



A cooperative approach for treatment of Zenker's diverticulum

Daniel Castaneda¹ · Francisco Franco Azar¹ · Ishtiaq Hussain^{1,2} · Luis F. Lara³ · Ronnie R. Pimentel¹ · Gilberto Alemar⁴ · Candace Hrelec⁴ · Jeffrey Ponsky⁵ · Tolga Erim¹

Received: 30 April 2021 / Accepted: 6 September 2021 / Published online: 15 September 2021
© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2021

Abstract

Background Symptomatic Zenker's diverticulum management has evolved from an open intervention to an endoscopic management. At our center, both an otolaryngologist and a gastroenterologist are present in the operating room when treating these lesions. An intra-procedural consensus is reached to undergo either rigid endoscopy or flexible endoscopic diverticulotomy with ENT guidance. We evaluated the real-world efficacy with a cooperative gastroenterology–otolaryngology approach.

Methods Single-center retrospective study of patients who underwent a cooperative endoscopic diverticulotomy by a gastroenterologist and otolaryngologist at Cleveland Clinic Florida between 2012 and 2019. Demographic and clinical data, intra-procedural findings/complications, post-procedural symptoms, recurrence rate, and reintervention variables were extracted. Patients included in the study were > 17 years old, with symptomatic confirmed typical single Zenker's diverticulum.

Results 63 subjects were identified. Patients were predominantly males (63.5%) and white (84.1%), with mean age 73.5 years (53–95). Most subjects presented dysphagia (98.4%), mostly to solids (79.4%). Other demographic and clinical data are described in Table 1. The diverticula had a mean size of 36.3 mm. In 30.1% of the cases food debris was found during the procedure. The mean procedure length was 38.4 minutes. All cases were performed as outpatient. Technical success was achieved in all cases. Patients were followed for a mean of 3.24 months post-procedure. Clinical success was achieved in 92% subjects. One intra-procedural perforation was treated with endoclip.

Conclusion A cooperative endoscopic approach by gastroenterology and otolaryngology for symptomatic Zenker's diverticulum management offered excellent technical and clinical success. This approach proved to be safe and effective.

Introduction

Zenker's diverticulum is a pharyngeal pouch that forms as a result of chronic pressure in an area of weakness in the posterior hypopharyngeal wall [1]. This pathology has an estimated prevalence of 0.01–0.1% in the general population [2], affecting patients usually in the seventh and eight decades of life with a variety of symptoms such as dysphagia, halitosis, regurgitation, vomiting, and chronic cough [3]. Even though it can be asymptomatic, the severity of the symptoms can significantly affect the quality of life and lead to major complications like recurrent aspiration pneumonia, airway fistula, ulceration, and squamous cell carcinoma [3, 4]. Thus, treatment of symptomatic ZD can have important repercussions in this population.

Management of symptomatic ZD has evolved throughout the decades. Initially performed as an open transcervical

surgery to excise the pharyngeal pouch in 1886 by Wheeler [5], the surgical technique progressed to less invasive interventions with the introduction of rigid diverticuloscopy in 1917 [6] which offered lower morbidity. The procedures were performed for years by otolaryngologists, but gastroenterologists and foregut surgeons implemented the use of flexible endoscopic myotomy since 1995 [7]. Both stapler-assisted rigid endoscopy and flexible endoscopy have proved to be safe and effective approaches for treating symptomatic ZD [8], with an overall clinical success rate of 86–94% rigid laryngoscopy [9] and 87.9% with flexible endoscopy [10].

At our institution, we identified referrals from otolaryngology to gastroenterology due to failed or incomplete rigid diverticulectomy. This observation led to the implementation of a new multi-disciplinary approach in which both a gastroenterologist and otolaryngologist would be present at the time of the procedure to establish the most suitable approach and perform the intervention in a single session—we have termed this the Zenker's Diverticulum Cooperative

Extended author information available on the last page of the article

Table 1 Pre-procedural demographic and clinical variables in patients undergoing Zenker's diverticulum cooperative approach

