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ORIGINAL ARTICLE

Thoracoscopic-laparoscopic Ivor-Lewis surgery *vs.* McKeown surgery in the treatment of thoracic middle-lower segment esophageal cancer

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Summary

Purpose: *The purpose of this study was to compare the efficacy and safety of thoracoscopic-laparoscopic Ivor-Lewis surgery and McKeown surgery in the treatment of thoracic middle-lower segment esophageal cancer.*

Methods: *The clinical data of 136 patients with thoracic middle-lower segment esophageal cancer were divided into Ivor-Lewis group (n=68) and McKeown group (n=68). The perioperative indexes and the levels of tumor markers were observed. The patients' long-term survival condition was recorded via follow-up. Finally, the long-term quality of life of patients with a survival time >3 years was compared between the two groups after operation using EORTC QLQ-C30 and EORTC QLQ-OES18.*

Results: *The operation time was significantly shorter in Ivor-Lewis group than that in McKeown group. The hospitalization expenses were obviously higher in Ivor-Lewis group than those in McKeown group. The incidence rate of anastomotic fistula, anastomotic stenosis and pulmonary infection was evidently lower in Ivor-Lewis group than that in McKeown group. Moreover, the levels of serum CYFRA21-1, CA125 and CEA evidently declined in both groups after treatment compared with those before treatment. The follow-up results revealed that the 3-year survival rate was 72.1% and 64.7%, respectively. The analysis results of postoperative 3-year quality of life manifested that no statistically significant difference was observed in each index in QLQ-C30 between the two groups, but the dysphagia and reflux scores in QLQ-EOS18 were remarkably superior in Ivor-Lewis group to those in McKeown group.*

Conclusions: *In the treatment of thoracic middle-lower segment esophageal cancer, minimally-invasive Ivor-Lewis surgery has shorter operation time, better life quality, and fewer postoperative complications (pulmonary infection, anastomotic fistula and anastomotic stenosis) than minimally-invasive McKeown surgery, while the treatment expenses are higher.*

Key words: *esophageal cancer, thoracoscope, laparoscope, Ivor-Lewis surgery, McKeown surgery*

Introduction

Esophageal cancer is one of the most common malignant tumors in China, and its morbidity rate is 21.62/100,000 (29.76/100,000 in males, 13.05/100,000 in females). There are more than 290,000 new cases of esophageal cancer every year in China, accounting for 53% of the total in the world [1-3]. Squamous carcinoma is dominated in the esophageal cancer in China, representing 95.6% of malignant esophageal tumors. Currently, surgical resection is still the preferred treatment of esophageal cancer. However, esophagectomy has great trauma, complicated operation and more perioperative complications. Despite continuous improvement of operation methods, the 5-year sur-

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vival rate of esophageal cancer patients is still not high (14-30%), and the perioperative mortality rate is 1-4% [4-6].

In recent years, thoracoscopic-laparoscopic esophagectomy has been widely applied in China and abroad, characterized by small trauma, quick recovery and few complications, mainly including total thoracic and laparoscopic Ivor-Lewis surgery and McKeown surgery [7,8]. McKeown surgery (through the right thorax - upper abdomen - neck) was adopted previously in the endoscopic esophagectomy, and then more minimally-invasive total endoscopic Ivor-Lewis surgery has been gradually applied with the development of instruments and improvement of skills [9,10]. Due to the different anastomotic positions in the two operations, the prognosis of patients has a certain difference. Which operation is safer and more effective remains controversial. In this paper, therefore, the clinical data of 136 patients with thoracic middle-lower segment esophageal cancer were retrospectively analyzed, and the efficacy and safety of thoracoscopic-laparoscopic Ivor-Lewis surgery and McKeown surgery in the treatment of thoracic middle-lower segment esophageal cancer were compared.

