LRYGB: Complications—Diagnosis and Management

23

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Abstract

Several significant and potentially catastrophic complications can occur after a laparoscopic Roux-en-Y gastric bypass (RYGB). Early complications include anastomotic leaks and hemorrhage, followed by internal herniation with possible small bowel ischemia, fistulation, ulceration, and nutritional and metabolic complications. Other complications include deep venous thrombosis and pulmonary embolism, skin and neurological complications, and cholelithiasis. Bariatric patients may have elusive and non-specific clinical signs and their weight may restrict the types of imaging investigations available. All these factors may make it difficult to detect complications when they occur. Hence, it is important that the treating surgeon have a high index of suspicion for complications in any bariatric patient, both when postoperative progress does not appear to be following the usual course, and in those presenting with unmanageable pain, fever or tachycardia. It is also important for the patient to be educated of the potential changes in a normal postoperative course. They should be advised that they or any other treating clinician should contact the primary bariatric surgeon in case of any untoward symptoms in the postoperative period, as these may be related to their operation, even if not obvious in the first instance. In the early postoperative stage, if there is any doubt about potential abdominal complications, a diagnostic laparoscopy should be performed without further delay, since these patients can deteriorate very quickly, and abdominal scans may often be unhelpful and/or falsely reassuring.

The complications of RYGB, their incidence, presentation, diagnosis and management are discussed in this chapter, and in addition, some tips for their prevention are provided.

Keywords

Leak • Internal hernia • Complication • Laparoscopic Roux-en-Y gastric bypass • Ulcer • Pulmonary Embolism • Fistula • Stenosis • Gastro-Intestinal bleed • Dumping syndrome

23.1 Introduction

Worldwide, there are currently more than 340,000 bariatric procedures performed annually, of which the Roux-en-Y gastric bypass (RYGB) remains the most common operation (46.6 %). Approximately 80 % of these operations are performed laparoscopically, and is termed a laparoscopic Roux-en-Y gastric bypass (LRYGB) [1]. Given the technical complexity of the LRYGB there are associated complications at a rate of approximately 21 % (12–33 %), and a re-operation rate of 3–20 % [1, 2]. There is a perioperative

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(<30 days post LRYGB) and postoperative (>30 days post LRYGB) mortality rate of approximately 0.38 % and 0.72 % respectively [2]. In the early postoperative period, these complications tend to be related to technical issues. Later, they can include metabolic or nutritional problems, though these may be minimized by ensuring good patient compliance with pos-operative care and the provision of lifelong regular follow-up in clinic. It is important to note that bariatric surgery patients do not behave in the same way as the average post-surgical patient during the postoperative period. Furthermore, bariatric surgery patients may exhibit fewer symptoms and signs of complications such as peritonitis, and may consequently deteriorate rapidly and suddenly. This stresses the importance of early diagnosis in this patient population. A bariatric surgeon, therefore, should be able to utilize diagnostic laparoscopy early in the postoperative course if a patient is not progressing satisfactorily and there is concern about an intra-abdominal complication. Laparoscopy enables a surgeon to make not only a prompt diagnosis, but also, in the most part, manage complications effectively, thus saving the patient from the surgical stress and further complications associated with a laparotomy. The fear of a negative diagnostic laparoscopy should not deter the surgeon from offering this potentially disaster-averting and life-saving treatment. Most bariatric surgeons, when it comes to recognizing postoperative complications, are very familiar with the expression, "delay is the deadliest form of denial" [3].

There have been some attempts to develop a pre-operative risk predictor score (Obesity Surgery Mortality Risk Score [OS-MRS]), which has recently been customized to make it applicable to the LRYGB, and the use of this tool may affect future outcomes and reduce complication rates [4]. The OS-MRS assigns points to patients for certain preoperative variables. These include: male gender, body mass index (BMI) >50 kg/m^2, age >45 years, hypertension and known risk factors for pulmonary embolism [4]. Patients who score 0–1 fall into the lowest risk group (A), 2–3 into intermediate group (B), and score 4–5, into high risk group (C) [4]. Nevertheless, it is wise to suspect every postoperative patient who is not progressing normally of having a complication. In general, it is suggested that the patient should be diagnosed within 4 h, and an intervention should be administered within 6–12 h.

Table 23.1 outlines the complications, their incidence and their time course that are considered in this chapter. The following complications are discussed in detail: bleeding, leak, ulcers, gastro-gastric (GG) fistula formation, bowel obstruction, deep vein thrombosis (DVT), and pulmonary embolism (PE); skin complications, nutritional, metabolic and neurological complications, cholelithiasis, and rarer complications. Weight gain following gastric bypass will be discussed in a separate chapter. For each complication, a description of the more common symptoms and signs, the investigations, management, and steps for prevention are defined. Table 23.2 summarizes the main clinical features found with these complications.

23.2 Early Complications

23.2.1 Gastrointestinal Bleeding

The current incidence of postoperative gastrointestinal (GI) bleeding is 0.8–4.4 %. It is more common in those patients who have been heavy users of non-steroidal anti-inflammatory drugs (NSAID) pre-operatively, particularly if they have not ceased taking them 7–10 days prior to surgery [5]. The problem is further compounded by the use of low molecular weight heparin (LMWH) prophylaxis for venous thromboembolic events (VTE). Most patients undergoing surgery receive a dose before or during surgery, which is then continued daily until they leave hospital, or in some centers, for even longer after discharge.

23.2.1.1 Types of Gastrointestinal Bleeding

Bleeding may arise from anywhere, including the bypassed (remnant or excluded) portion of the stomach. It may present

Table 23.1 Incidence and timings of postoperative complications after LRYGB

Complication	Incidence (%)	Timing (early <1 week, intermediate 1 week – 1 month, or late >1 month)
GI bleed	1–2	Early
Leak	1–2	Early/intermediate
Ulcers and GG fistula	4	Late
GI obstruction	5	Late but may occur early/intermediate
Thromboembolism	0.1–1.3	Early/intermediate
Skin complications	variable	Late
Nutritional complications (of some degree)	variable	Late
Metabolic complications	variable	Intermediate/late
Cholelithiasis	7–10	Late

GG gastro-gastric, *GI* gastrointestinal, *LRYGB* laparoscopic Roux-en-Y gastric bypass

Table 23.2 "Symptom sorter": a list of the common symptoms and their causes to aid diagnosis

Tachycardia	Hypotension	Abdominal pain	Pyrexia	Nausea and vomiting
GI bleed	GI bleed	GI bleed	Leak	Ulcer/fistula
Leak	(Leak)	Leak	Pneumonia/sepsis	Intestinal obstruction/internal hernia
PE		Ulcer/fistula		Cholelithiasis
		Intestinal obstruction/internal hernia		"Hockey stick" syndrome
		Cholelithiasis		
		"Hockey stick" syndrome		

It should be remembered that in bariatric patients symptoms and signs may be elusive so this table should be considered to be a guide rather than a definitive list
GI gastrointestinal, *PE* pulmonary embolism

clinically as a GI bleed with hematemesis or melena, or covertly as intraperitoneal bleeding, or both. If a GI bleed occurs within the first 48 h, a staple line bleed should be suspected. The most commonly affected site is at the gastro-jejunal (G-J) anastomosis, which usually represents an inadequate hemostasis (intra-abdominal or intra-luminal). Other staple lines that may bleed include those of the gastric remnant, gastric pouch, or jejuno-jejunal (J-J) anastomosis. If the hemorrhage occurs from the gastric pouch itself, it tends to present as hematemesis; a per-rectal (PR) bleed can be indicative of bleeding from any of the sites intra-luminally [4]. If the bleeding occurs more than 48 h postoperatively, it is most likely from a G-J marginal ulcer. Occasionally, bleeding can also be due to an alternative intra-abdominal source such as a tear in the mesentery or spleen. General oozing or even a more significant hemorrhage can be due to the use of low molecular weight heparins after the induction of anesthesia. It must also be borne in mind that a GI bleed can result in a blood clot blocking the jejuno-jejunostomy, thus resulting in bowel obstruction and abdominal distension. Bleeding into the gastric remnant may not present with overt PR bleeding, but instead can present with acute gastric distension if the blood stays within the gastric remnant.

23.2.1.2 Symptoms and Presentation

The most commonly observed symptoms are as follows:

- Tachycardia (early) and hypotension (later), with or without pallor and collapse
- Hematemesis or bleeding per rectum (PR) in the form of melena or bright red blood
- Abdominal pain or abdominal distension
- Frank blood arising from any intra-abdominal drainage (note that lack of blood in drainage fluid does not indicate an absence of internal bleeding)

23.2.1.3 Management

The key steps in the diagnosis and management of a postoperative bleeding episode are outlined in Fig. 23.1.

23.2.1.4 Immediate Steps

- Promptly resuscitate with intravenous fluid
- Discontinue heparin or LMWH
- Correct any coagulopathy
- Check serial measurements of hemoglobin levels and hematocrit
- Commence transfusion of blood products as per the clinical findings, and in line with the local hospital guidelines
- Administer tranexamic acid and coagulation products as appropriate

An upper GI endoscopy should be considered; however, accessing the excluded stomach and the Roux limb is not usually possible with a direct esophagogastroduodenoscopy (EGD), and it may be necessary to perform a gastrostomy to enable the insertion of a scope into the stomach [5]. Unfortunately, due to the high vasculature in the stomach, angiography with embolization is often not useful. Surgical intervention, such as diagnostic laparoscopy, may be required in the first instance in about 40 % of the cases. This depends on the rate of blood loss, the hemodynamic stability of the patient, and extent of bleeding [5]. During repeat laparoscopy, it is recommended to oversew the bleeding points and staple lines, decompress the remnant stomach and to place a gastrostomy tube [5]. Extra-luminal bleeding is best managed by performing a repeat laparoscopy, followed by evacuation and washout of the clot (because leaving the clot adjacent to a staple line may increase the risk of a leak), oversewing of all staple lines, and using other hemostatic agents, if deemed necessary. A drain should be left to monitor the area for further bleeding.

23.2.1.5 Prevention

There are several measures that can be adopted to prevent GI hemorrhage. One is to oversew the staple lines. Although not routinely recommended, persistent intraoperative ooze from a particular site may warrant oversewing. It is important to select the correct staple height, as short staples may help prevent bleeding, but if the staple height is too short, it will lead to the incorrect staple formation and hence predispose

