ANZJSurg.com

Endoscopic modalities for upper gastrointestinal leaks, fistulae and perforations

Michael Talbot,*† Gary Yee*† and Payal Saxena†‡§

*Department of Surgery, St George Hospital, Sydney, New South Wales, Australia
†University of New South Wales, Sydney, New South Wales, Australia
‡Department of Gastroenterology, Royal Prince Alfred Hospital, Sydney, New South Wales, Australia and
§The University of Sydney, Sydney, New South Wales, Australia

Key words
endoscopy, fistula, leak, perforation.

Correspondence
Dr Michael Talbot, Suite 3, Level 5, St George Private Hospital, 1 South Street, Kogarah, NSW 2217, Australia. Email: m.talbot@unsw.edu.au

M. Talbot MBChB, FRACS; **G. Yee** MBBS, FRACS; **P. Saxena** MBBS, FRACP.

Some patients in this series were presented at the 2011 RACS meeting.

Accepted for publication 2 September 2015.

doi: 10.1111/ans.13355

Abstract

Background: Endotherapy techniques are a recent addition to the suite of non-surgical and minimally invasive strategies to manage patients with perforations, leaks and fistulae. The emergency nature of these conditions and the heterogeneity of pathologies encountered create difficulties when trying to select appropriate tools in these complex situations. The purpose of this article is to review experience at a tertiary academic centre, describe the various endoscopic tools available and the situations where they can be considered for use.
Methods: Single-centre series and review of the published literature.
Results: Of 64 patients, 57 were successfully treated using endoscopic therapy, with surgery used only to provide drainage and suture fully covered metal stents in place to prevent migration.
Discussion: Selection of an appropriate endotherapy or stent for a patient with an oesophago-gastric perforation or fistula requires an understanding of the anatomy and physiology underlying the patient's presentation and an understanding of the strengths and weaknesses of the available methods. Standard surgical principles of drainage, avoidance of distal obstruction and nutrition remain central to successful outcomes. A combination of surgical and endoscopic treatments may reduce the number of required treatments and can provide the ability to anchor fully covered stents to prevent them from migrating.

Introduction

Oesophago-gastric leaks, perforations and fistulae are complex and often require surgical intervention. Wide uptake of resection bariatric surgery and interventional endoscopy has increased prevalence of the upper gastrointestinal tract injuries beyond that of leaks following cancer surgery. An indication of increasing frequency of such conditions in the last decade is the proliferation of literature related to the use of endoscopic therapies as alternatives to surgical management.[1–6] Endoscopic approaches not only seek to minimize invasive surgery and trauma to patients but they also present challenges due to the acuity of presentation and variability of the underlying pathologies.

The aim of this article is to review the endoscopic therapies available and the results of the application of such endoscopic therapies to this complex group of patients.

Methods

Between 2004 and July 2015, 64 patients presenting to the senior author with oesophago-gastric leaks or perforations were managed with an endoscopic modality as the primary therapy.

A suite of endoscopic modalities was used. Techniques and equipment were refined over the duration of this retrospective series. Endoscopic options employed included self-expanding metal stents (SEMS), pneumatic dilation to 30–35 mm, pigtail stents for internal drainage of abscesses, tissue apposition using clips (through-the-scope clips (TTSC) or over-the-scope clips (OTSC)), fistula plugs or glue. Fully covered SEMS (FCSEMS) were generally sutured in place surgically when they were deployed (Fig. S1), and if surgery was not planned self-retaining partially covered SEMS (PCSEMS) were used.

Patients were offered tailored therapy based on the degree of tissue injury and sepsis (Table 1). Endoscopic therapy was

Table 1. Algorithm for management of oesophago-gastric injury

Presentation	Pathway	Management
Endoscopic injury	Simple/small defect without stenosis	Endoscopic clipping. Early commencement of fluid diet.
	Complex defect, or defect with stenosis	FCSEMS if stenosis present or PCSEMS held with clips if no luminal stenosis. Early fluid diet, and stent removal 2–3 weeks.
GI leak with severe contamination or Boerhaave syndrome		Open or laparoscopic thoracic or abdominal debridement and external drainage. FCSEMS sutured in position. Enteral feeding if no ileus.
GI leak with localized abscess		Gastroscopy and insertion of internal drain. Plan for early oral feeding. 20 mm (early) or 30 mm dilation (after 2 weeks) for sleeve gastrectomy.
		Gastroscopy + FCSEMS sutured with laparoscopic drainage if uncertain about contamination.
Persisting fistula	Large leak	Replace FCSEMS with PCSEMS.
	Contained leak	Internal drainage ± dilation.

