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Guidelines for Surgical Treatment of Gastroesophageal Reflux Disease

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Preamble

The guidelines for the surgical treatment of gastroesophageal reflux disease (GERD) are a series of systematically developed statements to assist physicians and patient decisions about the appropriate use of laparoscopic surgery for GERD. The statements included in this guideline are the product of a systematic review of published literature on the topic, and the recommendations are explicitly linked to the supporting evidence. The strengths and weaknesses of the available evidence are highlighted and expert opinion sought where the evidence is lacking. This is an update of previous guidelines on this topic (last revision 06/2001) as new information has accumulated.

Disclaimer

Clinical practice guidelines are intended to indicate the best available approach to medical conditions as established by a systematic review of available data and expert opinion. The approach suggested may not necessarily be the only acceptable approach given the complexity of the healthcare environment. These guidelines are intended to be flexible, as the surgeon must always choose the approach best suited to the patient and to the variables at the moment of decision. These guidelines are applicable to all physicians who are appropriately credentialed regardless of specialty and address the clinical situation in question.

These guidelines are developed under the auspices of SAGES, the guidelines committee and approved by the Board of Governors. The recommendations of each guideline undergo multidisciplinary review and are considered valid at the time of production based on the data available. New developments in medical research and practice pertinent to each guideline are reviewed, and guidelines will be periodically updated.

Literature Review Method

A large body of literature on the surgical treatment of GERD exists. A systematic literature search was performed on MEDLINE in March 2008. The search strategy was limited to adult English language articles and is shown in **Figure 1**.

We identified 448 relevant articles. The abstracts were reviewed by four committee members (DS, WH, PR, GK) and divided into the following categories:

a) Randomized studies, metaanalyses, and systematic reviews
b) Prospective studies
c) Retrospective studies
d) Case reports
e) Review articles

Randomized controlled trials, metaanalyses, and systematic reviews were selected for further review along with prospective and retrospective studies that included at least 50 patients. Studies with smaller samples were considered when additional evidence was lacking. The most recent reviews were also included. All case reports, older reviews, and smaller studies were excluded. According to these exclusion criteria, 227 articles were reviewed. Whenever the available evidence from Level I studies was considered to be adequate, lower evidence level studies were not considered. A review of the available evidence on endoluminal treatment of GERD has recently been published by SAGES in April 2009.

The reviewers graded the level of evidence and manually searched the bibliography of each article for additional articles that may have been missed during the original search. The additional relevant articles (n=66) found were also included in the review. A total of 293 graded articles relevant to this guideline were reviewed. To facilitate review by multiple reviewers, these articles were divided into the following topics:

a. Fundoplication versus medical treatment
b. Laparoscopic versus open fundoplication
c. Partial versus full fundoplication or partial versus partial
d. Other technique
e. Revisions
f. Outcome
g. Predictors of success
h. Other articles

The recommendations included in this guideline were devised based on the reviewers' grading of all articles.

Levels of Evidence

Level I	Evidence from properly conducted randomized, controlled trials

Level I	Evidence from properly conducted randomized, controlled trials
	Evidence from controlled trials without randomization
Level II	Cohort or case-control studies Multiple time series dramatic uncontrolled experiments
Level III	Descriptive case series, opinions of expert panels

Limitations of the Available Literature

Despite the availability of several randomized controlled trials and metaanalyses, most available studies are either prospective or retrospective reports. Several limitations exist in the examined literature. First, the general methodological quality of the available trials is low due to small patient numbers, inadequate trial design or methodology, lack of standardization, and lack of objective outcome assessment [1]. Only a few studies report a power analysis and define a main outcome variable. Thus, the validity of several of the pooled analyses of the available metaanalyses is hampered by statistically significant heterogeneity related to small sample sizes. In addition, the reporting of outcomes varies significantly as does the follow-up period making it difficult to combine and compare such data. Furthermore, there are several differences in the surgical technique used that may directly impact the outcomes of interest and introduce bias into the reported outcomes. Finally, the majority of the studies do not report details on the expertise of their surgeons, and most have been conducted in single institutions making the generalization of their findings difficult.

