Thoracoscopic lobectomy is associated with lower morbidity than open lobectomy: A propensity-matched analysis from the STS database

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Background: Several single-institution series have demonstrated that compared with open thoracotomy, video-assisted thoracoscopic lobectomy may be associated with fewer postoperative complications. In the absence of randomized trials, we queried the Society of Thoracic Surgeons database to compare postoperative mortality and morbidity following open and video-assisted thoracoscopic lobectomy. A propensity-matched analysis using a large national database may enable a more comprehensive comparison of postoperative outcomes.

Methods: All patients having lobectomy as the primary procedure via thoracoscopy or thoracotomy were identified in the Society of Thoracic Surgeons database from 2002 to 2007. After exclusions, 6323 patients were identified: 5042 having thoracotomy, 1281 having thoracoscopy. A propensity analysis was performed, incorporating preoperative variables, and the incidence of postoperative complications was compared.

Results: Matching based on propensity scores produced 1281 patients in each group for analysis of postoperative outcomes. After video-assisted thoracoscopic lobectomy, 945 patients (73.8%) had no complications, compared with 847 patients (65.3%) who had lobectomy via thoracotomy ($P < .0001$). Compared with open lobectomy, video-assisted thoracoscopic lobectomy was associated with a lower incidence of arrhythmias [n = 93 (7.3%) vs 147 (11.5%); $P = .0004$], reintubation [n = 18 (1.4%) vs 40 (3.1%); $P = .0046$], and blood transfusion [n = 31 (2.4%) vs n = 60 (4.7%); $P = .0028$], as well as a shorter length of stay (4.0 vs 6.0 days; $P < .0001$) and chest tube duration (3.0 vs 4.0 days; $P < .0001$). There was no difference in operative mortality between the 2 groups.

Conclusions: Video-assisted thoracoscopic lobectomy is associated with a lower incidence of complications compared with lobectomy via thoracotomy. For appropriate candidates, video-assisted thoracoscopic lobectomy may be the preferred strategy for appropriately selected patients with lung cancer. (J Thorac Cardiovasc Surg 2010;139:366-78)

Thoracoscopic lobectomy, also referred to as video-assisted thoracoscopic surgery (VATS) lobectomy, is associated with many outcome advantages compared with lobectomy by thoracotomy.[1-11] Recently, it has been proposed that surgical outcomes are superior with thoracoscopic lobectomy, based on analysis of postoperative complications in single institutional series.[12-14] However, to date there is no large randomized trial comparing VATS lobectomy to lobectomy by thoracotomy.

In the absence of robust data from phase III trials, we queried the Society of Thoracic Surgeons (STS) General Thoracic Database (STS-GTD) to compare the postoperative mortality and morbidity following open and thoracoscopic lobectomy. A propensity-matched analysis using a large national database may enable a more powerful and comprehensive comparison of postoperative outcomes.

PATIENTS AND METHODS

Data Source

The STS has maintained a prospective database of patients having cardiothoracic surgery in the United States since 1987 with the database expanded in 1999 to include general thoracic surgery operations. At the time of the latest report, there were more than 80 participating sites (hospitals, group practices, or individual surgeons). Harvested data are maintained and analyzed by the Duke Clinical Research Institute in compliance with the Health Insurance Portability and Accountability Act of 1996. Variables are collected on a standardized data form that includes information about patient demographics, medical history, surgical procedures, cancer staging, and outcome (http://www.ctsnet.org/file/ThoracicDCFV2_07_Nonannotated.pdf). Institutional Review Boards of each participating site approved the use of this database for quality improvement research. The collection and maintenance of the general thoracic surgery portion of the database has been described elsewhere.[15,16]

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Abbreviations and Acronyms

STS = Society of Thoracic Surgeons
STS-GTD = Society of Thoracic Surgeons General Thoracic Database
VATS = video-assisted thoracoscopic surgery

Patient Population

The study population consists of patients having lobectomy as the primary procedure at STS-participating hospitals between January 1, 2002, and December 31, 2007. All data were collected using STS-GTSD 1.30, 1.31, 2.06, 2.061, and 2.07 data collection forms. Patients were excluded from the study if they had prior thoracic surgery, a pulmonary procedure other than lobectomy, an approach other than thoracoscopy and thoracotomy was listed, if both thoracoscopy and thoracotomy were listed as the approach, and if data were missing on age (6 patients, 0.13% excluded from analysis) and gender (17 patients, 0.27% excluded from analysis). Six thousand three hundred twenty-three patients were identified (5042 having thoracotomy, 1281 having thoracoscopy; Appendix Table 1). The distribution of techniques used for lobectomies performed during that time interval is shown in Figure 1.

