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ORIGINAL CONTRIBUTIONS

Multidisciplinary Management of Leaks After One-Anastomosis Gastric Bypass in a Single-Center Series of 2780 Consecutive Patients

Arnaud Liagre[1] · Michel Queralto[2] · Gildas Juglard[1] · Yves Anduze[1] · Antonio Iannelli[3,4,5] · Francesco Martini[6]

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Abstract

Purpose Few data exist in the literature concerning leaks after one-anastomosis gastric bypass (OAGB). Our aim was to describe the incidence, presentation, and management of leaks after OAGB.

Setting A private clinic in France.

Methods Between May 2010 and December 2017, 2780 consecutive patients underwent OAGB. A retrospective chart review was performed on the 46 patients (1.7%) who experienced postoperative leaks.

Results Leaks arose from the anastomosis in 6 cases (13%) and from the gastric pouch in 27 cases (59%), while the remaining 13 patients (28%) had leaks from an undetermined origin. Management followed a standardized algorithm taking into consideration the clinical situation and findings on an oral contrast computed tomography (CT) scan. All patients were treated by fasting, total parenteral nutrition, and antimicrobial therapy. Nine patients (20%) could be managed by medical treatment only, 13 patients (28%) underwent laparoscopic management (washout and drainage plus T-tube placement in 5 cases or conversion to Roux-en-Y gastric bypass (RYGB) in one case). The remaining 23 patients (50%) were managed by percutaneous drainage and/or endoscopy. No mortality was observed; the major morbidity rate was 20%. The median length of a hospital stay was 17 days (5–80).

Conclusion Management of leaks after OAGB depends on clinical conditions and presence, size, and location of an abscess and/or a fistula. If endoscopy and interventional radiology are available, reoperation can be avoided in most patients. In most leaks at the gastrojejunal anastomosis, inserting a T-tube in the leak orifice avoids the necessity for conversion to RYGB.

Keywords One-anastomosis gastric bypass · Leak · Multidisciplinary management · Surgical treatment · Percutaneous drainage · Endoscopic drainage

Introduction

Laparoscopic one-anastomosis gastric bypass (OAGB) is gaining popularity worldwide because of its technical simplicity and its efficacy on both weight loss and the improvement and resolution of comorbidities [1–4].

Among postoperative complications of bariatric surgery, the occurrence of a leak is a dreaded event carrying a high

✉ Francesco Martini
framartini77@hotmail.com

Arnaud Liagre
arnaud.liagre@orange.fr

Michel Queralto
michel.queralto@wanadoo.fr

Gildas Juglard
drjuglard@orange.fr

Yves Anduze
anduze.yves@wanadoo.fr

Antonio Iannelli
iannelli.a@chu-nice.fr

[1] Digestive and Bariatric Surgery Unit, Clinique des Cedres, Cornebarrieu, France

[2] Gastrointestinal Endoscopy Unit, Clinique des Cedres, Cornebarrieu, France

[3] Université Côte d'Azur, Nice, France

[4] Digestive Surgery and Liver Transplantation Unit, Archet 2 Hospital, Centre Hospitalier Universitaire de Nice, Nice, France

[5] Inserm, U1065, Team 8 "Hepatic complications of obesity", Nice, France

[6] Digestive and Bariatric Surgery Unit, Hôpital Joseph Ducuing, 15 Rue Varsovie, 31027 Toulouse, France

morbidity. The incidence of leaks after OAGB in the literature is reported to be very low, varying between 0.1% and 1.5% [5–12], which is comparable to incidence rates after Roux-en-Y gastric bypass (RYGB, 0.1–5.6%) or sleeve gastrectomy (SG, 0–7%) [13, 14]. A recent study on a large cohort of > 150,000 patients showed leak rates of 0.45% for RYGB and 0.26% for SG [15]. The low incidence rate of leaks after OAGB could explain why the literature concerning the presentation and management of this life-threatening complication is so scanty, in comparison to other bariatric procedures. In most cases, leakages arise from the gastrojejunal anastomosis (GJA) or gastric tube (GT). Nevertheless, leaks from other localities have been reported such as the remnant stomach, afferent or efferent limbs, and colon [5, 7, 10]. Moreover, the series by Genser et al. reported that 57% of leaks were of undetermined origin even after surgical exploration [7].

The main series of OAGB reported data concerning postoperative leaks are presented in Table 1.

The main physiologic features of OAGB in comparison to RYGB and SG are the following: the presence of bile in the afferent limb, a low pressure in the GT (as opposed to the SG in which the pylorus when closed increases the intraluminal pressure), a good vascular supply to the GT and the GJA due to the relatively tension-free GJA, and the absence of mesenteric interruption.

The higher flow of bilio-pancreatic juice passing through the GJA in the OAGB as compared to the RYGB (in which this juice is excluded from the GT and GJA by the Roux-en-Y loop) is responsible for the potential severity of peritonitis when there is a leak and explains the aggressive attitude usually adopted by surgeons in this situation, with reoperation rates of 90–100% reported in the three main series addressing this issue [5, 7, 10] and with the study by Beaupel et al. [5] strongly supporting the conversion to RYGB.

