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Laparoscopic Posterior Partial Fundoplication: Analysis of 100 Consecutive Cases

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ABSTRACT

Performance of a laparoscopic posterior partial fundoplication (LPPF) for severe gastroesophageal reflux disease may have significant advantages. These include a low incidence of postop dysphagia, maintenance of the ability to belch, excellent antireflux effects, and the ease of performance of the surgery. The purpose of this study was to evaluate this antireflux procedure for these advantages to determine both its safety and effectiveness. Over 200 LPPFs have been performed by the authors in a community setting. One hundred consecutive cases are evaluated for indications, preop, and postop studies (EGD, manometry, 24 h pH), time of operation, hospital stay, complications, and conversions to an open procedure. Our technique of LPPF is presented in detail. All patients maintained the ability to belch. Postop dysphagia resolved totally in 4 patients by 7 days. Four pneumothoraces occurred; 1 patient required bilateral chest tube placement. There were no esophageal, stomach, or splenic injuries. The average hospital stay was 1.6 days. Postop 24 h pH studies revealed resolution of the esophageal reflux. Postop manometric studies show a median increase of 9.2 mm Hg for the LES pressure. No patients have resumed antireflux medication. No short gastric vessels were divided and no esophageal sutures were placed. There were no conversions to a laparotomy. Laparoscopic posterior partial fundoplication is a safe and effective antireflux procedure.

INTRODUCTION

LAPAROSCOPIC ANTIREFLUX SURGERY has been performed over the past 5 years with early results as good if not better than the traditional or "open" method.[1–3] Patients and referring physicians have a high acceptance rate for laparoscopic antireflux surgery because of the advantages associated with a minimal access procedure. Surgeons performing laparoscopic antireflux procedures are seeing an increasing number of patients that are potential surgical candidates. Workup of these patients reveals that a large proportion have esophageal dysmotility.[4] A weakened esophageal pump may potentiate postoperative dysphagia or gas-bloat symptoms if a Nissen (360° fundoplication) is performed.[5] In the setting of poor esophageal motil-

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ity a partial fundoplication may be beneficial. In a partial fundoplication the associated increases in distal lower esophageal sphincter pressure are lower than those in a Nissen fundoplication, thus avoiding potential problems with esophageal emptying.[6]

Early in our laparoscopic antireflux experience we confronted the problem of surgically treating our patients with severe gastroesophageal reflux disease (GERD) and decreased esophageal motility. In response we developed a technique of laparoscopic partial fundoplication that could be performed safely with excellent antireflux effects. To date we have performed over 200 LPPF cases in a community setting. Our 100 consecutive cases reported here reveals the laparoscopic posterior partial fundoplication (LPPF) to be effective surgical treatment for severe GERD with a low attendant morbidity.

MATERIALS AND METHODS

Between January 1993 and September 1994, 112 patients were referred for surgical therapy of gastroesophageal reflux disease. All patients had a trial of medical treatment. The vast majority of these patients were referred for surgical intervention by a board certified gastroenterologist. Twelve patients were excluded after further workup. Two patients had achalasia, three patients were excluded because of severe cardiopulmonary disease, three patients had paraesophageal hernias that were repaired laparoscopically, and four patients had previous antireflux surgery performed at other centers. The latter four patients subsequently underwent successful repeat antireflux procedures. The remaining 100 patients who had a LPPF performed comprise the patients of this study. There were 62 females and 38 males. The age range was 16–79 years, with a mean of 56.5, and a median of 53. The weight range was 104–250 pounds, with a mean of 176.2, and a median of 174.

The presenting symptoms included indigestion, regurgitation, dysphagia, asthma, chronic cough, laryngitis, abdominal pain, chest pain, or gastrointestinal bleeding. Symptoms were present from 4 to 360 months, with a mean of 87.4, and a median of 108. All patients underwent EGD with biopsies. Fifteen patients had esophageal strictures that were dilated prior to surgery, 7 had Barrett's esophagus, 36 had grade 2, and 32 had grade 3 esophagitis, Savory-Miller.[7] Esophageal manometry was obtained when patients presented with difficulty swallowing, pain with swallowing, or history of esophageal strictures. Twenty-four hour pH monitoring was performed when the diagnosis of severe GERD was in doubt. Other indications for surgery included intractability in 17 patients, respiratory symptoms in 20 patients, and severe GERD requiring prolonged prilosec in 38 patients. Forty-eight patients had a history of previous abdominal surgery including subtotal gastrectomies, cholecystectomies, appendectomies, colectomies, and gynecologic procedures.

