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ORIGINAL CONTRIBUTIONS

Indications and Long-Term Outcomes of Conversion of Sleeve Gastrectomy to Roux-en-Y Gastric Bypass

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Abstract

Purpose Long-term results on sleeve gastrectomy (SG) with more than 10 years report patients needing sleeve revision for weight loss failure, de novo gastroesophageal reflux (GERD), or sleeve complications. The aim of this study was to analyze the results of laparoscopic conversion of failed SG to Roux-en-Y gastric bypass (RYGB).

Materials and Methods Retrospective review of a prospectively institutional maintained database to identify patients who underwent conversion of SG to RYGB between 2012 and June 2020.

Results Sixty patients(50 females) underwent conversion to RYGB. Average time to conversion was 5.6 years (2–11). Mean %WL and TWL after SG were respectively 26±8.8% and 33.2±14.1kg. Mean BMI at the time of RYGB was 38.1±7.1 kg/m^2. Mean follow-up was 30.4±16.8 months (6–84). Available patients at each time of follow-up: 1 year 59 (98.3%); 2 years 47 (78.3%); 3 years 39 (71.6%); and 5 years 33 (55%). Patients were divided according to indication for revision in weight regain/insufficient weight loss (30 patients) group 1 and GERD/complications (25 patients) group 2. Percentage of excess weight loss at 1, 3, and 5 years follow-up after bypass was for group 1 40.3±17.6, 34.3±19.5, and 23.2±19.4 and for group 2 90.4±37, 62.6 ±28.2, and 56±35.02. Total weight loss at last follow-up since sleeve was respectively 31kg in group 1 and 46.7kg in group 2 (p=0.002). No mortality was observed. Thirty-day complication rate was 3.3%.

Conclusion RYGB after SG is a safe and effective revisional procedure to manage weight regain and de novo GERD, to address complications, and to improve comorbidities.

Keywords Sleeve gastrectomy · Revisional gastric bypass · Weight failure · GERD · Sleeve complication

Introduction

Laparoscopic sleeve gastrectomy (SG) is now currently performed as a single bariatric procedure [1, 2]. The 2019 IFSO registry reports that SG represents 58.6% of primary surgeries worldwide in the calendar years between 2015 and 2018, being the second procedure only in Latin America [3].

SG has become increasingly popular because it is less technically demanding with shorter operative time, relative safety, lower micronutrient deficiencies, and lesser need for substitutive treatment. SGe has shown its efficacy in weight loss while preserving the access to the duodenum [4].

Long-term results on SG with more than 10-year follow-up are becoming available and report patients presenting with weight loss failure (WLF) either because of weight regain (WR) or insufficient weight loss (IWL) and/or complications such as de novo gastroesophageal reflux (GERD). Weight loss failure is reported in about 40 to 50% of patients [5], while GERD in about 31% of cases with symptoms appear between the third and the sixth postoperative year [6, 7]. Weight failure is multifactorial, involving poor adherence to the new lifestyle and nutritional habits and procedural failure or technical error [8, 9].

Therefore, revisional surgery after SG is becoming more and more common for bariatric surgeons. The reported mean time to the second operation is 4 years [10]. Patient candidate for revision should be referred to psychiatric counseling and to detect and manage behavioral or eating problems. The first line of treatment in patients with GERD should be high dose

Keypoints Sleeve revision, revisional gastric bypass, weight failure, sleeve complication

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of proton pump inhibitors (PPI). Patients who do not respond to PPI or present esophagitis on PPI should be offered revisional surgery.

Once the indication for revisional surgery is established, the surgeon has to choose between different options according to the WR/IWL, the functional and morphological problem: revisional SG (ReSG), conversion to Roux-en-Y gastric bypass (RYGB), biliopancreatic diversion with duodenal switch (BPD-DS), or one anastomosis gastric bypass (OAGB) (currently not indicated in France) and single anastomosis duodeno-ileal bypass (SADI). RYGB is the most common reported in the literature in terms of safety and results [11] especially to relief GERD symptoms when PPI therapy fails [12].

The aim of this study was to analyze the results of laparoscopic conversion of failed SG to RYGB.

Methods

We performed a retrospective review of our prospectively institutional maintained database (registered at Clinicaltrials.gov identifier number NCT02811900) to identify patients who underwent conversion of SG to RYGB between 2012 and June 2020. In case of lack of data, a bariatric staff member telephonically interviewed patients.

All patients with indication for revision were discussed and validated by a multidisciplinary committee. All patients underwent at least 6 months of nutritional and psychiatric counseling before the conversion. Patients were asked to have a regular physical activity as recommended by the World Health Organization (WHO) (https://www.who.int/dietphysicalactivity/factsheet_adults/en/).

