

# Gastroesophageal Reflux and its Surgical Management

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## Introduction

In Western societies, gastroesophageal reflux has assumed importance for two reasons. First it is a common disorder with as many as 40% of the adult population having heartburn at least once a month and 7% experiencing it daily. Secondly, it is associated with adenocarcinoma of the cardia. Because the incidence of this is rising at a considerable rate (particularly in white Western males), cure of reflux may assume an important role in preventing this cancer in the future.

In the past, surgical treatment of gastroesophageal reflux disease has tended to be limited to those patients with complicated reflux disease or those with very severe symptoms of reflux. Recently the surgical role has changed somewhat, and although varying from country to country, there is now an increasing tendency to utilize surgery at earlier stages in the course of reflux disease. This is because of changes in surgical technique (most notably the introduction of laparoscopic surgery), the previously mentioned rising incidence of adenocarcinoma of the cardia associated with uncontrolled reflux disease and, paradoxically, because of improvements in medical therapy (see later).

## Which patients should be considered for antireflux surgery?

Patients with gastroesophageal reflux disease can be divided broadly into 2 groups:

- first are patients who have complicated reflux disease, and
- second are patients who have straight forward symptoms without complications.

## ■ Patients with complicated reflux disease

■ **Reflux with stricture formation.** With extremely dense and undilatable fibrotic strictures, resection is the only effective treatment, but fortunately it is unusual today to see patients with such advanced strictures. Dilatable strictures in young and fit patients are best treated by fundoplication and dilatation [2]. However, many patients who develop strictures are elderly or infirm and the use of proton pump inhibitors with dilatation has proven very effective treatment and thus has lessened the need for operation in high risk patients [3].

■ **Reflux with respiratory complications.** When gastro-esophageal regurgitation leads to spill-over into the respiratory tree, this can cause chronic respiratory illness, such as recurrent pneumonia and asthma [4]. This is a firm indication for antireflux surgery, as proton pump inhibitors' predominant action is to block acid secretion rather than alter gastroesophageal regurgitation.

Such problems as halitosis, acid taste in the mouth, chronic laryngitis, chronic pharyngitis, and loss of enamel on teeth are sometimes attributed to gastroesophageal reflux. There is a little doubt that on occasions such problems do arise in refluxing patients, but acid is usually the damaging agent in these situations, and antireflux surgery should not be considered unless proton pump inhibition has shown unequivocally that it ameliorates the problem.

■ **Reflux with columnar lined esophagus (Barrett's esophagus).** At the present time it remains an open question whether Barrett's esophagus per se is an indication for antireflux surgery. There is experimental evidence to suggest that con-

tinuing reflux may be deleterious in regard to malignant change in esophagus mucosa [5], and one prospective randomized trial has suggested that antireflux surgery gives superior results to drug therapy [6]. However proton pump inhibitors were only introduced into the medical arm of that trial in its later years.

Therefore, one recommendation which might be given at present is that the indications for surgery are related to the reflux symptoms and not to the presence of columnar lined esophagus per se. However, as most observers regard columnar lined esophagus as being at the severe end of the reflux spectrum, it seems reasonable to factor it in as a further reason for giving strong consideration to antireflux surgery. One must also keep an open mind in regard to the link between reflux and intestinal metaplasia at the lower end of the esophagus. If this link and the progression to adenocarcinoma become firmly established, then the role of antireflux surgery will almost certainly be expanded.

### ■ Patients with uncomplicated reflux disease

In the past, it was easy to make the recommendation for antireflux surgery on the basis when the disorder was spoiling the patients' enjoyment of living, in spite of the best that medical therapy has to offer. This indication remains valid, but medical therapy in the form of proton pump inhibitors is so effective today that it is only a small minority of patients who do not get substantial or complete relief to their symptoms with the use of such agents [7]. Why then does there appear to be a trend for patients to present for antireflux surgery in greater numbers than ever? There are several reasons for this.

