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Comparison the Outcomes of Open Thoracotomy and Minimally Invasive Thoracoscopic Esophagectomy in Esophageal Cancer

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ABSTRACT

Introduction: Surgery is the first therapeutic option for esophageal cancer. There is controversy over the selection of the best surgical approach. Regarding this, the present study aimed to compare the minimally invasive and open esophagectomy in terms of their short-term outcomes and preoperative complications.

Materials & Methods: This randomized clinical trial was conducted on 61 patients in Ghaem Hospital, Mashhad, Iran, within 2011-2013. The patients were assigned into two groups based on the type of therapeutic approach they received. The minimally invasive esophagectomy (MIE) and open esophagectomy (OE) groups consisted of 31 and 30 patients, respectively. For the purpose of the study, we collected such data as age, gender, site of lesion, bleeding, duration of surgery, rate of switch to open approach, post-operative morbidity, duration of hospital stay, and mortality rate.

Results: According to the results of the study, 60.7% of the participants were male. The mean age of the patients was 62.39±11.91 years. There was no significant difference between the two groups regarding the site of lesion (P=0.014) and stage of tumor (P=0.108). No significant difference was observed between the MIE and OE groups in terms of the blood transfusion (P=0.981). Considering the complications, there was one case of fistula in the MIE group; furthermore, one and two cases of wound infection and pleural effusions were observed in the OE group, respectively. There were no significant differences between the two groups in terms of the post-operative complications, namely fistula, pleural effusions, and wound infection (P=0.492, P=0.238, and P=0.492, respectively). The MIE group had longer operation time (P≤0.001). There was one patient in the MIE group converted to open approach. The duration of hospitalization was significantly longer in the OE group, and there was no mortality.

Conclusion: As the findings of the present study demonstrated, the MIE outcomes were comparable with those of the OE with improved short-term outcomes.

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Introduction

Esophageal cancer is one of the rapidly increasing malignancies in the world. The incidence of this disease has grown by 50% in the past two decades (1), and turned it to the fifth most frequent cancer in the developing countries (2). Surgery is usually the first therapeutic option for the patients inflicted with esophageal cancer, which can be accompanied with or without chemotherapy and radiation. Despite the improvement in the surgical techniques, the 5-year survival rate is estimated as 15-25%. There is controversy over the selection of the best surgical approach (3).

Esophagectomy can be performed through open and minimally invasive approaches. The open surgery technique includes different types, such as transhiatal esophagectomy, transthoracic esophagectomy, and Ivor Lewis. Due to the disadvantages and complications of open esophagectomy (OE), the surgeons advocate the approach, which does not compromise the lymph node dissection and oncologic integrity and leads to less complications. The video-assisted esophagectomy provides a direct visual field for the mobilization of the esophagus and thoracic lymphadenectomy and results in improved postoperative quality of life (4).

On the other hand, the minimally invasive esophagectomy (MIE) reduces the wound complications and preoperative blood loss (5). This approach leads to lower postoperative pain and faster recovery, compared to the OE (6). In some studies, MIE was reported to result in improved outcomes and reduced morbidity (7, 3). With this background in mind, the present clinical trial aimed to compare the MIE and OE in terms of their short-term outcomes and preoperative complications.

Materials and Methods

This randomized clinical trial was conducted on 200 patients in Ghaem Hospital, Mashhad, Iran, within 2011-2013. The patients underwent a complete staging workup, including barium swallow test, endoscopic ultrasound, bronchoscopy, esophagoscopy, as well as computed tomography of the chest, abdomen, and pelvis. Based on the examinations, 61 patients were candidates for surgery. Based on the type of the study patients are randomized by a person out of the research group.

The inclusion criteria were middle and lower esophageal cancer, absence of unresectable tumor, and patient's tolerance for surgery. On the other hand, the exclusion criteria included: 1) cervical esophageal cancer or another malignancy, 2) severe nutritional disorders (Alb<3), 3) distant metastases, and 4) unwillingness to undergo the surgery. The participants were randomly divided into two groups of MIE (n=31) and OE (n=30). All the candidates for esophagectomy had resectable esophageal cancer or high-grade dysplasia with a lesion in the middle and lower esophagus. The informed consent was obtained from all these patients.

The data collected for each patient included age, gender, pathology, lesion site, operative time, intraoperative blood transfusion requirement, conversion rate, postoperative respiratory complications (diagnosed by signs and symptoms), chest X-ray and computed tomography scan, wound infection, total hospital stays, pre- and post-operative mortality, as well as tumor, node, and metastasis (TNM) staging. No chemo-radiotherapy was performed prior to the surgery, and all operations were performed by a unique thoracic surgeon. In both groups, the patients received similar preoperative evaluations. All the subjects received preoperative intravenous antibiotics (e.g., second-generation cephalosporin), a central venous pressure line, and an arterial line during the operation.