Preoperative workup included standard blood test, biochemical and endocrine re-evaluation, cardiological evaluation, thorax X-Ray, abdominal ultrasound, upper GI series, GI endoscopy with biopsy for screening of Helicobacter pylori (HP), and manometry for patients presenting with GERD. The Obesity Surgery Mortality Risk Score (OSMRS) was calculated, and patients were divided according to results in low, medium, and high risk. The OSMRS was calculated assigning 1 point to each of 5 preoperative variables: body mass index ≥50 kg/m^2, male gender, hypertension, known risk factors for pulmonary embolism (previous thromboembolism, preoperative vena cava filter, hypoventilation, pulmonary hypertension), and age ≥45 years. Patients with total score of 0 to 1 are classified as "A" (lowest) risk group, score 2 to 3 as "B" (intermediate) risk group, and score 4 to 5 as "C" (high) risk group [13]. Recurrent GERD was evaluated following Montreal criteria.

Indications for revision were weight loss failure (insufficient weight loss/weight regain) and complications (GERD, sleeve stenosis/twist associated to GERD). Weight loss failure was defined as a percentage of excess weight loss (%EWL) less than 50% at 18 months follow-up [14]. Weight regain was defined as a regain of at least 30% of lost weight or regain of more than 10 kg from the lowest weight obtained.

Indication for GERD was retained when symptoms were refractory to high dosage of PPI treatment and/or associated with endoscopic signs of esophagitis and disruption of the esophago-gastric junction. In case of GERD associated to sleeve stenosis/twist, the workup was completed by a CT scan with oral contrast ingestion.

Weight parameters registered were body mass index (BMI), percentage of excess weight loss (%EWL) during the follow-up period, total weight loss (TWL), and percentage of total weight loss (%TWL) calculated at the nadir of weight loss and at the last follow-up after RYGB and since the sleeve. Preoperative and postoperative data were collected and evaluated.

Patient's results were evaluated for overall and separating patients according to indications IWL/WR, GERD, and IWL/WR+GERD. Postoperative complications were divided in early (within 30 days after the operation) and late (after 30 days).

Definition of comorbidities resolution was made adopting the guidelines of the American association of metabolic and bariatric surgery (ASMBS) [15]. Diabetes remission was defined as stopping of treatment and HbA1c <6%. Resolution of sleep apnea was confirmed by a postoperative test to verify the apnea and the discontinuation of continuous positive airway pressure machine. Improvement in blood pressure was defined as decrease in number or dosage of antihypertensive medication. Informed consent does not apply.

Data were analyzed using SPSS for Windows, version 25 (SPSS Inc., Chicago, IL, USA). A p value < 0.05 was considered statistically significant.

Surgical Technique

Pneumoperitoneum was created in all cases with a Hasson technique. Three 12 mm and two 5 mm trocars were used. An intra-operative endoscopy was performed in all patients for pouch creation and to check the anastomosis. The gastric pouch was created using three purples 60mm cartridges EndoGia from Medtronic aiming to achieve a pouch volume of 30 ml.

A 150 cm alimentary limb and 70cm biliary limb were measured. The gastro-jejunal anastomosis was created with a 45 mm purple cartridge (Medtronic) sized at 2cm. A brown 60 mm cartridge (Medtronic) was used for the jejuno-jejunal anastomosis. The introduction sites of staplers were closed by a running absorbable non-knitted suture. The Petersen space and the jejuno-jejunal defect were closed with non-absorbable suture. No feeding tube was inserted in the gastric remnant and no drain placed at the end of the procedure.

Results

Between January 2012 and December 2019, 634 primary sleeve gastrectomy were performed at our institution, and 60 patients (50 females, 10 males) underwent conversion of sleeve gastrectomy to Roux-en-Y gastric bypass. Sixteen patients received the sleeve in another institution. The conversion rate of sleeve gastrectomy performed at our institution was 6.9%.

Mean patient age was 45±10.3 years (26–68). The OSMRS was low in 40 patients (66.6%), medium in 19 (31.6%), and high in one (1.6%). The average time to conversion was 5.6 years (2–11). Mean BMI at the time of SG was 45.9±7.4 kg/m^2. Mean %EWL at the nadir after SG was 56.2±21. Mean %WL and TWL after SG were respectively 26±8.8% and 33.2 ±14.1kg. Mean BMI at the time of RYGB was 38.1±7.1 kg/m^2 (p=0.0000007). Mean postoperative hospital stay was 2.6 days (1–6 days).

