

Original article

Persistent gastric fistula after sleeve gastrectomy: an analysis of the time between discovery and reoperation

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Abstract

Background: Gastric leak (GL) represents one of the main early-onset postoperative complication of sleeve gastrectomy (SG). Most studies of GL featured short series and no data on the time to reoperation for persistent GL.

Objectives: Characterize the time between discovery of persistent post-SG GL and the implementation of reoperation.

Setting: University hospital, France, public practice.

Methods: All patients treated for post-SG GL between November 2004 and December 2013 were included. The primary efficacy criterion was the time interval between discovery of a persistent GL and reoperation. The secondary efficacy criteria were demographic, surgical, and endoscopic data; mortality rate; time to GL healing; treatment success rate; and risk factors for failure treatment.

Results: Eighty-six patients were treated for post-SG GL. Forty patients (46.5%) had early-onset GL (postoperative day ≤ 7). Two patients (2.3%) presented primary gastrobronchial fistula. Fifty-six patients (70%) underwent immediate reoperation. Endoscopic treatment was required to treat the GL in 92.7% of the cases ($n = 77$). The mortality rate was 1.2% ($n = 1$). The treatment success rate was 89.1%. The median time to healing GL was 84 days (14–423 d). Eighty percent of the GLs had healed 120 days after discovery. After 120 days, the incidence of complications related to GL increased and few additional GLs healed. The only identified risk factor for treatment failure was large retained gastric fundus ($P \leq .05$).

Conclusions: Most cases of GL can be adequately treated by incorporating endoscopic stenting. Surgery for persistent GL should be performed within 120 days of discovery; after this cut-off, the incidence of GL-related complications increases. Large retained gastric fundus is a risk factor for treatment failure and may prompt the surgeon to consider earlier reoperation. (Surg Obes Relat Dis 2016;12:84–93.) © 2016 American Society for Metabolic and Bariatric Surgery. All rights reserved.

Keywords:

Sleeve gastrectomy; Gastric leak; Persistent gastric leak; Double pigtail stent; Gastric covered stent; Roux-en-Y gastrojejunal anastomosis

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Along with postoperative hemorrhage, gastric leak (GL) is the main surgical postoperative complication of sleeve gastrectomy (SG). According to a recent meta-analysis, the incidence of this complication is 2.2% [1]. Early-onset and/

or poorly tolerated GLs may require further reoperation [2]. Ancillary treatment involves endoscopy, with implantation of a coated stent (CS) [3–5], a double pigtail stent (DPS) [6], or both [7] (depending on the series). Additional options include percutaneous radiologic drainage [8] or stricturotomy combined with endoscopic dilation [9,10].

Persistent GL occurs in between 0% and 41% of cases [3–6] and requires reoperation such as total gastrectomy with esophagojejunal anastomosis [11], proximal gastrectomy with esophagojejunal anastomosis [12], Roux-en-Y gastric bypass (RYGB) [13], or Roux-en-Y side-to-side gastrojejunal anastomosis [14].

Most published studies of post-SG GL have been performed in small ($n < 45$) group of patients [3–6]. Furthermore, these studies had several limitations: The management of GL was not standardized, GL healing was not clearly defined and no information on the criteria for performing reoperation for persistent GL (despite endoscopic treatment) was provided.

The objective of the present study was to assess the time interval between discovery of persistent GL and the performance of reoperation (despite optimized endoscopic treatment).

Methods

Population

A retrospective analysis of prospectively gathered data on a group of patients with GL after the performance of primary SG (with no history of bariatric surgery) or revisional SG (with a history of gastric banding, gastric banding removal, and SG in the same procedure), between November 2004 and March 2014, was performed.

Inclusion criteria

Patients included in the study had to meet the following criterion: post-SG GL visualized during an abdominal computed tomography (CT) scan, endoscopy, or surgery.

Exclusion criteria

Patients who underwent bariatric procedures other than SG were excluded from the study. Patients with primary gastrobronchial fistula (GBF) after SG were excluded from the data analysis because the diagnosis of GL was based on pulmonary symptoms (i.e., endoscopic treatment had not failed). Patients with secondary GBF were not excluded because these cases followed on from the failure of endoscopic treatment.

Surgical procedures for SG

Surgical procedures for primary and secondary SGs [15–17] and the related patient management procedures [18] have been described elsewhere.

