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Treatment of Esophageal Perforation: Endoscopic Vacuum-Assisted Closure

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Abstract: Surgical repair of type C esophageal atresia (EA) with distal tracheoesophageal fistula (TEF) is complicated by an anastomotic leak in 10%–30% of cases with associated morbidity. A novel procedure in the pediatric population, endoscopic vacuum-assisted closure (EVAC), accelerates the healing of esophageal leaks by using the effects of VAC therapy, including fluid removal and stimulation of granulation tissue formation. We report 2 additional cases of chronic esophageal leak treated with EVAC in EA patients. The first is a patient with a previously repaired type C EA/TEF and left congenital diaphragmatic hernia complicated by an infected diaphragmatic hernia patch erosion into the esophagus and colon. Additionally, we discuss a second case using EVAC for early anastomotic leak following type C EA/TEF repair in a patient who was later found to have a distal congenital esophageal stricture.

Key Words: tracheoesophageal fistula, anastomosis, pediatrics, sponge, hernia

Esophageal leaks and perforations are potentially life-threatening complications. Endoscopic vacuum-assisted closure (EVAC) is a novel endoscopic procedure that facilitates more rapid healing of esophageal perforations than traditional drainage methods such as esophageal stenting or observation (1,2). EVAC takes advantage of VAC therapy's fluid removal and facilitated healing. By placing a sponge spanning the esophageal perforation, suction removes potential infection and edema while secondarily promoting blood flow and granulation tissue formation (3). By adapting VAC therapy to the esophagus, perforations can heal more quickly with potentially better outcomes than the traditional therapies. Here, we describe 2 complex pediatric patients with esophageal leaks treated with EVAC and their outcomes.

CASE REPORTS

Our first patient was a 3-year-old male with a complex history of type C esophageal atresia (EA) with a distal tracheoesophageal fistula (TEF). He underwent left congenital diaphragmatic hernia (CDH) repair in a staged fashion during infancy, complicated by multiple recurrent diaphragmatic hernias. He presented to our institution with esophageal and colonic perforations related to diaphragmatic Gore-Tex patch erosion. The infected patch was surgically removed, the affected colon resected, and a V.A.C. GRANUFOAM Dressing (sponge, 3M-KCl, San Antonio, TX) was inserted across the chronically eroded esophageal perforation during recurrent CDH repair. Chronic inflammation and fibrosis rendered the esophageal tissue unamenable to surgical repair. EVAC was chosen because of its superior drainage and decompression properties. A 15-French round BLAKE Drain (Blake drain, Ethicon US, Raritan, NJ) was placed as a chest tube for extensive washout of the empyema related to patch erosion into the esophagus and colon. An Olympus GIF-XP180N neonatal endoscope (external diameter 5.9 mm) was used to visualize the sizeable esophageal perforation (Fig. 1A, B). The endoscope was then advanced into the stomach. The gastrostomy button was removed, and the biopsy forceps were advanced out of the gastrocutaneous fistula. The 15-French round Jackson-Pratt Wound Drain (JP drain, Cardinal Health, Dublin, OH) was grasped and pulled retrogradely through the stomach, esophagus, and mouth. A 6 cm length, cylinder-shaped sponge was placed over the JP drain (Fig. 2A). The sponge was secured to the drain at the top and bottom ends with 0-silk ties. A 2-0 Prolene tie was placed through the end and tied in a loop to be grasped later to aid in removal (Fig. 2B). The sponge was soaked in radiopaque contrast and lubricating jelly, pulled antegrade through the mouth, down the esophagus, and carefully placed across the esophageal perforation under endoscopic and fluoroscopic guidance (Fig. 2C). The suction pressure was set to 125 mm Hg, and contrast was injected into the esophagus above the sponge to test the integrity of the vacuum suction. The sponge was endoscopically replaced 3 times on days 7, 14, and 25 and removed on day 32 after no esophageal leak was present (Fig. 3A), and the perforation had healed well (Fig. 1C). At 1-year follow-up, endoscopy revealed a healed esophagus with a slight residual diverticulum related to a chronic gastroesophageal junction stricture; the balloon was dilated to 12 mm (Fig. 3B).

