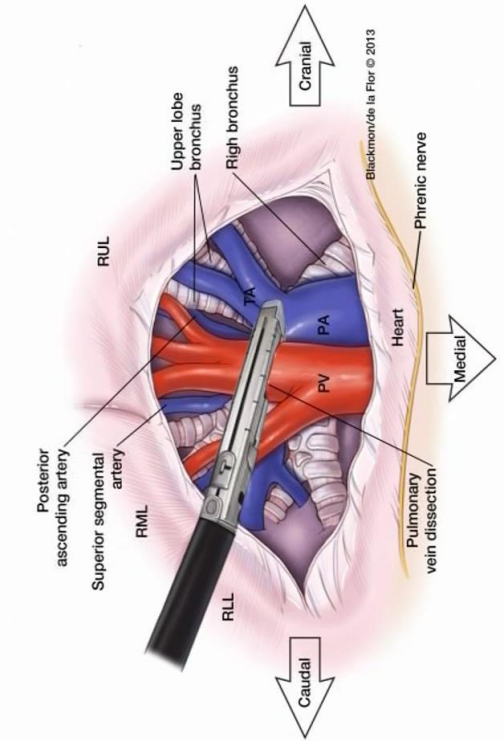


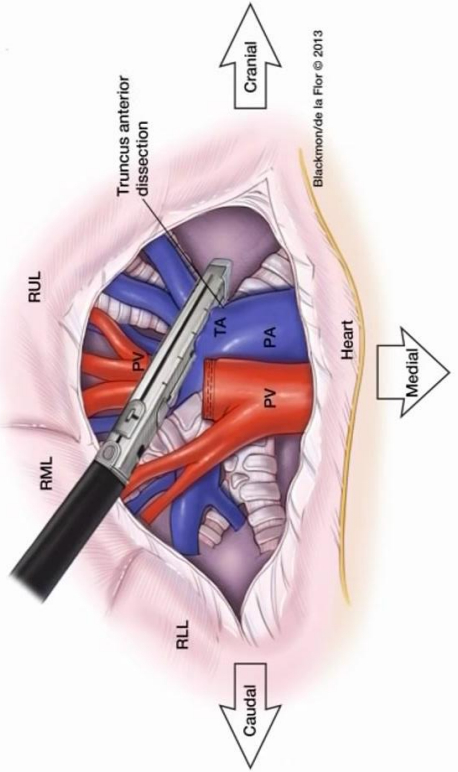




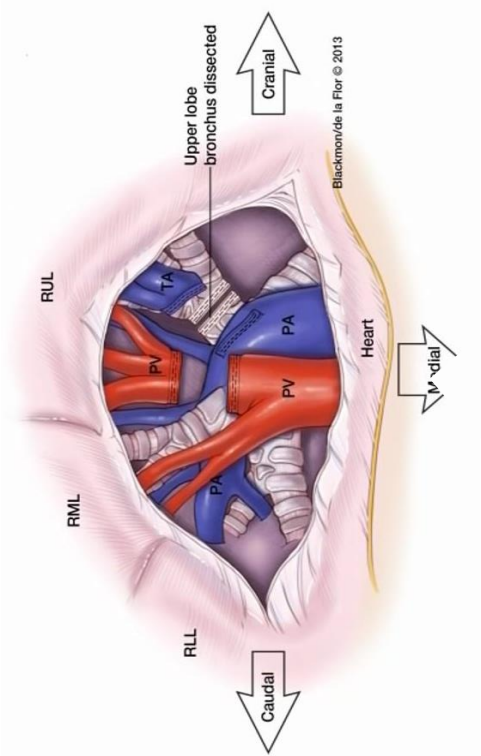
VATS RULobectomy

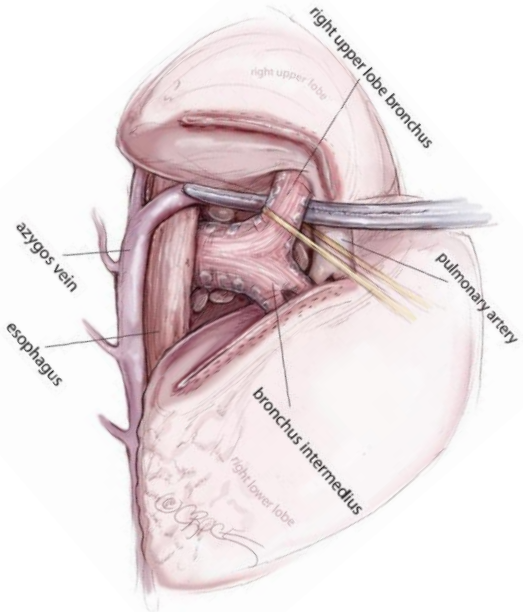






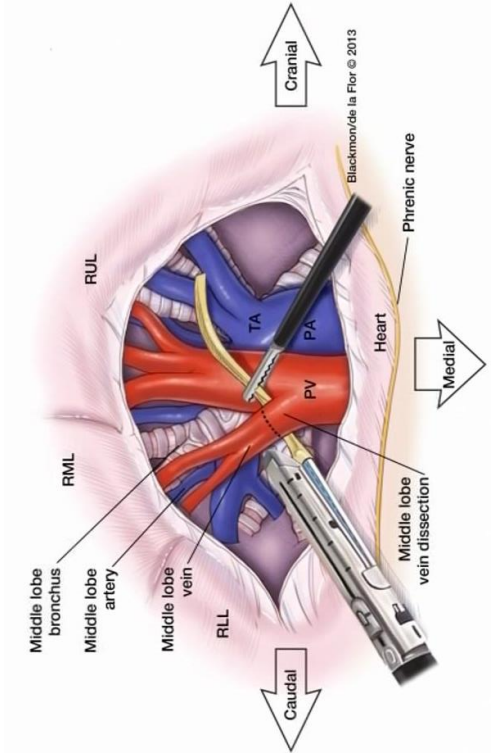
VATS RULobectomy

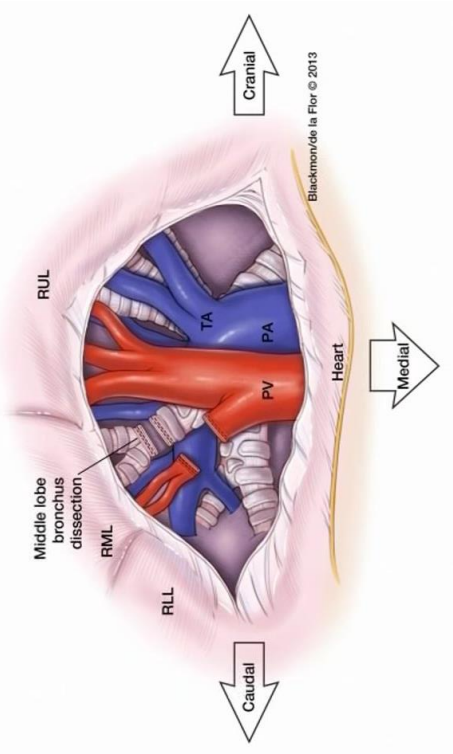


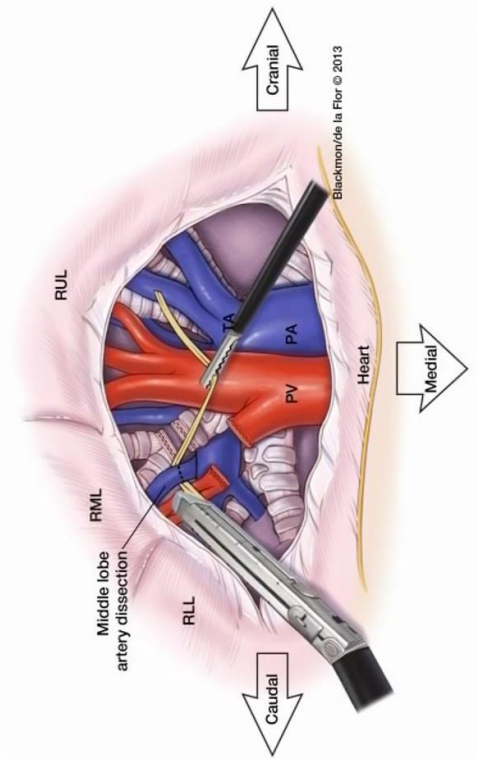


[Surgical video clip]

