Open Surgery for Zenker Diverticulum

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Background

Patients with Zenker diverticulum have long been known to benefit from surgical repair, yet early attempts at transcervical treatment had significant morbidity [1]. Innovations in endoscopic surgery, such as use of the endoscopic stapler first reported in 1993 [2], allowed for transoral diverticulotomy which effectively reduced the previously high rates of complications following open surgery. Yet, as surgical sterility, device technology, and overall technique ~~has~~ have improved, open and endoscopic procedures have a more comparable risk profile [3]. It is an often-debated topic without clarity as to which technique is superior.

To date, there has been no randomized control trial completed to directly answer this question. Most of the data regarding surgical repair of ZD is in the form of retrospective review, often with limited follow-up. While it is easy to bemoan the lack of prospective comparative data, many have admirably examined this topic within the limitations of their clinical practice, and there is certainly much to be gleaned from these reports.

Verdonck and Morton [4] completed a systematic review in 2015 of the comparative and cohort studies on ZD treatment. Seventy-one studies were included, looking both at outcomes between groups (i.e., open vs. endoscopic) and within groups

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(i.e., laser vs. stapler in endoscopic repair). Rate of failure, defined as inability to manage the pouch and resolve the dysphagia, was significantly higher with endoscopic compared to open techniques, most notably in short-term failures (14.5% vs. 1.3%, respectively). Overall rates of failure were reported at 18.4% for endoscopic procedures and 4.2% for open procedures, with a minimum mean follow-up time of 12 months. Complications were more frequent in the open approach (11% vs. 7%). Types of complications were different as well, with emphysema and mediastinitis being more common following endoscopic repair and nerve palsy, fistula, and hematoma more common following open repair. Of note, this paper examined several different methods of endoscopic repair (laser, coagulation, flexible, and stapler); the risk of mediastinitis was noted to be 0.2% for stapler repair (2 of 1089 patients), 0.4% for flexible repair (1 of 251 patients), 1.5% for laser procedures (13 of 894 patients), and 3% (13 of 437 patients) when the pouch was removed with argon laser; this led to an overall risk of 1.2% during endoscopic procedures (compared to 0.3% in open procedures). The average risk of mediastinitis for endoscopic procedures was increased in this study due to inclusion of argon laser procedures. Surgery-related death rates were very low in both groups (0.9% open and 0.4% endoscopic). Length of stay was significantly shorter for those treated by endoscopic repair. This particular publication reviewed series that spanned several decades of treatments, and thus may not adequately reflect improvements in technique, changes in method preference, or current rates of complications.

Yuan et al. [5] also completed a systematic review of the literature. They identified 93 studies, totaling 6915 patients between the years of 1990 and 2011, which met their search criteria. Nineteen of these studies compared results of open and endoscopic approaches. Complications were reported in 8.7% and 10.5% of cases, respectively; mortality was reported in 0.2% of open cases and 0.6% of endoscopic cases. Reports of recurrence were not uniformly defined, and thus no conclusions were made.

Albers et al. [6] completed a meta-analysis including 11 studies, totaling 596 patients, comparing endoscopic and open techniques from 1975 to 2014. The authors concluded that endoscopic treatments required less time in the operating room, less time without a diet, and fewer complications than the open surgical treatments. Open surgical treatments, on the other hand, were associated with less recurrence. A few things should be noted about this meta-analysis. First, the majority of the 11 studies analyzed did not report means or standard deviations, and thus were not included in calculations of length of operating room procedure or time to diet. Complications were reported in all 11 studies, and only data from 1 study was removed due to heterogeneity; these complications were reported in 7.6% of endoscopic and 15.8% of open procedures. Specifically, the most common complications when assessing both approaches were cervical leak, hoarseness, aspiration pneumonia, chest pain, and esophageal perforation. All 11 studies were included in the report of recurrence; patients with ZD treated endoscopically recurred at a rate of 13%, whereas those treated with the open method had a rate of 6.4% recurrence. Mean follow-up time was not quantified. This analysis spanned greater than three decades of research studies, allowing for incorporation of many studies, yet also including shifts in practice which have accompanied endoscopic innovations.

Smaller studies have corroborated some of these findings. Chang et al. [7] examined 52 patients treated consecutively, with 28 open procedures and 24 endoscopic cases. Again, the endoscopic procedure was shorter than the open procedure (47 min compared to 170 min). No recurrences were seen for patients treated with the open procedure, but 3 of 24 patients (12.5%) treated endoscopically required revision. In this particular study, there was no difference in length of hospital stay or rate of complication. The authors concluded there is a higher likelihood of recurrence following endoscopic repair. Multiple other studies have supported this conclusion, with recurrence rates reported anywhere from 12 to 32% [8–10] for endoscopic case series. Follow-up is inconsistent between studies, however, making a direct comparison between these numbers is inadvisable.

