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Unforeseen pathological and anatomical findings during primary metabolic and bariatric surgery – a retrospective cohort study and review of the literature

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Abstract

Introduction The prevalence of morbid obesity has surpassed our previous projections and has become a real pandemic. An increasing number of patients are undergoing metabolic bariatric surgery (MBS), and a small but significant proportion of them present with unexpected pathological or anatomical findings that pose intraoperative challenges for bariatric surgeons.

Patients and methods A retrospective analysis of our prospectively maintained database revealed that 46 of the 2387 patients (1.9%) who underwent primary MBS between June 2010 and April 2024 presented with previously undiagnosed pathological or anatomical findings during their operation. The patients' characteristics and surgical outcomes were reviewed, and extensive literature research was conducted to establish the incidence of these findings.

Results The incidence of gastrointestinal stromal tumors (GISTs) was 0.54%, with > 60% of cases presenting on the gastric fundus. R0 resection was considered in all patients. Seven patients (0.3%) had liver cirrhosis, which was confirmed intraoperatively through surgical biopsy. Large hiatal hernias incidence was 0.8% and all required crural approximation. The incidence of benign lesions was 0.2%, and incidental primary or disseminated malignancies accounted for only 0.1% of the cases.

Conclusion Bariatric surgeons should be cognizant of potential intraoperative pathological or anatomical abnormalities, and this paper provides systematic and plausible strategies for managing these challenging situations.

Keywords Bariatric surgery, GIST, Liver cirrhosis, Hiatus hernia, Incidental lesion

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Introduction

The prevalence of morbid obesity exceeds all our previous expectations and has become a real pandemic worldwide. Despite recent advancements in medically available appetite suppressants and various minimally invasive procedures, metabolic and bariatric surgery (MBS) remains the only sustainable and definitive solution for people with morbid obesity. Bariatric surgeons are currently experiencing a substantial surge in potential patients, and consequently, well-established, globally accepted preoperative protocols - endorsed by IFSO (International Federation for the Surgery of Obesity and Metabolic Disorders) - have been developed to facilitate the efficient but safe flow of patients to operating theatre. The primary aims of these pathways are to mitigate perioperative risks, diminish the need for intensive care facilities, and ultimately enhance outcomes, the quality of bariatric surgery and patient satisfaction. Despite the use of the most rigorous preoperative screening methods and comprehensive medical tests, bariatric surgeons may encounter unforeseen pathological and anatomical abnormalities during MBS [1–3]. The aim of our study is to present incidental, unexpected pathologies and unforeseen anatomical abnormalities during MBS from a tertiary referral center and recommends a range of safe and scientifically rationalised exit strategies.

Long-established and busy bariatric units in tertiary referral centres now have more than a decade of experience based on many thousand successful bariatric cases. However, some rare pathologies can be challenging intraoperatively, even for the most experienced bariatric surgeons. Given the rarity of these pathologies, the current surgical opinion is based on level 6 or 7 evidence. Therefore, we conducted an extensive literature review on each of these findings.

Materials and methods

A retrospective review of our prospectively maintained departmental database was conducted, following the STROCSS 2021 guidelines [4] and reviewing all cases from June 2010 to April 2024 (167 months). This period covered both our government-funded and privately funded bariatric surgical activities and was previously published from multiple perspectives [5–10]. The relevant IFSO and national (BOMSS - British Obesity and Metabolic Specialist Society) guidelines were followed in the patient selection and a multidisciplinary team approval was obtained in all cases prior to embarking on primary MBS. The pre-operative investigation protocol - also being fully compliant with the national guideline - involved full lab tests, medical- and metabolical optimization, and psychological assessment; however upper gastrointestinal endoscopy (UGI) was indicated and completed when patient was either older than 55 years old, or had significant reflux symptoms [11]. We identified all patients who had unexpected finding during primary MBS, and a comprehensive case note reviews of these patients were subsequently conducted.

Unexpected pathology was defined as any unanticipated or unforeseen findings of disease or abnormality, which was not known prior to surgery and was discovered during the MBS. These findings can influence patient management and treatment decisions.

Upon the identification of an unexpected pathology, owing to the low incidence, PubMed searches were independently conducted by PV and AA, further elaborating their incidence and investigating their clinical relevance. We used the name of the identified abnormality and all realistic equivalent as keywords and restricted our research to publications written in English. A comprehensive discussion was subsequently held to elucidate the findings. Demographic information, including age, sex, BMI, medical history and comorbidities, was systematically collected and analyzed.

