

Guidelines for Surgical Treatment of Gastro esophageal Reflux Disease (GERD)

Introduction

In the field of surgery, present era, GERD has long been noted as a public health concern of immense importance. Heartburn affects nearly two thirds of US adults at different ages in their lives, and touches for 4¹/₂ to 5 million physician office visits every year.

Definition

According to the Montreal consensus GERD was defined as "a condition which develops when the reflux of stomach contents causes troublesome symptoms and/or complications." Symptoms were considered "troublesome" if they adversely affected an individual's well being.

In view of surgery, GERD is the failure of the antireflux barrier, allowing abnormal reflux of gastric contents into the esophagus. It is a mechanical disorder, which is caused by a defective lower esophageal sphincter (LES), a gastric emptying disorder, or failed esophageal peristalsis. These abnormalities result in a spectrum of disease ranging from symptoms only, such as "heartburn", to esophageal tissue damage with or without subsequent complications including malignancy or airway disease. While the exact nature of the antireflux barrier is not completely understood, the current view is that the LES, the diaphragmatic crura, and the phrenoesophageal ligament are key components.

WHO CAN BE AN APPROPRIATE CANDIDATE FOR SURGERY?

When the diagnosis of reflux is objectively confirmed, surgical therapy should be considered in individuals who:

1) Have complications of GERD (e.g., Barrett's esophagus, peptic stricture)

OR

2) Have failed medical management (inadequate symptom control, severe regurgitation not controlled with acid suppression, or medication side effects)

OR

3) have extra-esophageal manifestations (asthma, hoarseness, cough, chest pain, aspiration)

OR

4) opt for surgery despite successful medical management (due to quality of life considerations, lifelong need for medication intake, expense of medications, etc.)

By many a clear indication for antireflux surgery is the coexistence of Barrett's esophagus with gastroesophageal reflux symptoms is considered. Surgical intervention for asymptomatic Barrett's esophagus is more controversial, however. While the metaplastic changes of Barrett's have been reported to regress to a greater degree in the post-surgical population compared with medically treated patients, till today there is no demonstrable improvement in esophageal adenocarcinoma rates.

Diagnosis

Prior to surgery, objective documentation of gastro esophageal reflux is compulsory. Flexible esophagoscopy is an important option. Endoscopic procedure for visualization of any "mucosal break", can be understood as an area of slough or erythema distinctly bifurcated from adjacent normal-appearing mucosa, is considered fundamental proof of GERD in the appropriate clinical setting. This mucosal break is the least endoscopic lesion that is a reliable indicator of reflux esophagitis.

In good setup, acceptable evidence of GERD is a peptic stricture, till malignancy has been ruled out by multiple biopsies. currently also considered objective evidence of GERD is Histological proof of Barrett's esophagus even though other very rare causes of Barrett's esophagus may also exist.

The current gold-standard objective test to diagnose gastro esophageal reflux is the 24-hour ambulatory esophageal pH-metry, in the absence of endoscopic evidence of reflux,. The variables with the highest sensitivity and specificity which are obtained from this test are: the total time with pH < 4 as recorded by a probe placed 5 cm above the LES, and a composite score (comprised of the following six variables: 1. upright acid exposure time, 2. number of reflux episodes lasting more than 5 minutes 3. total esophageal acid exposure time, 4. supine acid exposure time, 5. number of episodes of reflux, and 6. the duration of the longest reflux episode). The 48-hour wireless esophageal pH-monitoring probe (Bravo™, Medtronic, Shoreview, MN) is an alternative diagnostic modality to the 24-hour catheter-based pH-metry is the wonder probe is considered equivalent to the catheter-based system, but no extra benefit has been realized by prolonging the study period to 48 hours.

The available evidence is insufficient to provide firm recommendations on a newer test to objectively document gastroesophageal reflux is multi-channel intraluminal esophageal impedance.

Medical Versus Surgical Treatment

Seven randomized controlled trials with follow-up of these studies ranging from 1 to 10.6 years have compared surgical therapy with medical therapy, For the treatment of GERD till date. These studies strongly support surgery as an effective alternative to medical therapy (level I) both for patients with good symptom control on medical therapy and for those who achieve only partial symptomatic relief from PPIs (level I).

Presenting convincing objective evidence for the effectiveness of surgery for the majority of available studies. Based on pH metry and manometric data, fundoplication results in significantly less acid exposure and significantly increased LES pressure compared with medical therapy (level I-III). The one level I study that failed to demonstrate differences in the duration of acid exposure was underpowered.

