Is video-assisted thoracoscopic surgery comparable with thoracotomy in perioperative and long-term survival outcomes for non-small-cell lung cancer after neoadjuvant treatment?

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Received 28 June 2022, received in revised form 13 October 2022

Abstract

A best evidence topic in thoracic surgery was written according to a structured protocol. The question addressed was ‘Is video-assisted thoracoscopic surgery (VATS) comparable with thoracotomy in perioperative and long-term survival outcomes for patients with non-small cell lung cancer following neoadjuvant therapy intended for anatomical lung resection?’ Altogether 655 papers were found using the reported search, of which 12 studies represented the best evidence to answer the clinical question. The author, journal, date and country of publication, patient group studied, study type and relevant outcomes and results of these papers are tabulated. Almost all of the enrolled cohort studies reported that video-assisted thoracoscopic surgery (VATS) was comparable with thoracotomy in negative surgical margin rate, postoperative mortality, complication rate, overall survival and disease-free survival. Moreover, 7 studies found patients in the VATS group had a significantly shorter hospital stay. Furthermore, in these well-matched cohort studies (6 studies), it still held true that VATS was comparable with thoracotomy in long-term prognosis with enhanced recovery. However, the issue regarding surgical radicality and intraoperative conversion to thoracotomy still should be noted carefully among these patients receiving VATS surgery because all the current available evidence was retrospective based on relatively small sample sizes. Nevertheless, thoracic surgeons should not consider VATS inferior to thoracotomy for patients after neoadjuvant treatment. VATS surgery could be an alternative for selected patients with locally advanced but relatively small, peripheral, fewer positive N2 lymph nodes and non-squamous NSCLC intended for anatomic lung resection.

Keywords: Review • Neoadjuvant treatment • Video-assisted thoracoscopic surgery • Thoracotomy • Non-small-cell lung cancer

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

THREE-PART QUESTION

In [patients with non-small-cell lung cancer (NSCLC) after neoadjuvant treatment intended for anatomical lung resection], regardless of the induction treatment regimens, is [video-assisted thoracoscopic surgery (VATS)] comparable with [thoracotomy] in [perioperative and long-term survival outcomes]?

CLINICAL SCENARIO

A 64-year-old male patient diagnosed with locally advanced but NSCLC was admitted to your hospital for multidisciplinary treatment. Neoadjuvant therapy was initially recommended for the patient and after neoadjuvant treatment, he was evaluated with excellent tumour response and suitable for surgical resection, and your team was discussing the surgical strategy. One of your colleagues suggested that we could perform VATS to reduce surgical trauma and postoperative complications, while you were uncertain whether VATS can achieve comparable long-term survival as thoracotomy. You resolved to check the literature for evidence.

SEARCH STRATEGY

We searched the Medline database using the PubMed interface from 1973 to July 2022 with the following search term: [l lung cancer] OR (lung carcinoma) AND [neoadjuvant] OR (preoperative) OR (induction) AND [thoracoscopic] OR (video-assisted) OR (minimally invasive) OR (VATS) OR (MIS)] AND [(thoracotomy] OR (open)].
SEARCH OUTCOME

A total of 655 papers were found using the reported search. In total, 12 papers were identified that provided the best evidence to answer the question (Table 1).

RESULTS

In 2016, Yang et al. [2] performed a retrospective single-centre analysis of 60 NSCLC patients who underwent lobectomy via thoracotomy or VATS following induction chemotherapy or chemoradiotherapy between 1996 and 2012. Propensity score matching (PSM) was employed to narrow selection bias, by which the patients’ baseline characteristics in the 2 groups were well-matched successfully. There were 7 conversions (10%) in the original VATS cohort due to difficulty either from fibrosis and adhesions (n = 5) or bleeding (n = 2). The thoracotomy group and the VATS group were comparable in postoperative complication rate, 30-day mortality, 3-year overall survival (OS) [VATS, 54%; thoracotomy, 49%; 95% confidence interval (CI), 34–71%; thoracotomy, 49%; 95% CI, 28–67%; P = 0.56] and 3-year recurrence-free survival (RFS) [VATS, 34%; 95% CI, 18–52%; thoracotomy, 24%; 95% CI, 9–42%; P = 0.24], but the VATS group presented significantly shorter hospitalization (P = 0.007). After multivariable adjustment of the entire cohort, there remained no significant difference in OS [hazard ratio (HR) = 0.88; 95% CI, 0.39–1.97; P = 0.76] or RFS (HR = 0.91; 95% CI, 0.46–1.83; P = 0.80) between the 2 groups. Thus, induction therapy should not be considered a contraindication to the application of VATS for patients with resectable NSCLC.