All revisional MBS patients were excluded, as were all patients who had prior open surgery, as the incidence of intra-abdominal adhesions is significant, which might impair the intraoperative laparoscopic view and can influence the detectability of the unexpected pathologies. Due to the nature of retrospective review, ethical approval was not formally required. Our database (without the patient identifiable data) is available on request.

Results

Over the reviewed 14-year period, our team completed a total of 2387 primary MBS cases, and overall, 46 patients (1.9%) were identified who had unexpected findings during MBS. Following the retrieval, review and critical assessment of the operative note, the identified abnormality was further searched and investigated through a comprehensive literature search. The abnormalities were subsequently categorized into pathological and anatomical groups as shown on Fig. 1.

Basic patient demographics are summarised on Table 1 (Supplementary file).

Pathological abnormalities

In total, 25 patients were identified for whom, during MBS, an unexpected pathological abnormality was diagnosed, posing a challenging intraoperative scenario. Consequently, it became necessary to either modify or alter the originally planned surgical procedure.

GIST

Gastrointestinal stromal tumours were the most frequently encountered pathological abnormality during MBS, and the overall incidence in our series was 0.54% (13 patients). Eleven of the tumours were smaller than

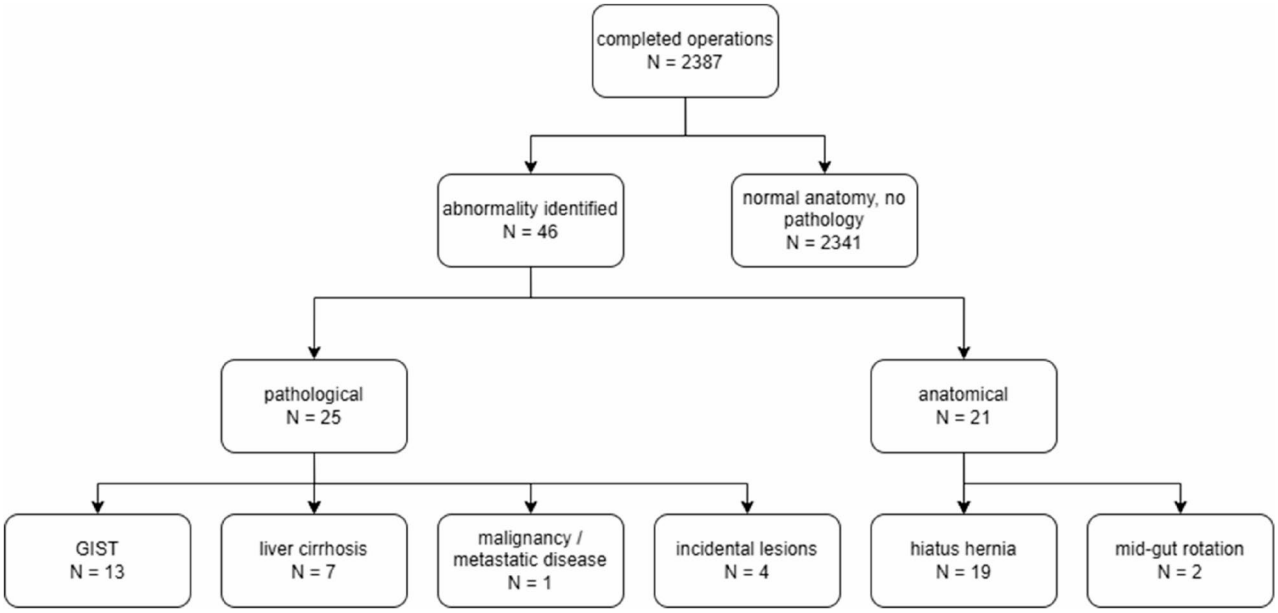

Fig. 1 study design, with the pre-liminary results

2 cm, whereas only two were larger, 2.5 and 3.2 cm, respectively. Eight lesions (61%) were located in the fundus, whereas four lesions (30%) were identified in the body, close to the greater curve. One lesion—detailed below—was found on the jejunum. The median age of these patients was 34 years (range 24–57 years), and the mean BMI was 39.62 kg/m^2 (range 34.70–58.21 kg/m^2). The weight measures are not significantly different from those of other patients in our cohort, however these patients were 8 years younger than the control group.

