Esophageal Perforation

17

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Esophageal perforations and leaks can be classified as acute or chronic and contained or uncontained. The management is usually dictated by the anatomical location of the perforation. Mortality and morbidity may be reduced by expedient management but is variably reported as between 3 and 67 % [1]. Factors associated with poorer prognosis include mediastinitis, empyema, and sepsis, which occur more frequently with perforation of the thoracic or abdominal esophagus. Outcomes may also be improved by managing these patients at large volume esophageal surgery centers [2].

Etiology

Nearly 60 % of all cases of esophageal perforation are iatrogenic [3]. A smaller percentage occur due to foreign body ingestion (12 %) or traumatic injury (9 %). Table 17.1 describes the causes and clinical findings associated with esophageal perforations of various etiologies. The majority of iatrogenic perforations are the result of therapeutic endoscopic procedures. Those patients undergoing pneumatic dilation for stricture or achalasia appear to be particularly vulnerable. Despite this, overall rate of perforation associated with endoscopy is less than 0.1 % [4]. Other iatrogenic causes of esophageal perforation or leak include surgery (e.g., Heller's myotomy, or Collis gastroplasty leak) and Sengstaken–Blakemore tubes. To reduce the risk of iatrogenic esophageal perforation when using a Sengstaken–Blakemore or Minnesota tube, the gastric balloon should be inflated under fluoroscopic surveillance and using a manometer.

Spontaneous esophageal perforation (Boerhaave's syndrome) results from abrupt increases in intraesophageal pressure. Originally described by Herman Boerhaave in 1724 on post-mortem examination of Baron de Wassenaer, the Grand Admiral of Holland, Boerhaave's syndrome has historically been associated with violent emesis following massive food consumption. However, the gluttonous Baron suffered a fatal esophageal rupture after self-induced vomiting [5].

Traumatic esophageal perforation is rare, but the cervical and thoracic esophagus are susceptible to injury from penetrating trauma. Gunshot wounds may inflict indirect thermal injury missed at initial examination that can subsequently progress to esophageal perforation. Blunt trauma may also cause esophageal disruption. Ingestion of caustic materials, both acidic and alkaline, can result in esophageal perforation, with alkaline fluid often causing more serious injury. Alkalis cause liquefactive necrosis and have a propensity for transmural progression of the injury. Acid ingestion results in a coagulative necrosis but has less potential for esophageal penetration than alkaline ingestion. Acute inflammation and infection may also lead to esophageal perforation, particularly in the immunocompromised patient. Eosinophilic esophagitis has been associated with spontaneous esophageal perforations [6, 7].

Clinical Presentation

The clinical signs and symptoms of esophageal perforation are largely dependent upon the anatomic location of the defect. Patients with cervical esophageal perforations are less likely to have systemic manifestations. When eliciting a history, these patients may describe neck pain, vocal disturbances that are classically described as "nasal" tonality, they may also complain of dysphagia symptoms and notice oral bleeding. On examination, these patients may have crepitus on neck palpation due to subcutaneous emphysema.

Patients with perforations of the thoracic or abdominal esophagus often present with a history of vomiting, chest and/or back pain, dyspnea and may have antecedent dysphagia symptoms. Clusters of clinical symptoms and signs have been described in relation to esophageal perforations and include Mackler's triad which describes a classic presentation of

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Table 17.1 Etiologies of esophageal perforations