FCSEM, fully covered self-expanding metal stents; GI, gastrointestinal; PCSEMS, partially covered self-expanding metal stents.

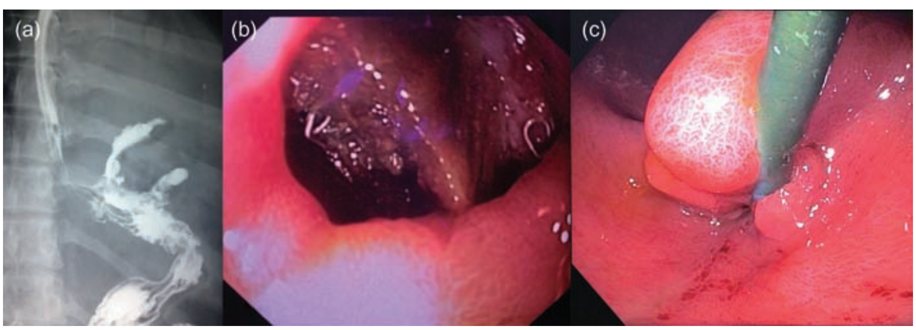

Fig. 1. (a) Contrast study of contained sleeve gastrectomy leak. (b) Endoscopic appearance of sleeve gastrectomy staple line defect prior to placement of biliary endoprosthesis. (c) Endoscopic appearance of internal drain prior to removal, following abscess resolution.

predominantly stent-based early in the series, although 'pathology specific' therapy emerged over time. Patients with clean or instrumental perforations were treated by direct closure with clips if the defects were small or by endoscopic stent placement without external drainage if the perforation was large or associated with luminal stenosis. For patients with leaks associated with surgical resection, the use of stenting was initially used as the preferred modality early in the series but is now reserved for patients with extensive peritoneal contamination and internal drainage has became the dominant therapy for the majority of patients either as primary or 'bail-out' therapy when other endoscopic therapies failed to completely resolve a leak.

Internal drainage of abscesses was achieved using pigtail (7-Fr × 7 cm) plastic biliary stents (Fig. 1), which are placed between the abscess cavity and the gut lumen as an alternative to external drainage using surgery or radiology. In sleeve gastrectomy cases, stenosis distal to the fistula was dilated with a 30–35 mm of pneumatic achalasia balloon if a fistula was noted to persist after SEMS removal or if an internal drain was placed (Fig. 2).

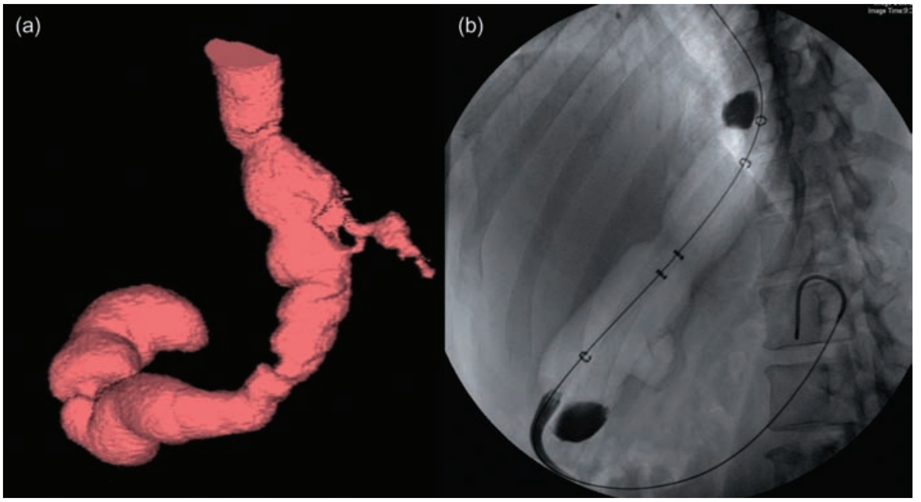

Fig. 2. (a) Three-dimensional image of sleeve stricture with fistula. (b) X-ray-guided 30-mm dilation of sleeve gastrectomy.

