

# Current Status of Antireflux Surgery

Derick J. Christian, MD, Jo Buyske, MD\*

*Department of Surgery, University of Pennsylvania Health System,  
Penn Presbyterian Medical Center, 38th and Market Street Philadelphia, PA 19104, USA*

Surgery for gastroesophageal reflux disease (GERD) has been in a state of evolution over the last 70 years. Nissen's fundoplication, Belsey's wrap, and Hill's gastropexy have all been introduced, studied, and modified. Different approaches have been used, including thoracotomy, laparotomy, thoracoscopy, laparoscopy, and robotic-assisted techniques. The merits of medical versus surgical management of the disorder, the role of laparoscopy in first-time and redo surgery, the need for esophageal lengthening procedures and partial fundoplications, and more recently, the role of endoluminal therapies for GERD have all been debated extensively. We are surely still in the midst of this evolution. This article attempts to summarize where we have been, where we are, and where we might be going in the surgical management of GERD.

## Historical aspects

### *Nissen*

In 1936, Rudolph Nissen excised the cardia of the stomach in a patient who had an esophageal ulcer, and anastomosed the esophagus to the stomach. He buttressed the suture line by wrapping the fundus of the stomach around it and the lower esophagus. Years later Nissen astutely noted that the patient had no heartburn, and rightfully attributed that to the "wrap" used at his surgery. In 1955, Nissen applied his theory in the operating room and wrapped a patient who had reflux esophagitis [1]. In 1956 he reported his work in the Swiss journal, *Schweizerische Medizinische Wochenschrift* (Fig. 1) [2].

### *Allison*

Before Nissens' work, hiatal hernia was thought to be the main cause of reflux [3]. It followed logically that reduction of hiatal hernia would restore

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\* Corresponding author.

*E-mail address:* Jo.buyske@uphs.upenn.edu (J. Buyske).

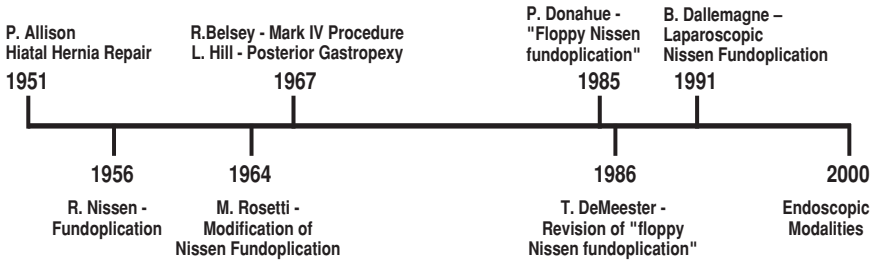


Fig. 1. Evolution of antireflux surgery.

the normal control mechanism, thus decreasing heartburn, reflux, and esophagitis. In 1951 Philip Allison [4] reported a technique for repair of hiatal hernia in the treatment of GERD. He described left thoracotomy, restoration of the abdominal length of the esophagus, posterior crural repair, and left phrenic nerve crush. The last was done to paralyze the left hemidiaphragm, causing eventration and securing the position of gastroesophageal (GE) junction in the abdomen. The long-term results of this operation, however, were unsatisfactory. Allison reported a 20-year retrospective survey of 553 patients operated on for various types of hiatal hernia [5]. Only 66% of the patients had symptomatic relief, and 49% had recurrence of the hiatal hernia.

### *Belsey*

In Bristol, England, Ronald Belsey was also working on the problem of GE reflux. His initial operation underwent multiple modifications before the final version, Mark IV, in 1967 [6]. He called his technique the Mark IV as a reminder of the trial and error that had preceded this final version. His repair emphasized physiology over anatomy. It was designed to restore all the normal functions of a competent cardia. Performed via a thoracotomy, his procedure emphasized mobilization of the esophagus and the cardia. The fundus was drawn through the chest to perform the 240° wrap, and then reduced back into the abdomen. Finally the crura were reapproximated to prevent a hiatal hernia. He theorized that the restoration of a 4- to 5-cm segment of the lower esophagus to the higher-pressure abdominal zone was essential in prevention of reflux.

