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Original article

Surgical therapy of weight regain after Roux-en-Y gastric bypass

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Abstract

Background: Roux-en-Y gastric bypass (RYGB) is a well-established surgical method for morbid obesity; however, weight regain (WR) after initially good results may be considered an issue, the treatment of which has found no consensus yet.

Objectives: The aim of this study was to compare the different surgical methods treating WR after RYGB that are used at the Vienna Medical University in a larger number of patients, concerning further weight loss, complications, and reoperations.

Setting: University hospital, Austria.

Methods: This study includes all patients with RYGB who were reoperated due to WR at the Vienna Medical University by December 2016 (n = 84). The follow-up rate was 93%. The following 4 approaches to treating WR after RYGB were taken: (1) pouch resizing, (2) pouch banding, (3) pouch resizing plus pouch banding, and (4) common limb shortening (i.e., distalization).

Results: The mean maximum excess weight loss referring to the WR procedure in the 4 groups was as follows: group 1: 69.0% ± 35.2%, group 2: 62.8% ± 39.5%, group 3: 83.1% ± 30.9%, and group 4: 81.5% ± 41.6%. Reoperations occurred in the following different groups: group 1 had 2 balloon dilations (20%), groups 2 (n = 13) and 3 (n = 29) had 5 (38% and 17%) band removals each, and group 4 had 9 reversal procedures due to malnutrition (30%).

Conclusions: There are nonsignificant differences in terms of additional weight loss between the different methods. However, differences lay in the areas of adverse symptoms and further reoperations. While there was no risk of malnutrition with pouch resizing, there was with distalization. Pouch banding (with or without resizing) poses a higher risk of dysphagia. (Surg Obes Relat Dis 2019;■:1–10.) © 2019 Published by Elsevier Inc. on behalf of American Society for Bariatric Surgery.

Key words: Roux-en-Y gastric bypass; Weight regain; Pouch resizing; Pouch banding; Distalization

First performed in 1966, Roux-en-Y gastric bypass (RYGB) is a well-established surgical method for treating morbid obesity [1]. RYGB has been thoroughly studied by means of long-term follow-ups and large patient cohorts. It used to be the most commonly performed bariatric procedure worldwide up until 2013, when it was overtaken by sleeve gastrectomy [2].

Weight regain (WR) after initially good results or insufficient weight loss may be considered an issue after RYGB—as with most bariatric procedures—to varying extents [3]. For example, Hawkins et al. [4], in a study of 617 patients,

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found weight loss failure in 10.2% of their patients after 10 years. Different ways have been used to define WR after a bariatric procedure. For example, King et al. [5] state the best association with the clinical outcome to be WR as the percentage of maximum weight lost.

Treating WR after a bariatric procedure initially requires a systematic evaluation of potential causes—surgical, medical, and behavioral [6]. However, the present study focuses on the interventional aspect of managing WR.

Various ways of treating WR after RYGB, aside from endoscopic procedures, have been used and described; these include shortening the resorptive bowel length, banding the pouch, or pouch remodeling (e.g., pouch resizing, re-establishment of the anastomosis) [7–9]. These methods may be used separately or even combined depending on the diagnosis (e.g., pouch resizing plus banding in case of pouch dilation). In any case, before method selection, thorough diagnostics, such as gastroscopy, should be run [10].

However, because only a limited number of studies are available that compare these methods with one another and studies on the different methods are mostly based on small patient numbers, a consensus has not been reached regarding how to treat WR after RYGB. Thus, the aim of this study was to compare the different surgical methods treating WR after RYGB that are used at our department in a larger number of patients, in terms of further weight loss, complications, and reoperations.

Methods

The present study includes all patients who had a reoperation for WR after RYGB at our bariatric center before December 2016. Based on the definition by Langer et al. [11], WR was defined as weight gain of at least 10 kg starting from the lowest postoperative weight. All participants were dietologically counseled and had gastroscopies and upper gastrointestinal double-contrast X-ray series at our department before and after their reoperation.

All patients provided their informed consent in written form. The ethics committee, the local institutional review board, approved this study (reference number 2262/2017).

Surgical technique

Roux-en-Y gastric bypass

Until December 2011, RYGB at our department included creating a short pouch using a 48 Fr (16 mm) bougie, a long alimentary limb (150 cm), and a short biliopancreatic limb (65 cm). In the present study, 91.7% (n = 77) of the participants had this long-limb RYGB. Surgical technique was then changed to RYGB with a long and narrow pouch, alimentary limb of 65 cm, and biliopancreatic limb of 150 cm using a 36 Fr (12 mm) bougie ("diverted one anastomosis gastric bypass"). The latter version of RYGB was performed in 8.3% (n = 7) of the patients.

