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Gastric Bypass after multiple restrictive procedures: Roux-en-Y or One Anastomosis? A retrospective multicentric study

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Abstract. – OBJECTIVE: When restrictive surgery fails, conversion to more malabsorptive techniques is frequently proposed. The aim of this study is to evaluate the weight loss figures between Roux-en-Y Gastric Bypass (RYGB) and One Anastomosis Gastric Bypass (OAGB) in patients who have already undergone Multiple Restrictive Procedures (MRP).

PATIENTS AND METHODS: All patients who underwent conversion of Laparoscopic Sleeve Gastrectomy (LSG) to RYGB or OAGB between 2010 and 2019 were retrospectively analyzed. Only patients who had conversion for Weight Regain (WR) or Insufficient Weight Loss (IWL) after both Laparoscopic Gastric Banding (LGB) and LSG entered the study population. Finally, 44 patients underwent conversion to RYGB, and 24 patients to OAGB.

RESULTS: Concerning Excess Weight Loss (%EWL) at 3, 6, 12, 24 postoperative months, the results for RYGB were 33.7%, 47.95%, 61.8%, 61.8%, while for OAGB were 38.3%, 51.9%, 63.75%, 79.45%. A significant difference was recorded in favor of OAGB at 3 (*p*=0.03) and 24 (*p*=0.046) postoperative months. % EWL at 24 months in the case of IWL was 57.8% for RYGB, while for OAGB was 72.7% (*p*=0.047). No significant difference was found considering patients with WR (80.9% and 80.5%; p= 0.999). Patients with better results at 24 months after surgery had a significantly longer time between sleeve and bypass than those with a lower % EWL.

CONCLUSIONS: The results of the present study seem to show that both techniques give good results at 24 months in patients who have undergone MRP. However, OAGB shows overall better results, particularly in patients with IWL.

Key Words:
Roux-en-Y gastric bypass, One anastomosis gastric bypass, Multiple restrictive procedures.

Introduction

Bariatric surgery is the treatment of choice for severe obesity as it provides good long-term results both in weight loss and resolution of comorbidities associated with obesity[1]. However, the various existing surgical procedures have a non-negligible failure rate concerning IWL, WR, poor control of comorbidities or onset of complications[2-4]. For the reasons mentioned above, approximately 10-25% of patients undergoing bariatric surgery require surgical revision in both cases of restrictive and malabsorptive techniques[5-9]. In such patients, revisional surgery is mandatory, although it is often burdened by a high complication rate exceeding 45%[10-13]. Conversion to more malabsorptive techniques, such as RYGB or OAGB, is frequently proposed as rescue treatment when solely restrictive surgery

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has failed[14,15]. However, it is not clear which procedure between RYGB and OAGB would be better to choose after failure with MRP, being literature data rare in this regard. The aim of our multicenter retrospective analysis is, therefore, to evaluate the weight loss figures between RYGB and OAGB in patients who have already undergone failed MRP, such as LGB and LSG.

Patients and Methods

The present multicenter study involved two French university hospitals, three French private centers and an Italian private center. All patients who underwent conversion of LSG to RYGB, or to OAGB, between 2010 and 2019 were retrospectively analyzed. The patients who had conversion due to WR, or IWL, after LGB or LSG with a minimum follow-up of 2 years entered the study population. The patients without an LGB history prior to LSG, plus the patients with conversion to one of the two bypass techniques for LSG complications (GERD, stenosis, fistula, etc.) were excluded from the initial analysis. IWL was defined as %EWL lower than 50% at least 18 months after surgery. WR was defined as regaining weight to achieve BMI > 35 or %EWL > 25% with respect to the minimum weight after MRP[15-17]. We chose the mean value obtained at 12 months after bypass (MV-12) as cut-off to determine the failed results at 24 months after MRP revisional surgery. This choice arises from literature evidence of a significant reduction in %EWL trend after 12 months in patients who had undergone revisional surgery[14-18]. Prior to conversion, all patients underwent a multidisciplinary evaluation. A minimum period of 6 months of preparation from a psychological point of view, along with a thorough nutritional and physical education, was required before making the patient eligible for surgical revision. All patients underwent a preoperative EGD and an Upper Gastrointestinal (UGI) Series. Patients were divided into two groups based on the type of revisional surgery received (RYGB group and OAGB group). Demographic characteristics, BMI and %EWL were assessed at 3, 6, 12, and 24 months, respectively.

