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Research article

Imaging features in management of laparoscopic mini/one anastomosis gastric bypass post-surgical complications

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HIGHLIGHTS

- Laparoscopic mini/one anastomosis gastric bypass (MGB/OAGB) is a recent metabolic/bariatric surgery (MBS) technique that proved safe and valid for patients who were morbidly obese as a malabsorptive or metabolic gastric bypass.
- Diagnostic imaging takes a significant role in the postoperative period, to detect possible complications both in the early and late postoperative period.
- Water-soluble contrast upper gastrointestinal (UGI) series represent the first radiological modality in the detection of early postoperative complications.
- Computed tomography (CT) is a more frequently used imaging technique in the clinical suspicion of possible early and late postoperative complications.

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ABSTRACT

Obesity is a widespread pathology among the population related to an increase in mortality and morbidity of patients. Bariatric surgery provides several forms of treatment for obese patients. Laparoscopic mini/one anastomosis gastric bypass (MGB/OAGB) is a recent low risk bariatric surgical procedure common in a large number of countries in the treatment of severe obesity. MGB/OAGB, compared to other bariatric surgery techniques, offers the significant technical improvement of requiring only one anastomosis in place of two. In this scenario, diagnostic imaging takes a significant role in the postoperative period, to evaluate the outcomes of surgical treatment and to detect possible complications both in early and late postoperative period. The prevalent radiological procedure to investigate suspicions of clinical post-operative complications is Computed tomography (CT) with oral and intravenous contrast administration. This pictorial essay aims to illustrate and identify normal radiological aspects of MGB/OAGB and post-surgery complication imaging features. We think that this article will serve to familiarize all the specialists with the diagnostic imaging of MGB/OAGB.

1. Introduction

In recent years, obesity and overweight have had an increasingly high incidence in the population. The World Health Organization estimating approximately 2 billion people being overweight on a global level [1]. Obesity is closely related to significant comorbidities such as cardiovascular, metabolic, pulmonary and musculoskeletal diseases. In the last few years, there has been an increase in metabolic/bariatric surgery (MBS) as a consequence of the vastly improved long-term weight reduction and resolution of comorbidities in comparison to non-surgical treatments.

Laparoscopic mini/one anastomosis gastric bypass (MGB/OAGB) is a recent MBS technique proliferating among several countries and appears to carry a low-risk profile in the treatment for severe obesity and comorbidities remission, especially type 2 diabetes mellitus [2].

The aim of this pictorial essay is to illustrate and report the normal radiological findings of Laparoscopic mini/one anastomosis gastric bypass, late and early post-surgery complications highlighting the main features of diagnostic imaging. Through the PubMed database, a non-systematic review of the articles in the scientific literature was also performed in the fields of metabolic/bariatric surgery (MBS) and in

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particular in laparoscopic mini/one anastomosis gastric bypass. Our literature research was conducted between January 2020 and May 2021.

Inclusion criteria of this pictorial essay were: patients who underwent laparoscopic mini/one anastomosis gastric bypass for severity obesity; availability of medical history and imaging studies; follow-up time of at least 1 year.

Our pictorial essay study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

2. Bariatric surgical procedures and MGB/OAGB operative technique

As reported in the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) registry (Calendar years 2014–2018) there were 72.645 Roux-en-Y gastric bypass (RYGB, 38.2%), 87.467 Sleeve Gastrectomy (SG, 46.0%), 14.516 MGB/OAGB (7.6%) and 9534 gastric banding operations (5.0%) [3]. Although SG is the most recorded operation, MGB/OAGB has become increasingly popular in bariatric