Methods

General data

The clinical data of 136 patients with thoracic middle-lower segment esophageal cancer admitted to our hospital were retrospectively analyzed. Inclusion criteria: 1) patients meeting the diagnostic criteria for esophageal cancer, and diagnosed with squamous cell carcinoma via esophagoscopic biopsy, 2) those without obvious tumor invasion into surrounding tissues and distant metastasis in preoperative imaging examination, 3) those with a Karnofsky performance scale (KPS) score ≥70 points, 4) those aged >18 years old, and 5) those who underwent the treatment for the first time. Exclusion criteria: 1) patients who needed an open operation due to dense thoracic or abdominal adhesion, 2) those accompanied by large-area serosal invasion (>10 cm) or a diameter of tumor >10 cm, lymph node metastases that fused and wrapped the important blood vessels, and/or

Table 1. Demographics and general clinical data of all studied patients

Indicators	*Lvor-Lewis group (n=68)* *n (%)*	*McKeown group (n=68)* *n (%)*	*p*
Gender (Male/Female)	49/19	44/24	0.461
Age (years)	56.64±10.38	58.12±10.09	0.401
Tumor location			0.482
Middle third	39 (57.4)	44 (64.7)	
Lower third	29 (42.6)	24 (35.3)	
Tumor differentiation grade			0.465
High	32 (47.1)	35 (51.5)	
Moderate	32 (47.1)	27 (39.7)	
Low	3 (4.4)	6 (8.9)	
Undifferentiated	1 (1.5)	0 (0)	
TNM stage			0.718
IA	6 (8.9)	5 (7.4)	
IB	15 (22.1)	12 (17.6)	
IIA	13 (19.1)	10 (14.7)	
IIB	9 (13.2)	11 (16.2)	
IIIA	18 (26.5)	22 (32.4)	
IIIB	4 (5.9)	6 (8.9)	
IIIC	3 (4.4)	2 (2.9)	
Vascular invasion	8 (11.8)	5 (7.4)	
ASA grade			0.660
II	48 (70.6)	45 (66.2)	
III	18 (26.5)	22 (32.4)	
IV	2 (2.9)	1 (1.5)	
Karnofsky Score			0.389
80-90	33 (48.5)	28 (41.2)	
70-80	35 (51.5)	40 (58.8)	

TNM: Tumor, lymph node, metastasis; ASA: American Society of Anesthesiologists.

extensive infiltration into such surrounding tissues as trachea, bronchus and aorta, 3) those complicated with malignant tumors of other sites, severe disease in the heart, lung, liver or kidney, or coagulation disorders, or 4) those who could not tolerate the surgery. According to different operation methods, the patients were divided into Ivor-Lewis group (n=68) and McKeown group (n=68). There were 93 males and 43 females, aged 34-75 years old with an average of 57.5 years old. The basic data (gender, age, tumor location, tumor differentiation, tumor stage, ASA grade and KPS score) had no statistically significant differences between the two groups ($p>0.05$), and they were comparable (Table 1). This study adhered to the *Declaration of Helsinki* and was approved by the Ethics Committee of Yantai Mountain Hospital. Signed written informed consent was obtained from all participants before the study.