Variable	Value (<i>n</i> =63)
Sex, <i>n</i> (%)	
Male	40 (63.5)
Female	23 (36.5)
Ethnicity/Race, <i>n</i> (%)	
Non-Hispanic White	53 (84.1)
Hispanic	7 (11.1)
Black	3 (4.8)
Smoking status, <i>n</i> (%)	
Never	29 (46.0)
Former	26 (41.3)
Active	8 (10.7)
Previous intervention for Zenker's diverticulum, <i>n</i> (%)	12 (19.1)
Dysphagia, <i>n</i> (%)	
Only to solids	50 (79.4)
Only to liquids	0 (0)
Both solids and liquids	12 (19.0)
Regurgitation of food, <i>n</i> (%)	
Chronic cough, <i>n</i> (%)	13 (20.6)
Halitosis, <i>n</i> (%)	9 (14.3)

Approach. We aimed to evaluate the efficacy, failure rate, and safety profile of a cooperative approach by a gastroenterologist and otolaryngologist in the treatment of Zenker's diverticulum.

Materials and methods

Study population and inclusion criteria

This is a single-center retrospective study of patients who had a history of symptomatic ZD and underwent a multidisciplinary cooperative interventional approach at Cleveland Clinic Florida between January 2012 and January 2019. Since 2012, the presence of both a gastroenterologist and an otolaryngologist in the operating room when patients undergo minimally invasive treatment became the standard approach. To determine the most suitable technique, a consensus is reached by both specialists taking into consideration the anatomy of the patient.

An initial query from the electronic medical record was performed utilizing ICD-9 and 10 codes for ZD (530.6 and K22.5). Eligible patients for the study included subjects ≥ 18 years with typical symptoms of single ZD confirmed with neck imaging (computerized tomography or barium esophagram) or endoscopy. Subjects were excluded from the study if < 18 years or pregnant.

Data collection

Demographic data, smoking status, presence and severity of dysphagia, presence of regurgitation, findings upon diverticula inspection (presence of food and diverticular size), procedural specifications, technical success, complications, need for emergent surgery, use of post-procedural antibiotics, symptom recurrence, need for repeat imaging/endoscopic evaluation, need for surgery, and symptom recurrence with recurrent intervention were collected. Data were collected by two different authors (FFA and IH). If there was any discrepancy in data consistency, a third author (DC) served as the final reviewer.

Outcomes

The primary outcome for our study was the technical and clinical success of the Zenker's Diverticulum Cooperative Approach. Secondary outcomes included the occurrence of adverse events and the investigations and interventions performed for a failed intervention.

Definitions and statistical analysis

Technical success was defined as the number of cases that achieved a satisfactory myotomy without the need to abort the procedure. Clinical success was defined as the absence of recurrent symptoms upon follow-up. In the case recurrent symptoms were present, a repeat evaluation was needed to confirm the presence of persistent ZD.

Basic descriptive statistics were calculated for the patients included in our study outlining the demographic, pre-endoscopic, peri-procedural, and post-endoscopic variables. The technical and clinical success were calculated based on the above definitions as percentage rates.

Description of the procedures

Each individual case was discussed between the gastroenterologist (TE, LL, or RP) and the otolaryngologist (GA or CH) in the preprocedural area to determine whether an initial flexible endoscopy or stapler-assisted rigid endoscopy should be performed first based on the patient's neck length and size, mouth opening width based on Mallampati score, and estimated diverticulum size based on previous imaging or previous endoscopic evaluation. Ultimately, intra-procedural decision to switch to the "backup" specialist was made if adequate insertion of the rigid endoscope was not possible, complete visualization of the diverticula was not achieved, or if there was a large size diverticulum with higher risk of perforation. The patients were seen in clinic by each specialist and then consented for both a flexible endoscopy and a

stapler-assisted rigid endoscopy. Subsequently, the patients received general anesthesia with endotracheal intubation to protect airway for intra-procedural aspiration.

For flexible endoscopic interventions, the procedures were performed with EVIS EXERA III Olympus GIF-HF190 gastroscopes (Olympus Corporation, Shinjuku City, Tokyo, Japan). A nasogastric tube was introduced. A transparent cap was attached to the tip of the gastroscope before insertion, allowing a complete evaluation of the hypopharynx, including the ZD characteristics and contents. A diverticulotomy was performed at the center of the muscular bar up to the base of the diverticulum in a diamond-shaped fashion [11] utilizing a 2.8 mm DualKnife electrosurgical knife (Olympus Corporation, Shinjuku City, Tokyo, Japan) with Endocut Q-3 cautery.

