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Laparoscopic Nissen Fundoplication

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Objective
The authors' laparoscopic approach for a Nissen fundoplication is presented.

Summary Background Data
The technique has been undertaken in 155 patients over 29 months, with 137 patients having been observed for more than 3 months.

Methods
Three hundred sixty degree fundoplication was undertaken using three or four sutures to secure the wrap. Short gastric vessels were not divided, and the anterior wall of the stomach was used to construct the wrap around the esophagus with a large bougie in position.

Results
The operation was not completed laparoscopically in 19 patients because a satisfactory wrap could not be achieved. Ten patients undergoing laparoscopic fundoplication underwent a subsequent operation related to the laparoscopic procedure within 6 months, and there was one postoperative death. Seven other patients were readmitted to the hospital several days subsequent to their discharge, four because of pulmonary emboli. Of 137 patients who have been observed for more than 3 months, 133 patients are well and currently are free from reflux symptoms.

Conclusions
In uncomplicated cases, laparoscopic fundoplication has similar advantages to laparoscopic cholecystectomy. In spite of the fact that it has not yet achieved the overall usefulness of open fundoplication, it seems likely that laparoscopic fundoplication will be used increasingly in the treatment of patients with gastroesophageal reflux disease.

Since fundoplication was reported by Rudolf Nissen in 1956,[1,2] this procedure or modifications of it have become widely accepted for the surgical management of gastroesophageal reflux disease, with long-term relief of symptoms reported in more than 90% of patients.[3–5] Modifications to Nissen's original procedure have included shortening the 360° fundoplication to 2 cm, ensuring a loose, "floppy" fundoplication, and division of the short gastric vessels.[3] Short gastric vessels were not divided by Nissen, who used either the posterior or the anterior wall of stomach to construct the fundoplication.[2]

With the advent of laparoscopic cholecystectomy[6] and its rapid adoption by gastrointestinal surgeons,[7] it has be-

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come clear that much of the morbidity associated with upper abdominal surgery is wound related. The laparoscopic approach avoids this morbidity to a large extent, with a more rapid recovery and earlier return to normal function achieved.[6–8] In 1991, Dallemagne[9] extended the application of laparoscopy by reporting an initial experience with 12 laparoscopic fundoplications demonstrating the feasibility of this technique. After this report and after an animal operating program, laparoscopic Nissen fundoplication was commenced at the Royal Adelaide Hospital. Our technique and initial experience with 155 patients is presented.

PATIENTS AND METHODS

Between September 1991 and February 1994, we prospectively evaluated 155 patients (95 male and 60 female) who had undergone a laparoscopic approach for a Nissen fundoplication. Patient age ranged from 19 to 91 years (median 45 years), and patient weight ranged from 52 to 123 kg (median 75 kg). Sixty-three patients had undergone previous open abdominal surgery (21 upper, 32 lower, 10 upper and lower). One patient had undergone transthoracic repair of hiatal hernia as an infant 40 years earlier.

In the same time frame, 22 patients had an open fundoplication either because the procedure was thought to be contraindicated laparoscopically or because of patient election.

Preoperative Management

All patients had symptomatic gastroesophageal reflux disease documented by endoscopy (154 patients) or esophageal manometry and 24-hour ambulatory pH monitoring (123 patients). Preoperative barium meal was performed in 113 patients. Hiatus hernia were present in 80 patients, but were greater than 5 cm in length in only 10. Two patients had large paraesophageal hiatus hernia associated with gastric volvulus, one requiring nasogastric tube decompression.

The duration of reflux symptoms ranged up to 20 years (median 5 years). All patients had undergone treatment with H_2 receptor antagonists or omeprazole for at least 3 months and were referred for surgery, either because of unsatisfactory symptom control or because of an expressed wish to avoid lifelong oral medication.

All patients had the advantages and disadvantages of the laparoscopic approach explained to them and were informed that laparoscopic access was a new technique for which we could not guarantee the outcome in the same way we could for an open operation.

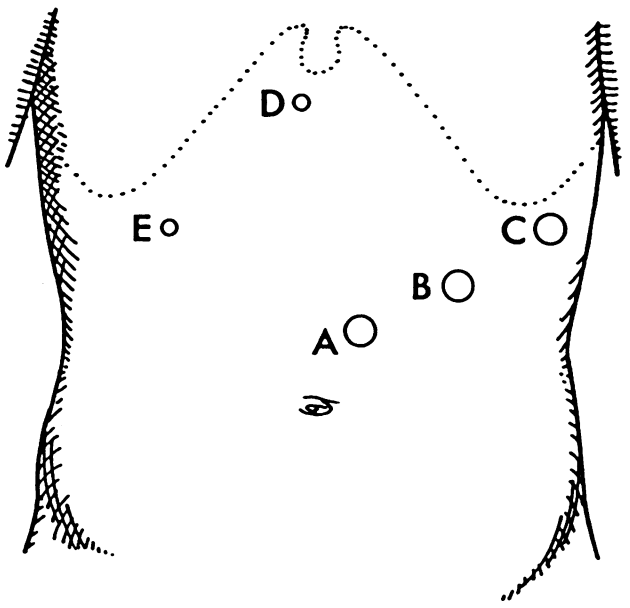

Figure 1. Abdominal port placement. Large circles represent 10-mm ports and small circles represent 5-mm ports.

