Original Article

Comparison of robot-assisted and video-assisted thoracic sleeve lobectomy in non-small cell lung cancer: insights from a high-volume center

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Background: Although minimally invasive sleeve lobectomy (SL) preserves lung function, it is a complex and demanding thoracic surgical technique. This study aimed to evaluate perioperative and long-term outcomes of robot-assisted thoracic surgery (RATS) versus video-assisted thoracic surgery (VATS) in patients with non-small cell lung cancer (NSCLC) undergoing SL, and explore the safety and feasibility of robot-assisted SL in patients following neoadjuvant therapy.

Methods: A retrospective analysis was performed on a cohort of patients diagnosed with NSCLC who underwent minimally invasive SL at a high-volume center between December 2019 and February 2023. Demographic characteristics, perioperative outcomes, and survival rates were compared between the RATS and VATS groups.

Results: The study enrolled 347 patients with NSCLC, 78 (22.5%) patients received RATS and 269 (77.5%) patients received VATS. In the overall cohort, the RATS group was associated with a greater number of dissected lymph nodes (18.0 *vs.* 16.0; P=0.048) and a lower conversion rate (6.4% *vs.* 18.2%; P=0.01) than the VATS group. The overall median follow-up for the entire cohort was 34 [interquartile range (IQR), 26–42] months, with 30 (IQR, 26–38) months in the RATS group and 35 (IQR, 25–44) months in the VATS group. The Kaplan-Meier survival curves showed no significant difference in overall survival and progression-free survival (P=0.68 and P=0.98, respectively) between the groups.

Conclusions: Robot-assisted SL shows comparable results to VATS group for perioperative and long-term tumor prognosis. For patients who have received neoadjuvant therapy, robot-assisted SL is a safe and feasible option.

Keywords: Neoadjuvant therapy; non-small cell lung cancer (NSCLC); robot-assisted thoracic surgery (RATS); sleeve lobectomy (SL); video-assisted thoracic surgery (VATS)

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Introduction

Lung cancer is the leading cause of cancer-related death worldwide and surgery plays an important of lung cancer treatment (1). For centrally located non-small cell lung cancer (NSCLC), sleeve resection preserves more lung function and improves the quality of patient survival compared to pneumonectomy (PN), with comparable long-term outcomes (2-4). Sleeve resections have typically been performed via thoracotomy (5). Recent advancements in minimally invasive surgery (MIS) have led to more studies confirming its efficacy. MIS, including both video-assisted thoracic surgery (VATS) and robot-assisted thoracic surgery (RATS), enables safe bronchial sleeve lobectomies and offers comparable operative times, reduced postoperative hospital stays, and similar perioperative and oncological outcomes compared to traditional open thoracotomy (6).

As an emerging technology, RATS potentially improves the precision and success of complex surgical procedures through advanced three-dimensional imaging and precise instruments. The first robotic sleeve surgery was performed on a cadaver in 2006 (7). Nakamura *et al.* reported the first robotic bronchoplastic lung resection in a 56-year-old lung cancer patient in 2013 (8). Afterward, several sleeve lobectomies via RATS confirmed its safety and feasibility for NSCLC (9,10). However, few studies have compared the effectiveness of robot-assisted and video-assisted sleeve lobectomy (SL), particularly in neoadjuvant patients (11,12).

Therefore, our study aimed to compare the perioperative and oncological outcomes of robot-assisted SL with conventional video-assisted surgical techniques in a high-volume center, including a detailed analysis of the neoadjuvant subgroup population. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1810/rc).

Highlight box

Key findings

- In minimally invasive sleeve lobectomy (SL), robot-assisted thoracic surgery (RATS) is associated with a higher number of lymph nodes dissected and a lower conversion rate compared to video-assisted thoracic surgery (VATS) in non-small cell lung cancer (NSCLC) patients. Furthermore, for patients who receive neoadjuvant therapy, robot-assisted SL is considered a safe and feasible option.

What is known and what is new?

- With the advancement of minimally invasive thoracic surgery, VATS has been proven safe and feasible for complex procedures, including SL. In recent years, studies on RATS for SL have also emerged progressively. However, comparisons between these two minimally invasive approaches and their long-term survival outcomes are still lacking.
- The perioperative outcomes and long-term survival of two minimally invasive approaches were compared, along with their application in neoadjuvant therapy patients.

