

Retrospective Study

Enhanced recovery after surgery in elderly patients with non-small cell lung cancer who underwent video-assisted thoracic surgery

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Abstract

BACKGROUND

This study was designed to investigate the clinical outcomes of enhanced recovery after surgery (ERAS) in the perioperative period in elderly patients with non-small cell lung cancer (NSCLC).

AIM

To investigate the potential enhancement of video-assisted thoracic surgery (VATS) in postoperative recovery in elderly patients with NSCLC.

METHODS

We retrospectively analysed the clinical data of 85 elderly NSCLC patients who underwent ERAS (the ERAS group) and 327 elderly NSCLC patients who received routine care (the control group) after VATS at the Department of Thoracic Surgery of Peking University Shenzhen Hospital between May 2015 and April 2017. After propensity score matching of baseline data, we analysed the postoperative stay, total hospital expenses, postoperative 48-h pain score, and postoperative complication rate for the 2 groups of patients who underwent lobectomy or sublobar resection.

RESULTS

After propensity score matching, ERAS significantly reduced the postoperative hospital stay (6.96 ± 4.16 vs 8.48 ± 4.18 d, $P = 0.001$) and total hospital expenses (48875.27 ± 18437.5 vs 55497.64 ± 21168.63 CNY, $P = 0.014$) and improved the satisfaction score (79.8 ± 7.55 vs 77.35 ± 7.72 , $P = 0.029$) relative to those for routine care. No significant between-group difference was observed in postoperative 48-h

pain score (4.68 ± 1.69 vs 5.28 ± 2.1 , $P = 0.090$) or postoperative complication rate (21.2% vs 27.1%, $P = 0.371$). Subgroup analysis showed that ERAS significantly reduced the postoperative hospital stay and total hospital expenses and increased the satisfaction score of patients who underwent lobectomy but not of patients who underwent sublobar resection.

CONCLUSION

ERAS effectively reduced the postoperative hospital stay and total hospital expenses and improved the satisfaction score in the perioperative period for elderly NSCLC patients who underwent lobectomy but not for patients who underwent sublobar resection.

Key Words: Enhanced recovery after surgery; Non-small cell lung cancer; Perioperative care; Propensity score; Video-assisted thoracic surgery

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Core Tip: This study was designed to investigate the clinical outcomes of enhanced recovery after surgery (ERAS) in the perioperative period in elderly patients with non-small cell lung cancer (NSCLC). ERAS significantly reduced the postoperative hospital stay (6.96 ± 4.16 vs 8.48 ± 4.18 d, $P = 0.001$) and total hospital expenses (48875.27 ± 18437.5 vs 55497.64 ± 21168.63 CNY, $P = 0.014$) and improved the satisfaction score (79.8 ± 7.55 vs 77.35 ± 7.72 , $P = 0.029$) relative to those for routine care. ERAS effectively reduced the postoperative hospital stay and total hospital expenses and improved the satisfaction score in the perioperative period for elderly NSCLC patients who underwent lobectomy but not for patients who underwent sublobar resection.

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INTRODUCTION

Lung cancer ranks first in all malignant tumours with respect to morbidity and mortality[1]. Surgery is the main treatment for early lung cancer[2], but the complication rate is approximately 30%-50%, resulting in delayed recovery, poor long-term outcomes, and high medical costs[3-5]. Elderly patients with lung cancer often experience a slow recovery and high complication rates after thoracic surgery and thus are a high-risk group for surgical treatment[6-8]. To reduce the postoperative complication rate and accelerate postoperative recovery, many treatment strategies and perioperative management approaches have been incorporated into the surgical field, including infection control, nutritional support, improved fluid management, and comprehensive preoperative assessment. In 2001, Henrik Kehlet, a Danish gastrointestinal surgeon, first proposed the concept of enhanced recovery after surgery (ERAS)[9]. Empirical evidence has demonstrated that effective perioperative management that incorporates ERAS reduces the stress response to surgical trauma and complications and improves surgical safety and patient satisfaction. ERAS has been proven to effectively reduce common complications and general pain in patients. In recent years, the application of ERAS after thoracic surgery has reduced the perioperative complication rate, length of hospital stay, and hospital expenses[10]. However, evidence of the effectiveness of ERAS following video-assisted thoracic surgery (VATS) is still remains uncertain. In particular, no clinical studies have been conducted to investigate ERAS in elderly patients with lung cancer who underwent VATS.

This study was designed to retrospectively analyse the clinical outcomes of ERAS in elderly patients with lung cancer who underwent VATS at Peking University Shenzhen Hospital over a 5-year period and to investigate the role of ERAS (after propensity score matching) in improving postoperative recovery.