Mean follow-up was 30.4±16.8 months (6–84). Two patients were lost during follow-up. Available patients at each time of follow-up were at 1 year 59 (98.3%), at 2 years 47 (78.3%), at 3 years 39 (71.6%), and at 5 years 33 (55%). At the time of the study, 49 patients (81%) are under follow-up. Clinical patient's characteristics and comorbidities are reported in Table 1.

The patients were divided according to indication for revision in WR/IWL (30 patients) group 1 and GERD and/or complications (25 patients) group 2; 5 patients presented at the same time GERD symptoms and associated weight regain. All patients converted for GERD were resistant to high dose PPI for at list 6 months of treatment. Between patients with GERD seven presented with twist/chicane of the sleeve (11%) at preoperative workup; 6 of them (86%) came from another institution.

Esophagitis was present in 9 patients (15%). According to Los Angeles classification, five were grade A, three grade B, and one grade C. Six patients (10%) presented a hiatal hernia less than 2 cm. Two patients (3.3%) presented with hiatal hernia more than 4cm. Seventeen patients (56.6%) presenting GERD symptoms were discovered to have reduced lower esophageal sphincter (LES) pressure and two patients (6.6%) esophageal motility disorder. One patient presented Barrett esophagus with mucosal dysplasia.

Four patients (6.6%) had antral gastritis. One patient (1.6%) was discovered to have HP infection treated before surgery. All procedures were performed laparoscopically with no conversion.

One patient with weight failure had only a laparoscopic exploration due to strong adhesions. Two patients presented with hiatal hernia more than 4 cm and received cruroplasty. One patient with a concomitant umbilical hernia received simple closure of hernia defect.

Table 1 Clinical data of patients converted to Roux-en-Y gastric bypass (RYGB)

Female no.	50		
Male no.	10		
Mean age (years)	45 (26–68)		
OSMRS score	Low 40 (61.6%)		
	Medium 19 (31.6%)		
	High 1 (1.6%)		
Average time to conversion (years)	5.6 (2–11)		
Mean BMI at time of RYGB	38.1kg/m^2		
Comorbidities		No.	%
	Hypertension	19	31.6
	Diabetes	6	10
	Asthma	4	6.6
	Articular disorders	14	23.3
	Obstructive apnea	21	35
	Dyslipidemia	4	6.6
	Cardiopathy	2	3.3
Mean postoperative stay (days)	2.6 (1–6)		
Early complications (no.)	Anastomotic stricture 1		
	Laparoscopic exploration 1		
Late complications		No.	%
	Anastomotic stricture	1	1.6
	Anastomotic ulcer	3	5
	Intestinal obstruction	1	1.6
	Jejuno-jejunal anastomosis perforation (bezoare)	1	1.6
	Malnutrition	1	1.6
	Incisional hernia	4	6.6
	Gallbladder stones	2	3.3

OSMRS Obesity Surgery Mortality Risk Score, *BMI* body mass index, *RYGB* Roux-en-Y gastric bypass

Mean preoperative BMI for groups 1 and 2 was respectively 42.4±5.3 kg/m^2 and 32±5.3 kg/m^2.

BMI at 1-, 3-, and 5-year follow-up after RYGB was for group 1 35.1±.5 kg/m^2, 35.6±4.2 kg/m^2, and 36.8+/-3.1kg/m^2 and for group 2 26.3±.3, 26.1+/-2.4 and 27.9±5.7, statistically different at 3 years (p=0.0006).

Percentage of excess weight loss at 1, 3, and 5 years follow-up after bypass was for group 1 40.3±17.6, 34.3±19.5, and 23.2±19.4 and for group 2 90.4±37, 62.6±28.2 and 56±35.02.

Percentage of total weight loss (%TWL) with RYGB was respectively 18±7.5% for group 1 and 18.4±7.3% for group 2 (p=0.3).

Percentage of excess weight loss calculated since sleeve was 62.7±22.7 for the entire series and respectively 50.8 ±13.9 for group 1 and 89.3±0.6 at 1 year, 45.3±13.2 for group 1 and 91.6±6.7 for group 2 (p=0.000006) at 3 years, and 33.8

±12.7 for group 1 and 77.7+/±24.6 for group 2 at 5-year follow-up.

Evolution of BMI and %EWL during the follow-up is reported in Figs. 1 and 2.

Percentage of weight loss at last follow-up after bypass and percentage of total weight loss since sleeve were not statistically different between the two groups except for percentage of weight loss at last follow-up since sleeve (p=0,00005) and are reported in Table 2. Overall mean change in BMI at five years follow-up since SG is 13 points (46 kg/m^2 vs 33 kg/m^2) while since RYGB is 5 points (38 kg/m^2 vs 33 kg/m^2). Mean BMI change in the subgroups showed respectively in weight loss failure group 12 points difference since SG (48 kg/m^2 vs 36 kg/m^2) 6 points difference since RYGB (42 kg/m^2 vs 36 kg/m^2). In GERD/complications group 16 points since SG (44 kg/m^2 vs 28 kg/m^2) and 4 points since RYGB (32 kg/m^2 vs 28 kg/m^2) (Fig. 3).

