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Early Results of Laparoscopic Trans-Hiatal Esophagectomy versus Three-Field Thoracoscopic Esophagectomy in the Treatment of Esophageal Cancer

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Abstract

Background: Esophageal cancer is an aggressive malignancy, often diagnosed at advanced stages, with high mortality rates. The main surgical approaches for its treatment include transthoracic and trans-hiatal esophagectomy, both of which can be performed using minimally invasive techniques. The choice of the most appropriate approach depends on anatomical, oncological, and clinical factors and remains a topic of debate in the literature, particularly regarding early morbidity and mortality outcomes. **Aim:** To compare the immediate outcomes of the transthoracic and trans-hiatal video-endoscopic approaches in the surgical treatment of esophageal cancer, with emphasis on early mortality and postoperative complications. **Methods:** This is a retrospective study based on the analysis of medical records of 90 patients who underwent video-assisted or thoracoscopic esophagectomy between October 2007 and March 2025. Demographic, clinical, surgical, histological, and postoperative data were collected and evaluated, and statistical comparisons were made between the transthoracic group (n = 35) and the trans-hiatal group (n = 55). **Results:** The transthoracic approach was associated with significantly higher thirty-day mortality, with a four-fold increase in risk compared with the trans-hiatal approach (p = 0.003). Other complications such as anastomotic leakage, pneumonia, sepsis, and chylothorax occurred in both groups without significant differences. Logistic regression revealed a higher risk of major complications in the transthoracic group (OR = 2.54; p = 0.036). This group also had a higher prevalence of squamous cell tumors in the mid-esophagus and greater exposure to neoadjuvant chemo-radiotherapy. **Conclusion:** Although both tech-

niques are feasible, the trans-hiatal approach was associated with lower mortality and reduced rates of major complications, suggesting it may be safer for patients with tumors located in the lower third of the esophagus and less locoregional involvement. The choice of surgical approach should be individualized, taking into account anatomical and oncological aspects.

Keywords

Esophageal Cancer, Esophagectomy, Laparoscopic Transhiatal Esophagectomy, Transthoracic Esophagectomy, Postoperative Complications

1. Introduction

Esophageal cancer is a malignancy with a higher incidence among males and elevated mortality rates, mainly due to its frequent late-stage diagnosis, often accompanied by significant weight loss and severe dysphagia. It ranks as the sixth leading cause of cancer-related deaths worldwide. There are two main histological subtypes: squamous cell carcinoma, commonly affecting the middle and lower third of the esophagus, and associated with low socioeconomic status, smoking, and alcohol consumption; and adenocarcinoma, typically found in the lower third and the esophagogastric junction/cardia, linked to Barrett's esophagus and chronic gastroesophageal reflux disease, particularly prevalent in obese individuals [1]-[3].

Historically, the first transthoracic esophagectomy for esophageal cancer was successfully performed by Franz Torek in New York in 1913. In 1946, Ivor Lewis introduced a two-stage right thoracic approach for mid-esophageal cancer. Later, in 1998, Luketich popularized a minimally invasive approach combining thoracoscopy and laparoscopy with cervical anastomosis in Pittsburgh [4]-[7].

The transhiatal esophagectomy was first performed by Gray Turner in 1933 in the UK using a midline supra-umbilical incision and blunt digital dissection of the esophagus. In 1978, Orringer in Ann Arbor, USA, popularized this technique for esophageal and gastroesophageal junction cancers. The first laparoscopic transhiatal approach was described by DePaula and colleagues in 1995 [4] [8]-[10].

Minimally invasive esophagectomy emerged to reduce morbidity, postoperative pain, hospital stay, and allow earlier return to normal activities. Enhanced imaging and magnification also improved the precision of lymphadenectomy without compromising oncologic outcomes [11]-[13].

The objective of this study was to conduct a retrospective analysis comparing immediate outcomes of patients undergoing transthoracic and transhiatal esophagectomy for esophageal cancer, focusing on perioperative and postoperative complications and aiming to improve the quality and of surgical care.

2. Methods

This is a retrospective study based on the medical records of 114 patients who underwent Video-Assisted Transthoracic Esophagectomy (TTE) and Laparo-

scopic Transhiatal Esophagectomy (THE) for esophageal cancer between October 2007 and March 2025.

