What Is New with Cervical Perforations? A Clinical Review Article

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KEYWORDS

• Cervical esophageal perforations • Esophageal disease • Endoscopic techniques
• Endovac therapy

KEY POINTS

- Cervical esophageal perforations are usually iatrogenic in nature, occurring most frequently as a result of endoscopic instrumentation.
- After prompt diagnosis, appropriate initial treatment of cervical esophageal perforations includes initiation of nil-per-os status and administration of broad-spectrum antibiotics, intravenous fluids, and nutrition via enteral access.
- Small defects without signs of systemic disease may be managed conservatively.
- Large defects, perforations with traumatic etiology, and/or presence of hemodynamic instability warrant operative intervention.
- Based on limited studies, novel endoscopic techniques offer promising methods of minimally invasive intervention for the management of esophageal perforations.

BACKGROUND

Esophageal perforations are historically uncommon but are associated with poor outcomes. While most esophageal perforations are iatrogenic in nature, less frequent etiologies include Boerhaave's syndrome, malignancy, trauma, and toxic ingestion.[1] Survival associated with esophageal perforation has significantly improved overtime, with mortality rates down trending from 18% to 10% over the last 25 years.[2] Despite this improvement, mortality from this disease remains relatively high. Prompt diagnosis and treatment have been associated with improved outcomes, as have improvements in perioperative management.[3,4]

Perforations most frequently occur within the thoracic esophagus, followed by the cervical and abdominal esophagus.[4,5] Unlike thoracic perforations, the management of cervical esophageal perforations is highly variable.[6,7] Clinical decision-making can be nuanced and often requires consideration of individual clinical scenario. Appreciation of cervical esophageal anatomy is imperative to understanding disease progression as well as deciding on method of intervention. A wide range of interventions are currently available to treat cervical perforations, including nonoperative, endoscopic, and operative management options.

DISCUSSION

Anatomy of the Cervical Esophagus

The cervical esophagus extends from the lower border of the cricoid cartilage to the level of the sternal notch. Coursing posterior to the trachea and anterior to the spinal column, the cervical esophagus is anchored to the prevertebral fascia along C6–T2. At this level, the muscular layer of the

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cervical esophagus is thin and there is no serosal layer to provide additional support, increasing risk of perforation.[6,8] The physiologic narrowing caused by the cricopharyngeal and inferior constrictor muscles also increases risk of perforation, and most iatrogenic esophageal perforations occur at this location.[1,6] Fortunately, because of adherence to prevertebral fascial planes, cervical perforations are often self-contained.[4] The outcomes of cervical esophageal perforations are less severe than those of thoracic and abdominal perforations, with a mortality of 6% compared to 10.9% and 13.2%, respectively.[9,10] This is likely due to limited spread of contamination, allowing for local drainage and avoidance of a thoracotomy or laparotomy.[4] Because of its proximity to the anterior cervical spine, the cervical esophagus is also at risk for iatrogenic perforations due to spinal surgery from orthopedic hardware as well as spontaneous rupture secondary to osteophytes.[4]

Diagnosis and Initial Management

The diagnostic pathway for cervical esophageal perforations is similar to that of thoracic and abdominal perforations. The first step in evaluation is a detailed history and physical examination. Common findings associated with esophageal perforations include pain, odynophagia, subcutaneous emphysema, and hemodynamic instability.[3] Findings specific to cervical perforations may include dysphagia, dysphonia, pain induced with neck flexion, and erythema, edema, or induration of the soft tissues of the neck.[4,11,12] Any of these signs and symptoms, particularly in the setting of recent instrumentation or existing esophageal disease, should prompt high suspicion of esophageal perforation. A timely diagnosis is imperative to maximizing patient outcomes and survival.[3]

