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ORIGINAL CONTRIBUTIONS

Percutaneous Image-Guided Abdominal Interventions for Leaks and Fistulas Following Sleeve Gastrectomy and Roux-en-Y Gastric Bypass

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Abstract

Background Bariatric surgery offers the only effective long-term weight loss therapy for morbidly obese patients. Numerous studies have demonstrated a mortality and morbidity reduction associated with weight loss surgery, but these interventions also have significant rates of complications. It is important for the bariatric surgeons to recognize these complications and acknowledge which of them can be solved in a minimally invasive manner in order to offer to patients the best treatment. The aim of this article was to review factors and success rates associated with percutaneous image guide abdominal interventions to treat the complications of bariatric surgery.

Materials and Methods Retrospective descriptive study. Eighty-two patients with complications after bariatric surgery were included. Of these, 56 presented fistula with or without abdominal collection.

Results Of the total patients, 54% are male and 46% female. The average age was 49.4 (range 16–62). Of the 56 cases, 37 (66.1%) occurred after laparoscopic sleeve gastrectomy, and 19 (33.9%) post-Roux-en-Y gastric bypass. The fistula was resolved by percutaneous image guide abdominal interventions in 49 opportunities, of which 67% required only conservative treatment afterwards, the remaining 33% required endoscopic treatment with prostheses, fibrin sealants, and/or clips. No mortality was reported in the series.

Conclusion Percutaneous image-guided abdominal interventions play a significant role in the treatment of complications following bariatric surgery. The minimally invasive treatment of fistula after bariatric surgery is safe and effective.

Keywords Obesity · Bariatric surgery · Surgical complications · Percutaneous surgery · Image-guided surgery

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Introduction

Obesity is growing all over the world in the last decades, especially the USA, Europe, South America, and Australia [1]. Currently, bariatric surgery offers the only effective long-term weight loss therapy for morbidly obese patients. Increased media attention to these procedures as well as the newer option of laparoscopic treatment has led patients and surgeons to embrace this surgical option in an elevated number, particularly the option of Roux-en-Y gastric bypass (RYGB) and laparoscopic sleeve gastrectomy (LSG). Numerous studies have demonstrated the reduction in death and disability associated with obesity surgery [2–4], but these surgeries also have significant rates of complications [5] which can be as high as 10%, such as bleeding, anastomotic or staple line leaks, abdominal abscess, intestinal obstruction, anastomotic strictures [6–8], and acute gastric dilatation[9].

It is important for the bariatric surgeon to recognize these complications and know which of them can be solved in a minimally invasive way in order to offer to the patients the best treatment. The aim of this study is to review factors and success rates associated with percutaneous image-guided abdominal interventions to treat complications of bariatric surgery.

Material and Methods

Retrospective descriptive study, conducted at the DAICIM Foundation in Buenos Aires, Argentina, between May 2004 and June 2018. Informed consent was obtained from all individual participants included in the study. Of a total of 82 patients underwent bariatric surgery with postoperative complications, 56 presented leak or fistula with or without abdominal collection/abscess, which were included consecutively in the presented series. All patients were operated and treated by the same Department of Multidisciplinary Bariatric.

Definitions

A "leak" is defined as leakage of luminal contents from a surgical junction between two hollow viscera or through a staple line of an organ. The leak is classified according to the period in which they appear in [10] early (between the 1st and 3rd days of the postoperative period), intermediate (between 4th and 7th days of the postoperative period), and late (beyond the 8th day of the postoperative period). The luminal content can exit through the wall and/or drain, or accumulate (collection) next to the anastomosis. A "collection" only contains fluid, but it can be consolidated and contaminated to form an "abscess" that has a purulent content and a consolidated wall.

A "fistula" is defined as an abnormal communication between two epithelia. It appears between two internal organs, or between an internal organ and the surface of the body. A "digestive system fistula" is an abnormal passage that communicates between any component of the digestive system and any part of it or surrounding organs. A "gastric fistula" is an abnormal passage that communicates with the stomach. This postoperative complication may appear after bariatric surgery and can be gastrogastric, gastroenteric, gastrocutaneous, gastrobronchial, among others. In the postoperative period, its pathophysiology could be divided into mechanical and/or ischemic, combined with an intraluminal pressure greater than the resistance of the tissue over the staple line or anastomosis [11].

Bariatric Surgical Techniques

The participants presented a correct preoperative preparation with all the corresponding studies. The patients were placed in the dorsal decubitus position with open legs. Antithrombotic and antibiotic prophylaxis was performed. The pneumoperitoneum was set at 12 mmHg.

To perform LSG, 4 ports were placed (1 of 12 mm for stapling, 1 of 10 mm for the camera, and 2 of 5 mm for the surgeon). The gastric sleeve was calibrated using a 32 Fr. orogastric tube. The gastrectomy was performed using 3.5 mm × 60 mm staplers. Staple line reinforcement with non-absorbable material was performed. Pneumatic test and methylene blue were used to rule out the presence of a leak. The specimen was removed in the bag. A silicone drain was left on the surgical site.

