

# Laparoscopic Transhiatal Esophagectomy at a Low-Volume Center

Brian J. Santin, MD, Phillip Price, MD

## ABSTRACT

**Background and Objectives:** Surgical treatment of esophageal cancer is associated with a high rate of morbidity, even in specialized centers. Minimally invasive esophageal resection has become increasingly feasible and is gaining popularity in some high-volume institutions. This study assesses the short-term outcomes of laparoscopic transhiatal esophagectomy performed by a single surgeon at a single low-volume institution over a 20-month period.

**Methods:** Over the study period, 16 patients underwent laparoscopic transhiatal esophagectomy. All patients were men with an average age of 70 years (range, 50 to 81).

**Results:** Two patients required intraoperative conversion to alternative surgical techniques, 1 to an Ivor-Lewis esophagectomy and 1 to an open transhiatal approach. Average operative time was 198 minutes (range, 147 to 303). Mean hospital stay was 16.7 days (range, 9 to 30). The average number of resected lymph nodes was 11.7, and 2 patients had benign pathology. No deaths occurred in the 30-day postoperative period.

**Conclusion:** Laparoscopic transhiatal esophagectomy is an advanced laparoscopic procedure that can be performed with equivalent morbidity and mortality by a low-volume surgeon in a low-volume center with results comparable to those of high-volume centers. While several authors have demonstrated a correlation between lower mortality rates and high-volume esophagectomy hospitals, our results support surgeon experience as more important than the absolute number of procedures performed each year.

**Key Words:** Laparoscopic transhiatal esophagectomy, Lymph nodes, Intraoperative conversion.

Mount Carmel Health System, Columbus, Ohio, USA (all authors).

We acknowledge the statistical assistance of Dave McCready, MAS.

Address correspondence to: Brian J. Santin, MD, Department of Surgery, Mount Carmel Medical Center, 793 West State Street, Columbus, Ohio 43222, USA. Telephone: (614) 234-5000, Fax: (614) 234-2772, E-mail: briansantin@gmail.com

DOI: 10.4293/108680811X13022985131138

© 2011 by JSLS, *Journal of the Society of Laparoendoscopic Surgeons*. Published by the Society of Laparoendoscopic Surgeons, Inc.

## INTRODUCTION

Ever since Franz Torek successfully performed the first esophagectomy in 1913, esophagectomy has been a daunting task associated with substantial morbidity and mortality.<sup>1</sup> Surgeons have long debated the optimal technique as well as physical location (volume-based reports) for such an operation to be performed safely.<sup>2-6</sup> With advancing technology, the role of a minimally invasive approach to this complex procedure has continued to evolve.<sup>7-9</sup> Based on the principal of achieving an equally successful oncologic resection and pathologic staging, minimally invasive esophagectomies (MIEs) have been believed to be associated with at least an equal and sometimes a lower morbidity rate than the more conventional open approaches.<sup>10-13</sup> In 2007, Gemmill and McCulloch<sup>14</sup> conducted the largest review of MIEs in the medical literature. This group concluded that while the operation may be associated with lower mortality, fewer respiratory complications, less blood loss, and shorter lengths of hospital stay, more studies would be needed to help shed light on the full realm of possible morbidities and mortalities related to the less-invasive approach.

Much of the current literature has focused on the overall number of esophageal resections performed each year, leading to the belief that higher volume centers have better success.<sup>3-6</sup> In 2005, Dimick et al<sup>6</sup> demonstrated a trend toward reduction in esophagectomy related mortality with increased hospital volume. In this study, they examined in-house mortality rates between low ( $\leq 7$  esophagectomies/year) and high volume ( $> 7$  esophagectomies/year) institutions. The results showed mortality rates as high as 15.3% for low-volume centers and 7.5% for high-volume hospitals. Thus, Dimick et al<sup>6</sup> concluded that the greater the number of esophagectomies a hospital performed each year, the lower their mortality rate. Similarly a meta-analysis<sup>5</sup> in 2004 focused on hospital volume and mortality rates from esophagectomy. Low-volume centers were defined as having performed 2 to 10 esophagectomies per year, and medium- and high-volume centers performed 11 to 20 and  $> 20$  per year, respectively. The authors concluded that significantly higher rates of mortality were demonstrated in low-volume hospitals (median 18% mortality rate) compared to high-volume

