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Thoracolaparoscopy in the lateral position for esophageal cancer: the experience of a single institution with 112 consecutive patients

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Abstract
Background Esophagectomy has been performed using a thoracoabdominal, transhiatal, or transthoracic approach. All these methods have an acknowledged high intra- and postoperative morbidity. The principle of minimally invasive esophagectomy is to perform the operation the same as by the open approach but through a smaller incision, thus reducing the operative trauma without compromising the principles of the operation. The authors report their experience with thoracoscopic esophagectomy performed for 112 patients in left lateral position.
Methods Patients with resectable thoracic or gastroesophageal junction cancer and medically fit for a three-stage esophagectomy underwent thoracoscopic esophagectomy in left lateral position. The procedure was converted to open surgery for 2 (1.79%) of the 112 patients.
Results Since June 2005, 112 patients have undergone thoracoscopic esophagectomy in left lateral position. Of these patients, 80 patients had middle-third esophageal cancer. The pathology of 100 patients showed squamous cell carcinoma. The average thoracoscopic operating time was 85 min (range, 40–120 min). The average blood loss was 200 ml, and the average number of harvested mediastinal nodes was 20. Postoperative morbidity occurred for 16 patients, with 8 patients (7.27%) experiencing respiratory complications. Postoperative mortality was experienced by three patients. The median follow-up period was 18 months.
Conclusions Thoracoscopic esophagectomy is surgically safe and oncologically adequate. Thoracoscopy for patients in the left lateral position does not require prolonged single-lung ventilation. The anatomic orientation in the left lateral position is the same as that for open surgery, reducing the learning curve for thoracic surgeons. The potential advantages and the morbidity trend of prone instead of left lateral thoracoscopic esophagectomy needs to be evaluated.

Keywords Esophageal cancer · Esophagectomy · Laparoscopy · Thoracoscopy

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Surgical resection is the primary therapy for local and locoregional disease in esophageal cancer due to its superior and more durable results in terms of swallowing quality compared with nonoperative methods. The prognosis for esophageal cancer is poor. It is the sixth leading cause of cancer death, with the median survival time ranging from 1 to 2 years [1]. Regardless of the surgical procedure used, avoiding or minimizing complications and rapid return to preoperative status are the obvious goals.

Traditional open surgical transthoracic and transhiatal esophagectomies are associated with a relatively high morbidity reaching 80% and a 5% mortality rate when performed by experienced surgeons [2]. The treatment of esophageal cancer has undergone many changes to improve this outcome. The potential advantages of minimally invasive esophagectomy are less trauma, easier postoperative recovery, and fewer wound and pulmonary complications. Depaula et al. [3] were the first to demonstrate the feasibility of laparoscopic transhiatal esophagectomy in a series of 12 patients.

Thoracoscopic esophagectomy facilitates mediastinal dissection by better visualization of the tumor and thorough dissection of both regional and distant lymph nodes. In this retrospective analysis, we describe the procedure of laparoscopic transthoracic esophagectomy and laparoscopic gastric mobilization as advocated at our institution. This analysis aimed to evaluate the technical feasibility, the surgical and oncologic safety, and the reproducibility of our technique.

Materials and methods

We retrospectively studied all the patients who underwent thoracoscopic esophageal dissection, laparoscopic stomach mobilization, and anastomosis of the gastric conduit in the neck at a single institution from June 2005 to June 2008. All the patients underwent preoperative diagnosis with esophagogastroscopy and biopsy, computed tomography of the chest and abdomen, and bronchoscopy when required. Operative medical fitness was determined by clinical assessment, pulmonary function testing, and two-dimensional echocardiography.

We followed the National Comprehensive Cancer Network (NCCN) guidelines for patient selection. Thus, all medically fit patients with resectable thoracic or gastroesophageal junction cancers (i.e., T1 to T3 tumors) with or without N1 nodal status were included in thoracoscopic arm of the study, whereas patients with T4 tumors were not. Thoracoscopic and laparoscopic esophagectomy was performed in three stages.

