Transthoracic Hiatal Hernia Repair

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With the widespread acceptance of and access to laparoscopy, the use of a transthoracic approach for repairing a hiatal hernia has become a rare event. Laparoscopic hiatal hernia repair, typically paired with a fundoplication and/or gastropexy, has become the most common method of dealing with this pathology. A NSQIP database retrospective review examined over 8000 patients who had paraesophageal hernia repair from 2005 to 2011; only 2.4% underwent transthoracic repair [1]. However, in certain situations, such as in a patient who has had multiple transabdominal repairs or otherwise has a hostile abdomen, transthoracic hiatal hernia can be an important alternative.

Indications

Any patient with a hiatal hernia or paraesophageal hernia is a candidate for this procedure. A laparoscopic or robotic transabdominal approach, however, is generally the first choice for a first-time or initial reoperative approach given its benefits in terms of recovery time, postoperative pain, and decreased respiratory complications. A transthoracic approach is particularly beneficial for a few subsets of patients. An obvious advantage is seen in the rare case of a patient also requiring treatment of disease of the left chest, whether it involves the lung, esophagus, or chest wall, in which simultaneous transthoracic hiatal hernia repair makes sense. A more common scenario involves a patient who has undergone multiple previous transabdominal

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hernia repair operations or multiple abdominal operations. Operating in a virgin field may reduce the chance of intraoperative complications related to accessing the abdominal cavity and the hernia itself. Prior transthoracic hiatal hernia repair also may predispose a patient to requiring a repeat transthoracic approach; that said, we often approach these patients through the abdomen and employ VATS or thoracotomy only if intrathoracic adhesions prevent the hernia from being reduced.

The answer to the question of whether to operate on all large paraesophageal hernias remains elusive. Conventional thinking dictates repair for any patient found to have one in order to eliminate the risk of strangulation. Others believe that the risk of needing emergency surgery for a paraesophageal hernia is low, at closer to 10–15% over a patient's lifetime, or around 1.1% per year [2, 3]. Therefore, some feel that asymptomatic patients can be managed conservatively, especially patients at higher operative risk. Generally speaking, however, paraesophageal hernia repair should be offered to *symptomatic* patients if their operative risk is acceptable. Symptoms of paraesophageal hernia include postprandial abdominal or chest pain, dysphagia, dyspnea, regurgitation, postprandial vomiting, GERD, and early satiety.

Preoperative Evaluation

As for any operation, a complete history and focused physical exam should be performed on all patients. Patients should be asked about the symptoms noted above. Anemia can also be a manifestation of paraesophageal hernia, as it can arise from the chronic low-grade loss of blood from gastric ulcers/erosions and gastritis in the incarcerated stomach. On the other hand, the clinician should not always assume that respiratory and gastrointestinal issues are automatically related to the hernia. A thorough assessment of the patient's cardiopulmonary and gastrointestinal issues with any relevant testing should be done. Specifically, the preoperative evaluation for a transthoracic hiatal hernia is the same as for a transabdominal approach. It consists of obtaining a barium or gastrografin swallow study to assess anatomy. Upper endoscopy can be employed but more often is performed on the day of surgery to detect the rare concomitant esophageal or gastric pathology that would dictate a different strategy. Manometry can be attempted but is often unsuccessful for patients with large paraesophageal hernias. Similarly, pH study is often difficult due to technical reasons. In addition, the conduct of the operation in our experience is unlikely to change based on results from this testing. A CT scan of the chest and abdomen is not mandatory but helpful for determining what organs are herniated into the chest and revealing any other intra-abdominal or intrathoracic abnormality that needs to be considered. Infrequently, a patient with an elevated hemidiaphragm due to eventration or paralysis can be confused with a large paraesophageal hernia; generally, however, the history of the patient can reveal the culprit injury in cases of diaphragmatic paralysis. Fluoroscopy with the patient sniffing or inspiring should detect paradoxical motion of the hemidiaphragm in these cases. In addition, close attention to the CT scan should be paid; a thin section of diaphragm may be visible

and allow for differentiation between a massive paraesophageal hernia and elevated hemidiaphragm.

