Zenker's diverticulum

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INTRODUCTION

Zenker's diverticulum (ZD) is a sac-like outpouching of the mucosa and submucosa through Killian's triangle, an area of muscular weakness between the transverse fibers of the cricopharyngeus muscle and the oblique fibers of the lower inferior constrictor (ie, thyropharyngeus) muscle (figure 1).

This topic review will focus on clinical issues surrounding ZD. Other causes of dysphagia are discussed in:

- (See "Oropharyngeal dysphagia: Etiology and pathogenesis".)
- (See "Oropharyngeal dysphagia: Clinical features, diagnosis, and management".)
- (See "Approach to the evaluation of dysphagia in adults".)

TERMINOLOGY AND CLASSIFICATION

Esophageal diverticula are outpouchings of one or more layers of the esophageal wall.

- True diverticula contain all layers of the intestinal wall
- False diverticula contain only mucosa and submucosa
- Intramural diverticula are confined to the submucosa

Esophageal diverticula are classified based upon their location in the esophagus:

- Near the upper esophageal sphincter (ZD)
- Near the midpoint of the esophagus (traction diverticulum)
- Immediately above the lower esophageal sphincter (epiphrenic diverticulum)

ZD is defined as a posterior "false" diverticulum that has a neck proximal to the cricopharyngeal muscle (image 1) [1,2].

EPIDEMIOLOGY AND PATHOGENESIS

Prevalence — The reported prevalence of ZD is between 0.01 and 0.11 percent. However, this is likely an underestimate as patients with diverticula may be asymptomatic [3]. Symptomatic ZD are male predominant (ratio 1:5) and typically seen in middle-aged adults and older adults in their seventh or eighth decade of life. The occurrence of ZD shows geographical variation and has been described more frequently in Northern Europe, North America, and Australia than in Southern Europe, Japan, or Indonesia [4].

Etiopathogenesis — ZD emerges from a natural area of weakness in the muscular wall of the hypopharynx known as Killian's triangle, which is formed by the oblique fibers of the inferior pharyngeal constrictor (ie, thyropharyngeus) muscle and the cricopharyngeal muscle (figure 1). Killian's triangle is more prevalent in males than in females (60 versus 34 percent), and the dimensions of the triangle correlated with the dimensions of the body and the length and the descensus of the larynx [5]. It is hypothesized that for the development of ZD, a variety of circumstances predisposing to herniation within Killian's triangle must be present, such as disorders associated with altered upper esophageal sphincter function, abnormal esophageal motility, or esophageal shortening [6-9]. Increased intrabolus pressures observed in patients with ZD may be secondary to impaired bolus passage in combination with or as a result of gastroesophageal reflux disease [10-12].

CLINICAL MANIFESTATIONS

Symptoms — Small diverticula can be asymptomatic. Transient oropharyngeal dysphagia in patients with ZD may be noted early in the course. The openings of large ZD are often aligned with the axis of the pharynx such that food is preferentially diverted into the diverticulum. When the pharyngeal sac becomes large enough to retain contents such as mucus, pills, sputum, and food, the patient may complain of halitosis, gurgling in the throat, appearance of a mass in the neck, or regurgitation of food into the mouth. Marked weight loss and malnourishment can occur in patients with longstanding dysphagia. In rare cases, the ZD may

become so large that its retained contents may push anteriorly and completely obstruct the esophagus.

Complications — Complications of ZD include aspiration pneumonia, ulceration and bleeding due to retained medication, fistula between the diverticulum and trachea lumen formation, and vocal cord paralysis due to the pressure from retained food [13,14]. Squamous cell carcinoma in the diverticulum is a rare complication with an incidence of cancer in ZD from 0.3 to 1.5 percent [15-19]. Risk factors for malignancy are older age, male sex, long-standing history, and larger diverticular size.

DIAGNOSIS

ZD should be suspected in middle age or older adults with progressive dysphagia (usually to solids) and regurgitation of undigested food debris. The diagnosis of ZD is made on barium swallow examination. An upper endoscopy is not required to confirm the diagnosis but is recommended to exclude a concurrent malignancy. ZD, which has the endoscopic appearance of a separate lumen, may not always be apparent if small.

Imaging

- **Fluoroscopy** – ZD appears as an out-pouching at the posterior aspect of the pharyngoesophageal junction and are best seen on barium swallow examinations (image 1) combined with dynamic continuous fluoroscopy. In some patients, the entire first glass of barium taken will disappear into the confines of an especially large diverticulum. However, small diverticula can be missed if they are superimposed on the main column of barium in the esophagus. This can be avoided by rotating the patient during the examination.

- **Ultrasound** – An alternative method to diagnose ZD and to differentiate from a thyroid or neck mass is transcutaneous ultrasound. This technique might be a good alternative in people who experience difficulties in swallowing barium, provided the technique is in experienced hands [20-22].

Differential diagnosis — The differential diagnosis of ZD includes other causes of progressive dysphagia (eg, peptic stricture and esophageal carcinoma). ZD can be distinguished from these by imaging and upper endoscopy. The differential diagnosis and evaluation of patients with dysphagia is discussed in detail separately. (See "Approach to the evaluation of dysphagia in adults", section on 'Solids only with progressive symptoms'.)

MANAGEMENT

Asymptomatic patients with diverticula <1 cm — Asymptomatic diverticula that are less than 1 cm in size do not warrant treatment. Patients can be managed expectantly until symptoms occur.