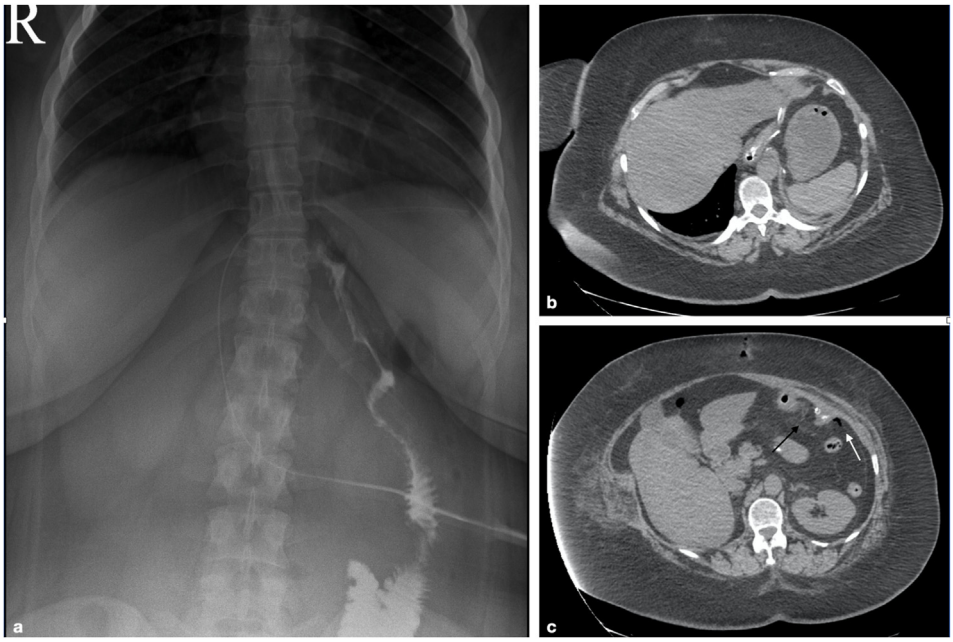

Figure 1. Normal early post-MGB/OAGB imaging after oral contrast medium administration. UGI (a) shows gastric pouch tubular configuration, rapid passage of oral contrast through GJA and following opacification of jejunal loops; axial CT images after oral contrast medium administration show gastric pouch tubular configuration (b), slight oedema, fat stranding (black arrow) and gas (white arrow) around GJA (c).

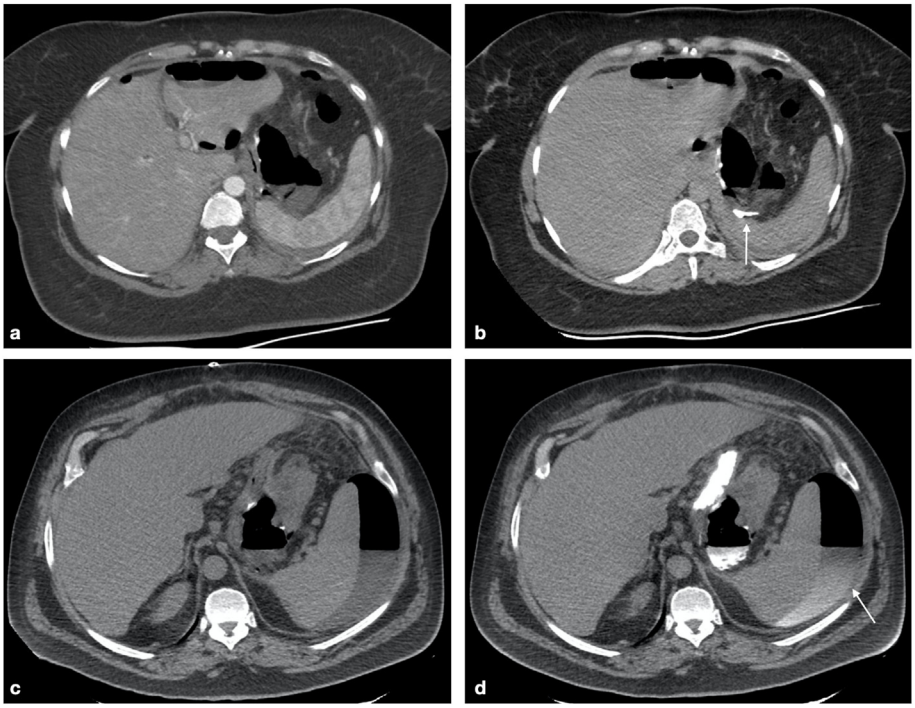

Figure 2. Limited gastric pouch leak in a 49- year-old woman with abdominal pain and tachycardia 3 days after MGB/OAGB surgery; axial CT images before (a) and after oral contrast medium administration (b) show a gastric pouch leak without extraluminal peritoneal contrast spreading (white arrow). Diffused gastric pouch leak in a 47- year-old man with abdominal pain and fever 4 days after MGB/OAGB surgery; axial CT images before (c) and after oral contrast medium administration (d) demonstrate the leak on the left side of the gastric pouch and just inferior to the gastro-oesophageal junction with extraluminal contrast spreading in peritoneal cavity and peritoneal gas, especially in the perisplenic region (white arrow).