Maximum of total weight loss since sleeve was respectively 34.3 kg in group 1 and 49.5 kg in group 2 (p=0.005). Total weight loss at last follow-up since sleeve was respectively 31 kg in group 1 and 46.7 kg in group 2 (p=0.002). No mortality was observed.

Thirty days complication rate was 3.3%: one anastomotic stricture treated by endoscopic pneumatic dilation; one negative laparoscopic exploration at 9POD for abdominal pain, inflammatory syndrome.

Late complication rate was 23.3% and resumed in Table 1. One patient with failed endoscopic pneumatic dilation for stricture had a surgical revision of the anastomosis 4 years after bypass. One patient with weight regain after bypass underwent Argon plasma revision of gastro-jejunal anastomosis 6 years after bypass. The rate of WLF for patients converted for insufficient weight loss or failure was 33%.

Resolution of GERD was obtained in all patients and during the follow-up period none of these patients needed reintroduction of PPI. Patients converted for weight loss failure presented complete remission of diabetes (2 pts), 90% of resolution of sleep apnea and 70% of reduction in high blood pressure treatment.

Discussion

WHO reported in 2018 that obesity rate has tripled since 1975 (https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight). Obesity today implies more risk for bad quality of life, death, and socio-economic problems such as job perspectives. There is a need to treat this pathology having durable results and improvement on patient conditions. Surgery seems to be actually the only best treatment for obesity. Due to its effectiveness, its relative simplicity, and low rate of complications, SG is increasingly popular worldwide. According to 2019 IFSO registry, SG as primary procedure has increased from 45.9 reported in 2018 to 58.6% of procedures reported in 2019. Even if registry does not represent all the centers worldwide, it can count of more than 833,000 procedures [16].

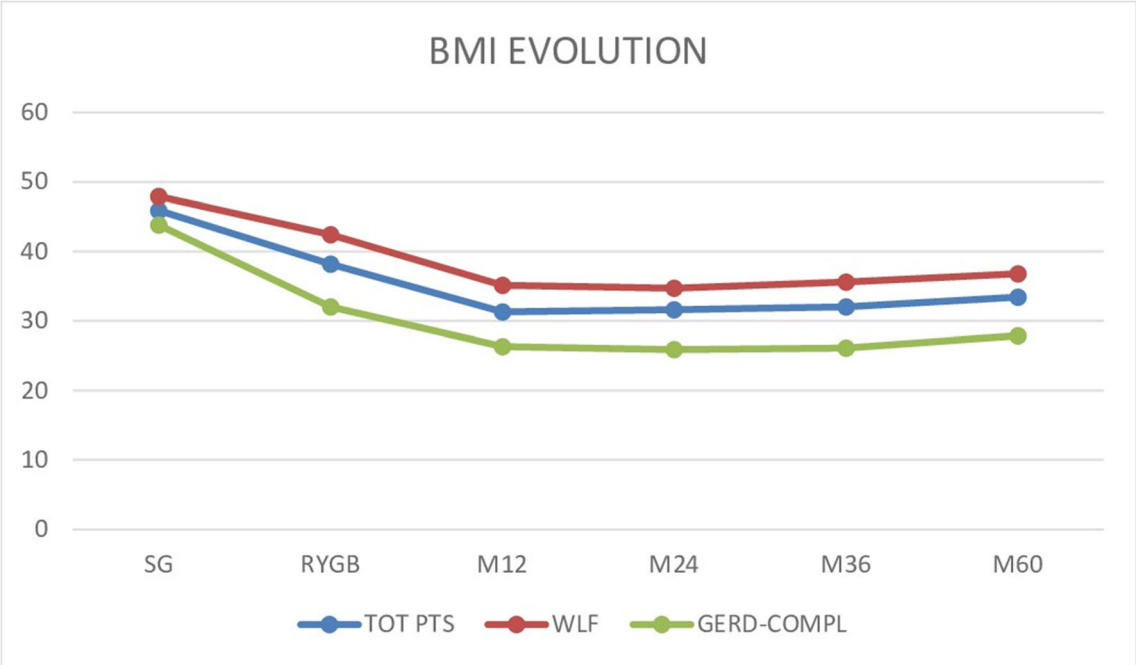

Fig. 1 BMI evolution during follow-up since sleeve gastrectomy. Available patients at each time of follow-up: 1 year 59 (98.3%), 2 years 47 (78.3%), 3 years 39 (71.6%), and 5 years 33 (55%). BMI, body mass index; TOT PTS, total patients series; WLF, weight loss failure; GERD-COMPL, de novo gastroesophageal reflux-complications

