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# Successful advanced third-space endoscopic surgery by per-oral endoscopic myotomy (Z-POEM) for Zenker's diverticulum: A case report and review of literature

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## ABSTRACT

**INTRODUCTION:** Zenker's diverticulum is a rare condition caused by herniation of the mucosa at the pharyngoesophageal junction, resulting in dysphagia. Third-space endoscopic surgery now plays an important role in its management, facilitating precise surgery with good outcomes. The aim of report is to demonstrate technical steps and outcomes of per-oral endoscopic myotomy (Z-POEM).

**PRESENTATION OF CASE:** We report two male patients presented with dysphagia. Esophagograms revealed Zenker's diverticula of 2.1 and 2.0 cm, respectively, and diagnostic gastroscopy showed the diverticula to be 17 cm from the incisors, with tight, thick septal muscle. A 2-cm mucosal incision was made with a triangle-tipped knife, and submucosal tunneling was created by spray coagulation. The gastroscope was advanced into the submucosal space of the esophageal lumen and the diverticulum site until the bottom of the diverticulum could be clearly identified. The septal muscle was completely divided, immediately allowing the gastroscope to pass through easily, and the mucosal defect was reapproximated with hemoclips.

**DISCUSSION:** As compared Z-POEM to previous technique; endoscopic septotomy, staple-assisted diverticulotomy, or open neck surgery, Z-POEM is less recurrent of symptoms and complications. Different types of endoscopic knife and lifting materials were used, but all provided the same outcomes. Most of the cases use through-the-scope clips to close the mucosal defect.

**CONCLUSION:** Z-POEM provided precise treatment and complete view of the entire septal muscle can help to avoid inadequate myotomy.

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## 1. Introduction

A Zenker's diverticulum is a pouch that forms at Killian's triangle as a result of herniation of the posterior pharyngeal wall [1]. This rare condition is found in 0.10% to 0.11% of the general population [2]. No standard surgical treatment has been established for this condition. Minimally invasive third-space endoscopic surgery now plays an important role in affected patients. Many procedures have been proposed for Zenker's diverticulum, including endoscopic stapler-assisted diverticulotomy, flexible endoscopic septotomy,

endoscopic treatment with a harmonic scalpel, and third-space endoscopic surgery by peroral endoscopic myotomy (Z-POEM). These procedures are associated with different success rates, complications, and recurrence rates. The present study was performed to report the technique of Z-POEM in two patients and summarize the outcomes of various endoscopic treatments for Zenker's diverticulum, especially Z-POEM.

## 2. Presentation of cases

We retrospectively reviewed the medical data of two men with dysphagia aged 71 and 75 years, respectively. This present cases has been reported in line with the SCARE 2018 criteria [3]. They had no underlying disease and medications used. A preoperative diagnostic barium swallow procedure revealed Zenker's diverticula measuring 2.0 and 2.1 cm, respectively, and gastroscopy showed

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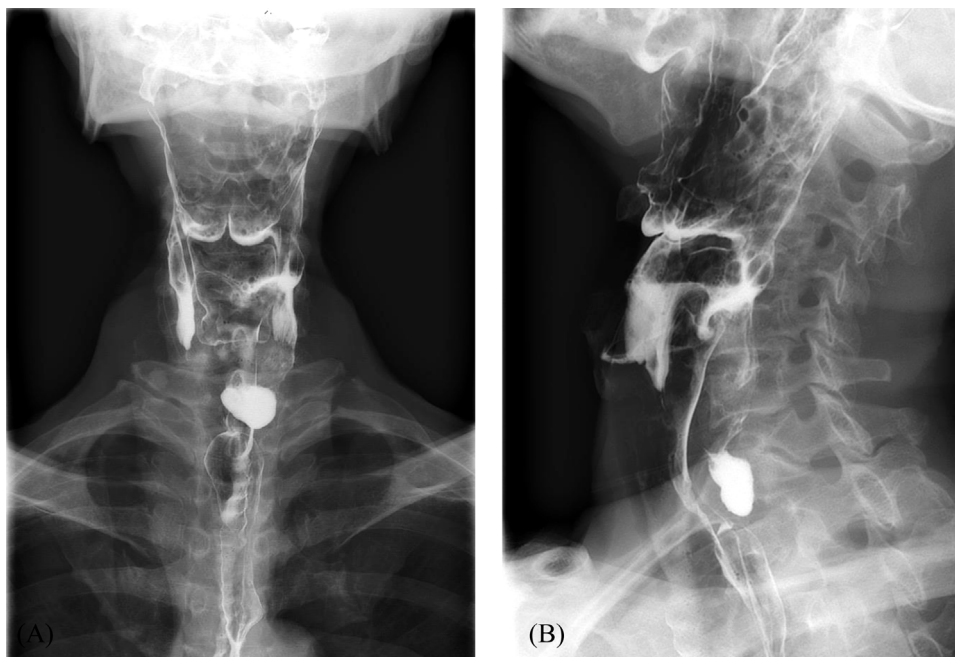
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**Table 1**