Stage 1: Thoracoscopic esophageal mobilization

General anesthesia with single-lung ventilation was used. The patient was placed in the left lateral decubitus position. Four ports were placed in diamond formation, as shown in the Fig. 1.

Pneumoinsufflation was performed under a low pressure of 7 mmHg. A 0° telescope was used as optics. A diagnostic thoracoscopy was performed to inspect the pleural cavity and the surface of the lung for any suspicious metastatic lesion. The right lung was retracted upward and medially to expose the thoracic esophagus.

The procedure was begun by incising the visceral pleura between the esophagus and the infra-azygous part of the aorta with either a bipolar forceps or a harmonic ultrasonic scalpel. The medial end of the pleura was held by the left hand lifting the esophagus. Thus the posterior vagus was exposed.

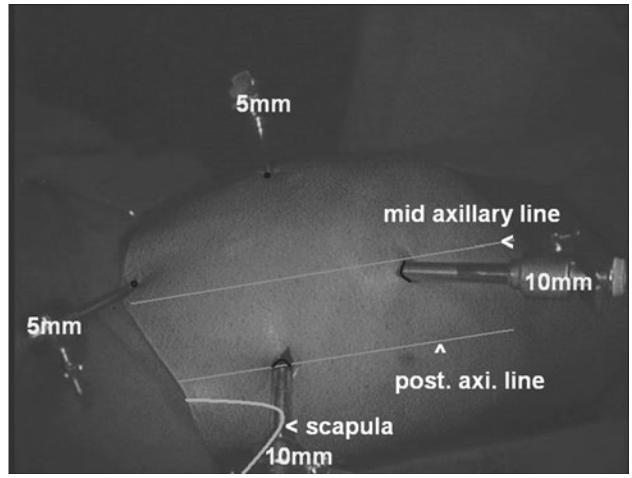

Fig. 1 Thoracoscopic port position

The plane of dissection was lateral to the vagus and not between the vagus and esophagus. The direct aortic branches were clipped and cut. The esophagus then was lifted from the arch of the aorta, which was seen at the level immediately below the azygous vein. The left main bronchus was exposed, and the left hilar nodes were dissected. The esophagus was completely separated posteriorly by a combination of sharp and blunt dissection. The caudal limit of posterior dissection was the hiatus. The thoracic duct was seen crossing the descending aorta, which was clipped.

The anterior pleural cut was made after the esophagus was pulled laterally, and the cut was extended cranially and caudally, remaining parallel to the esophagus. The plane of dissection was between the anterior vagus and the pericardium. The carinal and the right hilar nodes were removed. The dissection was carried caudally between the pericardium and the esophagus, stripping the pericardium of all fibrofatty tissue and nodes. The caudal end point was the hiatus, and this completed the infraazygous dissection.

The supraazygous area was exposed by the assistant pulling down the apex of the lung. The pleura over the esophagus was lifted and cut. The cut was extended upward to the root of the neck. The vagus nerve was identified, and the vagal fibers going to the bronchus were preserved.

The dissection was started posteriorly between the esophagus and the vertebrae. All the fibrofatty tissue together with the nodes was pushed with the esophagus. We normally preserved the azygous vein, but when required for better visualization or clearance, the vein can be clipped and cut. The fascia over the vein was removed. When the azygous vein was preserved, the pleura over the vein was cut, and a plane was created posterior to the vein and anterior to the esophagus. Retroazygous dissection was facilitated by retraction of the azygous vein.

The esophagus was dissected all around the circumference in the supraazygous region, and these planes were joined with those in the infraazygous region, thus completely freeing the esophagus. This was confirmed by pulling the esophagus craniocaudally (shoeshine effect). The left recurrent nerve was identified in the tracheoesophageal groove. The nodes along this nerve were removed.

The esophageal dissection was carried cranially up to the root of the neck. An intercostal drainage tube was inserted through the working 10-mm port. The lung was inflated, and the camera port was removed under vision.

Stage 2: Laparoscopic gastric mobilization

The patient was placed in a modified Lloyd-Davis 15°–20° head-up position. The surgeon stood between the legs of the patient, with the camera man and one assistant on left and with the second assistant and scrub nurse on the right. Five ports were used, as shown in Fig. 2.

