

Harmonic Scalpel in the Treatment of Zenker's Diverticulum

Anthony F. Fama, MD; Eric J. Moore, MD; Jan L. Kasperbauer, MD

Objectives/Hypothesis: To describe the transoral treatment of Zenker's diverticulum with a harmonic scalpel and review the initial outcomes of patients treated with this technique.

Study Design and Methods: Retrospective study of 25 patients with symptomatic Zenker's diverticula who were treated endoscopically with the harmonic scalpel (Ethicon Endo-Surgery, Inc, Cincinnati, OH). Electronic medical records were reviewed. Extracted data included outpatient clinic notes, operative reports, hospital summaries, and follow-up visits.

Results: All identified patients (N = 25) were treated successfully and safely with the harmonic scalpel. All patients were observed overnight, and 21 (84%) were dismissed the day after surgery. One patient with a history of cardiac disease had a non-ST-elevation myocardial infarction, one patient had aspiration pneumonia, and two patients had chest pain (both stayed for complete evaluations with negative findings). One patient had subcutaneous emphysema. No patients had hemorrhage, infection, mediastinitis, or death in the postoperative period. The average length of follow-up was 10.3 months. One patient had a recurrent diverticulum that was treated with an open surgical technique.

Conclusions: Various treatment options are available for Zenker's diverticulum. There has been a trend toward less invasive techniques, and the harmonic scalpel is one useful treatment option. This review demonstrates that the harmonic scalpel is a safe and effective alternative. Longer follow-up time is needed to assess long-term success and incidence of recurrence with this new technique.

Key Words: Harmonic scalpel, Zenker's diverticulum.

Laryngoscope, 119:1265–1269, 2009

INTRODUCTION

A Zenker's diverticulum is a specific type of esophageal diverticulum that results in herniation of mucosa between the inferior aspect of the inferior constrictor muscle and the cricopharyngeus muscle. Zenker's diverticulum was first described by Ludlow¹ in 1769; however, Friedrich Albert von Zenker² was the first to recognize that it resulted from increased intrapharyngeal pressure and described 27 cases in 1877.

These diverticula occur in a natural area of weakness, sometimes termed *Killian's triangle*. They generally are thought to result from poor relaxation of the cricopharyngeus muscle, which creates a zone of high pressure in the hypopharynx. Gastroesophageal reflux disease has been implicated as a possible cause, because it may lead to scarring of the upper esophageal sphincter and also to uncoordinated relaxation of this region. A bridge of tissue between the esophageal lumen and the diverticulum is composed of mucosa, submucosa, connective tissue, and a cricopharyngeal muscle layer.³

Zenker's diverticula typically affect the elderly and predominantly occur in men. Although some patients with small diverticula likely do not seek medical attention and are thus undiagnosed, the annual incidence rate is estimated to be 2 per 100,000.⁴ The incidence rate may also be low because many patients either believe or are told by physicians that dysphagia, a common symptom of Zenker's diverticula, is a normal part of aging. Other common symptoms include regurgitation of undigested food, halitosis, cough, and aspiration. These symptoms can lead to decreased oral intake, pneumonia, weight loss, or malnutrition. The diagnosis of a Zenker's diverticulum is made on the basis of the patient's history, but it typically is confirmed with a barium swallow study. The risks of not treating a Zenker's diverticulum include aspiration, weight loss, ulceration, bleeding, or, rarely, development of a carcinoma within the pouch.

The treatment of Zenker's diverticulum has evolved over time, and the trend is to use less invasive surgical methods.⁵⁻⁷ The main goals of surgery are to eliminate the reservoir that collects food and to release the cricopharyngeus muscle. Initially, surgeons treated Zenker's diverticula through a transcervical approach, which typically consisted of an open diverticulectomy with or

From the Department of Otorhinolaryngology, Mayo Clinic, Rochester, Minnesota, U.S.A.

Editor's Note: This Manuscript was accepted for publication February 10, 2009.

Send correspondence to Eric J. Moore, Department of Otorhinolaryngology, Mayo Clinic, 200 First Street SW, Rochester, MN 55905. E-mail: moore.eric@mayo.edu

DOI: 10.1002/lary.20247

without a cricopharyngeal myotomy. Others favored a diverticulopexy with a cricopharyngeal myotomy. With time, surgeons began using endoscopic techniques to decrease operative time and to avoid an external neck incision, thereby decreasing the risk of serious complications.

