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Which Laparoscopic Sleeve Gastrectomies Convert into Roux En Y Gastric Bypass? A Prospective Monocentric Study About 50 Patients

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1. Abstract

1.1. Background: Despite promising short-term results, revision from Sleeve Gastrectomy (SG) to Roux-en-Y gastric bypass (RYGBP) can be required due to either inadequate weight loss or

weight regain (IWL/WR), or de novo complications, such as gastroesophageal reflux disease (GERD) or gastric stenosis.

1.2. Objectives: To report surgical outcomes in converting SG to RYGBP and to assess mid-term outcomes according to failed or complicated SG, respectively.

1.3. Methods: Retrospective review of a prospectively collected database identifying patients who underwent laparoscopic SG done from June 2005 to February 2016 in a university Hospital and Tertiary Center of Bariatric Surgery. All consecutive patients who underwent revision from SG to RYGBP were studied. Demographics, anthropometrics, pre-operative work-up and perioperative data were retrieved.

1.4. Results: Fifty patients were identified, mean age 46 ± 11 years, 36 (72%) women. Mean time to revision was 40.7 ± 25.7 months, and mean follow-up after RYGBP was 25 ± 21 months. Indications for revision were GERD (n=9), IWL (n= 23), GERD with IWL (n=10), stricture (n=7), stricture with IWL (n=1). There were no mortality. Postoperative complications rate was 12% and delayed complications occurred in 14 patients (28%). GERD and stenosis symptoms resolved in 95% and in 100% of patients, respectively. For 34 patients in IWL situation, global EWL and global EBMIL were 63.5 +/- 18.2% and 66.1 +/- 19.1%, respectively.

1.5. Conclusion: Conversion of SG to RYGBP seems feasible with acceptable morbidity, achieving successful treatment of de novo complications such as Gastroesophageal Reflux Disease (GERD) or gastric stenosis.

2. Introduction

Bariatric surgery is currently the most effective treatment against obesity achieving long term weight loss and a high percentage of obesity-related co-morbidities remission. On this way, laparoscopic sleeve gastrectomy (LSG) gained popularity as primary bariatric procedure during the last decade because of its technically less demanding, lower incidence of postoperative complications and excellent weight loss in the short term [1,2]. However, in a subset of patients, inadequate weight loss (IWL), weight regain (WR) or de novo complications such as gastroesophageal reflux disease (GERD) or gastric stenosis [3-5] often require revisional bariatric strategies6. The current revision rate after LSG ranges from 5.5% to 36% [1, 7-12] and their number is continuously rising. Debates about which procedure is most suitable remain persistent [13]. Numerous options including revisional SG, biliopancreatic diversion, and duodenal

switch, omega loop gastric bypass and conversion to classic LRYGB exist. Previously studies [14, 15] reported that conversion from SG to RYGBP was a reasonable treatment approach and a viable option for revisional surgery which seems effective in treating GERD and inducing weight loss. To our knowledge, there are very few large studies reporting mid-term data on outcomes for LRYGB after failed LSG 16 (Table 1). Furthermore, data regarding predictive factors of revisional bariatric surgery success according to specific indications are scarce. Thus, the aims of this study were: i) to review the overall surgical outcomes of RYGBP after failed or complicated LSG (i.e., GERD or stenosis); ii) to separately reported mid-terms outcomes for these two indications.

Table 1: Literature review reporting on conversion of SG to RYGBP.

