J Metab Bariatr Surg. 2022 Jun;11(1):1-12
https://doi.org/10.17476/jmbs.2022.11.1.1
pISSN 2287-2930·eISSN 2508-5956

Journal of Metabolic and Bariatric Surgery JMBS

Review Article

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Diagnosis and Management of Postoperative Complications After Sleeve Gastrectomy

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OPEN ACCESS

Received: Aug 22, 2022
Revised: Aug 26, 2022
Accepted: Aug 29, 2022
Published online: Aug 30, 2022

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Funding
No funding was obtained for this study.

Conflict of Interest
Author has any conflict of interest.

ABSTRACT

Sleeve gastrectomy (SG) has demonstrated excellent outcomes in terms of weight loss and resolution of obesity-related comorbidities as a single procedure. It has gained rapidly increasing popularity among bariatric surgeons and patients over the last two decades. This is due to its relative ease of use and less frequent morbidities related to the procedure. Even though the overall complication rate after SG is reported to be lower than conventional Roux-en-Y gastric bypass or biliopancreatic diversion, it still affects 1–10% of the patients undergoing SG, which is not negligible. Early postoperative complications that can occur within 30 days after SG include hemorrhage, leakage, sleeve stenosis, and reflux. Thromboembolic events are rare but can occur after surgery. Here, we review the incidence, diagnosis, and management of these early postoperative complications.

Keywords: Morbid obesity; Bariatric surgery; Postoperative complications

INTRODUCTION

In the early 2000's, laparoscopic sleeve gastrectomy (SG) was originally devised as the initial step of the two-staged duodenal switch in high-risk patients [1]. As the SG procedure alone had been proven effective in weight loss and was technically easier compared to other conventional bariatric procedures, it had gained popularity among surgeons and patients over the last two decades. Currently, it is the most commonly performed bariatric procedure worldwide [2].

As SG has become the most popular standalone bariatric procedure, surgeons need to be more aware of and prepared for possible postoperative complications. The overall incidence of postoperative complications was not very high. However, relatively common complications reported in the literature were postoperative bleeding, leakage, sleeve stenosis, and gastroesophageal reflux. There were also relatively rare but fatal complications like portomesenteric vein thrombosis (PMVTs). These complications may lead to unfavorable outcomes, ranging from prolonged hospital stays and deterioration in the quality of life to mortality. Therefore, it is critical to adequately assess patients when complications occur and to provide timely management.

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According to a previous study that evaluated the metabolic and bariatric surgery accreditation and quality improvement (MBSAQIP) registry data in 2015 in the United States, the 30-day morbidity and mortality after SG were 5.8% and 0.1% among the 93,062 registered SG patients [3]. Relatively common complications were surgical site infection, sepsis, bleeding, and venous or pulmonary thromboembolism among various kinds of complications, which occurred in 0.11–0.29% of the total SG patients.

The nationwide registry data from the Korean Society of Metabolic and Bariatric Surgery (KSMBS) showed a similar trend in the incidence of postoperative complications after SG. A review of the data registered in 2019–2021, when the national insurance covered bariatric surgery, revealed that the overall complication rate was 2.2%, which gradually decreased over the years (**Table 1**). Postoperative leak, bleeding, and sleeve stenosis were the most common complications, with a 0.6–1.1% incidence rate for each.

Herein, we review major complications occurring in the early postoperative period (within 30 days) after SG in terms of incidence, diagnosis, and management.

POSTOPERATIVE BLEEDING

Incidence

Postoperative bleeding has been reported to occur in 1–6% of SG patients, but some studies report up to 15% [4-8]. The difference in incidence might be attributable to the different definitions of postoperative bleeding or hemorrhage across the literature. The long staple lines in SG were mostly responsible for postoperative bleeding, which usually causes intraabdominal bleeding. Other possible bleeding foci include the omentum, trocar insertion site, and injured liver or spleen. Intraluminal bleeding occurs infrequently [9].

