Intraoperative conversion from video-assisted thoracoscopic lobectomy to thoracotomy for non-small-cell lung cancer: Does it have an impact on long-term survival?

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Summary

A best evidence topic in thoracic surgery was written according to a structured protocol. The question addressed was whether intraoperative conversions to thoracotomy have an impact on long-term survival for patients with non-small-cell lung cancer who underwent video-assisted thoracoscopic lobectomy initially. A total of 461 papers were found using the reported search, of which 6 retrospective cohort studies represented the best evidence to answer the clinical question. The authors, date of publication, journal, country of the authors, patient group, study type, relevant outcomes and results of these papers were tabulated. Five cohort studies clarified that conversion did not compromise long-term survival, whereas 1 cohort study reported worse long-term outcomes after conversion to thoracotomy. However, the limited samples, different characteristics between groups and selection bias due to inherent design made it difficult to make a conclusion. Based on the current evidence, we concluded that intraoperative conversion from video-assisted thoracoscopic surgery (VATS) to thoracotomy for non-small-cell lung cancer might not impact long-term survival compared to a successful VATS lobectomy. In-hospital mortality might not be prejudiced, whereas longer hospitalizations were observed. However, whether conversion would adversely affect postoperative complication rates remained unclear because of the conflicting results. Moreover, 3 studies reported no statistical differences in short- and long-term survival between emergency and non-emergency conversions. Therefore, we suggest that thoracic surgeons should not hesitate to convert VATS into thoracotomy in the case of blood vessel injury or difficult hilum.

Keywords: Intraoperative conversion • VATS • Thoracotomy • Long-term survival

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

In [patients underwent video-assisted thoracoscopic lobectomy for non-small-cell lung cancer (NSCLC)], does [intraoperative conversion to thoracotomy] have any impact on [long-term survival including overall survival and recurrence-free survival]?

A 65-year-old male diagnosed with NSCLC was admitted to our hospital for surgical treatment and underwent VATS lobectomy for the tumour. However, you found thoracoscopic dissection difficult because of hilar lymphadenopathy and consequent hilar adhesion. The subsequent surgical strategy was discussed by the heart team. One of your colleagues suggested converting to thoracotomy immediately, but none of you had any idea whether conversion to thoracotomy would impact long-term survival of the patient. You resolved to check the matter further.

We searched the Medline database using the PubMed interface from 1993 to May 2022 with the following search terms: (((((thoracoscopic lung resection) OR (video-assisted thoracoscopic surgery)) OR (thoracotomy)) OR (VATS)) AND (((lung cancer) OR (lung tumour))) AND ((conversion) OR (converted)) AND ((thoracotomy) OR (open surgery))) AND (((prognosis) OR (outcome)) OR (survival)).

A total of 461 papers were found preliminarily. Papers were excluded for (i) being a conference paper, (ii) focusing on survival after robotic-assisted thoracoscopic surgery, (iii) including only the short-term outcomes, (iv) comparing conversion to an open procedure rather than to a successful VATS and (v) not specifically focusing on conversion during lobectomy. After screening, 6 papers were identified as the best evidence to answer the question. These are presented in Table 1.

In 2011, Park et al. analysed the clinical outcomes of 738 patients who underwent VATS lobectomy, 34 (4.61%) of whom were converted to thoracotomy [2]. Although the hospital stay was longer ($P<0.0001$) for converted patients, there was no

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significant difference in postoperative complication rate ($P = 0.457$, Fisher’s exact test; $P = 0.307$, logistic regression analysis). Simultaneously, intraoperative unplanned conversion was not related to the impaired survival ($P = 0.626$) or recurrence ($P = 0.767$) with regard to long-term survival; it was also comparable ($P = 0.789$ and $0.760$, respectively) after adjusting for age and sex. The median follow-up period was 30.0 months. The conversion rate fluctuated with the technical experience of the surgeon. It indicated that thoracoscopic lobectomy could be performed safely in the case of unplanned conversion, and the long-term survival might not be compromised.

