Devices and techniques for flexible endoscopic management of Zenker's diverticulum (with videos)

Prepared by: Pichamol Jirapinyo, MD, MPH,[1,*] Amrita Sethi, MD, FASGE,[2,*] Barham K. Abu Dayyeh, MD, MPH, FASGE,[3] Manoop S. Bhutani, MD, FASGE,[4] Vinay Chandrasekhara, MD, FASGE,[5] Nikhil A. Kumta, MD, MS,[6] Joshua Melson, MD, MPH, FASGE,[7] Rahul Pannala, MD, MPH, FASGE,[8] Erik F. Rahimi, MD,[9] Guru Trikudanathan, MBBS,[10] John T. Maple, DO, FASGE[11] (previous Committee Chair, 2016-2019), David R. Lichtenstein, MD, FASGE[12] (ASGE Technology Committee Chair)

This document is from the American Society for Gastrointestinal Endoscopy Technology Committee and was reviewed and approved by the Governing Board of the American Society for Gastrointestinal Endoscopy.

Background and Aims: Zenker's diverticulum (ZD) has traditionally been treated with open surgery or rigid endoscopy. With the advances in endoscopy, alternative flexible endoscopic treatments have been developed.

Methods: This document reviews current endoscopic techniques and devices used to treat ZD.

Results: The endoscopic techniques may be categorized as the traditional flexible endoscopic septal division and the more recent submucosal tunneling endoscopic septum division, also known as peroral endoscopic myotomy for ZD. This document also addresses clinical outcomes, safety, and financial considerations.

Conclusions: Flexible endoscopic approaches treat symptomatic ZD with results that are favorable compared with traditional open surgical or rigid endoscopic alternatives. (Gastrointest Endosc 2021;94:3-13.)

The American Society for Gastrointestinal Endoscopy (ASGE) Technology Committee provides reviews of existing, new, or emerging endoscopic technologies that have an impact on the practice of GI endoscopy. Evidence-based methods are used, with a MEDLINE literature search to identify pertinent clinical studies on the topic. This is supplemented by accessing the "related articles" feature of PubMed and by scrutinizing pertinent references cited by the identified studies. Controlled clinical trials are emphasized, but in many cases data from randomized controlled trials are lacking. In such cases, large case series, preliminary clinical studies, and expert opinions are used. Technical data are gathered from traditional and Web-based publications, proprietary publications, and informal communications with pertinent vendors. Technology Status Evaluation Reports are drafted by 1 or 2 members of the ASGE Technology Committee, reviewed and edited by the committee as a whole, and approved by the Governing Board of the ASGE. When financial guidance is indicated, the most recent coding data and list prices at the time of publication are provided. For this review the MEDLINE database was searched through March 2019 for articles related to endoscopic treatment of Zenker's diverticulum by using keywords such as "endoscopy" or "endoscopic" combined with "Zenker" or "Zenker's diverticulum," among others. Technology Status Evaluation Reports are scientific reviews provided solely for educational and informational purposes. Technology Status Evaluation Reports are not rules and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment or payment for such treatment.

Zenker's diverticulum (ZD), also known as cricopharyngeal (CP) or pharyngoesophageal diverticulum, is an acquired pulsion-type pseudodiverticulum in the pharyngoesophagus. An increase in intraluminal pressure leads to an outpouching of the mucosa and submucosa through an area of weakness of the posterior hypopharynx known as Killian's triangle (Fig. 1). ZD is a relatively uncommon condition, with an overall prevalence of .01% to .11% in the United States.[1] It occurs more frequently in men than women, commonly presents in the seventh and eighth decades of life, and has a higher incidence in Western than Asian countries.[2,3] Symptoms may include dysphagia, regurgitation, aspiration, cough, foreign body sensation, halitosis, and weight loss.[4]