The study typically used in the initial diagnosis of esophageal perforation is an upper gastrointestinal swallow study with water-soluble contrast. When positive, this study demonstrates location of the perforation and extent of disease. However, water-soluble contrast carries a high false-negative rate, especially in the upper esophagus.[4,12,13] Swallow studies using barium contrast have higher specificity and can be used in the setting of negative findings and high clinical suspicion.[4,12] Barium contrast is not used in the initial diagnosis due to risk of mediastinitis.[14] Another method of diagnostic imaging includes an oral-contrasted computed tomographic (CT) esophagram. While this has not historically been recommended as initial imaging for diagnosis of esophageal perforation, this technique is widely available and can be performed without the need of a fluoroscopy team.[3] Additionally, there is mounting evidence that CT esophagram can be more sensitive than fluoroscopic examination.[4]

Because most cervical esophageal perforations occur from endoscopy, some cases may be diagnosed at the time of injury.[4] However, the use of endoscopy to diagnose esophageal perforations is controversial. Endoscopy in the setting of esophageal perforation is associated with risk of full-thickness conversion of partial-thickness defects and tension pneumothorax formation from insufflation. Endoscopy does provide the ability to directly visualize and characterize the injury and viability of the surrounding tissue. This technique also provides the option of immediate therapeutic intervention. The use of endoscopy is often reserved for cases of critically ill and/or intubated patients who are unable to participate safely in radiological studies as well as cases with high clinical suspicion despite negative imaging.[3]

Treatment Options

The management of cervical esophageal perforation is less well-studied than perforations in other regions of the esophagus. Consequently, there is no single best practice recommendation for treatment.[4] Regardless of management strategy, all patients diagnosed with esophageal perforation should be made nil-per-os (npo) and started on broad-spectrum antibiotics, enteral nutrition, and intravenous fluid resuscitation.[3] Further treatment course is dependent on patient clinical status and disease. Patients found to have small defects while demonstrating hemodynamic stability may be treated with nonoperative management. Perforations associated with hemodynamic instability, large mucosal defects, widespread contamination, as well as those with delayed presentation or diagnosis warrant surgical intervention[6] (**Table 1**). While novel endoscopic procedures are being studied in the management of cervical perforations, there are limited data on the efficacy of these interventions. There have been smaller studies, case series, and case reports of successful management using endoscopic stents, clips, sutures, negative pressure therapy, and adhesives (**Table 2**).

Nonoperative management

Patients who are hemodynamically stable with a defect smaller than 1 cm may initially be managed medically if no signs of free extravasation are seen on imaging.[6,12] Nonoperative management includes hospital admission, strict npo status, broad-spectrum antibiotic initiation, and nutrition via enteric or parenteral access.[6] If the patient remains stable, a repeat swallow study should be obtained in 5 to 7 days to reassess the perforation prior to allowing oral intake.[7,12] Clinical deterioration during