Operative techniques

A. Endoscopic technique

In the MIE group, the double-lumen tube was inserted under general anesthesia while the patient adopted the lateral decubitus position. The surgery was performed using four ports. The camera was placed in the eighth intercostals space at anterior superior iliac spine. Three instrument ports were made on five anterior and posterior auxiliary lines, and one port was placed at the eighth posterior intracostal space (the stapler was used via this port). After the mobilization of the esophagus, the total lymph node dissection was performed. Subsequently, the azygos vein was ligated and cut by means of a stapler. Following the dissection and after the achievement of homeostasis and allostasis, one chest tube was inserted, and the port incision was closed.

B. Open technique

In the OE group, this procedure was performed through standard transthoracic and transhiatal approaches, which were performed for the lower 1/3 lesion and middle 1/3 lesion, respectively.

C. Abdominal and neck approach (common in two groups)

The midline mini-laparotomy and gastrolysis were performed in supine position while preserving the right gastroepiploic and gastric

vessels. Proximal gastric resection was accomplished using a GIA stapler. Subsequently, the esophagus was dissected through a standard neck incision. The cuts in the neck and stomach were used as conduits, and the hand-sewn anastomosis was performed in the neck. In both techniques,the feeding jejunostomy used was utilized at the end of the surgery, and the patients were admitted to the Intensive Care Unit (ICU) following the extubation. They were transferred from the ICU to the general surgical ward the next day.

To regain early mobilization in the first day of the surgery, the patients were encouraged to move out of the bed. Enteral feeding was started on a day after surgery through a tube jejunostomy catheter. The patients were discharged when they could tolerate the normal diet and move. The TNM staging system was used to report the tumor stage after the analysis of pathology reports. Post-surgery, the patients were routinely followed-up 24 h, 1 week, 3 weeks, and monthly after getting discharged for six months. This study was approved in the Regional Ethics Committee of Mashhad University of Medical Sciences with the proposal code of 911313.

Statistical analysis

The data analysis was performed using the Mann Whitney U, Chi-square, and Fisher's exact tests as well as independent sample t-test through the SPSS version 19. P-value less than 0.05 was considered statistically significant.

Results

Out of the 61 patients who underwent esophagectomy, 31 (50.8%) and 30 (49.2%) cases were managed through the MIE and OE, respectively. The mean age of the patients was 62.39±11.91 years. Additionally, the mean ages of the patients in the MIE and OE groups were 64.94±12.09 and 59.77±11.33 years, respectively. According to the results, 60.7% of the participants were male. Furthermore, the males comprised 20 (64.5%) and 17 (56.7%) patients in the MIE and OE groups, respectively. There were no statistically significant differences between the two groups in terms of the age and gender (P=0.090 and P=0.53, respectively).

The pathology assessment revealed squamous cell carcinoma and adenocarcinoma in 46 (75.4%) and 15 (24.6%) patients, respectively. These conditions accounted for 25 (80.6%) and 6 (19.4%) subjects in the MIE group and 21 (70%) and 9 (30%) cases in the OE group, respectively. No statistical difference was observed between two groups in this regard (P=0.334). The sites of the lesions were in middle 1/3 and lower 1/3 parts of the esophagus in 36 (59%) and 25 (41%) patients, respectively.

In addition, 23 (74.2%) and 8 (25.8%) participants in the MIE group, 13 (43.3%) and 17 (56.7%) patients in the OE group had the middle 1/3 and lower 1/3 parts of the esophagus, respectively. No statistical significant difference was observed between the two groups regarding the site of lesion (P=0.014). The most common tumor stage was T3N1, which was observed in 23 (36.1%) patients. The pre- and post-operative outcomes of the MIE and OE are listed in Table 1.