The primary outcomes evaluated were %EWL in both groups and the correlation with the time elapsed since LSG surgery. The secondary outcome evaluated was %EWL at 24 months by focusing attention to the two groups of patients who had WR compared to those who had IWL after MPR.

Surgical Technique

1-RYGB

Conversion to LRYGB after LSG was performed using a five-port technique. The stomach was stapled transversally at the level of the second gastric vessels of the lesser curvature. A gastric pouch was resized over a 36-38 French orogastric bougie followed by a further vertical stapling. A possible hiatal defect was repaired with non-absorbable thread. The jejunum was divided at 100-110 cm distally from the ligament of Treitz, and the alimentary limb was positioned in ante-colic and ante-gastric manner. A linear mechanical side-to-side Gastro-jejunal Anastomosis (GJA) was performed using a linear stapler, and the opening was closed using an absorbable running suture. The anastomosis was tested with methylene blue instilled through the orogastric bougie. A side-to-side linear mechanical Jejuno-jejunal Anastomosis (JJA) was performed with an alimentary limb length of 150 cm. A drain behind the GJA was not routinely placed. All peritoneal defects were closed with non-absorbable thread.

2-OAGB

Revisional OAGB was performed using a five-port technique. To create a long and narrow gastric tube, the previous gastric sleeve was resized over a 38 French gastric bougie by a 60 mm horizontal linear stapling at the angle of the lesser curvature, and by a 3 to 5 vertical 60 mm linear stapling towards the angle of His. Two hundred cm of the jejunum distally from the ligament of Treitz were measured. The jejunal loop was pulled into position in ante-colic fashion, and an end-to-side GJA was performed with a linear 60 mm stapler. The stapler openings were closed with Monocryl 2/0-running suture. A perioperative methylene blue dye test was performed to identify leakage. A closed vacuum drain was systematically placed behind the anastomosis and removed before discharge.

Postoperative Management and Follow-Up

An upper GI series was systematically performed at Postoperative Day (POD) 1, and if negative for a leak, an oral clear liquid diet was started. Patients were discharged between POD 3 and POD 5 according to the different center postoperative protocols. All patients received a systematic postoperative multivitamin supplementation prescription, 40 mg of proton pump inhibitors during the first postoperative months, and a specific RYGB alimentary program. The postoperative assessments were conducted at 1, 3, 6, 9, 12, 18 and 24 months postoperatively, then annually from the third year.

Statistical Analysis

The characteristics of the study sample were analyzed using descriptive statistics. The discrete and nominal variables were expressed in terms of frequencies and percentages, and the continuous variables were expressed as median values and Interquartile Ranges (IQRs). The sample was stratified into two groups based on the surgical technique of gastric bypass. The Wilcoxon-Mann-Whitney test was used for the paired comparison analysis of continuous variables; given the non-normal data distribution (Shapiro-Wilk test), the χ^2 test, or Fisher's exact test as appropriate, was performed for qualitative variables.

The relationship between %EWL and months of follow-up, based on the surgical technique of gastric bypass, was analyzed through the slope of the regression line.

Choosing a cut-off equal to MV-12 for %EWL at 24 months, the sample was then stratified into two groups: those with %EWL ≤ MV-12 ("failure of GB" group) and those with %EWL > MV-12 ("success of GB" group). Univariate and multiple logistic regressions were performed to identify GB predictors of success, with associations reported as Odds Ratios (ORs) and 95% as Confidence Intervals (CIs). Predictors that had a p-value ≤ 0.05 in univariate models were included in the multiple logistic regression model, with adjustments for age, sex, and pre-GB BMI.

Statistical analyses were carried out using Stata Statistical Software: Release 15 (Stata Corp LP, College Station, TX, USA). All tests were two-tailed, and p-value ≤ *0.05* was considered statistically significant.