Symptomatic patients or diverticula >1 cm

Choice of procedure — The definitive treatment of symptomatic ZD is surgical. The decision to use an open or transoral approach (rigid endoscope or a flexible endoscope) is made by clinicians on the basis of the ability to visualize the ZD and septum endoscopically, patient's body habitus, support of the ZD pouch against the posterior wall, and local expertise [23,24]. Short necks, decreased hyomental distance, and/or a high body mass index are most often associated with difficult exposures and require an open approach [25,26]. Diverticula less than 2 cm long are usually treated with endoscopic methods [27].

Transoral (endoscopic) approaches are less invasive than open surgery and are associated with shorter operation times, hospital stays, more rapid resumption of oral intake, lower rate of complications, and easy access in case of recurrence [28]. However, endoscopic approaches are also associated with higher rates of symptom recurrence [29]. A systematic review and meta-analysis of 71 studies reported failure rates of 4.2 and 18.4 percent for open and endoscopic approaches, respectively, and corresponding complication rates of 11 and 7 percent [30].

For patients who are poor surgical candidates, flexible endoscopic approach is the procedure of choice if expertise is available [31-34]. The main advantage of the flexible endoscopic approach is that it can be performed without the need for general anesthesia, which is required for both open surgical and rigid endoscopic approaches. While the two endoscopic techniques have not been compared directly in randomized trials, evidence suggests there may be a higher recurrence rate and need for revision with flexible as compared with rigid endoscopic technique. In a 2019 systematic review and meta-analysis of 115 studies (29 flexible endoscopy studies) that compared rigid and flexible endoscopic approaches mortality, infection, and perforation rates were not significantly different [35]. Bleeding (20 versus <10 percent) and recurrence (4 versus 0 percent) were more likely after flexible endoscopic techniques. Dental injury and vocal fold palsy occurred only in the rigid endoscopic group, but were rare.

Open transcervical surgical approach — The choice of operation depends on the size of the ZD pouch and surgical/anesthesia risk.

- For patients receiving open surgical treatment, cricopharyngeal myotomy with diverticulectomy is the preferred operation in good surgical candidates. Diverticulectomy is a total diverticular pouch resection and is performed commonly in combination with cricomyotomy. The efficacy of myotomy is supported by a number of surgical series in which excellent or very good responses have been observed in 80 to 100 percent of patients [36-43]. Recurrence rates for symptomatic diverticula of 15 to 35 percent with diverticulectomy alone confirm the importance of cricopharyngeal myotomy performed at the time of surgery [25,44].

- In high-risk surgical patients or in moderate-size pouches, cricopharyngeal myotomy and diverticulopexy is often the treatment of choice to avoid the potential high-risk complications associated with a myotomy [39,45]. The procedure involves suspension of the lumen of the diverticulum in the caudal direction such that the orifice is directed away from the hypopharynx, thereby preventing the entry of food and secretions. Moderate ZD is usually defined as 2 to 3 cm to 5 cm in size.

- Small symptomatic pouches can be treated with suspension diverticulopexy alone or cricopharyngeal myotomy alone [46]. Small ZD is usually defined as <2 cm in size.

Complications of the open transcervical approach for ZD include mediastinitis, vocal cord paralysis, pharyngocutaneous fistula, esophageal stenosis, and a recurrent or persistent ZD. A review of the literature of 41 studies with more than 2800 patients in total showed an overall surgical morbidity of 11 percent [47]. Cervical infection (including mediastinitis) occurred in 2 percent of the cases, leak or perforation in 3 percent, and recurrent laryngeal nerve damage in 3 percent. The recurrence rate of ZD after open surgical repair is between 5 and 10 percent.

Transoral intraluminal approach

Rigid endoscopy

- **Techniques** – Rigid endoscopy is usually performed under general anesthesia. A Weerda diverticuloscope is used to expose the common wall between the diverticulum and the esophagus. Different techniques using a variety of coagulation and cutting devices including a CO_2 laser can then be used to divide this septum between the esophagus and the diverticulum [48-50]:

  - Stapler-assisted method (endoscopic stapler esophagodiverticulostomy [ESED]) is safe and effective in the short term, with a significant reduction in hospital stay and convalescence when compared with other surgical techniques [4,31,51-54].

ESED may afford better symptomatic relief than other endoscopic techniques, especially in patients with small diverticula [25]. While it was previously maintained that diverticula smaller than 2 cm cannot be successfully treated with this method [52], modifications of the stapler-assisted method have been described [55], some of which enable this technique to be used for smaller diverticula as well [56].

- The Dohlman technique involves coagulation of the septum between the esophagus and the diverticulum with insulated forceps, and subsequent division of the coagulated tissue with a diathermic knife [49].

- Harmonic scalpel or LigaSure can cut and coagulate tissues with minimal spread of thermal energy. Either can be used through the diverticuloscope and both are especially suitable for cutting the septa of small ZDs (<2 cm) [57-59].

- **Complications** – Dental injuries, perforations, and recurrent laryngeal nerve paralysis are concerns with the rigid endoscopic technique [47,60].

Flexible endoscopy — Flexible endoscopic techniques involve midline dissection of the septum, followed by myotomy of fibers of the cricopharyngeal muscle, in between esophageal lumen and diverticulum [61-64]. The objective is to create an overflow tract from the ZD to the esophagus (figure 2 and image 2 and image 3 and picture 1 and movie 1). (See 'Transoral intraluminal approach' above.)