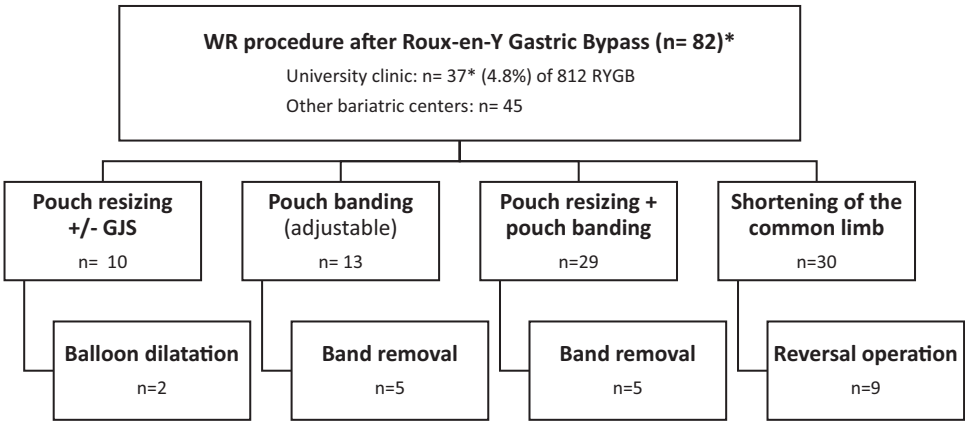
Reoperations

All patients had gastroscopies and double-contrast X-ray of the upper gastrointestinal tract before the reoperation, the results of which were used to choose the type of procedure for WR. In case of pouch dilation they had pouch resizing. A dilation of the pouch is defined as an enlargement making an inversion of the gastroscope possible, correlating to a minimum pouch diameter of 5 cm. If the efferent jejunal loop was dilated as well, pouch resizing combined with pouch banding was used to re-establish restriction. Finally, if no dilation of the pouch was detected, either pouch banding or shortening of the common limb were the procedures chosen. The decision was made for each patient individually here; however, decisive factors were whether the patient was a high-volume eater and whether he or she would be able to tolerate mild dysphagia.

In this retrospective survey, 4 approaches to treat WR after RYGB were used until December 2016. The first group of 10 patients (12%) had pouch resizing, which included decreasing the pouch's volume using a 36-Fr bougie. Five patients (6%) in this group additionally had a re-establishment of the gastrojejunal anastomosis. This part of the procedure was dropped later. The second approach was pouch banding using an adjustable band, which was placed 2 cm above the anastomosis (13 patients, 16%). The filling of the bands was adjusted individually for each patient. Third, 29 patients (35%) had pouch resizing combined with pouch banding, loosely placing nonadjustable bands at a minimum circumference of 6.5 or 7 cm. The last group of 30 patients (37%) only includes patients with long-limb RYGB who had a shortening of the common limb, which describes a distalization of the jejunojejunostomy. In this procedure, the biliopancreatic limb was elongated at the expense of the common limb, which was shortened to 100 cm. The alimentary limb (Roux limb) maintained a length of 150 cm, so the resorptive tract had a total length of 250 cm. It was assured preoperatively that all patients in this group were able to eat a normal portion of food to rule out a significant restriction (Fig. 1; Table 1).

Follow-up

The follow-up rate of this study was 93% (n = 76) with a minimal follow-up period of 1 year and a median follow-up of 43 months (range, 12–127 mo) after the reoperation. It is mandatory for inhabitants of Austria to inform the central state registry about their current home address. Based on this information it was possible to reach a high number of patients, who were contacted via telephone or mail. Participants were then invited to the clinic to check their present



Abbreviations: GJS: gastro-jejunostomy

The follow-up rate of this study was 93% (n=76)

* Two deceased patients were removed from this calculation.

Fig. 1. Study design.

weight and to enquire about any gastrointestinal symptoms, weight loss history, and history of reoperations.

Statistical analysis

The number of patients in this retrospective survey was limited by the sum of reoperations after RYGB due to weight regain until December 2016. Data are presented within the median and range, by mean and standard deviation or as percentages (where appropriate). X^2 tests, log rank test, and the nonparametric Mann-Whitney *U* test were used to compare sets of data. Univariate analyses were 2-tailed, with significance set at a *P* value of $< .05$. Percent excess weight loss (%EWL) was calculated based on an ideal body mass index (BMI) of 25 kg/m^2. Statistical calculations were performed using SPSS version 24 for Windows (IMB, Corp, Armonk, NY, USA).

Table 1
Patient characteristics

	All patients (n = 82)*
RYGB	
Median age OP, yr	36.5 (range, 17–61)
Sex (female), %	74 (90)
Weight, kg	131.2 ± 21.0
BMI, kg/m^2	46.8 ± 7.5
Previous bariatric operations	32 (39%)
Sleeve gastrectomy	7 (9%)
Vertical banded gastroplasty	4 (5%)
Gastric banding	21 (25%)
Treatments for WR	
Pouch resizing	10 (12%)
Pouch banding	13 (16%)
Pouch resizing and pouch banding	29 (35%)
Shortening of the common limb	30 (37%)

RYGB = Roux-en-Y gastric bypass; OP = operation; BMI = body mass index; EWL = excess weight loss; WR = weight regain.

* Two deceased patients were removed from this calculation.

Results

A total of 812 patients had an RYGB in our department by December 2016. Thirty-nine of these patients had to have a procedure for WR (4.8%). Forty-five patients who underwent RYGB at a different Austrian bariatric center had a WR procedure at our department as well in this time period. In total, this study includes 84 patients (n = 39 [46% from our center]; n = 45 [54% from other bariatric centers]) who were reoperated due to WR by December 2016. Two deceased patients were removed from the study; their deaths were unrelated to the procedures they had undergone. Of 82 remaining patients with reoperations for WR after RYGB, 90% were female and 10% male. Thirty-two of 82 patients (39%) had another bariatric procedure (sleeve gastrectomy, n = 7; vertical banded gastroplasty, n = 4; gastric banding, n = 21) before their RYGB.

