

Open transthoracic or transhiatal esophagectomy versus minimally invasive esophagectomy in terms of morbidity, mortality and survival

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Abstract

Background: Surgical treatment of esophageal cancer is associated with a high rate of morbidity and mortality even in specialized centers. Minimally invasive surgery has been proposed to decrease these complications.

Methods: The authors present their results regarding postoperative complications and the survival rate at 3 years, comparing the classic open procedures (transthoracic or transhiatal esophagectomy) with minimally invasive surgery. Surgical procedures were performed according to procedures published elsewhere.

Results: The study enrolled 166 patients who underwent surgery between 1990 and 2003. Open transthoracic surgery was performed for 60 patients. In this group of patients, postoperative mortality was observed in 11% of the cases. Major, minor, and late complications were observed in 61.6% of the patients, and the 3-year survival rate was 30% for this group. Open transhiatal surgery was performed for 59 patients. The morbidity, mortality, and 3-year rate were almost the same as for the transthoracic surgery group. For the 47 patients submitted to minimally invasive procedures (thoracoscopic and laparoscopic), the complications and mortality rates were significantly reduced (38.2% and 6.4%, respectively). For the patients submitted to minimally invasive surgery, the 3-year survival rate was 45.4%. It is important to clarify that the patients submitted to minimally invasive surgery manifested early stages of the diseases, and that this the reason why the morbimortality and survival rates were better.

Conclusions: The transthoracic and transhiatal open approaches have similar early and late results. Minimally invasive surgery is an option for patients with esophageal carcinoma, with reported results similar to

those for open surgery. This approach is indicated mainly for selected patients with early stages of the disease.

Key words: Esophageal carcinoma — Esophagectomy — Laparoscopy — Minimally invasive surgery — Thoracoscopy

Open transthoracic esophagectomy (Ivor Lewis's or Akijama's procedure) is associated with significant morbidity (60–80%) and an operative mortality rate of 5% to 10% [9, 11, 12, 25]. To diminish these complications, transhiatal esophagectomy with cervical esophagogastric anastomosis (Orringer's procedure) has been suggested. The results from comparisons of the transthoracic and transhiatal approaches have been controversial. Some reports have argued that the transhiatal approach has a lower rate of pulmonary complications and lower mortality than the transthoracic approach, whereas other prospective reports have demonstrated similar postoperative results and similar 5-year survival rates. According to the reported results, the transthoracic approach has been more advisable for tumors located in the supracarinal esophagus, and transhiatal approach is the procedure of choice for tumors located at the distal esophagus [6, 12, 16, 19, 20].

More recently, video-assisted and thoracoscopic/laparoscopic procedures have offered an advantageous alternative because of less operative trauma than experienced with thoracotomy or manual blind or blunt transhiatal esophagectomy. Several reports have presented very promising results concerning surgical performance, early complications, postoperative mortality, and long-term follow-up results [7, 13, 14, 17, 18, 23].

In 1993, we presented our video-assisted transhiatal technique during the 4th World Congress of the International Gastrointestinal Club [1–3]. Others have presented the technique and the results for minimally

invasive esophagectomy. We also have published our method of transhiatal laparoscopic esophagectomy, gastric mobilization, and tubulization for esophageal replacement [3, 8, 21, 24].

This report aims to compare the morbidity, mortality, and survival rate for open transthoracic or transhiatal esophagectomy with those for the minimally invasive procedures.

Patients and methods

Over a 13-year period (1990–2003), we performed esophageal resection for carcinoma in 166 patients. All the patients were submitted to the preoperative protocol, which included upper endoscopy with biopsy, barium swallow, computed axial tomography (CAT) thoracic and abdominal scan, cardiopulmonary functional and nutritional test for general evaluation, and staging of esophageal carcinoma according to the tumor node metastasis (TNM) classification. Of the 166 study patients, 16 corresponded to stage I (9.6%), 22 to stage IIa (13.3%), 42 to stage IIb (25%), 54 to stage IIIa (32.5%), and 32 to stage IIIb (19.3%). Patients classified as stage IV were excluded from esophageal resection because endoscopic palliative treatment was indicated for them. This group comprised 98 men (60.1%) and 68 women (40.9%) with a mean age of 63.5 years (range, 37–82 years). Histologic analysis of the resected esophagus demonstrated squamous carcinoma in 96 patients (57.4%) and adenocarcinoma in 70 patients (42.6%). Supracarinal tumors were diagnosed in 67 patients (40.3%), whereas in 99 patients (59.7%), the tumor was located in the infracarinal esophagus. None of the patients received neoadjuvant chemo- or radiotherapy, but adjuvant chemoradiotherapy after surgery was indicated for patients with stage II or III disease.

