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Revisional versus primary Roux-en-Y gastric bypass: a case-matched analysis

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Abstract
Background Laparoscopic adjustable gastric banding (LAGB) has been a widely performed bariatric procedure. Unfortunately, revisional surgery is required in 20–30 % of cases. Data comparing revisional and primary gastric bypass procedures are scarce. This study compared revisional malabsorptive laparoscopic very very long limb (VVLL) Roux-en-Y gastric bypass (RYGB) with primary VVLL RYGB and tested the hypothesis that one-stage revisional laparoscopic VVLL RYGB is an effective procedure after failed LAGB.
Methods In this study, 48 revisional VVLL RYGBs were matched one-to-one with 48 primary VVLL RYGBs. The outcome measures were operating time, conversion to open surgery, excess weight loss (EWL), and early and late morbidity.
Results Surgical and medical morbidities did not differ significantly. No conversions occurred. The revisional group showed an EWL of 41.8 % after 12 months of follow-up evaluation and 45.1 % after 24 months based on the pre-revisional weight. The total EWL based on the weight before the LAGB was calculated to be 54.3 % after 12 months and 57.2 % after 24 months. The EWL in the primary RYGB group was significantly higher for both types of calculation: 41.8 %/54.3 % versus 64.1 % ($p < 0.001$ and <0.01) after 12 months and 45.1 %/57.2 % versus 70.4 % ($p < 0.001$ and <0.002) after 24 months.
Conclusions Revisional laproscopic VVLL RYGB can be performed as a one-stage procedure by experienced bariatric surgeons but shows less effective EWL than primary RYGB procedures.

Keywords LAGB · Laparoscopic adjustable gastric banding · Primary gastric bypass · Revisional gastric bypass

Bariatric surgery, the only effective treatment for morbid obesity, has shown effective long-term weight loss and good control of concomitant medical morbidity in randomized controlled trials [1, 2]. The number of operations performed is increasing worldwide. According to Buchwald's [3] report, 344,221 bariatric operations were performed by 4,680 bariatric surgeons in 2008. Of these operations, 220,000 were performed in the United States and Canada by 1,625 surgeons.

The most commonly performed procedures were laparoscopic adjustable gastric banding (LAGB, 42 %) and laparoscopic standard Roux-en-Y gastric bypass (RYGB, 40 %). The choice of procedure was dependent on patient factors and surgeon preference.

In terms of weight loss, biliopancreatic diversion (BPD) delivers the best results followed by RYGB, sleeve gastrectomy (SG), vertical banded gastroplasty (VBG), and LAGB [4]. Although studies have shown LAGB to be safe, with a low incidence of perioperative complications, higher reoperation rates than with other bariatric procedures were reported [5, 6]. Failure of LAGB may be due to

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implant-related problems (band slippage, intragastric band migration and leakage, breakage or disconnection of the tubing), dilation of the esophagus with consecutive motility disorders, or poor adaption of eating behavior to the restrictive situation [7].

To date, for patients with failed LAGB have several options for revisional surgery: rebanding or removal of the band and conversion to a malabsorptive procedure such as RYGB or BPD. This can be performed by either laparoscopic or open surgery, in one or two stages [8–11].

Independent of the indication for conversion, RYGB currently is the most commonly performed "rescue" operation [12, 13]. Findings have shown revisional RYGB to be safe and excess weight loss (EWL) to be satisfactory [14]. However, most of the studies have been case series with a moderate number of patients, a short follow-up period, and most importantly, differences in the pre-revisional body mass index (BMI). Few reports have compared primary and revisional RYGB in comparable cohorts of patients with respect to preoperative descriptives such as BMI or number of comorbidities [15]. Hence, this study aimed to compare the clinical outcomes of laparoscopic revisional and primary RYGB in a case-matched study.

Patients and methods

From January 2000 to December 2012, every patient who underwent a surgical procedure for morbid obesity and had a minimum follow-up period of 5 years was prospectively entered into our institutional database ($n = 789$). Demographics, perioperative parameters, early and late postoperative morbidity, mortality, and weight loss were collected.

Data collection

All patients with a revisional procedure for failed LAGB and a BMI higher than 35 kg/m^2 were enrolled in the study and matched one-to-one with patients from the prospectively collected database who were undergoing primary RYGB for morbid obesity. The matching criteria were gender, age, preoperative/pre-revisional BMI, and diabetes.