Immediately before the RYGB, the mean weight and BMI in this study's collective were 131.2 kg and 46.8 kg/m^2, respectively. Patients had an averaging maximum EWL of 71.6% after their RYGB. The mean WR then was 20.3 kg, calculated from the lowest postoperative weight, which decreased EWL to 36.9%. The median interval between RYGB and the procedure for WR was 60 months (range, 9–144 mo). The results according to this study's 4 groups of patients (sorted by the type of surgery they had for WR) are as follows (also refer to Table 2). For a graphic representation of patient weight history refer to Fig. 2.

Table 2
History of weight after RYGB and weight regain procedure

	All patients (n = 82)*	*Pouch resizing* (n = 10)	*Pouch banding* (n = 13)	*Pouch resizing & pouch banding* (n = 29)	*Shortening of the common limb* (n = 30)	*P value*†
RYGB						
Median age at OP, yr	36.5 (R, 17–61)	33.2 (R, 21–61)	36.4 (R, 17–51)	34.7 (R, 17–56)	39.0 (R, 17–61)	.16
Sex (female), %	90	100	92	86	90	.57
Weight, kg	131.2 ± 21.0	121.5 ± 21.7	144.3 ± 18.2	128.3 ± 17.7	130.6 ± 23.1	.07
BMI, kg/m^2	46.8 ± 7.5	44.3 ± 8.4	51.0 ± 6.9	45.2 ± 6.0	47.0 ± 8.2	.10
Nadir 1						
Weight, kg	89.7 ± 22.5	87.0 ± 21.4	97.8 ± 19.1	80.9 ± 15.8	95.8 ± 27.4	.35
BMI, kg/m^2	32.2 ± 10.1	31.4 ± 7.7	31.0 ± 11.8	30.6 ± 10.9	34.5 ± 9.2	.49
Change BMI, kg/m^2	14.6 ± 7.0	12.9 ± 9.0	20.0 ± 10.2	14.6 ± 4.1	12.5 ± 6.1	.06
EWL, %	71.6 ± 28.9	66.0 ± 40.9	66.2 ± 17.7	85.0 ± 19.8	62.4 ± 33.3	.07
TWL, %	31.6 ± 11.2	28.4 ± 16.3	32.2 ± 8.2	36.9 ± 10.3	26.6 ± 12.5	.12
Median post-OP time, mo	12 (R 6–48)	12 (R 12–12)	12 (R 9–48)	12 (R 7–40)	12 (R 6–41)	.54
Reoperation						
Weight, kg	110.0 ± 22.5	108.3 ± 21.3	118.5 ± 23.9	107.8 ± 22.8	109.4 ± 22.4	.55
BMI, kg/m^2	38.9 ± 7.2	39.0 ± 8.1	41.3 ± 6.9	37.7 ± 6.5	39.1 ± 7.7	.34
EWL, %	36.9 ± 29.9	27.8 ± 26.2	36.3 ± 24.6	44.1 ± 23.9	33.8 ± 21.3	.49
TWL, %	16.2 ± 6.5	10.8 ± 5.6	17.9 ± 7.9	15.9 ± 5.3	16.2 ± 4.9	.26
Median post-OP time, mo	60 (R 9–144)	54 (R 24–144)	43 (R 19–98)	72 (R 9–136)	60 (R 9–120)	.49
Nadir 2 (n = 76)						
Weight, kg	84.1 ± 21.7	78.4 ± 23.3	94.8 ± 28.3	83.9 ± 16.9	80.1 ± 20.7	.27
BMI, kg/m^2	30.0 ± 7.4	28.5 ± 8.3	33.2 ± 9.1	29.9 ± 5.6	29.1 ± 7.4	.37
Change BMI, kg/m^2‡	8.9 ± 5.4	10.5 ± 5.7	8.1 ± 5.2	7.8 ± 3.7	10.0 ± 5.7	.11
EWL, %‡	78.7 ± 39.7	69.0 ± 35.2	62.8 ± 39.5	83.1 ± 30.9	81.5 ± 41.6	.78
TWL, %‡	23.5 ± 9.2	27.6 ± 10.8	20.0 ± 11.3	22.2 ± 8.4	26.7 ± 12.8	.44
Median post-OP time, mo	12 (R 3–120)	12 (R 6–120)	12 (R 6–29)	12 (R 3–60)	15 (R 6–90)	.54
Actual (n = 76)						
Weight, kg	93.2 ± 22.4	87.6 ± 22.4	107.2 ± 29.6	88.0 ± 17.1	93.0 ± 21.1	.09
BMI, kg/m^2	32.8 ± 8.5	31.8 ± 7.7	34.1 ± 14.1	31.3 ± 5.4	33.9 ± 7.7	.70
Change BMI, kg/m^2‡	6.1 ± 3.6	7.2 ± 4.7	7.2 ± 3.7	6.4 ± 3.6	5.2 ± 3.0	.35
EWL, %‡	51.4 ± 35.3	43.8 ± 40.3	42.5 ± 35.5	61.6 ± 35.1	45.6 ± 32.0	.22
TWL, %‡	15.2 ± 5.5	19.1 ± 7.3	9.5 ± 4.4	18.4 ± 7.1	15.0 ± 5.1	.09
Median post-OP time, mo	43 (R 12–127)	27 (R 12–127)	81 (R 19–117)	32 (R 12–97)	55 (R 12–103)	**.02**

RYGB = Roux-en-Y gastric bypass; OP = operation; R = Range; BMI = body mass index; EWL = excess weight loss; TWL = total weight loss.
Bold *P* value .02 indicates median post-OP time is significantly different across the groups.
* Two deceased patients were removed from this calculation.
† Comparison of most differing values of each line.
‡ Referring to the reoperation.