To carry out RYGB five ports were placed (2 of 12 mm for the stapler, 1 of 10 mm for the camera, and 2 of 5 mm for the surgeon). The gastrectomy was performed using 3.5 mm × 60 mm cartridges. Roux-Y reconstruction was made antecolic mode. The length of the alimentary and the biliopancreatic loop varied according to the patient's metabolic pathology. For the anastomoses, staples were used. A silicone drain was left on the surgical site.

All the patients underwent an oral contrast fluoroscopic control at 48 h, prior to the start of oral nutrition.

Percutaneous Technique

The technique consisted in performing a puncture of the collection or abscess with a 16 gauge needle under image guidance, and then a 0.035″ wire with "J" tip was inserted through the needle until it was rolled up inside the abscess in order to secure the access. Once this was confirmed with the image guidance, a multipurpose catheter (multipurpose catheter 10.2 Fr, Cook Medical, USA) was placed inside the abscess (Fig. 1) with the Seldinger technique. Finally, the catheter was irrigated with 5 cc of saline solution to ensure its permeability. The catheter was secured to the skin by a fixation system provided by the same company responsible for the manufacture of the catheter.

The types of catheters used were determined by the characteristics of the leak, fistula, collection, or abscess that were treated. Usually, we use pigtail type catheters, 10.2 Fr, which accept guide wires up to 0.038″, and with a length of 45 cm. In super-obese patients or in deep collections, we use catheters of 60 cm long. When the collections were small or were close to vascular structures, we used smaller pigtail catheters. In the case of extensive collections, we apply the technique of multiple catheters or use catheters from 12 to 2 Fr.

Treatment of Leaks/Fistula and Collections/Abscess

For the diagnosis of leaks, fistula, collections, and abscess, computed tomography (CT) was used in most cases (90%), although ultrasound (US) was also useful. The diagnosis of these abscesses on occasion was a challenge because it was

