Techniques

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SURGICAL ENDOSCOPY and Other Interventional Techniques

Prone thoracoscopic esophageal mobilization for minimally invasive esophagectomy

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Abstract
Background: Minimally invasive esophagectomy is a complex surgical procedure. We recently began performing thoracic mobilization of the esophagus with the patient in the prone position, not the left lateral decubitus position, in the hope of minimizing the number of technical challenges.
Methods: Six consecutive minimally invasive esophagectomies were performed using prone thoracoscopic esophageal mobilization with creation of cervical anastamosis. Our esophagectomy database was evaluated for outcomes, including operative time, estimated blood loss, complications, and length of hospital stay.
Results: We were successful in our first six attempts, with a mean blood loss of 61 cc. Mean operative time for thoracoscopy was 80 min. Operative times were steady over the first six prone cases at 105, 85, 70, 55, 80, and 85 min. Three of the six patients had no complications. Median postoperative length of hospital stay was 11.5 days, and there were no deaths.
Conclusions: This technical report and case series demonstrates that prone thoracoscopic esophageal mobilization appears to be a reasonable alternative to the same procedure performed with the patient in the decubitus position. We find the technique to simplify portions of an otherwise difficult surgical procedure. Further evaluation with larger number of patients should be performed.

Key words: Thoracoscopy, esophageal — Cancer, general — Cancer, esophageal — Surgical — Technical

Minimally invasive esophagectomy (MIE) is being performed at an increasing number of institutions. Different minimally invasive and hybrid approaches are being used to perform the procedures, comparable to transhiatal and Ivor Lewis esophagectomy. At our institution the MIE via right thoracoscopic mobilization, followed by laparoscopy with cervical anastomosis is the most commonly performed esophagectomy. Cuschieri [1] first performed thoracoscopic esophageal mobilization with the patient in the prone position in 1994. Most centers performing MIE have not adopted the prone technique, however, and continue to use lateral decubitus positioning. Although lateral positioning is familiar to surgeons and allows for conversion to an open procedure if necessary, it carries several disadvantages for thoracoscopy. We report a case series of our first six patients in whom prone thoracoscopic mobilization was performed, and detail our operative technique.

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Methods

Following Institutional Review Board approval at the Hospital of St. Raphael, New Haven CT, a prospectively maintained MIE database was reviewed to evaluate outcomes of our first six esophagectomies performed using prone thoracoscopic esophageal mobilization technique. The six consecutive cases were managed by three different surgeons at a single institution between January and March of 2006. No patients were excluded, and all patients underwent thoracoscopic mobilization with transcervical anastomosis.

After induction of general anesthesia with placement of a double-lumen endobronchial tube, the patient is placed in the prone position on an operative beanbag. The arms are abducted to 90 degrees with the forearms flexed an additional 90 degrees. The operating table is flexed 25 degrees at the patient's hips. The operative field is prepped and draped on the patient's right, posteriorly from the epidural catheter dressing as far anteriorly as possible. A 12-mm Versastep port (U.S. Surgical, Norwalk, CT) is placed in the eighth intercostal space in the posterior axillary line, and CO_2 insufflation is accomplished with a pressure of 8 mmHg. This insufflation depresses the diaphragm caudally and the right lung anteriorly, maximizing exposure of the intrathoracic esophagus. A second 5-mm port is placed immediately cephalad and posterior to the tip of the scapula, and a 10-mm port is placed halfway between the spine and the original 8th intercostal port. This 10-mm port serves as the camera site and alternatively could be a 5-mm port (Fig. 1).

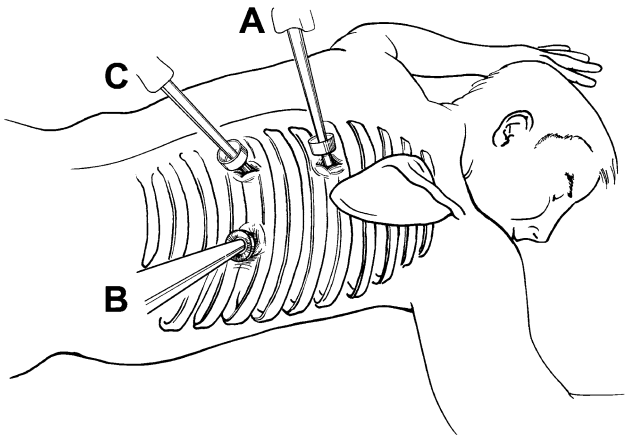

Fig. 1. Port placement for prone esophageal mobilization. A 5-mm right-handed working port (A), a 12-mm left-handed working port (B), and 5- or 10-mm camera port (C).