Authors	Year	N° patients	Male	Mean age	Initial BMI before SG	BMI >50	Indications for conversion			Delai of conversion
							IWL/ WR	GERD	Others or mixed	
Abdemur	2015	30	7	50.3+/-13.8	40.7+/-5.0	Na	7	9	14	43.6+/-27.5
Alsabah	2016	12	2	34	52	na	12	na	Na	
Carmelli	2015	10	3	45.8+/-16.3	45.5+/-5	Na	10	0	0	36+/-17
Casillas	2016	48	2	44 (23-65)	45.9	Na	11	14	23	26 (2-60)
El chaar	2016	9	Na	44 (23-62)	39.2 (34-52)	Na	3	6	0	29 (20-41)
Felsenreich	2016	17	4	Na	na	NA	11	6	0	36
Gautier	2013	18		40.9 (24-55)	55 (38-72)	11 (61%)	9	6	3	23.8 (4.3-51)
Homan	2015	18	10	50 (31-63)	49 (40-63)	2 (11%)	11	1	6	31 (9-57)
Iannelli	2016	40	9	40.2 (20-61)	47.5 (37.6-66)	13 (32.5%)	29	11	0	32.6 (8-113)
Parmar	2017	22	6	51 (32-70)	45.8 (37.6-66.7)	Na	10	11	1	
Poghosyan	2016	34	8	47.8+/-12	53.3+/-11.5	Na	31	3	0	32 (7.8-69)
Quesada	2016	50	8	39+/-8.4	36.4 (34-40)	NA	28	16	6	49 (24-67)
Van rutte	2012	18	5	46.5	44		4	5	9	11.2
Van wezenbeek	2017	68	51	44.7+/-11.1	49.3+/-10.7	15 (22%)	15	11	42	
Yorke	2017	18	4	42+/-11	50.5+/-12	1 (5.5%)	9	7	2	41.8+/-12.5
Lee Bion	2017	50	14	46,1 +/- 11,2	52,1 +/- 9,5	28 (56%)	27	15	8	
YILMAZ	2017	9	3	37.3+/-9.1				36		

3. Material and Methods

3.1. Patients

All consecutive patients who underwent conversion from LSG to RYGB between June 2005 (date of introduction of SG at our center) and February 2016 were retrospectively selected from a prospective database dedicated to bariatric surgery. This study has been approved by the local medical ethics committee; no individual inform consent was necessary as it was a retrospective analysis. The relevant information for each patient was prospectively collected and included demographics [body mass index prior to the index surgery, but also before the revisional procedure, preoperative and postoperative co-morbidities (diabetes, hypertension, obstructive sleep apnea syndrome) indication for conversion, time from the original surgery to the revisional procedure, operative time, length of hospital stay, and morbidity and mortality rates. Excess body weight was defined number of weight with BMI up to 25 kg/m^2. Insufficient Weight Loss (IWL) was defined by BMI > 35 kg/m^2 and/or excess weight loss (EWL) < 50% after LSG at the end of follow-up including also patients who regain weight. On the same way, severe intractable GERD was defined as persistent GERD symptoms despite medical treatment with high dosage of Proton Pump Inhibitors (PPI). Another functional problems included persistent complaints of dysphagia and solid food intolerance due to gastric stenosis. Patients were first offered a back on track program that consisted of intensive

dietary, psychological and physiotherapeutic supervision. Patients that failed to regain control over their weight using this program and still met the criteria for bariatric surgery were offered secondary surgery. Before conversion, all patients underwent an additional nutritional and psychiatric evaluation. Anatomic assessment was performed by gastroscopy, upper gastrointestinal series and computed tomography if necessary. A new abdominal ultrasonography was carried out to search for cholelithiasis. Like the first bariatric procedures, all cases were discussed at a multidisciplinary meeting according to the French guidelines (HAS) [17].

3.2. Surgical Procedure

All procedures were carried out by three experienced bariatric surgeons or under their direct supervision. Author's Sleeve technique had minor changes over the reported period of time. Standard technique using a 36Fr Bougie and beginning the dissection 5cm proximal from the pylorus on the greater curvature of the stomach. The short gastric vessels were divided using bipolar energy. The staple line was routinely over sewn with imbricating non reabsorbable sutures. We have previously reported our surgical technique of laparoscopic conversion from LSG to RYGB14. Briefly, the gastric sleeve was horizontally transected using a linear stapler Echelon® 60 mm (Ethicon Endo Surgery Inc., Cincinnati, OH, USA) with a green cartridge (4.1 mm) with sometimes a vertical resizing of the gastric sleeve. Using a hand-over-hand technique along the mesenteric border, a biliopancreatic limb of approximately 70 cm and a long alimentary limb of 150 cm (range 125-175 cm) were performed. All anatomoses were closed with PDS sutures. A prophylactic cholecystectomy was added when gallstones were seen at the preoperative abdominal ultrasound.

