Enteral stents in the management of post–bariatric surgery leaks

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Abstract

A post–bariatric surgery leak is a rare but grave condition and remains every bariatric surgeon’s nightmare. Endoscopic therapy with the insertion of self-expandable stents provides an effective minimally invasive approach for the management of leaks. Self-expandable stents, however, are still hampered by their tendency for migration and are not always well tolerated. Recently, double-pigtail stents have been proposed as an alternative endoscopic therapeutic modality. Both types of stents have been shown to be very effective in the management of leaks; however, most studies have pooled gastrointestinal leaks due to different etiologies together. In this article, we review the current status and foreseen innovations in gastrointestinal stenting for post–bariatric surgery leaks. (Surg Obes Relat Dis 2018;14:393–403.) © 2018 American Society for Metabolic and Bariatric Surgery. All rights reserved.

Proven to be the most effective weight loss interventions, bariatric surgeries have witnessed a surge in the number of yearly procedures over the last 2 decades, providing effective and sustained weight loss in a large number of patients [1]. However, this has also been accompanied by a surge in the related complications, the most serious of which is a staple-line leak. Leaks remain a catastrophic complication associated with significant morbidity and mortality, occurring in approximately 1% to 5% of primary surgeries and up to 13% of revisional surgeries [2–5]. Conventionally, leaks have been managed by either an aggressive surgical approach or conservative expectant management reliant on total parenteral nutrition and prolonged use of antibiotics. Surgery for leaks—whether by radical resections or simple attempts at repair—is a perilous endeavor that frequently fails, with morbidity up to 50% and mortality in 2% to 10% [6–8]. Conservative management entails prolonged hospitalization, frequent infections, and numerous complications of prolonged total parenteral nutrition and frequently fails to heal the leak [9].

Peroral endoscopy provides minimally invasive access to the site of leakage, allowing therapeutic procedures to be performed with minimal anesthesia and minimal stress to an already critical patient. Of all the endoscopic techniques described, stents have been the most studied and most popular to this date [10]. Self-expandable stents isolate the site of leakage from contents of the alimentary tract, allowing the leaks to heal while simultaneously allowing enteral feeding to resume. Double-pigtail plastic stents work by a different concept: the maintenance of an open fistulous tract allowing constant drainage of the leak cavities internally [11]. Numerous studies have addressed the use of stents in leaks; however, the vast majority has pooled the results of leaks due to different etiologies, including endoscopic perforations [12]. Post–bariatric surgery leaks have their particular characteristics with regard to the surgical anatomy and the morbid nature of the patient. In this article, we review the current status of the use of stents in the management of post–bariatric surgery leaks and the foreseen innovations in this field.

Self-Expandable Stents

Types

Numerous self-expandable stents are commercially available, and the endoscopist must be knowledgeable of the

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features and pros and cons of each. Although each endoscopist may have a tendency to prefer one stent over another, an experienced endoscopist knows that there is no “one-size-fits-all” stent for postsurgical leaks.

Self-expandable stents are made of different materials but can be broadly classified into plastic and metallic stents. The Polyflex plastic stent (Boston Scientific, Marlborough, MA) was initially popular in the management of esophageal strictures and leaks, having the advantage of easy extraction and a strong radial force. However, their very high axial force renders them more traumatic and painful, less conformable to any angulated anatomy, and much more liable to migration [10]. Other disadvantages of plastic stents are a large caliber insertion system and the need for preloading. Their use in post–bariatric leaks is thus now limited to very few indications. The vast majority of self-expandable metal stents (SEMS) are now made of nitinol, an inert metal alloy of nickel and titanium. Nitinol has the great advantage of high flexibility and the ability to retain its shape; this comes with a slight drawback of a lower radial force. Apart from the stent material, the way the mesh is woven strongly contributes to the physical characteristics of the stent. For example, knitted stents have a lower axial force (more flexible, less traumatic) compared with braided stents, at the expense of a lower radial force (less compression against the walls, liability to collapse/kink). To date, no studies have clearly confirmed superiority of one stent material or mesh design over another, yet the physical characteristics should be taken in consideration when selecting a stent for a particular patient.

