Thoracoscopic Segmentectomy: Why, When, and How

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Lobectomy – Optimal Resection for Early Stage Lung Cancer

Prospective, multi-institutional, randomized trial of lobectomy versus limited resection for T1 N0 non-small cell lung cancer

- 1982-1988
- Results reported in 1995 with 4.5 years minimum follow-up

276 patients randomized (247 analyzed)

Compared to lobectomy, patients undergoing limited resection had:

- 75% increase in recurrence rates (p=0.02)
- 30% increase in overall death rate (p=0.08)
- 50% increase in death with cancer rate (p=0.09)

*Ann Thorac Surg* 1995;60:615-622
But times have changed…

Diagnostic and staging modalities have clearly changed since the randomized trial was performed. The increased use of radiologic studies in general and particularly screening with computerized tomography (CT) scans are likely leading to the identification of a higher proportion of tumors with smaller sizes than what was typically seen in the 1980s.

However, resection via lobectomy may not be necessary to optimize survival for all patients presenting with NSCLC, most notably subsets of patients with Stage IA tumors.
Sublobar resection and lobectomy may have similar outcomes for older patients and smaller tumors

<table>
<thead>
<tr>
<th>Study</th>
<th>Patient population</th>
<th>Outcome Comparison</th>
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<tbody>
<tr>
<td>Landreneau et al</td>
<td>Single institution/propensity matched cohort of patients with clinical stage I NSCLC (mean size 2,2 cm) underwent anatomic segmentectomy (n=312) or lobectomy (n=312)</td>
<td>No differences in 5 year freedom from recurrence (70% vs 71%, p=0.47) or 5 year survival (54% vs 60%, p=0.26) between segmentectomy and lobectomy</td>
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<td>Wisnivesky et al</td>
<td>SEER-Medicare database study of stage I NSCLC patients (tumor size ≤ 2 cm) who underwent sublobar resection (n=196) or lobectomy (n=969)</td>
<td>Multivariable analysis showed extent of resection did not impact long-term survival.</td>
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<td>Altorki et al</td>
<td>Clinical stage NSCLC patients (tumor size ≤ 3 cm) in the International Early Lung Cancer Action Program who underwent lobectomy (n=294) or sublobar resection (n=53)</td>
<td>10-year Kaplan–Meier for 53 patients treated by sublobar resection compared with 294 patients treated by lobectomy was 85% (95% confidence interval, 80-91) versus 86% (confidence interval, 75-96) (p=0.86)</td>
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<td>Okada et al</td>
<td>Single institution review of 1272 patients who underwent complete resection of non-small cell lung cancer</td>
<td>5-year cancer-specific survival for pathologic stage I disease with tumors ≤ 2 cm was 92.4% after lobectomy, 96.7% after segmentectomy, and 85.7% after wedge resection.</td>
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<td>Wolf et al</td>
<td>Single institution study of stage I NSCLC patients (tumor size ≤ 2 cm) who underwent sublobar resection (n=154) or lobectomy (n=84)</td>
<td>Lobectomy was associated with improved overall survival and recurrence free survival overall, but advantage did not persist when sublobar resection included lymph node sampling</td>
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Radical sublobar resection for small-sized non–small cell lung cancer: A multicenter study

Morihito Okada, MD, PhD, Teruaki Koike, MD, PhD, Masahiko Higashiyama, MD, PhD, Yasushi Yamato, MD, PhD, Ken Kodama, MD, PhD, and Noriaki Tsubota, MD, PhD

Overall Survival

Disease-Free Survival
Anatomic Segmentectomy for the Solitary Pulmonary Nodule and Early-Stage Lung Cancer

Matthew J. Schuchert, MD, Ghulam Abbas, MD, Omar Awais, MD, Arjun Pennathur, MD, Katie S. Nason, MD, MPH, David O. Wilson, MD, Jill M. Siegfried, PhD, James D. Luketich, MD, and Rodney J. Landreneau, MD

![Graph showing freedom from recurrence over time with different surgical procedures and their respective patients at risk numbers.](img)

*Ann Thorac Surg 2012;93:1780-7*
Survival After Lobectomy Versus Segmentectomy for Stage I Non-Small Cell Lung Cancer: A Population-Based Analysis

Bryan A. Whitson, MD, PhD, Shawn S. Groth, MD, Rafael S. Andrade, MD, Michael A. Maddaus, MD, Elizabeth B. Habermann, PhD, and Jonathan D’Cunha, MD, PhD


Cancer Specific Survival (<2.1 cm tumors)
Why not just a wedge resection?