For stapler-assisted rigid endoscopy, a Weerda diverticuloscope (Karl Storz Endoscopy, Culver City, CA, USA) was introduced into the oral cavity and advanced distally until the post-cricoid region was brought into view. The scope was advanced under direct visualization of the posterior pharyngeal wall until the ZD muscular bar was observed. A 0 degree endoscope was used to confirm adequate exposure. Next, an Endopath 45 stapler (Ethicon Endo-Surgery, Cincinnati, OH, USA) was engaged onto the muscular bar and subsequently fired. If no muscular bar division was achieved, a Harmonic endoscopic scalpel was used to cut the tissue or Endopath scissors were used to cut the midline of the stapler and a second stapling pass was performed as mentioned before.

In the case the initial intervention was technically not possible or incomplete, a flexible endoscopy or stapler-assisted rigid endoscopy followed, depending on which procedure was performed first. Both physicians were present during the procedure as backup in case the switch to a different intervention was needed. A decision tree algorithm is depicted in Fig. 1. The procedures were performed by gastroenterologists and otolaryngologists with ample experience in ZD management.

Study oversight

The Institutional Review Board approved this retrospective study, Cleveland Clinic Florida (IRB FLA 19-038).

Results

A total of 63 patients met the inclusion criteria for the study. Overall, the cohort had a mean age of 73.5 years (range 53–95 years) and was predominantly composed of Non-Hispanic White (84.1%) and male (63.5%) subjects. Among these patients, 12/63 patients (19.1%) underwent a previous intervention for symptomatic ZD—seven patients

had a history of stapler-assisted rigid endoscopy, one had a flexible endoscopic myotomy, and one had a transcervical diverticulectomy. The most common symptom upon initial presentation was the presence of dysphagia (98.6%), which was more frequent with solid food ingestion (79.4%). Other preprocedural demographic and clinical variables are listed in Table 1.

Upon initial flexible endoscopy/stapler-assisted rigid endoscopy, patients were found to have a mean diverticular size of 36.29 mm (15–96 mm). There was presence of food in 19 cases (30.2%), which was removed in all cases to allow adequate diverticula inspection and instrument positioning. Length of the procedure varied, with a mean duration of 38.49 min (range of 20–97 min). Technical success for myotomy was achieved in 100% of the patients. Among all the procedures, the initial attempt was performed by otolaryngology in all of the cases, requiring assistance by the gastroenterologist in 50.9% as there was difficulty obtaining adequate anteroposterior dimension for intervention due to neck mobility and mouth opening (69.2%), difficulty positioning the diverticuloscope (15.4%), small diverticulum size (7.7%), and persistence of diverticulum base with difficult repositioning (7.7%). From these patients, 19.05% of the procedures required intra-procedural assistance by otolaryngology to identify the tissue planes due to large diverticulum size (75%) or tortuous anatomy (25%). All cases were performed in the outpatient setting and none of the patients required a hospital admission for post-procedural observation. A single intraprocedurally recognized perforation was closed with three endoclips and did not require any further intervention. All patients received preprocedural antibiotics. Soft mechanical diet advanced to regular was recommended over 72 h. Upon discharge, prophylactic oral antibiotics were prescribed to 50 patients (79.4%) for a median length of 7 days (5–10 days). Other peri-procedural variables are listed in Table 2.

Patients were followed for a mean of 3.24 months (range 0.25–22 months) after the intervention and a median of two follow-up appointments (range 1–3). Fourteen patients (22.2%) presented recurrent symptoms at an average of 4.9 months (range 0.5–21.5). From these patients, further evaluation with repeat imaging was performed in eight subjects, all of which had persistence of residual cricopharyngeal bar. Out of the remaining six patients with persistent/recurrent symptoms, two did not follow-up in our clinic subsequently and four had eventual resolution of the symptoms. Among the eight patients with repeat imaging, persistent symptoms were only found in five patients all of whom underwent a repeat intervention as follows: Three patients pursued repeat flexible endoscopy (one patient underwent a repeat endoscopic myotomy, while the other two patients were to have minuscule diverticula not amenable to intervention); One patient underwent successful repeat

