3 Interventional Endoscopy: Endoluminal Therapy – Stenting, Clipping, and Suctioning

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Introduction

As the global obesity epidemic rages on, the bariatric surgeon remains an integral part of its solution. Bariatric surgery is the most effective therapeutic option for the treatment of morbid obesity [1]. The minimally invasive bariatric surgeon first stepped to the forefront with the shift from open to laparoscopic surgical approaches. Compared to open surgery, laparoscopic bariatric surgery decreased wound infection rates, lengths of stay, postoperative pain, and overall mortality [2]. Ongoing refinement of effective surgical pathways continued to drastically lower morbidity and mortality [3]. This improved safety profile increased the number of procedures performed worldwide. In the United States alone, the number of procedures approached 216,000 in 2016 [3].

Increasing procedures translated into an obvious increase in the incidence of postoperative bariatric complications. The bariatric surgeon has, out of necessity, once again stepped up to meet the challenges of managing the obligatory rise in complication occurrences. The bariatric endoscopist has an expanded arsenal available as a wide array of endoscopic options has emerged. In the appropriate setting, these lower morbidity procedures offer non-operative alternatives, provide primary definitive management, function as a bridge to more definitive operative management, and provide the opportunity for patient optimization in the interim. The following is a description of the role of endoscopic therapies for bariatric surgery complications.

Leaks

A leak is the most dreaded and morbid complication in bariatric surgery. Leaks can occur either at the anastomoses, along the gastric remnant or gastric pouch staple lines for the Roux-en-Y gastric bypass (RYGB) patient, or along the gastric staple line for sleeve gastrectomy (SG) patients. Overall leak rates for primary operative events vary between 1% and 5% for RYGB and 0 and 8% for SG. The leak rates for revisional surgery are substantially higher at ~13% [4, 5]. The technical and epidemiological factors predictive of a leak remain debatable. Recent studies, however, support that the type of anastomosis (stapled vs. hand-sewn) does not affect leaks rates [6]. Moreover, the use of staple line reinforcement is

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protective [7], and the use of buttressing is deleterious [8]. Several studies have demonstrated that male sex, age > 55, diabetes mellitus (DM), sleep apnea, revisional surgery, and super obesity (BMI > 50) are associated with higher leak rates [9].

Timely diagnosis of a leak remains challenging given the lack of specificity in its clinical presentation in the morbidly obese patient. Objective diagnosis is often quite difficult, if not impossible, as contrasted imaging series and CT scans are often negative despite the presence of a leak [10]. The bariatric surgeon must be ever vigilant as symptoms of abdominal pain, nausea, and emesis are not uncommon after bariatric surgery. A high index of suspicion is essential for prompt diagnosis as sustained postoperative tachycardia may often be the only signal of an early complication. Vital sign abnormalities including tachycardia, fever, and tachypnea herald sepsis and, in these vexing situations, operative exploration should remain part of the diagnostic algorithm especially in the hemodynamically abnormal patient.

Presentation of a postoperative leak can occur over a range of days to weeks. Leaks presenting within 5–7 days after surgery are considered early leaks, while those presented after this early period are considered late [11, 12]. The timing of presentation offers insight into the potential etiology for failure and helps to guide the surgeon's management strategy. Leaks presenting within 48–72 hours of surgery are usually due to technical failure. Later presentations are more likely due to tissue ischemia related to tension, inadequate blood supply, and distal obstruction.

Prompt diagnosis is a major determinant of outcome. Early recognition with earlier initiation of therapy prevents ongoing progression of the local injury and increasing morbidity. Delays in therapy of more than 24 hours are associated with a significantly increased mortality rate [13]. Contrast media imaging studies, CT scan, and endoscopic evaluation in hemodynamically stable patients are useful tools in the diagnostic workup.

For RYGB, up to 68% of leaks occur at the gastrojejunal anastomosis (GJA), 10% at the gastric pouch, 7% at the jejunojejunal anastomosis (JJA), 4% at the remnant stomach, or (14%) at a combination of these [11]. SG leaks occur along the gastric staple line with more than 75% occurring along the proximal third of the stomach near the cardiac notch [14]. SG leaks are most commonly due to increased pressure within the lumen due to narrowing at the incisura, followed by tissue ischemia due to ligation of the short gastric vessels.

Hemodynamically unstable patients presenting with hypotension, tachycardia, and a suspected leak mandate operative exploration, drainage, repair, and initiation of nutritional support regardless of the timing of the presentation. Stable patients presenting early after surgery (within 48–72 hours) with suggestion of technical failure are also best managed with early operative intervention for drainage, control, and possible repair of the leak.

Hemodynamically stable patients with small, controlled anastomotic leaks (<2 cm) can be safely managed non-operatively with medical management, bowel rest, nutritional support, percutaneous drainage, and broad-spectrum antibiotics [10]. While often effective, this approach may require intensive care unit admissions, prolonged hospital stays, and extensive resource use. Even with early control using a conservative approach, patients may still require reoperation for definitive therapy.

Ultimately, patient presentation dictates the plan of care: unstable patients require surgery; stable patients may be safely managed non-operatively. For those patients in between, a wide variety of options exist, and the plan of care is not standardized. Interventional endoscopy is emerging as a useful option for prompt diagnosis and initiation of therapy for those patients in the middle – the hemodynamically stable patient with a controllable leak.

