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Esophageal Perforations: An Endoscopic Approach to Management

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Abstract

Purpose of Review Esophageal perforations are associated with high morbidity and mortality. As opposed to surgical repair, endoscopic closure techniques have emerged over the years as a more minimally invasive approach for management. Our goal is to discuss different modalities for closure.

Recent Findings Through-the-scope clips (TTSCs), over-the-scope clips (OTSCs), and esophageal stent placement are well known options for closure. We will also discuss the more recent technique of endoscopic suturing for closure of larger defects as well as prevention of esophageal stent migration. For mediastinal collections associated with perforations, a more novel endoluminal vacuum therapy (EVT) for drainage may be an option.

Summary Overall, there are several different endoscopic options that can tailored to the specific features of an esophageal perforation. This review will discuss various techniques with which a gastroenterologist or thoracic surgeon should be familiar.

Keywords Esophagus · Perforation · Endoscopic management · Over-the-scope clip · Esophageal stent · Endoscopic suturing

Introduction

Esophageal perforation is a rare, life-threatening condition with an incidence of 3.1 per 1,000,000 per year. Esophageal perforation can be classified as either iatrogenic or non-iatrogenic, the former being more common [1]. Iatrogenic perforations occur following esophageal instrumentation, which includes both surgery and endoscopy. The risk of perforation can range from 0.03 to 0.11% following diagnostic procedures; however, this risk significantly increases with more advanced therapeutic procedures such as pneumatic dilation (2–5%) and per-oral endoscopic myotomy (0.3–9%) [2, 3]. With regard to non-iatrogenic causes, Boerhaave syndrome, otherwise known as spontaneous esophageal rupture, accounts for 15% of all esophageal perforations [4]. Other causes of non-iatrogenic perforation include trauma and malignancy.

Presenting symptoms can depend on the location of the esophageal perforation. While intrathoracic perforations can commonly present with retrosternal chest pain, cervical and intra-abdominal perforations can present with neck pain/dysphagia and epigastric pain respectively. On physical exam, the clinician may note crepitus, indicating subcutaneous emphysema [5]. Patients can worsen clinically within hours, developing possible mediastinitis, sepsis, and even multiple organ dysfunction.

Given its high associated morbidity and mortality, timely diagnosis and management of esophageal perforations are vital. Specifically, for the endoscopist, close examination of the esophagus after therapeutic intervention, along with possible follow-up imaging if needed, is important to evaluate for perforation. Diagnosis occurs either with immediate identification during a procedure or by follow-up imaging, typically either chest computed tomography (CT) or esophagography with water-soluble contrast. Contrast esophagram is usually the preferred modality but can be associated with falsely negative results in up to 10% of cases [6].

After diagnosis, initial management should always include avoidance of oral intake with other means of nutritional support, intravenous antibiotics, drainage of fluid collections, and debridement of tissue if indicated. Subsequent definitive management for closure with surgery, endoscopic therapy, or a combination of both is then pursued. Collaboration between a thoracic surgeon and a skilled endoscopist is important to optimize management for an individual patient. Surgical management options include primary repair, resection of the

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defect, drainage of fluid collections, or possible esophagectomy. However, advances in endoscopic techniques are granting a larger role to minimally invasive approaches, specifically in the subset of patients who lack more systemic complications of perforation (i.e., mediastinal collections, severe sepsis) or who are poor surgical candidates.

Regardless of the type of endoscopic closure technique used for esophageal perforations, follow-up imaging (usually a contrast esophagram) is needed to verify the intervention's technical success. Frequently, this imaging occurs post-procedurally in the radiology suite, which requires the patient to be transferred out of the endoscopy unit. An alternative and more immediate evaluation with an intraprocedural contrast esophagram could be considered, with the advantage of providing the endoscopist with a real-time assessment of the intervention and the opportunity to further modify the closure within a single procedure. With a few additional supplies, this step can be incorporated easily into the procedural workflow. We have applied this technique at our own institution with good clinical outcomes.

Endoscopic Management

Once a perforation has been identified endoscopically, specific parameters such as the location, size, and margins of the defect need to be evaluated to determine what kind of endoscopic closure technique may be utilized. Options include through-the-scope clips (TTSCs), over-the-scope clips (OTSCs), esophageal stents, and endoscopic suturing. A recent endoscopic drainage technique for mediastinal collections has also been developed. Our overall aim in this review article is to discuss the current endoscopic techniques available for the management of esophageal perforations.

