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ORIGINAL CONTRIBUTIONS

Greater Weight Loss with the Omega Loop Bypass Compared to the Roux-en-Y Gastric Bypass: a Comparative Study

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Abstract
Background Despite similar initial results on weight loss and metabolic control, with a better feasibility than the Roux-en-Y gastric bypass (RYGBP), the omega loop bypass (OLB) remains controversial. The aim of this study was to compare the short-term outcomes of the laparoscopic OLB versus the RYGBP in terms of weight loss, metabolic control, and safety.
Methods Two groups of consecutive patients who underwent laparoscopic gastric bypass surgery were selected: 20 OLB patients and 61 RYGBP patients. Patients were matched for age, gender, and initial body mass index (BMI). Data concerning weight loss, metabolic outcomes, and complications were collected prospectively.
Results Mean duration of the surgical procedure was shorter in the OLB group (105 vs 152 min in the RYGBP group; $p<0.001$). Mean excess BMI loss percent (EBL%) at 6 months and at 1 year was greater in the OLB group (76.3 vs 60.0 %, $p=0.001$, and 89.0 vs 71.0 %, $p=0.002$, respectively). After adjustment for age, sex, initial BMI, and history of previous bariatric surgery, the OLB procedure was still associated with a significantly greater 1-year EBL%. Diabetes improvement at 6 months was similar between both groups. The early and late complication rates were not statistically different. There were three anastomotic ulcers in the OLB group, in smokers, over 60 years old, who were not taking proton pump inhibitor medication.
Conclusions In this short-term study, we observed a greater weight loss with OLB and similar efficiency on metabolic control compared to RYGBP. Long-term evaluation is necessary to confirm these outcomes.

Keywords Roux-en-Y gastric bypass · Omega loop bypass · Weight loss · Morbid obesity · Bariatric surgery

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Introduction

Several prospective trials and meta-analysis have demonstrated the superiority of bariatric surgery on the medical treatment of severe obesity [1–3]. The Roux-en-Y gastric bypass (RYGBP) has been performed for more than 30 years [4] and is the procedure of choice for severe obesity with metabolic disorders in most of the bariatric surgical centers worldwide [5–7]. Nevertheless, the RYGBP is a technically demanding procedure, with a learning curve of more than 75 cases. The complication rate is 5 to 10 % in expert centers [8–10].

More recently, a simplified malabsorptive and restrictive procedure was described to be consisting of a unique gastrojejunal

anastomosis between a long gastric pouch and a jejunal omega loop of 200 cm. This procedure, as first described by Rutledge in 2001 and commonly called mini-gastric bypass or omega loop bypass (OLB), has the advantage of being technically simple with a low morbidity rate, especially in super obese patients with a high operative risk [11–13]. A small number of studies have compared the results of the OLB to those of the RYGBP. These studies, including only one randomized trial, have reported similar weight loss and metabolic improvement with the OLB compared to the RYGBP and a better feasibility with a lower complication rate in favor of the OLB [8, 12, 14, 15]. However, the OLB is still controversial, some arguing an increased risk of biliary reflux and consequent dysplastic changes of the gastric and esophageal mucosa in the long term [16].

Therefore, despite its promising previous results, the OLB has only been developed by a few teams and remains a controversial topic. Obviously, data on the OLB outcomes are still insufficient to consider this technique as a procedure of choice for most of the bariatric teams. The OLB efficiency, safety, and advantages have still to be confirmed in order to draw conclusion in regard to its real benefit to obese patients who apply for bariatric surgery.

The aim of this comparative study was to assess the outcomes of the laparoscopic OLB versus the RYGBP in terms of weight loss, metabolic control, and safety.

Methods

Population and Study Design

Between May 2007 and February 2013, 366 laparoscopic gastric bypass procedures were performed in two expert centers of bariatric surgery (Edouard Herriot Hospital, Lyon, and Private Hospital of Loire, St Etienne, France) by two experienced surgeons. Fifty-six were omega loop bypass (15 %), and 310 (85 %) were Roux-en-Y gastric bypass. Patients with esophageal reflux or hiatal hernia were contraindicated for OLB. Data concerning weight loss, metabolic outcomes, and complications were collected prospectively at 2, 6, and 12 months postsurgery and then every 6 months. In order to adequately compare OLB and RYGBP procedures, we matched patients by age (±2 years), gender, and body mass index (BMI) (±2 points). The first 20 OLB patients were compared to 61 RYGBP patients (n=81), matching one OLB to three RYGBP patients (Table 1).

