Original Article

Early enhanced recovery after lung surgery: early ambulation 1 hour after extubation

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Background: In this study, we describe our experience regarding the implementation of early enhanced recovery after lung surgery. We achieved early ambulation within 1 hour after extubation mainly by minimally invasive surgery combined with fast-track thoracic anesthesia.

Methods: We retrospectively analyzed the clinical outcomes of early enhanced recovery in 211 patients who underwent lung resection using miniport video-assisted thoracic surgery (VATS) by a multidisciplinary team in a single institution in the period from August 2018 to August 2019.

Results: Out of the 211 patients, 178 achieved early ambulation 1 hour after extubation. The mean age of patients in the early ambulation group was 58.6±10.8 years, and 69 men and 109 women were included. The anesthesia time (100.8±26.6 minutes), extubation time (10±2.1 minutes), and operating time (71.1±25.3 minutes) were lower in the early ambulation group (P=0.001, P<0.001, and P=0.002, respectively). Segmentectomy was performed in 48.9% of patients in the early ambulation group. The mean length of postoperative hospital stay was 4.1±3.1 days, and the 30-day morbidity was 13.7% (29/211). Prolonged air leak was the main complication, which accounted for 75.9% (22/29). No reinsertion of chest tubes, no 30-day readmissions, and no reoperations in the postoperative 30-day period occurred in any of the patients.

Conclusions: Early enhanced recovery after lung surgery is feasible and safe, and may facilitate early ambulation and lay the foundation for the implementation of day surgery.

Keywords: Video-assisted thoracic surgery (VATS); lung cancer; enhanced recovery after surgery (ERAS); early ambulation

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Introduction

Enhanced recovery after surgery (ERAS) represents a multidisciplinary and multimodal evidence-based improvement approach to maximize patient recovery after surgery, which was initially developed in colorectal surgery (1). In recent years, many studies regarding enhanced recovery after lung surgery with better patient outcomes have been published (2-4). Recommendations for guidelines for enhanced recovery after lung surgery have been proposed by the ERAS Society and the European Society of Thoracic Surgeons (ESTS) in 2018 (5). Compared with other elements, several key elements, including minimally invasive surgery and early ambulation, appear to be more influential in improving outcomes (4,6). The combination of several elements in the ERAS protocol can create a synergistic effect to reduce surgical stress in order to retain anabolic homeostasis and have a more positive impact on surgical outcome than individual care elements themselves (1,7).

Early enhanced recovery after lung surgery is defined by early ambulation in the postanesthesia care unit (PACU) 1 hour after extubation following surgical treatment performed by minimally invasive thoracic surgery (MIS) combined with fast-track thoracic anesthesia (FTTA). After extubation, patients walk autonomously from the PACU to the ward (distance of around 80 m). The purpose of this study was to describe our experience implementing early enhanced recovery after lung surgery and facilitating early ambulation within an hour after extubation, and analyzed the clinical data.

We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/apm-21-2102).

Methods

In this study, we retrospectively analyzed the clinical outcomes of 211 patients with early enhanced recovery after lung surgery who underwent video-assisted thoracic surgery (VATS) lung resection with 2 miniports by our multidisciplinary team in Taizhou Municipal Hospital from August 2018 to August 2019.

All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board and Ethics Committee of Taizhou Municipal Hospital and informed consent was taken from all the patients.

Patient inclusion criteria

All patients who underwent VATS lung resection due to lung tumors were able to perform everyday activities autonomously before surgery. Patients had no severe comorbidities such as chronic obstructive pulmonary disease, bronchial asthma, heart disease, morbid obesity, and diabetes, among others. Also, patients from whom no feedback was received postoperatively during the follow-up before the third postoperative month were excluded. Patients who underwent thoracotomy conversion due to intraoperative bleeding, invasion of the tumor, or extensive adhesion were excluded, and patients who underwent pneumonectomy were also excluded.