We considered that an aggressive surgical intervention was not justified in all patients and therefore developed a specific multidisciplinary algorithm for the management of patients with OAGB presenting with potential leaks after surgery, including digestive endoscopy and interventional radiology.

The aims of the present study were to report the incidence and presentation of leaks after OAGB in a large monocentric series and to analyze the specific management according to our multidisciplinary standardized algorithm.

Methods

Patients

Between May 2010 and December 2017, 2780 consecutive patients underwent laparoscopic OAGB at the digestive surgery department of a private clinic, the Clinique des Cedres in Cornebarrieu, France. There were 2454 primary OAGB (88%) and 326 revisional procedures (12%). Revisional OAGB followed the failure of adjustable gastric banding (AGB) in 233 cases, SG in 63 cases, and vertical banded gastrectomy (VBG) in 22 cases. A previous fundoplication was present in 8 other cases. Written and oral information on immediate and long-term complications of OAGB including leaks were provided to all patients before surgery. Patients were also instructed to contact freely and reach the emergency department (ER) quickly if specific symptoms appeared.

All patients were entered into a prospectively maintained database that was retrospectively queried for the purpose of the present study.

Surgical Technique for Primary and Revisional OAGB

All procedures were performed laparoscopically by the same surgeon (AL) using a standardized surgical technique.

The patient was placed in a modified lithotomy position with the surgeon standing between the patient's legs (French position), and the only assistant on the left side. Five trocars were normally used. The first step involved the dissection of the His angle. Then, the lesser sac was entered close to the gastric wall just proximal to the crow's foot and the stomach was divided horizontally with an endoscopic stapler (Echelon Flex, Ethicon Endosurgery, Cincinnati, OH, USA) loaded with one 60-mm blue or gold cartridge. A long narrow gastric pouch was fashioned over a 36-Fr calibration tube by 3 to 5 consecutive 60-mm firings toward the His angle. The choice of the cartridge height varied from blue to green in relation to the thickness of the stomach as estimated by the operating surgeon. The staple line was not reinforced. In patients with central obesity, the omentum was divided vertically. A 150-cm jejunal loop was measured from the ligament of Treitz using marked graspers, and an antecolic side-to-side gastrojejunostomy was fashioned using a 60-mm linear stapler, white cartridge. The stapler opening was closed with two resorbable running sutures using 3/0 Vicryl (Ethicon Inc., Cornelia, GA, USA). A methylene blue dye test was routinely performed. The Petersen space was not closed. One or two peritoneal drains were placed between the left hepatic lobe and the GT and/or behind the GJA in case of revisional surgery or perioperative difficulties. Drains were usually removed before discharge.

In patients with AGB, band removal was performed simultaneously in 72 cases (31%). The remaining 161 procedures (69%) were performed in two stages with a median interval between the two operations of 7 months (range 2–50). The decision to do the procedure in two stages was taken by the operating surgeon at the time of band removal.

In a conversion from SG, a vertical resizing over a 36-Fr calibration boogie was performed because of sleeve dilation in 62 out of 63 patients.

Table 1 Main series reporting data concerning leaks after OAGB

Authors, year (Country)	Number of patients	Leaks	Time to diagnosis (days)*	Previous surgery	Leak site				Leak management	Further invasive treatment	Mortality for leaks	Hospital stay (days)*
					Identified			ND				
					Anast	Pouch	Other					
Rutledge et al.2005 (USA) [12]	2410	26 (1.1%)	NR	NR	NR	NR	NR	NR	Lap repair	NR	NR	NR
Noun et al. 2012 (Lebanon) [11]	1000	7 (0.7%)	NR	3 (AGB or VBG)	0	5 (71%)	2 (29%) remn stom	0	5 conservative tx 1 conversion RYGB 1 suture and drainage	NR	0	NR
Lee et al. 2012 (Taiwan) [9]	1163	15 (1.3%)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Kular et al. 2014 (India) [8]	1054	2 (0.1%)	NR	NR	NR	NR	NR	NR	Lap repair	NR	NR	NR
Genser et al. 2016 (France) [7]	2321	35 (1.5%)	9 (0–28)	17 AGB	4 (11%)	11 (31%)	0	20 (57%)	Suture and omentoplasty if leak identified + irrigation-aspiration drainage with lactic acid (94% laparoscopy)	10 second look 2 endoscopic stents 1 pleural drainage	0	19 (11–45)
Musella et al. 2017 (Italy) Multicenter [10]	2678	21 (0.8%)	NR	4 procedures not specified	5 (24%)	8 (38%)	8 (38%) 2 remn stom 6 small bow	0	2 conservative tx, 19 surgery 89% laparoscopy (13 repair, 2 RYGB, 1 reversal, 2 Braun, 1 fundus resection)	2 second look by laparotomy	2 (10%)	NR
Carbajo et al. 2017 (Spain) [6]	1200	13 (1%)	NR	NR	NR	NR	NR	NR	10 conservative tx, 3 reoperation (2 laparotomies)	3 endosc stents 1 radiol stent	0	NR
Beaupel et al. 2017 (France) [5]	1430	10 (0.7%) + 7 other centers	4 (1–28)	5 AGB	7 (41%)	3 (18%)	6 (35%) 1 remn stom 2 colon 3 biliary limb	1 (6%)	16 reoperations (69% open): suture or anast refection or T-tube + conv RYGB 6 cases	1 second look 4 percut drainage 2 endosc drainage	0	25 (11–125)
Present series	2780	46 (1.7%)	10 (1–42)	10 AGB 2 VBG 1 fundopl	6 (13%)	27 (59%)	0	13 (28%)	10 conservative tx 18 percut drainage 9 endoscopy 7 lap drainage 5 lap T-tube 1 lap conversion RYGB	3 percut drainage 2 endoscopy 5 percut drainage of pleural effusion 1 left thoracotomy	0	17 (5–80)

