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# Embracing the second chance: efficacy and safety of revisional bariatric surgery for weight regain

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## Abstract

**Aim:** Weight recidivism following bariatric surgery has major physical and psychological consequences. Revisional surgery is a common management option but is associated with increased complications compared to primary surgery. The objective of this study was to assess the efficacy and safety of revisional bariatric surgery for weight regain at our institution.

**Methods:** A retrospective database review identified patients who underwent revisional bariatric surgery for weight regain at our institution from 2014 to 2023. Emergent operations were excluded. The primary outcomes were percentage total (%TWL) and excess weight loss (%EWL) using revisional surgery weight as the baseline. Secondary outcomes were 30-day morbidity, mortality, readmission, and reoperation rates.

**Results:** Seventy patients were identified. Five types of revisional procedures were performed: 39 (55.7%) Roux-en-Y gastric bypass (RYGB) revisions (21 endoscopic, 11 laparoscopic, 6 robotic, 1 open), 15 (21.4%) sleeve gastrectomy (SG) to one-anastomosis gastric bypass (OAGB) conversions (8 robotic, 7 laparoscopic), 8 (11.4%) SG revisions (7 laparoscopic, 1 robotic), 7 (10.0%) laparoscopic gastric band to SG conversions, and 1 (1.4%) laparoscopic gastric band to OAGB conversion. SG to OAGB conversion had the largest mean 12-month %EWL at  $67.9 \pm 25.1$ , which was significantly greater than SG revision at  $47.4 \pm 6.7$  ( $P = 0.04$ ) and gastric band to SG conversion at  $44.1 \pm 21.1$  ( $P = 0.04$ ). SG to OAGB conversion also had the largest mean 12-month %TWL at  $19.1 \pm 9.4$ , significantly greater than RYGB revision at  $9.0 \pm 6.0$  ( $P < 0.001$ ). The 30-day morbidity rate for all patients was 7.1% ( $N = 5$ ), including 1 anastomotic leak following an SG revision requiring 1 reoperation (1.4%). The 30-day



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readmission rate was 5.7% ( $N = 4$ ) and there were no 30-day mortalities.

**Conclusion:** Revisional bariatric surgery is an effective tool for addressing weight regain and achieving sustained weight loss. Among the revisional options, converting SG to OAGB was most effective at promoting significant weight loss at 12 months. These findings highlight the important role of tailored revisional procedures in the broader context of bariatric care.

**Keywords:** Revisional bariatric surgery, weight regain, gastric bypass, sleeve gastrectomy

## INTRODUCTION

Weight recidivism following bariatric surgery is a significant clinical challenge with both physical and psychological consequences. Although metabolic and bariatric surgery (MBS) is the most effective evidence-based therapy for obesity, up to 30% of patients experience significant weight regain within five years postoperatively<sup>[1,2]</sup>. Weight regain can compromise a patient's quality of life and lead to the recurrence of several obesity-related comorbidities, such as type 2 diabetes, cardiovascular disease, and sleep apnea<sup>[3,4]</sup>. Additionally, the psychological toll of weight regain is an important consideration, as many patients experience feelings of failure, frustration, and lowered self-esteem, which can exacerbate underlying depression and anxiety<sup>[5]</sup>.

Revisional bariatric surgery is a common therapeutic option used to address weight regain. There are also several emerging medical weight loss therapies, such as glucagon-like peptide 1 (GLP-1) receptor agonists, that have demonstrated efficacy in treating weight regain<sup>[6]</sup>. However, revisional bariatric procedures are often more technically challenging than primary surgery due to the presence of altered anatomy in reoperative surgical fields. Revisional procedures are generally associated with higher postoperative morbidity compared to primary bariatric surgery due to these factors<sup>[7]</sup>. Despite these risks, revisional surgery can provide meaningful weight loss and improvements in obesity-related comorbidities for patients who experience unsatisfactory weight loss or significant weight gain after their initial procedure<sup>[8,9]</sup>.

The purpose of this investigation was to evaluate the efficacy and safety of revisional bariatric surgery for weight regain at our institution. We assess the perioperative and weight loss outcomes for several revisional bariatric procedures to better characterize the risk-benefit profile of revisional surgery and to inform patient decision making.