VATS RMLobectomy



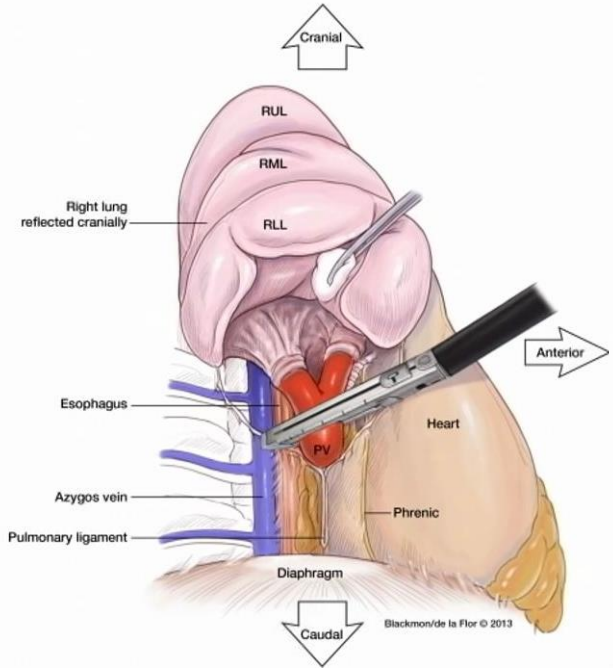


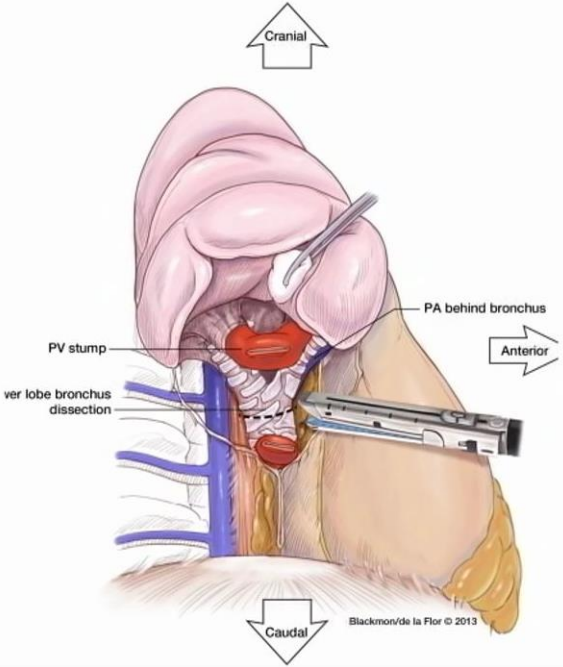


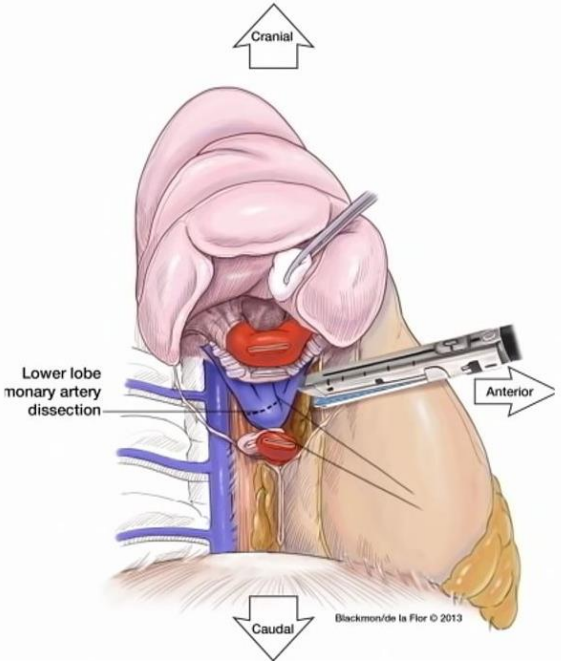
VATS RMLobectomy

Surgical video clip

VATS RLLobectomy







VATS RLLobectomy

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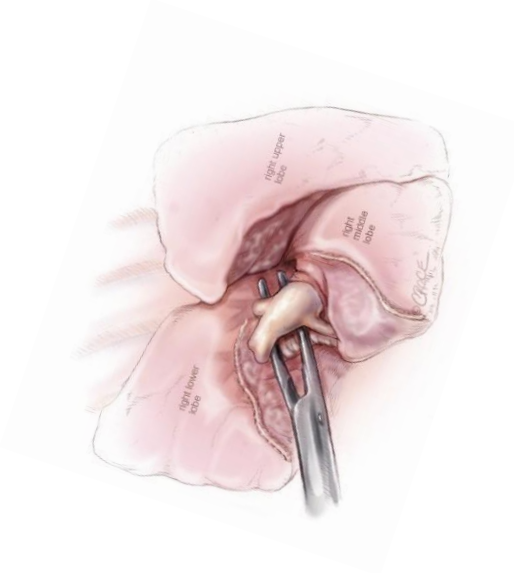
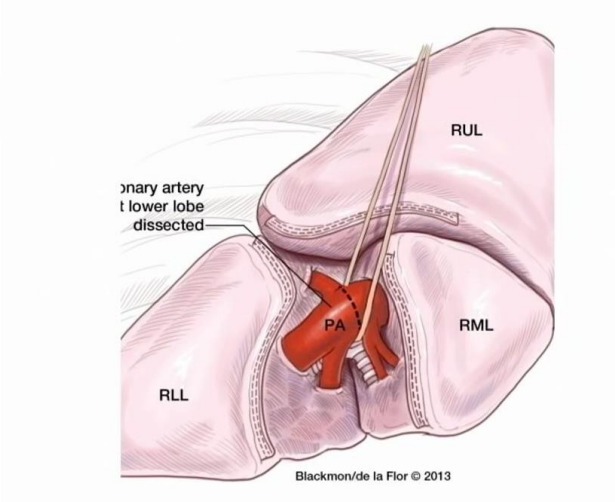
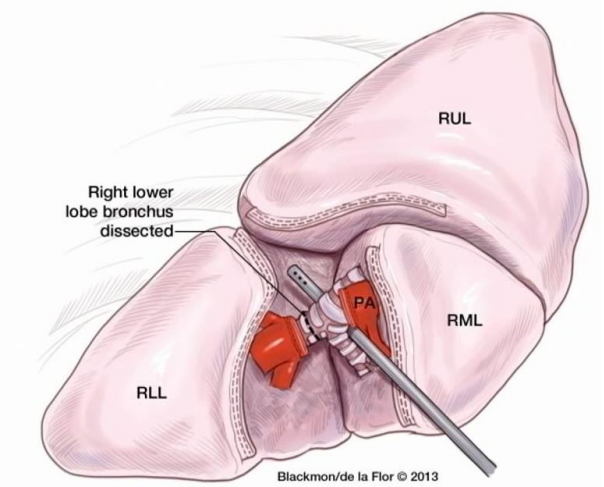
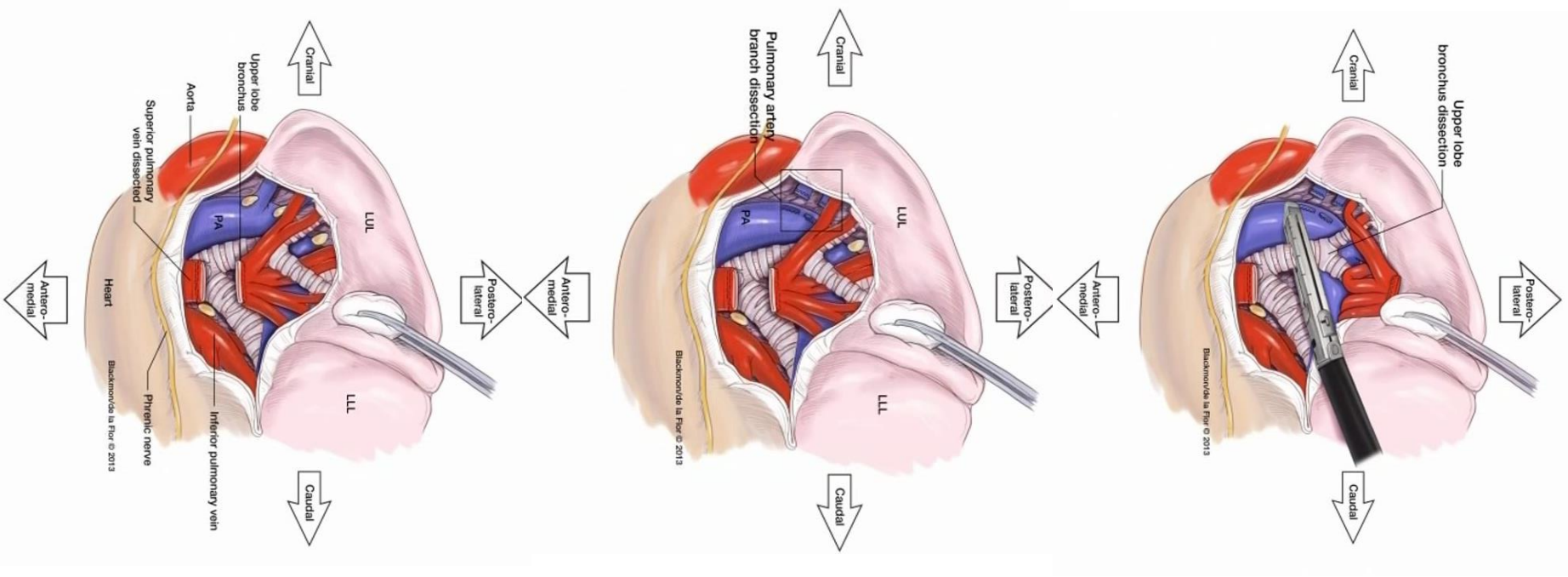