Kamel et al. [3] retrospectively investigated 114 NSCLC patients who underwent lobectomy after various induction therapy. Despite of PSM method applied, differences still remained as the thoracotomy group presented larger clinical tumour sizes (P = 0.038). A conversion from VATS to thoracotomy occurred in 5 cases due to severe adhesions. They found the 2 groups comparable in the R1 resection rate, hospital mortality and postoperative complications. After 75 months of the median follow-up, the median time to recurrence was 18 months for the entire cohorts, and there was no difference in 5-year disease-free survival (DFS) [VATS, 73.2%; thoracotomy, 47.8%; P = 0.097] or 5-year RFS (VATS, 76.6%; thoracotomy, 56.1%; P = 0.206). Notably, the VATS group reported shorter hospital stay (P < 0.001). The multivariable analysis indicated that not the surgical approach but the clinical N1/2 status (HR = 4.86; 95% CI, 2.00–11.82, P < 0.001) was independently related to poor DFS. The VATS approach appeared to improve the perioperative outcomes without compromising long-term survival.

Matsuoka et al. [4] retrospectively reviewed 110 NSCLC patients who received preoperative chemotherapy with or without radiotherapy prior to anatomical pulmonary resection. Dissection of regional lymph nodes was completed in all patients. Four patients in the VATS group underwent conversion to thoracotomy for angioplasty (n = 2) or combined resection of chest wall (n = 2). There were no significant difference in high-grade postoperative complications, in-hospital death, 5-year OS (VATS, 53.5%; thoracotomy, 39.8%; P = 0.2726) and 5-year RFS (VATS, 36.3%; thoracotomy, 45.5%; P = 0.2654). However, the thoracotomy group presented more lung squamous cell carcinoma (LSCC) and more complicated procedures (P < 0.0001). The unbalanced baseline characteristics and surgical complexity between groups might impact the interpretations of their findings. Fang et al. [5] included 83 patients with LSCC in a retrospective study who underwent pulmonary resection preceded by neoadjuvant chemotherapy. Two patients converted to thoracotomy due to severe adhesion were eliminated from further analysis. The 2 groups had comparable outcomes in the surgical margin, complication rate, 3-year OS (VATS, 79.6%; thoracotomy, 80.5%; P = 0.925) and 3-year DFS (VATS, 88.6%; thoracotomy, 64.3%; P = 0.335). The VATS group trended towards an earlier discharge from the hospital (P = 0.066), and their findings supported the VATS approach practicable for stage IIA-B LSCC patients.

In 2018, Jeon et al. [6] retrospectively analysed 35 patients with stage IIA N2 NSCLC who underwent anatomic resection and mediastinal lymph node dissection (MLND) by 1 single surgeon after completing preoperative concurrent chemoradiation therapy (CCRT) between November 2009 and December 2013. Five patients were converted to thoracotomy due to anthracofibrotic nodes (n = 4) or tight adhesions (n = 1). No significant difference was noted in the R0 resection rate, postoperative complications, length of hospitalization, 5-year OS (VATS, 76.0%; thoracotomy, 57.8%; P = 0.39) and 5-year DFS (VATS, 40.3%; thoracotomy, 38.9%; P = 0.8). They concluded that VATS following neoadjuvant therapy could be feasible for stage IIA N2 NSCLC patients without compromising oncologic efficacy.