What is the implication, and what should change now?

- Robot-assisted SL is a safe and feasible option for NSCLC patients, including those treated with neoadjuvant therapy.

Methods

Study design

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Shanghai Pulmonary Hospital (No. K24-332; approval date: 26 April 2024). Patients enrolled in this study provided informed consent.

The study included all consecutive patients who underwent minimally invasive SL in Shanghai Pulmonary Hospital from December 2019 to February 2023. Patients were excluded for: (I) benign disease; (II) small cell lung cancer (SCLC); (III) missing data; and (IV) lost to follow-up.

Each patient requiring SL or PN undergoes a multidisciplinary evaluation in our department to determine the most suitable surgical approach. The decision regarding whether to perform SL or PN, and the choice of surgical technique (VATS, RATS, or open surgery), is influenced by multiple factors, including comprehensive team discussions, individual surgeon preferences based on clinical judgment, and patient-specific considerations such as personal preferences and economic factors (13,14). Patients in the RATS group underwent robotic surgery using the Da Vinci Xi system (Intuitive Surgical, Inc., Santa Clara, CA, USA).

All patients underwent a preoperative evaluation, including high-resolution chest computed tomography, bronchoscopy, pulmonary and cardiac function tests, blood gas analysis, and basic laboratory tests. Brain magnetic resonance imaging (MRI), abdominal ultrasonography, and bone scintigraphy were performed to evaluate the presence of distant metastases. The patient data were collected and analyzed, including demographics, preoperative assessments, and perioperative factors. Tumor-node-metastasis (TNM) staging was determined based on the 8th

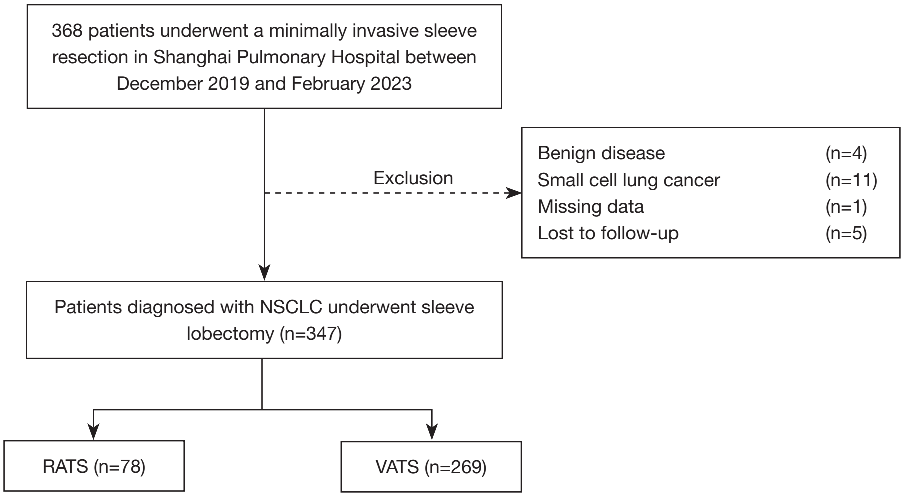

Figure 1 Flow diagram of patient selection steps. NSCLC, non-small cell lung cancer; RATS, robot-assisted thoracic surgery; VATS, video-assisted thoracic surgery.

edition of the American Joint Committee on Cancer (AJCC) staging system.

Outcomes measured

Prolonged air leakage was defined as persisting for more than 7 days postoperatively (15). Postoperative care was standardized for all patients, irrespective of the surgical approach (16). Follow-up was performed through outpatient visits or telephonic interviews. Overall survival (OS) was calculated from the surgery date to the date of death from any cause, or the last follow-up. Progression-free survival (PFS) was defined as the interval from the date of surgery to the first occurrence of disease progression, death from any cause, or the last follow-up. Follow-up continued until death or the latest follow-up date of December 28, 2024.

Statistical analysis

Normally distributed continuous variables were presented as the mean ± standard deviation and analyzed using Student's *t*-test. Non-normally distributed continuous variables were represented as the median and interquartile range (IQR) and analyzed with the Mann-Whitney *U* test. Categorical variables were examined using the chi-square test or Fisher's exact test as appropriate. OS analysis was performed using the log-rank test and depicted by Kaplan-Meier curves. Statistical analyses were performed using R software (version 4.1.3), with a significance threshold set at P<0.05.

