MINIMALLY INVASIVE PROCEDURES FOR GASTROESOPHAGEAL REFLUX DISEASE (GERD)

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INSTRUCTIONS FOR USE

This Medical Policy provides assistance in interpreting UnitedHealthcare benefit plans. When deciding coverage, the member specific benefit plan document must be referenced. The terms of the member specific benefit plan document [e.g., Certificate of Coverage (COC), Schedule of Benefits (SOB), and/or Summary Plan Description (SPD)] may differ greatly from the standard benefit plan upon which this Medical Policy is based. In the event of a conflict, the member specific benefit plan document supersedes this Medical Policy. All reviewers must first identify member eligibility, any federal or state regulatory requirements, and the member specific benefit plan coverage prior to use of this Medical Policy. Other Policies and Coverage Determination Guidelines may apply. UnitedHealthcare reserves the right, in its sole discretion, to modify its Policies and Guidelines as necessary. This Medical Policy is provided for informational purposes. It does not constitute medical advice.

UnitedHealthcare may also use tools developed by third parties, such as the MCG™ Care Guidelines, to assist us in administering health benefits. The MCG™ Care Guidelines are intended to be used in connection with the independent professional medical judgment of a qualified health care provider and do not constitute the practice of medicine or medical advice.

BENEFIT CONSIDERATIONS

Before using this policy, please check the member specific benefit plan document and any federal or state mandates, if applicable.

Essential Health Benefits for Individual and Small Group
For plan years beginning on or after January 1, 2014, the Affordable Care Act of 2010 (ACA) requires fully insured non-grandfathered individual and small group plans (inside and outside of Exchanges) to provide coverage for ten categories of Essential Health Benefits (“EHBs”). Large group plans (both self-funded and fully insured), and small group ASO plans, are not subject to the requirement to offer coverage for EHBs. However, if such plans choose to provide coverage for benefits which are deemed EHBs, the ACA requires all dollar limits on those benefits to be removed on all Grandfathered and Non-Grandfathered plans. The determination of which benefits constitute EHBs is made on a state by state basis. As such, when using this policy, it is important to refer to the member specific benefit plan document to determine benefit coverage.

COVERAGE RATIONALE

Endoscopic therapies are unproven and not medically necessary for treating gastroesophageal reflux disease (GERD).
Endoscopic therapies include:
- Radiofrequency energy:
  - Stretta System
- Endoscopic plication or suturing:

Minimally Invasive Procedures for Gastroesophageal Reflux Disease (GERD)
UnitedHealthcare Commercial Medical Policy

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The safety and efficacy of endoscopic therapies for the treatment of GERD have not been established in the published medical literature. Current studies are generally of small to moderate size, lack adequate control or comparison groups, and provide only short-term follow-up. Well-designed clinical trials with long-term follow-up are required to establish that endoscopic therapies benefit health outcomes in patients with GERD by eliminating symptoms, preventing recurrence of symptoms or progression of disease, healing esophagitis, and reducing or eliminating the need for pharmacologic therapy.

The LINX™ Reflux Management System is unproven and not medically necessary for treating GERD. The safety and efficacy of this system has not been established in the peer-reviewed medical literature. Available studies are hampered by a number of limitations, including small study size, lack of statistical power, lack of controls or comparators, and lack of long-term follow-up.

See the Medical Policy titled Bariatric Surgery for information regarding transoral endoscopic surgery (such as transoral gastroplasty [TOGA®], StomaphyX, and Restorative Obesity Surgery, Endoluminal [ROSE] procedure) for the treatment of obesity.

APPLICABLE CODES

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies and Coverage Determination Guidelines may apply.

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<tr>
<th>CPT Code</th>
<th>Description</th>
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<tr>
<td>43210</td>
<td>Esophagogastroduodenoscopy, flexible, transoral; with esophagogastic fundoplasty, partial or complete, includes duodenoscopy when performed</td>
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<tr>
<td>43284</td>
<td>Laparoscopy, surgical, esophageal sphincter augmentation procedure, placement of sphincter augmentation device (i.e., magnetic band), including cruroplasty when performed</td>
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<td>43257</td>
<td>Esophagogastroduodenoscopy, flexible, transoral; with delivery of thermal energy to the muscle of lower esophageal sphincter and/or gastric cardia, for treatment of gastroesophageal reflux disease</td>
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<td>43499</td>
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<td>Unlisted procedure, stomach</td>
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DESCRIPTION OF SERVICES

Gastroesophageal reflux disease (GERD) is a condition that is characterized by either a weak or dysfunctional lower esophageal sphincter (LES) that results in partially digested food from the stomach to flow back into the esophagus, a process known as reflux. Persistent GERD may lead to esophageal damage or other serious conditions, such as severe esophagitis, strictures, Barrett’s metaplasia, and adenocarcinoma of the esophagus.

Initial treatment of GERD usually involves over-the-counter (OTC) antacids, OTC histamine-2-receptor antagonists (H2RAs; also called H2 blockers), and proton pump inhibitors (PPI), all of which generally provide effective control of symptoms, depending on the severity of the disease and clinical response. For patients who wish to discontinue use of these medications due to concern of long term side effects or for patients whose GERD is refractory to pharmacologic treatment, an open or laparoscopic Nissen fundoplication may be considered. However, some patients may not be suitable candidates given the invasiveness and risks associated with surgery. As a result, minimally invasive procedures, including endoscopic or endoluminal therapies and laparoscopic approaches, have been proposed as
alternative treatment methods to improve the function of the LES, with the objective of eliminating symptoms, healing esophagitis, preventing recurrence of symptoms or progression of disease, and reducing the need for lifelong pharmacologic therapy.

Minimally invasive approaches used to treat GERD, including the following:

- **Radiofrequency energy:** The Stretta procedure administers radiofrequency (RF) energy via endoscopic needles placed in the tissues surrounding the lower esophageal sphincter. The RF energy heats this neighboring tissue, creating thermal lesions. Submucosal scarring forms as the lesions heal, causing shrinkage and tightening around the LES. Theoretically, these changes to the esophageal sphincter reduce acid reflux by restoring the natural barrier function of the LES, and reducing the spontaneous regurgitation caused by transient relaxation of the LES (SAGES, 2013).

- **Endoscopic plication or suturing:** The Bard EndoCinch and the Endoscopic Suturing Device (ESD), involves endoscopic suturing, allows for the placement of proximal to the LES, and the NDO Endoscopic Plication System, also known as the NDO Plicator System, places a full-thickness transmural plication near the gastroesophageal junction under direct endoscopic visualization. EsophyX is an endoluminal therapeutic option that uses a trans-oral and fastener deploying device. The device is passed into the stomach, where it deploys a series of full-thickness fasteners to create a neogastroesophageal valve. The EsophyX device creates a transoral incisionless fundoplication (TIF). Endoscopic plication procedures that are performed through the mouth or anus (natural orifice) are examples of natural orifice surgical procedures.

