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Endoscopic Management of Benign Esophageal Ruptures and Leaks

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Opinion statement

Esophageal leaks (EL) and ruptures (ER) are rare conditions associated with a high risk of mortality and morbidity. Historically, EL and ER have been surgically treated, but current treatment options also include conservative management and endoscopy. Over the last decades, interventional endoscopy has evolved as an effective and less invasive alternative to primary surgery in these cases. A variety of techniques are currently available to re-establish the continuity of the digestive tract, prevent or treat infection related to the leak/rupture, prevent further contamination, drain potential collections, and provide nutritional support. Endoscopic options include clips, both through the scope (TTS) and over the scope (OTS), stent placement, vacuum therapy, tissue adhesive, and endoscopic suturing techniques. Theoretically, all of these can be used alone or with a multimodality approach. Endoscopic therapy should be combined with medical therapy but also with percutaneous drainage of collections, where present. There is robust evidence suggesting that this change of therapeutic paradigm in the form of endoscopic therapy is associated with improved outcome, better quality of life, and shortened length of hospital stay. Moreover, recent European guidelines on endoscopic management of iatrogenic perforation have strengthened and to some degree regulated and redefined the role of endoscopy

in the management of conditions where there is a breach in the continuity of the GI wall. Certainly, due to the complexity of these conditions and the variety of available treatment options, a multidisciplinary approach is strongly recommended, with close clinical monitoring (by endoscopists, surgeons, and intensive care physicians) and special attention to signs of sepsis, which can lead to the need for urgent surgical management. This review article will critically discuss the literature regarding endoscopic modalities for esophageal leak and perforation management and attempt to place them in perspective for the physician.

Introduction

To better treat ER and EL, it is extremely important to understand the causes and the type of wall defect (site, length, time, and presence of necrosis). This information will serve as a guide in choosing the most appropriate and effective endoscopic approach.

Esophageal rupture (ER) is a full-thickness disruption of the esophageal wall. When a spontaneous esophageal rupture occurs without a pre-existing condition, the condition is also known as Boerhaave's syndrome [1, 2]. Esophageal rupture is a rare condition, with an incidence of 3.1/1,000,000 per year as reported in a recent cohort study [3]. Another retrospective study described an incidence of 31.8 patients/year in the Danish population [4], with a small prevalence in males and a mean age of 60 years.

In the literature reviewed, spontaneous esophageal perforations accounted for 12–33% of patients [3–6] with a diagnosis of esophageal perforation. This condition has a high mortality rate, ranging from 20 to 40% [1, 4, 5, 7].

Esophageal leak is defined as a defect of surgical anastomosis, giving rise to communication between the intra- and extraluminal space [8, 9]. Unfortunately, the literature shows wide variations in the definition of anastomotic leak. Anastomotic esophageal leak is the most common complication of esophageal surgery. Its incidence depends on the type of surgery and can range from 0 to 35% following esophagectomy [10]. However, the incidence is higher in cervical anastomosis than in intrathoracic anastomosis [11, 12], ranging from 12.3 to 13.6% and from 3 to 9.3%, respectively [13–15].

The etiology of benign esophageal rupture can be classified as spontaneous or iatrogenic. Spontaneous esophageal rupture generally occurs in subjects with a normal esophagus but unrecognized underlying pathological conditions such as eosinophilic esophagitis, medication-induced esophagitis, or severe gastroesophageal reflux [16]. Spontaneous rupture is considered a barogenic rupture that results from a rapid increase in intraluminal pressure in the distal esophagus, typically during vomiting. For this reason, the rupture is more often localized in the lower third of the esophagus, in the left posterolateral area [1, 2].

Iatrogenic causes of esophageal rupture are related to endoscopic procedures. Iatrogenic etiology is more frequent than other causes, accounting for 47.6–60% of total esophageal perforations [4, 5, 17].