- Achievement of adequate margins – better deep margin with segmentectomy
- Better lymph node harvest - anatomic dissection of segmental bronchial and vascular structures leads to more retrieval of interlobar, lobar, segmental, and subsegmental lymph nodes than a wedge resection
  - Some degree of lymph node harvest is mandatory
    - Several studies have demonstrated the importance of lymph node evaluation at the time of sublobar resection
  - Lymph node information can be both prognostic and direct further therapy
    - Completion lobectomy and/or adjuvant chemotherapy
  - The randomized CALGB 14053 trial restricted to tumors less than or equal to 2 cm requires pathologic lymph node assessment prior to treatment randomization
  - In one study, 23% of patients with clinical IA NSCLC were found to have pathologic lymph node involvement or intrapulmonary metastases
- Being able to pathologically assess margins and nodal status is one major advantage of resection over non-surgical ablative therapy (stereotactic radiation)
- Wedge resection should probably be reserved for very small peripheral lesions, particularly if they straddle a segmental boundary such segmentectomy is not really an option
PRINCIPLES OF SURGICAL THERAPY

- Determination of resectability should be performed by Board-certified thoracic surgeons who perform lung cancer surgery as a prominent part of their practice.
- Resection, including wedge resection, is a preferred local treatment modality (other modalities include radiofrequency ablation, cryotherapy, stereotactic ablative RT [SABR]). Thoracic surgical oncology consultation should be part of the evaluation of any patient being considered for curative local therapy. In cases where SABR is considered for high-risk patients, a multidisciplinary evaluation including a radiation oncologist is recommended.
- Surgical staging and pulmonary resection should be performed by Board-certified thoracic surgeons who perform lung cancer surgery as a prominent part of their practice.
- The overall plan of treatment as well as needed imaging studies should be determined before any non-emergency treatment is initiated.
- Thoracic surgeons should actively participate in multidisciplinary discussions and meetings regarding lung cancer patients (e.g. multidisciplinary clinic and/or Tumor Board).
- Anatomic pulmonary resection is preferred for the majority of patients with non-small cell lung cancer.
Other reasons to do a segmentectomy instead of lobectomy

- Patients with impaired pulmonary function.
  - Segmentectomy is associated with significant preservation of pulmonary function compared with lobectomy
  - May be the best resection option that balances the risk and benefits of anatomic resection in patients with poor lung function

- Patients who are older or have other significant comorbidities
  - The survival benefit of lobectomy over sublobar resection is less in these patients
    - Higher perioperative mortality
    - Competing risk of mortality from other comorbidities
  - Segmentectomy if technically feasible may be a good resection option in these higher risk patients.

- Patients with multiple lesions where utilizing a lobectomy to achieve resection of all lesions is not physiologically feasible
  - Patients with multifocal adenocarcinoma

- Patients undergoing pulmonary metastasectomy where wedge resection not feasible
  - Complete resection is important, not anatomic resection
  - Minimize parenchymal resection and preserve pulmonary function so that patients can tolerate resection/treatment of synchronous or metachronous disease
Why do it minimally invasively?