Results

Baseline characteristics

Between December 2019 and February 2023, 368 consecutive patients underwent minimally invasive SL for centrally located NSCLC. As detailed in *Figure 1*, four patients with pathologically confirmed benign disease, eleven patients diagnosed with SCLC and six patients without complete clinical or survival data were excluded from the current study. The study enrolled 347 patients into the final cohort, with 78 (22.5%) patients receiving RATS and 269 (77.5%) receiving VATS. Most of the patients were male (89.6%, 311/347), and most had a history of smoking (76.9%, 267/347). The forced expiratory volume in 1 second was similar between the RATS and VATS groups [2.48 (IQR, 2.14–2.83) *vs.* 2.39 (IQR, 2.00–2.78) L, P=0.16]. Squamous carcinoma was the most common histology (75.6% *vs.* 75.5%; P=0.42). Of the 92 (26.5%) patients who underwent neoadjuvant therapy, 16 (20.5%) underwent RATS, and 76 (28.3%) received VATS (P=0.17) (*Table 1*).

Perioperative outcomes

Compared with the VATS group, the RATS group had a lower rate of conversion to thoracotomy (6.4% *vs.* 18.2%; P=0.01) and significantly more lymph nodes dissected [18.0 (IQR, 15.0–22.8) *vs.* 16.0 (IQR, 13.0–22.0), P=0.048]. No significant differences for the number of stations of lymph nodes dissected [6 (IQR, 6–7) *vs.* 6 (IQR, 6–7), P=0.38],

Table 1 Baseline clinical characteristics of the patients underwent minimally invasive sleeve lobectomy

Variables	Overall (n=347)	RATS (n=78)	VATS (n=269)	P
Age (years)				0.50
>65	131 (37.8)	32 (41.0)	99 (36.8)	
≤65	216 (62.2)	46 (59.0)	170 (63.2)	
Gender				0.22
Male	311 (89.6)	67 (85.9)	244 (90.7)	
Female	36 (10.4)	11 (14.1)	25 (9.3)	
Smoking history				>0.99
No	267 (76.9)	60 (76.9)	207 (77.0)	
Yes	80 (23.1)	18 (23.1)	62 (23.0)	
BMI (kg/m^2)	24.53±3.11	24.64±3.40	24.50±3.03	0.71
FEV1 (L)	2.43 (2.02–2.80)	2.48 (2.14–2.83)	2.39 (2.00–2.78)	0.16
ECOG score				0.66
0	316 (91.1)	72 (92.3)	244 (90.7)	
1	31 (8.9)	6 (7.7)	25 (9.3)	
Tumor location				0.17
RLL	41 (11.8)	8 (10.3)	33 (12.3)	
RML	18 (5.2)	6 (7.7)	12 (4.5)	
RUL	133 (38.3)	22 (28.2)	111 (41.3)	
LLL	61 (17.6)	15 (19.2)	46 (17.1)	
LUL	94 (27.1)	27 (34.6)	67 (24.9)	
Histology				0.42
Squamous carcinomas	262 (75.5)	59 (75.6)	203 (75.5)	
Adenocarcinoma	47 (13.5)	8 (10.3)	39 (14.5)	
Others	38 (11.0)	11 (14.1)	27 (10.0)	
pT stage				0.07
T1	15 (4.3)	3 (3.8)	12 (4.5)	
T2	278 (80.1)	70 (89.7)	208 (77.3)	
T3	34 (9.8)	4 (5.1)	30 (11.2)	
T4	20 (5.8)	1 (1.3)	19 (7.1)	
pN stage				0.46
N0	190 (54.8)	46 (59.0)	144 (53.5)	
N1	90 (25.9)	16 (20.5)	74 (27.5)	
N2	67 (19.3)	16 (20.5)	51 (19.0)	

Table 1 (*continued*)

Table 1 (*continued*)

Variables	Overall (n=347)	RATS (n=78)	VATS (n=269)	P
pTNM stage				0.18
I	142 (40.9)	39 (50.0)	103 (38.3)	
II	112 (32.3)	21 (26.9)	91 (33.8)	
III	93 (26.8)	18 (23.1)	75 (27.9)	
Neoadjuvant therapy				0.17
No	255 (73.5)	62 (79.5)	193 (71.7)	
Yes	92 (26.5)	16 (20.5)	76 (28.3)	