Among endoscopic procedures, pneumatic dilation for achalasia has an incidence of perforation between 2 and 6% of cases [18, 19]. Another risky endoscopic procedure is stricture dilation, especially in the case of complex strictures or strictures associated with caustic ingestion or radiation therapy [20, 21].

Endoscopic mucosa resection (EMR) and endoscopic submucosal dissection (ESD) may also be associated with a significant risk of esophageal perforation. As shown in two recent meta-analyses [22, 23], the perforation rates are similar in EMR and ESD (less than 3%) and are generally manageable by endoscopic treatment. In these procedures, the ESGE guidelines [24••] recommend an appropriate submucosal lift and carbon dioxide insufflation in order to reduce the risk of perforation and its consequences.

Esophageal perforation has also been reported as a complication of other endoscopic procedures such as per-oral endoscopic esophageal myotomy (POEM) [25, 26], foreign body removal [27], and endoscopic variceal ligation, though these procedures are associated with a much lower incidence of serious adverse events, including perforation.

In the case of purely diagnostic upper endoscopic procedures, the risk of esophageal perforation is extremely low, estimated at around 0.04% of cases, with a slightly increased risk in the case of esophageal diverticula [28, 29]. Ingestion of foreign bodies can cause esophageal perforation by itself, because of prolonged impaction, or by endoscopic extraction.

Anastomotic leak is a significant complication following esophageal surgery that considerably increases postoperative mortality. Messager et al. classified predictive factors for esophageal anastomotic leak in a recent review [12] and divided them into five categories: local, technical, general, tumor predictors, and center volume. The authors also suggested the importance of identifying predictive factors in order to adopt preventive measures and to personalize postoperative surveillance.

Clinical manifestations of esophageal rupture depend on the esophageal segment involved, the size of the perforation, and the time between event and presentation [30]. Early detection is crucial for a better outcome, as it guarantees prompt therapy [31]. However, diagnosis is often difficult because the clinical features may mimic other more common conditions.

In the most common localization, the intrathoracic segment of the esophagus, chest pain is reported in the majority of patients (70%). Typically, the pain is mainly retrosternal, with radiation to the back or to the left shoulder. This may be preceded by episodes of severe retching and vomiting, which, however, occur in only 25% of patients [32]. A third clinical feature of esophageal rupture is subcutaneous emphysema, which, along with pain and vomiting, comprises the Mackler triad [33].

In cervical perforation, patients may report neck pain, dysphagia, and dysphonia [34], and cervical subcutaneous emphysema may be present. Perforations of the abdominal esophageal segment are characterized by acute abdominal or epigastric pain and peritoneal signs [30]. Rarely, gastrointestinal bleeding, including hematemesis, is a manifestation of esophageal perforation. Clinical signs such as tachycardia and fever develop rapidly with mediastinitis; if this is not treated, subsequent multiple organ failure (MOF) may occur.

Iatrogenic perforation due to endoscopic therapeutic procedures may be diagnosed, or at least suspected, by the presence of a "target sign" post-EMR, or by difficult-to-maintain insufflation.

Laboratory findings are not specific for esophageal rupture and may only make a small initial contribution to the diagnostic work-up. However, they are useful for identifying the severity of the condition and monitoring the clinical course.

Chest radiography may reveal indirect signs of esophageal perforation, thus anticipating the diagnosis of a condition that may take several hours to develop [35]. In a retrospective study, Pate et al. [36] showed an abnormal chest radiograph in 97% of patients, though only 27% had findings interpreted as esophageal rupture.

Therefore, in the event of clinical suspicion of esophageal rupture, fluoroscopy with water-soluble contrast medium and CT scan with oral contrast are the best imaging modalities for the diagnosis [36–38]. In addition to a standard fluoroscopic study, the CT scan shows the presence of local complications, if any, such as collection of air or fluid in the mediastinum and pleural effusions [39–41].

