# Thoracoscopic Esophagectomy in Prone Position; A Cross-Sectional Study

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**Abstract**- Surgical resection with curative intent is still a central therapeutic option for resectable esophageal cancer. Thoracoscopicesophagectomy in a prone position would give each benefit of the lateral position. The present research aimed to analyze the short-term outcomes of thoracoscopicesophagectomy in the prone position. This was a retrospective cross-sectional study. Patients who underwent thoracoscopicesophagectomy in the prone position at Tehran University Cancer institute from January 2017 to December 2018 entered the study. The esophagus was mobilized through the thoracoscopic approach in a prone position. The stomach was released using a laparoscopic approach for the gastric pull-up. Finally, an end-to-end hand-sewn cervical anastomosis was performed. Three, four, seven, one, and one patient suffered from pneumonia, leakage, tracheal tearing, chylothorax, and pneumothorax, respectively, after the operation. In 91.5% of patients, more than ten lymph nodes were resected. Sixty percent of patients were discharged from the hospital earlier than one week. Laparoscopicesophagectomy in the prone position is a feasible alternative. Better exposure and fewer complications were reported.



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**Keywords:** Thoracoscopy; Esophagectomy; Prone position

## Introduction

Esophageal cancer is usually followed by poor overall outcomes and dramatically occurs in Asia such as India. It is notable that surgical resections with the healing aim would be a central therapeutic option for resectable esophageal cancer. In fact, conventional techniques of esophagectomy have been considered as the most physiologically difficult process conducted in the surgical operation of the gastrointestinal tract (1). There is a relationship between such conventional open transthoracic and trans-hiatal esophagectomy and comparatively great morbidity reaching 80% and mortality rate of 5% when operated by qualified surgeons (2). Some studies showed that minimally invasive esophagectomy (MIE) could potentially diminish the morbidity of open operations and result in a faster return to normal activities (3,4). For example, Torek demonstrated the first case of a transthoracic esophagectomy in 1913 (5). His study included a 67-year-old woman who was operated on via the left thoracic cavity while the proximal ends of the 4$^{th}$ through 7$^{th}$ ribs were transected close to their tubercles (5,6). Actually, food would pass through the stoma in the proximal esophagus via an exterior tube to the gastrostomy (5). Nevertheless, the above method was considered as one of the most invasive procedures and correlated to increased morbidity (7,8). However, 100 years after reporting the first case in the world, MIE as a thoracoscopic and or laparoscopic surgery has been spreading worldwide (9,10). Researchers clarified multiple methods for minimally invasive procedures for esophagectomy, such as thoracoscopic, laparoscopic transhiatalthoracolaparoscopic, and video mediastinoscopic and endoscopic Ivor Lewis. One of the studies showed that thoracoscopic mobilization in the prone position would have the benefit of more acceptable ergonomics and allow gravity to make easy the optimum

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exposure of the esophagus and thus a superb surgical view. Oxygenation afforded by the prone positioning would be superior compared to the lateral decubitus position during one-lung ventilation in the esophagectomy (11). The present research aimed to evaluate the possibility of thoracoscopicesophagectomy in the prone position.

## Materials and Methods

This study retrospectively analyzed information obtained from patients who underwent thoracoscopicesophagectomy in the prone position at Tehran University Cancer institute from January 2017 to December 2018.

Inclusion criteria were tumor staging of $T_2$ or more, ejection fraction of more than 40%, and FEV1>1.25. All patients were assessed with a preoperative computed tomography scan of the chest and abdomen, histologic confirmation, and upper gastrointestinal endoscopy. The operation was performed 6 to 8 weeks after neoadjuvant chemotherapy. Written informed consent was obtained from each patient. The study protocol was in accordance with the Helsinki declaration.

**Anesthesia**

Patients underwent a combined general and epidural anesthesia. Intubation was performed with a double-lumen endotracheal tube in a standard traditional way with possible two-lung ventilation (left-lung ventilation with probable periodic ventilation of the right lung). In addition, the right lung was collapsed, accompanied by the $CO_2$ pneumothorax at 6-8 mm Hg pressure monitored with the end-tidal $CO_2$ (ET $CO_2$).

