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Zenker's diverticulostomy with cricopharyngeal myotomy

The endoscopic approach

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Abstract
Background: The gold standard for the surgical treatment of Zenker's diverticulum is diverticulectomy and cricopharyngeal myotomy by an external approach. Unfortunately, many of the patients who present with this entity are elderly and have significant comorbidities that increase operative risk. Traditional minimally invasive approaches have not met with widespread success. However, by combining the exposure afforded by the otolaryngologist's newer bivalved operating laryngoscopes with the operative techniques made possible by the general surgeon's laparoscopic instrumentation and staplers, it is possible to achieve reliable and safe endoscopic outpatient management of this disease entity, with resumption of a normal diet on the same day.
Methods: We reviewed the physiologic basis, instrumentation, and technical considerations for this endoscopic procedure. We also documented our operative experience with 21 patients treated over an 18-month period.
Results: Successful minimally invasive management of Zenker's diverticulum was possible in 18 of 21 patients. In two patients, anatomic limitations of mouth and neck anatomy precluded exposure of the diverticulum; in another patient, the diverticulum was too small. Small operative perforations of the apex of the diverticulum occurred in three cases. Two of these perforations were repaired primarily with minimally invasive techniques; in the other case, treatment consisted of observation alone. In all but this last patient, oral diet was resumed on the day of the operation. Eleven of the patients were discharged from the hospital on the same day; the remaining patients went home the following morning.
Conclusions: With proper patient selection, minimally invasive management of Zenker's diverticulum is a safe and effective surgical technique that allows for outpatient management of the majority of patients who present with this disease.

Key words: Zenker's diverticulum — Endoscopy — Cricopharyngeal myotomy — Dysphagia

Fueled by technological advancements and a greater understanding of the pathophysiologic process, surgical therapies for pharyngoesophageal diverticula have evolved over the past several decades. First described by Ludlow in 1764 as a "preternatural dilation of, and bag formed in, the pharynx" [6], a Zenker's diverticulum is now more precisely defined as the herniation of a mucosal sac between the fibers of the inferior pharyngeal constrictor muscle and the cricopharyngeus. Detailed anatomic and manometric studies have shown that cricopharyngeal spasm is to be the likely etiologic agent [4]. The spasm intermittently increases the intraluminal pressure in the proximal pharynx, forcing the outward mucosal herniation between the fibers of the inferior constrictor and the cricopharyngeus muscles (Fig. 1).

Surgical therapies have two main objectives—alleviation of cricopharyngeal spasm via cricopharyngeal myotomy, and removal or repositioning of the diverticular sac. These aims have traditionally been accomplished with open procedures that, although effective, require inpatient hospitalization and postoperative feeding delay, with the potential for a significant degree of morbidity [1].

Surgeons long ago proposed a better way to do the operation. In 1916, Mosher introduced the idea of an endoscopic division of the common wall between the diverticular sac and the esophagus. This division, directed vertically through the common wall, would provide the needed cricopharyngeal myotomy, since the cricopharyngeus itself con-

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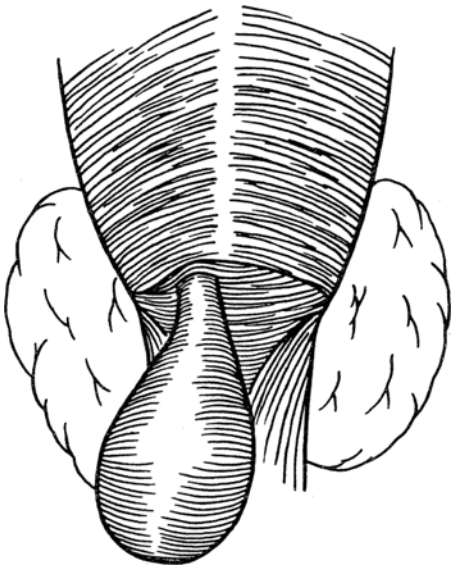

Fig. 1. Posterior aspect of the pharyngoesophageal junction with Zenker's diverticulum emerging between the inferior pharyngeal constrictor and cricopharyngeus muscles.

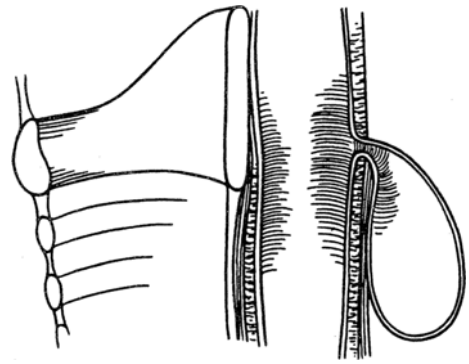

Fig. 2. Sagittal section through Zenker's diverticulum and esophagus showing common wall composed primarily of cricopharyngeal fibers covered by mucosa.