3.3. Outcomes

The primary endpoint was the postoperative complications according to the Clavien-Dindo classification [18]. A Clavien-Dindo classification of three points or higher was defined as a severe complication. Early complications were defined as those that occurred within 30 days of surgery such as reoperation, anastomotic leakage (on computed tomography or with reoperation), bleeding (requiring blood transfusion or reoperation), wound infection (requiring antibiotics or surgical drainage), readmission rate or unexpected events within 30 days after the surgery. Secondary endpoints were long term complications defined as those occurring during the follow-up (which was at least 12 months), such as reoperation due to incisional herniation, cholecystectomy or internal herniation, or readmission for vitamin, mineral or nutritional deficiencies. Others secondary outcomes included additional weight loss and resolution of any known obesity-related co-morbidities. The percentage of excess BMI loss after conversion (EBMIL) was calculated from the initial BMI (Global EBMIL) and from BMI before conversion (Additional EBMIL). In other words, Global EBMIL is calculated from the first surgery (i.e. LSG with initial BMI) until the end of the follow-up. The percentage of Excess Weight Loss (EWL) after conversion was calculated from the initial weight (Global EWL) and from weight loss before conversion (Additional EWL). In other words, Global EWL is calculated from the first surgery (i.e LSG with initial weight) until the end of the follow-up. EWL and EBMIL were computed using the weight after conversion with a follow-up of 15 months. Success about weight was defined as BMI < 35 kg/m² and Global EWL > 50% after two-step strategy. Resolution of GERD was defined as clinical absence of GERD and definitive cessation of PPI medication. Success in diabetes, hypertension and obstructive sleep apnea syndrome were defined as a cessation of any medication for the respective comorbidities. Success about treatment of stricture was defined by food oral intake without symptoms.

3.4. Statistical Analysis

Categorical variables were described by numbers and percentages, continuous variables were described by means and standard deviation. To explore the association between initial BMI and EBMIL after conversion, we computed linear regression analysis using SAS software V9.4 (SAS institute, NC, Cary) regardless of the indication for the second surgery and within the patients with an IWL. A p-value<0.05 was considered statistically significant. Initial BMI before the index operation (LSG) was used to predict EBMIL after revisional bariatric surgery. The value of initial BMI was assessed by calculating the areas under the receiver-operating characteristic (ROC) curves by DeLong test using the MedCalc statistical software. The optimal cut-off values were chosen to maximize the sum of the sensitivity and specificity. All statistical tests were two-sided.

4. Results

4.1. Patients Characteristics

During the study period, 456 consecutive patients underwent LSG at our department. A total of 50 patients (11.0%) underwent conversion from LSG to RYGBP of which 32 (7%) also had their primary LSG in the same institution. Demographic characteristics of the study population are listed in (Table 1A). Mean patient age was 46 years old (SD: 11), and 72% were female. Twenty-eight patients (56%) suffered from super obesity (i.e BMI > 50kg/m²). The mean interval for conversion was 40.7 +/- 25.7 months. There were several indications for revision: GERD (n=9), IWL (n= 23), GERD with IWL (n=10), stricture (n=7) stricture with IWL (n=1). Among all the patients, seven suffered from recurrent diabetes and underwent revisional RYGBP due to IWL. At the end of follow-up, 2/7 patients (28%) did not have type 2 diabetic mellitus (T2DM), 8/16 patients (50%) did not have hypertension and 6/10 patients (60%) did not have OSAS. After conversion, 18 of 19 patients experienced complete remission of GERD (95%). Only one patient still requiring daily medication after revision. After conversion, stricture complications were improved in all 8 patients (100%).

Table 1A: Population of the study

Legends: IWL: inadequate weight loss, GERD: gastroesophageal reflux disease, SG: sleeve gastrectomy, SD: standard deviation, BMI: Body Mass index, EWL: excess weight loss, EBMIL : excess BMI loss.