First, if patients will stop taking their proton pump inhibitors, symptoms of reflux recur very rapidly, and sometimes the symptoms are worse than they were prior to taking proton pump inhibitors. This may relate to parietal cell hyperplasia which has been reported in patients taking proton pump inhibitors [8]. The importance of this finding remains to be elucidated. Regardless, many patients do not like to be dependent on drugs to be symptom free. Thus, the second and related reason is that many patients with reflux potentially have

years of life remaining, and they do not wish to take drugs in the long term when the drugs have not been established as safe if taken for many years. It must be said, however, that there is no particular reason to think they will not establish such a record of safety.

The cost of proton pump inhibitors to the patients varies from country to country, but it is an additional factor, as is the cost of the drugs to society as a whole.

An additional factor, already mentioned, is the rising incidence of adenocarcinoma of the cardia associated with gastroesophageal reflux disease [9, 10]. However, whether antireflux surgery is more effective at preventing the development of columnar lined esophagus and carcinoma of the cardia than long term proton pump inhibition remains a controversial issue.

But perhaps none of these reasons, even taken together, would have convinced patients to take the operative alternative, if open surgery had remained the standard. There seems little doubt that the advent of laparoscopic fundoplication [11, 12] with its greatly reduced morbidity has also been a major factor in the swing to operation in the treatment to reflux.

## What are the advantages and disadvantages of antireflux surgery?

### ■ Advantages

The advantages are fairly clear. The operation is the only treatment which actually cures the problem, i.e. stops gastric contents from refluxing into the esophagus. So in terms of their reflux, patients can eat whatever foods they choose, they can lie down flat, bend over etc., without reflux occurring; importantly, they do not have to take any tablets.

### ■ Disadvantages

The first disadvantage is the morbidity associated with the operation (see later in regard to complications). It is true that the advent of laparoscopic surgery has meant that the pain of the open operation has abolished. Neverthe-

less, most patients have some difficulty in swallowing in the immediate postoperative period. Fortunately, in the great majority of cases this is only a temporary problem, but the time it takes to get better is widely variable and occasionally takes several months [12].

Furthermore, the great majority of patients feel very full after eating even small meals, which often leads to some postoperative weight loss. In the patients who are overweight at the time of surgery (the majority!) this is sometimes seen as an advantage of the operation, rather than a disadvantage. This restriction on meal size also usually disappears over a few months. Because fundoplication, along with all other effective antireflux operations, produces a one way valve, swallowed air, which has passed into the stomach, usually cannot pass back through the valve. Thus, patients have to be forewarned that they will not be able to belch effectively after the operation and so should be cautious about taking gassy drinks. As swallowed gas cannot be belched either, the great majority of patients are aware of increased flatulence with increased borborygmi and increased passage of wind after the procedure. For similar reasons, patients will be unable to vomit after the procedure, and should be informed of this. This is not of importance with such conditions as gastroenteritis, when patients will dry retch only. In fact, it only assumes importance if the patient should develop gastrointestinal obstruction. As vomiting cannot occur in such circumstance, the patient has a unique, large, closed loop obstruction (which can be decompressed by passing a nasogastric tube).

An overwhelming majority of patients state that the disadvantage of the procedure is far outweighed by the advantages of the operation, but occasionally this is not the case. Perhaps it may prove possible, by the use of preoperative psychological questioning, to predict those patients who will be troubled by what to the majority of patients are minor nuisances, although this remains to be proven [13].

## Operations available

There is no doubt that the fundoplication introduced by Rudolf Nissen in 1956, or some variant of it, is overwhelmingly the most popular operation in the world today. Total fundoplications such as the Nissen or partial fundoplications, whether anterior or posterior, probably all work in similar fashion. And the fashion may be as much mechanical as physiological, as it has been demonstrated that these procedures are effective, not only when placed in the chest *in vivo* [14] but also on the benchtop, *i.e. ex vivo* [15].