Yang et al. [7] conducted a retrospective study among 876 patients in the National Cancer Database (NCDB) diagnosed with clinical T2-2 N0M0 or T1-4N1-2M0 NSCLC between 2010 and 2014. All the patients received neoadjuvant chemotherapy or chemoradiotherapy followed by lobectomy, and their baseline characteristics were well matched via PSM. Conversion to thoracotomy was performed in 96 cases. There was no significant difference in the positive resection margins and 5-year OS (VATS, 48.1%; 95% CI, 41.9–54.1%; thoracotomy, 49.6%; 95% CI, 43.4–55.4%; P = 0.80) between the 2 groups. The VATS group had shorter in-hospital stay (P < 0.01) and a trend of fewer postoperative death (P = 0.06). Moreover, the 5-year OS was comparable in both the sub-analyses of patients who received only preoperative chemotherapy (VATS, 48.9%; 95% CI, 40.3–56.9%; thoracotomy, 48.4%; 95% CI, 39.7–56.5%; P = 0.72) and of patients who received preoperative chemoradiotherapy (VATS, 47.5%; 95% CI, 38.1–56.2%; thoracotomy, 43.2%; 95% CI, 32.6–53.0%; P = 0.76). The multivariable analysis indicated that the chemoradiotherapy is an independent predictor of conversion to thoracotomy (P = 0.05). However, the absence of other critical outcomes limited the conclusions.

Tian et al. [8] enrolled 56 NSCLC patients who received neoadjuvant therapy followed by radical pulmonary resection (including lobectomy, bilobectomy, sleeve lobectomy and pneumonectomy) and MLND in a retrospective study. There were 28 well-matched pairs of patients in each group after employing PSM, while the original overall cohort indicated that the patients in the thoracotomy group were more likely to have male gender, LSCC, higher clinical T descriptor and/or pneumonectomy. Six patients in the original VATS group underwent conversion due to either tight adhesions (n = 3) or anatomic factors (n = 3). The 2 groups were comparable in the completion of resection, postoperative mortality, 5-year OS (VATS, 45.5%; thoracotomy, 21.5%; P = 0.379) and 5-year RFS (VATS, 42.7%; thoracotomy, 28.8%; P = 0.613), and a significantly shorter postoperative stay (P < 0.001) was observed in the VATS group. According to the multivariable analyses, VATS was not an
| Author, date, journal and country | Patient group | Outcomes | Key results | Comments |
|----------------------------------|---------------|----------|-------------|----------|
| **Yang et al. (2016), Eur J Cardiothorac Surg, USA [2]** | 60 NSCLC patients<sup>a</sup> | Postoperative complications | VATS, 40%; thoracotomy, 57%, \( P = 0.20 \) | Well-matched by age, gender, coronary artery disease, COPD, pathological T and N status, distant metastases, tumour location, radiation and operative date |
| Cohort study (level III) | Neoadjuvant chemotherapy or chemoradiotherapy preceding lobectomy within a year 1996–2012 | 30-Day mortality | VATS, 3%; thoracotomy, 7%, \( P = 0.55 \) |  |
|  | With PSM | LOS (days), median (IQR) | VATS, 4 (3–5); thoracotomy, 5 (4–8); \( P < 0.007 \) |  |
|  | VATS, \( n = 30 \) (including 10% conversions) | 3-Year OS | VATS, 54%, 95% CI, 34–71%; thoracotomy, 49%, 95% CI, 28–67%; \( P = 0.56 \) |  |
|  | Thoracotomy, \( n = 30 \) | 3-Year RFS | VATS, 34%, 95% CI, 18–52%; thoracotomy, 24%, 95% CI, 9–42%; \( P = 0.24 \) |  |
| **Kamel et al. (2017), J Laparoendosc Adv Surg Tech A, USA [3]** | 114 NSCLC patients<sup>a</sup> | Non-R0 resection | VATS, 5.0%, thoracotomy, 4.1%, \( P = 0.814 \) | Matched by age, gender and clinical stage |
| Cohort study (level III) | Conventional chemotherapy for cN2 or other clinical trials (erlotinib alone, pazopanib alone or chemotherapy combined with a cyclooxygenase-2 inhibitor) for cN0-1 before lobectomy | 30-Day mortality | None | Larger clinical tumour size in the thoracotomy group (\( P = 0.038 \)) |
|  | January 2002 to December 2014 | Postoperative complications | VATS, 15%; thoracotomy, 31%, \( P = 0.06 \) |  |
|  | With PSM | LOS (days) | VATS, 4 (3–5); thoracotomy, 6 (5–8); \( P < 0.001 \) |  |
|  | VATS, \( n = 40 \) (including 5 conversions) | 5-Year DFS | VATS, 73.2%; thoracotomy, 47.8%, \( P = 0.097 \) | Inconsistency in the neoadjuvant treatment |
|  | Thoracotomy, \( n = 74 \) | 5-Year RFS | VATS, 76.6%; thoracotomy, 56.1%, \( P = 0.206 \) | Limited sample size in the VATS group |
| **Matsuoka et al. (2018), Asian Cardiovasc Thorac Ann, Japan [4]** | 110 NSCLC patients<sup>a</sup> | Postoperative complications with CTCAE grade \( \geq 2 \) | VATS, 36.7%; thoracotomy, 32.2%, \( P > 0.05 \) | Significantly more LSCLC and combined resection in the thoracotomy group (\( P < 0.05 \) and \( P < 0.0001 \), respectively) |
| Cohort study (level III) | Neoadjuvant chemotherapy or chemoradiotherapy before anatomical resection January 2009 to December 2014 | 30-Day mortality | VATS, \( n = 1 \); thoracotomy, \( n = 1 \) |  |
|  | Excluded patients with previous treatment or small-cell lung cancer | LOS | VATS, \( n = 1 \); thoracotomy, \( n = 1 \) \( P < 0.05 \) (favour VATS) | Lacked comparison and statistical test of baseline characteristics |
|  | Without PSM | 5-Year OS | VATS, 53.5%; thoracotomy, 39.8%, \( P = 0.2726 \) | Limited sample size in the thoracotomy group |
|  | VATS, \( n = 79 \) (including 4 conversions) | 5-Year RFS | VATS, 36.3%; thoracotomy, 45.5%, \( P = 0.2654 \) | Only further examined patients with complete resection (103 of 110) |
|  | Thoracotomy, \( n = 31 \) |  |  |  |
| **Fang et al. (2018), J Cardiothorac Surg, China [5]** | 83 LSCLC patients without distant metastasis | R0 resection rate | VATS, 21.4%; thoracotomy, 29.9%, \( P = 0.729 \) | Confined to LSCLC patients |
| Cohort study (level III) | Neoadjuvant chemotherapy before lung resection within 6 months October 2013 to October 2017 | Postoperative complications | VATS, 6 (4–16); thoracotomy, 7 (4–21), \( P = 0.066 \) | Limited sample size in the VATS group |
|  | Excluded conversion cases and patients with previous cancer or lung resection and other concurrent malignant diseases | LOS (days) | VATS, 6 (4–16); thoracotomy, 7 (4–21), \( P = 0.066 \) | Limited follow-up duration (median 15 months) |
|  | Without PSM | 3-Year OS | VATS, 79.6%; thoracotomy, 80.5%, \( P = 0.925 \) | Incomplete follow-up (73 of 81 patients) |
|  | VATS, \( n = 14 \) | 3-Year DFS | VATS, 88.6%; thoracotomy, 64.3%, \( P = 0.335 \) |  |