Pouch resizing (n = 10)

Mean weight and BMI at the time of pouch resizing were 108.3 kg and 39.0 kg/m^2, respectively. Patients were able to lose 29.9 kg (69.0% EWL) after this procedure. The follow-up rate in this group was 90% (n = 9). Initial postoperative symptoms were reflux in 40% (n = 4) and dysphagia in 50% (n = 5) of the patients. Two (20%) needed a balloon dilation after the procedure. No significant differences could be found between the 5 patients (6%) who additionally had a re-establishment of the gastrojejunal anastomosis and the rest in terms of %EWL. None of the patients in this group had to be reoperated within the follow-up period.

Pouch banding (n = 13)

In the second group, mean weight and BMI at the time of pouch banding were 118.5 kg and 41.3 kg/m^2, respectively. Patients lost 23.7 kg (62.8% EWL) on average after this procedure. The follow-up rate in this group was 92% (n = 12). Postoperative symptoms were reflux in 8% (n = 1) and dysphagia in 54% (n = 7) of the patients. Five (38%) had to have the band removed after a mean of 28.0 months (range, 6.0–62.0 mo) due to dysphagia. These 5 patients had an initial EWL of 93.9% referring to the WR procedure before the band removal—by comparison, those patients who maintained their bands (n = 8) had a lower initial EWL of 47.2% (nonsignificant difference). By the end of the follow-up period (81 months), %EWL in both groups was nearly the same.

Pouch resizing combined with pouch banding (n = 29)

In this group, mean weight and BMI at the time of this procedure were 107.8 kg and 37.7 kg/m^2, respectively. Patients managed to lose a mean of 23.9 kg (83.1% EWL) after pouch resizing plus pouch banding. The follow-up rate in this group was 93% (n = 27). Postoperative symptoms were reflux in 17% (n = 5) and dysphagia in 31% (n = 9) of the patients. Bands had to be removed in 5 (17%) patients

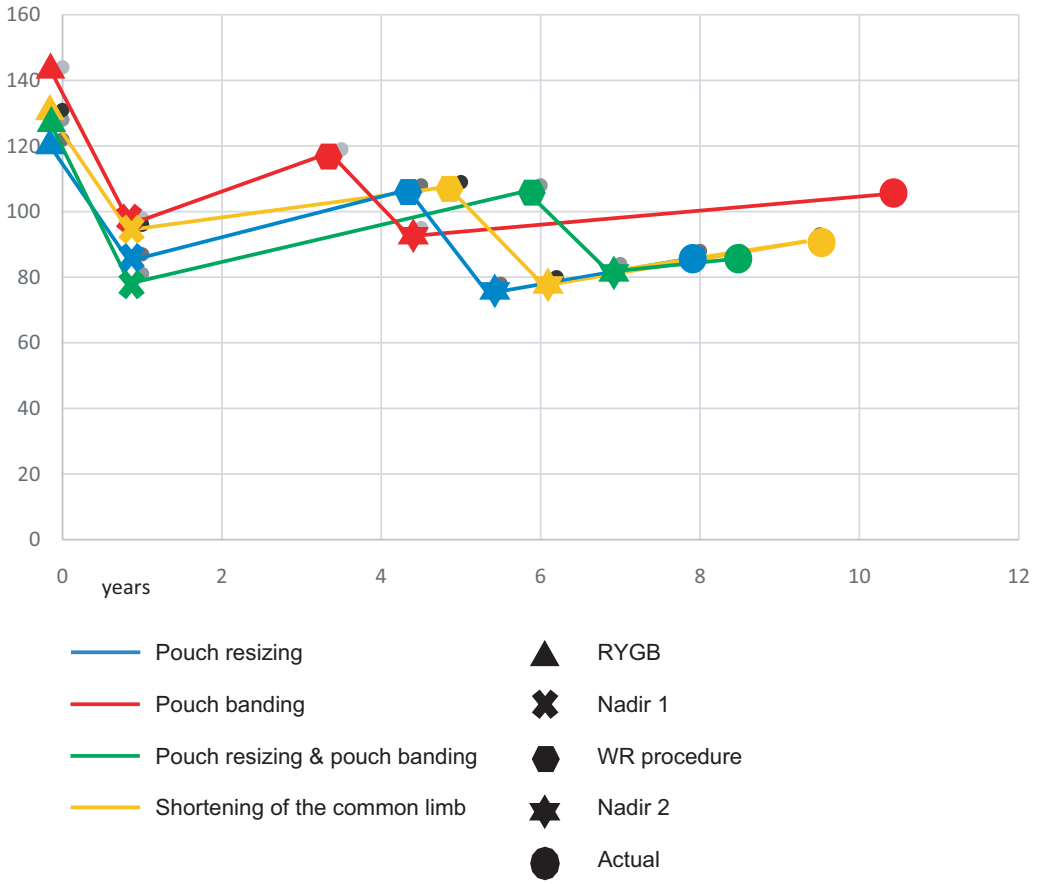


Fig. 2. History of weight in kilograms (n = 82).

after a mean 20.0 months (range, 5.0-44.0 mo) due to dysphagia. The removed bands all had a circumference of 6.5 cm. Again, there was no significant difference between participants who had their bands removed and those with bands in terms of %EWL by the end of the follow-up period (32 mo).