Perhaps the larger ongoing debate is whether to use fully or partially covered stents. Fully covered SEMS (FCSEMS) have silicone or polyurethane covering the entire length of the stent. This covering helps isolate the site of leakage from any of the luminal contents, and it also prevents the metal mesh from being embedded within the mucosa and avoids tissue ingrowth, allowing easy and safe stent extraction. Being fully covered, however, renders the stent much more liable to migration as there is no anchoring to the walls. Partially covered stents (PCSEMS) are similarly covered but have exposed segments of 1 to 2 cm at each end where the metal mesh is not covered. Once inserted, tissue hyperplasia occurs at the exposed segments; as early as within a week, the metal mesh becomes completely embedded in this hyperplastic tissue. This gives rise to 2 main advantages: (1) the stent is fixed to the wall and will not migrate, and (2) as the upper edge is adherent circumferentially to the walls, there is no risk of liquids seeping around the stent and reaching the site of leakage. Partially covered stents, however, are very difficult to extract as they are embedded in the mucosa, and the risk of failing to extract these stents still deters many endoscopists from their use. A “stent-in-stent” technique has proven effective to facilitate the removal of PCSEMS (described below) [13].

**Bariatrics-specific stents.** Until recently, all available stents were relatively primitive in design because they were simply esophageal stents designed for the management of malignant dysphagia, not specifically adapted to the postsurgical anatomy or the indication of leaks [14]. The performance of these stents is hampered by their short lengths, small calibers and lack of flexibility. Only recently have a few designs been proposed to be more suited to the bariatric anatomy. All so far are fully covered nitinol stents (Fig. 1) [15–17]. The MEGA stent (Taewoong Medical, Gimpo, South Korea) is a fully covered ultra-large stent with a shaft diameter of 28 mm and both ends are 36 mm [15]. It is made of braided nitinol with a relatively low axial force, which gives more flexibility and allows the stent to better conform to the tight angulations frequently observed after sleeve gastrectomy. The BETA stent (Taewoong Medical) has 2 proximal antimigration cuffs, each 32 mm

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*Fig. 1. Examples of Bariatrics-specific Stents. Left: the MEGA stent (Taewoong; www.stent.net with permission). Middle: BETA stent (Taewoong; www.stent.net with permission). Right: GASTROSEAL stent (MITECH; www.mitech.co.kr with permission).*
wide, with a long shaft measuring up to 23 cm in length and 24 mm in diameter [16]. The latest innovation is the GASTROSEAL stent (MITECH, Seoul, South Korea) that is also a large stent (26- to 28-mm diameter, 24-cm length) yet with design features that avoid the traumatic effect caused by large stents [17]. The stent has 2 flexible segments made of knitted rather than braided segments, thus reducing the axial force to almost nil. It also has a rounded curled-in lower edge to avoid the risk of ulceration or perforation that is frequently seen with large stents (Fig. 1).

**Stenting Procedure**

Before embarking on the treatment of a post–bariatric surgery leak, the magnitude of the problem has to be well appreciated. A patient with a bariatric surgery leak is not just another case on the daily endoscopy list, nor is there a standardized approach that can be simply applied to all patients. The endoscopist must be aware that there is more to it than just “plugging the defect”; it is the assurance of a permanent closure that is the ultimate goal. This requires the endoscopist to adopt a wider angle view of the patient, appreciating that there are multiple factors pertaining to successful leak closure, the most basic of which are adequate drainage, the absence of distal obstruction, ensuring the fistulous track is not epithelialized, and maintenance of adequate nutrition. The gravity of the condition must also be appreciated, and it should be known that this may be the only attempt available for treating this patient. It is imperative that these procedures be performed by an experienced “bariatric endoscopist” in a well-equipped unit having all options for endoscopic closure available (including stents, clips, tissue sealants), as it is difficult (almost impossible) to predict which endoscopic modality will be used in a certain patient.