Operative Technique

Our operative technique evolved initially, but has been relatively standard for the last 100 patients. The patient is positioned on the operating table in the lithotomy position with the table tilted 30°, head up, and the surgeon is seated between the patient's legs. After placing a nasogastric tube to deflate the stomach, a Verres needle is inserted in the midclavicular line immediately below the left costal margin, and the abdomen is insufflated with CO_2 gas to a maximum pressure of 10 mm Hg. Five ports are placed, as shown in Figure 1. A 10-mm port (A) is introduced just to the left of the midline, midway from the xiphisternum to the umbilicus; this is used initially for the laparoscope. Most procedures are completed using the 0° laparoscope, although the 30° laparoscope can be useful if adequate vision is not obtained. Additional ports are placed under vision. Five-millimeter ports are placed in the midclavicular line just below the right costal margin (E) for insertion of a grasping forceps for dissection or liver retraction, and in the epigastrium just below the xiphisternum (D), also for a grasping forceps or liver retractor. A 10-mm port is placed in the left anterior axillary line just below the costal margin (C) for the passage of an "endo-Babcock" or similar atraumatic grasper. The fifth port is a 10-mm port (12 mm if a "hernia stapler" is to be used) placed in the left midclavicular line a variable distance from the costal margin (B). This distance is determined by the width of the patient's costal angle and the need to avoid instruments clashing with other ports. This is the principal operating port for dis-

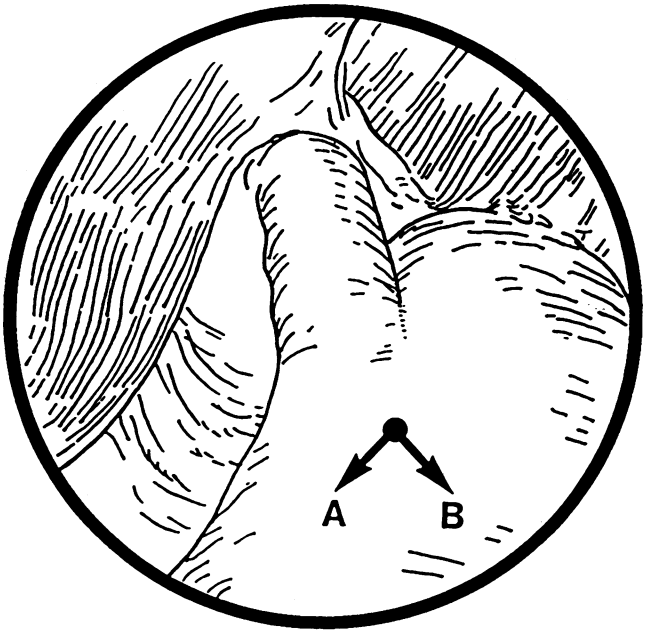

Figure 2. The gastroesophageal junction is grasped at point • and pulled in direction A for dissection of the left crus and direction B for dissection of the right crus.

secting and suturing; it also is used for the laparoscope if any difficulty is encountered in seeing the left side of the esophagus.

The surgeon operates through port B and either D or E (Fig. 1). The first assistant, standing to the patient's left, controls the laparoscope and grasps the cardia of the stomach (via C) to facilitate esophageal dissection. The second assistant, standing to the patient's right, elevates the left lobe of the liver with a 5-mm grasper or a sucker/irrigator, through D or E, to aid in the display of the esophageal hiatus.

Dissection of the esophagus is commenced by dividing vertically the transparent window of peritoneum forming the cephalad part of the lesser omentum above the hepatic branch of the anterior vagus nerve, which nearly always can be seen clearly coursing to the right. We find this maneuver useful because it helps orient the surgeon and it reveals, from right to left, the caudate lobe, the right pillar of the diaphragmatic hiatus, and the esophageal hiatus with contained esophagus. Next, the peritoneum to the left of the right pillar is divided horizontally for about 2 cm—this is the region in front of the esophagus. The cardia is pulled in the direction of the left iliac fossa by the first assistant, (Fig. 2) and the space between the right pillar of the esophageal hiatus and the esophagus is dissected vertically using a hook diathermy dissector or diathermy scissors. The aim is to clean the right pillar of tissue; this serendipitously begins the mobilization of the esophagus. The peritoneum overlying the pillar is divided caudad until a thick, fatty bundle of tissue is reached. This contains the hepatic branch of the vagus nerve and the left gastric artery. Similarly, with the cardia pulled toward the right iliac fossa, (Fig. 2) the peritoneum over the left pillar of the hiatus is divided. When undertaking the procedure for the first few times, it can aid the surgeon enormously at this point to have an assistant pass a flexible endoscope down the esophagus, because the light inside the esophagus makes identification of that structure simple. Without such an aid, exact identification of the esophagus is not quite as simple as the surgeon might expect from experience with the procedure in the open setting.

