ORIGINAL ARTICLE

Enhanced recovery after surgery using uniportal video-assisted thoracic surgery for lung cancer: A preliminary study

Haitao Huang, Haitao Ma & Shaomu Chen [iD]

Department of Thoracic Surgery, The First Affiliated Hospital of Soochow University, Suzhou, China

Correspondence
Shaomu Chen, Department of Thoracic Surgery, The First Affiliated Hospital of Soochow University, No.188, Shizi Street, Suzhou 215006, China.
Tel: +86 135 8487 0712
Fax: +86 512 6778 0125
Email: michaelchensm@163.com

Haitao Ma, Department of Thoracic Surgery, The First Affiliated Hospital of Soochow University, No. 188, Shizi Street, Suzhou 215006, China.
Tel: +86 133 7518 2028
Fax: +86 512 6778 0337
Email: mht7403@163.com

Abstract

Background: This study investigated the clinical efficiency of enhanced recovery after surgery (ERAS) using uniportal video-assisted thoracoscopic surgery for lung cancer.

Methods: The clinical data of 83 patients with early-stage non-small cell lung cancer (NSCLC) at the First Affiliated Hospital of Soochow University from January 2016 to February 2017 were retrospectively analyzed. ERAS was applied to 38 patients (ERAS group), while 45 patients received conventional surgical treatment (control group). The operative duration, number of lymph nodes retrieved, blood loss, visual analogue scale (VAS), postoperative duration of chest tube placement, length of hospital stay, and postoperative complications were compared between the groups.

Results: Surgeries were conducted successfully in all patients, and no mortality occurred during the perioperative period. The ERAS group had better VAS on the third postoperative day, shorter chest tube duration, and shorter length of hospital stay ($P < 0.05$). No differences between the groups in terms of operative duration, number of lymph nodes retrieved, blood loss, VAS on the first postoperative day, or complication rate were found ($P > 0.05$).

Conclusions: ERAS using uniportal video-assisted thoracoscopic surgery for NSCLC patients is safe and practicable, and could also reduce the length of hospital stay.

Introduction

The concept of enhanced recovery after surgery (ERAS) refers to the application of preoperative, intraoperative, and postoperative methods to reduce surgical stress, subsequently reducing the rate of complications and accelerating patient recovery.[1] Video-assisted thoracoscopic surgery (VATS) has been gradually applied in thoracic surgery since the 1990s. VATS lobectomy causes less trauma and fewer postoperative complications compared to traditional open thoracotomy, and could accelerate patient recovery.[2] It has been widely used in the surgical treatment of patients with early-stage non-small cell lung cancer. Uniportal VATS lobectomy has been conducted in recent years and can reduce postoperative pain, which is beneficial to postoperative recovery. This study explored the application of ERAS using uniportal VATS for lung cancer.

Methods

General data

The clinical data of 83 patients with early-stage non-small cell lung cancer (NSCLC) at the First Affiliated Hospital of Soochow University from January 2016 to February 2017 were retrospectively analyzed. ERAS was applied to 38 patients (ERAS group), while 45 synchronous patients received conventional surgical treatment (control group). All patients met the following criteria: (i) confirmed

NSCLC (adenocarcinoma, squamous cell carcinoma, other); (ii) single peripheral mass ≤4 cm, without tumor invasion of the chest wall or great vessels; (iii) no distant metastasis, confirmed by preoperative examination; (iv) no history of chest trauma, preoperative radiotherapy, and/or chemotherapy; and (v) favorable cardiopulmonary function that could tolerate lobectomy. No significant differences in gender, age, surgical site, pathological type, or postoperative pathological stage were observed between the groups (*P* > 0.05) (Tables 1–2).

All patients were informed about the study objectives and provided their consent before inclusion. The Ethics Review Committee of The First Affiliated Hospital of Soochow University granted ethical approval of the study.