To lead to improve or at least comparable quality of life to that of medically treated patients and is associated with high patient satisfaction rates Fundoplication has also been demonstrated (level I-III). If they were not taking acid reducing medications postoperatively, One study reported no difference or worse quality of life of postfundoplication patients (level I).

whereas the majority of the available literature cites a much lower incidence (9% to 21%) up to 8 years after surgery, regarding the use of acid reducing medications postoperatively, one level I evidence study reported it to be up to 62% of postfundoplication patients (level I), (level I-III). Importantly, several studies have demonstrated that most patients who

resume acid reducing medications postoperatively have no objective evidence for GERD recurrence on 24-hour pH studies(level II).

There has been one randomized controlled trial evaluating cost between medical (omeprazole) and surgical therapy (open total and partial fundoplication) over a 5-year period. The study reported that total treatment costs in the medical group were significantly lower than for antireflux surgery in three European countries (Denmark, Norway, and Sweden) and higher in one (Finland) (level I). One modeling study found that the cost equivalency point for medical and surgical therapy was at 10 years, whereas another still reported lower cost with medical therapy at 10 years (level III).

WHAT ARE THE PREPARATION REQUIRED FOR THE SURGERY?

To get outcomes of highest order the aim of preoperative investigations is to select the appropriate reflux patients for surgical treatment. There is currently no liberty and significant variability among surgeons regarding which studies should be obtained before surgery and in what order.

1) EGD: It can confirm the diagnosis of GERD or identify other etiologies of esophagogastric mucosal abnormalities and allows biopsies to be taken as this is the one study that all patients should have preoperatively.

2) pH-metry: Important for patients when the diagnosis of GERD cannot be confirmed on EGD or diagnostic uncertainty exists. A normal 24-hour intraesophageal pH study after an H2-blocker and proton pump inhibitor- (PPI) free interval should strongly suggest an alternate diagnosis and lead to additional diagnostic investigations.

3) Esophageal manometry: Frequently performed before surgery and advocated by many experts in order to identify conditions that might contraindicate fundoplication (such as achalasia) or modify the type of fundoplication according to a tailored approach based on esophageal motility. Nevertheless, there is no support in the literature for mandatory preoperative manometry, and there are numerous studies not accepting the need for a tailored approach to fundoplication.

4) Barium swallow: Frequently obtained test for better delineation of the anatomy. May be particularly valuable in patients with large hiatal hernias who have a shortened esophagus.

Other preoperative tests have been examined, such as gastric emptying studies, but a correlation between their results and postoperative outcomes do not bear no data to support. This test may be important, however, in patients who require reoperation, as it may provide indirect evidence for vagal nerve injury during the original surgery.

Surgical Technique, Learning Curves, and their Influence on Outcome

This approach has been criticized in the literature as the lack of standardization makes outcome comparisons difficult because the choice of technique for antireflux surgery has traditionally been based on anatomic considerations and the surgeon's preference and expertise. Recently, a randomized trial designed to compare medical and surgical therapy managed to standardize the Nissen fundoplication technique across several institutions and surgeons. Based on a consensus of 40 experienced foregut surgeons, the following standardized approach to Nissen fundoplication was followed: a) opening of the phrenoesophageal ligament in a left to right fashion, b) preservation of the hepatic branch of the anterior vagus nerve, c) dissection of both crura, d) transhiatal mobilization to allow approximately 3 cm of intraabdominal esophagus, e) short gastric vessel division to ensure a tension-free wrap, f) crural closure posteriorly with nonabsorbable sutures, g) creation of a 1.5

to 2-cm wrap with the most distal suture incorporating the anterior muscular wall of the esophagus, and h) bougie placement at the time of wrap construction. This standardization led to excellent postoperative outcomes comparable with medical treatment and included a 2% conversion rate, 3% postoperative complication rate, and a median postoperative length of stay of 2 days (level I).

Nevertheless, good results have been reported by young surgeons after appropriate training in laparoscopic surgery (level II-III). The learning curve for laparoscopic antireflux surgery has been well documented in the literature with reports of increased failure rates, complications, reoperations, operative time, hospital days, and conversions to open surgery (level III) by less experienced surgeons. Surgeons seek experienced supervision during their first 15-20 laparoscopic antireflux procedures (level III) to minimize adverse outcomes as a result of the learning curve, studies have suggested that The literature also suggests that reoperative antireflux surgery should be undertaken in high volume tertiary centers by experienced antireflux surgeons citing a decreased conversion rate compared with lower volume centers (level II).

