Endoscopic Treatment of Refractory Gastroesophageal Reflux Disease

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In Kyung Yoo and Joo Young Cho

Abstract

The key advantages of endoscopic treatment of refractory gastroesophageal reflux disease are that it is less invasive and has less adverse events. Nissen fundoplication has long been considered the gold standard for antireflux surgery. However, it leads to adverse events such as dysphagia, gas bloating, and inability to belch, and 15–30% of patients require re-intervention after surgery. Currently, there are three categories of currently available endoscopic treatments of refractory gastroesophageal reflux disease: endoscopic devices for ablative therapy, gastric fundoplication, and mucosal resection of the gastroesophageal junction (GEJ) which we introduce in this chapter. Stretta utilizes radiofrequency therapy to improve the lower esophageal sphincter (LES) function. Transoral incisionless fundoplication (TIF) was developed to mimic antireflux surgery by constructing a valve at the GEJ. TIF reconfigures the tissue to obtain a full-thickness gastroesophageal valve from inside the stomach, by serosa-to-serosa plications that include the muscle layers. Mucosectomy was based on the principle that after mucosal resection, mucosal healing results in scar formation.

Key Summary

- The main strength of endoscopic treatments of refractory gastroesophageal reflux disease is less invasive.
- Radiofrequency energy delivery to the EGJ (Stretta) has improved the lower esophageal sphincter (LES) function.
- Transoral incisionless fundoplication (TIF) creates molding of tissue and placement of polypropylene suture material in the region of the EGJ. A fundoplication device (EsophyX) is used with a flexible endoscope. The MUSE is an endoscopic stapling device for transoral partial fundoplication.
- Antireflux mucosectomy (ARMS) is based on the principle that after mucosal resection, the mucosal healing results in scar formation and controls reflux symptoms and acid reflux parameters.
- There are several new techniques that have been increasingly used in PPI-refractory GERD. Their selection of options should be tailored and individualized based on the pathophysiology of PPI-refractory GERD.

24.1 General Information

Gastroesophageal reflux disease (GERD) is one of the most common diseases encountered by clinicians, and its prevalence is estimated to be as high as 20–30% in westernized countries. GERD results from the failure of the antireflux barrier, commonly a defective lower esophageal sphincter, which allows for abnormal reflux of gastric contents to the esophagus. Medical treatment for GERD, which is the first-line therapy, results in incomplete resolution of symptoms in up to 40% patients, as medicine alone does not address the mechanical pathophysiology of the disease. Nissen fundoplication has long been considered the gold standard for antireflux surgery. However, studies with longer follow-up have reported relapse rates of up to 50% at 12 years post-laparoscopic Nissen fundoplication [1]. Complications from antireflux surgery include dysphagia of sufficient

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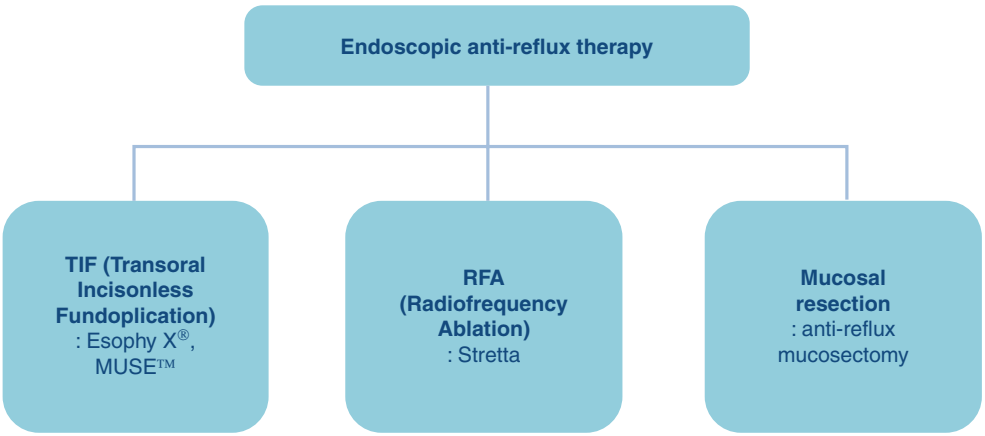


Fig. 24.1 Endoscopic management of refractory GERD

severity that requires esophageal dilation in about 6% of patients treated with fundoplication surgery, as well as a significant increase in flatulence and inability to belch (gas bloat syndrome). Since proton pump inhibitors (PPIs) are known to be associated with multiple adverse events and fundoplication is an invasive procedure, endoscopic treatments ought to be an alternative, especially in cases of refractory symptoms. Among selected patients who have mild forms of the disease without complications and without major anatomical disruptions, patients who are refractory to PPI, those who are not willing to undergo surgery, endoscopic therapy could be an alternative choice of treatment [2] (Fig. 24.1). Radiofrequency ablation (Stretta), transoral incisionless fundoplication (TIF), and mucosectomy are representative endoscopic treatments for refractory GERD. There has been an increased interest in these endoscopic interventions by both patients and practitioners as an alternative to surgical intervention. In this review, we discuss the current endoscopic antireflux therapies and available evidence for their role in the management of GERD.

24.2 Indication

24.2.1 Definition of Refractory GERD

Despite PPIs having been the mainstay of medical management of GERD, 30–40% of patients do not respond to PPIs, and no significant improvement is observed in symptoms when the dose of PPIs is doubled in some patients. Failure of response to PPIs or long-term use of PPIs has now become the most common presentation of GERD in clinical practice. Some authors consider refractory GERD as the failure of response to the standard PPI regimen (once daily), while others believe that only patients who show incomplete or partial response to PPI twice daily should be considered as failure of medical management.

24.2.2 Causes of Refractory GERD

GERD is a multifactorial disease. Factors affecting the development of GERD include mechanical impairment of the GEJ, hiatal hernias (HH), and esophageal acid exposure (EAE). Pathological reflux can result in GERD-type symptoms (heartburn, regurgitation, heartburn) and mucosal disease (esophagitis, strictures, metaplasia, and cancer). Patients who fail to respond to PPI therapy should be first assessed for drug compliance and adequacy of lifestyle modifications. Then, further investigations are usually required because GERD could result from a structural or functional defect in the esophagus.