centers (median 4.9% mortality rate). As we have reported previously, this conclusion may not paint the whole picture or account for the multitude of factors that play a role in postoperative outcomes.<sup>15</sup> In this report, we present our current retrospective cohort series of MIEs to investigate whether volume status is a predictor for successful outcomes in a low-volume institution.

## MATERIALS AND METHODS

We queried the surgeon's operative case log to identify patients who had undergone MIE. Data were queried using ChartMaxx (MedPlus Inc., Mason, OH) and then analyzed using Microsoft Excel (Microsoft Corp, Redmond, WA). Data were collected for an approximate 20-month period beginning December 23, 2006 (when the surgeon first began performing this operation) and ending September 15, 2008. We chose the time frame to obtain an inclusive operative experience of a single surgeon in a community-based, tertiary care teaching hospital. The surgeon has not completed any advanced training for this operation. Patients were selected for this review if they had undergone a complete MIE or attempted MIE that was converted to an open procedure during the specified time period. The surgeon did not perform an esophagectomy using any technique other than those included in this study during this time period. Of note, there were no other esophagectomies performed by other surgeons at this institution during the study period.

The preoperative workup included esophagogastroduodenotomy (EGD), endoscopic ultrasound (EUS), positron emission tomography (PET) scanning, and all patients underwent computed tomographic (CT) scanning. Nutritional parameters were assessed uniformly, and each patient was required to have a prealbumin >15 before undergoing the operation. This was achieved via Dobhoff tube feeding placement in the preoperative setting. If patients were selected for preoperative neoadjuvant chemo- and radiation therapy, the surgeon followed these patients closely to ensure adequate nutritional status was maintained. Additionally, all patients were evaluated preoperatively by a cardiologist and pulmonologist.

Variables queried for included patient age at the time of operation, race, comorbid conditions including positive social histories, operative time (skin incision to skin closure), intra- and postoperative complications, estimated blood loss, and length of hospital stay. Preoperative evaluation, including EGD, EUS, PET scan, or CT, were also queried, as were perioperative adjuvant treatments with chemotherapy or radiation.

