

TITLE: Zenker's Diverticulum

**SOURCE: Grand Rounds Presentation, University of Texas Medical Branch,
Department of Otolaryngology**

DATE: May 28, 2010

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Introduction:

Zenker's Diverticulum is a rare cause of dysphagia worldwide. Surgical management of Zenker's diverticulum is complex and requires the expertise of an experienced Otolaryngologist.

History:

Descriptions of hypopharyngeal diverticula have appeared in scientific literature for over two hundred years. They were first described by Abraham Ludlow, in 1764, and described by several pathologists in the following years. The seminal work on hypopharyngeal diverticula was carried out in collaboration between German pathologists Albert von Zenker and Hugo von Ziemssen in 1867, titled *Krankheiten des Oesophagus*, or Diseases of the Esophagus.

Surgical repair of Zenker's Diverticulum was rarely attempted prior to mid-20th century due to high rates of morbidity and mortality. The first successful diverticulectomy was carried out by von Bergman in 1892, though surgical techniques had been postulated for decades. In 1909 Goldmann introduced a two-stage surgical technique which caused fistulization and rejection of the diverticulum. The late 1930s saw the refinement of technique into a single-stage procedure, and in 1951 the cricopharyngeal myotomy technique was introduced by Kaplan. Diverticulopexy with myotomy was first used in 1966 by Belsey and was successful in decreasing operative time and hospital stays. The importance of myotomy in the treatment of Zenker's Diverticulum was highlighted by studies done by Einarsson and Hallen, which showed the decrease in recurrence rate when myotomy is performed. Endoscopic techniques were first attempted in the early 1900s, but the mortality rate was considered unacceptably high, and the procedures were abandoned. In the 1960s, Dohlman and Mattson introduced diathermy as a method to divide the common wall of the diverticula and the esophagus. Von Overbeek

continued this endoscopic trend and over the next thirty years improved on the Dohlman technique, using the CO₂ laser rather than diathermy. In 1993, Collard et al introduced what is now widely considered to be the standard surgical approach to a moderate-sized diverticulum, the endoscopic stapling technique.

Anatomy and Physiology:

Zenker's diverticulum is a posterior esophageal outpouching of mucosa through an area of weakness between the inferior constrictor muscle and the cricopharyngeus. The neck of the diverticulum is proximal to the cricopharyngeus. This area of weakness, also known as Killian's triangle, or Killian's dehiscence, is the most common location for a Zenker's diverticulum. Rarely, two other areas can be involved: Killian-Jamieson area, between the oblique and transverse fibers of the cricopharyngeus muscle, and the Laimer triangle, between the cricopharyngeus and the superior esophageal wall circular muscles.

Zenker's Diverticulum is found almost exclusively in humans, which is thought to be due to the fact that the human larynx is larger and located more caudally in humans than in other animals. The caudal location results in an oblique orientation of the constrictor muscles, and consequently areas of weakness develop through which esophageal mucosa can herniate.

The incidence of Zenker's Diverticulum is estimated at 2 per 100,000, with highest rates of diagnosis in the seventh and eighth decades of life. Risk factors for development of Zenker's Diverticulum include increasing age, male gender, presence of hiatal hernia, and/or gastroesophageal reflux disorder (GERD). Up to 94% of patients with pharyngeal pouches have concurrent hiatal hernias or GERD. This link is also supported by the fact that Zenker's diverticulum is extremely rare in Asia and Africa, where GERD is also very uncommon. Pediatric Zenker's Diverticulum can occur as a congenital esophageal pouch, and can often be fatal secondary to massive aspiration pneumonia.

Zenker's diverticulum is a pulsion-type diverticulum, the result of herniation of the esophageal mucosa and submucosa through the area of natural weakness. As such, it is a false diverticulum, meaning it does not involve the muscularis layer. Evagination of the cricopharyngeal sphincter is believed to occur secondary to chronic increased pressure over esophageal areas of weakness. The presences of abnormal esophageal motility, esophageal shortening, and upper esophageal sphincter dysfunction have all been implicated in the pathogenesis of Zenker's Diverticulum. Data supporting these hypotheses have been obtained through manometry studies, and consensus opinion is that occlusive mechanisms are the most important. Uncoordinated swallowing, allied with impaired relaxation and spasm of cricopharyngeal muscle leads to an increase in pressure in distal esophagus, so that its wall herniates through the point of maximal weakness – Killian's triangle.