MATERIALS AND METHODS

Clinical data

We retrospectively analysed the clinical data of 412 elderly patients with lung cancer who underwent VATS at the Department of Thoracic Surgery of Peking University Shenzhen Hospital between May 2015 and April 2017. Of these patients, 271 were men, and 141 were women; their mean age was 72.41 ± 4.7 years; and 85 patients underwent ERAS (the ERAS group), and 327 patients received routine care (the control group). Moreover, 187 patients underwent sublobar resection, and 225 patients underwent lobectomy; 330 patients were diagnosed with adenocarcinoma, and 82 patients were diagnosed with squamous cell carcinoma; and 235 patients were in tumor-node-metastasis (TNM) stage I, and 92

patients were in TNM stage II.

The inclusion criteria were as follows: (1) Patients who underwent VATS and were pathologically confirmed to have non-small cell lung cancer (NSCLC) after surgery; (2) patients aged 65-80 years old; (3) patients with NSCLC in TNM stage I to II confirmed by postoperative pathology; and (4) patients with complete clinical data. The exclusion criteria were as follows: (1) Patients with pneumonectomy; or (2) patients with pathologically confirmed small cell lung cancer.

Methods

Perioperative management: The patients were divided into the control group and the ERAS group. The control group received routine care, and the ERAS group underwent ERAS (Table 1).

Preoperative management: All patients underwent a one-stop preoperative assessment by surgeons, anaesthesiologists, and nurses to facilitate optimal preoperative preparation and were closely monitored during and after the operation for any complications. The ERAS group was given a copy of an ERAS education brochure with detailed descriptions about daily goals and was asked to complete a diary. **Intraoperative management:** All patients were given prophylactic antibiotics during the induction period. General anaesthesia was administered with double-lumen tracheal intubation and single-lung breathing. Intraoperative rehydration was achieved with intravenous infusion of balanced fluid, and hypertensive or antihypertensive drugs were given based on blood pressure monitoring during the operation. The indications and the feasibility for surgery were determined in accordance with the China Guidelines for the Diagnosis and Treatment of Primary Lung Cancer (2015). The scope of surgical resection was determined by the treating physician based on patient conditions. Effort was taken to make a small incision, and absorbable sutures were used to close the incision. At the end of surgery, a closed thoracic drainage tube was placed according to routine procedures. **Postoperative management:** Intravenous infusion was minimized, with adequate analgesia. Non-steroidal anti-inflammatory drugs and acetaminophen were used for pain management. Opioids were avoided whenever possible to prevent postoperative nausea and vomiting and other opioid-related adverse reactions. Patients were encouraged to get out of bed as soon as possible. The catheter was removed at 12 h after operation (Table 2).

Criteria for discharge and follow-up: Discharge criteria were as follows: (1) Removal of the closed thoracic drainage tube; physical mobility; (2) no difficulty breathing (no shortness of breath, wheezing or stridor; oxygen saturation > 94%); and (3) no serious complications; complications (if any) were under control.

Calculation of medical expenses: The hospital medical records were used to record and calculate the total medical expenses, including laboratory tests, physical examinations, medications, nursing, surgery, supplies, and postoperative rehabilitation.

Satisfaction: A homemade satisfaction questionnaire was used during the week after discharge to evaluate patient satisfaction. The contents included staff attitude, operating techniques, timeliness of nursing, overall hospital experience, and pain score. Quality of life was analysed, including physical performance, physical pain, mental state, and general health.

Statistical analysis: R language 3.5.3 was used for propensity score matching of pathological classification, TNM stage, and surgical approach at 1:1 between the ERAS group and the control group.

SPSS v25.0 was used for statistical analysis. Measurement data are expressed as the mean value $\pm$ SD and analysed with the independent sample *t*-test or Mann-Whitney U test; count data are expressed as the frequency and were analysed with the chi-square test or Fisher's exact test. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

RESULTS

Baseline data

Among the 412 elderly patients with lung cancer who underwent VATS, 327 patients were in the control group and 85 patients were in the ERAS group. No significant between-group differences were observed regarding age ($P = 0.220$), sex ($P = 0.982$), body mass index ($P = 0.540$), or forced expiratory volume in the first second ($P = 0.615$) (Figure 1). Moreover, 330 patients had adenocarcinoma, and 82 patients had squamous cell carcinoma; 290 patients were in TNM stage I, and 122 patients were in stage II; 187 patients underwent sublobar resection, and 225 patients underwent lobectomy (Table 3). After matching, the control group and the ERAS group each included 85 patients.

No patient died during the perioperative period or required blood transfusion. At the end of surgery, the tracheal intubation was removed in the operating room, and the patients were able to breathe spontaneously with normal blood gas analysis results. All patients were sent back to the general ward, and no patient required mechanical ventilation in the intensive care unit. Before discharge, any postoperative complications were alleviated and resolved with treatment.