- Minimally invasive resection via video-assisted thoracoscopic surgery (VATS) has well documented short-term benefits of reduced peri-operative morbidity over thoracotomy without compromise of oncologic outcomes for lobectomy
  - Performing segmentectomy via VATS has also been shown to have less short-term morbidity than thoracotomy
    - fewer complications (atrial arrhythmia, pulmonary complications, and prolonged air leak are most common)
    - reduced hospital stay than an open procedure
    - can be used for all potential segmental resections
- 0-6.4% conversion rate at experienced centers

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<tr>
<th>Study</th>
<th>Use of VATS approach</th>
<th>VATS Mortality</th>
<th>VATS Morbidity</th>
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<tbody>
<tr>
<td>Duke (2000-2006)</td>
<td>62% (48 of 77 patients)</td>
<td>0% (2.6% overall)</td>
<td>Atrial arrhythmia 15%</td>
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<td>Emory (2002-2009)</td>
<td>37% (15 of 41 patients)</td>
<td>0% (4.8% overall)</td>
<td>None reported</td>
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<td>Pitt (2002-2010)</td>
<td>60% (468 of 785 patients)</td>
<td>Not specifically reported (1.1% overall)</td>
<td>Not specifically reported.</td>
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Summary of when to consider segmentectomy

- Small (T1) tumors amenable to segmentectomy
  - Size (especially sub-centimeter and detected by screening studies)
  - Non-solid nodule or Adenocarcinoma in situ histology (bronchoalveolar carcinoma)
- Clinical node negative
- Documented low rate of growth – evidence of long doubling time
- If the patient cannot tolerate lobectomy (but can tolerate an operation)
  - Elderly
  - Limited cardiopulmonary reserve
  - Other co-morbid conditions
- Concern for synchronous or metachronous primary tumors
- Metastatic disease not amenable to wedge resection
Anatomic Segmentectomies

Right Side

Superior Segmentectomy

Basilar Segmentectomy

Left Side

Left Tri-Segmentectomy (Lingular Sparing Upper Lobectomy)

Superior Segmentectomy

Lingulectomy

Basilar Segmentectomy

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Superior Segmentectomy

- 56 year-old male with metastatic renal cell carcinoma
  - growing right lower lobe lung nodules that were biopsied and shown to be mets
  - Wedge was not feasible due to the central location adjacent to the bronchus intermedius and lower lobe pulmonary artery trunk

- Operative steps
  - Dissect posterior major fissure and take superior segment artery branch
  - Dissect posterior hilum and take superior segment vein branch
  - Divide superior segment bronchus
  - Divide segmental parenchyma
Superior Segmentectomy
Basilar Segmentectomy

- 66 year-old female found to have a left lower lobe lung nodule
  - Enlarged over time
  - Nothing else suspicious on PET or CT
  - Pre-op biopsy not feasible due to location next to the pericardium
  - I did not feel wedge was feasible due to somewhat central location

- Operative Steps:
  - Take down ligament
  - Take basilar segment vein branches
  - Take basilar segment artery branches
  - Take basilar segment bronchus
  - Divide segmental parenchyma
Basilar Segmentectomy
Lingular-Sparing Upper Lobectomy (Tri-Segmentectomy)

- 48 Year-old male with a history of metastatic colorectal cancer
  - multiple pulmonary metastases
  - multi-disciplinary plan to treat with a combination of ablation, stereotactic radiation, and surgery
  - two central left upper lobe masses not amenable to ablative techniques

- Operative steps
  - Dissect posterior hilum and take posterior ascending artery branch
  - Take upper division venous branches
  - Take trunchus branch of artery
  - Take upper division bronchus
  - Divide parenchyma
Lingular-Sparing Upper Lobectomy (Tri-Segmentectomy)
Summary

- Lobectomy is currently the recommended resection for early-stage lung cancer
  - Evidence is increasing that a lesser resection may be adequate oncologic treatment for small stage IA NSCLC tumors.
  - Surgeons should generally be cautious when utilizing a sublobar resection for clinical stage IA NSCLC, but the therapy may be appropriate in select patients, particularly those with significant comorbidities or poor lung function.
  - Segmentectomy is likely the ideal sublobar treatment, as it likely leads to better lymph node assessment and wider margins than a non-anatomic wedge resection.
- Segmentectomy should be considered as an alternative to lobectomy if feasible for patients undergoing pulmonary metastasectomy
- Minimally invasive resection via VATS has been shown to be feasible with very low perioperative mortality.