Shortening of the common limb (n = 30)

In the fourth group, mean weight and BMI at the time of this procedure were 109.4 kg and 39.1 kg/m^2, respectively. Patients lost an average of 29.3 kg (81.5% EWL) after the shortening of the common limb. The follow-up rate in this group was 93% (n = 28). Postoperative diarrhea was reported by 40% (n = 12) of the patients. None of the participants suffered from reflux or dysphagia. Because severe malabsorption could not be treated conservatively in 30% (n = 9) of the patients, they had to have another revisional surgery where the common limb was lengthened by 150 cm at the expense of the biliopancreatic limb, which was thus shortened by 150 cm. Hence, the total length of the small bowel in the food stream was 400 cm (150 cm of alimentary limb plus 250 cm of common limb).

These 9 patients had an initial %EWL of 146.6 referring to the WR procedure before the bypass restoration and an EWL of 67.7% by the end of the follow-up (55 mo), all symptoms of malnutrition were treated successfully.

To sum up, there were no significant differences between patients of the 4 groups in terms of weight loss or %EWL. However, it may be noted that group 3 (pouch resizing and pouch banding) had achieved the highest %EWL by the end of the follow-up, referring to the WR procedure (see Table 2). Starting from the lowest postoperative weight after the WR procedure, there was a decrease of %EWL and an increase of weight and BMI in all groups by the end of the follow-up period.

Subset analysis: primary RYGB and weight-regain procedure (n = 50)

This subset analysis includes all patients with RYGB as their primary procedure, followed by 1 of 4 WR procedures

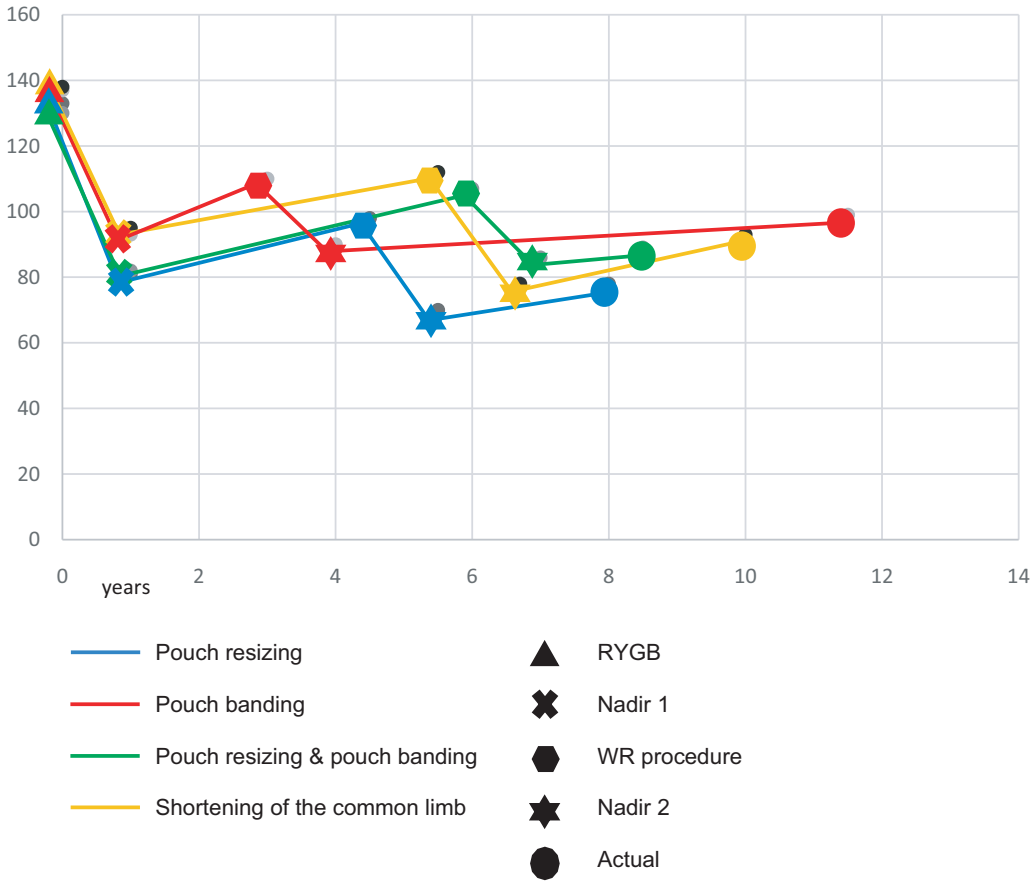


Fig. 3. History of weight in kilograms after primary Roux-en-Y gastric bypass (n = 50).

mentioned above. Hence, all patients who had had any other bariatric procedure before the RYGB were excluded from this subset analysis (Fig. 3).

Comparing the 4 groups here, there were no significant differences concerning %EWL; however, pouch banding (group 2) was slightly less effective (see Table 3). There were no significant differences when comparing patients who had had a bariatric procedure before RYGB (n = 32) and those who had not (n = 50).

Discussion

The current report presents nonsignificant differences in terms of additional weight loss between the different methods to treat WR after RYGB. However, differences lay in the areas of adverse symptoms and further reoperations.

WR (calculated from the lowest postoperative weight) after RYGB (as after most bariatric procedures) is a well-documented issue, and studies with long-term follow-up have been illustrating this fact to various degrees [4,12,13]. There are different reasons for WR: dilation of the pouch, gastrojejunal anastomosis or the jejunum, or a gastrogastric fistula. Further reasons may be the patients' eating behavior or metabolic imbalances [3]. In any case, as Yimcharoen et al. [14] argue in their survey of 205 RYGB patients, it should be considered performing gastroscopies on patients with WR as they found abnormalities (e.g., large gastrojejunostomy, large pouch) in 71.2% of their patients.