*Values are expressed as median with range

OAGB: one anastomosis gastric bypass; NR: not reported; ND: not determined; AGB: adjustable gastric banding; VBG: vertical banded gastroplasty; RYGB: Roux-en-Y gastric bypass

For a conversion from a VBG (a laparotomic non-divided Mason in all cases), the lesser sac was entered just proximal to the band. The gastric pouch was then fashioned, taking care to divide the stomach medially to the previous staple line in order to avoid the creation of a blind segment of the stomach between the two staple lines. A gastrectomy including a variable amount of the remnant stomach was performed to remove the previously stapled stomach, and the operative specimen was always inspected to identify the vertical staple line of the VBG at the end of the procedure.

When a fundoplication was present, the wrap was systematically taken down from right to left and the gastric fundus resected.

Definitions of Leak, Sepsis, Septic Shock, and Clinical Stability

A leak was defined as an extravasation of gastrointestinal content in the peritoneal cavity. A diagnosis was confirmed by oral contrast computed tomography (OC CT) scan and/or endoscopic findings and/or intraoperative findings. When an intraabdominal collection was found but the origin of the leak could not be clearly identified, patients were considered to present a leak of undetermined origin.

Sepsis and septic shock were defined according to the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) [16].

Patients were defined as clinically stable in the absence of sepsis.

Initial Assessment of the Patients and Medical Management

Where there was a suspicion of a leak, a clinical examination, standard blood tests, and an OC CT scan were performed systematically.

Where there was sepsis, an appropriate resuscitation was performed with hospitalization in the intensive care unit (ICU).

After the diagnosis of a leak, all patients received a medical treatment consisting of fasting, total parenteral nutrition, and empirical antimicrobial therapy by beta-lactam/beta-lactamase inhibitor plus aminoglycoside antibiotics, which was adapted on the basis of cultural bacteriological swabs whenever available. In case of sepsis, an antifungal therapy (fluconazole or caspofungin) was associated.

Classification of Patients According to Clinical and Radiologic Features

The decision to manage a leak was taken after considering the clinical conditions and findings on the OC CT scan, according to the algorithm shown in Fig. 1.

The patients in the cohort were then divided into four groups:

A) Sepsis and/or radiologic signs of diffuse peritonitis
B) Clinical stability with a large abscess (diameter between 3 and 10 cm) with or without the origin of the leak identified at the CT scan
C) Clinical stability with a small abscess (diameter < 3 cm) with or without the origin of the leak identified at the CT scan
D) Clinical stability with a leak well exteriorized through the abdominal drain and no abscess at the CT scan

Medical Treatment Alone

A medical treatment alone was attempted when the CT scan showed an abscess <3 cm in diameter (with or without the origin of the leak identified) or a well-drained leak through a surgical drain (no intraabdominal collection) with a low output (< 50 cc/24 h).

Where a small deep collection was present, a second CT scan was usually performed 3–4 days after the first one in order to assess the evolution. If the diameter of the collection increased, management was the same as for abscesses with a diameter > 3 cm (i.e., percutaneous or laparoscopic drainage eventually associated with endoscopic management).

Where there was a well-drained leak with a low output, endoscopic management was performed if the leak persisted for more than 10 days.

Surgical and Radiologic Management

Where there was sepsis and/or radiologic signs of diffuse peritonitis, an emergency laparoscopic exploration was carried out. When the site of leakage was not clearly identified, a methylene blue dye test was performed. A thorough peritoneal washing with the systematic placement of one or more aspiration drainages was carried out. If a leak was found at the anterior aspect of the GJA, a T-tube (9 to 14-Fr gauge according to the size of the orifice) was inserted in the leak and fixed with absorbable sutures on each side. If the leak was found on the posterior aspect of the anastomosis, a conversion to RYGB was performed. A stapler was fired to divide the biliary limb proximal to the GJA, a 70-cm alimentary limb was measured from the GJA, and a side-to-side semi-mechanical jejuno-jejunostomy was fashioned in order to create a Roux-en-Y loop.

