Review Article

Thoracoscopic versus open lobectomy: short-term outcomes

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Abstract: Video-assisted thoracoscopic surgery (VATS) lobectomy for patients with early-stage non-small cell lung cancer (NSCLC) has spread worldwide and it has become a safe and viable alternative to thoracotomy. The aim of this review was to analyse the evidence presents in the current literature in order to assess the safety and efficacy of VATS versus open lobectomy, in terms of short-term outcomes. To identify relevant articles for inclusion in our analysis, we performed a search of PubMed/Medline database. We looked for randomized controlled trials, case series and comparative studies that reported outcomes following VATS or open lobectomy for NSCLC. Morbidity rates are reduced to 7.7–24.1% and mortality to 0.8–2.5% by the VATS approach. The reported lower morbidity rates included less intraoperative bleeding; shorter duration of air leak; lower incidence of post-operative pneumonia, atelectasis requiring bronchoscopy and atrial fibrillation. Furthermore, VATS lobectomy showed shorter chest tube duration; shorter length of hospital stays; reduced post-operative pain and inflammation; a better pulmonary function in the early post-operative phase, when compared with thoracotomy. Summarizing, thoracoscopic approach represents a valid alternative technique to treat NSCLC compared with standard thoracotomy; it offers patients a faster recovery and a better quality of life and allows high-risk patients to benefit from curative surgical treatment. VATS lobectomy might become the choice surgical approach for early-stage NSCLC.

Keywords: Video-assisted thoracoscopic surgery lobectomy (VATS lobectomy); early-stage non-small cell lung cancer (early-stage NSCLC); short-term outcomes; morbidity; post-operative pain

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Introduction

Since the introduction of minimally invasive surgical approach, video-assisted thoracoscopic surgery (VATS) has more and more spread and it has become a feasible technique for the treatment of lung cancer. The cornerstone of surgical practice for operable non-small cell lung cancer (NSCLC) is anatomic pulmonary lobectomy. Since the first reported VATS lobectomy by Roviaro *et al.* in 1992 (1), the number of VATS lobectomies for NSCLC has constantly growing worldwide. While the 1990s were characterized by several controversies regarding the safety and the oncological validity of VATS versus open lobectomy, in the past decade the feasibility and the efficacy of VATS for the treatment of operable NSCLC has been proven (2,3). In particular, VATS lobectomy has been shown to be associated with less postoperative pain, less surgical morbidity, fewer complications, better pulmonary function in the early postoperative period, shorter chest tube duration, faster recovery and shorter hospitalization compared to thoracotomy, without affecting overall survival (4-8). Accordingly, National Comprehensive Cancer Network (NCCN) Guidelines introduced the use of VATS lobectomy in NSCLC management in 2006 and this surgical technique has been recommended as a viable alternative for NSCLC since 2007.

Furthermore, with the increasingly use of new specialized thoracoscopic instruments, many concerns have arisen about the costs of VATS procedures. Despite potential longer operating room time and higher operative equipment expenses, it has been demonstrated that mini-invasive approach may be low-cost than open surgery (9). Indeed, the significantly shorter hospital stay combined with fewer postoperative complications offsets the more expensive operating room costs, resulting in savings hospital expenses (10,11).

Evidence supporting the use of VATS lobectomy arises from randomized controlled trials (12-18), meta-analysis (5,6,19), case-control series (4,8) and a large number of retrospective single/multicentre series (2,7,20-23). Nowadays, both the guidelines coming from the American College of Chest Physician (ACCP) and those from the European Society of Medical Oncology (ESMO) promote either the use of VATS procedure or thoracotomy in patients with early-stage NSCLC in experienced centres (24,25).

We have reviewed the literature in order to clarify the state of the art of available evidence and compare the safety and efficacy of VATS versus open lobectomy, particularly referring to short-term outcomes.

Methods

A search was conducted of database PubMed/Medline, using combinations of the keywords "lung cancer", "lobectomy", "video-assisted thoracic surgery" and "thoracotomy", for article in English that were published between 1990 and 2018. We included randomized controlled trials, case series and comparative studies of VATS versus thoracotomy in resectable NSCLC patients undergoing lobectomy. Studies results concerned short-term outcomes. We excluded abstracts, letters, editorials, case reports or small series <10 patients. A manual search using the bibliography from these articles has also been performed.

