Paraconduit hernias after minimally invasive esophagectomy

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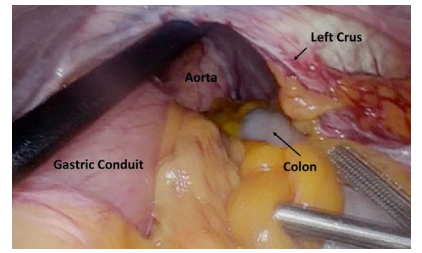
Video clip is available online.



Paraconduit hernia with colon herniating to the left of the conduit.

CENTRAL MESSAGE

Paraconduit hernias after minimally invasive esophagectomy are managed with surgical repair. Multiple repair techniques have been described, although roughly 1/3 of repairs still result in recurrence.

Esophageal cancer remains an aggressive malignancy, with surgery playing a critical role in treatment of resectable disease. Esophagectomy is a complex procedure, with the potential for the patient developing a paraconduit hernia months to years after surgery.[1-3] The likely etiology is recurrent gastric distention and decompression, leading to gradual enlargement of the hiatus.[4] Although some patients with a paraconduit hernia may be asymptomatic, a majority of patients (56-83%) have symptoms such as abdominal pain, dyspnea, dysphagia, chest pain, nausea, or constipation.[3,5] Patients with these symptoms should undergo a computed tomography scan of the chest and abdomen to assess for possible paraconduit hernia.

The most common hernia contents are colon (67-92%), small bowel (8-21%), pancreas (11%), and omentum.[3,6] In the series by Kent and colleagues,[3] 87% of paraconduit hernias were located to the left of the gastric conduit, with abdominal contents herniating into the left pleural space. The other 13% of patients had the hernia posterior to the conduit, with abdominal contents in the right chest.[3] The hernia may also compress the distal conduit, leading to outflow obstruction (Figure 1).

INCIDENCE AFTER MINIMALLY INVASIVE ESOPHAGECTOMY (MIE)

Interestingly, as the technique of esophagectomy has changed from open resection to minimally invasive, the incidence of paraconduit hernia has also risen. In a large single-institution analysis, the incidence of diaphragmatic/hiatal hernia after MIE was 2.8% (16/581) versus 0.8% (4/494) after open esophagectomy.[3] A meta-analysis of 26 studies showed similar findings, with symptomatic hiatal hernia occurring in 4.5% of MIE versus 1.0% of open esophagectomy cases,[5] whereas another institutional study showed a rate of 15% in MIE versus 8% in open.[6] One possible explanation is fewer postoperative adhesions with MIE, allowing for more mobility of intra-abdominal contents through the hiatus. In addition, the time from surgery to diagnosis of hiatal hernia was shorter in MIE, with a median of 8.8 months (range, 6-29 months) after MIE versus 21 months (range, 9-31 months) after open esophagectomy.[5] The role of Ivor Lewis versus transhiatal esophagectomy, effect of neoadjuvant treatment, and effect of obesity on the incidence of paraconduit hernia development are unclear.[7]

INDICATIONS FOR REPAIR

All patients who present with symptoms from a paraconduit hernia should undergo operative repair (Video 1). Although surgical repair in asymptomatic patients is controversial, there is risk associated with conservative management of paraconduit hernias. An untreated paraconduit hernia could have continued progression and

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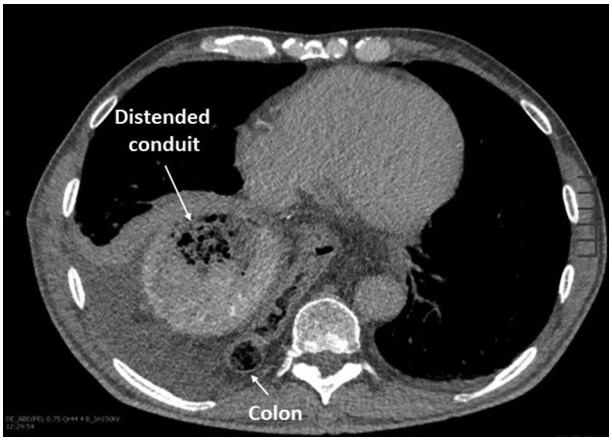