When the patient did not present sepsis or diffuse peritonitis on a CT scan, all deep abdominal collections >3 cm underwent CT scan–guided percutaneous drainage or laparoscopic drainage according to their accessibility. In some cases, an irrigation–aspiration system was placed. An endoscopic management of leaks was eventually associated.

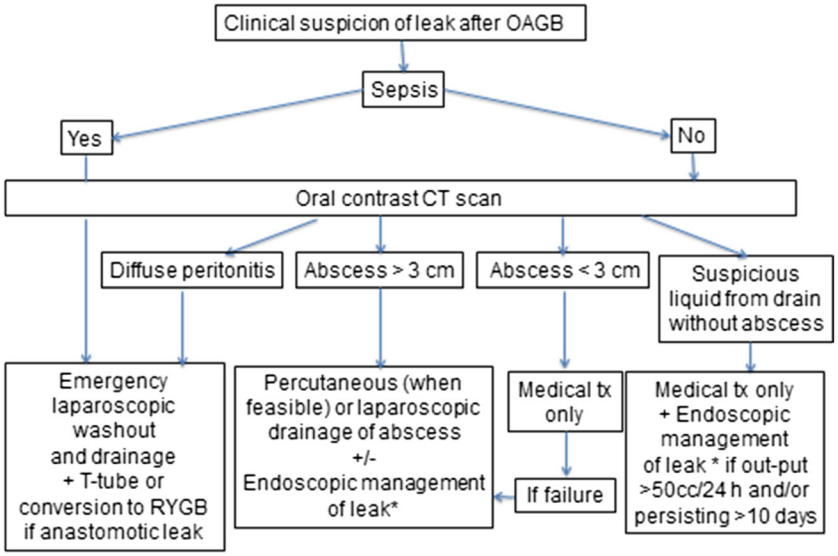

Fig. 1 Algorithm for management of leaks after OAGB

*Double pigtail drain(s) or T-tube according to leak size and presence of an abdominal drain. All patients received a medical treatment consisting in fasting, total parenteral nutrition, and antimicrobial therapy. OAGB one-anastomosis gastric bypass, RYGB Roux-en-Y gastric bypass, CT computed tomography.

Endoscopic Management

Endoscopic management of leaks was performed in the following three situations: the failure of medical treatment alone, association to percutaneous drainage of a large abscess with a leak orifice clearly identified on a CT scan, and the presence of digestive fluid leaking through the abdominal drain left in place after surgical exploration.

Where the leak orifice on the digestive side was < 1 cm in diameter, one double pigtail drain (DPD) was placed in order to obtain an intraluminal drainage of the collection.

For leaks >1 cm, usually following gastric staple line disruption at the esophagogastric junction (EGJ), a ^{covered} metallic stent was placed at the beginning of the experience (first 2 cases) but this policy was abandoned because of poor patient tolerance and the intraluminal drainage with multiple DPDs has become the option of choice.

DPDs (Wilson Cook, Bloomington, IN, USA) were 7 Fr in caliber and 5 or 7 cm in length depending on the size of the collection. When the collection was >5 cm in diameter, a nasobiliary drain was placed first into the cavity to provide continuous washing during the 10 days before placing the DPDs.

A particular situation was represented by a fistula tract directed to the skin by a surgical drain (gastrocutaneous fistula), with a leak orifice > 2 cm, therefore, at a high risk of migration for DPDs. For such cases, a new strategy was developed through using endoscopic intubation by a 14-Fr T-tube.

Endoscopic Placement of the T-tube

This technique included endoscopic diagnosis and localization of the leak orifice, anterograde or retrograde passage of a guidewire along the fistula path by using the surgical drain as a guide, fixation of a diathermic loop to the guidewire, progression of the diathermic loop from the stomach to the skin orifice, fixation of the T-tube to the diathermic loop, and retrograde progression of the T-tube up to the stomach, where it was placed with the short arm inside the gastric lumen. The surgical drain used as a guide was removed at the end of the procedure.

Management of the T-tubes (Both Surgically and Endoscopically Placed)

The patient was allowed to drink water in order to wash the cavity of the abscess and the fistula path. In the case of endoscopic placement, a naso-cavitary drain was also positioned for continuous washing of the abscess cavity for 10 days. In the case where abdominal drains were present, they were removed when no residual purulent flow was observed. After 10 days, the T-tube was clamped and progressive oral feeding was started. Withdrawal was usually performed 30 days after discharge during an outpatient visit.

Definition of Morbidity Following Leak Management

Early morbidity after leak management was defined as any complication that occurred within 90 days from diagnosis. Complications were ranked using the Clavien–Dindo score [17]. Major early morbidity was defined as a grade > IIIa adverse event.