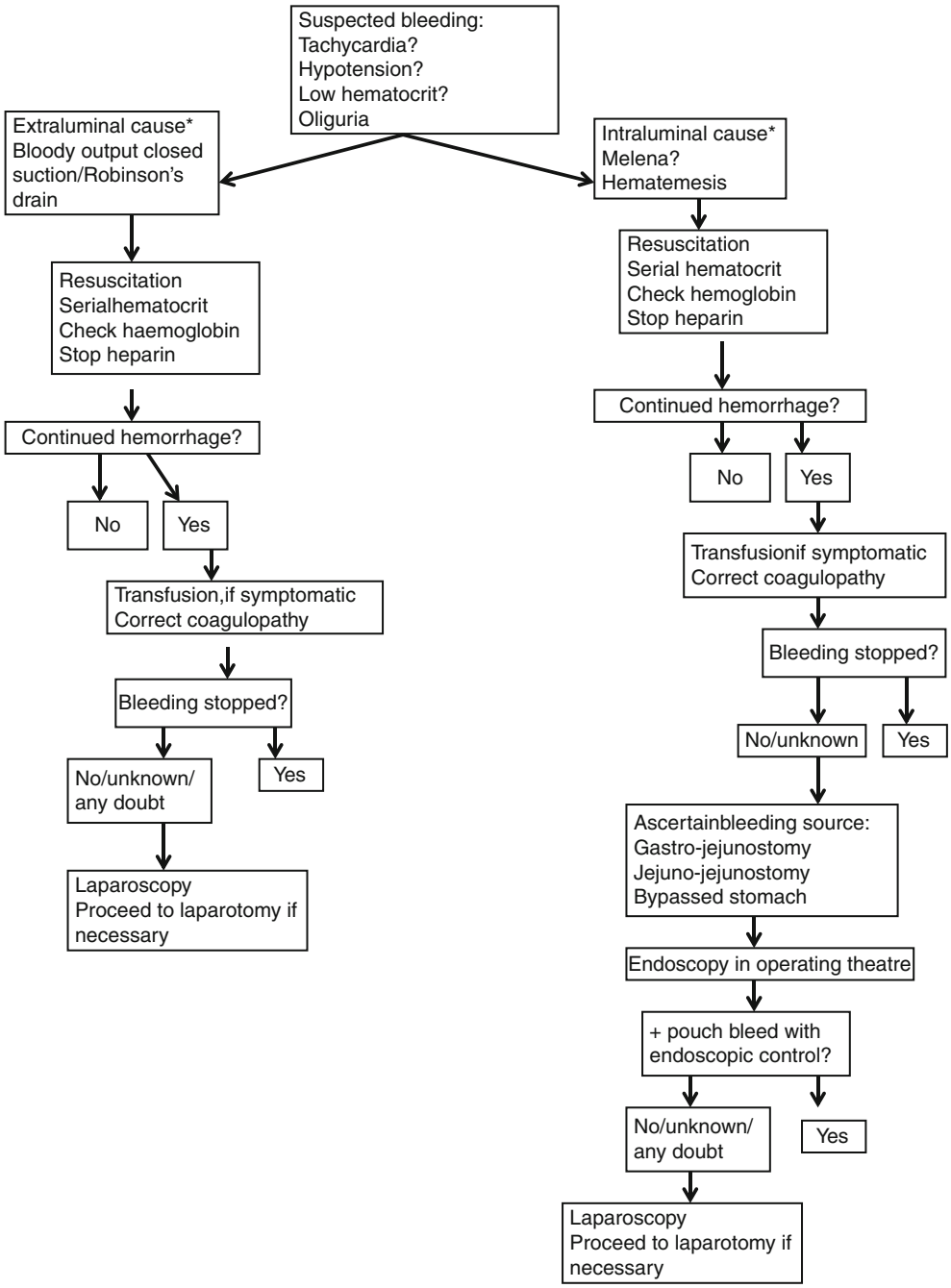

Fig. 23.1 Diagnosis and management algorithm for gastrointestinal bleeding post gastric bypass (Adapted Mehran et al. [5])

the patient to a risk of leak. The stapler gun should be fired as directed by the manufacturer; for example, clamping and maintaining pressure on the tissue for a period of time prior to firing, helps to enable hemostasis.

There have been reports of a significant reduction in the number of bleeding sites following the division of gastric, jejunal, and mesenteric tissue, and the overall intra-operative blood loss, by using staple-line reinforcement (SLR), especially those made of absorbable material [6]. The advantages of these reinforcements must be weighed against their potential disadvantages, which include high cost and the additional time required to load the SLR onto the stapler [6]. Fibrin glues have also been used to manage leaks, and may be beneficial in preventing bleeding; however, although they are easy to use, they are also expensive and can induce patient immunological reactions since they are derived from blood products [7].

The risk of postoperative bleeding complications can be minimized further by performing a final careful inspection of all staple lines, the divided mesentery and omentum, to ensure hemostasis prior to exiting the abdomen, once the blood pressure has returned to normal [8].

23.2.2 Leak

Anastomotic and staple line leaks occur after approximately 2–4.4 % of LRYGB operations, and can result in significant morbidity, cutaneous fistula, peritonitis, abscess formation, sepsis, multi-organ failure, and eventually death [9]. Leaks occur most commonly from the G-J anastomosis. They occur less commonly from staple lines, more dangerously from the J-J anastomosis, the remnant stomach, and from an unrecognized iatrogenic intestinal injury. Early detection has been proven to reduce morbidity and mortality. This may be challenging, however, both due to the physical effects of obesity itself rendering it difficult to elicit the usual clinical signs, and with the weight limits of the computed tomography (CT) table [8], restricting the ability to obtain good postoperative scans.

23.2.2.1 Symptoms and Presentation

The most commonly observed symptoms are as follows:

- Tachycardia, with or without hypotension
- Tachypnea
- Pyrexia
- Abdominal pain, although they seldom present with overt peritonitis
- Excessive abdominal pain, shoulder tip pain, and hiccups are ominous symptoms, especially in the presence of a persistent tachycardia; a leak should be suspected when the heart rate is more than 120, until proven otherwise

Fig. 23.2 Typical leak from the gastrojejunostomy 24 h after surgery (Reproduced with kind permission from Springer from: Trenkner [56])

23.2.2.2 Diagnosis

Intra-operative Diagnosis

Leak must be ruled out intra-operatively after completion of the G-J anastomosis, with either a methylene blue dye test, or by using air insufflation under saline via the orogastric tube [9]. The air test is preferred for several reasons: first, it is thought to be more sensitive as it tests the entire anastomosis and not just the visible area (the methylene blue test may miss a leak on the anastomosis back wall); second, it is faster; third, it is cheaper, and fourth, it does not color all areas if there is a leak [10]. An alternative approach is to perform an on-table endoscopy to check the anastomosis for both its lumen size and for any leaking points. However, this can be expensive and time consuming to perform and needs to be done carefully to avoid traumatizing the newly formed gastric pouch and anastomosis.

Postoperative Diagnosis

Upper gastrointestinal (UGI) contrast studies are frequently used to evaluate the gastric pouch for leaks, stenosis or obstruction (Fig. 23.2.). However, routine imaging during the early postoperative care is neither necessary nor cost-effective [11]. Review of the published literature [11] suggest that most leaks occur between postoperative day 2 to day 5, and are more likely to be detected using a CT scan with oral contrast (Table 23.3), (Fig. 23.3). The sensitivity of UGI studies can be influenced by the experience of the radiologist, the size of the leak, and the contrast material used, and is the preferred study for detecting alimentary limb obstruction such as stenosis [11, 12]. Though there is minimal patient-associated risk, this investigation cannot reliably detect a leak; reports indicate true-positive rates of only 1 in 9 [12, 13]. It also does not rule out a leak at the jejunojejunostomy site or in the remnant stomach. It is suggested that a routine postoperative UGI contrast study should be avoided, as it is unreliable, and should only be performed selectively when a patient demonstrates clinical signs and symptoms of a leak [11, 14, 15].

The routine practice of placing a surgical drain is advantageous in detecting an increased sanguineous or abnormal drain output that may aid in the diagnosis of a bleed or leak, respectively [9]. Those who argue against the use of drains suggest that they can be falsely reassuring if there is no output, and the drain may be blocked or in the wrong position. Some suggest that the drains themselves may cause a leak or obstruction and result in a route for infection [16]. Yet there is some

Table 23.3 Representation of the timelines when common complications occur

Time after surgery	Complication				
Day 1–2	GI bleed (staple line)				DVT/PE
Day 3–5	GI bleed (ulcer)	Leak			
Day 5–10				GI obstruction	
1–6 months			Ulcer/fistula		
6–12 months					
12–24 months					
24–36 months					

DVT deep vein thrombosis, *GI* gastrointestinal, *PE* pulmonary embolism

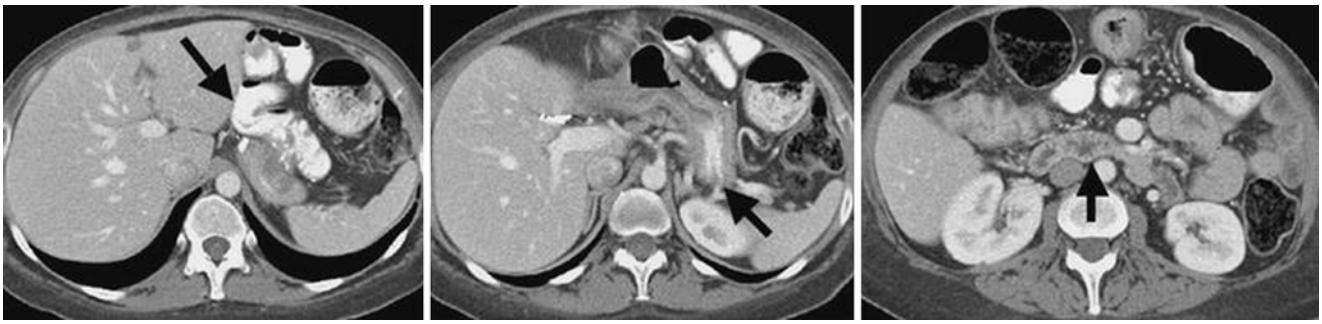

Fig. 23.3 Leak across the staple line into the bypassed stomach diagnosed by computed tomography. In the first image note the contrast in the Roux limb (*arrow*). In the second image note the contrast in the excluded stomach (*arrow*). On the final image no contrast is seen in the duodenum (s) (Reproduced with kind permission from Springer from: Trenkner [56])

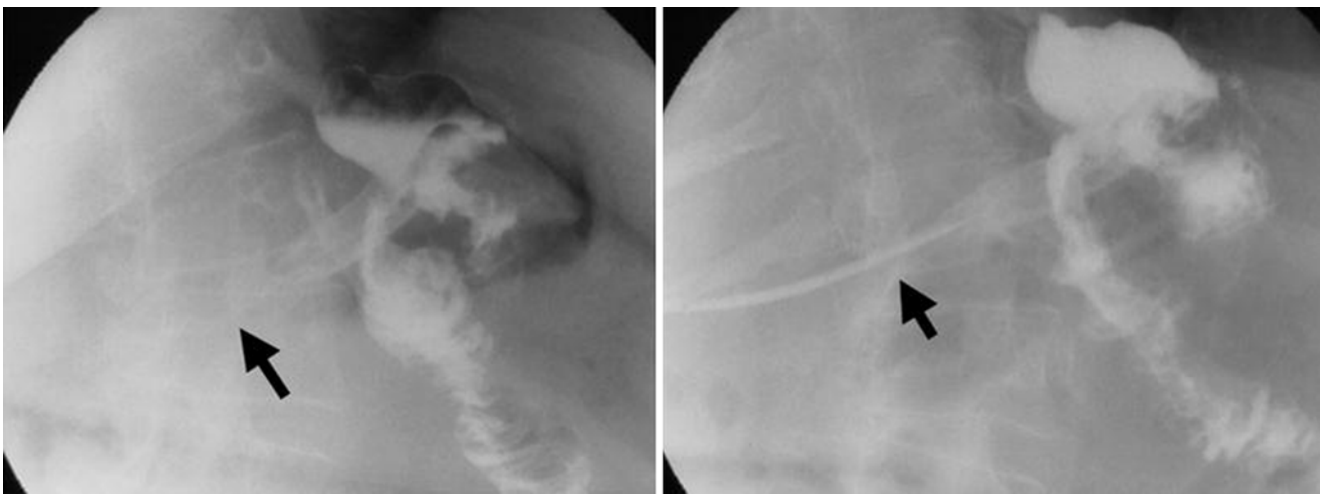

Fig. 23.4 Leak diagnosed only by presence of contrast in the drain (*arrows*). The first image is early in the study and the second is later (Reproduced with kind permission from Springer from: Trenkner [56])

evidence to show that sometimes a leak is only diagnosed by UGI studies or in the presence of a drain (Fig. 23.4) [17, 18].

If an anastomotic leak is suspected in a patient, a prompt diagnostic laparoscopy remains the gold standard approach, as it provides the ability to accurately diagnose the problem as well as providing prompt treatment. ACT scan can be helpful in making a diagnosis when the patient is stable, but it has limited feasibility as patient weight and girth can exceed the parameters of the imaging equipment. Additionally, it can sometimes be falsely reassuring, if interpreted incorrectly.