Usual supportive care including radiologic drainage and enteral feeding were used as appropriate and surgery, when utilized, was limited to the establishment of drainage, stent fixation and access for nutrition.

Success was defined as (i) successful application of an endotherapy with (ii) healing of perforation or fistula resolution and (iii) discharge of the patient on a normal diet without fistula recurrence.

Results

A total of 64 patients were treated since 2004. Of these, 21 were post-sleeve gastrectomy, 10 had contaminated oesophago-gastric oesophageal perforation or Boerhaave syndrome, 10 had clean endoscopic perforation, nine had leak after Ivor–Lewis oesophagogastrectomy, nine had leak following total gastrectomy and five had leak following Roux-en-Y gastric bypass surgery. There were five (7.8%) deaths in the cohort and two patients required surgery for persisting fistulae. Successful management with initial therapy was achieved in 53 out of 64 patients (83%) and follow-up with alternate endotherapy led to a final success rate of 89%.

Of the 43 non-sleeve gastrectomy patients, 32 were treated with FCSEMS, with initial fistula control or closure achieved in 28 instances (87.5%). Replacement of a FCSEMS with a PCSEMS resulted in fistula closure in one patient with Boerhaave syndrome in whom the original FCSEMS impacted the gastric fundus (Fig. S2). Another patient, with a surgical perforation of the cardia, who failed to achieve early fistula control with a FCSEMS and external drain, had the stent removed and the defect closed with an OTSC (Ovesco Endoscopy AG, Tubingen, Germany). A further patient who failed to get adequate control with two sequential PCSEMS had the stents removed and replaced by endoscopically placed pigtail drains into a persisting cavity external to the anastomosis.

In the non-sleeve gastrectomy group, a total of five deaths occurred. One patient died of a late gastrointestinal bleed secondary to anti-coagulation, two patients died of organ failure and one of an aspiration event due to stent-related reflux. The only patient who had a fistula draining luminal content at the time of death was a patient with a massively dilated oesophagus who died of respiratory failure 3 months after an oesophageal myotomy and diverticulum excision. Fistula closure failed despite use of sequential large diameter PCSEMS, FCSEMS and placement of an OTSC. These stents were subsequently removed and the leak was left to close secondarily as end-stage pulmonary fibrosis precluded thoracotomy for oesophageal exclusion.

Of the 21 sleeve gastrectomy patients, 12 were treated with FCSEMS (eight sutured at laparoscopy). In comparison with non-sleeve gastrectomy patients, this cohort did not experience rapid cessation of fistula drainage post SEMS placement. These patients often did not tolerate oral fluids and required enteral feeding. Three patients failed initial treatment with SEMS placement. The first had the SEMS removed early due to intolerance and failed other endoscopic modalities (OTSC, fistula plug, glue placement) before undergoing Roux-en-Y anastomosis to the low-volume fistula 6 months later. One was not a candidate for surgical fixation of a FCSEMS due to late diagnosis and a hostile abdomen. After failed FCSEMS, PCSEMS, clips, fistula embolization and conversion to gastric bypass, the patient eventually underwent total gastrectomy with a mediastinal oesophago-jejunal anastomosis. The final patient with reasonable fistula control by a sutured FCSEMS had the stent removed and replaced by internal pigtail drains after a gastrointestinal bleed associated with dialysis.

Internal abscess drainage was employed as a primary therapy in 12 patients with contained abscesses complicating resectional surgery, and a further two patients as follow-up therapy after SEMS placement (sleeve gastrectomy combined with 30 mm pneumatic dilation $n = 7$, total gastrectomy $n = 5$, Ivor–Lewis oesophagogastrectomy $n = 2$). This involves placement of a pigtail biliary plastic stent into the abscess via the fistula orifice at endoscopy as an internal–external drain.[7] These patients were able to recommence a fluid diet soon after drain placement and had an uncomplicated recovery without recurrence of their leak or abscess.