Quality of life outcomes following the two treatments have also been investigated. Seth and colleagues in 2014 [11] surveyed postoperative patients using the gastrointestinal quality of life scale, specifically inquiring about regurgitation, halitosis, dysphagia, and choking; patients retrospectively recalled their symptoms at both 1 month postoperatively and at the time of the current follow-up phone call. Fifty-five patients with at least 1 year of follow-up were successfully contacted; mean follow-up was 5.1 years for patients who underwent open repair and 3.7 years for those who underwent endoscopic repair. All patients reported marked improvement in symptoms compared to their preoperative state, but complete resolution was reported more often by those treated with open repair (93.5% vs. 66.7%). Interestingly, those treated with endoscopic repair on average reported worsened symptoms at their follow-up phone call compared to 1 month postoperatively. The authors posited that this recurrence of symptoms is due to incomplete myotomy which may occur during the endoscopic repair; notably, all endoscopic repairs in this series were performed with the stapler. Wirth et al. [3] found similar results in their questionnaire administered to 47 patients, with dysphagia symptoms reported to be absent in 91% of open surgical patients compared to 83% of those treated with endoscopic surgery.

Voice and swallowing outcomes have also been examined between the open approach and the endoscopic approach using a laser for diverticulotomy and myotomy. Schoeff et al. [12] obtained survey data using the Voice Handicap Index 10 (VHI-10) and the Eating Assessment Tool-10 (EAT-10) both pre- and postoperatively for patients with ZD. This was a retrospective review, and only 11 patients had data sufficient for analysis. Interestingly, however, both swallowing and voice outcomes improved following surgery. The authors attribute this improved subjective quality of voice to the elderly age of most ZD patients; they suggest that subclinical, age-related dysphonia is not perceived until after surgical repair confers a slight benefit to the clarity and loudness of the patients' voice. This may be related to the often reported "wet" voice of patients with ZD, due to pooling of secretions which may overflow into the laryngeal vestibule.

While again there is no direct comparison between endoscopic and open repair of ZD, most of the current literature suggests that both approaches are relatively safe. The endoscopic repair requires a shorter operative time, and often a shorter hospital stay, but confers a greater risk of recurrence. With respect to complications, some studies show relatively equivalent complication rates [4, 5], while others suggest that the open approach has higher rates [7]. This begs the question: how should the physician and patient decide on the most appropriate treatment?

Patient factors certainly play a role in deciding which is the best approach to surgical intervention. Elderly patients or those with comorbidities have more anesthetic risk [13, 14]. In this population, endoscopic approach may be preferable due to reduced operative time and shorter hospitalization. Similarly, endoscopic procedures may be favorable in previously operated or radiated necks as the risk of complication may be increased in a scarred or radiated field. Alternatively, certain patient characteristics may favor the open approach. Anatomic factors such as poor neck extension, high body mass index (BMI), short neck, and prominent teeth may make endoscopic procedures less successful [15, 16]. Additionally, younger patients may benefit from an open approach, as recurrence rates are lower with the open approach and these patients will have many decades to develop recurrence. Therefore, each patient should be individually considered, and risks and benefits must be thoroughly discussed. Characteristics of the diverticulum also should play a role in determination of approach. Both very large and very small diverticula are likely to benefit from an open procedure. For extremely large sacs, the remnant which is left following endoscopic diverticulotomy is relatively hypotonic which creates an adynamic segment. Anecdotally, an endoscopic repair on a very large diverticulum can leave behind a poorly motile segment, though it is unclear what implication this remnant has on either function or recurrence. The authors typically encourage patients to consider open diverticulectomy for diverticula larger than 3 cm. For patients with small sacs, myotomy may be all that is necessary. Endoscopic repair in small sacs can be more challenging [5, 17–19]. While endoscopic cricopharyngeal myotomy is an option for ZD [20], van Overbeek, who performed 646 endoscopic treatments of ZD, suggested that for “patients with a small diverticulum, an external sphincterotomy (myotomy) alone is to be preferred” [21].

Indications

Dysphagia is the main indication for ZD treatment. Overtly concerning symptoms such as weight loss and aspiration pneumonia are more pressing indications for surgery, as the patient’s health rather than the patient’s quality of life is at risk. The aim of surgical treatment is to first improve the safety of swallow and next improve quality. Though meaningful postoperative oral intake is not always possible due to long-term outflow obstruction causing pharyngeal pump weakness, appropriate treatment can mitigate any aspiration of pooled secretions or food contents. Consideration of other swallow pathology preoperatively is relevant as esophageal dysmotility can be prominent in this population. This effectively could reduce postsurgical swallow performance, a concept that should be introduced during preoperative counseling to allow patients to have appropriate postoperative expectations.

Symptoms of dysphagia due to ZD often present in the seventh or eighth decade of life. Given the relative late presentation and likelihood of having other more pressing medical comorbidities at this age, the physician should first consider whether surgical intervention should be recommended at all. Though this is a surgical disease, unless the patient is unable to obtain adequate nutrition or is aspirating due to pharyngeal pooling, surgery is not mandatory; many patients can live long and healthy lives with their disease. If disease severity is placing patients' health at risk and surgery is recommended, the patient should then decide whether or not to pursue treatment at all based on a thorough discussion of risks and benefits. Following this, patient characteristics and diverticular size, as outlined above, should direct the discussion when deciding upon surgical approach.