Multidisciplinary team and early ERAS protocol

Effective implementation of ERAS requires strong collaboration of a multidisciplinary team. All operations were performed by a single surgical team of the Thoracic Surgery Department of Shanghai Chest Hospital. Perioperative management was performed by 2 thoracic surgeons and 2 nurses of Taizhou Municipal Hospital. Anesthetic management was performed by 1 anesthesiologist from the Department of Anesthesiology of Dongfang Hospital. An early ERAS pathway was established on the basis of both clinical experience and guidelines for enhanced recovery after lung surgery of the ERAS Society and ESTS (5). The key elements of the early ERAS protocol were MIS and FTTA (*Table 1*).

Data collection

Patients were divided into 2 groups according to whether they could achieve early ambulation or not. Early ambulation was defined as patients achieving a minimum target to walk for 5 minutes without any help within 1 hour after extubation. The chest tube was removed when there was no evident air leakage and bleeding, the 24-hour drainage was ≤200 mL, and chest X-ray was normal postoperatively. The patient was discharged the same day. The medical records for all patients were collected corresponding clinicopathologic data, including sex, age, pulmonary function, histological type, treatment and anesthesia information and ambulation time.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation and median. Categorical variables were expressed as counts and percentages. The analysis between groups was conducted using the Mann-Whitney U test or *t*-test for continuous variables as appropriate. Categorical variables were analyzed using Pearson's chi-square test. A P value of less than 0.05 was considered statistically significant. Analysis and figures were produced with SPSS for Windows

Table 1 The key elements of the early enhanced recovery after lung surgery protocol

Minimally invasive surgery
Miniport VATS approach
Intrapleural intercostal nerve block (3.5 mg/mL ropivacaine 20 mL) and pleural block (1% lidocaine 10 mL)
Single chest drain (24-Fr)
Fast-track thoracic anesthesia
Anesthesia induction
Midazolam 0.025 mg/kg and sufentanil 0.25 μg/kg
Intravenous injection of propofol 1.5–2.5 mg/kg until the patient was under anesthesia
Intravenous injection of cisatracurium besilate 0.16 mg/kg and BIS monitoring [40–50]
A smaller sized double-lumen endobronchial tube according to CT evaluation was inserted
Anesthesia maintenance
Propofol (4–5 mg/kg/h) and remifentanil (0.01 g/kg/h) pumped continuously to maintain anesthesia and stopped 5 minutes before the end of surgery, and BIS monitoring was about 55
Cisatracurium besilate (0.07 mg/kg/h) pumped continuously to maintain muscle relaxation 20 minutes after induction and stopped 20 minutes before the end of surgery
Intravenous PCA performed 30 minutes before the end of surgery
Anesthesia recovery
Antagonizing cisatracurium 10 minutes after the surgery (depending on the recovery of muscle relaxation)
Light exercises (no oxygen intake and SpO2 >96%)

VATS, video-assisted thoracoscopic surgery; BIS, bispectral index; PCA, patient-controlled analgesia; PACU, postanesthesia care unit.

version 23.0 (SPSS, Inc., Chicago, IL, USA).

Results

Patient characteristics and clinical outcomes

A total of 211 patients underwent VATS lung resection for lung tumors in the period between August 2018 and August 2019. The mean age was 59.9±11.5 years, and 87 men and 124 women were included. A total of 176 patients were diagnosed with lung cancer, while the other patients had benign tumors. All patients had the same type of anesthesia and underwent the minimally invasive VATS approach with miniports (*Figure 1*). Patient characteristics are summarized in *Table 2*. All of the patients were extubated in the PACU. The mean time between the anesthesia-free period and extubation was 10.5±3 minutes. No intraoperative awareness occurred in any of the patients. On the day of surgery, 208 patients were immediately stimulated and encouraged to do light exercises, as well as breathing exercises and coughing after extubation. The mean time between extubation and light exercises was 19.4±7.6 [6–45] minutes. A total of 35.1% (73/208) of patients felt slight pain while coughing, and 206 patients were seated in bed by themselves at least 5 minutes after extubation on the day of surgery. The mean time recorded was 31±7.9 minutes. Afterwards, the period between standing beside the bed and extubation was 42.1±10.7 minutes, and the mean time of getting out of bed early in patients undergoing lung cancer surgery was 43.3±10.6 minutes. The delay between walking and extubation was 50.8±9.8 minutes. Some patients finished a jog for about 30 seconds (*Video 1*). Five patients did not achieve ambulation on the day of surgery because of poor lung function (Diffusing capacity of the lungs for carbon monoxide, DLCO%: 41.2%) and longer operation time (203.4±51.3 minutes) resulting from intraoperative bleeding, complex surgical procedure, and extensive pleural adhesion. The percentages of the 206 patients who felt weak and unsteady while they were seated in bed, standing beside the bed, and walking were 13.6% (28/206), 8.3% (17/206), and 2.4% (17/206), respectively. No postoperative nausea and vomiting (PONV) occurred in any of the patients