- **Procedure** – Flexible endoscopic-assisted diverticulotomy should only be performed by experienced interventional endoscopists. The procedure is generally performed under deep sedation with monitored anesthesia care or general anesthesia to ensure airway protection. High-resolution video endoscopes are preferred, although the procedure can be performed using older fiberoptic endoscopes. Carbon dioxide (CO_2) should be used for insufflation. Adequate endoscopic exposure of the ZD septum is essential. This is usually achieved by insertion of an orogastric tube (CH 14-18) and/or a rigid guide wire, which is left in the esophageal lumen during the procedure. The orogastric tube also protects the contralateral esophageal wall from thermal injury during sectioning of the ZD septum (image 2). However, exposure of the septum with the orogastric tube can be suboptimal, particularly in small diverticula or in those with a distorted axis with respect to the esophageal lumen. One can use a rigid guide wire instead or use a plastic overtube, which has been designed based upon the otolaryngology experience with the rigid diverticuloscope [65]. A transparent oblique-end hood attached to the tip of the endoscope may also improve exposure [66].

Using a knife or monopolar forceps, the initial cut or coagulation is made at the top of the ZD septum (movie 1). The transverse fibers of the cricopharyngeal muscle should be visualized (picture 1).

The cutting/coagulation should be performed in the midline of the septum. Mixed current (use Erbe setting Endocut) can be used for the initial cut and coagulation current for dissecting the muscle fibers. Other endoscopic cutting accessories developed for submucosal dissection (ie, hook knife, flush-knife, hybrid knife) can also be used to cut the septum and muscle fibers [67-72]. The use of argon plasma coagulation for septal division is obsolete and its use is reserved only for hemostasis [73].

To minimize the risk of perforation, the esophageal and diverticular lumens should be kept under direct vision at all times, which usually becomes easier after the initial cut has been made. Early in the learning curve, it is advisable to divide one-half to two-thirds of the ZD septum and then stop and repeat the procedure after a few weeks. Full myotomy is achieved when the buccopharyngeal fascia is reached. This is a shiny, thin film-like layer [74]. Making a deeper cut results in perforation.

If (micro) perforations are suspected, the bottom of the cut can be closed using endoclips (movie 1). These can also be used to achieve hemostasis if bleeding occurs. A clip-assisted technique, where prior to dissection with needle-knife, two endoclips were placed on either side of the ZD septum, has been used to prevent microperforations [75].

- **Postprocedural care** – The orogastric tube is left in place until the patient is fully awake. If no perforation or other complication is suspected clinically, the orogastric tube can be removed and only oral fluid intake is advised. The diet can then be advanced within the next few days.

  If, during the procedure, a large visible perforation occurs that is difficult to close with clips, we leave the orogastric tube in place to secure passage to the esophagus and better visualization in case re-intervention is required. Conservative treatment with nasogastric tube feeding, antibiotics, and pain control is usually sufficient to heal the leak. Imaging studies are not very useful.

  Evidence regarding the benefit of prophylactic antibiotics are lacking. Follow-up radiologic studies of patients treated endoscopically for ZD are generally not indicated to evaluate postoperative results since they do not correlate with symptoms of dysphagia [31]. After endoscopic treatment, the diverticulum will still remain visible on radiographs as a residual pouch, but swallowed contrast will pass more easily due to the created overflow (image 3)[76].

With increasing experience in different centers, endoscopic diverticulotomy is becoming an outpatient procedure. However, based on the difficulty of the procedure and patient age and comorbidities, patients may require overnight observation [70,77].

- **Complications** – The most common postprocedural symptoms include pain or discomfort of the throat. In case of carbon dioxide or air leakage to the mediastinum caused by (micro) perforation during the procedure, patients may experience chest and/or back pain. In some cases, serious subcutaneous emphysema can cause temporary dysphagia, changed voice, and local neck pain. Symptoms usually subside after a few days. Large esophageal perforations are rare. Substantial bleeding is very rare. Other complications have been mainly related to sedation, such as periprocedural myocardial infarction and pulmonary complications. (See "Monitored anesthesia care in adults", section on 'Complications during monitored anesthesia care'.)

  In a systematic review that included 20 studies with a total of 813 patients who underwent flexible endoscopic septum division the pooled success, adverse events and recurrence rates were 91, 11, and 11 percent, respectively [78].

Peroral endoscopic myotomy — Zenker-peroral endoscopic myotomy (Z-POEM) is a newer flexible endoscopic technique for the management of ZD which is considered the endoscopic equivalent of surgical myotomy [79-81]. Z-POEM relies on submucosal tunneling to completely expose and dissect the septum. Submucosal tunneling may be particularly suitable for treating small (<2 cm) ZD because the small pocket may disappear after the myotomy is performed. For larger ZDs (>2 cm), however, division of some of the mucosa is also required to create a common channel between the diverticulum and the native esophageal lumen, which ensures proper drainage of the ZD.

Data comparing the efficacy of POEM with other approaches are limited and conflicting, and expertise in Z-POEM is not widely available [24,82]. The Z-POEM technique is discussed in detail separately. (See "Peroral endoscopic myotomy (POEM)", section on 'POEM for Zenker's diverticula'.)

Procedural precautions in all patients — Caution must be used during endoscopy or passage of nasogastric tubes because of the risk of inadvertent perforation of the diverticulum. In patients with a known ZD, it is advisable to intubate the esophagus under direct visualization. Endoscopes requiring blind passage (such as side-viewing endoscopes used for endoscopic retrograde cholangiopancreatography, endoscopic ultrasound endoscopes, and probes for transesophageal cardiac ultrasound) can be passed after an initial endoscopy with a forward-

viewing endoscope and passage of an overtube or a guidewire [83]. Nasogastric tubes should be passed over a guide wire or under direct endoscopic visualization.