*continued*
| Author, date, journal and country Study type (level of evidence) | Patient group | Outcomes | Key results | Comments |
| --- | --- | --- | --- | --- |
| **Thoracotomy, n = 67** | 35 patients with stage IIIA N2 NSCLC Neoadjuvant CCRT before anatomic resection and MLND by a single surgeon November 2009 to December 2013 Without PSM VATS, n = 17 Thoracotomy, n = 18 (including 5 conversions) | Non-R0 resection | None | P > 0.05 | More patients in the VATS group had higher BMI (P < 0.05) |
| Jeon et al. (2018), Korean J Thorac Cardiovasc Surg, South Korea [6] Cohort study (level III) | 876 patients with clinical T2–T4 N0 M0 and T1-4N1-2M0 NSCLC Neoadjuvant chemotherapy or chemoradiotherapy before lobectomy 2010–2014 Excluded patients with nonmalignant pathology and previous unrelated malignancy With PSM VATS, n = 438 (including 96 conversions) Thoracotomy, n = 438 | Non-R0 resection | P = 0.58 | Well-matched by age, gender, race, Charlson/Deyo comorbidity score, median census-tract education and income levels, clinical T- and N-status, tumour size, tumour location, type of induction therapy, time from preoperative-chemotherapy to surgery, insurance type, histology, grade, distance from facility, facility type and year of diagnosis |
| Yang et al. (2019), Ann Thorac Surg, USA [7] Cohort study (level III) | 56 patients with clinical or biopsy-proven N2 or T3-4N0-1 NSCLC Platinum-based doublet neoadjuvant chemotherapy with or without radiotherapy before radical resection and MLND 2000–2016 Excluded patients with multiple primary tumours With PSM VATS, n = 28 (including 3 conversions) Thoracotomy, n = 28 | R0 resection | VATS, 96.4%; thoracotomy, 89.3%; P = 0.611 | Well-matched by age, gender, tumour histology, comorbidities, neoadjuvant therapy modality, surgical procedure and pathological T and N stages |
| Tian et al. (2019), Thorac Cancer, China [8] Cohort study (level III) | 85 NSCLC patients* Neoadjuvant cisplatin-based CRT before lung resection January 2008 to December 2017 Excluded non-anatomical and sublobar resection Without PSM VATS, n = 26 Thoracotomy, n = 59 (including 6 conversions) | R0 resection | VATS, 100%; thoracotomy, 98.3%; P = 0.504 | Limited sample size in the VATS group |
| Suh et al. (2019), Thorac Cancer, South Korea [9] Cohort study (level III) | | Operative mortality | VATS, 11.5%; thoracotomy, 5.1%; P = 0.284 | Short follow-up period (median 12.6 months) |
| | | LOS (days), mean ± SD | VATS, 8.62 ± 4.72; thoracotomy, 14.46 ± 16.94; P = 0.017 | More invasion to other structures and combined procedures in the thoracotomy group (P = 0.043 and 0.003, respectively) |
| | | Postoperative complications | VATS, 26.9%; thoracotomy, 28.8%; P = 0.858 | |
Table 1: Continued