Statistical Analysis

Continuous data are reported as medians and ranges. Nominal data are expressed as numbers and percentages. Comparisons

were made using the χ^2 test for nominal data or Mann–Whitney test for continuous data. A P value ≤ 0.05 was considered to be statistically significant. All statistical analyses were performed using IBM SPSS software version 20.

Results

Patients' Characteristics

During the 92-month study period, a total of 46 patients experienced postoperative leaks (1.7% of the entire cohort) and were included in the study. Follow-up data at 90 days after OAGB were available for the entire cohort. Clinical characteristics of patients and radiologic features are reported in Table 2.

Ten patients had a previous laparoscopic AGB, which had been removed at the same time as the OAGB in 4 cases and before OAGB in the remaining 6 cases at a median interval of 5 months (3–50). Two patients had a previous laparotomic non-divided Mason VBG, and one patient had a previous laparoscopic fundoplication. Patients with revisional surgery showed a significantly higher rate of leaks compared to patients without previous gastric surgery: 4% (13 leaks/326 cases) vs 1.3% (33 leaks/2454 cases) ($P = 0.0044$). When the type of primary procedure was taken into consideration, leak rates were as follows: 10/233 (4%) after conversion from AGB, 2/22 (9%) after conversion from non-divided Mason VBG, 0/63 (0%) after conversion from SG, and 1/8 (13%) after conversion from fundoplication.

Clinical Presentation of Leaks

Patients became symptomatic at a median delay of 10 days (1–42) after OAGB (Table 2). Symptoms appeared within 3 days from surgery in only 3 patients (7%) and within 1 week in 14 patients (30%). Thirty-eight patients (83%) had been discharged before the onset of symptoms, after an uneventful postoperative course during the primary hospital stay. The most common symptoms were fever, abdominal pain, tachycardia, and dysphagia. In 5 cases, a suspicious fluid through the drain left during OAGB was observed. Five patients (11%), all with leaks arising from the GJA, presented signs of sepsis and/or generalized peritonitis.

Sites of Leakage

Two types of leak could be identified: 6 patients (13% of the entire cohort) presented leaks arising from the GJA, while 27 patients (59%) presented leaks arising from the GT; in the remaining 13 cases (28%) with leaks, no origin was found and they were classified as leaks of undetermined origin. If we consider the 13 patients operated on for revisional OAGB, in 12 cases (92%), the leak arose at the upper part of the GT, near the EGJ and in only one case (after AGB) at the GJA.

Radiological Findings

Radiological findings are reproduced in Table 2. The OC CT scan confirmed a generalized peritonitis in 2 cases and allowed the identification of a deep abdominal collection in 40 cases. The sensitivity of the CT scan for detecting leaks was 70%, which is 23 out of 33 diagnosed leaks, and higher for leaks from the GT than from the GJA (22 out of 27 vs 1 out of 6, respectively). The remaining 10 leaks were identified during laparoscopic exploration in 5 cases (all leaks from GJA) and by endoscopy in 5 cases (all leaks from GT).

Management of Leaks in the Entire Cohort and According to Clinical and Radiologic Features

The management of leaks in the entire cohort and according to clinical and radiologic features is described in Table 3.

In 10 patients (22%), a medical treatment alone was effective.

Only 13 patients (28%) needed laparoscopic management. No conversion to laparotomy was required. All 5 patients with sepsis and/or radiologic signs of diffuse peritonitis underwent an emergency laparoscopic exploration. A leak from the GJA was identified in all cases. In 4 cases, the leak was found at the anterior aspect and was catheterized with a T-tube, while, in one case, the leak was found after a methylene blue dye test on the posterior aspect and a conversion to RYGB was performed. Eight patients underwent laparoscopic peritoneal washing and drainage for a large abscess, which was associated with T-tube placement in the case of a GJA leak.

The remaining 23 patients (50%) were managed by CT-guided percutaneous drainage and/or endoscopy.

The median length of the hospital stay and total time to healing for the entire cohort were 17 (5–80) days and 19 (5–160) days, respectively. Seven patients (15%) required hospitalization in the ICU. No secondary leak was observed and no chronic fistula developed. No mortality was observed; however, 9 patients (20%) experienced a grade > IIIa adverse event after initial management.

Management of Leaks According to the Site of Leakage

There was a significantly higher rate of surgical treatment in the group with leaks at the GJA in comparison to the groups with leaks at the GT and with leaks of undetermined origin (100% vs 19% vs 15%, respectively, $P = 0.001$). The median length of hospital stay was also significantly higher in this group (30 vs 18 vs 11 days, $P = 0.025$).

