Background and Aims: GI perforations, leaks, and fistulas are types of full-thickness mural defects that frequently occur as adverse events from GI surgeries such as esophagectomy for malignancy and bariatric surgery. Historically, treatment has entailed a combination of reoperation, percutaneous drainage, and bowel rest. Recently, there has been a changing paradigm in the management of these defects. Endoscopic interventions, including endoclipping and placement of self-expanding metal stents (SEMSs), have been increasingly used with good success. Despite this, some defects remain refractory to these techniques. Endoscopic vacuum-assisted closure (EVAC) is a new, promising endoscopic approach to repairing these defects. EVAC works through applying continuous, controlled negative pressure at the defect with the use of an endoscopically placed polyurethane sponge connected to an electronic vacuum device. EVAC has been shown to be feasible, safe, and effective.

Methods: We present a video series of 3 cases demonstrating the successful application of EVAC for the treatment of anastomotic leakage after esophagectomy and of fistula formation after bariatric surgery.

Results: Two patients experienced anastomotic leakage after esophagectomy for esophageal adenocarcinoma, and 1 patient experienced a chronic gastric fistula after Roux-en-Y gastric bypass. The gastric bypass patient’s fistula failed to resolve with over-the-scope-clip placement, and all 3 patients’ defects did not heal despite SEMS placement; therefore, EVAC was performed. The bariatric surgery patient required 9 sponge exchanges over 35 days, and the 2 esophagectomy patients each required 3 sponge exchanges over 13 days. All 3 patients had resolution of their defects with EVAC. No adverse events occurred, and all patients have had no recurrence for several months.

Conclusions: These cases help to highlight the feasibility, safety, and efficacy of EVAC for the closure of full-thickness GI defects. On the basis of our experience, the use of EVAC should be considered for these complex and refractory cases. (Gastrointest Endosc 2019;4:40-4.)
controlled, continuous negative pressure. The endoscope is then carefully removed, ensuring no dislodgement of the vacuum sponge/nasogastric tube complex. The sponge is then exchanged every 3 to 5 days until healing of the defect.

**CASE REPORTS**

**Patient 1**

An 82-year-old man with a history of stage IIIA esophageal adenocarcinoma, who had undergone neoadjuvant concurrent chemotherapy and radiation followed by a robot-assisted Ivor-Lewis esophagectomy, was subsequently found to have a distal esophageal perforation on an esophagram after experiencing a febrile episode postoperatively.

Our service was consulted for attempted endoscopic management. EGD showed a 2- to 3-cm linear esophageal perforation in the esophagus (Fig. 3), which was treated with fully covered SEMS placement. Despite this procedure, the patient continued to show radiologic and clinical signs of persistent leakage.

Repeated EGD revealed that the pre-existing esophageal SEMS appeared to be positioned appropriately; however, a large amount of purulent secretions could be drawn into the lumen with suction from within the stent. Therefore, a persistent leak was suspected, and an additional fully covered SEMS was deployed within the pre-existing stent. Despite this additional esophageal stent placement, the leak did not resolve; therefore, EVAC was performed as described above.

The sponge was subsequently exchanged 3 times over the next 12 days. EGD performed 15 days after initial sponge placement showed apparent resolution of the leak (Fig. 4), with a tiny persistent depression at the site, and the sponge was not replaced.

An esophagram confirmed no active leak. The patient has not had symptoms of recurrent leak for over 1 month.
Patient 2

A 60-year-old man with esophageal adenocarcinoma who had undergone neoadjuvant concurrent chemotheraphy and radiation followed by a robot-assisted Ivor-Lewis esophagectomy was subsequently found to have evidence of an anastomotic leak postoperatively.

Our service was consulted for attempted endoscopic management. EGD showed a 1-cm defect at the site of the surgical anastomosis (Fig. 5), which was treated with fully covered esophageal SEMS placement. Unfortunately, the patient showed continued radiologic and clinical signs of persistent leakage despite this intervention.

Repeated EGD revealed that the stent had migrated out of position. The migrated stent was removed, and a new fully covered SEMS was deployed. The proximal end was sutured into place in an attempt to prevent recurrent migration. However, despite repeated SEMS placement, there was persistent anastomotic leakage.