Table 1
Operative, nonoperative, and combined technique interventions

Author	Study Design	# Of Cervical Perforations	Etiology of Perforation[a]	Intervention	Outcomes
Tang et al,[15] 2021	Retrospective	18/335 patients	Mixed	• 17 patients with primary repair • 1 patient with diversion	• Cervical perforations more likely to have repair ($P = .0001$)
Abbas et al,[51] 2009	Retrospective	26/119 patients	Mixed	• 15 operative • 11 nonoperative	• Cervical perforations with 8% mortality compared to 14% overall
Aghajanzadeh et al,[16] 2015	Retrospective	26/26 patients	Mixed	• Primary repair: 38.46% • Primary repair and drainage: 26.92% • Drainage alone: 19.23% • Stenting: 11.53% • Esophagectomy and J tube 15.4%	• Overall mortality: 7.7% • High mortality among esophagectomies • 21.4% of patients who had drainage as part of their treatment experienced drain leaks
Bhatia et al,[17] 2011	Retrospective	15/119 patients	Mixed	• 10 primary repair • 1 palliative care • 2 drainage • 1 resection	• 7.6% mortality among patients with perforations in cervical esophagus
Bufkin et al,[18] 1996	Retrospective	9/66 patients	Mixed	• 5 operative • 4 nonoperative	• No mortalities for nonoperative management
Eroglu et al,[19] 2009	Retrospective	14/44 patients	Mixed	• 11 primary repair • 3 nonoperative	• No mortalities • 2 leaks in operative group
Schmidt et al,[20] 2010	Retrospective	8/62 patients	Mixed	• 6 primary repair • 2 nonoperative	• No mortality in cervical perforation group
Montminy et al,[21] 2023	Retrospective	8/32 patients	Iatrogenic	• 3 endoscopic (2 self expanding metal stent [SEMS], 1 clips) • 4 nonoperative • 1 operative	• 25% mortality • Both within upper esophageal sphincter (UES), both endoscopic ultrasound (EUS) related
Sarr et al,[13] 1982	Retrospective	18/47 patients	Iatrogenic	• 3 nonoperative • 15 operative repair (3 primary repair + drainage, 12 drainage only)	• 1 death in nonoperative group • 0 death in operative group • 1 patient in nonoperative group required later drainage • 4 patients in the operative group developed fistulas and 1 developed abscess

[a] Etiology describes the cause of perforation, including iatrogenic, spontaneous, traumatic, caustic, foreign body related, and malignant. Mixed etiology describes studies with 2 or more etiologies included within the sample size.

Table 2
Endoscopic interventions

Authors	Study Design	# Of Cervical Perforations	Etiology of Perforation[a]	Intervention	Outcomes
Bae,[22] 2019	Case study	1 patient[b]	Spontaneous	Injection of glue	• Resolved
Parapar Alvarez et al,[23] 2023	Retrospective	1 patient	Spontaneous	Endovac therapy	• Resolved • Treatment duration: <3 wk • 4 endovac changes
Loeck et al,[24] 2021	Retrospective	5/10 patients	Iatrogenic	Endovac therapy	• 100% rate of closure • Treatment duration median: 7.6 d • Average of 2 changes per treatment
Kimura et al,[25] 2013	Case study	1 patient	Foreign body	Injection of fibrin glue	• Resolved
Takahashi et al,[26] 2017	Retrospective	1/17 patients	Iatrogenic	Endoscopic clip placement	• Resolved
Freeman et al,[27] 2012	Retrospective	15/187 patients	Mixed	Endoscopic stent	• 4/15 cervical perforation patients failed stent therapy • Cervical perforation has higher rates of stent failure compared to thoracic
Yoon et al,[28] 2015	Case report	1 patient	Foreign body	Endovac therapy	• Resolved
Fischer et al,[29] 2007	Case series	1/4 patients	Malignant	Endoscopic clip placement	• Resolved
Gerke et al,[30] 2007	Case report	1 patient	Iatrogenic	Endoscopic clip placement	• Resolved
Jung et al,[31] 2021	Retrospective analysis	1/7 patients	Iatrogenic	Endovac therapy	• Successful treatment • 12 endovac changes
Kumbhari et al,[32] 2015	Case series	2 patients	Iatrogenic	Fully covered self-expanding metallic stents	• Resolved within 3 d • Had to remain intubated during therapy
Horvath et al,[33] 2018	Retrospective	7/43 patients	Mixed	3 diagnostic endoscopy and medical management, 4 therapeutic endoscopy[c]	• No mortality
Ben-David et al,[34] 2014	Retrospective	2 patients	Iatrogenic	Removable covered stent placement	• Resolved
Anoldo et al,[35] 2017	Case report	1 patient	Iatrogenic	10 d of drainage followed by glue injection	• Resolved
Wasano et al,[36] 2014	Case Report	1 patient	Iatrogenic	Endoscopic suturing using laparoscopic needle driver and knot pusher	• Resolved

[a] Etiology describes the cause of perforation, including iatrogenic, spontaneous, traumatic, caustic, foreign body related, and malignant. Mixed etiology describes studies with 2 or more etiologies included within the sample size.
[b] Patient initially diagnosed with perforation, but prolonged treatment ultimately led to fistula at time of glue.
[c] Therapeutic endoscopy describes interventions using stents, clips, endovacs, or drains.

this period of observation should prompt reimaging and surgical exploration.

