Surg Today (2016) 46:129–134
DOI 10.1007/s00595-015-1247-7

HOW TO DO IT

Laparoscopic mediastinal dissection via an open left diaphragm approach for advanced Siewert type II adenocarcinoma

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Received: 3 July 2015 / Accepted: 6 August 2015 / Published online: 15 September 2015

Abstract Around the lower esophagus, the diaphragm obstructs the laparoscopic dissection of mediastinal lymph nodes in surgery for Siewert type II cancer. To address this problem, we developed the open left diaphragm approach. After dissecting the esophageal hiatus along the diaphragm, the anterior mediastinum is dissected along the pericardium. The left side of the mediastinal pleura is then opened and the left diaphragm is incised with a 60-mm linear stapler to create sufficient working space in the lower mediastinum for the lower mediastinal lymph nodes to be resected with a good view. Six patients who received neoadjuvant chemotherapy underwent mediastinal dissection using this technique. The median operative time and estimated blood loss were 479 (390–750) min and 250 (130–500) ml, respectively, and there were no deaths or severe complications. The open left diaphragm approach provides clear surgical space and a good view for performing mediastinal lymph node dissection and is useful for laparoscopic mediastinal dissection and reconstruction.

Keywords Laparoscopic gastrectomy · Mediastinal · Esophagogastric junction · Lymph node dissection

Introduction

The incidence of adenocarcinoma of the esophagogastric junction (AEGJ) has been increasing in both Asian and Western countries [1–5]. AEGJ has a poor prognosis, with a 5-year survival rate of less than 30 % [6]. Although chemotherapy and chemoradiotherapy play important roles, surgical treatment, including lymph node dissection, is the primary curative treatment. However, the indications for lower mediastinal lymph node dissection remain controversial and a standard technique has not yet been established.

A Japanese group conducted a randomized controlled trial comparing the left transthoracic and transhiatal approaches to operate on patients with Siewert type I and II tumors [7]. Despite the assumption that the left transthoracic approach would be better for clearance of the mediastinal lymph nodes because it could provide direct view, that study demonstrated no survival benefit and higher morbidity associated with the transthoracic approach. Moreover, the disadvantage of this approach is the invasiveness of thoracotomy, which requires a long skin incision; possibly why it is associated with a higher complication rate. During mediastinal lymphadenectomy via the transhiatal approach, the operative view tends to be inadequate. It was speculated that laparoscopy could be effective because it provides a magnified view, which might enable more accurate lymph node dissection.

Laparoscopic lymph node dissection for early gastric cancer is recognized as a standard option [8, 9]. Conversely, for advanced gastric cancer, the indications for laparoscopic lymph node dissection remain controversial. There are some ongoing randomized studies addressing this question [10, 11]. Nevertheless, the indications for thoracoscopic esophagectomy have expanded from early cancer to advanced cancer because of its minimal invasiveness in the thoracic cavity [12]. To perform laparoscopic mediastinal dissection, endoscopic manipulation in the mediastinum, which is similar to the pelvic cavity, was a problem that needed to be addressed, as the diaphragm around the

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esophagus obstructs surgical manipulation during lower mediastinal dissection. Thus, we developed the open left diaphragm approach to overcome this problem. This technique is simple and effective for lymph node dissection as well as reconstruction. We describe this method and present the results of our small series.

Materials and methods

Indications

The subjects of this study were patients with advanced Siewert type II adenocarcinoma with a clinical tumor depth over T3 [tumor invading the subserosa (SS)] or positive lymph node metastasis, representing the indications for this procedure. Patients were scheduled to receive two cycles of the DCS regimen before surgery. The DCS regimen consisted of docetaxel (40 mg/m^2) and cisplatin (60 mg/m^2) on day 1, and S-1 (80 mg/m^2/day) on days 1–14, followed by a 14-day rest period [13].