**Drainage.** Although this may be self-evident to many surgeons, it may be a principle frequently forgotten by many endoscopists. Drainage of any collections (rather than stent insertion) is the single most important life-saving procedure that should be performed before or simultaneously with stent placement. Stenting in the absence of drainage may actually be hazardous: The leak site may be the only draining point for a collection of pus, and blocking this by a stent may thus aggravate the condition by turning this collection to a frank closed abscess [18]. Drainage is usually achieved by immediate laparoscopy, washout, and insertion of wide-bore drains. Ultrasound- or computed tomography–guided drainage may be preferred in smaller contained collections. Peroral endoscopy itself may provide an excellent method of drainage by passing the endoscope through the leak (if wide enough) into the adjacent leak cavities; these cavities may be difficult to reach safely by other drainage modalities [19]. With the endoscope inside the cavity, pus is aspirated and necrotic tissue and foreign bodies may be removed by several accessories, such as snares, Roth nets, and Dormia baskets. Over a decade ago, an endoscopist would have tried his or her best to avoid going through the leak; now, however, it should be considered an opportunity not to be missed.

**Timing of endoscopic intervention.** Many surgeons are weary of having their patient undergo an endoscopy very early after the surgery. The theoretical risk is that the endoscope or air insufflation may damage the staple line. The other problem is that many surgeons may remain in a state of denial of the gravity of the condition and just hope that the problem will resolve simply by conservative measures. To our knowledge, no reports exist regarding endoscope-induced rupture of staple lines; however, numerous reports have confirmed the superiority of earlier endoscopic intervention [19–22]. The principle is to perform endoscopy as soon as possible, provided that the patient is stable enough to undergo the procedure. Once a leak is suspected, we frequently proceed with endoscopy before contrast studies. Computed tomography and gastrografin meals may frequently give false negative results [23]. Endoscopy combined with fluoroscopy and contrast injection at the suspected leak site is probably the most accurate procedure for the diagnosis of leaks and has the advantage of allowing endoscopic therapy to be performed during the same procedure.

**Technique.** The procedure can be performed under simple sedation, yet general anesthesia may be preferred, especially in prolonged procedures and in cases in which a large volume of liquid is injected endoscopically (contrast or lavage fluid), to avoid the risk of aspiration. The supine position is preferred for easier interpretation of the fluoroscopic images; it is also preferred by the anesthetist for better ventilation and easier access to the airway. If, however, the patient is not intubated, the left lateral position becomes safer to reduce the risk of aspiration. The site of leak is visualized endoscopically and confirmed by contrast injection. As stated earlier, before deploying a stent it is important to aspirate the contents of the leak cavities and possibly debride them if passage of the endoscope through the leak orifice is possible. Care should be taken to avoid rupture of these fragile leak cavities by using minimal insufflation, preferably with CO2. Once the decision has been made to insert a stent, a guidewire is passed inside the lumen for at least 30 cm beyond the site of leak. Rigid metal guidewires are preferred, especially in the presence of an angulated lumen (e.g., after sleeve gastrectomy). The site of leak and the level of the cardia are marked by external metal markers on the patient’s skin. Under fluoroscopic guidance, the stent is then inserted over the guidewire and situated so that at
least 5 cm of the stent is present above and below the site of leak (Fig. 2).

Variations in the technique include deployment under solely endoscopic view and use of through-the-scope stents (TTS). Theoretically, the procedure can be performed using solely endoscopic view; however, fluoroscopy allows one to appreciate the actual length and position of the stent at all times. With the phenomena of stent foreshortening, stent length may vary especially in the presence of strictures; this will not be possible to assess by solely an endoscopic view. TTS stents are more convenient and shorten the procedure time; however, currently available TTS stents (e.g., Niti-S [Taewoong Medical] and Hanaro stents [MITECH]) are disadvantaged by their small calibers (18–20 mm).

Oral intake is withheld for 24 to 48 hours to allow for full stent expansion. A contrast study is then performed. If stent position is adequate and no leak is present, oral liquids are allowed. A liquid to semisolid diet is permitted throughout the stenting duration. Pain and vomiting occur almost universally and are worse with larger stents. Antiemetics and analgesics are usually required especially in the first week, but despite the use of medications, symptoms may persist throughout the stenting period. A plain x-ray may be performed every 1 to 2 weeks to confirm the stent position. Contrast studies are not routinely obtained during the stenting period but should be performed if there is any change in symptoms that could suggest stent migration (e.g., change in intensity or site of pain, fever, recurrence of pain, and vomiting after a period of quiescence).