Results

Morbidity and mortality (Table 1)

Mortality from open lobectomy is estimated at 1–2%, with a morbidity rate of 32–37% (32,33).

Data from several prospective and large retrospective studies have shown favourable outcomes in patients operated

Table 1 Reports comparing morbidity and mortality between VATS and open lobectomy in patients who underwent surgery for NSCLC

Author (Ref.)	Year and country	Design	No. of patients	Mortality (%, VATS *vs.* open)	Morbidity (%, VATS *vs.* open)	Blood loss (VATS *vs.* open)	Chest tube duration (days, VATS *vs.* open)	Hospital stay (days, VATS *vs.* open)
Kirby *et al.* (12)	1995, USA	RCT	61	–	6 *vs.* 16 (pts); P<0.05	25 *vs.* 30 (pts); NS	4.6±3.3 *vs.* 6.5±4.8; NS	7.1±5.5 *vs.* 8.3±5.7; NS
Demmy *et al.* (26)	1999, USA	NRCT	19	3 *vs.* 1 (pts)	3 *vs.* 5 (pts)	–	4.0±2.8 *vs.* 8.3±8.9; NS	5.3±3.7 *vs.* 12.2±11.1; P=0.02
Sugiura *et al.* (27)	1999, Japan	NRCT	44	0 *vs.* 0; NS	27.3 *vs.* 27.3; NS	150±126 *vs.* 300±192 mL; P=0.0089	–	23±18 *vs.* 22±15; NS
McKenna *et al.* (2) -only VATS patients-	2006, USA	NRCT	1,100	0.8 (only VATS)	15.3 (only VATS)	–	–	–
Onaitis *et al.* (3) -only VATS patients-	2006, USA	NRCT	500	1.2 (only VATS)	22.4 (only VATS)	1 (pts requiring reoperation)	Median: 3 (only VATS)	Median: 3 (only VATS)
Swanson *et al.* (28)- only VATS patients-	2007, USA	RCT	127	2.7 (only VATS)	9.5 (only VATS)	2 (pts requiring conversion)	Median: 3 (only VATS)	–

Table 1 (*continued*)

Table 1 *(continued)*

Author (Ref.)	Year and country	Design	No. of patients	Mortality (%, VATS *vs.* open)	Morbidity (%, VATS *vs.* open)	Blood loss (VATS *vs.* open)	Chest tube duration (days, VATS *vs.* open)	Hospital stay (days, VATS *vs.* open)
Park *et al.* (29)	2007, USA	NRCT	244	0 *vs.* 2.5; NS	17.2 *vs.* 27.9; P=0.046	–	–	4.9±2.4 *vs.* 7.2±3.8; P=0.001
Whitson *et al.* (4)	2008, USA	Review	6,370	–	16.4 *vs.* 31.2; P=0.018	–	4.2 *vs.* 5.7; P=0.025	8.3 *vs.* 13.3; P=0.016
Flores *et al.* (22)	2009, USA	NRCT	741	–	23 *vs.* 33; P=0.03	–	–	5 *vs.* 7; P<0.0001
Scott *et al.* (18)	2010, USA	RCT	244	0 *vs.* 1.6 NS	–	3% *vs.* 1.9%; NS	1.5% *vs.* 10.8%; P=0.029 (chest tube draining >7 days)	5 *vs.* 7; P<0.001
Gopaldas *et al.* (20)	2010, USA	NRCT	13,619	3.1 *vs.* 3.4; NS	VATS; OR 1.6; [95% CI, 1.0–2.4; P=0.04]; intraoperative complications	–	–	9.3±0.1 *vs.* 9.2±0.4; NS
Cao *et al.* (30)	2012, Australia	MTA	7,730	1.4 *vs.* 1.9; NS	26.7 *vs.* 36.1; P<0.0001	NS	–	P<0.00001
Li *et al.* (5)	2012, China	MTA	1,362	–	29.6 *vs.* 46.4; P<0.0001	–	–	–
Cai *et al.* (19)	2013, China	MTA	2,104	–	VATS; OR 0.45; [95% CI, 0.24–0.84; P=0.013]	–	–	–
Chen *et al.* (6)	2013, China	MTA	3,457	–	VATS; OR 0.61; [95% CI, 0.49–0.76; P<0.01]	P<0.01	P=0.01	P<0.01
Falcoz *et al.* (21)	2015, France	NRCT	5,442	1 *vs.* 1.9; P=0.002	29.1 *vs.* 31.7; P=0.0357	–	–	Mean: 7.8 *vs.* 9.8; P=0.0003
Long *et al.* (17)	2018, China	RCT	425	NS	10.23 *vs.* 10.95 NS	100 *vs.* 100 mL; P=0.001	4 *vs.* 4; NS	14 *vs.* 15; NS
Al-Ameri *et al.* (31)	2018, Sweden	NRCT	1,601	0.7 *vs.* 0.3 NS	14 *vs.* 17 NS	1.4% *vs.* 5%; P=0.008 (% of pts requiring transfusions)	54% *vs.* 21%; P<0.001 (% of pts chest drain removed on POD 1)	Median: 4 *vs.* 6; P<0.001
Dziedzic *et al.* (23)	2018, Poland	NRCT	982	1 *vs.* 1 NS	–	4% *vs.* 12%; P=0.0054 (% of pts requiring transfusions)	–	Mean: 7.25 *vs.* 9.34; P<0.0001