24.2.3 Pre-GERD Evaluation

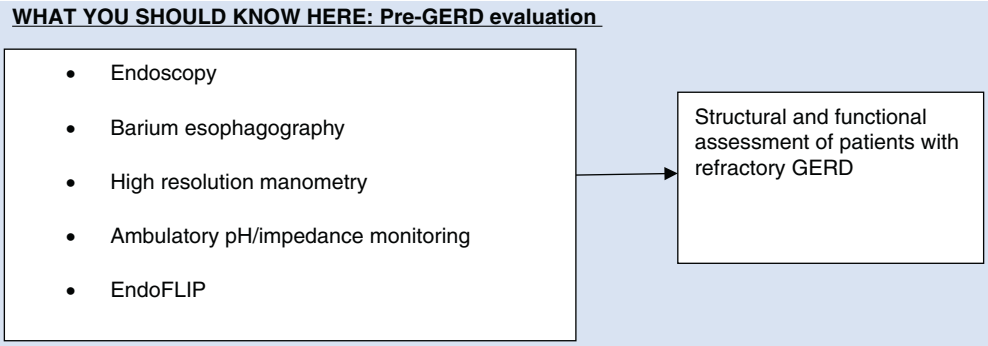
- The structural assessment can be done by endoscopy with biopsy and barium esophagography.
- Functional assessment can be accomplished using high-resolution manometry (HRM), ambulatory impedance-pH monitoring, and endoluminal functional lumen imaging probe (EndoFLIP).
- Upper gastrointestinal endoscopy is also used to evaluate the grade of esophagitis with gastroesophageal flap valve grading (Table 24.1) used to describe the size and grade of HH.

Table 24.1 Hill's grade of gastroesophageal flap valve

	Definition
Grade I valves	Normal ridge of tissue closely approximated to the endoscope
Grade II valves	Presence of a moderately prominent tissue fold; rarely opens with respiration and closes promptly
Grade III valves	A barely present fold; fails to close around the endoscope
Grade IV valves	Lack of a muscular folds, lumen of esophagus stays open all the time, allowing the squamous epithelium to be viewed from below

- Upper gastrointestinal endoscopy also could be helpful in identifying Barrett's esophagus or a peptic ulcer and differentiating from other non-GERD causes such as eosinophilic esophagitis and cancer.
- Ambulatory esophageal pH determines whether the symptoms are truly due to reflux or the existence of persistent abnormal esophageal exposure.
- Esophageal impedance monitoring detects retrograde bolus movement and can determine the nature and proximal extent of reflux, regardless of acidity.
- HRM helps in ruling out motor disorders like achalasia and also assesses ineffective esophageal peristalsis, which plays an important role in the induction of refractory reflux symptoms.
- The EndoFLIP system uses impedance planimetry to determine multiple adjacent cross-sectional areas during volumetric distention. Increased esophagogastric junction (EGJ) distensibility significantly affects the volume of reflux.

What You Should Know Here: Pre-GERD evaluation



24.3 Endoscopic Treatment

Endoscopic therapies are represented by radiofrequency heat treatment, Stretta procedures (Mederi Therapeutics, Greenwich, CT, USA), use of endoscopic staplers for performing endoscopic partial fundoplication, transoral fundoplication with EsophyX® (TIF: Transoral Incisionless Fundoplication) [Endo Gastric Solutions, Redmond, WA, USA], MUSE™ ultrasound endoscopic endostapler (Medigus, Omer, Israel), and antireflux resection of the GEJ mucosa by electrocoagulation (ARMS, antireflux mucosectomy).

24.4 Stretta® Procedure

24.4.1 Definition

Stretta® (Mederi Therapeutics, Norwalk, CT, USA) uses radiofrequency (RF) energy to remodel the EGJ and lower esophageal sphincter (LES). The technology consists of a four-channel low-power (5 W) RF generator and a specialized balloon/catheter system that is used to treat the EGJ and cardia in a series of 1-min treatment cycles. It generates low tissue temperatures (65–85 °C). Stretta therapy remodels the musculature of the LES and gastric cardia. These mechanisms act to restore the barrier function of LES, as well as to significantly reduce regurgitation significantly caused by decreasing the number of transient LES relaxations, TLESRs.

24.4.2 Procedure

The Stretta system consists of a RF generator and single-use RF energy catheters (Fig. 24.2). The RF generator (RF module, Mederi Therapeutics Inc., Norwalk, CT, USA), a multichannel electrosurgical generator, produces low-power (5 W to each of its four independent RF channels) radiofrequency energy using a sinusoidal waveform of 460 kHz. This system employs a special balloon equipped with four needle electrodes (22 G, 5.5 mm), which is extended into the GEJ. The electrodes are inserted into the esophagus or stomach walls, and electricity is passed through the electrodes, creating RF energy (Fig. 24.3). Automatic thermoregulation maintains the target temperature of the electrodes at 65–85 °C by chilled irrigation during the treatment. RF energy is delivered for 60 s. First, the catheter is placed 1 cm above the *Z*-line, and the RF energy is applied through the four needles. Second, the electrodes are rotated 45°, and RF energy is applied for about 60 s using a foot pedal. The RF energy is applied to eight points in the same way at the Z-line and 0.5 cm above and below as well. Next, after the catheter is inserted into the stomach, the balloon is inflated to 25 ml and

Fig. 24.2 Mederi RF generator and Stretta Disposable Catheter (©2018 Mederi RF, LLC)

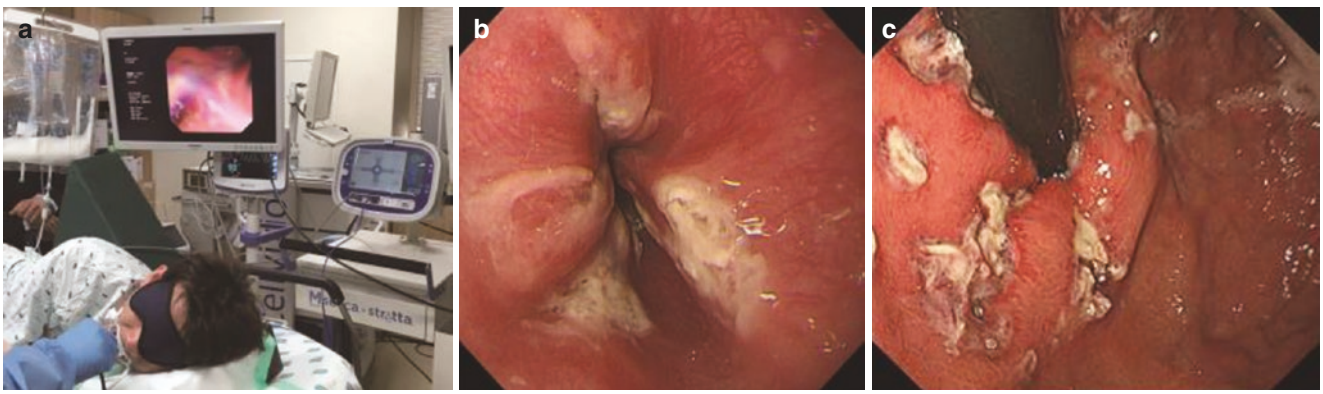


Fig. 24.3 Stretta procedure. (**a**) RF energy catheters insertion state. (**b**) Antegrade view of the squamocolumnar junction. (**c**) Retrograde view of the cardia

then pulled to the proximal site until it is located at the cardia site. RF energy is then applied to 12 points (0°, 30°, and −30°) at this level. Finally, the balloon is inflated to 22 ml and then pulled to the proximal site until it is located at the cardia site. RF energy is applied at 12 places in the same way as before. Therefore, the total therapy points are 56 points, 5 mm apart from six levels (Fig. 24.4), four in LES, and two in the gastric cardia [3].