Management

The management strategy for bleeding after SG was not significantly different from that of other general abdominal surgeries. Surgical re-exploration had to be carefully considered when a patient was hemodynamically unstable or required a transfusion of two or more units of blood in a short period. In stable patients without evidence of active bleeding on dynamic computed tomography (CT) scans with contrast, conservative management can be attempted. In a previous study by De Angelis et al., [10] however, half of the patients who bled out but were conservatively managed eventually developed an infected hematoma that evolved into a later leak and required additional radiologic or surgical intervention. Aboueisha et al. [11] conducted a propensity-matched analysis using the MBSAQIP database

Table 1. The early complication rate after sleeve gastrectomy (within 30 days) in Korean bariatric patients according to the nationwide registry data from the Korean Society of Metabolic and Bariatric Surgery

Variables	Year of operation			Total
	2019	2020	2021	
Total number of procedures	1,158	1,226	1,213	3,597
Overall complication rates	35 (3.0)	28 (2.3)	16 (1.3)	79 (2.2)
Types of complication				
Leak	14 (1.2)	10 (0.8)	6 (0.5)	30 (0.8)
Bleeding	14 (1.2)	16 (1.3)	8 (0.7)	38 (1.1)
Obstruction (stenosis)	20 (1.7)	2 (0.2)	4 (0.3)	26 (0.7)
Reoperation	8 (0.7)	9 (0.7)	4 (0.3)	21 (0.6)
Mortality	1 (0.1)	1 (0.1)	1 (0.1)	3 (0.1)

Values are presented as number (%).

https://doi.org/10.17476/jmbs.2022.11.1.1

including 513,354 SG cases and demonstrated that bleeding after SG was significantly associated with an increased incidence of leaks (4.4% vs. 0.3%) along with higher morbidity. These results suggest that early re-exploration in cases of postoperative bleeding could prevent delayed complications like leakages or abscesses.

Prevention

Bleeding from the staple line can be influenced by stapling techniques. Selection of the proper stapler height against gastric wall thickness was the first step to prevent stapling failure or bleeding [12]. Yeo et al. [13] reported that using staple heights shorter than the typical recommendations could decrease intraoperative bleeding rates by exerting higher staple loading pressure in SG. Precompression before staple firing has usually been recommended to resolve tissue edema and optimize staple formation [14].

Various reinforcement techniques have been used to prevent postoperative bleeding. Among them, placing seromuscular sutures or oversewing the staple line is the most cost-effective and commonly used method in Korea. This procedure usually takes some time in the early learning curve of SG and can be decreased to approximately 10–15 minutes along with the accumulation of surgical experience. Continuous oversewing with a barbed suture material may further reduce the overall procedure time.

Another method for hemostasis involves the use of buttressing materials. Several buttressing products made from different materials have been introduced into the market, including bovine pericardium (Peri-Strips Dry with Veritas, Synovis, Deerfield, IL, USA), absorbable synthetic polymer membranes (SEAMGUARD®, Gore®, W. L. Gore & Associates, Inc., Newark, DE, USA, or Tri-Staple™ 2.0 Reinforced Reload, Medtronic, Minneapolis, MN, USA). Many previous studies have been conducted to elucidate the efficacy of these buttressing products in preventing bleeding from staple lines and leakage from staple line disruption. Although the results from these studies were not entirely consistent, using the buttressing product along the staple line during SG appeared to reduce the incidence of staple line bleeding; its efficacy on leakage has not been clearly demonstrated [4,11,15,16]. However, these buttressing products are not commercially available in Korea yet.

Another method involves the application of fibrin sealants. A recent meta-analysis including 2,136 SG patients from nine randomized controlled trials showed that there was a tendency toward less bleeding with fibrin sealant application compared to no reinforcement [8]. However, the hemostatic role of sealants was not evident in that meta-analysis of trials with larger samples [17]. It is still not clear whether applying fibrin sealant alone could reduce the incidence of postoperative bleeding.

