Original Article

Ten-year survival outcomes of video-assisted thoracic surgery *vs.* open major lung resection for stage I–III non-small cell lung cancer: a large cohort study in China

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Background: Despite the widespread adoption of video-assisted thoracoscopic surgery (VATS) for major lung resection, the 10-year long-term survival outcomes of non-small cell lung cancer (NSCLC) treated with VATS compared with open major lung resection is lacking. The purpose of this study was to analyze the short- and long-term outcomes of VATS *vs.* open major lung resection for NSCLC.

Methods: The perioperative outcomes and long-term survival of p-stage I–III NSCLC patients who underwent major lung resection via VATS *vs.* open major lung resection in the Western China Lung Cancer Database (WCLCD) between May 2006 and June 2018 were studied using propensity score matching (PSM).

Results: Of the 10,167 patients who underwent surgery for lung malignancies, 6,405 patients with stage I–III NSCLC were included in the study, including 4,224 in the VATS group and 2,181 in the open group. PSM resulted in 1,487 patients in both the VATS and open groups. The patients were matched by patient demographics, Charlson comorbidity index (CCI), tumor histology and TNM stage. Compared with open surgery, major lung resection via VATS resulted in less blood loss (median: 50 *vs.* 100 mL, P<0.001) and a shorter postoperative hospital stay (7.6±6.0 *vs.* 8.6±4.9 days, P<0.001) but higher total hospital costs (52.5±21.2 *vs.* 45.0±16.4 kRMB, P<0.001). The matched cohort showed that patients who underwent major lung resection via VATS had better overall survival (OS) and recurrence-free survival (RFS) than did patients who underwent major lung resection via open surgery (5-year survival: 64.9% *vs.* 57.7%, P<0.001; 5-year RFS: 50.3% *vs.* 45.3%, P=0.003). Patients who underwent VATS had a better 10-year OS rate (47.8% *vs.* 42.6%). According to the subgroup analysis, patients with stage II NSCLC who underwent major lung resection via VATS had better OS and RFS (OS: P<0.001; RFS: P=0.004), while there were no significant differences in OS or RFS between stage I and III NSCLC patients.

Conclusions: Major lung resection via the VATS should be the preferred surgical option for stage I–III NSCLC patients due to its superior long-term survival outcome and advantages of less blood loss and shorter postoperative hospital stays.

Keywords: Non-small cell lung cancer (NSCLC); thoracic surgery; video-assisted thoracic surgery (VATS); major lung resection; open surgery

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Introduction

Since the introduction of video-assisted thoracic surgery (VATS) for the treatment of lung cancer, minimally invasive major lung resection has been recommended as the preferred method for early-stage lung cancer in numerous evidence-based guidelines (1-4). However, for oncologic surgery, the most important evaluation metric is long-term survival outcomes, and long-term survival after minimally invasive surgery is not necessarily superior to that of open surgery (5,6). In recent years, there has been substantial evidence confirming the advantages of VATS over open surgery for non-small cell lung cancer (NSCLC), but after years of widespread adoption of the VATS approach, only a few articles have comprehensively compared the prognostic differences between VATS and open surgery in the treatment of lung cancer beyond 5 years (7-14).

Evaluations of the efficacy of VATS and open surgery in patients with different stages of lung cancer have been inconsistent, and evaluations of 10-year survival outcomes are lacking (11-14). In a previous study, we concluded that VATS lobectomy provided better 5-year survival rates than did the open approach and should be the preferred surgical treatment for stage I–II NSCLC (11). The present large single-center cohort study evaluated the outcomes of VATS and open major lung resection performed by experienced surgeons and reported the 10-year survival outcomes of these patients. This study also analyzed the short-term results of surgery and total in-hospital costs of VATS *vs.* open major lung resection using data from the Western China Lung Cancer Database (WCLCD). The database collected data on lung cancer patients undergoing surgery at West China Hospital of Sichuan University. We present this article in accordance with the STROBE reporting checklist (available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-150/rc).

Highlight box

Key findings

- The purpose of this study was to analyze the short- and long-term outcomes of video-assisted thoracoscopic surgery (VATS) *vs.* open major lung resection for non-small cell lung cancer (NSCLC).

What is known and what is new?

- Evaluations of the efficacy of VATS and open surgery in patients with different stages of lung cancer have been inconsistent, and evaluations of 10-year survival outcomes are lacking. In a previous study, we concluded that VATS lobectomy provided better 5-year survival rates than did the open approach and should be the preferred surgical treatment for stage I–II NSCLC.
- The present large single-center cohort study evaluated the outcomes of VATS and open major lung resection performed by experienced surgeons and reported the 10-year survival outcomes of these patients. This study also analyzed the short-term results of surgery and total in-hospital costs of VATS *vs.* open major lung resection.

What is the implication, and what should change now?

- Major lung resection via the VATS should be the preferred surgical option for stage I–III NSCLC patients due to its superior long-term survival outcome and advantages of less blood loss and shorter postoperative hospital stays.

Methods

Data source

The WCLCD was established in September 2005. Since then, all lung cancer patients who underwent surgery at the Department of Thoracic Surgery, West China Hospital, Sichuan University, have been registered in the database. The database is currently updated through May 2023. The study conformed to the provisions of the Declaration of Helsinki (as revised in 2013) and was approved by the Institutional Review Board (IRB) of West China Hospital (No. 2023-1406). Individual consent for this retrospective analysis was waived.