Two surgical principles are used to treat WR after RYGB: re-establishing restriction or adding malabsorption. The former includes pouch resizing, pouch banding (adjustable or nonadjustable), a combination of both, as well as endoscopic transoral interventions (e.g., sclerotherapy, endoscopic suturing). Malabsorption, on the other hand, is added by a distalization of the jejunojejunostomy, which includes a lengthening of the biliopancreatic limb and a shortening of the common limb [3]. Himpens et al. [15] have described various restrictive procedures and distalization

Table 3
Subset analysis: history of weight after primary RYGB and weight-regain procedure*

	All patients (n = 50)	*Pouch resizing* (n = 6)	*Pouch banding* (n = 7)	*Pouch resizing & pouch banding* (n = 23)	*Shortening of the common limb* (n = 14)	*P value*†
RYGB						
Weight, kg	133.5 ± 17.8	132.8 ± 12.6	137.0 ± 10.3	129.8 ± 17.5	138.2 ± 22.7	.55
BMI, kg/m^2	47.6 ± 6.6	47.3 ± 6.2	49.1.0 ± 5.0	45.8 ± 5.9	49.9 ± 8.4	.31
Nadir 1						
Weight, kg	86.7 ± 21.2	81.4 ± 23.4	93.3 ± 10.4	82.2 ± 15.8	94.8 ± 30.9	.30
BMI, kg/m^2	31.1 ± 10.8	29.0 ± 8.4	32.7 ± 13.3	29.1 ± 5.0	32.0 ± 9.9	.24
EWL, %	77.4 ± 24.3	86.6 ± 36.4	66.5 ± 17.0	82.0 ± 18.5	69.1 ± 29.7	.23
TWL, %	35.1 ± 12.4	38.7 ± 13.3	31.9 ± 8.9	36.6 ± 11.3	31.4 ± 11.9	.66
Median post-OP time, mo	12 (R 6–40)	12 (R 12–12)	12 (R 9–30)	12 (R 7–40)	12 (R 6–39)	.58
Reoperation						
Weight, kg	107.4 ± 21.8	97.5 ± 17.0	110.2 ± 17.0	107.0 ± 21.7	111.5 ± 26.2	.63
BMI, kg/m^2	37.9 ± 6.8	34.5 ± 6.2	38.6 ± 4.5	37.5 ± 6.2	39.8 ± 8.9	.46
EWL, %	41.3 ± 30.5	63.8 ± 20.4	38.7 ± 32.8	38.4.1 ± 29.9	38.9 ± 24.0	.39
TWL, %	19.5 ± 8.5	26.6 ± 10.3	19.6 ± 8.2	17.5 ± 5.9	19.3 ± 6.9	.24
Median post-OP time, mo	60 (R 14–136)	54 (R 24–84)	38 (R 24–72)	72 (R 24–136)	66 (R 14–120)	.08
Nadir 2 (n = 47)						
Weight, kg	82.4 ± 17.8	70.5 ± 7.5	90.6 ± 23.0	85.5 ± 16.9	78.2 ± 15.6	.11
BMI, kg/m^2	29.3 ± 5.9	26.5 ± 3.9	32.2 ± 8.1	30.0 ± 5.5	28.0 ± 4.9	.11
EWL, %‡	83.6 ± 39.7	95.2 ± 45.0	64.6 ± 42.3	81.1 ± 40.9	89.5 ± 52.6	.37
TWL, %‡	23.2 ± 8.6	27.7 ± 11.2	17.8 ± 14.3	22.2 ± 8.4	29.8 ± 11.8	.22
Median post-OP time, mo	12 (R 3–50)	11 (R 6–12)	12 (R 6–29)	12 (R 3–30)	15 (R 6–50)	.34
Actual (n = 47)						
Weight (kg)	89.4 ±17.4	78.0 ±5.1	99.2 ±24.9	89.7 ±16.6	98.7 ±16.5	0.26
BMI (kg/m^2)	31.1 ±7.7	27.6.8 ±2.4	33.5 ±16.6	31.7 ±5.2	32.7 ±7.3	0.34
EWL (%)†	57.6 ±32.3	64 ±33.8	40.4 ±42.5	58.4 ±42.1	56.3 ±44.3	0.25
TWL (%)†	16.7 ±5.8	19.1 ±7.3	9.5 ±4.4	16.2 ±5.1	11.5 ±6.6	0.18
Median post-OP time (mo)	40 (R 12–127)	27 (R 12–127)	100 (R 29–117)	32 (R 12–97)	52 (R 12–103)	**0.004**

RYGB = Roux-en-Y gastric bypass; OP = operation; R = Range; BMI = body mass index; EWL = excess weight loss; TWL = total weight loss.
Bold *P* value .004 indicates median post-OP time is significantly different across the groups.
* Patients with any bariatric procedure before RYGB were excluded; 2 deceased patients were removed from this calculation.
† Comparison of most differing values of each line.
‡ Referring to the reoperation.

and conclude that all have significant morbidity; the authors report a severe complications rate of 20.7%. Of course, weight loss after RYGB is also caused by a change in hormone release (e.g., ghrelin, peptide YY, or glucagon-like peptide 1) as well as an altered composition of the microbiome and bile acids [16–18]. Last, medication may be an option, as reported by Stanford et al. [19], who studied topiramate in this context.