Type	Causes	Features
Pyriform sinus	Singing, yelling, trumpet playing, recent endoscopy	Marked mediastinal and cervical subcutaneous emphysema
Anastomotic/Staple line	Leakage at the site of a surgical anastomosis/staple line	History of surgically created esophageal anastomosis
Boerhaave's	Vomiting, straining, retching, weight lifting, hyperemesis causing a full-thickness tear at the gastroesophageal junction	Characteristic longitudinal tear on the left side of the esophagus, typically in the distal 1/3 segment
		Mucosal defect typically longer than muscular defect
Iatrogenic	Endoscopic: Ablation, dilation, sclerotherapy, instrumentation	Recent history of surgery or endoscopy
	Surgical: Esophageal surgery, foregut cyst decortication, spine surgery	
Traumatic	Penetrating or blunt trauma to neck or torso	Strong association with neck hyperextension
Cancer	Perforation of an esophageal tumor	Gas near or abutting the tumor on imaging
	Erosion of surrounding tumor through esophageal wall	
Paraesophageal hernia	Incarceration with necrosis of the distal esophagus	History and imaging demonstrating paraesophageal hernia
		Left sided pleural effusion or fluid associated with hernia
Foreign body	Ingestion of a foreign body (i.e., chicken bone) that becomes lodged	May be associated with underlying esophageal abnormality, e.g. esophageal web or stricture
Esophagitis	Eosinophilic esophagitis Inflammation and erosion of ulceration	Immunocompromised patient
	Zollinger–Ellison syndrome	
	Barrett's ulcer	
	Infection (candida, herpes simplex, viruses, CMV)	
Ingestion	Ingestion of caustic substance	Tetracycline
		Potassium
		Quinidine
		NSAIDS
		Sustained-release formulations
	Drug ingestion/impaction	

CMV cytomegalovirus, *NSAIDS* nonsteroidal anti-inflammatory drugs

spontaneous esophageal rupture: vomiting, lower chest pain, and subcutaneous emphysema. An alternative is the Anderson triad, which may be more applicable to intra-abdominal esophageal perforation and includes: subcutaneous emphysema, rapid respirations, and abdominal rigidity. Intra-abdominal esophageal leaks and perforations commonly cause abdominal pain with signs and symptoms of peritonitis.

Evaluation

Evaluation of the patient with suspected esophageal perforation begins with a detailed history and physical examination. Particular attention should be given to any recent history of esophageal instrumentation, trauma to the neck or torso, quantitative assessment of recent food and liquid consumption, documented or suspected esophageal malignancy (any recent weight loss or dysphagia), or any symptoms of progressing sepsis. Tachycardia, tachypnea, hypotension, and pyrexia should be noted if present. Hemodynamic instability should be immediately addressed with placement of large-bore intravenous catheters and fluid administration. When esophageal perforation is suspected, antero-posterior and lateral upright chest and abdominal radiographs should be obtained without delay. Radiographic findings suspicious for perforation include subcutaneous emphysema, pleural effusions, pneumomediastinum, hydro/pneumothorax, and pleural thickening. Radiographs are particularly useful in the setting of suspected iatrogenic perforation, as they are diagnostic in up to 80 % of these patients. Plain radiographs may help localize the perforation, a right pleural effusion suggests a mid-esophageal perforation, while a left effusion portends a lower esophageal lesion. Despite these clues, the gold standard for diagnosis of esophageal perforation is an esophagogastroduodenoscopy which may be diagnostic and therapeutic.

Esophageal perforations may be investigated by a contrast swallow. The patient should be oriented obliquely relative to the source and remain in a standing, semi-erect position to facilitate detection of small leaks (Figs. 17.1, 17.2, and 17.3). There is a risk of pneumonitis associated with gastrografin aspiration, and angiography contrast agents may be preferable. Barium can complicate future imaging and cause complications from extraluminal leak, therefore is infrequently used. Although useful in the evaluation of suspected esophageal