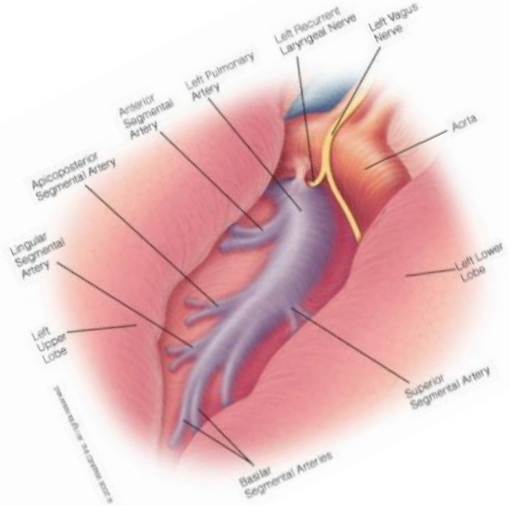


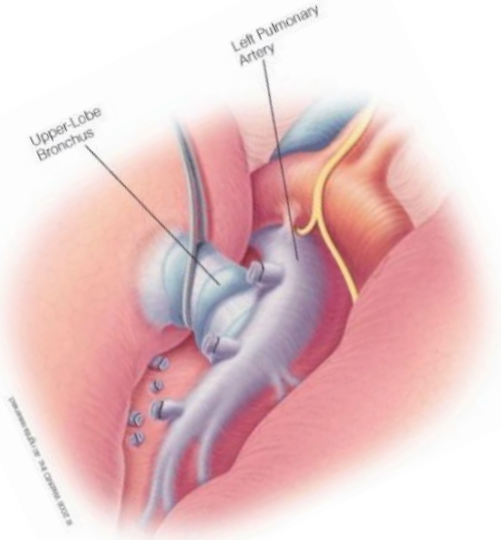
VATS LULobectomy



VATS LULobectomy

Surgical video clip





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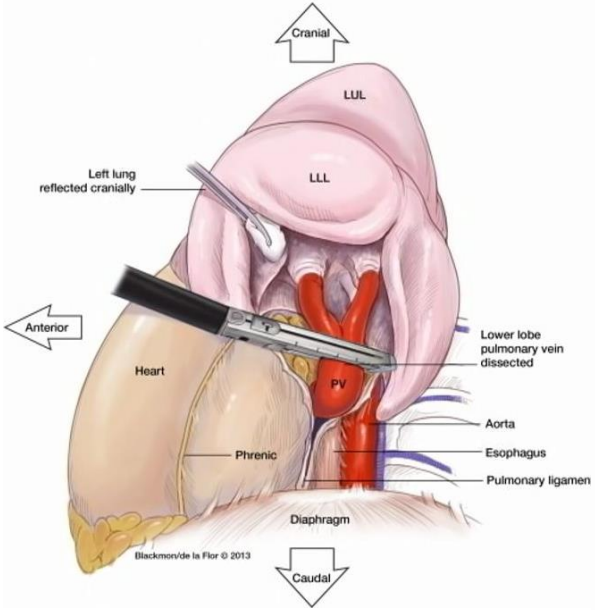
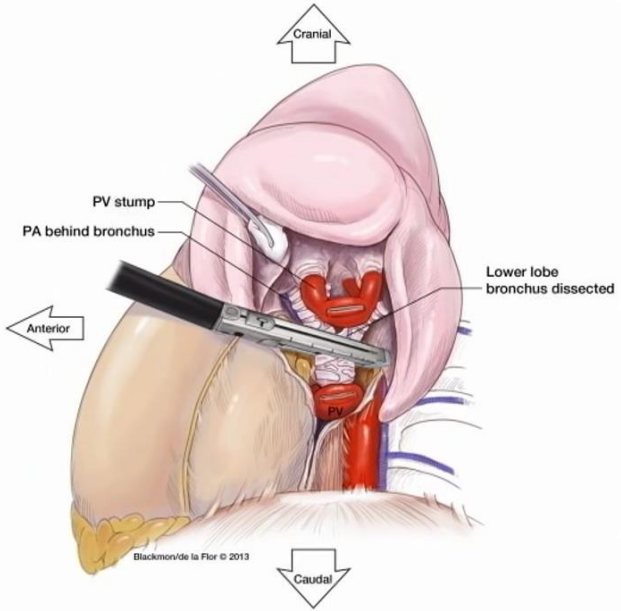
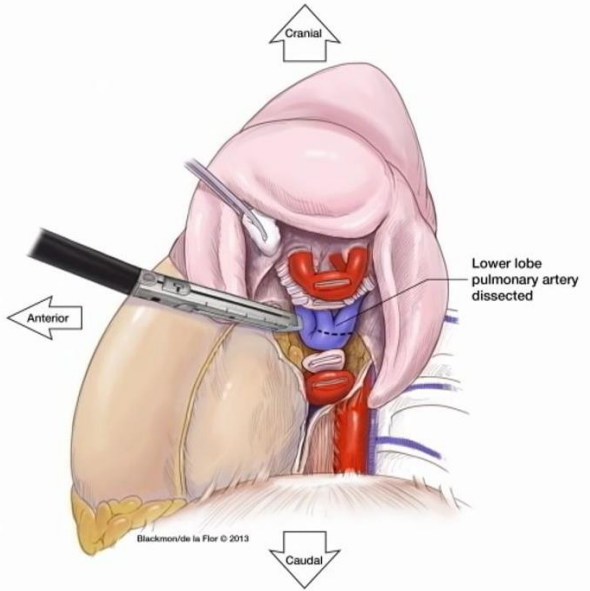




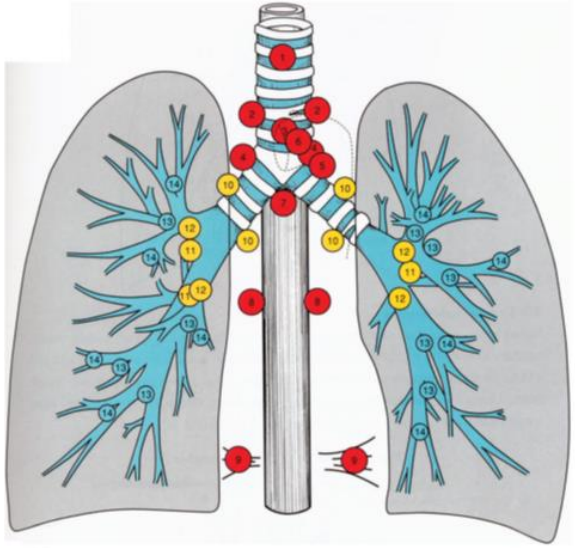


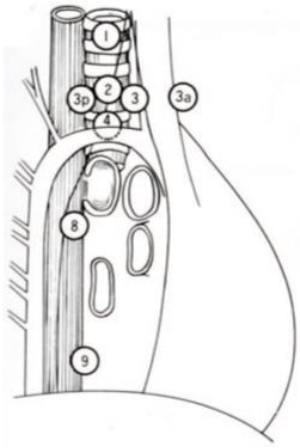
VATS LLLobectomy

Surgical video clip

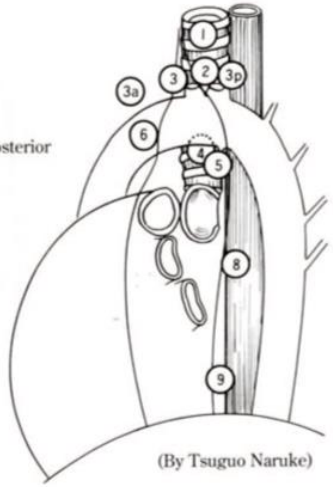
Lymph node dissection for lung cancer

- 1st lymph node map by Naruke (1967)