Duration of stent placement remains a point of debate, yet most authors agree that 4 to 6 weeks is sufficient. Leaving stents for longer periods may increase the chances of healing; however, it has been shown that stenting beyond 6 weeks is strongly associated with the occurrence of complications [24]. It seems reasonable to remove the stents at 4 to 6 weeks; if a leak still persists, then another stent may be inserted, taking care to ensure that it is deployed in a slightly different position to avoid persistent pressure by the stent edges at the same points. Stent extraction is usually straightforward with FCSEMS: The upper edge or lasso is grasped by forceps and pulled. The upper edge of PCSEMS is deeply embedded within hyperplastic tissue and usually cannot be simply pulled out. A FCSEMS or Self-expandable plastic stents (SEPS) is inserted inside the PCSEMS for 1 to 2 weeks, which induces pressure necrosis on the hyperplastic tissue, thus freeing the uncovered portion of the PCSEMS and allowing both to be extracted in another session (stent-in-stent technique) [13].

Outcomes of Stent Therapy

Several studies have addressed the use of stents in postsurgical leaks, with the vast majority showing
Encouraging outcomes [10,12]. These results, however, should be interpreted with caution for the following reasons. First, many studies are actually very small case series with fewer than 10 patients each. Second, the majority of studies pooled postsurgical leaks with endoscopic perforations, 2 very different entities with a largely different prognosis. Third, many studies pooled different postsurgical leaks together (e.g., postbariatric and postesophagectomy leaks). In the section below, we try to depict the results of the larger studies involving mainly patients with post–bariatric surgery leaks (Table 1).

**Partially covered stents.** Success rates range between 76% and 94% with migration rates of 6% to 15% [21,25–28]. Salinas et al. [25] published one of the earlier reports including 17 patients with anastomotic leaks post Roux-en-Y gastric bypass (RYGB) [25]. All were treated by the partially covered Ultraflex stent (Boston Scientific). After a mean stent indwell time of 3.2 months, healing occurred in 16 patients (94%). Stent migration occurred in only 1 patient; however, the authors described extreme difficulty in extraction of the stents and had to use Argon plasma coagulation to cut the stents in very lengthy procedures. This was, of course, before the advent of the stent-in-stent technique that facilitates stent extraction. Alazami et al. [26] used PCSEMS in 17 patients with post–sleeve gastrectomy leaks. After a mean indwell time of 42 days, healing occurred in 76% of patients. Stent migration was also rare, occurring in 1 patient (6%). Stent extraction was successful in all patients with the stent-in-stent technique using a SEPS. The largest experience with PCSEMS comes from the team of Murino et al. [21], in which 91 patients were treated by the Ultraflex stent (36 sleeve, 55 RYGB). Permanent closure was achieved in 81% of patients using stents alone and in an additional 7% using endoscopic pigtail stents. Closure was achieved using 1 stent only in 39% of patients, while 42% required 2 or more stents. Stent migration occurred in 8% of cases, but the most noticeable complication was esophageal strictures occurring in 14% of patients.

**Fully covered stents.** Success rates range between 77% and 100% with migration rates of 44% to 59% [11,19,20,29]. An earlier report by Eubanks et al. [29] included 13 patients with post–bariatric surgery leaks. They were treated by either plastic or metal fully covered stents (Polyflex; Boston Scientific, or Alimaxx; Alveolus, Inc., Charlotte, NC). Despite a stent migration rate of 58%, leak healing eventually occurred in 11 patients (85%). Bége et al. [19] used wider FCSEMS (Colonic Niti-S; Taewoong Medical) to treat 27 patients with leaks (25 sleeve, 2 RYGB). The authors used a modified approach by inserting a nasocavitary drain initially through the leak in the majority of patients before inserting a stent in a second procedure. Leak healing occurred in all patients after a mean of 86 days from the initiation of endoscopic therapy. It should be noted, however, that 70% of cases required additional endoscopic modalities, such as clips or fibrin glue. Stent migration was also very common, occurring in 59% of cases. This translated to a mean of 4.4 endoscopic procedures per patient and a mean of 2.3 stents per patient. Pequignot et al. [11] treated 18 patients with