Data are presented as mean ± SD, n (%), or median (IQR). BMI, body mass index; ECOG, Eastern Cooperative Oncology Group; FEV1, forced expiratory volume in 1 second; IQR, interquartile range; LLL, left lower lobe; LUL, left upper lobe; pTNM, pathological tumor-node-metastasis; RATS, robot-assisted thoracic surgery; RLL, right lower lobe; RML, right middle lobe; RUL, right upper lobe; SD, standard deviation; VATS, video-assisted thoracic surgery.

operative time [205.0 (IQR, 179.3–250.0) *vs.* 193.0 (IQR, 154.0–240.0) min, P=0.13], intraoperative blood loss [50 (IQR, 50–100) *vs.* 50 (IQR, 50–100) mL, P=0.93], postoperative hospital stay [5.5 (IQR, 4.0–7.0) *vs.* 5.0 (IQR, 4.0–7.0) days, P=0.82], and drainage volume for the initial 3 days [675.0 (IQR, 550.0–897.5) *vs.* 720.0 (IQR, 530.0–950.0) mL, P=0.50], as detailed in *Table 2*.

The total incidence of complications was 18.4% (64/347), with no significant difference between the RATS and VATS groups (19.2% *vs.* 18.2%; P=0.84). After the operation, bronchopleural fistulae (BPF) were observed in five patients: one in the RATS group and four in the VATS group. One patient (0.4%) in the VATS group died due to a BPF, 1 patient (1.3%) in the RATS group died of acute respiratory distress syndrome due to severe lung infection within 30 days after the operation. However, there was no significant difference in mortality rates within 30 days postoperatively (P>0.05) between the groups.

Long-term outcomes

The overall median follow-up for the whole cohort was 34 (IQR, 26–42) months, with 30 (IQR, 26–38) months in the RATS group and 35 (IQR, 25–44) months in the VATS group. At the last follow-up, 32 patients were confirmed dead and a total of 73 patients experienced recurrence or metastasis. The Kaplan-Meier survival curves showed no significant difference in OS and PFS (P=0.68 and P=0.98, respectively) between the groups (*Figure 2*).

Neoadjuvant therapy subgroup analysis

In the neoadjuvant treatment subgroup, the main modalities of neoadjuvant therapy included immune-combination chemotherapy 69.6% (64/92), neoadjuvant chemotherapy 22.8% (21/92), targeted therapy 5.4% (5/92) and chemotherapy combined with anti-vascular 2.2% (2/92). There was no statistical difference in neoadjuvant modality between the two groups (P=0.85).

After neoadjuvant therapy, tissue necrosis and structural changes in lung tumors pose challenges for surgery, particularly in patients with central lung cancer undergoing SL. Evaluation of RATS versus VATS for SL following neoadjuvant therapy revealed that among 92 patients scheduled for the procedure, 16 (17.4%) underwent RATS and 76 (82.6%) underwent VATS. No significant differences between the groups in baseline characteristics, as detailed in *Table 3*.

The median operative time for RATS [227.5 (IQR, 200.0–272.5) min] was comparable to VATS [209.0 (IQR, 173.8–252.5) min; P=0.25]. No significant difference was found between the RATS (n=1, 6.2%) and VATS (n=13, 17.1%) groups in the conversion rate after neoadjuvant therapy (P=0.27). However, the conversion rate to thoracotomy in the robotic surgery group remains lower than that observed in the thoracoscopic surgery group. In addition, no significant differences were found in postoperative complication rates (P=0.67) or 30-day mortality (P=0.64). It's worth noting that all five patients