## METHODS

### Patient selection and demographics

A retrospective database review identified patients who underwent revisional bariatric surgery for weight regain at our academic center from 2014 to 2023. Emergent operations were excluded. Patient characteristics included age, sex, body mass index (BMI) at the time of revisional surgery, Charlson Comorbidity Index (CCI), surgical approach, operative time, hospital length of stay (LOS), and follow-up time. The type of initial and revisional bariatric procedure that each patient underwent was also tabulated.

### Weight loss and perioperative outcomes

The primary outcomes were percentage total (%TWL) and excess weight loss (%EWL) using weight at the time of revisional surgery as the baseline. Weight loss was calculated at 3, 6, 9, and 12 months postoperatively. Weight loss outcomes were compared between each type of revisional procedure at 12 months to determine the procedure that was most effective at treating weight regain. Secondary outcomes were 30-day morbidity, mortality, readmission, and reoperation rates.

### Surgical technique

For conversion from sleeve gastrectomy (SG) to one-anastomosis gastric bypass (OAGB), we begin by using a 34 Fr bougie dilator as a guide to create an approximately 15-20 cm gastric pouch with a 60 mm linear stapler. Indocyanine green (ICG) is used to assess vascular perfusion during this step. Hook cautery is then used to create an opening in the gastric pouch posterior to the staple line. We then identify the ligament of Treitz and count 200 cm distally. The small bowel is then brought up to the gastric pouch at this point and a stapled gastrojejunal anastomosis is created with a linear stapler. The bougie is then advanced into the small bowel and the common enterotomy is closed in 2 layers (inner absorbable, outer permanent). A complete upper endoscopy is then performed.

Re-SG was performed for SG revision. A 34 Fr bougie dilator is first advanced into the pylorus and placed under suction. Using this as a guide, vertical SG is then performed using a 60 mm linear stapler with staple line reinforcement beginning about 6 cm from the pylorus. The stomach is stapled from the pylorus parallel to the lesser curve toward the angle of His. The upper 10 cm of the staple line is then imbricated with absorbable suture and reinforced with surgical glue. A complete upper endoscopy is then performed. Two-stage gastric band to SG conversion is performed in a similar fashion after removing the band.

Roux-en-Y gastric bypass (RYGB) revisions were performed endoscopically and surgically. Endoscopic revisions involved plication of the gastric pouch and gastrojejunal anastomosis or gastrogastic fistula closure. Surgical revisions involved a stapled gastric pouch revision with or without candy cane limb resection.

### Statistical analysis

For categorical variables, Fisher's exact test was used to compare small samples, otherwise Pearson's chi-square test was used. Independent sample *t*-test was used to compare continuous variables. A *P*-value of < 0.05 was considered statistically significant. All statistical analyses were performed in R (Version 4.4.1, Vienna, Austria).

## RESULTS

### Patient demographics and operative data

Seventy patients were identified. Patient demographics and operative data are detailed in [Table 1](#). The average patient age was  $46.3 \pm 9.9$  years, most were female (97.1%), and the average BMI at the time of revisional surgery was  $40.2 \pm 6.3$  kg/m<sup>2</sup>. Among all patients, the most common initial weight loss procedure performed prior to undergoing revisional surgery was laparoscopic RYGB (40.0%, *N* = 28), followed by laparoscopic SG (32.9%, *N* = 23), open RYGB (15.7%, *N* = 11), and laparoscopic gastric band (11.4%, *N* = 8). The mean operative time across all revisional cases was  $79.5 \pm 37.2$  minutes, the mean LOS was  $1.1 \pm 0.8$  days, and the mean follow-up time was  $8.7 \pm 4.7$  months.

Five types of revisional procedures were performed: 39 (55.7%) RYGB revisions (21 endoscopic, 11 laparoscopic, 6 robotic, 1 open), 15 (21.4%) SG to OAGB conversions (8 robotic, 7 laparoscopic), 8 (11.4%) SG revisions (7 laparoscopic, 1 robotic), 7 (10.0%) laparoscopic gastric band to SG conversions, and 1 (1.4%) laparoscopic gastric band to OAGB conversion. The most common RYGB revision was for gastric pouch and/or gastrojejunostomy (GJ) revision (79.5%, *N* = 31), followed by closure of a gastrogastic fistula (15.4%, *N* = 6), and candy cane limb resection (5.1%, *N* = 2). All SG revisions were performed for retained gastric fundus.