### *Hill*

Another important contributor was Lucius Hill. He demonstrated that the antireflux barrier consisted of the gastroesophageal valve, the lower esophageal sphincter (LES), the diaphragm, and posterior fixation of the gastroesophageal junction [7]. He initially demonstrated this in cadaver experiments. Later he used a retroflexed endoscope in live patients to demonstrate the mucoso-mucosal fold created by the entry of the esophagus

into the stomach. His technique aimed to re-establish that 180° fold that was lost in patients who have severe reflux. Using an upper midline incision, he placed sutures between the proximal lesser curvature of the stomach, the median arcuate ligament, and the anterior and posterior phrenoesophageal fascial bundles. He included placement of cardio-diaphragmatic sutures for fixation of the GE junction, along with closure of the hiatus.

### Nissen modifications

Nissen's original fundoplication included mobilization of the lower 5 to 8 cm of esophagus, and takedown of the gastrohepatic omentum, including the hepatic branch of the vagus nerve. The anterior and posterior walls of the fundus were wrapped around the esophagus (Fig. 2). Since that initial description, multiple modifications have been made. For example, Nissen and Rossetti suggested tightening the wrap in very obese patients by using only the anterior fundic wall [8].

A large experience with Nissen fundoplication was gained (Table 1) [9–14]. Polk and Zeppa [9] reported a series of 994 patients, 96% of whom reported symptomatic improvement during a short follow-up period of

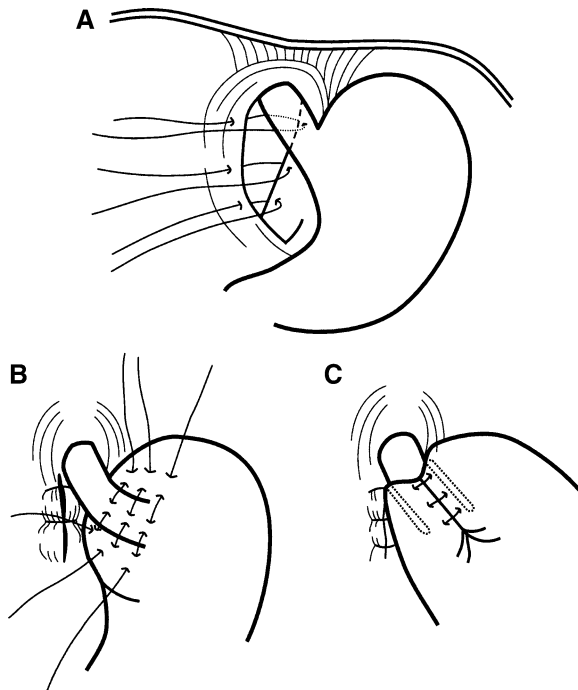


Fig. 2. Performing Nissen fundoplication. (A) Sutures to reapproximate the crura. (B) Sutures taken in the anterior wall of the fundus to perform the wrap. (C) Completed Nissen fundoplication.

Table 1  
Large series of Nissen fundoplication

Study	Year	No. of patients	Length of follow-up (years)	% patients symptoms free
Polk and Zeppa [9]	1971	994	2.5	96.0
Rossetti and Heill [10]	1977	590	Not available	87.5
Bushkin et al [11]	1976	165	10	92.0
Nicholson and Nohl-Oser [12]	1976	141	12	97.1
Negre et al [13]	1983	94	10	81.0
Ellis and Crozier [14]	1984	82	5.75	90.0

2.5 years. Rossetti and Heill [10] reported their series of 590 patients. They showed improvement of symptoms in 87.5% of the patients. These reports confirmed efficacy, but also reported significant postoperative problems. Dysphagia and gas bloat syndrome were issues of major concern. Woodward and colleagues [15] noted postoperative dysphagia in 24% of the patients. Furthermore, gas bloat syndrome was reported in 54% of the patients. This decreased to 21% after 1 year, and 11% after a longer follow-up period.

