Obesity Surgery (2019) 29:1281–1286
https://doi.org/10.1007/s11695-018-03672-9

ORIGINAL CONTRIBUTIONS

Unexpected Intraoperative Findings, Situations, and Complications in Bariatric Surgery

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Published online: 4 January 2019

Abstract

Background Bariatric surgery is considered a safe therapy to treat obesity. Postoperative complications are well known; however, there is a lack of data describing intraoperative complications and/or unexpected findings, and if there is further impact on outcomes.

Methods Retrospective study with patients operated between 2013 and 2016 at a single institution. All operative information was collected prospectively and aimed to analyze the incidence and causes of unexpected intraoperative findings, complications, change in surgical plan, extra surgeries, and procedure interruption in patients submitted to bariatric surgery. Secondarily, a morbidity analysis was performed, correlating intraoperative complications with postoperative complications and length of stay.

Results Four-hundred and five patients were included. Female sex comprised 82% of cases, and a median age of 38 years old was observed; almost 90% were gastric bypass. In 29.3% of cases, there were intraoperative findings, mainly adhesions, abdominal wall hernias, positive methylene blue test, hiatal hernias, and gastrointestinal stromal tumors. Associated surgeries were performed in 8.6% cases, and intraoperative adverse events reported in 7.1%, where organ injury and anastomosis problems were the most frequent. A change in the operative plan was done in 0.9% and surgery interruption in 1.2% of the cases. Early complications were observed in 6.6%. There was no correlation between intraoperative complications and length of stay or early complications.

Conclusion Unexpected intraoperative findings/complications are common in bariatric surgery, but without increasing morbidity or length of stay. Surgery suspension, change in the planned technique, or adding extra (non-bariatric) procedures may occur.

Keywords Bariatric surgery complications · Laparoscopic gastric bypass · Postoperative complications · Intraoperative complications · Unexpected findings · Laparoscopic sleeve gastrectomy · Obesity · Morbid obesity · Intraoperative adverse events

Background

Obesity is a significant and growing problem for public health [1]. In the USA, more than 35% of men and women live with obesity [2], where bariatric surgery has taken a high significance by showing a greater effect on sustained weight loss, in addition to a drastic effect on associated comorbidities [3, 4]. In the early years, bariatric surgery had a mortality of 0.5–1% [5]; subsequently, with the advent of laparoscopic surgery, there was a decrease to 0.1–0.5% [5–7].

Major morbidity in bariatric surgery is reported in approximately 13% of cases, with a complications rate of 8 to 13% in laparoscopic sleeve gastrectomy (SG) [8, 9] and 3–12.5% for laparoscopic gastric bypass (RYGB) [10]. The most frequent major complications are as follows: anastomotic leakage, bleeding, intestinal occlusion, and stenosis [11, 12]. These complications are described as early complications (within the first 30 days after surgery), and this is how the most postoperative problems in bariatric surgery are reported [13]. Bariatric procedures may be technically complex in some cases, and there is little information in the literature on complications that occur during surgery, especially if there was or not a later impact [11]. Also, there could be findings/complications during the procedure which may stop or modify the planned surgery, add more non-bariatric procedures at the

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same operative time, or even turn it into an open surgery. [14]. These types of intraoperative events have been briefly described in general surgery, but with little or almost none evidence in bariatric patients [11, 14, 15]. In this study, the frequency of such events was analyzed, as well as their correlation in postoperative evolution in a group of patients submitted to RYGB and SG.

Material and Methods

A retrospective study (with prospective data collection) was performed, analyzing every patient submitted to bariatric surgery (RYGB, SG, and revisional surgery) in a single institution between January 2013 and March 2016. An initial demographic analysis (anthropometric and comorbidities) and a perioperative analysis focused in intraoperative findings and intraoperative adverse events (iAE) were performed. Also, the type of surgery, surgical time, change in the surgical plan, surgery interruption, type of unexpected intraoperative findings/complications, early postoperative complications, and hospital stay were analyzed. A specific data collection sheet was used to collect the intraoperative and postoperative information included in the main objectives. Such information was added prospectively to an electronic database. If there was confusion or dubiousness in the database, the operative notes and recorded surgeries were reviewed. We included all bariatric patients that met the guidelines defined by the National Institutes of Health (NIH) consensus: body mass index (BMI) equal or greater to 40 kg/m^2 or BMI 35–40 kg/m^2 with some comorbidity [16]. Patients not included were those with incomplete data collection sheet, surgery suspension due to non-surgical problems (anesthesia related), open surgery, or when a less common bariatric procedure was performed (one anastomosis gastric bypass, gastric banding and single anastomosis duodeno-ileal bypass). The definition of *adhesions* as operative finding was considered positive only when such adhesions blocked the main operative field and/or intestine mobilization was difficult; therefore, extensive adhesiolysis was necessary. This protocol was approved by the Ethics Committee (Institutional Register Number 212-010-22-17; National Register Number 09-CEI-001-2016-0404) and registered in www.ClinicalTrials.gov (NCT03556306).