General surgical oncological guidelines were followed during the procedure, and R0 resections and subsequent histological analysis were performed in every case where a GIST-suspected lesion was detected within the gastric wall. In all instances, where the GIST was located in the fundus, a laparoscopic fundectomy (as depicted in Fig. 2A and B) was carried out, and the specimen was retrieved via a Bert-bag to prevent a potential peritoneal dissemination.

In contrast, a more challenging intraoperative situation occurred in a 56-year-old female with a BMI of 44 (Fig. 3A and B) during a Roux-en-Y gastric bypass procedure. A 10 mm jejunal lesion was identified *after* the gastric pouch was created. This finding resulted in a "one-way direction only" situation, necessitating the completion of the original procedure and leaving the lesion undisturbed; subsequently, postoperatively initiation of cross-sectional imaging and oncological surveillance was undertaken. After 6 months, the patient remained asymptomatic and exhibited no signs of obstruction nor any tumor growing.

Liver cirrhosis

In the reviewed database, 7 patients were unexpectedly diagnosed with liver cirrhosis intraoperatively (incidence of 0.3%); however, these patients were who had no previous formal diagnosis of liver cirrhosis, nor any significant liver function test abnormality. Five of the patients were male (71% male dominance), with a mean age of 39.5 years and a BMI of 48.5 kg/m^2 (Fig. 4).

Malignancy/metastatic disease (N = 1)

In our single case, a 44-year-old gentleman (Wt: 139 kg, BMI: 39 kg/m^2) had a history of renal cell cancer (pT2N0M0) 7 years prior to the planned MBS (Fig. 5) and had a nephrectomy. Despite extensive follow-up, multiple negative surveillance cross-sectional images and the supportive opinion of the oncologist, peritoneal deposits were identified without any apparent primary lesions at the time of surgery. After multiple biopsies, the procedure was abandoned, and subsequently, histology revealed moderately differentiated adenocarcinoma. However, neither cross-sectional imaging nor subsequent oncological follow-up identified the primary site. Consequently, the patient received chemotherapy empirically, and 6 months later, the metastatic deposits persisted (confirmed by a repeated laparoscopy), while the primary site remained unidentified.

Incidental lesions

Ectopic pancreas tissue was identified in 3 patients (incidence: 0.2%), manifesting as a solitary nodule, mass or lesion on the anti-mesenteric border of the small bowel. Since it is asymptomatic and entirely benign, no action

Table 1 Clinical characteristics of the Patients; including the sub-populations

Variable	All Patients	Without abnormality	With abnormality	*p*-value
All MBS patients, N (%)	2387 (100)	2341 (98.1)	46 (1.9)	---
Age, years (SD)	42.14 (10.8)	42.29 (10.6)	41.98 (10.9)	0.26
Female, N (%)	1898 (79.5)	1860 (79.45)	38 (82.6)	0.094
Baseline weight, kg (SD)	121.73 (21.59)	122.6 (18.7)	118.9 (24.2)	0.58
Baseline BMI, kg/m2 (SD)	42.86 (9.82)	42.92 (6.12)	41.05 (7.94)	0.09
Hypertension, N (%)	620 (26)	611 (26.1)	9 (19.5)	0.06
T2DM, N (%)	652 (27.3)	641 (27.4)	11 (23.9)	0.075
GIST:			*n* = 13	
Age, years (SD)	---	---	34.10 (12.6)	
Baseline weight, kg (SD)	---	---	116.28 (8.3)	
Baseline BMI, kg/m2 (SD)	---	---	39.62 (7.2)	
Cirrhosis:			*n* = 7	
Age, years (SD)	---	---	39.5 (6.5)	
Baseline weight, kg (SD)	---	---	136.65 (14.6)	
Baseline BMI, kg/m2 (SD)	---	---	48.5 (12.5)	
Hiatus hernia:			*n* = 19	
Age, years (SD)	---	---	47.6 (8.4)	
Baseline weight, kg (SD)	---	---	118.7 (9.8)	
Baseline BMI, kg/m2 (SD)	---	---	40.2 (8.2)	

or intervention was necessary, and observation alone was deemed appropriate. All scheduled procedures (gastric bypass) were performed as originally planned.

An ectopic spleen was identified in one patient (34 y, female, BMI 38.5 kg/m^2), when a 1.5 cm purple lump was identified in the left upper quadrant of the abdomen, 10 cm below the spleen. As it is a benign condition, no modification to the surgical plan was required.