#1 Superior mediastinal or highest mediastinal
#2 Paratracheal
#3 Pretracheal
#3a Anterior mediastinal
#3p Retrotracheal mediastinal or posterior mediastinal
#4 Tracheobronchial
#5 Subaortic or Botallo's
#6 Paraaortic (ascending aorta)
#7 Subcarinal
#8 Paraesophageal (below carina)
#9 Pulmonary ligament
#10 Hilar (main bronchus)
#11 Interlobar
#12 Lobar···upper lobar, middle lobar, and lower lobar
#13 Segmental
#14 Subsegmental



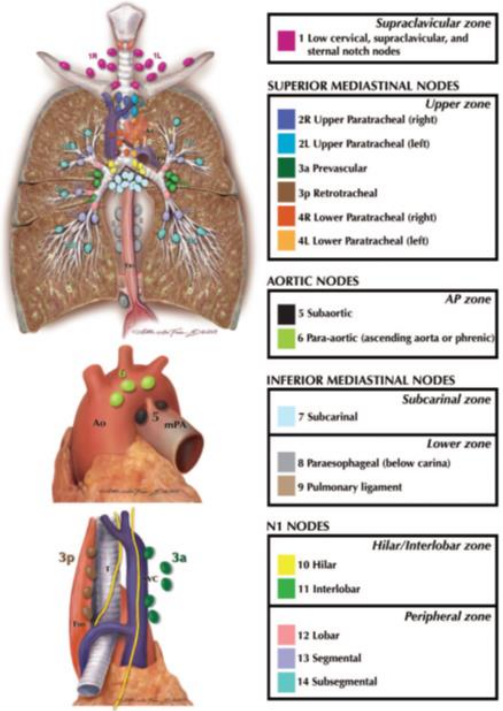
(By Tsuguo Naruke)

Lymph node dissection for lung cancer

Lymph nodes distribution

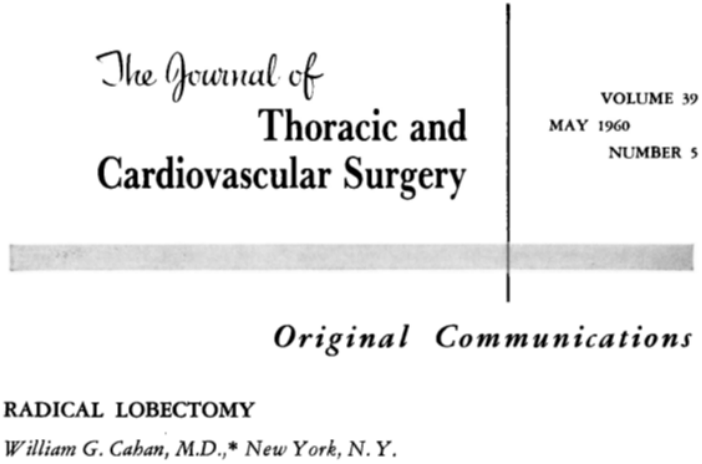
- IASLC Map (2009)
- UICC and AJCC staging
- Discrepancies in nomenclature
  between Naruke and MD-ATS lymph node map
  ex) 7 in MD-ATS map(N2)
  vs 7/10 in Naruke map (N1or N2)

- N0: No nodes involved
  N1: Ipsilateral peribronchial, interlobar,
  hilar node involvement
  N2: Ipsilateral mediastinal node involvement
  N3: Contralateral mediastinal, hilar or
  supraclavicular node involvement



Lymph node dissection for lung cancer

- Systemic lymph node dissection was first reported by Cahan In 1960.



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Cardiovascular Surgery

VOLUME 39
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Original Communications

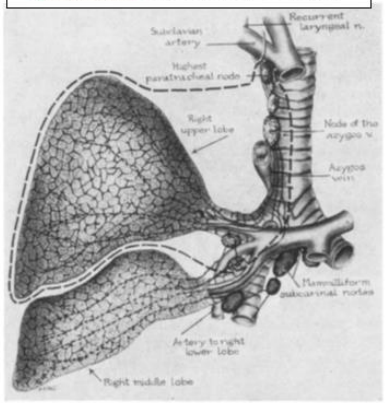
RADICAL LOBECTOMY

William G. Cahan, M.D., New York, N. Y.*

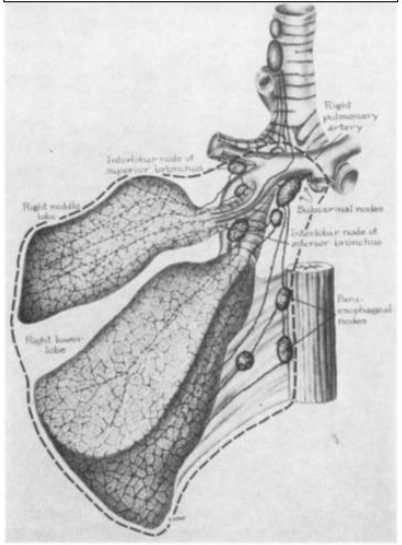
Radical lobectomy as an operation in which one or two lobes of an entire lung are excised in a block dissection with certain of their regional hilar and mediastinal lymphatics.

Lymph node dissection for lung cancer

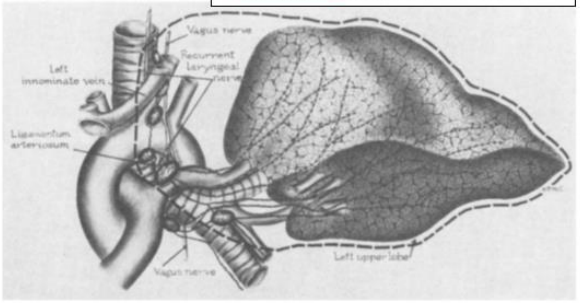
RULobar radical lobectomy



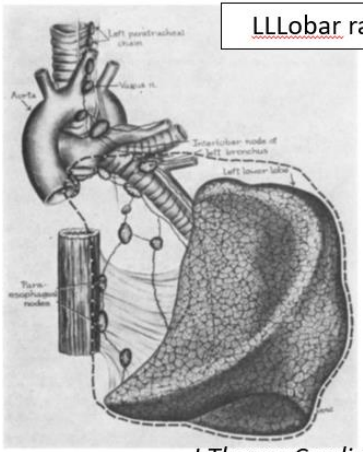
RML/RLLobar radical lobectomy



LULobar radical lobectomy



LLLobar radical lobectomy



J Thorac Cardiovasc Surg. 1960;39:555-72

Lymph node dissection for lung cancer

ELSEVIER

Lung Cancer 18 (1997) 107–111

LUNG CANCER

IASLC

Meeting Summary

Report on the international workshop on intrathoracic staging. London, October 1996

Peter Goldstraw

Consultant Thoracic Surgeon, Royal Brompton Hospital, Sydney Street, London SW3 6NP, England, UK

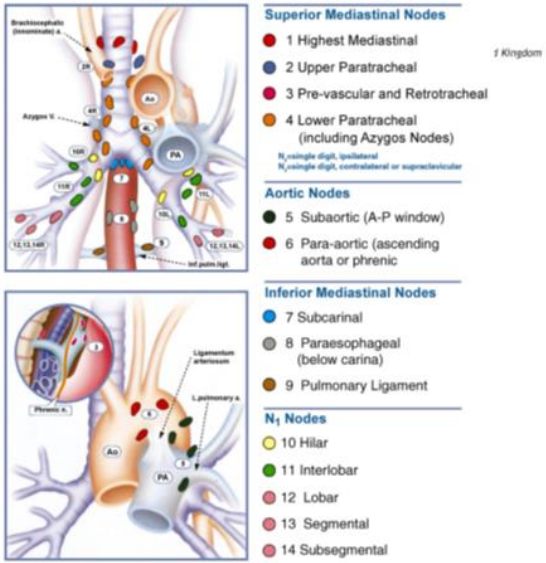
Systemic Nodal Dissection

1. Any new nodal chart must be retrospectively compatible with existing databases.
2. The pleural reflection should be used to separate nodes in the mediastinum from those in the hilum.
3. The lymphatic watershed in the superior mediastinum should be along the left margin of the trachea, thus rendering pre-tracheal nodes N2 for right sided tumors and N3 for left sided tumors. The descript no. 3 is therefore no longer required for pretracheal stations.
4. Station 3 would be reserved for nodes in the anterior mediastinum along the phrenic nerve, on the right along the superior vena cava and on the left extending to the left innominate vein.
5. Nodes along side the esophagus, no. 8, would be divided into 8s and 8i if above or below the azygos arch on the right or the aorta on the left.
6. N1 nodes require clarification, especially no. 12 used to delineate lobar nodes.