Introduction

GERD has long been recognized as a significant public health concern. Heartburn afflicts nearly two thirds of US adults at some point in their lives[2], and accounts for 4 to 5 million physician office visits every year [3]. This document outlines the indications for and surgical treatment of GERD. This document is not intended to debate the issues of medical or endoscopic management of GERD, which are well described in prior publications [4, 5].

Definition

GERD was defined according to the Montreal consensus as â€œa condition which develops when the reflux of stomach contents causes troublesome symptoms and/or complications.â€• Symptoms were considered â€œtroublesomeâ€• if they adversely affected an individual's well being [5].

From a surgical perspective, GERD is the failure of the antireflux barrier, allowing abnormal reflux of gastric contents into the esophagus [6]. 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 incompletely understood, the current view is that the LES, the diaphragmatic crura, and the phrenoesophageal ligament are key components [7, 8].

Diagnosis

Before considering surgery, objective documentation of gastroesophageal reflux is mandatory. This can often be achieved by flexible esophagoscopy. Endoscopic visualization of any â€œmucosal breakâ€•, defined as an area of slough or erythema clearly demarcated from adjacent normal appearing mucosa [9], is considered objective proof of GERD in the appropriate clinical setting. This mucosal break is the minimum endoscopic lesion that is a reliable indicator of reflux esophagitis [10].

In an appropriate setting, a peptic stricture is also acceptable evidence of GERD [11], as long as malignancy has been ruled out by multiple biopsies. Histological proof of Barrett's esophagus is currently also considered objective evidence of GERD even though other very rare causes of Barrett's esophagus may also exist [12, 13].

In the absence of endoscopic evidence of reflux, the current gold-standard objective test to diagnose gastroesophageal reflux is the 24-hour ambulatory esophageal pH-metry. 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. total esophageal acid exposure time, 2. upright acid exposure time, 3. supine acid exposure time, 4. number of episodes of reflux, 5. number of reflux episodes lasting more than 5 minutes and 6. the duration of the longest reflux episode) [14]. An alternative diagnostic modality to the 24-hour catheter-based pH-metry is the 48-hour wireless esophageal pH-monitoring probe (Bravoâ"¢, Medtronic, Shoreview, MN). The Bravo probe is considered equivalent to the catheter-based system, but no additional benefit has been realized by prolonging the study period to 48 hours [15, 16].

Recommendation

Based on the available evidence, the diagnosis of GERD can be confirmed if at least one of the following conditions exists: a mucosal break seen on endoscopy in a patient with typical symptoms, Barrett's esophagus on biopsy, a peptic stricture in the absence of malignancy, or positive pHâ€"metry (Grade A).

A newer test to objectively document gastroesophageal reflux is multichannel intraluminal esophageal impedance but the available evidence is insufficient to provide firm recommendations [17].

Indications for Surgery

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

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

OR

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

OR

3) have complications of GERD (e.g., Barrett's esophagus, peptic stricture) [18, 19]

OR

4) have extra-esophageal manifestations (asthma, hoarseness, cough, chest pain, aspiration) [20-23].

The coexistence of Barrett's esophagus with gastroesophageal reflux symptoms is considered by many a clear indication for antireflux surgery [24]. 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, to date there is no demonstrable improvement in esophageal adenocarcinoma rates [25, 26].

Preoperative Workup

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

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

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 [27-29], and there are numerous studies refuting 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 [30], but there are no data to support a correlation between their results and postoperative outcomes. 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.

Medical Versus Surgical Treatment

To date, 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 [31-37]. These studies strongly support surgery as an effective alternative to medical therapy [32-37] (level I) both for patients with good symptom control on medical therapy [32-37] and for those who achieve only partial symptomatic relief from PPIs [34] (level I).

The majority of available studies also provide convincing objective evidence for the effectiveness of surgery. Based on pH metry and manometric data, fundoplication results in significantly less acid exposure and significantly increased LES pressure compared with medical therapy [32, 33, 38-40] (level I-III). The one level I study that failed to demonstrate differences in the duration of acid exposure was underpowered [31].

Fundoplication has also been demonstrated to lead to improved or at least comparable quality of life to that of medically treated patients and is associated with high patient satisfaction rates [32, 33, 35, 36, 39] (level I-III). One study reported no difference or worse quality of life of postfundoplication patients if they were not taking acid reducing medications postoperatively [31] (level I).