Patient and method

All patients who underwent VATS or open lung cancer resection at the Department of Thoracic Surgery, West China Hospital, Sichuan University, between May 2006 and June 2018 were recruited for this study. The inclusion criteria included VATS or open major lung resection (including lobectomy, bilobectomy, pneumonectomy and lobectomy combined with sublobectomy) for postoperative stage I–III NSCLC according to the 8^{th} edition of the tumor, node and metastasis (TNM) staging system after

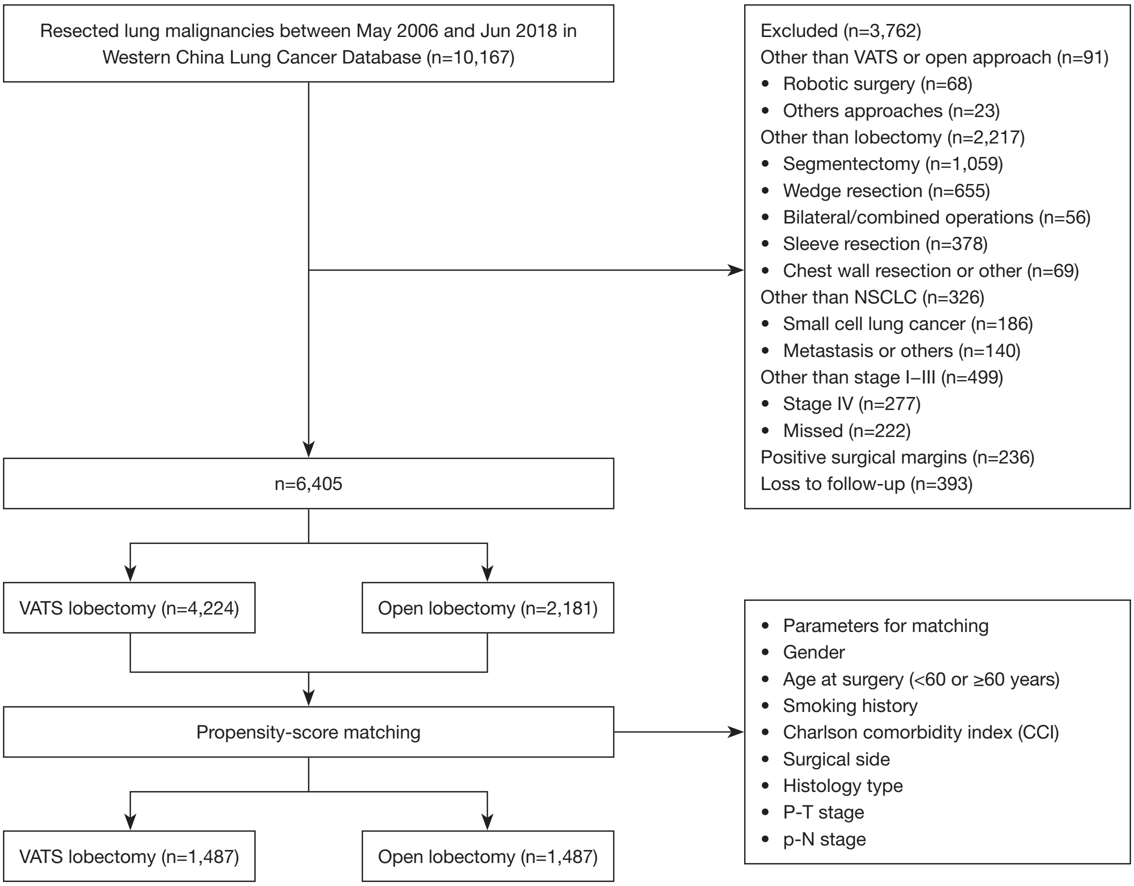

Figure 1 Study subject selection (pathological stage I–III patients). NSCLC, non-small cell lung cancer; VATS, video-assisted thoracic surgery.

surgery. The exclusion criteria were as follows: VATS or open access (video-assisted mini-thoracoscopy was also considered VATS), non-lobectomy (segmental resection, wedge resection, sleeve resection, bilateral surgery, chest wall resection or other extended resection), stage IV NSCLC with pulmonary metastases, incomplete data, or positive surgical margins.

We adopted a propensity score matching (PSM) approach to minimize potential selection bias, balancing confounding factors between the two groups with a 1:1 nearest matching approach. Matching indicators included sex (male, female), age at the time of surgery (<60 years, ≥60 years), smoking history (never smoked, current or ever smoked), Charlson comorbidity index (CCI), side of surgery (right, left), histology (adenocarcinoma, squamous, adenosquamous carcinoma and other types of primary NSCLC), p-T status (8th edition of TNM staging system: T1, T2, T3), p-N status (8th edition of TNM staging system: N0, N1, N2) and adjuvant therapy. The patient inclusion process is shown in *Figure 1*.

Outcomes

The primary outcomes were 10-year overall survival (OS), 5-year recurrence-free survival (RFS) and lung cancer-specific survival (LCSS). Patient follow-up began on the day of surgery, and patient status was determined based on periodic follow-up [including chest computed tomography (CT), brain magnetic resonance imaging or CT, and upper abdominal CT]. Follow-up was performed every 3–6 months for the first 3 years, every 6 months for the next 2 years, and once a year thereafter. In addition, patients should undergo a bone scan every year to detect bone metastases, and positron emission tomography (PET)-CT or biopsy may be performed if necessary. Patients who did not return to the outpatient clinic were followed up with regular telephone visits.