In an effort to address these issues, Philip Donahue introduced the “floppy Nissen fundoplication” in a dog model [16]. Using a 15 Hegar dilator underneath the fundoplication and a 50 French esophageal bougie during the creation of the fundoplication, he ensured a standard, large diameter to the wrap. In 1985 he reported 8-year follow-up of 77 patients who had floppy Nissen fundoplication [17]. Ninety-seven percent of patients were symptom-free. Only 2 patients reported the adverse effect of gas bloat syndrome and inability to belch.

Dr. Tom DeMeester further modified this technique in his landmark study in 1986 [18]. He used a 60 French esophageal bougie, shortened the fundoplication length to 1 cm, and performed complete mobilization of the gastric fundus with division of the short gastric vessels. His group reported that 91% of patients remained symptom-free in a 10-year follow-period. Importantly, the incidence of persistent dysphagia was decreased from 21% to 3%.

In the 1960s, Gurner [19], Menguy [20], and Toupet [21] all worked on modifications that allowed the partial fundoplication of Belsey’s Mark IV to be done through the abdomen instead of the more morbid thoracic approach (Fig. 3). These approaches had in common mobilization of the abdominal portion of the esophagus, narrowing of the crura, and finally a partial fundoplication, suturing the gastric fundus to the esophagus.

### Partial versus total fundoplication

Advocates of partial fundoplication claim that it results in fewer side effects than a 360° fundoplication. Complications such as gas bloat and

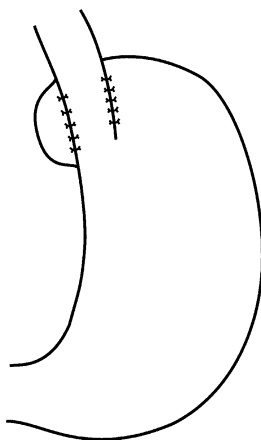


Fig. 3. Schematic of posterior partial fundoplication.

persistent dysphagia appear to be less frequent. Partial fundoplication was recommended as the initial procedure of choice for patients who have poor esophageal motility [22]. Patients suffering from postoperative dysphagia had their 360° wraps revised to partial fundoplication [23]. Some authors propose partial wraps as the operation of choice, regardless of esophageal motility [24].

Unfortunately, long-term follow-up revealed a high failure rate of partial wraps in terms of control of acid reflux. Jobe and coworkers [25] showed a worse outcome with a partial fundoplication than with total fundoplication. Other authors noted that as many as 50% of the patients who had partial fundoplication had evidence of reflux when studied postoperatively [26].

### Minimally invasive era

Bernard Dallemagne and coworkers [27] reported the first laparoscopic Nissen fundoplication in 1991. Cushieri and colleagues [28] subsequently reported a multicenter trial of 116 patients undergoing laparoscopic fundoplication. Randomized trials showed there to be a benefit to the laparoscopic approach [29]. John Hunter at Emory University in Atlanta, Georgia and Jeff Peters at the University of Southern California in Los Angeles, among others, developed standardized approaches and prospectively gathered data bases to follow the outcomes. Since then, many single-center trials have been published (Table 2) [30–35].

Initial nonrandomized studies comparing open and laparoscopic approaches to fundoplication suggested that although the laparoscopic approach took more time to perform, the incidence of postoperative complications such as incisional pain and respiratory compromise was

Table 2  
Single center laparoscopic Nissen fundoplication trials

Study	Year	Number of patients	OR time (minutes)	F/U period (months)	% patients symptom free
Hinder et al [30]	1994	198	150	32	97.0
Jamieson et al [31]	1994	155	120	3	97.1
Hunter et al [32]	1996	252	185	17	93.0
Gotley et al [33]	1996	200	149	12	99.5
Watson et al [34]	1996	174	80	3	91.0
Cathey et al [35]	1996	100	101	19	90.0

*Abbreviations:* F/U, follow-up; OR, operating room.