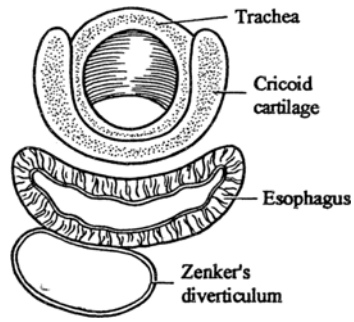

Fig. 3. Axial section through Zenker's diverticulum and esophagus demonstrating preoperative two-lumen construct.

stitutes a large portion of this common wall (Fig. 2). Additionally, transecting the common wall would open the diverticular sac into the esophagus, converting the two-lumen construct shown in Fig. 3 to one "common" lumen, with the cut edges of the common wall marsupialized into the wall of the esophagus. Mosher performed several such procedures, sharply dividing the common wall with a long, cutting instrument. However, the procedure was complicated by mediastinitis due to leakage from the cut edges of the common wall; therefore, it was soon abandoned.

Dohlman introduced the use of electrocautery for division of the common wall some 40 years ago, and more recently the laser has been used to the same end [3, 8]. Both modalities proved effective and less morbid than sharp division, but they are still viewed (and applied) with some reservation, given their requisite "sutureless division" of the common wall.

The most recent refinement to this diverticulostomy procedure is the use of an endoscopic stapling device to transect the common wall. The ability of this endoscopic stapler to not only transect the wall but also to staple each of the cut edges securely closed is a distinct advantage over previous methods. Collard et al. introduced the technique in 1993, reporting its success and safety in a small series of patients [2]. Subsequent case series showed similar results [5, 7]. Herein we describe the specifics of the procedure and its instrumentation, as well as reporting our own early experience.

Materials and methods

Preoperative evaluation

In addition to routine head and neck examination, all patients undergo preoperative assessment with a modified barium swallow, preferably with the assistance of a trained speech and language pathologist. Cricopharyngeal spasm often does not exist in isolation. There may also be evidence of significant dysfunction of either tongue mobility, pharyngeal motility, or esophageal peristalsis, which will predict a less-than-optimal swallowing result despite successful myotomy and diverticulostomy. This problem should be discussed with the patient preoperatively.

The size of the diverticulum must be assessed, because very small diverticula (<3.0 cm) may prohibit adequate positioning of the stapler about the common wall. Equally important is the degree of neck extension and mouth opening attainable by the patient; limitation in either parameter may predict difficulty in the placement and angulation of the instrumentation. The patient should be cautioned that a fair amount of pressure will be applied to the maxillary incisors and that chipping of these teeth is possible.

We view none of these factors as absolute contraindications and will at least attempt a minimally invasive diverticulostomy in almost all cases. However, the information is helpful in preoperative discussions with the patient and his or her family about the likelihood of conversion to an open procedure. All patients should be prepared and give consent for an open procedure in the event that minimally invasive instrumentation proves unfeasible intraoperatively. Since we perform direct laryngoscopy to pack the diverticular sac as part of our open approach, an initial effort to perform the procedure endoscopically does not add much time to the procedure, even if the attempt proves unsuccessful.

In our experience, the majority of patients with cricopharyngeal spasm/Zenker's diverticulum have significant gastroesophageal reflux, which can be worsened after myotomy when the cricopharyngeal barrier to pharyngeal reflux is removed. Patients should be counseled as to this possibility and prepared for the subsequent possibility of either medical or surgical treatment of the reflux.

Operative procedure

Dexamethasone (10 mg) and ampicillin/sulbactam (3 g) are given intravenously on arrival in the operating room. The patient is positioned supine,

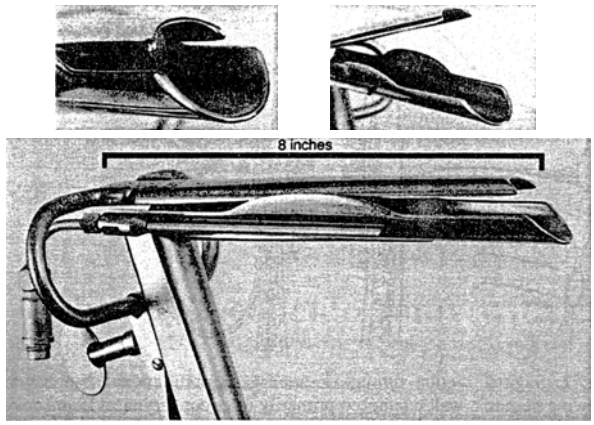

Fig. 4. Weerda laryngoscope. Adjustment of the distal aperture.