A ZD may prevent passage of a wireless video capsule endoscopy [84,85]. If capsule endoscopy is required, the capsule can be placed in the duodenum by endoscopy to avoid this problem. (See "Wireless video capsule endoscopy", section on 'Contraindications'.)

RECURRENT SYMPTOMS

Recurrent symptoms may develop if a myotomy has been inadequate or if there is reapposition of the cut muscle edges. The motor abnormality of the hypopharynx often persists after treatment and can impair the propulsive activity of the hypopharynx also causing dysphagia. The choice of treatment approach in patients with recurrent symptoms depends on the size of the residual diverticulum, patient's surgical risk, need for definitive treatment, and available expertise. Flexible endoscopic retreatment may be effective in patients with an incomplete septotomy because a safer extension of septotomy is possible once an adhesion between the esophageal and diverticular walls has developed. However, open surgery and rigid endoscopy with endostapling may be preferable to achieve more definitive success. (See 'Choice of procedure' above.)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Zenker's diverticulum".)

SUMMARY AND RECOMMENDATIONS

- Zenker's diverticulum (ZD) is a sac-like outpouching of the mucosa and submucosa through Killian's triangle, an area of muscular weakness between the transverse fibers of the cricopharyngeus muscle and the oblique fibers of the lower inferior constrictor (ie, thyropharyngeus) muscle (figure 1). ZD is defined as a posterior "false" diverticulum that has a neck proximal to the cricopharyngeal muscle (image 1). (See 'Terminology and classification' above.)

- The precise cause of ZD remains unsettled, but it occurs in a variety of circumstances predisposing to herniation within Killian's triangle, most notably disorders associated with upper esophageal sphincter dysfunction. (See 'Etiopathogenesis' above.)

- Small diverticula can be asymptomatic. Transient oropharyngeal dysphagia in patients with ZD may be noted early in the course. When the pharyngeal sac becomes large enough to retain contents such as mucus, pills, sputum, and food, the patient may complain of halitosis, gurgling in the throat, appearance of a mass in the neck, or regurgitation of food into the mouth. Complications of ZD include aspiration pneumonia, ulceration and bleeding due to retained medication, fistula between the diverticulum and trachea lumen formation, vocal cord paralysis, and in rare cases, squamous cell carcinoma of the esophagus. (See 'Clinical manifestations' above.)

- ZD should be suspected in middle age or older adults with progressive oropharyngeal dysphagia (usually to solids and liquids) or regurgitation of undigested food debris. The diagnosis of ZD is made on barium swallow examination. An upper endoscopy under direct vision should be performed to exclude malignancy. (See 'Diagnosis' above.)

- Asymptomatic ZD that are less than 1 cm in size do not warrant treatment. Patients can be managed conservatively until symptoms occur or diverticulum increases in size. Treatment of patients with symptomatic ZD or diverticula >1 cm in size should be considered by the availability of local expertise. (See 'Choice of procedure' above.)

- The definitive treatment of symptomatic ZD is surgical. The decision to use an open or transoral approach (rigid endoscope or a flexible endoscope) is made by otolaryngologists on the basis of visualization, patient's body habitus, support of the ZD pouch against the posterior wall and local expertise. Zenker-Peroral endoscopic myotomy is the endoscopic equivalent of surgical myotomy and a newer technique for the management of ZD. (See 'Choice of procedure' above.)

- Recurrent symptoms may develop if a myotomy has been inadequate or if there is reapposition of the cut muscle edges. Recurrence is more likely in patients with wide diverticula. The motor abnormality of the hypopharynx often persists after treatment, and myotomy may impair the propulsive activity of the hypopharynx. (See 'Recurrent symptoms' above.)

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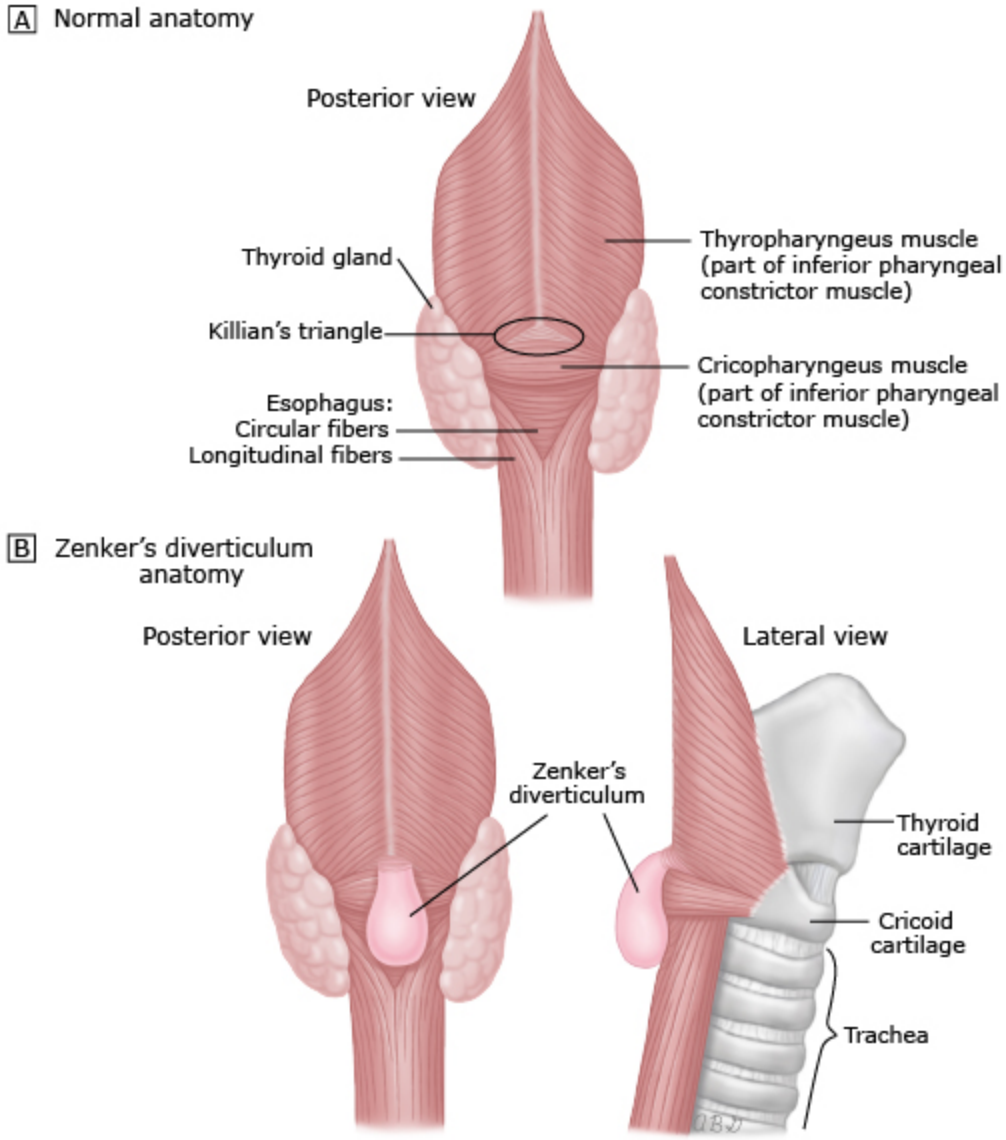
GRAPHICS

