

Diaphragmatic herniation after thoracoscopic esophagectomy for carcinoma of the esophagus: a report of six cases

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Received: 6 September 2014 / Accepted: 13 January 2015 / Published online: 10 February 2015
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Abstract Diaphragmatic herniation after esophagectomy for carcinoma of the esophagus is a rare postoperative complication. Several recent reports reveal that minimally invasive esophagectomy (MIE) with mediastinal reconstruction is associated with a higher incidence of herniation compared with open esophagectomy. Thoracoscopic esophagectomy (TLE), also called “total MIE”, results in fewer peritoneal adhesions around the hiatal region of both the thoracic and abdominal cavities. This may cause abdominal contents to be taken up to the thoracic cavity. We report six cases of diaphragmatic herniation after TLE. Of these, five patients underwent surgical repair and one patient without symptoms is followed up carefully. In TLE, anchoring the gastric conduit to the hiatus is essential for preventing herniation.

Keywords Diaphragmatic herniation · Minimally invasive esophagectomy · Esophageal carcinoma

Introduction

Recently, surgical resection for esophageal carcinoma has become safer due to improvements in operative techniques and perioperative management. However, rare complications can occur after resection. Diaphragmatic herniation, the prolapse of abdominal contents via the diaphragmatic hiatus, is a rare but potentially life-threatening complication after esophagectomy. It occurs in 1–4 % of cases of

open esophagectomy (OE) [1, 2]. Recent evidence suggests that diaphragmatic herniation is more common following minimally invasive esophagectomy (MIE) [3]. Here, we report six cases of diaphragmatic herniation after thoracoscopic esophagectomy (TLE), also called total MIE [4].

Case presentations

Beginning in 2010, standard treatment for esophageal carcinoma in our institution was TLE with three field lymph node dissection. TLE consisted of thoracoscopic subtotal esophagectomy in the prone position (TSEP) with mediastinal lymph node dissection and laparoscopic gastric mobilization in the supine position. After intubation, the patient was placed in the prone position upon operative table, and the patient’s right arm was raised cranially to expose the right axillary fossa. TSEP was performed with six ports, and carbon dioxide was insufflated at a pressure of 8–12 mmHg to expand the mediastinum. After the thoracic manipulation, the patient was placed in the supine position. Subsequently, abdominal and cervical operations were performed simultaneously. In abdominal manipulation, gastric mobilization with upper abdominal lymph node dissection was performed with total laparoscopic technique. The wound of umbilical port was extended to 5 cm in length, then esophagus and stomach taken out from abdominal cavity. Gastric transection was performed under direct vision, of which the width of the gastric conduit was 4–5 cm in diameter. Manual dilatation of hiatus through the umbilical wound was performed before reconstruction so that the surgeon could pass through 4 fingers. If the hiatus was too wide, sutures were placed to narrow the hiatus. Reconstruction was performed via gastric pull-up through the mediastinum route

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and cervical esophago-gastric anastomosis. To prevent gastric outlet obstruction, suture fixation of the gastric conduit to the hiatus was not done routinely. In a previous report, TSEP techniques were described in detail [5].

For the past four years, diaphragmatic herniation after TLE occurred in six of 150 patients (4 %) (Table 1). All patients were men with a median body mass index of 20. The time to diagnosis ranged from one to eight months postoperatively. Five patients who underwent surgical intervention were symptomatic and one was asymptomatic, with herniation found on routine follow-up computed tomography scan for postoperative surveillance. In all six cases, herniations were seen in the left hemithorax. The contents consisted of transverse colon in all cases and short bowel and omentum in four cases (Fig. 1). Of these five symptomatic patients, four had obstructive bowel symptoms requiring urgent open repairs. One patient underwent elective laparoscopic repair because of spontaneous remission of symptoms after admission. At surgery, after reduction of herniated bowels, the hiatal defect was closed by interrupted sutures and the gastric conduit was anchored to the re-approximated hiatus. One case required resection of the transverse colon because of ischemic damage.