Four sleeve gastrectomy patients with persisting low-volume fistulae despite SEMS placement by other clinicians were referred for management. Stent extraction and 30-mm pneumatic balloon dilatation of the sleeve tube resulted in successful fistula resolution.

Discussion

Endotherapy methods

Endotherapies aim to reproduce the surgical strategies of (i) tissue closure; (ii) diversion of enteric stream (stenting); (iii) drainage; and (iv) stricture management. Many of these methods can be used in combination with others, and if a patient fails to obtain a successful outcome with their initial management then other alternatives can be attempted (Table 1).

Endoscopic tissue closure: laceration, perforation or fistula

Tissue closure can be achieved with endoscopic clips or glue. A variety of TTSCs and an OTSC[8] can be used and is the case surgically, a clipped laceration or perforation can be expected to heal in the absence of sepsis and diffuse tissue injury. Chronic fistula tracts can be amenable to clipping and/or embolization with glue or plugs,[9] but only if (i) the abscess cavity has been ablated by adequate drainage, (ii) downstream obstruction has been treated and (iii) consideration has been given to obliteration of sinus tract epithelium. Literature about this particular topic is sparse and there are no large series in the current literature perhaps suggesting a significant failure rate as seen in this cohort.

Diversion of enteric stream: SEMS

The success rates of endoscopic SEMS placement in the published literature range from 40 to 80%.[10] After stent placement some patients can tolerate a fluid diet if a complete seal has been obtained, and while optimal duration of placement may vary, stents can generally be removed within 2–6 weeks. SEMS placement can be associated with significant post-procedure discomfort and dysphagia, which is why internal drainage has become the author's preferred therapy in patients with localized leaks.

It is known that stent migration and treatment delays can lead to failure but there is little in the literature to guide stent selection.[11–16] Most stents used for fistula management are being used 'off-label', but understanding their physical characteristics can help when selecting a stent for a particular patient. Stents are characterized by their length, width, the 'weave' of the expanding component, whether the stent is a single piece or segmented, proximal and distal flare diameter, and whether there is an uncovered or anti-migration segment present.

Stent types: PCSEMS. Partially covered stents[17–19] are probably the most frequently used, attesting to their ease of deployment and efficacy. A stent such as the Boston Scientific Wallflex (Natick, MA, USA; 18 × 100–150 mm) is placed with the covered portion covering the defect. The stent has proximal and distal 23 mm uncovered mesh flares for tissue ingrowth to prevent stent migration and create an effective seal. The stent may be anchored in place by an endoscopic clip to maintain its position until tissue ingrowth is fully established (Fig. S3).

PCSEMS are removed as a two-stage "stent-in-stent" procedure. After the fistula has healed, placing a wider and longer FCSEMS within the PCSEMS facilitates stent detachment. Decubitus pressure upon the mesh component of the narrow stent by the larger stent inside it makes the mesh ingrowth tissue retreat, allowing removal within a week.

FCSEMS. Fully covered stents lack the ability to integrate into tissues and can be removed with ease. Lack of tissue integration, however, leads to migration risk[2] and poor outcomes that may have affected the wider usage of stenting among surgeons. Fixation of the stent in good position requires placement across a stenosis, fixation with clips or anti-migration features in the stent itself.

Stent failure. There are many factors that may contribute to stent failure, including luminal disparity, stent migration and stent straightening and if stent placement is not associated with total or near total cessation of fistula output, the patient will be exposed to the risks of failed therapy. A stent that is too narrow may not effectively seal a leak but care also has to be taken in the oesophagus not to select a stent of excessive diameter and to remove stents by 6 weeks in order to prevent decubitus ulceration, which can lead to stenosis and, although rare, stent migration through the oesophageal wall.[20]

Metal stents are 'self expanding'[21] and after deployment they have a tendency to straighten, creating the risk of impingement against a curving or deformable gut wall causing obstruction and decubitus ulceration. This effect can be accentuated by even minor distal migration of the stent and typically occurs when a stent passes through the gastro-oesophageal junction and impacts on the fundus or greater curve of the stomach, or in sleeve gastrectomy where the stent impacts on the lateral wall of the antrum just distal to the incisura. This can be diagnosed radiologically by contrast studies that will show the stent to be full of fluid, with contrast running external to it and endoscopy through the stent will reveal a characteristic traumatic pseudo-polyp (Fig. S4) in the gut lumen at the point of impaction.

