

Minimally invasive esophagectomy for esophageal cancer – results of surgical therapy

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Abstract

Introduction: The indication for minimally invasive esophagectomy (MIE) in esophageal cancer has an increasing tendency.

Aim: To present our cohort of patients operated on between 2006 and 2012.

Material and methods: A single centre study of 106 consecutive esophagectomies performed for esophageal cancer by a minimally invasive approach in 79 patients was performed. Transhiatal laparoscopic esophagectomy (THLE) was performed in 66 patients, transthoracic esophagectomy (TTE) in 13 patients, with histological findings of squamous cell carcinoma in 28 and adenocarcinoma in 51 patients.

Results: The MIE was completed in 76 (96.2%) patients. In cases of TTE, the operation was converted to an open procedure in 3 cases. Operation time ranged from 225 to 370 min (average 256 min). The number of lymph nodes removed was 7–16 (11 on average). The postoperative course was without any complications in 54 (68.3%) patients. Respiratory complications were observed in 14 (17.7%) patients (9 following THLE, 5 following TTE). Other serious complications included acute myocardial infarction (1 patient) and necrosis of the gastroplasty (1 patient). Anastomotic dehiscence was observed in 8 patients, left recurrent laryngeal nerve paralysis in 8 patients, intra-abdominal abscesses in 2 patients, and pleural empyema in 1 case. The overall morbidity of patients operated on by MIE was 31.6%. Thirty-day mortality was 10.1%.

Conclusions: The MIE belongs to the therapeutic portfolio of surgical procedures performed for esophageal cancer. Successful performance requires erudition of the surgical team in both minimally invasive procedures as well as in classical surgical treatment of esophageal cancer; therefore centralization of patients is imperative.

Key words: esophageal cancer surgery, minimally invasive esophagectomy, esophageal cancer.

Introduction

Esophageal cancer is a serious malignant disease of the upper gastrointestinal tract. It is a tumor disease with poor prognosis; 5-year survival of patients after surgical treatment is approximately 15% [1]. The only curative treatment of esophageal cancer is radical surgical resection – esophagectomy. The operation remains associated with relatively high morbidity and mortality. The morbidity of the procedure ranges from

17.9% to 58%, with up to 6% mortality [2, 3]. A possible way to improve the immediate surgical results may be the use of minimally invasive techniques.

Aim

Our paper reports on the results of minimally invasive esophagectomy for esophageal cancer. The procedure was performed using either the transhiatal laparoscopic or transthoracic thoracoscopic approach.

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Material and methods

In the years 2006 to 2012, 106 esophagectomies for esophageal cancer were performed at the First Department of Surgery (Table I). The minimally invasive surgical technique was preferred, and this procedure was performed in 79 (100%) patients. Transhiatal laparoscopic esophagectomy was performed in 66 (83.5%) patients, transthoracic esophagectomy in 13 (16.5%) patients. In both types of operations, the resection phase was performed by minimally invasive technique; the reconstruction phase was performed classically from minilaparotomy and cervical incision. The operation was performed classically in 27 patients. In 4 patients, Orringer's modified operation from laparotomy was used. These patients had either prior operations on the stomach or the laparoscopic approach was contraindicated due to internal comorbidities. In 23 patients with large esophageal tumors with suspicion of spread to the respiratory tract, the procedure was primarily performed from a right-sided thoracotomy. In our set of patients operated on by a minimally invasive technique, there were 67 (84.8%) males and 12 (15.2%) females. The average age of the patients was 55.7 years. Histologically, 28 (35.4%) patients had squamous cell cancer and 51 (64.6%) patients had adenocarcinoma. In patients with stage T2,3 N0,1 without disease generalization, neoadjuvant chemoradiotherapy was indicated, which was completed by 68 (86%) patients. Neoadjuvant therapy consisted of concomitant radiotherapy in a total fractionated dose of 55 Gy and chemotherapy – a combination of 5-fluorouracil and cisplatin. Tran-