Zenker's diverticulum anatomy



Modified from:

1. *The pharynx and larynx. In: Anatomy for Surgeons: Volume 1, The Head and Neck, 2nd ed, Hollinshead WH (Ed), Harper & Row, Publishers, New York 1968.*
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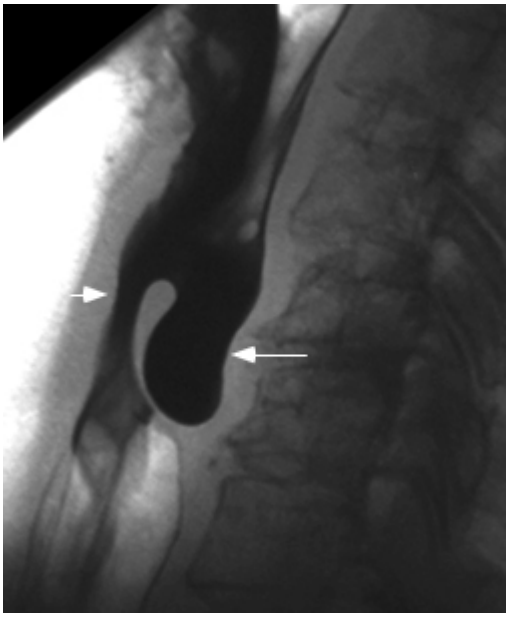
Zenker's diverticulum



Barium study of the upper esophagus of an 82-year-old woman with dysphagia demonstrates a large diverticulum arising from the posterior wall of the upper esophagus (large arrow) producing extrinsic narrowing of the more anterior esophageal lumen (arrow head).

Courtesy of Jonathan Kruskal, MD, PhD.

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Illustration of endoscopic approach to endoscopic Zenker's therapy