Partial Versus Total Fundoplication

The differences between partial and total funduplications and one randomized controlled trial between two partial funduplications (level I) have been done by undertaking eleven randomized controlled trials and two metaanalyses investigated.

A single perioperative death, for an incidence of 0.07% across all these studies, has been reported. This death was a consequence of esophageal injury resulting in mediastinitis. No differences in perioperative morbidity were found across all published studies by the two published metaanalyses (level I). In addition, no differences in the length of the operative procedure between partial (independent of type) and total fundoplication have been reported, with an average duration across studies of approximately 90 minutes.

Interestingly, no significant differences between the two types of procedures were noted in the incidence of esophagitis, heartburn, persisting acid reflux, in the proportion of patients experiencing a good or excellent long-term outcome, or in the proportion of patients with a Visick I or II score (level I). On the other hand, the notion that the type of fundoplication should be tailored to esophageal motility (level III) has been challenged by several studies. The available evidence suggests that the outcomes of patients with esophageal dysmotility are not affected by the type of fundoplication (level I). Regarding specific postoperative patient outcomes, a significantly higher incidence of postoperative dysphagia, bloating, flatulence, and reoperation rate has been found for total compared with partial fundoplication (level I).

Since there is significant inhomogeneity in the type of partial fundoplication evaluated in the available randomized controlled trials, we also report outcomes in three different categories: anterior versus total, posterior versus total, and anterior versus posterior fundoplication.

Laparoscopic Versus Open Treatment of GERD

Till today 12 randomized controlled trials and two metaanalyses have compared the results of open with laparoscopic fundoplication. All but one of these trials compared open with laparoscopic Nissen fundoplication with some technical variations.

Regarding immediate preoperative results, no study reported any mortality. In the most recent meta analysis, preoperative morbidity was found to be significantly lower (65%) after laparoscopic compared with open fundoplication (level I).

The conversion rate to open surgery varied between 0 and 9.6% with the most recent randomized controlled trial reporting lower conversion rates (<5%). Compared with the open approach (level I) Laparoscopic surgery was associated with longer operative duration (approximately 40 minutes) but also with significant reductions in the hospital stay (2.68 days) and in the return to normal activity (7.75 days)

The two approaches have been demonstrated to have similar postoperative outcomes at the reported follow-up intervals (range 3 to 24 months) including reflux recurrence, dysphagia, bloating, and reoperation rates(level I). Nevertheless, the most recent metaanalysis found a higher requirement for further surgery in the laparoscopic group even though treatment failures between the two techniques were comparable (level I). Interestingly one randomized controlled trial that had shown significantly higher rates of reoperation after laparoscopic Nissen compared with open Nissen in the short term did not find similar differences 5 years later (level I). In another recent randomized controlled trial, the reoperation rate was similar; however, reoperation in the laparoscopic Toupet group was due to continued heartburn, and it was due to incisional hernias in the open Toupet group (level I).

No significant differences in serum cortisol levels indicative of the less invasive nature of the laparoscopic procedure(level I) but randomized studies investigating the immune system demonstrated significantly reduced white blood cells counts and serum C-reactive protein levels after laparoscopic fundoplication.

Anterior versus Nissen fundoplication

Four randomized controlled trials reporting on 457 patients with a follow-up ranging from 6 months to 10 years have been published(level I) that compare the laparoscopic anterior fundoplication with the laparoscopic Nissen fundoplication. Two studies included a 180 degree anterior fundoplication and the other two a 90 degree one. Based on the findings of these trials, the anterior fundoplication was associated with significantly less postoperative dysphagia according to at least one of the evaluated dysphagia parameters compared with the Nissen fundoplication even during long term follow-up (up to 10 years) (level I). On the other hand, the anterior fundoplication was found to be less effective for reflux control (based on patient symptoms and objective tests) as more patients required reoperations for reflux control (level I). Patient satisfaction ratings were similar between the groups in all studies up to 10 years after surgery (level I). Whether there are differences between a 90- and a 180 degree fundoplication is unclear, as no comparative studies exist; however, Engstrom et al have suggested that the 90 degree is inadequate (level I).

Anterior versus Toupet fundoplication

One randomized controlled trial has compared two partial fundoplications, 120 degree anterior and 180 to 200 degree posterior (level I). This study followed 95 patients for 5 years (93% follow-up) and found that posterior fundoplication was superior to the anterior by achieving better reflux control without increased incidence of postoperative dysphagia. In addition, this study demonstrated statistically significantly higher PPI intake, more esophageal acid exposure, higher reoperation rates, and lower patient satisfaction after anterior fundoplication during long-term follow-up and concluded that an anterior repair cannot be recommended for GERD due to insufficient reflux control (level I).