The mucosal outpouching of a Zenker's diverticulum can be visualized via a barium swallow study. Two-thirds of Zenker's diverticula protrude directly in the midline, and the remaining preferentially protrude to the left. This is likely secondary to the more lateral location of the carotid artery on the left, and subsequent esophageal curvature. Contrast radiography can confirm the diagnosis. Two commonly used classification schemes are Brombart (1980) and Morton and Bartley (1993). Other classification schemes include vertebral body measurements,

and simple radiologic appearance, but categories are becoming increasingly complex and incorporate elements from several of the classic methods of classification.

Clinically, Zenker's diverticulum presents as a progressive dysphagia. Initially, patient can describe minor throat irritation, foreign body sensation, and coughing. Symptoms worsen as the diverticulum enlarges, and pouch becomes large enough to contain food, sputum or even medications. Patients can complain of food regurgitation several hours after a meal, and typically describe weight loss. Cachexia and malnutrition can develop with Zenker's Diverticulum, particularly in the elderly who develop a "fear of eating" secondary to choking spells. The most common complication of Zenker's Diverticulum is aspiration pneumonia, which occurs in up to 30% of patients. Other complications include compression of the trachea and esophageal obstruction with large diverticula, as well as ulceration secondary to retained aspirin. Development of squamous cell carcinoma of the diverticulum can occur in 0.3-0.5% of patients.

Indications:

Due to the high risk of complications if untreated, surgical intervention is the mainstay of Zenker's Diverticulum therapy.

Standard treatment is excision of diverticulum and cricopharyngeal (CP) myotomy, including upper 3cm of posterior esophageal wall. Size of the diverticulum determines which procedure to carry out. If diverticulum is less than two centimeters, a CP myotomy alone is sufficient. If diverticulum is between three and six centimeters, endoscopic or open procedure must be used. When the diverticulum exceeds 6cm, an open approach is generally considered a more favorable procedure.

Cricopharyngeal myotomy must always be performed in the course of a Zenker's diverticulum repair, as without it there is an unacceptably high rate of recurrence.

Procedures:

- Cricopharyngeal myotomy
- Endoscopic techniques:
 - Endoscopic staple diverticulostomy
 - CO2 laser
 - electrocautery
- External techniques:
 - Cricopharyngeal myotomy with diverticulectomy
 - Cricopharyngeal myotomy with diverticulopexy

Surgical Preparation

For all procedures, patient should undergo a pre-operative evaluation to determine cardiac function and hemodynamic status. Evaluation of diverticulum should guide the choice of procedure as described above.

Cricopharyngeal myotomy

External cricopharyngeal myotomy can be performed under local or general anesthesia. Endotracheal intubation provides distention of the cervical esophagus to aid in visualization of the muscle. Left-sided anterior cervical incision is made over the cricoid cartilage, and subplatysmal skin flaps are retracted to expose superior and inferior border of cricopharyngeus muscle. Anterior border of sternocleidomastoid is identified and then retracted posteriorly to reveal the carotid sheath. The omohyoid may be sectioned to provide greater exposure of the surgical target. The larynx is rotated to the right, bringing forward the distended cervical esophagus. Fibers of the cricopharyngeus are visualized with a magnifying loupe, and then sequentially incised until the underlying mucosa appears. The myotomy is often four to five centimeters in length to ensure complete release of the muscle.

Wound should then be irrigated, drain placed, platysmal borders re-attached and skin incision closed.

Endoscopic staple diverticulostomy

Endoscopic staple diverticulostomy is performed under general endotracheal intubation, using a modified laryngoscope to expose common wall between lumen of esophagus and diverticulum. A magnified view of the procedure can be obtained by using a rigid 0- or 30-degree telescope connected to a camera. With a suturing device, retraction sutures are placed on the lateral aspects of the common wall. The common wall is then positioned between the blades of the stapler, and divided. The retraction sutures are cut and removed. By dividing the common wall, an internal cricopharyngeal myotomy is performed, creating a single lumen without removal of the pouch. The telescope is then used to carefully inspect the esophagus and incision area to evaluate for surgical debris such as staples. Patient can be discharged on same day as surgery if no post-operative complications arise in the three or four hours following the procedure.