Surgical Procedures

Laparoscopic Roux-en-Y Gastric Bypass

A five-port technique was used as described by Lonroth et al. [17]. It consisted in a small gastric pouch (30 cm^3) by stapling the stomach using a linear stapler. The first jejunal loop was used and moved up into an antecolic position after an epiploic transection so as to perform the gastrojujenal anastomosis. An end-to-side gastrojejunal anastomosis was performed using a linear stapler. Closure of the anterior part of the anastomosis was done using a running suture. The alimentary limb was 150 cm long. A latero-lateral jejuno-jejunal anastomosis was performed with a linear stapler. The closure of the Petersen area was systematic, using a non-resorbable silk suture (2/0).

Laparoscopic Omega Loop Bypass

A five-port technique was also used as described by Rutledge [11]. A long and narrow gastric tube calibrated with a 37-French bougie was performed using a linear stapler and began at the angle of the lesser curvature until the angle of His. A unique anastomosis was made between the bottom of the gastric tube and a long jejunal omega loop of 200 cm. It was an end-to-side gastrojejunal anastomosis done with a linear stapler and closed on its anterior part with a running suture.

Perioperative Data Analysis

Operative data evaluating the feasibility of the procedure were reported (duration of the procedure, operative complications, mean length of stay, conversions to laparotomy). Postoperative features at 2 and 6 months, 1 year, and at the end of the follow-up were prospectively collected using a computerized database devoted to bariatric surgery. The early complications (within 30 days after surgery) as well as the late complications rate were recorded. Reflux symptoms and dumping syndrome rate at 1 year were also recorded in both groups. Body weight, BMI, and excess BMI loss percent (EBL%) were reported and calculated to assess weight loss. Comorbidities including high blood pressure, type 2 diabetes (T2D), dyslipidemia, sleep apnea, and joint pain were evaluated and recorded at baseline and during the follow-up. Type 2 diabetes remission was defined as a cessation of antidiabetic treatments and HbA1c of <6 % and/or fasting blood glucose levels of <100 mg/dl, according to the American Diabetes Association (ADA) guidelines [18]. Improvement of dyslipidemia, high blood pressure, and T2D was considered to be established when medications were reduced. These comorbidities were considered in remission when medication was stopped. Obstructive sleep apnea syndrome (OSAS) was considered cured when continuous positive airway pressure (CPAP) was stopped and when apnea-hypopnea index (AHI) was inferior to 5/h. OSAS was considered improved when AHI decreased from baseline.

Statistical Analysis

MedCalc 9.0 (MedCalc Software, Belgium) was used for statistical analysis. Baseline differences between groups were assessed by Student's t test for quantitative variables. A chi-square test with Yates' correction for continuity was applied

Table 1 Baseline characteristics of the study groups

	OLB (n=20)	RYGBP (n=61)	p
Age (years) (range)	49.5 (21–65)	47 (20–70)	0.45
BMI (kg/m^2) (range)	40.1 (41.3–45)	42.3 (34.3–55.4)	0.10
Waist circumference (cm) (range)	116 (86–150)	121.8 (89–155)	0.23
Sex ratio (female, %)	70	70.5	0.81
Previous bariatric surgery (%)	2 (10)	28 (45.9)	0.009
Arterial hypertension (%)	10 (50)	26 (42.6)	0.75
Type 2 diabetes (%)	8 (40)	23 (37.7)	0.94
Insulin treatment	2 (25)	8 (35)	0.24
>1 antidiabetic drug	2 (25)	9 (39)	0.1
Sleep apnea (%)	5 (25)	28 (45.9)	0.17
Dyslipidemia (%)	8 (40)	25 (40.9)	0.86
Joint pain (%)	12 (60)	35 (57.3)	0.96

OLB omega loop bypass, *RYGBP* Roux-en-Y gastric bypass, *BMI* body mass index

for comparison of proportions. The impact of the surgical procedure and the effect of time on EBL% during the 1-year follow-up were determined using a statistical mixed model. A multiple regression analysis using several dependent variables (type of surgical procedure, age, initial BMI, gender, and history of previous bariatric surgery) was performed to explain EBL% variance. $p<0.05$ was considered significant.

Results

Operative Data

The mean duration of the surgical procedure was 105 min for the OLB group (range 75 to 210) and 152 min for the RYGBP group (range 70 to 285) ($p<0.001$). Neither conversion to laparotomy nor intraoperative complications occurred in whatever study group. The mean length of stay was 4.2 days in the OLB group versus 4.8 days in the RYGBP group ($p=0.019$).