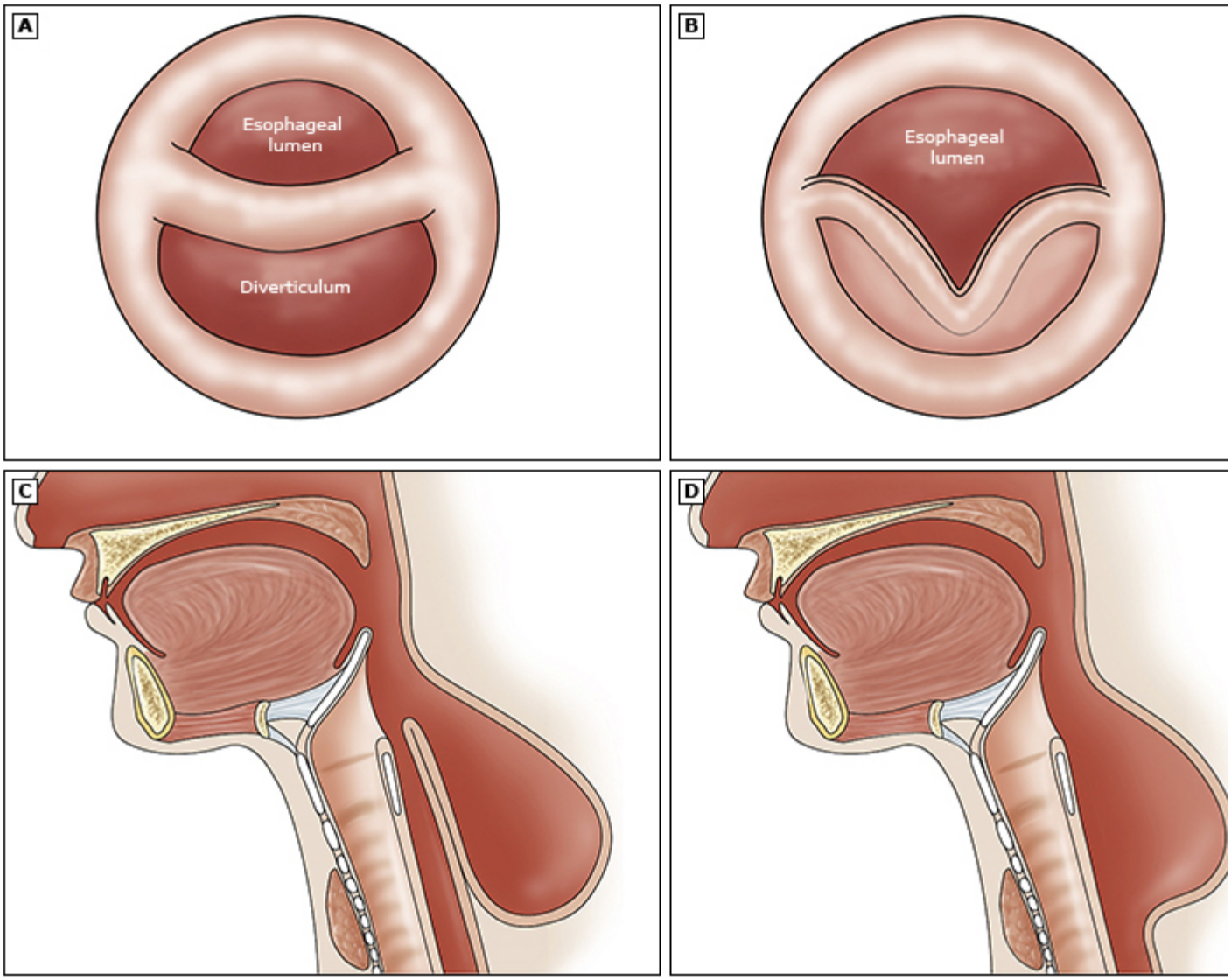

Illustration of endoscopic approach to endoscopic Zenker's therapy.

(A) Zenker's diverticulum from a proximal lumenal perspective. The esophageal lumen is seen above and the diverticulum below.

(B) After therapy, the septum has been severed creating a common cavity between the esophagus and diverticulum.

(C) Lateral view of neck before treatment corresponding to panel A.

(D) Lateral view of neck before treatment corresponding to panel B.

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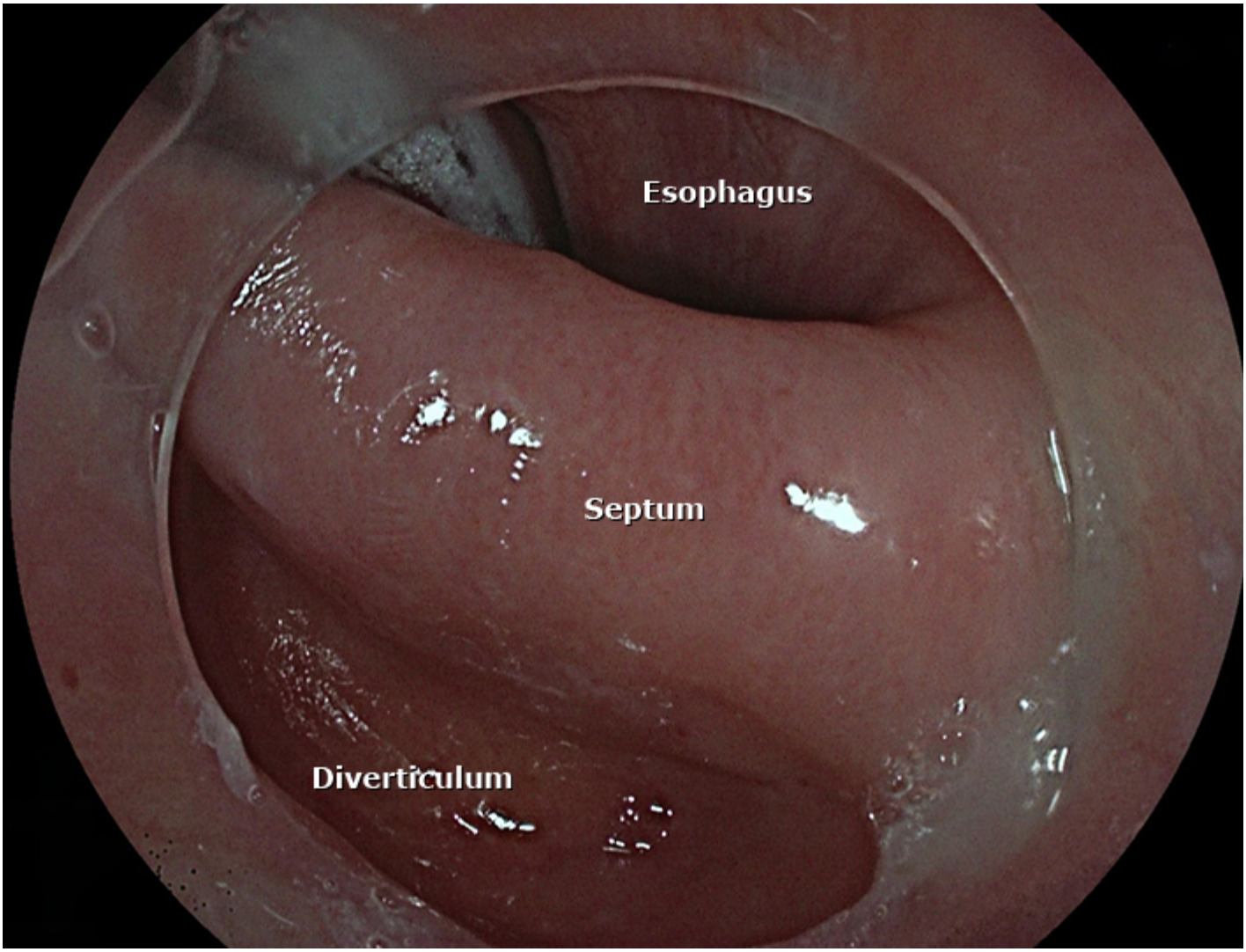
Endoscopic view of Zenker's diverticulum