Factor	IWL	GERD	Stricture
Number of patients	27	15	8
Sex F/M (ratio)	21/6 (3,5)	11/4 (2,75)	5/3 (1,67)
Age Mean+/- SD	44,3 +/- 11,6	44,0 +/- 9,44	56,3 +/- 7,4
Gastric banding history	4/27 (14,8%)	1/15 (6,7%)	3/8 (37,5%)
Before SG			
Mean weight (kg)	153,9 +/- 25,6	138,5 +/- 32,0	128,9 +/- 10,2
Mean BMI (kg/m2)	56,1 +/- 8,7 (41,9-78,1)	49,0 +/- 9,2 (38,6-68,6)	44,3 +/- 5,4 (35-51,7)
Superobese (%)	20/27 (74%)	6/15 (40%)	2/8 (25%)
Time between SG and conversion (months)	34,6	49,8	44,6
Before Conversion			
Mean EWL (%)	35 +/- 14%	70 +/- 29%	64,2 +/- 29,5%
Mean EBMIL (%)	36 +/- 15%	74 +/- 30%	67,1 +/- 31,0 %
Mean weight (kg)	122 +/- 20	90 +/- 21,6	90 +/- 17
Mean BMI (kg/m2)	44,3 +/- 6,3	32,0 +/- 7,1	30,4 +/- 3,6
Surgery	161 +/- 42	156 +/- 39	157 +/- 42
Mean operative time (min)	21/27 (78%)	13/15 (87%)	7/8 (88%)
Drainage	1/27 (3,7%)	3/15 (20%)	1/8 (12,5%)
Hiatal hernia repair			
After conversion Lenght of stay (days)	7,4 (2-30)	7,4 (4-30)	7,6 (4-11)

4.2. Per Operative Datas

Revisional surgery was attempted by laparoscopy in 49 patients and conversion to laparotomy was necessary in one patient because of extensive adhesions. One patient underwent open RYGBP due to previous operations that resulted in significant intraabdominal adhesions. A hiatal hernia was identified in 5 patients and was repaired at the same time of revision to RYGBP. The mean operative time was 160 minutes (range 95-300min).

4.3. Main outcome results: post-operative complications

No patients died during the study period. Seventeen out of Fifty patients (34%) experienced early and late post-operative complications. Early complications were experienced in six patients (12%) and late complications were experienced in 11 patients. According to Dindo-Clavien classification, major postoperative complications (≥ IIIa) were experiences in two patients (4%) who required reoperation on postoperative day 1 due to: intraabdominal bleeding of the omentum in one patient and missed enterotomy during adhesiolysis in the other one. Both underwent second reoperation by laparotomy with secondary postoperative outcome uneventful. Two additional patients (4%) developed major adverse events requiring percutaneous drainage combined with antibiotherapy for an intraabdominal abscess and endoscopic balloon dilatation for a gastro-jejunal stenosis. Mean length of stay was 7 ± 4 days (range 2-30 days).

4.4. Long-Term Results

The mean follow-up after conversion of SG to RYGBP was 25.7 +/- 21 months. Median Follow-up was 15 months [3-60]. The follow-up rate was 100%. Mean global EWL was 63.9 % +/- 22.8, 2 years after surgery and 62.8 % +/- 20.5, 4 years after surgery. Mean global EBMI was 66.6 % +/- 24.0, 2 years after surgery and 64.7 % +/- 21.8, 4 years after surgery. Delayed complications occurred in 14 patients of whom 6 required additional surgery for correction of symptomatic internal hernia of Petersen's space (n=3) or incisional hernia (n=3). Other specific complications of revisional bypass procedures included: dumping syndrome (n=3), marginal ulcer (n=1) and malabsorption combined with vitamin deficiencies (n=5).

4.5. Weight Loss Outcomes

Sixteen patients were not in IWL situation. For these patients, mean global EWL, mean additional EWL, and mean EBMIL were 87.8 +/- 22.0%, 44.3 +/- 54.3%, and 91.8 +/- 23.2% respectively. A subgroup analysis of 34 patients was done to evaluate all of those patients who had a revision to RYGBP in IWL situation. Mean global EWL and EBMIL in these patients were 63.5 +/- 18.2% and 66.1 +/- 19.1%, respectively. Mean additional EWL and EBMIL in these patients were 43.1 +/- 27.0% and 46.2 +/- 29.0%, respectively. Success rate after the two-step procedure was 56% (19/34). Initial BMI before the index operation (LSG) was used in these 34 patients, in order to predict EBMIL after revisional bariatric surgery. For the prediction of EBMIL after revisional surgery, the sensitivity, specificity, predictive negative value and predictive positive value of BMI<50.3 were 93%, 58%, 92%, and 64%, respectively. Using this measure, we were able to estimate revisional bariatric failure in patients with IWL or WR after LSG (Figure 1).