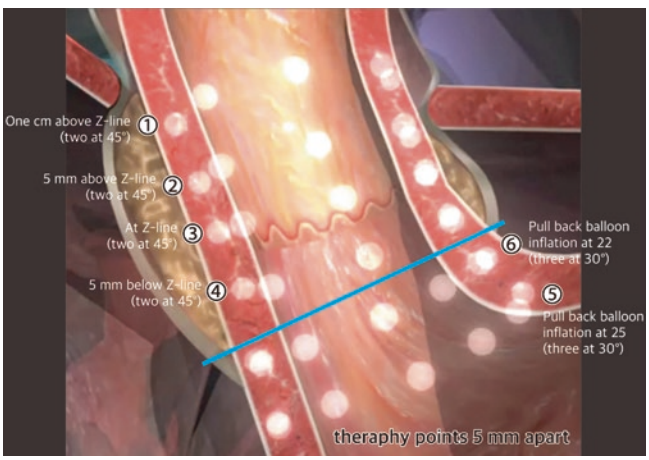


Fig. 24.4 Delivering RF energy to the six treatment levels (©2018 Mederi RF, LLC)

24.4.3 Efficacy and Safety

During short- and midterm follow-up, there has been evidence of significant improvement in subjective and objective indicators of GERD [4]. Long-term efficacy has not been consistently demonstrated, with some series showing that

60% of patients proceed to antireflux surgery, while other series showing a more durable response [5].

Stretta procedures have been performed in more than 18,000 cases worldwide for over 10 years. There are 100 separate publications from 37 clinical studies, and all studies have concluded that Stretta is safe and effective.

Clinical data results have shown that 86% of patients are off daily medication at 4 years post-procedure. Long-term 8-year and 10-year data published in 2014 demonstrated that 76% of patients are off medications at 8 years and 64% of patients are off daily medications at 10 years. Other clinical studies have demonstrated that the Stretta RF treatment results in significant reductions in tissue compliance and transient LES relaxations. Many studies have shown a decrease in esophageal acid exposure after Stretta [6]. Also, a meta-analysis of the studies on Stretta procedure showed a reduction in esophageal acid exposure and improvement in DeMeester scores. The mechanism of Stretta has been noted as decreased tissue compliance, decreased acid exposure, decreased TLESRs, fewer reflux events, increased LES muscle thicknesses, and improved quality of life (Fig. 24.5). Complication rates and adverse events have been reported in less than 1% of patients.

In conclusion, in the short- and long-term follow-up, Stretta is a safe and effective treatment. Use of stretta has shown improvements in subjective and objective outcomes.

24.4.4 Indication

The Mederi RF Generator when used with the Stretta Disposable Catheter is intended for treatment of GERD.

24.4.5 Exclusion Criteria

1. Subjects under the age of 18
2. Pregnant women
3. Patients without a diagnosis of GERD
4. Hiatal hernia >2 cm
5. Achalasia or incomplete LES relaxation in response to swallowing
6. Poor surgical candidate, ASA IV classification

24.5 Transoral Incisionless Fundoplication

24.5.1 Definition

Transoral incisionless fundoplication (TIF) procedure is useful in reinforcing the valve strength. TIF procedure can reduce the distensibility of EGJ, which is associated with a decreased volume of reflux. These results suggest that the intact flap valve may play an assistive role in antireflux barrier and that reporting Hill classification on endoscopy would be helpful in identifying GERD patients.

24.5.2 EsophyX Device (Fig. 24.6)

The EsophyX device (EndoGastric Solutions, Inc., Redmond, WA, USA) was developed for restoring the valve at the GEJ through an endoluminal fundoplication technique. The device is for a single use, handheld flexible instrument that is introduced transorally through the center channel of a flexi-

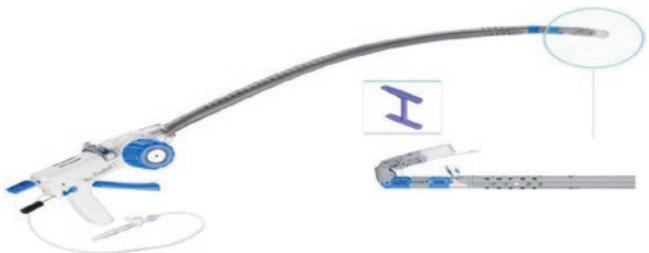


Fig. 24.6 EsophyX® Z+ Device and SerosaFuse® Fastener (© All rights reserved to EndoGastric Solutions, Inc.)

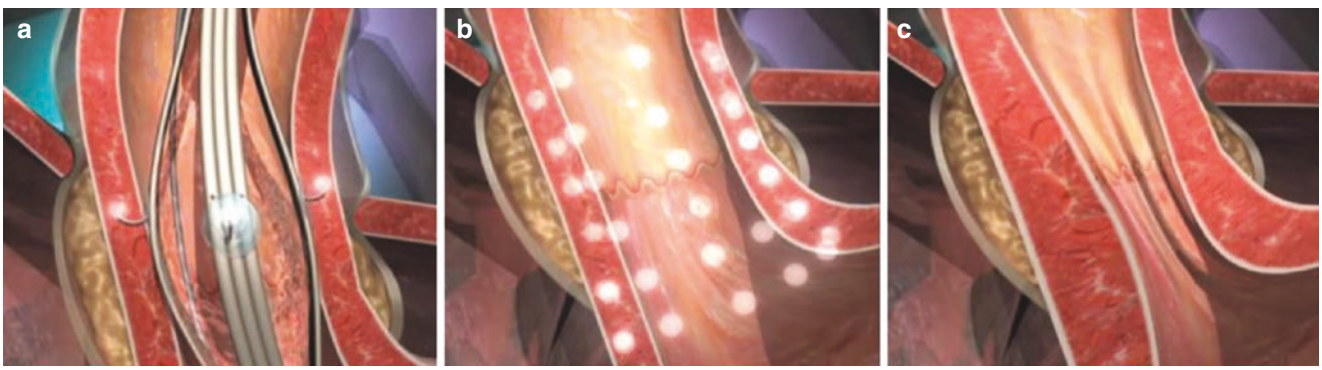


Fig. 24.5 Stretta Mechanism (©2018 Mederi RF, LLC). (**a**) Low-power RF energy delivered to tissue. (**b**) Multilevel treatment at muscle depth improves muscle in the LES and gastric cardia. (**c**) Function improved

