

ORIGINAL ARTICLE

Left sleeve lobectomy versus left pneumonectomy for the management of patients with non-small cell lung cancer

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Keywords

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Abstract

Background: The study was conducted to compare the outcomes of sleeve lobectomy (SL) and pneumonectomy (PN) for management of the left lung in patients with non-small cell lung cancer (NSCLC).

Methods: One hundred and thirty-five patients who underwent left SL ($n = 87$) or left PN ($n = 48$) for NSCLC from January 2006 to December 2011 were enrolled in this retrospective study. Left SL was performed when technically possible. The clinicopathological features and treatment outcomes in both groups were compared. Survival was evaluated using the Kaplan-Meier method, and significant differences were calculated using the log-rank test. Multivariate analysis was conducted using the Cox proportional hazards model to analyze significant variables associated with the outcomes of left SL.

Results: There were no significant differences in general clinicopathological features (age, gender, lymph node metastasis, pathological stage, and complications of bronchial fistula) between patients who underwent left SL and left PN. The operation duration was markedly longer and the extent of bleeding was greater for left SL than left PN; however patients who underwent left SL achieved significantly longer overall survival than patients who underwent left PN. The outcomes of left SL were only associated with pathological stage.

Conclusions: Our results indicate that left SL may offer superior survival than left PN in selected patients. If anatomically feasible, left SL may be a preferred alternative to left PN for NSCLC patients. Pathological stage is an important factor to determine the outcome of SL.

Introduction

Lung cancer is the leading cause of cancer-related mortality worldwide,¹ in which non-small cell lung cancer (NSCLC) accounts for up to 85%.² Despite great advances in diagnosis and therapeutic options, the five-year overall survival (OS) rate of patients with NSCLC remains < 15%.³

Surgical resection remains the mainstay of management for localized NSCLC.^{4,5} Pneumonectomy (PN) is considered the gold standard for the treatment of centrally located NSCLC;⁶ however, PN is accompanied with high risks of postoperative morbidity, mortality, and reduced quality of life.⁷⁻⁹ Sleeve lobectomy (SL) was first introduced for patients with compromised lung function unable to tolerate PN. SL was initially considered as an alternative

procedure to PN because PN has a complex surgical technique and complete resection is not always possible.¹⁰ Nevertheless, SL is widely used at present and is preferred in suitable patients because of the better long-term survival outcomes and fewer incidences of operative complications and postoperative mortality.^{11,12} Although accumulating studies have compared the outcomes of SL and PN for the management of patients with NSCLC, little research has been conducted to compare such outcomes for the management of the left lung.

In this retrospective study, we compared left SL and left PN focusing on operative outcomes and survival to further determine which was more favorable for the management of the left lung in NSCLC patients. The significant

clinicopathological features associated with the outcomes of surgery were also determined. The findings of this study provide theoretical guidance for clinical practice.

Methods

Study population and data collection

A total of 135 patients who were diagnosed with primary NSCLC and underwent left lung resection surgery in our hospital from January 2006 to December 2011 were enrolled in this retrospective study. Left SL was performed whenever technically feasible, otherwise left PN was performed. Consequently, 87 patients underwent left SL and 48 underwent left PN for NSCLC. The clinicopathological features, including age, gender, lymph node metastasis, pathological stage, and complications (bronchial fistula), were collected before surgery and the treatment outcomes, such as operation duration, bleeding, length of hospital stay, tumor size, and OS were also recorded. All patients were followed-up annually for five years. The ethics committee of our hospital approved the study and each participant provided written informed consent.

Statistical analysis

The Kolmogorov-Smirnov test was used to test the normal distribution of enumeration data. If data were normally distributed, they were presented as mean \pm standard deviation and significant differences between groups were evaluated using a *t*-test. If the data were not normally distributed, they were expressed as interquartile range and significant differences were calculated using the Mann-Whitney *U* test. Differences in qualitative data between groups were analyzed using the chi-squared (χ^2) test. The

Kaplan-Meier method was used for univariate survival analysis and significant differences were compared by log-rank test. In order to further analyze significant variables associated with the outcomes of left SL, multivariate analysis using the Cox proportional hazards model was performed and evaluated using hazard ratios (HR) with 95% confidence intervals (CIs). SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses and a two-sided *P* value of <0.05 indicated statistical significance.