Summary of previous report of per-oral endoscopic myotomy(Z-POEM) for Zenker's diverticulum.

Author/publication year	Study design	Age	Presenting symptom	Diverticulum Size (cm)	Knife type	Lifting material	Mucosal closure technique	Procedure time (minutes)	Start oral diet (day)	Length of hospital stay (days)	Complication	Recurrent	Follow up (months)
Present case	Case report	71	-Dysphagia -Weight loss	2.1	Triangle knife	Glycerol with indigo carmine	TTC	45	1	3	No	No	2
Present case	Case report	75	-Dysphagia	2	Triangle knife	NSS with indigo carmine	TTC	60	1	3	No	No	12
Margarida Flor de Lima 2019 [14]	Case report	79	-Dysphasia - Regurgitation -Halitosis	2	T-type Hybrid knife	NA	TTC	64	1	2	No	No	8
Juliana Yang 2019 [2]	Retrospective	73.3	-Dysphagia	3.1	Triangle tip knife	Saline with indigo carmine and adrenaline	TCC	52.4	NA	1.8	Yes	Yes	12
Olaya I. Brewer Gutierrez 2018 [15]	Case report	94	-Dysphagia - Regurgitation	4	-Triangle tip knife -Insulated tip knife	Saline with indigo carmine	TTC	NA	1	3	No	No	3
Valerio Balassone 2018 [1]	Case report	77	NA	6	Hybrid knife	NA	OVESCO	NA	NA	NA	No	No	1
Bertrand Bribeau 2017 [16]	Case report	72	-Dysphagia	NA	T-type Flush knife	NA	TTC	NA	NA	3	No	NA	NA

Abbreviations: TTSC, through-the-scope clip; OTSC, over-the-scope clip; NA, not applicable.



**Fig. 1.** Preoperative esophagogram showing Zenker's diverticulum.

A. Anteroposterior view; B. Lateral view. Size, 2.1 cm.

that the diverticula were 17 cm from the incisors. The procedure was performed by two endoscopists who used the same technique. Informed consent for the procedure was obtained from each patient after explaining the prognosis, results, and potential complications of the procedure. The decision to perform Z-POEM was made after confirming the diagnosis by esophagography and gastroscopy (Figs. 1 and 2). The operators are the surgical endoscopist in university hospital with learning curve of POEM more than 25 cases. Both patients underwent Z-POEM under general anesthesia with an endotracheal tube. Carbon dioxide gas insufflation through the endoscope was mandatory. The Z-POEM procedure was performed using a single-channel gastroscope (GIF H-180; Olympus Corporation, Tokyo, Japan). A triangle-tipped knife (KD-645; Olympus Corporation) was used for the mucosal incisions, submucosal dissection, and myotomy. A distal attachment cap (D-201-11804; Olympus Corporation) was used to maintain and stabilize the operative field. Glycerol with a few drops of indigo carmine was used to lift the submucosal layer. The surgery was performed using a high-frequency electrosurgical energy generator (VIO 300 D; Erbe Elektromedizin, Tübingen, Germany) in endo cut mode (effect 2,3 W) and spray coagulation mode (effect 1100 W). The procedure time was defined as the time from insertion of the endoscope to application of the last through-the-scope clip. The septal muscle of Zenker's diverticulum was located 17 cm from the incisors. The submucosa was lifted using glycerol and indigo carmine, and a mucosal incision was made 2 cm above the septal muscle using a triangle-tipped knife in endo cut mode (effect 2,3 W). Submucosal tunneling was performed with cap assistance, and submucosal dissection was performed by coagulation along both sides of the septal wall using the spray coagulation mode (effect 1100 W) until the bottom of the diverticulum and septal muscle could be clearly identified. The endo cut mode (effect 2,3 W) was then applied to achieve complete septal myotomy. Through-the-scope clips were applied to achieve mucosal apposition (Fig. 2). Neither patient developed bleeding or perforation. The total procedure time was 45 and 60 min, respectively. Esophagography was performed on postoperative day 1 to confirm the absence of leakage, and the patients were able to resume an oral diet thereafter. Esophagography was repeated on postoperative day 7 to confirm that the diverticulum had been