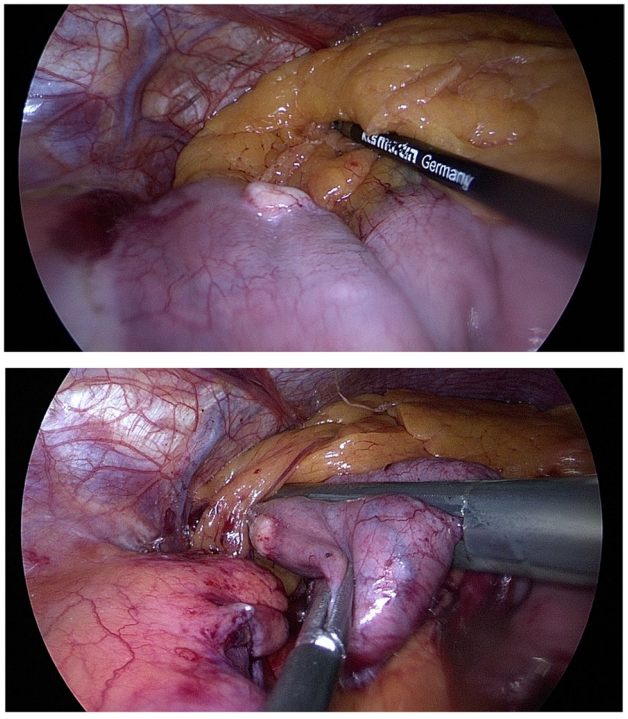

Fig. 2 **A** and **B**: GIST in the fundus of the stomach and resection after pouch creation for Roux-en-Y gastric bypass

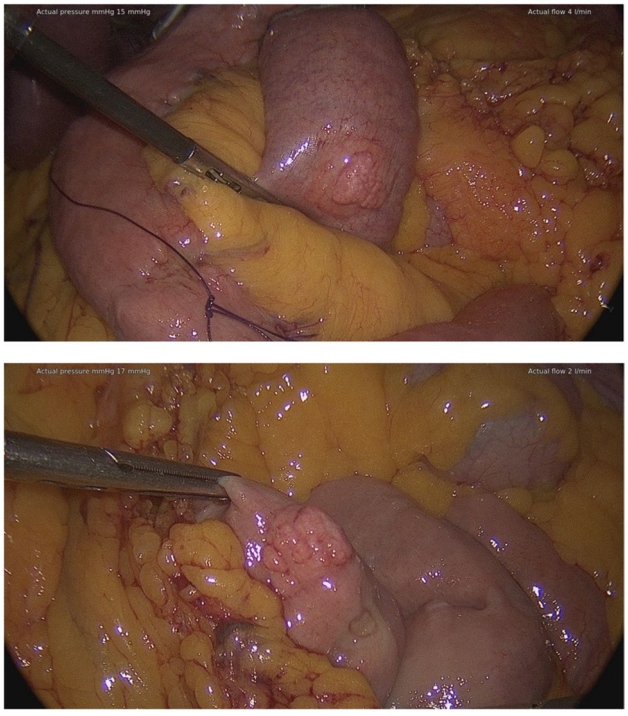

Fig. 3 **A** and **B**: jejunal GIST identified during Roux-en-Y gastric bypass

Anatomical abnormalities (*N* = 21)

Hiatal hernia, greater than 2 cm

A hiatus hernia larger than 2 cm in size was newly diagnosed (intraoperatively) in 19 patients during the MBS