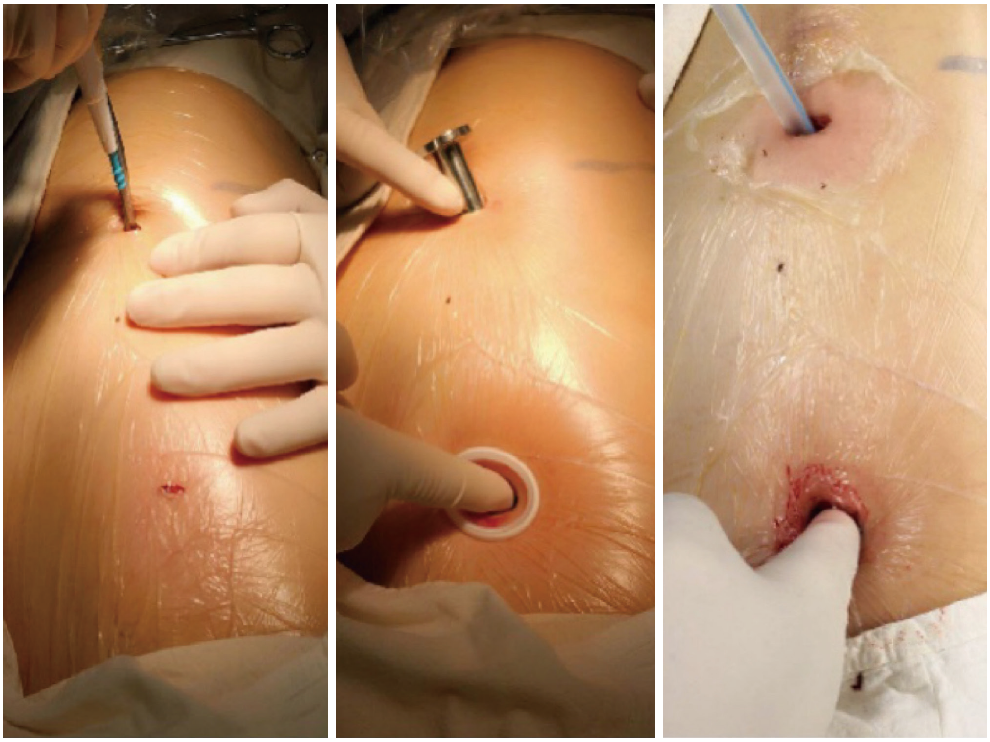

Figure 1 Two miniports: around 1.2 cm utility incision and 1cm port (usually camera port).

during the early postoperative period.

Segmentectomy was the most frequently performed procedure and accounted for 109 (51.7%) patients. Lobectomy and wedge resection were performed in 45 (21.3%) and 57 (27%) patients, respectively. The mean operation time was 76.1±34 minutes. The mean chest drain duration was 4.1±2.9 days. The median length of postoperative hospital stay (LPOS) was 3 days (1–26 days). The mean indwelling time of chest tube and the mean LPOS in patients undergoing lung cancer surgery were 4.1±2.6 days. The 30-day morbidity was 13.7% (29/211). Prolonged air leak was the main complication and accounted for 75.9% (22/29). No reinsertion of the chest tube, no 30-day readmissions, and no 30-day reoperations occurred in all the patients.