Regarding the use of acid reducing medications postoperatively, one level I evidence study reported it to be up to 62% of postfundoplication patients [31] (level I), whereas the majority of the available literature cites a much lower incidence (9% to 21%) up to 8 years after surgery [34, 41-45] (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 [46, 47] (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 [48]. 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) [48] (level I). One modeling study found that the cost equivalency point for medical and surgical therapy was at 10 years [49], whereas another still reported lower cost with medical therapy at 10 years [50] (level III).

Recommendation

Surgical therapy for GERD is an equally effective alternative to medical therapy and should be offered to appropriately selected patients by appropriately skilled surgeons (Grade A). Surgical therapy effectively addresses the mechanical issues associated with the disease and results in long-term patient satisfaction (Grade A). For surgery to compete with medical treatment, it has to be associated with minimal morbidity and cost.

Surgical Technique, Learning Curves, and their Influence on Outcome

While the choice of technique for antireflux surgery has traditionally been based on anatomic considerations and the surgeon's preference and expertise, this approach has been criticized in the literature as the lack of standardization makes outcome comparisons difficult. Recently, a randomized trial designed to compare medical and surgical therapy managed to standardize the Nissen fundoplication technique across several institutions and surgeons [51]. 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 [51]. 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 [51] (level I).

The learning curve for laparoscopic antireflux surgery has been well documented in the literature with reports of increased failure rates [52], complications [53], reoperations [53], operative time [54], hospital days [54], and conversions to open surgery [53, 54] (level III) by less experienced surgeons. To minimize adverse outcomes as a result of the learning curve, studies have suggested that surgeons seek experienced supervision during their first 15-20 laparoscopic antireflux procedures [53] (level III). Nevertheless, good results have been reported by young surgeons after appropriate training in laparoscopic surgery [55, 56] (level II-III). 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 [57] (level II).

Recommendation

The standardization of antireflux surgery technique is highly desirable, as it has been shown to lead to good postoperative patient outcomes (Grade A). Like any other surgical procedure, laparoscopic antireflux surgery is subject to a learning curve, which may impact patient outcomes. Therefore, surgeons with little experience in advanced laparoscopic techniques and fundoplication in particular should have expert supervision during their early experience with the procedure to minimize morbidity and improve patient outcomes (Grade B). On the other hand, reoperative antireflux surgery should be performed in a high-volume center by an experienced foregut surgeon (Grade B).

Laparoscopic Versus Open Treatment of GERD

To date 12 randomized controlled trials and two metaanalyses have compared the results of open with laparoscopic fundoplication [58-78]. All but one of these trials compared open with laparoscopic Nissen

fundoplication with some technical variations.

Regarding immediate perioperative results, no study reported any mortality. In the most recent metaanalysis, perioperative morbidity was found to be significantly lower (65%) after laparoscopic compared with open fundoplication [75] (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%). 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) compared with the open approach [75] (level I).

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 [59] (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 [75] (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 [58] did not find similar differences 5 years later [62] (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 [64] (level I).

Randomized studies investigating the immune system demonstrated significantly reduced white blood cells counts and serum C-reactive protein levels after laparoscopic fundoplication but no significant differences in serum cortisol levels indicative of the less invasive nature of the laparoscopic procedure [70, 74, 79, 80] (level I).

Recommendation

Based on the available evidence that is of high quality (level I), laparoscopic fundoplication should be preferred over its open alternative as it is associated with superior early outcomes (shorter hospital stay and return to normal activities, and fewer complications) and no significant differences in late outcomes (failure rates) (Grade A). Nevertheless, antireflux surgeons should be aware that laparoscopic fundoplication takes longer to perform and has a higher incidence of reoperations at least in the short term (Grade A). Further study is needed to identify ways to minimize the incidence of reoperations after laparoscopic fundoplication.

Partial Versus Total Fundoplication

Eleven randomized controlled trials and two metaanalyses have investigated the differences between partial and total fundoplications and one randomized controlled trial between two partial fundoplications [1, 27, 59, 76, 81-94] (level I).

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 [1, 59] (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.

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 [1] (level I).

