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A retrospective cohort study of total laparoscopic Ivor Lewis esophagectomy versus open esophagectomy

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Abstract: Objective To compare baseline characteristics, intraoperative outcomes, and postoperative complications between patients undergoing total laparoscopic versus open Ivor Lewis esophagectomy. **Methods** The clinical data of 188 esophageal cancer patients who underwent Ivor Lewis esophagectomy at Nanjing Drum Tower Hospital, the Affiliated Hospital of Nanjing University Medical School from December 2021 to May 2024 were retrospectively collected. According to whether the total laparoscopic and thoracoscopic Ivor Lewis esophagectomy was adopted, they were divided into the total laparoscopic group (group T, n=130) and open esophagectomy group (group O, n=58). The surgical conditions and complications of the two groups of patients were analyzed. **Results** Baseline: there was no significant difference between the two groups in age, neoadjuvant therapy, history of malignant tumor, tumor location, pathological type and pathological stage (P>0.05). The proportions of women and basic diseases in group T were higher than those in group O (P<0.05). Operation situation: the negative rate of the esophageal stump margin was 100% in both groups. Compared with group O, group T had less intraoperative bleeding [(173.9±78.3) mL *vs* (246.6±68.1) mL, shorter hospital stays [(12.2±2.4) days *vs* (13.5±3.4) days, t=2.634, P<0.05], but longer operative time and higher hospitalization costs (P<0.01). Complications: there was no statistically significant difference in the incidences of lung infection, anastomotic leakage, recurrent laryngeal nerve injury, thoracic puncture catheter placement, and secondary surgery between the two groups (P>0.05). The incidence of pleural effusion in group T was higher than that in group O (P<0.01), while the severity of pain score was lower than that in group O (P<0.01). **Conclusion** Compared with the open esophagectomy, although total laparoscopic will prolong the operation time, increase hospitalization expenses, and increase the incidence of pleural effusion, it has obvious advantages in reducing intraoperative blood loss, increasing the number of lymph node dissections, shortening the hospital stay, and alleviating postoperative pain, and is a safe and feasible surgical method.

Keywords: Esophageal cancer; Ivor Lewis esophagectomy; Thoracoscopy; Laparoscopy; Open esophagectomy; Safety

Esophageal cancer is one of the most common malignant tumors globally, with the incidence and mortality rates in China accounting for more than half of the global total [1-2]. Data released by the National Cancer Center show that in 2022, the incidence and mortality rates of esophageal cancer in China ranked seventh and fifth, respectively, among all malignant tumors, with annual new cases and deaths reaching 224,000 and 187,500, respectively [3]. The overall prognosis for esophageal cancer patients remains poor, with a 5-year survival rate below 30%. Surgery is the primary treatment for esophageal cancer which can be resected [4]. Open esophagectomy (OE) has significant trauma, severe pain, and high rates of complications and mortality. Thoracoscopic surgery, with advantages such as reduced trauma, less pain, and faster postoperative recovery, is widely used for the diagnosis and treatment of thoracic diseases. The introduction of thoracoscopic surgery into esophageal cancer treatment led to the development of minimally invasive esophagectomy (MIE). With advancements in surgical equipment and techniques, MIE has become increasingly widespread [5]. Currently, Ivor Lewis esophagectomy has become the preferred surgical approach for middle and lower thoracic esophageal cancer in some medical centers. To minimize perioperative complications associated with open surgery and the McKeown procedure, some centers have developed minimally invasive Ivor Lewis esophagectomy. However, its safety and efficacy still require substantial research evidence for validation [6]. This study aims to comprehensively evaluate the safety of totally minimally invasive Ivor Lewis esophagectomy compared with open Ivor Lewis esophagectomy, providing evidence-based medical support for its clinical application and laying a theoretical foundation for subsequent research on its medium- and long-term outcomes.

1 Data and Methods

1.1 Clinical Data and Grouping

A retrospective analysis was conducted on the clinical data of 188 patients with esophageal cancer who underwent Ivor Lewis esophagectomy at Nanjing Drum Tower Hospital, Affiliated Hospital of Medical School, Nanjing University, from December 2021 to May 2024. Patients were divided into a totally minimally invasive group (Group T, n=130) and an open esophagectomy group (Group O, n=58) based on whether a totally minimally invasive approach was used.

Inclusion criteria: Pathologically confirmed esophageal cancer and undergoing radical esophagectomy at our hospital.

Exclusion criteria: (1) palliative surgery; (2) non-Ivor Lewis surgical approach; (3) distant tumor metastasis; (4) severe thoracic or abdominal adhesions or combined organ dysfunction rendering the patient unable to tolerate surgery or single-lung ventilation; (5) other diseases that could directly affect survival.

This study was approved by the Medical Ethics Committee of Nanjing Drum Tower Hospital, Affiliated Hospital of Medical School, Nanjing University (Approval No. 2024-915-01).

No statistically significant differences were observed between the two groups in terms of age (P=0.309), neoadjuvant therapy (P=0.329), history of malignant tumors (P=0.752), tumor location (P=0.765), pathological type (P=0.433), or pathological stage (P=0.840). However, statistically significant differences were found between the two groups in terms of gender (P=0.048) and the presence of underlying diseases (P<0.001). See **Table 1**.

