Original Article

Esophageal stenting with minimally-invasive surgical intervention for delayed spontaneous esophageal perforation

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Background: Spontaneous esophageal perforation is a challenging surgical emergency with significant morbidity and mortality, and timely primary repair carries good outcomes. However, direct repair for a delayed spontaneous esophageal perforation is not always feasible and is associated with high mortality. Esophageal stenting can provide therapeutic benefits in the management of esophageal perforations. In this study, we review our experience with placing esophageal stents in combination with minimally-invasive surgical drainage to treat delayed spontaneous esophageal perforations.

Methods: We retrospectively analyzed patients with delayed spontaneous esophageal perforations between September 2018 and March 2021. All patients were treated using a hybrid approach, including esophageal stenting across the gastroesophageal junction (GEJ) to reduce continued contamination, gastric decompression with extraluminal sutures to prevent stent migration, early enteral nutrition, and aggressive minimally-invasive thoracoscopic debridement and drainage of infected material.

Results: There were 5 patients with delayed spontaneous esophageal perforation treated with this hybrid approach. The mean duration between symptoms and diagnosis was 5 days, and the interval between symptoms and esophageal stent insertion was 7 days. The median time to oral nutrition and to esophageal stent removal was 43 and 66 days. There was no stent migration or hospital mortality. Three patients (60%) had postoperative complications. All patients were successfully resumed on oral nutrition with esophageal preservation.

Conclusions: A hybrid approach combining endoscopic esophageal stent placement with extraluminal sutures to prevent stent migration, thoracoscopic decortication with chest tube drainage, gastric decompression, and jejunostomy tube placement for early nutrition was feasible and effective in the treatment of delayed spontaneous esophageal perforations. This technique offers a less invasive treatment approach for a challenging clinical problem which has traditionally carried a high rate of morbidity and mortality.

Keywords: Esophageal stenting; esophageal perforation; delayed esophageal perforation; spontaneous esophageal perforation

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Introduction

Spontaneous esophageal perforation, also known as Boerhaave's Syndrome, most commonly occurs as a full-thickness tear along the left aspect of the distal intrathoracic esophagus near the gastroesophageal junction (GEJ). Esophageal perforation is a surgical emergency with a high morbidity and mortality. Timely primary repair within 24-hour after symptom onset carries good outcomes (1,2). However, delayed diagnosis and treatment of esophageal perforation is not uncommon and can lead to high mortality due to ongoing mediastinal contamination (2-4). Direct repair to prevent continued leakage from the esophagus is not always feasible due to severe tissue necrosis.

Esophageal stenting can provide therapeutic benefits in the management of benign and malignant esophageal diseases (5,6). Several studies have shown the safety and efficacy of stent placement in the treatment of esophageal strictures, including self-expanding plastic (SEPS) and metal stents (SEMS) (4-15). Fully covered self-expanding metal stents (FCSEMS) are preferable over partially covered self-expanding metal stents (PCSEMS) in benign esophageal perforation due to less complications from tissue ingrowth and better coverage of the perforated area (5,12). However, benign lesions, distal esophageal perforation, and FCSEMS are risk factors for stent migration which may result in severe complications (13,16-18).

Highlight box

Key findings

- Esophageal stenting with minimally-invasive surgical intervention was feasible and effective for delayed spontaneous esophageal perforation, a challenging clinical problem which has traditionally carried a high rate of morbidity and mortality.

What is known and what is new?

- Delayed spontaneous esophageal perforation can lead to high mortality. Primary repair is the standard surgical approach but it is not always feasible. Currently, there is no consensus for the management of delayed spontaneous esophageal perforations.
- Endoscopic esophageal stent placement with extraluminal sutures to prevent stent migration, thoracic decortication with chest tube drainage, gastric decompression, and jejunostomy tube placement for early nutrition was feasible and effective in the treatment of delayed spontaneous esophageal perforation.

What is the implication, and what should change now?