lower, and postoperative disability and hospital stay were shorter. Since then, multiple randomized studies also have been performed (Table 3) [36–40]. In 1997, Laine and coworkers [40] reported a randomized trial of 110 patients comparing laparoscopic versus open Nissen fundoplication. Esophageal monitoring and pH recording were performed during both the preoperative and postoperative periods. During the 3-month follow-up period, 24-hour pH tracing was normal in 97% of the patients in the laparoscopic Nissen fundoplication group and 68% of the patients in the open group. Likewise, LES pressure had increased by 80% in the laparoscopic group and only 40% in the open group. The mean duration of the operation was 88 minutes in the laparoscopic group and 57 minutes in the open group. The average hospital stay was 3.2 days in the laparoscopic

Table 3  
Randomized trials of open vs. laparoscopic Nissen fundoplication

Study	Year	F/U period	Number patients	OR time (min)	(%) Postop pain	Postop hospital stay (days)	(%) patients with severe heartburn
Nilson et al [36]	2004	5 years	17 lap	na	na	na	6
			23 open				4
Ackreyd et al [37]	2004	12 months	52 lap	82	4	3	8
			47 open	46	30	5	2
Chrysos et al [38]	2002	3 months	56 lap	77	5	2	4
			50 open	83	92	6	2
Wenner et al [39]	2001	6 months	30 lap	na	na	na	4
			30 open				7
Laine et al [40]	1997	3 months	55 lap	88	na	3	0
			55 open	57		6	4

*Abbreviations:* lap, laparoscopic; na, not available; postop, postoperative.

group, versus an average 6.4-day stay in the open group. Similarly in 2002, Chrysos and colleagues [38] reported a randomized trial of laparoscopic versus open Nissen fundoplication in 106 patients. This showed the open group to have more pain as well as more frequent respiratory complications. At 12-month follow-up, both open and laparoscopic groups were shown to have increased lower LES tone. Follow-up pH monitoring confirmed reduction of reflux in both groups as well.

### **Patient selection**

In the properly selected patient, laparoscopic antireflux surgery with a short, floppy fundoplication has a success rate of greater than 90% in addressing the classic symptoms of reflux, specifically heartburn and regurgitation [41]. Patients who have atypical presenting symptoms such as cough, hoarseness, or mouth burning are less likely to have relief of these complaints [42]. The patient most likely to do well has been fairly clearly delineated, and can be identified with a thorough evaluation.

A good history elicits all reflux-related symptoms, as well as all symptoms the patient may wrongly attribute to reflux. The authors routinely ask extensive questions about the nature, timing, and duration of heartburn symptoms. We ask about temporal relationships to eating, lying down, bending over, or stress. We discuss habits of air swallowing, gum chewing, caffeine ingestion, and cigarette smoking. We also ask about lower digestive symptoms such as abdominal pain, constipation, diarrhea, or flatulence. Extraesophageal symptoms such as cough, especially night cough, throat clearing, sinus infections, pneumonias, dental caries, and pneumonias should be sought.

A history of abdominal pain bears more discussion and evaluation. The authors have a low threshold for getting a sonogram of the right upper quadrant to look for gallstones as a potential cause of this, and a low threshold as well for cholecystectomy at the time of antireflux surgery should gallstones be present. Constipation and diarrhea should elicit a search for either inflammatory bowel disease, if appropriate, or irritable bowel syndrome, which may be a poor prognostic indicator for results from reflux surgery [43,44].

Complaints of bloating, postprandial distention, and dyspepsia should raise the suspicion of delayed gastric emptying as a contributing factor in reflux [45,46]. A gastric emptying study should be obtained to confirm or refute the existence of this disorder. If present, these patients should be counseled about the risk of gas bloat symptoms after fundoplication. In mild to moderate cases, fundoplication may actually increase the rate of gastric emptying [47]. In severe cases, consideration should be given to adding a gastric emptying procedure to the operation.