Some investigators have suggested that increasing the systolic blood pressure beyond the normal range (>140 mmHg) in cooperation with anesthesiologists and simultaneously decreasing the intraabdominal pressure below 10 mmHg at the end of surgery can help detect silent bleeding during surgery. De Angelis et al. [10] reported that after adopting this intraoperative protocol, all silent bleeding was detected and properly controlled during surgery, and there were no postoperative bleeding events after surgery. In addition, Sroka et al. [7] also demonstrated that routine elevation of systolic blood pressure and over-suturing of the staple line minimized the incidence of hemorrhagic events down to 0% with reasonable prolongation of the procedure in their randomized controlled trial.

https://doi.org/10.17476/jmbs.2022.11.1.1

LEAKAGE

Incidence

Leakage is one of the most dreaded complications after SG, and the long staple lines and high intraluminal pressure are known to make SG more susceptible to leakage than Roux-en-Y Gastric Bypass (RYGB). The incidence has been reported as 1–6%, which became closer to 1% in the recent series due to better recognition and prevention of potential risk factors [16,18]. Up to 90% of the leak after SG occurs at the upper end of the long staple lines near the esophagogastric junction and the angle of His [19].

Causes and risk factors

Leaks on the staple lines can usually be caused by two factors: excessive mechanical forces on the staple lines, which usually cause a leak within the first two days after surgery; and ischemic injury in the remnant stomach, which usually leads to leakage between five and six days after surgery [20]. Stapling-related surgical techniques were major factors in the development of leaks after SG. The selection of an improper staple height or inappropriate traction during stapling can cause postoperative leaks. Extensive dissection can cause tissue ischemia and may contribute to leakage. Gastric stenosis or stricture is a major contributor to the leaks. Stenosis can easily develop at the level of angularis incisura, and using a smaller bougie size of less than 40 French during resection can increase the risk of sleeve stenosis or kinking of the sleeve, which raises intraluminal pressure and causes a leak [21]. Non-surgical factors include various kinds of underlying comorbidities, such as diabetes, sarcopenia, hypoalbuminemia, and chronic use of steroids, which are similar to the risk factors of postoperative complications in other general surgical patients [22].

Diagnosis

The clinical presentation can vary widely; patients can be completely asymptomatic or present with symptoms of abdominal pain, fever, or signs of septic shock, including tachycardia and hypotension. Upper gastrointestinal radiography after contrast swallow might detect a leak from the staple lines but has a relatively low sensitivity of 0–25% in detecting leaks [23,24]. Extravasation of contrast into fluid collection near the sleeve indicates a leak from the staple line in a dynamic abdominal CT scan with oral contrast (**Fig. 1**) [25,26]. Nonetheless, imaging studies can be false-negative, and hemodynamically unstable patients should undergo surgical exploration, whether with or without positive findings on CT scans.

When a leak occurs, its onset, location, and severity should be determined because these factors are likely to influence the initial management [27]. According to previous consensus statements, leaks can be classified as acute (within 7 days), early (within 1 to 6 weeks), late (after 6 weeks), and chronic (after 12 weeks) according to the observation period [28]. Leaks can also be classified according to radiologic findings. Recently, Johari et al. suggested a radiologic classification system for sleeve leaks, which divided leaks into four groups based on the CT findings, demonstrating a step-wise increased risk of complication severity and salvage surgery (**Fig. 2**) [29].

Management

Management of leaks after SG is difficult and complicated. The mainstays of leak management include proper medical resuscitation, proper drainage of the complicated fluid collection, and repair of the wall defect. The early use of broad-spectrum antibiotics, along with high-dose proton pump inhibitors, is essential for initial management. Thus,