FCSEMS have significant migration/impaction risk if only endoclips or moderate stenoses are relied upon to hold them in place and increasing stent diameter does not appear to change migration rate.[22] Newer purpose-built stents[23] designed to conform to gastrointestinal anatomy or with anti-migration elements may reduce migration rate but data are lacking. Suturing the stent in place with absorbable sutures at the time of placement is a simple and reliable method of ensuring stent fixation (Fig. S1). Because many patients require laparoscopy for lavage and drain placement, this can be performed at the time of stent placement. The larger OTSC may be a suitable alternative to hold the stent in position if laparoscopy is not considered[24,25] as is endoscopic suturing.[26]

Surgery and disease processes create idiosyncratic anatomy. Therefore, consideration of the anatomy should lead to differing stent choices. No stent is suitable for all situations, so an inventory of several stents, including long PCSEMS, and variable length and diameter FCSEMS is required, taking into account the variabilities of patient anatomy and the locations where stents could be required.

The 'holy grail' of stents would have at least three segments to allow the proximal and distal ends to conform to the gastrointestinal tract, wide proximal and distal flares to create a seal against antegrade and retrograde leak, a reliable anti-migration feature and be easy to remove. At present, such a stent does not exist. Although purpose-built stents for benign indications exist, they are imperfect; hence, the 'off label' use of stents designed for different purposes remains the norm.

Endoscopic drainage

Endoscopic placement of stents across the gut wall to allow internal drainage has shown high technical and clinical success rates in the management of pancreatic pathologies.[27,28] However, this is not a commonly employed method for management of oesophago-gastric pathologies.

In this series of patients with contained or externally drained abscess, the 100% success rate and ability to safely start a fluid diet within days appears encouraging, although the method is unlikely to be suitable for uncontained perforations.

Stricture or stenosis management

Stenosis distal to a perforation can be addressed with through-the-scope dilating balloons or pneumatic dilation to 30 mm or above. If a covered stent is chosen to manage a sleeve leak, the angularis has to be taken into account – usually by traversing it to have the distal part of the stent pointing at the pylorus. Stents placed above even a slight angularis stenosis are prone to failure and the authors advocate the use of long stents or dual stent placement to span the stomach from the antrum to several centimetres above the gastro-oesophageal junction.

Patient factors

Patients with free perforation, severe sepsis and bowel obstruction are more likely to require surgery, and it seems that there are also some factors that can predict the likelihood of early versus late healing of a perforation or leak. Patients with minimal tissue loss, a ‘dry’ gut lumen and low intraluminal pressure appear more likely to rapidly heal. Typical ‘dry/low pressure’ patients are those with fistulas after gastric bypass, total gastrectomy and patients with oesophageal perforation above the lower oesophageal sphincter. In these patients the gut is empty (except for swallowed secretions) and no obstruction to enteric flow exists. Typical ‘wet/high pressure’ cases are patients with significant ileus or distal bowel obstruction and patients where there is a sphincter or stricture distal to the fistula such as oesophagectomy and sleeve gastrectomy patients. In these cases, there are significant volumes of enteric content or gas distending the gut lumen leading to retrograde movement of gut content and difficulty in creating a seal with SEMS.

The sleeve gastrectomy leak typifies potentially the most difficult type of fistula. These patients have a low volume but ‘wet’, low compliance/high pressure stomach with stenosis at the angularis and pylorus with fistulae commonly occurring at the upper stomach where the insertion of the oesophagus can lead to pulling of the cardia into the negative pressure environment of the thoracic cavity with each swallow.