Postoperatively, one patient developed a recurrent herniation due to coughing two days after the first repair and an emergent reoperation was performed. The other cases were uneventful with no recurrence of herniation.

Discussion

Minimally invasive esophagectomy, using the thoracoscopic or laparoscopic approach, was first described by Cuschieri et al. [6]. After this report, numerous less invasive approaches to esophageal resection have been described. MIE might have the potential to lower rates of morbidity and mortality compared to an open procedure and might allow a quicker return to normal function [7]. In the first randomized controlled trial of MIE versus OE [8], MIE was associated with fewer pulmonary infections, less blood loss, and some improved short-term quality of life factors. With respect to oncological outcomes, MIE is not inferior to OE in the 3- and 5-year survival rates [9, 10].

Diaphragmatic herniation occurs due to a combination of factors, including negative intra-thoracic and positive intra-abdominal pressure, lack of peritoneal adhesions, and enlarged hiatus. In a retrospective analysis of 218 patients who underwent OE, Van Sandick et al. [1] reported that extended enlargement (incision of the surrounding hiatal tissues) and partial resection of the diaphragm were statistically significant. Aly et al. [11] reported the first case of diaphragmatic hernia occurring after MIE in 2004. To date, 15 cases of diaphragmatic hernia occurring after MIE have

Table 1 Six cases of diaphragmatic herniation after TLE

Patient	Age/sex	BMI	Past history	Neoadjuvant chemotherapy	Indication for Resection	Interval between resection and herniation (months)	Site of herniation	Content of herniation	Surgical intervention	Postoperative course
1	57/M	19	Gastric ulcer	No	SCC Lt T1aN0M0	3 M	Left thoracic cavity	SB/TC/O	Open reduction, colectomy and hiatoplasty	14POD discharged
2	66/M	20	Mental retardation	No	AC EGI T3N3M0	1 M	Left thoracic cavity	SB/TC/O	Open reduction and hiatoplasty	52POD discharged
3	73/M	19	Chronic heart failure	No	BC Lt T1bN0M0	1.5 M	Left thoracic cavity	SB/TC/O	Open reduction and hiatoplasty	10POD discharged
4	46/M	24	None	No	AC EGI T1bN0M0	2.5 M	Left thoracic cavity	SB/TC/O	Open reduction and hiatoplasty	2POD reoperation 9POD discharged
5	72/M	19	None	Yes	SCC Mt T1bN1M0	8 M	Left thoracic cavity	TC	Laparoscopic Reduction and hiatoplasty	7POD discharged
6	75/M	20	None	No	AC EGI T1bN0M0	7 M	Left thoracic cavity	TC	None	-

BMI body mass index, *M* male, *SCC* squamous cell carcinoma, *AC* adenocarcinoma, *BC* basaloid carcinoma, *Lt* lower thoracic esophagus, *EGJ* esophago-gastric junction, *Mt* middle thoracic esophagus, *SB* small bowel, *TC* transverse colon, *O* omentum, *POD* postoperative day