Pulmonary function should be assessed; many patients will describe dyspnea as a symptom of their hernia, and it is helpful to know how impaired their lungs are and if they have any coexisting pulmonary disease that would make recovery from a thoracotomy more difficult. This also serves as a baseline to which postoperative values can be compared. Consideration to having a workup for myocardial ischemia in higher-risk patients should be given.

Technique

The technique described is for the open transthoracic hiatal hernia repair. Few case reports of completely thoracoscopic hiatal hernia repair exist [4, 5]. A double-lumen endotracheal tube is placed at the time of intubation. An esophagoscope can be inserted in order to act as a stent preventing the hiatal repair from being too tight, although the surgeon should recognize that an adult endoscope is equivalent only to an approximately 36 Fr bougie (standard bougie size for this purpose is 51–54 Fr). The patient is positioned in right lateral decubitus. A left posterolateral thoracotomy is performed. The chest is typically entered through the sixth or seventh interspace. The left lung must be mobilized superiorly to provide adequate exposure to the hiatus. Therefore, the inferior pulmonary ligament is incised to the level of the inferior pulmonary vein. Next, the mediastinal pleura is incised and the pleura overlying the esophagus is opened. Adequate mobilization is then performed by mobilizing the esophagus from the carina to the diaphragm. The hernia sac is then dissected off the esophagus and mobilized so that it can be reduced through hiatal defect. This generally requires circumferential freeing of the sac from the edge of the hiatal defect. Occasionally short gastric vessels require division in order to fully reduce the stomach. The diaphragmatic hiatus can be purposefully enlarged during the process of mobilizing and reducing the hernia to facilitate this process. The fundus of the stomach is restored to its normal anatomic position; the crural approximation sutures are placed, but not tied. During mobilization of the anterior esophageal fat pad, the vagus nerves need to be identified and protected. Mobilization of the fat pad enables identification of GEJ to determine if there is appropriate intra-abdominal esophageal length. Additionally, the dissection not only allows for identification of the anterior vagus but also creates better adhesion of the stomach to the future fundoplication. If the patient has a shortened esophagus, a Collis gastroplasty can be performed at this time. If performing this, consideration should be given to replacing the esophagoscope with a 54 Fr bougie to avoid narrowing. Gastroplasty is accomplished by using a GIA stapler and stapling into the stomach, parallel to the esophagus near the cardia of the stomach.

After this is completed, both crura are identified. It is critical to identify clearly the right crus of the diaphragm, which can be difficult to see as it is located at the bottom of the surgical field; a Babcock or Allis clamp can be used to grasp the crus and ensure that solid tissue is available for suturing. Once all of the anatomy is

delineated, the crural sutures may be placed. Crural sutures are usually needed both posterior and anterior to the esophagus and left untied for now. The use of laparotomy pads or surgical towels to keep the abdominal contents in place during this part of the operation can be helpful. Sutures to reapproximate the cut edges of any diaphragm that was divided to help reduce the hernia can be placed and tied.

We typically perform a Belsey Mark IV fundoplication [6]. This fundoplication is a partial wrap of 270 degrees made with two rows of three horizontal mattressed, 2–0 or 3–0 braided polyester or silk sutures (Fig. 20.1). The sutures should be placed in the seromuscular layer (or to be accurate, in the adventitial and muscular layers of the esophagus and seromuscular layer of the stomach), but deep enough to bring the fundus to the esophagus without tension or tearing. If a staple line is present from the gastroplasty, the middle suture of each row should straddle it. The other sutures of each row are therefore 135 degrees left and right of the middle suture. The