- **Injection or implantation techniques include the following:**
  - The Plexiglas (polymethylmethacrylate [PMMA]) procedure involves injection of an inert polymer material into the submucosa of the proximal lower esophageal sphincter zone to provide bulking support to the sphincter and decrease transient relaxation of the lower esophageal sphincter (tLESRs).
  - Another bulking agent, pyrolytic carbon-coated beads (Durasphere®), is being evaluated for treatment of GERD. Durasphere is approved by the U.S. Food and Drug Administration (FDA) as a submucosal urethral bulking agent. Use of this product for esophageal reflux would be considered off-label use.
  - The LINX™ Reflux Management System is an implant that consists of a ring that fits around the esophagus and is intended to prevent reflux of bile and acid from the stomach into the esophagus. According to the company website, the LINX system is a small flexible band of interlinked titanium beads with magnetic cores. The magnetic attraction is intended to help the (LES) resist opening to gastric pressures, preventing reflux from the stomach into the esophagus. A surgeon uses a laparoscopic incision to implant the device around the patient’s esophagus just above the stomach while the patient is under general anesthesia.

Specific manipulation of the endoscopic and laparoscopic devices is a surgical skill requiring extensive training and experience. Performance of these procedures requires a physician with the training and experience in the particular endoscopic system in use.

**CLINICAL EVIDENCE**

**Radiofrequency Energy (Stretta System)**

No new well-designed clinical trials evaluating radiofrequency energy (Stretta System) were identified.

In a single center cohort study, Dughera et al. (2014) assessed the durability of the Stretta procedure for patients with GERD with 4 to 8 year follow-up results. Of the original 86 patients, 26 reached the 8-year follow-up end point. All patients underwent clinical evaluation by upper endoscopy, oesophageal pressure, and pH studies. After 4 and 8 years, 21 patients (80.7%, P=0.0001) and 20 patients (76.9%, P=0.0001) were completely off PPIs. Median LES pressure did not show significant amelioration at 4 and 8 years and mean oesophageal acid exposure significantly improved at 4 years (P=0.001) but returned to baseline values after 8 years. The authors conclude that the results of their follow-up study from 4 to 8 years sustain the concept that Stretta might represent a viable treatment option for selected patients with symptomatic mild to moderate GERD. They suggest that these results need to be confirmed in larger cohorts of patients, and could ultimately result in a reasonable recommendation for younger GERD sufferers as a “bridge therapy” between the continuous medical treatment and the optimal timing for laparoscopic fundoplication.

Noar et al. (2014) prospectively assessed the long-term safety, efficacy, and durability of response to radiofrequency treatment of the lower esophageal sphincter (Stretta) in 217 patients with medically refractory GERD. There was no control arm in this study. The primary outcome measure (normalization of GERD-health-related quality of life (GERD-HRQL) in 70% or greater of patients at 10 years) was achieved in 72% of patients (95% confidence interval 65–79). For secondary outcomes, a 50% or greater reduction in PPI use occurred in 64% of patients, (41% eliminating PPIs entirely), and a 60% or greater increase in satisfaction occurred in 54% of patients. Both secondary endpoints were achieved. The most common side effect was short-term chest pain (50%). Preexisting Barrett’s metaplasia regressed in 85% of biopsied patients. No cases of esophageal cancer occurred. The authors concluded that In this single-group evaluation of 217 patients before and after Stretta, GERD-HRQL scores, satisfaction, and PPI use significantly improved and results were immediate and durable at 10 years.
Arts et al. (2012) conducted a double-blind randomized cross-over study of Stretta and sham treatment. Patients underwent two upper gastrointestinal endoscopies with 3 months interval, during which active or sham Stretta treatment was performed in a randomized double-blind manner. In all, 22 GERD patients (17 females, mean age 47±12 years) participated in the study; 11 in each group. Initial sham treatment did not affect any of the parameters studied. Three months after initial Stretta procedure, no changes were observed in esophageal acid exposure and lower esophageal sphincter (LES) pressure. In contrast, symptom score was significantly improved and gastro-esophageal junction (GEJ) compliance was significantly decreased. Administration of sildenafil, an esophageal smooth muscle relaxant, normalized GEJ compliance to pre-Stretta level, arguing against GEJ fibrosis as the underlying mechanism. The authors concluded that Stretta improved GERD symptoms and decreased GEJ compliance. According to the authors, the limitation of this study was reflux evaluation did not include impedance monitoring. The study was also limited by a small patient population, short follow-up, and lack of comparison to other surgical alternatives.

In a RCT, 36 patients were randomized into three groups. In group A, 12 patients underwent a single session Stretta procedure (Aziz et al., 2010). In group B, 12 patients underwent a sham Stretta procedure (mirror of the active procedure in all aspects except there was no deployment of the electrodes). In group C, 12 patients underwent a single Stretta treatment followed by repeat Stretta if GERD health-related quality of life (HRQL) was not 75% improved after 4 months. At 12 months, the mean HRQL scores of patients no longer on medications, the lower esophageal sphincter (LES) basal pressure, the 24-hr pH scores, and the PPI daily dose consumption were significantly improved from baseline in both Stretta groups. The double Stretta was numerically but not significantly better than the single Stretta for mean HRQL, mean 24 h pH, mean LES pressure, and PPI use. Seven patients in the double Stretta treatment group reported normal HRQL scores at 12 months compared with 2 patients in the single-treatment group. The sham group patients had a small but statistically significant decrease in their daily PPI dosages and mean HRQL scores. The investigators concluded that the Stretta procedure significantly reduced HRQL associated with GERD, use of PPI drugs, esophageal acid exposure, LES pressure, and grade of esophagitis compared with the sham procedure. The double Stretta therapy had numerically superior outcomes for most parameters and a significantly more frequent normalization of HRQL scores compared with the single Stretta group. According to the investigators, the Stretta procedure is partially effective for the treatment of GERD symptoms. Double Stretta therapy has better efficacy than single therapy, but has greater side effects. The investigators also noted that antireflux surgery (fundoplication) has a higher success rate than that of Stretta. Furthermore, a more prolonged effect is found with antireflux surgery. The conclusions of this study are limited by small sample size and lack of comparison to other surgical alternatives.

In another RCT, Coron et al. (2008) compared radiofrequency and a PPI in PPI-dependent patients. Patients were randomly allocated to either RF or PPI regimen alone. The primary endpoint, evaluated at 6-months, was defined as the possibility for the patient to stop or to decrease PPI use to <50% of the effective dose required at baseline. In the radiofrequency group, 18/20 patients stopped (n=3) or decreased (n=15) PPI use compared to eight of 16 in the PPI group. None of the control patients could stop PPI. HR-QOL scores were not significantly different between groups. No significant change in oesophageal acid exposure (OAE) was noted between baseline and 6-months after radiofrequency treatment. The investigators concluded that in a majority of patients, PPI therapy cannot be completely stopped. Furthermore, the efficacy of RF does not seem to be related to a decrease in OAE.

In a controlled trial, Jeansson et al. (2009) compared the effectiveness of endoscopic full-thickness plication (FTP) and endoscopic radiofrequency treatments for patients with GERD. Follow-up data was obtained for 63 patients (mean follow-up was 6 months). Outcome measures included comparison of medication use, symptom scores, and pH values at baseline and follow-up. In the RF group, patients with moderate to severe heartburn decreased from 55% to 22%, and PPI use decreased from 84% to 50%. Decreases were also seen for dysphagia, voice symptoms, and cough. The pH values were unchanged. In the FTP group, patients with moderate to severe heartburn decreased from 53% to 43%, and PPI use decreased from 95% to 43%. Percentage of time that the pH was less than 4 decreased from 10.0% to 6.1%. Decreases were also seen for regurgitation, voice symptoms, and dysphagia. According to the investigators, RF and FTP both resulted in a decrease in both PPI use and in scores for voice symptoms and dysphagia. In addition, RF resulted in decreased heartburn and cough, while FTP resulted in the most dramatic reduction in regurgitation. The investigators concluded that both procedures are effective, providing symptomatic relief and reduction in PPI use. For patients whose chief complaint is regurgitation, FTP may be the preferred procedure. Study limitations included lack of randomization, small sample size, and short follow-up.