The transthoracic approach was indicated for tumors located above the level of the tracheal bifurcation, and the transhiatal procedure was indicated for tumors located below this level. Patients with cardiac carcinoma were excluded from this prospective study. Patients with early stages of the diseases were treated using the minimally invasive procedure, and patients with more advanced stages were submitted to open surgery.

Open transthoracic surgery was performed for 60 patients (36.1%), and the open transhiatal procedure was used for 59 patients (35.5%). For 47 patients (22.3%), a minimally invasive surgical procedure was performed, either transthoracic video-assisted surgery or transhiatal laparoscopic esophagectomy and gastric mobilization.

Early postoperative complications (within 30 days after surgery), 30-day postoperative mortality, late complications (30 days after the operation), and the 3-year survival rate were studied. Major complications were considered if they required any medical or surgical intervention or prolonged recovery. Minor complications were considered as transitory and not requiring special medication or intervention. Pathologic staging after surgery was done according to the American Joint Cancer Commission (AJCC) system. Follow-up chest and abdominal CAT scan was performed at 6 months and 12 months. Statistical analysis was performed for comparisons between the open and mini-invasive surgery groups in terms of complications and mortality. A *p* value less than 0.05 was considered significant.

Surgical technique

Open transthoracic esophagectomy (group A)

Right posterolateral thoracotomy, the first step for esophageal resection, includes paraesophageal lymph nodes, thoracic duct, right pleura, and section of the azygos vein to reach the upper third of intramediastinal esophagus for resection of the paratracheal nodes. The operation is completed with a xifoumbilical midline incision to resect the celiac, paracardial, and lesser curvature nodes, and to accomplish gastric tubulization that ascends the tubulized stomach to the neck for the cervical esophago-gastric anastomosis according to the technique published elsewhere [9, 11, 20, 23].

Open transhiatal esophagectomy (group B)

This procedure starts with an xifoumbilical incision for abdominal paraesophageal, paracardial, and celiac node clearance as well as gastric tubulization. A complete Pinotti's maneuver is performed to open the diaphragmatic hiatus, proceeding to intramediastinal esophageal and lymph node resection above the inferior pulmonary vein. This procedure is followed by esophageal isolation and paraesophageal node dissection in a blind and blunt manner up to the upper mediastinum to complete the dissection of the upper third of the esophagus. Through a left lateral cervicotomy, the cervical esophagus is dissected and divided, completing the esophagectomy. The tubulized stomach is ascended up to the neck for the esophago-gastric anastomosis [5, 6, 19].

Minimally invasive esophagectomy (MIE) (group C)

We choose this procedure after a complete preoperative evaluation (e.g., CAT scan, endosonography) to ensure the resectability of the tumor. If the tumor is located in the supracarinal esophagus, we indicate video-assisted thoracoscopic isolation of the esophagus and lymph node resection. If the tumor is infracarinal, we perform transhiatal esophagectomy.

Thoracoscopic video-assisted esophagectomy (VATS)

A left-sided, double-lumen endotracheal intubation is inserted into the tracheobronchial tree, and the patient is placed in a left lateral decubitus position for a right VATS. The lung is deflated, and four ports are placed: one (10 mm) in the fifth intercostal space at the midaxillary line, one (10 mm) in the fourth anterior intercostal space, and two in the eighth intercostal space at the posterior axillary line for work below the scapular tip. The mediastinal pleura is opened immediately below the azygos vein, which is dissected and divided. Then the esophagus is dissected, followed by resection of the lymph nodes and paraesophageal fat *en bloc* with the specimen. Endoclips are used to avoid chylothorax or bleeding. Finally, a 28-Fr drain tube is placed in the basal hemithorax, and the port sites are closed.