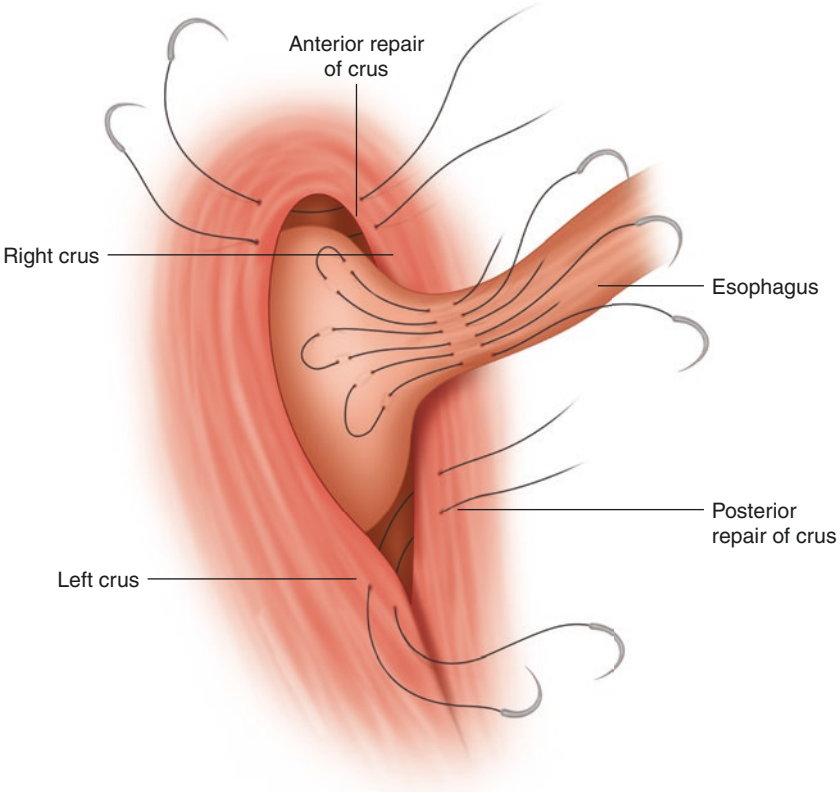

Fig. 20.1 (**a**) First row of horizontal mattress sutures for Belsey Mark IV fundoplication during transthoracic hiatal hernia repair. (**b**) Second row of horizontal mattress sutures (transdiaphragmatic) for Belsey Mark IV fundoplication

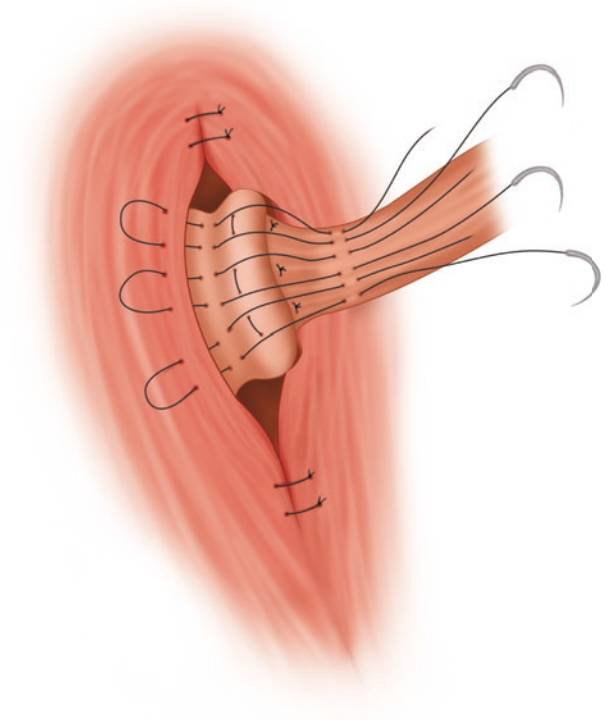

Fig. 20.1 (continued)

next row is spaced 1–1.5 cm from the fold created by tying down the sutures in the previous row. This row of sutures is placed into the diaphragm as well, to secure the repair to it. After the esophageal and gastric "bites" are taken, the needle is then passed through the diaphragm about 1 centimeter from the edge, from inferior to the diaphragm to superior so that the knot is tied on the thoracic side of the repair. These should follow in the orientation of the previous rows and respect the 270-degree spacing of the fundoplication. The GEJ and the fundoplication are translocated into the abdomen when these sutures are tied.