Conclusion

This large single-centre series demonstrates a variety of endoscopic techniques that can offer successful minimally invasive therapies for the management of perforations and post-surgical leaks and fistulae. Any clinician undertaking endoscopic management of patients should be familiar with a broad range of therapeutic options and have a suitable armamentarium of devices at their disposal. Endotherapies seek to replicate surgical strategies of tissue closure, enteric diversion, abscess drainage and stenosis management. While avoiding the potential trauma of surgery, endoscopic therapy is still an evolving complex field. Surgeons will remain central to the management of these patients even if they are not performing the endoscopic intervention, as there are likely to be patients in whom endoscopic therapies will fail. Not every clinician is expected to be facile with these techniques, and while the occasional user of these therapies is to be discouraged, knowledge of which patients may be managed endoscopically can help reduce the impact of these conditions on both patients and their treating surgeons.

References

1. Johnsson E, Lundell L, Liedman B. Sealing of esophageal perforation or ruptures with expandable metallic stents: a prospective controlled study on treatment efficacy and limitations. *Dis. Esophagus* 2005; **18**: 262–6.
2. Bakken JC, Wong Kee Song LM, de Groen PC, Baron TH. Use of a fully covered self-expandable metal stent for the treatment of benign esophageal diseases. *Gastrointest. Endosc.* 2010; **72**: 712–20.
3. Blackmon SH, Santora R, Schwarz P, Barroso A, Dunkin BJ. Utility of removable esophageal covered self-expanding metal stents for leak and fistula management. *Ann. Thorac. Surg.* 2010; **89**: 931–6.
4. D’Cunha J. Esophageal stents for leaks and perforations. *Semin. Thorac. Cardiovasc. Surg.* 2011; **23**: 163–7.
5. Yimcharoen P, Heneghan HM, Tariq N, Brethauer SA, Kroh M, Chand B. Endoscopic stent management of leaks and anastomotic strictures after foregut surgery. *Surg. Obes. Relat. Dis.* 2011; **7**: 628–36.
6. van Halsema EE, Wong Kee Song LM, Baron TH *et al*. Safety of endoscopic removal of self-expandable stents after treatment of benign esophageal diseases. *Gastrointest. Endosc.* 2013; **77**: 18–28.
7. Slim R, Smayra T, Noun R. Biliary endoprosthesis in the management of gastric leak after sleeve gastrectomy. *Surg. Obes. Relat. Dis.* 2013; **9**: 485–6.
8. Weiland T, Fehlker M, Gottwald T, Schurr MO. Performance of the OTSC System in the endoscopic closure of iatrogenic gastrointestinal perforations: a systematic review. *Surg. Endosc.* 2013; **27**: 2258–74.
9. Tringali A, Daniel FB, Familiari P *et al*. Endoscopic treatment of a recalcitrant esophageal fistula with new tools: stents, Surgisis, and nitinol staples (with video). *Gastrointest. Endosc.* 2010; **72**: 647–50.
10. Swinnen J, Eisendrath P, Rigaux J *et al*. Self-expandable metal stents for the treatment of benign upper GI leaks and perforations. *Gastrointest. Endosc.* 2011; **73**: 890–9.
11. Dasari BV, Neely D, Kennedy A *et al*. The role of esophageal stents in the management of esophageal anastomotic leaks and benign esophageal perforations. *Ann. Surg.* 2014; **259**: 852–60.
12. El Hajj II, Imperiale TF, Rex DK *et al*. Treatment of esophageal leaks, fistulae, and perforations with temporary stents: evaluation of efficacy, adverse events, and factors associated with successful outcomes. *Gastrointest. Endosc.* 2014; **79**: 589–98.
13. Repici A, Rando G. Stent for nonmalignant leaks, perforations, and ruptures. *Gastrointest. Endosc.* 2010; **12**: 237–45.
14. van Boeckel PG, Sijbring A, Vleggaar FP, Siersema PD. Systematic review: temporary stent placement for benign rupture or anastomotic leak of the oesophagus. *Aliment. Pharmacol. Ther.* 2011; **33**: 1292–301.
15. Freeman RK, Ascioti AJ, Giannini T, Mahidhara RJ. Analysis of unsuccessful esophageal stent placements for esophageal perforation, fistula, or anastomotic leak. *Ann. Thorac. Surg.* 2012; **94**: 959–65.
16. Gubler C, Bauerfeind P. Self-expandable stents for benign esophageal leakages and perforations: long-term single-center experience. *Scand. J. Gastroenterol.* 2014; **49**: 23–9.

