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# Laparoscopic repair of hiatal hernia after minimally invasive esophagectomy

**Beatrice Ulloa Severino[1] · David Fuks[1] · Christos Christidis[1] · Christine Denet[1] · Brice Gayet[1] · Thierry Perniceni[1]**

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**Abstract**
*Introduction* Minimally invasive esophagectomy for cancer decreases respiratory postoperative complications but seems to be associated with higher occurrence of hiatal hernia (HH). This study describes the incidence of this complication and the results of surgical repair.
*Methods* Among 390 patients with esophageal cancer treated by esophagectomies with laparoscopic gastric dissection from 2000 to 2013, 32 (8.2 %) patients developed HH. Demographics, diagnostic, surgical management and outcomes data were collected retrospectively.
*Results* There were 25 men and 7 women with a median age of 60 years (39–78). The median time between esophagectomy and diagnosis of HH was 10 months (3 days–96 months). The most frequent symptoms at the time of diagnosis were pain (32 %), dyspnea (21 %) and vomiting (10 %), while HH was asymptomatic in 10 patients. HH was located in the left chest in 97 % of patients and involved either the transverse colon (91 %), or omentum (25 %) or the small bowel (12 %). The operation included the reintegration of the viscera associated with the closure of the pillars (100 %) and the establishment of a mesh (71 %). The operation was carried out by laparoscopy in 19 (59 %) patients and was conducted in emergency in 6 (19 %) patients. No patient died, and the overall morbidity was 25 %. After a median follow-up of 40 months (range 1–55), five patients died due to oncologic evolution and six (19 %) patients had recurrence of HH who required a second operation.
*Conclusion* HH is a common complication after laparoscopic-assisted esophagectomy. Despite the use of mesh, postoperative morbidity and recurrence incidence remain high.

**Keywords** Laparoscopic-assisted esophagectomy · Hiatal hernia · Laparoscopic repair

During esophagectomy, the diaphragmatic hiatus is frequently widened in order to prevent obstruction and ischemia of the gastric conduit. However, enlargement of the hiatus increases the risk of a hernia, allowing abdominal contents to pass into the chest. The hernia can occur either during early postoperative period or during follow-up. This complication may be caused by a progressive hiatal dilatation which is the result of increased intra-abdominal pressure and suction effect of the negative intrathoracic pressure. This result is facilitated by the increased use of minimally invasive approaches that decreases the amount of postoperative peritoneal adhesions [1–3]. The incidence of hiatal hernia (HH) after traditional open esophagectomy has been reported to be between 0.6 and 7 % [1, 3] and is associated with an operative mortality between 5 and 17 % and morbidity up to 70 % [3]. Indeed, herniation of the colon or small bowel adjacent to the gastric conduit may result in bowel obstruction, or colonic or small bowel ischemia requiring emergent repair. The treatment of HH consists of reduction of the abdominal contents into the abdomen, assessment of the gastric conduit and herniated bowel viability, and closure of the hiatus around the gastric conduit. Although the body of literature on complications after open and minimally invasive

✉ Beatrice Ulloa Severino
bea310301@libero.it

David Fuks
david.fuks@imm.fr

[1] Department of Digestive Diseases, Institut Mutualiste Montsouris, Université Paris-Descartes, 42 Boulevard Jourdan, 75014 Paris, France

esophagectomy is abundant, reports on HH after minimally invasive esophagectomy are sparse and inconsistently reported [4–8]. Hence, the aim of this study was to estimate the incidence and to describe the presentation and management of this rare type of hernia in a single center.

## Methods

### Patient's selection

From January 2000 and May 2013, all patients who had undergone minimally invasive esophagectomy and survived more than 30 days after operation were analyzed from a prospectively maintained Esophageal Cancer and Related Diseases database. HH was defined as any abdominal organ other than the normal gastric conduit in or above the diaphragmatic hiatus as identified on computed tomography read by a board-certified radiologist. Formal review of available radiographs performed for either oncologic surveillance or clinical suspicion of hernia. Given the potential risk of complication, HH was systematically surgically repaired at the time of diagnosis. Patients who had a HH before esophagectomy were not excluded. This retrospective cohort study was approved by the Institutional Review Board.