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*Including the SEPS inserted to remove the embedded PCSEMS.
†Two in early and 4 in delayed leaks.
postsleeve leaks using FCSEMS (Hanaro stent; MITECH). The authors made a distinction between early-onset (<7 d) and late-onset (>7 d) leaks. Healing occurred in 12 of 14 early leaks (86%) but only 2 of 4 delayed leaks (50%). A median of 2 and 4 stents per patient was required in early and delayed leaks, respectively. Stent migration occurred in 44% of cases.

**Bariatrics-specific stents.** We recently published our experience with 62 patients treated by MEGA stents [30]. The approach relied on the use of MEGA stents in all patients with the occasional use of Over-the-scope clips (OTSC) clips simultaneously with stents or after stent removal in selected cases. Forty-six (74%) were sleeve gastrectomies, while 16 (27%) were RYGB. Leak closure was attained in 82% of patients solely by endoscopic techniques. The noticeable result was that this success rate was achieved with a low number of procedures per patient (3) and stents per patient (1.3). Stent migration occurred in only 11 of 62 patients (18%), a lower rate than the average 50% reported with other FCSEMS. This, however, comes at the expense of a higher incidence of stent-induced complications; pain and vomiting were almost universal, and intolerance necessitating premature removal occurred in 7 of 62 patients (11%). Deep ulcers at the site of impaction were seen in 58 patients (94%), perforation in 4 patients (6.7%), self-limited bleeding in 4 patients (6.7%), and esophageal strictures in 8 patients (13%). No stent-induced mortality occurred. Fishman et al. [31] treated 21 patients with postsleeve leaks using a slimmer version of the MEGA stent (20- to 24-mm diameter) with the same length (18–23 cm). Five patients were also treated using the long HANAROSTENT (18–22 mm, 24 cm; MITECH). Leak healing occurred in 17 patients (73%) of patients. Similar to our experience, the authors made the same observation of a low number of stents required per patient (1). Despite the smaller diameter, nausea, pain, and ulceration also occurred universally. Stent migration occurred in 7 patients (27%).

The BETA stent was used to treat 10 patients with postsleeve leaks [16]. After a mean duration of stenting of 34 days, healing occurred in 8 of 10 (80%) using stents alone and eventually in all patients with additional endoscopic procedures, such as double-pigtail stents. Migration occurred in 2 patients (18%), and this was attributed to a wider mesh design that was particularly tested in these 2 stents. Similar to the MEGA stent, nausea and vomiting occurred universally in all patients, and symptoms were tolerated after a mean of 10 days of symptomatic treatment.

The larger stents such as the MEGA and BETA seem to perform well, with lower migration rates and a lower number of procedures and stents required per patient, as well as maintaining the advantage of a simple 1-step extraction. However, this comes at the expense of noticeably higher complication rates. The GASTROSEAL stent was designed with a similarly large caliber, yet with negligible axial force and a rounded nontraumatic distal edge to reduce the risk of ulceration/perforation and improve patient tolerance. Experience is still limited; in 3 patients with postsleeve leaks, the GASTROSEAL achieved healing in all 3. The stents were well tolerated and most importantly no ulcers were observed at the site of stent impaction (Fig. 3) [17].

**Factors associated with stent success**

In view of the low number of patients in each study, it is difficult to depict the factors associated with success of stent therapy. Nevertheless, it is now clear that earlier endoscopic intervention is strongly associated with successful outcome [19–22]. Other described factors include shorter interval between surgery and diagnosis of the leak, smaller fistula size, male sex, and absence of a history of gastric banding. In 1 study including 27 patients, 13 presented early (<30 d after the diagnosis of leak) while 14 presented late (>30 d) [19]. Although healing eventually occurred in all patients, those treated by stents earlier achieved healing in a significantly shorter time (95 versus 210 d, $P = .005$). The results were mirrored in a similar study by Quezada et al. [20] including 29 patients: The use of stents as the