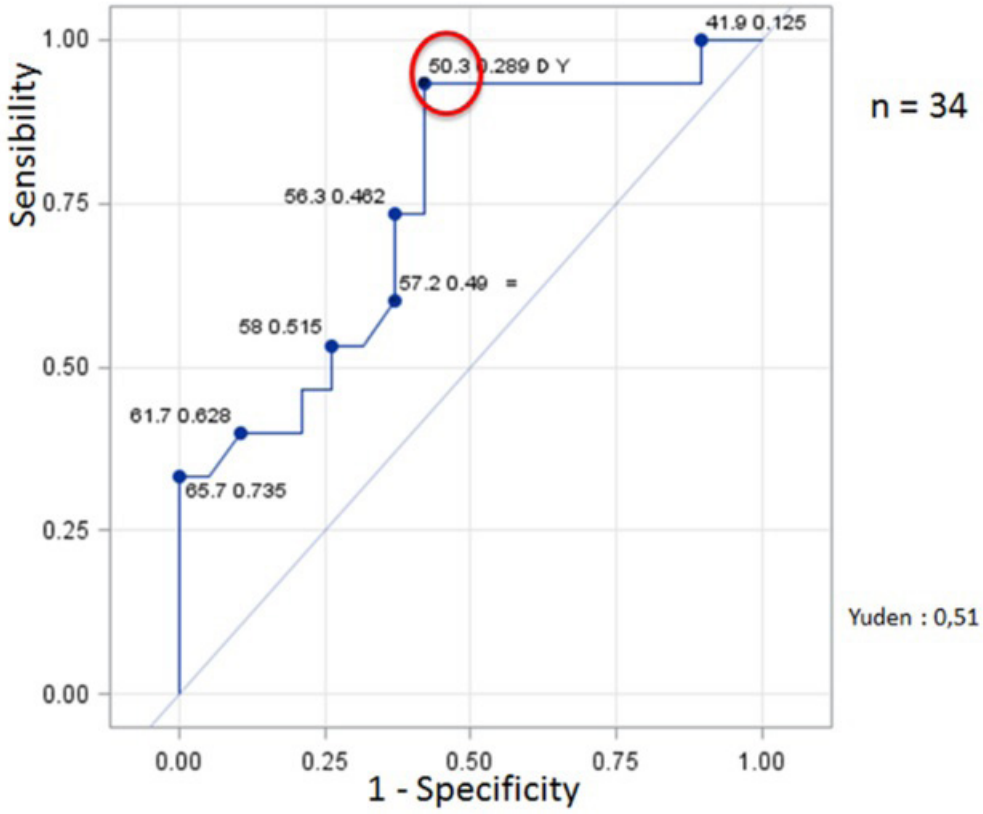

Figure 1: BMI Cut-off to predict failure in IWL group.

5. Discussion

The present study suggests that laparoscopic conversion of SG to RYGBP is safe and feasible, leading to acceptable postoperative morbidity. Furthermore, conversion of SG to RYGBP is highly effective in terms of relief of GERD and stenosis complaints (complicated SG), although it may not be the best option in terms of IWL (failed SG), especially in super-obese patients.

As data describing revision of SG to RYGB is scarce (Table 1), this study represents one of the largest series published in the literature (Table 2). During the study period, a total of 50 patients underwent revisional RYGBP, whom 32 (7%) only underwent LSG at our institution. This revision rate is lower than that reported in the recent literature which varied from 5.5% to 36%1,7-12. At our institution, RYGBP remains the most commonly performed bariatric operation, especially in case of GERD, although relations between SG and GERD still remain today unclear.