A 34-gauge French bougie was used when transecting the greater gastric curvature. Gastric resection was initiated 6 cm above the pylorus (in the antrum). For patients having undergone SG between January 2004 and December 2009, stapling was performed using Endo GIA Universal XL 60 (COVIDEN France SAS, Elancourt, France), with 2 4.8-mm green reloads, and then 4 or 5 3.5-mm blue reloads. For patients having undergone SG between January 2010 and December 2013, purple Tri-Staple reloads (COVIDEN France SAS) were used. In the authors' institution, the staple line is not reinforced for first-line SGs. For SGs performed after 2010, the abdominal drain was not left in place. For second-line SG, black Tri-Staple reloads (COVIDEN France SAS) with GORE SEAMGUARD bioabsorbable staple line reinforcement (WL GORE & Associés, Paris, France) for the last 2 staples (in cases of previous gastric banding or cases of gastric banding removal and SG in the same procedure). For repeat SG, black Tri-Staple reloads (COVIDEN France SAS) with GORE SEAMGUARD bioabsorbable staple line reinforcement (WL GORE & Associés) for all stapling. A methylene blue test was always performed at the end of the surgical procedure. All patients underwent an upper gastrointestinal swallow study with oral contrast agent (a gastrograffin study test) on postoperative day (POD) 1 or 2, to check for the absence of complications and thus to enable oral refeeding.

These data were not available for SG performed in other institutions.

Definition of GL

The presentation, time to onset, and staple line site of gastric leakage were classified according to the modified UK Surgical Infection Study Group definitions [19,20]. The patient's clinical presentation was further described in terms of systemic signs of inflammation (tachycardia [> 100 beats/min] and hyperthermia [$> 38^{\circ}\text{C}$]), peritonitis (diffuse abdominal tenderness), pulmonary symptoms (cough and expectoration), and intraabdominal abscess (localized abdominal tenderness). The time to onset after SG was used to differentiate between early-onset gastric leakage (from POD 1 to 7) and delayed-onset gastric leakage ($\geq$ POD 8). The definition for early- versus delayed-onset GL was decided on the authors' experience of GL after the first cases managed for GL. Oral contrast-enhanced abdominal CT was used to determine the site of leakage along the staple line.

Management of GL

All cases of post-SG GL were discussed in a multidisciplinary staff meeting that included bariatric surgeons, a radiologist, an endoscopist, and an intensive care physician. This allowed for the development of a standard protocol for standardized management of post-SG GL, on the basis of leak-related data and the patient's clinical status.

Management of early-onset or poorly tolerated GLs. Reoperation procedures for GL have been described in detail elsewhere [2]. In cases of early-onset ($\leq$ POD 7), poorly tolerated GL, open surgery consisted of sample collection for bacteriologic and yeast cultures [21], washing of the abdominal cavity, suturing of the leak's orifice (if possible and depending on intraoperative local conditions), drainage of the GL (with 2 drains for postoperative irrigation and drainage), and implementation of feeding jejunostomy. For early-onset, well-tolerated GLs, laparoscopy was performed [22] (Fig. 1).

Management of delayed-onset, well-tolerated GLs and after reoperation. Endoscopy was performed by gastroenterologists with extensive experience in the management of postoperative complications. For cases of GL requiring immediate reoperation, an oral contrast-enhanced abdominal CT scan was performed 6 days after reoperation (to check that the GL was well drained before endoscopy). Endoscopic treatment was performed 7 days after reoperation (the day after oral contrast-enhanced abdominal CT scan). In cases of delayed (POD $>$ 7) well-tolerated GL (not requiring reoperation), endoscopy was performed on the day that the leak was discovered.

Stents (either a CS [Hanaostent, Life Partners Europe, Bagnolet, France] or a DPS [Zimmon Biliary Stent, Cook Ireland Ltd, Limerick, Ireland], depending on the case) were implanted with radiologic guidance.

During the study period, endoscopic procedures for GL treatment were changed. Before 2008, CSs were used. From 2008 onward, CSs were progressively abandoned and DPSs began to be used to drain the GL inside the stomach [6].

After stent implantation, patients were allowed to drink water and thus wash the GL.

After endoscopic stent implantation, an oral contrast-enhanced abdominal CT scan was performed 3 to 4 weeks after implantation of a CS or 6 weeks after implantation of a DPS. The day after the abdominal CT scan, endoscopy was performed to remove the stent (if the GL had healed) or change the stent (if the GL had not healed) (Fig. 1).

Definition of GL healing

In multidisciplinary staff meetings at the authors' institution, healing of a GL was defined as the resumption of oral feeding in the absence of (1) surgical drainage or endoscopic stenting, (2) flow through a previous surgical drainage path (e.g., a gastrocutaneous fistula), and (3) collections near the staple line site on an abdominal CT scan (whether contrast enhanced or not).