The role of endoscopy in the diagnosis of esophageal rupture is limited and controversial, but it has high sensitivity and specificity (100 and 92.4%, respectively) [42].

The clinical manifestations of esophageal leaks are similar to those of ruptures. In leaks, inspection of surgical drains (if present) helps in the early identification of surgical complication. The presence of digestive fluids, saliva-type fluid, and air discharge into drains are signs that are highly suggestive of the presence of a leak. Oral administration of staining solutions such as methylene blue may provide further evidence to the clinical suspicion of anastomotic leak [43].

The imaging modalities for diagnosing anastomotic esophageal leaks are the same used for diagnosis of esophageal rupture. However, the sensitivity of X-ray with contrast and CT scan is less than 50% [44]. Therefore, endoscopic examination becomes crucial to confirm a diagnosis in cases where there are uncertain results [45] and to obtain additional information on local damage such as size, location, and presence of ischemia [46].

Therapeutic Options

The aims of therapy in esophageal rupture and esophageal leak are to re-establish digestive tract continuity, prevent or treat infections, prevent further contamination, drain collections, and provide nutritional support [19, 47, 48]. Three approaches are available to achieve these purposes: conservative

management, endoscopic therapy, and surgery. In order to choose the best treatment option, the clinician should take into account the characteristics of the esophageal wall defect (site, length, time, and presence of necrosis) but also the patient characteristics and associated comorbidities.

Conservative Management

Conservative therapies include intravenous broad-spectrum antibiotics, restriction of oral intake, nasogastric suction, pain control, gastric acid suppression, and hemodynamic monitoring and support. Parenteral nutrition is recommended in undernourished patients or in well-nourished patients who will be unable to be fed via the enteral route for more than 7 days [49]. If collections or abscesses are present, percutaneous drainage is suggested, and a sample of the fluid should be sent for bacteriological analysis.

In the literature reviewed, a number of case series describe patients with esophageal ruptures treated with conservative therapy alone. In the first study, Ivey et al. [50] described three patients with Boerhaave's syndrome successfully managed with non-operative treatment. The authors concluded that conservative management of spontaneous esophageal perforation is feasible under the following conditions: perforation already 5 days old, absence of signs of severe sepsis, esophageal barium study showing a wide-mouthed cavity that drains freely back into the esophagus, and absence of contamination in the pleural space. However, they added that surgical therapy remains the treatment of choice when the diagnosis is made promptly. Similar criteria were used in choosing non-operative treatment in eight patients, as reported by Cameron et al. [51], with 100% success, and by Altorjay et al. [52], as shown in Table 1. Walker et al. [32] reported successful conservative management in only two cases of 14 patients with Boerhaave's syndrome. Smyth et al. [53] described a successful case of a patient managed with total parenteral nutrition.

Abbas et al. [54] conducted a retrospective study in order to establish an esophageal perforation severity score to aid in choosing the best treatment option, using ten clinical variables. In particular, they suggested non-operative management for patients with a lower clinical score (minimal mediastinal

Table 1. Indications for medical treatment of esophageal perforation (ref. Altorjay et al. [52])

I. Intramural perforation
II. Transmural perforation, if all of the following characteristics are present
1. Early detection (<24 h), or when detected late, the perforation is circumscribed
2. Well-encapsulated extravasation in the mediastinum, without pleura involvement
3. Adequate passage of contrast medium from the extra-esophageal space into the esophageal lumen
4. No neoplastic etiology
5. Absence of abdominal cavity involvement
6. Absence of downstream obstructive esophageal disease
7. Symptoms are minimal, and no symptoms and signs of septicemia present
8. Skilled team for clinical and radiological surveillance, and for endoscopic or surgical intervention

contamination and no respiratory compromise).