### Surgical procedures

At the time of esophagectomy, neither the right nor the left pillar was sectioned. The hiatus was widened during the dissection, including most of the time, the opening of the diaphragmatic peritoneum and the pleural cavity. Then, we proceed to a blunted dissection of the esophagus without injuring the pillars. The gastric conduit was not sutured to the hiatus, but at the end of the surgery the staple line on the gastric conduit was located in front of the right pillar.

No patient had an elective repair of a HH after esophagectomy by open approach. During the repair, the abdomen was explored with a 0° laparoscope, after adequate insufflation to a pressure of 12 mmHg, looking for adhesions and metastatic disease. Assessment of hiatal's anatomy followed with careful identification of herniated specimens that usually borders the patient's hiatal right pillar. Four additional 5-mm ports were placed in the right upper quadrant, mid-right abdomen and left upper quadrant. The abdominal contents were sharply dissected off the hiatus alongside the left crus. In some patients, the left crus was sectioned on its anterolateral portion, facilitating the herniated viscera reduction. We then identified the right crus with only the gastric conduit passing through the hiatus. The defect was then closed by reapproximating the right and left crural fibers anterolaterally using interrupted 0 Ticron suture. A 1-cm gap remains to maintain adequate area for the gastric conduit and the vascular supply. Since the gastric conduit and its vascular supply lay posteriorly in each of our patients, an anterior crural reapproximation was necessary. If the conduit lies anteriorly, a posterior closure may be chosen, with the primary consideration always being the preservation of the conduit. If the defect was not amenable to primary closure, a Parietex® or Goretex® mesh precut in reverse "C" was sutured to the crura to both the left and the right pillars and fixed anteriorly to the conduit with Vicryl 0 stitches. A Jackson-Pratt drain was inserted into the left chest cavity and brought out through one of the port sites in the left upper quadrant. The bowel was inspected to ensure viability and to exclude injury. Fascia to the umbilical port site was closed with simples Vicryl 0 stitches.

### Postoperative outcomes

The Jackson–Pratt drain was removed only when output was less than 30 ml. All patients were admitted to a normal hospital floor bed with a nasogastric tube which was removed on postoperative day 1. Their diet was advanced as tolerated. Discharge criteria included pain control with oral pain medication, passage of flatus, and ambulation without assistance or supplemental oxygen. No routine postoperative scans or X-rays were routinely done.

### Studied criteria

The following clinical information was collected for each patient: age, sex and body mass index (BMI) of the patient; the histopathology and location of the esophageal tumor; type of surgery performed; time between esophagectomy and diagnosis of hernia; symptoms (if any) in patients who had hernia; presence of any interval hernia progression; operation performed for hiatal herniation; and morbidity and mortality were all recorded for analysis. Postoperative complications were stratified according to the Clavien–Dindo classification, which defines major complications by a score of 3 or more. Both complications and operative mortality were considered as those occurring within 90 days of surgery, or at any time during the postoperative hospital stay.

### Statistical analysis

Quantitative variables are expressed as mean (±standard deviation) or as median (range) as appropriate. Qualitative variables are expressed as frequencies (percentages). A Student's t test or Mann–Whitney *U* test was used for intergroup comparisons of quantitative variables as appropriate, whereas a $\chi^2$ test or Fisher's exact test was

used to compare categorical data. Statistical significance was defined as $p < 0.05$. All statistical analyses were performed with SPSS version 20.0 (SPSS Inc., an IBM Company, Chicago, IL, USA).

## Results

### Population studied

During a 13-year period, among the 390 minimally invasive Ivor Lewis esophagectomy, 32 (8.2 %) patients met our inclusion criteria for treatment of HH. There were 25 men and 7 women with a median age of 60 years (39–78).

### Cancer staging and treatment

Twenty-four (75 %) patients had adenocarcinoma, while the remaining 8 (25.0 %) patients had squamous cell carcinoma. The tumor was located at gastroesophageal junction in 16 (50.0 %) patients, in the middle esophage in 7 (21.8 %) and in the lower part of the esophage in the remaining 9 (28.1 %). Five patients were treated with both neoadjuvant chemotherapy and radiation therapy; 19 (59.3 %) patients were treated with chemotherapy alone prior to surgery. Eight (25.0 %) patients had suspected stage I disease and underwent surgery without adjuvant therapy. The pathologic T stage was pT0 in 4 (9.3 %) patient, pTIA in 5 (15.6 %), pTIB in 7 (21.8 %), pTIIA in 5 (15.6 %), pTIIB in 5 (15.6 %) and pTIIIA in 6 (18.7 %). Among pT0 patients, 2 had neoadjuvant chemotherapy, and one patient had pTis. At the time of the esophagectomy, the diaphragmatic hiatus was completely widened in 7 patients and partially in 1. One patient had a HH before esophagectomy.