Treatment methods

Ivor-Lewis surgery: After general anesthesia, the artificial pneumoperitoneum was established in a 15^0 dorsal elevated position. After laparoscopic exploration, the stomach was dissociated using an ultrasonic knife. The omentum at the greater curvature was dissociated along the hemal arch first, and then the omentum at the lesser curvature was also dissociated. After the left and right diaphragm angles were isolated, the esophageal hiatus was slightly expanded to 5 cm. The right gastric vessels were cut off at 5 cm above the pylorus, and most of the tubular stomach was made using the endoscopic cutting stapler (JNJ Echelon), with some gastric fundus tissues retained. The gastric stump was discontinuously embedded into the seromuscular layer using the absorbable suture under the endoscope. In some cases, endoscopic puncture was conducted for jejunostomy, and the jejunostomy tube was placed. Then the stomach was placed at the normal anatomical position, and the abdominal latex tube was routinely placed. Under a left semi-prone position or lateral position, whether there was pleural adhesion or metastasis was explored using the thoracoscope. The mediastinal pleura was cut open using coagulation hook through the esophagus bed, the esophagus was lifted up, and the arch of azygos vein was clamped and separated using the Hemo-Lock clamp. Then the upper esophagus was dissociated to 3-5 cm above the superior margin of the arch of azygos vein, and the lymph nodes below the protuberance, near the esophagus, in the lower pulmonary ligament, and near the trachea and left-right recurrent laryngeal nerves were dissected. The operating hole at the 4^{th} intercostal space was extended to 3.5 cm, from which the incision protective sleeve was placed. The tubular stomach was lifted from the expanded esophageal hiatus into the thoracic cavity, and sutured with the 3-0 non-invasive thread at 5-7 cm above the esophageal tumor. The esophagus was cut open at 2-3 cm below the suture, the anastomat head was placed, and the suture was tightened and knotted. The esophagus was cut off in a "split-level" way, and the mucosal layer was 5 mm longer than the muscular layer. The diseased esophagus, cardia and part of the tubular stomach were pulled out of the thoracic incision, and the diseased esophagus and cardia tissues were excised. The anastomat rod was placed from the stomach incision into the thoracic cavity via the main operating hole, followed by esophagogastric anastomosis. Later, the remaining tubular stomach was made using the endoscopic cutting stapler (JNJ Echelon), and the anastomotic stoma was embedded in the mediastinal pleura reserved. Finally, the gastric tube was placed under the thoracoscope, and the thoracic drainage tube was routinely indwelled.

McKeown surgery: The mediastinal pleura was cut open, the esophagus was lifted up, and the arch of azygos vein was clamped and separated using the Hemo-Lock clamp. The thoracic esophagus was dissociated along the surgical plane, and the lymph nodes below the protuberance, near the esophagus, in the lower pulmonary ligament, and near the trachea and left-right recurrent laryngeal nerves were dissected. Finally, whether the thoracic duct was injured was detected, and the thoracic drainage tube was routinely indwelled. Then in a horizontal position, whether there was abdominal adhesion or metastasis was explored using the laparoscope. The omentum at the greater curvature was isolated along the lateral hemal arch using the ultrasonic knife, and the gastrocolic ligament, left gastroepiploic artery, short gastric vessels and vessels around gastric cardia were cut off. The lesser omental bursa was cut open, the stomach was lifted to the upper left, and the left gastric vessels were exposed and "skeletonized". Subsequently, the left gastric vessels were clamped and separated using the Hemo-Lock clamp, and the lymph nodes near the common hepatic artery, splenic artery and left gastric vessels were dissected. Finally, the posterior gastric and fundus vessels were processed. Then the esophageal hiatus was cut open, and the stomach was dissociated. An incision was made at the anterior border of sternocleidomastoid muscle on the left neck, from which the cervical esophagus was dissociated and cut off. A 5 cm-long incision was made downward at the pulling hole, the esophagus and stomach were pulled out of the incision, and the tubular stomach was made using the linear cutting stapler (JNJ). The tubular stomach was lifted along the mediastinum to the left neck, followed by mechanical esophagogastric anastomosis. The gastrointestinal decompression tube and duodenal feeding tube were placed transnasally, and jejunostomy was performed in some cases. The drainage tube was routinely placed on the neck and abdomen.

Observation indexes

The operation time, intraoperative bleeding volume, number of lymph nodes dissected, indwelling time of thoracic drainage tube, time of first postoperative meal, postoperative length of stay and hospitalization expenses were compared between the two groups. The incidence of postoperative complications (pulmonary infection, incision infection, delayed gastric emptying, chylothorax, anastomotic fistula, anastomotic stenosis, recurrent laryngeal nerve injury and arrhythmia) was recorded in both groups. The levels of tumor markers cytokeratin 19 fragment antigen 21-1 (CYFRA21-1), carbohydrate antigen 125 (CA125) and carcinoembryonic antigen (CEA) were detected before and after operation.