Results

Eighty-seven patients who underwent left SL and 48 who underwent left PN for NSCLC were eligible for this study. No significant difference was found in regard to general clinicopathological features, including age, gender, lymph node metastasis, pathological stage, and complications (bronchial fistula), between left SL and left PN patients (all $P > 0.05$) (Table 1).

The outcomes of left SL and left PN in patients with NSCLC were subsequently compared. As shown in Table 2, the operation duration of left SL was markedly longer ($P = 0.011$), and the extent of bleeding of left SL was significantly greater ($P < 0.001$) than left PN. However, patients who underwent left SL achieved significantly longer OS than patients who underwent left PN ($P = 0.014$). No significant difference was observed between the two groups regarding tumor size or length of hospital stay ($P > 0.05$). Notably, Kaplan-Meier univariate survival analysis revealed that OS was longer in patients who underwent left SL than left PN ($P = 0.031$) (Fig 1).

Multivariate analysis was therefore conducted to identify the significant clinicopathological features associated with the outcomes of left SL (Table 3). The results showed that

Table 1 Comparison of the clinicopathological features in patients undergoing sleeve lobectomy and left pneumonectomy

Clinicopathological features	Sleeve lobectomy (n = 87)	Left pneumonectomy (n = 48)	Statistic	<i>P</i>
Gender			0.210†	0.646
Male, n (%)	80 (92.0)	43 (89.6)		
Female, n (%)	7 (8.0)	5 (9.3)		
Lymph node metastasis			0.339†	0.560
No, n (%)	22 (25.3)	10 (20.8)		
Yes, n (%)	65 (74.7)	38 (79.2)		
Pathological stage			0.278†	0.870
1, n (%)	20 (23.0)	10 (18.5)		
2, n (%)	24 (27.6)	12 (25.0)		
3-4, n (%)	43 (49.4)	26 (54.2)		
Complication (bronchial fistula)			2.082†	0.149
No, n (%)	87 (100.0)	47 (97.9)		
Yes, n (%)	0 (0.0)	1 (2.1)		
Age, mean (SD)	57.2 (7.6)	56.5 (7.8)	0.537‡	0.592

† χ^2 test; ‡*t*-test; SD, standard deviation.

Table 2 Comparison of the outcomes of sleeve lobectomy and left pneumonectomy in NSCLC patients

Clinicopathological features	Sleeve lobectomy (n = 87)	Left pneumonectomy (n = 48)	Statistic	P
Operation duration (min)	261 (57.5)	234 (60.0)	2.579†	0.011
Tumor size (cm)	3.4 (1.7)	3.8 (1.7)	-1.474†	0.143
Bleeding (mL)	90 (80-100)	30 (20-50)	-8.185‡	< 0.001
Length of hospital stay (days)	11 (9-14)	12.5 (9-14)	-0.593‡	0.553
Overall survival (months)	46 (24-63)	30 (10-58)	-2.463‡	0.014

†t-test; ‡Mann-Whitney U test; NSCLC, non-small cell lung cancer.

the outcomes of left SL were only associated with pathological stage ($P < 0.001$). Other clinicopathological features, such as age, gender, lymph node metastasis, and tumor size, had no significant effects on the outcome in NSCLC patients who underwent left SL (all $P > 0.05$).

Discussion

In this retrospective study, we compared the outcomes of NSCLC patients who underwent left SL and left PN. The results showed that although operation duration and the extent of bleeding in patients who underwent left SL were significantly greater than in patients who underwent left PN, patients who underwent left SL achieved significantly longer OS than patients who underwent left PN, suggesting that left SL might be a preferred alternative for patients with NSCLC. Significantly, the outcomes of left SL were only associated with pathological stage, implying the important role of pathological stage in determining survival in NSCLC patients who undergo left SL.