On the other hand, 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 [1] (level I). Interestingly, the notion that the type of fundoplication should be tailored to esophageal motility [95, 96] (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 [94, 97] (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.

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 [81, 88, 90, 98-100] (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) [98] (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 [90] (level I). Patient satisfaction ratings were similar between the groups in all studies up to 10 years after surgery [98] (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 [101] (level I).

Toupet versus Nissen fundoplication

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. [27, 82, 83, 85, 86, 91-94, 97, 102, 103] (level I). 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). In addition, no differences have been demonstrated for any of the other outcome parameters. 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. 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. [102] (level I). 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 [104, 105] (level III).

Anterior versus Toupet fundoplication

One randomized controlled trial has compared two partial fundoplications, 120 degree anterior and 180 to 200 degree posterior [101, 106] (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 [101] (level I).

Recommendation

Based on the available evidence that is of high quality (level I), partial fundoplication is associated with less postoperative dysphagia, fewer reoperations, and similar patient satisfaction and effectiveness in controlling GERD compared with total fundoplication up to five years after surgery (Grade A). Furthermore, a tailored approach to esophageal motility appears unwarranted (Grade B). Nevertheless, the paucity of long-term follow-up data that compare the effectiveness of the procedures makes it hard to recommend one type of fundoplication over the other especially in an era where the long-term effectiveness of surgical treatment for GERD is questioned. It should also be noted that a body of literature suggests that anterior partial fundoplication may be less effective in the long term (Grade B) and retrospective data suggests that partial fundoplication may not be as effective as total in the long run (Grade C). Nonetheless, the evidence suggests that surgeons appropriately trained in minimally invasive techniques that perform surgery for GERD may minimize postoperative dysphagia by choosing a partial fundoplication (Grade A) or a short total fundoplication (1 to 2 cm) over a large bougie (56 French) (Grade C) and maximize the effectiveness of the procedure by choosing a a total fundoplication (Grade C) or a longer (at least 3 cm) posterior fundoplication (Grade C). It should also be noted that there are regional differences in expert opinion and practice in the choice of fundoplication type for GERD with most North American experts choosing a total fundoplication due to concerns for the long term effectiveness of the procedure. Controlled studies that take into account these guidelines are needed.

Other Technical Aspects 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 [107-111] (level I). Furthermore, division of short gastric vessels at the time of fundoplication has been found to increase operating time [107, 110-112] (level I-II), increase flatus production and epigastric bloating, and decrease the ability to vent air from the stomach [108, 109, 111] (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 [113] and expert opinion in North America advocates for routine division.

Recommendations

When the fundus can be wrapped around the esophagus without significant tension, no division of the short gastrics seems necessary (Grade A). Division should be undertaken when a tension-free fundopliaction cannot be accomplished (Grade B). It should also be noted that expert opinion in North America advocates for the routine division of the short gastric vessels to minimize tension (grade C).

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 [114-116], but others report no difference in outcomes [27, 110, 117-119]. Several authors have reported selective crural closure based on the size of the hiatal opening, but no clinical comparisons exist [38, 40, 43, 45, 120-125]. 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 [116] (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 [119] (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 [126] (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 [127] (level II).

Minimal esophageal dissection techniques have also been proposed and reported as an acceptable method for fundoplication [123] (level II) with reports of decreased wrap transmigration in the pediatric population related to this technique [128] (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).

Recommendations

Crural closure should be strongly considered during fundoplication when the hiatal opening is large and mesh reinforcement may be beneficial in decreasing the incidence of wrap herniation (Grade B). Anterior crural closure may be associated with less postoperative dysphagia, but additional evidence is needed to provide a firm recommendation (Grade C).

Use of robotic surgery

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 [125, 129-133] (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 [125, 132, 133] (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 [134].

Recommendation

While robotic assistance can be safely and effectively used for fundoplication, its higher cost compared with conventional laparoscopy and similar short-term patient outcomes make it a less than ideal initial choice (Grade

B). Nevertheless, further study regarding learning curves and surgeon workload with the robotic technique are needed before stronger recommendations can be made.

