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Endoscopic vacuum therapy of anastomotic leakage and iatrogenic perforation in the esophagus

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Abstract
Background The management of anastomotic leakage and iatrogenic esophageal perforation has shifted over recent decades from aggressive surgery to conservative and, recently, endoscopic therapy alternatives. The authors present their results for endoscopic vacuum therapy used to treat both entities.
Methods In the authors' institution, 17 cases of anastomotic leakage and 7 cases of iatrogenic perforation due to interventional endoscopy or rigid panendoscopy with either intraluminal or intracavitary endoscopic vacuum therapy were treated.
Results In 23 of 24 cases, the endoscopic treatment was successful. The median duration of therapy was 11 days (range, 4–46 days). All 7 cases of iatrogenic perforation and 16 of 17 anastomotic leakage cases were cured after a median therapy duration of 5 and 12 days, respectively.
Conclusions Endoscopic vacuum therapy is applicable for a wide range of esophageal defects. In the authors' experience, it has seemed to be the best choice for iatrogenic perforations and has been a potent supplement in the management of anastomotic leakages.

Keywords Anastomotic leakage · Anastomosis · Perforation · Esophageal · Esophagus · Endoscopy · Vacuum therapy · Complication

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Esophageal perforation currently is more than 60 % iatrogenic, mainly due to rigid, flexible, and interventional endoscopy [1, 2]. Anastomotic leakage after esophagectomy and esophagogastrectomy still is a major threat with high mortality rates [2–4].

The treatment of esophageal leakages is challenging regardless of their origin. The aim of any therapeutical strategy is closure of the defect and effective drainage of the septic paraesophageal and mediastinal focus. Early detection of the defect, uncompromised tissue perfusion, small defect size, absence of sepsis, and immediate therapy are described as favorable factors [5].

Therapy itself ranges from aggressive surgical intervention, thoracotomy and intrathoracic primary repair, reconstruction of anastomosis, esophagectomy, and cervical esophagostomy to conservative treatment with placement of chest drains and gastrointestinal tubes as well as prolonged parenteral nutrition [6, 7]. A variety of innovative endoscopic methods for defect closure have been introduced in recent years including endoscopic clip, suture, stents, and specialized drainage systems [8, 9].

We have adapted endoscopic techniques of vacuum therapy to close and simultaneously drain intestinal defects at several locations within the gastrointestinal tract [10, 11]. Our work is based on decades of experience using vacuum sponge devices to treat surface wounds and on the work of Weidenhagen et al. [12] in establishing a vacuum drainage device to treat anastomotic insufficiencies after rectal resections.

Since 2006, we have treated esophageal leakages with endoscopic vacuum therapy. In this report, we present our results using endoscopic vacuum therapy for esophageal defects, with a focus on the management of anastomotic leakage ($n = 17$) and iatrogenic perforation ($n = 7$).

Methods

An open-pore polyurethane sponge (Endo-SPONGE® B. Braun Medical; Melsungen, Germany) is fixed by suture at the distal end of a gastric tube (Ventrol™, 14 Ch × 120; Mallinchrodt Medical, Athlone, Ireland). The sponge tip is trimmed to the desired shape, fixed to the distal end of a polyp grabber–equipped endoscope, and placed under complete visualization according to the therapy method. We use carbon dioxide (CO_2) insufflation during interventional endoscopy. The vacuum drainage is kept in position by applying a continuous negative pressure of 125 mmHg, created and controlled by an electronic vacuum device (V.A.C. Freedom®; KCI USA Inc., St. Antonio, TX, USA). The evacuating tube is diverted transnasally.

To remove the vacuum drainage, it is gently pulled after discontinuation of the applied negative pressure. A new drainage is placed using the described technique. The therapy is terminated if stable granulation tissue forms a contamination barrier, and the wound is self-cleaning controlled by follow-up endoscopy. We distinguish between intracavitary and intraluminal vacuum therapy.

Intracavitary vacuum therapy

The sponge tip trimmed to minimal size is placed through an intestinal defect into the extraluminal cavity. In case of a small defect, we currently first use a nasal endoscope to inspect the paraesophageal cavity. If necessary, the defect is widened to allow passage of the standard endoscope, examination of the extraluminal septic focus, and placement of the sponge drainage. During therapy, the wound cavity collapses around the vacuum-applied sponge drainage, and the intestinal defect is sealed, in principle allowing oral nutrition (Fig. 1).