Semiconservative management is reported in other papers. Vyas [55] described a patient with a 3-day-old esophageal perforation managed with feeding jejunostomy and prokinetic drugs. Santos et al. [56] reported good results obtained with continuous per oral transesophageal irrigation of the mediastinum or, if the patient cannot swallow, irrigation via a nasogastric tube positioned in the upper esophagus proximal to the perforation, combined with draining the irrigating fluid using accurately positioned chest tubes connected to a wall-suctioning system.

In general, conservative treatment is not used alone, due to the high mortality associated with this approach in Boerhaave's syndrome [57, 58]. However, non-operative treatment is the first appropriate management modality for patients with iatrogenic perforation [4, 30].

On the contrary, medical management is the most frequent approach used for esophageal anastomotic leakage, especially for cervical leaks [12]. For example, in the cohort of Sarli et al. [59], 79% of intra-thoracic leakages and 59% of cervical leakages were treated conservatively. This difference could be explained by the higher risk of mediastinitis and sepsis in intrathoracic leaks as opposed to cervical leaks due to anatomical factors.

Surgical Treatment

Surgical management is another option in patients with esophageal rupture. The surgical approach depends on the size of the perforation, the presence of local complications, and the time of diagnosis [34, 60]. The types of intervention reported in the literature include esophageal repair [61], thoracotomy with hemifundoplication [62], and resection and reconstruction [63].

Unfortunately, no randomized controlled studies comparing the different approaches have been carried out. In a recent literature review, Schipper et al. [1] proposed a treatment algorithm for Boerhaave's syndrome. Following their proposal, surgical treatment should be reserved to patients with an early diagnosis of Boerhaave's syndrome (less than 48 h) with sepsis or pleura involvement, or in patients with late diagnosis and failure of conservative treatment. As the same authors reported, several limitations hamper the value of the proposed algorithm, due to the limited literature reporting retrospective case series and expert opinions. Nevertheless, Søreide et al. [30] suggested a similar approach for spontaneous perforation. For instrumental perforation, on the other hand, the authors recommended starting with non-operative management unless the patient's condition deteriorates.

The choice of surgical options for esophageal leak depends mostly on the leakage site and the presence of necrosis. For leaks associated with cervical anastomoses, the most common surgery involves wound opening, curettage of infected, necrotic and granulation tissue, and packing. However, external esophagostomy can be an option in the case of advanced local infection. To treat intrathoracic leaks, the surgical options are primarily anastomotic repair, reinforcement of the anastomosis with viable tissue, and esophageal diversion [64]. With respect to conservative management, the outcomes are comparable in terms of mortality and successful closure [64, 65]. Considering the high mortality and morbidity associated with surgical re-intervention, surgical management of esophageal anastomotic leaks should only be considered in

patients with an uncontained leak and those for whom other approaches have failed [48]. However, also in leakage treatment, evidence supporting one approach over the other is lacking.

Endoscopic Therapy

Endoscopic management remains an extremely valuable option when dealing with esophageal rupture. The use of carbon dioxide insufflation is mandatory during the entire procedure, because the rapid absorption of CO_2 reduces the consequences of insufflation.

Generally, this approach should be combined with percutaneous/surgical drainage of collections and with medical treatments including intravenous broad-spectrum antibiotics, restriction of oral intake, pain control, gastric acid suppression, and hemodynamic monitoring and support.

Timing

Consensus regarding the optimal timing of intervention is still lacking and the existing data are quite conflicting. The duration of the perforation is a factor associated with predicting closure time in the systematic review conducted by Qadeer et al. [7]. On multivariable linear regression analysis, for every 10-day increase in the duration of a perforation, healing time increased by 8 days after endoscopic therapy. On the contrary, the study conducted by Bhatia et al. [6] showed that the timing of closure was not statistically significant for patient outcome.

