Laparoscopic Nissen Fundoplication

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Nissen fundoplication was first reported in 1955 by the Swiss surgeon, Rudolph Nissen. The procedure was considered effective in the treatment of gastroesophageal reflux disease (GERD); however, it carried morbidity that limited the procedure’s use to extreme cases. The first laparoscopic Nissen fundoplication was performed in 1991 by Dr. Bernard Dallemagne. The subsequent 15 years have seen both dramatic improvements in medical therapy and dramatic increases in the number of patients treated surgically. Proton pump inhibitors (PPIs) have revolutionized the medical management of GERD in the last 17 years. These medications are extremely effective at limiting greater than 95% of acid production in the stomach and are widely prescribed as first-line therapy for GERD. The increase in surgical therapy is largely attributed to the advances of the laparoscopic approach and patient awareness of reflux disease. More recently, endoluminal therapies for GERD have become available and are selectively utilized. Thus, the surgeon must provide a comprehensive approach and have knowledge of all treatment modalities to have successful outcomes and improve patient satisfaction.

**Patient Selection**

**Confirm the Diagnosis**

The classic diagnosis of GERD can be achieved by a history of typical symptoms (see Table 1) that are relieved following antacid administration. Indeed, most patients present for a surgical opinion having already seen their primary care physician or gastroenterologist with subsequent administration of a PPI.

Barium swallows have limited utility in the diagnosis of GERD. Reflux cannot be accurately diagnosed radiographically. This study primarily allows diagnosis and assessment of a hiatal hernia. Esophagogastroduodenoscopy (EGD) is an excellent tool in the diagnosis of GERD. A history of typical symptoms in conjunction with endoscopic findings of mucosal irritation (esophagitis) is specific for the diagnosis of GERD. Biopsies at the time of endoscopy can help to confirm the diagnosis. However, as noted previously, it is rare for a patient to present for surgical evaluation without first receiving empiric medical treatment. Thus, it is now unusual to see a patient with untreated GERD demonstrating classic endoscopic findings of esophagitis. In addition, many patients are being referred as a result of atypical symptoms (see Table 1) with otolaryngologists now comprising a significant portion of the referring physician pool. Without the combination of classic symptoms and endoscopic findings, it is important to objectively confirm the diagnosis of GERD.

The gold standard objective diagnostic tool for GERD remains the 24 pH study. Symptoms alone have been shown to not always correlate with abnormal pH studies and it is important to distinguish GERD from other etiologies of the patient’s symptoms. The pH study allows calculation of the Johnson-Demeester (J-D) score and the evaluation of the percent time during which the distal esophagus is exposed to a pH less than 4. An abnormal J-D score and pH less than 4 greater than 4% of the time confirms the diagnosis of pathologic GERD. The advent of catheter-less pH probes, which attach to the distal esophagus and transmit pH readings to a receiver (Bravo probe, Medtronic), has further improved the accuracy of the pH study for GERD. The discomfort and cosmetic effect of a nasal catheter is negated with the wireless probe and allows the patient to conduct their “normal” activities during the period of their study.

**Exclude Alternate/Additional Pathology**

Manometry is essential in excluding a functional abnormality of the body of the esophagus. Symptoms of achalasia can be misinterpreted as GERD, and occasional patients will have ineffective esophageal motility (IEM) in addition to GERD. Manometry is diagnostic in achalasia with incomplete LES relaxation and aperistalsis of the esophagus. Esophageal contraction amplitudes of less than 30 mmHg with greater than 20% of swallows not being peristaltic are indicative of IEM. In either of these circumstances, a 360 degree fundoplication is contraindicated and can lead poor outcome for the patient, and possible worsening of symptoms. Upper endoscopy has a dual role in both confirming the diagnosis of GERD and excluding alternate/additional pathology: malignancy, benign stricture, intestinal metaplasia, hiatal hernia, and peptic ulcer disease are all easily detected endoscopically.