FIGURE 1. Axial image of computed tomography scan of the chest demonstrated a dilated conduit with evidence of outlet obstruction and *right*-sided paraconduit hernia containing colon.

lead to eventual emergent repair, which has a reported mortality of 14% to 25%.[5,6] Given the risk of eventual incarceration or perforation, with resultant greater morbidity and mortality, careful consideration should be given to repairing all paraconduit hernias at the time of presentation. Before offering surgical repair, patients with a history of malignancy should undergo a positron emission tomography scan to assess for recurrent or metastatic disease.

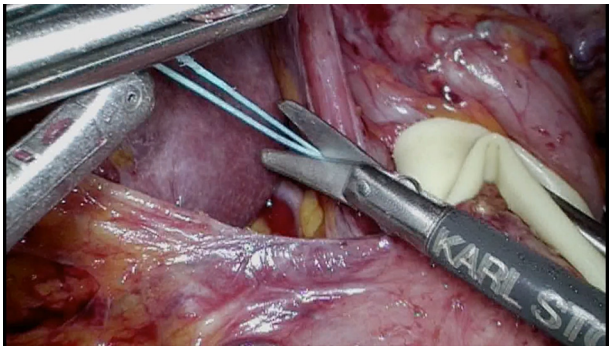
REPAIR OF PARACONDUIT HERNIA

When repairing the paraconduit hernia, the primary steps are to reduce the hernia contents, create a tension-free closure of the defect, and preserve the blood supply to the gastric conduit. Often, these hernias can be closed with primary repair using a minimally invasive abdominal approach. In rare situations, such as redundant conduit requiring concurrent repair or perforated viscus in the thoracic space, a thoracotomy or minimally invasive thoracic surgery may also be needed to repair those complications.

Ports should be placed in the standard position for a hiatal hernia repair, with port placement depending on robotic abdominal or laparoscopic approach. After accessing the abdomen and placement of a liver retractor, lysis of adhesions should be performed to expose the hiatus. Once the hiatus and hernia are visible, the hernia contents are mobilized and reduced (Figure 2). Due to previous dissection of the hiatus during the MIE, no true hernia sac is present. Any intrathoracic adhesions to the hernia contents should be divided to appropriately reduce all abdominal organs. Throughout the dissection, care must be taken to not injury the gastroepiploic artery feeding the gastric conduit (right gastroepiploic).

The defect should be closely evaluated. The crura is reapproximated to help decrease the size of the defect. The posterior crural space should be closed primarily with large (0) nonabsorbable suture. The closure can either be performed with interrupted sutures or running with locking sutures. Pledgets should not be used due to risk of erosion into the conduit. During the posterior crural closure, the conduit is retracted using a Penrose drain (Figure 3), and attention should be given to prevent anterior displacement of the conduit. Although other papers describe anterior crural closure being preferential to posterior crural closure, the authors recommend posterior closure in order to maintain the curve of the anterior crura. To close the residual hernia defect, the conduit is tacked to the left crus (Figure 4), anterior crura, and to the right crura (Figure 5), such that the only area of weakness is when the right gastroepiploic arcade enters the hiatus. For all these steps, the right gastroepiploic artery should be visualized and protected from injury.

In larger defects, a tension-free closure with reapproximation of the crura and tacking the conduit to the hiatus may not be feasible. In these situations, mesh is necessary to help create a tension-free repair with elimination of the defect. Although direct placement of the mesh to the conduit and crura has been described,[8] this technique is



VIDEO 1. Paraconduit hernia surgery. Video available at: https://www.jtcvs.org/article/S2666-2507(24)00060-9/fulltext.