Weight Loss Results

There was no lost to follow-up. Mean EBL% evolution is presented in Fig. 1. Using a mixed model, we observed the influence of time ($p<0.0001$), of the type of surgical procedure ($p=0.0008$), and of the interaction time × procedure ($p=0.009$), on EBL%. From 6 months to 1 year, we observed a significantly greater EBL% in the OLB group versus the RYGBP group. Mean EBL% obtained at 6 months with the OLB procedure (76.3 %) was equivalent to mean EBL% obtained at 12 months with the RYGBP procedure (71 %). EBL% at 1 year was 89 % in the OLB group and 71 % in the RYGBP group ($p=0.002$). BMI was lower in the OLB group at 6 months (28.8 vs 32.3 kg m^{-2}, $p=0.001$) and 12 months (26.89 vs 30.40 kg m^{-2}, $p=0.002$).

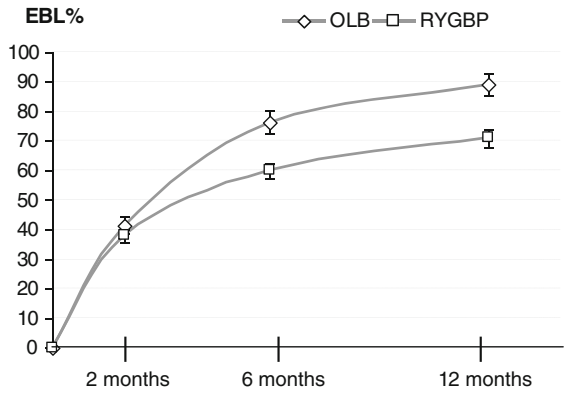
Using a multiple regression model, we determined that the OLB procedure was associated with a greater 1-year EBL%, regardless of a history of revision surgery ($p=0.01$). Factors significantly associated with the best EBL% at 1 year were OLB procedure ($p=0.07$), absence of previous bariatric surgery ($p=0.02$), and low initial BMI ($p=0.001$). Female gender was not significantly associated with better EBL% ($p=0.058$). In dividing the population into three age groups (<40 years old, between 40 and 55 years old, and >60 years old), we did not observe any influence of age on weight loss results regardless of the procedure.

Remission Rates of Baseline Comorbidities and Metabolic Control

All comorbidities were improved after OLB and RYGBP procedures. Remission rates of these comorbidities were similar between both groups, 6 months after surgery (Table 2). Concerning type 2 diabetes, especially, we observed a high rate of improvement in both groups. In the RYGBP group, six patients were able to stop insulin (75 %), and 15 had their oral antidiabetic medication reduced (65 %) versus 1 (100 %) and 3 (37.5 %) in the OLB group, respectively.

Complications

The mean follow-up was 21.4 months. There was no gastro-esophageal reflux in the RYGBP group and a 10 % rate in the OLB group at 1 year. No patient complained of dumping syndrome in the OLB group, whereas four patients had a Sigstad score over 7 in the RYGBP (6.5 %) and were improved by alpha-glucosidase inhibitor medication. The early and late complication rates were not statistically different between OLB and RYGBP groups ($p=0.97$ and $p=0.55$, respectively). Early complications occurred in two patients



OLB	41.5%	76.3%	89.0%
RYGBP	37.9%	60.0%	71.0%
p	*0.36*	*0.001*	*0.002*

Fig. 1 Evolution of excess BMI loss percent (*EBL%*) in omega loop bypass (*OLB*) and Roux-en-Y gastric bypass (*RYGBP*) groups during the first year of follow-up. Data presented are arithmetic means ± standard error of the mean

in the OLB group (10 %). Both concerned patients over 60 years of age. One required a drainage at postoperative day 1 due to hemorrhage on the port site. The other one presented with an anastomotic ulcer and complained of epigastric pain and food intolerance. The patient did not take the proton pump inhibitor (PPI) medication. The upper gastrointestinal endoscopy confirmed the diagnosis at postoperative day 30. The anastomotic ulcer healed after good observance of PPI medication (80 mg/day during 2 months). There were also two late complications in the OLB group (10 %). Both were complicated anastomotic ulcers in smokers over 60 years of age. One presented with a perforated anastomotic ulcer 11 months after surgery, after cessation of PPI treatment. He required a coelioscopic suture of the perforated ulcer. The other patient presented with an anastomotic bleeding ulcer 2 months after surgery when he was treated with antiplatelet drug and had stopped his PPI medication. He benefited from an emergency surgery with reversal of the OLB into normal anatomy. No death occurred in the OLB group.

