Preoperative Evaluation of Gastroesophageal Reflux Disease

Vikas Singhal, MBBSa, Leena Khaitan, MD, MPAb,*

INTRODUCTION: NATURE OF THE PROBLEM

Gastroesophageal reflux disease (GERD) has been defined per the Montreal definition as “Reflux that causes troublesome symptoms, mucosal injury in the esophagus, or both of these.”1 The prevalence of GERD has been noted to be extremely high in Western countries. In 2004, approximately 20% of the US population reported reflux symptoms that occurred at least weekly. 2 According to data from the Gallup organization (1988) approximately 44% of Americans experience heartburn at least a Department of GI and Bariatric Surgery, Jaypee Hospital, Wishtown Sector 128, Noida, UP 201304, India; b Department of Surgery, University Hospitals Case Medical Center, 11100 Euclid Avenue, Cleveland, OH 44106, USA
* Corresponding author.
E-mail address: Leena.khaitan@uhhospitals.org

KEYWORDS

GERD evaluation • Preoperative assessment • Diagnostic evaluation

KEY POINTS

• Gastroesophageal reflux disease (GERD) causes troublesome symptoms, mucosal injury in the esophagus, or both of these.
• The objective diagnosis of GERD should be made with an ambulatory acid or nonacid reflux study before proceeding with surgical intervention to get the best outcome.
• The preoperative evaluation of GERD should not only confirm the diagnosis of GERD but also help to determine the true cause of the GERD to help guide treatment.
• Symptom correlation is a key aspect when diagnosing GERD to help predict outcome of a procedure and set patient expectation.
• GERD can be caused by poor gastric emptying and this should be evaluated as part of the work-up either symptomatically or with objective evaluation.
• GERD can be caused by some dysfunction of the LES, such as hiatal hernia, hypotensive LES, or transient inappropriate LES relaxations that result from gastric distention.
• Once the cause of GERD is elucidated, the surgeon can determine whether medications, surgical intervention with Nissen fundoplication, partial fundoplication, Linx placement, hiatal hernia repair, or an endoscopic treatment will have the desired outcome for the patient.
• Esophageal motility disorders should be assessed before any surgery with manometry and esophagram.

http://dx.doi.org/10.1016/j.suc.2015.02.013
surgical.theclinics.com
0039-6109/15/$ – see front matter © 2015 Elsevier Inc. All rights reserved.
once per month. Almost 18% of Americans take nonprescription drugs for reflux-related symptoms. It is remarkable that this disease is so prevalent and yet the treatment options are significantly underused. Despite the availability of multiple treatments on the market, medications remain the primary treatment modality offered to patients.

Adaptations to equipment and technique have resulted in newer laparoscopic and endoscopic procedures being approved for GERD. If patients decide to proceed with a procedure for their reflux, there are several options available. Apart from the gold standard Nissen fundoplication, newer laparoscopic procedures, such as lower esophageal sphincter (LES) augmentation with the LINX reflux (Torax Medical, Shoreview, MN) management system, are now in the armamentarium of surgeon and patient. Endoscopic procedures, such as radiofrequency ablation (Stretta procedure) and transoral incisionless fundoplication, are also becoming popular because patients are desiring less invasive procedures for reflux disease. In addition, multiple new interventional treatments for GERD are on the horizon. Each of these treatments addresses a different mechanism of GERD. As a result the preoperative assessment for treatment of GERD now includes not only confirmation of the diagnosis of GERD but also the determination of the cause of GERD to tailor the appropriate treatment option to the patient.

RELEVANT ANATOMY AND PATHOPHYSIOLOGY

Etiology of Gastroesophageal Reflux Disease

Stein and DeMeester provided the concept of the plumbing circuit where the esophagus functions as an antegrade pump, the LES as a valve, and stomach as a reservoir. Problems with any component of the circuit (either poor esophageal motility, a dysfunctional LES, or delayed gastric emptying) can lead to GERD. From a medical or surgical standpoint, it is extremely important to identify which of these components is defective so that effective therapy can be applied.