Early endoscopic evaluation is not only safe [15], it is essential for providing accurate defect localization and thorough interrogation of the defect characteristics. An important first step involves endoscopic debridement of necrotic tissues and irrigation and drainage of the suppuration. After this preparation a thorough endo-

scopic assessment of the area can take place as well as endoscopic drain placement within the extraluminal abscess cavity. Endoscopic evaluation should include localization of the defect noted as distance from the incisors, defect orientation relative to adjacent structures, defect diameter, and extraluminal cavity dimensions if possible. These details assist with formulating the therapeutic strategy and plan. Additionally, endoscopic preparation of the site prior to endoscopic therapy improves luminal control with subsequent sepsis control and progression toward overall healing and leak resolution.

Stenting

Endoscopic stenting and internal drainage for containment and coverage of the leak allow for sepsis control and early nutritional support with enteral feeding. Improved nutrition and resolution of the systemic burden contribute to primary healing and sealing of the leak. Even if a complete seal is not achieved, control of the leak at least provides a stable bridge for patient optimization in preparation for definitive operative management with improved outcomes.

Endoscopic stenting can be considered for leak management at the RYGB gastrojejunal anastomosis and for leaks along the SG gastric staple line. Endoscopic stenting is an appropriate therapeutic option in stable patients with a leak controlled by adequate external drainage. Stenting encourages healing and sealing of the leak site by providing coverage of the defect and isolation of the area of injury. Additionally, the stent exerts an outward axial force that decreases intraluminal pressure down the length of the stent, also promoting overall healing.

The stents of choice are self-expanding stents available in either plastic or metal. Plastic stents, once popular in the endoscopic management of esophageal pathology and perforation, are not well suited for post-bariatric patients due to their high axial force and high migration rates. Self-expandable metal stents (SEMS), however, are ideally suited for post-bariatric complications. SEMS are made of nitinol, which provides the advantage of combining flexibility while maintaining stent shape and integrity. SEMS exerts a lower axial force than plastic stents, making them more tolerable for the patient. To prevent tissue ingrowth into the stent, SEMS are either fully covered or partially covered. Fully covered (FC) stents are covered along the entire length with silicone or polyurethane, while partially covered (PC) stents leave an uncovered gap of 1–2 cm at both ends. FC stents will cover the leak site and are easy to remove, but they have a high rate of migration. PC stents allow for some tissue ingrowth, fixing the stent in place and ensuring diversion of luminal contents from the leak (Fig. 3.1). Removal of PC stents, however, is more difficult and prone to complications.

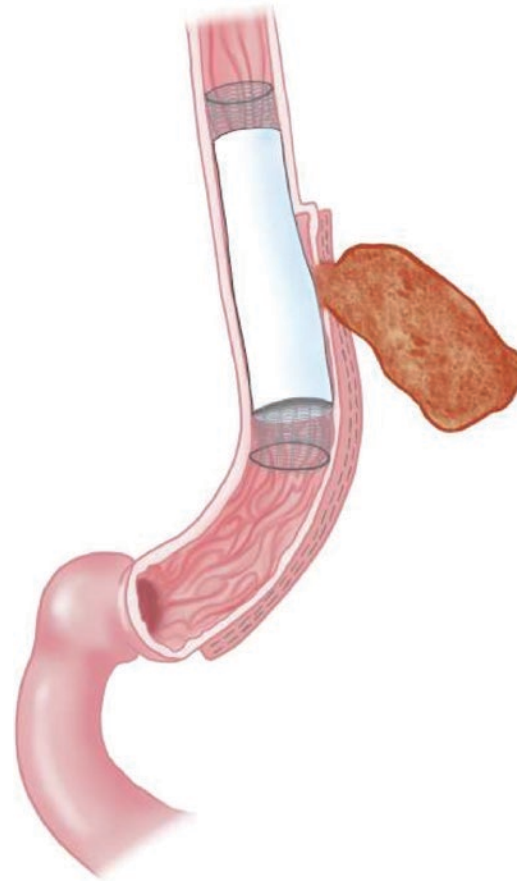

Fig. 3.1 Depicting partially covered stenting of a sleeve gastrectomy leak

Bariatric-specific stents have been recently developed and provide a promising alternative to standard linear stents. These newer stents are fully covered and specifically contoured to the anatomy of a postoperative RYGB or SG patient. They also attempt to decrease the axial force of the stent, making them less prone to migration. Their larger diameter, however, can increase pain and nausea and is thus not always well tolerated.

Endoscopic management of postoperative bariatric complications requires appropriate patient preparation. Enlisting anesthesia support for the administration, monitoring, and management of anesthesia during the procedure is essential. General anesthesia is often necessary for these complex procedures to ensure safe airway management. Anticipate longer procedure times if debridement and drainage of the leak cavity are required. Stent choice also dictates procedural preparation. SEMS placement requires fluoroscopic support during the procedure for accurate localization of the leak site and thorough interrogation of its extent prior to stent placement. Moreover, fluoroscopy confirms stent positioning and ensures appropriate deployment. The smaller caliber through-the-scope stents do not allow for fluoroscopic visualization during the procedure to confirm final stent placement.

Nausea and pain should be anticipated after stent placement and appropriately managed. After 24–48 hours of clinical stability, a liquid diet can be initiated if a contrast imaging study confirms satisfactory stent position and control of the leak site. Early initiation of oral nutrition, starting with liquids and semisolids, represents the greatest benefit of early endoscopic stenting of bariatric complications as improved nutrition promotes leak resolution.

The duration of endoscopic stent therapy varies. Recent reports suggest that stent therapy lengths between 4 and 6 weeks suffice; however longer treatment durations are sometimes required to ensure complete closure of the defect. Increasing the treatment timeline, however, needs to be balanced with the increased risk for complications associated with longer durations [16].