Stomach mobilization was begun by opening the gastrocolic ligament and entering the lesser sac. The greater omentum was divided. The stomach was lifted from the pancreas by cutting the congenital bands. The fundus and entire stomach were pushed to the right side by the assistant rolling the fundus toward the right, and the gastrosplenic ligament was cut while the short gastric vessels were coagulated and cut.

The hepatic flexure and the transverse colon reflection were cut, and the colon was retracted caudally. This exposed the second part of duodenum, which was Kocherized. The left lobe of liver was retracted by the left assistant, and the gastrohepatic ligament was cut. The cut was extended upward to the lower end of the hiatus. The right crus of the diaphragm was identified, and the peritoneum over it was cut. This cut was extended up to the hiatus. The dissection was continued posteriorly until the left crus was identified. The esophagus was dissected all around at the level of the hiatus.

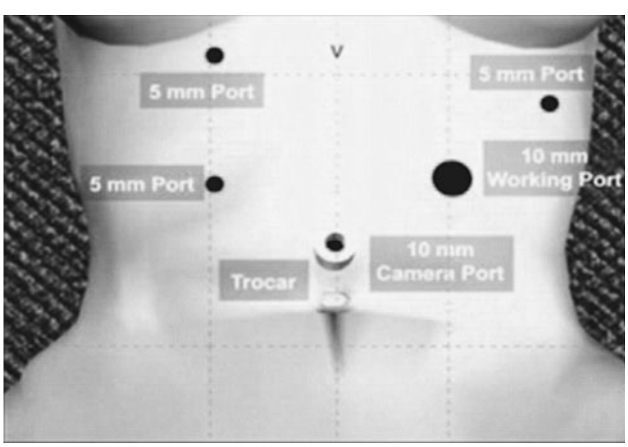

Fig. 2 Laparoscopic gastric mobilization port position

All the nodes along the celiac trunk together with the common hepatic, splenic, and left gastric artery were removed. The left gastric artery and vein were clipped and cut. The hiatal opening then was widened.

Stage 3: Cervicotomy and esophagogastric anastomosis

The patient was placed in the head-up position, with the neck extended and turned toward the right. A left supraclavicular transverse incision was made. The two heads of the sternocleidomastoid were separated, exposing the carotid sheath together with the internal jugular vein and the common carotid artery. The inferior thyroid vein was ligated, and the vessels were retracted laterally to reach the prevertebral fascia. The esophagus was lifted from its posterior bed, and the dissection was continued posteriorly until the right lateral wall was reached. The esophagus was separated from the trachea and completely encircled. Mobilization was confirmed by pulling the esophagus into the neck. The esophagus was divided by placing two stay sutures. The distal end was tied, and a nasogastric tube was tied to the distal end. The entire esophagus together with the nasogastric tube was pulled through the hiatus laparoscopically.

A small abdominal incision was made at the level of the camera port. The stomach and esophagus were delivered using a skin barrier. An extracorporeal stomach tube was prepared and pulled back through the posterior mediastinum into the neck, and an esophagogastric anastomosis was done in two layers. A feeding jejunostomy was established in all cases.

Postoperatively, the patients were kept overnight in the intensive care unit. They were extubated the next day if their vitals were normal. Jejunostomy feeds were begun on postoperative day 1. Epidural analgesia was given for 48 h, and later pain was relieved by nonsteroidal antiinflammatory drugs. A water-soluble swallow was administered on day 8, and then oral feeds were started. Patients were discharged after the commencement of oral feeds.