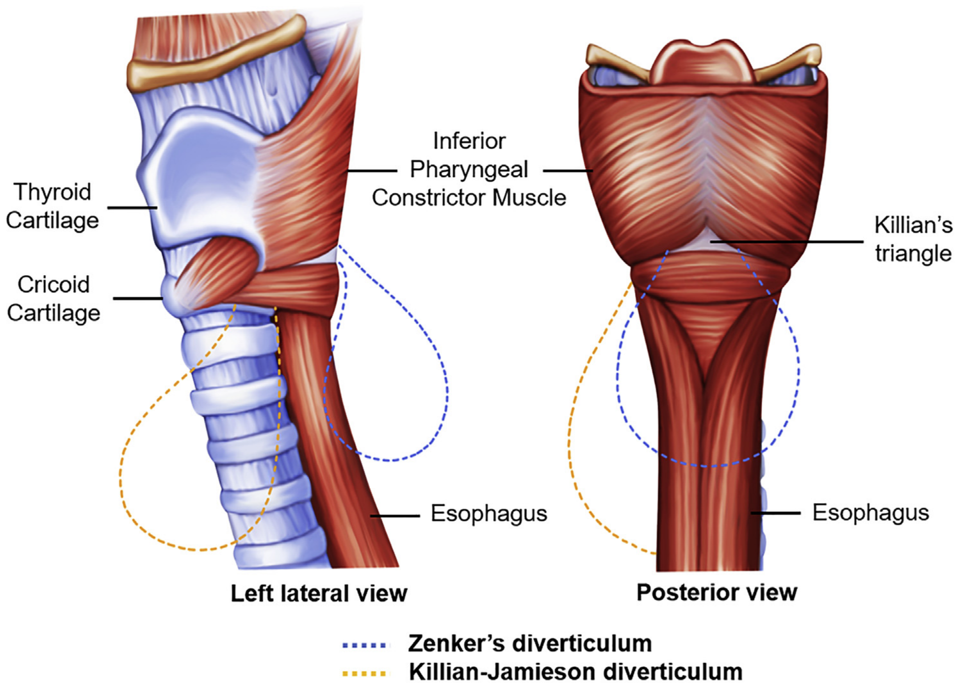

Figure 1. Zenker's diverticulum arising as an acquired outpouching of mucosa and submucosa through an area of the posterior hypopharynx known as Killian's triangle. Killian's triangle is located between the cricopharyngeus and thyropharyngeus of the inferior constrictor muscles. In contrast, a Killian Jamieson diverticulum arises inferolateral to the cricopharyngeus muscle.

Traditionally, treatment options for ZD have included open surgery (ie, transcervical diverticulectomy, diverticulopexy, or diverticular inversion with or without myotomy of the CP muscle) and rigid endoscopy (ie, endoscopic stapling or CO_2 laser treatment). Flexible endoscopic treatment of ZD was first described in 1995 and provides several potential advantages compared with open surgical or rigid endoscopic approaches, including the avoidance of general anesthesia (necessary for surgical approach) and neck hyperextension (necessary for rigid endoscopic approach).[5] Over the past 2 decades, several flexible endoscopic techniques and devices have been developed for the treatment of ZD. This review summarizes available and emerging devices and techniques for the flexible endoscopic treatment of ZD, including safety and efficacy data.

TECHNICAL CONSIDERATIONS

The common principle of ZD treatment is the ablation or division of the CP septum (CP septotomy or myotomy) to allow improved relaxation of the upper esophageal sphincter and to reduce the size of the diverticulum. There are many variations in the techniques for performing septotomy/myotomy. The traditional technique, flexible endoscopic septal division (FESD), involves incision and division of the entire septum including mucosa and muscular fibers (Fig. 2A). In contrast, during submucosal tunneling endoscopic septum division (STESD; also known as peroral endoscopic myotomy [POEM] for ZD [Z-POEM]), a septal myotomy is performed via a submucosal tunnel while leaving the overlying mucosa intact (Fig. 2B).

Preprocedural assessment and preparation

Barium esophagram remains the criterion standard modality for the diagnosis of ZD, because it allows for dynamic visualization at various stages of deglutition and assessment of diverticular sac dimensions. An index upper endoscopy may also be performed. On a radiologic and/or endoscopic examination, it is important to note the location and orientation of the diverticulum. Specifically, in contrast to ZD, which is located posteriorly to the cervical esophagus, a Killian-Jamieson diverticulum represents an outpouching that is located anteriorly and laterally (Fig. 1). Accurate diagnosis is essential because Killian-Jamieson diverticulum requires a different treatment approach from ZD. In addition to barium esophagram and endoscopy, several assessment tools to quantify dysphagia severity have been developed and validated, including the Swallow Quality of Life questionnaire,[6,7] which is a 44-item tool that assesses dysphagia-related quality of life, and the Eating Assessment Tool questionnaire,[8] which is a self-administered 10-item symptom-specific outcome instrument for dysphagia.