Table 2 Clinical characteristics, radiologic and/or surgical findings of patients presenting leaks after OAGB

	Entire cohort ($n = 46$)	Group A ($n = 5$)	Group B ($n = 26$)	Group C ($n = 11$)	Group D ($n = 4$)	P value
Male gender n (%)	7 (15%)	1	5	1	0	0.971
Age (years)*	45 (26–64)	49 (31–55)	43 (31–64)	48 (26–61)	46 (45–48)	0.822
Weight (kg)*	108 (89–156)	100 (93–133)	107 (89–156)	117 (91–147)	109 (89–156)	0.720
BMI (kg/m2)*	41.5 (31–55)	40 (36–45)	42 (31–50)	41 (36–55)	44 (39–46)	0.506
Previous gastric surgery n (%)	13 (28%)	0	9 (35%)	0	4 (100%)	**0.011**
AGB	*10*	–	*8*	–	*2*	
Laparotomic non-divided Mason VBG	*2*	–	–	–	*2*	
Sleeve	*0*	–	–	–	–	
Fundoplication	*1*	–	*1*	–	–	
Interval OAGB-leak diagnosis (days)	10 (1–42)	10 (1–11)	13 (3–30)	15 (6–42)	4 (2–8)	**0.007**
Discharge before diagnosis n (%)	38 (83%)	4 (80%)	24 (92%)	10 (91%)	0	**0.001**
Sepsis n (%)	5 (11%)	5 (100%)	0	0	0	1.260
Clinical presentation n (%)						
Generalized peritonitis	*2 (4%)*	*2 (40%)*	–	–	–	**0.030**
Fever	*27 (59%)*	*3 (60%)*	*19 (73%)*	*5 (45%)*	–	0.128
Abdominal pain	*26 (56%)*	*5 (100%)*	*16 (62%)*	*5 (45%)*	–	0.125
Dyspnea	*1 (2%)*	–	*1 (4%)*	–	–	0.290
Dysphagia	*6 (13%)*	–	*3 (12%)*	*2 (18%)*	*1 (25%)*	0.977
Suspicious liquid from surgical drain	*5 (11%)*	–	*1 (4%)*	–	*4 (100%)*	1.272
Tachycardia	*15 (33%)*	*3 (60%)*	*9 (35%)*	*1 (9%)*	*2 (50%)*	0.469
Findings at OC CT scan						
Generalized peritonitis (*n* (%)	*2 (4%)*	*2 (40%)*	*0*	*0*	*0*	**0.030**
Abscess n (%)	*40 (87%)*	*3 (60%)*	*26*	*11*	*0*	2.107
Subphrenic	*3*	–	*3*	–	–	
Subhepatic/intergastric	*37*	*3*	*23*	*11*	–	
Leak identified n (%)	*23 (50%)*	*1 (20%)*	*12 (75%)*	*8 (73%)*	*1 (25%)*	0.060
Anastomosis	*1*	*1*	–	–	–	
Gastric pouch	*22*	–	*12*	*8*	*1*	
Type of leak[#]						**0.001**
Anastomosis	*6 (13%)*	*5 (100%)*	*1 (4%)*	*0*	*0*	
Gastric pouch	*27 (59%)*	*0*	*15 (58%)*	*8 (73%)*	*4 (100%)*	
Undetermined origin	*13 (28%)*	*0*	*10 (38%)*	*3 (27%)*	*0*	

*Values are expressed as median with range

[#] Identified after OC CT scan plus eventual surgical exploration and/or endoscopy

Groups: A) sepsis and/or radiologic signs of diffuse peritonitis; B) clinical stability with a large abscess (diameter between 3 and 10 cm) with or without the origin of the leak identified at the CT scan; C) clinical stability with a small abscess (diameter < 3 cm) with or without the origin of the leak identified at the CT scan; D) Clinical stability with a leak well exteriorized through the abdominal drain and no abscess at the CT scan

OAGB one anastomosis gastric bypass, *BMI* body mass index, *GJA* gastrojejunal anastomosis, *AGB* adjustable gastric banding, *VBG* vertical banded gastroplasty, *OC CT* oral contrast computed tomography, *DVT* deep vein thrombosis

Discussion

The present study, reporting the outcome of the management of 46 leaks after OAGB, shows that surgical treatment is not mandatory as only 28% of patients required surgical exploration and non-surgical management was safe and effective in the remaining 72% of cases. Such a result could be obtained thanks to the availability of a multidisciplinary technical platform, which included ER, ICU, digestive endoscopy, and interventional radiology as well as an expert bariatric surgical team.

This study also provides evidence that in the case of a GJA leak, surgical management is mandatory but the strategy of directing the leak to the skin through a T-tube avoids the conversion to RYGB in patients with an anterior leak (5 out of 6 cases, in the present series).