Lymph node dissection for lung cancer

ESTS guidelines for intraoperative lymph node staging in non-small cell lung cancer☆

Didier Lardinois[a], Paul De Leyn[b], Paul Van Schil[c], Ramon Rami Porta[d], David Waller[e], Bernward Passlick[f], Marcin Zielinski[g], Klaus Junker[h], Erino Angelo Rendina[i], Hans-Beat Ris[j], Joachim Hasse[k], Frank Detterbeck[l], Toni Lerut[b], Walter Weder[a,*]



- Definitions of lymph node assessment
  1. Selected lymph node biopsy
  2. Sampling
  3. Systematic nodal dissection
  4. Lobe-specific systematic nodal dissection
  5. Extended lymph node dissection

➔ *For complete resection of non-small cell lung cancer, a systematic nodal dissection is recommended in all cases*.
- Rt side: 2R, 4R, 3a, 3p, 7, 8, 9
- Lt side: 4L, 5, 6

➔ Peripheral squamous T1 : Selective nodal dissection (At least six nodes)
- RUL/RML : 2R, 4R, 7
- RLL: 4R, 7, 8, 9
- LUL : 5, 6, 7
- LLL : 7, 8, 9

Eur J cardiothorac surg 2006;30:787-92

Lymph node dissection for lung cancer

STATE OF THE ART: CONCISE REVIEW

Lymph Node Dissection for Lung Cancer

Significance, Strategy, and Technique

Shun-ichi Watanabe, MD, and Hisao Asamura, MD

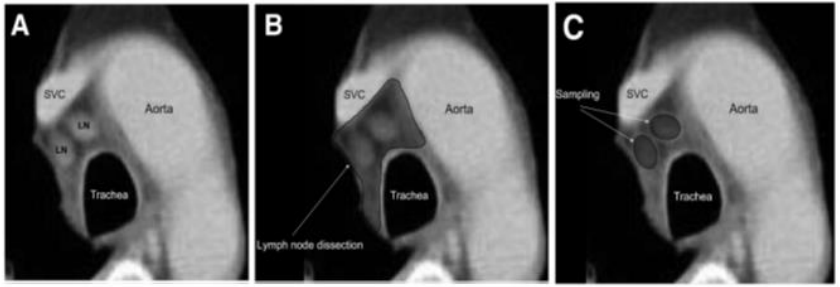
J Thorac Oncol 2009;4:652-7

1) Resection of at least three lymph nodes or three stations from hilar and intrapulmonary nodules
2) Resection of at least three lymph nodes or three stations from mediastinal nodes
3) Resection of at least six lymph nodes or six stations in total.

by The Japan Lung Cancer Society (2010)

- **Definition of lymph node dissection**

: En block removal of all tissue that may contain cancer cells, including the lymph nodes and surrounding fatty tissue within anatomic landmarks such as the trachea, bronchus, superior vena cava, and the aorta and its branches, pulmonary vessels, and pericardium.



Lymph node dissection for lung cancer

- Significance of lymph node dissection: Accurate staging
  - CT in assessing mediastinal nodal involvement
    : sensitivity 52-79%, specificity 69-78%
  - PET-CT in assessing mediastinal nodal involvement
    : sensitivity 79-85%, specificity 90-91%
  - "unexpected N2" – 60% of cN1 adenocarcinoma ➔ Pn2
  - Small sized lung cancer (<2cm) : hilar and mediastinal nodal involvement – more than 20%
  - Skip metastasis : 20-38% in N2 patients

J Thorac Oncol 2009;4:652-7

Lymph node dissection for lung cancer

- Significance of lymph node dissection : Survival benefit

TABLE 1. Previous Reports of Prospective Randomized Trials Comparing Systematic Nodal Dissection and Nodal Sampling

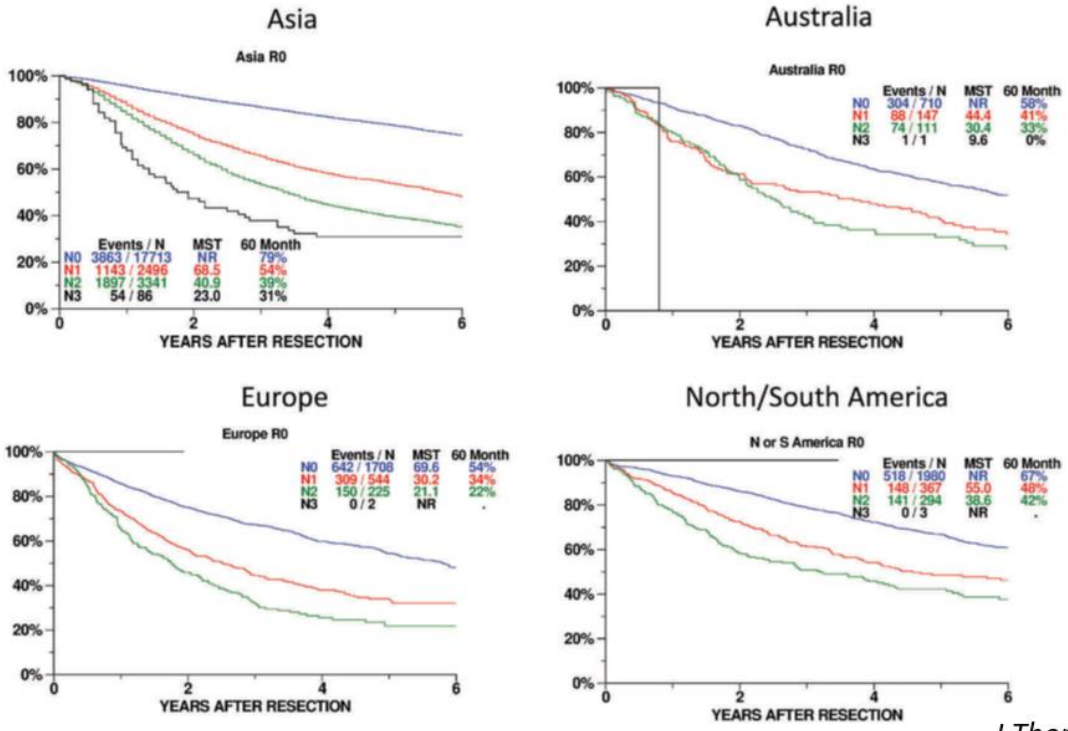
Author	Reported Year	Years Analyzed	Detailed Description of Randomization Method	Intention-to-Treat Analysis	Patients	No. of Patients (SND/Sampling)	Median Follow-Up (Months)	Overall Survival (SND/Sampling)	Disease Free Survival
Izbicki	1998	NA	Yes	No	Operable NSCLC	169 (76/93)	47.5	HR 0.76, $p = 0.273$	HR 0.82, $p = 0.338$
Sugi	1998	1985–1992	No	No	Peripheral NSCLC less than 2 cm in size	115 (59/56)	65	5-yr survival 81.4%/ 83.9%, p = NS	NA
Wu	2002	1989–1995	No	No	Clinical stage I–IIIA NSCLC	471 (240/231)	NA	5-yr survival 48.4%/ 37.0%, $p = 0.0000$	NA

NSCLC, non-small cell lung cancer; HR, hazard ratio; SND, systematic nodal dissection; NA, not applicable.

❖ Whether lymph node dissection has a survival benefit is still unknown.