Endoscopic treatment of ZD has been reported using moderate sedation, deep sedation, and general anesthesia.[9] Patients may be placed in a left lateral decubitus or supine position. Some authors have reported the use of prophylactic periprocedural antibiotics.[5,10-16]

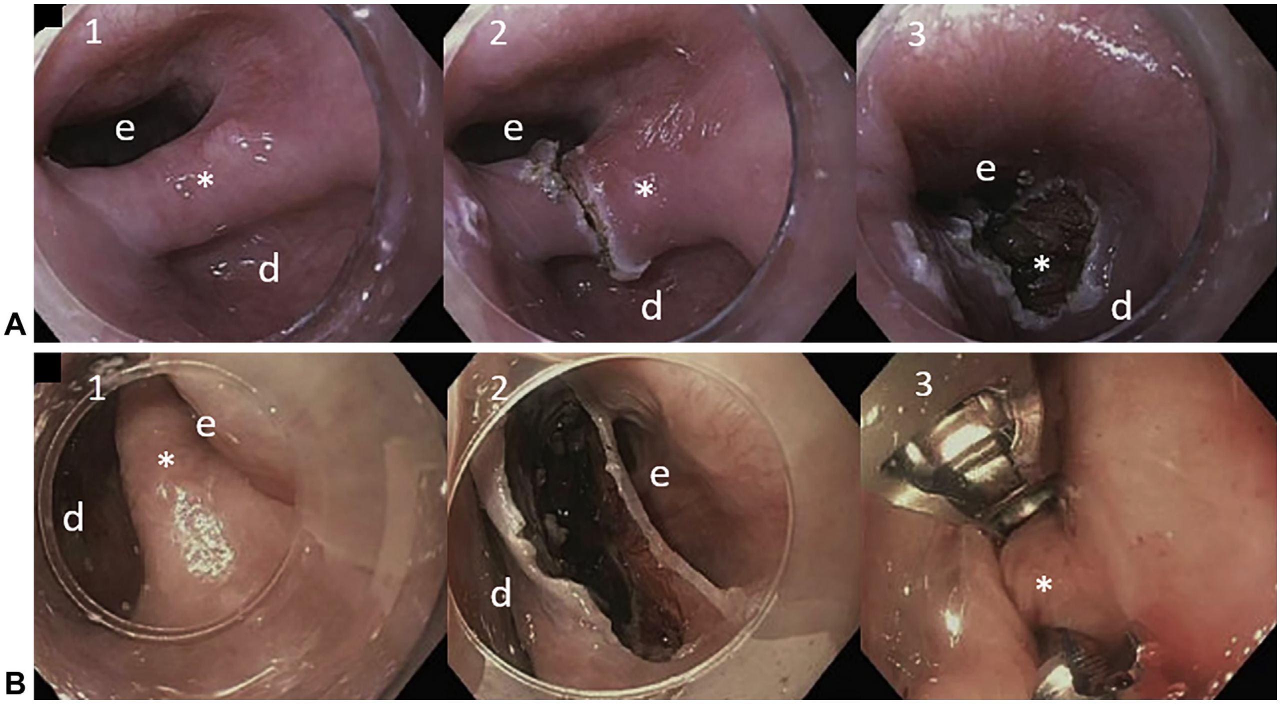

Figure 2. Flexible endoscopic treatment of Zenker's diverticulum. **A,** Flexible Endoscopic Septal Division (FESD). 1) In this image, the septum (*) is seen separating the esophageal lumen (*e*) from the diverticulum (*d*). (2 and 3) A cutting device has been used to divide the septum down to the base of the diverticulum. **B,** Submucosal Tunneling Endoscopic Septal Division (STESD), also known as Zenker's Peroral Endoscopic Myotomy (Z-POEM). 1) The septum (*) is visualized separating the esophageal lumen (*e*) and the diverticulum (*d*). 2) A mucosal incision has been made along the rim of the septum, submucosal tunneling has been performed along each side of the septal muscle and this has then been cut (myotomy). 3) The mucosal incision is then closed (in this image suturing is performed using the Overstitch device [Apollo Endosurgery Inc, Austin, Tex, USA]). Courtesy of Dr Pichamol Jirapinyo and Dr Christopher C. Thompson, Brigham and Women's Hospital, Boston, Mass, USA.

Intraprocedural devices and considerations

Specific techniques and associated outcomes are discussed below. Devices that are common to different techniques during different aspects of the procedure are reviewed in this section.

Septal exposure devices. Various devices have been used to improve septal exposure, stabilize the endoscopic position, and protect the esophagus and pouch from thermal injury. These devices are typically used after diagnostic endoscopy and before the myotomy or septotomy (Fig. 3).