Data Collection and Statistical Model

Data collected for each patient included continuous variables [age at time of surgery, body mass index with missing values (9.2% missing) entered according to gender-specific median values, forced vital capacity as a percent of predicted with missing values (27.11% missing) entered according to median values, forced expiratory volume in 1 second as a percent of predicted with missing values (22.81% missing) entered according to median values, carbon monoxide diffusing capacity as a percent of predicted with missing values (42.15% missing) entered according to median values]; binary variables (0% missing) with all missing values defaulted to ''no'' per the STS database [hypertension, preoperative thoracic radiation therapy, congestive heart failure, coronary artery disease, peripheral vascular disease, preoperative steroid use steroid, current smoker (patient smokes or quit less than 1 month), cerebrovascular disease, diabetes, and renal insufficiency (dialysis or creatinine level greater than 2)]; and categorical variables [Zubrod score (5.05% missing), American Society of Anesthesiologists Risk Scale (7.92% missing), status (clinical status of the patient at the time of the primary surgical procedure; 3.67% missing), and clinical (43% missing) and pathologic cancer stage (23% missing)]. Clinical stage was not included in the model due to the significant amount of missing data. Missing data variables were treated as above to limit the introduction of bias by their exclusion.

Propensity scores were estimated using a logistic model including the following variables: age, gender, Zubrod score, American Society of Anesthesiologists Risk Scale, body mass index, hypertension, coronary artery disease, congestive heart failure, renal insufficiency, diabetes, current smoker, preoperative chemotherapy or radiotherapy, cerebrovascular disease, steroid use, clinical status, forced vital capacity as a percent of predicted, forced expiratory volume in 1 second as a percent of predicted, and carbon monoxide diffusing capacity as a percent of predicted. Patients were then matched using a Greedy 5 to 1 digit matching algorithm.[17] Missing values in Zubrod score, American Society of Anesthesiologists Risk Scale, and clinical status were kept as separate levels. Standardized difference $[(X_2 - X_1)/((S_2^2 + S_1^2)/2)^{1/2}$, where X_1 and X_2 are samples means in the thoracotomy and groups, respectively, and $S_2^2 + S_1^2$ are the sample standard deviations] was used to assess significance in differences of preoperative variables as well as clinical and pathologic staging between the 2 groups (>20 and <−20 being significantly different). Standardize difference was used rather than *P* value as it has been shown by others to not be sensitive to sample size, as *P* value is, and hence better for propensity matching.[18] Matching based on propensity scores produced 1281 patients in each group for analysis of postoperative outcomes (Table 1). Postoperative outcomes analyzed for each group were assessed for significance (*P* values) based on McNemar tests (matched comparison) or Pearson chi-square (unmatched comparison) for categorical outcomes and Wilcoxon signed–rank tests for continuous outcomes with significance adjusted for Bonferroni correction where needed (Table 2). Postoperative outcomes as well as clinical and pathologic staging of the unmatched cohort of 6323 patients can be found in the appendix for comparison (Appendix Tables 2–5). Analysis was performed using S-Plus 6 (Insightful Corp, Seattle, WA) and SAS 9.1 (SAS Institute, Cary, NC).

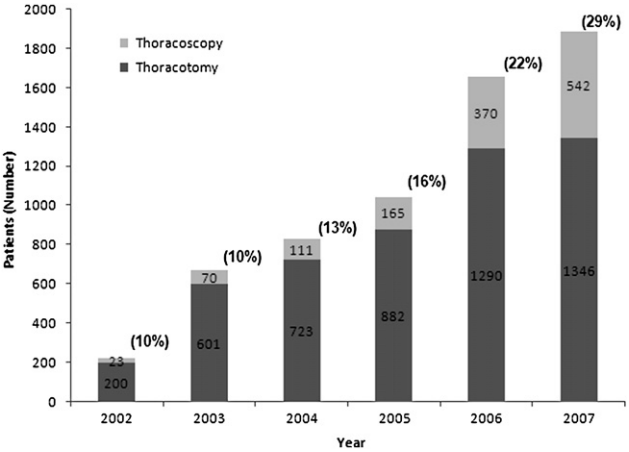

FIGURE 1. Lobectomy by thoracotomy or thoracoscopy by year in Society of Thoracic Surgeons (STS) general thoracic database.

RESULTS

Patient Characteristics

The baseline characteristics of the 1281 patients in each group who were derived by propensity matching from the initial cohort of 6323 patients are shown in Table 1. A total of 83 centers participating in the STS-GTD contributed patients to these matched groups (70 having VATS, 83 having thoracotomy). The contribution from each center can be found in Appendix Table 2. As designed, the baseline characteristics of the 2 cohorts are statistically similar for the preoperative variables used for propensity matching.

The clinical and pathologic stages for the matched cohorts are shown in Table 2. Clinical staging information was missing in a large number of patients in both groups including 430 patients (33.6%) who had VATS lobectomy and 591 patients (46.1%) who had an open lobectomy. There was no statistically significant difference in the pathologic stage distribution between the 2 groups, with the majority of lobectomies performed for pathologic stage I disease. Thus, although clinical and pathologic stages were not included in the propensity matching analysis, the final pathologic stage distribution in the 2 groups is similar.

Perioperative Mortality and Morbidity

Analysis of the propensity-matched groups for postoperative outcomes demonstrated that VATS lobectomy was associated with significantly lower morbidity: 945 patients