Video-assisted thoracoscopic trisegmentectomy and left upper lobectomy provide equivalent survivals for stage IA and IB lung cancer

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Objectives: Despite a trend toward sublobar resections for lung cancers, some question the adequacy of limited resections in the treatment of lung cancer and questions remain about performing these procedures by video-assisted thoracoscopic surgery (VATS). We compared the survival for lung cancers treated with VATS segmentectomy versus VATS lobectomy.

Methods: VATS segmentectomy and lobectomy for both malignant and benign lung pathology are reviewed from a single institution.

Results: Between 1998 and 2010, 73 VATS trisegmentectomies were performed in 49 women and 24 men (mean age, 72 years). Diagnoses included primary lung cancer (91%), benign disease (4%), and metastatic disease (5%). Primary lung cancers were 68% for stage IA, 17% for stage IB, and 15% for stage II-IV. Seventy-three left upper lobe (LUL) trisegmentectomies were performed. Mean hospital stay after VATS trisegmentectomy was 3.8 days, versus 5.5 days after VATS LUL lobectomy ($P = .0736$). Complication rates for trisegmentectomy group (37%) and lobectomy (17%; $P > .05$) were not statistically different. Survival after VATS trisegmentectomy and LUL lobectomy for either stage IA lung cancer or stage IB lung cancer was not statistically significant.

Conclusions: Segmentectomy can be performed by VATS with no greater morbidity and mortality than with VATS lobectomy. LUL trisegmentectomy provides the same survival as lobectomy for stage IA and IB tumors. Our experience supports the use of lingular-sparing trisegmentectomy in the treatment of stage IA and IB lung cancer. (J Thorac Cardiovasc Surg 2012;144:S23-6)

Anatomic lung resection for lung cancer has traditionally involved lobectomy and node dissection.¹ The shift to this lesser resection was a natural progression from pneumonectomy, the previous criterion standard for the treatment of lung cancer. As this desire to perform lesser resections while maintaining oncologic principles continues to evolve, surgeons have probed into the use of anatomic segmental resections for small lung cancers (<2 cm)^{2,3}; however, most of these studies have looked at node-negative tumors of stage IA.⁴⁻⁶

Additionally, there are newer options to the surgical approach in the performance of anatomic segmentectomy. Video-assisted thoracoscopic surgery (VATS) has presented itself as an alternative approach to the open technique. VATS has been demonstrated to be associated with shorter

stay, faster recovery, and greater ability for the patient to tolerate adjuvant therapy, thus allowing more complete delivery of adjuvant therapy.^{7,8}

The literature is not as robust when it comes to stage IB tumors.⁹ Some have postulated that increasing the amount of lung parenchyma taken and thus extending the surgical margins could overcome the increased recurrence risk imposed by the larger tumor size.^{9,10}

There remain questions regarding the applicability of segmentectomy in patients with lung cancer. In this article we review our experience with the largest single-institution series of VATS anatomic segmentectomy and VATS lobectomies to date and evaluate hospital stay as well as cancer outcomes.

MATERIALS AND METHODS

Patients

Approval for this study was provided by the institutional review board of Cedars-Sinai Medical Center (approval 4267). A retrospective review of a prospectively gathered data base was performed. We identified 149 consecutive VATS segmentectomies performed at our institution from 1998 to 2010. Diagnoses included primary lung cancer, benign disease, and metastatic disease. The primary lung cancers included stage IA, stage IB, and stage II and greater.

We compared the results of 73 VATS trisegmentectomies for stage IA ($n = 45$) and IB ($n = 11$) lung cancer at our institution with 266 VATS left upper lobe (LUL) lobectomies for stage IA ($n = 105$) and IB ($n = 73$) lung cancer performed during the same period at our institution.

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Disclosures: Authors have nothing to disclose with regard to commercial support. Presented at the 3rd International Minimally Invasive Thoracic Surgery Summit, Boston, Massachusetts, October 7-8, 2011.

Received for publication Nov 14, 2011; revisions received April 18, 2012; accepted for publication May 18, 2012.