**Table 1. Patient demographics and operative data**

	All patients (N = 70)
<b>Demographics, mean ± SD</b>	
Age (years)	46.3 ± 9.9
Female, N (%)	68 (97.1)
BMI (kg/m <sup>2</sup> )	40.2 ± 6.3
CCI	1.3 ± 1.2
Time to revisional surgery (years)	10.1 ± 5.4
<b>Initial procedure, N (%)</b>	
Laparoscopic RYGB	28 (40.0)
Laparoscopic SG	23 (32.9)
Open RYGB	11 (15.7)
Laparoscopic gastric band	8 (11.4)
<b>Revision procedure, N (%)</b>	
RYGB revision	39 (55.7)
SG to OAGB	15 (21.4)
SG revision	8 (11.4)
Band to SG	7 (10.0)
Band to OAGB	1 (1.4)
<b>Revision procedure approach, N (%)</b>	
Laparoscopic	33 (47.1)
Endoscopic	21 (30.0)
Robotic	15 (21.4)
Open	1 (1.4)
<b>Operative time, mean ± SD (min)</b>	79.5 ± 37.2
<b>LOS, mean ± SD (days)</b>	1.1 ± 0.8
<b>Follow-up, mean ± SD (months)</b>	8.7 ± 4.7

SD: Standard deviation; BMI: body mass index; CCI: Charlson Comorbidity Index; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy; OAGB: one anastomosis gastric bypass; LOS: length of stay.

### Weight loss outcomes

The mean percentage EWL and TWL for each type of revisional procedure were calculated at 3, 6, 9, and 12 months. The mean percentage EWL and TWL for each procedure at 12 months were compared to determine the most effective revisional procedure for treating weight regain.

SG to OAGB conversion had the largest mean 12-month %EWL at  $67.9 \pm 25.1$ , which was significantly greater than SG revision at  $47.4 \pm 6.7$  ( $P = 0.04$ ) and gastric band to SG conversion at  $44.1 \pm 21.1$  ( $P = 0.04$ ). The mean 12-month %EWL for SG revision was significantly greater than RYGB revision at  $28.9 \pm 14.5$  ( $P = 0.001$ ). The mean 12-month %EWL for RYGB revision was significantly lower than all other revisional procedures [Table 2].

SG to OAGB conversion also had the largest mean 12-month %TWL at  $19.1 \pm 9.4$ , significantly greater than RYGB revision at  $9.0 \pm 6.0$  ( $P < 0.001$ ). The mean 12-month %TWL for RYGB revision was significantly lower than all other revisional procedures. There were otherwise no statistically significant differences in terms of %TWL [Table 3].

### Perioperative outcomes

The 30-day morbidity rate for all patients was 7.1% ( $N = 5$ , Table 3). There were 2 postoperative superficial surgical site infections managed with bedside wound drainage and antibiotics, 1 rectus sheath hematoma, 1 case of postoperative pneumonia, and 1 anastomotic leak following an SG revision. The leak was detected on postoperative day 18 and was managed with laparoscopic washout and drain placement with concurrent upper endoscopy and Ovesco clipping of the leak site. The 30-day readmission rate was 5.7% ( $N = 4$ ) and the reoperation rate was 1.4% ( $N = 1$ ). There were no 30-day mortalities.

**Table 2. %EWL following revisional bariatric surgery by procedure type**

Procedure	%EWL, mean $\pm$ SD				P-value*
	3 Months	6 Months	9 Months	12 Months	
SG to OAGB	30.9 $\pm$ 17.2	51.0 $\pm$ 27.9	62.5 $\pm$ 34.1	67.9 $\pm$ 25.1	vs. SG revision: <b>0.04</b> vs. band to SG: <b>0.04</b> vs. RYGB revision: <b>&lt; 0.001</b>
SG revision	24.3 $\pm$ 10.2	38.3 $\pm$ 8.4	26.8 $\pm$ 18.1	47.4 $\pm$ 6.7	vs. band to SG: 0.68 vs. RYGB revision: <b>0.001</b>
Band to SG	26.6 $\pm$ 2.4	34.0 $\pm$ 15.8	31.8 $\pm$ 13.3	44.1 $\pm$ 21.1	vs. RYGB revision: <b>0.02</b>
RYGB revision	16.2 $\pm$ 9.9	18.6 $\pm$ 11.9	20.1 $\pm$ 11.4	28.9 $\pm$ 14.5	-

\*Comparisons between %EWL at 12 months. P-values in bold indicate statistical significance. %EWL: Percentage excess weight loss; SD: standard deviation; SG: sleeve gastrectomy; OAGB: one anastomosis gastric bypass; RYGB: Roux-en-Y gastric bypass.