Toupet versus Nissen fundoplication

The majority of published studies have demonstrated lower dysphagia rates after Toupet fundoplication and no difference in heartburn control between the two procedures at follow up

(level I). Nine randomized controlled trials (including both open and laparoscopic techniques) with follow-up of 1 to 5 years have compared the Toupet fundoplication with the Nissen. (level I). In addition, no differences have been demonstrated for any of the other outcome parameters. The Nissen fundoplication length did not influence reflux control, but a trend for a higher dysphagia rate was noted with the 3-cm wrap compared with the 1.5 cm wrap at the 12 month follow up of this study. (level I). Interestingly, a very recent study that compared variable lengths of fundoplication (1.5 cm vs 3 cm) for both procedures demonstrated that the 3-cm Toupet achieved superior reflux control over the 1.5 cm Toupet without differences in postoperative dysphagia. Longer follow-up data are needed to confirm the long-term comparative effectiveness between the Toupet and Nissen fundoplications as the current level I evidence does not go beyond 5 years. This is especially important because retrospective studies suggest inferior long-term reflux control after Toupet (level III).

Technical Factors That May Influence Outcomes

The following technical issues and patient factors may influence the outcome of fundoplication and are discussed separately:

Short gastric vessel division

Five randomized controlled trials have evaluated the impact of short gastric vessel division on outcomes following laparoscopic antireflux surgery. Evidence from these high quality studies suggests no difference in physiologic, symptomatic, and quality of life outcomes up to 10 years after surgery (level I). Furthermore, division of short gastric vessels at the time of fundoplication has been found to increase operating time (level I-II), increase flatus production and epigastric bloating, and decrease the ability to vent air from the stomach (level I). However, it must be mentioned that a previous review based on the data from all but the most recent randomized controlled trial gave a low grade recommendation due to the inconsistency of results and expert opinion in North America advocates for routine division.

Robotic surgery and its use

The use of robotic surgery has been reported to be safe and feasible with similar outcomes during up to 1 year follow-up compared with laparoscopic antireflux surgery (level I-II). Most of the five available randomized controlled trials have reported a significant increase in operating times and cost when the robot is used (level I). Unfortunately, there are no clinical data comparing ergonomics and surgeon workload between these two approaches; however, level I data from simulator studies have shown less surgeon workload with the use of the robot .

Crural closure

There have been no randomized controlled trials comparing closure with no closure of the crura. Individual reports stress the benefits of posterior crural repair for satisfactory outcomes, but others report no difference in outcomes. Several authors have reported selective crural closure based on the size of the hiatal opening, but no clinical comparisons exist. One study recommended division of the short gastric vessels, posterior closure of the crura, and fixation of the wrap to the crus demonstrating significantly decreased incidence of wrap slippage and need for secondary intervention when following this approach (level III). One randomized controlled trial compared the efficacy of anterior with posterior crural repair and reported no difference in the anterior or posterior closure groups in terms of postoperative dysphagia, heartburn, and overall satisfaction at 6 month follow-up. To achieve a similar dysphagia rate, however, more patients in the posterior closure group had to undergo a second surgical procedure (level I).

Other potential technical factors that may reduce the incidence of wrap migration related to crural closure have also been evaluated. The use of prosthetic mesh as a buttress to a posterior crural closure has been reported to significantly decrease intrathoracic wrap migration (level I) with one report recommending tailoring the type of crural closure, suture alone, mesh buttress, or tension free mesh closure, based on the size of the hiatal surface area (level II).

Minimal esophageal dissection techniques have also been proposed and reported as an acceptable method for fundoplication (level II) with reports of decreased wrap transmigration in the pediatric population related to this technique (level III). Nevertheless, expert opinion suggests that, in the case of a short esophagus, a more extensive mediastinal mobilization is needed to increase the segment of intraabdominal esophagus (at least 2 to 3 cm) and thus decrease the chance of herniation (level III).

The morbidly obese patient and Antireflux surgery

There is a clear association between GERD and morbid obesity with the disease being more prevalent as the body mass index (BMI) increases. The long-term effectiveness of fundoplication in obese individuals (BMI >30) has been questioned due to higher failure rates (level II-III) compared with normal weight patients. Nevertheless, others have reported equivalent outcomes in obese and normal weight individuals (level II-III). The laparoscopic Roux-en-Y gastric bypass (LRYGB) is the most effective and advantageous treatment option for GERD in the morbidly obese patient, since it treats GERD effectively and provides the additional benefit of weight loss and improvement in comorbidities and is therefore the procedure of choice by many experts (level II-III). Laparoscopic Roux-en-Y gastric bypass has also been reported to be a feasible and efficacious treatment in morbidly obese patients who have previously undergone laparoscopic antireflux surgery, although it is technically demanding and has a higher morbidity (level III). While adjustable gastric banding may also improve GERD symptoms, conflicting reports exist, and it is therefore not the procedure of choice for this indication .

