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# Endoscopic Therapy of Zenker's Diverticulum

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**Abstract**

Zenker's diverticulum (ZD) is an upper esophageal diverticulum that results from evagination of the hypopharyngeal mucosa in the Killian's triangle. The defect lies in an area between the oblique fibers of the inferior pharyngeal constrictor muscle and the transverse fibers of the cricopharyngeal muscle. Symptoms range from transient dysphagia to frequent regurgitation complicated by aspiration pneumonia. Diagnosis is usually made at endoscopy or barium imaging. Surgical treatment of ZD is a well-established modality being effective in 80–100% of patients. However, patients with ZD are often old with several comorbidities which increases the procedural risks. The development of several accessories, such as an oblique transparent cap, a diverticuloscope which facilitates electrodissection of the septum using a needle-knife, argon plasma coagulation or a harmonic scalpel, has led to an increasing use of flexible endoscopic approaches. Development of novel accessories and techniques along with better animal/computer training models are likely to help improve outcomes following treatment of ZD using flexible endoscopes.



Zenker's diverticulum (ZD) results from evagination of the hypopharyngeal mucosa in the Killian's triangle, an area between the oblique fibers of the inferior pharyngeal constrictor muscle and the transverse fibers of the cricopharyngeal muscle. The condition is generally acquired and has a male predominance. While first described by Ludlow in 1767, Zenker and Ziemssen published the first review in 1877, hence its name [1]. It is believed that motor dysfunction in the upper esophagus leads to evagination of an area of weakness immediately above the posterior aspect of the upper esophageal sphincter, more commonly on the left side [1]. In early stages, these outpouchings spontaneously reverse in the relaxed state. However, in later stages, the diverticulum progressively enlarges and descends into the neck, occasionally extending down into the superior mediastinum.

The size of ZD may be measured by endoscopically or radiologically. Conventionally the lesion is considered small when the size is <2.0 cm in length, medium when the size is between 2.0 and 4.0 cm, and large when the size >4.0 cm. The size of the vertebra may be used as a reference; small being <1, medium up to 3, and large >3 vertebrae.

## Clinical Symptoms and Diagnosis

Symptoms depend on the size of the ZD. Transient dysphagia may be the only complaint early-on. When the pouch becomes large and starts to retain sputum and food, patients may complain of regurgitation and develop aspiration pneumonia. This usually results when the opening of a large ZD is aligned with the pharyngeal sac. Patients usually do not present until their sixth or seventh decade and often have had symptoms for months to years preceding clinical presentation. Diagnosis is usually made at endoscopy or barium imaging in a patient presenting with dysphagia. Small diverticula can often be missed, and require a rotated film to prevent overlap of ZD with the esophageal column of barium. Manometry has no role as studies evaluating upper esophageal sphincter pressures in such patients have been inconsistent and are conclusive.

## Treatment

*Surgical Treatment.* Surgical treatment of ZD is a well-established modality and effective in 80–100% of patients. In a technical review, The American Gastroenterological Association reported surgery as the treatment of choice [2]. While there are several variations of the procedure, the preferred approach involves resection of the pouch (diverticulectomy) in conjunction with cricopharyngeal myotomy through a left cervicotomy [2]. Other methods include mobilization and excision of the ZD, cricopharyngeal myotomy leaving the ZD undisturbed. Any surgical intervention carries a high morbidity and mortality rate mainly due to the advanced age of the patients and presence of several comorbidities. Complications include mediastinitis, vocal cord paralysis, pharyngocutaneous fistula, esophageal stenosis and recurrent or persistent ZD.

*Endoscopic Treatment.* An alternate modality using the endoscopic approach was first reported in the early 1900s. This modality often achieves the same clinical results as surgical treatment while reducing the incidence of complications and mortality [3–6]. Endoscopic modality has been increasingly used in Europe and South America.

The first human trials describing endoscopic myotomy through a flexible endoscope were published simultaneously by Ishioka et al. [3] and Mulder et al. [4]. Following placement of a nasogastric tube as a guide, the septum was incised using pure cut/coagulation electrical current. The endoscopic technique involves sectioning the bridge of the ZD which is mainly constituted by the cricopharyngeal muscle, lying in between the esophagus and the diverticulum. This eliminates the anterior wall, resulting in an overflow of contents from the ZD into the esophagus. We believe that cutting the septum in one stage for a small or medium-sized ZD and in two or more stages for a large ZD limits the complication rate. Several accessories have been developed to facilitate visualization during this procedure, including a hood attached to the endoscope [7] and a flexible overtube called diverticuloscope [8].