Close outpatient follow-up is essential and should be established every 1–2 weeks. Routine imaging monitors the stent's position and allows for early identification and management of issues that may require repeat endoscopic intervention. Symptoms suggestive of a stent complication, such as increased pain, nausea, or poor oral tolerance, should prompt evaluation. Additionally, stent type and size should be considered when interrogating post-procedural complaints. Larger stent diameters, like those seen with bariatric-specific stents, have a higher incidence of pain and vomiting as well as deep ulceration at the stent borders causing bleeding, perforation, and post-inflammatory stricture [17].

Most series report that approximately 80% of endoscopically stented leaks clinically resolve [16–18]. A recent review article comparing leak resolution by stent type demonstrated success rates of 76–94% with PC stents, 77–100% with FC stents, and 73–100% for bariatric-specific stents [17]. Leak resolution can be correlated to leak size and time from surgery to stent placement. Larger leaks diagnosed later in the postoperative course have a lower rate of closure, often requiring a longer duration of treatment and need for repeated intervention.

These reassuring resolution rates make temporary endoscopic stents useful tools in early leak management. More importantly, even if complete clinical leak resolution is not primarily achieved, temporary stent therapy can provide a valuable window of time to optimize a patient prior to definitive repair.

While the reported endoscopic stenting success rates of 80–90% are impressive, there are serious drawbacks warranting consideration. Although complications uncommonly occur during stent placement, post-procedural issues are common. Stent migration rates of 34–60% are expected for FC stents, 18–27% for bariatric stents, and 6–15% for PC stents [17]. The high migration rates for FC stents may mean repeated intervention and the possibility of prolonging therapy duration [19, 20].

Complications due to the radial traction of the stent along the intestinal wall occur in ~20% of individuals. These include digestive wall trauma, mucosal ingrowth, mucosal friability, and resulting post-inflammatory strictures, which

are attributed to longer treatment durations and PC stents. The higher rate of post-inflammatory esophageal stricture associated with PC stents may require balloon dilation [18]. Mortality rates of less than 5% are expected and are usually due to the intense inflammatory processes causing erosion into adjacent structures resulting in aorto-esophageal, aorto-enteric, and tracheoesophageal fistulas. Most fatal events are noted upon stent removal; thus a thorough understanding of the relationship of the zone of damage with its surrounding structures is mandatory when determining the feasibility of this therapeutic option.

After the anticipated 4–6 weeks of stent therapy, removal typically requires the use of simple endoscopic forceps securely grasping the proximal end of the stent and withdrawal along with the endoscope. Longer therapeutic durations increase the time for tissue integration and mucosal trauma upon removal. Significant tissue ingrowth, particularly with PC stents, may necessitate stent removal with either argon beam ablation of the area of hyperplasia or utilization of the stent in stent technique. The stent-in-stent technique deploys a second FC stent inside the first stent. Over a few weeks, the increased pressure generated causes ischemia in the hyperplastic tissue, thus allowing easier removal of both stents.

The high success rates with relatively low morbidity of SEMS make it an effective tool in the management of leaks after bariatric surgery. Although complication rates are high, they are often not severe and are typically managed endoscopically and with less morbidity than re-operative events. Additionally, even with failure of defect closure, these procedures offer leak control and initiation of nutrition repletion allowing for reduction and ultimate resolution of the systemic burden, optimizing the patient for future definitive interventions.

Clipping

Another important tool available to the bariatric endoscopist is the unassuming endoscopic clip. Through-the-scope endoscopic clips have been available for nearly 40 years. Previously primarily used for hemorrhage control due to ulceration, Mallory-Weiss tears, diverticular bleeding, or high bleeding risk polypectomy sites, its role expanded in the 1990s as the bariatric surgeon's endoscopic experience increased. Improved clip technology further advanced its use as an adjunctive tool for securing stents, feeding tubes, fistula closure, sealing of the luminal entry site in experimental natural orifice transluminal endoscopic surgery (NOTES), and for the management of bariatric postoperative anastomotic leaks and perforations [21].

Earlier generations of endoscopic clips were reusable varieties that required manually reloading a disposable clip placed onto a hook at the end of a reusable metal cable that ran through a plastic sheath. Disposal preloaded versions are now more commonly used. Modern preloaded clips further expanded its application for more complex issues as ease of use offered the endoscopist increased speed, maneuverability, and control. Improvements including increasing jaw opening diameters (5–11 mm), eliminating the need for plastic sheathing, and adding the capacity for clip reopening prior to finally deployment allow for increased flexibility of use. The bariatric surgeon can now seriously consider use of the endoscopic clip as a viable adjunct or alternative endoscopic tool for expanded indications. The endoscopist must be aware, however, of the appropriate FDA-approved indications for the selected device.

Two-pronged clip options are the most commonly used. Three major options are available in the United States: Cook Medical Instinct (USA, 2011), Olympus Corporation QuickClip Pro (Japan, 2014), and Boston Scientific Corporation Resolution Clip 360 (USA, 2016). Indications for use include endoscopic marking, hemostasis, affixing jejunal feeding tubes to the bowel wall, as well as a supplementary closing method for GI tract luminal perforations <20 mm that can be treated conservatively. Small luminal defects may be closed with serial clip placement, reducing the defect size with each subsequent clip application, until the tissues are re-approximated (Fig. 3.2).