Endoscopic techniques are used to perform a diverticulotomy, which is the division of the common wall of mucosa and muscle between the diverticulum and esophagus to create a common pouch and relieve the area of functional stenosis.⁵ Depending on the length of the division, a partial or complete cricopharyngeal myotomy is performed with the endoscopic techniques. The endoscopic approach was first described in 1960 by Dohlman and Mattsson,⁸ who used diathermy to cut the common wall. Their report included 100 patients, and none died or had serious complications. Use of the CO₂ laser to divide the septum was introduced as an alternative to the diathermy technique in 1981 by van Overbeek.⁹ This laser technique is still used frequently by many surgeons, although studies suggest it is associated with some risks. Another popular technique is the endoscopic gastrointestinal anastomosis (endo-GIA) stapler, first introduced in 1993 by Collard et al.¹⁰ and Martin-Hirsch and Newbegin.¹¹ The laser and stapler techniques have become the most popular, and numerous studies have been conducted to determine whether one is superior.¹² Some believe the endoscopic stapler is safer, because it uses multiple rows of staples to seal the mucosal and muscular edges before cutting between them, but many surgeons use the laser technique effectively to treat Zenker's diverticula.¹³

The harmonic scalpel is an instrument that has gained popularity among surgeons for various procedures. It initially was used for laparoscopic surgery but is increasingly common in otolaryngologic procedures, especially thyroid and parathyroid surgery. It is also being used by some surgeons to perform neck dissections and parotid surgery. The harmonic scalpel uses ultrasonographic energy to coagulate and seal tissue before dividing it. Similar to the stapling technique, it has the security of sealing the tissue.

MATERIALS AND METHODS

Data Collection

This study was approved by the Mayo Clinic Institutional Review Board. Our electronic medical records database was searched to identify patients who had been treated for Zenker's diverticulum with the harmonic scalpel. We verified that all patients in the study signed a release form to allow their records to be reviewed for research purposes. Patient information was abstracted from the database and retrospectively reviewed. Abstracted data included outpatient clinic notes, operative reports, hospital summaries, and follow-up visits.

Surgical Technique

Each patient was placed under general anesthesia and intubated. After the patient was prepared and draped, the teeth were protected with an appropriate guard, and the head was extended to expose the diverticulum. The exposure was accomplished with a diverticuloscope such as the Weerda (Karl Storz, Tuttlingen, Germany). The anterior portion of the diverticuloscope was placed in the esophagus and the posterior portion in the superior part of the diverticulum, exposing the intervening septum or common wall. The harmonic scalpel (Ethicon Endo-Surgery, Inc, Cincinnati, OH) was inserted with the shears open, and they were closed around the septum. The machine was set to a minimum value of 3 and a maximum value of 5. The harmonic scalpel was activated to seal and divide the tissue. After one cut, the intervening septum was reassessed; if necessary, additional cuts were made to divide the septum down to the inferior aspect of the diverticular pouch. After satisfactory division and inspection of the area to ensure hemostasis, the diverticuloscope was carefully removed. The patient was awakened, extubated, and taken to recovery. Figures 1 and 2 show intraoperative photos representative of the surgical steps.

RESULTS

We identified 25 patients who were treated from March 1, 2007 through August 1, 2008 for a Zenker's diverticulum with the harmonic scalpel at Mayo Clinic (Rochester, MN). Patient characteristics are shown in Table I. All patients had preoperative barium swallow studies to confirm the diagnosis (Fig. 3). Two patients had been treated previously with the endo-GIA stapler technique but had recurrent symptoms; recurrent Zenker's