Initial conservative management of cervical esophageal perforations has been found to have better success rates compared to thoracic perforations, with a 13% failure rate compared to 62%.[4] One study demonstrated that npo status between injury and diagnosis affects outcomes, as patients who remain npo fare better with conservative measurement.[7]

Mechanism of perforation has also been found to affect outcomes. Though most cases of cervical perforation are iatrogenic in nature, approximately 15% are secondary to penetrating trauma.[15] Several studies have reported improved outcomes associated with early surgical intervention in cases of traumatic cervical esophageal perforation.[7] Thus, it may be prudent to pursue operative intervention in the setting of trauma even if the patients appear stable or have small defects.

Endoscopic management

Significant advances in the field of endoscopy over the years have expanded interventions available to gastroenterologists and surgeons. There are limited data regarding endoscopic management of cervical esophageal perforations relative to intrathoracic perforations.

Esophageal stent placement is the most frequently utilized intervention in cases of intrathoracic esophageal perforation, but stenting in the cervical esophagus is considered relatively contraindicated due to the risk of airway compression and compromise, migration, and patient discomfort.[3,16] However, this technique has been implemented successfully in the literature.[15,17–19] Most perforations are categorized by region rather than by specific measurement, and there are no recommendations on cervical stent placement based on level of perforation. Stenting of proximal cervical perforations spanning the hypopharynx has been described, but patients required intubation to mitigate risk of airway compromise. In these cases, patients remained in the intensive care unit until stents were removed on post-procedure day 3.[19] In contrast, intrathoracic stent management generally occurs over the course of several weeks prior to replacement over removal.[20]

Endoscopic clipping has been successfully used to treat esophageal perforations with success rates of 59% to 83%.[21] Through-the-scope clipping is recommended for defects less than 1 cm, while over-the-scope clipping is recommended for defects 1 to 2 cm.[22] There is no need for clip removal, precluding the need for further intervention after successful treatment.[23] Endoscopic clipping within the cervical esophagus has been described in case studies with successful resolution of perforation.[24–27] An alternative method of primary closure is endoscopic suturing (**Fig. 1**).[6,28] Wasano and colleagues describe endoscopic suture closure of an iatrogenic esophageal injury spanning the pharynx and hypopharynx using a laparoscopic needle holder and knot pusher with complete resolution of the injury.[28] Because these techniques do not offer source control in cases of contamination, they are limited to patients with small defects, good tissue quality, and limited contamination of the cervical soft tissues.[22]

Endoscopic vacuum therapy (EVT), or endovac therapy, is a relatively new technique in the management of esophageal perforations. This intervention is performed by placing a sponge at the tip of a nasogastric tube within the perforation bed and applying negative pressure therapy. This system reduces bacterial contamination while promoting wound healing.[22] The sponge can be placed over the luminal defect or within the cavity itself, allowing for drainage of contamination while facilitating wound closure.[29] The use of EVT is not well described in the cervical esophagus compared to other regions, but successful case reports have been reported in the literature.[29–32] Drawbacks to this therapy include patient discomfort and need for repetitive procedures for sponge change. This therapy can also be limited by proximity to carotid sheath due to bleeding risk.[20,32]

The use of adhesives has been described for the treatment of various esophageal perforations. These include cyanoacrylate glue plugs, polyglycolic acid sheet sealant, and fibrin glue. These measures have been described more frequently for iatrogenic perforations of the middle and lower esophagus, but implementation in the cervical esophagus perforations has only been described in case reports.[24,33–36]