Table 2 Perioperative outcomes comparisons between RATS and VATS groups

Variables	Overall (n=347)	RATS (n=78)	VATS (n=269)	P
Operative time (min)	200.0 [158.5–242.5]	205.0 [179.3–250.0]	193.0 [154.0–240.0]	0.13
Estimated blood loss (mL)	50 [50–100]	50 [50–100]	50 [500–100]	0.93
Conversion to thoracotomy				0.01
No	293 (84.4)	73 (93.6)	220 (81.8)	
Yes	54 (15.6)	5 (6.4)	49 (18.2)	
Blood transfusion				
No	326 (93.9)	76 (97.4)	250 (92.9)	0.14
Yes	21 (6.1)	2 (2.6)	19 (7.1)	
Drainage duration (days)	5.0 [4.0–7.0]	6.0 [4.0–7.0]	5.0 [4.0–7.0]	0.63
Drainage amount in 3 days (mL)	700.0 [540.0–910.0]	675.0 [550.0–897.5]	720.0 [530.0–950.0]	0.50
Hospital stay (days)	5.0 [4.0–7.0]	5.5 [4.0–7.0]	5.0 [4.0–7.0]	0.82
Lymph nodes				
Total numbers	17.0 [13.0–22.0]	18.0 [15.0–22.8]	16.0 [13.0–22.0]	0.048
Total stations	6 [6–7]	6 [6–7]	6 [6–7]	0.38
Postoperative complications	64 (18.4)	15 (19.2)	49 (18.2)	0.84
Prolonged air leak	33 (9.5)	10 (12.8)	23 (8.6)	0.26
Hydrothorax	31 (8.9)	5 (6.4)	26 (9.7)	0.37
Empyema	3 (0.9)	1 (1.3)	2 (0.7)	0.65
Pneumonia	21 (6.1)	5 (6.4)	16 (5.9)	0.90
Bronchopleural fistula	5 (1.4)	1 (1.3)	4 (1.5)	0.89
Readmission within 30 days	11 (3.2)	3 (3.8)	8 (3.0)	0.70
Reoperation within 30 days	8 (2.3)	2 (2.6)	6 (2.2)	0.86
Mortality within 30 days	2 (0.6)	1 (1.3)	1 (0.4)	0.35

Data are presented as n (%) or median [IQR]. IQR, interquartile range; RATS, robot-assisted thoracic surgery; VATS, video-assisted thoracic surgery.

who developed postoperative BPF had undergone neoadjuvant therapy (RATS =1; VATS =4). Therefore, precise manipulation is crucial for patients undergoing neoadjuvant therapy. In the neoadjuvant treatment subgroup, no significant difference between the groups was found in OS and PFS (P=0.67 and P=0.85, respectively) (*Figure 2*), as detailed in *Table 4*.

Discussion

This retrospective study evaluated the effects of robot-assisted SL on perioperative and oncological outcomes in patients diagnosed with NSCLC. We found that RATS group had an advantage over VATS group in removing more lymph nodes with a lower conversion rate to thoracotomy. No significant differences in complications and survival were observed in the neoadjuvant therapy subgroup between the groups. Compared to VATS, RATS is safe and feasible for SL, even in patients who have received neoadjuvant therapy.

Considering the intricacy and complexity of bronchial anastomosis, SL remains challenging for surgeons. Although thoracotomy surgery provides a broader field of view and greater surgical flexibility, it may cause significant surgical trauma and slower postoperative recovery. MIS approaches are now considered safe and feasible for