In 1917, Mosher first described an endoscopic approach to treatment of ZD. The technique was later popularized by Dohlman and Mattson [9] in the 1960s. They devised a rigid, double-lipped laryngoscope to facilitate electrocoagulation of the bridge using an insulated forceps with a diathermic knife. In 1984, Van Overbeek et al. [10] used the $CO_2$ laser via a rigid laryngoscope. Endoscopic stapler-assisted esophagodiverticulostomy has been shown by Collard et al. [11] to be safe and effective, but requires general anesthesia along with a specialized long and rigid laryngoscope. The procedure is unsuitable for patients with a small diverticulum and may also


**Fig. 1.** Schematic sequence of endoscopic diverticulostomy by needle-knife.

result in cervical injuries in elderly patients with spondyloarthroses. Several studies utilizing the stapler-assisted method have reported short-term effectiveness with shortened hospital stays. For larger diverticulum, the residual cavity may be large enough, even following two applications and not completely empty with inadequate symptom relief.

Endoscopic treatment of ZD using a flexible endoscope is a feasible and practical alternative to surgical intervention. A monopolar forceps or a needle-knife is utilized to cut the septum/bridge in patients with ZD. Argon plasma coagulation (APC) has also been reported for this purpose. More recently, we have utilized the harmonic scalpel [unpubl. data].

## Indications for Endoscopic Treatment

Endoscopic treatment of ZD is mainly indicated for older and debilitated patients who are often at high risk for general anesthesia and surgical intervention. Although this condition mainly afflicts the elderly, younger patients under 50–60 years with symptoms are referred for treatment. We offer these patients both surgical and endoscopic alternatives. An important advantage of the endoscopic procedure is that it is easier to repeat in case of treatment failure.

## Technique for Endoscopic Dissection

Adequate sedation facilitates the procedure and general anesthesia with orotracheal intubation is preferable in order to prevent aspiration. A standard upper endoscope is introduced with the patient in the left lateral position. Contents of the pouch are aspirated and the esophageal orifice is outlined by insertion of a nasogastric tube (fig. 1), which is additionally used for enteral feeding following the procedure.

The attachment of an oblique cap or hood [10] is useful to obtain an adequate wide view of the septum which separates the diverticulum from the esophageal lumen (fig. 2). A flexible overtube, also termed a diverticuloscope [11], has a double-lipped extremity which fits the anterior esophageal wall and the posterior wall of the diverticulum, leaving the septum in the center of the endoscopic field (fig. 3). While this device helps maintain stability during the procedure, it often is unsuitable for a small ZD.

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**Fig. 2.** The hood that attaches to a flexible endoscope (Olympus). **Fig. 3.** Diverticuloscope with distal end to facilitate (ZDO overtube – Wilson-Cook).

Electrodissection of the septum using a needle-knife is performed using monopolar cautery with blended or pure coagulation current (fig. 1). Occasionally pure coagulation current provides an adequate cut. Dissection is performed in the mid-section of the septum in a craniocaudal approach from the esophageal side. The aim of the procedure is to completely section the septum along the diverticular pouch downwards close to the bottom, thus achieving a wide communication between the diverticulum and the esophagus. It is important to not dissect all the way to the bottom of the diverticulum, rather to leave a 5-mm lip in order to avoid the risk of perforation into the mediastinum.

Argon beam equipment has also been utilized as a 'knife', but in our personal experience it is difficult to use and has not been effective. It may however be utilized as rescue therapy for excessive bleeding with needle-knife or other techniques.

A 5-mm harmonic scalpel may alternatively be utilized for endoscopic dissection of ZD. Following insertion of a flexible overtube (diverticuloscope), the septum is identified and isolated and the harmonic scalpel 'scissors' is then applied to the mid-portion under full endoscopic view. A pediatric endoscope is preferable for this procedure alongside which the harmonic scalpel is deployed. Activation of the scalpel blade leads to coaptive coagulation of the septum along with the vessels and tissue [12].

If repeated endoscopic interventions are required, 2 or 3 weeks should be allowed to elapse before reintervening. A nasogastric tube is left in situ for enteral feeding for 48–72 h following the procedure as patients often complain of dysphagia. Oral feeding may be gradually resumed thereafter. In event of perforation, pneumomediastinum may often present as subcutaneous emphysema palpable in the neck or alternatively be visualized on CT scan. Perforation can often be managed conservatively by leaving a nasogastric tube for 1 week followed by a contrast study of the upper airway esophagus to evaluate for leakage of contrast. Prophylactic antibiotics may be administered intravenously, just prior to the procedure and continued if perforation occurs.