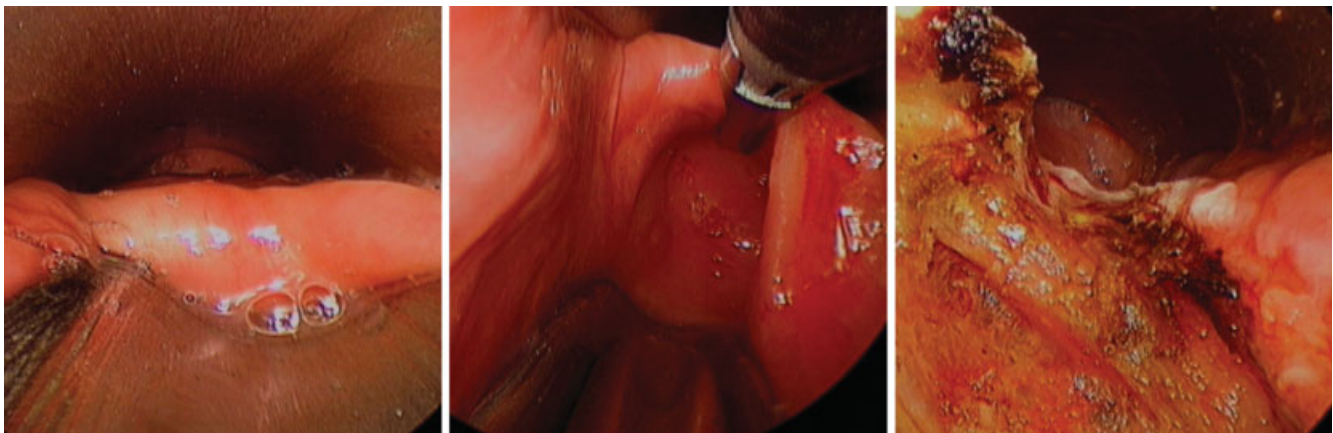


Fig. 1. Treatment of Zenker's diverticulum with the harmonic scalpel. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

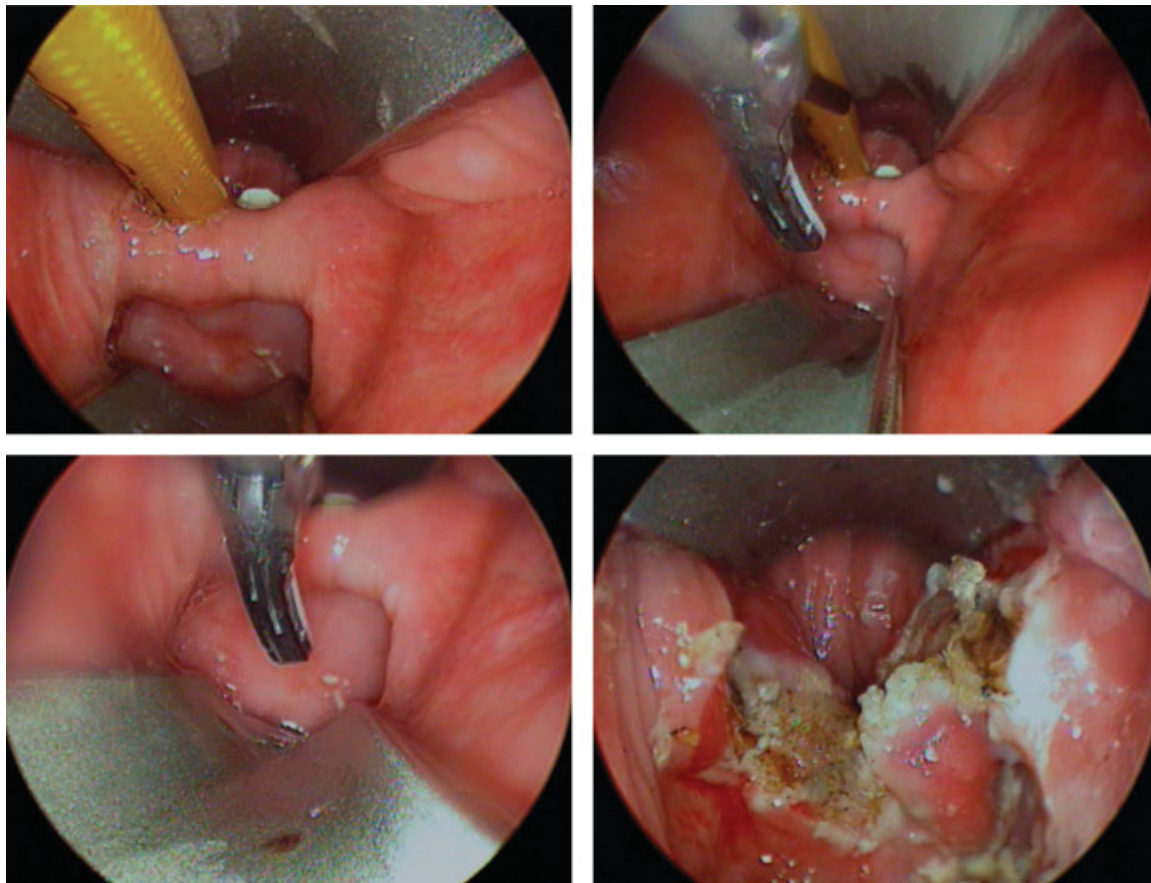


Fig. 2. The Weerda diverticuloscope is used to identify the intervening septum. The bougie here is in the esophageal lumen. The harmonic scalpel is brought into the field and closed around the common wall. At the conclusion, the diverticular sac has a drainage pathway into the esophagus. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

diverticula were verified with barium swallow studies. For five patients, surgery initially was performed with the endo-GIA stapler, but because of a residual intervening wall, surgery was completed with the harmonic scalpel. Duration of surgery with the harmonic scalpel is similar to that of other endoscopic techniques, and use of this instrument is easy to learn. All patients were started on a liquid diet the night of surgery.