- This technique offers a less invasive treatment approach for a challenging clinical problem which has traditionally carried a high rate of morbidity and mortality.

In this study, we review our experience utilizing a hybrid approach combining endoscopic esophageal stent placement with extraluminal sutures to prevent stent migration and minimally invasive surgical drainage to treat delayed spontaneous esophageal perforations. We present the following article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1316/rc).

Methods

Patients

This retrospective, observational study enrolled all patients referred to the thoracic surgery service for delayed spontaneous esophageal perforation at Chang Gung Memorial Hospital (Linkou, Taoyuan) between September 2018 and March 2021. Delayed spontaneous esophageal perforation was defined as an interval between initial symptoms and a confirmed perforation of more than 24 hours. All patients with recent upper endoscopy, esophageal instrumentation, recent intrathoracic or upper abdominal surgery, or perforation associated with esophageal malignancy, achalasia, or paraesophageal hernia were excluded. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional review board of Chang Gung Memorial Hospital (No. 202100306B0) and informed consent was waived for this retrospective study.

The diagnosis of an esophageal perforation was documented on esophagram with water soluble contrast which showed the extravasation of oral contrast identifying the location of the perforation (*Figure 1*). The Pittsburgh perforation severity score (PSS) was used to classify the esophageal perforation (19). The PSS was determined according to the following scale: 1= age >75 years, tachycardia, leukocytosis, or pleural effusion; 2= fever >38.5 ℃, non-contained leak, respiratory compromise, or time to diagnosis >24 hours; and 3= presence of cancer or hypotension. Low PSS, intermediate PSS and high PSS groups were defined as PSS <2, PSS 3–5, and PSS >5, respectively. All patients underwent computed tomography imaging from the neck to the abdomen to evaluate for contamination of the mediastinum, pleural cavity, or peritoneal cavity (*Figure 2*).

Surgery

All procedures were done in the operating room under

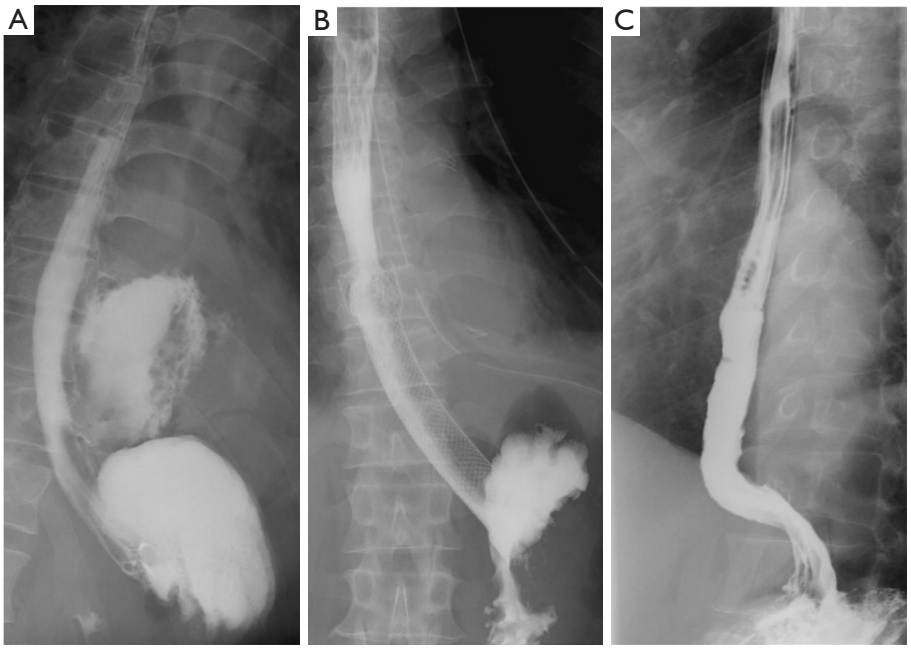

Figure 1 Esophagogram showing (A) a distal esophageal perforation at initial diagnosis, (B) no leak from the esophageal perforation after esophageal stent placement, and (C) a healed esophageal perforation after stent removal.