Preoperative Imaging

Swallow imaging is essential for assessment of any swallow disorder. Fluoroscopic swallow evaluation allows for confirmation of presence of the diverticulum, assessment of the prominence of the cricopharyngeal muscle, estimation of the size of the diverticulum, and laterality, all important factors in the preoperative surgical decision-making process. Laterality is of particular importance for open surgery. While most ZD are left sided, there is incidence of right-side dominant lesions which can be difficult to reach via a left-sided approach. For this reason, anterior-posterior fluoroscopy is recommended in addition to the typical sagittal view.

In young, highly functioning patients, modified barium swallow (MBS) may not be necessary, and barium esophagram (BA) may suffice. In the authors' institutions, this is an easier study to obtain, reduces time of workup, and provides all necessary information. For older patients or those with more questionable swallow function, MBS or both MBS and BA may be worthwhile studies. Information regarding additional oropharyngeal or esophageal sources for dysfunction may contribute to a more informed decision-making process regarding the choice to proceed with surgery and counseling regarding postsurgical expectations of function.

Additionally, imaging can help differentiate ZD from other rarer diverticula. A Killian-Jamieson diverticulum protrudes through Killian's dehiscence *antero*laterally, under the cricopharyngeus muscle and lateral to the longitudinal tendon of the esophagus. Though symptoms may be similar when present, Killian-Jamieson pouches are more likely to be asymptomatic [22]; this may occur because the CP muscle lies above the pouch, and closure of this muscle can prevent reflux through the upper esophageal sphincter. Though the surgical approach can be somewhat similar, it is of obvious importance to distinguish whether the esophagus lies anterior or medial to the diverticulum. This diagnosis is made primarily on radiographic studies. Though this can be treated both endoscopically and open, an open approach is preferred due to the close proximity of the recurrent laryngeal nerve [23]. Pharyngocele, another hypopharyngeal diverticulum, is an outpouching in the pyriform sinus through the thyrohyoid membrane; this can present with symptoms similar to a ZD, such as dysphagia and regurgitation. Pharyngoceles are classically associated with increased luminal pressure (e.g., trumpet players) [24, 25]. Pharyngoceles, when repair is required, may also be addressed either open or endoscopically [26]. Further details of management of Killian-Jamieson diverticula and pharyngoceles are outside of the scope of this chapter.

Technique

The operation is performed in the following sequence:

1. General anesthesia is induced with the patient orotracheally intubated and the patient positioned with the head in extension.
2. Endoscopy:
   (a) Cricopharyngeal bar, sac, and esophagus are identified.
   (b) Contents inside sac are cleared.
   (c) The sac is packed with methylene blue-colored 1/4″ plain strip gauze.
   (d) A soft bougie is placed into the esophagus, 36–40 Fr, size permitting.
3. Open procedure:
   (a) A horizontal incision immediately below the level of the cricoid, approximately 4–5 cm in length, is made just left of midline extending to the anterior border of the sternocleidomastoid.
   (b) The omohyoid muscle is identified and retracted or divided.
   (c) Blunt dissection is used to create space medial to the vascular compartment and extended down to the anterior aspect of the prevertebral fascia.
   (d) The sac is then identified and completely dissected free from the pharynx and esophagus via blunt dissection.
   (e) The packing is removed transorally by a member of the operating room team.
   (f) The sac is then placed on moderate tension and removed, and the pharyngotomy is repaired (usually with a stapling device).
   (g) A full cricopharyngeal (CP) myotomy is performed with myectomy by feathering a #15 blade across the muscle until only the mucosa remains.
   (h) The bougie is removed transorally.
   (i) If desired, a feeding tube is placed trans-nasally with digital pressure placed across the anastomotic line.
   (j) The wound is irrigated and a passive drain is placed.

Detailed narrative ZD surgery is performed under general anesthesia. Use of a small endotracheal tube can improve the ease of maneuvering the endoscope. It is imperative that endoscopic evaluation be performed at the time of definitive open surgery. The hypopharynx and cervical esophagus are exposed with any one of a number of endoscopes. Two of the most useful endoscopes for visualization are the distracting Weerda diverticuloscope (Karl Storz, Tuttlingen, Germany) and the non-distracting Benjamin-Hollinger diverticuloscope (Karl Storz, Tuttlingen, Germany); both of these may be put in suspension. In cases of difficult exposure, a Miller 3 blade (an anesthesia-intubating laryngoscope) can be used to engage the cervical esophagus; this offers an excellent view of the sac and bar, but suspension is not an option. Adequate visualization of the cricopharyngeal (CP) bar can be quite difficult but is necessary for appropriate investigation of the native esophagus and sac (Fig. 5.1).