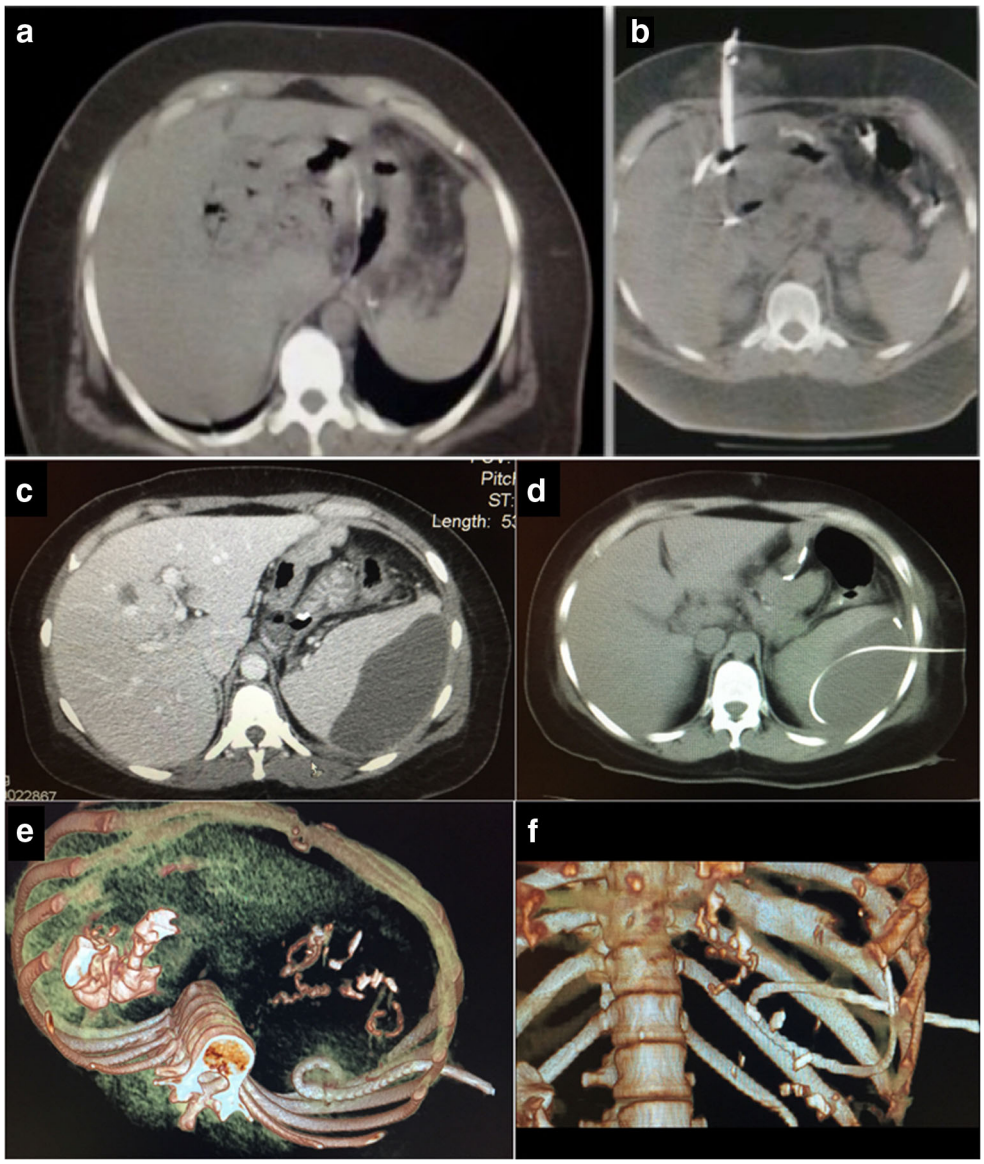

Figure 1 **a** Central abdominal abscess after sleeve gastrectomy, and the multipurpose catheter placement. **b** Notice how the catheter goes through the liver left lobe, if the patient has an adequate coagulation and platelet count this does not generate further complications but it is important not to puncture any significant vascular or biliary branch. **c** Posterior abdominal abscess after gastric bypass, and the multipurpose catheter placement. **d** A multipurpose drainage catheter was placed under tomographic guidance. **e**, **f** The three-dimensional reconstruction allows to check the correct position of the catheter

difficult to differentiate the abscess from the digestive lumen (Fig. 2a). The absence of the wall, the location and the size of the abscess helped to differentiate it from normal structures, and in case of doubt, a superior gastrointestinal series could help to recognize the leak [12] (Fig. 2b, c). This study was carried out with water-soluble contrast to avoid later complications due to the loss of contrast.

Once the catheter was placed, follow-up was performed paying attention to the clinical evolution of the patient and the semiology of the catheter (Fig. 3). If the patient persisted with the systemic inflammatory response syndrome (SIRS) (fever, increased heart rate, hypoxemia, or increased white blood cell count), a new image was made. In the case of residual abscess or intermediate cavity along the leak or fistula, a new drainage was performed. On the other hand, if there was no abscess and generalized free fluid was found in the abdominal cavity, the possibility of a new laparoscopy was considered.

Broad-spectrum intravenous antibiotic therapy was instituted to cover facultative and gram-negative aerobic bacteria. The treatment began for a period of 15 days, which could end or be prolonged according to the patient's clinical response. The antibiotic therapy was adapted according to the result of the cultures of the material obtained when placing the catheter.

It is also important to consider the drainage characteristics. If the catheter persists with a large amount of fluid and this fluid is seen as gastric or intestinal fluid, a new image must also be made. In this case, a fistulogram may be useful to confirm communication between the collection or abscess and the digestive lumen (Fig. 4).

Once the infection is controlled and the SIRS is no longer present, adequate nutrition and a high level of protein are essential to achieving closure of the fistula. A standard hypercaloric nutritional formula (Fresubin® Energy, Fresenius Kabi, Germany) of 1500 ml, equivalent

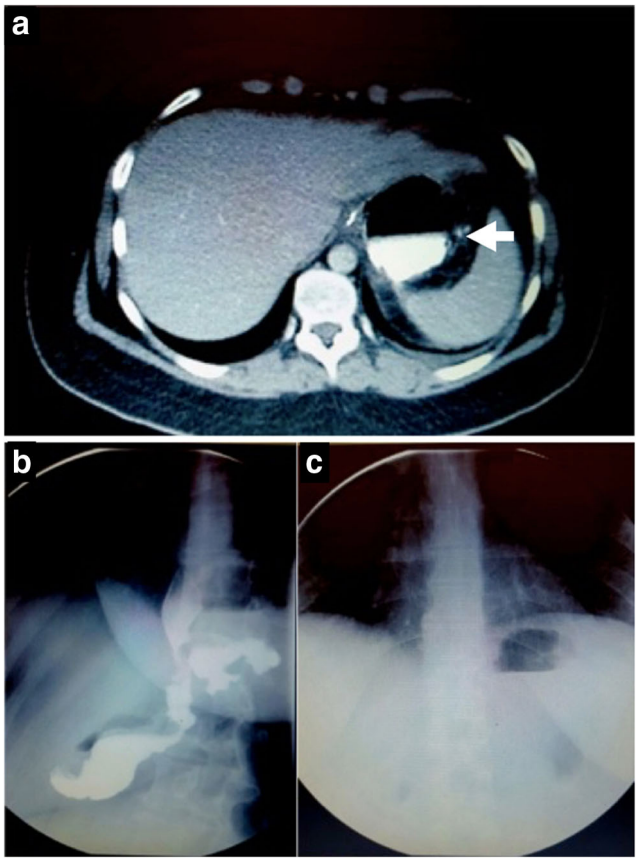

Figure 2 **a** Abdominal abscess with contrast and air (white arrow) after sleeve gastrectomy that could be mistaken as gastric lumen. Notice the absence of thick walls and the diameter size much bigger than the usual sleeves. **b** Upper gastrointestinal series of the same patient with sleeve gastrectomy where a leakage is present. **c** Notice how the air of the abscess could be mistaken with fundus air

to 2250 kcal, was used as an exclusive nutritional supplement, distributed in three daily doses for a minimum period of 1 week. To achieve this, a nasojejunal tube with the tip distal to the leak should be placed to avoid leakage of the enteral feeding. The exclusive nutritional support was progressively withdrawn as the patient presented clinical improvement. Total parenteral nutrition (TPN) was not necessary for any patient.