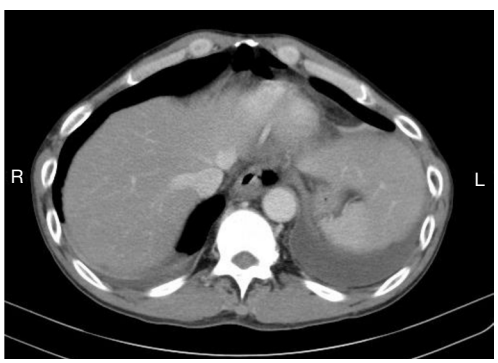

Figure 2 CT imaging showing pneumomediastinum and bilateral pleural effusions consistent with an esophageal perforation. CT, computed tomography.

general anesthesia. The contaminated area was adequately drained by video-assisted thoracic surgery (VATS) in order to achieve optimal infection control. The patient was first placed in a lateral position, and single lung ventilation was accomplished using a double-lumen endotracheal tube. VATS decortication was performed through two ports. The working port was placed in the 5th intercostal space in the mid axillary line. The camera port was inserted in the 7th or 8th intercostal space. Once the pleural cavity was entered, all pleural effusion, pus, debris and fibrinous tissue were evacuated. Pneumonolysis was done to separate all adherent lung from the pleural surface. The esophageal perforation site was then evaluated under VATS, including the size and location of the perforation as well as the viability of the surrounding tissues (*Figure 3*). The visceral pleural peel was removed using ring forceps or a curette to prevent entrapment of the lung. At the end of the procedure, we copiously irrigated the pleural cavity with saline. Chest tubes were placed adjacent to the perforation and at a dependent site to achieve adequate drainage and prevent the accumulation of infected material.

The patient was positioned supine for the second portion of the procedure. Flexible esophagoscopy was performed to characterize the location and extent of the esophageal perforation. We avoided esophageal stent placement in the presence of obvious circumferential esophageal necrosis or a long perforation unable to be covered by a single stent. The size of the esophageal stent was chosen according to the diameter of the esophagus on the preoperative esophagram. All esophageal stents (WallFlex; Boston Scientific, Natick, MA, USA) were placed under fluoroscopic guidance. During mini-laparotomy for feeding tube placement, stents were sutured to the esophagus extraluminally using absorbable polydioxanone (PDS; Ethicon US, LLC, Guaynabo, Puerto Rico) or polyglycolic acid (Dexon; Medtronic, Minneapolis,

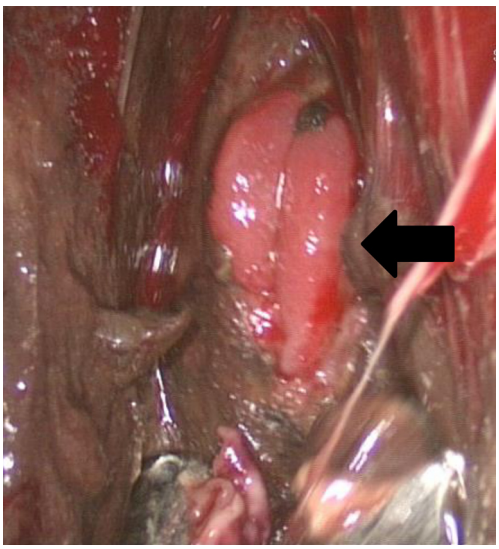

Figure 3 Thoracoscopic view showing an esophageal perforation (arrow) and necrotic tissue in the mediastinum and pleural cavity.