Fig. 4 Newly diagnosed liver cirrhosis

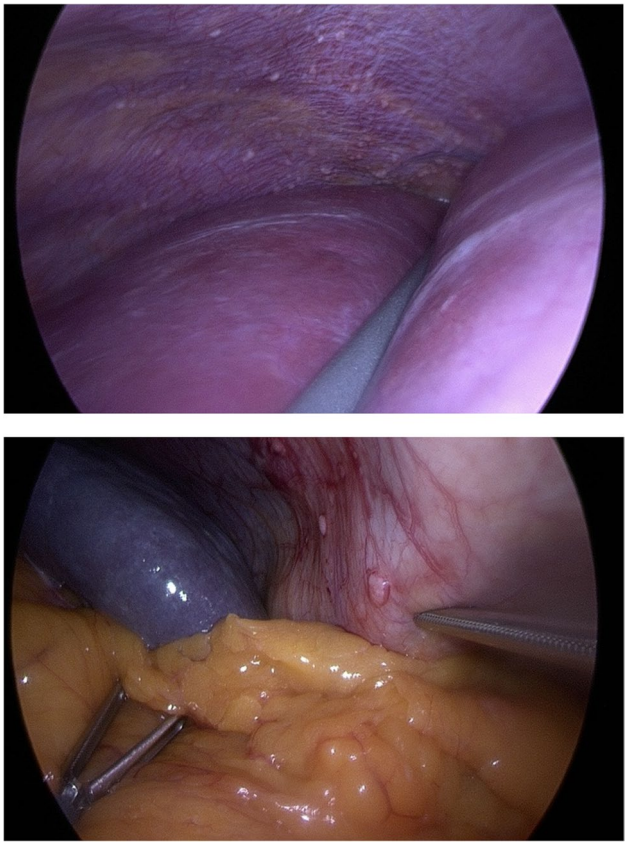

Fig. 5 Intraoperative diagnosis of metastatic disease during the initial phase of bariatric surgery

procedure (0.8% incidence), despite 8 of them had previous OGD which did not confirm the presence of it. With this size of the hernia, formal crural repair was always performed, which involved anterior and posterior crural approximation with interrupted non-absorbed sutures (Fig. 6). The aim of the repair is not only to prevent acid reflux, but also to prevent pouch-migration - or in case of a sleeve- a sleeve-cardia migration into the mediastinum.

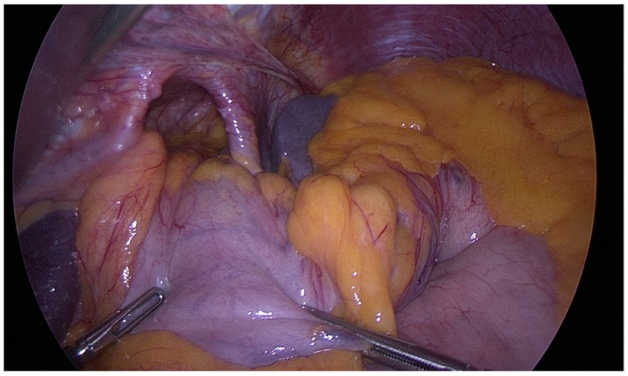

Fig. 6 Hiatus hernia, type 3, size 5 cm, AFS grade 4

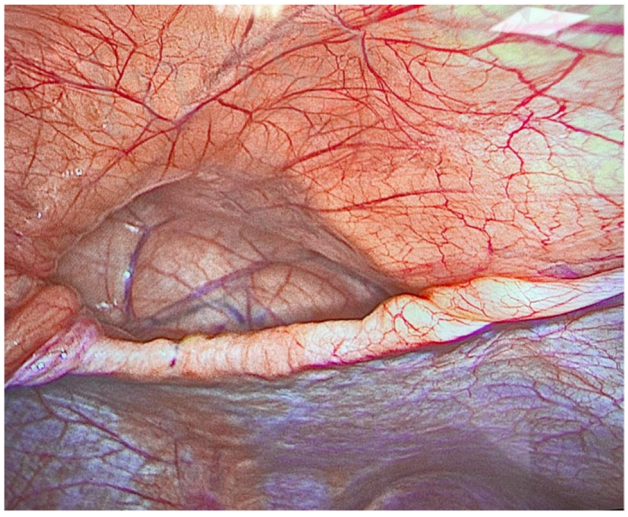

Fig. 7 Morgagni-Larrey hernia

Among those 19 patients, one patient had a Morgagni–Larrey hernia (anterior retrosternal hernia), a rare form of congenital diaphragmatic hernia. Although Morgagni-Larrey hernias are asymptomatic, they can cause bowel obstruction and vomiting, necessitating their repair during MBS [12] (Fig. 7).

Mid-gut malrotation

Two cases of midgut malrotation were diagnosed (both female, 24 and 36 years old) when the proximal jejunal loops were identified in the right upper quadrant during Roux-en-Y gastric bypass (Figures 8 and 9). In these cases the Treitz-ligament was not found in the infra-colic compartment in the left upper-quadrant and required to identify the caecum and perform an oral directional step-by-step small bowel manipulation to find the displaced Treitz-ligament, which were in the right-upper quadrant, near the gallbladder.