Accurate and secure placement is possible with the ~11 mm jaw spans that can be opened and closed up to five times prior to final clip

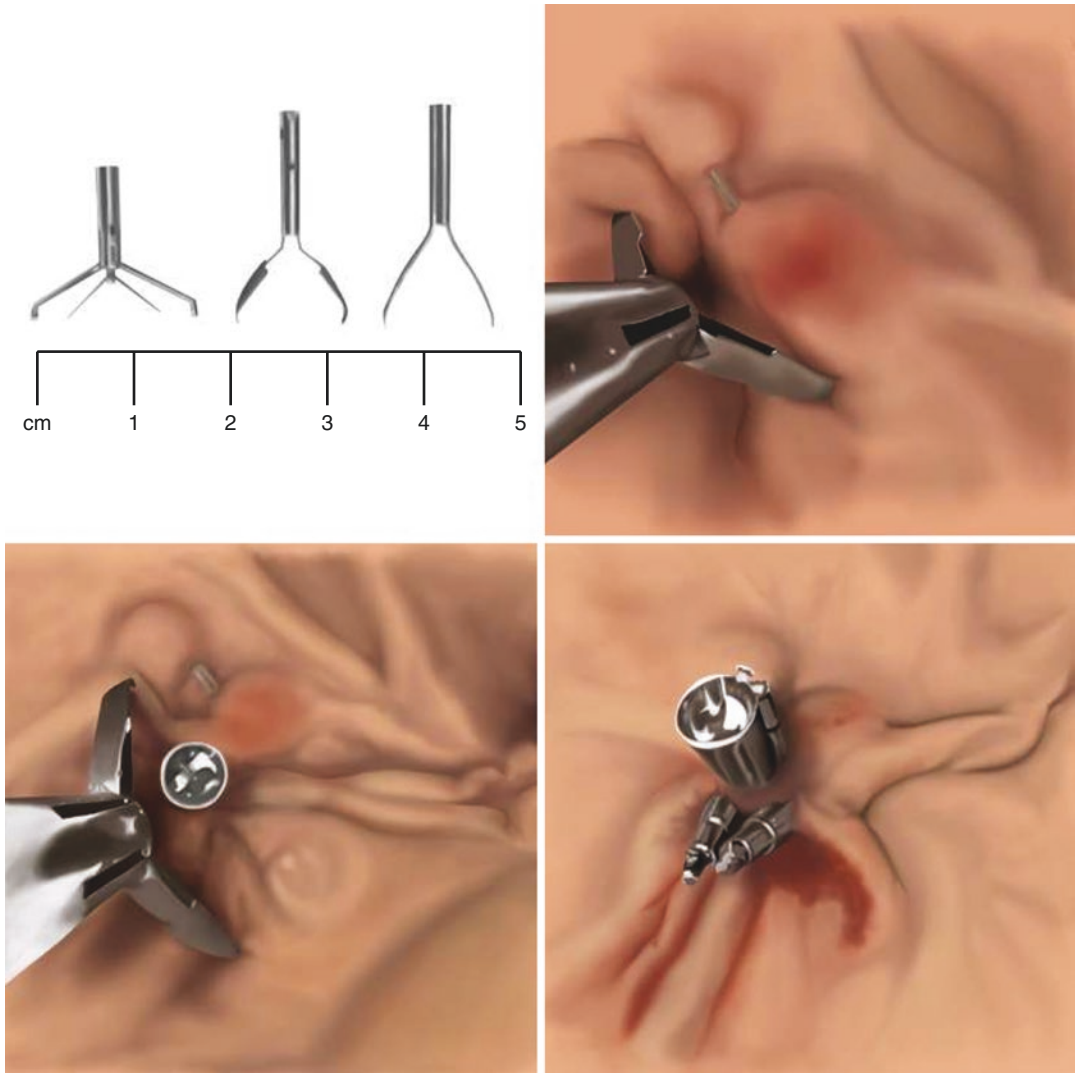

Fig. 3.2 Through the scope clip options for intraluminal control of bleeding/perforation

deployment. Today's endoscopist also benefits from the 360°, one to one positional rotating capacity and tactile feedback provided through the cable during manipulations available with these modern endoclips. Note that the capacity for full rotation and repeated opening and closing may be limited by the patient's anatomy, torque forces applied along the scope, and the unique conditions of the case.

Prior to committing to the final position, the endoscopist must confirm the clip's firm grasp of the tissues prior to complete closure to ensure maximum tissue capture. Once confirmed, the GI technician firmly squeezes for final clip deployment. The clip should unhook spontaneously from its inner cable. Once free from the clip, the catheter can be removed from the scope. If the clip remains attached to the cable, a gentle "jiggle" along the catheter encourages complete disengagement of the clip. Care should be taken not to remove the catheter until the clip is completed unhooked from the inner cable, otherwise tissue injury or clip dislodgement can result.

Two endoclips (QuikClip Pro [Olympus Corporation, Japan] and Instinct [Cook Medical, USA]) require a plastic over sheath. Clip deployment with these devices requires advancing the clip beyond the plastic over sheath to expose all portions of the clip's functioning mechanism. Advancement partially opens the clip as it is pushed forward. The clip is then "primed" by squeezing the trigger part way. This opens the clip to its maximum diameter. Once "primed" and fully opened, this clip can now be directed toward the target tissue. The GI technician needs to be aware that if the trigger is squeezed too far, the clip will start to irreversibly close, severely limiting its full function. With the clip properly "primed" in its fully opened position, the desired deployment site is targeted and squarely placed between the clip jaws with endoscopic maneuvering. If needed, clip rotation at the catheter or by the technician is done prior pressing the clip firmly against the target tissue. Once the clip is in position, the GI technician then squeezes the trigger all the way until a "click" is heard and felt. This completes the deployment cycle, and the clip can no longer be opened. The clip is released from the catheter in a similar fashion to that described above.