Puri et al. investigated the causes and impacts of intraoperative conversion to thoracotomy between 2004 and 2012 [3]. A total of 517 successful VATS lobectomy patients, along with 87 (17%) converted cases, were enrolled in the study. Worse short-term outcomes after conversion, such as more frequent complications ($P < 0.001$) and longer hospital stays, were detected in the conversion group; the surgical mortality was similar. However, intraoperative conversion was not associated with a greater hazard of long-term death (hazard ratio = 0.550; 95% confidence interval, 0.290–1.042; $P = 0.067$) for pathological stage I NSCLC. The potential advantages for VATS might result from better tolerance and less disrupted immune surveillance. The conversion rate dropped over a 3-year interval as experience developed. Only male gender was reported to confer an elevated risk of unplanned conversion. Moreover, further subgroup analysis found emergency conversion did not affect postoperative mortality and morbidity detrimentally. Overall, the authors concluded that VATS should still be strongly favoured.

Augustin et al. performed an analysis of their institutional database in 2016, including 217 patients who had successful VATS lobectomies and 15 (6.5%) patients who underwent conversion to thoracotomy [4]. They reported that conversion would not give rise to higher postoperative complication rates ($P = 0.767$) or increasing in-hospital deaths ($P = 1.00$). Nor was overall survival negatively affected by the conversion procedure ($P = 0.638$). However, hospital stays were significantly extended ($P = 0.028$), and more disease recurrences were seen following conversion (60% vs 30.5%, $P = 0.024$). Multivariate analysis demonstrated that induction therapy and tumour size were associated with conversion, which potentially explained the higher recurrence rate. Given the limited number of converted cases and the heterogeneous tumour stages, one should interpret the survival results with caution.

In 2019, Sezen et al. carried out a single-centre analysis of 147 patients with NSCLC who underwent VATS lobectomy [5]. 18 (12.2%) were converted to a thoracotomy. Although the length of the hospital stay was longer in converted patients, no statistical difference was noted in short-term outcomes (postoperative complication rate, 22.2% vs 20.9%, $P = 0.900$) and long-term survival (5-year survival rate, 80% vs 71.4%, $P = 0.548$) compared to patients whose VATS was completed. Advanced age was identified as the main risk factor for conversion, which could be attributed to age-related loss of vascular elasticity. The results also supported the safety and feasibility of conversion from VATS to thoracotomy.

Gabryel et al. investigated the clinical outcomes of 1002 patients eligible for a NSCLC thoracoscopic lobectomy; of these, 897 patients underwent completed VATS and 105 were converted to a thoracotomy [6]. The results indicated that conversion might prejudice short-term outcomes. The conversion group had longer hospitalizations ($P < 0.001$) and more complications ($P = 0.018$), for example, supraventricular arrhythmia. Of note, contrary to results from previous studies, conversion was associated with worse long-term outcomes for patients with stages I–IV NSCLC compared to those who were in the completed VATS group (5-year survival rate, 65% vs 81%, $P = 0.045$). Subsequent subgroup analysis presented similarly worse results for stage I NSCLC (70% vs 87%, $P = 0.014$) but not for stage II NSCLC ($P = 0.294$) or stage III NSCLC ($P = 0.944$). Pleural adhesions and mediastinal lymph node metastases were identified as independent risk factors for conversion, early identification of which was crucial for oncological treatment. They also identified different frequencies of conversion among surgeons, regardless of their experience. In addition, further subgroup analysis regarding the short-term outcomes of the emergency conversion group found no statistically significant differences in hospital stay ($P = 0.174$), postoperative complications ($P = 0.933$) and in-hospital deaths ($P = 0.652$) compared to the non-emergency conversion group. Similarly, long-term survival of the emergency conversion group was not prejudiced (5-year survival rate, 65% vs 63%, $P = 0.794$). As claimed by the authors, the poor clinical outcomes of conversion were difficult to interpret, and they supposed that it might be explained by the possible immune system disturbances and undesirable effects of postoperative complications.