The principles of fundoplication are to mobilize the lower esophagus and to wrap the fundus of the stomach, either partially or totally, around the esophagus. When the esophageal hiatus is enlarged, it is narrowed by sutures to prevent paraesophageal herniation postoperatively, and also prevent the wrap being pulled up into the chest (although the fundoplication will work in the chest, other complications such as gastric ulceration sometimes occur in this situation).

These operations can be undertaken either transthoracically or transabdominally. Although the latter seems a simpler approach, the choice tends to depend on whether the surgeon is predominantly a thoracic or predominantly an abdominal surgeon.

Operations which are limited to one or the other approach (e.g. thoracic-Belsey and abdominal-Hill) have never gained the widespread popularity of the Nissen fundoplication operation.

## Traditional open fundoplication

Fundoplication was first described by Nissen 1956 [16] following the serendipitous discovery that a fundal patch, used to reinforce an esophageal suture line, also prevented gastroesophageal reflux. Whilst achieving good control of pathological reflux in the majority of patients [17], an incidence of adverse sequelae has led to the subsequent modification of Nissen's original technique. Shortening the fundoplication

plication length to 1 to 2 cm, dividing the short gastric vessels to achieve full mobilization of the gastric fundus, calibration of a loose fundoplication over a large intra-esophageal bougie, and modification of the complete fundoplication to one of a number of partial fundoplication variants, have all been advocated. Few of these modifications, however, have been evaluated within the context of prospective randomized trials.

Following four decades of experience with antireflux procedures, long term outcomes following open surgery have been well described. The postoperative hospital stay following open surgery ranges from 7 to 14 days, and short term morbidity is acceptable. Long-term success is achieved in the majority of patients [18, 19].

Adverse outcomes following open Nissen fundoplication include persistent dysphagia and the gas bloat symptoms. Although less common in late follow-up, many patients report troublesome early dysphagia [21]. The assessment of dysphagia symptoms, however, can be difficult because variable methods of clinical assessment and scoring are used in the various reported studies. There is also the potential for the introduction of assessment bias by clinician investigators, particularly if follow-up is performed by the operating surgeon. Despite these difficulties, it is likely that the incidence of persistent long-term troublesome dysphagia is less than 5% following Nissen fundoplication. Uncontrolled reports suggest that the performance of a partial fundoplication variant may reduce this incidence [22]. However, to date, this proposal has not been proven by randomized trials.

Despite the large number of publications describing fundoplication outcomes in the era of open surgery, few randomized trials have been conducted. Three trials have compared a Nissen fundoplication with a posterior partial fundoplication [23, 24], and one has compared a Nissen fundoplication with a Hill and a Belsey procedure [25]. None of these studies describe any significant increase in the likelihood or severity of dysphagia following Nissen fundoplication, compared to a posterior partial fundoplication procedure. However, with the exception of the study reported by Lundell et al. [21] which enrolled 137 patients, all of the

studies assessing the partial fundoplication variants enrolled small numbers of patients, which were inadequate to allow one to draw statistically valid conclusions. Other small studies have compared Nissen fundoplication with the Angelchik prosthesis and with the Ligamentum teres cardiopexy, demonstrating advantages for Nissen fundoplication [26, 27]. Another compared the Nissen procedure with and without division of short gastric vessels showing no difference [28], and a recent larger study compared medication with surgical treatment therapy [29]. Although findings were in favor of operation, neither the medical nor the surgical therapy used would now be regarded as optimal.