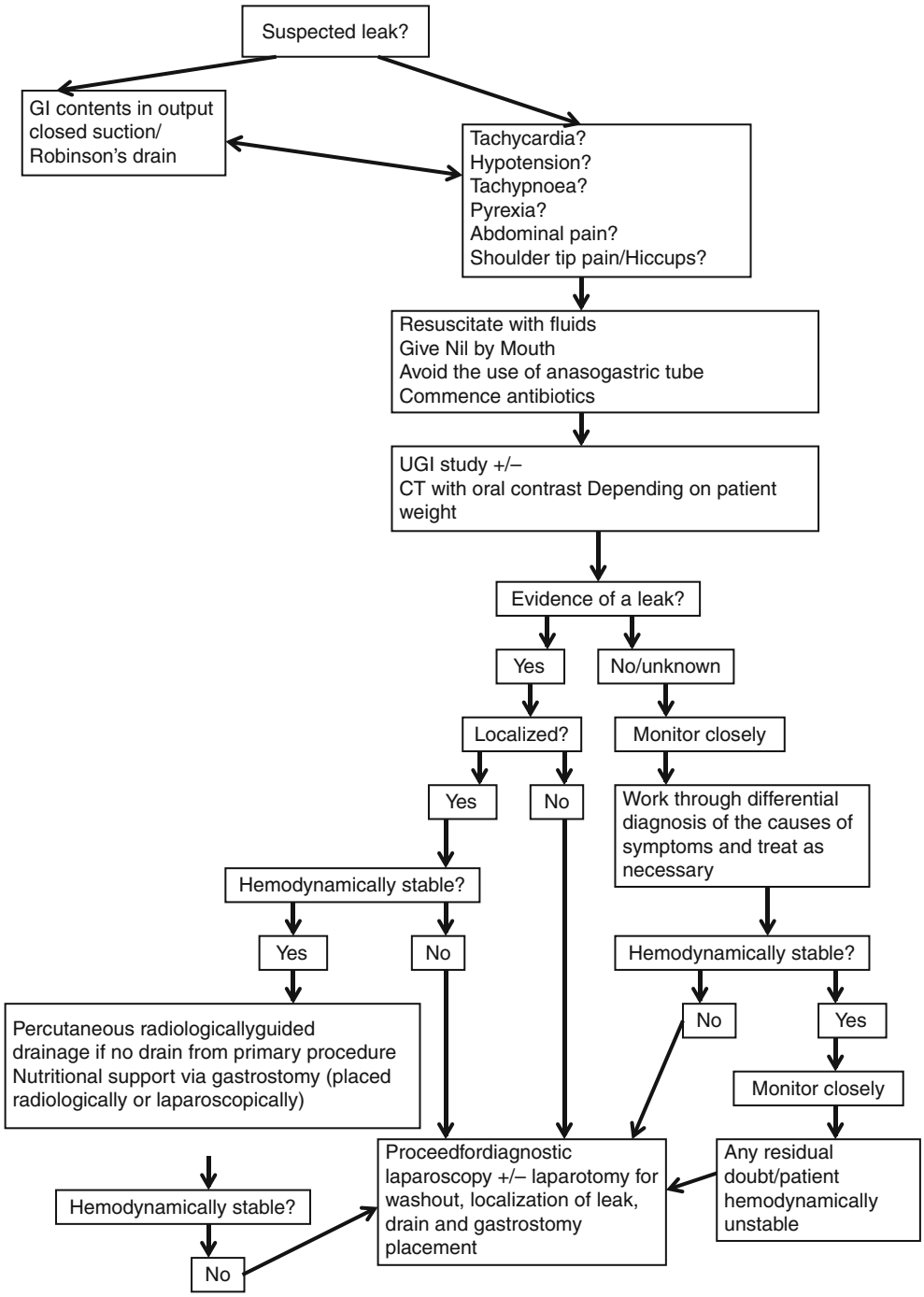

Fig. 23.5 Diagnosis and management algorithm for anastomotic leak post gastric bypass

23.2.2.3 Management

Immediate steps to be adopted in the management of a leak are as follows:

- Fluid resuscitation
- Nasogastric tube placement
- Commence antibiotics
- Definitive treatment strategies, such as diagnostic laparoscopy in unwell patients
- CT scan in stable patients (Fig. 23.5)

Conservative management includes drainage, either via a drain placed at the primary procedure site or through a radiologically guided percutaneous drain, intravenous antibiotics, and nutritional support (nil by mouth and feeding parenterally or via a radiologically placed gastrostomy tube), may be sufficient for treatment of patients who are hemodynamically stable [19, 20]. If the patient is unstable and unwell, or if there is an uncontrolled leak, then the patient should proceed to the operating room immediately. The operative procedure would usually start with a laparoscopy, but the surgeon may

have to perform a laparotomy. The aim of surgery is to drain and washout all the contamination and any intra-abdominal GI contents, followed by an attempt to localize the site of the leak in order to repair it or ensure well-placed drains for controlling the leak. A fresh leak may be amenable to being oversewn and/or patched. A leak that is over 24 h old usually has friable edges that will be difficult to approximate. The key maneuvers are to place drains and establish a method for enteral feeding if appropriate (e.g., remnant stomach gastrostomy or feeding jejunostomy tube), or central venous access for parenteral nutrition.

Non-healing leaks and fistulas may develop, and endoscopic placement of covered self-expandable stents (SES) may be a minimally invasive treatment option for the management of such postoperative leaks, even in patients with acute symptoms [19, 21]. SESs are a relatively well-tolerated, safe and effective means of achieving leak closure, with success rates of up to 87 % [19, 21]. Stent migration is the most common complication of SES placement, which may require endoscopic stent repositioning, retrieval or replacement [19]. In some circumstances, surgical retrieval is necessary [19]. Further additional drawbacks associated with migration are the need for both X-ray surveillance to assess possible stent migration, and for repeated endoscopic procedures [19]. At present, however, the stents being used are not designed specifically for this purpose, and with further modifications, there may be an improvement in the migration risk, and consequently the morbidity rates associated with this technique.

23.2.2.4 Prevention

Three simple ways to help prevent leaks include (i) avoiding excess tension at the gastro-jejunal anastomosis, (ii) avoiding devascularization of the gastric pouch through meticulous dissection and identification of the anatomy, and (iii) using the correct size endostapler cartridge for the tissue being divided or anastomosed.

It has been reported that the use of staple-line reinforcement is associated with a reduced leak rate in LRYGB [7]. It is crucial to select the correct staple size as the reinforcement gives additional tissue thickness, which can result in staple-gun misfiring [6]. There is an associated mortality in patients who have post-bypass leaks. In those who do not succumb, the recovery is often prolonged and complicated. Therefore, it cannot be understated that every measure should be taken to prevent a leak.

23.2.3 Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)

The risk of developing a DVT or a PE after bariatric surgery is between 0.1 and 1.3 %, although recent studies suggest this to be grossly under-reported. It should be considered as one of the strongest independent factors for perioperative mortality [22–24]. It is most common in the first 2 weeks after surgery when patients are least ambulant [22–24]. There are certain risk factors for venous thromboembolism, which include hypercoagulability, increased BMI (>50), history of thrombosis, surgical interventions at the pelvis, heart failure, venous insufficiency, supplementary hormonal therapy, male gender, expected long operative time, smoking, and obstructive sleep apnea [22–25]. Extreme body weight, high intra-abdominal pressure and reverse-Trendelenburg positioning in laparoscopic surgery reduce venous backflow, but creation of the pneumoperitoneum has not been shown to be an independent risk factor for the development of thromboembolism despite the potential for increased venous stasis [22].

Table 23.4 Differential diagnosis of chest pain after LRYGB

<48 h after surgery	>48 h after surgery
PE	PE
MI	MI
Retained gas from pneumoperitoneum	Pneumonia
Abdominal compartment syndrome	Leak

LRYGB laparoscopic Roux-en-Y gastric bypass, *MI* myocardial infarction, *PE* pulmonary embolism

23.2.3.1 Signs and Presentation

DVT: Pain or swelling involving the lower extremities (though not always observed in obese patients)

PE: Hypoxia, tachypnea, and tachycardia. The patient may also complain of chest pain. It can be difficult to distinguish a PE from a leak or sometimes from atelectasis and pneumonia (Table 23.4).

23.2.3.2 Investigations and Management

Diagnosis of a DVT can be made using a Duplex ultrasound, and the patient should be treated with anti-coagulants [22]. A PE can be diagnosed with a CT angiogram, or a V/Q scan. If the weight of the patient restricts the use of CT, then it is advisable to initiate anti-coagulation therapy for these patients and accept the small risk of potential postoperative hemorrhage rather than risk the consequences of a possible PE.

23.2.3.3 Prevention

The American Society for Metabolic and Bariatric surgery currently recommend mechanical calf compression devices and compression stockings, early ambulation and anticoagulation, wherever possible [25]. The risk for DVT is reduced by 62 % with intermittent pneumatic compression, by 47 % with anti-thrombotic stockings, and by 48 % with low-molecular weight heparin [22]. There is a 2.4 % risk of developing a DVT if chemoprophylaxis is not administered [22]. However, the optimal approach for reasonable prophylaxis is unknown since a balance should be drawn between

Fig. 23.6 Normal gastrojejunostomy as seen on postoperative endoscopy in a patient who underwent Roux-en-Y gastric bypass patient (Reproduced with kind permission from Springer from: Narula et al. [57])

reducing the risk of a clot versus that of postoperative bleeding [22, 25]. There is no consensus on the dosage, application mode or duration of therapy [22, 25, 26]. For high-risk patients, defined as those patients in a hypercoagulable state, BMI >60, medical history significant for DVT or PE and venous stasis; the use of intraoperative 1000 IU heparin per hour intravenously and an IVC filter is recommended [22, 26]. Although the filter has been shown to reduce, but not eliminate, the risk of venous thrombosis, placement is not without serious risks. These include filter migration, vessel rupture, and IVC thrombosis [27]. The risk of these complications is reduced when the filter is only placed temporarily, and it should therefore ideally be removed at approximately 6 weeks, or once the patient is fully ambulant [27]. Others recommend that those patients at a high risk for VTE should undergo a period of extended prophylaxis with low molecular weight heparin for a suggested 14–28 days post operation. This is the current practice of most bariatric surgeons to reduce the risk of VTE in their patients.

23.3 Late Complications

23.3.1 Ulcers and Fistulas

The overall incidence of marginal ulcers and fistulas is approximately 4 %, with a reported range of <1–36 %. There is an increased incidence of fistulas in patients who undergo revisional surgery, which has an associated mortality of 8–37.5 % [28]. The ulcers usually occur at the gastrojejunostomy (GJ) anastomosis, often on the intestinal side, between 1 and 6 months post surgery. The etiology of ulcers is not entirely clear, but suggested mechanisms include increased acid production in an oversized pouch, the presence of Helicobacter pylori, ischemia of the pouch or alimentary limb, staple-line disruption, and/or the presence of staples and suture material within the pouch [29]. Fistulas may result from an untreated leak, a marginal ulcer perforating into the remnant stomach, or iatrogenically from an incompletely divided pouch. Marginal ulcer risk seems to be increased with the use of NSAIDS, and in smokers, and decreased with the use of proton pump inhibitors (PPI) [29, 30].

23.3.1.1 Symptoms and Presentation

- Abdominal pain, especially post-prandial
- Nausea, vomiting
- GI bleed
- Asymptomatic (occasionally)
- Weight regain or plateau in weight loss

23.3.1.2 Diagnosis

The usual diagnostic investigation is an upper GI endoscopy or an upper GI contrast study (Figs. 23.6 and 23.7).

23.3.1.3 Management

Medical management can be through the use of proton-pump inhibitors and sucralfate, treatment of H. pylori infection, and the cessation of any exacerbating factors such as smoking or the use of NSAIDs (Fig. 23.8) [29, 31]. It is not