Endpoints and data recorded

The study's primary efficacy endpoint was the time interval between the discovery of persistent GL and the reoperation (despite optimal endoscopic treatment).

The secondary endpoints were preoperative demographic data, the frequencies of early- and delayed-onset GL, the frequency of immediate reoperation, operating data (the frequencies of laparoscopy and feeding jejunostomy), the frequency of radiologic drainage, endoscopic data (the frequency of endoscopic procedures, the number of stents

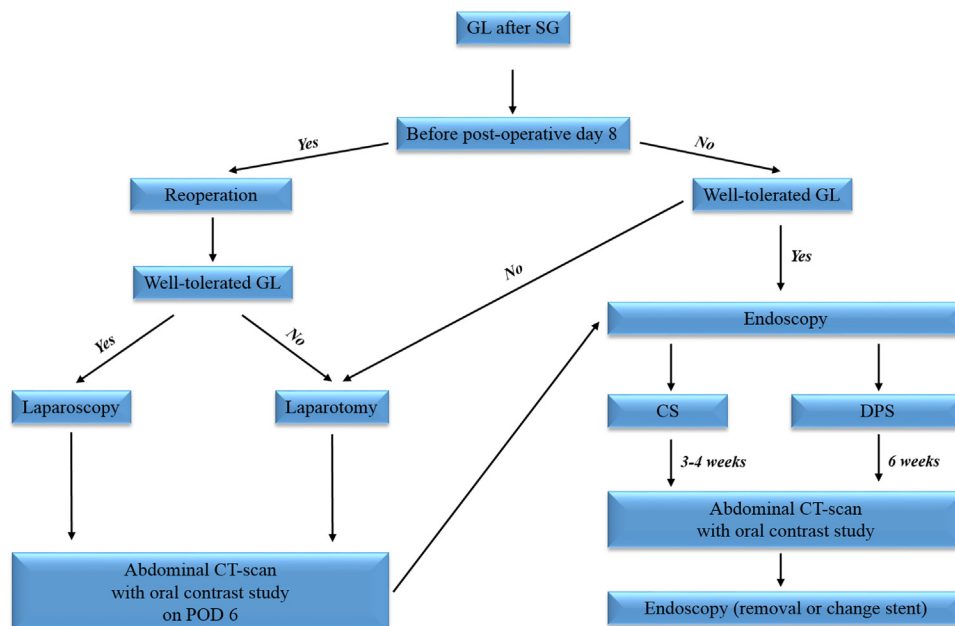


Fig. 1. Synopsis of the treatment procedures for post-SG GL. GL = gastric leak; SG = sleeve gastrectomy; CS = coated stent; DPS = double pigtail stent; CT = computed tomography; POD = postoperative day.

used, the difference between the 2 types of endoscopic procedures, and the frequency of stent migration), the mortality rate, the length of stay (LOS) after discovery of the GL, the time to healing of the GL, the treatment failure rate (i.e., the proportion of patients requiring reoperation for GBF and persistent GL, who were considered as failures of GL treatment), and risk factors for endoscopic treatment failure.

Statistical analysis

The patients' baseline characteristics are expressed as the mean $\pm$ SD and the median (interquartile range) for continuous data and as the number (frequency) for categorical data. A univariate analysis was based on the Student's *t* test for quantitative variables. The Mann–Whitney *U* test was used for nonparametric variables. The threshold for statistical significance was set to $P < .05$. All statistical tests were performed with SPSS software (version 15.0 for Windows; SPSS Inc., Chicago, IL).

A receiver operating characteristic curve was used to determine the mean time to reoperation for cases of persistent post-SG GL. This analysis included all cases of GL managed during the study period, with the exception of 3 patients (2 cases of primary GBF and 1 pulmonary embolism on the day of admission for GL treatment in our institution). When determining the optimal cut-off time for reoperation after endoscopic treatment of GL had failed, secondary GBF, persistent GL requiring reoperation, and death after endoscopic implantation of a stent (Fig. 2) were taken into account.

Results

Status before the primary LSG

During the study period, 1205 patients underwent primary SG in the authors' institution and 239 patients underwent secondary SG (94 SGs with a history of gastric banding removal, 115 gastric banding removals and SG in the same procedure, and 30 repeat SGs). Over the same period, 86 patients were managed for post-SG GL in the authors' institution. Forty-three patients had undergone SG (the incidence of GL after all types of SG performed was 2.9%), whereas the other 43 had been referred after SG in other institutions.