Clinical outcome measures

ERAS significantly improved postoperative hospital stay (6.98 ± 4.3 vs 8.92 ± 4.42 d, $P = 0.002$), total hospital expenses (52041.86 ± 19062.33 vs 60760.79 ± 20511.58 , $P = 0.016$), and overall satisfaction (79.66 ± 7.5 vs 76.26 ± 7.42 , $P = 0.013$) in the lobectomy subgroup (Table 4). Postoperative hospital stay also improved in the sublobar resection subgroup (6.94 ± 4.03 vs 7.86 ± 3.78 d, $P = 0.09$), but the differences of total hospital expenses ($P = 0.247$) and overall satisfaction ($P = 0.621$) did not reach statistical significance. In the ERAS group ($n = 85$), 3 patients had atelectasis, 9 had pulmonary infection, 4 had

Table 1 Perioperative management

	Measures	Routine care	ERAS
Preoperative	Education	Routine preoperative education	ERAS education
	Diet	Fasting for 6 h	Drink 1000 mL of 10% glucose the night before surgery; drink 200 mL of 10% glucose 2 h before surgery
	Sedatives (to improve sleep)	Yes	Yes
Intraoperative	Indwelling catheter after anaesthesia	Yes	Yes
	Temperature maintenance	No	Yes
Postoperative	Analgesia	Patient-controlled epidural analgesia	Use of NSAIDs for 48 h
	Infusion volume	Total intravenous infusion during the first 24 h after the operation < 1500 mL, infusion rate 20-30 mL/min; vasoconstrictors may be used in the case of hypotension or urine output < 20 mL/h	Rapid intravenous drip of 250 mL of saline within 1 h; the remaining parameters were the same as those in the routine care group
	Diet during the first 6 hours after the operation	A small amount of water	400 mL of liquid food
	Promote bowel movements	No	Chewing gum
	Catheter removal	24 h after the operation	12 h after the operation
	Early exercise	Patient choice	Lower limb movements

NSAIDs: Non-steroidal anti-inflammatory drugs.

Table 2 Patient education

Patient preoperative education	
Pre-operative	Be familiar with the environment and hospitalization process
	Preoperative nutritional risk screening
	Eat a healthy diet & stay active (1-2 wk before surgery)
	Normal diet the day before surgery
	Drink moderate glucose 2 h before surgery
	Preventive use of antibiotics
Postoperative	Eating liquid food moderately within six hours after surgery & infusion
	Receive any necessary medications
	Removed catheter at 12 h after operation
Day after surgery	Normal diet
	Use mixture of non-narcotic pain medication to keep comfortable
	Get out of bed as soon as possible
	Try to cough and expectorate

atrial fibrillation, and 2 had arrhythmia; the postoperative complication rate was 21.2%. In the control group ($n = 85$), 4 patients had atelectasis, 12 had pulmonary infection, 4 had atrial fibrillation, and 3 had arrhythmia; the postoperative complication rate was 27.1%. The difference did not reach statistical significance (Table 5).

DISCUSSION

ERAS is a multimodal perioperative protocol based on best medical evidence. In the 1990s, Kehlet *et al* [11] first used it for

Table 3 Baseline data

Baseline data		Before the match (n = 412)			After match (n = 170)		
		Routine care (n = 327)	ERAS (n = 85)	P value	Routine care (n = 85)	ERAS (n = 85)	P value
Age		72.18 ± 4.53	72.91 ± 4.94	0.22	72.55 ± 5	72.91 ± 4.94	0.643
Sex	Male	215	56	0.982	59	56	0.624
	Female	112	29		26	29	
BMI (kg/m ²)		22.54 ± 2.69	22.73 ± 2.62	0.54	22.51 ± 2.4	22.73 ± 2.62	0.565
FEV1 (L)		3.21 ± 0.45	3.24 ± 0.41	0.615	3.24 ± 0.41	3.24 ± 0.41	0.983
Pathological classification	Adenocarcinoma	261	69	0.78	69	69	1
	Squamous cell carcinoma	66	16		16	16	
TNM stage	I	235	55	0.198	55	55	1
	II	92	30		30	30	
Surgical approach	Uniportal VATS	282	69	0.242	75	69	0.201
	Three ports VATS	45	16		10	16	
Scope of resection	Pulmonary wedge	66	14	0.64	14	14	1
	Lung segment	86	21		21	21	
	Lobectomy	175	50		50	50	

ERAS: Enhanced recovery after surgery; BMI: Body mass index; FEV1: Forced expiratory volume in the first second; TNM: Tumor-node-metastasis; VATS: Video-assisted thoracic surgery.