RCT, randomized controlled trial; NRCT, non-randomized controlled trial; MTA, meta-analysis; VATS, video-assisted thoracic surgery; pts, patients; NS, not significant; CI, confidence interval; OR, odd ratio; POD, post-operative day.

on by VATS lobectomy compared to open lobectomy (2,21-23,27,31). Morbidity rates are reduced to 7.7–24.1% and mortality to 0.8–2.5% by the VATS approach. The main described lower rates of morbidity were represented by shorter duration of air leak, lower incidence of post-operative pneumonia and atrial fibrillation.

One of the largest series published to date was conducted by Mckenna *et al.* and included 1,100 patients who underwent VATS lobectomies between 1992 and 2004 (2). In this paper, a 0.8% mortality rate with a morbidity rate of 15.3% was reported. The risk of intraoperative bleeding was minimal. Onaitis *et al.* investigated on a prospective database of 500 consecutive patients who underwent VATS lobectomy between 1999 and 2006 (3). The operative mortality was 0% and the perioperative one (30-day) amounted to 1%.

The safety of VATS procedures was also demonstrated by Swanson and colleagues, who published the Cancer and Leukemia Group B (CALGB) 39802 trial, planned to evaluate the perioperative outcomes of 127 patients affected by early-stage NSCLC who underwent VATS lobectomy (28). Within 30 days, mortality was 2.7%, no directly related to VATS technique; conversely, morbidity rate was only 7.4%.

In 1999, Sugiura *et al.*, in their nonrandomized study that compared patients undergoing VATS lobectomy (22 patients) with thoracotomy (22 patients), showed a significant decrease of blood loss for the VATS group (150±126 *vs.* 300±192 mL) (27). Similar results were found by Demmy and Curtis (26).

Almost 25 years ago, Kirby and colleagues performed a randomized controlled trial comparing VATS lobectomy with muscle-sparing thoracotomy (12). VATS resection presented lesser complication rates, but no significant differences in decrease of blood loss, chest tube duration, length of hospital stay and postoperative pain were observed.

In a retrospective analysis of 741 prospective collected patients affected by clinical stage IA NSCLC undergoing lobectomy, Flores *et al.* compared 343 thoracotomies to 398 VATS lobectomy (22). They identified increased age and tumour size as significant predictors of complications. VATS procedures appeared to yield fewer complications (OR =0.73; P=0.06) when controlling for tumour size and age. A 2-day shorter hospitalization was found in patients undergoing VATS lobectomy compared with thoracotomy (P<0.001).

A secondary analysis of data from the American College of Surgeons Oncology Group (ACOSOG) Z0030 randomized clinical trial was performed by Scott and colleagues in 2010 (18). They compared outcomes from participants in a randomized, multi-institutional study matching lymph node sampling versus mediastinal dissection for early-stage lung cancer who underwent either VATS or open lobectomy. Operative mortality was similar (VATS 0% *vs.* open 1.6%; P=1.0). The occurrence of bleeding requiring transfusion (VATS 3% *vs.* open 1.9%; P=1.17) and the number of instances of haemorrhage requiring reoperation (VATS 1.5% *vs.* open 1.3%; P=1.02) were each similar for the two cohorts. Less atelectasis requiring bronchoscopy (0% *vs.* 6.3%; P=0.035), fewer chest tubes draining greater than 7 days (1.5% *vs.* 10.8%; P=0.029) and shorter median length of stay (5 *vs.* 7 days; P<0.001) were observed in the VATS group. These results confirmed the previous findings of Park *et al.* in their analysis comparing 122 patients who underwent VATS lobectomy with 122 patients who underwent open lobectomy. The VATS group showed fewer overall complications (17.2% *vs.* 27.9%; P=0.046) (29).