### Laparoscopic fundoplication

Initial reports of small case series of laparoscopic Nissen fundoplication with follow-up of 3 months or less first appeared in the published literature in 1991 [11, 30]. Although these studies confirmed the technical feasibility of laparoscopic antireflux surgery, the lack of adequate follow-up data and the small patient numbers precluded any adequate assessment of the merits of the procedures described. The first large study was published by Cuschieri et al. in 1993, who reported promising results from a multicenter series of 116 patients [31]. Further large single center experiences describing series of more than 100 patients have been published since, with follow-up intervals of 2 to 3 years described in some later studies [32]. Mean or median operating times vary from 30 to 185 minutes in these studies. Some of the reported variation in operating may be due to differences in laparoscopic technique, as well as possible increased operation times in some centers involved in teaching surgical trainees [33, 34]. Reported complication rates range from 2 to 26%, and surgical revision has been needed in a small group of patients in most series. Variation in these rates may be influenced by the effect of the institutional learning curve, technical factors associated with the choice of surgical technique, and different criteria used for the recognition and classification of com-

plications in different reports. For example dysphagia rates may depend on the choice of clinical measure used to determine post-operative dysphagia, and who applies the measure chosen. The operating surgeon may elicit a different response from an independent investigator.

Laparoscopic Nissen fundoplication is reported to control reflux symptoms in 91 to 100% of patients followed for up to two years, results which mirror previous experience with open antireflux surgery. Post-operative hospital stays have been short in all published reports, with mean/median stays ranging from 2 to 5 days. Overall results from these initial case series suggest that laparoscopic antireflux surgery is effective, and that it results in an overall reduction in the short term morbidity associated with surgery for reflux. However, several complications, some of which may be unique to the laparoscopic approach, have now been described.

■ **Pneumothorax.** This and accompanying pneumomediastinum is not an infrequent occurrence in more difficult cases, such as reoperative surgery. However, they are of no particular concern, and the CO<sub>2</sub> is rapidly absorbed.

■ **Vascular injury.** Vascular injury to the inferior vena cava, the left hepatic vein, the abdominal aorta, and the inferior phrenic vessels has all been reported [35]. It is possible that this complication is associated with a combination of aberrant anatomy, inexperience, and the excessive use of monopolar diathermy dissection. Intraoperative bleeding more commonly follows inadvertent laceration of the left lobe of the liver by a laparoscopic liver retractor or other instrument, or hemorrhage from short gastric vessels during fundal mobilization. A rare complication is cardiac tamponade due to laceration of the right ventricle by a liver retractor [36].

The overall risk of perioperative hemorrhage associated with antireflux surgery, however, may well be reduced by the laparoscopic approach. The risk of splenectomy due to inadvertent splenic injury during Nissen fundoplication is dramatically reduced by the laparoscopic approach [37]. Whilst splenectomy rates of 1 to 3% have been reported in association

with open fundoplication, splenectomy is a rare event following laparoscopic fundal mobilization. It is likely that the more precise dissection and better anatomical exposure afforded by the laparoscopic approach minimizes the likelihood of inadvertent splenic trauma.

■ **Para-esophageal hiatus herniation.** Although para-esophagus hiatus herniation may occasionally present in the late follow-up period following open fundoplication, most large case series of the laparoscopic procedure report an incidence of paraesophagus herniation, particularly in the immediate post-operative period. The incidence of this has ranged up to 7% in published reports [38]. This problem may be more likely following laparoscopic surgery for several reasons. First is the tendency to extend laparoscopic esophagus dissection well into the thorax, second is the increased risk of breaching the left pleural membrane, and third is the effect of reduced post-operative pain. Reduced pain may permit more abdominal force to be transmitted to the hiatal area during coughing, vomiting or other forms of early exertion, thereby pushing the stomach into the thorax. It is likely routine hiatal repair will reduce the risk of this problem [38, 39]. It is also possible that some of the apparent variation in the incidence of this problem reflects the steps taken to actively look for this complication. Also, the incidence following open fundoplication may be greater than previously recognized [21].