Upper airway symptoms need to be addressed carefully. To date we have a very poor ability to predict which patients who have a primary

extraesophageal complaint will respond well to antireflux surgery [48,49]. An exhaustive search for other causes should be undertaken, and objective proof of the simultaneous presence of reflux is mandatory. Good symptom correlation to episodes of reflux on a 24-hour pH study may be reassuring, but we still have no sure way of separating responders from nonresponders. The patient must clearly understand this, and be a partner in the decision-making should a decision be made to proceed.

Response to medication has been shown to be a valuable prognostic indicator [50]. This can be assessed qualitatively by simply asking patients if their medications make them feel better, and if they feel worse when they are stopped. Acid suppression is often withheld for several days before 24 hour pH testing, which can provide a useful window for this assessment.

### **Diagnostic studies**

The core group of studies consists of upper gastrointestinal endoscopy (EGD), upper gastrointestinal fluoroscopy with barium, 24-hour pH testing, and esophageal manometry.

EGD allows examination of the esophageal mucosa. It is useful in identifying the presence of esophagitis and grading the severity. Endoscopy can help identify other pathology, such as diverticula, hiatal hernia, webs, rings, or strictures. Tissue biopsies to screen for Barrett's esophagus and esophagitis should be obtained. EGD is less useful in stratifying the size or significance of a hiatal hernia, and should not be exclusively relied upon for that information.

The 24-hour pH test is the gold standard for presence of pathologic reflux. A small catheter bearing a pH probe at its end is placed transnasally. The tip is positioned 5 cm above the LES, with additional probes placed in the stomach and 15 cm above the LES. Quantitative measures of esophageal acid exposure are made every 4 to 6 seconds. The patient activates an event marker in response to symptoms, meals, and body position changes. The catheter remains in place for 24 hours. Multiple parameters can be calculated. These include total number of reflux episodes, duration of the longest reflux episode, and percentage of total time the esophageal pH is less than 4 [51]. The "DeMeester score" is obtained by combining these results. Normal individuals have a DeMeester score of 14 or less [52]. It is important to note that this is a relative scale, and there is no absolute value that clearly identifies pathologic GERD.

Use of the 24-hour pH probe is somewhat limited by the patient's ability to tolerate a small catheter down the nose for 24 hours. An alternative is a probe that is attached endoscopically to the mucosa 6 cm above the GE junction. It gathers pH data for 2 days. During the next 10 to 14 days it detaches itself from the mucosa. Because there is only a single probe, it provides less information than the traditional 24-hour pH probe; however, it may be better tolerated in some patients.

Esophageal manometry should also be routinely performed. It provides information on the function of the LES and esophageal body. The ideal candidate for surgery has a mechanically defective sphincter. Stein, DeMeester, and Naspetti [53] looked at the LES of 50 normal individuals and also of 622 patients who had GERD. They arrived at the following criteria for a defective LES: mean pressure less than 6 mm/Hg, overall length less than 2 cm. and intra-abdominal length less than 1 cm. Esophageal manometry may also identify patients who have abnormal esophageal motility, such as achalasia or scleroderma. Other patients who have ineffective or absent peristalsis may be candidates for a partial fundoplication, or may be better served avoiding operation all together.

Barium esophagram is the most useful test to delineate the anatomy of esophagus. It aids in identifying the length of the esophagus and the presence or absence of a hiatal hernia, both of which will influence the procedure of choice. Barium esophagram can also identify subtle stricture or Shatski's rings, which may not be apparent on endoscopy.

### **Short esophagus**

The entity of short esophagus warrants some discussion. There is no consensus in the literature on the incidence, definition, or even the very existence of short esophagus. In theory, severe and chronic exposure to acid produces fibrosis and esophageal shortening. This may compromise the ability of the surgeon to reduce the GE junction into the abdomen, or to keep it there for the long term. Historically the incidence of short esophagus has been variously reported as ranging from 60%, as described by Pearson and Todd [54], to 0% as reported by Hill and coworkers [55]. More recently, two large studies reported the incidence of short esophagus requiring an esophageal lengthening procedure to be 3% to 4%[56,57].