A *transparent distal attachment (cap)* is attached to the tip of the endoscope. It allows better visualization of the tissue bridge between the esophagus and the diverticulum by preventing closure of the upper esophageal sphincter. It may also aid cases of difficult intubation arising from ZD. Caps are disposable and available from many manufacturers with various modifications and are described in detail in a previous American Society for Gastrointestinal Endoscopy (ASGE) technology assessment entitled "Endoscopic submucosal dissection."[17]

The *diverticuloscope* (ZDO-22-30; Cook Medical, Bloomington, Ind, USA) consists of a rubber overtube (22 mm in diameter, 30 cm in length) with 2 distal flaps that protect the anterior esophageal and posterior diverticular walls. The diverticuloscope is advanced over the endoscope and positioned such that the septum is effectively straddled. The diverticuloscope is not currently available and not expected to become available in the United States

A *nasogastric* or *orogastric tube* may be placed into the esophagus over an endoscopically placed guidewire; this may require cutting the tip of the tube to create an end hole. In addition to enhancing visualization, nasogastric or orogastric tube placement may protect the anterior esophageal wall from thermal injury during septotomy. Nasogastric and orogastric tubes have been described in detail in an ASGE technology assessment entitled "Enteral nutrition access devices."[18]

Cutting devices. Multiple electrosurgical devices have been used for the performance of the septotomy or myotomy, most commonly knives and scissor devices and less commonly argon plasma coagulation and forceps devices, among others (Fig. 4). These devices are summarized in Table 1. The ASGE technology assessment on endoscopic submucosal dissection (ESD) also describes many of these devices in greater detail.[17] Among electrosurgical knives, those with a central capillary for a water jet function are more commonly used with ZD myotomy techniques that use submucosal tunneling (detailed below).

Electrosurgical generator unit. An *electrosurgical generator unit* is required to power the cutting devices.

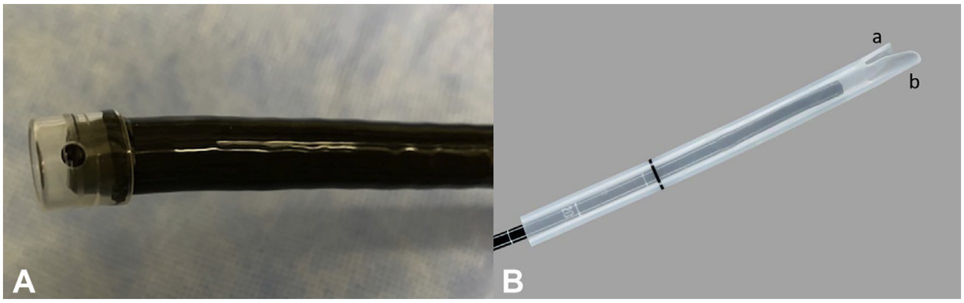

Figure 3. Septal exposure devices. **A,** Transparent distal attachment (cap). **B,** Diverticuloscope. Permission for use granted by Cook Medical, Bloomington, Indiana. This overtube is used during flexible endoscopic diverticulotomy. The tube is guided into place over the endoscope and the septum is fit into the groove so that the shorter lip (*a*) is placed into the diverticulum and the longer bill (*b*) is kept in the esophageal lumen.

Figure 4. Cutting devices for flexible endoscopic management of Zenker's diverticulum. **A,** Needle knife papillotome. Reprinted with permission from Olympus America. **B,** Hook knife. Reprinted with permission from GIE 2015;81:1311-25.[17] **C,** ITKnife. Reprinted with permission from GIE 2015;81:1311-25.[17] **D**, ITKnife2. Reprinted with permission from GIE 2015;81:1311-25.[17] **E,** DualKnife. Reprinted with permission from GIE 2015;81:1311-25.[17] **F,** Coagrasper hemostatic forceps. Reprinted with permission from GIE 2015;81:1311-25.[17] **G,** SB knife. Reprinted with permission from Olympus America. **H,** Clutch cutter. Permission for use granted by FujiFilm Corporation. **I,** HybridKnife I type. Reprinted with permission from GIE 2015;81:1311-25.[17] **J,** HybridKnife T type. Reprinted with permission from GIE 2015;81:1311-25.[17]

Several newer electrosurgical generator units provide multiple features and functionality that facilitate safe and effective septotomy and/or myotomy. Details of electrosurgical generator units and their settings are discussed in separate ASGE statements entitled "Electrosurgical generators" and "Endoscopic submucosal dissection."[17,30] In 2 large series

Figure 4. Continued

of FESD, a fractionated cutting mode that alternated cutting and coagulation cycles was used for the mucosal incision and septotomy.[14,16] Series using scissor-type knives for FESD have also reported the use of a fractionated cutting mode.[23,24] Electrosurgical generator unit settings for the different steps in STESD are similar to those used for POEM and are described in the ASGE technology assessment of POEM.[31] As in ESD and POEM, hemostatic forceps may be used to treat or prevent bleeding from larger vessels, often using "soft" coagulation current.