Operative procedure

There are four key steps to LPPF: (1) crural repair, (2) 200° posterior partial fundoplication, (3) posterior gastropexy, and (4) fundic wrap secured to anterior phrenoesophageal bundle. The phrenoesophageal bundle, as described by Hill, is the thickened, tough tissue that reflects downward at the esophagogastric junction after transection of the phrenoesophageal membrane at the level of the diaphragm.[14] Important points to safe and easy performance of a LPPF include no use of electrosurgery or laser, never grasp the esophagus, and proper port placement to achieve excellent exposure and to avoid struggling.

LPPF is performed with the patient under general anesthesia in the low lithotomy position with a foley catheter and an orogastric tube in place. Zofran is given intravenously for nausea prophylaxis at the beginning of the case. The patient is prepped from the nipple line to the pubis anteriorly, to the midaxillary line bilaterally. Pneumoperitoneum is achieved with a 10-mm Hasson cannula placed at the umbilicus by the open technique.[8] Three 10-mm ports and one 5-mm port are placed in the upper abdomen under direct visualization by the videolaparoscope positioned at the umbilical port. Port placement is tailored to the flare of the costal margin and size of the intraabdominal organs. The 5-mm port is placed immediately to the right of the xiphoid process through which a blunt probe can be utilized to retract the left lobe of the liver. Alternatively, for a large or floppy left lobe a 10-mm port can be placed in the right subcostal area through which a fan retractor can be used to retract the left lobe cephalad and anteriorly. Downward traction on the

stomach is maintained with a Babcock clamp placed through the umbilical port. A 10-mm camera port is placed immediately to the left of the xiphoid process. A 0° laparoscope placed through the "camera port" gives great visualization of the esophageal hiatus. Two 10-mm operating ports are placed midway between the xiphoid and the umbilicus on either side of the midline. It is important to place the ports at least 7 cm apart to avoid clashing of instruments.

Initially the surgeon stands on the patients left side, the assistant on the right, with the camera person between the patients legs. As the procedure progresses the surgeon and camera person may find it easier to switch positions. The initial dissection is performed at the esophageal hiatus using blunt tipped grasping instruments. It is strongly recommended that all laparoscopic instruments used be at least 38 cm in length to prevent struggling to reach the hiatus and distal esophagus. The gastrohepatic ligament is incised above the level of the hepatic branch of the anterior vagal nerve. Hemostasis is maintained with clips. No energy source is used around the hiatus to prevent injuring the esophagus or vagus nerves. At this time only an 18 Fr orogastric tube is present in the esophagus. The dissection is carried out on either side of the esophagus until the aorta is identified and the posterior esophagus is freed.

Once the proper plane of dissection around the distal esophagus is identified an esophageal retractor (Access Surgical, Plymouth, MA) is placed in the preaortic space with care to gently encircle the distal esophagus (Fig. 1). If severe inflammation is present it is often necessary to perform the dissection more cephalad in the posterior mediastinum.

The dissection posterior to the esophagogastric junction (EGJ) is extremely important in performing a partial fundoplication without tension. With the esophagus retracted to the patients left the surgeon frees the posterior aspect of the esophagus and proximal stomach for 7 cm. Properly performed this posterior dissection reveals the right and left crus, the posterior vagal nerve trunk, and the fundus as viewed from the patients right side of the esophagus. The crural repair is performed posterior to the esophagus with several interrupted switches of nonabsorbable 0 suture tied extracorporally. After approximation of the esophageal hiatus a 50 Fr esophageal dilator is carefully placed by the anesthesiologist through the hiatus to gauge the repair. It is very important that the anesthesiologist view the video monitor when placing the esophageal dilator to prevent injury to the esophagus or stomach. Next, the esophageal dilator is pulled back to the mid esophageal level allowing for easy retraction of the distal esophagus during the wrapping of the fundus. With the esophageal retractor placed around the distal esophagus from the patient's left side, the assistant