shiatal laparoscopic esophagectomy was indicated in patients with tumors located in the distal esophagus, where the oral tumor margin was endoscopically 30 cm from the incisors. Patients were operated on under endotracheal anesthesia in the supine position with abducted lower limbs. Surgery was performed from 5 incisions using 5 ports – four 10 mm ports and one 5 mm port. A 30-degree laparoscope was introduced through a port positioned 5 cm above the umbilicus. The surgeon used a 10 mm port located on the left side in the midaxillary line, using his right hand to manipulate a dissector with monopolar coagulation, harmonic scalpel and scissors. His left hand worked with an endoclinch in a 5 mm port located under the right ribcage 5 cm from the linea alba. Another 10 mm port was placed under the xiphoid process for the liver retractor to elevate the left liver lobe. The final 10 mm port was placed under the left ribcage in the anterior axillary line for the atraumatic Babcock. After dissection of the lesser omentum using the harmonic scalpel and separation of the diaphragmatic crura, the esophagus with tumor was carefully transhiatally separated from the mediastinal pleura and isolated from the mediastinum orally to the level of the azygos vein (Photo 1 A, B). After completion of the minimally invasive resection phase, the operation was converted. From a left-sided cervical approach, the esophagus was transected in the deep cervical space, which was then extirpated from a minilaparotomy. A partially resected tubulized stomach with preserved blood supply via the right gastroepiploic artery was used for the reconstruction of the upper portion of the gastrointestinal tract in all patients. The anastomosis of the gastroplasty to the cervical esophagus was constructed by single-layer continuous suture. A Holle pyloroplasty was always performed. Transthoracic esophagectomy was performed from a right-sided thoracoscopic approach with the patient in a prone position. Selective endotracheal intubation to the left bronchus with a collapsed right lung was used in all cases. Four 10 mm ports were used. The camera port was located in the posterior axillary line of the 5th intercostal space, the surgeon used ports in the scapular line and midaxillary line in the 7th intercostal space, and the final port was placed in the scapular line in the 3rd intercostal space. The surgeon manipulated a harmonic scalpel in his right hand and a dissector in his left. The assistant held the 30-degree thoracoscope and

Table I. Results of minimally invasive esophagectomy

Variable	Transhiatal esophagectomy	Thoracoscopic esophagectomy
Total	66	13
Neoadjuvant therapy	59	9
Number of patients without complications	47	7
Average number of removed lymph nodes	13	9
Complete response to neoadjuvant therapy (CR)	8	5

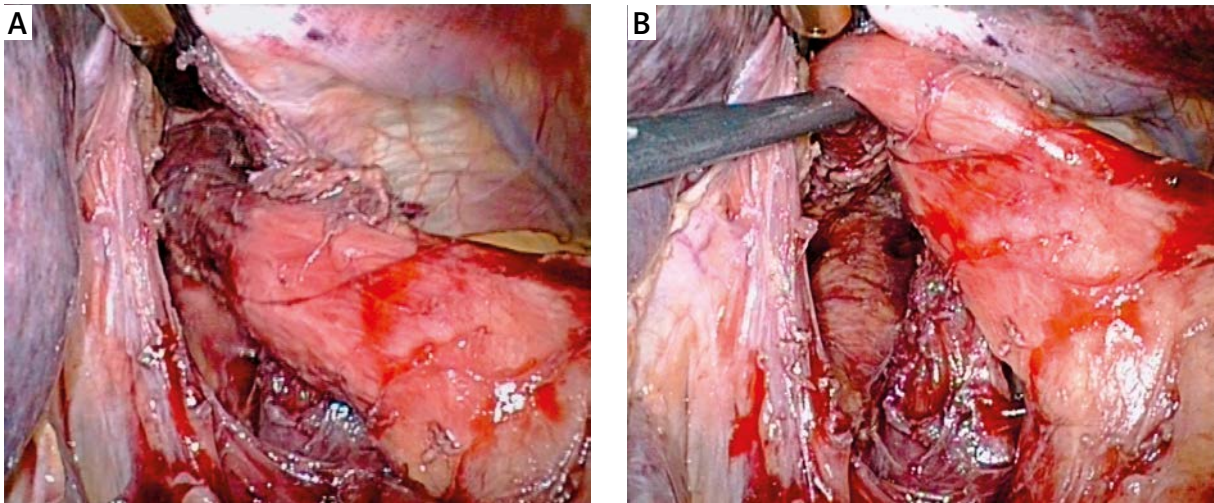


Figure 1 A, B. Transhiatal laparoscopic esophagectomy, mobilized esophagus with tumor in the mediastinum