Goals of endoscopy are threefold. First, one must identify and characterize the diverticulum and position relative to the native esophagus. Next, the sac should be emptied of food contents (Fig. 5.2). Finally, other sources of obstruction should be ruled out by endoscopic inspection such as malignancy or stricture, as they can impact the decision of approach and surgical outcome (Fig. 5.3).

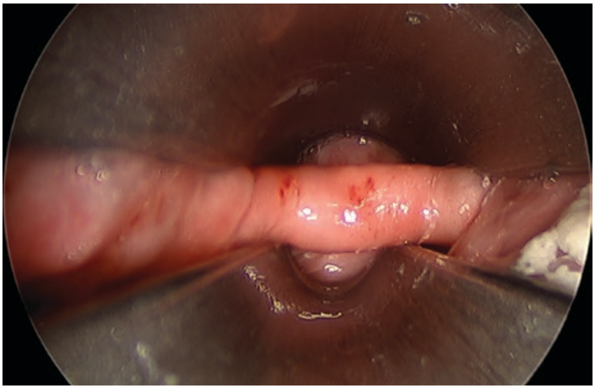

Fig. 5.1 Endoscopic view of a cricopharyngeal bar. A Weerda distending diverticuloscope is in place, putting the transverse posterior portion of the cricopharyngeal muscle—or “bar”—on tension

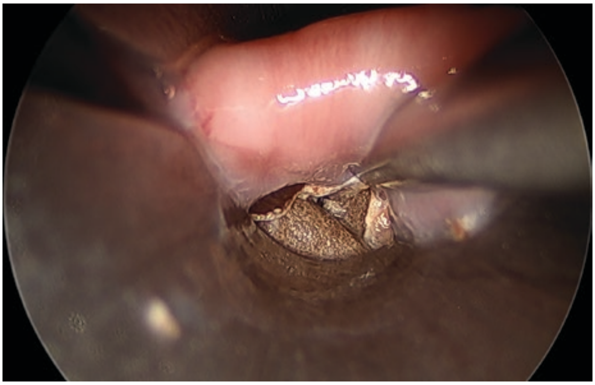

Fig. 5.2 Endoscopic view preoperatively of Zenker diverticulum with debris in the sac

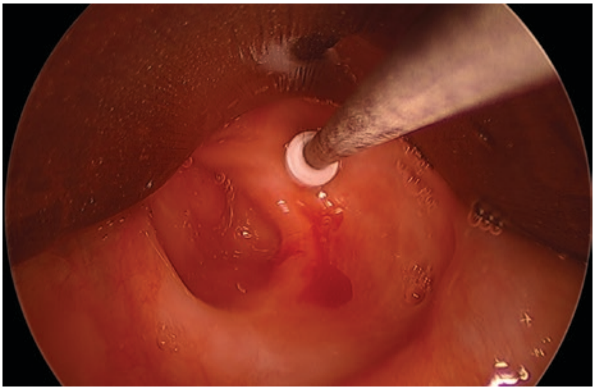

Fig. 5.3 Patient with a recurrent Zenker diverticulum and esophageal stricture. following prior endoscopic approach. Jackson esophageal probe is placed anteriorly through the true esophageal lumen.

Once this is complete, the surgeon should pack the diverticulum with 1/4″ plain strip gauze colored with methylene blue-colored saline (Fig. 5.4). This packing facilitates identification and palpation during the open portion of the case. The methylene blue causes transmucosal staining of the diverticulum wall, enabling easier identification during the open surgical steps. Next, a bougie is placed in the esophagus; the authors most often use a soft Maloney dilator (36 or 38 French). One should note that the direction of the bougie may be much more anterior than anticipated because the packed diverticulum accentuates the lordosis of the cervicothoracic junction. In the rare instance where the diverticula cannot be visualized transorally, the procedure can continue with bougie placement only, however, identification of the diverticula transcervically may be difficult. When exposure of the diverticula is difficult, use of a Miller 3 can allow improved access due to its low profile as compared to more traditional laryngoscopes.

Next, the patient is prepped and draped. A 4–5 cm incision is then planned with a marking pen. A 5 cm incision is adequate for even the largest of sacs. The incision should begin a few millimeters (mm) below the cricoid on the left side of the neck and extend to the anterior border of the sternocleidomastoid muscle (SCM). The neck of the sac is at the level of the cricoid, thus an incision made directly below it affords appropriate exposure. The incision is planned on the left side of the neck for two reasons. First, the cervical esophagus gradually tracks to the left as it descends into the upper chest. Second, the course of the left recurrent laryngeal nerve (RLN) is more predictable (and possibly more stretch-resistant [27]) than the right, and there is no risk for a nonrecurrent laryngeal nerve.