Studies comparing the various clip options have not identified dramatic differences between them. It is more important to be familiar with the selected device and to ensure appropriate patient selection and indication for use. Remember that the through-the-scope clips will have limited efficacy in primary leak closure if the defect is too large relative to the maximum clip opening width and if poor tissue quality precludes durable apposition of healthy tissue. Additionally, discussion with the GI technician team prior to use of a specific clip ensures the team's familiarity with the selected device and the overall success of the procedure.

Over-the-scope clips (OTSC) have shown promise as a more effective option for leak seal. These clips are larger and have been used to close leak defects up to 3 cm with good result. Small, clean defects are best suited for clip placement as a stand-alone therapy for closure. Larger defects with friable tissue are better approached with stenting in addition to clips. Leak closure rates of ~ 80% have been reported when a combination of endoscopic procedures, either concurrently or in series, is utilized. Clip placement for leak closure is often combined with stenting and fibrin glue application [22–24]. While earlier studies primarily looked at clipping leaks from LSG, more recent data has confirmed the utility of clipping for RYGB surgery as well.

The OTSC system (Ovesco) is assembled prior to insertion of the endoscope. The clip comes loaded onto a cap that is placed over the tip of the scope. A string connected to the clip is pulled through the working port of the scope and into the endoscopists' hand. The scope is placed over the visualized defect, and suction is used to bring the tissue into the cap, while the endoscopist pulls the string, and the clip is deployed. Clips and caps both have different sizes, and selection is based on the specific characteristics and dimensions of the defect.

An essential tenet for success in endoscopic therapeutic modalities is meticulous preparation of the target tissue. Adequate drainage of the leak cavity and debridement of necrotic tissue if present is imperative prior to attempts at endoscopic closure. Debridement and freshening of the edges of the leak cavity with the argon plasma coagulation prior to clip placement encourage local inflammation, incite wound healing, enhance scarring, and improve wound closure.

All of the options discussed are more effective when key concepts that significantly improve accurate and secure clip placement are carefully considered. First and foremost, effective clip deployment is best achieved when the distance between the scope and the target tissue is minimized. It's best to keep the clip tip to within 2–4 cm from the scope tip to improve accuracy, ensure appropriate deployment, and prevent bowing or bending of the catheter. Increasing the exposed catheter length decreases the translational force to the tissue, decreasing overall accuracy and control. Additionally, keeping the catheter perpendicular to the target tissue minimizes a tangential approach, which improves accuracy, maximizes the amount of tissue captured, and ensures proper clip deployment. If a

retroflexed position is needed, advancing the catheter out of the scope before retroflexion eases navigation beyond the extreme angulation at the scope tip. Most importantly, have a clear and confirmed strategic plan before exposing the clip. Extraneous maneuvering of the scope with an open clip can cause luminal damage or dislodge the clip from its catheter prematurely.

Suctioning

Intraluminal techniques, such as stenting, provide leak coverage and prevent growth, but often ignore and isolate the associated extraluminal cavity. Cavity isolation can lead to abscess formation and ongoing systemic sepsis. Access to these cavities, even with radiographic guidance, can be difficult. Although endoscopic stent placement is an option and procedural risks are low, as stated before, post-stent complications other than migration can be expected in up to 22% of patients [19, 25].

An emerging alternative is endoscopic vacuum-assisted closure (Endo VAC) therapy. Endo VAC therapy was first reported in 2008 for the treatment of anastomotic leaks after anterior resection of the rectum [26]. Its use has since expanded to the management of upper gastrointestinal leaks and bariatric surgery. High success rates of 60–80% with relatively lower morbidity have been reported confirming Endo VAC as a useful adjunct for leak and perforation management when conventional treatment options are unsuccessful or contraindicated. The minimally invasive nature of this therapy also contributes to its appeal.

The principles of therapy are based on the even distribution of continuous negative pressure suction by the open-pore polyurethane sponge attached to the tip of a drainage tube endoscopically positioned in the damaged zone of tissue (Fig. 3.3). The transnasal end of the tube is connected to the external vacuum system. Endoscopic assessment and preparation of the area confer the advantage of allowing potential sponge placement into the extraluminal cavity when feasible. The negative pressure