https://doi.org/10.17476/jmbs.2022.11.1.1

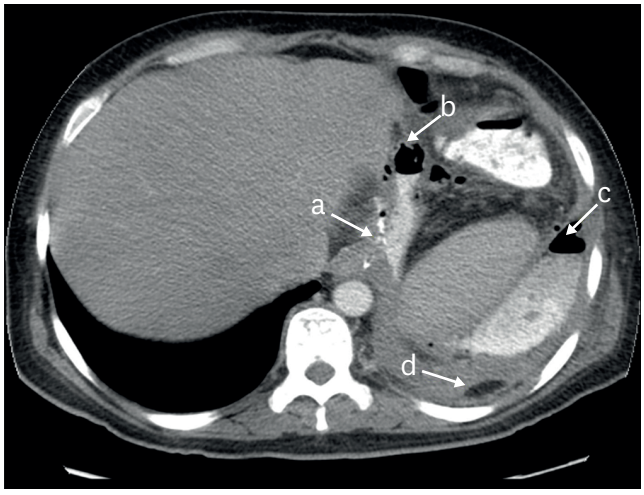

Fig. 1. Abdominal CT after contrast swallow in a patient with a sleeve leak. Disruption of the staple lines (a), extralumination of the contrast medium to the left subphrenic area (b, c), reactive pleural effusion (d).
Figure reprinted from Alban et al. Obes Surg 2018;28(9):2923-2931, with permission from the publisher, Springer Nature [26].
CT = computed tomography.