and general anesthesia is administered via an oral endotracheal tube. To ensure maximal mouth opening and neck extension, a "zero twitch" level of paralysis on the anesthesia twitch monitor is maintained throughout the procedure. A tooth guard is placed as necessary, and direct endoscopy proceeds via Weerda laryngoscope or the newer specially designed diverticuloscope (Karl Storz, Culver City, CA, USA) (Fig. 4). We usually begin with a small Weerda laryngoscope and change to a larger scope as needed. With the scope closed, the esophageal lumen, diverticular lumen, and common wall are visualized, and the common wall is centered in the scope's aperture. A suspension arm is then attached to the laryngoscope and mounted on the chest or suspension bracket.

Once the larynx is suspended forward, the bivalved distal aperture of the scope is adjusted open, so that the posterior flange applies pressure to the posterior pharyngeal wall. This serves to tent open both the esophageal lumen and diverticular lumen to some degree (Fig. 4). The proximal aperture of the scope is widened to the maximal dimension allowed by the patient's anatomy (Fig. 5). This facilitates lateral insertion of the viewing telescopes and allows for the necessary angulation to place the straight stapling device across the relatively anteriorly placed party wall. Angulation of the stapler can be difficult if the patient's neck extension or mouth opening are inadequate, or if the patient has large incisors; all of these circumstances will steer the stapler more posteriorly than desired. Depending on the amount of anterior visualization required, either a 0° or 30° is inserted at an oblique angle through the side slots of the laryngoscope (Fig. 6). It is used in conjunction with an attached endoscopic camera and video monitor to perform the procedure. Oblique placement of the telescope allows more room to maneuver the stapling device within the scope itself without interfering with visualization.

An orogastric sump tube is inserted well into the esophagus under direct vision to confirm orientation and is then removed. The Endo-GIA 30 stapler (US Surgical Corp., Norwalk, CT, USA) is introduced through the laryngoscope (Fig. 7), and its jaws are positioned on the common wall with the longer end in the esophageal lumen. The stapler itself has a long neck and is of low profile. It will make a cut along its long axis for a maximal distance of 3.2 cm, while simultaneously putting a triple row of staples in each of the cut edges. A certain degree of anterior angulation is usually needed to engage the common wall, and repositioning of the laryngoscope is sometimes needed at this point. The jaws of the stapler are closed and locked on the common wall, and a few tugs are given on the stapler to assure good grasp and purchase.

If the common wall is difficult to grasp, retraction sutures can be placed laterally through the party wall with an Endosuture device (US Surgical Corp.) and used to help pull the wall into the jaws of the stapler. This is preferable to applying excess downward pressure to the stapler, since this may result in a perforation in the apex of the diverticulum. If there is any question about the stapler position, the jaws are reopened and the device reapplied. If doubts still remain, it should not be fired, and the minimally invasive approach should be abandoned in favor of an open one, since an improper staple position will not only fail to alleviate symptoms, but it will also significantly complicate any subsequent open revision approach.

Once its proper position is confirmed, the stapler is fired and removed. The cut edges of the party wall should immediately retract laterally due to the action of the divided cricopharyngeus muscle. A more open esophageal lumen should then be apparent. Next, the common wall cut is inspected. If a significant portion of common wall remains (>1 cm), the staple cartridge is replaced and a second pass is made with the stapler. The sump tube or a laryngoscopic biopsy forceps can be placed into the residual diverticular sac (which at this point is more of a small shelf than a sac) to confirm that the depth of the common wall cut approximates the depth of the diverticular floor. Finally, the diverticulum mucosa is inspected, hemostasis is confirmed, and the procedure is terminated.