Data from the European Society of Thoracic Surgeons (ESTS) database confirmed that VATS lobectomy is associated with better short-term outcomes compared with thoracotomy (21). Indeed, patients undergoing VATS procedures presented a lower incidence of total complications (29.1% *vs.* 31.7%; P=0.0357), major cardiopulmonary complications (15.9% *vs.* 19.6%; P=0.0094), atelectasis requiring bronchoscopy (2.4% *vs.* 5.5%; P<0.0001), initial ventilation >48 h (0.7% *vs.* 1.4%; P=0.0075) and wound infection (0.2% *vs.* 0.6%; P=0.0218). The VATS group had a 2-day shorter postoperative hospital stay (mean: 7.8 *vs.* 9.8 days; P=0.0003). Perioperative mortality was 1% in the VATS group *vs.* 1.9% in the open group (P=0.002).

A recent randomized controlled trial has been conducted by Long *et al.* and included 425 patients operated on for clinically early-stage NSCLC (215 VATS and 210 axillary thoracotomy) (17). Fewer intraoperative blood loss has been shown in patients undergoing VATS lobectomy (P=0.001), while postoperative chest tube drain duration, length of hospital stay and rates of morbidity and mortality did not differ between the two groups.

Al-Ameri and co-workers observed 1,601 patients from the Swedish national quality register for general thoracic surgery who underwent open (n=1,316) or VATS (n=285) lobectomy for NSCLC (31). The VATS group presented less postoperative complications than standard thoracotomy group. Patients who underwent open thoracotomy had significantly more transfusions (5.0% *vs.*

1.4%; P=0.008) and pneumonia (5.5% *vs.* 0.6%; P=0.002), compared to patients who underwent VATS procedure. In 54% of VATS patients the chest drainage tubes were removed on postoperative day (POD) 1 compared to 21% of open thoracotomy patients (P<0.001). The length of hospitalization was significantly lower for patients who underwent VATS lobectomy compared to the open group (median: 4 *vs.* 6 days; P<0.001). No significant differences in the 30-day mortality (0.7% *vs.* 0.3%; P=0.38) and 90-day mortality (1.7% *vs.* 0.3%; P=0.09) were observed in the open thoracotomy and VATS group, respectively.

Similar results were found in the report of Dziedzic and colleagues, dealing with 982 patients affected by stage I-IIA NSCLC operated on with VATS (n=225) or thoracotomy (n=757) lobectomy (23). A propensity score-matched analysis was performed to compare the two groups of patients. The authors reported that VATS surgical approach reduced both the need for blood transfusions (4% for VATS *vs.* 12% for open thoracotomy; P=0.0054) and the incidence of postoperative atelectasis (4% *vs.* 10% respectively; P=0.0052). Moreover, a significant shorter postoperative length of hospital stay was observed in patients who underwent VATS lobectomy (mean 7.25 *vs.* 9.34 days; P<0.0001). The two groups did not differ in the 30-day mortality (1% *vs.* 1%; P=0.66) and 90-day mortality (1% *vs.* 1%; P=0.48) rates.

Conversely, the only study demonstrating that VATS procedure is associated with a major incidence of intraoperative complications was performed by Gopaldas *et al.* in 2010 (20). The authors carried out a retrospective analysis on 13,619 patients undergoing thoracotomy (n=12,860) or VATS (n=759) lobectomy in all non-federal hospitals in the United States between 2004 and 2006. Patients operated on with VATS lobectomy were 1.6 more likely to have intraoperative complications than patients who underwent open lobectomy (95% CI, 1.0–2.4; P=0.04). However, respiratory complications (32.2% *vs.* 31.2%; P=0.55), cardiovascular complications (3.4% *vs.* 3.9%; P=0.43), in-hospital mortality rates (3.1% *vs.* 3.4%; P=0.67), length of hospitalization (9.3±0.1 *vs.* 9.2±0.4 days; P=0.84) and incidence of wound infection (0.8% *vs.* 1.3%; P=0.15) were similar in the open thoracotomy group compared to VATS group.