Transhiatal laparoscopic esophagectomy and gastric mobilization

The patient is placed in the supine decubitus Grassi's position with the extended neck turned to the right and with both legs in abduction for a better location of the surgical team for the laparoscopic phase of the operation. The assistants are placed at both sides of the patient. Pneumoperitoneum is created, and five 10-mm trocars are placed: one 3 cm supraumbilically for the video-camera, one subxiphoidally for hepatic and gastric retraction and hiatal opening, one in the anterior right middle clavicular line, one in the left anteroaxillary line, and one in the left middle clavicular line as an access for work.

The gastric mobilization starts by opening of the gastrocolic omentum outside the right gastroepiploic artery, followed by dissection and hemostasis using the ultrasonic dissector or Ligasure. Dissection of the gastrocolic omentum is completed to the right, then ascends up to the short vessels. By turning the patient slightly to the right, a better visual range is obtained as well as dissection of the short vessels and gastric fundus. The phrenoesophageal membrane is dissected, with sectioning of the anterior vagus nerve and dissection of the left crus of the diaphragm and the left lateral wall of the esophagus. The stomach is tractioned to the right with the help of the hepatic retractor, and a grasper for the approach to the retroperitoneal vessels is used, thus making the trunk of the left gastric artery and vein visible.

The patient then is placed in the supine decubitus position, and a window is opened in the avascular membranous pars of the gastrohepatic omentum. By performing hemostasis simultaneously with the ultrasonic dissector and eventual placement of hemostatic clips, the esophagus and diaphragmatic hiatus are dissected, and the posterior vagus nerve is sectioned. Fat and lymphatic tissues that cover the celiac trunk are dissected and separated. Hemostasis for both the left gastric

Table 1. Postoperative morbidity after esophagectomy ($n = 166$)

Early complications	TT ($n = 60$) n (%)	TH ($n = 59$) n (%)	MIE ($n = 47$) n (%)	p Value TT + TH vs MIE
Pneumonia	12 (20)	10 (17.3)	7 (14.8)	NS.
Pleural effusion (minor) ^a	5 (8.3)	8 (13.5)	2 (4.3)	
Anastomotic leakage symptomatic	10 (16.6)	7 (11.8)	3 (6.4)	NS.
Asymptomatic ^a	3 (5)	6 (10.1)	1 (2.1)	
Recurrent nerve injury	2 (3.3)			
Pulmonary embolism	1 (1.6)			
Gastric volvulus		1 (1.7)		
Gastric dilation (transitory ^a)			1 (2.7)	
Cardiac failure	1 (1.6%)	1 (1.7)		
Total	34 (56.6)	33 (55.9)	14 (29.7)	0.004
Late complications				
Chylotorax			1 (12.5)	
Anastomotic stricture		2	2	
Chronic Diarrhea	3		1	
Total	37 (61.6)	35 (59.3)	18 (38.2)	0.015

TT, transthoracic; TH, transhiatal; MIE, minimally invasive esophagectomy

^a Minor complications

vein and artery is performed with three proximal clips and two clips distal from their origin. Section of these elements then is completed. If available, a vascular endosuture also can be used. Afterward, with the stomach already mobilized, laparoscopic dissection of the esophagus starts through the transhiatal route by opening and raising of the hiatus with the liver retractor (a “mini” Pinotti’s maneuver performed only if necessary), or by sectioning of a diaphragmatic crus. For our patients, none of these maneuvers was necessary.

Next, the esophagus is dissected from the inferior mediastinum. Hemostasis is performed simultaneously using the ultrasonic dissector and electrocautery with hook or clips. The surgeon reaches as high as possible, always surpassing the tumor level with the help of small sponges and gauze to separate the areolar paraesophageal tissue, which is easy to dissect. For the performance of gastric tubulization through a minilaparotomy of 5 cm, the stomach and esophagus, previously isolated, are exteriorized, and the gastric tube is prepared by applying two loads of mechanical suture (GIA 80). The esophagus, the gastroesophageal junction, the pericardial lymph nodes, the upper segment of the lesser curvature of the stomach, and the celiac trunk are resected *en bloc*. Then an invaginating running suture of Monocril (Ethicon, Cincinnati, Ohio, USA) is placed to reinforce the stapler-line suture and to prevent possible postoperative leaks into the mediastinum. A left lateral cervicotomy is performed in front of the anterior edge of the sternocleidomastoid muscle for the approach of the cervical esophagus. Then the dissection of the cervical and upper mediastinal esophagus is performed for communication with the thoracic dissection and for completion of upper esophagus resection.