Morbidity was classified as early (30 days) postoperative in-hospital morbidity or late postoperative morbidity. Early morbidity was further stratified into surgical morbidity (i.e., anastomotic leak, wound infection) and medical morbidity (i.e., not directly related to the surgical procedure such as cardiac or pulmonary complications). Internal hernia, anastomotic stenosis, and gastrointestinal ulcer were considered to be late postoperative complications.

Weight loss was measured as EWL related to preoperative weight before the first procedure (i.e., the LAGB) and also as EWL related to the preoperative weight before the revisional procedure. This allowed differentiation between the absolute EWL of the primary and revisional procedures together and the absolute weight loss of the revisional procedure itself. The ideal weight for EWL calculations was based on Broca's formula [16]. The study was approved by the ethics committee of the state of Zurich, Switzerland.

Surgery

The standard procedure for failed LAGB at the time of the study was a laparoscopic RYGB with a long Roux limb, a common channel of 100 cm, and a biliopancreatic limb of 50 cm, known as the very-very-long-limb (VVLL) RYGB. A one-stage laparoscopic removal of the band together with RYGB was planned for all cases. A six-port approach was used.

The first step was removal of the gastric band followed by construction of the gastric pouch in an L-shaped manner with a linear stapler (Endo-GIA; U.S. Headquarters, Covidien, Mansfield, MA). Stapling in the scarred area of the stomach was avoided, and the stapler was used just below the scar tissue.

After construction of a small gastric pouch, a gastroenterostomy using a transorally introduced circular stapler (CEEA 25 mm; U.S. Headquarters, Covidien) was performed. After a distance of 100 cm had been measured orally from the ileocoecal junction, a jejuno-ileosteomy was performed using a linear stapler technique (Endo-GIA: medium/thick reloads with 3 rows; inner-to-outer row sizes of 3, 3.5, and 4 mm; Covidien). Before the end of 2008, all mesenteric defects were left open. After that, all mesenteric defects were closed as a routine step of the procedure.

Follow-up evaluation

The postoperative follow-up evaluation entailed four visits during the first year and annual visits thereafter for a minimum of 5 years.

Statistical analysis

Statistical analysis was performed with MedCalc, version 9, for Windows. Data are presented as medians with 95 % confidence intervals (95 % CI) or as means with standard deviations as appropriate. Comparison of variables used for the matching process between the two patient groups was undertaken using the Chi square test for categorical data and the independent t test for continuous data.

Because of the matching arrangement, comparison of outcomes was performed with the paired t test for continuous data and with the McNemar paired test for categorical data. The power analysis showed that a sample size of 37

patients in each group would have a 92 % power to detect a difference of EWL after 24 months in a mean of −0.120, assuming a standard deviation of differences of 0.211 using a paired *t* test with a 0.050 two-sided significance level. A *p* value lower than 0.05 was considered statistically significant.

Results

Descriptives

The revisional RYGB group consisted of 48 patients (12 males and 36 females) with a mean prerevisional BMI of 41.9 ± 6.7 kg/m^2 and a mean age of 43.5 ± 8.8 years. Of the 48 patients, 13 (28 %) had preexisting diabetes mellitus.

The primary RYGB group consisted of 48 patients (12 males and 36 females). All of the patients in the revisional group had undergone LAGB as a primary bariatric procedure. The indications for revisional surgery were band intolerance (with reflux, dysphagia, and/or esophageal dilation) in 30 patients, port or band leakage in 5 patients, band slippage in 8 patients, and poor weight loss without other band problems in 5 patients.

The mean interval between LAGB and the revisional procedure was 63.7 ± 32.2 months. The mean operative time differed significantly, with a mean of 201 ± 66.9 min in the revisional group and a mean of 161 ± 39.0 min in the primary group ($p < 0.002$). All procedures were performed laparoscopically without conversion, and all the patients underwent one-stage surgery except for one patient whose band had already been removed at another institution. The descriptive data for the two matched groups are shown in Table 1. The follow-up rate was 84.4 % after 24 months.

Table 1 Preoperative descriptives of the revisional and primary RYGB groups

	Revisional ($n = 48$)	Primary ($n = 48$)	*p* value
Mean age (years)	43.5 ± 8.8	42.7 ± 8.2	0.663
Mean BMI (kg/m^2)	41.9 ± 6.7	43.2 ± 5.6	0.356
Gender			
Male	12	12	0.877
Female	36	36	
Diabetes			
Yes	13	13	0.647
No	33	33	

BMI body mass index

Mortality and early and late morbidity between the groups

No mortality was observed. Table 2 shows the early and late morbidity in the groups. The two groups did not differ significantly, especially in terms of leak rate or septic complication rate.