Fourdrain et al. enrolled 533 patients in the study cohort, including 439 in the full VATS group and 94 (17.6%) in the conversion group [7]. All consecutive patients were treated by anatomical lobar pulmonary resection (486 by lobectomy and 8 by bilobectomy, 92.7% or anatomical sublobar pulmonary resection (39 segmentectomy) for NSCLC. It is well established that the completed VATS lobectomy offered improved short-term benefits of fewer complications, shorter hospitalizations and a trend towards fewer short-term deaths for both stage I NSCLC and the entire group of patients with NSCLC. Although, in terms of long-term outcomes, it was comparable in overall survival ($P = 0.47$) and disease-free survival (full VATS vs conversion, $P = 0.32$), it was also comparable among the patients with locally advanced NSCLC in disease-free survival ($P = 0.071$) for stage II (n = 133) and stage III NSCLC (n = 118). Despite the favoured long-term overall survival in the full VATS group with advanced NSCLC, it was likely to be interpreted carefully by limited sample size and different ratio of patients with stage II/III. Moreover, the subgroup analysis also revealed comparable outcomes between the emergency and non-emergency conversion groups in early postoperative outcomes, overall survival ($P = 0.122$) and disease-free survival ($P = 0.151$).

The preceding 6 papers comparing VATS to VATS conversion in long-term survival of selected patients with NSCLC were retrospective studies. One concern about the findings was that the limited sample size of the conversion group, the short follow-up time and the heterogeneity in baseline characteristics (e.g. gender, tumour stage) between the 2 groups might reduce the power of the comparison. The retrospective design of studies confined to a single centre and the different management styles among surgeons inevitably have led to selection bias and therefore impact the interpretation of outcomes.