Antireflux surgery in the morbidly obese patient

There is a clear association between GERD and morbid obesity with the disease being more prevalent as the body mass index (BMI) increases [135-142]. The long-term effectiveness of fundoplication in obese individuals (BMI >30) has been questioned due to higher failure rates [143, 144] (level II-III) compared with normal weight patients. Nevertheless, others have reported equivalent outcomes in obese and normal weight individuals [145-148] (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 [149, 150], 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 [151-156] (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 [157] (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 [137, 158-161].

Recommendation

Due to concerns for higher failure rates after fundoplication in the morbidly obese patient (BMI >35 kg/m2) and the inability of fundoplication to address the underlying problem (obesity) and its associated comorbidities, gastric bypass should be the procedure of choice when treating GERD in this patient group (Grade B). The benefits in patients with BMI>30 is less clear and needs further study.

Use of esophageal dilators

Level I evidence suggests that the use of an esophageal dilator decreases the long-term incidence of dysphagia [162]. 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 [162] (level I). There was, however, a 1.2% incidence of esophageal injury due to placement of the bougie [162] (level I).

Recommendation

The placement of an esophageal dilator during the creation of laparoscopic fundoplication is advisable as it leads to decreased postoperative dysphagia but should be weighed against a small risk of esophageal injury (Grade B). A 56 French bougie has been found to be effective but the evidence is limited (Grade C).

Predictors of Success

Preoperative patient compliance with antireflux medications [163]

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

Age has not been found to significantly affect 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 [164].

Postoperative â€œdiaphragmatic stressorsâ€•

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 [165] (level III). In addition, hiatal hernias >3 cm at original operation have been reported to be predictors for anatomic failure (level II).

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 [166] (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 [166] (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 [167] (level I).

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 [168] are known to respond less well to fundoplication compared with patients with typical symptoms (heartburn and regurgitation) [169] (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 [170] (level II), and a positive Bernstein esophageal acid infusion test [171] (level II).

Esophageal function

A normal LES pressure on manometry has not been shown to be associated with increased rates of postoperative dysphagia [172, 173] (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 [174] (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 [175]. Nevertheless, with the exception of one study that suggested that patients with upright reflux have an increased rate of gas bloat syndrome postoperatively [176], the preponderance of evidence suggests that laparoscopic Nissen fundoplication is equally effective regardless of the pattern of reflux [30, 175] (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 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 [143] (level II). However, non-response to PPI is not considered a contraindication to antireflux surgery [177] as studies have demonstrated very good success rates in these patients (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 [30] (level II).

Recommendations

1. Surgeons should be aware that fundoplication in patients demonstrating poor compliance with PPI therapy preoperatively or with poor response to preoperative PPI treatment is associated with poorer outcomes (Grade C).

2. Age should not be considered a contraindication for antireflux surgery in otherwise acceptable operative candidates, as outcomes in this patient group are similar to outcomes of younger patients (Grade C).

3. Care should be taken to minimize early postoperative severe gagging, belching, and vomiting as weak evidence suggests that they may lead to anatomical failure of fundoplication (Grade C).

4. A partial wrap should be considered in patients with a preoperative diagnosis of major depression, as it may lead to better postfundoplication outcomes in this patient group that tends to have generally inferior outcomes (Grade C).

Revisional Surgery for Failed Antireflux Procedures

Most authors recommend the same surgical approach for the reoperative patient as for the primary procedure [2, 178-181] (level III). Multiple retrospective studies have evaluated the short- and long-term outcomes of revisional laparoscopic antireflux surgery with up to 12 years follow-up. Compared with primary repair, revisional surgery requires longer operative times and is associated with higher conversion rates to open surgery [179, 182] (level III), and higher complication rates (30 day mortality <1%, esophagogastric perforations in 11 to 25% [179, 183], gastric more often than esophageal perforation [180], pneumothorax in 7% to 18% [180, 184], splenic injuries in 2% [185], and vagal nerve injuries in 7%) [179, 180]. Nevertheless, postoperative dysphagia (3% to 17%) [179, 184-187] and gas bloat syndrome (5% to 34%) do not seem to be significantly higher after reoperation compared with primary repair. Patient satisfaction after reoperative laparoscopic antireflux surgery has been reported to be high (89%) [185] with resolution of heartburn symptoms in 68% to 89% of patients [186] and resolution of regurgitation in 83% to 88% [2, 181, 185] up to 18 months after revisional surgery. Nevertheless, up to 13% of patients may experience reflux recurrence at 3 months follow-up based on objective testing [187].