Several authors have attempted to identify factors that would allow the diagnosis of short esophagus before surgery. Awad and colleagues [58] looked at variables such as endoscopic evidence of stricture, Barrett's esophagus, irreducible hernia greater than 5 cm, and esophageal shortening on manometric studies. The group concluded that only endoscopic evidence of stricture or Barrett's esophagus was associated with a short esophagus. Gastel and coworkers [59] also concluded that only esophageal stricture predicted short esophagus. At this time, the only reliable way to exclude a short esophagus is at surgery. An effective antireflux valve requires 2.5 to 3 cm of intra-abdominal esophagus [60]. If the distal esophagus cannot be brought fairly easily below the diaphragm, then there is a presumptive diagnosis of short esophagus.

Multiple operations have been described for the management of the shortened esophagus. These include intrathoracic fundoplication, esophageal lengthening procedures, or ultimately, esophagectomy. Collis initially described an esophageal lengthening procedure using a thoracoabdominal

incision for esophageal mobilization. He established additional length by dividing the proximal stomach in line with the esophagus, a Collis gastroplasty [60]. Pearson and Henderson [61] later described a transthoracic Collis gastroplasty combined with Belsey's fundoplication. A series of 26 patients showed that 76% were symptom free at 5- to 12-year follow-up. Orringer combined the Collis gastroplasty with a Nissen fundoplication, a transthoracic Collis-Nissen procedure. He demonstrated reflux control in 88% of 261 patients during a 10-year follow-up period [62]. Steichen [63] later introduced the use of circular and linear staplers to create an abdominal Collis-Nissen procedure. In 1996, Swanstrom and colleagues [56] described a combined laparoscopic/thoracoscopic Collis gastroplasty, which, though effective, was not widely adopted. Johnson and coworkers [57] described a totally laparoscopic Collis gastroplasty using staplers in 1998. A short follow-up period of 6 weeks showed symptomatic improvement in 93% of the 15 patients.

### **Mesh repair of hiatal hernia**

Some authors have looked at the use of prosthetic material for the reapproximation of the hiatus. This would create an intense scar that might prevent wrap migration or disruption of the crural repair. The proponents of this method report a significant decrease in hernia recurrence. Frantzides and colleagues [64] showed a significant decrease in recurrence rate by using prosthetic material for hiatal defects greater than 8 cm. Champion's group [65] showed the same results in patients who had hernias of 5 cm. The same group proposes the use of prosthetic material routinely for redo-fundoplication. Granderath and coworkers [66] reported the use of polypropylene mesh in 24 patients undergoing laparoscopic redo-fundoplication. Concern about the potential for complication related to mesh in this position has limited adoption of this approach. There is no consensus in the surgical community on this subject.

### **Technique**

The patient is placed in a supine split-leg position. This allows the surgeon to stand in the midline between the patient's legs. Access to the abdominal cavity is obtained with either a Veress needle or a Hassan technique. A standard five-port technique is used (Fig. 4). The authors begin the dissection by opening the bare area of the gastrohepatic ligament, taking care to preserve the hepatic branch of the vagus nerve whenever possible. The phrenoesophageal ligament is lifted off the esophagus and divided. The retroesophageal space is then opened by sweeping down the right side of the hiatus until the left leaflet of the crus is seen behind the esophagus. The left leaflet is then likewise swept clean, effectively encircling the esophagus without actually dissecting near it. With aid of an atraumatic esophageal

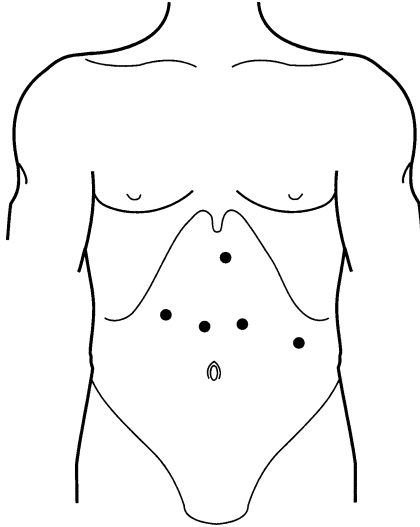


Fig. 4. Port placement sites for laparoscopic antireflux surgery.

retractor or soft rubber drain, the esophagus is freed of its mediastinal attachments to obtain at least 4 cm of intra-abdominal length. The short gastric vessels are then taken down completely with the aid of a harmonic scalpel. A short, loose fundoplication is created over a 60 French bougie. A nasogastric tube is left in position.