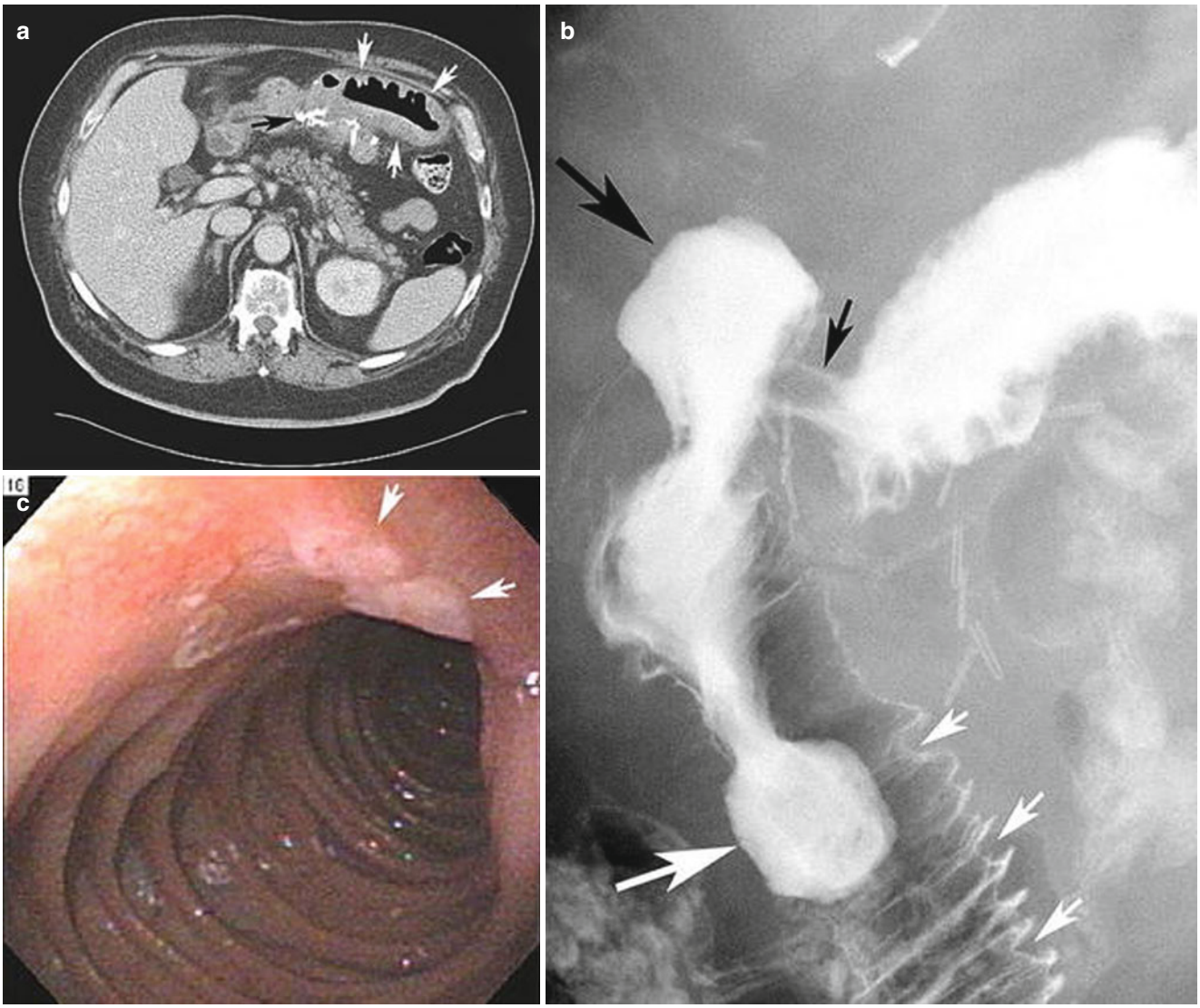

Fig. 23.7 Giant jejunal ulcers in a 66-year-old man with abdominal pain and melena after Roux-en-Y gastric bypass. (**a**) Intravenous contrast-enhanced axial computed tomography scan through upper abdomen shows thickening of the bowel wall (*white arrows*) in the Roux limb of proximal jejunum abutting the gastrojejunal anastomosis (*black arrow* denoted staples at anastomosis). Note how jejunal folds are thickened along the anterior wall of this abnormal loop of jejunum. (**b**) Right posterior oblique spot image from single-contrast upper gastrointestinal tract barium study showing a 3-cm diameter ulcer (*large black arrow*) in the Roux limb on the jejunal side of the gastrojejunal anastomosis (*small black arrow*), and a 2.5 cm diameter ulcer (*large white arrow*) more distally in the Roux limb. Thickened folds (*small white arrows*) are also seen in the proximal jejunum in the region of the more distal ulcer. (**c**) Upper endoscopy shows a giant ulcer (*arrows*) in the jejunal Roux limb distal to the gastrojejunal anastomosis. Note the appearance of the jejunal folds (Reproduced with kind permission from: Ruutiainen et al. [58])

necessary to proceed immediately to surgery, unless there is evidence of perforation. The operative approach should involve exploration; excision of the fistula and ulcer, and revision of the G-J anastomosis; and reduction in the size of the pouch if it is oversized as necessary. If there is tension in the Roux limb and mucosal ischemia, then the Roux limb should be mobilized. If the ulcer is associated with a foreign body such as suture material, this should be removed [29, 32]. The difficulty with the surgical repair of fistulas is the tissue quality; it is hard to suture due to the excessive contamination and inflammation.

It has been reported that a conservative approach is useful, prior to reoperation, in these very high-risk patients [33]. Endotherapy with the use of SESs, and particularly self-expanding metal stents (SEMS), are a management option [19, 33]. Advantages of endoscopy are that it is less affected by BMI, is less invasive than surgery, and does not induce local inflammation that can have a negative impact on healing [28]. There is an ongoing concern regarding the feasibility of removal of these stents and possible migration. There has been some improvement in this with the use of self-expanding plastic stent (SEPS)

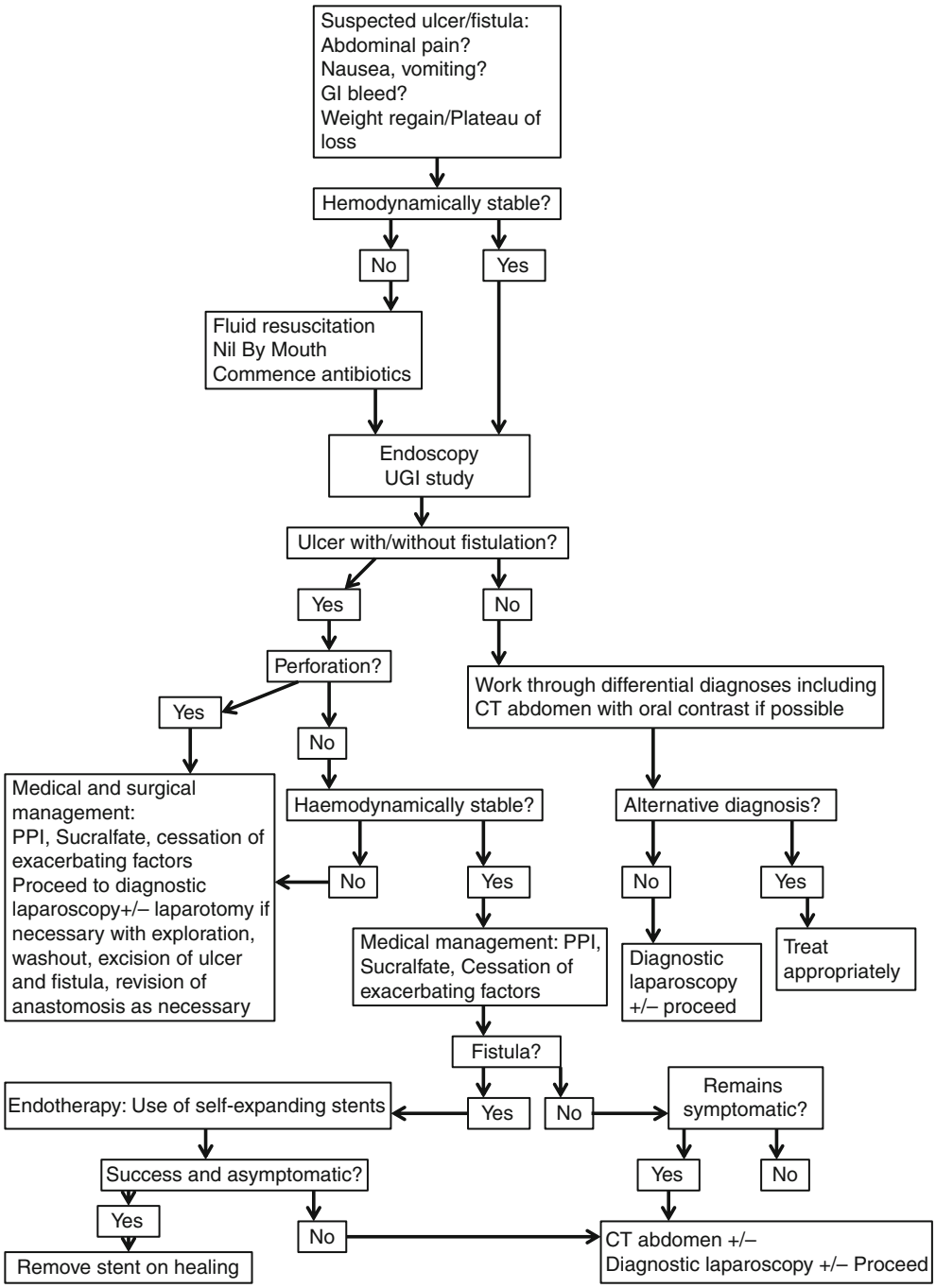

Fig. 23.8 Algorithm for the diagnosis and management of gastrojejunostomy ulceration and fistula after gastric bypass

with the subsequent extraction of both stents together. Endoscopy is currently applied more imaginatively, such as in the drainage and washout of the peri-fistula debris, along with debridement if necessary using the natural orifice translumenal endoscopic surgery (NOTES) procedure, placement of a stent with or without use of clips and/or glue with collagen plugs to close the fistulous trajectory [28]. The evidence is not yet conclusive enough to define specific management guidelines using these techniques; however, they will almost certainly play a more significant role in future.

23.3.1.4 Prevention

These measures include those advised for preventing a leak. Further, more the use of PPI postoperatively is strongly recommended [30].

23.3.2 Gastrointestinal Obstruction

Yet another complication specifically related to the LRYGB is gastrointestinal tract obstruction. This is the commonest complication after a LRYGB with a reported incidence of

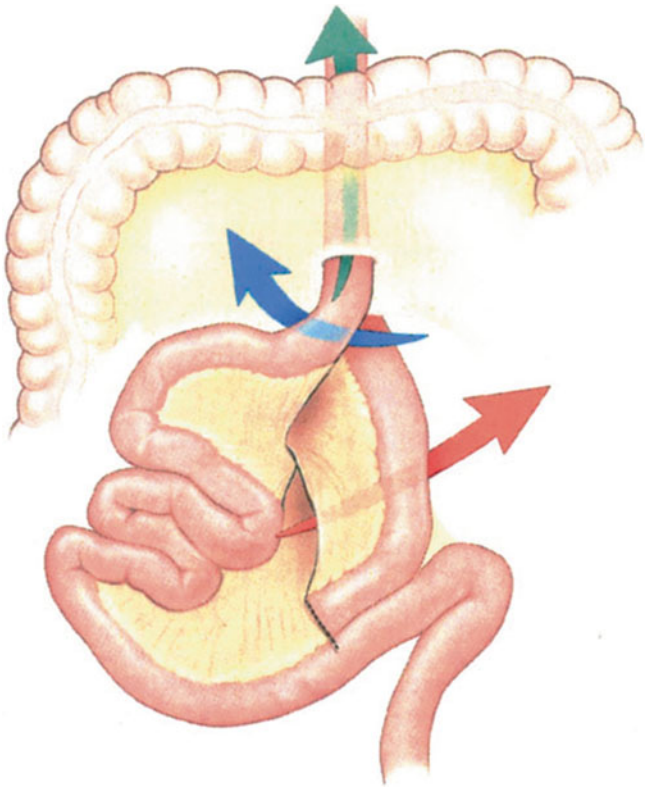

Fig. 23.9 Sites of retroanastomotic or transmesenteric internal hernias, including mesocolic window or retrocolic tunnel (*green arrow*) mesenteric defect, Petersen's mesenteric defect (*blue arrow*), and enteroenterostomy or distal anastomosis mesenteric defect (*red arrow*) (Reproduced with kind permission from Springer from: Comeau et al. [59])

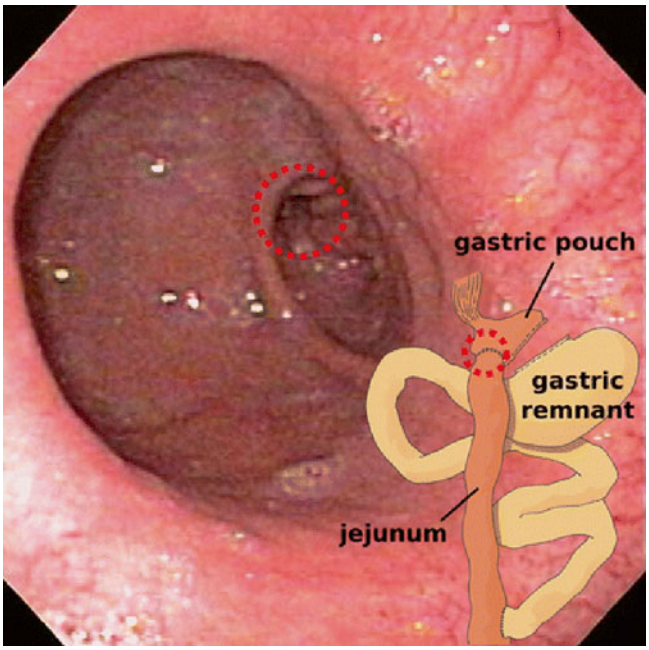

Fig. 23.10 Stricture at the site of gastrojejunal anastomosis. An endoscopic view from the esophagus into the gastric remnant is shown. Marked narrowing of the gastrojejunal anastomosis (*dotted circle*) was noted at the time of endoscopy. The inset depicts the surgical anatomy following gastric bypass (Reproduced with kind permission from Springer from: Limketkai and Zucker [60]).