Tab. 1 Clinical basic data of patients [case(%)]

Clinical data	Group T (n=130)	Group O (n=58)	$t/\chi^2/Z$ value	P value
Age(years, $\bar{x} \pm s$)	68.6±9.4	67.3±7.4	1.020	0.309
Gender			3.919	0.048
Male	95(73.1)	50(86.2)		
Female	35(26.9)	8(13.8)		
Underlying disease			13.118	<0.001
Yes	94(72.3)	26(44.8)		
No	36(27.7)	32(55.2)		
Neoadjuvant therapy			0.951	0.329
Yes	15(11.5)	4(6.9)		
No	115(88.5)	54(93.1)		
History of malignant tumors			0.099	0.752
Yes	5(3.8)	1(1.7)		
No	125(96.2)	57(98.3)		
Tumor location			0.534	0.765
Upper thoracic segment	1(0.8)	1(1.7)		
Middle thoracic segment	68(52.3)	32(55.2)		
lower thoracic segment	61(46.9)	25(43.1)		
Pathological type			4.863	0.433
Squamous Cell Carcinoma	119(91.5)	51(87.9)		
Adenocarcinoma	6(4.6)	3(5.2)		
Adenosquamous Carcinoma	0(0.0)	1(1.7)		
Small Cell Carcinoma	3(2.3)	1(1.7)		
Undifferentiated Carcinoma	2(1.5)	1(1.7)		
Sarcomatoid Carcinoma	0(0.0)	1(1.7)		
Pathological Staging			0.202	0.840
IA	7(5.4)	4(6.9)		
IB	26(20.0)	9(15.5)		
IIA	22(16.9)	8(13.8)		
IIB	20(15.4)	11(19.0)		
IIIA	9(6.9)	8(13.8)		
IIIB	40(30.8)	15(25.9)		
IVA	6(4.6)	3(5.2)		

1.2 Surgical Methods

1.2.1 Abdominal Part

(1) Group T: The patient was placed in the supine position. A 1 cm incision was made at the lower edge of the umbilicus, through which a 10 mm trocar was inserted as the observation port. A laparoscope was introduced, and pneumoperitoneum was established, with intra-abdominal pressure maintained at approximately 11 mmHg. Subsequently, 0.5 cm and 1 cm incisions were made at the lateral borders of the rectus abdominis muscles, 3–5 cm above the umbilicus on the left and right sides, through which 5 mm and 12 mm trocars were inserted, respectively. Additionally, 1 cm and 0.5 cm incisions were made at the costal margins along the midclavicular lines on the left and right sides, through which 10 mm and 5 mm trocars were inserted, respectively. These four incisions served as operating ports. Under the five-port approach, the abdominal cavity was explored. The greater and lesser omenta were dissected while preserving the right gastroepiploic vascular arch. The left gastric artery, short gastric arteries, and left gastroepiploic artery were ligated and divided. Distal dissection extended to the pylorus, while proximal dissection extended above the cardia. The esophageal hiatus was opened, and a short segment of the esophagus was further mobilized superiorly. Abdominal lymph node dissection was performed. The esophagus was transected above the cardia using a linear stapler, and a silk suture was placed at the proximal end for traction. A 5 cm midline incision was made below the xiphoid process in the upper abdomen, and the abdominal layers were incised sequentially to access the abdominal cavity. The stomach was exteriorized through this incision, and the right gastric artery was ligated and divided. The stomach was tailored along the greater curvature using a linear stapler, with resection of the cardia and the lesser curvature gastric body, forming a gastric conduit approximately 3 cm in width. The gastric conduit was serosalized with continuous sutures using polypropylene non-absorbable sutures (Prolene®). The proximal end of the gastric conduit was sutured with silk and connected to the esophagus before being returned to the abdominal cavity for subsequent use. See **Figure 1**.

(2) Group O: The patient was placed in the supine position. A 20 cm midline incision was made in the upper abdomen through the linea alba to access the abdominal cavity. Under direct visualization, the same procedures as those in Group T were performed.

1.2.2 Thoracic Part

(1) Group T: The patient was placed in the left lateral decubitus position with the chest elevated. A 1 cm incision was made in the right seventh intercostal space along the midaxillary line for thoracic access, through which a thoracoscopic trocar was inserted as the observation port. A thoracoscope was introduced. Subsequently, a 3 cm incision was made in the right third intercostal space along the anterior axillary line as the

operating port. Under thoracoscopic guidance, the thoracic cavity was explored to determine the location of the esophageal tumor and the extent of invasion. The azygos vein was mobilized, ligated, and divided. The thoracic esophagus was mobilized superiorly to the thoracic inlet and inferiorly to the esophageal hiatus of the diaphragm, with complete dissection of the periesophageal tissues to achieve full esophageal mobilization. The traction suture of the gastric conduit was then pulled into the thoracic cavity and subsequently cut, with the distal end clamped using forceps to prevent retraction into the abdominal cavity. A purse-string suture was placed using 3-0 absorbable sutures (VICRYL®) at a point at least 5 cm above the esophageal tumor. The distal opening of the purse-string was used to insert the anvil of the stapler into the proximal esophagus. The purse-string suture was tightened to secure the anvil, and a double-layer purse-string suture was applied to approximate the esophageal muscularis and mucosa, reducing mucosal eversion and minimizing the risk of anastomotic leakage. The esophagus was transected approximately 0.5 cm from the purse-string suture, achieving complete resection of the esophagus and tumor. Intrathoracic lymph node dissection was performed. The traction suture of the gastric conduit was pulled to exteriorize the gastric conduit from the thoracic cavity. The proximal end of the gastric conduit was opened, and gastric contents were suctioned before inserting the stapler base. Under thoracoscopic guidance, the anvil was connected to the stapler base, and a circular anastomosis was completed after gradual approximation. The open end of the gastric conduit was closed and divided using a linear stapler. The anastomosis and the gastric conduit stump were reinforced with 3-0 VICRYL® sutures. After rinsing the thoracic cavity, one chest drainage tube and one mediastinal drainage tube were placed, along with one nasogastric tube. See **Figure 2**.