Complications are outlined in Table II. At the time of manuscript submission, no serious complications (e.g., hemorrhage, infection, mediastinitis, or death) had occurred in any of the patients. One patient stayed 4 nights in the hospital for urinary retention and poor respiratory status. He had multiple comorbid conditions that included chronic obstructive pulmonary disease, which was treated preoperatively with home oxygen therapy. He received a diagnosis of aspiration pneumonia and was dismissed home with antibiotics. One patient with a history of cardiac disease had a non-ST-elevation myocardial infarction. Two patients had chest pain and stayed in the hospital for a complete evaluation, and both had negative findings.

Of the 21 patients who were dismissed the day after surgery, 20 had an uneventful hospital course with no fever, chest pain, or subcutaneous emphysema, and all

were tolerating a liquid diet at the time of dismissal. The remaining patient had cervical subcutaneous air noted during a postoperative physical examination. He was observed initially and dismissed home with instructions to watch for worrisome signs and symptoms. He was seen 3 weeks postoperatively, and at that time, he was tolerating a regular diet with no chest pain and had resolution of neck and chest crepitus.

Patients typically were seen 6 to 8 weeks after surgery. At the time of manuscript submission, the average

TABLE I.
Patient Characteristics.

Characteristic	Value
Male, No. of patients (%)	15 (60)
Age, y	
Average	76
Range	62–85
Hospital stay, d	
Average	1.3
Range	1–4
Dismissal the day after surgery, No. of patients (%)	21 (84)