Closure devices. Through-the-scope (TTS) endoscopic clips are available in a variety of dimensions and features (eg, rotatability). After FESD, TTS clips may be placed at the distal aspect of the septotomy to treat microperforations and prevent delayed perforations. TTS clips can also be used to close the mucosotomy when STESD is performed.

An endoscopic suturing device (Overstitch; Apollo Endosurgery, Austin, Tex, USA) is available in 2 iterations: the legacy Overstitch device, which requires a double-channel endoscope, and the newer Overstitch Sx, which is compatible with single-channel endoscopes. These are described in detail in an ASGE technology assessment entitled "Endoscopic closure devices."[32] The Overstitch device has been used to close the mucosotomy when STESD is performed. Additionally, the suturing device can be used to secure the CP muscle to provide traction during septotomy, further described below.[33]

Postprocedural care

Patients may be discharged as outpatients as long as there are no apparent adverse events (AEs). However, given that many ZD patients are older and may have associated medical comorbidities, most endoscopists elect to hospitalize patients for 24 to 48 hours for observation. Patients usually take nothing by mouth on the day of the procedure before advancing to a clear liquid diet the next day, with further advancement of the diet as tolerated. Postprocedural antibiotics and follow-up endoscopies are used variably in the available literature. Similarly, although postprocedural radiologic studies are usually performed only when perforation is suspected, other endoscopists routinely obtain a contrast study. The presence of residual diverticulum and its filling with contrast do not appear to correlate significantly with symptomatic recurrence.[34]

TECHNIQUES AND CLINICAL OUTCOMES

At the time of ZD treatment, it is important to carefully evaluate the diverticulum. Specifically, the width and length of the diverticulum should be measured. The location and orientation of the diverticulum should also be assessed because these characteristics may affect the treatment approach. All food and debris should be cleared from the diverticulum before commencing treatment.

TABLE 1. Cutting devices for flexible endoscopic management of Zenker's diverticulum

Device	Manufacturer	Characteristics	Specific features
Electrosurgical knives			
Needle-knife papillotome (sphincterotome)	Boston Scientific Cook Medical Mediglobe Olympus	A straight, fine-wire electrode	Low cost Easy accessibility
Hook knife[19,20]	Olympus	Bent tip at a right angle to create an L-shape rotatable hook A 4.5-mm knife electrode A 1.3-mm hook	Upward direction of muscle cutting may reduce the risk of perforation
Insulated-tip knife and IT-Knife 2[15]	Olympus	A 4-mm knife electrode A 2.2-mm insulated ceramic ball A triangular electrode beneath the ceramic ball to facilitate cutting (IT-Knife 2 only)	The ceramic ball helps protect the esophageal or diverticular wall from thermal injury
Hybrid knife, DualKnife and DualKnife J[21]	Erbe USA Olympus	A 5-mm cutting knife (Hybrid knife) A 2-mm cutting knife (DualKnife, DualKnife J) A central capillary within the cutting knife for water jet (Hybrid knife, DualKnife J) Flared tip	The flared tip allows the exact amount of tissue to be grasped and dissected without having to rotate or reorient the system Simultaneous injection and dissection (Hybrid knife, DualKnife J)
Forceps			
Hot biopsy forceps[5]	Boston Scientific Conmed Cook Medical Olympus US Endoscopy	Two jaws with blunted edges An insulated catheter shaft	Low cost Easy accessibility
Coagulation forceps[22]	Olympus	Two flat jaws A rotatable shaft	Ease of use Easy accessibility
Electrosurgical scissors			
Stag-beetle knife[23-25]	Olympus	A scissor-shaped cutting tool Comes in 3 sizes Junior: 3.5-mm forceps length Short: 6-mm forceps length Standard: 7-mm forceps length Insulated exterior portion of the blades A rotatable shaft	Efficient incision of the diverticular septum via a scissor-like movement Rotatability allows the blades to be aligned perpendicular to the septum Insulated exterior minimizes injury to adjacent tissue
Clutch cutter[26]	Fujifilm	A forceps-type resection device A 3.5- or 5-mm-long and a .4-mm-wide serrated cutting edge A rotatable shaft Insulated exterior portion of the jaws	Insulated exterior minimizes injury to adjacent tissue

Others that are beyond the scope of this review because of limited literature are stapling devices (MicroCutter XCHANGE 30, Cardica Inc, Redwood City, Calif, USA),[27] flexible rotatable bipolar forceps (Johnson & Johnson),[28] and Ligasure (Medtronic).[29] Also see Figure 4 for examples of these cutting devices.