a retractor for the collapsed lung. After dissection of the mediastinal pleura, the entire thoracic esophagus with tumor was removed (Photo 2 A, B) and the azygos vein was transected by a vascular endostapler. Once the minimally invasive esophageal resection was completed, chest drains were placed in the thoracic cavity. The patient was then repositioned to the supine position and the reconstruction phase ensued, which was identical to the reconstruction phase performed during transhiatal esophagectomy. In 1 case where the patient had already had a gastric resection due to ulcer, a coloplasty from the right bowel with blood supply via the colic artery was used for reconstruction of the gastrointestinal tract.

Results

The operation was completed by minimally invasive technique in 76 (96.2%) patients (Table II). The operation time ranged from 225 to 370 min; the average time was 256 min. The transhiatal laparoscopic phase was 51 min on average, and the thoracoscopic phase was 84 min. Perioperative blood loss did not exceed 350 ml; the average blood substitution volume was 300 ml TU. The number of lymph nodes removed ranged from 7 to 16, 11 nodes on average. In cases of transhiatal laparoscopic esophagectomy, the procedure was not converted in any of the patients. Due to the intimate proximity of the tumor and the mediastinal pleura, in order to perform the proce-

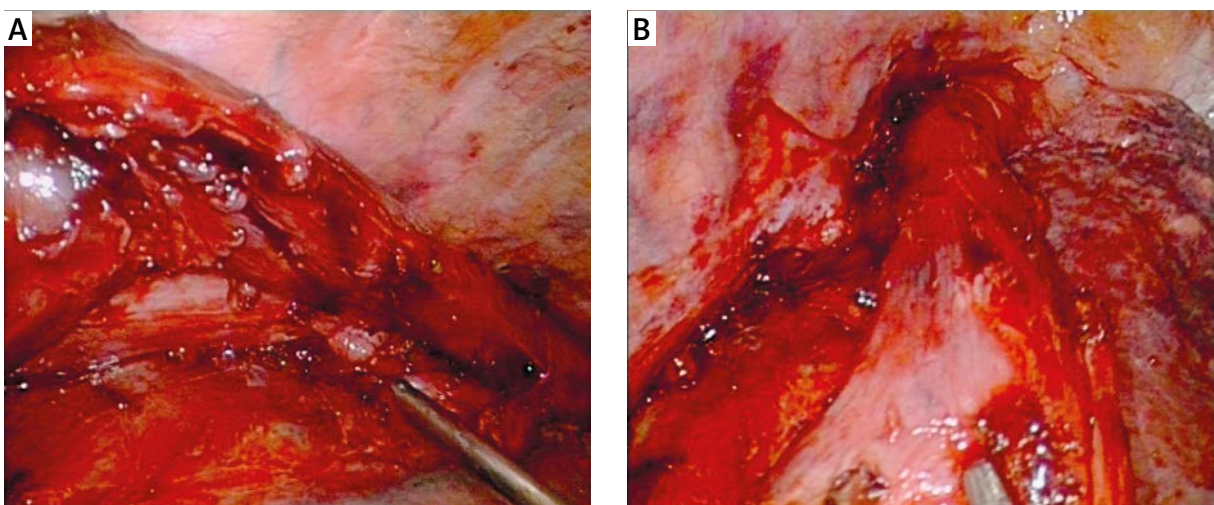


Figure 2 A, B. Transthoracic thoracoscopic esophagectomy, mobilized esophagus in the thoracic cavity

Table II. Minimally invasive esophagectomy for esophageal cancer – number of procedures and complications of surgical treatment