A Nissen fundoplication can be performed through a thoracotomy as well; for obvious reasons, this requires somewhat greater mobilization of the fundus than a Belsey fundoplication.

At this point, the crural sutures are then tied, reapproximating the hiatus. When tied, the reconstructed hiatus should open enough to slide a finger next to and past the esophagus.

A chest tube should be placed in the left chest and the thoracotomy closed in the usual fashion.

Postoperative Care

Immediately postoperatively, two key patient factors must be assessed and controlled. These are patient nausea and gastric distension. Both directly affect the tension and stress placed on the newly reconstructed hiatus and constructed fundoplication. Scheduled antiemetics should be considered given the recent gastric surgery and possible emetogenic effects of anesthetics and analgesics. We do not routinely place a nasogastric tube. However, if significant distention is visible on postoperative radiograph, placement can be considered.

Pain control is critical following thoracotomy. Modalities to control pain should be escalated if necessary. Patient-controlled intravenous analgesia is often, but not always, necessary. Certain institutions may prefer preoperative placement of an epidural catheter, paravertebral catheter or nerve block, or long-acting liposomal bupivacaine nerve block. Non-narcotic measures such as nonsteroidal anti-inflammatory drugs, acetaminophen, lidocaine patches, and muscle relaxants should also be utilized in order to decrease the amount of narcotic required and thereby reduce the adverse side effects of their administration. Intravenous fluids should be minimized given that they appear to increase the risk of pulmonary complications. Any of these outcomes could prolong recovery. The head of the patient's bed is best to be elevated to 30 degrees. This should assist in reducing edema, helping pulmonary function, and draining any fluid in the chest. Chest tube management can be left to the surgeon's preference, but we recommend obtaining a chest x-ray to ensure proper re-expansion of the lung and proper position of the chest tube and nasogastric tube, if employed. Patients can take sips of liquid the afternoon/evening of surgery but should be instructed to seek assistance if there is any urge to retch or vomit.

On postoperative day 1, the patient should be instructed and encouraged to be out of bed and ambulate as much as he or she can tolerate. An esophagram is generally obtained to both check for perforation and to establish a baseline with regard to the radiographic appearance of the esophagogastric junction and wrap. Some postoperative edema, manifested by slow transit of contrast through the fundoplication, is to be expected. If it had been placed, the nasogastric tube can usually be removed. Chest tube removal should follow usual parameters in terms of absence of air leak and reasonable daily output (up to 400–500 cc per day) and full re-expansion of the lung with minimal to no pneumothorax. Deep vein thrombosis prophylaxis should be used (and should have been initiated prior to general anesthesia).

The appropriate progression of the diet is always a question following any alimentary surgery, and the transthoracic hiatal hernia repair is no different. Delayed gastric emptying should always be on the mind of the surgeon. Even the patient tolerating clear liquids may not be able to advance to regular or soft diet quickly. A postoperative ileus is not uncommon following transthoracic hiatal hernia repair. Conservative management would wait for the patient to have evidence of return of bowel function in the form of flatus prior to advancing past clears. This pace may be too slow for some. Each surgeon should prepare their own algorithm to advance the patient's diet. We generally only advance to a soft diet while in the hospital. Patients

may be discharged when the chest tube has been removed, tolerating a reasonable diet, and pain control managed with oral medications alone. Proton-pump inhibitors or other GERD medications are generally continued in the acute setting and may be discontinued later if the patient is able.

At discharge, instructions to the patient include remaining on a soft diet for 2–3 weeks and to chew food very thoroughly prior to swallowing. As with any post-operative patients, activity and weight lifting restrictions do apply. An increase in intra-abdominal pressure could result in injury to the repair and recurrence, as well as pose a risk of incisional hernia and bowel obstruction. Follow-up is scheduled within 2–4 weeks. A repeat esophagram at that visit is unnecessary.