17. Tunçözgür B, Savaş MC, Işık AF, Sarımehmetoğlu A, Şanlı M, Elbeyli L. Removal of metallic stent by using polyflex stent in esophago-colic anastomotic stricture. *Ann. Thorac. Surg.* 2006; **82**: 1913–4.
18. Langer FB, Schoppmann SF, Prager G, Riegler FM, Zacherl J. Solving the problem of difficult stent removal due to tissue ingrowth in partially uncovered esophageal self-expanding metal stents. *Ann. Thorac. Surg.* 2010; **89**: 1691–2.
19. van Heel NC, Haringsma J, Spaander MC, Bruno MJ, Kuipers EJ. Short-term esophageal stenting in the management of benign perforations. *Am. J. Gastroenterol.* 2010; **105**: 1515–20.
20. Bick BL, Wong Kee Song LM, Buttar NS *et al*. Stent-associated esophagorespiratory fistulas: incidence and risk factors. *Gastrointest. Endosc.* 2013; **77**: 181–9.
21. Hindy P, Hong J, Lam-Tsai Y, Gress FA. comprehensive review of esophageal stents. *Gastroenterol. Hepatol.* 2012; **8**: 526–34.
22. Van Den Berg MW, Kerbert A, Van Soest EJ, Schwartz MP, Gilissen LP, Van Hooft JE. Safety and efficacy of a fully covered colonic stent (hanaro CCI stent) for the treatment of oesophageal perforations, anastomotic leakages and fistula. *Gastrointest. Endosc.* 2013; **77**: AB353.
23. Galloro G, Magno L, Musella M, Manta R, Zullo A, Forestieri P. A novel dedicated endoscopic stent for staple-line leaks after laparoscopic sleeve gastrectomy: a case series. *Surg. Obes. Relat. Dis.* 2014; **10**: 607–11.
24. Irani S, Baron TH, Gluck M, Gan I, Ross AS, Kozarek RA. Preventing migration of fully covered esophageal stents with an over-the-scope clip device (with videos). *Gastrointest. Endosc.* 2014; **79**: 844–51.
25. Kantsevoy SV, Bitner M. Esophageal stent fixation with endoscopic suturing device (with video). *Gastrointest. Endosc.* 2012; **76**: 1251–5.
26. Kumta NA, Boumitri C, Kahaleh M. New devices and techniques for handling adverse events: claw, suture, or cover? *Gastrointest. Endosc. Clin. N. Am.* 2015; **25**: 159–68.
27. Saxena P, Singh VK, Messallam A *et al*. Resolution of walled-off pancreatic necrosis by EUS-guided drainage when using a fully covered through-the-scope self-expandable metal stent in a single procedure (with video). *Gastrointest. Endosc.* 2014; **80**: 319–24.
28. Akshintala VS, Saxena P, Zaheer A *et al*. A comparative evaluation of outcomes of endoscopic versus percutaneous drainage for symptomatic pancreatic pseudocysts. *Gastrointest. Endosc.* 2014; **79**: 921–8.

Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure S1. Stent fixation at laparotomy for major disruption of stapled oesophago-jejunostomy anastomosis.

Figure S2. (a) Endoscopic appearance of incomplete stent seal secondary to stent straightening and impaction in a Boerhaave syndrome patient after transabdominal laparoscopic mediastinal debridement and endoscopic FCSEMS placement. (b) Contrast swallow of incomplete stent seal in Boerhaave patient. (c) Unobstructed, segmented stent conforming to patient anatomy in another Boerhaave patient.

Figure S3. (a) Endoscopic clipping to hold PCSEMS in position. (b) Later stent incorporation prior to removal.

Figure S4. Typical pseudo-polyp in the antrum of a sleeve gastrectomy patient with a migrated FCSEMS and ongoing fistula output.