Feasibility of hybrid thoracoscopic lobectomy and en-bloc chest wall resection†

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Abstract

OBJECTIVES: Lobectomy with an en-bloc chest wall resection is an effective but potentially morbid treatment of lung cancer invading the chest wall. Minimally invasive approaches to lobectomy have reduced morbidity compared with thoracotomy for early stage lung cancer, but there is insufficient evidence regarding the feasibility of hybrid thoracoscopic lobectomy chest wall resection. We reviewed our experience with an en-bloc chest wall resection and lobectomy to evaluate the outcomes of a hybrid approach using thoracoscopic lobectomy combined with the chest wall resection where rib spreading is avoided.

METHODS: All patients who underwent lobectomy and en-bloc chest wall resection with ribs for primary non-small cell lung cancer from January 2000 to July 2010 were reviewed. Starting in April 2003, a hybrid approach was introduced where thoracoscopic techniques were utilized to accomplish the pulmonary resection and a limited counter incision was used to perform the en-bloc resection of the chest wall, avoiding scapular mobilization and rib spreading. Preoperative, perioperative and outcome variables were assessed using the standard descriptive statistics.

RESULTS: During the study period, 105 patients underwent en-bloc lobectomy and chest wall resection, including 93 patients with resection via thoracotomy and 12 patients with resection via the hybrid thoracoscopic approach. Complete resection was achieved in all patients in both groups. Tumor size and the extent of resection were similar in the two groups. There were no conversions and no perioperative mortality in the hybrid group. Post-operative outcomes were similar, although patients who underwent the hybrid approach had a shorter length of stay (P = 0.03).

CONCLUSIONS: A hybrid approach that combines thoracoscopic lobectomy and chest wall resection is feasible and effective in selected patients. The use of a limited counter incision without rib spreading does not compromise oncologic efficacy. Further experience is needed to determine if this approach provides any advantage in outcomes, including post-operative morbidity.

Keywords: Lung cancer surgery • Chest wall • Thoracoscopy/VATS

INTRODUCTION

The optimal treatment of lung cancer that invades the chest wall is complete surgical resection via lobectomy and en-bloc chest wall resection, which has a 40–50% 5-year survival when there is no lymph node involvement [1–10]. However, lobectomy with an en-bloc chest wall resection is a potentially morbid procedure and has mortality of up to 6%, significantly higher than the mortality associated with a standard lobectomy [2, 3]. Several reports have shown that minimally invasive approaches to lobectomy with thoracoscopy is safe and effective for resectable non-small cell lung cancer (NSCLC), with equivalent oncologic outcomes and lower overall complication rates and shorter hospital stays compared with thoracotomy [11–19]. The use of minimally invasive techniques to accomplish or assist the chest wall resection has been reported, but there is insufficient evidence in the literature regarding the feasibility of hybrid thoracoscopic lobectomy and chest wall resection [20–22]. The purpose of this study was to test the hypothesis that patients undergoing a hybrid approach using thoracoscopic lobectomy combined with the chest wall resection where rib spreading and scapular mobilization is avoided had equivalent outcomes to patients undergoing en-bloc lobectomy and chest wall resection via traditional thoracotomy.

MATERIALS AND METHODS

After the local Institutional Review Board approval was granted, including the waiver of the need for patient consent, the Duke University Medical Center Data Center was queried to identify...
patients who had undergone combined pulmonary and chest wall resection for primary NSCLC between January 2000 and July 2010. The retrospective review of these patients documented demographics, preoperative characteristics and comorbidities, the histology and stage of disease, intraoperative details and post-operative course. Any post-operative event prolonging or otherwise altering the post-operative course was recorded along with all operative deaths, which were defined as deaths that occurred within 30 days after operation or those that occurred later but during the same hospitalization. Deaths were captured by both the chart review and the use of the Social Security Death Index Database. The definitions of post-operative events were based on the Society of Thoracic Surgeons General Thoracic Surgery Database [http://www.sts.org/sections/stsnationaldatabase (5 March 2009, date last accessed)]. Overall morbidity was defined as the occurrence of at least one post-operative event.