Clinical records were reviewed for data including age, sex, operative time, surgical conversion, hospital stay duration, 30-day postoperative mortality, histological tumor type, tumor location, immediate postoperative complications, and whether adjuvant chemo-radiotherapy was administered. These variables were used as inclusion criteria.

Strict inclusion and exclusion criteria were applied. Of the 114 patients, 24 were excluded, resulting in 90 patients included in the final analysis. Seven were excluded due to undergoing esophagectomy for non-malignant conditions: 1 case of esophageal atresia, 2 cases of achalasia, 2 cases of gastric GISTs, 1 leiomyoma, and 1 severe caustic stricture. Seventeen were excluded due to insufficient clinical data.

Data were categorized according to the surgical approach: Video-Assisted Transthoracic Esophagectomy (TTE) or Laparoscopic Transhiatal Esophagectomy (THE). Demographic and clinical characteristics are presented in **Table 1**, whereas postoperative complications and outcomes are presented in **Table 2**.

Postoperative complications were classified according to the Clavien-Dindo classification, a stratification tool for adverse events based on the type of therapeutic intervention required. Grade I complications include any deviation from the normal postoperative course that does not require pharmacological, surgical, endoscopic, or radiological treatment. Grade II involves the need for pharmacological treatment beyond standard postoperative therapy (e.g., antibiotics, blood transfusions, or total parenteral nutrition). Grade III complications require surgical, endoscopic, or radiological intervention (IIIa without and IIIb with general anesthesia). Grade IV comprises life-threatening complications requiring intensive care unit management (IVa with single-organ failure and IVb with multiorgan failure), and Grade V corresponds to death. For statistical purposes, minor complications were defined as grades I - II, and major complications as grades III - V [14] [15].

Major postoperative complications were defined as a composite outcome including thirty-day mortality, anastomotic fistula, sepsis, pneumonia, evisceration, esophagopleural fistula, empyema, and tumor recurrence. A binary logistic regression model was used to evaluate the association between surgical approach (TTE vs. THE) and the occurrence of major complications. No additional covariates were included in the model.

Categorical variables were expressed as absolute and relative frequencies (n, %) and compared between groups using Pearson's chi-square test. Fisher's exact test was applied in cases where at least one expected frequency in the contingency table was less than five.

Continuous variables were reported as median and interquartile range (Q1~Q3), as they did not follow a normal distribution (assessed by graphical inspection and the Shapiro-Wilk test). To compare the TTE and THE groups, the Mann-Whitney

U test (Wilcoxon rank-sum test for independent samples) was used. A p-value less than 0.05 was considered statistically significant. All statistical analyses were performed using RStudio Software (version 2025.05.0+496).

3. Results

A statistical analysis was conducted of the 90 patients included in the study, of whom 35 patients (38.9%) underwent transthoracic esophagectomy (TTE) and 55 patients (61.1%) underwent trans-hiatal esophagectomy (THE). Demographic and clinical characteristics are presented in Table 1.

Table 1. Clinical and demographic characteristics of patients undergoing transthoracic (TT) and trans-hiatal (TH) esophagectomy.

	Transthoracic (n = 35)	Trans-hiatal (n = 55)	p-value
Age	62.0 [54.0 - 67.5]	64.0 [59.0 - 70.5]	0.174
Sex			
Female	7 (20%)	14 (25.5%)	0.733
Male	28 (80%)	41 (74.5%)	0.733
Operation time	143.0 [115.8 - 177.8]	180.0 [130.5 - 208.5]	0.108
Hospitalization days	14.5 [5.8-26.0]	9.0 [6.0 - 16.5]	0.189
Conversion			
Yes	1 (2.9%)	0 (0.0%)	0.389
No	34 (97.1%)	55 (100%)	0.389
Tumor site			
Upper third	1 (2.9%)	0 (0.0%)	0.012
Middle third	20 (57.1%)	12 (21.8%)	0.012
Lower third	12 (34.3%)	22 (40%)	0.012
Antrum and lesser curvature	0 (0%)	1 (1.8%)	0.012
Cardia	1 (2.3%)	2 (3.6%)	0.012
Cardia and lower third	0 (0%)	3 (5.5%)	0.012
Cardia and gastric fundus	0 (0%)	1 (1.8%)	0.012
Gastric body	0 (0%)	1 (1.8%)	0.012
Gastric fundus	0 (0%)	1 (1.8%)	0.012
Linitis platica	0 (0%)	1 (1.8%)	0.012
Histology			
CEC	32 (91.4%)	20 (36.4%)	0
Adenocarcinoma	3 (8.6%)	26 (47.3%)	0