Demographic data

The study population's mean (range) age was 39.7 ± 11 years (21–64 y) and the mean body mass index (BMI) was 45.2 ± 7.5 kg/m² (31.9–64.4 kg/m²). There were 78 women (90.7%). Preoperative co-morbidities were diabetes mellitus in 24.4% of cases ($n = 21$), hypertension in 29% ($n = 25$), dyslipidemia in 23.2% ($n = 20$), and obstructive sleep apnea in 15.1% ($n = 13$). Twenty patients (23.2%) had a BMI ≥ 50 kg/m² (Table 1).

Sixty-three of these patients had undergone primary SG, whereas the remainder had undergone revisional SG, as follows: 9 underwent SG with a history of gastric banding removal, 10 patients underwent gastric banding removal and SG in the same procedure, and 4 patients underwent repeat SG. There were no conversions to laparotomy during any of the initial SG procedures.

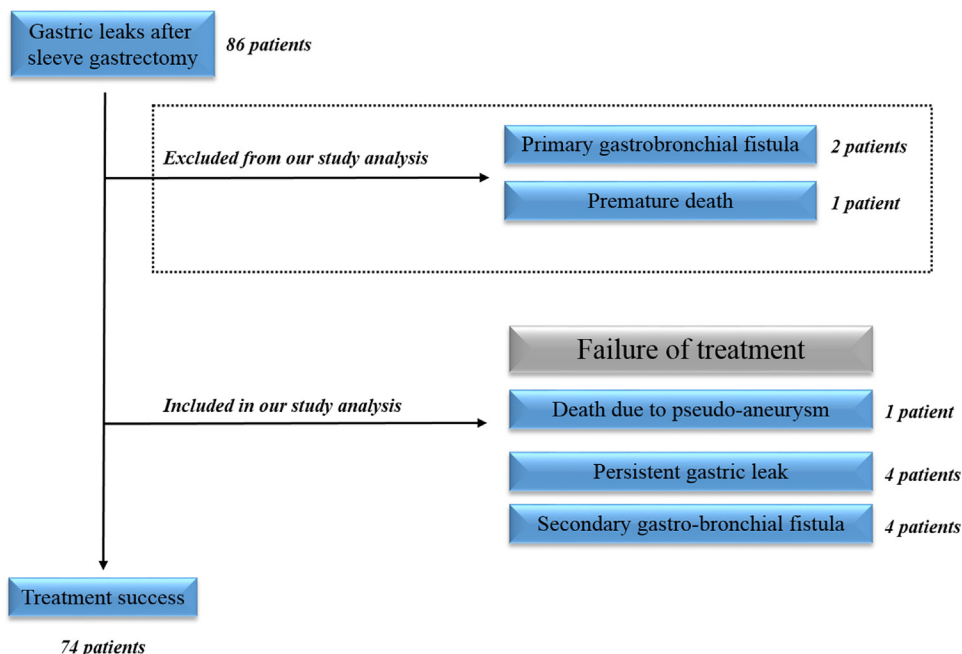


Fig. 2. Study flow chart.

Table 1
Demographic and gastric leak data for the study population

		Study population (n = 86)
Preoperative data		
	Female sex, n (%)	78 (90.7)
	Mean age (yr) (range)	39.7 (21–64)
	Mean BMI (kg/m ²) (range)	45.2 (31.9–64.4)
	BMI ≥ 50 kg/m ²	20 (23.2)
	Diabetes mellitus, n (%)	21 (24.4)
	Hypertension, n (%)	25 (29)
	Dyslipidemia, n (%)	20 (23.2)
	OSA, n (%)	13 (15.1)
GL data		
	Mean time to discovery of GL (d)	26.5 (1–649)
	Median time to discovery of GL (d) (range)	8 (1–649)
	Early-onset GL, n (%)	40 (46.5)
	Reoperation, n (%)	56 (65)
Type of refeeding		
	Feeding jejunostomy, n (%)	45 (54.2)
	Nasojejunal tube, n (%)	24 (29)
	Parenteral nutrition, n (%)	14 (16.8)

BMI = body mass index; OSA = obstructive sleep apnea; GL = gastric leak.

Gastric leak data

The mean time to appearance of post-SG GL was 26.5 days (1–649 d), whereas the median time to appearance of post-SG GL was 8 days. Forty patients had early-onset GL, whereas the others had delayed-onset GL. All but 1 of the GLs were located on the upper third of the staple line (near the esophagus-stomach junction). Two patients presented with a primary GBF after SG (Table 2).