With this approach, 70% of leaks heal and no additional treatment is needed, but sometimes months must elapse to achieve success. The criteria used to define a cured leak were negative drainage, CT without collection and clinical status without infection.

If the leak does not heal, additional treatment should be performed, such as the placement of a fully covered gastric stent [13–16] (Evolution® Esophageal Controlled-Release Stent - Fully Covered, Cook Medical, USA) (Fig. 5). The goal of this procedure is to block the leak with the stent cover until it is healed. Although it may seem like a great solution, some problems may arise, such as migration of the stent or the persistence of leaks due to leakage between the gastric wall and the stent cover.

There are also other options available, such as placement of an endoscopic clip [17–27] or biological fibrin sealants [28–31] to close the leak, but more researches are needed to define the success of these treatments.

Results

Of the patients recruited ($n = 56$), 54% were male and 46% female. The average age was 49.4 (range 16 to 62 years). The characteristics of patients were average of body mass index (BMI) 43%, dyslipidemias 43%, diabetes 42%, and hypertension 38%. Of the total cases, 37 (66.1%) occurred after LSG, and 19 (33.9%) post RYGB. The average time of symptoms presentation was 4.3 days (range from 3 to 8). The clinical presentation was debit due to postoperative drainage 41.1% (23), SIRS and sepsis 16.1% (9), ileus 14.2% (8), abdominal pain 10.7% (6), and others (asthenia, hyporexia) 17.8% (10).

Of the total of 56 patients analyzed, 49 (87.5%—32 LSG, 17 RYGB) of the cases were resolved by percutaneous or endoscopic approaches; the remaining 7 (12.5%—5 LSG, 2

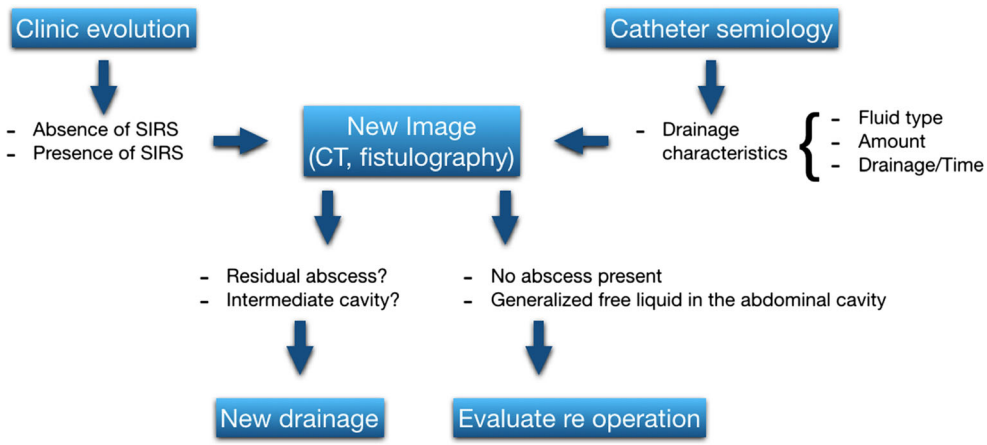

Figure 3 The algorithm used to follow up the patient, once the catheter was placed. (SIRS = systemic inflammatory response syndrome; CT = computed tomography)

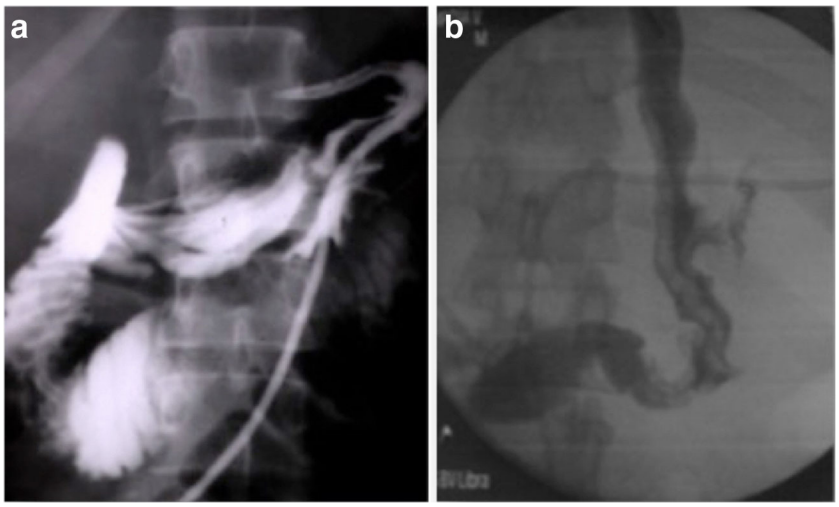

Figure 4 **a** Fistulography of patients with sleeve gastrectomy. **b** Contrast is instilled through the catheter and the sleeve can be seen