![Fig. 3. The GASTROSEAL stent (MITECH) inserted simultaneously with an over-the-scope clip, (red arrow) in a gastric sleeve. The stent is notably flexible and extends from the esophagus to the duodenum. The rounded lower edge is specifically designed to reduce trauma to the duodenal bulb.](image-url)
primary therapeutic choice was associated with a significantly shorter leak resolution time compared with its use as a salvage after failed surgical attempts at leak repair (50 versus 109 d, \( P = .008 \)). In a multivariate analysis by Murino et al. [21] including 91 patients, male sex \( (P = .035) \) and delay between surgery and SEMS placement \( (25 \text{ versus } 49 \text{ d}; P = .042) \) were independently confirmed as positive predictive factors for success using a single stent. In a multicenter study including 110 patients with post-sleeve leaks, 80 had stents inserted. Multivariate analysis identified 4 predictive factors of healing after endoscopic treatment: interval <21 days between leak diagnosis and first endoscopy \( (P = .003) \), small fistula \( (P = .01) \), interval between sleeve gastrectomy and leak ≤3 days \( (P = .01) \), and absence of a history of gastric banding \( (P = .04) \) [22].

Of all the factors mentioned, earlier intervention is the most evident and reproducible factor associated with success and is actually the only modifiable factor. Therefore, it cannot be understated that earlier endoscopic intervention is imperative. Although in a few studies large leak size has been shown to be associated with poorer outcome, we do not believe that leak size should deter an endoscopist from attempting to treat it. We and other authors have successfully treated leaks up to 4 cm in diameter and almost complete dehiscence of gastrojejunos- tómies [15]. So long as other factors pertaining to healing are addressed (e.g., adequate nutrition, absence of foreign bodies, distal stricture, infection), large leaks may respond very well to endoscopic interventions.

**Adverse events**

Stent migration remains the most common complication, representing the “Achilles heel” for this technique and occurring in approximately 44% to 59% (FCSEMS) and 6% to 15% (PCSEMS) [11,19–21,25–29]. Stent migration necessitates repeated procedures for repositioning and, more importantly, leads to failure of healing. Migrated stents are usually easily retrievable endoscopically; however, stent migration into the small bowel necessitating surgical intervention has been occasionally reported [32–34]. Having an uncovered part of the stent (PCSEMS) is probably the best antimigration feature available to date. However, these stents come with some significant drawbacks. First, stent extraction is difficult necessitating by default an additional procedure and stent (stent-in-stent technique). Second, esophageal strictures are common after stent extraction, occurring in 13% at a mean of 52 days in 1 large series [21]. Finally, stent extraction is not possible in rare cases despite the stent-in-stent technique necessitating surgical intervention [13]. The newer bariatrics-specific stents are fully covered but depend on their large size and better conformability to the angulated lumen as antimigration features. The longer length seems to be the more effective feature as the distal edge of the stent abuts against the duodenal bulb (in sleeve gastrectomy) or first jejunal loop (in RYGB) preventing further migration [15–17]. Fixation of stents with TTS clips has largely proven ineffective, yet the larger OTSC clips (OVESCO, Tubingen, Germany) are very effective in fixing the upper edge of the stents to the esophagus [19,35,36]. Stent extraction, however, becomes difficult, necessitating breaking the OTSC using Argon plasma coagulation or a dedicated clip cutter (OVESCO, Tubingen, Germany) before extracting the stent. Suturing the stent to the esophageal wall using the Over-stitch device (Apollo Endosurgery, Austin, TX) was successful in 43 of 47 patients (91%) in 1 study [37]. It remains, however, a relatively costly and complex procedure.

Nausea, vomiting, and pain occur almost universally with the use of stents, but intolerance necessitating early removal is rare. Larger stents seem to be less tolerated, with up to 11% requiring premature removal in 1 study [30]. In our experience, paradoxically, a semisolid diet may be better tolerated than liquids. Esophageal strictures are commonly reported with the use of PCSEMS due to tissue hyperplasia (14%) and with ultra-large stents due to ulceration caused by stent compression (13%) [21,30]. These strictures usually respond to endoscopic balloon dilation; however, they may be tenacious and require several sessions of dilation due to the intense fibrosis [21].