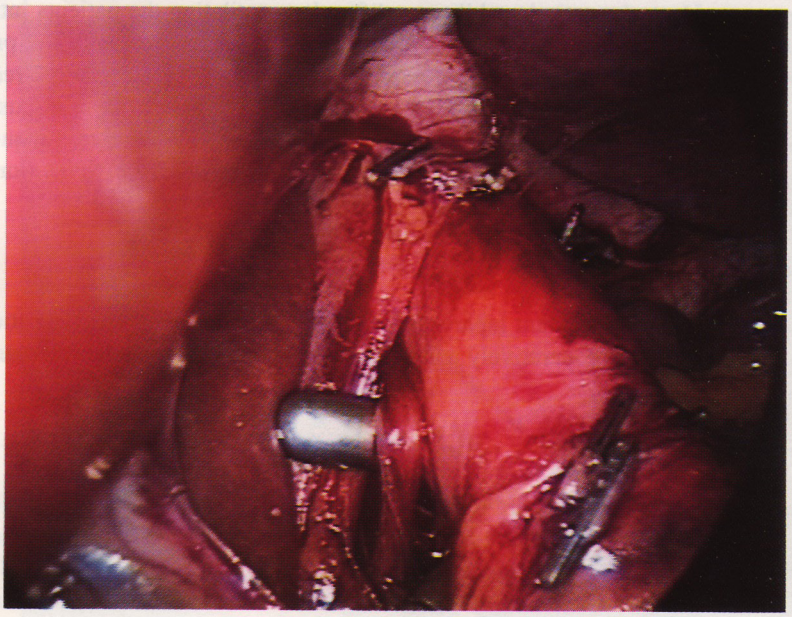

FIG. 1. Esophageal retractor around distal esophagus and posterior vagus nerve.

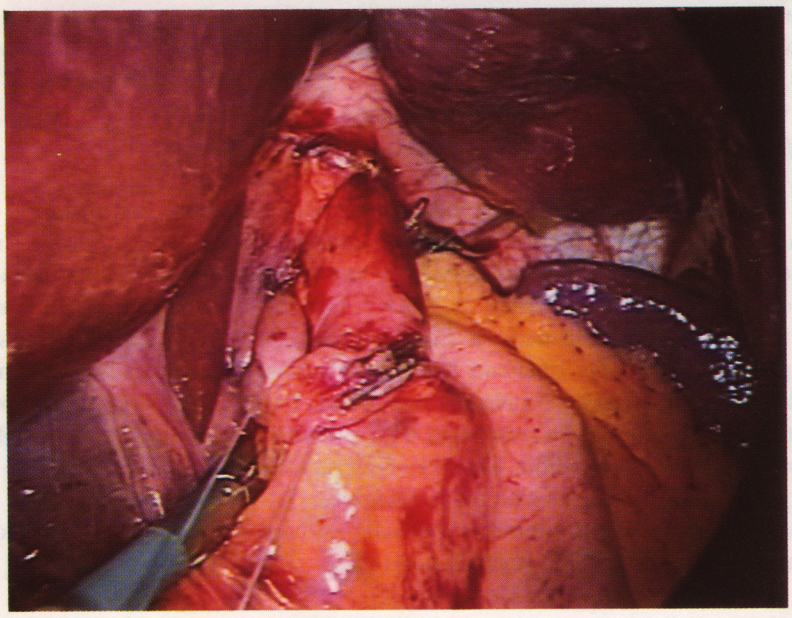

FIG. 2. Anterior phrenoesophageal bundle secured to posteriorly wrapped fundus (right side of esophagus).

average hospital stay ranged from 0 to 7 days, with a mean of 1.6 days, and a median of 1.0. The return to work time or to baseline preoperative status ranged from 4 to 28 days, with a mean of 10.8, and a median of 12.

Postoperative complications

Two patients with a history of esophageal stricture and preop dysphagia had dysphagia for 1 month postop that resolved with esophageal dilatation. Two patients developed cholecystitis within the first year