Two leaks occurred in the revisional group compared with no leak in the primary group. The one leak occurred on postoperative day 5 and led to reoperation with revision of the gastroenterostomy, an omental patch, and drainage. Under total parenteral nutrition and antibiotic therapy, the patients showed no signs of leakage on computer tomography on postoperative day 31.

The other leak occurred on postoperative day 1 and led to reoperation with oversewing of the leakage and drainage. Control contrast studies showed a persistent leakage, and the patient underwent stenting combined with total parenteral nutrition and antibiotic therapy. This led to a full clinical and radiologic recovery of the patient, with consecutive removal of the stent.

Postoperative BMI and EWL

The maximum EWL after LAGB was 44.8 %. The prerevisional EWL (between initial weight and weight before revision) was 27.1 %. The revisional procedure itself led to a significantly higher EWL after 12 months (54.3 vs 27.1 %; $p < 0.001$) and after 24 months (57.2 vs 27.1 %; $p < 0.001$) than before revisional EWL.

The revisional group showed an EWL of 41.8 ± 17.9 % after 12 months of follow-up evaluation and 45.1 ± 21.4 % after 24 months, as calculated on the basis of the pre-revisional weight. Calculation of the total EWL based on the weight before the LAGB was 54.3 ± 16.6 % after 12 months and 57.2 ± 19.71 % after 24 months. The EWL in the primary RYGB group was significantly higher with both types of calculation: 64.1 ± 16.6 % after 12 months and 70.4 ± 12.2 % after 24 months. Tables 3 and 4 show the EWL and BMI data.

Discussion

The main finding of our study was the significantly lower EWL in the revisional RYGB group. According to the power analysis, we included a sufficient number of patients in our study to demonstrate less EWL in the revisional RYGB patients than in the primary RYGB patients. We calculated the EWL on the basis of the initial weight before both LAGB and the revisional procedure, and both showed a significantly lower EWL.

Table 2 Early and late postoperative complications

	Revisional RYGB ($n = 48$)	Primary RYGB ($n = 48$)	p value
Early surgical morbidity			
Leaks	2	0	0.5
Wound infections	3	3	1.0
Bleeding	1	1	1.0
Intraabdominal abscess/sepsis	2	0	0.5
Incisional hernia	1	1	1.0
Late complications			
Gastrointestinal stricture	2	1	1.0
Gastrointestinal ulcer	1	1	1.0
Incisional hernia	2	3	1.0
Internal hernia	3	0	0.25
Ileus	3	3	1.0

RYGB Roux-en-Y gastric bypass

Table 3 EWL data of revisional and primary RYGB groups

	Revisional ($n = 48$)	Primary ($n = 48$)	p value
12 months			
Based on initial weight	54.3 ± 16.6	64.1 ± 16.6	<0.01
Based on pre-revisional weight	41.76 ± 17.9	64.1 ± 16.6	<0.001
24 months			
Based on initial weight	57.2 ± 19.7	70.4 ± 12.2	<0.002
Based on pre-revisional weight	45.1 ± 21.4	70.4 ± 12.2	<0.001

Table 4 Postoperative BMI data of revisional and primary RYGB groups

	Revisional ($n = 48$)	Primary ($n = 48$)	p value
12-month BMI	32.7 ± 5.1	28.6 ± 4.1	<0.001
24-month BMI	31.8 ± 5.4	27.4 ± 3.9	<0.001

Overall, the complete EWL was satisfactory for revisional surgery patients, at almost 60 % after 2 years. Still, the weight loss with LAGB followed by revisional RYGB was significantly lower than with the primary RYGB. This finding of a lower EWL in patients undergoing revisional surgery is consistent with the few other matched comparative studies [12, 15].

One strength of our study was the homogeneity of the revisional patients, all of whom had LAGB as their primary procedure. In contrast, other studies had a heterogeneous collective consisting of LAGB, VBG, and other procedures [15].

The majority of our patients had either long-term complications of the gastric band (e.g., esophageal dilation, reflux, and motility disorders) or inadequate weight loss. Only 13 patients had technical band-related problems. We did not perform a stratified EWL comparison between these subgroups due to the small number of patients.