Esophageal dilators and its use

Level I evidence suggests that the use of an esophageal dilator decreases the long-term incidence of dysphagia. The only available randomized controlled trial reported a significant decrease in the postoperative dysphasia rate at 11 months follow-up in patients who had a 56 French bougie placed at the time of surgery versus patients who did not have a bougie placed, and there was no difference in perioperative morbidity and mortality (level I). There was, however, a 1.2% incidence of esophageal injury due to placement of the bougie (level I).

Success and its Indicator/Predictors

Preoperative patient compliance with antireflux medications

One study examined the predictive value of self-reported preoperative compliance with medical treatment. Patients compliant with their preoperative medical treatment of GERD with PPI showed a statistically significant larger improvement in the postoperative gastrointestinal quality of life index than patients who were non-compliant preoperatively. In addition, non-compliant patients had higher rates of post-fundoplication dysphagia at 1 year follow-up.

Age

No significant affect of age has been found to the outcomes of antireflux surgery. Besides a tendency for longer postoperative hospitalization, patients > 65 years of age can expect an excellent outcome after surgery in at least 90% of cases, similar to younger patients.

Psychological disease and intervention

While major depression has not been shown to influence objective physiologic outcomes of fundoplication, it appears to impact postoperative quality of life. In particular, quality of life scores have been shown to improve postoperatively in depressed patients but to a lesser extent than in healthy subjects. In addition, severe postoperative dysphagia and severe bloating were found to be statistically significantly more common in patients with major depression compared with healthy controls (level II). One study concluded that a 270 degree partial fundoplication had better outcomes in patients with major depression compared with a 360 degree fundoplication due to a lower incidence of postoperative dysphagia and gas bloat syndrome (level II).

Cognitive behavioral therapy in the postoperative period has been shown to improve dysphagia and gastrointestinal symptoms such as flatulence and abdominal pain in patients with a preoperative diagnosis of anxiety (level I).

Postoperative "diaphragmatic stressors"

Sudden increases in intra-abdominal pressure in the early postoperative period are thought to predispose a patient to anatomical failure of fundoplication. One study has suggested that early postoperative gagging, belching, and vomiting (especially when associated with gagging) are predisposing factors for anatomical failure and the need for revision (level III). In addition, hiatal hernias >3 cm at original operation have been reported to be predictors for anatomic failure (level II).

Esophageal function

A normal LES pressure on manometry has not been shown to be associated with increased rates of postoperative dysphagia (level II). Patients with nonspecific spastic esophageal motor disorders (such as nutcracker esophagus, hypertensive LES syndrome) have been reported to be at increased risk for postoperative heartburn, regurgitation, and dysphagia after a 360 degree wrap (level II).

Atypical symptoms

Patients with atypical symptoms of GERD, such as chest pain, asthma, chronic cough, hoarseness, otitis media, atypical loss of dental enamel, idiopathic pulmonary fibrosis, recurrent pneumonia, and chronic bronchitis are known to respond less well to fundoplication compared with patients with typical symptoms (heartburn and regurgitation) (level II). For this reason, several investigators have sought ways to preoperatively predict the success of fundoplication performed for atypical symptoms. Of the factors examined, the best predictors have been found to be good symptom correlation with reflux episodes during combined esophageal multichannel intraluminal impedance and pH monitoring (level II), and a positive Bernstein esophageal acid infusion test (level II).

Patterns of reflux

Patients with upright reflux are thought to have more maladaptive behaviors associated with their reflux, including aerophagia, regurgitation, and dyspepsia compared with patients who experience typical reflux when supine. Nevertheless, with the exception of one study that suggested that patients with upright reflux have an increased rate of gas bloat syndrome postoperatively, the preponderance of evidence suggests that laparoscopic Nissen fundoplication is equally effective regardless of the pattern of reflux (level II).

Response to preoperative PPI

Symptomatic response to preoperative PPI treatment has been shown to be an excellent predictor of symptomatic response to fundoplication. One non-response to PPI is not considered a contraindication to antireflux surgery as studies have demonstrated very good success rates in these patients (level II). However, study found that patients with no response to preoperative PPI administration had lower satisfaction rates after fundoplication compared with patients who had at least a partial response (level II).