Results

Since June 2005, we have performed video-assisted transthoracic esophagectomy for 112 patients at Galaxy Laparoscopy Institite Pune in India. The surgery was done in three stages, namely, thoracoscopy in the left lateral position, laparoscopic gastric mobilization in the supine position, and neck exploration. The mean age of these patients was 54 years (range, 25–78 years). The male:female ratio was 2.2:1 (78/34). The indication for surgery was malignancy for all 112 patients. For 80 patients (71.4%), the tumor was situated in middle third of the esophagus,

Table 1 Patient and tumor characteristics

Patients	
No. of patients	112
Median age: years (range)	54 (25–78)
Male/female	78/34
Site	
Upper third	0
Middle third	80
Lower third	32
Histologic type: *n* (%)	
Squamous carcinoma	100 (89.29)
Adenocarcinoma	12 (10.71)
Tumor size	
T1	03
T2	20
T3	89
T4	00

whereas for 32 patients (28.6%) the tumor was in the lower third. For 100 patients (89.29%), the malignancy was squamous cell cancer. The remaining 12 patients (10.71%) had adenocarcinoma (Table 1). Preoperative chemotherapy was administered to 10 patients (8.93%). At presentation, 22 patients had comorbid conditions in the form of diabetes and hypertension. Patients with severe obstructive and restrictive airway disease were excluded from the study.

Conversion to open thoracotomy was required for two patients (1.79%) due to pericardial adherence. Thoracoscopic esophagectomy mobilization was performed for 110 patients. The majority of our patients had T3 tumors ($n = 89$). Only 3 patients had T1 tumor, whereas 20 patients had T2 tumor. Two patients with T3 tumor had pericardial adherence intraoperatively and hence were staged as T4. There was no conversion during laparoscopic gastric mobilization.

The average operative thoracoscopic time was 85 min (range, 40–120 min), and the average time for the entire procedure was 185 min (range, 120–200 min). The gastric mobilization and neck dissection were performed simultaneously by two teams. Blood loss during the thoracic phase averaged 200 ml (range, 30–1,000 ml). Two patients had azygous vein bleed, with blood loss exceeding 800 ml. Both of these cases were managed thoracoscopically, and conversion was not required. The average number of harvested mediastinal nodes was 20 (range, 7–30), whereas the harvested abdominal nodes numbered 15 (range, 10–25) (Table 2). There was no intraoperative mortality.

The median stay in the intensive care unit was 24 h, and the median hospital stay was 9 days (range, 5–20 days). Postoperative complications were experienced by 16 patients (14.55%), with postoperative pneumonia developing in 8 patients (7.27%), who required antibiotics for clinical and radiologic evidence of chest infection. Anastomotic leak was detected in three patients. The leak was minor and managed conservatively. Oral feeding was delayed in this group. Four patients experienced hoarseness of voice reflecting recurrent laryngeal injury (paresis), which resolved within 6 weeks. One patient had myocardial infarction. Three patients (2.73%) died postoperatively: one of myocardial infarction, one of sepsis resulting from pneumonia, and of aspiration 30 days after discharge. Eight patients (7.2%) experienced long-term complications in the form of stenosis, with dysphagia that required serial dilations. No port-site metastasis was seen (Table 3).

The median follow-up period was 18 months (range, 1–47 months). Recurrence was mainly systemic in the form of liver and lung metastasis. At this writing, no patient has had any intrathoracic recurrence.

Table 2 Results

Results	Median (range)
Blood loss (ml)	200 (30–1,000)
Operative time (min)	
Thoracoscopic	85 (40–120)
Total	185 (120–200)
No. of lymph nodes removed	
Mediastinal	20 (7–30)
Abdominal	15 (10–25)

Table 3 Postoperative course

Median hospital stay: days (range)	9 (5–20)
Postoperative complications: *n* (%)	16 (14.55)
Pneumonia	8
Anastomotic leak	3
Hoarseness of voice	4
Myocardial infarction	1
Mortality: *n* (%)	3 (2.73)
Sepsis	1
Myocardial infarction	1
Aspiration (30-day mortality)	1

Discussion

Surgical resection is the preferred treatment for resectable esophageal cancers. Morbidity due to surgical access can impair quality of life [4]. The development of minimally invasive surgery at the beginning of the 1990s gained consensus for a mini-invasive approach to esophagectomy. In a prospective randomized trial, Goldminc et al. [5]

concluded that intrathoracic esophageal mobilization allows better clearance of tumor and lymph nodes. Transthoracic esophagectomy is safer, especially if the tumor is adherent to mediastinal structures, because esophageal dissection is performed under visual guidance, thus avoiding the risks of blind mobilization. However, thoracoscopic esophagectomy gained disrepute because it required the use of prolonged single-lung ventilation.