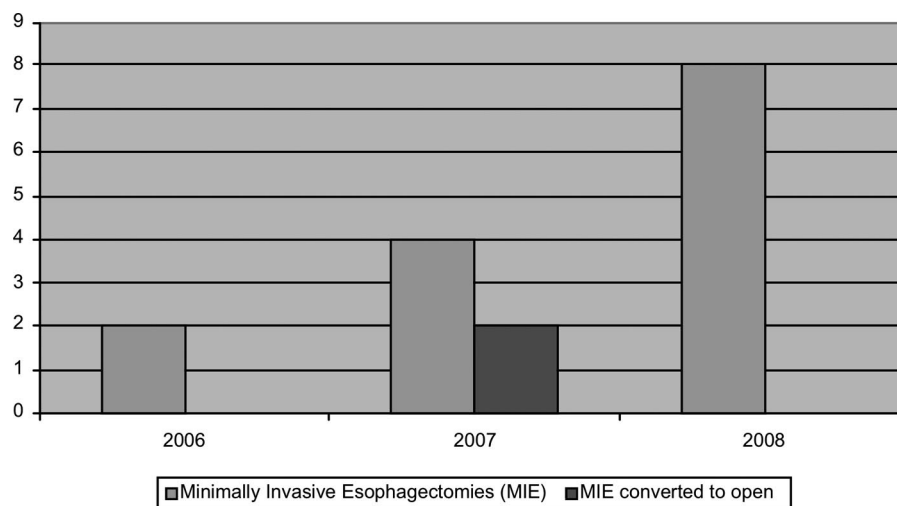
## Surgical Procedure

The abdominal trocars are placed after gaining pneumoperitoneum by Veress needle access in the left upper quadrant (eg, Palmer's point). The trocars are placed in the standard location used for esophagogastric surgery, such as Heller myotomy and fundoplication. Examination is carried out laparoscopically to look for undetected intraperitoneal spread, and laparoscopic ultrasound and biopsy are utilized for any questionable liver lesions. The dissection is begun at the hiatus freeing the esophagus and proximal stomach from their attachments. The esophageal hiatus is then enlarged if needed by dissecting between the central tendon of the diaphragm and pericardium with a blunt right angle dissector and dividing the tendon with a white laparoscopic load in the stapling device.

The stomach is then mobilized starting at the origin of the left gastroepiploic artery and carried toward the duodenum, carefully preserving the gastroepiploic arcade. The short gastrics are then taken down until the greater curve of the stomach is mobilized to the hiatus. Attachments in the lesser sac are then divided. The Harmonic scalpel (Ethicon Endo-Surgery, Inc., Cincinnati, Ohio) is used to complete all of the sharp dissection. The left gastric artery is then divided using a grey load in the stapling device.

If further mobilization of the stomach is needed, a Kocher maneuver is then performed. The viability of the stomach is assessed, and if it is adequate to allow formation of a gastric tube with anastomosis in the neck, the esophageal dissection is begun. A second surgeon dissects out the cervical esophagus as dissection is carried out from above and below. The Nathanson retractor (Mediflex, Islandia, NY) which, up to this point, has been used to hold the left lateral liver segments anterior and superiorly out of the field of dissection, is now repositioned to hold open the divided hiatus. This also allows for wide exposure into the chest. The esophageal dissection is completed under direct vision to above the left mainstem bronchus. Care is taken to dissect all nodes in continuity with the specimen.

Once the esophageal dissection is complete, the stomach is divided with multiple green loads in the stapling device from the third or fourth neurovascular bundle on the lesser curve to the fundus to create a gastric tube. A long three-quarter inch wide Penrose drain is then sewn to the gastric tube at the proposed site of esophagogastrostomy. The specimen is delivered through the neck with gentle retraction and upward pressure on the Penrose with a long laparoscopic Babcock grasper.



**Figure 1.** Esophagectomies per year by a single surgeon.

The cervical esophagus is divided, and margins are checked both grossly and with frozen section. The nasogastric tube is measured and inserted into the gastric pull-up prior to completing the anastomosis. The anastomosis is created using either the double staple technique described by Orringer et al<sup>16</sup> or a single layer of 2-0 Vicryl if there is not enough laxity to staple the anastomosis. The anastomosis is then coated with Evicel (OMRIX Biopharmaceuticals, Somerville, NJ), a fibrin glue product. A laparoscopic J-tube is placed. Two 10-flat Blake closed suction drains are placed near the anastomosis, and chest tubes are placed, if needed.

## RESULTS

Over the 20-month time period, the surgeon performed 16 esophagectomies (**Figure 1**). There were 2 MIEs performed in 2006, 6 in 2007, and the remaining 8 performed in 2008. All patients were men, with an average age of 70 years (range, 54 to 81). Patient comorbidities are listed in **Table 1**; the most common comorbidity was hypertension (found in 62.5% of the patients). Preoperative workup included an EGD in 11/16 patients, EUS in 13/16 patients, and PET scan in 9/16 patients. Operative time averaged 198 minutes (range, 147 to 303; median, 166), the average estimated blood loss was 393mL (range, 100 to 2400; median, 200), and the length of hospital stay averaged 16.7 days (range, 9 to 30; median, 12; mode, 9). All cases were performed on an elective basis. The surgeon billed for 1632 procedures ranging from central line insertions to complex abdominal operations during the study time period. Of these procedures, 483 were laparoscopic. Of the esophagectomies performed, 14 (87.5%) were resected