Continued

Early gastric carcinoma	0 (0%)	1 (1.8%)	0
NeoQT	23 (65.7%)	19 (34.5%)	0.005
NeoRT	28 (80%)	21 (38.2%)	0

Continuous variables are expressed as median (interquartile range, IQR) and were compared using the Mann-Whitney test. Categorical variables are presented as absolute numbers (percentages) and were compared using Fisher's exact test or the chi-square test, as appropriate. Values are presented as median (IQR) for continuous variables and absolute count (percentage) for categorical variables.

The median age was 62.0 years (interquartile range [IQR]: 54.0 - 67.5) in the TTE group and 64.0 years (IQR: 59.0 - 70.5) in the THE group, with no statistically significant difference ($p = 0.174$). Male sex was predominated in both groups, accounting for 80.0% (28 patients) in the TTE group and 74.5% (41 patients) in the THE group ($p = 0.733$).

The median operative time was longer in the THE group, though without statistical significance: 180.0 minutes (IQR: 130.5 - 208.5) versus 143.0 minutes (IQR: 115.8 - 177.8) in the TTE group ($p = 0.108$).

Hospital length of stay was slightly shorter in the THE group, with a median of 9.0 days (IQR: 6.0 - 16.5), compared with 14.5 days (IQR: 5.8 - 26.0) in the TTE group; however, this difference was not statistically significant ($p = 0.189$).

Only one case of surgical conversion was recorded in the TTE group (2.9%), whereas no conversions occurred in the THE group ($p = 0.389$).

There was a statistically significant difference in tumor location between the groups ($p = 0.012$). Tumors located in the middle third of the esophagus were more common in the TTE group (57.1%), while tumors involving the lower third and the gastroesophageal junction were more frequently observed in the THE group (40%).

Regarding histological type, 52 patients were diagnosed with esophageal squamous cell carcinoma (SCC) of the esophagus, of whom 32 patients (91.4%) underwent TTE and 20 patients (36.4%) underwent THE. Among the 29 patients diagnosed with adenocarcinoma, 3 patients (8.6%) were treated with TTE and 26 (47.3%) via THE. Thus, SCC was more commonly treated with TTE, while adenocarcinoma predominated in patients undergoing THE ($p < 0.001$).

As for neoadjuvant treatment, the TTE group had a higher proportion of patients receiving chemotherapy (65.7% vs. 34.5%; $p = 0.005$) and radiotherapy (80.0% vs. 38.2%; $p < 0.001$), compared with the THE group.

Continuous variables are expressed as median (interquartile range, IQR) and were compared using the Mann-Whitney test. Categorical variables are presented as absolute numbers (percentages) and were compared using Fisher's exact test or the chi-square test, as appropriate.

4. Postoperative Complications and Outcomes

Postoperative complications were observed in both groups (Table 2), with varia-

tions in frequency and distribution.

Table 2. Clinical and demographic characteristics of patients undergoing transthoracic (TT) and trans-hiatal (TH) esophagectomy.

	Transthoracic (n= 35)	Transhiatal (n = 55)	p-value
30-day mortality	14 (40%)	6 (10.9%)	0.003
Anastomotic leakage	8 (22.9%)	15 (27.3%)	0.826
Atelectasis	3 (8.6%)	0 (0.0%)	0.056
Chylothorax	2 (5.7%)	1 (1.8%)	0.558
Sepsis	8 (22.9%)	8 (14.5%)	0.470
Anastomotic stricture	2 (5.7%)	5 (9.1%)	0.701
Pleural effusion	2 (5.7%)	2 (3.6%)	0.641
Tracheobronchial fistula	1 (2.9%)	0 (0.0%)	0.389
Paralytic ileus	1 (2.9%)	0 (0.0%)	0.389
Pneumonia	3 (8.6%)	10 (18.2%)	0.238
Evisceration	1 (2.9%)	0 (0.0%)	0.389
Pneumothorax	3 (8.6%)	5 (9.1%)	1
Esophagopleural fistula	1 (2.9%)	3 (5.5%)	1
Recurrent laryngeal nerve injury	2 (5.7%)	0 (0.0%)	0.149
Gastrointestinal bleeding	1 (2.9%)	0 (0.0%)	0.389
Tumor recurrence	0 (0.0%)	2 (3.6%)	0.519
Right main bronchus injury	1 (2.9%)	0 (0.0%)	0.389
Empyema	1 (2.9%)	5 (9.1%)	0.398
Jugular vein injury	0 (0.0%)	1 (1.8%)	1
Surgical site infection	0 (0.0%)	1 (1.8%)	1
Pulmonary embolism	0 (0.0%)	1 (1.9%)	1
Deep vein thrombosis	0 (0.0%)	1 (1.8%)	1
Tracheal thermal injury	1 (2.9%)	0 (0.0%)	0.389
Tracheoesophageal fistula	0 (0.0%)	1 (1.8%)	1
Thoracic aorta injury	1 (2.9%)	0 (0.0%)	0.389

