Thoracoscopic Lobectomy

Increasingly, evidence suggests that thoracoscopic lobectomy can be performed with similar, if not reduced, morbidity and equivalent oncologic outcomes when compared with open lobectomy [1-5]. Despite the potential advantages of minimally invasive surgery, only 20% of pulmonary resections are currently completed in the United States using the thoracoscopic technique [6]. There are still several potential barriers to adoption of thoracoscopic lobectomy. The belief that pulmonary artery bleeding would be uncontrollable thoracoscopically is an obstacle that is likely to dissuade surgeons from considering learning thoracoscopic lobectomy. Most practicing thoracic surgeons in Asia, Europe and North America completed their training prior to the advent of thoracoscopic lobectomy, and post-graduate training is an extensive process. While it is probable that most training programs in Thoracic Surgery provide exposure to thoracoscopic lobectomy, it is unknown what the actual operative experience is for residents and fellows.

Recently, single and multi-institutional studies have demonstrated thoracoscopic lobectomy as an accepted oncologic procedure for patients with early stage lung cancer [2-5]. Thoracoscopic lobectomy has been demonstrated to decrease morbidity, including shorter length of stay, shorter chest tube duration, decreased post-operative pain, improved preservation of pulmonary function, reduced inflammatory response and shorter recovery time when compare to conventional thoracotomy [6-9]. In addition, it has been demonstrated the thoracoscopic lobectomy is a safer procedure than lobectomy by thoracotomy, as it is associated with fewer postoperative complications [3, 4, 10].

ADVANCED TECHNIQUES

As comfort and facility with thoracoscopic lobectomy increases, it is being more readily applied to more complex cases and surgical interventions, including sleeve lobectomy [11, 12] and segmentectomy [13-15]. While there have not been studies that demonstrate advantages of these thoracoscopic techniques compared to the conventional procedures, it is probable that the avoidance of rib spreading and the use of modern thoracoscopic techniques will confer similar advantages, such as less pain, fewer air leaks, shorter length of stay, and a lower rate of complications.

OUTCOMES

Using a prospective database, the outcomes of patients who underwent lobectomy at Duke from 1999-2009 were analyzed with respect to postoperative complications [3]. Propensity-matched groups were analyzed, based on preoperative variables and stage. Of the 1079 patients in the study, 697 underwent thoracoscopic lobectomy and 382 underwent lobectomy by thoracotomy. In the overall analysis, thoracoscopic lobectomy was associated with a lower incidence of prolonged air leak (p=0.0004), atrial fibrillation (p=0.01), atelectasis (p=0.0001), transfusion (p=0.0001), pneumonia (p=0.001), sepsis (p=0.008), renal failure (p=0.003), and death (p=0.003). In the propensity-matched analysis based on preoperative variables, comparing 284 patients in each group, 196 patients (69%) who underwent thoracoscopic lobectomy had no complications, versus 144 patients (51%) who underwent thoracotomy (p=0.0001). In addition, thoracoscopic lobectomy was associated with fewer prolonged air leaks (13% vs 19%; p=0.05), a lower incidence of atrial fibrillation (13% vs 21%; p=0.01), less atelectasis (5% vs 12%;

p=0.006), , fewer transfusions (4% vs 13%; p=0.002), less pneumonia (5% vs 10%; p=0.05), less renal failure (1.4% vs 5%; p=0.02), shorter chest tube duration (median 3 vs 4 days; p<0.0001) and shorter length of hospital stay (median 4 vs 5 days; p<0.0001) [3].