The incidence of major adverse events (namely bleeding and perforation) is low but not negligible (3%–7%), with a stent-related mortality of <0.5% [10,12,38]. The occurrence of adverse events is unpredictable, but a few factors have been shown to be related. In 1 study, a longer duration of stenting was associated with more complications, stenting for less than 2 or 4 weeks led to a reduction of 56% and 39% in the occurrence of stent-induced complications, respectively [39]. In our experience with large stents, a history of open surgery was strongly associated with the occurrence of complications [30]. In a series of 62 patients, only 7 had an undergone open surgery, 5 (77%) of whom suffered major complications (bleeding, perforation, stric- tures) in comparison to only 10 of 55 (18%) of those without open surgery (\( P = .002 \)). Our hypothesis is that the intense adhesions to the abdominal wall render the gastric sleeve or jejunal loops (in case of RYGB) adherent and fixed to the abdominal wall. This lack of flexibility makes the tissue much more vulnerable to the traumatic edges of the stents. We now rarely use stents (especially large ones) in patients who have undergone an open surgery.

**Double-Pigtail Plastic Stents (Endoscopic Internal Drainage)**

Double-pigtail transfistulitary plastic stents are rapidly gaining popularity as a therapeutic modality for leaks. They differ morphologically and conceptually from self-expandable stents, yet they are correctly named “stents” as they conform to the definition: “a tube designed to be inserted into a vessel or
passageway to keep it open.” Paradoxically, this type of stenting aims to maintain the patency of the fistulous track rather than closing it. Synonymous to pancreatic pseudocyst drainage, the aim is to ensure continuous drainage of the contents of the leak cavity into the stomach. This will lead to collapse of the cavity and stimulation of granulation tissue formation and the eventual closure of the leak. The concept may sound counterintuitive, but it has been well proven to be effective [11].

**Technique**

The same prerequisites for endoscopic therapy by SEMS (e.g., timing, setting, experience) apply also to endoscopic internal drainage (EID), with 1 major exception: Drainage (surgical or percutaneous) may not be essential in all cases provided the patient is stable and that EID can adequately drain all collections. After passage of a guidewire into the leak cavity, one to three 7- to 10-Fr double-pigtail stents are inserted with one end in the leak cavity and the other in the digestive lumen (Fig. 4). A side-viewing endoscope may be used to facilitate the insertion due to the tangential position of the leaks, especially after sleeve gastrectomy. Once EID is performed, any external drains should be removed immediately. Persistence of any external drain may provide a lower pressure system with preferential drainage through this external drain, leading eventually to a chronic cutaneous fistula. There is still no consensus on the timing of resuming oral feeding, but most authors recommend at least 4 weeks of nasojejunal tube (NJT) feeding [40–43]. Conversely, some endoscopists prefer commencing oral feeding earlier.

![Fig. 4. Endoscopic internal drainage. (A) Leak from gastric pouch localizing to a collection in the left subphrenic space. (B) A guidewire is passed into the leak cavity. (C) Two 10-Fr double-pigtail stents inserted. (D) Four weeks later, complete resolution of the leak after removal of the stents. (E) The double-pigtail plastic stent (Solus stent; Wilson-Cook Medical, Winston-Salem, NC, stent image (4.E.) obtained from www.cookmedical.com with permission).](image-url)
feeding early and using NJT feeding only if leakage is still evident on contrast studies. There is also still no consensus on the time of stent removal. Commonly, the stents are removed after 4 weeks, and another stent is inserted for a longer period if the leak still persists.