(2) Group O: The patient was placed in the left lateral decubitus position with the chest elevated. A 20 cm incision was made along the right fourth intercostal space for thoracic access. Under direct visualization, the same procedures as those in Group T were performed.

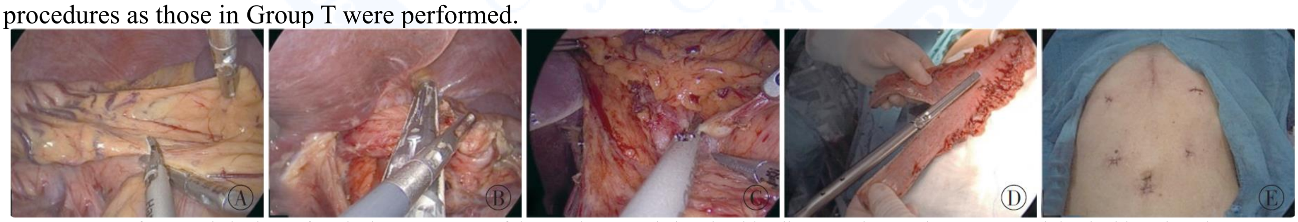
1.3 Observation Indicators

(1) Surgical outcomes: Operation time (duration from the start to the end of surgery), intraoperative blood loss, number of lymph nodes dissected, hospital stay (total days from admission to discharge), hospitalization costs (total expenses during the entire hospitalization), and negative margin rate of esophageal resection margins (percentage of patients with pathologically confirmed negative esophageal resection margins among all surgical patients).

(2) Complication rates: Pulmonary infection (postoperative chest X-ray or CT indicating pulmonary infection or pulmonary exudation), anastomotic leakage (postoperative upper gastrointestinal radiography or gastroscopy revealing anastomotic leakage), recurrent laryngeal nerve injury (symptoms such as hoarseness or choking upon drinking water, or electronic laryngoscopy indicating vocal cord fixation), pleural effusion (postoperative chest X-ray or CT indicating pleural effusion), thoracentesis and drainage (postoperative thoracentesis and drainage due to pleural effusion or pneumothorax), reoperation (reoperation after the initial surgery due to bleeding, chylothorax, or other reasons), and pain score [assessed using the Numerical Rating Scale (NRS), where 0 indicates no pain, 1–3 indicates mild pain, 4–6 indicates moderate pain, and 7–10 indicates severe pain].

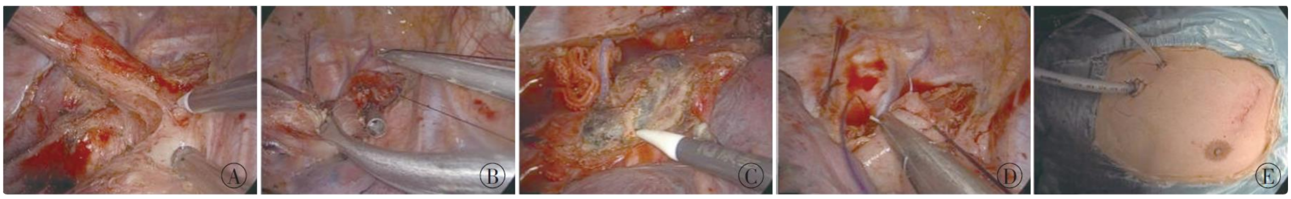
1.4 Statistical Methods

Statistical analysis was performed using SPSS 18.0 software. Measurement data were described as $\bar{x} \pm s$. For data conforming to a normal distribution, independent sample *t*-tests were used for statistical inference. In cases of unequal variances, corrected *t*-tests were applied. Categorical data were described as *n* (%), and statistical inference was performed using the chi-square test or corrected chi-square test. Ordinal data were analyzed using the rank-sum test. A two-tailed test was used, and $P<0.05$ was considered statistically significant.



Note: A, free gastric body; B, free the lower segment of the esophagus and close it with a linear cutting stapler; C, sweep abdominal lymph nodes; D, create a tubular stomach using a linear cutting closure device; E, distribution of incisions in laparoscopic surgery.

Fig.1 Diagrams of abdominal total laparoscopic surgery



Note: A, free esophagus; B, tighten the purse after inserting a stapler anvil into the proximal esophagus; C, sweep the thoracic lymph nodes; D, strengthen the suturing of the anastomotic site after gastroesophageal anastomosis; E, distribution of incisions and drainage tubes in thoracoscopic surgery.

Fig.2 Diagrams of total endoscopic thoracic surgery

2 Results

2.1 Surgical Outcomes

The negative margin rate of esophageal resection margins was 100% in both groups. Compared with Group O, Group T had less intraoperative blood loss, more lymph nodes dissected, and a shorter hospital stay (P<0.05). However, the operation time was longer, and hospitalization costs were higher in Group T, with statistically significant differences (P<0.01). See **Table 2**.

2.2 Complications

There was no statistically significant difference between the two groups in the incidence of pulmonary infection, anastomotic leakage, recurrent laryngeal nerve injury, thoracentesis and drainage, or reoperation (P>0.05). The incidence of pleural effusion was higher in Group T compared with Group O (73.1% *vs* 51.7%, χ^2=8.207, P=0.004). However, in terms of pain scores, Group T had lower pain levels than Group O (P<0.01). See **Table 3**.