RYGB) patients required reoperation (laparoscopic drainage of collections and abscesses). Of those undergoing LSG, 22 (68.7%) received percutaneous treatment and 10 (31.3%) received endoscopic treatment, of which 7 (70%) were by clips (TriClip™, Cook Medical, US), 3 (30%) by prosthesis (Evolution® Esophageal Controlled-Release Stent - Fully Covered, Cook Medical, US), and in no case were used fibrin sealants (Surgisis™, Cook Medical, US). With respect to the group after RYGB, 11 (64.7%) received percutaneous treatment and 6 (35.3%) received endoscopic treatment, of which 4 (66.6%) were by clips, 1 (16.6%) by prosthesis, and 1 (16.6%) by fibrin sealants.

The average of instrumentations per patients was 1.5 (range from 1 to 3), and the average of hospitalization days was 8.6 (range from 5 to 16, 6.7 corresponded to LSG and 12.1 to RYGB). All patients evolved satisfactorily. No mortality was reported in the series.

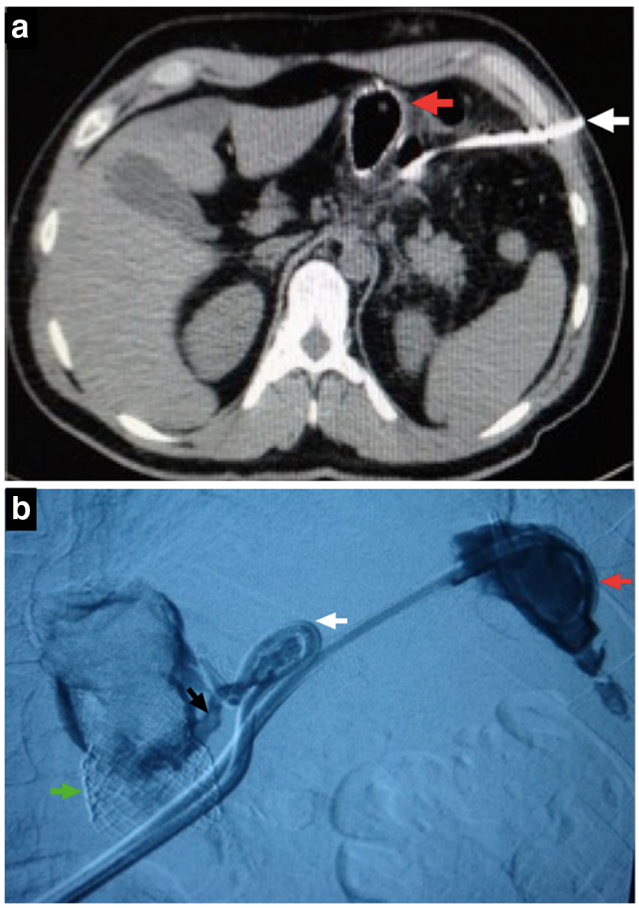

Figure 5 **a** CT-scan of patient with fistula after sleeve gastrectomy. White arrow: multipurpose catheter draining the abscess; Red arrow: gastric stent. B) Stent placement in a patient with sleeve gastrectomy fistula. Green arrow: gastric stent. Black arrow: the fistula. White arrow: intermediate cavity with drainage. Red arrow: abscess with drainage

Discussion

Complications Treated by Percutaneous Image Guided Surgery

One of the most common complications after bariatric surgery are the leaks [4, 32–35] due to inadequate tissue healing allowing the exit of gastrointestinal material through the staple or suture line. It can be as high as 2.4% in the LSG [36], while the RYGB can reach 1% incidence in large series [37]. Regarding the RYGB, there are six potential sites of leaking: esophageal perforation with a bougie, gastrojejunostomy, gastric pouch staple line, roux limb staple line, jejunojejunostomy, and gastric remnant staple line, while in the sleeve gastrectomy the leaks can occur at the stapler line of the sleeve, being more common at the proximal third of the stomach in 89% of cases [4].

We found that the number of patients who presented postoperative complications such as leaks, fistulas, and/or abdominal collections was greater in patients undergoing LSG than in RYGB. This could be because the stomach supports higher

pressure (high pressure) in LSG than in RYGB (low pressure). Despite this concept being known, the etiology and pathogenesis of leaks and fistulas during the postoperative period are multifactorial, being determined by the operative technique, the tactics, the quality of the manipulated tissue, its irrigation, the devices used, and others. Even though in this situation, the period of hospitalization for the first group was shorter. These results can estimate that the therapeutic response in the postoperative complications of LSG was better, but we know that this single parameter is not enough to affirm that.