The LES is defined by manometry as a zone of elevated intraluminal pressure at the esophagogastric junction. It is a 3- to 5-cm segment of contracted circular smooth muscle at the distal end of the esophagus, the resting tone of which varies from 10 to 35 mm Hg when measured at end expiration. Hypotensive pressure within the sphincter is often a cause of severe reflux. At least 2 cm of the sphincter should be intra-abdominal.

Another cause of reflux is transient inappropriate LES relaxations (relaxation in the absence of swallowing). These transient LES relaxations (TLESRs) are vagally mediated reflexes triggered by gastric distention and serve to vent the stomach. Prolonged or more frequent TLESRs have been investigated as a cause of reflux disease and it is agreed that TLESRs are a common mechanism of reflux. Patients with reflux have a low gastric yield pressure such that these relaxations can be stimulated by minimal gastric distention and volume intake.

Apart from the LES itself there are two other anatomic structures that contribute to preventing reflux at the esophagogastric junction: the diaphragmatic crura, and the
phrenoesophageal ligament, which help form the angle of His. For proper LES function, this junction must be located in the abdomen so that the diaphragmatic crura can assist the action of the LES, thus functioning as an extrinsic sphincter. If this mechanism is defective, GERD is exacerbated. A hiatal hernia may contribute to reflux because proximal migration of the LES may result in loss of its abdominal high-pressure zone, or the length of the high-pressure zone may decrease. Also the crural mechanisms are not effective in preventing reflux. Hence reduction of hiatal hernia with re-establishing the intra-abdominal length of the esophagus, with proper crural closure, apart from a fundic wrap are key components to surgical correction of GERD.

A chronically increased intragastric pressure and increased frequency of TLESRs are thought to play the major role in obesity-related GERD and reflux disease in pregnancy. Another mechanism of GERD to be considered is poor gastric emptying. If the stomach empties poorly, there is a backup in the plumbing circuit that then leads to reflux of gastric contents into the esophagus.

A newer line of investigation is the realization that not all reflux is acid. Other components of the reflux fluid, such as bile acids, pepsin, and gas, apart from hypersensitivity to the volume of reflux itself have all been thought to contribute to reflux disease, especially reflux with atypical symptoms and those symptoms that do not respond to proton pump inhibitors (PPIs). This makes sense with the various mechanisms outlined previously.

**CLINICAL PRESENTATION AND EXAMINATION**

A thorough assessment of symptoms preoperatively is important as an initial screening for the causes of the patient’s reflux. Symptoms related to reflux disease can be extensive and varied (Table 1). The most typical symptoms of GERD are heartburn and regurgitation, belching, and sometimes epigastric discomfort. Atypical symptoms of GERD are many including bloating; dysphagia; and oropharyngeal symptoms, such as hoarseness, globus, and chronic cough. Patients can also present with chest symptoms or etiologies, such as chest pain, pneumonia, chronic aspiration, and asthma. It is key in such patients to exclude cardiac causes of pain before labeling it as noncardiac chest pain. Other manifestations include dental erosions, sinusitis, otitis media, and sleep apnea. Finally, patients can have complications of GERD that include stricture, ulceration, and Barrett esophagus. The timing of the reflux, relationship to meals, exacerbation of symptoms with upright or supine position, and

<table>
<thead>
<tr>
<th>Typical Symptoms</th>
<th>Atypical Symptoms</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heartburn</td>
<td>Chronic cough</td>
<td>Stricture</td>
</tr>
<tr>
<td>Regurgitation(^\text{a})</td>
<td>Hoarseness</td>
<td>Esophagitis</td>
</tr>
<tr>
<td>Epigastric pain</td>
<td>Globus</td>
<td>Ulceration</td>
</tr>
<tr>
<td>Belching</td>
<td>Dysphagia</td>
<td>Barrett esophagus</td>
</tr>
<tr>
<td></td>
<td>Chest pain</td>
<td>Adenocarcinoma</td>
</tr>
<tr>
<td></td>
<td>Chronic aspiration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bronchitis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sinusitis</td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) Regurgitation is one of the most important symptoms that can be impacted by a surgical intervention for GERD.
difficulty swallowing should be noted. Elicitation of this history can help the surgeon to
set patient expectation for success of a procedure once the work-up is completed.
Symptoms alone can never be the only tool used for the diagnosis of reflux. It is
well established that symptoms alone have limited positive predictive value for suc-
cess with intervention.⁶,⁷

Patients should also be assessed for their surgical candidacy. Patients should be
able to withstand surgery and should also be mentally prepared for surgery. There
are studies that suggest patients with psychiatric diagnoses may do poorly with anti-
reflux surgery.