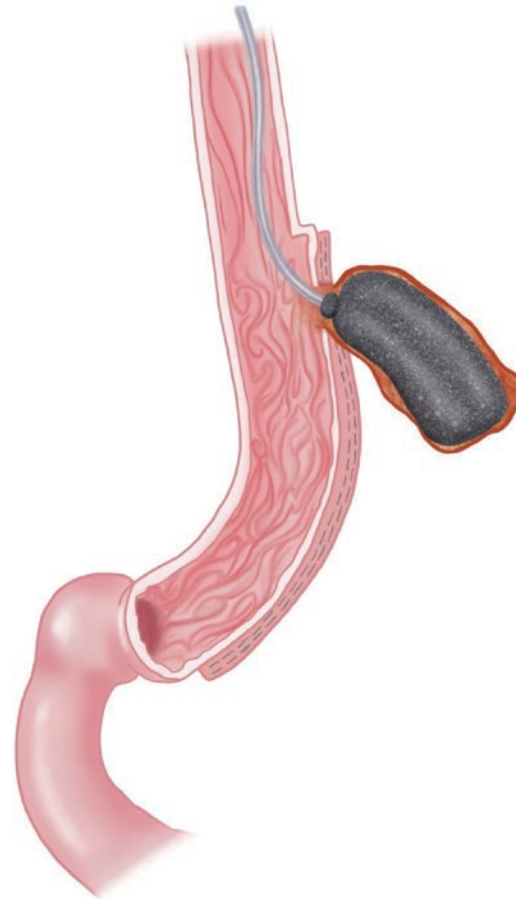

Fig. 3.3 Depicting Endo VAC therapy of a sleeve gastrectomy leak

mechanically clears intracavitary microorganisms and improves microcirculation that reduces interstitial edema. Collapse and closure of the extraluminal cavity occur as granulation tissue increases and re-epithelialization is initiated. After intracavitary closure as suggested by endoscopic evaluation or radiographic resolution, therapy continues with intraluminal placement of the polyurethane sponge, leading to primary defect closure. Alternatively, even if intracavitary sponge placement is not feasible, intraluminal sponge placement and external drainage of the cavity remain useful.

The initial Endo VAC procedure requires general anesthesia with the patient positioned supine. Endoscopic assessment is essential for appropriate sponge positioning. Thorough evaluation of

the luminal defect, its position from the incisors, orientation, and defect diameter as well as a similar assessment of the extraluminal cavity location and dimensions is essential. Gentle balloon dilation of the sinus tract improves access to and subsequent drainage of the extraluminal cavity. Placement of an endoscope overtube is sometimes necessary if a significant amount of preparatory intervention is required for this phase of the procedure. Preparation of the zone of therapy involves thorough irrigation and appropriate debridement of necrotic tissue.

Once endoscopic preparation and assessment is completed, a 12-French nasogastric tube (NGT) is placed transnasally and brought out through the mouth. The NGT may need to be trimmed to achieve the appropriate length. The sponge is tailored to fit the previously assessed leak cavity and secured to the tip of the NGT using 2-0 silk suture. The sponge should cover all of the NGT side holes. A looped suture is placed at the distal end of the apparatus to allow for guided placement using an endoscopic biopsy forceps.

A jaw lift maneuver opens the oropharyngeal area to allow for reintroduction of the gastroscope with the biopsy forceps within the therapeutic channel grasping the looped suture on the distal end of the sponge-tipped NGT. The sponge-tipped NGT is held alongside the gastroscope as the entire system is guided beyond the cricopharyngeal area. Once in the area of interest, the open-jawed forceps are used to push the sponge into the leak cavity. Once in position, continuous negative pressure at 100–125 mm Hg is applied prior to scope withdrawal. The pressure fixes the sponge in position, preventing dislodgement.

This apparatus is changed regularly, typically every 2–4 days, in order to prevent significant foam ingrowth into the wound cavity and for proper wound control. The suction must be interrupted when changing the Endo VAC tube apparatus. Gentle irrigation through the NGT with ~30–50 mL of sterile water also allows for ease of removal. Repeat endoscopic assessment allows for re-customization of the sponge if needed.

Procedure times of about 30–60 minutes should be initially expected. Procedure times are expected to decrease with subsequent treatment events as less time will be needed for endoscopic preparation and sponge customization. Preassembled Endo VAC sets for upper gastrointestinal leak and perforation management are also becoming more readily available commercially.

Treatment durations vary and depend on the wound response to therapy. Therapy should continue until the extraluminal cavity has completely collapsed and closed and the wound cavity is fully lined with granulation tissue. A recent series identified cavity characteristics associated with improved outcomes. Simple, contained, and relatively small cavity sizes of <8 cm in maximal dimension were more responsive to Endo VAC therapy. This group also noted an increased risk for procedure-associated complications in chronic, larger, loculated cavities. The chronicity of the inflammatory process and track fibrosis increased the risk of injury to adherent adjacent structures during Endo VAC tube changes and less responsiveness to therapy despite ongoing therapy [25, 27, 28].

Overall healing rates of 78–90% have been reported. Its minimally invasive approach demonstrated advantages over surgical revisions and primary SEMS management [25]. As previously discussed, differing endoscopic modalities can be employed in the same patient during different phases of the patient's treatment, depending on the specific need and situation. Endo VAC can easily be used in conjunction with other therapies, such as SEMS or endoclip placement, particularly after initial reduction of the extraluminal cavity by Endo VAC. The customizable and varied endoscopic treatment pathways nonetheless work toward minimizing morbidity and mortality and decreasing hospital lengths of stay. Of note, Endo VAC's promising primary healing rates and low morbidity demonstrate its potential to become a safe nonsurgical primary therapeutic approach to these complex and clinically challenging clinical problems [27, 28].