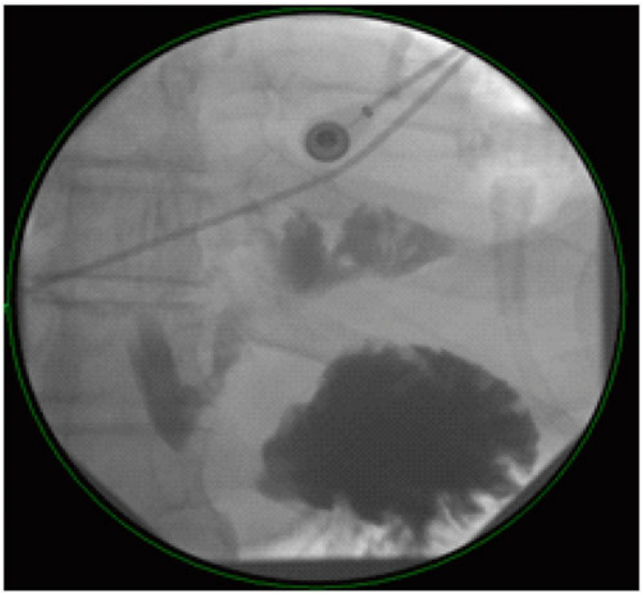

Fig. 17.1 Contrast esophagram of a Boerhaave perforation of the esophagus at the gastroesophageal junction resulting in left pleural contamination

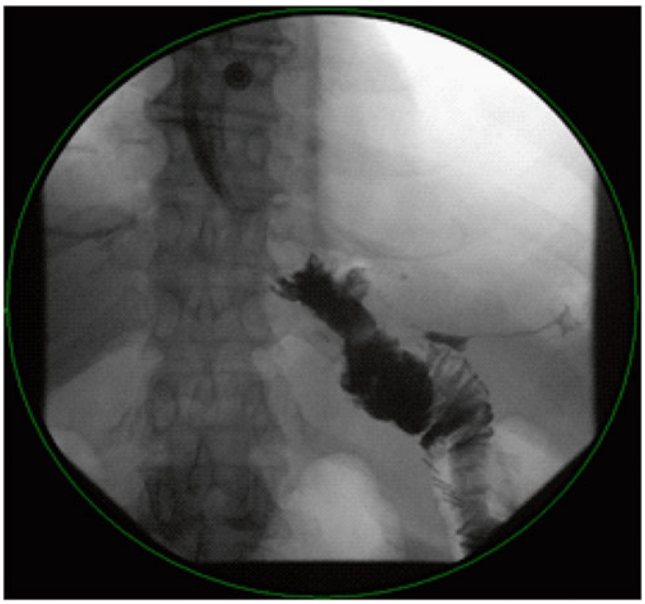

Fig. 17.3 Contrast esophagram of a gastric bypass leak resulting in left pleural and abdominal contamination

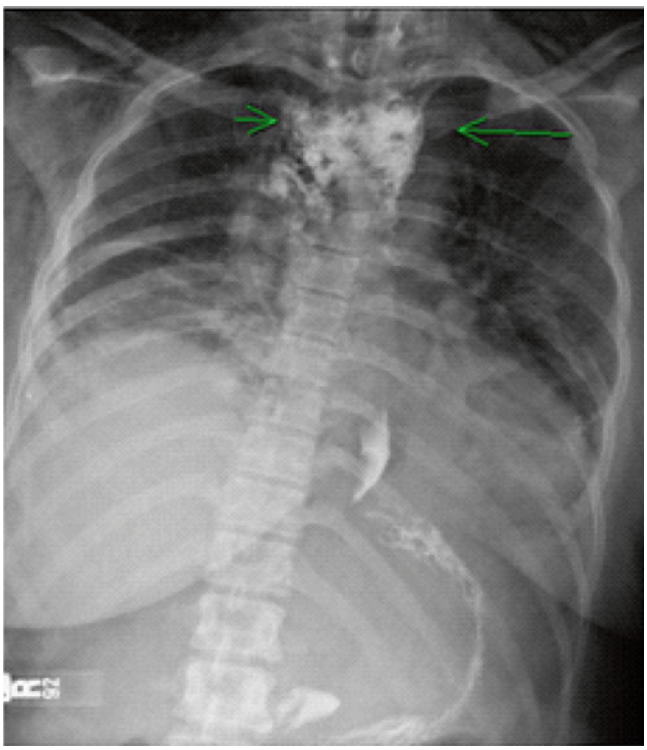

Fig. 17.2 Contrast esophagram of a fish bone perforation of the cervical esophagus resulting in mediastinal contamination

