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Outcomes of Sleeve Lobectomy versus Pneumonectomy for Lung Cancer

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Background: Sleeve lobectomy for lung cancer in close proximity to or involving the carina is widely accepted. Operative morbidity and mortality rates, recurrence, and survival rates have varied considerably across studies. ***Materials and Methods:*** From March of 2005 to July of 2010, sleeve lobectomy was performed in 19 patients and pneumonectomy was performed in 20 patients. In this paper, the results of sleeve lobectomy and pneumonectomy for patients with lung cancer will be compared and evaluated. ***Results:*** There were no postoperative complications in either group, but there was one mortality in the pneumonectomy group. There was better preservation of pulmonary function in the sleeve lobectomy group than the pneumonectomy group (p=0.066 in FVC, p=0.019 in FEV1). The 3-year survival rates were 46.7% in the sleeve lobectomy group and 54.5% in the pneumonectomy group (p=0.505). The 3-year disease-free survival rates were 38% in the sleeve lobectomy group and 45.8% in the pneumonectomy group (p=0.200). ***Conclusion:*** Sleeve lobectomy for lung cancer showed low mortality, low bronchial anastomotic complication rates, and good preservation of pulmonary function.

Key words: 1. Lobectomy
2. Lung
3. Cancer

INTRODUCTION

Sleeve lobectomy is removal of the part of the main stem bronchus in continuity with the adjacent lobe or bilobe followed by end-to-end bronchial anastomosis [1]. Since the first report by Price-Thomas [2], sleeve lobectomy has been widely used to treat patients with lung cancer in close proximity to or involving the carina [3-6]. Since sleeve lobectomy yielded survival results at least equal to those of pneumonectomy, as well as better functional results, it became an accepted procedure for patients with lung cancer who have anatomically suitable tumors, regardless of lung function [7-9]. Functional lung parenchyma can be preserved, and the reimplanted lobes contribute to postoperative quality of life. If a second case of primary lung cancer develops, subsequent resection may be offered to selected patients [10,11]. However, bronchial anastomotic complications and operative mortality rates show considerable variation across studies [12,13].

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We performed this study to determine the outcomes of our use of sleeve lobectomy for primary lung cancer.

MATERIALS AND METHODS

Between March 2005 and July 2010, 19 patients underwent sleeve lobectomy and 20 patients underwent pneumonectomy for primary lung cancer. In the sleeve lobectomy group, there were 14 men and 5 women, with a mean age of 62.1±8.9 years (range, 41 to 75 years). In the pneumonectomy group, there were 16 men and 4 women, with a mean age of 64.3±8.8 years (range, 46 to 81 years). The decision to perform sleeve lobectomy was based on the preoperative bronchoscopic evaluation in 18 patients and was made during the operation in 1 patient who had bronchial margin involvement determined by frozen-section examination.

Tumor spread and functional status were evaluated preoperatively. Physical examination, chest X-ray, chest computed tomography (CT), 18F-Fluorodeoxyglucose positron emission tomography (FDG-PET), spirometry, arterial blood gases, and quantitative ventilation and perfusion scans were performed routinely to evaluate functional status. Patients at high risk for heart disease were screened by echocardiography. Tumor spread to the airway was evaluated by fiberoptic bronchoscopy, which plays a key role in selecting patients for sleeve lobectomy; patients who have submucosal invasion or extrinsic compression of a lobar orifice with a positive elective biopsy are good candidates for sleeve lobectomy.

Single-lung ventilation was established through a double-lumen endotracheal tube. A posterolateral thoracotomy was performed in the fifth intercostal space. The hilar, carinal, paratracheal, esophageal, and inferior pulmonary ligament lymph nodes were routinely dissected. In sleeve resection, circumferential bronchial resection was performed with a knife to obtain a straight margin distance from the tumor. Specimens of the resection margins were taken for frozen-section examination to ensure complete resection and provide that extension to sleeve lobectomy was feasible. Most patients were extubated in the operating room after the procedure. When postoperative mechanical ventilation was necessary, a standard endotracheal tube was substituted for the double-lumen tube.

Table 1. Type of resection

	Sleeve lobectomy	Pneumonectomy
Right		7
RUL	7	
RLL	1	
RML+RLL	3	
Left		13
LUL	2	
LLL	6	
Total	19	20

RUL=Right upper lobe; RLL=Right lower lobe; RML=Right middle lobe; LUL=Left upper lobe; LLL=Left lower lobe.

Patients were followed up by routine chest X-ray and chest CT scans. Fiberoptic bronchoscopy was performed routinely in all patients before discharge between day 7 and 10, and when atelectasis indicated. 1 month after surgery, a pulmonary function test was performed. Operative mortality was defined as death within 30 days of the operation or death directly related to the surgical procedure.

Findings from follow-up investigations were used to categorize recurrences as in the anastomosed area, regional, or distant.