Numerous non-randomized and non-comparative cohort studies evaluated radiofrequency energy for the treatment of GERD (Dughera et al., 2011; Liu et al., 2011; White et al., 2009; Dundon et al., 2008; Noar and Lotfi-Emran et al., 2007; Reymunde and Santiago, 2007; Lutfi et al., 2005). The body of evidence is of low quality due to overall weaknesses in study design, including lack of comparison groups, lack of randomization, and small patient populations.

Torquati et al. (2007) conducted an evidence-based systematic review of the literature of FDA-approved modalities of endoluminal treatment of GERD. Study authors concluded that the methodological quality of most of the included
studies was average. The authors stated that there is grade 1b (individual randomized trial) and 2b (individual cohort study) evidence demonstrating that the Stretta procedure is effective in reducing GERD symptoms at short- and mid-term follow-up. However, in the majority of the studies analyzed, the procedure did not significantly reduce acid exposure in the distal esophagus.

Additional well-designed clinical trials comparing radiofrequency energy with other surgical alternatives are needed to determine the efficacy and long-term effectiveness of radiofrequency energy. The current body of evidence is of low to moderate quality with several study limitations, including lack of generalizability and lack of sufficient follow-up data. There are persistent questions regarding the safety of radiofrequency energy over the long term.

**Endoscopic Plication or Suturing**

**EndoCinch**

No new well-designed clinical trials evaluating the EndoCinch were identified.

Schwartz et al. (2007) conducted a single-center, double-blind, randomized, sham-controlled trial of endoscopic gastroplication by the Endocinch suturing system in 60 patients. Patients with GERD were randomly assigned to three endoscopic gastroplications (n=20), a sham procedure (n=20) or observation (n=20). The research nurse and patients in the active and sham groups were blinded to the procedure assignment. After 3 months, open-label active treatment was offered to all patients. At 3 months, the percentage of patients who had reduced drug use by ≥50% was greater in the active treatment group (65%) than in the sham (25%) or observation groups (0%). The active treatment effects on PPI use, symptoms and quality of life persisted after 6 and 12 months of open-label follow-up (n=41), but 29% of patients were retreated in this period. The investigators concluded that endoscopic gastroplication, using the Endocinch device, reduced acid-inhibitory drug use, improved GERD symptoms, and improved the quality of life at 3 months compared with a sham procedure with durable effects up to 12 months. However, the reduction in oesophageal acid exposure was not significantly different between treatment and sham groups.

In a randomized, placebo controlled study by Montgomery et al. (2006), 46 patients with GERD requiring regular use of PPIs were enrolled to evaluate the effects of the EndoCinch plication technique. Patients were randomized to the EndoCinch plication technique or a sham procedure. Reflux-specific symptoms and use of PPIs (total intake, as well as number of patients not taking PPIs) significantly improved in the treatment group compared with the sham control group at 3 months of follow-up. Gastro-esophageal endoscopy showed that 71% and 67% of sutures remained at 3 and 12 months, respectively. The authors concluded that although some short-term positive effects were achieved, there were no significant differences between the treatment and control groups after 12 months. Additionally, the lack of reduction of oesophageal acid exposure suggests that the EndoCinch plication technique is not recommended for use in clinical practice. Researchers suggest that the lack of long-term effects is primarily due to detachment of the sutures in about 30% of patients.

In a RCT, endoluminal gastroplasty (EndoCinch) was compared with polymer injection (Enteryx). The study included 51 patients dependent on PPI therapy. Twenty-six patients were assigned to EndoCinch treatment, 23 patients received Enteryx implantation, and 2 patients dropped out before applying endoscopic therapy. At 6 months, PPI therapy could be stopped or dosage was reduced by ≥50% in 20 of 26 EndoCinch-treated patients and in 20 of 23 patients treated by Enteryx. The authors concluded that EndoCinch and Enteryx seem to be equally successful in the treatment of GERD by significantly reducing the PPI dosages, and also improving symptoms of patients (Domagk et al., 2006). Conclusions regarding long-term health outcomes could not be made based on the short-term follow-up duration of this study.

Torquati et al. (2007) conducted a systematic review of endoluminal therapies for GERD, including EndoCinch. The authors identified evidence demonstrating that EndoCinch plication is effective in reducing GERD symptoms in the short term. However, they noted that the procedure does not significantly reduce the acid exposure in the distal esophagus.

Other clinical trials for EndoCinch are limited to observational case series that do not allow for conclusions about durability and long term effectiveness (Paulsen and Lindsetmo, 2008; Ozawa et al., 2009).

**Endoscopic Plicator or Suturing**

No new well-designed clinical trials evaluating endoscopic plicator or suturing techniques were identified.

In a randomized, single-blind, prospective, multicenter trial by Rothstein et al. (2006), 159 patients were selected to either undergo endoscopic full-thickness restructuring of the gastric cardia with transmural suture (n=78) or a sham procedure (n=81) to determine the effectiveness of endoscopic full-thickness plication for the treatment of GERD. Group assignments were revealed following the 3-month evaluation. By intention-to-treat analysis, at 3 months, the proportion of patients achieving ≥50% improvement in GERD-HRQL score was significantly greater in the active group compared with the sham group. Complete cessation of PPI therapy was higher among patients in the active group.
than in the sham group. However, the median percent time that pH < 4 was not significantly improved between the active and sham group. Between-group analysis revealed the active therapy was superior to sham treatment in improving the median percent time that the pH value was < 4. The authors concluded that endoscopic full-thickness plication was effective in reducing GERD symptoms and PPI use compared with a sham procedure. Additional studies are needed to evaluate the durability of endoscopic full-thickness plication for the treatment of GERD.

In a RCT, Antoniou et al. (2012) evaluated the effectiveness of endoscopic plication and laparoscopic fundoplication in terms of QOL and symptom control. A total of 60 patients with documented GERD were randomly assigned to undergo either endoscopic plication or laparoscopic fundoplication. QOL scores and symptom grading were recorded before treatment and at 3- and 12-months of follow-up. Twenty-nine patients from the endoscopic group and 27 patients from the operative group were available at follow-up. QOL scores showed a substantial and similar increase for both groups after treatment. Symptoms of heartburn, regurgitation, and asthma were significantly improved in the endoscopic group, whereas laparoscopic fundoplication was more effective in controlling symptoms of heartburn and regurgitation compared to the endoscopic procedure. The authors concluded that endoscopic plication and laparoscopic fundoplication resulted in significant symptom improvement with similar QOL scores in a selected patient population with GERD, whereas operative treatment was more effective in the relief of heartburn and regurgitation at the expense of higher short-term dysphagia rates. Small sample size and lack of long-term follow-up limit the validity of these conclusions.

Other clinical trials regarding endoscopic plicator or suturing are limited to observational case series that do not allow for conclusions about durability and long-term effectiveness (Birk et al., 2009; von Renteln et al., 2009).