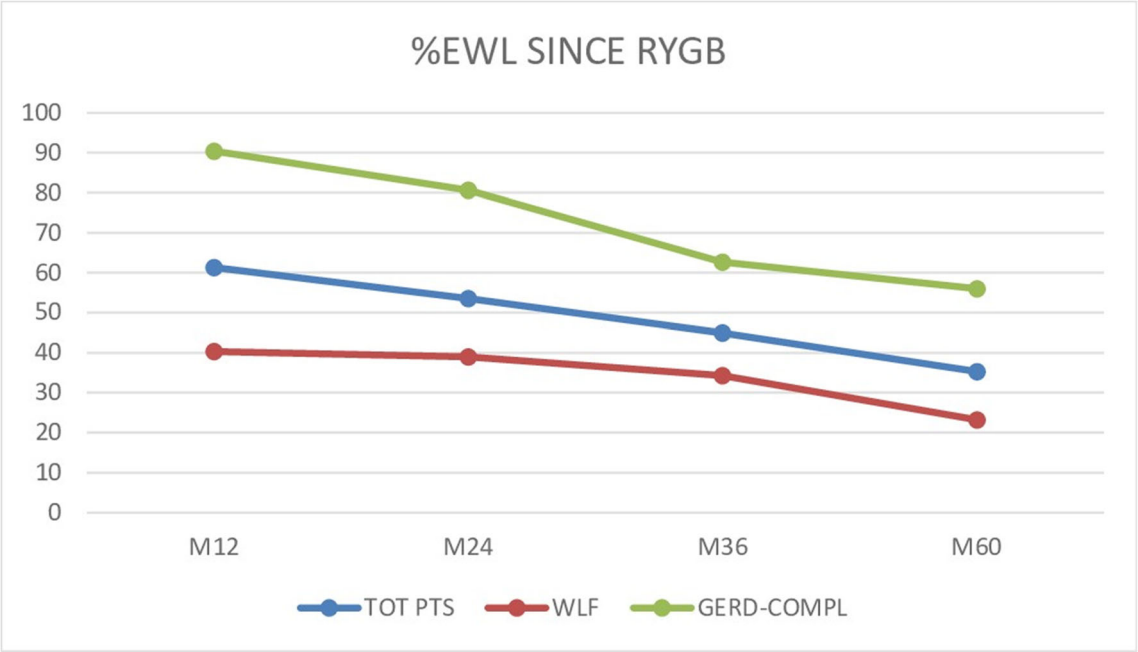

Fig. 2 Percentage of excess weight loss since Roux-en-Y gastric bypass. Available patients at each time of follow-up: 1 year 59 (98.3%), 2 years 47 (78.3%), 3 years 39 (71.6%), and 5 years 33 (55%). %EWL, percentage of excess weight loss; RYGB, Roux-en-Y gastric bypass; TOT PTS, total patients series; WLF, weight loss failure; GERD-COMPL, de novo gastroesophageal reflux-complications

We can expect that due to the increased number of SG performed each year, the number of revisional surgeries will increase at the same time.

In literature a number of patients with previous SG are found to fail in achieving adequate weight loss or regain weight after nadir or present with complications [17–19].

There is no uniform or internationally recognized definition for what constitutes failure of bariatric surgery. Mann et al. in a systematic review of definitions of failure in revisional bariatric surgery described the inconsistency in reporting and defining the reasons for failure of a primary bariatric procedure. In the majority of studies, concerning revisional operations, there is no clear evidence of patients selected for revision. For weight loss, the most frequently cited definition for failure of the primary operation was <50 % of excess weight loss (EWL), with or without BMI of greater than 35 m/kg^2, at 18 months post-operation. The second most frequent definition of weight loss failure was <25% of excess weight loss (without a time-frame specified) [14]. These two definitions are attributed to the 1991 NIH consensus guidelines [20] and the 1982 Reinhold criteria [21]; however, given the variation in expected weight loss between different surgical procedures, it is not surprising that different thresholds are reported for failure.

Table 2 Percentage of total weight loss

	Overall	WLF	RGO-COMPL
%TWL with bypass	18.1	18	18.4
%WL at last follow-up since bypass	15.3	15.5	13.7
%TWL since sleeve	31.1	32.9	28.2
%WL at last follow-up since sleeve	29.3	23.2	37.7

%TWL percentage of total weight loss, *%WL* percentage of weight loss, *WLF* weight loss failure, *GERD-COMPL* de novo gastroesophageal reflux-complications

None of the current thresholds for failure is based on the evidence that the expected clinical benefit of the operation has been lost. In our series, all patients presenting with weight loss failure underwent at least 6-month nutritional and psychiatric counseling in order to assess and address maladaptive eating habits, psychosocial stressors, and decreased physical activity.