Subplatysmal flaps are elevated, and the fascia is incised along the anterior border of the SCM. The omohyoid muscle is identified as it crosses the field; this should be divided if necessary for improved exposure and can be tagged for later repair. A tunnel is then created in the viscerovertebral angle using blunt dissection, similar to an anterior approach to the spine; no traction should be placed on the tracheoesophageal groove so as not to cause injury to the RLN. Throughout this maneuver, the vascular compartment should not be disturbed. Once the spine is

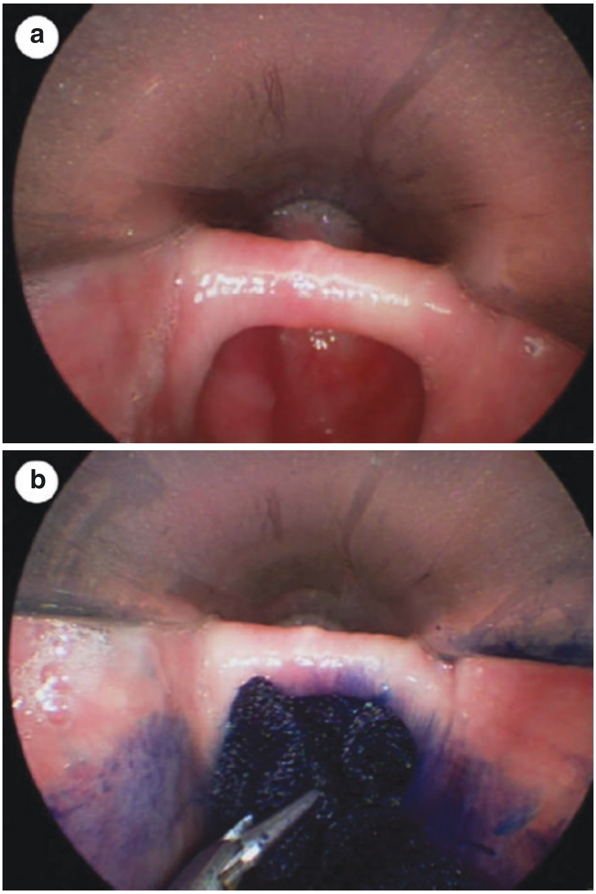

Fig. 5.4 (**a**) Endoscopic view of esophagus anteriorly, cricopharyngeal bar, and posterior sac. (**b**) Methylene blue-soaked plain strip gauze packed into the sac posteriorly

reached, the bougie should be easily palpable and often the sac itself due to the packing. Gentle staining from the methylene blue can be helpful to identify the sac. Using gentle finger dissection, it may be further delineated as it comes free from soft tissue attachments (Fig. 5.5). It may be necessary to retract the lateral aspect of the thyroid lobe medially in order to gain exposure.

Large diverticula may be paradoxically difficult to find. This is especially true in older male patients with low-lying larynges. The sac can settle into the upper mediastinum beyond the lordotic changes of the spine. Gentle manipulation of the laryngotracheal complex and bougie can “deliver” the sac into the operative field; again, care should be taken not to place traction on the RLN. The attachments between the sac and esophagus all the way up to the neck of the sac must be cleared. Often, this fascia over the expanding sac has become invested in the CP muscle itself. If not cleared up to the neck of the sac, this could lead to symptomatic failure.

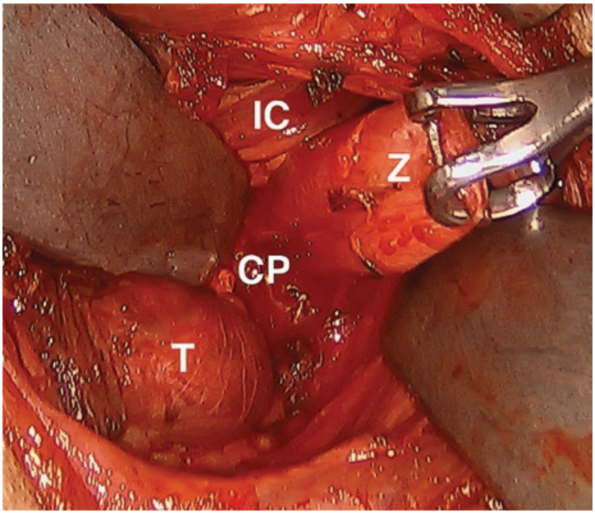

Fig. 5.5 Intraoperative photo of a Zenker diverticulum (Z) protruding between the left inferior constrictor (IC) and cricopharyngeal muscle (CP). Note the Army Navy retractor on the left side of the image is behind the posterior thyroid ala, safely away from the cricothyroid joint and recurrent laryngeal nerve. Thyroid lobe (T)

The methylene blue packing is removed by a non-scrubbed operating room staff member. It is imperative that the ETT must be kept in place as the packing is removed transorally. If accidental extubation occurs, it can be difficult to re-intubate an airway in which the pharynx has been colored with methylene blue and the larynx is often low-lying.