A systematic review conducted by Whitson *et al.* included 39 studies involving 3,256 thoracotomy and 3,114 VATS patients treated by lobectomy for early-stage NSCLC (4). They found that VATS approach was associated with a lower morbidity rate (16.4% *vs.* 31.2%; P=0.018), a shorter chest tube duration (4.2 *vs.* 5.7 days; P=0.025) and inferior hospitalization times (8.3 *vs.* 13.3 days; P=0.016).

Several recent meta-analyses have confirmed that VATS lobectomy compares favourably with open surgery (5,6,19,30). Cao *et al.* compared unmatched and PS-matched groups of VATS and open thoracotomy resections; they found a significantly lower overall perioperative morbidity rate, incidences of pneumonia and atrial arrhythmias, and a shorter length of hospital stay after VATS (30).

A significant lower incidence of complication rate in patients who received VATS compared to open lobectomy was observed by Li and colleagues (OR =0.36; 95% CI, 0.23–0.57; P<0.0001) (5) and Cai *et al.* (OR =0.45; 95% CI, 0.24–0.84; P=0.013) (19).

Chen and associates carried out a meta-analysis consisting of 20 reports with 3,457 clinical stage I NSCLC patients undergoing VATS or thoracotomy lobectomy (6). The two groups did not differ in operation time (P=0.14), but VATS surgery was associated with distinct advantages in terms of intra-operative blood loss (95% CI, −79.32 to −45.66; P<0.01), chest drainage time (95% CI, −0.69 to −0.09; P=0.01), hospital stay (95% CI, −0.20 to −1.28; P<0.01) and complication incidence (OR 0.61; 95% CI, 0.49–0.76; P<0.01).

Pain and pulmonary function

The short-term quality of life of patients operated on for NSCLC appears to be better after minimally invasive surgery. Several reports concluded that VATS lobectomy is less painful than thoracotomy and causes a less impairment of pulmonary function, bringing to a faster recovery (7,16,26,27,34-38).

In the series by Demmy and Curtis, comparing thoracoscopic versus open lobectomy in patients with unfavourable risk factors, VATS patients had earlier returns to full preoperative activities (2.2±1.0 *vs.* 3.6±1.0 months; P<0.01) (26). Pain was noticeably better in the VATS group (none or mild: 63% *vs.* 6%; severe: 6% *vs.* 63%; P<0.01) at 3 weeks follow-up.

Similarly, in the randomized controlled trial of Bendixen *et al.*, comparing patients treated by lobectomy for stage I NSCLC (102 VATS and 99 anterolateral thoracotomy), the authors founded a fewer postoperative pain and a better quality of life (P=0.014) in VATS procedures compared to open approach (16). In particular it has been shown that, on POD 1, a clinically relevant pain (NRS ≥3) was significantly lower in patients who underwent VATS than anterolateral thoracotomy (VATS 38%; 95% CI, 0.28–0.48 *vs.* thoracotomy 63%; 95% CI, 0.52–0.72; P=0.0012).

Similar results had been previously obtained by Long and associates in their randomised controlled trial analysing clinically early-stage NSCLC patients with the aim of compare quality of life after VATS versus open lobectomy (35). In the VATS group, the authors found a significantly lower dyspnoea (10.9±7.4 *vs.* 17.4±9.6; P=0.047) and pain score (13.7±9.5 *vs.* 23.0±12.2; P=0.028) a month after operation.

Sugiura and co-workers, in their nonrandomized study about postoperative acute pain in patients operated on by thoracoscopic or open procedure, detected many elements supporting the minimally invasive approach: duration of epidural catheter (3±2 *vs.* 7±4 days; P=0.0001), less postoperative narcotics (P=0.0439) and mean frequency of analgesic use (14±5 *vs.* 18±5 times) (27).

In 1998 Walker reported his experience with 150 patients undergoing VATS lobectomy (34). Open thoracotomy patients required 42% more morphine (P<0.001) and 25% more nerve blocks than VATS patients (P<0.001), who, conversely, were 33% more likely to sleep following surgery (P<0.01).