To date, the management of leaks after OAGB has been specifically addressed by only two French single-

Table 3 Management of 46 patients presenting leaks after OAGB

	Entire cohort ($n = 46$)	Group A ($n = 5$)	Group B ($n = 26$)	Group C ($n = 11$)	Group D ($n = 4$)	*P* value
Primary management						
Medical only n (%)	10 (22%)	0	0	9 (82%)	1 (25%)	7.328
Laparoscopy n (%)	13 (28%)	5 (100%)	8 (31%)	0	0	**0.004**
Drainage	*7*	–	*7*	–	–	
Surgical T-tube	*5*	*4*	*1*	–	–	
Conversion RYGB	*1*	*1*	–	–	–	
Percutaneous drainage n (%)[§]	18 (39%)[§]	0	18 (69%)[§]	0	0	**0.001**
Endoscopy n (%)[§]	9 (20%)[§]	0	4 (15%)[§]	2 (18%)	3 (75%)	0.162
Double pigtail drain(s)	*5*	–	*2*	*2*	1	
Stent	*2*		*2*	–	–	
GJA balloon dilatation	*1*	–	–	–	1	
Endoscopic T-tube	*1*	–	–	–	1	
Further invasive procedures n (%)	9 (20%)	2 (40%)	7 (27%)	0	0	0.468
Second percutaneous drainage	*2*	–	*2*	–	–	
Endoscopy[#]	*2*[#]	–	*2*[#]	–	–	
Double pigtail drain(s)	*1*	–	*1*	–	–	
Endoscopic T-tube	*1*	–	*1*	–	–	
Percutaneous drainage of pleural effusion	*5*	*2*	*3*	–	–	
Left thoracotomy for pleural empyema following gastropleural fistula	*1*	–	*1*	–	–	
Transgluteal drainage of pelvic collection	*1*	*1*	–	–	–	
Medical complications n (%)	4 (9%)	0	4 (15%)	0	0	0.785
Pneumonia	*3*	–	*3*	–	–	
Pulmonary embolism from DVT	*1*	–	*1*	–	–	
Patients requiring ICU n (%)	7 (27%)	2 (40%)	5 (19%)	0	0	0.587
ICU (days)	5 (3–27)*	3, 15	3, 5, 5, 20 ,27	–	–	
Hospital stay (days)*	17 (5–80)	30 (11–50)	18 (5–80)	8 (5–18)	20 (8–31)	**0.018**
Time until healing (days)*	19 (5–160)	30 (19–50)	18 (5–160)	8 (5–30)	21 (8–60)	0.206
Development of chronic fistula n (%)	0	0	0	0	0	
Mortality n (%)	0	0	0	0	0	

[§] Combined management (percutaneous + endoscopic) in 4 cases (15%)

[#] In case of leak appeared after surgical exploration through an abdominal drain

*Values are expressed as median with range

Groups: A) sepsis and/or radiologic signs of diffuse peritonitis; B) clinical stability with a large abscess (diameter between 3 and 10 cm) with or without the origin of the leak identified at the CT scan; C) clinical stability with a small abscess (diameter < 3 cm) with or without the origin of the leak identified at the CT scan; D) clinical stability with a leak well exteriorized through the abdominal drain and no abscess at the CT scan

OAGB one anastomosis gastric bypass, *GJA* gastrojejunal anastomosis, *ICU* intensive care unit, *AGB* adjustable gastric banding, *VBG* vertical banded gastroplasty, *OC CT* oral contrast computed tomography, *RYGB* Roux-en-Y gastric bypass

center studies. A study by Genser et al. [7] reported 35 leaks with surgical treatment in all cases, consisting of laparoscopic peritoneal washing and drainage, associated to direct suture and omentoplasty when the leak site was identified. The study by Beaupel et al. [5] reported surgical management in 16 out of 17 cases, by laparotomy in 11 cases, with 6 emergency conversions to RYGB. In the analysis, a high rate of sepsis caused by diffuse peritonitis must be taken into account (13/17).

Similar to the abovementioned studies, the Italian multi-institutional survey by Musella et al. [10] reported 21 cases of leaks with surgical treatment in 19 cases (89% by laparoscopy).

Two single-center series by Carbajo et al. and by Noun et al. [6, 11] reported a different approach, with a medical treatment effective in 77% of patients (10/13) and 71% of patients (5/7), respectively. Their results were similar to those of the present series.

Two conditions are mandatory in the case where a conservative strategy is chosen for the management of a leak after OAGB. First, patients should be instructed to return to the hospital that performed the surgery as soon as possible after the onset of symptoms. Indeed, if the patient is assessed at the ER of an institution where no bariatric team is available, the eventual delay may compromise the success of conservative management. The second condition is that the choice of a conservative treatment should be made by an experienced bariatric team including a surgeon with extensive hands-on experience.

For the development of the leak management algorithm, several factors were considered: on the one side, we considered the patients' clinical conditions (presence of sepsis and stability) and OC CT scan findings (presence, size, and location of the collection and/or leak), and on the other side, we considered two important physiologic features of OAGB, which is the presence of bile in the afferent limb and low pressure in the GT, with the small bowel representing a preferential path for the leak to seep into.

First, we observed that cases presenting as surgical emergencies for sepsis were relatively rare (11% in our series) and, in the vast majority of cases, the management could be discussed together with the radiologist and the endoscopist on the basis of OC CT scan findings. Indeed, our series is in accordance with data reported by Kalff et al. indicating that, in stable patients, the CT scan can decrease the reoperation rates [18].