**Consider the Pros and Cons of Alternate Treatment Strategies**

Unlike many surgical diseases, it is after the confirmation of the diagnosis and exclusion of alternate pathology that the
Table 1  GERD Symptoms

<table>
<thead>
<tr>
<th>Typical</th>
<th>Atypical</th>
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<tr>
<td>Heartburn</td>
<td>Hoarseness</td>
</tr>
<tr>
<td>Regurgitation</td>
<td>Cough</td>
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<tr>
<td>Dysphagia</td>
<td>Aspiration</td>
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<td>Globus</td>
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<td>Dental erosion</td>
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real patient selection becomes challenging in patients with GERD. Medical management and PPIs have evolved to the point where a true failure of medical management is rare. Surgical therapy has been proven extremely effective in the treatment of GERD, however, has potential for morbidity. As many as 5% to 10% of patients may suffer prolonged dysphagia, or complain of bloating or diarrhea following fundoplication. Furthermore, it has been well-established that those patients who respond well to medications are the patients who have the best outcomes after surgery. Paradoxically, current indications for surgery include significant reflux that has truly failed medical management. These patients are typically on twice-daily medication with intermittent but persistent symptoms and/or significant esophageal injury. Many of these patients will also complain of regurgitation as one of their primary symptoms. More commonly, patients are selected on the basis of reluctance to commit to a lifetime of medication dependence. This reluctance stems from financial concerns, psychological resistance, unbearable side effects of the medications, or concerns regarding potential but unknown side effects of a lifetime of acid suppression. Most patients with atypical (respiratory or laryngeal) symptoms do respond well to fundoplication and poorly to medications. These patients should be counseled that these symptoms will take longer to resolve postoperatively than typical GERD symptoms.

To fully educate the patient, one must also discuss endoscopic therapies for GERD with the patient. Endoscopic treatments are appealing to patients because they can be done without incisions on an outpatient basis with supposed minimal morbidity. Endoscopic therapies that have been Food and Drug Administration approved thus far include injectable materials, suturing devices, and radiofrequency ablation. Many of these have already been pulled from the market because of some bad outcomes or ineffectiveness because of nonreproducibility. The remaining treatments that have shown some beneficial effect for patients at this point in time include endoscopic plication (NDO Plicator) and radiofrequency ablation (Stretta, Curon Medical, Sunnyvale, CA). These treatments have shown improvements in approximately two-thirds of patients who undergo these procedures, but not normalization of acid exposure. Patient selection is even more important for these procedures. Patients should be counseled extensively about the pros and cons, including the success rates and risks of complications. None of these procedures should be offered to patients with a hiatal hernia greater than 2 cm, or extremely low lower esophageal sphincter (LES) pressures. We use the manometric and endoscopic findings to help guide therapy if the patient wishes to pursue and has been deemed a candidate for endoscopic therapy. If the patient has a flattened or patulous LES on retroflexed endoscopic view of the cardia, we tend to counsel the patient toward endoscopic plication. If manometrically, the patient has transient inappropriate LES relaxations noted during the study, we counsel them toward radiofrequency ablation.

Contraindications to Nissen Fundoplication

There are relatively few contraindications to this procedure. Patients who have had prior gastric or esophageal surgery should be approached with caution when considering any antireflux procedure. Prior antireflux surgery is a relative contraindication. Patients should be worked up for recurrence of pathologic acid exposure in the distal esophagus and other anatomic abnormalities. Endoscopic procedures may be considered for these patients so that reoperation may be avoided. Another relative contraindication for antireflux surgery is obesity. Those patients who are morbidly obese (BMI ≥40 kg/m²) may benefit more from bariatric surgery and patients should be counseled about this.

Technique

Port Placement/Room Setup

The patient is placed in the supine position on a split leg table. If one is not available, the patient can be placed in lithotomy so that the surgeon can operate from between the legs (French position). It is often helpful to place the patient on a bean bag when in lithotomy so that they do not slide off of the bed while in the reverse Trendelenberg position. Sequential compression devices are used for deep venous thrombosis prophylaxis. A second generation cephalosporin is used for antibiotic prophylaxis.