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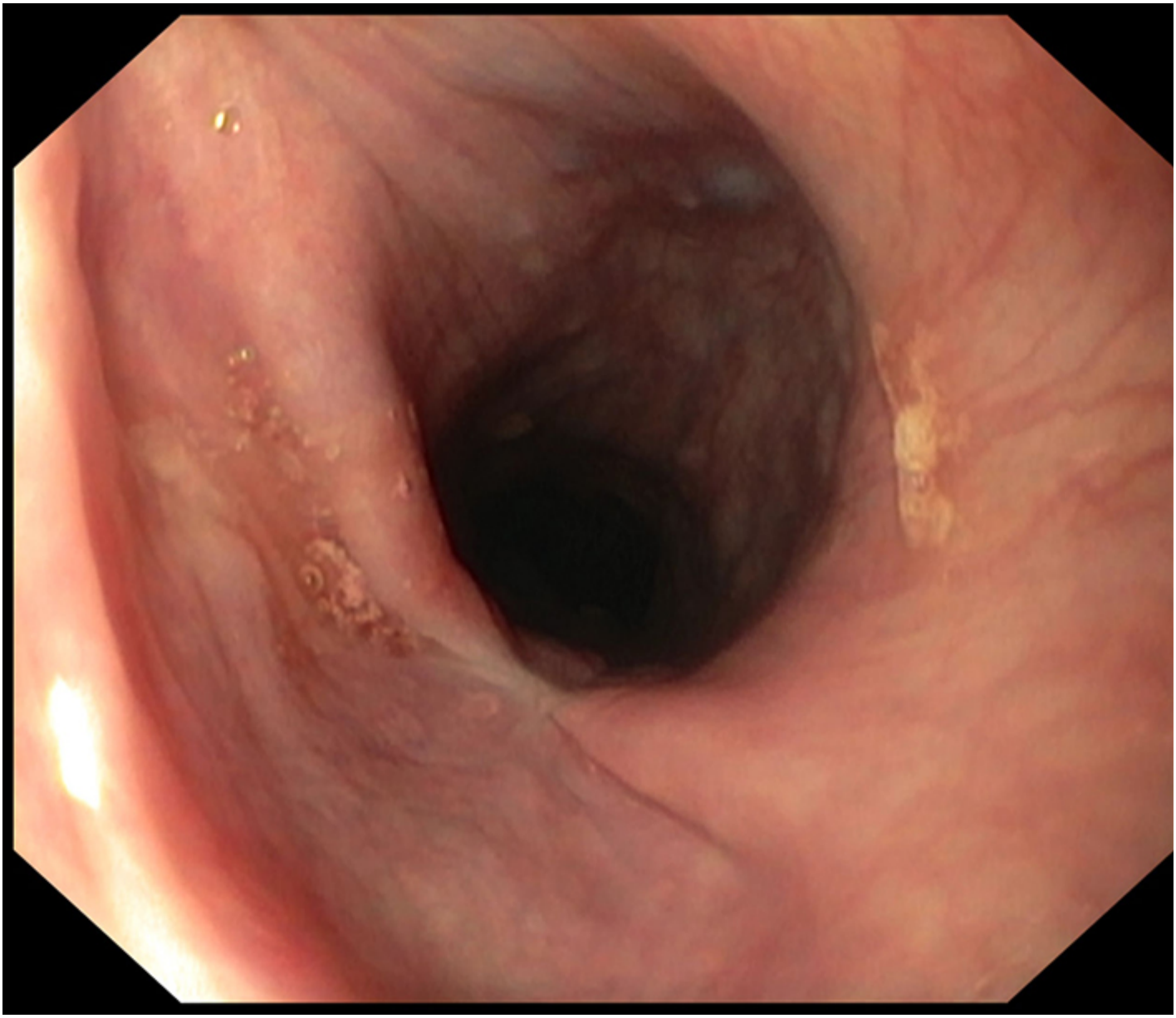
Zenker's diverticulum after treatment