The gastric ascensus is completed either through the posterior mediastinum or through a retrosternal tunnel prepared to ascend the stomach to the neck and to carry out the esophagogastric anastomosis at the cervical level in a manual fashion with 3/0 interrupted absorbable suture.

Results

An open thoracotomy with resection of the esophagus was performed for 60 patients. Of these patients, 34 (56.6%) presented with various early complications, the most common of which was severe pneumonia or atelectasis. Minor pleural effusion was seen in five patients. Seven patients died (11.6%) of severe respiratory or cardiac complications. Anastomotic symptomatic leakage was seen in 10 patients, who needed local drainage or repeated lavages. These patients prolonged their recovery for 7 or 12 days. Later, three of these patients

Table 2. Comparison of complications and mortality between open and minimally invasive procedures

	Open surgery ($n = 119$) n (%)	Minimally invasive surgery ($n = 47$) n (%)	p Value
Major complications	45 (37.8)	10 (21.3)	0.06
Minor complications	22 (18.4)	4 (8.5)	0.18
Late complications	5 (4.2)	4 (8.5)	0.47
Total	72 (60.5)	18 (38.2)	0.015
Mortality	13 (10.9)	3 (6.3%)	0.54

needed one or two endoscopic ambulatory dilations after their discharge due to partial stricture of the anastomosis. Another three patients presented with minimal leaks at the barium swallow without local or clinical manifestation.

For 59 patients, the treatment was a transhiatal classic open esophagectomy. In this group, 35 patients (59.3%) presented with almost the same complications with similar frequency. Most of these ($n = 13$) were minor complications, but two patients did present later with anastomotic strictures. Six patients (10.1%), died during the postoperative period. A total of 47 patients underwent minimally invasive procedures. No intraoperative mortality occurred in this group, and there was no conversion to open surgery. Postoperative mortality claimed 3 patients (6.4%), and an overall morbidity was observed in 18 patients (45.5%). Again, respiratory complications were the most common (Table 1).

In Table 2, we separate the occurrence of major or minor complications and late postoperative complications, comparing open and minimally invasive surgery. A total of 45 patients (45/119) who underwent open surgery presented with major complications (37.8%), whereas minor complications occurred in 22 patients (18.4%), especially transitory pleural effusions and minor radiologic leaks without clinical repercussions. Late complications were seen in five patients. Fewer major complications and a lower mortality rate were

Table 3. Comparison of morbidity, mortality, and 3-year survival rate between open and minimally invasive techniques

Technique	n	Morbidity		Mortality		3-year survival		
		n	%	n	%	n	%	
a	Open surgery							
	Transthoracic	60	37	61.6	7	11.6	16	30
b	Transhiatal	59	35	59.3	6	10.1	18	33.9
	Total open surgery	119	72	60.5	13	10.9	54	32.5
c	Minimally invasive surgery	47	18	38.2	3	6.4	20	45.5
	p Value a + b vs c			0.015		0.5		
	Odds ratio: 2.3							

Table 4. Comparison of 3-year survival rates between open and minimally invasive procedures

Stage	n	Open n (%)	Survival n (%)	MIE n (%)	Survival n (%)	Total % n (%)
I	16	—	—	16	15 (93.8)	15 (93.8)
IIa	22	128 (66)	104 (40)	12 (54.5)		
IIb	42	27	13 (48.1)	151 (6.6)		14 (33.3)
IIIa	54	48	12 (25)	6	—	12 (22.2)
IIIb	32	32	1 (3.1)	—	—	1 (3.1)
Total	166	119	34 (28.5)	47	20 (42.5)	54 (32.5)

observed in patients who underwent minimally invasive surgery ($p = 0.015$).