The RYGB ("simplified technique") was performed in an antecolic fashion, with a calibrated 2-cm gastrojejunal anastomosis (linear stapler); biliary and alimentary limbs measured 70 and 150 cm, respectively [17]. Mesenteric defects were closed and the omentum divided. The SG was performed at 5–6 cm from the pylorus over a 36 Fr. bougie, with oversuture of the staple line (2–0 polypropylene). Methylene blue test and the use of drains were done routinely in both types of surgeries.

The intraoperative complications, or iAE, were categorized according to a validated severity classification system proposed in 2014 [18, 19]. This system has six classes, where minor iAE are class I (injuries not requiring any repair) and class II (surgical repair without organ removal or change in planned procedure). Major iAE are class III (injuries requiring organ/tissue resection but completing the original procedure), class IV (change or incompletion of planned procedure), class V (reoperation within 7 days due to an inadvertent injury), and class VI (intraoperative death owing to hemorrhage).

Statistical Analysis

Data were expressed as mean ± standard deviation (SD) values and analyzed by paired and unpaired *t* test as appropriate. A Spearman correlation analysis was performed between the presence of intraoperative complications and findings with the increase of early postoperative complications prevalence and hospital stay. Significance was reached when $p < 0.05$. Analysis was performed using NCSS 2007 (NCSS, Kaysville, Utah, USA).

Results

In a term of 36 months, 405 procedures were performed. Female sex represented 82% of the cases with a median age of 38 years and average initial BMI of 44.3 kg/m^2. Surgical analysis showed that 353 RYGB (87.1%), 48 SG (11.9%), and 4 revisional surgeries (0.9%) were performed. The rest of the initial demographics and perioperative analysis is described under Table 1. One hundred and nineteen (29.3%) intraoperative findings, 35 (8.6%) additional procedures, 29 (7.1%) intraoperative complications, 4 surgery modifications (0.9%), and 3 (1.2%) procedure suspensions occurred. The early reintervention rate was 0.7% (Fig. 1). Based in intraoperative findings, the RYGB changed to SG in three cases (2 because of suspected cirrhosis and 1 for short mesentery) and from SG to RYGB in one case (big hiatal hernia not previously diagnosed). Surgery suspension was due to one evident macronodular cirrhosis, a ventral hernia with content loss and multiple adhesions, and a mesentery injury by trocar insertion.

The most frequent intraoperative findings were as follows: blocking adhesions (15.8%), abdominal wall hernias (5.9%), and positive methylene blue test (2.9%) (Table 2). The most common additional procedures (non-bariatric) were the following: cholecystectomy (2.5%), hiatal hernia repair (1.7%), and abdominal hernia repair (1.2%). Intraoperative complications were observed in 7.1% of the cases, and the most common were organ injury (4.1%) and anastomosis problems (1.5%); the detailed analysis is under Table 3. Using the iAE severity classification (minor in 89.6% and major in 10.3%),

Table 1 Initial demographic, anthropometric, comorbidities, and perioperative analysis

	n = 405
Female sex; *n* (%)	332 (82)
Age (years); mean ± SD	38.7 ± 9.44
Weight (kg); mean ± SD	115.8 ± 20.5
BMI (kg/m^2); mean ± SD	44.3 ± 6.1
Hypertension; *n* (%)	147 (36.3)
Dyslipidemia; *n* (%)	132 (32.6)
T2DM; *n* (%)	79 (19.5)
Gastric bypass; *n* (%)	353 (87.1)
Sleeve gastrectomy; *n* (%)	48 (11.9)
Revisional surgery; *n* (%)	4 (0.9)
Surgical time (min); mean ± SD	156.9 ± 38.3
Length of stay (days); mean ± SD	3.1 ± 0.4
ICU (days); mean ± SD	0
Major postoperative complications[a]; *n* (%)	27 (6.6)