Relationship between clinicopathological factors and early ambulation

Of the 211 patients, 178 achieved early ambulation within 1 hour after extubation (*Table 3*). The anesthesia time (100.8±26.6 minutes), extubation time (10±2.1 minutes), and operating time (71.1±25.3 minutes) were lower in the early ambulation group, and these differences were statistically significant (P=0.001, P<0.001, and P=0.002, respectively). The delay between extubation and first ambulation was significantly shortened by intraoperative bispectral index (BIS) monitoring (P=0.004). Intrapleural intercostal nerve block (IINB) did not reduce postoperative pain more effectively to shorten the time of ambulation compared with intravenous patient-controlled analgesia (PCA) (P=0.719). However, 5 patients who did not achieve ambulation on the day of surgery were excluded, and IINB had significant advantages in terms of the time of postoperative physical exercises and ambulation (*Table 4*). There were no significant differences in gender (P=0.091), BMI (P=0.624), Forced expiratory volume in 1 second (FEV1)% (P=0.189), surgical procedures (P=0.086), and LPOS (P=0.378) between the 2 groups.

Discussion

The ERAS protocol for thoracic surgery has become more popular and has been applied in many thoracic surgery centers worldwide. Recently, published literature has demonstrated that the implementation of the ERAS

Table 2 Patient characteristics and clinical outcomes

Characteristic	Number of patients (%)
Sex	
Male	87 (41.2)
Female	124 (58.8)
Age, years (mean ± SD)	59.9±11.5
BMI, kg/m^2 (mean ± SD)	23.3±3.6
Pulmonary function, mean ± SD	
FEV1 %	93.4±15.9
MVV %	90.6±22.1
DLCO %	75.2±14.3
Anesthetic and analgesia management	
Bispectral index (BIS), yes *vs.* no	155 (73.5) *vs.* 56 (26.5)
Anesthesia time (min), mean ± SD	106.2±35.5
Intrapleural intercostal nerve block	71 (33.6)
Venous patient-controlled analgesia	140 (66.4)
Surgical procedures	
Wedge resection	55 (26.1)
Segmentectomy	98 (46.4)
Lobectomy	38 (18.0)
Lobectomy plus wedge resection	7 (3.3)
Segmentectomy plus wedge resection	10 (4.7)
Double segmentectomy	1 (0.5)
Double wedge resection	2 (0.9)
Postoperative outcomes	
Operation time (min), mean ± SD	76.1±34
Chest drain duration (days), mean ± SD	4.1±2.9
Median LPOS, (days)	3
30-day morbidity	29 (13.7)
30-day mortality	0
Histological type, n (%)	
Benign	35 (16.6)
Atypical adenomatoid hyperplasia	15 (42.9)
Organizing pneumonia	2 (5.7)
Pulmonary hamartoma	5 (14.3)
Pulmonary sclerosing hemangioma	3 (8.6)
Pulmonary granulomas	7 (20.0)
Pulmonary sequestration	1 (2.8)
Lymphoid reactive hyperplasia	2 (5.7)
Malignant	176 (83.4)
Adenocarcinoma *in situ*	26 (14.8)
Minimally invasive adenocarcinoma	22 (12.5)
Invasive adenocarcinoma	115 (65.3)
Squamous carcinoma	8 (4.5)
Adenosquamous carcinoma	1 (0.6)
Small cell lung cancer	1 (0.6)
Metastatic adenocarcinoma	3 (1.7)

FEV1, forced expiratory volume in 1 second; MVV, Maximal Voluntary Ventilation; DLCO, diffusing capacity of the lung for carbon monoxide; LPOS, length of postoperative hospital stay.

protocol can result in a reduction in postoperative pulmonary and cardiac complications, hospital costs, and LPOS (5,6,8). However, Brunelli *et al.* found no benefit resulting from the ERAS protocol on outcomes such as cardiopulmonary complications, 30- and 90-day mortality, length of stay, and readmissions (7). Perhaps not all components of ERAS are necessary for patients undergoing VATS lung resection. ERAS is not a simple addition and subtraction but a reasonable compromise. Khandhar *et al.* reported that early postoperative ambulation was a key element in reducing morbidity after VATS lobectomy (9). Moreover, Rogers *et al.* (6) reported that early ambulation (OR: 0.43, 95% CI: 0.26–0.71) was an independent predictor of prolonged length of stay in the multivariate analysis, which appeared to be more influential and important than other elements.