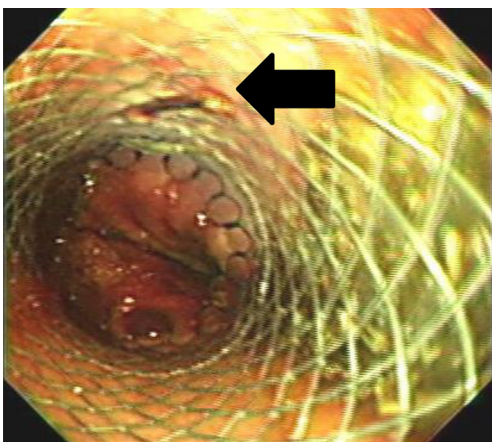

Figure 4 Endoscopic view showing fixation of the esophageal stent to the esophageal mucosa using absorbable suture (arrow).

MN, USA) sutures. The sutures were placed at the level of the abdominal esophagus and passed through all layers of the esophagus and the stent to prevent stent migration. This extraluminal suture was confirmed on endoscopic surveillance (*Figure 4*). For adequate coverage of the perforation, the distal end of the stent must be situated 2 cm below the GEJ. A feeding jejunostomy was then placed for early enteral nutrition. The stomach was decompressed with either a gastrostomy or nasogastric tube.

Post-stent placement, an esophagram was obtained to confirm adequate coverage of the esophageal perforation once the patient was able to tolerate the examination (*Figure 1*). Patients were started on a liquid diet and then gradually advanced to a soft diet in the absence of any esophageal leakage. All esophageal stents were removed by 8–12 weeks after initial stent insertion. The timing of stent removal was individualized according to the extent of the perforation and the patient's nutritional condition as well as control of any ongoing infection. All esophageal stents were removed by endoscopy using sedation. An esophagram was performed within 24 hours after esophageal stent removal to evaluate for any persistent esophageal leak (*Figure 1*). All patients were assessed for dysphagia and adequate oral nutrition for at least 6 months.

Statistical analysis

A descriptive analysis was used for the variables in this study. Counts and percentages were used for categorical variables while median and interquartile range were shown for continuous variables.

Results

During the 54-month study period, 5 patients were identified with delayed spontaneous esophageal perforation. All perforations were located in the distal esophagus. Most patients (4/5, 80%) were male, and their mean age was 58 years (range, 48 to 86 years). The mean duration between symptoms and diagnosis was 5 days (range, 1 to 14 days). The mean interval between symptoms and esophageal stent insertion was 7 days (range, 2 to 18 days). All patients were classified in the high PSS group with a mean PSS of 11 (range, 8 to 14). No patients had a known malignancy, achalasia, or paraesophageal hernia (*Table 1*).

All patients received a FCSEMS with suture fixation, feeding jejunostomy, and thoracoscopic decortication. One patient received a gastrostomy tube for decompression whereas the others had a nasogastric tube (*Table 2*).

Adequate coverage of the esophageal perforation was confirmed in all patients on esophagram. The median length of stay in the intensive care unit and mechanical ventilation was 4 days and 1 day. There was no esophageal stent migration. The median length of hospital stay was 33 days. The median time to oral nutrition and esophageal stent removal was 43 and 66 days. Three patients (60%) had postoperative complications including respiratory failure [1], sepsis [1], arrhythmia [1], gastrointestinal bleeding [1], and prolonged ileus [1]. Two patients had ongoing infection

Table 1 Patient demographics

Variables	Patients				
	1	2	3	4	5
Age, years	86	58	48	49	48
Gender	M	M	M	F	M
Charlson comorbidity index	4	2	0	3	0
Time to diagnosis, days	6	4	2	14	1
Time to esophageal stent, days	7	6	3	18	2
Location of the perforation	Distal	Distal	Distal	Distal	Distal
Spontaneous perforation	Yes	Yes	Yes	Yes	Yes
Shock	Yes	No	No	Yes	Yes
Presence of cancer	No	No	No	No	No
PSS score	12	10	8	14	13

PSS, Pittsburgh Perforation Severity.