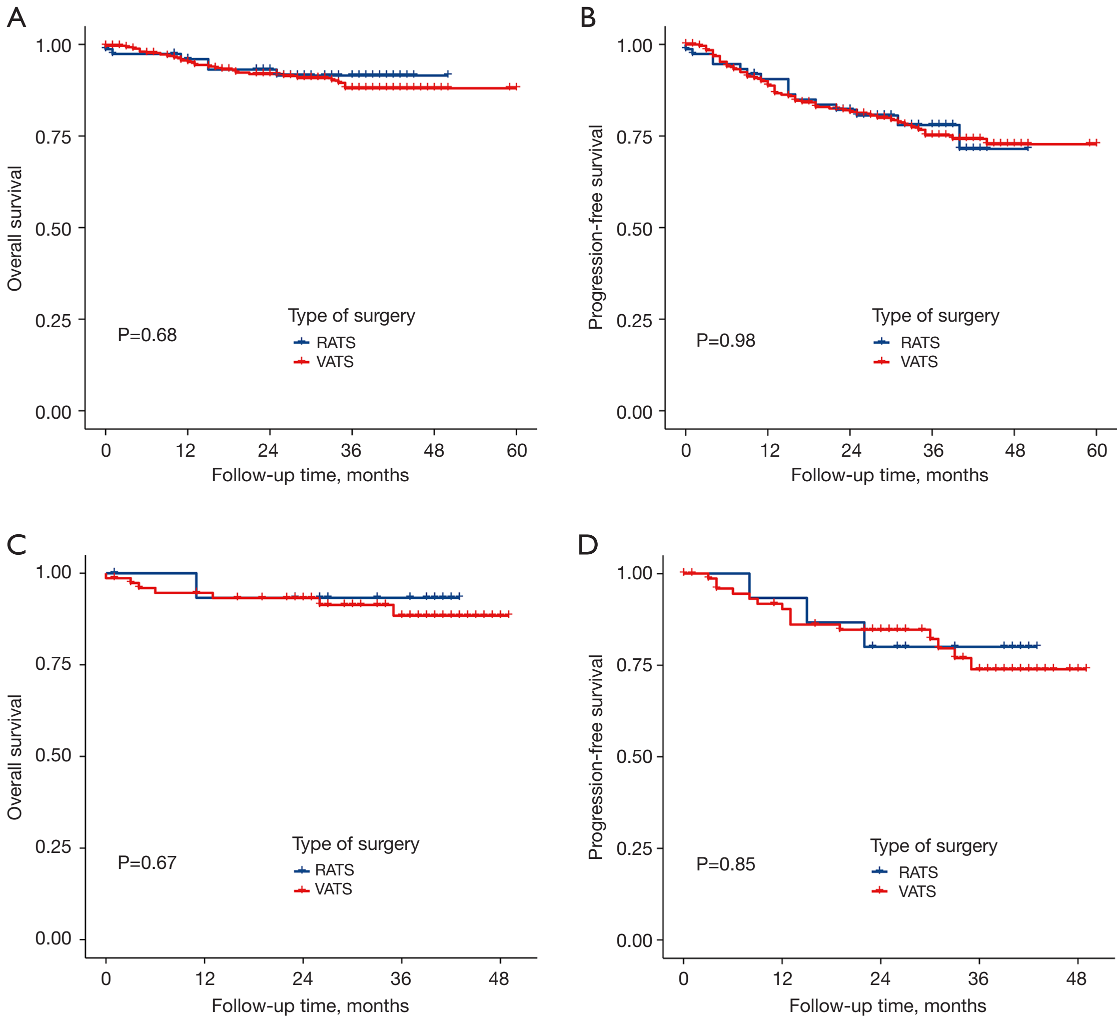

Figure 2 Kaplan-Meier survival curves of overall survival (A) and progression-free survival (B) in the entire cohort; Kaplan-Meier survival curves of overall survival (C) and progression-free survival (D) in neoadjuvant subgroup. RATS, robot-assisted thoracic surgery; VATS, video-assisted thoracic surgery.

bronchial sleeve resection compared with thoracotomy (17). As the proficiency in endoscopic suturing and tying techniques increases with VATS, some experienced centers have begun exploring VATS sleeve resection. VATS offers similar operation times, shorter postoperative hospital stays, and improved recovery (11,18).

Surgical bronchial anastomosis and reconstruction under endoscopy are relatively demanding for surgeons (19). Robotic surgical systems with three-dimensional vision and Endo Wrist technology allow surgeons to perform suturing and knotting on small anatomical structures. Therefore, robotic assistance facilitates the performance of numerous complex thoracic surgeries (20, 21).

In a study of Qiu *et al.* (11), robotic-assisted surgery demonstrated shorter operative and drainage time without significantly different short-term postoperative prognoses compared to VATS and open techniques. Jin *et al.* reported shorter operative times, more lymph node removal, and slower postoperative recovery times for robotic-assisted surgery (12). These experiences provide preliminary evidence that robotic surgery is safe, feasible, and effective as a new minimally invasive procedure.

Squamous carcinomas are the pathologically predominant type in patients undergoing sleeve surgery (11,12,18), consistent with our study (75.5%). Surgical time is calculated from the incision start and does not include the

Table 3 Baseline clinical characteristics of the neoadjuvant therapy patients underwent minimally invasive sleeve lobectomy

