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RESEARCH ARTICLE

High Mortality Rate for Patients Requiring Intensive Care After Surgical Revision Following Bariatric Surgery

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Abstract
Background To report the prognosis and management of patients reoperated for severe intraabdominal sepsis (IAS) after bariatric surgery (S0) and admitted to the surgical intensive care unit (ICU) for organ failure.
Methods A French observational study in a 12-bed adult surgical intensive care unit in a 1,200-bed teaching hospital with expertise in bariatric surgery. From January 2001 to August 2006, 27 morbidly obese patients (18 transferred from other institutions) developed severe postoperative IAS (within 45 days). Clinical signs, biochemical and radiologic findings, and treatment during the postoperative course after S0 were reviewed. Time to reoperation, characteristics of IAS, demographic data, and disease severity scores at ICU admission were recorded and their influence on prognosis was analyzed.
Results The presence of respiratory signs after S0 led to an incorrect diagnosis in more than 50% of the patients. Preoperative weight (body mass index [BMI]>50 kg/m^2) and multiple reoperations were associated with a poorer prognosis in the ICU. The ICU mortality rate was 33% and increased with the number of organ failures at reoperation.
Conclusion During the initial postoperative course after bariatric surgery, physical examination of the abdomen is unreliable to identify surgical complications. The presence of respiratory signs should prompt abdominal investigations before the onset of organ failure. An urgent laparoscopy, as soon as abnormal clinical events are detected, is a valuable tool for early diagnosis and could shorten the delay in treatment.

Keywords Bariatric surgery · Obesity · Postoperative peritonitis · Sepsis · Intensive care unit

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Introduction

Morbid obesity is a major worldwide public health concern leading to decreased life expectancy [1]. Bariatric surgery is the only treatment that consistently helps patients to achieve significant and sustained weight loss and improvements in comorbid medical conditions [2]. However, the beneficial effects of bariatric surgery need to be weighed up against the risks of perioperative complications and short-term fatal outcome [3]. Common causes of complications include acute respiratory failure, pulmonary embolism, and anastomotic leaks that may require intensive care unit (ICU) admission [4].

Postoperative intraabdominal sepsis (IAS) is usually because of perforation after gastric restrictive procedures or anastomotic leakage in the case of Roux-en-Y gastric bypass (RYGB) [5]. One of the most difficult issues in the management of postoperative IAS is its identification before the onset of organ dysfunction, as clinical signs can be misleading or atypical in obese patients and the lack of specificity on imaging studies can make the diagnosis of IAS challenging [5, 6]. Thus, similarly to what has been observed in nonobese patients, increased mortality could be expected in the case of delayed management.

To our knowledge, prognosis and management of severe IAS requiring ICU after bariatric surgery have been poorly described in the literature. In this observational study, we addressed this issue in a cohort of patients with these characteristics, admitted to a referent surgical ICU with expertise in the management of complications after abdominal surgery [7, 8]. In addition, we examined the course of IAS with particular attention to the clinical, biochemical, and radiological features observed in the interval between initial bariatric surgery and reoperation.

Patients and Methods

Patient Selection

This observational study analyzed patients admitted to the ICU for IAS with organ dysfunction after bariatric surgery. Patients were morbidly obese (body mass index [BMI] ≥ 40 or ≥ 35 kg/m^2 with underlying disease related to overweight) and underwent bariatric surgery at our hospital or were referred from another institution. All patients developed postoperative IAS within 45 days after initial surgery (S0). The diagnosis of postoperative IAS was assessed by our surgical team with reoperation (R1) on admission to the ICU. The definition of IAS was based on intraoperative findings such as purulent material in the peritoneal cavity combined with an anatomic injury and positive bacterial culture of peritoneal fluid. Adequate surgery was performed in every case, defined as selective treatment, source control, and abundant peritoneal lavage. No informed consent was required by the Institutional Review Board because of the observational and nonrandomized nature of the study.