SD (standard deviation), BMI (body mass index), T2DM (type 2 diabetes mellitus), ICU (intensive care unit)

[a] Early complications (< 30 days)

Table 2 Analysis of unexpected intraoperative findings/situations

	n = 405
Adhesions; *n* (%)	64 (15.8)
Abdominal wall hernias; *n* (%)	24 (5.9)
Positive methylene blue test; *n* (%)	12 (2.9)
Hiatal hernia; *n* (%)	10 (2.5)
Liver fibrosis/cirrhosis; *n* (%)	4 (1)
GISTs; *n* (%)	3 (0.7)
Others[a]; *n* (%)	2 (0.4)
Total; *n* (%)	119 (29.3)

GISTs (gastrointestinal stromal tumors)

[a] Splenic hemangioma and accessory spleen

there were eight events in class I (27.5%), 18 in class II (62%), 2 in class III (6.8%), and 1 in class IV (3.4%); Class V and VI did not occurred.

The resolution of class I and II iAE were as follows: hepatic and splenic injuries/hematomas, resolved with conservative treatment and hemostatic agents, as well as two of the trocar related injuries (mesentery). The esophageal perforation related to calibration bougie (distal esophagus) was in a patient with a conversion from Nissen fundoplication to bypass; the crus repair was to thigh and had an impact in such injury. The resolution was primary repair and the bypass continued, adding a gastrostomy tube into the excluded stomach. The specific treatments for stomach, pouch, bowel, and diaphragmatic injuries were primary repair and/or reinforcement. Three patients with incomplete stapling during gastrojejunal (GJ) anastomosis (only serosa involved) required mucosa opening and suturing it with absorbable sutures to the layers already involved within the anastomosis. One patient had GJ stenosis related to tight oversuture that was released. In class III, one patient with twisted jejuno-jejunal anastomosis required complete section and redo (finishing with three anastomosis sites), and another with ischemic GJ had a pouch and anastomosis redo. In class IV, one patient required laparotomy due to trocar injury (no major vessel was injured) and surgery interruption.

Early major complications (< 30 days) occurred in 6.6%, which included mainly fistulas and postoperative bleeding (both with an incidence of 1.5%) (Table 4).

A correlation was found between the early postoperative complications presence and increase in hospital stay