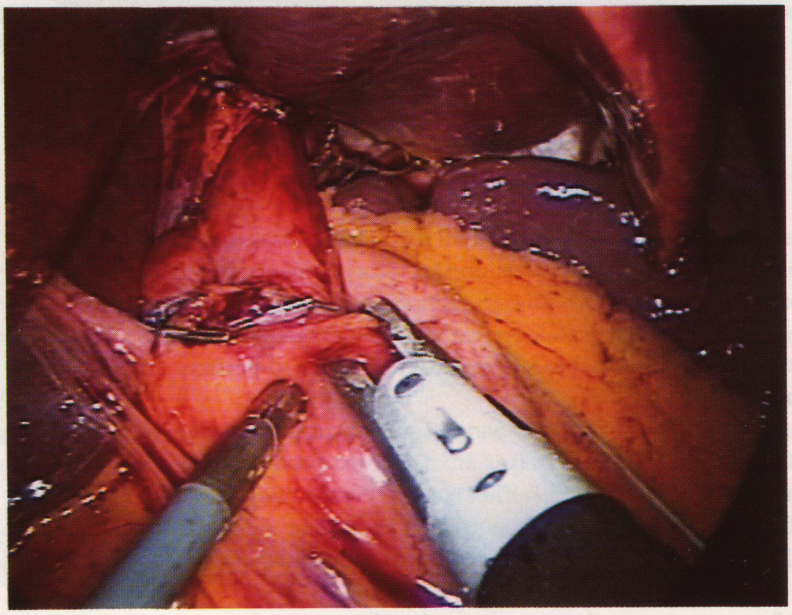

FIG. 3. Anterior phrenoesophageal bundle secured to anterior fundus (left side of esophagus).

places the Babcock clamp posterior to the esophagus from the right side and grasps the fundus at the level of the EGJ. The fundus is gently pulled posterior to the esophagus until it is adjacent to the EGJ on the right side. If there is tension appreciated the fundus is released and further dissection posterior to the esophagus is carried out freeing the left crus entirely. In addition, one must ensure that the attachments of the fundus to the diaphragm are cut. The extensive dissection of the posterior hiatus has made division of short gastric vessels unnecessary. On the right side of the esophagus the fundus is secured to the anterior phrenoesophageal bundle (gastric portion of transected phrenoesophageal membrane) with two stitches of 0 nonabsorbable suture placed laparoscopically (Fig. 2). The knots are placed extracorporally with a closed ring knot pusher. Before placing the suture the esophageal dilator is pushed back into the stomach by the anesthesiologist to size the wrap. On the left side of the esophagus the anterior fundus is approximated to the anterior phrenoesophageal bundle with two stitches of 0 nonabsorbable suture. While placing stitches care is taken to avoid the anterior vagal nerve trunk and full thickness suture penetration (Fig. 3).

A posterior gastropexy is performed securing the posterior aspect of the fundic wrap to the base of the right and left crura and preaortic fascia with two stitches of 0 nonabsorbable suture (Fig. 4). This step is safely performed with the help of the excellent visualization of the area posterior to the esophagus obtained with the videolaparoscopic approach. The prior extensive dissection of the distal esophagus and left crus allows for retraction of the esophagus anteriorly and to the left thus opening up the area at the base of the crura above the celiac axis and pancreas. To date no injuries of the pancreas or celiac axis have occurred. The posterior vagal nerve trunk is identified in the posterior esophageal dissection and spared of injury. It is frequently incorporated into the fundic wrap being intimately attached to the posterior esophagus. The posterior gastropexy fixes the repair posteriorly and intraabdominally. The fascia over the crura is most substantial at its base. Encorporation of the underlying preaortic fascia in the stitches gives additional strength to the gastropexy (Fig. 5) (Endostitch, US Surgical, Norwalk, CT).

At the completion of the procedure the ports are removed under videolaparoscopic inspection at 7 mm Hg abdominal pressure to assure hemostasis. All 10-mm port sites fascial defects are closed with 0 absorbable suture. The incisions are closed with skin staples. The esophageal dilator, orogastric tube, and foley catheter are removed at the end of the procedure.

Operative complications

Pneumothoraces occurred in four patients as evidenced by tenting of the left hemidiaphragm or increase in ventilatory pressures. Hemodynamic instability or difficulty ventilating the patients intraoperatively did not occur. Extensive subcutaneous emphysema occurred in two of the four patients and proved to be of no consequence. Small 8 Fr closed thoracostomy tubes were placed in two patients in the recovery room. All four patients made uneventful recoveries. No esophageal, gastric, or other hollow viscus perforations occurred. No bleeding requiring transfusion occurred. There were no splenic injuries. Frequent minor lacerations of the undersurface of the left lobe of the liver occurred in the course of retraction and were of no consequence. There were no conversions to open procedures.

Concomitant laparoscopic procedures

Fifteen patients underwent concomitant laparoscopic procedures. Fourteen symptomatic patients had ultrasound evidence of gallstones preoperatively and underwent laparoscopic cholecystectomies. One patient had a liver biopsy.