The secondary outcomes included VATS conversion rate, intraoperative blood loss volume, postoperative complications, chest tube duration, postoperative length of stay, and total hospital costs. Postoperative complications included prolonged air leakage (>5 days), pneumonia, bronchopleural fistula (BPF), empyema, chylothorax, reoperation, pulmonary embolism, arrhythmia, reintubation, and 30-day mortality.

Statistical analysis

All the statistical analyses were performed using R (version 4.2.1). Quantitative data were expressed as the mean ± standard deviation. Independent samples t tests were used to compare differences between groups. Enumerated data were expressed as percentages, and differences between groups were compared using Fisher's exact test or the Chi-square test. Kaplan-Meier survival curves were used to describe the OS and RFS times before and after PSM in both groups, and survival outcomes were compared using log-rank tests. In addition, Cox regression models were used to determine independent prognostic factors for these patients. Missing data for each variable were assessed independently and evaluated if it was missing at random or systematically, potentially introducing selection bias. A P value <0.05 indicated statistical significance.

Results

Patient characteristics

A total of 10,167 patients underwent surgery for pulmonary malignancies in the Department of Thoracic Surgery, West China Hospital, Sichuan University, between May 2006 and June 2018. A total of 3,762 patients were excluded based on the exclusion criteria, while the remaining 6,405 patients were included in the study (including 4,224 patients who underwent major lung resection via VATS and 2,181 patients who underwent major lung resection via open surgery). The subsequent PSM identified 1,487 patients who underwent major lung resection via VATS and 1,487 patients who underwent open major lung resection based on patient demographics, CCI, tumor histology, and TNM stage.

Unmatched population

Patient characteristics are shown in *Table 1*. Patients who underwent major lung resection via VATS were older than those in the open group (47.6% *vs.* 42.5% of patients in the ≥60 years group, P<0.001). Compared with the open group, the VATS group had more female patients and more patients with comorbidities but fewer current or former smokers. The mean tumor size was smaller in the VATS group than in the open group (2.7±2.1 *vs.* 4.5±2.0 cm, P<0.001). The proportion of patients with adenocarcinoma was greater in the VATS group than in the open group (79.5% *vs.* 42.4%, P<0.001). More patients in the VATS group than in the open group had p-TNM stage I disease (70.7% *vs.* 31.9%, P<0.001).

In the VATS group, 190 (4.0%) patients were converted to open surgery (*Table 2*). Compared with open major lung resection, major lung resection via VATS resulted in less blood loss (median: 50 *vs.* 100 mL, P<0.001), shorter operation times (145 *vs.* 156 min, P<0.001) and more harvested lymph node stations (5.6±1.6 *vs.* 5.3±1.8, P<0.001) but fewer lymph nodes harvested (11.6±6.4 *vs.* 14.0±8.6, P<0.001).

The overall postoperative complication rate was significantly lower in the VATS group (18.4% *vs.* 23.0%, P<0.001). The VATS approach was associated with a lower incidence of postoperative pneumonia (3.0% *vs.* 5.4%, P<0.001), less frequent development of a BPF and/or empyema (0.2% *vs.* 0.5%, P<0.001) and a lower risk of mortality within 30 days (0.3% *vs.* 0.8%, P=0.009). Compared with the open group, the VATS group had shorter chest tube drainage times (4.2±3.3 *vs.* 4.5±2.8 days, P<0.001) and shorter postoperative hospital stays (7.1±5.9 *vs.* 8.8±4.9 days, P<0.001). However, the VATS group had a higher incidence of postoperative air leakage (6.0% *vs.* 4.6%, P=0.03) and a higher total hospitalization cost (53.8±17.0 *vs.* 43.6±16.5 kRMB, P<0.001).

Matched population

The baseline clinical characteristics and surgical outcomes of the PSM-matched patients are listed in *Tables 3,4*. The two groups were comparable in terms of age, sex, comorbidities, smoking status, tumor size, histology, and TNM stage. The blood loss volume was lower in matched VATS major lung resection patients than in open major lung resection patients (median blood loss: 50 *vs.* 100 mL, P<0.001). There was no significant difference in the overall incidence of postoperative complications between the matched VATS group and the open group (21.3% *vs.* 21.7%, P=0.39), and major lung resection via VATS was associated with a higher incidence of postoperative air leakage (7.2% *vs.* 4.6%, P=0.004). Patients who underwent open major lung resection still had longer postoperative hospital stays

Table 1 VATS *vs.* open major lung resection: baseline clinical characteristics of unmatched and matched patients