CO2 laser

Transoral tissue bridge dissection with CO2 laser is carried out under general anesthesia with endotracheal intubation. For optimal exposure of the common bridge, a Weerda laryngoscope is inserted transorally and opened, tightening the muscular septum. After evaluation of the tissue bridge, debris is suctioned from the diverticulum. Microscope with manipulator and CO2 laser are focused on the common bridge at a working distance of 400mm. Laser dissection begins in the center of the tissue bridge, causing a split of the muscle fibers and allowing increased visualization of the esophagus. The tissue bridge is dissected to the base of the diverticulum,

Electrocautery

Esophageal diverticulotomy with electrocautery is carried out under general anesthesia with endotracheal intubation. A modified, slotted, Holinger 9mm x 30 cm esophagoscope is inserted to trap the common wall, where the upper lip of the instrument will be placed in the esophagus and the lower lip in the diverticulum. The common wall is thus isolated and then divided using insulated electrocautery and laparoscopy scissors. The common wall is cauterized

until it thins near the base of the diverticulum, and incision is continued to ensure division of the cricopharyngeus muscle also.

Cricopharyngeal myotomy with diverticulectomy

Cricopharyngeal myotomy with diverticulectomy is carried out under general anesthesia with endotracheal intubation. An anterior cervical incision is made over cricoid cartilage, or, alternatively, along anterior border of sternocleidomastoid muscle. Dissection of soft tissue underlying the incision follows, with medial retraction of trachea, strap muscles and thyroid gland, while the sternocleidomastoid muscle is retracted laterally. This allows exposure of the diverticulum and the cricopharyngeus muscle. Once identified, the cricopharyngeus is divided, and the diverticulum is excised. The defect can be closed by purse-string suture, or by stapler.

Cricopharyngeal myotomy with diverticulopexy

Following the same operative technique as the diverticulectomy procedure, cricopharyngeal muscle and diverticulum are identified. After a cricopharyngeal myotomy is performed and the diverticulum is freed, the hypopharyngeal pouch is tacked with 2-0 silk sutures superiorly to the prevertebral fascia. The suspension reverses the dependent positioning of the pouch in the erect patient, and. Ideal for diverticula between 1 and 4cm.

Potential Complications of Surgical Management of Zenker's Diverticulum

Esophageal perforation

The esophagus lacks a serosal layer, and thus is at higher risk of rupture or perforation. Patient should be allowed nothing by mouth after midnight and broad-spectrum antibiotics given. Gastrografin study should be obtained to evaluate level of possible perforation. Perforation of cervical esophagus can be managed with close observation or with exploration and drainage procedure. Thoracic esophagus perforation requires early exploration. If symptoms resolve in 7-10 days, one repeats the gastrografin to evaluate resolution of perforation, and antibiotics can be discontinued if there is no evidence of infection. Close monitoring of vital signs and white blood cell count is essential.

Mediastinitis

Once esophagus is ruptured, retained gastric content, saliva, bile, and other substance may enter mediastinum. Patient will present with severe dyspnea, chest pain and fever, Diagnosis can be confirmed with CXR or CT scan which will show the characteristic mediastinal widening. Aggressive therapy is required: mortality rate is between 14-40%. Treatment consists of aggressive drainage and IV antibiotics, as well as close monitoring by a thoracic surgery team.

Laryngeal nerve damage

The recurrent laryngeal nerve courses below the inferior constrictor muscle to innervate the laryngeal muscles (with the exception of the cricothyroid.) This muscle is innervated by the superior laryngeal nerve). Damage sustained during diverticulum surgery is usually unilateral, and so patient may present with post-operative hoarseness but without airway impairment.

Discussion by Dr. Michael Underbrink – Zenker’s Diverticulum 28 May 2010

Dr. Underbrink: That was an excellent presentation. It was very thorough and complete and it gave us a lot of information about the pathogenesis and treatment options for Zenker’s diverticulum. I think the important things to realize is patient selection for the type of surgery that you have. As far as grading the Zenker’s by one of the classification scales noting that in small diverticula, are you going to be able to treat these by myotomy alone? This can be done endoscopically although most people prefer an open technique for that. The size of the diverticulum as was presented being between three and six centimeters is a good size for the approach endoscopically which also reduces the complication rate. So that in some patients, case selection is important. And inbetween that you’ll be watching for the most common complications postoperatively which we all know. The most devastating would be mediastinitis. Good talk. Thank you.

Dr. Francis B. Quinn: How do you find the opening of the diverticulum endoscopically?

Dr. Underbrink: The answer is that using the instrumentation we have in our operating room, the Werdacope opens in two directions, both distally and proximally, as you enter under the cricoid cartilage just opening a small bit the posterior tine will find the diverticulum, and the anterior tine if opened correctly will find the esophagus and you’re looking for a double bubble on your exam and when you see that you’re advancing slowly being careful not to perforate a large diverticulum with your posterior tine. That might be one of the complications of placement. You want to make sure that the cricopharyngeus muscle or the bridge of mucosa over the muscle easily visible so you can place sutures and retract that so you can make the incision.

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