Laparoscopic Heller Myotomy with Toupet Partial Posterior Fundoplication

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Introduction

Invasive treatment for esophageal achalasia dates back to 1674 when Thomas Willis first described esophageal dilation for "cardiospasm" by means of a sponge-tipped whalebone [1, 2]. Heller's description of the anterior and posterior esophagogastric myotomy via a thoracotomy approach launched the era of achalasia as a surgical disease over 100 years ago [3]. Since that time, a large number of refinements in both the approach and procedure have been made, particularly with the advent of minimally invasive surgical techniques in the late 1980s and early 1990s. Though the thoracoscopic method was the first minimally invasive approach to be described, the laparoscopic anterior esophagogastric myotomy, allowing for a longer myotomy distal to the esophagogastric junction with even better results in relieving dysphagia [4] is currently the most commonly employed surgical approach to the patient with this disease. This is typically combined with an antireflux procedure, as the incidence of post-myotomy acid reflux (though often asymptomatic) in patients without an antireflux procedure is in excess of 50 %.

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Workup and Indications for Esophagogastric Myotomy

Since medical therapy is relatively ineffective in the treatment of achalasia, some form of invasive therapy is usually necessary. Endoscopic injection of botulinum toxin at the level of the LES has very limited efficacy, and further it is believed by many to make a subsequent surgical myotomy more difficult with a higher risk of esophageal perforation. Esophageal pneumatic balloon dilation is relatively effective, however is associated with an approximately 3 % risk of perforation, and has a higher likelihood of requiring subsequent therapy for recurrent symptoms than does surgical management. Therefore Heller myotomy is currently indicated as first-line therapy for the majority of patients with esophageal achalasia, provided that they are deemed fit enough to undergo a laparoscopic operation.

Most patients referred to the surgeon for treatment of achalasia have already undergone at least some of the necessary preoperative workup. These studies include upper endoscopy, upper GI radiography, and esophageal manometry. Further studies may be indicated depending on findings of the above-mentioned examinations, but are not routinely ordered in every patient.

The primary role of endoscopy in the workup of achalasia is to rule out any other cause of mechanical obstruction in the patient presenting with dysphagia, such as peptic stricture,

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esophageal cancer, or a benign esophageal tumor. Typically endoscopy will demonstrate a dilated esophageal lumen with retained food particles, and the LES will remain closed. Classically, the endoscope only enters the stomach by pushing through the esophagogastric junction with some resistance, giving rise to the term "clasp-knife sensation" that is often used by endoscopists to describe this finding in patients with achalasia.

Upper GI radiography is useful in further defining the anatomy of the esophagus, and may be able to better demonstrate findings that might suggest extrinsic compression on the distal esophagus as the true etiology of the patient's dysphagia symptoms. The demonstration of a "bird's beak" sharply tapered narrowing at the level of the esophagogastric junction is most commonly seen in achalasia and can help to confirm the diagnosis in conjunction with other studies. In addition, the degree of dilation and tortuosity (i.e., the presence or absence of "sigmoid esophagus") is assessed by radiography. This can be important in prognosis, as patients with severe dilation or sigmoid esophagus have been shown to have a higher incidence of symptom recurrence after myotomy [5, 6].

Esophageal manometry is diagnostic. Currently, high-resolution manometry (HRM) is commonly employed, and 3 distinct achalasia subtypes are recognized: type I (non-relaxing LES and complete absence of esophageal peristalsis or pressurization), type II (non-relaxing LES and at least 20 % of swallows resulting in pan-esophageal pressurization), and type III (non-relaxing LES without any true peristalsis at least 20 % of swallows resulting in simultaneous high-amplitude contractions, formerly recognized as "vigorous achalasia"). The subtypes may have some relevance to the surgeon in that some investigators have found that the outcomes of Heller myotomy in terms of symptom relief vary by subtype [7–9], which will be discussed later in the chapter.