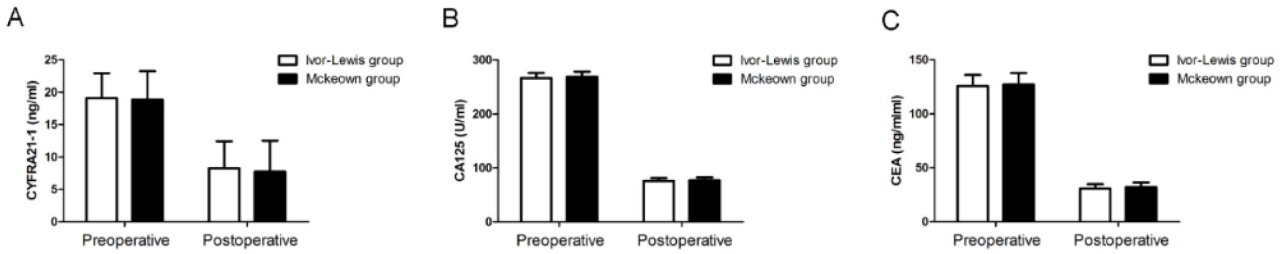

Figure 1. Comparison of serum CYFRA21- 1, CA125 and CEA levels between the two groups of patients. Preoperative CYFRA21- 1 (A), CA125 (B) and CEA (C) levels of patients had no significant differences between Ivor-Lewis group and McKeown group (p=0.735, p=0.105, p=0.410). Postoperative serum CYFRA21- 1 (A), CA125 (B) and CEA (C) levels of patients in both groups were significantly decreased after surgery (p<0.05). The differences in postoperative serum CYFRA21- 1 (A), CA125 (B) and CEA (C) levels of patients in Ivor-Lewis group and McKeown group had no statistical significance (p=0.559, p=0.178, p=0.093).

All patients were followed up by clinic and telephone till September 2019, and the survival condition was recorded. The patients with a survival time >3 years were enrolled into the questionnaire survey about the quality of life using EORTC QLQ-C30 and EORTC QLQ-OES18 [11,12]. The final results were converted into 0-100 points according to the scoring guideline of EORTC. Higher points of function corresponded to higher quality of life, and higher total points and higher points of symptom represented lower quality of life.

Statistics

SPSS 22.0 software (IBM, Armonk, NY, USA) was used for statistical analyses. Measurement data were expressed as mean ± standard deviation (x±s), and t-test was performed for intergroup comparison. Enumeration data were expressed as rate (%), and x^2 test was performed for intergroup comparison. The survival curves were plotted using the Kaplan-Meier method, and whether there was a statistically significant difference in the survival rate between the two groups was detected using log-rank test. p<0.05 suggested statistically significant difference.

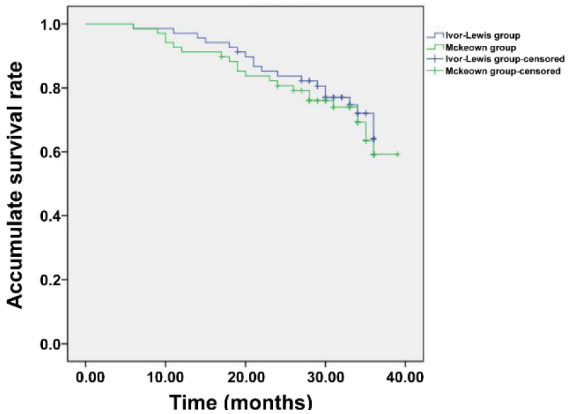

Figure 2. Kaplan-Meier survival curves of patients in Ivor-Lewis group and McKeown group. The differences in overall survival rate of patients in Ivor-Lewis group and Mckeown group had no statistical significance (p=0.472).