| Author, date, journal and country | Study type | Patient group | Outcomes | Key results | Comments |
|----------------------------------|------------|---------------|----------|-------------|----------|
| Dell’Amore et al. (2021), Surg Endosc, Italy [10] | Cohort study (level III) | 155 NSCLC patients * | Non-R0 resection | VATS, 61.9%; thoracotomy, 76.6%, P = 0.516 | Well-matched by age, gender, BMI, diabetes, ischemic heart disease, preoperative FEV1 and DLCO, smoking history, ASA score, histology, tumour location, TNM and N status |
| Jeon et al. (2022), Semin Thorac Cardiovasc Surg, South Korea [11] | Cohort study (level III) | 143 cN2 NSCLC patients with peripheral tumours smaller than 5 cm after induction, non-bulky N2 (axial diameter <2.5 cm) and fewer than 4 positive N2 stations | VATS, n = 31 (including 17.1% conversions) Thoracotomy, n = 112 | VATS, 100%; thoracotomy, 96.4%; P = 0.651 None VATS, 9.7%; thoracotomy, 30.4%; P = 0.036 | Well-matched by gender, age, pulmonary function test (FEV1, DLCO), method of N stage, histology and clinical T stage |
| Dai et al. (2022), Transl Lung Cancer Res, China [12] | Cohort study (level III) | 23 patients with clinical stage III–IIIB(N2) NSCLC, ageing 18–75, EGFR and ALK wild type and ECOG score 0–1 Neoadjuvant platinum-based chemotherapy combined with PD-1 inhibitors before sleeve resection | VATS, n = 8 (including 1 conversion) Thoracotomy, n = 15 | VATS, 5.5 ± 2.8; thoracotomy, 9.2 ± 11.2; P = 0.416 | Confined to sleeve resection Limited sample sizes in both groups Lacked long-term survival outcomes |
| Zhang et al. (2022), Front Oncol, China [13] | Cohort study (level III) | 88 patients with clinical stage IIB or T3–4N2M0 (single N2) NSCLC and ECOG score 0–1 Neoadjuvant PD-1 inhibitors plus chemotherapy before surgery | VATS, n = 42; thoracotomy, n = 41; P = 0.645 | VATS, n = 0; thoracotomy, n = 1 Overall VATS, n = 10; thoracotomy, n = 18, P = 0.05 Prolonged air leak: VATS, n = 5; thoracotomy, n = 1, e = 0.013 VATS, 6.8 ± 4.2; thoracotomy, 6.9 ± 3.0; P = 0.907 VATS, 92.2%; thoracotomy, 84.2%; P = 0.204 | Well-matched by tumour length before therapy, tumour location, clinical T and N stage, clinical TNM stage and radiographic tumour response Limited follow-up time (median 13.2 months) and sample sizes Relatively high conversion rate |

*No other detailed eligible criteria were mentioned in the study, such as histologic type and clinical or pathological staging.