Fig. 1 Diagnostic and treatment algorithm for symptomatic Zenker's diverticulum patients—successful and failed treatment

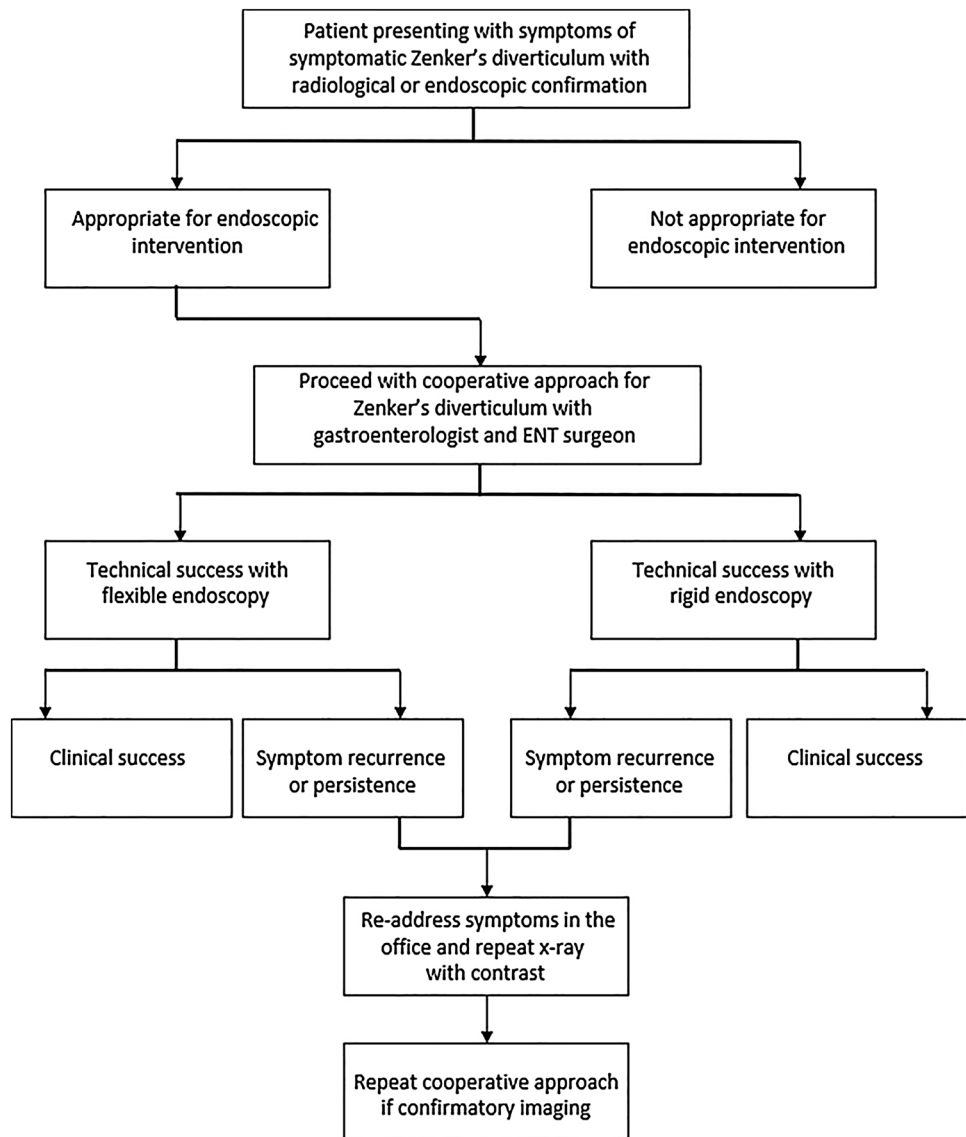


Table 2 Intra-procedural and immediate post-procedural variables in patients undergoing Zenker's diverticulum cooperative approach

Variable	Value (n=63)
Diverticulum size, mean mm (range)	36.3 (15–95)
Food present in diverticulum, n (%)	19 (30.2)
Procedure length, mean minutes (range)	38.49 (20–97)
Use of post-procedural antibiotics	50 (79.4)
Amoxicillin	23 (36.5)
Amoxicillin-clavulanate	11 (17.5)
Cephalexin	7 (11.1)
Clindamycin	5 (7.9)
Azithromycin	2 (3.2)
Ciprofloxacin	2 (3.2)

stapler-assisted rigid endoscopy; One patient underwent open transcervical diverticulectomy at an outside facility. Overall, the initial intervention had clinical success in 58 patients (92.1%).