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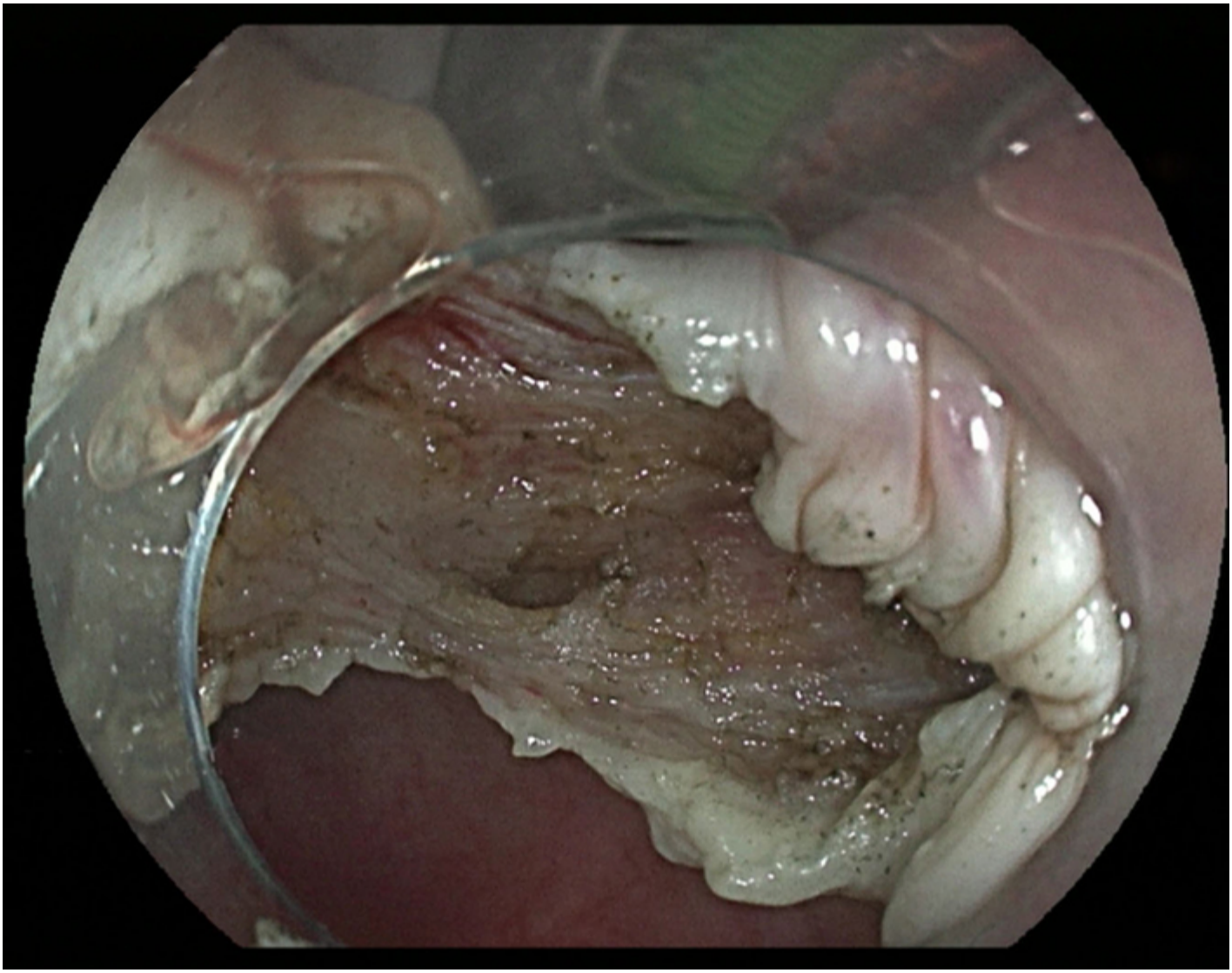
Exposure cricopharyngeal muscle



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Foke van Delft, MD, FEBGH No relevant financial relationship(s) with ineligible companies to disclose. **Nicholas J Talley, MD, PhD** Patent Holder: Australian Provisional Patent [Diagnostic marker for functional gastrointestinal disorders]; Biomarkers of irritable bowel syndrome [Irritable bowel syndrome]; Mayo Clinic [Dysphagia questionnaire]; Mayo Clinic [Bowel Disease questionnaire]; Nepean Dyspepsia Index [Dyspepsia]; Nestec [Irritable bowel syndrome]; Singapore Provisional Patent [BDNF Tissue Repair Pathway]. Grant/Research/Clinical Trial Support: Alimetry [Gastric mapping device research collaboration]; Allakos [Gastric eosinophilic disease]; AstraZeneca [Eosinophilic gastritis, eosinophilic gastroenteritis]; Intrinsic Medicine [Bowel syndrome with constipation]; NHMRC Centre for Research Excellence in Digestive Health [NHMRC Investigator grant]. Consultant/Advisory Boards: Adelphi Values [Functional dyspepsia]; Allakos [Gastric eosinophilic disease, AK002]; AstraZeneca [Eosinophilic gastritis, eosinophilic gastroenteritis]; AusEE [Eosinophilic gut diseases]; Bayer [Inflammatory bowel syndrome]; BluMaiden [Microbiome Ad Board]; Comvita Mānuka Honey [Digestive health]; Dr Falk Pharma [Eosinophilia]; GlaxoSmithKline Australia [Educational speaker eosinophilic gut disease]; Glutagen [Celiac disease]; International Foundation for Functional Gastrointestinal Disorders [Advisory board, functional GI disorders]; Intrinsic Medicine [Human milk oligosaccharide]; IsoThrive [Esophageal microbiome]; Planet Innovation [Gas capsule, inflammatory bowel syndrome]; Progenity Inc [Intestinal capsule]; Rose Pharma [IBS]; Viscera Labs [Inflammatory bowel syndrome, diarrhea]. Other Financial Interest: Elsevier textbook royalties [Medical education]. All of the relevant financial relationships listed have been mitigated. **Brian E Louie, MD, MHA, MPH, FRCSC, FACS** Grant/Research/Clinical Trial Support: Intuitive [Robotic thoracic surgery]; Torax Medical [Gastroesophageal reflux disease]. All of the relevant financial relationships listed have been mitigated. **Shilpa Grover, MD, MPH, AGAF** No relevant financial relationship(s) with ineligible companies to disclose. **Wenliang Chen, MD, PhD** No relevant financial relationship(s) with ineligible companies to disclose.

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Conflict of interest policy

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