Surgical procedure

After the induction of general anesthesia, patients were placed in the reverse Trendelenburg position with their legs apart. Pneumoperitoneum was established via an open technique at the umbilicus and a flexible laparoscope was introduced through the trocar. Four other trocars were inserted into the upper abdomen as shown in Fig. 1. Prior to the main dissection, the lateral segment of the liver was mobilized and moved to the right, using a Nathanson liver retractor to expose the esophageal hiatus. The root of the left gastroepiploic artery was divided (No. 4sb) after dividing the omentum along the gastroepiploic artery. The communicating vessels between the right and left gastroepiploic arteries were also divided. The distal margin of the stomach was decided and marked with crystal violet, if necessary, using an intraoperative fiberscope. The stomach was transected with two cartridges from a 60 mm endoscopic linear stapler. The proximal part of the stomach was moved to the sub-diaphragmatic space to make room around the suprapancreatic target, which included the lymph nodes along the left gastric artery (No. 7), common hepatic artery (No. 8a), and celiac artery (No. 9). These structures were retrieved after the left gastric artery was divided at its root. The lymph nodes along the proximal splenic artery (No. 11p) were dissected after mobilizing the body of the pancreas from Gerota's fascia. After mobilization of the fornix from the retroperitoneal cavity, the short gastric vessels were divided at the splenic hilum.

Laparoscopic mediastinal dissection proceeded as follows. The phrenicoesophageal ligament around the

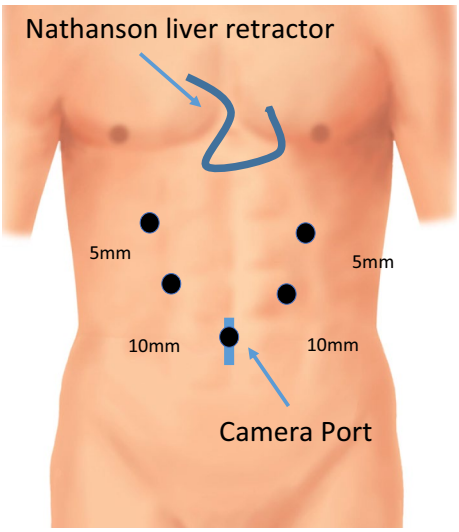

Fig. 1 Four trocars were inserted into the upper abdomen. The lateral segment of the liver was mobilized and moved to the right using a Nathanson liver retractor to expose the esophageal hiatus

esophagus was divided along the esophageal hiatus (Fig. 2). Both sides of the crus were revealed using an ultrasonic device (Fig. 3). After dividing the muscle fibers of the esophageal hiatus in the midline, the pericardium was revealed. The anterior side of the lower mediastinal tissue (No. 110) was then dissected up to the inferior pulmonary vein along the pericardium. The left parietal pleura was incised near the pericardium and the left thoracic cavity was opened to the mediastinal space. The left crus was divided at the 2 o'clock position with a 60 mm linear stapler (Fig. 4). The surface of the aorta was revealed after dissecting the area where the muscle fibers of the esophageal hiatus cross. The posterior layer of the dissection was this aortic surface, and esophageal vessels from the aorta were divided (No. 110, 112Ao). The thoracic duct was routinely preserved. Subsequently, the left thoracic cavity and the mediastinum were connected, resulting in a large surgical field (Fig. 5). The right side of the mediastinum tissue was dissected while preserving the parietal pleura surface of the right lung. After incising the left pulmonary ligament and resecting the left side of the mediastinal pleura, the lower thoracic esophageal (No. 110), supra-diaphragmatic (No. 111), and posterior mediastinal nodes (No. 112) were dissected. The lower esophagus was transected after intraoperative endoscopy. The lower esophagus and proximal stomach were dissected with LN nodes. Following this resection, double tract reconstruction was also performed easily because there was a wide window between the thorax and the abdomen (Fig. 6a, b). It was still necessary to close this window using a running suture, to prevent a hiatus hernia (Fig. 6c, d).