No peer-reviewed published studies were identified that evaluated ESD/Sew-Right (an endoscopic/plication suturing technique).

EsophyX™ System with SerosaFuse™ Fastener (Transoral Incisionless Fundoplication Procedure)

Ebright et al. (2017) reported follow-up data on endoscopic fundoplication performed on 80 patients. Although symptoms and satisfaction improved significantly over a mean follow-up period of 24 months, approximately 30% of patients continued to take PPIs. Future studies are needed to focus on longer-term durability and comparisons with laparoscopic techniques.

Stefanidis et al. (2017) evaluated the long-term benefit of transoral incisionless fundoplication using the EsophyX device (n=45) for the management of GERD responsive to medical therapy. After a median follow-up period of 59 months (36-75) the median GERD-HRQL scores improved significantly from 27 (2-45) at baseline to 4 (0-26) (P < 0.001) in the 44 patients completing the study. Heartburn was eliminated in 12 out of the 21 patients included (57.1%), regurgitation was eliminated in 15 out of the 17 patients included (88.2%) and finally chest pain was eliminated in 5 patients out of the six patients included (83.3%). Overall, 32 patients out of the 44 patients (72.7%) that completed the study follow up reported elimination of their main symptom, without the need for PPI administration. Furthermore, six more patients (13.6%), five with heartburn, and one with regurgitation reported half PPI dose taken for <50% of the preceding follow up period (occasional PPI usage), while six more patients (four with heartburn, one with regurgitation, and one with chest pain) reported full or half PPI dose taken for more than 50% of the preceding follow up period (daily PPI usage). Randomized clinical trials are needed to validate these results in comparison with other treatments for GERD.

In a double-blind sham-controlled study in patients with moderate to severe GERD who were chronic PPI users, Häkansson et al. (2015) evaluated the transoral incisionless fundoplication (TIF2) procedure (using the EsophyX device with SerosaFuse fasteners) versus sham (upper GI endoscopy). Patients (n=44) were randomized into two groups. The primary effectiveness endpoint was the proportion of patients in clinical remission after 6-month follow-up. Secondary outcomes were: PPI consumption, esophageal acid exposure, reduction in Quality of Life in Reflux and Dyspepsia and Gastrointestinal Symptom Rating Scale scores and healing of reflux esophagitis. The time (average days) in remission offered by the TIF2 procedure (197) was significantly longer compared to those submitted to the sham intervention (107), P < 0.001. After 6 months 13/22 (59%) of the chronic GERD patients remained in clinical remission after the active intervention. Likewise, the secondary outcome measures were all in favor of the TIF2 procedure. No safety issues were raised. Although the authors concluded that the TIF2 procedure is effective in chronic PPI-dependent GERD patients, the study was limited by small patient population and short follow-up period.

In a prospective, sham-controlled trial, Hunter et al. (2015) aimed to determine if transoral incisionless fundoplication (TF) reduced troublesome regurgitation to a greater extent than PPIs in patients with GERD. Patients with GERD, taking daily PPIs, and hiatal hernias ≤2 cm were randomly assigned to groups that underwent TF and then received 6 months of placebo (n=87), or sham surgery and 6 months of once- or twice-daily omeprazole (controls, n = 42). Patients were blinded to therapy during follow-up period and reassessed at 2, 12, and 26 weeks. At 6 months, patients underwent 48-hour esophageal pH monitoring and esophagogastroduodenoscopy. By intention-to-treat analysis, TF eliminated troublesome regurgitation in a larger proportion of patients (67%) than PPIs (45%) (P=.023).
A larger proportion of controls had no response at 3 months (36%) than subjects that received TF (11%; P=.004). Control of esophageal pH improved after TF (mean 9.3% before and 6.3% after; P < .001), but not after sham surgery (mean 8.6% before and 8.9% after). Subjects from both groups who completed the protocol had similar reductions in GERD symptom scores. Severe complications were rare (3 subjects receiving TF and 1 receiving the sham surgery). Based on evaluation 6 months after the procedure, the authors concluded that TF was an effective treatment for patients with GERD symptoms, particularly in those with persistent regurgitation despite PPI therapy. Short follow-up period and smaller control group were limitations of this study.

In a RCT, Svoboda et al. (2011) evaluated the safety and efficacy of the Natural Orifice Transluminal Surgery (NOTES). Patients indicated for surgery of GERD were randomly assigned to transoral incisionless fundoplication (TIF group, n=34) and a control group, in which patients underwent the gold standard Nissen laparoscopic fundoplication (NLF group, n=18). For TIF, the Plicator method was initially used for 18 patients. During the last 2 years, the EsophyX method was used for 16 patients. The TIF and NLF procedures demonstrated similar efficacy at 3 and 12 months. The length of hospital stay was significantly shorter in the TIF group than in the NLF group. The TIF procedure appeared to be safe and comparable; one serious adverse event in the TIF group and three in the NLF group were observed. The authors concluded that both the NOTES TIF procedures are safe and effective methods for treatment of GERD, notably reducing the length of hospital stay. The effect of both procedures was sustained over 12 months. According to the authors, longer follow-up is necessary to verify the durability of efficacy. This study is also limited by a small sample size and the variable methods used to conduct TIF (both Plicator and EsophyX).

Cadiere et al. (2008) evaluated a TIF procedure using the EsophyX system in a prospective multicenter trial of 86 patients with GERD. Serious adverse events consisted of two esophageal perforations upon device insertion and one case of postoperative intraluminal bleeding. At 12 months, aggregate (n=79) and stratified Hill grade I tight (n=21) results showed 73% and 86% of patients with ≥50% improvement in GERD health-related quality of life (HRQL) scores; 85% discontinuation of daily PPI use and 81% complete cessation of PPIs; 37% and 48% normalization of esophageal acid exposure; 60% and 89% hiatal hernia reduction; and 62% and 80% esophagitis reduction, respectively. Resting pressure of the lower esophageal sphincter (LES) was improved significantly by 53%. According to the investigators, EsophyX-TIF cured GERD in 56% of patients based on their symptom reduction and PPI discontinuation. Study limitations included lack of a comparison group, small sample size, and short length follow-up.

Frazzoni et al. (2011) assessed reflux parameters before and after EsophyX or laparoscopic fundoplication and their relationship with symptoms in refractory GERD in 10 patients. The investigators found that in patients with refractory GERD, EsophyX fundoplication is significantly less effective than laparoscopic fundoplication in improving reflux parameters and in inducing symptom remission.

Hoppo et al. (2010) performed a small prospective study to evaluate safety and efficacy of the TIF procedure using the EsophyX system in 19 consecutive patients for the surgical treatment of GERD. At a mean 10.8 months follow-up, 5/19 had completely discontinued PPIs, and 3/19 had decreased their PPI dose. However, 10/19 had been converted to laparoscopic fundoplication for recurrent reflux symptoms and an endoscopically-confirmed failed valve. Nine of 17 were dissatisfied with the outcome, and eight were satisfied. Thirteen of 19 (68%) were considered to have been unsuccessful. According to the authors, at short-term follow-up, the TIF procedure is associated with an excessive early symptomatic failure rate, and a high surgical re-intervention rate. The authors conclude that this procedure should not be performed outside of a clinical trial.