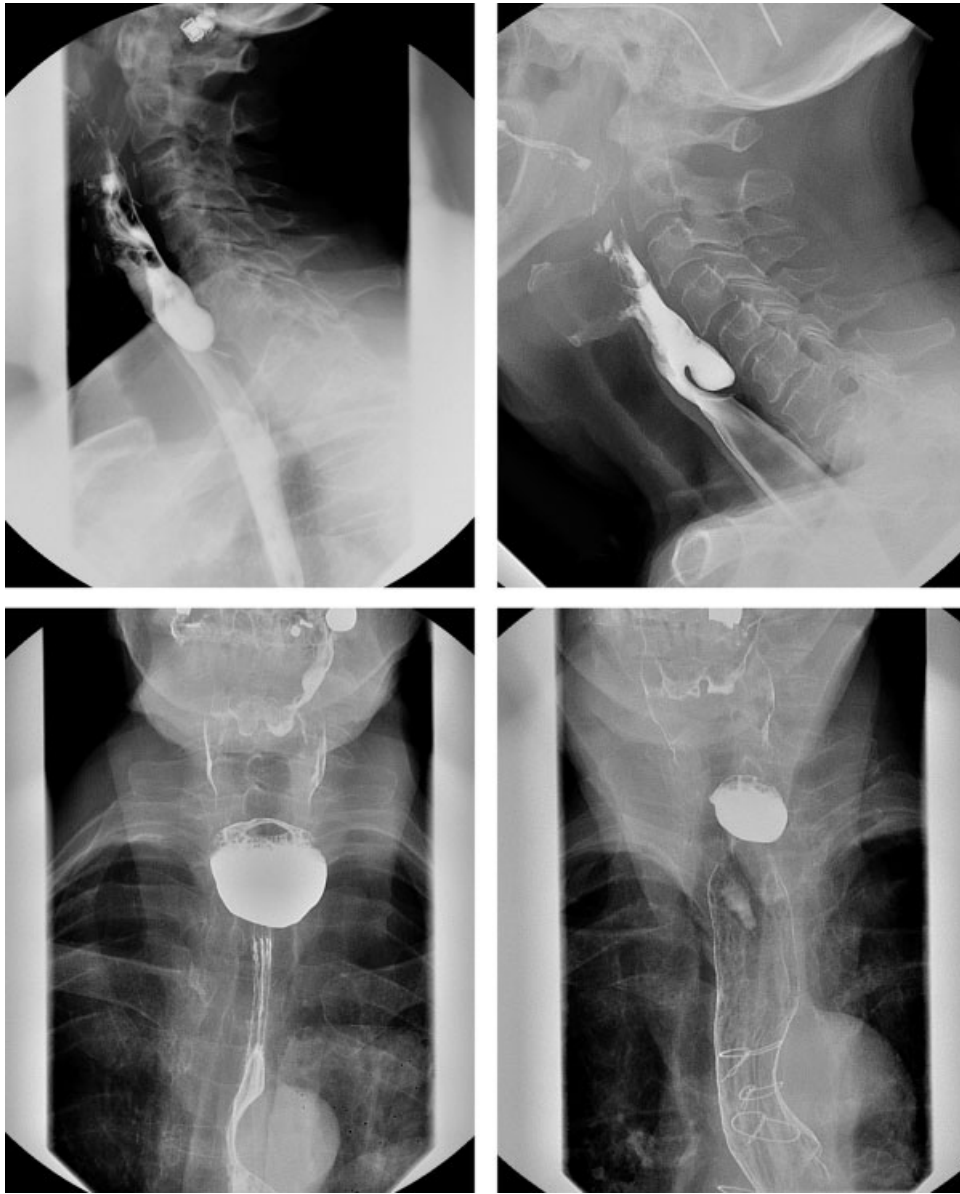


Fig. 3. Preoperative barium swallow studies demonstrate various Zenker's diverticula.

length of follow-up was 10.3 months. One patient had a recurrence that was proven with a barium swallow study; this patient was treated with an open surgical technique.

DISCUSSION

Zenker's diverticulum is a cause of dysphagia in elderly patients, but it also can cause other disruptive symptoms. Although various reasonable treatment options have evolved over time, the benefits and risks to the patient must be considered when choosing the treatment method. Studies have demonstrated that less invasive methods decrease the risk of postoperative complications to the patient, operative time, length of hospital stay, and time to oral intake.^{5-7,14}

One of the most common endoscopic techniques currently used is the endo-GIA stapler. The stapler securely

seals the mucosal and muscular edges together; however, it has limitations because of its physical design.⁶ The stapler is a large instrument that can obstruct visualization of the septum during surgery, and most surgeons find it is beneficial only for diverticula >2 cm. Furthermore, the anvil of the stapler extends beyond the end of the staples

TABLE II.
Complications.

Complication	No. of Patients
Chest pain	2
Non-ST-elevation myocardial infarction	1
Aspiration pneumonia	1
Subcutaneous emphysema	1

and the cutting apparatus; therefore, some residual common wall is inevitably left behind when using this technique.^{5,13,14} Some surgeons believe that leaving a small intervening septum or residual pouch has no clinical consequences, but others have demonstrated that this may lead to a higher rate of persistent symptoms or an increased risk of a recurrent diverticulum.^{5,14} Thus, some surgeons perform the initial division with the stapler but complete the procedure with a different technique.

Another common endoscopic technique is the CO₂ laser. The drawback of the laser is that the surgeon divides the intervening septum without a safe seal, and some have noted difficulty in determining where to stop dividing the tissue. Many have noted that air sometimes leaks into the neck when dividing the septum, but the protective fascial layers around the pharynx and esophagus seal off this opening.^{5,12} The incidence of postoperative cervical emphysema with the laser technique is 0% to 11.1%.^{5,12} In these cases, the enveloping fascia is thought to prevent the development of mediastinitis by separating the diverticulum from the mediastinum. Again, with the laser technique, the septum should be divided down to the bottom of the diverticulum, but it is difficult to know at what point to stop. Lastly, safety precautions are taken any time a laser is used in surgery, but it is still associated with a risk to the patient and a remote chance of fire.

Another technique recently developed is the use of flexible endoscopes to divide the intervening septum.³ This technique is performed mostly by gastroenterologists. It has the benefits of not requiring general anesthesia or hyperextension of the neck, although some have noted difficulty in determining where to stop dividing the intervening septum, and some patients thus have required repeat treatment sessions.¹⁵ A number of studies have been published using the flexible endoscopic technique, with great variability in results.^{3,15,16} The rate of cervical emphysema has ranged from 0% to 23%. The required number of treatment sessions has ranged from 1 to 12, and recurrence rates were as high as 39%.¹⁶ Although flexible endoscopic procedures are a useful alternative for patients who are poor surgical candidates, details pertaining to safety and technique are still being optimized.