Dissection of fibro fatty areolar tissue is now undertaken in the trough between the esophagus and the left pillar of the hiatus and then in the trough between the esophagus and the right pillar of the hiatus. The posterior vagus nerve usually is seen during this latter dissection, and it usually lies with the right posterior aspect of the esophagus. It must be dissected away from the esophagus if it is not to be included in the wrap. This latter point is worth emphasizing because in the open procedure, the posterior vagus usually lies away from the esophagus posteriorly and to the right of the esophagus. This difference presumably occurs because the dissection laparoscopically starts out more posteriorly than with the open approach. Dissection is continued around the distal esophagus particularly posteriorly, eventually opening a "window" behind the esophagus.

During the dissection of the esophageal hiatus and the esophagus, because of the angle that the dissecting instruments unavoidably take, there is a tendency to take the dissection through the hiatus and into the mediastinum. The left pleura is seen easily if this occurs, and it should be avoided because if it is perforated, it leads to a pneumothorax. Although this may not be a problem during positive pressure ventilation, it may cause a postoperative problem if it goes unrecognized. Further esophageal dissection can be facilitated by the passage of a tape around the esophagus to lift it forward (Fig. 3). A nylon tape is passed through port D or B, behind the esophagus, and brought back through the same port. The port then is removed, the tape is grasped by an artery forceps extracorporeally, and the port is replaced beside the tape. Then a grasper is used to pick up the two limbs of the tape about 3 cm in front of the esophagus, and traction is exerted in whichever direction facilitates the procedure. This maneuver is particularly helpful if the hiatal pillars are to be sutured behind the esophagus. A large "window" is dissected out behind the esophagus to allow easy passage of the stomach and ensure a compression-free fundoplication. This window is developed between the posterior vagus nerve, behind, and the esophagus, in front. If a hiatal repair is performed, we use in-

Figure 3. A tape pulling the esophagus forward.

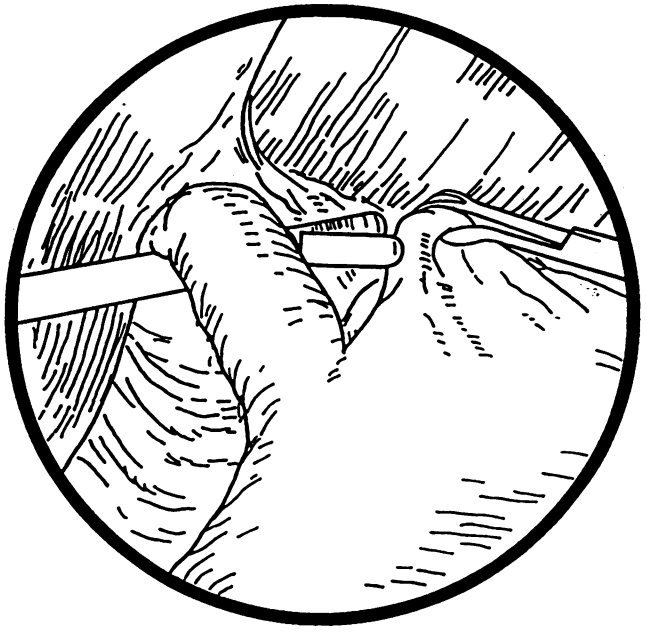

Figure 4. The anterior wall of the fundus, at approximately the fundus/body junction, is picked up and passed to the forceps behind the esophagus.

terrupted 2/0 prolene sutures before performing the fundoplication. We have used both anterior and posterior closure of the hiatus. Anterior closure is easier to achieve and leaves the esophagus in a more anatomic position. However, if there is any doubt about esophageal length, it is better to use a posterior hiatal closure.