Thirty-day mortality was significantly higher in the transthoracic group, with 14 deaths versus 6 in the trans-hiatal group (p = 0.003). The incidence of anastomotic leaks was similar between groups, occurring in 15 patients (27.3%) in the THE group and 8 patients (22.9%) in the TTE group (p = 0.826). There was no statistically significant difference in the occurrence of anastomotic strictures,

which were observed in 5.7% of TTE cases and 9.1% of THE cases (p = 0.701).

Although not statistically significant, the TTE group presented a higher number of pulmonary complications, including atelectasis (8.6% vs. 0.0%; p = 0.056) and pneumonia (8.6% vs. 18.2%; p = 0.238). The incidence of pleural effusion was similar between groups (5.7% vs. 9.1%; p = 0.641), whereas chylothorax was identified in 2 patients (5.7%) in the TTE group and 1 patient (1.8%) in the THE group (p = 0.558).

Sepsis was more frequent in the TTE group (22.9% vs. 14.5%; p = 0.470). Other complications, such as pneumothorax, esophagopleural fistula, recurrent laryngeal nerve injury, empyema, gastrointestinal bleeding, tumor recurrence, and other specific iatrogenic injuries, were infrequent and showed no statistically significant differences between the groups (p > 0.05).

Rare complications such as right main bronchus injury, thoracic aorta injury, jugular vein injury, surgical site infection, pulmonary embolism, deep vein thrombosis, and thermal tracheal injury occurred at low frequencies, without statistical impact.

Postoperative complications were classified according to the Clavien-Dindo grading system; however, major postoperative complications reported in the present study refer specifically to the *composite outcome* defined in the Methods section (including thirty-day mortality, anastomotic fistula, sepsis, pneumonia, evisceration, esophagopleural fistula, empyema, and tumor recurrence), rather than exclusively to Clavien-Dindo grade ≥ III. Using this composite definition, major complications were observed in 22 patients (40.0%) in the THE group and 22 patients (62.9%) in the TTE group.

In the logistic regression analysis, the transthoracic approach was significantly associated with a higher likelihood of major complications compared with the trans-hiatal technique (OR = 2.54; 95% CI 1.07–6.20; p = 0.036) (Table 3).

Table 3. Association between surgical approach (TT vs. TH) and major complications.

Variable	Transhiatal (n = 55)	Transthoracic (n = 35)	p-value[1]	OR (IC95%)[2]	p-value[2]
Major complication, n (%)	22 (40.0%)	22(62.9%)	0.058	2.54 (1.07 - 6.20)	0.036

[1]p-value calculated using the chi-square test. [2]OR = odds ratio obtained through binary logistic regression, with a 95% confidence interval (95% CI).

5. Discussion

The present study aimed to analyze retrospectively 90 patients who underwent transthoracic (TTE) or transhiatal (THE) esophagectomy for the treatment of esophageal cancer, focusing on immediate postoperative outcomes.

The findings align with established evidence in the literature regarding the surgical management of esophageal cancer. The minimally invasive transhiatal approach was associated with a lower rate of major complications (Clavien-Dindo grade ≥ III) and reduced 30-day mortality compared with the transthoracic ap-

proach. Similarly, Luketich *et al*. (2003) reported a mortality rate below 5% using the minimally invasive technique, while Omloo *et al*. (2007) described serious complications in up to 50% of patients undergoing conventional transthoracic esophagectomy. These findings support the notion that minimally invasive surgery may result in reduced early morbidity and mortality, particularly in well-selected patients [16] [17].