ble endoscope, so that the entire procedure can be performed safely under direct visualization. Designed in this manner that the physicians can manipulate the esophageal and gastric tissue and deploy 20 or more, H-shaped polypropylene fasteners in order to secure the rebuilt lower esophageal anatomy to prevent GERD.

24.5.3 Procedure (Figs. 24.7 and 24.8)

The procedure is performed under general anesthesia. An endoscope inserted into the center channel of the EsophyX device is introduced into the stomach. The endoscope is retroflexed, and the device is positioned at the GEJ to rebuild the valve. The TIF procedure plicates the fundus of the stomach around the distal esophagus; then, suction is applied to position the distal esophagus in the abdominal cavity beyond the diaphragm. Strong polypropylene fasteners (same material as 3–0 sutures) are deployed through the apposed layers of esophageal and fundal tissues to anchor the repair. This process is repeated multiple times to create a full-thickness, 270°, 2–3 cm fundoplication, and form the valve. Depending on the device used, total procedure times vary from 30 to 60 min. The procedure is carried out with a third-generation disposable device called "EsophyX Z." The new "EsophyX Z®" device, approved by the FDA in May 2016, has many advantages over the old "EsophyX 2™": fastener deployment performed by pulling a trigger similar to surgical staplers, more efficient dual fastener deployment, safer stylets protected by a sheath, and a 50% shorter operative time.

24.5.4 Indications

The TIF procedure is effective for patients with HH ≤2 cm and Hill Grade I/II valves.

24.5.5 Exclusion Criteria

1. Subjects under the age of 18
2. Body mass index (BMI) >35 kg/m^2
3. Hiatal hernia >2 cm (if it cannot be laparoscopically reduced immediately prior)
4. Esophagitis, Los Angeles classification C or D
5. Barrett's esophagus >2 cm
6. Fixed esophageal stricture or narrowing
7. History of any of the following: resective gastric or esophageal surgery, antireflux surgery with unsuitable anatomy for TIF procedure per physician judgment, achalasia, scleroderma, or dermatomyositis

24.5.6 Efficacy and Safety

Two-year results from the TIF registry showed a 65% normalization in the reflux symptom index score. Furthermore, a randomized controlled trial known as TEMPO indicated sustained improvements in quality of life, including elimination of difficult to control regurgitation (86%) and atypical symptoms (80%) at 5-year follow-up [8]. The TIF 2.0 procedure using the EsophyX may be effective for symptom control and reduced daily dependence on (including cessation) PPI for up to 2–6 years. However, normalization of acid exposure time and complete cessation of PPIs are not achieved in long-term follow-up studies [9]. The TIF procedure is a relatively safe procedure with rare risk of severe complications such as esophageal perforations, bleeding, and pneumothorax.

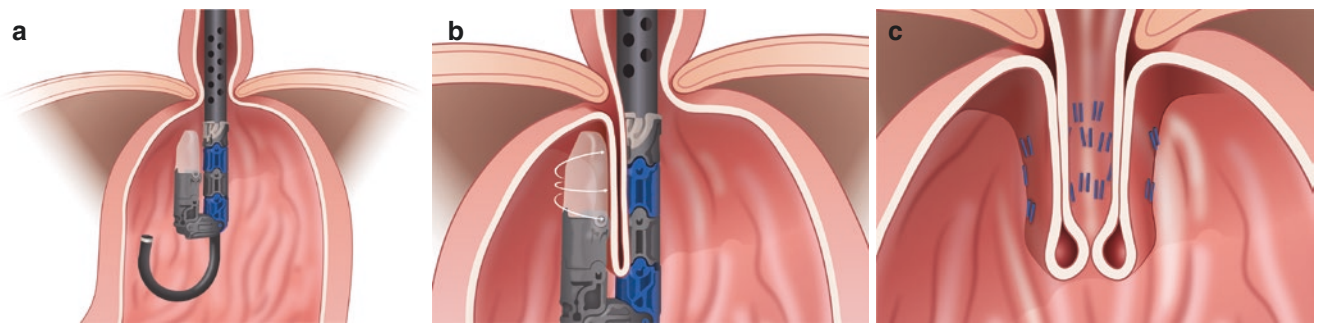


Fig. 24.7 Schematic representation of the procedure with EsophyX® device. (**a**) The EsophyX® device enters the esophagus through the mouth. The endoscope is retroflexed, and device is positioned at the GEJ. (**b**) The device wraps the fundus around the distal esophagus and fastens a tissue fold. (**c**) This step is then repeated until multiple sutures are placed forming a finished valve omega-shaped valve (© All rights reserved to EndoGastric Solutions, Inc.)