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0022-5223/\$36.00

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doi:10.1016/j.jtcvs.2012.05.071

Operative Technique

Under single-lung anesthesia, the VATS lobectomies and segmentectomies were anatomic dissections with individual ligation of the vessels and bronchi. A 5-mm trocar for the 5-mm, 30° thoracoscope was placed through the 8th intercostal space in the midaxillary line. A 2-cm incision was made in the 6th intercostal space in the midclavicular line. A utility incision was made directly lateral from the vein for upper and middle lobectomies, or 1 intercostal space lower for lower lobectomies. This incision started on the anterior border of the latissimus muscle and extended anteriorly for 4 to 6 cm. In some cases, another 1-cm incision was made in the auscultatory triangle.¹¹ Lymph nodes were either sampled or dissected.

Statistical Analysis

Segmentectomy and lobectomy cohorts were compared with respect to clinical, pathologic, and demographic findings. The Student *t* test was used to compare morbidity rates and stays, and χ^2 tests were used to calculate probability distributions (*P* values). Kaplan-Meier survival curves with log-rank test were used to compare survival distributions between the segmentectomy and lobectomy arms and to detect trends in survival, and the associated *P* value. Values are mean $\pm$ SD.

RESULTS

The average age of patients treated with trisegmentectomy was 72 years. Sex distribution was 49 female and 24 male patients.

Mean hospital stay for patients undergoing VATS trisegmentectomy was 3.8 ± 3.3 days, versus 5.5 ± 7.9 days for VATS LUL lobectomy (*P* = .0736).

Seventy-three LUL trisegmentectomies were performed. Diagnoses for the trisegmentectomies included primary lung cancer (91%; 66/73), benign disease (4%; 3/73), and metastatic disease (5%; 4/73). Of the VATS trisegmentectomies for primary lung cancers, 68% (45/66) were for stage IA disease, 17% (11/66) were for stage IB disease, and 15% (10/66) were for stage II and greater disease.

In the trisegmentectomy group, the complication rate was 37% (*n* = 27), versus 17% (*n* = 44) for VATS LUL lobectomy (*P* > .05). There was no statistical difference in overall complication rate between the groups (Table 1).

Survival

There was no difference in survival between patients undergoing VATS trisegmentectomy and those undergoing LUL lobectomy for either stage IA lung cancer or stage IB lung cancer (Figures 1-3).

DISCUSSION

There is a long history of segmentectomy for pulmonary disease. Churchill and Belsey¹² reported performing a segmentectomy for bronchiectasis in 1939, and Jensik and colleagues¹³ reported a 15-year experience of segmentectomy for lung cancer in 1973. In the 1980s, the Lung Cancer Study Group demonstrated a 20% better survival for patients who underwent a lobectomy rather than a sublobar resection.^{1,14} Because of this disparity, lobectomy has been adopted as the criterion standard and is the most common

TABLE 1. Comparison of the complications for trisegmentectomies and left upper lobectomies

Complications	Trisegmentectomy		Left upper lobectomy	
	n	%	n	%
Air leak	10	13.7	13	4.9
Atrial fibrillation	6	8.2	9	3.4
Urinary retention	2	2.7	0	0
Perioperative mortality	1	1.4	2	0.8
Pneumonia	1	1.4	2	0.8
Subcutaneous emphysema	1	1.4	2	0.8
Conversion to thoracotomy	1	1.4	0	0
Recurrent laryngeal nerve damage	1	1.4	0	0
Pain	1	1.4	0	0
Wound infection	1	1.4	0	0
Syncope	1	1.4	0	0
Bradycardia	1	1.4	0	0
Bleeding	0	0	3	1.1
Readmission	0	0	4	1.5
Empyema	0	0	1	0.4
Bronchopleural fistula	0	0	1	0.4
Atelectasis	0	0	1	0.4
Urinary tract infection	0	0	1	0.4
Myocardial infarction	0	0	2	0.8
Pneumothorax	0	0	1	0.4
Cerebrovascular accident	0	0	1	0.4
Splenic injury	0	0	1	0.4
None	46	63	222	83.5
Total	73	100	266	100.0
Complication rate	27	37	44	17

For comparison of overall complication rate, *P* > .05.

option in the surgical treatment of lung cancer. Lesser resections are being revisited, however, as a result of screening and earlier diagnosis, with the finding of smaller and earlier lung tumors. Beginning in the 1990s, reports have suggested that anatomic segmentectomy may result in survival as good as that of lobectomy in the

FIGURE 1. The Kaplan-Meier curves compare the overall survivals for patients who underwent trisegmentectomy (TRISEG) and left upper lobectomy (LUL LOBE). There is no difference in overall survival between the patient populations.