EVAC was then performed as previously described. The sponge was exchanged 3 times over the next 13 days. EGD performed 19 days after the initial sponge placement showed apparent resolution of the leak (Fig. 6), and this was confirmed with an esophagram. The patient has not had symptoms of recurrent leak for over 4 months.

Patient 3

A 67-year-old woman was referred for further management of persistent leakage from a gastroesophageal-junction fistula. She had undergone a vertical banded gastroplasty in 1983, which had required revision to a Roux-en-Y gastric bypass in 2003.

The patient subsequently experienced a gastric fistula in early 2016 and underwent exploratory laparotomy, subtotal gastrectomy, and attempted closure of the fistula at the referring institution. The fistula failed to resolve despite these measures, and she was referred to our institution.

EGD revealed a 2-mm fistulous tract opening surrounded by apparent scar tissue just proximal to the gastroesophageal junction (Fig. 7). For attempted closure, the tissue surrounding the defect was treated with argon plasma coagulation, and an over-the-scope clip (OTSC) was successfully placed over the defect. There was persistent leakage despite OTSC placement, and she
subsequently twice underwent fully covered esophageal SEMS placement for attempted closure. Despite initial improvement with SEMS placement, the fistula continued to leak.

Because the fistula failed to resolve despite OTSC and SEMS placement, EVAC was performed as previously described. The sponge was exchanged 9 times over the next 35 days. EGD 40 days after initial sponge placement showed replacement of the previous fistulous opening with healthy-appearing granulation tissue (Fig. 8). No evidence of persistent leak was seen endoscopically, and this was confirmed with an esophagram. The patient has not had symptoms of recurrent fistula formation for over 3 months.

**DISCUSSION**

EVAC works through applying continuous, controlled negative pressure at the defect with the use of an endoscopically placed polyurethane sponge connected to an electronic vacuum device (Fig. 9). EVAC uses the main principles of negative pressure wound therapy. Continuous suction and drainage decrease bacterial contamination and local edema while promoting perfusion and granulation tissue formation. The sponge complex can be placed in either an intraluminal or an intracavitary manner, both with successful results.

In our patient series, all sponges were placed intraluminally because of the relatively small size of the defects, the ease and feasibility of intraluminal placement, and the presence of indwelling percutaneous drains, which would have made intracavitary placement less beneficial.

EVAC has been shown to be feasible, safe, and effective. The first endoscopic use of negative pressure wound therapy was described by Weidenhagen et al in 2004, followed by a case series of 29 patients treated with EVAC for anastomotic leakage after rectal resection. Since that time, the technique has been increasingly used in Germany for various full-thickness GI defects, with its adoption in the United States and Asia thereafter.

In 2015, the first case series on the use of EVAC for upper-GI defects was published in the United States. In that series, 6 patients were treated with EVAC for esophageal and gastric perforations, with successful closure in all patients.

In 2017, Kuehn et al reviewed all case series reporting the use of EVAC for the treatment of upper-GI defects published between 2007 and 2016. In that review, they found 210 patients treated with EVAC for esophageal defects, with an overall success rate of 90%, a median duration of therapy of 17 days (range, 11-36 days), and a total follow-up period of 235 days (range, 106-383 days). Our experience found similar results, with a 100% success rate and a median duration of therapy of 20 days.

This case series highlights some of the potential applications of EVAC for various upper-GI full-thickness defects. Despite the increasing use of EVAC and publication in the
surgical literature, there remains a paucity of articles in the GI literature regarding its utility and safety, and this video will help increase awareness regarding this promising technique. In all 3 cases, EVAC was successfully implemented after failure of endoclipping, SEMS placement, or both. On the basis of our experience, EVAC is a safe and efficacious therapy that can be used for these complex and refractory cases.

DISCLOSURE

All authors disclosed no financial relationships relevant to this publication.

Abbreviations: EVAC, endoscopic vacuum-assisted closure; OTSC, over-the-scope clip; SEMS, self-expanding metal stent

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