Outcomes

In comparison to SEMS, experience with EID is still very limited. After the initial report by Pequignot et al. [11], only 3 case series have so far been published [41–43]. Donatelli et al. [42] have the greatest experience with this technique, applying it to 67 patients with postsleeve leaks; 9 of patients, however, were still being treated at the time of publication. EID was performed at a mean of 60 days after the inciting surgery. A mean of 3.1 endoscopic sessions and 57 days were required to achieve healing in 50 of 58 patients (86%). It should be noted that only 26 (52%) achieved healing after only 1 endoscopic attempt. Oral feeding was possible in only 11 patients; 41 required NJT feeding, 6 surgical feeding jejunostomies, and 8 parenteral nutrition. The same group recently published their experience with EID in 33 post-RYGB leaks [41]. Similarly, only one third of patients achieved healing after 1 endoscopic attempt (10/33); however, all leaks (33/33) healed after the second attempt. Perhaps the most interesting finding was the occurrence of gastrogastric fistulas in 21 patients (64%). The authors described these as insignificant as all patients had significant weight loss. Bouchard et al. [43] also used EID in 33 patients with postbariatric leaks (28 sleeve, 5 RYGB). Success was achieved in 79%. Noticeably, success was similar in patients who had already failed previous endoscopic attempts including SEMS.

Adverse events

Complications are rare but not completely benign, as previously thought. External stent migration has been reported to occur to the spleen, causing splenic abscess formation and bleeding [44,45]. In 1 case, migration occurred into the abdominal wall, leading to abscess formation [46]. Pneumoperitoneum has been reported in 2 patients; it is caused by perforation of the leak cavity by the stent during insertion [42]. In both patients, no surgery was required, and the condition resolved by conservative measures. Strictures occurred in 9% of patients in one series; the cause is postulated to be the granulation tissue induced by the stent and subsequent intense fibrosis [42]. In 1 recent series, premature stent removal was performed due to ulcers (3/33) and intolerable symptoms (3/33) [43].

SEMS versus EID

To date, there is still no agreement on the “optimal” endoscopic technique for the management of leaks, and probably there never will be. This is due to the basic fact that not all leaks are the same and numerous factors contribute to the persistence of a leak. Accordingly, each patient may benefit the most from a different endoscopic technique. SEMS have the major advantage of being able to treat concomitant strictures, which are frequently the inciting factor for the occurrence and persistence of a leak. The other significant advantage is the early resumption of oral intake and avoiding the need of NJT feeding. Drawbacks include pain and vomiting, stent migration, rare complications such as bleeding and perforation, and finally the very poor performance in late/chronic leaks. The beauty of EID lies in the minimal discomfort to the patient and good results even in chronic leaks. Drawbacks include the dependence on NJT feeding in the majority of patients, the possibility of external migration, and frequent formation of gastrogastric fistulas. EID is also frequently not possible in very early, large leaks as there is no clear leak cavity or fistulous track to stabilize the stent in place (Table 2). In our practice, the main role of EID is in delayed/late leaks with a well-defined leak cavity or after failure of SEMS. Otherwise, SEMS perform very well, especially if applied within the first week.

Table 2

<table>
<thead>
<tr>
<th>Concomitant strictures</th>
<th>Nasojejunal feeding</th>
<th>Contained leak cavity</th>
<th>Intolerance</th>
<th>Migration</th>
<th>Efficacy in late leaks</th>
<th>Overall success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated by the stent</td>
<td>Not required</td>
<td>Not a prerequisite</td>
<td>Very common</td>
<td>Common</td>
<td>Poor</td>
<td>~80%–90%</td>
</tr>
<tr>
<td>SEMS</td>
<td>EID</td>
<td>SEMS</td>
<td>EID</td>
<td>EID</td>
<td>EID</td>
<td>EID</td>
</tr>
<tr>
<td>Self-expandable stents</td>
<td>Endoscopic internal drainage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

SEMS remain a very effective, minimally invasive method for the treatment of post–bariatric surgery leaks, especially if used very early. SEMS are generally safe but should be used with vigilance and proper awareness due to the rare but serious nature of their complications. Current stent designs are still far from optimal; the new bariatricspecific stents hold promise for better results and hopefully better tolerability and lower migration rates. Double-pigtail stents are similarly effective and are a welcome addition to the armamentarium of endoscopic therapies for postsurgical leaks. Both SEMS and EID should be used interchangeably rather than be considered competing methods, as both have a clear role in the management of post–bariatric surgery leaks.

Disclosures

Dr. Shehab is a consultant and speaker for MITECH and speaker for Boston Scientific.
References