small-bowel obstruction ranging from 1.5 to 5 % (Table 23.1) [34]. The majority of cases present within the first 12 months, however, this can range up to at least 42 months post surgery [34]. Depending on the method adopted for the surgical construction of the gastric bypass, the altered anatomy can result in blockages from scarring at the various anastomoses or by kinking of the loops of small intestine, secondary to it getting stuck in spaces within the peritoneal cavity that did not exist before the surgery (internal hernia) (Fig. 23.9). A blockage can occur at the GJ anastomosis from a postoperative stricture (1 %) or food bolus obstruction (Figs. 23.10, 23.11, and 23.12). More distally, small bowel obstruction (SBO) may be related to internal hernia formation (1–2 %) (Figs. 23.13 and 23.14). A further complication, more specifically, of the retrocolic LRYGB, is Roux limb obstruction caused by narrowing within the transverse mesocolic defect (Figs. 23.15 and 23.16). This tends to present earlier than internal herniation, and is usually caused by scar formation and extrinsic circumferential compression of the Roux limb. Other possible causes of SBO in this population include intussusception; adhesions; port site hernias; and obstruction at the jejuno-jejunostomy from kinking, stricture, blood clot or bezoar (Table 23.5) (Figs. 23.17, 23.18, and 23.19) [34]. An iatrogenic cause that should not be ignored in the immediate post-surgical setting, particularly with the

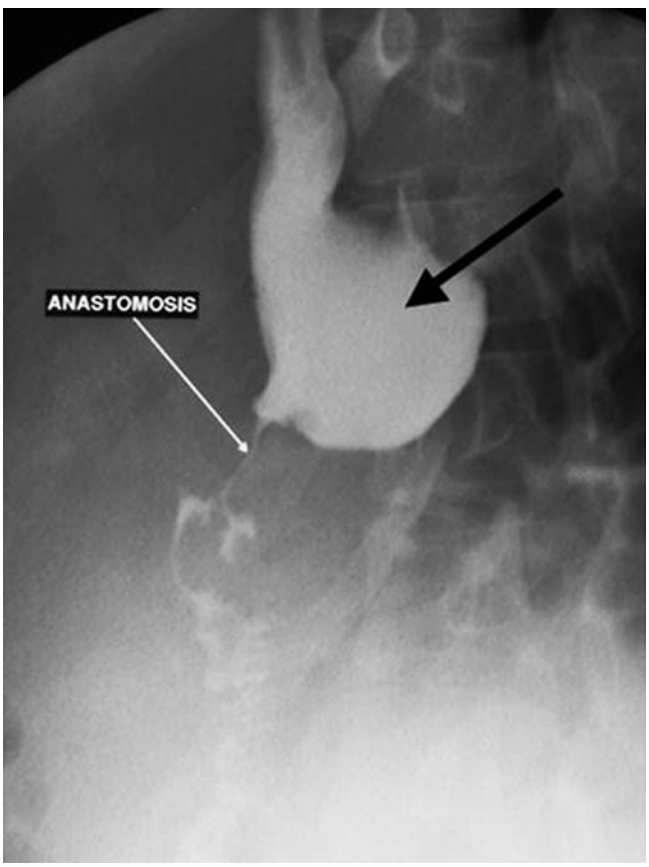

Fig. 23.11 Stenotic gastrojejunostomy. Note the dilated pouch (*arrow*) (Reproduced with kind permission from Springer from: Trenkner [56])

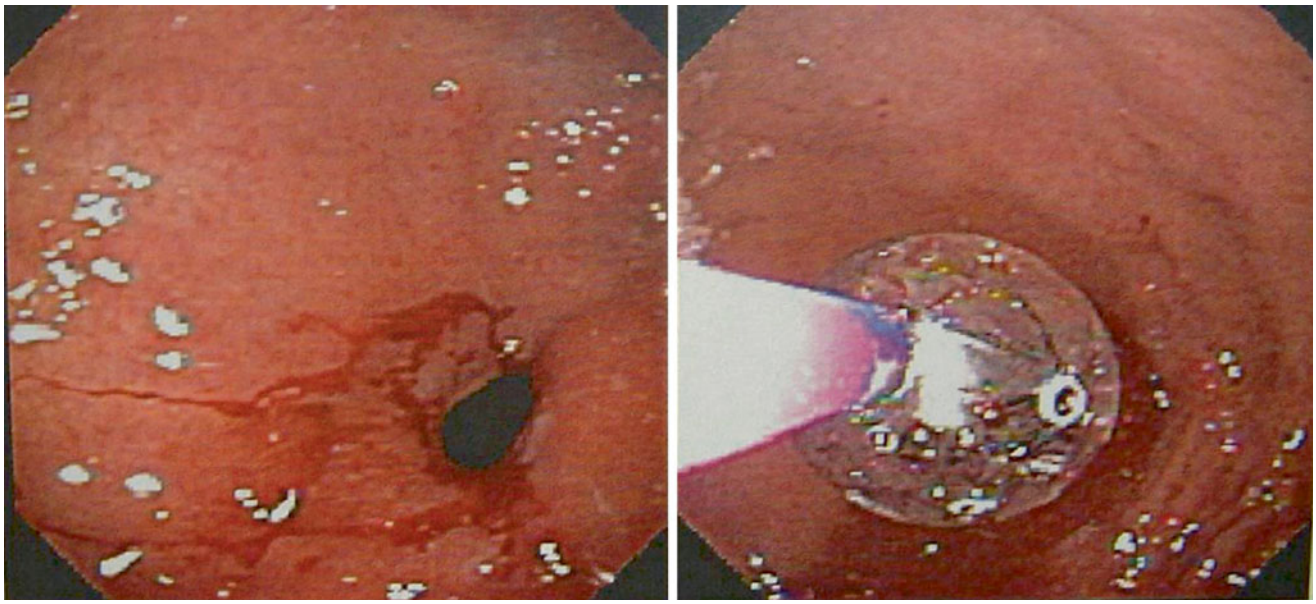

Fig. 23.12 Dilating a strictured gastrojejunal anastomosis in a postoperative Roux-en-Y gastric bypass patient (Reproduced with kind permission from Springer from: Narula et al. [57])

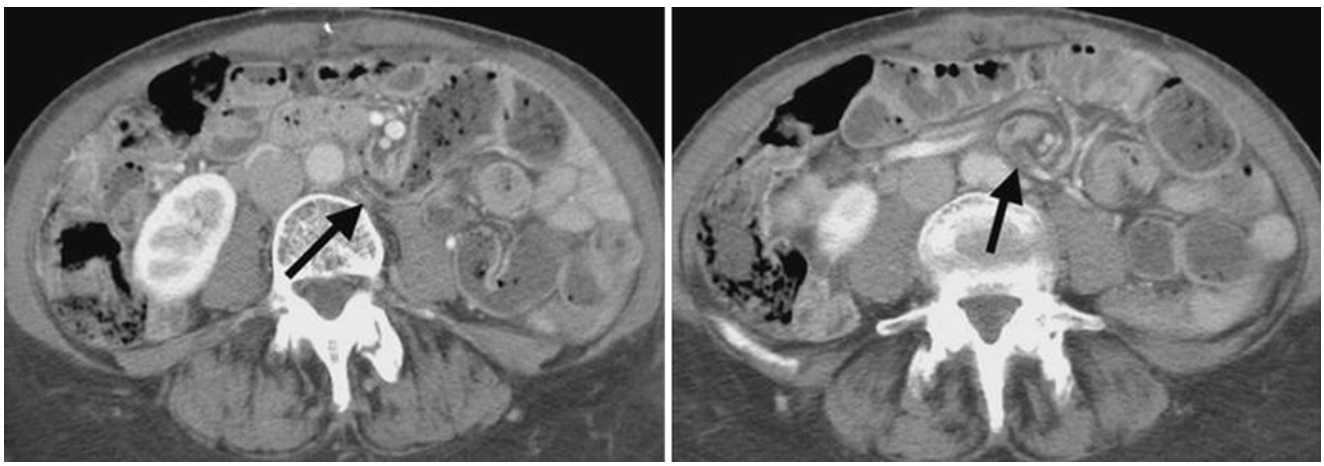

Fig. 23.13 Internal hernia through the mesenteric defect at the jejunojejunostomy. In the first image note the point of obstruction (*arrow*). In the second image the mesenteric swirl is seen (*arrow*) (Reproduced with kind permission from Springer from: Trenkner [56])

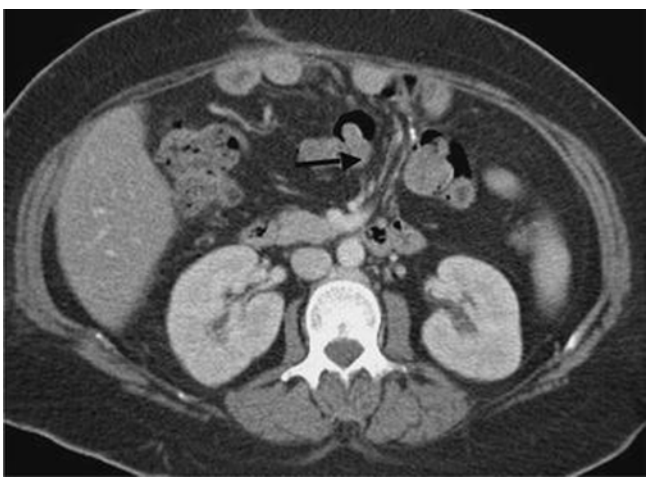

Fig. 23.14 Internal hernia through the transverse mesocolon (*arrow*) (Reproduced with kind permission from Springer from: Trenkner [56])

laparoscopic approach, is a Roux-en-O formation where the small bowel becomes a closed loop (Fig. 23.20).

Interestingly, the laparoscopic approach results in a higher incidence of postoperative bowel obstruction. In a review that included 3464 patients, a higher frequency of both early and late obstructions were reported in LRYGB when compared to open cases [35]. One reason attributed to this is that very few adhesions are formed allowing small bowel loops freedom to move and become 'stuck' in spaces that did not exist before the surgical 're-organization' of anatomy that occurs with the gastric bypass [36, 37].

23.3.2.1 Symptoms and Presentation

It should be remembered that unlike the usual symptoms in patients with small bowel obstruction, large volumes of vomit are rare due to the small size of the gastric pouch, and

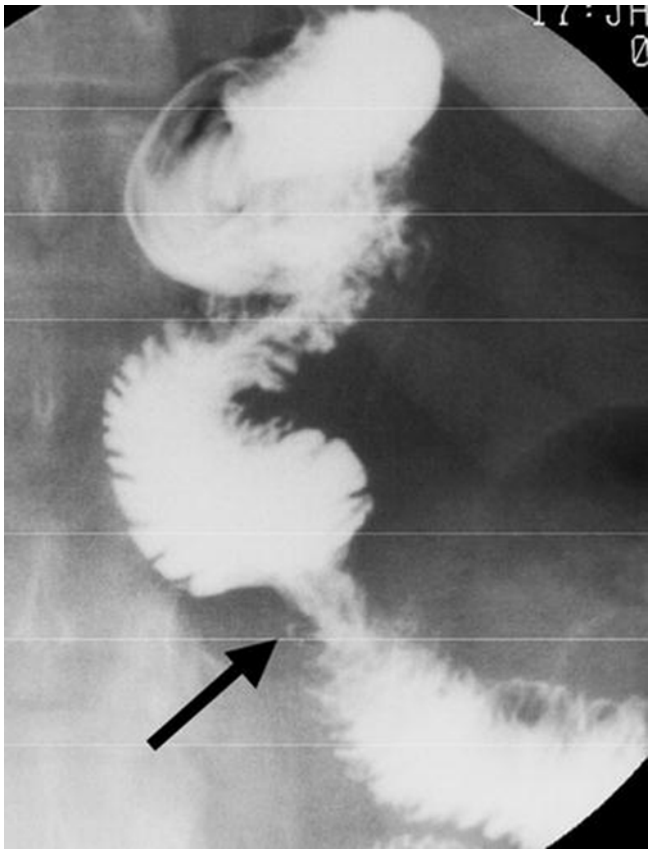

Fig. 23.15 Narrowing of the Roux limb where it passes through the transverse mesocolon (Reproduced with kind permission from Springer from: Trenkner [56])

nausea or retching may in fact be more significant [34]. Small bowel obstruction can present in these patients as an acute event with severe colic and complete obstruction or as vague abdominal discomfort after eating (Table 23.2).

