The Evolution and Current Utility of Esophageal Stent Placement for the Treatment of Acute Esophageal Perforation

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KEYWORDS

• Esophageal perforation • Esophageal stent placement • Hybrid treatment strategy

KEY POINTS

- As part of a hybrid treatment strategy, including surgical drainage of infected spaces, enteral nutrition, and aggressive supportive care, esophageal stent placement has produced results that can exceed those of traditional surgical repair.

INTRODUCTION

The use of an esophageal stent for the treatment of an acute esophageal perforation was rarely reported or discussed before 2001. As discussed in this article, this is when advances in biomaterial allowed a new generation of stents to be manufactured that combined a nonpermeable covering, radial force sufficient to occlude a transmural esophageal injury, and improved removability. These developments set the stage for the use of an esophageal stent as part of an approach for the treatment of an acute esophageal perforation that eliminated the need for direct primary repair and its significant failure rate. Esophageal stent placement for the treatment of esophageal perforation or failed operative repair also had the potential to minimize the need for esophageal resection and diversion. This review summarizes the modern history of esophageal stent use in the treatment of esophageal perforation as well as the evidenced-based recommendations for the use of esophageal stent placement in the treatment of acute esophageal perforation.

HISTORY

The use of an endoluminal esophageal stent to treat esophageal stenosis, fistulae, and leaks is not a new concept for the thoracic surgeon. Esophageal intubation has been used since the nineteenth century when Symonds[1] in 1887 described the first successful experience with prostheses made of ivory and silver. In 1914, Guisez[2] was the first to place esophageal "tubes" to palliate esophageal obstructions under direct vision. Ten years later, Soutter[3] published his results using metallic tubes with a rubber funnel. Coyas[4] subsequently designed a plastic tube with metallic rings of equal diameter, which was better tolerated by patients with malignant dysphagia.

In more recent times, Mousseau and colleagues,[5] Atkinson and colleagues,[6] and Ferguson developed devices for esophageal intubation. Celestin,[7] modifying a French design by Mousseau and Barbin, developed a polythene stent for inoperable malignant strictures that was successful in maintaining oral intake. However, difficulty with

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insertion, migration, and extraction limited the use of these prostheses.

Taking advantage of the technology used to make endovascular stents, self-expanding metallic esophageal stents became available in the 1990s. These stents are woven, knitted, or laser-cut metallic mesh designed to exert self-expansive forces up to a fixed diameter. The metallic part is most often a steel alloy such as Elgiloy or nitinol. Elgiloy (cobalt, nickel, and chromium) is corrosion resistant and able to generate high radial pressures, whereas nitinol (nickel and titanium) allows more flexibility with less radial forces.[8,9]

Self-expanding metal stents offered the advantages of being inserted with flexible esophagoscopy, required significantly less esophageal dilatation, had a lower rate of migration, and provided improved palliation for malignant esophageal strictures and malignant tracheoesophageal fistulae.[10,11] However, there continued to be a reluctance to place these prostheses in the esophagus of a patient for conditions other than palliative therapy for a malignancy because of the potential esophageal damage associated with extraction, including reports of irreparable, sometimes life-threatening, fistulae.

In order to minimize tumor ingrowth and its complications, a second generation of metallic stent designs incorporated a covering of silicone, polyurethane, or other polymers.[12] This modification offered the advantage of diminishing the amount of tumor ingrowth and fixation of the stent to the esophageal wall theoretically at the cost of higher migration rates. In an attempt to minimize migration, metallic stents are also manufactured partially covered with a margin of 1.5 cm on the proximal and distal ends to optimize purchase of the esophageal wall.[13,14]

The next step in the evolution of esophageal stent biomaterials was the ability to produce an occlusive plastic prosthesis coated with silicone. This design has resulted in an esophageal stent with ease of insertion, a minimal requirement for esophageal dilation, and the ability to form an occlusive seal within the lumen of the esophagus.[15] A distinct advantage of these nonmetallic endoprostheses is also their ability to be removed or replaced even after long periods of time without damaging the esophagus. However, these stents are associated with a higher incidence of migration.[16]

The ability to easily place and remove a covered, occlusive stent in the esophagus led some investigators to implant these stents in select patients as a temporary measure to treat intrathoracic anastomotic leaks following esophagogastrostomy and acute perforations. Segalin and colleagues[16] and Roy-Choudhury and colleagues[17] were among the first to report the successful treatment of an esophageal perforation or an anastomotic leak using a self-expanding metal stent, respectively.

EARLY IMPLEMENTATION

Several other investigators reported their initial experiences treating acute perforations or anastomotic leaks between 2000 and 2005. Success rates in these series varied significantly as do the frequencies of stent migration, mortality, and healing. The variability in results is not unexpected given the lack of treatment protocols among investigators, the evolutionary nature of the technique during this period, and the diversity of stents used. Pleural drainage and enteral nutrition are noticeably absent as a consistent part of the treatment protocol.

Between 2005 and 2011, several series were reported containing at least 10 acute perforation patients treated with esophageal stent placement. Johnsson and colleagues[18] in 2005 and Fischer and colleagues[19] in 2006 reported 20 and 15 esophageal perforation patients, respectively, treated with self-expanding metal stents. Johnsson reported a 95% sealing rate for the perforation but only a 77% rate of healing. Fisher and colleagues realized a 100% rate of sealing the perforation and ultimate healing. Seven patients in this series developed an empyema requiring further intervention.

The evolution of esophageal stent use in the authors' practice began in patients who either were exceedingly high risk for the transthoracic repair of an esophageal leak or had undergone a previous operative repair that failed. The authors found this technique to be beneficial in these complex patients and reported their initial experience in 2007.[20] In this series, 21 patients who had undergone at least one failed operative repair of a chronic esophageal leak had a silicone-coated plastic stent placed in an attempt to seal the fistula without further surgery, resulting in 95% of these leaks being sealed without further surgery.

The encouraging results of this initial investigation led the authors to consider whether endoluminal esophageal stenting would be superior to primary operative repair in acute esophageal perforations. Recognizing the traditional goals of operative therapy for an esophageal perforation, they designed a hybrid treatment protocol that included operative or percutaneous drainage of infected spaces, the establishment of enteral nutrition, along with esophageal stet placement. They also thought it was important for the thoracic