A grasper is passed behind the esophagus via port E. Once again, the oblique angle means that the grasper tip tends to pass above the diaphragm into the left chest, and care is needed to keep the tip distal to the diaphragm. This step may be facilitated by using a curved dissector, which must be placed through a malleable port. We have used this instrument only recently however, and think it is useful, but not essential. The anterior wall of the fundus approximately 5 cm from the cardia and midway between the cardia and greater curve is picked up by a grasper held by the first assistant (Fig. 4) and passed to the jaws of the grasper behind the esophagus. Once the surgeon is satisfied that he has obtained a secure grip on the stomach, this is pulled around behind the esophagus (Fig. 5). Then the wrapped stomach is approximated to the anterior wall of the stomach in front of the esophagus, aiming to form as loose a wrap as possible. This step usually can be achieved without division of short gastric vessels. If the wrap seems tight, the stomach should be pulled back into its normal position, and a spot should be chosen further distally on the anterior wall of the stomach. It is important to realize that the anterior wall of the stomach is being slid upward on itself to create enough stomach to pass behind the esophagus. When a wrap without undue tension has been fashioned, a 52 French-gauge bougie is placed in the esophagus before suturing. A hernia stapler can be used to staple the wrap, to stabilize it before suturing. This is not an essential step for the procedure, but we used it in some of our early patients.

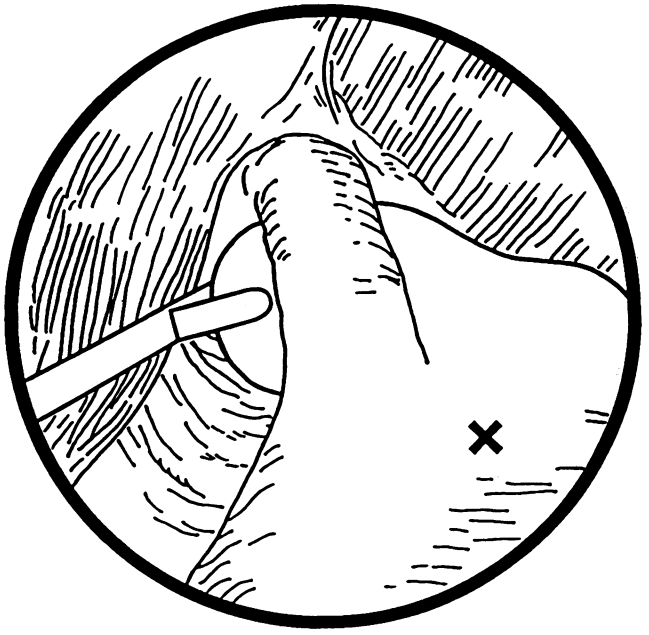

Figure 5. The anterior wall of stomach is brought behind the esophagus. The point X marks the approximate region that will be picked up for the left side of the wrap.

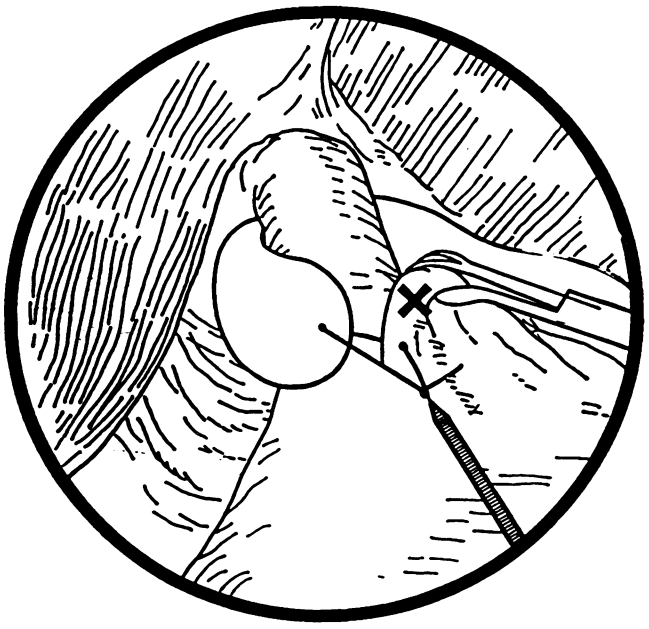

Figure 6. One suture is being tied with a pushing rod, transporting the knot. The relationship of the anterior gastric wall to the developing fundoplication is shown; the point X marks the approximate region that will be picked up for the left side of the wrap.

Nonabsorbable sutures are used for the fundoplication. Three or four interrupted sutures are placed, using 2/0 silk or prolene for intracorporeally tied sutures or 2/0 prolene for extracorporeally tied sutures (Fig. 6). Our current practice is to tie all knots extracorporeally. A fundoplication approximately 2 cm in length is achieved. Then the bougie is removed.

Postoperative Management

Early in the series, a nasogastric tube was placed perioperatively and then removed on the first postoperative day, and fluid intake commenced on the same or the next day. In the majority of patients, a nasogastric tube has not been used. Solids are commenced on the second or third day. The patient usually leaves the hospital on the third or fourth postoperative day.

Postoperative follow-up has involved clinical review, with esophageal manometry and barium meal performed after 3 months. Endoscopy has been performed only when indicated clinically.