Postoperative Complications

The complications of this operation are a combination of the typical complications seen in hiatal and paraesophageal surgery and thoracic surgery. The use of a thoracotomy does cause increased pain, especially in comparison with laparoscopic approaches. Atrial fibrillation is a risk following thoracotomy but is controlled with rate and/or rhythm control and is usually self-limited. Pneumonia can occur; post-operative pulmonary toilet and early ambulation are used to prevent this complication, which is managed with antibiotics. If significant adhesions between the hernia and the lung were lysed, an air leak may be present; this typically resolves with observation alone. Chest tube output tends to be higher following thoracotomy than VATS. Bleeding requiring transfusion and/or reoperation is, and should be, quite rare. Short gastric arteries can be susceptible to delayed bleeding. Additionally, Belsey described the presence of a communicating artery that connects the inferior phrenic artery to the left gastric artery. It is typically in a thick tissue band that must be divided to properly mobilize the stomach from the hiatus. As with any surgery, scrupulous detail to hemostasis must be performed. Additionally, Orringer reported bleeding from shallow ulcers after this operation [7]. These were formed proximal to strictures and resulted from erosive esophagitis. Management, as with any upper gastrointestinal bleeds, involves endoscopy to assess and possibly control the bleeding, blood transfusion if the patient is unstable, and intravenous antacid therapy. In Orringer's series, no surgery was required, and only PPI or H2 blockers were needed [7].

Dysphagia is the most common complication in both immediate and delayed postoperative period. Initially, this is due to edema at the surgical site and resolves with time and patience. Prolonged dysphagia is often due to stricture of the distal esophagus. This stricture is often present at the time of the operation and can be the result of overtightening of the hiatus. Often, a single dilation with a balloon or bougie is all that is necessary to improve the patient's swallowing. In a few patients, repeated dilatations may be needed.

Leak can occur either in the esophagus or the stomach. For the esophagus and sometimes the proximal esophagus, a contrast exam is helpful. An uncontained leak

in the esophagus may benefit from stent placement, while a contained leak typically can be managed without it. The leak should be reassessed in 3–4 weeks; if healed, oral nutrition should be initiated. Reoperative thoracotomy should be considered if stenting is unsuccessful. If a gastroplasty is performed or if considerable amount of tension is placed on the repair due to inadequate mobilization or retching or gastric distension, the stomach can leak. With a stapled gastroplasty, inadequate tissue compression or overdistension prior to healing can be the cause. Any patient with unexplained tachycardia or signs of sepsis should be evaluated for a leak. Many patients can be treated nonoperatively by making the patient NPO and starting intravenous antibiotics. Some form of nutrition should be instituted, whether enterally via a feeding tube of some kind or parenterally. Clinical deterioration or peritonitis should provide the impetus for operative reexploration and repair, typically through a transabdominal route in cases of suspected gastric perforation. Alternatively, the hiatal hernia repair can be taken down and the stomach examined through the chest.

With mobilization of the esophagus from the arch to the diaphragm and dissection at the gastroesophageal junction, permanent or temporary injury to one or both vagus nerves can result in delayed gastric emptying, or gastroparesis. This is manifested by nausea/vomiting and inability to tolerate oral intake after surgery, sometimes accompanied by bloating and/or abdominal pain. A distinction should be drawn between stricture and gastroparesis given their differing treatments; esophagram and gastric emptying study can be helpful for diagnosis. As transthoracic hiatal hernia repair often tends to be performed in the context of prior operations on the esophagogastric junction, delayed gastric emptying is not uncommon. If delayed gastric emptying is suspected in the preoperative setting, a gastric emptying study should be performed in order to confirm that this is a pre-existing problem. Promotility agents often relieve the symptoms of gastroparesis. Placement of gastric pacemakers and pyloroplasty are more extreme options for gastroparesis not responding to medical therapy.