While it is not customary to order ambulatory pH testing in patients with suspected achalasia, these studies are occasionally performed in cases in which the patient is initially suspected of having gastroesophageal reflux disease, since dysphagia is a common symptom presentation for that disorder. Numerically, achalasia patients will often have abnormal pH studies, however they typically exhibit a very characteristic "fermentation pattern" on pH monitoring wherein the pH in the distal esophagus will slowly drop below 4.0 and remain below this threshold for prolonged periods of time, because of the conversion of retained food to lactic acid by bacteria in the achalasia esophagus [10]. Thus, ambulatory pH monitoring can actually help to confirm the diagnosis in such situations.

Additional studies are occasionally warranted, particularly if the findings from the routine workup do not clearly indicate achalasia. Computed tomography can help to rule out causes of extrinsic compression of the distal esophagus, as can esophageal endoscopic ultrasound (EUS). EUS can be particularly useful in these situations, as a biopsy of such a lesion can often be obtained in order to achieve a more definitive diagnosis.

Technique of Esophagogastric Myotomy

Patient Preparation

In preparation for surgery, patients are kept NPO from midnight the night before the operation at a minimum. Depending on the degree of esophageal dilation and the practice of the surgeon, it may be helpful for the patient to actually be on a clear liquid diet for one or more days prior to the operation, to minimize the amount of retained food that will be present in the esophageal lumen at the time of surgery. This both reduces the risk of aspiration upon endotracheal intubation as well as facilitates the performance of intraoperative upper endoscopy if required.

Patient Positioning

As a minimally invasive foregut operation, the most practical patient positioning for laparoscopic Heller myotomy is identical to that most

commonly used for laparoscopic antireflux surgery, which is to have the patient supine with the legs spread apart, either by means of the low-lithotomy stirrup positioners or a split-leg table configuration in which the primary operating surgeon stands between the patient's legs and the assistant stands on the left side of the patient. Both arms may be left out, and it is often helpful to turn the axis of the table approximately 30° from the long axis of the room, with the left shoulder angled away from the anesthesia machine so that the monitor may be placed just above the left shoulder while leaving enough room for an upper endoscopy to be comfortably performed during the procedure. Since it will be necessary to place the patient in steep reverse-Trendelenberg position throughout the majority of the operation, the use of bilateral thigh straps mounted to the sides of the operating table, creating a "climbing harness" effect, is very helpful in preventing the patient from slipping during the case. Alternatively, one can use a bean-bag positioner, which can be molded into a kind of "saddle" below the perineum.

Trocar Placement

The first incision, big enough to accommodate an 11 mm laparoscopic trocar, is made just inferior to the left costal margin at the mid-clavicular line. After dissecting through the subcutaneous tissue, the fascia is grasped with two kocher clamps and elevated so that a veress needle may be inserted to insufflate the peritoneum to 15 mmHg pressure. The use of an optical trocar, in which entry through each layer of the abdominal wall and the peritoneum is visualized with the laparoscope, is particularly useful with this access technique and is quite safe. An 11 mm trocar is used at this site, which is necessary for laparoscopic suturing later in the procedure. While a Hassan "open" access technique may be used alternatively, this is considerably more difficult in this location because of the relative thickness of the abdominal wall here. Once the laparoscope has been introduced and an inspection of the peritoneal cavity has been made to ensure that there is no injury from the initial access, the next port is placed under laparoscopic guidance in the epigastrium just to the left of the midline between 2 and 6 cm above the level of the umbilicus, depending on the size of the patient. This may be either a 5 mm port, if a 5 mm laparoscope is used, or an 11 mm port if the 10 mm laparoscope is chosen; in either case a 30° laparoscope should be used. At this point, the laparoscope is moved to the epigastric port site and the remaining 3 ports, all 5 mm diameter, are placed in the left flank (for the assistant), right flank (for the liver retractor), and right subcostal (for the primary surgeon's left hand instrument) positions respectively. The left lateral segment is then retracted anteriorly with a flexible articulating 5 mm liver retracting device to expose the proximal stomach and region of the hiatus. Alternatively the Nathanson liver retractor may be used through a small stab incision just beneath the xiphoid without a trocar, in which case no right flank port is necessary. The liver retractor is secured with a table mounted self-retaining device (such as the "iron intern").