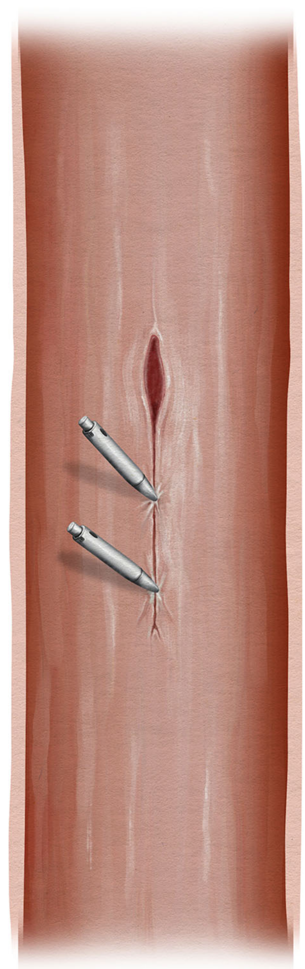

Fig. 1 "Zipper"-like closure of an esophageal perforation using TTSCs, starting at the most distal edge

Clips—TTSC, OTSC

Clips can be classified into two categories: TTSCs and OTSCs. The former category was initially utilized for hemostasis, but over time its application has expanded to include the closure of gastrointestinal defects [7]. If the mucosal edges of a perforation appear healthy and the defect is approximately less than a centimeter is size, TTSCs are a suitable option for closure [8]. QuickPro™ (Olympus, PA), Resolution™ (Boston Scientific, MA), and Instinct™ (Cook Medical, IN) clips are three types of commercially available clips that are commonly utilized. The jaw diameter of these clips ranges from 11 to 16 mm. Some of these clips can be rotated and come with a two to three step deployment mechanism [9]. TTSCs are typically deployed sequentially in a "zipper"-like pattern for closure, starting at the most distal edge of the defect, taking care not to overlap the opposing mucosal edges (Fig. 1). By starting distally and working proximally, the risk of inadvertently dislodging clips with the scope decreases [10].

OTSC® (Ovesco, Germany) is another option for clip closure. These clips are available in three sizes (11, 12, and 14 mm) and come pre-loaded on a clear cap that is mounted over the end of the endoscope. The defect can either be suctioned into the cap or grasped with forceps to help anchor the defect into the cap before clip deployment (Fig. 2). Studies have shown successful rates of closure for perforations with OTSCs. In a large multicenter retrospective study of 188 patients with gastrointestinal (GI) defects, 90% of 48 luminal perforations had successful closure with OTSCs [11]. There were 10 esophageal perforations within this cohort, and the closure of all of these was technically successful. In contrast to TTSCs, OTSCs offer greater closing force and tissue capture. However, OTSC placement may be unsuccessful for defects larger than 20 mm in length or with defects that have inflammatory or necrotic margins [12].

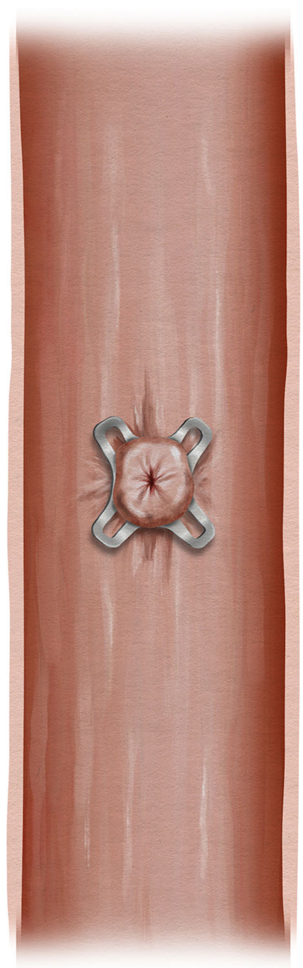

Fig. 2 Closure of an esophageal perforation utilizing an OTSC

In terms of follow-up, retention rates of TTSCs can vary, with the longest duration reported at about 4 to 5 weeks in a porcine model, while OTSCs are assumed to fall off within 3 months based on data from colonic full-thickness resections [13, 14]. Although rarely reported, complications with clip closure of esophageal perforations can include mucosal injury, deployment malfunction, and dysphagia. A rare case of esophageal perforation was noted with the use of the OTSC in a prospective multicenter study, so caution with direct visualization should always be undertaken [15].

Esophageal Stents

Initially developed as a palliative option for the treatment of luminal malignant obstruction, esophageal stents (and in particular self-expandable metallic stents [SEMS]) are now more recognized as a viable option for the management of esophageal perforations. SEMS are composed of various metal alloys and vary in length, shaft diameter, and mechanism of deployment. In addition, an anti-reflux valve may be present if placing the stent across the gastroesophageal junction to prevent reflux. Either a fully covered self-expandable metal stent (FCSEMS) or partially covered self-expandable metal stent (PCSEMS) can be placed for esophageal perforations. High success rates have been reported with stent placement for esophageal perforations, with a recent systemic review noting 91.4% technical success and 81.1% clinical success in a total of 340 patients from 27 case series [16].