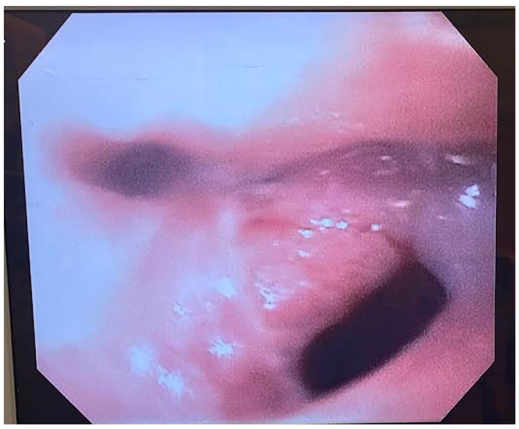

Fig. 1. Cervical esophageal perforation on esophagogastroduodenoscopy (EGD).

Surgical management

Surgical management of cervical esophageal perforations is always warranted in patients with instability, delayed presentation, and significant contamination. Principally, the management of the contaminated space is no different from any other, and the most straightforward intervention is open surgical drainage alone via cervicotomy through the left neck.[6] Perforations that occur in the cervical esophagus are often contained within the prevertebral space, allowing for open operative drainage without extensive dissection and collateral damage to surrounding structures. This has been associated with lower rates of morbidity compared to open drainage of thoracic and abdominal disease, which require access through thoracotomy or laparotomy.[4]

Following opening of the prevertebral space, accurate assessment of the perforation and viability of the surrounding tissue is mandatory. Whenever possible, primary repair should be performed following adequate debridement of nonviable esophageal tissue.[3] The full extent of mucosal injury should be exposed by opening the muscular layers longitudinally cephalad and caudal to the mucosal perforation.[12,37] If primary repair is not feasible secondary to the quality of tissue or the size of the defect, debridement and drainage can be followed by T-tube placement. This technique creates a controlled esophago-cutaneous fistula that can be managed overtime with T-tube removal when the patient's contamination is controlled and nutritional status improves.[14] T-tube placement is typically reserved for critically ill patients, allowing for timely source control.[38]

When primary repair is possible, it is performed by drainage and thorough debridement of the area followed with 2 layer closure. Longitudinal myotomy is again sometimes required to visualize the full extent of the mucosal defect to allow for a complete mucosal repair.[3] Primary repair can be augmented with muscle flap creation for additional reinforcement with vascularized tissue. Addition of a flap has been found to reduce risk of sepsis and accelerate initiation of feeding. Because the cervical esophagus is vulnerable to injuries related to cervical spine hardware or osteophytes, flaps also serve to provide a layer of protection in the prevertebral space.[6] Options for flaps include rotated sternocleidomastoid muscle (SCM), omohyoid, or strap muscles due to their proximity.[4] SCM flaps have demonstrated lower morbidity than other flaps, but patients may develop chronic neck pain or functional deficits secondary to spinal accessory nerve injury.[39] For small perforations, omohyoid flaps may be more appropriate as they are associated with decreased risk of pain.[6,7]

Perforations in the cervical esophagus are often contained, making them amenable to localized drainage. However, in critically ill patients or in cases primary repair cannot be achieved, esophageal diversion can be performed.[14] Diversion in esophageal perforation has a mortality of 23%, much higher than 11% reported in patients who undergo primary repair. However, diversion has been found to have improved outcomes in patients who are critically ill.[40] When performing a diversion, an end esophagostomy is created and externalized through the left neck. While creation of a side esophagostomy has been described, it is not frequently performed due to technical difficulty, habitus limitations, and risk of incomplete diversion.[41,42] After diversion, the remaining esophagus is reduced into the abdomen and the hiatal diaphragm is closed.[2,14] Alternatively, esophageal exclusion is a technique in which the esophagus is stapled distal to the perforation and left in place to heal.[3] Patients can pursue reconstruction 6 to 12 months after diversion.[2,3,14]