Dissection and Mobilization

Dissection is begun by dividing the hepatogastric omentum with either electrocautery or the ultrasonic coagulator, moving cephalad until the junction between the right crus of the hiatus and the phrenoesophageal membrane is reached. The hiatus is then opened anteriorly from right to left, exposing the distal esophagus and esophagogastric junction (EGJ) (Fig. 11.1). In addition, it is necessary to create a posterior window behind the esophagogastric junction but below the level of the hiatus, leaving the phrenoesophageal membrane intact posteriorly if possible. However, if there is a hiatus hernia as is sometimes observed, it may be necessary to fully dissect the hiatus and reduce the EGJ into the abdomen. A point along the greater curvature of the stomach approximately one-fourth to one-third of the way distal to the EGJ is chosen to begin dividing the short gastric vessels in order to mobilize the fundus for the creation of the Toupet partial posterior fundopli-

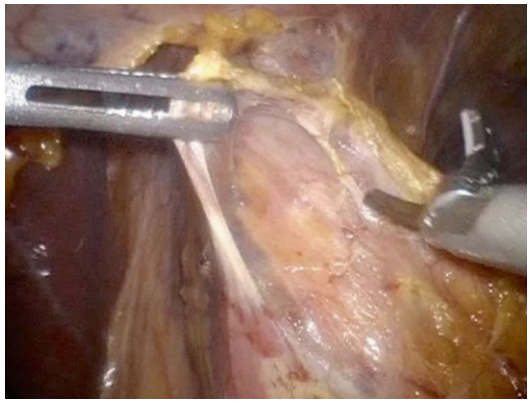

Fig. 11.1 Dissection along right crus

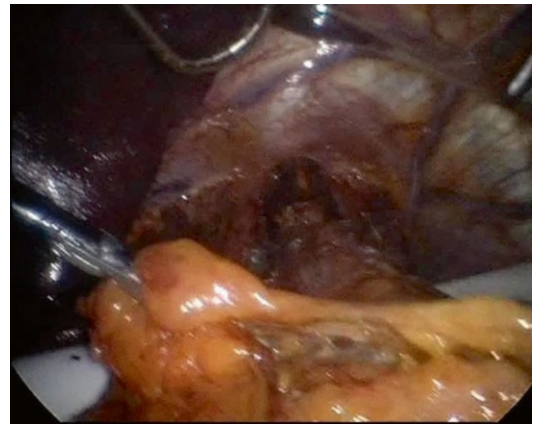

Fig. 11.2 Elevation of the epigastric fatpad

cation later in the case. The ultrasonic coagulator works very well for this purpose, and it is recommended to continue proximally along a line approximately 1 cm away from the gastric serosa. The short gastrics are divided all the way up to the level of the left crus. An alternative approach to this dissection is to begin with the division of the short gastrics, and then dissect the hiatus from left to right, which works equally well and is chosen based upon the preference of the surgeon.

At this point it is helpful to place a penrose drain around the esophagogastric junction, securing it loosely anteriorly with an endoloop suture. This enables retraction of the EGJ and distal esophagus, facilitating further dissection of the anterior esophagus above the hiatus and enabling a longer proximal myotomy. The hiatus is generally not closed even though it has typically been enlarged to some degree in the course of this dissection. However in the case of the patient with a hiatus hernia, the hiatus should be reapproximated with interrupted sutures posterior to the esophagus, taking care not to narrow the hiatus too much and ensuring that a grasper can easily be passed alongside the esophagus at a minimum once the sutures have been placed.