Although most anastomotic leaks occur 5 to 7 days after surgery and are thought to be related to ischemia, 95% of anastomotic leaks that occur within 2 days of surgery probably resulted from technical error [38]. It is important to know this because as sooner as the leak emerge more likely because of a committed technical error during the surgery, and this will indicate that a reoperation may be needed because this kind of leaks tend to come out as a peritonitis [39]. In the other hand, if more time have passed, it is possible that the leak appears as an abdominal abscess or collection, and if this is the case, a minimally invasive approach can be attempted by draining the abscess in a percutaneous fashion [40]. To make a correct treatment, it is necessary to differentiate between the abdominal collection and the abscess. While the first only contains fluid, the abscess has a purulent content and a more consolidated wall. Its diagnosis can be performed non-invasively by using CT scan contrast-enhanced or in an invasive mode with puncture aspiration and analysis of its content.

Given the complexity of these abscesses, it is necessary in many cases to perform the drainage under CT guidance. While in more easy cases, like big abscesses near the abdominal wall, US guidance can be used.

No gastrobronchial fistula was reported after LSG in this article, and our team has no experience. These complications, serious in themselves, require energetic treatment with a combined surgical and endoscopic approach [41]. Oral feeding should be discontinued, which would only be possible in cases in which the patient has an orogastric feeding tube prior to the formation of the gastrobronchial fistula. Placing an orogastric feeding tube under endoscopic guidance can be dangerous and worsen the condition. We have experience in the placement of orogastric feeding tubes under fluoroscopic guidance but in patients with unscathed esophagus. Nutrition should be exclusive TPN. In case of presenting an associated mediastinal and/or thoracic collection, it can be treated by thoracoscopy, thoracotomy, or percutaneously. Antibiotic therapy is essential to reduce infectious complications (such as mediastinitis), as well as the administration of somatostatin analogs. The treatment of the fistulous orifice should be done by placing a tracheobronchial and/or esophagogastric fully covered prosthesis (stent) endoscopically [41], with air at low pressure.

Chronic fistulas were not reported in this article. This may be due to the rapid diagnosis of postoperative complications and aggressive treatment from the time of detection. The management of chronic fistulas is complex. In these cases, the work of the multidisciplinary team should be highlighted. Once the problem is diagnosed, it is essential to drain the associated collection or tutor the fistulous tract using a catheter. In most cases, the cultures are positive for germs of the gastrointestinal tract or fungi. The administration of antibiotic therapy and antifungals should be guided according to cultures, antibiogram, and by the Department of Infectology. The nutritional status can be affected due to the catabolic state of this type of patients. If necessary, consider the placement of supplementary parenteral nutrition. Chronic anemia, together with leukopenia, renal failure, and hydroelectrolytic alterations should be considered. This situation can lead to a state of chronic stress that leads to depression and anxiety of the patient. Psychological support must accompany the entire recovery process.

Different endoscopic techniques can help the treatment of fistulas. We have used clips, biological fibrin sealant, and stent. Some centers reported that the use of endoluminal vacuum (E-Vac) therapy showed promising results. E-Vac works with the intraluminal application of a polyurethane sponge in the area of the defect, and negative pressure. The placement of the sponge allows coaptation into the digestive lumen through suction. Bacterial contamination, accumulation of secretions, and local edema are reduced. The cavity collapses around the sponge, and perfusion and granulation tissues are promoted. Several studies have demonstrated their feasibility in patients with postoperative fistulas of the upper and lower gastrointestinal tract [42, 43]. They require more studies to determine their application criteria.

Some of the patients with leaks had signs and symptoms of systemic inflammatory response syndrome (SIRS). The literature reports an association between leakage after bariatric surgery and SIRS in more than 50% [44]. It should be noted that the postoperative complication-related outcome (CRO) rates may vary according to the experience of the surgical team [45]. Early diagnosis of leaks, drainage of collections, and abscesses, as well as antibiotic therapy were a good combination to obtain favorable results. After the beginning of the treatment of these complications, it was observed that they were associated with a rapid improvement of the septic pattern.

This work has several limitations. Firstly, the number of patients analyzed is not large, which forces us to continue working to draw definitive conclusions. On the other hand, although the hospitalization period was shorter for patients undergoing LSG than for the RYGB group, this report does not allow us to conclude that postoperative complications after LSG respond better to mini-invasive treatment. We must bear in mind that, in general, patients who are candidates for RYGB have a higher metabolic commitment (dyslipidemia, diabetes, hypertension, etc.). This factor could negatively influence the speed of recovery after a postoperative

complication. Finally, the need for technology to treat these patients through MIS procedures should be highlighted as limiting. The possibility of fluoroscopy, ultrasonography, tomography, often used simultaneously in the same operating room, is not available in all centers that perform this type of procedure.

