VATS Versus Open Surgery for Lung Cancer Resection: Moving Toward a Minimally Invasive Approach

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Abstract
The use of video-assisted thoracoscopic surgery (VATS) has become the standard approach for the surgical resection of early-stage lung cancer. Although no large prospective, randomized, controlled trial has compared VATS lobectomy with thoracotomy, well-designed retrospective studies have consistently shown that VATS has comparable oncologic outcomes and is associated with fewer complications, reduced length of hospital stay, improvement in patient quality of life, and superior tolerance of adjuvant therapies. (J Natl Compr Canc Netw 2015;13:162–164)

Oncologic Outcomes
The acceptance of any new approach requires evidence that the results are comparable or superior to traditional techniques. Multiple studies have evaluated both locoregional recurrence and survival after VATS lobectomy. Shirasaki et al9 found no difference in disease-free or locoregional recurrence-free survival in clinical stage I lung cancers treated using VATS or thoracotomy. Similarly, Sugi et al,10 in a prospective randomized study of 100 consecutive patients with clinical stage IA non–small cell lung cancer treated with VATS or thoracotomy, detected no difference in recurrence or 5-year survival. For patients with more advanced-stage malignancies, Yamamoto et al11 and Yang et al12 reported, stage-for-stage, 5-year survivals that were similar for VATS and thoracotomy. Despite the evidence from the aforementioned studies, their retrospective nature and selection bias are often cited by critics. Recent meta-analyses, however, have pooled the results from thousands of patients and suggest not only oncologic equivalency, but also superiority in terms of 5-year survival rates.13,14 Several hypotheses might explain the survival superiority associated with VATS lobectomy, including a lower level of surgical trauma, which might be protective of the immune system, and the superior compliance with adjuvant chemotherapy.

Although the extent of the lymph node dissection that can be accomplished via VATS has been a matter of debate, the literature suggests equivalency. Watanabe et al15 compared systematic node dissection in 191 patients undergoing VATS versus 159 patients receiving thoracotomy, reporting no difference in adverse out-

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Submitted November 30, 2013; accepted for publication June 16, 2014.
The authors have disclosed that they have no financial interests, arrangements, affiliations, or commercial interests with the manufacturers of any products discussed in this article or their competitors.
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comes or the number of nodes removed. Likewise, a multi-institutional study from the NCCN Oncology Outcomes Database analyzed the adequacy of mediastinal lymph node dissection based on the number of N2 stations and the total number of nodes removed in patients undergoing either a VATS or thoracotomy. In this study, which captured practice patterns across 8 NCCN Member Institutions, a minimally invasive approach resulted in at least three N2 lymph node stations being dissected in 66% of the patients undergoing VATS lobectomy versus 58% in the thoracotomy group \((P = .12)\). In addition, no difference was seen in the median number of N1+N2 nodes resected for each group \((median 4; \ P = .06)\). Additionally, Boffa et al\(^\text{17}\) compared rates of upstaging in patients undergoing either VATS or thoracotomy, and concluded that both techniques resulted in comparable rates of mediastinal upstaging \((N0 to N2)\) at 5.0% and 4.9%, respectively.

### Quality of Life

Through avoiding rib spreading and the division of chest wall musculature, VATS not only minimizes pain but is also associated with fewer complications.\(^\text{18}\) In 2 large single-institution studies, VATS lobectomy was associated with fewer complications, shorter chest tube duration, and decreased length of stay compared with thoracotomy.\(^\text{5,19}\) Two subsequent reviews of the STS database confirmed that these results were applicable to the general thoracic community, particularly in patients with limited pulmonary function.\(^\text{10,21}\)

Patients undergoing VATS have been evaluated to assess their overall function and quality of life postoperatively. Nicasri et al\(^\text{22}\) collected data on 153 patients undergoing VATS lobectomy and found that only 27% of these individuals were taking narcotics after a median follow-up of 2 weeks. Handy et al\(^\text{23}\) analyzed functional outcomes in patients undergoing VATS versus open lobectomy using the Short Form-36 Health Survey and Ferrans and Powers Quality of Life Index, concluding that patients who underwent VATS had better preservation of preoperative performance status, less pain, and improved general health.