Repici et al. (2010) evaluated the short- and mid-term clinical results of endoluminal fundoplication (ELF) with EsophyX in 20 patients. Within the first year following ELF, four patients underwent a laparoscopic fundoplication because of persistent symptoms. One patient was lost to follow-up between 6 and 12 months. Among the other 15 patients who completed 12 months follow-up, the GERD health-related quality of life (HR-QOL) score decreased from a median of 40 to 10, and 7 patients were avoided proton pump inhibitors. An improvement in esophageal acid exposure was recorded in 16.6% of patients, while in 66.7%, it worsened. The investigators concluded that ELF induced improvement of GERD symptoms and patient QOL with a reduced need for medication, in a select subgroup of patients. However, the procedure did not significantly change esophageal acid exposure in these patients. The need for revision standard laparoscopic fundoplication was high.

In a review article, Zagol and Mikami (2011) evaluated transoral fundoplication devices (included EndoCinch, NDO Plicator, EsophyX, and Stretta) for GERD that have been commercially available within the last 5 years. Both blinded and unblinded randomized studies were evaluated. Reviews of all studies with greater than 20 patients were evaluated to assess the efficacy and safety of transoral fundoplication devices. These endoluminal devices were primary matched against sham procedures. The EndoCinch and Stretta procedures were the only devices compared to laparoscopic fundoplication, the current standard for surgical management of GERD. The authors concluded that endoluminal treatment of GERD has been shown to be safe and effective in recent studies. However, the authors indicated that more RCTs need to be carried out to determine if endoluminal therapies will be a durable option for patients with GERD.
Bell and Freeman (2011) retrospectively evaluated the efficacy and safety of a rotational/longitudinal esophagogastric transoral incisionless fundoplication (TIF) in 37 patients on antisecretory medication, and with proven gastroesophageal reflux and limited hiatal hernia. Five patients were re-operations for failed laparoscopic fundoplication. The authors concluded that rotational/longitudinal esophagogastric fundoplication using the EsophyX device significantly improved symptomatic and objective outcomes in over 70% of patients at median 6-month follow-up. According to the authors, limitations of this study include its retrospective study design an incomplete data set for all patients, and the short 6-month duration of follow-up.

A feasibility study that included 19 patients evaluated the safety and initial efficacy of transoral incisionless fundoplication (TIF) for the treatment of GERD. The results at 1 year (n=17) indicated that TIF was safe and had a significant effect on reducing GERD symptoms, PPI usage, acid exposure, and small hiatal hernia (Cadiere et al., 2008). A follow-up study evaluated the long-term safety and durability of TIF. Fourteen patients completed the 2-year follow-up assessment tests. Global assessment of all outcomes in each patient revealed that 79% of patients experienced complete cure (29%) or remission (50%) of GERD at 2 years after TIF (Cadiere et al., 2009). Study limitations included lack of a comparison group and small sample size.

In a retrospective study, Barnes et al. (2011) evaluated clinical outcomes in 110 consecutive GERD patients who underwent TIF. At a median 7-month follow-up, typical and atypical symptom scores were normalized in 75% to 80% of patients and PPIs were completely discontinued by 93% of patients. According to the authors, these results supported the safety and efficacy of TIF. However, the retrospective study design, the lack of a control group, and the short term follow up limits the validity of these study results.

Huang et al. (2017) performed a systematic review with meta-analysis of studies evaluating the role of TIF in GERD. Only randomized controlled trials (RCTs) evaluating the efficacy of TIF, and prospective observational studies reporting outcomes after TIF were included. The authors identified that the total number of refluxes was reduced after TIF compared with the PPIs/sham group. The esophageal acid exposure time and acid reflux episodes after TIF were not significantly improved. PPI usage increased with time and most of the patients resumed PPIs treatment at reduced dosage during the long-term follow-up. The total satisfaction rate after TIF was about 69.15 % in 6 months. The incidence of severe adverse events consisting of gastrointestinal perforation and bleeding was 2.4 %. The authors concluded that TIF has comparable short-term patient satisfaction as an alternative intervention to GERD-related symptoms. Long-term results showed decreased efficacy with time and patients often resumed PPIs at reduced doses.

Other clinical trials for EsophyX are limited to observational case series that do not allow for conclusions about durability and long-term effectiveness (Trad et al., 2012; Narsule et al., 2012; Testoni et al., 2012; Demyttenaere et al., 2010; Testoni et al., 2010).

**Polymer Injection and Implantation Techniques**

**Plexiglas and Durasphere**

No new studies that provide substantial new evidence regarding polymer injection and implantation techniques were identified.

In a nonrandomized uncontrolled study, Ganz et al. (2009) assessed the long-term safety and effectiveness of Durasphere (Carbon Medical Technologies), an injectable bulking agent, in the treatment of mild to moderate GERD. Nine patients completed the 12-month trial. There were no adverse events. The procedure was well tolerated with minimal patient discomfort and no dysphagia. At 12 months, 70% of patients discontinued all antacid medication completely and 90% of patients reduced PPI use by greater than 50%. There were no reports of esophagitis (at 12 months), erosion, ulceration, or sloughing of material at any injection site. The Durasphere material did not appear to migrate. The authors concluded that Durasphere appears to be a promising new injectable bulking agent for the treatment of mild to moderate GERD, with demonstrable efficacy and no significant adverse events in a small cohort of patients. Study limitations include nonrandomized study design without a control group and small number of subjects.

Chen et al. (2009) conducted a systematic review that included 33 studies examining 7 endoscopic procedures (Stretta procedure, Bard EndoCinch, Wilson-Cook Endoscopic Suturing Device, NDO Plicator, Enteryx, Gatekeeper Reflux Repair System and Plexiglas) Of the three procedures that were compared with sham controls (Stretta procedure, Bard EndoCinch and Enteryx), patient outcomes in the treatment group were either as good as, or significantly better than, those of control patients in terms of heartburn symptoms, QOL, and medication usage. However, for the two procedures that were compared with the laparoscopic fundoplication (Stretta) procedure and the Bard EndoCinch device, outcomes for patients in the endoscopic group were conflicting. Some patients in the endoscopic group experienced comparable outcomes as patients undergoing the laparoscopic approach, while others experienced inferior outcomes. The authors concluded that there is insufficient evidence to determine the safety and efficacy of endoscopic procedures for GERD, particularly over the long term (Chen et al., 2009).
**LINX Reflux Management System**

Saino, et al. (2015) completed the 5-year follow-up from a prospective, multicenter study which evaluated the safety and efficacy of the MSAD. Prior to MSAD placement, patients (n=44) had abnormal esophageal acid and symptoms poorly controlled by proton pump inhibitors (PPIs). Patients served as their own control, which allowed comparison between baseline and postoperative measurements to determine individual treatment effect. 33 patients completed the 5-year follow-up. Mean total percentage of time with pH <4 was 11.9% at baseline and 4.6% at 5 years (P<.001), with 85% of patients achieving pH normalization or at least a 50% reduction. Mean total GERD-HRQL score improved significantly from 25.7 to 2.9 (P<.001) when comparing baseline and 5 years, and 93.9% of patients had at least a 50% reduction in total score compared with baseline. Complete discontinuation of PPIs was achieved by 87.8% of patients. No complications occurred in the long term, including no device erosions or migrations at any point. Based on long-term reduction in esophageal acid, symptom improvement, and no late complications, the authors concluded that this study shows the relative safety and efficacy of magnetic sphincter augmentation for GERD. The study was limited by small patient population and no control arm.