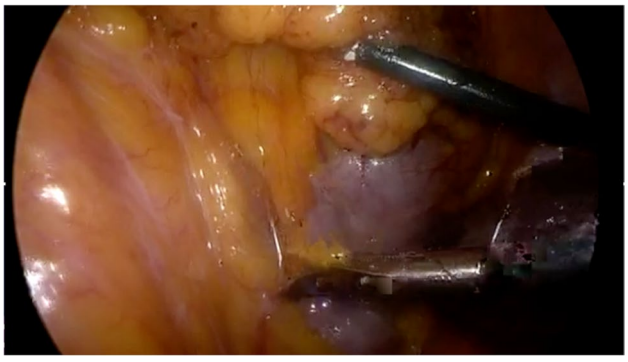

Fig. 8 Empty subcolonic compartment secondary to mid-gut rotation

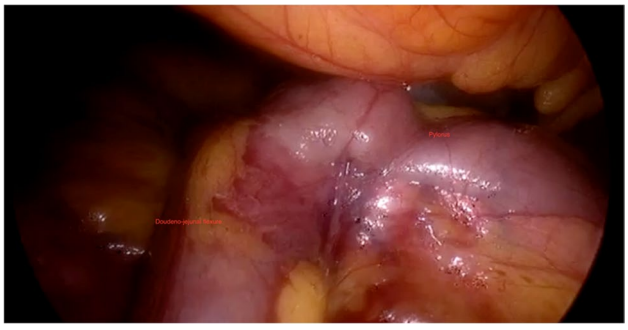

Fig. 9 Position of the duodeno-jejunal flexure secondary to mid-gut malrotation

Discussion

Owing to the recent reduction in eligibility criteria by IFSO and ASMBS, significantly more individuals have become eligible for MBS [13]. These individuals likely represent the less metabolically affected individuals (i.e., healthier) patient population; however, this does not imply that they are devoid of various undiagnosed pathological and/or anatomical abnormalities that become evident only during MBS. Globally, approximately 580,000 individuals undergo bariatric surgery annually. It was estimated that 1–2% of these patients, or approximately 6,000–10,000, may have unexpected surgical findings during the procedure; however this estimate was based on expert opinions (level 7 evidence). This work is intended to assist bariatric surgeons in making intraoperative decisions in those situations.

Intraoperative findings can be categorized into *pathological* and *anatomical* abnormalities.

Among *pathological* abnormalities, gastrointestinal stromal tumors (**GISTs)** are the most prevalent. GISTs are rare mesenchymal neoplasms predominantly located in the fundus (60–70%) and generally pose a low risk of malignant transformation and distant metastasis formation. Therefore, complete surgical resection with negative margins should be considered in all intraoperatively diagnosed patients, as it is a curative and definitive treatment for GISTs. The incidence of GIST is approximately 4 to 22 per million people per year [14–16]; however, recent studies indicate that morbidly obese patients may have a higher incidence of GIST than the general population does [17]. All studies have demonstrated that the median age of diagnosis is approximately 60–65 years, which is significantly greater than the average age of patients undergoing bariatric surgery, as it was 34 years in our subgroup (for the newly diagnosed GISTs). The occurrence of GIST in younger patients (under 40 years) is generally very rare, accounting for less than 5% of all GIST cases [18], as reported by Ijzerman et al. in their study on the basis of a nationwide registry in the Netherlands. These "young-adult" GIST patients constitute a distinct subset with significantly different mutation statuses and genetic backgrounds than the >40 y population. Notably, the metastasis rate in these patients is approximately 13% (ie. much higher than in the older sub-population), with a relatively high prevalence in the small intestine. Based on this fact, it is recommendable that in case of GIST (-suspected) lesion identified during MBS, the bariatric surgeon carries out a visual inspection of the entire small bowel, even in patients undergoing laparoscopic sleeve gastrectomy (LSG).

In our study and in all other reviewed studies [3, 17, 19] it has been observed that the GISTs are predominantly located in the fundus or in the body of the stomach, typically exhibiting unifocality and rarely exceeding a 2 cm diameter. This finding is of paramount importance, and these tumors generally have a very low or low risk of recurrence rate. It is generally recommended that GIST-suspicious lesions be surgically removed [16], and this recommendation applies to MBS patients as well [3]. As the tumor typically resides in the fundus, LSG can effectively serve both purposes, i.e., lesion removal and weight loss induction, with R0 resection being easily achievable. As it was shown on Fig. 2, fundus resection is also easily feasible during a Roux-en-Y gastric bypass (RYGB) as well. However, if the lesion is situated near the lesser curve, RYGB and removal of the gastric remnant containing the lesion may be safe but undoubtedly more complex procedure. Lesions close to the gastroesophageal junction require specialized experience and training in radical oesophagogastric cancer surgery, and many bariatric surgeons may not possess these skills these days. Consequently, abandoning the intended MBS is a safe and recommended practice in such situations. The only concern is surgical biopsy, which should not be performed during laparoscopic surgery, as it can cause peritoneal disruption and potentially promote intraperitoneal spread and decreased long-term survival. Instead, as GISTs exhibit typical radiological features, cross-sectional imaging is recommended postoperatively. Computer tomography (CT) can provide the necessary assurance regarding the diagnosis, enabling the patient to proceed with

resectional surgery [20]. In both scenarios, formal referral to the local sarcoma or cancer center is mandatory.