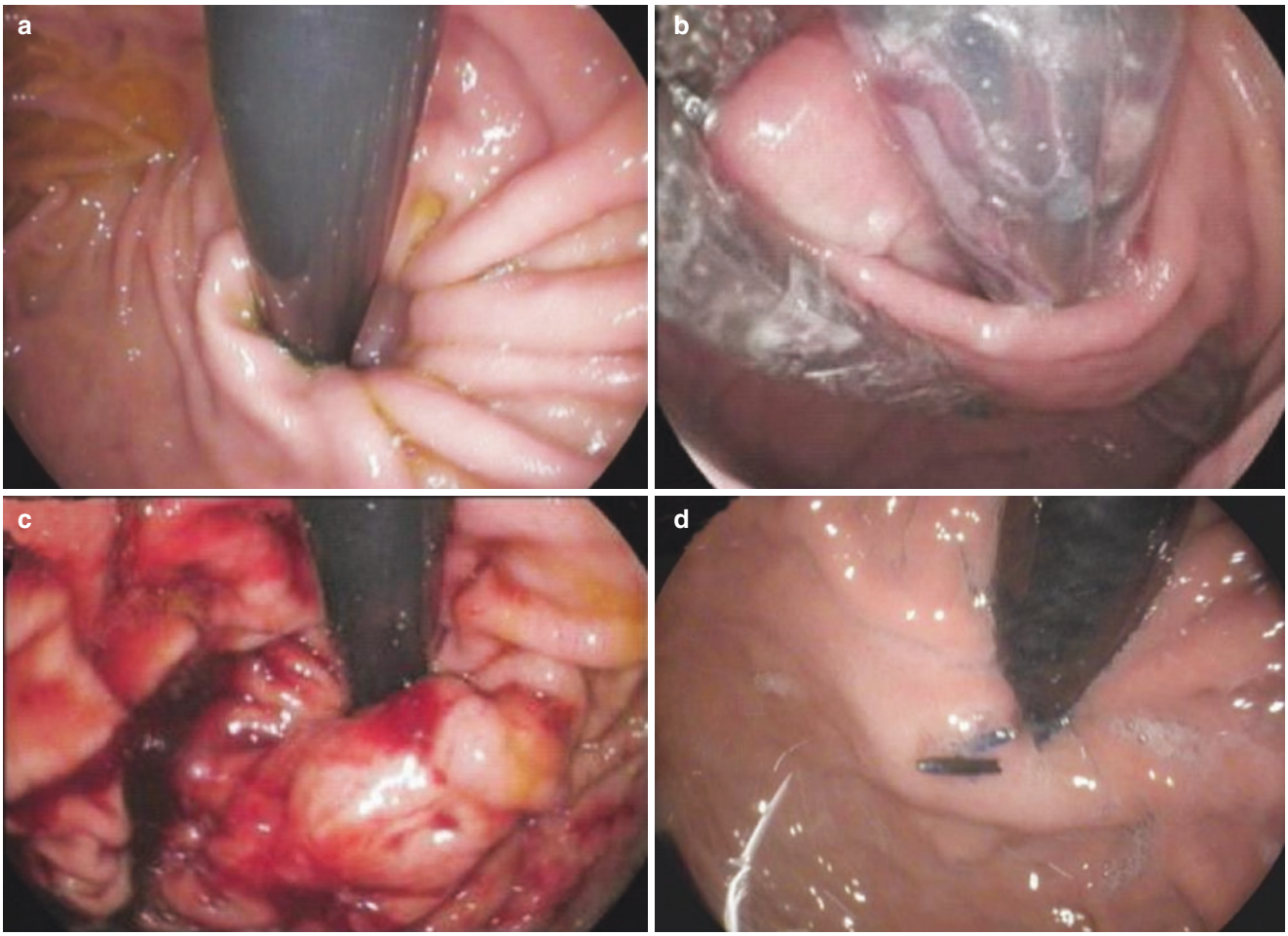


Fig. 24.8 Endoscopic views of the gastroesophageal valve before and immediately after the transoral incisionless fundoplication procedure by EsophyX® device. (**a**) The gastroesophageal valve: before the procedure. (**b**) Create the new gastroesophageal valve: "Bell Roll" maneuver. (**c**) Immediately after the procedure. (**d**) Six months after the procedure (© All rights reserved to Baishideng Publishing Group Inc.) [7]

24.6 MUSE™

24.6.1 Definition (Fig. 24.9)

The MUSE (Medigus, Omer, Israel) is an endoscopic stapling device for transoral partial fundoplication. The complete device consists of a flexible endoscope, an endostapler, a video camera, and an ultrasound transducer (Fig. 24.9). The endostapler, designed to be operated by a single user, includes a handle with controls, a long flexible shaft, a short rigid section holding a cartridge with five standard 4.8 mm titanium surgical staples, a ratchet controlled one-way articulating section, and a distal tip. The distal tip houses an anvil for bending the staples into a B shape, an ultrasonic transducer, a miniature video camera, a light source, and two fine (~21 G) screws. The screws, secured by two nuts in the cartridge, provide a means for compressing tissue and a counterforce for bending the staples. The tip also contains suction/air insufflation and irrigation channels. The control unit interprets signals from the device and displays the resulting data on a video monitor, including the bending angle and force, ultrasound signal level, screw position, and the gap between the distal tip and the cartridge.

24.6.2 Procedure (Figs. 24.10 and 24.11)

The procedure is performed under general anesthesia and endotracheal intubation in the operating room or the endoscopy unit. An overtube is used to insert the endostapler into the stomach where the stapler is retroflexed under video guidance. The stapler cartridge is then pulled back and placed in the esophagus around 3 cm proximal to the EGJ. The operator then use the articulation knob to bend the device tip to press the fundus against the esophagus. The two

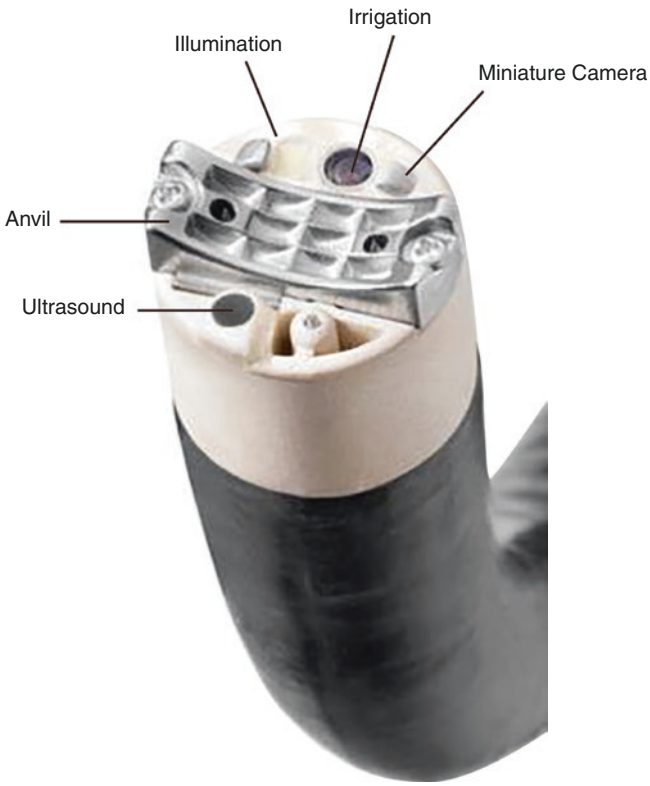


Fig. 24.9 Medigus Surgical Ultrasonic Endostapler system, MUSE™ (Courtesy of Medigus Ltd., Omer, Israel) (©2018 Medigus Ltd)

screws are then deployed to compress the fundus against the esophagus, and tissue thickness is monitored using ultrasonic guidance. The stapler is fired when tissue thickness is 1.4–1.6 cm. The stapler is then withdrawn and reloaded. The procedure is repeated to add additional quintuplets of staples, as allowed by the protocol. The goal was to mimic a partial anterior fundoplication, determined by a Hill Grade I valve, so that no esophageal mucosa is visible around the device in retrograde view.

