A study of 362 consecutive laparoscopic Nissen fundoplications

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Background. *Open Nissen fundoplication has been shown to be a very effective operation in the treatment of intractable gastroesophageal reflux. Because of its technical rather than amputative nature, this procedure offers itself to a completely laparoscopic approach. Several studies have shown the feasibility; however, very few have dealt with the effectiveness of the laparoscopic approach.*

Methods. *Results of laparoscopic Nissen fundoplications performed during a 6-year period were reviewed including duration of operation, number of hospital days, number of conversions to open procedures, complications, and symptoms. All 362 patients had evidence of gastroesophageal reflux disease documented by radiographic, endoscopic, or pH monitoring testing before the operation. Patients with dysphagia or odynophagia underwent manometric evaluation before operation. Postoperative evaluation included esophagography and endoscopy at 2 to 3 months with an esophagogram yearly thereafter. Follow-up time was 6 months to 6 years.*

Results. *The mean time of operation decreased from 2.7 ± 0.4 hours during the period from 1991 to 1994 to 1.8 ± 0.3 hours from 1994 to 1997. During those same periods, the number of days of hospitalization decreased from 2.2 days to a mean of 1.5 days. Manometric studies done before the operation (n = 58) showed a pressure of 4 ± 1.2 mm Hg compared with postoperative values (n = 39) of 14 ± 1.8 mm Hg. The conversion rate was 0.8% (n = 3), and the complication rate of 1.9% (n = 7) included the 3 conversions, 2 pneumothoraces, 1 patient with postoperative bleeding, and 1 patient with a large abdominal wall hematoma. There were 5 failures of the procedure (1.2%). Thirteen patients (3.6%) described postoperative symptoms that persisted beyond 2 months, including bloating, flatulence, dysphagia, and diarrhea.*

Conclusions. *With strict selection criteria and increasing experience and standardization of technique, laparoscopic Nissen fundoplication can provide both safe and effective results for patients with chronic symptoms of gastroesophageal reflux disease. (Surgery 1998;124:651-5.)*

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GASTROESOPHAGEAL REFLUX DISEASE (GERD) affects approximately 40 million people in the United States.[1] Before the advent of laparoscopic operations, the only patients referred for operative correction of GERD were those who had severe intractable reflux, usually with complications (eg, stricture, aspiration, and epithelial dysplasia).[2] However, now that antireflux operations may be performed with minimally invasive methods,[3,6] more patients are being referred earlier for operative correction of the reflux. This article reviews a series of 362 consecutive patients who have undergone laparoscopic Nissen fundoplication for GERD during a period of 6 years.

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METHODS

Three hundred sixty-two patients (173 men and 189 women; average age 48 years; range 11 to 78 years) were selected to undergo a laparoscopic Nissen fundoplication. Preoperative evaluation included esophagogastroduodenoscopy and esophagography. Individuals without evidence of esophagitis underwent 24-hour ambulatory pH monitoring. Patients with evidence of dysmotility on esophagogram or who reported symptoms of dysphagia or odynophagia also underwent manometry. Fifty-eight patients underwent preoperative manometry and 39 patients underwent postoperative manometry. All patients had GERD, 128 (35.3%) had associated hiatal hernias, and 41 (11.3%) underwent another laparoscopic procedure at the same time (cholecystectomy, adhesiolysis, inguinal herniorraphy, liver biopsy, gastrostomy, or lymph node biopsy). One hundred fourteen patients (31.5%) had undergone previous abdominal operations.

The surgical technique used, although described

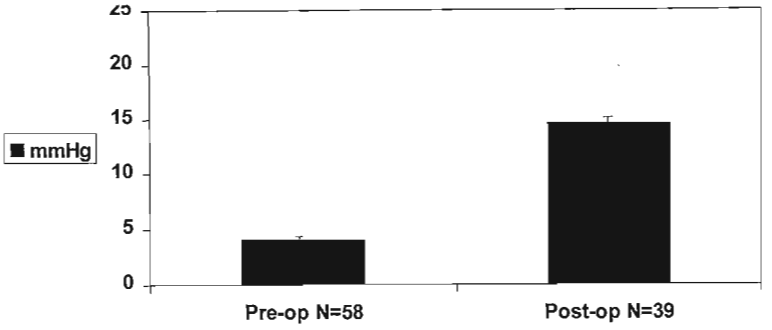

Fig 1. Mean lower esophageal sphincter pressures before and after laparoscopic Nissen fundoplication.

previously,[3] is presented here in brief because of introduction of newer instrumentation.