Patient characteristics	For unmatched patient			For matched patient		
	VATS (n=4,224)	Open (n=2,181)	P value	VATS (n=1,487)	Open (n=1,487)	P value
Age at surgery (years), n (%)			<0.001			0.06
<60 years	2,213 (52.4)	1,255 (57.5)		841 (56.6)	789 (53.1)	
≥60 years	2,011 (47.6)	926 (42.5)		646 (43.4)	698 (46.9)	
Gender, n (%)			<0.001			0.56
Male	2,148 (50.9)	1,612 (73.9)		980 (65.9)	996 (67.0)	
Female	2,076 (49.1)	569 (26.1)		507 (34.1)	491 (33.0)	
Tumor size (cm), mean (SD)	2.68 (2.09)	4.48 (1.98)	<0.001	4.25 (2.98)	4.47 (2.01)	0.07
CCI score, n (%)			<0.001			0.99
0	3,264 (77.3)	1,770 (81.2)		1,155 (77.7)	1,157 (77.8)	
1	701 (16.6)	327 (15.0)		256 (17.2)	257 (17.3)	
2	216 (5.1)	78 (3.6)		68 (4.6)	68 (4.6)	
3	41 (1.0)	6 (0.3)		6 (0.4)	5 (0.3)	
4	2 (0.0)	0 (0.0)		2 (0.1)	0 (0.0)	
Smoking, n (%)			<0.001			0.48
Non-smokers	2,576 (61.0)	799 (36.6)		672 (45.1)	652 (43.8)	
Current or former smokers	1,648 (39.0)	1,382 (63.4)		815 (54.8)	835 (56.2)	
Surgical side, n (%)			<0.001			0.12
Right side	1,636 (38.7)	1,043 (47.8)		846 (56.9)	803 (54.0)	
Left side	2,588 (61.3)	1,138 (52.2)		641 (43.1)	684 (46.0)	
pT stage, n (%)			<0.001			0.42
1	1,203 (28.5)	218 (10.0)		215 (14.5)	198 (13.3)	
2	2,858 (67.7)	1,389 (63.7)		1,092 (73.4)	1,129 (75.9)	
3	126 (3.0)	383 (17.6)		136 (9.1)	125 (8.4)	
4	36 (0.9)	191 (8.8)		44 (3.0)	35 (2.4)	
pN stage, n (%)			<0.001			0.33
0	3,158 (74.8)	1,094 (50.2)		830 (55.8)	833 (56.0)	
1	391 (9.3)	461 (21.1)		268 (18.0)	242 (16.3)	
2	669 (15.8)	615 (28.2)		380 (25.6)	407 (27.4)	
3	6 (0.1)	11 (0.5)		9 (0.6)	5 (0.3)	
Histology, n (%)			<0.001			0.61
Adenocarcinoma	3,360 (79.5)	924 (42.4)		841 (56.6)	839 (56.4)	
Squamous carcinoma	545 (12.9)	961 (44.1)		431 (29.0)	452 (30.4)	
Adenosquamous carcinoma	92 (2.2)	120 (5.5)		87 (5.9)	73 (4.9)	
Other	227 (5.4)	176 (8.1)		128 (8.6)	123 (8.3)	
Post-therapy, n (%)	1,455 (34.4)	1,075 (49.3)	<0.001	712 (47.9)	758 (51.0)	0.08
Follow-up duration (months)	66.2	95.8	<0.001	69.4	95.1	<0.001

VATS, video-assisted thoracic surgery; SD, standard deviation; CCI, Charlson comorbidity index.

Table 2 VATS *vs.* open major lung resection: short- and long-term outcomes of unmatched and matched patients

Patient characteristics	For unmatched patient			For matched patient		
	VATS (n=4,224)	Open (n=2,181)	P value	VATS (n=1,487)	Open (n=1,487)	P value
Convert to open surgery, n (%)	190 (4.5)	NA	NA	100 (6.7)	NA	NA
Pleural adhesions	71 (1.7)					
Calcified lymph nodes adherent to surrounding blood vessels or trachea	45 (1.1)					
Bleeding	23 (0.5)					
Extracapsular extension of metastatic lymph nodes	8 (0.2)					
Tumor invasion	6 (0.1)					
Other	32 (0.8)					
Blood loss (mL), median (1st Qu., 3rd Qu.)	50 [20–100]	100 [100–200]	<0.001	50 [30–100]	100 [100–200]	<0.001
Operation time (min), mean (SD)	145.41 (56.33)	155.53 (56.64)	<0.001	148.78 (53.40)	155.26 (58.90)	0.002
Chest tube duration (days), mean (SD)	4.15 (3.26)	4.53 (2.84)	<0.001	4.42 (3.56)	4.46 (2.80)	0.76
Hospital stay (days), mean (SD)	7.07 (5.89)	8.75 (4.91)	<0.001	7.60 (5.98)	8.57 (4.92)	<0.001
Postoperative complications, n (%)						
Total complications	776 (18.4)	502 (23.0)	<0.001	317 (21.3)	320 (21.7)	0.39
Air leak >5 days	254 (6.0)	101 (4.6)	0.03	107 (7.2)	69 (4.6)	0.004
Pneumonia	127 (3.0)	117 (5.4)	<0.001	63 (4.2)	74 (5.0)	0.38
BPF and/or empyema	7 (0.2)	11 (0.5)	0.03	0 (0.0)	7 (0.5)	0.02
Chylothorax	36 (0.9)	11 (0.5)	0.16	11 (0.7)	8 (0.5)	0.65
Reoperation	18 (0.4)	4 (0.2)	0.43	2 (0.1)	4 (0.3)	0.68
Pulmonary embolism	8 (0.2)	4 (0.2)	>0.99	3 (0.2)	1 (0.1)	0.62
Arrhythmia	2 (0.0)	3 (0.1)	0.45	1 (0.1)	1 (0.1)	>0.99
Chest re-intubation	50 (1.2)	21 (1.0)	0.88	17 (1.2)	17 (1.2)	>0.99
30-day mortality	12 (0.3)	17 (0.8)	0.009	5 (0.3)	10 (0.7)	0.30
Number of LN stations harvested, mean (SD)	5.61 (1.61)	5.26 (1.84)	<0.001	5.68 (1.61)	5.18 (1.87)	<0.001
Total number of LNs harvested, mean (SD)	11.57 (6.84)	13.96 (8.59)	<0.001	12.47 (7.47)	13.26 (8.43)	0.04
Total hospital cost (kRMB), mean (SD)	53.8 (17.0)	43.6 (16.5)	<0.001	52.5 (21.2)	45.0 (16.4)	<0.001

VATS, video-assisted thoracic surgery; NA, not applicable; Qu., quartile; SD, standard deviation.

