



# State-of-the-art of Esophagectomy for Cancer: From Open to Laparoscopic and Robotic Technique

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## Abstract

**INTRODUCTION:** The results for the meta-analytical review, which contrasted laparoscopic or robotically assisted esophagectomy for cancer against open esophagectomy (OE), indicated feasibility and safety associated with the robotic method.

**AIM:** The objective of this study is to review the current literature on MIE (Laparo-thoroscopic and Robotic approach) and open approach and check the state-of-the-art of esophagectomy for cancer.

**MATERIALS AND METHODS:** The comparison of studies which contrasted laparoscopic or robotically assisted esophagectomy for cancer against open esophagectomy (OE).

**RESULTS:** This review represented the largest sequence of mini-invasive esophagectomy (MIE) to date and the results appear to be comparable to those attained by the traditional open approach. MIE constitutes a safe procedure with a learning curve of around 36 cases.

**CONCLUSION:** The studies did not reveal variations in mortality and morbidity rate, conversion rate, intensive care unit stay, 1-month mortality, and post-operative complications between the mini-invasive esophagectomy cohort and OE cohort.

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## Introduction

Esophagectomy for cancer is a challenging and complex operation associated with a 25%–50% rate of mortality and 2–8% mortality rate. Esophagectomy for cancer could be repaired using mini-invasive esophagectomy (MIE) laparoscopic or robotic. Research has shown that MIE led to reduced perioperative mortality, mortality, faster recovery, and shorter stay in hospital than open esophagectomy (OE). At present, mini-invasive method is becoming the standard for cancer. Surgical injury can be reduced using robotic methods in thoracic subjects and can lead to beneficial results in terms of anatomical recurrence and life quality. All subjects suffering from esophageal cancer can be given a minimally invasive surgical choice with the da Vinci Surgical System accessibility. All subjects suffering from esophageal cancer can be given a minimally invasive surgical choice with the da Vinci Surgical System accessibility. Although, only 15% esophagectomy cases are carried out worldwide by making the use of traditional laparoscopic-thoroscopic or robotic techniques [1]. The objective of this study is to review the current literature on MIE (Laparo-thoroscopic and Robotic approach)

and open approach and check the state-of-the-art of esophagectomy for cancer.

## Materials and Methods

### Study selection

A systematic literature search from the GOOGLE SCHOLAR, EMBASE, MEDLINE, and PUBMED databases for studies published in the past 20 years (that is, 1998–2018) was conducted. Several terms were used in the search, including “esophageal cancer,” “robotic,” “laparoscopic,” “open,” “minimally-invasive,” “esophagectomy,” “Ivor-Lewis,” and “three field esophagectomy.” Two investigators independently performed selection of manuscript based on these criteria.

### Inclusion and exclusion criteria

The criteria for inclusion included: (1) Comparison of laparoscopic/robotically assisted esophagectomy (MIE) versus OE.

(2) Studies featuring over 60 patients were taken into account. Intraoperative data, non-comparative studies, low-quality studies, reviews, case reports, and abstracts that could not be obtained from the research published were left out.

### Outcomes of interest

The following information was utilized for comparing patients on MIE to those undergoing OE: Pulmonary complications, significant morbidity, anastomotic leakage, hospital duration, mortality, time of operation, and loss of blood.

### Outcomes

For what concern open approach, at moment various techniques exist for esophagectomy: Transthoracic esophagectomy (TTE) as Ivor-Lewis or McKeown and transhiatal esophagectomy (THE). While TTE provides extensive thoracic and mediastinal lymph nodes dissection, THE seems to have lower respiratory complication. Other scientific studies demonstrated similar 5 years results [2].

Babatunde *et al.* reported a review MIE versus OE among 4266 patients, 1308 (30.6%) of these underwent MIE. Subjects with MIE had considerably more lymph nodes assessed and shorter periods of hospital stay but similar resection margin positivity, readmission, and 30-day mortality. Survival for adenocarcinoma and squamous cell carcinoma both was comparable among the matched assembly at 3 years. They matched two groups using robotic-MIE versus Laparoscopic-MIE, and no discrepancies were found between R-MIE and L-MIE in lymph nodes harvested, positive resection margin, hospital stay period, 30 day readmission, or 30 day mortality. In 3 years survival, no significant differences were seen between R-MIE and L-MIE in subjects suffering from adenocarcinoma. Although, they noted “subjects suffering from squamous cell carcinoma who ‘R-MIE’ had statistically superior survival (84% vs. 56% at 2 years;  $p = 0.034$ ).” They stated that “the minimally invasive procedures use for performing esophagectomy for esophageal cancer is correlated with perioperative results that are moderately enhanced with no compromise in survival” [3], [4].

One recent case-controlled study split 154 patients on MIE (56) versus OE (98). In-hospital deaths and rates of morbidity did not differ considerably. Surgery period in MIE was longer and loss of blood was less. No disparity among the 2 categories was seen with respect to survival. The authors suggested that MIE is equivalent with the OE. In MIE, the major use of neoadjuvant therapy increases “the surgical morbidity risk” [5].