The association between the transthoracic approach and higher rates of major complications persisted in the logistic regression model; however, as no covariates were included, this analysis reflects a univariate comparison and may be influenced by baseline differences between groups—particularly tumor location, histological subtype, and exposure to neoadjuvant therapy.

The significantly higher mortality observed in the TTE group may be associated with clinical and oncological factors such as tumor location and the higher prevalence of squamous cell carcinoma (SCC) among these patients. Studies by Grimm *et al*. (2011) and Elliott & Berry (2009) have shown that mid-esophageal tumors—frequently managed via the transthoracic route—tend to be more aggressive and often require extended lymphadenectomy, thereby increasing the risk of complications. Wiley *et al*. (2006) further emphasized the correlation between tumor location and surgical approach, highlighting the prognostic implications of these factors [18]-[20].

It is important to acknowledge that the two surgical groups differed markedly in several baseline characteristics that are known to influence short-term outcomes—particularly tumor location, histological subtype, and exposure to neoadjuvant chemo-radiotherapy. These imbalances introduce potential confounding by indication, meaning that the observed differences in mortality and major postoperative complications may reflect underlying oncologic severity rather than the surgical technique itself. Therefore, the findings of the present study should be interpreted cautiously, as the non-randomized, retrospective design limits the ability to determine causal relationships between the surgical approach and postoperative outcomes.

Another important aspect concerns the impact of neoadjuvant therapy on postoperative outcomes. In our cohort, patients in the TTE group had higher exposure to both chemotherapy and radiotherapy, which may have contributed to poorer clinical outcomes. Bosch *et al*. (2014) reported a significant increase in pneumonia and pleural effusion in patients treated with the CROSS protocol prior to esophagectomy. Likewise, Gronnier *et al*. (2014) associated preoperative radiotherapy with a higher incidence of anastomotic leaks and respiratory complications, possibly due to treatment-induced tissue fragility [21] [22].

Pulmonary complications such as atelectasis and pneumonia were more frequently observed in the TTE group, though not all differences reached statistical significance. Lung manipulation and pleural cavity exposure in the transthoracic approach are known predisposing factors, as previously reported by Omloo *et al*. (2007) and Rice *et al*. (2001). These authors noted that thoracotomy, even when

video-assisted, carries an increased risk of pulmonary injury, whereas the transhiatal approach avoids pleural violation and may therefore result in a lower incidence of respiratory complications [17] [23].

Finally, it should be acknowledged that, despite the greater safety profile observed with the transhiatal approach, it may not be suitable in all cases. As suggested by Hulscher *et al*. (2002) and Law *et al*. (2004), the transthoracic route may still be preferred in locally advanced tumors or when extended lymphadenectomy is required to ensure adequate oncologic control. Therefore, surgical approach selection must be individualized, considering anatomical, histological, clinical factors, and the surgical team's expertise [24] [25].

6. Conclusions

This retrospective study showed that, although both transthoracic (TTE) and transhiatal (THE) video-assisted esophagectomies are established approaches for the surgical treatment of esophageal cancer, the TTE route was associated with a higher incidence of major complications. Factors such as mid-esophageal tumor location, greater prevalence of squamous cell carcinoma (SCC), and increased exposure to neoadjuvant therapy—particularly radiotherapy—may have contributed to these adverse outcomes.

Conversely, the trans-hiatal approach was associated with lower early mortality and fewer pulmonary complications; however, this association should be interpreted with caution, as these outcomes likely reflect baseline differences rather than intrinsic advantages of the technique. Therefore, the choice of surgical approach should remain individualized, taking into consideration anatomical and oncologic characteristics as well as multidisciplinary assessment, rather than implying intrinsic superiority of one technique over the other.

These findings underscore the importance of meticulous patient selection and comprehensive multidisciplinary care throughout the preoperative and postoperative periods. Surgical technique selection should always strive to balance oncologic adequacy with patient safety, considering the complexity of each individual case.

Future prospective, randomized, and multicenter studies will be essential for support the development of personalized, effective, and safer surgical protocols in the management of esophageal cancer.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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