SEMS placement involves first carefully identifying the location and size of the esophageal perforation to determine which specific stent device will be suitable. A guidewire is then threaded through the endoscope to help guide stent placement. Using fluoroscopy, radio-opaque markers are then utilized to delineate the perforation site in addition to the distal and proximal margins of the planned stent placement. The stent is then deployed under fluoroscopic guidance to ensure that the stent is centered over the defect site. Stents are typically left in place for 2–4 weeks before endoscopic removal. An embedded PCSEMS may require a stent-in-stent (SIS) removal technique, which has been shown to be safe and effective. This approach involves placing a FCSEMS inside a PCSEMS, which causes pressure necrosis of the mucosal tissue that is embedded between the stents. Repeat endoscopy is then performed approximately 2 weeks later to safely remove both stents [17]. Early treatment of esophageal perforations with stents is likely associated with better outcomes. Fischer et al. reported that delayed stent placement for esophageal perforations (average time delay of 45 min vs. median delay of 123 h) led to increased hospital stay (5 vs 44 days) and increased sepsis and organ failure (6 of 8 patients) [18].

The most common complication of stent placement is stent migration. In contrast to PCSEMS, FCSEMS have a higher risk of migration given that they lack the uncovered portion of PCSEMS that allows for better tissue embedment [19]. On the other hand, tissue ingrowth seen with PCSEMS may pose difficulties with removal. Suture fixation of FCSEMS has emerged as a means to reduce stent migration rates (Fig. 3). Wright et al. showed that suture fixation of FCSEMS was associated with reduced risk of stent migration (19.0 vs. 63.4%, $p = 0.0012$) [20]. In addition, a 2016 retrospective study showed migration rates were significantly lower in patients undergoing suture fixation with FCSEMS placement (16% vs. 33%, $p = 0.03$) [21].

Regardless of fixation technique, close follow-up with serial X-ray imaging (on the day of stent placement and on the day following) is important to ensure correct positioning of stent. If there is a concern of even minor migration, the esophageal stent should be promptly repositioned to avoid future complete migration into the stomach. If the esophageal stent has a proximal monofilament lasso, this can be grasped with rat-tooth forceps, collapsing the upper flange of the stent and allowing for repositioning [22].

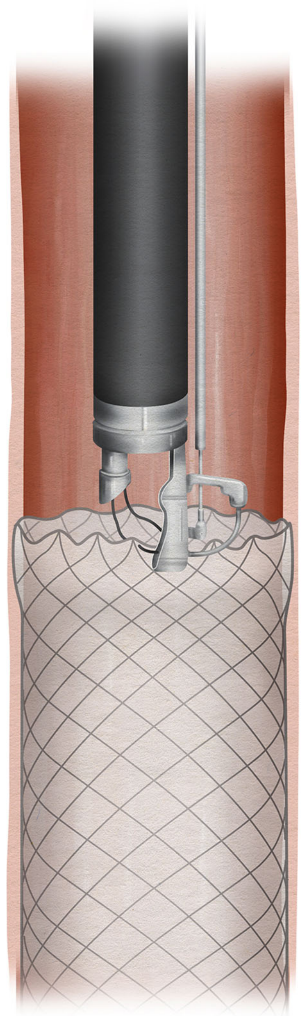

Fig. 3 Endoscopic suturing of the proximal end of an esophageal stent to reduce risk of migration

Careful consideration should be given to possible stent placement in patients with more proximal cervical perforations given the risk of migration and close proximity to the upper esophageal sphincter; the function of which can be disrupted by stent traversal. Clinical failure of stent placement in the context of esophageal perforation has been noted to be more frequent with defects that cross the gastroesophageal junction and those that are larger than 6 cm in size [23].

Endoscopic Suturing

In addition to suture fixation of esophageal stents, endoscopic suturing technique can also be utilized for primary closure of esophageal perforations. Endoscopic suturing technique allows for placement of full-thickness sutures across a defect that would otherwise not be well-managed by other techniques as described above, particularly larger defects.

The first commercially available and Food and Drug Administration (FDA) approved endoscopic suturing device was the OverStitch™ (Apollo Endosurgery Inc., Texas), which obligated the use of a dual-channel therapeutic endoscope. In 2018, the OverStitch Sx™ was released, which is compatible with over 20 single-channel flexible endoscopes. The endoscopic suturing device consists of a handle for needle driving as well as a suture exchange catheter unit, which is attached to the control head. The distal attachment consists of a curved needle, suture, and tissue helix grasper. The curved needle notably allows for sufficient depth approximation with suture placement. While maintaining good visualization of the defect site, sutures can be deployed and then reloaded without having to remove the endoscope. Furthermore, the defect can either be closed in a continuous or interrupted fashion. The tissue helix can be utilized to grasp the esophageal mucosa, thereby allowing for better suture insertion (Fig. 4).