Results

During the period considered, 85 patients met the inclusion criteria. Eleven patients were lost to follow-up (12.9%) and six patients (8.1%) were excluded for the appearance of post-operative bypass complications (4 RYGB and 2 OAGB). The anastomotic leak rate was 2.2% (1pt), and 0% for RYGB and OAGB, respectively. The reoperation rate was 4.3 (2 pts) for RYGB, and 7.7% (2 pts) for OAGB. The remaining 68 patients were analyzed. Forty-four patients received LRYGB as conversional treatment (RYGB group) and 24 patients OAGB (OAGB group) (Figure 1). No significant differ-

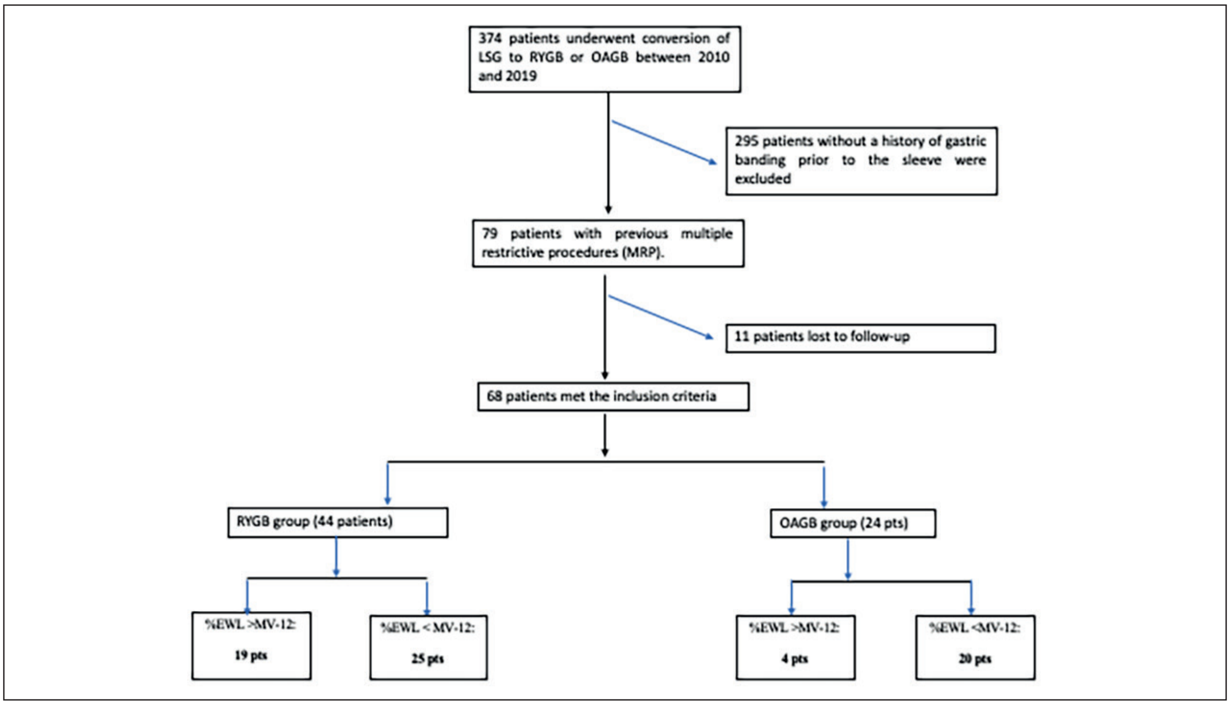


Figure 1. Study flowchart.

Table I. Patient characteristics.

	Total N=68	RYGB n=44	OAGB n=24	*p*-value
Age, median (IQR)	47 (37.5-57)	46.5 (37-56)	49.5 (39-62)	0.182*
Sex, n (%)				0.649**
Female	63 (92.65)	40 (90.91)	23 (95.83)	
Male	5 (7.35)	4 (9.09)	1 (4.17)	
Time LAGB-LSG (months), median (IQR)	53.5 (24-96)	42 (20.5-96)	71.5 (45.5-109.5)	0.080*
BMI before LAGB, median (IQR)	44.25 (39.2-48.5)	44.4 (38.9-49.8)	44.25 (39.8-48)	0.873*
BMI after LAGB median (IQR)	39.5 (34.1-44.15)	39.85 (35.5-45.1)	39.25 (33.1-43.75)	0.305*
BMI before LSG, median (IQR)	44.3 (42.4-46.3)	44.1 (40.2-48.9)	44.4 (39.9-48.6)	0.283
%EWL after MRP (pre-bypass) median (IQR)	1.4 (-42.55-23.05)	1.4 (-35.4-17.7)	1.9 (-60.65-25.8)	0.857*
Results MPR, n (%)				
0.636***				
IWL	45 (66.18)	30 (68.18)	15 (62.50)	
WR	23 (33.82)	14 (31.82)	9 (37.50)	
Time LSG-Bypass, median (IQR)	43.5 (29.5-66.5)	43.5 (27.5-67.5)	45.5 (35.5-60.5)	0.934*
BMI after MRP (pre-bypass), median (IQR)	38.9 (36.6-42.55)	39.8 (36.8-44.3)	37.85 (36.4-41.7)	0.128*