RESULTS

Of 155 laparoscopic Nissen fundoplications attempted, 136 were completed laparoscopically. Two of those not completed laparoscopically were early in the series (cases 1 and 5). The first was abandoned because of an inability to pull the stomach around behind the esophagus, probably because of inadequate dissection of the posterior window, so that there was not enough room behind the esophagus for passage of the stomach. The second was a patient with a large sliding hiatus hernia. Failure to realize, at this early stage, the necessity of traction on the cardia meant that the esophagus and proximal stomach kept retracting into the chest. The resulting intrathoracic dissection via the abdomen was difficult, and instruments could not be passed behind the esophagus to open a posterior window. One patient was morbidly obese, which meant the instruments proved too short and the procedure was abandoned at an early stage. The remaining patients have required conversion to open operation because of obesity, large fixed hiatus hernia, adhesions or large fatty left lobe of the liver, or combinations of these. All of the patients having a conversion currently are free of reflux symptoms.

Operating time ranged from 45 to 290 minutes (median 120 minutes). The time taken to complete the procedure decreased significantly as experience improved. The median time taken for the last 35 procedures was 90 minutes. Intracorporeal knot tying was used in 9 of the first 12 procedures, whereas extracorporeal knot tying has been used almost exclusively for the rest of the operations completed laparoscopically, leading to a large reduction in operating time.

After problems early in the series in two patients with significant hiatus hernia, early patient selection precluded large hernia. However, with developing experience, ten later patients with a hiatus hernia >5 cm in size underwent laparoscopic fundoplication with hiatal repair.

Postoperative hospital stay for completed laparoscopic fundoplications ranged from 2 to 8 days (median 4 days). All patients were able to return to normal activity within 2 weeks of laparoscopic surgery.

Postoperative complications occurred in 15 patients (Table 1). Four patients (in all of whom the operations were completed open) were readmitted within 3 weeks of their discharge with chest pain because of pulmonary embolism. All are well after anticoagulation. Another patient was readmitted with pneumonia 2 weeks after surgery. Two patients suffered a left pneumothorax caused by presumed breach of the pleura during mobilization of the esophagus. A chest drain was placed and removed the next day, and this did not slow their recovery. One patient experienced respiratory distress caused by aspiration after extubation at the conclusion of his operation. After 2 days of assisted ventilation, he made a good recovery and was discharged 8 days postoperatively. One patient developed cervical and mediastinal surgical emphysema caused by CO_2 gas tracking into the mediastinum and neck. The insufflation pressure had

Table 1. COMPLICATIONS

Pulmonary embolus	4
Pneumonia	1
Pneumothorax	2
Aspiration	1
Mediastinal and cervical surgical emphysema	1
Gastric dilatation/obstruction	2
Reoperation	
Rolling hiatus hernia	2
Recurrent reflux	2
Gastric obstruction/misplaced fundoplication	1
Dysphagia	4
Cholecystectomy	2
Mesenteric ischemia	1

been increased from 15 to 18 mm Hg during surgery. Severe chest pain ensued postoperatively, with narcotic analgesia being required for 2 days; discharge was delayed to 7 days after surgery. The maximum insufflation pressure used was reduced to 10 mm Hg after this complication. One patient was readmitted with vomiting 3 days after discharge. A barium meal showed an intra-abdominal gastric volvulus. The patient settled down with nasogastric aspiration, without the need for any other treatment, and currently is well. Another patient readmitted as gastric obstruction, settled without the need for nasogastric intubation.

Twelve patients underwent open surgery within 6 months of their laparoscopic fundoplication. Ten of these operations were a result of poor outcomes from the laparoscopic procedure, i.e., two for recurrent reflux, four for severe dysphagia, two for acute paraesophageal hiatus hernia, and one for gastric obstruction. One patient, described next, required a laparotomy for mesenteric ischemia. The remaining two patients had their reflux controlled, but continued to get epigastric pain which was shown to be caused by gallstones. Subsequently, they underwent uneventful laparoscopic cholecystectomies.

There has been one death, which occurred in a 53-year old female patient who died of mesenteric infarction. Following her laparoscopic procedure, continuous pain led to several further laparotomies over the course of 2 weeks as she slowly infarcted the whole of her gastrointestinal tract and every intra-abdominal organ. Autopsy revealed a congenitally abnormally small celiac axis, but normal superior mesenteric artery. The celiac axis was occluded with proximal thrombus, as had been the superior mesenteric vessels in resected specimens.

Early troublesome dysphagia for solids, lasting more than 3 months, was experienced by 23 patients, excluding the 4 patients reoperated on for this problem. The dysphagia has resolved in 16 patients, but 5 patients have mild dysphagia for solids at follow-up of 12 months, and 2 patients have continuing dysphagia, which is troublesome enough for the patients to state that they would not have had the operation had they known the outcome. The follow-up is 20 and 22 months, respectively, in these patients. Gas bloat has not been a problem in any patient.