J Thorac Oncol 2009;4:652-7

Lymph node dissection for lung cancer



J Thorac Oncol. 2015;10:1675-1684

Lymph node dissection for lung cancer

STATE OF THE ART: CONCISE REVIEW

Lymph Node Dissection for Lung Cancer

Significance, Strategy, and Technique

Shun-ichi Watanabe, MD, and Hisao Asamura, MD

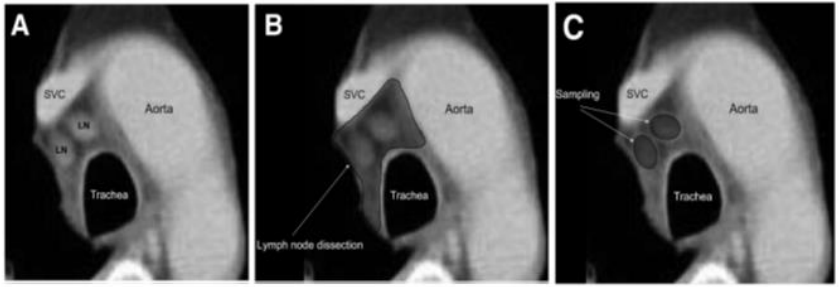
J Thorac Oncol 2009;4:652-7

1) Resection of at least three lymph nodes or three stations from hilar and intrapulmonary nodules
2) Resection of at least three lymph nodes or three stations from mediastinal nodes
3) Resection of at least six lymph nodes or six stations in total.

by The Japan Lung Cancer Society (2010)

- **Definition of lymph node dissection**

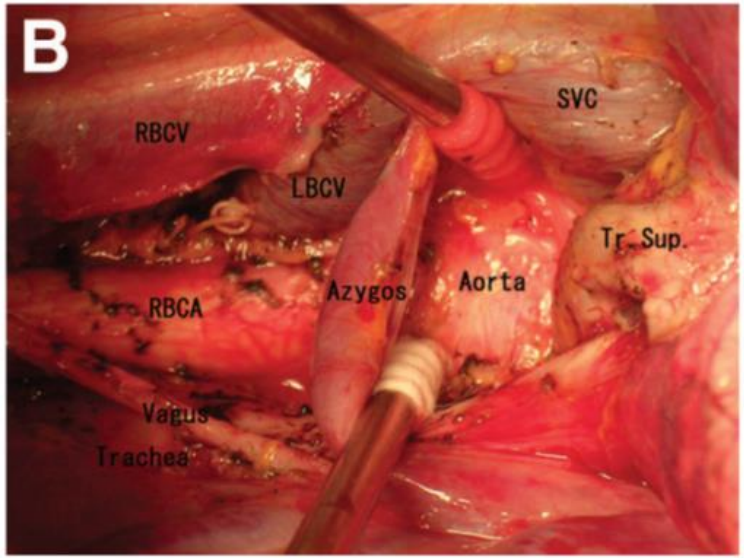
: En block removal of all tissue that may contain cancer cells, including the lymph nodes and surrounding fatty tissue within anatomic landmarks such as the trachea, bronchus, superior vena cava, and the aorta and its branches, pulmonary vessels, and pericardium.



Lymph node dissection for lung cancer

- Technique of lymph node dissection

Removed lymph nodes and surrounding fatty tissue en block within anatomic landmarks



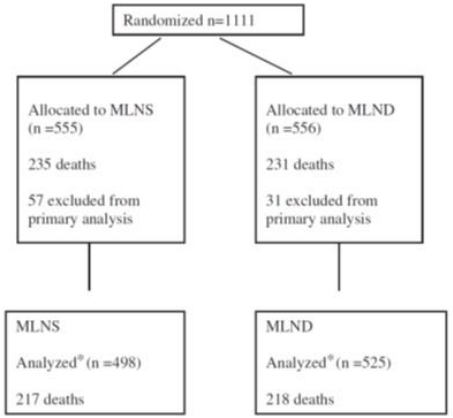
Skeletonized anatomic structures after systematic nodal dissection

Lymph node dissection for lung cancer

- Lymph node dissection vs Lymph node sampling

Randomized trial of mediastinal lymph node sampling versus complete lymphadenectomy during pulmonary resection in the patient with N0 or N1 (less than hilar) non–small cell carcinoma: Results of the American College of Surgery Oncology Group Z0030 Trial

Gail E. Darling, MD,[a] Mark S. Allen, MD,[b] Paul A. Decker, MS,[b] Karla Ballman, PhD,[b] Richard A. Malthaner, MD,[c] Richard I. Inculet, MD,[c] David R. Jones, MD,[d] Robert J. McKenna, MD,[e] Rodney J. Landreneau, MD,[f] Valerie W. Rusch, MD,[g] and Joe B. Putnam, Jr, MD[h]



* Note: intent to treat analyses were also performed.

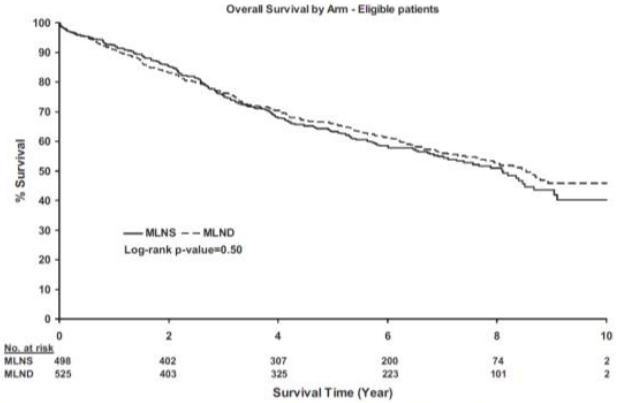


FIGURE 2. Overall survival. *MLNS,* Mediastinal lymph node sampling; *MLND,* mediastinal lymph node dissection.

TABLE 2. Overall and disease-free survival estimates on all eligible patients

Time	MLNS (N = 498) estimate (95% CI)	MNLD (n = 525) estimate (95% CI)
Overall survival		
2 y	85.1 (82.0–88.3)	83.0 (79.8–86.4)
4 y	67.8 (63.7–72.2)	70.5 (66.5–74.6)
6 y	58.1 (53.7–62.9)	61.4 (57.1–66.0)
8 y	50.9 (45.9–56.5)	52.4 (47.6–57.7)
Disease-free survival		
2 y	79.5 (75.7–83.4)	80.5 (76.9–84.3)
4 y	70.6 (66.2–75.2)	71.7 (67.4–76.2)
6 y	65.2 (60.4–70.4)	66.3 (61.8–71.3)
8 y	61.1 (55.4–67.3)	59.4 (53.8–65.6)

Lymph node dissection for lung cancer

Lymph node dissection vs Lymph node sampling

First author, year, location	Participants	Study Group	Patients, n	Men, n	Age, y, median	Outcomes (MLND/MLNS)
Darling [10], 2011, USA	N0 or N1 NSCLC	MLND	525	272	67	Overall survival (52.4%/50.9%); local recurrence (5.7%/4.8%); distant metastasis (21.7%/22.3%)
		MLNS	498	257	68	
Allen [17], 2006, USA	N0 or N1 NSCLC	MLND	525	272	67	Complications (e.g., arrhythmia, prolonged air leakage, and pneumonia)
		MLNS	498	257	68	
Izbicki [18], 1998, Germany	In stage I–IIIA NSCLC	MLND	76	52	ND	Overall survival (70.6%/47.9%); local recurrence (28.9%/34.4%); distant metastasis (26.3%/31.2%)
		MLNS	93	73		
Izbicki [19], 1994, Germany	In stage I–IIIA NSCLC	MLND	82	56	58.5	Complications (e.g., arrhythmia, prolonged air leakage, and pneumonia)
		MLNS	100	80	60.9	
Sugi [20], 1998, Japan	Peripheral NSCLC<2 cm diameter	MLND	59	31	64.7±1.2	Overall survival (81.4%/83.9%); local recurrence (3.4%/3.6%); distant metastasis (10.2%/8.9%); complications (e.g., arrhythmia, prolonged air leakage, and pneumonia)
		MLNS	56	26	66.7±2.6	
Wu [21], 2002, China	In stage I–IIIA NSCLC	MLND	240	182	57	Overall survival (48.37%/36.98%); local recurrence (2.9%/4.8%); distant metastasis (22.5%/30.7%)
		MLNS	231	184	57	

PLoS One 2014;9:e1009979

Lymph node dissection for lung cancer

Lymph node dissection vs Lymph node sampling

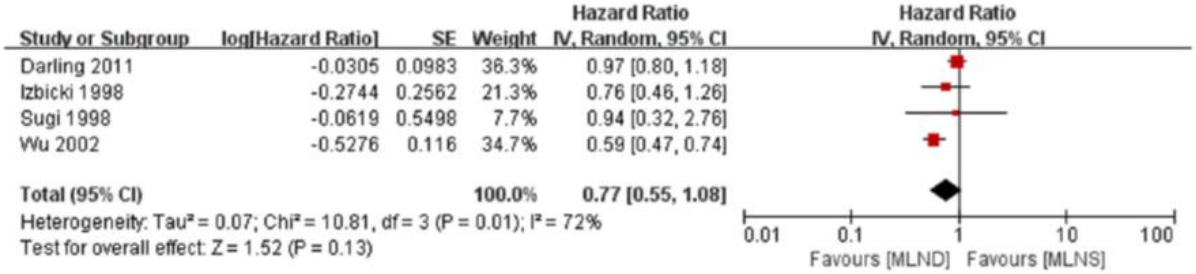


Figure 3. Forest plot of overall survival for the MLND vs. MLNS groups. MLND, mediastinal lymph node dissection; MLNS, mediastinal lymph node sampling; HR, hazard ratio; CI, confidence interval.