Results

Surgery-related conditions in both groups

The operation time was significantly shorter in Ivor-Lewis group than that in McKeown group [(288.9±30.4) min *vs.* (303.5±42.6) min] (p=0.023). In Ivor-Lewis group and McKeown group, the intraoperative bleeding volume was (163.3±72.7) mL and (150.6±80.8) mL, there were 3 cases and 1 case of perioperative blood transfusion, the number of lymph nodes dissection was (25.8±9.5) and (27.1±9.7), the time of postoperative drainage tube removal time was (5.7±2.9) d and (5.0±2.5) d, the time of first postoperative first eating time was (10.4±3.1) d and (11.7±5.3) d, and the postoperative in-hospital time was (13.9±5.5) d and (15.4±6.7) d, respectively, showing no statistically significant differences between the two groups (p=0.337, p=0.310, p=0.431, p=0.134, p=0.083, p=0.156). The hospitalization expenses were obviously higher in Ivor-Lewis group than those in McKeown group [(77,000±18,000) yuan *vs.* (68,000±20,000) yuan] (p=0.007) (Table 2).

Postoperative complications

In Ivor-Lewis group, there were 4 cases of incision infection, 5 cases of pulmonary infection, 2 cases of delayed gastric emptying, 1 case of anastomotic fistula, 1 case of recurrent laryngeal nerve injury, 5 cases of arrhythmia, and 1 case of respiratory failure. In McKeown group, there were 2 cases of incision infection, 11 cases of pulmonary infection, 4 cases of delayed gastric emptying, 1 case of chylothorax, 6 cases of anastomotic fistula, 5 cases of anastomotic stenosis, 4 cases of recurrent laryngeal nerve injury, 7 cases of arrhythmia, and 1 case of respiratory failure. It could be seen that the incidence rates of anastomotic fistula, anastomotic stenosis and pulmonary infection were lower in

Ivor-Lewis group than those in McKeown group (p<0.05). However, there were no statistically significant differences in the incidence rates of incision infection, arrhythmia, delayed gastric emptying, chylothorax and respiratory failure between the two groups (p>0.05) (Table 3).

Comparison of levels of tumor markers between the two groups

Before treatment, the level of serum CYFRA21-1 was (19.11±3.83) ng/mL and (18.87±4.40) ng/mL, the level of CA125 was (266.65±9.53) U/mL and (269.27±9.19) U/mL, and the level of CEA was (125.67±10.33) ng/mL and (127.17±10.81) ng/mL, respectively, in Ivor-Lewis group and McKeown group, displaying no statistically significant differences between the two groups (p=0.735, p=0.105, p=0.410). After treatment, the levels of serum CYFRA21-1, CA125 and CEA evidently declined to (8.24±4.21) ng/mL and (7.79±4.74) ng/mL, (75.82±5.59) U/mL and (77.08±5.25) U/mL, (30.83±4.04) ng/mL and (32.03±4.24) ng/mL, respectively, in the two groups compared with those before treatment, but they had no statistically significant differences between the two groups (p=0.559, p=0.178, p=0.093) (Figure 1).

Follow-up results of patients' survival

All patients were followed up for 6-36 months, with a median of 23.3 months and 23.8 months in the two groups. By the end of follow-up period, there were 19 and 24 cases of death, and the 3-year survival rate was 72.1% (49/68) and 64.7% (44/68), respectively, in Ivor-Lewis group and McKeown group. The Kaplan-Meier survival curves in both groups after operation are shown in Figure 2. The survival rate had no statistically significant difference between the two groups according to the log-rank test (p=0.472).

Comparison of quality of life

A total of 93 patients had a survival time >3 years and completed the questionnaire survey, including 49 cases in Ivor-Lewis group and 44 cases in McKeown group. The quality of life was analyzed using EORTC QLQ-C30 and EORTC QLQ-EOS18. No statistically significant difference was found in each index in QLQ-C30 between the two groups (p>0.05), but the dysphagia and reflux scores in QLQ-EOS18 were remarkably superior in Ivor-Lewis group to those in McKeown group (p=0.041, p=0.010) (Table 4).