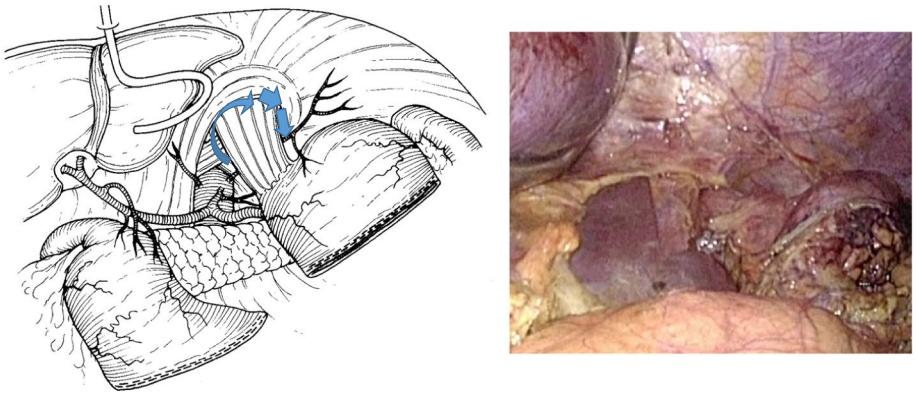

Fig. 2 The phrenicoesophageal ligament around the esophagus was divided along the esophageal hiatus

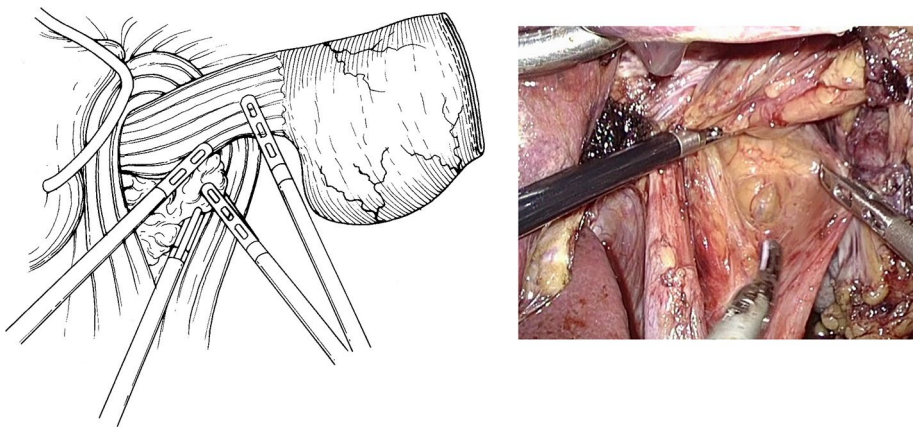

Fig. 3 Both sides of the crus were revealed using an ultrasound device

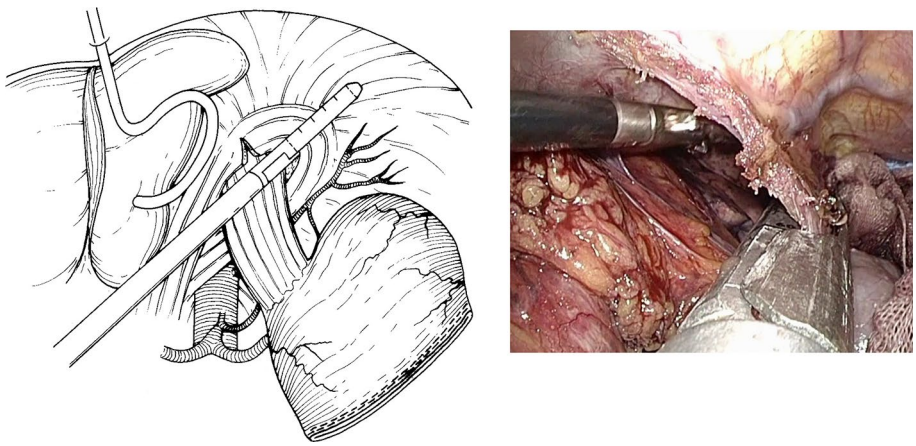

Fig. 4 The left parietal pleura was incised near the pericardium and the left thoracic cavity was connected to the mediastinal space. The left crus was divided at the 2 o'clock position, with a 60 mm linear stapler