Recommendations

Laparoscopic reoperative antireflux surgery is feasible, safe, and effective but has higher complication rates compared with primary repair and should be undertaken only by experienced surgeons using a similar approach to primary fundoplication (Grade B).

Outcomes

Laparoscopic antireflux surgery has proven to be a safe, effective, and durable treatment option for GERD (level I-III). Multiple studies have evaluated the short- and long-term outcomes of laparoscopic antireflux surgery with follow-up ranging up to 11 years [143, 188].

Response of typical GERD symptoms to antireflux surgery

Typical symptoms of gastrointestinal reflux disease improve in the majority of patients after surgery during short- [32, 36, 39, 42, 189-198] (level I-III) and long-term follow-up (>5 years) [31, 36, 37, 41, 42, 44, 47, 107, 109, 188, 199] (level I-III). Nevertheless, symptom control may be waning over time as studies [36] 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 [31, 37] (level I). Improvements have also been demonstrated for patients with Barrett's esophagus [200], elderly patients [195], and patients with and without preoperative esophagitis [201].

Following laparoscopic antireflux surgery, dysphagia has been reported to significantly improve from preoperative values [47, 188, 197, 198, 200-204] (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% [33, 34, 38, 39, 143, 196, 205-207] (level I-III) and endoscopic dilatation rates ranging from 0 to 25% [34, 121, 143, 145, 189, 195, 196, 208-213] (level I-III). Although perioperative and early postoperative dysphagia have been reported as high as 76% [191] (level II), the majority of studies show early and mid dysphagia rates, up to 1 year postoperatively, less than 20% [33, 34, 38, 39, 44, 47, 120, 122, 189, 191, 192, 195, 196, 199, 200, 209, 210, 212, 214-221] (level I-III) and long-term rates around 5% to 8% [45, 109, 207, 222] (level I-II).

Likewise, significant improvement in heartburn symptoms have been reported following laparoscopic antireflux surgery [47, 109, 110, 143, 188, 190, 193, 197, 198, 200-204, 209, 215, 221, 223, 224] (level I-III) with recurrence rates of d10% in the majority of studies [41, 47, 120, 143, 190, 196, 199, 203, 213, 215-217, 221, 225, 226] (level II-III). Regurgitation rates have also shown to be significantly improved following surgery with improvement rates of 87% to 97% reported [109, 143, 188, 190, 195, 198, 202, 203, 227] (level I-III). Although recurrent or new onset regurgitation has been reported in up to 23% [43] (level III) of patients following surgery, the majority of studies reported rates ranging from 0 to 11% [107, 109, 110, 143, 193, 196, 200, 201, 214-216, 221] (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 [190, 193, 196, 209] (level II-III). Specifically, cough has been shown to significantly improve following laparoscopic antireflux surgery [20, 190, 193, 221, 223, 226] (level II-III) with cure rates of 53% [226] (level II), short-term improvement rates from 69% to100% [20, 221, 223, 226] (level II), and long-term improvement rates of 71% [223] (level II). Hoarseness [190, 193, 202, 221] (level II-III), sore throat [190, 193] (level II-III), and bronchitis [193, 202] (level III) have also been reported significantly improved following surgery. Improvement has also been reported for pulmonary symptoms [143, 196] (level II-III), aspiration [202, 206] (level III), and wheezing [190, 206] (level II-III) symptoms. While some reports have shown improvement in asthma [20, 193] (level II-III) and laryngitis [193] (level III) following antireflux surgery, others have reported no benefit [143, 202, 221] (level II-III).