We have access to an Aesop robot device to assist with holding the camera. This is placed on the operating room bed at the right shoulder with the right arm tucked. The assistant stands to the patient’s left and will operate the camera with a remote control from there. The patient is placed in reverse Trendelenberg position with the table as low as it goes. The surgeon stands between the legs to operate in the French position. The cautery pedal is placed at the surgeon’s right foot. The laparoscopic viewing screens are placed directly above the patient’s head so that the surgeon can view the straight on and the assistant’s screen is placed just lateral to the patient’s right shoulder facing toward the patient’s left side. The patient is prepped and draped in the usual sterile fashion. Alternatively, the patient can be placed supine on the table with the surgeon operating from the patient’s right side with the same trocar placement, however, this positioning is less ergonomic for the surgeon. The advantage this offers is less set up time once the patient is brought to the operating room (Fig 1).

The first trocar is placed 15 cm from the xyphoid process just to the left of midline. This will be the camera port. We use an optical 10 mm trocar and zero degree scope so that the peritoneal cavity can be entered under direct visualization. We then switch to an angled scope for the remainder of the procedure; usually, a 30 degree scope is sufficient. Occasionally, a patient’s anatomy lends itself to improved visualization.
with the 45 degree scope. The abdomen is then insufflated with \( CO_2 \) to 15 mmHg and three additional ports are placed. A 10 mm trocar is placed 10 cm from the xyphoid process off the left costal margin (measured with the abdomen insufflated). A 5 mm trocar is placed 20 cm from the xyphoid process off of the left costal margin (this is approximately the anterior axillary line). All ports are placed under direct visualization after anesthetizing the area with 0.5% bupivacaine for preemptive anesthesia. The last 5 mm port is placed four finger breadths from the xyphoid process off of the right costal margin at a slight angle toward the patient’s left side. Intraperitoneally, the port enters at approximately the junction between the base of the falciform ligament and the left lobe of the liver. Most often, it helps to place this last port after the liver retractor has been placed, so that it is not on top of the left lobe of the liver. The surgeon operates through the 5 mm right upper quadrant port and the 10 mm left upper quadrant port. The assistant uses the 5 mm port in the axillary line off of the left costal margin and also operates the camera (Fig 1).

**Exposure/Liver Retraction**

We use a Nathanson retractor to retract the left lobe of the liver. This is an S-shaped retractor that is placed just below the xyphoid process. Manipulating this into place can be tricky initially until one gains some experience with it. An incision is made just caudad and to the left of the xyphoid process. The 5 mm trocar is passed through the abdominal wall, through the fascia, but not through the peritoneum to create a tract for placement of the retractor. The retractor, facing the patient’s left, is passed through this tract and manipulated into place to elevate the left lobe of the liver and expose the esophageal hiatus. The retractor is held in place using a Bookwalter retractor affixed to the bed on the patient’s left side. Now you are set up to begin the procedure.

One can still use the snake liver retractor for elevation of the left lobe. This is placed through a 5 mm trocar that is placed 20 cm from the xyphoid process off of the right costal margin. This is passed into the left upper quadrant under direct visualization and tightened into the shape of a triangle.
This is held in place using a Bookwalter retractor affixed to the right side of the bed or on the leg of a split leg table.

**Dissection of Right Crus and Passing the Penrose**

First the clear portion of the gastrohepatic omentum is incised with cautery vertically just above the hepatic branch of the vagus, exposing the right crus. Then below the hepatic branch of the vagus, the gastrohepatic omentum is incised transversely so that one can easily see the base of the crura. Cautery is then used gently along the lower third of the right crus down to the base to open the peritoneum at the base of the crura behind the esophagus or stomach into the mediastinal space. Then a “pars flacida” technique is used to dissect behind the esophagus and a 5 inch penrose drain is passed behind the esophagus, anterior to the base of the crura, toward the left upper quadrant. The penrose is left here and attention is turned to the greater curvature of the stomach. The placement of the penrose is the first step to gaining control of the esophagus so that it can be manipulated atraumatically in all directions for circumferential dissection (Fig 2).