Patients who present with typical symptoms usually respond the most to treatment
either medical or surgical. To objectively stratify GERD symptoms, such question-
naires as GERD-Q and GERD-HRQL (health-related quality of life) have been
developed. These may be used to screen patients with GERD and assess response
to intervention by comparing preintervention with postintervention surveys. The
GERD-HRQL has been validated by Velanovich⁸ for this purpose. Through these
questionnaires it has become clear that GERD can affect quality of life as severely
as other chronic diseases, such as diabetes, arthritis, and heart failure.⁹

Physical examination is usually not very contributory in the assessment of GERD.

**DIAGNOSTIC PROCEDURES**

*Presumptive Treatment As a Diagnostic Measure*

GERD is unusual in that one of the initial modes of diagnosis is by initiating therapy.
Patients with reflux symptoms are frequently started on antacid medications as a
diagnostic and therapeutic maneuver. This has been the standard for several years.
These medications are extremely effective at blocking acid and are thought to have
few side effects. The recent American College of Gastroenterology guidelines recom-
mand that in patients with symptoms and history consistent with uncomplicated
GERD, the diagnosis of GERD may be assumed and empirical therapy begun. Patients
who show signs of GERD complications or other illness or who do not respond to
therapy should be considered for further diagnostic testing.¹⁰ However, these recom-
mandations are now being challenged because there is growing evidence that an
endoscopy at baseline can be very helpful in determining further management
of the patient’s GERD and can evaluate for a complication of reflux, such as inflamma-
tion, strictures, or Barrett-type changes. In addition, the long-term use of medications,
such as PPIs, is now being shown to have serious potential side effects (Box 1). These
side effects may drive more patients to think about a procedure for treatment of their
GERD rather than remain on medications.

*Upper Gastrointestinal Tract Endoscopy*

Upper endoscopy is often the first diagnostic test in a GERD evaluation. Endoscopy
itself has a low sensitivity to diagnose reflux disease. However, it is useful in the diag-
osis of complications of GERD, such as inflammation, strictures, and Barrett esoph-
agus. It is also essential to rule out cancer. Biopsies can be taken of erosive disease to
identify reflux-related changes in the esophagus. If erosive disease is found there is a
school of thought that no further testing is necessary before doing an antireflux proce-
dure. However, studies have shown that even with erosive disease, a 24-hour pH test
maybe negative. These patients often have poor outcomes with surgical interven-
tion.¹¹ However, patients may have reflux and no evidence of erosive disease or
mucosal changes in the esophagus. The authors recommend doing ambulatory pH
monitoring before making a final diagnosis of GERD.
With endoscopy, a retroflexed view at the cardia can help to identify hiatal hernias and visualize the flap at the LES. The endoscopist can make a subjective assessment of the LES as to its “looseness” and function. Furthermore, a poor man’s assessment can be made of gastric yield pressure in that in patients with low gastric yield pressure, it is difficult to fully insufflate the stomach when retroflexing at the cardia. Endoscopy can also be therapeutic to dilate strictures and take biopsies at the time of the study. The endoscopy can be performed by gastroenterology or by the surgeon who is considering a procedure for the patient. Because of the increasing incidence of Barrett esophagus, many physicians now advocate that any patient requiring long-term PPIs should have at least one endoscopy to look for any anatomic abnormalities. Of note, if the patient complains of dysphagia, an esophagram should be done first to alert the endoscopist to strictures or diverticula that may complicate the endoscopy.