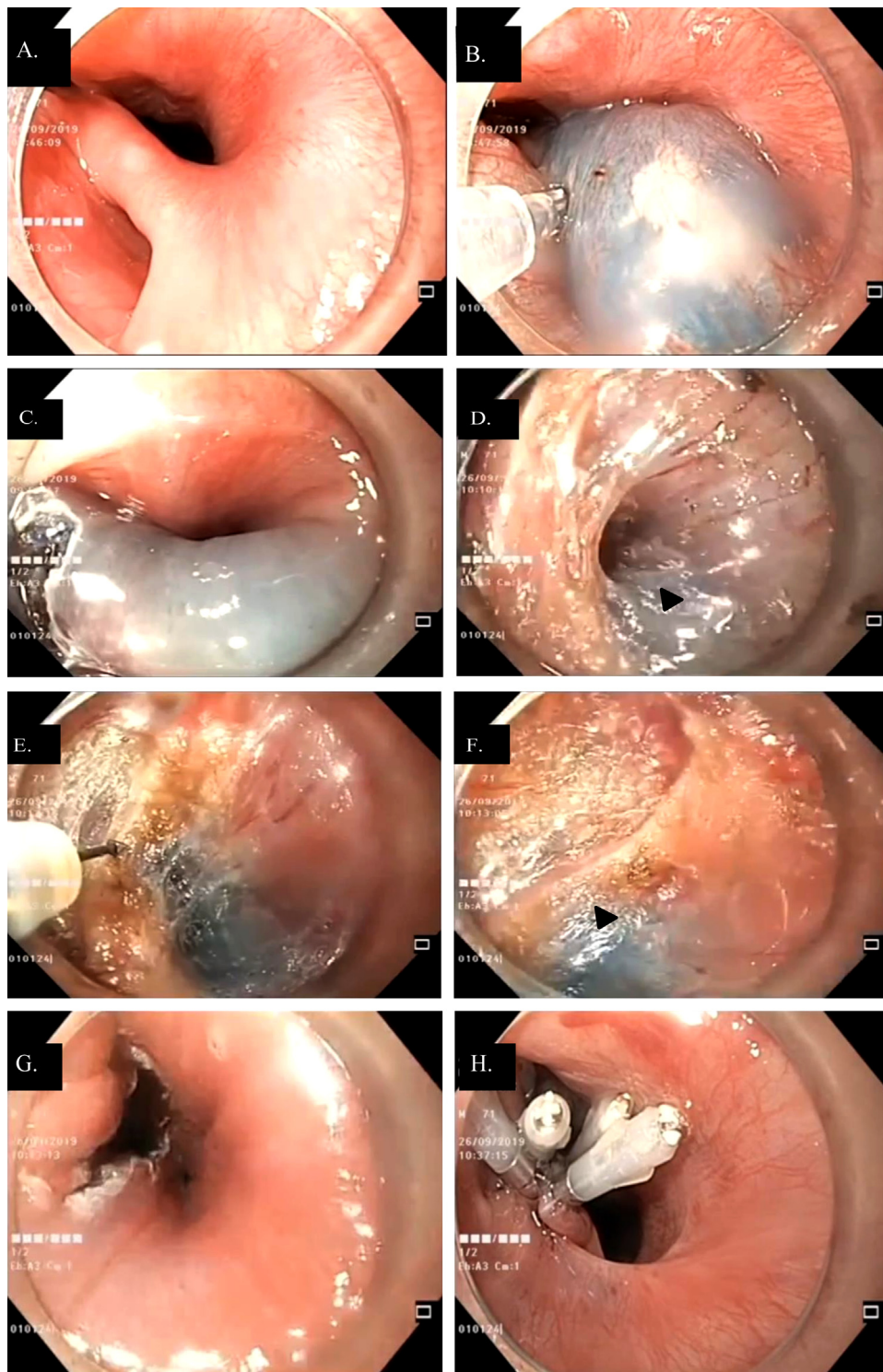
resolved (Fig. 3). Both patients can discharge home with no caution to eat. On postoperative day 14 of follow up the patients has better swallow solid food with satisfied weight gain 4 kgs. The patients' data are summarized along with a literature review in Table 1.