Now that the sac is fully exposed and the packing has been removed, the sac should be resected; this can be done using an enteral stapler or sharply with concomitant repair. The stapler resection can be easy and rapid, but the surgeon must be familiar with the various sizes of staplers in order to choose the appropriate one. The stapler automatically closes the hypopharyngeal defect (Fig. 5.6). The authors typically use a 45 mm blue load for an Ethicon ENDOPATH® ETS Articulating Linear Cutters (Ethicon, Cincinnati, OH). A single firing of the stapler is ideal. If multiple firings are required, careful note must be made to ensure staple lines overlap and there is no gap between staple lines. Alternatively, one may also resect the sac sharply over a clamp. The resulting hypopharyngeal defect is repaired using an imbricating suture with a 3-0 Vicryl on a small tapered (CV-23) needle.

Once the defect is repaired, a CP myotomy should be performed. A no. 15 blade can be used to feather through the muscle, or a sharp tenotomy scissors is used to dissect the plane between the muscle itself and the mucosa and allow for sharp transection of the muscle. This plane can be obscured in patients with previous dilation or other surgical procedures in the region such as anterior spine surgery, prior ZD repair, or carotid endarterectomy. The entirety of the CP muscle should be incised extending all the way from the proximal cervical esophagus to the neck of the sac. Care should be taken, however, not to extend

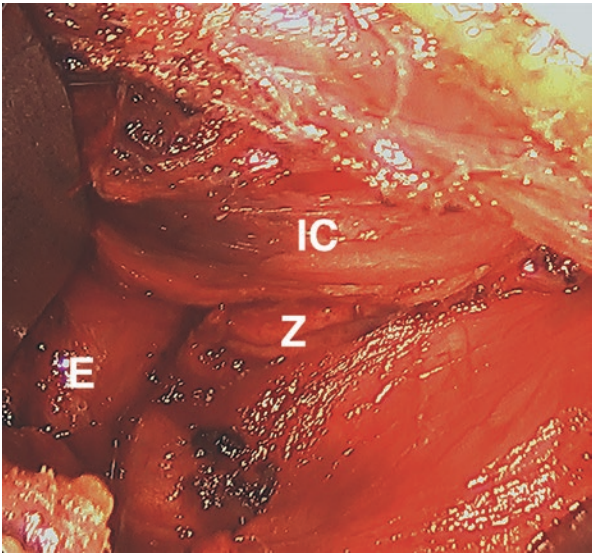

Fig. 5.6 Post-diverticulectomy and cricopharyngeal myotomy. The staple line is visible (Z), and only esophageal mucosa (E) remains post-myotomy.

this too superiorly as the inferior constrictor is superior to the CP and plays a role in pharyngeal clearance.

Once the myotomy is completed, the bougie is removed. If one wishes to place a feeding tube, it should be placed carefully at this point. When passing the tube, ensure the diverticulectomy site is reinforced with digital pressure to prevent accidental perforation of the staple or suture line. Again, care should be taken not to dislodge the endotracheal tube. The surgical site is inspected for possible tears in the esophageal or hypopharyngeal mucosa. The surgical wound should then be copiously irrigated, and a dependent drain should be placed in the paraesophageal space. The omohyoid muscle should be reapproximated. A layered closure should be performed next with a 3-0 Vicryl for the platysmal/dermal layer and a 5-0 nylon for the skin. The drain is then secured with a stitch. Antibiotic ointment is applied. Next fluffs and a light elastic mesh dressing are placed.

The patient is then returned to the anesthesia team for emergence. It is important that positive pressure be avoided during wakeup. If positive pressure is needed (due to obstruction or neuromuscular weakness), it would be preferable for the patient to be re-intubated and then reevaluated for another extubation attempt.

Surgical Options

It should be noted that the preferred method of the authors is the diverticulectomy and myotomy (or myectomy) which happens to be the most common in practice [5], yet several other techniques for open procedures exist. Similar to endoscopic vs. open repair, solid evidence in favor of one approach over another is lacking.

Three main techniques are used—resection, inversion, and suspension. Resection (previously described) is the only technique which violates the mucosa. Inversion involves invagination of the mucosa into the esophageal lumen and oversewing of this inverted tissue. Diverticulopexy involves suturing the sac superiorly in a nondependent position, often to the prevertebral fascia or posterior pharyngeal wall.

Both the inversion and suspension techniques have a lower theoretical risk of leak because the mucosa is not entered. Mantsopoulos et al. [28] retrospectively compared outcomes of diverticulectomy with myotomy to the inversion technique. Fifty-four patients were included, only fourteen of whom (25.9%) underwent diverticulum inversion. Hospital times were significantly shorter for patients who underwent inversion, (8.9 days for inversion vs. 11 days for diverticulectomy). No significant differences were noted with respect to duration of operation, complication rates, or recurrence rates. From their own experience, the authors recommended the inversion procedure specifically for smaller diverticula. Others have also shown shorter time to oral intake as well as decreased complications for inversion rather than resection [29].