The outcome of our initial experience with patients at greater than 3 months follow-up is summarized in Table 2. One hundred thirty-five of 137 patients are free of reflux symptoms; 114 patients have undergone laparoscopic surgery alone. Twenty-nine patients who have undergone initial or revisional open surgery also are free of reflux and other symptoms. One patient continues to have symptoms of gastroesophageal reflux disease, and another continues to have dysphagia for solids. Clinical follow-up has ranged from 3 to 30 months (mean 9 months). Esophageal manometry has been performed whenever patients would agree to it and has been undertaken in 70 patients. This revealed an adequate high-pressure zone in all patients, with a rise in mean lower esophageal sphincter pressure in these patients from a mean 11 mm Hg preoperatively to a mean 23 mm Hg postoperatively. It also demonstrated elevation in the residual relaxation pressure of the lower sphincter region from a mean of 2 mm Hg preoperatively to a mean of 9.5 mm Hg postoperatively. No reflux has been demonstrable on short term pH testing in any of these patients. Of the 84 barium meal examinations performed, a satisfactory fundoplication was present in all asymptomatic patients (Fig. 7).

One unexpected finding, however, has revealed itself on postoperative barium studies and endoscopy. In nine patients, the wrap appears to have been fashioned from the body of the stomach rather than the fundus. In one patient, this led to an open operation because the stomach was virtually occluded; the other presented with gastric volvulus which settled, as described previously. However, in seven other patients, all of whom have had excellent clinical results, the stomach has been converted to a sort of bilobed organ (Figs. 8,9).

DISCUSSION

Laparoscopic and other minimally invasive approaches to abdominal surgery have great potential to

Table 2. OUTCOME—137 PATIENTS

Complete symptomatic relief of reflux	135
Laparoscopy only	114
Immediate laparotomy	19
Delayed laparotomy	12
Ongoing symptoms of reflux	2
Dysphagia (troublesome)	7

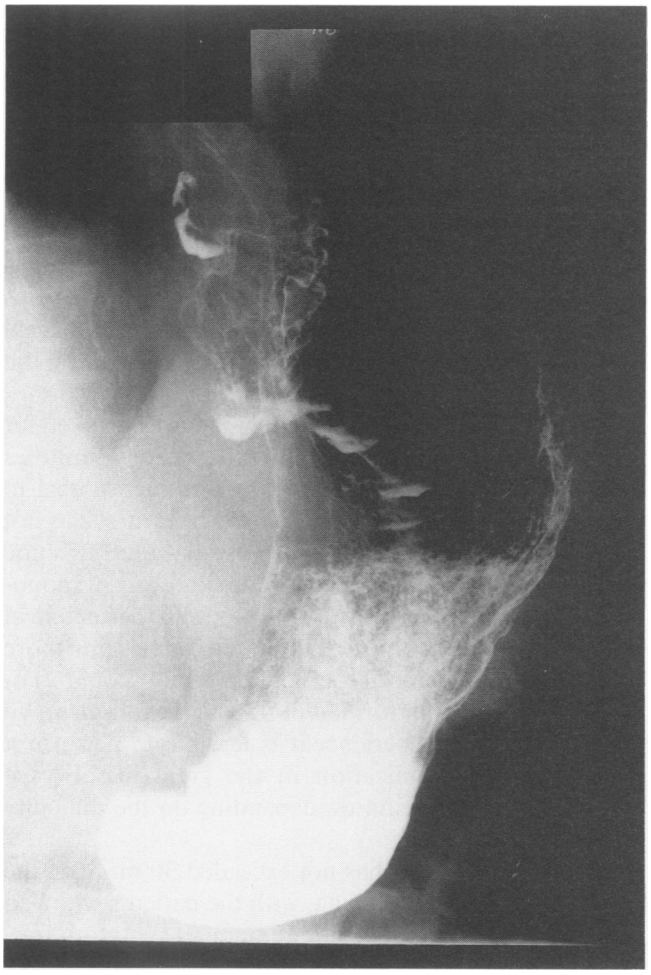

Figure 7. Barium meal after laparoscopic fundoplication, demonstrating a satisfactory fundoplication.

reduce patient morbidity and to result in significant savings to hospitals and patients from earlier discharge and earlier return to full activity.[6–8] Several laparoscopic antireflux operations have been described.[9–15] However, not all of these reproduce the criteria demonstrated to provide effective control of reflux with open surgery. We agree with Stein and DeMeester[16] that the established principles of antireflux surgery should not be abandoned to perform a procedure laparoscopically. They state that the construction of a short, loose 360-degree fundoplication should be the goal. Dallemagne et al.[9] demonstrated the feasibility of this in their initial series of 12 patients. Geagea[14] also reported good initial results in a preliminary series of ten patients. Cuschieri et al.[10] have shown that this procedure can be performed in patients with large hiatal hernia. No series reports follow-up exceeding 3 months, although initial results have been promising. We believe that it is justifiable to present this series at such an early stage for two reasons. First, in a rapidly developing field, it is worth presenting a detailed account of a technique and some of the problems we have encountered to help others avoid similar problems. Second, problems such as dysphagia are evident early after antireflux surgery, and even recurrent reflux problems often are evident within the first months.[16]