The data were compared with the independent t-test. Survival data were calculated according to the Kaplan-Meier method from the date of operation and included postoperative deaths. Any value of p less than 0.05 was considered statistically significant.

RESULTS

In the sleeve lobectomy group, there were 7 right upper lobectomies, 1 right lower lobectomy, 3 bilobectomies, 2 left upper lobectomies, and 6 left lower lobectomies. In the pneumonectomy group, there were 13 left pneumonectomies and 7 right pneumonectomies (Table 1). The permanent sections showed squamous cell cancer in 13 patients (68.4%), adenocarcinoma 4 in patients (21%), and other types of cancer in 2 patients (10.5%) in the sleeve lobectomy group, and squamous cell cancer in 14 patients (70%), adenocarcinoma in 4 patients (20%), and other types in 2 patients (10%) in the pneumonectomy group. According to the TNM classification, in the sleeve lobectomy group, 5 patients (26.3%) were in

Table 2. Comparison of clinical variables of the sleeve lobectomy and pneumonectomy groups

	Sleeve lobectomy	Pneumonectomy
Sex		
Male	15	16
Female	4	4
Diagnosis		
Squamous cell carcinoma	13	14
Adenocarcinoma	4	4
Other	2	2
Postoperative Staging		
Ia/Ib	2/3	0/8
IIa/IIb	5/3	2/3
IIIa/IIIb	6	6/1
Adjuvant therapy	13	15
Radiation	2	1
Chemotherapy	5	9
Both	6	5

Table 3. Pulmonary function test

	Sleeve lobectomy	Pneumonectomy	p-value
Mean FVC (postoperative/ preoperative)	2.87/3.22 (89.1%)	2.36/3.32 (71.0%)	0.066
Mean FEV1 (postoperative/ preoperative)	1.99/2.13 (93.4%)	1.74/2.40 (72.5%)	0.019

FVC=Forced vital capacity; FEV1=Forced expiratory volume in one second.

Table 4. Patterns of recurrence

	Sleeve lobectomy	Pneumonectomy
Anastomosis site	0	0
Regional	2	2
Distant	2	5
Locoregional + distant	1	2
Total	5	9

stage I (2 IA and 3 IB), 8 (42.1%) were in stage II (5 IIA and 3 IIB), and 6 (31.5%) were in stage III (6 IIIA). 4 patients (21%) had T1, 11 (57.8%) T2, 3 (15.7%) T3, and 1 (5.2%) T4 disease. 10 (52.6%) had N0, 5 (26.3%) N1, and 4 (21%) N2 disease. In the pneumonectomy group, 8 patients (40%) were in stage I (8 IB), 5 (25%) in stage II (2 IIA and 3 IIB), and 7 (35%) in stage III (6 IIIA and 1 IIIB). 1 patient (5%) had T1, 14 (70%) T2, 4 (20%) T3, and 1 (5%) T4 disease. 10 (50%) had N0, 4 (20%) N1, and 6 (30%) N2 disease (Table 2).

In the sleeve lobectomy group, 1 patient had incomplete resection in which frozen sections of the bronchial margin were positive but pneumonectomy was contraindicated by the results of preoperative investigations. In the pneumonectomy group, all patients underwent complete resection. In the sleeve lobectomy group, postoperative radiation therapies were used in 2 patients and postoperative chemotherapies were used in 5 patients. 6 patients received both chemotherapy and radiation therapy after the operations. In the pneumonectomy group, postoperative radiation therapy was used in 1 patient and postoperative chemotherapy was used in 9 patients. 5 patients received both chemotherapy and radiation therapy after the operation (Table 2). There were no postoperative complications in either group, but there was one mortality associated with the operation, repiratory failure in the pneumonectomy group. In the sleeve lobectomy group, a preoperative pulmonary function test showed mean values of forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC), of 2.13 L and 3.22 L, repectively. The mean values of FEV1 and FVC showed 1.99 L and 2.87 L 1 month after surgery, with no significant difference (p=0.605 and p=0.377, respectively). In the pneumonectomy group, the mean values of FEV1 and FVC decreased from 2.40 L to 1.74 L and 3.32 L to 2.36 L 1 month after surgery, with significant changes both p=0.002. There was better preservation of pulmonary function in the sleeve lobectomy group than the pneumonectomy group (89.1% of mean FVC and 93.4% of mean FEV1 in the sleeve lobectomy group, 71% of mean FVC and 72.5% of mean FEV1 in the pneumonectomy group) (Table 3).