Andreetti *et al.* analyzed 145 patients undergoing lobectomy by VATS or mini-thoracotomy approach with the purpose to compare postoperative pain between the two groups (36). The authors observed significantly differences in pain scores at 1, 12, 24 and 48 h postoperatively (6.24 *vs.* 8.74, 5.16 *vs.* 7.66, 4.19 *vs.* 6.89 and 2.23 *vs.* 5.33; P=0.000). Moreover, mean forced expiratory volume in 1 second (FEV1) and six-minute walking test (6MWT) were better in the VATS group both at 48 h and 1 month after surgery. Particularly, mean FEV1 values were 1.83±0.65 *vs.* 1.33±0.52 and 2.09±0.65 *vs.* 1.82±0.63, respectively, at 48 h and 1 month (P=0.028); mean 6MWT values (m) were 371.23±55.36 *vs.* 312.03±48.54 and 392.07±56.12 *vs.* 331.83±47.99, respectively, at 48 h and 1 month (P=0.000) after surgery.

Such findings were confirmed by Nagahiro and colleagues (7). They found a significantly decrease of postoperative pain in the VATS group on PODs 0, 1, 7 and 14 compared to posterolateral thoracotomy approach (P<0.01). Serum pro-inflammatory cytokine IL-6 level was significantly higher in open lobectomy patients on POD 0 (P=0.03). VATS lobectomy was associated with quicker and enhanced recovery rates of FVC, FEV1 and vital capacity compared with open group at 1 and 2 weeks following surgery. Recovery rates of respiratory function were negatively correlated with postoperative pain on POD 7.

Postoperative pulmonary function seemed to be improved after thoracoscopic procedures rather than after standard open approach also in a non-randomized study carried out by Nakata *et al.* (37). They found better peak flow rate during the early postoperative period in patients who had undergone VATS lobectomy: 70.3±13.0 *vs.* 55.1±10.5% on POD 7 (P=0.008); 83.8±18.5 *vs.* 65.0±15.8% on POD 14 (P=0.03). Additionally, PaO_2 (P=0.054), O_2 saturation (P=0.063), FVC (P=0.10) and FEV1 (P=0.08) showed a better trend in the VATS group compared to open lobectomy at 1 week following surgery.

In the retrospective analysis conducted by Nomori and co-workers in patients who underwent a lobectomy by VATS, an anterior limited thoracotomy, an anteroaxillary thoracotomy or a posterolateral thoracotomy without muscle sparing, a significant lower injury of vital capacity was observed in VATS group from 1 to 24 weeks after surgery (P<0.05–0.001) and a better 6MWT on POD 7 (P<0.01–0.001) than thoracotomy groups (38).

Discussion

VATS technique has certainly been one of the greatest progresses in thoracic surgery over the past decades. The VATS lobectomy has more and more become a safe and feasible alternative surgical approach to open lobectomy and it is now practiced worldwide. In some centres, such as in Hong Kong, VATS lobectomy has been routinely performed for the majority of clinically early-stage NSCLC since the mid-1990s (39). By contrast, the spread of VATS lobectomy has been slower in other countries, because of the lack of adequate evidence support, especially randomized controlled trials. In the United States, the proportion of lobectomies performed by VATS was only 45% in 2012 (40). In Europe, Denmark had the highest minimally invasive resection rate with 55% of all lobectomies achieved by thoracoscopic approach in 2011 (41).

Although the feasibility of VATS lobectomy in patients with early-stage NSCLC has been established (2,3,30), the benefits of the minimally invasive approach over thoracotomy were difficult to demonstrate due the absence of standardization in defining the VATS lobectomy procedure. The most influential and acknowledged definition of the VATS approach to date has been provided by the CALGB 39802 trial of the American Society of Clinical Oncology (28). The authors defined VATS lobectomy by the following criteria: no rib spreading;

utility incision up to 8 cm long; distinct dissection of the vein, arteries and bronchus for the lobe in question and standard node sampling or dissection (equal to an open thoracotomy). Using this mainstay definition, the supporters of VATS lobectomy have proven that VATS is a safe and viable surgical technique and produces excellent perioperative results (12).