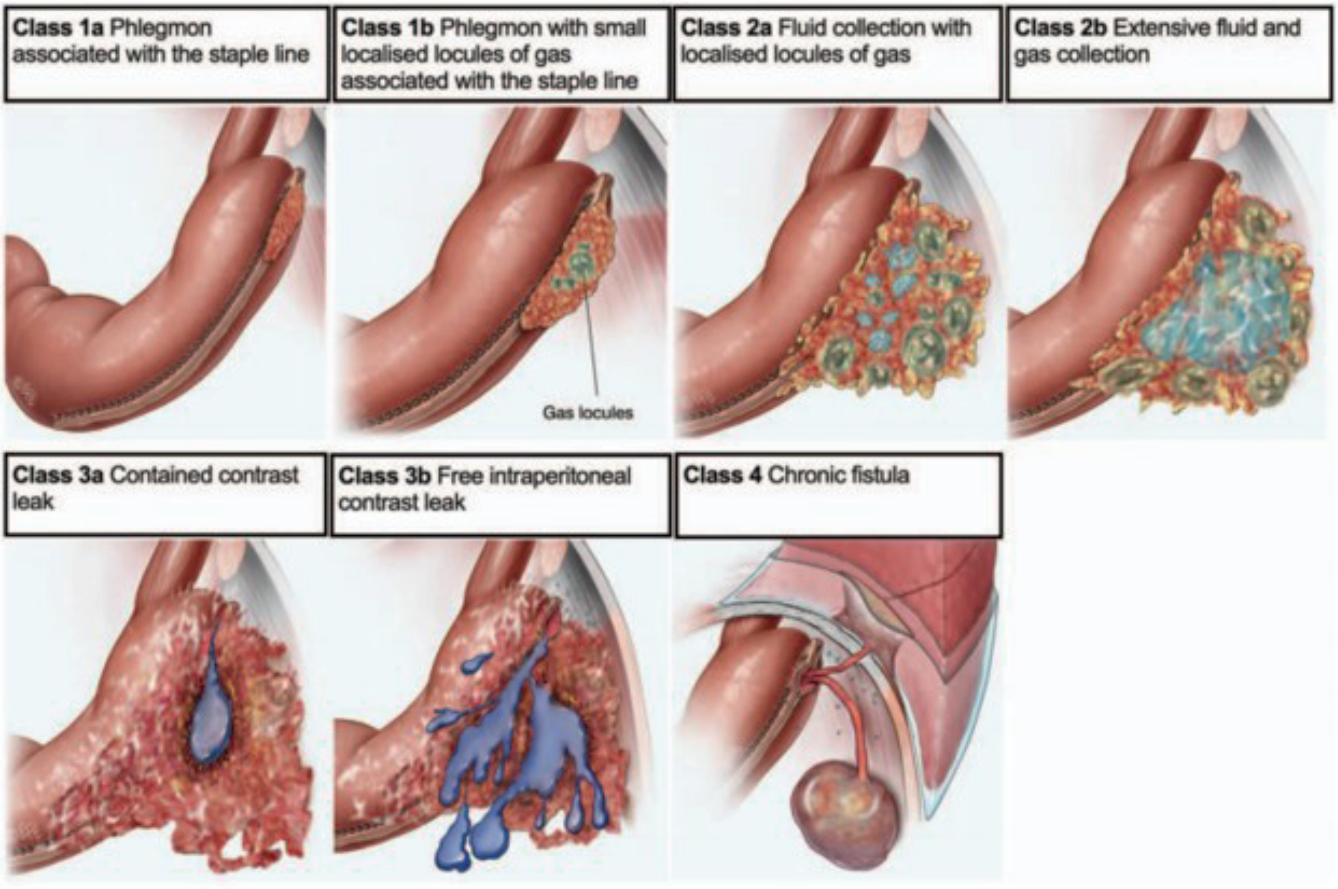

Fig. 2. Schematic representation of the four-tier classification of sleeve gastrectomy leak.
Figure reprinted from Johari et al. Ann Surg 2022;275(2):e401-e409, with permission from the publisher, Wolters Kluwer Health [29].

https://doi.org/10.17476/jmbs.2022.11.1.1

patient stability will guide further management plans. Hemodynamically unstable patients with septic shock usually require immediate surgical intervention. Less invasive therapeutic options such as endoscopic interventions are preferred.

When surgical exploration was performed on leak patients in the earlier period, the goal of surgical management was not a definitive repair of the leak but to wash out and remove the necrotic debris and to place proper drains. A simple primary repair might be attempted in acute leaks within three days after surgery when promptly diagnosed [30]. Nonetheless, it is usually less successful, with a high incidence of recurrence owing to extensive inflammation in the surrounding tissue. In the latter phase, when non-surgical management fails after three to six months, surgery can be used as a step-up or salvage therapy. This includes conversion to RYGB and fistulojejunostomy.

In stable patients, less-invasive non-surgical management should be attempted. This includes a wide range of endoscopic interventions, from endoscopic stenting and direct fistula closure, to internal drainage and radiologic interventions. Adequate drainage has been the most important treatment for early leaks, and abscesses can be drained percutaneously or endoscopically. The gastric wall defect needs to be repaired either by diverting the fistula or by direct closure. Endoscopic intervention depends on the size and characteristics of the defect [22].

The placement of self-expandable metabolic stents (SEMS) is one of the most commonly used methods for managing acute or early leaks after SG. It allows food materials to bypass the defect during fistula healing and enables early oral feeding or even discharge. The most frequent problem in stenting is migration, which is reported to be up to 30% depending on the type of stent. Therefore, some experts recommend additional clipping to secure the stent in place [31]. Other common complaints from patients are chest discomfort, nausea, and reflux after the procedure, and some patients might require premature removal of the stent due to intolerance. Stents are usually placed for four to six weeks, and fistula status needs to be reevaluated. Recently, several bariatric-specific SEMS have been introduced and are now available for clinical use. They are fully covered stents with a larger caliber and a longer length than usual stents to fit the bariatric anatomy (**Fig. 3**). The leak closure rate has been reported to be up to 100% with these bariatric-specific stents at the expense of a higher incidence of stent-related complications such as esophageal stricture, bleeding, perforation, and intolerance [31-35].