Tab. 2 Comparison of surgical conditions between the two groups ($\bar{x} \pm s$)

Indicators	Group T (n=130)	Group O (n=58)	t value	P value
Surgical duration (min)	262.5±39.9	216.1±45.1	7.070	<0.001
Intraoperative bleeding volume (mL)	173.9±78.3	246.6±68.1	6.113	<0.001
Number of lymph node dissection (s)	19.9±7.9	17.0±6.5	2.449	0.015
Hospitalization time (d)	12.2±2.4	13.5±3.4	2.634	0.010
Hospitalization expenses (10,000 yuan)	8.6±1.1	7.1±1.2	8.395	<0.001

Tab. 3 Comparison of postoperative complications between the two groups [case(%)]

Indicators	Group T (n=130)	Group O (n=58)	χ^2/Z value	P value
Pulmonary infection	21(16.2)	7(12.1)	0.528	0.467
Anastomotic leakage	4(3.1)	2(3.4)	0.099	0.753
Recurrent laryngeal nerve injury	6(4.6)	0(0.0)	1.473	0.225
Pleural effusion	95(73.1)	30(51.7)	8.207	0.004
Thoracic puncture catheterization	6(4.6)	2(3.4)	0.001	0.980
Second surgery	1(0.8)	0(0.0)	0.449	0.503
Pain level			17.789	<0.001
Mild	90(69.2)	25(43.1)		
Moderate	34(26.2)	33(56.9)		
Severe	6(4.6)	0(0.0)		

3 Discussion

Surgical resection is the main treatment method for esophageal cancer. Even for patients with locally advanced disease without distant metastasis, adopting a surgery-centered multidisciplinary comprehensive treatment, including neoadjuvant therapy, can significantly improve survival rates [7]. However, due to the complex and meticulous procedures of radical esophagectomy, involving multiple surgical sites such as the chest, abdomen, and neck, the surgical requirements are high. In the past, postoperative complication rates and mortality have been high. Therefore, thoracic surgeons have made various attempts to reduce the surgical trauma of radical esophagectomy. In addition to conventional measures such as early enteral nutrition, epidural anesthesia, and early ambulation, hybrid or totally minimally invasive surgical techniques aim to perform more precise operations with less trauma, ensuring surgical safety while achieving equivalent or superior efficacy, reducing postoperative pain, promoting rapid recovery, improving quality of life, and enhancing prognosis [8-10]. However, according to oncological principles, the completeness of tumor resection, including an adequate negative margin rate of the esophageal resection stump and thorough lymph node dissection, is a prerequisite for evaluating the quality of surgery [11]. The results of this study show that both open surgery and totally minimally invasive surgery achieved a 100% negative margin rate for the esophageal resection stump. However, in terms of lymph node dissection, the totally minimally invasive approach had an advantage, possibly related to the clearer and magnified view provided by the endoscope, which facilitates lymph node dissection.

In general, the application of minimally invasive thoracoabdominal surgery in radical esophagectomy has been relatively late. On one hand, the surgery itself is a challenge; on the other hand, the development of video-assisted thoracic surgery (VATS) lagged behind that of laparoscopic surgery [12]. Minimally invasive surgery combining thoracoscopy and laparoscopy often requires a high level of professional skill to achieve low complication rates and satisfactory treatment outcomes. Only in this way can minimally invasive surgery be meaningful and beneficial for patients. Therefore, the development of totally minimally invasive radical esophagectomy has been relatively slow, and many centers both domestically and internationally still adopt open radical esophagectomy. However, the exploration and validation of minimally invasive techniques in esophageal surgery have never ceased. For a long time, thoracic surgeons have eagerly awaited rigorous clinical evidence to assess their true clinical value. According to relevant literature, MIE has significant advantages in early ambulation, reducing postoperative pain, and lowering the incidence of pneumonia [13-14]. As recently as 2017, the results of the TIME trial indicated that MIE and open surgery have comparable oncological outcomes, but MIE is superior in terms of perioperative and postoperative recovery [15].

Ivor Lewis esophagectomy is the preferred surgical method for treating esophageal cancer, especially for middle and lower thoracic esophageal cancer and malignant tumors of the esophagogastric junction. In various retrospective studies and two randomized controlled trials, MIE has been considered an alternative to open surgery [16], but concerns remain regarding the safety of thoracoscopic esophagogastric anastomosis [17]. According to data from the International Esophageal Cancer Collaboration, which includes major surgical centers worldwide, the incidence of anastomotic leakage is 15.1% for MIE Ivor Lewis esophagectomy, significantly higher than that for hybrid surgery (10.7%) and open surgery (7.3%) [18]. However, contrary to this, the results of this study show that the totally minimally invasive Ivor Lewis procedure did not increase the risk of postoperative anastomotic leakage compared with the open procedure.

Esophagectomy is clinically applied to various diseases, including esophageal cancer, benign esophageal tumors, and achalasia. Its complication rate ranges from approximately 40% to 50%, depending on the surgical method [19]. The current consensus is that prolonged operative time is associated with an increased incidence of postoperative complications, and the average operative time for MIE is longer than that for OE [20]. The results of this study indicate that the operative time in Group T was approximately 45 min longer on average than that in the Group O. There was no significant difference in the incidence of most postoperative complications between the two groups. However, the incidence of postoperative pleural effusion in Group T reached 73.1%, significantly higher than the 51.7% in Group O. This may be related to the prolonged operative time and the more thorough lymph node dissection in Group T. The incidence of thoracentesis and drainage in Group T was only 4.6%, with no statistically significant difference compared with Group O, indicating that most cases of pleural effusion in both groups were mild and required no special treatment. Additionally, although one patient in Group T required reoperation due to postoperative bleeding and six patients developed recurrent laryngeal nerve injury postoperatively, the incidence rates were not statistically significant compared with Group O.