patients undergoing colectomy to enhance postoperative recovery[11]. It includes preoperative optimization, intraoperative stress management, and enhanced postoperative recovery, with the goal of accelerating the recovery and resumption of normal activities. It reduces the length of the hospital stay and hospital expenses without increasing the readmission rate. With the gratifying results and low surgical wound, VATS approach is recommended as the standard scheme by several international academic organizations, including the European Society of Thoracic Surgeon, the American College of Chest Physicians and Minimally Invasive Cardiothoracic Surgery[12]. In thoracic surgeries, VATS is a main part of ERAS protocols in the relevant guidelines[13]. At present, class I evidence of the effectiveness of ERAS after thoracic surgery is scarce, especially in elderly patients with lung cancer. This study showed that ERAS improved the clinical efficacy of VATS in elderly patients with lung cancer. At present, data on ERAS in patients undergoing thoracic surgery are limited. Cerfolio *et al*[14] applied ERAS in patients undergoing open pneumonectomy, with a special focus on preoperative patient education, the use of epidural anaesthesia, active standardized removal of the catheter and drainage tube after surgery, early physical movement, and a daily plan for discharge within 4 days after surgery[14]. The intervention accelerated recovery without increasing the complication or mortality rate. A small randomized controlled study also showed that preoperative food intake (no fasting), conduction anaesthesia, early postoperative food intake, and early physical movement significantly reduced the incidence of postoperative pulmonary complications[15]. Salati *et al*[16] performed propensity score matching and demonstrated that ERAS effectively reduced the length of the hospital stay. The study focused on preoperative patient education, standardized postoperative care, and active drainage tube management[16]. In recent years, thoracic surgery-specific ERAS has gradually improved. Madani *et al*[17] described their ERAS procedures for open lobectomy, including standardized care, as well as preoperative, intraoperative, and postoperative management. The study showed that ERAS significantly reduced the length of the hospital stay and complications without increasing the readmission rate. However, their procedures were relatively conservative. Recent studies have shown that paraspinal block (instead of epidural analgesia) and a more aggressive closed thoracic drainage regimen may provide greater benefits to patients[18-20]. This study showed that ERAS significantly reduced postoperative hospital stay, total hospital expenses, and postoperative complications and improved satisfaction. Subgroup analysis per surgical approach (lobectomy *vs* sublobar resection) showed that ERAS did not significantly reduce postoperative hospital stay, total hospital expenses, and postoperative complications nor significantly improve satisfaction in the sublobar resection subgroup. The scope of sublobar resection was relatively small, with less impact on postoperative recovery, which may explain the lack of a significant difference between patients with sublobar resection in the ERAS group and the control group. On the other hand, lobectomy involves a greater scope of resection and surgical trauma, and thus, ERAS was superior to routine care in postoperative recovery. These data provide a reference for the selection of an appropriate rehabilitation regime. For ERAS, clinicians must pay attention to the readmission rate. Some studies have shown that for patients with lung cancer, readmission is related to shorter survival[19]. However, it is not clear whether ERAS will increase the readmission rate of lung cancer patients[17]. In this study, the 30-d readmission rate was 1.2%

Table 4 Clinical outcome measures (scope of resection subgroup analysis)

Outcome Measures	Total (n = 170)			Pulmonary wedge (n = 28)			Segmentectomy (n = 42)			Pulmonary lobe (n = 100)		
	ERAS (n = 85)	Routine care (n = 85)	P value	ERAS (n = 14)	Routine care (n = 14)	P value	ERAS (n = 21)	Routine care (n = 21)	P value	ERAS (n = 50)	Routine care (n = 50)	P value
Postoperative hospital stay (d)	6.06 ± 2.07	6.61 ± 1.68	0.024	5.43 ± 1.91	6.14 ± 1.99	0.352	5.9 ± 2.51	6.29 ± 1.65	0.325	6.3 ± 1.91	6.88 ± 1.59	0.040
Total hospital expenses (CNY)	42757.63 ± 14963.16	53748.72 ± 18356.11	0.000	37812.08 ± 13327.54	41836.7 ± 13282.69	0.454	39187.44 ± 18933.83	51245.25 ± 16865.5	0.007	45641.86 ± 13016.75	58135.55 ± 18757.68	0.001
Postoperative 48-h pain score	2.38 ± 0.91	2.59 ± 0.88	0.109	2.29 ± 0.83	2.43 ± 0.76	0.667	2.33 ± 1.11	2.48 ± 0.87	0.560	2.42 ± 0.86	2.68 ± 0.91	0.135
Satisfaction score	80.65 ± 7.74	76.67 ± 7.1	0.001	80 ± 7.99	77 ± 6.86	0.427	80.29 ± 7.12	76.9 ± 5.66	0.130	80.98 ± 8.04	76.48 ± 7.79	0.003
Readmission within 30 d	0	1	1.000	0	0		0	0		0	1	1.000
Complications (n)	14	26	0.030	2	2	1.000	5	12	0.028	7	12	0.065
Air leakage	7	13	0.153	1	1	1.000	3	7	0.277	3	5	0.712
Atelectasis	2	4	0.678	0	0		1	2	1.000	1	2	1.000
Pulmonary infection	3	6	0.493	1	1	1.000	1	1	1.000	1	4	0.359
Atrial fibrillation	1	2	1.000	0	0		0	1	1.000	1	1	1.000
Arrhythmia	1	1	1.000	0	0		0	1	1.000	1	0	1.000