Data Collection

Demographic Data The following basic demographic and clinical data were collected on ICU admission from the medical and surgical reports of all patients. Age; gender; comorbid conditions (diabetes mellitus, hypertension, chronic obstructive pulmonary disease, and obstructive apnea syndrome); BMI (kg/m^2); and disease severity scores such as the Simplified Acute Physiologic Score II (SAPS II), the Acute Physiology and Chronic Health Evaluation System (APACHE II), and the Sequential Organ Failure Assessment (SOFA) were recorded [9]. The characteristics of the initial bariatric surgery, its type, route, and wound class were also noted.

Initial Management of IAS Clinical signs and symptoms, biochemical and radiologic findings, and treatment initiated during the postoperative course after S0 were reviewed. Data collected included: (1) signs of systemic inflammatory response syndrome (SIRS) if at least two criteria were present: fever (temperature ≥38.5°C), tachycardia (heart rate ≥90 bpm), tachypnea (respiratory rate ≥20 breaths/min), and leukocytosis (white blood cell count ≥12,000/mm^3); (2) signs of IAS: abdominal pain (its site was assessed), tension or rigidity of rectus abdominis, ileus (vomiting or abundant gastric effusion through suction tube), and pus effusion through wound or abdominal drains; (3) signs of organ failure, using the definitions of the 2001 International Sepsis Definitions Conference [10]; (4) chest radiographs, upper gastrointestinal (GI) studies, and abdominal computed tomography (CT) scan; and (5) the diagnosis made by the attending team and all treatments initiated. Diagnosis was deemed incorrect when IAS was not initially considered by the attending team. The interval between S0 and R1 was determined.

Microbiologic Features of Peritonitis The type and susceptibility of the microorganisms cultured from peritoneal fluid and positive blood cultures collected during the 24 h preceding and after reoperation were analyzed.

ICU Outcome

The type and duration of empirical antibiotic therapy (monotherapy or combination therapy) prescribed at the time of R1 and antibiotic therapy decided on susceptibility testing and identification were recorded. Antibiotic therapy was deemed adequate when it targeted all microorganisms cultured from peritoneal fluid and inadequate when at least one organism was not treated (except for yeasts). Number of reoperations, nosocomial infections, duration of mechanical ventilation, and need for vasoactive and renal support were recorded. ICU length of stay, ICU mortality, and causes of death were collected.

Statistical Analysis

Quantitative values were expressed as median and quartiles (25th–75th percentiles) and were compared between survivors and deceased patients using the Mann–Whitney test. Qualitative data were expressed as percentages and were

Table 1 Characteristics of the initial bariatric surgery and severity of the patients according to referring center

	Transferred patients (n=18)	Nontransferred patients (n=9)
Previous bariatric surgery (n)	8	2
Initial bariatric surgery (S0)		
Gastroplasty	10	3
Bypass	7	5
Other	1 sleeve gastrectomy	1 biliopancreatic diversion
Laparoscopic procedures, n, %	9 (50%)	8 (89%)
Surgery wound class (n)		
Clean	6	2
Clean–contaminated	5	6
Contaminated	5	1
Septic	2	0
SAPS II	54 (33–71)	36 (15–55)
APACHE II	26 (18–32)	20 (13–25)
SOFA	9 (4–12)	4 (1–9)
Delay between S0 and reoperation (R1), days	10.5 (7–16)	7 (4–11)
Number of deceased patients	7	2

Values are expressed as median (25th–75th percentiles).
BMI: body mass index, *SAPS II*: Simplified Acute Physiologic Score II, *APACHE II*: Acute Physiology and Chronic Health Evaluation System, *SOFA*: Sequential Organ Failure Assessment.

compared by chi-square test or Fisher's exact test. A p value <0.05 was considered significant. All analyses were performed using the Statview software package (version 5.0; SAS Institute, Cary, NC, USA).

Results

Demographics on Admission to ICU

From January 2001 to August 2006, 27 patients with IAS after bariatric surgery were admitted to our ICU. Table 1 displays the characteristics of the initial bariatric surgery (S0), 18 (69%) of which were performed in other institutions. Ten patients (37%) had a previous bariatric procedure and underwent a revision or conversion to RYGB, most commonly for failed or complicated adjustable gastric banding. Demographic data and disease severity scores calculated within 24 h after ICU admission are presented in Table 2. During the study period, 528 adjustable gastric bandings, 480 RYGB, and 20 sleeve gastrectomies were performed at our institution with a mortality rate of 0% for gastric banding and sleeve gastrectomies, and 0.004% for RYGB.