**Thoracoscopic part**

The patient was positioned in a prone position after the completion of anesthesia. Then, the left arm of the patient was kept at the side of the body while the right arm was abducted 100° over the shoulder and fastened on an armrest. Patient's position secured to the table with straps. The surgeon stood on the right side of the patient. Moreover, the camera surgeon stood to the left of the surgeon, and the other assistant on the left side of the patient. In addition, the scrub nurse stood on the patient's left side. Finally, the laparoscopic cart with a monitor was positioned at the left shoulder of the patient.

**Position of ports**

At first, the Veress needle was placed in the seventh intercostal space in the midaxillary line. After insufflation to 8-mmHg with $CO_2$ gas, three ports were placed in the thoracic cavity. Two 5 mm ports were inserted in the fifth and ninth intercostal spaces. Besides, a 10 mm port was inserted in the seventh intercostal space (Figure 1).

**Esophageal mobilization and lymphadenectomy**

The esophagus tumor region, azygous vein, and pleura were inspected. Moreover, the tumor invasion to adjacent structures was evaluated. The inferior pulmonary ligament was divided for retracting the inferior lobe of the lung. Afterward, division of the mediastinal pleura over and beneath the azygous vein was performed with an electrocautery hook dissector. Actually, the azygous vein was thoroughly encircled, ligated with silk, and Hemoloc applied on both sides. The mediastinal pleura above the tumor and the entire esophagus were excised en bloc. The esophagus was encircled with umbilical tape. By retracting the esophagus ventrally, the esophagus was dissected from the chest walls and descending thoracic aorta. Then, the thoracic duct was occasionally visualized. It was tried to avoid injuries to the membranous trachea and the recurrent laryngeal nerves.

In addition, the vagus nerves were usually divided under the level of the carina after its cardio-pulmonary branching.

The most difficult step was to separate the membranous portion of the trachea from the esophagus by dissection with electro-cautery hook and esophageal traction. Furthermore, lateral dissection was performed to the left pleura. Finally, the whole esophagus from the thoracic inlet to the esophageal hiatus was mobilized.

Then, we obtained a complete nodal clearance in the infrarenal mediastinal space. Then, the lymph nodes and soft tissue were dissected from the caudal aspect near the hiatus, and then dissection continued up to the carina through 5-mm harmonic shears that avoid injuries to the pericardium anteriorly and both bronchi on the sides. Hemostasis was secured, and an intercostal drainage tube was placed. The lung was allowed to inflate, and trocars were eliminated (Figure 2). Then, the patients returned to the supine position.

**Figure 1.** Port position for prone patient

**Figure 2.** View of esophagus and azigus vein

### Abdominal part

The abdominal part was conducted by laparoscopic approach. Pyloromyotomy was performed for all patients. Each patient experienced a gastric conduit of 5 to 6 cm in width, and right gastric and gastro-epiploic vessels were cautiously maintained in all patients.

### Cervical part

For all patients, a 5 cm classic neck incision was created just anterior to the SCM muscle. Then, a cervical end-to-end hand-sewn anastomosis was performed with 2-0vicryl interrupted sutures. Since the present research focused on the thoracoscopic part in the prone position, abdominal and cervical parts were not described technically in detail.

## Results

Forty patients entered the study, of whom 21 (52.5%) were male. Moreover,the mean age of patients was 59.27±10.53 years ranging between 37 and 79 years. Twenty-five participants (62.5%) had adenocarcinoma versus 15 SCC (37.5%).

Twenty-three (57.5%) participants had a tumor in the middle third of the thoracic esophagus, whereas 10 (25%) in the lower thoracic esophageal or GE junction and 7 (17.5%) in the upper third. All participants had undergone neoadjuvant chemotherapy.

No conversion to open thoracotomy occurred. In seven patients, a tracheal tearing occurred during mobilization of the esophagus, which was repaired using 4-0 Vicryl interrupted sutures in one patient only. But in the other six patients, it was very small which did not need any repair. All microscopic injuries were recovered with conservative treatment for 24 hours.

The mean operating time was 298.65±30.90 min with a minimum and maximum of 240 and 410 minutes. The total approximated blood loss during the operation was 210±41 mL. Patients were ambulated on the first postoperative day. In addition, the mean intensive care unit (ICU) stay was 2.21±0.73, and the mean hospital stay was 6.21±1.11 days (min;4, max;9).

All the resections were R0 resections with 12 to 40 lymph nodes resected. There was no intraoperative mortality.