Second, we estimated that because of the low pressure in the GT, a simple drainage was sufficient to obtain the closure of leaks in most cases. Whenever possible, a percutaneous or endoscopic drainage was preferred because of the reduced invasiveness. In the case of a GJA leak located on the anterior aspect of the anastomosis, usually associated with diffuse peritonitis and sepsis, the management involved the insertion of a T-tube directly through the leaking orifice on the GJA [19]. The conversion to RYGB was reserved to the leaks situated on the posterior aspect of the GJA, therefore inaccessible to intubation.

Unlike other articles in the literature [5, 7], our study found a correlation between the presence and site of a leak and the gravity of the clinical situation. Patients with leaks arising from the GJA showed a significantly higher rate of surgical management as well as a significantly superior length of hospital stay. Simplifying at most leads to two "extreme" situations with the majority of patients placed in between. The first situation is the leak at the GJA: a relatively rare situation, with an acute clinical presentation of diffuse peritonitis and sepsis due to the spread of bilio-pancreatic secretions in the abdominal cavity. In this setting, an emergency surgical exploration is mandatory. On the opposite side of the gravity scale is the leak at the GT staple line, which is a more frequent situation, with a subacute clinical presentation and a good clinical tolerance by the patient; the bilio-pancreatic fluid remains confined to a closed space between the left hepatic lobe, the two gastric staple lines, and the lesser sac, developing an abscess. CT scan–guided percutaneous and/or endoscopic drainage are usually effective, with surgical exploration in cases of technical impossibility or failure.

Unfortunately, identifying the site of the leak is very often a complicated issue. A CT scan is reliable for detecting the location and size of fluid collections, but its sensitivity for detecting the origin of leakages is lower (70% in our series, similar to the data in the literature [18, 20]). The low sensitivity of the CT scan is not the only problem. In this study, we failed to find the site of the leak in 28% of cases, in two patients even after surgical exploration. In the paper by Genser et al. [7], the rate of leaks of undetermined origin was even higher, 57%. We can speculate that, in some cases, the leak exudes from a very small orifice with a low output, or the leak may have already closed at the time of surgical exploration. Moreover, in some cases (two patients in the present series), a leak of ischemic origin can appear or reactivate after surgical exploration through a peritoneal drain. Another possible explanation is that some abdominal collections are caused by the infection of a hematoma in the absence of any leak.

In the present study, revisional OAGB carried a significantly higher risk for staple leak at the EGJ, compared to primary OAGB (4% vs 1.3%). In detail, the increased risk concerned patients converted from AGB and VBG, and not those converted from SG; however, the low numbers do not allow any strong conclusion to be drawn. In the only other study addressing the issue, by Genser et al. [7], a failed AGB was not found to be a risk factor for leaks. Recently, Benois et al. [21] also found that, in the context of pouch resizing for a failed RYGB, a previous history of AGB favored the occurrence of a leak at the staple line.

A point that deserves particular attention is the progressive rise in endoscopic management as a consequence of its effectiveness and lower invasiveness. In fact, we performed an endoscopy in every stable patient when a leak is suspected. Like most bariatric centers in France, we consider DPDs as the reference for a leak after bariatric surgery < 1 cm in diameter because of their good efficacy and tolerability [22]. Concerning larger orifices, the management is still far from being standardized. The most common option is represented by the placement of a covered metallic stent, which is poorly tolerated by patients and accompanied by a high rate of complications, especially in the form of migration [23]. After some disappointing experiences at the beginning of our series, the use of metallic stents was abandoned and our tendency was to privilege transfistulary drainage by multiple DPDs, despite an augmentation in the risk of migration in parallel with the diameter of the leak. In the case of a leak with a large orifice, directed to the skin by a surgical drain, a new strategy was developed, involving the endoscopic intubation of the leak by a T-tube. Although only the results involving the use of the T-tube technique in the setting of OAGB are reported in this study, the use of this technique also yielded favorable results

in the management of gastrocutaneous fistulas complicating other bariatric procedures (RYGB, SG, SADI-S) in our hands.

The present study has several limitations including its single-center and retrospective study design with a small number of patients and the fact that the algorithm reported requires centers with a large experience and a multidisciplinary technical platform available full-time. However, bariatric surgery is becoming a distinct branch of digestive surgery with specialized surgeons but also anesthesiologists and endoscopists and patients with complications should be managed in high-volume third-level referral centers to obtain the best outcome.

Conclusion

Management of leaks after OAGB depends on the stability of clinical conditions and presence, size, and location of an abscess and/or a fistula. The use of a specific algorithm to manage these patients in a referral bariatric center proved to be safe and effective, allowing the management without surgery of 72% of cases with no mortality and a relatively low morbidity. Although all the leaks at the GJA require surgical management, inserting a T-tube in the leak orifice avoids the conversion to RYGB in all but the cases in which the leak is on the posterior aspect of the GJA and avoids the risk of secondary leaks.

Compliance with Ethical Standards

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

Statement of Human and Animal Rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statement of Informed Consent For this type of study formal consent is not required.

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