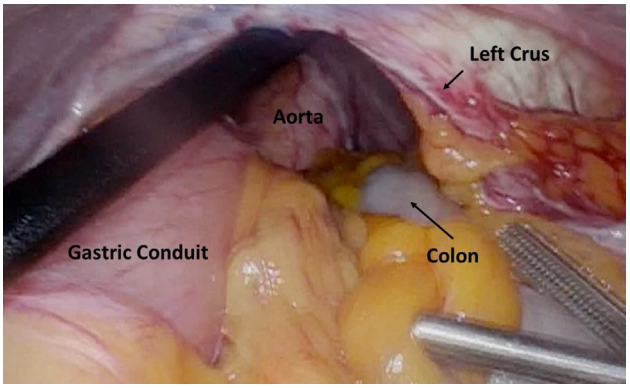


FIGURE 2. Paraconduit hernia with gastric conduit on the right and colon herniating between the conduit and left crus.

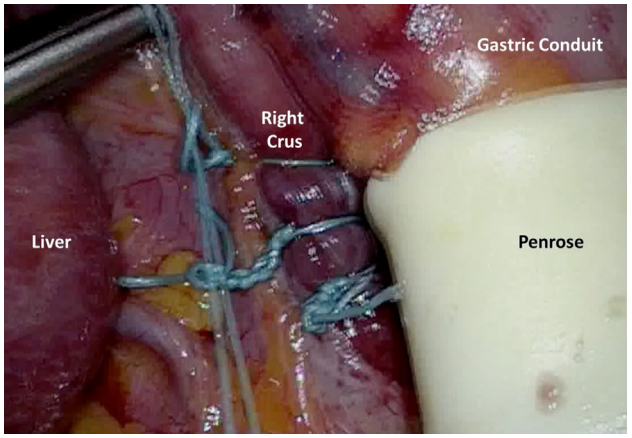


FIGURE 3. Posterior crural stitches are being placed, with the gastric conduit encircled by a Penrose drain and retracted to allow for visualization.

not recommended due to reports of mesh eroding into the pedicle or the gastric conduit. The rate of erosion is less with biologic mesh, but there is a greater failure rate. If mesh is necessary, a relaxing incision should be created with primary closure of the defect as described in the previous paragraph, and synthetic mesh (such as Gore-Tex) closure of the relaxing incision with nonabsorbable suture. The relaxing incision can be created in the right diaphragm between the inferior vena cava and right crus (for smaller defects) or in the lateral left diaphragm along the insertion of the ribs (for larger defects). If a thoracotomy is indicated for repair, another alternative is the use a pedicle flap of pericardium to close the large hiatal defect using nonabsorbable suture, with mesh closure (such as bovine pericardium) of the pericardium with nonabsorbable suture.

At the end of the operation, an esophagogastroscopy should be performed to ensure that the conduit is not kinked from the crural closure. There should be a low threshold for pyloric dilation to help with emptying and decompression of the conduit.

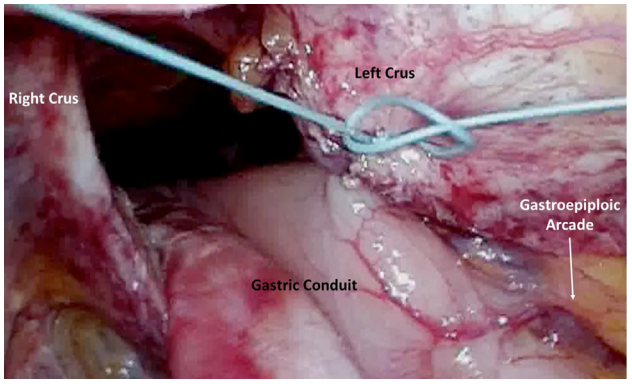


FIGURE 4. The gastric conduit is being tacked to the left crus using permanent suture.