In conclusion, the totally minimally invasive procedure is safe and feasible. Combined with its advantages in reducing postoperative pain and accelerating recovery, it is worthy of preferential selection, consistent with relevant literature reports. However, further studies and data are still needed for validation [21].

Conflict of Interest None

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·消化道肿瘤专题·论著·

全腔镜Ivor Lewis食管癌根治术对比开放手术的回顾性队列研究

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摘要：目的　比较全腔镜与开放手术下行Ivor Lewis食管癌根治术患者的基线情况、手术情况、并发症情况。**方法**　回顾性收集2021年12月至2024年5月在南京大学医学院附属鼓楼医院接受Ivor Lewis食管癌根治术的188例食管癌患者的临床资料，根据是否采用全腔镜术式分为全腔镜组（130例）和开放组（58例）。分析两组患者手术情况和并发症情况。**结果**　基线情况：两组在年龄、是否接受新辅助治疗、有无恶性肿瘤史、肿瘤位置、病理类型、病理分期方面差异无统计学意义（$P>0.05$）；全腔镜组女性和有基础疾病占比高于开放组（$P<0.05$）。手术情况：两组食管断端切缘阴性率均为100%。与开放组比较，全腔镜组术中出血量更少[（173.9±78.3）mL *vs*（246.6±68.1）mL，$t=6.113$，$P<0.01$]、淋巴结清扫数量更多[（19.9±7.9）个 *vs*（17.0±6.5）个，$t=2.449$，$P<0.05$]、住院时间更短[（12.2±2.4）d *vs*（13.5±3.4）d，$t=2.634$，$P<0.05$]，但手术时间较长、住院费用较高（$P<0.01$）。并发症情况：两组肺部感染、吻合口瘘、喉返神经损伤、胸腔穿刺置管、二次手术的发生率差异无统计学意义（$P>0.05$）；尽管全腔镜组胸腔积液发生率高于开放组（$P<0.01$），但疼痛程度低于开放组（$P<0.01$）。**结论**　相较于开放术式，全腔镜Ivor Lewis食管癌根治术虽然会延长手术时间、增加住院费用、增加胸腔积液发生率，但在减少术中出血量、增加淋巴结清扫量、缩短住院时间、减轻术后疼痛方面有明显优势，是一种安全可行的手术方式。

关键词：食管癌；Ivor Lewis食管切除术；胸腔镜；腹腔镜；开放手术；安全性
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A retrospective cohort study of total laparoscopic Ivor Lewis esophagectomy versus open esophagectomy

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Abstract: Objective　To compare baseline characteristics, intraoperative outcomes, and postoperative complications between patients undergoing total laparoscopic versus open Ivor Lewis esophagectomy. **Methods**　The clinical data of 188 esophageal cancer patients who underwent Ivor Lewis esophagectomy at Nanjing Drum Tower Hospital, the Affiliated Hospital of Nanjing University Medical School from December 2021 to May 2024 were retrospectively collected. According to whether the total laparoscopic and thoracoscopic Ivor Lewis esophagectomy was adopted, they were divided into the total laparoscopic group (group T, $n=130$) and open esophagectomy group (group O, $n=58$). The surgical conditions and complications of the two groups of patients were analyzed. **Results**　Baseline: there was no significant difference between the two groups in age, neoadjuvant therapy, history of malignant tumor, tumor location, pathological type and pathological stage ($P>0.05$). The proportions of women and basic diseases in group T were higher than those in group O ($P<0.05$). Operation situation: the negative rate of the esophageal stump margin was 100% in both groups. Compared with group O, group T had less intraoperative bleeding [(173.9±78.3) mL *vs* (246.6±68.1) mL,

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t=6.113, P<0.01], a greater number of lymph node dissection [(19.9±7.9) *vs* (17.0±6.5), t=2.449, P<0.05], and shorter hospital stay [(12.2±2.4) days *vs* (13.5±3.4) days, t=2.634, P<0.05], but longer operative time and higher hospitalization costs (P<0.01). Complications: there was no statistically significant difference in the incidences of lung infection, anastomotic leakage, recurrent laryngeal nerve injury, thoracic puncture catheter placement, and secondary surgery between the two groups (P>0.05). The incidence of pleural effusion in group T was higher than that in group O (P<0.01), while the severity of pain score was lower than that in group O (P<0.01). **Conclusion** Compared with the open esophagectomy, although total laparoscopic will prolong the operation time, increase hospitalization expenses, and increase the incidence of pleural effusion, it has obvious advantages in reducing intraoperative blood loss, increasing the number of lymph node dissections, shortening the hospital stay, and alleviating postoperative pain, and is a safe and feasible surgical method.

Keywords: Esophageal cancer; Ivor Lewis esophagectomy; Thoracoscopy; Laparoscopy; Open esophagectomy; Safety

食管癌是全球高发的恶性肿瘤之一，中国食管癌发病和死亡人数均占全球总数的一半以上[1-2]。国家癌症中心发布的数据显示，2022年我国食管癌发病率和死亡率分别位居恶性肿瘤的第七位和第五位，年发病人数和死亡人数分别达到了22.40万和18.75万[3]。食管癌患者整体预后欠佳，5年生存率低于30%，手术是可切除食管癌的主要治疗手段[4]。开放食管切除术（open esophagectomy，OE）创伤大，疼痛剧烈，并发症发生率和病死率较高。胸腔镜手术具有创伤小、疼痛轻、术后恢复快等优点，广泛用于胸部疾病诊治，将胸腔镜手术引入食管癌治疗，微创食管切除术（minimally invasive esophagectomy，MIE）应运而生。随着手术设备升级和技术进步，MIE应用越来越广泛[5]。目前，Ivor Lewis食管癌根治术已成为一些医疗中心切除胸中下段食管癌的首选术式，为了尽量降低与开放术式及McKeown术式相关的围手术期并发症发生率，一些中心开发了微创Ivor Lewis食管癌根治术，但其安全性和有效性仍亟需大量的研究证据支持[6]。本研究通过与开放Ivor Lewis食管癌根治术相对比，综合评价全腔镜Ivor Lewis食管癌根治术的安全性，为其临床应用提供循证医学证据，并为后续研究其中远期疗效奠定理论基础。