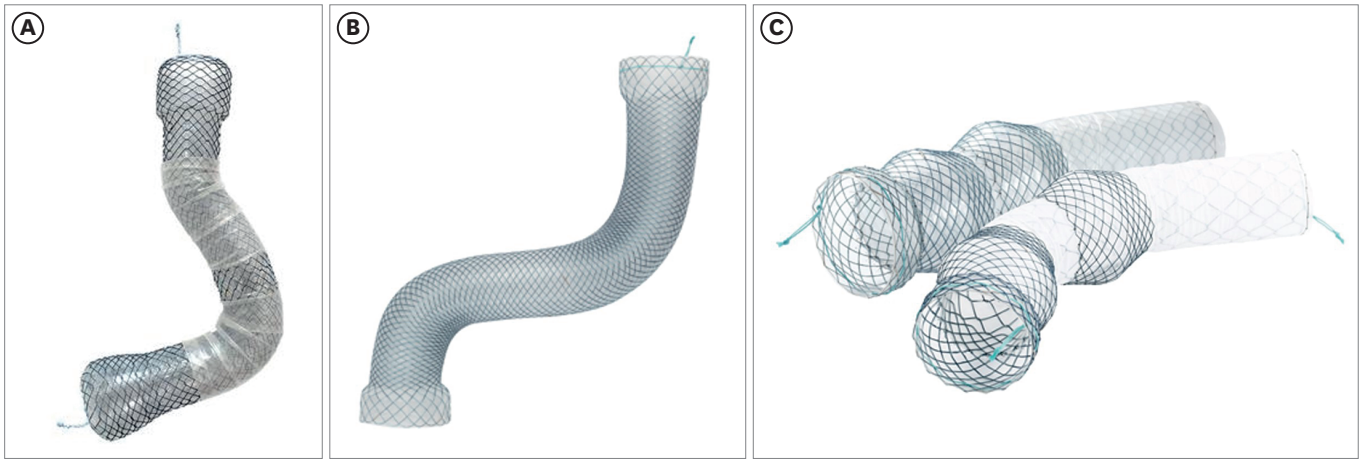

Fig. 3. Bariatric-specific endoscopic stents. (A) GastroSeal™ stent (M.I.TECH, Pyeongtaek, Korea), (B) MEGA™ stent (TaewoongMedical Co., Ltd. Gimpo, Korea), (C) BETA™ stent (TaewoongMedical Co., Ltd. Gimpo, Korea).

Direct fistula closure can be attempted in the case of a small fistula opening. Closure with conventional through-the-scope clips might work in very small defects of less than 1 cm and in much less inflamed tissue, but demonstrates limited efficacy. Over-the-scope clips (OTSC) provide full-thickness closure of the fistula and show promising results [36]. Successful closure can be expected in early small-sized fistulas with less fibrotic tissue, and the success rate depends on operator experience. Mizrahi et al. retrospectively reviewed 26 patients who were treated with OTSC for sleeve leaks and reported that OTSC alone demonstrated a disappointing success rate of 56.8%, and additional endoscopic procedures were required in the majority of the patients to achieve successful defect closure [37].

Tissue sealants have also been used to close the fistulas. Fibrin glue functions in two ways: mechanical occlusion of the defect and promotion of fibroblast proliferation. The glue can be delivered endoscopically or radiologically, and multiple sessions with intervals of several days are usually required to occlude the fistula completely. Assalia et al. [38] reported that percutaneous application of fibrin glue with fluoroscopic guidance under endoscopic visualization achieved successful fistula closure in 23 of 24 patients with sleeve leak patients with 2.2 sessions on average (range, 1–6). This suggests that plugging leaky sleeves with tissue sealant is a simple, tolerable, and effective method to treat sleeve leaks with fewer complications.

Endoscopic internal drainage (EID) with double-pigtail stents is another method to treat sleeve leaks. The stent keeps the fistula tract open and facilitates drainage of the abscess in the gastric lumen, which eventually leads to the collapse of the abscess cavity and the closure of the leak. It can be used for well-contained leaks and usually requires a nasojejunal feeding tube for enteral feeding for a couple of weeks. EID with endoscopic pigtail stents showed a success rate of up to 95% at relatively lower costs and fewer complications than SEMS, as well as minimal discomfort for the patients [39-41]. Therefore, it is rapidly gaining popularity as a therapeutic modality for leaks among bariatric experts.