ERAS: Enhanced recovery after surgery.

(only 1 patient in the ERAS group; $P > 0.05$), which was lower than those reported by other studies.

In recent years, a large body of evidence has demonstrated that VATS reduces complications and improves the prognosis of patients with lung cancer[5,21]. At present, however, evidence of the effectiveness of ERAS following VATS is inadequate, especially evidence on the role of ERAS following VATS in elderly patients with lung cancer. This was the first study to investigate the role of ERAS in the perioperative period in elderly patients with lung cancer. We performed propensity score matching to optimize the control group and comprehensively analysed perioperative outcome measures, including postoperative hospital stay, total hospital expenses, postoperative 48-hour pain score, and satisfaction score. This study showed that for elderly patients with lung cancer, ERAS effectively improved postoperative recovery (including hospital stay and hospital expenses) and patient satisfaction and reduced the postoperative complication rates.

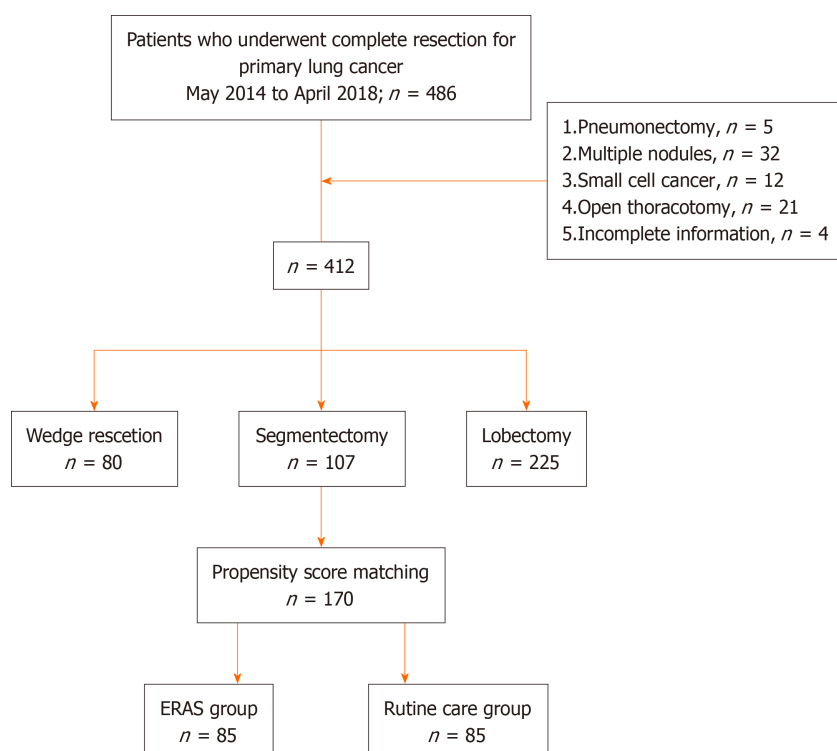
CONCLUSION

This is the first study to perform propensity score matching to demonstrate the effectiveness of ERAS for elderly patients

Table 5 Clinical outcome measures (age subgroup analysis)