1　资料与方法

1.1　临床资料和分组　回顾性分析2021年12月至2024年5月在南京大学医学院附属鼓楼医院接受Ivor Lewis食管癌根治术治疗的188例食管癌患者的临床资料，根据是否采用全腔镜术式分为全腔镜组（130例）和开放组（58例）。纳入标准：病理确诊食管癌，在本院接受食管癌根治术。排除标准：（1）行姑息性手术；（2）采用非Ivor Lewis术式；（3）肿瘤远处转移；（4）严重胸腹腔粘连或合并脏器功能障碍，无法耐受手术或单肺通气者；（5）合并其他可能直接影响生存期的疾病。本研究经南京大学医学院附属鼓楼医院医学伦理委员会批准（批件编号：2024-915-01）。

两组在年龄（P=0.309）、是否接受新辅助治疗（P=0.329）、是否有恶性肿瘤史（P=0.752）、肿瘤位置（P=0.765）、病理类型（P=0.433）、病理分期（P=0.840）方面差异均无统计学意义。两组在性别（P=0.048）和是否存在基础疾病（P<0.01）方面差异有统计学意义。见表1。

表1　患者临床基本信息　[例(%)]

Tab.1　Clinical basic information of patients　[case(%)]

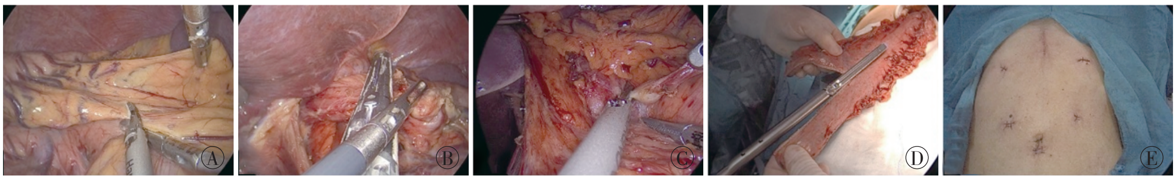
临床资料	全腔镜组(n=130)	开放组(n=58)	$t/\chi^2/Z$值	P值
年龄(岁，$\bar{x}\pm s$)	68.6±9.4	67.3±7.4	1.020	0.309
性别				
男	95(73.1)	50(86.2)	3.919	0.048
女	35(26.9)	8(13.8)		
基础疾病				
有	94(72.3)	26(44.8)	13.118	<0.001
无	36(27.7)	32(55.2)		
新辅助治疗				
有	15(11.5)	4(6.9)	0.951	0.329
无	115(88.5)	54(93.1)		
恶性肿瘤史				
有	5(3.8)	1(1.7)	0.099	0.752
无	125(96.2)	57(98.3)		
肿瘤位置				
胸上段	1(0.8)	1(1.7)	0.534	0.765
胸中段	68(52.3)	32(55.2)		
胸下段	61(46.9)	25(43.1)		
病理类型				
鳞癌	119(91.6)	51(87.9)	4.863	0.433
腺癌	6(4.6)	3(5.3)		
腺鳞癌	0	1(1.7)		
小细胞癌	3(2.3)	1(1.7)		
未分化癌	2(1.5)	1(1.7)		
肉瘤样癌	0	1(1.7)		
病理分期				
ⅠA	7(5.4)	4(6.9)	0.202	0.840
ⅠB	26(20.0)	9(15.5)		
ⅡA	22(16.9)	8(13.8)		
ⅡB	20(15.4)	11(19.0)		
ⅢA	9(6.9)	8(13.8)		
ⅢB	40(30.8)	15(25.8)		
ⅣA	6(4.6)	3(5.2)		

1.2　手术方式

1.2.1　腹部部分　(1) 全腔镜术式：取仰卧位，于脐下缘作一约1 cm切口，置入10 mm穿刺套管(trocar)作为观察孔，置入腹腔镜镜头，并形成气腹，气腹压力控制在11 mmHg左右。然后分别取左右侧腹直肌外缘脐上3~5 cm处约0.5 cm和1 cm切口，分别置入5 mm和12 mm trocar，分别取左右侧锁骨中线肋缘下约1 cm和0.5 cm切口，分别置入10 mm和5 mm trocar，以此四孔为操作孔。在五孔法下探查腹腔，游离胃大小网膜，保留胃网膜右血管弓，分别离断胃左动脉、胃短动脉、胃网膜左动脉，远端游离至幽门，近端至贲门上方，并打开食管裂孔，继续向上游离一小段食管。清扫腹腔淋巴结。自贲门上方用直线切割闭合器闭合离断食管，近端缝合丝线做牵引。取上腹正中剑突下约5 cm切口，逐层切开进腹，自该切口拉出胃体，离断胃右动脉，用直线切割闭合器沿大弯侧裁剪胃，切除贲门、小弯胃体，形成宽度约3 cm的管状胃，用聚丙烯不可吸收缝合线(普理灵)连续缝合使管状胃浆膜化。管状胃近端丝线缝合并与食管相连，放回腹腔后备用。见图1。(2) 开放术式：取仰卧位，取上腹正中约20 cm切口经腹白线进腹，在直视下与全腔镜术式同法处理。