**Esophagram**

An esophagram is a useful test in assessing function of the proximal gastrointestinal tract. It is a noninvasive way to look for structural abnormalities, such as stricture, paraesophageal hernia, hiatal hernia (sliding or fixed), and diverticula. Extrinsic compression of the esophagus and mucosal abnormalities can be seen in addition to a real-time view of the anatomy and function of the gastroesophageal junction (Figs. 1 and 2). The physician performing the procedure can give a subjective assessment of reflux; however, this should not be a substitute for ambulatory pH. Barium swallow has a sensitivity of only 34% and cannot be definitively diagnostic for GERD.12 Many patients with GERD may have no significant findings on radiographic study. Additionally, this radiologic study can elucidate other motility disorders that may mimic reflux, such as achalasia.

**Ambulatory pH Testing**

If further evaluation is warranted or a procedure for reflux is being considered then an ambulatory pH study needs to be done to objectively measure the patient’s reflux. Ambulatory pH monitoring is considered the gold standard confirmatory test. The testing is done with patients off PPIs for a minimum of 7 days and H2 receptor blockers.
Fig. 1. An abnormal barium esophagram demonstrating a corkscrew pattern.

Fig. 2. Hiatal hernia with upside down stomach.
for 3 days. The gold standard is a catheter-based study first described by DeMeester and colleagues.\textsuperscript{13} The endoscope is placed and the gastroesophageal junction is measured. Then 5 cm above the gastroesophageal junction the pH probe is placed with the aid of a suction device that helps it to hook on the mucosa. The total time with pH less than 4 is considered acid reflux and is transduced and recorded. A drop of pH below 4 for more than 4% of the time in a 24-hour period is considered an abnormal study.

Scoring systems have been developed and used to derive results from the pH testing study. Several parameters are considered and a composite score is calculated. One of the most commonly used scores initially designed by Johnson and DeMeester and later modified by Jameison and DeMeester comprises six variables.\textsuperscript{13} The components of the DeMeester score are (normal <14.72) as follows:

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
6. The duration of the longest reflux episode

A total acid reflux time greater than 4.2\% is considered a positive study for pathologic acid reflux disease. A DeMeester score greater than 14.72 is considered positive for pathologic acid reflux disease.\textsuperscript{13} In addition to these two parameters, the most important piece of information gleaned from this study is the symptom correlation.

The patients chart their symptoms during the period of testing and the symptoms are then correlated with periods of acid reflux on pH testing. The Symptom Index (SI),\textsuperscript{14} Symptom Sensitivity Index, and Symptom-Associated Probability (SAP)\textsuperscript{15} scores are then derived. SI is the percentage of symptom episodes that were associated with reflux during the study period. For example, if the patients noted 10 symptom episodes and five of them were associated with positive reflux on pH testing, then the SI would be 50\% or 0.5. An SI value greater than 0.5 is generally considered to be clinically significant. However, the SI does not take into account the total number of reflux events and if a patient has many reflux events a high SI may be falsely obtained because of chance.

The SAP was hence developed as a statistical calculation that derives a \( P \) value and reduces the chance factor in association of symptoms with reflux episodes. The SAP calculation is based on constructing a \( 2 \times 2 \) contingency table with symptoms and reflux. The Fisher exact test is then applied to calculate the probability that the observed association between reflux and symptoms occurred by chance or was significant. By understanding exactly which symptoms are most closely associated with the presence of a reflux episode, the surgeon can set expectations for the patient as to which symptoms are most likely to resolve with a procedure that inhibits reflux.

Over the last several years, the wireless pH monitoring system has become the new standard of care in pH monitoring (Bravo Capsule; Given Imaging, Yoqneam, Israel).\textsuperscript{16} This study monitors acid reflux for 48 hours and is considered to be more accurate because the patient is more likely to go about their daily activities without a catheter in place.\textsuperscript{17} The sensor can be placed endoscopically with sedation or transorally without sedation. The capsule is placed 6 cm above the gastroesophageal junction. The DeMeester score has been adapted to this study and scores and acid reflux time are reported for each day individually and in total for the 48 hours. This is one of the most important studies in objectively establishing the presence of GERD.
Nonacid Reflux Studies