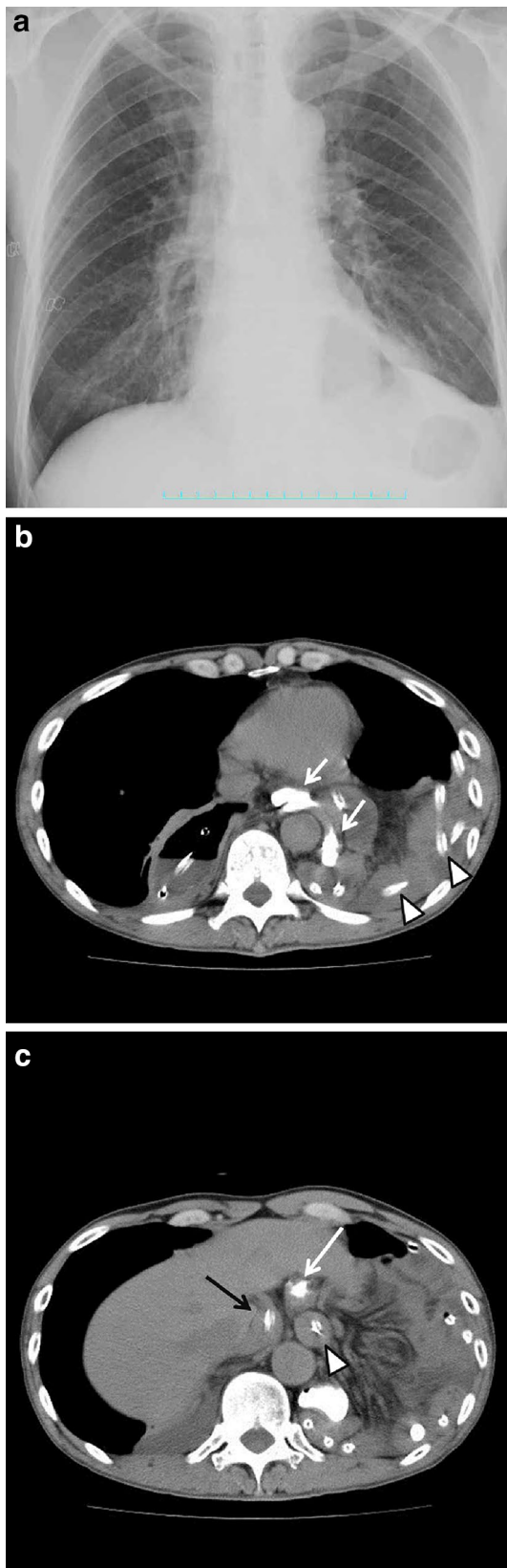


Fig. 1 Chest roentgenogram of Patient #1 shows bowel gas overlapping with cardiac shadow (a). Computed tomography reveals diaphragmatic herniation to the left hemithorax containing transverse colon (white arrow) and jejunum containing ileus tube (white arrow head) (b). Transverse colon and jejunum herniating via the enlarged hiatus (black arrow gastric conduit) (c)

been reported in the English-language literature (Table 2) [3, 11–14]. In 21 cases, including the present six cases, only one case occurred in the early postoperative period, and other cases occurred 1–20 months after MIE. In 20 cases (95 %), abdominal organs had herniated into the left hemithorax. Herniated organs were the colon, the small bowel, the omentum or both. Of the 21 patients, 15 cases (71 %) underwent surgical repair of the herniation: laparoscopic approach was used in 3 of the 15 patients (20 %). However, 6 cases (29 %) were treated with a conservative waiting and watching approach. Willer et al. [3] reported the first series comparing head-to-head incidence of postoperative diaphragmatic herniation after MIE and OE. MIE had a significantly higher incidence of herniation compared to OE (5 cases in the MIE group (26 %) and 0 in the OE group, $p = 0.01$). Furthermore, the problem of herniation may become more prevalent as length of follow-up increases [15].

In our institution, we began performing TLE with three-field lymph node dissection for esophageal carcinoma in 2010. The rate of diaphragmatic herniation after TLE was 4 % (six of 150 cases). This was more frequent than the 1 % (two of 168 cases) rate in an historical series of patients who underwent OE [2]. To our knowledge, this is the first report of diaphragmatic herniation after TLE from Japan in the English-language literature.

The reason for the tendency to herniate specific to TLE with the mediastinal reconstruction is considered. TLE results in much fewer adhesions, which serve to anchor the abdominal viscera, compared to OE or Hybrid MIE (either thoracoscopic or laparoscopic approach) [4]. Upon surgical repair of herniation, it became apparent that the gastrointestinal tract and omentum did not adhere to either the inferior or superior region of the hiatus. As a consequence, the abdominal contents tend to migrate to the thoracic cavity due to the negative intra-thoracic and positive intra-abdominal pressure.