Table 2 Demographic data on admission to ICU according to prognosis

	All patients (n=27)	Alive (n=18)	Deceased (n=9)	P value
Age (years)	45 (37–52)	39 (36–45)	48 (45–53)	0.09
Sex ratio M/F	6/21	5/13	1/8	
BMI (kg/m^2)	47 (40–55)	45 (40–48)	57 (51–61)	0.005
Comorbidities	1 (0–3)	1 (0–3)	3 (1–3)	0.21
Hypertension (n)	12	5	7	
Diabetes (n)	9	5	4	
Respiratory disease including sleep disordered breathing (n)	13	7	6	
Other (n)	2	2	0	
SAPS II	47 (31–63)	34 (16–54)	70 (53–81)	0.001
APACHE II	23 (17–31)	18 (13–26)	32 (26–35)	0.001
SOFA	9 (3–11)	4 (2–9)	13 (10–17)	0.0004

Values are expressed as median (25th–75th percentiles).
BMI: body mass index, *SAPS II*: Simplified Acute Physiologic Score II, *APACHE II*: Acute Physiology and Chronic Health Evaluation System, *SOFA*: Sequential Organ Failure Assessment.

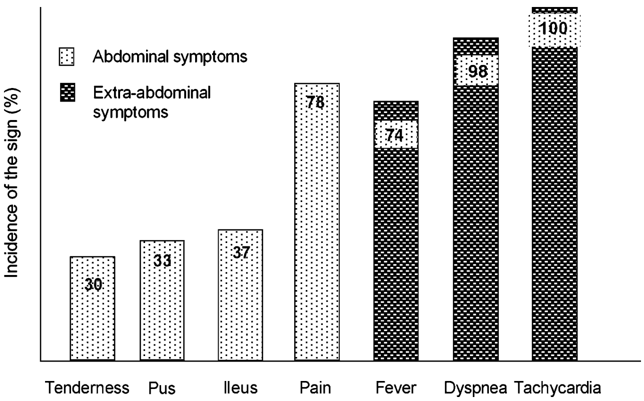

Fig. 1 Physical signs recorded during the postoperative course after bariatric surgery

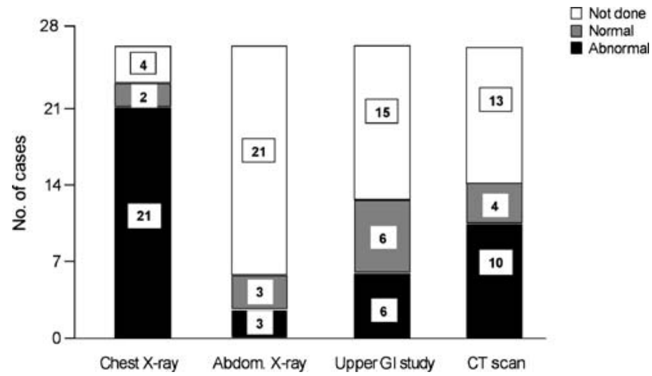

Fig. 2 Radiologic studies performed after bariatric surgery

Initial Management of IAS

After S0, 8 of the 18 transferred patients were initially discharged home and were subsequently rehospitalized for postoperative complications. The other patients remained hospitalized, eight of whom were admitted to the ICU. Physical signs collected between S0 and R1 are shown in Fig. 1. The site of abdominal pain was frequently left-sided or epigastric (n=17) and diffuse in only four patients. A total of 13 patients (48%) presented early features of SIRS (within 48 h of index surgery), whereas abdominal pain was present in only 7 patients (26%) (Table 3). A higher percentage of patients subsequently developed SIRS, abdominal pain, and multiple organ failures, predominantly respiratory distress (PaO_2/FiO_2=190 mmHg [150–250]).