Discussion

Symptomatic ZD management has evolved through the years from an open surgical associated with comorbidities to minimally invasive rigid or flexible endoscopic approaches which are safe and effective [10–13]. Previous studies suggested a rate of conversion to open surgery in up to 18% of patients following rigid endoscopy stapling namely due to poor exposure of the septum, but with data now indicating >90%

success rate we advocate flexible endoscopic management which in our case benefitted from a comprehensive approach including gastroenterology and otolaryngology [14].

Our study showed an excellent technical success and no procedures had to be aborted. The combined approach resulted in immediate alternative intervention which also helped avoid a need for a second consultation and operative procedure in 58 patients (92%). Usually, anatomical complexity as a result of severe cervical arthrosis and osteophytes and diverticula size affected the approach. The majority of the patients in our cohort were referred from the community where interventions had been ruled out due to comorbidities, age, and previous failed interventions, emphasizing the importance of a comprehensive approach resulting in a single procedure for the patient.

A recent meta-analysis by Jain et al. [15] evaluated the pooled clinical efficacy with rigid and flexible endoscopy, including retrospective and prospective series. Overall, clinical remission was achieved in 75.4% when endoscopy was performed with a cap and 94.0% if no cap was used, and rigid diverticuloscopy had a computed success of 86.8%. There was study heterogeneity and follow-up intervals varied in that meta-analysis; nonetheless, our results of 92.1% clinical success are favorable and support our combined approach.

The Zenker's Diverticulum Cooperative Approach proved to be safe, with minimal occurrence of complications. A single perforation during flexible endoscopy, which we would characterize as type 2, was treated with endoscopic clip closure and same day discharge. All patients received preprocedural antibiotics as part of our institution protocol. It should be noted that 20% of our patients did not receive post-procedure antibiotics and no infectious complications were recorded. Finally, even though several series [16–18] have described varying degrees of intra- or post-procedural bleeding rates of up to 32%, none of our patients had this adverse event. The overall low complication occurrence could be potentially explained by the intra-procedural active assessment from two specialists that work together to expose the ZD in its entirety, while reducing the risk of further damage by providing guidance with the rigid diverticuloscope or with an endoscopic guidewire.

Interestingly, new endoscopic techniques have been developed, including endoscopic submucosal dissection techniques used in achalasia treatment, including the Zenker's per oral endoscopic myotomy (Z-POEM). Multi-center observational prospective and retrospective studies have been performed in small cohorts [19, 20], demonstrating similar safety and technical/clinical efficacy when indirectly compared to other endoscopic approaches. A meta-analysis [21] including 3 observational studies calculated a pooled technical success of 95% and 6% adverse event rate, but no clinical success rates were reported. Recently, two

non-randomized retrospective studies have compared the outcomes of Z-POEM to other endoscopic myotomy techniques, with one study [22] showing 21% less adverse events with Z-POEM, while no differences in technical, clinical, or adverse events were found in a study comparing Z-POEM, flexible, and rigid endoscopy, separately [23]. Hence, due to the paucity of studies, the Z-POEM is still considered an experimental therapy. Future studies are needed to determine if there are any differences when compared to other endoscopic myotomy techniques.

The current study has several strengths. To our knowledge, this is one of the largest series reporting the outcomes of patients undergoing endoscopic management of ZD. Importantly, it is the first study describing an active collaboration between gastroenterology and otolaryngology to perform a single procedure to treat these lesions by introducing real-time conjoint decision-making, reducing the necessity to abort an anesthesia-requiring procedure in elder patients with other concomitant comorbidities where further interventions, reversal of anticoagulation, and exposure to general anesthesia may not be desirable. While a randomized trial comparing these interventions would be ideal, it would be technically difficult and would require a large enrollment given the reported success of both approaches.