Technique. The patient is placed in a modified lithotomy position, and the abdomen is prepared and draped in the usual sterile manner. A 1 cm incision is made below the left costal margin at the midclavicular line, and the Optiview trocar (Ethicon-Endosurgery, Cincinnati, Ohio) is used to enter the abdominal cavity. $C0_2$ pneumoperitoneum is then established and maintained at 15 mm Hg. Four additional 10- to 11-mm trocars are placed: 1 in the right upper quadrant, 1 on the subcostal left anterior axillary line, 1 about 3 cm above the umbilicus in the midline, and 1 in the subxiphoid area. All trocars are placed under direct view and by transillumination of the abdominal wall. The laparoscope is introduced through the supraumbilical port. The left lobe of the liver is retracted cephalad and to the right, with an inflatable balloon retractor introduced through the subxiphoid port (Soft Wand Retractor; Circon, Santa Barbara, Calif). Babcock forceps with atraumatic inserts (Pilling Weck, Inc, Research Triangle Park, NC) is used through the left lateral port to retract the stomach caudad and to the left. The gastrohepatic ligament is then opened above the caudad lobe of the liver and the lesser sac is entered. The gastrohepatic ligament is separated up to the area of the esophageal hiatus. The phrenoesophageal ligament is divided exposing the anterior wall of the esophagus. Accurate identification of the esophagus is facilitated, especially in obese patients, with the introduction of a lighted bougie (Bioentrics Corp, Carpinteria, Calif) into the esophagus by the anesthesiologist. The esophagus is then safely mobilized primarily by blunt dissection with a palpation probe. During this dissection, the esophageal hiatus is exposed and the right crus and posterior vagus are identified. We prefer to leave the posterior vagus attached to the esophagus so that injury or entrapment of the nerve can be avoided during cruroplasty.

The next step in the procedure is to ligate the short gastric vessels. To facilitate division of these vessels, the stomach is retracted to the right by atraumatic Babcock forceps. The Harmonic scalpel (Ultracision Ethicon Endosurgery, Cincinnati, Ohio) is used for the division of the short gastric vessels beginning at a point high on the greater curvature and extending up to the gastroesophageal junction. A 30-degree laparoscope is used when the short gastric vessels are divided at the upper pole of the spleen. Further mobilization of the esophagus is carried out and a window posterior to the esophagus is created. If necessary, depending on the presence of a hiatal hernia, a posterior cruroplasty is carried out. Before the crural sutures are placed, a 50F bougie is passed into the stomach. The sutures are placed from caudad to cephalad direction with generous bites of the left and right bundles of the right crus. A Babcock forceps is then passed posterior to the esophagus, and the fundus is brought around the esophagus to form the wrap. A 3-cm long, 360-degree fundoplication is created loosely around the 50F bougie, with 3 interrupted 2-0 nonabsorbable sutures taking bites of the fundus. To prevent slippage of the wrap, the anterior arch of the crus is incorporated in the upper stitch. Before evacuation of the pneumoperitoneum, the fascial defects at the ports are closed with a fascial closer (Carter-Thomason, Eden Prairie, Minn). All operations were performed by the same surgeon.

Patients were discharged from the hospital with written instructions to avoid red meat for 1 week; carbonated beverages and gas-producing foods (eg, beans, peas, broccoli, and onions) were to be avoided for 2 months. Individuals were also instructed to chew their food well, eat small meals the first few weeks, and avoid alcohol, citrus juices,

Table I. Early postoperative gastrointestinal symptoms

Symptom	*n*	*(%)*
Early satiety	263	(72.6)
Bloating-flatulence	147	(40.6)
Dysphagia	75	(20.7)
Constipation	28	(7.7)
Diarrhea	15	(4.1)
Odynophagia	13	(3.5)
Nausea	7	(1.9)
Dry heaves	6	(1.6)

and spicy foods. Postoperative pain was managed with acetaminophen/oxycodone or ketorolac.