Results

Between July 2012 and December 2013, we performed laparoscopic 16a2 lateral lymph node dissection for advanced type II junctional cancer in six patients (four men and two women). One patient underwent total gastrectomy for concurrent early gastric cancer in the antrum. Table 1 shows the clinical characteristics of the study participants. All patients completed two cycles of the protocol preoperative chemotherapy regimen. The median tumor size and length of esophageal invasion were 3.3 (2.0–8.0) and 1.5 (0.0–5.0) cm, respectively. The clinical TNM stage was IIA in two patients, IIB in two patients, IIIA in one patient, and IIIC in one patient.

There were no conversions to open surgery. The median operative time and estimated blood loss were 479

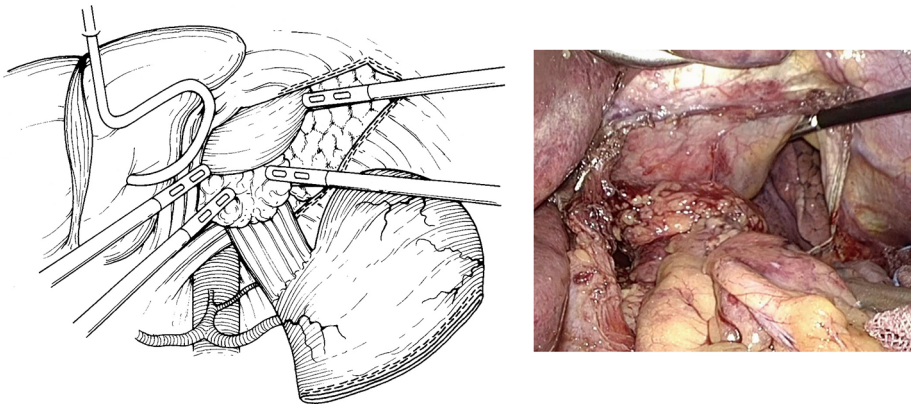

Fig. 5 The left thoracic cavity and mediastinum were combined to create a large surgical field

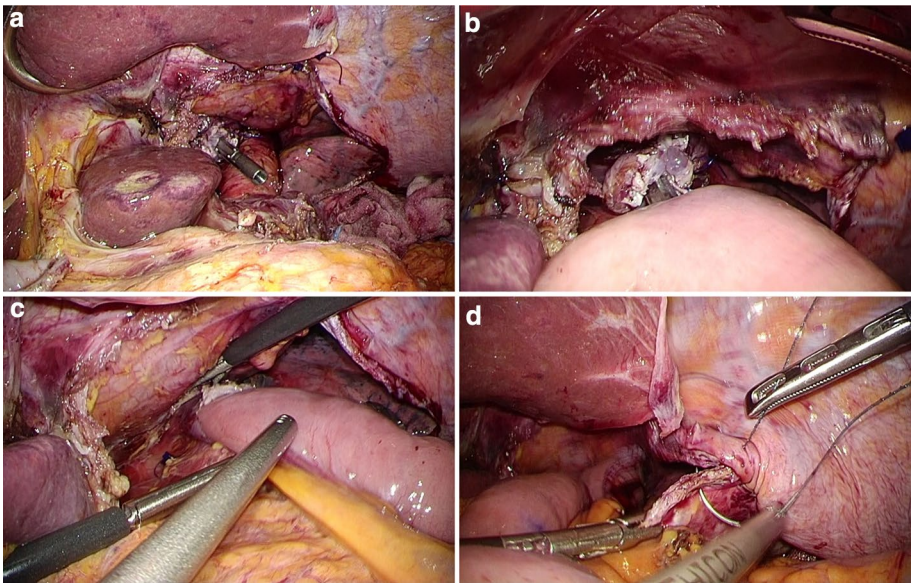

Fig. 6 Performing reconstruction was easy, even using the circular stapler, because there was a wide window between the thorax and abdomen (**a**, **b**). It was necessary to close this window using a running suture to prevent a hiatus hernia (**c**, **d**)