Variable	Transhiatal esophagectomy	Thoracoscopic esophagectomy
Total	66	13
Conversions	0	3
Opening of the pleural cavity	40	
Bleeding	1	
Respiratory complications	9	5
Cardiac complications	1	
Necrosis of the esophageal replacement	1	
Anastomosis dehiscence	5	3
Infectious complications	2	1
Paralysis of the recurrent laryngeal nerve	6	2

dures to the extent of an R0 resection, one or both of the pleural cavities were opened during transhiatal esophagectomy. The pleural cavity was opened in 40 (60.6%) patients. Open pleural cavities were treated by perioperative thoracic drainage. Bleeding complications were observed in 1 patient. The patient underwent surgical revision 4 h after primary laparoscopic esophagectomy due to hemodynamically significant bleeding in the mediastinum, which was treated from a right-sided thoracotomy. Transthoracic esophagectomy was completed by minimally invasive technique in 10 (77%) patients; in 3 (23%) patients the operation had to be converted due to injury to the left bronchus during tumor dissection. The injured bronchus was treated by suture. Postoperatively, 54 (68.3%) patients were without any complications. Standardly on the 7th postoperative day, a swallow with water-soluble contrast of the esophageal replacement was performed in all patients. If there were no signs of leak or other pathology, oral nutrition was introduced. Postoperatively, complications were observed in 25 (31.7%) patients. Respiratory complications dominated, which were seen in 14 (17.7%) patients: in 9 patients following transhiatal laparoscopic esophagectomy, and in 5 after transthoracic esophagectomy. Respiratory com-

plications were successfully managed conservatively in 8 cases. In 6 cases, patients developed acute respiratory distress syndrome and subsequently died. An extensive acute myocardial infarction on the 4th postoperative day was the cause of death in 1 patient. One patient gradually went into septic shock and revision surgery showed necrosis of the gastroplasty due to ischemia. The gastroplasty was extirpated and a cervical esophagotomy was performed. Nutrition of the patient was ensured by a nutritive jejunostomy. Subsequently, the patient died due to severe shock. The other observed complications were not as severe, and were successfully managed in all cases. Dehiscence of the cervical anastomosis was seen in 8 patients. In patients in good overall clinical condition with minimal dehiscence, treatment was conservative; in 4 patients the dehiscence gradually healed. In 3 patients, the dehiscence was treated surgically; drainage and toilette of the fistula was performed from a cervical approach. Paralysis of the left recurrent laryngeal nerve was observed in 8 of our patients. Infectious complications were reported in 3 patients; 2 patients had a subphrenic abscess after splenectomy and 1 patient had right-sided empyema. The subphrenic abscess was drained using a pigtail catheter under CT guidance; the empyema was treated by introduction of a chest drain. Early complications were observed in three patients; all had an abscess in the laparotomy. The overall morbidity of the patients operated on minimally invasively was 31.6%. Thirty-day mortality of our patient set was 10.1%. Based on TNM classification according to definitive histopathological examination of the resected esophagus with tumor, the following stages were represented in our patient set: stage I – 4 patients, stage IIA – 25 patients, stage IIB – 20 patients, stage III – 16 patients, stage IV – 1 patient. A complete response to oncological treatment with no histopathological tumor findings in the resected esophagus was seen in 13 patients (Table III).

Discussion

Minimally invasive surgical techniques are gradually being used in a greater spectrum of surgical procedures in the treatment of malignant diseases (stomach, colorectal cancer, lung tumors). Minimally invasive techniques are also gaining a place in esophageal cancer surgery [1]. Transthoracic dissection and esophagus mobilization was first described

Table III. Results of surgical therapy – esophagectomy for esophageal cancer by classical and minimally invasive techniques based on published studies