There was no significant difference between the two groups in terms of the tumor staging

Table 1. Pre- and post-operative outcomes of minimally invasive and open esophagectomy

Variables	Minimally invasive esophagectomy	Open esophagectomy	P-value
Age	64.94±12.09	59.77 ± 11.33	0.090
Gender			
Male	20(32.8%)	17(27.9%)	0.53
Female	11(18.03%)	13(21.31%)	
Pathology			
Squamous cell carcinoma	25(80.6%)	21(70%)	0.334
Adenocarcinoma	6(19.4%)	9(30%)	
Site of lesion			
Middle 1/3	23(74.2%)	13(43.3%)	0.014
Lower 1/3	8(25.8%)	17(56.7)	
Stage			
T3N1	10(32.3)	12(40%)	
T2N0	10(32.3)	7(23.3)	
T3N0	6(19.4)	8(26.7)	0.108
T3N2	1(3.2%)	3(10%)	
T2N1	4(12.9)	0(0%)	
Operation time	170.68±9.57	150.47±57.53	0<0.001
Blood transfusion	0(0%)	1(3.3%)	0.981
Conversion to open esophagectomy	1		0.492
Operative complication			
Fistula	1(3.3%)	0(0%)	0.492
Pleural effusion	0(0%)	2(6.7%)	0.238
Wound infection	0	1(3.3%)	0.492
Inhospitalization	7.68±0.48	9.13±0.68	0<0.001
Mortality	0(0%)	0(0%)	-

(P=0.108). The median of surgery duration was 160.74±41.83 min. This variable was reported to be 170.68±9.57 and 150.47±57.53 months in the MIE and PE groups, respectively. There was a significant difference between the two groups regarding the median of surgery duration (P<0.001). The rate of blood transfusion in all operations was 3.3%, and there was no statistical significant difference between the two groups in this regard.

We only had one patient in the MIE group who was switched to undergo OE due to the severe tumor adhesion. Regarding the post-operative complications, there was 1 (1.6%) case of fistula in the MIE group (P=0.492). Additionally, the OE group entailed 1 (1.6%) case of wound infection and 2 (3.3%) cases of pleural effusion (P=0.492 and P=0.238, respectively). There was no significant difference between the two groups in terms of the post-operative complications. The mean duration of hospital stay was 8.39±0.94 days. This variable was reported as 7.68±0.48 and 9.13±0.68 days in the MIE and OE groups, respectively. There was a statistically significant difference between the two groups in this regard (P<0.001). There was no mortality in both groups, and the patients were followed-up for six months.

Discussion

Esophageal cancer is one of the most frequent tumors of gastrointestinal system, which is more prevalent in some special areas. The invasion rate and chance of macroscopic and microscopic metastasis in this disease differ according to the geographic region (8). In a study, Noble et al. compared the totally minimally invasive thoracolaparoscopic 2 stage esophagectomy (MIE-2) with open Ivor Lewis within January 2005-November 2010.

According to their results, the MIE-2 was found to be more efficient, compared to the other approach. In the mentioned study, there was a significant difference between the two groups in terms of the blood loss, which was lower in the MIE-2 group. However, in our study, no significant difference was observed between the two groups in this regard. Additionally, in the mentioned study, the patient hospitalization was not different between the groups; however, we found a significant difference between our study groups in terms of this variable, i.e., the OE group had a longer hospital stay, compared to the MIE group (9).

Biere et al. conducted a multicentre, open-label, randomized controlled trial between June 1, 2009 and March 31, 2011. They compared the outcomes of the open transthoracic with those of the minimally invasive transthoracic esophagectomy. Their results revealed that the patients, who underwent the MIE had better short-term outcomes in terms of the pulmonary infections, hospital stay, and quality of life than those undergoing the OE (10). Nevertheless, in the present study, we did not evaluate the quality of life. Furthermore, there was no significant difference between the two groups regarding the pulmonary infections.

In another study, Wang et al. investigated the short-term quality of life in the patients with esophageal cancer after subtotal esophagectomy through video-assisted thoracoscopic or open surgery within January 2007-February 2008 (11). They demonstrated the MIE group had improved quality of life during the six month follow-up after esophagectomy, compared to those undergoing the OE. Furthermore, their results indicated no significant difference between the groups regarding the mean of operation time. Nonetheless, in the present study, the surgery was longer in the MIE group, compared to that in the OP group.

Pham et al. compared the preoperative results of combined thoracoscopic-laparoscopic esophagectomy and open Ivor Lewis esophagectomy within 2005-2009. They concluded that despite having longer surgical time, thoracoscopic-laparoscopic esophagectomy reduced the intraoperative blood loss and wound complications (5). In a study, Mori et al. compared the short-term outcomes of non-transthoracic esophagectomy (NTTE) process merging the video-assisted cervical and robot-assisted transhiatal approaches for the upper and middle/lower mediastinum, respectively, with the conventional transthoracic surgery within November 2012-July 2014.

They demonstrated that NTTE prevented the pulmonary complications in the management of esophageal cancer promisingly better than the conventional transthoracic surgery. In the mentioned study, no variation was observed in the frequency of major postoperative complications between the groups. Additionally, the postoperative hospital stay was reported to be shorter in the NTTE group. The results of the mentioned study are in line with those of our study (12).