Ganz et al. (2016) reported the 5-year follow-up evaluation of patients who received a magnetic sphincter augmentation (MSA) device for GERD. The original prospective study at 14 centers in the United States and the Netherlands was conducted on 100 adults with GERD for 6 months or more, who were partially responsive to daily proton pump inhibitors (PPIs) and had evidence of pathologic esophageal acid exposure. At baseline, the median GERD-HRQL scores were 27 in patients not taking PPIs and 11 in patients on PPIs; 5 years after device placement this score decreased to 4. All patients used PPIs at baseline; this value decreased to 15.3% at 5 years. Moderate or severe regurgitation occurred in 57% of subjects at baseline, but only 1.2% at 5 years. All patients reported the ability to belch and vomit if needed. Bothesome dysphagia was present in 5% at baseline and in 6% at 5 years. bothersome gas-bloat was present in 52% at baseline and decreased to 8.3% at 5 years. The authors concluded that MSA provides significant and sustained control of reflux, with minimal side effects or complications, which in their opinion validates the long-term safety and efficacy of MSA for patients with GERD.

Lipham et al. (2012) conducted a case series of antireflux surgery with a Magnetic Sphincter Augmentation Device (MSAD). MSAD is used to restore the competency of the lower esophageal sphincter with a device rather than a tissue fundoplication. The aim of the study was to examine the safety profile of the MSAD in the first 1000 implanted patients. The author compiled data from multiple sources starting in July 1, 2013. The analysis included intra/periopeative complications, hospital readmissions, procedure-related interventions, reoperations, and device malfunctions leading to injury or inability to complete the procedure. Approximately 1000 patients worldwide have been implanted with the MSAD, at 82 institutions with median implant duration of 274 days. The author concluded that the safety analysis of the first 1000 patients treated with MSAD for gastroesophageal reflux disease confirms the safety of this device and the implantation technique. The preliminary and positive results of this study are hampered by lack of an adequate control or comparator group, and lack of randomization and blinding.

Ganz et al. (2013) conducted a nonrandomized uncontrolled study (n=100; 52% men; median age, 53 years, range 18-75) in patients with a history of GERD for at least 6 months and who had experienced a partial response to PPI treatment. The primary outcomes were normalization of esophageal acid exposure or a ≥50% reduction in acid exposure at 1 year of follow-up. Secondary outcomes were 50% reduction in the QOL score compared with the score without PPIs at baseline. The esophageal sphincter device was implanted using standard laparoscopy by surgeons with experience with fundoplication. Normalization of or at least a 50% reduction in esophageal acid exposure was achieved in 64% of all patients (64/100). Secondary outcomes of a 50% reduction in the QOL score compared with the score without PPI at baseline was achieved in 925 of all patients (92/100). Post-hoc analysis demonstrated a reduction of ≥50% in the average daily dose of PPI was observed in 93% of all patients (93/100). Six patients experienced serious adverse effects, 4 of whom required removal of the device. In 3 patients, the device was removed at various time points following implantation because of persistent dysphagia. The most frequently reported adverse effect was dysphagia occurring in 68% of all patients. At 1 year, 11% of patients reported persistent and ongoing dysphagia. The preliminary and positive results of this study are hampered by the poor quality design, which includes lack of an adequate control or comparator group, and lack of randomization and blinding.

Bonavina et al. (2010) conducted 1- and 2-year evaluations of a feasibility trial to assess the safety and efficacy of a laparoscopically implanted sphincter augmentation device (LINX Reflux Management System) in 44 patients with GERD. Complete cessation of PPI use was reported by 90% of patients at 1 year and by 86% of patients at 2 years. One device was laparoscopically explanted for persistent dysphagia without disruption of the anatomy or function of the cardia. There were no device migrations, erosions, or induced mucosal injuries. At 1 and 2 years, 77% and 90% of patients, respectively, had a normal esophageal acid exposure. According to the authors, the new laparoscopically implanted sphincter augmentation device eliminates GERD symptoms without creating undue side effects and is effective at 1 and 2 years of follow-up. Further research with a larger patient population is needed to confirm these preliminary results and determine the clinical relevance of these findings.
As a follow-up to the Bonavina et al. (2010) study, Lipham et al. (2012) evaluated 44 patients who underwent a laparoscopic surgical procedure for placement of the LINX System. Each patient’s baseline GERD status served as the control for post implant evaluations. For esophageal acid exposure, the mean total % time pH < 4 was reduced from 11.9% at baseline to 3.8% at 3 years, with 80% of patients achieving pH normalization. At ≥4 years, 100% of the patients had improved QOL measures for GERD, and 80% had complete cessation of the use of PPIs. There have been no reports of long-term device-related complications such as migration or erosion. The authors concluded that sphincter augmentation with the LINX Reflux Management System provided long-term clinical benefits with no safety issues. According to the authors, patients with inadequate symptom control with acid suppression therapy may benefit from treatment with sphincter augmentation. Limitations of the study include the lack of controls and a small sample size.

Bonavina et al. (2008) conducted a multi-center feasibility trial to evaluate safety and efficacy of a magnetic sphincter augmentation (MSA) device. Over a 1-year period, 38 out of 41 enrolled patients underwent implantation of this device. The mean follow-up was 209 days. At 3 months post-operatively, 89% of patients were no longer taking anti-reflux medications and 79% of patients had a normal 24-hr pH test. Mild dysphagia occurred in 45% of patients. No migrations or erosions of the device occurred. The authors concluded that laparoscopic implant of the MSA device is safe and well tolerated. It requires minimal surgical dissection and a short learning curve compared to the conventional Nissen fundoplication. The small study population limits the validity of the conclusion of this study.

In an observational cohort study, Asti et al. (2016) compared the quality of life in patients undergoing laparoscopic Toupet fundoplication (LTF) versus LINX. Consecutive patients undergoing LTF or LINX over the same time period were compared by using the propensity score full matching method and generalized estimating equation. Of 238 eligible patients, 103 underwent an LTF and 135 a LINX procedure. All patients had a minimum 1-year follow-up. Over time, patients in both groups had similar GERDHRQL scores (odds ratio [OR] 1.04, confidence interval [CI] 0.89–1.27; P=0.578), PPI use (OR 1.18, CI 0.81–1.70; P=0.388), gas related symptoms (OR 0.69, CI 0.21–2.28; P=0.542), dysphagia (OR 0.62, CI 0.26–1.30; P=0.241), and reoperation-free probability (stratified log-rank test=0.556). In 2 concurrent cohorts of patients with early stage GERD undergoing LTF or LINX and matched by propensity score analysis, health related quality of life significantly improved and GERD-HRQL scores had a similar decreasing trend over time up to 7 years of follow-up. Based on these findings, the authors concluded that LTF and LINX provide similar disease-specific quality of life over time in patients with early stage GERD.