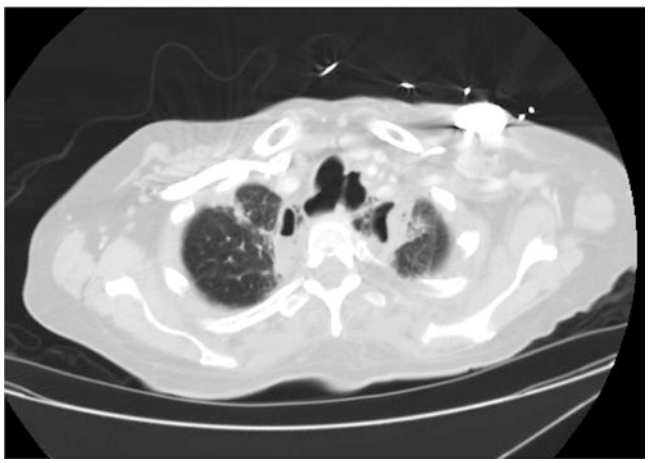

Fig. 17.4 Computed tomography (CT) scan of a tracheo-esophageal fistula after chemotherapy and radiation therapy for esophageal squamous cell carcinoma

perforation, the false negative rate of contrast swallow approaches 30 %. Computed tomography (CT) is useful for cases of suspected perforation with non-diagnostic swallow and gives important additional information regarding empyema or collections (Figs. 17.4 and 17.5). CT is the primary diagnostic modality for intubated patients or those in whom a swallow evaluation is not possible. It is essential to ensure that the endotracheal tube or tracheostomy cuff is inflated prior to contrast administration to prevent aspiration.

Endoscopic assessment of esophageal perforations allows diagnosis, assessment of the mucosa component of the perforation, and can facilitate irrigation and drainage of large perforations prior to intervention. Endoscopic therapy is being increasingly used for definitive management of esophageal perforation in carefully selected patients.

Management

The first successful surgical repair of esophageal perforation was reported in 1944 [8]. Currently surgery is widely considered definitive treatment for esophageal perforations, but the increased use of endoluminal therapy is challenging this perception [9–11]. The goals of any treatment for esophageal perforation are: complete drainage of extraluminal infection, restoration of esophageal integrity to prevent continued contamination, and nutritional support (Fig. 17.6).

Fig. 17.5 CT scan of an intrathoracic anastomotic leak after esophagectomy resulting in left pleural contamination

Surgical treatment of esophageal perforation should drain all contaminated spaces and preserve the esophagus when this is appropriate. Intra-thoracic contamination and empyema necessitate decortication through either a thoracotomy or video-assisted thoracoscopic surgery (VATS) approach when appropriate [12]. Thorough decortication allowing full expansion of the lung will augment healing. Tube thoracostomies with a minimum caliber tube of 32-French should be placed generously to achieve optimum postoperative drainage. Smaller caliber tubes are vulnerable to obstruction and should be avoided.

Cervical esophageal perforations can be accessed via a left oblique neck incision anterior to sternocleidomastoid (Fig. 17.7, #1). In the upper two-thirds of the thoracic esophagus, a right posterolateral (often muscle-sparing) thoracotomy in the fourth or fifth intercostal space is required (Fig. 17.7, #2). If an intercostal muscle flap is planned to buttress the esophageal repair, it should be harvested when the thoracotomy is performed. A muscle-sparing approach is preferred when performing open thoracotomy to preserve chest wall musculature for later surgeries if required, e.g. muscle flaps. Perforations in the lower third of the esophagus are best accessed through a left posterolateral thoracotomy in the sixth or seventh intercostal space (Fig. 17.7, #3). Intra-abdominal esophageal perforations can be approach through laparotomy or through a laparoscopic approach (Fig. 17.7, #4).