Diverticulopexy has been investigated as an alternative to resection as well. Greene et al. [30] retrospectively reviewed their series. Of open transcervical cases, 74% of these subjects (50 patients) underwent diverticulopexy, and 26% underwent diverticulectomy (18 patients). Complete resolution of symptoms occurred more often with diverticulopexy than diverticulectomy, but this was not found to be significant. Complication rates were not subdivided by the type of open technique. Simic et al. [31] compared resection with suspension (both with myotomy) in 50 patients. Eleven percent of suspension patients and 14% of diverticulectomy patients had recurrence of dysphagia; all patients were then symptom-free within 1 year of surgery. No pharyngocutaneous fistulas were observed.

Of note, when diverticulopexy or inversion is performed, the pouch itself is not removed, leaving behind poorly functional hypopharyngeal tissue. Secondly, there have been case reports of carcinoma arising in a long-standing pouch [32, 33], so one must take this into consideration when performing inversion and suspension which do not remove the pouch in its entirety.

Perioperative Care

Decisions about postoperative feeding are best made preoperatively based on the patient's swallowing status. Most patients fall somewhere between clearly needing a feeding tube preoperatively and clearly not needing one. Options for postoperative care include a G-tube, a nasogastric feeding tube, or a short period of nothing by mouth without a feeding tube. Some patient characteristics or comorbidities which may prompt enteral feeding include severe oropharyngeal dysphagia, extreme malnutrition, or extensive prior cervical surgery. If a feeding tube is to be placed after leaving the OR, interventional radiology placement is recommended, as blind

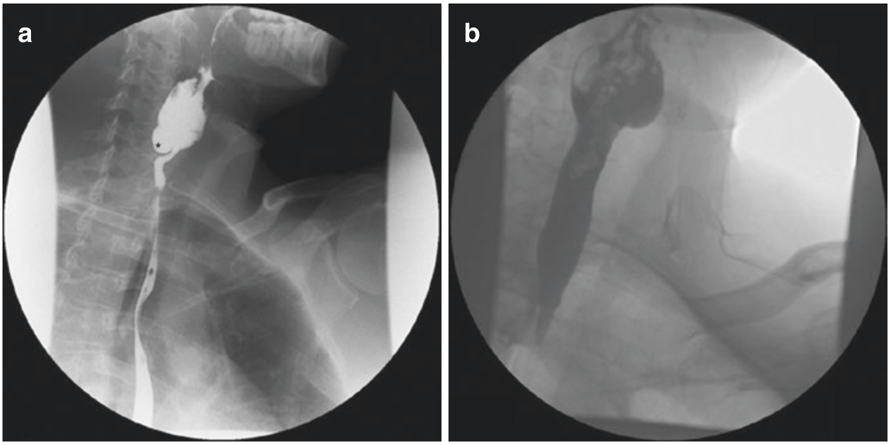

Fig. 5.7 (**a**) Preoperative barium swallow with small Zenker diverticulum seen posteriorly (asterisk). (**b**) Same patient, postoperatively, showing interval resolution of diverticulum on barium swallow

and even endoscopic placement of a feeding tube can be difficult in a patient with a recent open repair.

It is preferred, for patients with normal pharyngeal function, to avoid a feeding tube altogether. NPO status is kept for 1–2 days, while maintenance intravenous fluids are administered. A modified barium swallow or barium esophagram is performed on the first or second postoperative day. MBS is used for patients with significant preoperative dysfunction to insure there is no aspiration postoperatively as diet usually is heavily weighted toward liquids initially. If there is good outflow and no leak, the NG tube may be removed if present, and the patient can then be started on clear liquid diet (Fig. 5.7). For patients with a G-tube, there is less urgency to radiographically test the hypopharyngeal repair.

Diet is gradually advanced from clear to full liquids over the first week. Most patients are seen in the office roughly 1 week postoperatively. If they are doing well and progressing appropriately, diet is advanced to puree, soft, and then normal diet over the next couple of weeks. For patients with prolonged periods of NPO prior to surgery, speech pathology and nutritional consultation are utilized as needed.

Patients should all be given ample options for antiemetics, and any potential nausea should be acted on quickly; postoperative emesis should be avoided especially in open cases so as not to stress the newly repaired diverticulectomy site.

All patients are given antibiotics for the first week following surgery. Ampicillin/sulbactam is preferred, though a combination of cefazolin and metronidazole is also used. Clindamycin can be considered in the penicillin-allergic population.

The drain should be removed after oral intake has started and prior to discharge from the hospital. The drain is not there only to avoid hematoma, but rather to allow egress in order to reduce the risk of mediastinitis if there is a leak. Sutures should be removed at 1 week.