The presenting symptoms vary according to the site of obstruction in the LRYGB. Vomiting of undigested food and abdominal cramps are present when the obstruction is proximal to the common channel. When the obstruction is at the level of, or distal to the jejuno-jejunostomy, bilious vomiting, fullness, tachycardia, nausea, retching, hiccups, shoulder pain (if GI contents decompress into excluded remnant stomach) are usually present. The differential diagnosis is a gastro-gastric fistula, which is rare. Fullness due to the stomach distending with fluid, with a sense of impending doom, is observed in cases of an obstructed bilio-pancreatic limb proximal to the common channel.

23.3.2.2 Investigations

Small bowel obstruction may sometimes be diagnosed using a standard plain abdominal radiograph, but a CT scan with oral contrast is the most helpful. A barium meal (UGI study) or follow through may also be helpful. With a barium meal, it is easier to diagnose a stricture than an internal hernia. Subtle radiological signs more usually seen on CT indicating bowel obstruction after LRYGB include an abundance of small bowel in the left upper quadrant, dilatation of the stomach remnant and duodenum, mild dilatation of bowel without obstruction, increased Roux limb contrast transit time, increased Roux limb redundancy, and thickened bowel loops.

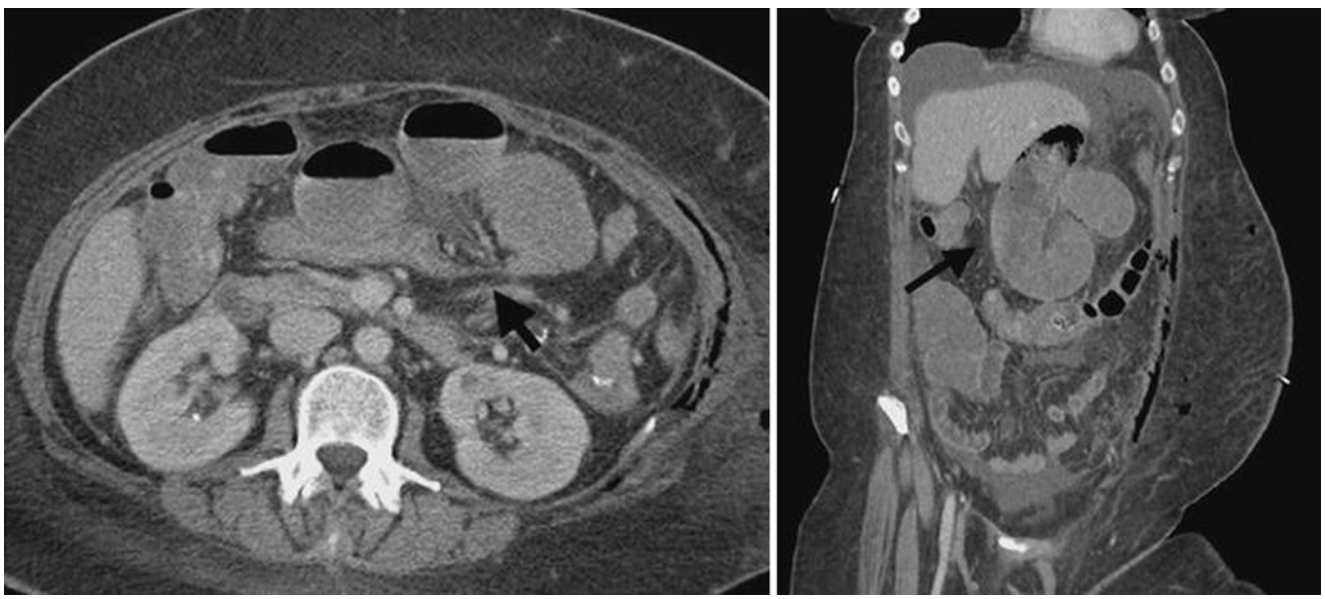

Fig. 23.16 High-grade obstruction at the defect in the transverse mesocolon 6 days after Roux-en-Ygastric bypass. The point of obstruction is seen on the axial image (*arrow*). On the coronal image note the dilated Roux limb (*arrow*) superior to the transverse colon (Reproduced with kind permission from Springer from: Trenkner [56])

Table 23.5 Incidence of the different causes of SBO after LRYGB [34]

Cause	Incidence (%) of all SBO
Internal hernia	53.9
Roux limb stricture	20.5
Adhesions	13.7
Angulation at entero-enterostomy	6.8
Port-site hernia	1.9

LRYGB laparoscopic Roux-en-Y gastric bypass, *SBO* small bowel obstruction

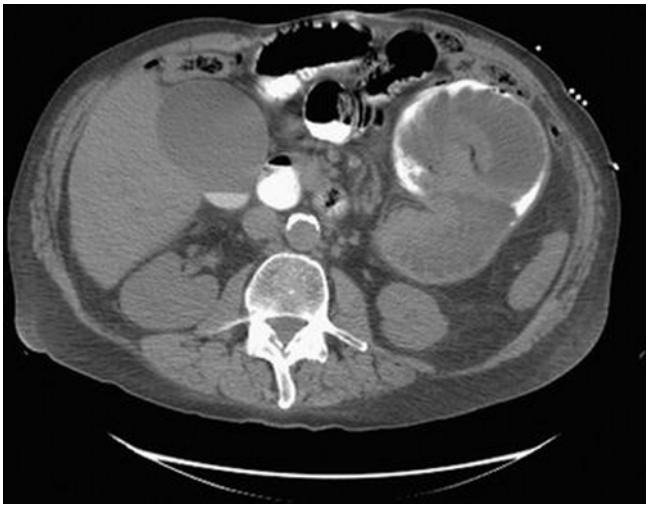

Fig. 23.17 Non-enhanced axial computed tomography of the abdomen showing a characteristic target sign in the left upper quadrant in the region of the jejunojejunostomy consistent with an intussusception (Reproduced with kind permission from: McAllister et al. [61])

In actuality, the precise cause of the obstruction can sometimes not even be determined by a skilled expert radiologist. Regardless, the decision to re-operate should not be delayed in order to exclude an internal hernia. This is different from the postoperative general surgical patient where the commonest cause of obstruction is from adhesions, which often resolve with a non-operative approach (Fig. 23.21).

23.3.3 Internal Hernia

From the review of a case series of over 2500 patients with retrocolic Roux limb placement, the internal hernia site, in order of frequency, was transverse mesocolon (46 %), entero-enterostomy (41 %) followed by Petersen's space (13 %), (the area between the posterior aspect of the mesentery of the Roux limb and the transverse mesocolon). Patients usually present after approximately 14 months, by which stage they have experienced good weight loss (59 % excess body weight loss [EBWL]) [36, 38]. This may be a consequence of

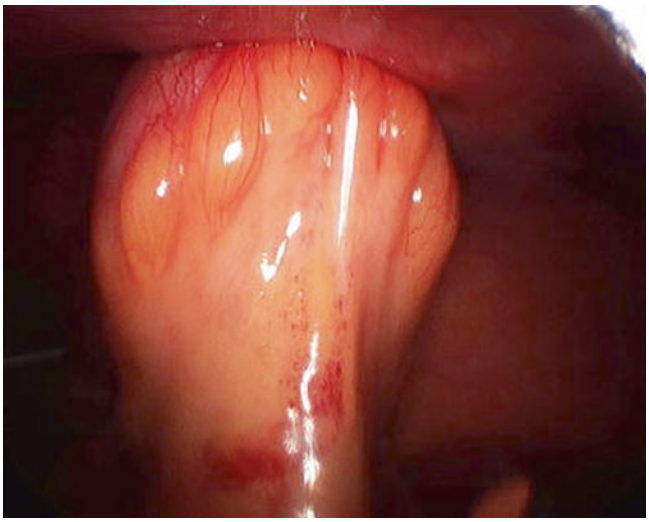

Fig. 23.18 A 5 mm port site containing small bowel (Reproduced with kind permission from Springer from: Thapar et al. [62])

reduced intra-peritoneal fat secondary to overall weight loss, which can result in larger mesenteric defects [36]. Unsurprisingly, there is a higher incidence of internal herniation with a retrocolic vs. antecolic Roux limb placement (Fig. 23.9) [36]. This is relevant because an antecolic approach removes the need to create a window in the transverse mesocolon, thus eliminating this as a site for potential herniation (Fig. 23.14) [36].

The consequences of an untreated internal hernia may include closed loop obstruction, leading to bowel strangulation, as well as gastric remnant dilatation, which may go on to cause bowel perforation [37]. Patients presenting with recurrent episodes of colicky abdominal pain with or without nausea and vomiting should raise a high index of suspicion of internal hernia. The differential diagnosis would include infectious gastroenteritis, pregnancy, biliary tract disease, ulcers and appendicitis.

23.3.3.1 Management

A careful history and the usual baseline blood tests and plain AXR may be helpful in making the diagnosis but if possible a CT scan should be obtained [36]. A diagnostic laparoscopy should be performed if the diagnosis of an internal hernia is suspected, irrespective of normal investigations [36–38]. At surgery, the whole small bowel should be traced and inspected, and any mesenteric defect(s) checked and closed and any non-viable bowel segments resected [36].

23.3.3.2 Prevention

Closure of all mesenteric defects does not avoid this complication, so some bariatric surgeons leave all spaces wide open thus allowing bowel loops to freely move in and out of these

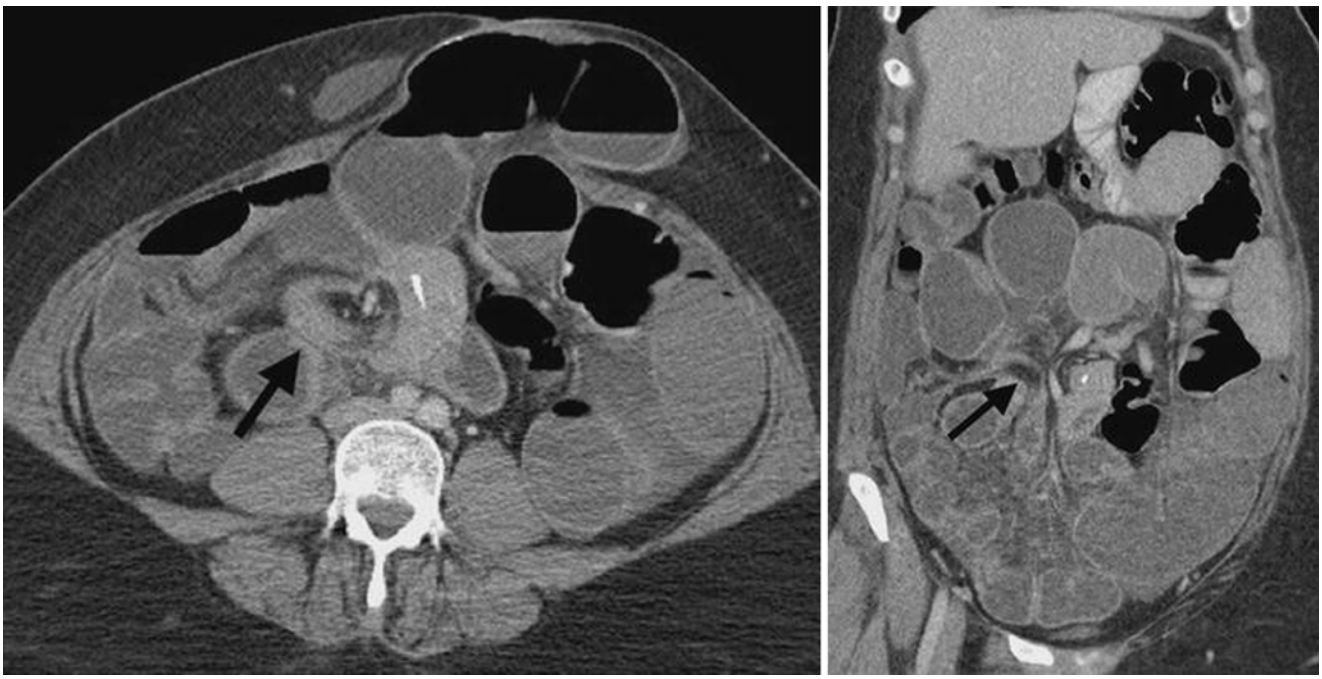

Fig. 23.19 Patient referred for a small bowel obstruction secondary to a ventral hernia. The actual obstruction is due to an internal hernia through the mesenteric defect at the jejunojejunostomy. Note the swirl (*arrow*) on the axial image and pinch (*arrow*) on the coronal image (Reproduced with kind permission from Springer from: Trenkner [56])

spaces. Others suture and close all mesenteric defects meticulously, using a running, non-absorbable suture. An antecolic Roux limb is also associated with a lower risk of internal hernias so should be the preferred approach where the surgeon has a choice [36]..