Most uncontained esophageal defects, particularly when detected early, are amenable to primary repair. This is done by closing the esophageal mucosa and muscularis in separate

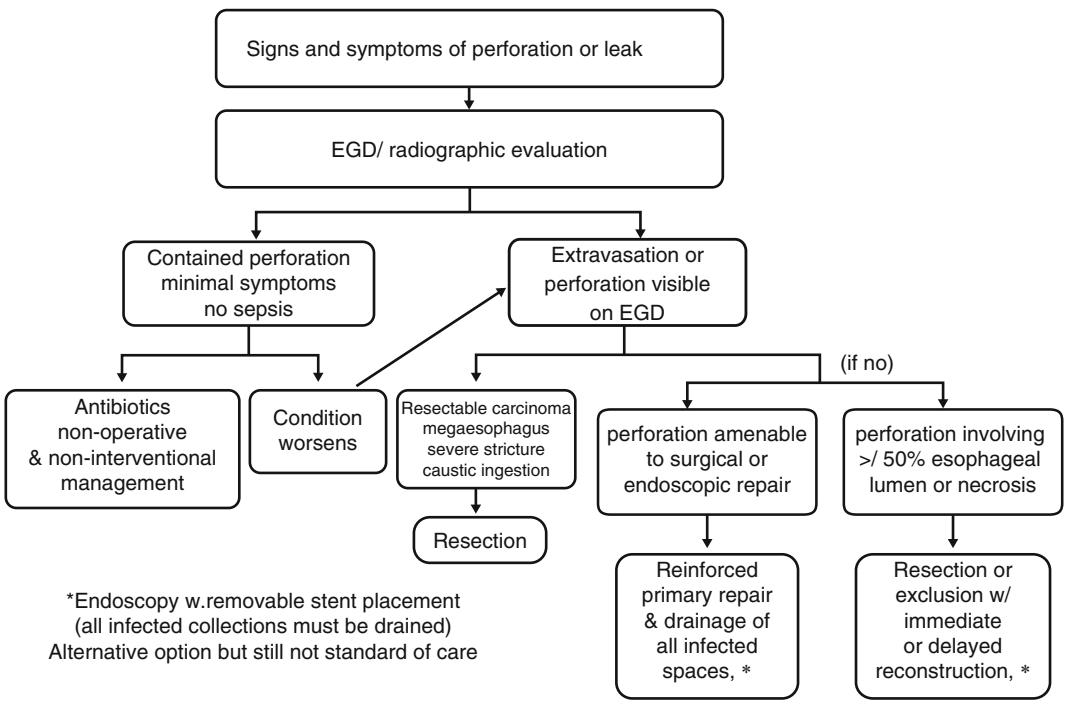

Fig. 17.6 Algorithm for the management of esophageal perforations

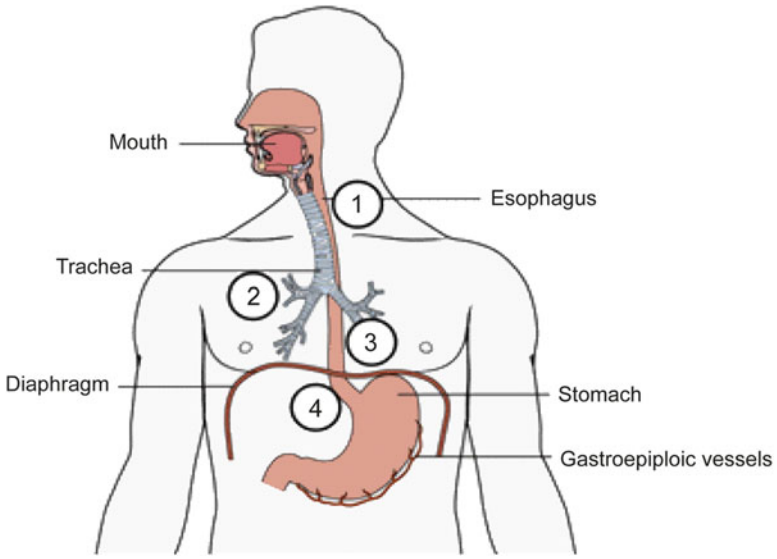

Fig. 17.7 Common locations of esophageal perforation

layers using 3-0 Vicryl or similar absorbable suture. It may be necessary to separate the outer components of the inner circular and outer longitudinal muscle layers in order to gain adequate exposure to the underlying mucosal disruption. The thoracic cavity is then filled with saline and the esophagus insufflated using an endoscope to assess the integrity of the repair, which may be buttressed using a flap. We commonly use a pedicled intercostal muscle flap for this purpose, although the latissimus dorsi, serratus, pericardial fat pad, diaphragm, omentum, or gastric fundus flap are alternate options [13]. The sternocleidomastoid, rhomboid, or pectoralis muscles are available for use in the repair of cervical esophageal perforations; however, these perforations typically heal well with drainage alone. Novel techniques such as fibrin tissue patches can be employed at the time of primary esophageal repair [14].

Defects not suitable for primary repair can be resected or stented. These include perforations involving more than 50 % of the circumference of the esophageal wall, or those longer than 3 cm as they confer an unacceptable risk of stricture formation. Surgical repair may not be suitable for patients with a delayed presentation (>48 h). Alternative management strategies for delayed perforations include hybrid endoscopic and surgical treatment. These include stenting the esophageal perforation in association with surgical placement of a buttressing muscle flap over the perforation, debridement of the contaminated area with wide local drainage. It is important to note that not all patients are suitable for this approach. In this highly selected population the surgeon must monitor to ensure adequate drainage of infected spaces and perforation closure postoperatively. If clinical deterioration occurs with failure of treatment, the surgeon should identify this promptly. In the case of a persistent leak from the esophagus T-tubes can be used to drain perforations deemed irreparable, but they are an unreliable means of ensuring fistula control. Esophagectomy may be performed when the esophagus is unsalvageable and whilst reconstruction may be possible, esophagostomy