In a systematic review and meta-analysis of the LINX® magnetic esophageal sphincter augmentation versus Nissen fundoplication for gastroesophageal reflux disease, Skubleny et al., (2016) included randomized controlled trials, non-randomized comparison study and case series with greater than 5 patients. Five hundred and forty-seven titles were identified through primary search, and 197 titles or abstracts were screened after removing duplicates. Meta-analysis was performed on postoperative quality of life outcomes, procedural efficacy and patient procedural satisfaction. Three primary studies identified a total of 688 patients, of whom 273 and 415 underwent Nissen fundoplication and MSA, respectively. MSA was statistically superior to LNF in preserving patient's ability to belch (95.2 vs 65.9%, p < 0.00001) and ability to emesis (93.5 vs 49.5%, p < 0.0001). There was no statistically significant difference between MSA and LNF in gas/bloating (26.7 vs 53.4%, p = 0.06), postoperative dysphagia (33.9 vs 47.1%, p = 0.43) and proton pump inhibitor (PPI) elimination (81.4 vs 81.5%, p = 0.68). The authors’ conclusion is that magnetic sphincter augmentation appears to be an effective treatment for GERD with short-term outcomes comparable to the more technically challenging and time-consuming Nissen fundoplication. Long-term comparative outcome data past 1 year are needed in order to further understand the efficacy of magnetic sphincter augmentation.

Warren et al. (2016) conducted a multi-institutional, retrospective cohort study of patients with GERD undergoing either magnetic sphincter augmentation (MSA) or Nissen fundoplication (NF). Comparisons were made at 1 year for the overall group and for a propensity-matched group. A total of 415 patients (201 MSA and 214 NF) underwent surgery. At a minimum of 1-year follow-up, 354 patients (169 MSA and 185 NF) had significant improvement in GERD-HRQL scores (pre to post: 21.3 and 19.4). MSA patients had greater ability to belch (96 vs. 69%) and vomit (95 vs. 43%) with less gas bloat (47 vs. 59%). Propensity-matched cases showed similar GERD-HRQL scores and the differences in ability to belch or vomit, and gas bloat persisted in favor of MSA. Mild dysphagia was higher for MSA (44 vs. 32%). Resumption of daily PPIs was higher for MSA (24 vs. 12, p=0.02) with similar patient-reported satisfaction rates. The authors concluded that in appropriate candidates, MSA is a valid alternative surgical treatment for GERD management, as MSA for uncomplicated GERD achieves similar improvements in quality of life and symptomatic relief, with fewer side effects. However, the authors found that MSA had lower PPI elimination rates when compared to propensity-matched NF cases.

Warren et al. (2017) conducted a retrospective review to evaluate the manometric changes, function, and impact of magnetic sphincter augmentation (MSA) on the lower esophageal sphincter (LES). Inclusion criteria (n=121) consisted of a confirmed diagnosis of gastroesophageal reflux disease by an abnormal esophageal pH study (body mass index <35kg/m, hiatal hernia <3cm, and absence of endoscopic Barrett disease). Manometric changes, pH testing, and proton pump inhibitor use were assessed preoperatively and 6 and 12 months after MSA. MSA was associated with an
overall increase in the median LES resting pressure (18 pre-MSA vs 23mm Hg post-MSA; P = 0.0003), residual pressure (4 vs 9mm Hg; P < 0.0001), and distal esophageal contraction amplitude (80 vs 90mm Hg; P = 0.02). The percent peristalsis remained unaltered (94% vs 87%; P = 0.71). Overall, patients with a manometrically defective LES were restored 67% of the time to a normal sphincter with MSA. Those with a structurally defective or severely defective LES improved to a normal LES in 77% and 56% of patients, respectively. Only 18% of patients with a normal preoperative manometric LES deteriorated to a lower category. The authors concluded that a manometrically defective LES can be restored to normal sphincter, whereas a normal LES remains stable. Details on the original studies were not disclosed in this abstract.

In a retrospective review, Desart et al. (2015) evaluated whether the LINX® magnetic sphincter augmentation system is a safe and effective option for patients with new gastroesophageal reflux disease following laparoscopic sleeve gastrectomy. At 2-4 weeks after the LINX procedure, all patients (n=7) were noted to have self-reported greatly improved gastroesophageal reflux symptoms: statistically significant improved severity and frequency of their reflux, regurgitation, epigastric pain, sensation of fullness, dysphagia, and cough symptoms in their postoperative GERD symptoms compared with their preoperative evaluation. The authors concluded that the LINX® device is a safe and effective option in patients with de novo refractory gastroesophageal reflux disease after a laparoscopic sleeve gastrectomy despite appropriate weight loss. The original study was limited by small sample size and short follow-up period. In addition, there was lack of information about use of PPIs prior to or after the procedure.

Reynolds et al. (2015) conducted a retrospective analysis of 1-year outcomes of patients undergoing magnetic sphincter augmentation (MSA) with the LINX device and laparoscopic Nissen fundoplication (LF) from June 2010 to June 2013. Patients were matched using propensity scores incorporating multiple preoperative variables. Outcomes were measured by GERD Health Related Quality of Life scores, proton-pump inhibitor use, satisfaction, and complications. One hundred and seventy-nine patients met inclusion criteria, 62 MSA and 117 LNF. At 1 year after surgery, both groups had similar GERD Health Related Quality of Life scores (4.2 MSA and 4.3 LNF; p=0.897) and proton-pump inhibitor use (17% of MSA and 8.5% of LNF; p=0.355). Analogous GERD patients had similar control of reflux symptoms after both MSA and LNF. The inability to belch and vomit were significantly fewer with MSA, along with a significantly lower incidence of severe gas-bloat symptoms. These results support the use of MSA as first-line therapy in patients with mild to moderate GERD.

Reigler et al. (2015) evaluated the evidence for magnetic sphincter augmentation device (MSA) and laparoscopic fundoplication (LF) in clinical practice. Two hundred forty nine patients (202 MSA patients and 47 LF patients) had completed one-year follow-up. The LF group was older and had a greater frequency of large hiatal hernias and Barrett’s esophagus than the MSA group (P < 0.001). The median GERD-health related quality of life score improved from 20.0 to 3.0 after MSA and 23.0 to 3.5 after LF. Moderate or severe regurgitation improved from 58.2 to 3.1% after MSA and 60.0 to 13.0% after LF (P=0.014). Discontinuation of PPIs was achieved by 81.8% of patients after MSA and 63.0% after LF (P=0.001). Following MSA, 91.3% of patients were able to vomit if needed, compared with 44.4% of those undergoing LF (P < 0.001). Reoperation rate was 4.0% following MSA and 6.4% following LF. The authors conveyed that antireflux surgery should be individualized to the characteristics of each patient, taking into consideration anatomy and propensity and tolerance of side effects. They concluded that both MSAD and LF showed significant improvements in reflux control, with similar safety and reoperation rates. In their opinion, in the treatment continuum of antireflux surgery, MSAD should be considered as a first-line surgical option in appropriately selected patients without Barrett’s esophagus or a large hiatal hernia in order to avoid unnecessary dissection and preserve the patient’s native gastric anatomy.

In 2013, the National Institute for Health and Care Excellence (NICE) updated its interventional procedure guidance document for Endoluminal Gastroplication for GERD, indicating that the current evidence suggests that there are no major safety concerns associated with endoluminal gastroplication for GERD. According to NICE, evidence from a number of randomized controlled trials (RCTs) shows a degree of efficacy in terms of reduced medication requirement in the short term, but changes in other efficacy outcomes are inconsistent and there is no good evidence of sustained improvement in oesophageal pH measurements.

Complications post magnetic sphincter device implantations are reportedly low as compared to the total number of procedures performed. Smith et al. (2017) reported that out of a total of 3283 procedures reviewed, device removal occurred in 2.7% of cases. The most common causes of removal were dysphagia, continued reflux, and device erosion into the esophagus. Salvador et al. (2017), Parmar et al. (2017), and Lipham, et al. (2015), report similar findings.