(7.6±6.0 *vs.* 8.6±4.9 days, P<0.001), but total hospital costs were higher in the VATS group than in the open major lung resection group (52.5±21.2 *vs.* 45.0±16.4 kRMB, P<0.001).

Long-term outcomes

In the 6,504 patients included in this study, the 5-year survival rate was 69.8%, the 10-year survival rate was 54.5%, and the 5-year RFS rate was 58.9%. Patients with stage I–III NSCLC who underwent major lung resection via VATS had significantly better 5-year and 10-year survival rates than did those who underwent major lung resection via open surgery (5-year survival rate: 77.1% *vs.* 55.9%; 10-year survival rate: 62.8% *vs.* 42.5%, P<0.001) (*Figure 2*). Moreover, patients with stage I–III NSCLC who underwent major lung resection via VATS had better RFS (5-year RFS: 66.2% *vs.* 45.0%, P<0.001) and LCSS (5-year LCSS rate: 82.2% *vs.* 63.0%; 10-year LCSS rate: 71.7% *vs.*

Table 3 VATS *vs.* open major lung resection: descriptions of recur sites or metastatic patterns

Descriptions of recur sites or metastatic patterns	VATS (n=4,634)	Open (n=1,806)	P value
Recur sites			
Mediastinal lymph node metastasis, n (%)	40 (2.2)	82 (1.8)	0.28
Pleural cavity implantation (including pleural nodules and malignant pleural effusion), n (%)	16 (0.9)	78 (1.7)	0.02
Pulmonary metastatic nodules, n (%)	65 (3.6)	189 (4.1)	0.41
Residual recurrence, n (%)	35 (1.9)	37 (0.8)	<0.001
Other, n (%)	27 (1.3)	34 (0.7)	0.02
Metastatic patterns			
Brain, n (%)	291 (16.1)	438 (9.5)	<0.001
Bone, n (%)	232 (12.8)	417 (9.0)	<0.001
Lung, n (%)	135 (7.5)	255 (5.5)	<0.001
Liver, n (%)	95 (5.3)	132 (2.8)	<0.001
Widespread metastasis, n (%)	44 (2.4)	52 (1.1)	<0.001
Adrenal gland, n (%)	34 (1.9)	47 (1.0)	0.007
Cervical lymph nodes, n (%)	31 (1.7)	53 (1.1)	0.09
Other, n (%)	106 (5.3)	175 (3.7)	<0.001

VATS, video-assisted thoracic surgery.

Table 4 Independent predictors of overall survival for patients with p-stage I–III NSCLC

Predictors of survival	Hazard ratio (95% CI)	P value
Age at surgery (ref: >60 years)	1.46 (1.28–1.65)	<0.001
Gender (ref: male)	1.25 (1.10–1.42)	<0.001
Smoking history (ref: non-smoker)	1.04 (0.92–1.18)	0.46
Charlson comorbidity index (ref: 0)	0.93 (0.84–1.02)	0.16
Surgical side (ref: right side)	0.97 (0.86–1.10)	0.41
Tumor size	1.01 (1.00–1.02)	<0.001
Histologic subtype (ref: adenocarcinoma)	0.92 (0.80–1.04)	0.50
pT stage (ref: T1)	0.54 (0.48–0.63)	<0.001
pN stage (ref: N0)	0.76 (0.65–0.87)	<0.001
Surgical approach (ref: VATS)	0.83 (0.74–0.94)	<0.001
Subgroup of excision extension		
Pneumonectomy (ref: VATS, n=164)	1.01 (0.36–1.66)	0.97
Bilobectomy (ref: VATS, n=418)	0.63 (0.32–0.94)	0.003
Lobectomy combined with sub-lobectomy (ref: VATS, n=431)	0.4 (0.10–0.69)	<0.001

NSCLC, non-small cell lung cancer; CI, confidence interval; ref, reference; VATS, video-assisted thoracic surgery.