The operation we have performed is essentially the same as originally described by Nissen,[1] except for a shortening of the fundoplication to 2 cm and the use of a 52 French-gauge bougie in the esophagus when constructing the fundoplication. It is identical to the procedure that has been performed, open, at the Royal Adelaide Hospital since 1990. We altered our technique at that time to the anterior wall fundoplication of Nissen, because we were aware of the excellent results achieved by Johansson et al. Their study had greater than 5-year follow-up, and the patients had been studied in a careful and objective manner. It has since been published and stands as a model study.[17] Our change to this technique was not related to the advent of laparoscopic fundoplication. It achieves the goals stated by DeMeester[18] without

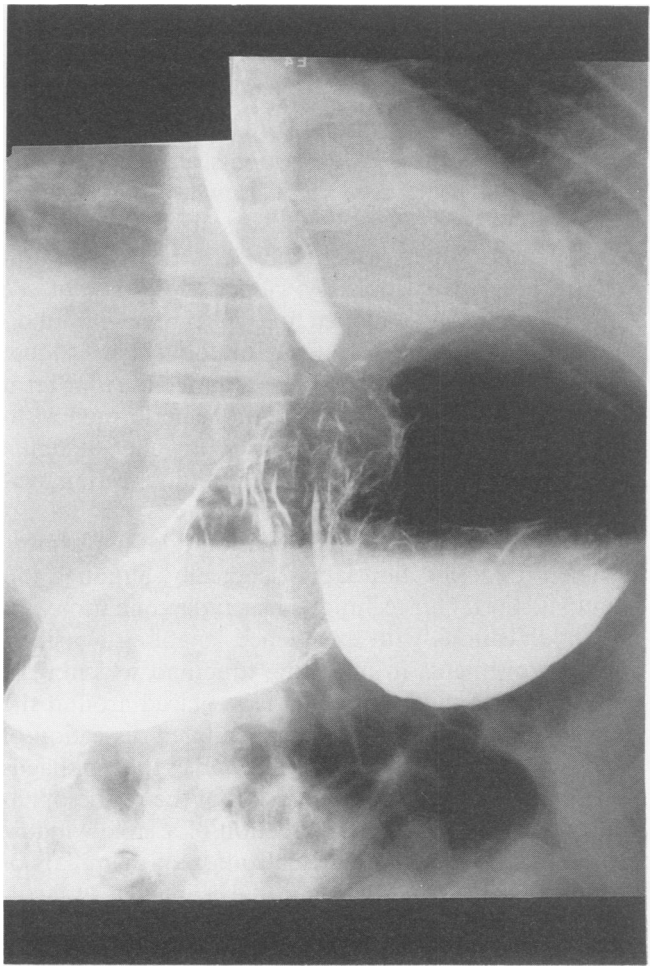

Figure 8. Barium meal in an asymptomatic patient revealing a "bilobed" appearance.

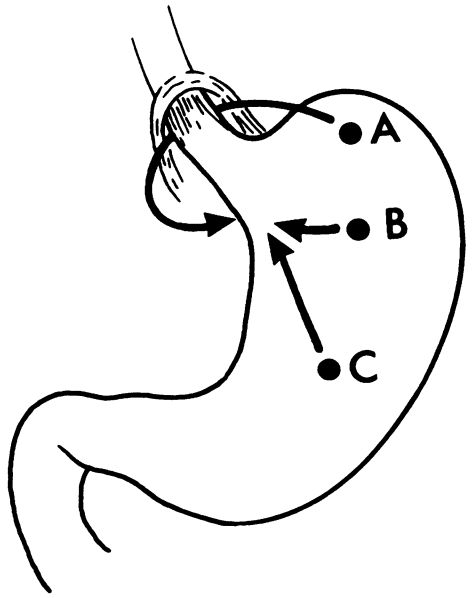

Figure 9. Construction of the fundoplication using the anterior wall of stomach. (A) Anterior wall of fundus pulled behind the esophagus. (B) Anterior wall pulled anterior to the esophagus to complete a satisfactory fundoplication. (C) Too distal part of stomach pulled anteriorly creating a "bilobed" stomach.

dividing short gastric vessels. Dallemagne[9] describes division of these vessels in some patients, although we have not found this necessary except in two of our patients. Likewise, Geagea[14] found it unnecessary to divide short gastric vessels when constructing a loose Nissen fundoplication laparoscopically. Good results can be achieved consistently at open fundoplication without dividing short gastric vessels if the fundoplication is loose and short.[17,19] Rossetti and Hall[20] reported the long term follow-up of 590 open fundoplications performed without dividing short gastric vessels, with relief of reflux symptoms and absence of any postfundoplication syndrome in 87.5% of patients.