Intraluminal vacuum therapy

The sponge tip is cylindrically shaped and long enough to cover the esophageal defect completely. The sponge drainage is placed intraluminally onto the defect. Secretion is drained endoluminally, and the continuous suction force results in temporary complete occlusion of the intestinal passage. Enteral nutrition is possible via an enteral feeding tube or percutaneous endoscopic gastrostomy (Fig. 2).

Whenever an extraluminal wound cavity large enough for a small sponge drainage is found, we prefer the intracavitary variant. Typically, anastomotic defects may lead to such an extraluminal wound formation. In the absence of an extraluminal wound cavity (e.g., with early diagnosis of a transmural defect such as a segmental tearing of the esophageal wall after balloon dilation), we use intraluminal sponge drainage covering the whole defect zone.

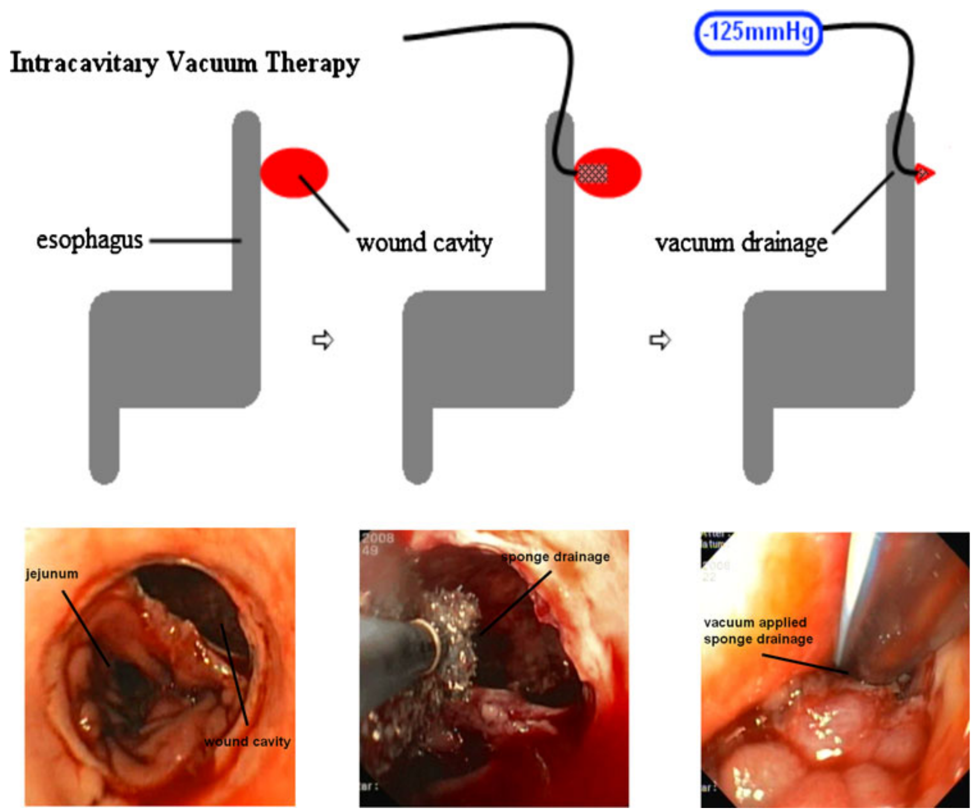

Fig. 1 Intracavitary vacuum therapy

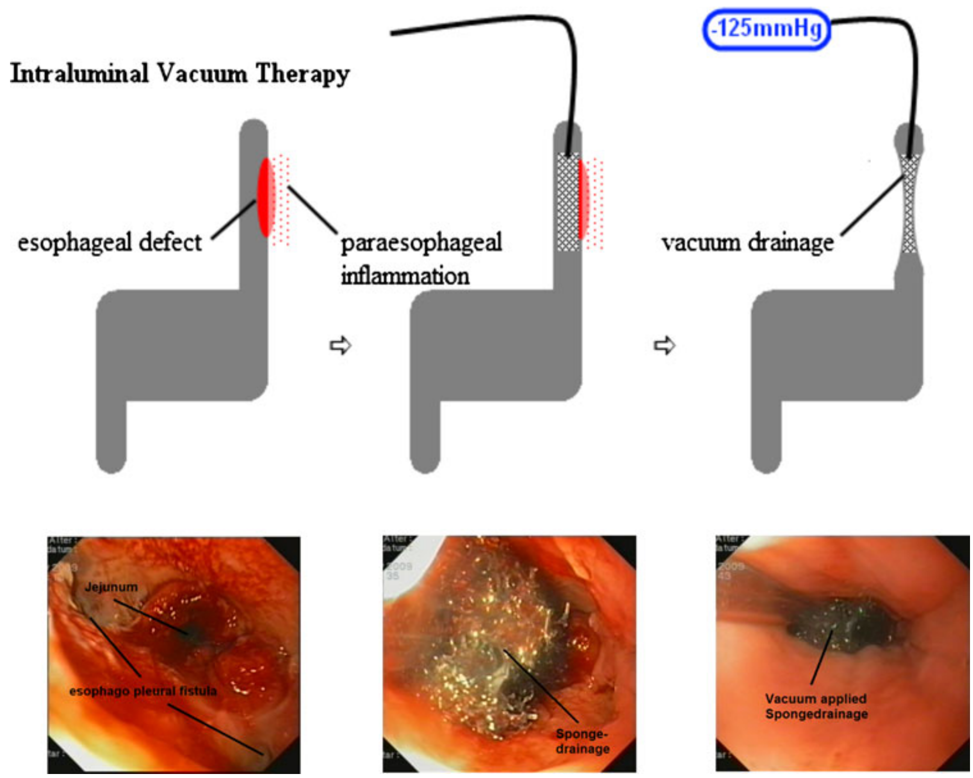

Fig. 2 Intracavitary vacuum therapy

Patients

From November 2006 to December 2011, we used endoscopic vacuum therapy in 24 cases of anastomotic insufficiencies or iatrogenic esophageal perforation. The cases involved 7 women and 17 men ages 45–84 years. The defect sizes ranged from small perforations to complete circular ruptures at any esophageal height.