In this study, we found that age (P<0.001), pulmonary function (MVV%: P=0.002, DLCO%: P<0.00), adequate anesthesia management, and the skill of the thoracic surgeon were significantly associated with early ambulation. The mean age of the 178 patients who reached early ambulation within an hour after extubation was 58.6±10.8 years. As shown by a previous study, various functional structures and corresponding physiological functions decrease with age, and thus physical flexibility and daily activities also decrease (10). The mortality and readmission

Table 3 Relationship between clinicopathological factors and early ambulation

Variable	Time (min)		
	≤60	>60	P value
Total, n	178	33	
Sex, n			
Male	69	18	
Female	109	15	0.091[a]
Age (years), mean ± SD	58.6±10.8	67±12.7	<0.001
BMI (kg/m^2), mean ± SD	23.3±3.6	22.9±3.5	0.624
Pulmonary function, mean ± SD			
FEV1 %	94±15.8	90±16.5	0.189[b]
MVV%	92.6±22.3	80±18.2	0.002[b]
DLCO SB%	76.8±13.7	66.4 ±14.2	<0.001[b]
Monitoring BIS			
Yes	124	31	
No	54	2	0.004[a]
Anesthesia time (min), mean ± SD	100.8±26.6	135.5±57.5	0.001
Extubation time (min), mean ± SD	10±2.1	13.7±4.7	<0.001
Pain management, n			
IINB	59	12	
Venous PCA	119	21	0.719[a]
Surgical procedures, n			
Wedge resection	53	4	
Segmentectomy	87	22	
Lobectomy	38	7	0.086[a]
Operation time (min), mean ± SD	71.1±25.3	102.6±56.4	0.002
LPOS (days), mean ± SD	4.1±3.1	4.1±2	0.378

[a], these P values were calculated using Pearson's chi-square test; [b], these P values were calculated using the *t*-test. All others were calculated with the Mann-Whitney U test. Time: delay between extubation and first ambulation of a 5-minute walk. BIS, bispectral index; IINB, intrapleural intercostal nerve block; PCA, patient-controlled analgesia; LPOS, length of postoperative hospital stay.

rates of older patients increase significantly due to the lack of early ambulation (11). Vital capacity, ventilatory capacity, and effective dispersion area will inevitably decrease after lung resection, which can cause ventilation/perfusion defects and impaired gas exchange function. This study found that better preoperative pulmonary function was more favorable for early ambulation. Additionally, surgical procedures were not associated with early ambulation (P=0.086). Whether preserving more lung function after surgery is beneficial to early ambulation still needs further research. However, early ambulation could improve postoperative pulmonary function and increase oxygen saturation. Rivas-Perez *et al.* indicated that patients are particularly vulnerable to orthostatic intolerance besides impaired lung function after lung surgery (12). Orthostatic intolerance mainly affects early ambulation. Pain and PONV represent the leading causes of orthostatic intolerance in the immediate postoperative period. This study found that the combination of MIS and FTTA could resolve the problem effectively.

Minimally invasive surgery

Nowadays, VATS represents the recommended surgical approach for the treatment of early-stage lung cancer (5). VATS is associated with less pain, earlier mobilization, better and earlier shoulder function, shorter LPOS, better preservation of pulmonary function, and better quality of life (13), as well as a better cosmetic effect. Wang *et al.* reported that VATS could shorten the operation time (148.6±39.6 min, P=0.002), reduce intraoperative blood loss (169.4±46.2 mL, P<0.001), and reduce perioperative pain (1.7±0.8, P<0.001) for early lung cancer (14). This study showed that reduced operation time, reduced anesthesia time, and early extubation were more conducive to early ambulation (P=0.002, P=0.001, and P<0.001, respectively). Given the success of VATS, many surgeons have paid attention to further reduce surgical access trauma in terms of the number and size of surgical incisions. A uniportal VATS with one 3–5 cm incision has been accepted around the world. Postoperative pain of uniportal VATS may be significantly reduced compared to multiport VATS (15). A randomized study demonstrated that postoperative pain was equivalent between uniportal and conventional multiport VATS lobectomy (16). Therefore, no conclusive evidence