### 3. Discussion

Zenker's diverticulum is a rare condition with no standard surgical treatment. In this report, we have described two cases of Zenker's diverticula treated by Z-POEM along with other cases in the literature. Analysis of these cases confirmed the precise technical outcome of peroral endoscopic myotomy by submucosal tunneling, which allows the entire septal muscle along both sides to be clearly identified.

Many treatment strategies for Zenker's diverticulum have been proposed. One of these is flexible endoscopic septotomy, in which the septal muscle is directly cut with an endoknife without submucosal lifting. This is a minimally invasive approach with a high success rate (91%) [3]. However, the rates of symptom recurrence and adverse events are quite high (11.3% and 11.0%, respectively) because the bottom of the diverticulum cannot be clearly identified, leading to incomplete division of the septal muscle [3–5]. In contrast, Z-POEM allows for clearer identification of the septal muscle, leading to complete septal division. Another treatment option is stapler-assisted Zenker's diverticulotomy using an Endo GIA 35-mm stapler or a fully rotatable surgical stapler. However, this linear cutting staple technique requires the patient's neck to be straightened to increase the working space for the linear instruments; therefore, the technique cannot be performed for patients with cervical spine problems. The advantage of this technique is that it allows for simultaneous resection and suturing of the septal muscle to create a cavity. The technique has a success rate of 64.7%, a mean procedure time of 14 min (range, 5–45 min), a minor complication rate of 2.8%, and a symptom recurrence rate of 19.8% [6–9]. Wilmsen et al. [7] reported technical staple failure in 35.3% of cases because of thickening of the septal muscle and insufficient hyperextension of the neck for instrument insertion. A third procedure is endoscopic treatment by a harmonic scalpel. This technique involves intermittent septal myotomy with a harmonic scalpel until the sur-





**Fig. 2.** Per-oral endoscopic myotomy for Zenker's diverticulum (Z-POEM) (A-H).

A. Endoscopic view of the Zenker's diverticulum, located 17 cm from the incisors; B. The submucosa was lifted by using glycerol with a few drops of indigo carmine injected 2 cm from the septum. C. Mucosal incision was performed by Endocut mode Effect 2,3 W; D. Submucosal tunneling and dissection was performed by Spray Coag Effect 1, 100 W along both sides of the septal wall until clearly identifying the bottom of the diverticulum and septal muscle was achieved.(arrow head) E. Myotomy was performed ; F. The last fiber of septal muscle was clearly identified at the bottom of diverticulum before cut.(arrow head) G. A mucosal defect; H. The mucosal defect closed by Through-the-scope clip (TTSC).

geon reaches a point 5 mm above the bottom of the diverticulum. However, this can result in incomplete myotomy and symptom recurrence. The technique has a success rate of 80% and a mean procedure time of 17.33 min (range, 15–20 min), with 5% of patients experiencing adverse events and 20% having to undergo a repeat

septotomy [10,11]. A standard open-neck technique approach to the left neck can effectively resolve symptoms by 90%–95%, but this technique is very invasive and is associated with more complications. An open-neck approach reportedly has an overall morbidity rate of 10.5% and high rates of adverse events, including medias-

**Table 2**  
Summarized outcomes of different surgical techniques treatment Zenker's diverticulum.

Outcome	Per-oral endoscopic myotomy (Z-POEM) [2]	Flexible endoscopic septotomy [4]	Stapler-assisted Zenker's diverticulotomy [6]	Endoscopic harmonic scalpel [11]	Standard open neck technique [13]
Technique	Require high endoscopic skill	Direct myotomy to septal muscle and mucosa	High rate technical failure if thick septal muscle	Need extension of the neck	Invasive Difficult approach
Suitable diverticulum size	Small to large	Small	Small	Small	Large
Operative time (mins)	55.53(45–65)	21.87(15–25)	14(5–45)	17.33(15–20)	87.6 ± 35.10
Length of hospital stay (days)	2.63(1.8–3)	2.5	1.06(0–5)	1.3(1–4)	5.1 ± 1.25
Complication (%)	6.17	11.3	2.8	5	10.5
Recurrent (%)	1.23	11	19.8	20	NA
Septal muscle management	Complete myotomy is achieved from precision surgery	Cannot identify a bottom of diverticulum which septal muscle located	Simultaneous resection and suture but high rate of incomplete myotomy	Myotomy until 5 mm above the diverticulum leads to incomplete myotomy	Large surgical wound High risk of fistula and recurrent laryngeal nerve injury