There are study limitations. Most patients came to our institution through referral, so a patient selection bias may exist. All patients undergoing management of ZD at Cleveland Clinic Florida undergo this cooperative approach, but the retrospective and non-randomized nature of the procedure have to be recognized. It is impossible to know if more patients would require salvage rigid diverticulotomy if a flexible endoscopic approach were tried first. We recognize a relevant limitation in our cohort is long-term follow-up, which could not be evaluated as many patients continued local follow-up. This limitation is inherent to the retrospective nature of our analysis. Furthermore, our study did not include post-procedural office visits with other specialties/primary care physician as part of the total length of follow-up to avoid inaccurately assuming the ZD symptoms were addressed during those visits. Similarly, two patients with persistent/recurrent symptoms did not undergo repeat imaging evaluation as they were lost to follow-up. Ideally, longer follow-up cohorts or prospective studies may decrease this limitation.

In summary, the implementation of the Zenker's Diverticulum Cooperative Approach with a gastroenterologist and an otolaryngologist proved to be both technically and clinically successful and safe. Hence, the presence of two specialists for ZD management can decrease the need for a more invasive intervention or aborting a procedure, providing the knowledge and skills of two different specialists in a single procedure. Further studies evaluating the long-term

clinical and economic implications of this approach, as well as patient satisfaction, are warranted.

Disclosures

Dr. Luis F. Lara is a consultant/speaker for Abbvie and Nestle. Dr. Jeffrey Ponsky is a consultant for Boston Scientific Corporation. Dr. Tolga Erim is a consultant for Boston Scientific Corporation. Drs. Daniel Castaneda, Francisco Franco Azar, Ishtiaq Hussain, Ronnie R. Pimentel, Gilberto Alemar, and Candace Hrelec have no conflicts of interest or financial ties to disclose.


Funding No funding sources or sponsors.