The details of the various radiologic studies are presented in Fig. 2. Chest radiograph revealed basal pulmonary atelectasis (n=10) and/or left-sided pleural effusion (n=12). Upper GI studies obtained in only 12 patients (44%) were reported as normal in 6 patients (50%). CT scan of the abdomen was performed in 14 patients (52%) at a median interval of 8 days (4–12) after S0 and was reported to be normal in 4 patients who suffered from generalized (n=2) and localized (n=2) IAS. Abnormal CT scan revealed subphrenic collections (n=7), supramesocolic collections (n=2), and small bowel obstruction (n=1). CT scan was not performed in 13 patients (48%) because the diagnosis of IAS was not raised by the attending physicians and/or because some patients exceeded the weight limitation of the CT scan table.

The attending teams made a diagnosis of IAS in less than 50% (12/27) of the patients and more frequently proposed the diagnoses of pneumonia (n=7), pulmonary embolism (n=4), wound abscess (n=2), and bowel obstruction (n=2). Accordingly, 13 patients (48%) were reoperated for IAS (n=12) and obstruction (n=1), a median of 8 days (7–11) after S0. Patients with an incorrect diagnosis were initially treated by antimicrobial therapy (n=9), pleural drainage (n=3), mechanical ventilation (n=2), and were finally reoperated after a median of 11 days (5–16) (Table 4).

Perioperative Findings

At relaparotomy, the source of infection was a perforation (n=15), a suture dehiscence (n=11), and purulent material with no anatomic cause (n=1). Of the 11 leaks, 9 (82%) were situated at the gastrojejunal anastomosis and the

Table 3 Postoperative time-course of SIRS, abdominal pain, and organ failures after initial bariatric surgery (S0)

	48 h after S0, n=27; n (%)	<2–7 days after S0, n=26; n (%)	≥7 days after S0, n=17; n (%)
SIRS	13 (48)	18 (69)	17 (100)
Abdominal pain	7 (26)	14 (54)	14 (82)
Respiratory failure	4 (15)	12 (46)	11 (65)
Ventilation required	1 (4)	6 (23)	6 (35)
Septic shock	0 (0)	4 (15)	5 (29)
Renal failure	3 (11)	4 (15)	6 (35)
Encephalopathy	2 (7)	5 (19)	5 (29)
Coma	0 (0)	2 (8)	3 (18)
Hepatic failure	0 (0)	2 (2)	0 (0)
Thrombocytopenia	0 (0)	0 (0)	0 (0)

Table 4 Organ failures and severe events before reoperation and during ICU stay

	All patients (*n*=27)		Alive (*n*=18)		Deceased (*n*=9)	
	N	%	*N*	%	*N*	%
Severe events within 48 h before reoperation						
Severe respiratory distress requiring ventilation*	9	33	3	16	6	66
Septic shock requiring vasoactive drugs*	6	22	1	5	5	55
Multiple organ failure*	3	11	0	0	3	33
Resuscitated cardiac arrest	2	7	0	0	2	22
Severe events acquired during ICU stay						
Pneumonia	9	33	6	33	3	33
Septic shock requiring vasoactive drugs*	11	41	3	16	8	89
Reoperation for persistent abdominal sepsis*	11	41	6	33	5	56
Resuscitated cardiac arrest	2	7	1	5	1	11
Other (PE, hemorrhage, seizure, peripheral neuropathy)	4	14	2	11	2	22

ICU: intensive care unit, *PE*; pulmonary embolism.
*$p<0.05$ by chi-square test.

other 2 were situated at the jejunojejunal anastomosis. IAS was localized in 17 cases and generalized in the remaining cases. Sixteen patients had been receiving antimicrobial therapy for 4.5 days (1–7) before reoperation. Operative intraabdominal microbiologic specimens were obtained for each patient and a total of 58 organisms were isolated from 25 samples (sterile isolates in 2 patients preoperatively treated with broad-spectrum antibiotics, Table 5). The median number of organisms per patients was 2 [1–3]. Among the staphylococcal strains, one methicillin-susceptible *S. aureus* and four methicillin-resistant coagulase-negative *Staphylococcus* strains were cultured. Nine yeasts were isolated, including *Candida albicans* (*n*=7), *C. glabrata* (*n*=1), and *C. tropicalis* (*n*=1).