Outcome measures	Total (n = 170)			Age 60-73 (n = 28)			Age 74-80 (n = 42)		
	ERAS (n = 85)	Routine (n = 85)	P value	ERAS (n = 14)	Routine care (n = 14)	P value	ERAS (n = 21)	Routine care (n = 21)	P value
Postoperative hospital stay (d)	6.06 ± 2.07	6.61 ± 1.68	0.024	5.96 ± 2	6.57 ± 1.7	0.057	6.18 ± 2.17	6.67 ± 1.69	0.188
Total hospital expenses (CNY)	42757.63 ± 14963.16	53748.72 ± 18356.11	0.000	42122.76 ± 13923.83	52334 ± 18206.28	0.008	43471.85 ± 16202.51	55417.37 ± 18628.5	0.001
Postoperative 48-h pain score	2.38 ± 0.91	2.59 ± 0.88	0.109	2.33 ± 0.83	2.8 ± 0.83	0.006	2.43 ± 1.01	2.33 ± 0.87	0.687
Satisfaction score	80.65 ± 7.74	76.67 ± 7.1	0.001	81.16 ± 7.52	76.78 ± 6.31	0.004	80.08 ± 8.04	76.54 ± 8.01	0.055
Readmission within 30 d	0	1	1.000	0	0		0	1	1.000
Complications (n)	14	26	0.030	5	11	0.109	8	15	0.071
Air leakage	7	13	0.153	4	5	1.000	3	8	0.179
Atelectasis	2	4	0.678	1	2	1.000	1	2	0.982
Pulmonary infection	3	6	0.493	1	3	0.625	2	3	0.977
Atrial fibrillation	1	2	1.000	0	1	1.000	1	1	1.000
Arrhythmia	1	1	1.000	0	0		1	1	1.000

ERAS: Enhanced recovery after surgery.

**Figure 1 Include standard flow chart.** ERAS: Enhanced recovery after surgery.

with lung cancer. Further subgroup analysis showed that ERAS had significant effects in the lobectomy subgroup. In summary, ERAS may be used as an effective treatment for elderly patients with lung cancer, especially patients undergoing lobectomy.

ARTICLE HIGHLIGHTS

Research background

Lung cancer is the leading cause of death worldwide, and non-small cell lung cancer (NSCLC) in the elderly accounts for a significant proportion. With the significant growth of the aging population, the need for surgical treatment of elderly patients has gradually become more prominent. Video-assisted thoracic surgery (VATS) has become an important choice for the treatment of senile NSCLC due to its characteristics of less trauma and rapid recovery. However, current systematic studies on VATS in postoperative recovery in elderly patients are relatively limited. Therefore, an in-depth understanding of the influence of VATS on elderly patients and revealing its potential role in postoperative rehabilitation are of great significance for guiding the individualized treatment of elderly patients with NSCLC and improving surgical results.

Research motivation

The aim of this study was to investigate the potential enhancement of VATS in postoperative recovery in elderly patients with NSCLC.

Research objectives

This study was designed to investigate the clinical outcomes of enhanced recovery after surgery (ERAS) in the perioperative period in elderly patients with NSCLC.

Research methods

We retrospectively analysed the clinical data of 85 elderly NSCLC patients who underwent ERAS (the ERAS group) and 327 elderly NSCLC patients who received routine care (the control group) after VATS at the Department of Thoracic Surgery of Peking University Shenzhen Hospital between May 2015 and April 2017. After propensity score matching of baseline data, we analysed the postoperative stay, total hospital expenses, postoperative 48-hour pain score, and postoperative complication rate for the 2 groups of patients who underwent lobectomy or sublobar resection.

Research results

After propensity score matching, ERAS significantly reduced the postoperative hospital stay (6.96 ± 4.16 vs 8.48 ± 4.18 d, $P = 0.001$) and total hospital expenses (48875.27 ± 18437.5 vs 55497.64 ± 21168.63 CNY, $P = 0.014$) and improved the satisfaction score (79.8 ± 7.55 vs 77.35 ± 7.72 , $P = 0.029$) relative to those for routine care. No significant between-group difference was observed in postoperative 48-h pain score (4.68 ± 1.69 vs 5.28 ± 2.1 , $P = 0.090$) or postoperative complication rate (21.2% vs 27.1%, $P = 0.371$). Subgroup analysis showed that ERAS significantly reduced the postoperative hospital stay and total hospital expenses and increased the satisfaction score of patients who underwent lobectomy but not of patients who underwent sublobar resection.

Research conclusions

ERAS effectively reduced the postoperative hospital stay and total hospital expenses and improved the satisfaction score in the perioperative period for elderly NSCLC patients who underwent lobectomy but not for patients who underwent sublobar resection.

Research perspectives

We look forward to more large-sample, multicenter studies to validate the recovery benefits of VATS in elderly patients with NSCLC and to further clarify the safety and effectiveness of the surgical technique. At the same time, combined with biological markers and imaging techniques, the specific mechanism of VATS on postoperative inflammatory response, immune function, and quality of life in elderly patients was further studied. With the help of advanced technical means, the individual differences of elderly patients were finely delineated to provide a more accurate basis for personalized surgical treatment. In addition, the long-term efficacy and survival rate of VATS in elderly patients were evaluated through long-term follow-up to comprehensively understand the long-term impact of surgery. These future research directions will provide an in-depth and comprehensive understanding for further promoting the development of surgical treatment for elderly NSCLC.