Table 2. Comparison of parameters related to surgery between the two groups of patients

Indicators	*Lvor-Lewis group (n=68)*	*McKeown group (n=68)*	*p*
Operation time (min)	288.9±30.4	303.5±42.6	0.023
Intraoperative bleeding volume (ml)	163.3±72.7	150.6±80.8	0.337
Blood transfusion (cases, %)	3 (4.4)	1 (1.5)	0.310
Number of lymph node dissection	25.8±9.5	27.1±9.7	0.431
Postoperative drainage tube removal time (d)	5.7±2.9	5.0±2.5	0.134
Postoperative first eating time (d)	10.4±3.1	11.7±5.3	0.083
Postoperative in-hospital time (d)	13.9±5.5	15.4±6.7	0.156
Hospitalization expense (ten thousand yuan)	7.7±1.8	6.8±2.0	0.007

Table 3. Comparison of postoperative complications between the two groups of patients

Complications	*Lvor-Lewis group (n=68)* *n (%)*	*McKeown group (n=68)* *n (%)*	*p*
Incision infection	4 (5.9)	2 (2.9)	0.404
Pulmonary infection	5 (7.4)	11 (16.2)	0.043
Anastomotic fistula	1 (1.5)	6 (8.8)	0.042
Anastomotic stenosis	0 (0)	5 (7.4)	0.023
Delayed gastric emptying	2 (2.9)	4 (5.9)	0.172
Chylothorax	0 (0)	1 (1.5)	0.316
Arrhythmia	5 (7.4)	7 (10.3)	0.189
Recurrent laryngeal nerve injury	1 (1.5)	4 (5.9)	0.095
Respiratory failure	1 (1.5)	1 (1.5)	0.316

Table 4. Comparison of 3-year postoperative EORTC-QLQ-C30 and EORTC-QLQ-OES18 scale scores between the two groups of patients

Complications	*Lvor-Lewis group (n=68)* *n (%)*	*McKeown group (n=68)* *n (%)*	*p*
QLQ-C30			
Functioning scales			
Physical	82.62 (17.41)	80.28 (19.18)	0.443
Role	80.21 (19.59)	79.10 (20.08)	0.542
Emotional	78.73 (16.74)	76.96 (17.49)	0.433
Social	79.71 (17.65)	78.14 (15.90)	0.592
Cognitive	83.36 (19.05)	84.67 (18.55)	0.556
Symptom scales			
Appetite loss	17.73 (21.15)	20.52 (20.04)	0.225
Constipation	9.07 (12.89)	9.64 (13.35)	0.513
Dyspnea	9.34 (12.98)	9.90 (15.09)	0.604
Fatigue	30.35 (18.26)	32.24 (29.02)	0.434
Financial impact	13.58 (17.45)	15.63 (18.33)	0.511
Nausea and vomiting	15.88 (19.48)	14.03 (16.93)	0.680
Pain	24.39 (18.75)	22.83 (19.73)	0.479
Sleep disturbance	23.98 (20.95)	25.68 (19.53)	0.575
QLQ-OES18			
Dysphagia	12.74 (10.47)	17.80 (10.85)	0.041
Deglutition	10.46 (10.45)	12.52 (11.04)	0.459
Reflux	11.83 (13.31)	23.51 (15.65)	0.010
Swallowing of saliva	4.13 (9.75)	4.82 (10.05)	0.691
Pain	13.56 (14.25)	14.79 (12.91)	0.508
Dry mouth	5.15 (8.85)	6.23 (10.12)	0.547
Cough while eating	12.39 (13.75)	14.04 (12.92)	0.493
Trouble with taste	6.64 (10.97)	7.88 (11.48)	0.421
Trouble with speaking	6.16 (10.84)	8.03 (12.77)	0.480

EORTC: European Organization for Research and Treatment of Cancer.

Discussion

Compared with traditional open surgery, endoscopic esophagectomy is characterized by smaller trauma, fewer postoperative complications, postoperative pain relief, shorter length of stay and quick postoperative recovery, so it has been widely applied in mainstream medical centers in China and beyond. Endoscopic esophagectomy mainly includes Ivor-Lewis surgery through the abdomen and right thorax, and McKeown surgery through the right thorax, abdomen and neck. The major difference between them is that two incisions are made on the right thorax and abdomen, followed by anastomosis in the right thorax in Ivor-Lewis surgery, while three incisions are made on the neck, right thorax and abdomen, followed by anastomosis in the neck in McKeown surgery [13,14]. It is reported in the literature that after minimally-invasive Ivor-Lewis surgery, the incidence rate of postoperative complications is lower, and the quality of life of patients is higher than those after McKeown surgery [15,16].