### Use of Chemotherapy and Radiation Therapy

A decline in functional status after surgery has the potential to limit patients’ tolerance of adjuvant therapies. Multiple studies have shown that chemotherapy is better tolerated after VATS lobectomy than after thoracotomy. Petersen et al\(^\text{24}\) analyzed 100 consecutive patients treated for lung cancer with lobectomy and adjuvant chemotherapy, and reported that, in all instances, patients undergoing VATS lobectomy had significantly fewer delayed \((18\% vs 58\%; \ P < .001)\) and reduced \((26\% vs 49\%; \ P = .02)\) doses. In addition, 61% of the patients undergoing VATS lobectomy received 75% or more of their planned adjuvant therapy versus 40% in the thoracotomy group \((P = .03)\). More recently, a report by the China Clinical Trials Consortium found that 62 of 67 patients undergoing VATS resection compared with only 53 of 67 of those undergoing thoracotomy received all 3 doses of adjuvant chemotherapy \((P < .01)\).

Because of the difficulty of hilar dissection after induction chemotherapy or radiation, many surgeons have been hesitant to use a VATS approach after induction chemotherapy and radiation therapy. Petersen et al\(^\text{25}\) reviewed 97 patients who underwent lobectomy via VATS or thoracotomy after induction therapy, and found that those undergoing VATS lobectomy had equivalent median survival with no significant increase in 30-day mortality, hemorrhage, pneumonia, or respiratory failure.

### Advantages in High-Risk Patients

Minimally invasive techniques are even more advantageous among the elderly and those with limited pulmonary function. Berry et al\(^\text{26}\) analyzed 338 patients older than 70 years undergoing lobectomy, and discovered that increasing age and the use of thoracotomy were significant predictors of morbidity, and that the use of thoracotomy was more predictive of complications than age. Likewise, Cattaneo et al\(^\text{27}\) reported improved morbidity after VATS lobectomy in elderly patients \((28\% vs 45\% \text{ with thoracotomy}; \ P = .04)\). In a more recent review of 12,000 patients who underwent VATS or open lobectomy collected from the STS database, Ceppa et al\(^\text{21}\) demonstrated that the incidence of at least 1 respiratory complication was lower in patients after VATS lobectomy. In addition, a significant difference was seen among those with a forced expiratory volume in the first second of expiration of less than 60%, with patients undergoing VATS having a significantly lower rate of pneumonia, need for reintubation, and adult respiratory distress syndrome compared with those who underwent thoracotomy.
Cost
Some contend that VATS may be associated with higher costs. In reality, as multiple studies have shown, the cost, initially at least, of longer operative times is offset by shorter hospital stays, fewer complications, and less frequent readmissions.\textsuperscript{29,30} A retrospective analysis of actual costs associated with thoracoscopic and open lobectomy was reported by Burffriend et al.\textsuperscript{29} In this study, 113 patients underwent lobectomy via thoracotomy or thoracotomy; cost and cost-utility analysis was performed using prospectively acquired quality-of-life measurements and calculating a quality-adjusted life-year for each patient. Total costs were significantly greater for the strategy of thoracotomy ($12,119) versus thoracotomy ($10,884; \textit{P}=0.0012). The use of minimally invasive techniques for the 50,000 lobectomies performed in the United States each year was estimated to represent a savings of approximately $100 million. Furthermore, Swanson et al.\textsuperscript{31} using the information collected from a national database of hospital claims, were able to demonstrate that hospital costs for VATS lobectomy were significantly lower than for open lobectomy ($20,316 vs $21,016; \textit{P}=0.027). Furthermore, when the authors then analyzed the adjusted hospital costs among “high-volume” VATS surgeons, the cost per case was even less, at $18,133.

Conclusions and Future Directions
During the past 20 years, multiple studies have shown that VATS is oncologically comparable (or perhaps superior) to thoracotomy, and it is clearly superior by many other measures. According to a recent report published by a panel of 55 experts in VATS lobectomy, this approach should be the standard of care for the resection of early-stage lung cancer except in certain clinical situations.\textsuperscript{32} Furthermore, the improved outcomes of thoracoscopic lobectomy will clarify the role of surgery in the multidisciplinary approach to lung cancer and influence the design of future clinical research.

References
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