Lymph Node Evaluation Achieved by Open Lobectomy Compared With Thoracoscopic Lobectomy for N0 Lung Cancer

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Background. **Controversy remains regarding the adequacy of the lymph node evaluation achieved by video-assisted thoracic surgery (VATS) lobectomy for lung cancer. This study compared the completeness of the lymph node dissection or sampling for patients undergoing lobectomy by open thoracotomy vs VATS for clinical N0 lung cancer.**

Methods. **This study was a retrospective review of 129 patients who underwent lobectomy for clinical N0 lung carcinoma from December 2008 to January 2012.**

Results. **Lobectomy was an open procedure in 69 patients (53.5%) and by VATS in 60 (46.5%). The VATS and open groups were well matched for age ($p = 0.50$) and forced expiratory volume in 1 second percentage predicted ($p = 0.16$). The mean pathologic tumor sizes were not significantly different (2.9 ± 0.26 vs 3.4 ± 0.25 cm, respectively; $p = 0.14$). The mean number of nodes dissected in the open group was significantly higher (14.7 ± 1.3 vs. 9.9 ± 0.8 nodes; $p = 0.003$). In the open lobectomy group, 24.6% of the patients were upstaged to pathologic N1 or N2 compared with 10% in the VATS group ($p = 0.05$). The Kaplan-Meier 3-year survival was similar between the groups.**

Conclusions. **In our hands, significantly more lymph nodes were dissected, and a higher percentage of patients were upstaged to N1/N2, during open lobectomy compared with VATS lobectomy in patients with clinical stage N0 lung cancer. Although this did not translate into improved survival at 3 years, concern is raised about the adequacy of lymph node dissection during VATS lobectomy.**

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Lung carcinoma remains the leading cause of cancer-related death in North America [1]. Most commonly, patients with clinical stage I non-small cell lung carcinoma (NSCLC) are managed with lobectomy and lymph node sampling or lymphadenectomy through an open thoracotomy incision. In recent years, video-assisted thoracic surgery (VATS) lobectomy has emerged as the technique of choice at some centers for patients with stage I NSCLC. Multiple studies analyzing the results of VATS lobectomy have established with reasonable certainty the advantages of less postoperative pain, less postoperative morbidity, and shorter hospital stay compared with open lobectomy [2–5].

Despite the purported benefits of VATS lobectomy, there have been conflicting reports on the adequacy of the lymph node dissection or sampling achieved during VATS lobectomy compared with open lobectomy. A number of authors have demonstrated no difference in the completeness of lymph node sampling or dissection for VATS lobectomy compared with open lobectomy [6–8]. In contrast, Denlinger and colleagues [9] demonstrated that VATS lobectomy was associated with fewer mediastinal lymph nodes being dissected compared with open lobectomy [9]. In a large The Society of Thoracic Surgeons database review of 11,500 patients, Boffa and colleagues [10] reported that VATS lobectomy had a lower rate of N1 upstaging, which may serve as a surrogate for completeness of lymph node evaluation [10].

Noninvasive staging modalities for lung carcinoma, such as computed tomography (CT) and positron-emission tomography (PET), have limited sensitivity and specificity in identifying lymph node metastasis. The importance of complete surgical nodal staging during lobectomy cannot be overemphasized, given the proven benefit of adjuvant chemotherapy in patients with node-positive lung carcinoma [11–13]. Furthermore, there is little doubt that complete surgical removal of lymph nodes with malignant involvement provides an improved chance for cure.

Given this background, we compared the completeness of the lymph node evaluation/excision in our hands during VATS lobectomy and open lobectomy in patients with clinical N0 NSCLC. We also determined the rate of nodal upstaging to N1 or N2 and the 3-year survival rates between the two groups.

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Abbreviations and Acronyms

ACSOG = American College of Surgeons Oncology Group
CAD = coronary artery disease
COPD = chronic obstructive pulmonary disease
CT = computed tomography
FEV_1 = forced expiratory volume in 1 second
NSCLC = non-small cell lung cancer
PET = positron emission tomography
SD = standard deviation
VATS = video-assisted thoracoscopic surgery

Patients and Methods

The Stanford University Institutional Review Board approved this study protocol. A waiver for informed consent was granted, and patient information was protected. This is a retrospective review of 129 patients who underwent lobectomy for clinical N0 lung carcinoma from December 2008 to January 2012. Patient demographics, progress notes, imaging studies, operative reports, discharge summaries, and pathology reports were obtained from the electronic medical records, clinic records, and the Division of Thoracic Surgery's prospective database.