Objective outcomes

Functional improvement, including a significant increase in LES pressure [32, 33, 38, 47, 122, 146, 198, 199, 215, 221, 223, 224, 226, 228-230] (level I-III) and a significant decrease in acid exposure [32-34, 38, 47, 120, 145, 146, 190, 198, 199, 203, 221, 223-225, 228-232] (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 [112] (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% [32-34, 39, 41, 43-45, 47, 59, 112, 120-125, 129-132, 145, 146, 157, 188, 195, 196, 198-200, 203, 204, 206, 208, 210, 212, 215, 219-222, 225-227, 229, 230, 232-241] (level I-III); however, most series from high-volume centers report conversion rates <2.4% [32-34, 39] (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% [33, 34, 38, 44, 45, 47, 112, 120, 123-125, 146, 188, 196, 201, 214, 227, 236, 241, 242] (level I-III) and several authors reporting 0% in series with at least 50 patients [38, 47, 112, 124, 125, 146, 227] (level I-II). The highest incidence of perforation (4%) has been reported after redo fundoplication [241] (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%) [237, 243] (level III).

Rates of pneumothorax during laparoscopic antireflux surgery in most series range from 0 to 1.5% [34, 38, 47, 112, 120, 124, 188, 195, 199, 214, 227, 228, 236, 241] (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 [130] (level I) and 4% in the laparoscopic group [131] (level I).

The duration of the operation is dependent on the technique used and has been reported to range from 49 to 210 minutes [43-45, 47, 120-122, 145, 146, 195-198, 200, 201, 203, 206, 208, 215, 219-221, 225, 226, 230, 241] (level I-III). A learning curve has been demonstrated with improved operating times as the number of cases increases [219, 220] (level II-III) and with high-volume centers reporting shorter operating room times (49 to 120 minutes) [33, 34, 38, 107, 110, 119, 124, 125, 130-133, 233] (level I). Length of stay following laparoscopic antireflux surgery ranges between 1 and 4 days [20, 33, 34, 38, 44, 47, 59, 120, 121, 123, 129, 145, 146, 188, 192, 195, 197, 198, 200, 202, 203, 206, 208-210, 214, 215, 220, 221, 225, 241] (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%) [56].

Postoperative 30-day mortality has rarely been reported and is usually 0% [33, 34, 188, 190, 196, 204, 209] (level I-III). Complications related to incisions include wound infections, which are reported to range from 0.2% to 3.1% [38, 45, 188, 195, 199] (level II-III) and port-site hernias ranging from 0.17% to 9% [38, 109, 121, 122, 199, 204] (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% [32-34, 38, 44, 47, 132, 196, 199, 227, 233] (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 [227] (level I). Reoperation rates also vary according to technique, indication, and follow-up and have been reported to range from 0 to 15% [32, 33, 39, 41, 43, 45, 47, 107, 109, 110, 112, 119, 121, 123, 145, 157, 188, 195, 196, 200, 201, 204, 214, 234, 241, 242] (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 [34, 107, 109, 123, 124, 130, 131, 234, 242 31, 41-45, 47, 145, 189-191, 195, 196, 198-202, 204, 207, 209-212, 214, 215, 218, 224, 230, 244] (level I-III). Long-term medication use has been reported to range from 5.8% to 62% [31, 34, 41-44, 47, 107, 109, 196] (level I-III) with most studies reporting rates <20% [41, 43, 44] (level II-III). One randomized controlled trial, however, reported a 62% incidence of antacid medication resumption after antireflux surgery, [31] which constitutes a very high rate compared with the rest of the literature.

Quality of life and satisfaction with surgery

Satisfaction rates for surgery range from 62% to 97% [20, 41-43, 47, 122, 143, 145, 188, 190, 191, 196, 199, 204, 206-208, 211, 212, 221-223, 230, 241, 244] (level II-III) with long-term satisfaction rates (follow-up >5 years) ranging from 80% to 96% [41, 42, 45, 47, 143, 188, 196, 222] (level II-III). Additionally, 81% to 95% of patients, in both short- and long-term follow-up, stated that they would undergo surgery again [20, 42, 43, 47, 143, 188, 204, 206, 212, 223] (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 [41-43, 189, 191-193, 197, 209, 213, 214, 224] (level II-III).

Recommendations

1. Laparoscopic antireflux surgery is effective at restoring the mechanical barrier to reflux with significant improvements in the LES pressure and acid reflux exposure, can be performed safely with minimal perioperative morbidity and mortality, and leads to high patient satisfaction rates and improved quality of life (Grade A).

2. Laparoscopic antireflux surgery is an effective treatment strategy for typical symptoms of GERD with

significant improvements in rates of dysphagia, heartburn, and regurgitation and should be considered in appropriately selected patients and be performed by appropriately trained surgeons (Grade A).