Treatment methods

ERAS group

All patients entered the ERAS pathway, which included preoperative teaching, ceasing smoking and drinking for two to four weeks, respiratory function exercises (respiratory training device), preparation of respiratory tract (aerosol inhalation), blood pressure and blood sugar control, correction of anemia and electrolyte disturbance, correction of hypoproteinemia, and assessment of thrombosis. Patients with a mid or high risk of thrombosis were required to wear elastic support stockings and low-molecular-weight heparin therapy was conducted if necessary (which was ceased eight hours before surgery). Each patient had a 300–500 mL liquid diet the night before surgery and drank 200 mL of 10% glucose solution two hours before surgery. Preoperative medication

Table 1 Patient characteristics

Characteristic	ERAS group	Control group	*P*
Gender (male/female)	16/22	25/20	0.273
Age (year)	60.71 ± 8.35	59.56 ± 10.24	0.580
Hypertension, *n* (%)	10 (26.3%)	13 (28.9%)	0.811
Diabetes, *n* (%)	5 (13.2%)	6 (13.3%)	0.748
Pulmonary function			
FEV1 (L)	2.29 ± 0.48	2.46 ± 0.71	0.195
FEV1 (% predicted)	94.09 ± 10.09	92.02 ± 16.00	0.492
MVV (% predicted)	88.90 ± 20.00	86.01 ± 19.86	0.512
Blood gas analysis			
PaO$_2$ (mm Hg)	85.18 ± 7.31	87.02 ± 6.75	0.236
PaCO$_2$ (mm Hg)	40.36 ± 2.78	40.77 ± 2.47	0.451
SaO$_2$ (%)	96.86 ± 1.11	96.70 ± 1.00	0.518
Location			0.609
Right upper lobe	11 (28.9%)	17 (37.8%)	
Right middle lobe	7 (18.4%)	7 (15.6%)	
Right lower lobe	11 (28.9%)	7 (15.6%)	
Left upper lobe	6 (15.8%)	9 (20.0%)	
Left lower lobe	3 (7.9%)	5 (11.1%)	

ERAS, enhanced recovery after surgery; FEV1, forced expiratory volume; MVV, maximal voluntary ventilation.

Table 2 Pathology type and stage

Pathology/stage	ERAS group	Control group	*P*
Pathology			0.479
AIS	7 (18.4%)	5 (11.1%)	
Adenocarcinoma	24 (63.2%)	35 (77.8%)	
SCC	3 (7.9%)	3 (6.7%)	
AdSqLC	4 (10.5%)	2 (4.4%)	
Stage			0.851
Ia	24 (63.2%)	27 (60.0%)	
Ib	7 (18.4%)	11 (24.4%)	
IIa	4 (1.5%)	5 (11.1%)	
IIb	3 (7.9%)	2 (4.4%)	

AIS, adenocarcinoma in situ; ERAS, enhanced recovery after surgery; SCC, squamous cell carcinoma; AdSqLC, adenosquamous lung carcinoma.

was replaced with a single dose of antibiotics. An injection of antibiotics would be repeated during surgery if necessary. Prophylactic analgesia was conducted preoperatively. Intraoperative anesthesia was provided by general anesthesia, local anesthesia, and intercostal nerve block. Light anesthesia without intraoperative consciousness was adopted. The use of long-acting sedatives and muscle relaxants was avoided. The fluid transfusion amount should be <1000 mL. A hot air warming blanket and an infusion heating device were used to maintain an intraoperative core body temperature of about 36°C.

Surgical methods

Double-lumen endotracheal intubation and single-lung ventilation were performed with the patient in the lateral position on the healthy side. The upper limbs had fixed abduction of 90°. The operating bed was placed in the jack-knife position to increase the width of the patient's intercostal space. The bed position was adjusted depending on the demand for better exposure. All patients underwent uniportal VATS. According to the position of the interlobar fissure and hilus, the incision was located between the midaxillary line and the anterior axillary line on the fourth or fifth intercostal space. The length of the incision was 3–5 cm, and a wound protector was placed. The camera was placed on the upper edge of the incision, and its position was adjusted if necessary. The surgeon used an elbow aspirator with a mushroom head-shape end to expose relevant tissue, assisted by an elbow coagulation hook and ultracision to dissociate the intrathoracic tissue and dissect lymph nodes.[3] In patients with a confirmed preoperative diagnosis, lobectomy and systemic lymph node dissection were directly performed. In patients without a pathological diagnosis, a wedge resection was performed and the frozen section checked first; lobectomy and systemic lymph node dissection were performed only if the frozen section showed malignancy. Lymph node dissection was performed on the