Variables	Overall (n=92)	RATS (n=16)	VATS (n=76)	P
Age (years)				0.13
>65	31 (33.7)	8 (50.0)	23 (30.3)	
≤65	61 (66.3)	8 (50.0)	53 (69.7)	
Gender				0.002
Male	88 (95.7)	13 (81.2)	75 (98.7)	
Female	4 (4.3)	3 (18.8)	1 (1.3)	
Smoking history				0.55
No	74 (80.4)	12 (75.0)	62 (81.6)	
Yes	18 (19.6)	4 (25.0)	14 (18.4)	0.35
BMI (kg/m^2)	24.48±3.26	25.18±3.55	24.33±3.21	0.85
FEV1 (L)	2.46 (2.19–2.84)	2.33 (2.13–2.84)	2.46 (2.19–2.84)	
ECOG score				0.82
0	85 (92.4)	15 (93.8)	70 (92.1)	
1	7 (7.6)	1 (6.2)	6 (7.9)	
Tumor location				0.98
RLL	10 (10.9)	2 (12.5)	8 (10.5)	
RUL	44 (47.8)	7 (43.8)	37 (48.7)	
LLL	17 (18.5)	3 (18.8)	14 (18.4)	
LUL	21 (22.8)	4 (25.0)	17 (22.4)	
Histology				0.51
Squamous carcinomas	74 (80.4)	13 (81.2)	61 (80.3)	
Adenocarcinoma	13 (14.1)	3 (18.8)	10 (13.2)	
Others	5 (5.4)	0	5 (6.6)	
pT stage				0.66
T1	11 (12.0)	2 (12.5)	9 (11.8)	
T2	74 (80.4)	14 (87.5)	60 (78.9)	
T3	3 (3.3)	0	3 (3.9)	
T4	4 (4.3)	0	4 (5.3)	
pN stage				0.11
N0	52 (56.5)	8 (50.0)	44 (57.9)	
N1	17 (18.5)	1 (6.2)	16 (21.1)	
N2	23 (25.0)	7 (43.8)	16 (21.1)	
pTNM stage				0.26
I	47 (51.1)	8 (50.0)	39 (51.3)	
II	17 (18.5)	1 (6.2)	16 (21.1)	
III	28 (30.4)	7 (43.8)	21 (27.6)	

Data are presented as mean ± SD, n (%), or median (IQR). BMI, body mass index; ECOG, Eastern Cooperative Oncology Group; FEV1, forced expiratory volume in 1 second; IQR, interquartile range; LLL, left lower lobe; LUL, left upper lobe; pTNM, pathological tumor-node-metastasis; RATS, robot-assisted thoracic surgery; RLL, right lower lobe; RUL, right upper lobe; SD, standard deviation; VATS, video-assisted thoracic surgery.

Table 4 Perioperative outcomes comparisons in neoadjuvant therapy subgroups

Variables	Overall (n=92)	RATS (n=16)	VATS (n=76)	P
Operative time (min)	212.0 [180.0–261.3]	227.5 [200.0–272.8]	209.0 [173.8–252.5]	0.25
Estimated blood loss (mL)	100.0 [50.0–100.0]	50.0 [50.0–100.0]	100.0 [50.0–112.5]	0.32
Conversion to thoracotomy				0.27
No	78 (84.8)	15 (93.8)	63 (82.9)	
Yes	14 (15.2)	1 (6.2)	13 (17.1)	
Blood transfusion				0.70
No	84 (91.3)	15 (93.8)	69 (90.8)	
Yes	8 (8.7)	1 (6.2)	7 (9.2)	
Drainage duration (days)	6.00 [5.00–7.00]	6.50 [5.00–7.25]	6.00 [5.00–7.00]	0.29
Drainage amount in 3 days (mL)	715.0 [545.0–922.5]	710.0 [637.5–897.5]	725.0 [530.0–935.0]	0.82
Hospital stay (days)	6 [5–7]	6 [5–7]	6.00 [5–7]	0.54
Lymph nodes				
Total numbers	7.00 [6.00–8.00]	7.50 [6.75–8.00]	7.00 [6.00–7.00]	0.15
Total stations	19.00 [15.00–23.25]	21.00 [16.50–26.25]	19.00 [15.00–22.25]	0.20
Postoperative complications	27 (29.3)	4 (25.0)	23 (30.3)	0.67
Prolonged air leak	14 (15.2)	2 (12.5)	12 (15.8)	0.74
Hydrothorax	11 (12.0)	0	11 (14.5)	0.10
Empyema	3 (3.3)	1 (6.2)	2 (2.6)	0.46
Pneumonia	8 (8.7)	1 (6.2)	7 (9.2)	0.70
Bronchopleural fistula	5 (5.4)	1 (6.2)	4 (5.3)	0.87
Readmission within 30 days	8 (8.7)	2 (12.5)	6 (7.9)	0.55
Reoperation within 30 days	6 (6.5)	1 (6.2)	5 (6.6)	0.96
Mortality within 30 days	1 (1.1)	0	1 (1.3)	0.64