Surgical management for GL

Fifty-six patients underwent reoperation, a result of early-onset GL in 39 cases, poorly tolerated GL in 13 cases, and perforation after an endoscopic procedure in 4 cases. Reoperation was not required in 27 cases. Laparoscopic surgery was performed in 18 cases and the fistulous orifice

was sutured in 19 cases (34% of all patients undergoing reoperation). Feeding jejunostomy was performed in 45 patients (Table 1).

Endoscopic management

Seven patients underwent primary radiologic drainage because it was impossible to perform primary endoscopic procedure (because of logistical limitations).

Endoscopic treatment with stents was used for the management of GL in 77 patients. Six patients did not require endoscopic stenting, thanks to primary radiologic drainage in 2 cases and suturing of the fistulous orifice during reoperation in 4 other cases. Four patients required reoperation after endoscopy as a result of endoscopic perforation in 3 cases and discovery of a pseudo-aneurysm in 1 case.

Table 2
Comparison of treatment with CS alone, DPS alone, and use of both CS and DPS

	DPS group	CS group	CS+DPS group
Number of patients	47	12	18
Total number of stents	148	39	96
Mean (range) number of stents per patient	3.1 (1–8)	3.2 (1–5)	5.3 (3–11)
Prosthesis migration, n (%)	2 (1.3)	1 (2.5)	11 (11.4)
Mean LOS (d) (range)	21 (7–78)*†	53 (20–131)	43 (14–130)
Mean treatment duration (d) (range)	109 (26–423)	116 (35–269)	122 (54–244)
Median treatment duration (d) (range)	80 (26–423)	98 (35–269)	101 (54–244)
Treatment success rate, n (%)	43 (91.6)	10 (83.4)	15 (83.3)
Incidence of GBF, n (%)	2 (4.2)	1 (8.3)	1 (5.5)
Incidence of persistent GL, n (%)	2 (4.2)	1 (8.3)	1 (5.5)
Mortality (%)	0 (0)	0 (0)	1 (5.5)

DPS = double pigtail stent; CS = coated stent; CS+DPS = combined and alternating CS and DPS; LOS = length of hospital stay; GBF = gastrobronchial fistula; GL = gastric leak.

*A significant difference between the DPS group and the CS group.

†A significant difference between the DPS group and the CS+DPS group.

For endoscopically treated patients, the mean number of endoscopic procedures per patient was 3 (0–8). The mean number of stent implanted per patient was 3.4 (0–11). There were 12 stent migrations (6 DPSs and 6 CSs) in 10 patients. This corresponds to migration frequencies of 8.8% for CSs and 2.7% for DPSs.

A CS was used in 29 patients (because of a large fistulous orifice in 13 cases, GL-associated gastric stenosis in 3 cases, the requirement for vacuum-assisted treatment of evisceration in 1 case, and the authors' preference of stent at the start of the GL care program in 12 cases). Data concerning the different types of endoscopic procedures are summarized in Table 2.

Outcomes

For the study population as a whole, the mortality rate was 2.3% ($n = 2$). When considering patients managed for GL, the mortality rate was 1.2% ($n = 1$). This death was due to cerebral anoxia after massive bleeding from a pseudo-aneurysm in a patient with persistent GL. The pseudo-aneurysm was diagnosed 118 days after discovery of the leak. The other patient died less than 10 minutes after admission in our institution of a massive pulmonary embolism; the SG was performed in another center and patient was referred for management of GL. This patient was excluded from our analysis because management of GL could not be started (Fig. 2).