Preoperative gastric emptying

It has been suggested that delayed gastric emptying may affect postoperative gastric distension and overall surgical outcomes. However, one large prospective non-randomized trial showed no relationship between gastric emptying and outcome following fundoplication (level II).

Outcomes

Multiple studies have evaluated the short- and long-term outcomes of laparoscopic antireflux surgery with follow-up ranging up to 11 years. Laparoscopic antireflux surgery has proven to be a safe, effective, and durable treatment option for GERD (level I-III).

Response of atypical reflux symptoms to antireflux surgery

Atypical symptom improvement has been reported in 67% to 92% of patients after antireflux surgery (level II-III). Specifically, cough has been shown to significantly improve following laparoscopic antireflux surgery (level II-III) with cure rates of 53% (level II), short-term improvement rates from 69% to 100% (level II), and long-term improvement rates of 71% (level II). Hoarseness (level II-III), sore throat (level II-III), and bronchitis (level III) have also been reported significantly improved following surgery. Improvement has also been reported for pulmonary symptoms (level II-III), aspiration (level III), and wheezing (level II-III) symptoms. While some reports have shown improvement in asthma (level II-III) and laryngitis (level III) following antireflux surgery, others have reported no benefit (level II-III).

Response of typical GERD symptoms to antireflux surgery

Typical symptoms of gastrointestinal reflux disease improve in the majority of patients after surgery during short- (level I-III) and long-term follow-up (>5 years) (level I-III). Nevertheless, symptom control may be waning over time as studies with shorter follow-up periods (3 years) report, in general, better symptom resolution (90%) than studies with longer term follow-up (67% of patients at 7-year follow-up (level I). Improvements have also been demonstrated for patients with Barrett's esophagus, elderly patients, and patients with and without preoperative esophagitis.

Following laparoscopic antireflux surgery, dysphagia has been reported to significantly improve from preoperative values (level II-III). Despite reports of improved dysphagia following surgery, postoperative dysphagia remains a significant problem with reported reoperation rates ranging from 1.8 to 10.8% (level I-III) and endoscopic dilatation rates ranging from 0 to 25% (level I-III). Although perioperative and early postoperative dysphagia have been reported as high as 76% (level II), the majority of studies show early and mid dysphagia rates, up to 1 year postoperatively, less than 20% (level I-III) and long-term rates around 5% to 8% (level I-II).

Likewise, significant improvement in heartburn symptoms have been reported following laparoscopic antireflux surgery (level I-III) with recurrence rates of $\leq 10\%$ in the majority of studies (level II-III). Regurgitation rates have also shown to be significantly improved following surgery with improvement rates of 87% to 97% reported (level I-III). Although recurrent or new onset regurgitation has been reported in up to 23% (level III) of patients following surgery, the majority of studies reported rates ranging from 0 to 11% (level I-III).

Objective outcomes

Functional improvement, including a significant increase in LES pressure (level I-III) and a significant decrease in acid exposure (level I-III) compared with preoperative values are documented in both short- and long-term studies, with pH studies returning to normal in approximately 88% to 94% of patients (level II).

Postoperative complications

Complication rates following antireflux surgery vary related to experience, technique, and degree and intensity of follow-up. Conversion rates to open surgery for laparoscopic antireflux surgery range from 0 to 24% (level I-III); however, most series from high-volume centers report conversion rates $< 2.4\%$ (level I).

Specific intraoperative complications related to laparoscopic antireflux surgery include gastric and esophageal perforation and pneumothorax. The gastric and esophageal perforation rate varies according to technique and experience, with reported ranges from 0 to 4% (level I-III) and several authors reporting 0% in series with at least 50 patients (level I-II). The highest incidence of perforation (4%) has been reported after redo fundoplication (level III). Other authors studying techniques of laparoscopic antireflux surgery, specifically the thoracoscopic Belsey, have reported higher gastric and esophageal perforation rates (6.7% to 9.1%) (level III).

Rates of pneumothorax during laparoscopic antireflux surgery in most series range from 0 to 1.5% (level I-III). Nevertheless, this complication rarely requires intervention as it is usually involves injury of the pleura but not the lung itself. Two series have evaluated the use of the robot and reported rates of 5% in the robot group (level I) and 4% in the laparoscopic group (level I).