Our second patient was a 16-day-old male born at 39 weeks gestation with type C EA/TEF that was repaired thoracoscopically. Postoperatively, he developed an esophageal leak that did not improve after a week of drainage and decompression with chest and nasogastric tubes. Esophagoscopy revealed a 1–2 mm perforation at the anastomosis. An endoluminal vacuum sponge was soaked in radiopaque contrast, secured to a 10-French round JP drain, and advanced through the mouth into the esophagus to the level of the leak using fluoroscopic and endoscopic guidance. An endotracheal tube-stylette was used to stiffen the JP drain and facilitate placement. The sponge was pushed into the proper position using a rigid esophagoscope and connected to vacuum suction. Contrast injection into the upper esophagus confirmed appropriate suction into the device. This allowed the healing of the leak in approximately 9 days, followed by the removal of the sponge. Endoscopic contrast esophagram demonstrated no leak. The patient was advanced to full oral feeds before discharge.

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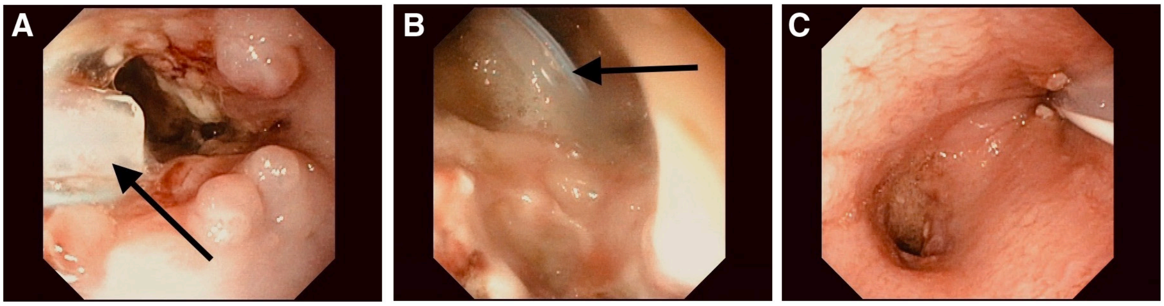

FIGURE 1. A and B) Two views of the indwelling chest tube (arrow) are seen through the esophagoscope erroneously near the esophageal perforation. This chest tube was removed and replaced with a shorter tube that would not protrude into the esophageal lumen. The endoscope forceps were used to grasp the new chest tube and maneuver it into an ideal position with direct visualization of the chest cavity (not pictured). C) Esophageal perforation, 1 week after EVAC treatment. Esophageal perforation was visualized on the left, and the NGT on the right. EVAC = endoscopic vacuum-assisted closure; NGT = nasogastric tube.