■ **Dysphagia.** Early severe dysphagia requiring surgical revision has been reported in a number of series. Conversion of a Nissen fundoplication to a posterior partial fundoplication has been performed for troublesome dysphagia by both open and laparoscopic techniques, usually with success. Over narrowing of the esophagus hiatus, another potential cause of early dysphagia may be difficult to assess intraoperatively because of reduced tactile feedback during laparoscopic surgery. This can be corrected by early laparoscopic re-intervention to release one or two hiatal sutures. Late narrowing of the esophagus hiatus due to the post-operative scarring, even in patient's not undergoing hiatal repair, has also been reported [40]. It is possible that this complication is due to an



idiosyncratic response to dissection which occurs in certain patients. Correction requires widening of the diaphragmatic hiatus by either open surgical or laparoscopic techniques.

■ **Pulmonary embolism.** Pulmonary embolism has been reported following laparoscopic antireflux surgery. This is likely to result from a combination of primarily mechanical factors. The combination of head up tilt of the operating table, intraabdominal insufflation of gas under pressure, and placement of the legs of patients in stirrups may greatly reduce venous flow in leg veins [41]. Coagulation changes associated with surgery are not altered by the application of laparoscopic techniques [42]. To prevent this problem it is mandatory that antithromboembolism prophylaxis is routinely applied.

■ **Perforation of the gastrointestinal tract.** Perforation of the esophagus, stomach, duodenum, or bowel has all been described following laparoscopic antireflux surgery. Whilst perforation of the small bowel and the colon may be related to laparoscopic access in general, esophagus and gastric perforations are specific risks of laparoscopic antireflux surgery, with an incidence of approximately 1% reported by most series. Perforation of the back wall of the esophagus can occur when dissecting the posterior aspect of the esophagus with laparoscopic instruments. The anterior esophagus wall is at risk when a bougie is passed to calibrate the tightness of the Nissen wrap. Gastric perforation is usually an avulsion injury of the gastric cardia due to rough handling by the surgical assistant, or the use of inappropriate grasping instruments to retract the stomach. These injuries can be repaired by sutures, applied either laparoscopically or by an open technique. Awareness of the potential for these injuries is likely to reduce their occurrence [43].

■ **Mortality.** Three deaths have been described following laparoscopic antireflux procedures [33, 44, 45]. The first was a patient who died secondary to peritonitis and sepsis from a duodenal perforation, presumably due to an instrumental injury occurring outside of the restricted field of view provided by the lapar-

scope [43]. Another was an instance of thrombosis of both the superior mesenteric artery and the coeliac axis [44]. This rare complication has also been seen following laparoscopic cholecystectomy, suggesting that it may be related to the use of positive pressure insufflation. A third was a case of infarction of the liver following laparoscopic fundoplication [45].

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### Laparoscopic versus open surgery

Although laparoscopic approaches may reduce short term surgical morbidity, on a priori ground, it does not seem likely that long-term outcomes will be different from equivalent open procedures. It is even possible that technical modifications introduced to facilitate various laparoscopic approaches will result in poorer long term outcomes. Equally the superior view of the operative field in laparoscopic surgery might lead to better outcomes. Until the results of long term studies are available the true outcome of laparoscopic antireflux surgery, and its status as compared with open antireflux surgery will remain unknown.

Few direct comparisons of clinical outcome, surgical morbidity, and cost effectiveness have been attempted between early series of laparoscopic Nissen fundoplication and open surgical experience (historical or otherwise) within single institutions. Of the cost comparisons attempted, all are within the context of the American health system. Given the constraints of the non-randomized research methodology for almost all of these studies, and the different cost structure of the American health care, a fair comparison of laparoscopic and open techniques is difficult. All published studies report that laparoscopic antireflux surgery reduces hospital treatment costs and early surgical morbidity. Similar advantages were identified by non-randomized studies which compared laparoscopic inguinal hernia repair, appendectomy, and cholecystectomy with their equivalent open procedures. However, these advantages have not always been supported when prospective randomized trials were reported subsequently. Three randomized controlled trials which compare a laparoscopic Nissen

fundoplication with its open surgical equivalent have been reported [46–48], two in abstract only. Nevertheless, the results of all of these early trials confirm advantages for the laparoscopic approach, albeit less dramatic than the advantages expected from the results of non-randomized studies.