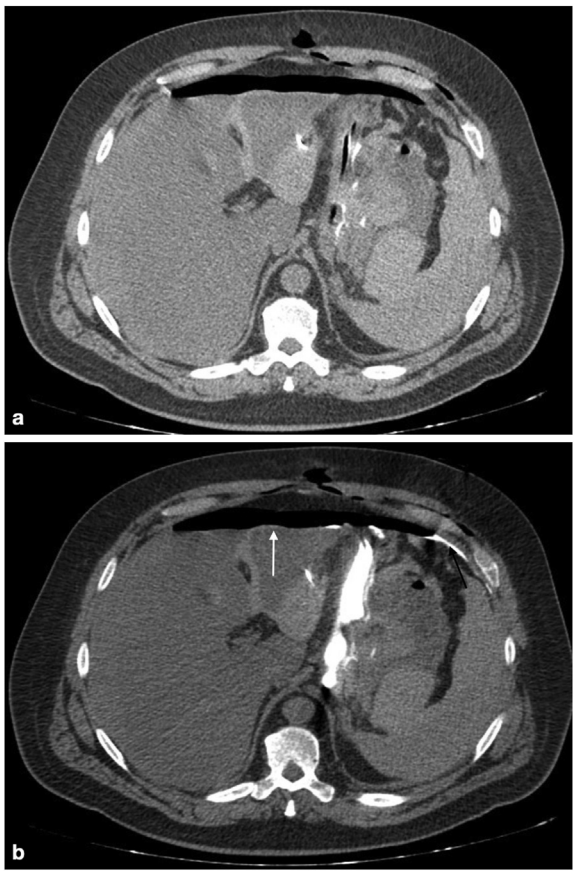

Figure 3. Anastomotic leak in a 51-year-old man with acute abdomen 2 days after MGB/OAGB surgery. Axial CT images before (a) and after oral contrast medium administration (b) show extraluminal gas in the abdominal cavity (white arrow) and extraluminal passage of oral contrast (black arrow).

surgery in Europe and Asia, though not as common as in the USA [4]. MGB/OAGB has also proven itself to be a faster procedure with fewer perioperative complications for revision surgery after failed SG for weight regain/loss failure, intractable malnutrition, gastroesophageal reflux disease and marginal ulceration [5].

Mini gastric bypass (MGB) was reported by Rutledge in 1997 as a technique that proved safe and valid for patients who were morbidly obese as a malabsorptive or metabolic gastric bypass. It consists of a combination of the Collis gastroplasty and an ante colic Billroth II loop gastrojejunostomy, which involves the use of 150 cm–200 cm afferent limb lengths from the ligament of Treitz. Unlike RYGB, this procedure afforded less demanding technical hurdles as a result of the requirement for just one anastomosis, which in turn resulted in shorter surgical procedure time [6].

Concerning biliary reflux, an anti-reflux variation of MGB was carried out in 2002 by Carbajo and Cabalero which consisted of a stapled side-to-side of the afferent limb to the pouch; this surgical procedure was named one-anastomosis gastric bypass (OAGB) [7].

MGB/OAGB has proven to be just as fast, safe and efficient as RYGB and SG [5, 6, 7, 8].

3. Regular post-operative imaging

In bariatric surgery literature, there has been some controversy regarding the usefulness of routine imaging, in particular when patients have generic and nonspecific symptoms.

As a premise to oral intake, in the initial post-surgical phase, water-soluble contrast upper gastrointestinal (UGI) series are normally carried out to exclude potential leaks and detect obstructions. Regular findings on UGI post-MGB/OAGB are the gastric pouch with a characteristic tubular layout and a fast passage of oral contrast through the gastro-jejunal anastomosis (Figure 1a).