Video-assisted transthoracic esophagectomy can be performed with the patient in either the prone or the left lateral position. We performed thoracoscopic esophagectomy with the patient in the left lateral position and laparoscopic gastric mobilization for 112 patients of esophageal cancer. This series demonstrates the technical feasibility, safety, and dublicability of performing the procedure in the left lateral position with all the other advantages of minimally invasive surgery. We performed the entire procedure in three stages, namely, thoracoscopy, laparoscopy, and cervicotomy.

All 112 patients in our series had invasive carcinoma. In particular, 80 patients had middle-third and 32 patients had lower third esophageal cancer. The pathology of 100 patients (89.29%) showed squamous cell carcinoma. In addition, 79.46% of the patients had T3 tumors. We had bulkier tumors with mainly squamous carcinoma (89%). This is in contrast to the series published by Luketich et al. [6], in which 90% of the patients had adenocarcinoma of the gastroesophageal junction. In the study by Smithers et al. [7], 63.58% of the patients had lower-third esophageal growths.

The port placement was in the form of a diamond. The triangulation allowed an ergonomatic advantage. This port position was different from the port placement in the Luketich et al. [6] series of thoracoscopy with the patient in the lateral position [6]. The camera port placement in the posterior axillary line allowed direct visualization of the esophagus. Thus, a 0° telescope could be used.

The left lateral position was preferred because we were trained and had experience to perform right lateral thoracotomy. The anatomic orientation was the same not only for the operating surgeon but also for the entire team. This led to early adaptation of the technique by our entire team. The minimally invasive surgery was thus just an application of another method for performing the same surgical steps as in open surgery. We believe that the familiar position and anatomy may encourage and stimulate more esophageal surgeons to adapt to minimally invasive surgery and also may reduce the learning curve. Besides, conversion to open surgery, if required, is better achieved with the patient in this position.

Thoracoscopic esophageal mobilization was performed for 110 patients. Two patients (1.7%) required conversion to open thoracotomy due to pericardial adherence of the tumor. Thus, in both cases, it was a planned decision. The conversion rate was 4% in the series of Law et al. [8] and 6.6% in the series of Luketich et al. [6]. In most series, the conversion was due to difficult access because of adhesions or emergency thoracotomy for bleeding. Luketich et al. [6] mentioned major intraoperative complications such as hypopharynx laceration, small bowel perforation, and tracheal tear. We encountered intraoperative complication in two patients with azygous vein tear. This occurred due to involvement of the vein in supracarinal growth. The bleeding was managed thoracoscopically in both cases and did not require conversion.

The median total operative time was 185 min (range, 120–200 min), and the median thoracoscopic time was 85 min (range, 40–120 min). The average thoracic time for the patients in the in prone position was 104 min in the series of Smithers et al. [7] and 183 min according to Dexter et al. [9]. Law et al. [8] performed thoracoscopy with patients in the left lateral position, with the thoracoscopy requiring 110 min and the total operation requiring 299 min (Table 4).

The proponents of the prone position have inferred that thoracoscopy with the patient in the lateral position requires the use of prolonged single-lung ventilation (much longer than with open methods) and that mediastinal trauma remains substantial, thus doing little to reduce the morbidity and mortality associated with this procedure. Because our thoracoscopic operative time was less than 2 h, we did not require prolonged single-lung ventilation, and thus the potential advantages of minimal access surgery were not lost.

The low conversion rate and the shorter thoracic time may be due to anatomic familiarity, a high-volume center, extensive experience with open thoracotomy, standardization of steps, disciplined teamwork, and multiple instruments (preventing any delay due to instrument failure). The average blood loss in our series was 200 ml (range, 30–1,000 ml). Two patients with azygous vein tear required blood transfusion. Simon et al. [8] had an average blood loss of 450 ml. The reduced blood loss was partly due to advanced vessel-sealing devices and to magnification resulting in better visualization of every structure. During thoracotomy, the access and the depth are both disadvantages especially for the supraazygous part, leading to increased blood loss.