Postoperative evaluation included esophagography and endoscopy at 2 to 3 months with an esophagogram yearly thereafter. Fifty-one patients (14%) who had been found to have Barrett's esophagus underwent yearly endoscopy and biopsy. One of the patients with Barrett's esophagus progressed to severe dysplasia despite the absence of reflux and was treated with ablation by photodynamic therapy.

RESULTS

With greater experience and improved instrumentation, the mean time of operation decreased from 2.7 ± 0.4 hours during the period from 1991 to 1994 to 1.8 ± 0.3 hours from 1994 to 1997. During those same periods, duration of hospitalization decreased from 2.2 days to a mean of 1.5 days.

The conversion rate was 0.8% (n = 3), with 1 of these conversions caused by gastric perforation with Babcock forceps; the other 2 conversions were the result of delayed gastric perforations. The complication rate was 1.9% (n = 7) and included the 3 conversions, 2 pneumothoraxes, 1 patient with postoperative bleeding who was managed expectantly, and 1 patient with a large abdominal wall hematoma at a trocar site, which resolved spontaneously.

There were 5 failures of the procedure (1.2%). Three of the failures were in patients with large hiatal hernia defects, 1 in a patient with persistent dysphagia, and 1 in a patient with a Nissen repair that "slipped," necessitating laparoscopic reconstruction.

Postoperative gastrointestinal symptoms were broken into 2 categories. The first category consisted of symptoms noted only within the first 2 months. These included early satiety, bloating and flatulence, dysphagia, odynophagia, constipation, diarrhea, dry heaves, and nausea. Table I outlines the relative frequency of these postoperative symptoms.

The second category consisted of symptoms that persisted beyond 2 months and included bloating and flatulence, dysphagia, and diarrhea (Table II).

Table II. Persistent gastrointestinal symptoms

Symptom	*n*	*(%)*
Bloating-flatulence	8	(2.2)
Dysphagia	2	(0.5)
Diarrhea	3	(0.8)

In the 2 patients with persistent dysphagia, 1 patient had a cruroplasty that was too tight; the cause in the other patient could not be determined. Extensive evaluation in the patients with diarrhea revealed no identifiable cause. One of these individuals had complaints of preoperative diarrhea that became worse after operation.

Fig 1 demonstrates lower esophageal sphincter pressures in patients both before and after the operation. Preoperative pressures (n = 58) were 4 ± 1.2 mm Hg compared with postoperative values (n = 39) of 14.6 ± 1.8 mm Hg.

DISCUSSION

This series of 362 patients presents some of the potential complications inherent in this particular operation. Experience has led to the development of various strategies to minimize the occurrence of these complications. Three patients had perforations requiring reoperation. One was recognized at the time of operation and was caused by perforation with the Babcock forceps. This complication occurred early in the course of this series (ninth patient). The operation was converted to open and the defect was sutured. It is likely that this perforation would now be repaired laparoscopically. Since that time, atraumatic Babcocks forceps (Pilling Weck, Inc) have been developed to prevent future perforations.

Two perforations had a delayed presentation (postoperative day 4). One was repaired laparoscopically; the other was converted to open. Potential causes of delayed perforation include cautery injury with subsequent necrosis of the gastric wall or stitches being tied overly tight resulting in necrosis.

Three patients with large (>8 cm) sliding hiatal hernias had a recurrence of the hernia within 6 months after laparoscopic repair. In an effort to reduce these recurrences, we initiated the use of polytetrafluoroethylene prostheses to reinforce the cruroplasty in large hiatal hernias.[7]

Several patients (n = 75) reported dysphagia after the operation, although only 2 of those reported symptoms persisting beyond 2 months. Initial dysphagia may be caused by edema or technical errors or necessitated changes in diet for patients with a newly constructed wrap. What was

previously a wide open canal may now require dietary modifications including more thorough chewing of food.