Table 4 Comparison of the time of postoperative physical exercises and ambulation in IINB patients and in PCA patients

Pain management	Time (min), mean ± SD							
	T1 (min)	P value	T2 (min)	P value	T3 (min)	P value	T4 (min)	P value
IINB	18.3±7.4[b]		29.3±7.3[c]		41.1±11.2[c]		48.6±10.9[c]	
Venous PCA	19.9±7.6[a]	0.06	31.8±8.1[a]	0.029	43.4±9.5[a]	0.012	51.9±9[a]	0.001

These P values were calculated with the Mann-Whitney U test. [a], one missing data record; [b], two missing data records; [c], four missing data records. T1: delay between extubation and moving the extremities; T2: delay between extubation and remaining seated in the bed without help for at least 5 minutes; T3: delay between extubation and remaining standing beside the bed; T4: delay between extubation and ambulation of a 5-minute walk. PCA, patient-controlled analgesia.

can prove that the number of ports affects postoperative pain. Our approach consisted of 2 small ports (miniports)—the port of the utility incision was around 1.2 cm and the other was a 1 cm port (usually used as the camera port). A smaller incision can affect the patient's sensory perception and reduce surgical fear and discomfort, and early ambulation on the day of surgery is more acceptable for these patients. Also, a smaller incision may make curative surgery more acceptable for patients who previously hesitated or resisted surgery. Whether using the uniportal VATS or multiport VATS approach, intercostal neuralgia is still an inevitable public health issue due to damage or compression of the intercostal nerves (17). Subxiphoid VATS (SVATS) is an increasingly popular alternative VATS approach which avoids intercostal neuralgia. A previous study showed that patients in the SVATS group had lower pain scores in the early postoperative period compared with those in the intercostal approach VATS group (P<0.001) (18). Minimizing acute pain may be beneficial in early ambulation. However, the role of SVATS for lung cancer patients still requires further research due to the lack of insufficient experience.

Fast-track thoracic anesthesia

FTTA is defined as multimodal thoracic anesthesia management, which applies multimodal opioid-free anesthesia and early postoperative rehabilitation strategies to enable patients to achieve early mobilization and shorten LPOS (19). Emphasis is placed on this approach as opioid-free anesthesia reduces PONV, which facilitates early ambulation. Intraoperative BIS monitoring can target appropriate anesthetic use to an individual and thereby decrease the incidence of PONV and recovery times (20). In this study, BIS monitoring was associated with early ambulation (P=0.004). Another study found that the use of BIS monitoring could obtain lower postoperative pain scores (21). How to reduce postoperative pain by maintaining multimodal analgesia is a crucial point. In this study, excluding non-painful factors, patients who underwent MIS in the IINB group had a shorter time to early ambulation (P=0.001). The postoperative acute pain scores of patients in the early ambulation group were lower (0.6±0.7 *vs.* 1.1±0.9, P=0.003), and the scores of patients in the IINB group were still lower (0.4±0.6 *vs.* 0.9±0.7, P<0.001) compared to the Venous PCA group. IINB associated with mini-thoracotomy was shown to reduce postoperative acute pain (22). Wurnig *et al.* (23) reported that thoracic epidural anesthesia and a paravertebral block might offer better pain control from the second day after surgery compared to intercostal block. However, epidural anesthesia is not suitable in all patients and is associated with several complications such as dural perforation, bleeding, infection, and hypotension. IINB is safe and effective for providing immediate postoperative pain relief. Additionally, warming blankets were applied in all patients, as active warming can offer good conditions for early extubation (24). This study demonstrated that early extubation was associated with early ambulation (P<0.001).