Flexible endoscopic septal division

Techniques. Traditionally, the incision technique involves a single midline incision of the septum in a craniocaudal direction, which exposes the transverse fibers of the CP muscle. This results in a "V"-shaped form of the incised diverticular bridge. The incision should not extend beyond the inferior portion of the diverticulum to minimize risk of perforation. TTS clips may be placed at the distal aspect of the septotomy to prevent delayed perforations (Video 1, available online at www.giejournal.org).

A double-incision technique (Fig. 5) has been described in which two 1-cm incisions are made 1 cm apart from each

Figure 5. Treatment of Zenker's diverticulum using the double incision technique. With the double incision combined with snare resection of the septum between the two incisions, a wide septotomy of the diverticular bridge in a "U"-shape is achieved. Reprinted with permission from Gölder SK, et al.[36]

other.[35,36] The septum between the incisions is then resected using a snare, and the base is clipped. This dissection pattern results in a "U" shape of the incised diverticular bridge. It has been hypothesized that this method may lead to a more complete dissection of the CP muscle, which may result in a reduced recurrence rate.[35,36] In a similar technique, the CP septum is fixed using a suture, which is then brought out through the mouth and secured with a clamp to provide traction. Parallel incisions along each side of the suture are then performed, followed by snare resection at the incision base.

Efficacy. A meta-analysis of 20 studies including 813 patients that used the FESD technique reported a pooled clinical success rate of 91% (range, 56.4%-100%) at mean follow-up durations ranging from 7 to 43 months.[9] The cutting devices used were a needle knife (13 studies), hook knife (4 studies), stag-beetle knife (2 studies), hybrid or dual knife (1 study), insulated-tip knife (1 study), coagulation forceps (1 study), argon plasma coagulation (1 study), and hot biopsy forceps (1 study). Of note, some studies reported a series of using different cutting devices. Clinical success was variably defined by improvement in a dysphagia symptom score, although different scoring systems were used in the included studies. Of 20 included studies, 10 (50%) used a needle knife, whereas a variety of electrosurgical devices were used in the other 10 studies, including hot biopsy forceps, hemostatic forceps, argon plasma coagulation, insulated-tip knife, and stag-beetle knife. A sensitivity analysis suggested that studies published after 2006 were associated with a higher success rate (97%) than studies published in 2005 or earlier (91%; $P = .039$). Diverticulum size or type of cutting device was not associated with the clinical outcome. The pooled recurrence rate was 11% (range, 0%-32%) with varied definitions of recurrence including deterioration in a symptom score, requiring additional treatment.

Another meta-analysis of 13 studies with 589 patients that included only studies using a needle knife for septotomy reported similar outcomes.[37] In this study, a subgroup analysis reported recurrence rates of 8% (95% confidence interval [CI], 4%-14%) and 18% (95% CI, 11%-27%) for large diverticula ($\geq$4 cm) versus small diverticula (<4 cm), respectively.[37] A separate prospective study including 89 patients who underwent FESD demonstrated that pretreatment ZD size ($\geq$50 mm), post-treatment ZD size ($\geq$10 mm), and length of the septotomy ($\leq$25 mm) were predictors of symptom recurrence within 48 months.[16] In a retrospective series of 150 patients, the recurrence rate after FESD was 23.1%. Of those who underwent repeat treatment (n = 23), 78.3% achieved symptom remission after redo-septotomy.[14] Efficacy data for other techniques that involve excision of a portion of the septum remain limited to small case series, with reported clinical success rates of 87.5% to 100%[36,38] and a recurrence rate of 9.5% in 1 series.[39]

Data on direct comparisons among different ZD treatment approaches (surgical vs rigid endoscopic vs flexible endoscopic) remain limited. A systematic review of 41 studies with 2826 patients who underwent open surgical treatment of ZD revealed symptom resolution in 90% to 95% with an overall morbidity of 10.5% and mortality of .6%.[40] A separate review of 19 studies with 1060 patients who underwent ZD treatment using a rigid endoscopic approach (CO_2 laser or stapled techniques) reported clinical success (satisfactory symptom relief) in 90.6% to 93% with an AE rate of 9.3% and a mortality rate of .2%.[40] In a meta-analysis of 11 studies with 596 patients that compared surgical and endoscopic (both rigid and flexible) approaches for ZD treatment, endoscopic treatment of ZD was associated with a shorter length of procedure and hospitalization, earlier diet introduction, and lower rates of AEs.[41] However, in this meta-analysis, an endoscopic approach was also associated with a higher rate of symptom recurrence.[41] In a retrospective observational study of 52 patients who underwent ZD treatment (33 surgical, 8 rigid endoscopic, and 11 flexible endoscopic), no differences were observed between the groups with regard to clinical success or AEs, whereas length of stay was shorter in the flexible endoscopy group.[42]