1.2.2　胸部部分　(1) 全腔镜术式：取左侧卧位，胸部垫高，取右侧腋中线第7肋间约1 cm切口进胸，置入胸腔镜trocar为观察孔，置入胸腔镜镜头，然后取右侧腋前线第3肋间约3 cm切口为操作孔，在胸腔镜下探查胸腔，确定食管肿瘤位置及外侵情况。游离并闭合离断奇静脉后游离胸段食管，上至胸顶，下至膈肌食管裂孔处，并完全游离食管周围组织，使食管完全松解，然后将管状胃牵引线拉入胸腔后离断牵引线，远端以钳子钳夹，防止牵引线回缩至腹腔。自食管肿瘤上方5 cm以上以3-0可吸收性缝线(VICRYL，薇乔线)缝合荷包，荷包远端开口向近端置入吻合器钉砧，收紧荷包固定钉砧，并缝合双层荷包收紧食管肌层和黏膜，减少黏膜回缩，降低吻合口漏风险。在距离荷包约0.5 cm处离断食管，完整切除食管及肿瘤。清扫胸内淋巴结。提拉管状胃牵引线，将管状胃从胸腔拉出，近端开口，吸净胃内容物后置入吻合器底座，并在胸腔镜下将钉砧与底座连接，逐渐收拢后行圆形吻合。直线切割闭合器闭合离断管状胃开孔残端。3-0薇乔线加强吻合口及管状胃残端。冲洗胸腔后留置胸腔引流管和纵隔引流管各1根，留置胃管1根。见图2。(2) 开放术式：取左侧卧位，胸部垫高，沿右胸第四肋间取长约20 cm切口进胸，在直视下与全腔镜术式同法处理。

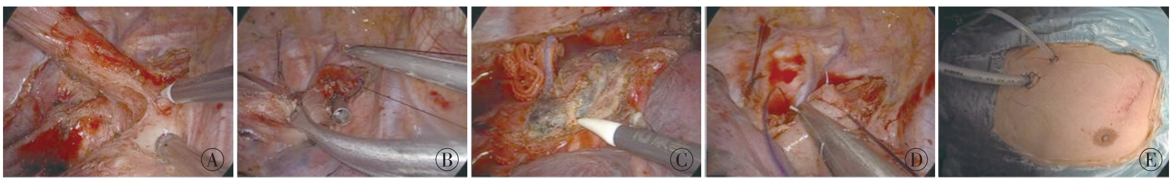
1.3　观察指标　(1) 手术情况：手术时长(手术开始到手术结束的时间)、术中出血量、淋巴结清扫个数、住院时间(从住院到出院的总天数)、住院费用(整个住院过程的总花费)、食管断端切缘阴性率(病理提示食管断端切缘阴性的患者占所有手术患者的百分比)；(2) 并发症发生率：肺部感染(术后X线胸片或CT提示肺部感染、肺部渗出)、吻合口瘘(术后经上消化道造影或胃镜检查，提示吻合口瘘)、喉返神经损伤(患者出现声音嘶哑或饮水呛咳等症状，或经电子喉镜检查提示声带固定)、胸腔积液(术后X线胸片或CT提示胸腔积液)、胸腔穿刺置管(术后因胸腔积液或积气行胸腔穿刺置管引流)、二次手术(术后因出血、乳糜胸等各种原因再次手术治疗)、疼痛评分[采



注：A，游离胃体；B，游离食管下段并用直线切割闭合器闭合离断；C，清扫腹腔淋巴结；D，用直线切割闭合器制作管状胃；E，腹腔镜手术切口分布。

图1　腹部部分全腔镜手术图

Fig.1　Diagrams of abdominal total laparoscopic surgery



注：A，游离食管；B，近端食管置入吻合器钉砧后收紧荷包；C，清扫胸腔淋巴结；D，胃食管吻合后加强缝合吻合口；E，胸腔镜手术切口和引流管分布。

图2　胸部部分全腔镜手术图

Fig.2　Diagrams of thoracic total endoscopic surgery

用数字分级评分法(Numerical Rating Scale, NRS),0分为无痛,1~3分为轻度疼痛,4~6分为中度疼痛,7~10分为重度疼痛]。

1.4 统计学方法 应用SPSS 18.0软件进行统计分析。计量资料采用$\bar{x}\pm s$进行统计描述,数据符合正态分布则采用独立样本t检验进行统计推断,方差不齐时采用校正t检验。计数资料采用例(%)进行统计描述,采用χ^2检验或校正χ^2检验进行统计推断,等级资料采用秩和检验进行统计推断。双侧检验,$P<0.05$为差异有统计学意义。

2 结 果

2.1 手术情况 两组食管断端切缘阴性率均为100%。与开放组相比,全腔镜组术中出血量更少、淋巴结清扫数量更多、住院时间更短($P<0.05$),但手术时间较长,且住院费用较高,差异有统计学意义($P<0.01$)。见表2。

2.2 并发症情况 两组在肺部感染、吻合口瘘、喉返神经损伤、胸腔穿刺置管、二次手术发生率方面差异无统计学意义($P>0.05$)。全腔镜组胸腔积液的发生率较开放组更高(73.1% *vs* 51.7%, χ^2=8.207, P=0.004);但在疼痛评分方面,全腔镜组疼痛程度低于开放组($P<0.01$)。见表3。