24.6.3 Indications

TIF is effective for patients with HH ≤2 cm and Hill Grade I/II valves.

24.6.4 Exclusion Criteria

1. Age <18 years
2. BMI >35 kg/m^2
3. Hiatal hernia >3 cm
4. Esophagitis, Los Angeles classification C or D
5. Barrett's esophagus >2 cm

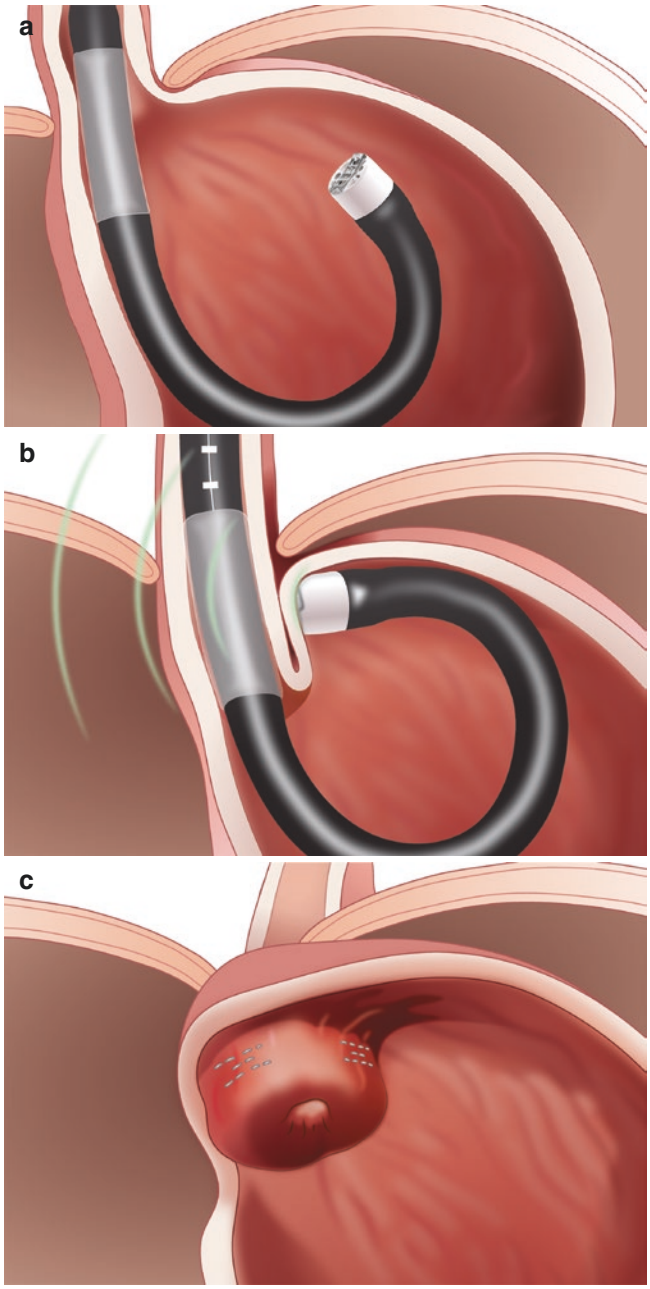


Fig. 24.10 Schematic representation of the (MUSE™) procedure. (**a**) The endostapler is inserted transorally through the overtube and gently advanced into the stomach under direct vision. (**b**) Once in the stomach, the stapler is advanced until the tip is approximately 5 cm past the EGJ and then retroflexed 180° to allow adequate visualization of the gastric fundus and EGJ to select the stapling location. Tissue is clamped and stapled under ultrasonic guidance. (**c**) This step is then repeated at least twice time to reconstruct a robust, tight valve (©2018 Medigus Ltd)

6. Fixed esophageal stricture or narrowing
7. History of any of the following: gastric or esophageal resection surgery, antireflux surgery with unsuitable anatomy for the TIF procedure based on physician's discretion, achalasia, scleroderma, or dermatomyositis

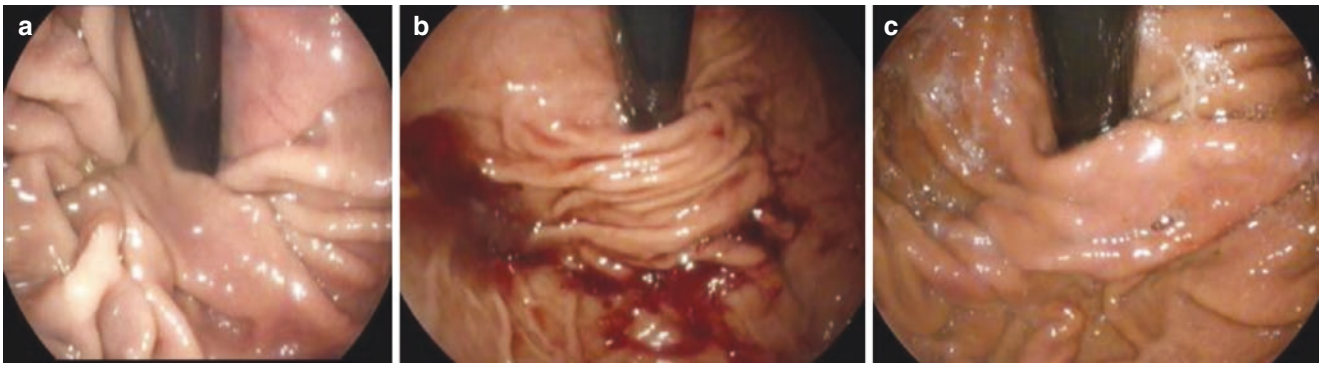


Fig. 24.11 Endoscopic views of the gastroesophageal valve before and after the TIF with the MUSE™. (**a**) The gastroesophageal valve: before the procedure. (**b**) Immediately after the procedure. (**c**) Six months after the procedure (© All rights reserved to Baishideng Publishing Group Inc.)