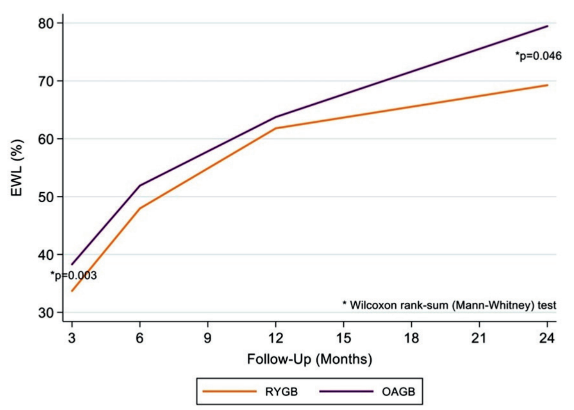
*Wilcoxon rank-sum (Mann-Whitney) test. **Fisher's exact test. ***χ^2-test. RYGB: Roux-en-Y gastric bypass; OAGB: one anastomosis gastric bypass; IQR: interquartile range; LAGB: laparoscopic gastric banding; MRP: multiple restrictive procedures; BMI: body mass index.

ences were found in the two groups for age, sex, BMI, %EWL during the steps of the MRP and at the time of conversion (Table I).

The %EWL results were 33.7% (21.9-38.4%), 47.95% (35.9-57.25%), 61.8% (44.1-74.25%), 61.8% (44.1-74.25%) and 38.3% (33.65-45.45%), 51.9% (44.95-57.65%), 63.75% (55.85-71.6%), 79.45% (68.55-88.45%) at 3, 6, 12, and 24 months, respectively, for RYGB and OAGB. Significant differences were found in favor of the OAGB group at 3 (p = 0.03) and 24 (p = 0.046) months after surgery (Figure 2).

Figure 2 also shows the trend in %EWL during the follow-up period for the two procedures. This trend was significant for the OAGB procedure, with an average of 1.83% of %EWL being lost per month (β coefficient = 1.83; 95% CI = 0.41-3.24, p = 0.031). For RYGB, the trend was not significant (β coefficient = 1.54; 95% CI = -0.55-3.64, p = 0.087). After LSG, 45 patients experienced an IWL (66.2%) and 23 patients had a WR (33.8%), with no significant difference between the RYGB and OAGB groups (p = 0.036). The average interval between MRP and bypass was 43.5 months, with no significant differences between the two groups (Table I).

The mean value of %EWL obtained at 12 months, chosen as cut-off, was 63.5% (Figure 2). Furthermore, considering the distribution of %EWL values at 24 months after bypass surgery, the intercept of the regression model best fits the data (y = 63.59; 95% CI 54.97-74.42; p < 0.001) that correspond to the chosen cut-off. The univariate and multivariate analyses showed an association between sleeve/bypass time and the results obtained (Table II). Patients with %EWL > 63.5 at 24 months after surgery had a time between sleeve and bypass significantly longer than those with a lower %EWL (OR 1.03, 95% CI 1.01-1.06, p = 0.037). The number of patients with a result at 24 months greater than the cut-off was significantly higher in the OAGB group than in the RYGB group (OR 4.93, 95% CI 1.11-21.89, p = 0.036). The results, in terms of %EWL obtained at 24 months in the case of IWL, were on average 57.8% in the RYGB group and 72.7% in the OAGB group, with a significant differ-



Trend test: RYGB: β coefficient=1.54; 95% CI= -0.55 - 3.64, p=0.087; OAGB: β coefficient=1.83; 95% CI= 0.41 - 3.24, p=0.031.

Figure 2. Percentage of excess weight loss (%EWL) at various follow-up intervals and trend test.