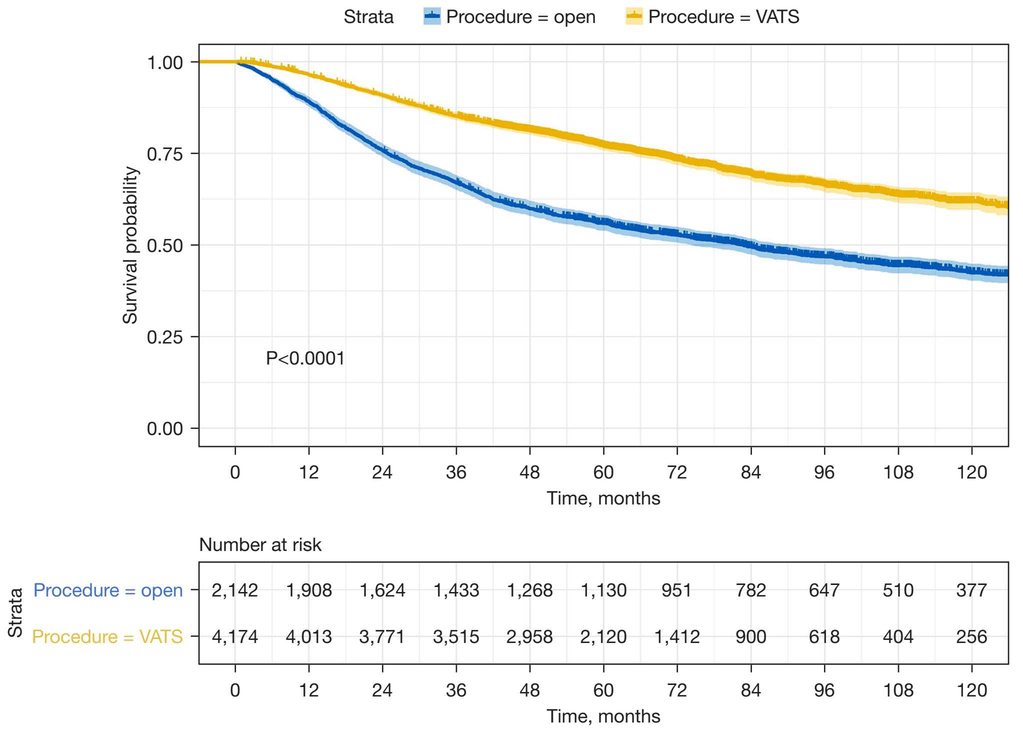

Figure 2 OS of p-stage I–III NSCLC patients stratified by VATS *vs.* open lobectomy. VATS, video-assisted thoracic surgery; OS, overall survival; NSCLC, non-small cell lung cancer.

52.6%, P<0.001) (*Figure 3*, Figure S1). The descriptions of recurrence sites or metastatic patterns are shown in *Table 3*. Multivariate adjusted survival analysis revealed that the VATS approach was associated with superior long-term survival [hazard ratio (HR) =0.83; 95% confidence interval (CI): 0.74–0.94; P<0.001] (*Table 4*). Other independent predictors of OS included age at the time of surgery, sex, tumor size, and pT and pN stages (*Table 4*).

After PSM analysis, compared with open major lung resection, major lung resection via VATS still had better OS, RFS and LCSS [5-year survival rate: 64.9% *vs.* 57.7%; 10-year survival rate: 47.8% *vs.* 42.6%, P<0.001; 5-year RFS: 50.3% *vs.* 45.3%, P=0.003; and LCSS (5-year LCSS rate: 71.2% *vs.* 63.0%; 10-year LCSS rate: 59.3% *vs.* 52.6%; P<0.001)] (*Figures 4,5*, Figure S2). According to our subgroup analysis, only stage II NSCLC patients who underwent major lung resection via VATS had better OS and RFS (OS: P<0.001; RFS: P=0.004), while the difference was not significant between stage I and stage III NSCLC patients.

Discussion

Owing to advances in television imaging systems and endoscopic cutting and suturing instruments in the 2000s, thoracoscopic surgery has been developed rapidly, and an increasing number of complex surgeries have been performed through thoracoscopic surgery in recent years. However, despite the various benefits of minimally invasive surgery, it still needs to be proven that its perioperative outcomes and long-term survival are not inferior to those of conventional surgery before it can be called a more advanced surgical approach (15,16). VATS has long been validated worldwide for its safety and efficacy (17-25). The advantages of the VATS operation over the open operation are that it results in less trauma to the patient and faster postoperative recovery. However, the most worrying aspect of major lung resection in VATS is that it could have limited visibility and handling capabilities compared to open surgery. According to published results, major lung resection via VATS is not only noninferior but also has lower 90-day mortality rates, less pain, fewer complications and better quality of life without compromising oncologic outcomes (18,22,25). Previously reported outcomes have been dominated by perioperative outcomes and 5-year survival outcomes, with little mention of long-term survival outcomes beyond 10 years. The aim of this study was to