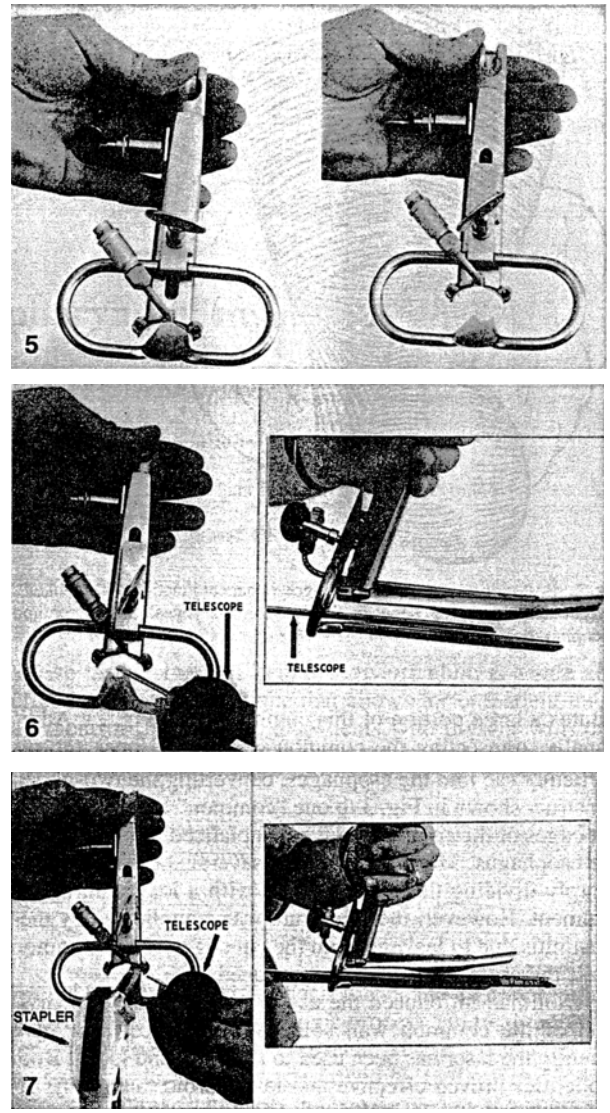

Fig. 5. Weerda laryngoscope. Adjustment of the proximal aperture.

Fig. 6. Telescope inserted obliquely through the side slots of the Weerda laryngoscope.

Fig. 7. Telescope and Endo-GIA 30 stapler in the Weerda laryngoscope.

Postoperative care

The patient is typically observed in the short-stay unit for 4–6 h. Regular diet is started immediately, as tolerated by the patient. In previous series, several days of liquid or soft diet were suggested [2, 5, 7], along with overnight hospitalization, but we have not found this to be necessary if the procedure has gone smoothly. The patient is discharged home if stable and tolerating adequate oral intake after the observation period. Prior to dis-

charge, the patient and family are counseled at length regarding the early signs and symptoms of mediastinitis— i.e., fever, palpitations, chest pain, and crepitance.

Although postoperative barium swallow is unnecessary, if it is done it will show the free flow of barium into the esophagus, without significant pharyngeal pooling. There is often a small residual shelf of diverticular tissue, but it does not retain significant barium or appear to cause symptoms. If swallowing problems persist, they are usually due to associated tongue, pharyngeal, or esophageal motility and coordination problems and need to be addressed as such.

Results

In the 18-month period from February 1997 to August 1998, we performed 21 minimally invasive cricopharyngeal myotomies for Zenker's diverticulum at our institution. Successful minimally invasive surgical management was possible in 18 of 21 patients. In two patients, limitations of the mouth and neck anatomy precluded exposure of the diverticulum. The third patient's diverticulum was too small at 1.5 cm and could not be grasped in the stapling device.

Small perforations of the apex of the diverticulum occurred in three patients due to attempts to grasp a "short" party wall in the stapler with the application of excess downward pressure rather than using traction sutures to engage it, as is now our practice. Two of these perforations were repaired with minimally invasive suturing techniques at the time of surgery. The other patient was observed for 2 days and then fed after a fluoroscopic swallowing study did not show any extravasation. In all but this last patient, oral diet was resumed on the date of the operation. The first 10 patients in this series were observed in the hospital overnight. In the absence of problems, our patients are now sent home on the same day as the surgery.

Discussion

The endoscopic technique for the management of endoscopic diverticulum has a learning curve that is best addressed via a cooperative effort between the otolaryngologist and general surgeon. By working together, each of them can stay within their comfort zone of technique and instrumentation dictated by their respective disciplines, and then, as the necessary elements of the other aspects of the technique are learned, they can begin to function independently. This has been the modus operandi at our institution, and it has served our patients well.

The key to this technique, which offers many advantages to the patient if it can be accomplished successfully, is patient selection. Adequate jaw opening and neck extension combined with adequate diverticulum length (>3.0 cm) are the criteria for selection. The problems that we encountered in this series were all due to attempts to complete the procedure in patients where one of these factors was suboptimal. The newer diverticuloscopes and the use of traction sutures has allowed this method to be applied in some patients who are less than ideal candidates, but the technical aspects are significantly more difficult. In order to deal with smaller diverticula or cricopharyngeal spasm alone endoscopically, we will need to be able to incise and repair the pharyngeal mucosa endoscopically to directly expose and divide the cricopharyngeus muscle. We are currently investigating the feasibility of this procedure in a canine model.

Conclusion

With appropriate patient selection and proper technique, the staple-assisted endoscopic Zenker's diverticulostomy is a safe, simple, and effective procedure that allows outpatient management of this condition.

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