The patients were divided into two groups according to the performed surgery for analysis of morbimortality and survival. The first group consisted of 119 patients (groups A and B) who underwent open classic transthoracic and transhiatal esophagectomy. The second group comprised 47 patients who had minimally invasive surgery. Morbidity and mortality were significantly reduced for the patients who had the minimally invasive approach. There were 72 complications (60.5%) among the patients submitted to open procedures, as compared with 18 complications (38.2%) in the minimally invasive group. This significant difference ($p = 0.015$) had an odds ratio of 2.3 (Table 3).

Survival also was compared, but no difference between the open groups was observed. The 3-year survival rate for the different stages was studied. Patients with stage I or II disease were selected for minimally invasive surgery. Survival was 93.8% for stage I and 54% for stage IIa, without any difference between the open and minimally invasive procedures. At the time of this report, 15 patients with stage I disease were alive. However one patient presented with a second mediastinal tumor and was submitted to chemoradiation. For the patients with stage IIb disease, the survival rate was 33.3%, and there was a significant difference between open (48.8%) and minimally invasive (6.6%) surgery. We did not perform minimally invasive esophagectomy for more advanced stages because of the risk for incomplete resection of metastatic lymph nodes with these patients. The complete survival rates were 28.4% for the patients submitted to open surgery and 42.5% for the patients submitted to the minimally invasive approach. However, in this group, only patients with early stages of the neoplastic disease were included. The total survival rate was 32.5% during the 3-year follow-up period (Table 4).

Discussion

The two most frequently performed operations for esophageal cancer are transthoracic and blunt transhiatal esophagectomy. Both operations require large thoracotomy or xifoumbical midline surgery and cervical incision for esophagogastric anastomosis. According to the more recent reports, there are no significant morbimortality or survival rate differences between classic transhiatal and open transthoracic esophagectomy. Although the transthoracic technique is associated with a higher rate of respiratory complications, bleeding, chylothorax, and operative mortality, the transhiatal technique presents a higher risk for vocal chord paralysis and anastomotic leakage.

Classic transhiatal esophagectomy with intrathoracic gastric placement together with cervical anastomosis is theoretically a procedure with less surgical trauma and fewer respiratory complications than the open transthoracic approach because it avoids invasive thoracotomy and decreases the risk of mediastinitis caused by anastomotic leakage. For these reasons, this procedure has been used over the past 20 years as the procedure of choice for patients with infracardiac cancer of the esophagus as either curative or palliative surgery [6, 25].

Some authors have criticized this technique as a blind procedure for dissecting the middle third of the esophagus with an increased risk of damage to the nearby structures and inadequate lymph node dissection at this level. They advise that it is not an oncologic procedure, as compared with the open transthoracic approach. Comparisons of the results for the two procedures are controversial.

According to the recent report of Hulscher et al. [12], which confirmed previous studies, transhiatal resection was associated with a shorter median duration of surgery (3.5 vs 6 h for transthoracic resection; $p < 0.001$),

lower blood loss (1000 vs 1900 lts; $p < 0.001$), fewer respiratory complications, less chylous leakage, shorter duration of mechanical ventilation, shorter intensive care unit and hospital stay, and lower mortality. However other recent reports comparing transthoracic and transhiatal esophagectomy show no difference in morbimortality or postoperative survival rates. Rindani et al. [20] reported no apparent difference in postoperative morbidity between the two procedures in terms of respiratory complications (24% vs 25%), cardiovascular complications (12.4% vs 10.5%), wound infection (8.8% vs 6.2%) or chylothorax (2.1% vs 3.4%). The transhiatal group presented a higher incidence of anastomotic leakage (16% vs 10%), anastomotic strictures (28% vs 16%) and recurrent laryngeal nerve damage (11.2% vs 4.8%), but the postoperative mortality was 6.3% after the transhiatal operation, as compared with 9.5% after the transthoracic approach. The overall 5-year survival rate was similar for the two groups (24% and 26%, respectively). Other authors also have found minimal differences between the two groups of patients [9, 16, 25].