Choosing the good candidate for a LAGB is very challenging. Difficult selection criteria and high failure rates are probably the main reasons why this potentially easy procedure technically decreased from 63.7 to 17.8 % in the period from 2003 to 2011 [17].

Another strength of the study, was the fact that all the patients had laparoscopic surgery, and with one exception, all the patients had a one-stage procedure. Other non-matched studies on revisional procedures found a surprisingly better EWL after revisional RYGB. Topart et al. [14] found similar EWL after conversion from LAGB to RYGB in a retrospective case series of 58 patients.

In contrast to our study, the patients in these retrospective studies were not matched for preoperative BMI, and EWL was measured on the basis of initial weight and not pre-revisional weight. Sanchez et al. [18] reported an EWL of 80 % after 12 months in a retrospective case series with 30 patients, 24 of whom had undergone LAGB before revision. In their study, not all the patients had undergone LAGB as the primary procedure. A recently published systematic review of revisional surgery after failed gastric banding identified 15 studies with a total of 514 patients converted to RYGB.

The main disadvantage of these studies was their heterogeneity in study design, lack of standardized outcome measures between studies, and thus different end points such as postoperative BMI loss and percentage of BMI loss

or EWL. The systematic review reported by Elnahas et al. [19] after revisional gastric bypass was 57.8 % after 12–24 months and 48.2 % after 24–48 months.

Another newly published article compared 55 patients with revisional RYGB and 667 patients with primary RYGB. After 2 years of follow-up evaluation, the findings showed significantly less EWL in the revisional group, but the results still were acceptable according to the Reinhold criteria, which is consistent with our findings [20].

We used Broca's formula to calculate ideal weight and used pre-revisional and initial weight (before the first bariatric procedure) to calculate EWL. In calculating ideal weight and EWL, it is important to describe exactly which method is used because comparison of different studies essentially depends on standardized calculations.

It is a fact that the same bariatric procedure leads to lower weight loss in revisional RYGB patients after LAGB than in primary RYGB patients. Several reasons may explain this finding. Patients undergoing revisional RYGB may have adjusted their eating behavior after the primary procedure. They may represent a select group of patients who had poor compliance with diet protocols. Postoperative eating behavior is a predictive factor for weight loss [21, 22]. Poor compliance with postoperative diet protocols is shown by up to two-thirds of patients and leads to poor weight loss after bariatric surgery [23, 24]. This behavioral component might be one factor leading to significantly lower EWL for the same procedure in different patient groups. Also, physiologic adaptation of energy metabolism and uptake in the intestine could lead to poorer EWL when conversion to a more complex procedure occurs after failed LAGB.

Another possible explanation might be the challenging aspect of creating a small gastric pouch in an area of scarred tissue in patients with a previous gastric band. As a result of the scarred tissue in the band area, the gastric pouch volume might be larger because the surgeon tries to avoid using a stapler device in thickened, scarred gastric tissue.

We did not calibrate the pouch with a balloon device. One single surgeon performed all the procedures, and the stapling of the gastric pouch was performed just below the scarred gastric wall. We believe that stapling through scarred and fibrosed tissue to create a small pouch is dangerous and may lead to an increased rate of leaks. The role of the gastric pouch has not been well studied, but creation of a small gastric pouch of $\sim$20 ml is recommended [25]. Two-dimensional pouch studies also have suggested better EWL in short-term follow-up assessment of patients with smaller pouches [26]. However, data are scarce, and three-dimensional pouch volume studies in a long-term follow-up setting are needed to investigate the role of initial pouch volume and possible pouch dilation in weight loss.

Early trends have favored gastric banding as the primary procedure for the treatment of morbid obesity because of its low early postoperative morbidity and mortality rates, easy technique, low rate of malnutrition, and especially the reversible nature of the procedure [27]. However, the long-term failure rate of the procedure is becoming more evident, with failure rates reaching 55 % [28–30]. This leads to an increasing number of revisional surgery procedures performed for failed gastric banding, challenging the daily work of bariatric surgeons [7].

Selection of good candidates for LAGB is difficult. Young women at the age of 40–45 years who have high compliance with nutrition protocols would be the best candidates for LAGB [31]. Unsatisfactory weight loss, currently defined as an EWL <50 % according to the Reinhold criteria [32], is only one of several reasons for revisional surgery after gastric banding. Available data show that insufficient weight loss is the reason for revision in up to 62 % of cases [33, 34], but other band-related problems that produce intolerable symptoms also lead to necessary band removal.