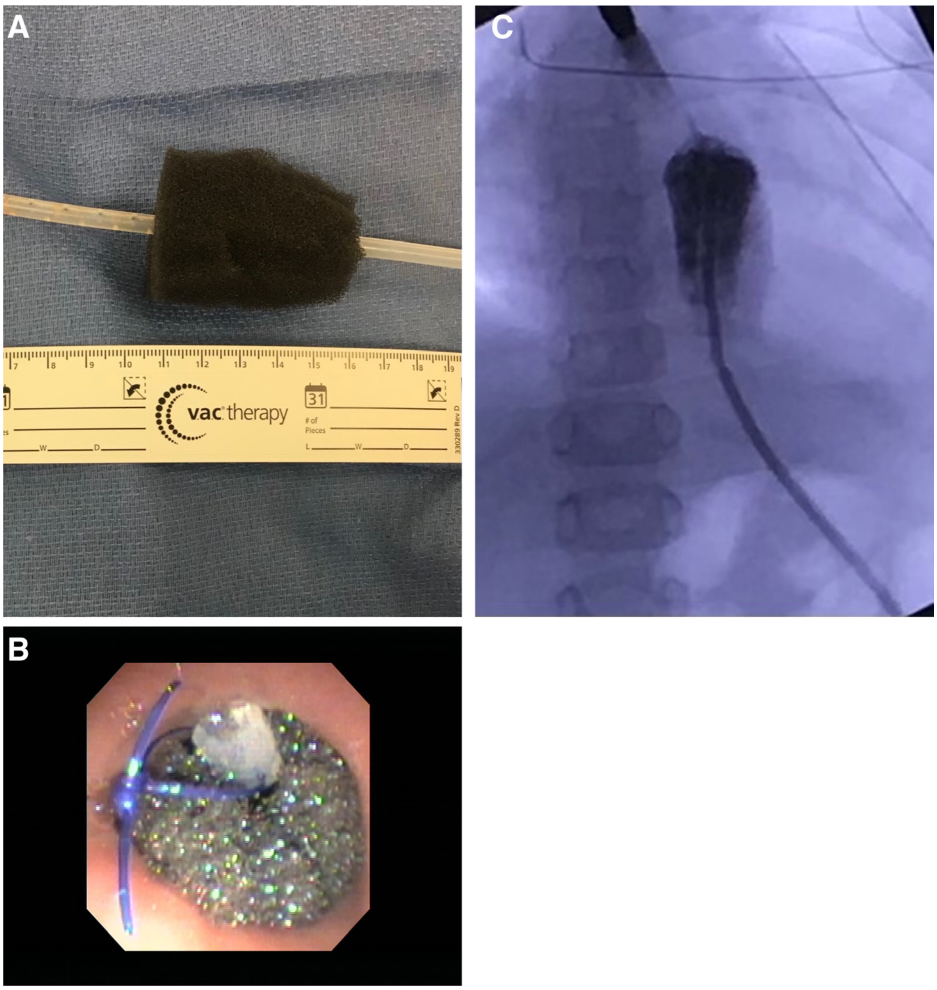

FIGURE 2. A) Vacuum sponge has been cut to size to cover the anastomotic leak. B) Proximal portion of vacuum sponge with a 2-0 Prolene tie (see article) placed to aid in endoscopic sponge removal. C) Fluoroscopy is used to position the vacuum sponge and JP drain apparatus across the esophageal perforation.

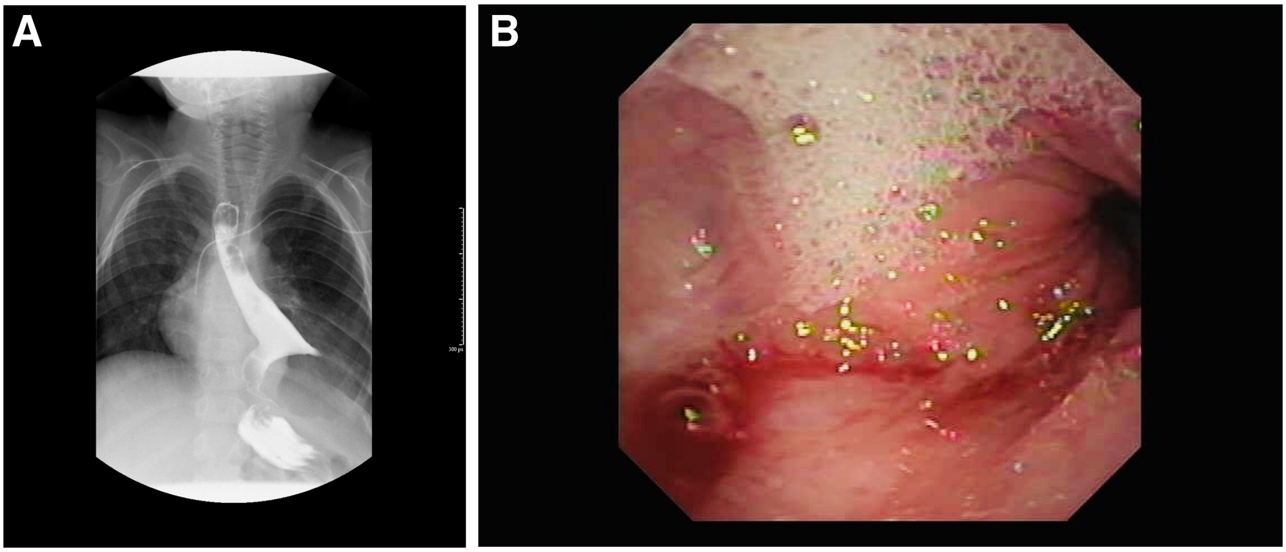

FIGURE 3. A) Contrast esophagram 1 month after starting EVAC therapy showing a left-lateral outpouching from thoracic scar tissue but no esophageal leakage. B) Healed esophageal perforation 1 year later with persistent diverticulum. EVAC = endoscopic vacuum-assisted closure.

Subsequent findings revealed a distal congenital esophageal stricture treated with serial dilations. The anastomotic site healed well without stricture formation.

DISCUSSION

Type C EA/TEF is a congenital anomaly that requires surgical repair and is complicated by an anastomotic leak in up to 30% of patients. Anastomotic leaks can develop into sepsis; thus, expeditious drainage and source control are essential to reduce morbidity and mortality. As demonstrated in our first case, esophageal leaks can originate from sources other than surgical anastomosis, such as erosions secondary to an infected Gore-Tex patch. Long-term esophageal anastomotic issues, such as chronic leaks, have been associated with developing esophageal strictures and recurrent TEF (4). Alternatives to surgical repair of an anastomotic leak include drainage and decompression, diversion, and stenting (1,5).