The duration of the operation is dependent on the technique used and has been reported to range from 49 to 210 minutes (level I-III). A learning curve has been demonstrated with improved operating times as the number of cases increases (level II-III) and with high-volume centers reporting shorter operating room times (49 to 120 minutes) (level I). Length of stay following laparoscopic antireflux surgery ranges between 1 and 4 days (level I-III). With regard to the effect of the learning curve on outcome, there is a marked paucity of data, with only one study being identified. The authors compared patient outcomes between the early and late experience of a single surgeon and reported that complication rates did not differ between his first 25 cases and a matched control group of 25 cases approximately 7 years later (level II). Nevertheless, during both periods, patients had high rates of dysphagia

(23% vs 21% at 2 years), persistence of heartburn (27% vs 25%), and persistence of regurgitation (8% vs 12%).

Postoperative 30-day mortality has rarely been reported and is usually 0% (level I-III). Complications related to incisions include wound infections, which are reported to range from 0.2% to 3.1% (level II-III) and port-site hernias ranging from 0.17% to 9% (level I-II). Herniation of the wrap and wrap migration vary related to the technique used and the duration of follow-up and have been reported to range from 0.8% to 26% (level I-III). One report demonstrated a significant decrease in the incidence of wrap herniation from 26% to 8% with the use of a mesh buttress at the hiatus (level I). Reoperation rates also vary according to technique, indication, and follow-up and have been reported to range from 0 to 15% (level II-III).

Quality of life and satisfaction with surgery

Satisfaction rates for surgery range from 62% to 97% (level II-III) with long-term satisfaction rates (follow-up >5 years) ranging from 80% to 96% (level II-III). Additionally, 81% to 95% of patients, in both short- and long-term follow-up, stated that they would undergo surgery again (level II-III). Quality of life significantly improved after laparoscopic antireflux surgery in both early and long-term studies as documented from a variety of quality of life surveys including generic and disease-specific quality of life surveys (level II-III).

Postoperative use of acid reducing medications

The resumption of acid reducing medications in patients after antireflux surgery has been reported to range widely (0 to 62%) at both short- and long-term follow-up (level I-III). Long-term medication use has been reported to range from 5.8% to 62% (level I-III) with most studies reporting rates <20% (level II-III). One randomized controlled trial, however, reported a 62% incidence of antacid medication resumption after antireflux surgery, which constitutes a very high rate compared with the rest of the literature.

Barrett's Esophagus and Antireflux Surgery

Definition and demographic

Barrett's esophagus is defined as a metaplastic change in which the squamous epithelium of the esophagus is replaced by a columnar epithelium containing goblet cells (intestinal metaplasia or IM). This metaplastic process is believed to be initiated by inflammation and injury induced by chronically refluxed acid and bile. Barrett's esophagus is present in 1.65% of the general population, 8.6% of symptomatic GERD patients presenting to a tertiary care center, and 10.8% of patients undergoing antireflux surgery. Barrett's esophagus (neoplasia not present) is associated with a significantly increased risk for developing esophageal adenocarcinoma (approximately 100 fold) over that of the general population. As intraepithelial neoplasia develops, the annual per patient risk for cancer increases further.

Histological assessment of Barrett's

The histological features of biopsy specimens from a Barrett's esophagus are graded according to the presence or absence of neoplasia; 1) no neoplasia (also known as non-neoplastic IM), 2) indefinite for neoplasia (IND), 3) low-grade intraepithelial neoplasia (LGIN), 4) high-grade intraepithelial neoplasia (HGIN), and intramucosal carcinoma (IMC). Standard, endoscopically-acquired biopsy specimens may not penetrate deeply enough into the esophageal wall to rule out involvement of the submucosa by cancer, therefore EMR or EUS may be indicated in cases suspicious for advanced neoplasia (level II). A finding of neoplasia

prompts review by more than one expert pathologist to confirm the diagnosis and grade, given the interobserver variability reported for Barrett's neoplasia (level I).

Preoperative endoscopy

Upper endoscopy should be performed as part of the preoperative work-up for antireflux surgery, as erosive esophagitis and Barrett's esophagus are independent objective diagnostic criteria for GERD. A diagnosis of Barrett's esophagus, depending on histological grade, may alter patient eligibility for and timing of antireflux surgery. When a columnar-lined esophagus is detected for the first time at preoperative endoscopy, four-quadrant biopsies are obtained from every 1-2 cm of the affected portion of the esophagus to confirm Barrett's and determine its histological grade. Endoscopic mucosal resection (EMR) may be used to remove eligible areas of nodularity or ulceration to rule out advanced neoplasia warranting immediate intervention (level II). If a patient has been diagnosed with Barrett's before preoperative endoscopy, expert review of the prior pathology or repeat biopsy may be considered to confirm the histological grade before antireflux surgery (level III).