Table 2: Revue of the literature reporting on conversion of SG to RYGBP

Authors	N° patients	Morbidity	Conversion	Follow-up	BMI after conversion	%EWL after conversion	peristance in co-morbidity profile			
							T2DM	GERD	HTA	OSAS
Abdemur	30	3 (10%)	0	18.3+/-15.8	28.6+/-4.8	76.5+/-30.7	Na	9-Feb	na	Na
Alsabah	12	2 (17%)*	0	12	36	61.3	Na	na	na	Na
Carmelli	10	1 (10%)	0	15.6+/-9	30.2+/-4.8	65.5+/-34	4-Mar	NA	3-Feb	NA
Casillas	48	15 (31%)µ	0	20 (0-48)	Na	Na	Na	Na	na	Na
El chaar	9	Na	3			75 (49-113)	Na	na	na	Na
Felsenreich	18			130 (120-152)			0/0	Na	4-Feb	0/0
Gautier	18	1 (5.5%)	0	15.5+/-1.9	35.8 (24-42.6)	61.7 (34.2-103.2)	0/3	0/3	na	0/7
Homan	18	6 (33%)	0	29(17-64)	Na	Na	Na	Na	na	Na
Iannelli	40	7 (17.5%)	3 (7.5%)	18.6 (9-60)	30.8 520.8-44.1)	48.8 (4.6-102.7)	9-Apr	0/11	13-Jun	11-Feb

Parmar	22	4 (18%) µ		16	28.5 (18.8-34.3)	NA	6-Mar	12-Feb	13-Sep	Na
Poghosyan	34	7 (20.5%)*	1 (3%)	36+/-23	40.9+/-8.5	63.1+/-36.2	11-Apr	0/9	13/13	14-Nov
Quesada	50	3 (6%)	0	36	28.6 (24-36)	70.5 (36-92)	Na	16-Jun	na	Na
Van rutte	18	5 (28%)				80.3	9-Mar	5-Feb	10-Apr	0/2
Van wezenbeek	68	8 (12%)	1 (1.4%)	24	na	68.3+/-28.6	Na/14	Na	Na/24	Na/8
Yorke	18	6 (33%)		21.1+/-11.3	36.4+/-9.0	Na	5-Jan	12-Mar	0/4	0/6
Lee Bion	50		Jan-49	15			7-May	19-Jan	16-Aug	10-Apr
YILMAZ	90	1 (11%)	4 544ù)	15	na	Na	0/2		0/1	na

Author (Country)	**Year**		**Indications**	**Mortality (%)**	**Complications (%)**	**Follow-up**	**Complications**	**EWL**	**Comments**
Abdelgawad (Italy)	2016	18 4 GBP après SG (+59 Resleeve)	54,5% WR	0	Major : 10,4% (n = 8)	22 months	Reprise : 50%	58 +/- 24,3%	55% resolution of comorbidities
			45,5% Other				Hematoma : 3		89% efficient on GERD
			2 stenosis				AL : 5		
			5 gastrogastric fistula						
Abdemur (US)	2015	30	40% chronic leak	0	13,3%	18,3 +/- 15,8 months	GERD : 1/9 : pneumonie	76,5 +/- 30,7%	1 conversion to laparotomy (no complication)
			30%GERD				Leak : 1 leak, 1 occlusion, 1 collection	additional : 30,9 +/- 24,3%	66% efficient on GERD
			23% WR						
Alsabah (Kuwait)	2016	12 (+24 ReSG)	WR or IWL 100%	0	0	12 months	2/12 Carences	61,6% à 1 an	2,6% non perte ou reprise de poids sur 1300 sleeve
Carmeli (Israel)	2015	10 (+9 switch)	WR 100%	0	0	16 +/- 9 mois GBP	Ulcère 1/10	66 +/-34%	
						(30+/-23 mois DS)	(2/10 carences DS)		
Casillas (US)	2016	48	GERD 14	0	31% total	24 months (0-48)	2 tranfusions, 6 dysphagies	39 ;34 ;24%	36 revision sur 2794 SG (1,2%)
			IWL 11		18,7 short term		2 reoperations : 1 recidive HH, 1 coelio blanche douleur, 3 stenoses dilatation ok.	1 ; 2 ; 3 ans	50% hiatal hernia (repaired)
			GERD + IWL 16						
			Stricture 4					sous groupe IWL or WR	WR AFTER REVISION ++
			Chronic leak 1					38.2%, 35.4% and 16.4%,	
			Recurrent diabetes 2						