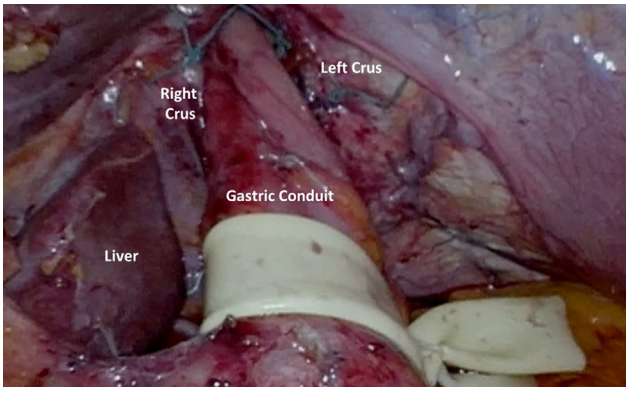


FIGURE 5. Completed repair of paraconduit hernia after posterior crural closure and primary closure of the defect with stitched tacking the esophagus to the right and left crus.

RECURRENCE AFTER REPAIR

Recurrent hernia after repair of paraconduit hernias remains high. In one study, 6 of 22 (27%) repairs recurred at 1 year, as seen on imaging.[3] All recurrences occurred along the greater curve, and all were repaired again. However, 2 of the 6 repairs resulted in a third paraconduit hernia. A different large institutional series showed 4 of 14 repairs failed.[6] Similarly, all recurrences were repaired with a 25% recurrence rate after the second repair. This high rate of recurrence demonstrates the technical challenge of repairing paraconduit hernias, as 360° closure of the defect is difficult due to need to preserve the gastroepiploic blood supply running through the hiatus.

One reported method that allows for 360° closure of the paraconduit hernia defect involves imbricating the gastric conduit over the gastroepiploic artery at the level of the hiatus.[9] This technique protects the blood supply to the gastric conduit and allows for the entire hiatal defect to be tacked to the gastric conduit. This repair was performed in 5 patients—long-term follow-up in 4 patients demonstrated no recurrence. Intraoperative use of indocyanine green demonstrated good perfusion of the conduit after repair, confirming protection of blood supply to the conduit.

PREVENTION

Given the challenge of creating a durable repair for a paraconduit hernia, prevention of the hernia at the time of MIE is essential. Although there are no proven methods to prevent paraconduit hernia, some techniques are available to potentially decrease the likelihood of hernia formation. It is essential to avoid unnecessarily enlarging the hiatus, which can occur with the surgeon's hand during transhiatal esophagectomies. Hiatal enlargement is rarely needed during Ivor Lewis esophagectomies (open or MIE). During the dissection of the hiatus, opening the left pleural space should be avoided, as many of the paraconduit hernias occur into the left chest. In transhiatal or modified McKeown

esophagectomies, the gastric conduit can be tacked to the left and right crus after the esophagogastric anastomosis is created.

During Ivor Lewis esophagectomies, tacking of the conduit the crus can also be performed. Some surgeons will push the gastric conduit into the right chest during the abdominal portion of the procedure and suture the conduit to the left and right crus; however, this technique can create issues if the gastric conduit is short, leading to tension on the esophagogastric anastomosis. Another possibility is selective prevention in high-risk patients, such as young patients, patients with a large hiatus, or those with a hiatal hernia at time of MIE. In this subset of patients, after the thoracic portion of the Ivor Lewis esophagectomy is done, the abdomen is re-entered for closure of the posterior crura and tacking the conduit to the bilateral crus.

CONCLUSIONS

Paraconduit hernia after MIE remains a complex problem with a high rate of recurrence after repair. Described preventative techniques have not been definitively shown to prevent formation of paraconduit. Repair of paraconduit hernias should focus on reducing the hernia contents, creating a tension-free repair of the defect with no mesh on the gastric conduit, and protection of the blood supply to the conduit.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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