The empirical antibiotic therapy prescribed at R1 in the 27 patients was monotherapy (*n*=6), two-agent therapy (*n*=8), or a combination of three or more agents (*n*=13). Piperacillin/tazobactam (*n*=22) was the agent most frequently prescribed. Adequate empirical treatment was obtained in all but three patients (methicillin-resistant coagulase-negative *Staphylococcus* (*n*=2) and *P. aeruginosa*) who had received antibiotic therapy between S0 and R1. After identification and susceptibility testing, adequate antibiotic therapy was achieved in all cases, and piperacillin/tazobactam (*n*=16) was the agent most frequently prescribed.

ICU Outcome

The ICU mortality rate was 33% with a higher mortality in more severely obese patients (BMI>50 kg/m^2). After S0, the frequency of clinical signs suggestive of IAS (SIRS and abdominal signs) did not differ between deceased patients and survivors. The time to a correct diagnosis of IAS was

Table 5 Microbiologic results obtained from culture of peritoneal fluids and blood cultures

	Peritoneal fluid	Blood cultures
Gram-positive isolates		
Streptococcus spp./*Enterococcus* spp.	19/1	2
Staphylococcus spp.	5	–
Corynebacteria spp.	2	–
Gram-negative isolates		
Escherichia coli	6	1
Klebsiella spp.	2	–
Morganella spp.	2	–
Enterobacter spp.	2	–
Proteus spp.	2	–
Pseudomonas aeruginosa	1	–
Anaerobes	7	–
Yeasts	9	1
Total	58	4

not statistically associated with mortality, as the median interval between S0 and R1 was 7 days (4–10) in deceased patients and 11 days (7–16) in survivors (p=0.1). A crucial factor for patient survival was the presence of organ failures after relaparotomy (Table 2). No mortality was observed among patients with one organ failure (SOFA = 3). Mortality rate was 11% in patients with two or three organ failures (SOFA ≤9) and increased to 50% for patients with four organ failures (SOFA ≤12) and 100% for patients with five or more organ failures (SOFA ≥15). The extent of IAS was also relevant to prognosis, as localized IAS was associated with a better outcome than generalized IAS (p=0.03).

Definitive operative resolution was achieved at initial reoperation in 16 patients (59%) with a mortality rate of 25% compared to a 45% mortality rate in patients who required additional reoperation. The median number of reoperations was higher in deceased patients than in survivors (2 [0–4] vs 0 [0–1], p=0.05). Deaths were attributed to persistent IAS (n=7), stroke with cerebral death (n=1), and acute hemorrhage (n=1). The median duration of antibiotics (10 days [7–15]), catecholamines (4 days [2–11]), mechanical ventilation (6 days [1–16]), and ICU length of stay (11 days [5–23]) were similar in deceased patients and survivors.

Discussion

This study emphasizes the severity of IAS after bariatric surgery, especially for patients with multiple organ failures. To our knowledge, there are no data in the bariatric surgery literature with which this high mortality rate can be compared. The observational nature of this study might be considered to be a weakness, and we cannot rule out the possibility that additional information may have been missed with this design. The study was also limited by the small number of heterogeneous patients mostly referred from other institutions, as this cohort illustrates the marked variability of surgical and institutional expertise for bariatric surgery among centers.

Anastomotic leaks are considered to be one of the most life-threatening complications [11]. Predictors of mortality were defined by Fernandez et al. based on a series of 3,073 RYGB, and include male gender, age, weight, and obstructive sleep apnea [12]. In the light of these results, the authors cautioned surgeons against operating on such patients early in their learning curve. Anastomotic leaks may occur in up to 5.6% of cases, making these events a more common postoperative complication than pulmonary embolism [5]. This issue was recently confirmed in an analysis of 107 autopsies, which examined the mechanisms and immediate causes of deaths after bariatric surgery [13]. Goldfeder et al. reported that 97 deaths were because of complications of surgery with anastomotic leakage (36%) as the leading cause of death, whereas pulmonary embolism accounted for only 13% of deaths.