**Takedown of the Short Gastrics**

Use the harmonic scalpel to take down the short gastric vessels on the greater curvature of the stomach beginning just below the base of the fundus along the body of the stomach. The surgeon should grasp the stomach and the assistant will grasp the omentum and retract it laterally. An angled scope will allow good visualization. Good fundic mobilization will allow for a tension-free fundoplication. Maintain meticulous hemostasis throughout this dissection and stay close to the stomach. Do not leave much residual tissue along the stomach. Once the lesser sac is entered, the surgeon should continue to grasp the stomach along the greater curvature and the assistant the omentum with one side of the grasper within the lesser sac. In this fashion, march up toward the left crus until all of the short gastrics are taken down. As you come around the fundus, it is often helpful for the surgeon to grasp the posterior stomach and rotate the stomach medially with gentle downward traction. There will also be a posterior veil of connective tissue from the fundus to the pancreas and this should also be taken down with the harmonic shears. As one approaches the left crus, the assistant then transitions to...
pushing the stomach medially so that the surgeon can see along the left crus and its base clearly.

One should then see the Penrose at the base of the crura that had been passed from the right side. Go ahead and pull this through (Fig 2).

**Control of the Esophagus**

The two ends of the Penrose are then grasped by the surgeon and are held together anteriorly with the surgeon’s left hand. An endoloop is passed into the peritoneal cavity toward the Penrose with the surgeon’s right hand. The assistant should then grasp the Penrose just below the surgeon’s left hand while passing his or her instrument through the endoloop. The endoloop is then passed over the ends of the Penrose and secured such that the Penrose encircles the esophagus snugly. The Penrose ends can then be grasped with a locking grasper by the assistant and used for gentle atraumatic retraction of the esophagus.

**Circumferential Dissection of the Crura**

Now the esophagus can be mobilized circumferentially so that you can attain 3 to 5 cm of intra-abdominal esophagus without tension. This dissection can be done with careful use of the cautery and scissors. It is important to remember that this is really a dissection of the crura and not of the esophagus. Dissection too close to the esophagus can lead to vagal or esophageal injury; however, if one stays close to the crura, then injuries are less likely to occur.

Now the assistant should retract the Penrose to the three o'clock position and the phrenoesophageal connective tissues can be taken down along the medial border of the right crus and around anteriorly. Care is taken to maintain peritoneal covering along the crura to allow some strength for closure and keep the muscular fibers from shredding. The dissection is continued anteriorly and then over to the left crus. Once the crura have been dissected circumferentially, then the esophagus can be retracted anteriorly to allow posterior dissection into the mediastinum. The posterior vagus...
should be identified and retracted anteriorly with the esophagus. Do not dissect too close to the esophagus as this may lead to vagal or esophageal injury, and too posterior may lead to aortic injury. Use cautery gingerly. Most of these connective tissues, especially further into the mediastinum, are avascular and can be taken down with sharp and blunt dissection without any energy source.

Laterally the dissection planes are bordered by the pleura. Avoid injuring the pleura. If the pleural cavity is entered, alert your anesthiologist to watch the patient’s ventilation. The patient should be minimally affected if they are on positive pressure ventilation. At the time of closure, a val salva maneuver can help to evacuate extra CO₂ from the pleural space.

Anteriorly, the pericardial sac forms the border of dissection. Visualize the vagus and be sure it stays on the esophagus. Some of the connective tissues here and laterally are vascular and short burst of cautery can be used to maintain meticulous hemostasis. Bleeding high in the mediastinum can be difficult to control and is best avoided.