Data are presented as n (%) or median [IQR]. IQR, interquartile range; RATS, robot-assisted thoracic surgery; VATS, video-assisted thoracic surgery.

docking time. In contrast to findings from earlier studies, our study found no significant difference in operating time between the RATS and VATS groups (205.0 *vs.* 193.0 min; P=0.13). This inconsistency in surgical time might be attributed to factors such as proficiency in robotic surgery and the potential inconvenience of changing instruments on the robotic arm during the procedure. This finding emphasizes the necessity for coordination between the operator and assistant. The extensive experience (16,22) of thoracoscopic surgery in our center may have increased our proficiency in VATS, contributing to the inconsistency in results. Lymph node dissection is a simple indicator for assessing the quality of lung cancer surgery (18). In our study, the vision and precision benefits of robotic systems in the robotic group enabled the dissection of more lymph nodes during surgery, consistent with previous reports (6,12).

Thoracotomy conversion compensates for intraoperative complications or stalled progress during MIS and should be promptly undertaken as needed (23). In our study, 6.4% and 18.2% of patients in the RATS and VATS groups underwent thoracotomy conversion, consistent with previous reports in which robot-assisted SL had a 6% conversion rate (24) and video-assisted SL had a greater rate (4.5–21.1%) (25). Servais *et al.* (24) reported that conversion from minimally invasive to thoracotomy was associated with increased morbidity and mortality; compared to RATS (6.0%), the VATS conversion rate was greater (11.0%). Conversion cases from RATS due to vascular injuries were more frequent, but the rates of major complications and mortality were statistically similar between the groups. Based on our experience, if a tumor is tightly adherent to the hilar vessels and requires angioplasty during SL, an immediate conversion to thoracotomy may be necessary for surgical safety, depending on the surgeon's discretion and the specific circumstances. Extensive intrapulmonary adhesion is also a risk factor for conversion. Further exploration is needed to determine whether robotic minimally invasive sleeve resections reduce the risk of conversion to thoracotomy without risking safety.

We present the first study to compare robotic and thoracoscopic approaches to sleeve surgery following neoadjuvant therapy. For patients with potentially resectable advanced central NSCLC, neoadjuvant therapy can shrink the tumor and lymph nodes, enabling surgical intervention and extending survival (26-29). According to previous reports from our center (22,30), the percentage of patients who have received neoadjuvant therapy for sleeve surgery has been rising significantly in recent years. Sleeve surgery is therefore particularly important in an era when neoadjuvant treatment modalities are being promoted. However, neoadjuvant therapy may cause adhesions and fibrosis around the hilum, increasing the difficulty and risk of surgery. Thus, selecting a safe and precise surgical approach for post-neoadjuvant sleeve procedures is crucial. In this study, we aim to explore the application of robotic surgery in achieving this objective. Reports on robot-assisted sleeve resections after neoadjuvant therapy are scarce, and there is a lack of comparison with other surgical modalities (31,32). Our study provides preliminary indications, yet a larger sample size is needed for further investigation.

Limitations

There are some limitations in this study. First, there is a potential for selection bias since this retrospective analysis was conducted at a single center. Second, we recognize that the follow-up duration may be insufficient for a comprehensive evaluation, leaving long-term prognosis still to be explored. Third, our study did not include specific data on individual surgeons; thus, we could not assess the impact of their personal workload or learning curve. Finally, we did not comprehensively address the economic and logistical aspects of robotic SL, but we plan to expand our data collection and incorporate these factors in future studies to provide a more thorough analysis. In addition, our findings need validation through larger-scale retrospective studies or randomized clinical trials.

Conclusions

Compared to VATS, RATS was associated with a higher number of lymph nodes dissected and a lower conversion rate, indicating its advantage in performing challenging lymph node dissections. Furthermore, the neoadjuvant therapy followed by robot-assisted SL might be considered a safe and feasible treatment option.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1810/rc

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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 was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Ethical approval for this study protocol was obtained from the Ethics Committee of Shanghai

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