Postoperative IAS after bariatric surgery appears to be difficult to detect and clinical signs can often be misleading [14]. In our series, respiratory distress and tachycardia were much more frequent than abdominal signs. The nonspecific early clinical features of IAS therefore led to a wrong diagnosis by the attending teams in more than one half of the patients. The predominance of respiratory signs over abdominal signs guided the initial diagnosis toward pleural or pulmonary diseases. Hamilton et al. previously reported that tachycardia >120 bpm and respiratory distress were the most sensitive indicators of gastrointestinal leakage after RYGB [6]. However, the authors noted that these clinical signs had a low sensitivity, as only 20% of their patients experienced an anastomosis leakage. The reasons for the low sensitivity of physical examination in morbidly obese patients remain unclear and might be related to many issues such as the large mass of the subcutaneous tissue of the abdomen, the subphrenic site of intraperitoneal sepsis, or the postoperative nature of the peritonitis.

Radiographic imaging techniques are highly recommended in the decision-making process for patients suspected of having postoperative peritonitis [15]. In a recent study, Madan et al. noted that routine upper GI studies after RYGB were more predictive of an early leak diagnosis than clinical signs [16]. In this study, positive and negative predictive values of leak using upper GI studies on postoperative day 1 were 67% and 99%, respectively. This practice also applies to each patient operated on in our institution. To the best of our knowledge, no study has ever assessed the specificity and sensitivity of CT scan in the diagnosis of complicated bariatric surgery. This point is of major importance and could be linked to some limitations in the use of imaging procedures encountered in this population: patients exceeding the weight limit of CT scan systems, contrast load, and radiologist experience…. All these issues might explain the low rate of imaging procedures carried out in our series.

Some authors have reported that obesity is an independent risk factor for death among critically ill patients [17, 18]. Obese patients undergoing surgery seem to be more susceptible than nonobese patients to postoperative complications, such as wound infections, acute respiratory distress, and multiple organ failure [19]. Recently, Nasraway et al. reported a 33% mortality rate in surgical obese (BMI ≥40 kg/m^2) critically ill patients who required prolonged ICU stay [20]. The authors suggested that the underlying comorbidities together with the practical difficulties involved in caring for obese patients in ICU could contribute to decreased survival during ICU stay.

Few studies have addressed the issue of outcome of obese patients requiring ICU resources after bariatric surgery. In a retrospective study conducted in 485 patients undergoing bariatric surgery, Helling et al. noted that one half of the patients required ICU care for >24 h [21]. A BMI > 60 kg/m^2 and the need for reoperation were independent factors involved in the need for ICU admission and prolonged mechanical ventilation. However, ICU mortality was not reported in this study. Similarly, Cendan et al. reported a 19% ICU admission rate for both urgent and scheduled reasons [22]. The authors noted a 2.9% mortality rate, related to anastomotic and pulmonary complications. Mortality was higher among patients undergoing revision surgery (6.5%) but remained far below the death rate reported in this study.

It is established in the literature from nonobese patients that delayed surgery is associated with increased organ dysfunction and mortality [23, 24]. The factors contributing to delayed surgery have been identified for a long time and apply to our study: failure to recognize the disease, course of watchful expectancy, reluctance to proceed with surgical procedures until confirmation of the diagnosis, and finally patient "too sick" to undergo surgery [25]. The number of patients in our study was too small to demonstrate a significant influence of the time to reoperation on prognosis. When IAS is suspected, standard practice should continue to be relaparotomy or laparoscopy within the first 48 h, at least before the onset of multiple organ dysfunction syndromes [26]. This issue was recently stressed by Gonzales et al. who reported a mortality rate as low as 6% for anastomotic leaks after RYGB [11]. In this study, performed in four high volume academic centers, the vast majority of patients had no organ failure and leaks were detected early (<48 h) after the index surgery, even before the onset of any clinical symptoms [11].

In summary, this observational study suggests that IAS requiring ICU after surgical revision after bariatric surgery is associated with high mortality, possibly related to delayed diagnosis with reoperation at the time of organ dysfunction. Earlier recognition of organ dysfunction may result in earlier diagnosis and operative treatment, and reduce this excessive mortality. Therefore, standard practice should include an early laparoscopy if possible. As described elsewhere, physical examination of the abdomen in obese patients is an unreliable tool for identifying surgical complications. In the presence of respiratory signs, a high level of suspicion of IAS should be kept in mind and prompt a diagnostic work-up including radiologic evaluation of the abdomen, followed by surgical exploration.

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