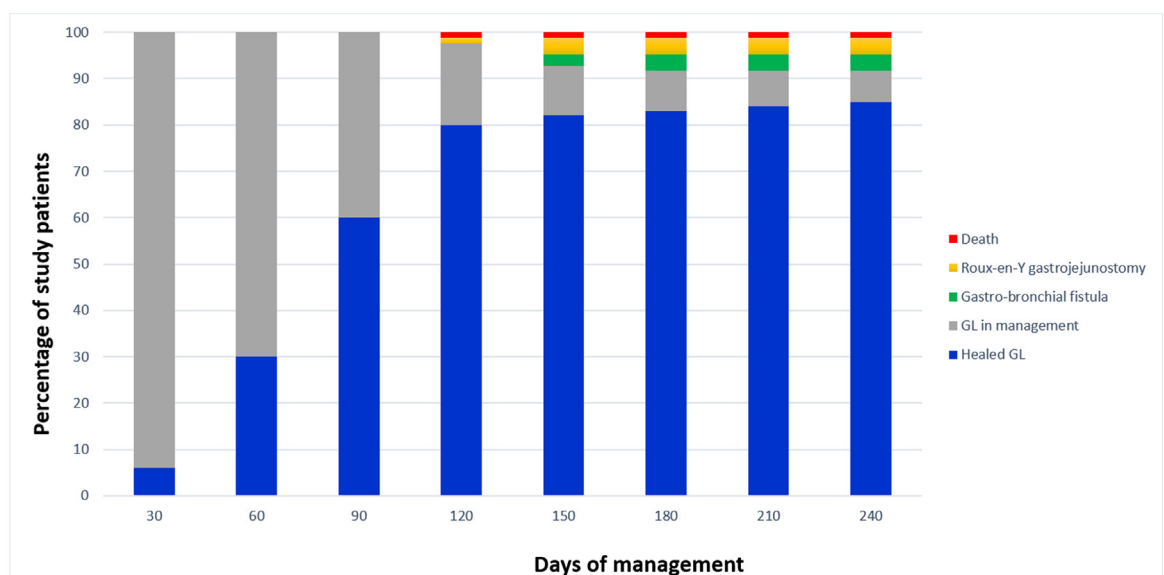
When a GL was discovered, the mean (range) LOS was 30 days (6–131 d). The success rate for treatment of GL was 89.1% ($n = 74$). Four patients developed GBF and 4 patients underwent surgery for persistent GL. The mean (range) time to healing of the GL was 111 days (14–423 d). The median time to healing of the GL was 84 days (Fig. 3).

Again, data concerning the different types of endoscopic procedures are summarized in Table 2.

Time to reoperation for persistent GL

Data on all patients managed for post-SG GL were analyzed. In the analysis, the fact that 1 patient had a pseudo-aneurysm associated with persistent post-SG GL and died from this complication after 118 days of treatment for GL was taken into account. The study also took account of 4 patients who underwent reoperation for persistent GL (after 91, 132, 132, and 335 d of treatment) and the 4 patients with secondary GBF (after 152, 178, 183, and 269 d of treatment).

It was found that 80% of all cases of GL managed endoscopically during the study period had healed within 120 days of discovery. In contrast, the frequency of complicated GL and persistent GL increased substantially over time, with 1 death after 118 days of treatment and 6 patients with treatment failure after 150 days. Even though some GLs did heal later than 120 days after discovery, this was rare: Only 3 GLs healed after 120 days of management.



Healed GLs (n)	5	25	50	67	68	69	69	70
GLs being managed (n)	78	58	33	14	9	7	7	6
Gastrobronchial fistula (n)	0	0	0	0	2	3	3	3
Roux-en-Y gastrojejunostomy (n)	0	0	0	1	3	3	3	3
Death (n)	0	0	0	1	1	1	1	1

Fig. 3. Treatment duration and percentage of the study population with a healed GL, including persistent GL, secondary gastrobronchial fistula, and death caused by a pseudo-aneurysm. GL = gastric leak.

Of the 6 patients still being treated for GL after 240 days, one required reoperation for persistent GL and another developed a GBF (Fig. 3).

For patients undergoing surgery for persistent GL (median time interval [range] between discover of GL and reoperation: 132 d [91–335d]), a 60-cm Roux-en-Y side-to-side gastrojejunal anastomosis with a midline laparotomy was performed. With a median (range) follow-up period of 12 months (6–18 mo), the clinical courses were uneventful.

Risk factors for persistent GL

When analyzing the preoperative data on all post-SG GLs (including age, gender, BMI, preoperative co-morbidities, type of surgery, and the institution where SG was performed), the postoperative GL (including time to onset, type of reoperation, the number and type of endoscopic procedures, and the type of refeeding) and the technical aspect of the sleeve tube, the only identified risk factor for treatment failure for post-SG GL was large retained gastric fundus ($P \leq .05$).

Discussion

The SG is an increasingly popular bariatric procedure because of its relative ease (compared with RYGB), a short learning curve (between 28 and 50 operations) [23,24], a low complication rate (with a GL rate around 2% [1,25]), good long-term weight loss (i.e., an excess weight loss $\geq 50\%$ more than 5 yr after SG [24,26,27]), and its ability to effectively correct obesity-related co-morbidities [28].