Esophageal diversion and exclusion leave the gastrointestinal tract in discontinuity, requiring enteric access for nutrition and decompression. This can be achieved by placement of a gastrostomy or gastrojejunostomy tube. These adjuncts may also be warranted in cases that require prolonged npo status while the space is being decontaminated, as enteral nutrition is preferable to parenteral.[6]

Looking to the Future

The outcomes of esophageal perforations have improved overtime, likely secondary to improvement in perioperative management, diagnostic technology, and surgical technique.[2,43] Management trends have also changed with a decreased rate of surgical diversion and increased rate of primary repair from 2005 to 2020.[2] While there are limited studies describing the effect of endoscopic interventions on esophageal perforation outcomes, development of new technology has certainly broadened the armamentarium of treatment options available to interventionalists. Endoscopic therapy has gained traction to the point that it is now well established in the algorithm for management of intrathoracic perforations. As these data accumulate and stent technology improves, this may translate to increased use in the cervical esophagus. Similarly, endovac therapy is now becoming a frequently employed method of managing intrathoracic perforations and anastomotic leaks following esophagectomy. It may be considerably more tolerable than stents within the cervical esophagus in critically ill patients and may accelerate closure of

defects when combined with drainage of the prevertebral space.

The literature is limited with regard to endoscopic management of cervical perforation at this time. In addition to techniques that have been applied to intrathoracic perforations, there are even more novel and innovative endoscopic techniques do show promise in the treatment of cervical esophageal perforations. For example, the combination of endovac and stent placement, aptly described as the sponge-over-stent technique, has been described in small studies in upper gastrointestinal perforations.[20] While it has been used for postoperative leaks in the cervical esophagus, it has yet to be determined whether this can be applied to patients with cervical perforations.[44,45] Cellular therapies may also yield some advancements in the future as authors have described the injection of emulsified adipose tissue stromal vascular fracture into esophageal fistulas resulting in successful closure of cervical esophageal fistulas.[46] While the need has moved relatively slowly in the arena of cervical perforations, these opportunities offer the possibility of continued progress in patient outcomes after cervical esophageal perforation.[47–50]

SUMMARY

The outcome of esophageal perforations is influenced by time to diagnosis/treatment, location and extent of the perforation, etiology of injury, and patient comorbidities. Unlike other regions of the esophagus, determining best treatment of cervical esophageal perforations is controversial and nuanced. All esophageal perforations warrant hospital admission for monitoring, initiation of broad-spectrum antibiotics, implementation of strict npo status, and provision of early nutrition via enteral or parenteral access. Further management with conservative, endoscopic, or operative measures is chosen based on individual patient factors. In the case of critically ill patients, operative intervention is always warranted to achieve prompt source control. Otherwise, some patients may be appropriately treated with medical or endoscopic management. While conservative and operative management has remained relatively unchanged in the management of cervical esophageal perforations, innovations in endoscopic technology have broadened the treatment options available to this patient population. Endoscopic stents, clips, sutures, endovac therapy, and adhesives have been described in the successful management of cervical esophageal perforations, but continued research is necessary to understand best application of these techniques within this patient population.

CLINICS CARE POINTS

- Prompt diagnosis and initiation of treatment is associated with improved esophageal perforation outcomes.
- Initial management includes admission for careful monitoring and implementation of broad-spectrum antibiotic coverage, nutrition via enteral or parenteral access, intravenous fluid resuscitation, and strict npo status.
- Conservative management can be successful in carefully selected patients without evidence of systematic disease, while hemodynamic instability always warrants prompt surgical intervention.
- Endoscopic techniques have been successfully used to treat cervical esophageal perforations, providing a minimally invasive procedural intervention.
- Endoscopic clips, sutures, and adhesives allow for primary repair.
- Endovac therapy and stent placement provide methods of source control while the defect heals secondarily.
- More research is needed to understand the population of patients who would benefit most from endoscopic intervention.

DISCLOSURE

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