ALK: anaplastic lymphoma kinase; ASA: American society of Anesthesiologists; BMI: body mass index; CCRT: concurrent chemoradiation therapy; CI: confidence interval; COPD: chronic obstructive pulmonary disease; CRT: chemoradiotherapy; CTCAE: common terminology criteria for adverse events; DFS: disease-free survival; DLCO: diffusing capacity for carbon monoxide; ECOG: Eastern Cooperative Oncology Group; EGFR: epidermal growth factor receptor; FEV1: forced expiratory volume in 1 s; IQR: interquartile range; LOS: length of hospital stay; LSCC: lung squamous cell carcinoma; MLND: mediastinal lymph node dissection; NSCLC: non-small cell lung cancer; OS: overall survival; PD-1: programmed death ligand 1; PSM: propensity score matching; RFS: recurrence-free survival; SD: standard difference; TNM: tumour node metastasis; VATS: video-assisted thoracoscopic surgery.
independent predictor of OS (HR = 0.841; 95% CI, 0.338–2.093; \( P = 0.709 \)) or RFS (HR = 0.955; 95% CI, 0.415–2.198; \( P = 0.913 \)), but pathologic N2 stage was a poor prognostic factor of OS (HR = 3.449; 95% CI, 1.147–10.37; \( P = 0.027 \)). Therefore, they considered VATS following neoadjuvant therapy as a qualified strategy for treating locally advanced NSCLC.

Suh et al. [9] retrospectively investigated the clinical outcomes and follow-up of anatomical lung resection (lobectomy, bilobectomy or pneumonectomy) and MLND after neoadjuvant chemoradiotherapy among 85 patients. Six patients were converted to thoracotomy due to bleeding \( (n = 1) \), oncologic causes \( (n = 1) \) and severe adhesions \( (n = 4) \). The R0 resection rate, operative mortality, complications rate and 3-year OS (VATS, 67.9%; thoracotomy, 69.3%; \( P = 0.879 \)) and DFS (VATS, 61.9%; thoracotomy, 76.6%; \( P = 0.516 \)) between the 2 groups were comparable, while patients in the VATS group had a shorter hospital stay \( (P = 0.017) \). However, significantly more complex procedures were conducted in the thoracotomy group \( (P = 0.031) \), especially chest wall resection \( (P = 0.016) \). They concluded that VATS could be an alternative for patients with advanced-stage NSCLC but with little adjacent structural invasion.

Dell’Amore et al. [10] conducted a multicentre retrospective study of 155 NSCLC patients who received neoadjuvant chemotherapy followed by lobectomy. There were 8 conversions, the reasons of which were bleeding \( (n = 3) \), metastatic lymph nodes \( (n = 4) \) and severe adhesions \( (n = 1) \). R0 resection and complete dissection of the hilar and mediastinal lymph node stations were completed among all the well-matched patients after PSM approach. There was no significant difference in in-hospital mortality, postoperative surgical complications rate, 5-year OS (VATS, 43%; thoracotomy, 54%; \( P = 0.57 \)) and 5-year DFS (VATS, 25%; thoracotomy, 37%; \( P = 0.9 \)) between the 2 groups. VATS approach was associated with shorter hospitalization \( (P < 0.01) \), while the number of dissected lymph nodes favoured the thoracotomy group \( (P = 0.022) \). In conclusion, VATS was feasible for patients with locally advanced NSCLC posterior to induction chemotherapy without impaired oncological efficacy.