Table II. Univariate and multivariate analyses of success predictors of gastric bypass.

	%EWL 24 mesi post-bypass		**Univariate Logistic Model**			**Multivariate Logistic Model**		
	≤ 63.5 n (%) 23 (33.82)	**> 63.5 n (% 45 (66.18)**	**OR**	**95% CI**	***p*-value**	**OR°**	**95% CI**	***p*-value**
Age, median (IQR)	49 (41-57)	46 (36-57)	0.98	0.94-1.02	0.351			
Sex, n (%)								
Female	21 (91.30)	42 (93.33)	1					
Male	2 (8.70)	3 (6.67)	0.75	0.12-4.84	0.762			
LAGB lifespan (months), median (IQR)	72 (25-137)	48 (24-73)	0.99	0.98-1.01	0.143			
BMI pre-LAGB, median (IQR)	47.2 (40.4-48.8)	43.5 (38.9-48.1)	0.98	0.91 1.05	0.538			
BMI post-LAGB, median (IQR)	41.3 (38.4-45.9)	38.5 (32.3-43.5)	0.95	0.90-1.01	0.077			
BMI pre-LSG, median (IQR)	44.3 (39.8-7.8)	40.9 (36.8-45.2)	0.96	0.90-1.03	0.299			
BMI post-LSG, median (IQR)	40.4 (38.2-43.5)	37.8 (36.4-42.5)	0.97	0.89-1.05	0.409			
Result MPR, n (%)								
IWL	23 (100.00)	22 (48.89)	1					
WR	0 (0.00)	23 (51.11)						
Time LSG, median (IQR)	34 (21 42)	59 (36 68)	1.03	1.01-1.06	0.012	1.03	1.01-1.06	0.037
Type of conversion, n (%)								
RYGB	19 (82.61)	25 (55.56)	1			1		
OAGB	4 (17.39)	20 (44.44)	3.8	1.11-12.98	0.033	4.93	1.11-21.89	0.036

°OR corrected for age, gender, BMI prior to bypass and for the other factors present in the model. %EWL: % excess weight loss, BMI: body mass index, LAGB: laparoscopic adjustable gastric banding; LSG: laparoscopic sleeve gastrectomy; OAGB: one anastomosis gastric bypass; RYGB: Roux-en-Y gastric bypass; MPR: multiple restrictive procedures; OR: odds ratio. IQR: interquartile range.

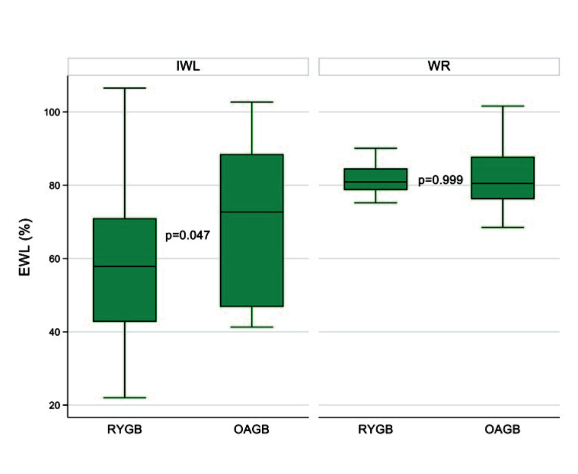


Figure 3. Boxplot of % EWL at 24 months in subjects operated on for RYGB or OAGB, stratified by MMR outcome.

ence between the two groups (p = 0.047). This significant difference was not found when considering the patient population who experienced WR (80.9% EWL in the RYGB group *vs.* 80.5% EWL in the OAGB group, p = 0.999) (Figure 3, Table III).

Finally, 13 patients (19.2%) experienced %EWL close to 0% (-2% < %EWL > 2%) after gastric banding and sleeve. In these patients, %EWL obtained at 24 months was 40.1% (35.5-48.5%) and 42.3% (41.3-43.6%) for RYGB and OAGB, respectively (p = 0.499). The mean %EWL after bypass in these patients (41.1%) at 24 months was statistically lower ($p < 0.05$) than the mean %EWL of the entire patient population (75.7%), and as well lower than the mean %EWL of patients who had WR (80.8%) (Figures 2 and 3).