Conclusion

Interventional radiology (IR) or image guide percutaneous surgery strongly has a role in the treatment of complications following bariatric surgery. We think that the combination of IR, endoscopy, and laparoscopy will solve more than 90% of the complications by these approaches. And in these ones, IR and endoscopy will treat the majority of them, leaving laparoscopy for extreme and acute cases. The minimally invasive treatment of leak after bariatric surgery is safe and effective and allows the avoidance of relapses in a significant number of cases. However, the complexity of drainage in these patients determines the management of these treatments by a trained group.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Mokdad AH, Bowman BA, Ford ES, et al. The continuing epidemic of obesity and diabetes in the United States. JAMA. 2001;286(10):1195–200.
2. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA. 2004;292(14):1724–37.
3. Basa NR, Dutson E, Lewis C, et al. Laparoscopic transgastric removal of eroded adjustable band: a novel approach. Surg Obes Relat Dis. 2008;4(2):194–7.
4. Schulman AR, Thompson CC. Complications of bariatric surgery: what you can expect to see in your GI practice. Am J Gastroenterol. 2017;112(11):1640–55.
5. Weller WE, Hannan EL. Relationship between provider volume and postoperative complications for bariatric procedures in New York state. J Am Coll Surg. 2006;202(5):753–61.
6. Escalona A, Devaud N, Boza C, et al. Gastrojejunal anastomotic stricture after Roux-en-Y gastric bypass: ambulatory management with the Savary-Gilliard dilator. Surg Endosc. 2007;21(5):765–8.
7. Fernandez-Esparrach G, Bordas JM, Llach J, et al. Endoscopic dilation with Savary-Gilliard bougies of stomal strictures after laparosocopic gastric bypass in morbidly obese patients. Obes Surg. 2008;18(2):155–61.
8. Csendes A, Burgos AM, Burdiles P. Incidence of anastomotic strictures after gastric bypass: a prospective consecutive routine endoscopic study 1 month and 17 months after surgery in 441 patients with morbid obesity. Obes Surg. 2009;19(3):269–73.
9. Racu C, Dutson EP, Mehran A. Laparoscopic gastrojejunostomy revision: a novel approach to intractable marginal ulcer management. Surg Obes Relat Dis. 2010;6(5):557–8.
10. Márquez MF, Ayza MF, Lozano RB, et al. Gastric leak after laparoscopic sleeve gastrectomy. Obes Surg. 2010;20(9):1306–11.
11. Okazaki O, Bernardo WM, Brunaldi VO, et al. Efficacy and safety of stents in the treatment of fistula after bariatric surgery: a systematic review and meta-analysis. Obes Surg. 2018;28(6):1788–96.
12. Cho M, Kaidar-Person O, Szomstein S, et al. Laparoscopic remnant gastrectomy: a novel approach to gastrogastric fistula after Roux-en-Y gastric bypass for morbid obesity. J Am Coll Surg. 2007;204(4):617–24.
13. Boza C, Gamboa C, Salinas J, et al. Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy: a case-control study and 3 years of follow-up. Surg Obes Relat Dis. 2012;8(3):243–9.
14. Puli SR, Spofford IS, Thompson CC. Use of self-expandable stents in the treatment of bariatric surgery leaks: a systematic review and meta-analysis. Gastrointest Endosc. 2012;75(2):287–93.
15. Eubanks S, Edwards CA, Fearing NM, et al. Use of endoscopic stents to treat anastomotic complications after bariatric surgery. J Am Coll Surg. 2008;206(5):935–8. discussion 938–9
16. Iqbal A, Miedema B, Ramaswamy A, et al. Long-term outcome after endoscopic stent therapy for complications after bariatric surgery. Surg Endosc. 2011;25(2):515–20.
17. Overcash WT. Natural orifice surgery (NOS) using StomaphyX for repair of gastric leaks after bariatric revisions. Obes Surg. 2008;18(7):882–5.
18. Mikami D, Needleman B, Narula V, et al. Natural orifice surgery: initial US experience utilizing the StomaphyX device to reduce gastric pouches after roux-en-Y gastric bypass. Surg Endosc. 2010;24(1):223–8.
19. de Wolfe MA, Bower CE. Using the StomaphyX (TM) endoplicator to treat a gastric bypass complication. JSLS. 2011;15(1):109–13.
20. Kantsevoy SV, Thuluvath PJ. Successful closure of a chronic refractory gastrocutaneous fistula with a new endoscopic suturing device (with video). Gastrointest Endosc. 2012;75(3):688–90.
21. Armengol-Miro JR, Dot J, Abu-Suboh Abadia M, et al. New endoscopic suturing device for closure of chronic gastrocutaneous fistula in an immunocompromised patient. Endoscopy. 2011;43 Suppl 2 UCTN:E403–4.
22. Jirapinyo P, Watson RR, Thompson CC. Use of a novel endoscopic suturing device to treat recalcitrant marginal ulceration (with video). Gastrointest Endosc. 2012;76(2):435–9.
23. Repici A, Arezzo A, De Caro G, et al. Clinical experience with a new endoscopic over-the-scope clip system for use in the GI tract. Dig Liver Dis. 2009;41(6):406–10.
24. Conio M, Blanchi S, Repici A, et al. Use of an over-the-scope clip for endoscopic sealing of a gastric fistula after sleeve gastrectomy. Endoscopy. 2010;42(Suppl 2):E71–2.
25. Kouklakis G, Zezos P, Liratzopoulos N, et al. Endoscopic treatment of a gastrocutaneous fistula using the over-the-scope-clip system: a case report. Diagn Ther Endosc. 2011;2011:384143.
26. Aly A, Lim HK. The use of over the scope clip (OTSC) device for sleeve gastrectomy leak. J Gastrointest Surg. 2013;17(3):606–8.
27. Surace M, Mercky P, Demarquay JF, et al. Endoscopic management of GI fistulae with the over-the-scope clip system (with video). Gastrointest Endosc. 2011;74(6):1416–9.
28. Papavramidis ST, Eleftheriadis EE, Papavramidis TS, et al. Endoscopic management of gastrocutaneous fistula after bariatric surgery by using a fibrin sealant. Gastrointest Endosc. 2004;59(2):296–300.