Computed tomography (CT) is not commonly performed as a routine in regular post-operative course due to the high radiation dose and without an adequate benefit-cost ratio. Indication for abdomen CT-scans is the clinical and laboratory suspicion of possible complications in the first days after surgery.

Intravenous contrast medium and oral water-soluble contrast administration are both parts of the CT-technique. Normal radiological findings in initial post-operative MGB/OAGB CT scans are opacification of the gastric pouch, negligible oedema and fat stranding around the gastro-jejunal anastomosis (GJA) (Figure 1b-c).

Chest-CT is also recommended in order to exclude other causes of pain with thoracic location [9].

4. MGB/OAGB complications

There have been several reports by authors concerning MGB/AOGB effectiveness and complications [8, 10].

Complications were classified into intraoperative (incidence of 0.5 %) which occurred in the course of the actual procedure, early postoperative (EPC, incidence of 3.1%) from the third day to one month afterwards and late postoperative (LPC, incidence of 10.1%) which includes the period from month 2 up to the 10 years after the operation [8, 10, 11].

During the postoperative period, if there is a clinical suspicion of complications, radiological examinations are carried out: UGI series, CT and magnetic resonance imaging (MRI). The clinical suspicion of possible complications is the onset of abdominal or chest pain, tachycardia, tachypnoea, dyspnoea, hypotension, hematemesis/melena and vomiting, fever and laboratory sign of infectious or inflammatory status such as leucocytosis and increased in PCR and VES values [9].

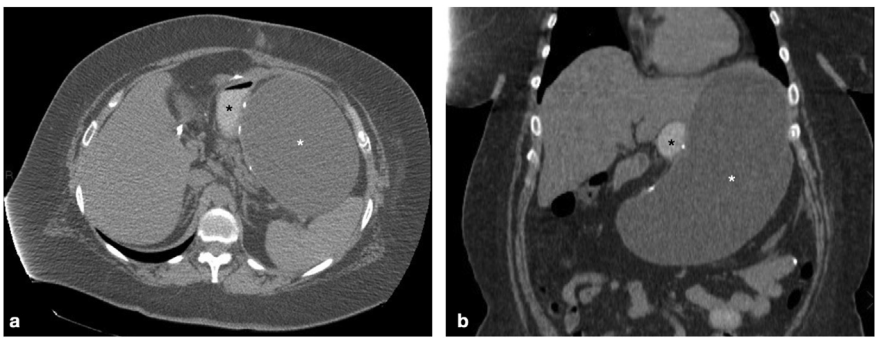

Figure 4. "Afferent loop syndrome" in a 46-year-old woman with abdominal pain and vomiting 18 days after MGB/OAGB surgery. Axial (a) and coronal (b) CT images after oral contrast medium administration show marked distension of excluded gastric lumen (white *) due to narrowing at the GJA and external compression on the gastric pouch (black *).