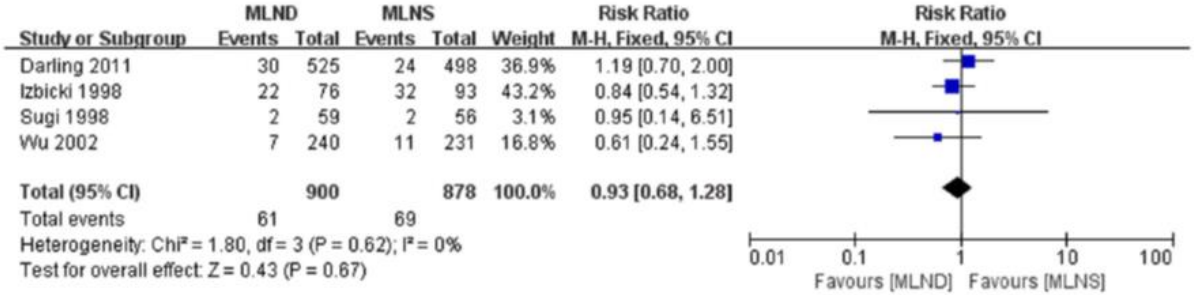
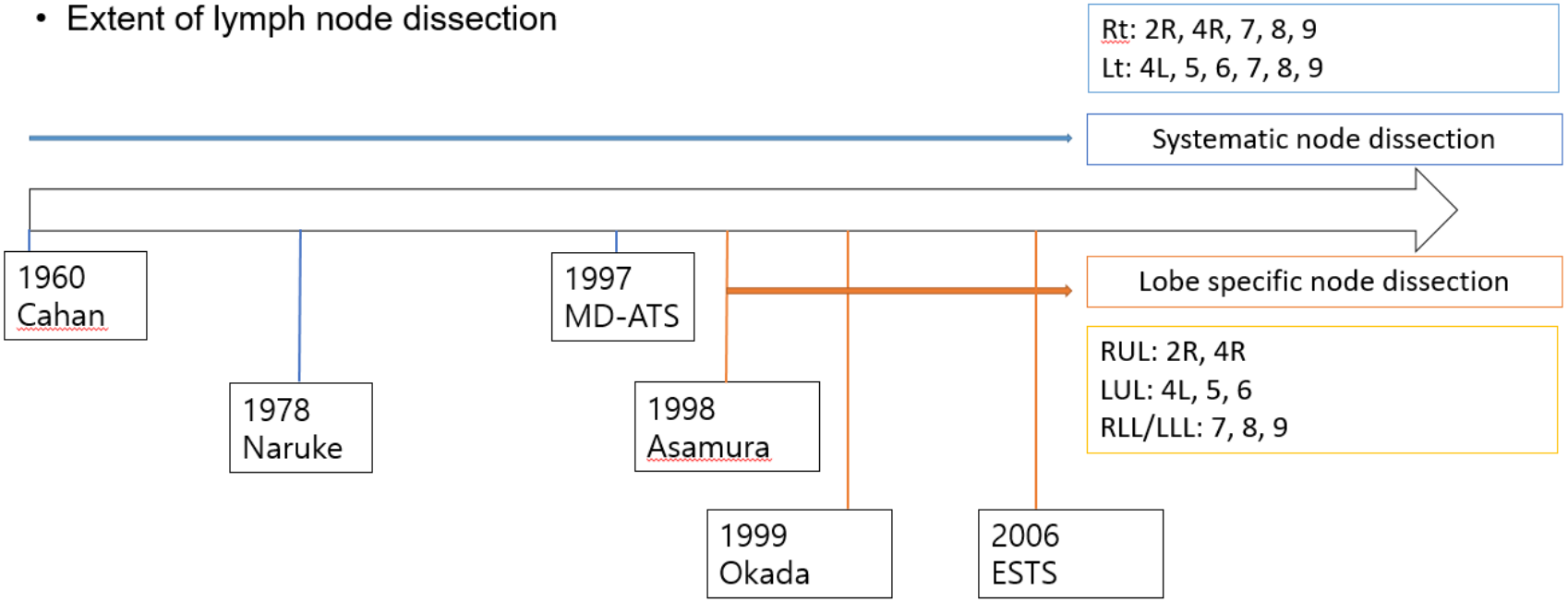


Figure 4. Forest plot of local recurrence for the MLND vs. MLNS groups. MLND, mediastinal lymph node dissection; MLNS, mediastinal lymph node sampling; RR, risk ratio; CI, confidence interval.

PLoS One 2014;9:e1009979

Lymph node dissection for lung cancer

- Extent of lymph node dissection



J Thorac Oncol 2017;12:85-93

Lymph node dissection for lung cancer

- Strategy of selective nodal dissection

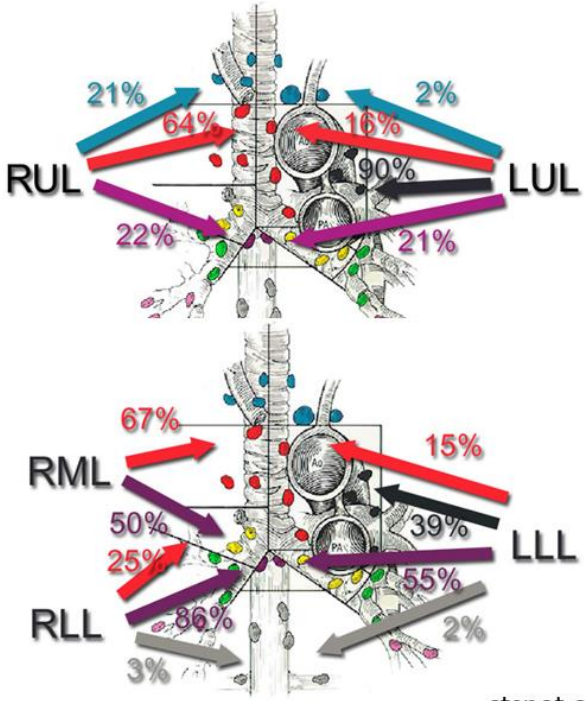


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TABLE 2. The Strategy of Selective Nodal Dissection Based on Lobe-Specific Patterns of Nodal Spread

	Location of the Primary Tumor		
Extent of Nodal Dissection	**RUL LUL-Superior Segment**	**RML LUL-Lingular Segment**	**RLL LLL**
Superior mediastinal nodes	Advisable	Advisable	Not always necessary[a]
Inferior mediastinal nodes			
Subcarinal node (#7)	Not always necessary[b]	Advisable	Advisable
Paraesophageal node (#8) and pulmonary ligament node (#9)	Unnecessary	Unnecessary	Advisable

[a] May be unnecessary when hilar and subcarinal (#7) nodes are negative on frozen section.

[b] May be unnecessary when hilar and superior mediastinal nodes are negative on frozen section.

RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; LUL, left upper lobe; LLL, left lower lobe.