Cheung (Canada)	2014	218	Divers	NC	NC	NC	NC	GBP 1 an/ 2 ans : 60/48 RSG 1 an / 2 ans : 68/44	REVUE DE LA LITTERATURE
Edholm (Sweden)	2014	66 (65 après AGA)	WR 77% Symptoms 23%	NC	NC	11,9 Years	NC	EBMIL median 41%	Questionnaire 90% patients would recommend the procedure
El chaar (US)	2016	9 (3 switch)	WR 33% GERD 66%	0	0 readmissions or reopertion (no leak)	> 12 months		75 (49-113) EBMIL 71,3 (48-111,5)	
Felsenreich (Austria)	2016	18 (1switch)	WR 11 GERD 6 Leak 1	0	NC	130 months (120-152) AFTER SG	NC		EWL no differnece between converted or not. (WR group) 36% de conversions sur 53 SG.
Gautier (France)	2013	18	WR 50% GERD 33% T2DM 16,7%	0	5,5%	15,5 +/- 1,9 months	small bowel injury : laparotomy	EWL 61,7 (34,2-103,2) EBMIL 64,6 (36,9-104,6) Pas de DS selon indication	1 laparotomy d'emblée. 100% efficient on GERD 12% de conversion
Homan (Holland)	2015	18 (+25 DS)	WR or IWL 11 2 step : 2 Dysphagia 4 GERD 1	0	1 reoperation (no focus)	WR or IWL : 34 months (14-79) 2 step :42 months	Long term : 4 reoperation : 3 internal herniation, 1 incisional hernia Carences	WR or IWL : 57% (20-91) 2 step : 44% (37-50)	11% (3) WR AFTER REVISION 100% efficient on GERD or dysphagia
Ianelli (France)	2016	40	WR 29 GERD 11	0	16,7%	18,6 months(9-60)	(grade II : 5 ; IIIa : 2) Stricture of GJA : 10% (endoscopic dilation) 1 collection 1 internal hernia 1 incisional hernia	EWL 64%	3 conversions to laparotomy 100% efficient on GERD Improvement in comorbidities 430 SG : 17,9% revisional surgery : 40 GBP, 31 DS, 6 RSG 4 reprises de poids après conversion
Langer (Austria)	2010	8	WR 5 GERD 3		1	33 months	Leak (prothesis)	WL 15,2+/- 8 kg	8 conversions sur 73 SG WR after SG lié à WR apres conversion

Poghosyan (France)	2016	34	31 WR 3 GERD	0	4 (11 ,7%)	NC	4 reinterventions 1 intrstinal xound/1 leak/ 1 strangulation on trocar port/ 1 negative laparoscopy 3 complications tardives : douleur abdo coelio blanche, 1 eventration, 1 ulcere perforé	63,1+/-36,2	1 laparotomie d'emblée/ 1 conversion
Quezada (Chile)	2016	50	56% WR 32% GERD 12% sten	0	3 (6%)	72% à 3 ans (WR group)	2 GJA stenosis 1 colitis	70,5% (36-92)	90% efficient on GERD 100% efficient on stenosis

Whatever the indications, revisional bariatric surgery remains more technically challenging than the primary surgery, due to tissue fibrosis and altered anatomy [19, 20]. According to a recent review [21] including more than 5,000 patients with primary or revisional RYGBP, overall complication and mortality rates were higher in revisional compared to primary groups (29.5% vs 13.9%, and 1.3% vs 0.2%, respectively). Furthermore, Coblijn et al have recently developed a risk model for postoperative complications in an attempt to predict the development of complications after bariatric surgery [22]. Among the six independent risk factors, revisional surgery increased significantly the risk on postoperative complications by itself (OR: 1.5). Conversion rate was 2% and the perioperative complication rate of 34% are consistent with the results of the literature which ranged from 3.0% to 27.8%, and from 14.3% to 46.3%, respectively [5, 23-24]. However, few studies have only reported long-term morbidity rate. Therefore, decision of revisional bariatric surgery must be undertaken with caution and selection may also take into account the individual patient's specific history and cause of failure [25, 26].