The principle of subtraction

To achieve early ambulation, minimizing barriers and invasive measures are very important. Urinary catheters, continued intravenous fluids, and chest tubes are important barriers to early ambulation. In this study, no urinary catheters were administered in patients unless necessary. Balanced postoperative intravenous fluids can reduce the time of bed rest. Thoracic surgeons have traditionally used 2 chest tubes to drain the pleural space after lobectomy. Nowadays, some thoracic surgeons still use 2 chest tubes, especially after upper lobectomy—one to the apex to drain air and another at the base to drain fluid. However, several randomized trials have demonstrated that the use of a single chest tube has equivalent clinical outcomes in residual pleural effusion and the need for tube reinsertion, compared with the use of 2 chest tubes. Additionally, a single chest tube is associated with less pain (25,26). In this study, although a single chest tube was used in all patients, patients in the early ambulation group had no advantage in chest tube removal (P=0.378). Chest tube removal was associated with surgical procedures (wedge resection: 3.9±3.7 d; lobectomy: 4.9±3.3 d; segmentectomy: 3.9±2.1 d, P=0.005). Moreover, chest tube duration can affect LPOS. It was possible that our criteria for chest tube removal were stricter than in other reports (5). In this study, one size smaller than the conventional size of a double-lumen endobronchial tube was intubated in all patients in order to reduce intubation-related airway injuries. Clayton-Smith *et al.* reported that intubation-related airway injuries were related more to the size of the double-lumen endobronchial tube (27). Avoiding intubation-related airway injuries can facilitate an easier and comfortable postoperative recovery. It is also important to mention that a central venous indwelling catheter was not inserted routinely to reduce the incidence of venous thromboembolism. If an intraoperative emergency occurred, such as bleeding, central venous access had to be established quickly while the patient was in the lateral position. Whether a central venous indwelling catheter was needed intraoperatively depended on the ability and experience of the anesthesiologist. Safety was always our first consideration.

With the development of ERAS, some traditional elements have been improved or eliminated. However, some key recommendations of guidelines for ERAS are indispensable, including preoperative counselling, nutritional screening, smoking cessation, rehabilitation for high-risk patients, avoidance of fasting, carbohydrate loading, venous thromboembolism prophylaxis, prevention of hypothermia, and euvolemic fluid management, among others. The implementation of ERAS reduces surgical trauma and the stress response, which improves outcomes including reduced LPOS and decreased postoperative morbidity. Emphasis was placed on early ambulation, which was the only independent factor influencing a reduced LPOS (28). Our team and institution will continue to improve the early ERAS protocol in patients to reduce LPOS. We hope that we can lay the foundation of ERAS for day surgery and conduct further analyses to support the feasibility and success of early ERAS for day surgery.

Limitations

Our study is a retrospective non-randomized non-controlled study involving a cohort of patients who underwent VATS lung resection based on early ERAS. This study represented data from one multidisciplinary team. There was limited evidence regarding the effectiveness of early ERAS on clinical outcomes such as complications, 30-day mortality, LPOS, and readmissions compared with other enhanced recovery pathways. Many elements of previous standards of perioperative care have been included in the early ERAS protocol. Our team optimized 2 key elements (MIS and FTTA) to facilitate early ambulation. However, whether surgical elements or anesthesia elements were more influential still requires further research.

Conclusions

In summary, we reported successful adoption of an early ERAS protocol for VATS lung surgery to implement early ambulation within 1 hour after extubation. Miniport MIS, decreased wound size, and consequent decreases in undesirable stress responses and pain were important for early functional recovery. FTTA mainly included optimal pain management and prevention of PONV, which was based on both nerve block and opioid-sparing or an opioid-free analgesia protocol and reduced use of muscle relaxants. The synergistic effect of the combination of MIS and FTTA should facilitate early ambulation, which is key to early ERAS and lays the foundation for the implementation of day surgery.

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Footnote

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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. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board and Ethics Committee of Taizhou Municipal Hospital and informed consent was taken from all the patients.

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