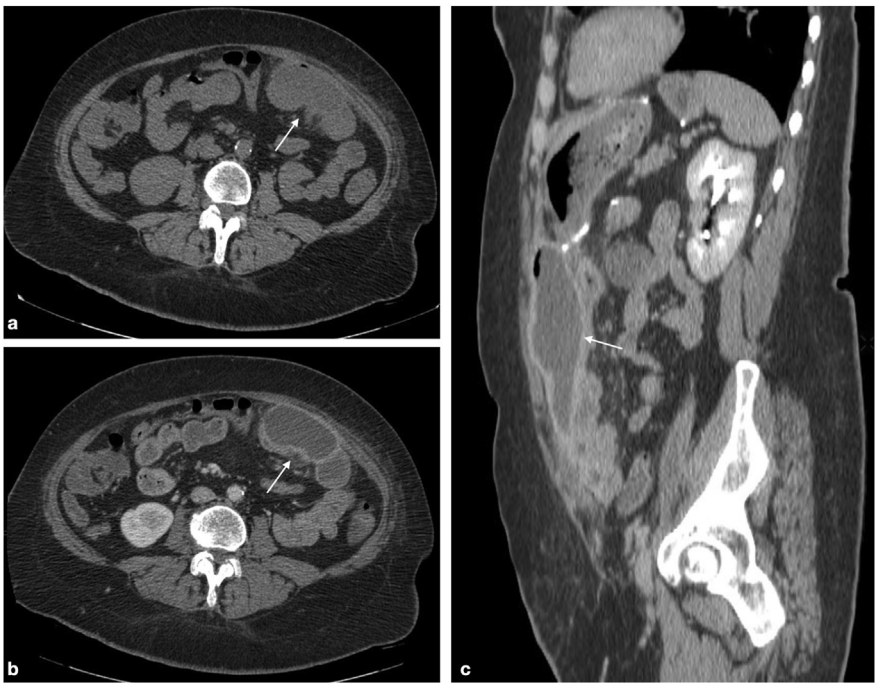

Figure 5. Early perianastomotic abscess in a 58-year-old woman with abdominal pain and fever 16 days after MGB/OAGB surgery. Axial CT images before (a) and axial (b) and sagittal (c) CT images after intravenous contrast medium administration show an abdominal fluid collection around GJA (white arrow).

4.1. Early postoperative complications

Early postoperative complications include:

- Endoluminal and intra-abdominal bleeding;
- Gastric pouch leak and/or anastomotic leak;
- Anastomotic stenosis;
- 'Afferent loop syndrome' (ALS);
- Abdominal abscess;
- Pulmonary complications such as pulmonary embolism, lung infection and pleural effusion.

Whenever a patient shows indications of abnormal recovery in the first 2 days, urgent laparoscopic re-exploration is highly recommended [12]. Patients who are clinically stable with a high suspicion of EPC should be CT scanned as soon as possible.

In the report of Musella et al [8], the incidence of EPC was very low (3.1%). Endoluminal and intra-abdominal bleeding are commonly reported EPC, normally identified with CT. Hematemesis or melena can be associated with endoluminal spreading, while in the intra-abdominal diffusion the blood is detected around the GJA and clinical features are severe abdominal pain, appearance of blood in the drainage, and signs of hypovolemic status with hypotension and/or tachycardia. Even if bleeding is often a self-limiting condition, though it could precede or favour the occurrence of a leak, patients should be closely monitored.

According to the United Kingdom Surgical Infection Study Group, a gastric leak is defined as an effluence of gastrointestinal content through a suture line, which may collect near the anastomosis, or exit through the wall or the drain [13].

Leaks can originate from the gastric pouch, on the left side and just inferior to the gastro-oesophageal junction, and from the GJA. The gastric leak can result from technical failure or vascular injury, and it can be classified based on the morphology and on the onset time passed after surgical treatment. GL can be morphologically distinguished as contained without diffusion of gastric contents into the abdominal cavity and with no evidence of systemic symptoms (type I), extensive or with fluid-sovrafluid collection and complex with the presence of internal subdiaphragmatic or gastrocutaneus fistula. According to the onset time, GL can be divided into "acute" (within 7 days of the procedure), "early" (1–6 weeks after the procedure), "late" (6–12 weeks after the procedure) and "chronic" (>12 weeks after the procedure).

Despite patients being asymptomatic, the most common clinical indicators of a gastric pouch leak are tachycardia, abdominal pain and chest pain.

CT scan is the most adopted diagnostic technique when imaging is necessary for assessment of complications; however, in some cases, UGI could be adequate to reach this diagnosis. When using CT imaging, gastric pouch leaks may appear as spreading of intestinal content limited to the surrounding tissues (contained perforation) or diffused within the abdominal cavity, specifically in the left subphrenic and perisplenic regions (Figure 2).

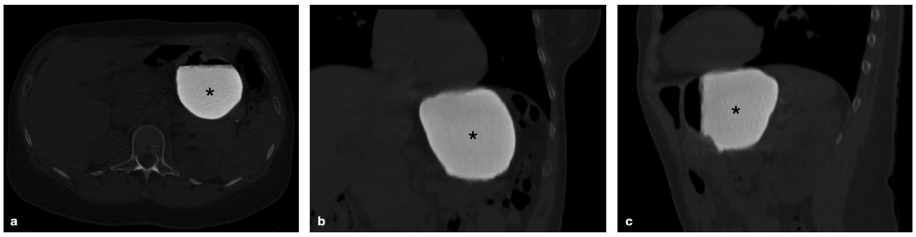

Figure 6. Gastric pouch dilatation in a 42-year-old woman with weight regain 5 years after MGB/OAGB surgery. Axial (a), coronal (b) and sagittal (c) CT images after oral contrast medium administration show an abnormal ectasia of functional gastric lumen (black *).