basis of lung cancer diagnosis. A #28 chest tube was placed in the incision. The top end of the chest tube was on the apex of the thorax to drain air. Another two notches were cut between 18 and 20 cm on the chest tube. The chest tube was adjusted to make the side holes between the diaphragm and the lung lobe to drain pleural effusion. Delicate intraoperative manipulation was necessary to avoid the postoperative leakage of gas and liquid. Multi-mode analgesia was adopted after surgery. Non-steroidal anti-inflammatory-based analgesics were used, and the use of opioids was decreased. Postoperative aerosol inhalation was required. Rolling and patting on the back were reinforced, and coughing and expectoration were encouraged. Respiratory function training was conducted early after surgery, including deep breathing and respiratory training gears. Dexamethasone and 5 hydroxytryptamine 3 receptor antagonists were used to prevent postoperative nausea and vomiting. One hour of activity out of bed within 24 hours after surgery was required, after which the patients should have four hours of activity out of bed every day. The fluid transfusion amount should be <500 mL/24 hours. Preventive antibiotics were used for 48 hours after surgery. Blood pressure and blood sugar were controlled. The urethra catheter was removed early and the chest tube was removed when the drainage volume was <400 mL/24 hours.

Control group

Patients in the control group were treated according to routine thoracic surgery. Conventional three-port VATS was conducted after the fulfillment of preoperative preparation and the exclusion of any contraindications for surgery. A trocar was placed in the 1.5 cm incision on the seventh intercostal space between the midaxillary line and the posterior axillary line as the camera port. The main surgical port was a 4 cm incision between the midaxillary line and the anterior axillary line. The subsidiary surgical port was a 1.5 cm incision on the sixth intercostal space between the subscapular line and the posterior line. Lobectomy and systemic lymph node dissection were conducted.

Chest tube placement

Two #28 chest tubes were placed through the camera and secondary ports after upper lobectomy, whereas one #28 chest tube was placed through the camera port after middle or lower lobectomy. Prevention of infection treatment, oxygen therapy, and atomizer treatment were routinely conducted. The chest tube was removed when the drainage volume was <200 mL/24 hours.

Observation parameters

Operation duration, intraoperative blood loss, number of lymph nodes dissected, postoperative duration of chest tube placement, length of hospital stay, and postoperative complications were recorded.

Visual analogue scale

The degree of wound pain was estimated using the visual analogue scale (VAS). Data were obtained on the first and third days after surgery. Zero indicated no pain at all, while 10 indicated the worst possible pain, requiring the injection of analgesic drugs; the higher the score, the more severe the pain. Two surgeons conducted all estimations and data collection.

Statistical methods

Patient demographics, in addition to operative variables, were represented as means or medians as necessary. The data was analyzed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were shown as $\bar{x} \pm s$, and comparisons were performed using Student t and Chi-square tests. $P < 0.05$ was considered statistically significant. Statistical analysis was performed according to the preferred guidelines.[4]

Results

Surgeries were conducted successfully in all patients, and no mortality occurred during the perioperative period. Conversion to open surgery was not required in any case. The ERAS group had better VAS on the third postoperative day ($P = 0.003$), shorter chest tube placement duration ($P = 0.021$), and shorter postoperative hospital stays ($P = 0.024$). No differences between these groups in terms of operation duration, number of lymph nodes dissected, intraoperative blood loss, VAS on the first postoperative day, reoperation, or complication rates were observed ($P > 0.05$). (Tables 3–4).

Discussion

In the1990s, Kehlet *et al.* first developed the enhanced recovery mode for colectomy, which reduced hospitalization time and morbidity dramatically.[5] This theory

Table 3 Surgical outcomes

Outcome	ERAS group	Control group	P
Surgical duration (min)	166.87 ± 34.15	152.00 ± 28.85	0.034
Blood loss (mL)	142.89 ± 95.07	130.22 ± 108.39	0.576
Lymph node yield	11.89 ± 3.46	10.89 ± 3.14	0.169
Duration of chest tube placement (day)	5.26 ± 3.41	7.02 ± 3.39	0.021

ERAS, enhanced recovery after surgery.