**Table 1.**  
Patient Comorbidities

Condition	Number of Cases	Percentage
Coronary Artery Disease	3	18.8
Diabetes Mellitus	5	31.3
COPD	2	12.5
Hypertension	10	62.5
Atrial Fibrillation	2	12.5
Asthma	1	6.3
GERD	4	25.0
Hypercholesterolemia	4	25.0
Hiatal Hernia	1	6.3
Ménière's Disease	1	6.3
Depression	1	6.3
Gout	1	6.3
Benign Prostatic Hypertrophy	3	18.8
Prior Lobectomy	1	6.3
Prostate Cancer	1	6.3
Tobacco use	10	62.5
Alcohol Use	4	25.0

successfully in a minimally invasive manner, while 2 (12.5%) were converted to open procedures. One was converted to an Ivor-Lewis esophagectomy secondary to tumor extension onto the midportion of the stomach. Thus, there was an insufficient stomach remnant length to reach the cervical esophagus. The second conversion was due to a

membranous trachea injury during the midesophageal mobilization. This case was converted to a transabdominal esophagectomy with diaphragmatic split resection. Intraoperative chest tubes were placed in 10 patients (62.5%); 6 of these were placed in the right chest, and 4 patients had bilateral chest tubes placed. Eleven patients received preoperative chemotherapy and radiation treatment.

The 30-day mortality during the study time period was 0. Estimated 30-day risk-adjusted mortality was calculated at 17.73% with a 95% confidence interval of 0%, 23.36%.<sup>17</sup> The postoperative 30-day morbidity included 13 complications in 7 patients (**Table 2**). The most common organ system involved in postoperative complications was the pulmonary system, with a total of 7 morbidities. Three of the 16 patients (18.8%) developed pneumonia postoperatively, 2 of which were secondary to methicillin-resistant *Staphylococcus aureus*. One of the patients who developed pneumonia subsequently declined into septic shock with acute respiratory distress syndrome (ARDS) requiring pressor support. This patient was re-explored on POD 10 and found to have a small segment of ischemic bowel believed to be secondary to low-flow ischemia and not an iatrogenic injury from the original surgery. Ultimately, this patient required a tracheostomy and was discharged to an extended care facility. Newly diagnosed cardiac issues including atrial fibrillation (2/16) and asymptomatic sinus tachycardia (1/16) developed in the postoperative setting. Of note, 1 patient was diagnosed with a urinary tract infection postoperatively, and 1 was found to have a recurrent laryngeal nerve injury.

Pathological analysis confirmed adenocarcinoma in 14 (87.5%) of the surgical specimens. Two (12.5%) of the

patients' specimens were found to contain only ulcerative disease, thus confirming complete clinical/pathological response to the neoadjuvant therapy. The average tumor diameter was 2.4cm. Barrett's metaplasia was noted in 3 (18.8%) of the cases. While lymphovascular invasion was confirmed in 4 (25%) of the specimens, tumor-free margins were achieved in all 16 (100%) cases. The average number of retrieved lymph nodes in the surgical specimen was 11.7 with a mode of 18.

## DISCUSSION

Debate continues about the safety of performing esophagectomies in institutions deemed to be low-volume for the procedure. While there is general consensus to define low- versus high-volume centers in regard to overall esophagectomies performed annually, there is a paucity of information in the current literature to clearly define these same criteria for those performing an esophagectomy via a minimally invasive approach.<sup>3-6,15</sup> However, a study supported by the American College of Surgeons Oncology Group (ACOSOG), the *E2202 Minimally Invasive Esophagectomy: A Multi-Center Feasibility Study*, aims to help establish a minimally invasive approach to esophageal resection as the standard of care.<sup>16</sup> Thus, with minimally invasive techniques increasingly becoming the norm, we believed it appropriate to determine whether the volume issue observed in the open esophagectomy population held true in the minimally invasive population.