The two-field nodal dissection we achieved was of the same quality as in open surgery. The paraesophageal, carinal, right hilar, paratracheal, and right recurrent nodes were removed. In the abdominal part of the operation, the left gastric, right hepatic and proximal splenic nodes were removed.

Akiyama et al. [10] observed that in the case of squamous esophageal carcinoma, radical lymphadenectomy

Table 4 Comparison with other series

	Smithers (prone) [7]	Dexter (prone) [9]	Simon (lateral) [8]	Luketich (lateral) [6]	Puntambekar (lateral)
No. of patients	153	22	18	60	112
Conversion: % (*n*)	7	4.5 (1)	4	5	1.7 (2)
Recurrent palsy: % (*n*)	5	36 (8)	22.2 (4)	2.6 (2)	3.64 (4)
Respiratory complications: % (*n*)	27 (39)	59 (13)	55.56 (10)	21	7.27 (8)
Anastomotic leak: % (*n*)	4	9 (2)	0	9.09 (7)	2.73 (3)
Chyle leak: % (*n*)	2.4 (4)	9 (2)	–	3.9 (3)	0
No. of lymph nodes: *n* (range)					
Total	–	13 (6–28)	–	16 (10–51)	17–55
Mediastinal	0–24	–	7 (2–13)	–	20 (7–30)
Median blood loss (ml)	165	–	450	–	200
Total operative time	299 (195–430 min)	–	–	7.5 (4.0–13.6 h)	185 (120–200 min)
Thoracoscopic time: min (range)	104 (30–240)	183	110 (55–165)	–	85 (40–120)
Mortality: % (*n*)	8.02 (13)	14	0	0	2.73 (3)

offers a survival advantage for node-positive patients. The mean mediastinal lymph node yield in our series was 20 mediastinal nodes (range, 7–30) and 15 abdominal nodes (range, 10–25), which was the same as our yield with open surgery. With regard to lymph node yield, Nguyen et al. [11] reported a mean yield of 10.3 nodes, Akaishi et al. [12] a mean yield of 19 nodes, Dexter et al. [9] a mean yield of 13 nodes, and Smithers et al. [7] a mean yield of 11 nodes.

We tried to achieve adequate lymph node clearance because 89% of our patients had squamous carcinoma. The quality of lymph node retrieval improved as experience accumulated. Dexter et al. [9] mentioned that the lymph node count did not always reflect the extent of resection because the specimens were examined by a number of pathologists, some of whom were more fastidious than others when searching for nodes in specimen [9]. To avoid sampling error in our series, the surgeon calculated the nodal yield.

We performed laparoscopically assisted gastric mobilization in all our cases. Luketich et al. [6] also performed laparoscopic gastric mobilization, but he formed an intracorporeal stomach tube using Endo-GI staplers (Johnson and Johnson, Cincinnati). This increased the total operative time (median, 7.5 h). In our series, the stomach tube was prepared extracorporeally by making a small abdominal incision required for both specimen delivery and feeding jejunostomy. This further reduced the total operative time. It also was safer and less expensive [13]. No morbidity occurred due to the abdominal incision.

We do not routinely perform pyloromyotomy. Most authors strongly support the need to perform a pyloromyotomy for gastric tubularization, believing they can improve the rate of gastric emptying [14, 15]. In our opinion, this is not mandatory. It is more physiological to preserve gastric integrity, avoiding the section of blood vessels along the lesser curvature. Furthermore, pyloromyotomy can increase bile reflux without improving the rate of gastric emptying. In our series, only two patients (1.82%) experienced delayed gastric emptying, with spontaneous resolution after 1–2 weeks, and no patient presented with digestive problems at the long-term follow-up visit.

The median intensive care unit stay was 24 h, and the median hospital stay was 9 days (range, 5–20 days). Postoperative complications occurred for 16 patients. Respiratory complications have been noted by all groups performing thoracoscopic esophagectomy. The incidence of such complications is variable. Cuschieri et al. [16] noted pulmonary consolidation in 12% of 26 patients. Gossot et al. [17] had a 17% incidence of atelectasis, and Smithers et al. [7] had a 27% incidence of respiratory complications even among patients in the prone position.