On the one hand, 17 of 24 cases were anastomotic insufficiencies after gastral or esophgageal resection. One of these had an additional stent-related perforation of the gastric sleeve, hereafter referred to as group A (Table 1). On the other hand, we managed seven cases with esophageal perforation after rigid or flexible endoscopy, hereafter referred to as group B (Table 1).

Table 1 Origin of defect: groups A and B

Origin of defect	Cases (*n*)	Group
Thoracoabdominal esophagogastrectomy	7	A (anastomotic leakage)
Transhiatal esophagogastrectomy	5	
Gastrectomy	5	
Rigid diagnostic endoscopy	2	B (iatrogenic perforation)
Rigid endoscopic bougie dilation	1	
Diagnostic flexible endoscopy	1	
Balloon dilation	2	
Meat bolus extraction	1	

Results

In 21 patients, the perforation was found by endoscopy, whereas one case was detected by conventional contrast imaging, one case by contrast-enhanced computed tomography, and one case during relaparotomy. Endoscopic examination evaluated the esophageal defects with respect to size of the defect, distance to the dental arch, signs of local inflammation, and degree of perfusion.

The median time until the diagnosis of anastomotic leakage was 10 postoperative days (range, 4–36 postoperative days), whereas iatrogenic perforations were diagnosed on postintervention day 1 (range, 0–4 postintervention days). In all cases, endoscopic vacuum therapy was initiated immediately after diagnosis.

The esophageal defects were located 15–40 cm distal to the dental arch, and the defect size ranged from 5 mm to complete anastomotic rupture. As shown in Table 2, the location and size of the defects were similar in groups A (anastomotic leakage) and B (iatrogenic perforation) (Table 2).