Safety. In a meta-analysis of 20 studies on FESD including 813 patients, the pooled AE rate was 11.3% (95% CI, 8%-16%). These included perforation (n = 28, 3.4%), bleeding (n = 24, 3.0%), subcutaneous emphysema (n = 16, 2.0%), fever (n = 15, 1.8%), pneumonia (n = 3, .4%), hemorrhage (n = 2, .2%), and neck abscess (n = 1, .1%).[9] All AEs were managed conservatively, including endoscopic management of bleeding. Only 2 cases of abscess or infection required further intervention with drainage; however, no surgical interventions were required.[8] Similarly, a meta-analysis on FESD of 13 published studies including 589 patients using a needle-knife technique reported a pooled AE rate of 13% (95% CI, 8%-22%) with a perforation rate of 7% (95% CI, 4%-12%) and a bleeding rate of 5% (95% CI, 3%-10%).

Submucosal tunneling endoscopic septum division

Techniques. STESD (Fig. 2B) refers to more recently described techniques for the endoscopic treatment of ZD that are based on principles similar to conventional esophageal POEM. These include full exposure of the muscular layer, allowing complete myotomy and mucosal closure of the submucosal tunnel, which prevents mediastinal infection. STESD has also been termed as Z-POEM and diverticular POEM by some authors.[43-46] For this procedure, the first step is an initial mucosal incision below the upper esophageal sphincter but proximal to the level of the septum. During the second step, a submucosal tunnel is created to the level of the septum and extended down both sides of the septum as well. This is followed by septal myotomy, which may extend a short distance beyond the level of the septum to ensure complete myotomy of the septal wall. Subsequent closure of the mucosotomy provides mediastinal protection by sealing off the tunnel and any exposed areas from luminal contents. As with POEM, the devices selected are based on endoscopist preference and parallel those used in POEM (Video 2, available online at www.giejournal.org). In a related technique termed ZD peroral septotomy, the mucosotomy is located along the rim of the septum.[47,48]

The STESD technique should be performed by endoscopists familiar with traditional esophageal POEM procedures. Additionally, there is a potential issue with patient discomfort because of the clips used to close the mucosal incision given the location in the proximal esophagus. A question has been raised regarding the physiologic effect of the remaining septal mucosal flap and whether it may result in persistent retention of food and recurrence of symptoms. In reports of the procedures to date, this does not seem to be the case. Further data on long-term follow-up are required to understand the potential effect on recurrence rates of ZD compared with other methods.

Efficacy and safety. Z-POEM could be a promising technique to allow complete transection of the ZD septum because submucosal tunneling enables complete exposure and dissection of the septum. However, outcomes data for STESD are very limited. A multicenter international series including 75 patients from 10 centers demonstrated a technical success rate of 97.3% and clinical success rate of 92% with a decrease in mean dysphagia score from 1.96 to 0.25 ($P < .0001$) at a median follow-up of 291.5 days (interquartile range, 103.5-436). The mean procedure time was 52.4 $\pm$ 2.9 minutes, and the mean length of hospital stay was 1.8 $\pm$ .2 days. The AE rate was 6.7%, which included 1 case of mild bleeding managed conservatively and 4 cases of perforation (1 severe, 3 moderate). At 1 year, 1 of 31 patients (3.2%) reported dysphagia recurrence, which was treated with repeat endoscopic diverticulotomy.[49]

EASE OF USE

Flexible endoscopic treatment of ZD requires specialized training and equipment. The parameters to assess competency in performing endoscopic Zenker's diverticulotomy have not been established. Endoscopists performing these procedures typically have training and experience with related procedures such as ERCP with needle-knife sphincterotomy, ESD, and POEM. Training for ZD therapies should follow a similar paradigm for physicians learning ESD and POEM. In addition, an ex vivo porcine ZD simulation model is commercially available.[50] Ex vivo tissue models allow limited practice in the management of certain AEs such as bleeding; live animal models, especially porcine models, whose native anatomy includes a Zenker's-like diverticulum in the proximal esophagus, overcome this limitation. No formal study of the learning curve of performing endoscopic Zenker's diverticulotomy exists.