This series demonstrates the feasibility of performing a Nissen fundoplication laparoscopically, although follow-up is short. Our technique has undergone some minor modifications with experience, enabling considerable improvements in operating time and widening of patient selection. The use of a tape placed around the esophagus at an early stage has facilitated dissection of the posterior esophagus because it enables the esophagus to be lifted forward for direct vision of the retroesophageal space. This enables the creation of a large window behind the esophagus and visualization of the pillars of the hiatus from the right side of the esophagus to facilitate posterior hiatal repair, if required.

It is essential that a large window be dissected behind the esophagus to enable a tension-free fundoplication to be constructed. Unless the stomach can be readily brought around behind the esophagus without tension, so that it does not retract when a large bougie is placed through the distal esophagus, the fundoplication will be too tight, and a different point on the anterior wall of the stomach must be sought.

The use of an endo-Babcock or equivalent atraumatic grasping instrument to grasp the cardia and draw the esophagus into the abdomen also greatly facilitates dissection. By placing tissues under tension, the esophagus is mobilized more readily. This maneuver also helps maintain dissection within the abdomen and esophageal hiatus and may reduce the likelihood of puncturing the pleura and creating a pneumothorax.

The most significant factor reducing the time taken for fundoplication from 3 to 4 hours initially to 95 minutes later in the series was a change from intracorporeal to extracorporeal knot tying. Placement of sutures has not been difficult, and the use of the Weston knot,[21] or some modification of it, has enabled secure knotting of monofilament, nonabsorbable sutures without the technical difficulties of intracorporeal knots. In two of our more recent cases, technically excellent laparoscopic fundoplications were performed in 45 and 50 minutes. We believe that with experience,it is feasible to perform a laparoscopic fundoplication in the great majority of cases in 60 to 120 minutes, depending on the difficulty of the case.

Although follow-up has not exceeded 30 months, the clinical results are promising, with the patients who had only a laparoscopic procedure remaining symptom free. Nevertheless, certain points need to be emphasized. Twelve of the 155 patients have required a second operation—an incidence of reoperation not much different from the much criticized (by us, as well as others) reoperation rate of the Angelchik device.[22] Also, four of the patients who were eventually opened had prolonged operations. The influence this may have on conditions such as deep venous thrombosis and pulmonary embolism is at present unknown, but these four patients who had emboli highlight this fact, and such an outcome should not be forgotten. We also believe it is possible that blood flow changes within the abdominal viscera, and possible changes in coagulant factors in the blood, both directly and as a result of the laparoscopic surgery, may have been important factors in the development of celiac axis thrombosis and superior mesenteric thrombosis, in our patient who died.

Furthermore, it is clear that certain features are not easy to judge laparoscopically. For instance, we have not yet learned to judge the width of the hiatus; thus, we are not certain which patients require hiatal closure. Whether all patients should have a hiatal closure remains an open question for laparoscopic fundoplication, as it does for open fundoplication. Nevertheless, the rate of

closure of about 20% in our patients is similar to the rate we have used previously in open fundoplication.

Also, it is not easy to judge exactly which part of the proximal stomach is being used for the fundoplication. We have noted that a "bilobed stomach" occurs in some patients—this was demonstrated by contrast radiology after the procedure. This was symptomatic on at least one (needing reoperation) and possibly two occasions. We do not yet know whether the patients who are asymptomatic with their bilobed stomachs will eventually get problems from it. We believe that this occurs because of the lack of three-dimensional vision. This leads to the body of the stomach being used for the wrap, rather than the fundus. It also could be argued that this anatomical distortion could have been prevented if we had divided some short gastric vessels. We are uncertain about this however, as division of the short gastric vessels is rarely needed in the open situation when using the anterior wall of the stomach as the wrap.

Although some of the problems we have encountered can be written off to our learning experience, we do not believe that laparoscopic fundoplication has yet achieved the overall utility of open fundoplication.

At the present time, there are certain patients in whom laparoscopic fundoplication probably should be avoided. These are patients with adynamic esophagus, patients with a fixed sliding hiatus hernia, and patients where periesophagitis is likely to be a major factor (e.g., patients with established strictures). Also, very obese patients can be difficult because of accumulation of fat in the omentum and gastrosplenic ligament and perihiatally. This fat tends to obscure the relevant anatomy.

Laparoscopic fundoplication has shown itself to be an effective antireflux operation in the short term. In uncomplicated and straightforward cases, it has similar advantages to laparoscopic cholecystectomy, and it seems likely that it will be used increasingly in the treatment of patients with gastroesophageal reflux disease.

Acknowledgments

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