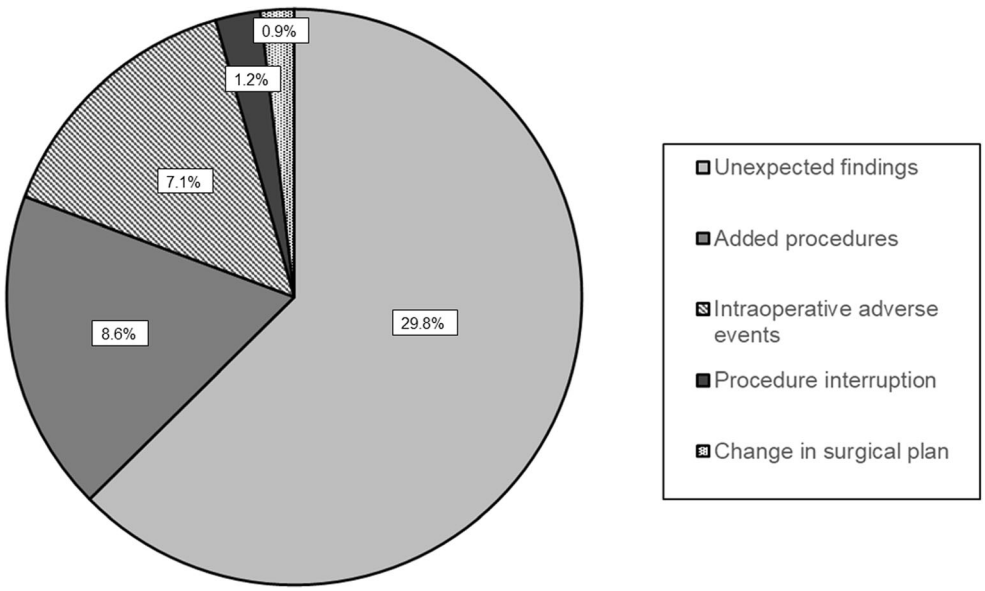

Fig. 1 Prevalence of intraoperative situations

Table 3 Intraoperative complications

	$n = 405$
Anastomosis technical problems[a]; *n* (%)	6 (1.5)
Bowel injury/perforation; *n* (%)	5 (1.2)
Pouch injury/perforation; *n* (%)	4 (1)
Gastric injury/perforation; *n* (%)	3 (0.7)
Mesentery injury; *n* (%)	3 (0.7)
Grade III liver injury; *n* (%)	2 (0.5)
Stapler misfiring/malfunction; *n* (%)	2 (0.5)
Splenic injury/hematoma; *n* (%)	2 (0.5)
Diaphragmatic injury; *n* (%)	1 (0.2)
Esophageal perforation[b]; *n* (%)	1 (0.2)
Total; *n* (%)	29 (7.1)

[a] Three incomplete stapling (only serosa involved), one twisting, one stenosis and one ischemic anastomosis

[b] Perforation by calibration bougie

($p < 0.001$, $r = 0.329$), but not when comparing iAE with postoperative complications ($p = 0.959$ $r = 0.03$).

Discussion

In this retrospective study with 405 patients submitted to bariatric surgery, an important number of intraoperative complications and/or findings was identified that in some cases required a change in the surgical technique, additional surgeries, and even procedure suspension. Despite the previous, postoperative morbidity was not higher in these patients.

Intraoperative complications in general surgery and bariatric surgery are not often reported; the great majority of the literature is focused on postoperative complications, whether early or late, or minor and major [13, 20, 21]. There is little information whether there is a real impact of what happens in the operating room, regarding outcomes and further morbi-mortality, and also a change in surgical plan. For bariatric surgery, an incidence of 2 to 8% of unexpected findings has been reported, but most of these reports are focused on neoplasia (mainly Gastrointestinal stroma tumors) [22] and gynecological problems (which can be as high as 80% of cases) [23].

Table 4 Early major postoperative complications

	$n = 405$
Fistula; *n* (%)	6 (1.5)
Endoluminal bleeding; *n* (%)[a]	6 (1.5)
Postoperative bleeding; *n* (%)[a]	6 (1.5)
GJA stenosis; *n* (%)	4 (1)
Pseudomembranous colitis; *n* (%)	2 (0.5)
Paroxysmal atrial fibrillation; *n* (%)	1 (0.2)
Incarcerated umbilical hernia; *n* (%)	1 (0.2)
DVT; *n* (%)	1 (0.2)
Total; *n* (%)	27 (6.6)

GJA (gastrojejunal anastomosis requiring therapeutic endoscopy), DVT (deep venous thrombosis)

[a] Required blood transfusion or surgical reoperation (only one patient had a sleeve gastrectomy)

For our analysis, we wanted to widen such concept of unexpected findings, reporting any unusual pathology not previously diagnosed, anatomical variants, and even hermeticity test results. We observed an incidence of 29.3%, the most frequent were adhesions, abdominal wall hernias, and positive methylene blue test. In the last years, different authors have been interested in this subject, one of the unexpected findings that has been most described in literature are gastrointestinal stromal tumors (GIST), with a prevalence of 0.8% [24–26], similar to the 0.7% found in our series. Specifically, for bariatric surgery, a series with 1502 patients had an incidence for such tumors in 0.9% (0.8% for RYGB cases and 0.3–1.2% for SG), being most common in elderly patients and in lower BMI [27]. The significance is in the risk for residual tumors non-diagnosed when the bariatric procedure is performed. A probable benefit of performing a SG in such cases could be a greater ease to resect completely the tumor, since a part of the antrum, body, and gastric fundus are included in the resection. In our practice, routine endoscopy is performed before surgery, but some of these tumors will go undiagnosed (extraluminal and intestinal localization). In the three GIST cases found in our series, one was in the proximal jejunum (required bowel resection during RYGB), one in the fundus (resected as part of the SG), and another one in the antrum (resected during RYGB with an antrectomy of the excluded stomach). All of them had negative margins in the histopathological study, and patients were sent to the oncology department for specialized treatment.