The data are mean (range) or mean ± SD. NA, not applicable.



**Fig. 3.** Postoperative esophagogram found completely resolution of the diverticulum.

tinitis (9.5%), esophageal stenosis (7.1%), cutaneous fistula (19.0%), and recurrent laryngeal nerve paralysis (12.9%) [9,12,13]. Because of the reported high adverse event rate and better outcomes associated with newer endoscopic approaches, the open-neck technique is now rarely used.

Our literature review showed that 81 patients underwent Z-POEM for Zenker's diverticulum with symptoms of dysphagia and/or regurgitation (Table 1) [1,2,14–16]. The patients' mean age was 77.3 years, and the mean size of the diverticulum was 3.2 cm. The mean procedure time was 55.35 min (range, 45–64 min). None of the patients showed leakage on esophagography, and all started an oral diet on postoperative day 1. The patients were discharged home after a mean of 2.63 days (range, 1.8–3 days).

Five patients (6.17%) experienced adverse events, including one case of bleeding and four of perforation (reported in Study 4 in Table 1); these were managed successfully without the need for an operation. A clinical success rate of 92.59% (75/81 cases) was achieved. Two technical failures occurred (the septum could not be located and the submucosal tunnel could not be created). In one patient, the mucosal defect was closed with an over-the-scope clip because of the large size of the diverticulum (6 cm). In all other patients, closure was achieved with a through-the-scope clip. The mean follow-up period was 6.33 months (range, 1–12 months), with only one patient experiencing symptom recurrence. Table 2 compares the technical aspects of Z-POEM with those of other procedures used to treat Zenker's diverticulum. The use of different types of endoknives and lifting materials did not affect the success or complication rates [14–16]. These instruments can therefore be selected according to the endoscopist's preferences.

Our review suggests that Z-POEM has two major advantages. First, it allows for precise myotomy of the septal muscle to prevent perforation and recurrence of symptoms, which can result from incomplete myotomy. Second, it allows for clear identification of the bottom of the diverticulum by submucosal tunneling, reducing the rate of mucosal perforation. However, a challenging aspect of Z-POEM is the narrow working space and the thinner pharyngeal mucosa layer, resulting in inadequate or difficult mucosal closure with a through-the-scope clip. A few studies of Z-POEM with follow-up periods of 1–12 months showed low rates of symptom recurrence; however, there is a need for long-term follow-up in further studies with high case volumes. Many endoknife or myotomy instruments have been selected for Z-POEM, but all result in the same outcome with no difference in complication rates. Therefore, their use can be based on the preference of the endoscopist.

**4. Conclusion**

Z-POEM can provide precise treatment for Zenker's diverticulum. Its safety and success result from integrity of the intact mucosa, clear identification of the bottom of the diverticulum through the creation of a submucosal tunnel to prevent perforation, and a complete view of the entire septal muscle, which helps to prevent inadequate myotomy. Major complications and recurrence are rare with Z-POEM.

**Declaration of Competing Interest**

The authors declare that they have no conflict of interest.

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## Ethical approval

Ethics approval was permitted from Mahidol University.

## Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

## Author contribution

Chonlada Krutsri: acquisition of data and interpretation, drafting the article.

Chainarong Phalanusitthepha: conception and design of the study, acquisition of data, revising article, final approval.

Pitichote Hiranyathep: acquisition of data.

Preeda Sumritpradit: revising article.

Pongsasit Singhatat: analysis.

Somchai Leelakusolvong: conception and design of the study.

Asada Methasate: conception and design of the study.

Thanida Janbavonkij: data acquisition.

## Registration of research studies

NA.

## Guarantor

The Guarantor is Dr.Chainarong Phalanusitthepha who is the corresponding author of this manuscript.

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