Band problems can be categorized into hardware, motility, or other factors [7]. Implant-related problems are band slippage, migration, leakage, breakage, or disconnection. Motility problems are gastric pouch dilation, esophageal dysmotility or dilation, and reflux, all of which are often summarized as band intolerance. Weight loss as a stand-alone problem was rarely the reason for revision in our cohort. Hardware and motility problems were the main problems, which led to insufficient weight loss as a secondary effect. In contrast to our study, Sanchez et al. [18] found insufficient weight loss in 40 % of patients to be the reason for revisional surgery.

After failure of a pure restrictive procedure, revision to a more complex bariatric method is recommended [9, 35, 36]. Findings have shown revisional surgery using the same type of surgery to be a poor alternative. Removal of the band and restoration of normal anatomy, which would be the easiest alternative, leads to weight regain and restoration of comorbidities [8, 37]. Conversion to a combined restrictive and malabsorbtive procedure is becoming the method of choice, but this still offers different options for bariatric surgeons.

Revisional surgery aims to offer a safe procedure with sufficient weight loss. Conversions to RYGB, BDP, and even SG have been suggested as revisional options. Topart et al. [39] showed that revision to the Scopinaro procedure, which consists of a diversion with a 200-cm alimentary limb, a 50-cm common limb, and a gastric volume varying between 200 and 500 ml, has higher morbidity and a longer operating time [38, 39].

Weight regain after RYGB still is a common and underestimated problem. Due to the high failure rate of

short-limb RYGB resulting in weight regain in up to 20 % of patients, we preferred the VVLL RYGB procedure, thus adding a malabsorbtive effect. A report by Muller et al. [37] in a nonrandomized trial showed no difference between a short-limb RYGB and an RYGB with a common channel of 100–150 cm after 4 years of follow-up evaluation. However, this trial was criticized as being underpowered because the detection of a 20 % reduction in the failure rate with a power of 0.8 would require 900 patients, and their study consisted of only 40 patients [40, 41].

The main reason for using a very very long type of bypass was the additional malabsorbtive effect for patients in whom creation of a small pouch was not always possible because of the previous surgery. Furthermore, we expected adapted eating behavior in the revisional patients. Considering an already failed bariatric procedure in the revisional group, the aim was to use a potential definitive revisional procedure for this group.

Revisional surgery for failed restrictive procedures has greater complexity, so a higher morbidity must be expected. Furthermore, a total laparoscopic approach might be difficult, and the need for primary open surgery or conversion from laparoscopic to open surgery may be more frequent. A two-step approach with band removal first followed by an interval and the second operation with the revisional procedure later also has been reported [12].

Our results showed that a laparoscopic removal and direct conversion to RYGB is safe and can be performed with early and late morbidity rates similar to those for primary procedures. We had two anastomotic leaks in the revisional group (4.2 %) compared with none (0 %) in the primary group. Although this difference was not significant, other reports show that revisional procedures might be associated with higher leak rates. Thus, we suggest that revisional procedures should be performed only by experienced bariatric surgeons.

We are aware that a very large number of patients would be needed to compare the safety of the two procedures. The operating time of the revisional procedures was significantly longer than that of primary procedures. The technique of stapling outside the fibrosed gastric scar tissue might be the reason for the low leak rate at the gastroenterostomy site. We believe that the scarred tissue after LAGB does not resolve in a timely manner, and the advantage of a two-step procedure might be overestimated. Furthermore, patients will regain weight after the sole removal of the band.

Increased experience with complex laparoscopic procedures can keep the conversion rate low, as demonstrated in our study. The rate of late complications was acceptable. Notably, more internal hernias occurred in the revisional group. We cannot explain this finding. After 2008, all mesenteric defects were closed with nonresorbable sutures. The two groups did not differ in terms of times required for the procedure.

In conclusion, revisional VVLL RYGB after failed LAGB has a good EWL but significantly less than primary VVLL RYGB. Primary RYGB has a higher EWL than LAGB and revisional RYGB combined.

We suggest a one-step procedure for removal of the band performed in experienced bariatric units to achieve low early and late morbidity rates and a low conversion rate. Avoiding stapling of the scarred tissue on the stomach might be the key to a low leak rate. Primary bypasses should be favored over revisional surgeries and over adjustable gastric banding.

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