Postoperative course

Nasogastric tubes and foley catheters are removed at the completion of the surgery. No routine postoperative contrast studies are ordered. Patients are initially given ice chips then clear liquids as desired. Intravenous fluids are given overnight. Patients are given iv or po narcotics for pain and iv or po phenergan for nausea. Patients are allowed to eat grits or soft eggs when bowel function has returned (passing flatus), usually on POD 1. Patients are counselled to eat slowly, small amounts, chewing their food well. The time to eating a regular diet ranged from 2 to 12 days, with a mean of 5.3, and a median of 6 days. The

postop and underwent laparoscopic cholecystectomy. Three patients had persistent pain at the left upper quadrant port site requiring local steroid injection with the subsequent resolution. There were no wound infections, hernias, or readmits to the hospital.

Postoperative follow-up

Patients were seen in the office at 1 week and 1, 3, 12, and 24 months after surgery. Patients were interviewed by one of the authors at each visit. One hundred patients were seen up to 3 months, 71 at 12 months, and 23 at 24 months. Two patients have been lost to follow-up (see Tables 1 and 2). Postop dysphagia in 4 patients resolved spontaneously by POD 7. Ninety-seven patients at 3 months reported they were pleased with the results of their surgery. Esophagogastroduodenoscopy (EGD) was performed postoperatively in 7 patients. Five of the 7 patients had Barrett's esophagus and had surveillance endoscopy after 1 year. No change in the Barrett's esophagus was found. Two of the 7 patients had postoperative dysphagia. Both patients had preoperative dysphagia with stricture. The postoperative dysphagia resolved in both patients after a single dilation within 6 weeks of surgery. Findings of EGD on all 7 patients revealed an intact partial wrap and crural repair with no esophagitis.

None of the patients is on chronic antireflux medications. Nine patients require occasional antacid therapy for heartburn or indigestion, which is easily controlled.

Follow-up esophageal manometry and 24 h pH studies

Twenty-five patients who had preoperative studies volunteered to have repeat esophageal manometry and 24 h pH studies 3–24 months after surgery. Eight of the 25 patients had transient postoperative symptoms of dysphagia, crampy abdominal pain, or increased flatus. Although a low number, our postoperative studies are comparable to other major published studies to date.[2,9,10] Comparison of preop and postop lower esophageal sphincter manometry revealed an increase range of 6–14 mm Hg, with a mean of 9.2, and a median of 10. LES pressures preop ranged from 5 to 25 mm Hg, with a mean of 9.1, and a median of 10. LES pressures postop ranged from 12 to 34 mm Hg, with a mean of 18.5, and a median of 17. All patients had an increased LES pressure postop, while still remaining within normal levels and associated with complete relaxation.

Twenty-four hour pH studies revealed no abnormal acid exposure of the distal esophagus after surgery. Preop 24 h pH study Johnson-Demeester scores ranged from 37 to 389, with a mean of 56.3, and a median of 60 (nl $<$ 22). Postop Johnson-Demeester scores ranged from 0.9 to 19.2, with a mean of 12.8, and a median of 11 (nl $<$ 22).

DISCUSSION

Surgical management of patients with severe GERD has been shown to be superior to medical management.[11] The most commonly performed antireflux procedures are the Nissen fundoplication, the Belsey Mark IV, and the Hill procedure.[12–14] Dissatisfaction with either intraoperative difficulty in performing the above procedures or with postoperative complaints of dysphagia and inability to belch or vomit has led surgeons to find alternative antireflux procedures that are easier to perform and associated with less postoperative complaints.

The Toupet and Guarner procedures are partial fundoplications in which the fundus is wrapped 180–300° around the distal esophagus.[15,16] Advantages are decreased postoperative complaints of dysphagia and gas-bloat while maintaining an effective antireflux barrier. Prospective studies comparing the Toupet procedure and the Nissen fundoplication, and the Guarner procedure and the Nissen fundoplication revealed equally effective antireflux effects with marked decreased postoperative morbidity in the partial fundoplication group.[17,18]

Over the past 5 years surgeons have performed various antireflux procedures laparoscopically with the advantages of minimal access surgery and results equal to that of the open procedure.[1,3,19]