If the traditional pH studies are all normal and the diagnosis of GERD is still being highly considered, then further testing to establish this diagnosis can be done. There is greater understanding now that in a certain group of patients the reflux may not be acidic. Traditionally, ambulatory pH testing has been designed with a cutoff pH of 4. It has been argued that this is an arbitrary cutoff and that some patients may have reflux disease even at a higher pH. This is where the role of multichannel intraluminal impedance (MII) in combination with conventional pH catheters (combined MII-pH) has come in, allowing a more comprehensive characterization of reflux episodes. Impedance technology allows assessment of bolus movement through the esophagus. When this is combined with pH monitoring, all episodes of reflux whether or not they are acid can be detected. The technology allows one to characterize the refluxate including physical properties (ie, liquid, gas, mixed), chemical properties (ie, acid or nonacid), height of the refluxate, and clearance of the refluxate. The study is similar to conventional catheter-based pH testing with a pH sensor located 5 cm above the gastroesophageal junction, combined with an impedance-measuring conductor at several levels in the esophagus. The main advantage of combined MII-pH over conventional pH monitoring is that it facilitates analysis of the relationship between symptoms and all types of reflux events, acid and nonacid. A negative combined MII-pH study is therefore more powerful in excluding reflux compared with regular pH monitoring. The most important reported datapoint is the symptom correlation seen with the presence of reflux (Fig. 3).

The impedance-pH study can also be helpful in patients who cannot stop medications but need better objective assessment of their reflux. These studies also allow for pH probes to be placed in the oropharynx and can be useful in evaluation of laryngopharyngeal reflux.

![Fig. 3. Nonacid reflux episode detected by impedance. The dashed line is the pH of 4 threshold and the arrow points to proximal extent of reflux (20 cm).](image-url)
Esophageal Function Testing (Used to Be Called Manometry)

The next study that every patient being considered for a procedure should have is an esophageal function study. Esophageal manometry is the gold standard esophageal function test (Fig. 4). Most modern machines can also perform high-resolution manometry. When combined with MII, it is referred to as esophageal function testing. This study allows evaluation of peristalsis and contraction amplitudes within the esophageal body, the pressure of LES, relaxation and length of the LES, and bolus transit through the esophagus. A normal LES pressure is between 10 and 45 mm Hg and relaxes with swallows. Peristalsis should be seen with greater than 70% of swallows and contraction amplitudes should be between 30 and 180 mm Hg. Abnormal LES can have pressure lower than 10 mm Hg, short total length (<2 cm), and less than 1 cm in the abdomen. Contraction amplitudes higher than 180 mm Hg may explain symptoms, such as chest pain and dysphagia. Contraction amplitudes lower than 30 mm Hg may suggest a weak esophagus and a partial fundoplication may be considered. It is imperative to rule out achalasia and other motility disorders before proceeding with a procedure for reflux disease (Figs. 5 and 6). This helps to guide further therapy based on the esophageal motility and the function of the LES. The new Chicago classification allows even better assessment of esophageal function. Esophageal motility disorders are discussed in detail elsewhere in this issue.

Lower Esophageal Sphincter Ultrasound

A high-frequency ultrasound probe has been used to study the LES. Mittal and colleagues proposed the LES and esophageal muscle thickness and esophageal muscle cross-sectional area as parameters that are increased in patients with esophageal motility disorders. The use of this evaluation is not widespread, being only used in specialized centers.

Gastric Emptying Study

A thorough assessment of gastric outlet obstruction should be done when assessing for reflux. This is because poor gastric emptying itself can be a cause of reflux with no dysfunction at the gastroesophageal junction and results from a backup in the “plumbing circuit.” An initial screening can be done based on history alone looking

Fig. 4. Normal manometry study with high resolution and impedance.
for bloating, nausea, and vomiting. The upper endoscopy can help to see if there is any mechanical obstruction at the gastric outlet or if there is retained food in the stomach. The radiographic study can also be helpful in this regard. If these studies are not diagnostic, or if there is high suspicion of poor gastric function, then a gastric emptying study can be done. This study is done in nuclear medicine and should be taken into consideration in any patient undergoing surgery for GERD. Often gastric emptying may improve with the treatment of GERD. Very poor emptying on this study may prompt the surgeon to do a gastric emptying procedure or place a gastrostomy tube at the time of plication.