with a chest wall stoma may be required in some situations. If possible, esophagostomies should be created on the left anterior chest wall just below the clavicle rather than with a neck incision, as this improves the fit and function of the ostomy appliance. High cervical defects with insufficient length for a diverting esophagostomy may require placement of a salivary bypass drainage tube. Placement of a surgical gastrostomy tube should be considered in diverted patients and in those in whom the need for prolonged gastric drainage is anticipated. Care should be taken to considering future reconstruction and the gastrostomy tube placed without injuring the right gastroepiploic artery. A jejunostomy tube offers alternative access for enteral feeding.

Vigilant postoperative monitoring is essential for these patients. Enteral nutritional support is always preferred. These patients should be continued on broad-spectrum antibiotics until they have recovered fully from the current infection. Narrowing the spectrum of antibiotic coverage is recommended once the sensitivities of the offending agent(s) are known. Microbes responsible for infections associated with esophageal perforations include *Staphylococcus*, *Pseudomonas*, *Streptococcus*, and *Bacteroides* and adequate coverage for each of these species should be provided.

Re-perforation following complete healing is rare. Persistence of a leak after what is considered to be otherwise standard therapy should prompt an investigation for the presence of cancer or other impediments to normal wound healing. These include epithelialization, steroids, retained foreign body, poor nutritional status, radiation damage, persistent undrained infection, or distal obstruction. Persistent esophageal

leakage after stent placement may also be due to technical issues with stent placement and these should be actively sought and managed [15]. Patients who develop any symptoms, such as dysphagia, odynophagia, regurgitation, or non-cardiac chest pain following hospital discharge should undergo a contrast swallow evaluation to assess for stricture, which may occur in up to 33 % of patients [16].

Conclusion

Esophageal perforations and leaks are life threatening and the management should be tailored to the individual patient to ensure the best chances of success. The principles of adequate drainage, esophageal repair, nutritional support, and antibiotics remain whether the treatment involves endoscopic therapy, surgery, or a combination thereof.

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