### Randomized trials of laparoscopic antireflux surgery

Apart from the above three randomized trials, which compare laparoscopic with open Nissen fundoplication, five other randomized trials examining laparoscopic antireflux surgery have been reported. Two of these studies compared different techniques for dividing the short gastric vessels during laparoscopic Nissen fundoplication. Laycock et al. [49] randomized 20 patients to have these vessels divided between metal clips or by the Ultracision Ultrasonic Shears (Ultracision, Smithfield, Rhode Island, USA). A time saving was demonstrated for the Ultrasonic Shears. Swanstrom and Pennings [50] randomized 31 patients in a similar study which also demonstrated a time saving of 10 minutes for the Ultrasonic Shear technique. Neither of these studies enrolled a large group of patients, or attempted to assess outcome differences between different antireflux procedures.

A third study, reported by Laws et al. [51], randomized 39 patients to undergo either a laparoscopic Nissen fundoplication or a laparoscopic Toupet fundoplication. No significant short term outcome differences were demonstrated between the two procedures.

The first of our own studies enrolled 103 patients to undergo either a total fundoplication without division of short gastrics vs a total fundoplication with division of short gastric vessels. At six months there were no significant or indeed appreciable differences between the two operations with regard to dysphagia, recurrent reflux, gas bloat, or patient satisfaction [52]. The second of our studies randomized 105 patients to undergo either a total fundoplication or an anterior fundoplication both without division of short gastric vessels. At six

months significant differences had emerged between the groups with the anterior group having less dysphagia, gas bloat, and a higher patient satisfaction rate [53]. Both of these trials are continuing in order to look at the important question of rates of recurrent reflux.

### Controversies and questions in regard to laparoscopic antireflux surgery

The advent of laparoscopic antireflux surgery has focused debate between protagonists of various antireflux surgical techniques. Whilst the Nissen fundoplication remains the technique advocated by the majority of surgeons, a number of variants such as posterior fundoplication, anterior partial fundoplication, and other techniques have been advocated to reduce the likelihood of post-operative dysphagia and gas bloat. Some surgeons advocate selective use of partial fundoplication variants for patients with esophagus dysmotility. Others advocate routine application of a particular partial fundoplication variant. Surgeons have not reached agreement on these questions which still require randomized studies for their resolution.

Even the incidence of disease induced by fibrotic shortening of the esophagus remains in doubt. Most surgeons report a very low incidence of shortened esophagus during laparoscopic antireflux surgery, with the incidence of conversion to an open procedure of this problem being less than 1% [54]. Although this suggests that the problem is infrequent, the ability of surgeons to determine adequate esophagus length at the time of laparoscopic antireflux surgery has been questioned with the suggestion that the problem is more common than usually appreciated [55, 56]. Because of this Kauer et al. [55] have advocated an open transthoracic approach to perform a Collis gastroplasty in patients with a hiatal hernia length of more than 5 cm. Swanstrom et al. [56] have described a method for the laparoscopic construction of a Collis gastroplasty if the surgeon considers the gastroesophageal junction cannot be brought down beyond the narrowed hiatus.

## Why do antireflux operations sometimes fail

■ **Inappropriate surgery.** If a patient does not have reflux, operation will cure whatever is causing the patient's symptoms. Perhaps the single most common non-reflux disorder, sometimes treated as reflux, is achalasia. In a collective review, the incidence of this occurring was 8% of cases presenting for re-operation [57].