In the RYGBP group, we observed four early complications (6.5 %): one anastomotic hemorrhage on postoperative day 3 which required a transfusion and an endoscopic metallic clip placement; one pneumonia; one anastomotic stenosis which was first dilated, followed by stent placement and a redo anastomosis 6 months after surgery; and one mesenteric hematoma at the jejuno-jejunal anastomosis responsible for bowel obstruction. This last patient was over 60 years of age and had benefited from a revision gastric bypass after failure of a gastric band. She required redo surgery on postoperative day 4 for drainage and adhesiolysis. The redo surgery was complicated by septic shock and a pulmonary embolism. The patient died 14 days after surgery of multiple organ failure. There were also two late complications in the RYGBP group (3.3 %), in patients under 45 years old: one anastomotic ulcer treated with prolonged PPI medication and one internal hernia, 1 year after the RYGBP, treated with laparoscopic reduction of the hernia, without bowel resection.

Table 2 Remission rates of comorbidities in omega loop bypass (OLB) and Roux-en-Y gastric bypass groups (RYGBP), 6 months after surgery

	OLB (%)	RYGBP (%)	Chi-square test (*p*)
Type 2 diabetes	62.5	26	0.16
Arterial hypertension	60	46	0.70
Sleep apnea	100	92.8	0.9
Dyslipidemia	75	44	0.26
Joint pain	50	34.3	0.54

Discussion

The omega loop bypass is quite a new bariatric procedure which has demonstrated initial promising results in terms of weight loss, feasibility, and safety [8, 12, 15]. However, its long-term safety remains controversial, and attitudes are slow to evolve, particularly since scientific evidence is lacking for most of the experienced bariatric surgeons. Therefore, the Roux-en-Y gastric bypass which has been carried out over 30 years is still the gold standard for many bariatric teams [4–7]. Our study compared the short-term efficiency and feasibility of the OLB versus the RYGBP. The main result of our bicentric study is that the OLB procedure achieved a significantly greater weight loss at 1 year than the RYGBP procedure (89 vs 71 %, p=0.002). This difference was not seen 2 months after surgery but appeared at the 6th month of evaluation. Indeed, we observed a time × procedure interaction in a statistical mixed model. This more significant weight loss effect observed with the OLB procedure represents an increase of +27 % of EBL% at 6 months and +25 % of EBL% at 1 year in comparison to the RYGBP. BMI decreased at 1 year from 40.13 to 26.89 kg m^{-2} in the OLB group and from 42.36 to 30.40 kg m^{-2} in the RYGBP group (p=0.002). These results are consistent with Lee et al.'s data [14] who found a higher EWL% with the OLB than with the RYGBP (72.9 vs 60.1 %) at 5 years. The weight loss superiority of OLB over RYGBP was independent of age, gender, initial BMI, and a history of previous bariatric surgery in a multiple regression model. All are more relevant in that the negative impact of advanced age, female gender, and previous bariatric surgery on weight loss after bariatric surgery is well-known [19–21]. Moreover, the rigorous patient selection that we performed in that study should avoid bias due to baseline characteristics of the study population. The reason why EBL% is better with the OLB compared to the RYGBP is still unknown, but we can postulate that

a greater malabsorptive effect could play a role, due to the long jejunal omega loop of 200 cm [8].

Beyond these good weight loss results, it is worth noting that all comorbidities, including T2D, high blood pressure, dyslipidemia, and OSAS were either improved or in remission 6 months after the OLB procedure. These results were similar and sometimes better than those obtained with the RYGBP ($p>0.05$), known to be the most efficient "metabolic bariatric procedure" [3, 22]. Concerning diabetes remission, even if it was not statistically significant ($p=0.16$), we observed a lower rate of remission in the RYGBP group (26 %) versus 62.5 % in the OLB group. This was probably due to a greater severity and a longer duration of type 2 diabetes in the RYGBP group. Indeed eight patients were treated by insulin (35 %) in the RYGBP group versus two (25 %) in the OLB group. Nine patients had more than one oral antidiabetic drug (39 %) in the RYGBP group versus two (25 %) in the OLB group. Nevertheless, although T2D was not cured for several patients in the RYGBP group, it was improved for many since the discontinuation of insulin therapy ($n=6$, 75 %) or reduction of oral antidiabetic drugs ($n=15$, 65 %) was possible.