Performance of the Myotomy

The esophagogastric fatpad is elevated and carefully dissected off of the area of the esophagogastric junction, taking care to identify and preserve the anterior vagus nerve (Fig. 11.2). The ultrasonic coagulator is an ideal instrument for this purpose, as there are frequently small vessels in this area which can bleed and obscure the field. At this point some surgeons will prefer to have a lighted esophageal dilator placed transorally (which is ideally done by the anesthesiologist as long as they are experienced and comfortable with the procedure) which can serve as a sort of "platform" for the performance of the myotomy itself. A point on the anterior gastric cardia approximately 2–2.5 cm to the left of the lesser curvature and 3 cm distal to the esophagogastric junction is chosen to start the myotomy. This is typically begun by scoring the serosa with the electrocautery hook for a distance of at least 1 cm up towards the EGJ, and then carefully dividing the muscle fibers one layer at a time until the submucosa is reached (Fig. 11.3). The submucosa is identifiable as a smooth surface that has a texture distinctly different than the muscularis. The muscle fibers can be disrupted using elevation with the hook and employing cautery only very sparingly. Hooking large bundles of fibers at once should be avoided. Bleeding on the surface of the submucosa can usually be very easily controlled by the gentle application of pressure with a blunt grasper. Notably, this part of the myotomy is the most difficult, because of both the thickness of the muscle in this region and the organization of the "clasp and sling" fibers that make up the gastric component of the LES, which is organized

Fig. 11.3 The myotomy is begun 3 cm distal to the esophagogastric junction

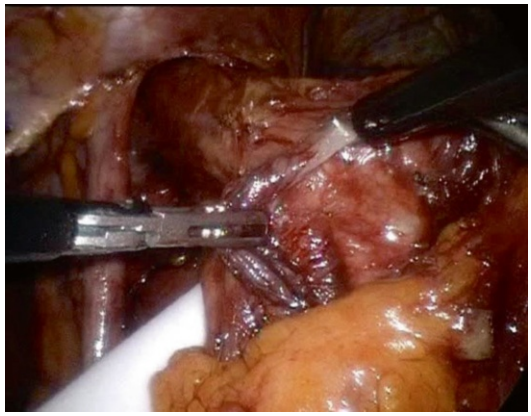

Fig. 11.4 The myotomy is continued using primarily blunt dissection with a hook cautery instrument

much differently than the more simple outer longitudinal and inner circular muscular layers of the esophageal body encountered in performing the proximal myotomy.

Once the initial area of the distal myotomy is established, blunt graspers are used to grasp either side of the muscularis on the myotomy edge with the assistant grasping the left side of the myotomy and the primary surgeon grasping the right, providing gentle traction which allows the myotomy to continue in a cephalad direction (Fig. 11.4). Alternatively, a babcock grasper can be used with jaws open to stretch the myotomy area laterally to achieve a similar effect. As the myotomy is carried underneath the epigastric fatpad and proximally past the EGJ, it becomes notably easier to bluntly divide the muscularis, particularly the longitudinal fibers, which become more distinct from the underlying circular fibers. Ultimately the myotomy should be continued proximally until the length above the EGJ is 6–8 cm with the esophagus not under tension. This can be measured directly by inserting a sterile measuring stick and holding it in place alongside the myotomy, or by introducing a pre-measured length of suture (Fig. 11.5).

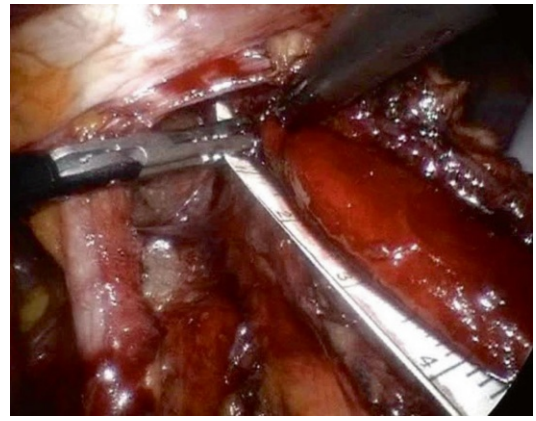

Fig. 11.5 Measuring the final length of the myotomy

Intraoperative Assessment of the Myotomy

At this point in the procedure, many surgeons will perform an upper endoscopy in order to evaluate the adequacy of the relief of the high-pressure zone of the LES. Observation that the area of the esophagogastric junction is widely patent and easily permits passage of the endoscope is a relatively easy method to determine the success of the procedure intraoperatively. In addition, this permits the visualization of any small areas of perforation that may have occurred during the myotomy, in the same way that the "leak test" is used after an anastomosis is performed in rectal surgery. The use of intraoperative esophageal manometry has been described, with the stated advantages being the ability to identify relatively small specific