Liver cirrhosis

The obesity epidemic has led to the emergence of numerous comorbidities, with the prevalence of metabolic dysfunction-associated steatotic liver disease (MASLD) reaching unprecedented levels. Consequently, bariatric surgeons are increasingly encountering patients with metabolic dysfunction-associated steatohepatitis (MASH) and MASH-related cirrhosis, either through preoperative diagnosis or unexpected findings [21]. Numerous studies have reviewed the recommended bariatric surgical pathway for patients with preoperatively diagnosed cirrhosis [2, 22–24]; however, few have addressed the situation of unexpected liver cirrhosis [25]. The presence of liver cirrhosis significantly elevates the perioperative mortality risk. Since the 1960 s, it has been recognized that even the Child–Pugh class A classification predicts a substantially elevated risk, reaching up to 10% [26, 27]. The diagnosis of liver cirrhosis is typically based on tissue diagnosis, prompting the recommendation of a peripherial liver biopsy (aka minor wedge resection) in unexpected cases.

Portal hypertension is a hallmark of liver cirrhosis, and theoretically increasing the risk of intraoperative bleeding. Therefore, it is advisable to perform this procedure at the beginning of the MBS, allowing sufficient time for hemostasis or surgical bleeding control. Wolter et al. reported on 12 patients who underwent intraoperative liver biopsy after an unexpected diagnosis of liver cirrhosis and experienced no complications from the liver biopsy itself [25].

Generally, hypo-absorptive procedures may increase the incidence of liver fibrosis. Therefore, the modification of the procedure, if necessary, to restrictive procedures, such as laparoscopic sleeve gastrectomy, is recommended. This concept was reviewed by Salman et al. in 71 patients with Child–Pugh class A cirrhosis [2, 22], and it is evident that a higher complication rate was found in patients with cirrhosis. However, the benefit of MBS is undeniable, as it has long-term benefits for both obesity and liver conditions, as significant improvements in MASH, MASLD and fibrosis are universally observed [28]. Data on the outcomes of patients with more advanced stages of liver cirrhosis (Child–Pugh class B or C), particularly those with advanced portal hypertension, are scarce [29, 30], however, encountering with those patients during a primary MBS with advanced cirrhosis is unrealistic.

Incidental lumps and lesions

Ectopic pancreas tissue is a rare finding on the peritoneum of small bowel, and its recognition is usually associated with small bowel manipulation during gastric bypass surgery. It is an entirely benign condition, and although technically feasible, surgical resection is generally not necessary. Deviating from the original surgical plan is also not required. A similar principle applies to the splenoma, or ectopic spleen.

Other, suspected malignancy and metastatic disease

Despite the absence of general symptoms and thorough preoperative investigations, there is a small likelihood (less than 1/1000 in our series) of encountering a suspicious intra-abdominal primary malignancy or metastatic deposit. Although technically feasible, we cannot recommend the use of intraoperative frozen section because of their limited availability and the associated logistical challenges. Our recommendation is to obtain adequate biopsies and terminate the surgical procedure; this will allow sufficient time to establish the definitive diagnosis, discuss the implications with the patient and conduct further tests before concluding the final diagnosis.

With respect to *anatomical* abnormalities, hiatal hernia (HH) is the most frequently observed. Lax hiatal structures and defects less than 1 cm in size are very common and generally have minimal surgical consequences [31]. Undiagnosed HHs greater than 2 cm are uncommon, and the prevalence of such hernias varies depending on the preoperative investigation protocol. The national guidelines differ regarding the preoperative requirements for upper GI endoscopy (UGI), but the IFSO recommends (but does not mandate!) performing UGI prior to MBS, regardless of the presence or absence of upper gastrointestinal symptoms [32]. A review of 22,000 pre-MBS patients by the IFSO revealed that 16% of patients had unexpected findings during UGI, which necessitated modification to their MBS. Furthermore, 0.4% of patients, as confirmed by Ansari et al., had absolute contraindications for having a MBS; and these facts, in conjunction with the aforementioned findings, strongly suggest that UGI should be considered a routine investigation prior to MBS [33].