The reported number of revisional surgery after sleeve varies in the literature ranging from 2.5 up to 31.7% [22]. In our series, revisional rate for all indications is 6.9%, in line with the median of reports.

We can expect that due to the continuous and increasing number in performed sleeve every year, the number of revisional procedures will increase progressively at the same time.

Common indications for revision after weight loss failure are complications such as stenosis, twist, or severe GERD refractory to medical treatment [19, 23, 24].

Landrenau et al. reported in 2018 47.1% of revision for complications including GERD and only 12.3% for weight recidivism [25]. In the reported 13-year experience of Chang in 2018, the number of conversion for GERD was 65.2%

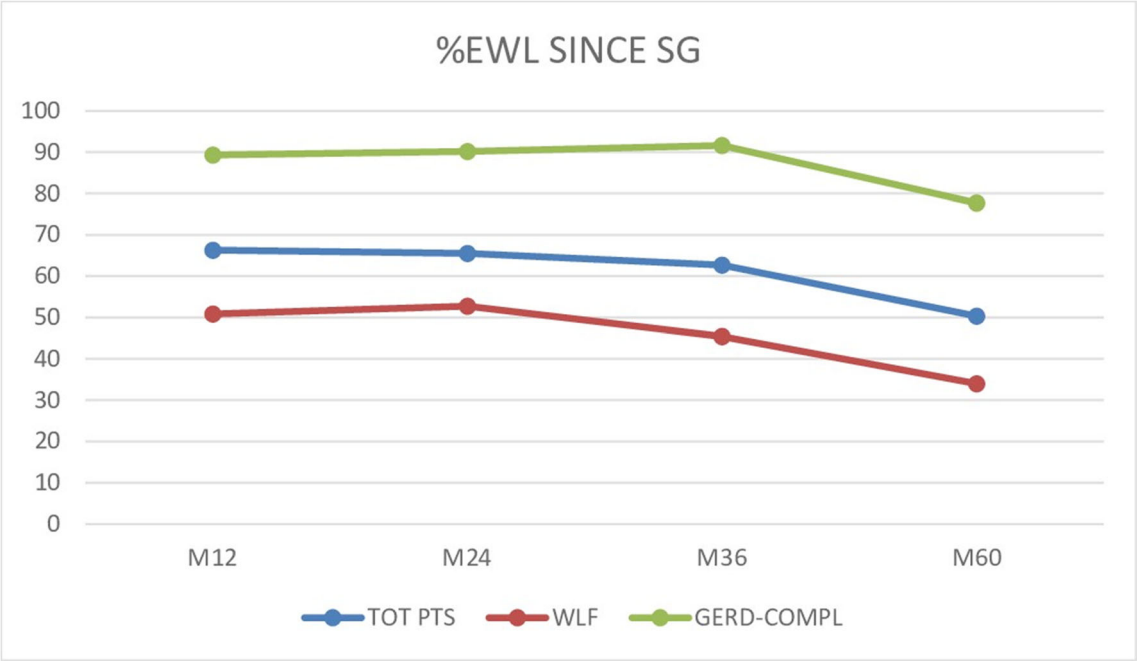

Fig. 3 Percentage of excess weight loss since sleeve gastrectomy. Available patients at each time of follow-up: 1 year 59 (98.3%), 2 years 47 (78.3%), 3 years 39 (71.6%), and 5 years 33 (55%). %EWL, percentage of excess weight loss; SG, sleeve gastrectomy; TOT PTS, total patients series; WLF, weight loss failure; GERD-COMPL, de novo gastroesophageal reflux-complications

while 27.5% for weight regain [26]. Boru in the same year reported that half of patients were converted for GERD [27]. While most of the available series report complications and refractory GERD as the main indication for revision, in our series, one of the largest, we had respectively 48.9% of indications for WLF, 41.6% for complications, and 8.3% for both. We had 26% of patients coming from another institution for complication associated with GERD, while only one patient of our series presented a twist. Maybe the difference with the literature in terms of less rate of revision for complications is related to our strict selection for primary sleeve. All of patients possibly candidate to a sleeve undergo upper endoscopy with upper GI series and high-resolution manometry. If patient complies with clinical symptoms of GERD, a RYGB is proposed.

