



# Video-assisted thoracoscopic surgery lobectomy for lung cancer: the state of art

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**Abstract:** Video-assisted thoracoscopic surgery (VATS) lobectomy represents, nowadays, the gold standard for the treatment of early-stage non-small cell lung cancer (NSCLC). This approach provides a viable alternative to open lobectomy, in terms of radical oncological surgery and of low incidence of complications, as a consequence of sustained innovations and improvements, due to the new available technology devices. Aim of the study was to evaluate the benefits and feasibility of such minimally invasive approaches throughout a careful review of the literature.

**Keywords:** Video-assisted thoracoscopic surgery (VATS) lobectomy; non-small cell lung cancer (NSCLC); minimally invasive surgical treatment

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## Introduction

Video-assisted thoracoscopic surgery (VATS) lobectomy, introduced in the early 90's (1), presents the same oncological radicality, a faster postoperative recovery and a significant reduction in overall morbidity when compared to an open approach in early-stage non-small cell lung cancer (NSCLC) patients (2). Wang *et al.* (3), reporting 828 VATS surgically treated NSCLC patients (average age of  $64.5 \pm 10.3$  years) (predominant histological postoperative diagnosis: adenocarcinoma in 686 patients and squamous carcinoma in 109), showed no intraoperative deaths and perioperative mortality of 1.1% (9 patients). However, 139 patients (16.8%) presented postoperative complications (PCs); among these, 69 (8.3%) suffered major ones, with prolonged air leak (PAL) the most common one. Authors experienced that major postoperative complications (MPCs) influenced a significant reduction in both 3-year

and 5-year disease free-survival rates (MPCs *vs.* no MPCs: 68.2% *vs.* 78.7% and 44.7% *vs.* 70.3%;  $P=0.001$ , respectively). Wolf *et al.* (4), throughout a comprehensive data analysis from "The Statewide Planning and Research Cooperative System of New York State Database" and aiming at an evaluation of the benefits and feasibility of VATS lobectomy compared to thoracotomy (3,187 standard *vs.* 2,318 VATS lobectomy) in order to identify risk factors influencing NSCLC patients' outcome, reported a lower statistically significant incidence of morbidity rate in VATS brace when compared to thoracotomy one (31% *vs.* 38%,  $P=0.0001$ ). Moreover, VATS compared to thoracotomy displayed a reduction in hospital stay (4 *vs.* 6 days,  $P=0.0001$ ) and perioperative mortality (22 *vs.* 66 patients, 0.9% *vs.* 2.1%;  $P=0.001$ ). In this context, Ezer *et al.* (5) demonstrated VATS lobectomy should also be considered the best surgical strategy in elderly NSCLC stage I–II patients, due to a better postoperative recovery

function and reduction of complications, minimizing life-threatening effects from comorbidities on outcomes. In particular, by both a Surveillance, Epidemiology and End-Results (SEER) cancer registries and medical claims files analysis and enrolling 1,185 VATS lobectomy patients, with an average age of  $75\pm 6$  years, and 8,323 patients, with an average age of  $74\pm 5$  years, who underwent lobectomy via thoracotomy, statistically significant differences were observed in morbidity between cohorts; in particular, concerning thromboembolic diseases [odds ratio (OR): 0.60; 95% CI: 0.48–0.75], cardiovascular complications (OR 0.68; 95% CI: 0.51–0.90) and extra-pulmonary infectious diseases (OR 0.71; 95% CI: 0.59–0.85). On the contrary, no statistically significant differences were found in regards to postoperative respiratory failure (OR: 0.91; 95% CI: 0.81–1.02). The purpose of the study was to point out advantages and disadvantages of minimally invasive approaches considering different technical innovations proposed.