Endoscopic Options

Clips

Endoscopic clips can be divided into two different categories. The first category is through-the-scope (TTS) clips, which are delivered through the working channel of the flexible endoscope. The second type is the over-the-scope (OTS) clip. This type of clip, recently available, is pre-loaded onto a transparent cap that fits the tip of the endoscope.

a. TTS

One of the endoscopic options for managing esophageal wall defects is the use of TTS clips. The aim of the procedure is to close the breach through clip placement from one extremity to the other (frequently from distal to proximal site). There are many different types of TTS clips, with different characteristics (size, opening length, and the possibility to be rotated and reopened). To date, no comparative human studies have been conducted on the different types to establish the superiority of one type over the other for perforation or leak closure. The choice is therefore based on the characteristics of the defect, device availability, operator experience/preference, and costs [66].

Qadeer et al. [7] performed a pooled analysis including 11 articles for a total of 17 patients with esophageal perforation treated using endoscopic clips. The authors concluded that endoclips may be an effective endoscopic modality to treat both acute and chronic esophageal perforations. However, the study showed that the duration of perforation is a statistically

significant factor for predicting closure time, which is longer for chronic perforations than for acute perforations. The authors also suggested using some form of epithelial ablation/damage prior to endoscopic clip application in chronic perforations in order to stimulate tissue regeneration and facilitate the closure of the breach.
Other recommended maneuvers for improving the success of clip closure are clip placement from the distal end to the proximal border of the defect, positioning an adequate number of clips in a zipper fashion, and gentle suction of air in order to facilitate the capture of more tissue [66].

b. OTS

Over-the-scope clips have been developed to overcome TTS clip limitations such as the ability to capture only a small volume of tissue, the inability to perform a full-thickness closure, and low compression force. The first OTS clip system developed was the OTSC® (Ovesco Endoscopy AG, Tübingen, Germany). The deployment system is similar to a variceal band ligator. The system includes different features/sizes of applicator caps and clips so that the endoscopist can choose the best option for the patient. A grasping or anchoring device can also be used, introduced into the working channel of the endoscope, for better approximation of tissue margins and for retracting more tissue into the cap.
The U.S. Food and Drug Administration (FDA) approved the OTSC® system for closure of luminal defects less than 20 mm in size; however, successful closure of 30-mm defects has also been reported.
A number of animal studies comparing OTS and TTS clips demonstrated the superiority of OTS over TTS clips for closure of defects resulting from natural orifice translumenal endoscopic surgery (NOTES) and colonic perforations [67, 68].
A recent systematic literature review performed by Yilmaz et al. [69] identified four studies [70–73] reporting the use of OTS clips in iatrogenic esophageal perforation, with a total of eight patients. The technical and clinical success rates were 100% for all patients. The authors suggested the use of OTS clips in the case of early detection, perforation diameter ranging from 10 to 20 mm, and absence of fluid collections. Another study showed that OTS clips can also be used to fix esophageal stents in order to prevent stent migration [74].
A new type of over-the-scope clip is the Padlock-G Clip (Aponos Medical Corp., Kingston, NH, USA). As yet, there are no published cases of esophageal perforation treated with this new system. However, Armellini et al. [75] described two patients with fistula (one with bulky mediastinal lymphoma complicated by a broncho-esophageal fistula, the other with tracheoesophageal fistula after laryngectomy followed by radio-chemotherapy), both successfully treated with Padlock clip placement.

Tissue Adhesive

The most commonly utilized tissue adhesives in GI endoscopy are cyanoacrylates and fibrin glue. The application of fibrin glue in the management of esophageal perforation is anecdotal, reported in a number of case reports

and often associated with other treatments [76–78].
The use of tissue adhesive in esophageal leaks and fistulas has been increasingly reported in the literature, though mainly in the form of case reports or limited case series. The successful use of cyanoacrylate in esophagojejunal anastomotic leaks following failed conservative therapy is described in the case report of Pramateftakis et al. [79]. Fibrin glue application has also been shown to be successful in the closure of anastomotic esophageal leaks [80].
The use of fibrin glue combined with endoscopic Vicryl mesh placement has been preliminarily described, showing a high success rate (13 of the 15 patients treated) and no procedure-related mortality [81].