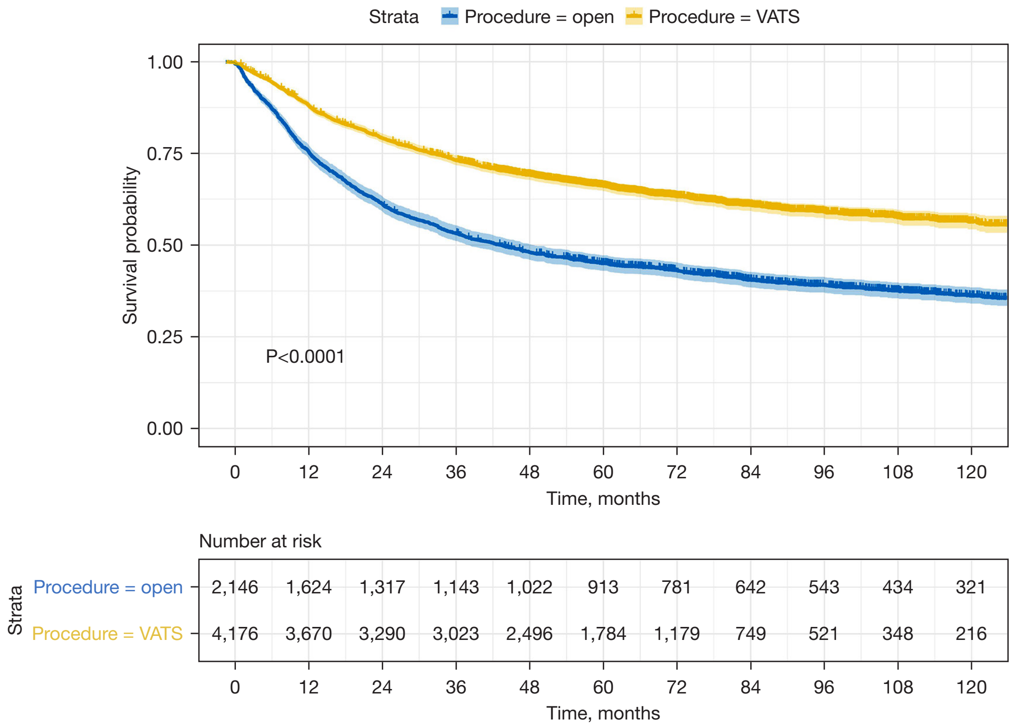

Figure 3 Recurrence-free survival of p-stage I–III NSCLC patients stratified by surgery *vs.* open lobectomy. VATS, video-assisted thoracic surgery; NSCLC, non-small cell lung cancer.

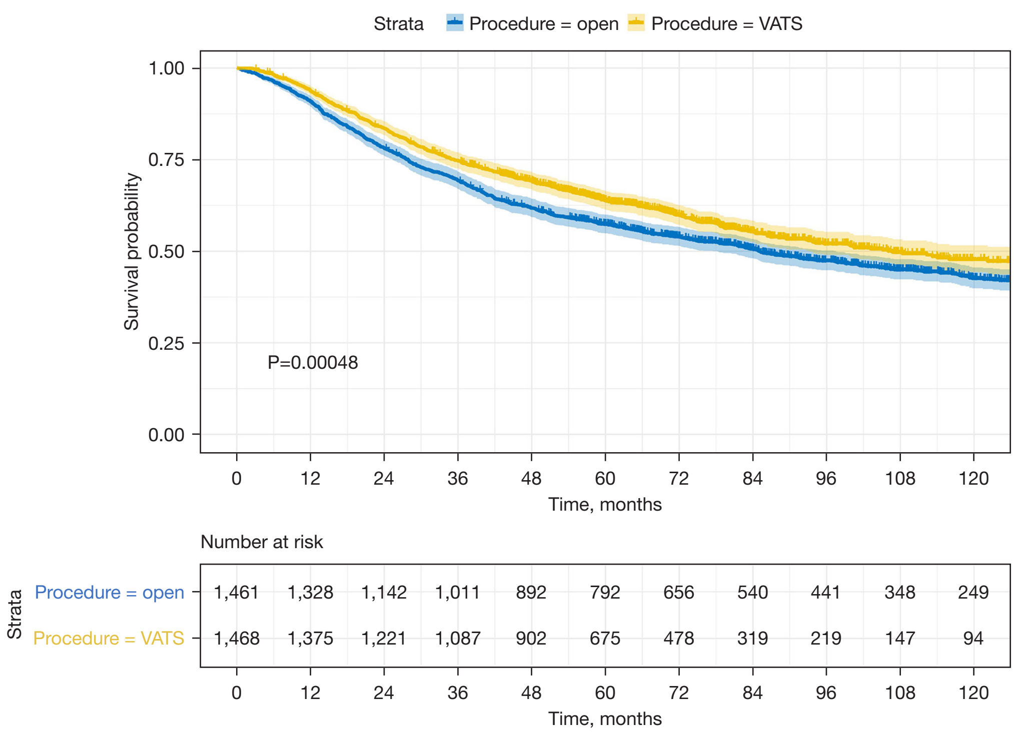

Figure 4 Overall survival of p-stage I–III NSCLC patients stratified by VATS *vs.* open lobectomy after propensity score-matched analysis. NSCLC, non-small cell lung cancer; VATS, video-assisted thoracic surgery.