To facilitate faster healing, endoscopic vacuum-assisted closure (EVAC) has been attempted [42]. Continuous negative pressure applied to the sponge absorbs complicated fluid collection in the cavity, reducing the risk of wide dissemination of infection and accelerating the growth of granulation tissue. However, the sponge should be changed every 3 to 5 days, which requires repeated endoscopic sessions, and either prolonged parenteral nutrition or feeding jejunostomy is necessary. In a small series, the success rate was reported as 87%, which was mostly achieved within a month, indicating that the treatment period was considerably shorter with EVAC than with EID [42].

SLEEVE STENOSIS

Incidence

The incidence of clinically significant sleeve stenosis is 0.5–3.5% [43]. It usually occurs at the level of the angularis incisura and is closely related to leakage at the proximal part of the sleeve owing to increased intraluminal pressure [18]. Mechanical stenosis typically occurs when using a narrow calibration tube and starting staple firing too close to the angularis. Abnormal kinking or twisting of the sleeve can cause functional stenosis [44]. Patients with stenosis would present with nausea, vomiting, and dysphagia, particularly after eating solid food.

https://doi.org/10.17476/jmbs.2022.11.1.1

Diagnosis and management

The diagnosis can be made by an upper gastrointestinal contrast study showing abrupt narrowing of the sleeve with or without a certain degree of contrast reflux. Thus, endoscopic evaluation is an effective diagnostic modality.

Management of stenosis includes watchful waiting, endoscopic interventions, stricturoplasty, and conversion surgery. Short-segment stenosis may be successfully managed with endoscopic balloon dilatation, although repeated attempts are usually required at least twice. In a recent study, Shnell et al. [45] reported a success rate of 70–80%. Placing a stent at the stenosis site is another option that can manage the stenosis and leak at the same time [46]. SEMS has also been reported to be effective in twisted sleeve cases [47]. Long-segment stenosis or twisted sleeves that do not respond to endoscopic techniques may ultimately require surgical revisions such as conversion to RYGB [46,48].

PMVT

Incidence

PMVT is a rare but life-threatening complication after bariatric surgery and is known to be much more common after SG than after other bariatric procedures, including RYGB. The incidence was reported as 0.3–0.4% in the previous studies that retrospectively reviewed a very large number of SG patients [49-52]. It mostly occurs within the first postoperative month, and the clinical presentation can vary. Patients may present with vague abdominal pain, nausea, vomiting, and diarrhea, which gradually progress to diffuse peritoneal irritation signs or frank shock due to bowel ischemia.

Diagnosis and management

When suspected, contrast abdominal CT scans can readily confirm the diagnosis, and the portal vein has been reported to be the most commonly affected vessel, according to a systematic review of 104 reported cases [53]. Therapeutic options for PMVT depend on the severity of thrombosis. Most patients respond to conservative treatment with extended anticoagulation for three to six months. This is similar to the treatment algorithm for deep vein thrombosis or pulmonary thromboembolism. However, some might require surgical bowel resection due to frank bowel infarction.

According to the systematic review of 104 cases, the mortality rate was as high as 4.8%, indicating that this complication can be fatal to SG patients. Therefore, early diagnosis and treatment are crucial, and a high index of suspicion needs to be maintained. However, there is very little evidence regarding the prevention and prophylaxis of PMVT after SG.

CONCLUSION

Early postoperative complications can occur in 3–5% of the patients after SG, which can lead to chronic complications. Management of these complications is difficult and complicated; therefore, following the preventive protocol in the first place is recommended to avoid fatal complications. These include adhering to standardized surgical techniques according to the consensus statements from expert surgeons, such as reinforcing the staple lines or using the proper size calibration tube [12]. It is important to have a high index of suspicion to detect

https://doi.org/10.17476/jmbs.2022.11.1.1

and manage these complications as early as possible, and a multidisciplinary team approach involving surgeons, endoscopists, and radiologists is highly recommended to manage complicated patients successfully.

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