Table 2 Treatment procedures

Procedures	N [%]
Esophageal stenting	
FCSEMS	5 [100]
PCSEMS	0 [0]
Esophageal stent fixation sutures	
Polyglycolic acid (Dexon)	3 [60]
PDS	2 [40]
Decompression	
Gastrostomy	1 [20]
Nasogastric tube	4 [80]
Feeding jejunostomy	5 [100]
Drainage method	
Chest tube only	0 [0]
Thoracoscopic decortication	5 [100]

All data were presented as number (%). FCSEMS, fully covered self-expandable metal stents; PCSEMS, partially covered self-expandable metal stents; PDS, polydioxanone.

and needed a prolonged course of antibiotic treatment. Among these patients, one needed another surgical drainage procedure due to uncontrolled infection and tracheostomy placement for respiratory failure. All patients experienced mild chest discomfort and gastroesophageal reflux which were well-controlled with proton-pump inhibitors and strict aspiration precautions. These symptoms resolved after esophageal stent removal. No esophageal stents needed to be replaced, and there was no hospital mortality.

All patients were discharged without chest tubes or antibiotics. All patients were able to tolerate a regular diet once the stent was removed. One fragile patient continued to require a jejunostomy tube for supplemental nutrition due to swallowing dysfunction while the jejunostomy tube was removed during follow-up for the other four patients. Two patients had symptoms of dysphagia which resolved without any additional interventions. No patients developed an esophageal stricture or required esophageal dilations. There were no 30-day or 6-month mortality (*Table 3*).

Discussion

Delayed spontaneous esophageal perforation is a challenging surgical emergency. In this study, we proposed a hybrid approach combining endoscopic esophageal stent placement with extraluminal sutures to prevent stent migration, thoracoscopic decortication with chest tube drainage, gastric decompression, and jejunostomy tube placement for early nutrition. There was no mortality in this cohort, and all patients were able to resume oral nutrition with esophageal preservation after stent removal.

Several studies have shown the safety and efficiency of esophageal stent placement in the treatment of benign

Table 3 Perioperative outcomes

Outcomes	N (%) or median (IQR)
Adequate coverage of perforation	5 (100.0)
Time to oral nutrition, days	43 (17.5, 81.0)
Time to stent removal, days	66 (55.5, 77.5)
Length of stay, days	33 (24.0, 77.5)
Length of ICU stay, days	4 (1.0, 26.5)
Length of mechanical ventilation, days	1 (1.0, 19.0)
Stent migration	0 (0)
Morbidity	3 (60.0)
Mortality	0 (0)

Categorical data were presented as n (%); continuous data were expressed as median (IQR). IQR, interquartile range; ICU, intensive care unit.

esophageal perforation (4-10). The most common site of spontaneous esophageal perforation was the left aspect of the distal esophagus near the GEJ. Dickinson *et al.* suggested that the esophageal stent should be placed 2–4 cm proximal and distal to the perforation for adequate coverage (20). For distal esophageal perforations, the stent often has to extend across the GEJ to get adequate coverage. Due to the size of the gastric lumen and necrotic tissue at the distal aspect of the perforation, finding a good distal landing zone for the stent can be challenging. As a result, the risk of stent migration is increased, and it is important to secure the stent to the esophagus.

There are various esophageal stents available for coverage of benign esophageal perforations including SEPS, FCSEMS, and PCSEMS (4-15). However, the risk of stent migration is higher with a SEPS than a FCSEMS or PCSEMS (5,13,14). Prolonged stent placement for benign esophageal disease is not recommended due to increased stent-associated complications including stent erosion with bleeding or fistula formation (21). Furthermore, tissue ingrowth occurs more frequently with PCSEMS compared to FCSEMS (5,12,13,15). The resulting granulation tissue increases the difficulty of stent retrieval and the risk of esophageal perforation (15,22,23). As a result, we recommend the placement of FCSEMS for managing benign esophageal perforations.