The patient is kept in-house overnight. Antiemetic medications are given liberally. The nasogastric tube is removed the next day. The patient is started on clear liquids and advanced rapidly to a soft-solid diet. The patient is discharged when tolerating a diet, usually on postoperative day 1 or 2. The authors do not obtain any routine postoperative testing in house. The first postoperative visit is 2 weeks after surgery, at which point the diet can be liberalized if there is no dysphagia. A second visit is scheduled 6 weeks after surgery. An esophagram is obtained at 1 year, and repeated annually for 5 years, with annual office visits as well. Twenty-four hour pH studies should be done if there is any question of recurrent or persistent reflux.

### **Surgical failure**

Failed surgery is heralded by recurrence or persistence of preoperative symptoms, or occurrence of new symptoms after an antireflux operation. The most common symptom is dysphagia [67]. Other commonly reported symptoms are early satiety, abdominal bloating, diarrhea, and recurrent reflux symptoms. Subjective reporting of symptoms, however, has very poor correlation with postoperative acid reflux. In one study [68], the positive predictive value of heartburn after reflux surgery was only 43%, although

a negative predictive value was 82%. A careful and thorough evaluation must be performed in a patient who has postoperative symptoms.

The first test to undertake when a patient complains of symptoms postoperatively is a video barium esophagram. In good hands this provides both anatomic and functional information. Radiologic abnormalities after antireflux procedures have been categorized into Types I, II, III, and IV failures (Fig. 5) [69]. Type I is a complete disruption of the fundoplication, with recurrence of the hiatal hernia. Type II is part of the stomach slipped above the diaphragm. Type III represents part of the stomach above the fundoplication but below the diaphragm. Finally, Type IV is the herniation of the fundoplication through the hiatus into the chest.

Beyond wrap disruption or displacement, other reasons for failure of antireflux surgery include breakdown of crural closure or inadequate closure at surgery, and perhaps lack of adequate mobilization of the esophagus. Some investigators report that failure to divide the short gastric vessels may be a cause of failure [70].