**Professional Societies**

**American Gastroenterological Association (AGA)**

In a position statement published in 2008, the AGA assigned a grade of “Insufficient” regarding the use of current and commercially available endoluminal antireflux procedures for the management of patients with an esophageal...
syndrome. The AGA provides no recommendation since there is insufficient evidence to recommend for or against its use (Kahrilas et al., 2008).

**American Society for Gastrointestinal Endoscopy (ASGE)**

In a 2015 guideline on the role of endoscopy in the management of GERD, ASGE states that the endoluminal treatment of GERD is evolving and may have the potential to decrease the need for long-term antisecretory medications in selected patients (ASGE, 2007). However, most studies of endoluminal therapies for GERD have involved small numbers of PPI-dependent patients and have provided relatively limited follow-up information, so the durability of these therapies remains in question. Additionally, both short and long-term safety issues surrounding the endoluminal devices continue to be a concern. The new endoscopic antireflux techniques represent a rapidly evolving area of GI endoscopy, but additional research is needed before they can be widely recommended. Appropriate patient selection and endoscopist experience should be carefully considered before pursuing these therapies. It is important that patients and practitioners alike be aware of the limitations in the evidence that exist with these devices at the present time.

**American College of Gastroenterology (ACG)**

In 2013, the ACG published practice guidelines regarding the diagnosis and management of GERD. They state that the “usage of current endoscopic therapy or transoral incisionless fundoplication cannot be recommended as an alternative to medical or traditional surgical therapy.” This recommendation is considered conditional, based on a moderate level of evidence (Katz et al., 2013).

**Society for Surgery of the Alimentary Tract (SSAT)**

Surgical treatment of GERD is best indicated in patients in whom symptoms are well controlled with PPIs and when GERD is objectively documented by a thorough diagnostic workup. Other indications for surgery include heartburn and regurgitation not completely controlled by medications; when it is suspected that respiratory symptoms or end-stage lung diseases are caused by gastroesophageal reflux; desire of the patient to stop chronic use of PPI; poor patient’s compliance with medical treatment; and when life-long medical treatment is not suitable (Fischella and Patti, 2014).

**American Society of General Surgeons (ASGS)**

In 2014, the ASGS published a position statement regarding its support for the LINX procedure. ASGS states that total management of GERD will likely rely upon a combination of medical and surgical care in the current and near future. ASGS recommends that when considering a surgical procedure, the procedure will need to provide safe control of GERD with minimal side effects. The ASGS states, “Based on currently available information and the experience of their members with the procedure, they support the LINX procedure as a mechanism for controlling GERD when it is placed by properly trained laparoscopic surgeons with experience in foregut surgery and the management of GERD patients.”

In April 2011, the ASGS published a position statement regarding the use of TIF stating that it supports the use of TIF in patients with symptomatic chronic GERD who are not responsive to a standard dose of PPI therapy (ASGS, 2011). The ASGS also supports its use for patients who wish to avoid lifetime drug therapy for this condition. The ASGS also supports the adoption of the procedure by trained general surgeons as a less invasive alternative to more conventional surgical techniques, stating that the preferred surgical technique should be based on the discretion and judgment of the surgeon and the patient’s clinical circumstances. While the ASGS issued a favorable position statement for TIF, their recommendation does not appear to be based on a comprehensive or systematic review of the evidence.

**Society of American Gastrointestinal and Endoscopic Surgeons (SAGES)**

In 2013, SAGES published clinical guidelines regarding endoluminal treatments for GERD. The guideline recommends that although long term data is not yet available, Esophyx may be effective over the short term (6 months to 2 years) in patients with a hiatal hernia with typical or atypical GERD. Additional evidence is required to define optimal techniques and establish appropriate patient selection criteria, and to further evaluate the safety of the device and technique. This recommendation was based on a weak quality of evidence. The guideline states that Stretta is considered an appropriate therapy for patients treated for GERD who are adults, age 18 years or older, with symptoms of heartburn, regurgitation, or both for 6 months or longer, who have been partially or completely responsive to anti-secretory medication therapy, and who have declined the option of laparoscopic fundoplication. This recommendation is based on a strong quality of evidence.

The SAGES Technology and Value Assessment Committee analyzed the safety and effectiveness of the LINX Reflux Management System (2013). They concluded that available data demonstrates a reasonable assurance as to the efficacy of the LINX Reflux Management System, and it may provide an option currently lacking in clinical practice for patients with medically refractory GERD who have not yet progressed to end-stage reflux disease with associated...
complications. They noted that direct comparative studies between the LINX procedure and Nissen fundoplication are needed.

**U.S. FOOD AND DRUG ADMINISTRATION (FDA)**

Several endoscopic antireflux (endoluminal) procedures have received approval by the FDA for treatment of gastroesophageal reflux disease (GERD).


The current generation of EsophyX, EsophyX2, was cleared for marketing as substantially equivalent to the original EsophyX system with minor changes in November 2009 under the U.S. Food and Drug Administration's (FDA) 510(k) process. The original system was cleared for marketing in September 2007 as substantially equivalent to the predicate devices NDO Surgical Endoscopic Plication System, Bard EndoCinch, and EGS StomaphyX Endoluminal Fasteners and Delivery System. According to the approval summary letter, EsophyX2 is indicated for:
- Use in transoral tissue approximation
- Full-thickness plication and ligation in the GI tract
- The treatment of symptomatic chronic gastroesophageal reflux disease in patients who require and respond to pharmacologic therapy
- Narrowing of the gastroesophageal junction
- Reduction of hiatal hernia <2 cm in patients with symptomatic chronic gastroesophageal reflux disease.

See the following websites for more information:
  (Accessed August 14, 2017)

These products are Class II devices (moderate risk) deemed substantially equivalent to other endoscopic devices utilizing other procedures.

Enteryx™, a biocompatible liquid polymer, received FDA approval in 2003 through the premarket approval (PMA) process for the treatment of symptomatic GERD. However, on September 22, 2005, Boston Scientific Corporation issued a recall of Enteryx due to the device polymerizing shortly after injection into a spongy material that cannot be removed. Serious adverse events involved unrecognized transmural injections of Enteryx into structures surrounding the esophagus, potentially resulting in serious injury or death. See the following website for more information: [https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfRes/res.cfm?id=42034](https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfRes/res.cfm?id=42034). (Accessed August 14, 2017)

Gatekeeper, which was expected to gain FDA approval, was withdrawn in late 2005 before approval and is not being marketed.


**CENTERS FOR MEDICARE AND MEDICAID SERVICES (CMS)**

Medicare does not have National Coverage Determinations (NCD) specifically for endoscopic therapies for treating gastroesophageal reflux disease (GERD). Local Coverage Determinations (LCDs) do exist; refer to the LCDs for Category III CPT® Codes, Endoscopic Treatment of GERD, Non-Covered Category III CPT Codes, Noncovered Procedures - Endoscopic Treatment of Gastroesophageal Reflux Disease (GERD), Services That Are Not Reasonable and Necessary, Stretta Procedure, Surgery: Transoral Incisionless Fundoplication (TIF), Transoral Incisionless Fundoplication and Upper Gastrointestinal Endoscopy (Diagnostic and Therapeutic). (Accessed June 15, 2017)
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