Endoscopic Internal Drainage (EID)

Another endoscopic technique that is gaining traction for leak management is internal drain-

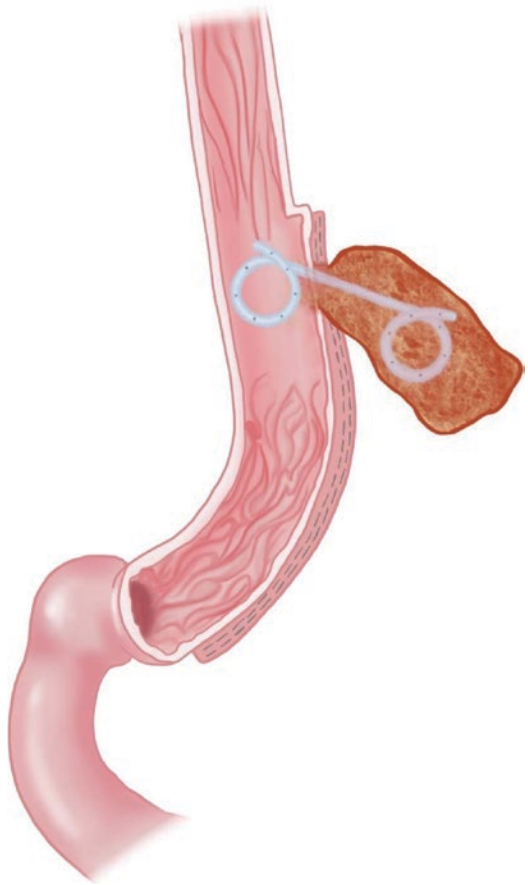

Fig. 3.4 Depicting endoscopic internal drainage of sleeve gastrectomy leak

age of the leak cavity using double pigtail plastic stents. A wire is endoscopically placed into the leak cavity, and one to three 7–10 Fr pigtail stents are inserted with one end in the cavity and the other in the natural lumen (Fig. 3.4). This encourages drainage of leak cavity contents into the natural lumen and also creates irritation by the plastic stents that stimulates epithelialization of the shrinking cavity [29, 30]. This helps to promote cavity closure as drainage continues. Internal drainage also allows for the removal of transcutaneous drains thereby avoiding fistula formation. There are few published studies on EID, but they show success rates of 86–100% and have fewer complications than stenting. One downside to EID is the need for longer treatment durations with average times until closure of 52 days [30] and a reliance on post pyloric enteral feeding. Data is also lacking on the optimal duration of therapy. Nevertheless, it is a safe and effective technique that is well tolerated and worthy of consideration in chronic leaks.

Bleeding

Bleeding complications associated with bariatric surgery can be described based on the temporal relationship of presentation to the operative event: intraoperative, the early postoperative period, and the late postoperative period. Endoscopic therapies can be applied for the management of either early or late bleeding presentations.

Early bleeding presents within 48 hours of the operative event. Early presentations can result from either intraluminal or intra-abdominal sources. Intra-abdominal bleeding can occur from any staple line created or adjacent organ injury and is best managed by urgent surgical intervention. Early bleeding occurs in 1–5% of bariatric patients after RYGB and 0–8% of SG patients [31].

For RYGB patients, intraluminal bleeding can occur at either anastomosis, but is most frequently seen at the GJ site. Bleeding can also occur from within the remnant stomach and the bypassed proximal gastrointestinal tract (Fig. 3.5). While rare, these scenarios must be considered in the RYGB patient presenting with gastrointestinal bleeding. Use of a double balloon enteroscopy or laparoscopic-assisted gastroduodenostomy may be necessary to access and interrogate the remnant stomach or bypassed intestinal tract as the source of bleeding.

Current literature supports the safe use of endoscopic therapies for the primary management of postoperative upper GI hemorrhage. Acceptable endoscopic therapies for hemorrhage control include sclerotherapy, surgical electricity, and clipping [32, 33]. Endoscopic clipping and sclerotherapy (Fig. 3.6) are the primary endoscopic methods employed, while monopolar or bipolar energy instruments for hemorrhage control are discouraged and should be used with caution. Use of electrosurgical modalities at the

Fig. 3.5 Depicting possible bleeding sites from Roux-en-Y gastric bypass

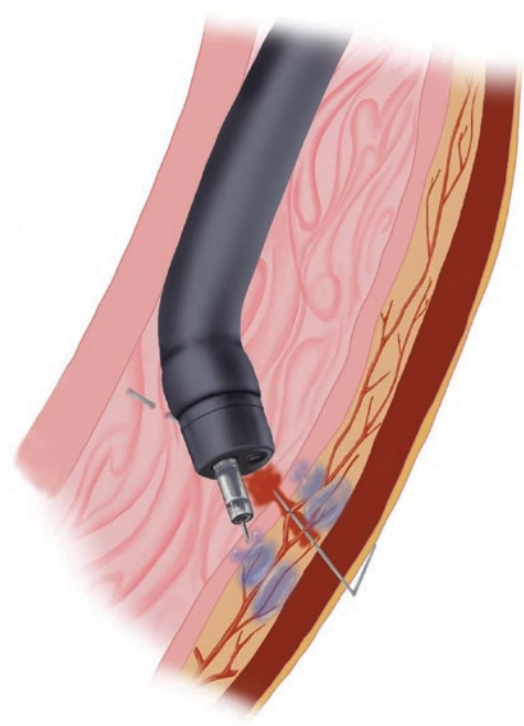

Fig. 3.6 Depicting endoscopic sclerotherapy of staple line bleeding

staple line invites the risk of thermal injury due to direct coupling with subsequent metal-to-metal arcing, resulting in injury that can lead to progressive tissue damage, ischemia, and possible necrosis with perforation.

Late bleeding is primarily due to an ulcerative processes. Patients often present with abdominal pain, nausea, emesis, and food intolerance in addition to clinical evidence of bleeding such as anemia. Endoscopic evaluation most commonly identifies the site of ulceration at the GJ anastomosis. Ulcers seen along the gastric side of the anastomosis (stomal ulcers) are typically due to ischemia secondary to technical factors of the operation. The etiological factors for ulcers seen on the jejunal side of the anastomosis (marginal ulcers) are not well understood. Possible risks for marginal ulcers include smoking, NSAID use, steroid use, alcohol use, acidic gastric secretions, and foreign bodies. For hemodynamically stable patients presenting with marginal ulceration and one or more of these risk factors, cessation or treatment of the underlying aggravating factor can be effective. Hemodynamically significant ulcerative bleeding can be safely and effectively managed with endoscopic clips, sclerotherapy, and electrosurgery. After initial hemorrhage control, all patients with marginal ulcers should be followed with regular endoscopic intervals, typically every 2 months, to monitor their response to therapy.