Nevertheless, postoperative GL is a difficult, life-threatening complication to manage; it is associated with a mortality rate of between 0% and 9%, depending on the series [3,5,29]. At present, the consensus view is that patients with early-onset and/or poorly tolerated GLs should undergo immediate reoperation to drain and contain the leakage [2], whereas in the case for delayed-onset, well-tolerated, or drained GL, treatment is most often based on endoscopic stenting. However, there is no consensus on the type of stent that should be used; CSs [3–5] and DPSs [6] have been used, depending on the series. In the authors' institution, standard procedure progressively shifted toward the use of a DPS because it was better tolerated than CS, and, by promoting internal drainage, reduced both LOS and treatment time [6]. Furthermore, CSs and DPSs work differently. A CS covers the fistula's orifice and simply diverts the flow but cannot drain a perigastric collection (e.g., an abscess). The latter requires additional radiologic or surgical drainage.

Suturing of the fistulous orifice was associated with complete healing of the GL in 4 cases (all early-onset GLs) and was not responsible for complex GL (as has been suggested by some researchers [30,31]). Hence, one of the

present study's important findings is the need to improve surgical training in this suturing procedure. Also, one of the major messages of the present series is the implementation of a feeding jejunostomy allowing simpler and well-tolerated renutrition. There were 2 mortalities in this series; the patients who died were being treated in 2010 (at the beginning of the GL treatment program). Since then, the authors have cared for 65 patients with no further deaths.

DPS is preferred for several reasons. First, this type of stent is better tolerated than a CS. Second, the migration and repeat endoscopy rates are lower (Table 2). Finally, the mean LOS (21 d for DPSs versus 53 d for CSs and 43 d for CS+DPS use) and the median treatment duration are shorter (80 d for DPSs versus 98 d for CSs and 101 d for CS+DPS use). At present, a CS is used only when a large (>2 cm) fistulous orifice causes a DPS to migrate. Even more recently, the authors have simultaneously implanted a CS and a DPS (with the DPS passing through the CS). This technique was used in 4 cases and appears to be associated with faster healing than the alternate use of a CS and a DPS. Hence, the authors now prefer simultaneous CS+DPS use to sequential CS+DPS use (DPS were placed after implementation of CS via a transprosthetic approach, through the CS [7]). Furthermore, the failure rate in the present series is lower than the literature values. For example, the Moszkowicz et al. series featured a high failure rate (41%) [5]; this might have been because the researchers did not perform SG on a routine basis and/or were not familiar with managing this type of complication [32].

At present, there are no consensual literature data on how long to wait before performing reoperation for GL if endoscopic treatment fails. Some data on the management of persistent post-SG GL (or chronic GL) have recently been published. The support period after discovery of the leak was highly variable, with a mean time (range) from discovery of the GL to reoperation of 14.4 months (5–44 mo) [13]. One study proposed systematic reoperation 3 months after treatment failure [33]. On the basis of the authors' experience and statistical analysis, reoperation 120 days after discovery of the GL is now proposed. If the authors had waited for only 90 days before performing surgery, approximately 20% of the patients would have undergone the procedure unnecessarily (because their GL would have healed between 90 and 120 d after discovery) (Fig. 3). This may explain the high reoperation rate (34.6%) reported by van de Vrande et al. [33].

Chouillard et al. [34] published their own experience of the management of post-SG GL in 62 patients. Forty-nine patients were admitted to their institution within 3 months of discovery of the GL. Eight patients (16.3%) underwent Roux-en-Y side-to-side gastrojejunal anastomosis for persistent GL. This contrasting result can be explained, first, by the fact that they performed only 1 or at most 2 endoscopic stenting procedures. Second, 3 of the patients in the Chouillard et al. study underwent repeat surgery for a

poorly tolerated CS. Third, Chouillard et al. used a CS, which was associated with a higher treatment failure rate in the present series (8.3% versus 4.2% for a DPS). The authors have stopped using CSs because of poor tolerance (nausea, gastroesophageal reflux, and pain), the difficulty of managing patients with CSs, and the rate of CS migration (2.5%) requiring immediate endoscopic stent removal, relative to DPSs.

Treatment of post-SG GL in a study population of 86 patients highlighted the period during which surgical treatment should be performed; in the first 120 days of management, 80% of patients with GL had been successfully treated. After this cut-off period, (1) 3 of the 4 patients with persistent GL underwent surgery, (2) all patients with secondary GBF were diagnosed, and (3) 1 patient died of cerebral anoxia after massive bleeding from a pseudoaneurysm (discovered after 118 d of GL management) after repeat SG [35].