Authors	Classical esophagectomy	Minimally invasive esophagectomy	Respiratory complications [%]	Anastomosis dehiscence [%]	Morbidity [%]	Mortality [%]
Neoral, Aujesky, Vrba <i>et al.</i>		79	17.7	10.1	31.6	10.1
Decker <i>et al.</i> [9]		1932	22	8.8	46	2.9
Ott <i>et al.</i> [18]	240		44	7.9	7.9	3.8
Luketich <i>et al.</i> [6]		222	1.3	11.7	32	1.4
Dumont <i>et al.</i> [23]	182		53		37	9
Whooly <i>et al.</i> [22]	710		31.9	3.5		11

by Cuschieri in 1992 [4]. Minimally invasive transhiatal laparoscopic esophagectomy was first described by DePaula *et al.* in 1995 [5]. Current literature describes minimally invasive esophagectomy in various modifications and using varying techniques (laparoscopically combined with thoracotomy, thoracoscopically combined with laparotomy, video-assisted with minithoracotomy, laparoscopically with minilaparotomy) [6, 7]. In most cited works, a hybrid operation technique is described, which involves a combination of a minimally invasive approach together with an open procedure; rarely is a procedure described as being performed completely by minimally invasive technique [8, 9]. At the First Department of Surgery, which has a longstanding tradition in the surgical treatment of esophageal cancer, a combined surgical procedure is preferred. The resection phase of the operation is performed by a minimally invasive approach (transhiatal laparoscopic and transthoracic thoracoscopic). Reconstruction of the upper portion of the gastrointestinal tract is completed classically by an open procedure from a minilaparotomy and in most cases using a left-sided cervical approach. Minimally invasive transhiatal laparoscopic esophagectomy was first performed at our department in 2003, based on years of experience with minimally invasive operations of hiatal hernias [10]. Currently, minimally invasive transhiatal laparoscopic esophagectomy is the predominant surgical procedure at our department for all tumors of the distal esophagus and has practically replaced the previously indicated esophagectomy from laparotomy according to Orringer. The classical surgical approach is selected only when there is a contraindication for a laparoscopic proce-

dures or on an individual basis in patients with previous surgery in the area of the diaphragmatic hiatus and stomach. A laparoscopic transhiatal approach is indicated for tumors endoscopically located 30 cm from the incisors and distally. For more orally located tumors, the surgery is performed from a right-sided transthoracic approach. When the minimally invasive procedure first started being performed, this phase of the surgery took approximately 60 to 85 min; now, after years of experience, the average operation time of the minimally invasive phase is 37 min. In accordance with most authors, we consider the main benefits of a minimally invasively performed esophagectomy to be perfect visualization of the operative field with a reduction of injury to surrounding structures in the mediastinum, minimization of blood loss (Fabian reported 50% less blood loss during minimally invasive esophagectomy compared to a classical operation) and, from an oncological viewpoint, a flawless lymphadenectomy in the mediastinum [5, 11, 12]. Decker reviewed 29 studies regarding minimally invasive esophagectomies and reported 5–62 removed lymph nodes with a median of 14 nodes [9]. Based on the gradual erudition of our team, we were also able to reduce the duration of the minimally invasive phase of the surgery and thus reduce the overall operating time of the esophagectomy. In our patient set, the most frequent complication after transhiatal laparoscopic esophagectomy was opening one or both pleural cavities in cases where the tumor was in intimate contact with the mediastinal pleura or due to peritumorous inflammation following neoadjuvant oncological therapy. However, we do not consider the opening of the pleural cavity to be a complication as

such, but as a necessary consequence of a radically performed resection, preferably to the extent of a complete surgical resection (R0). In our set of patients, the opening of the pleural cavity did not consequently necessitate conversion in any of the patients. In the literature, conversions of minimally invasive operations are described in an extent ranging from 3% to 18% [8]. The most common reasons for conversion are bleeding and liver injuries [8]. After completion of the minimally invasive phase of the operation, a minilaparotomy ensues. In most cases, the esophagus is replaced by a gastroplasty with blood supply maintained by the right gastroepiploic artery. A coloplasty is used for the reconstruction only in cases where a gastroplasty is contraindicated for some reason (most often due to previous surgery on the stomach) [13]. For reconstruction of the gastrointestinal tract, we prefer a cervical anastomosis with the stump of the cervical esophagus, which we perform using a single-layer continuous suture. We favor this anastomosis to one in the thoracic cavity, because of the less serious complications in case of dehiscence; in patients with thoracic anastomosis, if dehiscence occurs, there is a risk that mediastinitis may develop along with severe sepsis [14]. A minimally invasive thoracoscopic esophagectomy is indicated in patients with tumors located in the middle and proximal esophagus. Based on prior experience, we currently prefer to perform the surgery from a right-sided thoracoscopic approach with the patient in a prone position [15]. We use this approach due to good visualization of the operative field by the surgeon, who operates in parallel to the view of the camera. Another benefit is localization of the collapsed lung and therefore an advantageous approach for mobilizing the esophagus with the tumor and performing a complete lymphadenectomy [16]. For the patients, a significant advantage of the minimally invasive approach is the avoidance of a painful thoracotomy and necessary costotomy. The most common reason for conversion of a minimally invasive procedure is pleural adhesions after past pneumonias [17]. A disadvantage of this approach is the absence of tactile perception of large tumors, where there is danger of injury to the left main bronchus and trachea. Based on our experience, if it is thoracoscopically apparent that there is intimate contact with the respiratory tract or the aorta, to prevent their injury, the procedure is converted and completed from a right-sided