29. Papavramidis ST, Eleftheriadis EE, Apostolidis DN, et al. Endoscopic fibrin sealing of high-output non-healing gastrocutaneous fistulas after vertical gastroplasty in morbidly obese patients. Obes Surg. 2001;11(6):766–9.
30. Papavramidis TS, Kotzampassi K, Kotidis E, et al. Endoscopic fibrin sealing of gastrocutaneous fistulas after sleeve gastrectomy and biliopancreatic diversion with duodenal switch. J Gastroenterol Hepatol. 2008;23(12):1802–5.
31. Maluf-Filho F, Hondo F, Halwan B, et al. Endoscopic treatment of Roux-en-Y gastric bypass-related gastrocutaneous fistulas using a novel biomaterial. Surg Endosc. 2009;23(7):1541–5.
32. Parikh M, Issa R, McCrillis A, et al. Surgical strategies that may decrease leak after laparoscopic sleeve gastrectomy: a systematic review and meta-analysis of 9991 cases. Ann Surg. 2013;257(2): 231–7.
33. Ballesta C, Berindoague R, Cabrera M, et al. Management of anastomotic leaks after laparoscopic Roux-en-Y gastric bypass. Obes Surg. 2008;18(6):623–30.
34. Gonzalez R, Sarr MG, Smith CD, et al. Diagnosis and contemporary management of anastomotic leaks after gastric bypass for obesity. J Am Coll Surg. 2007;204(1):47–55.
35. Thaler K. Treatment of leaks and other bariatric complications with endoluminal stents. J Gastrointest Surg. 2009;13(9):1567–9.
36. Aurora AR, Khaitan L, Saber AA. Sleeve gastrectomy and the risk of leak: a systematic analysis of 4,888 patients. Surg Endosc. 2012;26(6):1509–15.
37. Livingston EH, Ko CY. Assessing the relative contribution of individual risk factors on surgical outcome for gastric bypass surgery: a baseline probability analysis. J Surg Res. 2002;105(1):48–52.
38. Baker RS, Foote J, Kemmeter P, et al. The science of stapling and leaks. Obes Surg. 2004;14(10):1290–8.
39. Palermo M, Giménez M, Gagner M. Laparoscopic gastrointestinal surgery. Novel techniques, extending the limits, vol. 1-2. 1st ed. Pomona: AMOCA; 2015.
40. Palermo M, Acquafresca PA, Rogula T, et al. Late surgical complications after gastric by-pass: a literature review. Arq Bras Cir Dig. 2015;28(2):139–43.
41. Silva LB, Moon RC, Teixeira AF, et al. Gastrobronchial fistula in sleeve gastrectomy and Roux-en-Y gastric bypass–a systematic review. Obes Surg. 2015;25(10):1959–65.
42. Leeds SG, Burdick JS. Management of gastric leaks after sleeve gastrectomy with endoluminal vacuum (E-Vac) therapy. Surg Obes Relat Dis. 2016;12(7):1278–85.
43. Schniewind B, Schafmayer C, Voehrs G, et al. Endoscopic endoluminal vacuum therapy is superior to other regimens in managing anastomotic leakage after esophagectomy: a comparative retrospective study. Surg Endosc. 2013;27(10):3883–90.
44. Al-Sabah S, Ladouceur M, Christou N. Anastomotic leaks after bariatric surgery: it is the host response that matters. Surg Obes Relat Dis. 2008;4(2):152–7.
45. Ali MR, Tichansky DS, Kothari SN, et al. Validation that a 1-year fellowship in minimally invasive and bariatric surgery can eliminate the learning curve for laparoscopic gastric bypass. Surg Endosc. 2010;24(1):138–44.