24.6.5 Efficacy and Safety

In a multicenter study including 66 patients, significant improvement in GERD-HRQL score was found in 73% of patients at 6 months after the procedure [10]. About 65% of patients completely discontinued PPIs, and significant reduction in PPI dosage was observed in 56% of patients who continued PPIs. Esophageal acid exposure time (EAET) also reduced at 6 months. In a long-term follow-up study, 69.4% were off PPIs at 4 years after the TIF procedure. A significant reduction in the GERD-HRQL scores and the daily dosage of GERD medications were found.

The most common adverse effects were chest pain (22%) and sore throat (15%). Serious adverse events such as pneumothorax leading to empyema, bleeding, and esophageal perforation have been reported. Although emerging data with MUSE is encouraging, it is a relatively new procedure with limited long-term data on efficacy and safety. The ideal stapling site for this procedure is also not well known. In summary, MUSE is a promising technique for TIF with additional advantages over EsophyX, including ultrasonic guidance and need for a single operator.

24.7 Mucosectomy

24.7.1 Definition

The mechanism is presumed to be due to scar formation after healing of the mucosal defect [11]. Mucosal healing after esophageal mucosal resection (EMR) or esophageal submucosal dissection (ESD) with an electrocautery knife results in scar formation, narrowing of the GEJ, remodeling of the mucosal flap valve, and reduced reflux. The lesser curvature side of the EGJ is shortened with scar formation, and the greater curve of the EGJ is non-scarred and retains its flexibility as a mucosal flap valve. In 2014, Inoue et al. first published a series of ten patients who underwent the antireflux mucosectomy (ARMS) procedure for refractory GERD with excellent results. This technique, called the ARMS procedure, involves resection of gastric (about 2 cm) and esophageal mucosa (about 1 cm) in crescentic fashion. This results in some remodeling of the mucosal flap valve as an effective antireflux mechanism at the anatomical level. The presence of Barrett's esophagus does not preclude the performance of mucosectomy. Unlike the Stretta procedure, patients with minimal HH or esophagitis could be included.

24.7.2 Indications

1. Moderate to severe GERD
2. Erosive esophagitis
3. Hiatal hernia <3 cm
4. Post gastrectomy with GERD symptoms
5. Barrett's esophagus
6. Post antireflux surgery with GERD symptoms

24.7.3 Exclusion Criteria

1. Hiatal hernia >3 cm
2. Achalasia or incomplete LES relaxation in response to swallow

24.7.4 Procedure (Figs. 24.12 and 24.13)

The mucosectomy procedure can be performed with ESD or EMR. Mucosectomy is performed under conscious sedation. After examining the area for mucosectomy, submucosal

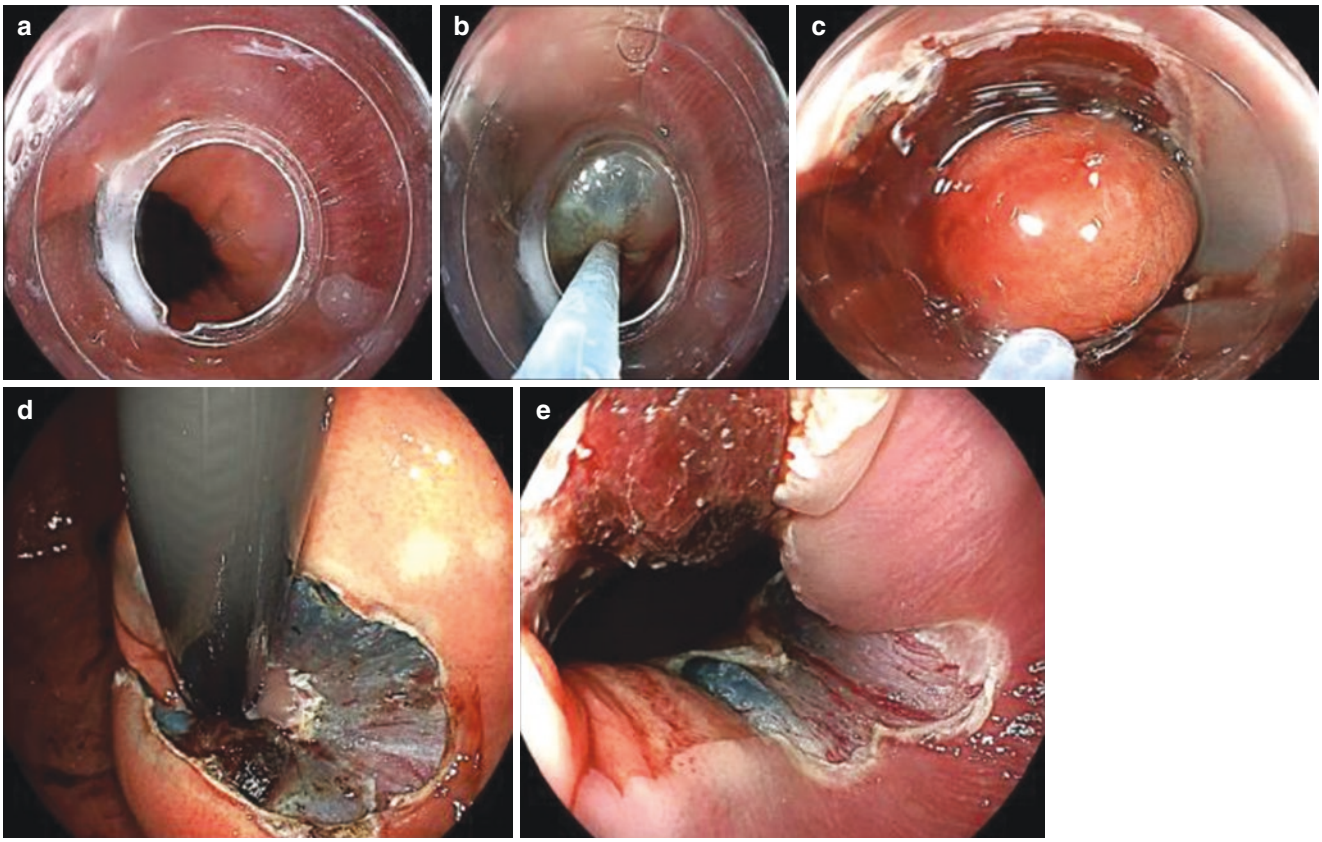


Fig. 24.12 Mucosectomy procedure. (**a**) Cap-equipped endoscope advanced into the EGJ under direct vision. (**b**) Submucosal injection of saline with indigo-carmine at the gastric cardia. (**c**) Application of snare over the mucosa with Cap-EMR technique. (**d**) Completion of near circumferential (2/3) resection of the gastric mucosa in the retroflex endoscopic view. (**e**) After post ARES state in the anterograde endoscopic view