Impact of histology findings on antireflux surgery candidacy and timing of surgery

A finding of HGIN or adenocarcinoma on preoperative biopsy requires immediate attention and may delay (in the case of HGIN and IMC) or exclude (in the case of adenocarcinoma with submucosal invasion or deeper) antireflux surgery. Additional work-up for HGIN or adenocarcinoma may include chest CT, EUS and/or staging EMR (if visible lesion exists that is amenable to resection) (level II).

Adenocarcinoma involving the submucosa (or deeper) is managed with esophagectomy, radiation therapy, and/or chemotherapy, as indicated by tumor stage.

HGIN and IMC have been historically managed with esophagectomy, although more recently certain endoscopic techniques (photodynamic therapy (PDT), EMR, and radiofrequency ablation (RFA)), alone and in combination, have been shown in randomized trials (as well as cohort trials and case series) to be safe and effective for complete histological eradication of the targeted lesion and for reducing the risk of neoplastic progression (level I). Endoscopic techniques have become first-line therapy for HGIN and IMC at most centers (level III). If endoscopic therapy is elected, antireflux surgery may be delayed until complete eradication of the Barrett's segment and accompanying neoplasia is achieved (level III).

Non-neoplastic IM, IND or LGIN may be effectively treated with endoscopic eradication followed by long-term surveillance endoscopy (level I and II) or surveillance endoscopy alone (Level III). If surveillance alone is elected, antireflux surgery may be performed immediately. If endoscopic eradication is elected, antireflux surgery may be performed before, during or after ablative therapy (level III). Of the ablation modalities available, RFA has been shown to achieve high rates of complete histological eradication of IM, IND, and LGIN with an acceptable adverse event profile (level I). Further, cost-utility studies show that ablative therapy is the preferred strategy over surveillance alone (all grades) and esophagectomy (HGIN).

Antireflux surgery for Barrett's esophagus

The goals of treatment for patients with Barrett's esophagus are similar to those of patients with gastroesophageal reflux disease patients and include relief of symptoms and cessation of ongoing epithelial damage related to reflux.

Despite numerous publications on the role of antireflux surgery in Barrett's esophagus, there are few randomized controlled trials. In a recent review evaluating the randomized trials in the

treatment of Barrett's done by Faybush and Sampliner in 2005, only one randomized trial compared medical and surgical therapy. This study, by Parilla et al, compared the results of Histamine 2 receptor antagonist (H2RA) and proton pump inhibitors (PPIs) versus open Nissen fundoplication with the outcome measure being preventing Barrett's esophagus to progressing to dysplasia and adenocarcinoma. With a median follow-up of 5 years, they reported that the Barrett's esophagus segment did not change during the treatment period with high grade dysplasia developing in 2 patients in each arm and no significant differences between the two groups in terms of progression to dysplasia or malignancy. They concluded that surgery cannot be advocated as the treatment of choice in patients with Barrett's esophagus and that PPI alone doesn't eliminate the risk of dysplasia or adenocarcinoma (level I).

Since 2005, there have been other published studies evaluating surgical and medical treatment for Barrett's esophagus. A non-randomized prospective study by Rossi et al. compared high dose PPIs versus laparoscopic Nissen fundoplication in patient with low-grade dysplasia and reported a significantly improved regression of Barrett's esophagus in the surgical group (level II).

Recently, a randomized prospective trial comparing treatment outcomes in patients with and without Barrett's esophagus submitted to laparoscopic antireflux surgery or PPI therapy reported clinical response to therapy at 3 years was similar in the Barrett's esophagus compared with the non- Barrett's esophagus group. They also reported similar symptom outcomes (Gastrointestinal Symptom Rating Scale and Quality of Life in Reflux and Dyspepsia) in the medical versus surgical treatment arms but reported improved control of reflux using pH data (level I).

Surveillance of Barrett's esophagus after antireflux surgery

Medical professional society guidelines recommend surveillance endoscopy with four-quadrant biopsies to detect neoplastic progression every 3 years for non-neoplastic IM, every 6-12 months for LGIN, and every 3 months for HGIN. In patients who have had successful complete eradication of Barrett's esophagus, surveillance should continue according to their baseline Barrett's histology grade until further evidence is available. Antireflux surgery does not change these recommended surveillance guidelines. Further, there is no evidence indicating that surveillance is more difficult or less effective after antireflux surgery.