23.3.4 Port-Site Hernia

Port-site hernias tend to occur at the sites where a 10 mm port was used rather than a 5-mm port. The diagnosis should be considered in the patient who presents with focal pain near port sites, with or without colic [39]. These patients may or may not have a palpable lump. CT or laparoscopy can be helpful in making the diagnosis (Fig. 23.18) [39]. The hernia should be reduced and the defect closed. To help prevent such hernias, or Richter hernias from occurring, the use of blunt-tipped dilating trocars that separate the muscle and fascia obliquely as the device is inserted is advocated [39], and the use of sharp cutting trocars discouraged. Blunt dilating ports, in the most part, remove the need for fascia closure and additionally reduce some of the risks involved with other techniques of creating a pneumoperitoneum [39]. The use of these ports, have decreased port site hernia rate to 0.2 %, at some centers [39]. The fascia at the midline or umbilical port sites should still be closed due to the lack of musculature at this site, and if there is any difficulty then a specific laparoscopic fascia-closing device can be used [39].

23.3.5 Stricture

There is an approximate 5 % incidence of stricture at the GJ anastomosis post LRYGB. There is an observed increased risk of the incidence of stricture with the use of a circular stapler (especially with 21 mm diameter), in the presence of scarring from a healing marginal ulcer, or if there was undue tension or evidence of ischemia at the anastomosis at the index operation [40]. Patients usually present with nausea, vomiting, and dysphagia for solids progressing to liquids, within the first year after surgery. UGI studies using barium can be helpful, although the diagnosis is usually confirmed during endoscopy, particularly if a 9 mm endoscope cannot be passed through the anastomosis [11, 41]. Furthermore, the presence of a concurrent marginal ulcer can be identified during endoscopy (Figs. 23.7, 23.10, 23.11, and 23.12). The management consists of endoscopic balloon dilatation of the anastomosis, which can be stretched to approximately 15 mm without any apparent impact on weight regain, or on the development of dumping syndrome (Fig. 23.12) [41, 42]. An anastomotic stricture has an associated recurrence rate of 17 %, however there is a success rate of approximately 95 % after two separate dilatations for patients who present early (within the first 3 months post-surgery). There is also the associated risk of perforation, which may be reduced by gradual dilatation [43]. For those presenting with symptoms later than 3 months postoperatively, it may still be possible to dilate the stricture; however, up to one third may require

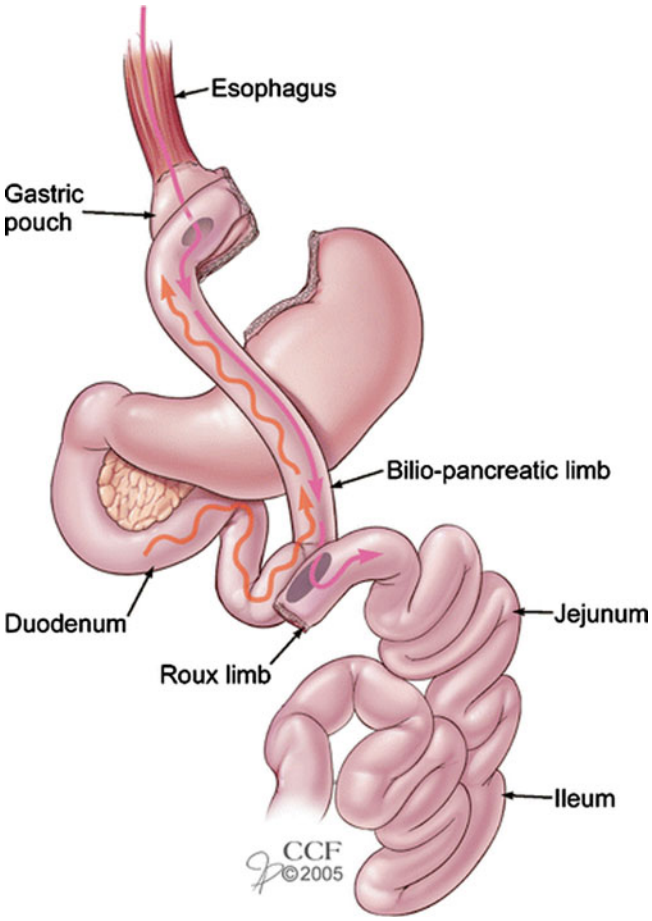

Fig. 23.20 The Roux-en-O configuration. The bilio-pancreatic limb is inadvertently anastomosed to the gastric pouch. The *wavy line* represents peristalsis and flow of bile. The *solid line* represents movement of a food bolus (Reproduced with kind permission from Springer from: Sherman et al. [63])

operative revision [44]. Surgery involves refashioning of the anastomosis. The rate of stricture can be reduced by creating a tension free, well-vascularized anastomosis, and by avoiding the use of 21 mm circular staplers for the anastomoses. Furthermore, any of the measures that prevent ulcer formation should also minimize the risk of strictures.

23.3.6 Acute Gastric Dilatation (of the Gastric Remnant)

This is unusual but can be very serious as it can lead to rapid clinical deterioration and hemodynamic instability due to blowout of the gastric remnant staple-line. It usually occurs after the biliopancreatic limb (or occasionally the common channel) has been obstructed, and can be diagnosed by evidence of gastric dilatation on a plain abdominal radiograph or CT in the postoperative patient with severe epigastric pain (Fig. 23.22). Gastric dilatation can also be caused by bleeding within the gastric remnant. Treatment is through percutaneous gastrostomy tube decompression and the subsequent management of the underlying biliary limb obstruction or bleeding point.

23.4 Long-Term Complications

23.4.1 Intussusception

Intussusception in general is uncommon. It is usually seen in children secondary to lymphoid hyperplasia in the distal ileum, and less frequently in adults due to a pathological process that acts as a lead point, and the proximal segment invaginates into the distal one (antegrade intussusception). It can also occur after LRYGB, with a prevalence of between 0.07 and 0.6 %. Different etiologies are possible with the most common being retrograde intussusception of the common channel into the jejuno-jejunostomy. It is not understood why it occurs; it is suggested that it is possibly due to the disruption of the usual anatomy and therefore the peristalsis pathway. This causes abnormal ectopic pacemaker potentials to occur in the Roux limb, thus altering the direction of the peristaltic flow. It also tends to be more common in women, which may be due to an underlying hormonal cause. The patients can present with recurrent abdominal pain and obstruction, with or without bowel ischemia and necrosis. However, they usually present with acute abdominal pain, with approximately 70 % experiencing nausea with or without vomiting. The mean time of occurrence is 3.6 years after LRYGB (range, 5 months–24 years), after a mean weight loss of 64.1 kg. A plain AXR or CT can demonstrate signs of small bowel obstruction (dilated loops or air-fluid levels), and additionally, a target sign can be viewed on CT (Fig. 23.17). Conservative management is discouraged since it is hard to ascertain the absence of necrosis from the clinical and radiological signs alone. Laparoscopic exploration followed by surgical reduction of the invaginated segment, and if indicated, subsequent bowel resection, should be performed. A reconstruction of the J-J anastomosis, and intestinal plication might also be necessary [45].

23.4.2 Bezoars

Food bezoars occur more commonly after gastric banding, but can still occur after LRYGB, particularly as an early postoperative complication. The patients tend to present with dysphagia, nausea, and vomiting. The simplest diagnostic and therapeutic technique is endoscopy, as the bezoar can be broken up and removed, and any associated G-J anastomotic stenosis can be dilated during the same procedure.

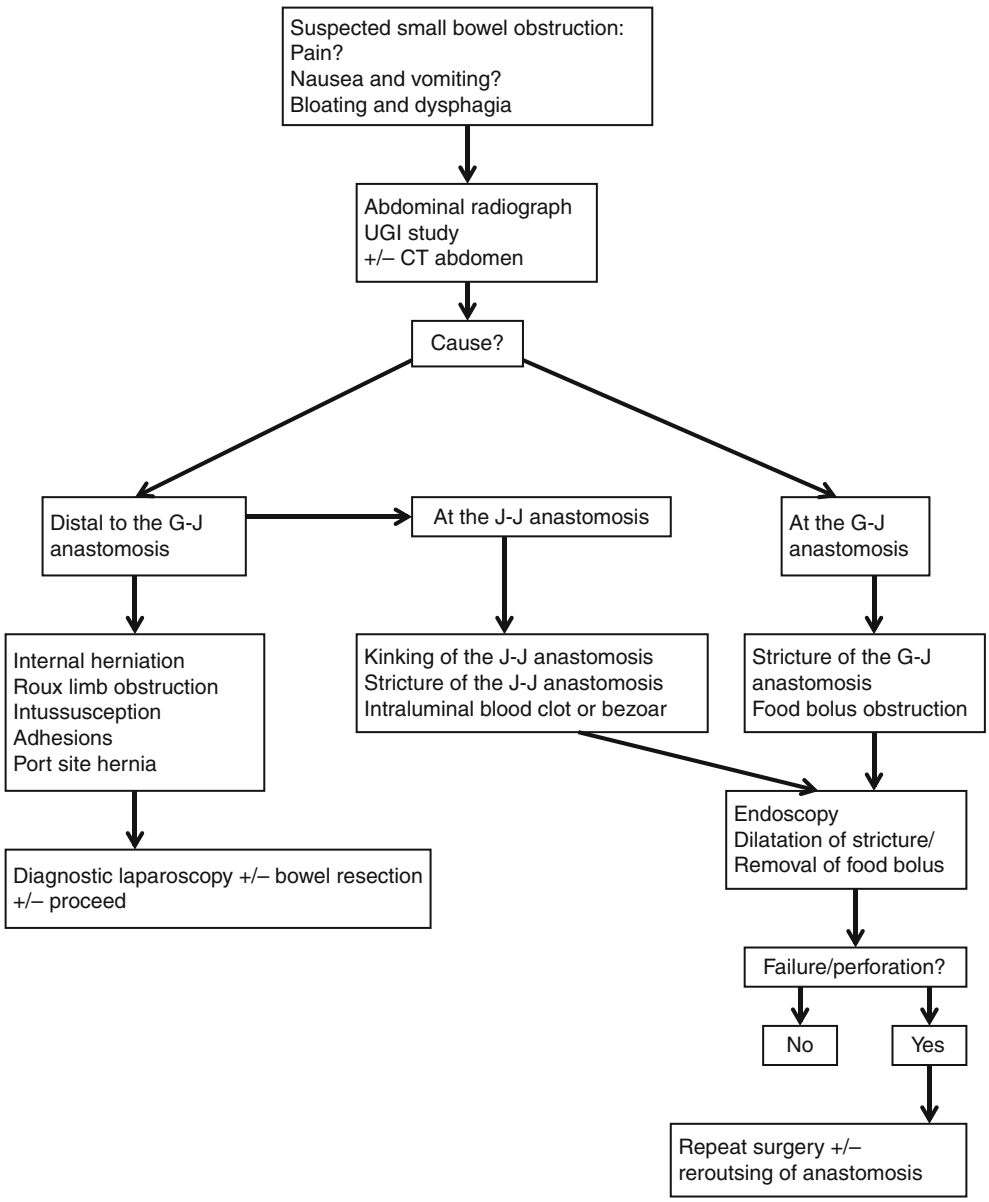

Fig. 23.21 Diagnosis and management algorithm for small bowel obstruction post gastric bypass