The staging work-up for all patients with suspected or proven lung cancer and chest wall invasion included positron emission tomography, brain imaging and cervical mediastinoscopy (at either the same or a previous operative setting) to exclude metastatic disease. Starting in April 2003, a hybrid approach was introduced to accomplish lobectomy and chest wall resection (Fig. 1). In this approach, the patient is positioned in the lateral decubitus and draped so that the expected region of chest wall involvement is exposed. Thoracoscopy is then performed as described previously, using a single port incision for the thoracoscope and a single anterior access incision [12]. The lung and the pleural space are carefully inspected for the presence of unexpected metastatic disease. Careful inspection of the area of chest wall involvement is then performed to determine the extent of chest wall resection required to obtain adequate margins. The lobar vessels and bronchus are divided using thoracoscopic techniques [12]. A limited counter incision is then centred directly over the area of planned chest wall resection. The ribs are divided and the specimen is retrieved via the counter incision without any rib spreading or scapular mobilization. If necessary, chest wall reconstruction is then performed and the incisions are closed.

Unpaired Student’s t-tests were used to compare continuous data, Fisher’s exact tests for dichotomous data and $\chi^2$ for categorical variables. A two-tailed $P$-value of <0.05 was considered significant. Data are presented as mean ± SEM unless otherwise noted. The SAS 9.2 statistical package (SAS Institute, Cary, NC, USA) was used for statistical analyses.

**RESULTS**

During the study period, 105 patients underwent en-bloc lobectomy and chest wall resection, including 93 patients with resection via thoracotomy and 12 patients with resection via the hybrid thoracoscopic approach. None of the patients that underwent a planned hybrid approach required conversion to thoracotomy. Demographic, baseline characteristics and comorbid conditions are shown in Table 1. In general, thoracotomy and...
hybrid thoracoscopic patients had similar ages, pulmonary function and incidences of comorbid conditions.

Resection details were similar in both groups (Table 2). Tumour sizes were similar: 5.4 ± 2.5 cm for the thoracotomy group versus 5.6 ± 2.6 cm for the hybrid thoracoscopic group (P = 0.8). The number of resected ribs was also similar: 3.3 ± 0.9 ribs for thoracotomy versus 3.1 ± 0.9 ribs for hybrid thoracoscopic (P = 0.4). Complete resection with negative chest wall margins was achieved in all patients in both groups. A higher percentage of patients in the thoracotomy group had resections of superior sulcus tumours, although this difference was not statistically significant [34 patients (37%) in the thoracotomy group versus two patients (17%) in the hybrid thoracoscopic group, P = 0.21].

The surgical approach for 32 of the 34 superior sulcus tumours resected via a thoracotomy was with a posterior lateral thoracotomy with superior posterior extension and via an anterior transclavicular approach in the other two patients. The counter incision for the two hybrid patients with superior sulcus tumours was in a posterior location. Forty of the patients in the thoracotomy group had reconstruction with mesh: polytetrafluoroethylene mesh in 30, polypropylene mesh in 7, vicryl mesh in 2 and fluoroethyl-fluoroethylene mesh in 1. Four of the hybrid patients had reconstruction with mesh: polytetrafluoroethylene mesh in 30, polypropylene mesh in 7, vicryl mesh in 2 and fluoroethyl-fluoroethylene mesh in 1. Four of the hybrid patients had reconstruction with mesh (all polytetrafluoroethylene mesh).

Post-operative events are listed in Table 3. There were no conversions and no perioperative mortality in the hybrid group. Post-operative outcomes were similar between the two approaches, although patients who underwent the hybrid approach had a shorter length of stay (P = 0.03). None of the complications observed in the hybrid group were unique to the approach, and none of the complications could be attributed to the use of thoracoscopy to achieve resection.