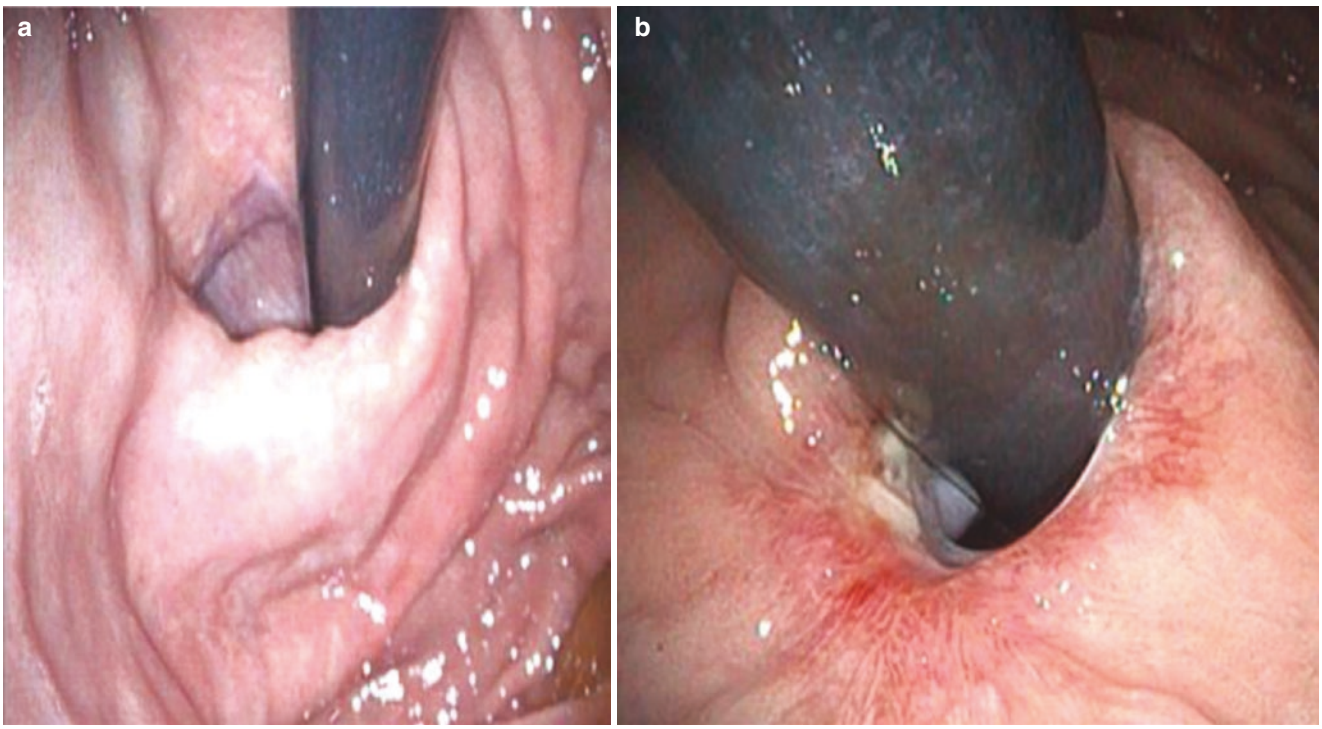


Fig. 24.13 Endoscopic views of the gastroesophageal valve before and 6 months after the mucosectomy. (**a**) Before mucosectomy. (**b**) Six months after the mucosectomy

injection is performed along the markings to ensure adequate lift to prevent deep injury or perforation. Saline with indigo carmine dye is injected into the submucosa. The mucosectomy is performed via EMR or ESD depending on the experience of the endoscopist and the presence of mucosal lesions. Mucosal resection is planned along the lesser curve of the gastric cardia in crescentic fashion. For Cap-EMR, it was carried out repeatedly until the marked mucosal area was completely resected. For ESD, submucosal dissection was completed using electrocautery knives (dual knife or IT knife, KD-612L, Olympus). The ERBE (Medical Systems, Tübingen, Germany) setting was forced coagulation mode 40 W, effect 3. Hemostasis was carried out using coagulating forceps or APC.

24.7.5 Efficacy and Safety

The advantages of ARMS include no requirement of any propriety devices and no endoprostheses left in situ. However, no randomized studies have been conducted, and the durability of response has been unknown. In addition, the amount of mucosa to be resected for optimal results is not known and needs further evaluation. However, in a pilot study of ARMS, there was a reduction in EAET and improvement in flap valve grade on endoscopic examination. In addition, all patients could discontinue PPIs after ARMS.

Bleeding is the most common complication, occurring in up to 8% of patients underwent standard EMR and in up to 7% of patients underwent ESD. Bleeding and perforation risks are likely to be minimal in "expert" hands and, even if experienced, can be resolved using standardized endoscopic recovery techniques such as coagulation forceps or clips. The quantity of mucosa to be resected to induce appropriate scar formation is a key issue in this procedure. Circumferential resection more than 80% causes the junction to become too tight, which requires balloon dilation. On the contrary, insufficient resection requires repeated mucosectomy. Since no randomized studies have been conducted, comparable and longitudinal results are needed.

24.8 Summary

See Table 24.2.

Table 24.2 Comparison of endoscopic antireflux therapies

	Advantage	Disadvantage	Serious adverse events
Stretta	Performed under conscious sedation as a day care procedure Repeatable procedure is possible No scars because of the incisionless approach Easy to perform Procedure duration is short Minimal adverse effects	Expensive Wide variability in response rates (16–86%) Patients with large HH and severe esophagitis are not indicated	Aspiration pneumonia Gastroparesis
Esophy X	No scars because of the incisionless approach Faster recovery Can be revised if required Fewer adverse events and complications	Performed under general anesthesia Conversion to laparoscopic Nissen fundoplication difficult	Bleeding, perforation, pneumothorax
MUSE	Having ultrasonic guidance Performed by a single operator	Not enough evidence to support routine use	Bleeding, pneumothorax, pneumomediastinum
Mucosectomy	No endoprostheses are left in situ Performed under conscious sedation Applied for Barrett's esophagus with high-grade dysplasia Not expensive Available for minimal HH	No randomized studies	Bleeding, perforation

What You Should Know Here: Indications of endoscopic treatment
• Endoscopic therapy of gastroesophageal disease may overcome the "treatment gap" for patients with refractory GERD who are unwilling to undergo surgery
• Endoscopic management of GERD is promising with obvious advantages of a less invasive procedure
• Proper endoscopic management of GERD is needed for each patient based on the patient's situation

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