**Table 3. %TWL following revisional bariatric surgery by procedure type**

Procedure	%TWL, mean $\pm$ SD				P-value*
	3 Months	6 Months	9 Months	12 Months	
SG to OAGB	9.4 $\pm$ 4.3	15.4 $\pm$ 5.7	18.0 $\pm$ 7.9	19.1 $\pm$ 9.4	vs. SG revision: 0.37 vs. band to SG: 0.66 vs. RYGB revision: <b>&lt; 0.001</b>
SG revision	7.3 $\pm$ 3.4	8.6 $\pm$ 5.9	12.5 $\pm$ 3.5	16.0 $\pm$ 0.2	vs. band to SG: 0.72 vs. RYGB revision: <b>0.002</b>
Band to SG	11.7 $\pm$ 5.5	12.7 $\pm$ 4.3	13.9 $\pm$ 7.3	17.2 $\pm$ 9.4	vs. RYGB revision: <b>0.004</b>
RYGB revision	5.4 $\pm$ 3.8	6.4 $\pm$ 4.5	7.1 $\pm$ 4.4	9.0 $\pm$ 6.0	-

\*Comparisons between %TWL at 12 months. P-values in bold indicate statistical significance. %TWL: Percentage total weight loss; SD: standard deviation; SG: sleeve gastrectomy; OAGB: one anastomosis gastric bypass; RYGB: Roux-en-Y gastric bypass.

## DISCUSSION

Weight recidivism following bariatric surgery is common and reduces surgery-associated health benefits. Revisional surgery is an increasingly utilized treatment option, as it accounted for 6% of all bariatric operations in 2011 and 16.8% in 2019<sup>[10,11]</sup>. The types of revisional procedures have shifted over time with the increasing popularity of SG and RYGB relative to other bariatric procedures, such as adjustable gastric banding and vertical banded gastroplasty<sup>[12]</sup>. With over 50% of the United States population projected to be obese by 2030, the demand for weight loss surgery and the bariatric population is likely to increase, further driving demand for revisional procedures<sup>[13]</sup>. It is therefore critical to examine the perioperative and weight loss outcomes of revisional MBS to inform clinical decision making and improve surgical quality more broadly. In this study, we found that conversion from SG to OAGB was the most efficacious procedure at 12 months. We also demonstrated a relatively low 30-day morbidity in our cohort with no mortalities.

Although the prevalence of weight regain varies depending on the definition, it is well-established that a large percentage of patients experience significant weight regain during long-term follow-up<sup>[14]</sup>. One systematic review found that up to 76% of patients after primary SG had significant weight regain at 6-year follow-up<sup>[15]</sup>. Another study of 300 RYGB patients demonstrated a 37% rate of weight regain (defined at  $\geq$  25% increase from nadir weight) at 7-year follow-up<sup>[16]</sup>. Various anatomical causes of weight regain after RYGB (e.g., pouch dilation or gastrogastic fistula) and SG (e.g., retained or dilated fundus) can be corrected with revisional surgery to achieve significant weight loss. A 2016 systematic review of RYGB revision found that reversal of weight regain as a percentage of excess BMI loss ranged from 43%-64% at 1 year and 14%-76% at 3 years after revision, depending on the procedure<sup>[17]</sup>. Conversion from one bariatric anatomy to another is also a viable treatment option, particularly when patients develop other