Two patients had continued dysphagia beyond 2 months. Despite extensive evaluation including esophagography and manometry, 1 patient had no identifiable cause. Evaluation of the other patient demonstrated stenosis at the gastroesophageal junction. Review of the intraoperative videotape revealed a cruroplasty that was too tight. Laparoscopic removal of 1 of the cruroplasty stitches resulted in resolution of symptoms. To avoid too tight of a wrap, it has become our practice to use several strategies. In addition to performing the wrap and cruroplasty around a 50F lighted bougie, the middle fundoplication stitch is placed first. This stitch is then elevated anterior and cephalad with grasping forceps, thus allowing evaluation of how tight the fundoplication is constructed; placement of subsequent stitches can be more exact, ensuring an optimal wrap. Although this same method is used in patients with dysmotility for whom a fundoplication is indicated, we elect to perform a "floppy" Nissen fundoplication around a 60F bougie rather than use a partial wrap as advocated by other authors.[8]

In one instance the failure of fundoplication was caused by a slipped Nissen. In this case a laparoscopic reconstruction was performed. Although some authors advocate incorporating tissue from the gastroesophageal junction or esophagus into the wrap stitches,[9] studies in animal models at our institution have shown this to be ineffective (unpublished data). These anchoring esophageal stitches avulse the sutured esophageal muscle with potential for esophageal perforation. Alternatively, we incorporate the anterior arch of the crus in the uppermost stitch of the fundoplication to prevent slippage.

In conclusion, with strict selection criteria and increasing experience and standardization of technique, laparoscopic Nissen fundoplication can provide both safe and effective results for patients with GERD.

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DISCUSSION

Dr E. Christopher Ellison (Columbus, Ohio). I think that several of the technical principles presented should be emphasized. These would include (1) the short gastric vessels should be divided, (2) a crural repair is mandatory in the majority of these patients, and (3) there should be some modification of the wrap based on esophageal dysmotility and relative peristalsis, particularly the lower third of the esophagus, as you indicated.

I found that your technique is similar to ours, with just a few differences. First, we have found that the procedure can be done with 4 ports of 5 mm in diameter, with a 5-mm laparoscope and a single 11-mm port for suturing. Second, we continue to place the esophageal sutures. I was interested in the comments you made about your animal studies and hope you can expound on that briefly.

In your selection criteria, what was the average duration of symptoms the patients had before operation? With your very good results, have you been able to work with the gastroenterologists to develop practice guidelines to shorten the duration of medical treatment in this group of patients?

Second, when you introduced the procedure to the resident staff, what methods and precautions did you take? Did you find any difference in operative times and morbidity, particularly with early postoperative complaints, in resident-performed operations?

Finally, what, if any, contraindications are there to laparoscopic Nissen fundoplication?

Dr Frantzides. The average duration of symptoms was 2 to 3 years, ranging from a few months to 2 decades. The gastroenterologists were reluctant at the beginning to refer patients for laparoscopic operations. After seeing the results of the operation, with the 3-month postoperative esophagogastroduodenoscopy, they were convinced. They would refer patients for whom medical management failed or those who did not want to receive long-term management.

It is important that residents undergo an advanced laparoscopic course; in addition, they should assist in several of these procedures before they are allowed to perform the operation. Residents are impressive in the way they adapt to this new way of doing operations, and I have not noticed any difference as far as who is doing the operation (staff vs resident).

I would consider as a contraindication to laparoscopic Nissen fundoplication, severe esophageal dysmotility, portal hypertension, and any coexisting condition that would endanger the life of the patient.

Dr Philip E. Donahue (Chicago, Ill). My first question addresses the pitfall of missing patients with symptomatic reflux who actually have another motility disorder, specifically achalasia, because you did motility studies in a minority of the patients and some of the patients who have hypomotility of distal esophagus would be missed by the algorithm you presented. How do you handle patients with a short esophagus? Although some groups advocate routine use of esophageal-lengthening procedures, I was surprised that you did not refer to any in this group; have you just excluded those for another report? Finally, have you had any instances of esophageal perforation caused by the bougie itself?