FIGURE 2. The Kaplan-Meier curves compare the overall survivals for patients who underwent trisegmentectomy (TRISEG) and left upper lobectomy (LUL LOBE) for stage IA lung cancer. There is no difference in survival between trisegmentectomy and left upper lobectomy for stage IA, NSCLC; Non-small cell lung cancer.

treatment of lung cancer,¹⁵⁻¹⁷ with better functional results.¹⁸ Additionally, Watanabe and coworkers¹⁹ showed that a node dissection by VATS is as good as the node dissection performed by thoracotomy.

Minimally invasive (VATS) lobectomy is now well established. Relative to a thoracotomy, a VATS approach to lobectomy has been shown to provide reduced morbidity and mortality,²⁰⁻²² shorter stay,²³ less pain,²⁴ earlier recovery,^{24,25} lower cost,²⁶ better pulmonary function,²⁷ less impact on the immune system,²⁸ and a better chance of receiving planned adjuvant chemotherapy.²⁹ The significant benefits for VATS were summarized nicely in a meta-analysis by Cheng and colleagues.³⁰

With the benefit of lobectomy by VATS compared to thoracotomy firmly established, the question remains, what about VATS segmentectomy?

FIGURE 3. The Kaplan-Meier curves compare the overall survivals for patients who underwent trisegmentectomy (TRISEG) and left upper lobectomy (LUL LOBE) for stage IB lung cancer. There is no difference in survival between trisegmentectomy and left upper lobectomy for stage IB, NSCLC; Non-small cell lung cancer.

A few small series of VATS segmentectomies have been reported.³¹⁻³³ When comparing 48 VATS and 29 open segmentectomies, Atkins and coworkers³¹ found no difference in morbidity, but hospital stay (mean, 4.3 vs 6.8 days) and mortality (0% vs 6.9%) favored VATS. When comparing 104 VATS and 121 open segmentectomies, Schuchert and colleagues³² found no difference in morbidity and mortality, but hospital stay favored VATS (median, 5 vs 7 days).

How does VATS segmentectomy compare with VATS lobectomy? In our series, VATS segmentectomy compares favorably with VATS lobectomy.

The biggest concern for a cancer operation is survival rates. In our series, the overall survival was the same for the segmentectomies and the lobectomies. That survival can be affected by many factors, including staging and comorbidities. The comparison of segmentectomy versus lobectomy was most illuminating for LUL cancers. The survival related to the treatment of stage IA and IB tumors was just as good for segmentectomy as for lobectomy.

Our findings are consistent with other published literature. In a comparison of lobectomy with sublobar resection, Warren³⁴ showed better survival with lobectomy. There was a significantly higher local recurrence rates for sublobar resections, especially for tumors larger than 3 cm (T2 tumors). In a comparison of VATS segmentectomy versus open segmentectomy, Atkins and coworkers³¹ found a significantly better survival for VATS; however, the mean tumor size in the VATS cases was 2.1 cm, versus 3.1 cm in the open cases. This is consistent with the difference in survival by stage, rather than any difference in VATS versus open surgery.

In summary, segmentectomy can be performed by VATS with no more morbidity or mortality than that seen with VATS lobectomy. Transecting parenchyma for the segmentectomy does not translate into a longer stay than after lobectomy. The lingular need not be resected for small apical lung cancers, because LUL trisegmentectomy provides the same survival as lobectomy for stage IA and IB tumors. Our experience supports the use of lingular-sparing trisegmentectomy in the treatment of IA and IB lung cancer.

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