We corroborated the overall impression that intraoperative conversion from VATS to thoracotomy might not impact long-term survival for NSCLC compared to those with successful VATS, no matter whether it was an emergency or not. Although intraoperative conversion might not result in a short-term survival disadvantage of in-hospital deaths, it did lead to longer hospitalizations. In addition, short- and long-term outcomes of emergency conversion might not be compromised. However, whether conversion adversely affects postoperative complications remained unclear because of the conflicting results. More multicentre, prospective well-designed studies with a large sample are needed to give further insight. In conclusion, the available
| Author, date, journal, and country | Study type (Level of evidence) | Patient group | Outcomes | Key results (full VATS group vs conversion group) | Comments |
|-----------------------------------|--------------------------------|---------------|----------|------------------------------------------------|----------|
| Park et al. (2011), World J Surg, Korea [2] | Cohort study (level 3) | 738 Patients diagnosed with NSCLC undergoing VATS lobectomy | Median follow-up period | 30.0 Months | Conversion rate fluctuated with the technical experience of the surgeons |
|                                     |                                | Full VATS: n = 704 | Mean hospital stay | 7.08 vs 10.12 Days, P < 0.0001 |          |
|                                     |                                | Conversion: n = 34 | Postoperative complications | P = 0.457 (Fisher’s exact test) |          |
|                                     |                                | Conversion rate: 4.61% | P = 0.307 (logistic regression analysis, after adjusting for age and sex) | |          |
|                                     |                                | Except 135 benign lung disease, 603 lung cancer cases reserved with 26 conversion cases | Overall survival | P = 0.626 |          |
|                                     |                                |                       | Disease recurrence | P = 0.789 (after adjusting for age and sex) |          |
|                                     |                                |                       |                       | P = 0.767 |          |
|                                     |                                |                       |                       | P = 0.760 (after adjusting for age and sex) |          |
| Puri et al. (2015), J Thorac Cardiovasc Surg, USA [3] | Cohort study (level 3) | 604 Patients diagnosed with lung cancer undergoing VATS lobectomy | Postoperative complications | 23% vs 46%, P < 0.001 | Conversion rates decreased with increasing experience |
|                                     |                                | Full VATS: n = 517 | Mean hospital stay | 4.6 vs 7.6 Days, P < 0.0001 |          |
|                                     |                                | Conversion: n = 87 | Surgical deaths | 0% vs 1%, P = 0.1b | Risk factor for conversion: male gender |
|                                     |                                | Conversion rate: 7% | | | |
|                                     |                                | 558 Patients with stage I NSCLC | Overall survival | HR 1.818; 95% CI, 0.960-3.448; P = 0.067 | |
|                                     |                                | Emergency conversion: n = 20 | Postoperative complications | 43% vs 55%, P = 0.446 | Comparable in patient and tumour characteristics within the emergency and non-emergency conversions |
|                                     |                                | Non-emergency conversion: n = 67 | Operative mortality | 2% vs 0%, P = 1.00 | |
|                                     |                                |                       | Mean hospital stay | 7.2 vs 8.8 Days*, P = 0.409 | |
| Augustin et al. (2016), Surg Endosc, Austria [4] | Cohort study (level 3) | 232 Patients intended for NSCLC undergoing VATS lobectomy (including 12 benign cases) | Postoperative complication | 29.5% vs 33.3%, P = 0.767 | Independent predictors of conversion: induction therapy and tumour size |
|                                     |                                | Full VATS: n = 217 | Mean hospital stay | 9 vs 11 Days, P = 0.028 | |
|                                     |                                | Conversion: n = 15 | In-hospital deaths | 2 vs 0 Cases, P = 1.0000 | |
|                                     |                                | Conversion rate: 6.5% | Overall survival | P = 0.638 | |
|                                     |                                |                       | Disease recurrence | 30.5% vs 60%, P = 0.024 | |
| Sezen et al. (2019), Gen Thorac Cardiovasc Surg, Turkey [5] | Cohort study (level 3) | 147 Patients with NSCLC undergoing VATS lobectomy | Mean follow-up period | 33 Months | Risk factor of conversion: age ≥ 70 years |
|                                     |                                | Full VATS: n = 129 | Median hospital stay | 4 vs 5 Days, P < 0.001 | |
|                                     |                                | Conversion cases: n = 18 | Postoperative complications | 20.9% vs 22.2%, P = 0.900 | |
|                                     |                                | Conversion rate: 12.2% | Mean survival time | Full VATS: 65.2 months; 95% CI, 59.6-70.8 months | |
|                                     |                                |                       |                       | Conversion: 54.9 months; 95% CI, 45.9-63.8 months | |
|                                     |                                |                       | 5-Year survival rate | 71.4% vs 80%, P = 0.548 | |
| Gabryel et al. (2021), Interact Cardiovasc Thorac Surg, Poland [6] | Cohort study (level 3) | 1002 Patients with lung cancer undergoing VATS lobectomy | Median hospital stay | 6 vs 8 Days, P < 0.001 | Risk factors of conversion: pleural adhesions, mediastinal lymph node metastases |
|                                     |                                | Full VATS: n = 897 | Postoperative complication | 27.1% vs 38.1%, P = 0.018 | |
|                                     |                                | Conversion: n = 105 | In-hospital mortality | 1.2% vs 1%, P = 0.818 | |
|                                     |                                | Conversion rate: 10.5% | 5-Year survival rate | 81% vs 65%, P = 0.045 | Different frequency of conversion among surgeons |
|                                     |                                | 1002 Patients in stage I-V NSCLC | 5-Year survival rate | 87% vs 70%, P = 0.014 | |
|                                     |                                | Conversion: n = 105 | 5-Year survival rate | P = 0.294 | Large sample size |
|                                     |                                | 640 Patients in stage I NSCLC | 5-Year survival rate | P = 0.944 | |
|                                     |                                | Conversion: n = 56 | Median hospital stay | 8 vs 7 days*, P = 0.174 | |
|                                     |                                | 240 Patients in stage II NSCLC | Postoperative complications | 37.8% vs 38.7%, P = 0.933 | |
|                                     |                                | Conversion: n = 26 | In-hospital deaths | 14% vs 0%, P = 0.652 | |
|                                     |                                | 103 Patients in stage III NSCLC | 5-Year survival rate | 65% vs 63%, P = 0.794 | |
evidence shows the safety and feasibility of conversion during VATS lobectomy and suggests that thoracic surgeons should not hesitate to convert VATS into a thoracotomy in the case of blood vessel injury or a difficult hilum.

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