Recurrence of the hernia after repair, whether transthoracic or otherwise, can occur. A distinction, however, should be drawn between recurrences that are clinically relevant and warrant reoperation and recurrences that are only radiologic in nature and asymptomatic or minimally symptomatic. Patients do not tolerate well a fundoplication that has herniated into the chest but remains intact. If significant dysphagia, regurgitation, or vomiting occurs, reoperative repair should be contemplated. Early dehiscence of the repair and recurrence of the hernia can occur acutely in the setting of postoperative retching/vomiting; reoperation should be offered in this situation.

Postoperative Outcomes

Few large series of transthoracic hiatal hernia repairs exist. The transthoracic approach comprised only 2.4% of all repairs performed from 2005 to 2011 in the NSQIP database [1]. The vast majority of patients in that review underwent laparoscopic repair (78.4%). The open transabdominal approach was less prevalent

but still almost ten times more common than the transthoracic approach (19.2%). In that study, the mortality of the transthoracic approach was more than laparoscopic, 1.5% vs. 0.5%, but less than the open transabdominal approach (2.6%). Length of stay was twice as long compared to the laparoscopic approach. However, patients were sicker and more likely to have CHF and COPD. After adjustment for age, ASA, emergency cases, functional status, and steroid use, the transthoracic approach still had increased odds of overall and serious morbidity compared to laparoscopic repair (OR 2.73 and OR 2.49 respectively, $p < 0.001$).

Long-term outcomes over a 20-year period were reported from Emory University in 1997 [8]. They reported 276 patients that underwent the Belsey Mark IV fundoplication. It should be noted that only 9.7% of these patients were noted to have a paraesophageal hernia. The overall perioperative morbidity and mortality rates were low, at 10.1% and 0.4%, respectively. Early reoperation (0.7%), leak (0.7%), stricture (0.4%), and other major complications were all rare. Late reoperations occurred in eight patients. Dysphagia was absent or only occasional in 79%; 6% required intervention for dysphagia. GERD symptoms were absent or occasional in 84% of patients.

In 2004, the University of Michigan published their 25-year experience of 240 patients undergoing transthoracic repair for paraesophageal hiatal hernia [9]. Of these, 96% underwent a combined Collis-Nissen operation in 96%, Nissen fundoplication in 3%, and a Belsey Mark IV in 1 patient. The investigators reported a 1.7% perioperative death rate, median length of hospital stay of 7 days, and early reoperation in 5% of patients. Median follow-up was 27.8 months, and "satisfactory" results by patient report were achieved in 85%. Of 153 patients who underwent routine pre-discharge postoperative esophagram, 77% had satisfactory postoperative appearance, with 17% having delayed esophageal emptying and 5% with esophageal dysmotility. Four patients had early anatomic recurrences that were all reoperated on. A liberal policy of dilational therapy led to 31% undergoing dilation for dysphagia after surgery, but only 8% received more than one dilation. Late postoperatively, only six patients required further surgery (four for recurrent herniation, two for esophagectomy due to stenosis at the GE junction). Of 45 patients who had both preoperative and postoperative pH testing, 88% had preoperative abnormal reflux compared to 4% postoperatively. Dysmotility also decreased postoperatively, from 27% preoperative to 7% postoperative.

Taylor et al. have demonstrated that reoperative transthoracic hiatal hernia repair can also be done safely [10]. Major postoperative complications occurred in only 12% of their overall group of 65 patients (42 patients in initial group, 23 patients in reoperative group). In-hospital mortality occurred in only one patient (initial repair). Reoperative transthoracic hiatal hernia repair was associated with higher postoperative symptomatic bloating and dysphagia scores and less improvement in GERD-related quality of life scores compared to initial repair. Overall quality of life scores, however, were similar.

Conclusion

Although a minimally invasive transabdominal approach is now the preferred initial approach to paraesophageal hernia due to decreased perioperative morbidity, transthoracic hiatal hernia repair is a useful operation for certain patients. The few reports that exist come from large, specialized centers but demonstrate very good short-term results and long-term freedom from reoperation, reflux, and dysphagia.

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