### Diagnosis of post-esophagectomy hiatal hernia

The interval from esophagectomy to diagnosis of HH was 10 months, ranging from 3 days to 58 months. In one patient, the diagnosis of HH was done on postoperative CT scan because the patient suffers from dyspnea 3 days after esophagectomy. Ten (31 %) patients had no symptoms, and these patients were found to have a HH on CT scans obtained for surveillance of their esophageal cancer. On the opposite, the 22 other patients presented with an intermittent cramping abdominal pain. Other symptoms included dyspnea on exertion (19 %) and recurrent vomit (12 %). These symptoms prompted clinic visits and eventually CT scans of the chest, abdomen and pelvis in these 22 patients. The median BMI of patients who developed HH was similar to that of patients who did not experience this complication (24 vs. 24, $p = 0.82$).

### Laparoscopic repair

At the time of surgery, HH occurred into the left thorax in 31 (97 %) patients. Twenty-nine (91 %) patients had herniation of the transverse colon, while 8 (25 %) had herniation of the greater omentum and 4 (12 %) had herniation of small bowel. Between the six patients who need emergent repair, one had left colectomy for transverse colon ischemia. Hernia repair was performed by laparoscopy in 19 (59 %) patients and midline incision in 5 (15.6 %). One patient had a voluminous HH that was responsible for a deep mucosal ulceration, confirmed by upper endoscopy. During the surgery, the surgeon found a small serosal defect in view of this mucosal ulceration. Besides this local defect, the whole conduit appeared well vascularized and the defect was sutured with three simple resorbable stitches by both thoracotomy and laparotomy. Six (18 %) patients required conversion to open laparotomy. Twelve (37.5 %) patients had primary closure of the hernia, while 20 (62.5 %) patients underwent repair with mesh.

### Postoperative care and outcomes

Three (9.3 %) patients developed postoperative complications: One had recurrent HH 3 days after the repair and one had a severe atrial fibrillation and the patient treated for a small serosal defect in view of this mucosal ulceration experienced a postoperative leakage treated with antibiotics. With a median follow-up of 40 months (ranging from 6 to 108), 5 (15.6 %) patients died due to cancer recurrence. Based on review of the charts, we observed that all symptomatic patients had a significant improvement in symptoms. Six (18.7 %) patients developed a recurrent HH. Among them, one did not have a mesh closure at his first repair, but subsequently underwent reduction of the small and large bowels and closure of the hiatal defect with a mesh. Among the five remaining patients, three underwent a laparoscopic repeat hiatal repair with insertion of a second mesh and they did not experience any recurrence. Two patients were not surgically treated.

## Discussion

While HH has been associated with both open and laparoscopic-assisted esophagectomy, evidence suggests that they are more likely to result from a minimally invasive approach [1–5, 9, 10]. However, reported incidence may be underestimated since median follow-up in most series is really short. With a 40-month follow-up, the present study showed that incidence is significantly higher. Indeed, more than 8 % experienced HH after minimally invasive esophagectomy. The present series suggest also

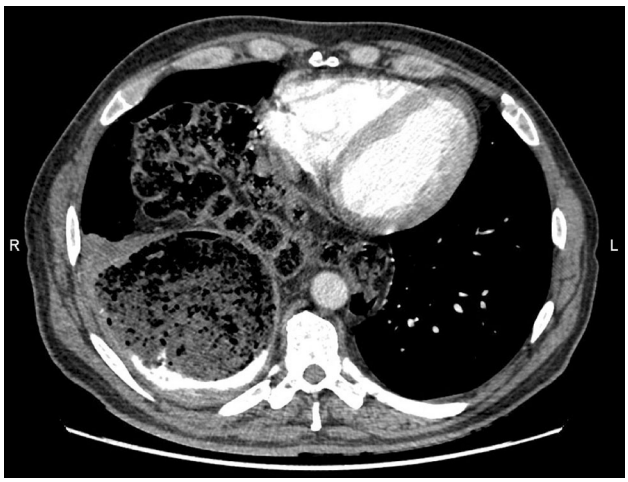


**Fig. 1** Enhanced computed tomography showing incarceration of flexure of the right colon in the *right side* of the chest

that hernia repair could be technically demanding and almost 20 % developed recurrence during follow-up requiring additional procedures.