Pouch remodeling

Al-Bader et al. [20] in a study of 170 patients with RYGB performed pouch resizing on 32 participants who had developed pouch dilation. After 14 months their BMI of initially 38.8 had gone down to 32.8 kg/m^2, the complications rate was 15.6%, and the reoperations rate 3.1% [20]. By comparison, Iannelli et al. [21] who performed pouch resizing due to WR after RYGB on 20 patients, found an %EWL of 72.2 and a complications rate of 30% after 12 months. Both studies present decent weight loss results after the pouch resizing procedure; however, long-term results on this method have yet to be published.

The results from Hamdi et al. [22] are interesting in this context. They performed pouch resizing by a resection and recreation of the gastrojejunostomy on 25 patients because of WR after RYGB. The authors found that up to 12 months postoperatively participants had statistically significant weight loss; however, at 24 months patients had regained enough weight to render their total weight loss statistically insignificant [22]. In comparison, the present study includes good results in terms of additional %EWL after pouch remodeling; however, there was an increase in weight toward the end of the follow-up as well. Symptoms of dysphagia were managed endoscopically.

León et al. [23] chose a slightly different but also restrictive approach to treating WR after RYGB. They performed a hand-sewn gastrojejunal plication (pouch, anastomosis, and "candy cane" are plicated and oversewn) in 4 patients who reached 46.2% additional weight loss after 6 months. Another method, laparoscopic wedge resection of the gastrojejunostomy, was performed on 9 patients after RYGB due to a dilated gastrojejunostomy (>2 cm) in a study by Elbahrawy et al. [23]. They report 64.6% further EWL after 12 months without complications [24].

While the studies discussed so far favor pouch remodeling procedures for WR after RYGB, Parikh et al. [25] come to a different conclusion. They performed gastrojejunal sleeve reduction (similar to pouch resizing) on 14 patients and an added lengthening of the Roux limb on 5 patients and found an additional EWL of only 12.0% after the revision. They argue that other methods should be considered for patients with WR after RYGB as neither procedure provided satisfactory results [25].

Pouch banding (combined with pouch resizing)

Another possibility to combat WR after RYGB is the placement of a loose nonadjustable silicon ring, which was studied by Dapri et al. [26] in a survey of 6 patients with hyperphagic behavior. At a mean follow-up of 14 months patients had an additional EWL of 23.4%, there were no complications. Gobble et al. [27] also studied gastric banding as revisional surgery after RYGB. Their study includes 11 patients who got adjustable bands for weight loss failure (initial EWL of only 38.0%) and who reached an additional EWL of 20.8% at 13 months follow-up. There were no complications; however, 1 patient was converted to open surgery.

A study on adjustable gastric banding after RYGB with a longer follow-up was presented by Bessler et al. [8]. Twenty-two patients had adjustable pouch banding due to a failed RYGB and reached an additional EWL of 47.0% after 5 years. Three patients had the following complications: small bowel obstruction, band slipping, and port infection, the latter of which required the band to be removed [8].

By comparison, patients who had gastric band placement in the present study were able to reach a higher additional % EWL. However, more bands had to be removed due to dysphagia and reflux, despite the fact that only adjustable bands had been used in the pouch-banding group (group 2).

Moon et al. [28] combined pouch resizing with pouch banding in a similar procedure as the present study's third group and presented comparable results. The authors describe the procedure as pouch resizing plus the placement of a pericardial patch ring (7–7.5-cm circumference) in their 46 patients who had this procedure due to WR or weight loss failure after RYGB. They reached 39.0% additional EWL after 12 months; however, by 24 months they only had 18.9% EWL, 8 patients (17.4%) with dysphagia, and 6 reoperations (4 band removals, 2 perforated ulcer repairs) [28]. The rate of band removals in the present study is higher, which may have been caused by the smaller circumference of the bands used (6.5 versus 7–7.5 cm). Another reason for the high removal rate may also be the length of the present study's follow-up, which is longer than most other studies performing secondary bypass banding. Thus, the authors recommend a circumference of at least 7 cm and a very loose placement of the band.

However, it has to be noted that while pouch banding usually prevents a (re-)dilation of the pouch, it comes at a cost. Some patients may develop symptoms, such as sickness and vomiting, and the band may need to be removed again. Even using adjustable bands has not prevented patients from developing these symptoms in the present study.

Shortening of the common limb

The first studies covering bypass distalization for WR after RYGB were published around the turn of the millennium. First, Sugerman et al. [29] described 5 patients who had had a bypass distalization with a common limb of only 50 cm, all of whom developed malnutrition and were revised. Two of them died due to hepatic failure. In a second group of 22 patients with a common limb length of 150 cm, the authors reported good weight loss results and 3 reoperations due to malnutrition [29]. Second, Fobi et al. [30] studied 65 patients who were converted from a Fobi pouch operation to a distal RYGB due to insufficient weight loss. Fifteen developed protein malnutrition, 6 of whom had to be converted to a short-limb gastric bypass [30]. Based on these results, bypass distalization procedures in this study's participants were performed, leaving a common limb of 100 cm in the passage, which was believed to be enough at the time.

Dapri et al. [7] studied shortening of the common limb as a way to handle WR after RYGB. In their survey of 7 patients and a mean follow-up of 19 months, they performed a bypass distalization to a common limb of 150 cm and report a total %EWL of 82.5 and 1 reoperation due to internal hernia [7]. In a retrospective study of 20 patients by Caruana et al. [31], the procedure was performed slightly differently. Ten patients had bypassed >70% of the small bowel length and 10 had bypassed <70%. In the first group, the authors found diarrhea in 5 patients and 3 had to be revised due to malnutrition. The additional EWL was 47% in the first and 26% in the second group [31].