At the moment of indication for revision, different options exist for bariatric surgeon: re-sleeve when indicated, conversion to BPD-DS, OAGB, SADI, and RYGB. When choosing for the optimal procedure, different factors should be considered: patient status, symptoms, anatomy, results of functional evaluation, results, and risks of each procedure. Revisional bariatric surgery is technically challenging due to tissue fibrosis and altered anatomy. Till now, there is no guideline to help surgeons because of the extreme variability in each patient. Re-sleeve allows reduction in gastric volume with decreased gastric output, less dumping syndrome, and decreased vitamins deficiencies [28]. However an increased risk of leak should be seriously considered, and patient should be clearly informed. This option should be proposed when the initial sleeve is too wide or there is a secondary dilation. Re-sleeve should not be considered in case of GERD symptoms [29, 30]. In our series, none of the patients presented with enlarged sleeve, and this option was not considered.

BPD-Ds is not the most common procedure for revisional surgery. Patients should be carefully selected in terms of their possibility to consume higher amounts of protein and excellent compliance with vitamin supplementation and follow-up. In 2016 Young performed a review and meta-analysis of BDP-Ds as revisional procedure after SG versus RYGB. There is a greater weight loss after BPD-DS; however, BPD-Ds is associated with longer operative time in some cases with greater complications and nutritional deficiencies. He suggests conversion to BPD-Ds especially in case of higher preoperative BMI (>50 kg/m^2). The persistent risk of development of Barret esophagus should be also considered for these patients candidate to conversion [31]. Conversion to OAGB has been reported, but the number is still limited. In France OAGB is not authorized anymore and can be done for the moment only in clinical trials. Since September 2019 the "Haute Autorité de Santé" (HAS), the French Health Control Institution, denied reimbursement for OAGB because of the lack of data on its efficacy of and for the risk of severe complications.

The SADI has become increasingly popular for patients with BMI > 50 as a primary or staged surgery. Zaveri et al. reported in 2019 a retrospective analysis of 96 patients coming from four centers divided in two groups: one had two-stage SADI because of insufficient weight loss, and the second had

Table 3 Reasons and complication rate of conversion of primary sleeve gastrectomy in recent literature (*SG* sleeve gastrectomy, *WLF* weight loss failure)

Author, year	No, of SG converted	No, conversion due to complications	No. conversion due to WLF	Complications rate
Carandina 2020 Multicenter [37]	80	80	-	6.2%
Barajas-Gamboa 2019 [38]	47	47	-	8.5%
Boru 2018 [27]	30	15	12	10%
Landreneau 2018 [25]	89 (36 planned two-stage approach)	42	11	31.5%
Yilmaz 2017 [43]	32	6	26	12%
Parmar 2017 [33]	22	10	6	4.5%
Yorke 2017 [44]	18	7	9	22.2%
Nevo 2017 [45]	23	-	23	13%
Van Wezenbeek 2017 [46]	68	38	30	8.8%
Felsenreich 2016 [47]	19	6	11	11.7%
Iannelli 2016 [38]	77	11	29	22%
Abdemur 2016 [12]	30	9	7	20%
Quezada 2016 [34]	50	16	36	6%

planned two-stage SADI because of super obesity (BMI > 50 kg/m^2). At 24 months, group 2 had higher %weight loss (WL) and change in BMI units compared to group 1 with statistically significant difference. The average WL and change in BMI for entire patient's population at 24 months after 2nd stage SADI was 20.5% and 9.4 units, respectively. The remission rate for DM was 93.7%. They conclude that this procedure needs more patients to understand its limitations [32].

The paucity of existing literature prevents widespread utilization of these techniques outside of institutional review board approved protocols.

Conversion to RYGB is likely the most common operation performed for weight loss failure and GERD, with metabolic effect similar to primary RYGB. Following this procedure, patients experience additional weight loss, GERD symptoms resolution, as well as resolution of weight-related comorbidities. Abdemur in a series of 30 patients shoved an additional 30.9% of EWL [12]. Parmar et al. reported a modest weight loss of 2–2.5 BMI points although nearly half of patients underwent conversion for GERD [33].

Boru et al. showed a mean BMI of 31.1% at 24months follow-up for patients converted for weight recidivism and resolution of GERD in 83% of patients. They asked to patients to evaluate outcome satisfaction after revision shoving that 90% of patients reported an excellent result [27].