points of remaining muscle fibers representing a residual high-pressure zone, as well as helping to guide length of the myotomy [11], however this is relatively cumbersome to perform.

Currently there is increasing interest in measuring the distensibility of the high-pressure zone during myotomy as a way to evaluate the success of the procedure intraoperatively. The functional luminal imaging probe (FLIP), using the principle of impedance planimetry to measure the cross-sectional area at several points along the myotomy in relation to pressure, generates a distensibility index expressed in mm^2/mmHg. Teitelbaum and colleagues have found that a distensibility index in the range of 4.5–8.5 mm^2/mmHg correlates with optimal symptom outcomes [12]. This technology is not widely available in clinical practice at the time of this writing, however, thus it remains to be seen whether or not the distensibility index will become a standard method for intraoperative assessment.

Creation of the Toupet Fundoplication

With the myotomy complete, the dilator, if used, can now be removed. To begin the Toupet fundoplication, the posterior fundus is passed through the retroesophageal window to the right side of the myotomy and its superior aspect can be fixed to the base of the right crus with a 2-0 silk or braided nylon to secure the fundus in this position. Next, a suture is placed between the superior aspect of the fundus on the right, the anterior right crus, and the right edge of the myotomy. This is followed by two additional sutures between the fundus and the right myotomy edge progressively more distally. These three sutures are repeated in an identical manner on the left side of the myotomy, adjoining the anteromedial aspect of the fundus to the cut muscularis edge (Fig. 11.6). The area is then inspected for bleeding, hemostasis is achieved as needed, the liver retractor is removed, and the port sites are all closed.

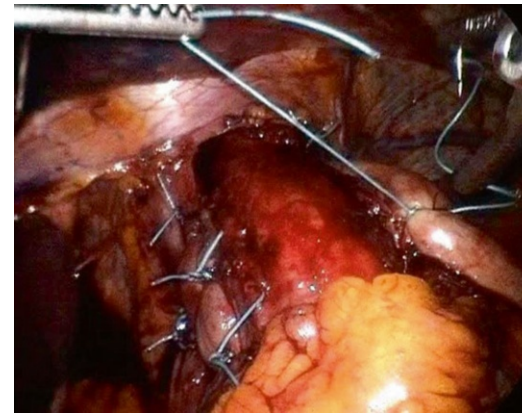

Fig. 11.6 Suturing the left aspect of the Toupet fundoplication

Postoperative Management

Immediately after transfer from the post-anesthesia recovery unit, patients may be started on a clear liquid diet, provided that there was no perforation of the esophagus during the myotomy. On postoperative day number one, a soft mechanical diet may be instituted. In the case of the patient in whom there was a perforation which was repaired intraoperatively, it is prudent to order a gastrografin esophagram on the first postoperative day to ensure that there is no leak; if none is seen, this is followed by barium, and if again there is no leak then the patient may begin a clear liquid diet with progression to the soft diet the following day. Initial pain management is best done with IV narcotics, and a patient-controlled analgesia technique works very well for this. Transition to oral narcotic pain medications, particularly those in elixir form, can usually be accomplished within 24 h or less, and most patients will be able to be discharged from the hospital on the first day after surgery. Generally, patients are maintained on the soft diet for 2–3 weeks after the operation, and if they are not experiencing any significant dysphagia at that time, they may fully liberalize their diet as tolerated.