Buchwald and Oien [32] studied 53 patients, 47 of whom had had a procedure in which both alimentary and common limb had been shortened to 75 to 100 cm, while 6 had them shortened to a total length of 250 cm, both groups due to failed RYGB. The mean BMI had decreased postoperatively from 47.2 to 31.4 kg/m^2 by 5 years. However, the complications rate was quite high; 23 patients (43.4%) needed total parenteral nutrition and 14 (26.4%) patients needed to be revised [32].

These results are quite similar to those of the present study in that the procedure caused good weight loss results on the one hand, and that the rate of patients in need of a relengthening of the common limb (RYGB restoration) was quite high on the other. This is why the procedure is performed differently at our department today, leaving a total length of at least 350 cm (common limb + alimentary limb) in the passage.

In a very present study, Ghiassi et al. [33] have published a retrospective study of 96 patients, reporting that after 3 years patients with a total length of 400 to 450 cm are less

likely to develop nutritional issues than patients with a total length of 250 to 300 cm in the passage. Most recently, Shin et al. [34] have reported bypass distalization to be an effective revisional procedure after failed RYGB in terms of additional weight loss and further improvement of comorbidities. They performed the procedure in 22 patients leaving a common limb of 100 to 200 cm and conclude that the risk of nutritional issues may be reduced by close follow-up and patient compliance [34].

In any case, the studies discussed in this section show that continuous follow-up is vital in patients that have been converted from RYGB to bypass distalization.

Endoscopic methods

A newer approach to treat WR after RYGB is endoscopic intervention, different methods of which have been presented by a number of authors. Baretta et al. [35] studied argon plasma coagulation in a nonrandomized prospective survey of 30 patients with dilation of the gastrojejunostomy. They had 3 sessions of argon plasma coagulation each and were able to lose 15.5 of 19.6 kg that patients had regained after the bypass. Complications were severe stenoses in 2 patients after the first session (they were removed from the study), and 1 patient with anastomotic ulcer after the final examination [35].

A randomized trial of endoscopic suturing for transoral outlet reduction was presented by Thompson et al. [36]. The study was based on 2 randomized groups, 50 patients who had the procedure and a sham group of 27 patients. The authors report level I evidence that the procedure is safe and effective at 6 months of follow-up to treat WR or insufficient weight loss after RYGB [36].

Some methods have been reported inefficient in treating WR after RYGB. Goyal et al., [37] for example, used the StomaphyX device on 59 RYGB patients with WR and state an average EWL of only 4.3% after 41 months. Thus, they do not recommend this tool to trigger weight loss in these patients [37]. Sclerotherapy as a means to treat WR after RYGB was explored by Giurgius et al. [38] in a study of 48 patients and a follow-up of 22 months. Patients received 2 sessions of the procedure each; however, no significant weight loss could be achieved [38].

Finally, Jirapinyo et al. [39] compared sclerotherapy (34 patients) with endoscopic suturing (9 patients) and report a total weight loss of 2.7% in the sclerotherapy group and 10.4% in the suturing group. They conclude that endoscopic suturing is superior to sclerotherapy in treating WR after RYGB [39]. In any case, long-term data still need to be awaited to draw a final conclusion.

Limitations of this study

As the present study is retrospective, the groups of patients were not randomized, but methods were selected individually for each patient as deemed most appropriate for their situation. Another limitation of this study is that while all patients had their WR surgery at our department, the procedures (RYGB) were performed at different Austrian bariatric centers. Furthermore, as this study includes every single RYGB performed at our center over the selected time period, not all of them were performed the same way. This is due to the fact that the technique was changed in 2012, as described earlier. Of course, this means this study is based on heterogenous groups of patients; however, this situation reflects the reality of bariatric surgery: methods do change and patients often do consult different clinics. Finally, this study is based on a small sample size, which was limited by the number of procedures performed at our department. Nevertheless, it should be added that compared to today's literature, this study is among the largest available.

Conclusions

There are different methods to combat WR after RYGB. Before any revisional procedure, dietologic counseling, double contrast X-ray of the upper gastrointestinal tract (or 3-dimensional volumetry), and endoscopic evaluation of the pouch and the anastomosis are advisable. Compared with one another, none of the 4 procedures applied in this study stood out in terms of nadir %EWL. However, referring to the WR procedure, pouch resizing combined with pouch banding achieved slightly better %EWL results by the end of the follow-up. Pouch banding may prevent a redilation of the pouch, but possibly at the cost of dysphagia and reflux. In any case, bands should be placed loosely and nonadjustable bands should have a minimum circumference of 7 cm. Shortening of the limb length increases the risk of malnutrition and diarrhea. Pouch resizing is safe and efficient in patients with pouch dilation. Weight loss after this procedure is comparable to common limb shortening; however, there is no risk of malnutrition.

Patients with WR after RYGB represent a difficult collective. Only 5% of our patients after RYGB had to be revised for WR. Nevertheless, 39% of those needing revisional surgery for WR after RYGB had another bariatric procedure (sleeve gastrectomy, vertical banded gastroplasty, gastric banding) before their RYGB. One might consider revising a mainly restrictive procedure to an operation with a considerable malabsorptive component (e.g., RYGB with a longer biliopancreatic limb).

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