The harmonic scalpel is an instrument that has gained popularity in a number of surgical fields, including otolaryngology. This report shows that it is a safe and reliable instrument for the endoscopic treatment of Zenker's diverticula. It is important to divide the intervening septum down to its base (that is, to perform an endoscopic cricopharyngeal myotomy). Patients undergoing surgery with the harmonic scalpel still need to be suitable surgical candidates for a transoral rigid endoscopic approach, with good oral cavity opening and neck extension. Patients who did not meet these criteria or had previous surgery typically had repairs made through an open incision. This study did not objectively assess patient symptoms before and after surgery, and although we have observed only one recurrence, additional follow-up is necessary to determine long-term patient outcomes.

CONCLUSION

The harmonic scalpel is a safe and effective option for endoscopic treatment of Zenker's diverticula, and it has become the treatment method of choice in our department. It is associated with low risk to the patient, and the results of this technique compare favorably with the recurrence rates reported in other studies. We reported a low rate of complications, most of which were due to the comorbid conditions of an elderly patient population. Ultimately, surgeons should use the technique that they are most comfortable with, but the harmonic scalpel is a useful option.

BIBLIOGRAPHY

1. Ludlow A. A case of obstructed deglutition from a preternatural bag formed in the pharynx. *Medical Observations and Inquiries by a Society of Physicians in London* 1769; 3:85–101.
2. Zenker FA, von Ziemssen H. Krankheiten des Oesophagus. *Handbuch der Speciellen Pathologie und Therapie* 1877; 7:1–87.
3. Christiaens P, De Roock W, Van Olmen A, Moons V, D'Haens G. Treatment of Zenker diverticulum through a flexible endoscope with a transparent oblique-end hood attached to the tip and a monopolar forceps. *Endoscopy* 2007;39:137–140.
4. Achem SR, Devault KR. Dysphagia in aging. *J Clin Gastroenterol* 2005;39:357–371.
5. Chang CW, Burkey BB, Netterville JL, Courey MS, Garrett CG, Bayles SW. Carbon dioxide laser endoscopic diverticulotomy versus open diverticulectomy for Zenker diverticulum. *Laryngoscope* 2004;114:519–527.
6. Chang CY, Payyapilli RJ, Scher RL. Endoscopic staple diverticulostomy for Zenker's diverticulum: review of literature and experience in 159 consecutive cases. *Laryngoscope* 2003;113:957–965.
7. Smith SR, Genden EM, Urken ML. Endoscopic stapling technique for the treatment of Zenker diverticulum vs standard open-neck technique: a direct comparison and charge analysis. *Arch Otolaryngol Head Neck Surg* 2002; 128:141–144.
8. Dohlman G, Mattsson O. The endoscopic operation for hypopharyngeal diverticula: a roentgen cinematographic study. *AMA Arch Otolaryngol* 1960;71:744–752.
9. van Overbeek JJ. Meditation on the pathogenesis of hypopharyngeal (Zenker's) diverticulum and a report of endoscopic treatment in 545 patients. *Ann Otol Rhinol Laryngol* 1994;103:178–185.
10. Collard JM, Otte JB, Kestens PJ. Endoscopic stapling technique of esophagodiverticulostomy for Zenker's diverticulum. *Ann Thorac Surg* 1993;56:573–576.
11. Martin-Hirsch DP, Newbegin CJ. Autosuture GIA gun: a new application in the treatment of hypopharyngeal diverticula. *J Laryngol Otol* 1993;107:723–725.
12. Miller FR, Bartley J, Otto RA. The endoscopic management of Zenker diverticulum: CO₂ laser versus endoscopic stapling. *Laryngoscope* 2006;116:1608–1611.
13. Richtsmeier WJ. Endoscopic management of Zenker diverticulum: the staple-assisted approach. *Am J Med* 2003; 115(suppl 3A):175S–178S.
14. Gutschow CA, Hamoir M, Rombaux P, Otte JB, Goncette L, Collard JM. Management of pharyngoesophageal (Zenker's) diverticulum: which technique? *Ann Thorac Surg* 2002;74:1677–1682.
15. Feussner H. Endoscopic therapy for Zenker diverticulum: the good and the bad. *Endoscopy* 2007;39:154–155.
16. Ferreira LE, Simmons DT, Baron TH. Zenker's diverticula: pathophysiology, clinical presentation, and flexible endoscopic management. *Dis Esophagus* 2008;21:1–8.