In a previous study,<sup>15</sup> we reviewed and cited a volume of 10 or more esophagectomies performed per year at a single institution to define a high-volume center. In keeping with this designation, the present study is, therefore, compatible with a low-volume institution. In a 20-month period, the surgeon has performed 16 esophagectomies. Each of these was initially begun via a minimally invasive approach, and 14 were successfully completed in this manner. The conversion rate of 12.5% is considerable; however, tumor extension onto the stomach requiring a more involved dissection was necessary to achieve a proper tension-free anastomosis in one case. Repair of a membranous trachea iatrogenic injury resulted in the delivery of the esophageal segment through the neck incision in one patient, thus requiring conversion to an open procedure for proper repair. It is believed that this was the result of a traction injury caused by the Penrose drain as the esophageal segment was pulled through while simultaneously upward pressure was applied from a long Babcock grasper. It is important to note that the surgeon referenced here is the only surgeon performing esophageal resections of any type at this institution.

**Table 2.**  
Postoperative Morbidities

Morbidity	Number of Cases	Percentage
Atrial Fibrillation	2	12.5
Small Bowel Resection	1	6.3
Acute Respiratory Distress Syndrome	1	6.3
Pneumonia	3	18.8
Sinus Tachycardia	1	6.3
Tracheostomy	1	6.3
Pleural Effusion	2	12.5
Recurrent Laryngeal Nerve Injury	1	6.3
Urinary Tract Infection	1	6.3



Morbidities associated with esophageal resections remain relatively stagnant irrespective to the approach taken, open versus minimally invasive. The morbidity at 30-days postoperatively reported here was 43.75%, comparable to that of others cited in the current literature. Previous reports cite a mortality rate ranging from 3% to 20%.<sup>3,5,15</sup> The case series presented here demonstrates a 30-day mortality rate of 0%. The risk-adjusted mortality in this study is relevant, because it reflects that this population is typical of those reported elsewhere in the literature. We also question the comment on the validity of a 30-day mortality reference when it is a well-known limitation of any designation of this form, because it is void of comment on patient outcomes after this defined end point. The percentage of patients who expire after postoperative day 30 but still within a reasonably short period after surgery are eliminated from this format of statistical reference and thus an inherent limitation of this data. Anastomotic leaks are one of the most dreaded complications of this procedure, resulting in an increased mortality rate of over 35% vs 4.2% in patients without leaks.<sup>5</sup> In our case series, we had no anastomotic leaks. The average length of stay (LOS) in our report (16.7 days) is longer than those reported elsewhere; however, we make reference to the fact that a few patients remained hospitalized for 30 days thereby skewing the average. A more accurate reflection of this measure might be the mode LOS, 9 days recorded for almost half of the patients in this study.

The inherent limitations of this study include the retrospective nature of the data collection and the population size. Due to the lack of uniformity in the collection of preoperative data, specifically related to preoperative workup imaging and staging, it is virtually impossible to draw any justifiable conclusions in regard to the outcomes in relation to preoperative stage. Despite extensive efforts to obtain all preoperative imaging studies and reports, we were unable to collect 100% of these and thus this limits the applicability of intense discussion regarding this aspect of our patient population.

Similar to our previous report, it is our opinion that preoperative nutritional optimization is a factor contributing to our positive results and is of the utmost importance for the short- and long-term outcomes in this patient population. Additionally, each patient is evaluated by pulmonologist and cardiologist colleagues preoperatively. This is beneficial in the postoperative time period if any issue arises; the consultant already has an established rapport with the patient and his or her specific medical history. The nursing staffs in both the surgical intensive care unit and surgical telemetry unit are familiar with the

care of these patients, and this intuitively plays a role in excellent patient outcomes. While these and other components of the perioperative care all contribute to patient outcomes, it should be mentioned that there was not a regression analysis undertaken in this study to suggest any type of causal relationship may exist.<sup>15</sup>

## CONCLUSION

The inherent complexity of this type of operation and the multitude of other confounding factors present in each patient make causality statements quite controversial. Therefore, aside from the small population size, our results would argue against the volume status of an institution being the dominant factor in postoperative mortality associated with MIEs. Rather, we offer surgeon experience and other variables, such as the meticulous perioperative attention being paid to nutritional status and both cardiac and pulmonary optimization, as more prominent factors in mortalities associated with MIEs.