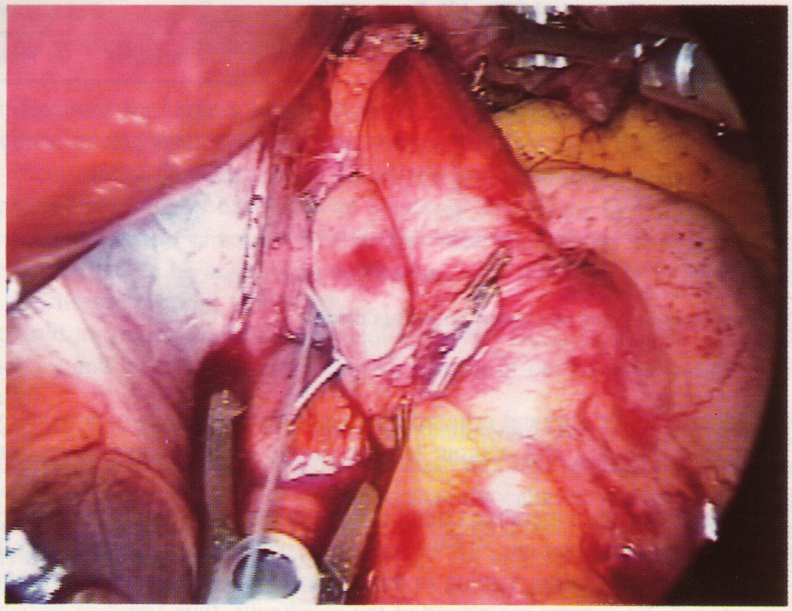

FIG. 4. Posterior gastropexy—securing the posterior fundic wrap to the crura/preaortic fascia.

As our initial laparoscopic antireflux experience grew (Nissen) we became aware that some of our patients with decreased esophageal motility as evidenced on esophageal manometry would benefit from a partial fundoplication.[20] Our technique of laparoscopic partial fundoplication combines what we believe to be the most beneficial aspects of the Nissen, the Hill, and the Toupet procedures. The laparoscopic posterior partial fundoplication differs from previous antireflux procedures in that recreation of the lower esophageal sphincter (LES) mechanism is combined with a posterior gastropexy. Securing of the posterior fundoplication by sutures to the base of the crura (preaortic fascia) ensures intraabdominal placement of the surgically

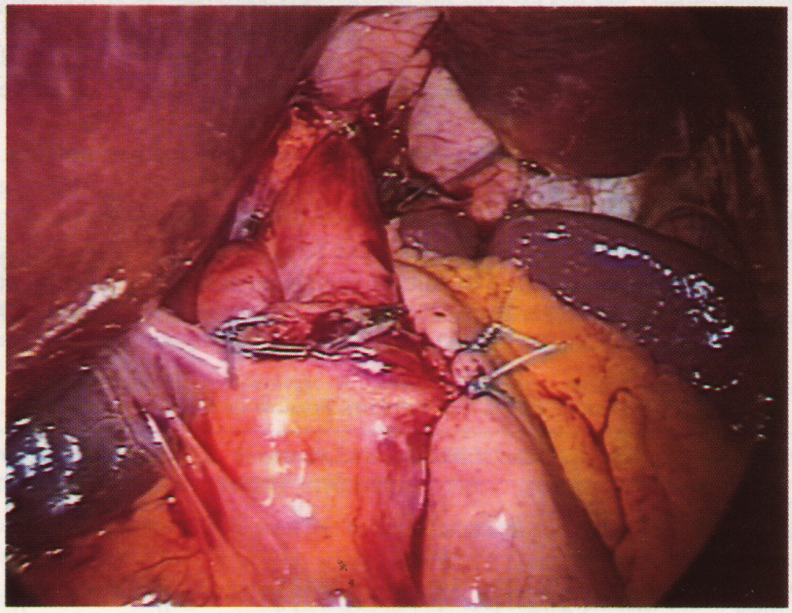

FIG. 5. Completed 200° posterior partial fundoplication (O'Reilly–Mullins procedure).

TABLE 1. LPPF: 100 PATIENTS FOLLOW-UP SURVEY

Reflux Sx's	*1 week*	*1 month*	*3 months*	*12 months*	*24 months*
Never	95	84	77	48	12
Rarely	2	10	18	16	5
Occasionally	3	6	5	7	2
Frequently	0	0	0	0	0
Always	0	0	0	0	0

71 patients total = 1 year.
23 patients total = 2 years.
No patients have resumed chronic antireflux meds.

created LES. LPPF adheres to the surgical principles of antireflux surgery which have evolved. The wrap is loose (200°), short (2.0–3.0 cm), and without tension due to the extensive dissection posterior to the esophagogastric junction.