Three (7.5%), four (10%), seven (17.5%), one (2.5%), and one (2.5%) of patients suffered from pneumonia, anastomosis leakage, tracheal tearing, chylothorax, and pneumothorax, respectively. Patients with pneumonia recovered with medical therapy. Patients with cervical anastomosis leakage were also diagnosed with discharge from the Penrose drain in the neck and recovered with re-anastomosis. Due to the rapid diagnosis of anastomosis leakage and timely treatment, no signs of mediastinitis were observed. All of the tracheal tearing repaired with thoracoscopic endsuturing technique with 4-0 Vicryl interrupted sutures. Only one patient (2.5%) was diagnosed with chylothorax, which was recovered with thoracoscopic mass ligation of the thoracic duct. One case also had pneumothorax, which improved with chest tube insertion. The signs of recurrent nerve injury were not observed in any patient. Surgical site infection, deep venous thrombosis, and pulmonary emboli were not observed as well.

**Table 1. Demographic characteristics of the participants**

| Variable | | |
|---|---|---|
| **Age, years** | | 59.27 ± 10.53 |
| **Gender, %** | **Male** | 21 (52.5%) |
| | **Female** | 19 (47.5%) |
| **Pathology** | **Adenocarcinoma, %** | 25 (62.5%) |
| | **SCC, %** | 15 (37.5%) |
| **Tumor location** | **Upper esophagus, %** | 7 (17.5%) |
| | **Mid esophagus, %** | 23 (57.5%) |
| | **Lower esophagus, %** | 10 (25%) |
| **Hospital stay, days** | | 6.21 ± 1.11 |
| **ICU stay, days** | | 2.21 ± 0.73 |

## Discussion

According to the literature, transthoracic esophagectomy is associated with some morbidities, though it would provide enough exposure for mediastinal lymphadenectomy (12-14).

Video-assisted Thoracoscopy has been used to reduce the complications by small intercostal incisions and providing a magnified view of the mediastinal structures. It minimizes the morbidity of the thoracic time and provides a proper path for a thorough mediastinal lymphadenectomy, decreasing postoperative pains and providing a surgical specimen consisting of each periesophageallymphoadiposal tissue and thoracic duct (9,15,16). It has been shown that minimal invasive methods considerably diminish the pains and morbidities of esophagectomy. It also causes broader mediastinal lymphadenectomy.

Cuschieri *et al*., (17) is the first researcher who published this. Since that time, minimal invasive or laparoscopic approaches have been significantly used as one of the potentially less-invasive approaches to esophagectomy for esophageal cancer. In addition, laparoscopic trans-hiatal esophagectomy has been first described by DePaula*et al*., (18), who reported their results on 12 patients. In their study, the mean surgical procedure time was 256 min ranging between 210 and 370 minutes. Moreover, the mean postoperative hospital stay was 7.6 days ranging from 4 to15 days.

In addition, Nguyen *et al*., reported 46 patients who underwent minimally invasive esophagectomy. They reported a mean operation time of 350 minutes ranging between 210 and 520 minutes and a mean blood loss of 279 mL ranging between 50 and 1000 mL. Furthermore, the mean length of ICU and hospital stay were 2 and 8 days, respectively. Overall mortality in their study was 4.3%, and the rate of anastomotic leak was 4.35% (4). Another study performed by Palanivelu *et al*., reported 130 MIE with thoracoscopic mobilization in the prone position. Besides, the mean operative time was 220 min ranging between 160 and 450 minutes. Moreover, the mean estimated blood loss was 180 mL ranging between 100 and 400 mL, and the mean ICU stays as one day ranging between 1 and 32 days. Additionally, the time for initiation of oral intake was four days ranging between 2 and 18 days. Postoperative hospital stay was eight days ranging between 4 to 68 days. Finally, 30-day postoperative mortality rate was 1.54 % (n=2) (9).

We believe that thoracoscopic mobilization in the prone position would benefit from gravity for facilitating the optimum exposure of lungs and esophagus. Thus, it would afford a superb surgical view. Oxygenation presented in the prone positioning would be more acceptable than the one afforded by lateral decubitus position during one-lung ventilation in esophagectomy (11).

We think the prone position would provide all advantages of the lateral position regarding respiratory parameters and ergonomics. Moreover, the prone position is ergonomically more acceptable than the lateral decubitus position in terms of thoracoscopic mobilization of the esophagus.

It is well known that the thoracoscopic part of the TLE in the prone position would be one of the feasible options, which would give all the benefits of a lateral position. However, further large-scale studies are required to compare two positions in randomized controlled trials.

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