A separate open label research selected 56 subjects randomly to the category of open esophagectomy and 59 to the group of minimally invasive

esophagectomy. (Biere *et al.* 2012, The Lancet). In the open esophagectomy category, 16, i.e., 29% subjects had pulmonary infection in the first 2 weeks in comparison to five, i.e., 9% in the category of minimally invasive. Nineteen, i.e., 34% subjects in the open esophagectomy category had in-hospital pulmonary infection in comparison to seven, i.e., 12% subjects in the minimally invasive category. For in-hospital deaths, a subject died from anastomotic leakage in the open esophagectomy category and two died from aspiration and mediastinitis in the minimally invasive category following anastomotic leakage. The authors posited that MIE gives only proof for the short-term benefits [6].

Santos-Sousa *et al.* performed a case-control study including 79 patients, 65 cases (Group A: 24 MIE – 13 totally MIE and 11 hybrid MIE; Group B: 41 OE, including five cases of conversion from MIE). They noted that post-operative morbidity in MIE was 37.5% versus in OE, it was 61%, with 16.7% and 22% respiratory complications rates, correspondingly. The classification of post-operative mortality and post-operative morbidity in Clavin showed significant statistical variations. They reveal the effectiveness and potential enhancements of MIE’s post-operative mortality and morbidity [7].

Sihag *et al.* showed collection data from the Society of Thoracic Surgeons (STS) National Database for all resection executed between 2008 and 2011 for esophageal cancer.

With respect to pre-operative risk factors, both MIE and open groupings were comparable. MIE has been correlated to longer median procedural times, but a shorter median hospital stay duration. Subjects who had suffered from MIE had higher reoperation and empyema rates. A higher infection rate with wounds, ileus, post-operative transfusion was contributed by open technique. They concluded that “Early results from the STS National Database indicate that MIE is safe, with comparable rates of morbidity and mortality as open technique” [8].

In 2015, Guo *et al.* performed a meta-analysis of 13 findings involving an overall 1549 patients suffering from resectable esophageal cancer and discovered that MIE does not affect the effect of long-term curing. In fact, following the MIE the 2-year rate of survival was higher than that preceding OE. The anastomosis leakage incidence was comparable in both categories, while the group of OE had greater operative loss of blood [9].

Robotic aided esophagectomy has been gaining acceptance in larger scale and broader consensus after this first study conducted [10]. Better maneuverability of “endo wrist” equipment, magnified 3D vision, tremor filtration, motion scaling, and a more relaxed surgical position could be of much more help in such a complex surgical process than conventional MIE particularly in thoracoscopic phase. The Endo

Wrist equipment's utilization, the motion scaling, tremor filtration and the finer high-definition 3D vision make it possible and smoother to achieve a hand-sewn intrathoracic anastomosis.

In 2007, revealed the first series of robotic esophagectomy demonstrated a long operative time for totally robotic esophagectomy, a rate of morbidity was 29% and a rate of disease-free survival was 87% [11], [12].

In 2012, stated a prospective study of 49 robotic-assisted McKeown esophagectomy demonstrating 46% total major morbidity with a reduced respiratory problem from 57 % with respect to OE to 33% in robotic aided esophagectomy [13].

Weksler *et al.*, in 2012, showed similar morbidity, mortality, length of stay (LFN), and leflunomide between robotic and laparoscopic esophagectomy [12].

In 2017, Okusanya *et al.* reported 25 RAMIE obtaining R0 in 96% cases and similar 30-day mortality, leakage, LFN and conversion rate to conventional laparoscopic technique [14], [15].

### Limitations

There are numerous limitations in the review. First, the review focused solely on English literature. Second, the selection and search of studies were conducted by one author. Third, there was no balance in the studies concerning the exactly lymph nodes retrieved, technique, conversion rate, outcomes in 5 years.

### Conclusion

This review represented the largest sequence of MIE to date and the results appear to be comparable to those attained by the traditional open approach. MIE constitutes a safe procedure with a learning curve of around 36 cases. With more experience, the complications, hospital, and operation time reduce without undermining the principles of surgery. Future studies with large patient cohorts alongside prospective randomized controlled trials are required to prove the durable nature of the procedure as opposed to the existing laparoscopic approach. In addition, several concerns should be addressed to establish the viability, safety, and clinical outcomes of robotic for elective surgical treatments of esophageal cancer in the future. They include for criteria of using robot, standard technique. MIE is achieving preponderating acceptance. The EndoWrist equipments' use, the more in-depth high-definition standard 3D vision, tremor filtration, and motion scaling render some benefits. In 2016, Haverkamp *et al.* carried out an assessment

on 1118 members of the International Society for Diseases of Esophagus, the World Organization for Specialized Studies on Diseases of the Esophagus, and the International Gastric Cancer Association. In 43% cases particularly in high volume centers, the minimally invasive transthoracic method was adopted. In the systematic review, it can be concluded that the two techniques produce comparable results in terms of complications and reoperation rate save for reduced time robotic technique. Nevertheless, there is need for further studies to prove the efficacy and long-term safety of certain forms of MIE before its routine implementation.

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