Several surgical procedures can be used to treat persistent GL: total gastrectomy, RYGB, and 60-cm Roux-en-Y side-to-side gastrojejunal anastomosis [14]. In the authors' experience, total gastrectomy is more difficult to perform (as described on a separate series of GBF after SG [36])

because of greater intraoperative blood loss and a longer operating time. Furthermore, Serra et al. [37] found that in the event of complications after a duodenal switch, total gastrectomy was associated with a high morbidity rate (with several cases of reoperation, some life-threatening situations, and a mean LOS of 4.5 mo). Vilallonga et al. [32] also placed a Roux limb on the defect with good outcomes—avoiding the need for total gastrectomy (required in 32% of the patients managed for post-SG GL in the series by Moszkowicz et al. [5]). Thus, the advantage of 60-cm Roux-en-Y side-to-side gastrojejunal anastomosis over total gastrectomy and RYGB is the lower risk of postoperative malabsorption and thus the less frequent need for burdensome postoperative monitoring for vitamin and protein deficiencies [36]. In the authors' experience, a 60-cm Roux-en-Y side-to-side gastrojejunal anastomosis is a good option for reoperation in persistent GL Table 3.

The only risk factor for persistent post-SG GL in the present series was large, retained gastric fundus during the SG procedure. This particular anatomic presentation was not picked up by the abdominal CT scan; however, an endoscopic assessment with contrast agent revealed the persistence of a pouch at the gastric fundus (normally, most

Table 3
The main published series on GL management

	Sakran et al. [3]	Simon et al. [4]	Moszkowicz et al. [5]	Csendes et al. [23]	Present series
Study yr	2006–2010	2009–2011	2004–2012	2005–2009	2004–2013
Number of SG procedures	2834	n.r.	n.r.	343	1417
Number of GLs (%)	44 (1.5)	9 (5.6)	22 (n.r.)	16 (4.6)	86 (3*)
Definition of early-onset GL	≤ POD 7	≤ POD 15	≤ POD 7	≤ POD 4	≤ POD 7
Incidence of early-onset GL (%)	61	66	n.r.	69	46.5
Median time to GL (d)	7 (1–120)	10 (2–29)	5 (1–11)	7 (2–20)	8 (1–649)
Site (upper)	75	100	n.r.	87.5	98.8
Reoperation rate (%)	61	88	41	50	65
Type of reoperation	Drainage (plus suturing in some cases)	Drainage (plus intraoperative CS in 7 cases)	Drainage (plus suturing in some cases)	Drainage (plus suturing in some cases)	Drainage (plus suturing in some cases)
Endoscopy rate (%)	25	100	41	6	92.7
Type of stent	CS	CS	CS	CS	CS, DPS, CS+DPS
Success rate (%)	n.r.	78	69	100	89
Healed GL defined?	n.r.	n.r.	n.r.	n.r.	Yes
Median time to GL healing (d)	40 (2–270)	42 (14–119)	n.r.	43–48	84 (14–423)
Mean LOS (d)	n.r.	n.r.	n.r.	n.r.	30 (6–131)
Proportion of persistent GLs (%)	4 (9)	2 (22)	9 (41)	0	4 (4.8)
Management for persistent GL	TG (4)	TG (2)	TG (6) and gastrojejunostomy (3)	0	Roux-en-Y gastrojejunal anastomosis
Death	4 (9)	0 (0)	1 (4.5)	0 (0)	1 (1.2)

SG = sleeve gastrectomy; n.r. = not recorded; GL = gastric leak; POD = postoperative day; LOS = length of hospital stay; CS = coated stent; DPS = double pigtail stent; CS+DPS = combined and alternating CS and DPS; TG = total gastrectomy.

*3.0% is the incidence of GL after SG performed in the authors' institution only (i.e., not in another hospital), n = 43 GLs out of 1433 SGs.

of the gastric fundus must be removed during SG). The 4 patients with persistent post-SG GL and a 60-cm Roux-en-Y side-to-side gastrojejunal anastomosis had undergone their primary SG procedure in another institution. The reason for performing reoperation on 3 of these patients was a fault in the initial surgical procedure: the persistence of a large retained gastric fundus. This characteristic was also noted in 2 cases of GBF (with the primary SG performed in another institution, in both cases). Large, retained gastric fundus makes endoscopic treatment less efficient because the CS cannot cover completely the GL's orifice and the DPS cannot provide optimal drainage. Overall, GL is easier to treat after optimal resection of the greater gastric curvature.

Conclusions

Gastric leak is a feared complication after SG. Most cases of GL can be adequately treated by incorporating endoscopic stenting and DPS appears to be a superior treatment option to CS. According to the present analysis of all the patients with GL treated in the authors' institution, surgery for persistent GL should be performed within 120 days of discovery of the leak. Large, retained gastric fundus is a risk factor for treatment failure and may prompt the surgeon to consider earlier reoperation.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

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