thoracotomy. After completion of the thoracoscopic phase of the operation, the patient is repositioned to the supine position, and the esophagectomy is completed by performing the reconstruction phase identically to the transhiatal laparoscopic approach. Predominant complications, which have the greatest influence on patient mortality following esophagectomy, are respiratory complications, which are described in the range of 19–44% [18, 19]. In the literature, there is no unanimous opinion regarding their incidence when comparing minimally invasive and open procedures. Some works describe a lower incidence of respiratory complications; however, other works cite a similar incidence of respiratory complications in minimally invasive esophagectomies compared to classical procedures [9]. Results from our patient set describe a lower incidence of respiratory complications in patients following a minimally invasive transhiatal laparoscopic esophagectomy versus after a procedure from a classical thoracotomy [12]. Among the most severe surgical postoperative complications are necroses of the esophageal replacement, most often as a result of ischemia. It is most often observed in coloplasties (13.3%); in cases where a gastroplasty is used, necrosis is reported in 0.5% of patients [20, 21]. Whooley described necrosis of the esophageal replacement in 0.8% of cases in a set of 710 patients operated on for esophageal cancer [22]. In the literature, the rate of anastomosis dehiscence is reported from 2% to 14% [18, 23]. It is more commonly seen in cervical anastomoses than in anastomoses constructed in the thorax; however, dehiscence of a thoracic anastomosis has up to 60% mortality rates with development of mediastinitis and organ failure along with septic shock [14]. Other typical complications include paralysis of the left recurrent laryngeal nerve, which is described in various studies with an incidence ranging from 7% to 30% (Kato). Injury to the thoracic duct may gradually lead to the development of chylothorax; if conservative therapy fails, surgical revision is indicated with direct suture of the injured thoracic duct. All patients are at risk of developing typical infectious complications of the operative field, such as abscesses in the abdominal cavity, inflammatory pleural effusion, or even empyema. Therapy involves targeted drainage, usually under CT guidance. There is an unequivocal consensus among the authors cited that esophagectomies should be performed at specialized centers with vast experience in the surgical treatment of

esophageal cancer, and where the type of procedure is in accordance with the philosophy of the given workplace [1, 24]. Minimally invasive esophagectomy represents a fully acceptable surgical treatment of esophageal cancer. To attain good operative and postoperative results, it is imperative that the surgery be performed by an experienced minimally invasive surgeon.

Conclusions

Esophagectomy performed by minimally invasive technique belongs to the current surgical treatment options indicated for patients with esophageal cancer. The primary benefits from a minimally invasive approach are perfect visualization of the operating field, oncological radicality and a decrease in blood loss during the operation. To achieve the best perioperative and postoperative results, it is necessary to perform such operations in specialized centers (high volume centers) with personnel experienced in the treatment of esophageal cancer [24, 25]. From a surgical standpoint, long-term experience of the surgical team with minimally invasive surgical techniques, especially in the area of the gastroesophageal junction and experience with thoracoscopic surgery, is imperative [10, 26, 27]. It is necessary, of course, to have a perfect understanding of classical operation techniques for esophageal cancer with the possibility of conversion and completion by an open procedure.

Conflict of interest

The authors declare no conflict of interest.

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