The situation with adynamic (scleroderma) esophagus is not quite so clear cut although in the collective review was seen as the reason for reoperative surgery in 8% of cases also. There is little doubt that the potential for creating a *relatively* tight wrap in a patient with adynamic esophagus is quite high. Nevertheless, authorities are divided as to whether the preoperative demonstration of an adynamic esophagus should preclude the construction of a total wrap. It seems not unreasonable to accept that a very floppy complete wrap as advocated by Siewert [53] should not prove obstructive, although Skinner has stated that a partial fundoplication is preferred in these circumstances [58]. Duranceau et al. have demonstrated that a loose, short fundoplication can be constructed in patients with scleroderma esophagus, but significant acid exposure persisted in 50% of 12 patients [60]. Our own preference when an adynamic esophagus has been demonstrated on manometry is to carry out an anterior fundoplication.

As a general rule, it can be stated that if reflux cannot be demonstrated then antireflux surgery should not be undertaken.

■ **Obstructive problems.** The usual problem is the construction of wrap which is too tight and therefore produces obstruction even to a normally contracting esophagus. As mentioned above, if the esophagus is adynamic, this problem is potentially more likely to occur. Shirazi et al. compared 250 patients who had a short total fundoplication carried out around a 60 Fr bougie with 200 patients who had a long total fundoplication carried out around a bougie of <40 Fr, and found the incidence of dysphagia in the latter group to be approximately double that in the former group [61].

In the collective review about 12% of patients had this indication for their reoperation [57].

Extrinsic obstruction can also occur by three other means. First is when the esophagus hiatus is narrowed too much in the placement of crural sutures, and second is when an Angelchik prosthesis is inserted. Although this device is effective in preventing reflux, it can cause severe dysphagia, leading to a need for early removal of the device in up to 20% of patients [62]. The third mechanism has only been described after laparoscopic fundoplication and consists of an excessive fibrous tissue reaction in the hiatus leading to extrinsic obstruction [40].

## ■ Gastric pullthrough (slipped Nissen)

In the presence of a shortened esophagus and fixed sliding hiatus hernia, it is sometimes difficult to be certain where the stomach finishes and the esophagus begins, when operating from the abdomen, or vice versa, when operating from the chest. Under these circumstances, it is possible that the inexperienced surgeon may mobilize the herniated stomach, believing it to be esophagus and then wrap the more distal stomach around this mobilized stomach – a so called gastric Nissen fundoplication. It is impossible to glean from the literature how often this occurs, as the end result is similar to the gastric pullthrough problem. The gastric pullthrough (slipped Nissen) is a moderately common form of failure reported. It is usually impossible to know if a gastric Nissen was fashioned in the first place, or if the fundoplication has slipped down from around the esophagus to lie around the stomach (which is probably unlikely), or if the longitudinal muscle of the esophagus has pulled the distal stomach through the fundoplication, which, a priori, seems inherently the most likely cause. This problem accounted for 29% of cases undergoing re-operative surgery in the collective review [57].



## ■ Breakdown of the repair

All patients who present with recurrent reflux probably have breakdown of their repair to some degree. Anatomical breakdown of the repair is the most common cause for re-operation (46% in the collective review [57]). The reasons why a repair should break down with time are conjectural. It might be expected that a loose wrap would be less likely to break down than a wrap constructed under some tension. There is no doubt that a floppy Nissen is associated with almost no tension, and a Nissen Rossetti repair (where only the anterior wall of the stomach is used) is often under quite a degree of tension. However, there is no evidence from the literature that the one type of repair is more likely to break down than the other. The fact that many of the repairs seem to break down early in the post-operative course suggests that precipitating factors such as straining coming out of anaesthesia, post-operative vomiting, or just post-operative gastric distension, may play a role. In the longer term it is not difficult to imagine gastric distension with eating chipping away at the repair, a factor which may explain why delayed gastric emptying seems to have a strong association with recurrent reflux [63].