Continue to dissect these tissues circumferentially up into the mediastinum until 3 to 5 cm of the esophagus sits comfortably in the abdomen. Avoid the use of any energy source close to the esophagus to avert delayed perforations.

**Closure of the Hiatus**

The esophageal hiatus is closed using 0-silk sutures with pledgets that are intracorporeally tied with slip knots. To set up for adequate visualization for this step, have the assistant retract the esophagus anteriorly and toward the patient’s left side. Angle the scope properly so that the base of the crura is well-visualized. We prepare the sutures to be 6 inches in length and one pledget loaded on the suture. This, along with another free pledget are loaded onto a needle driver and introduced into the peritoneal cavity with the surgeon’s right hand. The suture is passed through the left crus, then the right, approximately one centimeter above the base of the crura. A slip knot is used to tie this down once the other pledget is placed on the suture. If the pledget cannot be sutured freehand, then it can be placed on the caudate lobe of the liver and the needle passed through the pledget into the liver. The liver acts as a “pin cushion” for this maneuver and this small pinhole rarely results in any untoward effect. The slip knot is used for tying as the crura are often on slight tension. When the needle is passed through the crura, be sure to catch some of the overlying peritoneum so that the muscle fibers are held together and do not shred.

Sutures are placed sequentially approximately 0.05 to 1 cm apart until the crura are closed snugly around the distended esophagus. The stitch closest to the esophagus should be placed without pledgets. Do not close the crura too tightly, or the patient will have dysphagia. One can use the modified orogastric tube described earlier to calibrate this opening by blowing the balloon up with 45 mL of saline to the size of a 56 French bougie, or by using a blunt tipped bougie itself. Usually for a standard Nissen fundoplication with a small to moderate-sized hernia, three to five sutures are adequate to close the hiatus. For larger hiatal hernias, more sutures may be needed. Any mesh reinforcement should be avoided in this area. Rarely does the patient need any sutures placed through the crura anterior to the esophagus. This can be done in the rare case where the posterior closure angulates the distal esophagus too much (Fig 3).

The hepatic branch of the vagus can sometimes obscure visualization for this step. We try to preserve it as much as possible and push it anteriorly or posteriorly, depending on whichever is easier. If visualization of the crura is very difficult, for example, in a patient with large amounts of intra-peritoneal fat, this branch can be divided. We believe it is
helpful to preserve to help keep the wrap from slipping and to avoid biliary dyskinesia.

Creation of the Fundoplication

With the esophagus retracted anteriorly, visualize the fundus from behind from the right side of the esophagus. The surgeon’s left hand grasps the fundus and pulls it around to the right side. The fundus should some around easily and stay in place without tension if the short gastrics were adequately taken down. Care should be taken to bring the fundus around such that a true fundoplication can be performed and not a “wrap.” The esophagus should essentially be invaginated into the fundus with the fundoplication facing the patient’s right side. A “shoe shine” maneuver can be performed to ensure that the proper portion of the fundus was brought around. Now you are ready to complete the wrap over a 56 French bougie. Again, we use the modified orogastric tube with the balloon inflated to that size (Fig 4).

The fundoplication is secured by placing three 2-0 silk sutures in simple fashion to create a 2-cm loose floppy Nissen. The first stitch is a long suture cut 9 inches. This is where the surgeon’s suturing skills are very important, especially in being able to manipulate the needle with one hand. The two sides of the fundus are sutured together, with a small bite of esophagus, so that the wrap faces the patient’s right side. Care is taken to not pass the suture or needle through the vagus, but can be placed around the vagus. The first suture is usually the most cephalad and should be placed up on the esophagus at least 2 to 3 cm above the gastroesophageal junction. A slip knot is usually used for this suture. The second suture is placed approximately 1 cm distal and includes a small bite of esophagus. The third and final suture is placed another centimeter distal and is a simple suture from fundus to fundus. No esophageal bite is taken (Fig 5).