Since first described in 2001, several publications have reported a low complication rate and a good feasibility of the OLB which is technically simple [13–15]. Indeed, the procedure requires a unique gastrojejunal anastomosis between a long and narrow gastric tube and a jejunal omega loop of 200 cm. The gastric pouch which is about 25 cm long and 1.5 cm wide is a barrier to esophageal reflux. The unique anastomosis without section of the intestinal tract has also the advantage of no mesentery opening. This avoids the risk of internal hernia which is the first cause of bowel obstruction and late complications after the RYGBP [23]. This OLB anastomosis, being lower, is tension free and easier to perform, which could decrease the risk of anastomotic leak [8]. In our series, we observed no leaks in both surgical groups, whereas we reported one internal hernia in the RYGBP group. These data are consistent with previous publications. Lee et al. reported their 10-year experience comparing 1,163 OLB to 494 RYGBP [14]. They found a similar rate of leakage in both groups (1.3 and 1.4 %, respectively) and a higher rate of bowel obstruction in the RYGBP which was statistically significant (0.8 vs 0.1 %, $p=0.014$). In the present study, the mean operative time was significantly reduced in the OLB group (105 vs 152 min, $p<0.001$), and the mean length of stay was also significantly lower in the OLB group (4.2 vs 4.8 days, $p=0.02$). The early and late complication rates were not statistically different between OLB and RYGBP groups. Thus, our study seems to confirm the better feasibility of the OLB procedure compared to the RYGBP. According to Lee et al., the learning curve of the OLB is estimated to be about 30 cases and shorter than the RYGBP previously reported to be over 75 cases [8].

Currently, the RYGBP is still considered as the procedure of choice in case of severe metabolic disorders associated with morbid obesity. However, in case of massive abdominal obesity and/or super obesity with metabolic disorders, a two-step bariatric strategy (first restrictive and then malabsorptive) is often proposed due to technical difficulties and a high operative risk [24]. For a few years, the OLB procedure which combines food restriction and malabsorption appeared to us as a better choice for super obese subjects over 55 years old and with severe metabolic syndrome. Indeed, it offers less technical difficulties and a lower operative risk than the RYGBP and has the advantage of being a one-step procedure. Thus, in our practice, the OLB is becoming an alternative procedure to the RYGBP and to the two-step strategy in these high-risk patients.

What is striking in this study is the rate of anastomotic ulcers in the OLB group; we observed three anastomotic ulcers in patients over 60 years of age with inadequate observance of the PPI treatment. These results highlight the risk factors of anastomotic ulcers after OLB as already described in previous studies, among which are the absence of PPI medication [25] and tobacco consumption [26, 27]. The over 60 age factor also seems to increase this risk. Therefore, our team is now treating every patient with 80 mg of PPI for 6 months after OLB surgery followed by 40 mg between the 6th and 12th month postsurgery. Tobacco consumption appears as a contraindication to OLB regarding the severity of anastomotic ulcer complications. Since this protocol was adopted, the anastomotic ulcer rate has decreased. Despite a similar complication rate in both surgical groups, we observed one death in the RYGBP group. It concerned a 60-year-old woman who benefited from revision surgery. She presented with a mesenteric hematoma at the jejuno-jejunal anastomosis that probably occurred during closure of the mesenteric space. She then had a bowel obstruction and septic shock, followed by pulmonary embolism and multiple organ failure. This case report highlights the technical difficulties in performing a RYGBP, especially in the case of redo surgery, even for an experienced surgeon, and the severity of the surgical complications that may occur. These results also underline that even if it does not impact weight loss results, an age over 60 years old may be more frequently associated with severe complications.

This study has some limitations: it is not a randomized trial and the sample size is small. The mean follow-up is short (21.4 months), and therefore, late complications in both groups may be underestimated. Nevertheless, the weight loss difference observed between both groups is so significant that it is unquestionable. Moreover, even in considering the influence of age, gender, initial BMI, and history of previous bariatric surgery, the OLB procedure has still better weight loss results than the RYGBP.

Conclusion

It can take a very long time before the OLB controversy ends, especially concerning biliary reflux incidence and its consequences. This short-term study does not aim to answer this question. However, our results confirm the few previous published data concerning weight loss and metabolic efficiency of the OLB procedure in the short term [14]. Indeed, we observed a significantly greater weight loss with OLB and similar efficiency on metabolic control compared to RYGBP. We also confirmed the better feasibility of the OLB with a shorter surgical procedure and a lower operative risk, especially in super obese patients with central adiposity [13]. The OLB is still a quite new procedure, and long-term evaluation is lacking. Other randomized clinical trials with high statistical power are necessary to confirm that the OLB is more efficient and even safer than the RYGBP.

Conflict of Interest The authors certify having no disclosure and no commercial interest in the subject of study.

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