Treatment of the 17 patients in group A involved dilation of the defect in one-third of the cases. Approximately

Table 2 Medical data vacuum therapy: groups A and B

Distance to dental arch (cm)	Defect size (mm)	Defect dilated to (mm) or not dilated (x)	IL or IC vacuum therapy
Group A (anastomotic leakage) (*n* = 17)			
16	15	x	IL
22	20	x	IL/IC
25	10	x	IL
25	5	x	IL
25	15	x	IC
30	5	15	IL
35	40	x	IL
35	10	x	IL
35	20	x	IC/IL
35	5	15	IL/IC
37	10	20	IC
37	5	15	IC
38	10	15	IC
38	10	20	IC
38	30	x	IC
38	25	x	IC
40	15	x	IL
Group B (iatrogenic perforation) (*n* = 7)			
15	30	x	IC/IL
15	10	x	IL
15	15	x	IL
30	10	x	IL
35	10	x	IC
37	5	x	IL
40	10	x	IL

Adjacent tissue perfusion was uncompromised in 23 cases; one patient after esophagectomy presented with ischemia of the gastric tube

IL intraluminal, *IC* intracavitary

one-half were treated using either intraluminal or intracavitary vacuum therapy. For three of these patients, we used both methods in the course of treatment. In group B, it was not necessary to dilate any defect, and the predominant method was intraluminal therapy. Only one patient received intracavitary vacuum therapy, and one patient was treated with both therapeutic alternatives (Table 2).

Altogether, 19 patients had an extraluminal wound cavity, which was examined through the esophageal defect. No unintended enlargement of esophageal defects occurred during endoscopic examination and therapy. Six cases were complicated by esophagopleural fistula formation and three cases by esophago-abdominal fistulas. Mediastinitis was seen in nine patients, and septic illness developed in ten patients. Whereas an extraluminal wound cavity was found in all the group A patients, it was found in only two group B patients. Likewise, group A had eight cases of mediastinitis and nine cases of septic illness, whereas group B had only one case of mediastinitis and septic illness.

Table 3 Overview of results

	Patients (*n*)	Success *n* (%)	Duration of therapy (days) Median (range)
Overall	24	23 (95)	11 (4–46)
Group A (anastomotic leakage)	17	16 (94)	12 (4–78)
Group B (iatrogenic perforation)	7	7 (100)	5 (4–7)

In seven group A cases (anastomotic leakage), we placed thoracic drainage in the course of treatment, whereas no patient in group B (iatrogenic perforation) received an additional chest tube. In only one case, we first attempted surgical repair of the chronic anastomotic defect using suture and muscle flap. The surgical intervention proved unsuccessful, and healing of the recurrent leakage was achieved by endoscopic vacuum therapy.

Overall, the median duration of therapy was 11 days (range 4–46 days), with two vacuum drainage placements (range 1–12 placements) and a change interval of 3 days (range 1–7 days). Of 24 patients, 23 (95 %) were completely healed.

Of the 17 patients in group A with postoperative anastomotic leakage, 16 (94 %) experienced healing of the esophageal defects after a median therapy duration of 12 days. All seven patients (100 %) in group B (iatrogenic perforation after rigid or flexible endoscopy) were cured after therapy for a median of 5 days (Table 3).

One patient with recurrence of esophageal carcinoma after radiochemotherapy presented with anastomotic insufficiency based on the ischemic gastric tube. Endoscopic vacuum therapy was used in this case as a bridging therapy to control the septic focus. The patient died during revision thoracotomy.

In all the patients, we observed distinct improvement of the wound aspect at the first system change. Necrosis was rejected, and granulation tissue developed. In ten cases, the condition of the inner wound allowed termination of vacuum therapy after the first interval. Intraluminal vacuum therapy comprises erosions in which the polyurethane sponge has contact with healthy esophageal epithelia. This erosion pattern subsides completely within 48 h.

Follow-up endoscopy was possible in 18 of 24 cases 8–380 days after therapy (average, ~3 months [94 days]). One case of esophageal stenosis after circular anastomotic insufficiency was managed by endoscopic balloon dilation.

Discussion

We use endoscopy as a first-line diagnostic procedure. If necessary, we combine endoscopic diagnostic procedure with computed tomography initially to search for an extraluminal septic focus and secondarily as a monitoring device to ensure that the septic focus is drained completely by the applied therapy. This diagnostic proceeding is indicated for both anastomotic leakage and iatrogenic perforation.