In the sleeve lobectomy group, the site of recurrence was the anastomosis site in 0, regional in 2, distant in 2, and locoregional and distant in 1. In the pneumonectomy group, the site of recurrence was regional in 2, distant in 5, and locoregional and distant in 2 (Table 4). The 3-year survival rates were 46.7% in the sleeve lobectomy group and 54.5% in the pneumonectomy group (p=0.505) (Fig. 1). The 3-year disease-free survival rates were 38% in the sleeve lobectomy

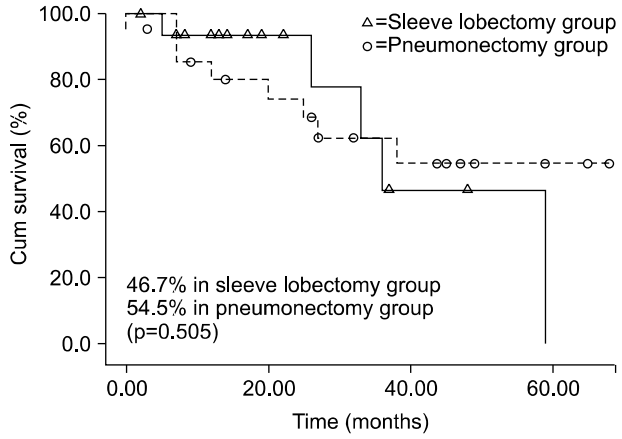

Fig. 1. Three-year overall survival.

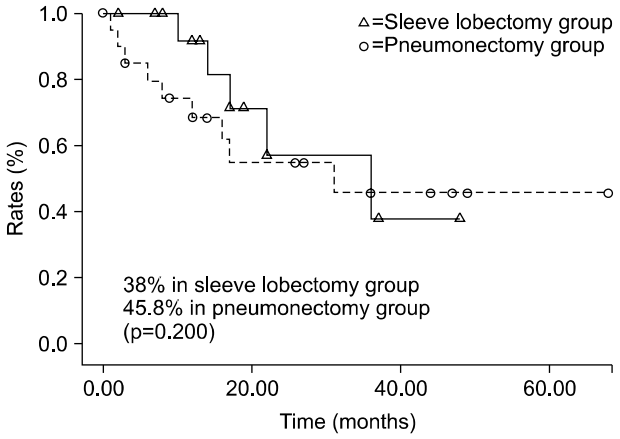

Fig. 2. Three-year recurrence-free survival.

group and 45.8% in the pneumonectomy group (p=0.200) (Fig. 2).

DISCUSSION

Since the first report by Price-Thomas [2], sleeve lobectomy has been generally used to treat patients with central bronchogenic cancer [3-6]. However, bronchial anastomotic complications and operative mortality rates show significant variation across studies [12,13]. Furthermore, the long-term results of sleeve resection in comparison with conventional lung cancer resections remain controversial, especially regarding nodal involvement and functional status [14].

The major complications after performing sleeve resection were the narrowing of the bronchoplasty site and atelectasis, whereas the pneumonectomy group suffered primarily from postpneumonectomy empyema and respiratory failure.

A 1992 collective review of 1,915 bronchoplastic procedures performed during a 12-year period in patients with bronchogenic tumors found that sleeve lobectomy was followed by morbidity and mortality similar to pneumonectomy but allowed for better lung function preservation [3]. In recent studies, operative mortality has ranged from 0% to 5.2% [4,6], which is comparable to the range after standard lobectomy [15] and lower than after standard pneumonectomy [13,16]. In our study, there was no operative mortality after sleeve lobectomy.

Specific procedure-related complications of bronchoplasty include impaired anastomotic healing and retention of bronchial secretions. The incidence of anastomotic dehiscence is estimated at approximately 3.5% [3] and reoperative management is rarely required. Bronchial ischemia is obvious following sleeve bronchoplasty. Reports of the overall incidence of stenosis range from 3 to 9% [3]. Retention of secretions may be associated with bronchial denervation, which has been shown to decrease mucociliary clearance and viscoelasticity of bronchial secretions [17]. The reported incidence varies from 4 to 12% [18]. We did not perform repetitive bronchoscopy for bronchial clearing, and there were no postoperative complications.

The risk of local recurrence is the main concern caused by the use of sleeve lobectomy to treat bronchogenic malignancy. Suture line recurrence may be related to lung preservation at the expense of adequate bronchial margins [3]. Therefore, Paulson and colleagues [19] recommended that the bronchial resection margins be at least 1.5 cm away from the tumor. The incidence of local recurrence has ranged from 5% to 51% [7]. In a recent study comparing sleeve lobectomy with pneumonectomy for NSCLC, Okada and colleagues [13] found that the local recurrence rate was lower after bronchoplastic procedures. In our study, there was 1 (5.2%) locoregional with distant recurrence after sleeve lobectomy.

Van Schil [14] reported that nodal status was the most significant determinant of long-term survival after sleeve lobectomy, with significantly shorter survival in patients with N2 disease than in those with N1 or N0 disease. It has been

shown that N2 disease is highly predictive of distant recurrences [20].

CONCLUSION

Sleeve lobectomy is accepted as appropriate for selected patients with resectable malignant tumors and presents an alternative to the otherwise unavoidable pneumonectomy, owing to low mortality and good preservation of pulmonary function.

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