The study excluded patients who underwent lobectomy for carcinoid tumors, secondary lung carcinoma, or benign diagnoses and those who underwent induction therapy, chest wall resection, sleeve resection, sublobar resection, or pneumonectomy. Importantly, patients with clinically suspected N1 or N2 nodal metastasis were also excluded on the basis of any lymph node with shortest diameter greater than 1 cm on CT scan or a standardized uptake value maximum greater than 2.5 on a PET scan. All patients underwent CT scans and all except 1 patient in each group underwent preoperative PET/CT. Patients were classified as clinical T1a N0, T1b N0, T2a N0, T2b N0, or T3 N0 according to the current NSCLC classification system [14].

The selection of VATS vs open lobectomy operative technique was at the discretion of the individual surgeon. We usually offer VATS lobectomy for patients with peripheral lung tumors that are 3 cm or smaller and without evidence of N2 nodal disease on imaging or mediastinoscopy. A routine lymph node evaluation was performed in every patient; however, the decision to perform a complete lymph node dissection vs a lymph node sampling was the choice of the individual surgeon. Lymph node stations that were typically sampled or dissected were 4R, 7, 11R, 10R, and 9R for right-sided procedures and 5, 6, 11L, 7, 10L, and 9L for left-sided procedures.

The VATS lobectomy procedures were performed using two or three 1-cm to 2-cm incisions and an anterior access incision no larger than 6 cm in length, without rib-spreading, as described in the Cancer and Leukemia Group B 39802 study [15]. The fissure is typically divided as the final step during VATS lobectomy, which is described as the "fissure-less" technique. When the fissure is complete in some cases, the pulmonary artery branches are dissected and divided initially.

Patient demographic data collected included age, sex, comorbidities, preoperative forced expiratory volume in 1 second percentage predicted, pack-years of smoking, and clinical stage. Postoperative complications recorded included pneumonia, respiratory failure, prolonged air leak ($>$ 5 days), atrial fibrillation, myocardial infarction, and pulmonary embolism. A postoperative death was recorded if it occurred within 30 days of the procedure or in the hospital before discharge home.

The number of hilar and mediastinal lymph nodes that were removed at the time of lobectomy was recorded from the final pathology report. Additional lymph nodes that were removed from the lobectomy specimen by the pathologist were also included in the lymph node count. The same core group of pathologists reviewed all of the pathology specimens in the VATS and open lobectomy groups. Lymph nodes that were collected in fragments were usually counted as a single node from the respective nodal station; however, some fragmented nodes could possibly have been counted as single nodes in the VATS or open lobectomy groups. Nodal upstaging was reported as the percentage of patients who were found to have lymph node metastasis in the surgical specimen after being clinically staged as N0 based on preoperative CT and PET scans and upon mediastinoscopy in those patients who underwent mediastinoscopy.

Categoric variables were analyzed with the χ^2 test and continuous variables with an unpaired t test. Arithmetic mean values are reported with the standard error of the means. The overall survival rates of the VATS and open lobectomy groups were estimated by the Kaplan-Meier method. The statistical analyses were performed using MedCalc software (MedCalc Software, Mariakerke, Belgium). Differences were considered significant when the probability of a false-positive result was 0.05 or less. The biostatistics department at Stanford University was consulted for review of statistical methods.

Results

From December 2008 to January 2012, 129 patients underwent lobectomy for clinical N0 lung carcinoma at Stanford University Hospital; of these, 69 (53.8%) underwent open lobectomy and 60 (46.2%) underwent VATS lobectomy. In the open lobectomy group, 18 (26%) underwent preoperative mediastinoscopy—nearly identical to the 15 (25%) in the VATS lobectomy group ($p = 0.94$).

The preoperative patient characteristics are listed in Table 1. There were no statistically significant differences between the groups on any of the examined variables. The clinical stage of the patients based on CT and PET scans and selective mediastinoscopy is listed in Table 2. The VATS lobectomy group had slightly more T1 lung carcinomas than the open lobectomy group (68.3% vs 52.2%; $p = 0.09$) and slightly fewer T2 ($p = 0.27$) and T3