Table 1 Characteristics of the study patients

	$N = 6$
Sex (male/female)	4/2
Age (years)	63 (36–75)
BMI (kg/m^2)	20.8 (17.6–22.4)
Tumor size (cm)	3.3 (2.0–8.0)
Length of esophageal invasion (cm)	1.5 (0–5)
cT stage (3/4a/4b)	3/2/1
cN stage (0/1/2/3)	3/2/1
cStage (IIA/IIB/IIIA/IIIB/IIIC)	2/2/1/0/1
Neoadjuvant chemotherapy (+/−)	6/0

N, median (range)

Table 2 Surgical and pathological results

	$N = 6$
Procedure (proximal/total gastrectomy)	5/1
Operative time (min)	479 (390–750)
Blood loss (ml)	250 (130–500)
pT stage (1b/2/3/4a/4b)	1/0/4/1/0
pN stage (0/1/2/3)	1/4/0/1
pStage (IA/IIA/IIB/IIIA/IIIB)	1/0/3/1/1
Histological response of the primary tumor (Grade 0/1a/1b/2/3)	0/6/0/0/0

N, median (range)

(390–750) min and 250 (130–500) ml, respectively. The saturation O_2 monitoring did not drop during the open thoracic condition under pneumoperitoneum in any patient. Table 2 shows the surgical and pathological results. There were no deaths and no severe complications, defined as Grade 3 or higher adverse events according to the Clavien–Dindo classification. There were several Grade 2 events, including intra-abdominal abscess, pneumothorax, and chylous ascites. The median hospital stay was 22 (17–54) days.

Discussion

During open surgery, the diaphragm is often divided on both sides, or scooped with the esophagus [14]. For laparoscopic surgery, our technique of making a long incision in the diaphragm using a linear stapler was considered effective for both lymph node dissection and reconstruction because right hand forceps inserted in the right lower abdomen by the operator always point towards the left side of the esophagus. The merits of this technique are as follows: first, the operative field in the mediastinum is enlarged, taking in the left thoracic cavity. This open space makes reconstruction easy and safe, although blood gases must be monitored continuously and carefully because the lung is deflated by the pneumoperitoneum. However, in this series, 10 mmHg of pneumoperitoneum did not interfere with positive ventilation or blood gas levels. Second, it provides for an easy and sure repair of the esophageal hiatus. Repairing the esophageal hiatus is important to prevent intestinal herniation. Esophageal hiatal hernias are critical complications [15, 16] that often occur, especially after laparoscopic surgery, because there is less postoperative adhesion formation than with open surgery. The hiatus must be closed properly, but it is difficult to do so laparoscopically because the diaphragm is easily torn during repair with thread. Thus, staples have been used to reinforce the cut edges of the muscular diaphragm, but this makes repair of the diaphragm more time consuming. To overcome this problem, continuous suturing was introduced. The suture line made by the stapling device can also function as guideline, like a fastener.

Lower esophagectomy and proximal gastrectomy have been adopted for even advanced junctional cancer [17]. Double tract reconstruction was performed in this case series mainly to prevent postoperative reflux esophagitis [18]. Esophagojejunostomy was usually performed with circular staples. A larger surgical field makes creation of the anastomosis safer because the tip of the circular stapler is so large that the view of docking via an endoscope with a built-in stapler is obscured by the jejunum. In contrast, the open left diaphragm approach provides a sufficient view for performing this reconstruction. One disadvantage of this approach is a higher risk of pneumothorax as a result of lung damage, so an air leak test is necessary before closing the diaphragm.

In conclusion, this technique, which creates a larger surgical field, is useful for laparoscopic mediastinal dissection and reconstruction in patients with Siewert type II esophageal cancer.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest or financial ties to disclose.

Human rights statement and informed consent All procedures were performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Informed consent or its equivalent was obtained from all patients for study participation.

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