The radial force of the esophageal stent, particularly the flared portions at the proximal and distal ends, help to keep the stent in place. However, stent migration may be more common with a benign esophageal perforation due to the lack of a stricture to anchor the stent in place. Non-malignant etiology, distal esophageal perforation, and a FCSEMS were risk factors for stents migration (13,15,16). Previous studies have reported a rate of stent migration between 16% to 29% with benign esophageal perforations (9,10,13-15). Migrated stents may cause life-threating complications and need further endoscopic or surgical interventions to retrieve the stent (13,14,16-18). In our cohort, we chose to place FCSEMS across the GEJ in an attempt to cover the distal esophageal perforation. Due to the increased risk for stent migration, the distal end of the stent was secured to the esophageal wall extraluminally with absorbable suture. There was no stent migration, and all stents were successfully removed endoscopically.

The need for gastric decompression via nasogastric tube or gastrostomy tube with an esophageal perforation is unclear. Cameron *et al.* claimed that a nasogastric tube was not necessary in esophageal perforation since a nasogastric tube may increase the risk of gastroesophageal reflux and therefore delay esophageal healing (24). Other studies recommend gastric decompression to reduce persistent contamination (1,3). Early enteral nutrition and aggressive debridement and drainage of any infected or nonviable tissue and fluid are critical in the management of esophageal perforations (11,25). In the current study, all patients underwent gastric decompression with either a nasogastric or gastrostomy tube placement due to the increased risk of delayed gastric emptying in critically ill patients. Furthermore, a feeding jejunostomy was placed for early enteral nutrition, and thoracoscopic decortication was performed to drain all infected material.

Based on the results of a large international study, the Pittsburgh Severity Score (PSS) was proposed to guide treatment of esophageal perforations based on the severity of the perforation (19). The high-risk groups (PSS >5) had increased morbidity and mortality rates (82.5% and 37.5% respectively). Furthermore, 14.2% of patients underwent esophagectomy as part of their management. The predictive value of the PSS is better in patients with a spontaneous esophageal perforation (26). Despite all patients in the current study having a high PSS (range, 8 to 14), there were no in-hospital deaths. In addition, all patients resumed oral nutrition with esophageal preservation.

Endoscopic vacuum therapy (EVT) is another emerging treatment modality for esophageal perforation (27,28). However, reports of EVT in delayed spontaneous esophageal perforation are limited. In general, multiple additional procedures (mean 6.4–7.4) were required for

EVT management of esophageal perforation (27,28). In addition, 30% of patients had dysphagia after recovery following EVT (28). In our hybrid approach, aside from one patient who needed another surgical drainage procedure due to uncontrolled infection and tracheostomy placement for respiratory failure, no additional interventions were required to manage the esophageal perforation. All patients resumed oral intake without dysphagia except one who had swallowing dysfunction.

The treatment approach demonstrated in the current study appears to be safe and effective. However, there were some limitations with this study. The patient cohort was small for this relatively rare condition. Furthermore, selection bias may exist in this retrospective study. Larger, prospective studies are needed to validate our findings.

Conclusions

Endoscopic esophageal stent placement with extraluminally sutures to prevent stent migration, thoracoscopic decortication with chest tube drainage, gastric decompression, and jejunostomy tube placement for early nutrition was feasible and effective in the treatment of delayed spontaneous esophageal perforation. FCSEMS placement across the gastroesophageal junction provided adequate coverage of the esophageal perforation and prevented continued mediastinal contamination. There were no cases of stent migration after securing the distal end of the stent to the esophagus with absorbable suture. All stents were successfully removed without complications and with complete healing of the esophageal perforation. At present, there is no consensus for the management of delayed esophageal perforations. The encouraging results from this study can provide clinicians with an alternative, less invasive treatment approach for a challenging clinical problem which has traditionally carried a high rate of morbidity and mortality.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1316/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1316/dss

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1316/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1316/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional review board of Chang Gung Memorial Hospital (No. 202100306B0) and informed consent was waived for this retrospective study.

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