Retrosternal reconstruction with closure of the hiatus is understandably the ideal approach to prevent diaphragmatic herniation. However, the optimal procedure for preventing herniation following mediastinal reconstruction is controversial. Some surgeons recommend anchoring the stomach anteriorly to the hiatus [16], but others do not routinely use this approach because it may lead to gastric outlet obstruction or injure the blood supply to

Table 2 Reported cases of diaphragmatic herniation after MIE

First author [Ref.]	No. of Patients	Type of approach	Excision or enlargement of hiatus	Interval between MIE and herniation (months)	Thoracic site of herniation	Content of herniation	Treatment	Postoperative morbidity
Aly. [11]	1	Thoracoscopic and hand-assisted laparoscopic	Yes	20 M	Left	SB/C/O	Open hiatoplasty with mesh	None
Fumagalli [12].	2	Transthoracic and laparoscopic	Yes	4 M and 8 M	1 Left, 1 bilateral	2 SB/C/O	2 Ooen direct hiatoplasty	None
Vallbohmer [13].	5	Transthoracic and laparoscopic	?	0.5–14 M	5 Left	2 SB/C	3 Open direct hiatoplasty, 2 no operation	?
Ganeshan [14].	2	?	?	6 M and 16 M	1 Right, 1 left	5 C	1 Laparotomy, 1 no operation	?
Willer [3].	5	TLE	Yes	3–20 M	5 Left	4 C, 1 O	2 Laparoscopic, 1 open direct hiatoplasty 2 no operation	?
Present cases	6	TLE	Yes	1–8 M	6 Left	4 SB/C/O, 2 C	1 Laparoscopic, 4 open direct hiatoplasty (1 colectomy) 1 no operation	1 Reoperation

the reconstructive organs [13]. In our institution, similar to OE, manual dilatation of the hiatus was performed to prevent gastric outlet obstruction during TLE. This temporary dilatation presumed that the hiatus spontaneously narrowed to some extent after surgery, thereby preventing prolapse of abdominal contents. However, after TLE, this prophylaxis proved inadequate. The reason of higher incidence of herniation in our TLE techniques is considered as additive effects of much fewer adhesions and lack of anchoring the conduit. Suture fixation of the gastric conduit to the hiatus is essential for preventing herniation, especially after TLE.

Options for repair of herniation include the use of mesh to reinforce the closure of large defects, but we never had time to use it. There is a possibility of the mesh eroding into the gastric conduit over time and compromising its vascular supply [17]. Narrowing the enlarged hiatus and fixation of the conduit to the diaphragmatic crus are essential. At surgical repair, the laparoscopic approach may be a safe option that offers diagnostic and technical advantages to the open approach, especially in visualization around the crus and right gastroepiploic artery supplying the conduit.

In conclusion, compared to OE, TLE has significant characteristics that make it prone to result in diaphragmatic herniation. In TLE, anchoring the gastric conduit to the hiatus is essential for preventing herniation. Given the recent increase in the use of TLE to treat esophageal carcinoma, diaphragmatic herniation will likely become more common. Surgeons should spare no effort to prevent herniation and be aware of the possibility of this complication in post-operative surveillance, especially after TLE.

Acknowledgments We greatly appreciate the members of the Division of Esophageal Surgery for their critical discussion of our manuscript. We also appreciate the members of the Division of Clinical Radiology for providing us with information about the imaging examinations.

Ethical Statement This article does not contain any studies with human or animal subjects performed by any of the authors.

Conflict of interest Author Kanamori, Author Fujita, and Author Daiko declare that they have no conflict of interest.

Human rights statement and informed consent All procedures followed were 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 revision. Informed consent or substitute for it was obtained from all patients for being included in the study.

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