We attribute the incidence of intraoperative complications in our study, which compare favorably to that of other published studies, to our technique.[2,19,21] Proper port placement allows for excellent exposure. No energy source is used, thus necessitating staying in the proper plane of dissection to prevent bleeding. The esophagus is never grasped. No sutures are placed in the esophagus, thus avoiding possible esophageal injury. Short gastric vessels are not divided thus avoiding possible attendant bleeding or splenic injury.

The intraop complication of pneumothorax occurred 4 times in our study, one bilateral and the remainder on the left, all in patients with large hiatal hernias (>5 cm). Tenting of the left hemidiaphragm and increased ventillatory pressures were noted. No intraop hemodynamic instability occurred. Extensive subcutaneous emphysema was noted on the anterior chest, neck and face in two patients which resolved within several hours without sequelae. Early in our series one patient had 8 Fr bilateral chest tubes placed in the recovery room. The last three patients were observed with rapid reabsorption of the CO_2 while in the recovery room. We do not believe it is necessary to routinely place chest tubes.

Two of our patients developed acute cholecystitis within the first year postop. We perform an ultrasound of the gallbladder on all patients preoperatively with symptoms suggestive of gallbladder disease, and perform a concurrent laparoscopic cholecystectomy if symptomatic gallstones are found.

Previous abdominal surgery did not prevent the laparoscopic performance of a posterior fundoplication in 48 patients. Three of these patients had a previous subtotal gastrectomy. In one patient the left lobe of the liver was densely adhered to the stomach. The left triangular ligament was transected and the left lobe pulled downward with a fan retractor. The posterior fundoplication was completed uneventfully above the left lobe of the liver.

Obese patients present a challenge but are not a contraindication to the performance of a LPPF. With proper port placement and the addition of extra ports as needed it is easier to achieve good exposure laparoscopically than open. Not uncommonly in patients over 220 pounds we place an extra 10-mm port to the left of the umbilicus through which a fan retractor can be placed to expose the esophageal hiatus.

Our followup data reveal a low incidence of foregut symptoms postop compared to other reports.[2,19,22] In recreating the lower esophageal sphincter mechanism an LPPF meets evolved surgical principles of an-

TABLE 2. LPPS: 100 PATIENTS FOLLOW-UP SURVEY

	1 week	*1 month*	*3 months*	*12 months*	*24 months*
Dysphagia	6	2	0	0	0
Inability to belch	12	2	1	1	0
Crampy pain	15	6	1	1	0
Flatulence	22	14	11	2	1
Diarrhea	4	2	1	0	0
Inability to vomit	2	2	1	0	0

tireflux surgery. Postop lower esophageal sphincter manometry shows complete relaxation of the recreated LES mechanism. This verifies the absence of tension. Postop 24 h pH studies show resolution of all pathologic esophageal reflux.

Reviewing the indications for surgery in our study shows approximately 40% were patients dissatisfied with prolonged medical management with prilosec. Although this drug is highly effective, it is expensive and the long-term effects are of concern to both the patient and treating physician. The decreased morbidity of laparoscopic antireflux surgery has led to an increased acceptance by both the patient and referring physician of the surgical treatment of severe GERD. This fact, plus studies showing surgical management of patients with severe GERD to be superior to medical management, will bring patients to surgical management earlier in the disease process, one hopes.

There is an increased awareness by both pulmonologists and otolaryngologists that GERD can lead to both chronic pulmonary and laryngeal disease. Twenty percent of our patients had problems secondary to GERD with aspiration.

The workup of our patients included EGD, selective manometery, and selective 24 h pH monitoring. In the current environment of increased cost consciousness we feel that selected patients with classic GERD symptomatology (without dysphagia) who demonstrate unequivocal evidence of esophagitis and or Barrets metaplasia on upper endoscopy can safely be referred for surgical evaluation for LPPF without the added expense of 24 h pH monitoring. In patients under 60 years old without dysphagia or difficulty swallowing a barium swallow or UGI was thought to be sufficient. In patients with difficulty swallowing or dysphagia, and in patients over 60 years old esophageal manometry is obtained. If the planned procedure is a Nissen fundoplication we strongly recommend preop esophageal manometry. We obtain 24 h pH studies when the diagnosis of severe GERD is in doubt. This is particularly helpful in working up patients with pulmonary symptoms secondary to severe GERD.