**How Studies Help Choose the Proper Treatment**

GERD is a common problem and affects a great portion of the population. The baseline treatments of lifestyle changes and acid-reducing medications can be used as diagnostic and therapeutic maneuvers. Patients for whom medications no longer work, those with side effects to medications, those with atypical symptoms, or those wishing to no longer take medications are candidates for an antireflux procedure. Also, patients with complications of reflux should be considered for a procedure. In this case further work-up for the disease should be done (Fig. 7). The first test that patients should have is an upper endoscopy. The exception is the patient with dysphagia. An esophagram first may alert the physician to conditions that may make the endoscopy
more complicated. If complications of GERD are seen then the authors suggest that interventional treatment should be considered. If patients were responsive to medications at one time but they no longer work, the patient may have progressive GERD and the patient can be considered for intervention. Before proceeding with any procedure the patient should undergo ambulatory pH testing, esophageal function testing, and esophagram. The other studies mentioned can be used as indicated. If the pH study is normal but the patient is suspected to have reflux, then consider a nonacid reflux study with impedance. If this study shows no symptom correlation and/or minimal reflux then a procedure should be aborted and other causes for the symptoms should be sought. Note that if at any point in the work-up the patient is noted to have a body mass index greater than 35 with comorbidities or more than 40, they are a candidate for weight loss surgery and all of the studies may not need to be done.

CLINICAL OUTCOMES IN THE LITERATURE

Preoperative studies are very important in predicting outcome following any procedure for GERD. This was pointed out early in the laparoscopic Nissen experience in 1999. The authors noted that the key to a good outcome was proper diagnosis of GERD using the ambulatory pH study. The key outcome measures to note are the presence of reflux (whether it be acid or nonacid) and symptom correlation. Then the surgeon can have a discussion with the patient regarding expectations and outcomes. Additional predictors of outcome noted were typical symptoms and response to antireflux medications. Now that 15 years have passed since the publication of this paper, more and more patients are presenting for treatment that may have been responsive to medications at one time and now are seeking surgical intervention because the medications have stopped working. It is important to take a thorough history to elicit this information. The symptom for which a procedure can have the

Fig. 7. Preoperative assessment for GERD. If the patient is morbidly obese, consider weight loss surgery. BMI, body mass index.
most impact is regurgitation. Procedures provide the mechanical approach to GERD that medications cannot provide. A more recent study looked at patients 10 years after fundoplication and noted similar conclusions.21

If a hiatal hernia is identified, it is likely to be contributing to the symptoms and should be repaired. All other procedures are designed to augment the LES. Dysfunctions of the LES found on evaluation, such as hypotensive LES or TLESR, can help to tailor which procedure should be used for augmentation of the LES. For hypotensive LES the patient has the option of Nissen fundoplication, endoscopic placation, or LINX. The LINX reflux management system is designed to augment LES pressure and gastric yield pressure. Transoral incisionless fundoplication is most helpful in the patient with a patulous flat LES seen on retroflexion with endoscopy. This procedure helps to reconstruct the angle of His. Radiofrequency ablation may be most helpful in those with TLESR as the cause of their reflux.

SUMMARY

GERD is a common problem. If prolonged therapy is needed, the patient should have at least an endoscopy to assess for complications of GERD. If a surgical treatment is being considered, a thorough preoperative evaluation should be done to confirm the presence of pathologic GERD. Studies that should be done before a procedure include ambulatory pH testing, esophageal function testing, endoscopy, and esophagram. Nonacid ambulatory studies can be done in those who seem to be suffering from nonacid reflux with careful note of symptom correlation. Gastric emptying studies should be done if gastroparesis or gastric outlet obstruction is suspected. Esophageal motility disorders should be assessed with manometry, especially to evaluate for achalasia, which can mimic reflux.

REFERENCES