complications after primary MBS, such as post-SG gastroesophageal reflux disease (GERD). For example, conversion from SG to RYGB resulted in a 6.4 kg/m<sup>2</sup> BMI reduction at 1 year in one meta-analysis of 556 patients<sup>[18]</sup>. Resolution of GERD after SG to RYGB conversion is also reported to be as high as 85%<sup>[19]</sup>. Two recent expert consensus panels favored biliopancreatic diversion with duodenal switch (BPD/DS) to RYGB after SG for limited weight loss and weight recidivism<sup>[20,21]</sup>. However, a recent meta-analysis of 1,771 patients analyzing weight loss and metabolic outcomes of conversion from SG and gastric band to OAGB found that mean BMI decreased from an initial average BMI of 45.70 kg/m<sup>2</sup> to 31.52, 31.40, and 30.54 kg/m<sup>2</sup> at 1, 3, and 5-year follow-ups, respectively<sup>[22]</sup>. The drawbacks of each revisional procedure should also be carefully considered. For example, there is evidence to suggest that OAGB may have a higher rate of cholelithiasis than purely restrictive procedures, which may require additional operative or medical intervention<sup>[23]</sup>. When considering surgical conversion, it is clear that the indication for revision should factor into the chosen operative approach and surgeons should be mindful of the unique postoperative complications that may arise.

The higher morbidity associated with revisional compared to primary MBS is also a significant concern. A recent international study of 65 bariatric centers and 750 patients found 30-day morbidity and mortality rates of 10.7% and 0.3%, respectively<sup>[24]</sup>. Previous studies have reported early morbidity rates of up to 33.9% following revisional surgery<sup>[25]</sup>. However, there are data suggesting that leveraging advances in robotic surgery may confer a morbidity benefit in these complex procedures. Our group recently reported an analysis of the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database, demonstrating lower postoperative morbidity with robotic surgery for revisional RYGB compared to laparoscopic<sup>[26]</sup>. There are also several less invasive endoscopic revisional bariatric procedures being performed for weight regain with varying results<sup>[27]</sup>. Close monitoring of these developing technologies/techniques and associated outcomes is warranted as their use becomes more widespread.

With the recognition of obesity as a chronic multifactorial disease, it is also important to consider non-operative treatment options for patients experiencing weight regain, especially in the context of the risks associated with revisional surgery. While dietary, behavioral, and exercise interventions are the cornerstone of initial obesity management, these options have demonstrated little to no efficacy in reversing weight regain after bariatric surgery<sup>[28]</sup>. Pharmacologic therapy with GLP-1 receptor agonists, in particular, has emerged as a promising treatment for weight regain<sup>[29]</sup>. There are also several other emerging incretin-based therapies that are likely to influence the obesity management landscape<sup>[30]</sup>. Counseling patients on the risks and benefits of medical weight loss versus revisional surgery as part of shared decision-making discussions will become increasingly important with continued advances in these treatment options. To that end, multidisciplinary collaboration between surgeons, obesity medicine physicians, nutritionists, and psychologists will be essential as the volume and complexity of bariatric patients increases over time.

There are multiple limitations to this retrospective cohort study. This study is limited to a single institution with a relatively small sample size, which limits the generalizability of the findings. Our follow-up time is also limited to 1 year postoperatively, preventing long-term comparisons of each revisional procedure. Large, prospective randomized trials are warranted to comprehensively evaluate the comparative risks and benefits of these procedures regarding revisional interventions for weight regain.

In conclusion, revisional bariatric surgery is a useful tool for addressing weight regain and achieving sustained weight loss. Among the revisional options, converting SG to OAGB was most effective at promoting significant weight loss at 12 months. These findings highlight the important role of tailored revisional procedures in the broader context of bariatric care.



## DECLARATIONS

### Authors' contributions

Conceptualization, methodology, data curation, formal analysis, writing - original draft, writing - review and editing: Spurzem GJ

Conceptualization, methodology, writing - original draft, writing - review and editing: Broderick RC

Conceptualization, methodology, data curation: Huang EY

Supervision, writing - review and editing: Hollandsworth HM, Sandler BJ, Jacobsen GR, Horgan S

### Availability of data and materials

Data are available from the corresponding author upon reasonable request.

### Financial support and sponsorship

None.

### Conflicts of interest

Broderick RC is a consultant for Stryker Corporation. Sandler BJ is a consultant for Boston Scientific. Jacobsen GR is a consultant for Gore Medical and Viacety. Horgan S is a consultant for Stryker Corporation and Ethicon. The other authors declared that there are no conflicts of interest.

### Ethical approval and consent to participate

Ethical approval for the development and maintenance of the prospectively maintained database used in this study was provided by the University of California, San Diego Institutional Review Board (Approval number 131544). Patient consent was not required, as this study is a retrospective review of medical records.

### Consent for publication

Not applicable.

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