As minimally invasive esophagectomy becomes more popular due to the shorter recovery time and reduced pulmonary complication rate, the incidence of HH may increase over time [6]. The rise in HH occurrence may also be due to longer survival of patients benefiting from efficient neoadjuvant therapy. Post-esophagectomy HH occurred most frequently into the left thorax, which is similar to results reported in other series. It is likely that the liver on the right side of the abdomen, the fibrosis due to the adhesions between the staple line and the right pillar and pleura, and finally the adhesions from the conduit to the liver after gastric pull-up may be predisposing factors for this left-sided predominance [1, 3, 5, 7, 10]. The gastric conduit is generally positioned in the right side of the chest, which may prevent herniation into the right hemithorax. However, we observed some unusual cases with important herniation of colon in the right side of the chest (Fig. 1). While HHs present the danger of obstruction and ischemia of both herniated bowel and gastric conduit, the surgical treatment of this condition is controversial [3, 6, 8, 10]. Symptomatic patients are usually treated immediately upon diagnosis, but there is no consensus on the treatment of asymptomatic patients who are often diagnosed incidentally during cancer surveillance imaging. The danger of possible obstruction and ischemia must be weighed against the risk of surgery in these patients and also in patients whose life expectancy is reduced due to metastatic disease. Even if patients do not have symptoms, the hernia is likely to enlarge with time, increasing the chance of incarceration or strangulation, making the repair more complicated [2]. This substantially increases the risk of morbidity and mortality. Based on these facts, it is our opinion that these HHs should be systematically repaired at the time of diagnosis. Repair should be discarded in patients with very small asymptomatic HH and those with significant comorbidities or a short life expectancy [1, 3, 5, 11–13]. Clinical judgment balancing the severity of symptoms and the risk of surgery should be exercised on a case-by-case basis. Our study confirmed that laparoscopic repair of HH after esophagectomy can be achieved with low morbidity and mortality. We believe that a laparoscopic approach to repairing HH following esophagectomy offers several advantages over a conventional, open repair. Laparoscopy spares the patient a large abdominal incision and decreases the recovery time [1–3, 14, 15]. It also provides assessment of peritoneal cavity, allowing us to rule out metastatic disease before hernia repair. In addition, laparoscopy enables superior visualization and preservation of the hernia contents and, most importantly, the vascular supply to the gastric conduit. Indeed, special care must be taken during the reduction of the hernia to avoid damage to the adjacent gastroepiploic artery. Laparoscopy affords much better visualization and consequent ease of preservation of this artery. Additionally, there are no objective parameters defining the tension at which the crura are neither loose enough to promote recurrent herniation nor tight enough to cause obstruction of or ischemia to the gastric conduit. While mesh can be used to reinforce the closure of the hernia defect, it could also erode into the gastric conduit over time and compromise its vascular supply [1, 2, 4, 10, 16, 17]. We only use mesh reinforcement when we cannot achieve primary closure of the defect and otherwise avoid using mesh in fear of endangering the conduit. Additionally, we emphasize that mesh should not be circular; in this setting, we systematically cut it in reverse "C" in order to avoid vascular injury of the conduit. Diaphragmatic hiatus may also be calibrated by direct suture.

There are limitations to our study. It represents the retrospective experience of a single institution including a limited number of patients. However, procedures were performed by two surgeons according to similar surgical techniques. All of the cases were for oncologic indications. Technical processes and clustering effects could have biased our results. The number of hernias and potential for hernia are likely also underestimated by our patient population.

In conclusion, HH is a common complication after laparoscopic-assisted esophagectomy. Laparoscopic repair is a safe option; however, despite the use of mesh, postoperative morbidity and recurrence incidence remain high.

**Disclosures** Beatrice Ulloa Severino, David Fuks, Christos Christidis, Christine Denet, Brice Gayet and Thierry Perniceni have no conflicts of interest or financial ties to disclose.

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