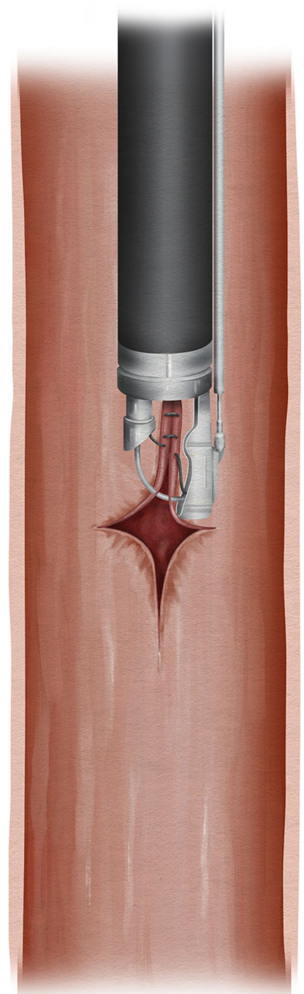

Fig. 4 Endoscopic suturing device placing consecutive sutures to close perforation site

A small cases series by Henderson et al. reported successful suture closure of 3 esophageal perforations; the largest of which was 30 mm in size [24]. In a 2016 retrospective study, Sharaiha et al. showed high technical success (95.7%) with endoscopic suturing of luminal perforations; in this series, all esophageal perforations (13/13) achieved successful closure at a mean day follow-up of 68 days, and defect sizes ranged from 25 to 50 mm [25••].

Mucosal injury is a possible complication with the use of suturing devices; however, this risk is largely avoided by placement of an overtube prior to procedure. In contrast to other endoscopic techniques for closure of esophageal perforations, endoscopic suturing may be associated with a more substantial procedural learning curve, which could present a barrier to more widespread use.

Endoluminal Vacuum Therapy

Esophageal perforations can be complicated by mediastinal collections; conventional management of which typically has involved surgical or CT-guided drainage. First utilized as a means for drainage with anastomotic perirectal abscesses following rectal surgery, endoluminal vacuum therapy (EVT) or endoscopic vacuum-assisted closure device (EVAC) can now be applied to collections in the upper gastrointestinal tract that are due to perforations and leaks. This minimally invasive drainage technique can be used in conjunction with the aforementioned closure methods [26]. In a large prospective trial of 52 patients treated with EVT for esophageal perforations or anastomotic insufficiency following esophagectomy or gastrectomy, Laukoetter et al. reported clinically successful healing rates in 94.2% [27••].

A commercially available wound vacuum-assisted closure device called Endo-sponge (B. Braun Melsungen AG, Germany) is only FDA approved for the management of rectal anastomotic leaks; however, it may have a role in the management of complications arising from esophageal perforations as well. The initial step for placement involves reviewing available imaging and examining the esophageal perforation site along with the associated cavity. After placement of an overtube, endoscopic irrigation and/or debridement of the cavity can be performed. A small sponge, which is cut to the estimated size of the cavity, is then attached to the distal tip of a nasogastric tube (NGT). The sponge must cover all of the holes at the distal end of the NGT, and suturing is performed to secure its position. The sponge is then introduced into the esophagus and positioned into the cavity. The overtube is then removed and sponge location is endoscopically verified, utilizing forceps to ensure proper placement. The proximal end of the NGT is then redirected transnasally and attached to a negative pressure pump to apply suction. Although there are no strict guidelines, sponge exchanges usually occur every 3 to 5 days. Laukoetter et al. reported an average of six total sponge exchanges, while some retrospective studies have noted a lower average of approximately four [27••, 28].

The overall goal of therapy is shrinkage of the mediastinal cavity along with the appearance of healthy granulation tissue. The defect site can then be definitively closed with one of the endoscopic procedures discussed above. Complications of endoscopic washout techniques include sponge malfunction and stricture formation, which occur in the context of granulation tissue. EVAC is a relatively intense treatment strategy that requires closer monitoring and can involve multiple follow-up endoscopic procedures over a short period of time.

Conclusion

Esophageal perforation is rare, life-threatening condition that requires prompt diagnosis and treatment given its associated high morbidity and mortality. Different endoscopic techniques are available for closure and may be preferable to surgical management in certain patient populations. We have discussed TTSCs, OTSCs, stents, suturing devices, and the more novel EVT as potential options. It is important for endoscopists to be familiar with these approaches in this rapidly evolving field in order to provide optimal care for patients.

Compliance with Ethical Standards

Conflict of Interest Shelly Gurwara and Steven Clayton declare no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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