Figure 7. Gastro-gastric fistula in a 47-year-old man with weight regain 6 years after MGB/OAGB surgery. Axial CT images before (a) and after oral contrast medium administration (b) show an inappropriate opacification of the excluded stomach (white arrow), determined by the passage of oral contrast across staple line and functional gastric lumen/gastric pouch (black arrow).

Patients affected by anastomotic leak usually experience intense abdominal pain, tachycardia, fever, rigid abdomen and often hemodynamic instability. Radiological CT aspects of a GJA leak are meaningful extraluminal gas within the abdominal cavity and extraluminal diffusion of oral contrast (Figure 3).

Anastomotic stenosis may be due to both the presence of post-operative oedema and the formation of stenosis or caused by iatrogenic incorrect manoeuvres.

Afferent loop syndrome is an uncommon mechanical obstruction that may occur after various upper gastrointestinal procedures; its reported prevalence ranges from 0.3 to 1.0% [14]. The etiologies of 'ALS' include adhesions, kinking, stenosis or internal herniation after surgery. Acute 'ALS' usually involves anastomosis of the stomach or oesophagus to the jejunum and is defined by a distal obstruction causing distension of the afferent limb due to the accumulation of bile, pancreatic fluid and proximal small bowel secretions (Figure 4).

An abscess is an early post-surgical complication that occurs in 0.1 % of patients. Radiological CT-appearance of an abscess is a rim-enhancing fluid collection, often containing a small air bubble, and usually results from a leak (Figure 5). Clinical features of abscess are abdominal pain, fever and leukocytosis.

Pneumonitis and pulmonary embolism are rare pulmonary complications after MGB/OAGB because of the short low-risk operation and thanks to the use of antithrombotic and antibiotic prophylaxis. As a consequence of bariatric surgery, a slight pleural effusion is a common occurrence, in particular on the left side [9].

4.2. Late postoperative complications

The incidence of late postoperative complications was likewise low (10.1%) [8].

The main LPC are:

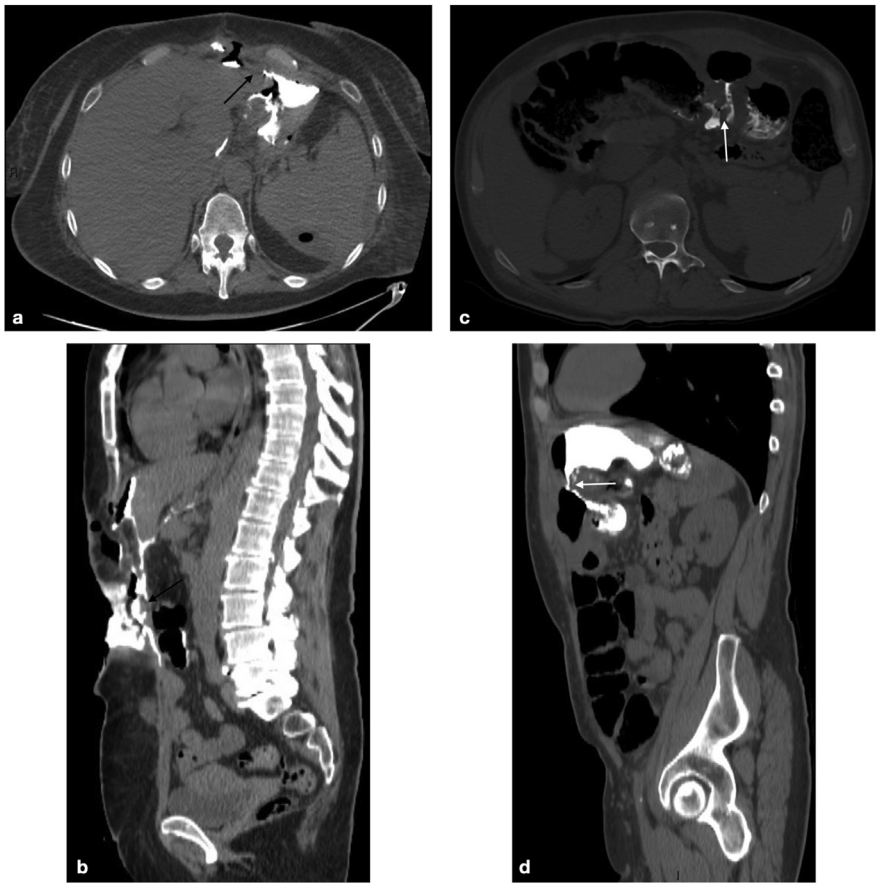

Figure 8. Entero-cutaneous fistula in a 49-year-old woman with abdominal pain and fever; axial (a) and sagittal (b) CT images after oral contrast medium administration show the fistulous tract from the gastric pouch to the skin (black arrow). Entero-colic fistula in a 43-year-old woman with diarrhoea and excessive weight loss, axial (c) and sagittal (d) CT images after oral contrast medium administration demonstrate the pathologic communication between the gastric pouch and the transverse colon (white arrow).

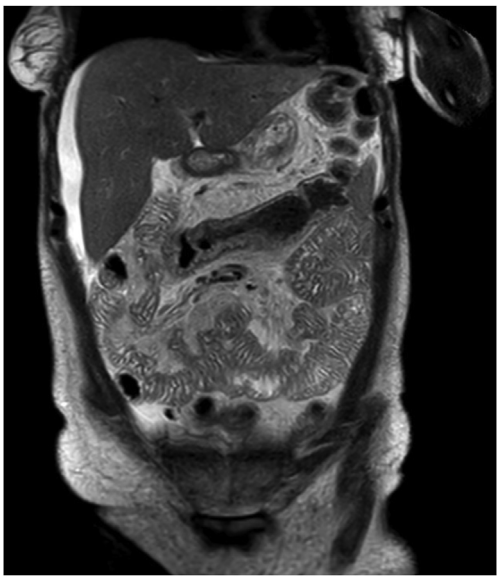

Figure 9. Excessive weight loss in a 40-year-old woman 6 years after MGB/OAGB surgery. Coronal T2 weighted MR image shows thinning of small bowel wall, greater intestinal folds representation and abdominal effusion.

- Weight regain, due to gastric pouch dilatation and/or gastro-gastric fistula;
- Excessive weight loss;
- Perianastomotic abscess;
- Marginal ulcer;
- Small bowel obstruction.

Weight regain is mainly due to gastric pouch dilatation, which consists of an abnormal ectasia of the gastric lumen, is detected via CT scan following oral contrast administration; 3D multiplanar measurements and reconstructions are useful for evaluation of the morphology and anatomical relationships of the stomach with other abdominal organs (Figure 6) [15].

Gastro-gastric fistula is a conduit formed between the proximal gastric pouch and the distal gastric remnant, seldom outlined among bariatric procedures (Figure 7). Entero-cutaneous and entero-colic fistulas are other possible rare late complications (Figure 8).

Excessive weight loss after procedure does not require radiological diagnosis but CT and MRI examinations can identify its manifestations. Radiological findings could be thinning of the small bowel wall, thickening of the intestinal folds and abdominal effusion (Figure 9).

MRI examination, not using ionizing radiation and thanks to its multiplanarity and multiparametric, allows studying abdominal organs in young patients. MRI can detect the normal and abnormal aspect of intestinal walls, the presence of focal or diffuse thickenings and/or fistulas. The main indications for MRI are excessive weight loss and evidence of malabsorption (diarrhoea and steatorrhea).