The minimally invasive procedures for esophagectomy and esophageal replacement have been suggested to decrease operative trauma and complications secondary to the large incisions and pain. These procedures have been associated with earlier and better return to normal respiratory function and ambulation, without detriment to the 5-year survival rate. Endoscopic dissection was first reported in Germany by Bumm et al [4], who used a special mediastinoscope for the transhiatal approach. Yahata et al. [26] do not consider this procedure appropriate for advanced tumors because of the limited operative field.

Thoracoscopic and laparoscopic esophagectomy offers better visual control, with better definition and accuracy for the mediastinal dissection. It avoids major complications such as tracheal damage, recurrent nerve damage, chylothorax, mediastinal bleeding, great vessel damage, and tumor rupture during dissection. This approach is not associated with severe hemodynamic changes secondary to cardiac compression during blind dissection, and therefore offers a decrease in operative trauma [6]. The transhiatal video-assisted esophagectomy that we have used since 1992 is similar to the technique described by Italian and Japanese surgeons (Sanmartino reported 11 cases from 1993 to 1997, and Yahata reported 6 cases from 1992 to 1995) [22, 26]. We emphasize that by using the same approach, we obtain a better view of the operative field for the inferior mediastinum, avoid a blind dissection, and decrease the risk for intraoperative and postoperative complications, especially blood loss. Moreover, with this approach, it is possible to resect visible paraesophageal lymph nodes for postoperative staging [18, 21, 22, 26].

De Paula, Swanstrom, [2, 24] and others have published their results after minimally invasive techniques for esophagectomy and gastric mobilization. They report low rates for complications and postoperative mortality, but in some cases, the operative time is very long [8, 13–16, 24]. Nguyen et al. [17] reported a mortality rate of 4.3% and 17.4% for major complications,

including two patients who died intraoperatively. Other authors have reported mortality rates ranging from 0% to 13.6% after the thoracoscopic approach. The largest series of total minimally invasive esophagectomy was reported by Luketich et al. [14], who described a 27% rate for major complications and a 55% rate for minor complications. The mortality rate for total minimally invasive esophagectomy reported by very specialized groups is surprisingly 0%. However, the number of patients undergoing this procedure are few, and these probably are selected patients [17].

For us, minimally invasive techniques represent the first choice for early stage tumors, for distal carcinomas, and for patients with diminished cardiopulmonary function. With an adequate use of adjuvant therapy, it is possible to achieve the same results as with open techniques. Our results in terms of morbimortality and survival rates are similar to those reported by authors who suggest the transthoracic or transhiatal open classic techniques. In the past decade, these rates were 2.5% to 15% for mortality, 40% for major complication, and 60% for minor complications [9–12, 16, 19].

The survival rate after minimally invasive esophagectomy is similar to that for patients who underwent surgery by the open approach. However, we have indicated this type of surgery only for early stages of the disease to avoid intraoperative or postoperative complications as well as incomplete lymph nodal resection. We think that for patients with advanced disease, it is better to offer an open technique to ensure a very complete resection of regional lymph nodes and an R0 curative operation. Hagen et al. [10] reported better survival rates after *en bloc* resection for early and advanced lesions. Currently, this is a very controversial issue.

All these aforementioned techniques still have not been evaluated in large comparative trials, and the available reports are limited in showing the surgical technique and perioperative results. A longer evaluation of the survival rates is needed.

We conclude that the minimally invasive procedures are feasible and reliable for esophageal and lymph node dissection under direct view control. The intraoperative complications are minimal, and the postoperative complications are less than with the blind technique. The anastomotic leakage at the cervical level is not dependent on the approach used. For us, this does not represent a severe complication because it often is autolimited. Currently, the mortality rate depends rather on respiratory complication or concomitant comorbidities. Until recently, the most important factor for esophageal carcinoma prognosis was the possibility of early diagnosis.

No prospective randomized reports have compared long-term results between classical and minimally invasive techniques. It seems that the latter technique offers surgical advantages without affecting the survival rate.

The surgical approach must be chosen according to preoperative staging, and the minimally invasive procedure can be as safe as open surgery when it is adequately indicated and performed in centers with large experience in esophageal surgery and by surgeons trained in advanced thoracoscopic or laparoscopic surgery.

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