The surgeon and camera operator stand at the patient's right side, and the video monitor is positioned directly opposite, on the patient's left. A 30-degree 5- or 10-mm thoracoscope is advanced through the posterior 10-mm port. The surgeon, using a grasper in the left hand and hook electrocautery in the right hand, begins by cauterizing the mediastinal pleura overlying the anterior aspect of the esophagus, mobilizing the esophagus away from the hilum and the pericardium. Mobilization extends to the level of the azygous vein, which is skeletonized and divided with an endovascular gastrointestinal anastomosis (GIA). With electrocautery the parietal pleura posterior to the esophagus is opened from the level of the azygous vein to the crus. Blunt dissection is undertaken to identify any potential thoracic duct branches as well as aortesophageal arteries. When identified, these structures are clipped and transected with a harmonic scalpel (Ethicon, Somerville, NJ). The esophagus is encircled with a 5/8-inch Penrose drain, which is then stapled as a ring with a vascular GIA. Grasping the Penrose drain with the left-handed instrument allows excellent counter-tension, simplifying complete mobilization and en-bloc resection of the subcarinal lymph node basin. The esophagus is mobilized from the crus to the thoracic inlet, where the Penrose drain is left tucked under a pleural flap allowing its retrieval from the neck. A single 28-F chest tube or, alternatively, a 19-F Blake drain (Ethicon, Somerville, NJ), is placed through the 12-mm incision and the lung is re-expanded. The remaining thoracostomy wounds are closed with Vicryl sutures and Dermabond (Ethicon, Somerville, NJ).

The patient is then repositioned supine. The double-lumen endotracheal tube is exchanged for a single-lumen tube, and the remaining laparoscopic and cervical portions of the procedure are then performed in a fashion similar to that described by the University of Pittsburgh group [2]. Briefly, the laparoscopic stage of the procedure requires five abdominal ports placed in the upper half of the abdominal wall. Dissection begins along the lesser and greater curvature of the stomach with preservation of the right gastroepiploic artery. Celiac lymph nodes are dissected, and the left gastric artery is transected with an endoscopic stapler. A 5-cm-wide gastric conduit is created by means of multiple firings of endoscopic stapler, starting on the lesser curve and extending to the fundus of the stomach. All patients then undergo an emptying procedure and feeding jejunostomy placement. A transverse cervical incision is then made in the left neck and the esophagus is encircled. The esophageal specimen is retrieved through this incision, as is the gastric conduit. The anastomosis is then created in the neck with a stapled side-to-side technique as described by Orringer et al. [3].

Results

During the 3-month interval January-March 2006, six consecutive minimally invasive esophagectomies were performed with the prone thoracoscopic approach. Table 1 summarizes patient demographics, tumor stage, and clinical outcomes. Mean duration of thoracic mobilization in these six cases was 80 (55–105) min. There were no intraoperative complications, iatrogenic injuries, or conversions. Mean blood loss for thoracoscopic mobilization was 61 (40–140) cc per case. Among the six patients three (50%) had no complications. Of the three who did, one patient developed atrial fibrillation and was diagnosed with a pulmonary embolism on the second postoperative day. The patient recovered from his complications and was discharged home on postoperative day 10. Another patient had an uneventful recovery but was readmitted to the hospital for 5 days to manage a unrelated lower gastrointestinal bleed requiring transfusion. The third patient required reintubation for hypoventilation and was discharged 32 days postoperatively. There was no 30-day or in-hospital mortality. The median postoperative length of stay was 11.5 (8–32) days, with three (50%) of the six patients discharged within 10 days of surgery. The average number of lymph nodes harvested per case was 13.6 (10–18).

Discussion

Most minimally invasive esophagectomies are performed at specialized centers with extensive experience in esophageal disease and minimally invasive surgery. In these centers, the operation has been performed with low morbidity and mortality rates as low as 1.4% [2]. The procedure is, however, technically challenging, with significant physical and mental demands on the surgeon and operative team.

Cuschieri [1] initially proposed positioning the patient in the prone position during thoracoscopic esophagectomy, in 1994. In that report, six patients were described. Few surgeons in Europe or North America have adopted this modification. Palanivelu et al. [4] have recently reported outcomes with prone thoracoscopic mobilization, which includes laparoscopic gastric mobilization and a small laparotomy to complete the esophagectomy. This approach differs from ours with regard to port placement and orientation of working ports to the camera port. Another important distinction between our series and theirs was site of pathology and treatment with neoadjuvant chemoradiation. In the Palanivelu et al. study all of the patients had squamous cell carcinomas of the middle third of the esophagus, and only one patient had received neoadjuvant chemotherapy. Our series is limited to distal third esophageal pathology of the gastroesophageal junction. Five (83%) of our six patients had adenocarcinoma, and three (60%) of those five patients had received neoadjuvant chemoradiation therapy.