Jeon et al. [11] retrospectively analysed surgical and survival outcomes among 143 patients with clinical stage IIIA N2 NSCLC between June 2012 and July 2017. All the patients underwent neoadjuvant CCRT prior to anatomical lung resection plus MLND. No significant differences in patients’ baseline characteristics were detected after applying the PSM method. Six of 35 patients \( (17.1\%) \) in the original VATS cohort were converted to thoracotomy due to either anthracofibrotic nodes \( (n = 2) \) or severe adhesions \( (n = 4) \). They found no significant difference in complete resection rate, 30-day mortality, length of hospitalization, 5-year OS (VATS, 77.1%; thoracotomy, 59.9%; \( P = 0.276 \)) and 5-year RFS (VATS, 66.3%; thoracotomy, 54.6%; \( P = 0.354 \)) between the 2 groups. However, the VATS group had significantly fewer major postoperative complications \( (P = 0.036) \). The multivariable analyses in matched patients indicated that ex-smoker \( (HR = 131.25, 95\% CI 4.13–4166.8; \( P = 0.003 \)) \), number of dissected lymph nodes \( (HR = 1.05, 95\% CI, 1.01–1.10; \( P = 0.015 \)) \) and completeness of adjuvant therapy \( (HR = 0.25, 95\% CI, 0.11–0.55; \( P = 0.001 \)) \) were significant factors of OS and multiple positive stations \( (HR = 7.46, 95\% CI, 1.34–41.40; \( P = 0.022 \)) \) were poor prognostic factors of RFS. Overall, VATS could reach comparable perioperative and long-term survival outcomes versus thoracotomy in cN2 NSCLC patients after neoadjuvant CCRT.

Dai et al. [12] retrospectively reviewed 23 patients with clinical stage II–IIIB(N2) NSCLC who underwent sleeve resection following neoadjuvant chemoimmunotherapy between May 2019 and April 2021. One patient was converted to thoracotomy because of extensive pleural adhesion. No patients exhibited serious treatment-related adverse events or positive surgical margin. There was no significant difference in perioperative mortality, postoperative complications and hospital stay between the VATS group and the thoracotomy group. However, the limited sample sizes and lack of long-term outcomes weakened the reliability of the authors’ recommendations.

Zhang et al. [13] performed a retrospective, single-centre, real-world observational study by enrolling 131 patients with clinical stage IIIB or T3-4N2M0 (single N2) NSCLC who received neoadjuvant chemoimmunotherapy prior to curative-intent resection. There were 42 patients who underwent conversion to thoracotomy in the original cohort, the reasons of which included primary tumour invasion \( (45.2\%) \), dense adhesion and fibrosis after neoadjuvant treatment \( (26.2\%) \), fibrocalcified nodes \( (14.3\%) \) and pleural adhesion \( (6.9\%) \). After well balanced via the PSM method, the 2 groups were comparable in R0 resection rate, postoperative complications, hospital stay and 1-year RFS (VATS, 92.2%; thoracotomy, 84.2%; \( P = 0.204 \)). Notably, more patients had prolonged air leak in the VATS group \( (P = 0.013) \). However, the short follow-up time and relatively high conversion rate limited their conclusions.

**CLINICAL BOTTOM LINE**

VATS, compared with thoracotomy, could yield similar surgical efficacy and survival outcomes and improved postoperative rehabilitation for those NSCLC patients received neoadjuvant therapy. However, the issue regarding surgical radicality and intraoperative conversion to thoracotomy still should be noted carefully among these patients receiving VATS surgery because all the current available evidence was retrospective based on relatively small sample sizes. The specific selection criteria of potential candidates suitable for VATS after neoadjuvant treatment have not come to an agreement for the lack of prospective evidence. Nevertheless, in conclusion, thoracic surgeons should not consider VATS inferior to thoracotomy, and VATS surgery could be an alternative for selected patients with locally advanced but relatively small, peripheral, fewer positive N2 lymph nodes and non-squamous NSCLC intended for anatomic lung resection.

**Funding**

This work was supported by the Department of Science and Technology of Sichuan Province (2022DKP0009).

**Conflict of interest:** none declared.

**Reviewer information**

Interactive CardioVascular and Thoracic Surgery thanks Giovanni Luca Carboni, Alessandro Gonfiotti and the other, anonymous reviewer(s) for their contribution to the peer review process of this article.
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