Eight of our patients (7.27%) had pulmonary consolidation, confirmed by clinical and radiologic evidence, and requiring prolonged antibiotic cover. This reduced rate of pulmonary complications was seen despite advanced (T3) tumor and the fact that 80% of our patients had a history of tobacco chewing or smoking and evidence of restrictive lung disease. The reduced pulmonary morbidity probably was due to the reduction in thoracoscopic operating time and minimal lung retraction, causing less lung parenchymal injury. The minimal lung retraction was due to the use of a double-lumen endotracheal tube, right lung air aspiration by the anesthetist, and carbon dioxide insufflation at reduced pressure (maximum, 6 mmHg).

The belief that persistent ventilation of both lungs of patients in the prone position leads to fewer respiratory complications may not be true and needs to be determined by a randomized control trial. Fewer intraoperative complications also reduced postoperative morbidity.

Chyle leak occurred in many series, with Smithers et al. [7] reporting a chyle leak rate of 2.4%, Dexter et al. [9] a leak rate of 9%, and Luketich et al. [6] a leak rate of 11.6%. Our series had no postoperative chyle leak. We always identified the thoracic duct and clipped it.

Recurrent laryngeal nerve injury has been reported, with an incidence of 7% to 33% after thoracoscopic esophagectomy [9]. In our series, the incidence was 3.64%. All the recurrent nerve palsies were transient and attributable to traction on the intrathoracic segment of the nerve during esophageal mobilization.

The incidence of anastomotic leak in our series was 2.7% compared with the incidences reported by Luketich et al. [6] (11.6%), Dexter et al. [9] (9%), and Smithers et al. [7] (4%). Our lower anastomotic leak rate compared with that of our open series and the leak rate of other series could be explained by our laparoscopic performance of gastric mobilization, resulting in minimum stomach handling, good vascularity of the stomach tube, and minimum or no dissection of the proximal cervical esophagus.

There was no perioperative mortality. Two patients experienced postoperative mortality: one because of myocardial infarction and one due to sepsis. One patient died of aspiration within 30 days after surgery. The mortality rate was lower than that of other series reported in the literature [7, 9].

The long-term complication in our series was anastomotic stricture, experienced by eight patients (7.2%). All these patients were symptom free after two or three dilations. No port-site metastasis was documented in the series of Martin et al. [18] or Simon et al. [8]. The median hospital stay was 9 days compared with 16 days in the Martin et al. [18] study. We emphasize that the postoperative outcome for patients who undergo esophagectomy is affected by the magnitude of the procedure itself. But the avoidance of thoracotomy, the smaller incision, the minimal blood loss, and the fewer pulmonary complications resulted in a shorter hospital stay.

The median follow-up period in our series was 18 months. The recurrence pattern was mainly systemic. No local or operative field recurrence was noted. At this writing, we have not had any port-site metastasis.

Summary

Thoracoscopic and laparoscopic esophagectomy is technically feasible, surgically safe, and oncologically adequate. The dissection is performed entirely under vision. Increased magnification results in precision, less blood loss, and meticulous sharp dissection. A complete nodal clearance can be achieved. A thoracotomy is avoided, with potentially faster postoperative recovery, and the time required for esophageal dissection is reduced due to standardization of steps.

The drawbacks and morbidity of single-lung ventilation is not seen due to reduced thoracoscopic time. There is no tactile sensation. Thus extensive surgical experience is a must. The procedure is duplicable and because the anatomic orientation with the left lateral position is the same as with open thoracotomy, the learning curve for the thoracic surgeon can be reduced.

Conclusion

The immediate oncologic goals of adequate margins and lymph node dissection can be achieved. The disease-free survival and overall survival rates need further evaluation. The morbidity of transthoracic esophagectomy can be reduced by minimally invasive thoracoscopic esophageal mobilization. A prospective randomized trial comparing open and minimally invasive esophagectomy is needed. Similarly we need to evaluate the potential advantages and the morbidity trend of prone compared with left lateral thoracoscopic esophagectomy.