Prone positioning during thoracoscopic mobilization provides advantages to the operating surgeon over the decubitus position. Prone position eliminates the need for a technically skilled assistant who is critical for exposure in the lateral position and replaces him/her with a camera holder. This position also optimizes the surgeon's orientation to the operative field and the video monitor. The surgeon's wrists are in a neutral position in

Table 1. Summary of six patients undergoing prone thoracoscopic esophageal mobilization

Patients age/sex	Pathology	Tumor location	Neoadjuvant therapy	Nodes harvested	Complications	Death	Length of stay (days)	Prone operative time (min)
Case 1 46/male	High-grade dysplasia	Distal $^1/_3$	No	NR	None	No	16	105
Case 2 62/male	T2N0M0 adeno-carcinoma	Distal $^1/_3$	Yes	11	Atrial fibrillation/ pulmonary embolism	No	10	85
Case 3 59/female	T1N0M0 adeno-carcinoma	Distal $^1/_3$	Yes	18	None	No	8	70
Case 4 72/female	T3N1M0 adenocarcinoma	Distal $^1/_3$	No	10	Readmission	No	9	55
Case 5 78/female	T3N0M0 adeno-carcinoma	Distal $^1/_3$	No	15	Reintubation for CO_2 retention	No	32	80
Case 6 72/female	T1N0M0 adeno-carcinoma	Distal $^1/_3$	Yes	14	None	No	13	85
65 (46–78) years of age	T1-T3 N0-N1	All Distal $^1/_3$	50% (3/6)	13.6 (10–18)	50% (3/6)	0% (0/6)	11.5 (8–32) median	80 (55–105)

relation to the forearms, minimizing fatigue and maximizing ergonomic function. Due to the effects of gravity the esophagus falls anteriorly out of its normal position, which creates natural tension and simplifies dissection. Flexing the operating table increases the intercostal spaces, minimizing restriction of ports. It also shortens the length and decreases the angle between the working ports and the cephalad and caudal extremes of the esophageal mobilization. This allows the use of straight instruments to complete the entire dissection.

With the lateral approach, the esophagus lies at the most dependant portion of the chest, where it is often obscured by overlying lung and small amounts of blood. Significant time is spent by the assistant maintaining retraction of the lung from the bed of the esophagus. Blood tends to accumulate and interfere with visualization during dissection. This requires the operating surgeon to frequently change instruments. This alternating of instruments between suction, cautery, and application of clips slows the progress of the procedure. The prone positioning minimizes these movements as blood pools outside of the operative field, allowing for continued dissection virtually without any alternating of instruments. This difference is most pronounced during subcarinal lymph node dissection.

Potential advantages of prone thoracoscopic mobilization may also include shortened operative times, less surgeon fatigue, shortening of the learning curve, and obviate the need for double-lumen intubation. We have, for the time being, continued to use double-lumen intubation to minimize confounding issues related to the change of technique, although this appears to be avoidable [4]. An advantage of using double-lumen intubation is the avoidance of excessive insufflation and its potential risks. Once the lung is compressed, insufflation can be stopped without interfering with the conduct of the procedure.

One obvious disadvantage with the prone technique would be if conversion to an open procedure were required emergently or electively. Although posterior thoracotomies can be performed with the patient in this position, it is a less familiar surgical approach and may be difficult for the surgeon. Alternatively, repositioning to allow for a more standard approach would be time consuming. Potential limitations of the prone approach have not yet been identified by our experience. However, larger tumors treated with neoadjuvant chemoradiation, particularly those adjacent to the left mainstem bronchus, can be difficult in open procedures, and we suspect the same would be true with the prone approach. Therefore we would not recommend attempting such a resection without significant experience with this technique first. The prone position appears to be a viable option to esophageal mobilization in most tumors occurring in the middle and distal third of the esophagus.

Conclusions

Although this technical report presents a limited case series, our initial results have been encouraging. Thoracoscopic esophageal mobilization with the patient in the prone position offers a reasonable alternative to the decubitus position. Further study to evaluate prone versus lateral decubitus thoracoscopic esophageal mobilization will define advantages and, perhaps, yet unidentified problems with this approach.

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