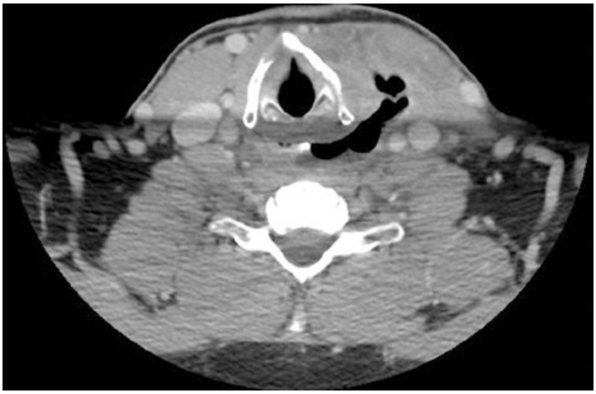

Fig. 5.8 Transcervical air seen on computed tomography on postoperative day 10 after starting CPAP on post-operative day 5 for central sleep apnea

Once the patient leaves the hospital, many standard instructions apply. Effort should be made to avoid strenuous activity or heavy lifting for 14 days. Antiplatelet and anticoagulant therapy should be avoided for 1 week (as long as this is permissible with respect to other comorbidities). For patients with obstructive sleep apnea, it is important not to use any positive pressure device, such as continuous positive airway pressure (CPAP), to avoid air expression through the pharyngotomy closure which can create crepitus, destabilize the closure, and lead to infection (Fig. 5.8). For the same reason, positive pressure ventilation should be avoided upon emergence from anesthesia.

At the first postoperative visit, flexible fiber-optic laryngoscopy should be performed to assess for vocal fold motion, pharyngeal edema, hematoma, and residual pharyngeal pooling.

Complications

Open ZD surgery carries with it both short-term and long-term risks. Shortly after surgery, RLN injury, hematoma, perforation or pharyngocutaneous fistula, or mediastinitis may occur. In the long term, the major risk is persistent dysphagia or lack of symptomatic improvement.

Two of these complications are major distinguishing features between endoscopic and open surgery. RLN injury is reported to occur in 0–5% [4, 5, 8, 34] of open ZD cases. Because of this, vocal fold motion should be evaluated preoperatively; this is particularly pertinent if there is a preexisting immobility on the right (nonoperative side). Additionally, a unilateral RLN injury in and of itself reduces pulmonary protection and effective cough and would prove to be a significant concern in a fragile patient with an already dysfunctional swallow. Hematoma is another complication seen only with open repair which occurs roughly at 1–2.2% [4, 5]. As is always true in the head and neck, hematomas should be identified and treated early due to the potential for airway compromise.

Pharyngocutaneous fistula is a potential feared complication. Reported rates range from 0 to 8.3% [3–5, 31, 34]. If leaks occur early, they are typically recognized by change in drain output or with postsurgical swallow imaging. Small leaks should heal quickly if flow through the esophagus is not obstructed; patients should be treated with enteral feeding and packing to the fistula site until output ceases.

Leaks can occur in a delayed fashion as well. These arguably are of more concern because drains typically have been removed and oral intake has been initiated. While all patients with leaks are at risk for mediastinitis, this population is more concerning because of possible delay in identification which can allow maturation of an infection.

Mediastinitis is a potentially fatal complication caused by bacteria in saliva or food leaking through the esophageal or hypopharyngeal perforation and infecting the surrounding soft tissues. As the fascial planes of the neck are connected to the mediastinum, this can cause infection of the chest which can quickly become fatal. These planes are disturbed during the dissection of the pouch. This is generally not experienced during endoscopic procedures which may explain, in part, why mediastinitis is a rare complication of ESD. Physicians should be alert for any of the classic symptoms of this infection, namely, fever, tachycardia, and chest or upper back pain. If present, one should obtain a white blood cell count to assess for potential infection (though notably in the postoperative period an elevated white blood cell count can be normal, a severe leukocytosis is indicative of something more nefarious). If the clinical picture is concerning for hypopharyngeal leak or mediastinitis, all feeds (oral or otherwise) must be stopped, and antibiotics should be continued and likely broadened.

If mediastinitis is suspected in the immediate post-op period, typically the quality of the drain output changes. If drainage worsens, returning to the operating room for wound washout and re-draining is prudent. If it is beyond the first couple of days postoperatively and the drain has been removed already, CT imaging with contrast is helpful in identifying the presence and extent of the process. Typically, mediastinitis can be managed via transcervical drainage; however, thoracic surgery consultation is advised in the event that infection advances.

Mediastinitis and hypopharyngeal fistulas typically improve with drainage and time. Reduction of salivary flow with use of scopolamine can help slow output. If the hypopharyngeal defect is small, patience and wound care often result in resolution. If more substantial, transcervical exploration with primary closure and reinforcement with a local or regional rotational flap is recommended. Once drainage ceases from the neck, esophageal imaging is repeated, and, if negative, oral intake is initiated.

Conclusions

Open Zenker diverticulum surgery is the most definitive treatment available for ZD. Though operating times tend to be longer, lengths of stay are longer, and complications are of a different ilk than those encountered with endoscopic procedures, overall the procedure is safe and effective. Open surgery, however, is not the appropriate choice for repair in every patient. Given this, surgeons should be competent in both open and endoscopic treatments.

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