FINANCIAL CONSIDERATIONS

A primary financial consideration regarding endoscopic methods of treatment of ZD is a lack of Current Procedural Terminology codes to describe endoscopic methods for the treatment of ZD. Most providers choose an unlisted code (Current Procedural Terminology code 43499) for upper endoscopy with variable reimbursement. Individual endoscopists often arrange internally within their hospitals for endoscopic ZD relative value units that are equivalent to surgical ZD relative value units. This needs to be negotiated with the individual payor. One other referable code is Current Procedural Terminology code 43180 (Esophagoscopy, rigid, transoral with diverticulectomy of hypopharynx or cervical esophagus [eg, ZD], with cricopharyngeal myotomy, includes use of telescope or operating microscope and repair, when performed). However, such arrangements are likely variably honored by payors.

Procedure costs include disposables, including knives; hemostasis devices; and closure methods. Financial considerations may also vary by technique, specifically with respect to the use of dedicated caps or overtubes versus tunneling techniques, and payors should be supplied with invoice information if unique resource costs are to be recognized properly. Most endoscopic procedures for ZD in the United States are done under general anesthesia, and these considerations affect procedural costs as well. It should be noted that general anesthesia for these procedures is not universally practiced, and in areas outside the United States, endoscopic ZD procedures are often performed with monitored anesthesia care.

Additional financial implications to consider of performing endoscopic ZD may include overnight hospital stays and follow-up studies such as barium swallows or contrast studies to evaluate for leak at the septotomy site. The practice of observing patients overnight or performing confirmatory contrast studies will vary by practice and by technique used. Much like the evolution in practice with POEM, there may be a shift over time toward same-day discharge and less need for formal confirmatory outcome testing.

AREAS FOR FUTURE RESEARCH

Given that current endoscopic techniques for management of ZD are based on principles extrapolated from third space endoscopy, it follows that future advances will similarly extend from developments in this arena. Formal comparisons of technique modifications are needed to confirm improved safety and outcomes because of a paucity of controlled data comparing existing surgical and endoscopic treatment modalities. One challenge in comparing outcomes between techniques and centers is the lack of standardization in important endoscopic endpoints, symptom scores, and AE reporting. In this regard, a ZD treatment-specific outcome and AE classification would be advantageous, which could be derived from validated questionnaires. This would allow for prospective comparative studies between septotomy techniques and tunneling techniques. Furthermore, data regarding long-term outcomes are needed to understand the underlying significance of different mechanisms such as septotomy versus myotomy or even myectomy. In addition, optimal training pathways need to be identified, and quality parameters to assess endoscopic proficiency also need to be defined.

SUMMARY

Treatment of ZD has evolved with the implementation of new devices and techniques in the field of interventional flexible endoscopy. The emphasis of ZD treatment has shifted from diverticulectomy to septotomy to myotomy. Currently, there are no randomized trials comparing different devices or techniques for ZD treatment. Therefore, the choice usually depends on physicians' expertise and preference. Further investigations and prospective studies are eagerly awaited to further define treatment algorithms and guidelines for the flexible endoscopic treatment of ZD.

DISCLOSURE

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Abbreviations: AE, adverse event; ASGE, American Society for Gastrointestinal Endoscopy; CP, cricopharyngeal; ESD, endoscopic submucosal dissection; FESD, flexible endoscopic septal division; POEM, peroral endoscopic myotomy; STESD, submucosal tunneling endoscopic septum division; TTS, through-the-scope; ZD, Zenker's diverticulum; Z-POEM, peroral endoscopic myotomy for Zenker's diverticulum.

*Drs Jirapinyo and Sethi contributed equally to this article.

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Current affiliations: Division of Gastroenterology, Hepatology and Endoscopy, Brigham and Women's Hospital, Boston, Massachusetts, USA (1), Department of Digestive and Liver Diseases, Columbia University Medical Center/New York-Presbyterian Medical Center, New York, New York, USA (2), Department of Gastroenterology and Hepatology, Mayo Clinic, Rochester, Minnesota, USA (3), Department of Gastroenterology Hepatology and Nutrition, Division of Internal Medicine, The University of Texas MD Anderson Cancer Center, Houston, Texas, USA (4), Department of Gastroenterology and Hepatology, Mayo Clinic, Rochester, Minnesota, USA (5), Division of Gastroenterology, Mount Sinai Hospital, New York, New York, USA (6), Division of Digestive Diseases, Department of Internal Medicine, Rush University Medical Center, Chicago, Illinois, USA (7), Department of Gastroenterology and Hepatology, Mayo Clinic, Scottsdale, Arizona, USA (8), Department of Gastroenterology, Baylor Scott & White Health, Lakeway, Texas, USA (9), Division of Gastroenterology, Hepatology and Nutrition, University of Minnesota, Minneapolis, Minnesota, USA (10), Division of Digestive Diseases and Nutrition, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, USA (11), Division of Gastroenterology, Boston Medical Center, Boston University School of Medicine, Boston, Massachusetts, USA (12).