A thorough assessment of the patients who need a conversion of SG to RYGBP is advisable to make a clear distinction between those with failed SG and those with complicated SG. Therefore, we decide to report our mid-term outcomes separately for these two different indications. Our findings suggest that the effect of RYGBP is dependent on the reason for which a conversion is performed. In case of severe GERD, conversion to RYGB seems to be the procedure of choice, as symptoms relief was achieved in 95% of our patients. These results have been reported in three other series 3, 4, 12, 27. Furthermore, hiatal hernia repair during revisional RYGB might also ameliorate post-SG GERD.

Currently, there is no consensus for the ideal procedure after failed LSG in case of IWL. Success of failure of bariatric procedures in individuals is often measured by weight loos or BMI. In this context, percent of excess weight loss (%EWL) is now recognized as one of the most reliable outcome measures that is least affected by the initial BMI [28]. A% EWL ≥50% after 12-18 months is widely accepted as an outcome measure and indicates success of the surgical procedure in addition to improvement or remission of comorbidities [29].

To better understand the effects of revision of SG to RYGBP for IWL, a sub group analysis was performed of those 34 patients who had surgery for weight related issues. Morbid obese patients with a BMI <50 showed a better EWL of 67% compared with 57.6% EWL in super-obese patients. In this study, when considering the BMI before primary surgery as the reference point (initial BMI), average weight loss after conversion was significantly higher when initial BMI was less than 50 kg/m². Our results suggest that RYGBP as an additional weight loss procedure after SG might not be the best option for achieving additional weight loss after failed SG for super-obese patients. According to Iannelli et al, super-obese patients

have a higher risk of WLF30. Some authors feel that a more malabsorptive procedure with a DS is warranted for lack of weight loss after SG. The number of studies describing the results of secondary surgery after LSG is limited. Homan et al, on 43 patients illustrated that BPD/DS is more effective in inducting weight loss compared with RYGBP after failed SG, especially in terms of insufficient weight loss or weight regain. In this study, the %EWL was 72% for BPD/DS versus 54% for RYGBP (p=0.025) after approximately 3 years. This finding is supported by other studies that demonstrate higher rates of %EWL for BPD/DS (up to 80%) compared to a RYGBP [30, 31]. However, more overall adverse events were significantly reported after BPD/DS (62%) compared to RYGBP (32%, p=0.021) according to a recent randomized controlled trial [32]. We considered that further studies with both larger series and longer follow-up will

help determine the appropriate treatment algorithms for those with IWL/WR. DS or SADI appears to have the upper hand over RYGBP in terms of additional weight loss, although serious postoperative deficiencies have to be taken into account when considering these procedures [28, 33]. Our results in group 2 are good when comparing them to those of several other studies confirming that RYGBP is a good redo option after failed LSG for new onset complications.

While there are studies looking at the effects on weight loss and GERD resolution after revision of SG to RYGBP, our study also reports the outcomes of obesity associated comorbidities. According to Yorke et al, co-morbidity resolution was achieved in 80% of diabetics, 75% of patients with reflux symptoms, all hypertensive patients and all patients with OSAS [34].

The present study has several limitations of which it was a single-center retrospective series in a tertiary center of obesity management. Moreover, the average duration of follow-up is limited to 15 months. Finally, the decision for revision was not standardized because there are currently not established guidelines. Therefore, the decision of subsequent intervention is mainly based on individual preference and expertise of the bariatric centre1. However, data on revisional surgery after LSG are scarce and to our knowledge, this is one of the largest series of conversions from SG to RYGBP published to date (Table 2). In conclusion, our results suggest that conversion of SG to RYGBP seems feasible with acceptable morbidity, achieving successful treatment of de novo complications such as gastroesophageal reflux disease (GERD) or gastric stenosis. Although initial BMI >50.3 before the index operation is able to predict failure of laparoscopic conversion of SG to RYGBP for IWL, further research is mandatory to assess which other factors contribute to determine weight loss. Additional research is needed to determine if there are predictive factors that determine which patient will have resolution of IWL after revision to RYGBP [35-44].

6. Conclusion

This procedure permits to cure GERD and stricture after SG in more than 90% patients. For IWL, RYGBP after SG is disappointing for weight loss. High initial BMI before SG is a predictor of poor weight loss outcomes. Biliopancreatic diversion with or without duodenal switch seems to be a good alternative in this situation but might be analyzed in further studies.

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