Similar results were obtained when the STS database was analyzed by Paul and colleagues [4]. All patients undergoing lobectomy as the primary procedure via thoracoscopy or thoracotomy were identified in the STS database from 2002-2007. After exclusions, 6323 patients were identified: 5042 thoracotomy, 1281 thoracoscopy. A propensity analysis was performed, incorporating preoperative variables, and the incidence of postoperative complications was compared. Matching based on propensity scores produced 1281 patients in each group for analysis of postoperative outcomes. After VATS lobectomy, 945 patients (73.8%) had no complications, compared to 847 patients (65.3%) who had lobectomy via thoracotomy (p<0.0001). Compared to open lobectomy, VATS lobectomy was associated with a lower incidence of arrhythmias [n=93 (7.3%) vs. 147 (11.5%); p=0.0004], reintubation [n=18 (1.4%) vs. 40 (3.1%); p=0.0046], and blood transfusion [n=31 (2.4%) vs. n=60 (4.7%); p=0.0028], as well as a shorter length of stay (4.0 vs. 6.0 days; p<0.0001) and chest tube duration (3.0 vs. 4.0 days; p<0.0001). There was no difference in operative mortality between the two groups [4].

Berry and colleagues reported a recent analysis of high-risk patients over 70 years of age [16]. During the study period, 338 patients older than 70 years (mean age 75.7±0.2) underwent lobectomy (219 thoracoscopy, 119 thoracotomy). Operative mortality was

3.8% (13 patients) and morbidity was 47% (159 patients). Patients with at least one complication had increased length of stay (8.3±0.6 vs 3.8±0.1 days; $p<0.0001$) and mortality [6.9% (11 of 159) vs 1.1% (2 of 179); $p=0.008$]. Significant predictors of morbidity by multivariable analysis included age (odds ratio 1.09; $p=0.01$) and thoracotomy as surgical approach (odds ratio 2.21; $p=0.004$). Thoracotomy remained a significant predictor of morbidity when the propensity to undergo thoracoscopy was considered (odds ratio 4.9; $p=0.002$) [16].

Finally, the role of thoracoscopic lobectomy was analyzed in patients with poor pulmonary function: DLCO or FEV1 ≤ 60% predicted [17]. In this study, 342 patients with (mean % predicted FEV1 55.2±0.9, mean % predicted DLCO 60.9±0.9) underwent lobectomy (173 thoracoscopy, 169 thoracotomy). Operative mortality was 5.0% (17 patients) and overall morbidity was 48.5% (166 patients). Pulmonary complications occurred in 57 patients (16.7%), and significant predictors of respiratory complications by multivariable analysis for all patients included DLCO (odds ratio 1.03,$p=0.003$), FEV1 (odds ratio 1.04,$p=0.003$) and thoracotomy as surgical approach (odds ratio 3.46,$p=0.0007$). When patients were analyzed separately according to operative approach, DLCO and FEV1 remained significant predictors of respiratory morbidity for patients undergoing thoracotomy but not thoracoscopy [17].

Administration of Adjuvant Chemotherapy

One of the most promising advantages associated with thoracoscopic lobectomy relates to the ability of patients to tolerate adjuvant therapy. In a recent study, the ability to deliver adjuvant chemotherapy was compared in 100 patients who underwent complete resection for NSCLC, by either thoracotomy or thoracoscopy [18]. Those undergoing thoracoscopic lobectomy had significantly fewer delayed (18% versus 58%; $p < 0.001$) and reduced (26% versus 49%; $p = 0.02$) chemotherapy doses. A higher percentage of patients undergoing thoracoscopic resection received 75% or more of their planned adjuvant regimen without delayed or reduced doses (61% versus 40%; $p = 0.03$). A separate group also looked at adjuvant chemotherapy received after VATS and noted that 85% of patients received all cycles of planned chemotherapy, with or without some delay [19]. Although long-term survival was not an end-point of either of these studies, similar differences in chemotherapy administered for other tumor types are associated with improved survival.

SUMMARY

Thoracoscopic lobectomy has become an accepted, safe, oncologically sound procedure when compared to open lobectomy, and should now be considered the gold standard for patients with early stage lung cancer [20]. A number of studies have demonstrated that it reduces the length of stay, post-operative pain, and post-operative complications, including air leaks. While there are specific technical considerations which must be taken into account, it is increasingly becoming the preferred method of anatomic lobectomy. Surgeons should be encouraged to embrace the minimally invasive strategy, which may be learned in courses using novel simulation techniques [21]. Future directions suggest that this technique will be expanded to address even the most challenging thoracic procedures.

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