Disclosures Shailesh P. Puntambekar, Geetanjali A. Agarwal, Saurabh N. Joshi, Neeraj V. Rayate, Ravindra M. Sathe, and Anjali M. Patil have no conflicts of interest or financial ties to disclose.

References

1. Ayiomamitis A (1988) Epidemiology of cancer of the esophagus in Canada: 1931–1984. Gastroenterology 94:374–380
2. Bailey SH, Bull DA, Harpole DH, Reutz JJ, Neumayer MD (2003) Outcomes after esophagectomy: a ten-year retrospective cohort. Ann Thorac Surg 75:217–222
3. DePaula AL, Hashiba K, Ferreira EA (1996) Transhiatal approach for esophagectomy. In: Tooli J, Gossot D, Hunter JG et al (eds) Endosurgery. Churchill Livingstone, New York, pp 293–299
4. Watson DI, Jamieson GG, Devitt PG (2000) Endoscopic cervicothoracoabdominal esophagectomy. J Am Coll Surg 190:372–378
5. Goldminc M, Maddern G, LePrise E, Meunier B (1993) Oesophagectomy by a transhiatal approach or thoracotomy: a prospective randomized trial. Br J Surg 80:367–370
6. Luketich JD, Alvelo-Rivera M, Buenaventura PO, Christie NA, McCaughan JS, Litle VR, Schauer PR, Close JM, Fernando HC (2003) Minimally invasive esophagectomy: outcomes in 222 patients. Ann Surg 238:486–495
7. Smithers BM, Gotley DC, McEwan D, Martin Bessell IJ, Doyle L (2001) Thoracoscopic mobilization of the esophagus: a 6-year experience. Surg Endosc 15:176–182
8. Law S, Fok M, Chu KM, Wong J (1997) Thoracoscopic esophagectomy for esophageal cancer. Surgery 122:8–14
9. Dexter SPL, Martin IG, McMahonz MJ (1996) Radical thoracoscopic esophagectomy for cancer. Surg Endosc 10:147–151
10. Akiyama H, Tsurumari M, Kawanuru T, Ono Y (1981) Principles of surgical treatment for carcinoma of the oesophagus: analysis of lymph node involvement. Ann Surg 194:435–446

11. Nguyen NT, Roberts P, Follette DM, Rivers R, Wolfe BM (2003) Thoracoscopic and laparoscopic esophagectomy for benign and malignant diseases: lessons learned from 46 consecutive procedures. J Am Coll Surg 197:902–913
12. Akaishi T, Kaneda I, Higuchin N (1996) Thoracoscopic en bloc total esophagectomy with radical mediastinal lymphadenectomy. J Thoracic Cardiovasc Surg 112:1533–1541
13. Van den Broek WT, Makay O, Berends FJ, Yuan JZ, Houdijk AP, Meijer S, Cuesta MA (2004) Laparoscopically assisted transhiatal resection for malignancies of the distal esophagus. Surg Endosc 18:812–817
14. Bemelman WA, Taat CW, Slors JF, van Lanschot JJ, Obertop H (1995) Delayed postoperative emptying after esophageal resection is dependent on the size of gastric substitute. J Am Coll Surg 180:461–464
15. Finley FJ, Lamy A, Clifton J, Evans KG, Fradet G, Nelems B (1995) Gastrointestinal function following esophagectomy for malignancy. Am J Surg 169:471–475
16. Cuschieri A, Shimi S, Banting S (1992) Endoscopic oesophagectomy through a right thoracoscopic approach. J R Coll Surg Edinb 37:7–11
17. Gossot D, Cattan P, Fritsch S, Halimi B, Sarfati E, Celerier M (1995) Can the morbidity of esophagectomy be reduced by the thoracoscopic approach? Surg Endosc 9:1113–1115
18. Martin DJ, Bessell JR, Chew A, Watson DI (2005) Thoracoscopic and laparoscopic esophagectomy: initial experience and outcomes. Surg Endosc 19:1597–1601