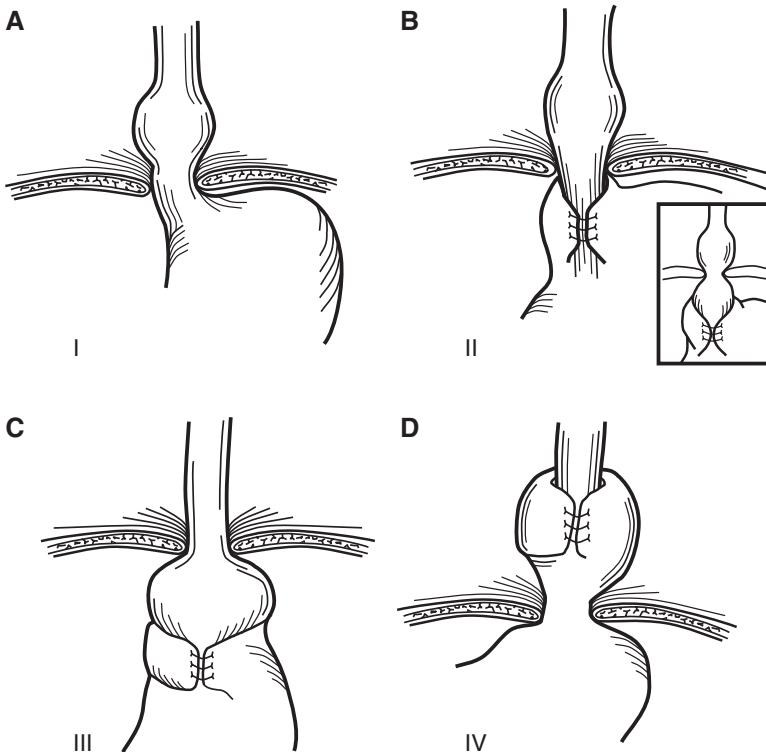


Fig. 5. (A–D) Anatomic failures of fundoplication. (Modified from Hinder RA: Gastroesophageal reflux disease. In: Bell RH Jr, Rikkers LF, Mulholland MW, editors. Digestive tract surgery: a text and atlas. Philadelphia: Lippincott-Raven Publishers; 1996. p. 19; with permission.)

Body habitus has also been implicated in the failure of fundoplication. Perez and colleagues [71] recently evaluated 224 patients after laparoscopic Nissen and open Belsey Mark IV repair. Patients who had a body mass index of greater than 30 had a significantly higher symptomatic recurrence rate (27%) than those who had a body mass index of less than 29 (8%).

### **Redo surgery**

Persistent or new troublesome symptoms after an antireflux procedure warrant a careful evaluation. Investigation should be directed at both the original preoperative evaluation and the current situation. The initial evaluation should be reviewed with an eye toward any predisposing problems. Esophageal manometry might show borderline function predisposing to persistent symptoms postoperatively. Review of the original 24-hour pH test might show poor symptom correlation, which suggests that postoperative symptoms may be due to something other than recurrent reflux. The operative report should be obtained and reviewed, with attention to such details as esophageal length, use of a bougie or dilator to size the wrap, closure of the hiatus, and division of the short gastric vessels. Variations on any of these steps may provide a clue to the cause for postoperative symptoms, and also the hope that revisiting the operation may offer more success.

Once the old evaluation and operation has been reviewed, a new, thorough evaluation is begun. Because the anatomy has been altered by surgery, the preoperative tests no longer pertain, and the entire preoperative work-up must be undertaken, including EGD, 24-hour pH testing, esophageal manometry, and video esophagography [72].

EGD will demonstrate exposed suture material, residual hiatal hernia, and even the integrity of the fundoplication in a retroflexed angle. Barium esophagram will allow visualization of the anatomic defect. Esophageal manometry may identify if the fundoplication is too tight (LES too high) or too loose (LES too low). Esophageal body motility testing may identify previously missed or newly unmasked motor abnormalities such as achalasia, Nutcracker esophagus, or diffuse esophageal spasm. A 24-hour pH test can confirm or refute recurrent or persistent reflux as part of the postoperative symptom complex.

The choice of a laparoscopic open approach to redo surgery depends on the surgeon's experience. Multiple reports exist in successful laparoscopic revision of funduplications in cases of failed antireflux surgery [73–75]. In either approach, the liver is densely adherent to the wrap, and requires meticulous dissection to avoid injury to the esophagus, stomach, or liver. The operative strategy should focus on any abnormalities demonstrated preoperatively, including recurrent hiatal hernia, existence of short esophagus, or a lack of short gastric division. The wrap should be taken down completely and the fundus returned to its usual anatomic position. Once the

anatomy of the area has been exposed, the authors proceed as we do for first-time antireflux surgery.

## Summary

Much progress has been made in the surgical management of gastroesophageal reflux disease. Early operations were plagued by hernia recurrence, gas bloat symptoms, and recurrence. The prospect of thoracotomy or laparotomy may have made patients and referring physicians reluctant to proceed with surgery. Thoughtful surgical research has led to better understanding of the mechanisms of reflux. Modifications based on this work have improved outcomes. The shorter, looser wrap is better tolerated than the original, and laparoscopic approaches have reduced recovery times while maintaining excellent results. The next era of treatment of acid reflux disorders will certainly build upon this work, continuing to fine-tune our approach to this widespread disorder.

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