On the basis of others' observations, preoperative upper GI endoscopy effectively excluded 95% of HHs greater than 2 cm in size [11]; however our experience does not confirm this, as 8 of the 19 large HH patients' had normal UGI preoperatively, highlighting the general diagnostic challenges of MBS patients. It may be argued that surgical repair of HHs during RYGB is unnecessary, as the procedure itself addresses reflux symptoms, however the migration of the pouch-jejunum complex to the mediastinum could be a long-term complication after RYGB [34] and other bariatric procedures [35]. Exposing the crura during MBS is relatively straightforward, therefore, we recommend formal crural repair via 2/0 non-absorbable interrupted sutures anteriorly and posteriorly

as well. Other abdominal wall hernias, such as Morgagni-Larrey hernias, small incisional hernias, and linea alba hernias, are recommended for suture repair to prevent bowel obstruction in the early postoperative period, which could be catastrophic after MBS [36].

Mid-gut rotation is a rare anatomical abnormality (incidence of 1 in 500) that can pose significant challenges during gastric bypass surgery, particularly when it is discovered after the gastric pouch has been created. Therefore, thorough assessment of the position of the duodeno-jejunal (Treiz-) ligament during the initial phase of gastric bypass surgery is highly recommended. This assessment should include identifying the Treiz-ligament and ensuring that the jejunal loops are fully mobile and reach the caudal end of the proposed pouch. If any doubts arise, it is entirely feasible to modify the surgical plan and proceed with sleeve gastrectomy instead.

In summary, our paper aims to provide valuable recapitulation in challenging intraoperative situations where bariatric surgeons encounter previously unknown conditions. The primary strength of our paper lies in its reliance on a robust, prospectively collected departmental database. However, it is essential to acknowledge the significant limitations of this study. The retrospective nature of the study and the rarity of the unexpected findings could lead to calculation bias; however large-scale, higher-evidence studies are unlikely to be conducted related to this topic. Further complicates the data-recollections that many of these procedures became interrupted (i.e. diagnostic laparoscopy being performed only) and hence many of these procedures never been recorded in any bariatric surgical database. We anticipate that national database reviews might provide valuable insights into the true prevalence of these pathologies in the future. The small number of cases is giving the rough incidence of the unexpected pathology during MBS which may differ if larger cohort of patients are included.

Conclusion

During a primary MBS, the bariatric surgeon—and ultimately the patient—may encounter an unexpected finding, potentially resulting in a 2% chance of such an occurrence and we recommend to prospectively discuss this fact with the patients at the pre-operative counselling. Our retrospective study provides insights into these situations and the following actions are recommended on the basis of our experience:

Unexpected Findings rate:

- Pathological abnormality: 1.0%.
- Anatomical abnormality: 0.88%.

Liver cirrhosis management:

- Intraoperative biopsy and refer the patient to liver specialists post-procedure.

GIST Management:

- Surgical biopsy is NOT recommended.
- Location check: If the lesion is in the fundus or greater curve, visible on the visceral peritoneum then perform R0 resection. If it is close to the GOJ and cannot resect leaving enough safe zone above it, then abandon the procedure and refer to tertiary oesophago-gastric center who have adequate experience with oesophago-jejunal reconstruction.
- Perform full-check of small bowel loops as the metastatic rate is higher.

Hiatus Hernia Management:

- Consider formal crural repair.

Malignancy:

- Abandon the procedure and take ample biopsies.

During the initial phase of gastric-bypass

- Identify Treitz-ligament and small bowel loops in the infra-colic compartment.

Disclosures and declarations

None of the authors have anything to disclose.

Authors' contributions

PV and AA designed the project and carried out the patient identifications and the literature review. AH, NS, SY and SB contributed to the paper formulation and the scientific summary. All authors reviewed the manuscript.

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Data availability

The datasets used and/or analyzed the current study are available from the corresponding author on reasonable request. Requests to access the datasets should be directed to Dr Peter Vasas, email: peter.vasas@nhs.net.

Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

This study was reviewed by the Doncaster and Bassetlaw Teaching Hospitals' NHS Research and Innovation Team and does not meet the UK Medical Research Council criteria for requiring NHS Research Ethics Committee approval and individual informed patients consent since it involves the use of retrospective, non-patient identifiable data.
This study is fully adherent to the WMA Declaration of Helsinki.

Consent for publication

Not applicable.

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