The overall surgical mortality of 0–2% for VATS compared favourably to the conventional thoracotomy (2,3,28). Additionally, it has been proven that the VATS approach reduces morbidity rates to 7.7–24.1%, compared to 32–37% in open lobectomy (4-6,30). The major short-term advantages of minimally invasive surgical procedure consist of less intraoperative bleeding (2,6,26,27); fewer postoperative complications (12,18,21,22); less postoperative pain, better pulmonary function in the early postoperative period, shorter chest tube duration, faster recovery and shorter hospitalization (7,16,26,27,34-38).

Many studies have shown the need of fewer postoperative bronchoscopies for atelectasis or secretion retention in patients who underwent VATS lobectomy (18,21,23). These results can be explained by a mixture of less impairment of pulmonary function, reduced postoperative pain and inflammation which allow an easier mobilization of secretions following minimally-invasive surgery. Consequently, benefits for faster recovery and decreased postoperative complications can be achieved with VATS approach (7,36,37).

It has been reported that 5% to 80% of patients experience significant levels of pain at 2 months or more after a standard thoracotomy (42). This pain can persist in up to 30% of patients at 4 to 5 years after surgery. A combination of factors can explain the origin of the postoperative pain; nevertheless, the hypothesis most accredited by the majority of surgeons is the severe rib spreading during thoracotomy. The VATS fundamental of minimize the surgical access without rib spreading allows a less postoperative pain. This evidence has been proven for many years in several retrospective studies, either by objective valuation in terms of analgesic requirements (27,34,36), or subjective assessment in terms of pain scoring, generally in a visual analogue scale form (26,36). Two recent randomized controlled trials comparing VATS with thoracotomy for lobectomy revealed a decreased postoperative pain and an enhanced quality of life associated with the VATS approach (16,35).

An interesting correlation between lower postoperative pain and better early postoperative pulmonary function following VATS surgery can be explained by a less cytokine production triggered by minimally invasive approaches (7). In line with the literature, a reduced and shorter period of acute inflammatory stress response was observed in VATS (43). Specifically, VATS lobectomy is associated with decreased postoperative release of both pro-inflammatory (IL-6, IL-8) and anti-inflammatory (IL-10) cytokines compared to the conventional thoracotomy (7).

The reduced pain and the consequently improved pulmonary function translate into faster recovery, allowing a significantly shorter hospitalization and a quicker return to normal daily life and previous work activities (26,27,37,38).

The reduction in morbidity associated with VATS approach paves the way for lowering the thresholds of surgery. Indeed, if the surgery itself causes fewer complications and pain, then supposedly it may be accessible to patients previously excluded from surgical treatment, because thought to be too high risk. As a result, surgery, the first broadly recognized treatment for early-stage NSCLC, may include those borderline surgical candidates to whom curative operations could be offered instead of compromised treatments (e.g., SBRT, thermal ablation) which are characterized only by limited possibilities of reaching tumour eradication.

For this purpose, many encouraging studies have already been published. Falcoz and colleagues, in their analysis from ESTS database, founded that VATS lobectomy was protective in elderly patients (more than 70 years old) compared to thoracotomy (21), as demonstrated by a previous single-centre US study (44) and a Japanese report (45). Importantly, they found a positive trend in Europe for VATS approach in patients with a prohibitive predicted postoperative FEV1 <40% (21). Patients with such poor respiratory function would traditionally have been excluded from any form of curative major lung surgery. Nonetheless, when this cohort was operated on by VATS, patients undergoing thoracoscopic lobectomy presented less major cardiopulmonary complications as well as a shorter hospitalization compared to thoracotomy group. These results are in line with worldwide evidence; such as data published from the STS database in the USA (46) and from an Asian report (47).

Conclusions

According to available literature, we can affirm that VATS lobectomy is a safe and feasible alternative technique to treat NSCLC compared with standard thoracotomy.

Particular advantages are less intra-operative blood loss, lower post-operative complications incidence, shorter chest drain duration and hospital stay. The reduction of post-operative pain associated with a less impairment of pulmonary function allows a faster recovery and the return to former normal life activities. Interestingly, VATS lobectomy presents a positive influence in high-risk patients and this can be translated into a greater number of NSCLC cases which should benefit from curative surgical treatment.

These evidences on short-term outcomes represent a solid benchmark for thoracic surgeons and suggest that VATS lobectomy might become the surgical approach of choice for early-stage NSCLC.

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Footnote

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