Stent

A number of types of stents are now available that can be used for treating esophageal perforation or leak anastomosis, including partially covered self-expandable metal stents (PCSEMS), fully covered self-expandable metal stents (FCSEMS), self-expandable plastic stents (SEPS), and biodegradable stents. The SEPS is currently the only one approved by FDA.
Stent placement can be performed under fluoroscopic or endoscopic control or both, preferably in patients under deep sedation (Fig. 1).
The choice of a type of stent depends on various factors, such as defect features (location, size of defect, presence of a concomitant stricture), esophageal diameter, operator preference, and device availability [66].
All stents need to be removed or replaced every 2–4 weeks, for a total length of treatment that is highly variable and may range from 2 to 12 weeks. A recent multicenter retrospective study [82•] demonstrated that esophageal stent removal in the setting of benign disease was a safe and feasible procedure, with a low rate of adverse events, which were not related to indwelling time. Moreover, FCSEMSs were more successfully removed than self-expandable plastic stents and PCSEMSs.
In the ESGE guidelines [83••], stent placement is one option in endoscopic treatment of esophageal leaks, fistulas, and perforations. However, the optimal duration of stenting therapy, the timing of stent retrieval, as well as

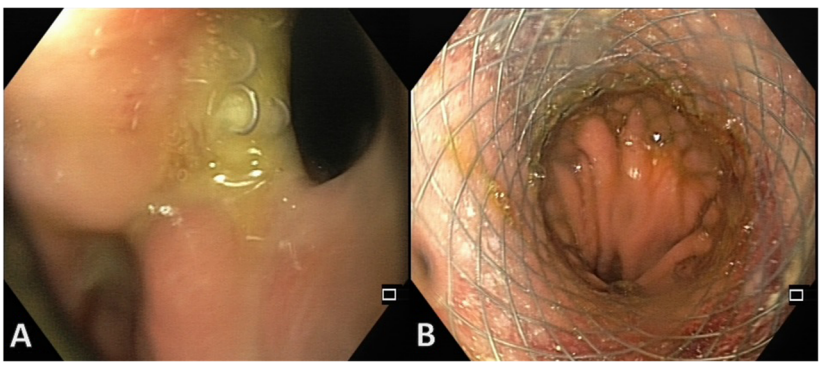

Fig. 1. Endoscopic views of an esophagogastric anastomosis with a leak (**a**), treated with a fully covered self-expandable metal stent (**b**).

the most suitable stent type, are still subject to debate.
Two systematic reviews and one pooled analysis compared the different types of stents for benign rupture or anastomotic leak of the esophagus [84, 85•, 86]. Clinical success rates were similar for plastic and metallic stents (86.2%). However, both reviews indicated that stent migration was statistically significantly higher with plastic than with metallic stents.
The systematic review conducted by van Boeckel et al. [84] did not find a significant difference in outcomes with different types of stents used for the treatment of leaks versus perforations. Data regarding the use of biodegradable stents are limited, and comparative studies with self-expandable stents are still lacking. The study by Cerna et al. [87] reported a case series of five patients with esophageal perforation or anastomotic leak treated with covered biodegradable stents. Technical success was achieved in 100% of patients and clinical success in four out of five patients (80%), with a high stent migration rate (60%). Unfortunately, covered biodegradable stents are still investigational devices and are not yet available on the market.
Three recent studies [88–90•] investigated factors predicting successful primary closure of esophageal defects. According to the retrospective study by El Hajj et al. [88], the factors predictive of successful stenting therapy are a shorter time between diagnosis of esophageal defect and initial stent placement, and a smaller luminal opening size. The factors identified by Freeman et al. [89] that can hamper the success of stenting therapy for esophageal wall defects include location of the defect at the proximal cervical esophagus, stent traversing the gastroesophageal junction, esophageal injury longer than 6 cm, and an anastomotic leak associated with a more distal conduit leak. Moreover, according to the results of Persson et al. [90•], other possible risk factors for the failure of SEMS placement to treat anastomotic leaks include persistent leakage after initial stent placement, the presence of an esophagotracheal fistula postoperatively, and decreased physical performance preoperatively.