Since SL was introduced for the treatment of lung cancer, it has been accepted as a reliable and safe procedure for the management of NSCLC patients who have low-

grade, centrally located lesions and cannot tolerate PN as they do not have sufficient pulmonary reserve.^{11,13} SL by single-incision video-assisted thoracic surgery is reportedly feasible and safe for patients with left lower central lung cancer.¹⁴ In centrally located NSCLC, extended SL is considered an alternative approach to avoid PN.¹⁵ Morgant *et al.* demonstrated that PN and bronchial SL could affect the rates of postoperative death following lung cancer surgery and the odd ratio (OR) range for PN was higher than for bronchial SL.¹⁶ Although the operation duration and extent of bleeding of left SL were significantly greater than for left PN in our study, there were no significant differences regarding postoperative death and length of hospital stay between the two groups. This result may be attributed to the low mortality associated with left PN in our study. In addition, we found that the OS of patients who underwent left SL was significantly longer than those who underwent left PN, which was consistent with previous findings. Ferguson and Lehman demonstrated that better long-term survival was achieved in patients with anatomically appropriate early-stage lung cancer after SL than PN.¹⁷ Ludwig *et al.* reported five-year OS rates of 39% for SL and 27% for PN, and confirmed that SL should be performed whenever possible.¹⁸ Maurizi *et al.* concluded that even after induction chemotherapy, SL represented a valid therapeutic procedure providing better long-term survival than PN.¹⁹ Pagès *et al.* also suggested that SL provided better outcomes than PN and was the preferred technique when technically feasible.²⁰ Based on our results, we therefore speculate that left SL may offer superior survival over left PN in selected patients, and could be a preferred alternative for NSCLC patients whenever possible.

Furthermore, the results of multivariate analysis showed that the outcomes of left SL were only associated with pathological stage, implying the important role of pathological stage on determining survival for NSCLC patients. In a previous study, Matsuoka *et al.* demonstrated that pathological stage is a key factor to determine survival in resected NSCLC patients.²¹ In addition, Hanagiri *et al.* found that the five-year survival rates of SL patients with different pathological nodal status (N0, N1, and N2) were 100.0%, 87.5%, and 41.7%, respectively,²² indicating that survival in SL patients can be affected by pathological nodal status. Given the similar results obtained in this

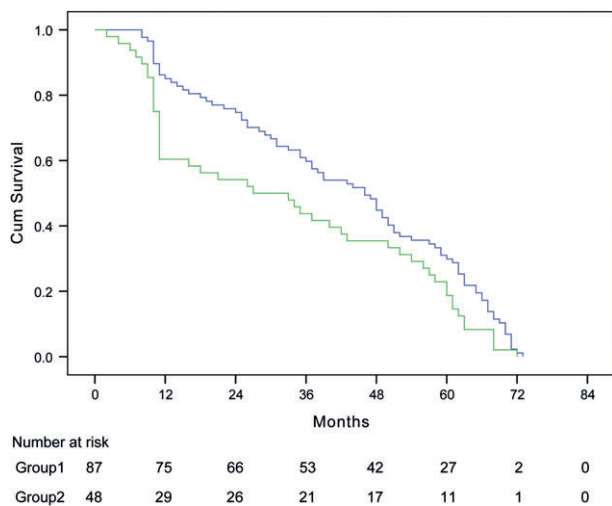


Figure 1 Survival analysis of patients who underwent sleeve lobectomy and left pneumonectomy for non-small cell lung cancer. Log rank test: $P = 0.031$. (—) Group 1: sleeve lobectomy; (—) Group 2: left pneumonectomy.

Table 3 Multivariate analysis of key variables associated with the outcomes of sleeve lobectomy

Variables	B	SE	Wald	P	HR	95% CI
Pathological stage (vs. 1)			75.341	< 0.001		
2	2.138	0.441	23.466	< 0.001	8.482	3.571-20.145
3	4.169	0.502	68.885	< 0.001	64.658	24.157-173.062
Age	-0.014	0.013	1.231	0.267	0.986	0.962-1.011
Gender (female vs. male)	-0.358	0.532	0.454	0.501	0.699	0.247-1.982
Lymph node metastasis (Yes vs. No)	0.076	0.757	0.010	0.919	1.079	0.245-4.758
Tumor size (cm)	-0.006	0.073	0.007	0.934	0.994	0.862-1.146

CI, confidence interval; HR, hazard ratio.

study, we speculate that pathological stage is an important factor affecting the outcome of SL in NSCLC patients.

In conclusion, this retrospective study indicates that left SL may offer superior survival than left PN in selected patients. If anatomically feasible, left SL should be performed to provide greater long-term survival benefits to NSCLC patients. Pathological stage is an important factor to determine the outcome after left SL. Despite these promising results, further prospective studies with larger sample sizes are required to verify our observations.

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Disclosure

No authors report any conflict of interest.

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