Dr Frantzides. We have very competent radiologists and I believe that they would detect any dysmotility, even with the silent cases of patients without dysphagia or odynophagia. We had no ill effects following the algorithm presented. I believe that we can avoid a test that is not so pleasant to the patients and we can avoid additional cost without adverse effects.

As far as the short esophagus, it is my belief that it is an overstated entity. We have not seen a short esophagus in our series. I believe that most of the time what is perceived as short esophagus is the inability to mobilize the esophagus adequately with large hiatal hernias.

No, we have not had a single perforation of the esophagus by the bougie.

Dr Robert J. Fitzgibbons, Jr (Omaha, Neb). I too share Dr Donahue's concern about the fact that such a large series would not be associated with any cases of short esophagus. I understand what you are saying about your radiologists, but with a series this big I cannot believe you would not run into patients unexpectedly having a short esophagus. I think we all have people prepared to do either transthoracic or transabdominal endoscopic lengthening procedures that are relatively easy to use.

It appears that you have your optics in the midline always. Many of us now are moving to placing the optics in the left upper quadrant to get a better view of the posterior stomach, to mobilize the posterior stomach, because I think that allows us to perform Nissen fundoplications routinely as opposed to performing partial wraps.

You must be quite confident in the Nissen fundoplication because you perform nothing else. You never use a partial wrap. You think that a looseness is as good as a partial wrap.

Dr Frantzides. The introduction of the laparoscope through the supraumbilical port allows for adequate visualization for carrying out the procedure. We use the 30-degree laparoscope when dividing the short gastric vessels and creating the retroesophageal window. The surgeon, however, should feel free to use any port for the introduction of the laparoscope if that would facilitate better visualization. Nissen fundoplication has been traditionally the antireflux procedure performed in our institution, and we carried that into our laparoscopic practice.

Dr Gerald M. Larson (Louisville, Ky). I have a question about your 50 patients with Barrett's esophagus, regarding the increased frequency of this diagnosis and the increased incidence of adenocarcinoma of the esophagus associated with Barrett's esophagus. What happens to the Barrett's esophagus, the columnar-lined mucosa, after your fundoplication? How far out have you followed these patients? Have you seen any regression, any return of the mucosa toward normal squamous mucosa in these 50 patients? As a follow-up, do you think the fundoplication is protective against adenocarcinoma in these patients?

Dr Frantzides. Fifty-one patients with Barrett's esophagus were followed up. In two of the patients we have seen a regression of Barrett's esophagus. This may be due to a sampling error. So far the literature has shown that antireflux procedure does not cause regression of Barrett's esophagus.

Dr M. Fein (Wurzburg, Germany). During my fellowship at Dr DeMeester's department in Los Angeles, I saw 3 patients with achalasia with symptoms of reflux disease. Unfortunately, 2 of them had already undergone a fundoplication. This should emphasize the importance of preoperative manometry.

How did you modify the operation in patients with impaired motility, and when did you not operate on them? Did you consider mucosal ablation in patients with Barrett's esophagus without dysplasia?

Dr Frantzides. I will not reiterate on the first question because I have already presented our views regarding this issue. The patients found to have esophageal dysmotiliy underwent a floppy Nissen fundoplication with the use of a 60F esophageal dilator and the construction of a loose wrap.

I have already mentioned the conditions that I consider contraindications to operation. Obviously, I would keep the patients on medical management.

I think the use of photodynamic therapy in patients with Barrett's esophagus before they progress to dysplagia may prove to be the way to go. This may be the subject of a prospective, randomized study.

Dr John R. Kirkpatrick (Washington, DC). Did any of your patients have strictures? If so, how did you manage them?

Dr Frantzides. Several patients had strictures. Invariably these patients underwent dilation before operation. In addition, they were dilated during the operation. A small percentage required additional dilations after the operation, but none required further management.