3. While atypical symptoms improve in a majority of patients after antireflux surgery, symptom persistence is higher compared with patients with typical symptoms and surgeons should therefore carefully select and counsel these patients preoperatively (Grade B).

4. Patients undergoing laparoscopic antireflux surgery should be counseled preoperatively about the reported rates of symptom relapse and resumption of acid reducing medications (Grade A).

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 [245-248]. 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 [249-251]. 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 [252, 253]. As intraepithelial neoplasia develops, the annual per patient risk for cancer increases further [245, 247, 248, 254-256].

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 [245, 247, 257]. 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).

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 [248, 257-260] (level I).

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) [247, 257, 261-265] (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 [264-285] (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 [277-285] (level I). Further, cost-utility studies show that ablative therapy is the preferred strategy over surveillance alone (all grades) and esophagectomy (HGIN) [286-289].

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[290], only one randomized trial compared medical and surgical therapy. This study, by Parilla et al. [291], 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 significantly differences between the two groups in terms of progression to dysplasia or malignancy [291]. 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 [291] (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 [25] (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 [251]. They also reported similar symptom outcomes (Gastrointestinal Symptom Rating Scale [GSRS] and Quality of Life in Reflux and Dyspepsia [QOLRAD]) in the medical versus surgical treatment arms but reported improved control of reflux using pH data [251] (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 [257]. 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 [210, 216, 247, 292, 293].

Recommendations

1. Detection of Barrett's esophagus with adenocarcinoma involving the submucosa or deeper excludes the patient from anti-reflux surgery and demands comprehensive stage-specific therapy (esophagectomy, chemotherapy, and/or radiation therapy) (Grade A).

2. HGIN and IMC can be effectively treated with endoscopic therapy including PDT, EMR and RFA, alone or in combination (Grade B). Anti-reflux surgery can be performed after achieving complete histological eradication of the lesion with endoscopic therapy (Grade C). Esophagectomy remains an option for HGIN and IMC, either as salvage in the case of endoscopic therapy failure or as primary therapy.

3. Antireflux surgery may be performed in a patient with non-neoplastic IM, IND and LGIN; with or without endoscopic therapy to eradicate the Barrett's tissue. Specifically, RFA has been shown to be safe, clinically effective, and cost-effective in these disease states and may be performed in eligible patients before, during, or after anti-reflux surgery (Grade B).

4. Antireflux surgery does not alter the need for continued surveillance endoscopy in patients with Barrett's esophagus. Patients who have undergone endoscopic ablative therapy and anti-reflux surgery should continue surveillance endoscopy according to their baseline grade of Barrett's (Grade A).

5. The available evidence is inconclusive about the resolution or improvement of Barrett's after antireflux surgery.

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Figure 1. MEDLINE SEARCH STRATEGY

March 2008

Database: Ovid MEDLINE® <1950 to March Week 2 2008>

Search Strategy:

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1 Gastroesophageal Reflux/ (16387)

2 exp Surgical Procedures, Minimally invasive/ (190792)

3 Robotics/ (5031)

4 Fundoplication/ (2421)

5 (*Gastroesophageal Reflux/ or *Fundoplication/) and (2 or 3) (3359)

6 limit 5 to (comment or letter or news or newspaper article) (185)

7 5 not 6 (3174)

8 limit 7 to english language (2522)

9 8 and *Gastroesophageal Reflux/th, su (1104)

10 limit 9 to systematic reviews (46)

11 limit 9 to meta analysis (3)

12 limit 9 to randomized controlled trial (66)

13 limit 9 to evidence based medicine reviews (3)

14 10 or 11 or 12 or 13 (112)

15 9 not 14 (992)

16 limit 15 to (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or clinical trial or consensus development conference or consensus development conference, nih or controlled clinical trial or guideline or practice guideline) (59)

17 15 not 16 (933)

18 limit 17 to "review articles" (236)

19 17 not 18 (699)

20 (surg$ or endoscop$ or laparo$ or digest$ or gastro$ or gut).jw. (748495)

21 19 and 20 (604)

22 limit 21 to humans (586)

23 limit 22 to yr="2003 - 2008" (236)

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