## When do antireflux operations fail?

■ **Open operations.** If an inappropriate operation has been carried out, or if a total wrap has been constructed too tightly, either in relative or absolute terms, or if the hiatus has been made too narrow, or if an Angelchik prosthesis is going to cause problems, then the failure of the surgery should be evident from the outset. The fact that, often, problems only become apparent some months after the surgery probably relates to the fact that many patients will take liquid diets initially and only slowly progress to solid food. It may also relate to the strong placebo effect of a major abdominal operation. However, it is surprising that many repairs break down early after surgery, as mentioned previously, with some even appearing to break down in the immediate post-operative period.

Leonardi et al. found that the mean time to reflux recurrence was 19 months [64], and a similar finding was reported in 29 children [65]. Furthermore, Varron et al. stated that 19 of their 37 patients who came to re-operation developed recurrent reflux within 12 months of their surgery [66]. Collected data from some older series similarly showed that the majority of reflux recurrences occurred within the first 2 years after surgery [67].

■ **Laparoscopic operations.** Most large series of laparoscopic antireflux surgery describe an incidence of adverse outcomes requiring subsequent surgical revision [32, 65]. The incidence varies with the length of post-operative follow-up and the criteria used for reporting. An incidence of 2 to 6% at short term follow-up is usual with many of the reoperations required to correct unique complications of the laparoscopic approach. Early identification of these problems may facilitate early laparoscopic repair. However, later identification, beyond the first post-operative week, often necessitates a more difficult open surgical procedure due to adhesion formation and fibrosis rendering the laparoscopic option in many instances more difficult.

Laparoscopic revision procedures performed more than 3 months after the original fundoplication have also been described [37, 68]. However, these are often technically demanding operations. On the other hand, laparoscopic revision within a few days of the original procedure for complications such as post-operative paraesophagus herniation or early severe dysphagia are technically less demanding, and may not add greatly to the overall morbidity of the laparoscopic approach [33, 37]. To facilitate this, we recommend routine early post-operative barium swallow x-rays to enable early identification of problems and laparoscopic correction.

## Re-operative surgery for failed antireflux procedures

In general terms, the indications for second time around surgery are similar to indications for primary surgery, i.e. intractability of symp-

toms in spite of the best that conservative measures have to offer. However, it must be remembered that operative mortality has to be considered here (unlike with primary surgery). For this reason it seems prudent to resort only when symptoms are making a patient's life miserable.

It is extremely difficult to determine from the literature what proportion of patients with recurrent (or new) symptoms come to re-operative surgery. In O'Hanrahan et al.'s series the number was 7 of 12 patients, with demonstrated recurrent reflux [69]. However, whatever the proportion has been in the past, it is reasonable to expect that, for recurrent reflux at least, the figure will be somewhat less in the future, since the introduction of proton pump inhibitors.

The incidence of patients overall who come to re-operation is also not known for certain, as no series has achieved 100% follow-up of their patients. Nevertheless, the figure is probably of the order of 4–6%.

As the esophagus hiatus can be approached either from the thorax or from the abdomen, theoretically it seems attractive to advocate an approach for reoperative surgery via the previously unoperated route. In practice, however, it seems that surgeons operate through the route with which they are most familiar. Some form of total fundoplication remains the most popular re-operation, but equally a fundoplication constructed around an esophagus extension procedure may need to be performed.

Perhaps somewhat surprisingly, the results of re-do antireflux surgery are not that much different from the primary surgery [57], with the one important exception being operative mortality. Most series of patients having primary antireflux surgery show no or very low mortality rates. Thus, Siewert et al. report a collected series of 1240 patients with a 0.34% mortality rate [70]. However, series of re-do cases show operative mortality rates which vary from 0 to 18%, underlining the fact that this surgery can be technically extremely challenging [57].

The results of surgery worsen with the number of previous operations a patient has undergone for the problem. For example, Little et al. found that 85% of 34 patients who had undergone one previous operation had a good result,

66% of 19 who had undergone two previous operations obtained a good result, and only 42% of 8 patients who had undergone three or more operations had a good result [71].

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