Our initial experience with the LPPF in patients with poor esophageal motility and severe GERD was very good. We were pleased with our initial patients outcomes. Subsequently, we now perform LPPF as our treatment of choice for all surgical candidates with severe GERD.

CONCLUSION

Laparoscopic posterior partial fundoplication is a safe and effective treatment of severe GERD. Excellent antireflux effects are associated with minimal postop dysphagia and preservation of the ability to belch. Avoidance of both esophageal suture placement and the division of short gastric vessels ensures a safer and simpler procedure.

REFERENCES

1. Weerts JM, Dallemagne B, Hamoir E, et al: Laparoscopic Nissen fundoplication: Detailed analysis of 132 patients. Endoscopy 1993;3:359–364.
2. Hinder RA, Charles JF, Wetscher G, Neary P, DeMeester TR, Perdikis G: Laparoscopic Nissen fundoplication is an effective treatment for gastroesophageal reflux disease. Ann Surg 1994;220:472–483.
3. Aye RW, Hill LD, Kraemer S, Snopkowski P: Results with the laparoscopic Hill repair. Am J Surg 1994;167:542–546.
4. Stein HJ, Eypasch EP, DeMeester TR, Smyrk TL, Attwood SE: Circadian esophageal motor function in patients with gastroesophageal reflux disease. Surgery 1990;108:769–778.
5. Stein HJ, Bremer RM, Jamieson J, DeMeester TR: Effect of Nissen fundoplication on esophageal motor function. Arch Surg 1992;127:788–791.
6. Lundell L, Abrahamsson H, Ruth M, Sandberg N, Olbe L: Lower esophageal sphincter characteristics and esophageal acid exposure following partial or 360 fundoplication: Results of a prospective, randomized, clinical study. World J Surg 1991;15:115–121.

7. Ollyo TB, Fontolliet C, Brossard E, Lang F: La nouvelle classification de Savary des oesophagites de reflux. Acta Endosc 1992;22:307–320.

8. Hasson HM: Modified instrument and method for laparoscopy. Am J Obstet Gynecol 1971;110:886–887.

9. DeMeester TR, Bonavina L, Albertucci M: Nissen fundoplication for gastroesophageal reflux disease. Ann Surg 1986;204:9–20.

10. Cadiere GB, Houben JJ, Bruyns J, Himpens J, Panzer JM, Gelin M: Laparoscopic Nissen fundoplication: Technique and preliminary results. Br J Surg 1994;81:400–403.

11. Spechler SJ: Comparison of medical and surgical therapy for complicated gastroesophageal reflux disease in veterns. N Engl J Med 1992;326:786–792.

12. Nissen R: Gastropexy and 'fundoplication' in surgical treatment of hiatus hernia. Am J Dig Dis 1961;6:954–961.

13. Belsey R: Mark IV repair of hiatal hernia by the transthoracic approach. World J Surg 1977;1:475.

14. Hill LD: An effective operation for hiatal hernia: An eight year appraisal. Ann Surg 1967;166:681.

15. Guarner V, Degollade JR, Tore NM: A new antireflux procedure at esophagogastric junction. Arch Surg 1975;110:101–106.

16. Toupet A: Technique d'oesophagogastroplastie avec phrenogastropexie appliquee dans la cure radical des hernies hiatales et comme complement de l'operation d'Heller dans les cardospasmes. Mem Acad Chir 1963;89:394.

17. Thor BA, Silander T: A long-term randomized prospective trial of the Nissen procedure versus a modified Toupet Technique. Ann Surg 1989;210:719–724.

18. Guarner V, Martinez N, Gavino J: Ten year evaluation of posterior fundoplasty in the treatment of gastroesophageal reflux. Am J Surg 1980;139:200–203.

19. Bittner HB, Meyers WC, Brazer SR, Pappas TN: Laparoscopic Nissen fundoplication: operative results and short-term follow-up. Am J Surg 1994;167:193–200.

20. O'Reilly MJ, Mullins SG: Laparoscopic fundoplication. In: Braverman MH, Tawes RL (eds): Surgical Technology International II. Surgical Technology International 1993, pp 73–77.

21. Cuschiere A, Hunter J, Wolfe B, Swanstrom L, Hutson W: Multicenter prospective evaluation of laparoscopic antireflux surgery. Surg Endosc 1993;7:505–510.

22. Swanstrom L, Wayne R: Spectrum of gastrointestinal symptoms after laparoscopic fundoplication. Am J Surg 1994;167:538–541.

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