References

- Law R, Katzka DA, Baron TH (2014) Zenker's diverticulum. *Clin Gastroenterol Hepatol* 12(11):1773–1782
- Watemberg S, Landau O, Avrahami R (1996) Zenker's diverticulum: reappraisal. *Am J Gastroenterol* 91(8):1494–1498
- Ferreira LE, Simmons DT, Baron TH (2008) Zenker's diverticula: pathophysiology, clinical presentation, and flexible endoscopic management. *Dis Esophagus* 21(1):1–8
- Bradley PJ, Quraishi MS (1999) Pharyngeal pouch carcinoma: real or imaginary risks? *Ann Otol Rhinol Laryngol* 108(11 Pt 1):1027–1032
- Wheeler WI (1886) Pharyngocele and dilatation of pharynx, with existing diverticulum at lower portion of pharynx lying posterior to the Esophagus, cured by pharyngotomy, being the first case of the kind recorded. *Dublin J Med Sci* 82:349–356
- Mosher HP (1917) Webs and pouches of the oesophagus, their diagnosis and treatment. *Surg Gynecol Obstet* 25:175–187
- Ishaq S, Sultan H, Siau K, Kuwai T, Mulder CJ, Neumann H (2018) New and emerging techniques for endoscopic treatment of Zenker's diverticulum: State-of-the-art review. *Dig Endosc* 30(4):449–460
- Crawley B, Dehom S, Tamares S, Marghalani A, Ongkasuwan J, Reder L et al (2019) Adverse events after rigid and flexible endoscopic repair of Zenker's diverticula: a systematic review and meta-analysis. *Otolaryngol Head Neck Surg* 161(3):388–400
- Wilken R, Whited C, Scher RL (2015) Endoscopic staple diverticulostomy for Zenker's diverticulum: review of experience in 337 cases. *Ann Otol Rhinol Laryngol* 124(1):21–29
- Dzeletovic I, Ekblom DC, Baron TH (2012) Flexible endoscopic and surgical management of Zenker's diverticulum. *Expert Rev Gastroenterol Hepatol* 6(4):449–465
- Lara LF, Erim T, Pimentel R (2015) Diamond-shaped flexible endoscopic cricopharyngeal myotomy for treatment of Zenker's diverticulum. *Gastrointest Endosc* 82(2):403
- Laing MR, Murthy P, Ah-See KW, Cockburn JS (1995) Surgery for pharyngeal pouch: audit of management with short- and longterm follow-up. *J R Coll Surg Edinb* 40(5):315–318
- Feeley MA, Righi PD, Weisberger EC, Hamaker RC, Spahn TJ, Radpour S et al (1999) Zenker's diverticulum: analysis of surgical complications from diverticulectomy and cricopharyngeal myotomy. *Laryngoscope* 109(6):858–861
- Calavas L, Brenet E, Rivory J, Guillaud O, Saurin JC, Ceruse P et al (2020) Zenker diverticulum treatment: retrospective comparison of flexible endoscopic window technique and surgical approaches. *Surg Endosc*. <https://doi.org/10.1007/s00464-020-07865-1>
- Jain D, Sharma A, Shah M, Patel U, Thosani N, Singhal S (2018) Efficacy and safety of flexible endoscopic management of Zenker's diverticulum. *J Clin Gastroenterol* 52(5):369–385
- Case DJ, Baron TH (2010) Flexible endoscopic management of Zenker diverticulum: the Mayo Clinic experience. *Mayo Clin Proc* 85(8):719–722
- de la Morena ME, Pérez AE, Rodríguez GI (2016) Flexible endoscopic treatment of Zenker's diverticulum: thirteen years' experience in Spain. *Rev Esp Enferm Dig* 108:297–303
- Laquiere A, Grandval P, Arpurt J, Boulant J, Belon S, Aboukheir S (2015) Interest of submucosal dissection knife for endoscopic treatment of Zenker's diverticulum. *Surg Endosc* 29:2802–2810
- Budnicka A, Januszewicz W, Białek AB, Spychalski M, Reguła J, Kaminski MJ (2021) Peroral endoscopic myotomy in the management of Zenker's diverticulum: a retrospective multicenter study. *J Clin Med* 10(2):187
- Elkholy S, El-Sherbiny M, Delano-Alonso R, Herrera-Esquivel JJ, Valenzuela-Salazar C, Rodriguez-Parra A et al (2021) Peroral endoscopic myotomy as treatment for Zenker's diverticulum (Z-POEM): a multi-center international study. *Esophagus* 18(3):693–699
- Kamal F, Ali Khan M, Lee-Smith W, Sharma S, Marella HK, Iqbal U et al (2020) Peroral endoscopic myotomy is a safe and feasible option in management of esophageal diverticula: systematic review and meta-analysis. *Dig Dis Sci*. <https://doi.org/10.1007/s10620-020-06678-5>
- Kahaleh M, Mahpour NY, Tyberg A, Bareket R, Shahid HM, Sarkar A et al (2021) per oral endoscopic myotomy for Zenker's diverticulum: a novel and superior technique compared with septotomy? *J Clin Gastroenterol*. <https://doi.org/10.1097/MCG.0000000000001579>
- Al Ghamdi SS, Farha J, Moran RA, Pioche M, Moll F, Yang DJ et al (2021) Zenker's peroral endoscopic myotomy, or flexible or rigid septotomy for Zenker's diverticulum: a multi-center retrospective comparison. *Endoscopy*. <https://doi.org/10.1055/a-1518-7223>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Daniel Castaneda¹  · Francisco Franco Azar¹ · Ishtiaq Hussain^{1,2} · Luis F. Lara³ · Ronnie R. Pimentel¹ · Gilberto Alemar⁴ · Candace Hrelec⁴ · Jeffrey Ponsky⁵ · Tolga Erim¹

✉ Daniel Castaneda
daniel.castaneda.m@gmail.com

¹ Digestive Disease Institute, Cleveland Clinic Florida, 2950 Cleveland Clinic Blvd, 2nd Floor, Weston, FL 33331, USA

² Medicine Department, Weiss Memorial Hospital, Chicago, IL, USA

³ Department of Gastroenterology, Wexner Medical Center, The Ohio State University, Columbus, OH, USA

⁴ Department of Otolaryngology, Cleveland Clinic Florida, Weston, FL 33331, USA

⁵ Department of Surgery, Cleveland Clinic, Weston, FL 33331, USA