Regarding marginal ulcer, not all authors agree on its incidence after MGB/OAGB [7, 8, 10], however especially heavy smokers remain eligible to develop ulcer following MGB/OAGB [16]. Diagnosis of peptic ulcer is not always easy, because the symptoms are often non-specific. The main clinical indicators are heartburn, epigastric pain, nausea, vomiting and dysphagia, though there have been reports of meaningful

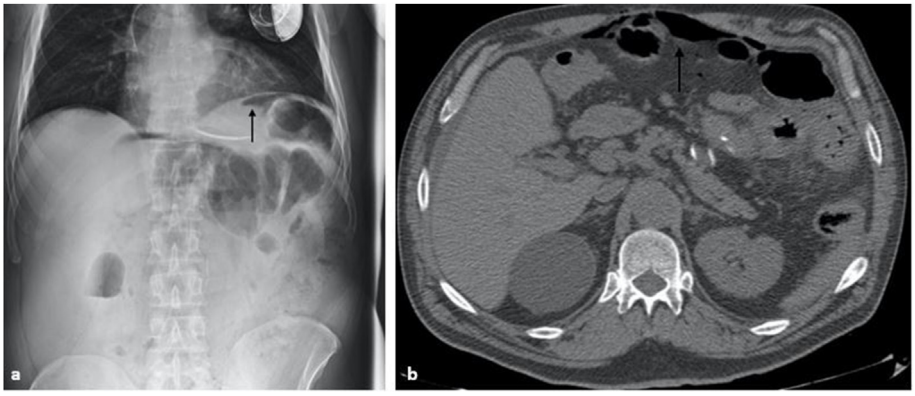

Figure 10. Anastomotic ulcer with gastric perforation in a smoker 53- year-old man with abdominal pain; X-ray image (a) and axial CT image without intravenous and oral contrast medium administration (b) show peritoneal gas, especially in the subdiaphragmatic spaces and around GJA (black arrow).

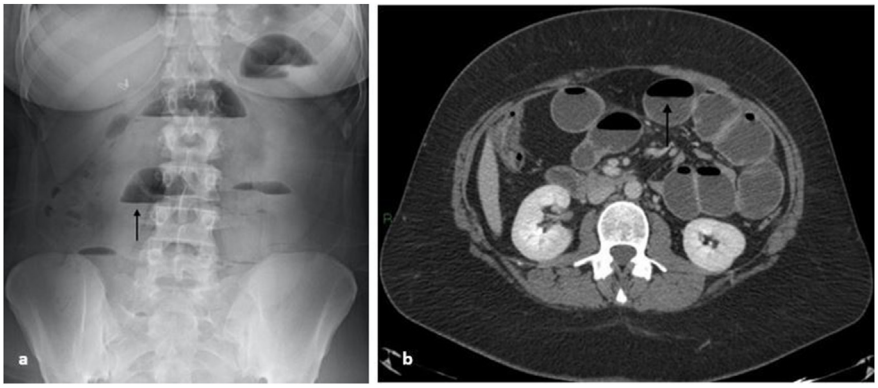

Figure 11. Small bowel obstruction in a 32-year-old woman with abdominal pain and vomiting 2 years after revisional MGB/OAGB surgery; X-ray image (a) shows air-fluid levels of small bowel (black arrow) and axial CT image after intravenous contrast medium administration (b) confirms air-fluid levels of small bowel (black arrow) and mechanical bowel obstruction due to the adhesions.

clinical features, namely bleeding or perforation, without preceding clinical indicators (Figure 10).

A small bowel obstruction is a rare mechanical complication caused by adhesion subsequent to bariatric surgery and gives rise to abdominal pain, vomiting and bloating. The diagnosis is made using X-ray or better CT, showing pathological distension and air-fluid levels (Figure 11).

Finally, an important limitation of MGB/OAGB is the modification of the normal anatomy with the creation of a new gastro-enteric channel that does not allow the exploration of the duodenal and pancreatic region with Esophagogastroduodenoscopy (EGD) and Endoscopic Retrograde Cholangio-Pancreatography (ERCP).

5. Conclusion

MGB/OAGB is a safe, simple and relatively fast surgical procedure for the loss of weight and the remission of comorbidities. In a clinical context, it is essential to be familiar with the radiological characteristics of a patient presenting regular post-surgery modifications and the complications of MGB OAGB. UGI-series can represent the first radiological modality in the detection of early postoperative complications, despite CT being a more frequently used imaging technique as it can accurately identify early and late postoperative complications.

Declarations

Author contribution statement

Giovanni Scavone: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Federica Castelli: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Daniele Carmelo Caltabiano, Maria Vittoria Raciti, Corrado Ini': Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Antonio Basile, Luigi Piazza, Antonio Scavone: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data included in article/supplementary material/referenced in article.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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