## Results and Complications

The primary indication for endoscopic therapy is an older patient with comorbidities [3]. Over 90% of patients report relief of dysphagia and 5–15% will report recurrence usually as a result of residual diverticulum. Repeat endoscopic intervention is feasible in such cases [13]. Complications include cervical or mediastinal emphysema in up to 23% of patients and

**Table 1.** Outcomes of flexible endoscopic treatment of ZD

| Author | Year | n | Endoscopic device | Incision | Sessions | Emphysema | Bleeding | Recurrence | Clinical resolution |
|---|---|---|---|---|---|---|---|---|---|
| Ishioka | 1995 | 20 | none | forceps coagulation | 1.8 | 1 (2%) | 1 (2.4%) | 3 (7.1%) | 92.80% |
| Mulder | 1995 | 42 | none | needle-knife | 3 (1–12) | none | none | n.a. | n.a. |
| Sakai | 2001 | 10 | hood | needle-knife | 1 | none | none | none | 100% |
| Hashiba | 1999 | 47 | none | needle-knife | (1–4) | 6 (13%) | 1 (2.1%) | n.a. | 96% |
| Mulder | 1999 | 125 | none | APC | 1.8 (1–12) | 19 (15%) | 2 (1.6%) | n.a. | 100% |
| Costamagna | 2007 | 28 | cap | needle-knife | n.a. | 5 (18%) | 4 (14%) | 8 (2.9%) | 43% |
| Costamagna | 2007 | 11 | diverticulo-scope | needle-knife | n.a. | none | none | 1 (9%) | 91% |
| Rabenstein | 2007 | 41 | cap | APC | 3 (2–10) | 1 (3%) | none | 17% | 95% |
| Christaens | 2007 | 21 | hood | monopolar forceps | 1.1 (1–2) | 1 (4.8%) | none | 10% | 100% |
| Vogelsang | 2007 | 31 | cap | needle-knife | 1.4 (1–3) | 7 (23%) | 1 (3.3%) | 35% | 84% |
| Hondo | 2009 | 13 | diverticulo-scope | harmonic scalpel | 1.07 (1–2) | 1 (7.7%) | none | 1 (7.7%) | 100% |

bleeding in up to 10% following endoscopic cricopharyngeal myotomy [14]. Mortality is usually related to complications unrelated to the procedure itself [13–22]. An overview of the results and complications is presented in table 1. Included are preliminary results using the harmonic scalpel in humans [unpubl. data] with complications mainly related to neck hyperextension (fig. 4).

## Conclusion

Endoscopic treatment of patients with ZD is best performed in centers with sufficient local expertise and experience. The primary indication for endoscopic intervention is in an older patient with co-morbidities, although younger patients may also be considered depending on operator expertise. Surgical intervention is a well established procedure with excellent results and is usually definitive with low recurrence rates [23]. In our own practice, patients are offered surgical and endoscopic alternatives. The major advantages of the flexible endoscopic approach are its minimally invasive nature, shorter postoperative course, lack of inpatient stays, early


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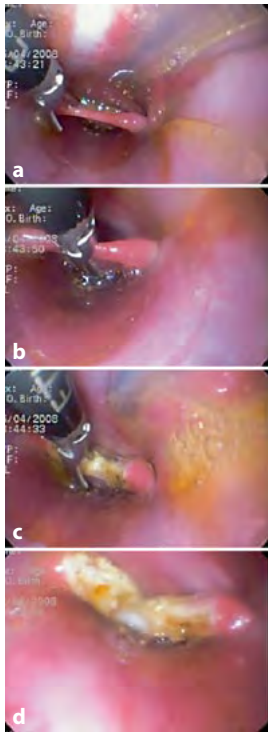


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**Fig. 4.** Harmonic scissors and the generator of Ultracision® (Ethicon-Johnson).

**Fig. 5.** Endoscopic view sequence of the procedure: (**a**) harmonic scissors are placed over the septum; (**b**) initiating cut using harmonic scissors; (**c**) diverticulum bridge is cut, and (**d**) final results.

resumption of oral intake, with the possibility of repeat intervention if ZD recurs. Given the incidence of ZD, the opportunity to train and gain adequate experience for endoscopic treatment of ZD is difficult. The swine model offers an excellent alternative for training and development of new techniques and accessories [15]. In our own experimental laboratory, the harmonic scissors through a flexible overtube facilitated the procedure and reduced the risk of bleeding with an excellent visualization of the bottom of the diverticulum (fig. 5). An articulated stapler has also been evaluated in feasibility studies [16]. Animal models are being further utilized to develop new and novel ZD treatment techniques and accessories, such as the flexible stapler and a flexible harmonic scalpel.

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