A novel procedure in the pediatric population, EVAC, uses the effects of VAC therapy, including fluid removal and stimulation of granulation tissue formation to accelerate the healing of esophageal leaks. As outlined in similar literature, EVAC placement is performed using a vacuum sponge cut to fit the dimensions of the patient's specific esophageal perforation and attached to a JP drain (6). Other studies have shown success with thin open-pore drainage films fashioned around a single-lumen 8 Fr suction catheter independently or followed by advancing to a polyurethane sponge dependent on the size of the esophageal lumen (7). The sponge is secured to the tube at either end using silk ties. A 2-0 Prolene tie is threaded through the end and fashioned as a retrieval loop. The sponge is lubricated, soaked in contrast, inserted through the mouth or an existing gastrostomy site, and connected to suction. As opposed to previous literature, we demonstrate that sponge placement can be achieved either retrograde through a current gastrostomy site or anterograde through the mouth using an endotracheal tube-stylette to assist in placement (6). The sponge is positioned across the esophageal perforation under fluoroscopic and endoscopic guidance. After suction is turned on, contrast injection into the esophagus ensures that the apparatus functions correctly. Suction strength and frequency are chosen based on the patient's response and the development of intolerable secretions (6,8). Previous literature states that the sponge should be removed every 4–7 days, after which the perforation status is re-evaluated for leakage (8). If required, a new sponge is placed across the residual leak site until the perforation heals completely. Another case series hypothesized that less frequent exchanges along with lower suction values could result in the failure of esophageal perforation closure (7). Our cases provide examples of successful closure of esophageal perforations with sponge exchanges at days 7, 8, and 11 using 125 mm Hg suction pressure. This difference in exchange rate further proves that a patient-specific approach should be taken when assessing each case.

Our patients represent unique examples of potential applications of EVAC therapy: one with a chronic leak related to recurrent CDH patch erosion and the other with an early anastomotic leak with a distal congenital stricture. In both the instances, EVAC was performed in line with the previously published methodology due to potentially better outcomes for pediatric patients than traditional methods (8). Our case report adds to the current literature highlighting the positive outcomes of using a patient-specific approach to EVAC of esophageal leaks. Careful consideration of retrograde versus anterograde approach of sponge placement, vacuum pressure settings, and frequency and number of sponge changes resulted in complete resolution of esophageal leaks without complication in both pediatric patients.

CONCLUSION

We describe 2 EA patients with esophageal perforation who were successfully treated with EVAC and the first with a chronic leak related to an infected CDH patch erosion into the esophagus and colon. EVAC uses the effects of VAC therapy, including fluid removal and granulation tissue stimulation, to promote more rapid healing than traditional methods.

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This statement confirms that informed consent was obtained from the parents of both patients for the publication of this work.

REFERENCES

1. Manfredi MA, Jennings RW, Anjum MW, et al. Externally removable stents in the treatment of benign recalcitrant strictures and esophageal perforations in pediatric patients with esophageal atresia. *Gastrointest Endosc*. 2014;80:246–252.
2. Cameron JL, Keiffer RF, Hendrix TR, et al. Selective nonoperative management of contained intrathoracic esophageal disruptions. *Ann Thorac Surg*. 1979;27:404–408.
3. Huang C, Leavitt T, Bayer LR, et al. Effect of negative pressure wound therapy on wound healing. *Curr Probl Surg*. 2014;51:301–331.
4. Smithers CJ, Hamilton TE, Manfredi MA, et al. Categorization and repair of recurrent and acquired tracheoesophageal fistulae occurring after esophageal atresia repair. *J Pediatr Surg*. 2017;52:424–430.
5. Nirula R. Esophageal perforation. *Surg Clin North Am*. 2014;94:35–41.
6. Glait M, Wong J, Krasaelap A, et al. Esophageal wound vacuum placement for anastomotic leak: lessons learned from first time use at a tertiary care center. *JPGN Reports*. 2021;2:e114.
7. Kaczmarek DJ, Heling DJ, Strassburg CP, et al. Management of esophageal perforations in infants by endoscopic vacuum therapy: a single center case series. *BMC Gastroenterol*. 2022;22:282.
8. Manfredi MA, Clark SJ, Staffa SJ, et al. Endoscopic esophageal vacuum therapy: a novel therapy for esophageal perforations in pediatric patients. *J Pediatr Gastroenterol Nutr*. 2018;67:706–712.