Table 4 Postoperative outcomes

Outcome	ERAS group	Control group	*P*
Postoperative stay (day)	6.58 ± 3.87	8.69 ± 4.40	0.024
Pulmonary infection, *n* (%)	1 (2.6%)	2 (4.4%)	0.659
Arrhythmia, *n* (%)	1 (2.6%)	1 (2.2%)	0.904
Postoperative air leak, *n* (%)	2 (5.3%)	3 (6.7%)	0.798
VAS on first postoperative day	4.95 ± 0.77	4.98 ± 0.81	0.862
VAS on third postoperative day	3.11 ± 0.80	3.69 ± 0.90	0.003

ERAS, enhanced recovery after surgery; VAS, visual analogue scale.

subsequently evolved into ERAS, which is based on the multi-mode clinical route to reduce surgical stress and optimize preoperative and postoperative administration. ERAS has been widely conducted in surgery, particularly colorectal surgery; however, related studies on thoracic surgery are rare. This study analyzed the clinical efficiency of ERAS using uniportal VATS for NSCLC and our findings indicate that this method is safe and practicable for NSCLC patients and could also reduce the length of hospital stay.

Rocco *et al.* reported the use of uniportal VATS for the diagnosis and treatment of thoracic diseases in 2004, which was limited to wedge resection.[3] Gonzalez *et al.* reported the use of uniportal lobectomy and systemic lymph node dissection. Uniportal lobectomy has subsequently been widely conducted and optimized.[6,7] According to published studies, the morbidity rate after VATS lobectomy is 7.4–14.8%.[8] In this study, no difference in postoperative morbidity was observed between the ERAS and control groups. Uniportal lobectomy did not increase postoperative morbidity, indicating that it was safe and feasible, yielded enhanced postoperative recovery, and could achieve satisfactory early clinical outcomes. This data is consistent with a previous report, which indicated that conversion from multiple port VATS to single port surgery is safe, efficient, and of high surgical quality.[9] However, more long-term data are required. Alternative approaches to performing thoracoscopic lung resection should be carefully evaluated and compared to establish minimally invasive techniques. According to published literature, the trauma to muscles, nerves, and blood vessels is reduced, with less postoperative pain and chest paresthesia if the incision of uniportal VATS is limited to one intercostal space and the length and number of incisions are less than those in conventional VATS.[10] This study found that the ERAS group had a better VAS score on the third day rather than on the first day, which may be a result of the technical advantages of uniportal VATS or the shorter duration of chest tube placement in the ERAS group.

Systemic lymph node dissection is very important to ensure a better prognosis and control local recurrence in patients with NSCLC. Systemic lymph node dissection is one of the difficulties associated with uniportal VATS. In this study, the lymph node yield in the ERAS group was similar to the control group, consistent with the results of a previous study, suggesting the improved efficiency of uniportal VATS for lymph node dissection compared to the conventional three-port VATS.[11] Moreover, the hospitalization duration of the ERAS group was shorter than that of the control group. One of the reasons might be the reduced trauma caused by uniportal VATS. Another important reason is that postoperative administration of the chest tube was optimized, and the extubation indications were extended for <400 mL/24 hours. The strict intraoperative and postoperative fluid management also contributed to reducing postoperative pleural effusion. Conventionally, thoracic surgeons removed the chest tube only when the drainage volume reached <200 mL/24 hours; however, Deng *et al.* found that a drainage volume of <400 mL/24 hours was also safe and could reduce hospitalization duration.[12] No differences in the morbidity rate were observed between these groups, indicating that ERAS was safe and would not increase postoperative morbidities.

The limitations of this study were the small sample size and short follow-up time. Further, analysis bias might exist because of the limitation of data. Future studies are necessary to include more patients and longer follow-up.

In conclusion, ERAS using uniportal VATS was safe and efficient, and could enhance patient recovery and reduce hospitalization.

Acknowledgment

Disclosure

No authors report any conflict of interest.

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