## Discussion

A significant evolution in VATS lobectomy has been noted over the last years, due to its diffusion, worldwide availability and technical improvements, as far as the adoption and success of learning curve courses. Concerning the latter, ability acquisition is influenced by several factors, such as surgeon skill and center volume. In fact, it is a common belief that a surgeon has to perform at least 100 minor procedures in order to face major resections, which claim a learning curve of about fifty procedures for a standard two-three port approach (6), as well as for an uniportal one. Notwithstanding some technical peculiarities, the method does not excessively deviate from conventional VATS lobectomy in skill acquisition (7) and so making this technique, introduced by Rocco *et al.* (8) for diagnostic purposes in the early 2000s, a valid alternative to conventional VATS. Gonzalez-Rivas (9) suggests that one of its greatest advantages, to this day, is the chance to use a robotized articulated arm with a stable camera and a wide margin of maneuver, in order to guarantee optimal vision for the operator and, above all, to reach the location of the lesion properly. This technique, performed by extremely expert surgeons, allows to step towards single surgeon VATS. In this case, the articulated arm would allow a constant vision, thanks to its camera and the possibility of the surgeon to move the lung cranially and caudally, by

putting the aim of interest at the center of the surgical field. With regards to patient outcome, Chung *et al.* (10) have conducted a retrospective analysis with the aim to evaluate any differences between uniportal VATS and conventional VATS lobectomy (biportal and triportal), reporting 150 NSCLC patients (90 uni-VATS *vs.* 60 conventional VATS). With an overall uni-to-standard conversion rate of 35.55%, no differences in morbidity according to video-assisted approach were found (uniportal *vs.* conventional VATS: 28.3% *vs.* 20.0%,  $P=0.237$ ). Furthermore, similar evidences were found concerning operative time (154.13 *vs.* 159.77 minutes;  $P=0.638$ ), hospital stay (6.95 *vs.* 8.50 days;  $P=0.071$ ), time of removal of pleural drainage (5.45 *vs.* 5.91 days;  $P=0.538$ ) and 30-day mortality rate (0 *vs.* 0), leading author to conclude uniportal VATS lobectomy was as a viable alternative to conventional VATS lobectomy. Similarly, French *et al.* (11) in a retrospective cohort study including 50 uniportal VATS patients and comparing them to a standard approach, stated the need for conversion to an open approach was minimal in both groups (U-VATS *vs.* VATS: 4% *vs.* 2%,  $P=0.56$ ). No statistically significant differences in the number of staplers used during the operation (9 *vs.* 8;  $P=0.58$ ), time of the surgery (154 *vs.* 146;  $P=0.08$ ) and major complications (20% *vs.* 10%;  $P=0.26$ ). Lin *et al.* (12), in their retrospective monocentric study on 67 NSCLC patients, have evaluated surgical outcome according to uniportal or biportal VATS approach (21 *vs.* 46 patients). No statistically significant differences in blood loss ( $P=0.089$ ), time of chest tube removal ( $P=0.138$ ) and hospital stay ( $P=0.108$ ) were found. Postoperative pain was lower in uniportal cohort ( $P=0.05$ ); however, time of surgery was significantly higher in the single port group ( $132.3\pm 13.2$  *vs.*  $105.4\pm 12.5$  min;  $P=0.012$ ). For these reasons, Author concluded favoring uniportal VATS strategy due to equal postoperative morbidity but lower postoperative pain. This aspect should be a cornerstone in decision making towards a minimally invasive approach. In this regard, Louis *et al.* (13) have carried out a study in a wide number of patients undergoing pulmonary lobectomy, aiming to evaluate some differences in pain management according to video-assisted approach (uniportal *vs.* multiportal VAT). Enrolling 84 patient (35 uni-VATS *vs.* 49 conventional VATS), a lower dose of narcotics had been administered in uni-VATS patients when compared to control brace [ $182.0$  *vs.*  $260.0$  oral morphine equivalent (OMEq);  $P=0.028$ ], especially on first postoperative day ( $66.0$  *vs.*  $112.0$  OMEq;  $P=0.024$ ).

## Conclusions

The validity of VATS lobectomy as an alternative surgical strategy to classic lobectomy via thoracotomy has been widely demonstrated, as it provides similar oncological radicality with a better outcome especially for postoperative pain management, morbidities, faster recovery and quicker hospital discharge. Moreover, comparing different approaches, equivalent results have been reported making them considered all valid options for NSCLC surgical treatment. However, conventional VATS approaches should not be overlapped by uniportal ones as being their efficacy and feasibility equivalent. So, the choice for an approach should be considered according to the surgeon's propensity and ability without interfering with patients' outcome and oncological radicality.

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