Anastomotic leakage after esophagectomy develops days after initial surgery. Infection spreads more easily after the complex trauma of preceding surgery. In addition, clinical symptoms and laboratory findings in case of anastomotic leakage can be very variable. In contrast, iatrogenic perforation is mainly detected during the examination or intervention that caused the perforation or at a control endoscopy 1 day later [6].

Development of mediastinitis and sepsis occurred in half of the group A patients, whereas it occurred in only one of the seven patients in group B. This might be explained by the short period between esophageal leakage and adequate therapy in group B, thus preventing further mediastinal contamination.

Leakage after surgical repair of esophageal perforation is reported in more than 50 % of cases [13]. Experimental studies have shown leakage and consecutive mediastinitis after endoscopic suture or clip procedures even in optimized settings [14].

Esophageal leakage imperatively leads to an infection of the adjacent tissue. Thus, primary closure techniques (over-the-scope clip and endoscopic suture procedures) can be applied only if the defect is detected very early or sufficient external drainage and debridement of the inner wound is performed beforehand to prevent extraluminal abscess formation. Also, these procedures are restricted to smaller defects.

The successful treatment of esophageal defects with implantation of self-expanding stents is reported frequently. The location of the defects is a distinct limitation of the method because stent placement in the cervical esophagus is not feasible and can be very difficult at the gastroesophageal junction because of the lumen incongruity. One patient with anastomotic insufficiency transferred from an external hospital presented with secondary perforation of the gastric tube at the distal end of the implanted stent. Both defects were treated successfully with vacuum therapy after stent removal.

Endoscopic vacuum therapy comprises efficient closure and drainage of esophageal defects. The luminal subatmospheric pressure communicated through the open pore polyurethane sponge seals the defect and drains the extraluminal septic focus. It counteracts the physiologic negative thoracic pressure, thereby preventing further contamination and mediastinitis. Thus, in principle, it can be used for early detected, clean wounds to prevent contamination and extraluminal inflammation. It also is applicable for advanced stages of esophageal leakage.

Vacuum drainage placement is feasible in the whole length of the esophagus. Using the appropriate variant, a broad range of possible defect sizes and paraesophageal wound cavities can be adequately treated.

Continuous negative pressure sufficiently high is obligatory for vacuum therapy to fix the vacuum drainage in its intended position. We exclusively use electronically controlled vacuum devices to secure permanent negative pressure (KCI Freedom settings: high intensity, continuous, −125 mmHg).

The most important precondition for successful endoscopic vacuum therapy is uncompromised local perfusion. Tissue ischemia requires full-scale surgical revision, and vacuum therapy can be only a supplement in the perioperative management.

A hypothetical risk for erosion bleeding derives from case reports of such incidences in external application of vacuum therapy [15]. We never saw such a bleed in any of our patients with esophageal defects. In more than 1,000 endoscopic vacuum drainage procedures overall, we have seen one bleed after pancreatic resection treating a gastropancreatic leakage with endoscopic vacuum therapy.

A main advantage of endoscopic vacuum therapy is visualization of the inner wound at every system change. Yet, in the intervals, close laboratory and clinical monitoring and short-notice radiologic imaging is essential to detect treatment failures.

Our results regarding iatrogenic perforation mirror the general good results of these defects described in the recent literature with various procedures [6]. The advantages of our minimally invasive endoscopic method lie in the short median therapy duration and the effective prevention of further contamination.

A far more heterogeneous patient population in the literature and in our case material experiences anastomotic leakage. All our patients (group A) experienced a paraesophageal wound cavity, and eight cases were complicated by esophagopleural or esophagoabdominal fistula formation. Overall, we were able to heal 94 % of these patients. The therapy duration in this group ranged from 4 to 46 days. The median duration of 12 days and the two endoscopic system changes can be attributed to a minimally invasive procedure, but the few patients with up to 12 endoscopic system changes and a therapy duration of up to 46 days experienced an impact comparable with full-scale surgery [16].

Endoscopic vacuum therapy with its two variants of intraluminal and intracavitary sponge placement is applicable for nearly all possible esophageal leakages. In our experience, it seems to be the best choice for iatrogenic perforations and is a potent supplement in the management of anastomotic leakages.

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Conflict of interest Tobias Schorsch has no conflicts of interest or financial ties to disclose.

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