Endoscopic Suturing

The only commercially available endoscopic suturing system is the Overstitch system (Overstitch, Apollo Endosurgery, Austin, TX, USA). The device is mounted on the distal tip of the double-channel therapeutic endoscope. In the working channel, devices such as a tissue-retracting helix and grasping forceps can be used to improve tissue approximation and suture placement.
One animal study [91] was performed to compare endoscopic clip closure, endoscopic closure with suturing, and the standard thoracoscopic closure. The results showed similar outcomes for the three groups; however, endoscopic suturing had the smallest number of histological defects in long-term repair.
There are a number of case reports in the literature dealing with endoscopic suturing of esophageal perforation [92–94] and esophageal leak [95], with good healing of the perforation site. Other studies have shown that endoscopic suturing can also be used for esophageal stent fixation in order to prevent stent migration [96, 97•, 98•].

Table 2. Pros and cons of endoscopic modalities to treat esophageal perforations/leaks

Endoscopic procedure	PROS	CONS
TTS clips	Easy availability, use, and management	Limited efficacy No full-thickness closure Often multiple sessions needed Percutaneous drainage of collection needed
OTS clips	Full-thickness closure "One step" procedure	Efficacy only for defect ≤20 mm Percutaneous drainage of collection needed
Tissue adhesive		Lack of data
Stent	Success rate >80%	Expensive Migration rate Often multiple sessions needed Percutaneous drainage of collection needed
Endoscopic suturing	Full-thickness closure	Expensive Lack of data Long learning curve Percutaneous drainage of collection needed
Vacuum therapy	Success rate >80% Drainage of collection in communication with esophageal lumen	Patient discomfort Multiple sessions needed

Vacuum Therapy

Endoscopic vacuum therapy (EVT) uses an open-pore polyurethane sponge (V.A.C. GranuForam, KCI Inc., San Antonio, TX, USA; Endo-SPONGE, B.Braun, Melsungen, Germany) sutured to the distal end of the nasogastric tube. Once the device is positioned in the desired site, the tube, led out transnasally, is connected to a vacuum system applying continuous negative pressure. The sponge can be placed in the intracavitary or intraluminal position [99]. During placement, the use of an overtube is recommended to ensure easy passage of the upper esophageal sphincter [100]. In intracavitary placement, the sponge enters the extraluminal cavity. In this position, the negative pressure allows the collapse of the wound cavity around the sponge in order to induce the formation of granulation tissue, and at the same time, the vacuum suction improves perfusion and removes wound secretions. In