**DISCUSSION**

The use of thoracoscopy to achieve major pulmonary resections for NSCLC has equivalent oncologic outcomes and lower overall complication rates and shorter hospital stays compared with thoracotomy [11–19]. However, reports on the use of minimally invasive techniques to accomplish or assist chest wall resection are limited [20–22]. In this current series, a hybrid approach that combines thoracoscopic lobectomy and chest wall resection is shown to be feasible and effective in selected patients. The use of a limited counter incision without rib spreading allowed...
complete resection with negative margins in all cases without increased morbidity compared with an approach via thoracotomy.

The role and advantage of avoiding a thoracotomy and rib spreading in a patient who is undergoing chest wall resection is not necessarily intuitive. Nonetheless, patients appear to have a benefit when rib spreading is avoided even when a chest wall resection is performed [20]. The benefits may be derived from less operative pain and better preservation of pulmonary function, especially considering that the main cause of mortality after combined chest wall and pulmonary resections is respiratory insufficiency [3]. Any reduction to intercostal nerve trauma during lung surgery is thought to improve both acute and chronic pain [3, 20, 23]. In addition, thoracoscopy may provide better preservation of chest wall mechanics than thoracotomy and allow improved pulmonary function in the immediate post-operative period [3, 15, 20, 23, 24]. A hybrid thoracoscopic approach may be especially beneficial to high-risk patients, considering that we have previously shown that the use of a thoracoscopic approach reduces complications in elderly patients and patients with poor pulmonary function [3, 15, 20, 23, 24].

However, it must be acknowledged that we have only demonstrated the feasibility of a hybrid approach in selected patients in this study and have not proved any benefits over a traditional approach that utilizes a thoracotomy. The patients in the hybrid group were selected because they were considered adequate candidates for that approach. The hybrid patients likely have some inherent differences which may not even be measurable or quantifiable compared with the patients in the thoracotomy group, particularly those thoracotomy patients who had surgery in the later years of the study when the hybrid approach was being more commonly utilized. For example, 31% of patients in the thoracotomy group were higher than stage II, while all the hybrid patients were stage II. This difference suggests that patients with larger tumours or with hilar lymph node involvement may not be suitable candidates for the hybrid approach, due to limited mobility of the tumour and hilum. Comparisons of outcomes between the hybrid and thoracotomy groups do not necessarily allow any conclusions about the advantages or disadvantages of either approach. However, analysing the results does at least allow demonstration of the feasibility of the hybrid approach.

Although this report demonstrates the feasibility of using a hybrid approach combining thoracoscopic lobectomy and chest wall resection, appropriate patient selection is clearly critical to ensure that this approach can be successfully completed. In addition to the size of the tumour and the presence of hilar adenopathy, as stated above, other factors influencing patient selection include the use of prior radiation therapy, which may also limit hilar mobility, and the location of the chest wall involvement. Tumours that require the resection of the first rib are particularly difficult to manage thoracoscopically, due to the dissection near the thoracic outlet, as well as limited visualization at the apex of the thorax. As well, tumours that involve the transverse processes are not attempted thoracoscopically in our experience. Finally, the area of chest wall involvement must not be in the immediate area where the incisions must be placed to allow the appropriate angle for the placement of instruments and staplers. The nature of the tumour and the chest wall involvement must also be such that the hilum can be adequately visualized and sufficiently mobilized to allow thoracoscopic isolation and division of the hilar lobar structures.

This study is limited both by its retrospective nature and because all patients were treated at a single institution. The patients reported in this series of our initial experiences with this hybrid approach were highly selected, and the results are not necessarily generalizable to all patients who require a combined pulmonary and chest wall resection. In addition, the retrospective nature of the study limits our ability to investigate potential advantages of this approach, including better pain control. Performing the hybrid approach may also not necessarily be feasible with surgeons who do not have extensive experience with thoracoscopic lobectomy. However, the current study has demonstrated the feasibility of this approach, which warrants additional investigation into its potential application in the treatment of lung cancer that invades the chest wall.

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