Landrenau et al. in a short-term evaluation of 12 months shoved a %EWL of 32.7%, a change in BMI of 7.9 from an initial BMI of 48.6 for patients converted for WLF, while for patients converted for complications 44.5% EWL and a change in BMI of 4.5 from a median BMI of 30.4 kg/m^2 [25]. Quezada et al. reported results of conversion at 3-year follow-up shoving for patients converted for weight recidivism 66.9% EWL and a BMI of 28.9kg/m^2 [34]. In our series, patients with complications experienced complete resolution of symptoms. They had also better results in terms of BMI and %EWL at 5 years (respectively of 27.9kg/m^2 and 56%). This difference is possibly related to more severe dietary modifications in patients that suffered of GERD to alleviate symptoms before revisional surgery especially for whom who presented with sleeve complications (twist/stenosis). This was expected because their lower BMI at time of revision with 10 points of kg/m^2 of difference with patients with WLF. Patients converted for WLF seemed to present with worse results at 5 years with BMI of 36.8 kg/m^2 and %EWL of 23.2%. However they maintained a cumulative %EWL of 33.8% and a BMI change since sleeve of 12 points with resolution and/or improvement of comorbidities (complete remission of diabetes (2 pts), 90% of resolution of sleep apnea and 70% of reduction in high blood pressure treatment). Patients were able to maintain a stable BMI all along the follow-up and presented the same %TWL as patients converted for GERD/complications (18±7.5% vs 18±7.3%). The BMI change they presented corresponds to a 27% of BMI decrease that can lead to an improvement in quality of life and health status as reported in literature [35]. Moreover the rate of reoperation related to the RYGB during the follow-up period was almost nil (one postoperative laparoscopic exploration and one jejuno-jejunal anastomosis revision for bezoare). In literature BPD-DS, OAGB, even being overall safe and effective procedures present with more weight loss but more nutrient deficiencies and, in some reports, reoperation rate; currently are proposed for super obese patients (BMI>50). Maybe lengthening the biliopancreatic limb can improve weight loss. Probably for these patients, the paradigm

has to change from "success and failure" to that of treating chronic disease with appreciation of clinical benefit and quality of life improvement rather than weight alone. A recent matched cohort comparison of SADI vs RYGB with 5 years follow-up showed that problems, including long-term complications, reinterventions, weight loss failure, and conversion, were more often associated with RYGB than with SADI and no significant difference in nutritional outcomes. The authors conclude that SADI may be considered one of the viable alternatives to RYGB [36]. Carandina et al. recently published a multicenter study of patients converted for GERD; 28.7% of patients maintained GERD symptoms, but the study includes also patients with previous gastric banding. And they found that GERD recurrence was more frequent for patients with previous GB [37].

Roux-en-Y gastric bypass is reported to have more complications when performed as revisional procedure. Landrenau et al. reported 31.5% of complications rate [25]. Carandina et al. reported 6.25% of postoperative complication rate: 2 leaks one necessitating reoperation and one gastrojejunal stenosis necessitating a redo surgery [37]. Boru et al. reported 10% of complications with 2 leaks necessitating surgery with one redo-anastomosis [27]. Iannelli et al. reported a postoperative complication rate of 16.7%: four patients experienced an anastomotic stricture treated endoscopically [38]. Barajas-Gamboa et al. reported recently 8.5% of postoperative complication rate. Our 30-day complication morbidity rate is 3.3%, one of the lowest compared to these reported in the literature [39] (Table 3).

Even currently most decisions of revisional surgery are based on the preference and comfort of surgeon, RYGB should be considered a valid option for revision especially for complications and comorbidity improvement.

Hiatal hernia repair together with a cruroplasty was performed at the revisional RYGB only if a hiatal hernia was present and detected at the preoperative workup (2 cases). As well described in the literature, the presence of a hiatal hernia is not the only factor responsible for GERD. Our group demonstrated that SG results in morphological and functional changes that can create a disruption of the esophagogastric junction and gastric physiology that can lead to GERD independently of the presence of a hiatal hernia. After SG the esophagogastric insertion angle, the esophageal opening, and the intragastric pressure are increased facilitating the development of GERD [40, 41].

In our series, revisional RYGB has proven to be a safe procedure with complication and reoperation rate similar to the reported rate of primary RYGB [42].

The strong point of this study is the standardization in the selection of patient and one of the largest reports of conversion of primary sleeve to RYGB. The weak point is the retrospective analysis and the presence of patients coming from other institutions.

Revisional sleeve gastrectomy will be more and more frequent in the next future especially for long-term complications and de novo GERD. Patients presenting with weight loss failure should be carefully selected. For only weight loss failure, more complex procedures such as BDP-Ds should be considered for super obese patients. Further studies are needed to compare outcomes between the different available revisional procedures. Currently RYGB, as revisional procedure, is feasible by laparoscopy with low conversion rate and reasonable morbidity and seems to be the best safe option to manage sleeve complications and manage weight regain and comorbidities (Table 3).

Declarations

Ethics Approval 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.

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

Conflict of Interest The authors declare no competing interests.

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