Safranek et al. reviewed the outcomes of the MIE (i.e., thoracoscopic–laparoscopic–cervical anastomosis), hybrid procedures (i.e., minimal invasive mobilization gastric thoracotomy), and OE (i.e., left thoracoabdominal, Ivor Lewis or transhiatal oesophagectomy) for oesophageal cancer. They showed that MIE lasted longer than the open surgery and required less epidural time, compared to the thorascoscopic hybrid. Despite the shorter duration of single-lung ventilation in the MIE, compared to Ivor Lewis and left thoracoabdominal, the respiratory complication rates and duration of hospital stay were similar. They concluded that MIE was technically feasible

and did not decrease the pulmonary complications or duration of stay (6). Nevertheless, in the present study, the hospital duration was significantly longer in the OE group.

In another study, Luketich et al. compared the modified McKeown minimally invasive approach (i.e., video thoracoscopic surgery, laparoscopy, neck anastomosis) with a modified Ivor Lewis approach (i.e., laparoscopy, video thoracoscopic surgery, chest anastomosis [MIE-chest]) during August 1, 1996-March 31, 2011. In the mentioned study, the MIE resulted in acceptable lymph node dissection, post-surgical outcomes, and mortality rate by means of either an MIE-neck or an MIE-chest approach. Furthermore, MIE Ivor Lewis was reported to be the preferred approach, which led to lower recurrent laryngeal nerve injury and a mortality rate of 0.9% (3).

In the Taipei Veterans General Hospital, Hsu et al. compared the clinical outcomes of open (i.e., transthoracic esophagectomy) and thoracoscopic esophagectomy in the patients with esophageal squamous cell carcinoma between 2008 and 2011. Their findings revealed that the thoracoscopic esophagectomy not only had some preoperative benefits, but also enjoyed less postoperative complications and shorter ICU stay. In the mentioned study, the thoracoscopic techniques and open procedures were reported to result in similar mid-term overall survival and 5-year disease-free survival (13). Our findings demonstrated no significant difference between the two groups in terms of the postoperative complications.

Pallazo et al. compared the patients' survival after MIE and open/hybrid esophagectomy among the patients with esophageal and gastroesophageal cancer between July 2008 and January 2013. They reported the MIE as an advanced course of action with respect to its general survival, pre-surgical mortality, and severity of post-operative complications (14). Additionally, Lazzarino et al. assessed the tendency of the MIE employment in England in the last 12 years (1996, 1997-2007, 2008) and compared their clinical outcomes with those of the OE. Their findings demonstrated that the use of minimal access surgery for esophageal resection in the patients with cancer is increasing exponentially.

In our study, the patients undergoing MIE showed similar outcomes in terms of the mortality and duration of stay, compared with those undergoing the conservative surgery. However, the length of stay was significantly shorter in the MIE group (15). Zingg et al. compared the MIE and OE (i.e., a synchronous combined abdominal and thoracic Ivor lewis) to show the clinical advantages of these approaches between 1997 and 2007. In the mentioned study, the MIE group had longer surgery duration and less blood loss than the OE group. Likewise, we found longer surgery duration in the MIE group; however, the blood loss was not different between the two groups (16).

Osug et al. performed a comparison of the open operation and video-assisted thoracoscopic surgery (VATS) for esophagectomy. In line with our findings, they reported equal blood loss and morbidity rate in the VATS and OE groups. However, the thoracic process was longer in the patients undergoing VATS. They concluded that VATS provided comparable results with those of the open radical oesophagectomy, with less surgical trauma (17). Schoppmann et al. performed a study comparing the patients who had undergone either MIE or OE. They observed statistically significant differences between the two groups regarding the surgical morbidity, transfusion rate, and rate of post-operative respiratory complications. Nevertheless, no statistical difference was revealed between our study groups in terms of these variables (18).

Nagpal et al. conducted a meta-analysis to utilize the minimally invasive surgery in the treatment of esophageal cancer and reported the MIE as a safe alternative for the open technique. They found no significant difference between these two approaches in terms of the 30-day mortality; however, the MIE group had lower blood loss, shorter hospital stay, as well as decreased overall morbidity and respiratory complications. There was no significant difference between the two groups in regarding other outcomes (19). Furthermore, our results demonstrated no statistical difference between the two groups in terms of the respiratory complications.

Conclusion

As the findings of the present study indicated, the MIE outcomes were comparable to those of the OE with short-term outcomes.

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Conflict of Interest

The authors of the present study declared no conflicts of interest.

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