Discussion

There are many reasons for revisional surgery after gastric banding and/or LSG. If we exclude long-term complications, the conversion of LAGB to LSG is often due to the patient's poor compliance with the banding and/or to IWL[4,5]. IWL is the most frequently recorded after LSG. Indeed, several authors have shown an important LSG failure rate, with a long-term incidence of WR ranging from 14% to 37%, and with up to 36% of patients needing revisional surgery at 10 years of follow-up[19,20]. In these patients, the choice of the best revisional surgery is complex caused by the lack of standardized guidelines[14,15,21-29]. Patients often do not tolerate the resizing of LSG due to the onset or aggravation of gastroesophageal reflux, and moreover LSG often does not allow sufficient weight loss. A recent Consensus Conference regarding revisional bariatric surgery showed that following LSG, experts indicated RYGB (94.3%) and OAGB (84.3%) as acceptable procedures with good results[30]. However, this study takes into consideration only patients with previous LSG, and not with a history of failure after multiple restrictive procedures. In our opinion, for these patients, the revisional procedure should be chosen appropriately, not only taking into account several aspects, such as eating habits and psychological attitude, but also the weight results obtained in the previous surgeries.

In the present study, the weight loss results after restrictive procedures seem to show a better response after OAGB as compared to RYGB at 2 years of follow-up. However, the specificity of the population analyzed makes it difficult the comparison with literature data. In a large multicenter study, Poublon et al[21] found that OAGB 2 years after surgery gave better results than

Table III. %EWL stratified by MPR outcome at 3, 6, 12, and 24 postoperative months.

Variable	IWL			WR		
	RYGB	OAGB	*p*-value*	RYGB	OAGB	*p*-value*
%EWL at 3 months	30.9 (17.8-38.1)	36.4 (31.3-38.5)	0.057	35.6 (28.9-38.9)	45.1 (42.5-46.6)	0.005
%EWL at 6 monts	38.5 (25.9-55.5)	47.5 (39.6-55.8)	0.092	55.8 (53.7-60.9)	57.5 (51.4-59.8)	0.723
%EWL t 12 monts	52.6 (38.8-62.4)	63.4 (41.6-72.4)	0.211	73.05 (71.4-77.7)	64.1 (62.5-65.6)	0.011
%EWL at 24 months	57.8 (42.7-92.1)	72.7 (46.8-88.5)	0.047	80.9 (78.7-84.6)	80.5 (76.2-87.8)	0.999

*Wilcoxon-Mann-Whitney test. IWL: insufficient weight loss; WR: weight regain; %EWL: % excess weight loss; RYGB: Roux-en-Y gastric bypass; OAGB: one anastomosis gastric bypass. *Wilcoxon-Mann-Whitney test. IWL: insufficient weight loss; WR: weight regain; %EWL: % excess weight loss; RYGB: Roux-en-Y gastric bypass; OAGB: one anastomosis gastric bypass.

RYGB in the case of conversion after banding or sleeve failure, even if the weight loss result was slightly lower than ours. Similarly, in a recent meta-analysis regarding OAGB as a revisional procedure after restrictive surgery, Yeo et al[31] found that, in the five studies comparing the two bypass techniques, weight loss results were better after conversion to OAGB than to RYGB. In the present study, for both types of bypasses, the gastric pouch had been recalibrated on a 36-38 Fr probe, which allowed the restrictive part to be recovered after the physiological dilation of the stomach following LSG. On the other hand, the more malabsorptive behavior of OAGB appeared to have a greater impact on weight loss in patients with a history of prior restrictive interventions.