FOOTNOTES

Co-first authors: Mei-Hua Sun and Liu-Sheng Wu.

Co-corresponding authors: Xiao-Qiang Li and Jun Yan.

Author contributions: Yan J and Li XQ conceived and designed the study; Qiu YY screened patients to obtain clinical data and data analysis; Wu LS and Sun MH wrote the paper; All authors have read and approved the final draft. Wu LS proposed, designed, and analyzed the data and wrote the first draft of the paper. Sun MH was responsible for patient screening, enrollment, and the collection of clinical data. Both authors have made vital and indispensable contributions to the completion of the project and are therefore qualified to be co-first authors of the paper. As co-corresponding authors, Yan J and Li XQ played an important and indispensable role in project design, data interpretation, and manuscript preparation. Yan J and Li XQ applied for and were successful in obtaining funding for this

project. Yan J conceived, designed, and supervised the entire project process. Li XQ assisted and was responsible for data reanalysis and reinterpretation, graphing, comprehensive literature search, preparation, and submission of the current version of the manuscript. The cooperation of Yan J and Li XQ was critical to the publication of this manuscript.

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Informed consent statement: As it was a retrospective clinical study, all the patients were contacted by telephone to obtain verbal informed consent and it was approved by the ethics committee.

Conflict-of-interest statement: All the authors report no relevant conflicts of interest for this article.

Data sharing statement: All data collected and analyzed in this study are included in this article, and technical appendix, statistical code, and dataset available from the corresponding author at dr.lixiaoqiang@gmail.com.

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REFERENCES

- 1 **Bray F**, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2018; **68**: 394-424 [PMID: 30207593 DOI: 10.3322/caac.21492]
- 2 **Osarogiagbon RU**, Veronesi G, Fang W, Ekman S, Suda K, Aerts JG, Donington J. Early-Stage NSCLC: Advances in Thoracic Oncology 2018. *J Thorac Oncol* 2019; **14**: 968-978 [PMID: 30851441 DOI: 10.1016/j.jtho.2019.02.029]
- 3 **Chen FF**, Zhang D, Wang YL, Xiong B. Video-assisted thoracoscopic surgery lobectomy versus open lobectomy in patients with clinical stage I non-small cell lung cancer: a meta-analysis. *Eur J Surg Oncol* 2013; **39**: 957-963 [PMID: 23845704 DOI: 10.1016/j.ejso.2013.06.016]
- 4 **Vannucci F**, Gonzalez-Rivas D. Is VATS lobectomy standard of care for operable non-small cell lung cancer? *Lung Cancer* 2016; **100**: 114-119 [PMID: 27597290 DOI: 10.1016/j.lungcan.2016.08.004]
- 5 **Falcoz PE**, Puyraveau M, Thomas PA, Decaluwe H, Hürtgen M, Petersen RH, Hansen H, Brunelli A; ESTS Database Committee and ESTS Minimally Invasive Interest Group. Video-assisted thoracoscopic surgery versus open lobectomy for primary non-small-cell lung cancer: a propensity-matched analysis of outcome from the European Society of Thoracic Surgeon database. *Eur J Cardiothorac Surg* 2016; **49**: 602-609 [PMID: 25913824 DOI: 10.1093/ejcts/ezv154]
- 6 **Birim O**, Zuydendorp HM, Maat AP, Kappetein AP, Eijkemans MJ, Bogers AJ. Lung resection for non-small-cell lung cancer in patients older than 70: mortality, morbidity, and late survival compared with the general population. *Ann Thorac Surg* 2003; **76**: 1796-1801 [PMID: 14667586 DOI: 10.1016/S0003-4975(03)01064-6]
- 7 **Kawaguchi Y**, Hanaoka J, Ohshio Y, Igarashi T, Kataoka Y, Okamoto K, Kaku R, Hayashi K. A risk score to predict postoperative complications after lobectomy in elderly lung cancer patients. *Gen Thorac Cardiovasc Surg* 2018; **66**: 537-542 [PMID: 29956048 DOI: 10.1007/s11748-018-0960-8]
- 8 **Im Y**, Park HY, Shin S, Shin SH, Lee H, Ahn JH, Sohn I, Cho JH, Kim HK, Zo JI, Shim YM, Lee HY, Kim J. Prevalence of and risk factors for pulmonary complications after curative resection in otherwise healthy elderly patients with early stage lung cancer. *Respir Res* 2019; **20**: 136 [PMID: 31272446 DOI: 10.1186/s12931-019-1087-x]
- 9 **Gonfiotti A**, Viggiano D, Bongiolatti S, Bertolaccini L, Solli P, Bertani A, Voltolini L, Crisci R, Droghetti A. Enhanced Recovery After Surgery (ERAS®) in thoracic surgical oncology. *Future Oncol* 2018; **14**: 33-40 [PMID: 29400559 DOI: 10.2217/fon-2017-0471]
- 10 **Rogers LJ**, Bleetman D, Messenger DE, Joshi NA, Wood L, Rasburn NJ, Batchelor TJP. The impact of enhanced recovery after surgery (ERAS) protocol compliance on morbidity from resection for primary lung cancer. *J Thorac Cardiovasc Surg* 2018; **155**: 1843-1852 [PMID: 29352586 DOI: 10.1016/j.jtcvs.2017.10.151]
- 11 **Kehlet H**. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth* 1997; **78**: 606-617 [PMID: 9175983 DOI: 10.1093/bja/78.5.606]
- 12 **Van Haren RM**, Mehran RJ, Mena GE, Correa AM, Antonoff MB, Baker CM, Woodard TC, Hofstetter WL, Roth JA, Sepesi B, Swisher SG, Vaporciyan AA, Walsh GL, Rice DC. Enhanced Recovery Decreases Pulmonary and Cardiac Complications After Thoracotomy for Lung Cancer. *Ann Thorac Surg* 2018; **106**: 272-279 [PMID: 29530770 DOI: 10.1016/j.athoracsur.2018.01.088]
- 13 **Nygren J**, Thacker J, Carli F, Fearon KC, Norderval S, Lobo DN, Ljungqvist O, Soop M, Ramirez J; Enhanced Recovery After Surgery Society. Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS®) Society