In this study, the perioperative indexes were compared between the two groups. The results showed that the operation time was significantly shorter in Ivor-Lewis group than that in McKeown group. The incidence rate of anastomotic fistula, anastomotic stenosis and pulmonary infection was lower in Ivor-Lewis group than that in McKeown group, but the hospitalization expenses were obviously higher in Ivor-Lewis group than those in McKeown group, which may be related to the high costs of surgical consumables. In McKeown surgery, the neck incision is made, so the operation time will be prolonged, and the risk of lung complications will be increased [17]. In Ivor-Lewis surgery, the tubular stomach can be directly fixed on the esophagus bed, thus avoiding the space-occupying effect of thoracic stomach, and the thoracic cavity can be rinsed and disinfected under direct

vision after anastomosis. In McKeown surgery, the tubular stomach cannot be placed accurately when lifted through the thoracic cavity, the position of drainage tube placed in advance may be changed, thus reducing the postoperative drainage effect, and the increase in pleural effusion raises the risk of lung complications [18]. Anastomotic stenosis and recurrent laryngeal nerve injury are common complications after esophageal cancer surgery, and the occurrence of anastomotic fistula will delay the recovery and even endanger the life of patients [19]. In this study, the incidence rate of anastomotic stenosis and anastomotic fistula was higher in McKeown group than that in Ivor-Lewis group. The reason is that the tubular stomach is lifted up for a longer distance in McKeown surgery, thus increasing the tension of anastomosis. The anastomotic stoma lies in the narrow neck and is exposed to a positive pressure environment in McKeown surgery, so its blood supply is weakened. Meanwhile, the neck operation in McKeown surgery may accidentally injure the recurrent laryngeal nerves, and the recurrent laryngeal nerves are repeatedly pulled and excessively bared during lymph node dissection, thereby increasing the risk of heat injury caused by the ultrasound knife and destroying the nutritional supply. For the above reasons, the incidence rate of recurrent laryngeal nerve injury was higher in McKeown group than that in Ivor-Lewis group, consistent with the report results of Luketich et al [20].

According to the literature reports, the 5-year survival rate after surgery of malignant esophageal cancer is about 35-55% [21-23]. With the development of minimally invasive surgery, its survival rate has been slightly improved. In this study, the 3-year survival rate was 72.1% (49/68) and 64.7% (44/68), respectively, in the two groups, displaying no statistically significant difference (p=0.472). The postoperative quality of life was evaluated using EORTC QLQ-C30 and QLQ-EOS18. The questionnaire can reflect the multidimensional structure of postoperative quality of life, and has good reliability, validity, sensitivity and psychological characteristics according to clinical verification. In this study, the dysphagia and reflux scores were remarkably superior in Ivor-Lewis group to those in McKeown group (p=0.041, p=0.010). During regular postoperative follow-up, the anastomotic stoma needed to be expanded for more patients in McKeown group than Ivor-Lewis group. The above findings confirmed that the anastomosis patency was better and there were fewer reflux symptoms after thoracic anastomosis than those after cervical anastomosis.

There were certain limitations in this study. For example, the sample size was relatively small, the follow-up period was not long enough, and the follow-up content was not comprehensive enough. In the future, the conclusion in this study needs to be confirmed by multicenter large-sample prospective clinical studies.

Conclusions

In the treatment of thoracic middle-lower segment esophageal cancer, minimally-invasive Ivor-Lewis surgery has shorter operation time, better life quality, and fewer postoperative complications (pulmonary infection, anastomotic fistula and anastomotic stenosis) than minimally-invasive McKeown surgery, while the treatment expenses are higher.

Conflict of interests

The authors declare no conflict of interests.

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