Helicobacter pylori association is controversial with some studies demonstrating higher rates of marginal ulcer formation in patients with existing *H. pylori* disease [34] and others showing no difference [35].

Foreign bodies near the operative sites can serve as a nidus for ulceration and irritation. The use of staples and permanent sutures, such as polyester, can cause local irritation, inflammation, and resulting erosions and ulceration in the area exposed to gastric secretions. These patients often present with chronic abdominal pain along with clinical evidence of bleeding. Endoscopic removal of the foreign body is an effective and safe treatment option [36].

Finally, in patients with ulcers refractory to treatment, a gastro-gastric (GG) fistula must be ruled out. These increase the direct jejunal acid exposure from the remnant stomach and can be difficult to identify. Contrasted studies and endoscopy are useful for evaluation and diagnosis of a GG fistula.

Stenosis/Stricture

Stricture or stenosis after bariatric surgery is a relatively common complication. Strictures are particularly common after RYGB, occurring in ~15% of patients, usually involving the GJ anastomosis. Technical error during anastomotic construction, ulceration due to ischemia or environmental factors, and prior endoscopic intervention for bleeding such as sclerotherapy are predisposing factors. Strictures are also the most common complication in the LSG population, occurring in ~4% of patients, with the area of the incisura being the most affected [37].

Patients typically present several weeks to months after surgery, but earlier presentations within 1 month of surgery can occur. Prospective studies evaluating the presence of GJ stenosis identified stenosis rates of 25–36% at 1 month, of which only one third are symptomatic [38]. Patients usually complain of dysphagia, nausea, emesis, and early satiety without abdominal pain. The acuity of the patient's presentation varies based on the degree of stenosis. Severe stenosis can severely limit the patient's capacity to maintain nutritional support, hydration, and saliva management. Appropriate clinical management including resuscitative efforts, repletion of electrolyte derangements, and nutritional support is essential for improving outcomes and response to therapies. Early endoscopic evaluation is essential in formulating a management strategy. Stenosis can be mild (7–9 mm), moderate (5–7 mm), and severe (<5 mm).

Retrospective reviews of symptomatic patients identified a 6–10% incidence of problematic strictures [39]. Symptomatic strictures are best treated endoscopically with through-the-scope (TTS) balloon dilators. The simplicity of TTS balloon dilation, requiring only a single intubation event of the esophagus, makes it the preferred method over bougienage. It is safe and effective with current data estimating acceptable perforation rates at 2–4%, including repeat dilations [38].

Bougienage with the serial oral advancement and passage of bougie dilators through the area of stricture is as effective as TTS balloon dilation with reported success rates approaching 100%. The lack of visualization during the bougie dilation event, however, makes this a less attractive option [40]. Regardless of technique, patients often require multiple dilation events prior to achieving durable results. Fortunately, these procedures are reasonably well tolerated, have minimal morbidity, and can produce lasting effects.

Compared to RYGB strictures, SG patients with stenosis are not as easily managed endoscopically. Balloon and bougie dilation are good options for treatment, but they are only successful 56% of the time. If durable resolution is not achieved after three dilations attempts, SG patients with symptomatic strictures should be considered for surgical intervention with conversion to Roux-en-Y gastric bypass [37]. Since revisional surgery is associated with significantly increased risk for perioperative morbidity, endoscopic interventions should be fully exhausted prior to considering reoperation.

Gastric Band Erosion

A relatively rare but serious complication of the adjustable gastric band is device erosion into the

stomach. This occurs in 1–2% of adjustable gastric band patients and occurs on average 3–4 years after band placement [41]. This complication sometimes presents with free gastric perforation requiring emergent surgical intervention, but the majority of patients present more insidiously with abdominal pain, nausea, and weight regain as the most common presenting symptoms. Port-site infections should also prompt investigation to rule out band erosion. Total endoscopic removal of the eroded band has been well documented and adopted by many bariatric surgeons. Complete endoscopic extraction has been shown to be effective and safe while avoiding a potentially major surgery. Success rates approach 90–95% in most series with low complication rates [42]. The best-described technique involves passing a guide wire around the band and re-grasping it to form a loop. A mechanical lithotripter is then used to cut the band with the looped guide wire. The band is disconnected from the subcutaneous port and removed transorally [42].

Conclusion

Today's bariatric endoscopist can choose from a wide variety of endoscopic therapies when managing postoperative bariatric surgical complications. These endoscopic alternatives or adjuncts offer less morbid and less invasive options to immediate reoperation. The surgeon is provided incredible flexibility to choose between concomitant applications and combinations of therapies, serial applications of the same therapy, or layering in different modalities across specialties. The art comes in selecting the appropriate modality, or combinations of modalities, along with its timing that allows for either clinical resolution or the luxury of time to strategize and plan for definitive surgical intervention. Either outcome is welcomed in these challenging situations. The availability of safe endoscopic options for managing challenging postoperative bariatric surgical complications undoubtedly strengthens the role of the bariatric surgeon as a part of the solution to the global obesity epidemic.

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