表2 两组手术情况比较 ($\bar{x}\pm s$)

Tab.2 Comparison of surgical conditions between the two groups ($\bar{x}\pm s$)

项目	全腔镜组(n=130)	开放组(n=58)	t值	P值
手术时间(min)	262.5±39.9	216.1±45.1	7.070	<0.001
术中出血量(mL)	173.9±78.3	246.6±68.1	6.113	<0.001
淋巴结清扫个数(个)	19.9±7.9	17.0±6.5	2.449	0.015
住院时间(d)	12.2±2.4	13.5±3.4	2.634	0.010
住院费用(万元)	8.6±1.1	7.1±1.2	8.395	<0.001

表3 两组术后并发症情况比较 [例(%)]

Tab.3 Comparison of postoperative complications between the two groups [case(%)]

项目	全腔镜组(n=130)	开放组(n=58)	χ^2/Z值	P值
肺部感染	21(16.2)	7(12.1)	0.528	0.467
吻合口瘘	4(3.1)	2(3.4)	0.099	0.753
喉返神经损伤	6(4.6)	0	1.473	0.225
胸腔积液	95(73.1)	30(51.7)	8.207	0.004
胸腔穿刺置管	6(4.6)	2(3.4)	0.001	0.980
二次手术	1(0.8)	0	0.449	0.503
疼痛程度				
轻度	90(69.2)	25(43.1)		
中度	34(26.2)	33(56.9)	17.789	<0.001
重度	6(4.6)	0		

3 讨 论

手术切除是食管癌的主要治疗方法,即使对于没有远处转移的局部晚期患者,采用以手术治疗为主的多学科综合治疗,包括新辅助治疗,亦可显著提高生存率[7]。然而,由于食管癌根治术步骤繁琐,细节多,涉及胸、腹、颈等多个手术部位,手术要求高,在过去,术后并发症发生率和死亡率一直很高。因此,胸外科医生做了各种尝试来减轻食管癌根治术的手术创伤。除早期肠内营养、硬膜外麻醉、早期活动等常规措施外,混合或全微创手术技术旨在以更小的创伤进行更加精细的操作,保证手术安全的同时达到等效或优效,减轻术后疼痛,促进快速康复,提高生活质量,改善预后[8-10]。然而,根据肿瘤学原则,肿瘤切除的完整性,包括足够的食管断端切缘阴性率和干净彻底的淋巴结清扫,是评判手术优劣的先决条件[11]。本研究结果显示,无论是开放手术还是全腔镜手术,其食管断端切缘阴性率均能达到100%,但在淋巴结清扫方面,全腔镜术式更有优势,考虑可能与腔镜能够提供更加清晰且放大的视野,更便于淋巴结清扫有关。

总的来说,胸腹微创手术在食管癌根治术中的应用相对较晚,一方面,手术本身就是一个挑战,另一方面,视频辅助胸腔镜手术(video-assisted thoracic surgery, VATS)的发展晚于腹腔镜手术[12]。胸腹腔镜联合的微创手术往往需要高水平的专业技能,以达到低并发症发生率和令人满意的治疗效果,也只有这样,微创手术才有意义,对患者来说才能够从中获益。因此,全腔镜食管癌根治术发展相对缓慢,国内外还有不少中心仍然采用开放食管癌根治术。然而,对于微创技术在食管外科中应用的探索与验证始终未曾中断。长久以来,胸外科医生都迫切期待通过严谨的临床证据,来评估其真正的临床价值。根据相关文献报道,MIE在早期活动、减少术后疼痛、降低肺炎发生率等方面具有明显的优势[13-14]。直到2017年,TIME试验结果表明,MIE与开放手术在肿瘤学方面效果相当,但MIE在围手术期和术后康复方面更胜一筹[15]。

Ivor Lewis食管癌根治术是治疗食管癌,尤其是胸中下段食管癌及食管胃交界处恶性肿瘤的首选手术方式。在各种回顾性研究和两项随机对照试验中,MIE被认为是开放手术的可替代选择[16],但仍然存在一些关于胸腔镜食管胃吻合安全性的担忧[17]。根据食管癌国际协作小组来自全世界各大手术中

心的数据显示，MIE术后的吻合口瘘发生率为15.1%，显著高于混合手术（10.7%）和开放手术（7.3%）[18]。但与此不同的是，本研究结果显示全腔镜Ivor Lewis术式相较于开放术式并未增加术后吻合口瘘的风险。

食管切除术临床应用于多种疾病，包括食管癌、食管良性肿瘤和贲门失弛缓症等，其并发症发生率约为40%~50%，具体取决于手术方式[19]。目前观点普遍认为手术时间延长与术后并发症发生率增加相关，且MIE平均手术时间较OE长[20-21]。本研究结果表明，全腔镜组的手术时间相较于开放组平均延长约45 min，两组之间术后大部分并发症发生率并无明显差异，但全腔镜组术后胸腔积液发生率达到了73.1%，明显高于开放组的51.7%，考虑和手术时间延长以及全腔镜组淋巴结清扫更加彻底有关。全腔镜组胸腔穿刺置管引流发生率仅为4.6%，与开放组差异无统计学意义，说明两组术后胸腔积液大部分为少量胸腔积液，均无需特殊处理。此外，虽然在全腔镜组有1例患者因术后出血行二次手术治疗，6例患者术后出现喉返神经损伤，但与开放组相比，其发生率差异无统计学意义。

综上所述，全腔镜术式是安全可行的，结合全腔镜术式在术后疼痛减轻以及加速康复方面的优势，值得优先选择，且与相关文献报道一致，但仍有待更多的研究和数据支持。

利益冲突　无

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