23.5 Skin Complications

Postoperatively, with progressive weight loss, patients can complain of loose and hanging skin as skin may not contract with volume loss, and this cannot always be adequately resolved with non-surgical measures such as exercise, creams, lotions or diet [46, 47]. The surgical options include body contouring, where excess tissue is removed, and approximately a quarter of bariatric patients elect to undergo such surgery [46]. Some people are so affected by the impact of the excess skin that they retrospectively state that they would rather not have undergone a bypass [47]. Despite pre-operative concerns of body image, some patients felt even worse about themselves after their bariatric surgery and pre-contouring surgery [48]. This surgery is not available to everyone and requires careful planning [46]. The patients' weight is required to be stable for a minimum of 6 months, to avoid further skin laxity [46]. Most patients are suitable for a panniculectomy, as it is the panniculus that often causes the most functional disturbances. These include skin rashes, sub-pannicular itching and intertriginous dermatitis, difficulty with exercise, finding clothes that fit, and sexual dysfunction [46–48]. Other areas of skin contouring tend to be reserved for those patients who have achieved a BMI of 35 or less. It is important to warn patients that it can be difficult to secure funding for such operations, and that they are not without side effects [46]. For example, they should be aware of the significant scarring that occurs with such procedures, which can make people feel self-conscious and have reduced sensation over these scars. They might need a staged approach with multiple surgeries, and they must be diligent with their intake of multi-vitamins and proteins to maximize

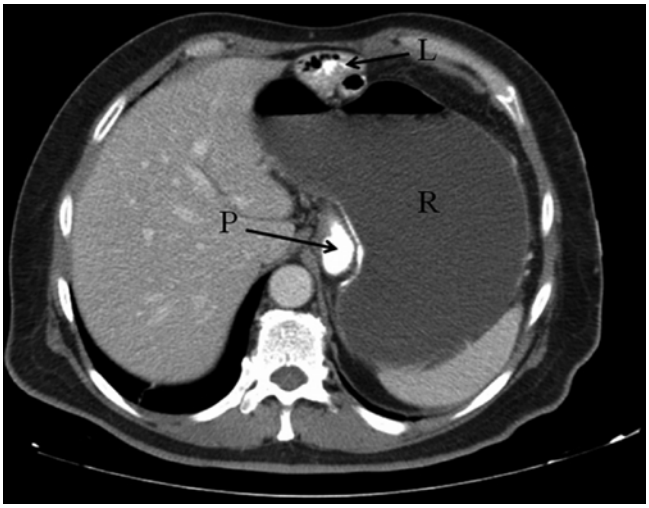

Fig. 23.22 Bypass obstruction. Note the distended, fluid-filled gastric remnant (R) surrounding the contrast-filled gastric pouch (P), and posterior to the antegastric, antecolic Roux limb (L), also filled with contrast. (Reproduced with kind permission from Springer from: Pieracci et al. [64])

wound healing [46–48]. Likewise, they should be dissuaded from smoking [46].

23.6 Nutritional, Metabolic, and Neurological complications

Within the first 12 postoperative months, almost 50 % of patients experience metabolic and nutritional deficiencies, particularly if they do not take the prescribed multivitamin daily supplements [49].

23.6.1 Post-prandial Hypoglycemia and Nesidioblastosis

LRYGB patients can present with some specific post-prandial symptoms termed as 'dumping syndrome, which may occur in some to a variable degree and may be absent in others. Dumping syndrome is a normal and advantageous side effect of surgery with the following characteristics:(i) vasomotor symptoms of weakness, diaphoresis, dizziness and flushing in the early phase (30 min after eating), and (ii) reactive hypoglycemia and accompanying symptoms and signs later. This dumping syndrome is attributed to the rapid emptying of gastric contents into the small intestine initially causing a fluid shift due to the hyperosmolality in the intestine, and later causing hypoglycemia triggered by an insulin response, especially if after the consumption of a carbohydrate-rich meal. A small proportion of patients may suffer from exaggerated responses to meal or fluid intake. The development of documented, severe hypoglycemic episodes after a LRYGB is quite rare (<1 %). Similarly, the development of autonomic instability after a meal is even rarer (Potts Syndrome). Such patients can present with postprandial symptoms after achieving satisfactory weight loss. The management of these patients can be challenging and should be addressed using a multi-disciplinary team approach. Early involvement of endocrine specialists is recommended. In the first instance, it is necessary to exclude patients with insulinoma or nesidioblastosis [50]. Investigations include an oral glucose tolerance test as well as continuous glucose monitoring. Occasionally, if any autonomic dysfunction is suspected, then table tilt testing may aid diagnosis [50].

Non-operative management, with dietary therapy such as the avoidance of high-glucose dense foods, and pharmacologic therapy (e.g., diazoxide, calcium channel blockers, acarbose, octreotide) should be administered in the first instance. Nevertheless, some patients do not respond to these non-operative approaches, and the neuroglycopenic symptoms persist, thereby, exposing them to a dangerous and even potentially life-threatening risk. A temporary solution involves the placement of a gastrostomy tube, and feeding via this route almost always relieves symptoms. Overall, subsequent definitive surgical correction is usually necessary, and occasionally even involves the reversal of the bypass [50].

23.6.2 Protein Malnutrition

Total body protein is monitored by checking patients' albumin levels, and deficiency after a standard LRYGB is extremely rare. It may result from a short common channel leading to malabsorption, or from an extreme restriction due to pouch outlet obstruction. Protein supplements and oral pancreatic enzymes can improve absorption when the deficiency is mild. Sometimes, after a period of prolonged starvation, an acute hypophosphatemia with cardiac failure can occur approximately 72 h after feeding is restarted (refeeding syndrome). Thiamine administration prevents this syndrome, and hence, it must always be considered after surgery when reinstating nutrition in a patient who has previously been chronically under-nourished [51]. The treatment for protein malnutrition depends on the underlying cause.

23.6.3 Vitamins and Trace Elements

Patients may experience iron deficiency after an LRYGB; the estimated prevalence is 30–40 %. However, 20 % of the obese patients may have pre-existing iron deficiency prior to surgery. It occurs due to multiple reasons, and should be investigated with an EGD or colonoscopy, as appropriate. It is advisable for patients to take regular iron replacement, with vitamin C, which aids absorption. Calcium supplements are suggested, particularly in post-menopausal women. Although there is no obvious evidence that there is a benefit of zinc

supplementation, zinc levels are commonly low in post bypass patients and supplementation can be recommended in those patients who suffer from hair loss, weak nails or wounds.

Vitamin B12 deficiency may take years to manifest, due to its long half-life and entero-hepatic circulation [49]. Rarely, thiamine related polyneuropathy, and occasional encephalopathy can occur. This presents at 6–12 weeks after surgery, following persistent nausea and vomiting, with severe weakness of the lower limbs [51]. In the outpatient clinic, patients should be monitored annually with certain blood tests that should include micronutrient levels (vitamin B6, vitamin B12, thiamine, vitamin D, vitamin E, folate, calcium, magnesium, phosphorus, selenium and copper) [49]. It should be ensured that the patient is well-educated about the benefits of micronutrient replacement through the use of a daily broad spectrum multivitamin and mineral supplement, and maintaining a high protein diet [49, 51].

23.7 Neurologic and Musculoskeletal Complications

Neurologic complications include compression mononeuropathies from poor positioning on the operating table and neurologic damage from micronutrient depletion as mentioned above [49]. Symptoms may include anesthesia, tingling paresthesia, severe pain, and can particularly affect the feet causing a burning sensation [49]. Signs may include tenderness on palpation of muscles, hyporeflexia, sensory impairment involving pain and light touch in a glove-and-stocking distribution, distal vibratory and proprioception loss, and foot drop [49].

Early or immediate musculoskeletal complications include rhabdomyolysis or myonecrosis [49]. This is more common in the super-obese due to the increased risk of compression, but should be considered if there are any signs of impaired renal function, as there is a significant associated morbidity. Blood should be checked for creatinine kinase levels. The prevention of compression injuries and rhabdomyolysis is aided by the careful positioning of the patient on the operating table and through the avoidance of a prolonged operating time [49].

23.8 Cholelithiasis

Morbid obesity and rapid weight loss are both risk factors for gallstone formation, and there is an approximate 7 % risk of cholelithiasis in patients who undergo LRYGB [52]. For simple gallstones, a laparoscopic cholecystectomy can be performed [52]. However, common bile duct stones are more difficult to treat using the conventional endoscopic retrograde cholangiopancreatography (ERCP). Given the surgical alteration in the anatomy after a LRYGB, there is no longer direct access to the duodenum, and different techniques have been devised to address this issue. One technique is the combination of laparoscopy and ERCP. A gastrostomy is performed in the remnant stomach after inserting a laparoscope. The endoscope can then be passed via a laparoscopic port through the gastrostomy and into the stomach and duodenum and the bile ducts accessed in the conventional manner [53].

23.9 Hockey Stick/Blind Limb/Candy Cane Syndrome and Other Causes of Postprandial Pain

A long, non-functional Roux limb tip, or "hockey stick" may cause persistent nausea, and postprandial epigastric pain. This may be relieved after vomiting an unexpectedly large volume of food. The patients may also complain of a lack of satiety and even weight gain, and their symptoms tend to get worse with time. The differential diagnoses for these symptoms include transient food intolerance, over-eating, marginal ulceration and G-J strictures. Investigations include an UGI study and endoscopy, and the management involves re-operation and removal of the excess tip [54]. A summary of the other causes are listed in Table 23.6 [55].

Table 23.6 Causes of abdominal pain after gastric bypass

Pouch, remnant stomach disorders	Small-intestine disorders	Behavioral, dietary disorders	Functional disorders	Biliary disorders	Other
Ulcer disease	Abdominal wall hernias: ventral, trocars	Overeating, rapid eating	Constipation, diarrhea, flatus	Cholelithiasis: colic, cholecystitis	Omental infarction
Gastrogastric fistula	Adhesions	Food intolerance	Irritable bowel syndrome	Choledocholithiasis: cholangitis, pancreatitis	SMA syndrome
GERD	Internal hernia	Micronutrient deficiencies	Esophageal motility syndrome	Sphincter of Oddi dysfunction	Bezoar
Hiatus hernia, gastrojejunostomy stenosis	Intussusception, jejunojejunostomy stenosis	Micronutrient supplementation	Dumping syndrome		

Modified from Greenstein and O'Rourke [55]
SMA superior mesenteric artery syndrome

Conclusion

Although the LRYGB has become increasingly common as a procedure, it can have numerous medical and surgical complications, both in the immediate and longer postoperative period. It is, therefore, prudent to have a high-level suspicion of the worst-case scenario for these patients, in order to maximize the detection of complications, and to give the patient a chance of the best possible outcome.

Key Learning Points

- Patients undergoing bariatric surgery often present with subtle signs when there is a serious complication; hence it is best to avoid any delay, and in case of any doubt, perform a re-laparoscopy (Table 23.7)
- A routine postoperative UGI study is not recommended, but may be helpful for specific situations when there is clinical suspicion of a complication
- Hemostatic, well-vascularized, tension free, antecolic, correctly orientated anastomoses and staple lines help prevent leaks, ulceration, fistulas and bleeding
- The patients should regularly consume multivitamins especially Vitamin B12 or thiamine and also a PPI, calcium supplement, along with a high protein diet

Table 23.7 Summary of important surgically reversible complications

	Signs/symptoms	Differential characteristics	Investigations/actions
Early complications	Persistent tachycardia (>120 beats/min) Supportive features: Fever, tachypnea, raised CRP or WCC, drop in Hb	Anastomotic or staple line leak Significant bleeding	Diagnostic laparoscopy/laparotomy ?EGD + diagnostic laparoscopy/laparotomy CT angiogram may be considered in stable patients for diagnosis of bleeding
	Bilious vomiting	Roux-en-O configuration Obstruction distal to JJ anastomosis	CT scan with oral contrast, diagnostic laparoscopy and revision
	Abdominal pain and vomiting, sense of impending doom	?Internal hernia/small bowel obstruction	Small bowel follow through, diagnostic laparoscopy
Late	Colicky abdominal pain after meals Excessive weight loss	?Internal hernia/	EGD, CT scan +/− diagnostic laparoscopy
	Profound weight loss and vomiting, colicky pain	?anastomotic stricture at GJ or JJ	EGD +/− dilatation, small bowel follow through studies, ?diagnostic laparoscopy

CRP C-reactive protein, *CT* computed tomography, *GJ* gastrojejunostomy, *Hb* hemoglobin, *JJ* jejuno-jejunal, *EGD* esophago-gastro duodenoscopy, *WCC* white cell count

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