The analysis of the different groups of patients who underwent revision showed that, for the IWL group, OAGB gave significantly better results than LRYGB, while, in the case of the WR group, there were no significant differences between the two interventions. In our opinion, these two groups of patients are different, and they have different responses to different surgical techniques. Patients who do not respond sufficiently to restrictive techniques are often the ones who have learned eating habits allowing them to bypass the caloric restriction induced by the surgery. The addition of an important malabsorptive component, such as after OAGB, could allow to improve the results in this particular subgroup of patients. On the other hand, our results seem to show that, 2 years after surgery, patients who had WR following MRP responded better than those who had IWL, regardless of the type of bypass. To our knowledge, there are no literature reports comparing the two techniques for patients with only WR after MRP. The analysis of the results of the single techniques often mixes patients who had WR with those who had IWL, with results consequently difficult to compare. In a recent retrospective study of 29 patients receiving OAGB for WR after LSG, AlSabah et al[32] have showed a response trend for OAGB similar to that recorded in our study. Gerges et al[32] have showed overall results after OAGB for LSG failure consistent with ours, but patients with IWL appeared to have better responses in their study. The explanation could be related with the short follow-up (12 months) reported in this study. Better results are evident if we compare our data on the conversion to one of the two types of bypass with another restrictive technique, such as the re-sleeve. The results recorded in the present study are significantly better than those of literature concerning a re-sleeve in the treatment of WR after LSG showing %EWL at 24 months between 46.5% and 53.4%[33,34]. This difference seems to reinforce the concept of the need for a more malabsorptive intervention after MPR.

The choice of calculating a cut-off to get a predictive value on the results of revisional surgery arises from the literature evidence of a significant reduction in %EWL trend after 12 months in patients undergoing malabsorptive revision surgery. This series shows %EWL at 12 months and at 24 months of 47.4-74% and 48.0-84%, respectively[14-18]. This reduction, which was also found in our study, is indicative of the weight loss potential of the procedure. Therefore, the mean value found at 12 months provides a good indicator of the Probability of Success (PS) at 24 months after revisional surgery. The PS of gastric bypass surgery is much higher in subjects in whom % EWL of 63.5% was recorded at 12 months after surgery. The statistical analysis of the performed regression model confirms both this evidence from literature and the choice of the cut-off. Based on the results obtained, it is noted that the PS increase in the bypass operation corresponds to the increase in the time elapsed between sleeve and bypass, as well as to the use of the OAGB procedure rather than the RYGB one (Table II and Figure 2). The best results found in those patients with a longer time elapsed between LSG and gastric bypass could have two explanations. The first one, in agreement with Yorke et al[29], is that, in this long period, the patients had probably tried and failed several other ways to increase %EWL, so as to become maximally compliant with the therapies and postoperative indications. The second one is that, as evidenced in several studies[35,36], the variations in ghrelin and GLP-1 induced by LSG determine a long-term change in the metabolic structure. This hormonal variation could be added to that induced by a bypass in the medium term (foregut hypothesis)[37], and therefore could further reduce the caloric intake after malabsorptive surgery.

We found that patients (19.2%) who had experienced a weight change close to 0% after the two restrictive techniques had unsuccessful results, even after malabsorptive surgery. Although several authors identify the cause of the bariatric surgery failure in the incorrect technique choice and in the poor patient's compliance, no data are currently available in literature regarding this topic in patients undergoing post-MRP malabsorptive surgery[27,38,39]. In our opinion, although adequately prepared from a psychological and nutritional point of view, there is a small percentage of individuals refractory to bariatric surgery, regardless of the surgical treatment performed. This could be due to an anomalous and ectopic entero-stomal production, not altered by the metabolic modifications induced by surgery, since they are controlled by other regulatory molecular pathways[40,41].

Finally, recent studies and meta-analyses[21,42-44] have highlighted how the choice of the revision procedure should be evaluated very carefully considering the high complication rate and the high incidence of readmissions for the two procedures. In the revisional setting, the incidence of anastomotic leaks (2.9% *vs.* 2.4% p=0.684)[43] and reoperations rate (5.4% *vs.* 8% p=0.182)[44] did not show significant differences between RYGB and OAGB. These data are comparable to those found in our case series.

The present multicenter study has several limitations. First, it is a retrospective study which enrolls a small number of patients; second, there was no standardization regarding the indications for surgical revision. In the absence of clear guidelines, the decision often arises from the patient's preferences in accordance with the surgeon's experience. Future prospective randomized studies on larger samples are needed to confirm our findings.

Conclusions

The results of the present study seem to show that both techniques give good results at 24 months for patients who have undergone multiple previous restrictive surgeries. However, OAGB would show better overall results, particularly in patients with IWL. The longer the time between the sleeve and the conversion is the better the patient's response appears to be. Finally, the data presented and the comparison with literature show the need for a careful study of patients in the preoperative phase in order to better select the bypass procedure.

Conflict of Interest

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

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Statement of Informed Consent

For this type of study informed consent does not apply.

Statement of Human Rights

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or National Research Committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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