At this point one should have a 2 cm loose floppy Nissen fundoplication created over a 56 French bougie facing the patient’s right side. The bougie or modified orogastric tube
can be deflated and removed. An instrument should be able to be easily passed between the wrap and the esophagus or stomach (Fig 5).

At this point, if an endoscope is readily available, an upper endoscopy can be performed. This is not necessary, but is helpful to do if you are just starting to do the procedure, or if you are teaching the procedure to others. A retroflexed view of the cardia should reveal a wrap comfortably hugs the scope and has a “stack of coins” appearance. It should not appear twisted or loose. You can be reassured that a proper fundoplication has been completed. If the patient requires a gastrostomy tube for any reason, it can be placed at this time.

Closure

The 10 mm trocar sites can then be closed at the level of the fascia using a laparoscopic suture passing device. A 0-Vicryl suture is placed in a simple fashion under direct visualization. If the noncutting optical trocars are used, these incisions can be left unsutured at the fascia. The Nathanson retractor is removed under direct visualization. The abdomen is deflated and the trocars are removed. The skin is closed with 4 to 0 vicryl or monocril sutures placed in a subcuticular fashion. Knots are not used. The suture is begun away from the incision and passed into the apex. The closure is completed and the suture is passed through the skin again from the opposite apex away from the incision. A liquid tissue adhesive such as Dermabond (Ethicon, Inc.) or Indermil (USSC) is then used to seal the wounds. No other dressings are required.

Postoperative In-Hospital Course

Patients are admitted into the hospital for a 23 hour overnight stay. Patients are given sips of clear liquids immediately postoperatively. On postoperative day 1, patients are given clear liquids as tolerated. Patients are ambulated on the day of surgery. Pain is controlled with intravenous medications until the patient is able to tolerate oral liquid pain medications. Antiemetics are used liberally in the perioperative period, as emesis and dry heaving can lead to early failure of the operation. The patient is discharge home on postoperative day 1 with liquid pain medication, stool softeners, and antiemetics.

Discharge Instructions

The patient is discharged on a full liquid diet for 1 week and then a pureed diet for the following 2 weeks. Patients are educated regarding the swelling postoperatively at the base of the esophagus, and that heavier foods may get stuck if not chewed well. They are instructed on getting adequate nutrition during the period they are on a modified diet. All medications are to be crushed or in a liquid form during the time. Patients are seen back in the office in 3 weeks time to check wounds and release them to a regular diet. Patients are back to work in 3 weeks on average. No restrictions are given to patients with regards to heavy lifting or activity.

Results and Outcomes

Open Nissen fundoplication has been shown to be effective long-term in controlling GERD with reports as far out as 20 years. Laparoscopic Nissen has relatively shorter published follow-up (5-8 years) but considerably larger numbers of patients. Success rates in controlling symptoms range from 83% to 95% in multiple series. Laparoscopic Nissen fundoplication is well tolerated with few serious side-effects. Some patients may present with acute dysphagia within the first 4 to 6 weeks postoperatively, but the vast majority will resolve with conservative treatment and as the edema dissipates. The recognized advantages of laparoscopic surgery in terms of patient recovery, postoperative pain, wound complications, return to work, and cosmetic result are well-supported for the laparoscopic Nissen fundoplication. It is the best surgical treatment for reflux that is currently available.

Partial fundoplications have minimal application in the long-term treatment of GERD. These procedures are not as effective as a total fundoplication and should be reserved for redos or patients being treated for achalasia.

To summarize, surgery is primarily indicated for patients with GERD refractory to medical treatment and those reluctant to submit to a lifetime of medication dependence. A thorough history in conjunction with an EGD can be sufficient to confirm the diagnosis but an ambulatory pH study is the best objective way to confirm pathologic GERD. An esophageal manometry study is then necessary to exclude the possibility of a functional disorder of the LES or esophageal body, and to guide surgical treatment in such patients. The laparoscopic Nissen is well tolerated by patients and demonstrates excellent control of symptoms with reasonable evidence of durability over time.

Suggested Reading


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