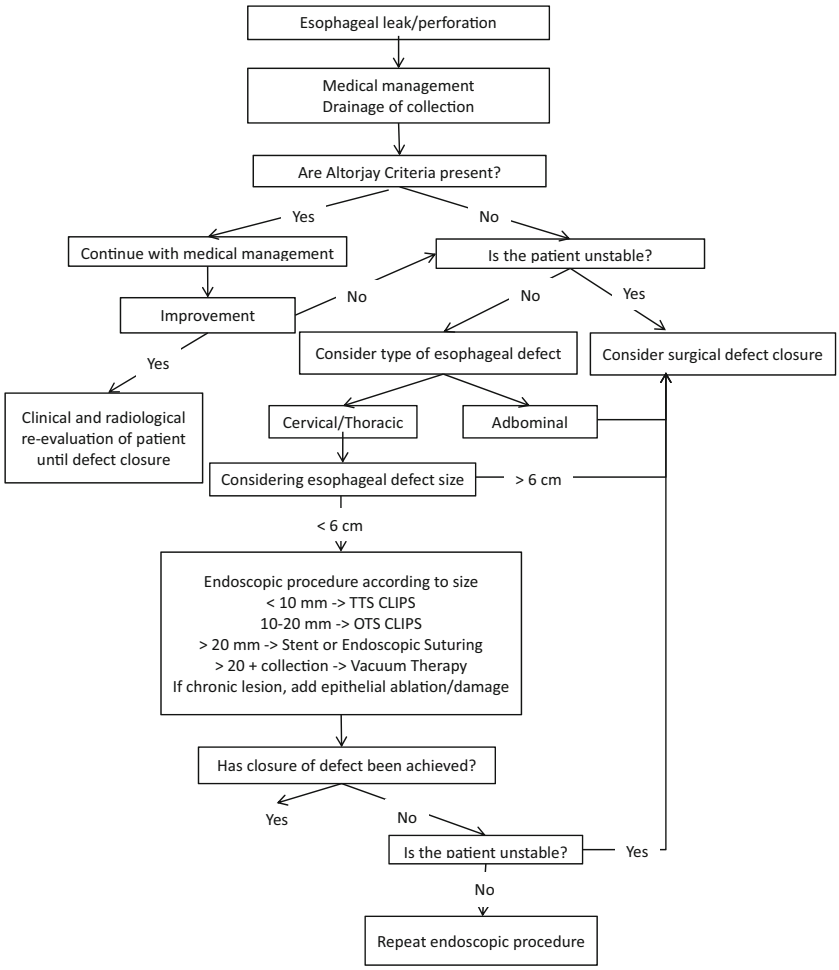

Fig. 2. Flow diagram proposed for treatment of esophageal perforations and leaks.

intracavitary therapy, the sponge is placed into the esophageal lumen above the defect, so periluminal wound secretions are drained thanks to negative pressure. The sponge position can be varied during the treatment depending on the local findings. The sponge needs to be changed after 3–5 days, until complete healing of the esophageal defect is achieved by secondary intention.

In a recent systematic literature search, Kuehn et al. [100] reviewed all the published case studies and case series (with more than five patients) on the application of endoscopic vacuum therapy to treat esophageal defects. For esophageal perforations, the authors identified six studies [101, 102•, 103–106]. The success rate for esophageal perforation ranged from 83 to 100%, with an overall success rate of

96%. The authors also reviewed the cases of 119 patients treated with vacuum therapy for anastomotic leaks as reported in nine studies [101, 102•, 103–105, 107–110], with an overall success rate of 90%, ranging from 83 to 100%.

Four of these studies compared vacuum therapy to stent placement in esophageal anastomotic leak treatment. With the limitation of retrospective analysis, all the studies concluded that there were better outcomes for vacuum therapy in terms of mortality [109], closure rate [108, 111, 112], and complication rate [108].

Conclusion

Esophageal rupture and esophageal anastomotic leak are rare events, but their life-threatening nature imposes careful evaluation. Early recognition and diagnosis are mandatory in order to reduce morbidity and mortality. The presence of a dedicated multidisciplinary team is strongly advised for the management of these conditions. Endoscopic therapy is an emerging modality associated with favorable outcomes and low complication rates. The choice of endoscopic treatment modality depends on different factors, including the location and size of the esophageal wall defect (Table 2 and Fig. 2). In particular, the use of through-the-scope clips is recommended for small defects (less than 1 cm), while over-the-scope clips can be applied in larger perforations up to 20 mm. In larger defects, stent placement should be considered. Other modalities such as vacuum therapy and tissue adhesives are available, though their role has not yet been completely defined.

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Author Contribution

All authors drafted the manuscript, contributed to the revision, and approved the final version.

Compliance with Ethical Standards

Conflict of Interest

Milena Di Leo, Roberta Maselli, Elisa Chiara Ferrara, Laura Poliani, Sameer Al Awadhi, and Alessandro Repici declare that they have 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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- • Of importance
- •• Of major importance

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