J Thorac Oncol 2009;4:652-7

Lymph node dissection for lung cancer

Systematic lymph node dissection vs lobe specific lymph node dissection

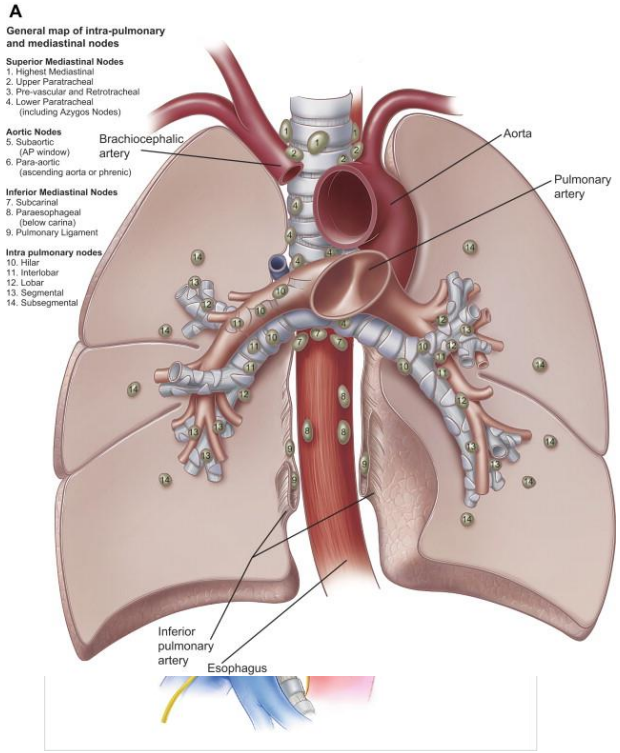
Table 1 Summary of studies comparing lobe-specific lymph node dissection and systematic lymph node dissection

First author	Patient cohort	Number of patients		5-year OS rate (%)		P value	Rate of occult pN2 (%)		P value	Postoperative complication (%)		P value
		L-SND	SND	L-SND	SND		L-SND	SND		L-SND	SND	
Okada *et al.*	c-stage I	377	358	76.3	73.4	0.376	0.5	0.8	0.719	10.1	17.3	0.005
Maniwa *et al.*	c-stage I–II	98	206	86.6	89.7	0.526	4.1	7.7	0.210	14.7	18.9	0.320
Ishiguro *et al.*	c-stage IA–IIIB	147	625	76.0	71.9	0.290	Not available	Not available	–	Not available	Not available	–
Adachi *et al.*	c-stage I–II	49*	49*	73.5*	75.3*	0.997	8.2*	8.2*	0.825	4.1*	2*	0.558

*, after Propensity Score matching. L-SND, lobe-specific lymph node dissection; SND, systematic lymph node dissection; OS, overall survival.

J Thorac Dis 2017;9(9):2728-31

Lymph node dissection for lung cancer



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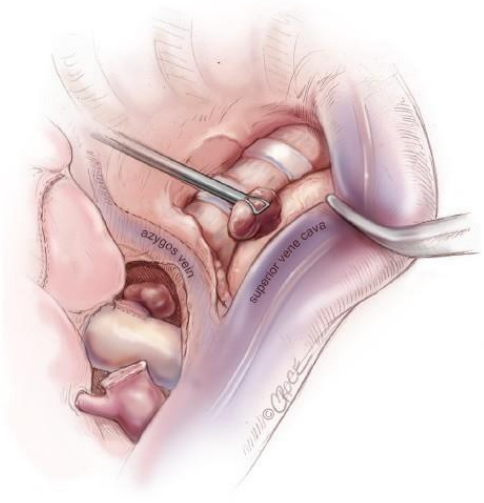

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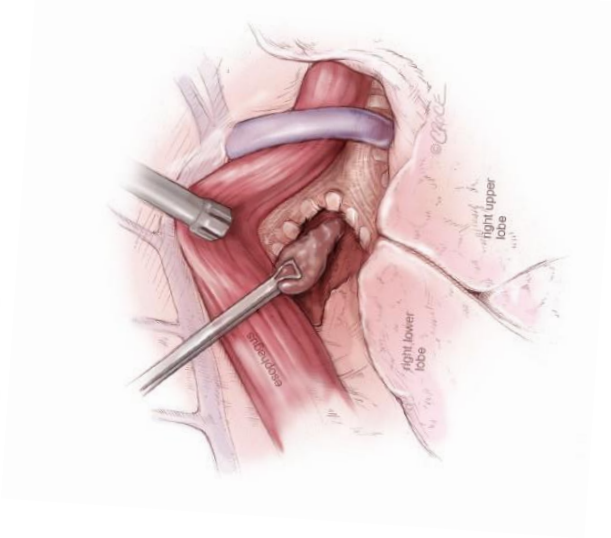
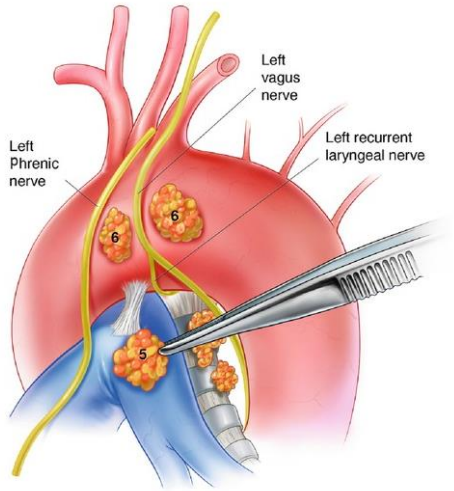


[Surgical clip]

Lymph node dissection for lung cancer

#5/6



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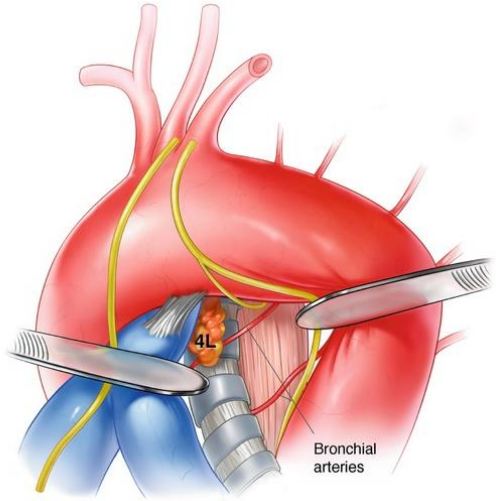

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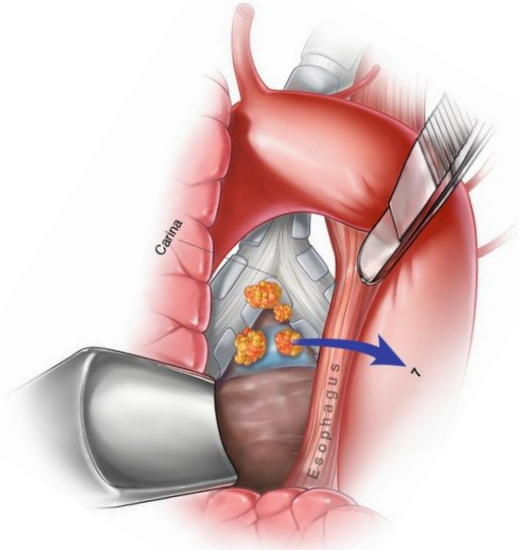

Surgical clip

Lymph node dissection for lung cancer

➢ **LN dissection related complications**

- Nerve damage: recurrent laryngeal nerve paralysis after dissection of nodal station 2R, 4L, 5
- Atrial fibrillation: postoperative local inflammation around the vagal nerve
- Chylothorax: after dissection of nodal station 7

➔ *Prevented by avoiding these stations using "Lobe specific lymph node dissection"*

- Bleeding, Pleural effusion , Prolonged hospital stay

Lymph node dissection for lung cancer

Table 1 Summary of studies comparing lobe-specific lymph node dissection and systematic lymph node dissection

First author	Patient cohort	Number of patients		5-year OS rate (%)		P value	Rate of occult pN2 (%)		P value	Postoperative complication (%)		P value
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*, after Propensity Score matching. L-SND, lobe-specific lymph node dissection; SND, systematic lymph node dissection; OS, overall survival.

arrhythmia

Table 2. Postoperative Complications

Complication	Complete Dissection (n = 358)	Selective Dissection (n = 377)
Dysrhythmia	19	12
Pneumonia or atelectasis	15	6
Prolonged air leak (>1 week)	14	11
Chylothorax	4	2
ARDS	3	1
Peptic ulcer	3	2
Lung infarction	2	0
Hemothorax	1	3
Myocardial infarction	1	1
Total	62 (17.3%)	38 (10.1%)

ARDS = adult respiratory distress syndrome.

Shorter op time (169.3 vs 201.9 min, p<0.001)
Less intraop blood loss (65 vs 220g, p<0.001)
Shorter hospital stay (13 vs 15days, p<0.001

Thank you for your attention