Outcomes of Extended Esophagogastric Myotomy

Multiple studies have demonstrated that Heller myotomy is the most effective and durable treatment for esophageal achalasia when compared to other less invasive techniques such as botulinum toxin injection or esophageal balloon dilation [13–15]. Campos and colleagues have published the largest meta-analysis to date on this subject, which included a subset of 2507 patients undergoing laparoscopic Heller myotomy with an antireflux procedure who were followed for a mean of 35 months. The overall long-term success in relief of dysphagia in this group was 90 %, with only 9 % of those patients exhibiting evidence of gastroesophageal reflux after myotomy [15].

Using the specific technique of laparoscopic Heller myotomy with Toupet fundoplication described in this chapter, with particular emphasis on the extension of the myotomy to 3 cm onto the gastric cardia, Wright et al. reported excellent symptom relief in 63 patients followed for a mean of 45 months, with a need for re-intervention of any kind of only 5 %. This was significantly lower than a comparison group of patients undergoing a shorter distal myotomy (approximately 1.5 cm onto the gastric cardia) with Dor anterior fundoplasty, in whom the re-intervention rate was 17 % [4]. This data reinforces the importance of the distal aspect of the myotomy and the complete division of the "clasp and sling" fibers of the LES in producing the most durable symptom relief in patients with this disease.

As noted earlier in this chapter, some authors have found that the outcome of Heller myotomy with respect to symptom relief varies by the manometric subtype as observed with high-resolution manometry. Pandolfino and colleagues found that patients with type II achalasia, characterized by the presence of pan-esophageal pressurizations on HRM, respond better to either dilation or myotomy than do patients with type I (with no esophageal body contractions of any kind) or type III (spastic distal esophageal contractions) [7]. Better symptom outcome for type II patients after myotomy was also observed in two subsequent studies, both involving large numbers of patients [8, 9]. It is worth noting, however, that in both of these studies the surgical technique involves extension of the myotomy to no more than 2 cm onto the gastric cardia. In contrast, a 2014 study by Greene et al. in which a 3 cm myotomy onto the cardia as described in this chapter was used found that there were no significant differences in symptom outcome between the three subtypes [16]. Similar findings have been observed at the University of Washington (data not yet published).

In addition to the commonly described symptoms of dysphagia and regurgitation, it has also been noted that a large proportion of achalasia patients (up to 57 %) experience various respiratory symptoms, such as cough, shortness of breath, and wheezing, as well as in some cases having recurrent episodes of pneumonia [17, 18]. These complaints are improved in all patients undergoing Heller myotomy, and 82 % of patients are free of recurrent pneumonia at 5 years after the operation [18].

With respect to the particular choice of antireflux procedure in conjunction with Heller myotomy, this is typically a matter of surgeon preference, with particular reasons cited for one technique versus another. The rationale behind the use of the Toupet fundoplication is that it is thought to potentially help stent open the myotomy itself and avoid subsequent scarring of the myotomized muscle edges, as well as to create more bulk and fixation posterior to the esophagus in order to avoid hiatal herniation. To date there is only one randomized trial of one antireflux procedure versus another in Heller myotomy, published in 2012 by Rawlings et al. In this trial 60 patients with achalasia undergoing laparoscopic Heller myotomy were randomized to either Dor anterior fundoplasty or Toupet partial posterior fundoplication. On postoperative follow up with ambulatory 24-h pH testing, the authors found no statistically significant differences in DeMeester scores or the percentage of time with pH<4 between Dor or Toupet, and similar postoperative symptom scores for both groups [19].

Conclusion

For patients with achalasia, a complete workup including upper endoscopy, esophageal radiography, and esophageal manometry is essential to definitively confirm the diagnosis. Laparoscopic Heller myotomy with Toupet partial posterior fundoplication is an extremely effective treatment for symptoms of dysphagia and regurgitation, as well as the respiratory symptoms that frequently accompany this disease, and can be considered as first line of therapy in the majority of patients. In particular, it is important to ensure that the length of the myotomy onto the gastric cardia is at least 3 cm in order to achieve the highest patient satisfaction rates with the least likelihood of needing subsequent intervention for dysphagia.

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