Other unexpected finding widely described is the presence of ovarian pathology, due to the association between obesity and polycystic ovary syndrome and ovarian cancer [28–31]. González reports prevalence for such findings in 2.5%, but without the need to modify the bariatric procedure, only by adding gynecological surgery [32]. In our study, we do not report gynecological pathology, since pelvis examination is not performed as a routine. Another issue we wanted to include in this analysis was a positive methylene blue test, since conceptually it could be classified as a "technical failure/problem" that if goes undiagnosed it can lead to higher postoperative problems. This test became an important tool in our practice to reinforce stapler lines or sutures when necessary; none of the patients with intraoperative positive blue test presented a postoperative leak/fistula.

In terms of extra non-bariatric surgeries during the primary procedure, Greenbaum reports an incidence of 10%, being the most frequent the ovarian cyst drainage (4.2%), biopsies (3%),

and salpingo-oophorectomy (1.2%) [23]. In comparison to our results, we observed a very similar incidence (8.6%), but with different procedures, such as cholecystectomies (2.5%) and hiatal hernia repair (1.7%). As previous reported, cholecystectomies were routinely performed in symptomatic patients with positive USG (sludge/gallstones), or if gallbladder adherences were observed during the bariatric procedure (associated also to positive preoperative USG). Since there is no consensus when managing hiatal and abdominal wall (especially umbilical) hernias, these can variate from center to center [33, 34]. In our center, hiatal hernia repair was performed only in symptomatic patients with hernias > 4 cm, and abdominal wall hernias (mainly umbilical) were managed in a conservative fashion (unless intestine was involved or content reduction occurred).

In recent literature, there is an overall incidence of serious morbidity (major complications) of 8%, being significantly higher in RYGB (11.7%) than SG (5.8%) [35]. We had similar tendencies, with an overall early morbidity of 6.6% (7.3% in RYGB and 2% in SG). Sometimes the presence of intraoperative unexpected findings and/or complications conditions the suspension of the procedure. One example is an injury during trocar/Veress insertion, from which we had three cases (mesentery involved), and one required laparotomy and surgery interruption. Vascular injuries associated to trocars have been described in around 0.1% (general population) [36], with epigastric vessels frequently involved [37], but fatal cases have been also observed with aortic, cava, iliac, and other major vessels injuries [36, 38]. Our suspension rate was 1.2%, being greater than other reports (0.2%) [20]. The previous is because unexpected intraoperative findings and complications were included together as suspension causes, not only complications as usually reported. In addition, we found a reintervention rate of 0.7%, which matches to prior reports [39]. Hospital stay in our study was also similar to the literature [40, 41], with correlation for longer stay in patients suffering from a postoperative complication, but not for those with iAE. The previous can be explained because this is a "small" series, compared with some general surgery studies, where a link between iAE and longer length of stay and higher morbi-mortality was associated [18, 19, 42]. Another reason could be that most of our iAE were minor (classes I and II) injuries (89.6%), and this type of events do not have higher 30-day morbidity [19].

During schedule surgery, there is a possibility of finding anatomic variants or unexpected pathologies (non-identified during preoperative workup) that require a biopsy, tissue removal, to add non-bariatric procedures, change in the primary surgical plan, or surgery suspension. Many of these findings may increase procedure morbidity and early postoperative complications, as it happens when bariatric surgeries and cholecystectomies are performed simultaneously [43, 44]. The change in the type of bariatric surgery based on intraoperative findings (for example, finding hepatic problems and multiple intestinal adhesions) shall be written in the informed consent and shall be clearly explained to the patient and his/her family. Aside from this, our routine practice includes a "time out" during surgery and a phone call to the patient's family member or legal responsible before making the decision of changing the type of bariatric surgery, all of this intraoperatively. Surgeons should always put patients' safety first, even if this includes suspension of the procedure, with further assessment based on these new findings.

The limits of our study include the retrospective nature and that is a single institution experience. Also, there are a small number of patients with major iAE; so, a correlation bias to postoperative complications and length of stay could be present. Multiple institutions with more patients are needed, since not everyone performs bariatric surgery in the same exact way, and also the criteria for extra non-bariatric surgeries may variate (especially for hiatal and abdominal wall hernias approach).

Conclusions

Unexpected intraoperative findings/complications are common in bariatric surgery. Identify and act in these situations does not increase morbidity or length of stay, since the majority of cases are minor adverse events. Surgery is a dynamic process, where procedure suspension, change in the original plan, or adding extra procedures may also occur.

Compliance with Ethical Standards

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

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution and/or national research committee and with 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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

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