## References:

1. Naef A. The mid-century revolution in thoracic and cardiovascular surgery: Part 3. *Interact Cardiovasc Thorac Surg*. 2004; 3:3–10.
2. Enestvedt CK, Perry KA, Kim C, et al. Trends in the management of esophageal carcinoma based on provider volume: treatment practices of 618 esophageal surgeons. *Dis Esophagus*. 2010;23:136–144.
3. Begg C, Cramer L, Hoskins W, Brennan M. Impact of hospital volume on operative mortality for major cancer surgery. *JAMA*. 1998;280:1747–1751.
4. Junemann-Ramirez M, Awan MY, Khan ZM, Rahamim JS. Anastomotic leakage post-esophagogastrectomy for esophageal carcinoma: retrospective analysis of predictive factors, management and influence on long-term survival in a high volume centre. *Eur J Cardiothorac Surg*. 2005;27:3–7.
5. Metzger R, Bollschweiler E, Vallböhmer D, Maish M, DeMeester TR, Hölscher A. High volume centers for esophagectomy: what is the number needed to achieve low postoperative mortality? *Dis Esophagus*. 2004;17:310–314.
6. Dimick JB, Wainess RM, Upchurch GR Jr., Iannettoni MD, Orringer MB. National trends in outcomes for esophageal resection. *Ann Thorac Surg*. 2005;79:212–216.
7. de Hoyos A, Litle VR, Luketich JD. Minimally invasive esophagectomy. *Surg Clin North Am*. 2005;85(3):631–647.
8. Kent MS, Schuchert M, Fernando H, Luketich JD. Minimally invasive esophagectomy: state of the art. *Dis Esophagus*. 2006; 19(3):137–145.

9. Litle VR, Buenaventura PO, Luketich JD. Minimally invasive resection for esophageal cancer. *Surg Clin North Am.* 2002; 82(4):711–728.
10. Parameswaran R, Veeramootoo D, Krishnadas R, Cooper M, Berrisford R, Wajed S. Comparative experience of open and minimally invasive esophagogastric resection. *World J Surg.* 2009;33:1868–1875.
11. Schoppmann SF, Prager G, Langer F, Riegler M, Fleischman E, Zacherl J. Fifty-five minimally invasive esophagectomies: a single centre experience. *Anticancer Res.* 29(7):2719–2725, 2009 Jul.
12. Birkmeyer J, Stukel T, Siewers A, Goodney P, Wennberg D, Lucas F. Surgeon volume and operative mortality in the United States. *N Engl J Med.* 2003;349:2117–2127.
13. Law S, Wong K, Kwok K, Chu K, Wong J. Predictive factors for postoperative pulmonary complications and mortality after esophagectomy for cancer. *Ann Surg.* 2004;240: 791–800.
14. Gemmill EH, McCulloch P. Systematic review of minimally invasive resection for gastro-oesophageal cancer. *Br J Surg.* 2007;94(12):1461–1467.
15. Santin B, Kulwicky A, Price P. Mortality rate associated with 56 consecutive esophagectomies performed at a “low-volume” hospital: is procedure volume as important as we are trying to make it? *J Gastrointest Surg.* 2008;12(8):1346–1350.
16. Orringer MB, Marshall B, Iannettoni MD. Transhiatal esophagectomy: clinical experience and refinements. *Ann Surg.* 1999; 230(3):392–400.
17. Steyerberg EW, Neville BA, Koppert LB, et al. Surgical mortality in patients with esophageal cancer: development and validation of a simple risk score. *J Clin Oncol.* 2006;24:4277–4284.