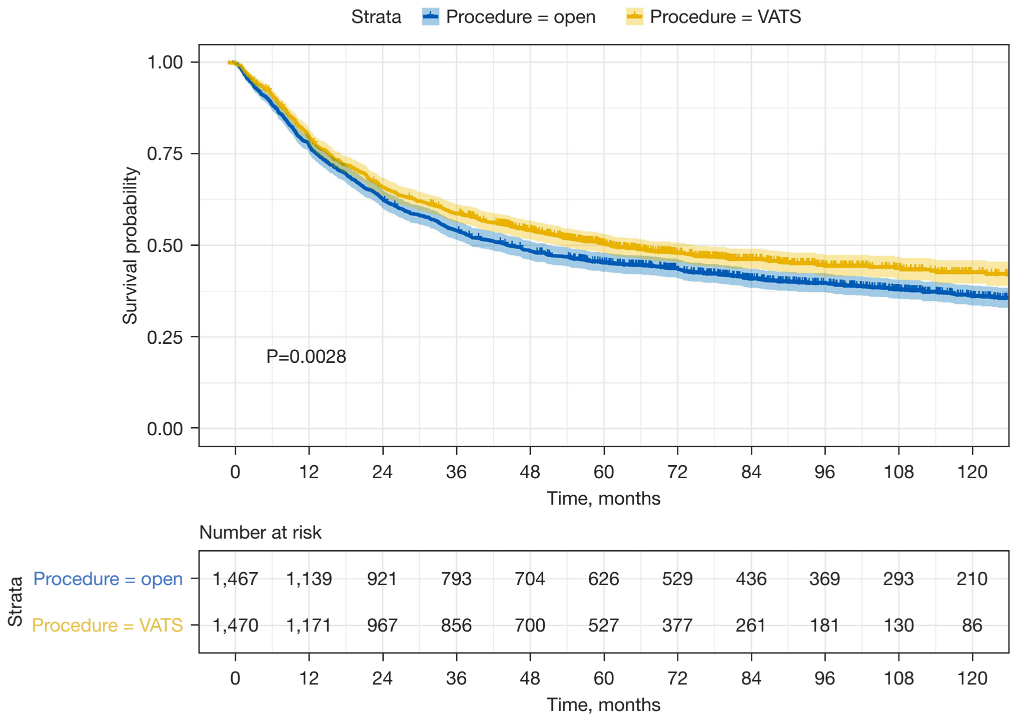

Figure 5 Recurrence free survival of p-stage I–III NSCLC patients stratified by VATS *vs.* open lobectomy after propensity score-matched analysis. NSCLC, non-small cell lung cancer; VATS, video-assisted thoracic surgery.

report long-term follow-up data from a high-volume center and to analyze the differences in perioperative outcomes and long-term survival outcomes between VATS major lung resection and open major lung resection.

In this study, we enrolled stage III NSCLC patients to investigate whether VATS was suitable for this group of patients. To answer the question of whether this group of patients is suitable for VATS, the present study included patients who underwent extended major lung resection rather than solely lobectomy, which included pneumonectomy, bilobectomy and lobectomy combined with sublobectomy. Our results showed that patients who underwent bilobectomy or lobectomy combined with sublobectomy had better survival times than did patients who underwent VATS alone, and there was no significant difference in survival time between the two surgical approaches for patients who underwent pneumonectomy (*Table 4*).

The most important finding of this study was that patients with stage I–III NSCLC who underwent major lung resection via VATS had better 10-year OS and 5-year RFS times than did those who underwent open major lung resection in both the unmatched and matched cohorts. In terms of perioperative outcomes, the overall postoperative complication rate in the VATS group was not significantly different from that in the open group. Notably, prolonged air leakage (>5 days) was more common in the VATS group after matching. However, there was no significant difference in postoperative chest tube duration. The VATS group had less intraoperative bleeding and shorter operative times and postoperative hospital stays than did the open group, which is consistent with the findings of many retrospective studies (9,11,12,26,27). Therefore, we believe that VATS is a safer surgical procedure than open surgery.

In our study, we found that the VATS approach was more expensive than the open approach because of the higher cost of surgical consumables. Several previous reports have shown that the increased surgical costs of major lung resection via VATS are compensated for by lower postoperative costs, improved postoperative prognosis and shorter hospital stays (14,28-30). In China, VATS is not more cost-efficient than is open surgery because of the use of staplers and other cost-related sealants or developing instruments, despite their potential to shorten hospital stays. This is attributed to the health care insurance system in China, which significantly reduces hospitalization costs, making them far lower than the costs of consumables.

Regarding survival outcomes, many articles have concluded that there is no significant difference in survival between patients who underwent major lung resection via VATS and those who underwent open surgery (26,27,31-33), and even patients who underwent open surgery had better survival outcomes (13). To reduce bias, we performed PSM on the included patients and stratified the matched patients by p-TNM stage. After matching, we found that the advantages of major lung resection in terms of OS and RFS were associated with stage II NSCLC. This result differs from the data provided by other national databases, and the discrepancy may be due to differences in the development of VATS and open surgery for major lung resection (34-36). For stage I and III patients, the choice of surgical approach did not affect their survival outcomes, as confirmed in other articles (26,31,37). Overall, VATS is the preferred surgical option for patients with stage I–III NSCLC with better long-term survival outcomes and superior perioperative outcomes.

Limitations to this study should also be acknowledged. First, this was a retrospective study. Although the Cox regression model and PSM can help reduce bias, the retrospective nature of the study may have led to unobserved confounding and selection bias between the two groups. Second, this was a single-center study from a high-volume center in China. Whether this study is representative of the reality in China requires further confirmation in a larger multicenter study. Finally, the proportion of VATS lobectomies increased annually over the study period, from 6.6% in 2006 to 96.5% in 2018. As an increasing number of lung cancer resections are performed via VATS, comparative studies are somewhat biased over time, and this bias is difficult to eliminate by PSM analysis.

Conclusions

In summary, the present study confirmed that major lung resection via VATS provides better 5-year RFS and 10-year OS than does the open approach. VATS major lung resection could be considered the preferred surgical option for stage I–III NSCLC due to its better survival outcomes and advantages of less blood loss and shorter postoperative hospital stays.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-150/rc

Data Sharing Statement: Available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-150/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-150/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study conformed to the provisions of the Declaration of Helsinki (as revised in 2013) and was approved by the Institutional Review Board (IRB) of West China Hospital (No. 2023-1406). Individual consent for this retrospective analysis was waived.

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