- recommendations. *Clin Nutr* 2012; **31**: 801-816 [PMID: 23062720 DOI: 10.1016/j.clnu.2012.08.012]
- 14 **Cerfolio RJ**, Pickens A, Bass C, Katholi C. Fast-tracking pulmonary resections. *J Thorac Cardiovasc Surg* 2001; **122**: 318-324 [PMID: 11479505 DOI: 10.1067/mtc.2001.114352]
 - 15 **Muehling BM**, Halter GL, Schelzig H, Meierhenrich R, Steffen P, Sunder-Plassmann L, Orend KH. Reduction of postoperative pulmonary complications after lung surgery using a fast track clinical pathway. *Eur J Cardiothorac Surg* 2008; **34**: 174-180 [PMID: 18490173 DOI: 10.1016/j.ejcts.2008.04.009]
 - 16 **Salati M**, Brunelli A, Xiumè F, Refai M, Pompili C, Sabbatini A. Does fast-tracking increase the readmission rate after pulmonary resection? A case-matched study. *Eur J Cardiothorac Surg* 2012; **41**: 1083-7; discussion 1087 [PMID: 22362624 DOI: 10.1093/ejcts/ezr171]
 - 17 **Madani A**, Fiore JF Jr, Wang Y, Bejjani J, Sivakumaran L, Mata J, Watson D, Carli F, Mulder DS, Sirois C, Ferri LE, Feldman LS. An enhanced recovery pathway reduces duration of stay and complications after open pulmonary lobectomy. *Surgery* 2015; **158**: 899-908; discussion 908 [PMID: 26189953 DOI: 10.1016/j.surg.2015.04.046]
 - 18 **Yeung JH**, Gates S, Naidu BV, Wilson MJ, Gao Smith F. Paravertebral block versus thoracic epidural for patients undergoing thoracotomy. *Cochrane Database Syst Rev* 2016; **2**: CD009121 [PMID: 26897642 DOI: 10.1002/14651858.CD009121.pub2]
 - 19 **Baidya DK**, Khanna P, Maitra S. Analgesic efficacy and safety of thoracic paravertebral and epidural analgesia for thoracic surgery: a systematic review and meta-analysis. *Interact Cardiovasc Thorac Surg* 2014; **18**: 626-635 [PMID: 24488821 DOI: 10.1093/icvts/ivt551]
 - 20 **Puri V**, Patel AP, Crabtree TD, Bell JM, Broderick SR, Kreisel D, Krupnick AS, Patterson GA, Meyers BF. Unexpected readmission after lung cancer surgery: A benign event? *J Thorac Cardiovasc Surg* 2015; **150**: 1496-1504, 1505.e1 [PMID: 26410004 DOI: 10.1016/j.jtcvs.2015.08.067]
 - 21 **Bendixen M**, Jørgensen OD, Kronborg C, Andersen C, Licht PB. Postoperative pain and quality of life after lobectomy via video-assisted thoracoscopic surgery or anterolateral thoracotomy for early stage lung cancer: a randomised controlled trial. *Lancet Oncol* 2016; **17**: 836-844 [PMID: 27160473 DOI: 10.1016/S1470-2045(16)00173-X]



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